SERVICE MANUAL (I)

LEGANZA

FOREWORD

This manual includes procedure for maintenance, adjustment, service operation and removal and installation of components.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of manual approval.

The right is reserved to make changes at any time without notice.

DAEWOO MOTOR CO., LTD.
INCHON, KOREA

SECTION INDEX

PERSONAL INJURY CAUTION

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles, as well as for the personal safety of the person doing the repair. There are many variations in procedures, techniques, tools and parts for servicing vehicles, as well as in the skills of the people doing the work. This manual cannot possibly anticipate all such variations and provide advice or precautions for each. Anyone who deviates from the instructions provided in this manual must ensure their own safety and preserve the safety and integrity of the vehicle. The following list contains general precautions that should always be followed while working on a vehicle.

- *Safety stands are required whenever a procedure calls for underbody work.*
- *Do not smoke when you work on a vehicle.*
- *To prevent serious burns, do not touch any hot metal parts.*
- *Set the parking brake when you work on the vehicle.*
- *Turn the ignition switch OFF unless a procedure states otherwise.*
- *The engine may operate only in a well-ventilated area.*
- *Avoid moving parts when the engine is running.*
- *Safety glasses must be worn for eye protection.*

1997 Daewoo LEGANZA BL2 Service Manual

FOREWORD

This manual includes procedures for maintenance, adjustment, service operations, and removal and installation of components for the LEGANZA BL2 vehicle.

When reference is made in this manual to a brand name, number, or specific tool, an equivalent product may be used in place of the recommended item.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

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SECTION 0B
GENERAL INFORMATION
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SPECIFICATIONS
TECHNICAL DATA

Performance - Manual Transaxle

Application	2.0L DOHC
Maximum Speed	206km/h (128.0 mph)
Gradeability	0.570 (tan ∅)
Minimum Turning Radius	5.5 m (18.0 ft)

Performance - Automatic Transaxle

Application	2.0L SOHC
Maximum Speed	192 km/h (119.3 mph)
Gradeability	0.650 (tan ∅)
Minimum Turning Radius	5.5 m (18.0 ft)

Engine

Application	2.0L DOHC
Engine Type	Dual Overhead Cam L-4
Bore	86 mm (3.4 in)
Stroke	86 mm (3.4 in)
Total Displacement	1 998 cm^3 (121.9 in^3)
Compression Ratio	9.6:1
Maximum Power	98 kw (131 hp) (at 5,400 rpm)
Maximum Torque	18.8 Kg•m (136 lb-ft) (at 4,600 rpm)

Ignition System

Application	2.0L DOHC
Ignition Type	Direct Ignition System
Ignition Timing	5° BTDC
Ignition Sequence	1-3-4-2
Spark Plug Gap	0.8 mm (0.03 in)
Spark Plug Maker	Bosch
Spark Plug Type	FR8LDC4

Clutch - Manual Transaxle

Application	2.0L DOHC
Type	Single Dry Plate
Outside Diameter	225 mm (8.9 in)
Inside Diameter	150 mm (5.9 in)
Thickness	4 mm (0.16 in)
Fluid Capacity	Common Use; Brake Fluid

Manual Transaxle

Application	2.0L DOHC
Maker	DWMC
Type or Model	D-20
Gear Ratio: 1st	3.545:1
2nd	2.158:1
3rd	1.478:1
4th	1.129:1
5th	0.886:1
Reverse	3.333:1
Final Drive Ratio	3.722:1 (*3.550)
Oil Capacity	1.8L (1.90 qt)

*** France only**

Automatic Transaxle

Application	2.0L DOHC
Maker	ZF
Type or Model	4HP14
Gear Ratio: 1st	2.412:1
2nd	1.369:1
3rd	1.000:1
4th	0.739:1
Reverse	2.828:1
Final Drive Ratio	3.979:1
Oil Capacity	5.35L (5.65 qt)

Brake

Application	2.0L DOHC
Booster Size: Booster 1	7 in. (177.8 mm)
Booster 2	8 in. (203.2 mm)
Master Cylinder Diameter	23.8 mm (0.94 in)
Booster Ratio	5.0:1
Front Brake: Disc Type	Ventilated
Rear Brake: Disc Type	Solid
Fluid Capacity	0.5L (0.527 qt)

Tire and Wheel

Application	2.0L DOHC
Standard Tire Size	205/60R15
Standard Wheel Size	6.0JX15
Inflation Pressure at Full Load: 205/60R15: Front	29
Rear	29

Steering System

Application	2.0L DOHC
Gear Type	Power Rack and Pinion
Wheel Alignment: Front: Total Toe-In (2 Occupants)	- 0.2 ± 0.2° (- 2 ± 2 mm) (0.08 ± 0.08 in)
Caster	3 ± 1°
Camber	- 0.2 ± 1°
Rear: Total Toe-In (2 occupants)	0.1 ± 0.1° (1 ± 1 mm) (0.04 ± 0.04 in)
Camber	- 0.8 ± 1°
Oil Capacity	1.0L (1.06 qt)

Suspension

Application	2.0L DOHC
Front Type	MacPherson Strut
Rear Type	Dual Link Strut

Fuel System

Application	2.0L DOHC
Fuel Delivery	MPI
Fuel Pump Type	Electric Motor Pump
Fuel Filter Type	Cartridge
Fuel Capacity	65L (17.2 gal)

Lubricating System

Application	2.0L DOHC
Lubricating Type	Forced Feed
Oil Pump Type	Duocentric Rotor
Oil Filter Type	Cartridge (Full Flow)
Oil Pan Capacity Including Oil Filter	4.0L (4.22 qt)

Electric System

Application	2.0L DOHC
Battery	610 Cold Cranking Amps
Alternator	95 amps
Starter (No-Load Test Current Draw): 1.4 kW	Minimum 80 Amps Maximum 120 Amps (at 10 Volts)

Cooling System

Application	2.0L DOHC
Cooling Type	Forced Water Circulation
Radiator Type	Cross-flow
Water Pump Type	Centrifugal
Thermostat Type	Pellet Type
Coolant Capacity	7.0L (7.25 qt)

VEHICLE DIMENSIONS AND WEIGHTS

Vehicle Dimensions - Manual and Automatic

Application	2.0L DOHC
Overall Length	4 671 mm (183.9 in)
Overall Width	1 779 mm (70.0 in)
Overall Height	1 437 mm (56.6 in)
Minimum Ground Clearance	167 mm (6.6 in)
Wheel Base	2 670 mm (105.1 in)
Tread: Front	1 515 mm (59.6 in)
Rear (Disc)	1 507 mm (59.3 in)

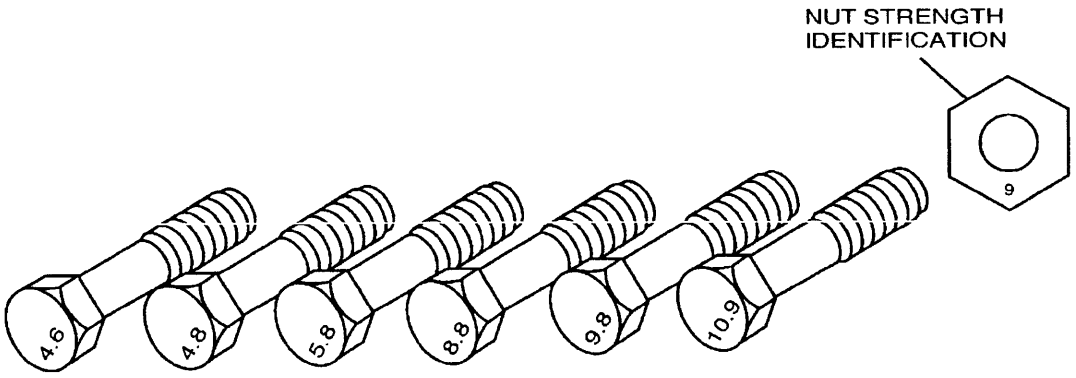
Vehicle Weights - 4 Door Notchback

Application	2.0L DOHC
Manual: Curb Weight	1,325-1,365kg (2,920-3,010 lb)
Gross Vehicle Weight	1,830 kg (4,034 lb)
Automatic: Curb Weight	1,336-1,376 kg (2,884-3,034 lb)
Gross Vehicle Weight	1,830 kg (4,034 lb)
Passenger Capacity	5

STANDARD BOLT SPECIFICATIONS

Bolt*	4T - Low Carbon Steel	7T - High Carbon Steel	7T - Alloy Steel
M6 X 1.0	4.1-8.1 N•m (36-72 lb-in)	4.1-9.5 N•m (48-84 lb-in)	-
M8 X 1.25	8.1-17.6 N•m (72-156 lb-in)	12.2-23.0 N•m (108-204 lb-in)	16-30 N•m (12-22 lb-ft)
M10 X 1.25	20-34 N•m (15-25 lb-ft)	27-46 N•m (20-34 lb-ft)	37-62 N•m (27-46 lb-ft)
M10 X 1.5	19-34 N•m (14-25 lb-ft)	27-45 N•m (20-33 lb-ft)	37-60 N•m (27-44 lb-ft)
M12 X 1.25	49-73 N•m (36-54 lb-ft)	61-91 N•m (45-67 lb-ft)	76-114 N•m (56-84 lb-ft)
M12 X 1.75	45-69 N•m (33-51 lb-ft)	57-84 N•m (42-62 lb-ft)	72-107 N•m (53-79 lb-ft)
M14 X 1.5	76-115 N•m (56-85 lb-ft)	94-140 N•m (69-103 lb-ft)	114-171 N•m (84-126 lb-ft)
M14 X 2.0	72-107 N•m (53-79 lb-ft)	88-132 N•m (65-97 lb-ft)	107-160 N•m (79-118 lb-ft)
M16 X 1.5	104-157 N•m (77-116 lb-ft)	136-203 N•m (100-150 lb-ft)	160-240 N•m (118-177 lb-ft)
M16 X 2.0	100-149 N•m (74-110 lb-ft)	129-194 N•m (95-143 lb-ft)	153-229 N•m (113-169 lb-ft)
M18 X 1.5	151-225 N•m (111-166 lb-ft)	195-293 N•m (144-216 lb-ft)	229-346 N•m (169-255 lb-ft)
M20 X 1.5	206-311 N•m (152-229 lb-ft)	270-405 N•m (199-299 lb-ft)	317-476 N•m (234-351 lb-ft)
M22 X 1.5	251-414 N•m (185-305 lb-ft)	363-544 N•m (268-401 lb-ft)	424-636 N•m (313-469 lb-ft)
M24 X 2.0	359-540 N•m (265-398 lb-ft)	431-710 N•m (318-524 lb-ft)	555-831 N•m (409-613 lb-ft)

* Diameter X pitch in millimeters



METRIC BOLTS - IDENTIFICATION CLASS NUMBERS CORRESPOND TO BOLT STRENGTH - INCREASING NUMBERS REPRESENT INCREASING STRENGTH.

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MAINTENANCE AND REPAIR

MAINTENANCE AND LUBRICATION

NORMAL VEHICLE USE

The maintenance instructions contained in the maintenance schedule are based on the assumption that the vehicle will be used for the following reasons:

- To carry passengers and cargo within the limitation indicated on the Tire Placard located on the edge of the driver's door.
- To be driven on reasonable road surfaces and within legal operating limits.

EXPLANATION OF SCHEDULED MAINTENANCE SERVICES

The services listed in the maintenance schedule are further explained below. When the following maintenance services are performed, make sure all the parts are replaced and all the necessary repairs are done before driving the vehicle. Always use the proper fluid and lubricants.

Drive Belt Inspection

When a separate belt drives the power steering pump, the air conditioning compressor and the generator, inspect it for cracks, fraying, wear, and proper tension. Adjust or replace the belt as needed.

Engine Oil and Oil Filter Change

Always use above the SH grade engine oil. The SH designation may be shown alone or in combination with other designations such as SH/CC, SH/CD, etc.

Engine Oil Viscosity

Engine oil viscosity (thickness) has an effect on fuel economy and cold weather operation. Lower viscosity engine oils can provide better fuel economy and cold weather performance; however, higher temperature weather conditions require higher viscosity engine oils for satisfactory lubrication. Using oils of any viscosity other than those viscosities recommended could result in engine damage.

Cooling System Service

Drain, flush and refill the system with new coolant. Refer to "Recommended Fluids and Lubricants" in this section.

Fuel Micro-Filter Replacement

Replace the engine fuel filter every 45 000 km (25,000 miles).

The engine fuel filter is located on the center dash panel near the brake booster.

Air Cleaner Element Replacement

Replace the air cleaner element every 30 000 km (18,000 miles).

Replace the air cleaner more often under dusty conditions.

Throttle Body Mounting Bolt Torque

Check the torque of the throttle body mounting bolts.

Tighten the throttle body mounting nuts to 9 N•m (80 lb-in) (DOHC), if necessary.

Spark Plug Replacement

Replace spark plugs with the same type.

- Type: Bosch Type FR8LDC4 (DOHC)
- Gap: 0.8 mm (0.03 in) (DOHC)

Spark Plug Wire Replacement

Clean the wires and inspect them for burns, cracks, or other damage. Check the wire boot fit at the direct ignition system (DIS) module and at the spark plugs. Replace the wires as needed.

Brake System Service

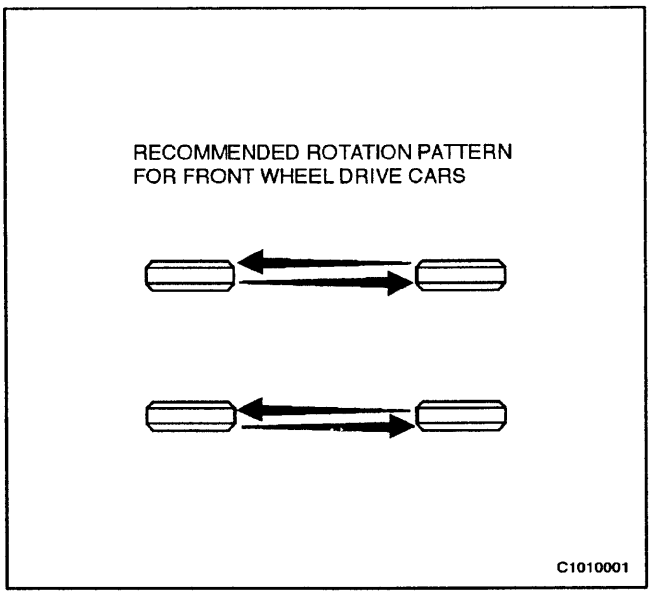
Check the disc brake pads every 10 000 km (6,000 miles) or 12 months. Check the pad and the lining thickness carefully. If the pads or the linings are not expected to last another 10 000 km (6,000 miles), replace the pads or the linings. Check the breather hole in the brake fluid reservoir cap to be sure it is free from dirt and the passage is open.

Transaxle Service

The manual transaxle oil does not require changing. The automatic transaxle fluid should be changed every 30 000 km (19,000 miles).

Tire and Wheel Inspection and Rotation

Check the tires for abnormal wear or damage. To equalize wear and obtain maximum tire life, rotate the tires. If irregular or premature wear exists, check the wheel alignment and check for damaged wheels. While the tires and wheels are removed, inspect the brakes. Refer to "Each Time The Oil Is Changed" in this section.



SCHEDULED MAINTENANCE CHARTS

Engine

Maintenance Item	Maintenance Interval								
	Kilometers (miles) or time in months, whichever comes first								
Kilometers x 1 000	1	15	30	45	60	75	90	105	120
Miles x 1 000	.6	9	18	27	36	45	54	63	72
Months	-	12	24	36	48	60	72	84	96
Drive belts (alternator, power steering)									
DOHC					I				I
Engine oil and oil filter[1, 3]	I	R	R	R	R	R	R	R	R
Cooling system and hose connection		I	I	I	I	I	I	I	I
Engine coolant[3]	I	I	I	R	I	I	R	I	I
Fuel filter				R			R		
Fuel line and connections		I	I	I	I	I	I	I	I
Air cleaner element[2]		I	I	R	I	I	R	I	I
Ignition timing		I	I	I	I	I	I	I	I
Spark plugs			I		R		I		R
DIS Module			I		I		I		I
Charcoal canister and vapor lines				I			I		
PCV System			I		I		I		I
Timing belt (camshaft belt)					I		R		I
Air condition filter*		R	R	R	R	R	R	R	R

Chart Symbols:

I - Inspect, and if necessary correct, clean, replenish or adjust.

R - Replace or change:

[1] If the vehicle is operated under severe conditions: short distance driving, extensive idling or driving in dusty conditions, change the engine oil every 7 500 km (5,000 miles) or six months, whichever comes first.

[2] More frequently if driving in dusty conditions.

[3] Refer to "Recommended Fluids and Lubricants."

Chassis and Body

Maintenance Item	Maintenance Interval								
	Kilometers (miles) or time in months, whichever comes first								
Kilometers x 1 000	1	15	30	45	60	75	90	105	120
Miles x 1 000	.6	9	18	27	36	48	54	63	72
Months	-	12	24	36	48	60	72	84	96
Brake and clutch fluid[1, 4]	I	I	R	I	R	I	R	I	R
Brake pads and discs[3]		I	I	I	I	I	I	I	I
Parking brake		I	I	I	I	I	I	I	I
Brake line and connections (including booster)		I	I	I	I	I	I	I	I
Rear hub bearing and clearance		I	I	I	I	I	I	I	I
Manual transaxle oil[1]		I	I	I	I	I	I	I	I
Clutch and brake pedal free play		I	I	I	I	I	I	I	I
Automatic transaxle fluid[1]	I	I	R	I	R	I	R	I	R
Tighten chassis and underbody bolts and nuts		I	I	I	I	I	I	I	I
Tire condition and inflation pressure	I	I	I	I	I	I	I	I	I
Wheel alignment[2]	Inspect when abnormal condition is noted								
Steering wheel and linkage		I	I	I	I	I	I	I	I
Power steering fluid and lines[1]	I	I	I	I	I	I	I	I	I
Drive shaft boots		I	I	I	I	I	I	I	I
Seat belts, buckles and anchors		I	I	I	I	I	I	I	I
Lubricate locks, hinges and hood latch		I	I	I	I	I	I	I	I

Chart Symbols:

I - Inspect, and if necessary correct, clean, replenish or adjust.

R - Replace or change:

[1] Refer to "Recommended Fluids And Lubricants."

[2] And if necessary, rotate and balance wheels.

[3] More frequently if operated under severe conditions: short distance driving, extensive idling, frequent low-speed operation in stop and go traffic, or driving in dusty conditions.

[4] Change the brake/clutch fluid every 15 000 km (9,000 miles) if the vehicle is mainly driven under severe conditions:
- driving in hilly or mountainous terrain, or
- towing a trailer/caravan frequently.

OWNER INSPECTIONS AND SERVICES

WHILE OPERATING THE VEHICLE

Horn Operation

Blow the horn occasionally to make sure it works. Check all the button locations.

Brake System Operation

Be alert for abnormal sounds, increased brake pedal travel, or repeated pulling to one side when braking. Also, if the brake warning light goes on or flashes, something may be wrong with part of the brake system.

Exhaust System Operation

Be alert to any changes in the sound of the system or the smell of the fumes. These are signs that the system may be leaking or overheating. Have the system inspected and repaired immediately.

Tires, Wheels and Alignment Operation

Be alert to any vibration of the steering wheel or the seats at normal highway speeds. This may mean a wheel needs to be balanced. Also, a pull right or left on a straight, level road may show the need for a tire pressure adjustment or a wheel alignment.

Steering System Operation

Be alert to changes in the steering action. An inspection is needed when the steering wheel is hard to turn or has too much free play, or if unusual sounds are noticed when turning or parking.

Headlamp Aim

Take note of the light pattern occasionally. Adjust the headlamps if the beams seem improperly aimed.

AT EACH FUEL FILL

A fluid loss in any (except windshield washer) system may indicate a problem. Have the system inspected and repaired immediately.

Engine Oil Level

Check the oil level and add oil if necessary. The best time to check the engine oil level is when the oil is warm.

1. After stopping the engine, wait a few minutes for the oil to drain back to the oil pan.
2. Pull out the oil level indicator (dipstick).
3. Wipe it clean, and push the oil level indicator back down all the way.
4. Pull out the oil level indicator and look at the oil level on it.
5. Add oil, if needed, to keep the oil level above the MIN line and within the area labeled "Operating Range." Avoid overfilling the engine, since this may cause engine damage.

6. Push the indicator all the way back down into the engine after taking the reading.

If you check the oil level when the oil is cold, do not run the engine first. The cold oil will not drain back to the pan fast enough to give a true oil level reading.

Engine Coolant Level and Condition

Check the coolant level in the coolant reservoir tank and add coolant if necessary. Inspect the coolant. Replace dirty or rusty coolant.

Windshield Washer Fluid Level

Check the washer fluid level in the reservoir. Add fluid if necessary.

AT LEAST MONTHLY

Tire and Wheel Inspection and Pressure Check

Check the tires for abnormal wear or damage. Also check for damaged wheels. Check the tire pressure when the tires are cold (check the spare also, unless it is a stowaway). Maintain the recommended pressures that are on the tire placard that is on the driver's door.

Lamp Operation

Check the operation of the license plate lamp, the headlamps (including the high beams), the parking lamps, the fog lamps, the taillamp, the brake lamps, the turn signals, the backup lamps, and the hazard warning flasher.

Fluid Leak Check

Periodically inspect the surface beneath the vehicle for water, oil, fuel or other fluids, after the vehicle has been parked for a while. Water dripping from the air conditioning system after use is normal. If you notice fuel leaks or fumes, find the cause and correct it at once.

AT LEAST TWICE A YEAR

Power Steering System Reservoir Level

Check the power steering fluid level. Keep the power steering fluid at the proper level. Refer to *Section 6A, Power Steering System*.

Brake Master Cylinder Reservoir Level

Check the fluid and keep it at the proper level. Refer to *Section 4B, Master Cylinder*. A low fluid level can indicate worn disc brake pads may need to be serviced. Check the breather hole in the reservoir cover to be free from dirt and check for an open passage.

Clutch Pedal Free Travel

Check clutch pedal free travel and adjust as necessary every 15 000 km (9,000 miles). Measure the distance from the center of the clutch pedal to the outer edge of the steering wheel with the clutch pedal not depressed. Then measure the distance from the center of the clutch pedal to the outer edge of the steering wheel with the clutch pedal fully depressed. The difference between the two values must be greater than 140 mm (5.5 in).

Weatherstrip Lubrication

Apply a thin film of silicone grease using a clean cloth.

EACH TIME THE OIL IS CHANGED

Automatic Transaxle Fluid

Refer to *Section 5A, ZF 4HP14 Automatic Transaxle.*

Manual Transaxle

Check the oil level and add oil as required. Refer to *Section 5B, Five-Speed Manual Transaxle.*

Brake System Inspection

This inspection should be done when the wheels are removed for rotation. Inspect the lines and the hoses for proper hookup, binding, leaks, cracks, chafing, etc. Inspect the disc brake pads for wear. Inspect the rotors for surface condition. Inspect other brake parts, including the parking brake, etc., at the same time. Check the parking brake adjustment. Inspect the brakes more often if habit or conditions result in frequent braking.

Steering, Suspension and Front Drive Axle Boot and Seal Inspection

Inspect the front and rear suspension and the steering system for damaged, loose, or missing parts; signs of wear; or lack of lubrication. Inspect the power steering lines and the hoses for proper hookup, binding, leaks, cracks and chafing, etc. Clean and inspect the drive axle boot and seals for damage, tears, or leakage. Replace the seals if necessary.

Exhaust System Inspection

Inspect the complete system (including the catalytic converter, if equipped). Inspect the body near the exhaust system. Look for broken, damaged, missing, or out-of-position parts, as well as open seams, holes, loose connections, or other conditions which could cause heat buildup in the floor pan or could let exhaust fumes seep into the trunk or passenger compartment.

Throttle Linkage Inspection

Inspect the throttle linkage for interference or binding, damaged, or missing parts. Lubricate all linkage joints and throttle cable joints, the intermediate throttle shaft bearing, the return spring at throttle valve assembly, and the accelerator pedal sliding face with suitable grease. Check the throttle cable for free movement.

Engine Drive Belts

Inspect all belts for cracks, fraying, wear, and proper tension. Adjust or replace the belts as needed.

Hood Latch Operation

When opening the hood, note the operation of the secondary latch. It should keep the hood from opening all the way when the primary latch is released. The hood must close firmly.

AT LEAST ANNUALLY

Lap and Shoulder Belt Condition and Operation

Inspect the belt system, including the webbing, the buckles, the latch plates, the retractor, the guide loops and the anchors.

Movable Head Restraint Operation

On vehicles with movable head restraints, the restraints must stay in the desired position.

Spare Tire and Jack Storage

Be alert to rattles in the rear of the vehicle. The spare tire, all the jacking equipment, and the tools must be securely stowed at all times. Oil the jack ratchet or the screw mechanism after each use.

Key Lock Service

Lubricate the key lock cylinder.

Body Lubrication Service

Lubricate all the body door hinges including the hood, the fuel door, the rear compartment hinges and the latches, the glove box and the console doors, and any folding seat hardware.

Transaxle Neutral Switch Operation on Automatic Transaxle

Caution: Take the following precautions because the vehicle could move without warning and possibly cause personal injury or property damage:

- ***Firmly apply the parking brake and the regular brakes.***
- ***Do not use the accelerator pedal.***
- ***Be ready to promptly turn off the ignition if the vehicle starts.***

On automatic transaxle vehicles, try to start the engine in each gear. The starter should crank only in P (PARK) and in N (NEUTRAL).

Parking Brake and Transaxle P (PARK) Mechanism Operation

Caution: In order to reduce the risk of personal injury or property damage, be prepared to apply the regular brakes promptly if the vehicle begins to move.

Park on a fairly steep hill with enough room for movement in the downhill direction. To check the parking brake, with the engine running and the transaxle in N (NEUTRAL), slowly remove foot pressure from the regular brake pedal (until only the parking brake is holding the vehicle).

To check the automatic transaxle P (PARK) mechanism's holding ability, release all brakes after shifting the transaxle to P (PARK).

Underbody Flushing

Flushing the underbody will remove any corrosive materials used for ice and snow removal and dust control. At least every spring, clean the underbody. First, loosen the sediment packed in closed areas of the vehicle. Then flush the underbody with plain water.

Engine Cooling System

Inspect the coolant and freeze protection fluid. If the fluid is dirty or rusty, drain, flush and refill the engine cooling system with new coolant. Keep the coolant at the proper mixture in order to ensure proper freeze protection, corrosion protection and engine operating temperature. Inspect the hoses. Replace the cracked, swollen, or deteriorated hoses. Tighten the clamps. Clean the outside of the radiator and the air conditioning condenser. Wash the filler cap and the neck. Pressure test the cooling system and the cap in order to help ensure proper operation.

RECOMMENDED FLUIDS AND LUBRICANTS

USAGE	CAPACITY	FLUID/LUBRICANT
Engine Oil	4L (4.23 qt)	SOHC - SAE 10W/30, API SH DOHC - SAE 5W/30, API SH
Engine Coolant	7.0L (7.40 qt)	Mixture of water and good quality silicate-base antifreeze (year-round coolant)
Brake and Clutch Fluid	0.5L (0.527 qt)	SSK-221 (DOT-3 Fluid)
Power Steering System Fluid	1.0L (1.06 qt)	DEXRON®-II or III
Automatic Transaxle Fluid	5.4L (5.70qt)	Refer to "Recommended Automatic Transaxle Fluids"
Manual Transaxle Fluid	1.8L (1.90 qt)	CASTROL 80W
Manual Transaxle Shift Linkage	As needed	Grease (M-8122)
Key Lock Cylinders	As needed	Grease (M-8104)
Automatic Transaxle Shift Linkage	As needed	Grease
Clutch Linkage Pivot Points	As needed	Grease
Floor Shift Linkage Points	As needed	Grease
Hood Latch Assembly 1. Pivots and Spring Anchor	As needed	Grease (M-8105)
Hood and door hinges Fuel door hinge Rear compartment lid hinges	As needed	Spray Grease (M-8149) Oil (M-8030)
Weatherstrips	As needed	Wetting Agent (M-8128)

RECOMMENDED AUTOMATIC TRANSAXLE FLUIDS

Manufacturer	Trade name
ADDINOL MINERALÖL GMBH, KRUMPA/D	ADDINOL ATF D III
AGIP PETROLI SPA, ROM/I	AGIP ATF II D
AGIP PETROLI SPA, ROM/I	AGIP DEXRON III
AGIP PETROLI SPA, ROM/I	AGIP ATF D 309
AGIP SCHMIERTECHNIK, WÜRZBURG/D	AUTOL GETRIEBEÖL ATF III D
AGIP SCHMIERTECHNIK, WÜRZBURG/D	AUTOL GETRIEBEÖL ATF-D
ARAL AG, BOCHUM/D	ARAL GETR ÖL ATF 55 F-30589
ARAL AG, BOCHUM/D	ARAL GETRIEBEÖL ATF 22
AVIA MINERALÖL-AG, MÜNCHEN/D	AVIA FLUID ATF 86
BLASER SWISSLUBE, HASLE-RÜEGSAU/CH	BLASOL 229
BP OIL DEUTSCHLAND, HAMBURG/D	FRONTOL UNIVERSAL-ATF 100
BP OIL INTERNATIONAL, LONDON/GB	AUTRAN MBX
BUCHER+CIE AG, LANGENTHAL/CH	MOTOREX ATF SUPER D-22656
BUCHER+CIE AG, LANGENTHAL/CH	MOTOREX ATF DEXRON III MC
C.J.DIEDERICHS SÖHNE, WUPPERTAL/D	CIDISOL-HYDR.-FLUID DEXRON II D
CALPAM GMBH, ASCHAFFENBURG/D	PAMATIC FLUID 289
CALPAM GMBH, ASCHAFFENBURG/D	CALPAMATIC FLUID III F
CALTEX PETROLEUM CORP., LONDON/GB	CALTEX ATF-HDA
CASTROL LTD. SWINDON/GB	CASTROL TQ-D (22765)
CASTROL LTD. SWINDON/GB	CASTROL TRANSMAX Z
CASTROL LTD. SWINDON/GB	CASTROL TQ-D (21289)
CASTROL LTD. SWINDON/GB	CASTROL ATF 21293
CASTROL LTD. SWINDON/GB	CASTROL TQ DEXRON III F-30520
CEPSA, MADRID/E	CEPSA ATF-70
DE OLIEBRON B.V., ZWIJNDRECHT/NL	ATF DMM
DE OLIEBRON B.V., ZWIJNDRECHT/NL	ATF 289
DEA MINERALÖL AG, HAMBURG/D	DEAFLUID 3003
DEA MINERALÖL AG, HAMBURG/D	DEAFLUID 4011
DEA MINERALÖL AG, HAMBURG/D	DEAMATIC
DEUTSCHE SHELL AG, HAMBURG/D	MAC ATF D-21666
DUCKHAMS OIL, BROMLEY/GB	UNIMATIC
ELF LUBRIFIANTS, PARIS/F	TRANSANTAR DF2
ELF LUBRIFIANTS, PARIS/F	ELFMATIC G3
ELF LUBRIFIANTS, PARIS/F	TRANSANTAR DF3
ELF LUBRIFIANTS, PARIS/F	ELFMATIC G2 22329
ELF LUBRIFIANTS, PARIS/F	HUILE RENAULT DIESEL STARMATIC
ELF LUBRIFIANTS, PARIS/F	ANTAR 22329
ELLER-MONTAN-COMP., DUISBURG/D	ELLMO-AUTOMATIK-FLUID 22233
ERTOIL SA, MADRID/E	TRANSMISSIONES AUTOMATICAS D2
ESSO AG, JAMBURG/D	ESSO ATF D (21065)
ESSO AG, JAMBURG/D	ESSO ATF D (21611)
ESSO AG, JAMBURG/D	ESSO ATF F-30320
FINA EUROPE SA, BRÜSSEL/B	FINAMATIC II-D
FUCHS LUBRICANTS (UK), DERBY/GB	SILKTRAN MP-ATF
FUCHS MINERALÖL WERKE, MANNHEIM/D	TITAN ATF 4000
GINOUVES GEORGES SA, LA FARLEDE/F	YORK LT 785
GULF OIL (GB) LTD, CHELTENHAM/GB	ATF 2
HANDEL-MIJNOVIOL B.V., NIJMEGEN/NL	KENDALL ATF DEXRON II D
HOMBERG GMBH+CO KG, WUPPERTAL/D	HOMBERG-GETRIEBE-FLUID D
IGOL FRANCE, PARIS/F	IGOL ATF 420
INA D.D. RAFINERIJA ZAGREB/YU	INA-ATF SUPER
ITALIANA PETROLI, GENOVA/I	TRANSMISSION FLUID DX
KÄPPLER K., STUTTGART/D	SELECTOL FLUID GETR. ÖL II D 23
KLÖCKNER ENERGIEHANDEL GMBH, KÖLN/D	DEUTZ OEL ATF-D
KROON OIL BV, ALMELO/NL	ATF DEXRON II D
KROON OIL BV, ALMELO/NL	ALMIROL ATF
KUWAIT PETROLEUM, HOOGVLIET/NL	Q8 AUTO 15
KUWAIT PETROLEUM, HOOGVLIET/NL	Q8 AUTO 14 (II D-21883)
KUWAIT PETROLEUM, HOOGVLIET/NL	Q8 AUTO 14 (II D-21677)
LEPRINCE+SIVEKE GMBH, HERFORD/D	LEPRINXOL FLUID CN
LIQUIMOLY / MEGUIN, ULM/D	MEGOL ATF II D
MAURAN SA, ODARS/F	INTER OIL INTER MATIC ATF D2
MIN.ÖL-RAFFIN, DOLLBERGEN, UETZE/D	PENNASOL FLUID-GETR. ÖL TYP PCN
MOBIL OIL, WEDEL/D	MOBIL ATF 220 D21412 / D22187
MOBIL OIL, WEDEL/D	MOBIL ATF 220 D20104 / D21685
MOL HUNGARIAN OIL, KOMARON/H	CARRIER ATF
MORRIS LUBRICANTS, SHREWSBURY/GB	LIQUIMATIC D II
NAFTEC, ALGIER/DZ	TASSILIA
NANHAI SUPERIOR LUB-OIL, CHINA	NANHAI ATF (D2)
NIS-RAFINERIJA NAFTE BEOGRAD/YU	GALAX MATIC DAC
OEST G. MIN. ÖLWERK, FREUDENSTADT/D	ATF T 4011
OMV AG, SCHWECHAT/A	OMV ATF D II (D22427)
OMV AG, SCHWECHAT/A	OMV ATF III (F-30580)
OPTIMOL ÖLWERKE, HAMBURG/D	OPTIMOL ATF T 4011
OSWALD KLUTH, BARGFELD-STEGEN/D	UNIVERSAL ATF-D
PAKELO MOTOR OIL, SAN BONIFACIO/I	MULTIPURPOSE TRANSM. FLUID II D
PANOLIN AG, MADETSWIL/CH	PANOLIN ATF MULTI 21996
PRINZ-SCHULTE, FRECHEN/D	AERO-LINE ATF-D
PRINZ-SCHULTE, FRECHEN/D	AERO-LINE ATF-2
REPSOL DISTRUBCION SA, MADRID/E	REPSOL MATIC ATF
S.A.E.L, ALCOBENDAS/E	GULF ATF D II D-22233
SCHMIERSTOFFRAFFINERIE SALZBERGEN/D	WINTERSHALL ATF D
SHELL ASEOL AG, BERN/CH	ASEOL ATF DB UNIVERSAL
SHELL INTERNATIONAL, LONDON/GB	SHELL DONAX TA (D-21666)
SLOVNAFT JS CO, BRATISLAVA/SLO	MADIT AUTOMATIC
SONOL ISRAEL LTD, HAIFA/IL	DEXRON 2 D
SOPROGRASA SA, MADRID/E	SOPRAL 164
STL TECNOL ESCALQUENS/F	TECNOL TECMATIC D2
SUN OIL COMPANY, AARTSELAAR/B	SUNAMATIC 149
SUN OIL COMPANY, AARTSELAAR/B	SUNAMATIC 153
SVENSKA STATOIL AB, NYNÄSHAMM/S	TRANSWAY DX III (F-30373)
TAMOIL LUBES, GENEVA/CH	TAMOIL ATF II D
TEXACO LUBRICANTS COMP., BEACON/USA	ATF MERCON / DEXRON III
TEXACO SERVICES LTD, BRÜSSEL/B	TEXAMATIC 9226
TEXACO SERVICES LTD, BRÜSSEL/B	TEXAMATIC 4291
TEXACO SERVICES LTD, BRÜSSEL/B	TEXAMATIC 4011
TEXACO SERVICES LTD, BRÜSSEL/B	TEXAMATIC 4261
TEXACO SERVICES LTD, BRÜSSEL/B	TEXAMATIC 7080
TOTAL RAFFINAGE DISTR., PARIS/F	TOTAL FLUIDE AT 42
TOTAL RAFFINAGE DISTR., PARIS/F	TOTAL FLUIDE II D
TOTAL RAFFINAGE DISTR., PARIS/F	TOTAL FLUIDE ATX
TOTAL SOUTH AFRICA, JOHANNESBURG/ZA	TOTAL FLUIDE ATD
TURBOTANK BÖSCHE+BÖDEKER, BREMEN/D	TURBO UNIV. ATF MERCON 4011
UFANEFTECHIM REFINERY, UFA/RUS	UFALUB ATF
UNIL DEUTSCHLAND GMBH, BREMEN/D	UNIL MATIC CN T 4011
VOLVOLINE INC., LEXINGTON/USA	VALVOLINE MULTI-PURPOSE ATF
VALVOLINE INTERNAT., DORDRECHT/NL	VALVOLINE ATF TYPE D
VEBA OEL AG, GELSENKIRCHEN/D	MOVARA ATF-GETRIEBEÖL DIID
VEEDOL INTERNATIONAL, SWINDON/GB	VEEDOL ATF-M (22764)
VEEDOL INTERNATIONAL, SWINDON/GB	VEEDOL UNITRANS Z
VEEDOL INTERNATIONAL, SWINDON/GB	VEEDOL ATF DEXRON III F-30521
YACCO SA, PIERRE-LES-ELBEUF/F	YACCO ATF D
ZELLER+GMELIN GMBH & CO, EISLINGEN/D	DIVINOL FLUID 666
ZF FRIEDRICHSHAFEN AG/D	ZF ECOFLUID "A"

GENERAL DESCRIPTION AND SYSTEM OPERATION

GENERAL REPAIR INSTRUCTIONS

If a floor jack is used, the following precautions are recommended:

- Park the vehicle on level ground, "block" the front or rear wheels, set the jack against the frame, raise the vehicle and support it with chassis stands, and then perform the service operation.
- Before performing the service operation, disconnect the negative battery cable in order to reduce the chance of cable damage and burning due to short-circuiting.
- Use a cover on the body, the seats and the floor to protect them against damage and contamination.
- Handle brake fluid and antifreeze solution with care as they can cause paint damage.
- The use of proper tools, and the required special tools where specified, is important for efficient and reliable performance of the service repairs.
- Use genuine DAEWOO parts.
- Discard used cotter pins, gaskets, O-rings, oil seals, lock washers and self-locking nuts. Prepare new ones for installation. Normal functioning of the vehicle's components cannot be maintained if these fasteners and seals are reused.
- Keep the disassembled parts in order to assist in reassembly.
- Keep attaching bolts and nuts separated, as they vary in hardness and design depending on the position of the installation.
- Clean the parts before inspection or reassembly.
- Also clean the oil parts, etc. Use compressed air to make certain they are free of restrictions.
- Lubricate rotating and sliding faces of parts with oil or grease before installation.
- When necessary, use a sealer on gaskets to prevent leakage.
- Carefully observe all specifications for bolt and nut torques.

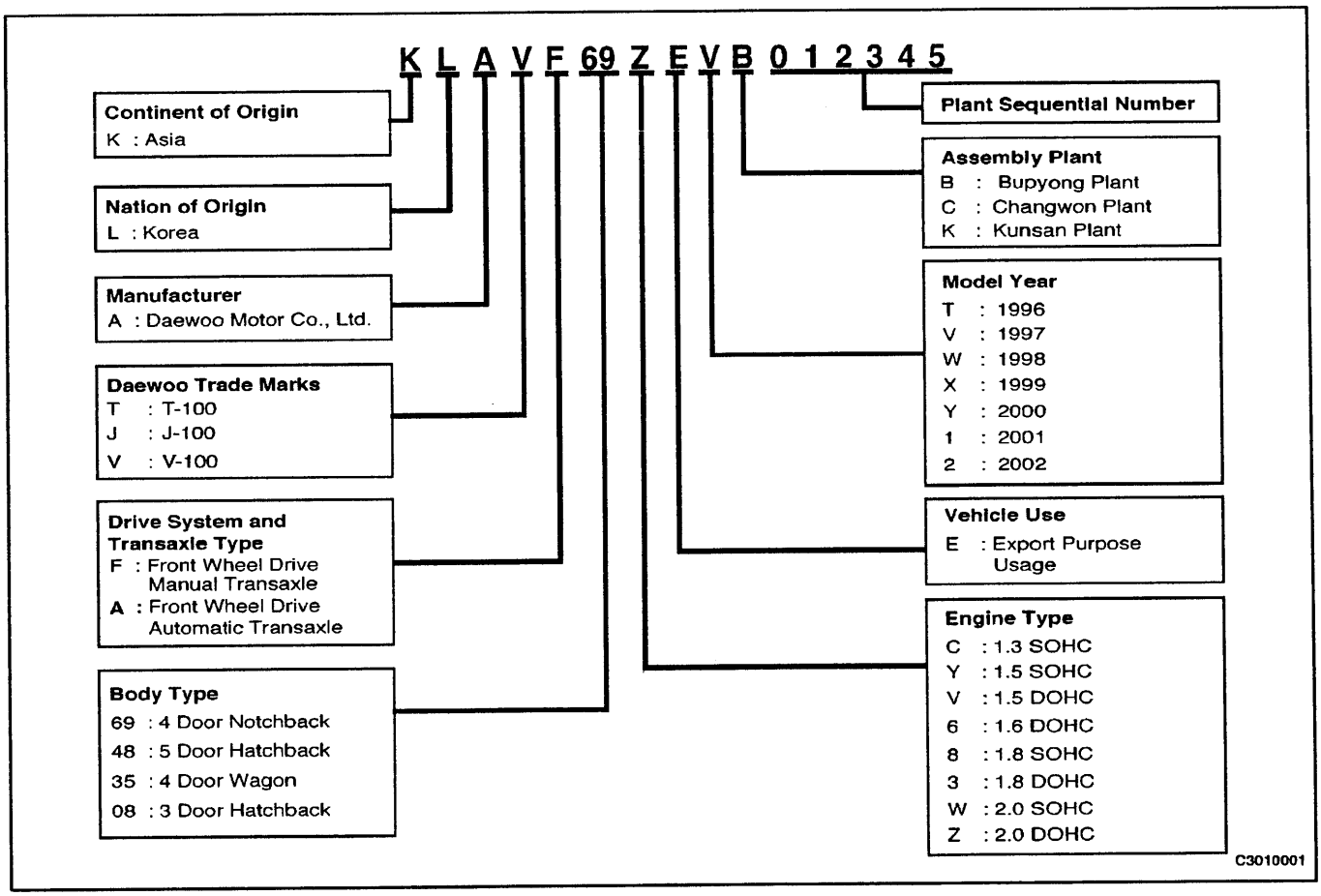
When service operation is complete, make a final check to be sure service was done properly and the problem was corrected.

GENERAL DESCRIPTION

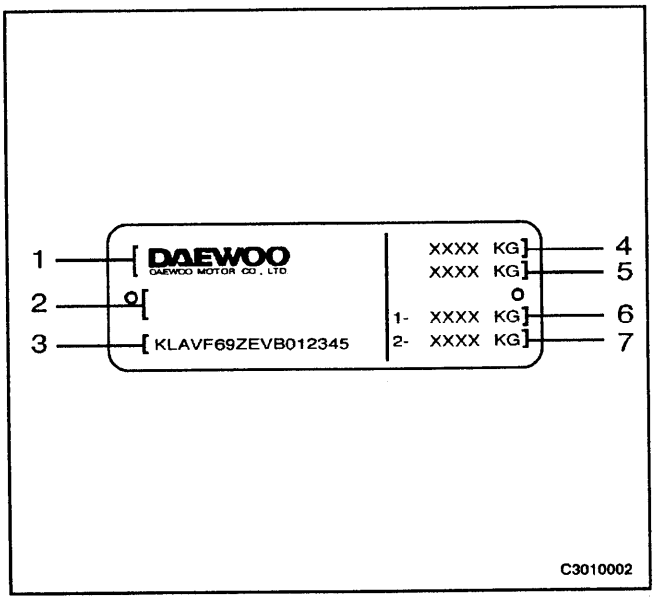
VEHICLE IDENTIFICATIONS

The vehicle identification number (VIN) plate is attached to the top right side of the front panel support. The VIN is also engraved in the top right side of the bulkhead.

Passenger Car VIN



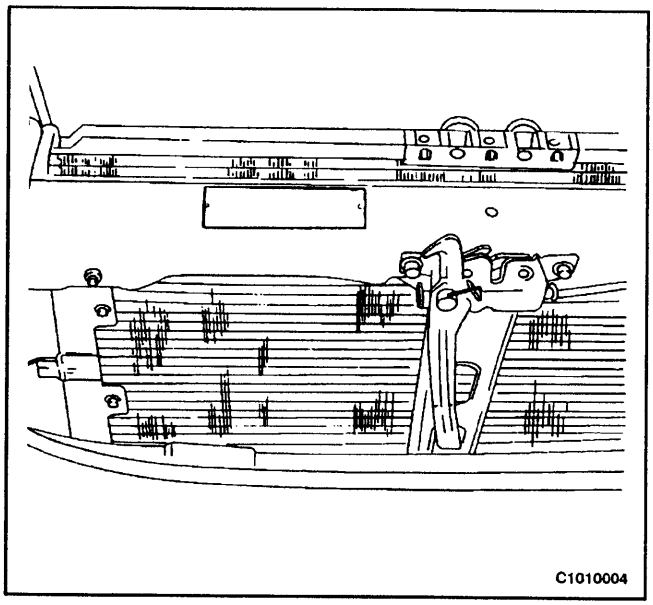
VIN Plate



1 Manufacturer's Name
2 NTA Number or WVTA Number
3 Vehicle Identification Number
4 Gross Vehicle Weight
5 Combination Weight
6 Front Axle Weight
7 Rear Axle Weight

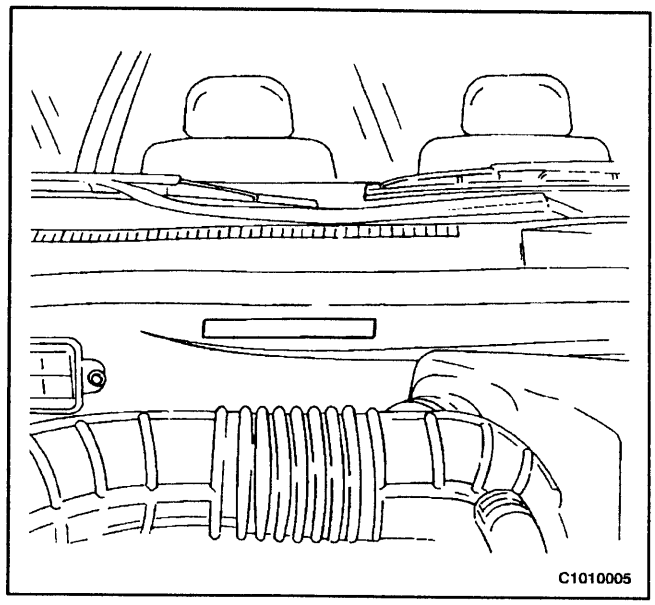
VIN Plate Location

The VIN plate is attached to the top right side of the front panel support.

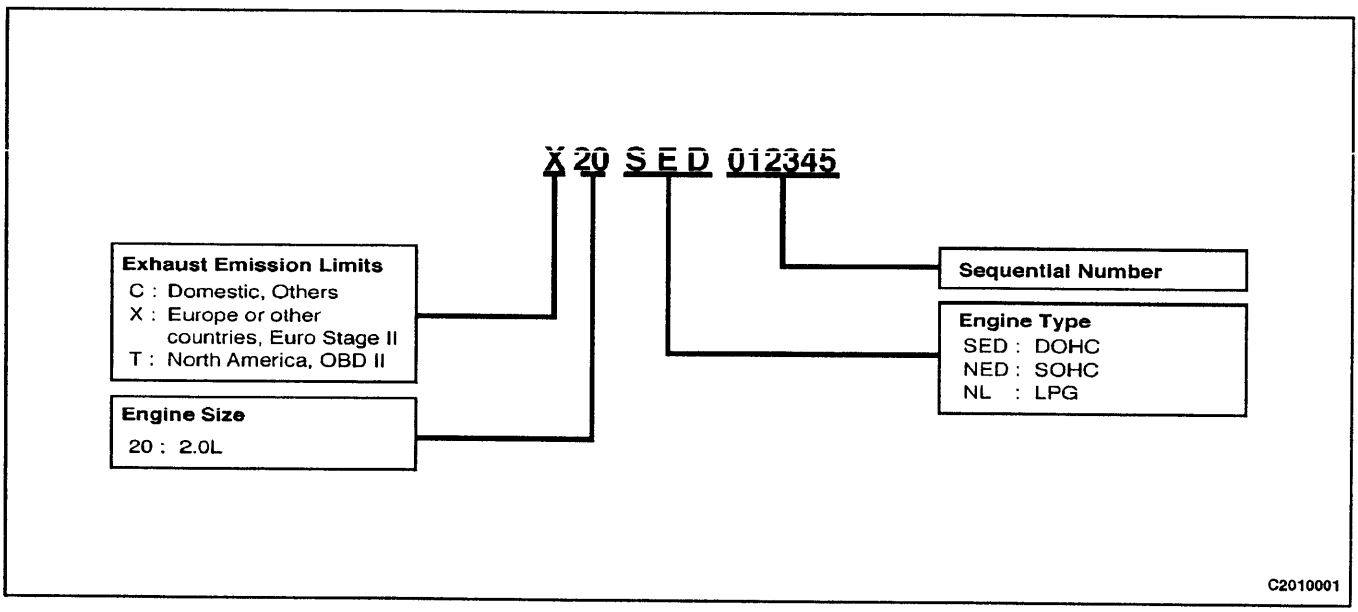


Engraved VIN Location

The engraved VIN is located on the top right side of the bulkhead.

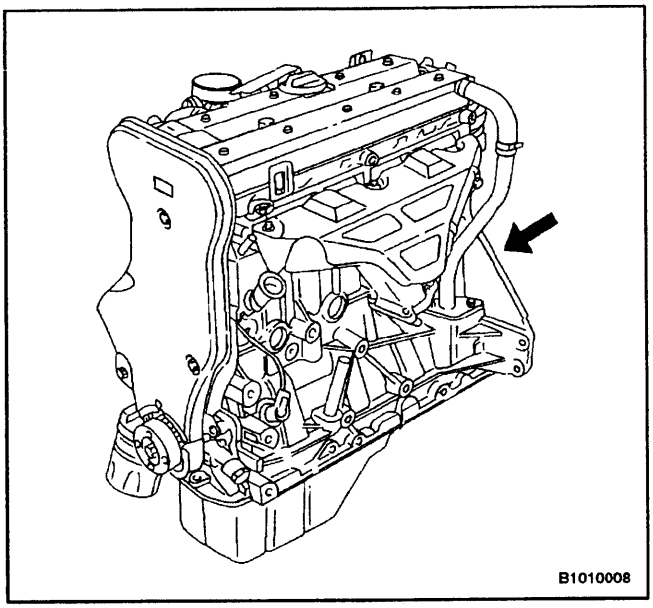


Engine Number



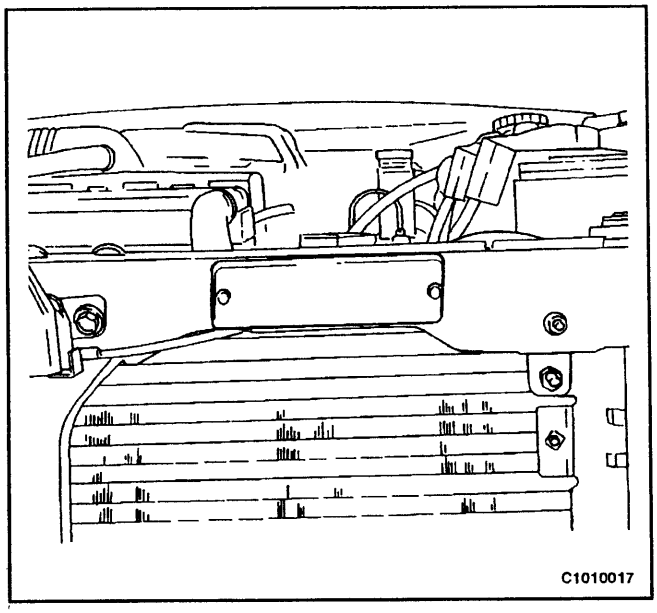
Engraved Engine Number Location

The engraved engine number is located on the engine block beneath the No. 4 exhaust manifold.

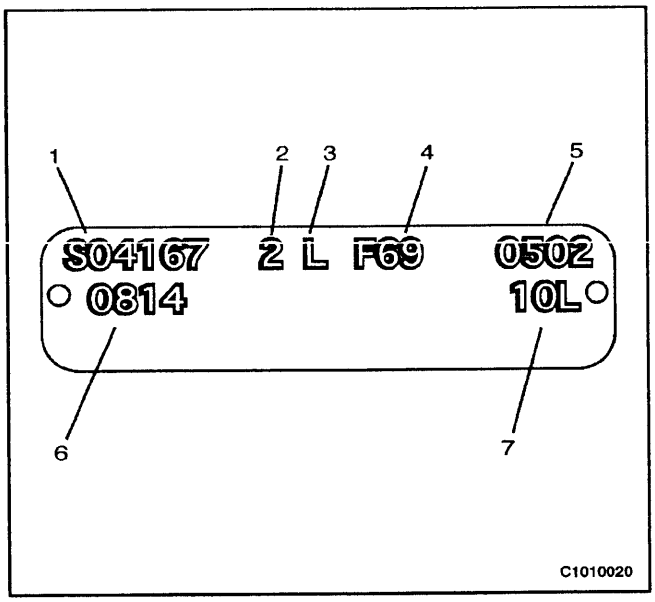


Body Identification Number Plate Location

The body identification number plate is attached to the top left side of the front panel support.

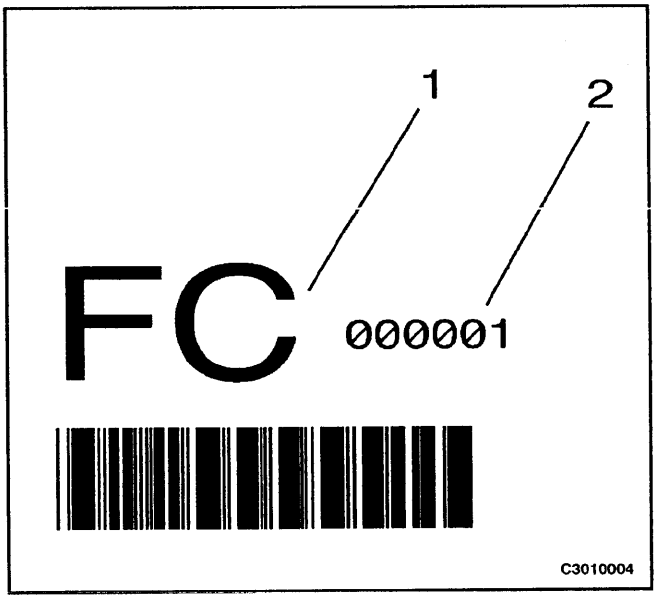


Body Identification Number Plate



1 P/O Number
2 Check Digit
3 Drive
4 Body Type
5 P/O Date
6 Sequential Number
7 Exterior Color

Manual Transaxle Identification Number Plate

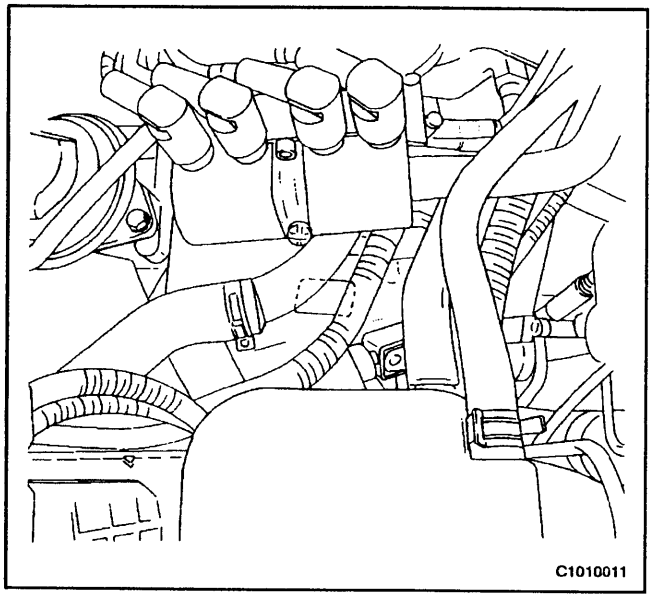


1 Identification Code
2 Sequential Number

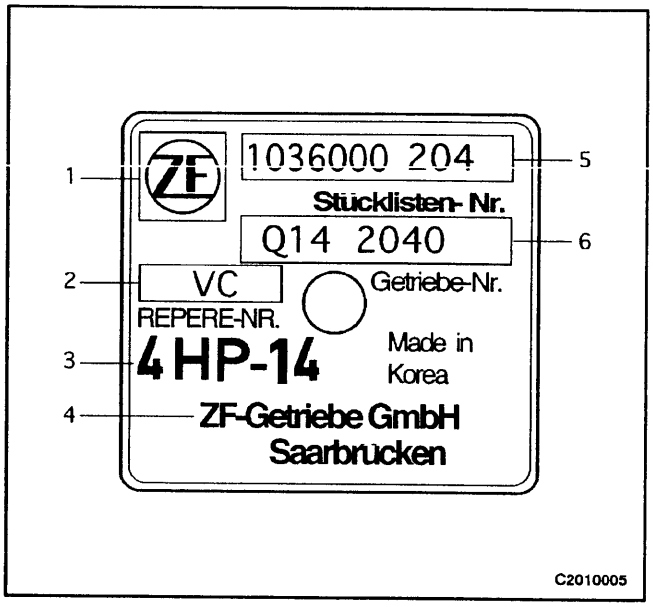
Identification Code	Engine	Gear Ratio
FC	2.0L DOHC	3.722 CR

Manual Transaxle Identification Number Plate Location

The manual transaxle identification number plate is attached to the top of the transaxle case near the engine.



Automatic Transaxle Identification Number Plate

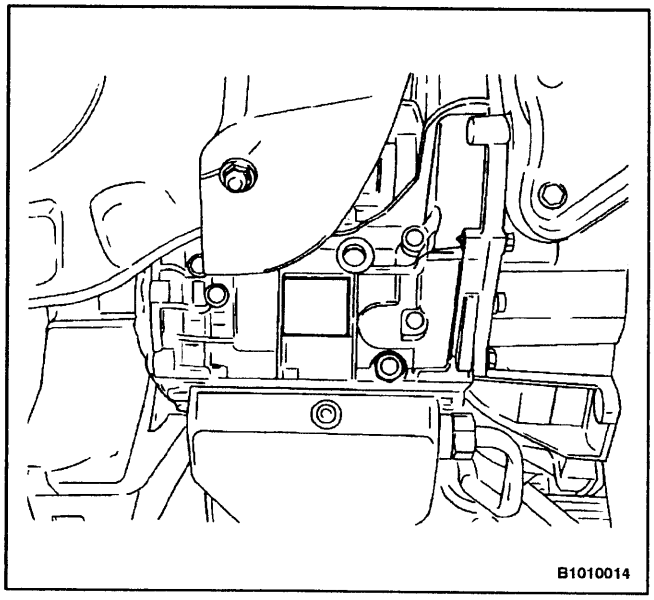


1 Manufacturer's Logo
2 Identification Code
3 Model Name (4HP-14)
4 Manufacturer
5 Part Number
6 Sequential Number

Identification Code	Engine
VC	2.0L DOHC

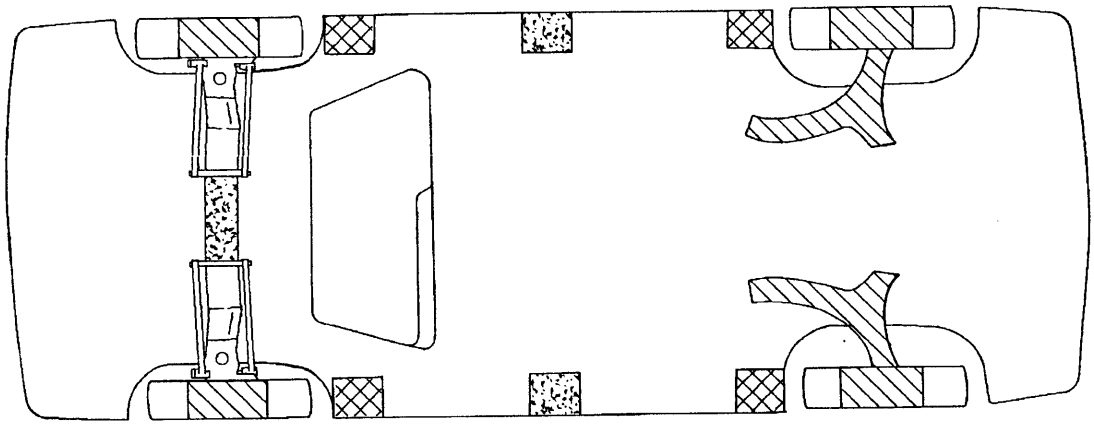
Automatic Transaxle Identification Number Plate Location

The automatic transaxle identification number plate is attached on the rear bottom side of the transaxle case near the bulkhead.

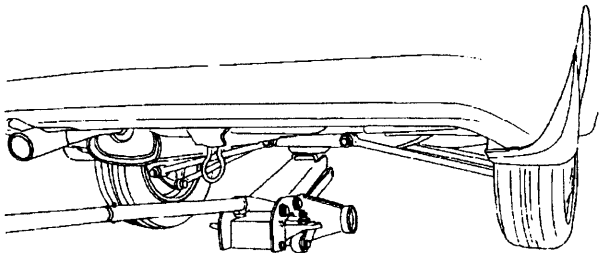


VEHICLE LIFTING PROCEDURES

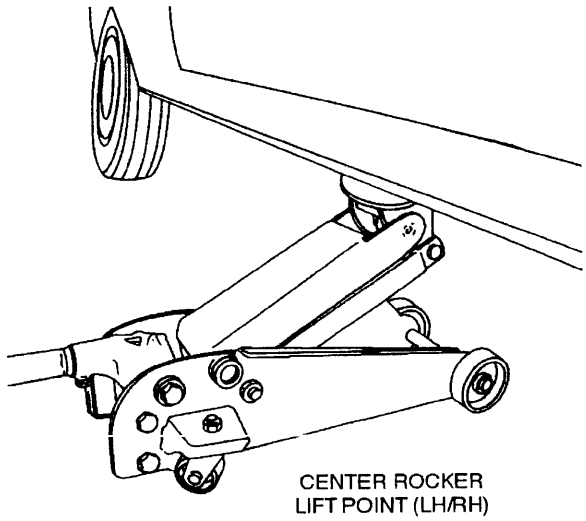
Notice: To raise the vehicle, place the lifting equipment only at the points indicated. Failure to use these precise positions may result in permanent body deformation. Many dealer service facilities and service stations are equipped with automotive hoists that bear upon some parts of the frame in order to lift the vehicle. If any other hoist method is used, use special care to avoid damaging the fuel tank, the filler neck, the exhaust system, or the underbody.



FRAME CONTACT HOIST SUSPENSION CONTACT HOIST FLOOR JACK



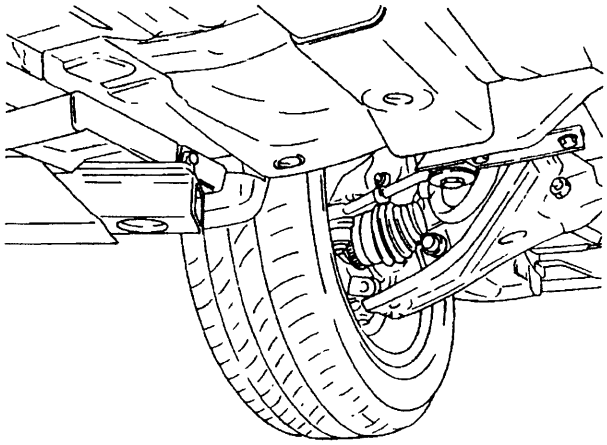
REAR SUSPENSION
AXLE LIFT POINT



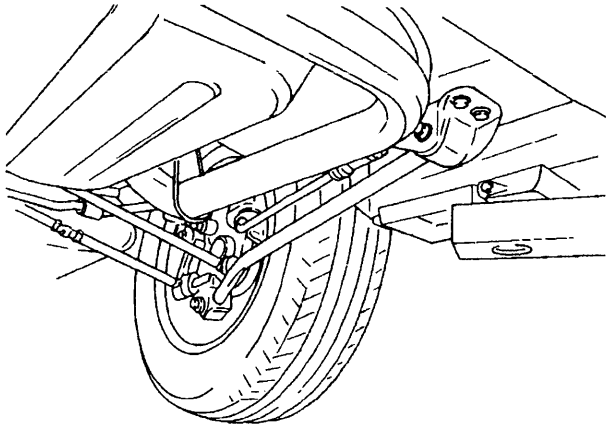
CENTER ROCKER
LIFT POINT (LH/RH)

B1010017

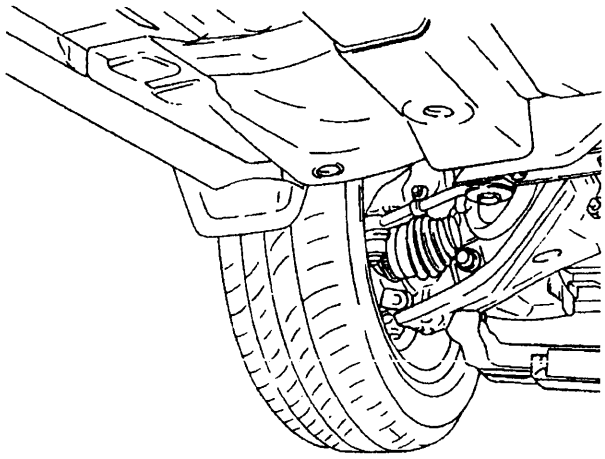
Vehicle Lifting Points



FRAME CONTACT HOIST
REARWARD OF FRONT TIRE



FRAME CONTACT HOIST
FORWARD OF REAR WHEEL



SUSPENSION CONTACT HOIST
UNDER FRONT LOWER CONTROL ARM

C1010014

ENGINE

CONTENTS

SECTION 1

ENGINE

SECTION 1A

GENERAL ENGINE INFORMATION

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DIAGNOSIS

COMPRESSION TEST

Important: Disconnect the Crankshaft Position Sensor (CPS) connector to disable the fuel and the ignition systems.

Test the compression pressure for each cylinder. Low compression pressure may be the fault of the valves or the pistons. The following conditions should be considered when you check the cylinder compression:

- The engine should be at normal operating temperature.
- The throttle must be wide open.
- All the spark plugs should be removed.
- The battery must be at or near full charge.

1. Place approximately three squirts of oil from a plunger type oiler into each spark plug port.
2. Insert the engine compression gauge into each spark plug port.
3. Crank test each cylinder with four to five compression strokes using the starter motor.
4. The lowest reading should not be less than 70% of the highest reading. The compression gauge reading should not be less than 689 kPa (100 psi) for any of the cylinders.
5. Examine the gauge readings obtained after the four "puffs" per cylinder are obtained from cranking the starter motor. The readings are explained in the following descriptions:

- Normal Condition - Compression builds up quickly and evenly to specified compression on each cylinder.
- Piston Rings Faulty - Compression is low on the first stroke and tends to build up on following strokes, but the compression pressure does not reach normal. The compression pressure improves considerably with the addition of oil into the cylinder.
- Valves Faulty - Low compression pressure on the first stroke. The compression pressure does not tend to build up on the following strokes. The compression pressure does not improve much with the addition of oil into the cylinder.

OIL PRESSURE TEST

Step	Action	Value(s)	Yes	No
1	Is low or no oil pressure indicated?	-	Go to *Step 2*	System OK
2	Check the oil level in the crankcase. Is the level low?	-	Go to *Step 3*	Go to *Step 4*
3	Add oil so that the oil level is up to the full mark on the indicator. Is the repair complete?	-	Go to *Step 1*	-
4	Check the idle speed. Is the idle speed below the value specified?	850 rpm	Go to *Step 5*	Go to *Step 6*
5	Increase the idle speed. Is the speed increased?	-	Go to *Step 1*	-
6	Inspect the oil pressure switch. Is the oil pressure switch incorrect or malfunctioning?	-	Go to *Step 7*	Go to *Step 8*
7	Install a new oil pressure switch. Is the repair complete?	-	Go to *Step 1*	-
8	Inspect the oil pressure gauge. Is the oil pressure gauge incorrect or malfunctioning?	-	Go to *Step 9*	Go to *Step 10*
9	Install a new oil pressure gauge. Is the repair complete?	-	Go to *Step 1*	-
10	Inspect the engine oil. Is the engine oil in the crankcase diluted or of the improper viscosity?	-	Go to *Step 11*	Go to *Step 12*
11	Install new engine oil of the proper viscosity for the expected temperatures. Is the repair complete?	-	Go to *Step 1*	-
12	Inspect the oil pump. Is the pump worn or dirty?	-	Go to *Step 13*	Go to *Step 14*
13	Replace the oil pump. Is the repair complete?	-	Go to *Step 1*	-
14	Inspect the oil filter. Is the oil filter plugged?	-	Go to *Step 15*	Go to *Step 16*
15	Install a new oil filter. Is the repair complete?	-	Go to *Step 1*	-
16	Inspect the oil pickup screen. Is the oil pickup screen loose or plugged?	-	Go to *Step 17*	Go to *Step 18*
17	Tighten or replace the oil pickup screen as necessary. Is the repair complete?	-	Go to *Step 1*	-
18	Inspect the oil pickup tube. Are there any holes in the oil pickup tube?	-	Go to *Step 19*	Go to *Step 20*
19	Replace the oil pickup tube. Is the repair complete?	-	Go to *Step 1*	-

OIL PRESSURE TEST (Cont'd)

Step	Action	Value(s)	Yes	No
20	Inspect the bearing clearances. Are the bearing clearances more than the values specified?	Crankshaft 0.040 mm (0.0016 in.) Connecting Rod 0.063 mm (0.0025 in.)	Go to *Step 21*	Go to *Step 22*
21	Replace the bearing if necessary. Is the repair complete?	-	Go to *Step 1*	-
22	Inspect the oil galleries. Are the oil galleries cracked, porous or plugged?	-	Go to *Step 23*	Go to *Step 24*
23	Repair or replace the engine block. Is the repair complete?	-	Go to *Step 1*	-
24	Inspect the gallery plugs. Are any of the gallery plugs missing or not installed properly?	-	Go to *Step 25*	Go to *Step 26*
25	Install plugs or repair as necessary. Is the repair complete?	-	Go to *Step 1*	-
26	Inspect the camshaft. Is the camshaft worn or is there evidence of poor machining?	-	Go to *Step 27*	System OK
27	Replace the camshaft. Is the repair complete?	-	Go to *Step 1*	-

OIL LEAK DIAGNOSIS

Most fluid oil leaks are easily located and repaired by visually finding the leak and replacing or repairing the necessary parts. On some occasions a fluid leak may be difficult to locate or repair. The following procedures may help you in locating and repairing most leaks.

Finding the Leak

1. Identify the fluid. Determine whether it is engine oil, automatic transmission fluid, power steering fluid, etc.
2. Identify where the fluid is leaking from.
   - 2.1. After running the vehicle at normal operating temperature, park the vehicle over a large sheet of paper.
   - 2.2. Wait a few minutes.
   - 2.3. You should be able to find the approximate location of the leak by the drippings on the paper.
3. Visually check around the suspected component. Check around all the gasket mating surfaces for leaks. A mirror is useful for finding leaks in areas that are hard to reach.
4. If the leak still cannot be found, it may be necessary to clean the suspected area with a degreaser, steam or spray solvent.
   - 4.1. Clean the area well.
   - 4.2. Dry the area.
   - 4.3. Operate the vehicle for several miles at normal operating temperature and varying speeds.
   - 4.4. After operating the vehicle, visually check the suspected component.
   - 4.5. If you still cannot locate the leak, try using the powder or black light and dye method.

Powder Method

1. Clean the suspected area.
2. Apply an aerosol-type powder (such as foot powder) to the suspected area.
3. Operate the vehicle under normal operating conditions.
4. Visually inspect the suspected component. You should be able to trace the leak path over the white powder surface to the source.

Black Light and Dye Method

A dye and light kit is available for finding leaks. Refer to the manufacturer's directions when using the kit.

1. Pour the specified amount of dye into the engine oil fill tube.
2. Operate the vehicle under normal operating conditions as directed in the kit.

3. Direct the light toward the suspected area. The dyed fluid will appear as a yellow path leading to the source.

Repairing the Leak

Once the origin of the leak has been pinpointed and traced back to its source, the cause of the leak must be determined in order for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, check for the following conditions and correct them as they may cause a leak.

Gaskets

- The fluid level/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The fasteners are tightened improperly or the threads are dirty or damaged.
- The flanges or the sealing surface is warped.
- There are scratches, burrs or other damage to the sealing surface.
- The gasket is damaged or worn.
- There is cracking or porosity of the component.
- An improper seal was used (where applicable).

Seals

- The fluid level/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The seal bore is damaged (scratched, burred or nicked).
- The seal is damaged or worn.
- Improper installation is evident.
- There are cracks in the component.
- The shaft surface is scratched, nicked or damaged.
- A loose or worn bearing is causing excess seal wear.

KNOCK DIAGNOSIS

Definition for Knock

Engine knock refers to various types of engine noise. Heavy knock is usually very loud and the result of broken or excessively worn internal engine components. Light knock is a noticeable noise, but not as loud. Light knock can be caused by worn internal engine components. Loose or broken external engine components can also cause heavy or light knock.

Engine Knocks Cold and Continues for Two-Three Minutes and/or Knock Increases with Engine Torque

Step	Action	Value(s)	Yes	No
1	Does the engine knock when it is cold and continue for two to three minutes or does the knock increase with torque?	-	Go to *Step 2*	System OK
2	Inspect the flywheel. Is the flywheel contacting the splash shield?	-	Go to *Step 3*	Go to *Step 4*
3	Reposition the splash shield. Is the repair complete?	-	Go to *Step 1*	-
4	Inspect the balancer and the drive pulleys. Is either the balancer or the drive pulleys loose or broken?	-	Go to *Step 5*	Go to *Step 6*
5	Tighten or replace the balancer or the drive pulleys. Is the repair complete?	-	Go to *Step 1*	-
6	Inspect the piston-to-bore clearance. Is the clearance more than the value specified?	0.030 mm (0.001 in.)	Go to *Step 7*	Go to *Step 8*
7	1. Rebore the cylinder and hone to size. 2. Replace the piston. Is the repair complete?*	-	Go to *Step 1*	-
8	Inspect the connecting rod. Is the connecting rod bent?	-	Go to *Step 9*	System OK
9	Replace the connecting rod. Is the repair complete?	-	Go to *Step 1*	-

* Cold engine piston knock usually disappears when the cylinder is grounded out. Cold engine piston knock, which disappears in about 1.5 minutes, is considered acceptable.

Heavy Knock Hot with Torque Applied

Step	Action	Value(s)	Yes	No
1	Is there a heavy knock when the engine is hot and torque is applied?	-	Go to *Step 2*	System OK
2	Inspect the balancer and pulley hub. Is the balancer or pulley hub broken?	-	Go to *Step 3*	Go to *Step 4*
3	Replace the broken balancer or pulley hub. Is the repair complete?	-	Go to *Step 1*	-
4	Inspect the torque converter bolts. Are the bolts tightened to value specified?	60 N•m (44 lb-ft)	Go to *Step 5*	Go to *Step 6*
5	Tighten the torque converter bolts. Is the repair complete?	-	Go to *Step 1*	-
6	Inspect the accessory belts. Are the belts too tight or nicked?	-	Go to *Step 7*	Go to *Step 8*
7	Replace and/or tension the belts to specifications as necessary. Is the repair complete?	-	Go to *Step 1*	-
8	Inspect the exhaust system. Is the system grounded?	-	Go to *Step 9*	Go to *Step 10*
9	Reposition the system as necessary. Is the repair complete?	-	Go to *Step 1*	-
10	Inspect the flywheel. Is the flywheel cracked?	-	Go to *Step 11*	Go to *Step 12*
11	Replace the flywheel. Is the repair complete?	-	Go to *Step 1*	-
12	Inspect the main bearing clearance. Is the clearance more than the value specified?	0.040 mm (0.0016 in.)	Go to *Step 13*	Go to *Step 14*
13	Replace the main bearings as necessary. Is the repair complete?	-	Go to *Step 1*	-
14	Inspect the rod bearing clearance. Is the clearance more than the value specified?	0.063 mm (0.0025 in.)	Go to *Step 15*	System OK
15	Replace the rod bearings as necessary. Is the repair complete?	-	Go to *Step 1*	-

Light Knock Hot

Step	Action	Value(s)	Yes	No
1	Is there a light knock when the engine is hot?	-	Go to *Step 2*	System OK
2	Is detonation or spark knock evident?	-	Go to *Step 3*	Go to *Step 4*
3	Check the engine timing and the fuel quality. Was the problem found?	-	Go to *Step 1*	-
4	Inspect the torque converter bolts. Are the bolts loose?	-	Go to *Step 5*	Go to *Step 6*
5	Tighten the torque converter bolts. Is the repair complete?	-	Go to *Step 1*	-
6	Inspect the manifold. Is there an exhaust leak at the manifold?	-	Go to *Step 7*	Go to *Step 8*
7	Tighten the bolts or replace the gasket. Is the repair complete?	-	Go to *Step 1*	-
8	Check the rod bearing clearance. Is the clearance within the value specified?	0.019-0.063 mm (0.0007-0.0024 in.)	Go to *Step 9*	System OK
9	Replace the rod bearings as necessary. Is the repair complete?	-	Go to *Step 1*	-

Knocks During Initial Start-Up But Lasts Only a Few Seconds

Step	Action	Value(s)	Yes	No
1	Does the engine knock during initial start-up but last only a few seconds?	-	Go to *Step 2*	System OK
2	Check the engine oil. Is the proper viscosity oil used in the crankcase?	-	Go to *Step 4*	Go to *Step 3*
3	Install oil of the proper viscosity for the expected seasonal temperatures. Is the repair complete?	-	Go to *Step 1*	-
4	Inspect the hydraulic lifters. Is there evidence of hydraulic lifter bleed-down?	-	Go to *Step 5*	Go to *Step 6*
5	Clean, test and replace the lifters as necessary. Is the repair complete?*	-	Go to *Step 1*	-
6	Inspect the crankshaft end clearance. Is the clearance more than value specified?	0.302 mm (0.012 in.)	Go to *Step 7*	Go to *Step 8*
7	Replace the crankshaft thrust bearing. Is the repair complete?	-	Go to *Step 1*	-
8	Inspect the front main bearing clearance. Is the clearance more than the value specified?	0.040 mm (0.0016 in.)	Go to *Step 9*	System OK
9	Replace the worn parts of the front main bearing. Is the repair complete?	-	Go to *Step 1*	-

* When the engine is stopped, some valves will be open. Spring pressure against the lifters will tend to bleed the lifter down. Attempts to repair this should be made only if the problem is consistent.

An engine that is operated for only short periods between start-ups may have lifter noise that lasts for a few minutes. This is a normal condition.

Knocks at Idle Hot

Step	Action	Value(s)	Yes	No
1	Does the engine knock at idle when hot?	-	Go to *Step 2*	System OK
2	Inspect the drive belts. Are the belts loose or worn?	-	Go to *Step 3*	Go to *Step 4*
3	Tension or replace the belts as necessary. Is the repair complete?	-	Go to *Step 1*	-
4	Inspect the A/C compressor and the generator. Is either the compressor or the generator faulty?	-	Go to *Step 5*	Go to *Step 6*
5	Replace the faulty A/C compressor or the generator. Is the repair complete?	-	Go to *Step 1*	-
6	Inspect the valve train. Are valve train components faulty?	-	Go to *Step 7*	Go to *Step 8*
7	Replace faulty valve train components. Is the repair complete?	-	Go to *Step 1*	-
8	Check the engine oil. Is the proper viscosity oil used in the crankcase?	-	Go to *Step 10*	Go to *Step 9*
9	Install oil of the proper viscosity for the expected seasonal temperatures. Is the repair complete?	-	Go to *Step 1*	-
10	Inspect the piston pin clearance. Is the clearance more than the value specified?	0.014 mm (0.0005 in.)	Go to *Step 11*	Go to *Step 12*
11	Replace the piston and the pin. Is the repair complete?	-	Go to *Step 1*	-
12	Check the connecting rod alignment. Is the alignment faulty?	-	Go to *Step 13*	Go to *Step 14*
13	Check and replace rods as necessary. Is the repair complete?	-	Go to *Step 1*	-
14	Inspect the piston-to-bore clearance. Is the clearance within the value specified?	0.03 mm (0.0012 in.)	Go to *Step 16*	Go to *Step 15*
15	Hone the bore and fit a new piston. Is the repair complete?	-	Go to *Step 1*	-
16	Inspect the crankshaft balancer. Is the balancer loose?	-	Go to *Step 17*	Go to *Step 18*
17	Torque or replace worn parts. Is the repair complete?	-	Go to *Step 1*	-
18	Check the piston pin offset. Is the offset at the value specified?	0.8 mm (0.031 in.) Toward Thrust Side	Go to *Step 19*	System OK
19	Install the correct piston. Is the repair complete?	-	Go to *Step 1*	-

NOISE DIAGNOSIS

Main Bearing Noise

Step	Action	Value(s)	Yes	No
1	Are dull thuds or knocks heard with every engine revolution?	-	Go to *Step 2*	System OK
2	Check the oil pump pressure. Is the oil pump pressure low?	-	Go to *Oil Pressure Test*	Go to *Step 3*
3	Inspect the crankshaft end play. Is there excessive crankshaft end play?	0.070 ~ 0.302 mm (0.0027 ~ 0.0119 in)	Go to *Crankshaft Replacement Procedure*	Go to *Step 4*
4	Inspect the crankshaft journals. Are the crankshaft journals out-of-round?	-	Go to *Crankshaft Replacement Procedure*	Go to *Step 5*
5	Inspect the belt tension. Is there excessive belt tension?	-	Go to *Timing Belt Replacement Procedure*	Go to *Step 6*
6	Inspect the crankshaft pulley. Is the crankshaft pulley loose?	-	Go to *Crankshaft Replacement Procedure*	System OK

Connecting Rod Bearing Noise Symptom

Step	Action	Value(s)	Yes	No
1	Is a knock noise heard under all engine speeds?	-	Go to *Step 2*	System OK
2	Inspect the crankshaft connecting rod journal. Is the crankshaft connecting rod journal worn?	-	Go to *Crankshaft Replacement Procedure*	Go to *Step 3*
3	Check the oil pump pressure. Is the oil pump pressure low?	-	Go to *Oil Pressure Test*	Go to *Step 4*
4	Inspect the crankshaft connecting rod journals. Are the journals out-of-round?	-	Go to *Crankshaft Replacement Procedure*	Go to *Step 5*
5	Inspect the connecting rods. Is there a misaligned connecting rod?	-	Go to *Pistons and Rods Replacement Procedure*	Go to *Step 6*
6	Inspect the connecting rod bolts. Are the connecting rod bolts torqued properly?	-	System OK	Go to *Pistons and Rods Replacement Procedure*

Piston Noises

Step	Action	Value(s)	Yes	No
1	Are any of the following noises heard: a sharp double knock when the engine is idling, a light ticking with no load on the engine, or a "slapping" noise when the engine is cold?	-	Go to *Step 2*	System OK
2	Inspect the piston pin and bushing. Is the piston pin or the bushing worn or loose?	-	Go to *Pistons and Rods Replacement Procedure*	Go to *Step 3*
3	Inspect the piston. Is the piston broken or cracked?	-	Go to *Pistons and Rods Replacement Procedure*	Go to *Step 4*
4	Inspect the connecting rods. Is there a misaligned connecting rod?	-	Go to *Pistons and Rods Replacement Procedure*	Go to *Step 5*
5	Inspect the piston position. Is the piston 180° out of position?	-	Go to *Pistons and Rods Replacement Procedure*	System OK

Valve Mechanism or Valve Train Noises

Step	Action	Value(s)	Yes	No
1	Is a light tapping sound heard from the engine?	-	Go to *Step 2*	System OK
2	Inspect the valve springs. Are the springs weak or broken?	-	Go to *Cylinder Head and Valve Train Components Replacement Procedure*	Go to *Step 3*
3	Inspect the valves. Are the valves sticking or warped?	-	Go to *Cylinder Head and Valve Train Components Replacement Procedure*	Go to Step 4
4	Inspect the valve lifters. Are the valve lifters dirty, stuck or worn?	-	Go to *Cylinder Head and Valve Train Components Replacement Procedure*	Go to *Step 5*
5	Inspect the camshaft lobes. Are the camshaft lobes damaged or improperly machined?	-	Go to *Camshaft Replacement Procedure*	Go to *Step 6*
6	Check the oil supply to the valve train. Is the oil supply insufficient or poor?	-	Go to *Cylinder Head and Valve Train Components Replacement Procedure*	Go to *Step 7*
7	Inspect the valve guides. Are the valve guides worn?	-	Go to *Cylinder Head and Valve Train Components Replacement Procedure*	Go to *Step 8*
8	Inspect the valve spring seat. Is the valve spring seat incorrect?	-	Go to *Cylinder Head and Valve Train Components Replacement Procedure*	System OK

GENERAL INFORMATION

CLEANLINESS AND CARE

An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the ten-thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly, to protect and lubricate the surfaces on initial operation. Proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Whenever valve train components are removed for service, they should be kept in order. They should be installed in the same locations, and with the same mating surfaces, as when they were removed.

Battery cables should be disconnected before any major work is performed on the engine. Failure to disconnect cables may result in damage to wire harness or other electrical parts.

ON-ENGINE SERVICE

Caution: Disconnect the negative battery cable before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

Notice: Any time the air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material, which could follow the intake passage into the cylinder and cause extensive damage when the engine is started.

SECTION 1C

DOHC ENGINE MECHANICAL

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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SPECIFICATIONS

ENGINE SPECIFICATIONS

Application	2.0L DOHC
General Data:	
Engine Type	4 Cylinder (In-Line)
Displacement	1 998 cm^3 (121 in^3)
Bore Stroke	86 x 86 mm (3.38 in x 3.38 in.)
Compression Ratio	9.6:1
Firing Order	1-3-4-2
Cylinder Bore:	
Diameter	85.975~86.025 mm (3.384~3.386 in.)
Out of Round (Maximum)	0.013 mm (0.0005 in.)
Cylinder Bore Taper (Maximum)	0.013 mm (0.0005 in.)
Piston Protrusion	0.5 mm Max (0.019 in.)
Oversize (Measure Replacement Piston before Re-boring)	Available in 0.50 mm to suit bore (0.019 in.)
Service Replacement Standard Bore	4 Piston, Pin, and Ring Assemblies Available
Block Face Distortion	0.01 mm Max (0.00039 in.)
Piston:	
Diameter	85.955~86.485 mm (3.384~3.404 in.)
Clearance to Bore	0.0100~0.0300 mm (0.00039~0.0011 in.)
Piston Protrusion	0.5 mm Max (0.019 in.)
Piston Taper	0.013 mm (0.0005 in.)
Piston Rings:	
Ring, End Gap, Top Compression	0.3~0.5 mm (0.011~0.019 in.)
Ring, End Gap, Second Compression	0.3~0.5 mm (0.011~0.019 in.)
Oil	0.4~1.4 mm (0.0015~0.055 in.)
Piston Pin:	
Diameter	20.9970~20.9985 mm (0.82665~0.82671 in.)
Pin Offset	0.8 mm (0.03 in.) Toward Thrust Side

ENGINE SPECIFICATIONS (Cont'd)

Application	2.0L DOHC
Clearance: In Piston	0.0035~0.0140 mm (0.00013~0.00055 in.)
Clearance: In Rod	Interference Fit in Rod
Length	61.5 mm (2.42 in.)
Camshaft:	
Lift - Intake	10.0 mm (0.39 in.)
Lift - Exhaust	10.0 mm (0.39 in.)
Camshaft Cap to Bearing Journal Clearance	0.04~0.144 mm (0.0015~0.0056 in.)
Bearing Journal OD	42.455~43.470 mm (1.6714~1.7114 in.)
Crankshaft:	
Main Journal	-
Diameter (All)	57.982~57.995 mm (2.2827~2.2832 in.)
Radial Runout (Shaft Support on No. 1 and No. 5 Bearings Measured at No. 3 Journal)	0.03 mm (0.001 in.)
Main Bearing Clearance (All)	0.015-0.040 mm (0.00059~0.00157 in.)
End Play	0.070~0.302 mm (0.0027~0.0118 in.)
Service Oversize, Available in 2 sizes	0.25 and 0.5 mm (0.00098~0.019 in.)
Connecting Rod Journal:	
Diameter (All)	48.981~48.987 mm (1.9283~1.9286 in.)
Out of Round (Maximum)	0.004 mm (0.00015 in.)
Rod Bearing Play	0.006~0.031 mm (0.00023~0.00122 in.)
Rod Bearing Clearance	0.019~0.063 mm (0.0007~0.0024 in.) (Production 0.013~0.041 mm (0.0005~0.0016 in.))
Cylinder Head:	
Valve Stem Protrusion	39.8 mm Max (1.566 in.)
Valve Guide Height	13.7~14.0 mm (0.53~0.55 in.)
Overall Height	134.0 ± 0.025 mm (5.275~0.0009 in.)
Minimum Overall Height After Machining	133.9 mm (5.271 in.)

ENGINE SPECIFICATIONS (Cont'd)

Application	2.0L DOHC
Valve System:	
Valve Lash Compensators	Hydraulic
Seat Runout (Maximum, All)	0.03 mm (0.001 in.)
Face Runout (Maximum, All)	0.03 mm (0.001 in.)
Valve Stem Diameter Intake	5.970~5.995 mm (0.235~0.236 in.)
Exhaust	5.960~5.945 mm (0.23464~0.2360 in.)
Valve Diameter Intake	32 ± 0.1 mm (1.2598 ± 0.0039 in.)
Exhaust	29 ± 0.1 mm (1.1417 ± 0.0039 in.)
Valve Seat Width Intake	1.0~1.5 mm (0.039~0.059 in.)
Exhaust	1.7~2.2 mm (0.066~0.086 in.)
Valve Face Angle	44°
Valve Seat Angle	45°
Valve Guide Inside Diameter	7.03~7.05 mm (0.276~0.277 in.)
Oil Pump:	
Gear Lash	0.10-0.20 mm (0.004-0.008 in.)
Outer Gear to Body	0.11-0.19 mm (0.0043-0.0074 in.)
Outer Gear to Crescent	0.11-0.24 mm (0.0043-0.009 in.)
Inner Gear to Crescent	0.18-0.26 mm (0.007-0.010 in.)
End Clearance	0.03-0.10 mm (0.001-0.004 in.)
Sealants and Adhesives:	
Rear Main Bearing Cap	GE p/n RTV 159
Camshaft Carrier-to-Cylinder Head	HN 1581 (Loctite® 515)
Oil Pan Bolts	HN 1256 (Loctite® 242)
Oil Pump Bolts	HN 1256 (Loctite® 242)
Oil Pan Pickup Tube Bolts	HN 1256 (Loctite® 242)
Oil Gallery Plug	HN 1256 (Loctite® 242)
Coolant Jacket Caps and Plugs (Freeze Plugs)	HN 1756 (Loctite® 176)
Exhaust Manifold Studs/Nuts	Anti-seize Compound (HMC Spec HN1325)

FASTENER TIGHTENING SPECIFICATIONS

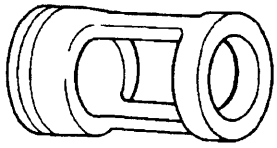
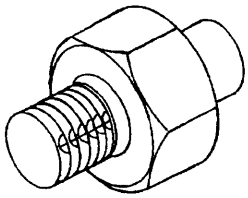
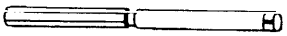
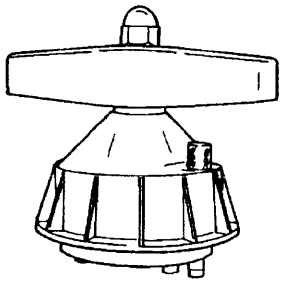
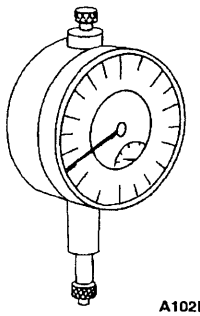
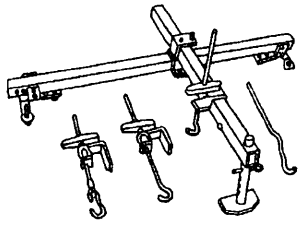
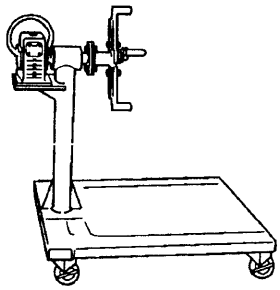
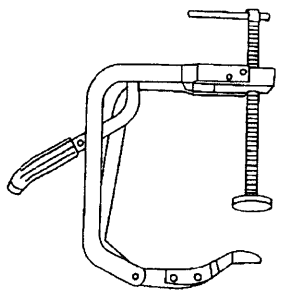
Application	N•m	Lb-Ft	Lb-In
A/C Compressor Hose Assembly Bolt	33	24	-
Air Filter Housing Bolts	8	-	71
Alternator-to-Intake Manifold Strap Bracket Bolts	20	15	-
Alternator-to-Intake Manifold Support Bracket Bolts	35	26	-
Camshaft Bearing Cap Bolts	8	-	71
Canister Purge Solenoid and Exhaust Gas Recirculation Solenoid Bracket Bolt	5	-	44
Connecting Rod Cap Bearing Bolts	35 + 45°	26 + 45°	-
Coolant Bypass Housing Bolts	15	11	-
Coolant Pump Retaining Bolts	20	15	-
Coolant Temperature Sensor	25	18	-
Crankshaft Bearing Cap Bolts	50 + 45° + 15°	37 +45° + 15°	-
Crankshaft Position Sensor Retaining Bolt	13	-	115
Crankshaft Pulley Bolts	20	15	-
Crankshaft Timing Belt Drive Gear Bolt	130 + 40° ~ 50°	96 + 40° ~ 50°	-
Cylinder Head Bolts	25 + 90°+ 90° 90° + 15°	18 + 90°+ 90° + 90° + 15°	-
DIS Ignition Coil and EGR Mounting Bracket Bolts	25	18	-
Engine Block Lower Support Bracket/Splash Shield Bolts	35	26	-
Engine Mount Bolts/Nuts	60	44	-
Engine Mount Bracket-to-Engine Block Nuts/Bolts	90	66	-
Engine to Intake Manifold Support Bracket	20	15	-
Exhaust Camshaft Gear Bolt	50 + 60°+ 15°	37 + 60°+ 15°	-
Exhaust Flex Pipe-to-Catalytic Converter Retaining Nuts	30	22	-
Exhaust Flex Pipe-to-Exhaust Manifold Retaining Nuts	22	16	-
Exhaust Flex Pipe Support Bracket Bolts	30	22	-
Exhaust Gas Recirculation Valve Bolts	20	15	-
Exhaust Manifold Heat Shield Bolts	8	-	71
Exhaust Manifold Retaining Nuts	22	16	-
Exhaust Support Bracket Bolts	30	22	
Flexible Plate Bolts	60	44	-
Flywheel Bolts	65 + 30° + 15°	48 + 30° + 15°	-
Front Timing Belt Cover Bolts	8	-	71
Fuel Rail Retaining Bolts	25	18	-
Ignition Coil Mounting Bolts	10	-	89

FASTENER TIGHTENING SPECIFICATIONS (Cont'd)

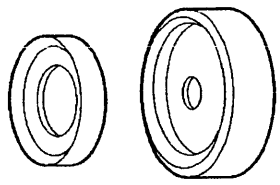
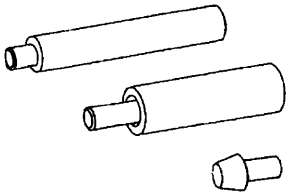
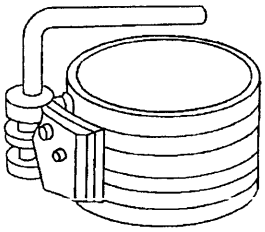
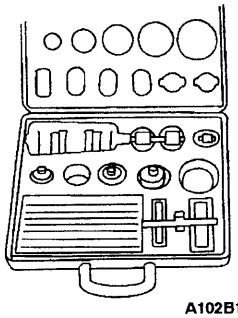
Application	N•m	Lb-Ft	Lb-In
Intake Camshaft Gear Bolt	50 + 60° + 15°	37 + 60° + 15°	-
Intake Manifold Retaining Nuts and Bolts	22	16	-
Intake Manifold Support Bracket Lower Bolts	20	15	-
Intake Manifold Support Bracket Upper Bolts	20	15	-
Oil Pan Drain Plug	35	26	-
Oil Pan Flange-to-Transaxle Retaining Bolts	40	30	-
Oil Pan Retaining Bolts	10	-	89
Oil Pressure Switch	40	30	-
Oil Pump Rear Cover Bolts	6	-	53
Oil Pump Retaining Bolts	10	-	89
Oil Pump Pickup Tube Bolts	8	-	71
Power Steering Hose Clamp Bolt	8	-	71
Pulse Pickup Sensor Disc	13	-	115
Rear Timing Belt Cover Bolts	10	-	89
Resonator Retaining Bolts	8	-	71
Safety Relief Valve Bolt	30	22	-
Spark Plug Cover Bolts	3	-	27
Spark Plugs	20	15	-
Thermostat Housing Mounting Bolts	15	11	-
Throttle Cable Bracket Bolts	8	-	71
Timing Belt Automatic Tensioner Bolt	25	18	-
Timing Belt Idler Pulley Nuts	25	18	-
Transaxle Bell Housing Bolts	75	55	-
Transaxle Torque Converter Bolts	60	44	-
Valve Cover Bolts	8	-	71

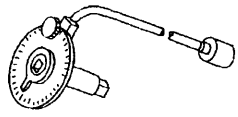
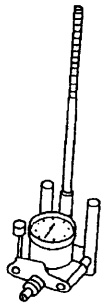
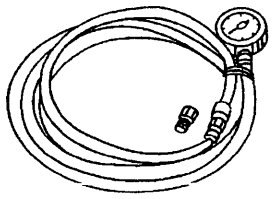
SPECIAL TOOLS

SPECIAL TOOLS TABLE

 A102C153	KM-653 Adapter
 B102C044	KM-135 Adapter
 A102C154	KM-805 Valve Guide Reamer
 A102C155	J-36792 Crankshaft Rear Oil Seal Installer
 A102B154	MKM-571-B Gauge
 A102B152	J-28467-B Engine Assembly Lift Support
 A102B159	KM-412 Engine Overhaul Stand
 A102B157	KM-348 Valve Spring Compressor

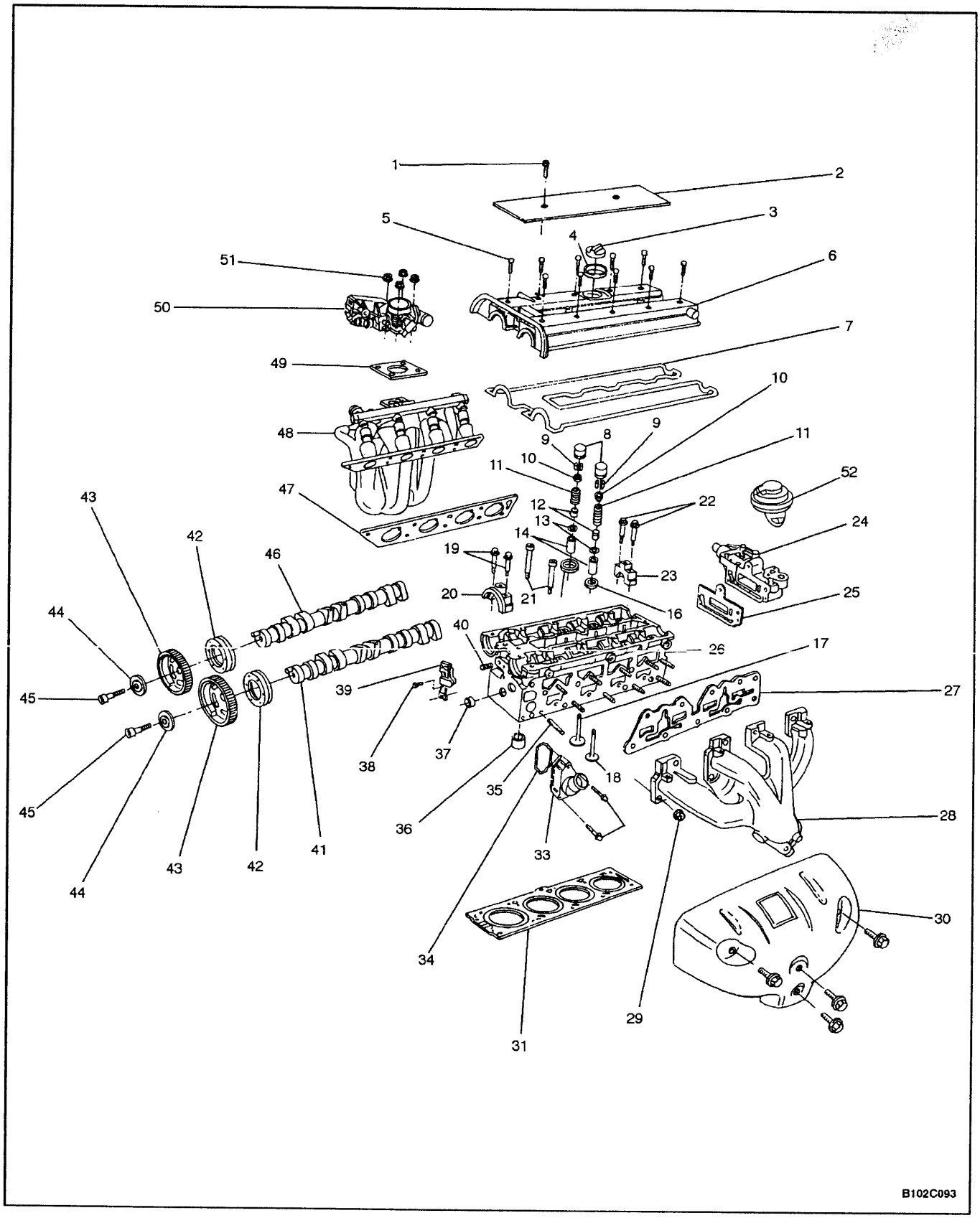
SPECIAL TOOLS TABLE (Cont'd)

 A102B160	KM-635 Crankshaft Rear Oil Seal Installer
 A102B153	KM-427 Piston Pin Service Set
 C102B004	J-8037 Universal Piston Ring Compressor
 A102B156	KM-340-0 Cutter Set Includes: KM-340-7 KM-340-13 KM-340-26

 A102B161	KM-470-B Angular Torque Gauge
 C102B005	J-8087 Cylinder Bore Check Gauge
 A202B005	KM-498-B Pressure Gauge

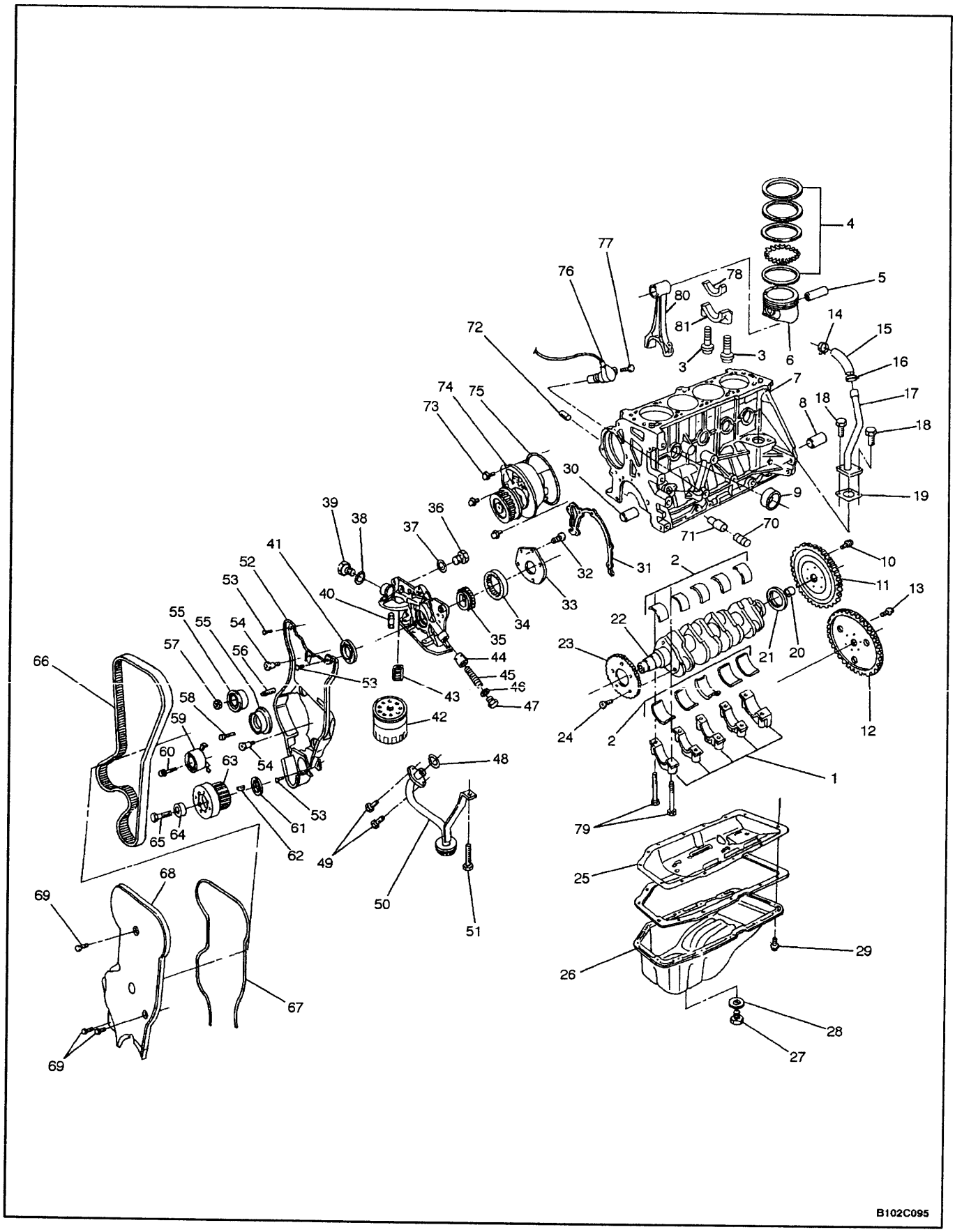
COMPONENT LOCATOR

UPPER END

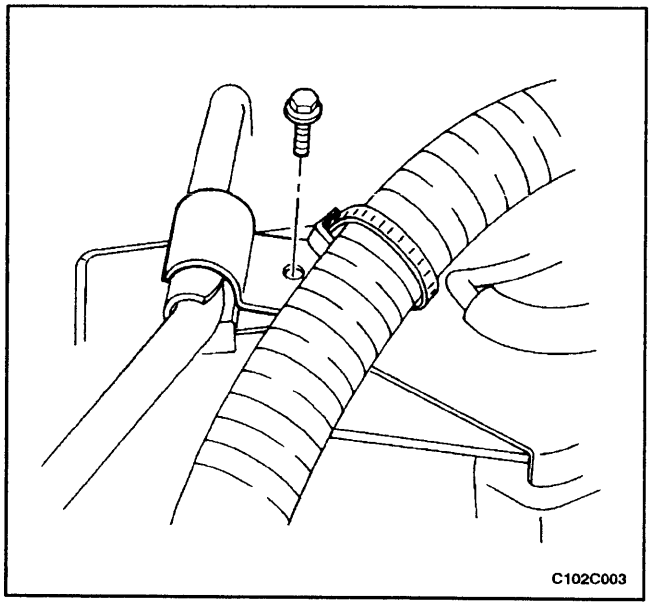


1 Bolt
2 Spark Plug Cover
3 Oil Cap
4 Oil Cap Seal
5 Bolt
6 Valve Cover
7 Valve Cover Gasket
8 Valve Lash Adjuster
9 Retainer
10 Valve Cap
11 Valve Spring
12 Valve Stem Seal
13 Valve Spring Seat
14 Valve Guide
15 Valve Spring Seat
16 Exhaust Seat
17 Inlet Valve
18 Exhaust Valve
19 Bolt
20 Front Bearing Cap
21 Head Bolt
22 Bolt
23 Bearing Cap
24 EGR Adapter
25 EGR Adapter Gasket
26 Cylinder Head
27 Exhaust Manifold Gasket
28 Exhaust Manifold
29 Nut
30 Exhaust Manifold Heat Shield
31 Cylinder Head Gasket
32 Bolt
33 Thermostat Housing
34 Thermostat Housing Gasket
35 Stud
36 Sleeve
37 Plug
38 Bolt
39 Camshaft Position Sensor
40 Oil Gallery Plug
41 Exhaust Camshaft
42 Seal Ring
43 Camshaft Gear
44 Washer
45 Camshaft Gear Bolt
46 Intake Camshaft
47 Intake Manifold Gasket
48 Intake Manifold
49 Throttle Body Gasket
50 Throttle Body
51 Nut
52 EGR Valve

LOWER END



1 Main Bearing Caps
2 Bearings, Main
3 Connecting Rod Bolt
4 Piston Ring Set
5 Piston Pin
6 Piston
7 Engine Block
8 Sleeve
9 Water Jacket Cap
10 Bolt (Manual Transaxle)
11 Flywheel (Manual Transaxle)
12 Flexible Plate (Automatic Transaxle)
13 Bolt (Automatic Transaxle)
14 Clamp
15 Hose
16 Clamp
17 Engine Vent Pipe
18 Bolt
19 Gasket
20 Transaxle Input Shaft Bearing
21 Rear Main Seal
22 Crankshaft
23 Ignition Transmit Disc
24 Bolt
25 Splash Pan and Gasket Assembly
26 Oil Pan
27 Drain Plug
28 Seal Ring
29 Bolt
30 Sleeve
31 Gasket
32 Bolt
33 Oil Pump Gear Cover
34 Ring Gear
35 Gear
36 Plug
37 Washer
38 Washer
39 Bypass Valve Plug
40 Special Screw
41 Seal
42 Oil Filter
43 Bypass Valve
44 Pressure Relief Valve Plunger
45 Pressure Relief Valve Spring
46 Washer
47 Pressure Relief Valve Plug
48 Ring Seal
49 Bolt
50 Oil Suction Pipe
51 Bolt
52 Rear Timing Belt Cover
53 Bolt
54 Special Bolt
55 Idler Pulley
56 Stud
57 Nut
58 Bolt
59 Tensioner
60 Bolt
61 Thrust Inner Washer
62 Woodruff Key
63 Crankshaft Gear
64 Thrust Outer Washer
65 Bolt
66 Camshaft Drive Belt
67 Seal
68 Front Timing Belt Cover
69 Bolt
70 Bushing Plug
71 Bushing
72 Oil Gallery Plug
73 Bolt
74 Water Pump
75 Seal Ring
76 Crankshaft Revolution Sensor
77 Bolt
78 Connecting Rod Bearings
79 Main Bearing Cap Bolts
80 Connecting Rod
81 Connecting Rod Cap


C102C003

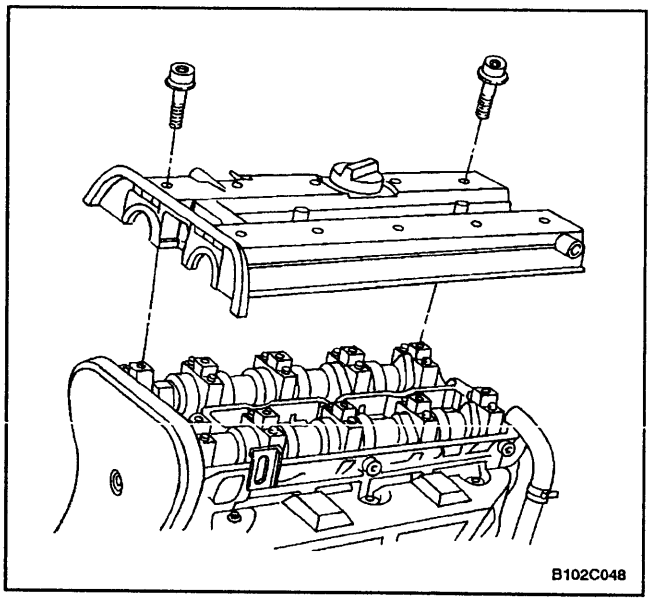
MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

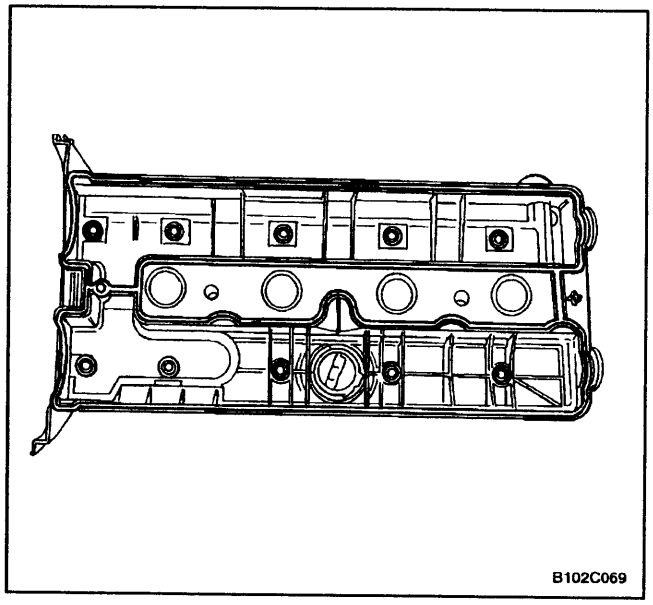
VALVE COVER

Removal Procedure

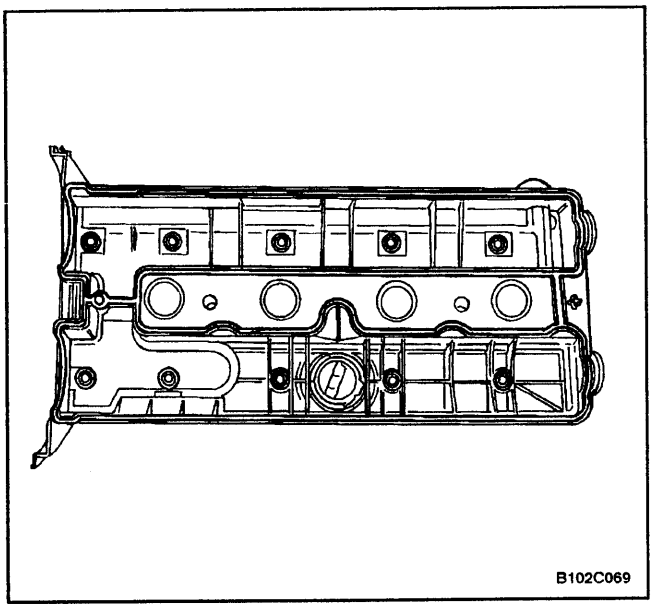
1. Disconnect the negative battery cable.
2. Disconnect the breather tube from the valve cover.
3. Disconnect all of the necessary vacuum lines.
4. Remove the spark plug cover bolts.
5. Remove the spark plug cover.
6. Disconnect the ignition wires from the spark plugs.
7. Remove the power steering hose clamp bolt and position power steering hose clamp clear of the repair area.


B102C048

8. Remove the valve cover bolts.
9. Remove the valve cover washers.
10. Remove the valve cover.

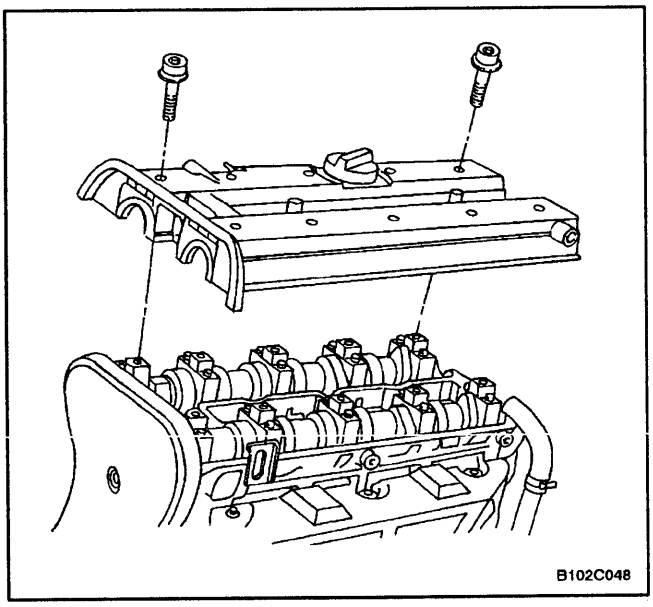

B102C069

11. Remove the valve cover gasket from the valve cover.


B102C069

Installation Procedure

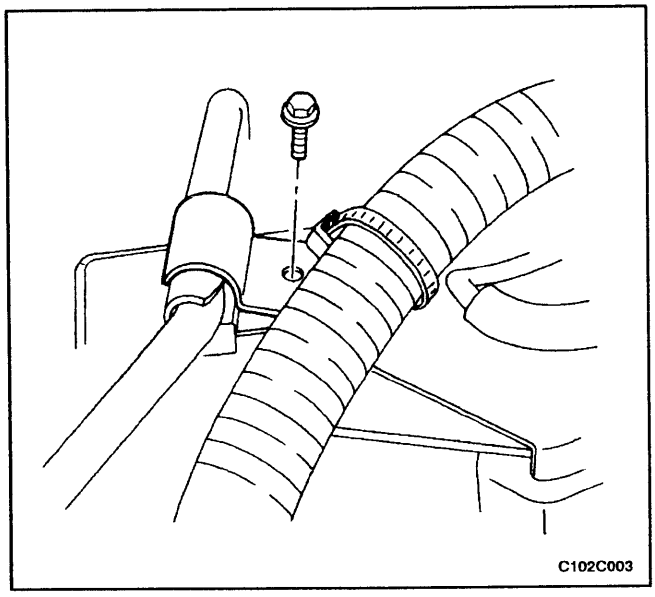
1. Apply a small amount of gasket sealant to the corners of the front camshaft caps and the top of the rear valve cover-to-cylinder head seal.
2. Install the new valve cover gasket to the valve cover.


B102C048

3. Install the valve cover.
4. Install the valve cover washers.
5. Install the valve cover bolts.

Tighten

Tighten the valve cover bolts to 8 N•m (71 lb-in).


C102C003

6. Connect the ignition wires to the spark plugs.
7. Install the spark plug cover.
8. Install the spark plug cover bolts.

Tighten

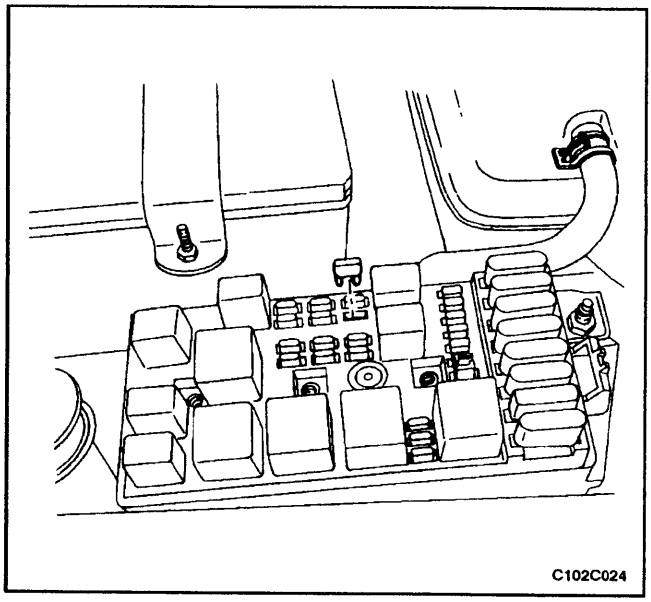
Tighten the spark plug cover bolts to 3 N•m (27 lb-in).

9. Connect all of the necessary vacuum lines.
10. Connect the breather tube to the valve cover.
11. Position the power steering pressure hose in place and install the bolt.

Tighten

Tighten the power steering hose clamp bolt to 8 N•m (71 lb-in).

12. Connect the negative battery cable.


C102C024

CYLINDER HEAD AND GASKET

(Left-Hand Drive Shown, Right-Hand Drive Similar)

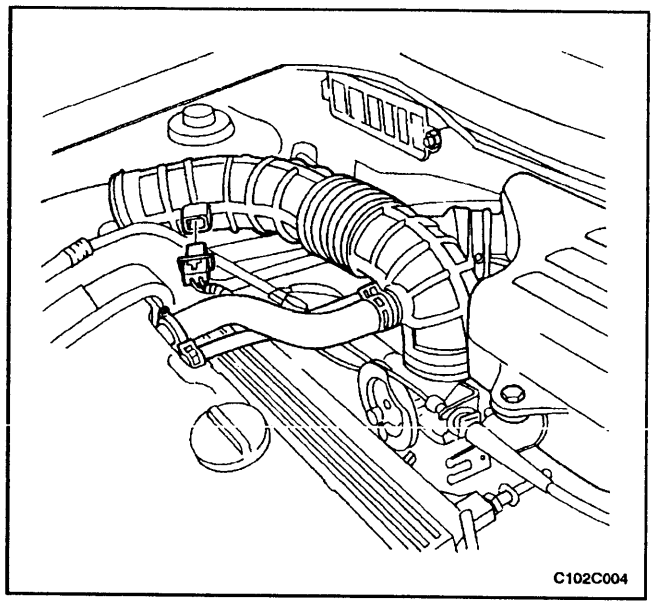
Tools Required

KM-470-B Angular Torque Gauge

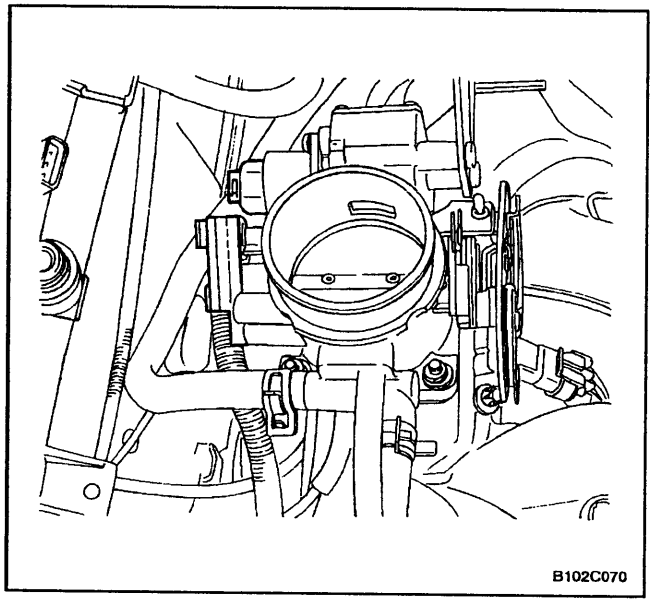
J-28467-B Engine Assembly Lift Support

Removal Procedure

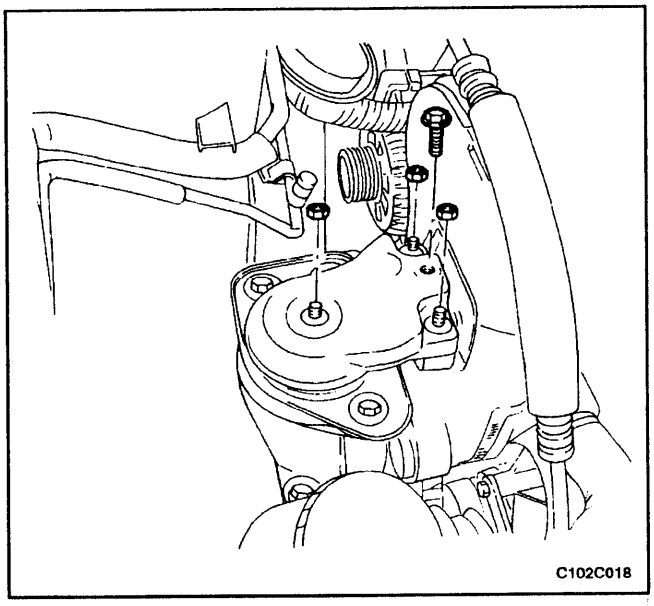
1. Remove the fuel pump fuse.
2. Start the engine. After it stalls, crank the engine for 10 seconds to rid the fuel system of fuel pressure.
3. Disconnect the negative battery cable.
4. Disconnect the electronic control module (ECM) ground terminal
5. Drain the engine coolant. Refer to *Section 1D, Engine Cooling.*


C102C004

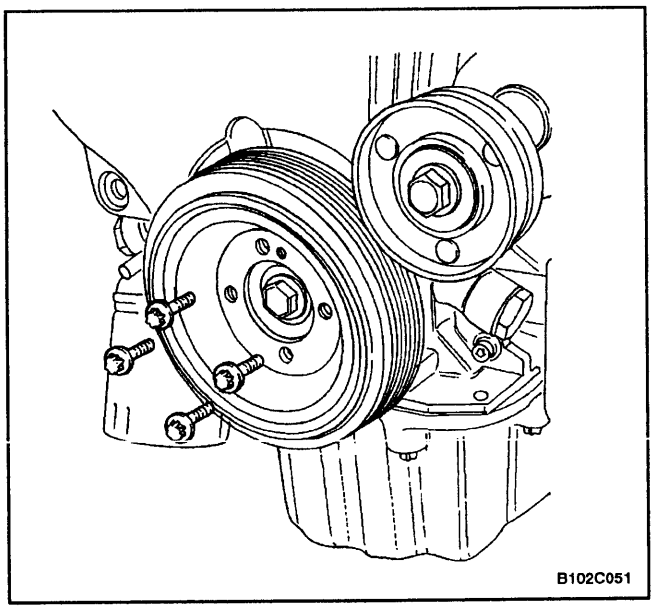
6. Disconnect the manifold air temperature sensor connector.
7. Disconnect the breather tube from the valve cover.
8. Remove the resonator retaining bolts and the resonator.
9. Remove the air intake tube.
10. Remove the canister purge and the exhaust gas recirculation (EGR) solenoids bracket bolt and reposition the cannister purge and the EGR solenoids clear of the repair area.


B102C070

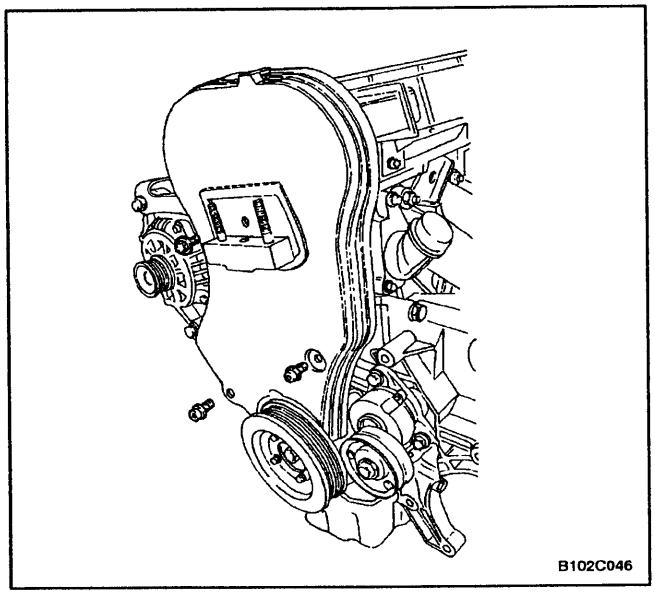
11. Disconnect the direct ignition system (DIS) ignition coil connector.
12. Disconnect the oxygen sensor connector.
13. Disconnect the idle air control valve connector.
14. Disconnect the throttle position sensor connector.
15. Disconnect the engine coolant temperature sensor connector.
16. Disconnect the coolant temperature sensor connector.


C102C018

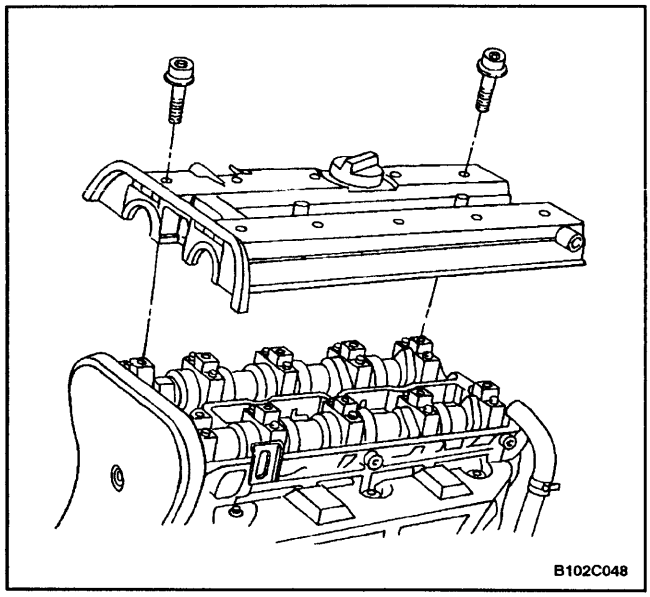
17. Remove the air filter housing bolts.
18. Remove the air filter housing.
19. Remove the right front wheel. Refer to *Section 2E, Tires and Wheels*.
20. Remove the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
21. Install the engine assembly lift support J-28467-B.
22. Remove the right engine mount bracket and the bolts.


B102C051

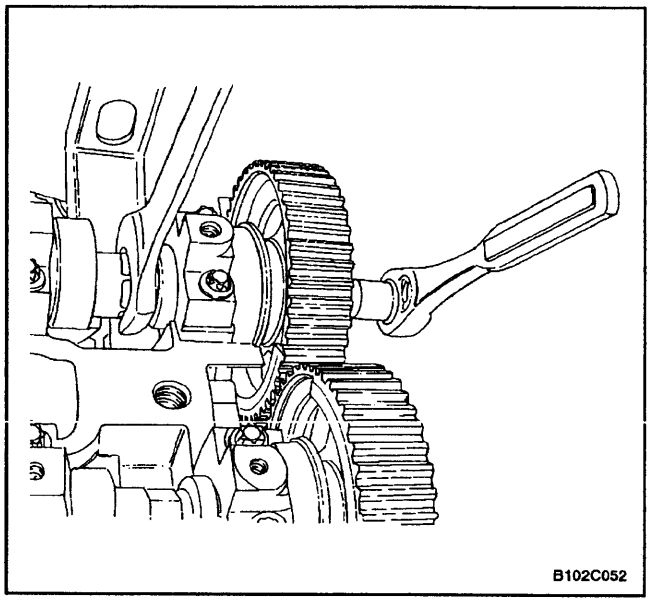
23. Disconnect the upper radiator hose at the thermostat housing.
24. Remove the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*
25. Remove the crankshaft pulley bolts.
26. Remove the crankshaft pulley.


B102C046

27. Remove the front timing belt cover bolts.
28. Remove the front timing belt cover.

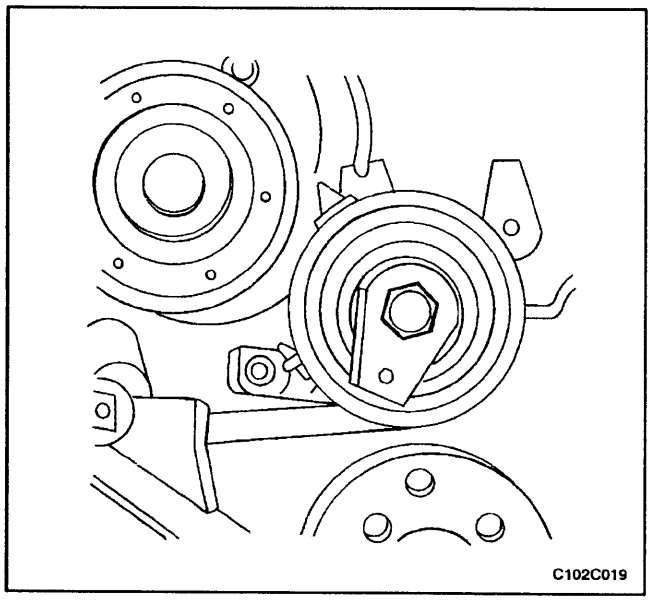

B102C048

29. Remove the timing belt. Refer to "Timing Belt" in this section.
30. Disconnect the breather tube at the valve cover.
31. Remove the spark plug cover bolts.
32. Remove the spark plug cover.
33. Disconnect the ignition wires from the spark plugs.
34. Remove the valve cover bolts.
35. Remove the valve cover washers.
36. Remove the valve cover and the valve cover gasket.

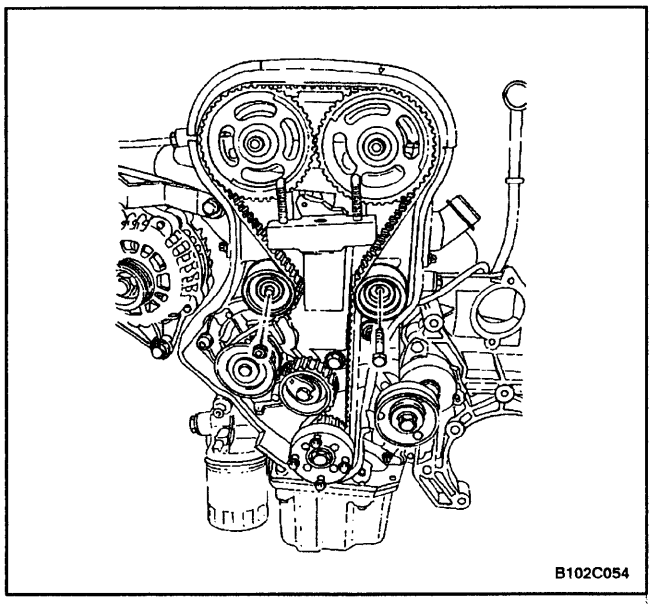

B102C052

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

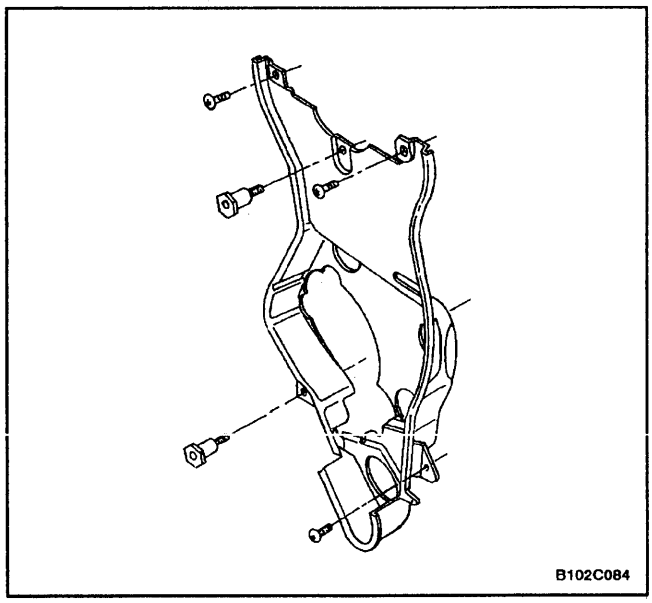
37. While holding the intake camshaft firmly in place, remove the intake camshaft gear bolt.
38. Remove the intake camshaft gear.
39. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft gear bolt.
40. Remove the exhaust camshaft gear.


C102C019

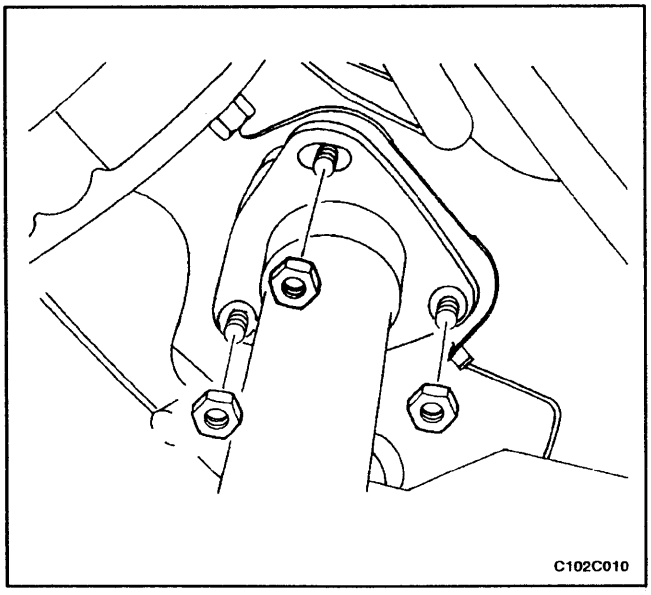
41. Remove the timing belt automatic tensioner bolts.
42. Remove the timing belt automatic tensioner.


B102C054

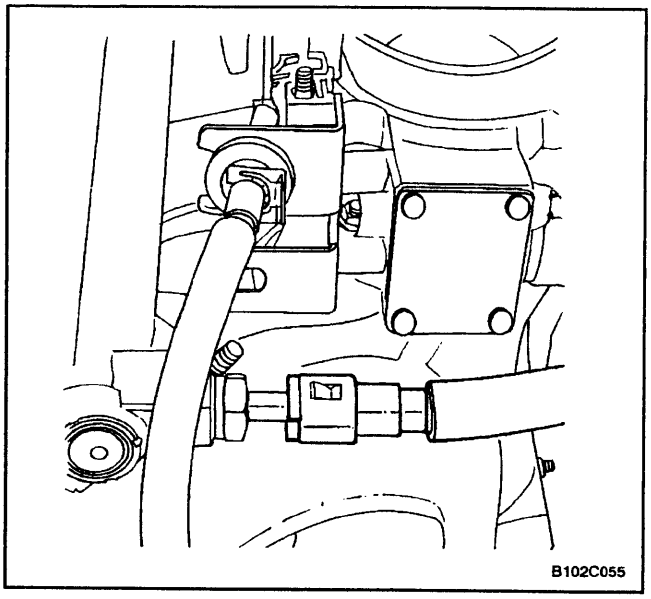
43. Remove the timing belt idler pulley nuts.
44. Remove the timing belt idler pulleys.
45. Remove the engine mount bolts.
46. Remove the engine mount.


B102C084

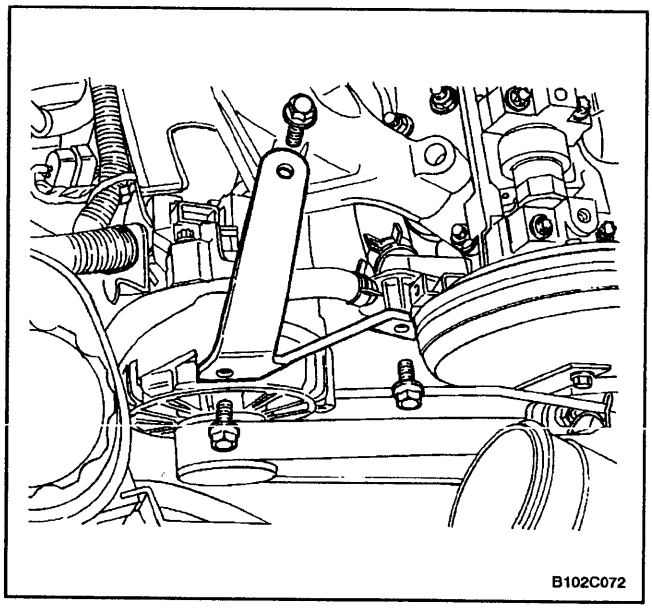
47. Remove the rear timing belt cover bolts.
48. Remove the rear timing belt cover.


C102C010

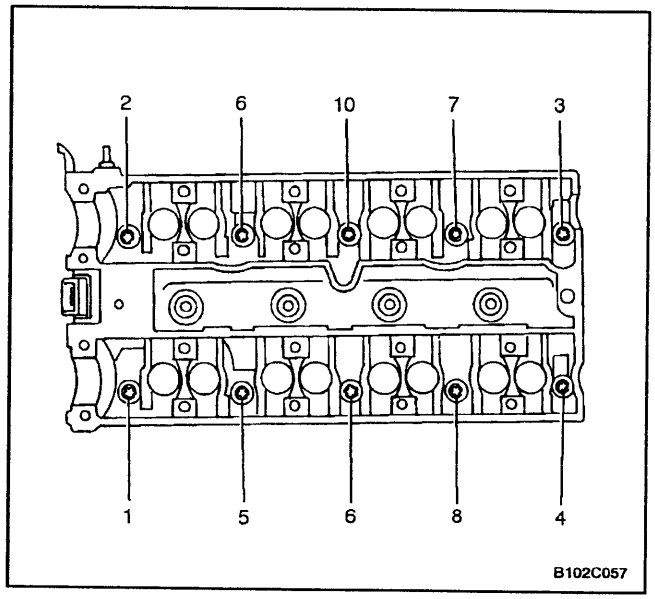
49. Remove the exhaust flex pipe retaining nuts from the exhaust manifold studs.
50. Disconnect all of the necessary vacuum hoses.


B102C055

51. Disconnect the fuel return line at the fuel pressure regulator.
52. Disconnect the fuel feed line at the fuel rail.
53. Disconnect the coolant hose at the rear cylinder head and ignition coil EGR bracket.
54. Disconnect the surge tank coolant hose at the throttle body.
55. Remove the fuel rail assembly. Refer to *Section 1F, Engine Controls.*


B102C072

56. Remove the alternator-to-intake manifold support bracket bolts at the cylinder head coolant bypass and the intake manifold.
57. Remove the alternator support bracket.
58. Remove the intake manifold-to-alternator strap bracket bolt and loosen the bolt on the alternator.
59. Move the strap clear of the intake manifold.

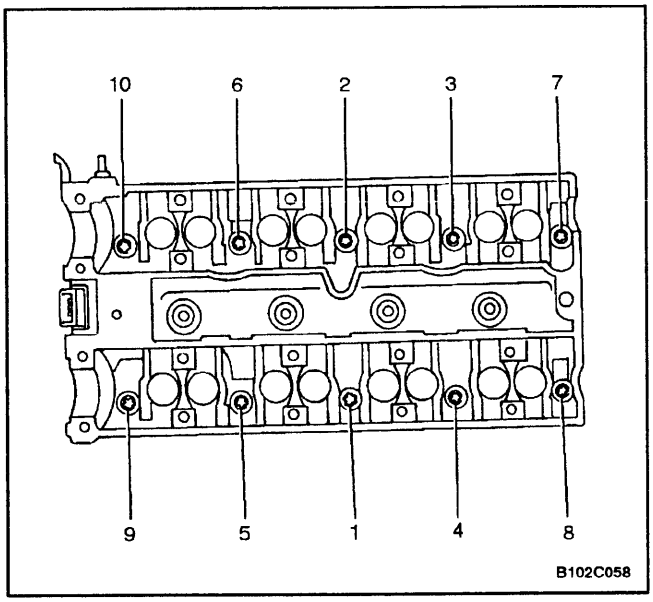


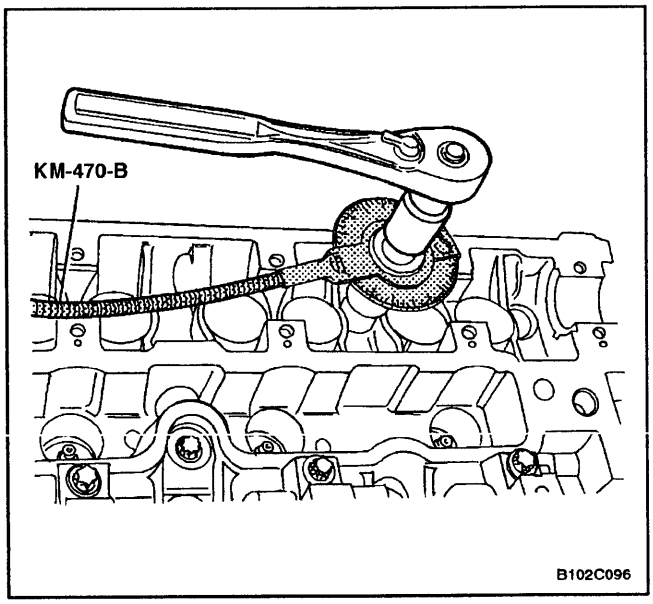
B102C057

60. Disconnect the throttle cable at the throttle body and the intake manifold.
61. Loosen all of the cylinder head bolts gradually and in the sequence shown.
62. Remove the cylinder head bolts.
63. Remove the cylinder head with the intake manifold and the exhaust manifold attached.

Notice: Prevent any engine oil or coolant from entering the cylinders when removing the cylinder head.

64. Remove the cylinder head gasket.





Cleaning Procedure

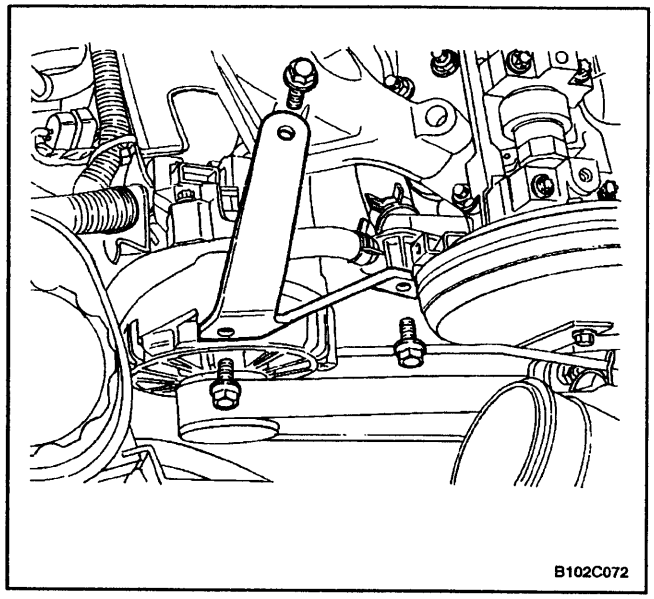
1. Clean the gasket surfaces of the cylinder head and the engine block.
2. Make sure the gasket surfaces of the cylinder head and the engine block are free of nicks and heavy scratches.
3. Clean the cylinder head bolts.
4. Inspect the cylinder head for warpage. Refer to "Cylinder Head and Valve Train Components" in this section.

Installation Procedure

1. Install the cylinder head gasket.
2. Install the cylinder head with the intake manifold and the exhaust manifold attached.
3. Install the cylinder head bolts.
4. Tighten the cylinder head bolts gradually and in the sequence shown.

Tighten

Tighten the cylinder head bolts to 25 N•m (18 lb-ft). After an engine warm-up of 30 to 50 minutes, turn the bolts another 3 turns of 90 degrees and 1 turn of 15 degrees, using the angular torque gauge KM-470-B.


B102C072

5. Connect the throttle cable at the throttle body and the intake manifold.
6. Install the alternator-to-intake manifold support bracket.
7. Install the alternator-to-intake manifold support bracket bolts.

Tighten

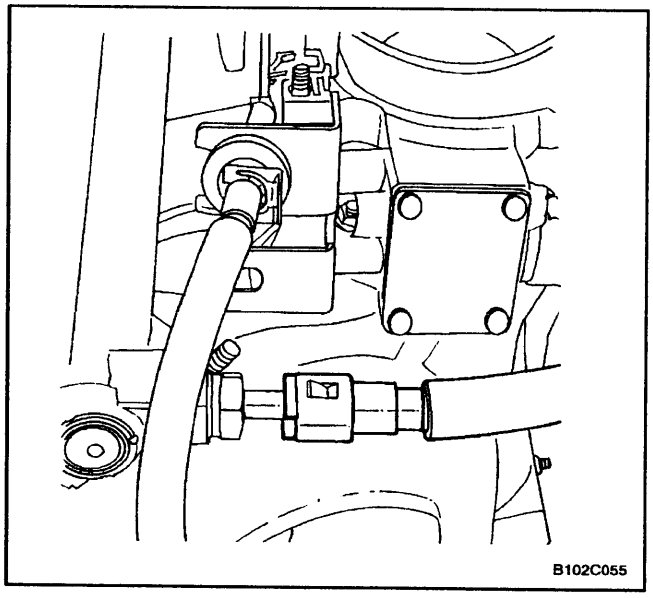
Tighten the alternator-to-intake manifold support bracket bolts to 35 N•m (26 lb-ft).

8. Install the intake manifold strap bracket bolts to the alternator.

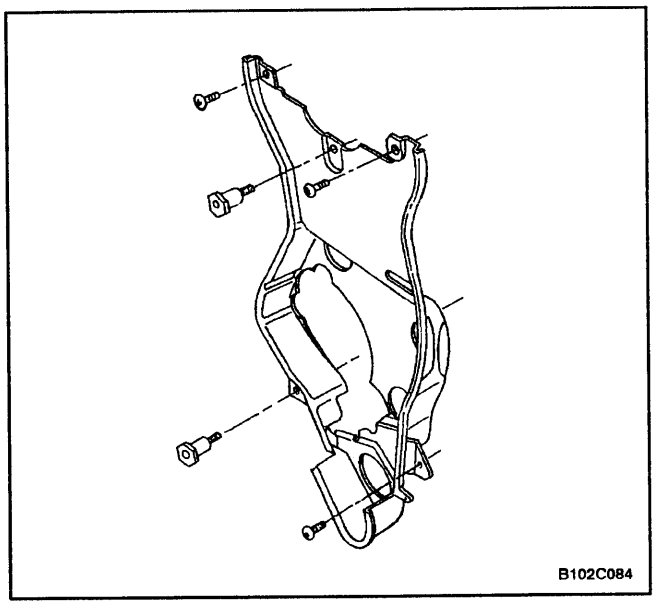
Tighten

Tighten the alternator-to-intake manifold strap bracket bolts to 20 N•m (15 lb-ft).

9. Connect the surge tank coolant hose at the throttle body.
10. Connect the coolant hose to the rear cylinder head and ignition coil EGR bracket.


B102C055

11. Connect the fuel feed line at the fuel rail.
12. Connect the fuel return line at the fuel rail.
13. Connect all of the necessary vacuum hoses.
14. Install the fuel rail assembly. Refer to *Section 1F, Engine Controls.*


B102C084

15. Install the exhaust flex pipe retaining nuts to the exhaust manifold studs.

Tighten

Tighten the exhaust flex pipe-to-exhaust manifold retaining nuts to 22 N•m (16 lb-ft).

16. Install the rear timing belt cover.
17. Install the rear timing belt cover bolts.

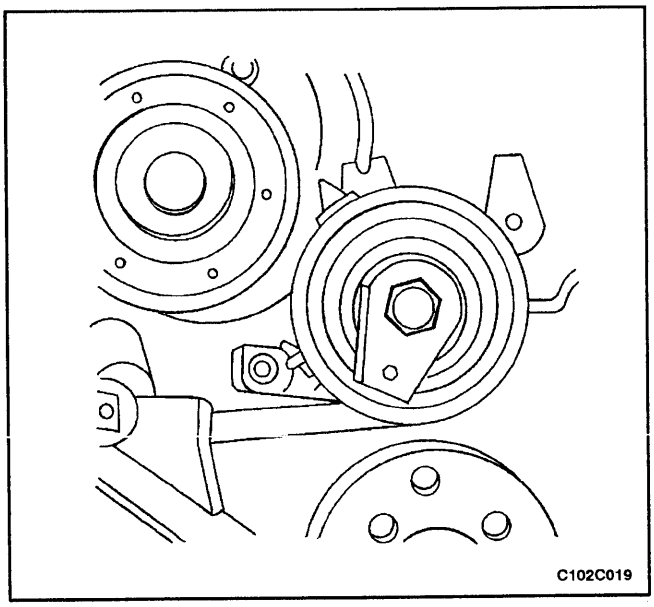
Tighten

Tighten the rear timing belt cover bolts to 10 N•m (89 lb-in).

18. Install the engine mount bolts.

Tighten

Tighten the engine mount bolts to 60 N•m (44 lb-ft).


C102C019

19. Install the timing belt automatic tensioner.
20. Install the timing belt automatic tensioner bolt.

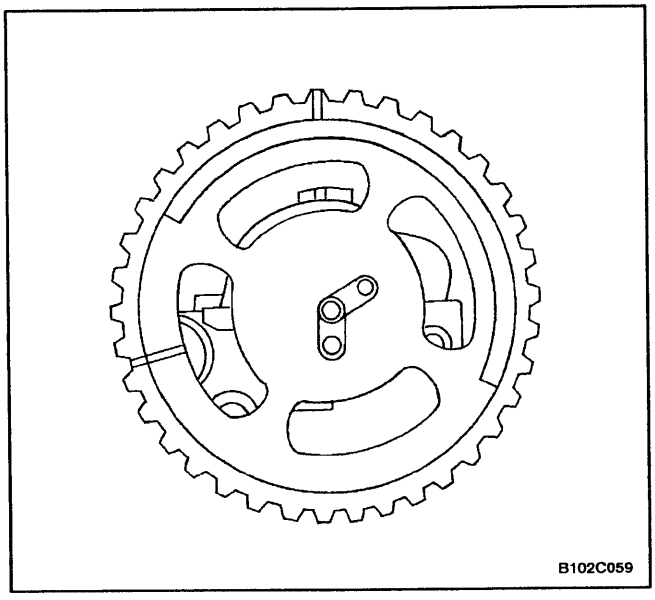
Tighten

Tighten the timing belt automatic tensioner bolt to 25 N•m (18 lb-ft).

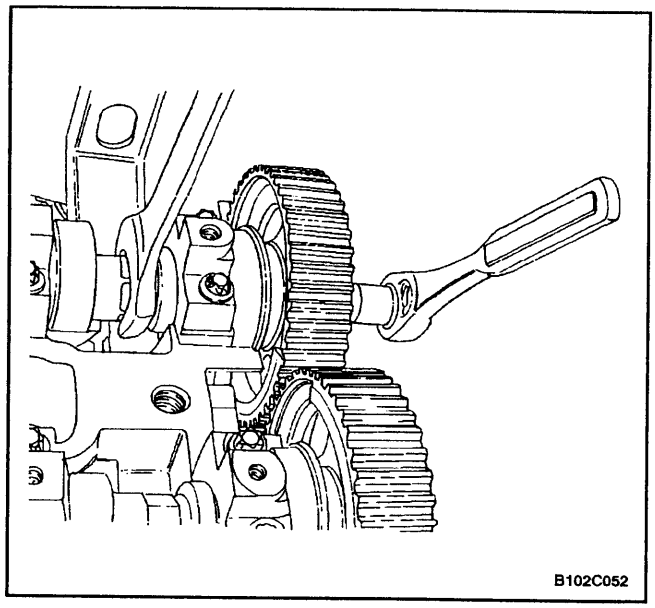
21. Install the timing belt idler pulleys.
22. Install the timing belt idler pulley nuts.

Tighten

Tighten the timing belt idler pulley nuts to 25 N•m (18 lb-ft).


B102C059

23. Install the camshaft gears with the timing marks at the front.
24. Insert the guide pin of the intake camshaft into the "IN" bore.
25. Insert the guide pin of the exhaust camshaft into the "EX" bore.



B102C052

26. Install the camshaft gears by counterholding on the hex of the camshaft with an open end wrench.
27. Install the camshaft gear with a new bolt to the camshaft.

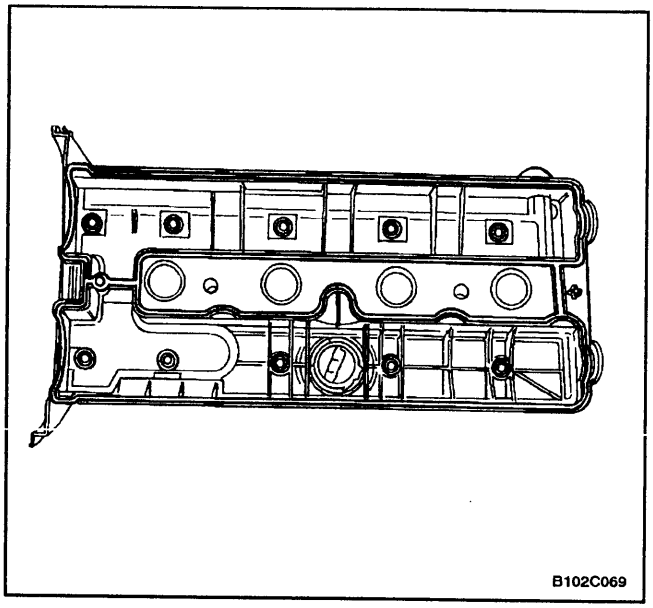
Tighten

Tighten the intake camshaft gear bolt to 50 N•m (37 lb-ft), turn the bolt another 60 degrees and 15 degrees using the angular torque gauge.

28. While holding the exhaust camshaft firmly in place, install the exhaust camshaft gear bolt.

Tighten

Tighten the exhaust camshaft gear bolt to 50 N•m (37 lb-ft), turn the bolt another 60 degrees and 15 degrees using the angular torque gauge.

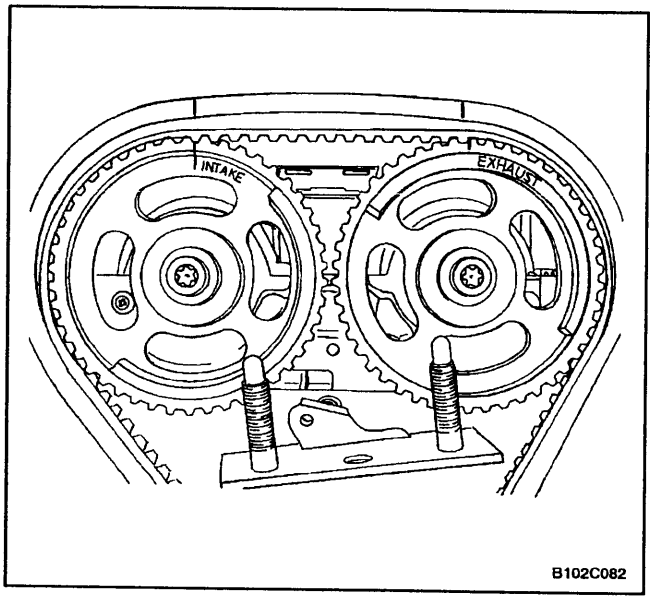


B102C069

29. Apply a small amount of gasket sealant to the corners of the front camshaft caps and to the top of the rear valve cover-to-cylinder head seal.
30. Install the valve cover and the valve cover gasket.
31. Install the valve cover washers.
32. Install the valve cover bolts.

Tighten

Tighten the valve cover bolts to 8 N•m (71 lb-in).



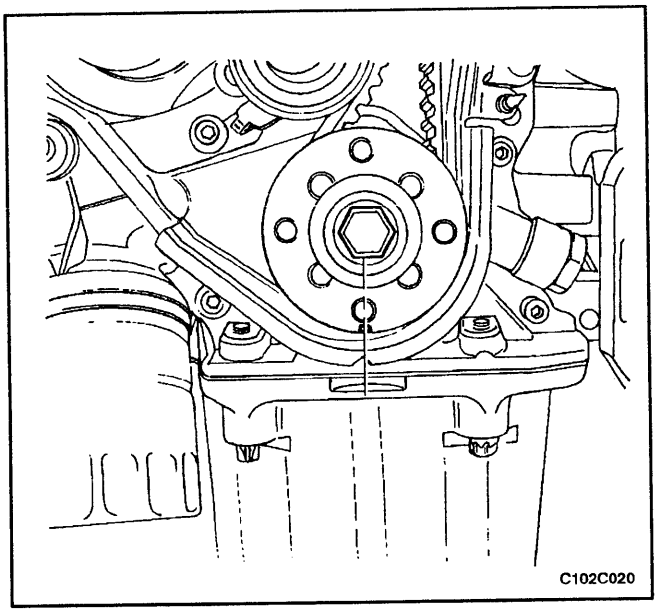
B102C082

33. Connect the ignition wires to the spark plugs.
34. Install the spark plug cover.
35. Install the spark plug cover bolts.

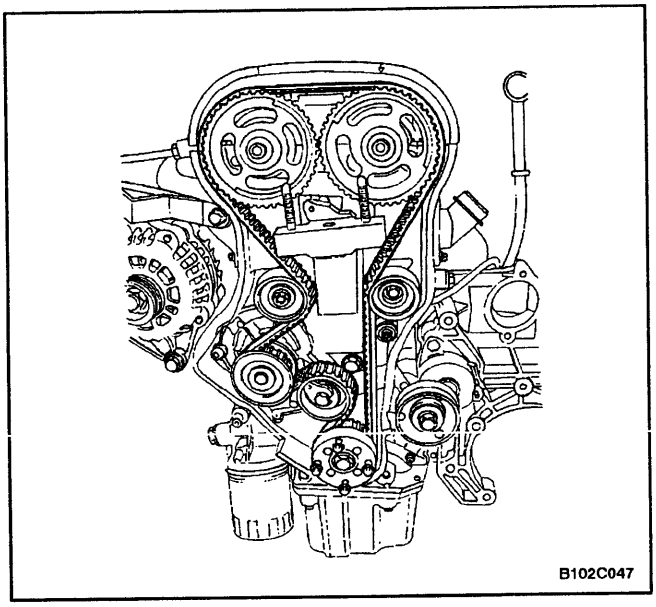
Tighten

Tighten the spark plug cover bolts to 3 N•m (27 lb-in).

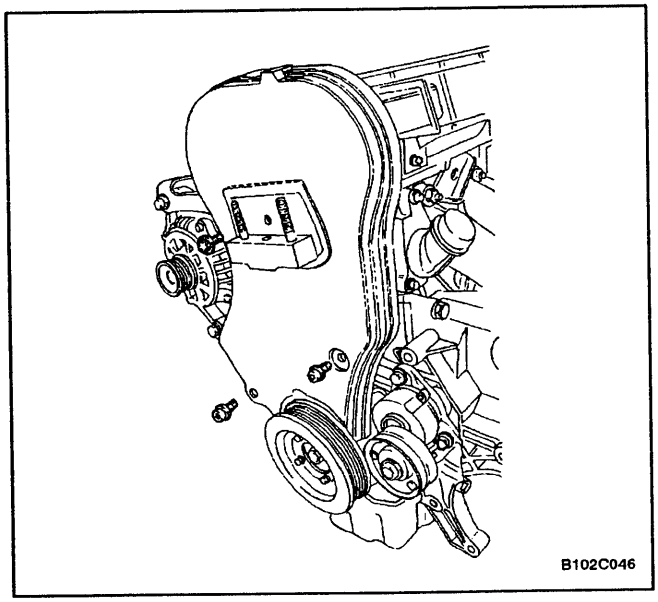
36. Connect the breather tube to the valve cover.
37. Align the timing marks on the camshaft gears to the notches on the valve cover, using the intake gear mark for the intake gear and the exhaust gear mark for the exhaust gear.


C102C020

38. Align the mark on the crankshaft gear with the notch at the bottom of the rear timing belt cover.


B102C047

39. Install the timing belt. Refer to "Timing Belt" in this section.
40. Check and adjust the timing belt tension. Refer to "Timing Belt Check and Adjust" in this section.


B102C046

41. Install the front timing belt cover.
42. Install the front timing belt cover bolts.

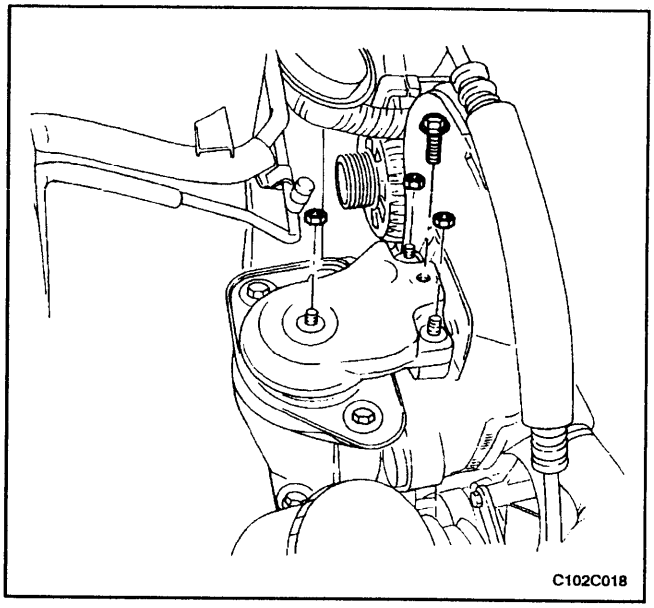
Tighten

Tighten the front timing belt cover bolts to 8 N•m (71 lb-in).

43. Install the crankshaft pulley.
44. Install the crankshaft pulley bolts.

Tighten

Tighten the crankshaft pulley bolts to 20 N•m (15 lb-ft).

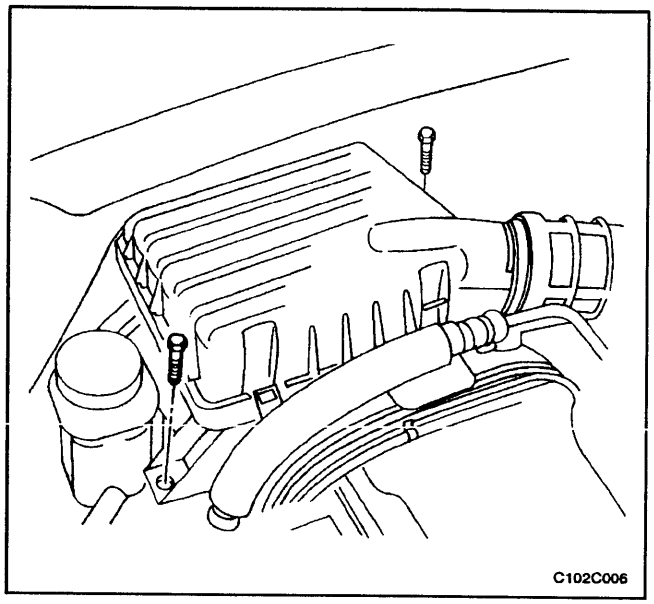

C102C018

45. Install the right engine mount bracket, the retaining bolts, and the nut.

Tighten

Tighten the engine mount bolts to 60 N•m (44 lb-ft).

46. Remove the engine assembly lift support J-28467-B.
47. Install the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*
48. Connect the upper radiator hose to the thermostat housing.
49. Install the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
50. Install the right front wheel. Refer to *Section 2E, Tires and Wheels.*


C102C006

51. Install the air filter housing.
52. Install the air filter housing bolts.

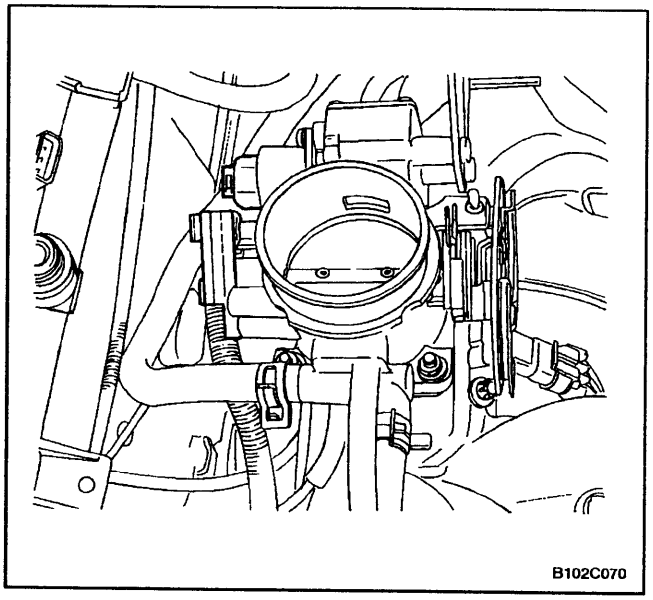
Tighten

Tighten the air filter housing bolts to 8 N•m (71 lb-in).

53. Connect the air intake tube to the throttle body.
54. Connect the breather tube to the valve cover.
55. Connect the manifold air temperature sensor connector.
56. Install the resonator and the retaining bolts.

Tighten

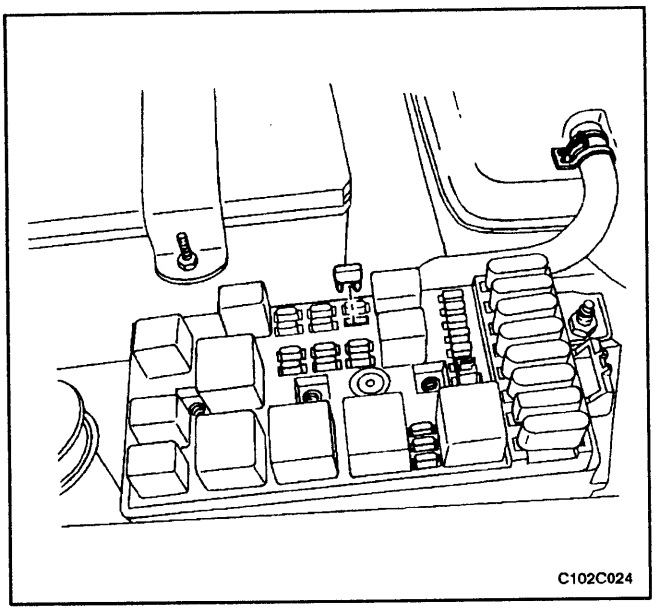
Tighten the resonator retaining bolts to 8 N•m (71 lb-in).


B102C070

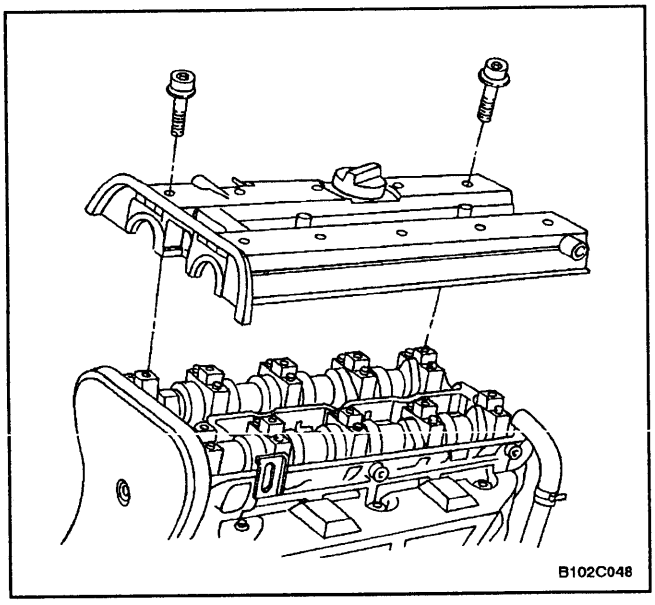
57. Connect the coolant temperature sensor connector.
58. Connect the engine coolant temperature sensor connector.
59. Connect the idle air control valve connector.
60. Connect the throttle position sensor connector.
61. Install the canister purge and the EGR solenoids bracket bolt.

Tighten

Tighten the canister purge and the EGR solenoids bracket bolt to 5 N•m (44 lb-in).


C102C024

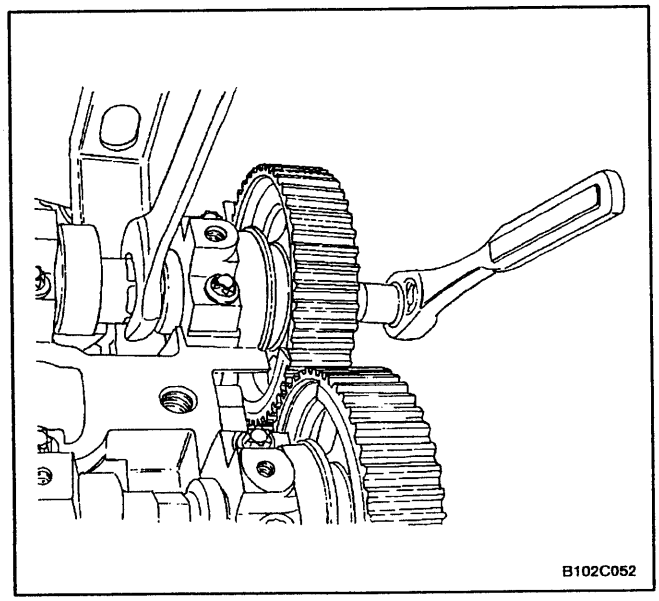
62. Connect the DIS ignition coil connector.
63. Connect the oxygen sensor connector.
64. Connect the ECM ground terminal.
65. Install the fuel pump fuse.
66. Connect the negative battery ground cable.
67. Refill the engine cooling system. Refer to *Section 1D, Engine Cooling.*


B102C048

CAMSHAFTS

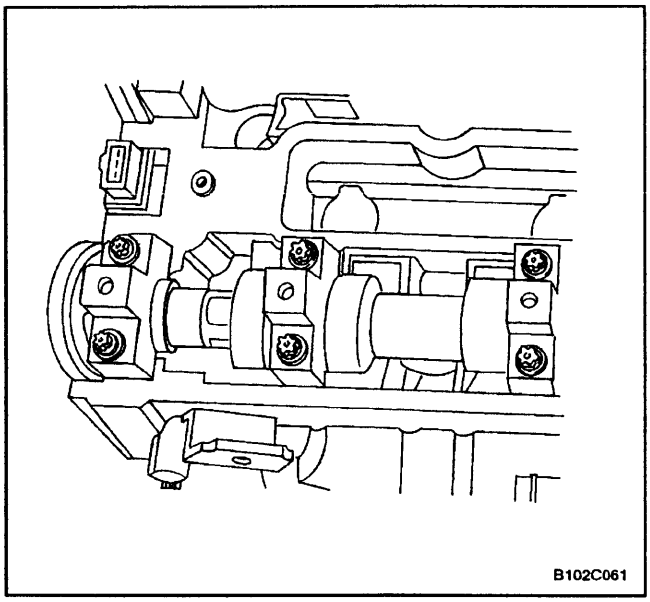
Removal Procedure

1. Remove the timing belt. Refer to "Timing Belt" in this section.
2. Disconnect the breather tube at the valve cover.
3. Disconnect the crankcase ventilation tube at the valve cover.
4. Remove the spark plug cover bolts.
5. Remove the spark plug cover.
6. Disconnect the ignition wires from the spark plugs.
7. Remove the valve cover bolts.
8. Remove the valve cover washers.
9. Remove the valve cover and the valve cover gasket.


B102C052

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

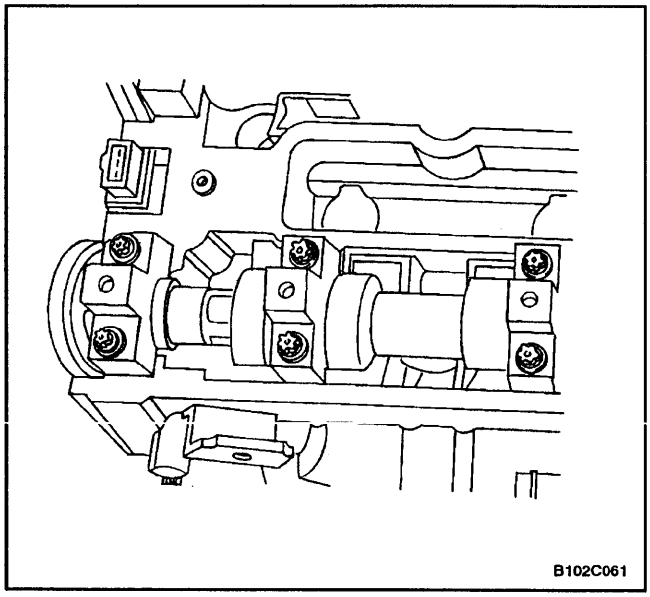
10. While holding the intake camshaft firmly in place, remove the intake camshaft gear bolt.
11. Remove the intake camshaft gear.
12. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft gear bolt.
13. Remove the exhaust camshaft gear.


B102C061

14. Loosen the camshaft bearing cap bolts in stages of one-half to one turn.
15. Remove the camshaft bearing cap bolts from the cylinder head.
16. Remove the camshafts.
17. Remove the seal ring from the camshafts.

Important: The camshaft must detach evenly from the bearing seats in the front guide bearing.

18. Check the camshaft and bearing seats for wear and replace them if necessary.


B102C061

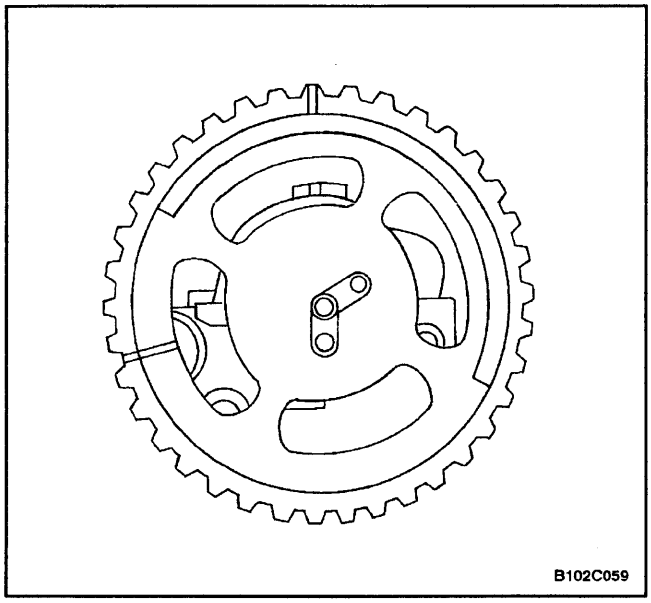
Installation Procedure

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

1. Lubricate the camshaft journals and the camshaft caps with engine oil.
2. Install the intake camshaft.
3. Install the intake camshaft caps in their original positions.
4. Install the intake camshaft cap bolts.
5. Install the exhaust camshaft.
6. Install the exhaust camshaft caps in their original positions.
7. Install the exhaust camshaft cap bolts.
8. Tighten the camshaft cap bolts gradually.

Tighten

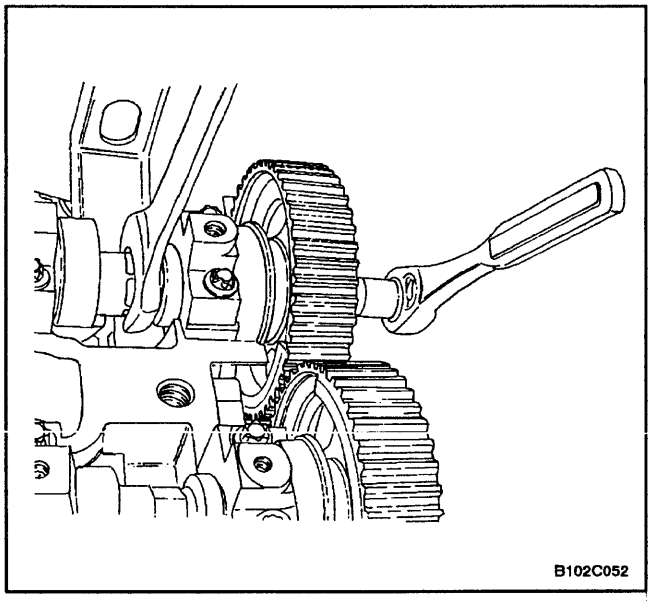
Tighten the camshaft bearing cap bolts to 8 N•m (71 lb-in).


B102C059

9. Measure the intake camshaft end play and the exhaust camshaft end play. Refer to "Engine Specifications" in this section.
10. Install the intake camshaft gear.
11. While holding the intake camshaft firmly in place, install the intake camshaft gear bolt.

Tighten

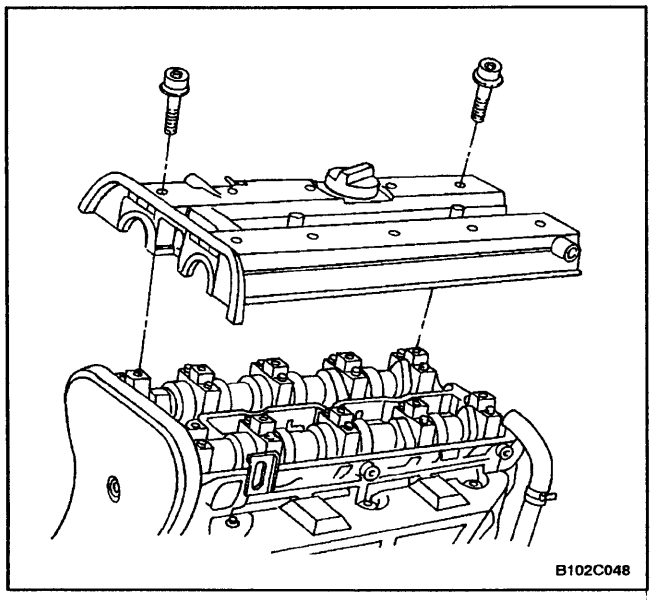
Tighten the intake camshaft gear bolt to 50 N•m (37 lb-ft), turn the bolt another 60 degrees and 15 degrees using the angular torque gauge.


B102C052

12. Install the exhaust camshaft gear.
13. While holding the exhaust camshaft firmly in place, install the exhaust camshaft gear bolt.

Tighten

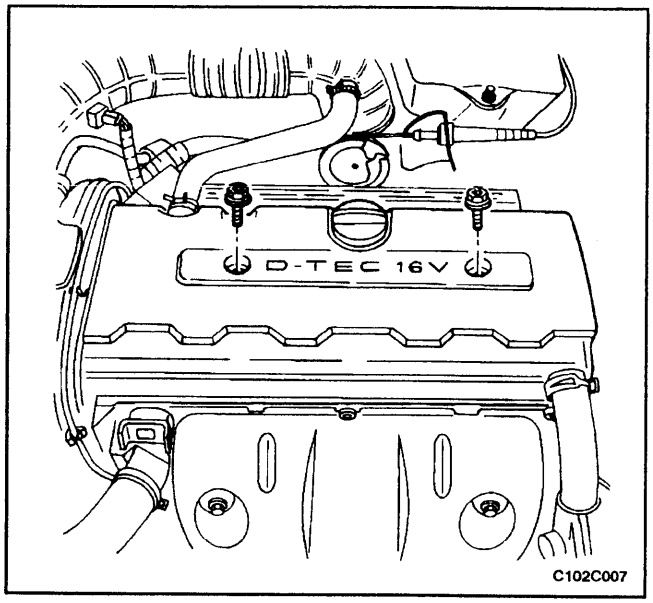
Tighten the exhaust camshaft gear bolt to 50 N•m (37 lb-ft), turn the bolt another 60 degrees and 15 degrees using the angular torque gauge.


B102C048

14. Install the valve cover and the valve cover gasket.
15. Install the valve cover washers.
16. Install the valve cover bolts.

Tighten

Tighten the valve cover bolts to 8 N•m (71 lb-in).

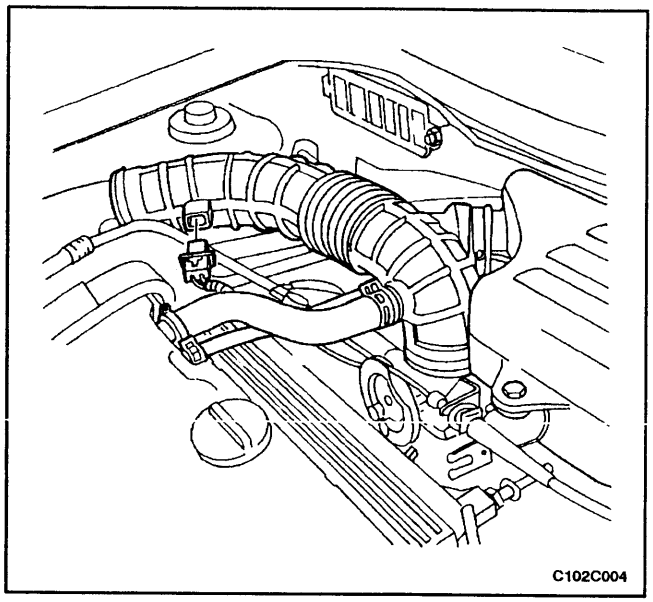


17. Connect the ignition wires to the spark plugs.
18. Install the spark plug cover.
19. Install the spark plug cover bolts.

Tighten

Tighten the spark plug cover bolts to 3 N•m (27 lb-in).

20. Connect the breather tube to the valve cover.
21. Connect the crankcase ventilation tube to the valve cover.
22. Install the timing belt. Refer to "Timing Belt" in this section.

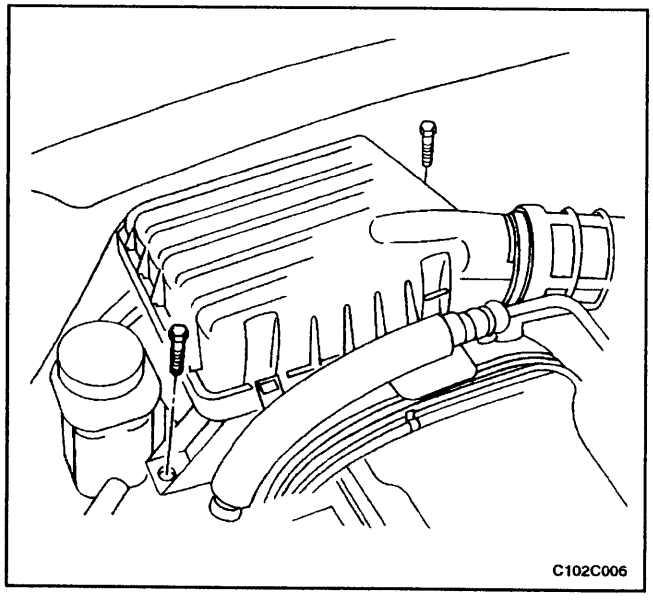


TIMING BELT CHECK AND ADJUST

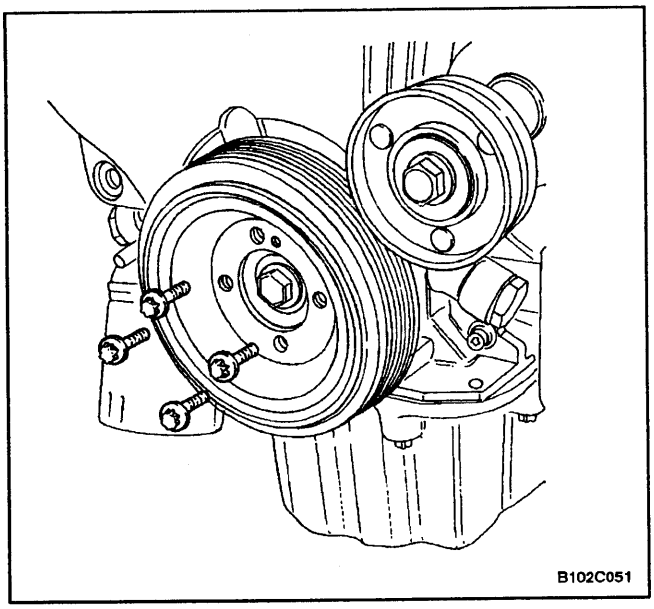
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Adjustment Procedure

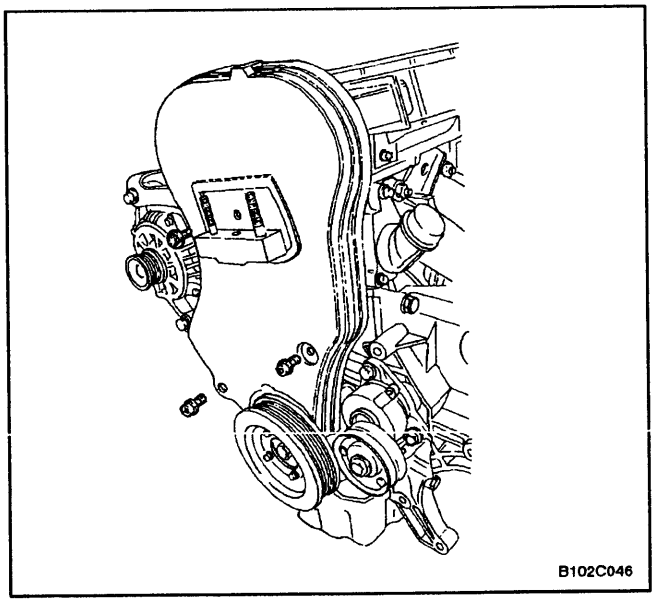
1. Disconnect the negative battery cable.
2. Disconnect the manifold air temperature sensor connector.
3. Remove the air intake tube from the throttle body.
4. Remove the breather tube from the valve cover.



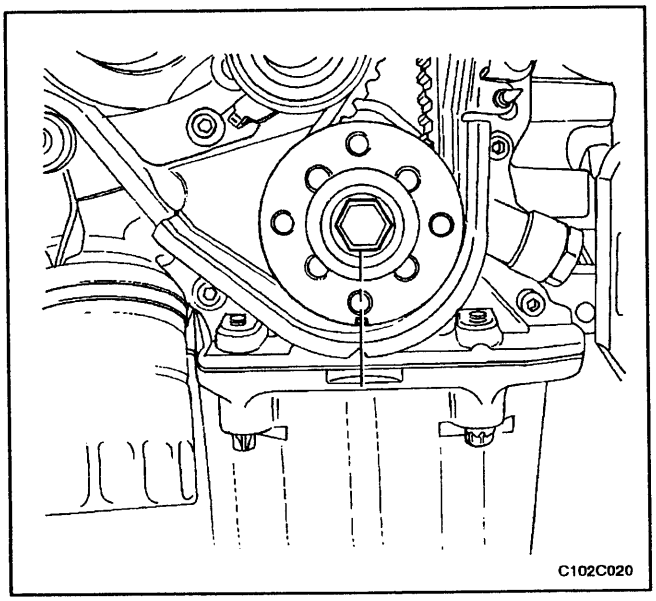
5. Remove the air filter housing bolts.
6. Remove the air filter housing.
7. Remove the right front wheel. Refer to *Section 2E, Tires and Wheels.*
8. Remove the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*


B102C051

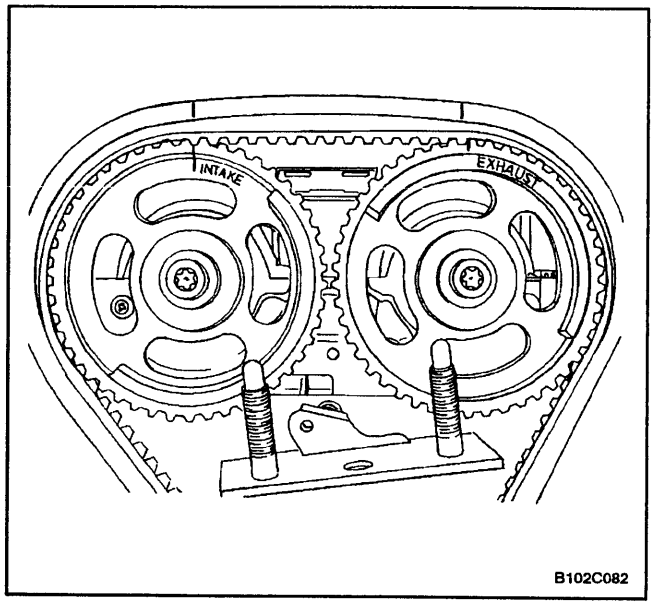
9. Remove the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*
10. Remove the crankshaft pulley bolts.
11. Remove the crankshaft pulley.
12. Remove the right engine mount bracket. Refer to "Engine Mount" in this section.


B102C046

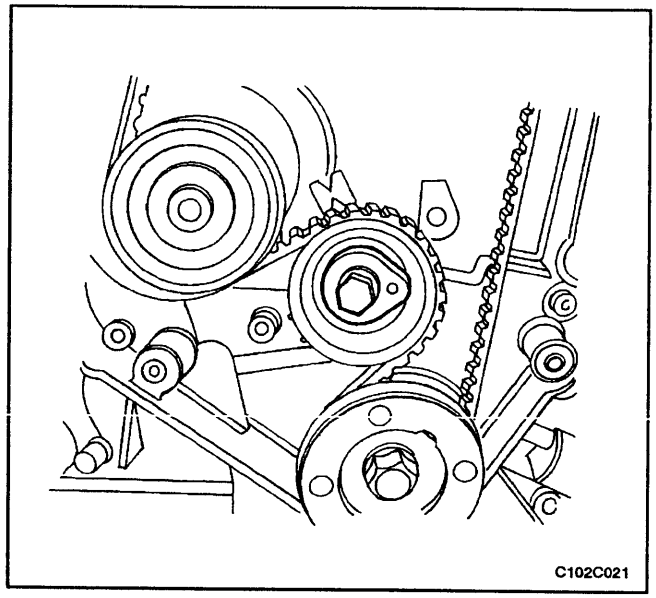
13. Remove the front timing belt cover bolts.
14. Remove the front timing belt cover.


C102C020

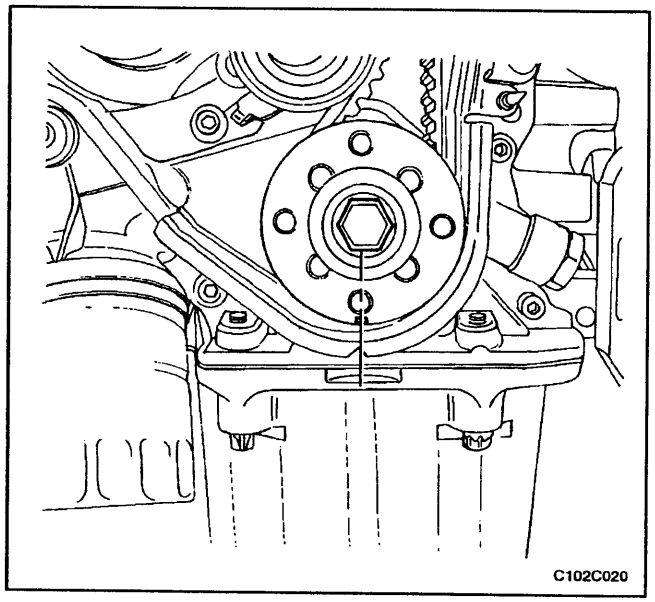
15. Rotate the crankshaft at least one full turn clockwise using the crankshaft gear bolt.
16. Align the mark on the crankshaft gear with the notch at the bottom of the rear timing belt cover.



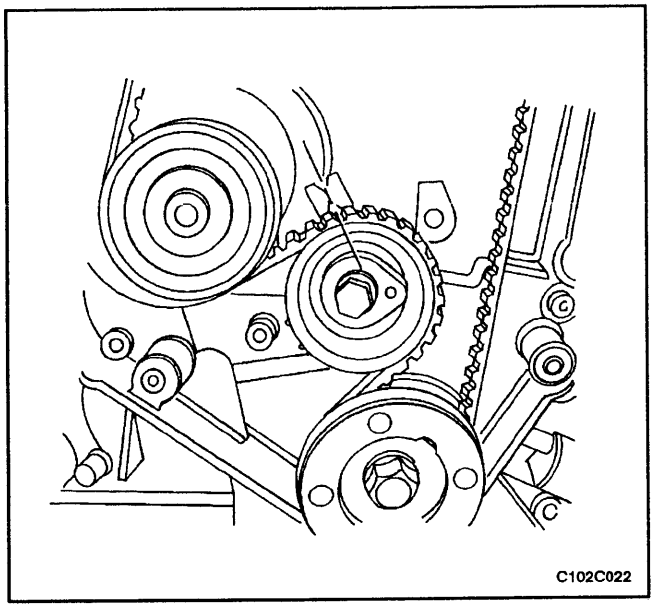
17. Align the camshaft gear timing marks. Use the exhaust gear mark for the exhaust gear and the intake gear mark for the intake gear, since the gears are interchangeable.



18. Loosen the automatic tensioner bolt. To tighten the belt tension, turn the hex-key tab counterclockwise.
19. Rotate the automatic tensioner hex-key tab clockwise until the adjust arm pointer of the timing belt automatic tensioner is aligned with the notch in the timing belt automatic tensioner bracket.



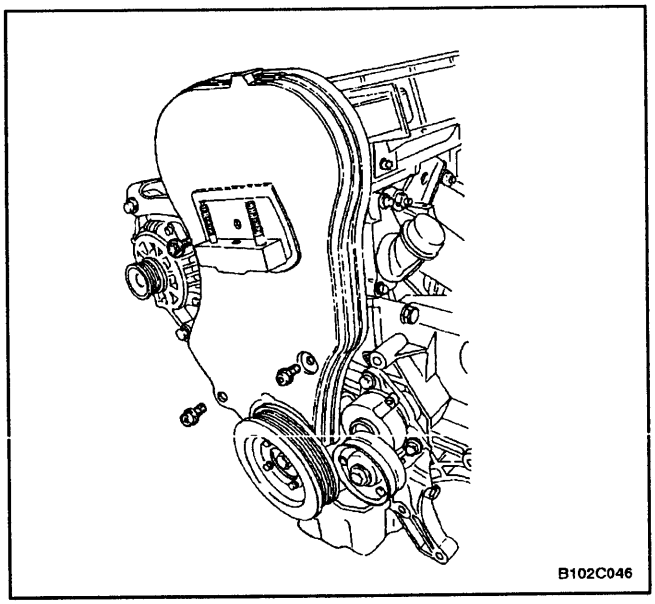
20. Tighten the automatic tensioner bolt.
21. Rotate the crankshaft two full turns clockwise using the crankshaft gear bolt.
22. Check the automatic tensioner pointer.


C102C022

23. When the adjust arm pointer of the timing belt automatic tensioner is aligned with the notch on the timing belt automatic tensioner bracket, the belt is tensioned correctly.

Tighten

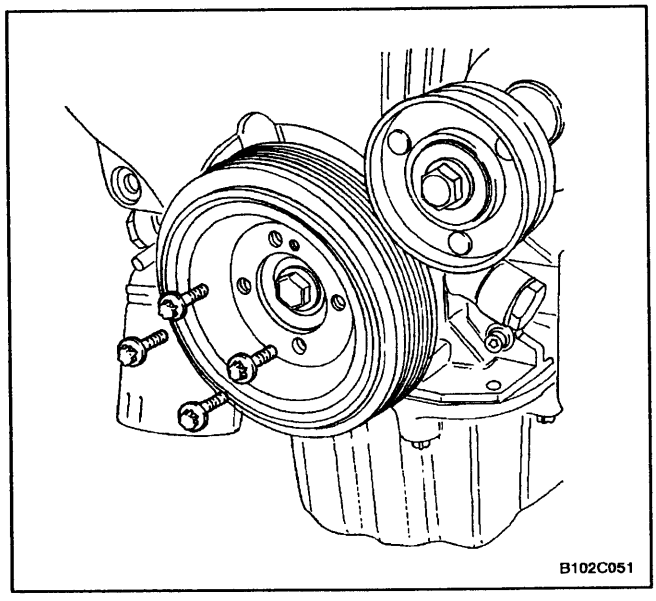
Tighten the timing belt automatic tensioner bolt to 25 N•m (18 lb-ft).


B102C046

24. Install the front timing belt cover.
25. Install the front timing belt cover bolts.

Tighten

Tighten the front timing belt cover bolts to 8 N•m (71 lb-in).

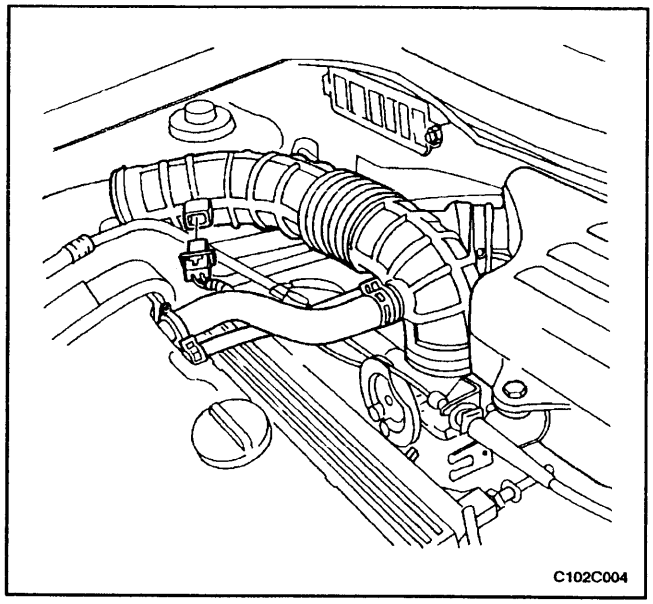

B102C051

26. Install the crankshaft pulley.
27. Install the crankshaft pulley bolts.

Tighten

Tighten the crankshaft pulley bolts to 20 N•m (15 lb-ft).

28. Install the right engine mount bracket. Refer to "Engine Mount" in this section.
29. Install the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*

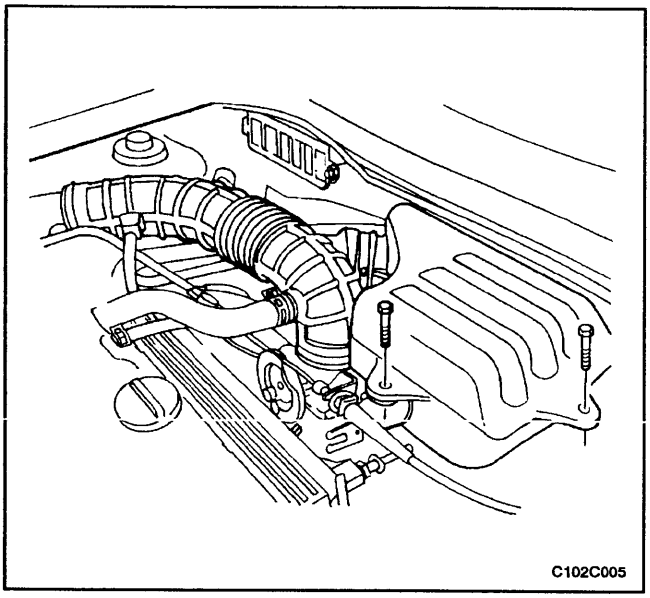

C102C004

30. Install the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
31. Install the right front wheel. Refer to *Section 2E, Tires and Wheels.*
32. Install the air filter housing.
33. Install the air filter housing bolts.

Tighten

Tighten the air filter housing bolts to 8 N•m (71 lb-in).

34. Connect the air intake tube to the throttle body.
35. Connect the breather tube to the valve cover.
36. Connect the manifold air temperature sensor connector.
37. Connect the negative battery cable.

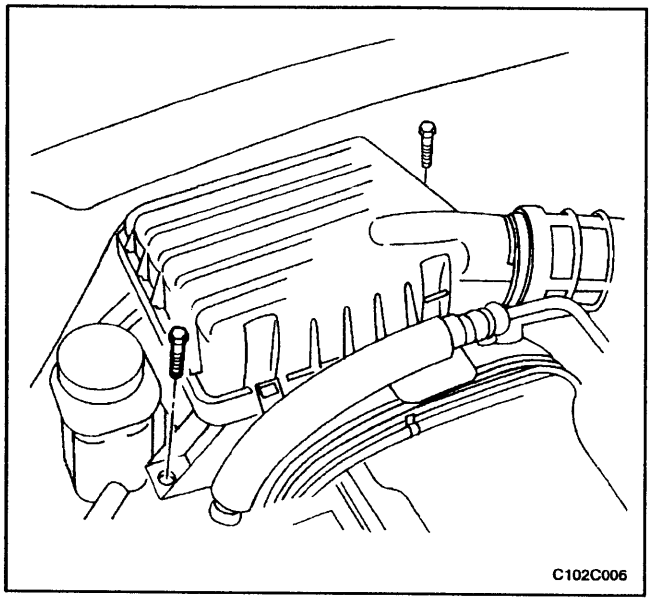

C102C005

TIMING BELT

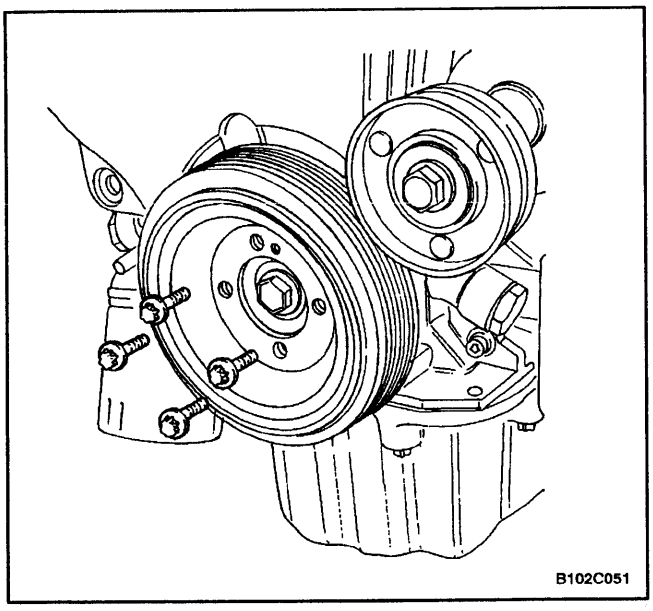
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

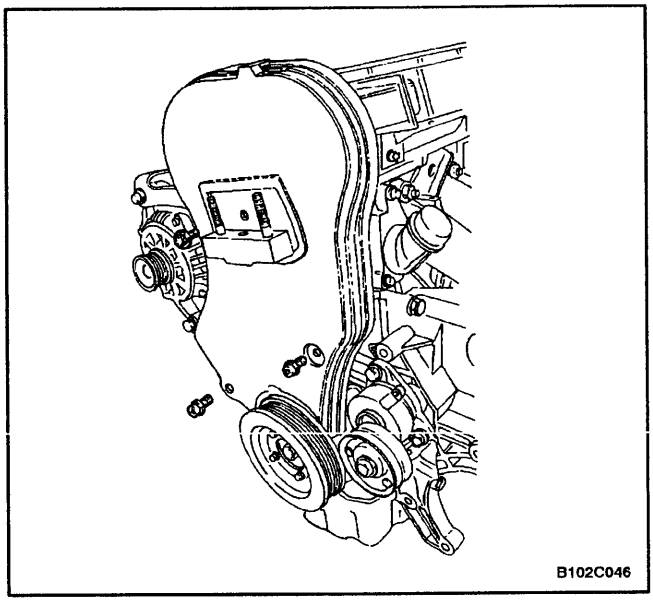
1. Disconnect the negative battery cable.
2. Disconnect the manifold air temperature sensor connector.
3. Disconnect the air intake tube from the throttle body.
4. Remove the resonator retaining bolts and the resonator from the throttle body.
5. Disconnect the breather tube from the valve cover.


C102C006

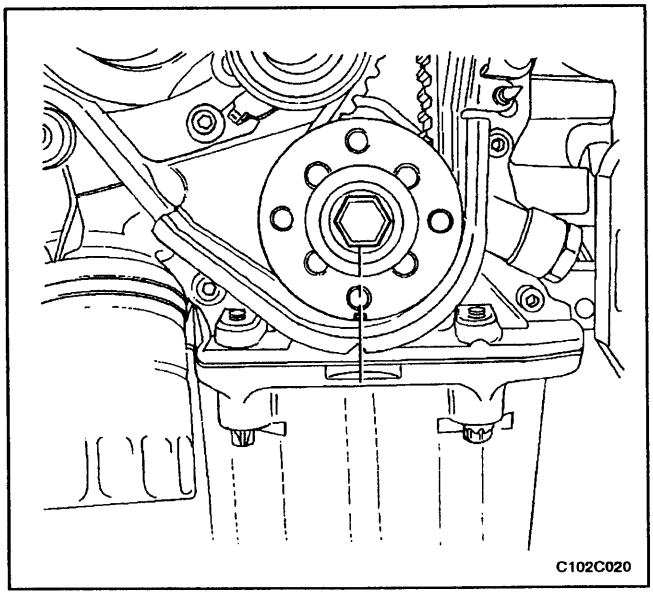
6. Remove the air filter housing bolts.
7. Remove the air filter housing.
8. Remove the right front wheel. Refer to *Section 2E, Tires and Wheels.*
9. Remove the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*


B102C051

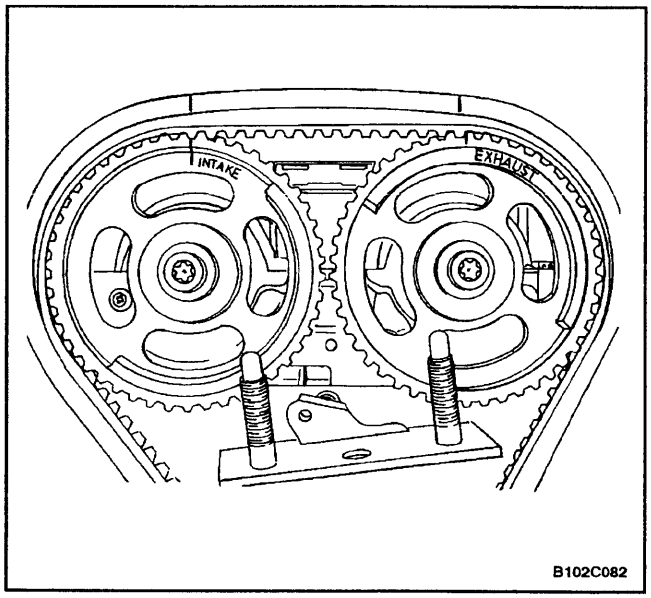
10. Remove the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump*.
11. Remove the crankshaft pulley bolts.
12. Remove the crankshaft pulley.
13. Remove the right engine mount bracket. Refer to "Engine Mount" in this section.


B102C046

14. Remove the power steering hose clamp bolt, and position the hose clear of the repair area.
15. Remove the front timing belt cover bolts.
16. Remove the front timing belt cover.


C102C020

17. Using the crankshaft gear bolt, rotate the crankshaft clockwise until the timing mark on the crankshaft gear is aligned with the notch at the bottom of the rear timing belt cover.

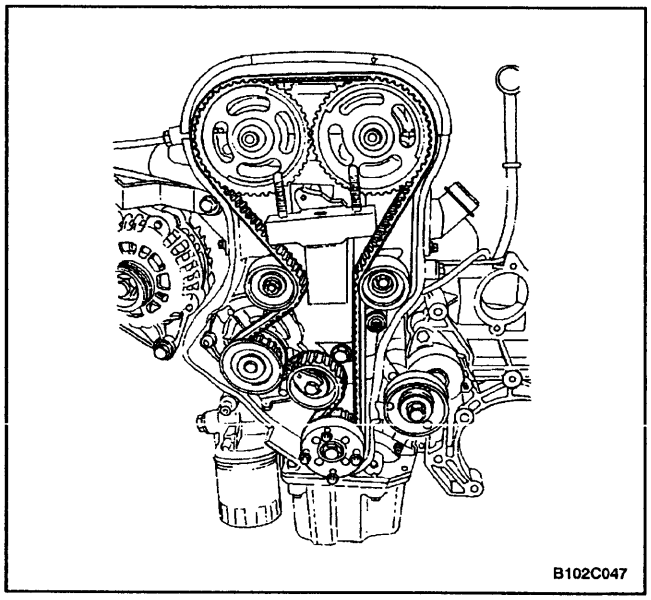


B102C082

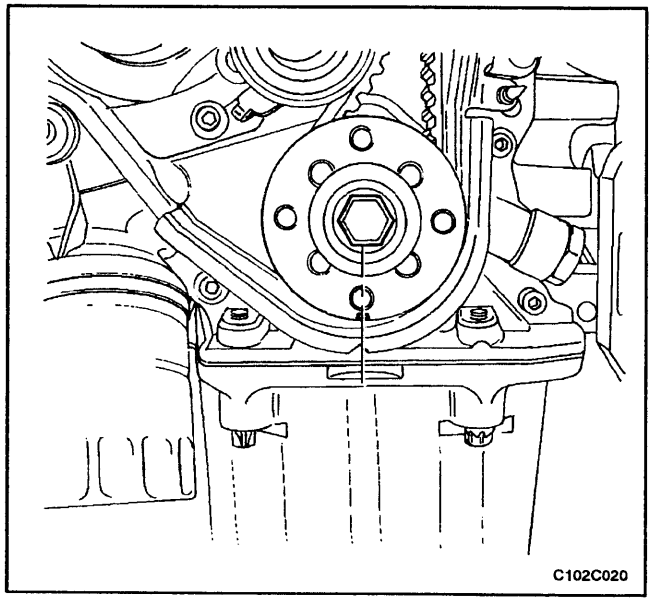
Notice: The camshaft gears must align with the notch on the valve cover or damage to the engine could result.

18. Align the camshaft gears with the notch on the valve cover.

Important: Use the intake gear mark for the intake camshaft gear and the exhaust gear mark for the exhaust camshaft gear since both gears are interchangeable.

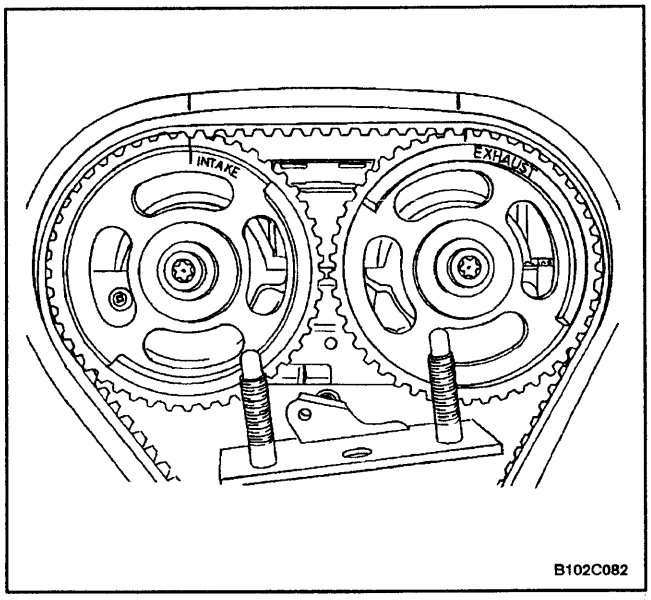

B102C047

19. Loosen the automatic tensioner bolt. Turn the hex-key tab to relieve belt tension.
20. Remove the timing belt.

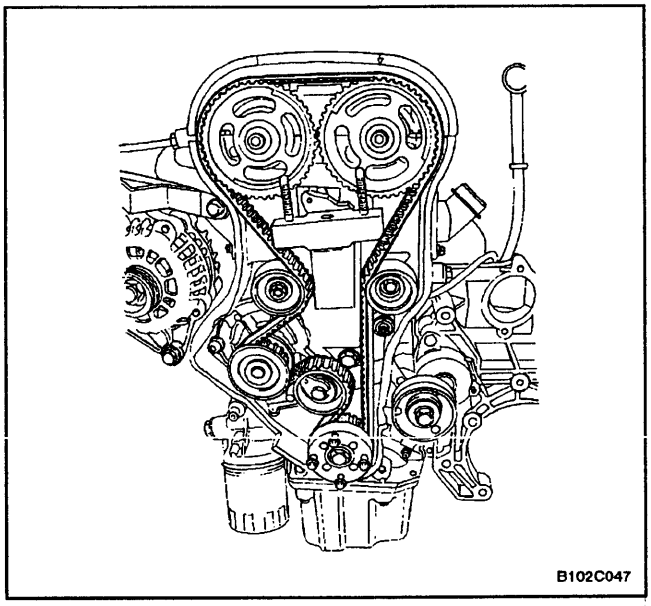

C102C020

Installation Procedure

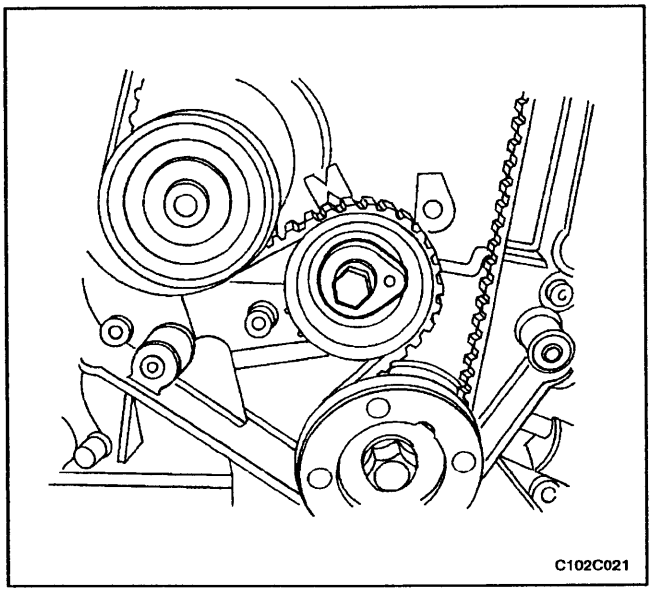
1. Align the timing mark on the crankshaft gear with the notch on the bottom of the rear timing belt cover.



2. Align the timing marks on the camshaft gears, using the intake gear mark for the intake gear and the exhaust gear mark for the exhaust gear.



3. Install the timing belt.

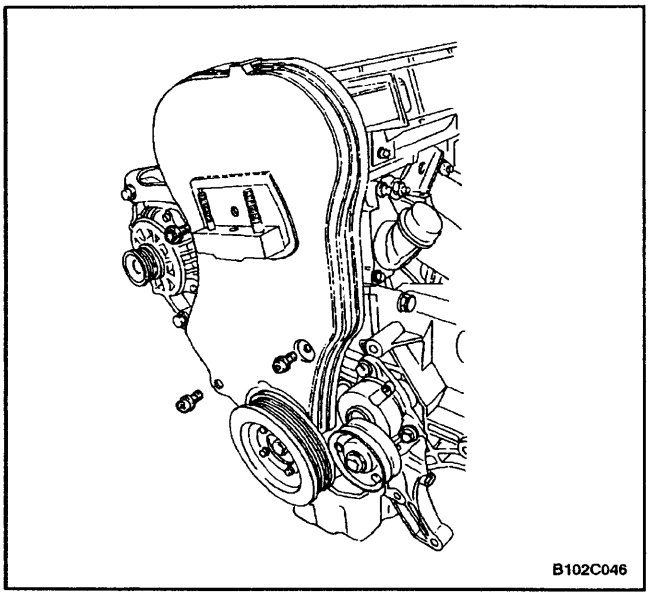


4. Turn the hex-key tab in a counterclockwise direction to tension the belt. Turn until the pointer aligns with the notch.
5. Install the automatic tensioner bolt.

Tighten

Tighten the timing belt automatic tensioner bolt to 25 N•m (18 lb-ft).

6. Rotate the crankshaft two full turns clockwise using the crankshaft gear bolt.
7. Recheck the automatic tensioner pointer.


B102C046

8. Install the front timing belt cover.
9. Install the front timing belt cover bolts.

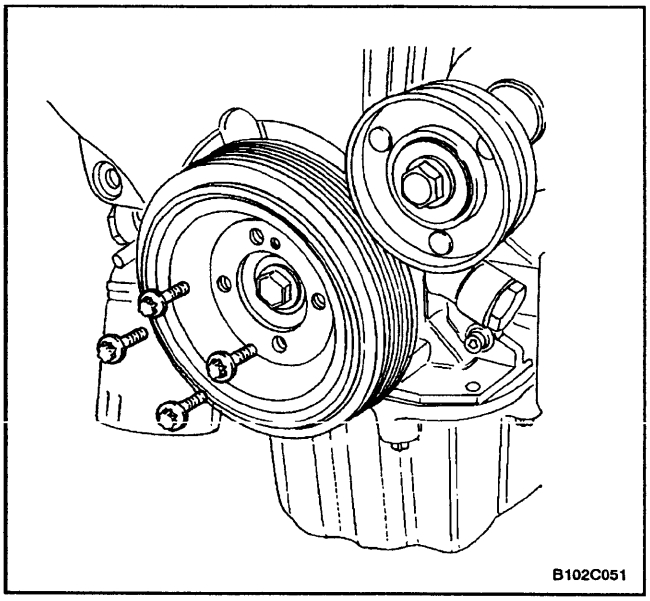
Tighten

Tighten the front timing belt cover bolts to 8 N•m (71 lb-in).

10. Install the right engine mount bracket. Refer to "Engine Mounts" in this section.
11. Position the power steering hose in place and install the clamp bolt.

Tighten

Tighten the power steering hose clamp bolt to 8 N•m (71 lb-in).


B102C051

12. Install the crankshaft pulley.
13. Install the crankshaft pulley bolts.

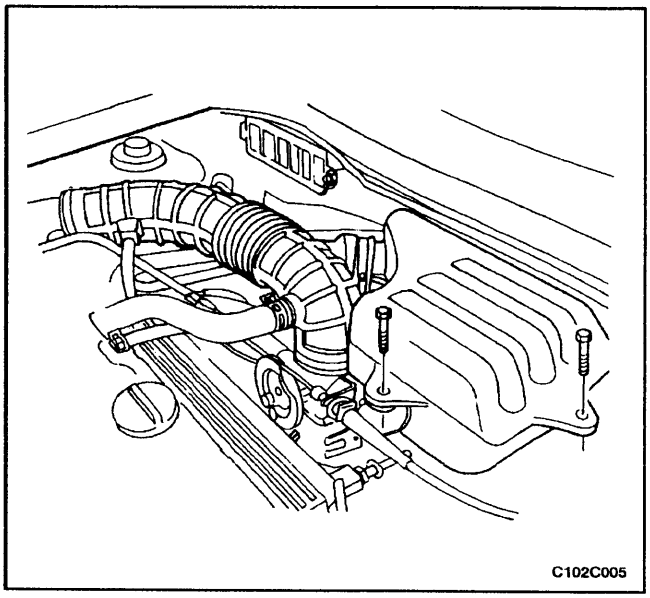
Tighten

Tighten the crankshaft pulley bolts to 20 N•m (15 lb-ft).

14. Install the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*
15. Install the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
16. Install the right front wheel. Refer to *Section 2E, Tires and Wheels.*
17. Install the air filter housing.
18. Install the air filter housing bolts.

Tighten

Tighten the air filter housing bolts to 8 N•m (71 lb-in).

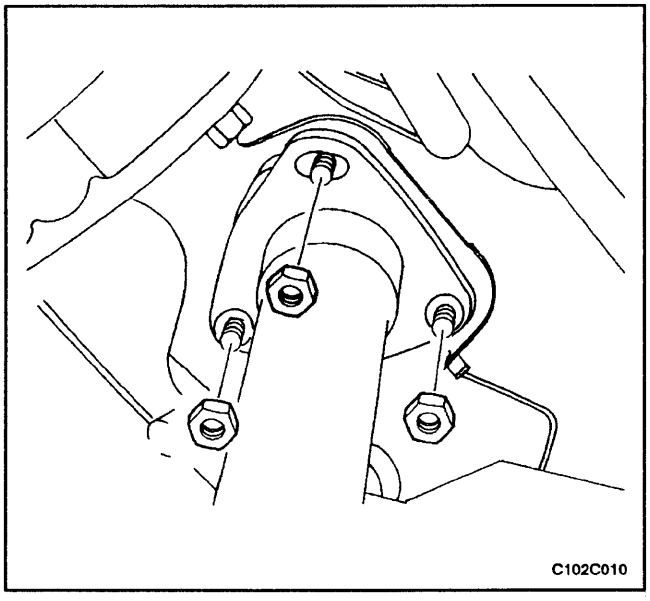

C102C005

19. Install the resonator and the retaining bolts.

Tighten

Tighten the resonator retaining bolts to 8 N•m (71 lb-in).

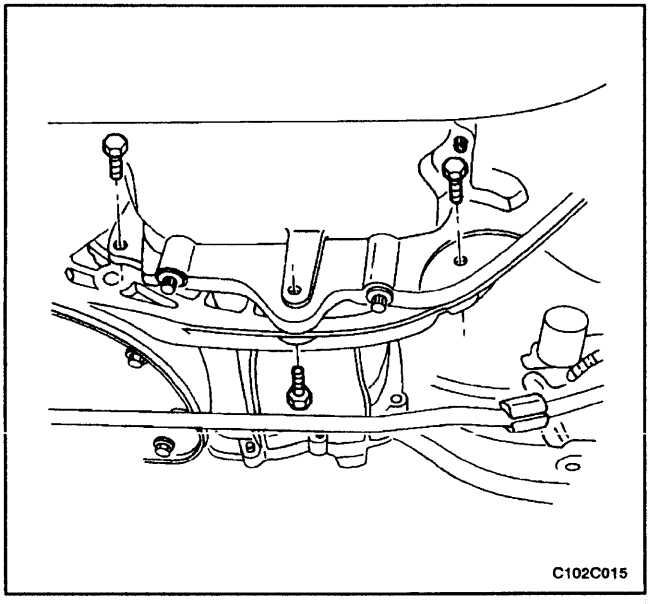
20. Connect the air intake tube to the throttle body.
21. Connect the breather tube to the valve cover.
22. Connect the manifold air temperature sensor connector.
23. Connect the negative battery cable.


C102C010

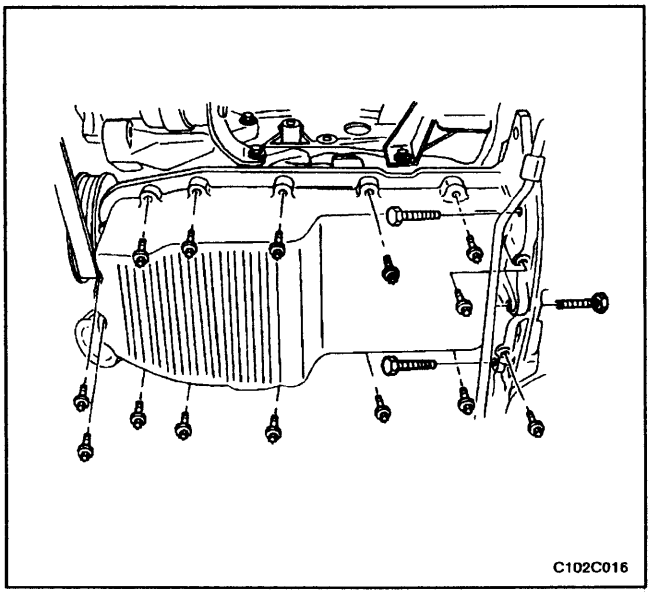
OIL PAN

Removal Procedure

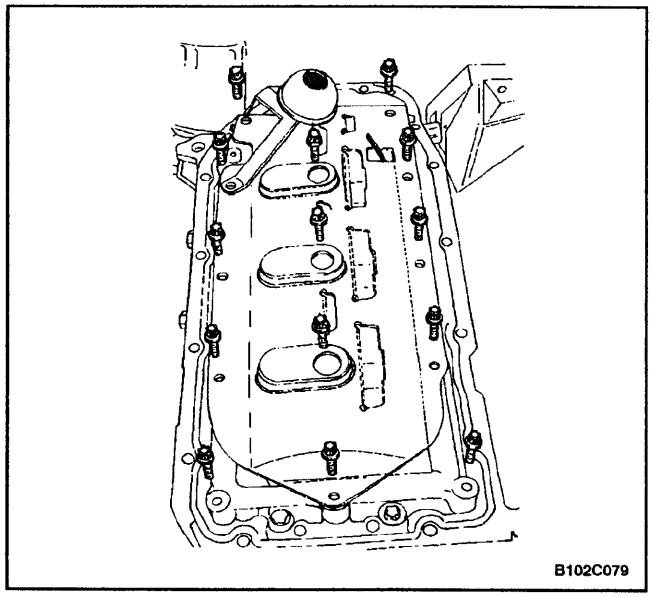
1. Disconnect the negative battery cable.
2. Drain the engine oil from the engine crankcase.
3. Remove the exhaust flex pipe retaining nuts from the exhaust manifold and the support bracket.
4. Remove the exhaust flex pipe retaining nuts from the catalytic converter.
5. Remove the exhaust flex pipe.


C102C015

6. Remove the oil pan flange-to-transaxle retaining bolts.

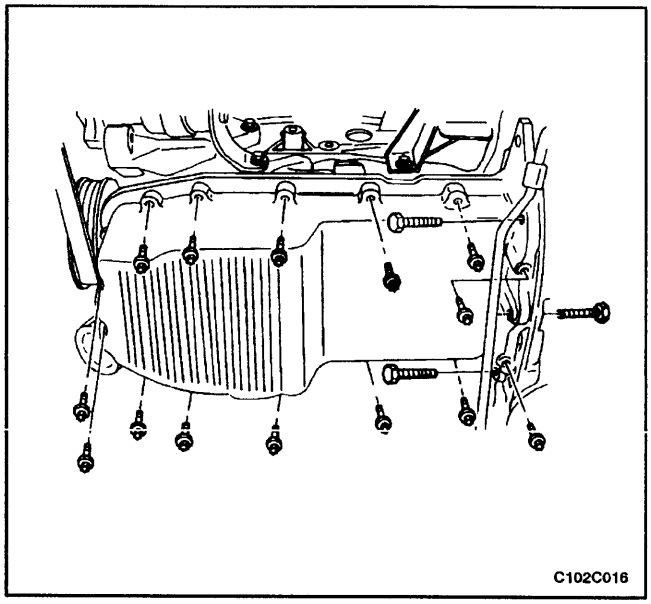

C102C016

7. Remove the oil pan retaining bolts.
8. Remove the oil pan from the engine block.
9. Remove the oil pan gasket from the oil pan.


B102C079

Cleaning Procedure

1. Clean the oil pan sealing surface.
2. Clean the engine block sealing surface.
3. Clean the oil pan retaining bolts.
4. Clean the oil pan attaching bolt holes in the engine block.
5. Clean the oil pan splash shield.

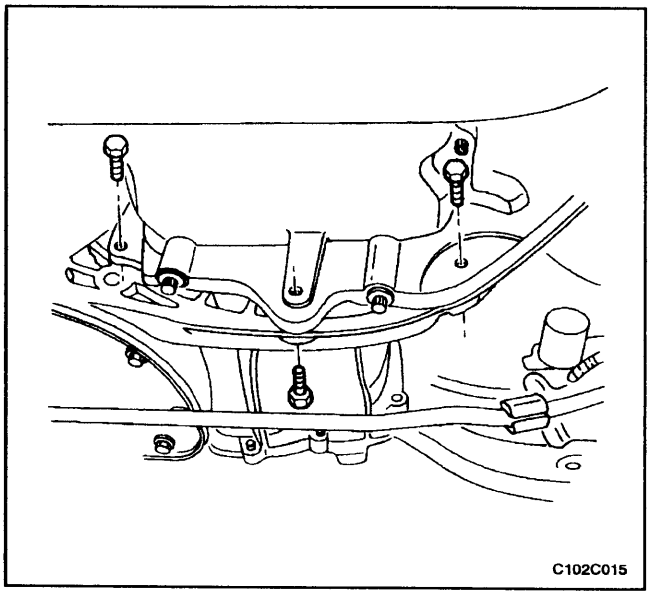

C102C016

Installation Procedure

1. Coat the new oil pan gasket with sealant.
2. Install the oil pan gasket to the oil pan.
3. Install the oil pan to the engine block.
4. Install the oil pan retaining bolts.

Tighten

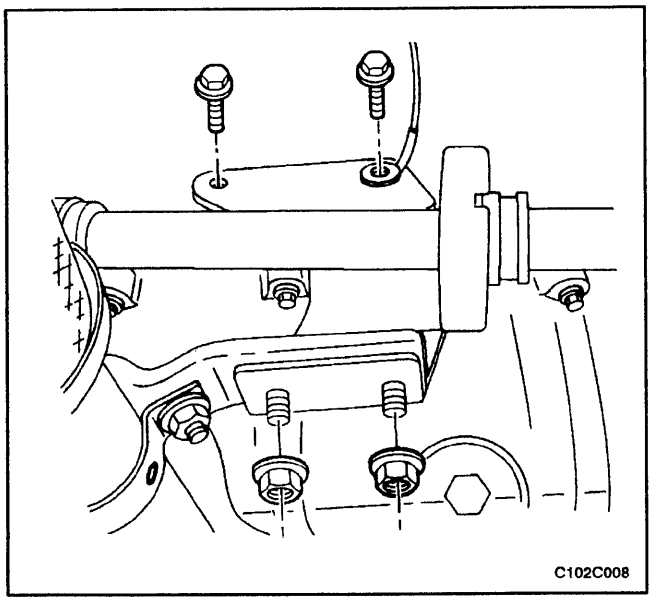
Tighten the oil pan retaining bolts to 10 N•m (89 lb-in).


C102C015

5. Install the oil pan flange-to-transaxle retaining bolts.

Tighten

Tighten the oil pan flange-to-transaxle retaining bolts to 40 N•m (30 lb-ft).



6. Install the exhaust flex pipe.
7. Install the exhaust flex pipe retaining nuts to the exhaust manifold and the support bracket.

Tighten

Tighten the exhaust flex pipe-to-exhaust manifold retaining nuts to 22 N•m (16 lb-ft).

Tighten the exhaust flex pipe support bracket bolts to 30 N•m (22 lb-ft).

8. Install the exhaust flex pipe-to-catalytic converter retaining nuts.

Tighten

Tighten the exhaust flex pipe-to-catalytic converter retaining nuts to 30 N•m (22 lb-ft).

9. Connect the negative battery cable.
10. Refill the engine crankcase with engine oil.

OIL PUMP

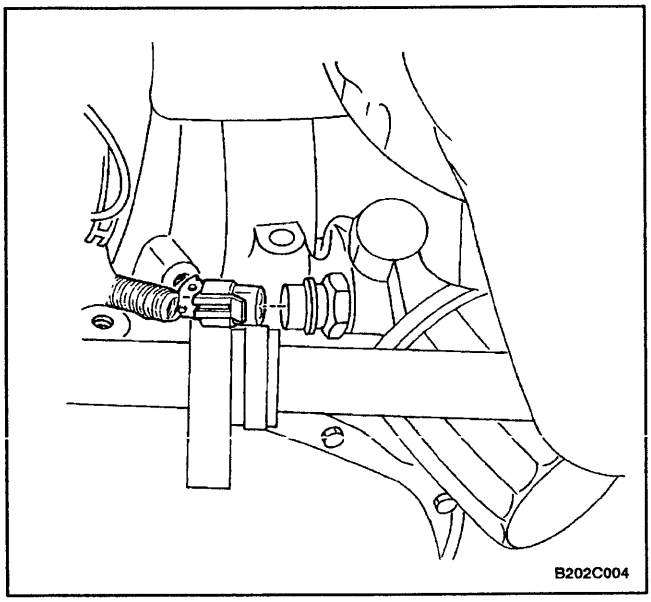
Tools Required

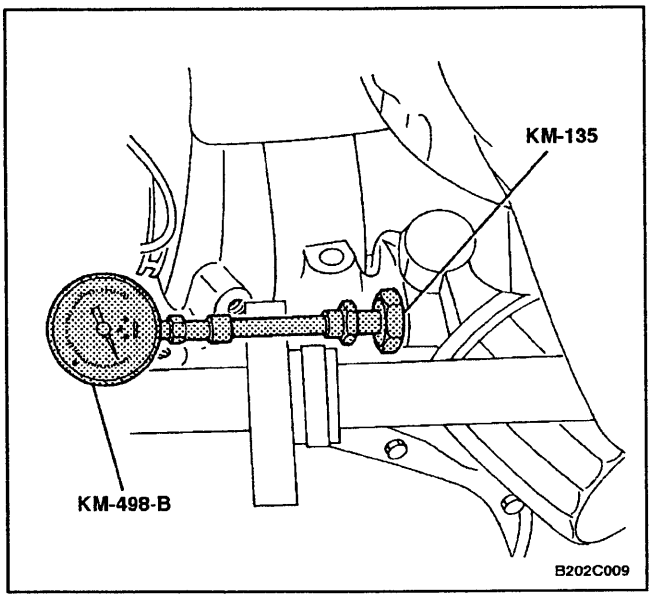
KM-498-B Pressure Gauge

KM-135 Adapter

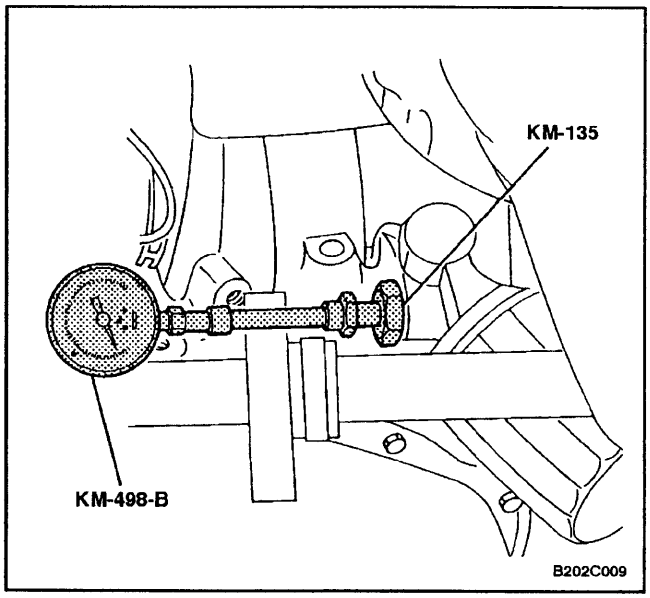
Engine Oil Pressure Inspection Procedure

1. Remove the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
2. Remove the oil pressure switch connector.





3. Install the adapter KM-135 in place of the oil pressure switch.
4. Connect the pressure gauge KM-498-B to the adapter.
5. Start the engine and check the oil pressure at idle speed and engine temperature of 80°C (176° F). The minimum oil pressure should be 30 kPa (4.35 psi).
6. Stop the engine and remove the oil pressure gauge KM-498-B and the adapter KM-135.

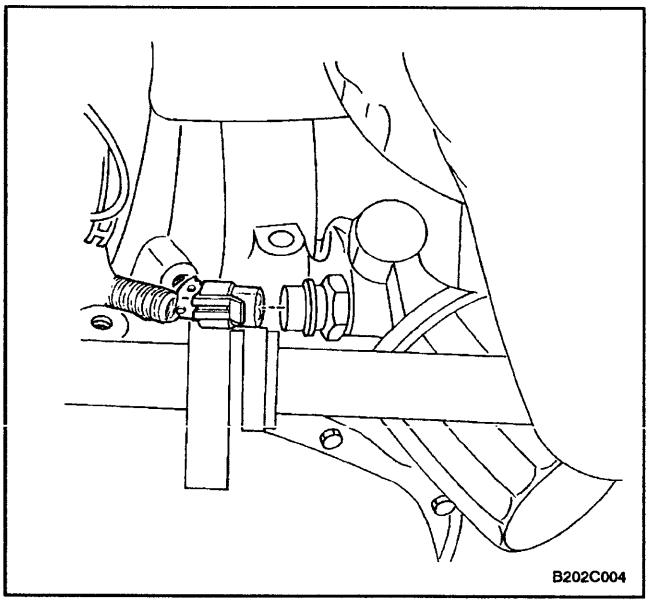


7. Install the oil pressure switch.

Tighten

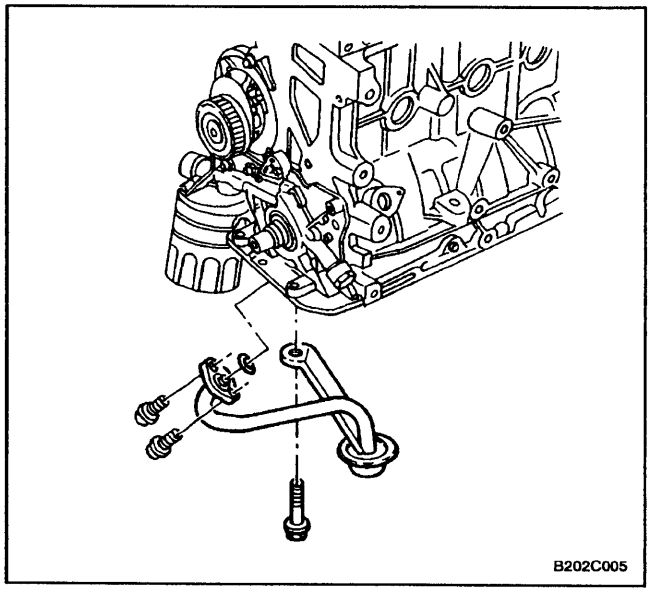
Tighten the oil pressure switch to 40 N•m (30 lb-ft).

8. Connect the electrical connector to the oil pressure switch.
9. Install the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
10. Check the oil level. Fill the oil reservoir to the full mark.

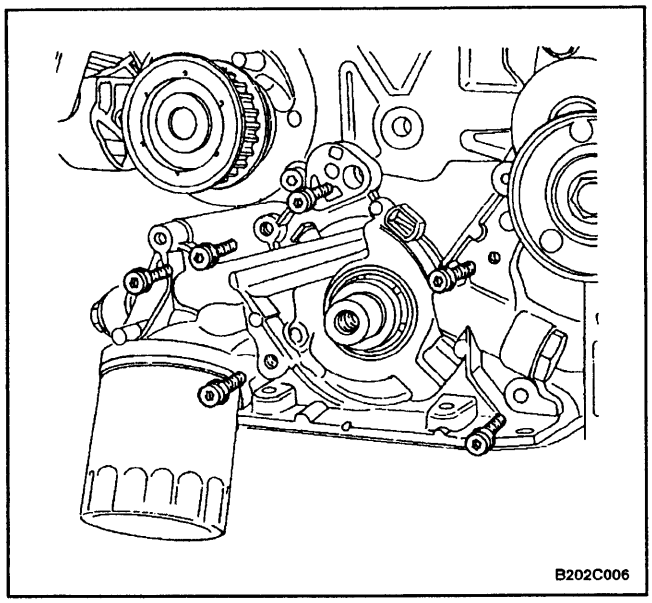


Removal Procedure

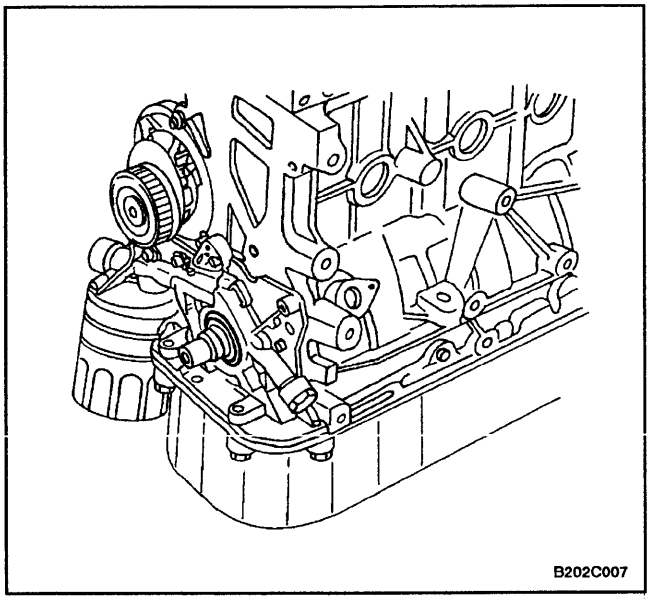
1. Disconnect the negative battery cable.
2. Remove the timing belt. Refer to "Timing Belt" in this section.
3. Remove the rear timing belt cover. Refer to "Rear Timing Belt Cover" in this section.
4. Disconnect the oil pressure switch connector.



5. Remove the oil pan. Refer to "Oil Pan" in this section.
6. Remove the oil pump pickup tube and support bracket bolts.
7. Remove the oil pump pickup tube.

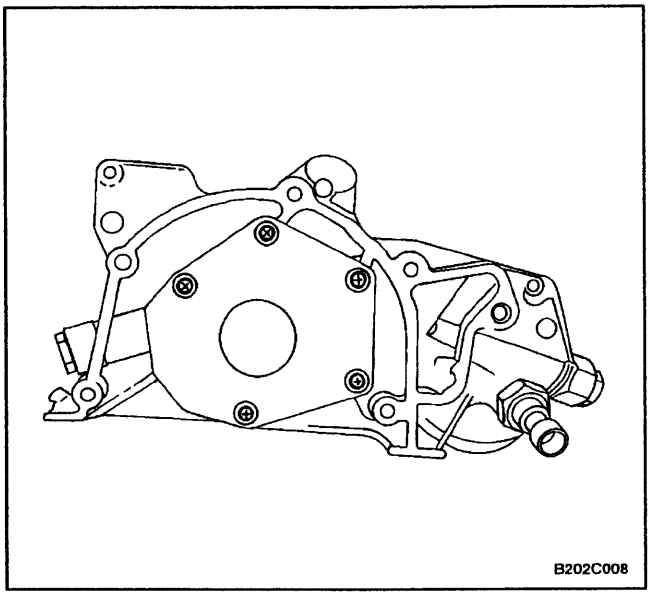

B202C006

8. Remove the oil pump retaining bolts.
9. Carefully separate the oil pump and the gasket from the engine block and the oil pan.
10. Remove the oil pump.

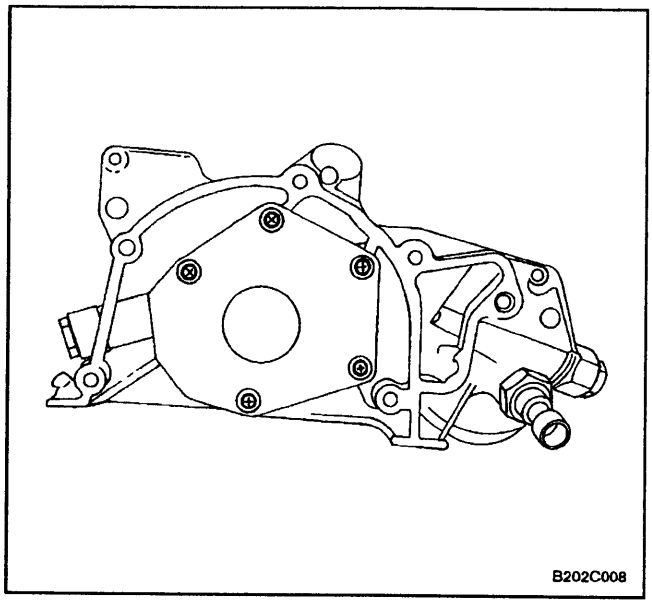

B202C007

Inspection Procedure

1. Clean the oil pump and the engine block gasket mating surfaces.
2. Remove the safety relief valve bolt.
3. Remove the safety relief valve and the spring.
4. Remove the oil pump-to-crankshaft seal.


B202C008

5. Remove the oil pump rear cover bolts.
6. Remove the rear cover.


B202C008

7. Clean the oil pump housing and all the oil pump parts.
8. Inspect all the oil pump parts for signs of wear. Refer to "Engine Specifications" in this section. Replace the worn oil pump parts.

Notice: Pack the oil pump gear cavity with petroleum jelly to ensure an oil pump prime, or engine damage could result.

9. Coat all the oil pump parts with clean engine oil. Install the oil pump parts.
10. Apply Loctite® 242 to the oil pump rear cover bolts and install the rear cover and the bolts.

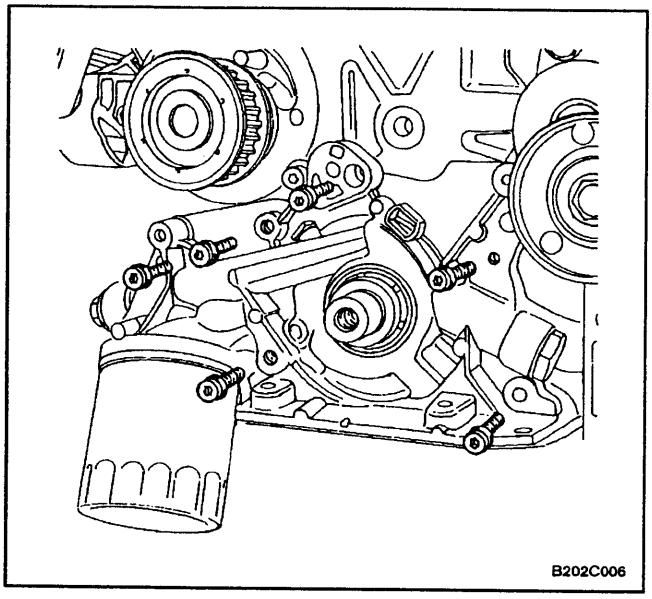
Tighten

Tighten the oil pump rear cover bolts to 6 N•m (53 lb-in).

11. Install the safety relief valve, the spring, the washer, and the bolt.

Tighten

Tighten the safety relief valve bolt to 30 N•m (22 lb-ft).

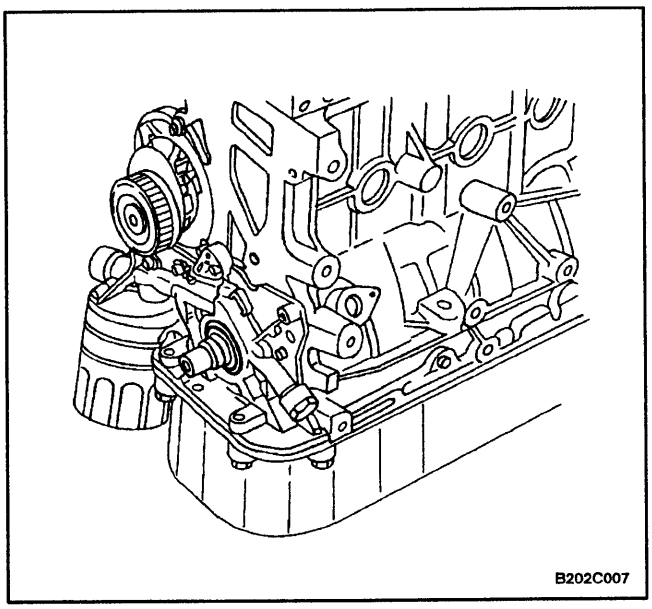

B202C006

Installation Procedure

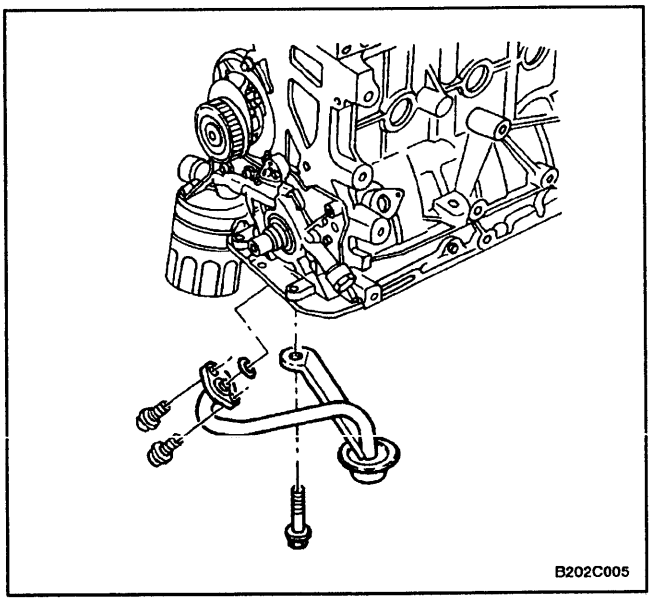
1. Apply Loctite® 242 to the oil pump bolts and room temperature vulcanizing (RTV) sealant to the new oil pump gasket.
2. Install the gasket to the oil pump and install the oil pump to the engine block with the bolts.

Tighten

Tighten the oil pump retaining bolts to 10 N•m (89 lb-in).


B202C007

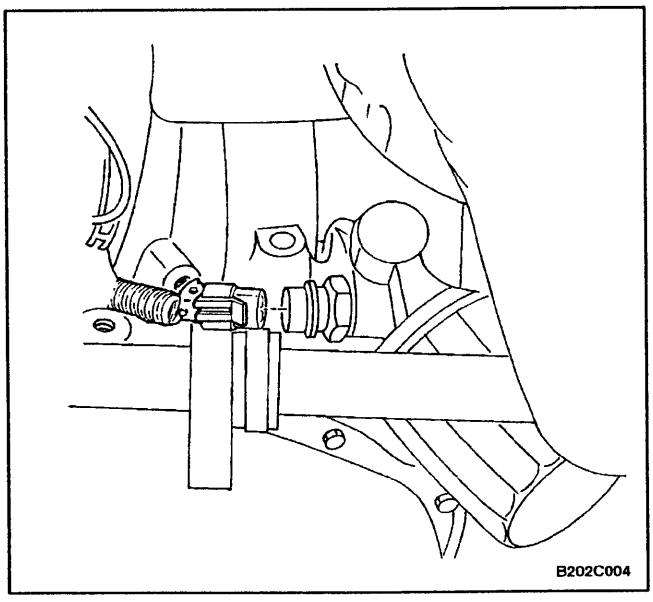
3. Install a new oil pump-to-crankshaft seal. Coat the lip of the seal with a thin coat of grease.


B202C005

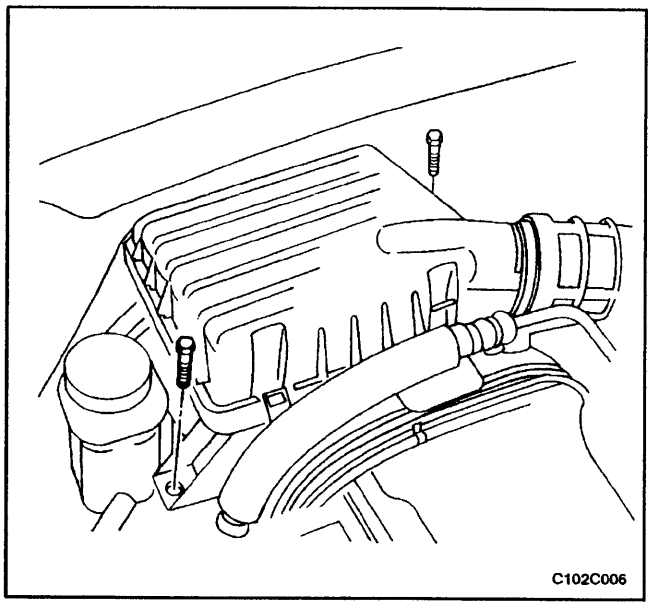
4. Coat the threads of the oil pump pickup tube and the support bracket bolts with Loctite® 242.
5. Install the oil pump pickup tube to the support bracket with the bolts.

Tighten

Tighten the oil pump pickup tube bolts to 8 N•m (71 lb-in).


B202C004

6. Install the oil pan. Refer to "Oil Pan" in this section.
7. Connect the oil pressure switch connector.
8. Install the rear timing belt cover. Refer to "Rear Timing Belt Cover" in this section.
9. Install the timing belt. Refer to "Timing Belt" in this section.
10. Connect the negative battery cable.


C102C006

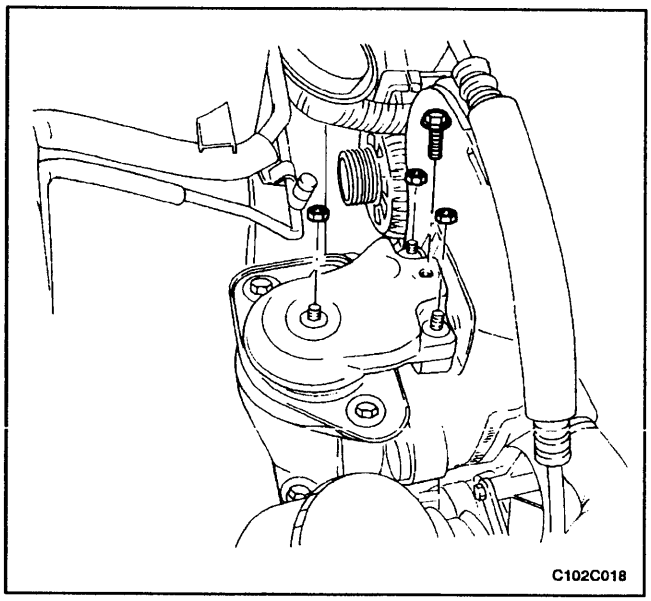
ENGINE MOUNT, RIGHT SIDE

Tools Required

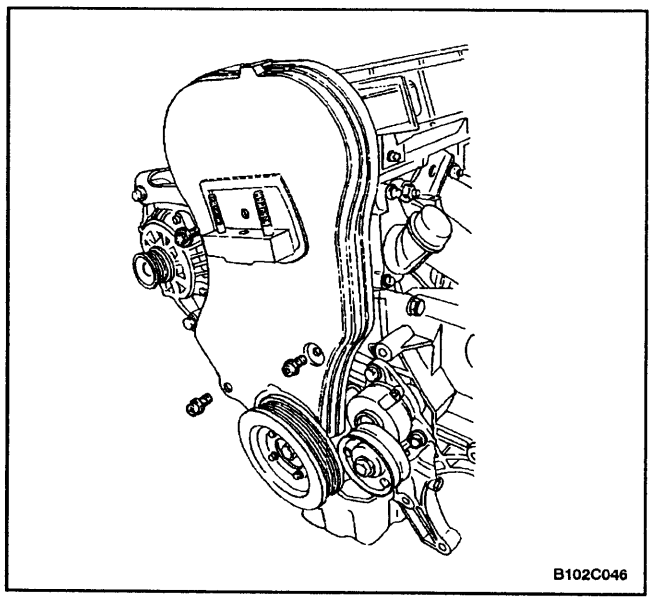
J-28467-B Engine Assembly Lift Support

Removal Procedure

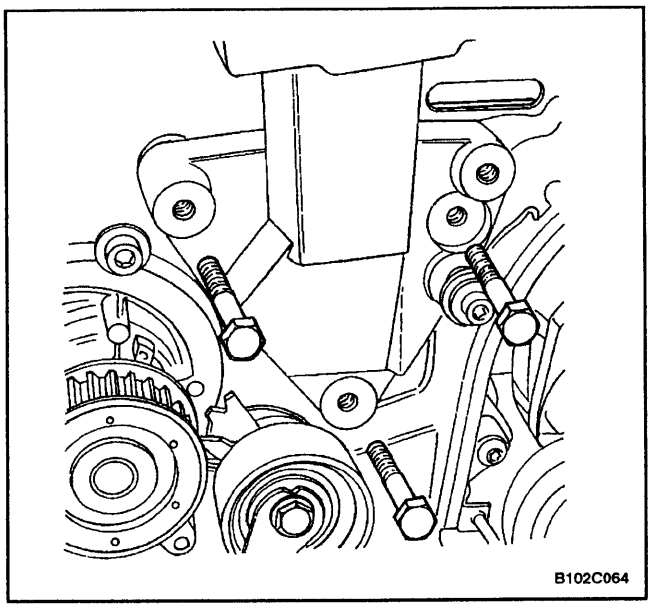
1. Disconnect the negative battery cable.
2. Support the engine assembly using the engine assembly lift support J-28467-B.
3. Remove the right front wheel well splash shield. refer to *Section 9R, Body Front End.*
4. Remove the air filter housing assembly bolts.
5. Remove the air filter housing assembly.


C102C018

6. Remove the engine mount bracket retaining bolts.
7. Remove the engine mount bracket.
8. Remove the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump*.


B102C046

9. Remove the front timing belt cover bolts and the front timing belt cover.
10. Align the crankshaft pulley timing mark with the pointer, and the camshaft gears with the timing marks on the rear cover, by turning the crankshaft gear bolt.
11. Loosen the timing belt automatic tensioner bolt.
12. Turn the hex-key tab to relieve belt tension.
13. Remove the timing belt idler pulley nuts.
14. Remove the timing belt idler pulley.
15. Remove the engine mount retaining bolts.
16. Remove the engine mount.

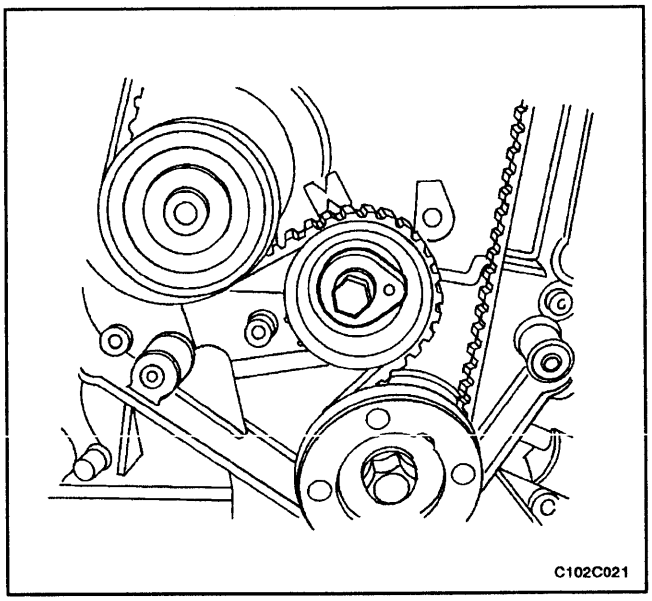


Installation Procedure

1. Install the engine mount.
2. Install the engine mount retaining bolts.

Tighten

Tighten the engine mount bolts to 60 N•m (44 lb-ft).



3. Install the timing belt idler pulleys.
4. Install the timing belt idler pulley nuts.

Tighten

Tighten the timing belt idler pulley nuts to 25 N•m (18 lb-ft).

5. Tension the timing belt by turning the timing belt automatic tensioner hex-key tab counterclockwise until the pointer is aligned to the indicator.

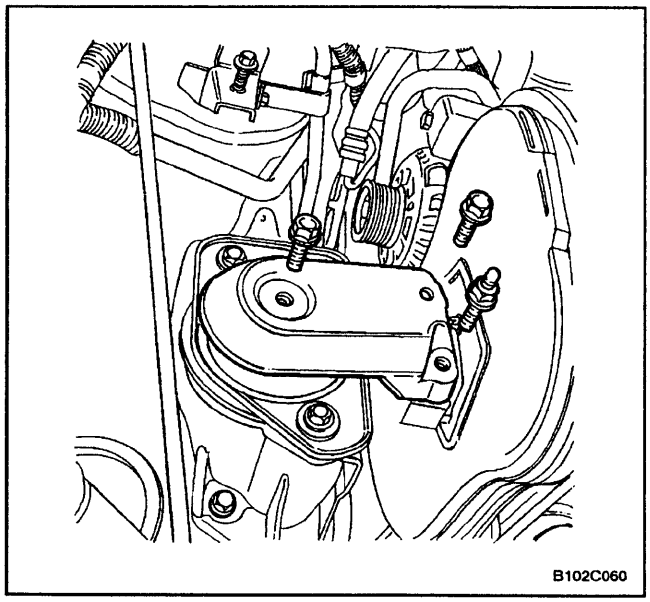
Tighten

Tighten the timing belt automatic tensioner bolt to 25 N•m (18 lb-ft).

6. Install the front timing belt cover.
7. Install the front timing belt cover bolts.

Tighten

Tighten the front timing belt cover bolts to 8 N•m (71 lb-in).


B102C060

8. Install the engine mount bracket and retaining bolts.

Tighten

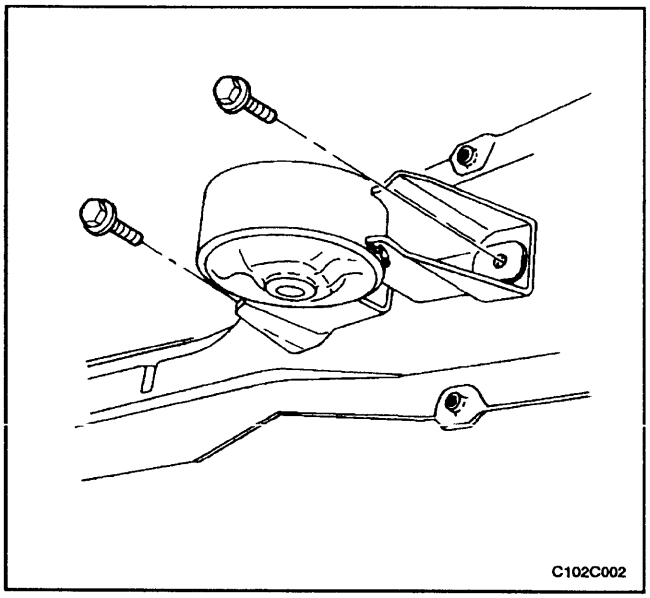
Tighten the engine mount bolts to 60 N•m (44 lb-ft).

9. Remove engine assembly lift support J-28467-B.
10. Install the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump*.
11. Install the air filter housing assembly with the bolts.

Tighten

Tighten the air filter housing assembly bolts to 8 N•m (71 lb-in).

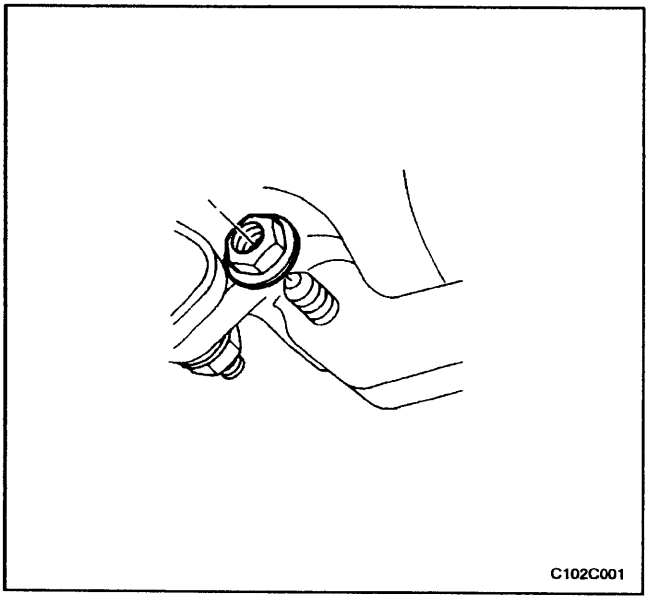
12. Install the right front wheel well splash shield. Refer to *Section 9R, Body Front End*.
13. Connect the negative battery cable.


C102C002

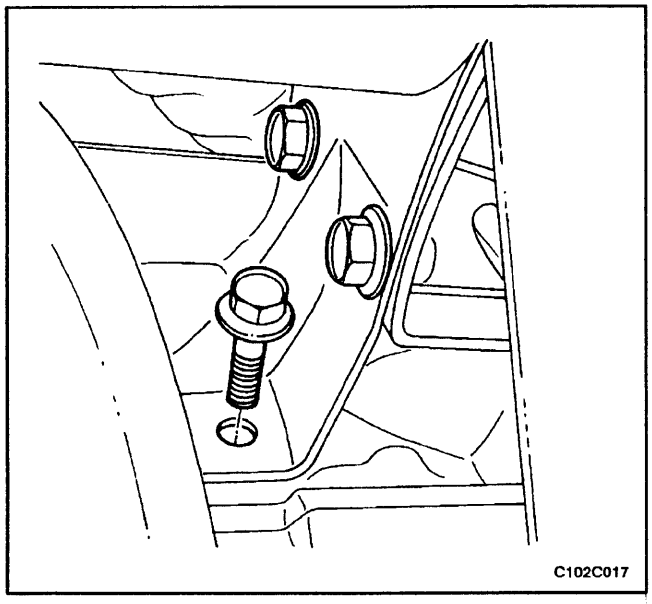
ENGINE MOUNT, FORWARD

Removal Procedure

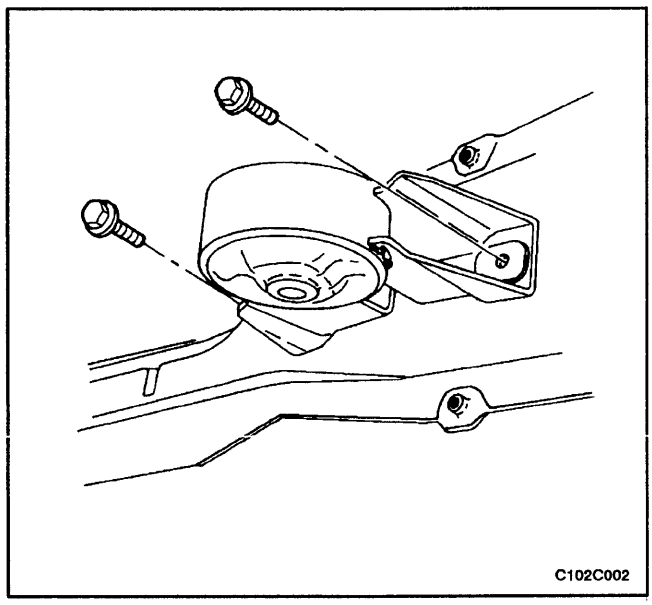
1. Disconnect the negative battery cable.
2. Raise and suitably support the vehicle.
3. Remove the center member. Refer to *Section 9N, Frame and Underbody.*
4. Remove the bolts that secure the engine mount to the center member.
5. Remove the engine mount.


C102C001

6. Remove the engine mount bracket-to-engine block nuts.



7. Remove the engine mount bracket-to-engine block bolts.
8. Remove the engine mount bracket.

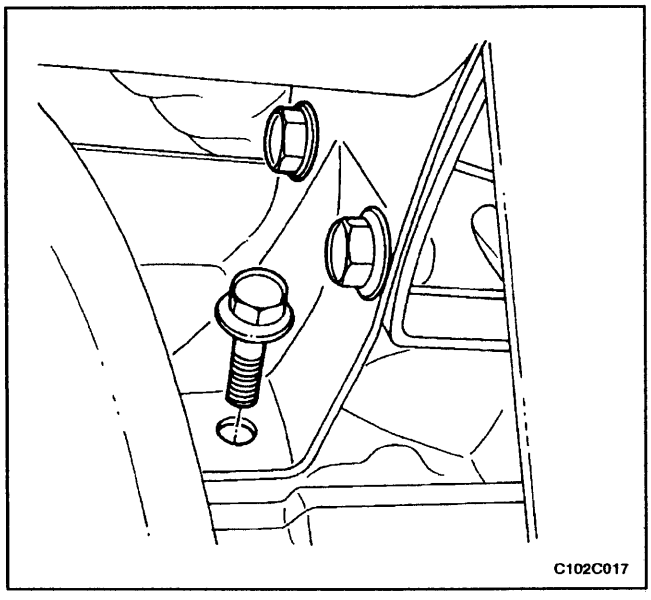


Installation Procedure

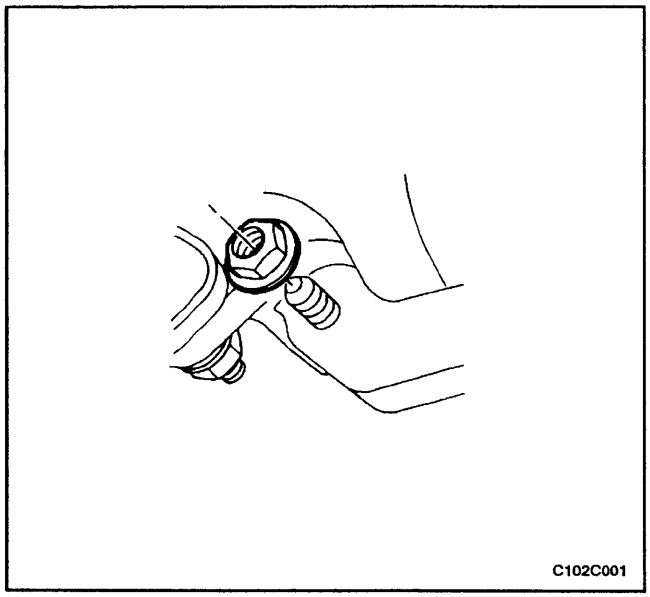
1. Install the engine mount and bolts to the center member.

Tighten

Tighten the engine mount bolts to 60 N•m (44 lb-ft).



2. Install the engine mount bracket-to-engine block bolts.

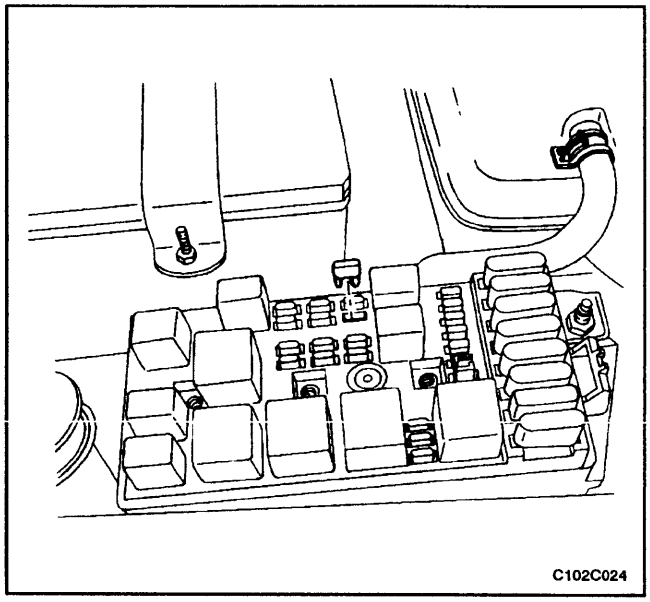

C102C001

3. Install the engine mount bracket-to-engine block nuts.

Tighten

Tighten the engine mount bracket-to-engine block bolts and nuts to 90 N•m (66 lb-ft).

4. Install the center member. Refer to *Section 9N, Frame and Underbody.*
5. Lower the vehicle.
6. Connect the negative battery cable.

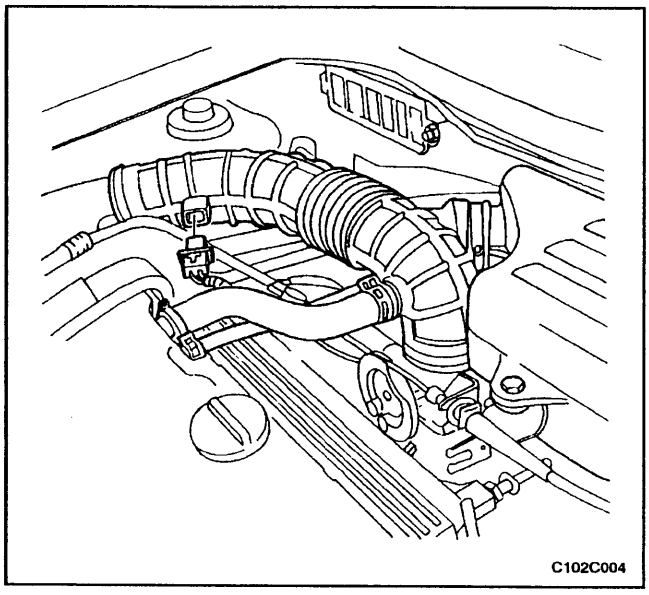

C102C024

INTAKE MANIFOLD

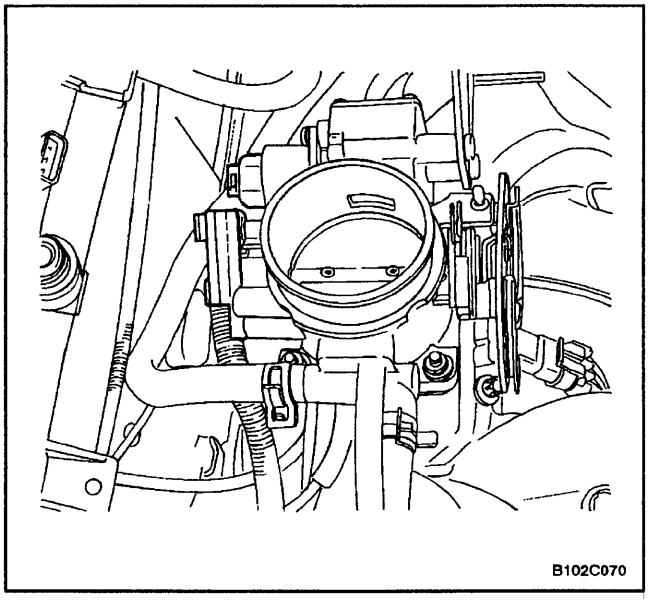
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

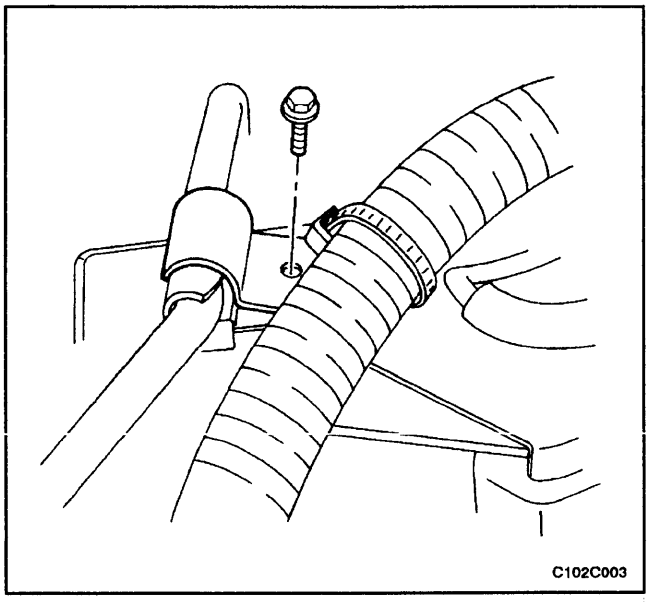
1. Remove the fuel pump fuse.
2. Start the engine. After it stalls, crank the engine for 10 seconds to rid the fuel system of fuel pressure.
3. Disconnect the negative battery cable.
4. Disconnect the canister purge and exhaust gas recirculation (EGR) solenoids from the intake manifold and loosen the bracket bolt.
5. Drain the engine coolant. Refer to *Section 1D, Engine Cooling.*


C102C004

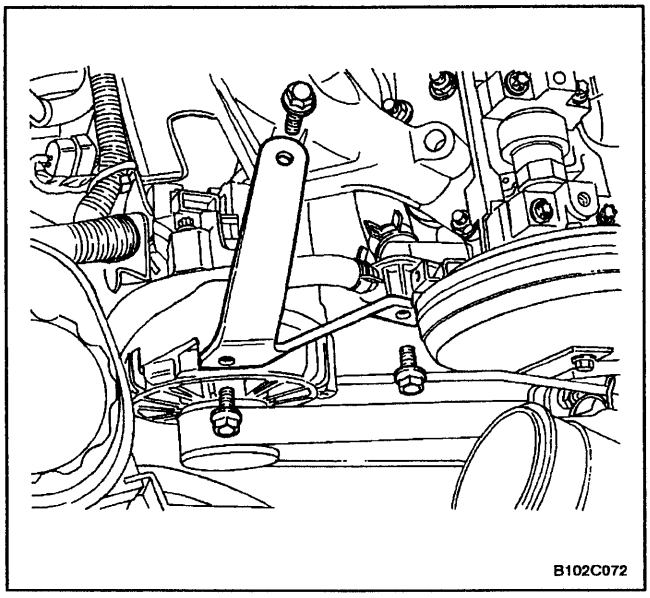
6. Disconnect the manifold air temperature sensor connector.
7. Disconnect the air intake tube from the throttle body.


B102C070

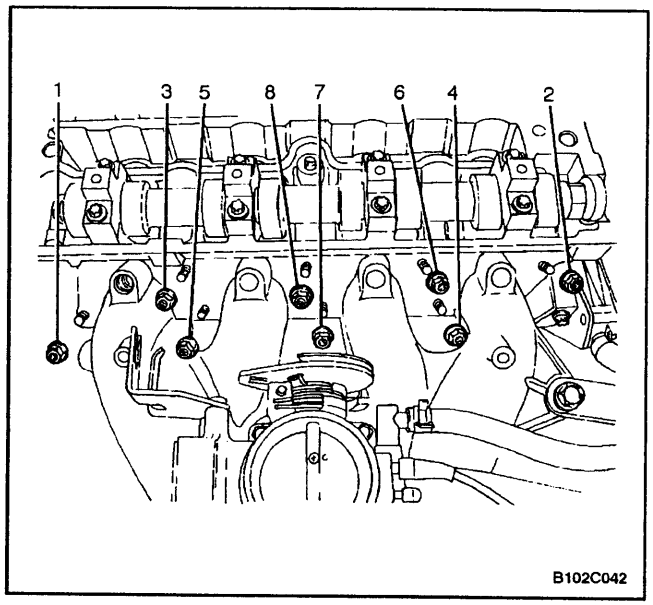
8. Disconnect the idle air control valve connector.
9. Disconnect the throttle position sensor connector.
10. Disconnect the manifold absolute pressure (MAP) sensor connector.
11. Disconnect the coolant hoses at the throttle body.


C102C003

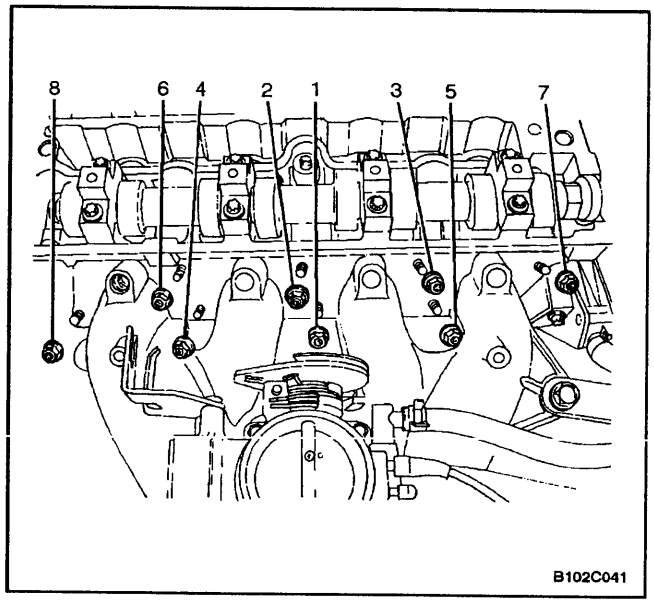
12. Disconnect all of the necessary vacuum hoses, including the vacuum hose at the fuel pressure regulator and the brake booster vacuum hose at the intake manifold.
13. Disconnect the throttle cable from the throttle body and the intake manifold.
14. Remove the throttle cable bracket bolts from the intake manifold.
15. Remove the throttle cable bracket.
16. Remove the alternator-to-intake manifold strap bracket bolts and the strap.
17. Remove the power steering hose clamp bolt, and position the hose clear of the repair area.


B102C072

18. Remove the fuel rail and the injector cover as an assembly. Refer to *Section 1F, Engine Controls.*
19. Remove the alternator-to-intake manifold support bracket bolts.
20. Remove the alternator-to-intake manifold support bracket.
21. Remove the intake manifold support bracket bolt at the engine block and the intake manifold.
22. Remove the intake manifold support bracket.



23. Remove the intake manifold retaining bolts and the nuts in the sequence shown.
24. Remove the intake manifold.
25. Remove the intake manifold gasket.
26. Clean the sealing surfaces of the intake manifold and the cylinder head.



Installation Procedure

1. Install the intake manifold gasket.
2. Install the intake manifold.
3. Install the intake manifold retaining bolts and the nuts in the sequence shown.

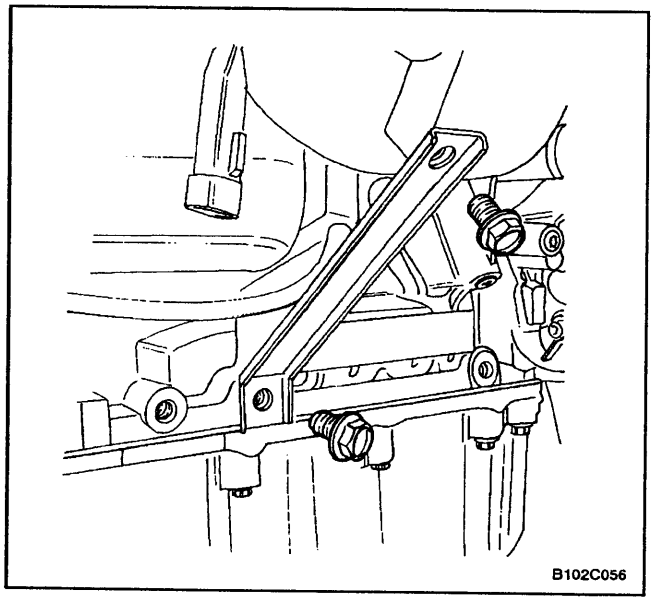
Tighten

Tighten the intake manifold retaining bolts and the nuts to 22 N•m (16 lb-ft).

4. Install the alternator-to-intake manifold strap bracket and bolts.

Tighten

Tighten the alternator-to-intake manifold strap bracket bolts to 20 N•m (15 lb-ft).



5. Install the intake manifold support bracket.
6. Install the intake manifold support bracket upper bolts to the intake manifold.

Tighten

Tighten the intake manifold support bracket upper bolts to the intake manifold to 20 N•m (15 lb-ft).

7. Install the intake manifold support bracket lower bolt to the engine block.

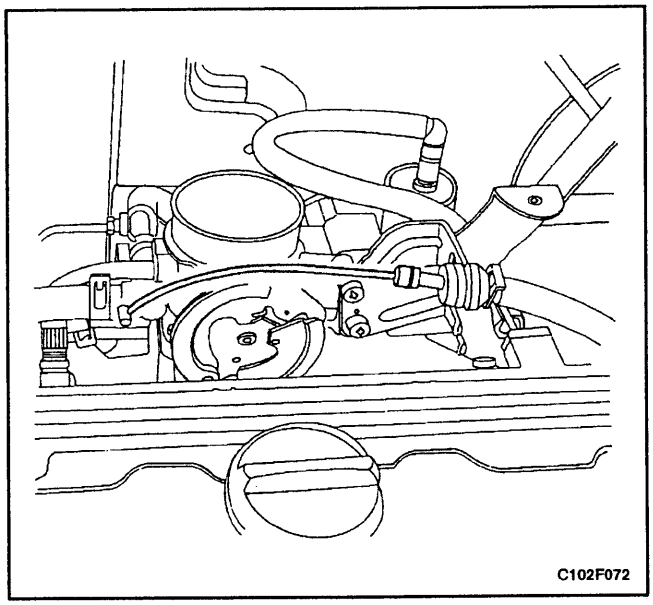
Tighten

Tighten the intake manifold support bracket lower bolt to the engine block to 20 N•m (15 lb-ft).

8. Install the alternator-to-intake manifold support bracket and bolts.

Tighten

Tighten the alternator-to-intake manifold support bracket bolts to 35 N•m (26 lb-ft).

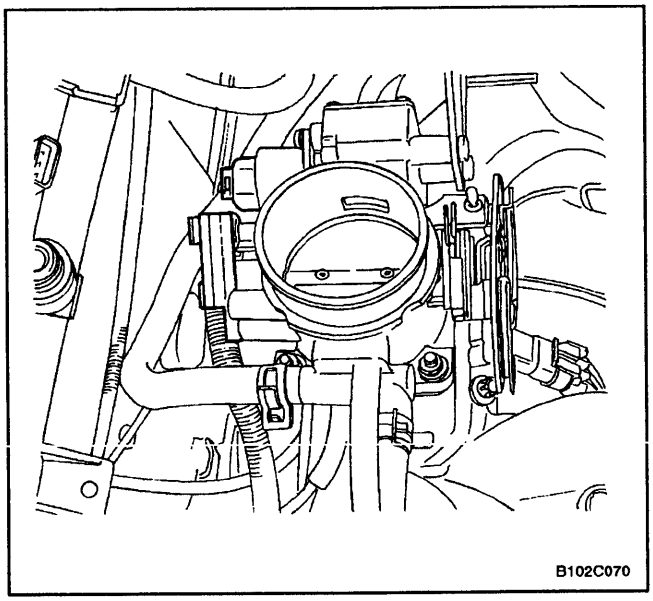

C102F072

9. Install the fuel rail and the injector cover as an assembly. Refer to *Section 1F, Engine Controls.*
10. Install the throttle cable bracket.
11. Install the throttle cable bracket bolts.

Tighten

Tighten the throttle cable bracket bolts to 8 N•m (71 lb-in).

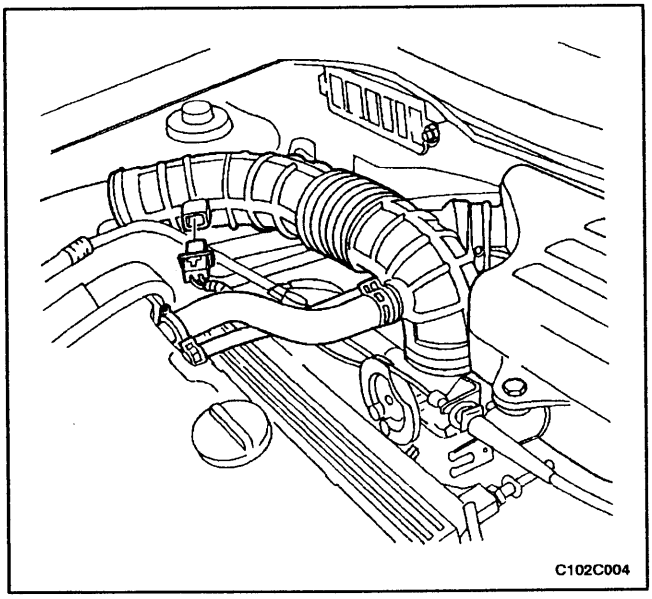
12. Connect the throttle cable to the intake manifold and the throttle body.
13. Connect all of the necessary vacuum lines that were previously disconnected.


B102C070

14. Connect the MAP sensor connector.
15. Connect the coolant hoses to the throttle body.
16. Connect the idle air control valve connector.
17. Connect the throttle position sensor connector.
18. Position the power steering hose in place and install the clamp bolt.

Tighten

Tighten the power steering hose clamp bolt to 8 N•m (71 lb-in).

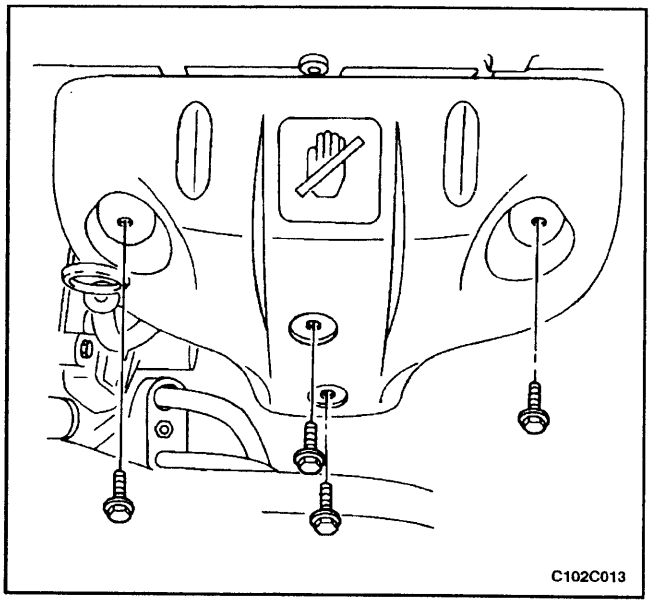

C102C004

19. Connect the air intake tube to the throttle body.
20. Connect the manifold air temperature sensor connector.
21. Connect the canister purge and the EGR solenoids at the intake manifold and tighten the bracket bolt.

Tighten

Tighten the canister purge and the EGR solenoids bracket bolt to 5 N•m (44 lb-in).

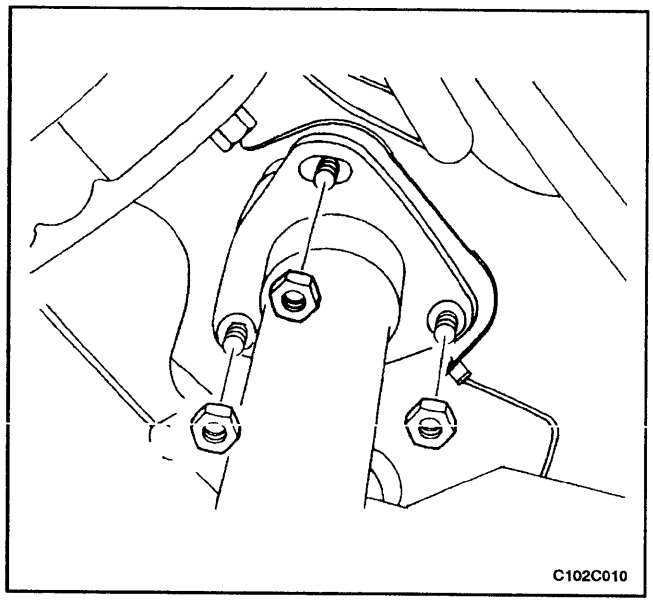
22. Install the fuel pump fuse.
23. Connect the negative battery cable.
24. Refill the engine cooling system. Refer to *Section 1D, Engine Cooling.*



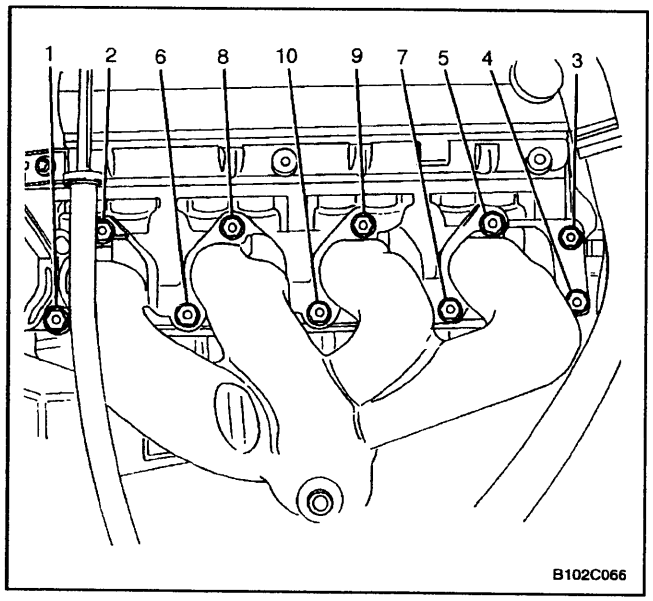
EXHAUST MANIFOLD

Removal Procedure

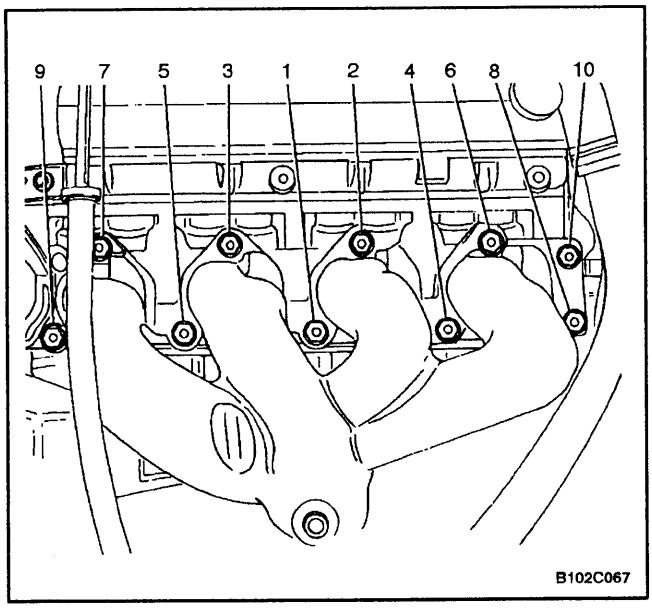
1. Disconnect the negative battery cable.
2. Disconnect the oxygen sensor connector.
3. Remove the exhaust manifold heat shield bolts.
4. Remove the exhaust manifold heat shield.



5. Remove the exhaust flex pipe retaining nuts from the exhaust manifold studs.



6. Remove the exhaust manifold retaining nuts in the sequence shown.
7. Remove the exhaust manifold.
8. Remove the exhaust manifold gasket.
9. Clean the sealing surfaces of the exhaust manifold and the cylinder head.

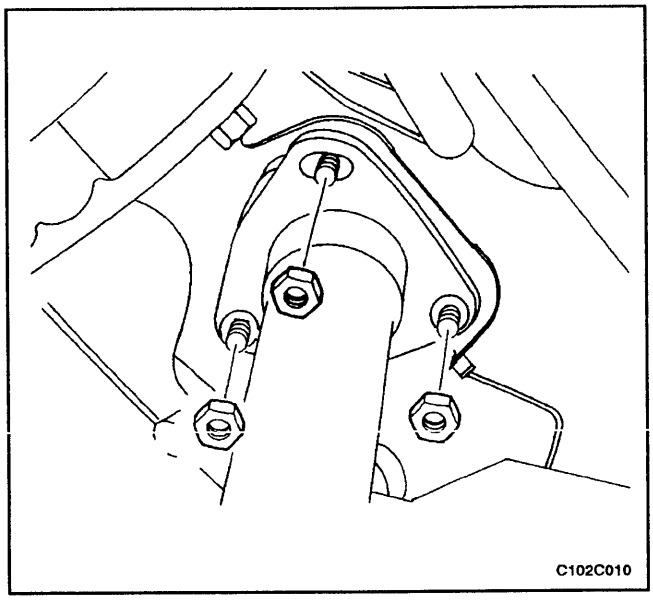


Installation Procedure

1. Install the exhaust manifold gasket.
2. Install the exhaust manifold.
3. Install the exhaust manifold retaining nuts and tighten in the sequence shown.

Tighten

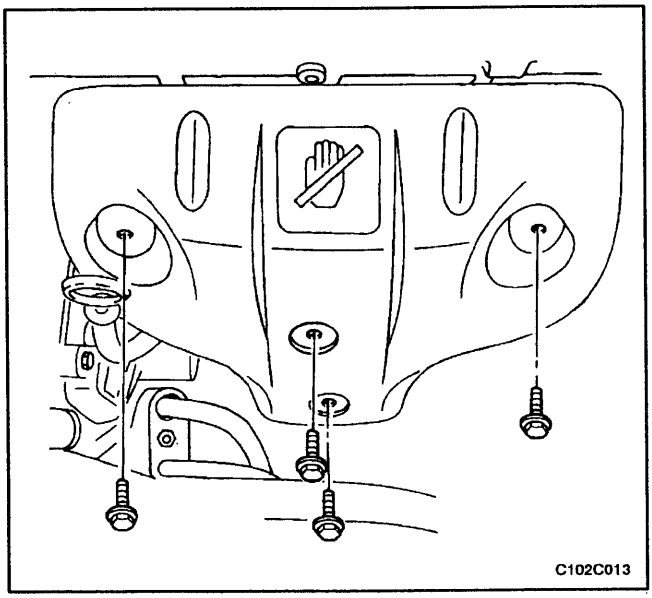
Tighten the exhaust manifold retaining nuts 22 N•m (16 lb-ft).



4. Install the exhaust flex pipe retaining nuts to the exhaust manifold.

Tighten

Tighten the exhaust flex pipe-to-exhaust manifold retaining nuts to 22 N•m (16 lb-ft).

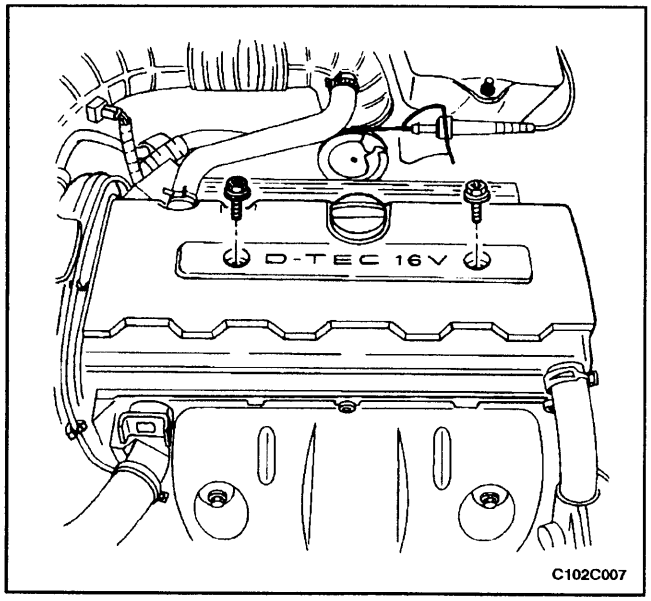


5. Install the exhaust manifold heat shield.
6. Install the exhaust manifold heat shield bolts.

Tighten

Tighten the exhaust manifold heat shield bolts to 8 N•m (71 lb-in).

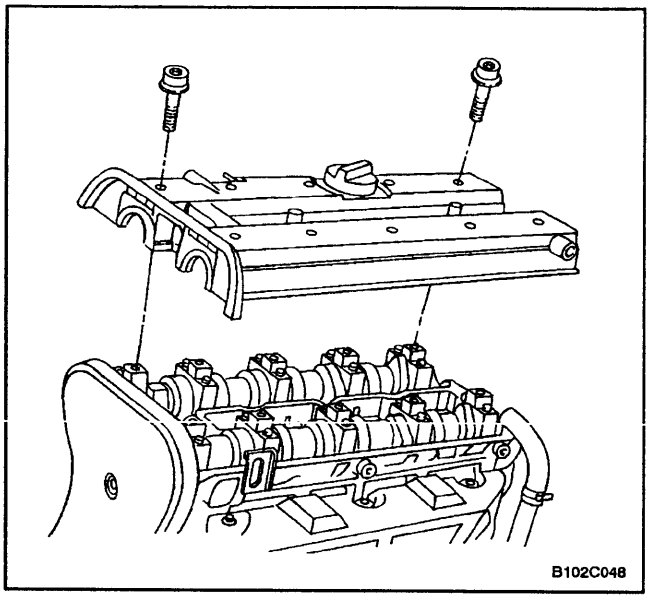
7. Connect the oxygen sensor connector.
8. Connect the negative battery.



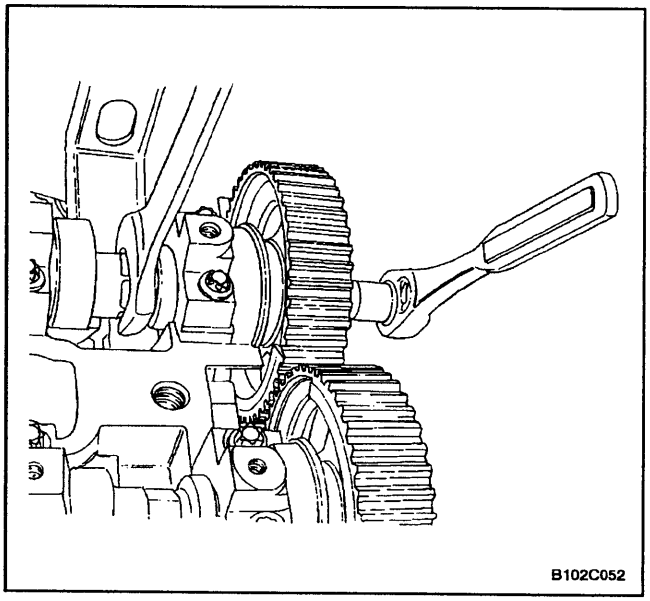
CAMSHAFT GEARS

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the timing belt. Refer to "Timing Belt" in this section.
3. Remove the spark plug cover bolts.
4. Remove the spark plug cover.
5. Disconnect the ignition wires from the spark plugs.
6. Disconnect the crankcase breather tubes from the valve cover.

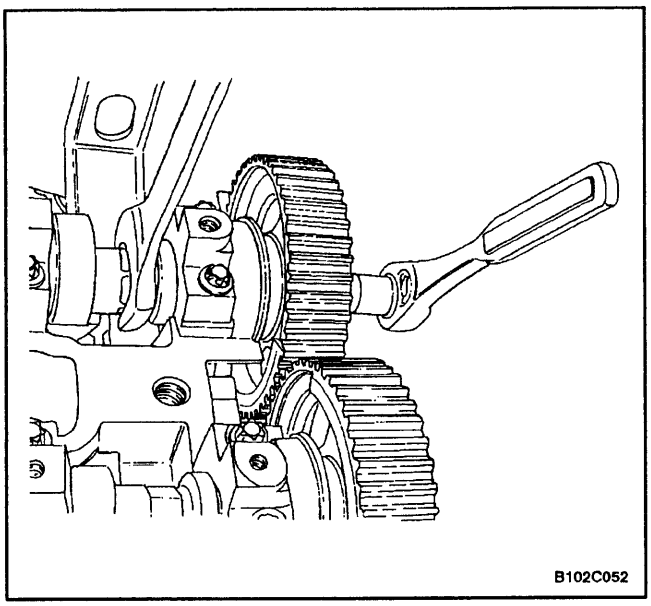


7. Remove the valve cover bolts.
8. Remove the valve cover washers.
9. Remove the valve cover and the valve cover gasket.



Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

10. While holding the intake camshaft firmly in place, remove the intake camshaft gear bolt.
11. Remove the intake camshaft gear.
12. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft gear bolt.
13. Remove the exhaust camshaft gear.


B102C052

Installation Procedure

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

1. Install the intake camshaft gear.
2. While holding the intake camshaft firmly in place, install the intake camshaft gear bolt.

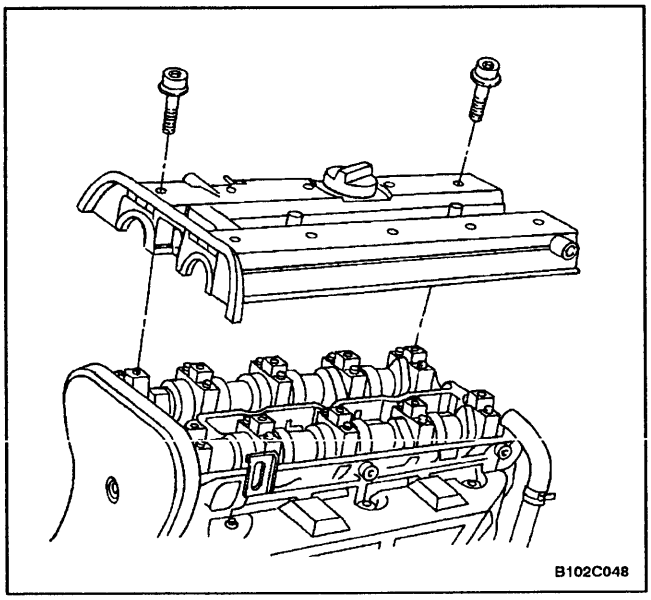
Tighten

Tighten the intake camshaft gear bolt to 50 N•m (37 lb-ft), turn another 60 degrees plus 15 degrees.

3. Install the exhaust camshaft gear.
4. While holding the exhaust camshaft firmly in place, install the exhaust camshaft gear bolt.

Tighten

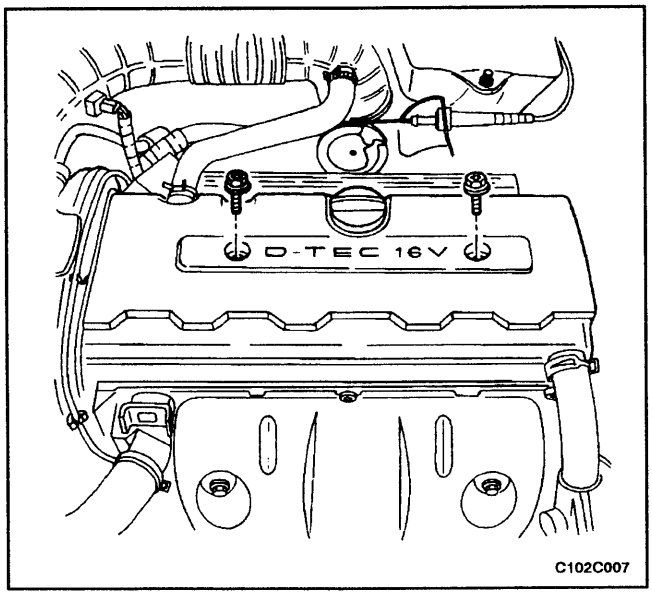
Tighten the exhaust camshaft gear bolt to 50 N•m (37 lb-ft), turn another 60 degrees plus 15 degrees.


B102C048

5. Apply a small amount of gasket sealant to the corners of the front camshaft caps and to the top of the rear valve cover-to-cylinder head seal.
6. Install the valve cover and the valve cover gasket.
7. Install the valve cover washers.
8. Install the valve cover bolts.

Tighten

Tighten the valve cover bolts to 8 N•m (71 lb-in).



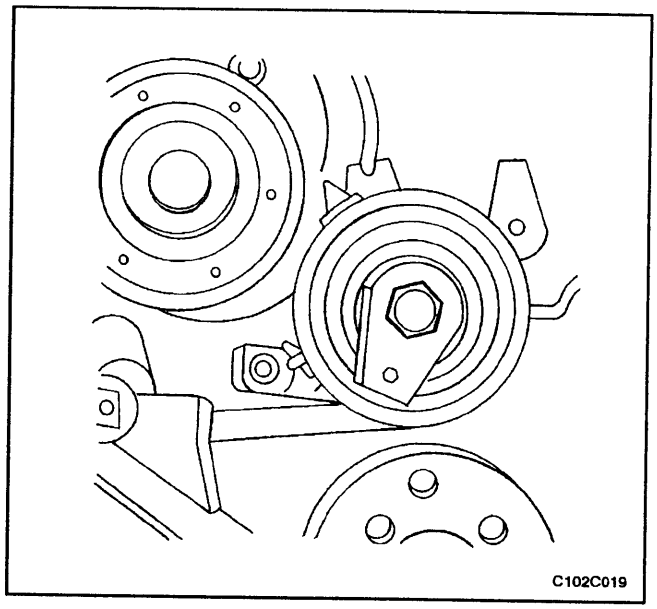
C102C007

9. Connect the crankcase breather tubes to the valve cover.
10. Connect the ignition wires to the spark plugs.
11. Install the spark plug cover.
12. Install the spark plug cover bolts.

Tighten

Tighten the spark plug cover bolts to 3 N•m (27 lb-in).

13. Install the timing belt. Refer to "Timing Belt" in this section.
14. Connect the negative battery cable.


C102C019

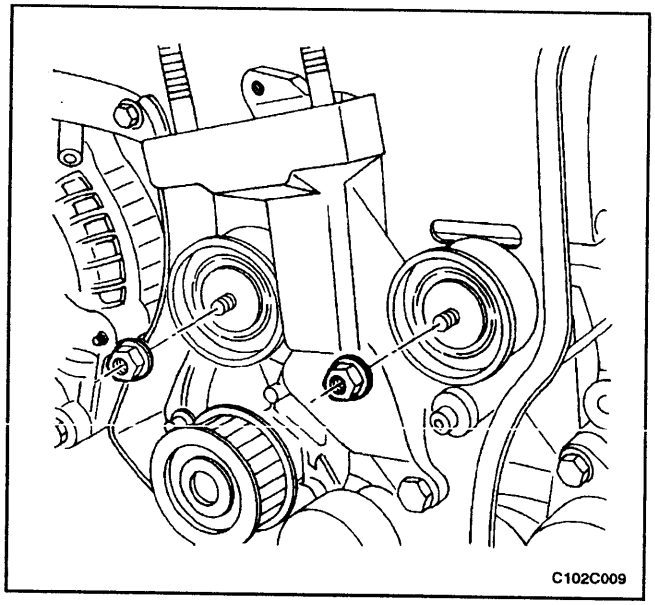
REAR TIMING BELT COVER

Tools Required

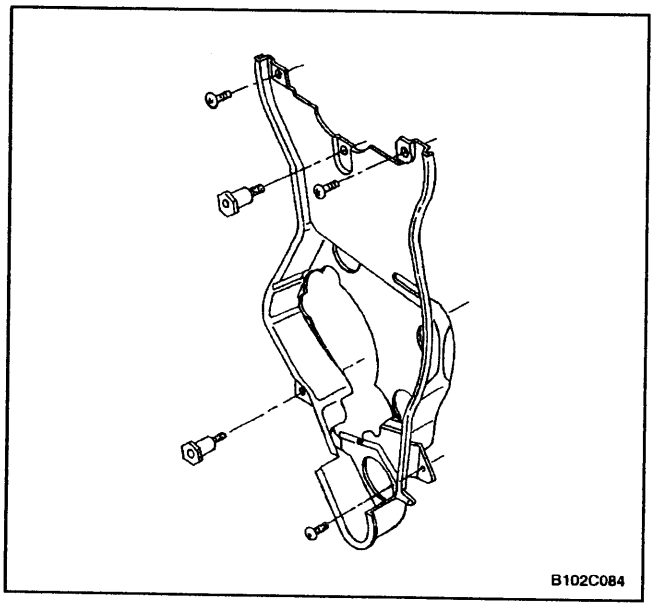
KM-470-B Torque Angular Gauge

Removal Procedure

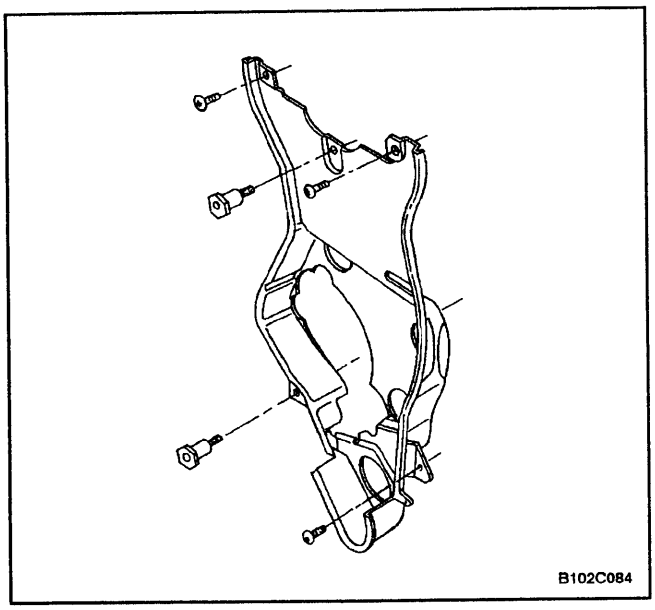
1. Disconnect the negative battery cable.
2. Remove the timing belt. Refer to "Timing Belt" in this section.
3. Remove the camshaft gears. Refer to "Camshaft Gears" in this section.
4. Remove the timing belt automatic tensioner bolt.
5. Remove the timing belt automatic tensioner.


C102C009

6. Remove the timing belt idler pulley nuts.
7. Remove the timing belt idler pulleys.
8. Remove the engine mount retaining bolts.
9. Remove the engine mount.
10. Remove the crankshaft timing belt drive gear bolt.
11. Remove the crankshaft gear.


B102C084

12. Remove the rear timing belt cover bolts.
13. Remove the rear timing belt cover.


B102C084

Installation Procedure

1. Install the rear timing belt cover.
2. Install the rear timing belt cover bolts.

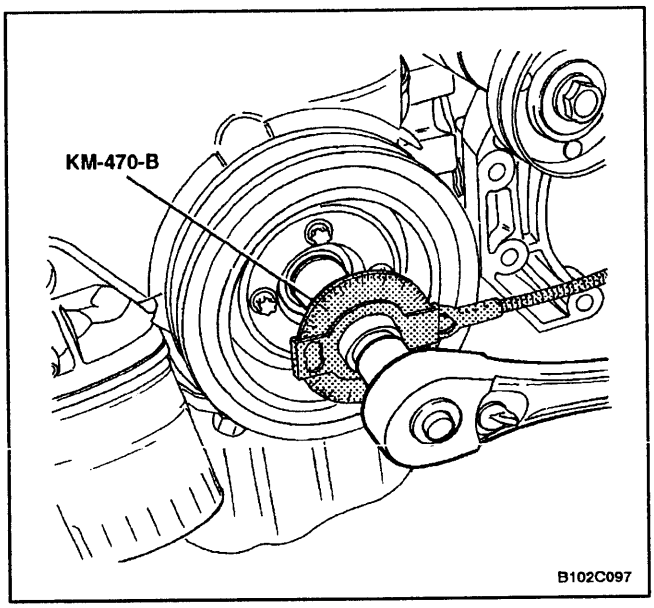
Tighten

Tighten the rear timing belt cover bolts to 10 N•m (89 lb-in).

3. Install the engine mount and the retaining bolts.

Tighten

Tighten the engine mount bolts to 60 N•m (44 lb-ft).



B102C097

4. Install the timing belt idler pulleys.
5. Install the timing belt idler pulley nuts.

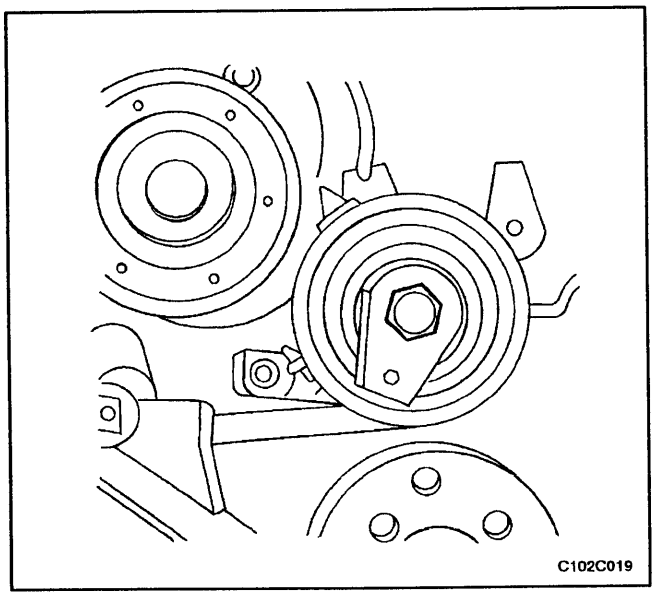
Tighten

Tighten the timing belt idler pulley nuts to 25 N•m (18 lb-ft).

6. Install the crankshaft timing belt drive gear and bolt.

Tighten

Tighten the crankshaft timing belt drive gear bolt to 130 N•m (96 lb-ft) plus 40° plus 50° using the angular torque gauge KM-470-B.

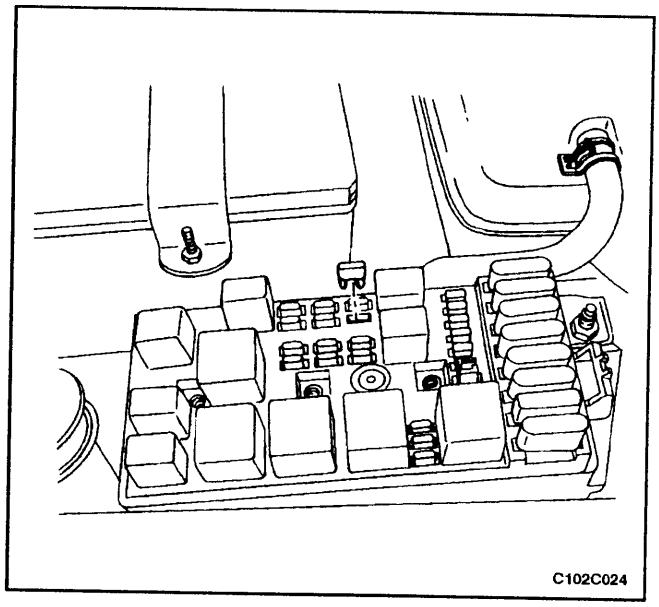

C102C019

7. Install the timing belt automatic tensioner and bolt.

Tighten

Tighten the timing belt automatic tensioner bolt to 25 N•m (18 lb-ft).

8. Install the camshaft gears. Refer to "Camshaft Gears" in this section.
9. Install the timing belt and timing belt cover. Refer to "Timing Belt" in this section.
10. Connect the negative battery cable.

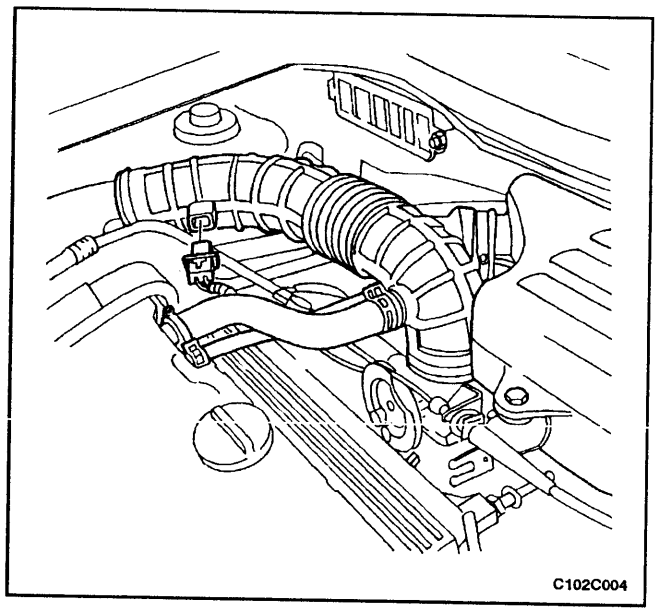

C102C024

ENGINE

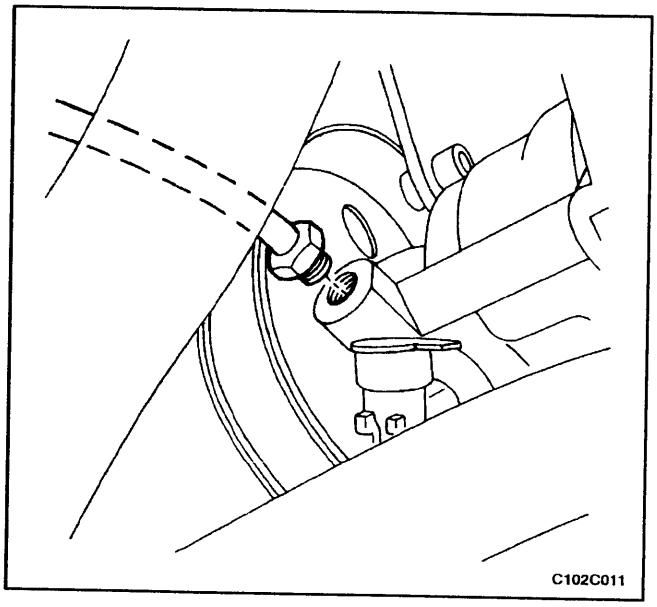
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

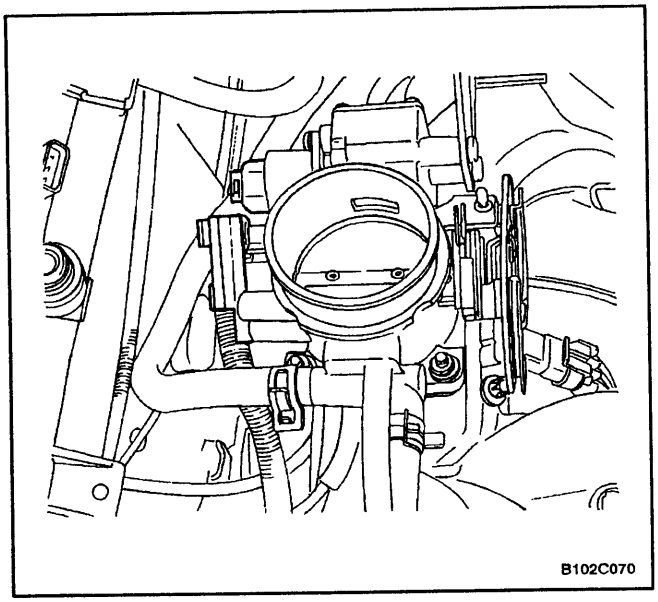
1. Remove the fuel pump fuse.
2. Start the engine. After it stalls, crank the engine for 10 seconds to rid the fuel system of fuel pressure.
3. Remove the hood. Refer to *Section 9R, Body Front End.*
4. Drain the engine oil.
5. Disconnect the negative battery cable.


C102C004

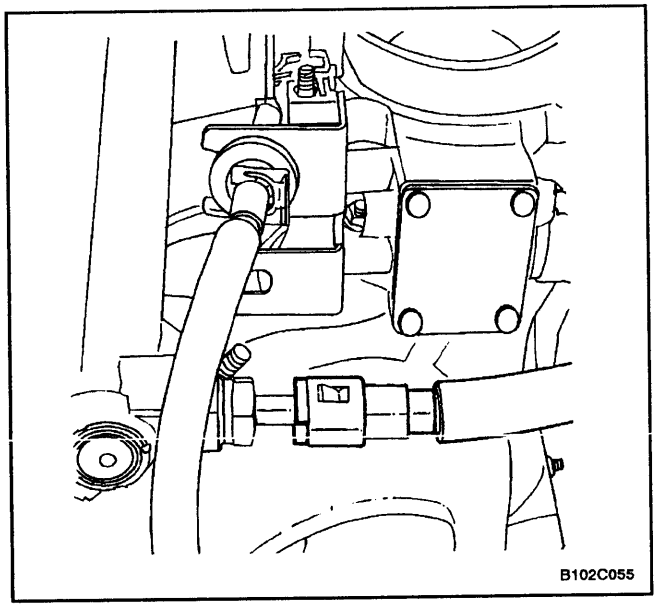
6. Discharge the air conditioning (A/C) system, if equipped. Refer to *Section 7B, Manual Control Heating, Ventilation, and Air Conditioning System.*
7. Disconnect the manifold air temperature sensor connector.
8. Remove the air intake tube.
9. Disconnect the breather tubes from the valve cover.
10. Remove the right front wheel. Refer to *Section 2E, Tires and Wheels.*
11. Remove the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
12. Remove the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*


C102C011

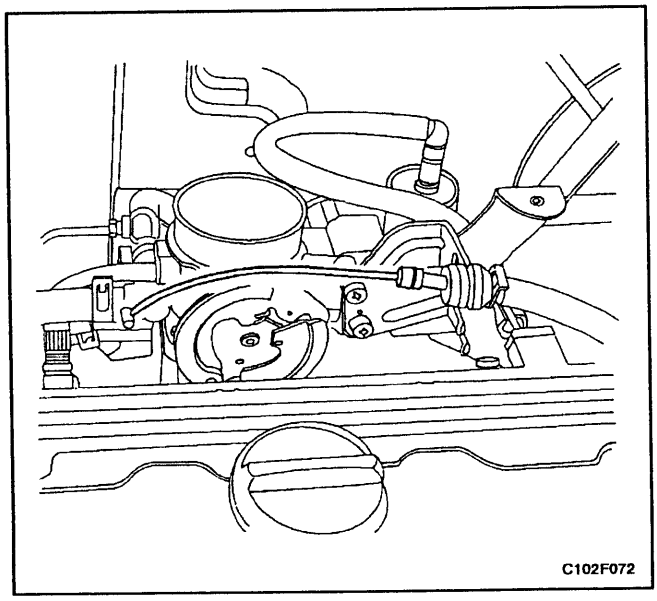
13. Drain the engine coolant. Refer to *Section 1D, Engine Cooling.*
14. Remove the cooling system radiator and the engine cooling fans. Refer to *Section 1D, Engine Cooling.*
15. Disconnect the upper radiator hose from the thermostat housing.
16. Disconnect the power steering return hose from the power steering pump. Collect the oil in a suitable container.
17. Disconnect the power steering pressure hose from the power steering pump. Collect the oil in a suitable container.
18. Disconnect the electrical connector at the direct ignition system (DIS) ignition coil and the electronic control module (ECM) ground terminal.


B102C070

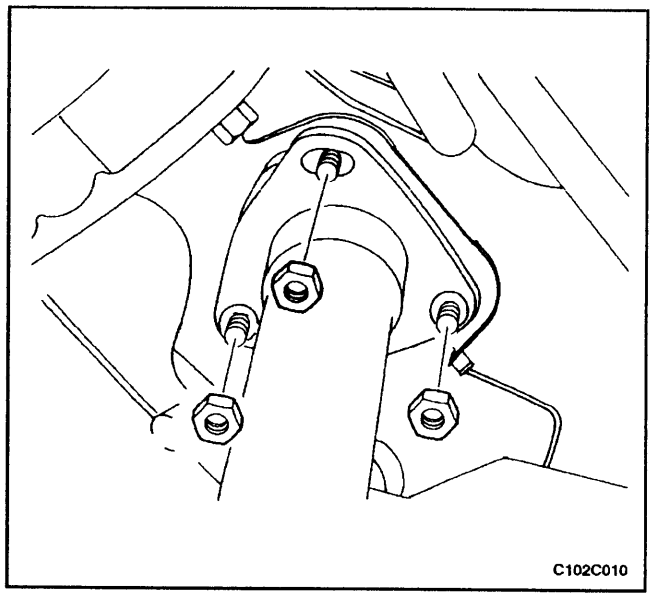
19. Disconnect the oxygen sensor connector.
20. Disconnect the idle air control valve connector and the manifold absolute pressure (MAP) sensor connector.
21. Disconnect the throttle position sensor (TPS) connector.
22. Disconnect the engine coolant temperature sensor (CTS) connector.
23. Disconnect the CTS connector.
24. Disconnect the alternator voltage regulator connector and the power lead.


B102C055

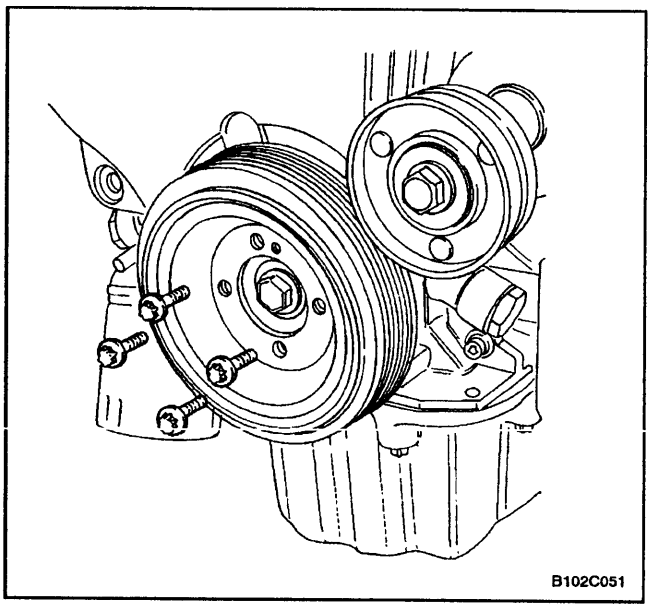
25. Disconnect all of the necessary vacuum lines including the brake booster vacuum hose.
26. Disconnect the fuel return line at the fuel pressure regulator.
27. Disconnect the fuel feed line at the fuel rail.
28. Remove the fuel rail and the injector channel cover as an assembly. Refer to *Section 1F, Engine Controls*.


C102F072

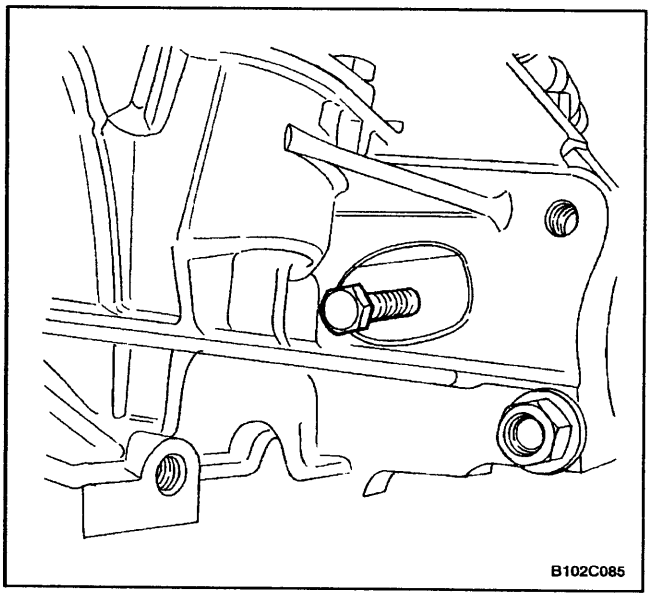
29. Disconnect the throttle cable from the throttle body and the intake manifold bracket.
30. Disconnect the coolant hose at the throttle body.
31. Disconnect the heater outlet hose at the coolant pipe.
32. Disconnect the coolant bypass hose from the cylinder head.
33. Disconnect the surge tank coolant hose from the coolant pipe.
34. Disconnect the lower radiator hose from the coolant pipe.
35. Disconnect the starter solenoid "S" terminal wire and the power lead.
36. Remove the A/C compressor. Refer to *Section 7B, Manual Control Heating, Ventilation, and Air Conditioning System.*



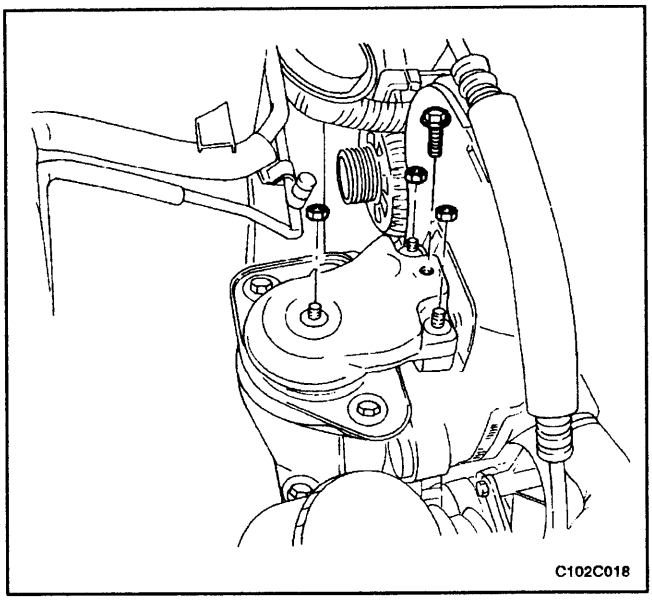
37. Remove the exhaust flex pipe retaining nuts from the exhaust manifold studs and the support bracket.
38. Remove the exhaust flex pipe retaining nuts from the catalytic converter.
39. Remove the exhaust flex pipe.



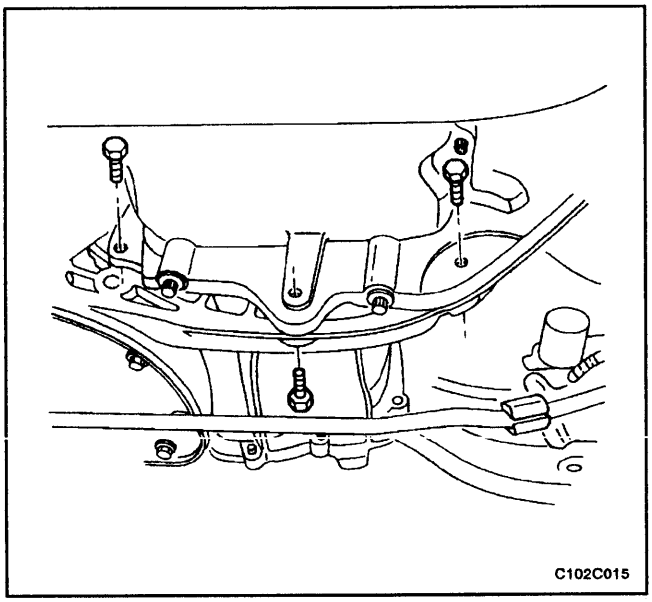
40. Remove the crankshaft pulley bolts.
41. Remove the crankshaft pulley.
42. Disconnect the vacuum lines at the charcoal canister purge (CCP) and the exhaust gas recirculation (EGR) solenoids.
43. Disconnect the electrical connectors at the CCP and the EGR solenoids.
44. Disconnect the electrical connector at the oil pressure switch.
45. Disconnect the crankshaft position and the knock sensor connectors.
46. Support the transaxle with a floor jack.
47. Remove the center member. Refer to *Section 9N, Frame and Underbody.*
48. Install the engine lifting device.



49. Remove the transaxle torque converter bolts from vehicles with an automatic transaxle.
50. Remove the transaxle bell housing bolts and the oil pan flange bolts.
51. Remove the right engine mount bracket. Refer to *Section 5B, Five-Speed Manual Transaxle,* or *Section 5A, ZF 4 HP 14 Automatic Transaxle.*
52. Remove the resonator bolts and the resonator.
53. Remove the air filter housing and the bolts.


C102C018

54. Disconnect the right engine mount bracket from the engine mount and the engine by removing the retaining bolts.
55. Separate the engine block from the transaxle. Remove the engine.


C102C015

Installation Procedure

1. Install the engine into the engine compartment.
2. Align the engine alignment pins to the transaxle.
3. Install the transaxle bell housing bolts.

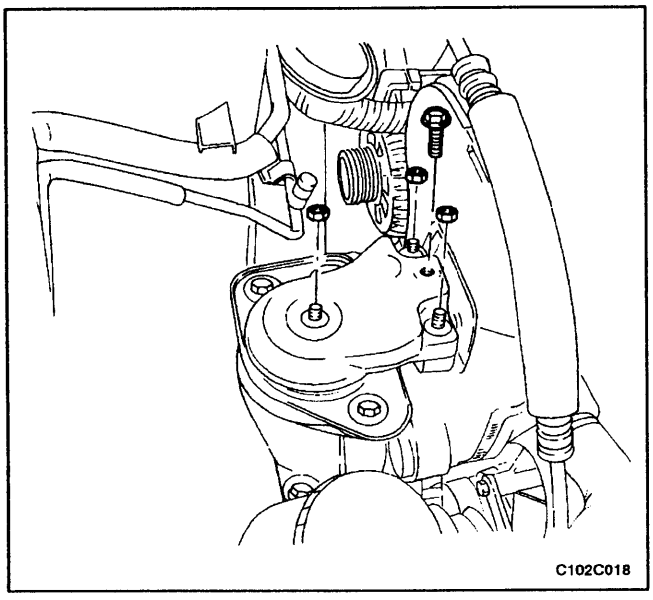
Tighten

Tighten the transaxle bell housing bolts to 75 N•m (55 lb-ft).

4. Install the oil pan flange-to-transaxle retaining bolts.

Tighten

Tighten the oil pan flange-to-transaxle retaining bolts to 40 N•m (30 lb-ft).

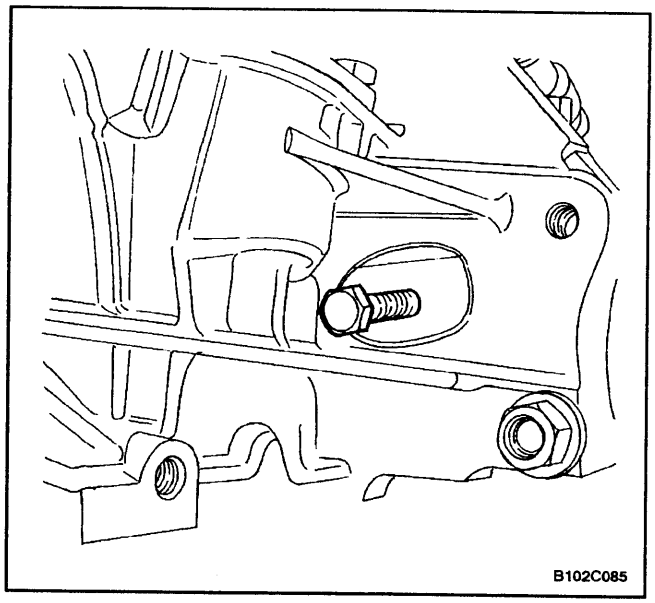

C102C018

5. Install the right engine mount bracket to the engine block mount and the frame mount.
6. Install the right engine mount bracket retaining bolts and the nuts.

Tighten

Tighten the engine mount bolts and the nuts to 60 N•m (44 lb-ft).

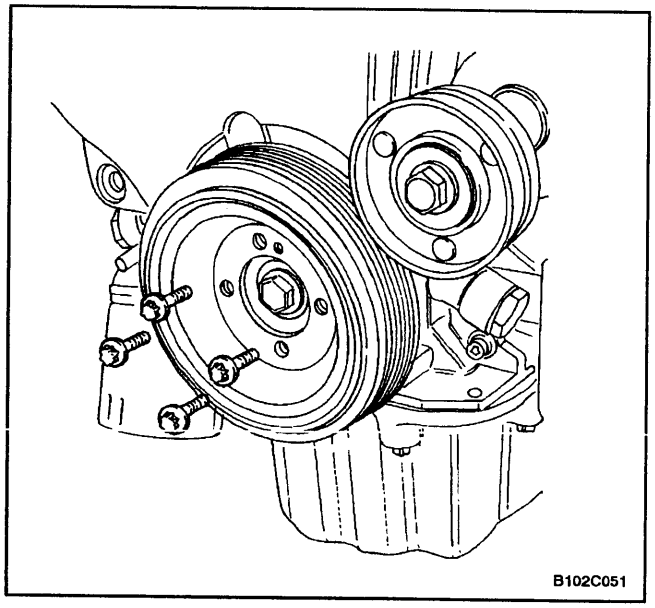
7. Install the rear engine/transaxle mount bracket. Refer to *Section 5A, ZF 4 HP 14 Automatic Transaxle,* or *Section 5B, Five-Speed Manual Transaxle.*
8. Install the center member. Refer to *Section 9N, Frame and Underbody.*



9. Remove the floor jack used for support of the transaxle.
10. Remove the engine lifting device.
11. Install the transaxle torque converter bolts on vehicles with an automatic transaxle.

Tighten

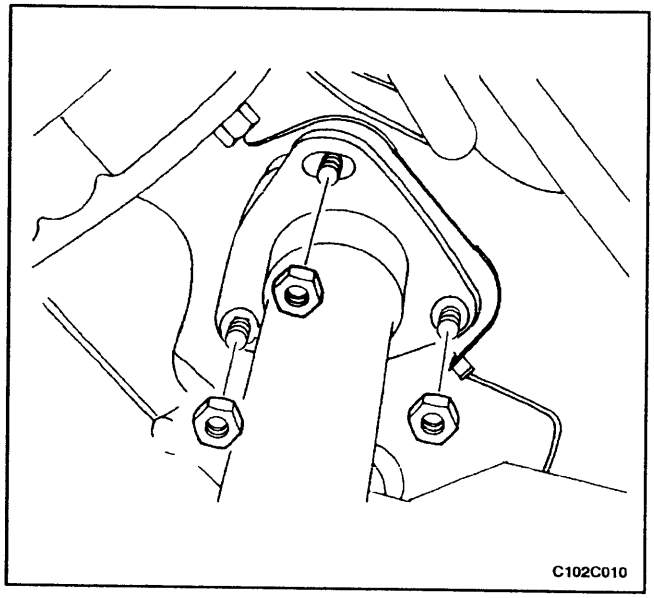
Tighten the transaxle torque converter bolts to 60 N•m (44 lb-ft).



12. Connect the vacuum lines at the charcoal canister purge and the EGR solenoids.
13. Connect the electrical connectors to the charcoal canister purge and the EGR solenoids.
14. Connect the oil pressure switch connector.
15. Install the crankshaft pulley.
16. Install the crankshaft pulley bolts.

Tighten

Tighten the crankshaft pulley bolts to 20 N•m (15 lb-ft) using a torque wrench.



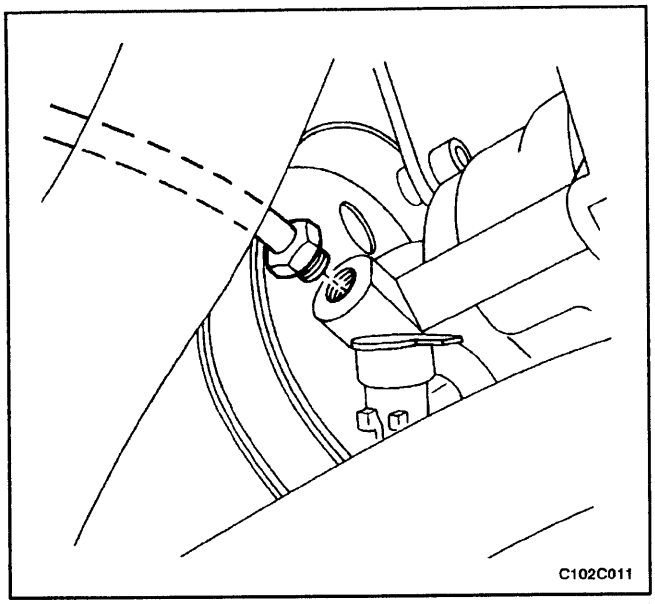
17. Connect the crankshaft position and the knock sensor connectors.
18. Install the exhaust flex pipe.
19. Install the exhaust flex pipe retaining nuts to the exhaust manifold studs and the support bracket.

Tighten

Tighten the exhaust flex pipe-to-exhaust manifold retaining nuts to 22 N•m (16 lb-ft).

Tighten

Tighten the exhaust flex pipe support bracket bolts to 30 N•m (22 lb-ft).

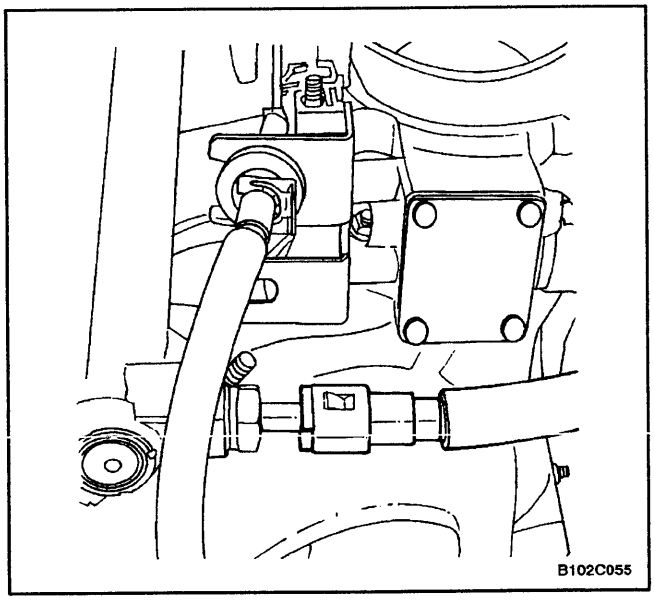


20. Install the exhaust flex pipe retaining nuts to the catalytic converter.

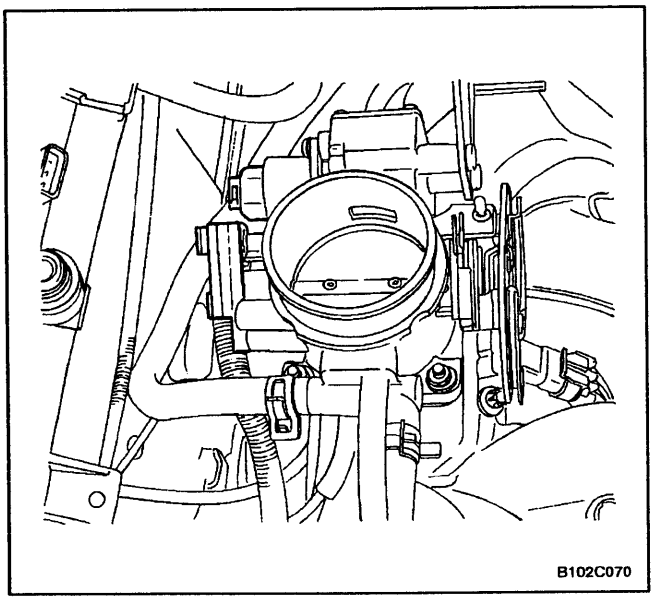
Tighten

Tighten the exhaust flex pipe-to-catalytic converter retaining nuts to 30 N•m (22 lb-ft).

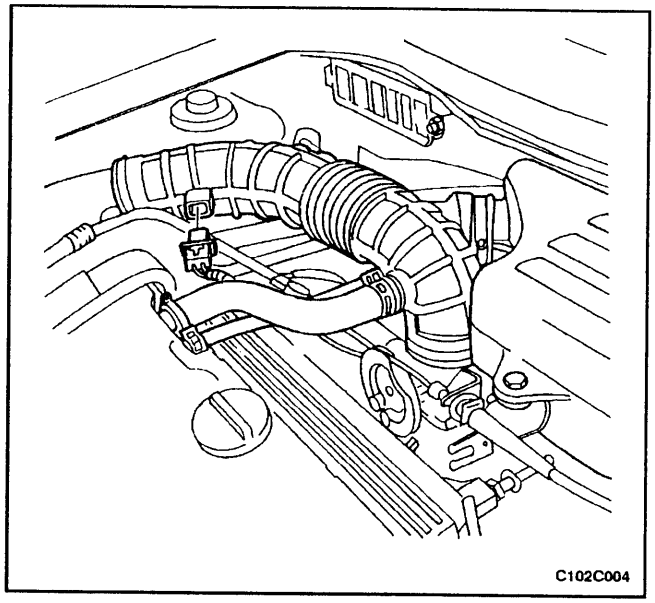
21. Connect the power steering pressure hose.
22. Connect the power steering return hose.
23. Install the A/C compressor, if equipped. Refer to *Section 7B, Manual Control Heating, Ventilation, and Air Conditioning System*.



24. Install the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*
25. Install the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
26. Install the right front wheel. Refer to *Section 2E, Tires and Wheels*.
27. Connect the fuel feed line to the fuel rail.
28. Connect the fuel return line to the fuel pressure regulator.
29. Install the fuel rail and the injector channel cover as an assembly. Refer to *Section 1F, Engine Controls.*



30. Connect all of the necessary vacuum lines including the brake booster vacuum hose.
31. Connect the oxygen sensor connector.
32. Connect the starter solenoid "S" terminal wire and the power lead.
33. Connect the alternator voltage regulator connector.
34. Connect the coolant temperature sensor connector.
35. Connect the engine coolant temperature sensor connector.
36. Connect the TPS connector.
37. Connect the IAC valve connector.
38. Connect the MAP sensor connector.


C102C004

39. Connect the electrical connector at the DIS ignition coil and the ECM ground terminal.
40. Install the air intake tube.
41. Install the air filter housing and the bolts.

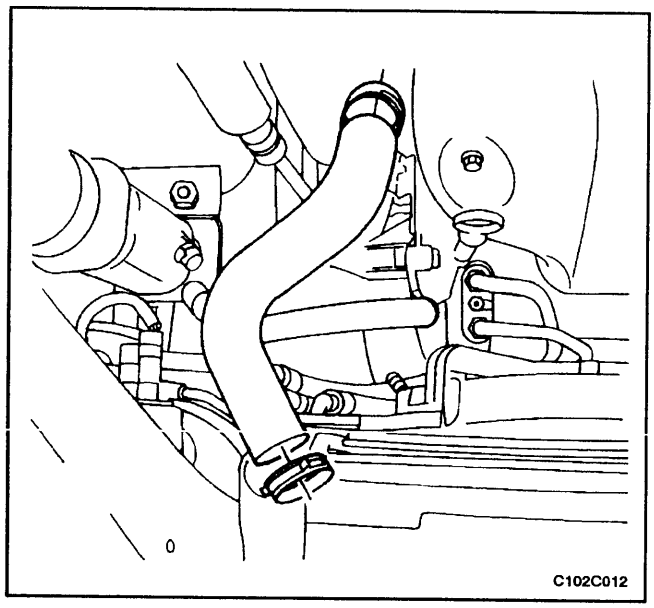
Tighten

Tighten the air filter housing bolts to 8 N•m (71 lb-in).

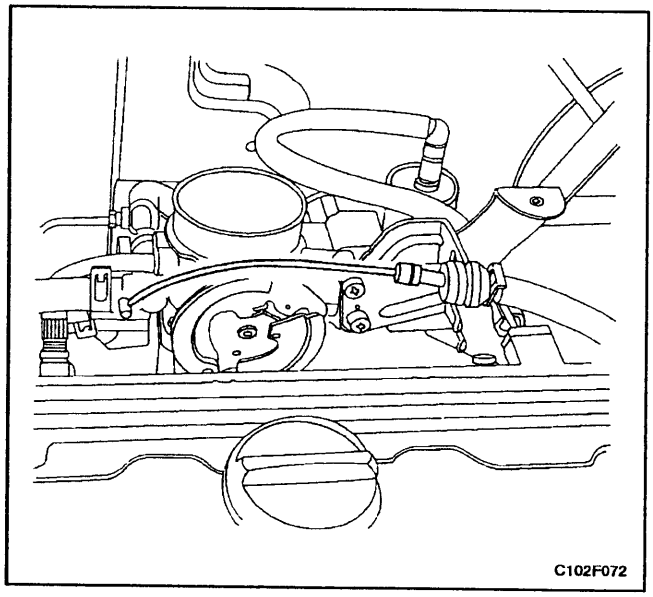
42. Connect the breather tubes to the valve cover.
43. Connect the manifold air temperature sensor connector.
44. Install the cooling system radiator and the engine cooling fans. Refer to *Section 1D, Engine Cooling.*
45. Install the resonator and the retaining bolts.

Tighten

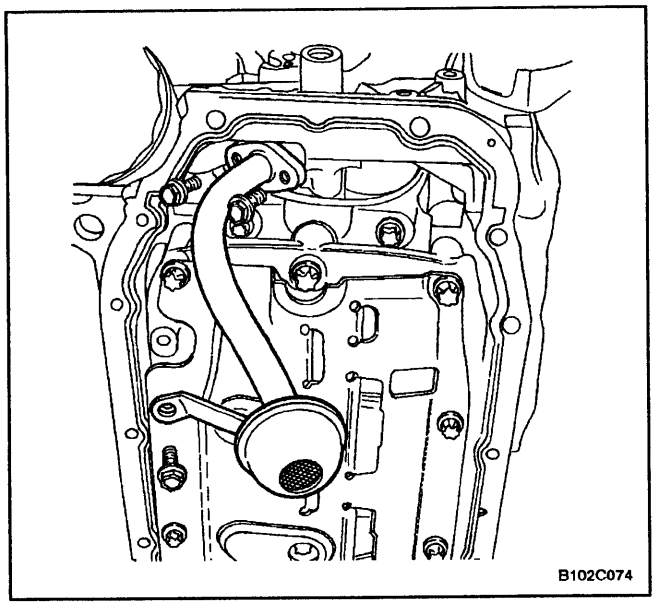
Tighten the resonator retaining bolts to 8 N•m (71 lb-in).


C102C012

46. Connect the lower radiator hose to the coolant pipe.
47. Connect the upper radiator hose to the thermostat housing.
48. Connect the heater inlet hose to the cylinder head.
49. Connect the heater outlet hose to the coolant pipe.
50. Connect the coolant surge tank hose to the coolant pipe.
51. Connect the coolant hose to the throttle body.


C102F072

52. Connect the throttle cable to the throttle body and the intake manifold bracket.
53. Install the fuel pump fuse.
54. Connect the negative battery cable.
55. Refill the engine crankcase with engine oil.
56. Refill the engine coolant system. Refer to *Section 1D, Engine Cooling.*
57. Fill and bleed the power steering system. Refer to *Section 6A, Power Steering System.*
58. Refill the A/C refrigerant system, if equipped. Refer to *Section 7B, Manual Control Heating, Ventilation, and Air Conditioning System.*
59. Install the hood. Refer to *Section 9R, Body Front End.*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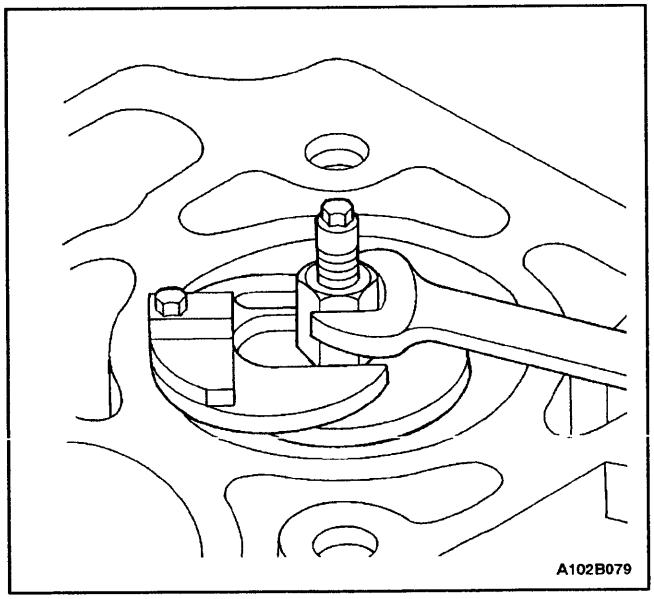
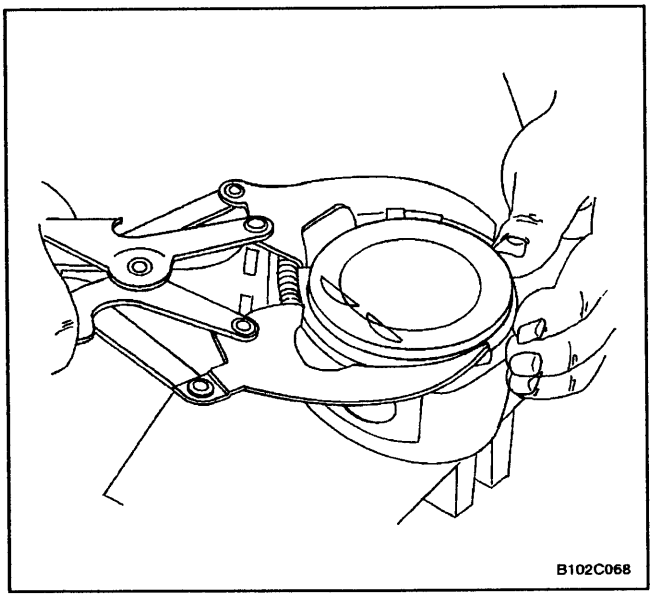

A102B079


B102C068

PISTONS AND CONNECTING RODS

Tools Required

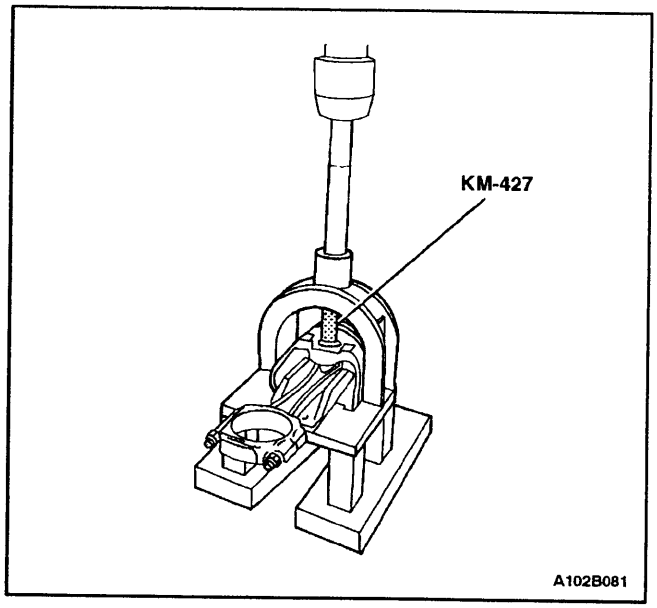
J-8037 Universal Piston Ring Compressor
J-8087 Cylinder Bore Check Gauge
KM-427 Piston Pin Service Set
KM-470-B Angular Torque Gauge

Removal Procedure

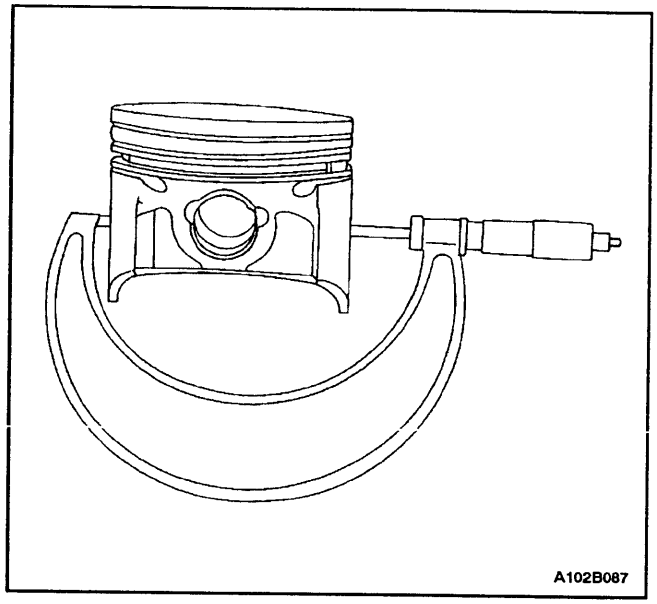
1. Remove the cylinder head with the intake manifold and the exhaust manifold attached. Refer to "Cylinder Head and Gasket" in this section.
2. Remove the oil pan. Refer to "Oil Pan" in this section.
3. Remove the oil pump pickup tube bolts.
4. Remove the oil pump pickup tube.
5. Remove the engine block lower support and the splash shield bolts.
6. Remove the engine block lower support and the splash shield.
7. Move the piston to the bottom of the piston stroke.
8. Mark the connecting rod cap for position.
9. Remove the connecting rod cap bolts.
10. Remove the connecting rod cap and the lower connecting rod bearing.
11. Remove the upper piston connecting rod bearing.
12. Ridge ream the cylinder wall.

Caution: Use care when handling the piston. Worn piston rings are sharp and may cause injury.

13. Remove the piston.
14. Use a piston ring expander tool to expand the piston rings.
15. Remove the piston rings.

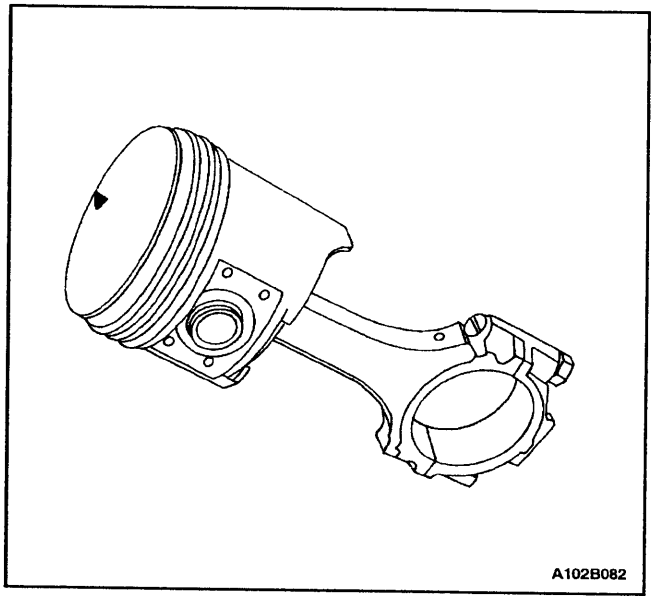


16. Remove the piston pin from the piston and connecting rod assembly using the piston pin service set KM-427.
17. Separate the piston from the connecting rod.

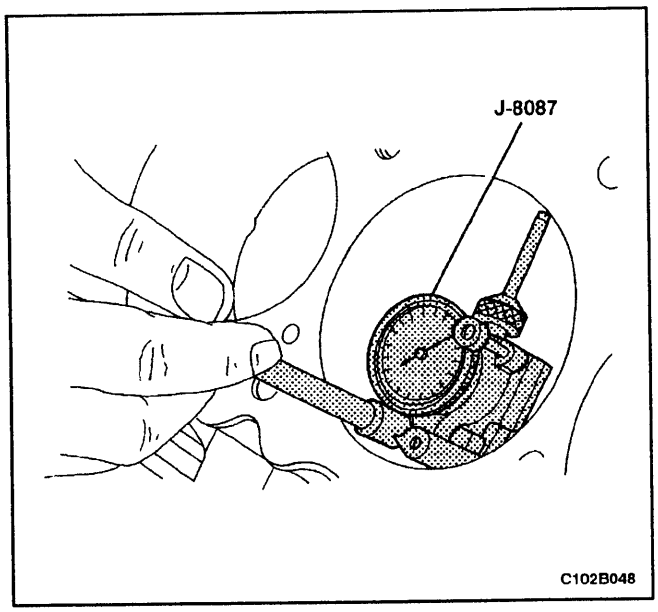


Inspection Procedure

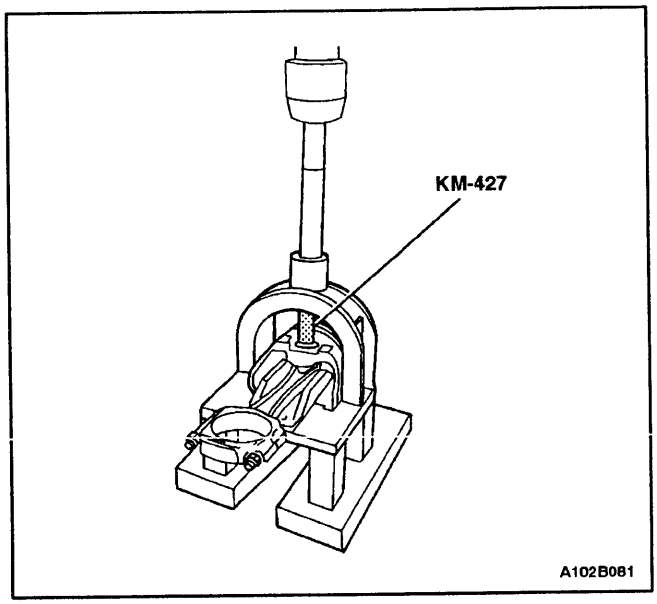
1. Inspect the connecting rod for bending or twisting. If the connecting rod is bent or twisted, replace the connecting rod.
2. Inspect the connecting rod bearings.
3. Inspect the connecting rod lower end for wear.
4. Inspect the connecting rod upper end for scoring.
5. Inspect the crankshaft rod bearing journal for wear. Refer to "Engine Specifications" in this section.
6. Inspect the piston for scoring, cracks, and wear.
7. Inspect the piston for taper using a micrometer.



8. Inspect the piston for fit to the connecting rod.



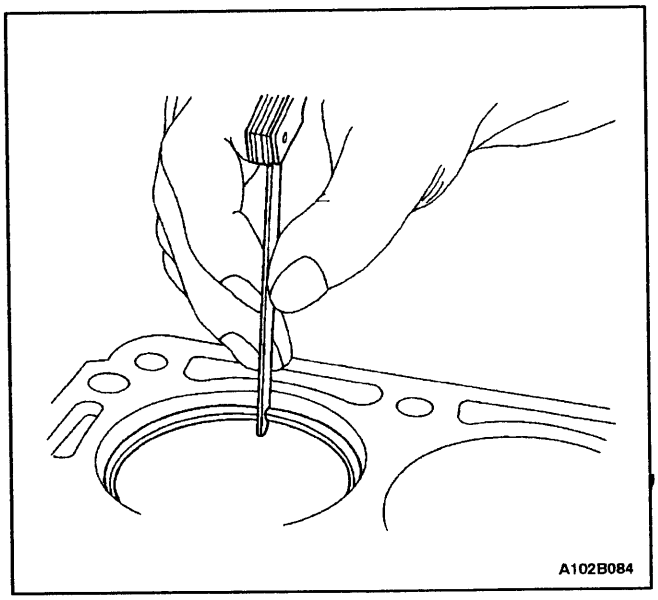
9. Inspect the engine block deck surface for flatness using a straight edge and a feeler gauge. Refer to "Engine Specifications" in this section.
10. Inspect the bearing bore for concentricity and alignment using cylinder bore check gauge J-8087. Refer to "Engine Specifications" in this section. If the bearing bore is beyond specifications, replace the engine block.
11. Inspect the engine block cylinder bore for wear, runout, ridging and taper using a bore gauge. Refer to "Engine Specifications" in this section.
12. Inspect the engine block cylinder bore for glazing. Lightly hone the cylinder bore as necessary.



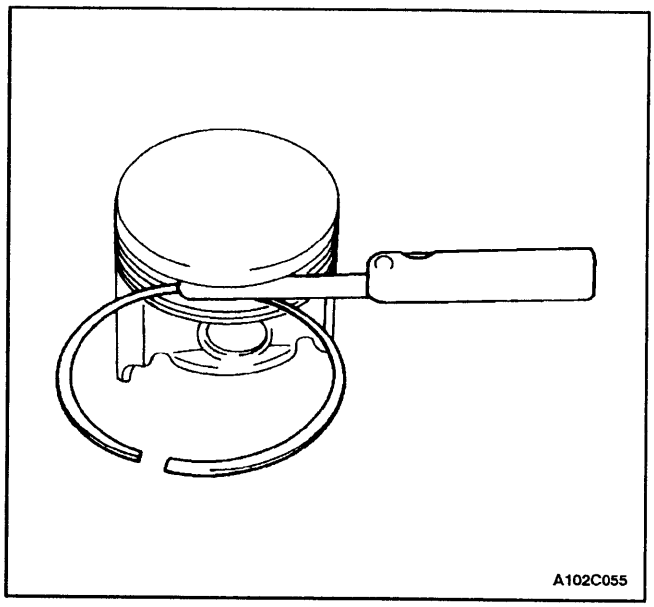
Installation Procedure

Important: For ease of installation of the piston pin, the connecting rod should be heated to 280°C (536°F). Heat the upper connecting rod only. Use commercial thermocolor material to determine the correct temperature. When the thermocolor material changes from black to green, the temperature is correct for installation.

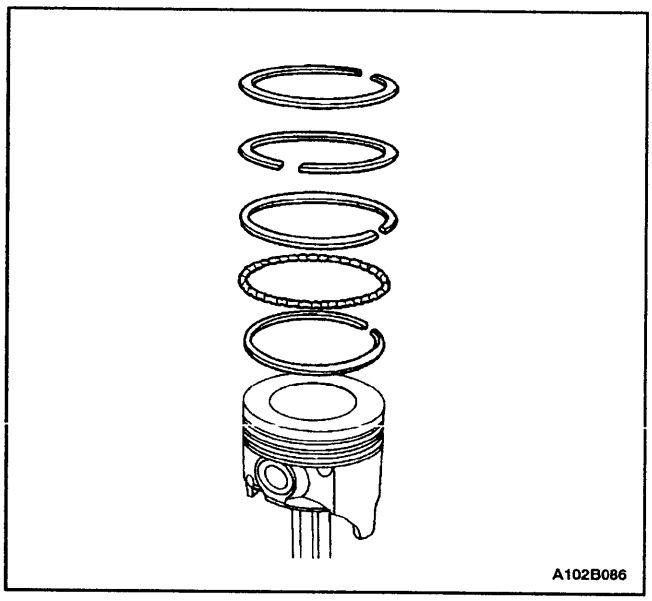
1. Align the notch on the piston and the connecting rod so that the proper sides will be facing the front of the engine.
2. Install the piston pin guide through the piston and the connecting rod.
3. Coat the piston pin with clean oil.
4. Install the piston pin into the opposite side of the piston.
5. Install the piston pin into the piston and the connecting rod assembly using the piston pin service set KM-427.



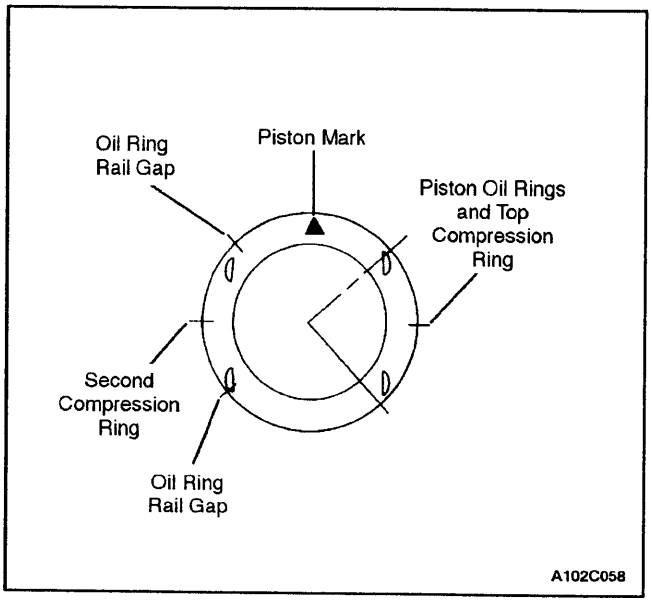
6. Select a set of new piston rings.
7. Measure the piston ring gap using a feeler gauge. Refer to "Engine Specifications" in this section.
8. Increase the piston ring gap by carefully filing off excess material if the piston ring gap is below specifications.


A102C055

9. Measure the piston ring side clearance using a feeler gauge. Refer to "Engine Specifications" in this section.
10. If the piston ring is too thick, try another piston ring.
11. If no piston ring can be found that fits to specifications, the piston ring may be ground to size with emery paper placed on a sheet of glass.

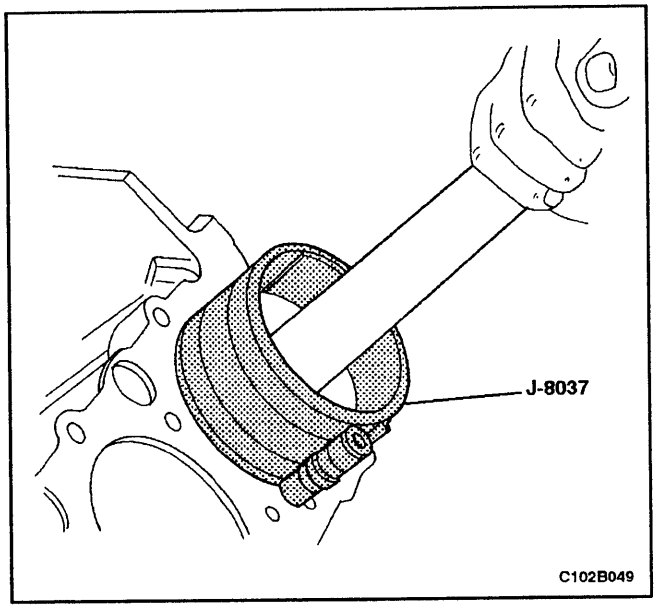

A102B086

12. Install a piston oil ring, the expander, then the second piston oil ring to the bottom ring groove of the piston.
13. Install the second compression ring to the middle ring groove of the piston.
14. Install the top compression ring to the top ring groove of the piston.

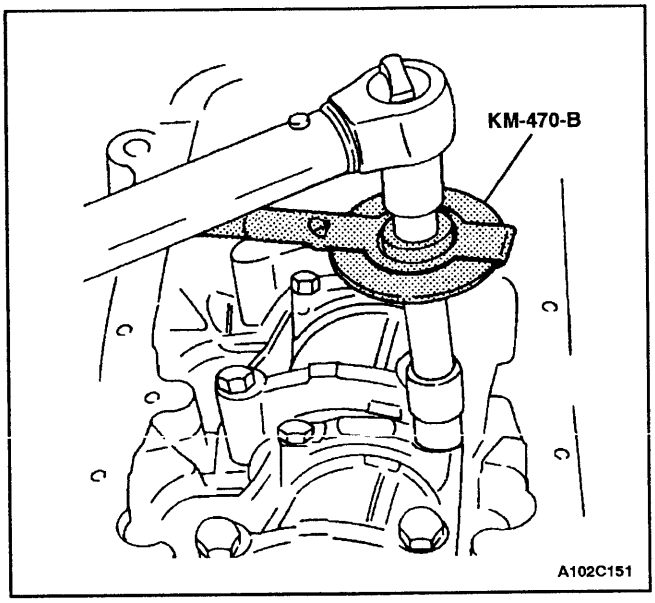


A102C058

15. Use a piston ring expander to install the piston rings. Do not expand the piston rings beyond the expansion necessary for installation.
16. Stagger the piston oil rings, the oil ring rail gaps, the second compression ring, and the top compression ring in relation to the notch on the top of the piston.



17. Lubricate the cylinder wall and the piston rings with clean engine oil.
18. Install the piston using the universal piston ring compressor J-8037 and a wood handle. Guide the lower connecting rod end to prevent damaging the crankshaft journal.
19. Install the connecting rod cap and bearings. Refer to "Crankshaft Bearings and Connecting Rod Bearings - Gauging Plastic" in this section.



20. Install the connecting rod cap bearing bolts.

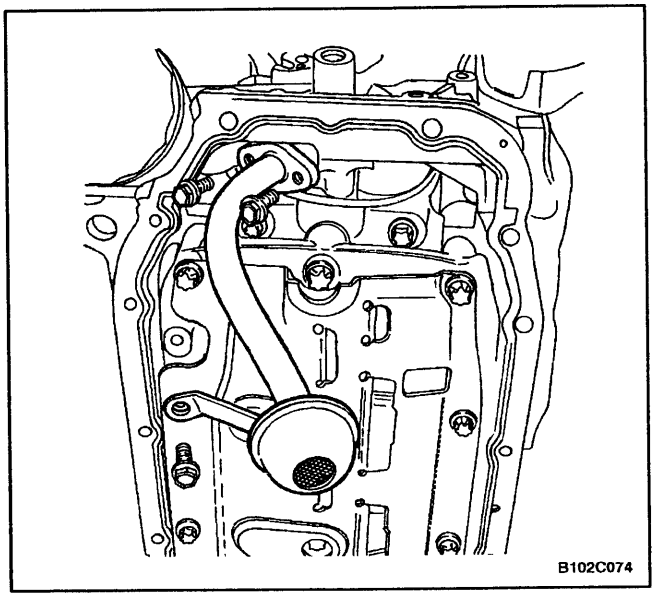
Tighten

Tighten the connecting rod cap bearing bolts to 35 N•m (26 lb-ft). Using the angular torque gauge KM-470-B, tighten the bolts one turn of 45 degrees.

21. Install the engine block lower support bracket/ splash shield bolts.

Tighten

Tighten the engine block lower support bracket/ splash shield bolts to 35 N•m (26 lb-ft).



22. Install the oil pump pickup tube.
23. Install the oil pump pickup tube bolts.

Tighten

Tighten the oil pump pickup tube bolts to 8 N•m (71 lb-in).

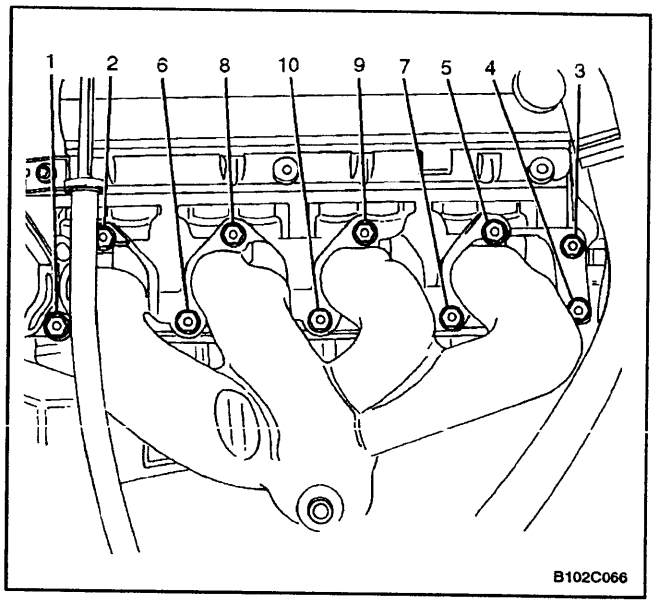
24. Install the oil pan. Refer to "Oil Pan" in this section.
25. Install the cylinder head with the intake manifold and exhaust manifold attached. Refer to "Cylinder Head and Gasket" in this section.

UNIT REPAIR

CYLINDER HEAD AND VALVE TRAIN COMPONENTS

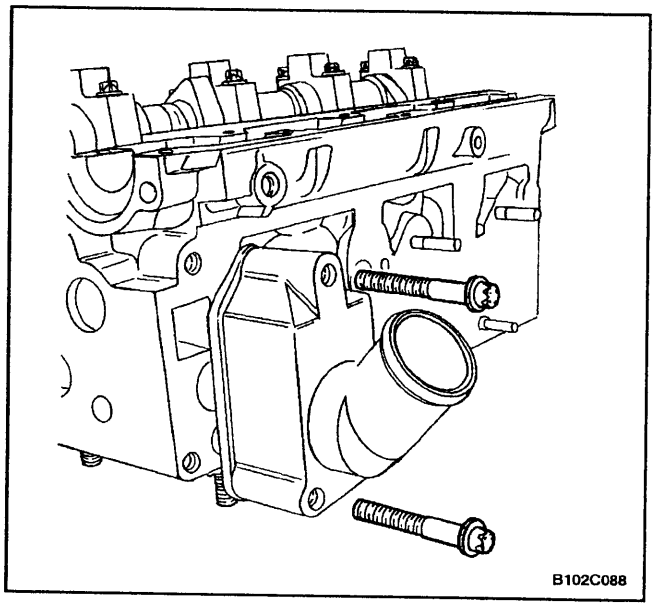
Tools Required

MKM-571-B Gauge
KM-340-0 Cutter Set
  KM-340-7 Guide Drift
  KM-340-13 Cutters
  KM-340-26 Cutters
KM-348 Valve Spring Compressor
KM-653 Adapter
KM-805 Valve Guide Reamer

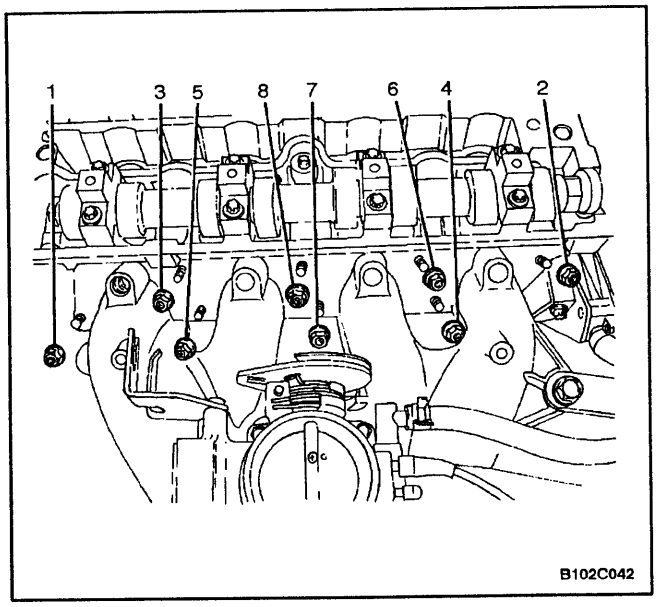


Disassembly Procedure

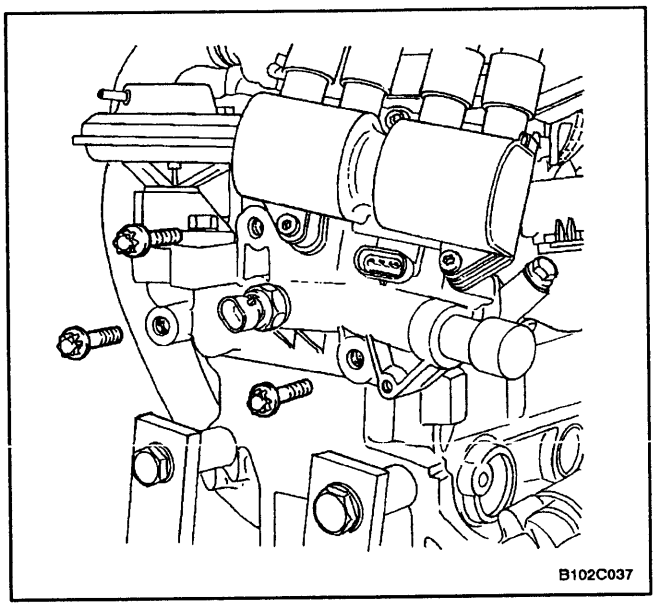
1. Remove the cylinder head with the intake manifold and the exhaust manifold attached. Refer to "Cylinder Head and Gasket" in this section.
2. Remove the coolant temperature sensor.
3. Remove the exhaust manifold heat shield bolts.
4. Remove the exhaust manifold heat shield.
5. Remove the exhaust manifold retaining nuts in the sequence shown.
6. Remove the exhaust manifold.
7. Remove the exhaust manifold gasket.
8. Remove the exhaust manifold studs.



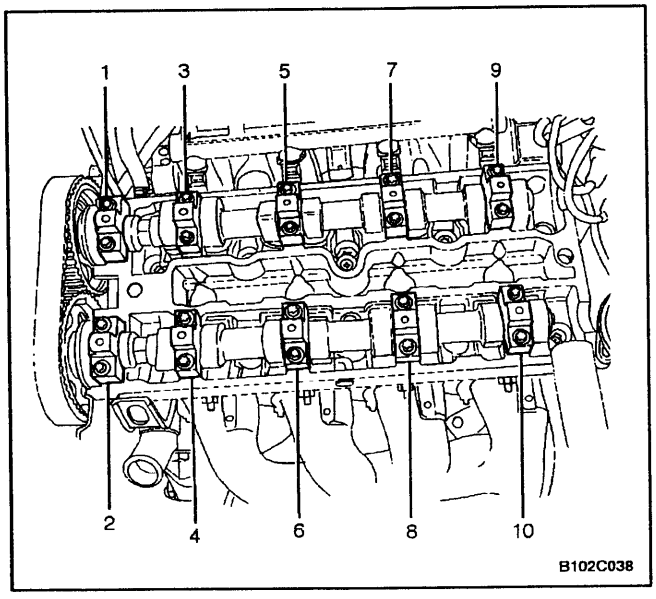
9. Remove the thermostat housing mounting bolts.
10. Remove the thermostat housing assembly.
11. Remove the fuel rail assembly. Refer to *Section 1F, Engine Controls*.
12. Remove the coolant bypass housing mounting bolts and the housing.



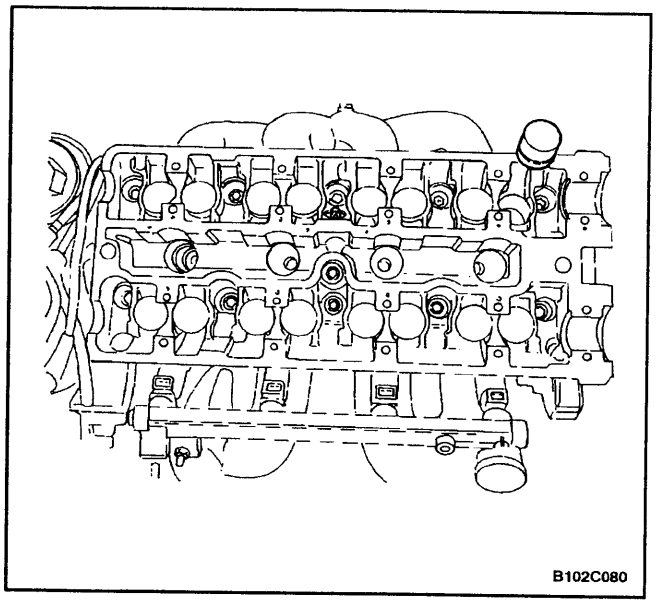
13. Remove the intake manifold retaining nuts and the bolts in the sequence shown.
14. Remove the intake manifold.
15. Remove the intake manifold gasket.



16. Remove the direct ignition system (DIS) ignition coil and exhaust gas recirculation (EGR) mounting bracket bolts.
17. Remove the DIS ignition coil, the EGR mounting bracket, and the ignition wires.
18. Remove the intake manifold studs.
19. Remove the spark plugs.

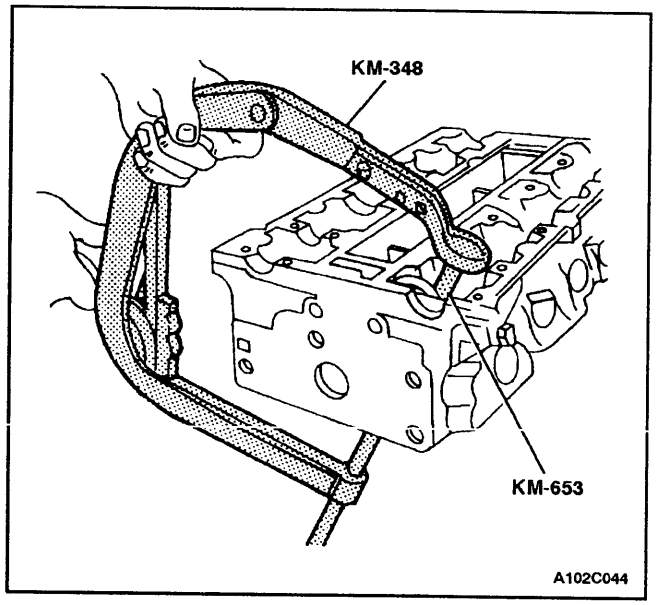


20. Remove the camshaft bearing cap bolts gradually and in the sequence shown for each camshaft cap.



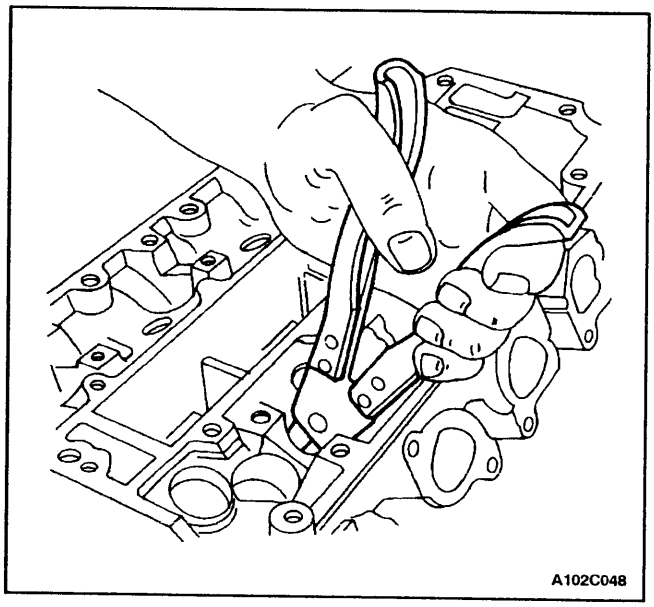
B102C080

21. Remove the intake camshaft caps. Maintain the correct positions for installation.
22. Remove the intake camshaft.
23. Remove the intake valve lash adjusters.
24. Remove the exhaust camshaft caps. Maintain the correct positions for installation.
25. Remove the exhaust camshaft.
26. Remove the exhaust valve lash adjusters.



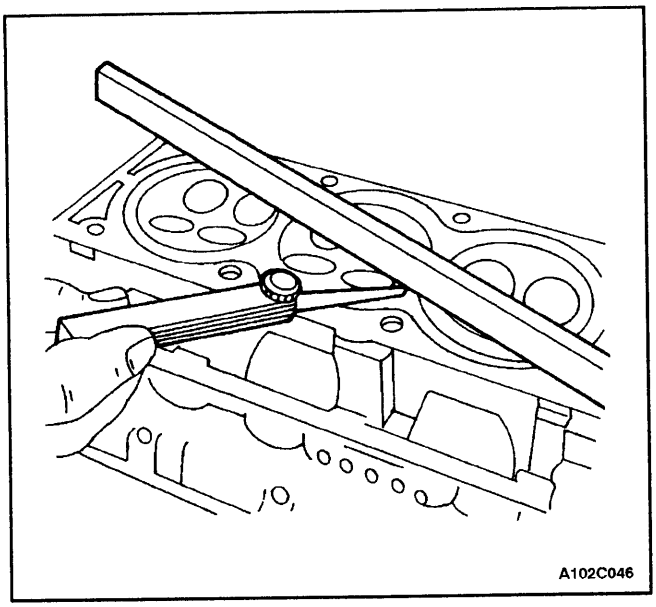
A102C044

27. Compress the valve springs with the valve spring compressor KM-348 and the adapter KM-653.
28. Remove the valve retainers.
29. Remove the valve spring compressor KM-348 and the adapter KM-653.
30. Remove the valve spring caps.
31. Remove the valve springs. Maintain the original position of the valve springs for installation.



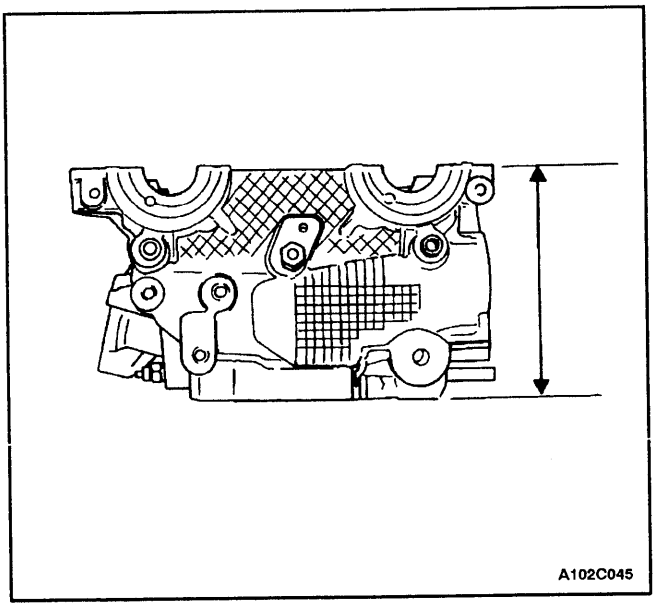
A102C048

32. Remove the valves. Maintain the original position of the valves for installation.
33. Remove the valve stem seals.

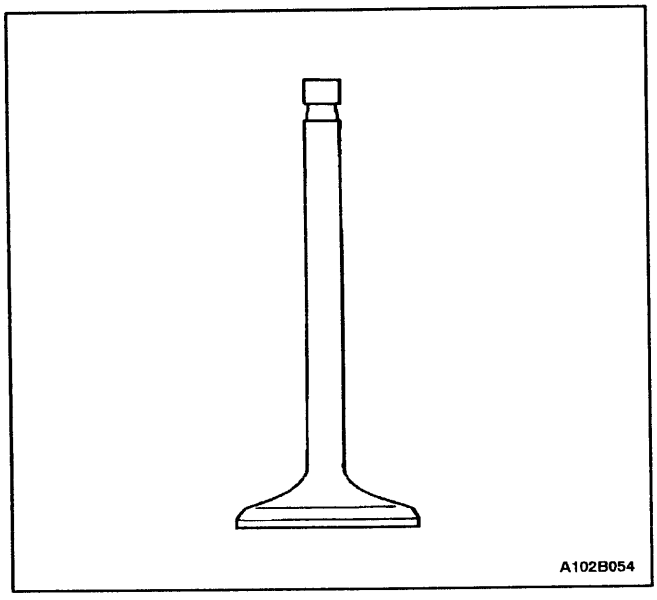

A102C046

Cylinder Head Inspection

1. Clean the sealing surfaces.
2. Inspect the cylinder head gasket and the mating surfaces for leaks, corrosion, and blowby.
3. Inspect the cylinder head for cracks.
4. Inspect the length and the width of the cylinder head using a feeler gauge and a straight edge.
5. Check the sealing surfaces for deformation and warpage. The cylinder head sealing surfaces must be flat within 0.025 mm (0.001 inch) maximum.

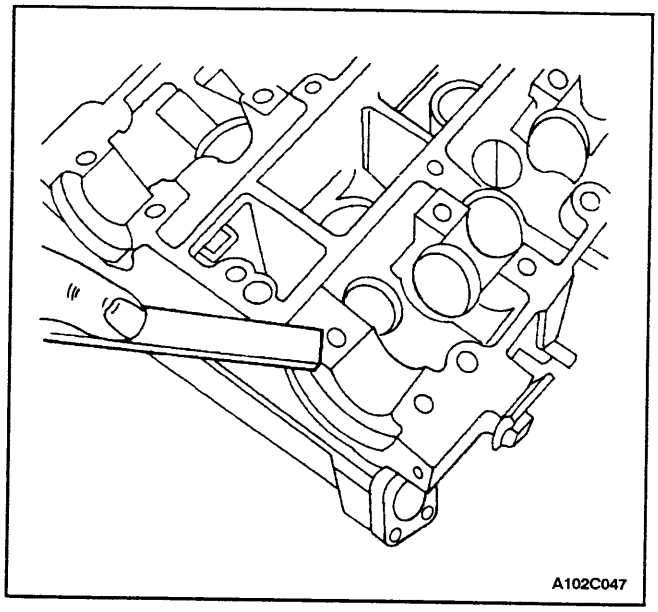

A102C045

6. Measure the height of the cylinder head from sealing surface to sealing surface. The cylinder head height should be 133.975 to 134.025 mm (5.274 to 5.276 inches). If the cylinder head height is less than 133.9 mm (5.271 inches), replace the cylinder head.
7. Inspect all threaded holes for damage.
8. Inspect the valve seats for excessive wear and burned spots.


A102B054

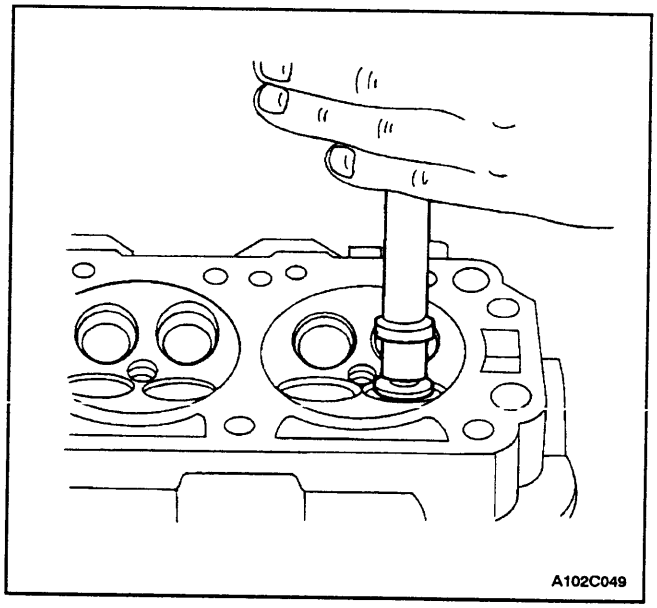
Valve Inspection

1. Inspect the valve stem tip for wear.
2. Inspect the valve retainer grooves and the oil seal grooves for chips and wear.
3. Inspect the valves for burns or cracks.
4. Inspect the valve stem for burrs and scratches.
5. Inspect the valve stem. The valve stem must be straight.
6. Inspect the valve face for grooving. If the groove is so deep that refacing the valve would result in a sharp edge, replace the valve.
7. Inspect the valve spring. If the valve spring ends are not parallel, replace the valve spring.
8. Inspect the valve spring seating surface of the valve rotators for wear or gouges. Replace as required.


A102C047

Cleaning Procedure

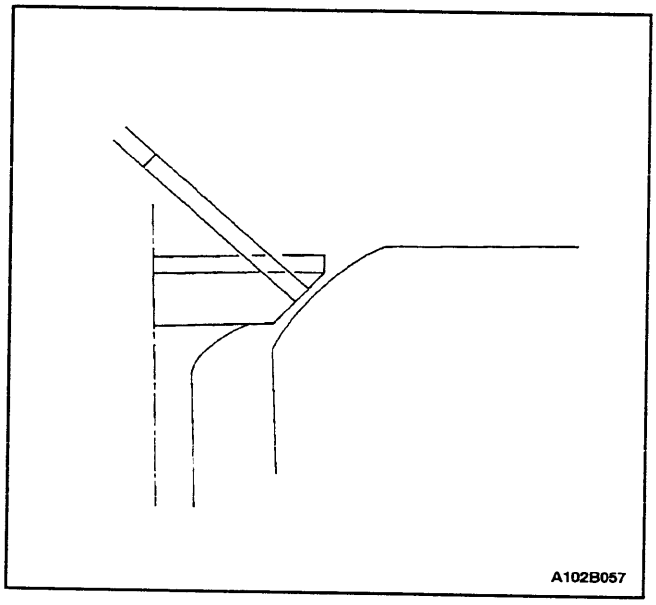
1. Clean the cylinder head.
2. Clean the valve guides.
3. Clean all of the threaded holes.
4. Clean the valves of carbon, oil, and varnish.


A102C049

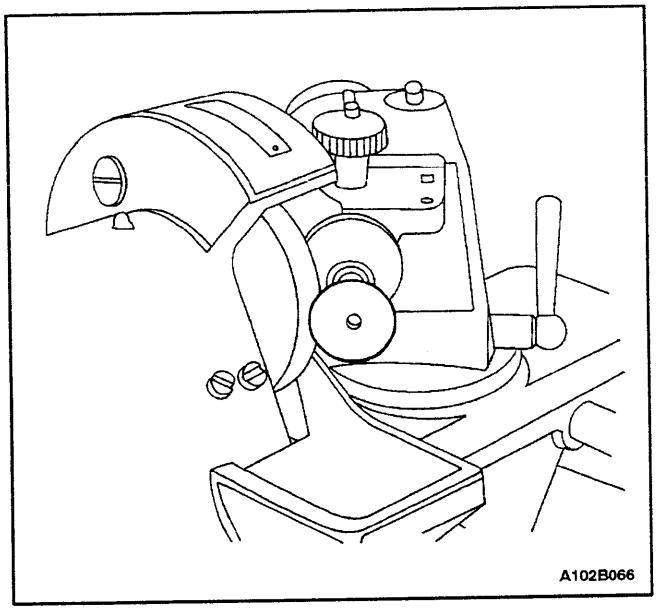
Cylinder Head Overhaul

Valve Grind-in

1. Lubricate the valve seat using a fine-grained paste.
2. Lift the valve rhythmically from the seat with a commercially available valve grinding tool in order to distribute the paste.

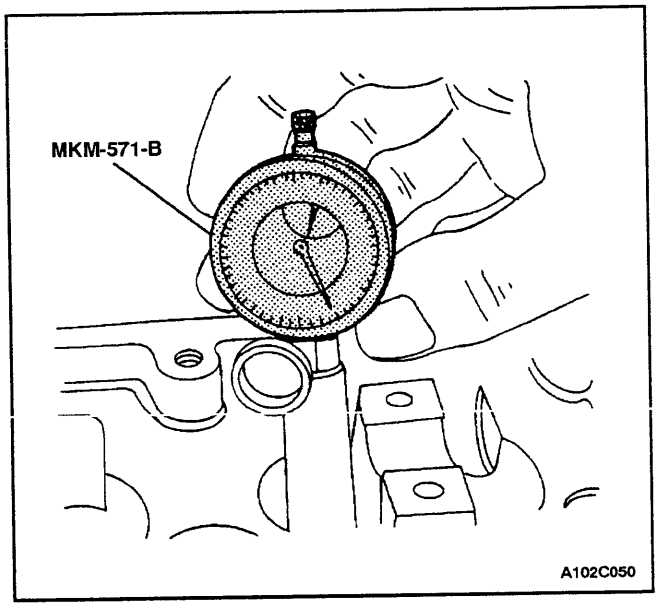

A102B057

3. Check the contact pattern on the valve head and in the cylinder head.
4. Clean the valves, the valve guides, and the cylinder head.



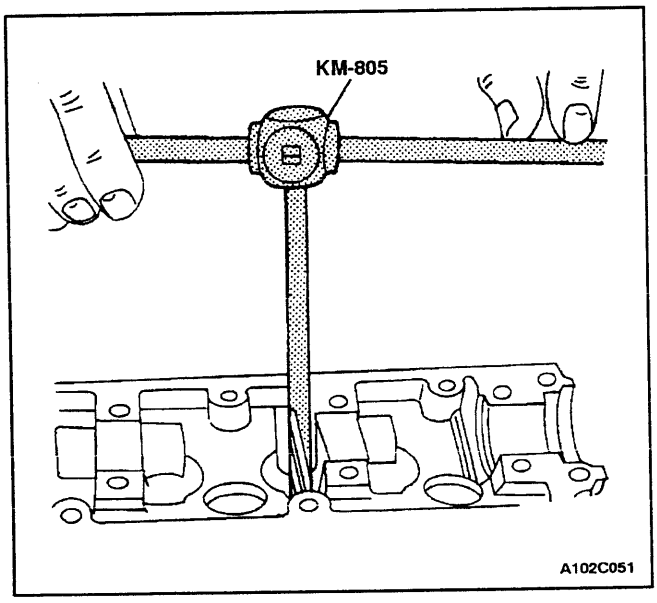
Valve Grind

1. Ensure that there are no crater line burns on the valve cone.
2. The valve may be reground only two times. Do not grind the valve stem end.
3. Ensure that the angle at the valve face is 45 degrees.
4. Inspect the assembly height of the intake valves and the exhaust valves.



Valve Guide - Ream

1. Measure the diameter of the valve guide using gauge MKM-571-B and a commercially available inside micrometer.

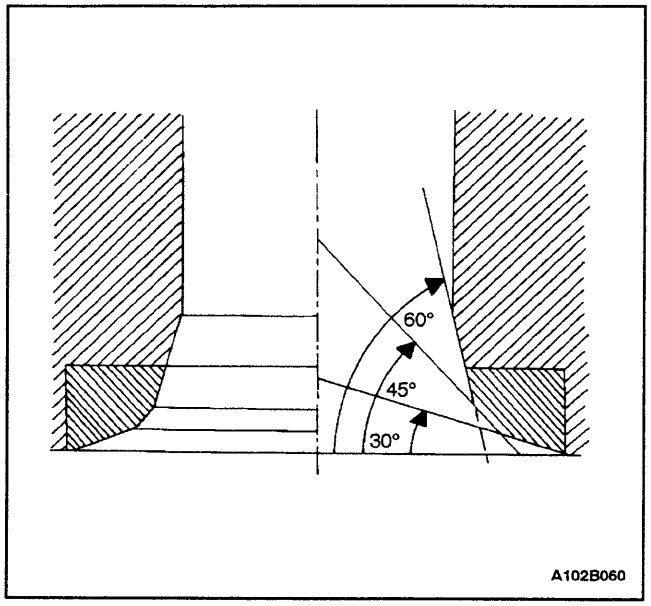


Important: Valve oversizes may already have been fitted in production.

2. An oversize service code is on the valve guide and the valve stem end. The following table gives the correct size, reamer, production code, and service code for each service.

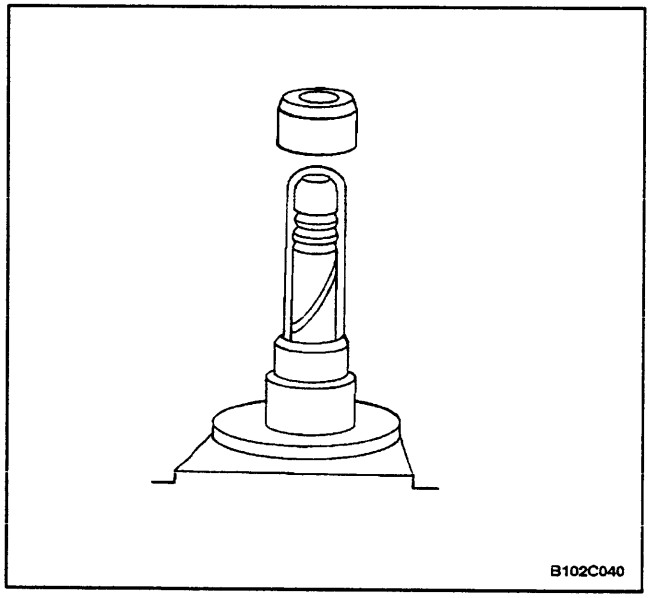
Size	Reamer	Production Code	Service Code
Normal	-	-	K
0.075	KM-805	1	K1
0.150		2	K2

3. Ream the valve guide from the upper side of the cylinder head to the next oversize.
4. After reaming, cross out the code and emboss the valve guide with the new code.



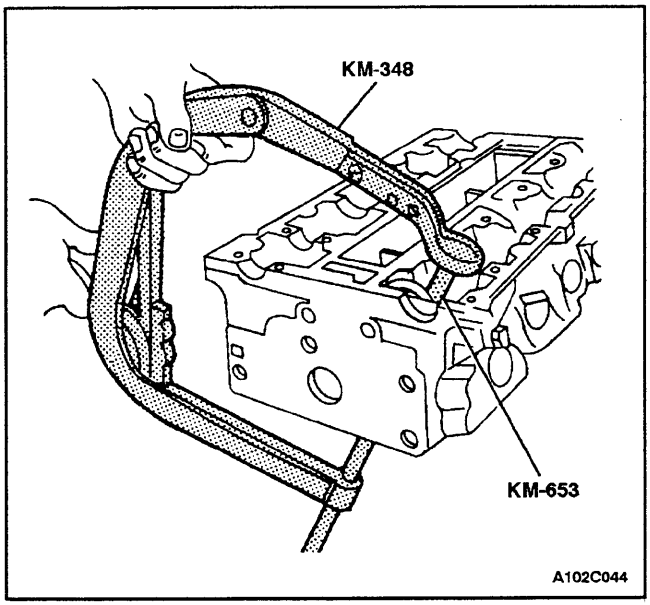
Valve Seat - Cut

1. Place the cylinder head on wooden blocks.
2. Cut the intake and the exhaust valve seats using the guide drift KM-340-7 as follows:
   - Valve seat - A 45-degree surface using the cutter KM-340-13.
   - Upper correction angle - A 30-degree surface using the cutter KM-340-13.
   - Lower correction angle - A 60-degree surface using the cutter KM-340-26.
3. Clean the chippings from the cylinder head.
4. Inspect the dimension for the valve seat width.
   - Intake: 1.2 to 1.4 mm (0.047 to 0.055 inch).
   - Exhaust: 1.4 to 1.8 mm (0.055 to 0.070 inch).
5. Inspect the assembly height of the intake valves and the exhaust valves. If the specified dimension is exceeded, install new valves. Inspect the assembly height of the intake valves and the exhaust valves again. If the valve assembly height is still too large despite replacing the valves, replace the cylinder head.

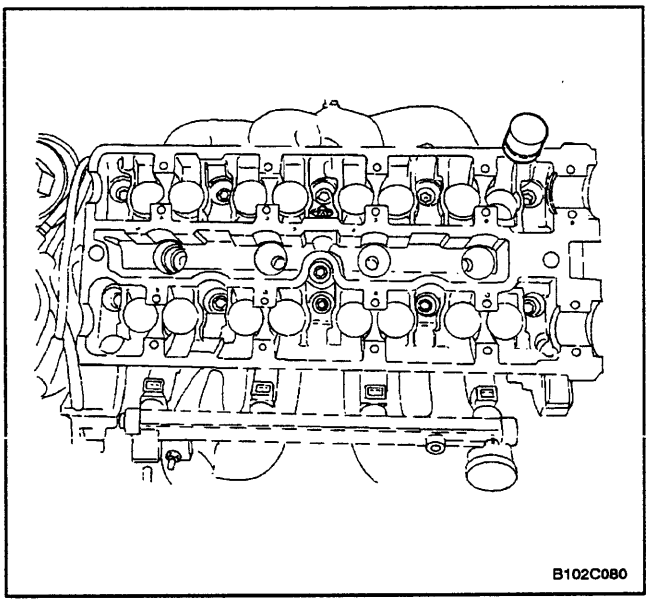


Assembly Procedure

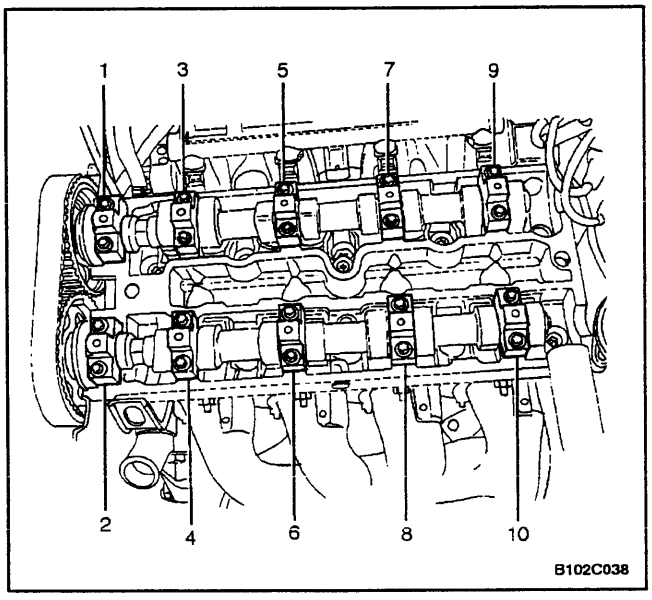
1. Coat the valve stems with engine oil.
2. Insert the valves in the cylinder head in their original positions.
3. Insert the valve spring seats.
4. Push the accompanying assembly sleeve onto the valve stem.
5. Insert the new valve stem seat.
6. Carefully drive the valve stem seal onto the stop with light taps.
7. Install the valve springs in their original positions.
8. Install the valve spring caps.



9. Compress the valve springs with the valve spring compressor KM-348 and adapter KM-653.
10. Install the valve retainers.
11. Remove the valve spring compressor KM-348 and adapter KM-653.



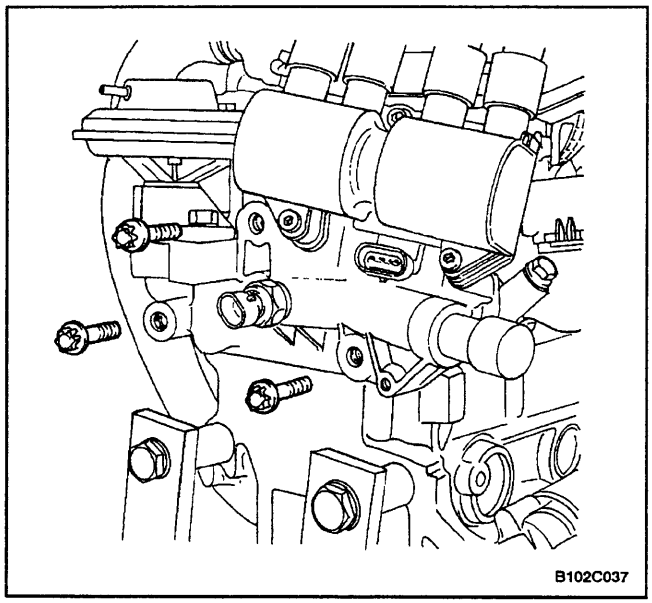
12. Lubricate the valve lash adjusters with engine oil.
13. Install the valve lash adjusters.



14. Install the intake camshaft.
15. Install the intake camshaft bearing caps in their original positions.
16. Install the exhaust camshaft.
17. Install the exhaust camshaft bearing caps in their original positions.
18. Install the camshaft bearing cap bolts.
19. Tighten the camshaft bearing cap bolts gradually and in the sequence shown for each camshaft cap.

Tighten

Tighten the camshaft bearing cap bolts to 8 N•m (71 lb-in).


B102C037

20. Install the spark plugs.

Tighten

Tighten the spark plugs to 20 N•m (15 lb-ft).

21. Install the DIS ignition coil and the EGR mounting bracket, and bolt.

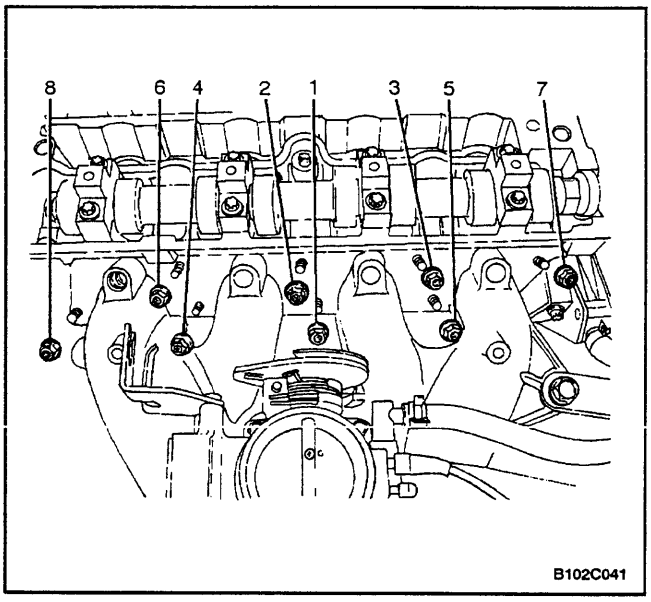
Tighten

Tighten the DIS ignition coil and EGR mounting bracket bolts to 25 N•m (18 lb-ft).

22. Install the DIS ignition coil and EGR.

Tighten

Tighten the DIS ignition coil and EGR to 10 N•m (89 lb-ft).

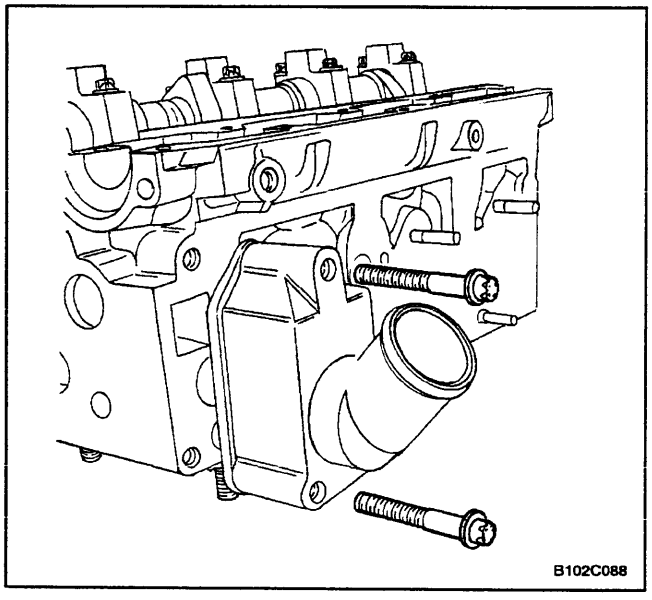


B102C041

23. Install the intake manifold studs.
24. Install the intake manifold gasket.
25. Install the intake manifold.
26. Install the intake manifold retaining nuts and bolts in the sequence shown.

Tighten

Tighten the intake manifold retaining nuts and bolts to 22 N•m (16 lb-ft).


B102C088

27. Install the fuel rail assembly. Refer to *Section 1F, Engine Controls.*
28. Install the thermostat housing assembly.
29. Install the thermostat housing mounting bolts.

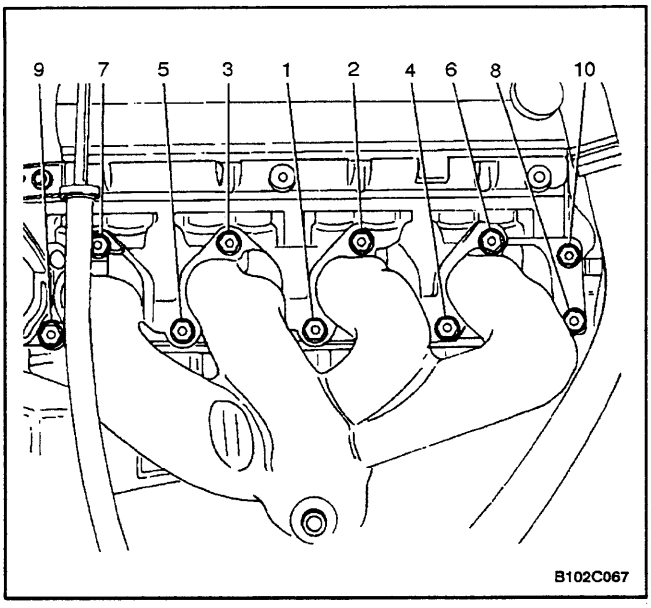
Tighten

Tighten the thermostat housing mounting bolts to 15 N•m (11 lb-ft).

30. Install the coolant bypass housing bolts.

Tighten

Tighten the coolant bypass housing bolts to 15 N•m (11 lb-ft).



31. Install the exhaust manifold studs.
32. Install the exhaust manifold gasket.
33. Install the exhaust manifold.
34. Install the exhaust manifold retaining nuts in the sequence shown.

Tighten

Tighten the exhaust manifold retaining nuts to 22 N•m (16 lb-ft).

35. Install the exhaust manifold heat shield.
36. Install the exhaust manifold heat shield bolts.

Tighten

Tighten the exhaust manifold heat shield bolts to 8 N•m (71 lb-in).

37. Install the cylinder head with the intake manifold and the exhaust manifold attached. Refer to "Cylinder Head and Gasket" in this section.

CRANKSHAFT

Tools Required

KM-412 Engine Overhaul Stand

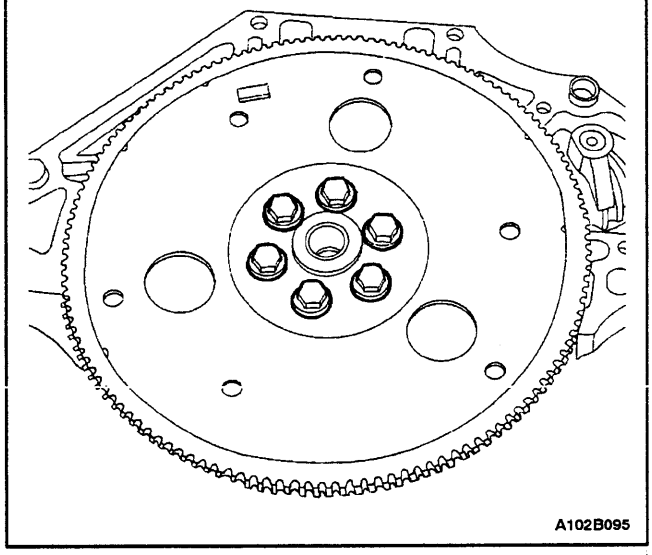
KM-470-B Angular Torque Gauge

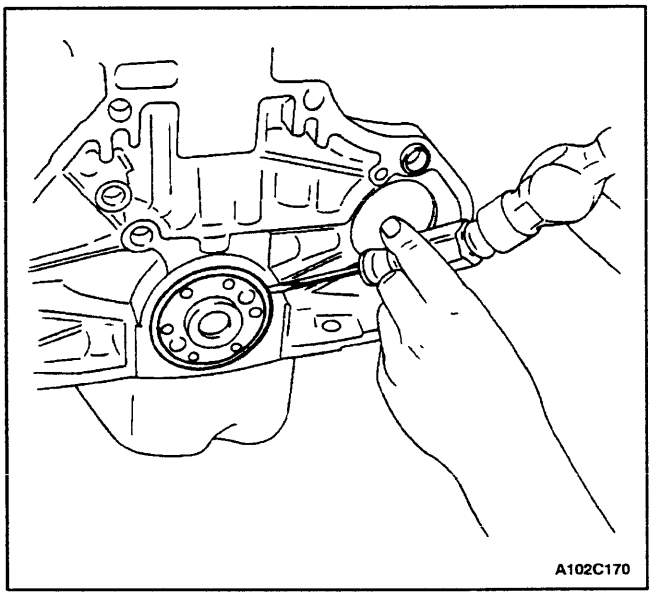
J-36792 or KM-635 Crankshaft Rear Oil Seal Installer

Notice: Take extreme care to prevent any scratches, nicks, or damage to the camshafts.

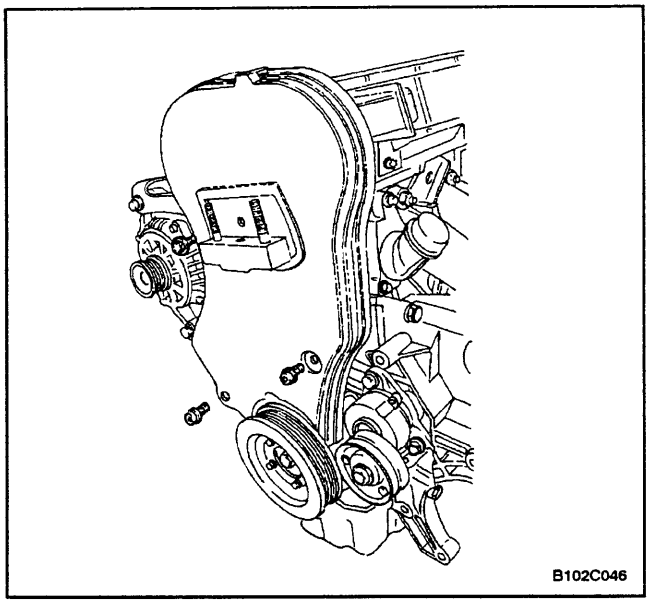
Disassembly Procedure

1. Remove the engine. Refer to "Engine" in this section.
2. Remove the flywheel, or the flexible plate bolts for the automatic transaxle.
3. Remove the flywheel, or the flexible plate for the automatic transaxle.

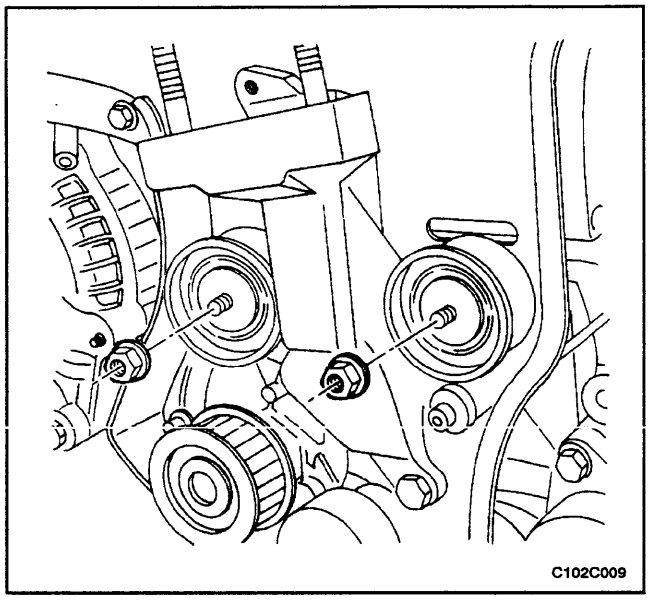




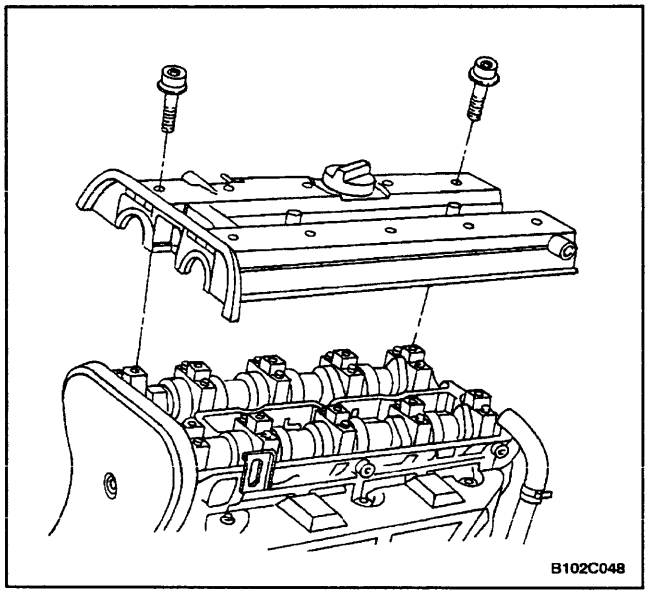
4. Remove the crankshaft rear oil seal.
5. Mount the engine assembly on the engine overhaul stand KM-412.


B102C046

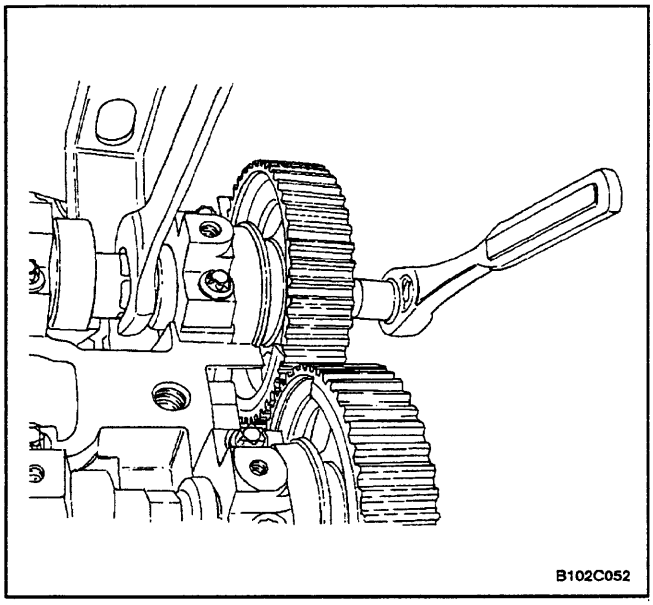
6. Remove the front timing belt cover bolts.
7. Remove the front timing belt cover.
8. Remove the crankshaft pulley bolts.
9. Remove the crankshaft pulley.


C102C009

10. Loosen the timing belt automatic tensioner bolt.
11. Rotate the timing belt automatic tensioner hex-key clockwise to release the tension.
12. Remove the timing belt idler pulley nuts.
13. Remove the timing belt idler pulleys.
14. Remove the timing belt.
15. Remove the engine mount retaining bolts.
16. Remove the engine mount.

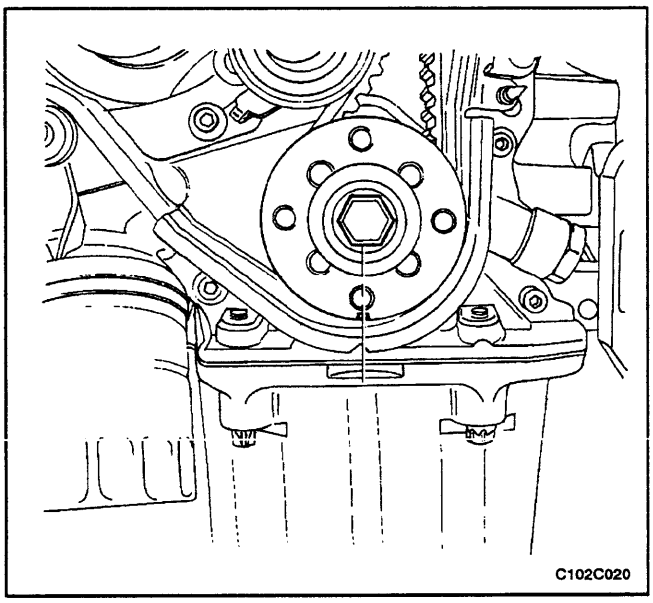

B102C048

17. Disconnect the crankcase breather tubes from the valve cover.
18. Remove the spark plug cover bolts.
19. Remove the spark plug cover.
20. Disconnect the ignition wires from the spark plugs.
21. Remove the valve cover bolts.
22. Remove the valve cover washers.
23. Remove the valve cover and the valve cover gasket.

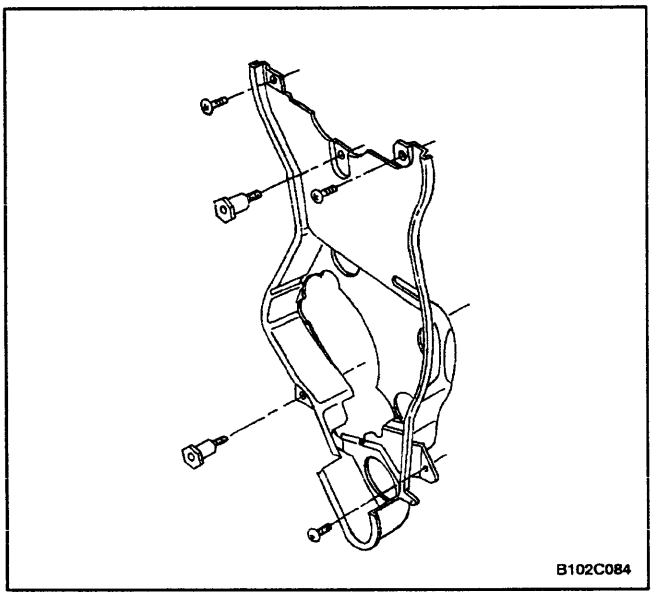

B102C052

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

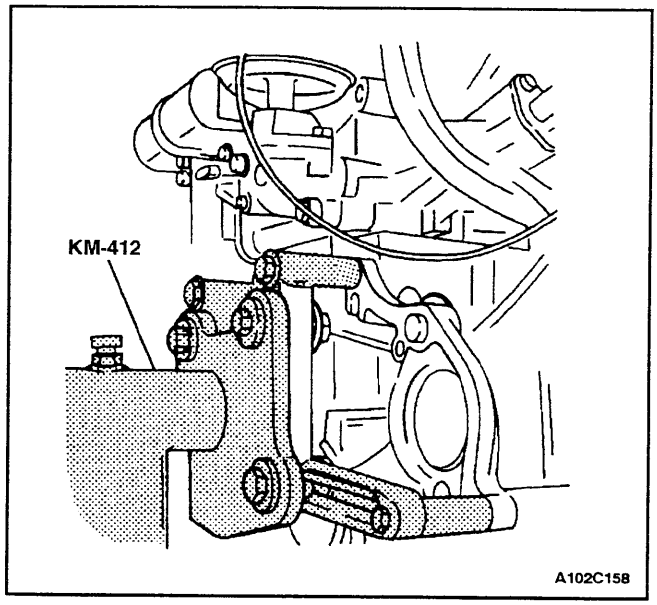
24. While holding the intake camshaft firmly in place, remove the intake camshaft bolt.
25. Remove the intake camshaft gear.
26. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft bolt.
27. Remove the exhaust camshaft gear.


C102C020

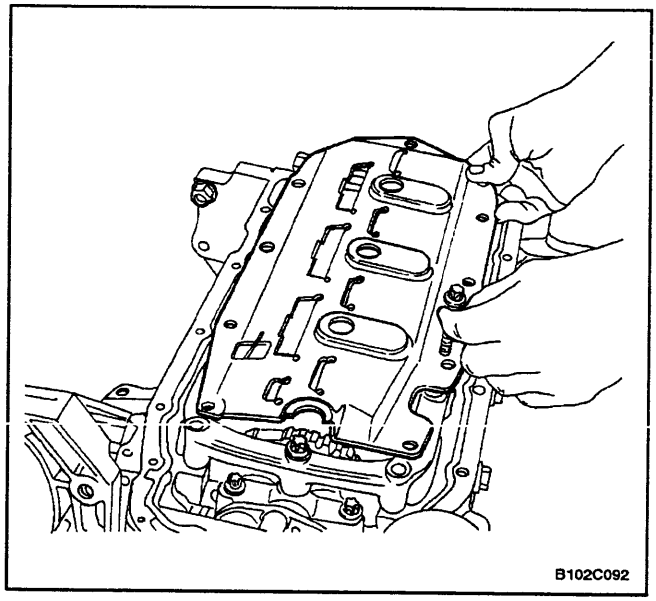
28. Remove the crankshaft timing belt gear.


B102C084

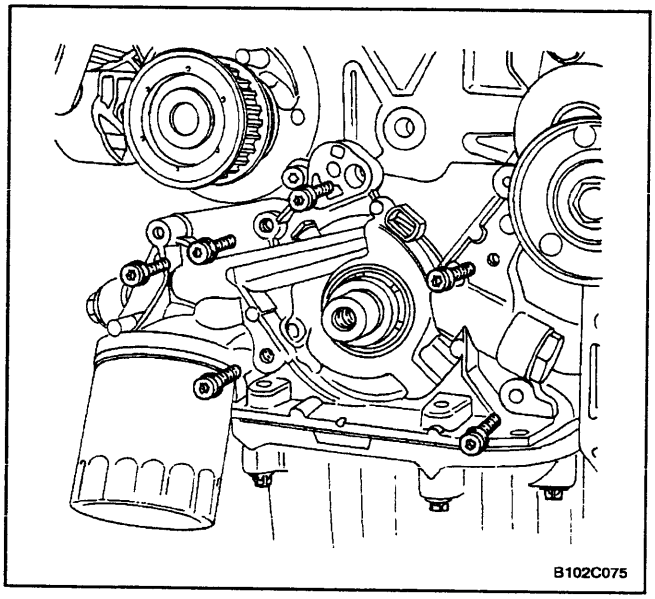
29. Remove the rear timing belt cover bolts and cover.



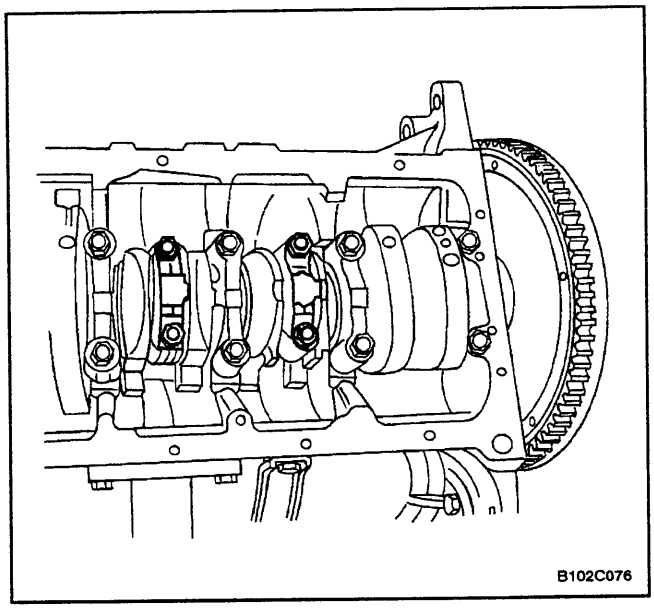
30. Rotate the engine on the engine overhaul stand KM-412.



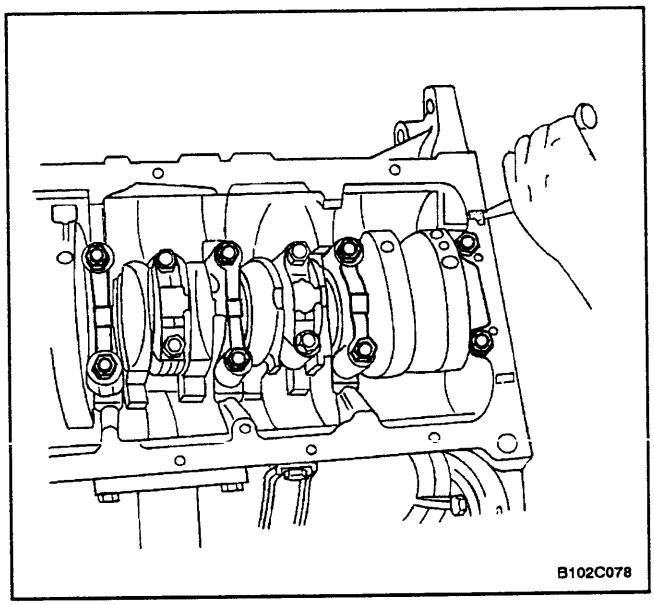
31. Remove the oil pan retaining bolts.
32. Remove the oil pan.
33. Remove the oil pump pickup tube bolts.
34. Remove the oil pump pickup tube.
35. Remove the lower block support bracket/splash shield bolts.
36. Remove the splash shield.
37. Remove the lower block support bracket bolts.
38. Remove the lower block support bracket.



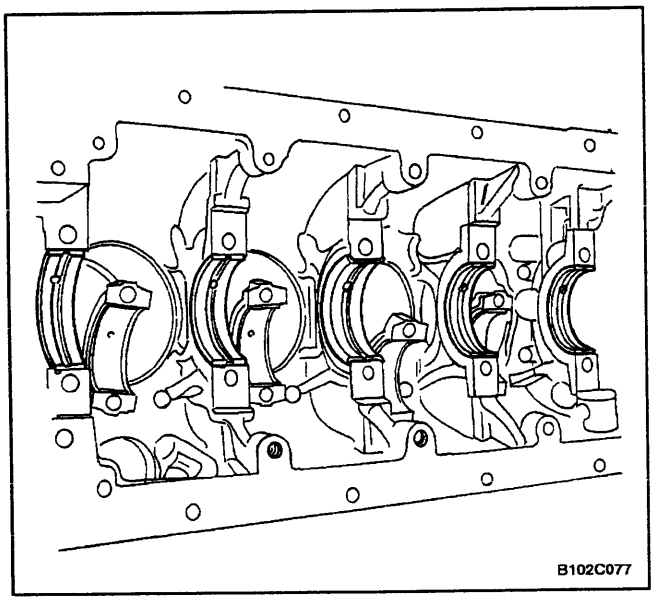
39. Remove the oil pump retaining bolts.
40. Remove the oil pump.


B102C076

41. Mark the order of the connecting rod bearing caps.
42. Remove the connecting rod bearing cap bolts for all of the pistons.
43. Remove the connecting rod bearing caps and the lower connecting rod bearings.

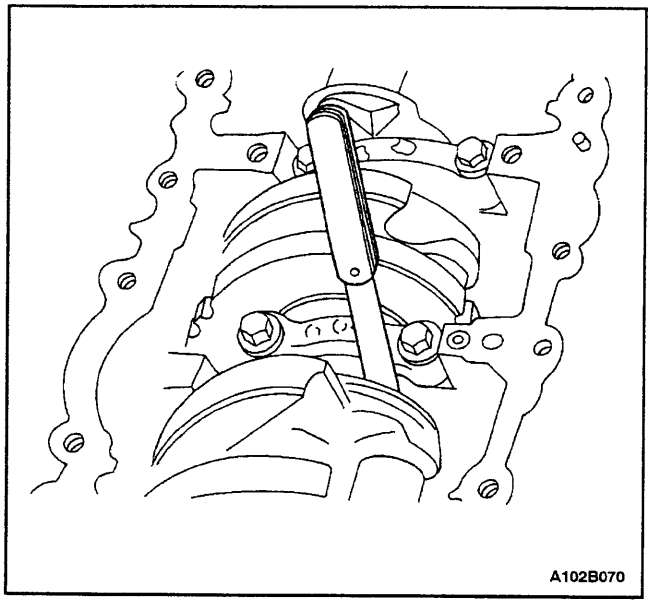

B102C078

44. Mark the order of the crankshaft bearing caps.
45. Remove the crankshaft bearing cap bolts.
46. Remove the crankshaft bearing caps and the lower crankshaft bearings.
47. Remove the crankshaft.
48. Clean those parts that need it.

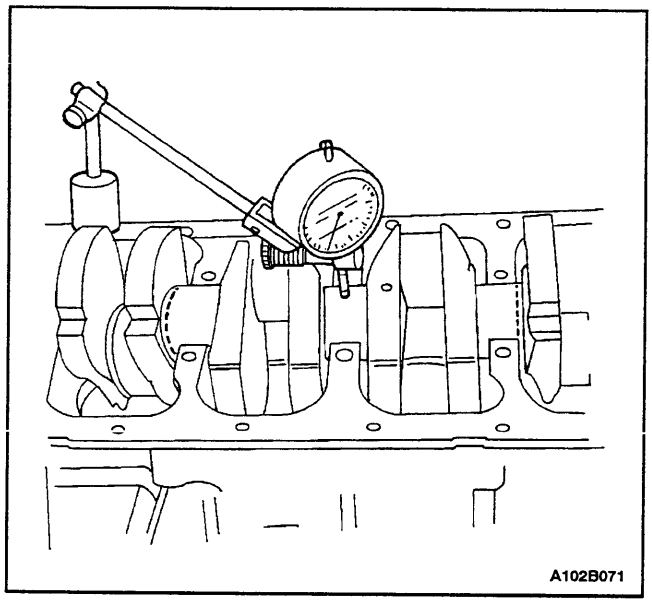

B102C077

Assembly Procedure

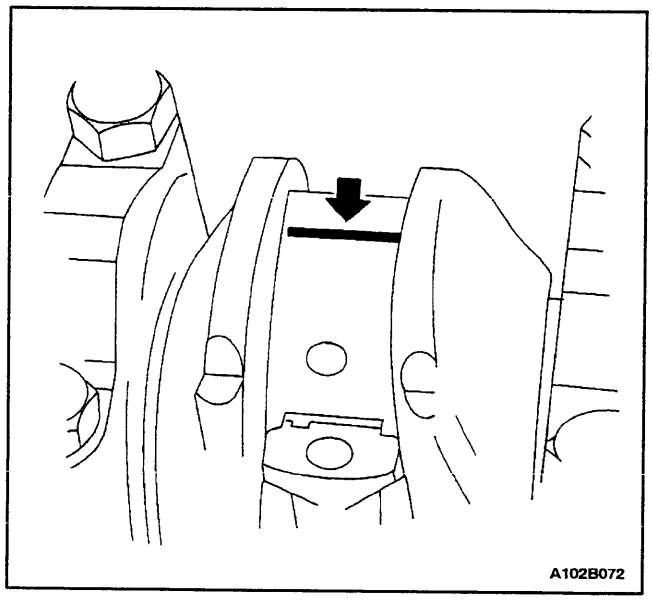
1. Coat the crankshaft bearings with engine oil.
2. If replacing the crankshaft, transfer the pulse pickup sensor disc to the new crankshaft.



3. Install the crankshaft.
4. Install the lower crankshaft bearings in the bearing caps.
5. Inspect the crankshaft end play with the crankshaft bearings installed.
6. Check for permissible crankshaft end play. Refer to "Engine Specifications" in this section.



7. With the crankshaft mounted on the front and rear crankshaft bearings, check the middle crankshaft journal for permissible out-of-round (runout). Refer to "Engine Specifications" in this section.

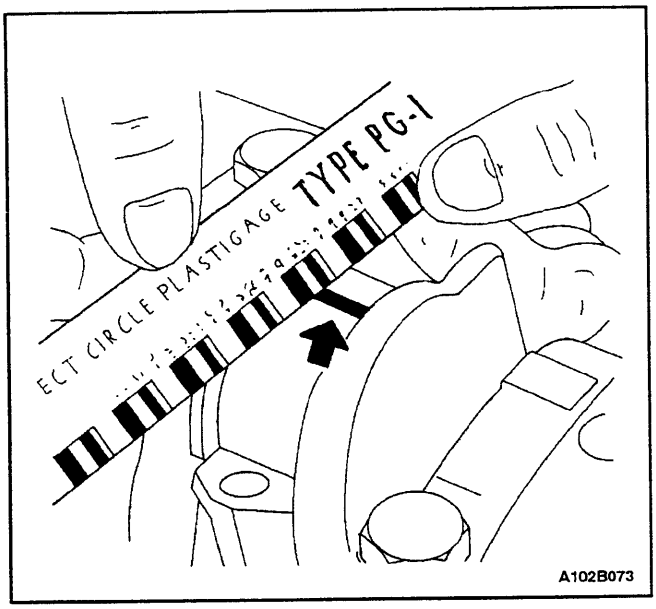


Important: Grease the crankshaft journals and lubricate the crankshaft bearings slightly so that the plastic gauging thread does not tear when the crankshaft bearing caps are removed.

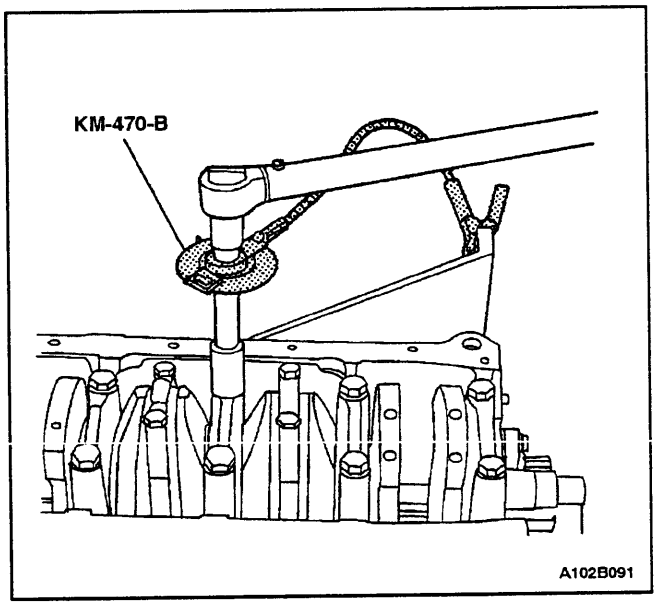
8. Inspect all of the crankshaft bearing clearances using a commercially available plastic gauging (ductile plastic threads).
9. Cut the plastic gauging threads to the length of the bearing width. Lay them axially between the crankshaft journals and the crankshaft bearings.
10. Install the crankshaft bearing caps and the bolts.

Tighten

Tighten the crankshaft bearing cap bolts to 50 N•m (37 lb-ft) plus 45 degrees and 15 degrees.



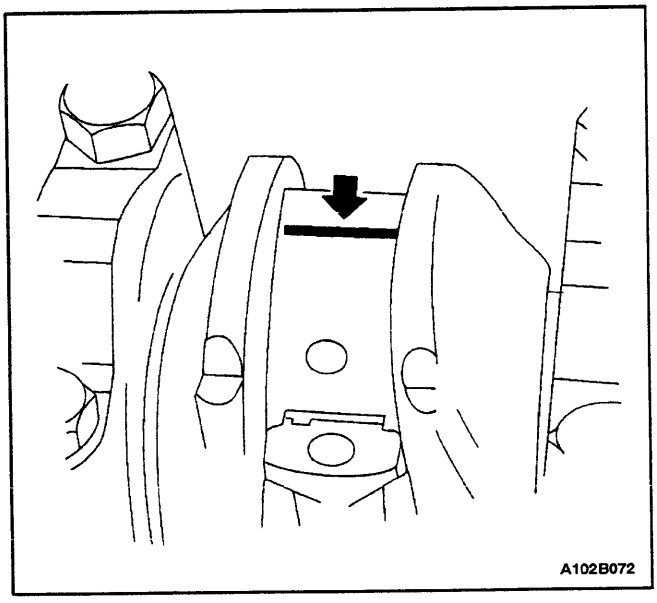
11. Remove the crankshaft bearing cap bolts and the caps.
12. Measure the width of the flattened plastic thread of the plastic gauging using a ruler. (Plastic gauging is available for different tolerance ranges.)
13. Inspect the bearing clearance for permissible tolerance ranges. Refer to "Engine Specifications" in this section.



14. Apply a bead of adhesive sealing compound to the grooves of the crankshaft bearing caps.
15. Install the crankshaft bearing caps to the engine block.
16. Tighten the crankshaft bearing caps using new bolts.

Tighten

Tighten the crankshaft bearing cap bolts to 50 N•m (37 lb-ft) using a torque wrench. Use the angular torque gauge KM-470-B to tighten the crankshaft bearings another 45 degrees plus 15 degrees.

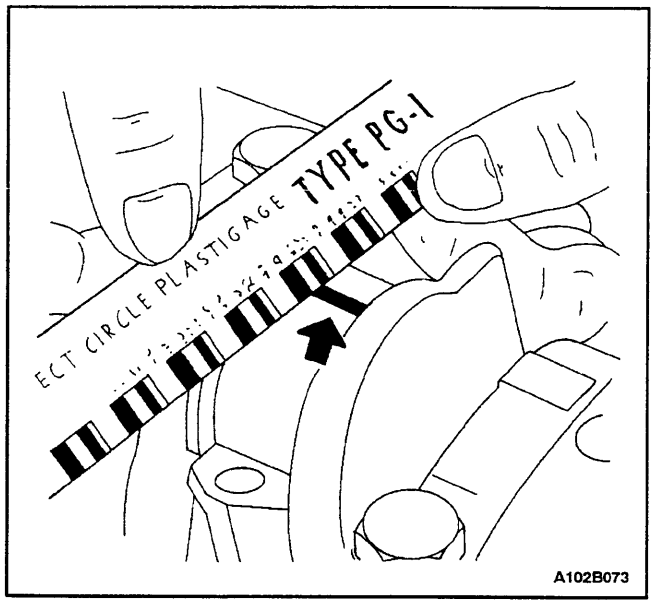


Important: Grease the connecting rod journals and lubricate the connecting rod bearings slightly so that the plastic gauging thread does not tear when the connecting rod bearing caps are removed.

17. Inspect all of the connecting rod bearing clearances using a commercially available plastic gauging (ductile plastic threads).
18. Cut the plastic gauging threads to the length of the connecting rod bearing width. Lay them axially between the connecting rod journals and the connecting rod bearings.
19. Install the connecting rod bearing caps.

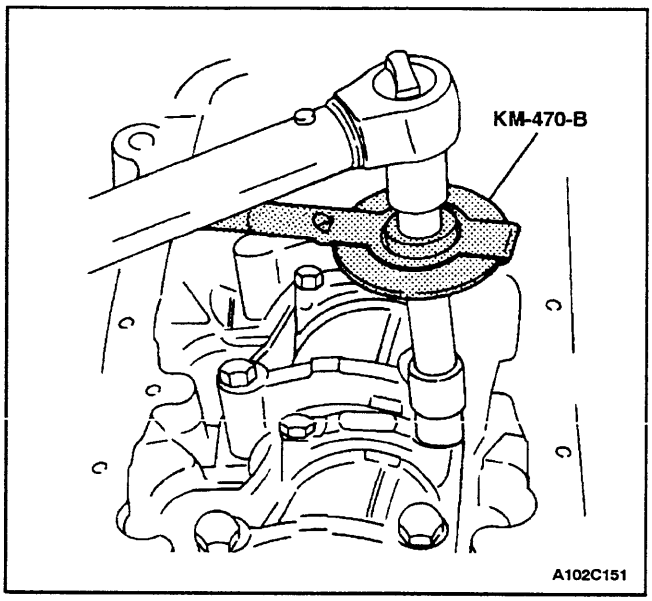
Tighten

Tighten the connecting rod bearing cap bolts to 35 N•m (26 lb-ft) using a torque wrench. Use the angular torque gauge KM-470-B to tighten the connecting rod bearing cap bolts another 45 degrees.



A102B073

20. Remove the connecting rod bearing caps.
21. Measure the width of the flattened plastic thread of the plastic gauging using a ruler. (Plastic gauging is available for different tolerance ranges.)
22. Inspect the bearing clearance for permissible tolerance ranges. Refer to "Engine Specifications" in this section.

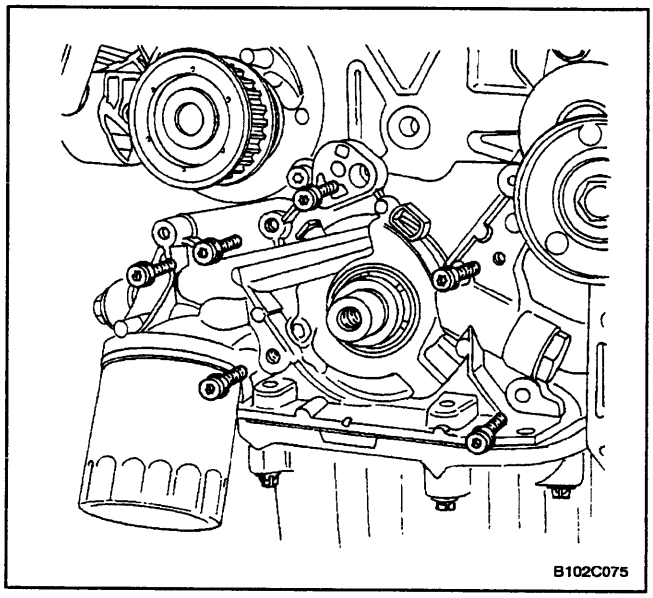


A102C151

23. Install the connecting rod bearing caps to the connecting rods.
24. Tighten the connecting rod bearing caps using new bolts.

Tighten

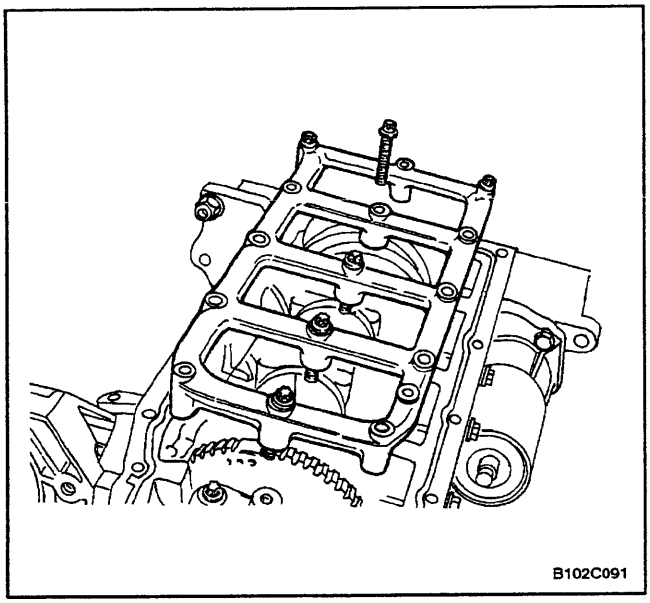
Tighten the connecting rod bearing cap bolts to 35 N•m (26 lb-ft) using a torque wrench. Use the angular torque gauge KM-470-B to tighten the connecting rod cap bolts another 45 degrees.


B102C075

25. Install the oil pump.
26. Install the oil pump retaining bolts.

Tighten

Tighten the oil pump retaining bolts to 10 N•m (89 lb-in).


B102C091

27. Install the engine lower block support bracket and the bolts.

Tighten

Tighten the engine lower block support bracket bolts to 35 N•m (26 lb-in).

28. Install the engine lower block support bracket splash shield and the bolts.

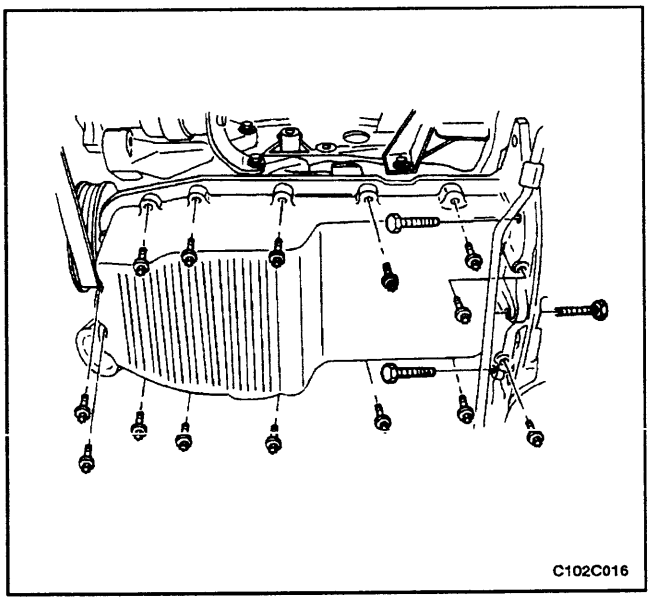
Tighten

Tighten the engine lower block support bracket splash shield bolts to 35 N•m (26 lb-ft).

29. Install the oil pump pickup tube.
30. Install the oil pump pickup tube bolts.

Tighten

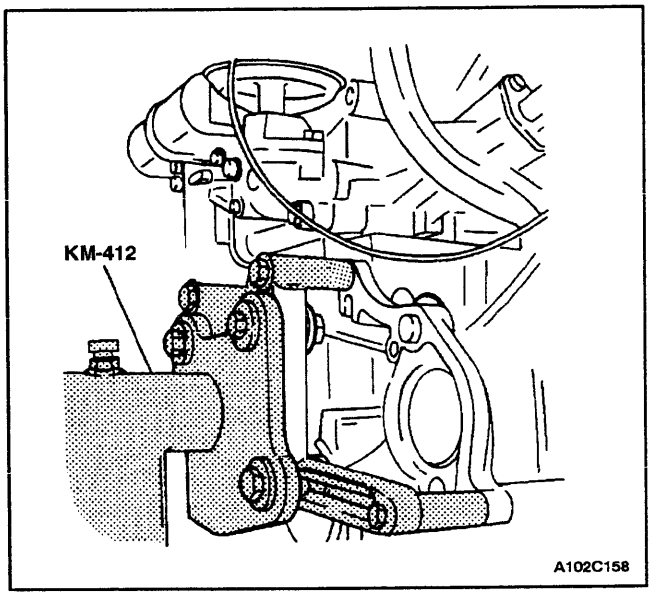
Tighten the oil pump pickup tube bolts to 8 N•m (71 lb-in).


C102C016

31. Coat the new oil pan gasket with the sealant.
32. Install the oil pan gasket to the oil pan.
33. Install the oil pan.
34. Install the oil pan retaining bolts.

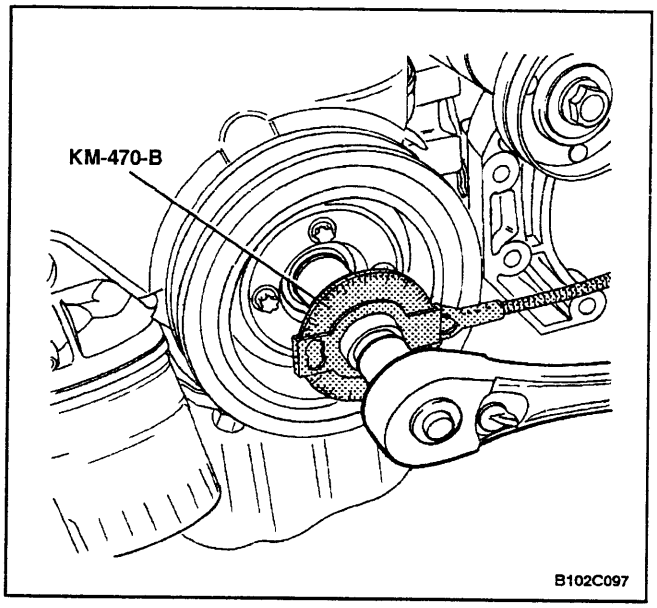
Tighten

Tighten the oil pan retaining bolts to 10 N•m (89 lb-in).



A102C158

35. Rotate the engine on the engine overhaul stand KM-412.



36. Install the rear timing belt cover.
37. Install the rear timing belt cover bolts.

Tighten

Tighten the rear timing belt cover bolts to 10 N•m (89 lb-in).

38. Install the crankshaft timing belt drive gear and the bolt.

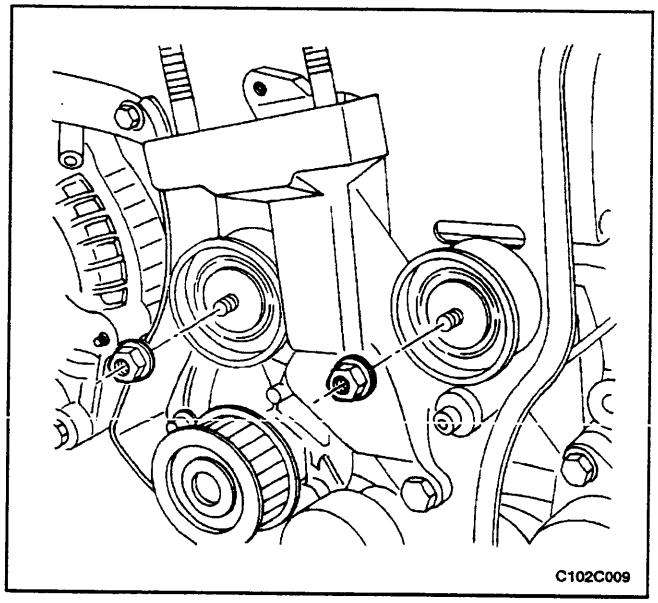
Tighten

Tighten the crankshaft timing belt drive gear bolt to 130 N•m (70 lb-ft) plus 40 degrees to 50 degrees using the torque angular gauge KM-470-B.

39. Install the engine mount and the retaining bolts.

Tighten

Tighten the engine mount bolts to 60 N•m (44 lb-ft).



40. Install the timing belt automatic tensioner.
41. Install the timing belt automatic tensioner bolts.

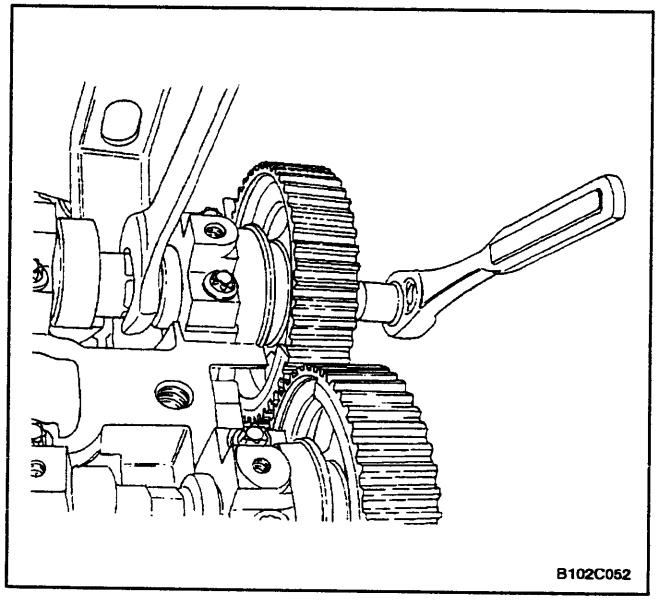
Tighten

Tighten the timing belt automatic tensioner bolts to 25 N•m (18 lb-ft).

42. Install the timing belt idler pulley.
43. Install the timing belt idler pulley nuts.

Tighten

Tighten the timing belt idler pulley nuts to 25 N•m (18 lb-ft).



Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

44. Install the intake camshaft gear.
45. Install the intake camshaft gear bolt while holding the intake camshaft firmly in place.

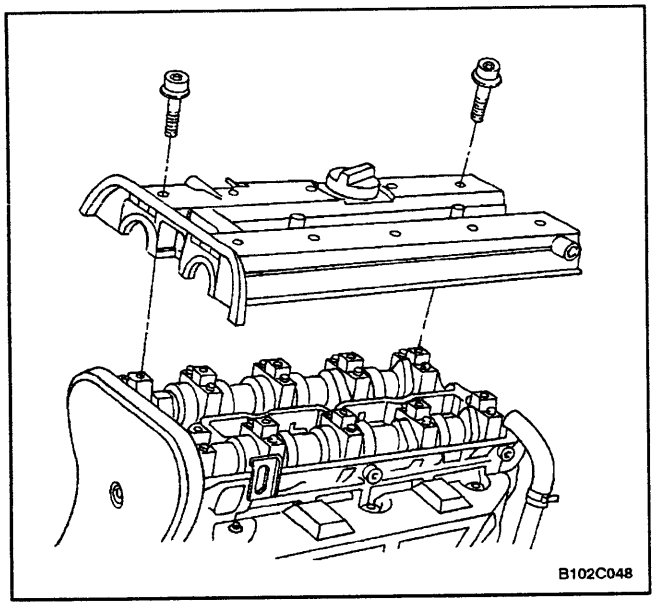
Tighten

Tighten the intake camshaft gear bolt to 50 N•m (37 lb-ft), plus 60 degrees and 15 degrees.

46. Install the exhaust camshaft gear.
47. Install the exhaust camshaft gear bolt while holding the exhaust camshaft firmly in place.

Tighten

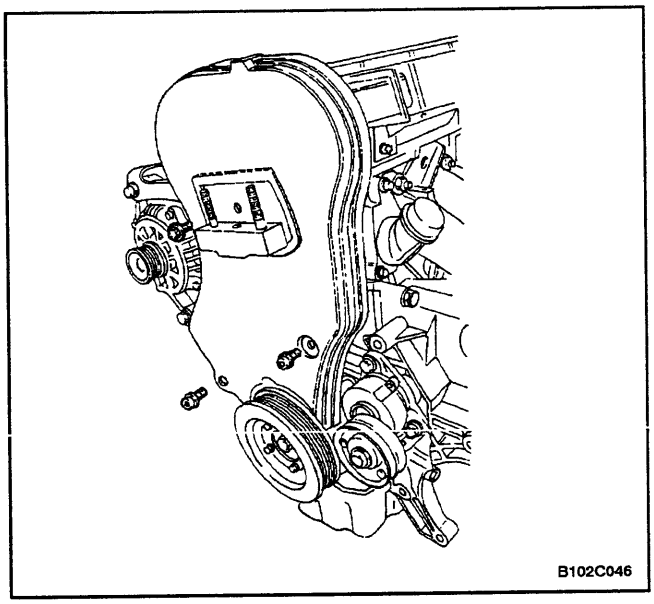
Tighten the exhaust camshaft gear bolt to 50 N•m (37 lb-ft), plus 60 degrees and 15 degrees.



48. Install the timing belt. Refer to "Timing Belt" in this section.
49. Adjust the timing belt tension. Refer to "Timing Belt Check and Adjust" in this section.
50. Apply a small amount of gasket sealant to the corners of the front camshaft caps and to the top of the rear valve cover to the cylinder head seal.
51. Install the valve cover and the valve cover gasket.
52. Install the valve cover washers.
53. Install the valve cover bolts.

Tighten

Tighten the valve cover bolts to 8 N•m (71 lb-in).



54. Connect the ignition wires to the spark plugs.
55. Install the spark plug cover.
56. Install the spark plug cover bolts.

Tighten

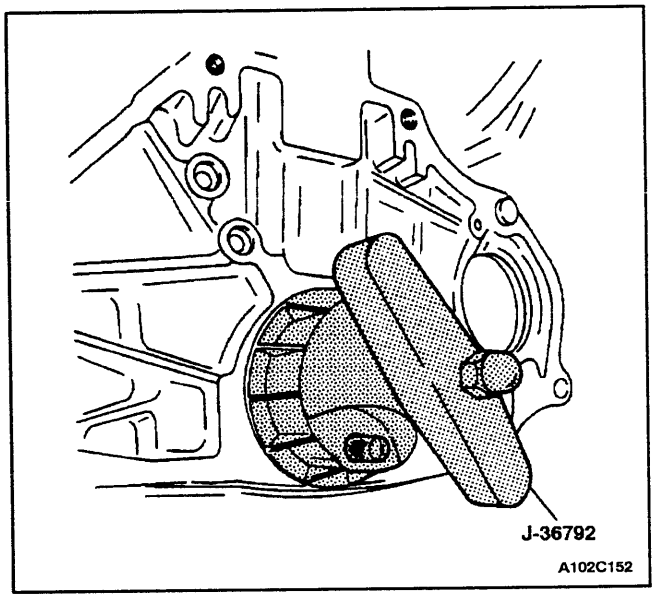
Tighten the spark plug cover bolts to 3 N•m (27 lb-in).

57. Connect the crankcase breather tube to the valve cover.
58. Install the front timing belt cover.
59. Install the front timing belt cover bolts.

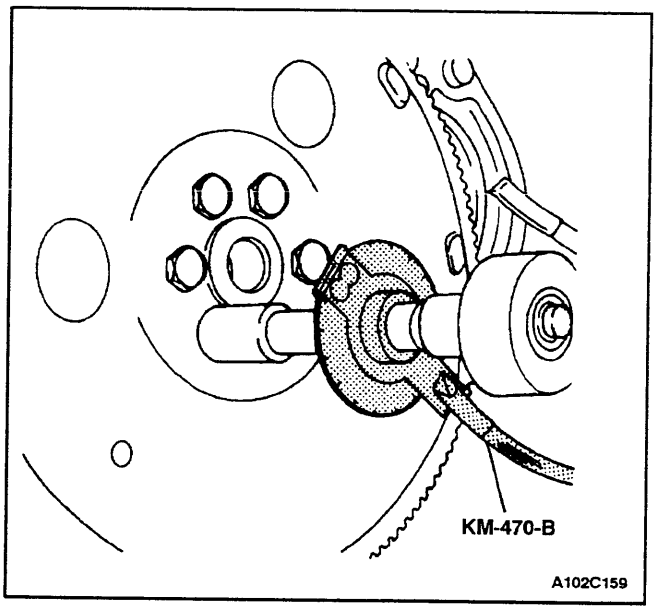
Tighten

Tighten the front timing belt cover bolts to 8 N•m (71 lb-in).

60. Install the engine lifting device.
61. Remove the engine from the engine overhaul stand KM-412.



62. Install a new crankshaft rear oil seal using installer J-36792 or KM-635.

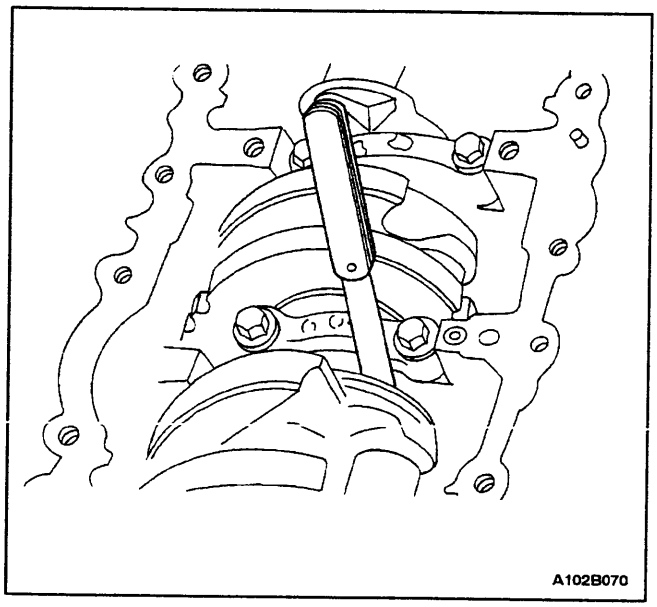


63. Install the flywheel, or flexible plate for vehicles with an automatic transaxle.
64. Install the flywheel, or the flexible plate bolts for vehicles with an automatic transaxle.

Tighten

Tighten the flywheel bolts to 65 N•m (48 lb-ft). Use the angular torque gauge KM-470-B to tighten the flywheel bolts another 30 degrees plus 15 degrees. For the automatic transaxle, tighten the flexible plate bolts to 60 N•m (44 lb-ft).

65. Install the engine. Refer to "Engine" in this section.



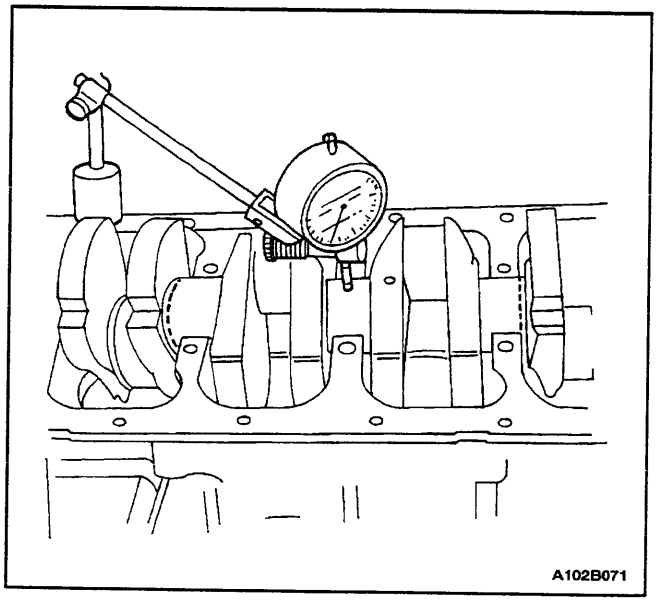
CRANKSHAFT BEARINGS AND CONNECTING ROD BEARINGS — GAUGING PLASTIC

Tools Required

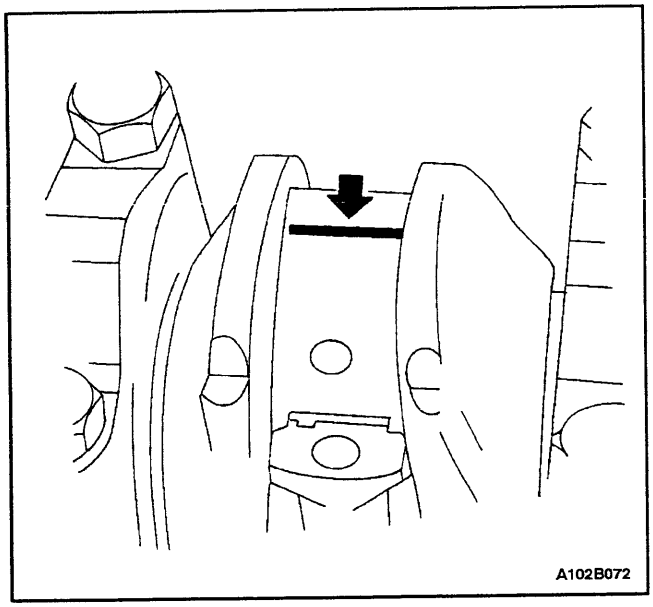
KM-470-B Angular Torque Gauge

Inspection Procedure - Crankshaft

1. Coat the crankshaft bearings with engine oil.
2. Install the upper crankshaft bearings into the engine block crankshaft journals.
3. Install the lower crankshaft bearings into the crankshaft bearing caps.
4. Install the crankshaft.
5. Inspect the crankshaft end play with the crankshaft bearings installed.
6. Check for permissible crankshaft end play. Refer to "Engine Specifications" in this section.

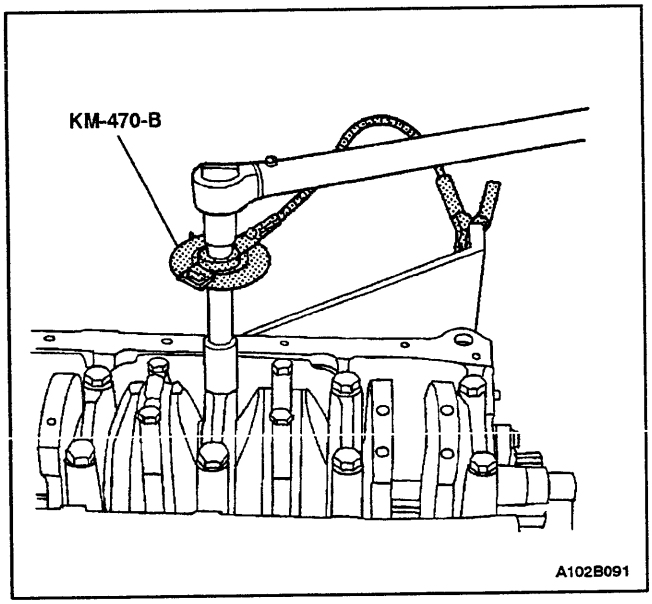


7. With the crankshaft mounted on the front and the rear crankshaft bearings, check the middle crankshaft journal for permissible out-of-round (runout). Refer to "Engine Specifications" in this section.



Important: Grease the crankshaft journals and lubricate the crankshaft bearings slightly so that the plastic gauging thread does not tear when the crankshaft bearing caps are removed.

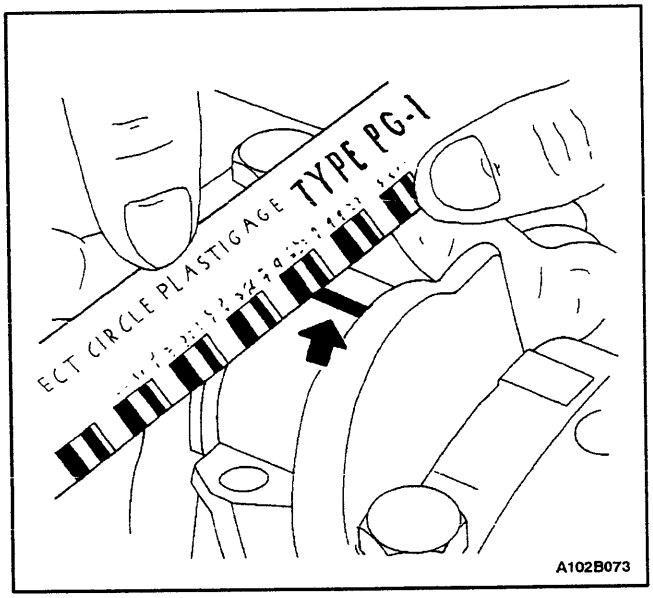
8. Inspect all of the crankshaft bearing clearances using a commercially available plastic gauging (ductile plastic threads).
9. Cut the plastic gauging threads to the length of the bearing width. Lay them axially between the crankshaft journals and the crankshaft bearings.



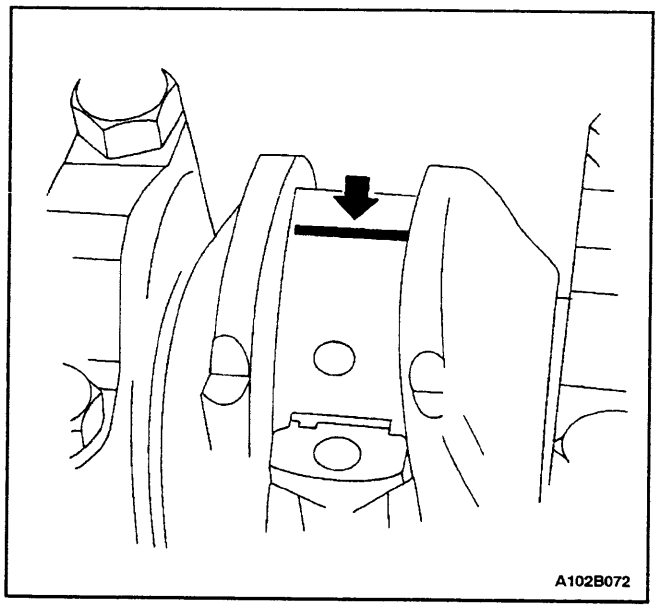
10. Install the crankshaft bearing caps.
11. Install the crankshaft bearing cap bolts.

Tighten

Tighten the crankshaft bearing cap bolts to 50 N•m (37 lb-ft). Using the angular torque gauge KM-470-B, tighten the crankshaft bearing cap bolts another 45 degrees plus 15 degrees.



12. Remove the crankshaft bearing caps.
13. Measure the width of the flattened plastic thread of the plastic gauging using a ruler. (Plastic gauging is available for different tolerance ranges.)
14. Inspect the bearing clearances for permissible tolerance ranges. Refer to "Engine Specifications" in this section.

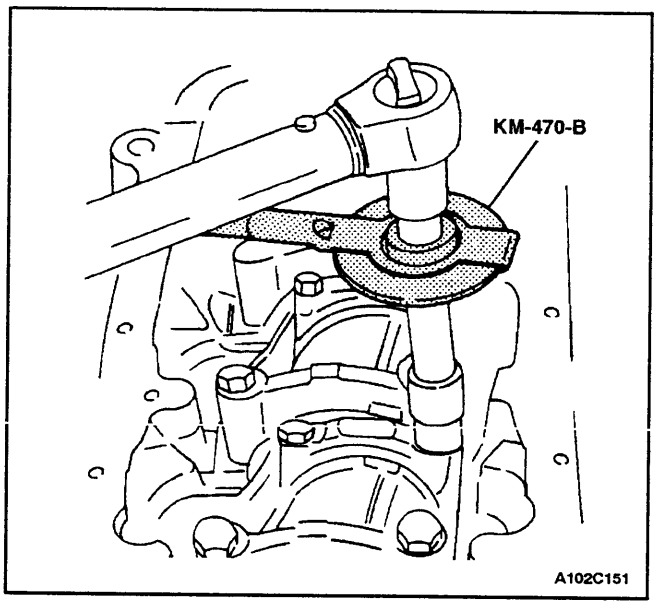

A102B072

Inspection Procedure - Connecting Rods

1. Coat the connecting rod bearings with engine oil.
2. Install the upper connecting rod bearings into the connecting rod journals.
3. Install the lower connecting rod bearings into the connecting rod bearing caps.

Important: Grease the connecting rod journals and lubricate the connecting rod bearings slightly so that the plastic gauging thread does not tear when the connecting rod bearing caps are removed.

4. Inspect all of the connecting rod bearing clearances using a commercially available plastic gauging (ductile plastic threads).
5. Cut the plastic gauging threads to the length of the bearing width. Lay them axially between the connecting rod journals and the connecting rod bearings.

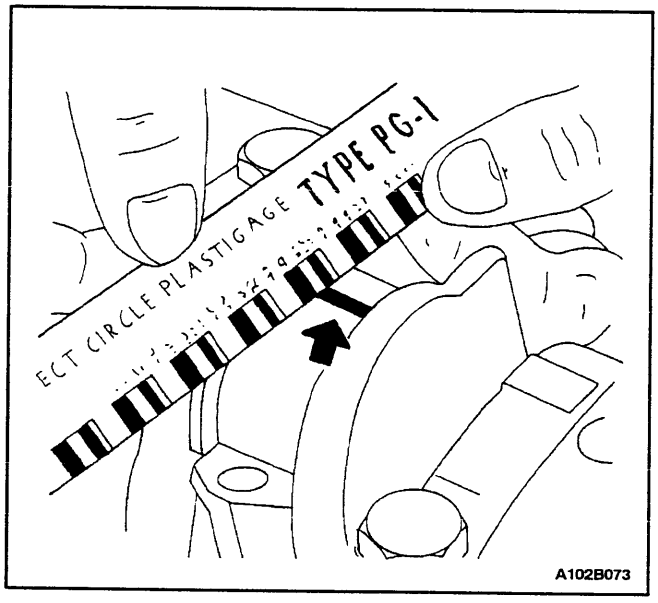


A102C151

6. Install the connecting rod bearing caps.
7. Install the connecting rod bearing cap bolts.

Tighten

Tighten the connecting rod bearing cap bolts 35 N•m (26 lb-ft). Using the angular torque gauge KM-470-B, tighten the connecting rod cap bolts another 45 degrees.



A102B073

8. Remove the connecting rod bearing caps.
9. Measure the width of the flattened plastic thread of the plastic gauging using a ruler. (Plastic gauging is available for different tolerance ranges.)
10. Inspect the bearing clearance for permissible tolerance ranges. Refer to "Engine Specifications" in this section.

GENERAL DESCRIPTION AND SYSTEM OPERATION

CYLINDER HEAD AND GASKET

The cylinder head is made of an aluminum alloy. The cylinder head uses cross-flow intake and exhaust ports. A spark plug is located in the center of each combustion chamber. The cylinder head houses the dual camshafts.

CRANKSHAFT

The crankshaft has eight integral weights which are cast with it for balancing. Oil holes run through the center of the crankshaft to supply oil to the connecting rods, the bearings, the pistons, and the other components. The end thrust load is taken by the thrust washers installed at the center journal.

TIMING BELT

The timing belt coordinates the crankshaft and the dual overhead camshafts and keeps them synchronized. The timing belt also turns the coolant pump. The timing belt and the pulleys are toothed so that there is no slippage between them. There are two idler pulleys. An automatic tensioner pulley maintains the timing belt's correct tension. The timing belt is made of a tough reinforced rubber similar to that used on the serpentine accessory drive belt. The timing belt requires no lubrication.

OIL PUMP

The oil pump draws engine oil from the oil pan and feeds it under pressure to the various parts of the engine. An oil strainer is mounted before the inlet of the oil pump to remove impurities which could clog or damage the oil pump or other engine components. When the crankshaft rotates, the oil pump driven gear rotates. This causes the space between the gears to open and narrow continually, pulling oil in from the oil pan when the space opens, and pumping the oil out to the engine as the space narrows.

At high engine speeds, the oil pump supplies a much higher amount of oil than required for lubrication of the engine. The oil pressure regulator prevents too much oil from entering the engine lubrication passages. During normal oil supply, a coil spring and a valve keep the bypass closed, directing all of the pumped oil to the engine. When the amount of oil being pumped increases, the pressure becomes high enough to overcome the force of the spring. This opens the valve of the oil pressure regulator, allowing the excess oil to flow through the valve and drain back to the oil pan.

OIL PAN

The engine oil pan is mounted to the bottom of the cylinder block. The engine oil pan houses the crankcase and is made of cast aluminum.

Engine oil is pumped from the oil pan by the oil pump. After it passes through the oil filter, it is fed through two paths to lubricate the cylinder block and the cylinder head. In one path, the oil is pumped through the oil passages in the crankshaft to the connecting rods, then to the pistons and the cylinders. It then drains back to the oil pan. In the second path, the oil is pumped through the oil passages to the camshaft. The oil passes through the internal passageways in the camshafts to lubricate the valve assemblies before draining back to the oil pan.

EXHAUST MANIFOLD

A single four-port, rear-takedown manifold is used with this engine. The manifold is designed to direct escaping exhaust gases out of the combustion chambers with a minimum of back pressure. The oxygen sensor is mounted to the exhaust manifold.

INTAKE MANIFOLD

The intake manifold has four independent long ports and utilizes an inertial supercharging effect to improve engine torque at low and moderate speeds.

CAMSHAFTS

This engine is a dual overhead camshaft (DOHC) type, which means there are two camshafts. One camshaft operates the intake valves, and the other camshaft operates the exhaust valves. The camshafts sit in journals on the top of the engine (in the cylinder head) and are held in place by camshaft caps. The camshaft journals of the cylinder head are drilled for oil passages. Engine oil travels to the camshafts under pressure where it lubricates each camshaft journal. The oil returns to the oil pan through drain holes in the cylinder head. The camshaft lobes are machined into the solid camshaft to open and close the intake and the exhaust valves the precisely correct amount at the precisely correct time. The camshaft lobes are oiled by the splash action from pressurized oil escaping from the camshaft journals.

EXHAUST GAS RECIRCULATION VALVE

The exhaust gas recirculation (EGR) system is used to lower oxides of nitrogen (NOX) emission levels caused by high combustion temperatures. The main element of the system is the EGR valve which is operated by vacuum and controlled by the ECM through the electrically actuated EGR solenoid.

The EGR valve feeds small amounts of exhaust gas into the intake manifold to decrease the combustion temperature. The amount of exhaust gas recirculated is controlled by variations in vacuum and exhaust back pressure. If too much exhaust gas enters, combustion will not take place. For this reason, very little exhaust gas is allowed to pass through the valve, especially at idle.

The EGR valve is usually open under the following conditions:

- Warm engine operation.
- Above idle speed.

SECTION 1D

ENGINE COOLING

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

TABLE OF CONTENTS

SPECIFICATIONS

CAPACITY

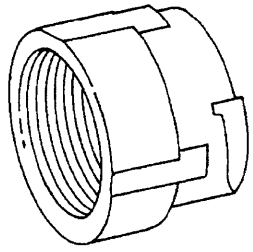
Application	Description
Coolant in the Cooling System (DOHC MPFI System)	7.0L (1.86 gal) for automatic transaxle 7.0L (1.88 gal) for manual transaxle

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Coolant Pump Mounting Bolts	20	15	-
Coolant Temperature Sensor	20	15	-
Fan Assembly Mounting Bolts	4	-	35
Fan Motor Nut	3.2	-	28
Fan Motor Retaining Screws	4	-	35
Radiator Retaining Bolts	4	-	35
Surge Tank Attaching Bolt	4	-	35
Thermostat Housing Mounting Bolt	15	11	-
Transaxle Fluid Cooler Pipe Bolt	22	16	-

SPECIAL TOOLS

SPECIAL TOOLS TABLE

 A102D020	**KM-471 Adapter**

DIAGNOSIS

THERMOSTAT TEST

1. Remove the thermostat from the vehicle. Refer to "Thermostat" in this section.
2. Make sure the valve spring is tight when the thermostat is fully closed. If the spring is not tight, replace the thermostat.
3. Suspend the thermostat and a thermometer in a pan of 50/50 mixture of ethylene glycol and water. Do not let the thermostat or the thermometer rest on the bottom of the pan because the uneven concentration of heat on the bottom could result in inaccurate temperature measurements.
4. Heat the pan on a burner.
5. Use the thermometer to measure the temperature of the heated solution.
6. The thermostat should begin to open at 87°C (189°F) and it should be fully open at 102°C (216°F). If it does not open at these temperatures, replace the thermostat.

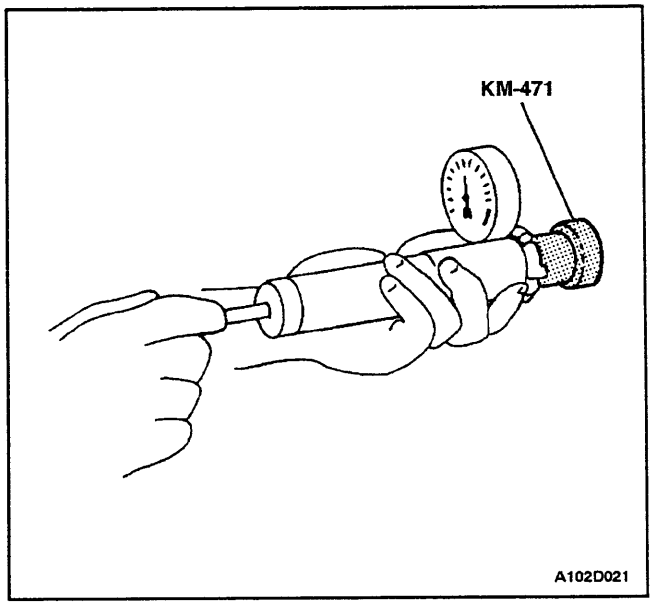
SURGE TANK CAP TEST

Tools Required

KM-471 Adapter

The surge tank cap maintains proper pressure, protects the system from high pressure by opening a pressure valve, and protects the coolant hoses from collapsing because of a vacuum.

1. Wash any sludge from the surge tank cap and the valve seat of the vacuum pressure valve for the surge tank cap.
2. Check for any damage or deformity to the vacuum pressure valve for the surge tank cap. If any damage or deformity is found, replace the cap.
3. Install a suitable cooling system pressure tester to the cap using the adapter KM-471.
4. Pull the vacuum pressure valve open. If the surge tank cap does not seal properly, replace the surge tank cap.
5. Pressurize the cap to 90 to 120 kPa (13 to 17 psi).
6. Wait 10 seconds and check the pressure held by the tank cap tester.



7. If the pressure held by the cooling system pressure tester falls below 80 kPa (11.6 psi), replace the surge tank cap.

COOLING SYSTEM DIAGNOSIS

Engine Overheats

Checks	Action
Check for a loss of the coolant.	Add the coolant.
Check for a weak coolant solution.	Confirm that the coolant solution is a 50/50 mixture of ethylene glycol and water.
Check the front of the radiator for any dirt, any leaves, or any insects.	Clean the front of the radiator.
Check for leakage from the hoses, the coolant pump, the heater, the thermostat housing, the radiator, the core plugs, or the head gasket.	Replace any damaged components.
Check for a faulty thermostat.	Replace a damaged thermostat.
Check for retarded ignition timing.	Perform an ECM code diagnosis. Confirm the integrity of the timing belt.
Check for an improperly operating electric cooling fan.	Replace the electric cooling fan.
Check for radiator hoses that are plugged or rotted.	Replace any damaged radiator hoses.
Check for a faulty water pump.	Replace a faulty water pump.
Check for a faulty surge tank cap.	Replace a faulty surge tank cap.
Check for a cylinder head or an engine block that is cracked or plugged.	Repair the damaged cylinder head or the damaged engine block.

Loss of Coolant

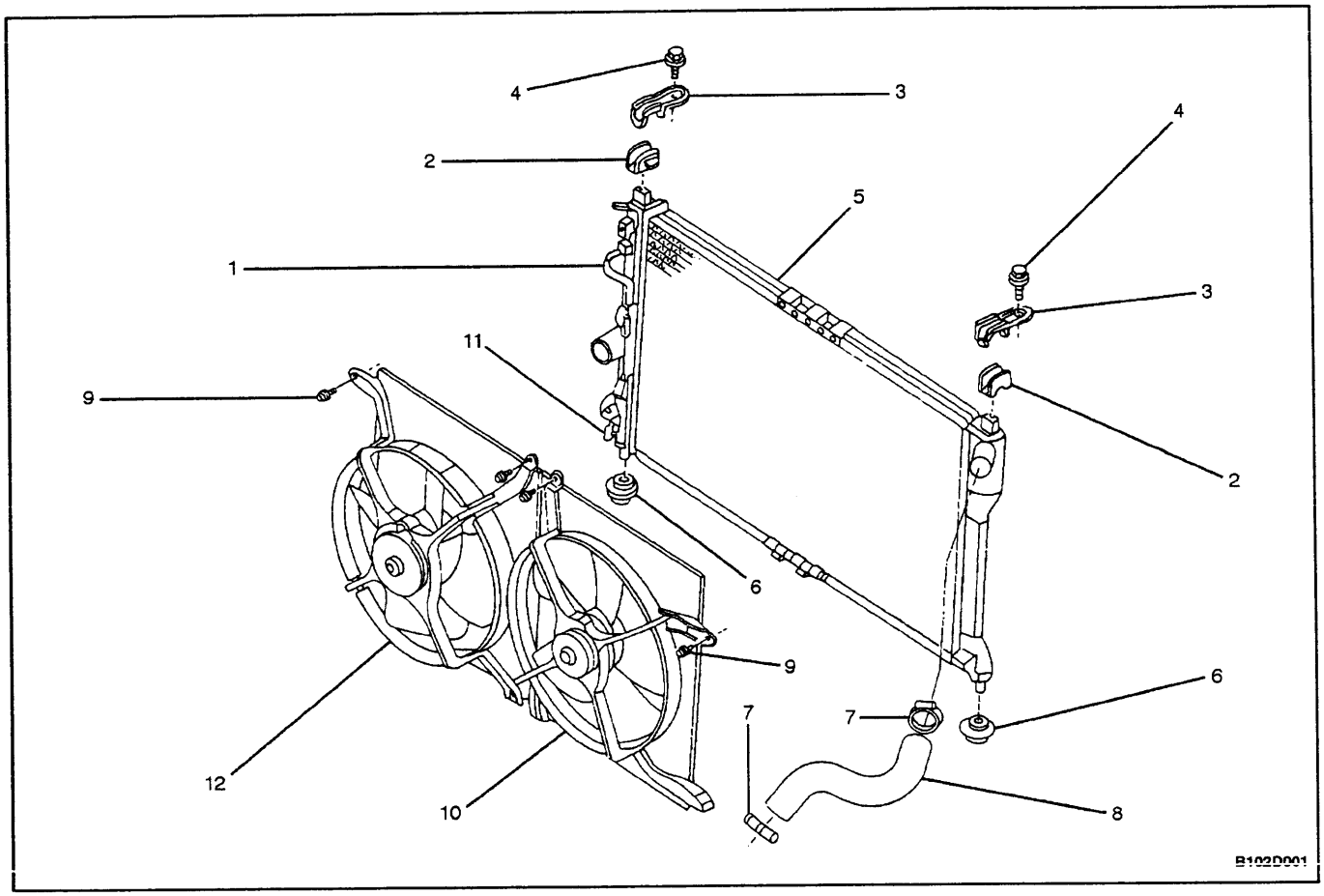
Checks	Action
Check for a leak in the radiator.	Replace a damaged radiator.
Check for a leak in the following locations: • Surge tank. • Hose.	Replace the following parts, as needed: • Surge tank. • Hose.
Check for loose or damaged radiator hoses, heater hoses, and connections.	Reseat the hoses. Replace the hoses or the clamps.
Check for leaks in the coolant pump seal.	Replace the coolant pump seal.
Check for leaks in the coolant pump gasket.	Replace the coolant pump gasket.
Check for an improper cylinder head torque.	Tighten the cylinder head bolts to specifications. Replace the cylinder head gasket, if needed.
Check for leaks in the following locations: • Intake manifold. • Cylinder head gasket. • Cylinder block plug. • Heater core. • Radiator drain plug.	Repair or replace any components, as needed, to correct the leak.

Engine Fails to Reach Normal Operating Temperature or Cool Air from the Heater

Checks	Action
Check to determine if the thermostat is stuck open or is the wrong type of thermostat.	Install a new thermostat of the correct type and heat range.
Check the coolant level to determine if it is below the MIN mark on the surge tank.	Add sufficient coolant to raise the fluid to the specified mark on the surge tank.

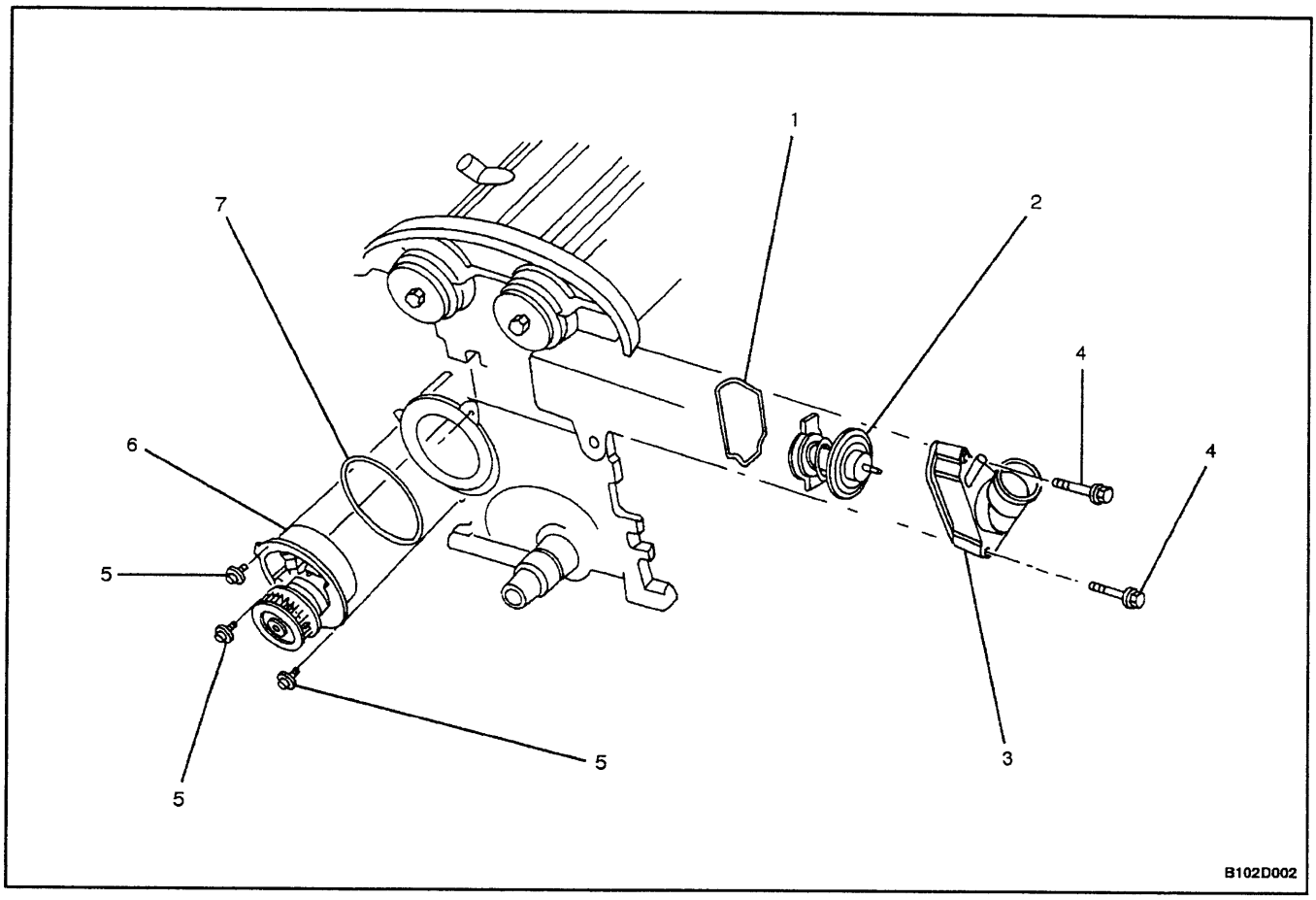
COMPONENT LOCATOR

RADIATOR/FAN

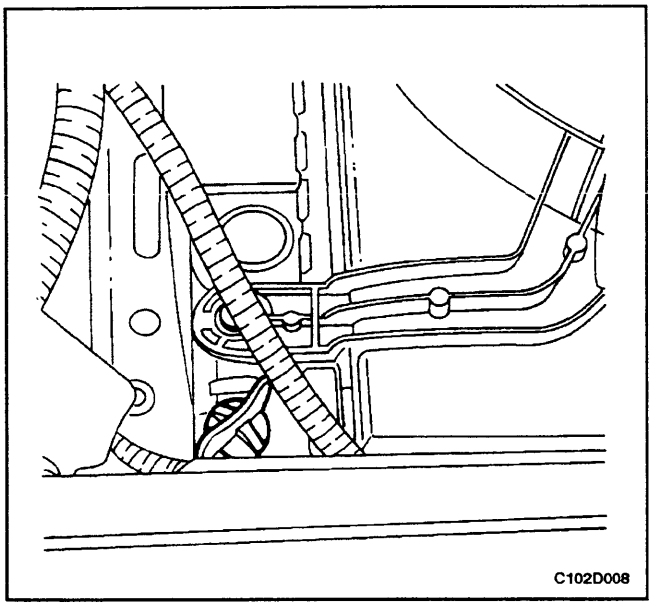


1 Transaxle Fluid Cooler Pipe Holder (Automatic Transaxle Only)
2 Upper Radiator Bumper
3 Radiator Bracket
4 Radiator Retaining Bolts
5 Radiator
6 Radiator Bumper
7 Spring Clamp
8 Upper Radiator Hose
9 Fan Assembly Mounting Bolts
10 Auxiliary Cooling Fan
11 Drain Plug
12 Main Cooling Fan

COOLANT PUMP/THERMOSTAT (DOHC)



1 O-Ring Seal
2 Thermostat
3 Thermostat Housing
4 Thermostat Housing Mounting Bolt
5 Coolant Pump Mounting Bolt
6 Coolant Pump
7 Ring Seal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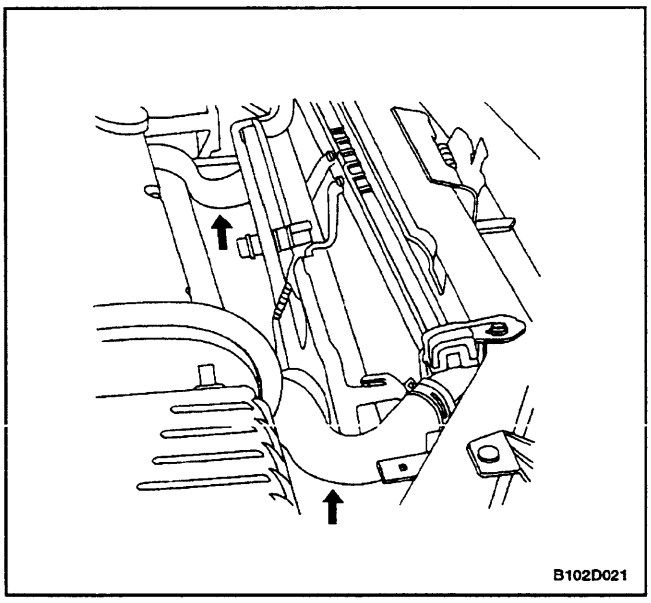

B102D021

MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

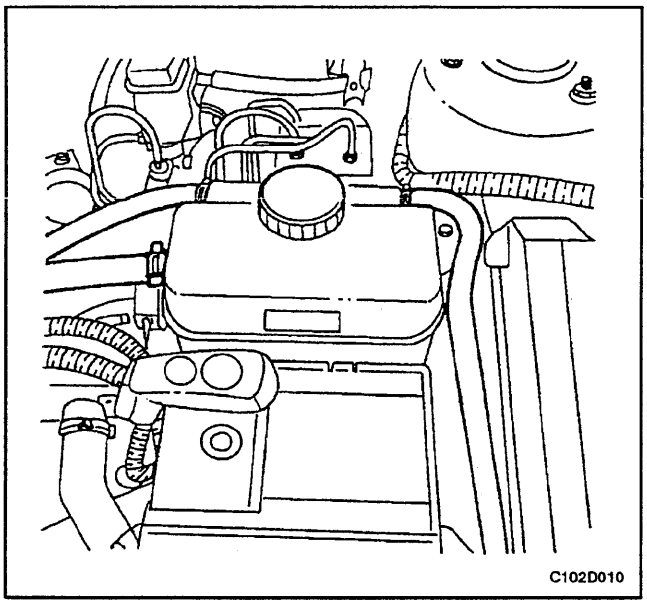
DRAINING AND REFILLING THE COOLING SYSTEM

Caution: To prevent personal injury, do not remove the surge tank cap while the engine and the radiator are hot. Scalding fluid and steam may be blown out under pressure.

1. Place a pan below the vehicle to catch the draining coolant.
2. Remove the surge tank cap.
3. Unplug the drain plug.

Caution: To prevent personal injury and to protect the environment, dispose of the used coolant in a used coolant holding tank to be picked up with the used oil for disposal. Never pour the used coolant down the drain. Ethylene glycol antifreeze is an extremely toxic chemical. Disposing of it into the sewer system or the ground water can contaminate the local environment.

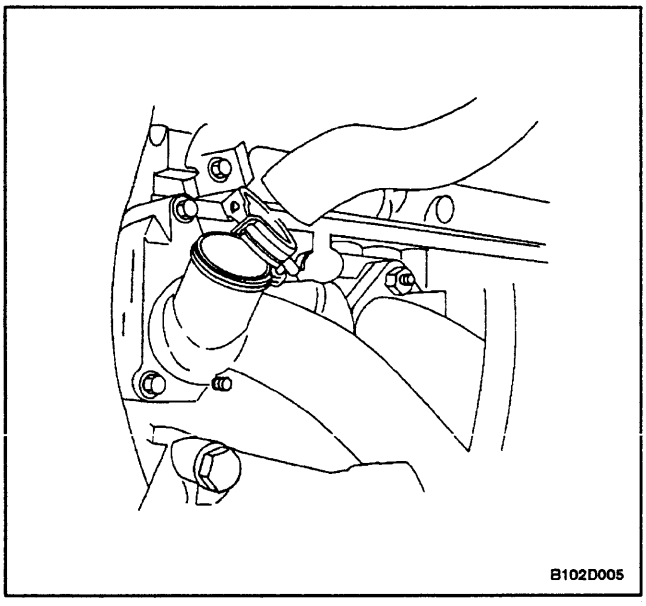
4. Catch the escaping fluid in a drain pan.
5. Remove all sludge and dirt from inside the surge tank. Refer to "Surge Tank" in this section.
6. Screw in the drain plug.
7. Add the clean water to the surge tank.
8. Fill the tank slowly so that the upper reservoir hose remains above the water line. This allows the air inside the cooling system to escape.
9. Start the engine.
10. Run the engine until the thermostat opens. You can tell the thermostat is open when both radiator hoses are hot to the touch.


C102D010

11. Stop the engine.
12. Repeat steps 1 through 9 until the drained water is clear and free of coolant and rust.

Notice: Never use an antifreeze mixture more concentrated than 60 percent antifreeze to 40 percent water. The solution freezing point increases above this concentration.

13. Fill the cooling system through the surge tank with a mixture of ethylene glycol antifreeze and water. The mixture must be at least 50 percent antifreeze, but not more than 60 percent antifreeze.
14. Fill the surge tank to the specified MAX fill mark on the outside of the tank.

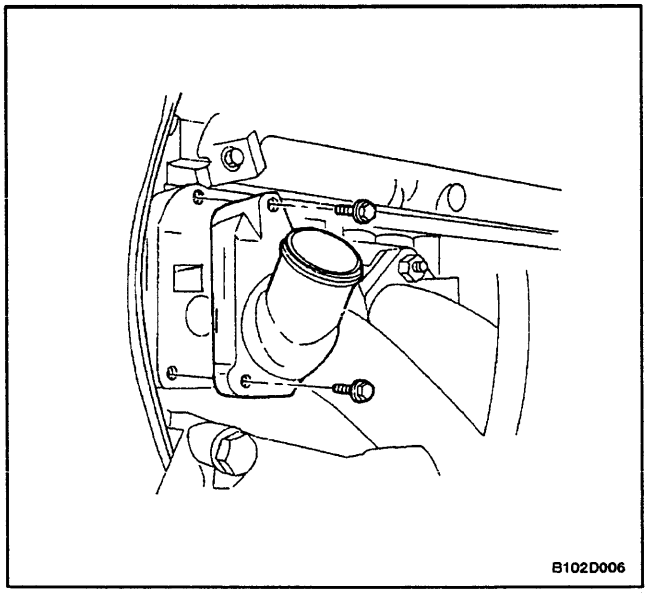

B102D005

THERMOSTAT

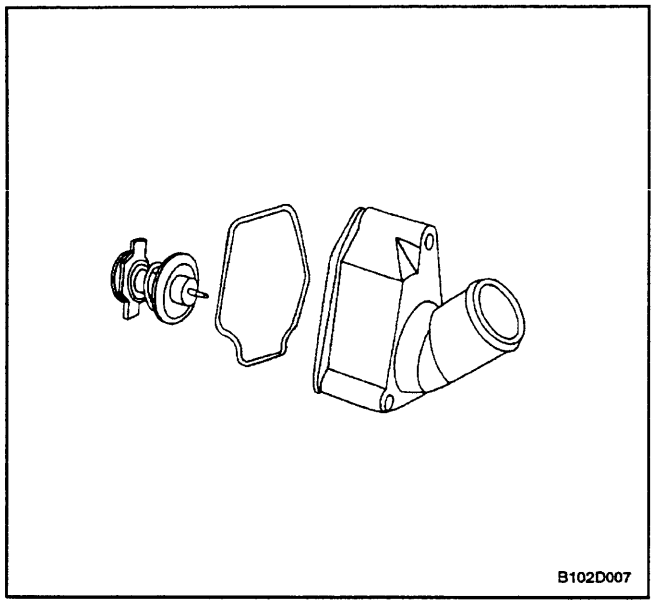
Removal Procedure

Caution: To prevent personal injury, do not remove the surge tank cap while the engine and the radiator are hot because the heat causes the system to remain under pressure. Scalding fluid and steam may be blown out under pressure.

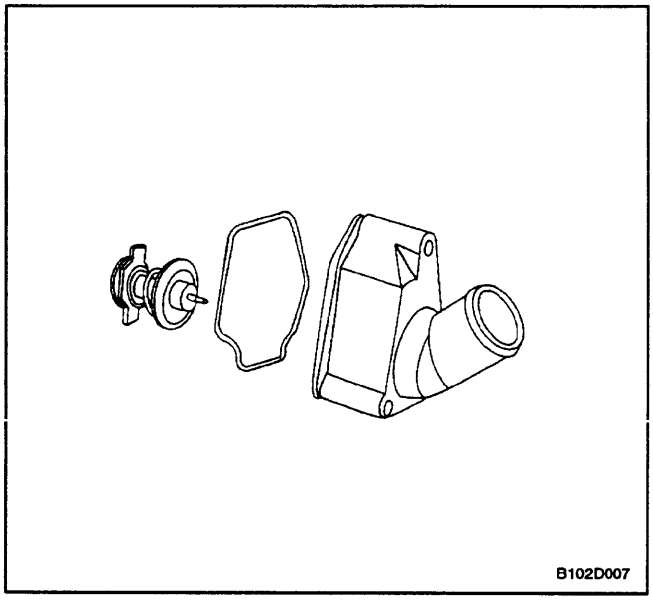
1. Drain the coolant. Refer to "Draining and Refilling the Cooling System" in this section.
2. Loosen the hose clamp on the upper radiator hose at the thermostat housing.
3. Disconnect the upper radiator hose from the thermostat housing.


B102D006

4. Remove the mounting bolts that hold the thermostat housing to the cylinder head.
5. Remove the thermostat housing from the cylinder head.

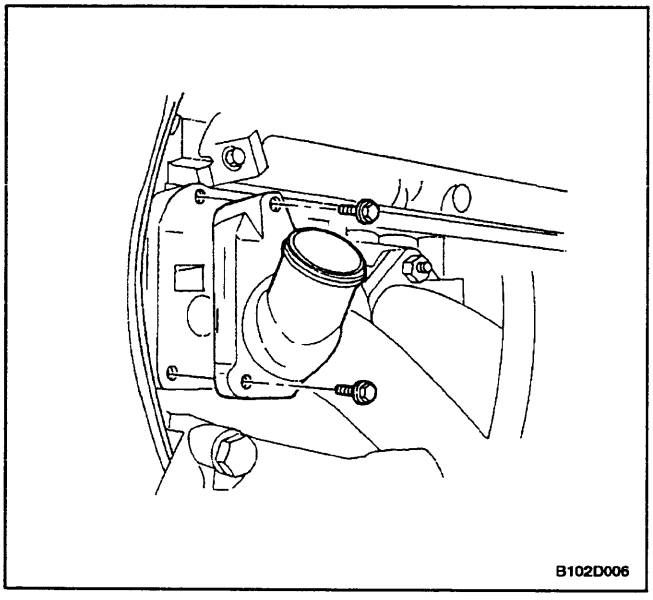

B102D007

6. Remove the O-ring seal from the thermostat housing.
7. Remove the thermostat from the thermostat housing by pressing the thermostat mounting flange downward and then rotating the flange clockwise.
8. Inspect the valve seat for foreign matter that could prevent the valve from sealing properly.
9. Inspect the thermostat for proper operation. Refer to "Thermostat Test" in this section.
10. Clean the thermostat housing and the cylinder head mating surfaces.


B102D007

Installation Procedure

1. Install the thermostat into the thermostat housing by pressing the thermostat mounting flange downward and then rotating the flange counterclockwise. Rotate the thermostat mounting flange until it is seated in the thermostat housing recesses.
2. Coat the sealing surface of a new O-ring seal with Lubriplate®.
3. Install a new O-ring seal into the recess in the thermostat housing.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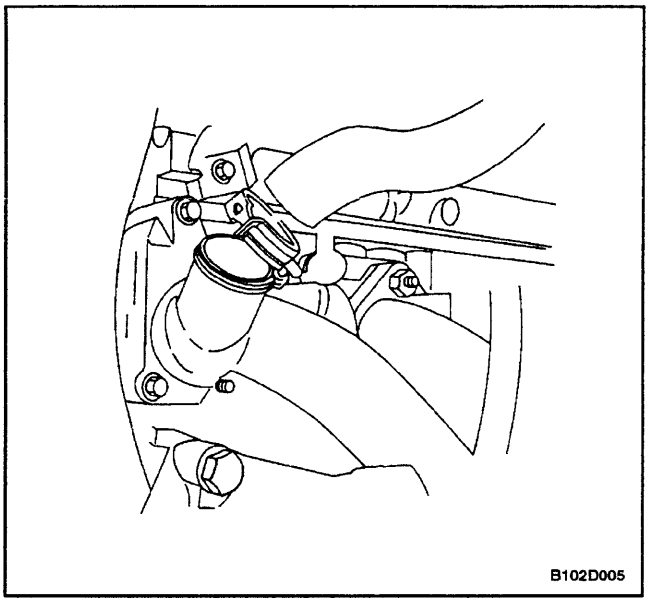
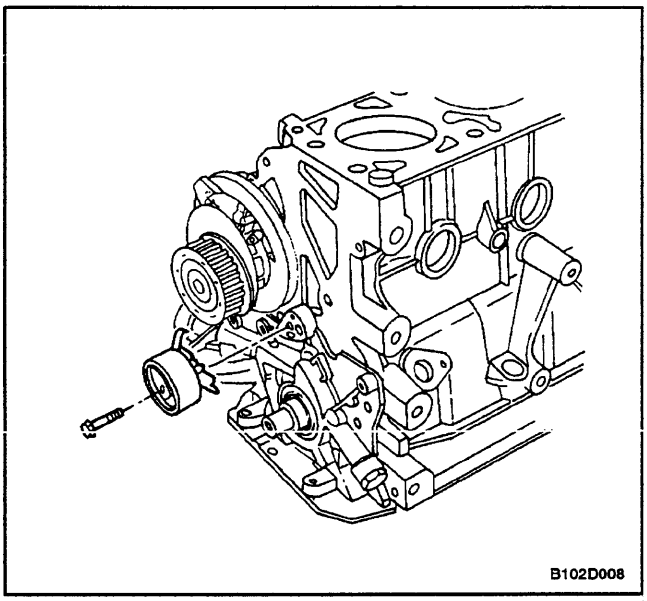
4. Install the thermostat housing to the cylinder head.
5. Secure the thermostat housing to the cylinder head with the mounting bolts.

Tighten

Tighten the thermostat housing mounting bolts to 15 N•m (11 lb-ft).


B102D005

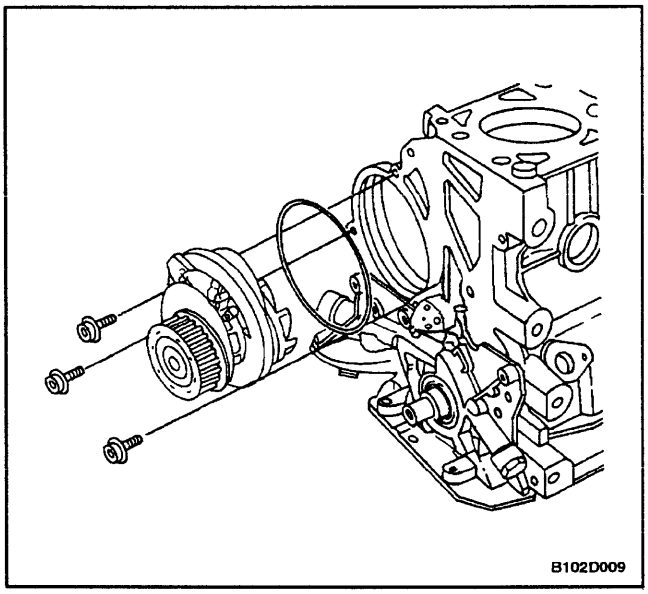
6. Connect the upper radiator hose to the thermostat housing.
7. Secure the upper radiator hose to the thermostat housing with a hose clamp.
8. Refill the engine cooling system. Refer to "Draining and Refilling the Cooling System" in this section.


B102D008

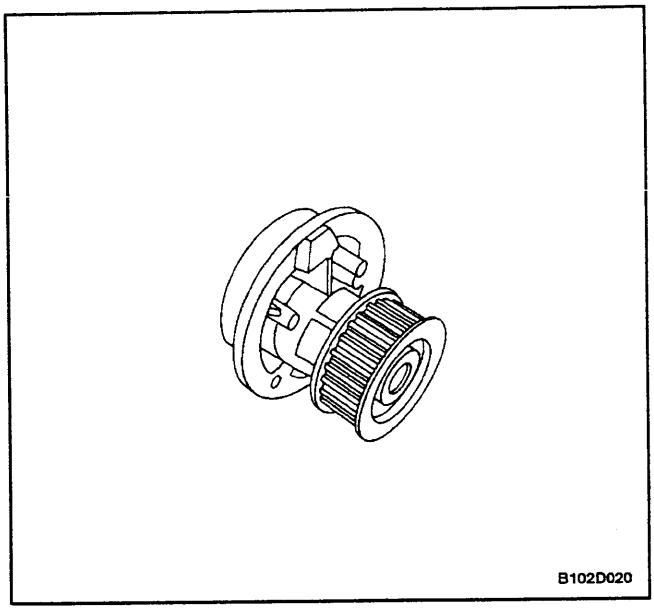
COOLANT PUMP

Removal Procedure

1. Drain the engine cooling system to a level below the thermostat housing. Refer to "Draining and Refilling the Cooling System" in this section.
2. Remove the timing belt. Refer to *Section 1C, DOHC Engine Mechanical.*
3. Remove the timing belt tension roller retaining bolt.
4. Remove the timing belt tension roller.

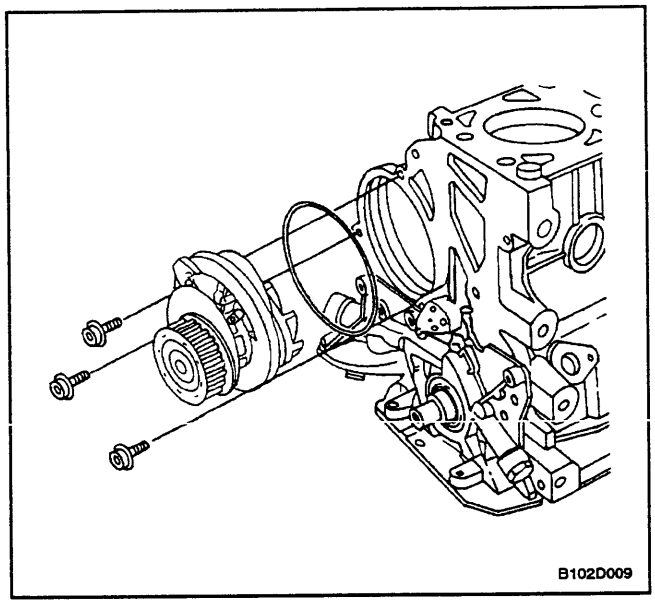

B102D009

5. Remove the coolant pump mounting bolts.
6. Remove the coolant pump from the engine block.
7. Remove the ring seal from the coolant pump.


B102D020

Inspection Cleaning Procedure

1. Inspect the coolant pump body for cracks and leaks.
2. Inspect the coolant pump bearing for play or abnormal noise.
3. Inspect the coolant pump pulley for excessive wear. If the coolant pump is defective, replace the coolant pump as a unit.
4. Clean the mating surfaces of the coolant pump and the engine block.

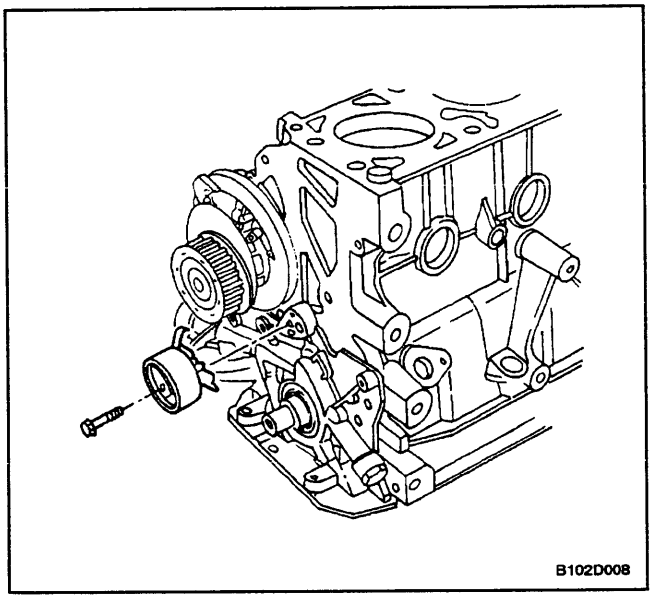

B102D009

Installation Procedure

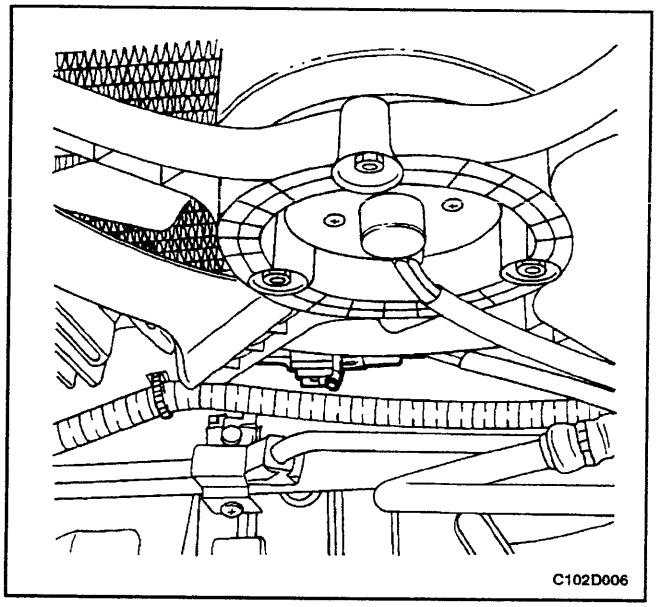
1. Install a new ring seal to the coolant pump.
2. Coat the sealing surface of the ring seal with Lubriplate®.
3. Install the coolant pump to the engine block with the flange aligned with the recess of the rear timing belt cover.
4. Secure the coolant pump to the engine block with the mounting bolts.

Tighten

Tighten the coolant pump mounting bolts to 20 N•m (15 lb-ft).


B102D008

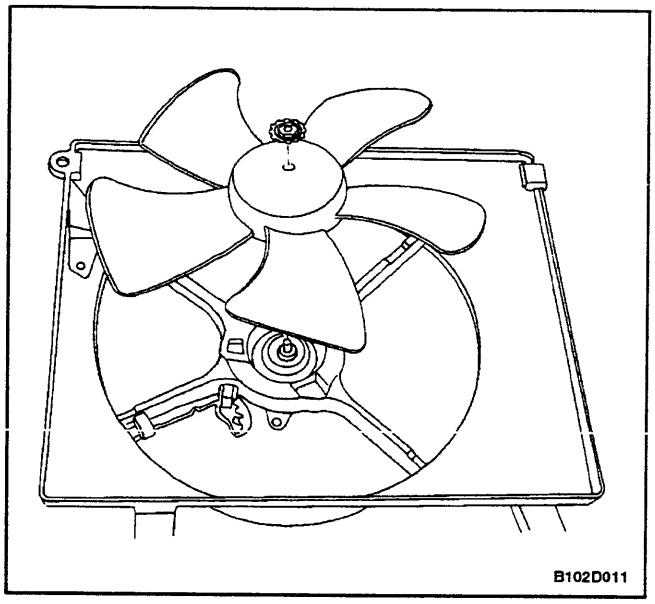
5. Install the timing belt tension roller to the oil pump with the flange inserted into the recess of the oil pump.
6. Install the timing belt tension roller bolt. Do not tighten the bolt at this time.
7. Install the timing belt. Refer to *Section 1C, DOHC Engine Mechanical.*
8. Refill the engine cooling system. Refer to "Draining and Refilling the Cooling System" in this section.


C102D006

ELECTRIC COOLING FAN - MAIN OR AUXILIARY

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the cooling fan electrical connector.
3. Remove the fan shroud mounting bolts.
4. Lift the fan shroud assembly upward, and remove the fan shroud assembly from the vehicle.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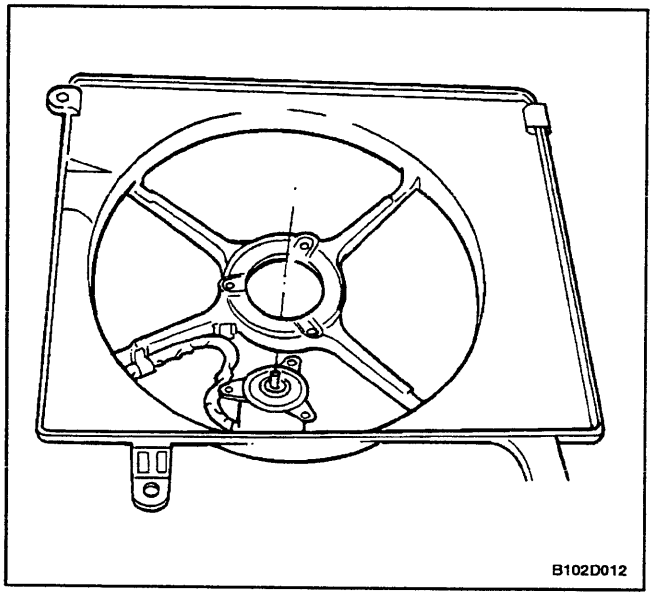
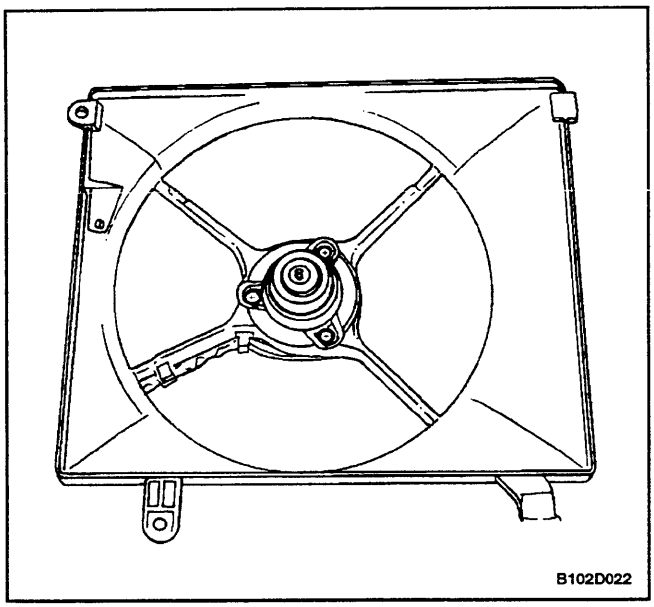
5. Remove the fan blade from the fan shroud assembly by removing the nut at the center of the fan hub.


B102D012

6. Remove the fan motor retaining screws.
7. Remove the fan motor from the shroud.


B102D022

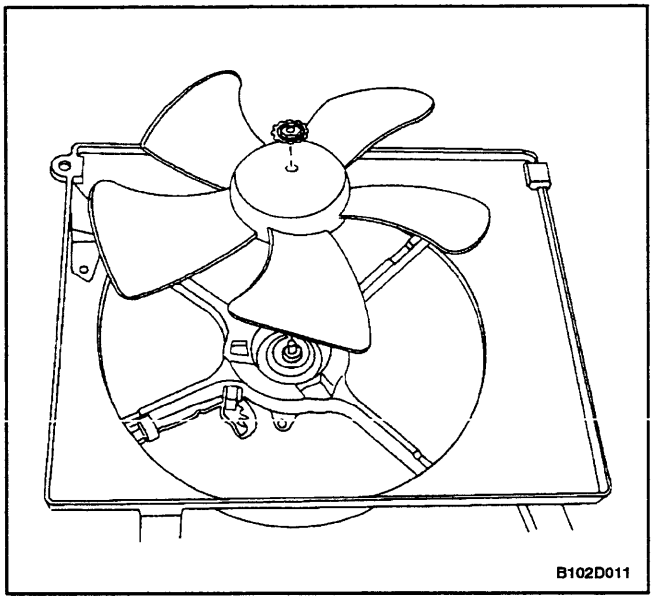
Installation Procedure

Caution: If a fan blade is bent or damaged in any way, no attempt should be made to repair or reuse the damaged part. A bent or damaged fan assembly must be replaced with a new fan assembly. It is essential that fan assemblies remain in proper balance. A fan assembly that is not in proper balance can fail and fly apart during use, creating extreme danger. Proper balance cannot be assured on a fan assembly that has been bent or damaged.

1. Install the fan motor to the shroud.
2. Secure the motor to the shroud with the retaining screws.

Tighten

Tighten the fan motor retaining screws to 4 N•m (35 lb-in).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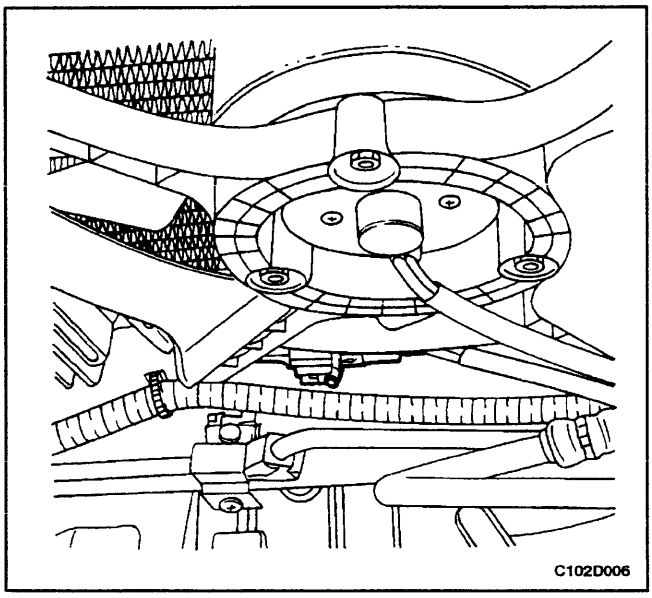
3. Install the fan to the fan shroud assembly with the single nut in the center of the fan hub.

Tighten

Tighten the fan motor nut to 3.2 N•m (28 lb-in).


C102D006

4. Install the fan shroud assembly to the radiator.

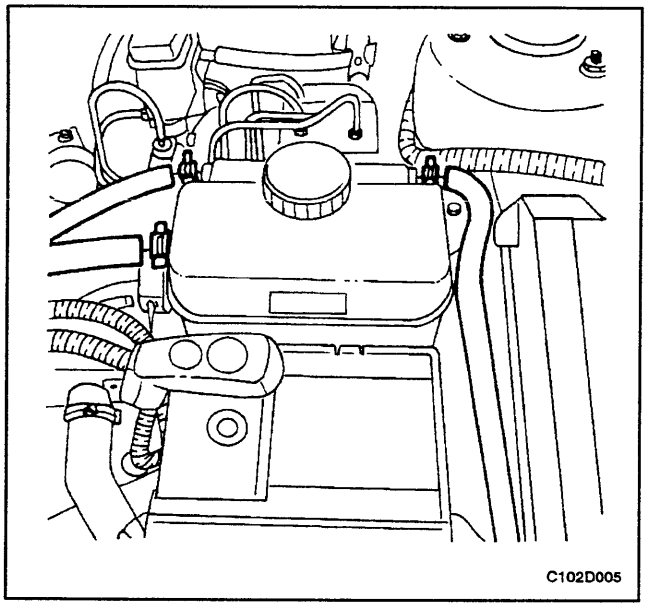
Important: Be careful to seat the mounting post on the fan shroud into the socket at the radiator left tank. Be sure to slip the tab at the bottom edge of the shroud into the retaining clip near the center of the radiator.

5. Secure the shroud to the top of the radiator with the mounting bolts.

Tighten

Tighten the fan assembly mounting bolts to 4 N•m (35 lb-in).

6. Connect the cooling fan electrical connector.
7. Connect the negative battery cable.

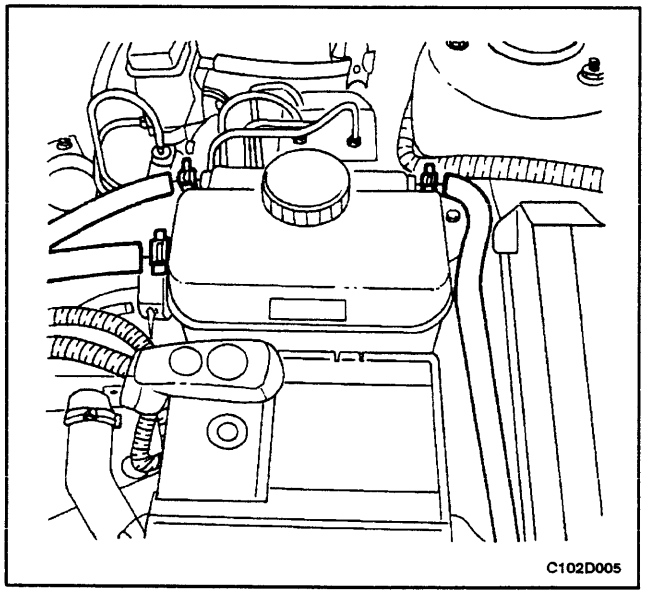

C102D005

SURGE TANK

Removal Procedure

Caution: To prevent personal injury, do not remove the surge tank cap while the engine and the radiator are hot, because the heat causes the system to remain under pressure. Scalding fluid and steam may be blown out under pressure.

1. Drain the engine coolant to below the level of the surge tank.
2. Loosen the return hose clamp and disconnect the return hose from the top of the surge tank.
3. Loosen the throttle body hose clamp and disconnect the throttle body hose from the top of the surge tank.
4. Loosen the feed hose clamp and disconnect the feed hose from the bottom of the surge tank.
5. Remove the surge tank attaching bolt.
6. Remove the surge tank from the support mount.
7. Clean the inside and the outside of the surge tank and the surge tank cap with soap and water.
8. Rinse the surge tank and the cap thoroughly.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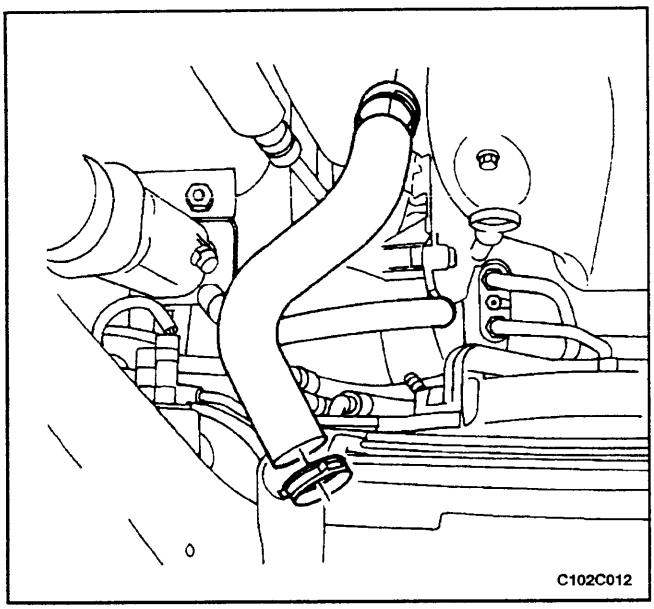
Installation Procedure

1. Install the surge tank to the support mount.
2. Secure the surge tank with the attaching bolt.

Tighten

Tighten the surge tank attaching bolt to 4 N•m (35 lb-in).

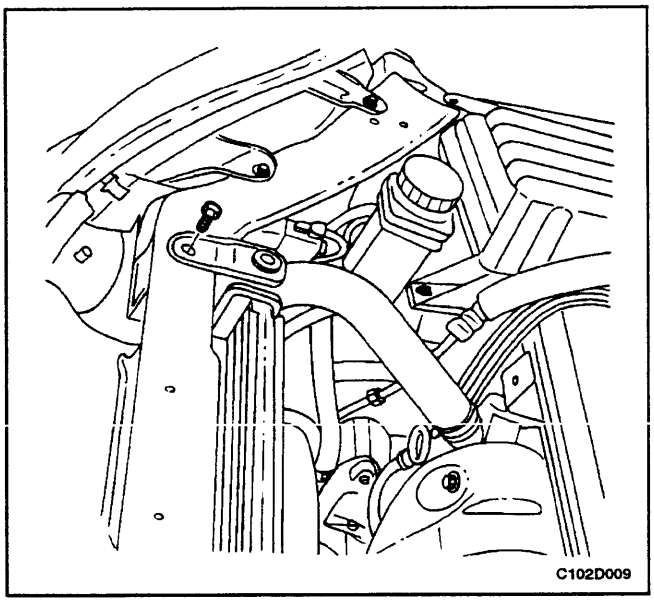
3. Connect the return hose and the throttle body hose to the top of the surge tank.
4. Connect the feed hose to the bottom of the surge tank.
5. Secure the return hose, the throttle body hose, and the feed hose to the surge tank with the hose clamps.
6. Fill the surge tank with the coolant to the center ridge, or to the MAX mark.



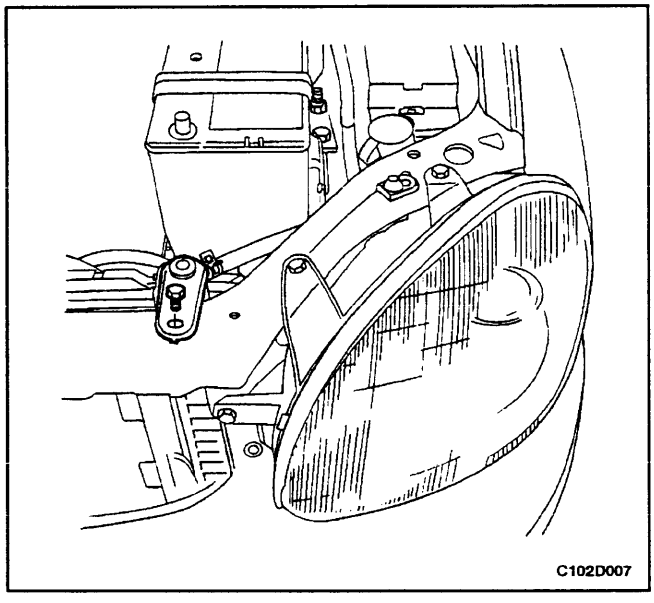
RADIATOR

Removal Procedure

1. Disconnect the negative battery cable.
2. Drain the engine cooling system. Refer to "Draining and Refilling the Cooling System" in this section.
3. Remove the main and the auxiliary cooling fans. Refer to "Electric Cooling Fan-Main or Auxiliary" in this section.
4. Remove the lower radiator hose clamp.
5. Disconnect the lower radiator hose from the radiator.
6. Remove the upper radiator hose clamp.
7. Disconnect the upper radiator hose from the radiator.

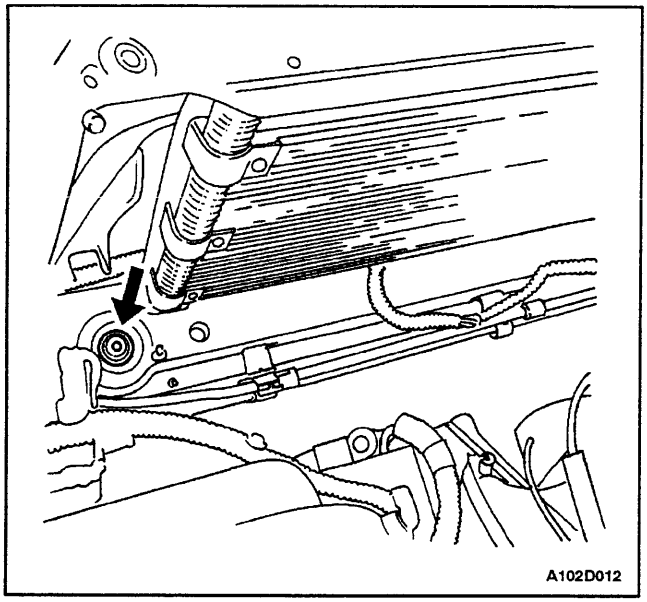


8. Remove the hose clamp from the surge tank hose at the radiator.
9. Disconnect the surge tank hose from the radiator.
10. Disconnect the transaxle fluid cooler pipes from the lower radiator tank, if equipped.
11. Remove the bolt and the transaxle fluid cooler pipe support clamp from the radiator.
12. Remove the left upper radiator retaining bolt.
13. Remove the left upper radiator retaining bracket.



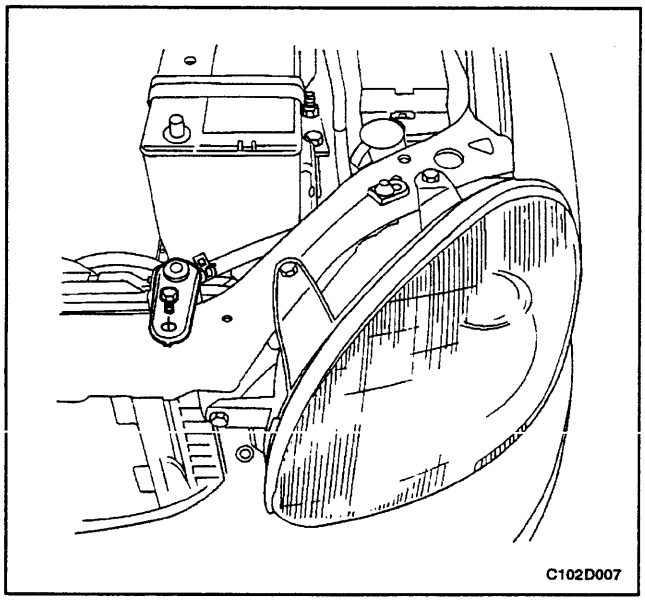
14. Remove the right upper radiator retaining bolt.
15. Remove the right upper radiator retaining bracket.
16. Remove the radiator from the vehicle.

Important: The radiator still contains a substantial amount of coolant. Drain the remainder of the coolant from the radiator into a drain pan.



Installation Procedure

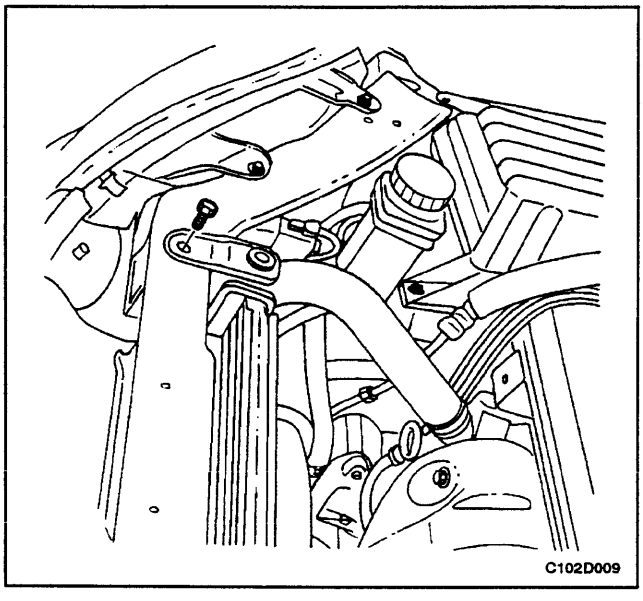
1. Set the radiator into place in the vehicle with the radiator bottom posts in the rubber shock bumpers.



2. Position the radiator retainers in place.
3. Install the right upper radiator retainer bracket.
4. Install the right upper radiator retaining bolt.

Tighten

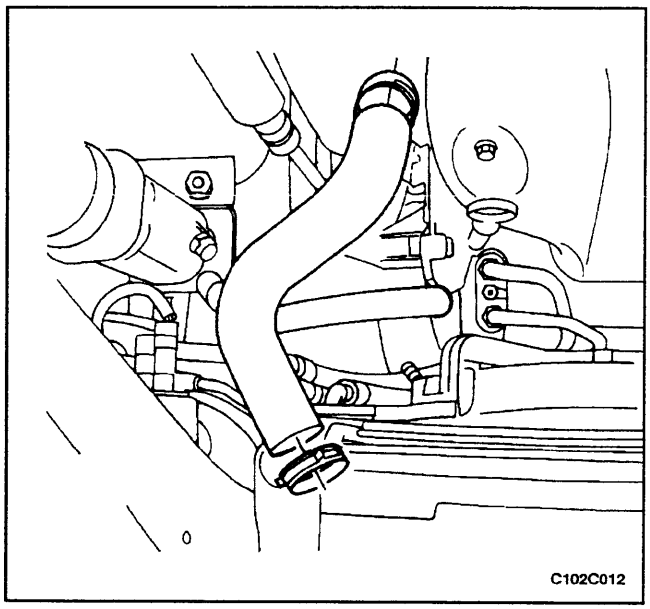
Tighten the radiator retaining bolt to 4 N•m (35 lb-in).



5. Install the left upper radiator retainer bracket.
6. Install the left upper radiator retaining bolt.

Tighten

Tighten the radiator retaining bolt to 4 N•m (35 lb-in).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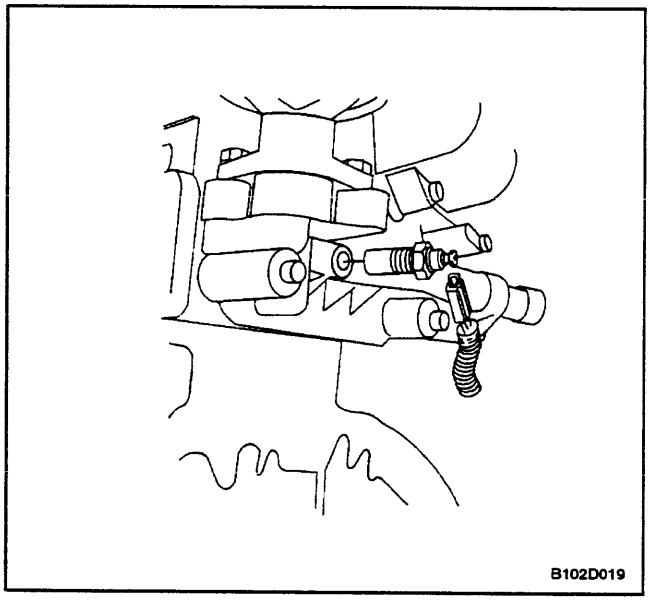
7. Connect the transaxle fluid cooler pipes to the lower radiator tank, if equipped.
8. Install the transaxle fluid cooler pipe and support clamp to the radiator with a bolt.

Tighten

Tighten the transaxle fluid cooler pipe bolt to 22 N•m (16 lb-ft).

9. Connect the surge tank hose to the radiator.
10. Secure the surge tank hose with a hose clamp.
11. Connect the upper radiator hose and the lower radiator hose to the radiator.
12. Secure each hose with a hose clamp.
13. Install the main and the auxiliary cooling fans. Refer to "Electric Cooling Fan-Main or Auxiliary" in this section.
14. Refill the engine cooling system. Refer to "Draining and Refilling the Cooling System" in this section.
15. Connect the negative battery cable.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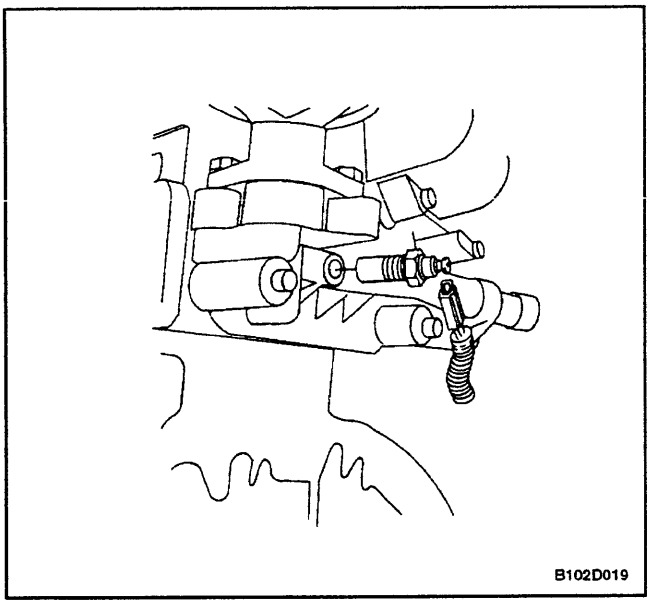
COOLANT TEMPERATURE SENSOR

Removal Procedure

1. Disconnect the negative battery cable.
2. Drain the coolant to a level below the coolant temperature sensor.
3. Disconnect the electrical connector from the coolant temperature sensor.
4. Remove the temperature sensor from the exhaust gas recirculation (EGR) valve mounting adapter.



Installation Procedure

1. Install the coolant temperature sensor into the threaded hole in the EGR valve mounting adapter.

Tighten

Tighten the coolant temperature sensor to 20 N•m (15 lb-ft).

2. Connect the electrical connector to the coolant temperature sensor.
3. Refill the engine cooling system. Refer to "Draining and Refilling the Cooling System" in this section.
4. Connect the negative battery cable.

GENERAL DESCRIPTION AND SYSTEM OPERATION

GENERAL DESCRIPTION

The cooling system maintains the engine temperature at an efficient level during all engine operating conditions. When the engine is cold, the cooling system cools the engine slowly or not at all. This slow cooling of the engine allows the engine to warm up quickly.

The cooling system includes a radiator and recovery subsystem, cooling fans, a thermostat and housing, a coolant pump, and a coolant pump drive belt. The timing belt drives the coolant pump.

All components must function properly in order for the cooling system to operate. The coolant pump draws the coolant from the radiator. The coolant then circulates through water jackets in the engine block, the intake manifold, and the cylinder head. When the coolant reaches the operating temperature of the thermostat, the thermostat opens. The coolant then goes back to the radiator where it cools.

This system directs some coolant through the hoses to the heater core. This provides for heating and defrosting. The surge tank is connected to the radiator to recover the coolant displaced by expansion from the high temperatures. The surge tank maintains the correct coolant level.

The cooling system for this vehicle has no radiator cap or filler neck. The coolant is added to the cooling system through the surge tank.

RADIATOR

This vehicle has a lightweight tube-and-fin aluminum radiator. Plastic tanks are mounted on the right and the left sides of the radiator core.

On vehicles equipped with automatic transaxles, the transaxle fluid cooler lines run through the left radiator tank. A radiator drain plug is on this radiator.

To drain the cooling system, open the drain plug.

SURGE TANK

The surge tank is a transparent plastic reservoir, similar to the windshield washer reservoir.

The surge tank is connected to the radiator by a hose and to the engine cooling system by another hose. As the vehicle is driven, the engine coolant heats and expands. The portion of the engine coolant displaced by this expansion flows from the radiator and the engine into the surge tank. The air trapped in the radiator and the engine is degassed into the surge tank.

When the engine stops, the engine coolant cools and contracts. The displaced engine coolant is then drawn back into the radiator and the engine. This keeps the radiator filled with the coolant to the desired level at all times and increases the cooling efficiency.

Maintain the coolant level between the MIN and the MAX marks on the surge tank when the system is cold.

COOLANT PUMP

The belt-driven centrifugal coolant pump consists of an impeller, a drive shaft, and a belt pulley. The coolant pump is mounted on the front of the transverse-mounted engine, and is driven by the timing belt.

The impeller is supported by a completely sealed bearing.

The coolant pump is serviced as an assembly and, therefore, cannot be disassembled.

THERMOSTAT

A wax pellet-type thermostat controls the flow of the engine coolant through the engine cooling system. The thermostat is mounted in the thermostat housing to the front of the cylinder head.

The thermostat stops the flow of the engine coolant from the engine to the radiator in order to provide faster warm-up, and to regulate the coolant temperature. The thermostat remains closed while the engine coolant is cold, preventing circulation of the engine coolant through the radiator. At this point, the engine coolant is allowed to circulate only throughout the heater core to warm it quickly and evenly.

As the engine warms, the thermostat opens. This allows the engine coolant to flow through the radiator where the heat is dissipated. This opening and closing of the thermostat permits enough engine coolant to enter the radiator to keep the engine within proper engine temperature operating limits.

The wax pellet in the thermostat is hermetically sealed in a metal case. The wax element of the thermostat expands when it is heated and contracts when it is cooled.

As the vehicle is driven and the engine warms, the engine coolant temperature increases. When the engine coolant reaches a specified temperature, the wax pellet element in the thermostat expands and exerts pressure against the metal case, forcing the valve open. This allows the engine coolant to flow through the engine cooling system and cool the engine.

As the wax pellet cools, the contraction allows a spring to close the valve.

The thermostat begins to open at 87°C (189°F) and is fully open at 102°C (216°F). The thermostat closes at 86°C (187°F).

ELECTRIC COOLING FAN

Caution: Keep hands, tools, and clothing away from the engine cooling fans to help prevent personal injury. This fan is electric and can turn on whether or not the engine is running.

Caution: If a fan blade is bent or damaged in any way, no attempt should be made to repair or reuse the damaged part. A bent or damaged fan assembly should always be replaced with a new one to prevent possible injury.

The cooling fans are mounted behind the radiator in the engine compartment. The electric cooling fans increase the flow of air across the radiator fins and across the condenser on air condition (A/C)-equipped vehicles. This helps to speed cooling when the vehicle is at idle or moving at low speeds.

All models have two fans. The main fan is 300 mm (11.8 inches) in diameter with five blades to aid the air flow through the radiator and the condenser. An electric motor attached to the radiator support drives the fan. The auxiliary fan is 300 mm (11.8 inches) in diameter.

A/C Off or Non-A/C Model

- The cooling fans are actuated by the electronic control module (ECM) using a low-speed cooling fan relay and a high-speed cooling fan relay and a series/parallel cooling fan relay.
- The ECM will turn the cooling fans on at low speed when the coolant temperature reaches 93°C (199°F) and at high speed when the coolant temperature reaches 97°C (207°F).
- The ECM will change the cooling fans from high speed to low speed at 94°C (201°F) and will turn the cooling fans off at 90°C (194°F).

COOLANT TEMPERATURE SENSOR

The coolant temperature sensor (CTS) uses a thermistor to control the signal voltage to the electronic control module (ECM).

ENGINE COOLANT TEMPERATURE SENSOR

The engine coolant temperature sensor controls the instrument panel temperature indicator. The engine coolant temperature sensor is located on the cylinder head under the intake manifold on a DOHC engine.

ENGINE BLOCK HEATER

The vehicle is designed to accept an engine block heater. The engine block heater helps to warm the engine for improved cold-weather starting. It can also help to reduce fuel consumption when a cold engine is warming up.

The engine block heater utilizes an existing expansion plug for installation and is located under the intake manifold.

Contact your Daewoo dealer for further information or installation.

SECTION 1E

ENGINE ELECTRICAL

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

TABLE OF CONTENTS

SPECIFICATIONS

STARTER SPECIFICATIONS

Application	Description
Starter	
No-Load Test @ 12.2 Volts	40-90 amps
Drive Pinion Speed	3,200-4,800 rpm
Solenoid	
Hold-in Windings @ 12.2 Volts	12-20 amps
Pull-in Windings @ 12.2 Volts	60-90 amps

GENERATOR SPECIFICATIONS

Application	Description
Type	CS-128D

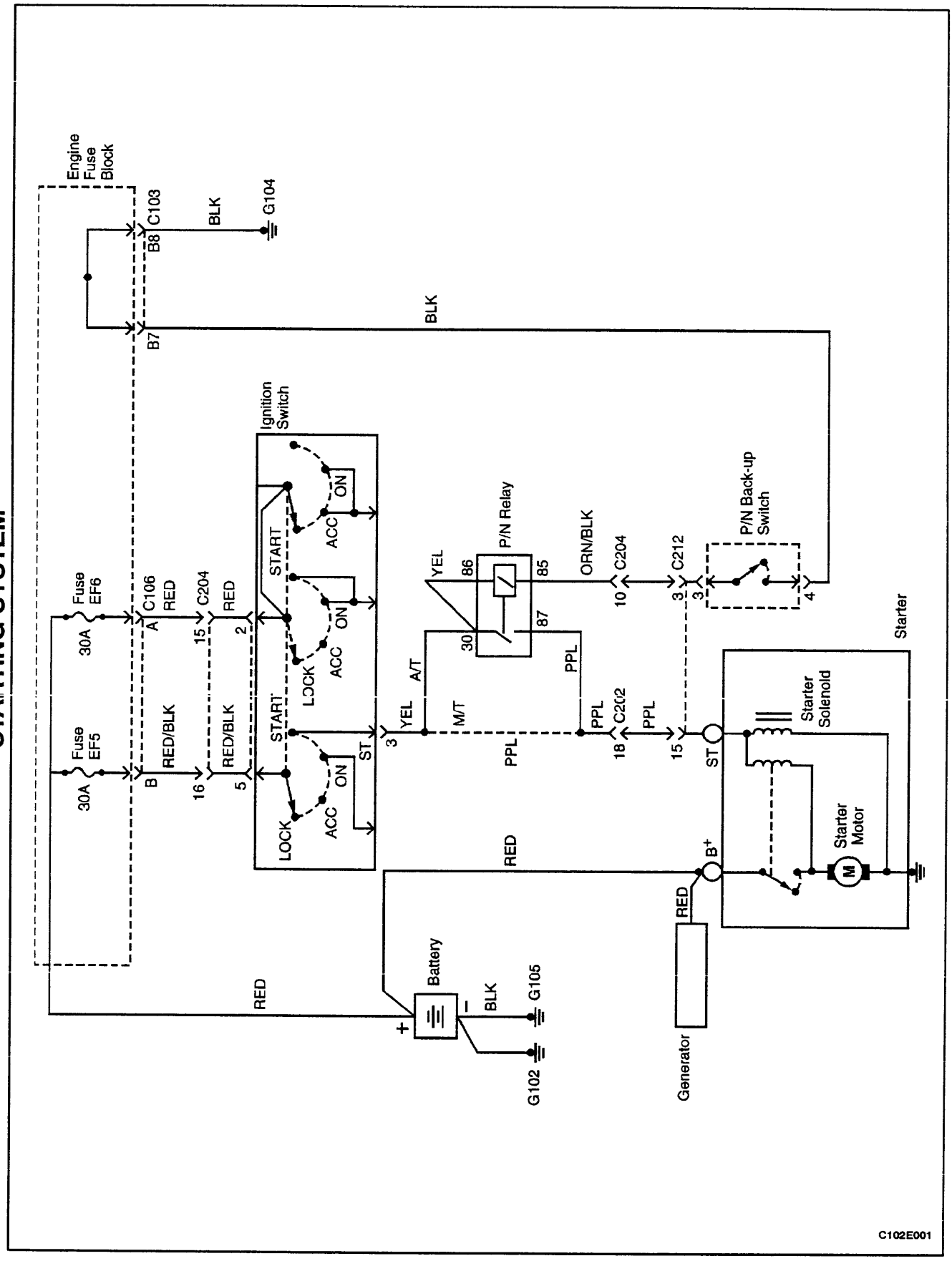
BATTERY SPECIFICATIONS

Application	Description
Cold Cranking Amps	610 amps
Reserve Capacity Minimum	90 minutes
Load Test	270 amps
Minimum Voltage:	Estimated Temperature:
9.6	21°C (69.8°F)
9.4	20°C (68°F)
9.1	0°C (32°F)
8.8	-10°C (14°F)
8.5	-18°C (0°F)
8.0	Below -18°C (0°F)

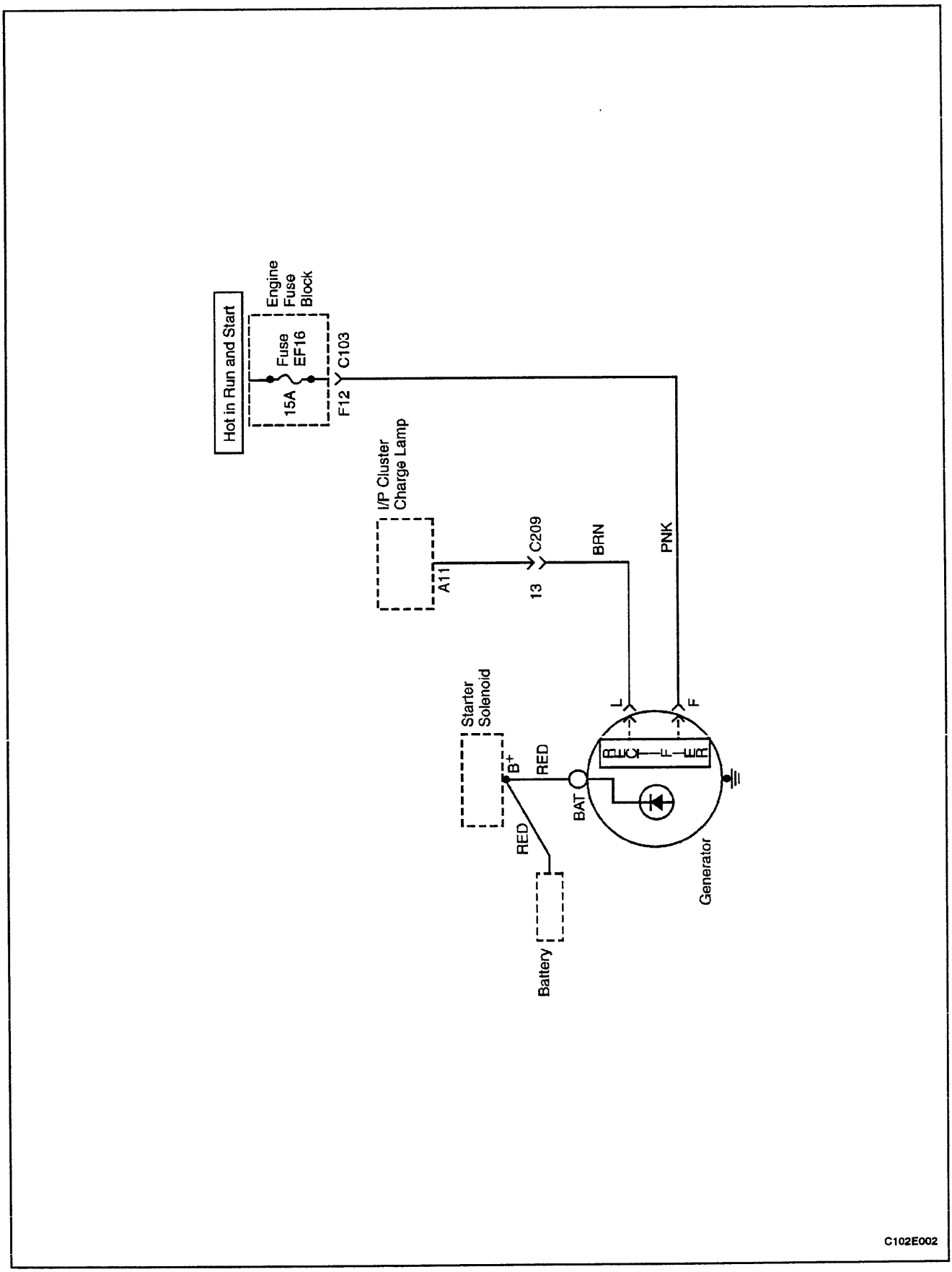
FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Battery Cable Nuts	15	11	-
Battery Carrier Tray Lower Bolts	10	-	89
Battery Carrier Tray Upper Bolts	20	15	-
Battery Retainer Clamp-to-Battery Rod Nuts	4	-	35
Battery Terminal Bolt	20	15	-
Battery-to-Generator Lead Nut	15	11	-
Generator Driveshaft Nut	100	74	-
Generator Lower Bracket-to-Engine Block Bolts	30	22	-
Generator Lower Bracket-to-Generator Nut	20	15	-
Generator Through-Bolts	25	18	-
Generator-to-Cylinder Head Support Bracket Bolt	20	15	-
Generator-to-Intake Manifold and Cylinder Head Support Bracket Bolts	35	26	-
Generator-to-Intake Manifold Strap Bracket Bolt	20	15	-
Intake Manifold-to-Engine Block Bracket Bolts (Over Starter)	20	15	-
Starter Field Connector Nut	8	-	71
Starter Solenoid Assembly Screws	8	-	71
Starter Solenoid Terminal-to-Battery Cable Terminal Nut	7	-	62
Starter Solenoid Terminal-to-Ignition Solenoid Terminal Nut	6	-	53
Starter Through-Bolts	6	-	53
Starter-to-Engine Block Mounting Bolt	45	33	-
Starter-to-Transmission Mounting Bolt	50	37	-

SCHEMATIC AND ROUTING DIAGRAMS



CHARGING SYSTEM



DIAGNOSIS

NO CRANK

Step	Action	Value	Yes	No
1	1. Turn the headlamps on. 2. Turn the dome lamps on. 3. Turn the ignition to START. Did the lights dim or go out?	-	Go to *Step 2*	Go to *Step 8*
2	Check the battery state of charge. Is the green eye showing from the built-in hydrometer?	-	Go to *Step 3*	Go to "Charging Procedure"
3	1. Connect the voltmeter positive lead to the positive battery terminal. 2. Connect the voltmeter negative lead to the negative battery terminal. 3. Turn the ignition to START. Does the voltmeter indicate the value specified?	< 9.6 v	Go to "Charging Procedure"	Go to *Step 4*
4	1. Connect the voltmeter negative lead to the negative battery terminal. 2. Connect the positive voltmeter lead to the engine block. Does the voltmeter indicate the value specified?	> 0.5 v	Go to *Step 5*	Go to *Step 6*
5	Clean, tighten, or replace the negative battery cable. Is the repair complete?	-	System OK	-
6	1. Connect the voltmeter positive lead to the starter "B" terminal. 2. Connect the voltmeter negative lead to the negative battery terminal. Does the voltmeter indicate the value specified?	< 9 v	Go to *Step 7*	Go to *Step 13*
7	Clean, tighten, or replace the positive battery cable. Is the repair complete?	-	System OK	-
8	Inspect the engine fuse block fuse EF5. Is the fuse OK?	-	Go to *Step 10*	Go to *Step 9*
9	Replace the fuse EF6. Is the repair complete?	-	System OK	-
10	Check the connection at the starter "ST" terminal. Is the connection OK?	-	Go to *Step 12*	Go to *Step 11*
11	Clean or tighten the connection as needed. Is the repair complete?	-	System OK	-
12	1. Connect the voltmeter positive lead to the starter "ST" terminal. 2. Connect the voltmeter negative lead to the negative battery terminal. 3. Turn the ignition to START. Does the voltmeter indicate the value specified?	> 7 v	Go to *Step 13*	Go to *Step 14*
13	Repair or replace the starter as needed. Is the repair complete?	-	System OK	-
14	Determine the type of transmission on the vehicle. Is the vehicle equipped with an automatic transmission?	-	Go to *Step 15*	Go to *Step 32*

NO CRANK (Continued)

Step	Action	Value	Yes	No
15	1. Disconnect the P/N relay. 2. Connect the negative voltmeter lead to the P/N relay connector terminal 86. 3. Connect the positive voltmeter lead to battery positive. Does the voltmeter indicate the value specified?	11-14 v	Go to *Step 20*	Go to *Step 16*
16	1. Disconnect the P/N back-up switch. 2. Connect the negative voltmeter lead to the P/N back-up switch connector terminal 4. 3. Connect the positive voltmeter lead to battery positive. Does the voltmeter indicate the value specified?	11-14 v	Go to *Step 17*	Go to *Step 25*
17	1. Jumper the P/N back-up switch connector terminals 3 and 4. 2. Connect the negative voltmeter lead to the P/N relay connector terminal 86. 3. Connect the positive voltmeter lead to battery positive. Does the voltmeter indicate the value specified?	11-14 v	Go to *Step 18*	Go to *Step 19*
18	Replace the neutral safety backup switch. Is the repair complete?	-	System OK	-
19	Repair the open wire between the P/N back-up switch connector terminal 3 and the P/N relay connector terminal 85. Is the repair complete?	-	System OK	-
20	1. Connect the positive voltmeter lead to the P/N relay connector terminal 30. 2. Connect the voltmeter negative lead to ground. 3. Turn the ignition to START. Does the voltmeter indicate the value specified?	11-14 v	Go to *Step 21*	Go to *Step 27*
21	1. Connect the positive voltmeter lead to the P/N relay connector terminal 86. 2. Connect the voltmeter negative lead to ground. 3. Turn the ignition to START. Does the voltmeter indicate the value specified?	11-14 v	Go to *Step 22*	Go to *Step 26*
22	1. Jumper connector terminals 30 and 87 of the P/N relay. 2. Turn the ignition to START. Does the starter crank?	-	Go to *Step 31*	Go to *Step 23*
23	Check for an open in the wire between the P/N relay connector terminal 87 and the starter "ST" terminal. Is the problem found?	-	Go to *Step 24*	Go to *Step 13*
24	Repair the wire as needed. Is the repair complete?	-	System OK	-
25	Repair the open wire between the P/N back-up switch connector terminal 4 and ground. Is the repair complete?	-	System OK	-

NO CRANK (Continued)

Step	Action	Value	Yes	No
26	Repair the open wire between the P/N relay connector terminal 86 and the ignition switch connector terminal 3. Is the repair complete?	-	System OK	-
27	1. Connect the voltmeter positive lead to the ignition switch connector terminal 5 by backprobing the connector. 2. Connect the voltmeter negative lead to ground. Does the voltmeter indicate the value specified?	11-14 v	Go to *Step 29*	Go to *Step 28*
28	Repair the open in the wiring between the engine block fuse EF5 and the ignition switch connector terminal 5. Is the repair complete?	-	System OK	-
29	1. Connect the voltmeter positive lead to the ignition switch connector terminal 3 by backprobing the connector. 2. Connect the voltmeter negative lead to ground. 3. Turn the ignition to START. Does the voltmeter indicate the value specified?	11-14 v	Go to *Step 30*	Go to *Step 36*
30	Repair the open in the wiring between the ignition switch connector terminal 3 and the P/N relay connector terminal 30. Is the repair complete?	-	System OK	-
31	Replace the P/N relay. Is the repair complete?	-	System OK	-
32	1. Connect the voltmeter positive lead to the ignition switch connector terminal 5 by backprobing the connector. 2. Connect the voltmeter negative lead to ground. Does the voltmeter indicate the value specified?	11-14 v	Go to *Step 34*	Go to *Step 33*
33	Repair the open in the wiring between the engine block fuse EF5 and the ignition switch connector terminal 5. Is the repair complete?	-	System OK	-
34	1. Connect the voltmeter positive lead to the ignition switch connector terminal 3 by backprobing the connector. 2. Connect the voltmeter negative lead to ground. 3. Turn the ignition to START. Does the voltmeter indicate the value specified?	11-14 v	Go to *Step 35*	Go to *Step 36*
35	Repair the open in the wiring between the ignition switch connector terminal 3 and the starter "ST" terminal. Is the repair complete?	-	System OK	-
36	Replace the ignition switch. Is the repair complete?	-	System OK	-

STARTER MOTOR NOISE

To correct starter motor noise during starting, use the following procedure:

Checks	Action
Check for a high-pitched whine during cranking before the engine fires. The engine cranks and fires properly.	The distance is too great between the starter pinion and the flywheel. Shimming the starter toward the flywheel is required.
Check for a high-pitched whine after the engine fires, as the key is being released. The engine cranks and fires properly. This intermittent complaint is often diagnosed as "starter hang-in" or "solenoid weak."	The distance is too small between the starter pinion and the flywheel. Shimming the starter away from the flywheel is required.
Check for a loud "whoop" after the engine fires but while the starter is still held engaged. The sound is like a siren if the engine is revved while the starter is engaged.	The most probable cause is a defective clutch. A new clutch will often correct this problem.
Check for a "rumble," a "growl," or, in severe cases, a "knock" as the starter is coasting down to a stop after starting the engine.	The most probable cause is a bent or an unbalanced starter armature. A new armature will often correct this problem.

If the complaint is noise, correction can be achieved by proper shimming as follows:

1. Check for a bent or a worn flywheel.
2. Start the engine and carefully touch the outside diameter of the rotating flywheel ring gear with chalk or a crayon to show the high point of the tooth runout. Turn the engine OFF and rotate the flywheel so that the marked teeth are in the area of the starter pinion gear.
3. Disconnect the negative battery cable to prevent the cranking of the engine.
4. Check the pinion-to-flywheel clearance by using a wire gauge of 0.5 mm (0.02 inch) minimum thickness or diameter. Center a pinion tooth between two flywheel teeth and the gauge. Do not gauge in the corners where a misleading larger dimension may be observed. If the clearance is under this minimum, shim the starter away from the flywheel.
5. If the clearance approaches 1.5 mm (0.06 inch) or more, shim the starter toward the flywheel. This condition is generally the cause of broken flywheel teeth or the starter housing. Shim the starter toward the flywheel by shimming only the outboard starter mounting pad. A shim of 0.40 mm (0.016 inch) thickness at this location will decrease the clearance by approximately 0.30 mm (0.012 inch). If normal starter shims are not available, plain washers or other suitable material may be used as shims.

BATTERY LOAD TEST

1. Check the battery for obvious damage, such as a cracked or broken case or cover, which could permit the loss of electrolyte. If damage is obvious, replace the battery.

Caution: Do not charge the battery if the hydrometer is clear or light yellow. Instead, replace the battery. If the battery feels hot or if violent gassing or spewing of electrolyte through the vent hole occurs, discontinue charging or reduce the charging rate to avoid personal injury.

Important: The battery temperature must be estimated by touch, taking into consideration the ambient temperature to which the battery has been exposed for the preceding few hours.

2. Check the hydrometer. If the green dot is visible, go to the load test procedure. If the indicator is dark but green is not visible, charge the battery. For charging a battery removed from the vehicle, refer to "Charging a Completely Discharged Battery" in this section.
3. Connect a voltmeter and a battery load tester across the battery terminals.
4. Apply a 300-ampere load for 15 seconds to remove the surface charge from the battery.
5. Remove the load.
6. Wait 15 seconds to let the battery recover.
7. Apply a 270-ampere load.
8. If the voltage does not drop below the minimum listed, the battery is good and should be reinstalled. If the voltage is less than the minimum listed, replace the battery. Refer to "Battery Specifications" in this section.

GENERATOR OUTPUT TEST

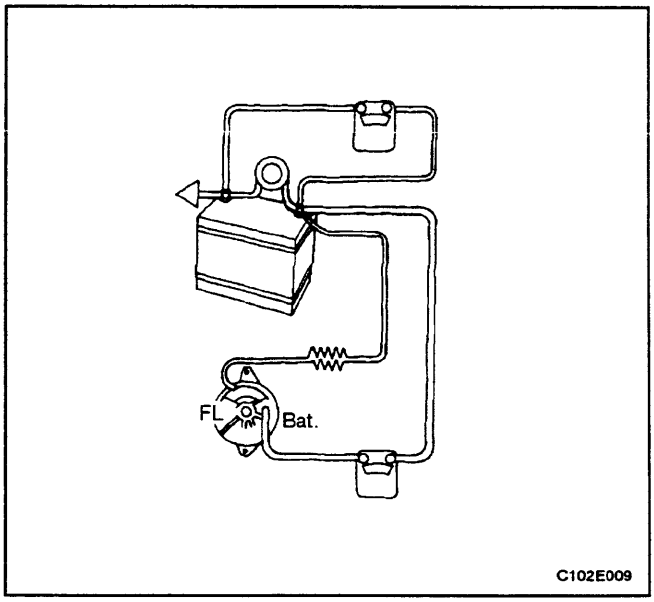
1. Perform the generator system test. Refer to "Generator System Check" in this section.
2. Replace the generator if it fails that test. Refer to "Generator" in the On-Vehicle Service portion of this section.
3. If the generator passes the test, perform the on-vehicle output test which follows.

Important: Always check the generator for output before assuming that a grounded "L" terminal circuit has damaged the regulator.

4. Attach a digital multimeter, an ammeter, and a carbon pile load to the vehicle.

Important: Be sure the vehicle battery is fully charged, and the carbon pile load is turned off.

5. With the ignition switch in the off position, check and record the battery voltage.
6. Remove the harness connector from the generator.
7. Turn the ignition switch to the RUN position with the engine not running.
8. Use a digital multimeter to check for voltage in the harness connector "L" terminal. The reading should be near the specified battery voltage of 12 volts.
9. If the voltage is too low, check the indicator "L" terminal circuits for open and grounded circuits causing voltage loss. Correct any open wires, terminal connections, etc., as necessary. Refer to "Charging System" in this section.
10. Attach the generator harness connector.
11. Run the engine at a moderate idle, and measure the voltage across the battery terminals. The reading should be above that recorded in step 15 but less than 16 volts. If the reading is over 16 volts or below the previous reading, replace the generator. Refer to "Generator" in the On-Vehicle Service portion of this section.
12. Run the engine at a moderate idle, and measure the generator amperage output.
13. Turn on the carbon pile, and adjust it to obtain the maximum amps while maintaining the battery voltage above 13 volts. If the reading is within 15 amps of the generator's rating listed on the generator, the generator is good. If not, replace the generator. Refer to "Generator" in the On-Vehicle Service portion of this section.
14. With the generator operating at the maximum output, measure the voltage between the generator housing and the battery negative terminal. The voltage drop should be 0.5 volt or less. If the voltage drop is more than 0.5 volt, check the ground path from the generator housing to the negative battery cable.
15. Check, clean, tighten, and recheck all of the ground connections.



GENERATOR SYSTEM CHECK

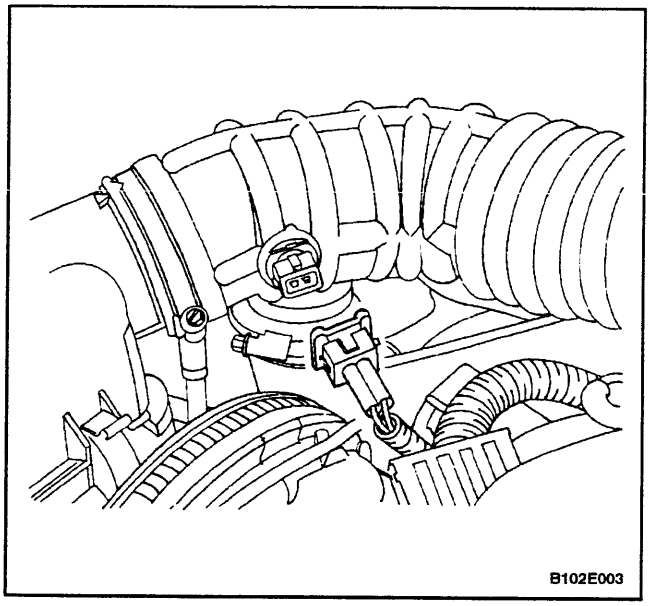
When operating normally, the generator indicator lamp will come on when the ignition switch is in the RUN position and go out when the engine starts. If the lamp operates abnormally or if an undercharged or overcharged battery condition occurs, the following procedure may be used to diagnose the charging system. Remember that an undercharged battery is often caused by accessories being left on overnight or by a defective switch that allows a lamp, such as a trunk or a glove box lamp, to stay on.

Diagnose the generator with the following procedure:

1. Visually check the belt and the wiring.
2. With the ignition switch in the RUN position and the engine stopped, the charge indicator lamp should be on. If not, detach the harness at the generator and ground the "L" terminal in the harness with a 5-ampere fused jumper lead.
   - If the lamp lights, replace the generator. Refer to "Generator" in the On-Vehicle Service portion of this section.
   - If the lamp does not light, locate the open circuit between the ignition switch and the harness connector. The indicator lamp bulb may be burned out.
3. With the ignition switch in the RUN position and the engine running at moderate speed, the charge indicator lamp should be off. If not, detach the wiring harness at the generator.
   - If the lamp goes off, replace the generator. Refer to "Generator" in the On-Vehicle Service portion of this section.

- If the lamp stays on, check for a short to ground in the harness between the connector and the indicator lamp.

Important: Always check the generator for output before assuming that a grounded "L" terminal circuit has damaged the regulator. Refer to "Generator" in the Unit Repair portion of this section.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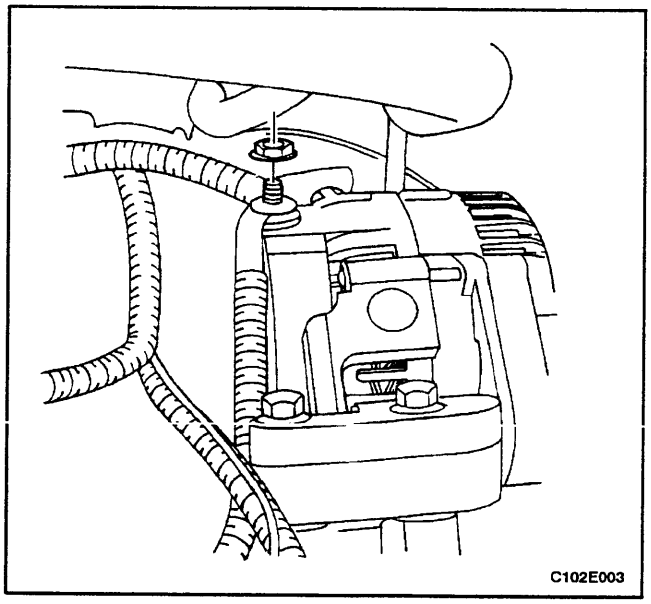
MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

GENERATOR - 95 AMP

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the manifold air temperature (MAT) connector from the air intake tube.
3. Remove the air intake tube.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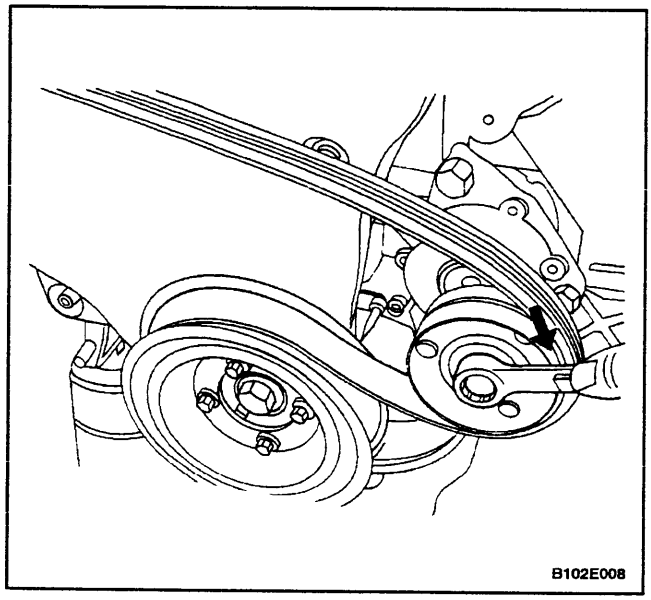
4. Remove the nut from the generator lead to the battery and disconnect the lead.
5. Disconnect the harness connector from the back of the generator.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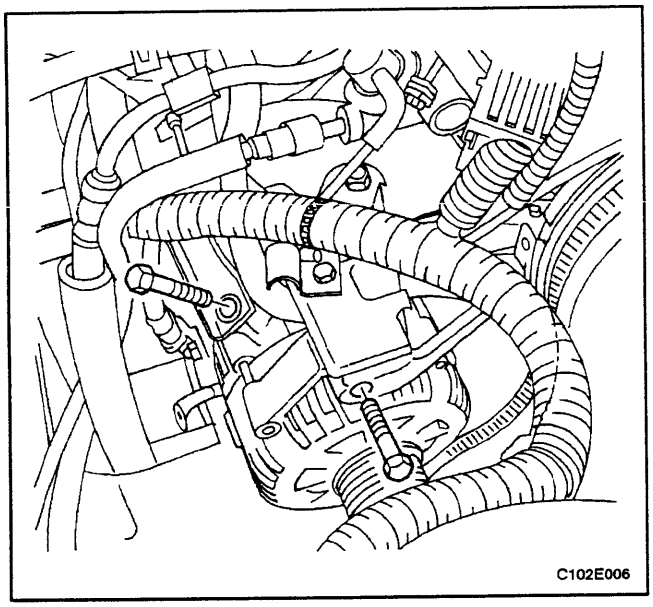
6. Remove the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump*.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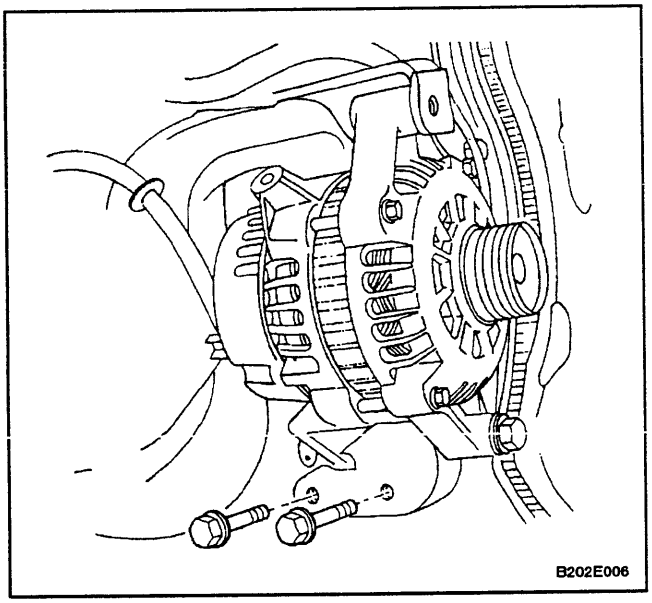
7. Remove the generator-to-intake manifold and cylinder head support bracket bolts, and the generator-to-intake manifold strap bracket bolt.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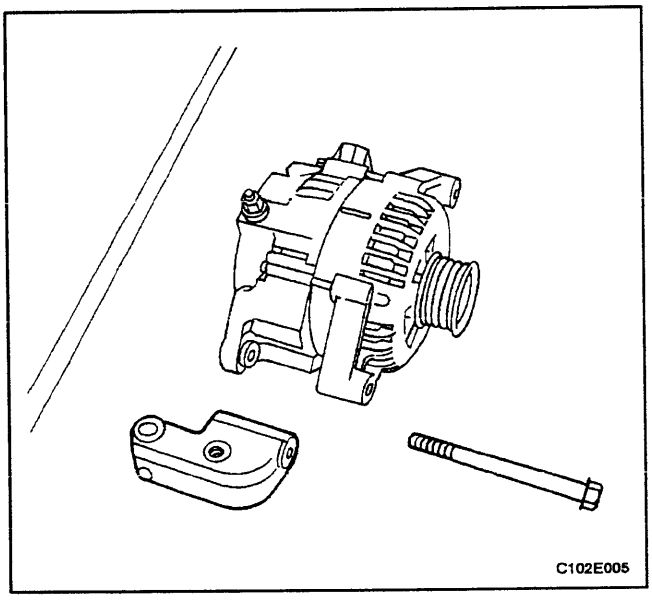
8. Raise the vehicle and remove the bolts that hold the generator lower bracket to the engine.
9. Carefully remove the generator with the lower bracket attached.
10. Remove the generator lower support bracket bolt and nut.


C102E005

Installation Procedure

1. Install the generator to the lower bracket with the bolts.
2. Install the nut and the washer on the lower bracket-to-generator bolt.

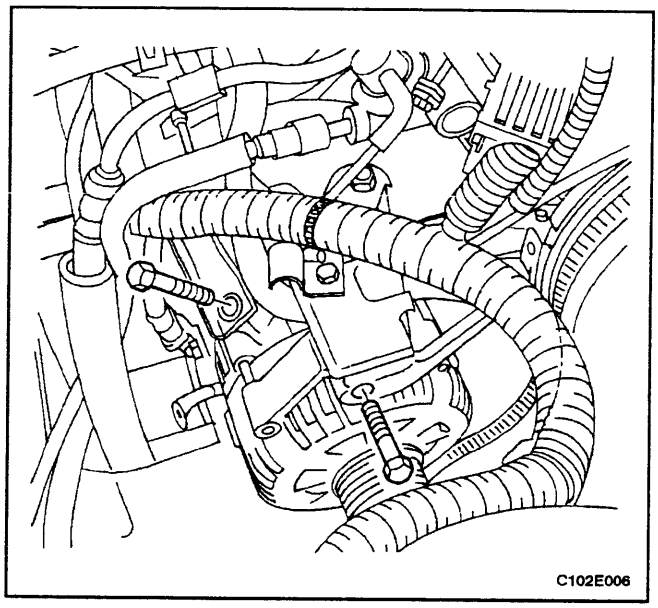
Tighten

Tighten the lower bracket-to-generator nut to 20 N•m (15 lb-ft).

3. Install the generator and the lower support bracket assembly to the engine block with the bolts.

Tighten

Tighten the generator lower bracket-to-engine block bolts to 30 N•m (22 lb-ft).


C102E006

4. Lower the vehicle and install the generator-to-intake manifold and cylinder head support bracket bolts.

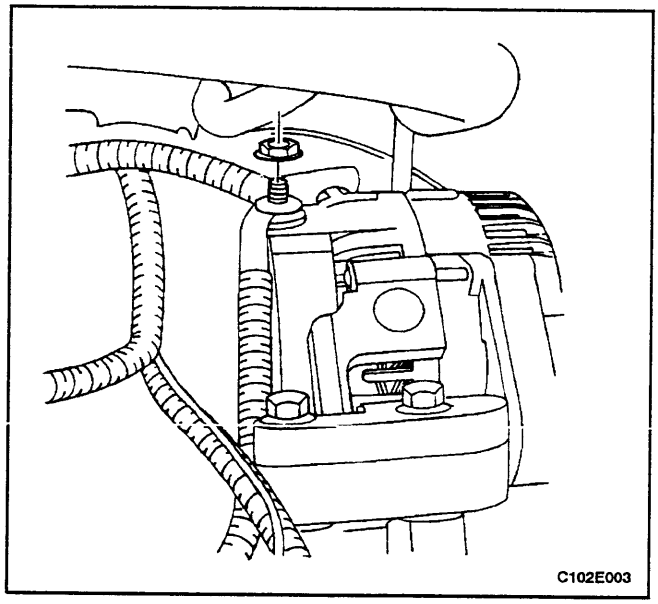
Tighten

Tighten the generator-to-intake manifold and cylinder head support bracket bolts to 35 N•m (26 lb-ft).

5. Install the generator-to-intake manifold strap bracket bolt.

Tighten

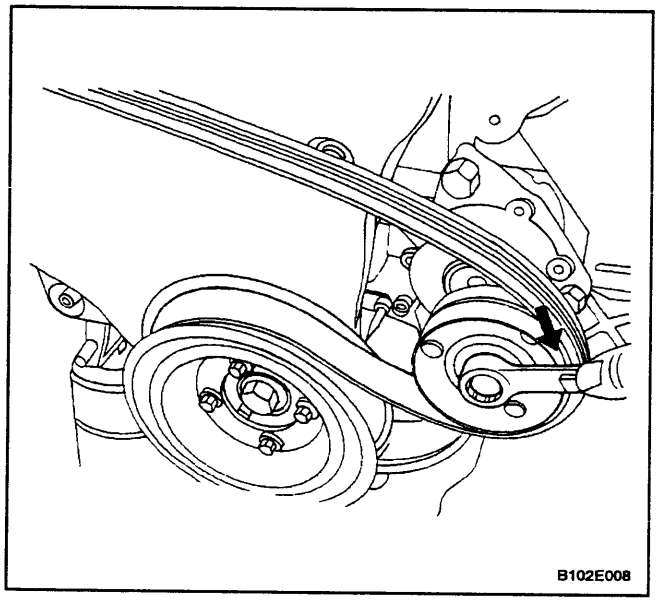
Tighten the generator-to-intake manifold strap bracket bolt to 20 N•m (15 lb-ft).


C102E003

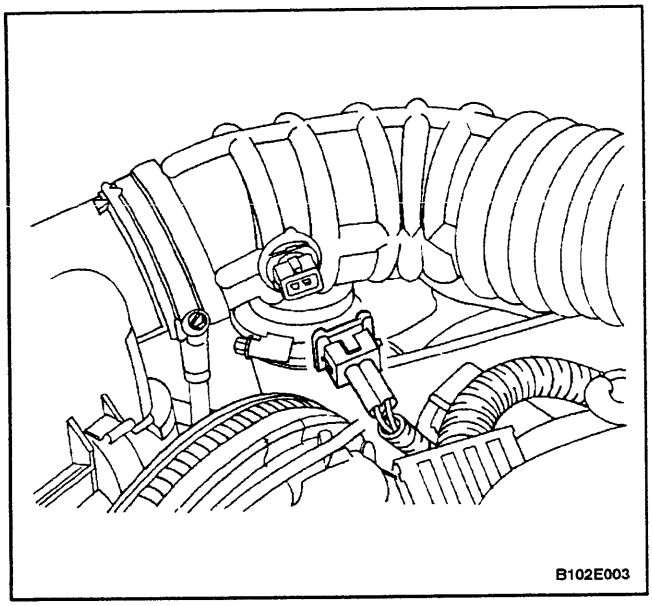
6. Connect the harness connector to the back of the generator.
7. Connect the battery lead to the generator and install the nut.

Tighten

Tighten the battery-to-generator lead to 15 N•m (11 lb-ft).


B102E008

8. Install the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*

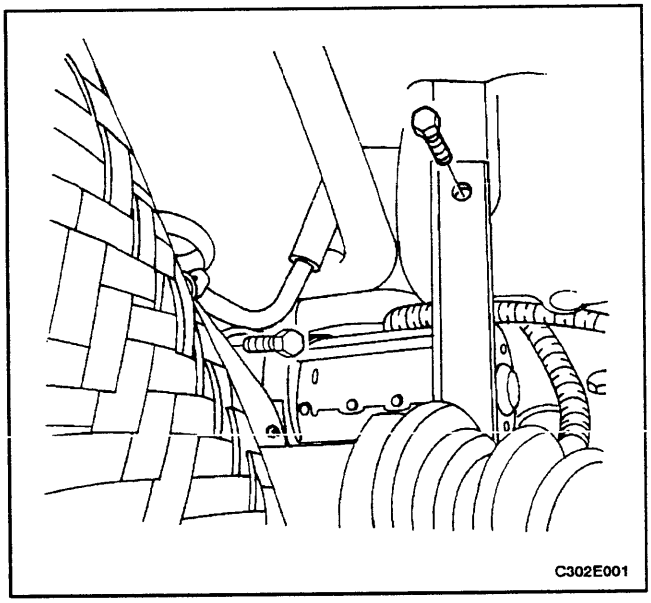

B102E003

9. Install the air intake tube and connect the MAT electrical connector.
10. Connect the negative battery cable.

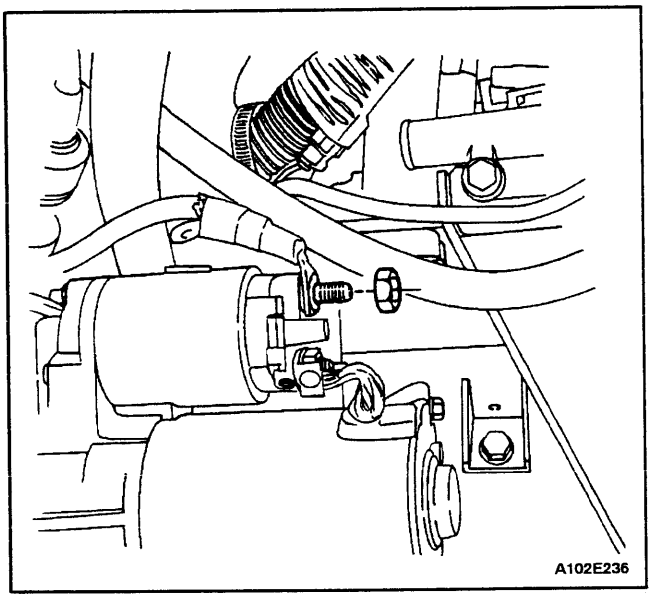
STARTER - PG 150S

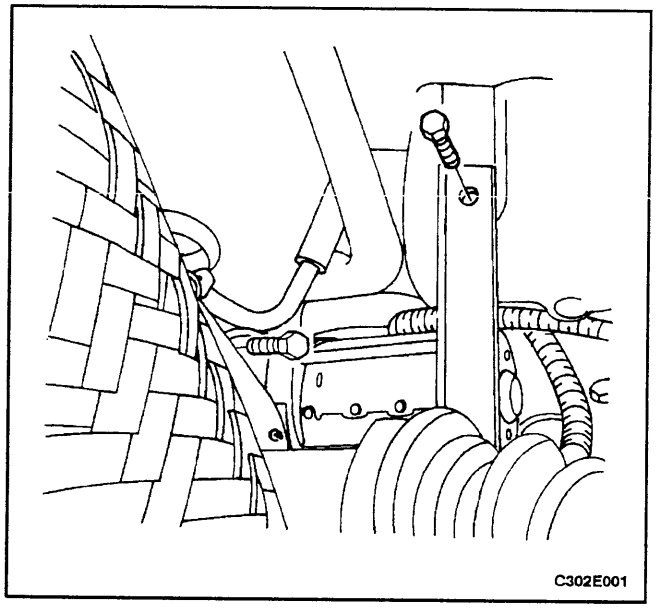
Removal Procedure

1. Remove the engine intake manifold-to-engine block strap bracket over the starter.
2. Remove the starter-to-transmission mounting bolt.
3. Remove the starter-to-engine block mounting bolt.


C302E001

4. Remove the starter solenoid nuts to disconnect the electrical cable.
5. Remove the starter assembly.


A102E236


C302E001

Installation Procedure

1. Place the starter assembly in position.
2. Install the upper and the lower starter mounting bolts.

Tighten

Tighten the starter-to-engine block mounting bolt to 45 N•m (33 lb-ft).

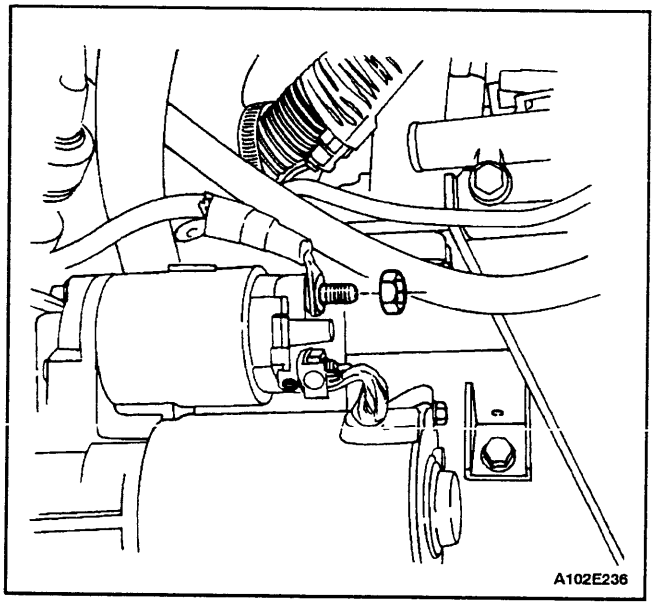
Tighten

Tighten the starter-to-transmission mounting bolt to 50 N•m (37 lb-ft).

3. Install the engine intake manifold-to-engine block strap bracket over the starter.

Tighten

Tighten the engine strap bracket over the starter to 20 N•m (15 lb-ft).


A102E236

4. Position the starter electrical wire on the solenoid terminal.
5. Install the starter solenoid terminal-to-ignition solenoid terminal nut.

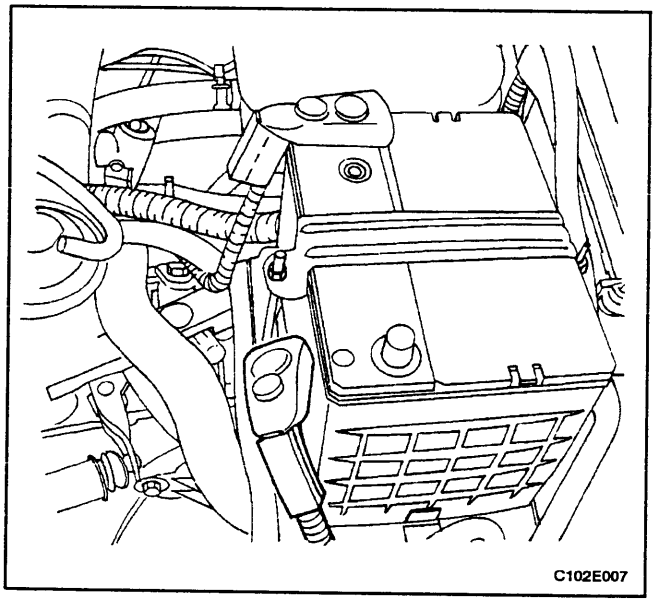
Tighten

Tighten the nut to 6 N•m (53 lb-in).

6. Install the starter solenoid terminal-to-battery cable terminal nut.

Tighten

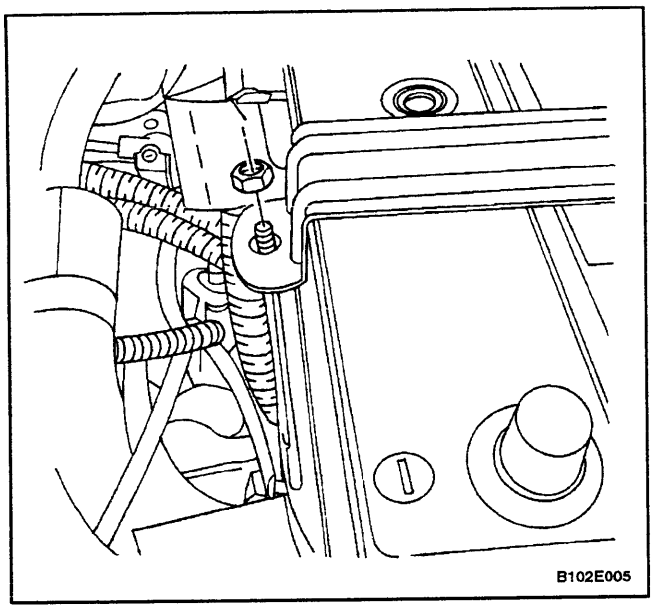
Tighten the nut to 7 N•m (62 lb-in).


C102E007

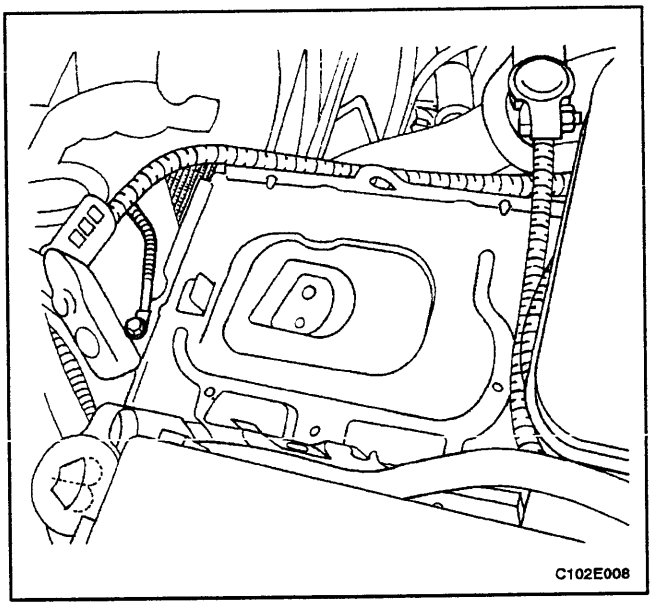
BATTERY/BATTERY TRAY

Removal Procedure

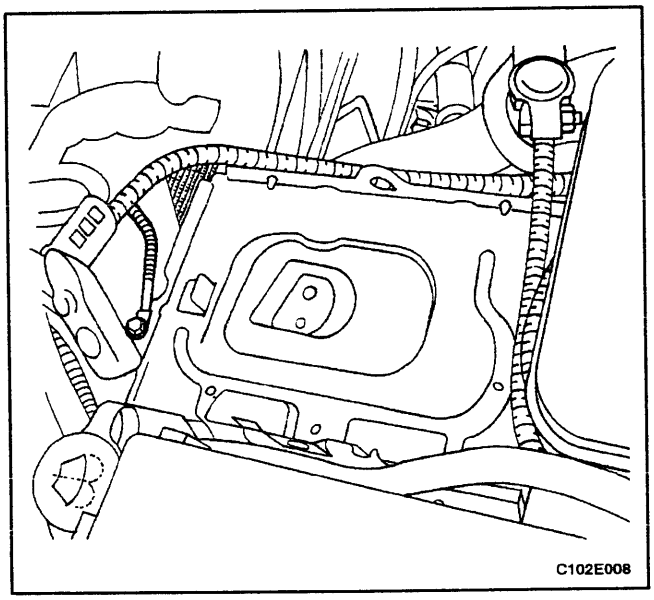
1. Disconnect the negative battery cable.


B102E005

2. Disconnect the positive battery cable.
3. Remove the nuts from the battery rods that fasten the battery hold-down bar clamp.


C102E008

4. Check the battery carrier tray for obvious cracks or damage.
5. Detach the carrier tray if necessary by removing the battery carrier tray upper bolts, including the bolt of the battery terminal.
6. Remove the battery carrier tray lower bolts.


C102E008

Installation Procedure

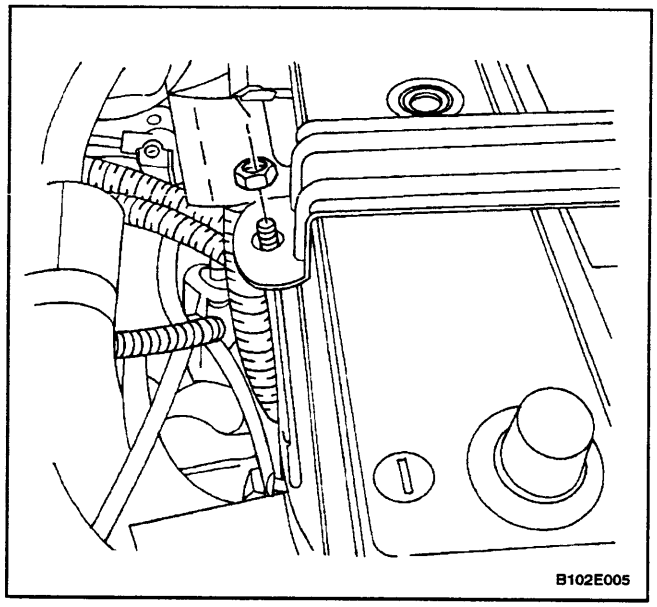
1. Install the battery carrier by fastening the carrier tray upper and the lower bolts.

Tighten

Tighten the battery carrier tray upper bolts, including the battery terminal bolts to 20 N•m (15 lb-ft).

Tighten

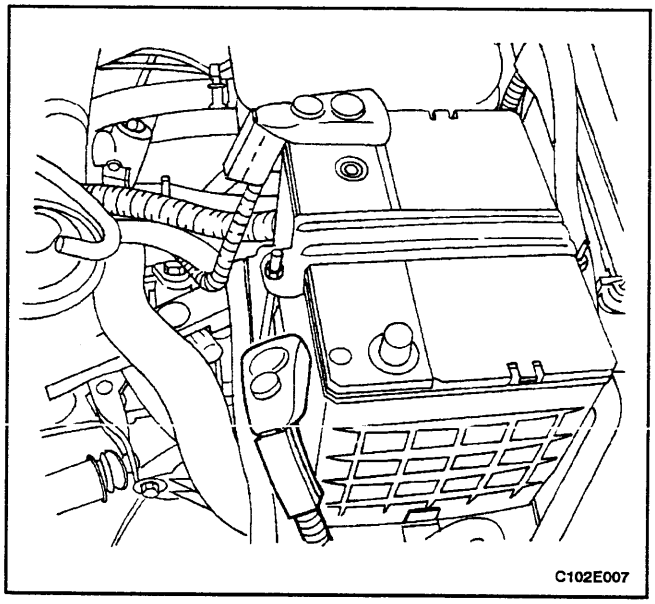
Tighten the battery carrier tray lower bolts to 10 N•m (89 lb-in).


B102E005

2. Install the battery into the tray.
3. Fasten the bar clamp to the battery by loosely attaching the battery rods from the battery tray cutouts through the bar clamp holes, and loosely tightening the nuts.

Tighten

Tighten the battery retainer clamp-to-battery rod nuts to 4 N•m (35 lb-in).


C102E007

4. Connect the positive battery cable.
5. Connect the negative battery cable.

Tighten

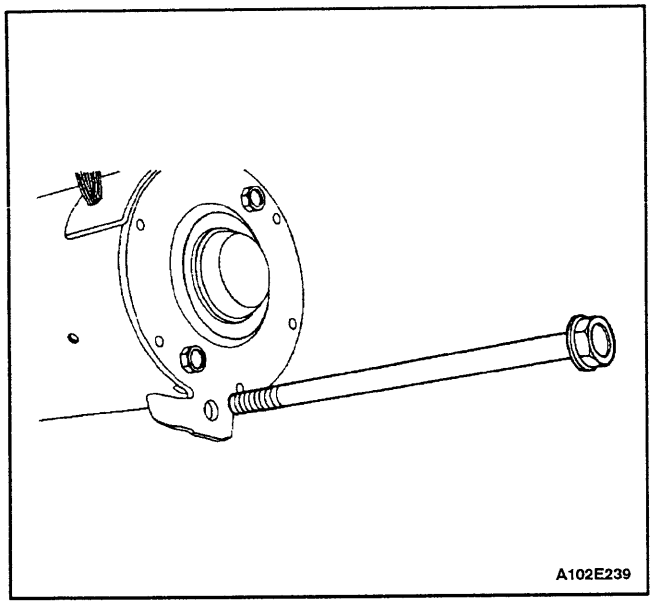
Tighten the battery cable nuts to 15 N•m (11 lb-ft).

UNIT REPAIR

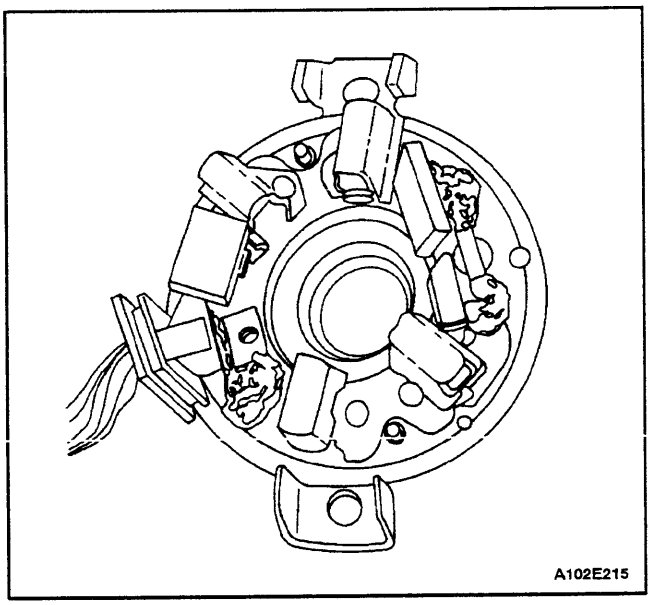
STARTER MOTOR

Disassembly Procedure

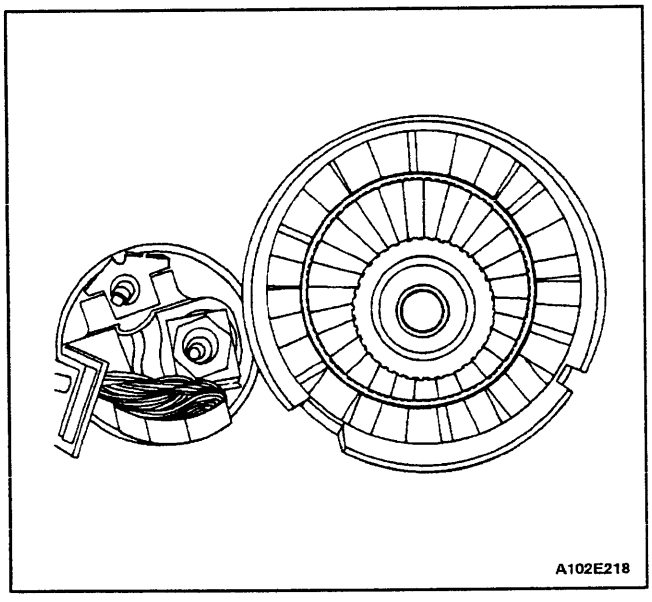
1. Remove the starter. Refer to "Starter" in the On-Vehicle Service portion of this section.
2. Remove the starter through-bolts.

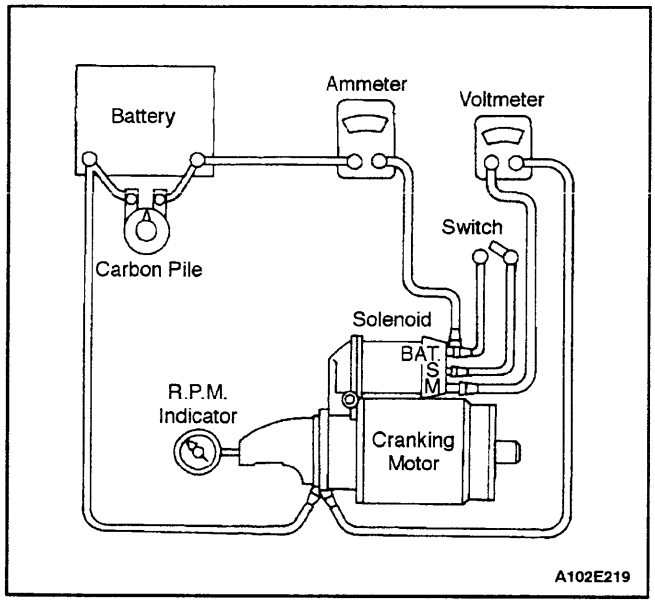

A102E239

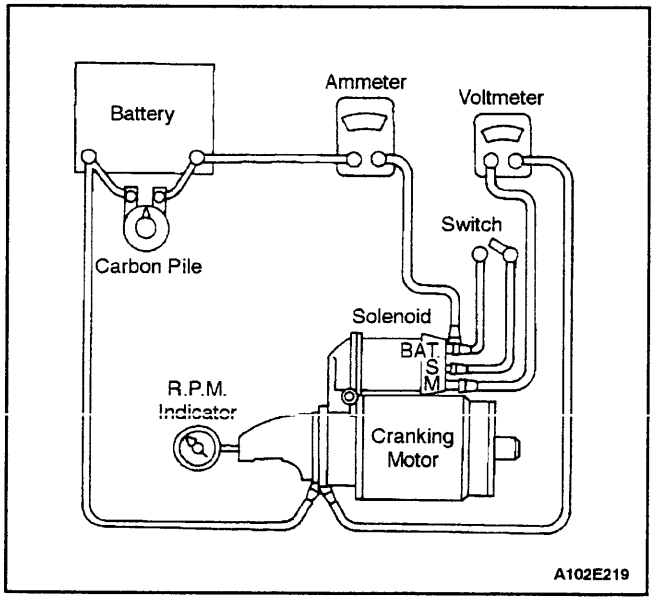
3. Remove the commutator end frame and brush holder assembly.
4. Inspect the brushes, the pop-out springs, and the brush holders for wear and damage. Replace the assembly if needed.


A102E215

5. Check the armature to see if it turns freely. If the armature does not turn freely, break down the assembly immediately, starting with Step 12 of this procedure. Otherwise, give the armature a no-load test.


A102E218

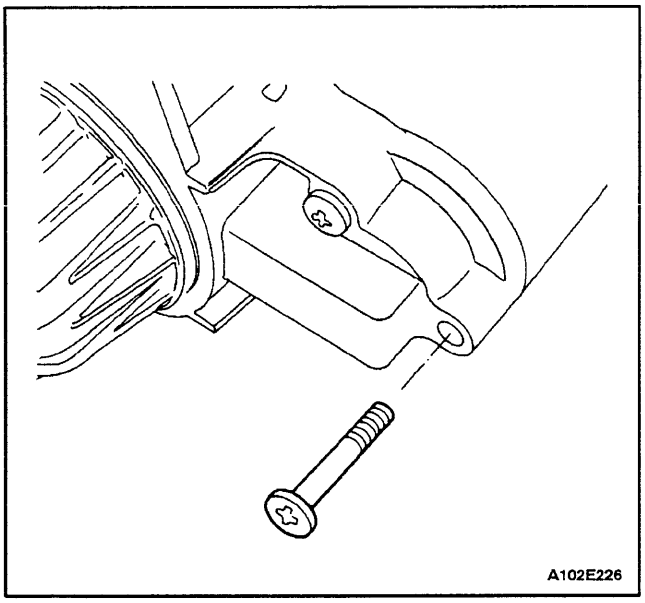




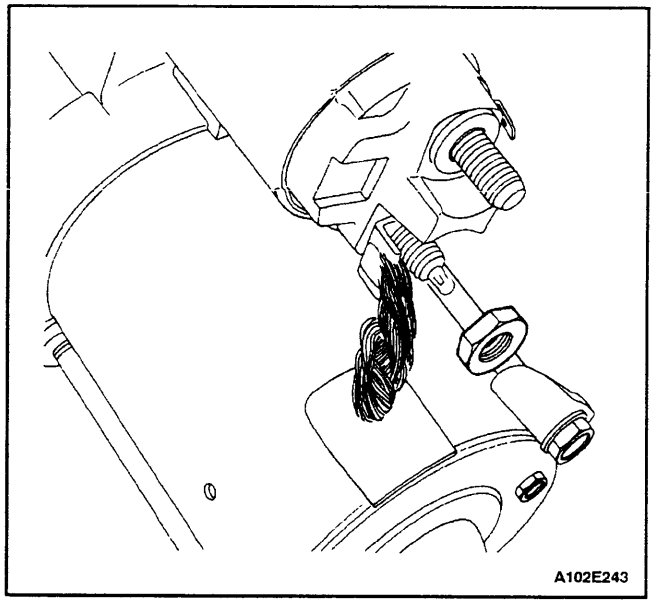
Notice: Complete the testing in a minimum amount of time to prevent overheating, and thus damaging the solenoid.

Important: If the specified current draw does not include the solenoid, deduct from the armature reading the specified current draw of the solenoid hold-in winding.

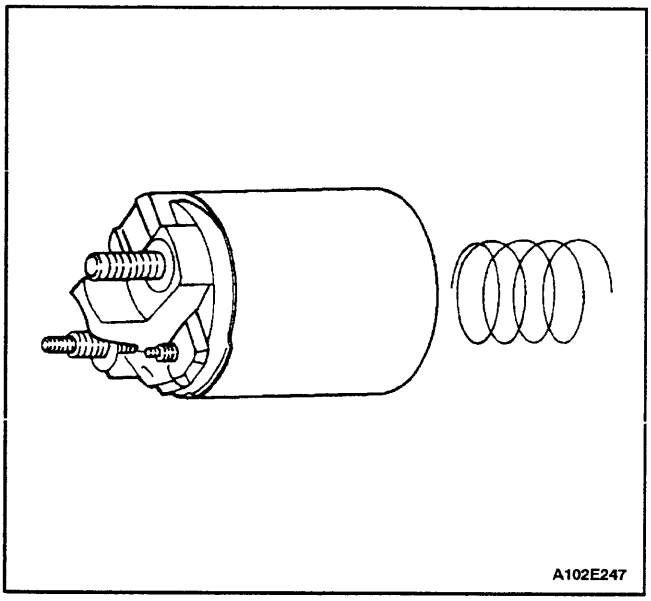
6. To begin the no-load test, close the switch and compare the RPM, the current, and the voltage readings with the specifications. Refer to "Starter Specifications" in this section. Make disconnections only with the switch open. Use the test results as follows.
   - 6.1 Rated current draw and no-load speed indicate the normal condition of the starter motor.
   - 6.2 Low free speed and high current draw indicate too much friction caused by tight, dirty or worn bearings, or a bent armature shaft; a shorted armature, or a shorted armature and fields.
   - 6.3 Failure to operate with high current draw indicates a direct ground in the terminal or fields, or "frozen" bearings.
   - 6.4 Failure to operate with no current draw indicates an open field circuit, open armature coils, broken brush springs, worn brushes, high insulation between the commutator bars, or other causes which would prevent good contact between the brushes and the commutator.
   - 6.5 Low no-load speed and low current indicate high internal resistance and high current draw, which usually mean shorted fields.



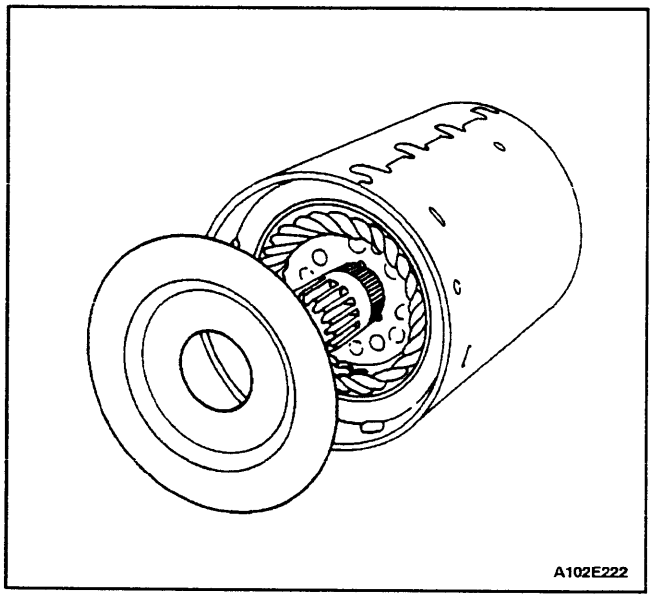
7. Remove the solenoid assembly screws.



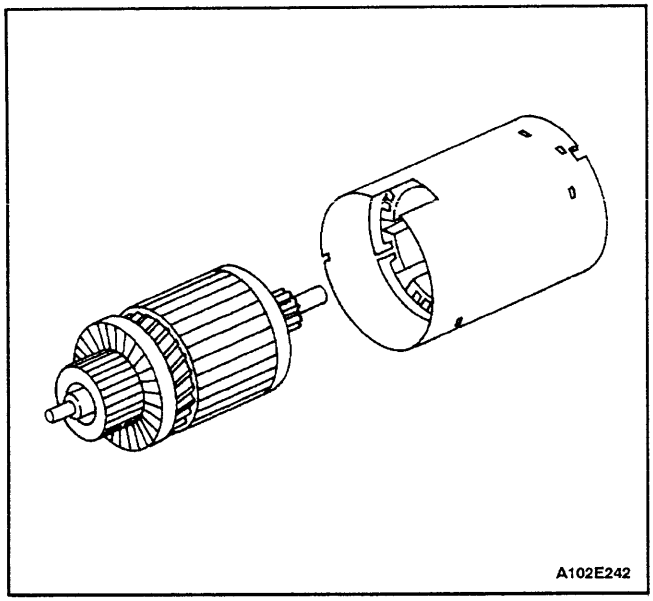
8. Remove the field connector nut. Disconnect the field connector.



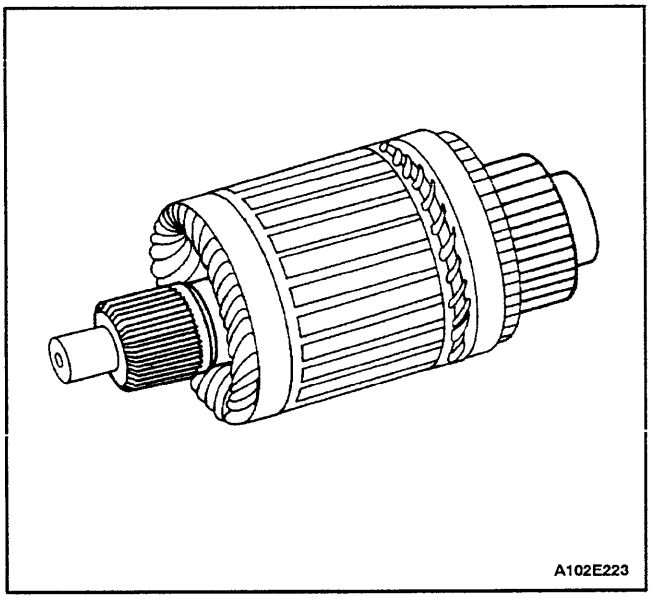
9. Rotate the solenoid 90 degrees and remove it along with the plunger return spring.



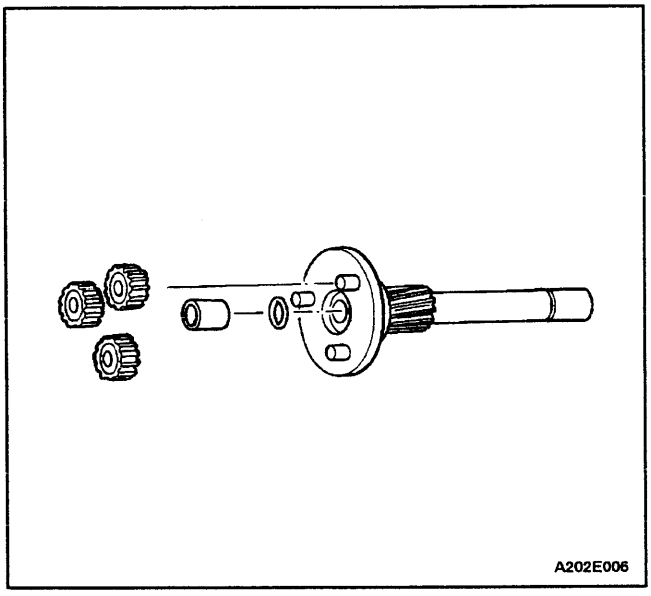
10. Slide the field frame with enclosed armature assembly away from the starter assembly.
11. Remove the shield.


A102E242

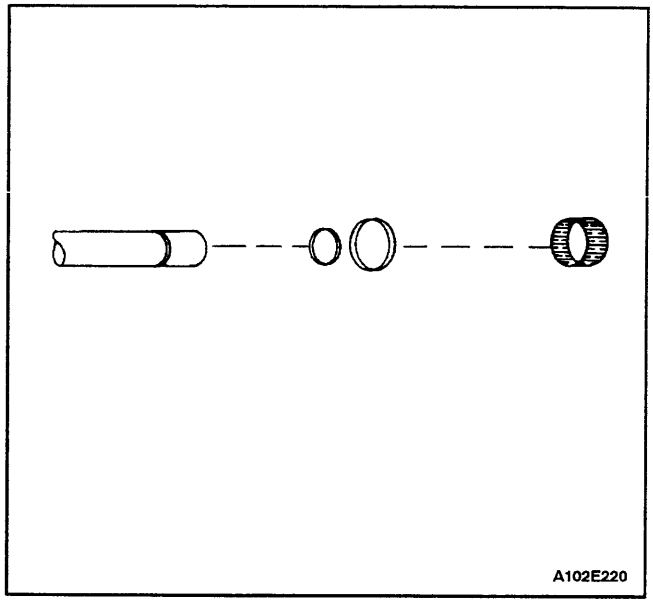
12. Separate the field frame from the armature.


A102E223

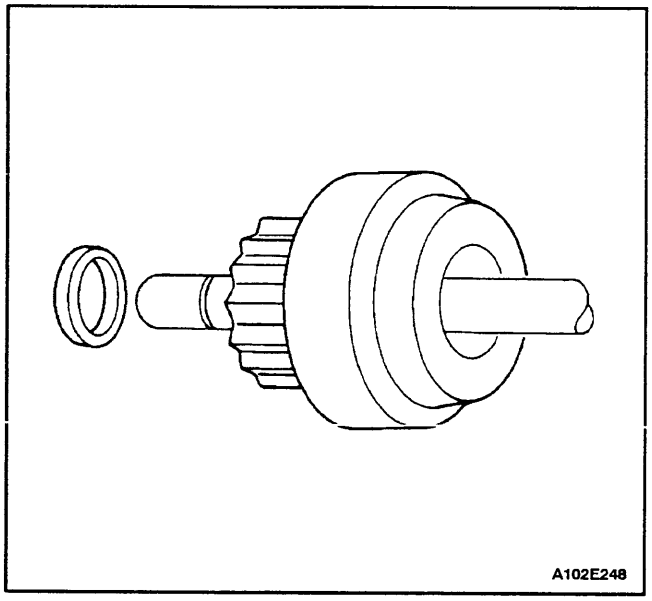
13. Inspect the shaft, the bearing, and the pinion for discoloration, damage, or wear. Replace if necessary.
14. Inspect the points where the armature conductors join the commutator bars. Make sure they have a good connection. A burned commutator bar is usually evidence of a poor connection.
15. If test equipment is available, check the armature for short circuits by placing it on a growler, and holding back a saw blade over the armature core while the armature is rotated. If the saw blade vibrates, replace the armature.
16. Recheck after cleaning between the commutator bars. If the saw blade vibrates, replace the armature.


A202E006

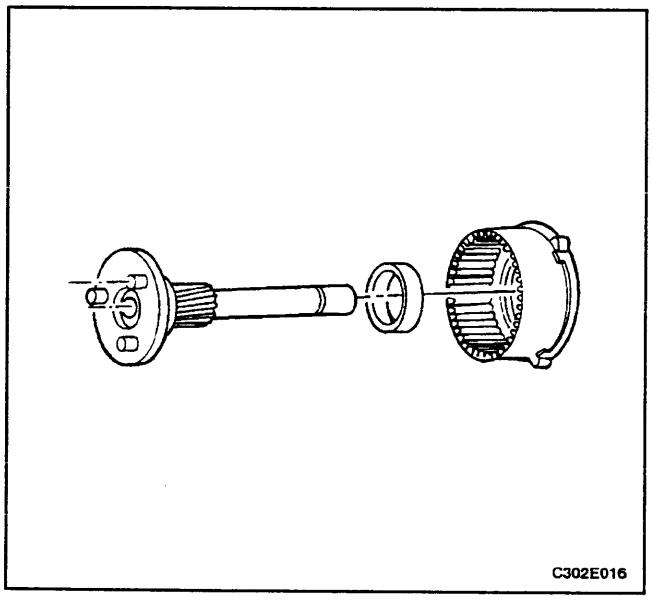
17. Remove the gears, the bushing, and the washer.
18. Remove the cushion and the driveshaft assembly from the starter housing.


A102E220

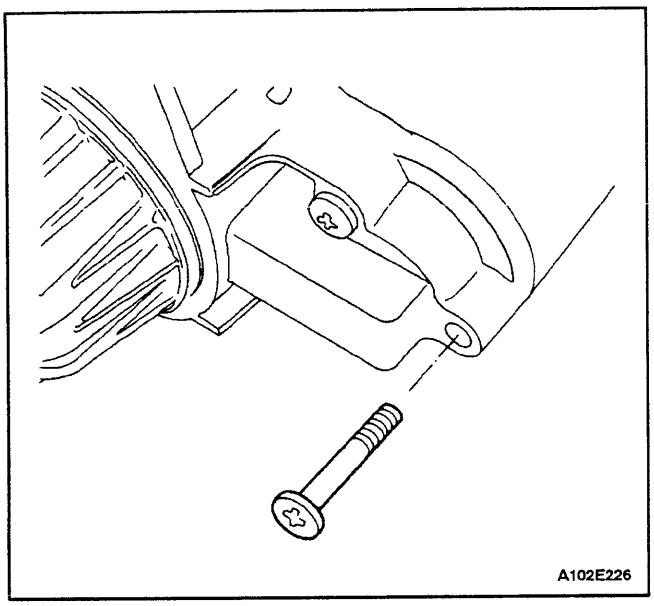
19. Disassemble the driveshaft assembly by first separating the needle bearing from the driveshaft.
20. Remove the collar and the locking ring from the groove in the driveshaft.


A102E248

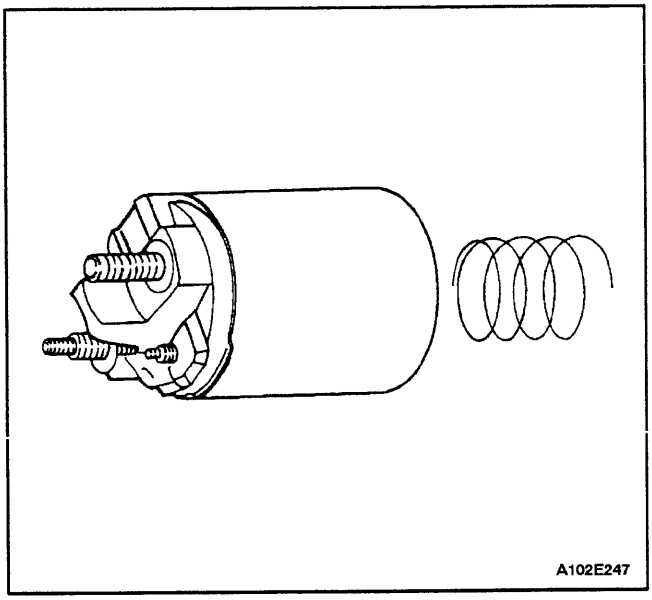
21. Remove the pinion stop and the drive from the driveshaft.


C302E016

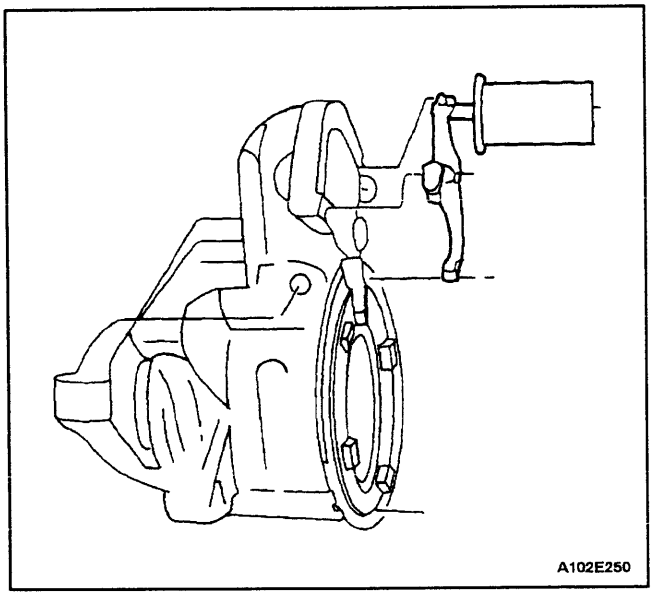
22. Remove the gear support and the collar from the driveshaft.



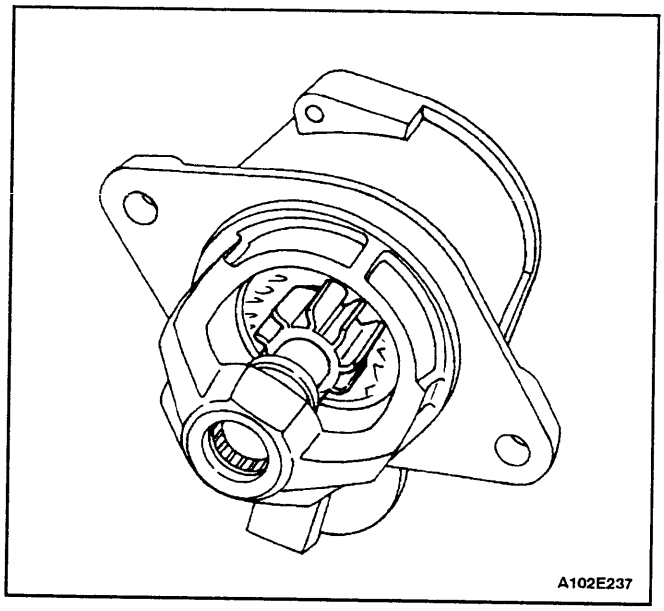
23. If not done in the previous steps, remove the screws holding the solenoid assembly into the housing, and remove the nut from the field coil connector.



24. Rotate the solenoid 90 degrees and remove it along with the return spring.

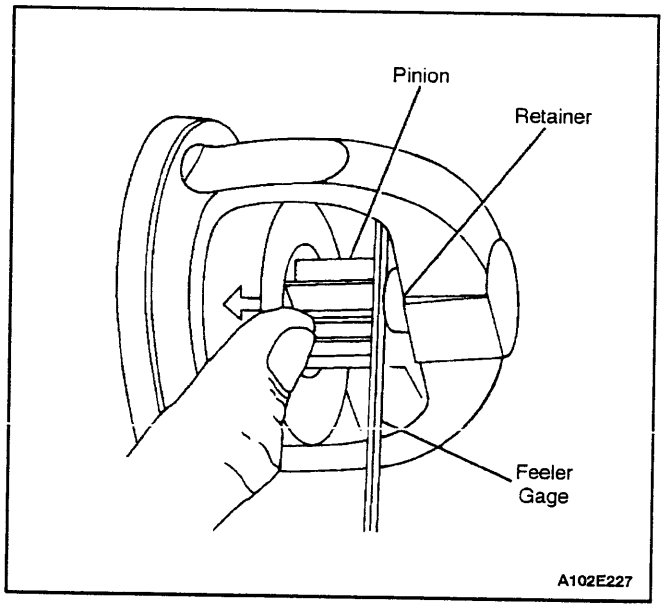


25. Remove the plunger with the boot and the shift lever assembly.


A102E237

Notice: The pinion clearance must be correct to prevent the buttons on the shift lever yoke from rubbing on the clutch collar during the cranking.

26. When the starter motor is disassembled and the solenoid is replaced, it is necessary to check the pinion clearance.

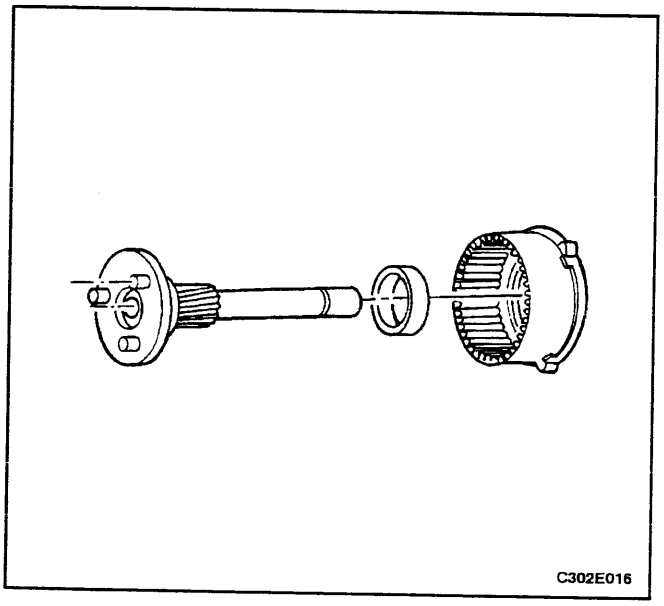


A102E227

27. Disconnect the motor field coil connector from the solenoid motor terminal and carefully insulate the connector.
28. Connect one 12-volt battery lead to the solenoid switch terminal and the other to the starter frame.
29. Flash a jumper lead momentarily from the solenoid motor terminal to the starter frame, allowing shifting of the pinion in the cranking position, where it will remain until the battery is disconnected.

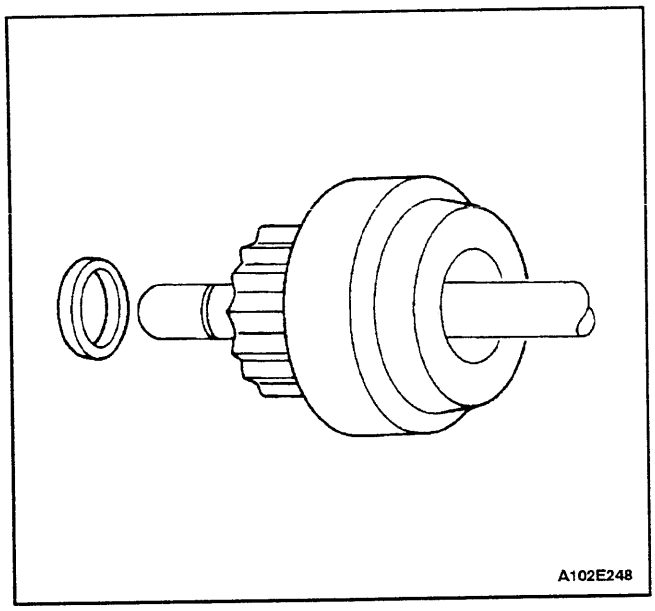
Important: A means for adjusting the pinion clearance is not provided on the starter motor. If the clearance does not fall within the limits, check for improper installation and replace all worn parts.

30. Push the pinion back as far as possible to take up any movement, and check the clearance with a feeler gauge. The clearance should be 0.25 to 3.56 mm (0.01 to 0.14 inch).

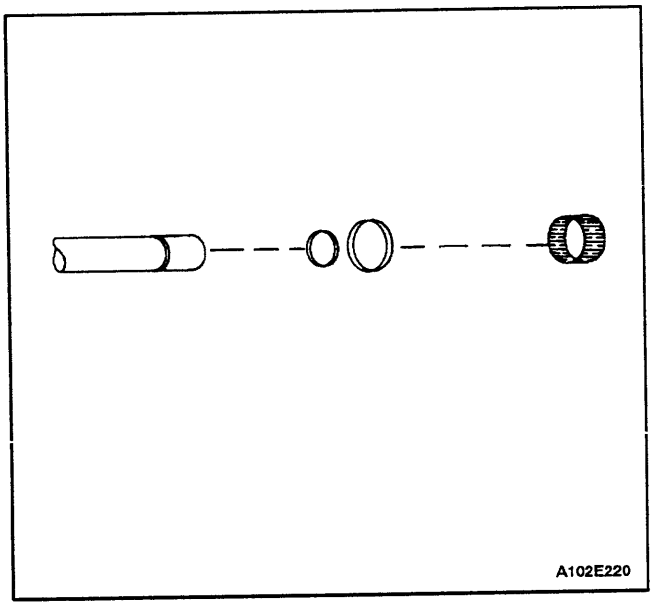

C302E016

Assembly Procedure

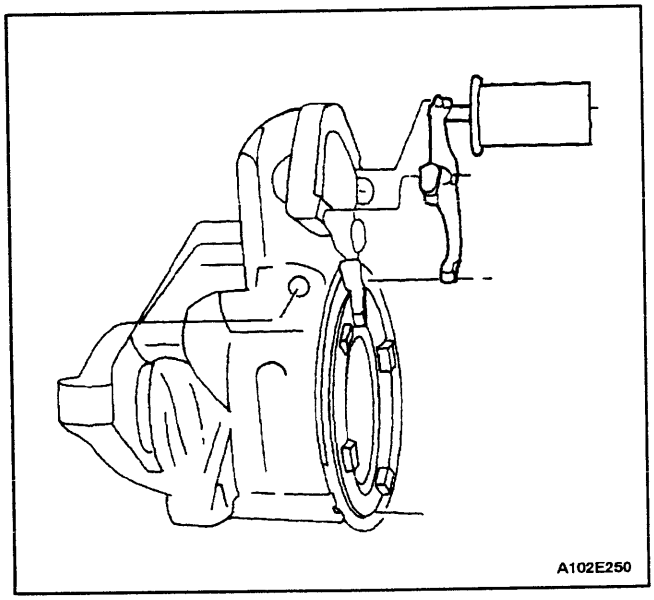
1. Clean all of the starter motor parts, but do not use grease-dissolving solvents for cleaning the armature and the field coils.
2. Lubricate the gears. To reassemble the solenoid only, go to Step 7. To reassemble the starter and the solenoid, go to Step 3.
3. If full disassembly of the starter and the solenoid was performed, begin reassembly by placing the gear support and collar on the driveshaft assembly.


A102E248

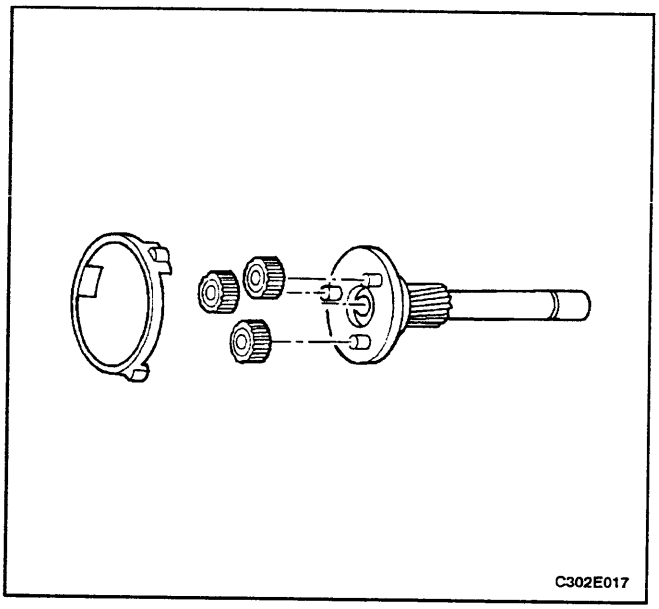
4. Install the drive and the pinion stop on the driveshaft.


A102E220

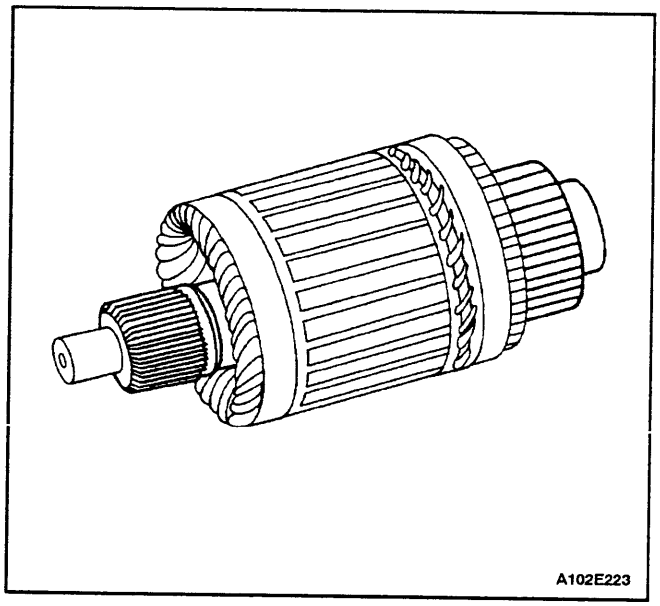
5. Install the lock ring into the groove on the driveshaft and insert the collar.
6. Install the needle bearing.


A102E250

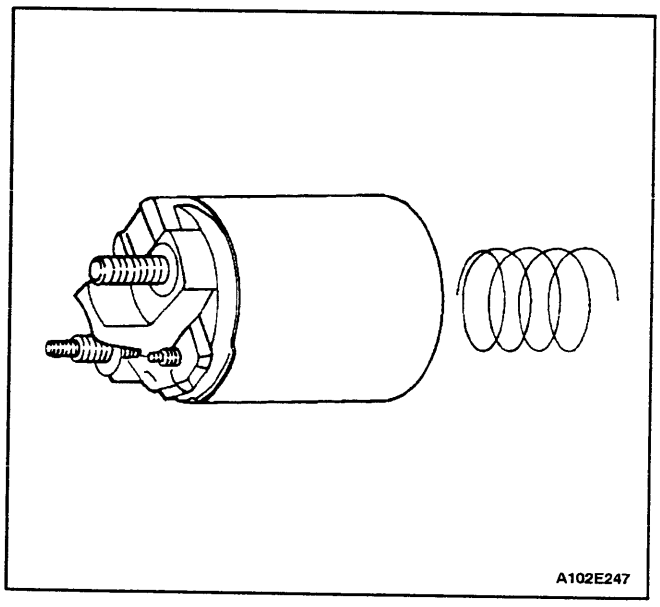
7. Install the shift lever assembly with the plunger and the boot.


C302E017

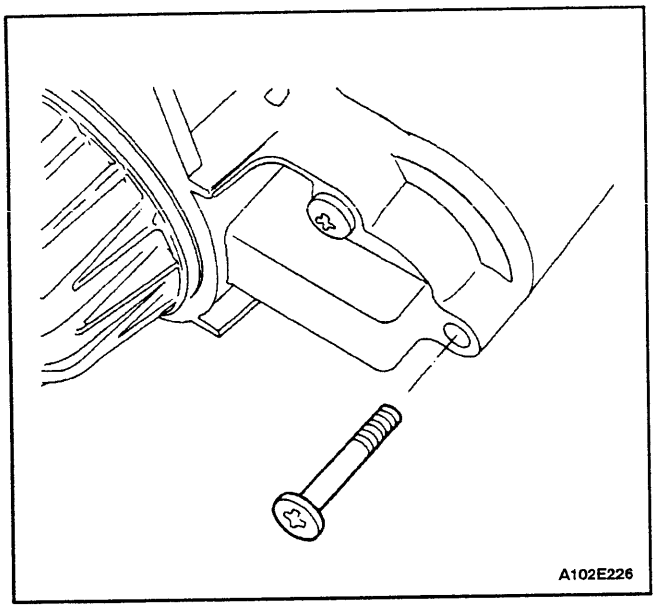
8. Lubricate the gears and install the driveshaft assembly.
9. Install the cushion and the gears.


A102E223

10. Lubricate the drive end of the armature shaft and install the new gear and the bearing, if needed.


A102E247

11. Position the solenoid assembly and the return spring against the plunger, applying sealer to the solenoid flange.


A102E226

12. Fasten the solenoid assembly with the screws.

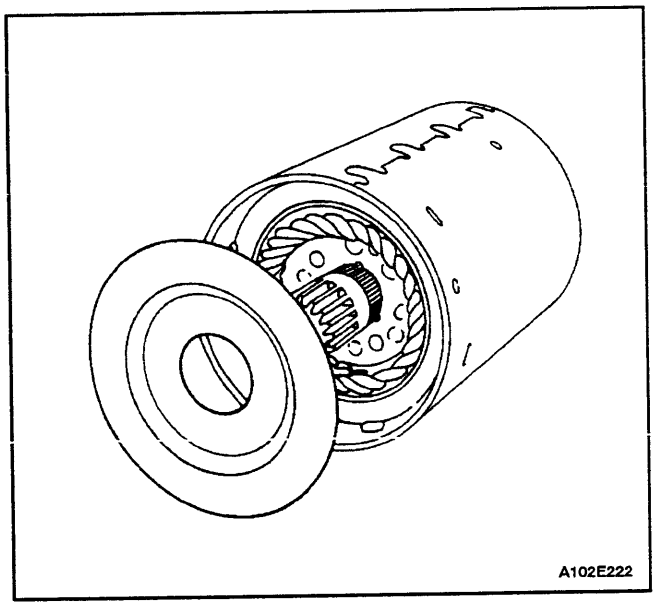
Tighten

Tighten the starter solenoid assembly screws to 8 N•m (71 lb-in).

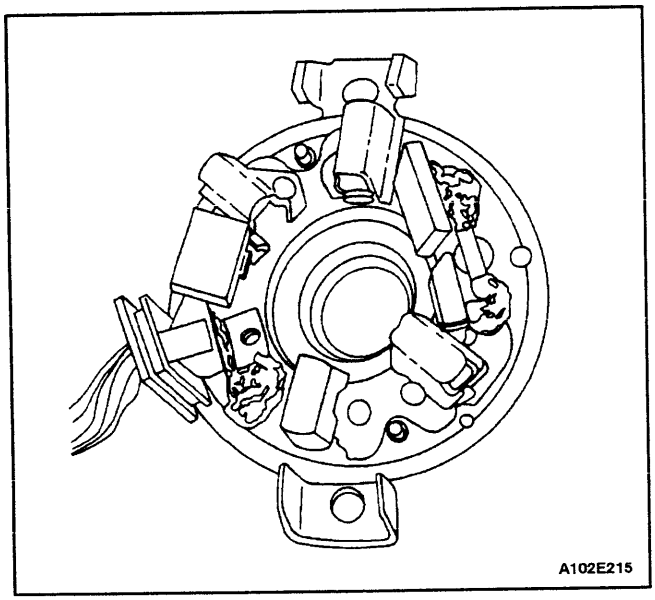
13. Install the field coil connection to the starter terminal. Install the nut.

Tighten

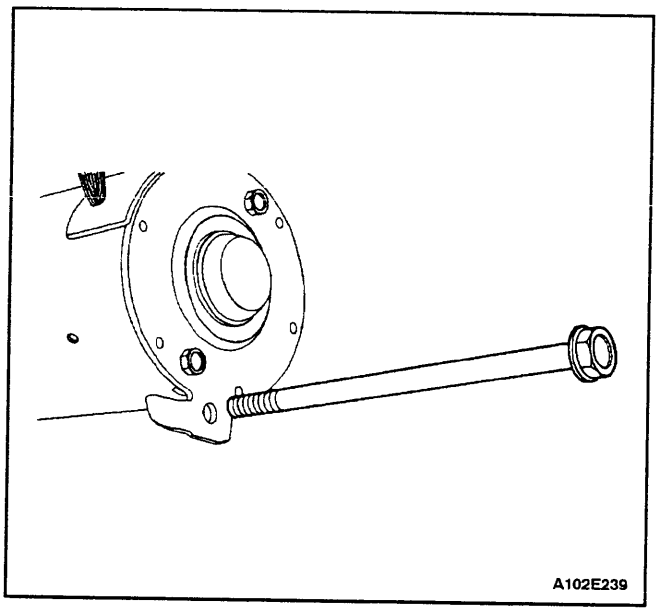
Tighten the starter field connector nut to 8 N•m (71 lb-in).


A102E222

14. Position the armature assembly into the field frame.
15. Place the shield on the armature and field frame assembly.
16. Install the armature and field frame assembly with the shield into the starter housing.


A102E215

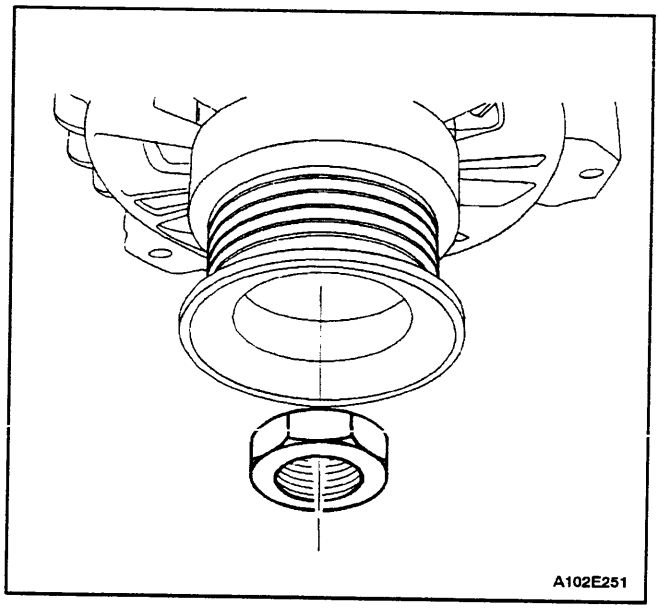
17. Position the commutator end frame and brush holder assembly, lining up the end frame holes with the through-bolt holes in the housing.


A102E239

18. Install the starter through-bolts.
19. Install the starter. Refer to "Starter" in the On-Vehicle Service portion of this section.

Tighten

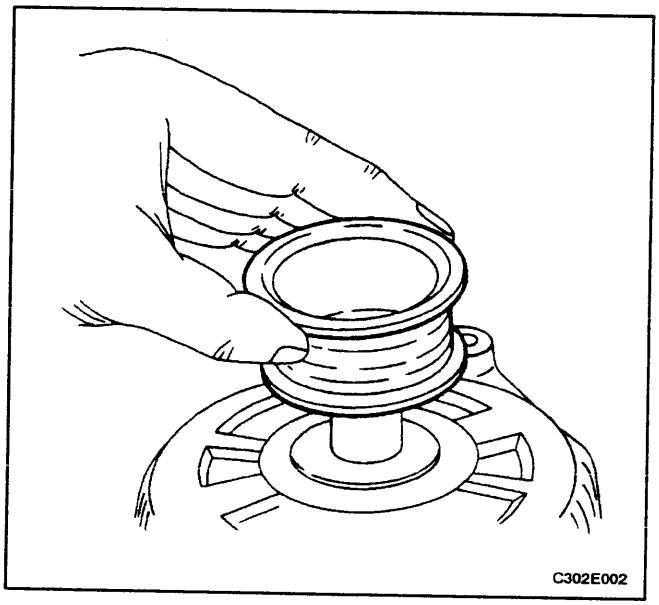
Tighten the starter through-bolts to 6 N•m (53 lb-in).


A102E251

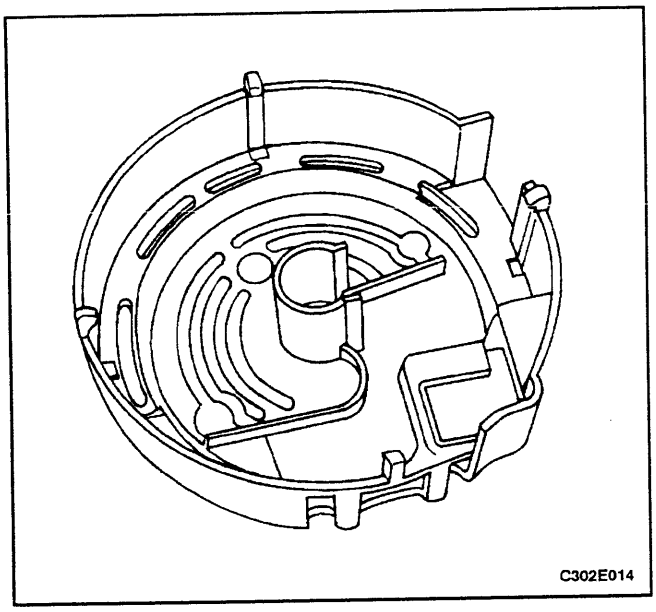
GENERATOR

Disassembly Procedure

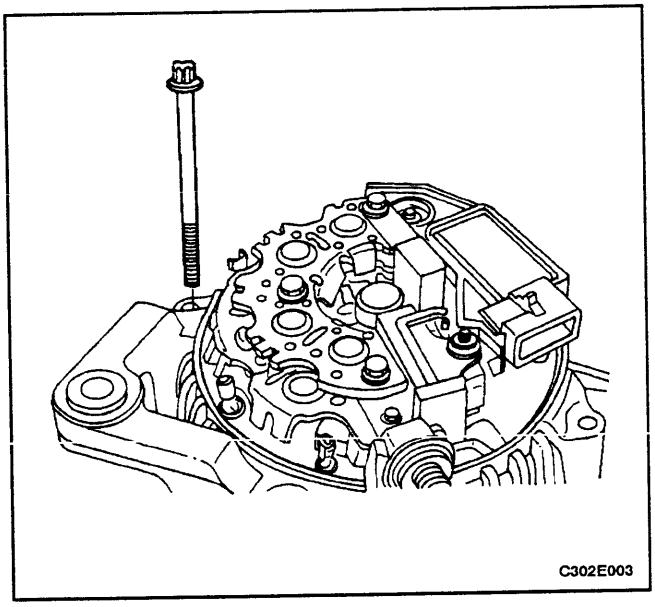
1. Remove the generator. Refer to "Generator" in this section.
2. Remove the drive shaft nut.


C302E002

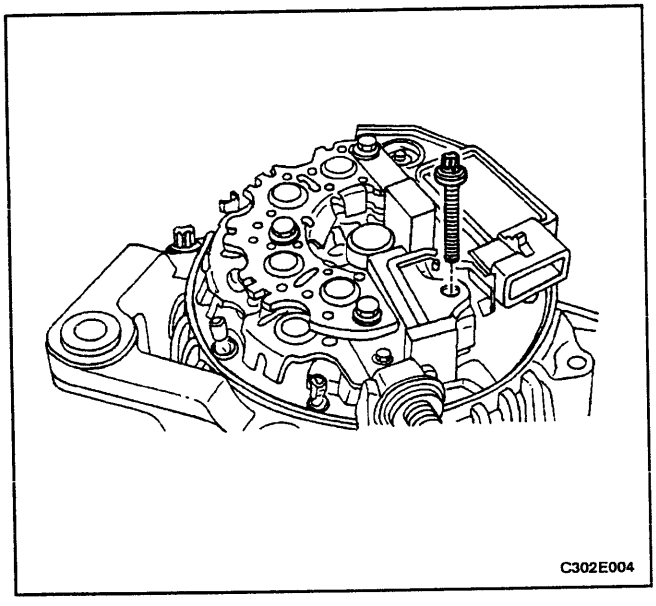
3. Remove the pulley and the collar from the drive shaft.



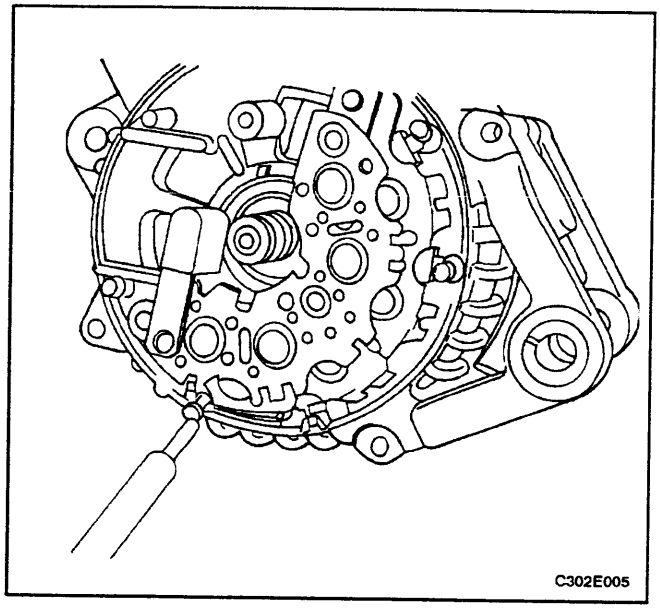
4. Pry off the plastic cover that encloses the rectifier and the regulator/brush holder assemblies. Inspect the cover for damage.



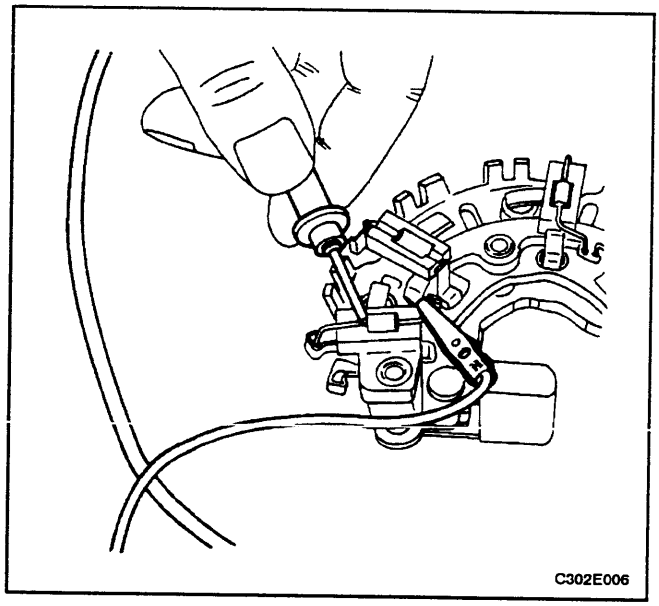
5. Remove the generator through-bolts.



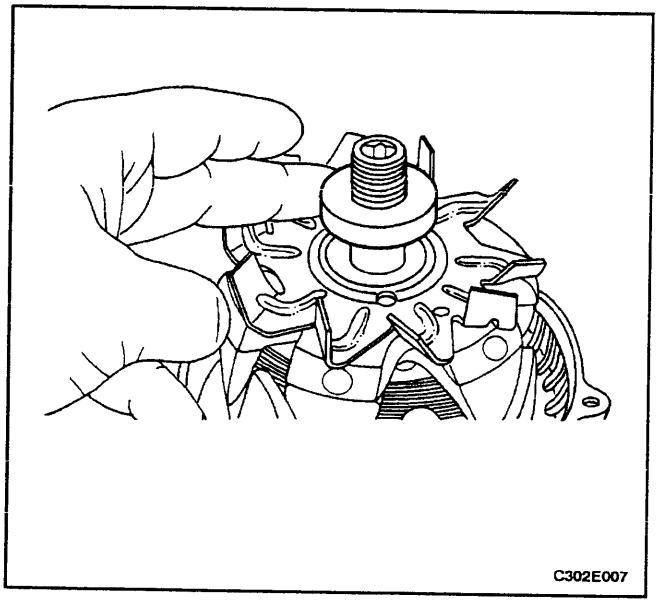
6. Remove the bolts that fasten the rectifier assembly and the regulator/brush holder assembly to the slip ring end frame.


C302E005

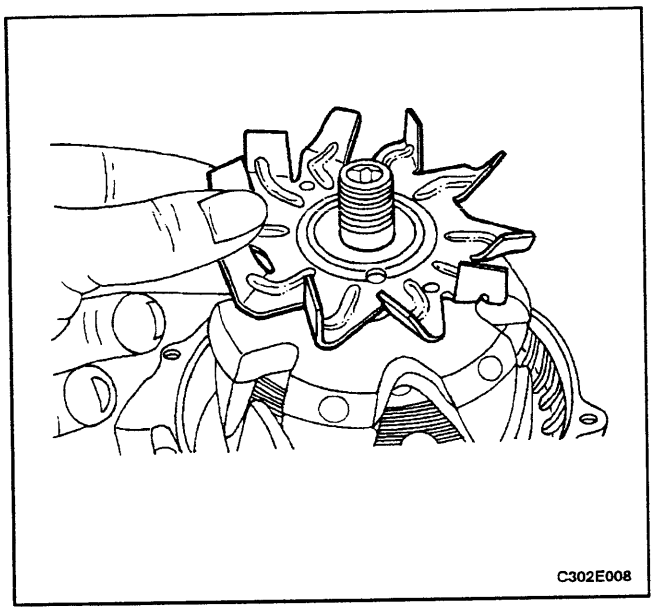
7. To remove the regulator/brush holder and the rectifier assemblies, first melt the solder of the lead connecting the regulator/brush holder assembly to the rectifier assembly lead to the stator. Do the same to the other rectifier assembly leads to the stator (as shown).


C302E006

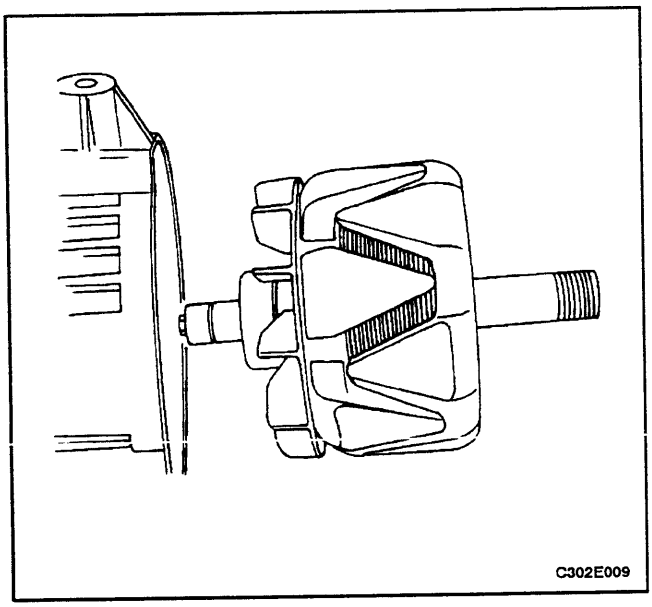
8. Test each of the three diodes of the rectifier assembly for continuity. Connect the ohmmeter probes on each side of the diode. Retest by connecting the ohmmeter probes reversely. If the readings are the same, replace the rectifier.


C302E007

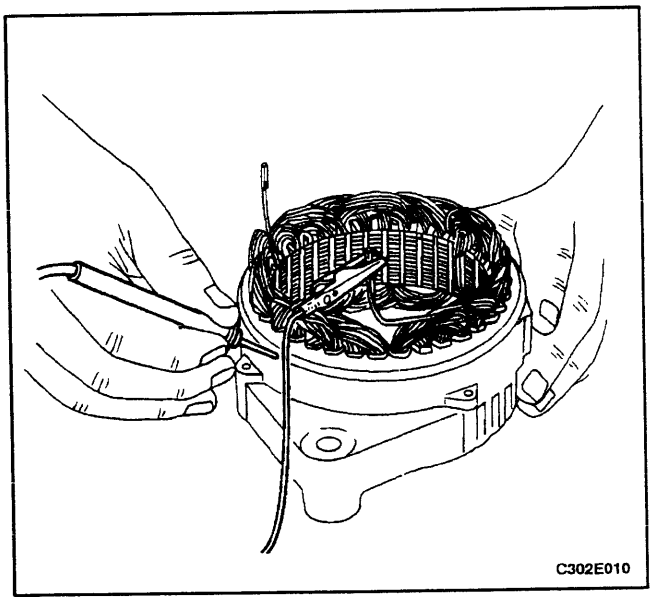
9. Mark a line perpendicular to the crack between the case of the drive end frame and that of the slip ring end frame.
10. Pry open the drive end frame from the slip ring end frame.
11. Remove the collar.


C302E008

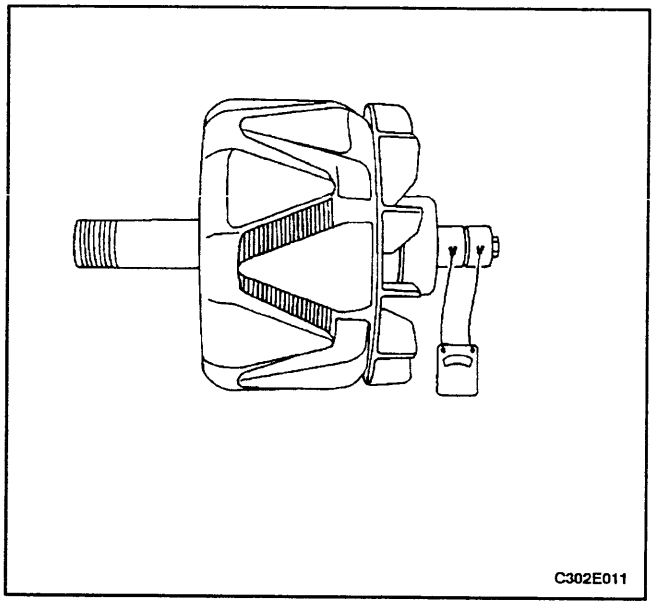
12. Remove the fan.


C302E009

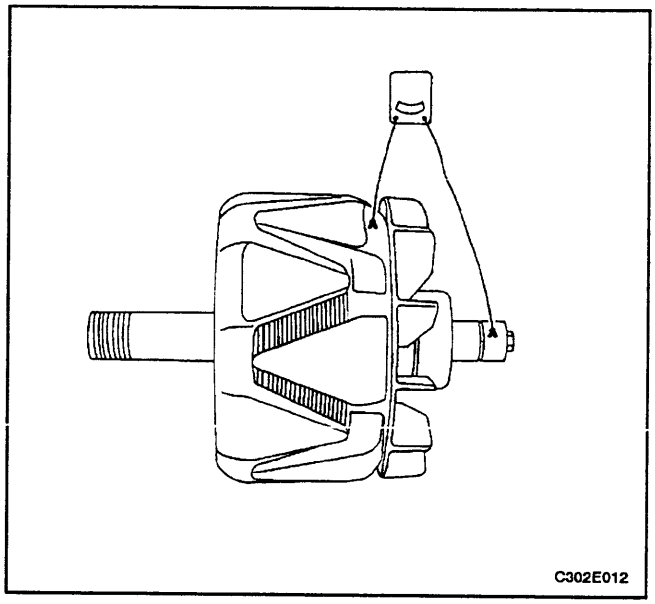
13. Separate the rotor from the slip ring end frame.


C302E010

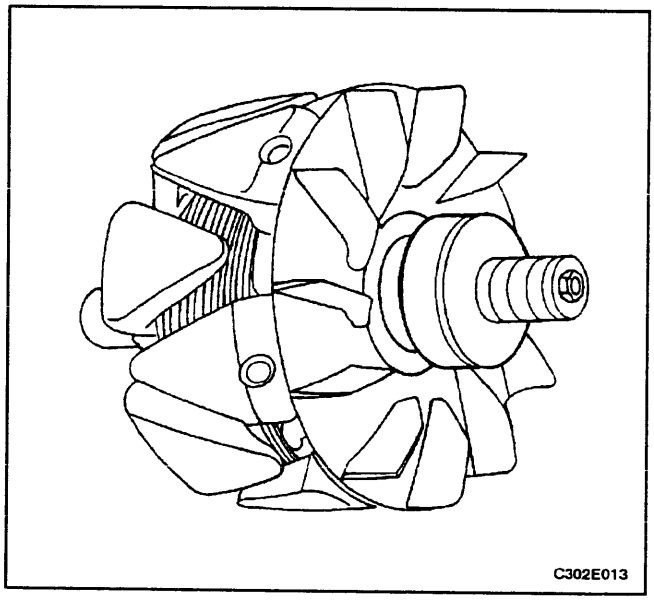
14. Using an ohmmeter, test the stator for ground. If the reading is low, replace the stator. Also check the stator for an open circuit by placing the probes on two terminals. If the reading is high (infinite), replace the stator.


C302E011

15. Using an ohmmeter, test the rotor for an open circuit. Check that there is continuity between the slip rings. Standard resistance (cold) is 2.8 to 3.0 ohms. If there is no continuity, replace the rotor.

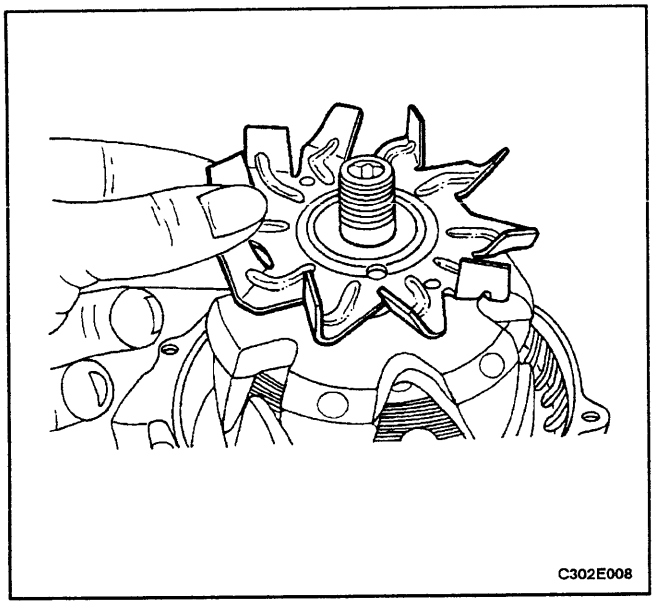

C302E012

16. Using an ohmmeter, inspect the rotor for ground. Check that there is no continuity between the rotor and the slip ring.

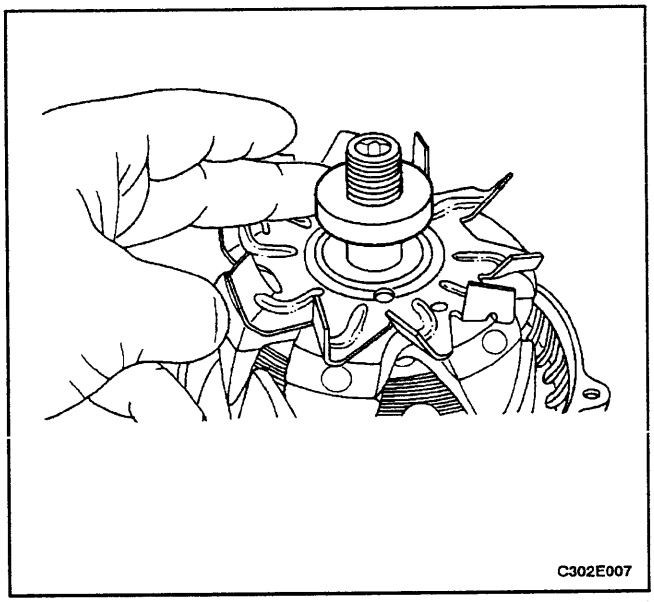

C302E013

Assembly Procedure

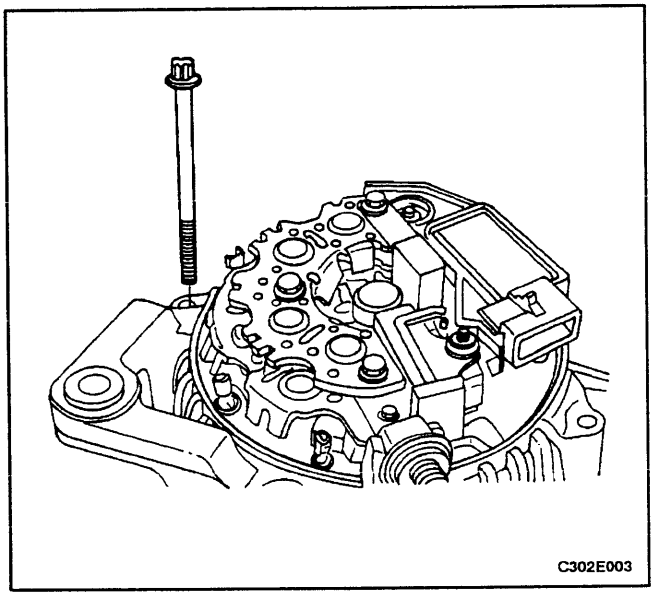
1. Check the bearing on the fan side of the rotor assembly. Replace the bearing if it is rough or worn, and especially if the generator was diagnosed as having a noisy bearing with the vehicle running.
2. If required, install a new bearing and insert the bearing retainer on the rotor assembly shaft.


C302E008

3. Press on rotor assembly into the end frame.
4. Install the fan on the rotor shaft.


C302E007

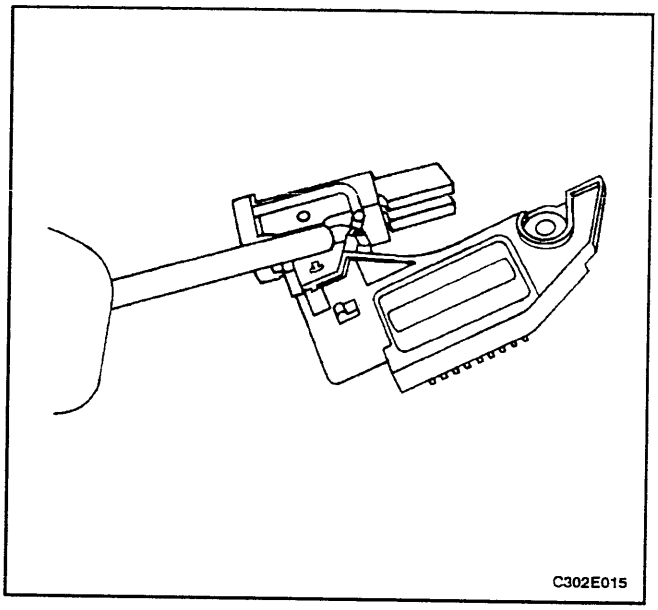
5. Install the collar.


C302E003

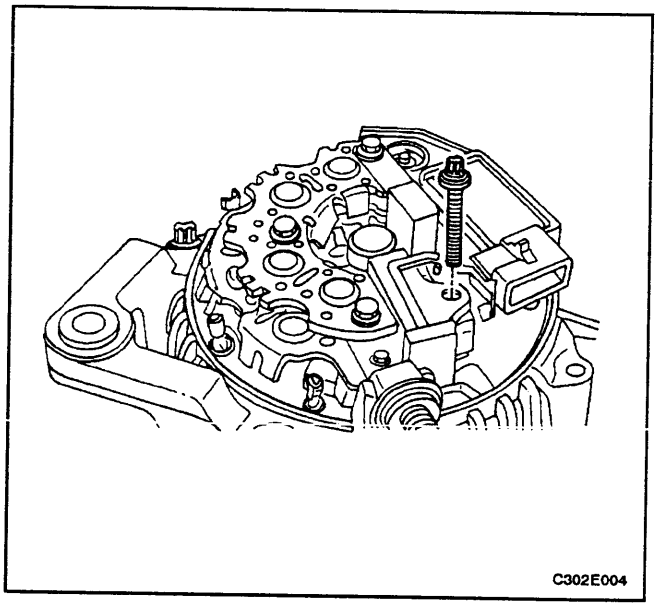
6. Install the slip ring end frame assembly by lining up the terminal ends of the stator with the end frame cover holes and then lining up the previously made marks on the drive end frame case and the slip ring end frame case before the two cases were separated.
7. Install the generator through-bolts.

Tighten

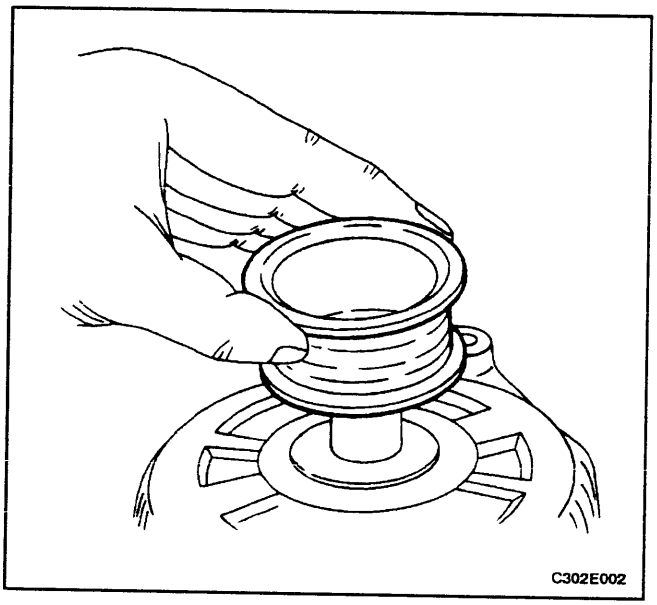
Tighten the generator through-bolts to 25 N•m (18 lb-ft).


C302E015

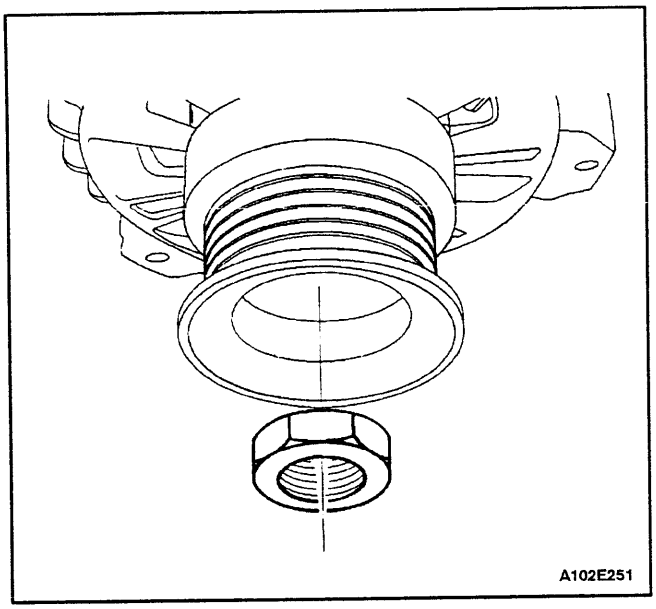
8. Install the rectifier assembly by first soldering its terminals to the stator terminal ends.
9. If the brushes are worn, solder the terminal of the new brush holder assembly to the regulator assembly.


C302E004

10. Solder the terminal of the regulator/brush holder assembly to the rectifier assembly and fasten the rectifier and the regulator/brush holder assemblies to the slip ring end frame with the bolts.
11. Tighten the rectifier and regulator/brush holder assembly bolts until they are touching their respective mounting plates, and tighten the bolts with an additional quarter turn.


C302E002

12. Snap on the cover.
13. Install the collar and pulley on the drive end shaft.



14. Install the drive shaft nut.

Tighten

Tighten the drive shaft nut to 100 N•m (74 lb-ft).

15. Install the generator. Refer to "Generator" in this section.

GENERAL DESCRIPTION AND SYSTEM OPERATION

BATTERY

The sealed battery is standard on all cars. There are no vent plugs in the cover. The battery is completely sealed, except for two small vent holes in the sides. These vent holes allow the small amount of gas produced in the battery to escape. The battery has the following advantages over conventional batteries:

- No water addition for the life of the battery.
- Overcharge protection. If too much voltage is applied to the battery, it will not accept as much current as a conventional battery. In a conventional battery, the excess voltage will still try to charge the battery, leading to gassing, which causes liquid loss.
- Not as liable to self-discharge as a conventional battery. This is particularly important when a battery is left standing for long periods of time.
- More power available in a lighter, smaller case.

The battery has three major functions in the electrical system. First, the battery provides a source of energy for cranking the engine. Second, the battery acts as a voltage stabilizer for the electrical system. Finally, the battery can, for a limited time, provide energy when the electrical demand exceeds the output of the generator.

RATINGS

A battery has two ratings: (1) a reserve capacity rating designated at 27°C (80°F), which is the time a fully charged battery will provide 25 amperes of current flow at or above 10.5 volts; (2) a cold cranking amp rating determined under testing at -18°C (0°F), which indicates the cranking load capacity.

RESERVE CAPACITY

The reserve capacity (RC) is the maximum length of time it is possible to travel at night with the minimum electrical load and no generator output. Expressed in minutes, the RC rating is the time required for a fully charged battery, at a temperature of 27°C (80°F) and being discharged at a current of 25 amperes, to reach a terminal voltage of 10.5 volts.

COLD CRANKING AMPERAGE

The cold cranking amperage test is expressed at a battery temperature of -18°C (0°F). The current rating is the minimum amperage, which must be maintained by the battery for 30 seconds at the specified temperature, while meeting a minimum voltage requirement of 7.2 volts. This rating is a measure of cold cranking capacity.

The battery is not designed to last indefinitely. However, with proper care, the battery will provide many years of service.

If the battery tests well, but fails to perform satisfactorily in service for no apparent reason, the following factors may point to the cause of the trouble:

- Vehicle accessories are left on overnight.
- Slow average driving speeds are used for short periods.
- The vehicle's electrical load is more than the generator output, particularly with the addition of aftermarket equipment.
- Defects in the charging system, such as electrical shorts, a slipping generator belt, a faulty generator, or a faulty voltage regulator.
- Battery abuse, including failure to keep the battery cable terminals clean and tight, or a loose battery hold-down clamp.
- Mechanical problems in the electrical system, such as shorted or pinched wires.

BUILT-IN HYDROMETER

The sealed battery has a built-in, temperature-compensated hydrometer in the top of the battery. This hydrometer is to be used with the following diagnostic procedure:

1. When observing the hydrometer, make sure that the battery has a clean top.
2. Under normal operation, two indications can be observed:
   - GREEN DOT VISIBLE - Any green appearance is interpreted as a "green dot," meaning the battery is ready for testing.
   - DARK GREEN DOT IS NOT VISIBLE - If there is a cranking complaint, the battery should be tested. The charging and electrical systems should also be checked at this time.
3. Occasionally, a third condition may appear:
   - CLEAR OR BRIGHT YELLOW - This means the fluid level is below the bottom of the hydrometer. This may have been caused by excessive or prolonged charging, a broken case, excessive tipping, or normal battery wear. Finding a battery in this condition may indicate high charging by a faulty charging system. Therefore, the charging and the electrical systems may need to be checked if a cranking complaint exists. If the cranking complaint is caused by the battery, replace the battery.

CHARGING PROCEDURE

1. Batteries with the green dot showing do not require charging unless they have just been discharged, such as in cranking a vehicle.
2. When charging sealed-terminal batteries out of the vehicle, install the adapter kit. Make sure all the charger connections are clean and tight. For best results, batteries should be charged while the electrolyte and the plates are at room temperature. A battery that is

extremely cold may not accept current for several hours after starting the charger.

3. Charge the battery until the green dot appears. The battery should be checked every half-hour while charging. Tipping or shaking the battery may be necessary to make the green dot appear.
4. After charging, the battery should be load tested. Refer to "Starter Motor" in this section.

CHARGING TIME REQUIRED

The time required to charge a battery will vary depending upon the following factors:

- **Size of Battery** - A completely discharged large heavy-duty battery requires more than twice the recharging time as a completely discharged small passenger car battery.
- **Temperature** - A longer time will be needed to charge any battery at -18°C (0°F) than at 27°C (80°F). When a fast charger is connected to a cold battery, the current accepted by the battery will be very low at first. The battery will accept a higher current rate as the battery warms.
- **Charger Capacity** - A charger which can supply only 5 amperes will require a much longer charging period than a charger that can supply 30 amperes or more.
- **State-of-Charge** - A completely discharged battery requires more than twice as much charge as a one-half charged battery. Because the electrolyte is nearly pure water and a poor conductor in a completely discharged battery, the current accepted by the battery is very low at first. Later, as the charging current causes the electrolyte acid content to increase, the charging current will likewise increase.

CHARGING A COMPLETELY DISCHARGED BATTERY (OFF THE VEHICLE)

Unless this procedure is properly followed, a perfectly good battery may be needlessly replaced.

The following procedure should be used to recharge a completely discharged battery:

1. Measure the voltage at the battery terminals with an accurate voltmeter. If the reading is below 10 volts, the charge current will be very low, and it could take some time before the battery accepts the current in excess of a few milliamperes. Refer to "Charging Time Required" in this section, which focuses on the factors affecting both the charging time required. Such low current may not be detectable on ammeters available in the field.
2. Set the battery charger on the high setting.

Important: Some chargers feature polarity protection circuitry, which prevents charging unless the charger leads are correctly connected to the battery terminals. A completely discharged battery may not have enough voltage to activate this circuitry, even though the leads are connected properly, making it appear that the battery will not accept charging current. Therefore, follow the specific charger manufacturer's instruction for bypassing or overriding the circuitry so that the charger will turn on and charge a low-voltage battery.

3. Continue to charge the battery until the charge current is measurable. Battery chargers vary in the amount of voltage and current provided. The time required for the battery to accept a measurable charger current at various voltages may be as follows:

Voltage	Hours
16.0 or more	Up to 4 hours
14.0-15.9	Up to 8 hours
13.9 or less	Up to 16 hours

- If the charge current is not measurable at the end of the above charging times, the battery should be replaced.
- If the charge current is measurable during the charging time, the battery is good, and charging should be completed in the normal manner.

Important: It is important to remember that a completely discharged battery must be recharged for a sufficient number of ampere hours (AH) to restore the battery to a usable state. As a general rule, using the reserve capacity rating (RC) as the number of ampere hours of charge usually brings the green dot into view.

- If the charge current is still not measurable after using the charging time calculated by the above method, the battery should be replaced.

JUMP STARTING PROCEDURE

1. Position the vehicle with the charged battery so that the jumper cables will reach from the charged battery to the battery that requires charging.
2. Turn off the ignition, all the lights, and all the electrical loads in both vehicles.
3. Leave the hazard flasher on if jump starting where there may be other traffic and any other lights needed for the work area.
4. Apply the parking brake firmly in both vehicles.

Notice: In order to avoid damaging the vehicle make sure the cables are not on or near pulleys, fans, or other parts that will move when the engine starts.

5. Shift an automatic transmission to PARK, or a manual transmission to NEUTRAL.

Caution: In order to avoid injury, do not use cables that have loose or missing insulation.

6. Clamp one end of the first jumper cable to the positive terminal on the booster battery. Make sure it does not touch any other metal parts.
7. Clamp the other end of the same cable to the positive terminal on the discharged battery. Never connect the other end to the negative terminal of the discharged battery.

Caution: Do not attach the cable directly to the negative terminal of the discharged battery. Doing so could cause sparks and possible battery explosion.

8. Clamp one end of the second cable to the negative terminal of the booster battery.
9. Make the final connection to a solid engine ground, such as the engine lift bracket at least 450 millimeters (18 inches) from the discharged battery.
10. Start the engine of the vehicle with the good battery. Run the engine at a moderate speed for several minutes.
11. Then start the engine of the vehicle with the discharged battery.
12. Remove the jumper cables by reversing the above sequence exactly, removing the negative cable from the vehicle with the discharged battery first. While removing each clamp, take care that it does not touch any other metal while the other end remains attached.

GENERATOR

The Delco-Remy CS charging system has several models available, including the CS-128D. The number denotes the outer diameter in millimeters of the stator lamination.

CS generators are equipped with internal regulators.

Unlike three-wire generators, the CS-128D may be used with only two connections: battery positive and an "L" terminal to the charge indicator lamp.

As with other charging systems, the charge indicator lamp lights when the ignition switch is turned to RUN, and goes out when the engine is running. If the charge indicator is on with the engine running, a charging system defect is indicated. This indicator light will glow at full brilliance for several kinds of defects as well as when the system voltage is too high or too low.

The regulator voltage setting varies with temperature and limits the system voltage by controlling rotor field current. Achieve correct average field current for proper system voltage control by varying the on-off time. At high speeds, the on-time may be 10 percent and the off-time 90 percent. At low speeds, with high electrical loads, the on-time may be 90 percent and the off-time 10 percent.

CHARGING SYSTEM

CS generators use a new type of regulator that incorporates a diode trio. A Delta stator, a rectifier bridge, and a rotor with slip rings and brushes are electrically similar to earlier generators. A conventional pulley and fan are used. There is no test hole.

STARTER

Wound field starter motors have pole pieces, arranged around the armature, which are energized by wound field coils.

Enclosed shift lever cranking motors have the shift lever mechanism and the solenoid plunger enclosed in the drive housing, protecting them from exposure to dirt, icy conditions, and splashes.

In the basic circuit, solenoid windings are energized when the switch is closed. The resulting plunger and shift lever movement causes the pinion to engage the engine flywheel ring gear. The solenoid main contacts close. Cranking then takes place.

When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened, at which time the return spring causes the pinion to disengage. To prevent excessive overrun, the switch should be released immediately after the engine starts.

STARTING SYSTEM

The engine electrical system includes the battery, the ignition, the starter, the generator, and all the related wiring. Diagnostic tables will aid in troubleshooting system faults. When a fault is traced to a particular component, refer to that component section of the service manual.

The starting system circuit consists of the battery, the starter motor, the ignition switch, and all the related electrical wiring. All of these components are connected electrically.

SECTION 1F

ENGINE CONTROLS

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

TABLE OF CONTENTS

SPECIFICATIONS

SCAN TOOL DATA TABLE

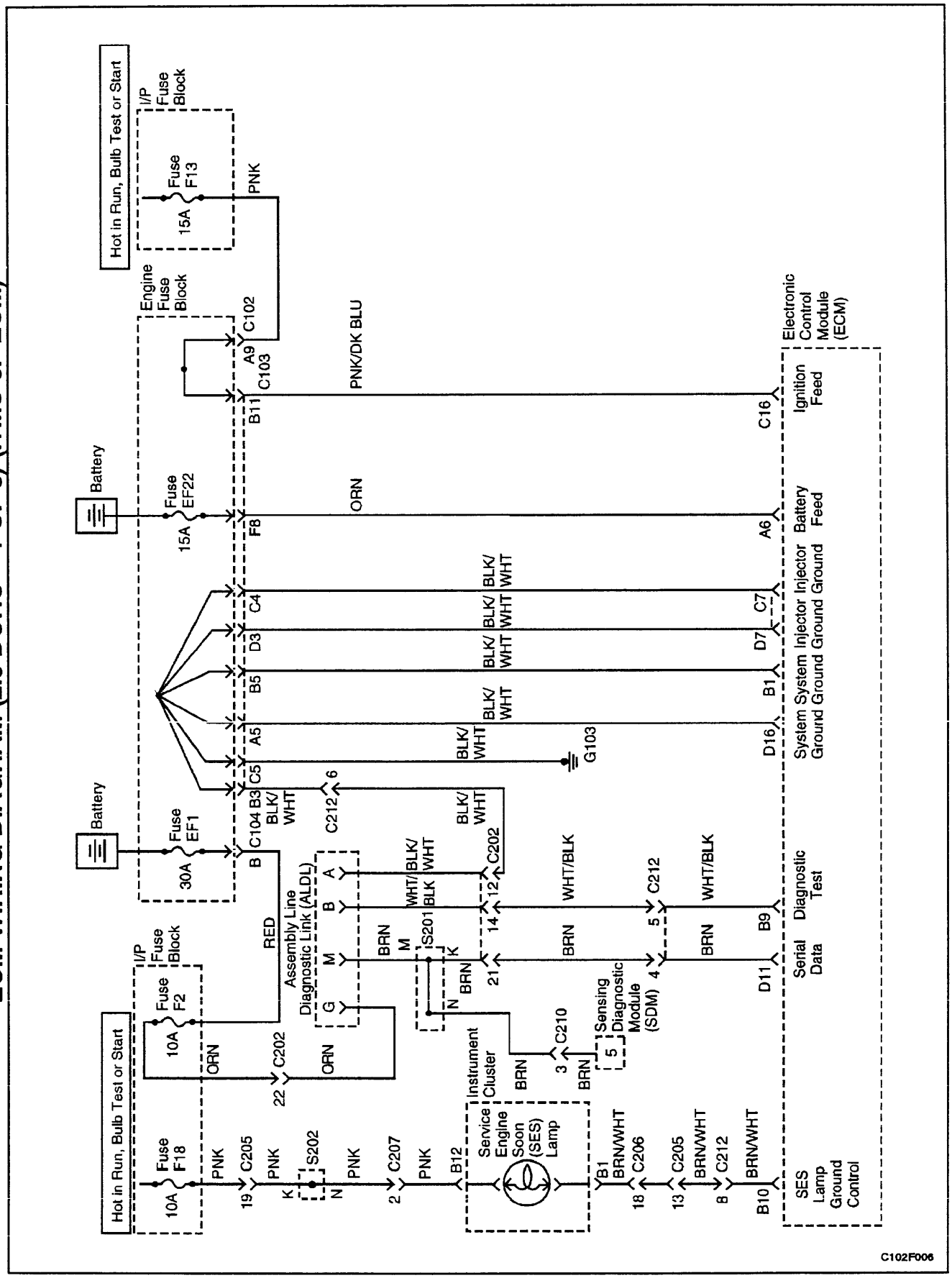
Parameter	Units Displayed	Typical Data Value
Engine Speed	rpm	±50 rpm from desired rpm in drive (A/T) ±50 rpm from desired rpm in neutral (M/T)
Desired Idle	rpm	ECM idle command (varies with temperature)
Coolant Temperature	degrees Celsius	85-105°C
MAT	degrees Celsius	10-90°C
MAP	kPa/volts	29-48 kPa/1-2 volts (varies with manifold and barometric pressure)
Barometric Pressure	kPa/volts	varies with altitude
Open/Closed Loop	open/closed	"Closed Loop" (may enter "Open Loop" at extended idle)
Throttle Position	volts	0.3-1.0 v
Throttle Angle	percent	0-1.5%
Oxygen Sensor	millivolts	1-1000 mv (varies continuously)
Injector-Pulse Width	milliseconds	0.8-2.5 ms
Spark Advance	degrees	varies
S.T. Fuel Trim	counts	118-138
L.T. Fuel Trim	counts	128-148
Idle Air Control	counts	1-50
P/N Switch	P-N and R-D-L	Park/Neutral (P/N)
Vehicle Speed	kph	0
TCC	on/off	off
Ignition/Battery Voltage	volts	13.5-14.8 v
Cooling Fan Relay	on/off	off
A/C Request	yes/no	no
A/C Clutch Relay	on/off	off
Fan Request	on/off	off
Prom ID	0-9999	PROM ID number varies
Fuel Evap Purge	%	0%
Knock Sensor Active	yes/no	no
EGR Solenoid	on/off	off

FASTENER TIGHTENING SPECIFICATIONS

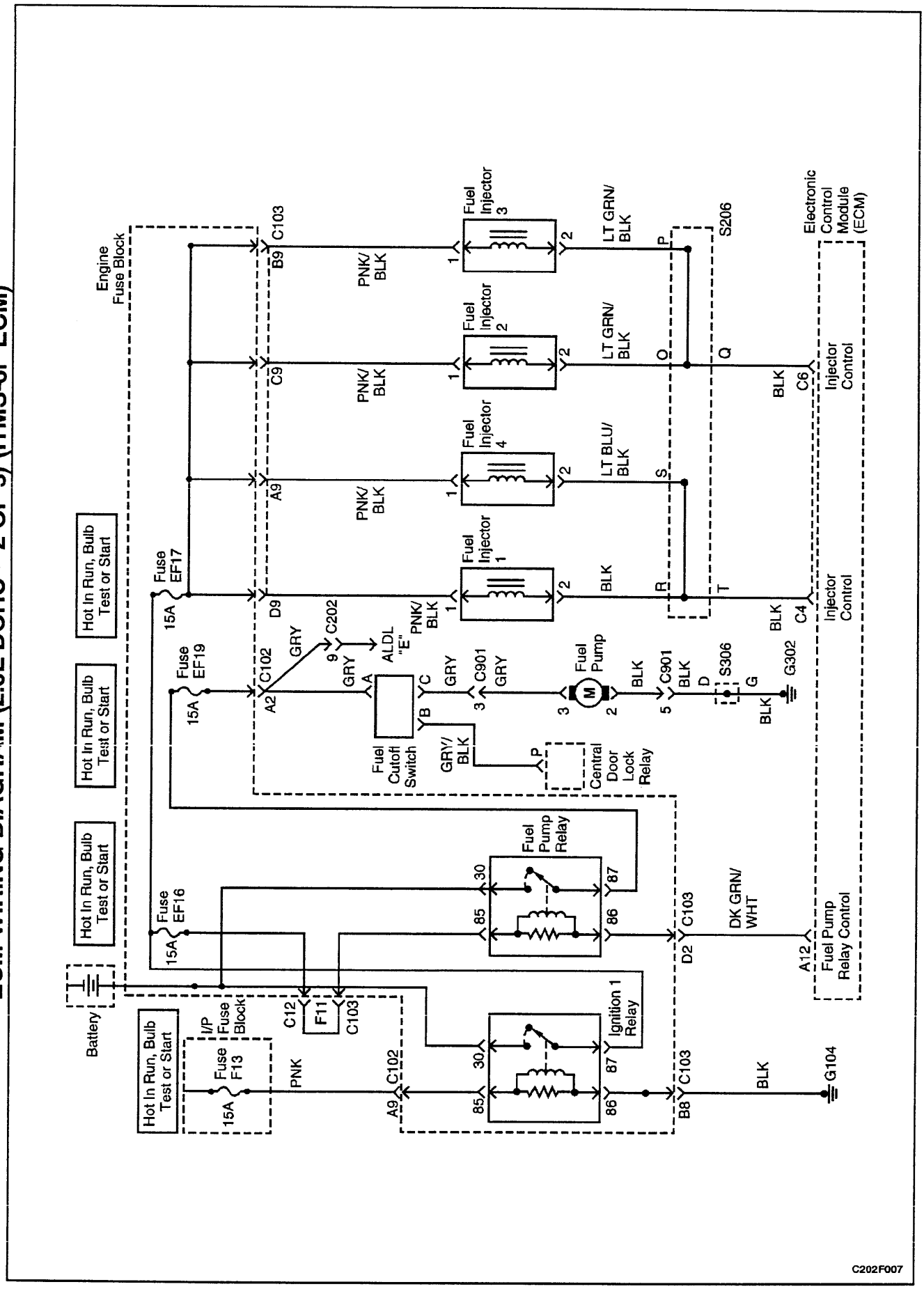
Application	N•m	Lb-Ft	Lb-In
Accessory Mounting Bracket Bolts	35	26	-
Controlled Canister Purge and EGR Solenoid Bracket Bolts	5	-	44
Coolant Temperature Sensor	25	18	-
Crankshaft Position Sensor (CPS) Retaining Bolt	10	-	89
Direct Ignition System (DIS) Ignition Coil Retaining Bolts	10	-	89
Evaporative Emission Canister Flange Bolt	20	15	-
Evaporative Emission Canister Protective Cover	8	-	71
Exhaust Gas Recirculation (EGR) Valve Retaining Bolts	20	15	-
Fuel Cutoff Switch Bolts	3	-	27
Fuel Injector Cover Bolts	10	-	89
Fuel Pressure Regulator Retaining Bolt	10	-	89
Fuel Pressure Regulator Retaining Clamp	12	-	106
Fuel Rail Retaining Bolts	25	18	-
Fuel Tank Strap Retaining Nuts	13	-	115
Idle Air Control (IAC) Valve Retaining Bolts	3	-	27
Knock Sensor Bolt	20	15	-
Manifold Absolute Pressure (MAP) Sensor Retaining Bolt	10	-	89
Oxygen Sensor	41	30	-
Rear A/C Compressor Mounting Bracket Bolts	35	26	-
Throttle Body Retaining Nuts (DOHC)	9	-	80
Throttle Body Retaining Nuts (SOHC)	15	11	-
Throttle Cable Bracket Bolts	10	-	89
Throttle Position Sensor Retaining Bolts	2	-	18

SCHEMATIC AND ROUTING DIAGRAMS

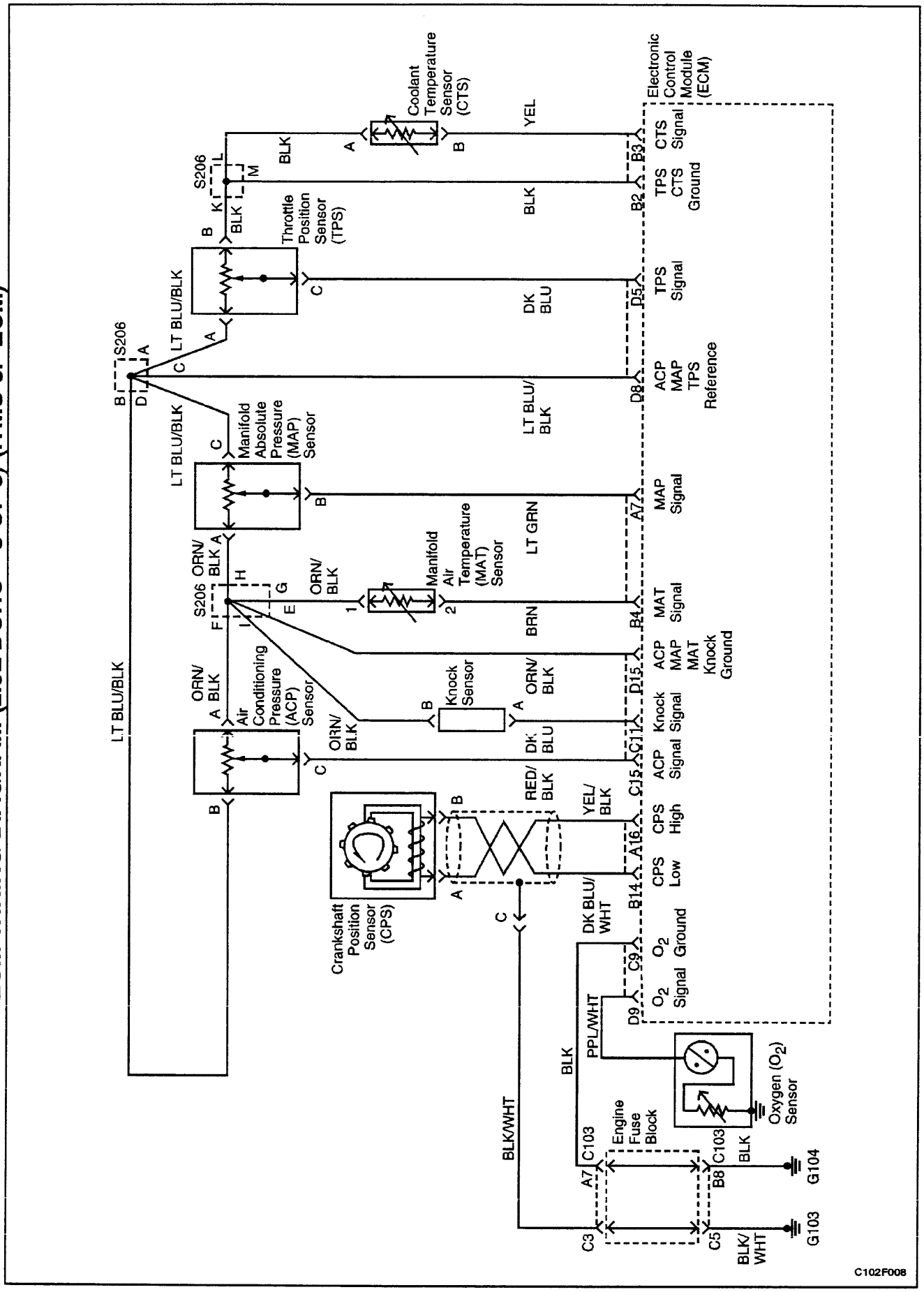
ECM WIRING DIAGRAM (2.0 DOHC - 1 OF 5) (ITMS-6F ECM)

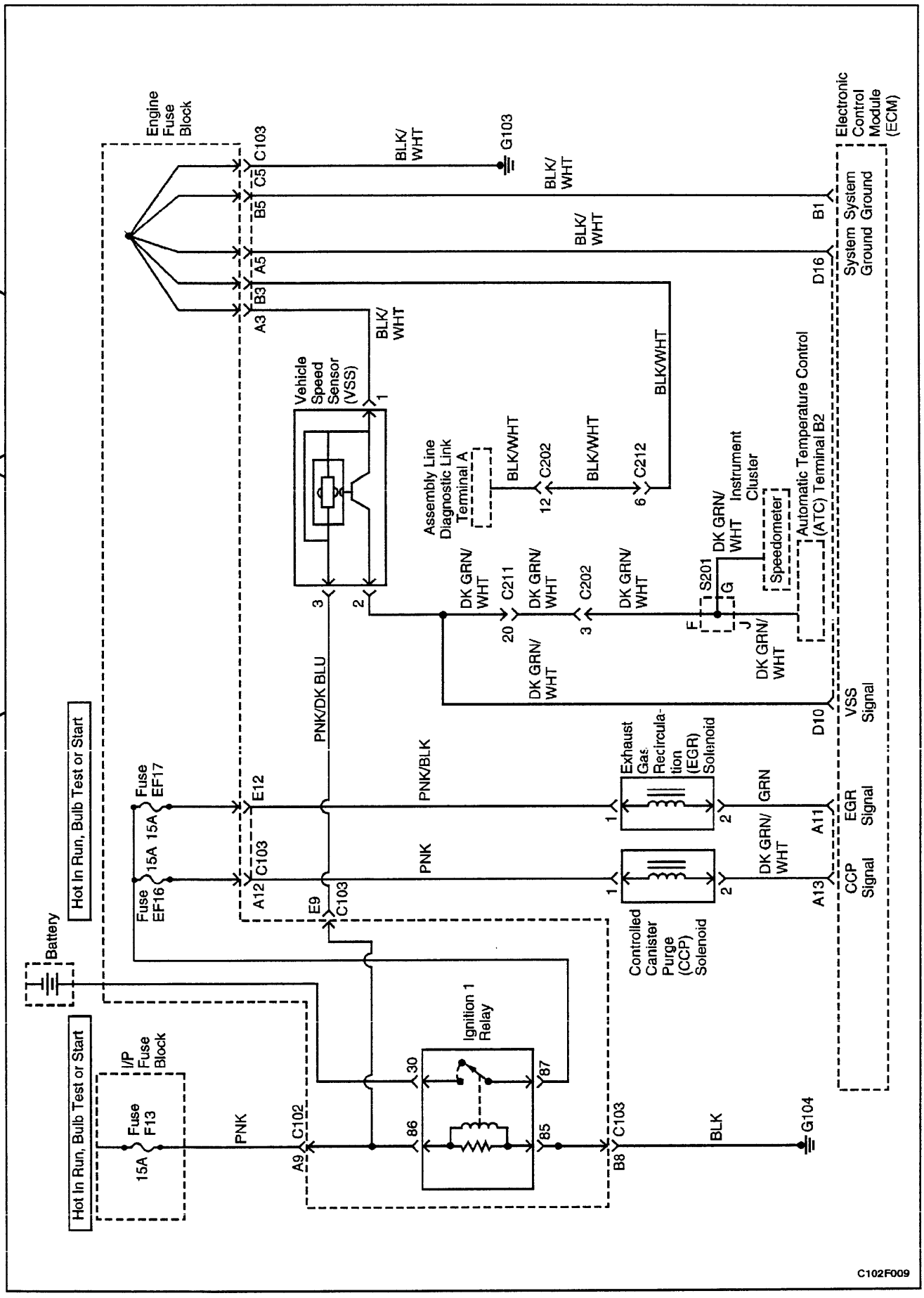


ECM WIRING DIAGRAM (2.0L DOHC - 2 OF 5) (ITMS-6F ECM)

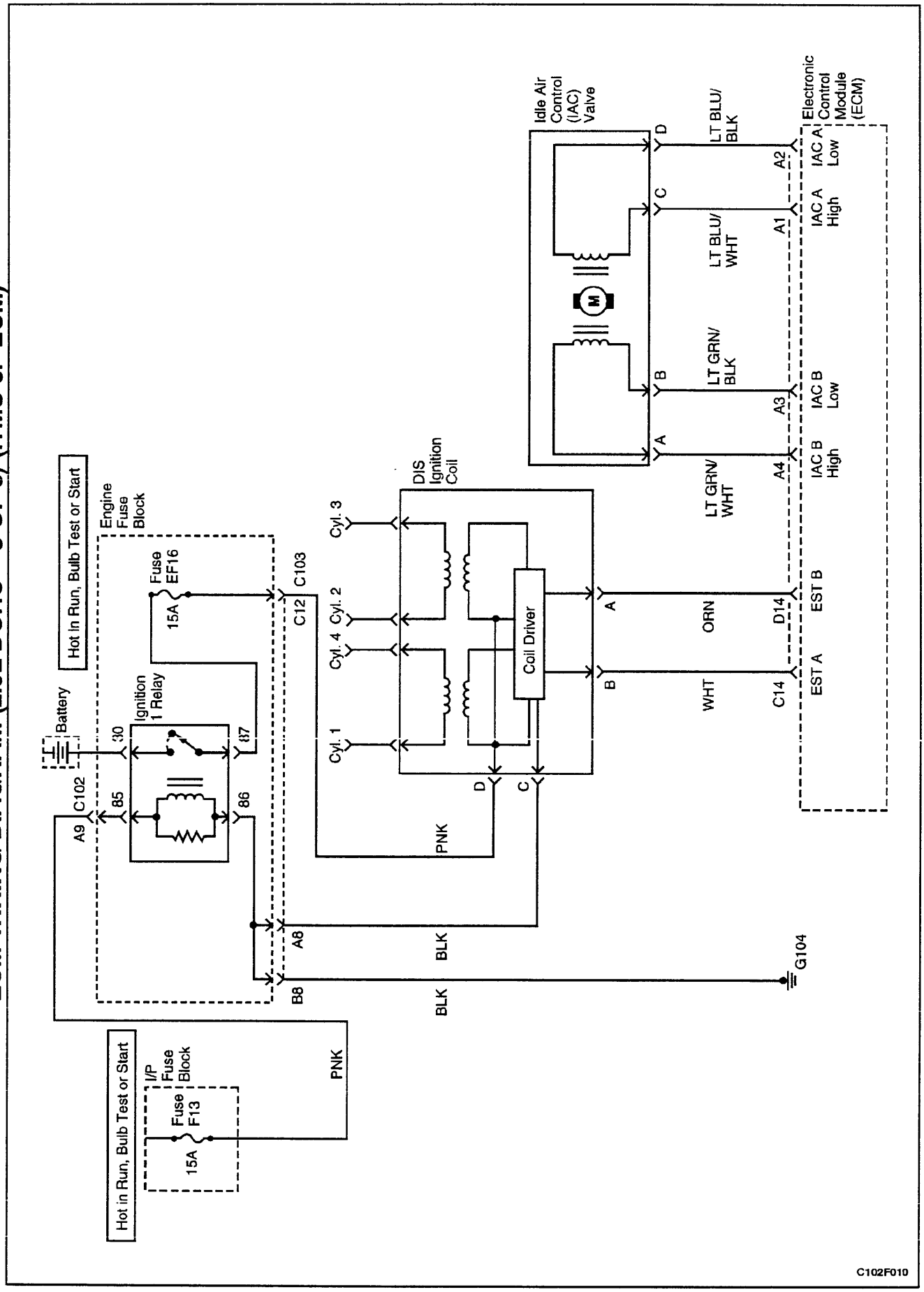


ECM WIRING DIAGRAM (2.0L DOHC - 3 OF 5) (ITMS-6F ECM)

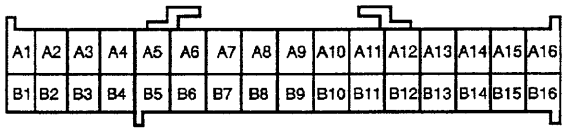



ECM WIRING DIAGRAM (2.0L DOHC - 4 OF 5) (ITMS-6F ECM)
Engine Fuse Block
C103
C5
B5
A5
B3
A3
BLK/WHT
G103
BLK/WHT
BLK/WHT
B1
D16
System Ground
System Ground
Electronic Control Module (ECM)
Vehicle Speed Sensor (VSS)
1
3
2
BLK/WHT
Assembly Line Diagnostic Link Terminal A
BLK/WHT
C202
12
BLK/WHT
C212
6
BLK/WHT
DK GRN/WHT
C211
20
DK GRN/WHT
C202
3
DK GRN/WHT
S201
F
G
J
DK GRN/WHT
Instrument Cluster
Speedometer
Automatic Temperature Control (ATC) Terminal B2
DK GRN/WHT
DK GRN/WHT
D10
VSS Signal
Battery
Hot In Run, Bulb Test or Start
Fuse EF17
15A
15A
E12
C103
A12
PNK/DK BLU
PNK/BLK
Exhaust Gas Recirculation (EGR) Solenoid
1
2
GRN
EGR Signal
A11
Fuse EF16
E9
C103
PNK
1
2
DK GRN/WHT
CCP Signal
A13
Controlled Canister Purge (CCP) Solenoid
Hot In Run, Bulb Test or Start
I/P Fuse Block
Fuse F13
15A
PNK
C102
A9
Ignition 1 Relay
30
87
86
85
C103
B8
BLK
G104
C102F009

ECM WIRING DIAGRAM (2.0L DOHC - 5 OF 5) (ITMS-6F ECM)

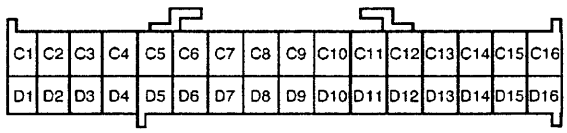


CONNECTOR END VIEW



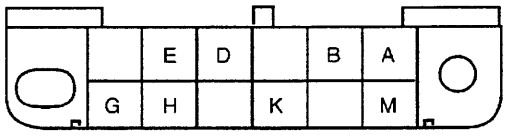
Electronic Control
Module (ECM) J2 (Red)
Connector
(2.0L DOHC)

C302F083



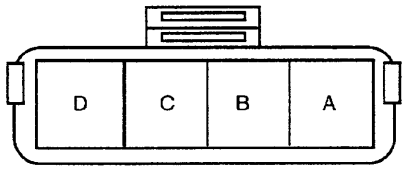
Electronic Control
Module (ECM) J1 (White)
Connector
(2.0 L DOHC)

C302F084



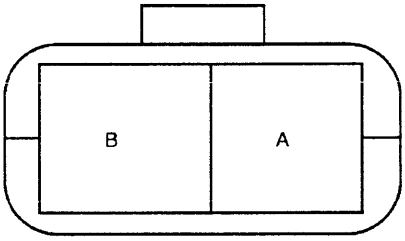
Assembly Line
Diagnostic Link
(ALDL)

C302F091



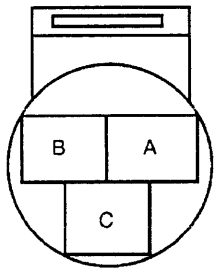
Direct Ignition System (DIS)
Ignition Coil
Connector

A102F080



Coolant Temperature
Sensor (CTS) Connector

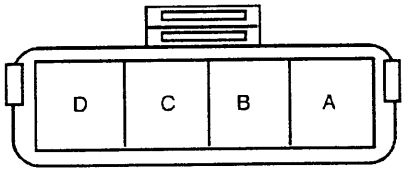
A102F085



Air Conditioning
Pressure (ACP) Sensor
Connector

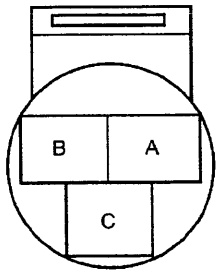
A102F088

CONNECTOR END VIEW (Cont'd)



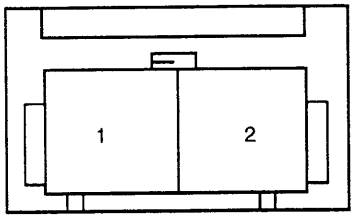
Idle Air Control (IAC) Valve Connector

A102F076



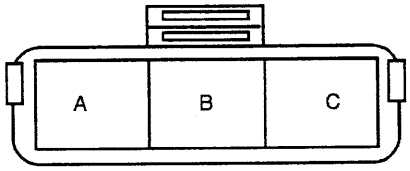
Throttle Position Sensor (TPS) Connector

A102F074



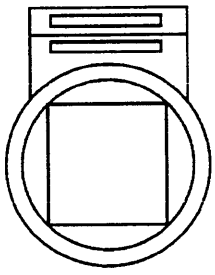
Manifold Air Temperature (MAT) Sensor Connector

A102F077



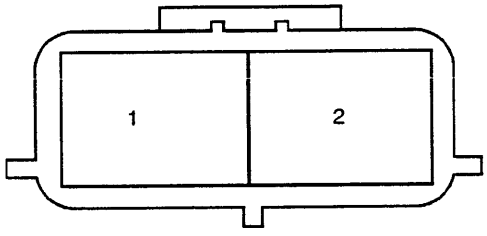
Vehicle Speed Sensor (VSS) Connector

C202F086



Oxygen (O2) Sensor Connector

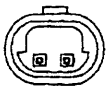
A102F081



Controlled Canister Purge (CCP) Solenoid Connector

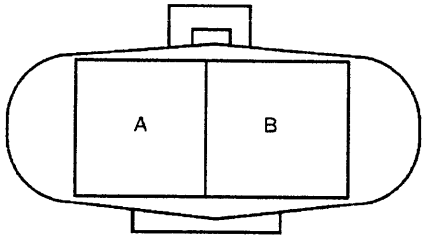
A102F078

CONNECTOR END VIEW (Cont'd)



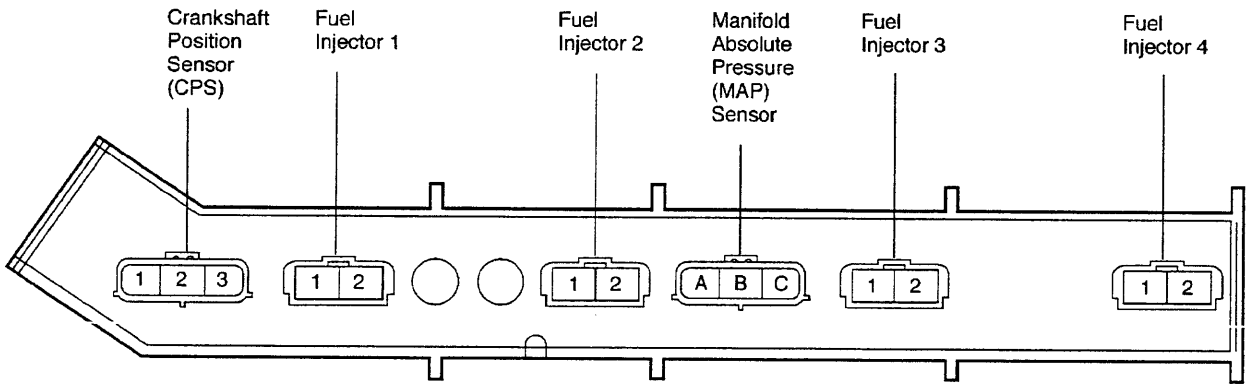
Knock Sensor Connector
(2.0L DOHC)

C302F092



Cooling Fan
Connector

A102F089



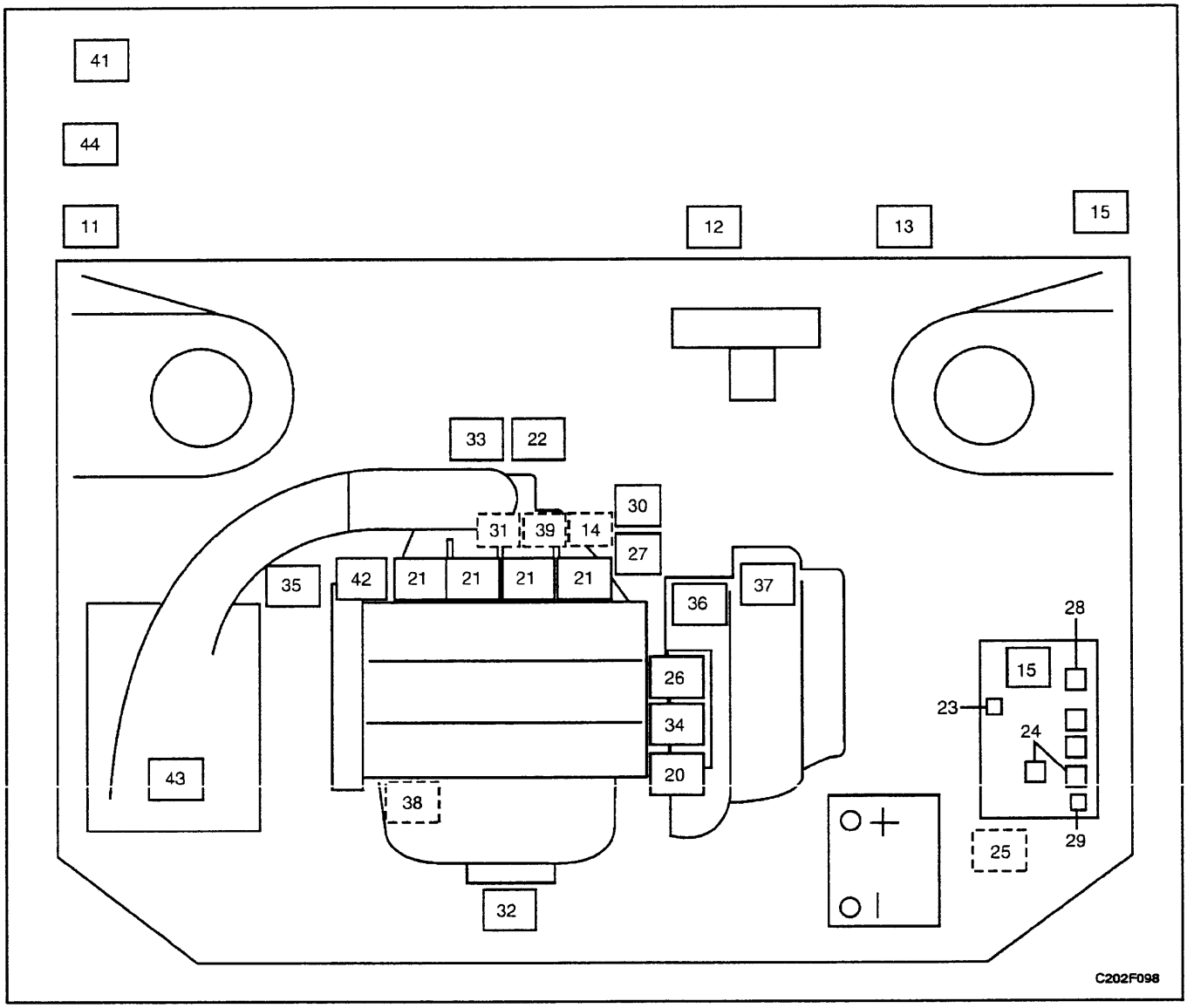
Fuel Injector Channel Cover (2.0L DOHC)

C302F090

COMPONENT LOCATOR

COMPONENT LOCATOR (2.0L DOHC)

(Left-Hand Drive Shown, Right-Hand Drive Similar)



Components on ECM Harness

11 Engine Control Module (ECM)
12 ALDL Diagnostic Connector
13 Service Engine Soon Lamp
14 ECM/ABS Harness Ground
15 Fuse Panel (2)

ECM Controlled Devices

20 Exhaust Gas Recirculation (EGR) Valve
21 Fuel Injector (4)
22 Idle Air Control (IAC) Valve
23 Fuel Pump Relay
24 Engine Fan Relays
25 Series/Parallel Cooling Fan Relay (A/C Only)
26 Direct Ignition System Ignition Coil
27 Controlled Canister Purge Solenoid
28 Ignition 1 Relay
29 A/C Compressor Relay

Information Sensors

30 EGR Solenoid
31 Manifold Absolute Pressure (MAP) Sensor
32 Oxygen (O_2) Sensor
33 Throttle Position Sensor (TPS)
34 Coolant Temperature Sensor (CTS)
35 Manifold Air Temperature (MAT) sensor
36 Vehicle Speed Sensor (VSS)
37 P/N Switch (Automatic Transaxle only)
38 Crankshaft Position Sensor (CPS)
39 Knock Sensor

Not ECM Connected

41 Evaporative Emission Canister (under vehicle, behind right rear wheel)
42 Oil Pressure Switch
43 Air Cleaner
44 Fuel Cutoff Switch

DIAGNOSIS

TROUBLE CODE DIAGNOSIS

CLEARING TROUBLE CODES

Notice: To prevent electronic control module damage, the key must be OFF when disconnecting or reconnecting the power to the electronic control module (for example battery cable, electronic control module pigtail connector, electronic control module fuse, jumper cables, etc.).

When the electronic control module sets a diagnostic trouble code, the service engine soon (SES) lamp will be turned on and a diagnostic trouble code will be stored in the electronic control module's memory. If the problem is intermittent, the light will go out after 10 seconds if the fault is no longer present. The diagnostic trouble code will stay in the electronic control module's memory until the battery voltage to the electronic control module is removed. Removing battery voltage for 10 seconds will clear all stored diagnostic trouble codes.

Diagnostic trouble codes should be cleared after repairs have been completed. Some diagnostic tables will tell you to clear the codes before using the chart. This allows the electronic control module to set the diagnostic trouble code while going through the chart, which will help to find the cause of the problem more quickly.

IDLE LEARN PROCEDURE

Whenever the battery cables, the electronic control module (ECM), or the ECM fuse is disconnected or replaced, the following idle learn procedure must be performed:

1. Turn the ignition ON for 5 seconds.
2. Turn the ignition OFF for 5 seconds.
3. Turn the ignition ON for 5 seconds.
4. Start the engine in park/neutral.
5. Allow the engine run until the engine coolant is above 85°C (185°F).
6. Turn the A/C ON for 10 seconds, if equipped.
7. Turn the A/C OFF for 10 seconds, if equipped.
8. If the vehicle is equipped with an automatic transaxle, apply the parking brake. While depressing the brake pedal, place the transaxle in D (drive).
9. Turn the A/C ON for 10 seconds, if equipped.
10. Turn the A/C OFF for 10 seconds, if equipped.
11. Turn the ignition OFF. The idle learn procedure is complete.

DIAGNOSTIC SYSTEM CHECK

Circuit Description

The diagnostic system check is an organized approach to identifying a problem created by an electronic engine control system malfunction. It must be the starting point for any driveability complaint diagnosis because it directs the technician to the next logical step in diagnosing the complaint. Understanding the table and using it correctly will reduce diagnostic time and prevent the unnecessary replacement of parts.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. Check for proper operation of the service engine soon (SES) lamp. When the ignition is ON and the engine is OFF, the SES lamp should come on and remain on steadily.
2. No SES at this point indicates that there is a problem with the SES circuit or the electronic control module (ECM) control of that circuit.
3. This step checks the ability of the ECM to control the SES lamp. With the assembly line diagnostic link (ALDL) terminal grounded, the SES lamp should flash a Code 12 three times, followed by any diagnostic trouble code stored in memory. Depending upon the type of ECM, an ECM error may result in the inability to flash Code 12.
4. Most procedures use a scan tool to aid diagnosis; therefore, serial data must be available. If an ECM error is present, the ECM may be able to illuminate the SES lamp, but not enable serial data.
5. Although the ECM is powered up, an "Engine Cranks But Will Not Start" symptom could exist because of an ECM or system problem.
6. This step will isolate if the customer complaint is an SES or a driveability problem with no SES. Refer to the diagnostic trouble code (DTC) in this section for a list of valid DTCs. An invalid DTC may be the result of a faulty scan tool or a faulty ECM.
7. Comparison of actual control system data with the typical values is a quick check to determine if any parameter is not within limits. Keep in mind that a basic engine problem (such as incorrect valve timing or a vacuum leak) may substantially alter sensor values.
8. Installation of a scan tool will provide a good ground path for the ECM and may hide a driveability complaint due to poor ECM grounds.
9. If the actual data is not within the typical values established, refer to the tables in "Symptom Diagnosis" to provide a functional check of the suspect component or system.

Diagnostic System Check

Step	Action	Value(s)	Yes	No
1	Verify the customer complaint(s). Are the customer's complaint(s) verified?	-	Go to *Step 2*	-
2	Turn the ignition ON. Is the service engine soon (SES) lamp on steadily?	-	Go to *Step 4*	Go to *Step 3*
3	Jumper the assembly line diagnostic link (ALDL) terminals A and B. Does the SES flash Code 12?	-	Go to *Step 4*	Go to "Will Not Flash SES"
4	1. Connect the scan tool to the ALDL. 2. Turn the ignition ON. Does the scan tool display serial data?	-	Go to *Step 5*	Go to *Step 12*
5	Start the engine. Does the engine start?	-	Go to *Step 6*	Go to "Engine Cranks But Will Not Start"
6	1. Turn the ignition OFF. 2. Connect the scan tool to the ALDL. 3. Turn the ignition ON. Are any diagnostic trouble codes (DTCs) displayed?	-	Go to *Step 8*	Go to *Step 7*
7	1. Start the engine. 2. Compare the scan tool data with typical values. Are the values normal or within the normal range?	-	Go to *Step 9*	Go to *Step 10*
8	Refer to the applicable DTC table. Start with the DTC with the lowest numerical value and move up. Are the DTC(s) identified as valid trouble code(s)?	-	Go to the applicable DTC table	Go to *Step 6*
9	Are there any symptoms that have been identified?	-	Go to the applicable symptom table	Go to *Step 11*
10	Identify the component that has a serial data value outside the normal range. Has the component been identified?	-	Go to "Diagnostic Aids"	-
11	1. Clear any DTC(s) from the ECM memory. 2. Verify that the DTC(s) have been cleared. 3. Road test the vehicle. 4. Recheck for the presence of any DTC(s). Is the repair complete?	-	System OK	Go to *Step 1*
12	1. Attach the scan tool to another vehicle. 2. Turn the ignition ON. Does the scan tool read serial data?	-	Go to *Step 13*	Go to *Step 16*
13	Check for an open or short in the wire between ECM terminal D11 and ALDL connector M. Is the problem found?	-	Go to *Step 14*	Go to *Step 15*
14	1. Repair the open or short as necessary. 2. Connect the scan tool to the ALDL. 3. Start the engine. Does the scan tool display serial data?	-	System OK	Go to *Step 15*

Diagnostic System Check (Cont'd)

Step	Action	Value(s)	Yes	No
15	1. Replace the electronic control module. 2. Connect the scan tool to the ALDL. 3. Start the engine. Does the scan tool display serial data?	-	Go to *Step 6*	-
16	1. Replace the scan tool. 2. Connect the scan tool to the ALDL. 3. Ignition ON. Does the scan tool read serial data?	-	Go to *Step 5*	-

DIAGNOSTIC AIDS

If an intermittent problem is evident, follow the guidelines below.

Preliminary Checks

Before using this section you should have already performed the "Diagnostic System Check."

Perform a thorough visual inspection. This inspection can often lead to correcting a problem without further checks and can save valuable time. Inspect for the following conditions:

- Electronic control module (ECM) grounds for being clean, tight, and in their proper location.
- Vacuum hoses for splits, kinks, collapsing and proper connections as shown on the Vehicle Emission Control Information label. Inspect thoroughly for any type of leak or restriction.
- Air leaks at the throttle body mounting area and the intake manifold sealing surfaces.
- Ignition wires for cracks, hardness, proper routing, and carbon tracking.
- Wiring for proper connections.
- Wiring for pinches or cuts.

Diagnostic Trouble Code Tables

Do not use the diagnostic trouble code (DTC) tables to try and correct an intermittent fault. The fault must be present to locate the problem.

Incorrect use of the DTC tables may result in the unnecessary replacement of parts.

Faulty Electrical Connections or Wiring

Most intermittent problems are caused by faulty electrical connections or wiring. Perform a careful inspection of suspect circuits for the following:

- Poor mating of the connector halves.
- Terminals not fully seated in the connector body.
- Improperly formed or damaged terminals. All connector terminals in a problem circuit should be carefully inspected, reformed, or replaced to insure contact tension.
- Poor terminal-to-wire connection. This requires removing the terminal from the connector body.

Road Test

If a visual inspection does not find the cause of the problem, the vehicle can be driven with a voltmeter or a scan tool connected to a suspected circuit. An abnormal voltage or scan tool reading will indicate that the problem is in that circuit.

If there are no wiring or connector problems found and a diagnostic trouble code (DTC) was stored for a circuit having a sensor, except for DTC 44 and DTC 45, replace the sensor.

Intermittent Service Engine Soon (SES) Lamp

An intermittent service engine soon (SES) lamp with no diagnostic trouble code (DTC) present may be caused by the following:

- Electrical system interference caused by a defective relay, electronic control module (ECM) driven solenoid, or switch.
- Improper installation of electrical options such as lights, two-way radios, sound systems, or security systems.
- Ignition control wires should be routed away from ignition wires, ignition system components, and the generator.
- Ignition secondary wires shorted to ground.
- SES lamp driver wire or diagnostic test terminal intermittently shorted to ground.
- Intermittent loss of ECM ground connections.

Fuel System

Some intermittent driveability problems can be attributed to poor fuel quality. If a vehicle is occasionally running rough, stalling, or otherwise performing badly, ask the customer about the following fuel buying habits:

- Do they always buy from the same source? If so, fuel quality problems can usually be discounted.
- Do they buy their fuel from whichever fuel station that is advertising the lowest price? If so, check the fuel tank for signs of debris, water, or other contamination.

ENGINE CRANKS BUT WILL NOT START

Test Description

The number(s) below refer to step(s) on the diagnostic table.

3. By performing a compression test, it can be determined if the engine has the mechanical ability to run.
9. It is important to check for the presence of spark from all of the ignition wires. If spark is present from one to three of the ignition coil terminals, the crankshaft position sensor (CPS) is OK.
19. In checking the electronic control module (ECM) outputs for the electronic spark timing signal, it recommended to use an oscilloscope to view the varying voltage signals. In measuring these outputs with a voltmeter, intermittent errors may occur that cannot be seen by a voltmeter.
35. This step checks for proper operation of the ECM's control of the fuel pump circuit.
59. This step checks for a ground signal being supplied by the ECM to operate the fuel injectors. If there is no ground present during the cranking of the engine, and the fuel injector wiring is OK, the ECM is at fault.

Engine Cranks But Will Not Start

Caution: Use only electrically insulated pliers when handling ignition wires with the engine running to prevent an electrical shock.

Caution: Do not pinch or restrict nylon fuel lines. Damage to the lines could cause a fuel leak, resulting in possible fire or personal injury.

Important: If a no start condition exists, ensure the fuel cutoff switch has not been tripped prior to further diagnosis.

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	Crank the engine. Does the engine start and continue to run?	-	System OK	Go to *Step 3*
3	Perform a cylinder compression test. Is the cylinder compression for all of the cylinders at or above the value specified?	689 kPa (100 psi)	Go to *Step 7*	Go to *Step 4*
4	Inspect the timing belt alignment. Is the timing belt in alignment?	-	Go to *Step 6*	Go to *Step 5*
5	Align or replace the timing belt as needed. Is the repair complete?	-	Go to *Step 2*	-
6	Repair the internal engine damage as needed. Is the repair complete?	-	Go to *Step 2*	-
7	Inspect the fuel pump fuse. Is the problem found?	-	Go to *Step 8*	Go to *Step 9*
8	Replace the fuse. Is the repair complete?	-	Go to *Step 2*	-
9	Check for the presence of spark from all of the ignition wires while cranking the engine. Is spark present from all of the ignition wires?	-	Go to *Step 34*	Go to *Step 10*
10	1. Measure the resistance of the ignition wires. 2. Replace any of the ignition wire(s) with a resistance above the value specified. 3. Check for the presence of spark from all of the ignition wires. Is spark present from all of the ignition wires?	30,000 Ω	Go to *Step 2*	Go to *Step 11*

Engine Cranks But Will Not Start (Cont'd)

Step	Action	Value(s)	Yes	No
11	1. Turn the ignition OFF. 2. Disconnect the crankshaft position sensor (CPS) connector. 3. Turn the ignition ON. 4. Measure the voltage between the CPS connector terminals A and C. Does the voltage measure near the value specified?	1.08 v	Go to *Step 12*	Go to *Step 13*
12	Measure the voltage between the CPS connector terminals B and C. Does the voltage measure near the value specified?	1.08 v	Go to *Step 19*	Go to *Step 14*
13	Measure the voltage between the CPS connector terminal A and ground. Does the voltage measure near the value specified?	1.08 v	Go to *Step 15*	Go to *Step 16*
14	Measure the voltage between the CPS connector terminal B and ground. Does the voltage measure near the value specified?	1.08 v	Go to *Step 15*	Go to *Step 17*
15	Check for an open or short in the wire between the CPS connector terminal C and ground. Is the problem found?	-	Go to *Step 18*	Go to *Step 33*
16	Check for an open or short in the wire between the CPS connector terminal A and the ECM connector terminal B14. Is the problem found?	-	Go to *Step 18*	Go to *Step 33*
17	Check for an open or short in the wire between the CPS connector terminal B and the ECM connector terminal A16. Is the problem found?	-	Go to *Step 18*	Go to *Step 33*
18	Repair the wiring as needed. Is the repair complete?	-	Go to *Step 2*	-
19	1. Disconnect the direct ignition system (DIS) ignition coil connector to prevent the vehicle from starting. 2. Measure the voltage at the ECM connector terminal B14 by backprobing the ECM connector. Are the voltage readings near the values specified?	1.08 v with ignition ON, 1.20 v during cranking	Go to *Step 20*	Go to *Step 21*
20	Measure the voltage at the ECM connector terminal A16 by backprobing the ECM connector. Are the voltage readings near the values specified?	1.08 v with ignition ON, 1.20 v during cranking	Go to Step 22	Go to *Step 21*
21	Replace the crankshaft position sensor. Is the repair complete?	-	Go to *Step 2*	-
22	1. Turn the ignition OFF. 2. Disconnect the electrical connector at the DIS ignition coil. 3. Connect a test light between terminal D of the DIS ignition coil connector and ground. 4. Turn the ignition ON. Is the test light on?	-	Go to *Step 23*	Go to *Step 24*
23	Connect a test light between terminal C of the DIS ignition coil connector and battery positive. Is the test light on?	-	Go to *Step 27*	Go to *Step 25*

Engine Cranks But Will Not Start (Cont'd)

Step	Action	Value(s)	Yes	No
24	Check for an open in the wiring between the battery and the DIS ignition coil connector terminal D. Is the problem found?	-	Go to *Step 26*	Go to "Ignition 1 Relay Circuit Check"
25	Check for an open in the wire from the DIS ignition coil to ground. Is the problem found?	-	Go to *Step 26*	-
26	1. Repair the wiring as needed. 2. Connect the DIS ignition coil connector. 3. Check for the presence of spark from all of the ignition wires. Is spark present from all of the ignition wires?	-	Go to *Step 2*	Go to *Step 27*
27	1. Turn the ignition OFF. 2. Disconnect the DIS ignition coil connector. 3. While cranking the engine, measure the voltage at the DIS ignition coil connector terminal B. Does the voltage fluctuate within the values specified?	0.2-2.0 v	Go to *Step 28*	Go to *Step 29*
28	While cranking the engine, measure the voltage at the DIS ignition coil connector terminal A. Does the voltage fluctuate within the values specified?	0.2-2.0 v	Go to *Step 32*	Go to *Step 30*
29	Check for an open in the wire from the DIS ignition coil connector terminal B to the ECM connector terminal C14. Is the problem found?	-	Go to *Step 31*	Go to *Step 33*
30	Check for an open in the wire from the DIS ignition coil connector terminal A to the ECM connector terminal D14. Is the problem found?	-	Go to *Step 31*	Go to *Step 33*
31	1. Repair the wiring as needed. 2. Connect the DIS ignition coil connector. 3. Check for the presence of spark from all of the ignition wires. Is spark present from all of the ignition wires?	-	Go to *Step 2*	Go to *Step 32*
32	Replace the direct ignition system ignition coil. Is the repair complete?	-	Go to *Step 2*	-
33	Replace the electronic control module. Is the repair complete?	-	Go to *Step 2*	-
34	1. Turn the ignition OFF. 2. Connect a fuel pressure gauge. 3. Crank the engine. Is any fuel pressure present?	-	Go to *Step 37*	Go to *Step 35*
35	1. Turn the ignition OFF. 2. Disconnect the electrical connector at the fuel pump. 3. Connect a test light between the fuel pump connector terminals 3 and 2. 4. Turn the ignition ON. 5. With the ignition ON, the test light should light for the time specified. Is the test light on?	2 sec	Go to *Step 36*	Go to *Step 46*

Engine Cranks But Will Not Start (Cont'd)

Step	Action	Value(s)	Yes	No
36	Replace the fuel pump. Is the repair complete?	-	Go to *Step 2*	-
37	Is the fuel pressure within the value specified?	283-324 kPa (41-47 psi)	Go to *Step 41*	Go to *Step 38*
38	1. Check the fuel filter for a restriction. 2. Inspect the fuel lines for kinks and restrictions. Is the problem found?	-	Go to *Step 39*	Go to *Step 40*
39	1. Replace the fuel filter and/or the fuel lines as needed. 2. Connect a fuel pressure gauge. 3. Crank the engine. Is the fuel pressure within the value specified?	283-324 kPa (41-47 psi)	Go to *Step 2*	Go to *Step 40*
40	1. Disconnect the vacuum line from the fuel pressure regulator. 2. Inspect the vacuum line for the presence of fuel. 3. Inspect the fuel pressure regulator vacuum port for the presence of fuel. Is any fuel present?	-	Go to *Step 43*	Go to *Step 44*
41	Check the fuel for contamination. Is the fuel contaminated?	-	Go to *Step 42*	Go to *Step 58*
42	1. Remove the contaminated fuel from the fuel tank. 2. Clean the fuel tank as needed. Is the repair complete?	-	Go to *Step 2*	-
43	Replace the fuel pressure regulator. Is the repair complete?	-	Go to *Step 2*	-
44	1. Remove the fuel pump assembly from the fuel tank. 2. Inspect the fuel pump sender and the fuel coupling hoses for a restriction. 3. Inspect the in-tank fuel filter for a restriction. Is the problem found?	-	Go to *Step 45*	Go to *Step 36*
45	Replace the fuel pump sender, the in-tank fuel filter, and/or the fuel coupling hoses as needed. Is the repair complete?	-	Go to *Step 2*	-
46	1. Turn the ignition OFF. 2. Disconnect the electrical connector at the fuel pump. 3. Connect a test light between the fuel pump connector terminal 3 and a known good ground. 4. Turn the ignition ON. 5. With the ignition ON, the test light should light for the time specified. Is the test light on?	2 sec	Go to *Step 47*	Go to *Step 48*
47	Repair the open wire between the fuel pump connector terminal 2 and ground. Is the repair complete?	-	Go to *Step 2*	-

Engine Cranks But Will Not Start (Cont'd)

Step	Action	Value(s)	Yes	No
48	1. Turn the ignition OFF. 2. Disconnect the fuel pump relay. 3. Connect a test light between the fuel pump relay connector terminal 85 and ground. 4. Turn the ignition ON. Is the test light on?	-	Go to *Step 49*	Go to *Step 54*
49	1. Turn the ignition OFF. 2. Connect a test light between the fuel pump relay connector terminal 86 and battery positive. 3. Turn the ignition ON. 4. With the ignition ON, the test light should light for the time specified. Is the test light on?	2 sec	Go to *Step 50*	Go to *Step 55*
50	1. Turn the ignition OFF. 2. Connect a test light between the fuel pump relay connector terminal 30 and ground. Is the test light on?	-	Go to *Step 51*	Go to *Step 57*
51	1. Turn the ignition OFF. 2. Check the wire between the fuel pump relay connector terminal 87 and the fuel pump connector terminal 3 for an open or short to ground. Is the problem found?	-	Go to *Step 52*	Go to *Step 53*
52	Repair the wire between the fuel pump relay connector terminal 87 and the fuel pump connector terminal 3. Is the repair complete?	-	Go to *Step 2*	-
53	Replace the fuel pump relay. Is the repair complete?	-	Go to *Step 2*	-
54	1. Inspect the engine fuse block fuse EF16. 2. Check for an open in the wiring between the ignition 1 relay connector terminal 87 and the fuel pump relay connector terminal 85. Is the problem found?	-	Go to *Step 65*	Go to "Ignition 1 Relay Circuit Check"
55	Check the wire between the fuel pump relay connector terminal 86 to the ECM connector terminal A12 for an open. Is the problem found?	-	Go to *Step 56*	Go to *Step 33*
56	Repair the wire between the fuel pump relay connector terminal 86 to the ECM connector terminal A12. Is the repair complete?	-	Go to *Step 2*	-
57	Repair the wire between the fuel pump relay connector terminal 30 and the battery. Is the repair complete?	-	Go to *Step 2*	-

Engine Cranks But Will Not Start (Cont'd)

Step	Action	Value(s)	Yes	No
58	1. Turn the ignition OFF. 2. Disconnect the fuel injector harness connectors from all of the fuel injectors. 3. Turn the ignition ON. 4. Connect a test light between the fuel injector harness connector 1 and ground. 5. Repeat step 4 for each of the remaining fuel injectors. Is the test light on at all of the fuel injectors?	-	Go to *Step 59*	Go to *Step 62*
59	1. Turn the ignition OFF. 2. Connect a test light between the fuel injector harness connector terminal 2 and battery positive. 3. Crank the engine. 4. Repeat steps three and four for each of the remaining fuel injectors. Does the test light flash for all of the fuel injectors?	-	Go to *Step 60*	Go to *Step 63*
60	Measure the resistance of each fuel injector. Is the resistance within the value specified (the resistance will increase slightly at higher temperatures)?	11.6-12.4 Ω	System OK	Go to *Step 61*
61	Replace any of the fuel injectors with a resistance out of specification. Is the repair complete?	-	Go to *Step 2*	-
62	Repair the open wire(s) between the fuel injector harness connector(s) terminal 1 and the battery. Is the repair complete?	-	Go to *Step 2*	-
63	1. Check for an open between the fuel injector harness connector terminal 2 and the ECM connector terminal C4 for the fuel injectors one and four. 2. Check for an open between the fuel injector harness connector terminal 2 and the ECM connector terminal C6 for the fuel injectors two and three. Is the problem found?	-	Go to *Step 64*	Go to *Step 66*
64	Repair the open fuel injector harness wire(s). Is the repair complete?	-	Go to *Step 2*	-
65	Replace the fuse or repair the wiring as needed. Is the repair complete?	-	Go to *Step 2*	-
66	1. Inspect the engine fuse block fuse EF17. 2. Check for an open between the circuit from terminal 1 for each of the four fuel injectors and the ignition 1 relay connector terminal 87. Is the problem found?	-	Go to *Step 65*	Go to "Ignition 1 Relay Circuit Check"

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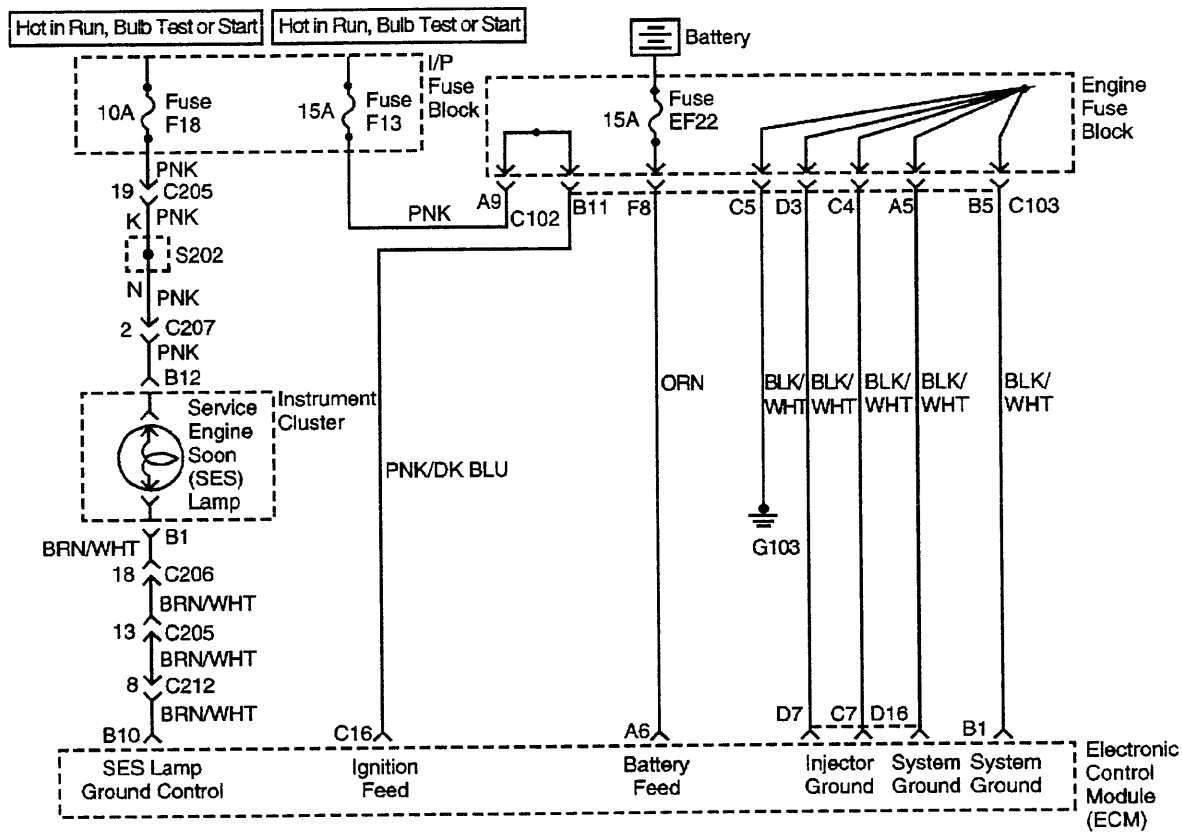

NO SERVICE ENGINE SOON LAMP

Circuit Description

There should always be a steady service engine soon (SES) lamp when the ignition is ON and the engine is stopped. Battery voltage is supplied directly to the SES bulb. The electronic control module (ECM) will control the SES lamp and turn it on by providing a ground path through the ECM connector terminal B10 wire to the SES lamp.

Diagnostic Aids

- If the engine runs OK, inspect for a faulty malfunction indicator lamp bulb.
- If the engine cranks but will not start, check for open fuses and poor electronic control module (ECM) connections. Particularly check for ECM ignition and battery feeds, including clean and tight ECM ground connections.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

4. This step checks for battery voltage in the instrument panel service engine soon (SES) lamp bulb socket.
8. This step checks for battery feed to the electronic control module (ECM).
9. This step checks for ignition feed to the ECM.
22. At this point the SES lamp wiring is OK. The problem is a faulty ECM.

No Service Engine Soon Lamp

Step	Action	Value(s)	Yes	No
1	Start the engine. Does the engine start?	-	Go to *Step 2*	Go to *Step 7*
2	1. Turn the ignition OFF. 2. Disconnect the electronic control module (ECM) connectors. 3. Turn the ignition ON. 4. Connect a test light between the ECM connector terminal B10 and ground. Is the service engine soon (SES) lamp on?	-	Go to *Step 13*	Go to *Step 3*
3	Inspect the kick panel fuse F18. Is the fuse OK?	-	Go to *Step 4*	Go to *Step 14*
4	Check the ignition feed to the SES bulb using a voltmeter. Is the voltage within the value specified?	11-14 v	Go to *Step 5*	Go to *Step 15*
5	Inspect the SES bulb. Is the SES bulb OK?	-	Go to *Step 6*	Go to *Step 16*
6	Check for an open or short to voltage in the wire between the ECM connector terminal B10 and the SES bulb. Is the problem found?	-	Go to *Step 17*	Go to *Step 12*
7	Inspect the ECM fuse F13. Is the problem found?	-	Go to *Step 18*	Go to *Step 8*
8	1. Turn the ignition OFF. 2. Disconnect the ECM red connector. 3. Connect a test light to ECM connector terminal A6 and ground. Is the test light on?	-	Go to *Step 9*	Go to *Step 19*
9	1. Turn the ignition OFF. 2. Disconnect the ECM white connector. 3. Connect a test light between the ECM connector terminal C16 and ground. Is the test light on?	-	Go to *Step 10*	Go to *Step 20*
10	Inspect the ECM connector terminals A6 and C16 for damage or poor mating. Is the problem found?	-	Go to *Step 11*	Go to *Step 13*
11	Repair the ECM connector terminal(s) as needed. Is the repair complete?	-	Go to "Diagnostic System Check"	-
12	Inspect for damage or poor mating at the ECM connector terminal B10. Is the problem found?	-	Go to *Step 11*	Go to *Step 13*
13	Check the ECM connector terminals B1 and D16 for ground. Are the grounds OK?	-	Go to *Step 22*	Go to *Step 21*
14	1. Turn the ignition OFF. 2. Replace the fuse. 3. Turn the ignition ON. Is the SES lamp on?	-	Go to "Diagnostic System Check"	Go to *Step 4*

No Service Engine Soon Lamp (Cont'd)

Step	Action	Value(s)	Yes	No
15	Repair the open in the ignition feed wire to the SES bulb. Is the repair complete?	-	Go to "Diagnostic System Check"	-
16	Replace the service engine soon bulb. Is the repair complete?	-	Go to "Diagnostic System Check"	-
17	Repair the wire between the ECM connector terminal B10 and the SES bulb. Is the repair complete?	-	Go to "Diagnostic System Check"	-
18	1. Turn the ignition OFF. 2. Replace the ECM fuse. 3. Turn the ignition ON. Is the SES lamp on?	-	Go to "Diagnostic System Check"	Go to *Step 1*
19	Repair the wire between the ECM connector terminal A6 and the battery. Is the repair complete?	-	Go to "Diagnostic System Check"	-
20	Repair the wire between the ECM connector terminal C16 and the battery. Is the repair complete?	-	Go to "Diagnostic System Check"	-
21	Repair the open wire between the ECM connector terminals B1 and/or D16 and ground. Is the repair complete?	-	Go to "Diagnostic System Check"	-
22	Replace the electronic control module. Is the repair complete?	-	Go to "Diagnostic System Check"	-

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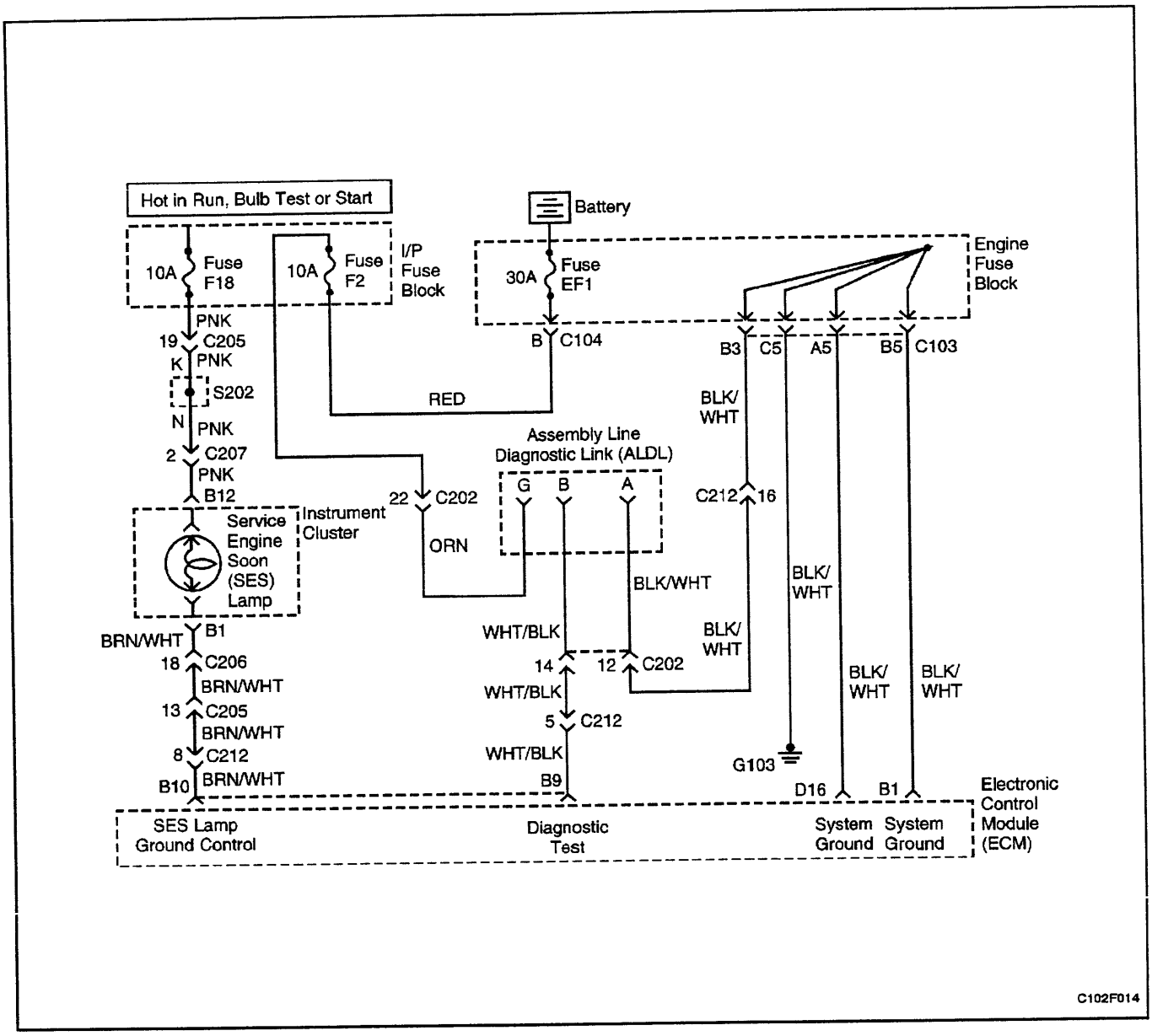

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WILL NOT FLASH SERVICE ENGINE SOON LAMP

Circuit Description

There should always be a steady service engine soon (SES) lamp when the ignition is ON and the engine stopped. Battery ignition voltage is supplied directly to the SES bulb. The engine control module (ECM) will turn the SES on by grounding the ECM connector terminal B10 wire. With the assembly line diagnostic link (ALDL) A and B terminals grounded, the SES lamp should flash a Code 12 followed by any diagnostic trouble code(s) stored in the ECM memory. A steady SES lamp suggests a short to ground in the ECM connector terminal B10 wire, or an open in the diagnostic test wire. A steady but dim light would indicate a failed quad-driver. The table will confirm and suggest the cause.

Diagnostic Aids

- If the engine runs OK, inspect for a faulty service engine soon (SES) bulb.
- If the engine cranks but will not start, check for open fuses and poor electronic control module (ECM) connections. Particularly check for ECM ignition and battery feeds, including clean and tight ECM ground connections.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

3. If the service engine soon (SES) lamp is on when the electronic control module (ECM) red connector is disconnected, the wire to the ECM connector terminal B10 is shorted to ground.
5. This step will check for an open diagnostic test wire.
11. At this point the SES wiring is OK. The problem is a faulty ECM.

Will Not Flash Service Engine Soon Lamp

Step	Action	Value(s)	Yes	No
1	Turn the ignition ON. Is the service engine soon (SES) lamp on?	-	Go to *Step 2*	Go to "No Service Engine Soon Lamp"
2	1. Turn the ignition OFF. 2. Jumper the assembly line diagnostic link (ALDL) terminals A and B. 3. Turn the ignition ON. Does the SES lamp flash the diagnostic trouble code (DTC) 12?	-	Go to "Diagnostic System Check"	Go to *Step 3*
3	1. Turn the ignition OFF. 2. Disconnect the ECM red connector. 3. Turn the ignition ON. Is the SES on?	-	Go to *Step 4*	Go to *Step 5*
4	Repair the short to ground in the wire between the ECM connector terminal B10 and the SES bulb. Is the repair complete?	-	Go to "Diagnostic System Check"	-
5	1. Turn the ignition OFF. 2. Reconnect the ECM red connector. 3. Turn the ignition ON. 4. Backprobe the ECM connector terminal B9 with a test light connected to ground. Does the SES flash DTC 12?	-	Go to *Step 6*	Go to *Step 8*
6	Check for an open wire between the ECM connector terminal B9 and the ALDL terminal B. Is the problem found?	-	Go to *Step 10*	Go to *Step 7*
7	Repair the open wire between the ALDL terminal A and ground. Is the repair complete?	-	Go to "Diagnostic System Check"	-
8	Check for damage or poor mating at the ECM connector terminal B9. Is the problem found?	-	Go to *Step 9*	Go to *Step 11*
9	Repair the ECM connector terminal B9. Is the repair complete?	-	Go to "Diagnostic System Check"	-
10	Repair the wire between the ECM connector terminal B9 and the ALDL terminal B. Is the repair complete?	-	Go to "Diagnostic System Check"	-
11	Replace the electronic control module. Is the repair complete?	-	Go to "Diagnostic System Check"	-

FUEL SYSTEM PRESSURE TEST

Circuit Description

The fuel pump is an in-tank fuel pump mounted to a fuel sender assembly. The fuel pump will remain on as long as the engine is cranking or running and the electronic control module (ECM) is receiving reference pulses from the crankshaft position sensor (CPS). If there are no reference pulses, the ECM will turn off the fuel pump two seconds after the ignition switch is turned ON or two seconds after the engine stops running. The fuel pump delivers fuel to the fuel rail and the fuel injectors, where the fuel system pressure is controlled from 284 to 325 kPa (41 to 47 psi) by the fuel pressure regulator. The excess fuel is returned to the fuel tank.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. When the engine is idling, the intake manifold vacuum is high. This vacuum is applied to the fuel pressure regulator diaphragm, offsetting the spring pressure inside the fuel pressure regulator and lowering the fuel pressure.
10. If there is fuel bleeding back through the fuel return outlet, this is due to a faulty fuel pressure regulator.
14. Another symptom often present when the fuel injectors are leaking is hard starting. Leaking fuel injectors can cause a flooding condition.
23. Fuel leaking from the fuel pump inlet is due to a faulty one-way check valve in the fuel pump.

Caution: The fuel system is under pressure. To avoid fuel spillage and the risk of personal injury or fire, it is necessary to relieve the fuel system pressure before disconnecting the fuel lines.

Caution: Do not pinch or restrict nylon fuel lines. Damage to the lines could cause a fuel leak, resulting in possible fire or personal injury.

Fuel Pressure Relief Procedure

1. Remove the fuel cap.
2. Remove the fuel pump fuse EF19 from the engine fuse box.
3. Start the engine and allow the engine to stall.
4. Crank the engine for an additional 10 seconds.

Fuel System Pressure Test

Step	Action	Value(s)	Yes	No
1	1. Relieve the fuel system pressure. 2. Install a fuel pressure gauge. 3. Turn the ignition ON. Is the fuel pressure within the values specified and holding steady?	284-325 kPa (41-47 psi)	Go to *Step 2*	Go to *Step 5*
2	1. Disconnect the fuel pressure regulator vacuum hose. 2. Start the engine. 3. Allow the engine to idle. 4. Connect the fuel pressure regulator vacuum hose. Did the fuel pressure decrease?	-	System OK	Go to *Step 3*
3	1. Allow the engine to idle. 2. Disconnect the vacuum hose from the fuel pressure regulator. 3. Connect a vacuum pump with a gauge to the fuel pressure regulator vacuum port. 4. Apply 41-47 kPa (12-14 in. Hg) of vacuum to the fuel pressure regulator. Did the fuel pressure decrease?	-	Go to *Step 4*	Go to *Step 16*
4	1. Locate and correct the cause of the vacuum restriction to the fuel pressure regulator. 2. Confirm the operation of the fuel pressure regulator. Is the repair complete?	-	System OK	-

Fuel System Pressure Test (Cont'd)

Step	Action	Value(s)	Yes	No
5	1. Relieve the fuel system pressure. 2. Install a fuel pressure gauge. 3. Turn the ignition ON. Is the fuel pressure within the values specified but not holding steady?	284-325 kPa (41-47 psi)	Go to *Step 6*	Go to *Step 17*
6	Inspect the fuel lines for a leak. Is the problem found?	-	Go to *Step 7*	Go to *Step 8*
7	1. Replace the fuel line(s) as needed. 2. Install a fuel pressure gauge. 3. Turn the ignition ON. Is the fuel pressure within the values specified and holding steady?	284-325 kPa (41-47 psi)	System OK	-
8	1. Remove the fuel pump assembly. 2. With the fuel pump under pressure, inspect the fuel pump coupling hoses for leaking. Is the problem found?	-	Go to *Step 9*	Go to *Step 10*
9	1. Tighten or replace the fuel pump coupling hoses as needed. 2. Install a fuel pressure gauge. 3. Turn the ignition ON. Is the fuel pressure within the values specified and holding steady?	284-325 kPa (41-47 psi)	System OK	-
10	With the fuel system under pressure, inspect the fuel return outlet for leaking. Is the problem found?	-	Go to *Step 11*	Go to *Step 12*
11	1. Replace the fuel pressure regulator. 2. Install a fuel pressure gauge. 3. Turn the ignition ON. Is the fuel pressure within the values specified and holding steady?	284-325 kPa (41-47 psi)	System OK	-
12	With the fuel system under pressure, inspect the fuel inlet for leaking. Is the problem found?	-	Go to *Step 13*	Go to *Step 14*
13	1. Replace the fuel pump assembly. 2. Install a fuel pressure gauge. 3. Turn the ignition ON. Is the fuel pressure within the values specified and holding steady?	284-325 kPa (41-47 psi)	System OK	-
14	1. Remove the fuel rail and the fuel injectors as an assembly. 2. With the fuel system under pressure, inspect all of the fuel injectors for leaking. Is the problem found?	-	Go to *Step 15*	-
15	1. Replace the leaking fuel injector(s). 2. Install a fuel pressure gauge. 3. Turn the ignition ON. Is the fuel pressure within the values specified and holding steady?	284-325 kPa (41-47 psi)	System OK	-

Fuel System Pressure Test (Cont'd)

Step	Action	Value(s)	Yes	No
16	1. Replace the fuel pressure regulator. 2. Disconnect the fuel pressure regulator vacuum hose. 3. Start the engine. 4. Allow the engine to idle. 5. Connect the fuel pressure regulator vacuum hose. Did the fuel pressure decrease?	-	System OK	-
17	1. Relieve the fuel system pressure. 2. Install a fuel pressure gauge. 3. Turn the ignition ON. Is the fuel system pressure below the values specified and holding steady?	284-325 kPa (41-47 psi)	Go to *Step 13*	Go to *Step 18*
18	1. Relieve the fuel system pressure. 2. Install a fuel pressure gauge. 3. Turn the ignition ON. Is the fuel system pressure below the values specified and not holding steady?	284-325 kPa (41-47 psi)	Go to *Step 19*	-
19	Inspect the fuel lines for leaks. Is the problem found?	-	Go to *Step 7*	Go to *Step 20*
20	1. Remove the fuel pump assembly. 2. With the fuel pump under pressure, inspect the fuel pump coupling hoses for leaking. Is the problem found?	-	Go to *Step 9*	Go to *Step 21*
21	1. Remove the fuel pump assembly. 2. With the fuel system under pressure, inspect the fuel return outlet for leaking. Is the problem found?	-	Go to *Step 11*	Go to *Step 22*
22	1. Remove the fuel pump assembly. 2. With the fuel system under pressure, inspect the fuel inlet for leaking. Is the problem found?	-	Go to *Step 13*	Go to *Step 23*
23	1. Remove the fuel rail and the fuel injectors as an assembly. 2. With the fuel system under pressure, inspect all of the fuel injectors for leaking. Is the problem found?	-	Go to *Step 15*	Go to *Step 13*

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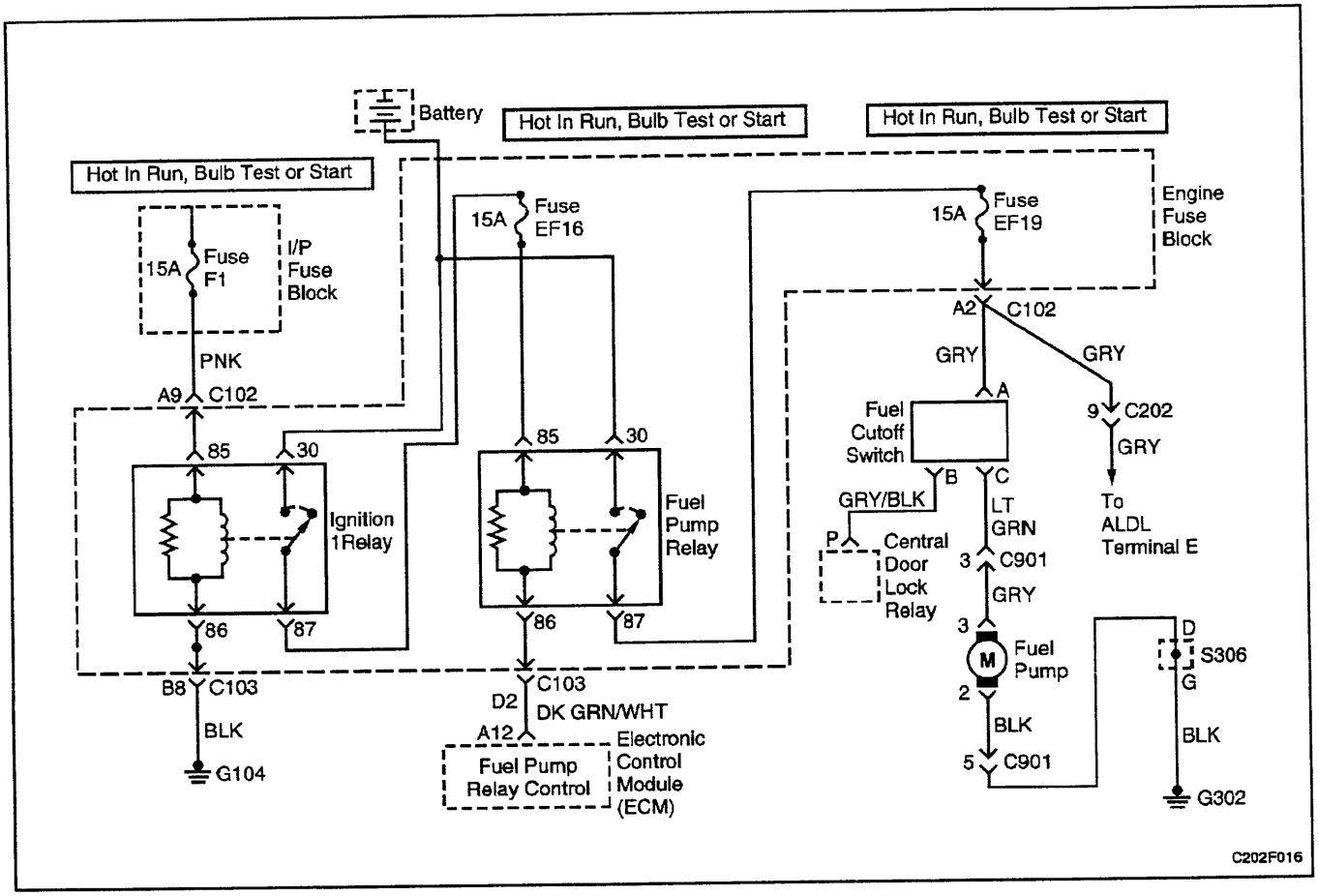

FUEL PUMP RELAY CIRCUIT CHECK

Circuit Description

When the ignition switch is turned ON, the electronic control module (ECM) will activate the fuel pump relay and run the in-tank fuel pump. The fuel pump will operate as long as the engine is cranking or running and the ECM is receiving ignition reference pulses.

If there are no reference pulses, the ECM will shut off the fuel pump within 2 seconds after the ignition switch is turned ON.

Diagnostic Aids

An intermittent problem may be caused by a poor connection, rubbed through wire insulation, or a broken wire inside the insulation.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

3. This step checks for the electronic control module (ECM) providing a ground for the operation of the fuel pump relay.
7. By confirming that the wiring is OK using steps 2 through 6, it can be determined that the fuel pump relay is at fault.
8. If there is no voltage present at the fuel pump relay connector terminal 85, the problem is an open engine fuse block fuse EF16, an open in the wiring between the fuel pump relay and the ignition 1 relay, or a fault is present in the ignition 1 relay circuit.
9. After determining that there is no ground being provided by the ECM to the fuel pump relay, the fault is either the ECM or the wiring between the ECM and the fuel pump relay.

Fuel Pump Relay Circuit Check

Step	Action	Value(s)	Yes	No
1	1. Turn the ignition OFF for 10 seconds. 2. Turn the ignition ON. 3. Listen for in-tank fuel pump operation. Does the fuel pump operate for the time specified?	2 sec	System OK	Go to *Step 2*
2	1. Turn the ignition OFF. 2. Disconnect the fuel pump relay. 3. Connect a test light between the fuel pump relay connector terminal 85 and ground. 4. Turn the ignition ON. Is the test light on?	-	Go to *Step 3*	Go to *Step 8*
3	1. Turn the ignition OFF. 2. Connect a test light between the fuel pump relay connector terminal 86 and battery positive. 3. Turn the ignition ON. 4. With the ignition ON, the test light should light for the time specified. Is the test light on?	2 sec	Go to *Step 4*	Go to *Step 9*
4	1. Turn the ignition OFF. 2. Connect a test light between the fuel pump relay connector terminal 30 and ground. Is the test light on?	-	Go to *Step 5*	Go to *Step 11*
5	Check for an open or short to ground in the wire between the fuel pump relay connector terminal 87 and the fuel pump connector terminal 3. Is the problem found?	-	Go to *Step 6*	Go to *Step 7*
6	1. Repair the wire between the fuel pump relay connector terminal 87 and the fuel pump connector terminal 3. 2. Install the fuel pump relay. 3. Turn the ignition OFF for 10 seconds. 4. Turn the ignition ON. Does the fuel pump operate for the time specified?	2 sec	System OK	-
7	1. Replace the fuel pump relay. 2. Turn the ignition OFF for 10 seconds. 3. Turn the ignition ON. Does the fuel pump operate for the time specified?	2 sec	System OK	-
8	Check for an open wire between the fuel pump relay connector terminal 85 and the ignition 1 relay connector terminal 87. Is the problem found?	-	Go to *Step 13*	Go to "Ignition 1 Relay Circuit Check"
9	Check for an open wire between the fuel pump relay connector terminal 86 to the ECM connector terminal A12. Is the problem found?	-	Go to *Step 10*	Go to *Step 12*
10	1. Repair the wire between the fuel pump relay connector terminal 86 to the ECM connector terminal A12. 2. Install the fuel pump relay. 3. Turn the ignition OFF for 10 seconds. 4. Turn the ignition ON. Does the fuel pump operate for the time specified?	2 sec	System OK	-

Fuel Pump Relay Circuit Check (Cont'd)

Step	Action	Value(s)	Yes	No
11	1. Repair the wire between the fuel pump relay connector terminal 30 and the battery. 2. Install the fuel pump relay. 3. Turn the ignition OFF for 10 seconds. 4. Turn the ignition ON. Does the fuel pump operate for the time specified?	2 sec	System OK	-
12	1. Replace the electronic control module. 2. Turn the ignition OFF for 10 seconds. 3. Turn the ignition ON. Does the fuel pump operate for the time specified?	2 sec	System OK	-
13	Repair the wire between the fuel pump relay connector terminal 85 and the battery. Is the repair complete?	-	System OK	-

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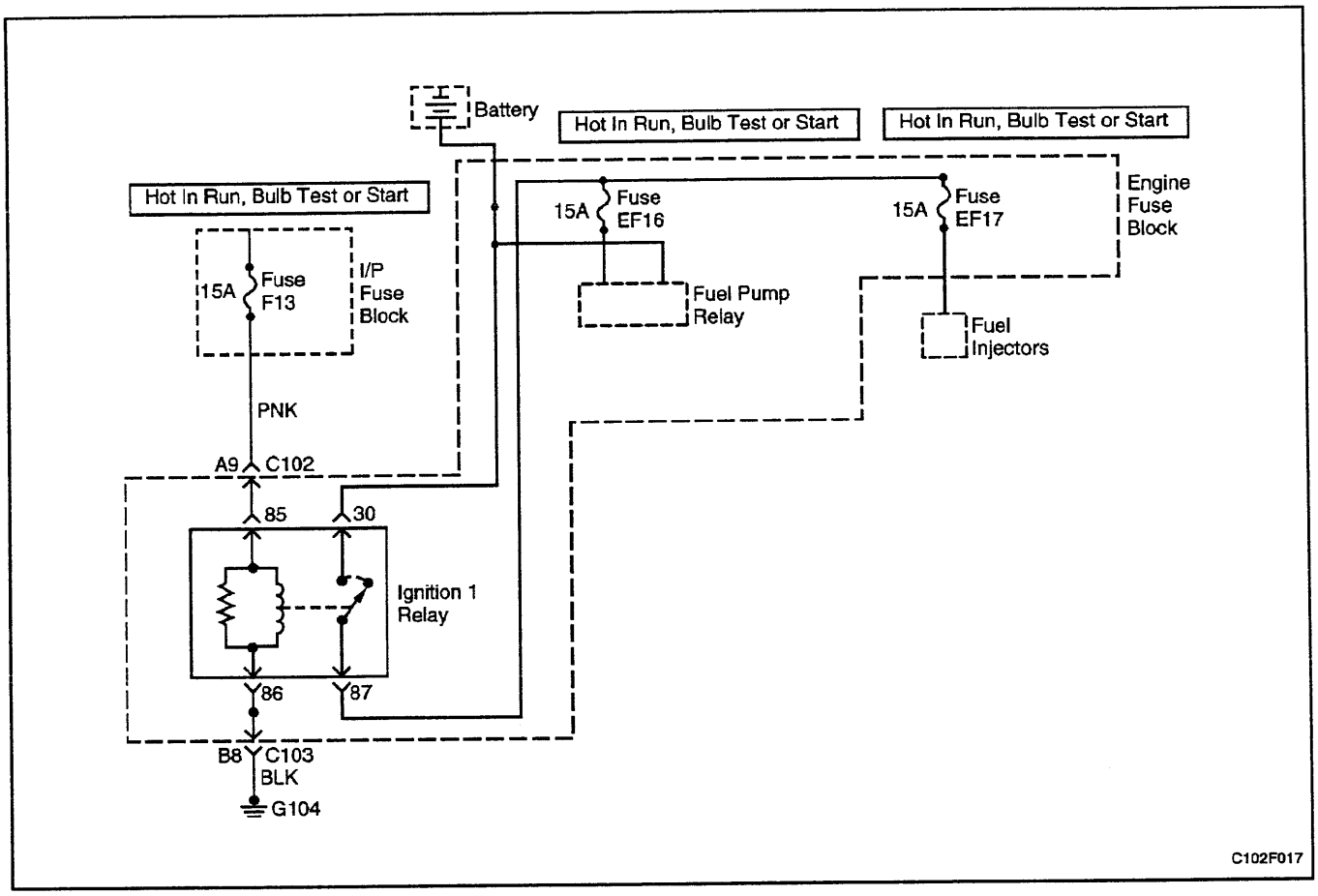


IGNITION 1 RELAY CIRCUIT CHECK

Circuit Description

When the ignition is turned ON or to the START position, the ignition 1 relay is energized. The ignition 1 relay then supplies voltage to the engine fuse box fuse EF16 and the engine fuse box fuse EF17. The direct ignition system ignition coil, the fuel pump relay (coil side), and the controlled canister purge solenoid are supplied voltage through the engine fuse box fuse EF16. The fuel injectors are supplied voltage through the engine fuse box fuse EF17.

Diagnostic Aids

- An intermittent problem may be caused by a poor connection, rubbed through wire insulation, or a broken wire inside the insulation.
- A faulty ignition 1 relay will cause a no start condition. There will be no voltage supplied to the direct ignition system ignition coil, the fuel pump relay (coil side), or the fuel injectors. Without voltage supplied to these components, they will not operate.

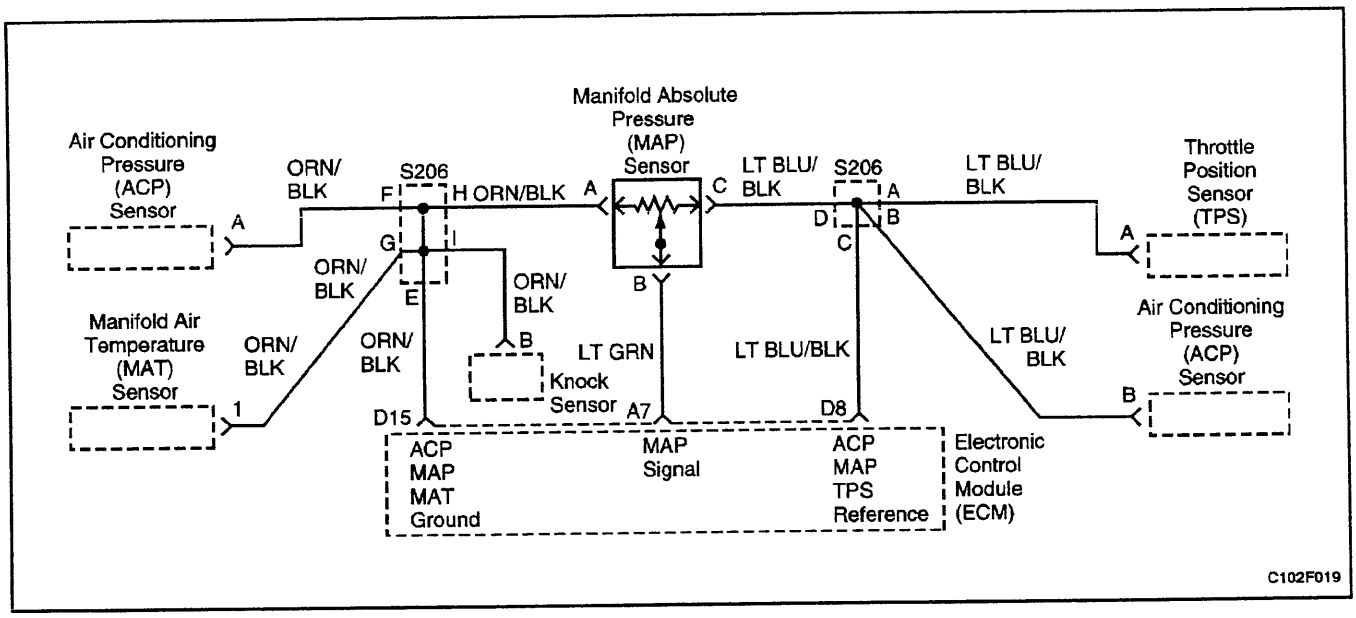
Test Description

The number(s) below refer to specific step(s) on the diagnostic table.

1. If the test light is on at both of the fuse terminals, the ignition 1 relay is OK.
5. This step, along with steps 6, 7, and 8, checks for correct voltage and ground to the ignition 1 relay terminals.
14. After confirming correct voltage and ground to the ignition 1 relay terminals, it can be determined that the ignition 1 relay is faulty.

Ignition 1 Relay Circuit Check

Step	Action	Value(s)	Yes	No
1	1. Turn the ignition OFF. 2. Disconnect the engine fuse block fuses EF16 and EF17. 3. Turn the ignition ON. 4. With a test light connected to ground, probe the fuse terminals nearest the ignition 1 relay for fuses EF16 and EF17. Is the test light on at both terminals?	-	System OK	Go to *Step 2*
2	Check the test light. Is the test light on at only one terminal?	-	Go to *Step 9*	Go to *Step 3*
3	Check the test light. Is the test light off at both terminals?	-	Go to *Step 4*	-
4	1. Turn the ignition OFF. 2. Inspect the instrument panel fuse block fuse F13. Is the fuse OK?	-	Go to *Step 5*	Go to *Step 10*
5	1. Disconnect the ignition 1 relay. 2. Connect a test light between the ignition 1 relay connector terminal 85 and ground. 3. Turn the ignition ON. Is the test light on?	-	Go to *Step 6*	Go to *Step 11*
6	Connect a test light between the ignition 1 relay connector terminal 86 and battery voltage. Is the test light on?	-	Go to *Step 7*	Go to *Step 12*
7	Connect a test light between the ignition 1 relay connector terminal 30 and ground. Is the test light on?	-	Go to *Step 8*	Go to *Step 13*
8	Check for an open in the wiring between the ignition 1 relay connector terminal 87 and the engine fuse block terminals for fuses EF16 and EF17. Is the problem found?	-	Go to *Step 9*	Go to *Step 14*
9	Repair the open in the wiring between the ignition 1 relay connector terminal 87 and the engine fuse block terminal(s) for fuses EF16 and/or EF17. Is the repair complete?	-	System OK	-
10	Replace the instrument panel fuse block fuse F13. Is the repair complete?	-	System OK	-
11	Repair the open in the wiring between the ignition 1 relay connector terminal 85 and the ignition switch. Is the repair complete?	-	System OK	-
12	Repair the open in the wiring between the ignition 1 relay connector terminal 86 and ground. Is the repair complete?	-	System OK	-
13	Repair the open in the wiring between the ignition 1 relay connector terminal 30 and the battery. Is the repair complete?	-	System OK	-
14	Replace the ignition 1 relay. Is the repair complete?	-	System OK	-



MANIFOLD ABSOLUTE PRESSURE CHECK

Circuit Description

The manifold absolute pressure (MAP) sensor measures the changes in the intake manifold pressure which result from engine load (intake manifold vacuum) and rpm changes. The MAP sensor converts these changes into a voltage output. The electronic control module (ECM) sends a 5-volt reference voltage to the MAP sensor. As the intake manifold pressure changes, the output voltage of the MAP sensor also changes. A low voltage (high vacuum) output of 1 to 2 volts is present at idle. A high voltage (low vacuum) output of 4.0 to 4.8 volts is present at wide open throttle. The MAP sensor is also used under certain conditions to measure barometric pressure. This allows the ECM to make adjustments for altitude changes. The ECM uses the MAP sensor for fuel delivery and ignition timing changes.

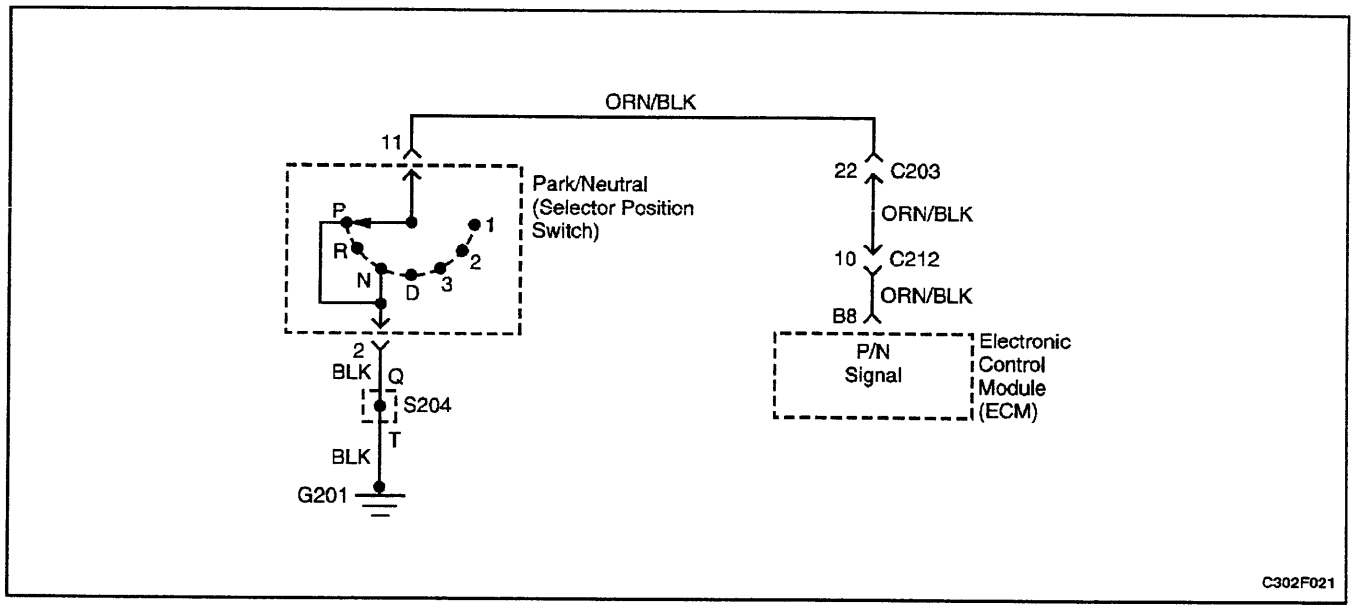
Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. Applying 34 kPa (10 inches Hg) of vacuum to the manifold absolute pressure (MAP) sensor should cause the voltage to change. Subtract the second voltage reading from the first. That voltage value should be more than 1.5 volts. When applying vacuum to the MAP sensor, the change in the voltage should happen instantly. A slow voltage change indicates a faulty MAP sensor.
3. Disconnect the MAP sensor from the bracket and twist the MAP sensor. Output changes more than 0.1 volt indicate a faulty connector or connection.

Manifold Absolute Pressure Check

Step	Action	Value(s)	Yes	No
1	1. Turn the ignition OFF. 2. Connect a scan tool to the assembly line diagnostic link (ALDL). 3. Turn the ignition ON. 4. Compare the manifold absolute pressure (MAP) sensor voltage reading from the scanner with that from a known good vehicle. Is the difference in the two voltage readings less than the value specified?	0.4 v	Go to *Step 2*	Go to *Step 5*
2	1. Turn the ignition OFF. 2. Connect a scan tool to the ALDL. 3. Disconnect the MAP sensor vacuum line. 4. Connect a hand vacuum pump to the MAP sensor. 5. Turn the ignition ON. 6. Note the MAP sensor voltage. 7. Apply 34 kPa (10 in. Hg) of vacuum to the MAP sensor and note the voltage change. Is the difference in voltage readings more than the value specified?	1.5 v	System OK	Go to *Step 3*
3	Inspect the MAP sensor connector terminals. Is the problem found?	-	Go to *Step 4*	Go to *Step 5*
4	Repair the MAP sensor connector terminals as needed. Is the repair complete?	-	System OK	-
5	Replace the manifold absolute pressure sensor. Is the repair complete?	-	System OK	-



PARK/NEUTRAL SWITCH

Circuit Description

The park/neutral (P/N) switch contacts are a part of the selector position switch. The contacts are closed to ground in park and neutral and open in the drive ranges.

The electronic control module (ECM) supplies ignition voltage through a current limiting resistor to the signal wire and senses a closed switch when the voltage on the signal wire drops to less than 1 volt. The ECM uses the P/N signal as one of the inputs to control idle air and spark timing.

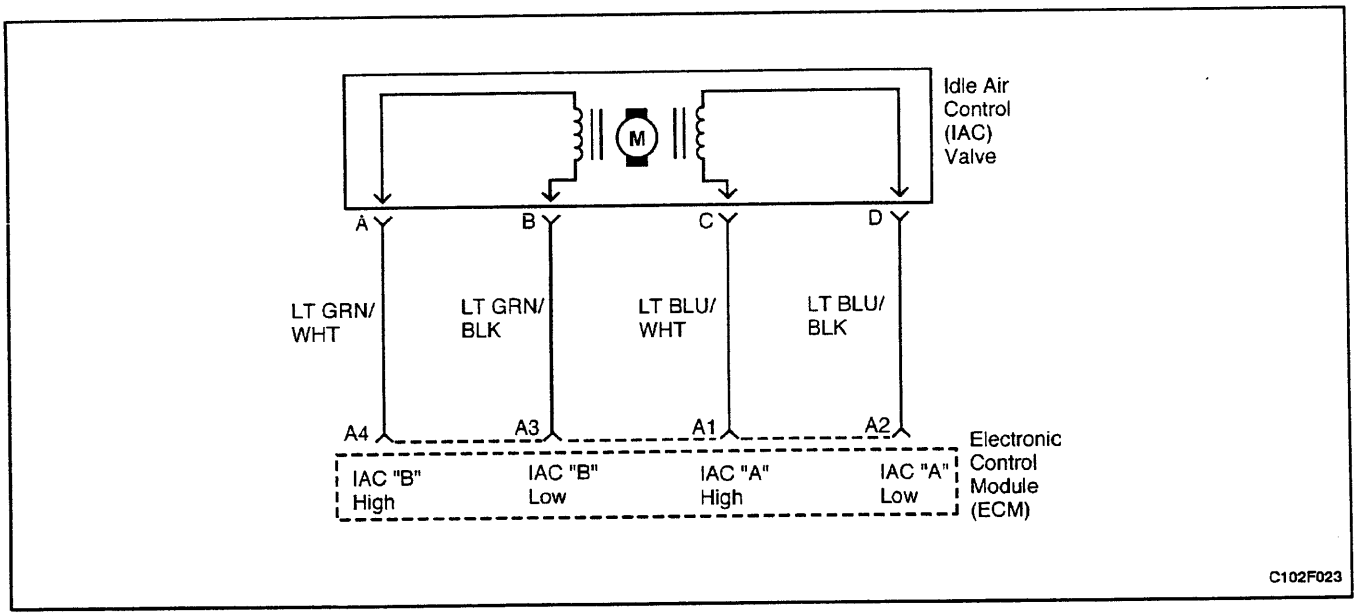
Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. Checks for the park/neutral (P/N) switch closed to ground in the park position. Different makes of scan tools will read park/neutral differently. Refer to the tool operations manual for the type of display used.
2. Checks for an open P/N switch in the drive range.

Park/Neutral Switch

Step	Action	Value(s)	Yes	No
1	1. Connect a scan tool to the assembly line diagnostic link (ALDL). 2. Place the transaxle in P (Park). 3. Turn the ignition ON. Does the scan tool indicate park or neutral?	-	Go to *Step 2*	Go to *Step 10*
2	Place the transaxle in D (Drive). Does the scan tool indicate drive?	-	System OK	Go to *Step 3*
3	Disconnect the park/neutral (P/N) switch. Does the scan tool indicate drive?	-	Go to *Step 4*	Go to *Step 7*
4	Check the P/N switch adjustment. Is the problem found?	-	Go to *Step 5*	Go to *Step 6*
5	Adjust the P/N switch. Is the repair complete?	-	System OK	-
6	Replace the P/N switch. Is the repair complete?	-	System OK	-
7	Check for an open or short to ground in the wire between the P/N switch connector terminal 11 and the ECM connector terminal B9. Is the problem found?	-	Go to *Step 8*	Go to *Step 9*
8	Repair the open or short to ground in the wire between the P/N switch connector terminal 11 and the ECM connector terminal B9. Is the repair complete?	-	System OK	-
9	Replace the electronic control module. Is the repair complete?	-	System OK	-
10	1. Disconnect the P/N switch. 2. Jumper the P/N switch connector terminals 11 and 2. 3. Turn the ignition ON. Does the scan tool indicate park?	-	Go to *Step 4*	Go to *Step 11*
11	Jumper the P/N switch connector terminal 11 to ground. Does the scan tool indicate park?	-	Go to *Step 12*	Go to *Step 7*
12	Repair the open wire between the P/N switch connector terminal 2 and ground. Is the repair complete?	-	System OK	-



IDLE AIR CONTROL SYSTEM CHECK

Circuit Description

The electronic control module (ECM) controls the engine idle speed with the idle air control (IAC) valve. To increase the idle speed, the ECM pulls the IAC pintle away from its seat, allowing more air to pass by the throttle bore. To decrease the idle speed, it extends the IAC valve pintle toward its seat, reducing bypass air flow. A scan tool will read the ECM commands to the IAC valve in counts. The higher counts indicate more air bypass (higher idle). The lower counts indicate less air is allowed to bypass (lower idle).

Diagnostic Aids

If the idle is too high, stop the engine. Fully extend the idle air control (IAC) valve with a IAC tester. Start the engine. If the idle speed is above 800 rpm, locate and repair the vacuum leak. Also, check for a binding throttle plate or throttle linkage or an incorrect base idle setting.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. The idle air control (IAC) valve is extended and retracted by the IAC driver. IAC valve movement is verified by an engine speed change. If no change in engine speed occurs, the valve can be removed from the throttle body and tested. Connect the IAC driver to the removed IAC valve and turn the ignition ON. Do not start the engine.
5. This step checks the quality of the IAC valve movement in step 2. Fully extending the IAC valve may cause an engine stall. This may be normal.
6. Steps 2 and 5 verify proper IAC valve operation. This step checks the IAC circuit for a wiring or electronic control module (ECM) fault.

Idle Air Control Valve Reset Procedure

Whenever the battery cable or the electronic control module (ECM) connector or the ECM fuse EF22 is disconnected or replaced, the following idle learn procedure must be performed:

1. Turn the ignition ON for 5 seconds.
2. Turn the ignition OFF for 5 seconds.
3. Turn the ignition ON for 5 seconds.
4. Start the engine in park/neutral.
5. Allow the engine to run until the engine coolant is above 85°C (185°F).
6. Turn the A/C ON for 10 seconds, if equipped.
7. Turn the A/C OFF for 10 seconds, if equipped.
8. If the vehicle is equipped with an automatic transaxle, apply the parking brake. While depressing the brake pedal, place the transaxle in D (drive).
9. Turn the A/C ON for 10 seconds, if equipped.
10. Turn the A/C OFF for 10 seconds, if equipped.
11. Turn the ignition OFF. The idle learn procedure is complete.

Idle Air Control System Check

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Turn the ignition OFF. 2. Connect the idle air control driver to the idle air control (IAC) valve. 3. Connect a scan tool to the assembly line diagnostic link (ALDL). 4. Start the engine. 5. With the IAC driver, extend and retract the IAC valve. Engine rpm should increase and decrease as the IAC valve is cycled. Does the engine rpm change?	-	Go to *Step 5*	Go to *Step 3*
3	1. Remove the IAC valve. 2. Inspect the IAC passages for restrictions. Is the problem found?	-	Go to *Step 4*	Go to *Step 19*
4	Clean the IAC passages. Is the repair complete?	-	System OK	-
5	1. Turn the ignition OFF. 2. Start the engine. 3. Using the IAC driver, extend and retract the IAC valve. Engine rpm should increase and decrease as the IAC valve is cycled. Does the rpm change smoothly within the value specified with each flash of the IAC driver?	700-1500 rpm	Go to *Step 6*	Go to *Step 3*
6	1. Turn the ignition OFF. 2. Connect the IAC driver to the IAC valve. 3. Install an IAC node light to the IAC valve connector. 4. Start the engine. 5. Cycle the IAC driver. 6. Watch the node lights of the IAC driver. Do both lights cycle red and green but never off as the rpm is changed?	-	Go to *Step 7*	Go to *Step 9*
7	1. Measure the resistance of the IAC valve between terminals A and B. 2. Measure the resistance of the IAC valve between terminals C and D. Does the resistance measure within the value specified?	40-80 Ω	Go to *Step 8*	Go to *Step 19*
8	1. Measure the resistance of the IAC valve between terminals B and C. 2. Measure the resistance of the IAC valve between terminals A and D. Does the ohmmeter show the specified value?	∞	Go to "Diagnostic Aids"	Go to *Step 19*
9	Inspect the IAC connector terminals. Is the problem found?	-	Go to *Step 10*	Go to *Step 11*
10	Repair or replace the IAC connector terminals as needed. Is the repair complete?	-	System OK	-

Idle Air Control System Check (Cont'd)

Step	Action	Value(s)	Yes	No
11	Check for an open or short in the wire between the IAC connector terminal A and the electronic control module (ECM) connector terminal A4. Is the problem found?	-	Go to *Step 15*	Go to *Step 12*
12	Check for an open or short in the wire between the IAC connector terminal B and the electronic control module (ECM) connector terminal A3. Is the problem found?	-	Go to *Step 15*	Go to *Step 13*
13	Check for an open or short in the wire between the IAC connector terminal C and the electronic control module (ECM) connector terminal A1. Is the problem found?	-	Go to *Step 15*	Go to *Step 14*
14	Check for an open or short in the wire between the IAC connector terminal D and the electronic control module (ECM) connector terminal A2. Is the problem found?	-	Go to *Step 15*	Go to *Step 16*
15	Repair the wire as needed. Is the repair complete?	-	System OK	-
16	Inspect the ECM connector terminals. Is the problem found?	-	Go to *Step 17*	Go to *Step 18*
17	Repair the ECM connector terminals as needed. Is the repair complete?	-	System OK	-
18	Replace the electronic control module. Is the repair complete?	-	System OK	-
19	Replace the idle air control valve. Is the repair complete?	-	System OK	-

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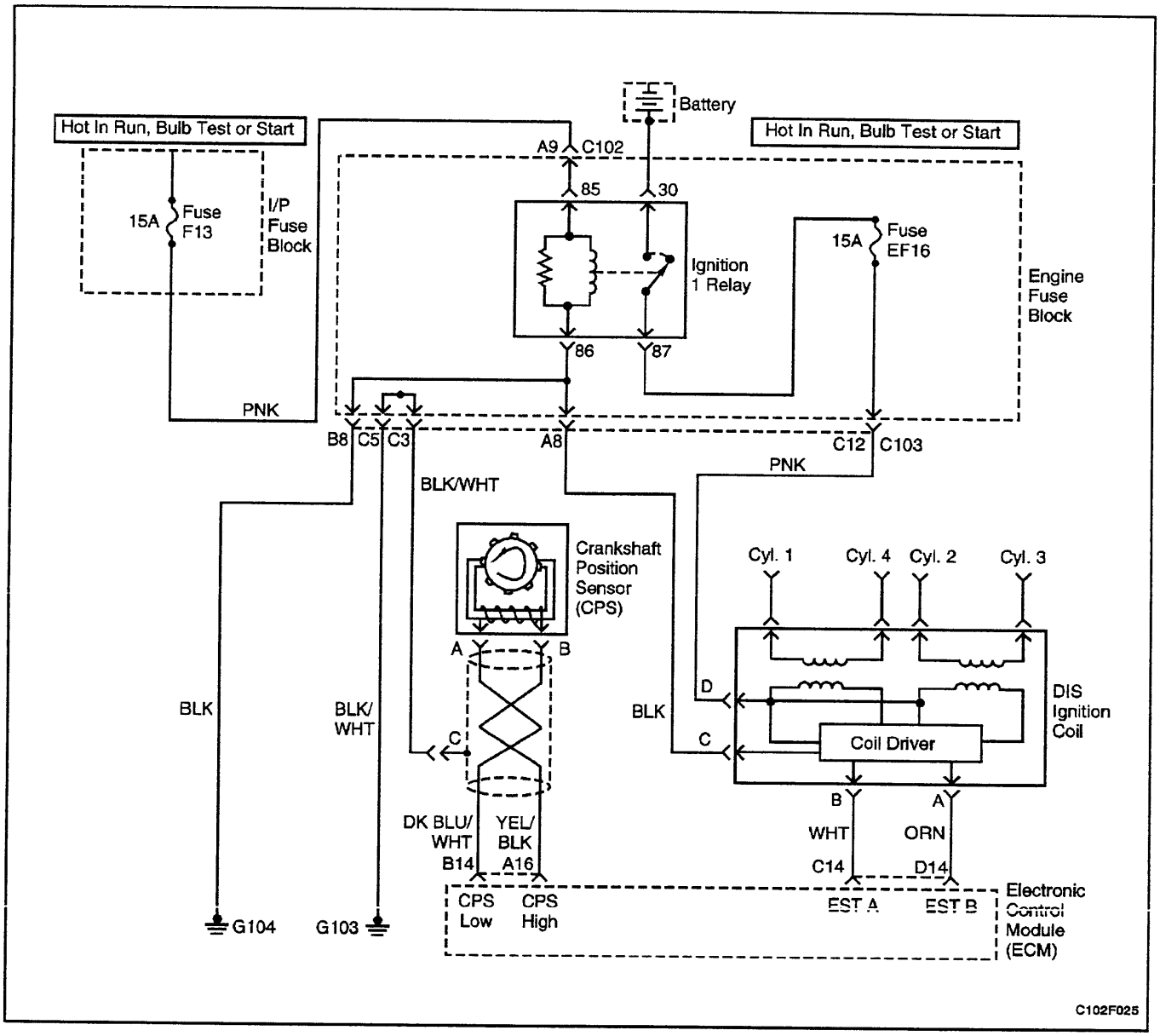


IGNITION SYSTEM CHECK

Circuit Description

The direct ignition system (DIS) uses a waste spark method of spark distribution. In this type of DIS system, the crankshaft position sensor (CPS) is mounted to the oil pump near a slotted wheel that is a part of the crankshaft pulley. The CPS sends reference pulses to the electronic control module (ECM). The ECM then triggers the DIS ignition coil. Once the ECM triggers the DIS ignition coil, both of the connected spark plugs fire at the same time. One cylinder is on its compression stroke at the same time that the other is on the exhaust stroke, resulting in lower energy needed to fire the spark plug in the cylinder on its exhaust stroke. This leaves the remainder of the high voltage to be used to fire the spark plug in the cylinder on its compression stroke. Since the CPS is in a fixed position, timing adjustments are not possible or needed.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. It is important to check for the presence of spark to all of the cylinders to isolate the problem to either direct ignition system (DIS) ignition coil inputs or outputs.

5. In checking the electronic control module (ECM) outputs for the electronic spark timing signal, it recommended to use an oscilloscope to view the varying voltage signals. In measuring these outputs with a voltmeter, intermittent errors may occur that cannot be seen by a voltmeter.
6. After confirming ECM inputs for the electronic spark timing to the DIS ignition coil are OK, it can be determined that a faulty DIS ignition coil is at fault.
11. After confirming proper crankshaft position sensor inputs to the ECM and no wiring problems present, it can be determined that the ECM is at fault.
24. This step, along with step 25, checks for battery voltage and a ground to the DIS ignition coil.
26. If the wiring between the DIS ignition coil and the ignition 1 relay connector terminal 87 is OK, the problem is in the ignition 1 relay circuit.

Ignition System Check

Caution: Use only electrically insulated pliers when handling ignition wires with the engine running to prevent an electrical shock.

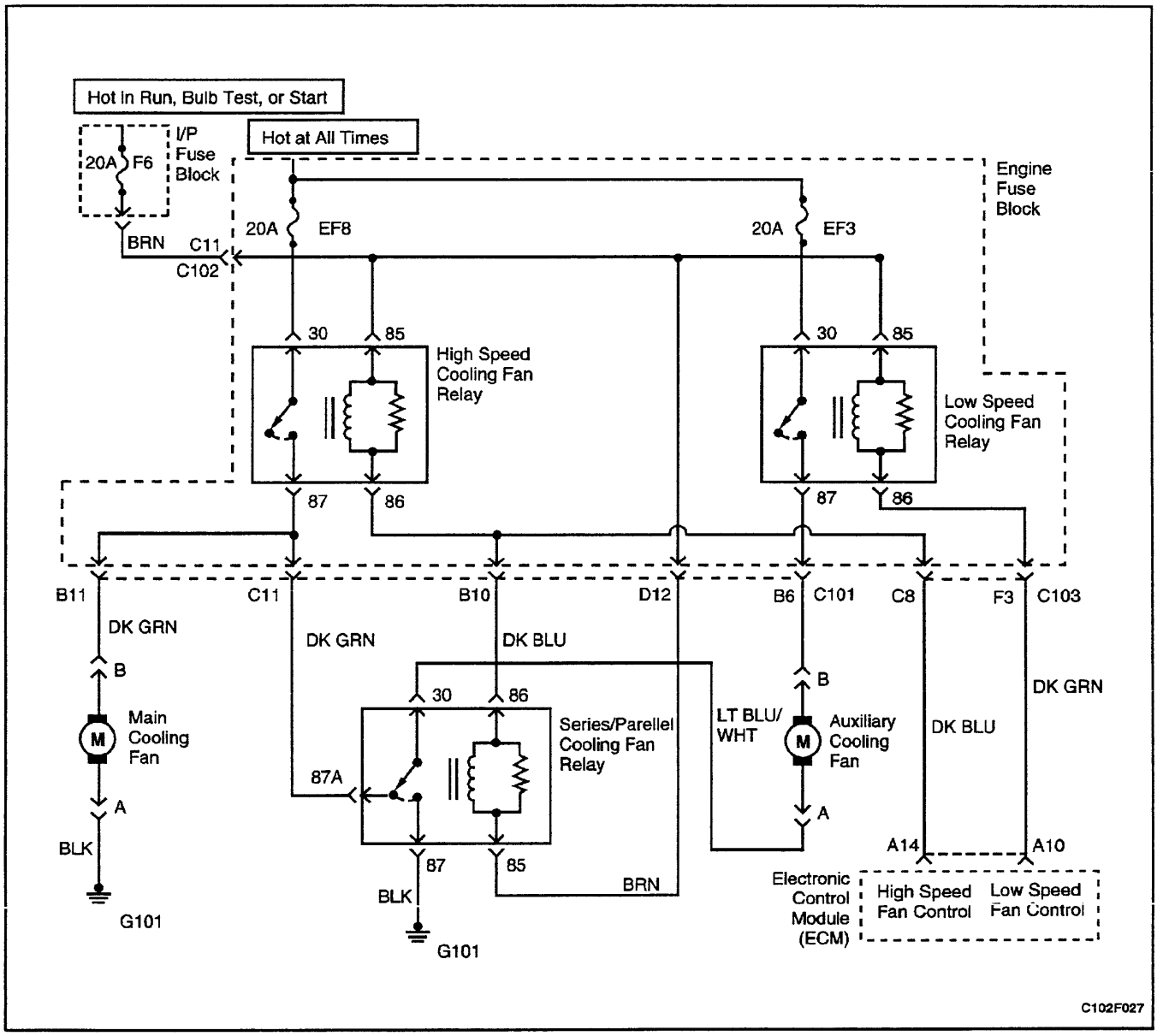
Step	Action	Value(s)	Yes	No
1	1. Remove the spark plugs. 2. Inspect for wet spark plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. 3. Replace the spark plugs as needed. Is the repair complete?	-	System OK	Go to *Step 2*
2	Check for the presence of spark from all of the ignition wires while cranking the engine. Is spark present from all of the ignition wires?	-	System OK	Go to *Step 3*
3	1. Measure the resistance of the ignition wires. 2. Replace any ignition wire(s) with a resistance above the value specified. 3. Check for the presence of spark from all of the ignition wires. Is spark present from all of the ignition wires?	30,000 Ω	System OK	Go to *Step 4*
4	Is spark present from at least one of the ignition wires, but not all of the ignition wires?	-	Go to *Step 5*	Go to *Step 12*
5	1. Turn the ignition OFF. 2. Disconnect the direct ignition system (DIS) ignition coil connector. 3. While cranking the engine, measure the voltage at the DIS ignition coil connector terminal B. Does the voltage fluctuate within the values specified?	0.2-2.0 v	Go to *Step 6*	Go to *Step 7*
6	While cranking the engine, measure the voltage at the DIS ignition coil connector terminal A. Does the voltage fluctuate within the values specified?	0.2-2.0 v	Go to *Step 10*	Go to *Step 8*
7	Check for an open in the wire from the DIS ignition coil connector terminal B to the electronic control module (ECM) connector terminal C14. Is the problem found?	-	Go to *Step 9*	Go to *Step 11*
8	Check for an open in the wire from the DIS ignition coil connector terminal A to the ECM connector terminal D14. Is the problem found?	-	Go to *Step 9*	Go to *Step 11*

Ignition System Check (Cont'd)

Step	Action	Value(s)	Yes	No
9	1. Repair the wiring as needed. 2. Connect the DIS ignition coil connector. 3. Check for the presence of spark from all of the ignition wires. Is spark present from all of the ignition wires?	-	System OK	-
10	1. Replace the direct ignition system ignition coil. 2. Connect the DIS ignition coil connector. 3. Check for the presence of spark from all of the ignition wires. Is spark present from all of the ignition wires?	-	System OK	-
11	1. Replace the electronic control module. 2. Connect the DIS ignition coil connector. 3. Check for the presence of spark from all of the ignition wires. Is spark present from all of the ignition wires?	-	System OK	-
12	1. Turn the ignition OFF. 2. Disconnect the crankshaft position sensor (CPS) connector. 3. Measure the resistance between the CPS terminals A and B. Is the resistance within the value specified?	400-600 Ω	Go to *Step 13*	Go to *Step 28*
13	1. Measure the resistance between the CPS terminals A and C. 2. Measure the resistance between the CPS terminals B and C. Is the resistance infinite (open circuit)?	-	Go to *Step 14*	Go to *Step 28*
14	1. Turn the ignition ON. 2. Measure the voltage between the CPS connector terminals A and C. Is the voltage within the value specified?	0.95-1.10 v	Go to *Step 20*	Go to *Step 15*
15	Measure the voltage between the CPS connector terminal A and ground. Is the voltage within the value specified?	0.95-1.10 v	Go to *Step 17*	Go to *Step 16*
16	Check the wire between the CPS connector terminal A and the ECM connector terminal B14 for an open or short. Is the problem found?	-	Go to *Step 18*	Go to *Step 11*
17	Check the wire between the CPS connector terminal C and ground for an open or short. Is the problem found?	-	Go to *Step 19*	Go to *Step 11*
18	Repair the wire between the CPS connector terminal A and the ECM connector terminal B14. Is the repair complete?	-	System OK	-
19	Repair the wire between the CPS connector terminal C and ground. Is the repair complete?	-	System OK	-
20	1. Turn the ignition ON. 2. Measure the voltage between the CPS connector terminals B and C. Is the voltage within the value specified?	0.95-1.10 v	Go to *Step 24*	Go to *Step 21*

Ignition System Check (Cont'd)

Step	Action	Value(s)	Yes	No
21	Measure the voltage between the CPS connector terminal B and ground. Is the voltage within the value specified?	0.95-1.10 v	Go to *Step 17*	Go to *Step 22*
22	Check the wire between the CPS connector terminal B and the ECM connector terminal A16 for an open or short. Is the problem found?	-	Go to *Step 23*	Go to *Step 11*
23	Repair the wire between the CPS connector terminal B and the ECM connector terminal A16. Is the repair complete?	-	System OK	-
24	1. Turn the ignition OFF. 2. Connect a test light between the DIS ignition coil connector terminal D and ground. 3. Turn the ignition ON. Is the test light on?	-	Go to *Step 25*	Go to *Step 26*
25	Connect a test light between the DIS ignition coil connector terminal C and battery positive. Is the test light on?	-	Go to *Step 5*	Go to *Step 27*
26	Check for an open in the wiring between the DIS ignition coil connector, terminal D and the ignition 1 relay connector terminal 87. Is the problem found?	-	Go to *Step 29*	Go to "Ignition 1 Relay Circuit Check"
27	Repair the wire between the DIS ignition coil connector terminal C and ground. Is the repair complete?	-	System OK	-
28	Replace the crankshaft position sensor. Is the repair complete?	-	System OK	-
29	Repair the open in the wiring between the DIS ignition coil connector terminal D and the ignition 1 relay connector terminal 87. Is the repair complete?	-	System OK	-



ENGINE COOLING FAN CIRCUIT CHECK - WITH A/C

Circuit Description

The engine cooling fan circuit operates the main cooling fan and the auxiliary cooling fan. The cooling fans are controlled by the electronic control module (ECM) based on inputs from the coolant temperature sensor (CTS) and the air conditioning pressure (ACP) sensor. The ECM controls the low speed cooling fan operation by internally grounding the ECM connector terminal A10. This energizes the low speed cooling fan relay and operates the main cooling fan and the auxiliary cooling fan at low speed as the cooling fans are connected in a series circuit. The ECM controls the high speed cooling fan operation by internally grounding the ECM connector terminal A10 and the ECM connector terminal A14 at the same time. This energizes the low speed cooling fan relay, the high speed cooling fan relay, and the series/parallel cooling fan relay resulting in high speed fan operation as the cooling fans are now connected in a parallel circuit.

Diagnostic Aids

- If the owner complained of an overheating problem, it must be determined if the complaint was due to an actual boil over, or the engine coolant temperature gauge indicated overheating. If the engine is overheating and the cooling fans are on, the cooling system should be checked.

- If the engine fuse block fuses EF3 or EF8 become open (blown) immediately after installation, inspect for a short to ground in the wiring of the appropriate circuit. If the fuses become open (blown) when the cooling fans are to be turned on by the electronic control module (ECM), suspect a faulty cooling fan motor.
- The ECM will turn the cooling fans on at low speed when the coolant temperature is 93°C (199°F). The ECM will turn the cooling fans off when the coolant temperature is 90°C (194°F).
- The ECM will turn the cooling fans on at high speed when the coolant temperature is 97°C (207°F). The ECM will change the cooling fans from high speed to low speed when the coolant temperature is 94°C (201°F).
- The ECM will turn the cooling fans on at low speed when the A/C system is on. The ECM will change the cooling fans from low speed to high speed when the high side A/C pressure is 1 859 kPa (270 psi) then return to low speed when the high side A/C pressure is 1 449 kPa (210 psi).
- The cooling fan circuit can be checked quickly by disconnecting the ECM red connector and grounding the connector terminal A10. This should create low speed cooling fan operation with the ignition ON. By grounding the ECM connector terminals A10 and A14 and turning the ignition ON, high speed cooling fan operation should be achieved.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

4. This step, along with step 5, checks for the ability of the electronic control module (ECM) to operate the cooling fans.
8. This step, along with step 9, checks for the ability of the ECM to operate the cooling fans in response to A/C pressure readings.
16. After confirming battery voltage and the ECM supplying a ground to the coil side of the low speed cooling fan relay, by jumpering connector terminals 30 and 87 it will be determined if the relay is at fault or a wiring problem is present.
31. This step checks for the presence of battery voltage to the main cooling fan when the A/C is on. If battery voltage is present and the cooling fans are not operating, the problem is in the ground side of the cooling fan circuit.
37. By directly grounding the ECM connector terminals A10 and A14, the main and auxiliary cooling fans should run at high speed.

Engine Cooling Fan Circuit Check - With A/C

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Check the engine fuse block fuse EF3. 2. Replace the fuse as needed. Is the fuse OK?	-	Go to *Step 3*	Go to "Diagnostic Aids"
3	1. Check the engine fuse block fuse EF8. 2. Replace the fuse as needed. Is the fuse OK?	-	Go to *Step 4*	Go to "Diagnostic Aids"
4	1. Turn the ignition OFF. 2. Turn the A/C switch OFF. 3. Connect a scan tool to the assembly line diagnostic link (ALDL). 4. Start the engine. 5. The cooling fans should run at low speed when the coolant temperature reaches 93°C (199°F). Do the cooling fans run at low speed?	-	Go to *Step 5*	Go to *Step 10*

Engine Cooling Fan Circuit Check - With A/C (Cont'd)

Step	Action	Value(s)	Yes	No
5	1. Turn the ignition OFF. 2. Turn the A/C switch OFF. 3. Connect a scan tool to the ALDL. 4. Start the engine. 5. The cooling fans should run at high speed when the coolant temperature reaches 97°C (207°F). Do the cooling fans run at high speed?	-	Go to *Step 6*	Go to *Step 33*
6	1. Turn the ignition OFF. 2. Start the engine. 3. Turn the A/C switch ON. Does the A/C compressor clutch engage?	-	Go to *Step 8*	Go to *Step 7*
7	1. Diagnose the A/C compressor clutch circuit. 2. Repair the A/C compressor clutch circuit as needed. 3. Start the engine. 4. Turn the A/C switch ON. Does the A/C compressor clutch engage?	-	Go to *Step 8*	-
8	Do the cooling fans run at low speed?	-	Go to *Step 9*	Go to *Step 31*
9	1. Turn the ignition OFF. 2. Connect the A/C pressure gauges. 3. Start the engine. 4. Turn the A/C switch ON. 5. The cooling fans should run at high speed when the high side A/C pressure reaches 1 859 kPa (270 psi). Do the cooling fans run at high speed?	-	System OK	-
10	1. Turn the ignition OFF. 2. Connect a scan tool to the ALDL. 3. The coolant temperature should be above 93°C (199°F). 4. Disconnect the auxiliary cooling fan connector. 5. Turn the ignition ON. 6. Connect a test light between the auxiliary cooling fan connector terminal B and ground. Is the test light on?	-	Go to *Step 11*	Go to *Step 12*
11	1. Turn the ignition OFF. 2. Connect a scan tool to the ALDL. 3. The coolant temperature should be above 93°C (199°F). 4. Disconnect the auxiliary cooling fan connector. 5. Connect a test light between the auxiliary cooling fan connector terminal A and battery positive. Is the test light on?	-	Go to *Step 28*	Go to *Step 17*
12	1. Turn the ignition OFF. 2. Disconnect the low speed cooling fan relay. 3. Connect a test light between the low speed cooling fan relay connector terminal 85 and ground. 4. Turn the ignition ON. Is the test light on?	-	Go to *Step 13*	Go to *Step 24*

Engine Cooling Fan Circuit Check - With A/C (Cont'd)

Step	Action	Value(s)	Yes	No
13	1. Turn the ignition OFF. 2. Connect the low speed cooling fan relay. 3. Disconnect the electronic control module (ECM) red connector. 4. Connect a fused jumper between the ECM connector terminal A10 and ground. 5. Turn the ignition ON. Do the cooling fans run at low speed?	-	Go to *Step 30*	Go to *Step 14*
14	Check for an open wire between the low speed cooling fan relay connector terminal 86 and the ECM connector terminal A10. Is the problem found?	-	Go to *Step 25*	Go to *Step 15*
15	1. Turn the ignition OFF. 2. Disconnect the low speed cooling fan relay. 3. Connect a test light between the low speed cooling fan relay connector terminal 30 and ground. Is the test light on?	-	Go to *Step 16*	Go to *Step 23*
16	Connect a fused jumper between the low speed cooling fan relay connector terminals 30 and 87. Do the cooling fans run at low speed?	-	Go to *Step 26*	Go to *Step 17*
17	1. Disconnect the series/parallel cooling fan relay. 2. Connect a fused jumper between the low speed cooling fan relay connector terminals 30 and 87. 3. Connect a fused jumper between the series/parallel cooling fan relay connector terminals 30 and 87. Do the cooling fans run at low speed?	-	Go to *Step 27*	Go to *Step 18*
18	Check the wire between the low speed cooling fan relay connector terminal 87 to the auxiliary cooling fan connector terminal B for an open. Is the problem found?	-	Go to *Step 22*	Go to *Step 19*
19	Check the wire between the auxiliary cooling fan connector terminal A and the series/parallel cooling fan relay connector terminal 30 for an open. Is the problem found?	-	Go to *Step 22*	Go to *Step 20*
20	Check the wire between the series/parallel cooling fan relay connector terminal 87 and the main cooling fan connector terminal B for an open. Is the problem found?	-	Go to *Step 22*	Go to *Step 21*
21	Check for an open wire between the main cooling fan connector terminal A and ground. Is the problem found?	-	Go to *Step 22*	Go to *Step 29*
22	Repair the open wire as needed. Is the repair complete?	-	System OK	-
23	Repair the open between the low speed cooling fan relay connector terminal 30 and the battery. Is the repair complete?	-	System OK	-
24	Repair the open between the low speed cooling fan relay connector terminal 85 and the ignition switch. Is the repair complete?	-	System OK	-

Engine Cooling Fan Circuit Check - With A/C (Cont'd)

Step	Action	Value(s)	Yes	No
25	Repair the open wire between the low speed cooling fan relay connector terminal 86 and the ECM connector terminal A10. Is the repair complete?	-	System OK	-
26	Replace the low speed cooling fan relay. Is the repair complete?	-	System OK	-
27	Replace the series/parallel cooling fan relay. Is the repair complete?	-	System OK	-
28	Replace the auxiliary cooling fan. Is the repair complete?	-	System OK	-
29	Replace the main cooling fan. Is the repair complete?	-	System OK	-
30	Replace the ECM. Is the repair complete?	-	System OK	-
31	1. Turn the ignition OFF. 2. Disconnect the auxiliary cooling fan connector. 3. Connect a test light between the main cooling fan connector terminal B and ground. 4. Turn the A/C switch ON. 5. Start the engine. Is the test light on?	-	Go to *Step 32*	Go to *Step 12*
32	1. Turn the ignition OFF. 2. Connect a test light between the auxiliary cooling fan connector terminal A and battery positive. 3. Turn the A/C switch ON. 4. Start the engine. Is the test light on?	-	Go to *Step 28*	Go to *Step 17*
33	1. Turn the ignition OFF. 2. Disconnect the high speed cooling fan relay. 3. Connect a test light between the high speed cooling fan relay connector terminal 85 and ground. 4. Turn the ignition ON. Is the test light on?	-	Go to *Step 34*	Go to *Step 44*
34	1. Turn the ignition OFF. 2. Connect a test light between the high speed cooling fan relay connector terminal 30 and ground. Is the test light on?	-	Go to *Step 35*	Go to *Step 45*
35	1. Disconnect the series/parallel cooling fan relay. 2. Connect a test light between the series/parallel cooling fan relay connector terminal 85 and ground. 3. Turn the ignition ON. Is the test light on?	-	Go to *Step 36*	Go to *Step 46*
36	1. Turn the ignition OFF. 2. Connect a test light between the series/parallel cooling fan relay connector terminal 87 and battery positive. Is the test light on?	-	Go to *Step 37*	Go to *Step 47*

Engine Cooling Fan Circuit Check - With A/C (Cont'd)

Step	Action	Value(s)	Yes	No
37	1. Connect the auxiliary cooling fan connector. 2. Connect the high speed cooling fan relay. 3. Connect the series/parallel cooling fan relay. 4. Disconnect the ECM red connector. 5. Connect a fused jumper between the ECM connector terminal A10 and ground. 6. Connect a fused jumper between the ECM connector terminal A14 and ground. 7. Turn the ignition ON. Do the cooling fans run at high speed?	-	Go to *Step 30*	Go to *Step 38*
38	1. Turn the ignition OFF. 2. Check for an open wire between the high speed cooling fan relay connector terminal 86 and the ECM connector terminal A14. Is the problem found?	-	Go to *Step 22*	Go to *Step 39*
39	1. Disconnect the high speed cooling fan relay. 2. Connect a test light between the high speed cooling fan relay connector terminal 87 and battery positive. Is the test light on?	-	Go to *Step 40*	Go to *Step 48*
40	1. Disconnect the ECM red connector. 2. Connect a fused jumper between the ECM connector terminal A14 and ground. 3. Disconnect the series/parallel cooling fan relay. 4. Connect a test light between the series/parallel cooling fan relay connector terminal 86 and battery positive. Is the test light on?	-	Go to *Step 41*	Go to *Step 49*
41	1. Connect the series/parallel cooling fan relay. 2. Connect a fused jumper between the ECM connector terminal A14 and ground. 3. Disconnect the high speed cooling fan relay. 4. Connect a fused jumper between the high speed cooling fan relay connector terminals 30 and 87. 5. Disconnect the low speed cooling fan relay. 6. Connect a fused jumper between the low speed cooling fan relay connector terminals 30 and 87. 7. Turn the ignition ON. Do the cooling fans run at high speed?	-	Go to *Step 43*	Go to *Step 42*
42	1. Turn the ignition OFF. 2. Connect a fused jumper between the ECM connector terminal A14 and ground. 3. Disconnect the series/parallel cooling fan relay. 4. Connect a fused jumper between the series/parallel cooling fan relay connector terminals 30 and 87. 5. Connect a fused jumper between the low speed cooling fan relay connector terminals 30 and 87. 6. Turn the ignition ON. Do the cooling fans run at high speed?	-	Go to *Step 27*	-

Engine Cooling Fan Circuit Check - With A/C (Cont'd)

Step	Action	Value(s)	Yes	No
43	Replace the high speed cooling fan relay. Is the repair complete?	-	System OK	-
44	Repair the open wire between the high speed cooling fan relay connector terminal 85 and the ignition switch. Is the repair complete?	-	System OK	-
45	Repair the open wire between the high speed cooling fan relay connector terminal 30 and the battery. Is the repair complete?	-	System OK	-
46	Repair the open wire between the series/parallel cooling fan relay connector terminal 85 and the ignition switch. Is the repair complete?	-	System OK	-
47	Repair the open wire between the series/parallel cooling fan relay connector terminal 87 and ground. Is the repair complete?	-	System OK	-
48	Repair the open wire between the high speed cooling fan relay connector terminal 87 and the main cooling fan connector terminal B. Is the repair complete?	-	System OK	-
49	Repair the open wire between the series/parallel cooling fan relay connector terminal 86 and the ECM connector terminal A14. Is the repair complete?	-	System OK	-

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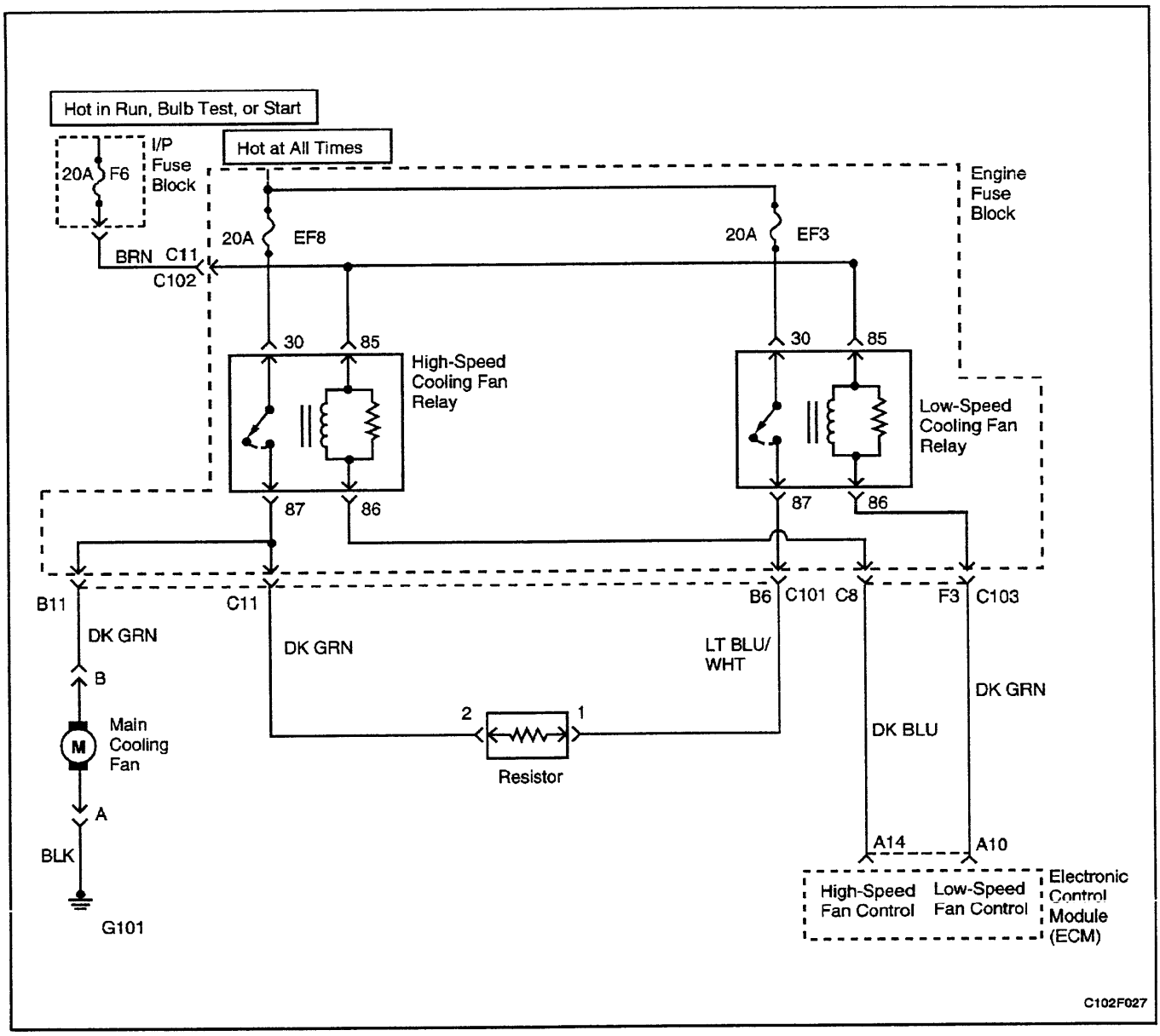

ENGINE COOLING FAN CIRCUIT CHECK - WITHOUT A/C

Circuit Description

The engine cooling fan circuit operates the main cooling fan and the auxiliary cooling fan. The cooling fans are controlled by the electronic control module (ECM) based on inputs from the coolant temperature sensor (CTS) and the air conditioning pressure (ACP) sensor. The ECM controls the low speed cooling fan operation by internally grounding the ECM connector terminal A10. This energizes the low speed cooling fan relay and operates the main cooling fan and the auxiliary cooling fan at low speed as the cooling fans are connected in a series circuit. The ECM controls the high speed cooling fan operation by internally grounding the ECM connector terminal A10 and the ECM connector terminal A14 at

Diagnostic Aids

- If the owner complained of an overheating problem, it must be determined if the complaint was due to an actual boil over, or the engine coolant temperature gauge indicated overheating. If the engine is overheating and the cooling fans are on, the cooling system should be checked.
- If the engine fuse block fuses EF3 or EF8 become open (blown) immediately after installation, inspect for a short to ground in the wiring of the appropriate circuit. If the fuses become open (blown) when the cooling fan is to be turned on by the ECM, suspect a faulty cooling fan motor.

- If the engine fuse block fuses EF3 or EF8 become open (blown) immediately after installation, inspect for a short to ground in the wiring of the appropriate circuit. If the fuses become open (blown) when the cooling fans are to be turned on by the electronic control module (ECM), suspect a faulty cooling fan motor.
- The ECM will turn the cooling fans on at low speed when the coolant temperature is 93°C (199°F). The ECM will turn the cooling fans off when the coolant temperature is 90°C (194°F).
- The ECM will turn the cooling fans on at high speed when the coolant temperature is 97°C (207°F). The ECM will change the cooling fans from high speed to low speed when the coolant temperature is 94°C (201°F).
- The cooling fan circuit can be checked quickly by disconnecting the ECM red connector and grounding the connector terminal A10. This should create low speed cooling fan operation with the ignition ON. By grounding the ECM connector terminals A10 and A14 and turning the ignition ON, high speed cooling fan operation should be achieved.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

4. This step, along with step 5, checks for the ability of the electronic control module (ECM) to operate the cooling fans.
8. This step, along with step 9, checks for the ability of the ECM to operate the cooling fans in response to A/C pressure readings.
16. After confirming battery voltage and the ECM supplying a ground to the coil side of the low speed cooling fan relay, by jumpering connector terminals 30 and 87 it will be determined if the relay is at fault or a wiring problem is present.
31. This step checks for the presence of battery voltage to the main cooling fan when the A/C is on. If battery voltage is present and the cooling fans are not operating, the problem is in the ground side of the cooling fan circuit.
37. By directly grounding the ECM connector terminals A10 and A14, the main and auxiliary cooling fans should run at high speed.

Engine Cooling Fan Circuit Check - With A/C

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Check the engine fuse block fuse EF3. 2. Replace the fuse as needed. Is the fuse OK?	-	Go to *Step 3*	Go to "Diagnostic Aids"
3	1. Check the engine fuse block fuse EF8. 2. Replace the fuse as needed. Is the fuse OK?	-	Go to *Step 4*	Go to "Diagnostic Aids"
4	1. Turn the ignition OFF. 2. Connect a scan tool to the assembly line diagnostic link (ALDL). 3. Start the engine. 4. The cooling fans should run at low speed when the coolant temperature reaches 93°C (199°F). Do the cooling fans run at low speed?	-	Go to *Step 5*	Go to *Step 6*

Engine Cooling Fan Circuit Check - With A/C (Cont'd)

Step	Action	Value(s)	Yes	No
5	1. Turn the ignition OFF. 2. Connect a scan tool to the ALDL. 3. Start the engine. 4. The cooling fans should run at high speed when the coolant temperature reaches 97°C (207°F). Do the cooling fans run at high speed?	-	System OK	Go to *Step 27*
6	1. Turn the ignition OFF. 2. Connect a scan tool to the ALDL. 3. The coolant temperature should be above 93°C (199°F). 4. Disconnect the auxiliary cooling fan connector. 5. Turn the ignition ON. 6. Connect a test light between the auxiliary cooling fan connector terminal B and ground. Is the test light on?	-	Go to *Step 7*	Go to *Step 8*
7	1. Turn the ignition OFF. 2. Connect a scan tool to the ALDL. 3. The coolant temperature should be above 93°C (199°F). 4. Disconnect the auxiliary cooling fan connector. 5. Connect a test light between the auxiliary cooling fan connector terminal A and battery positive. Is the test light on?	-	Go to *Step 24*	Go to *Step 13*
8	1. Turn the ignition OFF. 2. Disconnect the low speed cooling fan relay. 3. Connect a test light between the low speed cooling fan relay connector terminal 85 and ground. 4. Turn the ignition ON. Is the test light on?	-	Go to *Step 9*	Go to *Step 20*
9	1. Turn the ignition OFF. 2. Connect the low speed cooling fan relay. 3. Disconnect the electronic control module (ECM) red connector. 4. Connect a fused jumper between the ECM connector terminal A10 and ground. 5. Turn the ignition ON. Do the cooling fans run at low speed?	-	Go to *Step 26*	Go to *Step 10*
10	Check for an open wire between the low speed cooling fan relay connector terminal 86 and the ECM connector terminal A10. Is the problem found?	-	Go to *Step 21*	Go to *Step 11*
11	1. Turn the ignition OFF. 2. Disconnect the low speed cooling fan relay. 3. Connect a test light between the low speed cooling fan relay connector terminal 30 and ground. Is the test light on?	-	Go to *Step 12*	Go to *Step 19*
12	Connect a fused jumper between the low speed cooling fan relay connector terminals 30 and 87. Do the cooling fans run at low speed?	-	Go to *Step 22*	Go to *Step 13*

Engine Cooling Fan Circuit Check - With A/C (Cont'd)

Step	Action	Value(s)	Yes	No
13	1. Disconnect the series/parallel cooling fan relay. 2. Connect a fused jumper between the low speed cooling fan relay connector terminals 30 and 87. 3. Connect a fused jumper between the series/parallel cooling fan relay connector terminals 30 and 87. Do the cooling fans run at low speed?	-	Go to *Step 23*	Go to *Step 14*
14	Check the wire between the low speed cooling fan relay connector terminal 87 to the auxiliary cooling fan connector terminal B for an open. Is the problem found?	-	Go to *Step 18*	Go to *Step 15*
15	Check the wire between the auxiliary cooling fan connector terminal A and the series/parallel cooling fan relay connector terminal 30 for an open. Is the problem found?	-	Go to *Step 18*	Go to *Step 16*
16	Check the wire between the series/parallel cooling fan relay connector terminal 87 and the main cooling fan connector terminal B for an open. Is the problem found?	-	Go to *Step 18*	Go to *Step 17*
17	Check for an open wire between the main cooling fan connector terminal A and ground. Is the problem found?	-	Go to *Step 18*	Go to *Step 25*
18	Repair the open wire as needed. Is the repair complete?	-	System OK	-
19	Repair the open between the low speed cooling fan relay connector terminal 30 and the battery. Is the repair complete?	-	System OK	-
20	Repair the open between the low speed cooling fan relay connector terminal 85 and the ignition switch. Is the repair complete?	-	System OK	-
21	Repair the open wire between the low speed cooling fan relay connector terminal 86 and the ECM connector terminal A10. Is the repair complete?	-	System OK	-
22	Replace the low speed cooling fan relay. Is the repair complete?	-	System OK	-
23	Replace the series/parallel cooling fan relay. Is the repair complete?	-	System OK	-
24	Replace the auxiliary cooling fan. Is the repair complete?	-	System OK	-
25	Replace the main cooling fan. Is the repair complete?	-	System OK	-
26	Replace the ECM. Is the repair complete?	-	System OK	-

Engine Cooling Fan Circuit Check - With A/C (Cont'd)

Step	Action	Value(s)	Yes	No
27	1. Turn the ignition OFF. 2. Disconnect the high speed cooling fan relay. 3. Connect a test light between the high speed cooling fan relay connector terminal 85 and ground. 4. Turn the ignition ON. Is the test light on?	-	Go to *Step 28*	Go to *Step 44*
28	1. Turn the ignition OFF. 2. Connect a test light between the high speed cooling fan relay connector terminal 30 and ground. Is the test light on?	-	Go to *Step 29*	Go to *Step 45*
29	1. Disconnect the series/parallel cooling fan relay. 2. Connect a test light between the series/parallel cooling fan relay connector terminal 85 and ground. 3. Turn the ignition ON. Is the test light on?	-	Go to *Step 30*	Go to *Step 46*
30	1. Turn the ignition OFF. 2. Connect a test light between the series/parallel cooling fan relay connector terminal 87 and battery positive. Is the test light on?	-	Go to *Step 31*	Go to *Step 47*
31	1. Connect the auxiliary cooling fan connector. 2. Connect the high speed cooling fan relay. 3. Connect the series/parallel cooling fan relay. 4. Disconnect the ECM red connector. 5. Connect a fused jumper between the ECM connector terminal A10 and ground. 6. Connect a fused jumper between the ECM connector terminal A14 and ground. 7. Turn the ignition ON. Do the cooling fans run at high speed?	-	Go to *Step 26*	Go to *Step 32*
32	1. Turn the ignition OFF. 2. Check for an open wire between the high speed cooling fan relay connector terminal 86 and the ECM connector terminal A14. Is the problem found?	-	Go to *Step 18*	Go to *Step 33*
33	1. Disconnect the high speed cooling fan relay. 2. Connect a test light between the high speed cooling fan relay connector terminal 87 and battery positive. Is the test light on?	-	Go to *Step 34*	Go to *Step 42*
34	1. Disconnect the ECM red connector. 2. Connect a fused jumper between the ECM connector terminal A14 and ground. 3. Disconnect the series/parallel cooling fan relay. 4. Connect a test light between the series/parallel cooling fan relay connector terminal 86 and battery positive. Is the test light on?	-	Go to *Step 35*	Go to *Step 43*

Engine Cooling Fan Circuit Check - With A/C (Cont'd)

Step	Action	Value(s)	Yes	No
35	1. Connect the series/parallel cooling fan relay. 2. Connect a fused jumper between the ECM connector terminal A14 and ground. 3. Disconnect the high speed cooling fan relay. 4. Connect a fused jumper between the high speed cooling fan relay connector terminals 30 and 87. 5. Disconnect the low speed cooling fan relay. 6. Connect a fused jumper between the low speed cooling fan relay connector terminals 30 and 87. 7. Turn the ignition ON. Do the cooling fans run at high speed?	-	Go to *Step 37*	Go to *Step 36*
36	1. Turn the ignition OFF. 2. Connect a fused jumper between the ECM connector terminal A14 and ground. 3. Disconnect the series/parallel cooling fan relay. 4. Connect a fused jumper between the series/parallel cooling fan relay connector terminals 30 and 87. 5. Connect a fused jumper between the low speed cooling fan relay connector terminals 30 and 87. 6. Turn the ignition ON. Do the cooling fans run at high speed?	-	Go to *Step 23*	-
37	Replace the high speed cooling fan relay. Is the repair complete?	-	System OK	-
38	Repair the open wire between the high speed cooling fan relay connector terminal 85 and the ignition switch. Is the repair complete?	-	System OK	-
39	Repair the open wire between the high speed cooling fan relay connector terminal 30 and the battery. Is the repair complete?	-	System OK	-
40	Repair the open wire between the series/parallel cooling fan relay connector terminal 85 and the ignition switch. Is the repair complete?	-	System OK	-
41	Repair the open wire between the series/parallel cooling fan relay connector terminal 87 and ground. Is the repair complete?	-	System OK	-
42	Repair the open wire between the high speed cooling fan relay connector terminal 87 and the main cooling fan connector terminal B. Is the repair complete?	-	System OK	-
43	Repair the open wire between the series/parallel cooling fan relay connector terminal 86 and the ECM connector terminal A14. Is the repair complete?	-	System OK	-

FUEL INJECTOR BALANCE TEST

A fuel injector tester is used to energize the injector for a precise amount of time, thus spraying a measured amount of fuel into the intake manifold. This causes a drop in the fuel rail pressure that can be recorded and used to compare each of the fuel injectors. All of the fuel injectors should have the same pressure drop 10 kPa (1.5 psi).

Injector Balance Test Example

Cylinder	1	2	3	4
First Reading	296 kPa (43 psi)	296 kPa (43 psi)	296 kPa (43 psi)	296 kPa (43 psi)
Second Reading	131 kPa (19 psi)	117 kPa (17 psi)	124 kPa (18 psi)	145 kPa (21 psi)
Amount Of Drop	165 kPa (24 psi)	179 kPa (26 psi)	172 kPa (25 psi)	151 kPa (22 psi)
Average Range: 156-176 kPa (22.5-25.5 psi)	Injector OK	Faulty Injector - Too Much Pressure Drop	Injector OK	Faulty Injector - Too Little Pressure Drop

Caution: The fuel system is under pressure. To avoid fuel spillage and the risk of personal injury or fire, it is necessary to relieve the fuel system pressure before disconnecting the fuel lines.

Caution: Do not pinch or restrict nylon fuel lines. Damage to the lines could cause a fuel leak, resulting in possible fire or personal injury.

Notice: In order to prevent flooding of the engine, do not perform the Injector Balance Test more than once (including any retest on faulty fuel injectors) without running the engine.

Test

1. An engine cool down period of 10 minutes is necessary in order to avoid irregular readings due to hot soak fuel boiling.
2. Connect the fuel pressure gauge carefully to avoid any fuel spillage.
3. The fuel pump should run about 2 seconds after the ignition is turned to the ON position.
4. Insert a clear tube attached to the vent valve of the fuel pressure gauge into a suitable container.
5. Bleed the air from the fuel pressure gauge and hose until all of the air is bled from the fuel pressure gauge.
6. The ignition switch must be in the OFF position at least 10 seconds in order to complete the electronic control module (ECM) shutdown cycle.
7. Turn the ignition ON in order to get the fuel pressure to its maximum level.
8. Allow the fuel pressure to stabilize and then record this initial pressure reading. Wait until there is no movement of the needle on the fuel pressure gauge.
9. Follow the manufacturer's instructions for the use of the adapter harness. Energize the fuel injector tester once and note the fuel pressure drop at its lowest point. Record this second reading. Subtract it from the first reading to determine the amount of the fuel pressure drop.
10. Disconnect the fuel injector tester from the fuel injector.
11. After turning the ignition ON, in order to obtain maximum pressure once again, make a connection at the next fuel injector. Energize the fuel injector tester and record the fuel pressure reading. Repeat this procedure for all the injectors.
12. Retest any of the fuel injectors that the pressure drop exceeds the 10 kPa (1.5 psi) specification.
13. Replace any of the fuel injectors that fail the retest.
14. If the pressure drop of all of the fuel injectors is within 10 kPa (1.5 psi), then the fuel injectors are flowing normally and no replacement should be necessary.
15. Reconnect the fuel injector harness and review the symptom diagnostic tables.

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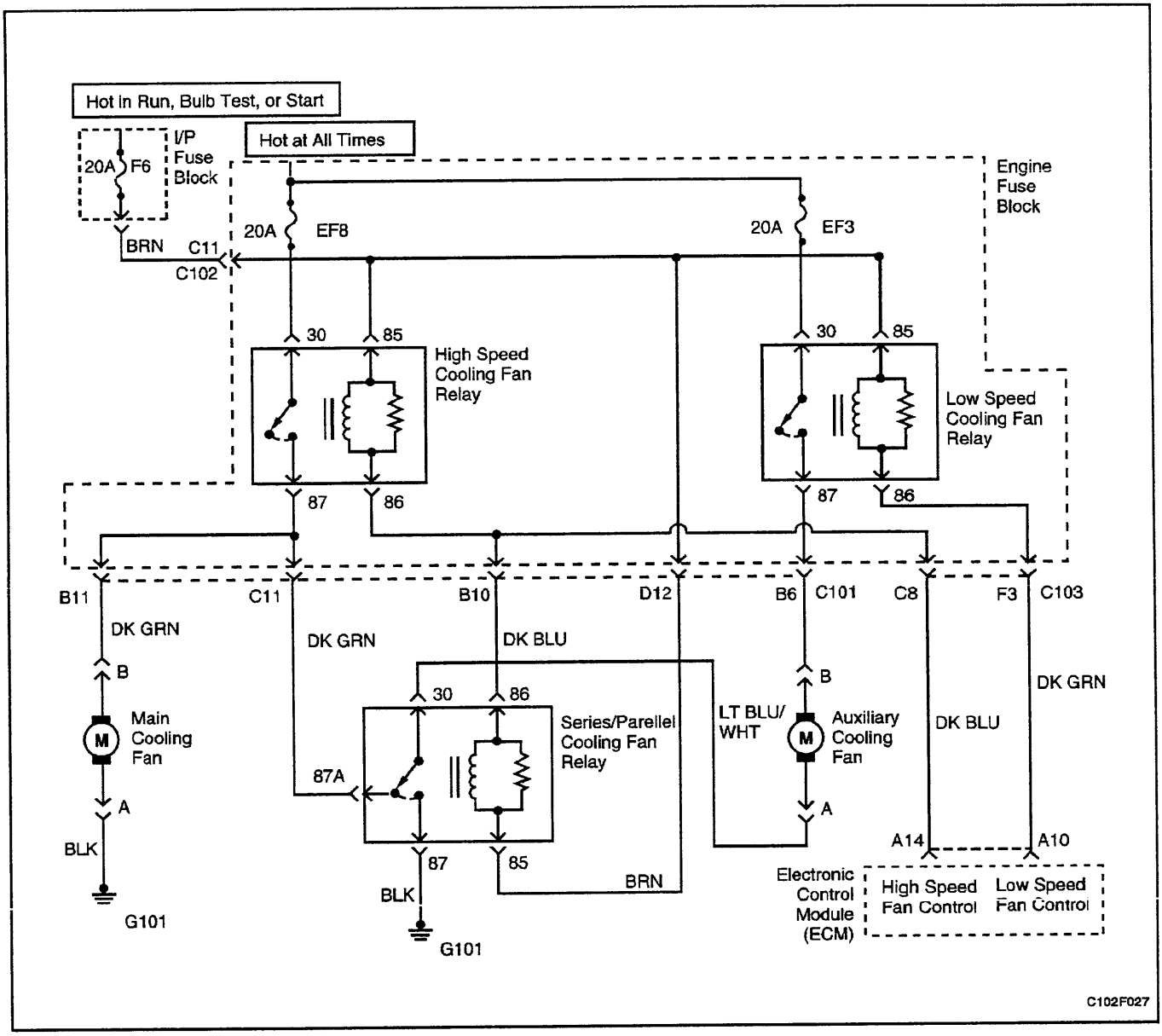

DIAGNOSTIC TROUBLE CODE (DTC) 3 FAN NUMBER TWO LOW (2.0L DOHC)

Circuit Description

The high speed cooling fan relay is controlled by the electronic control module (ECM). The ECM applies a ground to the high speed cooling fan relay, while also applying ground to the low speed cooling fan relay, to achieve high speed cooling fan operation. The ECM determines when to activate the high speed cooling fan relay depending on the coolant temperature and the A/C system high side pressure.

DTC 3 Will Set When

- A short to ground condition exists and is present for more than 2 seconds.

Diagnostic Aids

- An intermittent problem may be caused by a poor connection, rubbed through wire insulation, or a broken wire inside the insulation.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

4. This step checks for a shorted relay.
6. This step checks for a shorted relay.
11. This step checks for the ability of the ECM to ground the fan circuits.

DTC 3 - Fan Number Two Low (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Determine whether the Diagnostic System Check has been performed. Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	Inspect the fuse F6. Is the fuse in good condition?	-	Go to *Step 4*	Go to *Step 3*
3	1. Replace the fuse. 2. Clear any diagnostic trouble codes (DTCs) from the electronic control module (ECM). 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
4	1. Disconnect the high speed cooling fan relay. 2. Measure the resistance between the high speed cooling fan relay terminals 85 and 86. Is the circuit shorted to ground?	-	Go to *Step 5*	Go to *Step 6*
5	1. Replace the high speed cooling fan relay. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
6	1. Disconnect the series/parallel cooling fan relay. 2. Measure the resistance between the series/parallel cooling fan relay terminals 85 and 86. Is the circuit shorted to ground?	-	Go to *Step 7*	Go to *Step 8*
7	1. Replace the series/parallel cooling fan relay. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
8	Check for a short to ground in the wiring between the high speed cooling fan relay connector terminal 86 and the ECM connector terminal A14. Is the problem found?	-	Go to *Step 10*	Go to *Step 9*
9	Check for a short to ground in the wiring between the series/parallel cooling fan relay connector terminal 86 and ECM connector terminal A14. Is the problem found?	-	Go to *Step 10*	Go to *Step 11*
10	1. Repair the short to ground in the wiring. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
11	1. Turn the ignition OFF. 2. Connect the high speed cooling fan relay. 3. Connect the series/parallel cooling fan relay. 4. Connect the ECM red connector. 5. Jumper terminals A and B of the assembly line diagnostic link (ALDL) connector. 6. Turn the ignition ON. 7. With a test light connected to battery voltage, backprobe the ECM connector terminal A14. Is the test light on?	-	Go to "Diagnostic Aids"	Go to *Step 12*

DTC 3 - Fan Number Two Low (2.0L DOHC) (Cont'd)

Step	Action	Value(s)	Yes	No
12	1. Turn the ignition OFF. 2. Disconnect the ECM red connector. 3. Inspect for a poor connection at the ECM connector terminal A14. Is the problem found?	-	Go to *Step 13*	Go to *Step 14*
13	1. Repair or replace the connector terminal as needed. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
14	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

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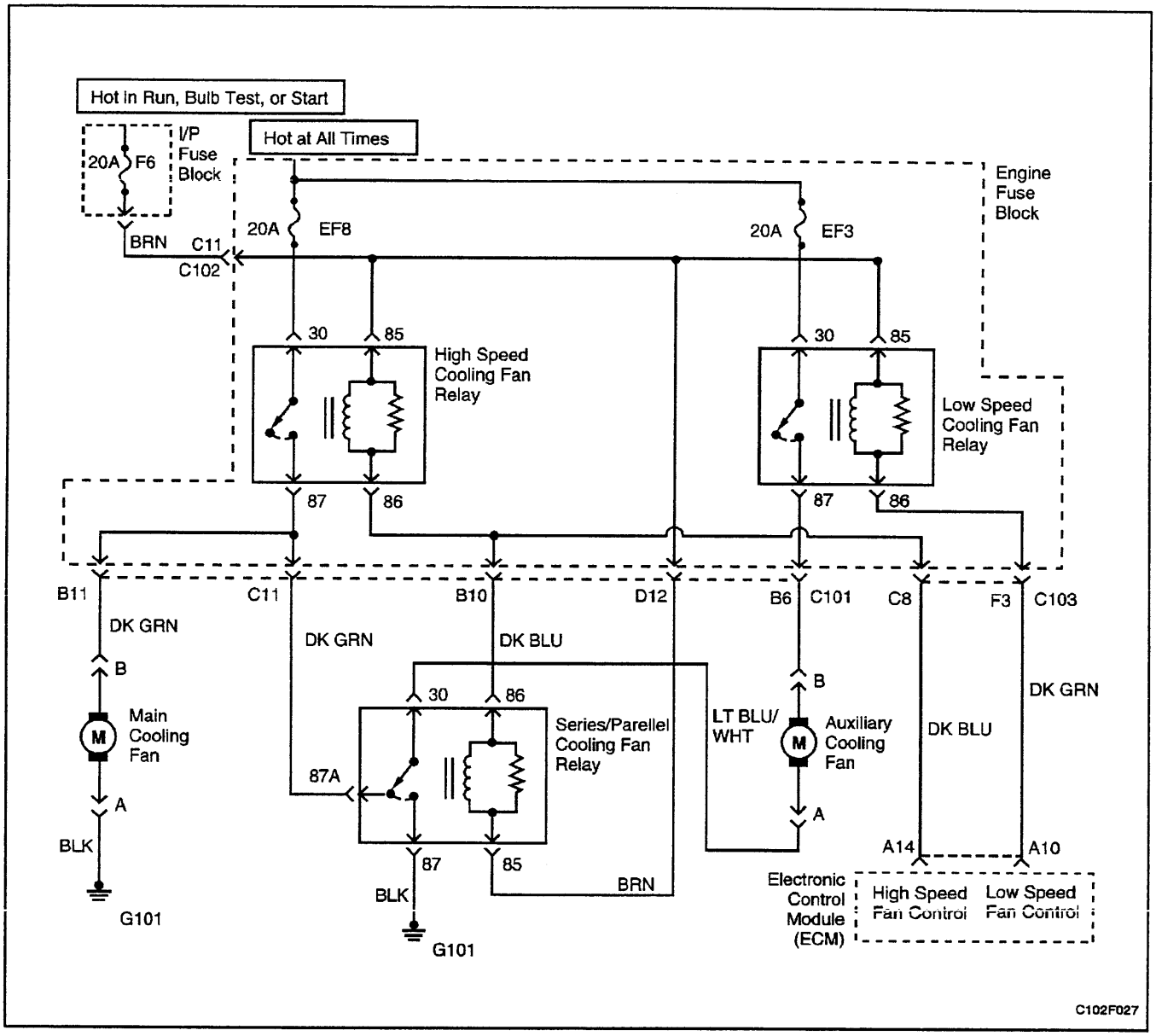


DIAGNOSTIC TROUBLE CODE (DTC) 4 FAN NUMBER TWO HIGH (2.0L DOHC)

Circuit Description

The high speed cooling fan relay is controlled by the electronic control module (ECM). The ECM applies a ground to the high speed cooling fan relay, while also applying ground to the low speed cooling fan relay, to achieve high speed cooling fan operation. The ECM determines when to activate the high speed cooling fan relay depending on the coolant temperature and the A/C system high side pressure.

DTC 4 Will Set When

- A short to battery voltage condition exists and is present for more than 2 seconds.

Diagnostic Aids

- An intermittent problem may be caused by a poor connection, rubbed through wire insulation, or a broken wire inside the insulation.

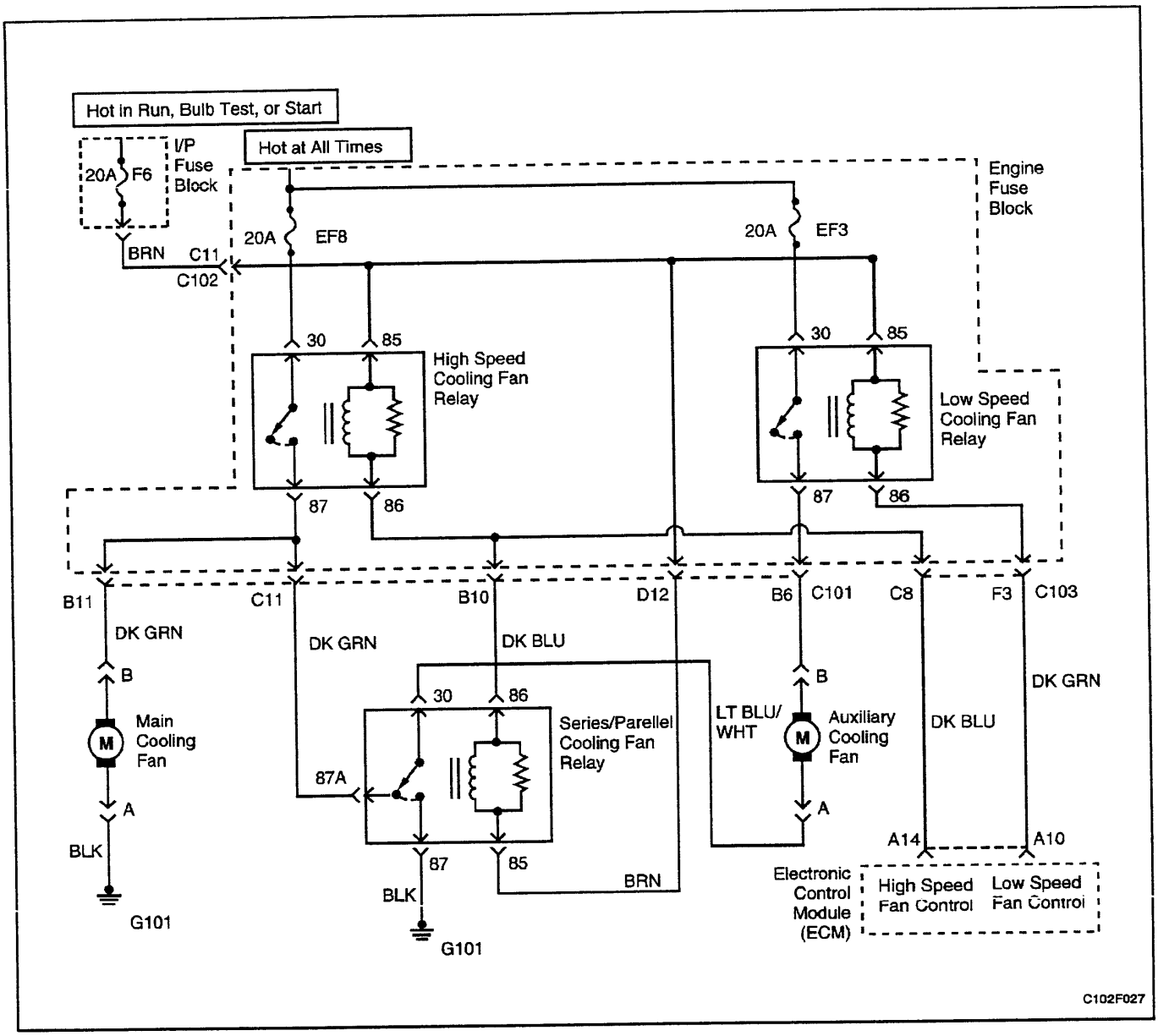
Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. This step checks the wires for a short to battery voltage.
4. This step checks for a shorted relay.
6. This step checks for a shorted relay.

DTC 4 - Fan Number Two High (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Determine whether the Diagnostic System Check has been performed. Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the electronic control module (ECM) red connector. 2. Disconnect the high speed cooling fan relay and the series/parallel cooling fan relay. 3. Measure the voltage between the ECM connector terminal A14 and ground. Does the voltage measure within the value specified?	0 v	Go to *Step 4*	Go to *Step 3*
3	1. Repair the short to voltage between the high speed cooling fan relay or the series/parallel cooling fan relay connector terminal 86 and the ECM connector terminal A14. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
4	Measure the resistance between the high speed cooling fan relay terminals 85 and 86. Does the resistance measure near the value specified?	≈ 0 Ω	Go to *Step 5*	Go to *Step 6*
5	1. Replace the high speed cooling fan relay. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
6	Measure the resistance between the series/parallel cooling fan relay terminals 85 and 86. Does the resistance measure near the value specified?	≈ 0 Ω	Go to *Step 7*	Go to *Step 8*
7	1. Replace the series/parallel cooling fan relay. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
8	Inspect for a poor connection at the ECM connector terminal A14. Is the problem found?	-	Go to *Step 9*	Go to *Step 10*
9	1. Repair or replace the connector terminal as needed. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
10	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 5 FAN NUMBER ONE LOW (2.0L DOHC)

Circuit Description

The low speed cooling fan relay is controlled by the electronic control module (ECM). The ECM applies a ground to the low speed cooling fan relay to achieve low speed cooling fan operation. The ECM determines when to activate the low speed cooling fan relay depending on the coolant temperature and the A/C system high side pressure.

DTC 5 Will Set When

- A short to ground condition exists and is present for more than 2 seconds.

Diagnostic Aids

- An intermittent problem may be caused by a poor connection, rubbed through wire insulation, or a broken wire inside the insulation.

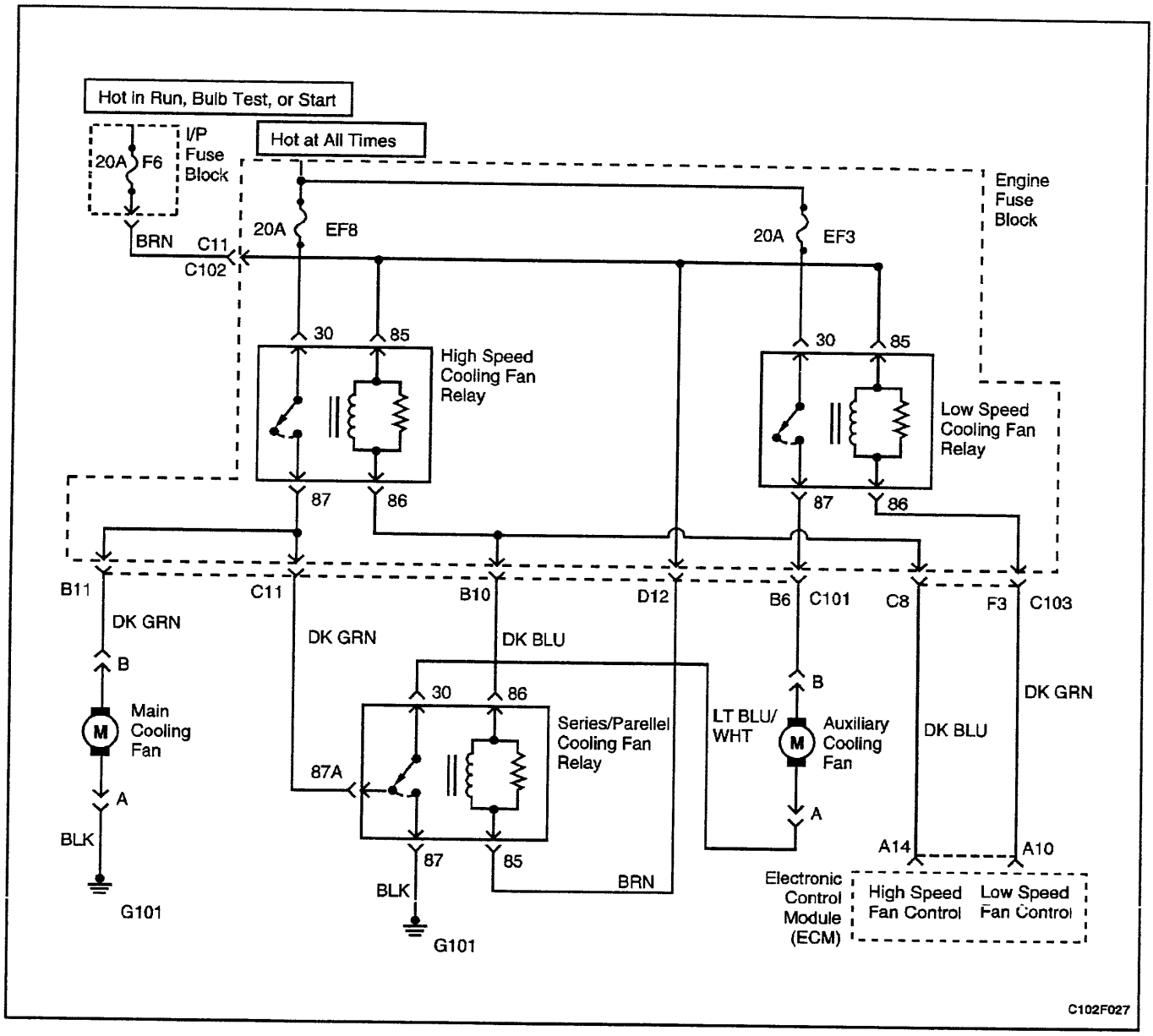
Test Description

The number(s) below refer to step(s) on the diagnostic table.

4. This step checks for a shorted relay.
8. This step checks for the ability of the ECM to ground the fan circuits.

DTC 5 - Fan Number One Low (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Determine whether the Diagnostic System Check has been performed. Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	Inspect the fuse F6. Is the fuse in good condition?	-	Go to *Step 4*	Go to *Step 3*
3	1. Replace the fuse. 2. Clear any diagnostic trouble codes (DTCs) from the electronic control module (ECM). 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
4	1. Disconnect the low speed cooling fan relay. 2. Measure the resistance between the low speed cooling fan relay terminals 85 and 86. Is the circuit shorted to ground?	-	Go to *Step 5*	Go to *Step 6*
5	1. Replace the low speed cooling fan relay. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
6	Check for a short to ground in the wiring between the low speed cooling fan relay connector terminal 86 and the ECM connector terminal A10. Is the problem found?	-	Go to *Step 7*	Go to *Step 8*
7	1. Repair the short to ground in the wiring. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
8	1. Turn the ignition OFF. 2. Connect the low speed cooling fan relay. 3. Connect the ECM red connector. 4. Jumper terminals A and B of the assembly line diagnostic link (ALDL) connector. 5. Turn the ignition ON. 6. With a test light connected to battery voltage, backprobe the ECM connector terminal A10. Is the test light on?	-	Go to "Diagnostic Aids"	Go to *Step 9*
9	1. Turn the ignition OFF. 2. Disconnect the ECM red connector. 3. Inspect for a poor connection at the ECM connector terminal A10. Is the problem found?	-	Go to *Step 10*	Go to *Step 11*
10	1. Repair or replace the connector terminal as needed. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
11	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 6 FAN NUMBER ONE HIGH (2.0L DOHC)

Circuit Description

The low speed cooling fan relay is controlled by the electronic control module (ECM). The ECM applies a ground to the low speed cooling fan relay to achieve low speed cooling fan operation. The ECM determines when to activate the low speed cooling fan relay depending on the coolant temperature and the A/C system high side pressure.

DTC 6 Will Set When

- A short to battery voltage condition exists and is present for more than 2 seconds.

Diagnostic Aids

- An intermittent problem may be caused by a poor connection, rubbed through wire insulation, or a broken wire inside the insulation.

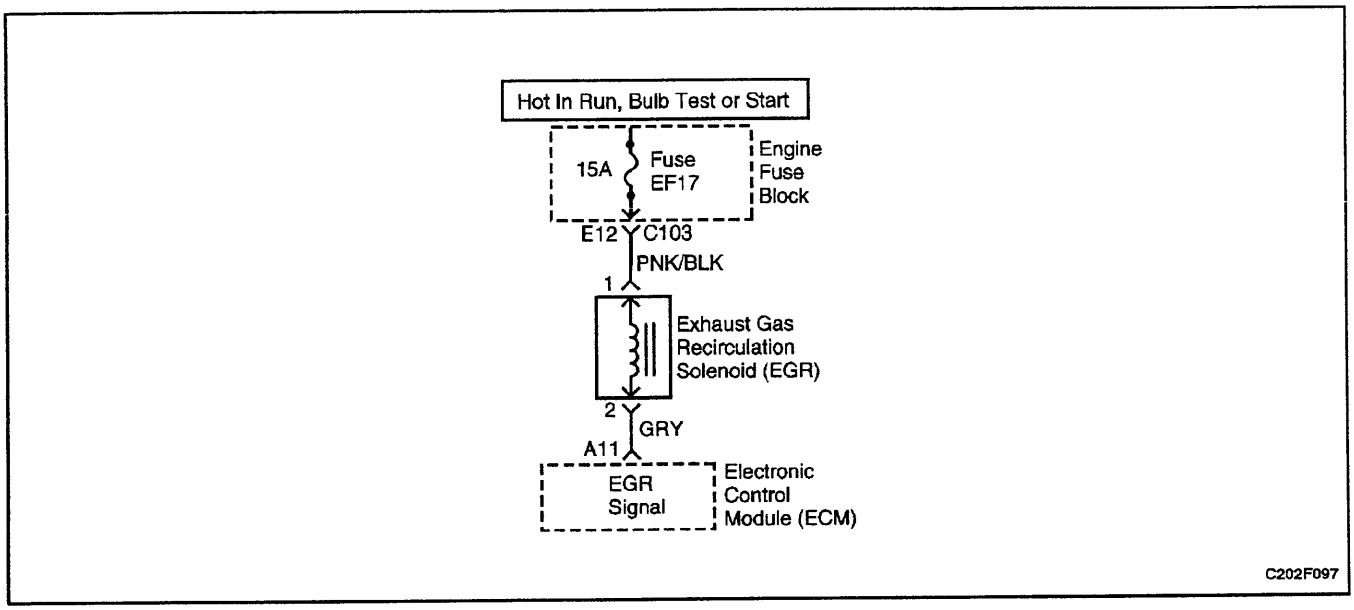
Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. This step checks the wires for a short to battery voltage.
4. This step checks for a shorted relay.

DTC 6 - Fan Number One High (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Determine whether the Diagnostic System Check has been performed. Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the electronic control module (ECM) red connector. 2. Disconnect the low speed cooling fan relay. 3. Measure the voltage between the ECM connector terminal A10 and ground. Does the voltage measure within the value specified?	0 v	Go to *Step 4*	Go to *Step 3*
3	1. Repair the short to voltage between the low speed cooling fan relay connector terminal 86 and the ECM connector terminal A10. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
4	Measure the resistance between the low speed cooling fan relay terminals 85 and 86. Does the resistance measure near the value specified?	≈ 0 Ω	Go to *Step 5*	Go to *Step 6*
5	1. Replace the low speed cooling fan relay. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
6	Inspect for a poor connection at the ECM connector terminal A10. Is the problem found?	-	Go to *Step 7*	Go to *Step 8*
7	1. Repair or replace the connector terminal as needed. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
8	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 7
BACK PRESSURE EGR ON/OFF SOLENOID LOW (2.0L DOHC)

Circuit Description

The electronic control module (ECM) operates a solenoid to control the back pressure (BP) exhaust gas recirculation (EGR) valve. The solenoid is normally closed. By providing a ground path, the ECM energizes the solenoid, which then allows vacuum to pass to the EGR valve.

The ECM monitors EGR effectiveness by de-energizing the EGR solenoid and shutting off vacuum to the EGR valve. With the EGR valve closed and the oxygen (O_2) sensor fluctuating normally, short-term fuel trim counts will be greater than they were during normal operation.

DTC 7 Will Set When

- A short to ground condition exists.

Diagnostic Aids

- Inspect the ECM wiring harness connectors for improper mating, broken locks, improperly formed or damaged terminals, a poor terminal-to-wire connection, or a damaged harness.
- If the connections and the wiring harness are in good condition, connect a test light between the controlled canister purge (CCP) solenoid connector terminal 2 and battery positive while moving the related connectors. If the fault is induced, the test light will turn on. This may help to isolate the location of an intermittent problem.

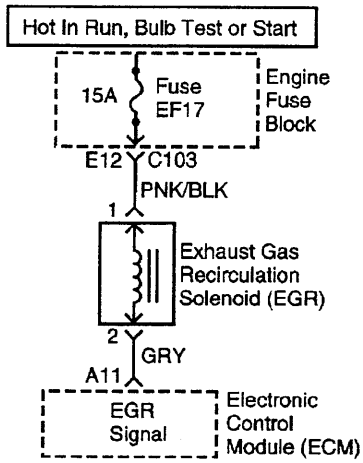
Test Description

The numbers below refer to steps in the diagnostic table.

2. With the ignition OFF, the ECM should not be applying ground to the EGR solenoid.
3. If the test light is still on after disconnecting the ECM red connector, the wire between the EGR solenoid and the ECM is shorted to ground. If the test light goes off, the ECM is at fault.

DTC 7 - Back Pressure EGR On/Off Solenoid Low (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Determine whether the Diagnostic System Check has been performed. Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the exhaust gas recirculation (EGR) solenoid connector. 2. Connect a test light between the EGR solenoid connector terminal 2 and battery positive. Is the test light on?	-	Go to *Step 3*	Go to "Diagnostic Aids"
3	Disconnect the electronic control module (ECM) red connector. Is the test light on?	-	Go to *Step 4*	Go to *Step 5*
4	1. Repair the short to ground in the wire between the EGR solenoid connector terminal 2 and the ECM connector terminal A11. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
5	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



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DIAGNOSTIC TROUBLE CODE (DTC) 8
BACK PRESSURE EGR ON/OFF SOLENOID HIGH (2.0L DOHC)

Circuit Description

The electronic control module (ECM) operates a solenoid to control the back pressure (BP) exhaust gas recirculation (EGR) valve. The solenoid is normally closed. By providing a ground path, the ECM energizes the solenoid, which then allows vacuum to pass to the EGR valve.

The ECM monitors EGR effectiveness by de-energizing the EGR solenoid and shutting off vacuum to the EGR valve. With the EGR valve closed and the oxygen (O_2) sensor fluctuating normally, short-term fuel trim counts will be greater than they were during normal operation.

DTC 8 Will Set When

- A short to battery voltage condition exists.

Diagnostic Aids

- Inspect the ECM wiring harness connectors for improper mating, broken locks, improperly formed or damaged terminals, a poor terminal-to-wire connection, or a damaged harness.
- If the connections and the wiring harness are in good condition, connect a test light between the controlled canister purge (CCP) solenoid connector terminal 2 and battery positive while moving related connectors. If the fault is induced, the test light will turn on. This may help to isolate the location of an intermittent problem.

Test Description

The number below refers to Step 4 on the diagnostic table.

4. If the test light is still on after disconnecting the ECM red connector, the wire between the CCP solenoid and the ECM is shorted to voltage. If the test light goes off, the ECM is at fault.

DTC 8 - Back Pressure EGR On/Off Solenoid High (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Determine whether the Diagnostic System Check has been performed. Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the exhaust gas recirculation (EGR) solenoid connector. 2. Measure the resistance of the EGR solenoid. Does the resistance measure near the value specified?	≈ 0 Ω	Go to *Step 6*	Go to *Step 3*
3	1. Disconnect the EGR solenoid connector. 2. Connect a test light between the EGR solenoid connector terminal 2 and ground. Is the test light on?	-	Go to *Step 4*	Go to "Diagnostic Aids"
4	Disconnect the electronic control module (ECM) red connector. Is the test light on?	-	Go to *Step 5*	Go to *Step 7*
5	1. Repair the short to voltage in the wire between the EGR solenoid connector terminal 2 and the ECM connector terminal A11. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
6	1. Replace the EGR solenoid. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
7	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

DIAGNOSTIC TROUBLE CODE (DTC) 12
NO PULSE REFERENCE ENGINE NOT RUNNING (2.0L DOHC)

Circuit Description

This is a normal code that the electronic control module (ECM) stores when the ignition key is ON, but the engine is not running.

DTC 12 Will Set When

- When the ignition key is ON, but the engine is not running.

Diagnostic Aids

This DTC indicates the following conditions:

- The vehicle is normal and not malfunctioning.
- The ECM has the ability to store codes.

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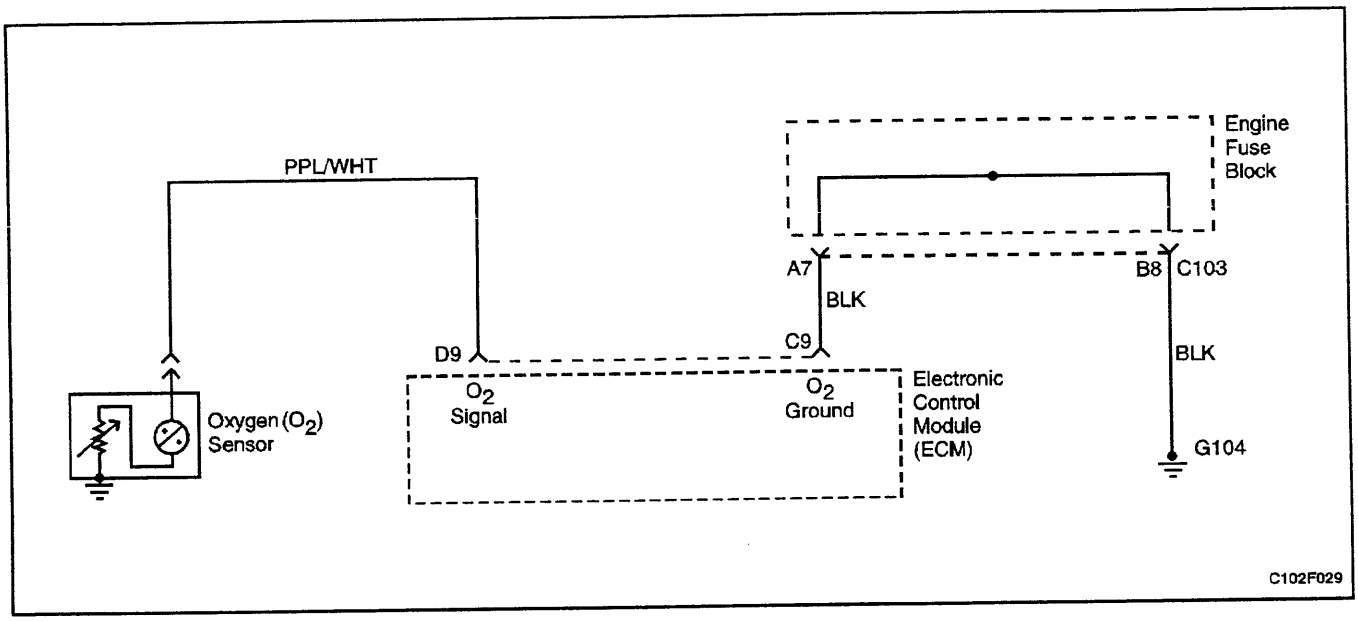

DIAGNOSTIC TROUBLE CODE (DTC) 13 OXYGEN SENSOR NOT TOGGLING (2.0L DOHC)

Circuit Description

The electronic control module (ECM) supplies a voltage of about 450 millivolts between the ECM terminals D9 and C9. The oxygen (O_2) sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down to about 100 millivolts if the exhaust is lean. The O_2 sensor is like an open circuit and produces no voltage when it is below 360°C (680°F). An open O_2 sensor circuit or a cold O_2 sensor causes "open loop" operation.

DTC 13 Will Set When

- The engine has been running for at least 60 seconds.
- Diagnostic trouble code (DTC) 21 has not set.
- DTC 22 has not set.
- DTC 33 has not set.
- DTC 34 has not set.
- The throttle angle is above 5 percent.
- The coolant temperature is above 70°C (158°F).
- The oxygen (O_2) sensor is steady between 340 millivolts and 540 millivolts.
- These conditions are present for 20 seconds.

Diagnostic Aids

Normal scan tool voltage varies between 100 millivolts and 999 millivolts while in closed loop.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. If the conditions for the diagnostic trouble code (DTC) 13 are present, the engine controls system will not operate in closed loop.

5. By making a vacuum leak, a lean running condition should now be present. If the oxygen (O_2) sensor toggles below 450 millivolts, the O_2 sensor is sensing the lean running condition.

6. By making a slight vacuum leak at the manifold absolute pressure (MAP) sensor, a rich running condition should now be present. If the O_2 sensor toggles above 550 millivolts, the O_2 sensor is sensing the rich running condition.

10. An open or short to ground in the O_2 sensor circuit will not allow the ECM to operate in closed loop.

DTC 13 - Oxygen Sensor Not Toggling (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Start the engine. 3. Run the engine until it reaches operating temperature. 4. Check for closed loop operation. Does the electronic control module (ECM) go into closed loop?	-	Go to *Step 3*	Go to *Step 8*
3	1. Run the engine until it reaches operating temperature. 2. Check the oxygen (O_2) sensor reading at different throttle settings. Does the scan tool read the O_2 sensor input toggling between the values specified?	100-900 mv	Go to *Step 7*	Go to *Step 4*
4	1. Turn the ignition OFF. 2. Disconnect the O_2 sensor connector. 3. Check the O_2 sensor pigtail lead at the sensor. Is the lead properly attached to the sensor?	-	Go to *Step 5*	Go to *Step 9*
5	1. Reconnect the O_2 sensor connector. 2. Start the engine. 3. Run the engine until it reaches operating temperature. 4. Make a vacuum leak by disconnecting or partially disconnecting a vacuum hose. Do not disconnect the manifold absolute pressure (MAP) sensor. Does the O_2 sensor input stay fixed at or below the value specified?	300 mv	Go to *Step 6*	Go to *Step 8*
6	1. Run the engine until it reaches operating temperature. 2. Make a slight vacuum leak at the MAP sensor vacuum hose connection. Does the O_2 sensor input stay fixed at or above the value specified?	600 mv	Go to *Step 7*	Go to *Step 8*
7	1. Clear the intermittent diagnostic trouble code (DTC) 13 from the ECM. 2. Road test the vehicle. 3. Perform the Diagnostic System Check. Did DTC 13 reset in the ECM?	-	Go to *Step 2*	Go to "Diagnostic Aids"
8	1. Turn the ignition OFF. 2. Disconnect the O_2 sensor connector. 3. Turn the ignition ON. 4. Measure the voltage at the O_2 sensor connector (ECM side of connector). Is the voltage within the value specified?	300-600 mv	Go to *Step 9*	Go to *Step 10*
9	1. Replace the O_2 sensor. 2. Road test the vehicle. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

DTC 13 - Oxygen Sensor Not Toggling (2.0L DOHC) (Cont'd)

Step	Action	Value(s)	Yes	No
10	Check for an open or short to ground between the O_2 sensor connector and the ECM connector terminal D9. Is the problem found?	-	Go to *Step 11*	Go to *Step 12*
11	1. Repair the wire as needed. 2. Road test the vehicle. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
12	1. Replace the ECM. 2. Road test the vehicle. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

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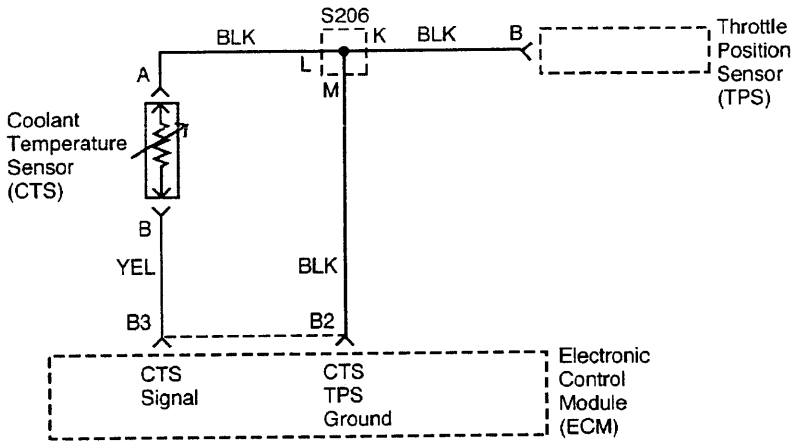

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DIAGNOSTIC TROUBLE CODE (DTC) 14 COOLANT TEMPERATURE HIGH (2.0L DOHC)

Circuit Description

The coolant temperature sensor (CTS) uses a thermistor to control the signal voltage to the electronic control module (ECM). The ECM applies a voltage to the CTS. When the engine is cold, the CTS resistance is high. Therefore, the ECM will see a high signal voltage. As the engine warms, the CTS resistance becomes less, and the voltage drops. At normal engine operating temperature the CTS signal will measure about 1.5 to 2.0 volts.

DTC 14 Will Set When

- The engine has been running for more than 2 seconds.
- The coolant temperature sensor signal voltage indicates a coolant temperature above 146°C (295°F).

Diagnostic Aids

- If the connections are OK, monitor the coolant temperature while moving related connectors and the wiring harness. If the failure is induced, the display on the scan tool will change. This may help to isolate the location of an intermittent malfunction.
- The "Temperature Vs. Resistance Values" scale may be used to test the coolant sensor at various temperatures to evaluate the possibility of a "shifted" or "miscaled" coolant temperature sensor which may result in driveability complaints.

COOLANT TEMPERATURE SENSOR		
TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°C	°F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
−5	23	12300
−10	14	16180
−15	5	21450
−20	−4	28680
−30	−22	52700
−40	−40	100700

Test Description

The number(s) below refer to step(s) on the diagnostic table.

4. This test simulates the conditions for setting diagnostic trouble code 14. If the electronic control module (ECM) recognizes the low signal voltage (high temperature) and the scan tool displays 180°C (356°F), the ECM wiring is OK.
6. This step checks for voltage reference from the ECM.

DTC 14 - Coolant Temperature High (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Run the engine until it reaches operating temperature. Does the scan tool display the engine coolant temperature within the value specified?	80-110°C (176-230°F)	Go to "Diagnostic Aids"	Go to *Step 3*
3	1. Turn the ignition OFF. 2. Disconnect the coolant temperature sensor (CTS) connector. 3. Turn the ignition ON. Does the scan tool display the engine coolant temperature within the value specified?	Below −30°C (−22°F)	Go to *Step 4*	Go to *Step 6*
4	1. Jumper terminals A and B of the CTS connector. 2. Turn the ignition ON. Does the scan tool display the engine coolant temperature within the value specified?	Above 180°C (356°F)	Go to *Step 5*	Go to *Step 6*
5	1. Replace the coolant temperature sensor. 2. Run the engine until it reaches operating temperature. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
6	Measure the voltage at the CTS connector terminal B. Is the voltage within the value specified?	4.5-5.5 v	Go to *Step 7*	Go to *Step 9*
7	1. Turn the ignition OFF. 2. Disconnect the ECM red connector. 3. Inspect the electronic control module (ECM) pins and connector for bent or damaged terminals. Repair or replace as needed. 4. Check the wire between the CTS connector terminal A and the ECM connector terminal B2 for a short to ECM reference voltage. Is the problem found?	-	Go to *Step 12*	Go to *Step 8*
8	1. Replace the electronic control module. 2. Run the engine until it reaches operating temperature. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
9	Check the wire for a short to ground between the CTS connector terminal B and the ECM connector terminal B3. Is the problem found?	-	Go to *Step 13*	Go to *Step 10*

DTC 14 - Coolant Temperature High (2.0L DOHC) (Cont'd)

Step	Action	Value(s)	Yes	No
10	1. Turn the ignition OFF. 2. Disconnect the ECM red connector. 3. Inspect the ECM pins and connector for bent or damaged terminals or pins. Is the problem found?	-	Go to *Step 11*	Go to *Step 8*
11	1. Repair the connector terminals and straighten the ECM pins as needed. 2. If the ECM pins are broken, the ECM must be replaced. Have the terminals and pins been repaired?	-	Go to *Step 6*	-
12	1. Repair the short to voltage in the wire between the CTS connector terminal A and the ECM connector terminal B2. 2. Run the engine until it reaches operating temperature. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
13	1. Repair the short to ground in the wire between the CTS connector terminal B and the ECM connector terminal B3. 2. Run the engine until it reaches operating temperature. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

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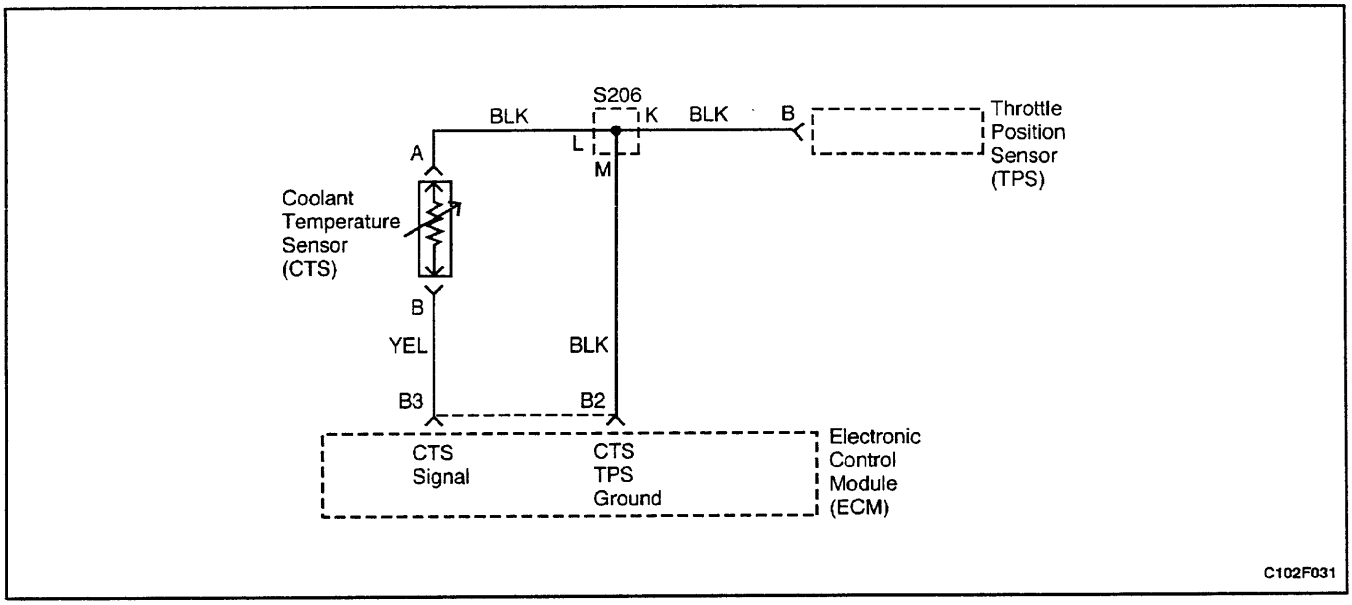

DIAGNOSTIC TROUBLE CODE (DTC) 15 COOLANT TEMPERATURE LOW (2.0L DOHC)

Circuit Description

The coolant temperature sensor (CTS) uses a thermistor to control the signal voltage to the electronic control module (ECM). The ECM applies a voltage to the CTS. When the engine is cold, the CTS resistance is high. Therefore, the ECM will see a high signal voltage. As the engine warms, the CTS resistance becomes less, and the voltage drops. At normal engine operating temperature the CTS signal will measure about 1.5 to 2.0 volts.

DTC 15 Will Set When

- The engine has been running for more than 50 seconds.
- The coolant temperature sensor signal voltage indicates a coolant temperature below −35°C (−31°F).

Diagnostic Aids

- If connections are OK, monitor the coolant temperature while moving related connectors and the wiring harness. If the failure is induced, the display on the scan tool will change. This may help to isolate the location of an intermittent malfunction.
- The "Temperature Vs. Resistance Values" scale may be used to test the coolant sensor at various temperatures to evaluate the possibility of a "shifted" or "miscaled" coolant temperature sensor which may result in driveability complaints.

COOLANT TEMPERATURE SENSOR		
TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°C	°F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
−5	23	12300
−10	14	16180
−15	5	21450
−20	−4	28680
−30	−22	52700
−40	−40	100700

Test Description

The number(s) below refer to step(s) on the diagnostic table.

4. This test simulates the conditions for setting diagnostic trouble code 14. If the electronic control module (ECM) recognizes the low signal voltage (high temperature) and the scan tool displays 180°C (356°F), the ECM wiring is OK.
6. This step checks for voltage reference from the ECM.

DTC 15 - Coolant Temperature Low (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Run the engine until it reaches operating temperature. Does the scan tool display engine coolant temperature within the value specified?	80-110°C (176-230°F)	Go to "Diagnostic Aids"	Go to *Step 3*
3	1. Turn the ignition OFF. 2. Disconnect the coolant temperature sensor (CTS) connector. 3. Turn the ignition ON. Does the scan tool display engine coolant temperature below the value specified?	−30°C (−22°F)	Go to *Step 4*	Go to *Step 6*
4	Jumper terminals A and B of the CTS connector. Does the scan tool display engine coolant temperature above the value specified?	180°C (356°F)	Go to *Step 5*	Go to *Step 6*
5	1. Replace the coolant temperature sensor. 2. Run the engine until it reaches operating temperature. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
6	Measure the voltage at the CTS connector terminal B. Is the voltage within the value specified?	4.5-5.5 v	Go to *Step 7*	Go to *Step 9*
7	1. Turn the ignition OFF. 2. Disconnect electronic control module (ECM) red connector. 3. Inspect the ECM pins and connector for bent or damaged terminals. Repair or replace damaged terminals as needed. 4. Check the wire between the CTS connector terminal A and the ECM connector terminal B2 for an open or short to battery voltage. Is the problem found?	-	Go to *Step 12*	Go to *Step 8*
8	1. Replace the electronic control module. 2. Run the engine until it reaches operating temperature. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
9	Check the wire between the CTS connector terminal B and the ECM connector terminal B3 for an open or short battery voltage. Is the problem found?	-	Go to *Step 13*	Go to *Step 10*

DTC 15 - Coolant Temperature Low (2.0L DOHC) (Cont'd)

Step	Action	Value(s)	Yes	No
10	1. Turn the ignition OFF. 2. Disconnect ECM red connector. 3. Check the ECM pins and the connector for bent or damaged terminals or pins. Is the problem found?	-	Go to *Step 11*	Go to *Step 8*
11	1. Repair the ECM connector terminals and straighten the ECM pins as needed. 2. If the ECM pins are broken, the ECM must be replaced. Have the terminals and pins been repaired?	-	Go to *Step 6*	-
12	1. Repair the open or short to voltage in the wire between the CTS connector terminal A and the ECM connector terminal B2. 2. Run the engine until it reaches operating temperature. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
13	1. Repair the open or short to voltage in the wire between the CTS connector terminal B and the ECM connector terminal B3. 2. Run the engine until it reaches operating temperature. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

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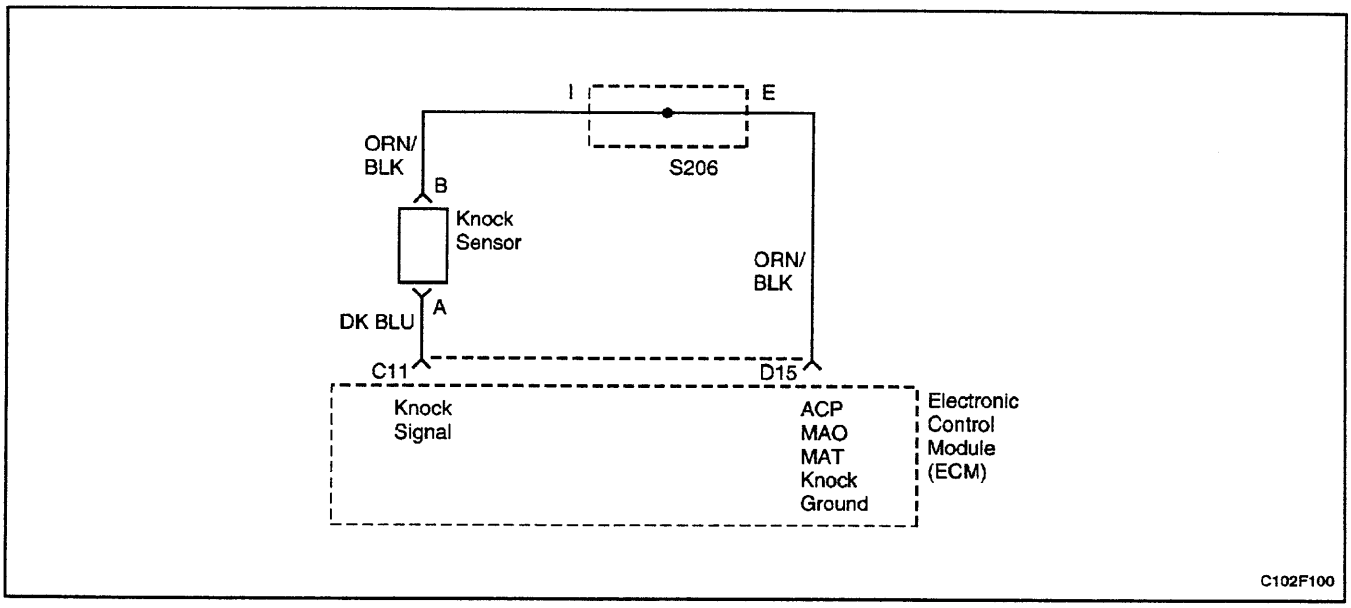


DIAGNOSTIC TROUBLE CODE (DTC) 16 KNOCK SENSOR FAILURE (2.0L DOHC)

Circuit Description

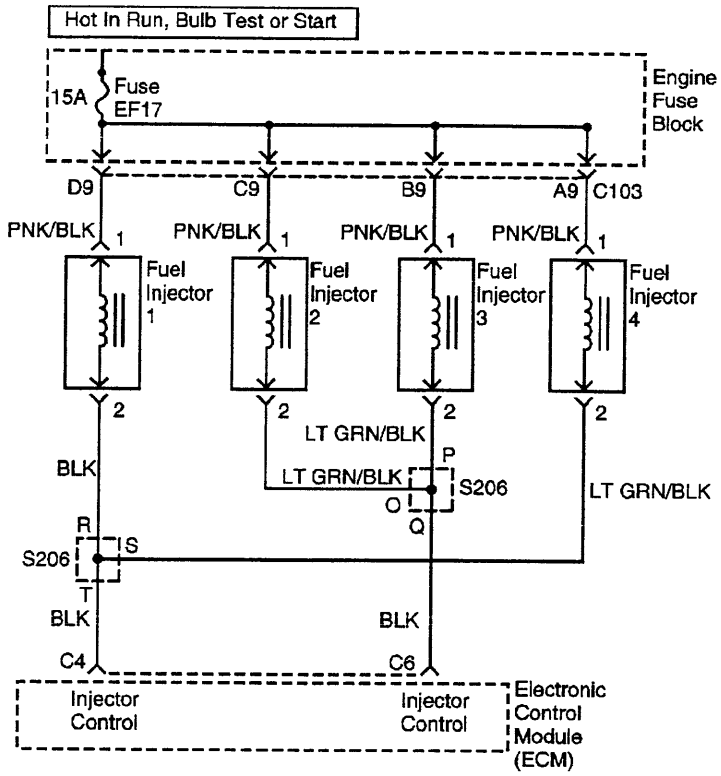
The knock sensor is used to detect engine detonation, allowing the electronic control module (ECM) to retard ignition control spark timing based on the knock sensor signal being received. The knock sensor produces an ac signal. The knock sensor signal's amplitude and frequency depend upon the amount of knock being experienced. The ECM contains a non-replaceable knock filter module called a signal-to-noise enhancement filter module. This filter module in the ECM determines whether knock is occurring by comparing the signal level on the knock sensor circuit with the voltage level on the noise channel. The noise channel allows the ECM to reject any false knock signal by knowing the amount of normal engine mechanical noise present. Normal engine noise varies depending on engine speed and load. When the ECM determines that an abnormally low noise channel voltage level is being experienced, DTC 16 will set.

DTC 16 Will Set When

- The engine speed is above 2,600 rpm.
- Maximum integrated value is above 192.
- Minimum integrated value is below 20.
- The set-up time is above 4 seconds.

DTC 16 - Knock Sensor Failure (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Perform the Diagnostic System Check. Is the Diagnostic System Check complete?	-	Go to *Step 2*	-
2	Replace electronic control module (ECM). Is the repair complete?	-	Go to "Diagnostic System Check"	-



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DIAGNOSTIC TROUBLE CODE (DTC) 17
INJECTOR SHORTED TO GROUND/BATTERY (2.0L DOHC)

Circuit Description

When the ignition switch is turned to ON or START, the engine control module (ECM) will energize and de-energize the fuel injector solenoid coil. With the solenoid coil energized, a plunger is activated, which allows pressurized fuel to be sprayed through the fuel injector into the combustion chamber where it is mixed with air from the intake manifold. This creates the proper air/fuel mixture needed for combustion.

DTC 17 Will Set When

- The fuel pump is running.
- Battery voltage is greater than 9 volts.
- Three consecutive fuel injector faults occurring at 1-second intervals have been detected.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. This step checks for the presence of battery voltage to the fuel injectors.
3. If the fuel injector test light does not flash for one of the fuel injectors, there is an open fuel injector control wire to the electronic control module (ECM) or the ECM is faulty.
13. An open coil in a fuel injector will prevent the fuel injector from operating.

DTC 17 - Injector Shorted to Ground/Battery (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the fuel injector harness from all of the fuel injectors. 2. Turn the ignition ON. 3. Measure the voltage at all of the fuel injector harness terminals. Is battery voltage present on the 1 terminal only of each connector?	-	Go to *Step 3*	Go to *Step 8*
3	Connect a fuel injector test light to each of the fuel injector harness connector while cranking the engine. Does the test light blink on all connectors?	-	Go to *Step 13*	Go to *Step 4*
4	Does the fuel injector test light stay off for one or more of the fuel injector(s)?	-	Go to *Step 6*	Go to *Step 5*
5	Does the fuel injector test light stay on for one or more fuel injector(s)?	-	Go to *Step 11*	-
6	1. Check for a short to battery positive between the fuel injector harness connector terminal 2 and the electronic control module (ECM) connector terminal C4 for fuel injectors 1 and 4. 2. Check for a short to battery positive between the fuel injector harness connector terminal 2 and the ECM connector terminal C6 for fuel injectors 2 and 3. Is the problem found?	-	Go to *Step 7*	Go to *Step 15*
7	1. Repair the short to battery positive as needed. 2. Connect an injector test light to each injector harness connector while cranking the engine. Does the test light blink on all connectors?	-	Go to "Diagnostic System Check"	-
8	Is battery voltage not present at the 1 terminal of any injector harness connector?	-	Go to *Step 10*	Go to *Step 9*
9	Is battery voltage present at the 2 terminal of any injector harness connector?	-	Go to *Step 6*	-
10	1. Check for a short to ground in the fuel injector harness. 2. Check the fuel injector harness connectors for damaged terminals. 3. Perform repairs as needed. 4. Check for battery voltage at the 1 terminals of all of the fuel injector harness connectors. Is battery voltage present on the 1 terminal only of each connector?	-	Go to *Step 3*	-
11	1. Check for a short to ground between the fuel injector harness connector terminal 2 to ECM connector terminal C4 for injectors 1 and 4. 2. Check for a short to ground between the fuel injector harness connector terminal 2 to ECM connector terminal C6 for injectors 2 and 3. Is the problem found?	-	Go to *Step 12*	Go to *Step 15*

DTC 17 - Injector Shorted to Ground/Battery (2.0L DOHC) (Cont'd)

Step	Action	Value(s)	Yes	No
12	1. Repair the short to ground as needed. 2. Connect a fuel injector test light to each of the fuel injector harness connectors while cranking the engine. Does the test light blink on all connectors?	-	Go to *Step 13*	Go to *Step 4*
13	Measure the resistance of each fuel injector. Is the fuel injector resistance within the value specified (the resistance will increase slightly at higher temperatures)?	11.6-12.4 Ω	System OK	Go to *Step 14*
14	1. Replace any of the fuel injectors with a resistance that is out of specification. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
15	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

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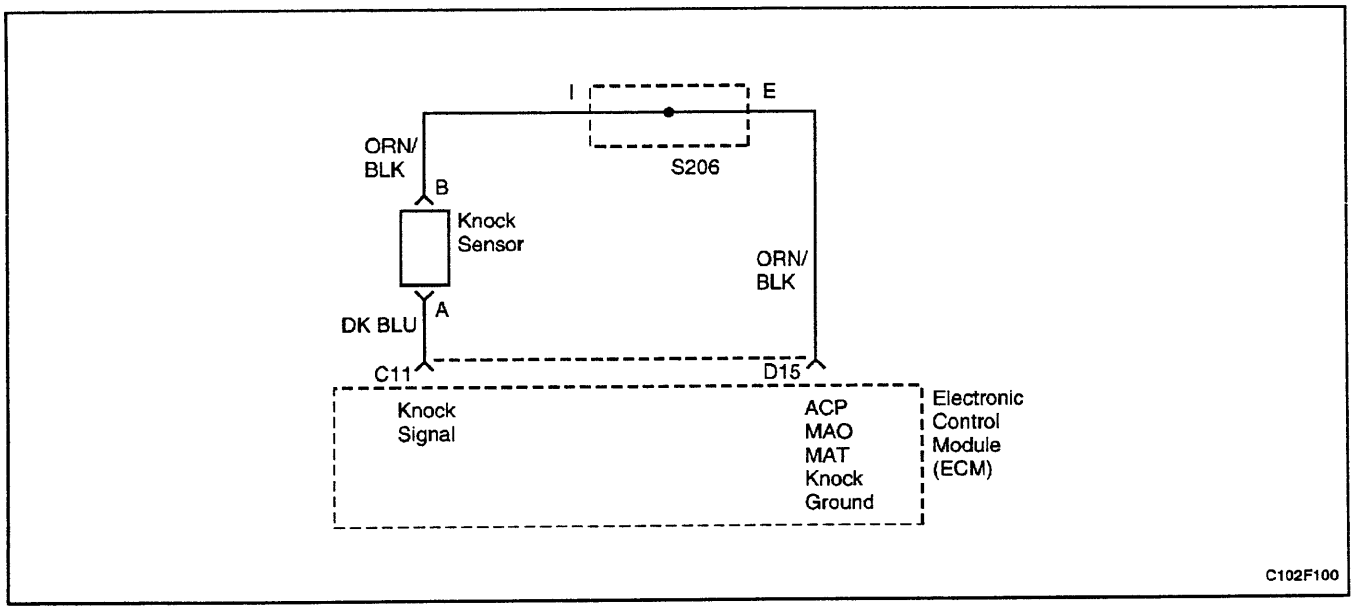


DIAGNOSTIC TROUBLE CODE (DTC) 18
KNOCK SENSOR ACTIVITY FAILURE (2.0L DOHC)

Circuit Description

The electronic control module (ECM) uses the knock sensor to detect engine detonation, allowing the ECM to retard ignition control spark timing based on the knock sensor signal being received. The knock sensor produces an ac signal. The signal amplitude and frequency are dependent upon the amount of knock being experienced.

DTC 18 Will Set When

- DTC 16 is not set.
- Knock detection is enabled.
- The engine speed is above 2,000 rpm.
- Maximum integrated value is above 110 for at least 2 seconds.
- Minimum integrated value is below 1 for at least 2 seconds.
- Noise value is above 55 counts for at least 4 seconds.
- Noise value is below 0 counts for at least 4 seconds.

Diagnostic Aids

- Repair any engine mechanical problem before proceeding with diagnostics.
- Make sure the correct fuel octane rating is used.

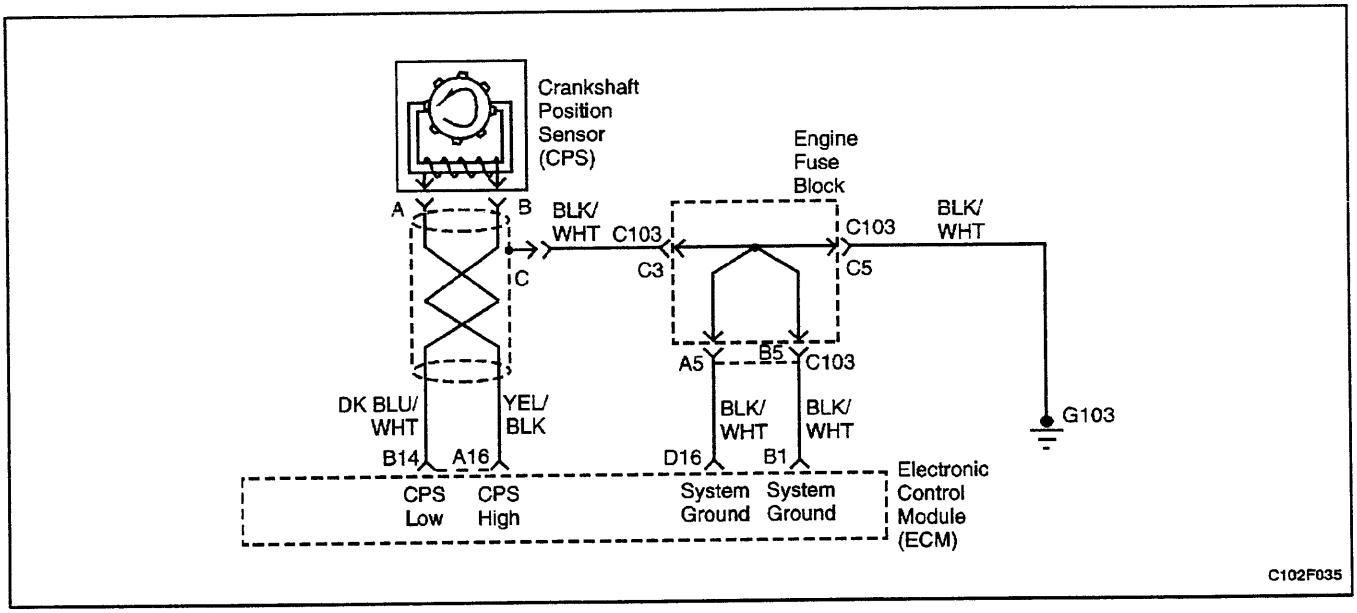
Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. Checks the signal circuit and not sensor voltage.
6. Check the ground side of the circuit for an open, a short to ground, or a short to battery.

DTC 18 - Knock Sensor Activity Failure (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Perform the Diagnostic System Check. Is the Diagnostic System Check complete?	-	Go to *Step 2*	-
2	1. Turn the ignition OFF. 2. Disconnect the electrical connector at electronic control module (ECM). 3. Connect a digital voltmeter (DVM) to monitor ac voltage between between terminal C11 of the ECM connector and ground. 4. Tap on the engine with a extension near the knock sensor while observing the signal on the DVM. Is any signal indicated on the DVM while tapping on the engine?	-	Go to *Step 3*	Go to *Step 4*
3	1. Connect the electrical connector at the ECM. 2. Disconnect the electrical connector at the knock sensor. 3. Using a test light to battery positive probe terminal B on the ECM side of the knock sensor. Did the test light illuminate?	-	Go to Step 6	Go to Step 8
4	Check the wire from terminal C11 on the ECM to terminal A on the ECM side of the knock sensor for an open, a short to ground, or a short to battery. Does the wire indicate an open, a short to ground, or a short to battery?	-	Go to *Step 5*	Go to *Step 7*
5	Repair the wire from terminal C11 of the ECM to terminal A on the ECM side of the knock sensor. Is the repair complete?	-	Go to "Diagnostic System Check"	-
6	Replace the ECM. Is the repair complete?	-	Go to "Diagnostic System Check"	-
7	Replace the knock sensor. Is the repair complete?	-	Go to "Diagnostic System Check"	-
8	Repair the wire from terminal B of the knock sensor to terminal D15 of the ECM. Is the repair complete?	-	Go to "Diagnostic System Check"	-



DIAGNOSTIC TROUBLE CODE (DTC) 19
58X SIGNAL ERROR (A AND B) (2.0L DOHC)

Circuit Description

The crankshaft position sensor is a Hall-effect sensor which senses a slotted wheel that is attached to the crankshaft. The slotted wheel interrupts a magnetic field and produces a reference signal from the sensor.

DTC Will Set When

- Starting manifold absolute pressure (MAP) drop is less than 0.600 kPa (0.178 inches Hg) for more than 3 seconds.
- Starting battery voltage drop is less than 0.8 volt for at least 3 seconds.
- There are consecutive missing pulses of 10 or more.
- The revolutions of the 58X signal are fewer than 64.

Diagnostic Aids

Check for poor connections at the electronic control module (ECM) and at the crankshaft position sensor (CPS).

Test Description

The number(s) below refer to step(s) on the diagnostic table.

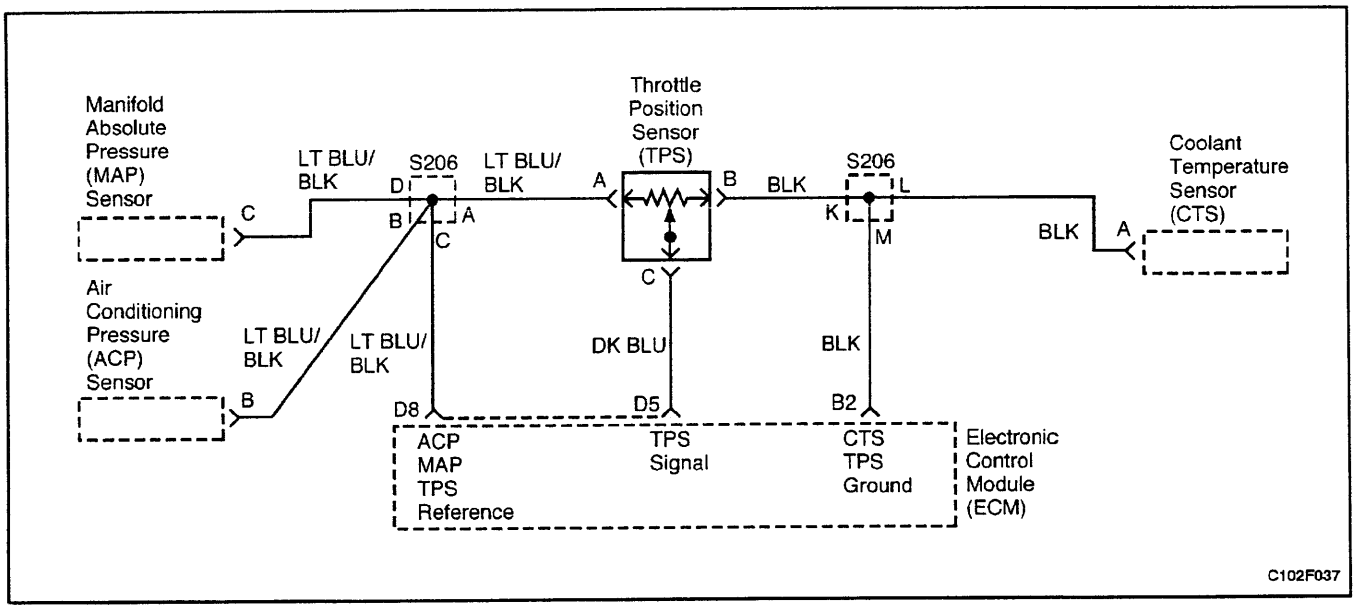
3. It is important to inspect all of the connector terminals to prevent inaccurate diagnosis.
6. The specified value during cranking is an average voltage produced as the sensor voltage oscillates.

DTC 19 - 58X Signal Error (A and B) (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	Start the engine. Does the engine start?	-	Go to *Step 3*	Go to "Engine Cranks But Will Not Start"
3	1. Turn the ignition OFF. 2. Disconnect the crankshaft position sensor (CPS) connector. 3. Inspect the CPS terminals. Are any terminals damaged?	-	Go to *Step 13*	Go to *Step 4*

DTC 19 - 58X Signal Error (A and B) (2.0L DOHC) (Cont'd)

Step	Action	Value(s)	Yes	No
4	Inspect CPS connector terminals. Are any connector terminals damaged?	-	Go to *Step 5*	Go to *Step 6*
5	1. Repair or replace any damaged terminals. 2. Clear any diagnostic trouble codes (DTCs) from the electronic control module (ECM). 3. Road test the vehicle. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
6	1. Connect the CPS connector. 2. Disconnect the direct ignition system (DIS) ignition coil connector to prevent the vehicle from starting. 3. Connect a voltmeter between ground and the ECM connector terminal B14 by backprobing the ECM connector. Are the voltage readings near the values specified?	1.08 v with the ignition ON, 1.20 v during cranking	Go to *Step 7*	Go to *Step 9*
7	Connect a voltmeter between ground and the ECM connector terminal A16 by backprobing the ECM connector. Are the voltage readings near the values specified?	1.08 v with the ignition ON, 1.20 v during cranking	Go to *Step 8*	Go to *Step 10*
8	1. Connect the DIS ignition coil connector 2. Replace the electronic control module. 3. Road test the vehicle. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
9	Check for an open or short in the wire between the CPS connector terminal A and the ECM connector terminal B14. Is the problem found?	-	Go to *Step 12*	Go to *Step 11*
10	Check for an open or short in the wire between the CPS connector terminal B and the ECM connector terminal A16. Is the problem found?	-	Go to *Step 12*	Go to *Step 11*
11	Check for an open or short in the wire between the CPS connector terminal C and ground. Is the problem found?	-	Go to *Step 12*	Go to *Step 13*
12	1. Connect the DIS ignition coil connector. 2. Repair the wiring needed. 3. Clear any DTCs from the ECM. 4. Road test the vehicle. 5. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
13	1. Connect the DIS ignition coil connector. 2. Replace the crankshaft position sensor. 3. Clear any DTCs from the ECM. 4. Road test the vehicle. 5. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 21
THROTTLE POSITION SENSOR HIGH (2.0L DOHC)

Circuit Description

The throttle position sensor (TPS) provides a voltage signal that changes in relation to the throttle plate angle. The signal voltage will vary from about 0.4 to 0.8 volt at idle to nearly 5.0 volts at wide open throttle. The TPS is one of the most important inputs used by the electronic control module (ECM) for fuel control and other functions such as idle, wide open throttle, deceleration enleanment, and acceleration enrichment.

DTC 21 Will Set When

- DTC 33 and DTC 34 are not set.
- The engine speed is less than 3,000 rpm.
- The manifold absolute pressure reading is below 85 kPa (25 inches Hg).
- The throttle position sensor reading is greater than 240 counts.
- These conditions are present for 2 seconds.

Diagnostic Aids

- Inspect the electronic control module connector (ECM) terminals and the throttle position sensor (TPS) connector terminals for improper mating and poor terminal-to-wire connections.
- Observe the TPS voltage on a scan tool with the ignition ON and the engine stopped. Press the accelerator pedal while watching for smooth changes in the voltage readings of the TPS.

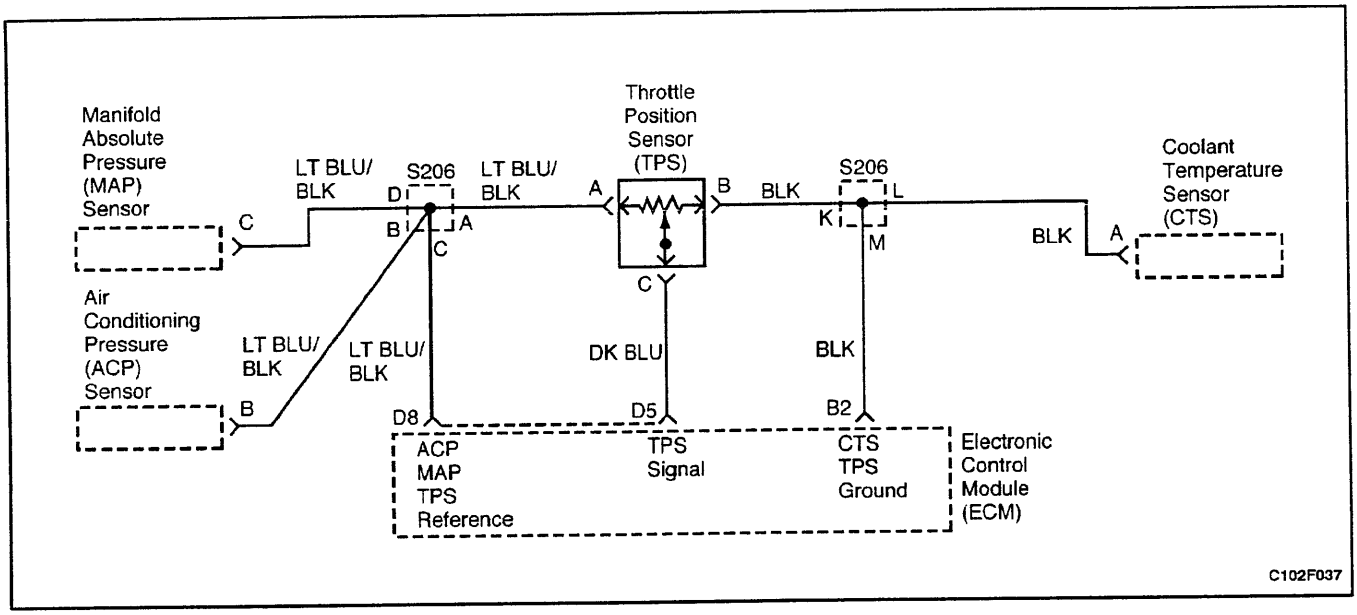
Test Description

The number(s) below refer to step(s) on the diagnostic table.

3. This step checks the voltage reference from the ECM and also the ground wire to the ECM.
4. This step checks the TPS signal wire. If the scan tool shows the TPS voltage above 4 volts, the signal wire is OK.
10. After checking the TPS wiring and confirming the ECM's ability to read a TPS signal, it can be determined that the TPS is at fault.

DTC 21 - Throttle Position Sensor High (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Connect a scan tool to the assembly line diagnostic link (ALDL). 2. Turn the ignition ON. 3. Operate the throttle lever from closed to open while watching the throttle position sensor (TPS) voltage on the scan tool. Does the scan tool show the TPS voltage change smoothly within the value specified?	0.10-0.90 v to 3.9-4.9 v	Go to "Diagnostic Aids"	Go to *Step 3*
3	1. Turn the ignition OFF. 2. Disconnect the TPS connector. 3. Turn the ignition ON. 4. Measure the voltage between the TPS connector terminals A and B. Does the voltage measure within the value specified?	4.5-5.5 v	Go to *Step 4*	Go to *Step 5*
4	Jumper the TPS connector terminals A and C. Does the scan tool show the TPS voltage above the value specified?	4.0 v	Go to *Step 10*	Go to *Step 8*
5	Measure the voltage between the TPS connector terminal A and ground. Does the voltage measure within the value specified?	4.5-5.5 v	Go to *Step 6*	Go to *Step 7*
6	Check for a short to battery voltage in the wire between the TPS connector terminal B and the electronic control module (ECM) connector terminal B2. Is the problem found?	-	Go to *Step 9*	Go to *Step 11*
7	Check for a short to battery voltage in the wire between the TPS connector terminal A and the ECM connector terminal D8. Is the problem found?	-	Go to *Step 9*	Go to *Step 11*
8	Check for a short to voltage in the wire between the TPS connector terminal C and the ECM connector terminal D5. Is the problem found?	-	Go to *Step 9*	Go to *Step 11*
9	1. Turn the ignition OFF. 2. Repair the wire or the connector terminal as needed. 3. Clear any diagnostic trouble codes (DTCs) from the ECM. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
10	1. Turn the ignition OFF. 2. Replace the throttle position sensor. 3. Clear any DTCs from the ECM. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
11	1. Turn the ignition OFF. 2. Replace the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 22 THROTTLE POSITION SENSOR LOW (2.0L DOHC)

Circuit Description

The throttle position sensor (TPS) provides a voltage signal that changes in relation to the throttle plate angle. The signal voltage will vary from about 0.4 to 0.8 volt at idle to nearly 5.0 volts at wide open throttle. The TPS is one of the most important inputs used by the electronic control module (ECM) for fuel control and other functions such as idle, wide open throttle, deceleration enleanment, and acceleration enrichment.

DTC 22 Will Set When

- The throttle position sensor reading is less than 11 counts.
- DTC 33 and DTC 34 are not set.

Diagnostic Aids

- Inspect the electronic control module connector (ECM) terminals and the throttle position sensor (TPS) connector terminals for improper mating and poor terminal-to-wire connections.
- Observe the TPS voltage on a scanner with the ignition ON and the engine stopped. Press the accelerator pedal while watching for smooth changes in the voltage readings of the TPS.

Test Description

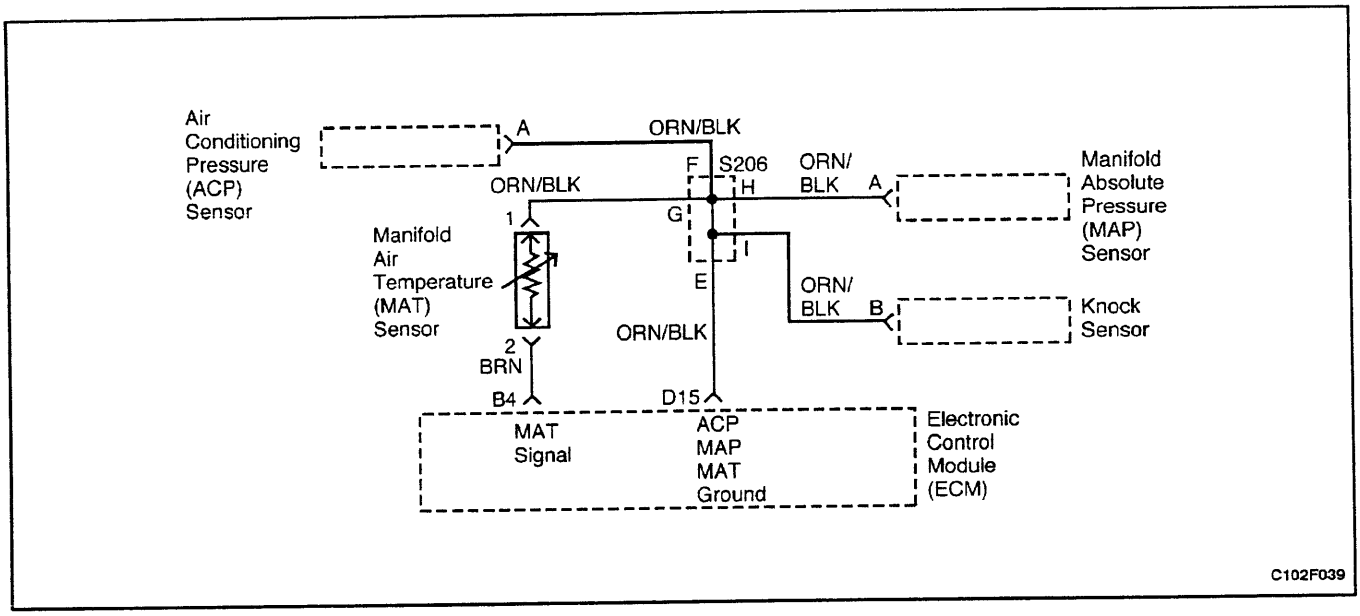
The number(s) below refer to step(s) on the diagnostic table.

1. When measuring the voltage between the throttle position sensor (TPS) terminals A and B, 4.5 to 5.5 volts confirms the 5-volt reference and ground from the electronic control module (ECM) are OK.

11. If there is a problem with the voltage reference or the ground from the ECM, confirm that the wiring is OK. If there is no problem present in the wiring, the ECM is at fault.

DTC 22 - Throttle Position Sensor Low (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Turn the ignition ON. 3. Operate the throttle lever from closed to open while watching the throttle position sensor (TPS) voltage on the scan tool. Does the scan tool show the TPS voltage change smoothly within the values specified?	0.10-0.90 v to 3.9-4.9 v	Go to "Diagnostic Aids"	Go to *Step 3*
3	1. Turn the ignition OFF. 2. Disconnect the TPS connector. 3. Turn the ignition ON. 4. Measure the voltage between the TPS connector terminals A and B. Is the voltage within the value specified?	4.5-5.5 v	Go to *Step 4*	Go to *Step 5*
4	Connect a fused jumper between the TPS connector terminals A and C. Does the scan tool show the TPS voltage above the value specified?	4 v	Go to *Step 10*	Go to *Step 8*
5	Measure the voltage between the TPS connector terminal A and the ground. Is the voltage within the value specified?	4.5-5.5 v	Go to *Step 6*	Go to *Step 7*
6	1. Turn the ignition OFF. 2. Check for an open in the wire between the TPS connector terminal B and the electronic control module (ECM) connector terminal B2. Is the problem found?	-	Go to *Step 9*	Go to *Step 11*
7	1. Turn the ignition OFF. 2. Check for an open or short to ground in the wire between the TPS connector terminal A and the ECM connector terminal D8. Is the problem found?	-	Go to *Step 9*	Go to *Step 11*
8	1. Turn the ignition OFF. 2. Check for an open or short to ground between the TPS connector terminal C and the ECM connector terminal D5. Is the problem found?	-	Go to *Step 9*	Go to *Step 11*
9	1. Repair the wire or the connector terminal as needed. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
10	1. Replace the throttle position sensor. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
11	1. Ignition OFF. 2. Replace the electronic control module. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 23
MANIFOLD AIR TEMPERATURE HIGH (2.0L DOHC)

Circuit Description

The manifold air temperature (MAT) sensor is a thermistor which measures the temperature of the air entering the engine. The electronic control module (ECM) applies 5 volts through a pull-up resistor to the MAT sensor. When the temperature is cold, the MAT sensor resistance is high and the ECM will monitor a high signal voltage on the MAT circuit. If the intake air is warm, the sensor resistance is lower, causing the ECM to monitor a lower voltage.

DTC 23 Will Set When

- The engine has been running longer than 120 seconds.
- The manifold air temperature (MAT) sensor signal voltage indicates a temperature above 140°C (284°F).

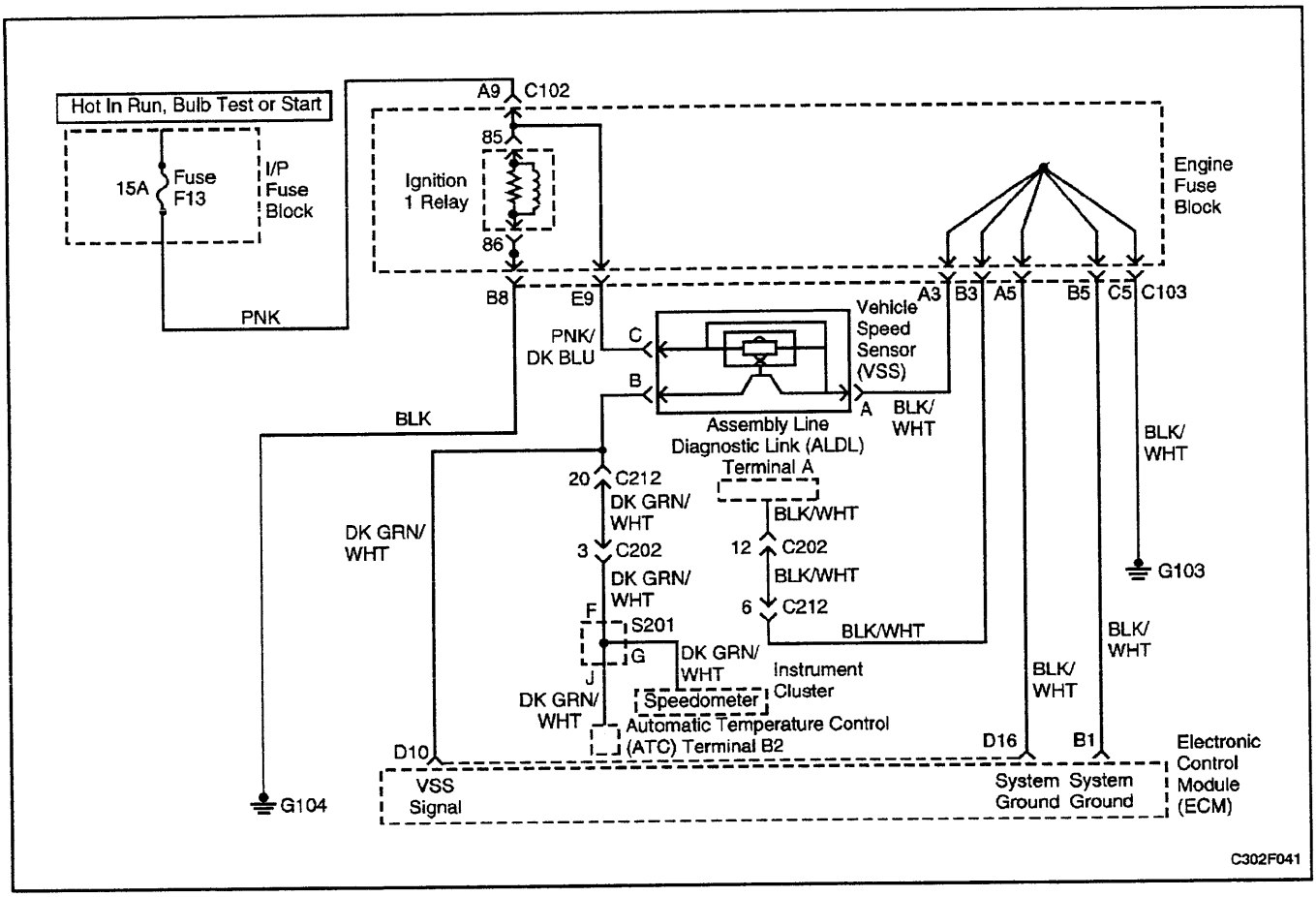
Diagnostic Aids

Inspect the wiring harness for damage. If the harness appears to be OK, observe the manifold air temperature (MAT) sensor display on the scan tool while moving the connectors and the wiring harnesses related to the MAT sensor. A change in the display will indicate the location of the fault.

MANIFOLD AIR TEMPERATURE SENSOR		
TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°C	°F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
−5	23	12300
−10	14	16180
−15	5	21450
−20	−4	28680
−30	−22	52700
−40	−40	100700

DTC 23 - Manifold Air Temperature High (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Run the engine until it reaches operating temperature. Does the scan tool show the manifold air temperature (MAT) sensor reading within the value specified?	10-80°C (50-176°F)	Go to "Diagnostic Aids"	Go to *Step 3*
3	1. Turn the ignition OFF. 2. Disconnect the MAT sensor connector. 3. Turn the ignition ON. Does the scan tool show the MAT sensor reading below the value specified?	Lower Than −35°C (−31°F)	Go to *Step 4*	Go to *Step 5*
4	Check for a faulty connector or terminals at the MAT sensor connector. Is the problem found?	-	Go to *Step 7*	Go to *Step 8*
5	Check the wire for a short to ground between the MAT connector terminal 2 and the electronic control module (ECM) connector terminal B4. Is the problem found?	-	Go to *Step 7*	Go to *Step 6*
6	Check the wire for a short to ECM reference voltage between the MAT connector terminal 1 and the ECM connector terminal D15. Is the problem found?	-	Go to *Step 7*	Go to *Step 9*
7	1. Turn the ignition OFF. 2. Repair the wire or the connector terminal as needed. 3. Clear any diagnostic trouble codes (DTCs) from the ECM. 4. Run the engine until it reaches operating temperature. 5. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	Go to *Step 2*
8	1. Turn the ignition OFF. 2. Replace the manifold air temperature sensor. 3. Clear any DTCs from the ECM. 4. Run the engine until it reaches operating temperature. 5. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
9	1. Turn the ignition OFF. 2. Replace the ECM. 3. Run the engine until it reaches operating temperature. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 24
VEHICLE SPEED SENSOR ERROR (2.0L DOHC)

Circuit Description

The electronic control module (ECM) applies and monitors 12 volts on the signal wire between the vehicle speed sensor (VSS) and the ECM. The signal wire connects to the vehicle speed sensor which alternately grounds the signal wire when the drive wheels are turning. This pulsing action takes place 2,289 times per kilometer (3,683 times per mile) and the ECM will calculate vehicle speed based on the time between the pulses. This information is also displayed by the vehicle speedometer.

DTC 24 Will Set When

- Diagnostic trouble codes (DTCs) 21, 22, 33, and 34 are not set.
- The engine speed is between 2,000 rpm and 5,000 rpm.
- The vehicle speed sensor indicates a speed less than 6 km/h (4 mph).
- The manifold absolute pressure sensor signal indicates less than 24 kPa (7 inches of Hg).
- These conditions are present for 4 seconds.

Diagnostic Aids

- Scan tool data should indicate a vehicle speed whenever the drive wheels are turning at more than 5 km/h (3 mph).

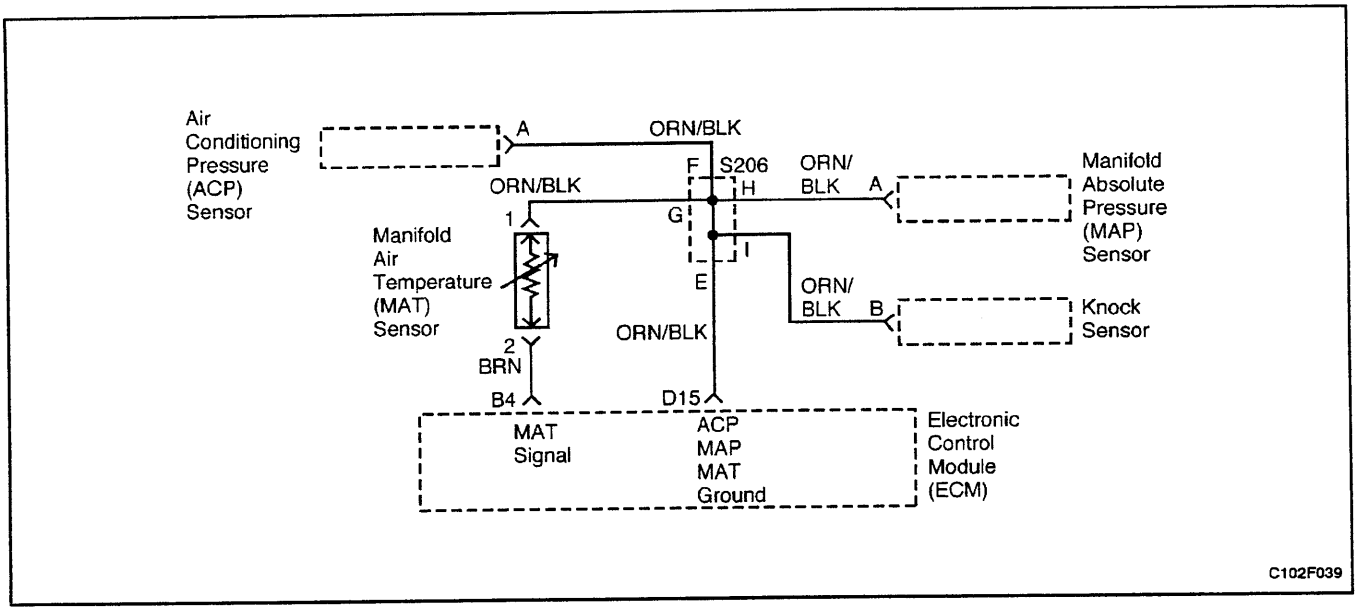
Test Description

The number(s) below refer to step(s) on the diagnostic table.

4. By momentarily touching the vehicle speed sensor (VSS) connector terminal B several times a second, a simulated VSS signal is created. If voltage and ground are present at the VSS, the VSS is faulty.

DTC 24 - Vehicle Speed Sensor Error (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Road test the vehicle. Does the scan tool read vehicle speed?	-	Go to "Diagnostic Aids"	Go to *Step 3*
3	1. Turn the ignition OFF. 2. Disconnect the vehicle speed sensor (VSS) connector. 3. Turn the ignition ON. 4. Connect a test light between the VSS connector terminal B and ground. Is the test light on?	-	Go to *Step 9*	Go to *Step 4*
4	With a test light connected to ground, momentarily touch the VSS connector terminal B several times a second. Does the scan tool read vehicle speed?	-	Go to *Step 5*	Go to *Step 11*
5	Connect a test light between the VSS connector terminal C and ground. Is the test light on?	-	Go to *Step 6*	Go to *Step 7*
6	1. Turn the ignition OFF. 2. Connect a test light between the VSS connector terminal A and battery positive. Is the test light on?	-	Go to *Step 10*	Go to *Step 8*
7	Repair the open wire between the VSS connector terminal C and the ignition switch. Is the repair complete?	-	System OK	-
8	Repair the open wire between the VSS connector terminal A and ground. Is the repair complete?	-	System OK	-
9	Repair the short to voltage in the wire between the VSS connector terminal B and the electronic control module (ECM) connector terminal D10. Is the repair complete?	-	System OK	-
10	Replace the vehicle speed sensor. Is the repair complete?	-	System OK	-
11	1. Turn the ignition OFF. 2. Check for an open wire between the VSS connector terminal B and the ECM connector terminal D10. Is the problem found?	-	Go to *Step 12*	Go to *Step 13*
12	Repair the open wire between the VSS connector terminal B and the ECM connector terminal D10. Is the repair complete?	-	System OK	-
13	Replace the ECM. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 25
MANIFOLD AIR TEMPERATURE LOW (2.0L DOHC)

Circuit Description

The manifold air temperature (MAT) sensor is a thermistor which measures the temperature of the air entering the engine. The electronic control module (ECM) applies 5 volts through a pull-up resistor to the MAT sensor. When the temperature is cold, the MAT sensor resistance is high and the ECM will monitor a high signal voltage on the MAT circuit. If the intake air is warm, the sensor resistance is lower, causing the ECM to monitor a lower voltage.

DTC 25 Will Set When

- The engine has been running longer than 120 seconds.
- The manifold air temperature (MAT) sensor signal voltage indicates a temperature less than −38.5°C (−37°F).

Diagnostic Aids

Inspect the wiring harness for damage. If the harness appears to be OK, observe the manifold air temperature (MAT) sensor display on the scan tool while moving the connectors and the wiring harnesses related to the MAT sensor. A change in the display will indicate the location of the fault.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

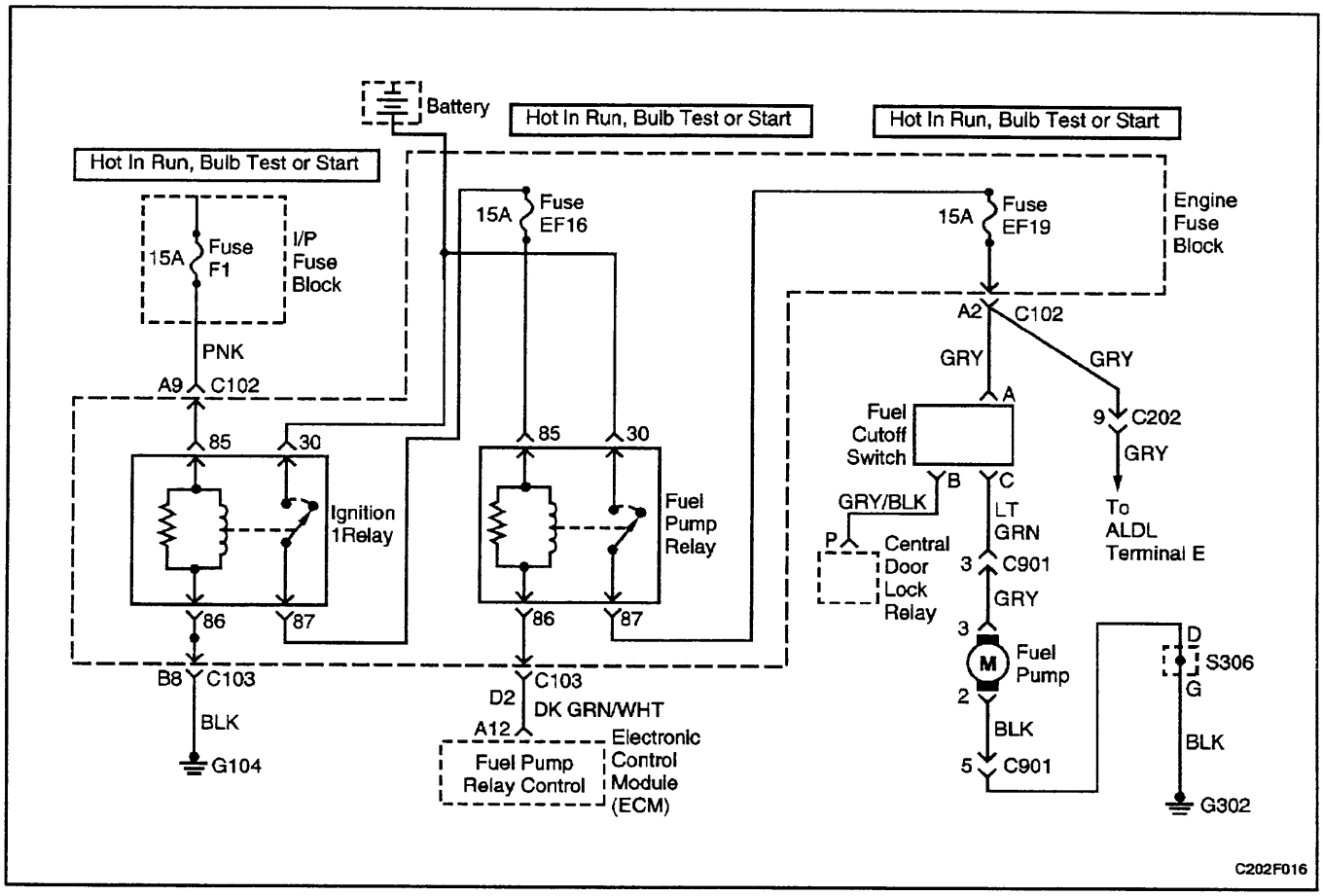
6. This step checks for reference voltage and ground from the electronic control module (ECM).

MANIFOLD AIR TEMPERATURE SENSOR		
TEMPERATURE VS. RESISTANCE VALUES (APPROXIMATE)		
°C	°F	OHMS
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
−5	23	12300
−10	14	16180
−15	5	21450
−20	−4	28680
−30	−22	52700
−40	−40	100700

DTC 25 - Manifold Air Temperature Low (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Run the engine until it reaches operating temperature. Does the scan tool show the manifold air temperature (MAT) sensor reading within the value specified?	10-80°C (50-176°F)	Go to "Diagnostic Aids"	Go to *Step 3*
3	1. Turn the ignition OFF. 2. Disconnect the MAT sensor connector. 3. Jumper the MAT connector terminals. 4. Turn the ignition ON. Does the scan tool show the MAT sensor reading above the value specified?	180°C (356°F)	Go to *Step 4*	Go to *Step 5*
4	Check for a faulty connector or terminals at the MAT sensor connector. Is the problem found?	-	Go to *Step 10*	Go to *Step 9*
5	Measure the voltage between terminals 1 and 2 of the MAT connector. Does the voltage measure within the value specified?	4.5-5.5 v	Go to *Step 11*	Go to *Step 6*
6	Measure the voltage between the MAT terminal 2 and the battery ground (negative) post. Does the voltage measure within the value specified?	4.5-5.5 v	Go to *Step 7*	Go to *Step 8*
7	1. Turn the ignition OFF. 2. Check for an open or short to battery voltage in the wire between the MAT connector terminal 1 and the electronic control module (ECM) connector terminal D15. Is the problem found?	-	Go to *Step 10*	Go to *Step 11*
8	1. Turn the ignition OFF. 2. Check for an open or short to battery voltage in the wire between the MAT connector terminal 2 and the ECM connector terminal B4. Is the problem found?	-	Go to *Step 10*	Go to *Step 11*
9	1. Turn the ignition OFF. 2. Replace the manifold air temperature sensor. 3. Clear any diagnostic trouble codes (DTCs) from the ECM. 4. Run the engine until it reaches operating temperature. 5. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

10	1. Turn the ignition OFF. 2. Repair the wire or the connector terminal as needed. 3. Clear any DTCs from the ECM. 4. Run the engine until It reaches operating temperature. 5. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
11	1. Replace the ECM. 2. Run the vehicle until it reaches operating temperature. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 29
FUEL PUMP RELAY SHORTED TO GROUND (2.0L DOHC)

Circuit Description

When the ignition is turned ON, the electronic control module (ECM) applies ground to the fuel pump relay coil side. The ECM will apply this ground for 2 seconds or until reference pulses are received by the ECM from the crankshaft position sensor. This activates the fuel pump relay, applying battery voltage to the fuel pump.

DTC 29 Will Set When

- The fuel pump relay circuit is shorted to ground for more than 1.6 seconds.

Diagnostic Aids

- Inspect the ECM wiring harness connectors for improper mating, broken locks, improperly formed or damaged terminals, a poor terminal-to-wire connection, and a damaged harness.
- If the connections and the wiring harness are in good condition, connect a test light between the fuel pump relay connector terminal 85 and battery positive while moving related connectors. If the fault is induced, the test light will turn on. This may help to isolate the location of an intermittent problem.

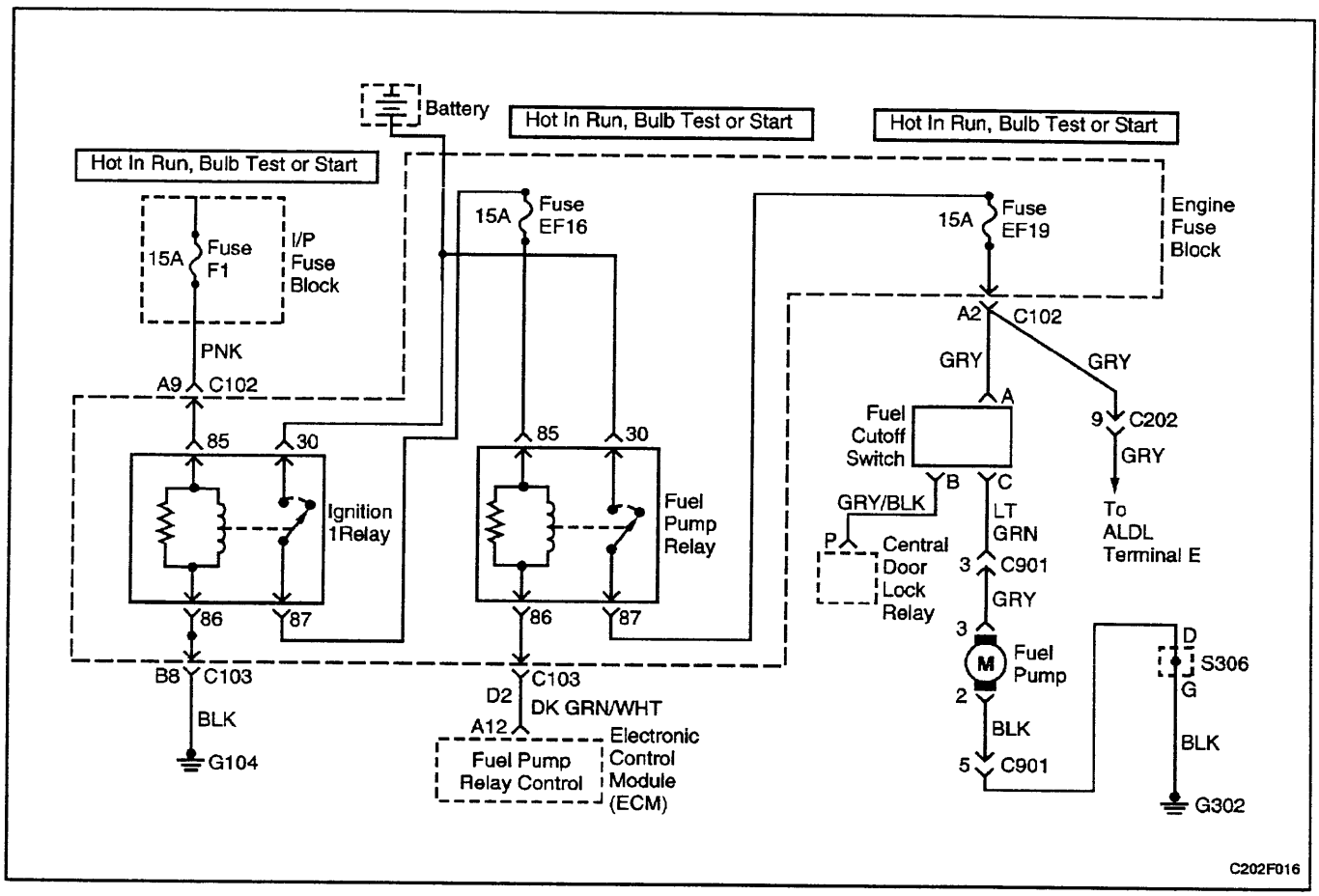
Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. With the ignition OFF, the ECM should not be applying ground to the fuel pump relay.
3. If the test light is still on after disconnecting the ECM red connector, the wire between the fuel pump relay and the ECM is shorted to ground. If the test light goes off, the ECM is at fault.

DTC 29 - Fuel Pump Relay Shorted to Ground (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Perform the Diagnostic System Check. Is the Diagnostic System Check complete?	-	Go to *Step 2*	-
2	1. Disconnect the fuel pump relay. 2. Connect a test light between the fuel pump relay connector terminal 86 and battery positive. Is the test light on?	-	Go to *Step 3*	Go to "Diagnostic Aids"
3	Disconnect the electronic control module (ECM) red connector. Is the test light on?	-	Go to *Step 4*	Go to *Step 5*
4	1. Repair the short to ground in the wire between the fuel pump relay connector terminal 86 and the ECM connector terminal A12. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
5	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 32
FUEL PUMP RELAY SHORTED TO BATTERY (2.0L DOHC)

Circuit Description

When the ignition is turned ON, the electronic control module (ECM) applies ground to the fuel pump relay coil side. The ECM will apply this ground for 2 seconds or until reference pulses are received by the ECM from the crankshaft position sensor. This activates the fuel pump relay, applying battery voltage to the fuel pump.

DTC 32 Will Set When

- The fuel pump relay circuit is shorted to battery for more than 1.6 seconds.

Diagnostic Aids

- Inspect the ECM wiring harness connectors for improper mating, broken locks, improperly formed or damaged terminals, a poor terminal-to-wire connection, and a damaged harness.
- If the connections and the wiring harness are in good condition, connect a test light between the fuel pump relay connector terminal 85 and ground while moving related connectors. If the fault is induced, the test light will turn on. This may help to isolate the location of an intermittent problem.

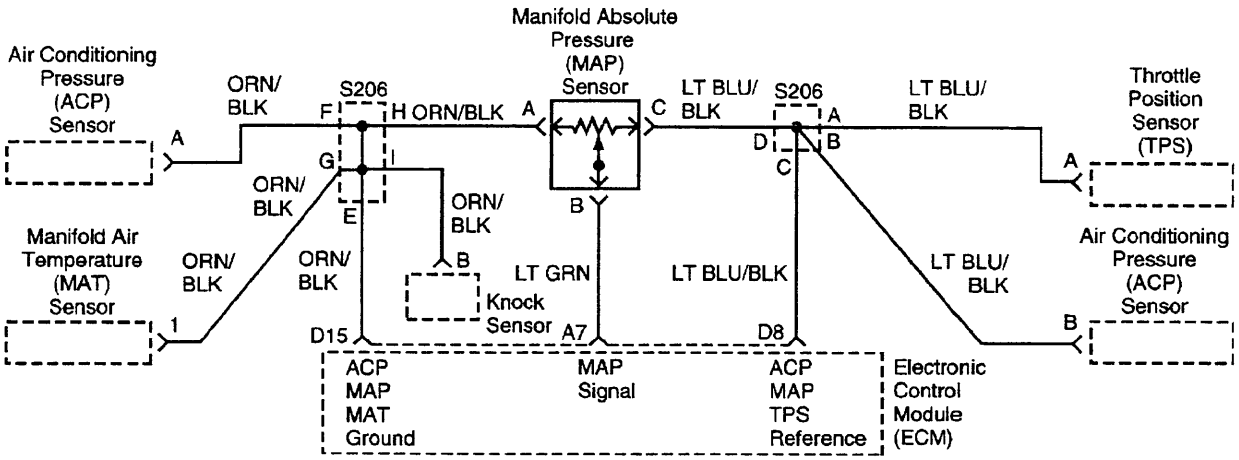
Test Description

The number(s) below refer to step(s) on the diagnostic table.

4. If the test light is still on after disconnecting the ECM red connector, the wire between the fuel pump relay and the ECM is shorted to voltage. If the test light goes off, the ECM is at fault.

DTC 32 - Fuel Pump Relay Shorted to Battery (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Perform the Diagnostic System Check. Is the Diagnostic System Check complete?	-	Go to *Step 2*	-
2	1. Disconnect the fuel pump relay. 2. Measure the resistance between the fuel pump relay terminals 85 and 86. Does the resistance measure near the value specified?	≈ 0 Ω	Go to *Step 6*	Go to *Step 3*
3	Connect a test light between the fuel pump relay connector terminal 86 and ground. Is the test light on?	-	Go to *Step 4*	Go to "Diagnostic Aids"
4	Disconnect the electronic control module (ECM) red connector. Is the test light on?	-	Go to *Step 5*	Go to *Step 7*
5	1. Repair the short to voltage in the wire between the fuel pump relay connector terminal 86 and the ECM connector terminal A12. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
6	1. Replace the fuel pump relay. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
7	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 33
MANIFOLD ABSOLUTE PRESSURE SENSOR HIGH (2.0L DOHC)

Circuit Description

The manifold absolute pressure (MAP) sensor responds to changes in the manifold vacuum. The electronic control module (ECM) receives this information as a signal voltage that will vary from about 1.0 to 1.5 volts at closed throttle (idle) to 4.5 to 5.0 volts at wide open throttle.

DTC 34 Will Set When

- Diagnostic trouble code (DTC) 21 is not set.
- DTC 22 is not set.
- The throttle angle is below 5 percent.
- The manifold absolute pressure (MAP) sensor signal indicates greater than 95 kPa (28 inches of Hg).
- These conditions are present for 5 seconds.

Diagnostic Aids

- If the connections are OK, monitor the manifold absolute pressure (MAP) sensor signal voltage while moving related connectors and the wiring harness. If the failure is induced, the display on the scan tool will change. This may help to isolate the location of an intermittent malfunction.
- With the ignition ON and the engine OFF, the MAP sensor pressure is equal to the atmospheric pressure. This information is used by the electronic control module (ECM) as an indication of altitude. Comparison of these readings with a known good vehicle with the same MAP sensor is a good way to check the accuracy of a questionable MAP sensor. The readings should be the same within 0.4 volt.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

4. With the ignition ON and the engine OFF, the manifold absolute pressure (MAP) sensor is reading atmospheric or barometric pressure. If this reading is below 4 volts, the electronic control module (ECM) may prevent the engine from starting.
6. This step checks for a reference voltage and a ground from the ECM.
7. This step is checking the voltage reference and the signal return wire to the ECM. If the ECM recognizes the voltage reference and there is not a problem in the ground side of the circuit, the MAP sensor is faulty.

DTC 33 - Manifold Absolute Pressure Sensor High (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	Check the vacuum line from the manifold absolute pressure (MAP) sensor for cracks, leaks, or restrictions. Is the problem found?	-	Go to *Step 3*	Go to *Step 4*
3	1. Repair or replace the vacuum line as needed. 2. Road test the vehicle. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
4	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Turn the ignition ON. Does the scan tool show the MAP sensor voltage above the value specified?	4 v	Go to *Step 5*	Go to *Step 6*
5	1. Disconnect the vacuum line from the MAP sensor. 2. Apply 68 kPa (20 in. of Hg) of vacuum to the MAP sensor. Does the scan tool show the MAP sensor voltage within the value specified?	1.0-1.5 v	Go to "Diagnostic Aids"	Go to *Step 6*
6	1. Turn the ignition OFF. 2. Disconnect the MAP sensor connector. 3. Turn the ignition ON. 4. Measure the voltage between MAP sensor connector terminals A and C. Does the voltage measure within the value specified?	4.5-5.5 v	Go to *Step 7*	Go to *Step 8*
7	Connect a fused jumper between the MAP sensor connector terminals B and C. Does the scan tool show the MAP sensor voltage above the value specified?	4 v	Go to *Step 13*	Go to *Step 11*
8	Measure the voltage between the MAP sensor connector terminal C and ground. Does the voltage measure within the value specified?	4.5-5.5 v	Go to *Step 9*	Go to *Step 10*
9	Check for a short to battery voltage in the wire between the MAP sensor connector terminal A and the electronic control module (ECM) connector terminal D15. Is the problem found?	-	Go to *Step 12*	Go to *Step 11*
10	Check for a short to battery voltage in the wire between the MAP sensor connector terminal C and the ECM connector terminal D8. Is the problem found?	-	Go to *Step 12*	Go to *Step 14*
11	Check for a short to voltage in the wire between the MAP sensor connector terminal B and the ECM connector terminal A7. Is the problem found?	-	Go to *Step 12*	Go to *Step 14*

DTC 33 - Manifold Absolute Pressure Sensor High (2.0L DOHC) (Cont'd)

Step	Action	Value(s)	Yes	No
12	1. Repair the wire or the connector terminal as needed. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	Go to *Step 5*
13	1. Replace the manifold absolute pressure sensor. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
14	1. Turn the ignition OFF. 2. Replace the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

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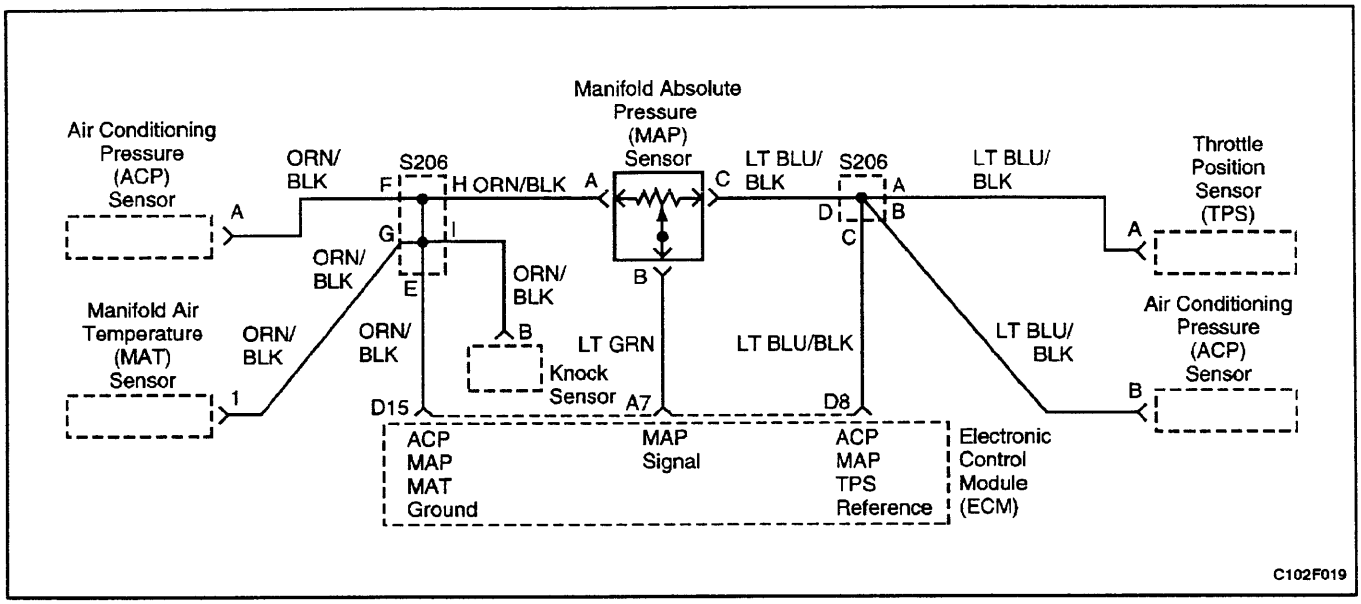

DIAGNOSTIC TROUBLE CODE (DTC) 34
MANIFOLD ABSOLUTE PRESSURE SENSOR LOW (2.0L DOHC)

Circuit Description

The manifold absolute pressure (MAP) sensor responds to changes in the manifold vacuum. The electronic control module (ECM) receives this information as a signal voltage that will vary from about 1.0 to 1.5 volts at closed throttle (idle) to 4.5 to 5.0 volts at wide open throttle.

DTC 34 Will Set When

- Diagnostic trouble codes (DTCs) 21 and 22 are not set.
- The engine speed is less than 1,050 rpm, or the engine speed is greater than 1,040 rpm and the throttle angle is greater than 18.8 percent.
- The manifold absolute pressure (MAP) sensor signal voltage indicates less than 14 kPa (4.0 inches of Hg).
- These conditions have been present for 1 second.

Diagnostic Aids

- If the connections are OK, monitor the manifold absolute pressure (MAP) sensor signal voltage while moving related connectors and the wiring harness. If the failure is induced, the display on the scan tool will change. This may help to isolate the location of an intermittent malfunction.
- With the ignition ON and the engine OFF, the MAP sensor pressure is equal to the atmospheric pressure. This information is used by the electronic control module (ECM) as an indication of altitude. Comparison of these readings with a known good vehicle with the same MAP sensor is a good way to check the accuracy of a questionable MAP sensor. The readings should be the same within 0.4 volt.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. With the ignition ON and the engine OFF, the manifold absolute pressure (MAP) sensor is reading atmospheric or barometric pressure. If this reading is below 4 volts, the electronic control module (ECM) may prevent the engine from starting.
4. This step checks for a reference voltage and a ground from the ECM.
5. This step is checking the voltage reference and the signal return wire to the ECM. If the ECM recognizes the voltage reference and there is not a problem in the ground side of the circuit, the MAP sensor is faulty.

DTC 34 - Manifold Absolute Pressure Sensor Low (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Turn the ignition ON. Does the scan tool show the manifold absolute pressure (MAP) sensor voltage above the value specified?	4 v	Go to *Step 3*	Go to *Step 4*
3	1. Disconnect the vacuum line from the MAP sensor. 2. Apply 68 kPa (20 in. of Hg) of vacuum to the MAP sensor. Does the scan tool show the MAP sensor voltage within the value specified?	1.0-1.5 v	Go to "Diagnostic Aids"	Go to *Step 4*
4	1. Turn the ignition OFF. 2. Disconnect the MAP sensor connector. 3. Turn the ignition ON. 4. Measure the voltage between the MAP sensor connector terminals A and C. Does the voltage measure within the value specified?	4.5-5.5 v	Go to *Step 5*	Go to *Step 6*
5	Connect a fused jumper between the MAP sensor connector terminals B and C. Does the scan tool show the MAP sensor voltage above the value specified?	4 v	Go to *Step 11*	Go to *Step 9*
6	Measure the voltage between the MAP sensor connector terminal C and ground. Does the voltage measure within the value specified?	4.5-5.5 v	Go to *Step 7*	Go to *Step 8*
7	1. Turn the ignition OFF. 2. Check for an open wire between the MAP sensor connector terminal A and the electronic control module (ECM) connector terminal D15. Is the problem found?	-	Go to *Step 10*	Go to *Step 12*
8	1. Turn the ignition OFF. 2. Check for an open or short to ground in the wire between the MAP sensor connector terminal C and the ECM connector terminal D8. Is the problem found?	-	Go to *Step 10*	Go to *Step 12*
9	1. Turn the ignition OFF. 2. Check for an open or short to ground in the wire between the MAP sensor connector terminal B and the ECM connector terminal A7. Is the problem found?	-	Go to *Step 10*	Go to *Step 12*
10	1. Repair the wire or the connector terminal as needed. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

DTC 34 - Manifold Absolute Pressure Sensor Low (2.0L DOHC) (Cont'd)

Step	Action	Value(s)	Yes	No
11	1. Replace the manifold absolute pressure sensor. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
12	1. Turn the ignition OFF. 2. Replace the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

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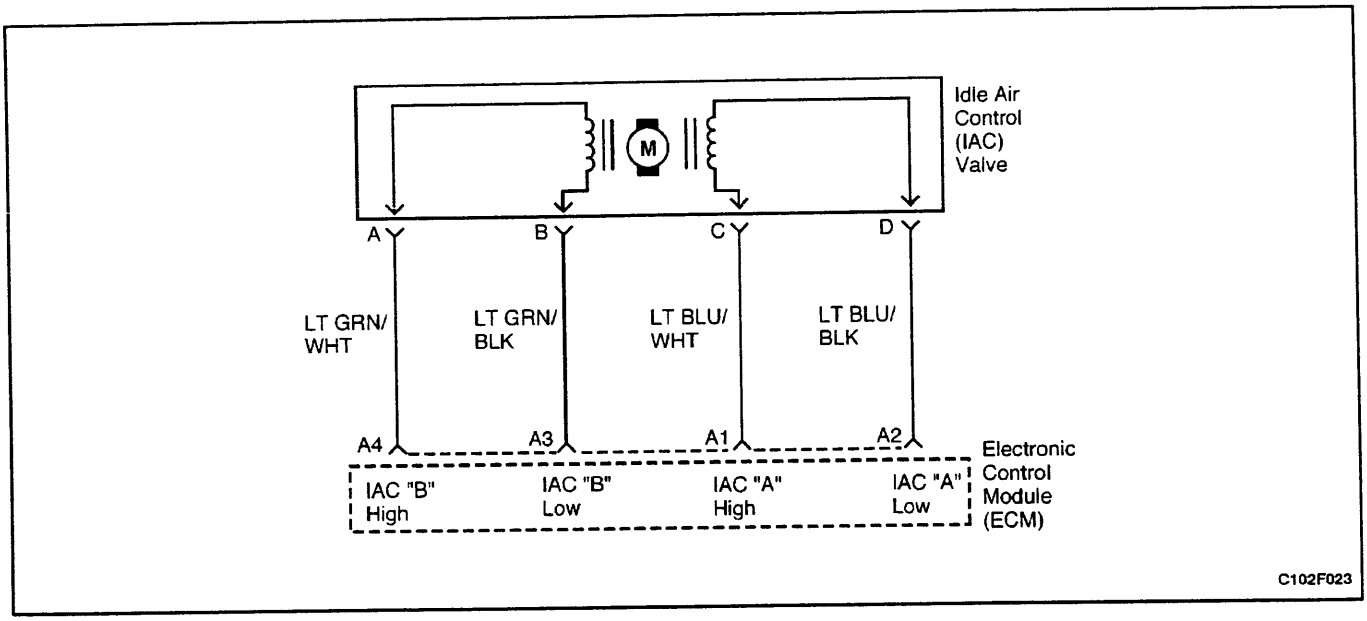

DIAGNOSTIC TROUBLE CODE (DTC) 35
IDLE AIR CONTROL ERROR (2.0L DOHC)

Circuit Description

The electronic control module (ECM) controls the idle speed to a calculated rpm based on inputs and the actual engine rpm. This is determined by the ignition reference pulses received by the ECM from the crankshaft position sensor. The ECM uses four circuits to move the idle air control (IAC) valve. The IAC valve allows varying amounts of air to flow into the intake manifold, controlling the idle speed.

DTC 35 Will Set When

- The engine speed is 175 rpm above or below the commanded idle speed for at least 20 seconds.
- DTCs 21, 22, and 24 are not set.
- The throttle is closed.

Diagnostic Aids

- Inspect for vacuum leaks, unconnected or brittle vacuum hoses, cuts, etc.
- Inspect the intake manifold and the throttle body gaskets for proper sealing.
- An idle air control (IAC) valve which does not respond to the electronic control module (ECM), an incorrect base idle adjustment, a damaged throttle body, or damage to the throttle body linkage could create the conditions for setting diagnostic trouble code 35.

DTC 35 - Idle Air Control Error (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Turn the ignition OFF. 2. Connect the scan tool to the assembly line diagnostic link (ALDL). 3. Monitor the engine rpm. 4. Disconnect the idle air control (IAC) valve connector. 5. Connect the IAC driver to the IAC valve. 6. Start the engine allow the engine to idle in P (PARK) (NEUTRAL for manual transaxle) with the A/C off and the parking brake applied. 7. Using the IAC driver, extend and retract the IAC valve. Does the rpm change as the IAC driver is cycled?	-	Go to *Step 5*	Go to *Step 3*
3	1. Turn the ignition OFF. 2. Disconnect the IAC driver from the IAC valve. 3. Remove the IAC valve from the throttle body. 4. Inspect the IAC passages for restrictions. Are the IAC passages restricted?	-	Go to *Step 4*	Go to *Step 14*
4	1. Clean the IAC passages. 2. Clear any diagnostic trouble codes (DTCs) from the electronic control module (ECM). 3. Perform the IAC valve reset procedure. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
5	Cycle the IAC driver while monitoring the engine rpm. Does the rpm change smoothly within the value specified with each flash of the IAC driver?	700-1500 rpm	Go to *Step 6*	Go to *Step 3*
6	1. Turn the ignition OFF. 2. Connect the IAC node light to the IAC connector. 3. Start the engine and cycle the IAC driver. Do both lights of the IAC node light cycle red and green but never turn off as the rpm is changed using the IAC driver?	-	Go to *Step 7*	Go to *Step 9*
7	1. Turn the ignition OFF. 2. Disconnect the IAC driver from the IAC valve. 3. Measure the resistance between IAC terminals A and B, then C and D. Is the resistance within the value specified?	40-80 Ω	Go to *Step 8*	Go to *Step 14*
8	Measure the resistance between IAC terminals B and C, then A and D. Does the resistance match the specified value?	∞	Go to "Diagnostic Aids"	Go to *Step 14*
9	1. Turn the ignition OFF. 2. Disconnect the IAC node light from the IAC valve connector. 3. Check for faulty connector terminals. Is the problem found?	-	Go to *Step 13*	Go to *Step 10*
10	Check for any open circuits, including connections, between the IAC valve connector terminals and the ECM. Is the problem found?	-	Go to *Step 13*	Go to *Step 11*

DTC 35 - Idle Air Control Error (2.0L DOHC) (Cont'd)

Step	Action	Value(s)	Yes	No
11	Check for a short to ground between the IAC valve connector terminals and the ECM. Is the problem found?	-	Go to *Step 13*	Go to *Step 12*
12	1. Turn the ignition ON. 2. Check for a short to voltage between the IAC valve connector terminals and the ECM. Is the problem found?	-	Go to *Step 13*	Go to *Step 15*
13	1. Turn the ignition OFF. 2. Repair the wire or the connector terminal as needed. 3. Clear any DTCs from the ECM. 4. Perform the IAC valve reset procedure. 5. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
14	1. Replace the idle air control valve. 2. Clear any DTCs from the ECM. 3. Perform the IAC valve reset procedure. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
15	1. Replace the ECM. 2. Clear any DTCs from the ECM. 3. Perform the IAC valve reset procedure. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

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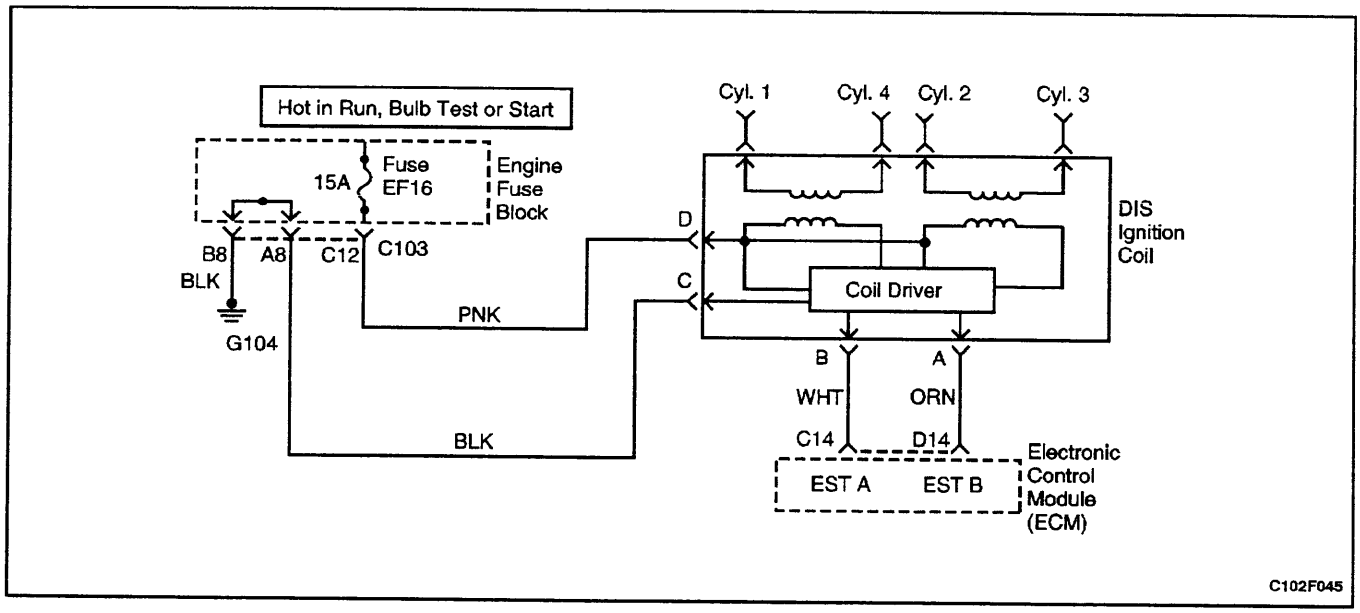


DIAGNOSTIC TROUBLE CODE (DTC) 41 ELECTRONIC SPARK TIMING "B" SHORTED TO BATTERY (2.0L DOHC)

Circuit Description

The direct ignition system (DIS) ignition coil is supplied with battery voltage when the ignition is ON. The electronic control module (ECM) triggers the circuit for the DIS ignition coil. Voltage is then induced in the secondary portion of the DIS ignition coil. Control of the DIS ignition coil is monitored separately for the two electronic spark timing lines.

DTC 41 Will Set When

- The electronic control module (ECM) receives voltage greater than 12 volts through the electronic spark timing (EST) "B" line while reference pulses are received by the ECM from the crankshaft position sensor.
- This error occurs over 6 times.

Diagnostic Aids

- Inspect the electronic control module (ECM) harness connectors for backed-out terminals, improperly formed or damaged terminals, a poor terminal-to-wire connection, and a damaged wiring harness.
- If the connections and the harness are OK, connect a digital voltmeter or an oscilloscope between the affected terminal and ground while moving the related connectors and the wiring harness. If the fault is induced, the voltage reading or the scope pattern will change.

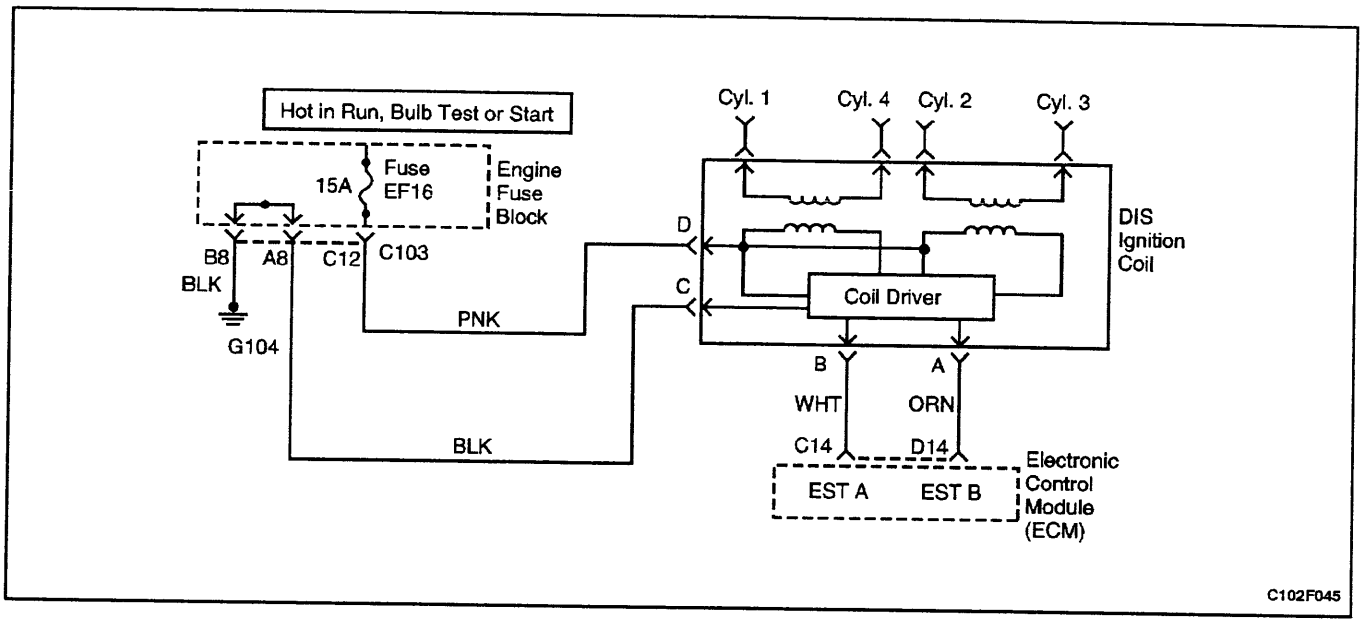
Test Description

The number(s) below refer to step(s) on the diagnostic table.

3. This step checks both the electronic spark timing (EST) "B" and the ground from the electronic control module (ECM).
6. A short to voltage that is intermittent may be at fault in the EST "B" wire from the ECM.
11. If there are not any problems in the wiring of the circuit, yet no output from the ECM, the ECM is faulty.

DTC 41 - Electronic Spark Timing "B" Shorted to Battery (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the direct ignition system (DIS) ignition coil connector. 2. Check the DIS ignition coil connector terminals to ensure that the terminals are correctly installed and none of them are touching. Is the problem found?	-	Go to *Step 9*	Go to *Step 3*
3	1. Measure the voltage between terminal A and terminal C of the DIS ignition coil connector. 2. Crank the engine. Does the voltage fluctuate within the value specified?	0.2-2.0 v	Go to *Step 10*	Go to *Step 4*
4	1. Turn the ignition OFF. 2. Disconnect the electronic control module (ECM) white connector. 3. Check for any damaged pins or terminals at the ECM connector terminal D14 or near terminal D14. Is the problem found?	-	Go to *Step 9*	Go to *Step 5*
5	1. Turn the ignition ON. 2. Measure the voltage at the DIS ignition coil connector terminal A. Is any voltage present?	-	Go to *Step 7*	Go to *Step 6*
6	Measure the voltage at the DIS ignition coil connector terminal A while moving the connectors and the wiring harness of the ignition circuit. Is any voltage present?	-	Go to *Step 7*	Go to *Step 8*
7	1. Turn the ignition OFF. 2. Repair the short to voltage between the DIS ignition coil connector terminal A and the ECM connector terminal D14. 3. Clear any diagnostic trouble codes (DTCs) from the ECM. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
8	1. Turn the ignition OFF. 2. Check the wires and harnesses of the ignition circuit for any damage that could cause an intermittent short to voltage. Is the problem found?	-	Go to *Step 9*	Go to *Step 11*
9	1. Repair any wire or connector terminal as needed. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
10	1. Turn the ignition OFF. 2. Replace the direct ignition system ignition coil assembly. 3. Clear any DTCs from the ECM. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
11	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 42 ELECTRONIC SPARK TIMING "A" SHORTED TO BATTERY (2.0L DOHC)

Circuit Description

The direct ignition system (DIS) ignition coil is supplied with battery voltage when the ignition is ON. The electronic control module (ECM) triggers the circuit for the DIS ignition coil. Voltage is then induced in the secondary portion of the DIS ignition coil. Control of the DIS ignition coil is monitored separately for the two electronic spark timing lines.

DTC 42 Will Set When

- The electronic control module (ECM) receives voltage greater than 12 volts through the electronic spark timing (EST) "A" line while reference pulses are received by the ECM from the crankshaft position sensor.
- This error occurs over 6 times.

Diagnostic Aids

- Inspect the electronic control module (ECM) harness connectors for backed-out terminals, improperly formed or damaged terminals, a poor terminal-to-wire connection, and a damaged wiring harness.
- If the connections and the harness are OK, connect a digital voltmeter or an oscilloscope between the affected terminal and ground while moving the related connectors and the wiring harness. If the fault is induced, the voltage reading or the scope pattern will change.

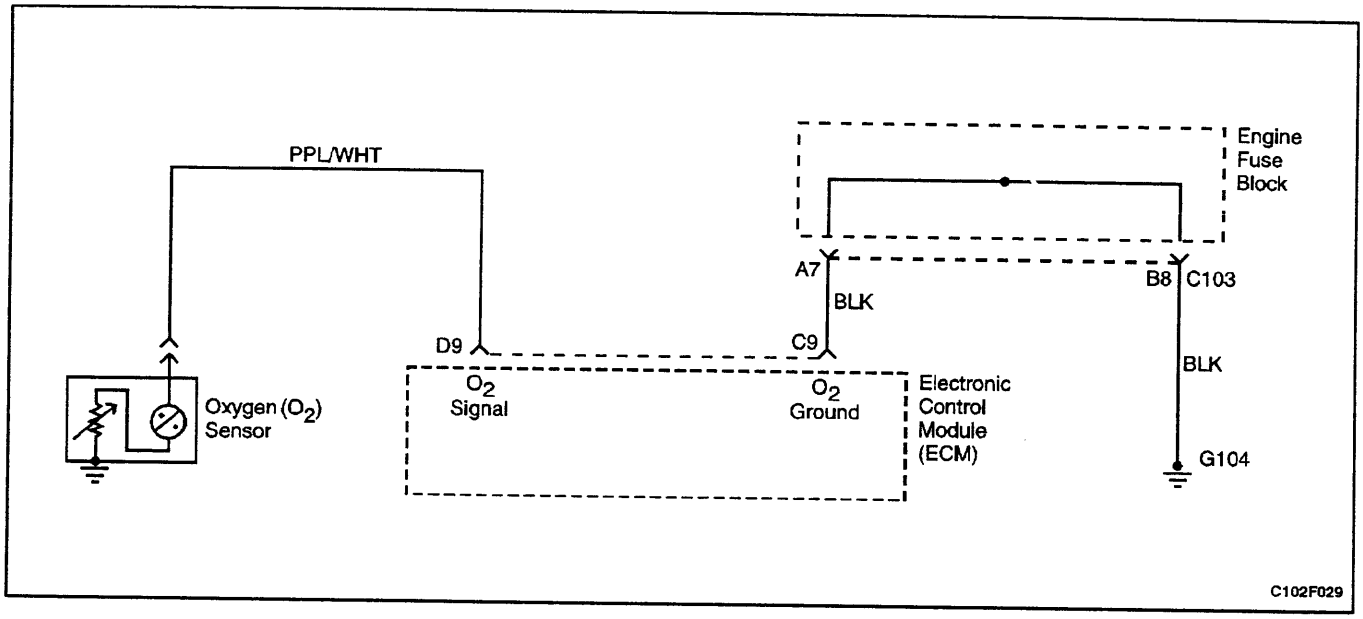
Test Description

The number(s) below refer to step(s) on the diagnostic table.

3. This step checks both the electronic spark timing (EST) "A" and the ground from the electronic control module (ECM).
6. A short to voltage that is intermittent may be at fault in the EST "A" wire from the ECM.
11. If there are not any problems in the wiring of the circuit, yet no output from the ECM, the ECM is faulty.

DTC 42 - Electronic Spark Timing "A" Shorted to Battery (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the direct ignition system (DIS) ignition coil connector. 2. Check the DIS ignition coil connector terminals to ensure that the terminals are correctly installed and none of them are touching. Is the problem found?	-	Go to *Step 9*	Go to *Step 3*
3	1. Measure the voltage between terminal B and terminal C of the DIS ignition coil connector. 2. Crank the engine. Does the voltage fluctuate within the values specified?	0.2-2.0 v	Go to *Step 10*	Go to *Step 4*
4	1. Turn the ignition OFF. 2. Disconnect the electronic control module (ECM) white connector. 3. Check for any damaged pins or terminals at the ECM connector terminal C14 or near terminal C14. Is the problem found?	-	Go to *Step 9*	Go to *Step 5*
5	1. Turn the ignition ON. 2. Measure the voltage at the DIS ignition coil connector terminal B. Is any voltage present?	-	Go to *Step 7*	Go to *Step 6*
6	Measure the voltage at the DIS ignition coil connector terminal B while moving the connectors and the wiring harness of the ignition circuit. Is any voltage present?	-	Go to *Step 7*	Go to *Step 8*
7	1. Turn the ignition OFF. 2. Repair the short to voltage between the DIS ignition coil connector terminal B and the ECM connector terminal C14. 3. Clear any DTCs from the ECM. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
8	1. Turn the ignition OFF. 2. Check the wires and the harnesses of the ignition circuit for any damage that could cause an intermittent short to voltage. Is the problem found?	-	Go to *Step 9*	Go to *Step 11*
9	1. Repair any wire or connector terminal as needed. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
10	1. Turn the ignition OFF. 2. Replace the direct ignition system ignition coil assembly. 3. Clear any DTCs from the ECM. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
11	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 44
OXYGEN SENSOR LEAN (2.0L DOHC)

Circuit Description

The electronic control module (ECM) supplies a voltage of about 450 millivolts between the ECM terminals D9 and C9. The oxygen (O_2) sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down to about 100 millivolts if the exhaust is lean. The O_2 sensor is like an open circuit and produces no voltage when it is below 360°C (680°F). An open O_2 sensor circuit or a cold O_2 sensor causes "open loop" operation.

DTC 44 Will Set When

- The engine controls system is in closed loop.
- The oxygen sensor voltage is below 274 millivolts.
- Coolant temperature is above 70°C (158°F).
- TPS is greater than 5 percent.
- DTCs 21, 22, 33, and 34 are not set.
- The engine has been running for more than 60 seconds.
- These conditions are present for at least 40 seconds.

Diagnostic Aids

- Normal scan tool voltage varies between 100 millivolts and 999 millivolts while in closed loop.
- Inspect the oxygen (O_2) sensor wire. The O_2 sensor pigtail may be positioned incorrectly and contacting the exhaust manifold.
- Check for an intermittent ground in the wire between the O_2 sensor and the electronic control module.
- Perform an injector balance test to determine if a restricted fuel injector may be causing the lean running condition.
- Vacuum or crankcase leaks will cause a lean running condition.
- An exhaust manifold gasket leak or a cracked exhaust manifold may cause outside air to be pulled into the exhaust and past the sensor.

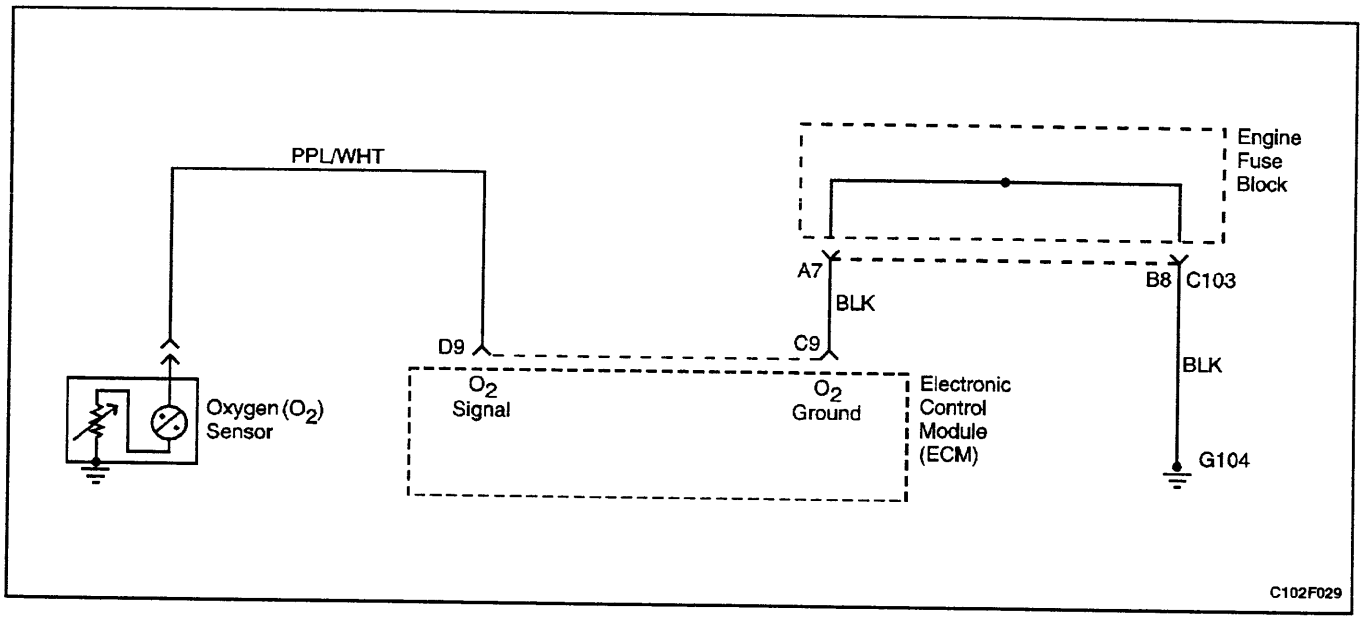
Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. Running the engine at 1,200 rpm keeps the oxygen (O_2) sensor hot so an accurate display voltage can be maintained.
4. If the O_2 sensor voltage stays fixed below 350 millivolts after disconnecting the O_2 sensor, there is either a short to ground in the O_2 sensor wire to the electronic control module (ECM) or a faulty ECM.

DTC 44 - Oxygen Sensor Lean (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Run the engine until it reaches operating temperature. 3. Run the engine at 1,200 rpm. Does the scan tool read the oxygen (O_2) sensor voltage fixed below the value specified?	274 mv	Go to *Step 3*	Go to "Diagnostic Aids"
3	1. Disconnect the O_2 sensor connector. 2. Run the warm engine at idle. Does the scan tool read O_2 sensor voltage within the value specified?	350-550 mv	Go to "Diagnostic Aids"	Go to *Step 4*
4	1. Turn the ignition OFF. 2. Check the O_2 sensor signal wire between the O_2 sensor and electronic control module (ECM) connector terminal D9 for a short to ground. Is the problem found?	-	Go to *Step 5*	Go to *Step 6*
5	1. Repair the wire or the connector terminal as needed. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Road test the vehicle. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
6	1. Replace the ECM. 2. Road test the vehicle. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 45 OXYGEN SENSOR RICH (2.0L DOHC)

Circuit Description

The electronic control module (ECM) supplies a voltage of about 450 millivolts between the ECM terminals D9 and C9. The oxygen (O_2) sensor varies the voltage within a range of about 1 volt if the exhaust is rich, down to about 100 millivolts if the exhaust is lean. The O_2 sensor is like an open circuit and produces no voltage when it is below 360°C (680°F). An open O_2 sensor circuit or a cold O_2 sensor causes "open loop" operation.

DTC 45 Will Set When

- DTCs 21, 22, 33, and 34 are not set.
- TPS is greater than 5 percent.
- Coolant temperature is greater than 70°C (158°F).
- The engine has been running for more than 60 seconds.
- The engine has been running for at least 60 seconds.
- The engine controls system is in closed loop.
- The oxygen sensor voltage is above 865 millivolts.
- These conditions are present for at least 10 seconds.

Diagnostic Aids

- Normal scan tool voltage varies between 100 millivolts and 999 millivolts while in closed loop.
- Fuel pressure that is too high may cause a rich running condition.
- A leaking fuel pressure regulator diaphragm will cause a rich running condition.
- Check for leaking fuel injectors by performing a fuel injector balance test.
- An intermittent throttle position sensor output will cause a rich running condition due to a false indication of the engine accelerating.
- A false rich indication due to silicone contamination of the oxygen (O_2) sensor. This will be indicated by the presence of the diagnostic trouble code 45 accompanied by lean driveability conditions and a powdery white deposit on the O_2 sensor.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. Running the engine at 1,200 rpm keeps the oxygen (O_2) sensor hot so an accurate display voltage can be maintained.
3. This step checks for the electronic control module ability to read a simulated lean O_2 sensor signal.

DTC 45 - Oxygen Sensor Rich (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Run the engine until it reaches operating temperature. 3. Run the engine at 1,200 rpm. Does the scan tool read the oxygen (O_2) sensor voltage fixed above the value specified?	800 mv	Go to *Step 3*	Go to "Diagnostic Aids"
3	1. Disconnect the O_2 sensor connector and jumper the connector terminal to ground (ECM side). 2. Run the warm engine at idle. Does the scan tool read the O_2 sensor voltage below the value specified?	350 mv	Go to "Diagnostic Aids"	Go to *Step 4*
4	1. Turn the ignition OFF. 2. Replace the ECM. 3. Road test the vehicle. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

DIAGNOSTIC TROUBLE CODE (DTC) 49
BATTERY VOLTAGE TOO HIGH (2.0L DOHC)

Circuit Description

The electronic control module (ECM) monitors the battery voltage at the ECM connector terminal C16. If the ECM detects voltage above the tolerance, the diagnostic trouble code (DTC) 49 will be set.

DTC 49 Will Set When

- The battery voltage is greater than 17.2 volts for more than 2 seconds.

Diagnostic Aids

- Charging the battery with a battery charger and starting the engine may set the diagnostic trouble code (DTC) 49.
- Inspect the electronic control module (ECM) wiring harness connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wire connection, and a damaged harness.
- If the connections and the wiring harness check OK, monitor the battery voltage display on the scan tool while moving related connectors. If the fault is induced, the battery voltage will abruptly change. This may help to isolate the location of the problem.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

3. If the scan tool is showing incorrect battery voltage, the electronic control module (ECM) is at fault.

DTC 49 - Battery Voltage Too High (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Start the engine and raise the engine speed to 1,200 rpm. 3. Monitor the battery voltage on the scan tool. Is the voltage at or above the value specified?	17.2 v	Go to *Step 3*	Go to *Step 4*
3	Measure the voltage across the battery. Is the voltage at or above the value specified?	17.2 v	Go to *Step 5*	Go to *Step 6*
4	1. Turn the headlamps ON. 2. Turn the A/C ON. 3. Turn the blower switch to HIGH. 4. Raise the engine speed to 2,000 rpm. 5. Monitor the battery voltage on the scan tool. Is the voltage at or above the value specified?	17.2 v	Go to *Step 5*	Go to "Diagnostic Aids"
5	1. Turn the ignition OFF. 2. Repair the generator or generator circuit as needed. 3. Clear any diagnostic trouble codes (DTCs) from the electronic control module (ECM). 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
6	1. Turn the ignition OFF. 2. Replace the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

DIAGNOSTIC TROUBLE CODE (DTC) 51 CHECKSUM OR KKPGMID ERROR (2.0L DOHC)

DTC Will Set When

- KKPGMID is not set into $99 or the calculated CHECKSUM is not consistent with the KKSUM.

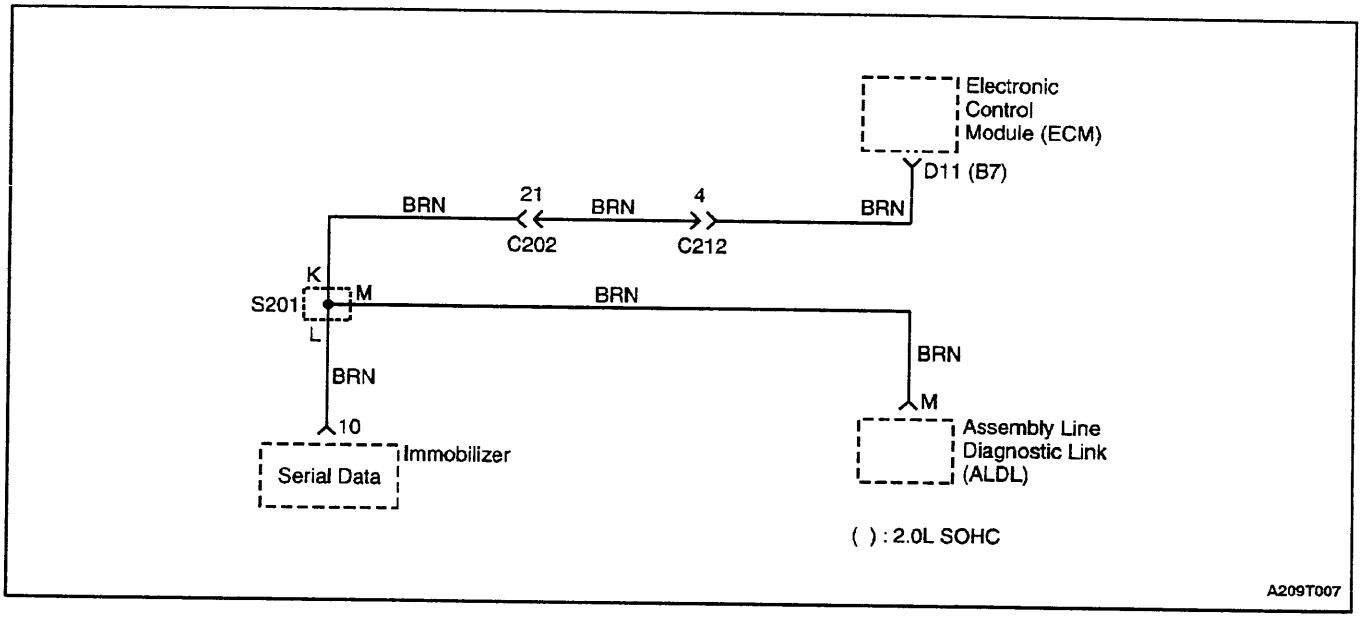
Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. A PROM that is incorrectly installed will set the diagnostic trouble code (DTC) 51.

DTC 51 - CHECKSUM or KKPGMID Error (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	Check that all of the programmable read only memory (PROM) pins are fully inserted in the socket. Is the problem found?	-	Go to *Step 3*	Go to *Step 4*
3	1. Install the PROM correctly in the socket. 2. Clear any diagnostic trouble codes (DTCs) from the electronic control module (ECM). 3. Check for the presence of any DTCs. Did the DTC 51 reappear?	-	Go to *Step 4*	Go to "Diagnostic System Check"
4	1. Replace the PROM. 2. Clear any DTCs from the ECM. 3. Check for the presence of any DTCs. Did the DTC 51 reappear?	-	Go to *Step 5*	Go to "Diagnostic System Check"
5	1. Replace the ECM. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 53 ECM IMMOBILIZED ERROR (2.0L DOHC)

Circuit Description

When the ignition is turned ON, the key is tested by the immobilizer anti-theft system. While the immobilizer control unit (ICU) is reading the key code, the engine can start and run with any key that will turn the lock cylinder. The ICU reads the key code and compares it with key codes stored in the ICU memory. If the ICU detects a valid key, the unit sends a serial data release message to the electronic control module (ECM). Included in the release message is an identification (ID) code which assures that neither the ICU nor the ECM has been substituted to defeat the system. If the ECM receives an invalid release message, the ECM performs the following actions:

- Disables the fuel injector circuit.
- Disables the fuel pump circuit.
- Disables the ignition coil.

DTC 53 Will Set When

- The ECM does not receive the signal from the ICU within 0.9 seconds when the vehicle is stationary, or within 1.8 seconds when the vehicle is moving.
- The ICU sends the ECM an incorrect release message more than five times.
- The above conditions continue until the ignition is switched OFF.

DTC 53 Will Clear When

- The ignition switch is turned OFF, or the scan tool CLEAR CODES command is issued.

DTC 53 - ECM Immobilized Error (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Connect the scan tool using the following procedure: 1. Insert the immobilizer data cartridge into the scan tool. 2. Turn the ignition switch OFF. 3. Connect the scan tool to the assembly line diagnostic link (ALDL). 4. Connect the scan tool's power cord to the cigar lighter socket. 5. Turn the ignition ON, but do not start the engine. Is communication established between the scan tool and the immobilizer control unit (ICU)?	-	Go to *Step 2*	Go to *Section 9T, Remote Keyless Entry and Anti-Theft System*
2	Select SYSTEM DIAGNOSIS from the scan tool menu. Does the KEY STATUS message indicate POS NR (position number) 00?	-	Go to *Section 9T, Remote Keyless Entry and Anti-Theft System*	Go to *Step 3*
3	Read the IMMO & ECM ID-CODE message that is displayed after requesting SYSTEM DIAGNOSIS. Does the message ID-CODE DIFFERENT appear?	-	Go to *Section 9T, Remote Keyless Entry and Anti-Theft System*	Go to *Step 4*
4	Check for an open serial data wire between the ICU and the electronic control module (ECM). Is the circuit open?	-	Go to *Step 5*	Go to *Step 6*
5	Repair the open serial data wire between the ECM and the ICU. Is the repair complete?	-	System OK	-
6	1. Replace the ECM. 2. Reprogram the ID code. *Refer to Section 9T, Remote Keyless Entry and Anti-Theft System.* Is the repair complete?	-	System OK	-

DIAGNOSTIC TROUBLE CODE (DTC) 55 EEPROM OR CONFIG REG ERROR (2.0L DOHC)

Circuit Description

The electronic control module (ECM) utilizes an electronically erasable programmable read only memory (EEPROM). The EEPROM contains program information and the calibrations required for engine diagnostics operation.

DTC 55 Will Set When

- Microprocessor configuration register is not equal to $08.

Diagnostic Aids

The diagnostic trouble code (DTC) 55 indicates that the contents of the electronically erasable programmable read only memory (EEPROM) have changed since the electronic control module (ECM) was programmed. The only possible repair is ECM replacement. Remember to program the replacement ECM with the correct software and calibration for the vehicle.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. When the electronic control module (ECM) is being replaced, the new ECM must be programmed.

DTC 55 - EEPROM or Config Reg Error (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Determine whether the Diagnostic System Check has been performed. Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

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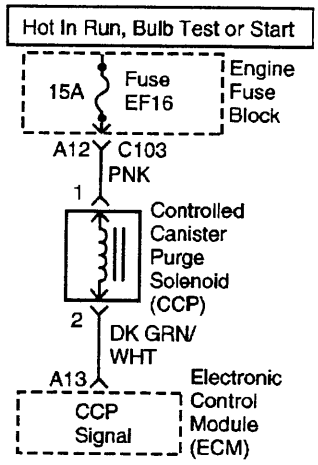


C102F049

DIAGNOSTIC TROUBLE CODE (DTC) 61 CONTROLLED CANISTER PURGE SOLENOID SHORTED TO GROUND (2.0L DOHC)

Circuit Description

Evaporative canister purge is controlled by the electronic control module (ECM). The ECM applies a ground to the controlled canister purge (CCP) solenoid. The ECM determines when to activate the CCP solenoid depending on operating conditions, including throttle position, engine speed, coolant temperature, and ambient temperature.

DTC 61 Will Set When

- A short to ground condition exists and is present for more than 2 seconds.

Diagnostic Aids

- Inspect the electronic control module (ECM) wiring harness connectors for improper mating, broken locks, improperly formed or damaged terminals, a poor terminal-to-wire connection, and a damaged harness.
- If the connections and the wiring harness are in good condition, connect a test light between the CCP solenoid connector terminal 2 and battery positive while moving related connectors. If the fault is induced, the test light will turn on. This may help to isolate the location of an intermittent problem.

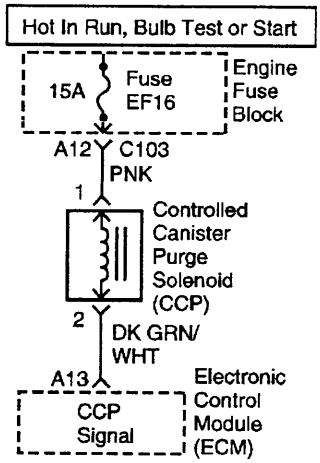
Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. With the ignition OFF, the electronic control module (ECM) should not be applying ground to the CCP solenoid.
3. If the test light is still on after disconnecting the ECM red connector, the wire between the CCP solenoid and the ECM is shorted to ground. If the test light goes off, the ECM is at fault.

DTC 61 - Controlled Canister Purge Solenoid Shorted to Ground (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Determine whether the Diagnostic System Check has been performed. Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the controlled canister purge (CCP) solenoid connector. 2. Connect a test light between the CCP solenoid connector terminal 2 and battery positive. Is the test light on?	-	Go to *Step 3*	Go to "Diagnostic Aids"
3	Disconnect the electronic control module (ECM) red connector. Is the test light on?	-	Go to *Step 4*	Go to *Step 5*
4	1. Repair the short to ground in the wire between the CCP solenoid connector terminal 2 and the ECM connector terminal A13. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
5	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



C102F049

DIAGNOSTIC TROUBLE CODE (DTC) 62 CONTROLLED CANISTER PURGE SOLENOID SHORTED TO BATTERY (2.0L DOHC)

Circuit Description

Evaporative canister purge is controlled by the electronic control module (ECM). The ECM applies a ground to the controlled canister purge (CCP) solenoid. The ECM determines when to activate the CCP solenoid depending on operating conditions, including throttle position, engine speed, coolant temperature, and ambient temperature.

DTC 62 Will Set When

- A short to battery voltage condition exists and is present for more than 2 seconds.

Diagnostic Aids

- Inspect the electronic control module (ECM) wiring harness connectors for improper mating, broken locks, improperly formed or damaged terminals, a poor terminal-to-wire connection, and a damaged harness.
- If the connections and the wiring harness are in good condition, connect a test light between the CCP solenoid connector terminal 2 and battery positive while moving related connectors. If the fault is induced, the test light will turn on. This may help to isolate the location of an intermittent problem.

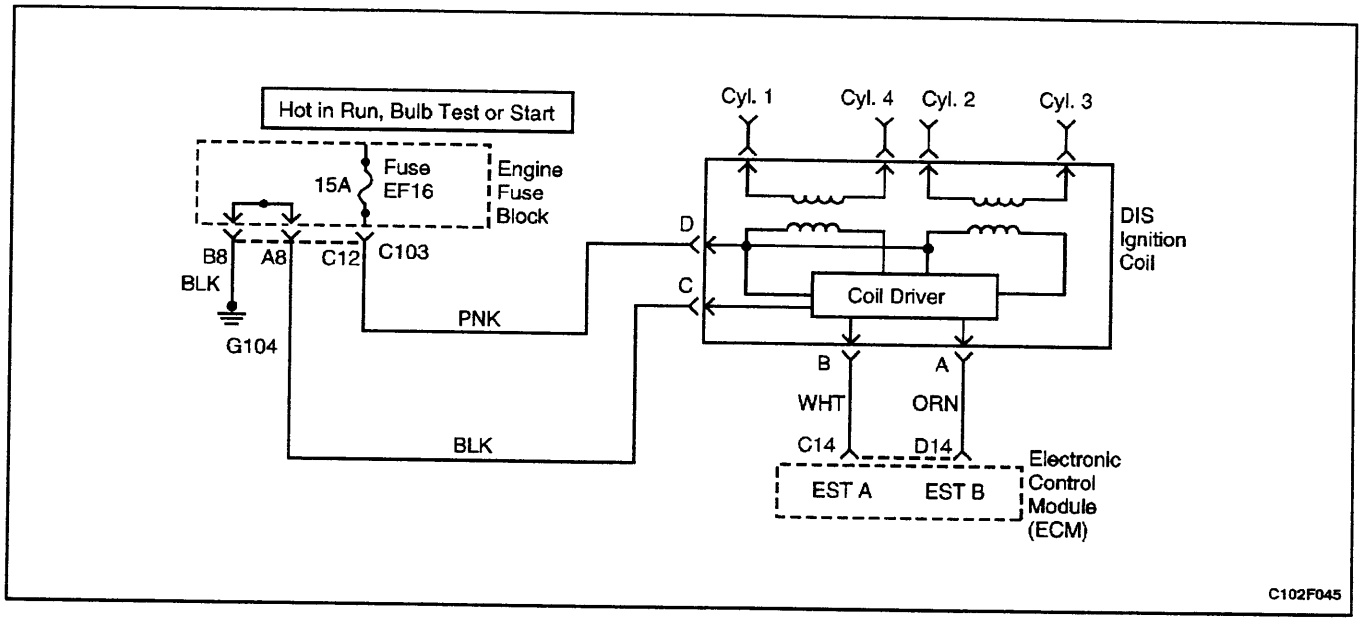
Test Description

The number(s) below refer to step(s) on the diagnostic table.

4. If the test light is still on after disconnecting the ECM red connector, the wire between the CCP solenoid and the ECM is shorted to voltage. If the test light goes off, the ECM is at fault.

DTC 62 - Controlled Canister Purge Solenoid Shorted to Battery (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Determine whether the Diagnostic System Check has been performed. Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the controlled canister purge (CCP) solenoid connector. 2. Measure the resistance of the CCP solenoid. Does the resistance measure near the value specified?	≈ 0 Ω	Go to *Step 6*	Go to *Step 3*
3	1. Disconnect the CCP solenoid connector. 2. Connect a test light between the CCP solenoid connector terminal 2 and ground. Is the test light on?	-	Go to *Step 4*	Go to "Diagnostic Aids"
4	Disconnect the electronic control module (ECM) red connector. Is the test light on?	-	Go to *Step 5*	Go to *Step 7*
5	1. Repair the short to voltage in the wire between the CCP solenoid connector terminal 2 and the ECM connector terminal A13. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
6	1. Replace the CCP solenoid. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
7	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 63 ELECTRONIC SPARK TIMING "B" SHORTED TO GROUND (2.0L DOHC)

Circuit Description

The direct ignition system (DIS) ignition coil is supplied with battery voltage when the ignition is ON. The electronic control module (ECM) triggers the circuit for the DIS ignition coil. Voltage is then induced in the secondary portion of the DIS ignition coil. Control of the DIS ignition coil is monitored separately for the two electronic spark timing lines.

DTC 63 Will Set When

- No voltage is supplied by the electronic control module (ECM) through the electronic spark timing "B" line while reference pulses are received by the ECM from the crankshaft position sensor.
- This error occurs over 6 times.

Diagnostic Aids

- Inspect the electronic control module (ECM) harness connectors for backed-out terminals, improperly formed or damaged terminals, a poor terminal-to-wire connection, and a damaged wiring harness.
- If connections and the harness are OK, connect a digital voltmeter or an oscilloscope between the affected terminal and ground while moving the related connectors and the wiring harness. If the fault is induced, the voltage reading or the scope pattern will change.

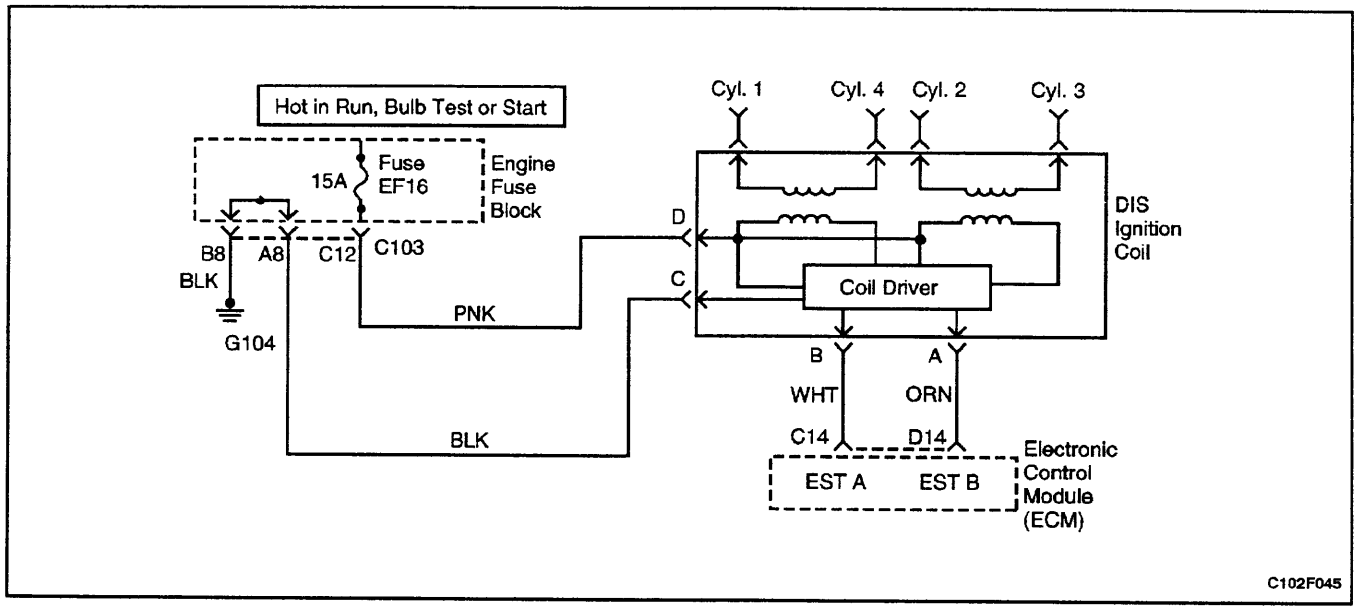
Test Description

The number(s) below refer to step(s) on the diagnostic table.

3. This step checks both the electronic spark timing (EST) "B" and the ground from the electronic control module (ECM).
6. An open circuit or short to ground that is intermittent may be at fault in the EST "B" wire from the ECM.
11. If there are not any problems in the wiring of the circuit, yet no output from the ECM, the ECM is faulty.

DTC 63 - Electronic Spark Timing "B" Shorted to Ground (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the direct ignition system (DIS) ignition coil connector. 2. Check the DIS ignition coil connector terminals to ensure that the terminals are correctly installed and none of them are touching. Is the problem found?	-	Go to *Step 9*	Go to *Step 3*
3	1. Connect a voltmeter between terminal A and terminal C of the DIS ignition coil. 2. Crank the engine. Does the voltage fluctuate within the values specified?	0.2-2.0 v	Go to *Step 4*	Go to *Step 10*
4	1. Turn the ignition OFF. 2. Disconnect the electronic control module (ECM) white connector. 3. Check for any damaged pins or terminals at the ECM connector terminal D14 or near the ECM connector terminal D14. Is the problem found?	-	Go to *Step 9*	Go to *Step 5*
5	Check for an open or short to ground between the DIS ignition coil connector terminal A and the ECM connector terminal D14. Is the problem found?	-	Go to *Step 7*	Go to *Step 6*
6	Check for an open or short to ground between the DIS ignition coil connector terminal A and the ECM connector terminal D14 while moving the connectors and the wiring harness of the ignition circuit. Is the problem found?	-	Go to *Step 7*	Go to *Step 8*
7	1. Repair the open or short to ground between the DIS ignition coil connector terminal A and the ECM connector terminal D14. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
8	Check the wires and wiring harnesses of the ignition circuit for any damage that could cause an intermittent open or short to ground. Is the problem found?	-	Go to *Step 9*	Go to *Step 11*
9	1. Repair any wire or connector terminal as needed. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
10	1. Turn the ignition OFF. 2. Replace the direct ignition system ignition coil assembly. 3. Clear any DTCs from the ECM. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
11	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 64 ELECTRONIC SPARK TIMING "A" SHORTED TO GROUND (2.0L DOHC)

Circuit Description

The direct ignition system (DIS) ignition coil is supplied with battery voltage when the ignition is ON. The electronic control module (ECM) triggers the circuit for the DIS ignition coil. Voltage is then induced in the secondary portion of the DIS ignition coil. Control of the DIS ignition coil is monitored separately for the two electronic spark timing lines.

DTC 64 Will Set When

- No voltage is supplied by the electronic control module (ECM) through the electronic spark timing "A" line while reference pulses are received by the ECM from the crankshaft position sensor.
- This error occurs over 6 times.

Diagnostic Aids

- Inspect the electronic control module (ECM) harness connectors for backed-out terminals, improperly formed or damaged terminals, a poor terminal-to-wire connection, and a damaged wiring harness.
- If connections and the harness are OK, connect a digital voltmeter or an oscilloscope between the affected terminal and ground while moving the related connectors and the wiring harness. If the fault is induced, the voltage reading or the scope pattern will change.

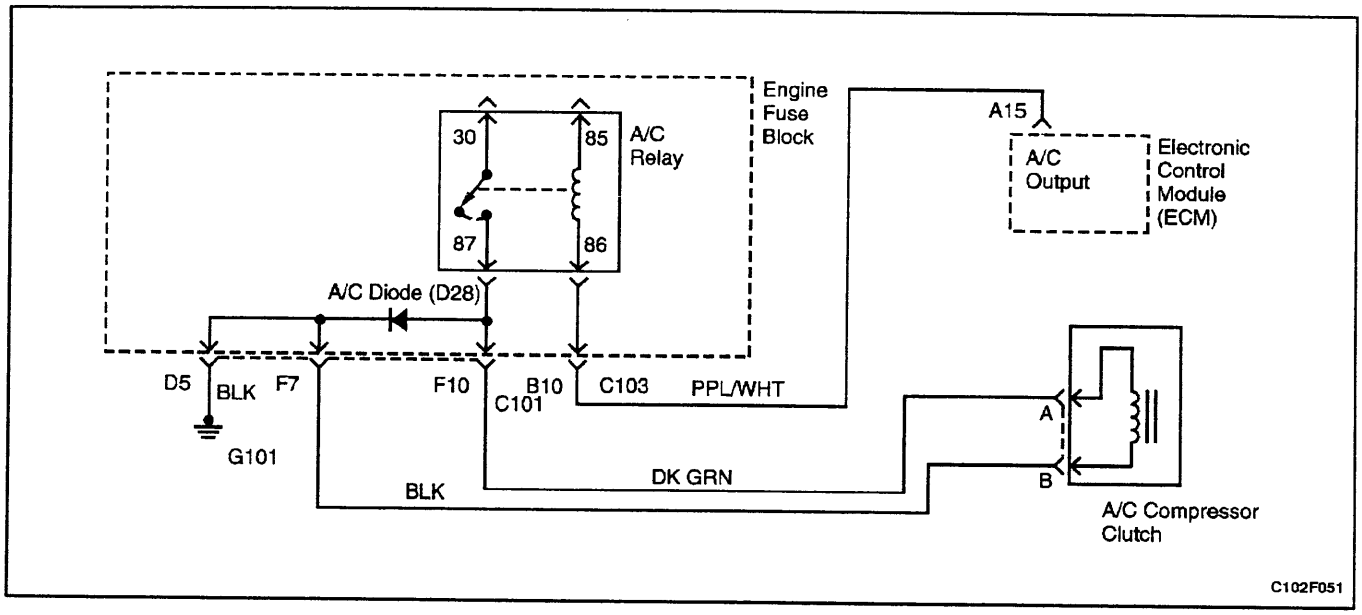
Test Description

The number(s) below refer to step(s) on the diagnostic table.

3. This step checks both the electronic spark timing (EST) "A" and the ground from the electronic control module (ECM).
6. An open circuit or short to ground that is intermittent may be at fault in the EST "A" wire from the ECM.
11. If there are not any problems in the wiring of the circuit, yet no output from the ECM, the ECM is faulty.

DTC 64 - Electronic Spark Timing "A" Shorted to Ground (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the direct ignition system (DIS) ignition coil connector. 2. Check the DIS ignition coil connector terminals to ensure that the terminals are correctly installed and none of them are touching. Is the problem found?	-	Go to *Step 9*	Go to *Step 3*
3	1. Connect a voltmeter between terminal B and terminal C of the DIS ignition coil. 2. Crank the engine. Does the voltage fluctuate within the values specified?	0.2-2.0 v	Go to *Step 4*	Go to *Step 10*
4	1. Turn the ignition OFF. 2. Disconnect the electronic control module (ECM) white connector. 3. Check for any damaged pins or terminals at the ECM connector terminal C14 or near terminal C14. Is the problem found?	-	Go to *Step 9*	Go to *Step 5*
5	Check for an open or short to ground between the DIS ignition coil connector terminal B and the ECM connector terminal C14. Is the problem found?	-	Go to *Step 7*	Go to *Step 6*
6	Check for an open or short to ground between the DIS ignition coil connector terminal B and the ECM connector terminal C14 while moving the connectors and the wiring harness of the ignition circuit. Is the problem found?	-	Go to *Step 7*	Go to *Step 8*
7	1. Repair the open or short to ground between the DIS ignition coil connector terminal B and the ECM connector terminal C14. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
8	Check the wires and wiring harnesses of the ignition circuit for any damage that could cause an intermittent open or short to ground. Is the problem found?	-	Go to *Step 9*	Go to *Step 11*
9	1. Repair any wire or connector terminal as needed. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
10	1. Turn the ignition OFF. 2. Replace the direct ignition system ignition coil assembly. 3. Clear any DTCs from the ECM. 4. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
11	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 87
AIR CONDITIONING COMPRESSOR RELAY SHORTED TO GROUND
(2.0L DOHC)

Circuit Description

When the A/C switch is turned ON, the electronic control module (ECM) grounds the A/C compressor relay to initiate A/C compressor operation. Under various operating conditions, the ECM will interrupt A/C compressor operation.

DTC 87 Will Set When

- A short to ground condition exists and is present for more than 2 seconds.

Diagnostic Aids

- Inspect the electronic control module (ECM) wiring harness connectors for improper mating, broken locks, improperly formed or damaged terminals, a poor terminal-to-wire connection, and a damaged harness.
- If the connections and the wiring harness are in good condition, connect a test light between the A/C compressor relay connector terminal 85 and battery positive while moving related connectors. If the fault is induced, the test light will turn on. This may help to isolate the location of an intermittent problem.

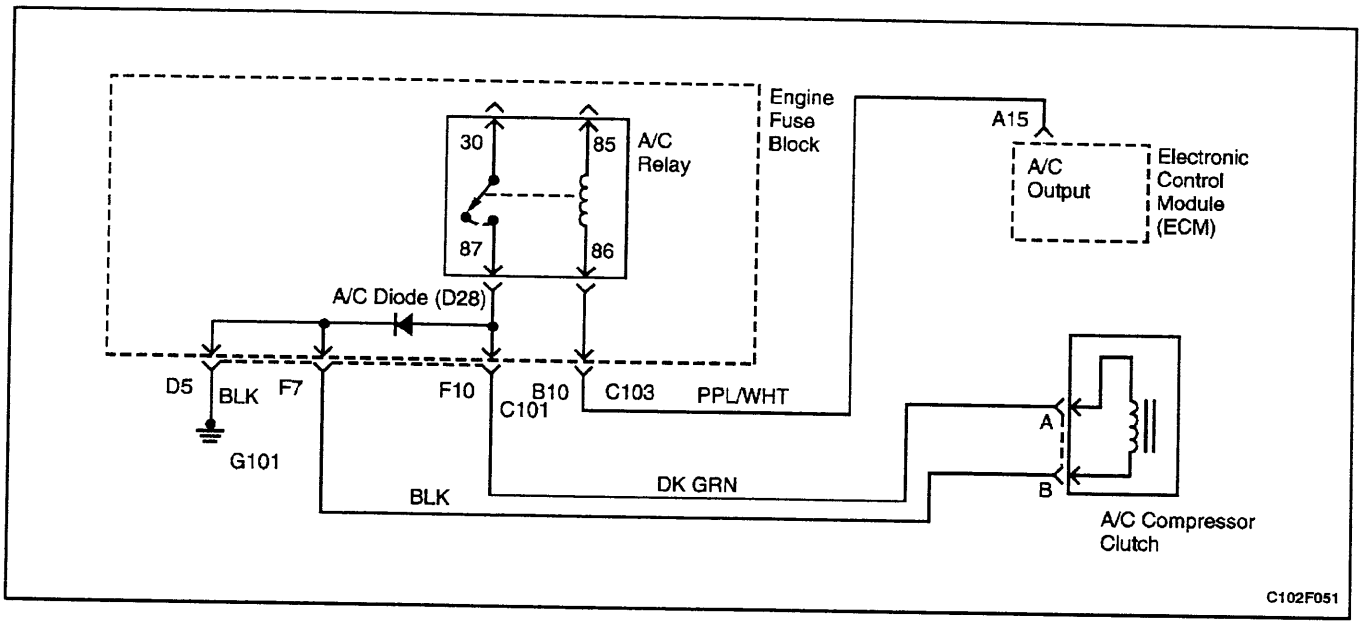
Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. With the ignition OFF, the electronic control module (ECM) should not be applying ground to the A/C compressor relay.
3. If the test light is still on after disconnecting the ECM red connector, the wire between the A/C compressor relay and the ECM is shorted to ground. If the test light goes off, the ECM is at fault.

DTC 87 - Air Conditioning Compressor Relay Shorted to Ground (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Determine whether the Diagnostic System Check has been performed. Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the A/C compressor relay. 2. Connect a test light between the A/C compressor relay connector terminal 86 and battery positive. Is the test light on?	-	Go to *Step 3*	Go to "Diagnostic Aids"
3	Disconnect the electronic control module (ECM) red connector. Is the test light on?	-	Go to *Step 4*	Go to *Step 5*
4	1. Repair the short to ground in the wire between the A/C compressor relay connector terminal 86 and the ECM connector terminal A15. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
5	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 88 AIR CONDITIONING COMPRESSOR RELAY SHORTED TO BATTERY (2.0L DOHC)

Circuit Description

When the A/C switch is turned ON, the electronic control module (ECM) grounds the A/C compressor relay to initiate A/C compressor operation. Under various operating conditions, the ECM will interrupt A/C compressor operation.

DTC 88 Will Set When

- A short to battery voltage condition exists and is present for more than 2 seconds.

Diagnostic Aids

- Inspect the electronic control module (ECM) wiring harness connectors for improper mating, broken locks, improperly formed or damaged terminals, a poor terminal-to-wire connection, and a damaged harness.
- If the connections and the wiring harness are in good condition, connect a test light between the A/C compressor relay connector terminal 85 and ground while moving related connectors. If the fault is induced, the test light will turn on. This may help to isolate the location of an intermittent problem.

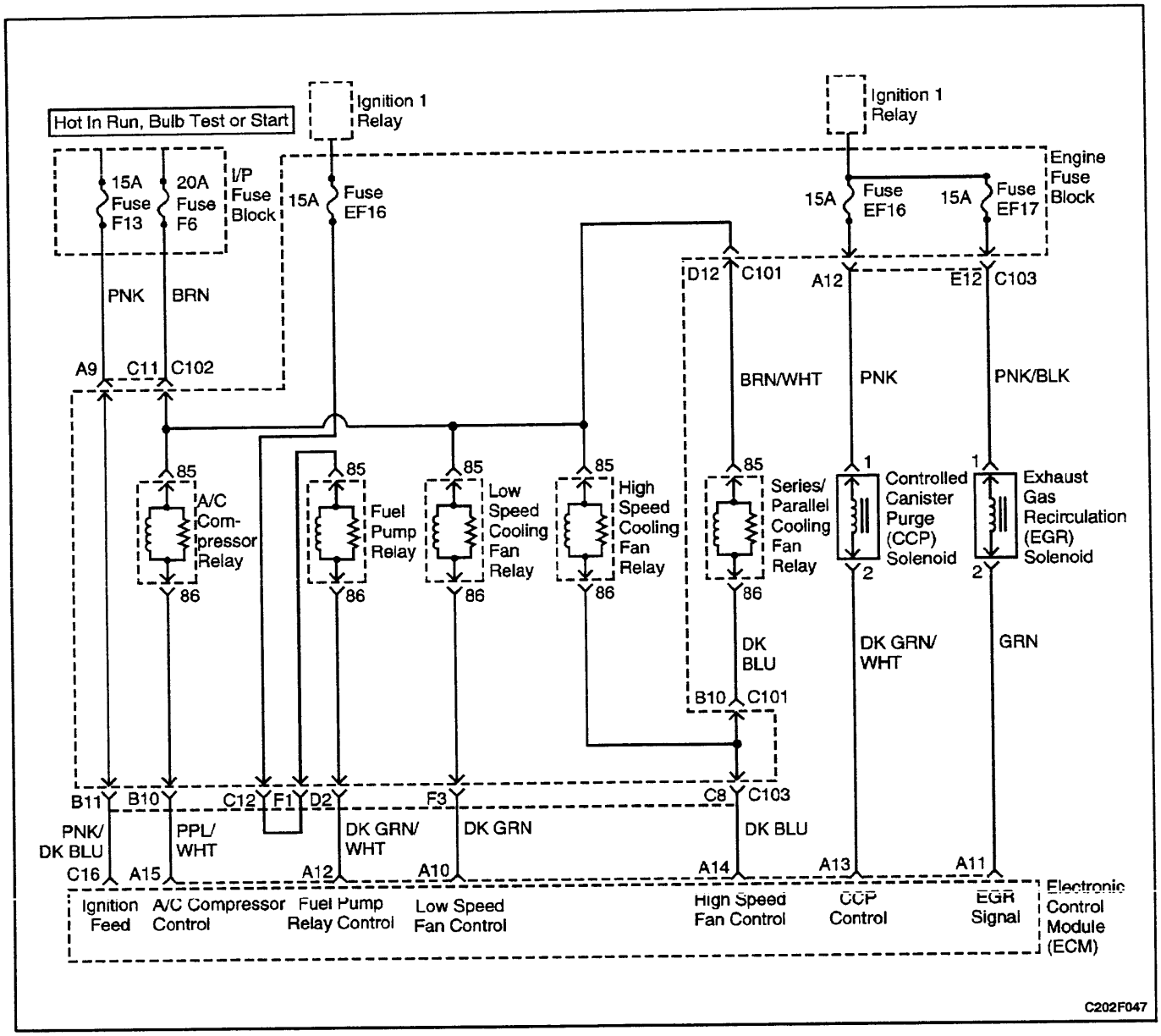
Test Description

The number(s) below refer to step(s) on the diagnostic table.

4. If the test light is still on after disconnecting the ECM red connector, the wire between the A/C compressor relay and the ECM is shorted to voltage. If the test light goes off, the ECM is at fault.

DTC 88 - Air Conditioning Compressor Relay Shorted to Battery (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Determine whether the Diagnostic System Check has been performed. Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the A/C compressor relay. 2. Measure the resistance between the A/C compressor relay terminals 85 and 86. Does the resistance measure near the value specified?	≈ 0 Ω	Go to *Step 6*	Go to *Step 3*
3	Connect a test light between the A/C compressor relay connector terminal 86 and ground. Is the test light on?	-	Go to *Step 4*	Go to "Diagnostic Aids"
4	Disconnect the electronic control module (ECM) red connector. Is the test light on?	-	Go to *Step 5*	Go to *Step 7*
5	1. Repair the short to voltage in the wire between the A/C compressor relay connector terminal 86 and the ECM connector terminal A15. 2. Clear any diagnostic trouble codes (DTCs) from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
6	1. Replace the A/C compressor relay. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
7	1. Replace the ECM. 2. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 93
ECM ERROR (QDM FAILURE) (2.0L DOHC)

Circuit Description

The electronic control module (ECM) is used to control several components such as those illustrated above. The ECM controls these devices through the use of a quad-driver module (QDM). When the ECM is commanding a component on, the voltage potential of the output circuit will be "low" (near 0 volts). When the ECM is commanding the output circuit to a component off, the voltage potential of the circuit will be "high" (near battery voltage). The primary function of the QDM is to supply the ground for the component being controlled.

The ECM has an internally protected QDM. This internal protection can be compared to a circuit breaker. If too much current flows in a controlled circuit, this type of QDM turns itself off. This allows the QDM to survive a shorted relay, solenoid, or wire. Repair the fault in the output circuit and the QDM will return to normal operation. It is not necessary to replace the ECM unless it is determined that the ECM itself is faulty.

Each QDM has a fault line which is monitored by the ECM. The ECM will compare the voltage at the QDM based on accepted values of the fault line. If the QDM fault detection circuit senses a voltage other than the accepted value, the diagnostic trouble code (DTC) 93 will be set.

DTC 93 Will Set When

- A QDM fault has been detected consecutively three times.

Diagnostic Aids

- Related symptoms of a QDM fault, such components on all the time or never on, will isolate the problem circuit.
- Monitor the voltage at connector terminals shown in the wiring diagram while moving related harness connectors, including the ECM harness. This may help in locating an intermittent condition.
- Check for bent connector terminals at the ECM connectors and the connectors of the relays and solenoids.
- Check for bent pins at the ECM.
- If the DTC 93 reoccurs with no apparent connector problem, replace the ECM.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

2. The electronic control module (ECM) does not know which controlled circuit caused the DTC 93. This step will go through each of the circuits to determine which is at fault.
3. By grounding the assembly line diagnostic link (ALDL), this causes the ECM to actuate all relays and solenoids.
4. By removing the jumper from the ALDL, only the ignition feed should be present to the relay or solenoid. The ECM should no longer be supplying a ground to complete the circuit.
5. With the ECM connectors disconnected, only a short to ground in the wiring between the affected component and the ECM will allow the test light to turn on.
7. If there are no problems found in the wiring and the connections are OK, replace the affected relay or solenoid.
11. If there is no ignition feed to the affected component, check for a blown fuse or open in the wiring. If the fuse is blown, locate and repair the short to ground in that ignition feed circuit.

DTC 93 - ECM Error (QDM Failure) (2.0L DOHC)

Step	Action	Value(s)	Yes	No
1	Was the Diagnostic System Check performed?	-	Go to *Step 2*	Go to "Diagnostic System Check"
2	1. Disconnect the electronic control module (ECM) red connector. 2. Turn the ignition ON. 3. Connect an ammeter (set to 2 amp scale) between each of the following ECM connector terminals and ground: • A10 - Fan low relay. • A11 - EGR solenoid. • A14 - Fan high relay. • A15 - A/C compressor relay. • A12 - Fuel pump relay. • A13 - CCP solenoid. Does the amperage of all circuits measure within the value specified?	<0.75 amps but not 0.0 amps	Go to "Diagnostic Aids"	Go to *Step 3*
3	1. Turn the ignition OFF. 2. Connect the ECM red connector. 3. Use the wiring diagram to determine the specific component terminals to be tested. 4. Disconnect the relay/solenoid from the affected circuit. 5. Jumper terminals A and B of the assembly line diagnostic link (ALDL). 6. Turn the ignition ON. 7. Connect a test light between the connector terminals for the component of the affected circuit. Is the test light on?	-	Go to *Step 4*	Go to *Step 8*

DTC 93 - ECM Error (QDM Failure) (2.0L DOHC) (Cont'd)

Step	Action	Value(s)	Yes	No
4	Remove the jumper from the ALDL. Is the test light on?	-	Go to *Step 5*	Go to *Step 7*
5	1. Turn the ignition OFF. 2. Disconnect the ECM red connector. 3. Turn the ignition ON. 4. Connect a test light between the connector terminals for the component of the affected circuit. Is the test light on?	-	Go to *Step 6*	Go to *Step 12*
6	1. Turn the ignition OFF. 2. Repair the short to ground between the component of the affected circuit and the ECM. 3. Connect the ECM red connector. 4. Clear any DTCs from the ECM. 5. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
7	1. Turn the ignition OFF. 2. Check for poor connections and repair as needed. 3. If the connections are OK, replace the component of the affected circuit. 4. Clear any DTCs from the ECM. 5. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
8	Connect the test light between the ignition feed connector terminal for the component of the affected circuit and ground. Is the test light on?	-	Go to *Step 9*	Go to *Step 11*
9	1. Turn the ignition OFF. 2. Check for an open in the wiring between the component of the affected circuit and the ECM. Is the problem found?	-	Go to *Step 10*	Go to *Step 12*
10	1. Repair the open wire. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
11	1. Repair the open in the affected component ignition feed circuit. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-
12	1. Replace the ECM. 2. Clear any DTCs from the ECM. 3. Perform the Diagnostic System Check. Is the repair complete?	-	System OK	-

SYMPTOM DIAGNOSIS

IMPORTANT PRELIMINARY CHECKS

Important: Several symptom procedures call for a careful visual/physical inspection. Always perform the visual/physical test first. Visual inspections may lead to correcting a problem without further checks and can save valuable time.

Step	Action	Value(s)	Yes	No
1	Perform the Diagnostic System Check. Are any diagnostic trouble code(s) (DTCs) stored in the electronic control module (ECM) memory?	-	Go to Appropriate DTC Table	Go to *Step 2*
2	1. Inspect all of the ECM ground connections. 2. Inspect all of the vacuum hoses for splits, kinks, and proper connections. 3. Check for air leaks at all of the mounting areas of the intake manifold sealing surfaces. 4. Inspect the ignition wires for cracking, hardness, proper routing, and carbon tracking. 5. Inspect the wiring for proper connections, pinches, and cuts. Are all checks complete?	-	Go to Appropriate Symptom Table	-

INTERMITTENTS

Definition: The problem may or may not turn on the service engine soon (SES) or store a diagnostic trouble code (DTC).

Important: Do not use the diagnostic trouble code (DTC) tables for intermittent problems. A fault must be present in order to locate the problem. If a fault is intermittent, use of diagnostic trouble code tables may result in the replacement of good parts.

Step	Action	Value(s)	Yes	No
1	Were the Important Preliminary Checks performed?	-	Go to *Step 2*	Go to "Important Preliminary Checks"
2	1. Perform a careful inspection of any suspect circuits. 2. Inspect for poor mating of the connector halves, or terminals not fully seated into the connector body. 3. Inspect for improperly formed or damaged terminals. 4. Inspect for poor terminal-to-wire connections. This requires removing the terminal from the connector body to inspect it. Are any problems present?	-	Go to *Step 3*	Go to *Step 4*
3	Repair the electrical connections as needed. Is the repair complete?	-	System OK	-
4	Road test the vehicle with a voltmeter connected to a suspected circuit or a scan tool connected to the assembly line diagnostic link (ALDL). Did the voltmeter or the scan tool indicate an abnormal voltage or scan reading?	-	Go to *Step 5*	Go to *Step 6*

Intermittents (Cont'd)

Step	Action	Value(s)	Yes	No
5	Replace the sensor in the affected circuit, if a diagnostic trouble code (DTC) was stored for this circuit (except for the DTCs 44 and 45). Is the repair complete?	-	System OK	-
6	Does an intermittent service engine soon (SES) or DTC occur?	-	Go to *Step 7*	Go to *Step 8*
7	1. Check for a faulty relay, electronic control module (ECM) driven solenoid, or switch. 2. Check for improper installation of electrical devices, such as lights, two-way radios, electric motors, etc. 3. Inspect the ignition control wires for proper routing (away from ignition wires, ignition system components, and the generator). 4. Check for a short-to-ground in the SES circuit or the ALDL "test" terminal. 5. Inspect the ECM ground connections. 6. Correct or repair the affected circuits as needed. Is the repair complete?	-	System OK	-
8	1. Check for a loss of DTC memory. 2. Disconnect the throttle position sensor. 3. Run the engine at idle until the SES comes on. 4. Turn the ignition OFF. Is DTC 22 stored in memory?	-	Go to *Step 10*	Go to *Step 9*
9	Replace the ECM. Is the repair complete?	-	System OK	-
10	Does the vehicle stall while driving?	-	Go to *Step 11*	Go to *Step 12*
11	Monitor the oxygen sensor and the injector base pulse width with the scan tool. Does the scan tool display a steady low voltage (about 0 mv) for the oxygen sensor with the control module commanding an injector base pulse width of the value specified?	8 ms	Go to *Step 9*	Go to *Step 12*
12	1. Check for an open diode across the A/C clutch and for other open diodes. 2. Repair or replace any components as needed. Is the repair complete?	-	System OK	-

HARD START

Definition: The engine cranks OK, but does not start for a long time. The engine eventually runs or may start and immediately die.

Important: Ensure that the driver is using the correct starting procedure. Before diagnosing, check service bulletins for updates.

Step	Action	Value(s)	Yes	No
1	Were the Important Preliminary Checks performed?	-	Go to *Step 2*	Go to "Important Preliminary Checks"
2	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Check the coolant temperature sensor (CTS) and the manifold air temperature (MAT) sensor using the scan tool. 3. Compare the coolant temperature and the manifold air temperature with the ambient temperature when the engine is cold. Does the CTS and the MAT readings differ from the ambient temperature by more than the value specified?	3°C (5°F)	Go to *Step 3*	Go to *Step 4*
3	1. Measure the resistance of the CTS and the MAT sensor. 2. Compare the resistance value to specifications using the Temperature Vs. Resistance tables for DTCs 14 and 23. 3. If the resistance is not the same, replace the faulty sensor. Is the repair complete?	-	System OK	-
4	1. Check for a sticking throttle shaft or a binding linkage that may cause a high throttle position sensor (TPS) voltage. Repair or replace as needed. 2. Check the TPS voltage reading with the throttle closed. Does the voltage measure within the value specified?	0.4-0.8 v	Go to *Step 5*	Go to *Step 26*
5	1. Check the manifold absolute pressure (MAP) sensor response and accuracy. 2. Replace the MAP sensor as needed. Is the repair complete?	-	System OK	Go to *Step 6*
6	Check the fuel pump operation. Does the fuel pump operate for the specified time when the ignition switch is turned ON?	2 sec	Go to *Step 7*	Go to "Fuel Pump Relay Circuit Check"
7	Check the fuel system pressure. Is the fuel pressure within the specifications?	284-325 kPa (41-47 psi)	Go to *Step 29*	Go to *Step 8*
8	Check for water contamination in the fuel. Is fuel contaminated?	-	Go to *Step 9*	Go to *Step 10*
9	Replace the contaminated fuel. Is the repair complete?	-	System OK	-

Hard Start (Cont'd)

Step	Action	Value(s)	Yes	No
10	1. Check the fuel injector driver circuit. 2. Disconnect all of the fuel injector harness connectors at the fuel injectors. 3. Connect an injector test light between the harness terminals of each fuel injector connector. 4. Note the test light while cranking the engine. Does the test light blink at all connectors?	-	Go to *Step 13*	Go to *Step 11*
11	Check the fuel injector driver wiring harness, the connectors, and the connector terminals for the proper connections. Is the problem found?	-	Go to *Step 12*	Go to *Step 30*
12	Repair the wiring harness, the connector, or the connector terminal as needed. Is the repair complete?	-	System OK	-
13	Measure the resistance of each fuel injector. Is the fuel injector resistance within the value specified (20°C [68°F] - the resistance will increase slightly at higher temperatures)?	11.6-12.4 Ω	Go to *Step 15*	Go to *Step 14*
14	Replace any fuel injector with a resistance that is out of specifications. Is the repair complete?	-	System OK	-
15	Perform an injector balance test. Is the problem found?	-	Go to *Step 16*	Go to *Step 17*
16	Replace any restricted or leaking fuel injectors as needed. Is the repair complete?	-	System OK	-
17	1. Check for the proper ignition voltage output for each cylinder with a spark tester. 2. Inspect the spark plugs for cracks, wear, improper gap, burned electrodes, or heavy deposits. 3. Inspect the ignition wires for short conditions. 4. Inspect all of the ignition grounds for loose connections. 5. Inspect the electronic control module (ECM) for the proper operation. Is the problem found?	-	Go to *Step 18*	Go to *Step 19*
18	Correct or replace any faulty ignition components. Is the repair complete?	-	System OK	-
19	Does the engine misfire or cut out under load or at idle?	-	Go to "Ignition System Check"	Go to *Step 20*
20	Does the engine start, but then immediately stall?	-	Go to *Step 21*	Go to *Step 23*
21	1. Remove the crankshaft position sensor (CPS). 2. Inspect for faulty connections and repair as needed. Is the problem found?	-	Go to *Step 22*	Go to *Step 25*
22	Repair the faulty connections as needed. Is the repair complete?	-	System OK	-

Hard Start (Cont'd)

Step	Action	Value(s)	Yes	No
23	1. Check for the proper valve timing. 2. Check the cylinder compression. 3. Inspect the pushrods, the rocker arms, the valve springs, and the camshaft lobes for excessive wear. 4. Inspect the intake manifold and the exhaust manifold passages for casting flash. Is the problem found?	-	Go to *Step 24*	Go to *Step 25*
24	Repair or replace any components as needed. Is the repair complete?	-	System OK	-
25	Check the idle air control valve operation. Repair or replace components as needed. Is the repair complete?	-	System OK	-
26	Check the base idle setting of the throttle body. Is the base idle setting properly adjusted?	-	Go to *Step 27*	Go to *Step 28*
27	Check the throttle position sensor circuit for proper operation. Repair or replace components as needed. Is the repair complete?	-	System OK	-
28	Adjust the base idle setting to specifications. Is the repair complete?	-	System OK	-
29	Repair the fuel system as needed. Is the repair complete?	-	System OK	-
30	Replace the ECM. Is the repair complete?	-	System OK	-

SURGES OR CHUGGLES

Definition: Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

Important: Make sure the driver understands torque converter clutch (TCC) and A/C compressor operation as described in the owner's manual.

The speedometer reading and the speed reading on the scan tool should be equal.

Before diagnosing the symptom, check service bulletins for updates.

Step	Action	Value(s)	Yes	No
1	Were the Important Preliminary Checks performed?	-	Go to *Step 2*	Go to "Important Preliminary Checks"
2	Connect the scan tool to the assembly line diagnostic link (ALDL). Does the oxygen (O_2) sensor respond quickly to different throttle positions?	-	Go to *Step 4*	Go to *Step 3*
3	1. Check the O_2 sensor for silicone or other contaminants from fuel or use of improper RTV sealant. 2. Replace the contaminated O_2 sensor. Is the repair complete?	-	System OK	-

Surges or Chuggles (Cont'd)

Step	Action	Value(s)	Yes	No
4	1. Drive the vehicle at the speed of the complaint. 2. Monitor the long term fuel trim reading using the scan tool. Is the long term fuel trim reading within the value specified?	115-150 counts	Go to *Step 7*	Go to *Step 5*
5	Is the long term fuel trim reading below the value specified?	115 counts	Go to "Diagnostic Aids for DTC 45"	Go to *Step 6*
6	Is the long term fuel trim reading above the value specified?	150 counts	Go to "Diagnostic Aids for DTC 44"	-
7	Check the fuel system pressure while the condition exists. Is the fuel system pressure within specifications?	284-325 kPa (41-47 psi)	Go to *Step 8*	Go to *Step 17*
8	Check the in-line fuel filter. Is the filter dirty or plugged?	-	Go to *Step 18*	Go to *Step 9*
9	Perform an injector balance test. Did the injector balance test pinpoint the problem?	-	Go to *Step 19*	Go to *Step 10*
10	1. Check for proper ignition voltage output using a spark tester. 2. Inspect the spark plugs for cracks, wear, improper gap, burned electrodes, or heavy deposits. Is the problem found?	-	Go to *Step* 11	Go to *Step 12*
11	Repair or replace any ignition system components as needed. Is the repair complete?	-	System OK	-
12	1. Inspect the engine control module grounds for being clean, tight, and in their proper locations. 2. Inspect the vacuum lines for kinks or leaks. Is the problem found?	-	Go to *Step* 13	Go to *Step 14*
13	Repair the electrical connections or the vacuum lines as needed. Is the repair complete?	-	System OK	-
14	Check the generator output voltage. Is the generator voltage within the value specified?	12-16 v	Go to *Step 16*	Go to *Step 15*
15	Repair the generator. Is the repair complete?	-	System OK	-
16	1. Check for intermittent exhaust gas recirculation (EGR) valve operation. 2. Check torque converter clutch (TCC) operation. 3. Repair or replace any components as needed. Is the repair complete?	-	System OK	-
17	Repair the fuel system as needed. Is the repair complete?	-	System OK	-
18	Replace the fuel filter. Is the repair complete?	-	System OK	-
19	Replace the leaking or restricted fuel injectors. Is the repair complete?	-	System OK	-

LACK OF POWER, SLUGGISHNESS, OR SPONGINESS

Definition: The engine delivers less than expected power. There is little or no increase in speed when the accelerator pedal is partially applied.

Step	Action	Value(s)	Yes	No
1	Were the Important Preliminary Checks performed?	-	Go to *Step 2*	Go to "Important Preliminary Checks"
2	1. Verify the customer's complaint. 2. Compare the performance of the customer's vehicle with a similar unit. Does the problem exist?	-	Go to *Step 3*	System OK
3	1. Inspect the air filter for excessive contamination. 2. Replace the air filter as needed. 3. Check the transaxle shift pattern and down shift operation. Does the transaxle operate properly?	-	Go to *Step 4*	Go to *Step 5*
4	Check the fuel system pressure. Is the fuel system pressure within specifications?	284-325 kPa (41-47 psi)	Go to *Step 7*	Go to *Step 6*
5	Repair the transaxle as needed. Is the repair complete?	-	System OK	-
6	Repair the fuel system as needed. Is the repair complete?	-	System OK	-
7	Check for a restricted fuel filter or contaminated fuel. Is the problem found?	-	Go to *Step 8*	Go to *Step 9*
8	Repair or replace any components as needed. Is the repair complete?	-	System OK	-
9	1. Check the ignition system output for all of the cylinders using a spark tester. 2. Check for proper ignition control operation. Is the ignition system operating properly?	-	Go to *Step 10*	Go to *Step 11*
10	1. With the engine at normal operating temperature, connect a vacuum gauge to a vacuum port on the intake manifold. 2. Operate the engine at 1000 rpm. 3. Record the vacuum reading. 4. Increase the engine speed to 2500 rpm. 5. Note the vacuum reading at a steady 2500 rpm. Does the vacuum decrease more than the value specified?	10 kPa (3 in. Hg)	Go to *Step 12*	Go to *Step 15*
11	Repair or replace any ignition system components as needed. Is the repair complete?	-	System OK	-
12	Inspect the exhaust system for restrictions and damaged or collapsed pipes. Is the problem found?	-	Go to *Step 13*	Go to *Step 14*
13	Repair or replace any components as needed. Is the repair complete?	-	System OK	-
14	1. Check the cylinder compression and valve timing. 2. Inspect the camshaft for excessive wear. Is the problem found?	-	Go to *Step 15*	Go to *Step 16*

Lack of Power, Sluggishness, or Sponginess (Cont'd)

Step	Action	Value(s)	Yes	No
15	Repair or replace any engine components as needed. Is the repair complete?	-	System OK	-
16	1. Check the engine control module grounds for being clean, tight, and in their proper location. 2. Check the exhaust recirculation valve for being open or partially open all the time. 3. Check the torque converter clutch operation. 4. Check the A/C system operation. 5. Check the generator output. 6. Repair the generator if the output is not within the specified range. Are all checks and repairs complete?	12-16 v	System OK	-

DETONATION/SPARK KNOCK

Step	Action	Value(s)	Yes	No
1	Were the Important Preliminary Checks performed?	-	Go to *Step 2*	Go to "Important Preliminary Checks"
2	1. Fill the fuel tank with a known good grade of gasoline that has the octane rating of the value specified. 2. Reevaluate the vehicle's performance. Does the detonation problem still exist?	87-89 octane	Go to *Step 3*	System OK
3	1. Inspect for low engine coolant. 2. Check for restricted air flow to the radiator or restricted coolant flow. 3. Check for a faulty thermostat. 4. Check for an incorrect coolant solution. Is the problem found?	-	Go to *Step 4*	Go to *Step* 5
4	Repair or replace any cooling system components as needed. Is the repair complete?	-	System OK	-
5	1. Check the voltage using the scan tool. 2. Replace the CTS if the resistance is not within specifications as listed in the Diagnostic Aids for diagnostic trouble code 14. Is the problem found?	-	Go to *Step 6*	Go to *Step* 7
6	Replace the CTS or repair the circuit as needed. Is the repair complete?	-	System OK	-
7	1. Check the ignition system output with a spark tester. 2. Inspect the spark plugs for the proper heat range and gap. 3. Check for the proper operation of the ignition controls. Is the ignition system operating properly?	-	Go to *Step 9*	Go to *Step 8*

Detonation/Spark Knock (Cont'd)

Step	Action	Value(s)	Yes	No
8	Repair or replace the ignition system components as needed. Is the repair complete?	-	System OK	-
9	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Road test the vehicle at the speed of the complaint. 3. Monitor the long term fuel trim reading from the scanner data stream. Is the long term fuel trim reading above the value specified?	150 counts	Go to "Diagnostic Aids for DTC 44"	Go to *Step 10*
10	Check the fuel system pressure. Is the problem found?	284-325 kPa (41-47 psi)	Go to *Step 11*	Go to *Step 12*
11	Repair or replace the fuel system components as needed. Is the repair complete?	-	System OK	-
12	1. Inspect for carbon buildup inside the engine. 2. Remove the carbon with a top engine cleaner. Follow the instructions supplied with the product. 3. Check the basic engine parts such as the camshaft, the cylinder head, the pistons, etc. for excessive wear. 4. Replace any excessively worn parts. Is the procedure complete?	-	Go to *Step 13*	-
13	1. Check the exhaust gas recirculation valve for proper operation. 2. Check the air intake system for proper operation. 3. Check the torque converter clutch operation and transaxle shift points. 4. Check the service bulletins for PROM updates. 5. Check the cylinder compression. 6. Repair or replace any faulty components. Are all checks and repairs complete?	-	System OK	-

HESITATION, SAG, STUMBLE

Definition: Momentary lack of response as the accelerator is pushed down. This can occur at any vehicle speed. It is usually the most severe when first trying to make the vehicle move, as from a stop. Hesitation, sag, or stumble may cause the engine to stall if severe enough.

Important: Before diagnosing this condition, check service bulletins for PROM updates.

Step	Action	Value(s)	Yes	No
1	Were the Important Preliminary Checks performed?	-	Go to *Step 2*	Go to "Important Preliminary Checks"
2	1. Check the fuel system pressure. If the pressure is not within the value specified, service the fuel system as needed. 2. Inspect the throttle position sensor (TPS) for binding or sticking. The TPS voltage should increase at a steady rate as the throttle is moved toward wide open throttle (WOT). Is the problem found?	284-325 kPa (41-47 psi)	Go to *Step 3*	Go to *Step 4*
3	Repair or replace any components as needed. Is the repair complete?	-	System OK	-
4	1. Check the manifold absolute pressure (MAP) sensor response and accuracy. 2. Inspect the fuel for water contamination. 3. Check the canister purge system for proper operation. Is the problem found?	-	Go to *Step 5*	Go to *Step 6*
5	Repair or replace any components as needed. Is the repair complete?	-	System OK	-
6	1. Disconnect all of the fuel injector harness connectors. 2. Connect an injector test light between the harness terminals of each fuel injector. 3. Note the test light while cranking the engine. Does the test light blink on all connectors?	-	Go to *Step 8*	Go to Step 7
7	1. Repair or replace the faulty fuel injector drive harness, the connector, or the connector terminal. 2. If the connections and the harnesses are good, replace the electronic control module (ECM) for an internal open in the fuel injector driver circuit. Is the repair complete?	-	System OK	-
8	Measure the resistance of each fuel injector. Is the fuel injector resistance within the value specified (the resistance will increase slightly at higher temperatures)?	11.6-12.4 Ω	Go to *Step 10*	Go to *Step 9*
9	Replace any of the fuel injectors with a resistance that is out of specifications. Is the repair complete?	-	System OK	-
10	Perform an injector balance test. Is the problem found?	-	Go to *Step* 11	Go to *Step 12*
11	Replace any restricted or leaking fuel injectors. Is the repair complete?	-	System OK	-

Hesitation, Sag, Stumble (Cont'd)

Step	Action	Value(s)	Yes	No
12	Check the fuel system pressure after a cold start or during moderate or full throttle acceleration. Is the fuel pressure within specifications?	284-325 kPa (41-47 psi)	Go to *Step 14*	Go to *Step 13*
13	Repair the restriction in the fuel system or replace the faulty fuel pump. Is the repair complete?	-	System OK	-
14	1. Check for faulty ignition wires. 2. Inspect for fouled spark plugs. 3. Check the ignition system output on each cylinder with a spark tester. Is the problem found?	-	Go to *Step 15*	Go to *Step 16*
15	Repair or replace any ignition components as needed. Is the repair complete?	-	System OK	-
16	1. Check the generator output voltage. 2. Repair or replace the generator if the generator output is less than the value specified. 3. Check the exhaust gas recirculation (EGR) valve operation. Are all checks and needed repairs complete?	12-16 v	System OK	-

CUTS OUT, MISSES

Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle or low speed.

Step	Action	Value(s)	Yes	No
1	Were the Important Preliminary Checks performed?	-	Go to *Step 2*	Go to "Important Preliminary Checks"
2	Check the ignition system output voltage for all of the cylinders using a spark tester. Is spark present on all of the cylinders?	-	Go to *Step 3*	Go to "Ignition System Check"
3	1. Inspect the spark plugs for excessive wear, insulation cracks, improper gap, or heavy deposits. 2. Check the resistance of the ignition wires. Replace any ignition wires that have a resistance greater than the value specified. Is the problem found?	30,000 Ω	Go to *Step 4*	Go to *Step 5*
4	Repair or replace any components as needed. Is the repair complete?	-	System OK	-
5	With the engine running, spray the ignition wires with a fine water mist to check for arcing and shorting to ground. Is the problem found?	-	Go to *Step 6*	Go to *Step 7*
6	Replace the ignition wires. Is the repair complete?	-	System OK	-

Cuts Out, Misses (Cont'd)

Step	Action	Value(s)	Yes	No
7	1. Perform a cylinder compression test. 2. If the compression is low, repair the engine as needed. 3. Inspect for proper valve timing, bent pushrods, worn rocker arms, broken or weak valve springs, and worn camshaft lobes. 4. Inspect the intake manifold and the exhaust manifold passages for casting flash. Is the problem found?	-	Go to *Step 8*	Go to *Step 9*
8	Repair or replace any components as needed. Is the repair complete?	-	System OK	-
9	1. Check the fuel system for a plugged in-line fuel filter. 2. Check the fuel system for low fuel pressure. If the fuel pressure is below the value specified, service the fuel system as needed. 3. Inspect for contaminated fuel. Is the problem found?	284-325 kPa (41-47 psi)	Go to *Step 10*	Go to *Step 11*
10	Repair or replace any components as needed. Is the repair complete?	-	System OK	-
11	1. Disconnect all of the fuel injector harness connectors at the fuel injectors. 2. Connect an injector test light to the harness terminals of each fuel injector connector. 3. Note the test light while cranking the engine for each fuel injector. Does the test light blink for all of the fuel injectors?	-	Go to *Step 13*	Go to *Step 12*
12	1. Repair or replace the faulty injector drive circuit harness, the connector, or the connector terminal. 2. If the harness, the connectors, and the terminals are OK, replace the electronic control module (ECM). Is the repair complete?	-	System OK	-
13	Measure the resistance of each fuel injector. Is the injector resistance within the value specified (the resistance will increase slightly at higher temperatures)?	11.6-12.4 Ω	Go to *Step 15*	Go to *Step 14*
14	Replace any fuel injectors with a resistance that is out of specifications. Is the repair complete?	-	System OK	-
15	Perform an injector balance test. Is the problem found?	-	Go to *Step 16*	Go to *Step 17*
16	Replace any restricted or leaking fuel injectors. Is the repair complete?	-	System OK	-
17	1. Check for electromagnetic interference. 2. Monitor the engine rpm with a scan tool. Does the scan tool rpm change greatly with little change in actual engine rpm?	-	Go to *Step 18*	-
18	1. Inspect the routing of the ignition wires. 2. Inspect all of the ignition system grounds. 3. Correct the routing or repair the ground connections as needed. Are all checks and needed repairs complete?	-	System OK	-

POOR FUEL ECONOMY

Definition: Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

Important: Driving habits affect fuel economy. Check the owner's driving habits by asking the following questions:

1. Is the A/C system (i.e. defroster mode) turned on all the time?
2. Are the tires at the correct air pressure?
3. Have excessively heavy loads been carried?
4. Does the driver accelerate too much and too often? Suggest the driver read the section in the owner's manual about fuel economy.

Step	Action	Value(s)	Yes	No
1	Were the Important Preliminary Checks performed?	-	Go to *Step 2*	Go to "Important Preliminary Checks"
2	1. Inspect the air filter for excessive contamination. 2. Inspect for fuel system leaks. Are all needed checks complete?	-	Go to *Step 3*	-
3	1. Inspect the spark plugs for excessive wear, insulation cracks, improper gap, or heavy deposits. 2. Replace any faulty spark plugs. 3. Inspect the ignition wires for cracking, hardness, and proper connections. Are all needed checks and repairs complete?	-	Go to *Step 4*	-
4	1. Inspect the engine coolant level. 2. Check the thermostat for being always open or for an incorrect heat range. 3. Replace the thermostat as needed. Are all needed checks and repairs complete?	-	Go to *Step 5*	-
5	1. Check the transaxle shift pattern. Ensure all transaxle gears are functioning. 2. Check the torque converter clutch (TCC) operation with a scan tool. The scan tool should indicate rpm drop when the TCC is commanded on. 3. Check for proper calibration of the speedometer. 4. Check the brakes for dragging. 5. Check the cylinder compression. 6. Repair, replace, or adjust any components as needed. Are all checks and needed repairs complete?	-	System OK	-

ROUGH, UNSTABLE, OR INCORRECT IDLE, STALLING

Definition: The engine runs unevenly at idle. If the condition is bad enough, the vehicle may shake. Also, the idle varies in rpm (called "hunting"). Either condition may be severe enough to cause stalling. The engine idles at incorrect idle speed.

Important: Before diagnosing the symptom, check service bulletins for updates.

Step	Action	Value(s)	Yes	No
1	Were the Important Preliminary Checks performed?	-	Go to *Step 2*	Go to "Important Preliminary Checks"
2	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Monitor the oxygen (O_2) sensor reading at different throttle positions. Does the O_2 sensor change quickly from rich to lean at the different throttle positions?	-	Go to *Step 5*	Go to *Step 3*
3	Check the O_2 sensor for contamination from fuel or improper use of RTV sealant. Is the O_2 sensor contaminated?	-	*Go to Step 4*	Go to *Step 5*
4	Replace the contaminated O_2 sensor as needed. Is the repair complete?	-	System OK	-
5	1. Check for a sticking throttle shaft or binding throttle linkage that may cause incorrect throttle position sensor (TPS) voltage. 2. Check the TPS voltage reading with the throttle closed. Is the TPS voltage within the value specified?	0.4-0.8 v	Go to *Step 6*	Go to "Diagnostic Aids for DTC 21"
6	1. Check the coolant temperature sensor (CTS) voltage reading using the scan tool. 2. Compare the CTS reading with the ambient temperature when the engine is cold. Does the CTS temperature reading differ from the ambient temperature by more than the value specified?	3°C (5°F)	Go to *Step 7*	Go to *Step 9*
7	Check for high resistance in the CTS circuit or the sensor itself. Is the problem found?	-	Go to *Step* 8	Go to *Step 9*
8	Replace the CTS or repair the circuit as needed. Is the repair complete?	-	System OK	-
9	Check the manifold absolute pressure (MAP) sensor for response and accuracy. Is the problem found?	-	Go to *Step 10*	Go to *Step 11*
10	Replace the MAP sensor or repair the MAP sensor circuit as needed. Is the repair complete?	-	System OK	-
11	1. Road test the vehicle at the speed of the complaint. 2. Monitor the fuel trim reading using the scan tool. Is the fuel trim reading within the value specified?	115-150 counts	Go to *Step 14*	Go to *Step 12*
12	Is the fuel trim reading below the value specified?	115 counts	Go to "Diagnostic Aids for DTC 45"	Go to *Step 13*

Rough, Unstable, or Incorrect Idle, Stalling (Cont'd)

Step	Action	Value(s)	Yes	No
13	Is the fuel trim reading above the value specified?	150 counts	Go to "Diagnostic Aids for DTC 44"	-
14	1. Disconnect all of the fuel injector harness connectors at the fuel injectors. 2. Connect an injector test light between the harness terminals of each fuel injector connector. 3. Note the test light while cranking the engine. Does the test light blink for all of the fuel injectors?	-	Go to *Step 16*	Go to *Step 15*
15	1. Repair or replace the faulty injector drive circuit harness, the connector, or the connector terminals as needed. 2. If the harness, the connectors, and the terminals are OK, replace the electronic control module (ECM). Is the repair complete?	-	System OK	-
16	Measure the resistance of each of the fuel injectors. Is the resistance within the value specified (the resistance will increase slightly at higher temperatures)?	11.6-12.4 Ω	Go to *Step 18*	Go to *Step 17*
17	Replace any fuel injectors with a resistance that is out of specifications. Is the repair complete?	-	System OK	-
18	Perform an injector balance test. Is the problem found?	-	Go to *Step 19*	Go to *Step 20*
19	Replace any leaking or restricted fuel injectors. Is the repair complete?	-	System OK	-
20	1. With the engine OFF, disconnect the fuel pressure regulator vacuum hose. 2. Thoroughly inspect the fuel pressure regulator vacuum port and the fuel pressure regulator vacuum hose for the presence of fuel. Is the problem found?	-	Go to *Step 21*	Go to *Step 22*
21	Replace the fuel pressure regulator as needed. Is the repair complete?	-	System OK	-
22	1. Check the ignition system output voltage for all of the cylinders using a spark tester. 2. Inspect the spark plugs for excessive wear, insulation cracks, improper gap, or heavy deposits. 3. Inspect the ignition wires for cracking, hardness, or improper connections. 4. Replace any ignition wires with a resistance over the value specified. Is the problem found?	30,000 Ω	Go to *Step 23*	Go to *Step 24*
23	Repair or replace any ignition system components as needed. Is the repair complete?	-	System OK	-
24	1. Inspect for vacuum leaks. 2. Check for proper positive crankcase ventilation (PCV) operation. 3. Check the idle air control (IAC) valve operation. 4. Inspect the ECM ground connections. Is the problem found?	-	Go to *Step 25*	Go to *Step 26*

Rough, Unstable, or Incorrect Idle, Stalling (Cont'd)

Step	Action	Value(s)	Yes	No
25	Repair or replace any components as needed. Is the repair complete?	-	System OK	-
26	1. Check the exhaust gas recirculation (EGR) valve for proper operation. 2. Inspect the battery cables and the ground straps for proper connections. 3. Check the generator voltage output. Repair or replace the generator if the voltage output is not within the value specified. Is the problem found?	12-16 v	Go to *Step 27*	Go to *Step 28*
27	Repair or replace any components as needed. Is the repair complete?	-	System OK	-
28	1. Inspect for broken engine mounts. 2. Check for proper valve timing. 3. Perform a cylinder compression test. 4. Inspect for bent pushrods, worn rocker arms, broken or weak valve springs, and a worn camshaft. 5. Perform repairs as needed. Are all of the checks and needed repairs complete?	-	System OK	-

EXCESSIVE EXHAUST EMISSIONS OR ODORS

Definition: A vehicle fails an emission test. The vehicle has an excessive rotten egg smell. Excessive odors do not necessarily indicate excessive emissions.

Step	Action	Value(s)	Yes	No
1	Were the Important Preliminary Checks performed?	-	Go to *Step 2*	Go to "Important Preliminary Checks"
2	1. Run the engine until it reaches operating temperature. 2. Perform an emission test. Did the vehicle pass the emission test?	-	System OK	Go to *Step 3*
3	1. Connect the scan tool to the assembly line diagnostic link (ALDL). 2. Road test the vehicle. 3. Monitor the long term fuel trim memory. Is the long term fuel trim memory within the value specified?	115-150 counts	Go to *Step 6*	Go to *Step 4*
4	Is the long term fuel trim memory below the value specified?	115 counts	Go to "Diagnostic Aids for DTC 45"	Go to *Step 5*
5	Is the long term fuel trim memory above the value specified?	150 counts	Go to "Diagnostic Aids for DTC 44"	-
6	1. Check for a properly installed fuel cap. 2. Check the fuel system pressure. 3. Perform an injector balance test. Is the problem found?	-	Go to *Step 7*	Go to *Step 8*

Excessive Exhaust Emissions or Odors (Cont'd)

Step	Action	Value(s)	Yes	No
7	1. Repair or replace any fuel system components as needed. 2. Perform an emission test. Did the vehicle pass the emission test?	-	System OK	-
8	1. Check the ignition system for proper operation. 2. Inspect the spark plugs for excessive wear, insulation cracks, improper gap, or heavy deposits. 3. Check the ignition wires for cracking, hardness, or improper connections. Is the problem found?	-	Go to *Step 9*	Go to *Step 10*
9	1. Repair or replace any ignition system components as needed. 2. Perform an emission test. Did the vehicle pass the emission test?	-	System OK	-
10	1. Inspect for vacuum leaks. 2. Inspect the catalytic converter for contamination. 3. Inspect for carbon buildup on the throttle body and the throttle plate and inside the engine. Remove with a top engine cleaner. 4. Check the exhaust gas recirculation (EGR) valve for not opening. 5. Check for proper positive crankcase ventilation (PCV) operation. Are all checks and needed repairs complete?	-	System OK	-

DIESELING, RUN-ON

Definition: An engine continues to run after the ignition switch is turned OFF.

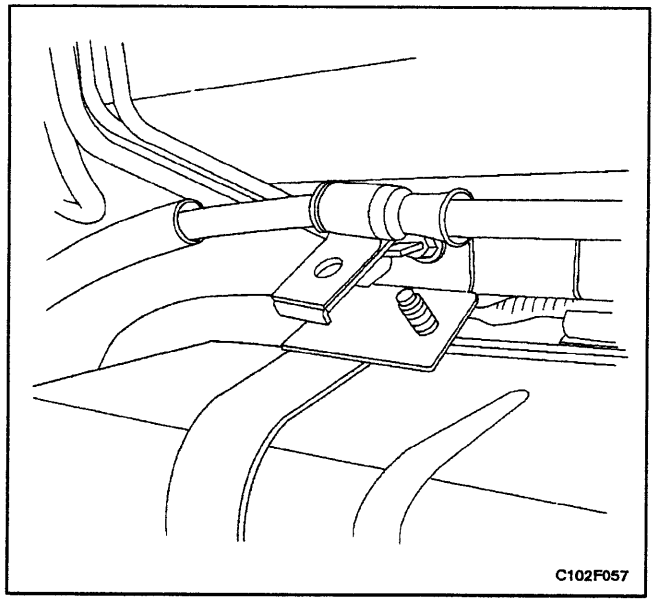
Step	Action	Value(s)	Yes	No
1	Were the Important Preliminary Checks performed?	-	Go to *Step 2*	Go to "Important Preliminary Checks"
2	Does the engine run smoothly after the ignition switch is turned OFF?	-	Go to *Step 3*	Go to *Step 4*
3	1. Check the ignition switch and the ignition switch adjustment. 2. Replace the ignition switch if needed. Is the repair complete?	-	System OK	-
4	1. Check the evaporative emission system. 2. Check for leaking fuel injectors. 3. Check the idle air control (IAC) valve operation. 4. Inspect for vacuum leaks. 5. Check for the proper base idle setting. Are all checks and repairs complete?	-	System OK	-

BACKFIRE

Definition: Fuel ignites in the intake manifold, or in the exhaust system, making a loud popping noise.

Important: Before diagnosing the symptom, check service bulletins for updates.

Step	Action	Value(s)	Yes	No
1	Were the Important Preliminary Checks performed?	-	Go to *Step 2*	Go to "Important Preliminary Checks"
2	1. Inspect for crossed or crossfiring ignition wires. 2. Check the ignition system output voltage for all cylinders using a spark tester. 3. Inspect the spark plugs for excessive wear, burned electrodes, improper gap, or heavy deposits. Is the problem found?	-	Go to *Step 3*	Go to *Step 4*
3	Repair or replace any ignition system components as needed. Is the repair complete?	-	System OK	-
4	1. Check the fuel system operation. 2. Check the fuel injectors by performing an injector balance test. Is the problem found?	-	Go to *Step 5*	Go to *Step 6*
5	Repair or replace any fuel system components as needed. Is the repair complete?	-	System OK	-
6	1. Inspect the exhaust gas recirculation (EGR) gasket for a leak or a loose fit. 2. Check the EGR valve for proper operation. 3. Inspect the intake manifold and the exhaust manifold for a casting flash. Is the problem found?	-	Go to *Step 7*	Go to *Step 8*
7	Repair or replace any components as needed. Is the repair complete?	-	System OK	-
8	1. Inspect the timing belt for proper installation and tension. 2. Check the engine compression. 3. Inspect the intake manifold gasket and the exhaust manifold gasket for leaks. 4. Check for sticking or leaking valves. 5. Repair or replace any components as needed. Are all checks and corrections complete?	-	System OK	-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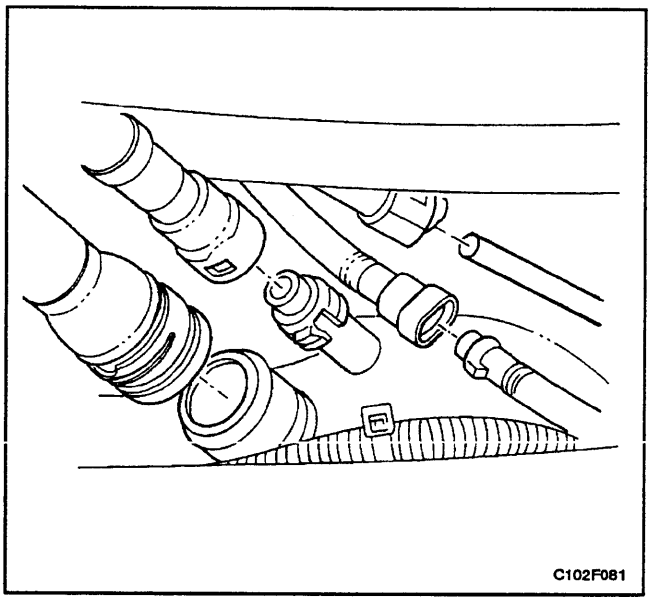
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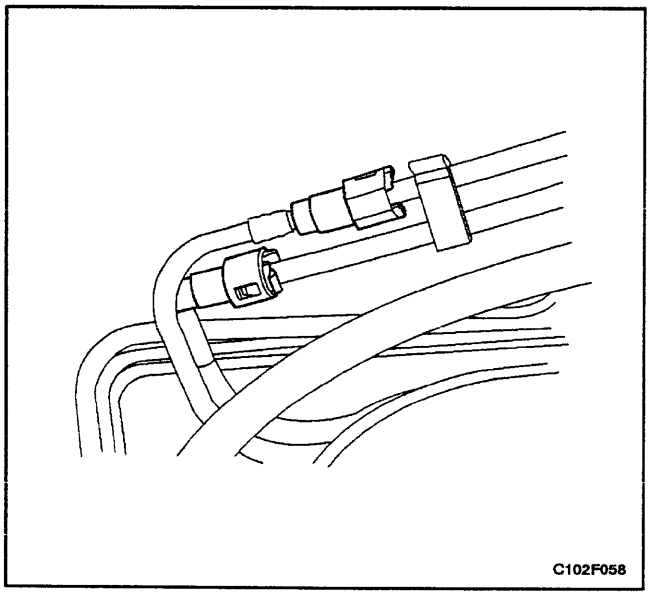
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MAINTENANCE AND REPAIR

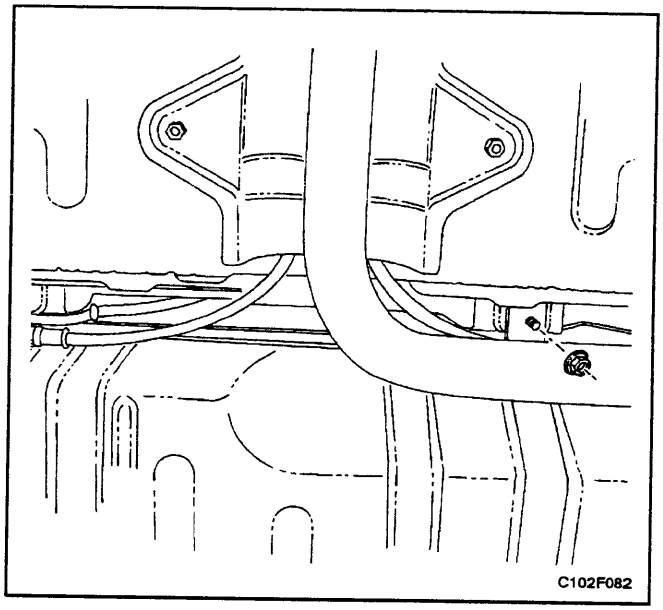
ON-VEHICLE SERVICE

FUEL TANK

Removal Procedure

Caution: The fuel system is under pressure. To avoid fuel spillage and the risk of personal injury or fire, it is necessary to relieve the fuel system pressure before disconnecting the fuel lines.

1. Relieve the fuel pressure. Refer to "Fuel Pump" in this section.
2. Disconnect the negative battery cable.
3. Drain the fuel tank.
4. Disconnect the right rear parking brake cable from the retaining bracket attached to the right side fuel tank strap.
5. Remove the fuel tank filler tube clamp at the fuel tank.
6. Disconnect the fuel tank filler tube.
7. Disconnect the fuel tank vent tube at the fuel tank.
8. Disconnect the fuel vapor line near the fuel tank filler tube.
9. Disconnect the fuel pump harness connector near the left rear corner of the fuel tank.
10. Disconnect the fuel inlet line and the fuel return line near the right front of the fuel tank.
11. Disconnect the wiring harness clips and the fuel line clips as needed.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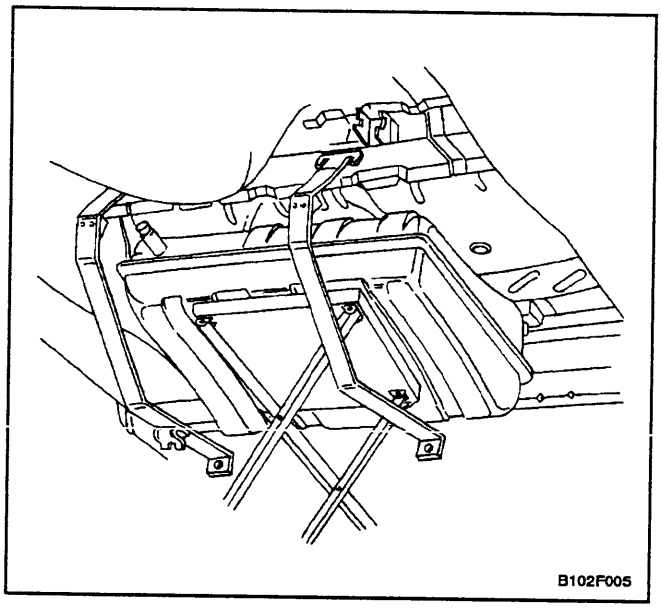
12. Support the fuel tank.
13. Remove the fuel tank strap retaining nuts.
14. Remove the fuel tank straps.
15. Carefully lower the fuel tank.
16. Remove the fuel tank.
17. Transfer any parts as needed.


B102F005

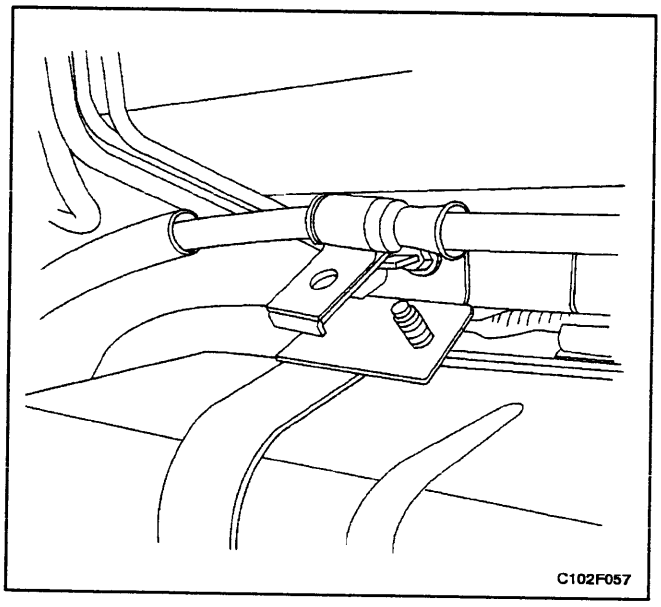
Installation Procedure

1. Raise the fuel tank into position.
2. Install the fuel tank straps.
3. Install the fuel tank strap retaining nuts.

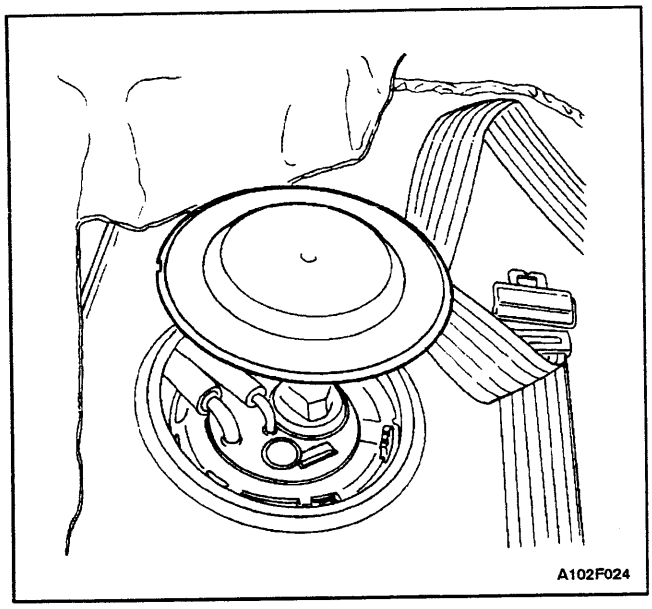
Tighten

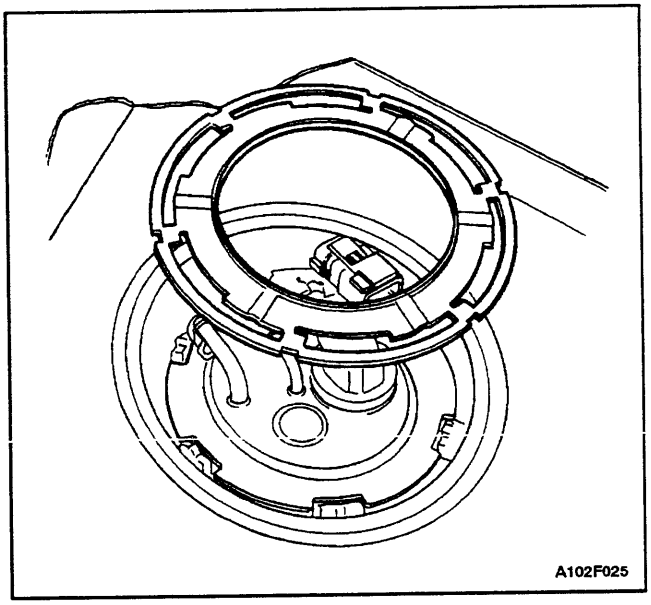
Tighten the fuel tank strap retaining nuts to 13 N•m (115 lb-in).

4. Connect the fuel outlet line and the fuel return line.
5. Connect the wiring harness clips and the fuel line clips as needed.
6. Connect the fuel pump harness connector.
7. Connect the fuel vapor line.
8. Connect the fuel tank filler tube.
9. Connect the fuel tank vent tube.
10. Install the fuel tank filler tube clamp at the fuel tank.


C102F057

11. Connect the right rear parking brake cable to the retaining bracket attached to the right side fuel tank strap.
12. Connect the negative battery cable.
13. Fill the fuel tank.
14. Perform a leak check of the fuel tank and the fuel line connections.


A102F024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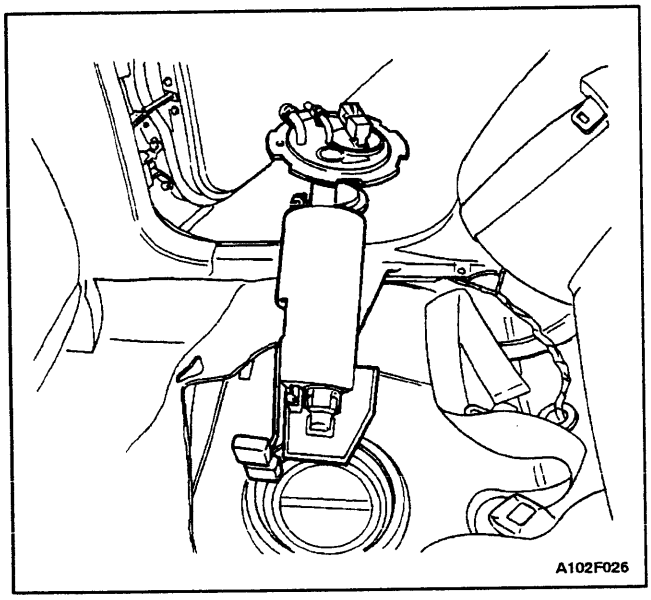

A102F026

FUEL PUMP

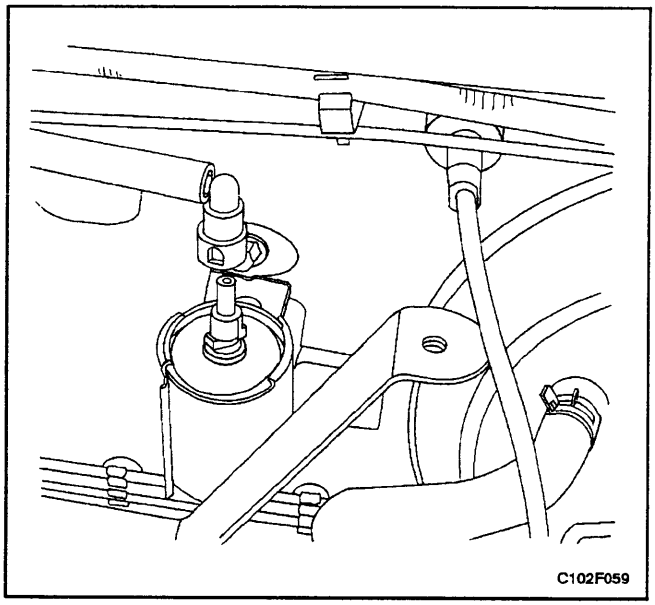
Removal Procedure

Caution: The fuel system is under pressure. To avoid fuel spillage and the risk of personal injury or fire, it is necessary to relieve the fuel system pressure before disconnecting the fuel lines.

1. Relieve the fuel system pressure.
   1.1. Remove the fuel cap.
   1.2. Remove fuel pump fuse EF18 from the engine fuse block.
   1.3. Start the engine and allow the engine to stall.
   1.4. Crank the engine for an additional 10 seconds.
2. Disconnect the negative battery cable.
3. Remove the rear seat. Refer to *Section 9H, Seats.*
4. Remove the fuel pump access cover.
5. Disconnect the electrical connector at the fuel pump assembly.
6. Disconnect the fuel outlet line.
7. Disconnect the fuel tank return line.
8. Turn the lock ring counterclockwise to clear the tank tabs.
9. Remove the fuel pump assembly from the tank.
10. Remove and discard the gasket.

Installation Procedure

1. Clean the gasket mating surface on the fuel tank.
2. Position the new gasket in place.
3. Install the fuel pump into the fuel tank in the same location as removed for ease of line and connector installation.
4. Position the lock ring in place and turn it clockwise until it contacts the tank stop.
5. Connect the fuel pump assembly connector.
6. Install the fuel pump outlet line.
7. Install the fuel tank return line.
8. Install the fuel pump access cover.
9. Connect the negative battery cable.
10. Perform an operational check of the fuel pump.
11. Install the rear seat. Refer to *Section 9H, Seats.*



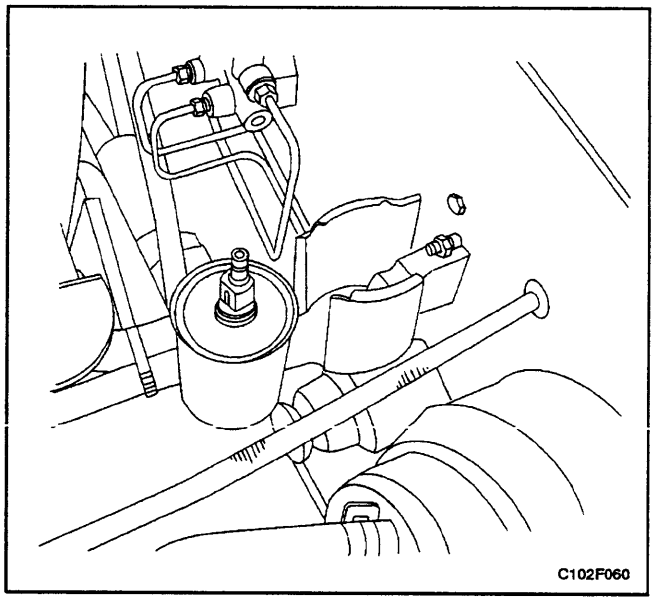
FUEL FILTER

Removal Procedure

1. Disconnect the negative battery cable.

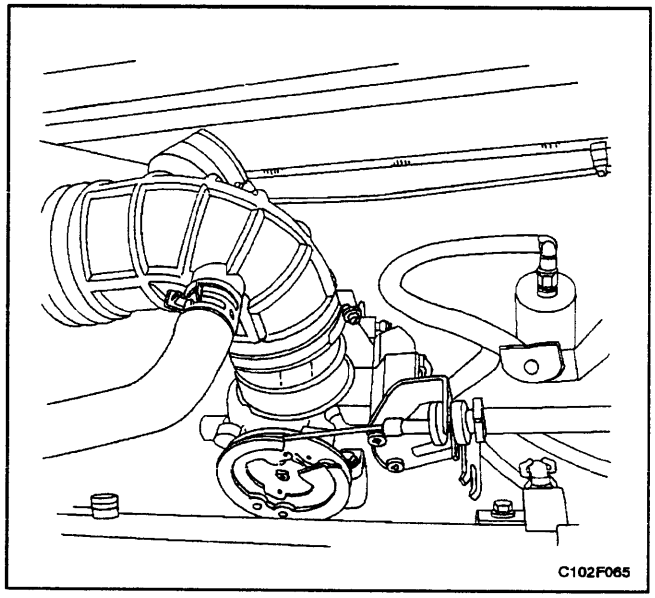
Caution: The fuel system is under pressure. To avoid fuel spillage and the risk of personal injury or fire, it is necessary to relieve the fuel system pressure before disconnecting the fuel lines.

2. Relieve the fuel system pressure. Refer to "Fuel Pump" in this section.
3. Disconnect the inlet/outlet fuel lines by moving the line connector lock forward and pulling the hose off of the fuel filter tube.
4. Remove the fuel filter.



Installation Procedure

1. Install the new fuel filter into the retaining clamp. Note the flow direction.
2. Install the fuel filter.
3. Connect the inlet/outlet lines. Secure the lines with the connector lock.
4. Connect the negative battery cable.
5. Perform a leak test of the fuel filter.

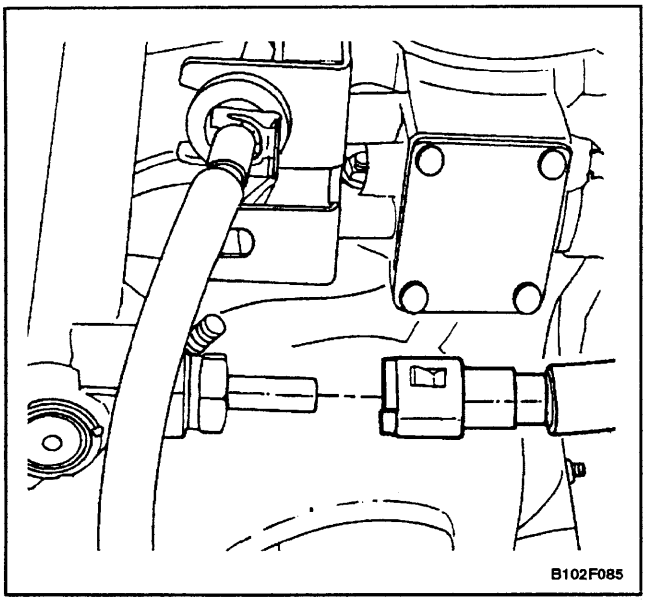


FUEL RAIL AND INJECTORS

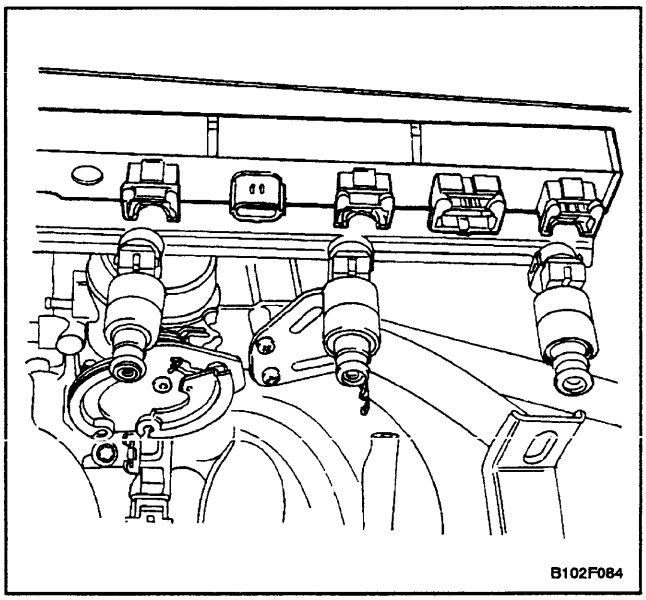
Removal Procedure

Caution: The fuel system is under pressure. To avoid fuel spillage and the risk of personal injury or fire, it is necessary to relieve the fuel system pressure before disconnecting the fuel lines.

1. Relieve the fuel system pressure. Refer to "Fuel Pump" in this section.
2. Disconnect the negative battery cable.
3. Disconnect the manifold air temperature (MAT) sensor connector.
4. Disconnect the breather hose from the valve cover.


B102F085

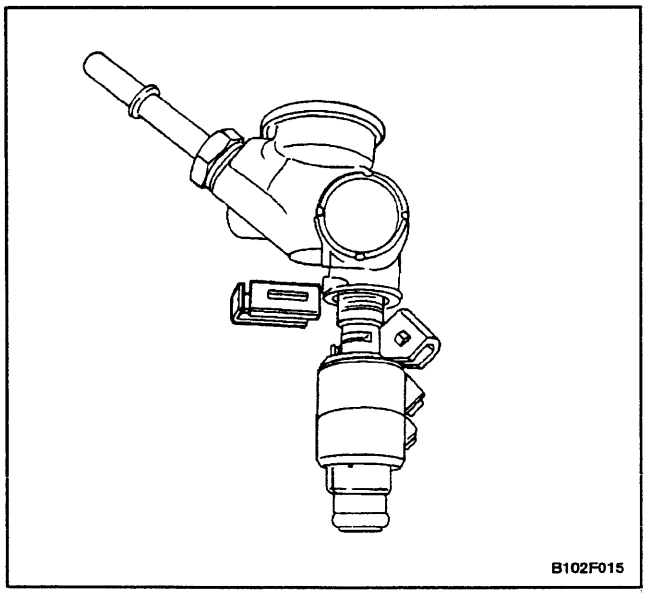
5. Remove the air intake tube and resonator.
6. Disconnect the positive crankcase ventilation (PCV) hose from the valve cover.
7. Disconnect the throttle cables from the throttle body and the bracket.
8. Remove the fuel pressure regulator. Refer to "Fuel Pressure Regulator" in this section.
9. Disconnect the fuel return line at the fuel rail.
10. Disconnect the fuel inlet line at the fuel rail.
11. Remove the fuel rail retaining bolts.
12. Remove the throttle cable bracket bolts and the brackets.


B102F084

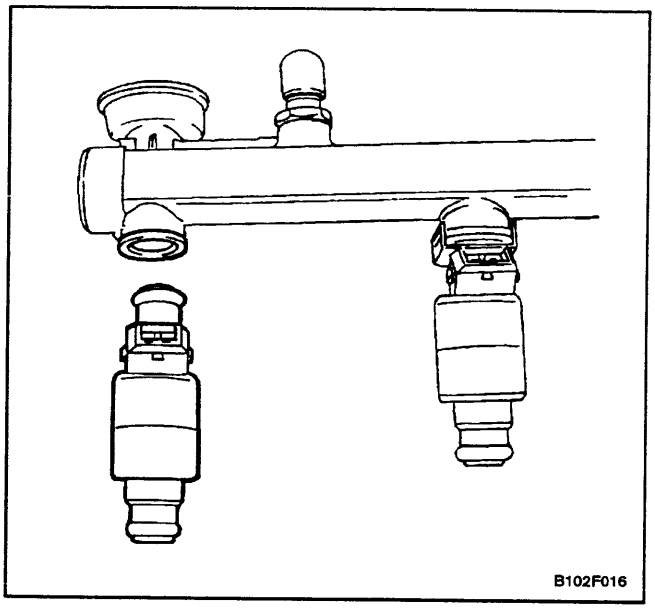
Notice: Before removal, the fuel rail assembly may be cleaned with a spray-type cleaner, following package instructions. Do not immerse the fuel rails in liquid cleaning solvent. Use care in removing the fuel rail assembly to prevent damage to the electrical connectors and the injector spray tips. Prevent dirt and other contaminants from entering open lines and passages. Fittings should be capped and holes plugged during service.

Important: If an injector becomes separated from the rail and remains in the cylinder head, replace the injector O-ring seals and the retaining clip.

13. Remove the fuel rail with the fuel injector channel cover and the injectors attached.
14. Disconnect the fuel injector channel cover connectors.


B102F015

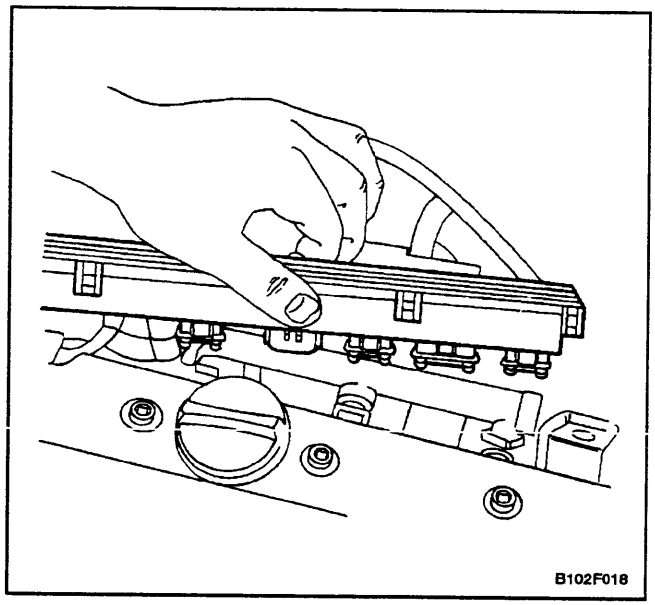
15. Remove the fuel injector retainer clips.
16. Remove the fuel injectors by pulling them down and out.
17. Discard the fuel injector O-rings.


B102F016

Installation Procedure

Important: Different injectors are calibrated for different flow rates. When ordering new fuel injectors, be certain to order the identical part number that is inscribed on the old injector.

1. Lubricate the new fuel injector O-rings with engine oil. Install the new O-rings on the fuel injectors.
2. Install the fuel injectors into the fuel rail sockets with the fuel injector terminals facing outward.
3. Install the fuel injector retaining clips onto the fuel injector and the fuel rail ledge.
4. Make sure that the clips are parallel to the fuel injector harness connector.

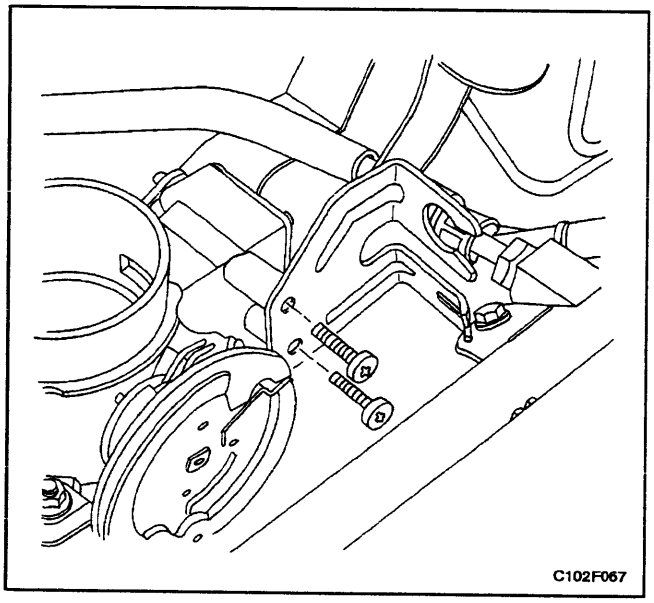

B102F018

5. Install the fuel rail assembly into the cylinder head.
6. Install the fuel rail retaining bolts.

Tighten

Tighten the fuel rail retaining bolts to 25 N•m (18 lb-ft).

7. Connect the fuel inlet line to the fuel rail.
8. Connect the fuel return line to the fuel rail
9. Install the fuel pressure regulator. Refer to "Fuel Pressure Regulator" in this section.
10. Connect the fuel injector channel cover and connectors. Rotate each fuel injector as required.

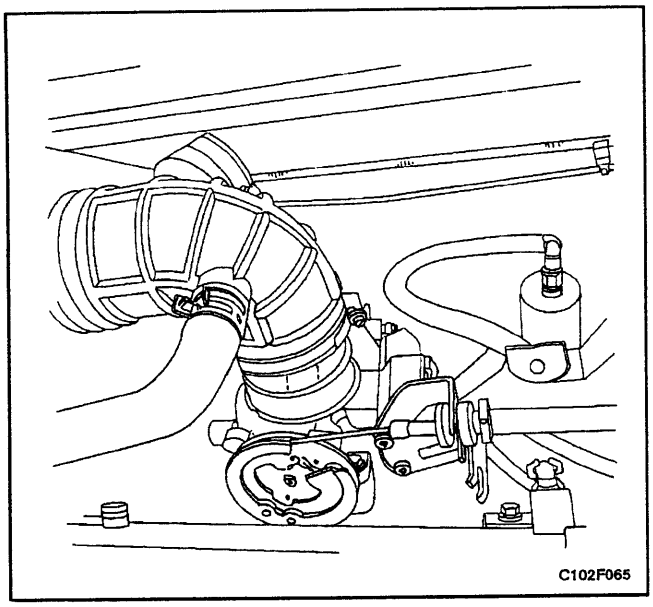

C102F067

11. Install the throttle cable bracket and the bolts.

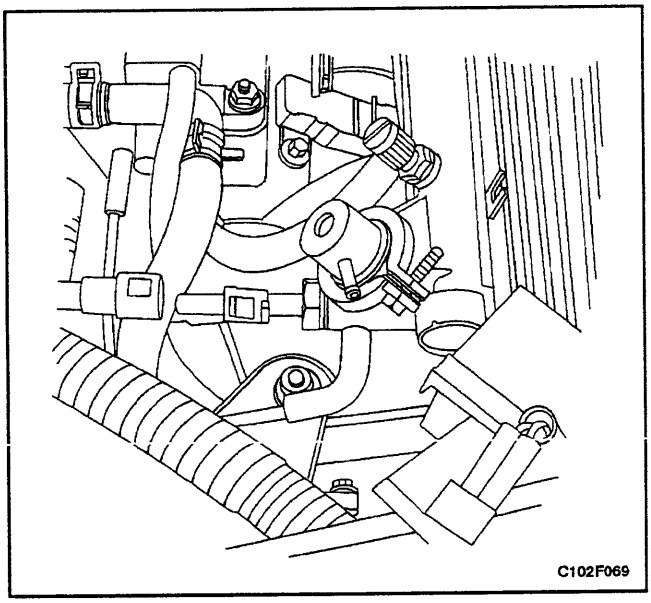
Tighten

Tighten the throttle cable bracket bolts to 10 N•m (89 lb-in).

12. Connect the PCV hose to the valve cover.
13. Connect the throttle cables to the throttle body and bracket.


C102F065

14. Install the air intake tube and resonator.
15. Connect the breather hose to the valve cover.
16. Connect the MAT sensor connector.
17. Connect the negative battery cable.
18. Perform a leak check of the fuel rail and fuel injectors.

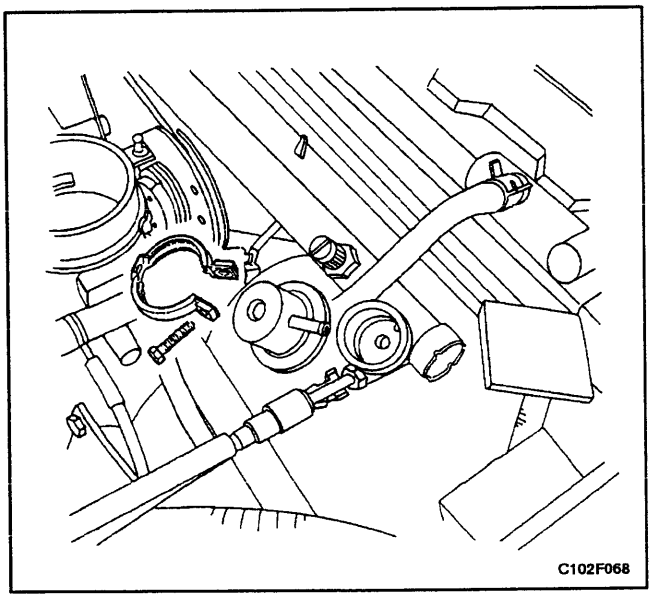

C102F069

FUEL PRESSURE REGULATOR

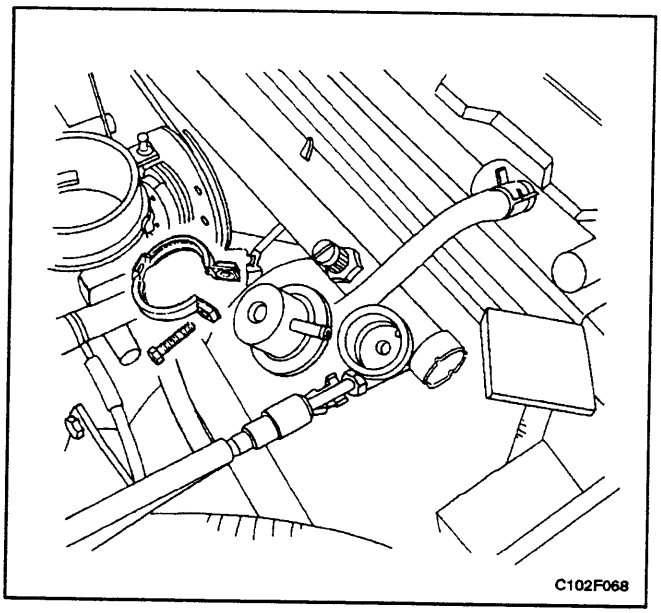
Removal Procedure

Caution: The fuel system is under pressure. To avoid fuel spillage and the risk of personal injury or fire, it is necessary to relieve the fuel system pressure before disconnecting the fuel lines.

1. Relieve the fuel pressure. Refer to "Fuel Pump" in this section.
2. Disconnect the negative battery cable.
3. Disconnect the manifold air temperature (MAT) sensor connector.
4. Disconnect the breather hose from the valve cover.
5. Remove the air intake tube.
6. Disconnect the vacuum hose from the fuel pressure regulator.


C102F068

7. Remove the fuel pressure regulator retaining clamp.
8. Remove the fuel pressure regulator by turning it back and forth and then pulling it out.
9. Discard the O-ring.

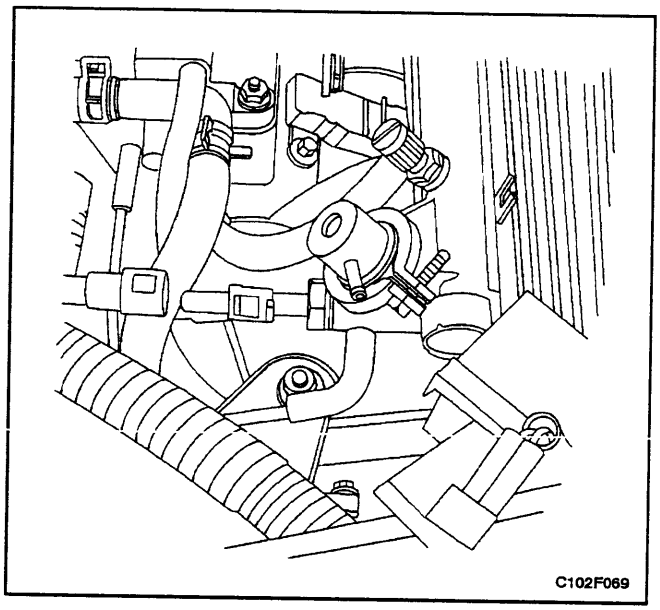

C102F068

Installation Procedure

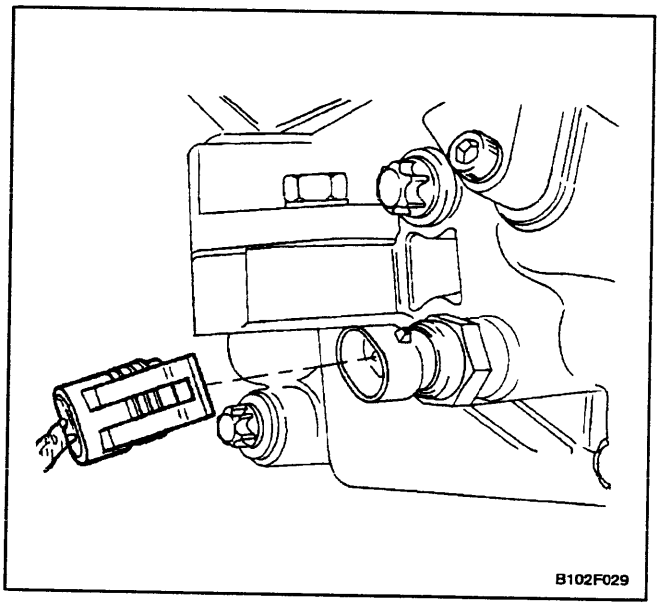
1. Lubricate a new O-ring. Install the new O-ring onto the fuel pressure regulator body.
2. Insert the fuel pressure regulator into the fuel rail body.
3. Install the fuel pressure regulator retaining clamp.

Tighten

Tighten the fuel pressure regulator retaining clamp to 12 N•m (106 lb-in).


C102F069

4. Connect the vacuum hose to the fuel pressure regulator.
5. Install the air intake tube.
6. Connect the breather hose to the valve cover.
7. Connect the MAT sensor connector.
8. Connect the negative battery cable.
9. Perform a leak test of the fuel pressure regulator with the engine off and the ignition ON.


B102F029

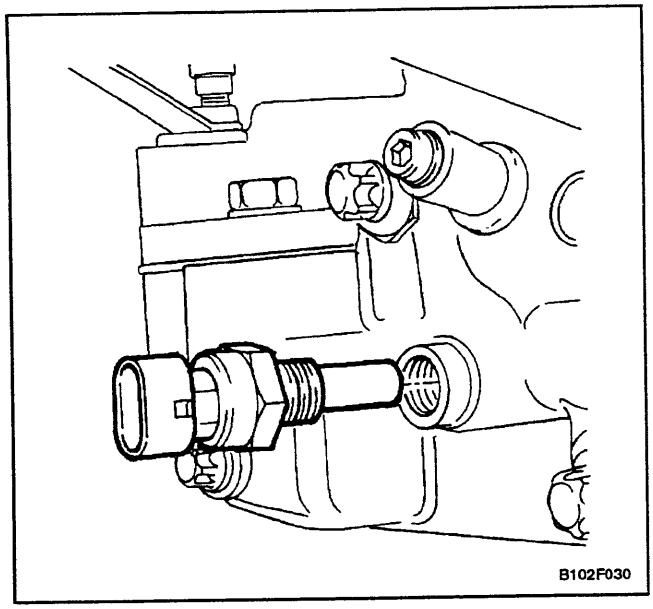
COOLANT TEMPERATURE SENSOR

Removal Procedure

1. Relieve the coolant system pressure.
2. Disconnect the negative battery cable.
3. Disconnect the coolant temperature sensor (CTS) connector.

Notice: Take care when handling the coolant temperature sensor. Damage to the sensor will affect the proper operation of the fuel injection system.

4. Remove the CTS from the direct ignition system (DIS) ignition coil adapter.


B102F030

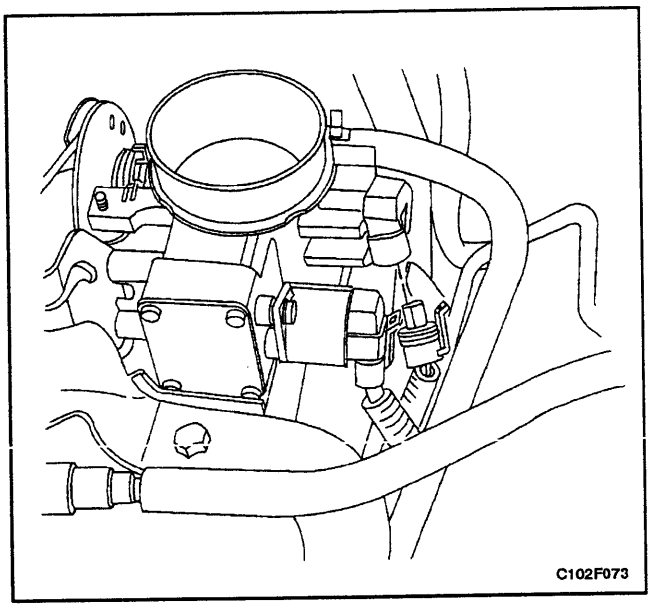
Installation Procedure

1. Coat the threads of the CTS with sealer.
2. Install the CTS into the DIS ignition coil adapter.

Tighten

Tighten the coolant temperature sensor to 25 N•m (18 lb-ft).

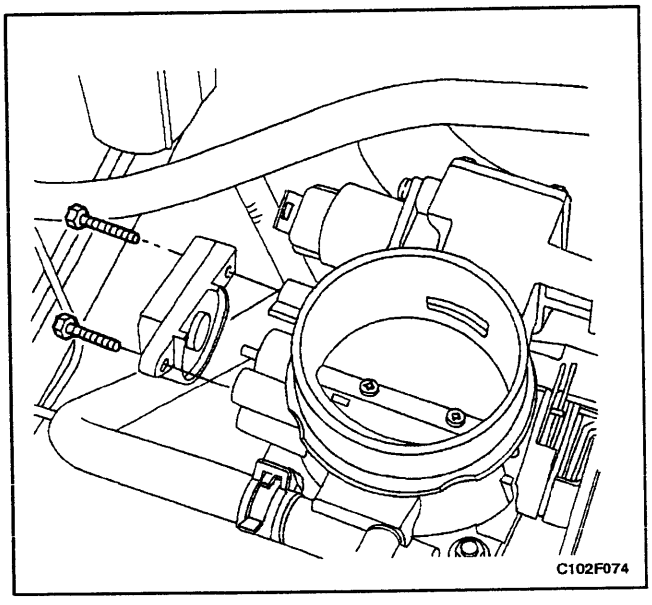
3. Connect the CTS connector.
4. Fill the coolant system.
5. Connect the negative battery cable.


C102F073

THROTTLE POSITION SENSOR

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the air intake tube and resonator.
3. Disconnect the throttle position sensor (TPS) connector.
4. Remove the TPS retaining bolts and the TPS.


C102F074

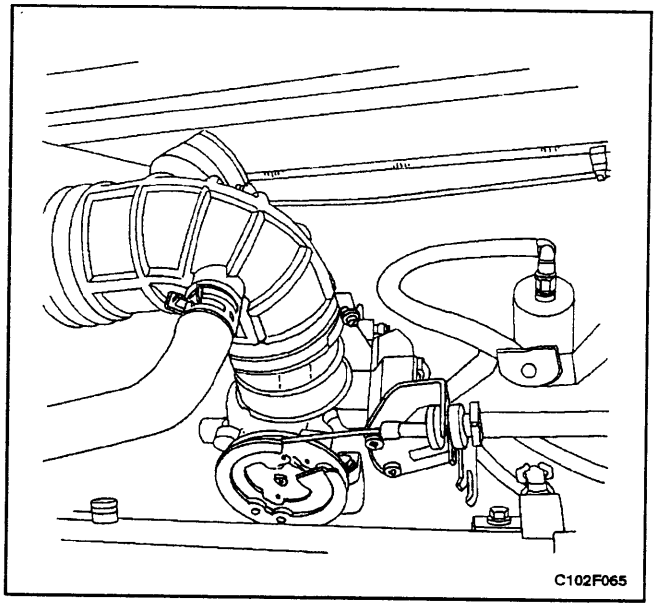
Installation Procedure

1. With the throttle valve closed, position the TPS on the throttle shaft. Align the TPS with the bolt holes.
2. Install the TPS retaining bolts.

Tighten

Tighten the throttle position sensor retaining bolts to 2 N•m (18 lb-in).

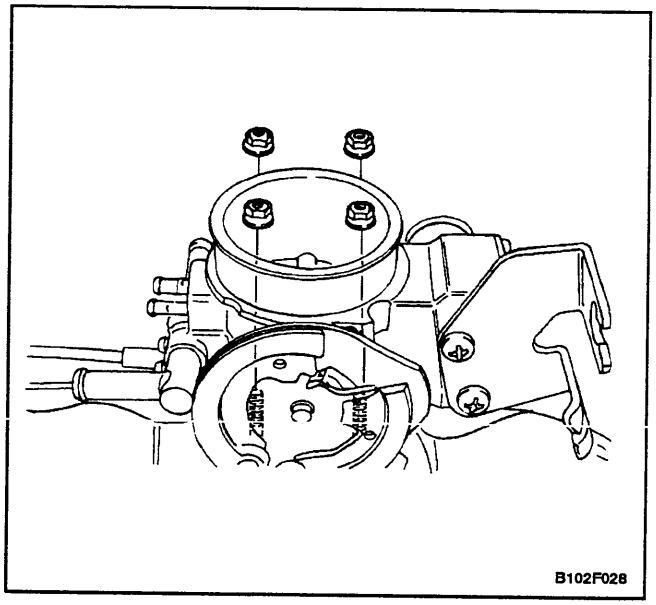
3. Connect the TPS connector.
4. Install the air intake tube and resonator.
5. Connect the negative battery cable.


C102F065

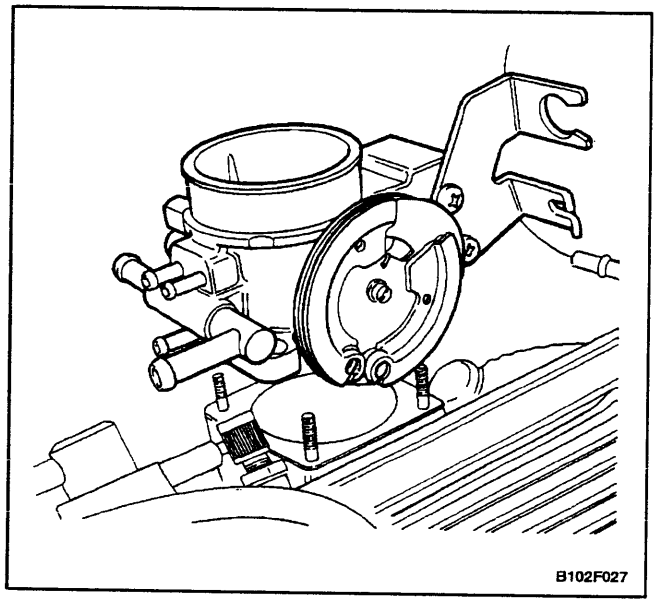
THROTTLE BODY

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the manifold air temperature (MAT) sensor connector.
3. Disconnect the breather hose from the valve cover.
4. Remove the air intake tube.

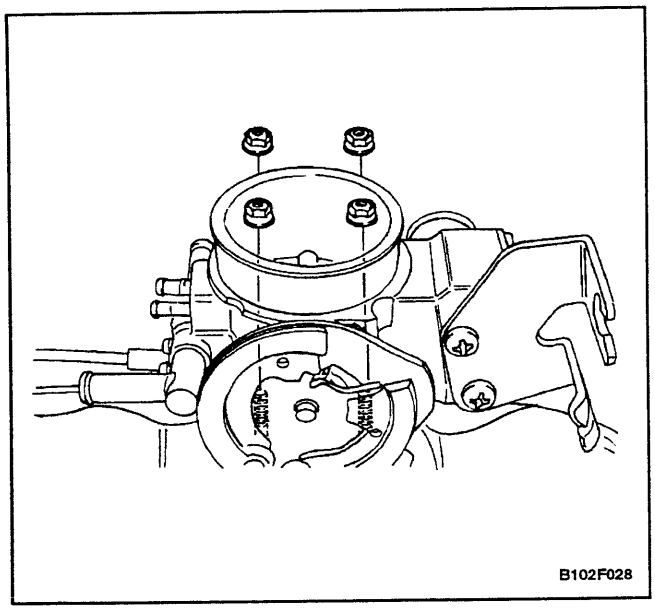

B102F028

5. Disconnect the throttle cables by opening the throttle and moving the cable through the release slot.
6. Disconnect the vacuum hoses from the throttle body.
7. Disconnect the throttle position sensor (TPS) and the idle air control valve connectors.
8. Disconnect the coolant hoses from the throttle body.
9. Remove the throttle body retaining nuts.


B102F027

Notice: Cover the opening of the intake manifold after removing the throttle body assembly. This will prevent any objects or debris from entering the engine which may cause damage.

10. Remove the throttle body and discard the gasket.
11. Remove the TPS. Refer to "Throttle Position Sensor" in this section.
12. Remove the idle air control (IAC) valve. Refer to "Idle Air Control Valve" in this section.


B102F028

Installation Procedure

Notice: Use care in cleaning old gasket material from machined aluminum surfaces. Sharp tools may damage sealing surfaces.

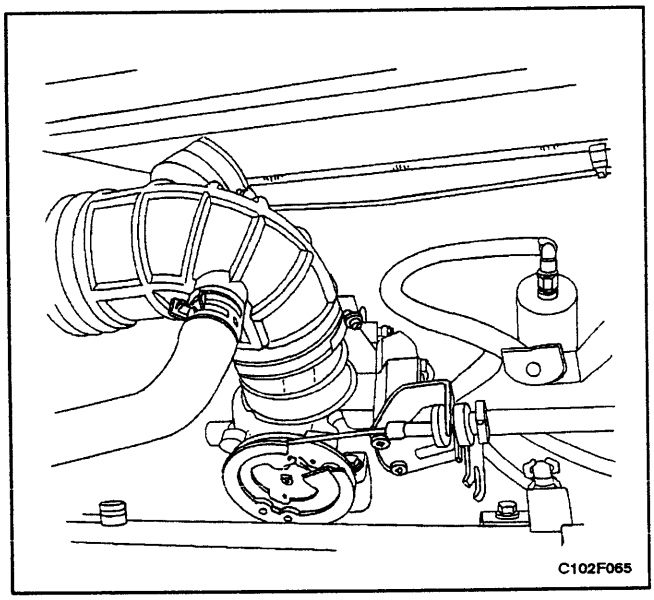
1. Clean the gasket mating surface on the intake manifold.

Notice: The throttle body may be cleaned in a cold immersion-type cleaner following disassembly. The TPS and the idle air control valve should not come in contact with any solvent or cleaner, as they may be damaged.

2. Clean the throttle body.
3. Install the TPS. Refer to "Throttle Position Sensor" in this section.
4. Install the IAC valve. Refer to "Idle Air Control Valve" in this section.
5. Install the throttle body assembly with a new gasket to the intake manifold.
6. Install the throttle body retaining nuts.

Tighten

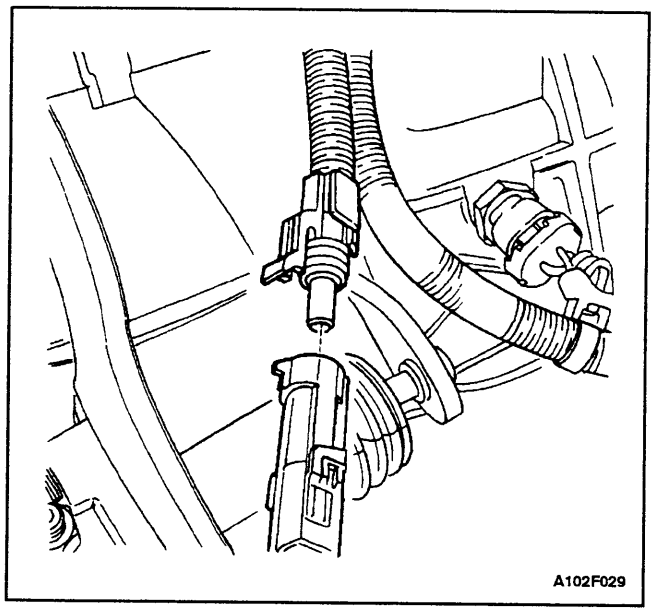
Tighten the throttle body retaining nuts to 9 N•m (80 lb-in).


C102F065

7. Connect the TPS connector and the IAC valve connector.
8. Connect the coolant hoses to the throttle body.
9. Connect the vacuum hoses to the throttle body.

Important: Make sure the throttle/cruise control cables do not hold the throttle open. With the engine off, check to see that the accelerator pedal is free.

10. Connect the throttle/cruise cables.
11. Install the air intake tube.
12. Connect the breather hose to the valve cover.
13. Connect the MAT sensor connector.
14. Connect the negative battery cable.
15. Fill the cooling system.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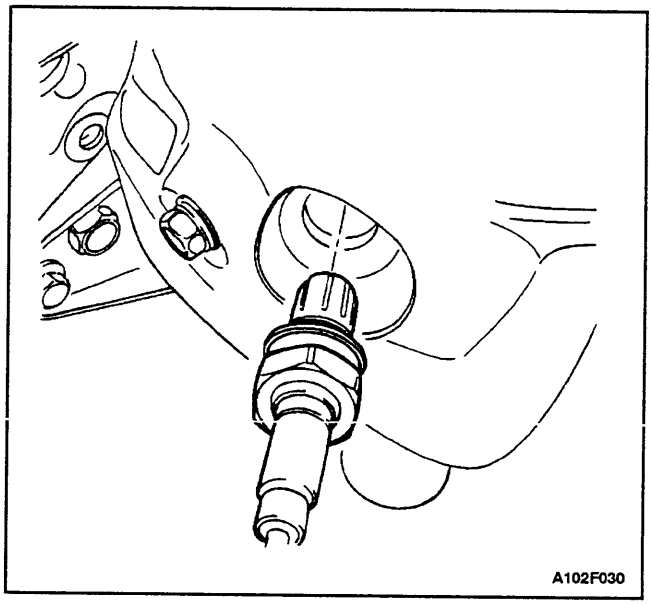
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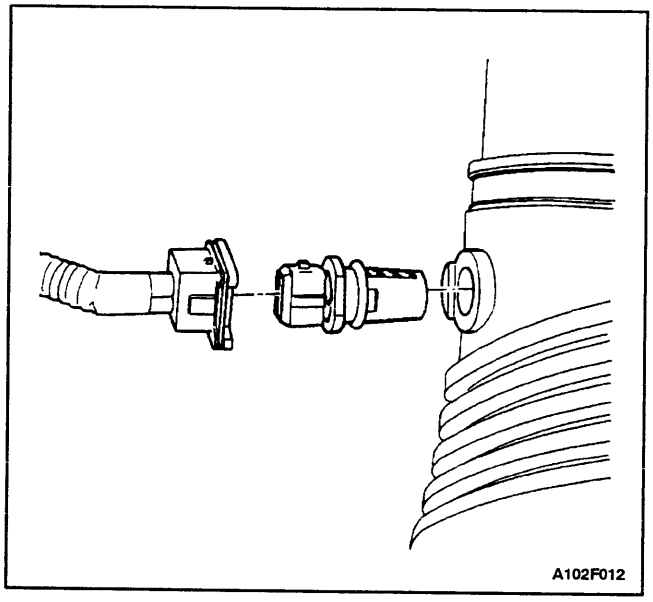

A102F012

OXYGEN SENSOR

Removal Procedure

1. Disconnect the negative battery cable.

Notice: The oxygen sensor uses a permanently attached pigtail and connector. This pigtail should not be removed from the oxygen sensor. Damage or removal of the pigtail or the connector could affect proper operation of the oxygen sensor. Take care when handling the oxygen sensor. Do not drop the oxygen sensor.

2. Disconnect the oxygen sensor connector.

Notice: The oxygen sensor may be difficult to remove when engine temperature is below 48°C (118°F). Excessive force may damage threads in the exhaust manifold.

3. Carefully remove the oxygen sensor from the exhaust manifold.

Installation Procedure

Important: A special anti-seize compound is used on the oxygen sensor threads. This compound consists of a liquid graphite and glass beads. The graphite will burn away, but the glass beads will remain, making the sensor easier to remove. New or serviced sensors will already have the compound applied to the threads. If a sensor is removed from any engine and is to be reinstalled, the threads must have an anti-seize compound applied before reinstallation.

1. Coat the threads of the oxygen sensor with an anti-seize compound, if needed.
2. Install the oxygen sensor into the exhaust manifold.

Tighten

Tighten the oxygen sensor to 41 N•m (30 lb-ft).

3. Connect the oxygen sensor connector.
4. Connect the negative battery cable.

MANIFOLD AIR TEMPERATURE SENSOR

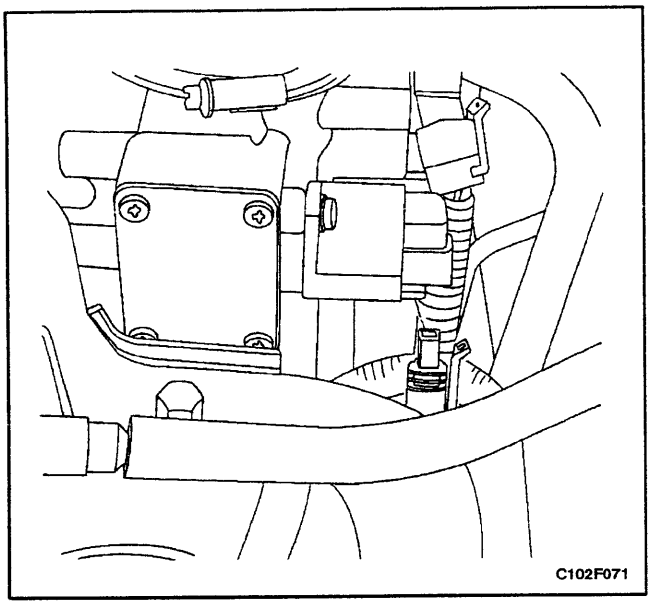
(Left-Hand Drive Shown, Right-Hand Drive Similar)

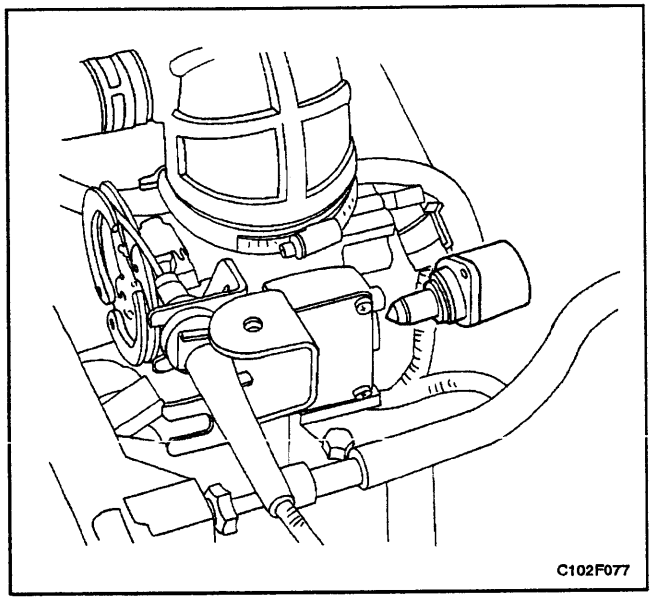
Removal Procedure

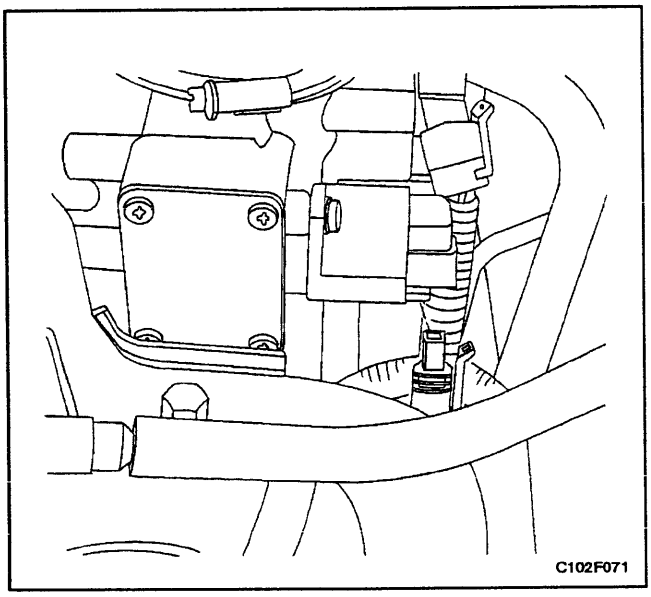
1. Disconnect the negative battery cable.
2. Disconnect the manifold air temperature (MAT) sensor connector.
3. Remove the MAT sensor by pulling it out of the air intake tube.

Installation Procedure

1. Install the MAT sensor into the air intake tube.
2. Connect the MAT connector.
3. Connect the negative battery cable.


C102F071


C102F077


C102F071

IDLE AIR CONTROL VALVE

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the air intake resonator.
3. Disconnect the idle air control (IAC) valve connector.
4. Remove the IAC valve retaining bolts.

Notice: On IAC valves that have been in service, do not push on the valve pintle. The force required to move the pintle may damage the threads on the worm drive.

5. Remove the IAC valve.

Notice: Do not use methyl ethyl ketone because it can damage the parts.

6. Clean the IAC valve O-ring seal area, the pintle valve seat, and the air passage with a suitable fuel system cleaner.

Installation Procedure

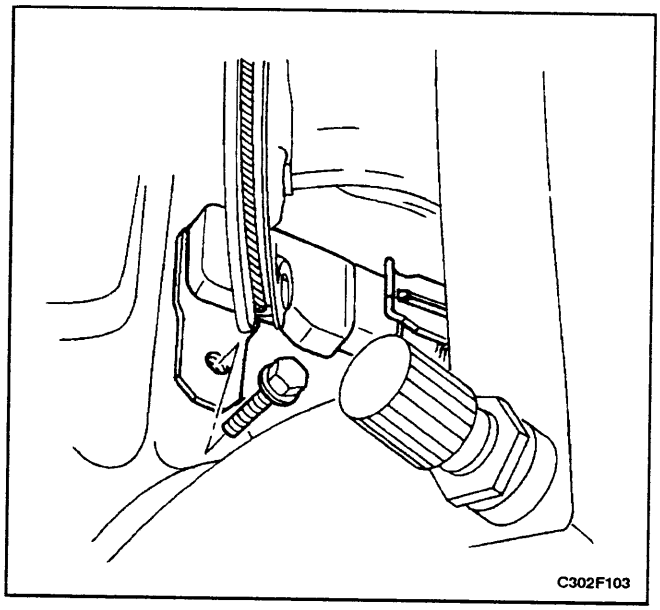
Important: If installing a new IAC valve, be sure to replace it with an identical part. The IAC valve pintle shape and diameter are designed for the specific application. Measure the distance between the tip of the IAC valve pintle and the mounting flange. If the distance is greater than 28 mm (1.1 inches), use finger pressure to slowly retract the pintle. The force required to retract the pintle will not damage the IAC valve. The purpose of the 28-mm (1.1-inch) setting is to prevent the IAC pintle from bottoming out on the pintle seat. This 28-mm (1.1-inch) setting is also an adequate setting for controlled idle on a restart.

1. Lubricate a new O-ring with engine oil. Install the new O-ring onto the valve.
2. Install the IAC valve into the throttle body.
3. Install the IAC valve retaining bolts.

Tighten

Tighten the idle air control valve retaining bolts to 3 N•m (27 lb-in).

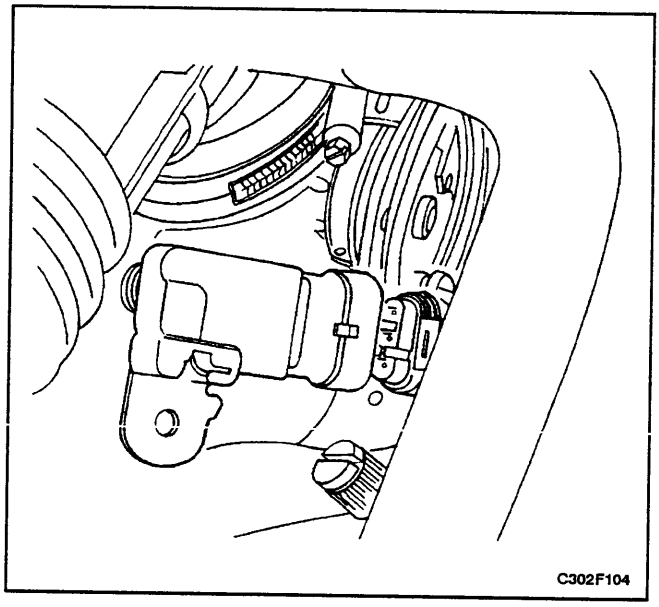
4. Connect the IAC valve connector.
5. Install the air intake resonator.
6. Connect the negative battery cable.
7. Start the engine and check for the proper idle speed.


C302F103

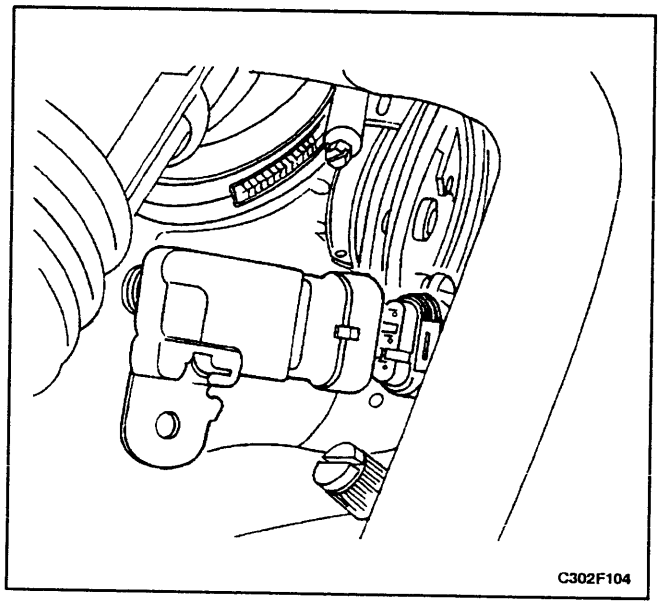
MANIFOLD ABSOLUTE PRESSURE SENSOR

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the MAP sensor bolt.

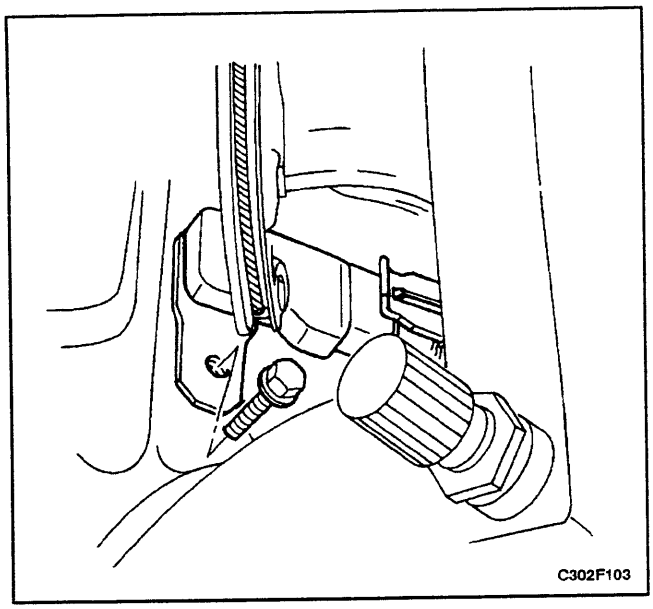

C302F104

3. Remove the MAP sensor up and away from the intake manifold recess.
4. Disconnect the MAP sensor connector.


C302F104

Installation Procedure

1. Connect the MAP sensor connector to the MAP sensor.
2. Install the MAP sensor into the intake manifold.

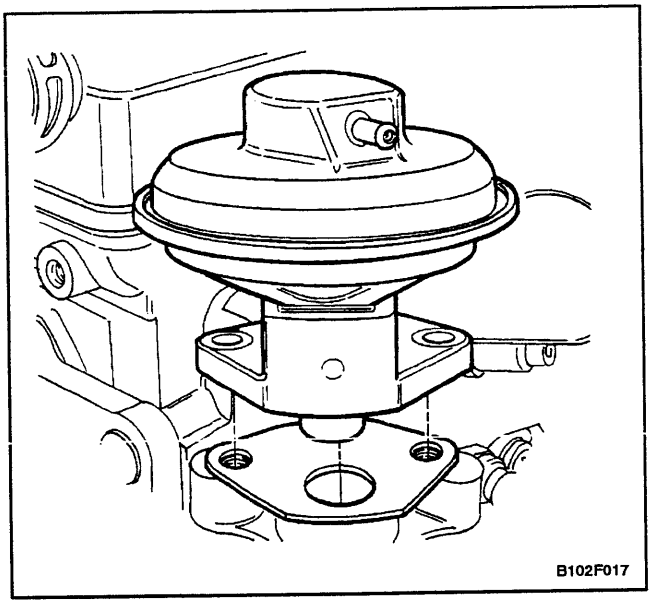

C302F103

3. Install the MAP sensor retaining bolt.

Tighten

Tighten the MAP sensor retaining bolt to 10 N•m (89 lb-in).

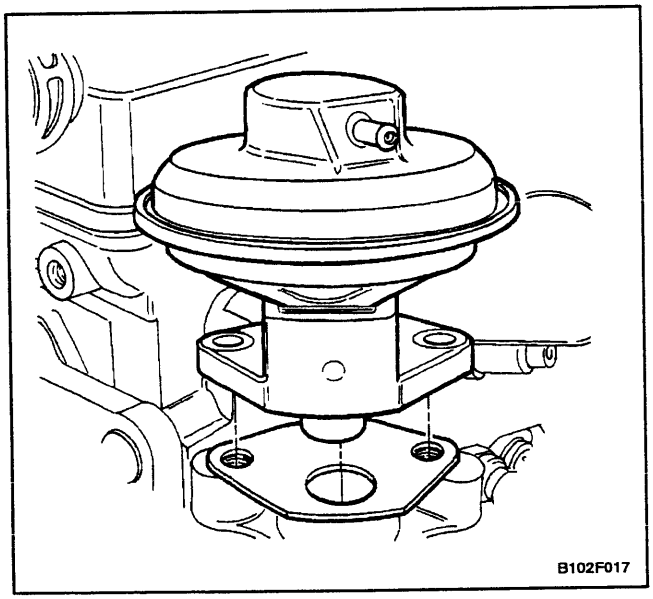
4. Connect the negative battery cable.


B102F017

EXHAUST GAS RECIRCULATION VALVE

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the vacuum hose from the exhaust gas recirculation (EGR) valve.
3. Remove the EGR valve retaining bolts.
4. Remove the EGR valve from the DIS ignition coil adapter.


B102F017

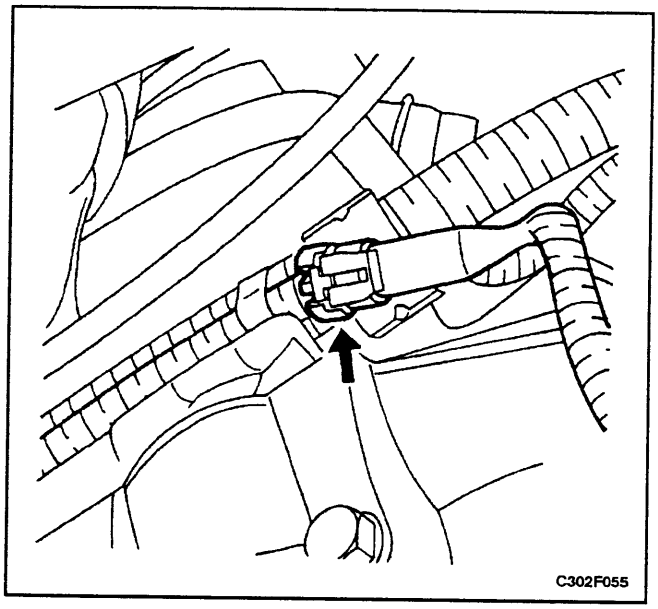
Installation Procedure

1. Clean the DIS ignition coil adapter mating surface.
2. Install a new EGR valve gasket.
3. Install the EGR valve with the bolts.

Tighten

Tighten the exhaust gas recirculation valve retaining bolts to 20 N•m (15 lb-ft).

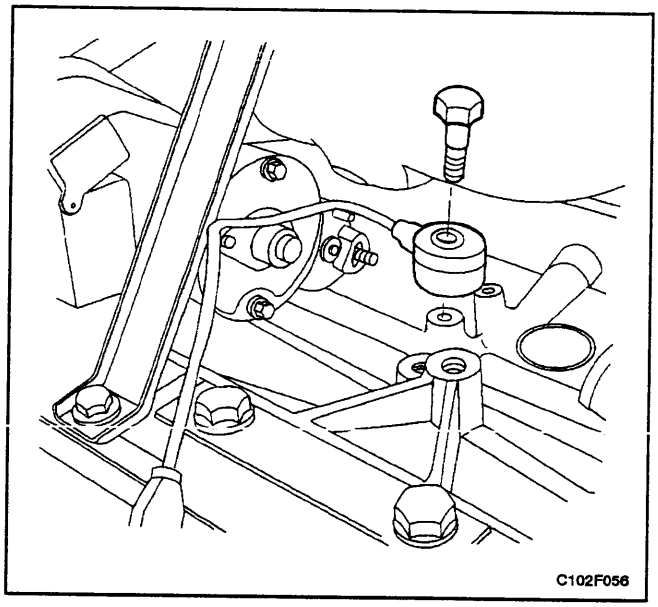
4. Connect the vacuum hose to the EGR valve.
5. Connect the negative battery cable.



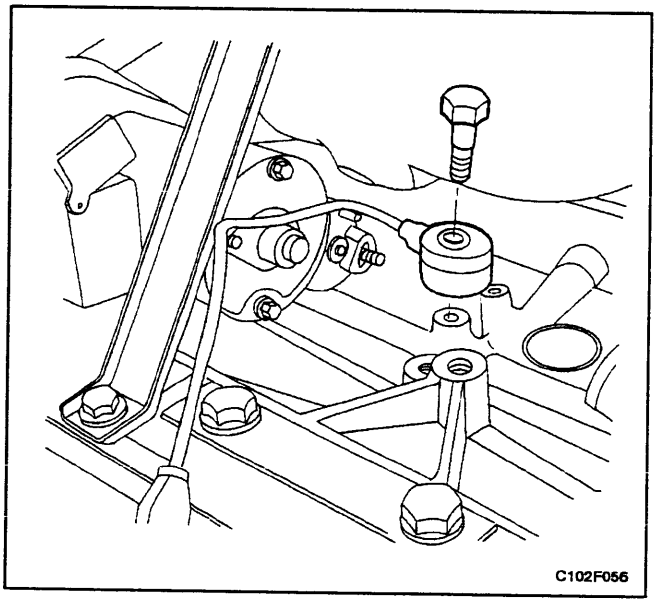
KNOCK SENSOR

Removal Procedure

1. Disconnect the negative battery cable.
2. Raise and suitably support the vehicle.
3. Disconnect electrical connector at the knock sensor.



4. Remove the bolt and the knock sensor.

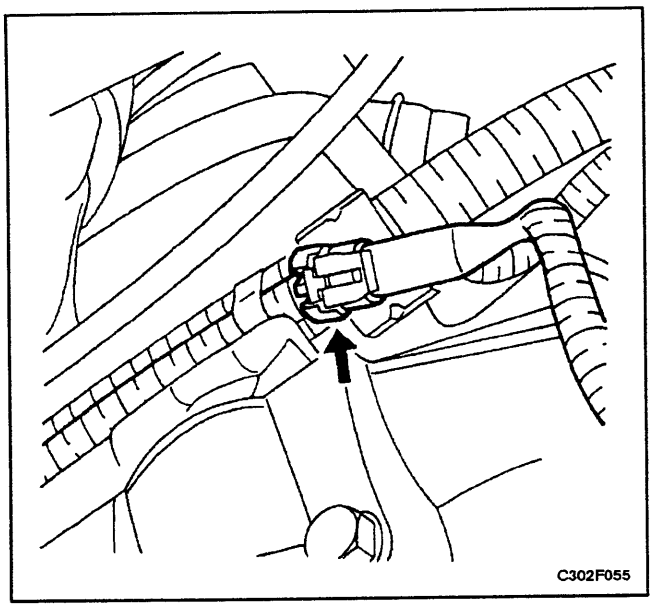


Installation Procedure

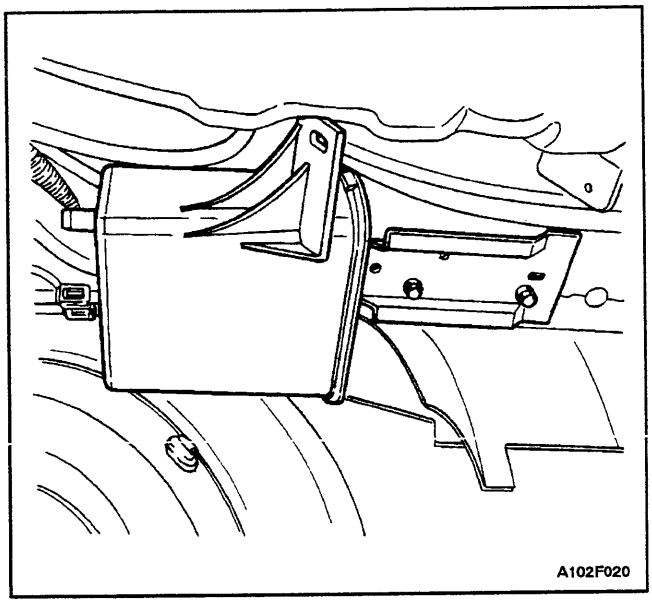
1. Install the knock sensor with the bolt.

Tighten

Tighten the knock sensor bolt to 20 N•m (15 lb-ft).


C302F055

2. Connect the electrical connector at the knock sensor.
3. Lower the vehicle.
4. Connect the negative battery cable.

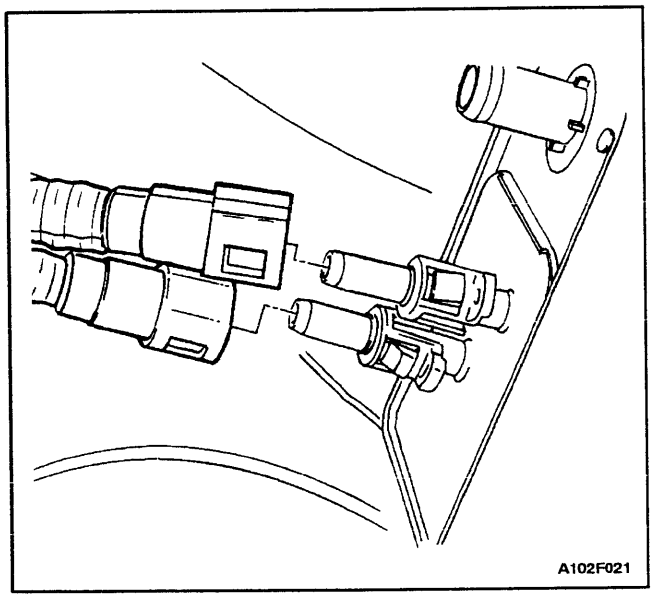

A102F020

EVAPORATIVE EMISSION CANISTER

Removal Procedure

Caution: Canister and vacuum hoses contain fuel vapors. Do not smoke in the area or permit an open flame.

1. Remove the canister protective cover.
2. Disconnect the canister fuel vapor hoses.
3. Remove the bolt that secures the canister flange to the vehicle.
4. Slide the canister out of the track holder.
5. Remove the canister.


A102F021

Installation Procedure

1. Insert the canister into the track and slide it into position.
2. Install the canister flange bolt.

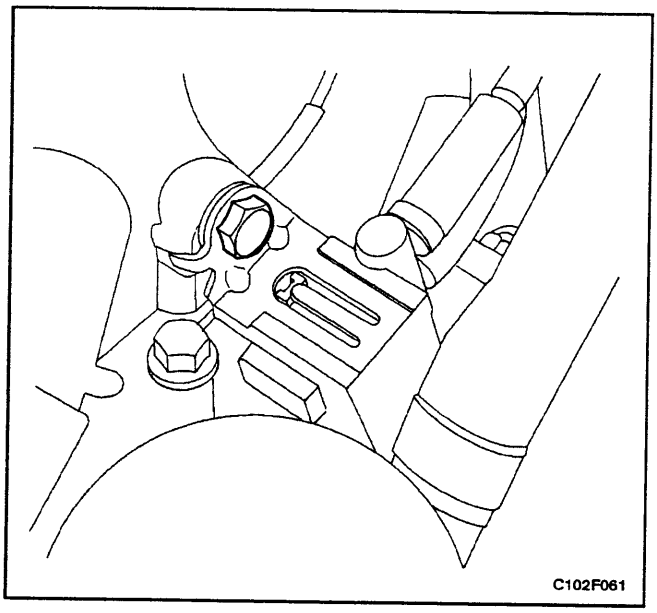
Tighten

Tighten the evaporative emission canister flange bolt to 20 N•m (15 lb-ft).

3. Connect the canister fuel vapor hoses.
4. Install the canister protective cover.

Tighten

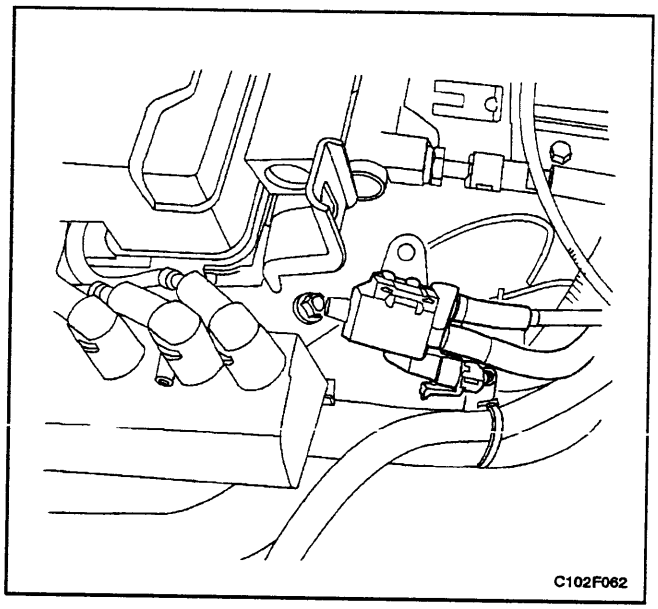
Tighten the evaporative emission canister protective cover to 8 N•m (71 lb-in).


C102F061

CONTROLLED CANISTER PURGE SOLENOID

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the EGR solenoid. Refer to "EGR Solenoid" in this section.
3. Disconnect the controlled canister purge (CCP) solenoid connector.
4. Disconnect the vacuum hoses from the CCP solenoid.
5. Remove the CCP solenoid bracket bolt from the intake manifold.
6. Unclip the CCP solenoid from the mounting bracket.

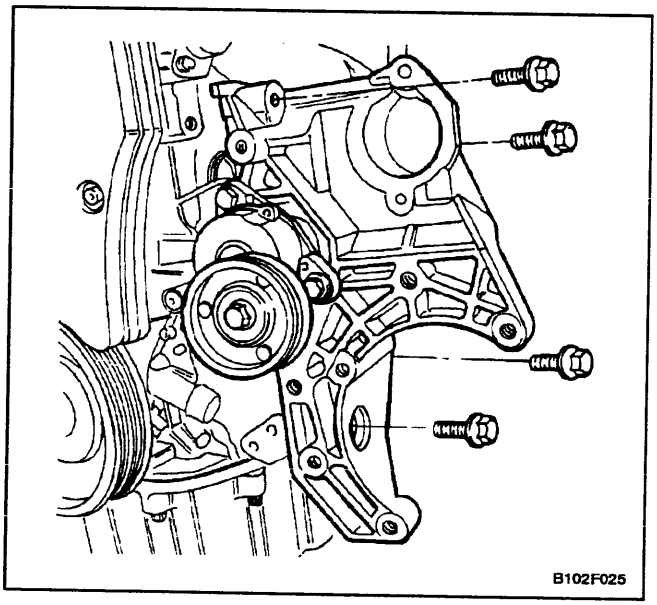

C102F062

Installation Procedure

1. Attach the CCP solenoid to the mounting bracket.
2. Install the CCP solenoid and the mounting bracket to the intake manifold with the bracket bolt.

   Tighten

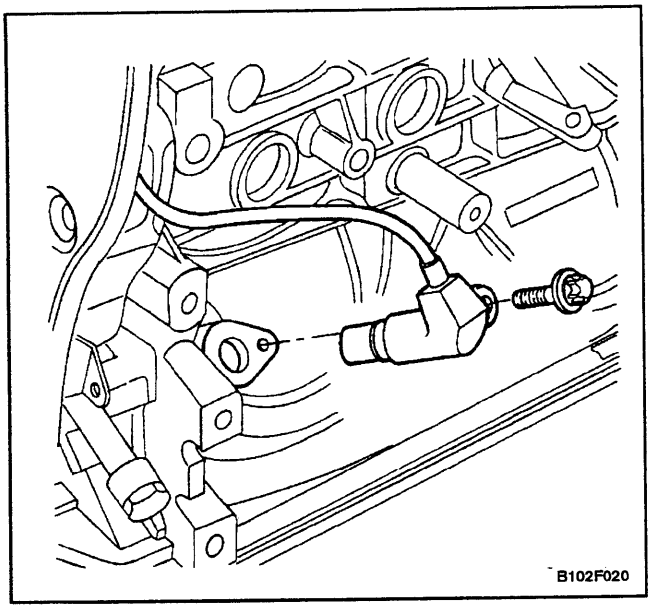
   Tighten the controlled canister purge solenoid bracket bolt to 5 N•m (44 lb-in).
3. Connect the vacuum hoses to the CCP solenoid.
4. Connect the CCP solenoid connector.
5. Install the EGR solenoid. Refer to "EGR Solenoid" in this section.
6. Connect the negative battery cable.


B102F025

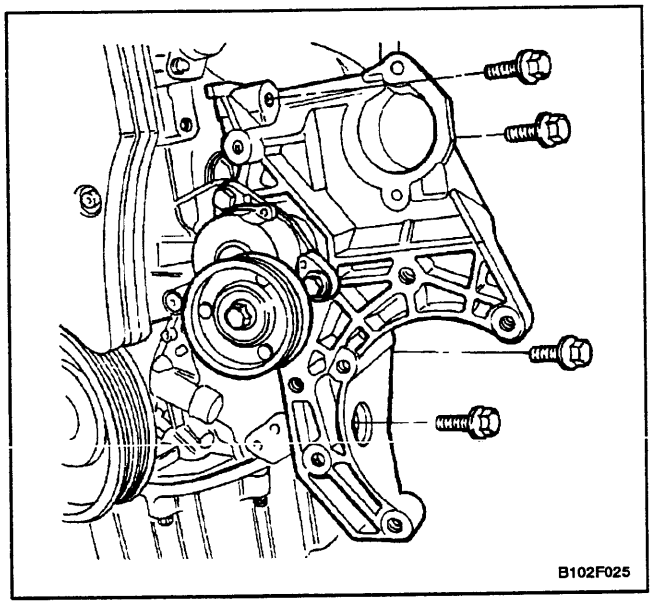
CRANKSHAFT POSITION SENSOR

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the power steering pump, if equipped. Refer to *Section 5B, Power Steering Pump*.
3. Remove the A/C compressor. Refer to *Section 8D, Automatic Temperature Control Heating, Ventilation, and Air Conditioning System*.
4. Remove the rear A/C compressor mounting bracket bolts and the rear A/C compressor mounting bracket.
5. Remove the accessory mounting bracket by removing the bolts.



6. Disconnect the crankshaft position sensor (CPS) connector.
7. Remove the CPS retaining bolt.
8. Gently rotate and remove the CPS from the engine block.



Installation Procedure

1. Insert the CPS into the engine block.
2. Install the CPS retaining bolt.

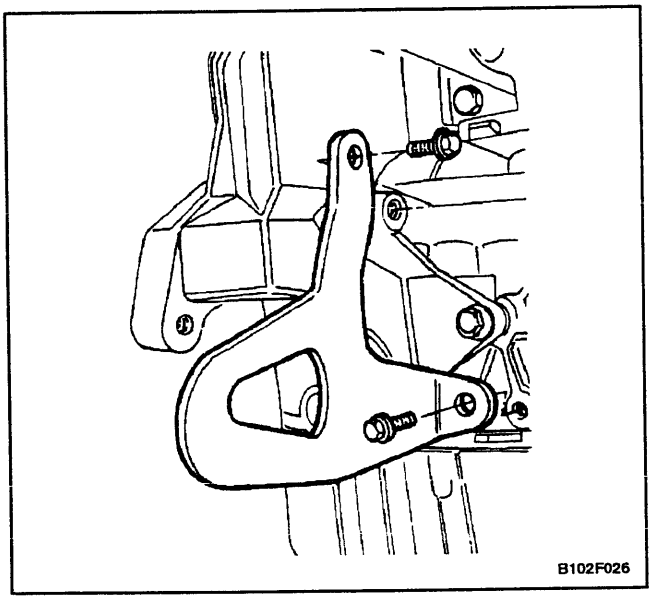
Tighten

Tighten the crankshaft position sensor retaining bolt to 10 N•m (89 lb-in).

3. Connect the CPS connector.
4. Install the accessory mounting bracket with the bolts.

Tighten

Tighten the accessory mounting bracket bolts to 35 N•m (26 lb-ft).

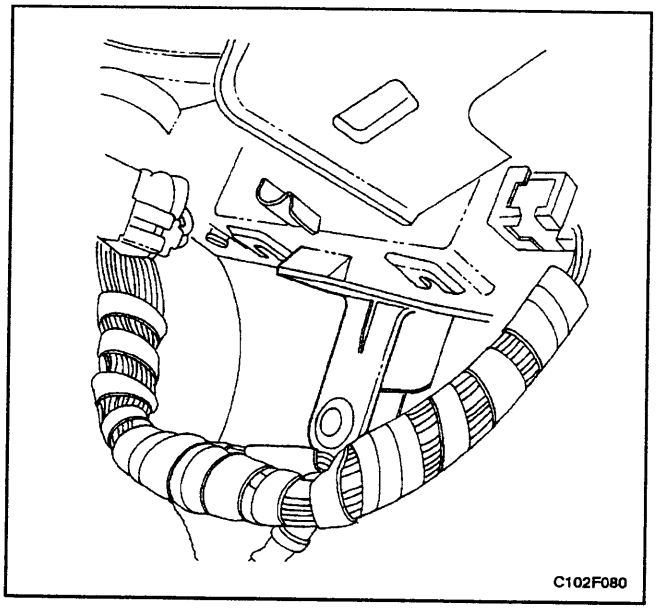


5. Install the rear A/C mounting bracket.

Tighten

Tighten the rear A/C mounting bracket bolts to 35 N•m (26 lb-ft).

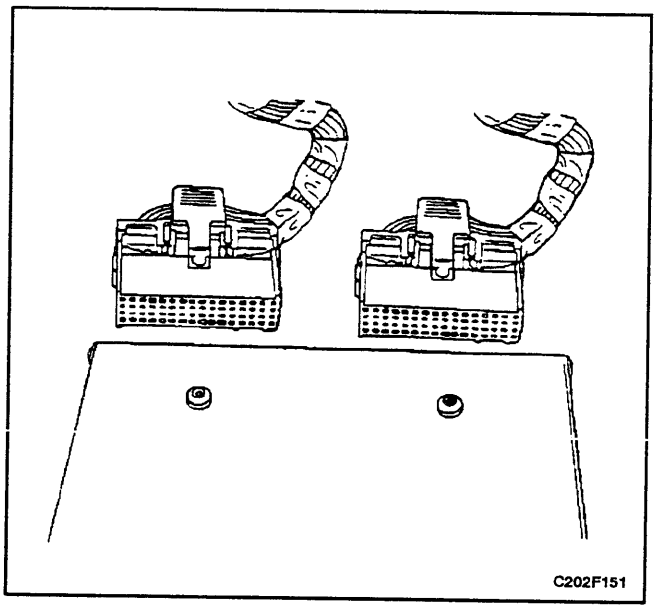
6. Install the A/C compressor. Refer to *Section 8D, Automatic Temperature Control Heating, Ventilation, and Air Conditioning System*.
7. Install the power steering pump. Refer to *Section 5B, Power Steering Pump*.
8. Connect the negative battery cable.


C102F080

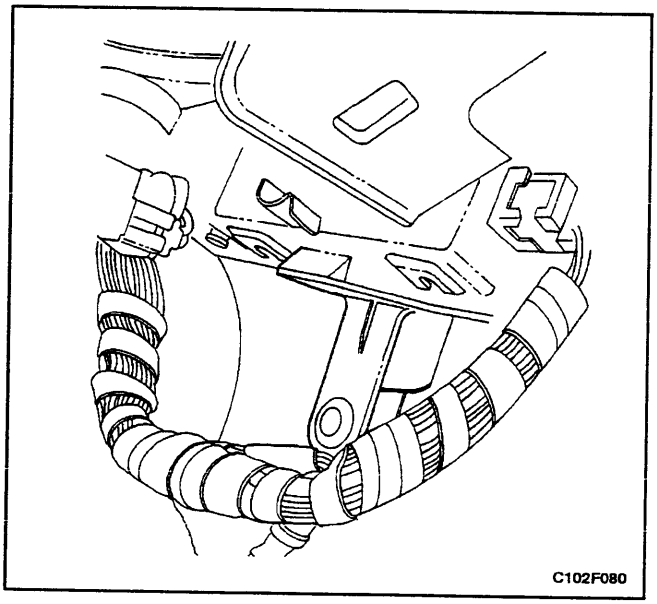
ELECTRONIC CONTROL MODULE

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the right side kick panel. Refer to *Section 9G, Interior Trim*.
3. Remove the electronic control module (ECM) bracket trim locks.
4. Pull the ECM down from the ECM mounting base.

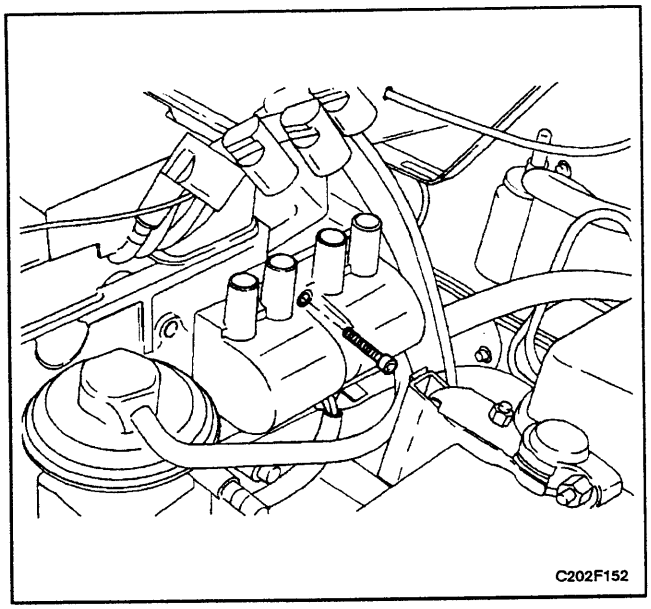

C202F151

5. Disconnect the ECM connectors from the ECM.


C102F080

Installation Procedure

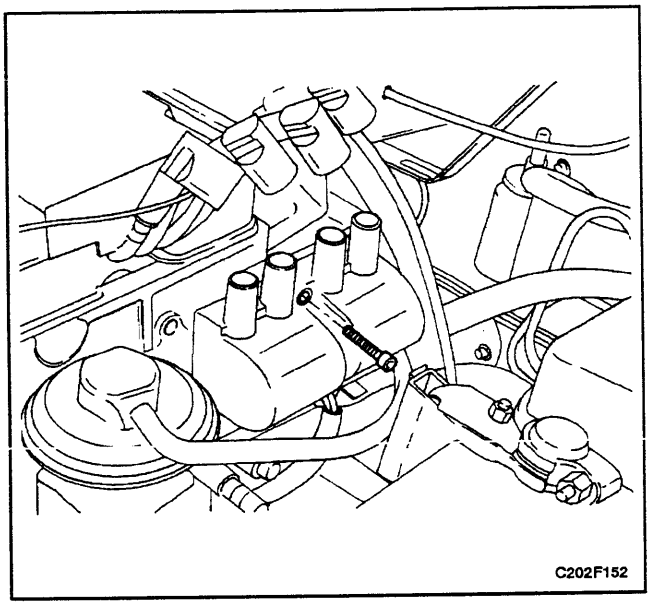
1. Connect the ECM connectors to the ECM.
2. Align the ECM into the mounting base.
3. Snap the ECM into its mounting base.
4. Install the ECM trim locks.
5. Install the passenger side kick panel. Refer to *Section 9G, Interior Trim*.
6. Connect the negative battery cable.


C202F152

DIRECT IGNITION SYSTEM IGNITION COIL

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the direct ignition system (DIS) ignition coil connector.
3. Note the ignition wire location and remove the ignition wires.
4. Remove the DIS ignition coil retaining bolts.
5. Remove the DIS ignition coil.

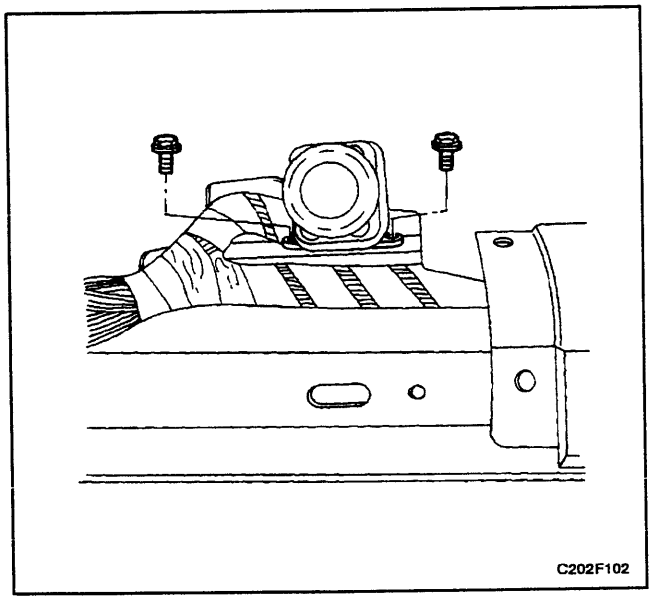

C202F152

Installation Procedure

1. Install the DIS ignition coil into the mounting location and install the retaining bolts.

   Tighten

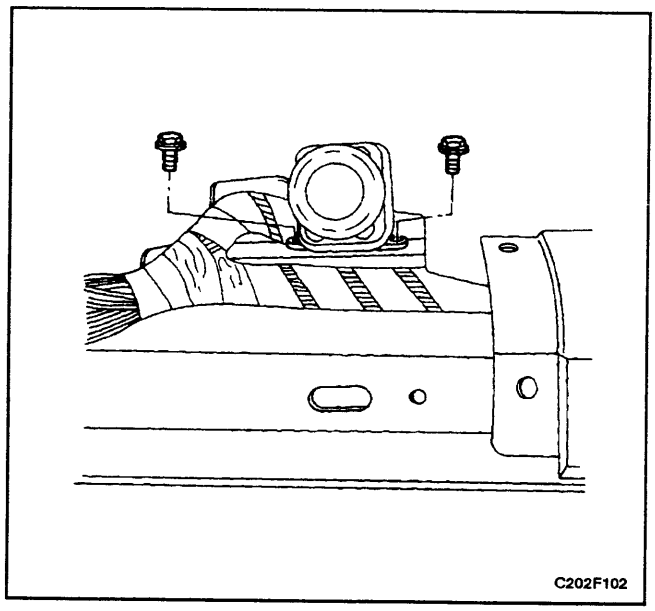
   Tighten the DIS ignition coil retaining bolts to 10 N•m (89 lb-in).
2. Connect the DIS ignition coil connector.
3. Install the ignition wires.
4. Connect the negative battery cable.


C202F102

FUEL CUTOFF SWITCH

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the passenger front rocker trim panel. Refer to *Section 9G, Interior Trim*.
3. Remove the lower B-pillar trim panel. Refer to *Section 9G, Interior Trim.*
4. Reposition the carpet.
5. Remove the fuel cutoff switch mounting bolts.
6. Disconnect the electrical connector at the fuel cutoff switch.


C202F102

Installation Procedure

1. Connect the electrical connector at the fuel cutoff switch.
2. Install the fuel cutoff switch mounting bolts.

Tighten

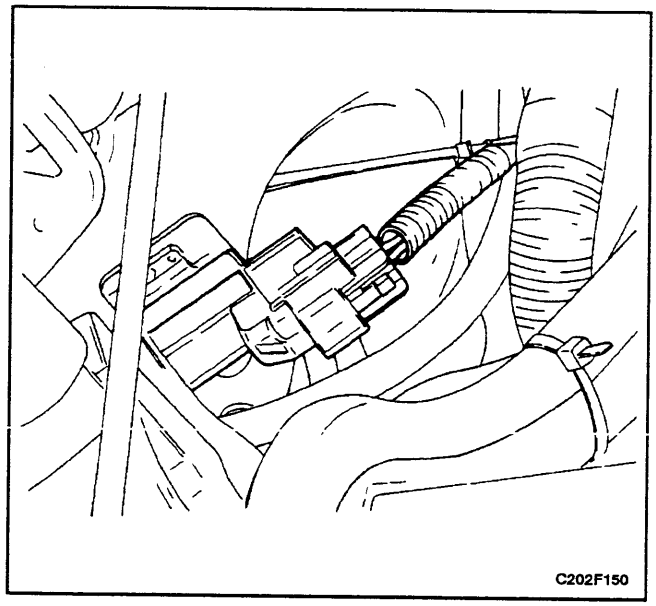
Tighten the fuel cutoff switch mounting bolts to 3 N•m (27 lb-in).

Important: The fuel cutoff switch may have to be reset in order to start the vehicle.

3. Reposition the carpet.
4. Install the lower B-pillar trim panel. Refer to *Section 9G, Interior Trim.*
5. Install the passenger front rocker trim panel. Refer to *Section 9G, Interior Trim.*
6. Connect the negative battery cable.

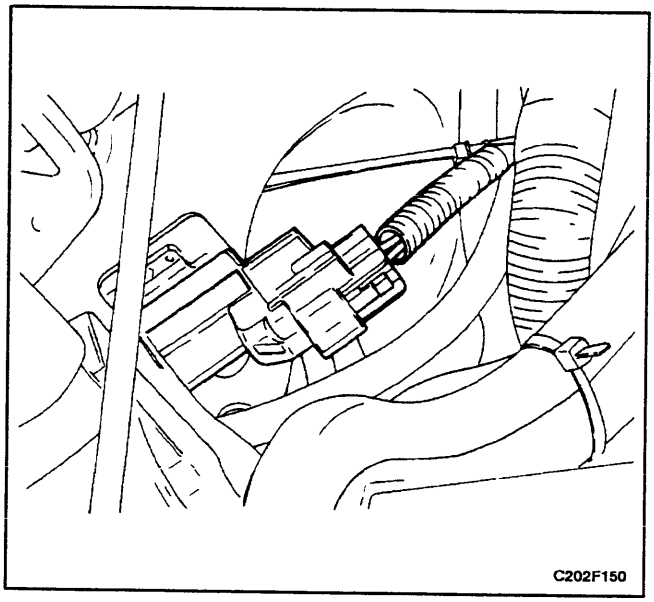
EGR SOLENOID

Removal Procedure


C202F150

1. Disconnect the negative battery cable.
2. Disconnect the electrical connector.
3. Disconnect the vacuum hose.
4. Apply thumb pressure outward on the solenoid retaining clip in order to free the lock tab.
5. Slide the solenoid from the mounting bracket.

Installation Procedure


C202F150

1. Slide the solenoid into position on the mounting bracket.
2. Engage the lock tab.
3. Connect the vacuum hose.
4. Connect the electrical connector.
5. Connect the negative battery cable.

GENERAL DESCRIPTION AND SYSTEM OPERATION

IGNITION SYSTEM OPERATION

This ignition system does not use a conventional distributor and coil. It uses a crankshaft position sensor input to the electronic control module (ECM). The ECM then determines electronic spark timing (EST) and triggers the direct ignition system ignition coil.

This type of distributorless ignition system uses a "waste spark" method of spark distribution. Each cylinder is paired with the cylinder that is opposite it (1-4 or 2-3). The spark occurs simultaneously in the cylinder coming up on the compression stroke and in the cylinder coming up on the exhaust stroke. The cylinder on the exhaust stroke requires very little of the available energy to fire the spark plug. The remaining energy is available to the spark plug in the cylinder on the compression stroke.

These systems use the EST signal from the ECM to control the EST. The ECM uses the following information:

- Engine load (manifold pressure or vacuum).
- Atmospheric (barometric) pressure.
- Engine temperature.
- Intake air temperature.
- Crankshaft position.
- Engine speed (rpm).

DIRECT IGNITION SYSTEM IGNITION COIL

The direct ignition system (DIS) ignition coil is mounted near the rear of the camshaft carrier on the single overhead camshaft engine. On the dual overhead camshaft engine, the DIS ignition coil is mounted near the rear of the cylinder head. Each pair of terminals of the DIS ignition coil provides the spark for two spark plugs simultaneously. The DIS ignition coil is not serviceable and must be replaced as an assembly.

CRANKSHAFT POSITION SENSOR

This direct ignition system uses a magnetic crankshaft position sensor. This sensor protrudes through its mount to within approximately 1.3 mm (0.05 inch) of the crankshaft reluctor. The reluctor is a special wheel attached to the crankshaft with 58 slots machined into it, 57 of which are equally spaced in 6-degree intervals. The last slot is wider and serves to generate a "sync pulse." As the crankshaft rotates, the slots in the reluctor change the magnetic field of the sensor, creating an induced voltage pulse. The longer pulse of the 58th slot identifies a specific orientation of the crankshaft and allows the electronic control module (ECM) to determine the crankshaft orientation at all times. The ECM uses this information to generate timed ignition and injection pulses that it sends to the ignition coils and to the fuel injectors.

IDLE AIR SYSTEM OPERATION

The idle air system operation is controlled by the base idle setting of the throttle body and the idle air control (IAC) valve.

The electronic control module (ECM) uses the IAC valve to set the idle speed dependent on conditions. The ECM uses information from various inputs, such as coolant temperature, manifold vacuum, etc., for the effective control of the idle speed.

FUEL CONTROL SYSTEM OPERATION

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions. The fuel is delivered to the engine by the individual fuel injectors mounted into the intake manifold near each cylinder.

The two main fuel control sensors are the manifold absolute pressure (MAP) sensor and the oxygen (O_2) sensor.

The MAP sensor measures or senses the intake manifold vacuum. Under high fuel demands, the MAP sensor reads a low vacuum condition, such as wide open throttle. The electronic control module (ECM) uses this information to enrich the mixture, thus increasing the fuel injector on-time, to provide the correct amount of fuel. When decelerating, the vacuum increases. This vacuum change is sensed by the MAP sensor and read by the ECM, which then decreases the fuel injector on-time due to the low fuel demand conditions.

The O_2 sensor is located in the exhaust manifold. The O_2 sensor indicates to the ECM the amount of oxygen in the exhaust gas and the ECM changes the air/fuel ratio to the engine by controlling the fuel injectors. The best air/fuel ratio to minimize exhaust emissions is 14.7 to 1, which allows the catalytic converter to operate most efficiently. Because of the constant measuring and adjusting of the air/fuel ratio, the fuel injection system is called a "closed loop" system.

The ECM uses voltage inputs from several sensors to determine how much fuel to provide to the engine. The fuel is delivered under one of several conditions, called "modes."

Starting Mode

When the ignition is turned ON, the ECM turns the fuel pump relay on for 2 seconds. The fuel pump then builds fuel pressure. The ECM also checks the coolant temperature sensor (CTS) and the throttle position sensor (TPS) and determines the proper air/fuel ratio for starting the engine. This ranges from 1.5 to 1 at −36°C (−33°F) coolant temperature to 14.7 to 1 at 94°C (201°F) coolant temperature. The ECM controls the

amount of fuel delivered in the starting mode by changing how long the fuel injector is turned on and off. This is done by "pulsing" the fuel injectors for very short times.

Clear Flood Mode

If the engine floods with excessive fuel, it may be cleared by pushing the accelerator pedal down all the way. The ECM will then completely turn off the fuel by eliminating any fuel injector signal. The ECM holds this injector rate as long as the throttle stays wide open and the engine is below approximately 400 rpm. If the throttle position becomes less than approximately 80 percent, the ECM returns to the starting mode.

Run Mode

The run mode has two conditions called "open loop" and "closed loop."

Open Loop

When the engine is first started and it is above 400 rpm, the system goes into "open loop" operation. In "open loop," the ECM ignores the signal from the oxygen sensor and calculates the air/fuel ratio based on inputs from the CTS and the MAP sensor. The ECM stays in "open loop" until the following conditions are met:

- The O_2 sensor has a varying voltage output, showing that it is hot enough to operate properly.
- The CTS is above a specified temperature.
- A specific amount of time has elapsed after starting the engine.

Closed Loop

The specific values for the above conditions vary with different engines and are stored in the electronically erasable programmable read only memory (EEPROM). When these conditions are met, the system goes into "closed loop" operation. In "closed loop," the ECM calculates the air/fuel ratio (fuel injector on-time) based on the signal from the oxygen sensor. This allows the air/fuel ratio to stay very close to 14.7 to 1.

Acceleration Mode

The ECM responds to rapid changes in throttle position and airflow and provides extra fuel.

Deceleration Mode

The ECM responds to changes in throttle position and airflow and reduces the amount of fuel. When deceleration is very fast, the ECM can cut off fuel completely for short periods of time.

Battery Voltage Correction Mode

When battery voltage is low, the ECM can compensate for a weak spark delivered by the ignition module by using the following methods:

- Increasing the fuel injector pulse width.
- Increasing the idle speed rpm.
- Increasing the ignition dwell time.

Fuel Cut-Off Mode

No fuel is delivered by the fuel injectors when the ignition is off. This prevents dieseling or engine run-on. Also, the fuel is not delivered if there are no reference pulses received from the CPS. This prevents flooding.

EVAPORATIVE EMISSION CONTROL SYSTEM OPERATION

The basic evaporative emission (EVAP) control system used is the charcoal canister storage method. This method transfers fuel vapor from the fuel tank to an activated carbon (charcoal) storage canister which holds the vapors when the vehicle is not operating. When the engine is running, the fuel vapor is purged from the carbon element by intake airflow and consumed in the normal combustion process.

Gasoline vapors from the fuel tank flow into the tube labeled TANK. These vapors are absorbed into the carbon. The canister is purged by electronic control module (ECM) when the engine has been running for a specified amount of time. Air is drawn into the canister and mixed with the vapor. This mixture is then drawn into the intake manifold.

The ECM supplies a ground to energize the controlled canister purge solenoid valve. This valve is pulse width modulated (PWM) or turned on and off several times a second. The controlled canister purge PWM duty cycle varies according to operating conditions determined by mass airflow, fuel trim, and intake air temperature.

Poor idle, stalling, and poor driveability can be caused by the following conditions:

- An inoperative controlled canister purge valve.
- A damaged canister.
- Hoses that are split, cracked, or not connected to the proper tubes.

EVAPORATIVE EMISSION CANISTER

The evaporative emission canister is an emission control device containing activated charcoal granules. The evaporative emission canister is used to store fuel vapors from the fuel tank. Once certain conditions are met, the electronic control module (ECM) activates the controlled canister purge solenoid, allowing the fuel vapors to be drawn into the engine cylinders and burned.

POSITIVE CRANKCASE VENTILATION CONTROL SYSTEM OPERATION

A positive crankcase ventilation (PCV) control system is used to provide complete use of the crankcase vapors. Fresh air from the air cleaner is supplied to the crankcase. The fresh air is mixed with blowby gases which is then passed through a vacuum hose into the intake manifold.

Periodically inspect the hoses and the clamps. Replace any crankcase ventilation components as required.

A restricted or plugged PCV hose may cause the following conditions:

- Rough idle.
- Stalling or low idle speed.
- Oil leaks.
- Oil in the air cleaner.
- Sludge in the engine.

A leaking PCV hose may cause the following conditions:

- Rough idle.
- Stalling.
- High idle speed.

COOLANT TEMPERATURE SENSOR

The coolant temperature sensor (CTS) is a thermistor (a resistor which changes value based on temperature) mounted in the engine coolant stream. Low coolant temperature produces a high resistance (100,000 ohms at −40°C [−40°F]) while high temperature causes low resistance (70 ohms at 130°C [266°F]).

The electronic control module (ECM) supplies 5 volts to the coolant sensor through a resistor in the ECM and measures the change in voltage. The voltage will be high when the engine is cold, and low when the engine is hot. By measuring the change in voltage, the ECM can determine the coolant temperature. The engine coolant temperature affects most of the systems that the ECM controls. A failure in the coolant sensor circuit should set a diagnostic trouble code 14 or 15. Remember, these diagnostic trouble codes indicate a failure in the coolant temperature circuit, so proper use of the chart will lead either to repairing a wiring problem or to replacing the sensor to repair a problem properly.

THROTTLE POSITION SENSOR

The throttle position sensor (TPS) is a potentiometer connected to the throttle shaft of the throttle body. The TPS electrical circuit consists of a 5-volt supply line and a ground line, both provided by the electronic control module (ECM). The ECM calculates the throttle position by monitoring the voltage on this signal line. The TPS output changes as the accelerator pedal is moved, changing the throttle valve angle. At a closed throttle position, the output of the TPS is low, about 0.5 volt. As the throttle valve opens, the output increases so that, at wide open throttle (WOT), the output voltage will be about 5 volts.

The ECM can determine fuel delivery based on throttle valve angle (driver demand). A broken or loose TPS can cause intermittent bursts of fuel from the injector and an unstable idle, because the ECM thinks the throttle is moving. A problem in any of the TPS circuits should set a diagnostic trouble code 21 or 22. Once the diagnostic trouble code is set, the ECM will substitute a default value for the TPS and some vehicle performance will return. A diagnostic trouble code 21 will cause a high idle speed.

OXYGEN SENSOR

The oxygen (O_2) sensor is mounted in the exhaust system where it can monitor the O_2 content of the exhaust gas stream. The oxygen content in the exhaust reacts with the sensor to produce a voltage output. This voltage ranges from approximately 0.1 volt (high O_2 - lean mixture) to 0.9 volt (low O_2 - rich mixture). This voltage can be measured with a digital voltmeter having at least 10 megohms input impedance. Use of standard shop type voltmeters will result in very inaccurate readings.

The electronic control module (ECM) monitors the O_2 sensor output and determines what changes are necessary in the fuel mixture command.

The O_2 sensor circuit sets a diagnostic trouble code 13 when it is open. A constant low voltage in the sensor circuit, indicating a lean mixture, sets a diagnostic trouble code 44. A constant high voltage, indicating a rich mixture, sets a diagnostic trouble code 45. Refer to the diagnostic trouble code charts for conditions that could cause a lean or a rich system.

EXHAUST GAS RECIRCULATION VALVE

The exhaust gas recirculation (EGR) system is used on engines equipped with an automatic transaxle to lower oxides of nitrogen (NOX) emission levels caused by high combustion temperature. The main element of the system is the EGR valve operated by vacuum and controlled electrically by the ECM and EGR solenoid. The EGR valve feeds small amounts of exhaust gas into the intake manifold to decrease combustion temperature. The amount of exhaust gas recirculated is controlled by variations in vacuum and exhaust back pressure. If too much exhaust gas enters, combustion will not take place. For this reason, very little exhaust gas is allowed to pass through the valve, especially at idle.

The EGR valve is usually open under the following conditions:

- Warm engine operation.
- Above idle speed.

Results of Incorrect Operation

Too much EGR flow tends to weaken combustion, causing the engine to run roughly or to stop. With too much EGR flow at idle, cruise, or cold operation, any of the following conditions may occur:

- The engine stops after a cold start.
- The engine stops at idle after deceleration.
- The vehicle surges during cruise.
- Rough idle.

If the EGR valve stays open all the time, the engine may not idle. Too little or no EGR flow allows combustion temperatures to get too high during acceleration and load conditions. This could cause the following conditions:

- Spark knock (detonation).
- Engine overheating.
- Emission test failure.

MANIFOLD AIR TEMPERATURE SENSOR

The manifold air temperature (MAT) sensor is a thermistor, a resistor which changes value based on the temperature of the air entering the engine. Low temperature produces a high resistance (100,000 ohms at −40°C [−40°F]), while high temperature causes a low resistance (70 ohms at 130°C [266°F]).

The electronic control module (ECM) provides 5 volts to the MAT sensor through a resistor in the ECM and measures the change in voltage to determine the MAT. The voltage will be high when the manifold air is cold and low when the air is hot. The ECM knows the intake MAT by measuring the voltage.

The MAT sensor is also used to control spark timing when the manifold air is cold.

A failure in the MAT sensor circuit sets a diagnostic trouble code 23 or 25.

IDLE AIR CONTROL VALVE

Notice: Do not attempt to remove the protective cap and readjust the stop screw. Misadjustment may result in damage to the idle air control (IAC) valve or to the throttle body.

The IAC valve is mounted on the throttle body where it controls the engine idle speed under the command of the electronic control module (ECM). The ECM sends voltage pulses to the IAC valve motor windings, causing the IAC valve pintle to move in or out a given distance (a step or count) for each pulse. The pintle movement controls the airflow around the throttle valves which, in turn, control the engine idle speed.

The desired idle speeds for all engine operating conditions are programmed into the calibration of the ECM. These programmed engine speeds are based on the coolant temperature, the park/neutral switch status, the vehicle speed, the battery voltage, and the A/C system pressure, if equipped.

The ECM "learns" the proper IAC valve positions to achieve warm, stabilized idle speeds (rpm) desired for the various conditions (park/neutral or drive, A/C on or off, if equipped). This information is stored in ECM "keep alive" memories (information is retained after the ignition is turned off). All other IAC valve positioning is calculated based on these memory values. As a result, engine variations due to wear and variations in the minimum throttle valve position (within limits) do not affect engine idle speeds. This system provides correct idle control under all conditions. This also means that disconnecting power to the ECM can result in incorrect idle control or the necessity to partially press the accelerator when starting until the ECM relearns idle control.

Engine idle speed is a function of total airflow into the engine based on the IAC valve pintle position, the throttle valve opening, and the calibrated vacuum loss through accessories. The minimum throttle valve position is set at the factory with a stop screw. This setting allows enough airflow by the throttle valve to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat during "controlled" idle operation. The minimum throttle valve position setting on this engine should not be considered the "minimum idle speed," as on other fuel injected engines. The throttle stop screw is covered with a plug at the factory following adjustment.

If the IAC valve is suspected as being the cause of improper idle speed, refer to "Idle Air Control System Check" in this section.

MANIFOLD ABSOLUTE PRESSURE SENSOR

The manifold absolute pressure (MAP) sensor measures the changes in the intake manifold pressure which result from engine load and speed changes and converts these to a voltage output.

A closed throttle on engine coast down produces a relatively low MAP output. MAP is the opposite of vacuum. When manifold pressure is high, vacuum is low. The MAP sensor is also used to measure barometric pressure. This is performed as part of MAP sensor calculations. With the ignition ON and the engine not running, the electronic control module (ECM) will read the manifold pressure as barometric pressure and adjust the air/fuel ratio accordingly. This compensation for altitude allows the system to maintain driving performance while holding emissions low. The barometric function will update periodically during steady driving or under a wide open throttle condition. In the case of a fault in the barometric portion of the MAP sensor, the ECM will set to the default value.

A failure in the MAP sensor circuit sets a diagnostic trouble code 33 or 34.

The following tables show the difference between absolute pressure and vacuum related to MAP sensor output, which appears as the top row of both tables.

MAP

Volts	4.9	4.4	3.8	3.3	2.7	2.2	1.7	1.1	0.6	0.3	0.3
kPa	100	90	80	70	60	50	40	30	20	10	0
in. Hg	29.6	26.6	23.7	20.7	17.7	14.8	11.8	8.9	5.9	2.9	0

VACUUM

Volts	4.9	4.4	3.8	3.3	2.7	2.2	1.7	1.1	0.6	0.3	0.3
kPa	0	10	20	30	40	50	60	70	80	90	100
in. Hg	0	2.9	5.9	8.9	11.8	14.8	17.7	20.7	23.7	26.7	29.6

ELECTRONIC CONTROL MODULE

The electronic control module (ECM), located inside the right side kick panel, is the control center of the fuel injection system. It constantly looks at the information from various sensors and controls the systems that affect the vehicle's performance. The ECM also performs the diagnostic functions of the system. It can recognize operational problems, alert the driver through the service engine soon (SES), and store diagnostic trouble code(s) which identify the problem areas to aid the technician in making repairs.

There are no serviceable parts in the ECM. The calibrations are stored in the ECM in the programmable read only memory (PROM).

The ECM supplies either 5 or 12 volts to power the sensors or switches. This is done through resistances in the ECM which are so high in value that a test light will not come on when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. You must use a digital voltmeter with a 10 megohm input impedance to get accurate voltage readings. The ECM controls output circuits such as the fuel injectors, the idle air control (IAC) valve, the A/C clutch relay, etc., by controlling the ground circuit through transistors or a device called a "quad-driver."

FUEL INJECTOR

The multi-port fuel injection (MPFI) assembly is a solenoid-operated device controlled by the electronic control module (ECM) that meters pressurized fuel to a single engine cylinder. The ECM energizes the fuel injector or solenoid to a normally closed ball or pintle valve. This allows fuel to flow into the top of the injector, past the ball or pintle valve, and through a recessed flow director plate at the injector outlet.

The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel from the tip is directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber. A fuel injector which is stuck partially open would cause a loss of fuel pressure after the engine is shut down. Also, an extended crank time would be noticed on some engines. Dieseling could also occur because some fuel could be delivered to the engine after the ignition is turned off.

FUEL CUTOFF SWITCH

The fuel cutoff switch is a safety device. In the event of a collision or a sudden impact, it automatically cuts off the fuel supply and activates the door lock relay. After the switch has been activated, it must be reset in order to restart the engine. Reset the fuel cutoff switch by pressing the rubber top of the switch. The switch is located near the right side of the passenger's seat.

KNOCK SENSOR

The knock sensor detects abnormal knocking in the engine. The sensor is mounted in the engine block near the cylinders. The sensor produces an AC output voltage which increases with the severity of the knock. This signal is sent to the electronic control module (ECM). The ECM then adjusts the ignition timing to reduce the spark knock.

SECTION 1G

ENGINE EXHAUST

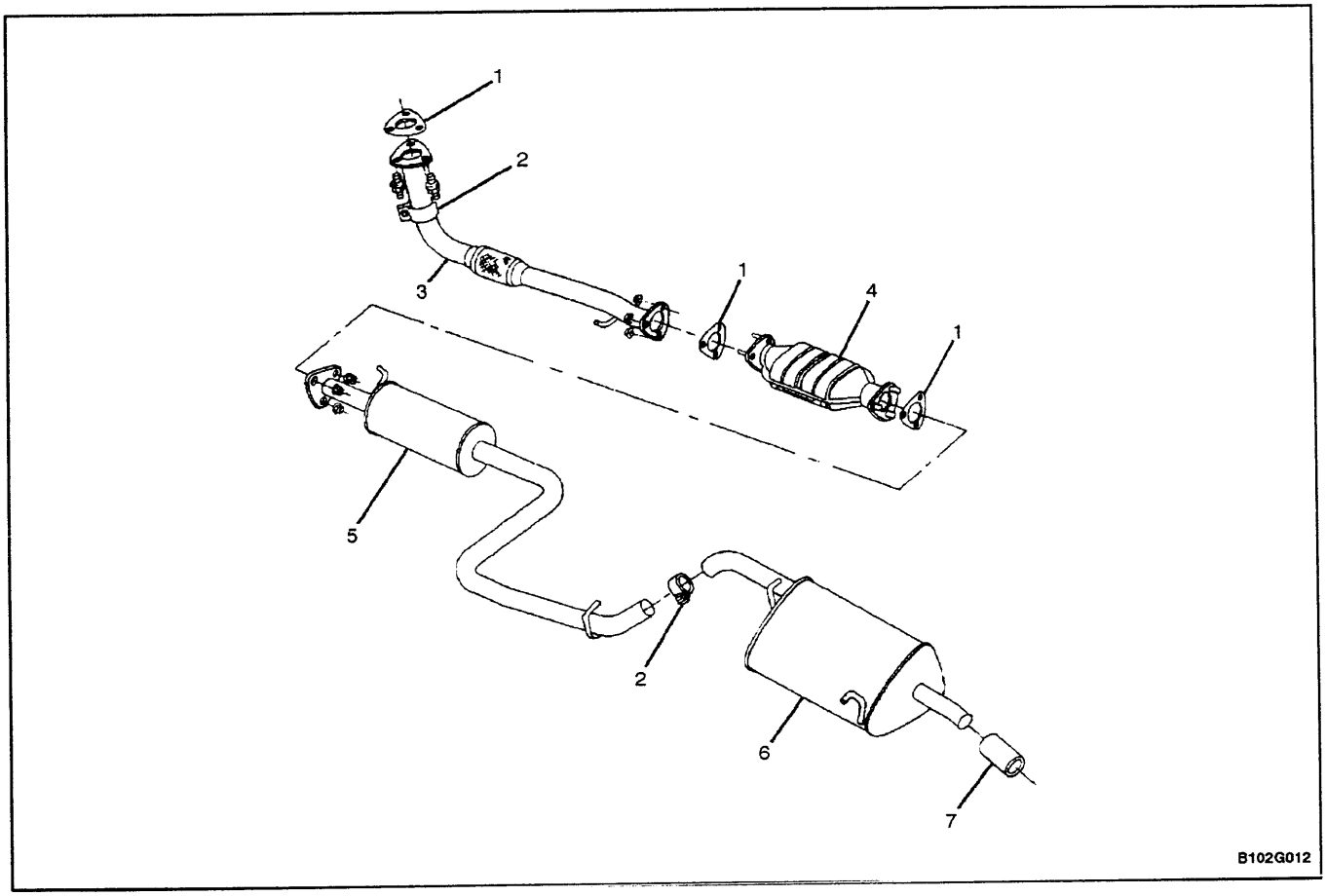
SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

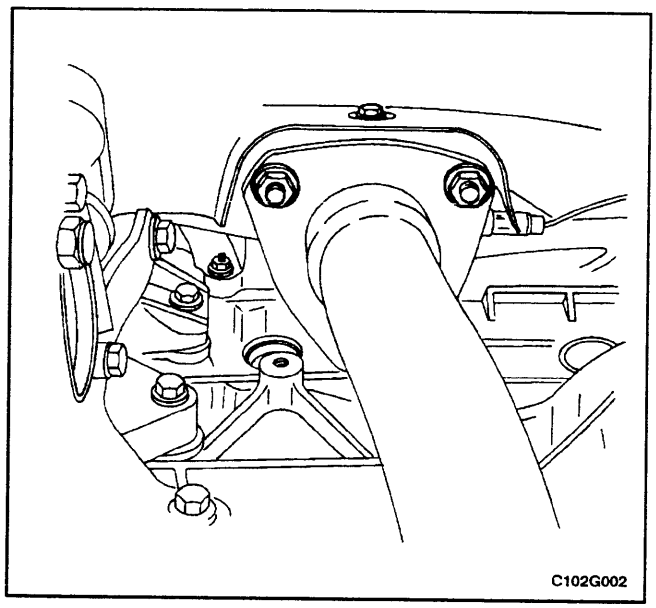
Application	N•m	Lb-Ft	Lb-In
Front Exhaust Pipe-to-Catalytic Converter Nuts	30	22	-
Front Exhaust Pipe-to-Exhaust Manifold Nuts	40	30	-
Front Muffler Pipe-to-Catalytic Converter Nuts	30	22	-
Front Muffler Pipe-to-Rear Muffler Pipe Nuts	30	22	-
Lower Front Exhaust Pipe Mounting Bracket Nuts	30	22	-
Rear Muffler Pipe-to-Exhaust Trim Ring Bolt	15	11	-

COMPONENT LOCATOR

EXHAUST SYSTEM



1 Metal Gasket
2 Metal Clamp
3 Front Exhaust Pipe
4 Catalytic Converter
5 Front Muffler
6 Rear Muffler
7 Trim Ring


C102G002

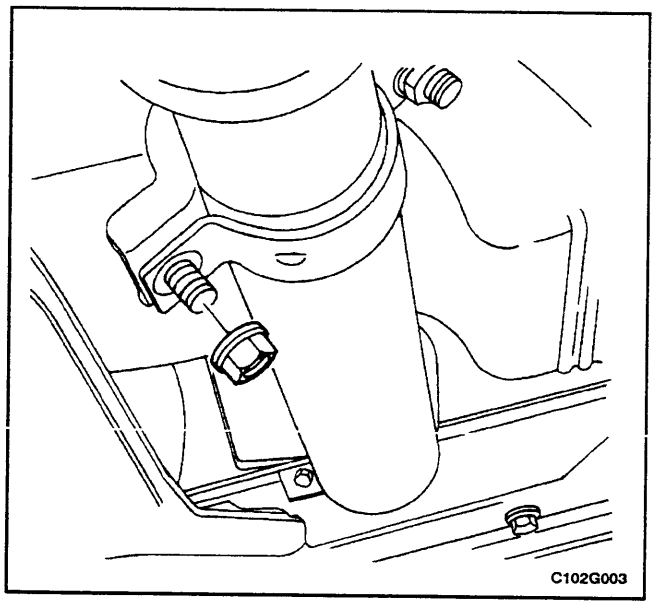
MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

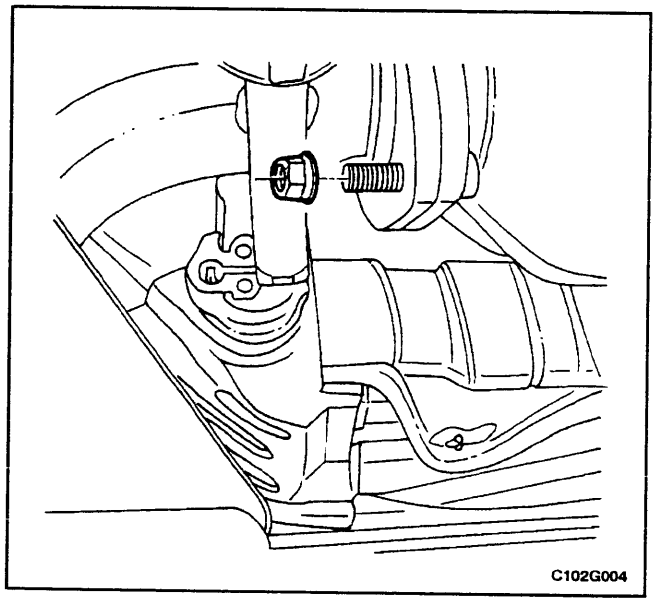
CATALYTIC CONVERTER

Removal Procedure

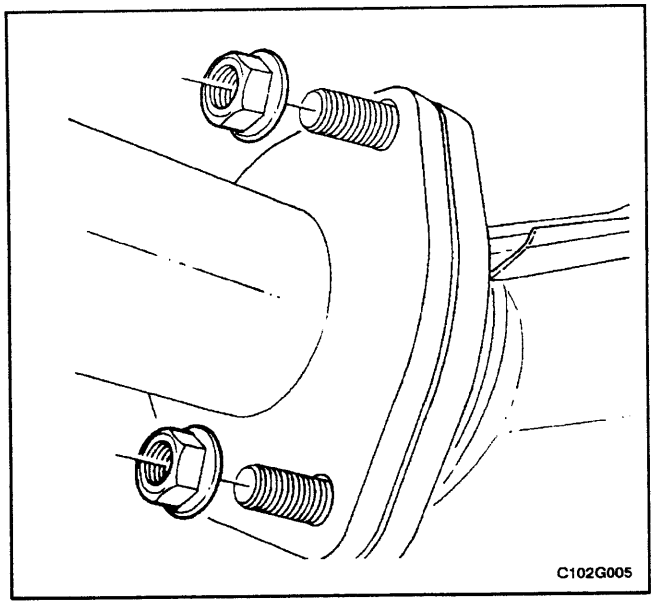
1. Remove the splash guard. Refer to *Section 9N, Frame and Underbody.*
2. Remove the front exhaust pipe nuts and the gasket from the exhaust manifold.


C102G003

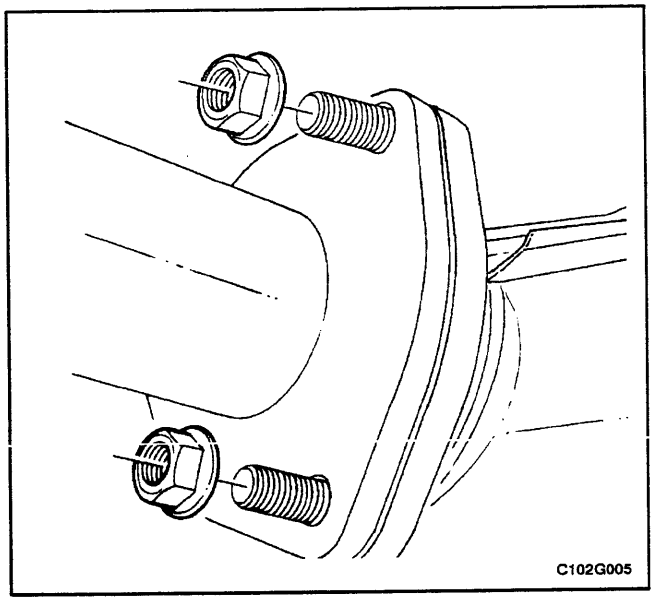
3. Remove the locking nuts from the lower front exhaust pipe mounting bracket which attaches to the welded bolts of the upper front exhaust pipe mounting bracket.
4. Remove the lower front exhaust pipe bracket.
5. Remove the front exhaust pipe from the upper front exhaust pipe mounting bracket.


C102G004

6. Remove the front exhaust pipe from the rubber ring hangers near where the front exhaust pipe flange connects to the catalytic converter flange.
7. Remove the nuts that secure the front exhaust pipe flange to the catalytic converter flange.



8. Remove the front exhaust pipe and the gasket.
9. Remove the nuts that secure the front muffler pipe to the catalytic converter flange.
10. Remove the catalytic converter and the gasket.
11. Clean the sealing surfaces on the front exhaust pipe flange and the exhaust manifold.
12. Check the front exhaust pipe and the catalytic converter for holes, damage, open seams, or other deterioration which could permit exhaust fumes to seep into the passenger compartment or the trunk.

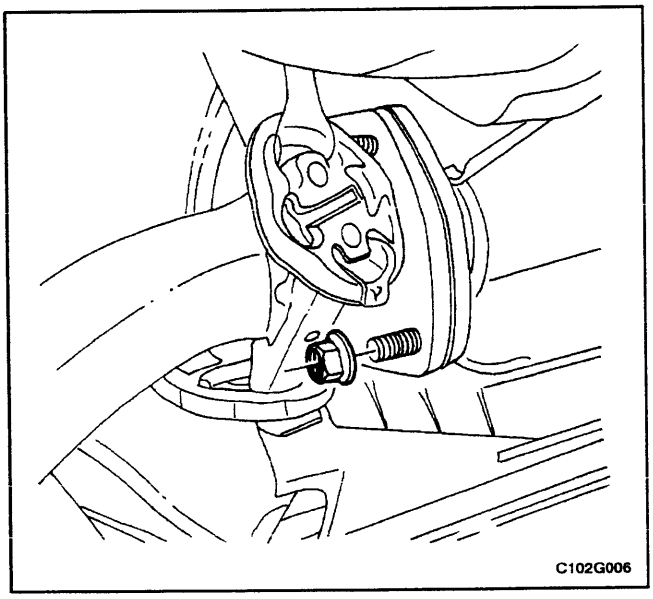


Installation Procedure

1. Install the gasket between the catalytic converter flange and the front muffler pipe flange.
2. Install the catalytic converter to the front muffler pipe.
3. Install the nuts to secure the front muffler pipe to the catalytic converter.

Tighten

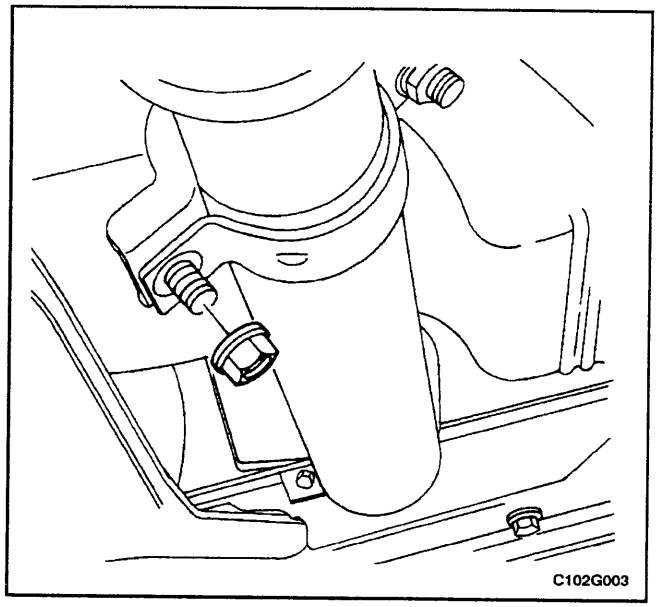
Tighten the front muffler pipe-to-catalytic converter nuts to 30 N•m (22 lb-ft).



4. Install the front exhaust pipe to the rubber ring hangers.
5. Install the gasket between the front exhaust pipe flange and the catalytic converter flange.
6. Install the front exhaust pipe to the catalytic converter using the nuts.

Tighten

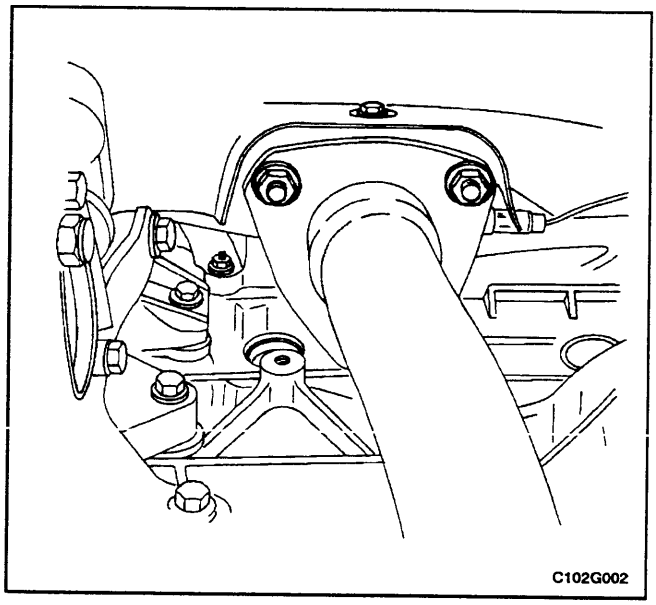
Tighten the front exhaust pipe-to-catalytic converter nuts to 30 N•m (22 lb-ft).



7. Install the front exhaust pipe into the upper front exhaust pipe mounting bracket.
8. Install the lower front exhaust pipe mounting bracket onto the front exhaust pipe.
9. Install the lower front exhaust pipe mounting bracket to the welded bolts of the upper front exhaust pipe mounting bracket using the nuts.

Tighten

Tighten the lower front exhaust pipe mounting bracket nuts to 30 N•m (22 lb-ft).

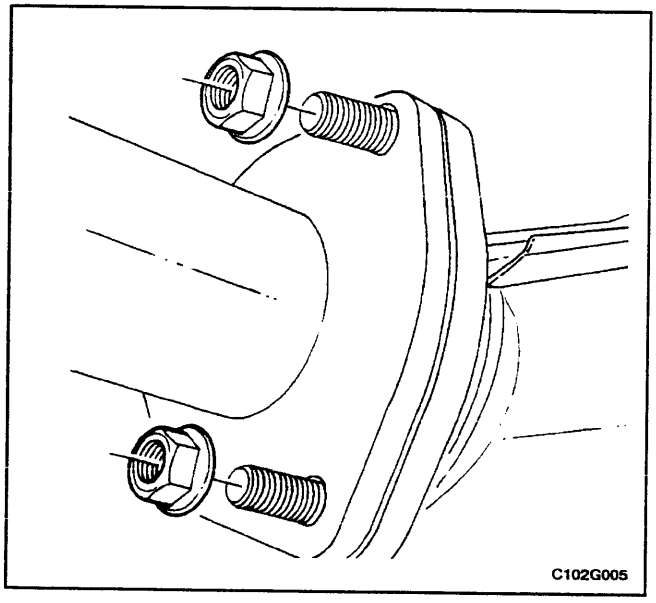


10. Install the gasket between the front exhaust pipe flange and the exhaust manifold.
11. Install the front exhaust pipe to the exhaust manifold using the nuts.

Tighten

Tighten the front exhaust pipe-to-exhaust manifold nuts to 40 N•m (30 lb-ft).

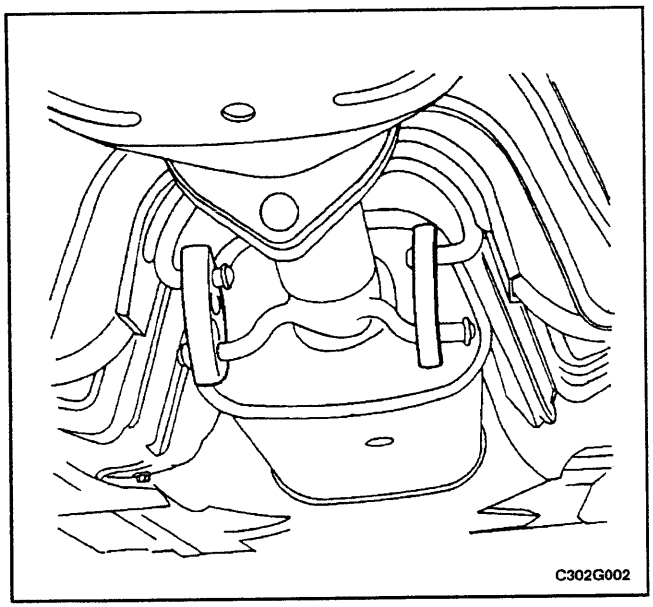
12. Install the splash guard. Refer to *Section 9N, Frame and Underbody.*



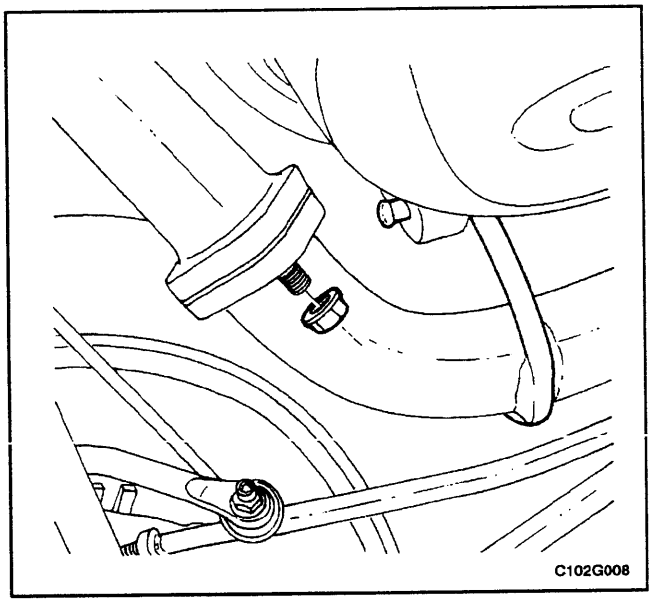
MUFFLER - FRONT

Removal Procedure

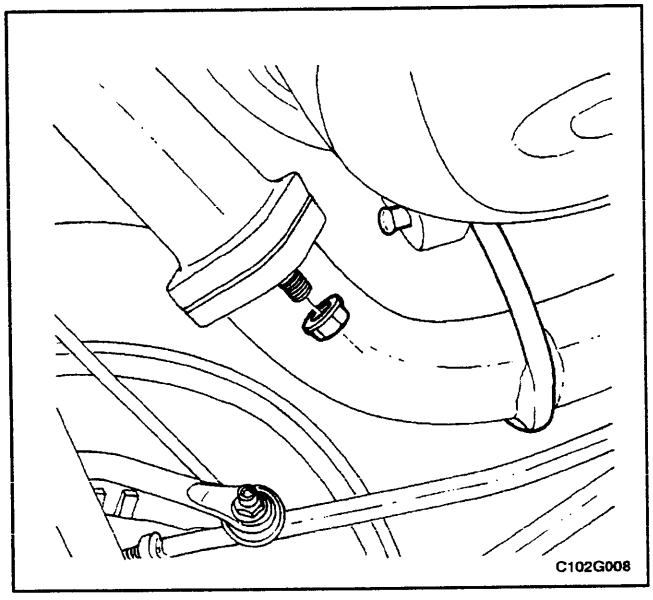
1. Remove the nuts that secure the front muffler pipe to the catalytic converter flange.
2. Remove the gasket.



3. Remove the front muffler from the rubber hangers.



4. Remove the nuts that secure the front muffler pipe flange to the rear muffler pipe flange.
5. Remove the gasket from between the front muffler pipe flange and the rear muffler pipe flange.
6. Disconnect the front muffler pipe from the rubber hanger.
7. Remove the front muffler pipe.
8. Check the exhaust pipe and the front muffler pipe for holes, damage, open seams, or other deterioration which could permit exhaust fumes to seep into the passenger compartment or the trunk.

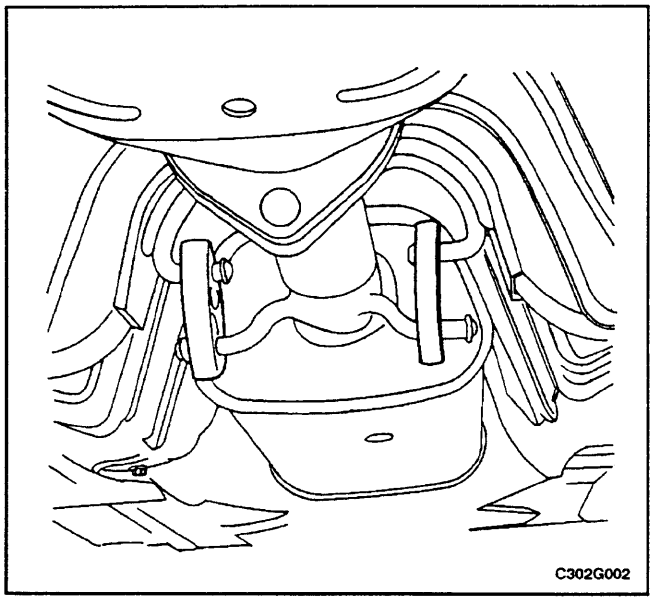


Installation Procedure

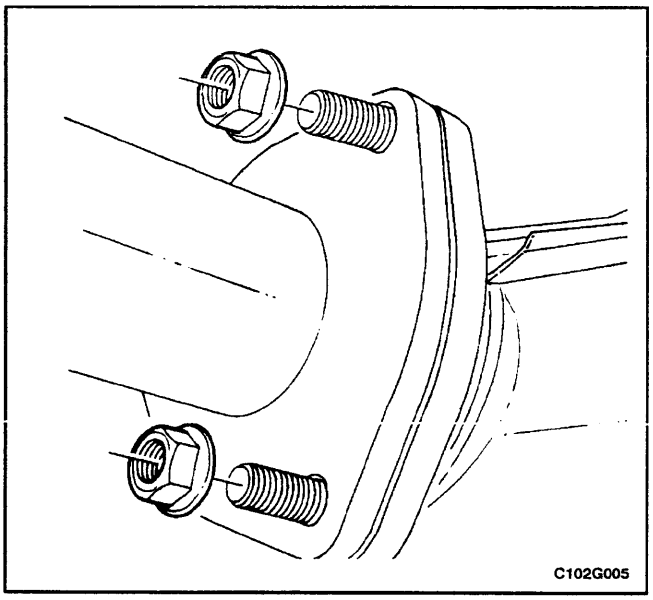
1. Install the front muffler pipe to the rubber hanger.
2. Install the gasket to the front muffler pipe.
3. Install the front muffler pipe to the rear muffler pipe with the nuts.

Tighten

Tighten the front muffler pipe-to-rear muffler pipe nuts to 30 N•m (22 lb-ft).


C302G002

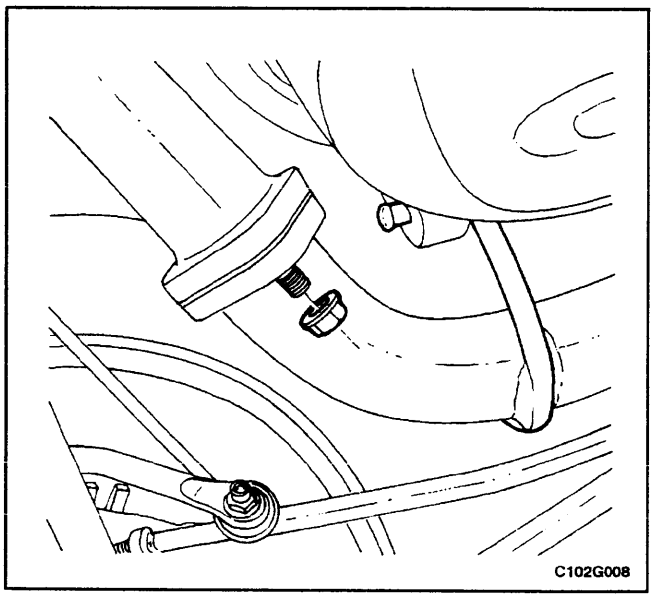
4. Install the front muffler assembly to the rubber hangers.
5. Install the front muffler pipe to the catalytic converter flange.


C102G005

6. Install the nuts to secure the front muffler pipe to the catalytic converter.

Tighten

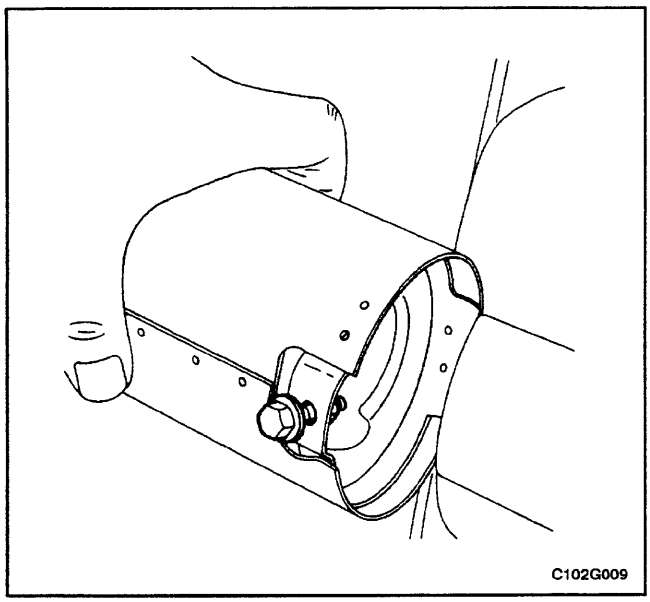
Tighten the front muffler pipe-to-catalytic converter nuts to 30 N•m (22 lb-ft).


C102G008

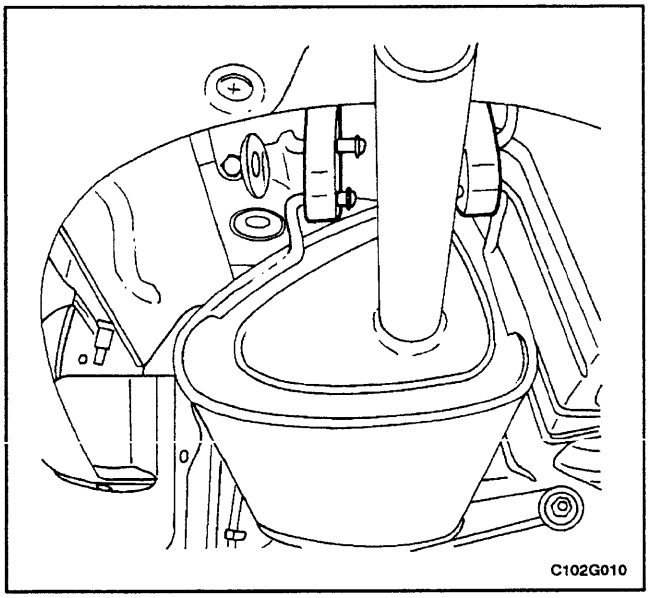
MUFFLER - REAR

Removal Procedure

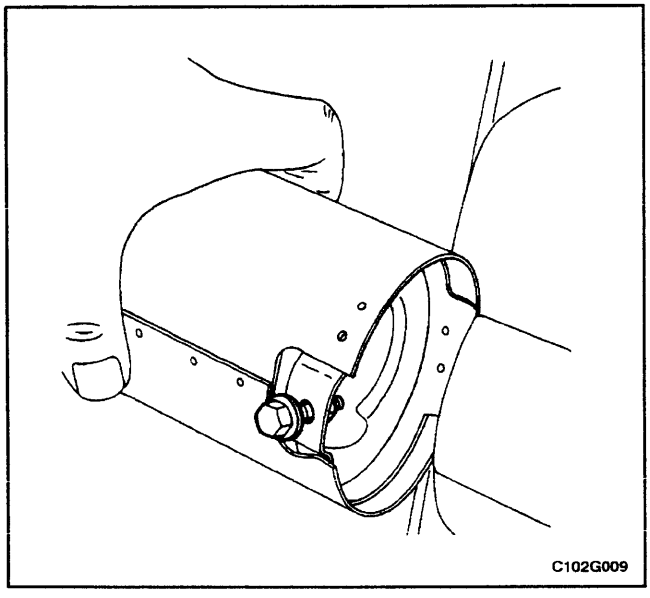
1. Remove the nuts that attach the rear muffler pipe flange to the front muffler pipe flange.
2. Remove the gasket from between the rear muffler pipe flange and the front muffler pipe flange.



3. Loosen the bolt that secures the trim ring to the rear muffler pipe.
4. Remove the trim ring.



5. Detach the rear muffler from the rubber hangers on the tail pipe end of the rear muffler assembly.
6. Remove the rear muffler assembly.
7. Check the rear muffler and the pipes for holes, damage, open seams, and other deterioration which could permit exhaust fumes to seep into the passenger compartment or the trunk.

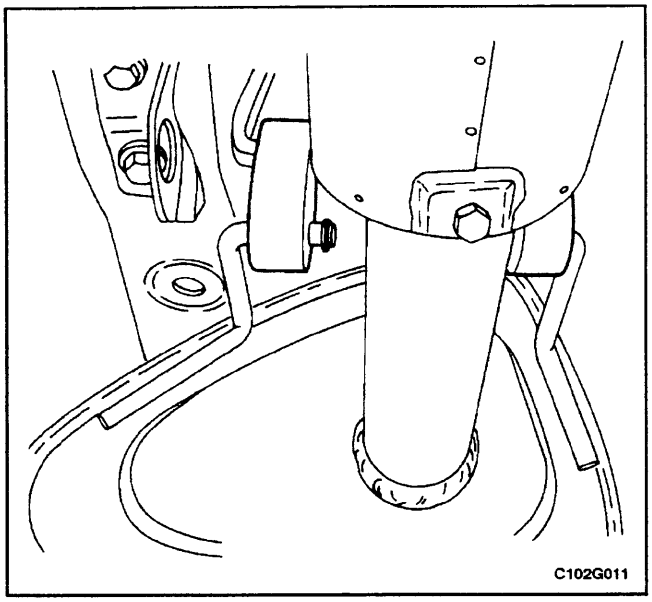


Installation Procedure

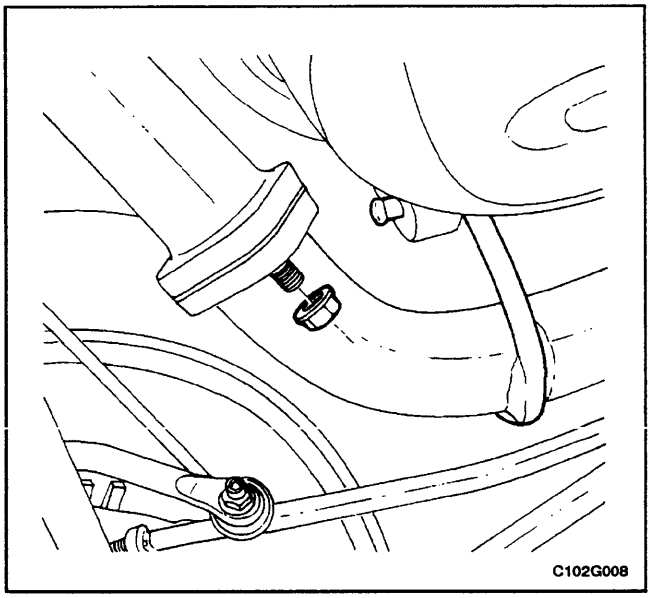
1. Place the exhaust tail pipe trim ring on the rear muffler pipe.
2. Secure the exhaust pipe trim ring on the rear muffler pipe with the bolt.

Tighten

Tighten the rear muffler pipe-to-exhaust trim ring bolt to 15 N•m (11 lb-ft).



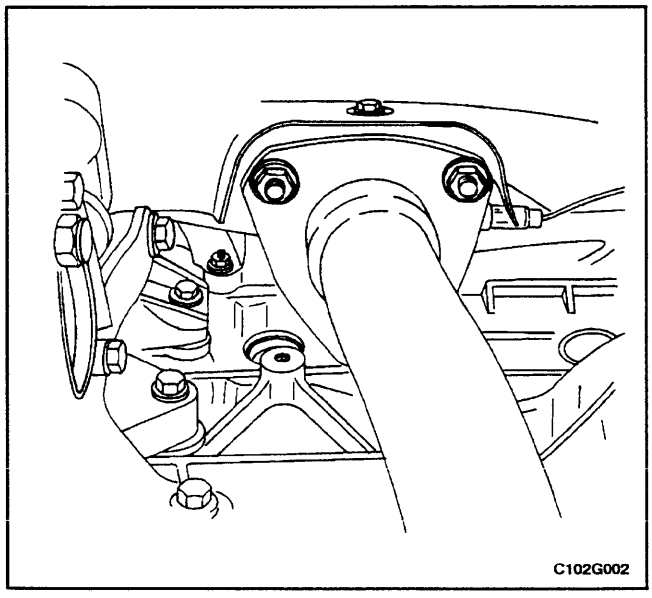
3. Install the rear muffler assembly on the rubber hangers.



4. Install the gasket between the rear muffler pipe flange and the front muffler pipe flange.
5. Install the front muffler pipe to the rear muffler pipe with the nuts.

Tighten

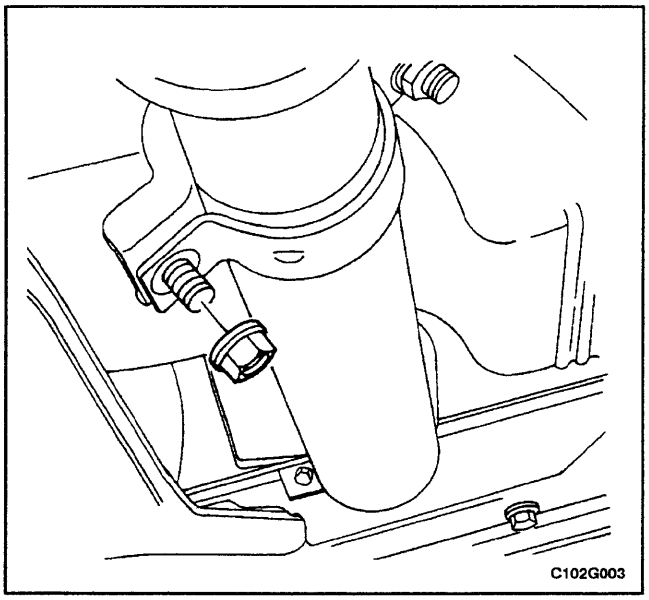
Tighten the front muffler pipe-to-rear muffler pipe nuts to 30 N•m (22 lb-ft).



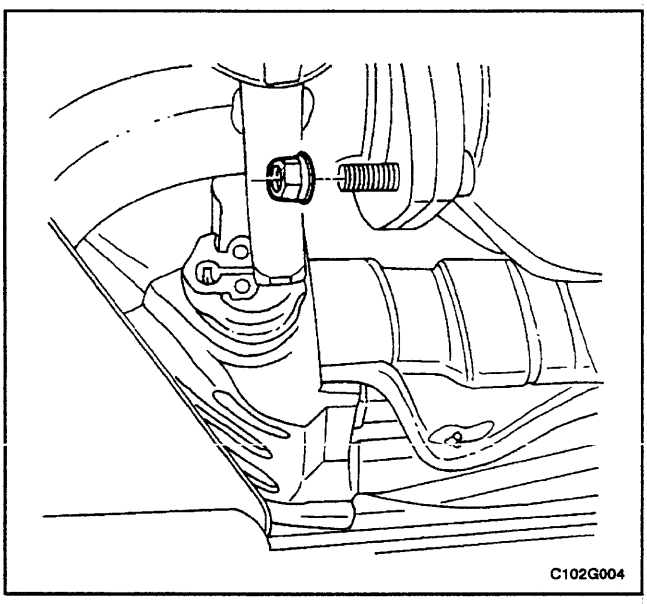
EXHAUST PIPE

Removal Procedure

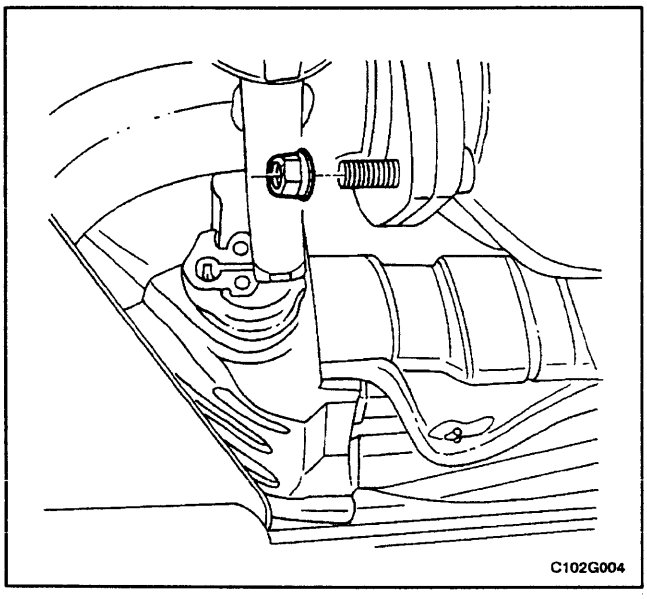
1. Remove the splash guard. Refer to *Section 9N, Frame and Underbody.*
2. Remove the front exhaust pipe nuts and the gasket from the exhaust manifold.


C102G003

3. Remove the locking nuts from the lower front exhaust pipe mounting bracket which attaches to the welded bolts of the upper front exhaust pipe mounting bracket.
4. Remove the lower front exhaust pipe bracket from the front exhaust pipe.
5. Remove the front exhaust pipe from the upper front exhaust pipe mounting bracket.


C102G004

6. Disconnect the front exhaust pipe from the rubber ring hangers near where the front exhaust pipe flange connects to the catalytic converter flange.
7. Remove the nuts that secure the front exhaust pipe flange to the catalytic converter flange.
8. Remove the front exhaust pipe and the gasket.
9. Check the front exhaust pipe and the catalytic converter for holes, damage, open seams, or other deterioration which could permit exhaust fumes to seep into the passenger compartment or the trunk.
10. Clean the sealing surfaces on the front exhaust pipe flange and the exhaust manifold.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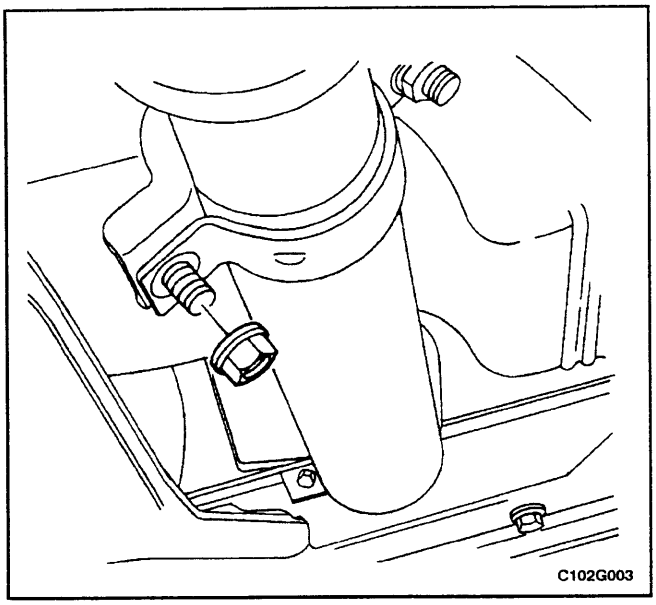
Installation Procedure

1. Install the front exhaust pipe on the rubber ring hangers.
2. Install the gasket between the front exhaust pipe and the catalytic converter.
3. Install the front exhaust pipe to the catalytic converter using the nuts.

Tighten

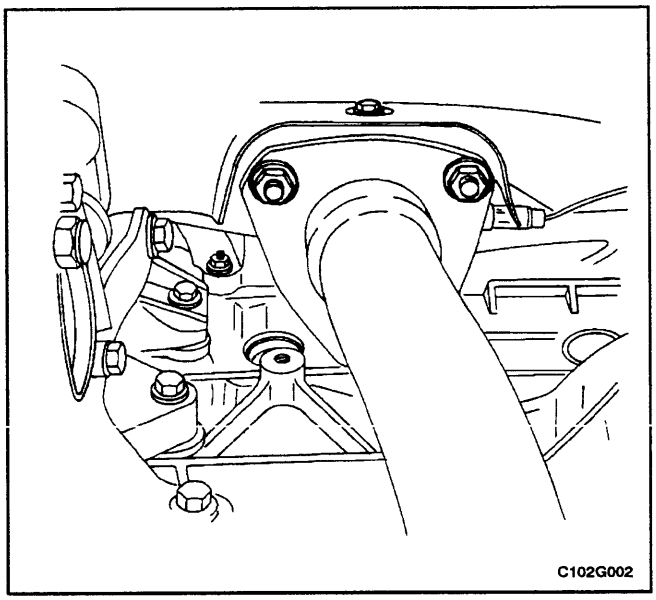
Tighten the front exhaust pipe-to-catalytic converter nuts to 30 N•m (22 lb-ft).



4. Install the front exhaust pipe into the upper front exhaust pipe mounting bracket.
5. Install the lower front exhaust pipe mounting bracket onto the front exhaust pipe.
6. Use the nuts to secure the lower front exhaust pipe mounting bracket to the welded bolts of the upper front exhaust pipe mounting bracket.

Tighten

Tighten the lower front exhaust pipe mounting bracket nuts to 30 N•m (22 lb-ft).



7. Install the front exhaust pipe and the gasket to the exhaust manifold using the nuts.

Tighten

Tighten the front exhaust pipe-to-exhaust manifold nuts to 40 N•m (30 lb-ft).

8. Install the splash guard. Refer to *Section 9N, Frame and Underbody.*

GENERAL DESCRIPTION AND SYSTEM OPERATION

EXHAUST SYSTEM

Notice: When you are inspecting or replacing exhaust system components, make sure there is adequate clearance from all points on the underbody to avoid possible overheating of the floor pan and possible damage to the passenger compartment insulation and trim materials.

Check the complete exhaust system and the nearby body areas and trunk lid for broken, damaged, missing or mispositioned parts, open seams, holes, loose connections, or other deterioration which could permit exhaust fumes to seep into the trunk or passenger compartment. Dust or water in the trunk may be an indication of a problem in one of these areas. Any defects should be corrected immediately.

The exhaust manifold-to-front exhaust pipe connection is a flex joint.

MUFFLER

Aside from the exhaust manifold connection, the exhaust system uses a flange and seal joint design rather than a slip joint coupling design with clamp and U-bolts. The exhaust manifold-to-exhaust pipe connection is a flex joint. If holes, open seams, or any deterioration is discovered upon inspection of the front muffler and pipe assembly, the complete assembly should be replaced. The same procedure is applicable to the rear muffler assembly.

Heat shields for the front and rear muffler assembly and the catalytic converter protect the vehicle and the environment from the high temperatures that the exhaust system develops.

CATALYTIC CONVERTER

Notice: When jacking or lifting the vehicle from the body side rails, be certain that the lift pads do not contact the catalytic converter, as this could damage the catalytic converter.

Notice: Use of anything other than unleaded fuel will damage the catalyst in the catalytic converter.

The catalytic converter is an emission-control device added to the exhaust system to reduce pollutants from the exhaust pipes.

The oxidation catalyst is coated with a catalytic material containing platinum and palladium, which reduces levels of hydrocarbon (HC) and carbon monoxide (CO) from the exhaust gas. The three-way catalyst has coatings which contain platinum and rhodium, which additionally lower the levels of oxides of nitrogen (NOx).

SUSPENSION

CONTENTS

SECTION 2A

SUSPENSION DIAGNOSIS

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DIAGNOSIS

GENERAL DIAGNOSIS

Problems in the steering, the suspension, the tires, and the wheels involve several systems. Consider all systems when you diagnose a complaint. Some problems, such as abnormal or excessive tire wear and scuffed tires, may be the result of hard driving. Always road test the vehicle first. If possible, do this road test with the customer.

Proceed with the following preliminary checks. Correct any substandard conditions.

Preliminary Checks

Checks	Action
Inspect the tires for improper pressure and uneven wear.	Inflate the tires to the proper pressure.
Inspect the joint from the steering column to the steering gear for loose connections or wear.	Tighten the intermediate shaft pinch bolts. Replace the intermediate shaft as needed.
Inspect the front and the rear suspension, the steering gear, and the linkage for loose or damaged parts.	Tighten the front and the rear suspension. Tighten the steering gear mounting bracket bolts. Tighten the intermediate shaft pinch bolts. Replace the front and the rear suspension as needed. Replace the steering gear as needed. Replace the intermediate shaft as needed.
Inspect for out-of-round tires.	Perform free runout test. Match-mount the tires.
Inspect for out-of-balance tires, bent wheels, and worn or loose wheel bearings.	Balance the wheels. Replace the wheels. Replace the hub and bearing assembly.
Check the power steering pump serpentine belt tension.	Tighten the power steering pump serpentine belt.
Inspect the power steering system for leaks. Also check the power steering fluid level.	Repair any leaks. Perform a power steering system test. Add power steering fluid as needed.

Car Lead/Pull

Checks	Action
Inspect for mismatched or uneven tires.	Replace the tires.
Inspect for a broken or a sagging spring.	Replace the spring.
Inspect for a radial tire lateral force.	Check the wheel alignment. Switch the tire and wheel assemblies. Replace the tires as needed.
Check the front-wheel alignment.	Align the front wheels.
Inspect for an off-center steering gear.	Reseat the pinion valve assembly. Replace the pinion valve assembly as needed.
Inspect for front-brake dragging.	Adjust the front brakes.

Abnormal or Excessive Tire Wear

Checks	Action
Check the front-wheel and rear-wheel alignment.	Align the front and the rear wheels.
Inspect for excessive toe on the front and rear wheels.	Adjust the toe on the front and rear wheels.
Inspect for a broken or a sagging spring.	Replace the spring.
Inspect for out-of-balance tires.	Balance the tires.
Inspect for worn strut dampeners.	Replace the strut dampeners.
Check for a failure to rotate tires.	Rotate the tires. Replace the tires as needed.
Check for an overloaded vehicle.	Maintain the proper load weight.
Inspect for low tire inflation.	Inflate the tires to the proper pressure.

Scuffed Tires

Checks	Action
Inspect for incorrect toe on the front and rear wheels.	Adjust the toe on the front and rear wheels.
Inspect for a twisted or a bent suspension arm.	Replace the suspension arm.

Wheel Tramp

Checks	Action
Inspect for an out-of-balance tire or wheel.	Balance the tire or the wheel.
Inspect for improper strut dampener action.	Replace the strut dampeners.

Shimmy, Shake, or Vibration

Checks	Action
Inspect for an out-of-balance tire or wheel.	Balance the tire or the wheel.
Inspect for excessive wheel hub runout.	Measure the hub flange runout. Replace the hub as needed.
Inspect for excessive brake drum or brake rotor imbalance.	Adjust the brakes. Replace the brake rotor or the brake drum as needed.
Inspect for worn tie rod ends.	Replace the outer tie rods.
Inspect for wheel trim imbalance.	Balance the wheel.
Inspect for a worn lower ball joint.	Replace the lower ball joint.
Inspect for excessive wheel runout.	Measure the wheel runout. Replace the wheel as needed.
Inspect for excessive loaded radial runout on the tire and wheel assembly.	Match-mount the tire and wheel assembly.

Hard Steering

Checks	Action
Check the steering gear preload adjustment.	Perform a rack bearing preload adjustment.
Check the hydraulic system. Test the power steering system pressure with a gauge.	Replace the seals and the hoses as needed.
Inspect for binding or catching in the steering gear.	Lubricate the steering gear. Repair or replace the steering gear as needed.
Inspect for a loose steering gear mounting.	Tighten the steering gear mounting bracket nuts and bolts.

Too Much Play in Steering

Checks	Action
Inspect for worn or loose wheel bearings.	Replace the hub and bearing assembly.
Inspect for a loose steering gear mounting.	Tighten the steering gear mounting bracket nuts and bolts.
Inspect the joint from the column to the steering gear for loose connections or wear.	Tighten the intermediate shaft pinch bolts. Replace the intermediate shaft as needed.
Check the steering gear preload adjustment.	Perform a rack bearing preload adjustment.

Poor Returnability

Checks	Action
Inspect for lack of lubrication of the ball joints and the tie rod ends.	Replace the ball joints and the outer tie rods.
Inspect for binding in the ball joints.	Replace the ball joint.
Inspect for binding in the steering column.	Lubricate the steering column. Replace the steering column as needed.
Check the front-wheel alignment.	Align the front wheels.
Check the steering gear preload adjustment.	Perform a rack bearing preload adjustment.
Inspect for a sticking valve.	Lubricate the pinion valve assembly. Replace the pinion valve assembly as needed.
Inspect for binding in the intermediate shaft on the steering gear.	Replace the intermediate shaft.

Abnormal Noise, Front Suspension

Checks	Action
Inspect for a lack of lubrication of the ball joints and the tie rod ends.	Replace the ball joints and the outer tie rods.
Inspect for damaged suspension components.	Replace the damaged suspension components.
Inspect for worn control arm bushings or tie rod ends.	Replace the control arm bushings or the tie rods.
Inspect for a loose stabilizer shaft link.	Tighten the stabilizer shaft link.
Inspect for loose wheel nuts.	Tighten the wheel nuts.
Inspect for loose suspension bolts or nuts.	Tighten the suspension bolts or the nuts.
Inspect for worn strut dampeners or strut mountings.	Replace the strut dampeners. Tighten the strut mounting bolts.
Inspect for an improperly positioned strut spring.	Adjust the strut spring to the proper position.

Wander or Poor Steering Ability

Checks	Action
Inspect for mismatched or uneven tires.	Replace the tires.
Inspect for lack of lubrication of the ball joints and the tie rod ends.	Replace the ball joints and the outer tie rods.
Inspect for worn strut dampeners.	Replace the strut dampeners.
Inspect for a loose stabilizer shaft link.	Tighten the stabilizer shaft link.
Inspect for a broken or a sagging spring.	Replace the spring.
Check the steering gear preload adjustment.	Perform a rack bearing preload adjustment.
Check the front-wheel and the rear-wheel alignment.	Align the front and the rear end wheels.

Erratic Steering when Braking

Checks	Action
Inspect for worn or loose wheel bearings.	Replace the hub and bearing assembly.
Inspect for a broken or a sagging spring.	Replace the spring.
Inspect for a leaking wheel cylinder or caliper.	Replace the wheel cylinder or the caliper.
Inspect for warped rotors.	Replace the rotors.
Inspect for an incorrect or an uneven caster.	If the caster is beyond specifications, check the frame and repair it as needed.

Low or Uneven Trim Height

Checks	Action
Inspect for a broken or a sagging spring.	Replace the spring.
Check for an overloaded vehicle.	Maintain the proper load weight.
Inspect for an incorrect or weak spring.	Replace the spring.

Ride Too Soft

Checks	Action
Inspect for worn strut dampeners.	Replace the strut dampeners.
Inspect for a broken or a sagging spring.	Replace the spring.

Ride Too Harsh

Checks	Action
Inspect for incorrect strut dampeners.	Replace the strut dampeners.
Inspect for an incorrect spring.	Replace the spring.

Body Leans or Sways in Corners

Checks	Action
Inspect for a loose stabilizer shaft link.	Tighten the stabilizer shaft link.
Inspect for worn strut dampeners or strut mountings.	Replace the strut dampeners. Tighten the strut assembly mounting bolts.
Check for an overloaded vehicle.	Maintain the proper load weight.
Inspect for a broken or a sagging spring.	Replace the spring.

Suspension Bottoms

Checks	Action
Inspect for worn strut dampeners.	Replace the strut dampeners.
Check for an overloaded vehicle.	Maintain the proper load weight.
Inspect for a broken or a sagging spring.	Replace the spring.

Steering Wheel Kickback

Checks	Action
Inspect for air in the power steering system.	Purge the power steering system of air.
Inspect for a loose steering gear mounting.	Tighten the steering gear mounting bracket nuts and bolts.
Inspect the joint from the column to the steering gear for loose connections or wear.	Tighten the intermediate shaft pinch bolts. Replace the intermediate shaft as needed.
Inspect for loose tie rod ends.	Tighten the tie rod ends. Replace the outer tie rods as needed.
Inspect for loose or worn wheel bearings.	Replace the hub and bearing assembly.

Steering Wheel Surges or Jerks

Checks	Action
Check the hydraulic system. Test the power steering system pressure with a gauge.	Replace the seals and the hoses as needed.
Inspect for a sluggish steering gear valve.	Clean the pinion valve assembly. Replace the pinion valve assembly as needed.
Inspect for a loose power steering pump serpentine belt.	Adjust the power steering pump serpentine belt.

Cupped Tires

Checks	Action
Check the front-wheel and the rear-wheel alignment.	Align the front and the rear wheels.
Inspect for worn strut dampeners.	Replace the strut dampeners.
Inspect for worn or loose wheel bearings.	Replace the hub and bearing assembly.
Inspect for excessive tire or wheel runout.	Match-mount the tires. Replace the tires as needed. Replace the wheels as needed.
Inspect for a worn ball joint.	Replace the ball joint.
Check the steering gear preload adjustment.	Perform a rack bearing preload adjustment.

TORQUE STEER

A degree of torque steer to the right may normally be experienced during the use of heavy throttle on some front-wheel drive cars with drive axles of unequal length. This torque steer to the right results from the right drive axle being longer than the left drive axle, which creates a difference in the drive axle angle. Cars with intermediate shaft assemblies have axles of almost equal length.

A difference in the drive axle lengths results in more torque toe-in in the left front wheel. You will notice the torque toe-in when the vehicle accelerates from a standing start or at lower speeds.

Inspection Procedure

1. Place a small piece of tape at the top center of the steering wheel.
2. Note the inches of steering wheel deflection required to keep the vehicle straight during heavy acceleration.
3. Compare this finding with similar cars.

Factors that may cause torque steer to be more apparent on a particular vehicle include the following:

- Variations in the tire and wheel assemblies. This has the most significant effect on torque steer. A slightly smaller diameter on the right front tire will increase a right torque lead.
- Large differences in the right and the left front tire pressure.
- Looseness in the control arm bushings, the tie rod assemblies, or the steering gear mounting. This looseness permits a front wheel to pull forward and toe-in under a torque greater than the wheel on the opposite side. A loose suspension component may result in an opposite lead upon deceleration.
- A high front trim height. This height would increase the drive axle angle and could cause wobble at speeds between 24 to 48 km/h (15 to 30 mph).

- Binding or a tight drive axle joint. A tight drive axle joint or a high front trim height may also cause a wobble at speeds between 24 to 48 km/h (15 to 30 mph).
- Incorrect, worn, or loose engine mounts causing adverse drive angles.

Refer to "General Diagnosis" in this section for actions to remedy these problems.

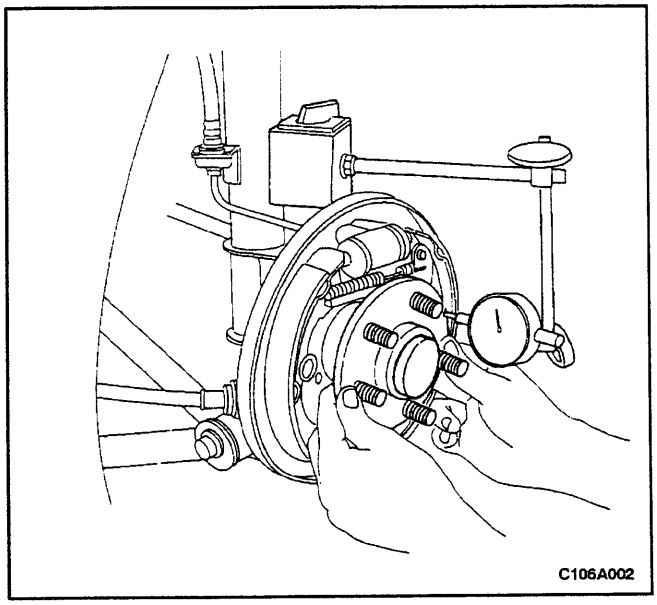
Conditions that may produce an effect similar to torque steer include the following:

- Incorrect front or rear alignment.
- Frame misalignment or defect.
- Front suspension damage.
- Incorrectly mounted rear crossmember.

HUB AND BEARING

Perform the following test to check for looseness in the hub and bearing assembly:

1. Raise and suitably support the vehicle.
2. Remove the rear wheel. Refer to *Section 2E, Tires and Wheels.*
3. Remove the brake disc caliper and the brake rotor. Refer to *Section 4E, Rear Disc Brakes.*
4. Mount a dial indicator set with a magnetic base to a stationary part of the vehicle.
5. Push and pull the wheel hub by hand. If the wheel hub movement exceeds 0.05 mm (0.002 inch), replace the wheel bearing. Refer to *Section 2D, Rear Suspension.*
6. Install the brake disc caliper and the brake rotor. Refer to *Section 4E, Rear Disc Brakes.*
7. Install the rear wheel. Refer to *Section 2E, Tires and Wheels.*
8. Lower the vehicle.



SECTION 2B

WHEEL ALIGNMENT

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SPECIFICATIONS

WHEEL ALIGNMENT SPECIFICATIONS

Application	Front	Rear
Camber	−0.2° ± 1.0°	−0.8° ± 1.0°
Caster	3.0° ± 1.0°	-
Toe-in (2-person load)	−0.2° ± 0.2° (-2 ± 2 mm)	−0.1° ± 0.1° (-1 ± 1 mm)

DIFFERENCE BETWEEN LEFT AND RIGHT

Application	Front	Rear
Camber	1° max	30′ max
Caster	1° max	-
Toe-in	-	15′ max

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Front Toe Adjusting Nut	22	16	-
Rear Toe Adjusting Screw Jam Nut	70	52	-

DIAGNOSIS

TIRE DIAGNOSIS

Irregular and Premature Wear

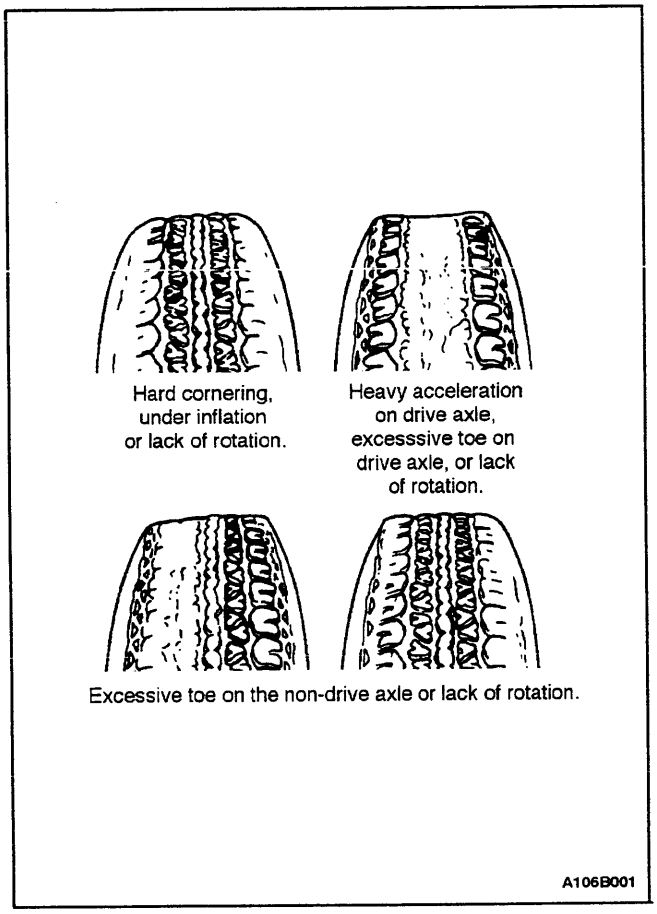
Irregular and premature tire wear has many causes. Some of them are incorrect inflation pressures, lack of regular rotation, poor driving habits, or improper wheel alignment. If the wheel alignment is reset because of tire wear, always reset the toe as close to zero degrees as the specification allows. Refer to "Rear Toe Adjustment" in this section.

Rotate the tires if

- The front tire wear is different from the rear.
- The left and right front tire wear is unequal.
- The left and right rear tire wear is unequal.

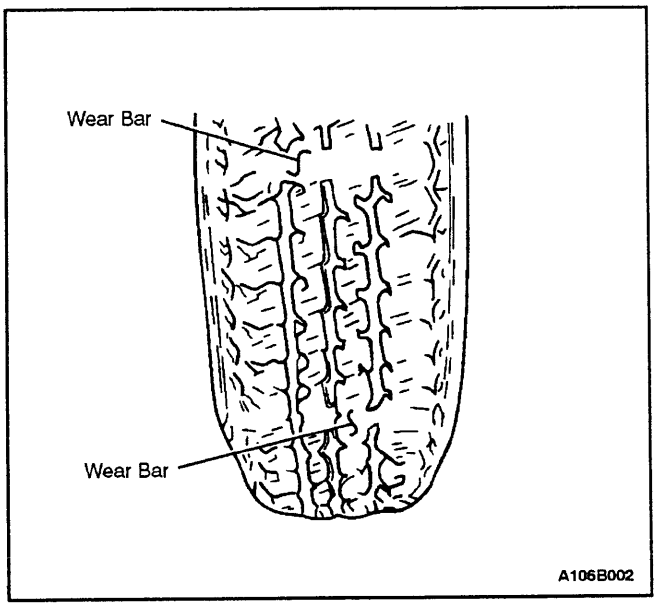
Check wheel alignment if

- The left and right front tire wear is unequal.
- The wear is uneven across the tread of either front tire.
- The front tire treads are scuffed with "feather" edges on the side of the tread ribs or blocks.



Tread Wear Indicators

The original equipment tires have built-in tread wear indicators to show when the tires need replacement. These indicators appear as bands when the tire tread depth becomes shallow. Tire replacement is recommended when the indicators appear in three or more grooves at six locations.



Radial Tire Waddle

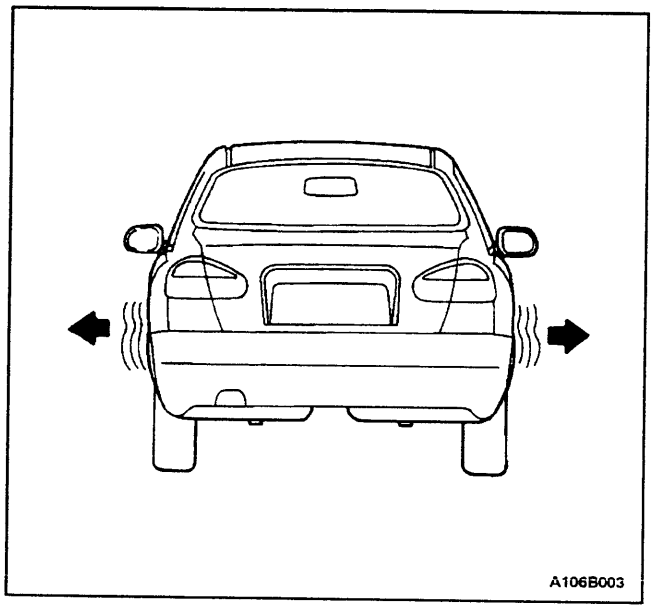
Waddle is side-to-side movement at the front or rear of the vehicle. It is caused by the steel belt not being straight within the tire, or by excessive lateral runout of the tire or wheel. It is most noticeable at low speeds, 8 to 48 km/h (5 to 30 mph), but may appear as ride roughness at 80 to 113 km/h (50 to 70 mph).

The vehicle must be road tested to determine which end of the vehicle has the faulty tire. The rear end of the vehicle will shake from side to side or "waddle" if the waddle tire is on the rear of the vehicle. From the driver's seat, it feels as though someone is pushing on the side of the vehicle. If the faulty tire is on the front of the vehicle, the waddle is more visual. The front sheet metal appears to be moving back and forth, and the driver's seat feels like the pivot point in the vehicle.

Waddle can be diagnosed using the method of substituting known good tire and wheel assemblies on the problem vehicle.

1. Road test the vehicle to determine if the waddle is coming from the front or the rear of the vehicle.
2. Install good tires and wheels from a similar vehicle in place of those on the offending end of the problem vehicle. If the source of the waddle is not obvious, change the rear tires.

3. Road test the vehicle. If there is improvement, install the original tires to find the offending tire. If there is no improvement, install good tires in place of all four offending tires.
4. Install original tires one at a time to find the offending tire.



RADIAL TIRE LEAD/PULL

Lead/pull is the deviation of the vehicle from a straight path on a level road with no pressure on the steering wheel. Lead is usually caused by

- Incorrect alignment.
- Uneven brake adjustment.
- Tire construction.

The way in which a tire is built can produce lead/pull in the vehicle. Off-center belts on radial tires can cause the tire to develop a side force while the vehicle rolls straight down the road. If one side of the tire has even a little larger diameter than the diameter of the other side, the tire will tend to roll to one side. Unequal diameters will cause the tire to develop a side force which can produce vehicle lead/pull.

The radial lead/pull diagnosis chart should be used to determine whether the problem originates from an alignment problem or from the tires. Part of the lead diagnosis procedure calls for tire rotation that is different from the proper tire rotation pattern. If a medium- to high-mileage tire is moved to the other side of the vehicle, be sure to check for ride roughness. Rear tires will not cause lead/pull.

Radial Tire Lead/Pull Diagnosis Chart

Step	Action	Value(s)	Yes	No
1	1. Perform wheel alignment preliminary inspection. 2. Check the brakes for dragging. 3. Road test the vehicle. Does the vehicle lead/pull?	-	Go to *Step 2*	System OK
2	1. Cross switch the front tire and wheel assemblies. 2. Road test the vehicle. Does the vehicle lead/pull?	-	Go to *Step 3*	System OK
3	Check the front wheel alignment. Is the alignment within specifications?	-	Go to *Step 4*	Adjust alignment
4	Compare the front camber and front caster to specifications. Are they within specifications?	-	Go to *Step 7*	Go to *Step 5*
5	Check the vehicle frame. Is the frame bent?	-	Go to *Step 6*	Go to *Step 1*
6	Straighten the frame. Is the repair complete?	-	Go to *Step 3*	-
7	1. The probable cause is the tires. 2. Switch the left front tire and wheel assembly with the left rear tire and wheel assembly. 3. Road test the vehicle. Does the vehicle still lead/pull?	-	Go to *Step 9*	Go to *Step 8*
8	Switch the left front tire and wheel assembly with the left rear tire and wheel assembly and replace the left front tire. Is the repair complete?	-	System OK	Go to *Step 1*
9	1. Switch the right front tire and wheel assembly with the right rear tire and wheel assembly. 2. Road test the vehicle. Does the vehicle still lead/pull?	-	Go to *Step 1*	Go to *Step 10*
10	Switch the right front tire and wheel assembly with the right rear tire and wheel assembly and replace the right front tire. Is the repair complete?	-	System OK	Go to *Step 1*

VIBRATION DIAGNOSIS

Wheel imbalance causes most highway speed vibration problems. A vibration can remain after dynamic balancing because

- A tire is out of round.
- A rim is out of round.
- A tire stiffness variation exists.

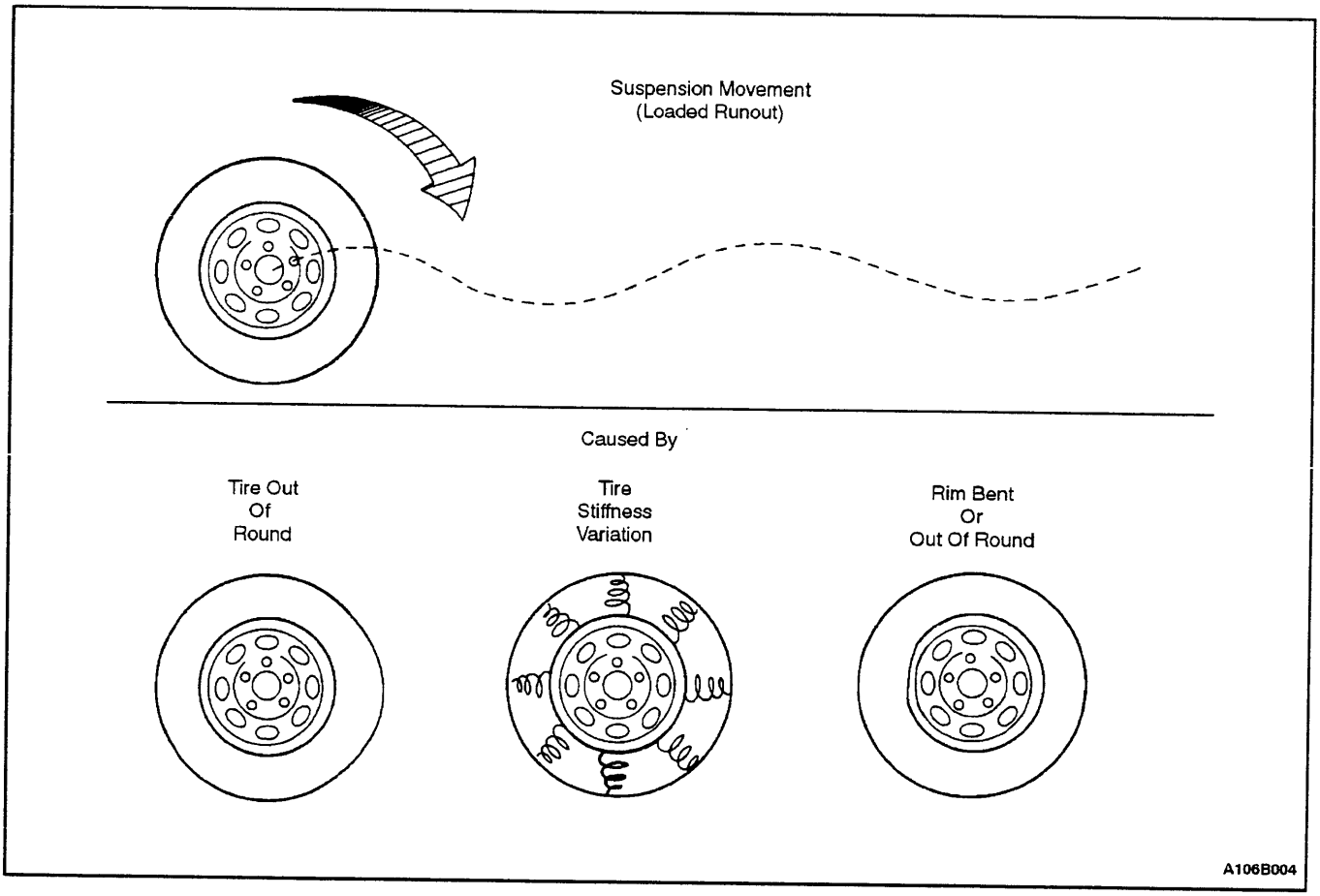
Measuring tire and wheel free runout will uncover only part of the problem. All three causes, known as loaded radial runout, must be checked using the method of substituting a known good tire and wheel assembly on the problem vehicle.

Low-speed vibrations, which occur below 64 km/h (40 mph), are usually caused by runout. High-speed vibrations, which occur above 64 km/h (40 mph), can be caused by either imbalance or runout.

Preliminary Checks

Prior to performing any work, always road test the car and perform a careful visual inspection for

- Obvious tire and wheel runout.
- Obvious drive axle runout.
- Improper tire inflation.
- Incorrect trim height.
- Bent or damaged wheels.
- Debris build-up on the tire or the wheel.
- Irregular or excessive tire wear.
- Improper tire bead seating on the rim.
- Imperfections in the tires, including tread deformations, separations, or bulges from impact damage. Slight sidewall indentations are normal and will not affect ride quality.



Tire Balancing

Balancing is the easiest procedure to perform and should be done first if the vibration occurs at high speeds. Do an off-vehicle, two-plane dynamic balance first to correct any imbalance in the tire and wheel assembly.

An on-vehicle finish balance will correct any brake drum, rotor, or wheel cover imbalance. If balancing does not correct the high-speed vibration, or if the vibration occurs at low speeds, runout is the probable cause.

Runout

Runout can be caused by the tire, the wheel, or the way the wheel is attached to the vehicle. To investigate the possibility of wheel runout, refer to the following procedures as well as the wheel runout diagnosis chart in this section.

1. If runout is suspected, measure the on-vehicle free lateral and free radial runout of the tire and wheel assembly. Refer to *Section 2E, Tires and Wheels*. Both

the free lateral and the free radial runout should be less than 1.5 mm (0.06 inch). If either measurement exceeds this number, proceed to step 2.

2. Mount the tire and the wheel on a dynamic balancing machine and remeasure the free lateral and the free radial runout. Record the amount of the free lateral and the free radial runout and the location of the highest measurement. Refer to *Section 2E, Tires and Wheels*. If the free radial or the free lateral runout exceeds 1.3 mm (0.05 inch) at the tire tread, proceed to Step 4.
3. Measure the wheel runout. Refer to *Section 2E, Tires and Wheels*. If the wheel exceeds specifications, replace it.
4. Deflate the tire and match-mount the high radial runout point of the tire to the low radial runout point of the wheel. Reinflate the tire and mount it on the dynamic balancing machine. Measure and record the free radial and the free lateral runout and their locations. In many cases, match mounting the tire on the wheel will bring the tire and wheel assembly's free runout into an acceptable range of 1.3 mm (0.05 inch) or less.
5. If the free runout of the tire and wheel assembly is 1.3 mm (0.05 inch) or less when it was measured off the vehicle, yet exceeds 1.3 mm (0.05 inch) when measured on the vehicle, the attachment of the tire and wheel assembly to the hub is the probable cause of the vibration. Rotate two of the assembly's wheel nuts and recheck the runout. Refer to *Section 2E, Tires and Wheels*. Several positions may have to be tried to find the best location for the nuts.
6. If the tire and wheel assembly free runout cannot be reduced to 1.3 mm (0.05 inch) or less, remove the assembly.
   - 6.1 Measure the hub stud runout using a dial indicator set with a magnetic base.
   - 6.2 Zero the dial indicator set button on one stud.
   - 6.3 Gently lift the set button off the stud. Rotate the flange to position the next stud against the dial indicator set.
   - 6.4 Record the runout of all the studs. The dial indicator should read zero when it is repositioned on the first stud that was checked.
   - 6.5 If the runout exceeds 0.76 mm (0.03 inch), the hub stud or the hub and bearing assembly should be replaced.

Whenever a tire is rotated on the wheel, or whenever a tire or wheel is replaced, rebalance the assembly.

Wheel Runout Diagnosis Chart

Step	Action	Value(s)	Yes	No
1	Road test the vehicle to verify the vibration complaint. Are the customer's concerns verified?	-	Go to *Step 2*	System OK
2	1. Perform a vibration diagnosis preliminary check. 2. Repair any of the problems found. Is the vibration still present?	-	Go to *Step 3*	System OK
3	Determine at what speed the vibration is present. Is the vibration over 64 km/h (40 mph)?	-	Go to *Step 4*	Go to *Step 6*
4	Perform an off-vehicle dynamic wheel balance. Is the vibration still present?	-	Go to *Step 5*	System OK
5	Perform an on-vehicle finish balance. Is the vibration still present?	-	Go to *Step 6*	System OK
6	Perform a free lateral and a radial on-vehicle runout check. Does the runout match the value specified?	1.5 mm (0.06 in.)	Go to *Step 4*	Go to *Step 7*
7	Perform a free lateral and a free radial off-vehicle runout check. Does the runout match the value specified?	1.3 mm (0.05 in.)	Go to *Step 8*	Go to *Step 12*
8	1. Index the tire and wheel assembly on the hub studs. 2. Obtain the least amount of runout possible. Does the runout match the value specified?	0.76 mm (0.03 in.)	Go to *Step 9*	Go to *Step 14*
9	Perform an off-vehicle dynamic wheel balance. Is the vibration still present?	-	Go to *Step 10*	System OK
10	Perform an on-vehicle finish balance. Is the vibration still present?	-	Go to *Step 11*	System OK
11	1. Check for any engine driveline imbalance. 2. Thoroughly inspect the drive axles and the constant velocity joints. 3. Repair any problems found. Are the repairs complete?	-	Go to *Step 1*	-
12	1. Match-mount the tire on the wheel. 2. Perform a free lateral and a free radial off-vehicle runout check. Does the runout match the value specified?	1.5mm (0.06 in.)	Go to *Step 9*	Go to *Step 13*
13	1. Dismount the tire from the wheel of the suspected assembly. 2. Measure the runout of the wheel. Does the runout match the value specified?	0.8 mm (0.03 in.)	Go to *Step 15*	Go to *Step 16*
14	Measure the hub flange runout. Does the runout match the value specified?	0.76 mm (0.03 in.)	Go to *Step 9*	Go to *Step 17*
15	Replace the tire. Is the repair complete?	-	Go to *Step 1*	-
16	Replace the wheel. Is the repair complete?	-	Go to *Step 1*	-
17	Replace the hub. Is the repair complete?	-	Go to *Step 1*	-

PRELIMINARY INSPECTION

Checks	Action
Check the tires for proper inflation pressures and normal tread wear.	Inflate the tires to the proper tire pressure. Replace the tires as needed.
Check the wheel bearings for looseness.	Replace the hub and bearing assembly.
Check for loose ball joints and tie rod ends.	Tighten the ball joints and the tie rods.
Check the runout of the wheels and the tires.	Measure and correct the tire runout.
Check the vehicle trim heights.	Correct the trim heights. Make the correction before adjusting the toe.
Check for loose rack and pinion mounting.	Tighten the mounting brackets for the rack and pinion assembly.
Check for improperly operating struts.	Replace the strut assembly.
Check for loose control arms.	Tighten the control arm attachment bolts. Replace the control arm bushings as needed.

FRONT TOE ADJUSTMENT

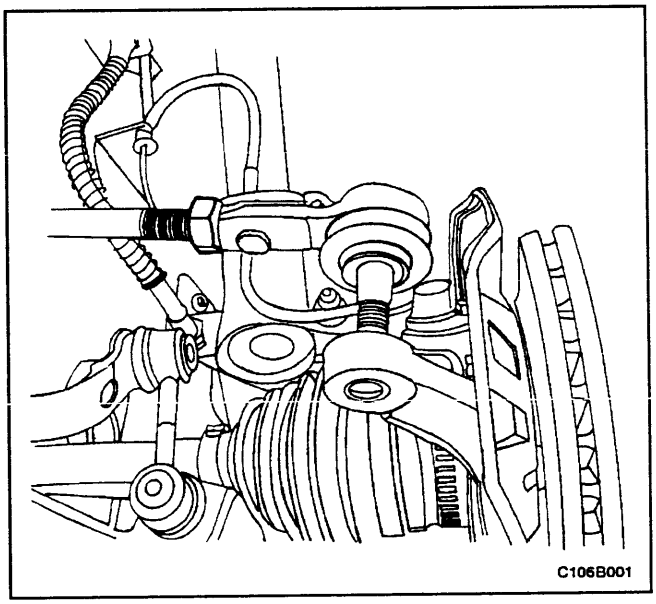
Adjustment Procedure

1. Disconnect the outer tie rods from the knuckle assemblies. Refer to *Section 6C, Power Steering Gear.*
2. Loosen the front toe adjusting nut.
3. Turn the right and the left outer tie rods to align the toe to the proper specifications. Refer to "Wheel Alignment Specifications" in this section.
4. Hold the outer tie rod and tighten the front toe adjusting nut.

   Tighten

   Tighten the front toe adjusting nut to 22 N•m (16 lb-ft).
5. Reconnect the outer tie rods to the knuckle assemblies. Refer to *Section 6C, Power Steering Gear.*

Notice: In this adjustment, the right and the left tie rods must be equal in length, or the tires will wear unevenly.



FRONT CAMBER AND CASTER CHECK

The front camber and caster are not adjustable. Refer to "Wheel Alignment Specifications" in this section. Jounce the bumper three times before measuring the camber or the caster in order to prevent an incorrect reading. If the front camber or caster measurements deviate from the specifications, locate and replace or repair any damaged, loose, bent, dented, or worn suspension part. If the problem is body related, repair the body.

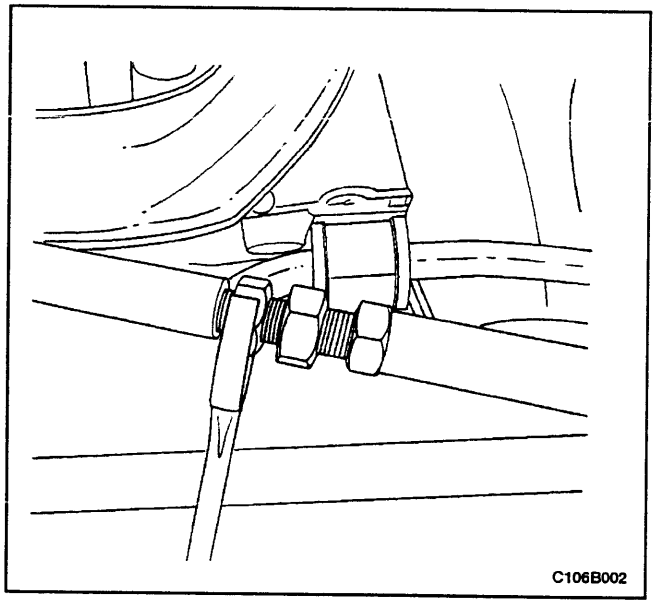
REAR CAMBER CHECK

The rear camber is not adjustable. Refer to "Wheel Alignment Specifications" in this section. If the rear camber deviates from the specification, locate the cause and correct it. If damaged, loose, bent, dented, or worn suspension parts are found, they should be repaired or replaced. If the problem is body related, repair the body.

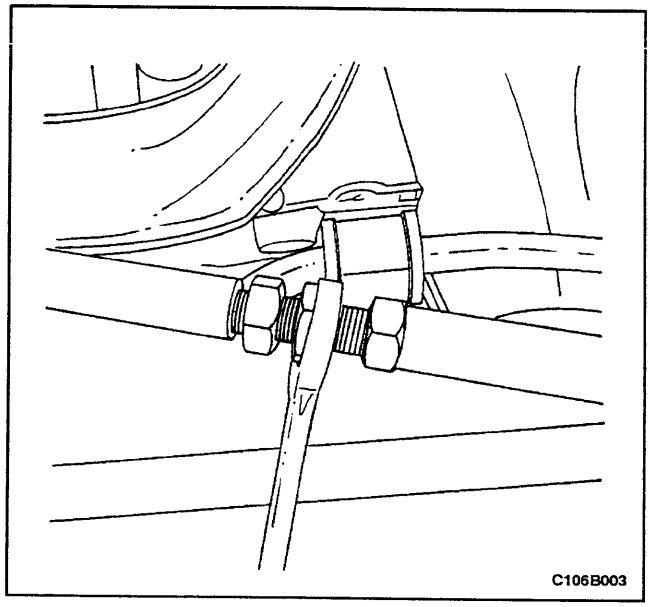
REAR TOE ADJUSTMENT

Adjustment Procedure

1. Perform a preliminary inspection before any attempt is made to change or correct the wheel alignment factors. Refer to "Preliminary Inspection" in this section.
2. Loosen the toe adjusting screw jam nuts on the rear parallel link.


C106B002

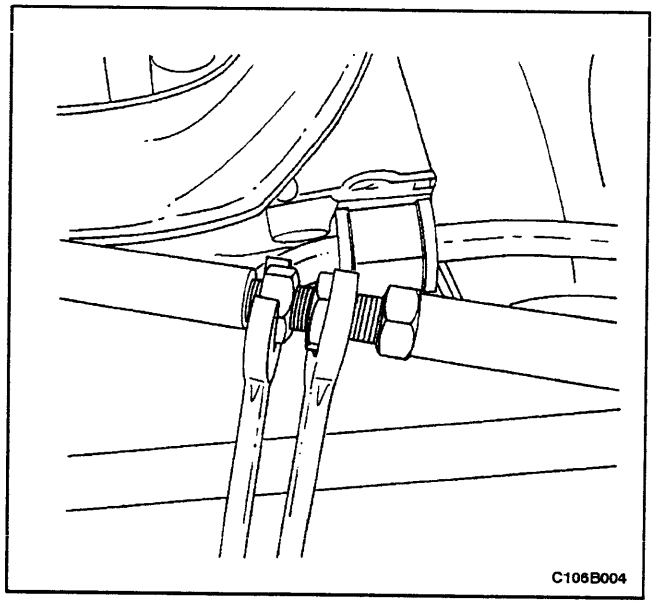
3. Turn the adjustment screw until the preferred rear toe specification is obtained. Refer to "Wheel Alignment Specifications" in this section for preferred specifications.


C106B003

4. Hold the adjustment screw and tighten the toe adjusting screw jam nut.

Tighten

Tighten the toe adjusting screw jam nut to 70 N•m (52 lb-ft).


C106B004

GENERAL DESCRIPTION AND SYSTEM OPERATION

FOUR WHEEL ALIGNMENT

The first responsibility of engineering is to design safe steering and suspension systems. Each component must be strong enough to withstand and absorb extreme punishment. Both the steering system and the front and the rear suspension must function geometrically with the body mass.

The steering and the suspension systems require that the front wheels self-return and that the tire rolling effort and the road friction be held to a negligible force in order to allow the customer to direct the vehicle with the least effort and the most comfort.

A complete wheel alignment check should include measurements of the rear toe and camber.

Four-wheel alignment assures that all four wheels will be running in precisely the same direction.

When the vehicle is geometrically aligned, fuel economy and tire life are at their peak, and steering and performance are maximized.

TOE

Toe-in is the turning in of the tires, while toe-out is the turning out of the tires from the geometric centerline or thrust line. The toe ensures parallel rolling of the wheels.

The toe serves to offset the small deflections of the wheel support system which occur when the vehicle is rolling forward. The specified toe angle is the setting which achieves 0 degrees of toe when the vehicle is moving.

Incorrect toe-in or toe-out will cause tire wear and reduced fuel economy. As the individual steering and suspension components wear from vehicle mileage, additional toe will be needed to compensate for the wear.

Always correct the toe dimension last.

CASTER

Caster is the tilting of the uppermost point of the steering axis either forward or backward from the vertical when viewed from the side of the vehicle. A backward tilt is positive, and a forward tilt is negative. Caster influences directional control of the steering but does not affect tire wear. Weak springs or overloading a vehicle will affect caster. One wheel with more positive caster will pull toward the center of the car. This condition will cause the car to move or lean toward the side with the least amount of positive caster. Caster is measured in degrees and is not adjustable.

CAMBER

Camber is the tilting of the top of the tire from the vertical when viewed from the front of the vehicle. When the tires tilt outward, the camber is positive. When the tires tilt inward, the camber is negative. The camber angle is measured in degrees from the vertical. Camber influences both directional control and tire wear.

If the vehicle has too much positive camber, the outside shoulder of the tire will wear. If the vehicle has too much negative camber, the inside shoulder of the tire will wear.

Camber is not adjustable.

STEERING AXIS INCLINATION

Steering axis inclination (SAI) is the tilt at the top of the steering knuckle from the vertical. Measure the SAI angle from the true vertical to a line through the center of the strut and the lower ball joint as viewed from the front of the vehicle.

SAI helps the vehicle track straight down the road and assists the wheel back into the straight ahead position. SAI on front wheel drive vehicles should be negative.

INCLUDED ANGLE

The included angle is the angle measured from the camber angle to the line through the center of the strut and the lower ball joint as viewed from the front of the vehicle.

The included angle is calculated in degrees. Most alignment racks will not measure the included angle directly. To determine the included angle, subtract the negative or add the positive camber readings to the steering axis inclination (SAI).

SCRUB RADIUS

The scrub radius is the distance between true vertical and the line through the center of the strut and lower ball joint to the road surface. Scrub radius is built into the design of the vehicle. Scrub radius is not adjustable.

SETBACK

The setback is the distance in which one front hub and bearing assembly may be rearward of the other front hub and bearing assembly. Setback is primarily caused by a road hazard or vehicle collision.

TURNING ANGLE

The turning angle is the angle of each front wheel to the vertical when the vehicle is making a turn.

SECTION 2C

FRONT SUSPENSION

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

TABLE OF CONTENTS

SPECIFICATIONS

GENERAL SPECIFICATIONS

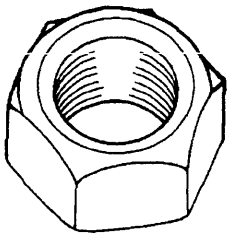
Application	Trim Height
Center of Front Wheel to Bottom of Front Wheel Well	379 mm (15 in.)
Center of Rear Wheel to Bottom of Rear Wheel Well	374 mm (14.7 in.)

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Ball Joint Pinch Bolt Nuts	90	66	-
Ball Joint-to-Control Arm Nuts	110	81	-
Control Arm Front Bushing Nuts	140	103	-
Control Arm Rear Bushing Clamp Bolts	75	55	-
Drive Axle-to-Hub Caulking Nuts (First Torque)	180	133	-
Drive Axle-to-Hub Caulking Nuts (Last Torque)	50 + 60°	37 + 60°	-
Piston Rod Nuts	70	52	-
Stabilizer Link-to-Control Arm Nuts	45	33	-
Stabilizer Shaft Clamp Bolts	37	27	-
Stabilizer Shaft-to-Stabilizer Link Nuts	45	33	-
Steering Knuckle-to-Strut Assembly Nuts	135	100	-
Strut Assembly-to-Body Nuts	45	33	-

SPECIAL TOOLS

SPECIAL TOOLS TABLE


A106C056

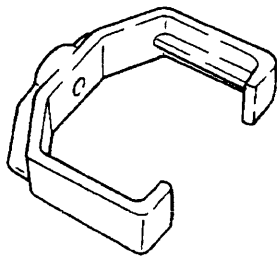
500-20
Hex Nut


A106C053

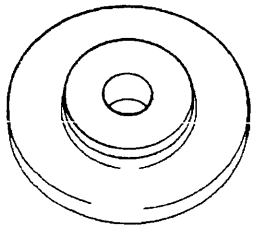
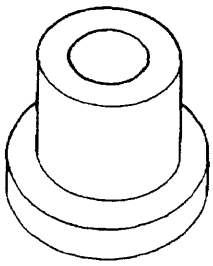
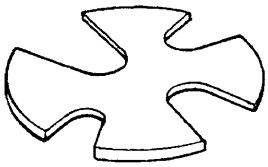
J-36661-2
Forcing Screw

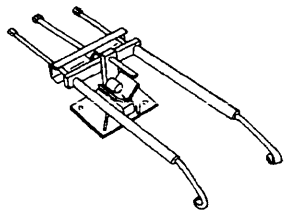
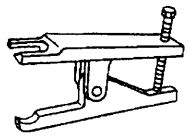
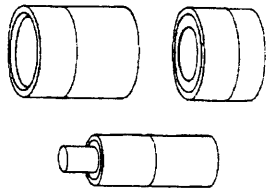

A106C062

DV-005
Front Strut
Mount Nut Wrench


A106C052

J-37105-40
Support Bridge

 A106C054	**J-37105-B-2 Bearing Adapter**
 A106C055	**J-37105-B-3 Hub Adapter**
 A106C030	**KM-307-B Removal Plate**

 A106C031	**KM-329-A Spring Compressor**
 C106C034	**KM-333 Ball Joint Remover**
 A106C035	**KM-508-A Remover/Installer**

DIAGNOSIS

STRUT DAMPENER

A strut dampener is basically a shock absorber. However, strut dampeners are easier to extend and retract by hand than are shock absorbers.

Struts Seem Weak

Checks	Action
Check the tire pressures.	Adjust the tire pressures to the specifications on the tire placard.
Check the load conditions under which the vehicle is normally driven.	Consult with the owner to confirm the owner's understanding of normal load conditions.
Check the compression and rebound effectiveness of the strut dampener.	Quickly push down and then lift up on the corner of the bumper nearest the strut dampener being tested. Compare the compression and rebound with those of a similar vehicle that has an acceptable ride quality. Replace the strut dampener, if needed.

Struts Are Noisy

Checks	Action
Check the mountings for looseness or damage.	Tighten the strut dampener mounting nuts. Replace the strut dampener, if needed.
Check the compression and rebound effectiveness of the strut dampener.	Quickly push down and then lift up on the corner of the bumper nearest the strut dampener being tested. Compare the compression and rebound with those of a similar vehicle that has an acceptable ride quality. Replace the strut dampener, if needed.

Leaks

Checks	Action
Check for a slight trace of fluid.	The strut dampener is OK.
Check the seal cover on the fully extended strut.	Replace the strut dampener.
Check for an excessive amount of fluid on the strut dampener.	Replace the strut dampener.

BALL JOINT AND KNUCKLE

Ball Joint Inspection

1. Raise the front of the vehicle to allow the front suspension to hang free.
2. Grasp the tire at the top and the bottom.
3. Move the top of the tire in an in-and-out motion.
4. Look for any horizontal movement of the knuckle relative to the control arm.
5. Ball joints must be replaced under the following conditions:
   - The joint is loose.
   - The ball seal is cut.
   - The ball stud is disconnected from the knuckle.
   - The ball stud is loose at the knuckle.
   - The ball stud can be twisted in its socket with finger pressure.

Ball Stud Inspection

Make sure to check the tightness of the ball stud in the knuckle boss during each inspection of the ball joint. One way to inspect the ball stud for wear is to shake the wheel and feel for movement of the stud end at the knuckle boss.

Another way to inspect the ball stud for wear is to check the fastener torque at the pinch nut. A loose nut can indicate a stressed stud or a hole in the knuckle boss.

Worn or damaged ball joints and knuckles must be replaced.

EXCESSIVE FRICTION CHECK

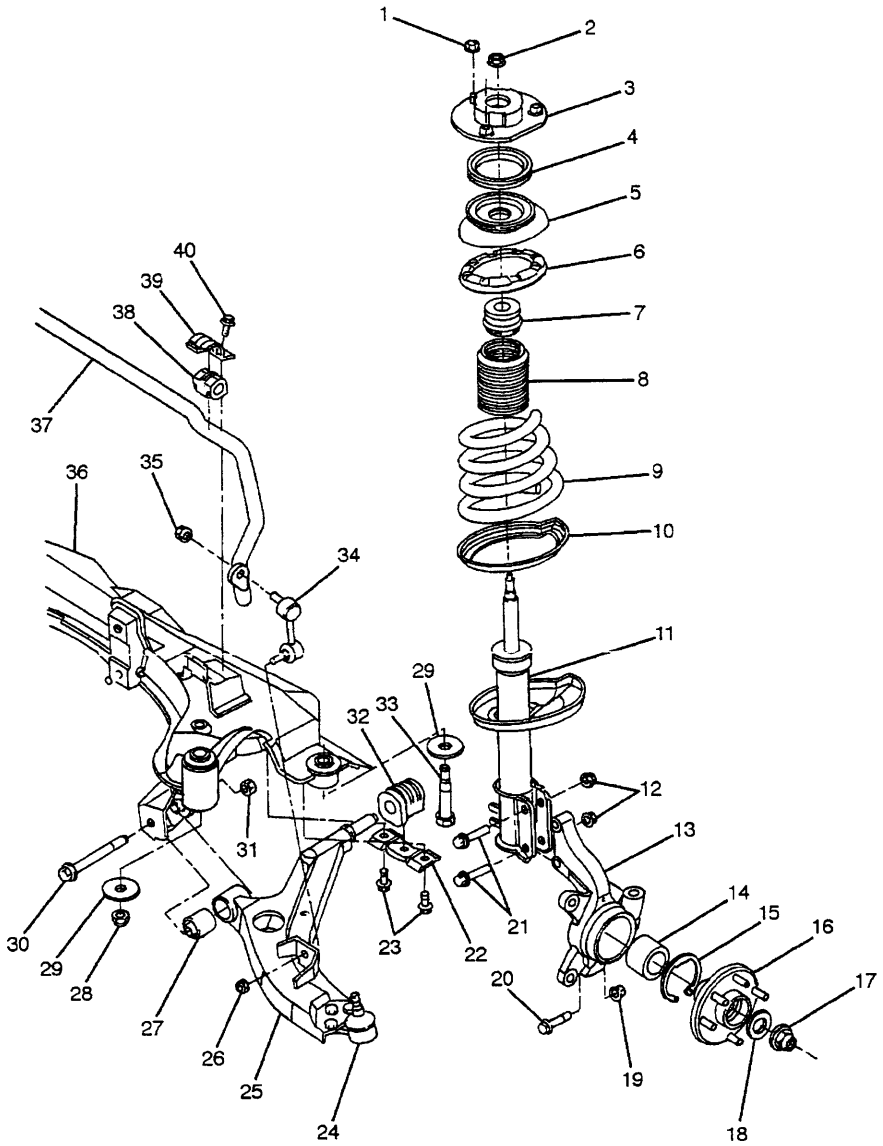
Use the following procedure to check for excessive friction in the front suspension:

1. Enlist the help of another technician to lift up on the front bumper, raising the vehicle as high as possible.
2. Slowly release the bumper, allowing the vehicle to assume its normal trim height. See "General Specifications" in this section.
3. Measure the distance from the street level to the center of the bumper.
4. Push down on the bumper, release slowly, and allow the vehicle to assume its normal trim height.
5. Measure the distance from the street level to the center of the bumper.
6. The difference between the two measurements should be less than 12.7 mm (0.5 inch). If the difference exceeds this limit, inspect the control arms, the struts, and the ball joints for damage or wear.

BLANK

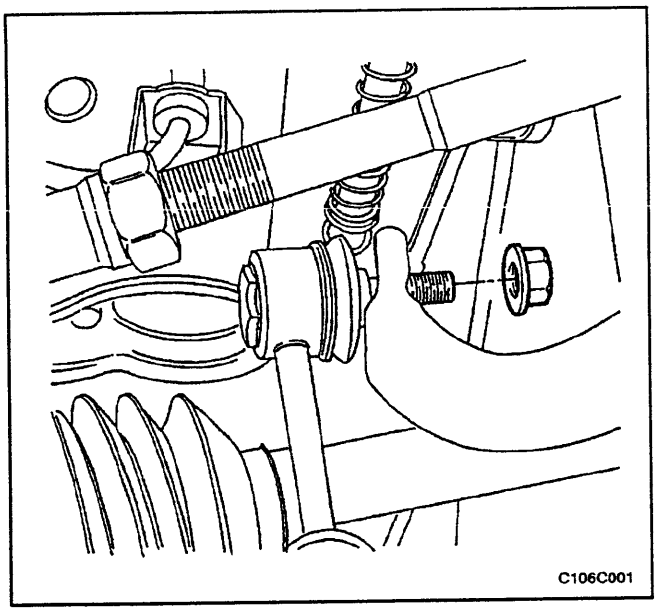
COMPONENT LOCATOR

FRONT SUSPENSION



C106C017

1 Strut Mount Body Nut
2 Piston Rod Nut
3 Strut Mount
4 Strut Mount Bearing
5 Upper Spring Seat
6 Upper Spring Insulator
7 Hollow Bumper
8 Piston Rod Boot
9 Front Spring
10 Lower Spring Insulator
11 Strut Dampener
12 Steering Knuckle-to-Strut Assembly Nut
13 Steering Knuckle
14 Front Wheel Bearing
15 Outer Snap Ring
16 Front Hub
17 Caulking Nut
18 Caulking Nut Washer
19 Ball Joint Pinch Bolt Nut
20 Ball Joint Pinch Bolt
21 Steering Knuckle-to-Strut Assembly Bolts
22 Control Arm Rear Bushing Clamp
23 Control Arm Rear Bushing Clamp Bolts
24 Ball Joint
25 Control Arm
26 Stabilizer Link-to-Control Arm Nut
27 Control Arm Front Damping Bushing
28 Crossmember-to-Body Front Connecting Nut
29 Washer
30 Control Arm Front Bushing Bolt
31 Control Arm Front Bushing Nut
32 Control Arm Rear Damping Bushing
33 Crossmember-to-Body Rear Bolt
34 Stabilizer Link
35 Stabilizer Shaft-to-Stabilizer Link Nut
36 Front Suspension Crossmember
37 Stabilizer Shaft
38 Stabilizer Shaft Bushing
39 Stabilizer Shaft Bushing Clamp
40 Stabilizer Shaft Bushing Clamp Bolt


C106C001

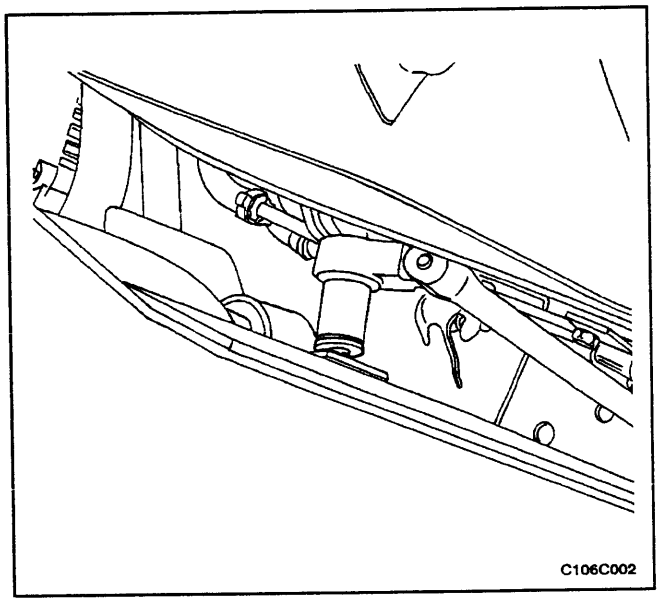
MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

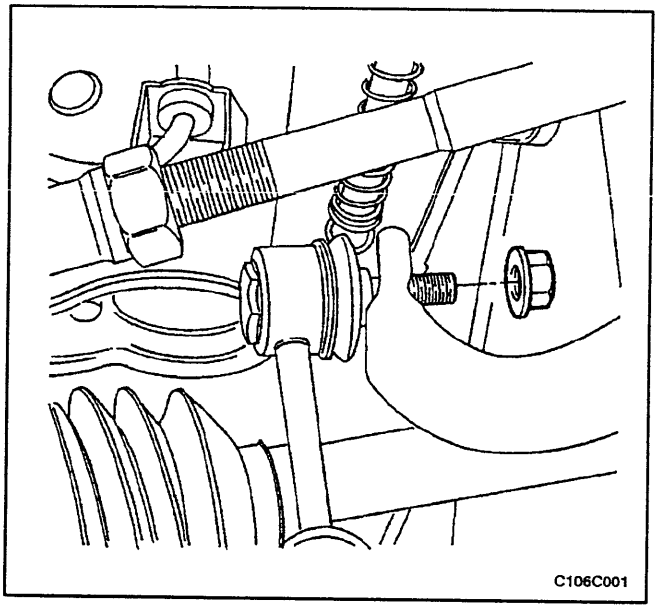
STABILIZER SHAFT AND INSULATORS

Removal Procedure

1. Raise and suitably support the vehicle.
2. Disconnect the power steering gear. Refer to *Section 6C, Power Steering Gear.*
3. Remove the crossmember front and rear support bolts. Refer to "Crossmember Assembly" in this section.
4. Lower the front crossmember until the stabilizer shaft clamp bolts can be reached.
5. Remove the stabilizer shaft-to-stabilizer link nuts. Disconnect the stabilizer shaft from the stabilizer links.


C106C002

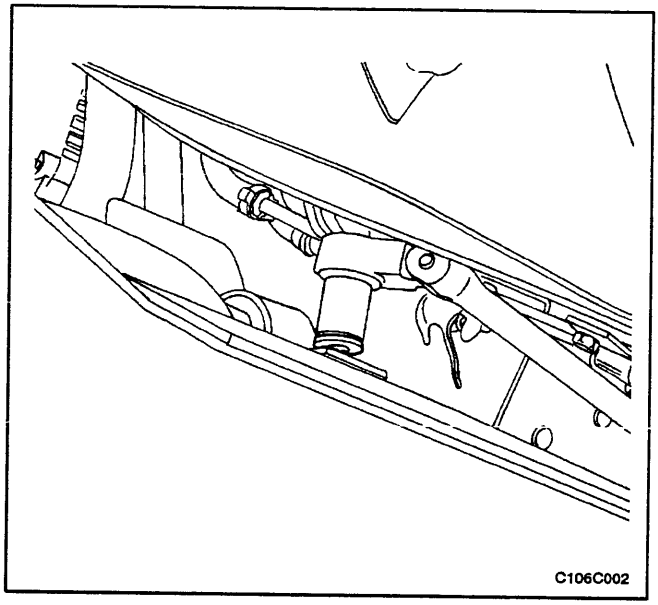
6. Remove the stabilizer shaft clamp bolts.
7. Remove the stabilizer shaft, the stabilizer shaft clamp, and the insulators from the vehicle.



Installation Procedure

Important: The weight of the vehicle must be supported by the control arms before the stabilizer link-to-control arm nuts are tightened. This can be done by lowering the vehicle onto jackstands under the control arms.

1. Install the stabilizer shaft.
2. Install the stabilizer shaft clamps, the stabilizer shaft clamp bolt, and the insulators. Do not tighten the bolt.
3. Install the stabilizer link onto the stabilizer shaft and connect them with the stabilizer shaft-to-stabilizer link nuts. Do not tighten.



Tighten

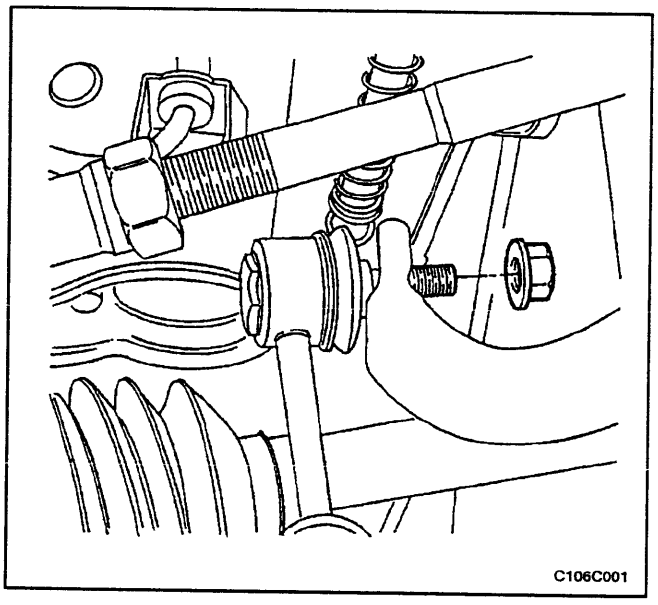
Tighten the stabilizer shaft clamp bolts to 37 N•m (27 lb-ft).

4. Raise the front crossmember and install the crossmember front and rear support bolts. Refer to "Crossmember Assembly" in this section.
5. Connect the power steering gear. Refer to *Section 6C, Power Steering Gear.*
6. Lower the vehicle so the control arms are supported by jackstands.

Tighten

Tighten the stabilizer shaft-to-stabilizer link nuts to 45 N•m (33 lb-ft).

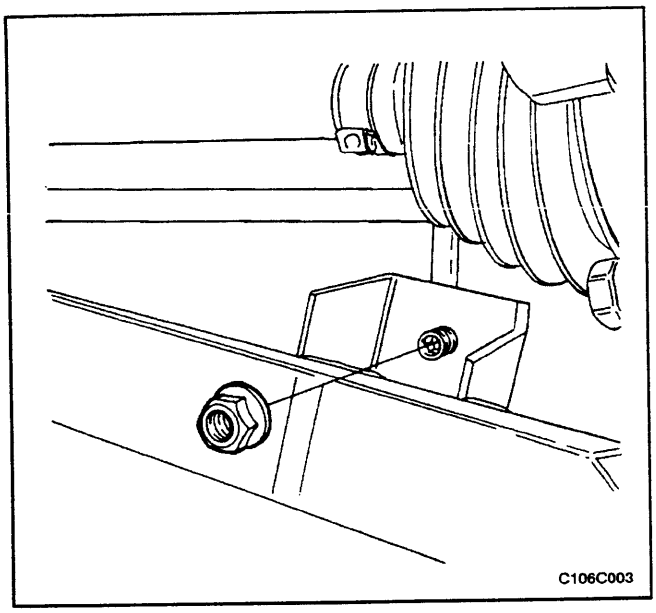
7. Remove the jackstands and lower the vehicle.



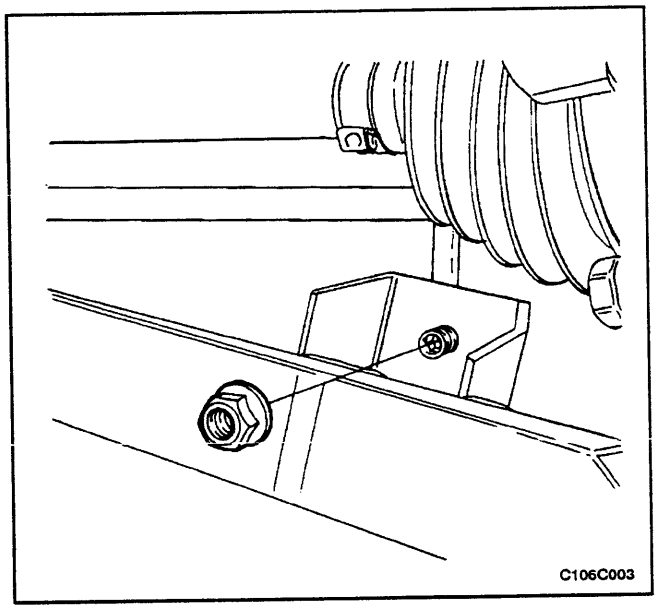
STABILIZER LINK

Removal Procedure

1. Raise and suitably support the vehicle.
2. Remove the stabilizer shaft-to-stabilizer link nut.



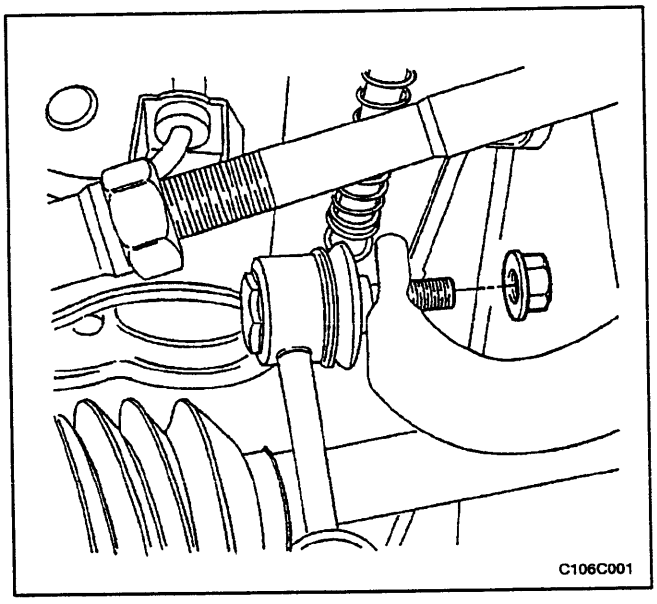
3. Remove the stabilizer link-to-control arm nut.
4. Remove the stabilizer link.



Installation Procedure

Important: The weight of the vehicle must be supported by the control arms before the stabilizer link-to-control arm nuts or the stabilizer shaft-to-stabilizer link nuts are tightened. This can be done by lowering the vehicle onto jackstands under the control arms.

1. Install the stabilizer link.
2. Install the stabilizer link-to-control arm nut.



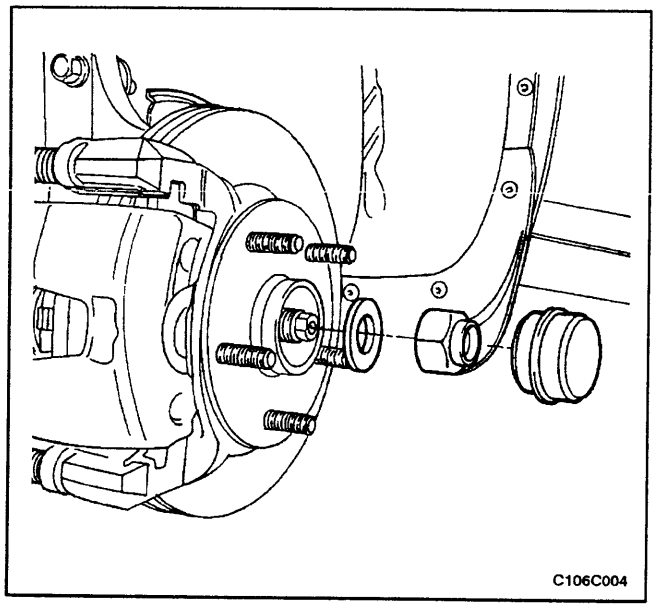
3. Install the stabilizer-to-stabilizer link nut.
4. Lower the vehicle so the control arms are supported by jackstands.

Tighten

Tighten the stabilizer-to-stabilizer link nut to 45 N•m (33 lb-ft).

Tighten the stabilizer link-to-control arm nut to 45 N•m (33 lb-ft).

5. Remove the jackstands and lower the vehicle.



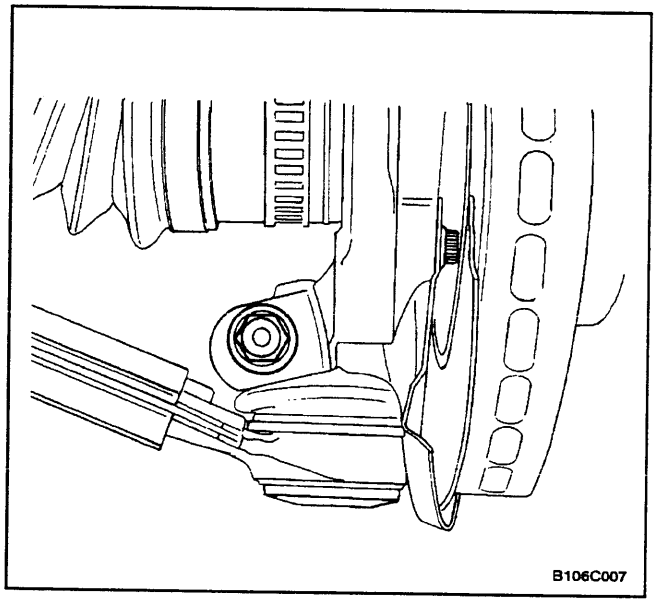
KNUCKLE ASSEMBLY

Tools Required

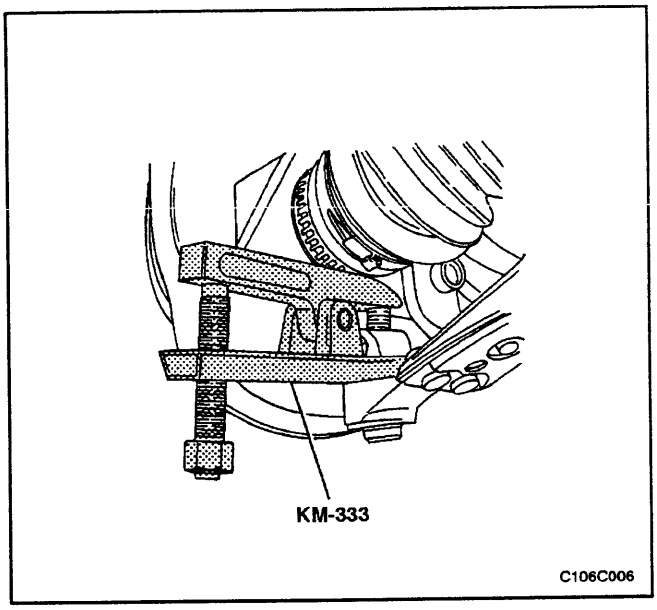
KM-333 Ball Joint Remover

Removal Procedure

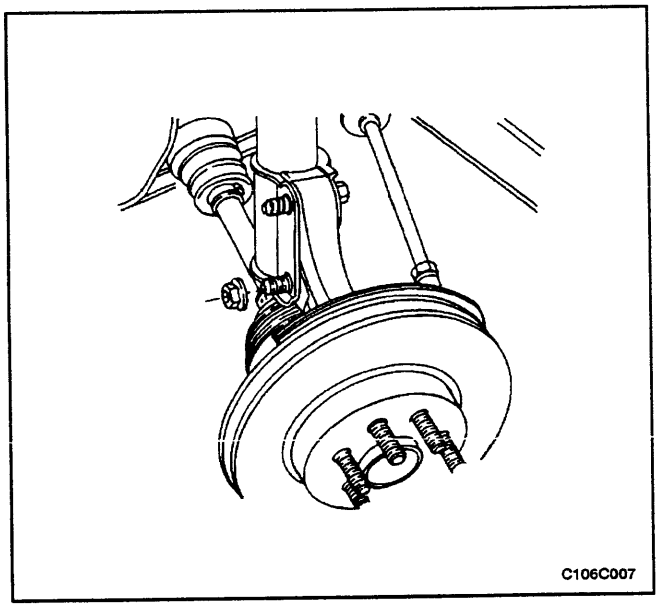
1. Raise and suitably support the vehicle.
2. Remove the wheel. Refer to *Section 2E, Tires and Wheels*.
3. Remove the dust cap, the caulking nut, and the washer from the axle shaft.
4. Remove the brake caliper from the rotor and the brake line from the strut assembly. Support the caliper so it does not hang from the hydraulic brake hose. Refer to *Section 4D, Front Disc Brakes*.
5. Remove the outer tie rod from the knuckle assembly. Refer to *Section 6C, Power Steering Gear.*
6. On vehicles equipped with the antilock braking system (ABS), disconnect the ABS speed sensor electrical connection from the knuckle. Refer to *Section 4F, Antilock Brake System and Traction Control System*.



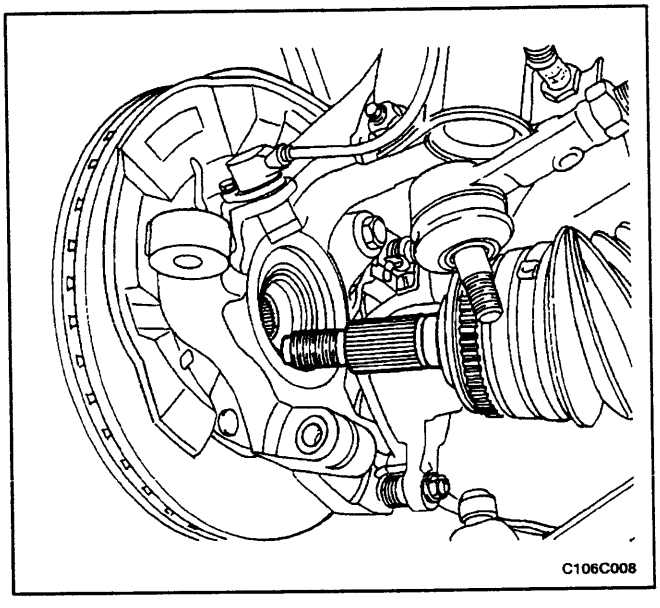
7. Remove the ball joint pinch bolt and the nut.



8. Separate the knuckle from the ball joint using the ball joint remover KM-333.

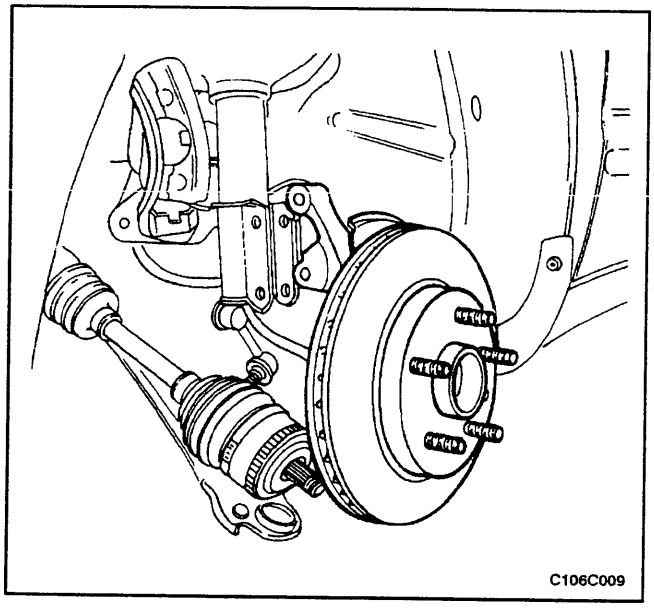


9. Remove the nuts from the bolts that connect the knuckle assembly to the strut assembly.

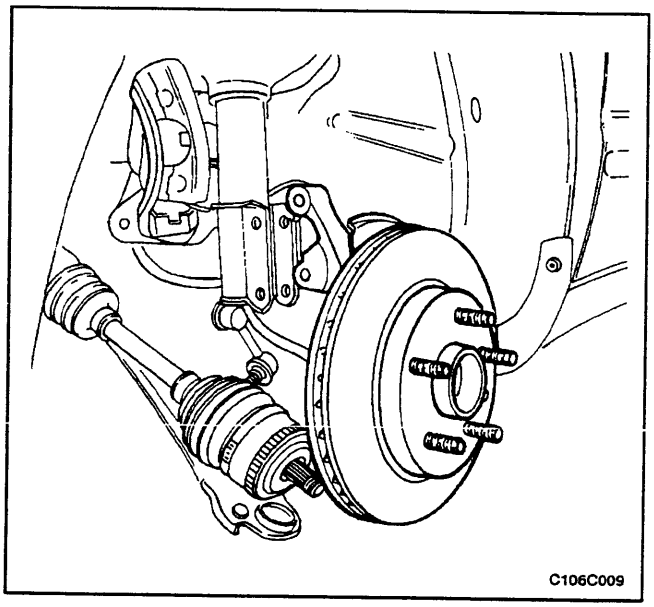


Notice: Do not overextend the axle joints. When either end of the shaft is disconnected, overextension of the joint can result in separation of internal components and possible joint failure. Use drive axle joint seal protectors whenever performing service on or near the drive axles. Failure to do so can cause internal joint or seal damage and result in possible joint failure.

10. Separate the drive axle shaft from the wheel hub.

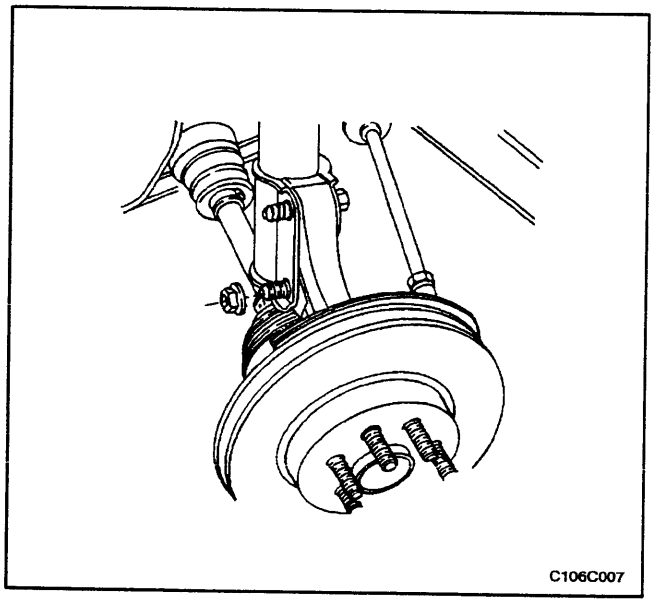


11. Support the drive axle.
12. Remove the bolts that connect the knuckle assembly to the strut assembly.
13. Remove the knuckle assembly from the vehicle.



Installation Procedure

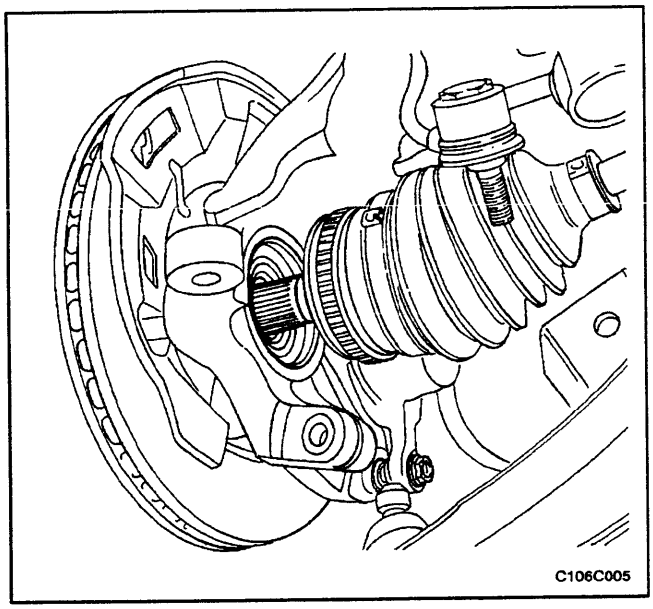
1. Install the knuckle assembly onto the vehicle.



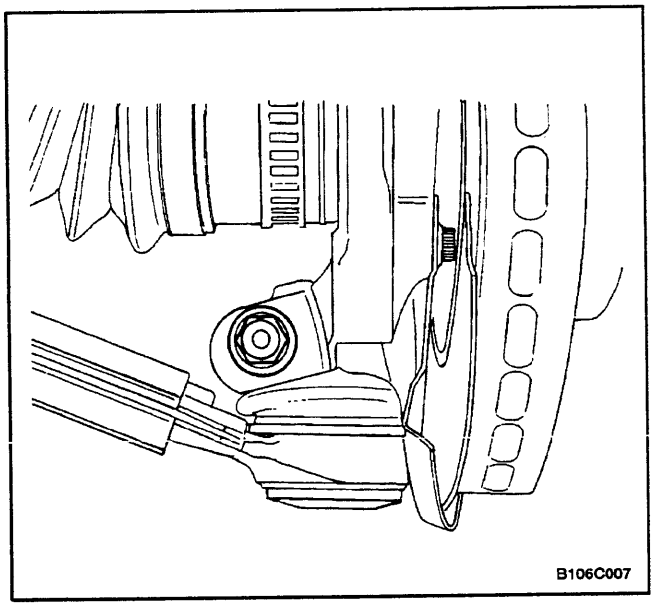
2. Install the steering knuckle-to-strut assembly nuts.

Tighten

Tighten the steering knuckle-to-strut assembly nuts to 135 N•m (100 lb-ft).


C106C005

3. Connect the drive axle to the front wheel hub.

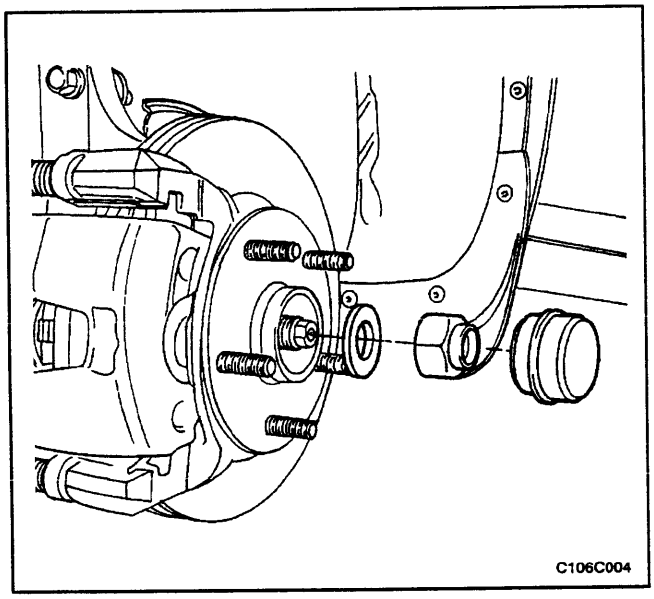

B106C007

4. Connect the ball joint to the knuckle assembly.
5. Install the ball joint pinch bolt and the nut.

Tighten

Tighten the ball joint pinch bolt nut to 90 N•m (66 lb-ft).

6. Connect the ABS speed sensor electrical connection. Refer to *Section 4F, Antilock Brake System and Traction Control System*.

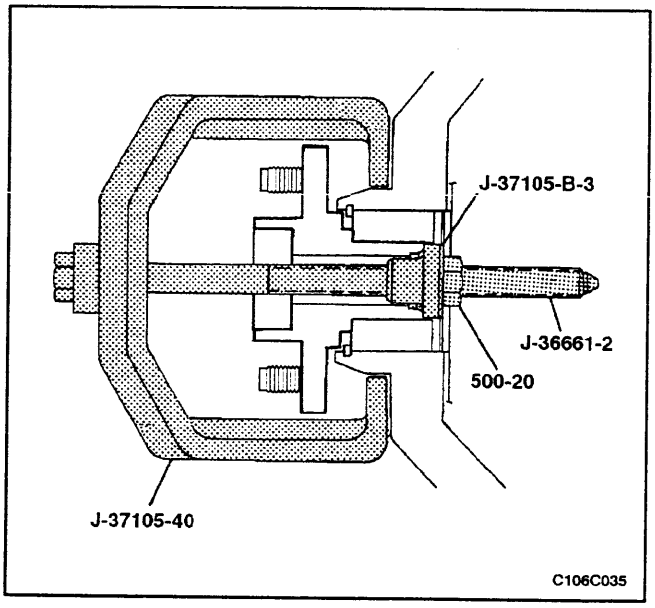

C106C004

7. Connect the outer tie rod to the knuckle assembly. Refer to *Section 6C, Power Steering Gear*.
8. Install the brake caliper onto the rotor and the brake line onto the strut. Refer to *Section 4D, Front Disc Brakes*.
9. Install the washer and the caulking nut onto the axle shaft.

Tighten

Tighten the drive axle-to-hub caulking nut to 180 N•m (133 lb-ft). Loosen the nut, then retighten it to 50 N•m (37 lb-ft) plus 60 degrees.

10. Install the dust cap.
11. Install the wheel. Refer to *Section 2E, Tires and Wheels*.
12. Lower the vehicle.



HUB AND BEARING

Tools Required

500-20 Hex Nut

J-36661-2 Forcing Screw

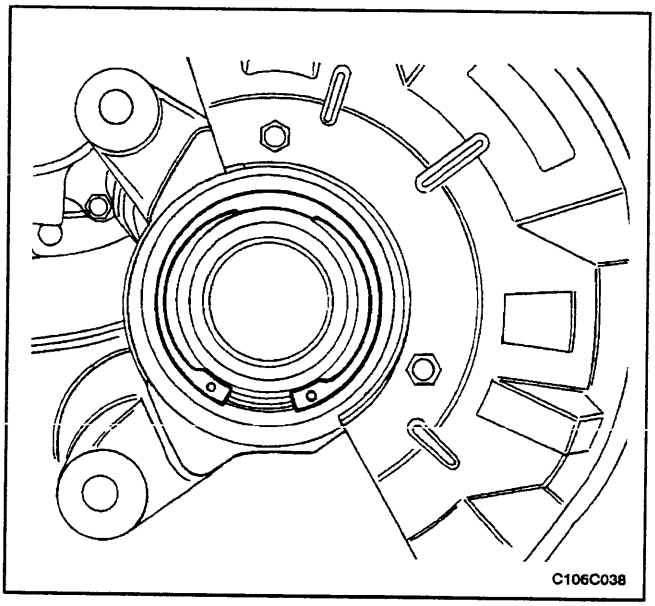
J-37105-40 Support Bridge

J-37105-B-2 Bearing Adapter

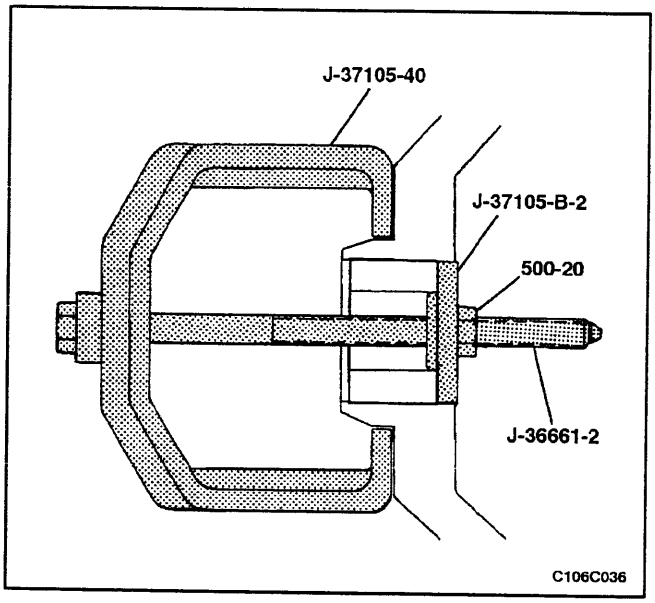
J-37105-B-3 Hub Adapter

Removal Procedure

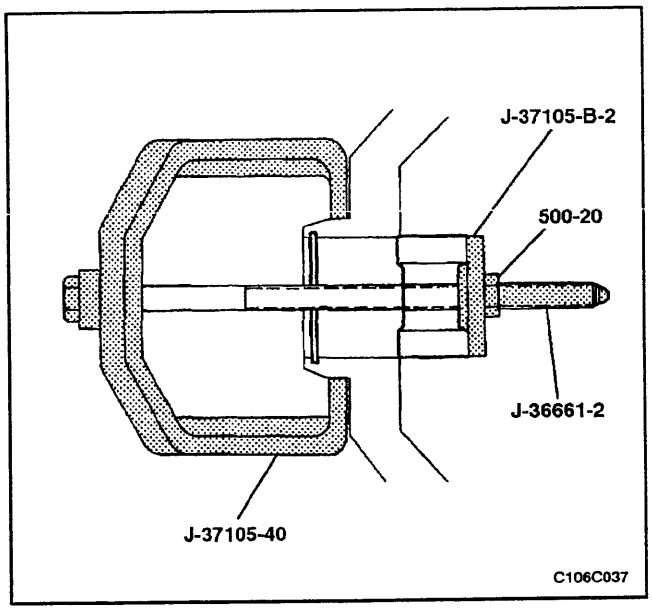
1. Remove the drive axle from the front wheel hub. Refer to "Knuckle Assembly" in this section.
2. Remove the wheel hub with the support bridge J-37105-40, the hub adapter J-37105-B-3, the hex nut 500-20, and the forcing screw J-36661-2.



3. Remove the outer snap ring.

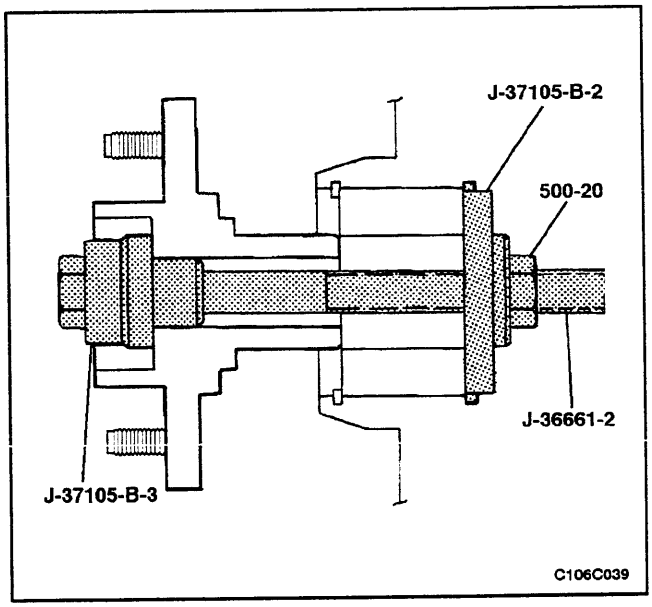


4. Remove the wheel bearing with the support bridge J-37105-40, the bearing adapter J-37105-B-2, the hex nut 500-20, and the forcing screw J-36661-2.
5. Clean the bore of the knuckle.

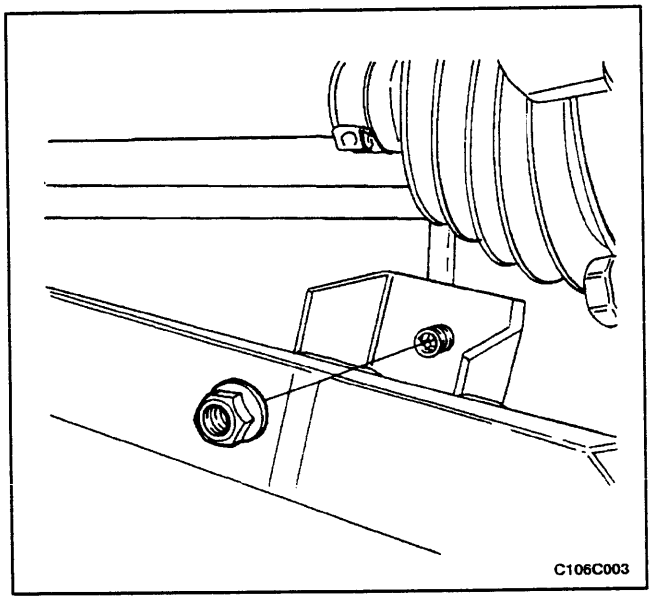


Installation Procedure

1. Install the outer snap ring and push the wheel bearing into place with the support bridge J-37105-40, the bearing adapter J-37105-B-2, the hex nut 500-20, and the forcing screw J-36661-2.



2. Push the wheel hub into place with the hub adapter J-37105-B-3, the bearing adapter J-37105-B-2, the hex nut 500-20, and the forcing screw J-36661-2.
3. Install the drive axle into the front wheel hub. Refer to "Knuckle Assembly" in this section.



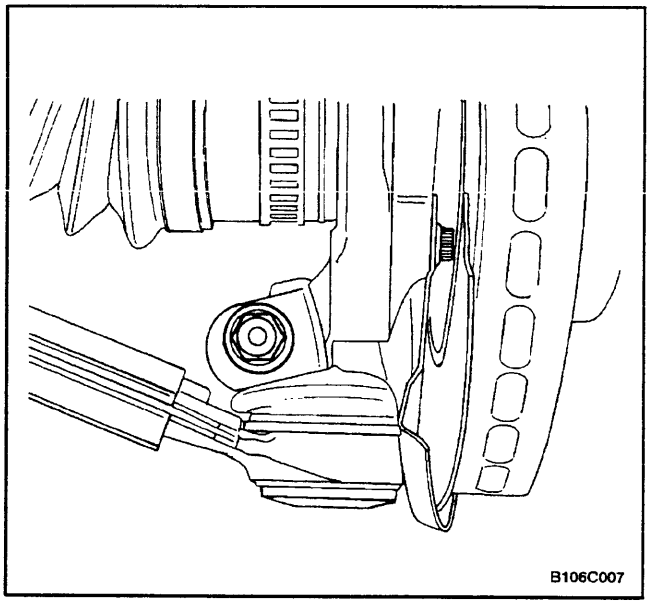
CONTROL ARM

Tools Required

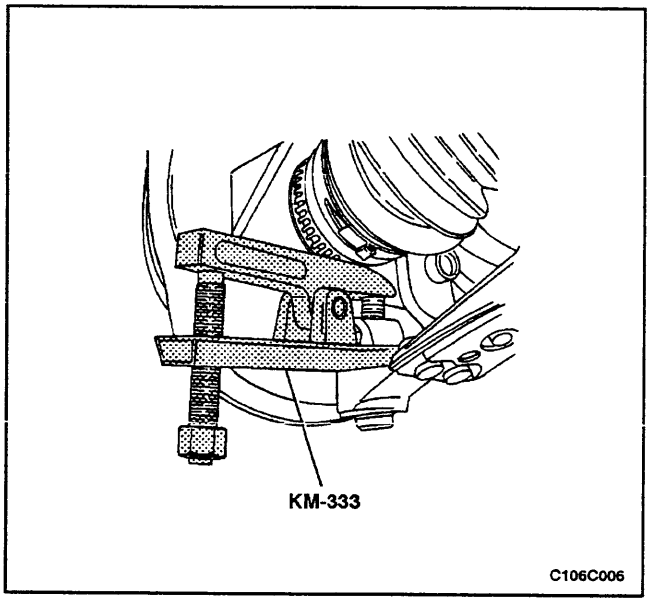
KM-333 Ball Joint Remover

Removal Procedure

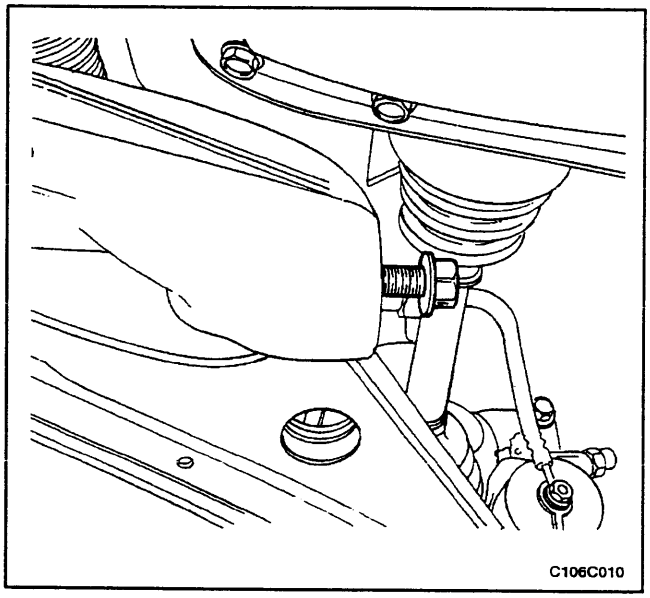
1. Raise and suitably support the vehicle. Let the control arms hang free.
2. Remove the wheel. Refer to *Section 2E, Tires and Wheels*.
3. Remove the stabilizer link-to-control arm nut and disconnect the stabilizer link from the control arm.



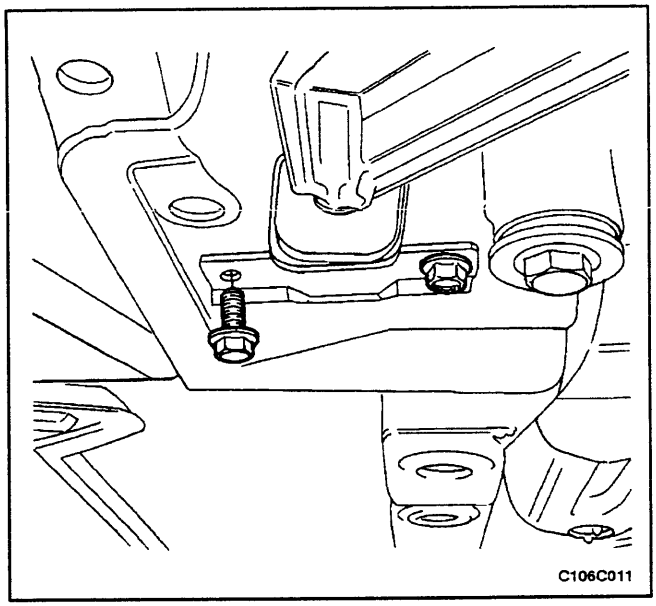
4. Remove the pinch bolt and the nut from the ball joint.



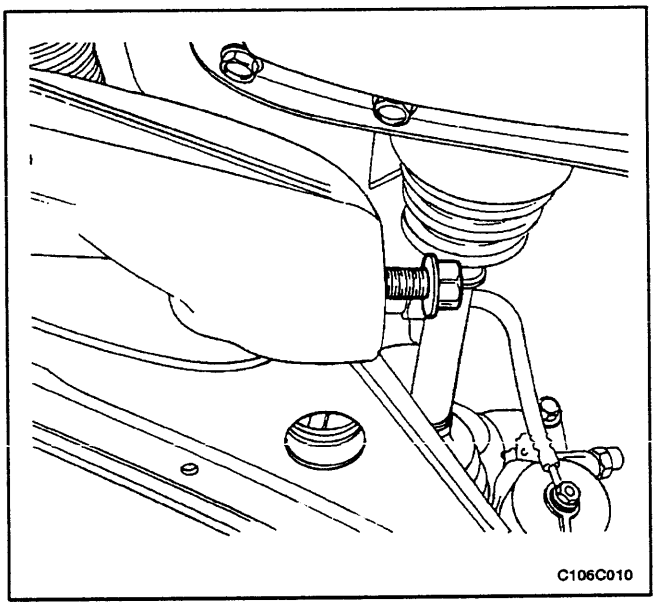
5. Disconnect the ball joint from the knuckle assembly using the ball joint remover KM-333.



6. Remove the control arm-to-crossmember nut and the bolt.



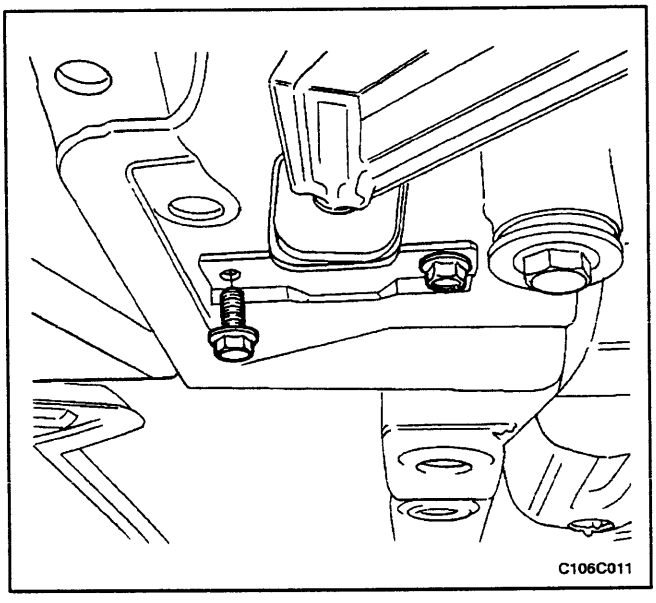
7. Remove the control arm rear bushing clamp bolts and the clamp.
8. Remove the control arm from the vehicle.



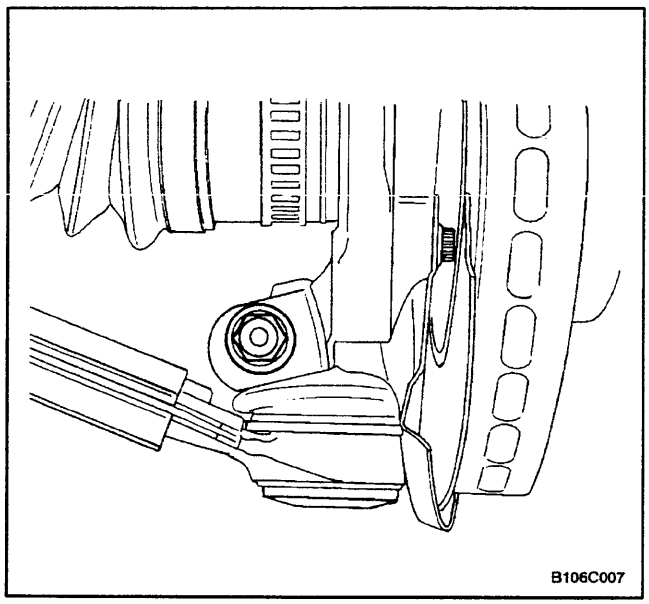
Installation Procedure

Important: The weight of the vehicle must be supported by the control arms before the control arm-to-crossmember and the control arm rear bushing clamp bolts are tightened. This can be done by lowering the vehicle onto jackstands under the control arms after the control arms have been installed.

1. Install the control arm.
2. Install the control arm-to-crossmember bolt and nut. Do not tighten the bolt.



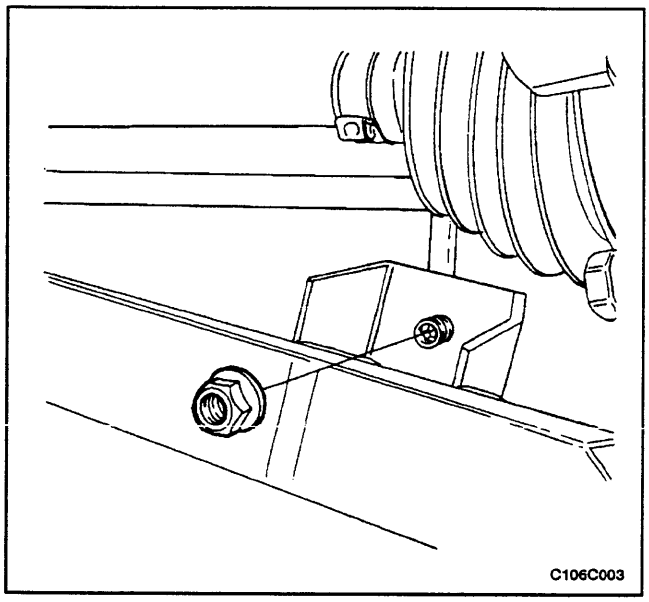
3. Install the control arm rear bushing clamp and bolts. Do not tighten.


B106C007

4. Connect the ball joint to the steering knuckle and install the ball joint pinch bolt and the nut.

Tighten

Tighten the ball joint pinch bolt nut to 90 N•m (66 lb-ft).


C106C003

5. Connect the stabilizer link to the control arm and install the stabilizer link-to-control arm nut.
6. Lower the vehicle so the control arms are supported by jackstands.

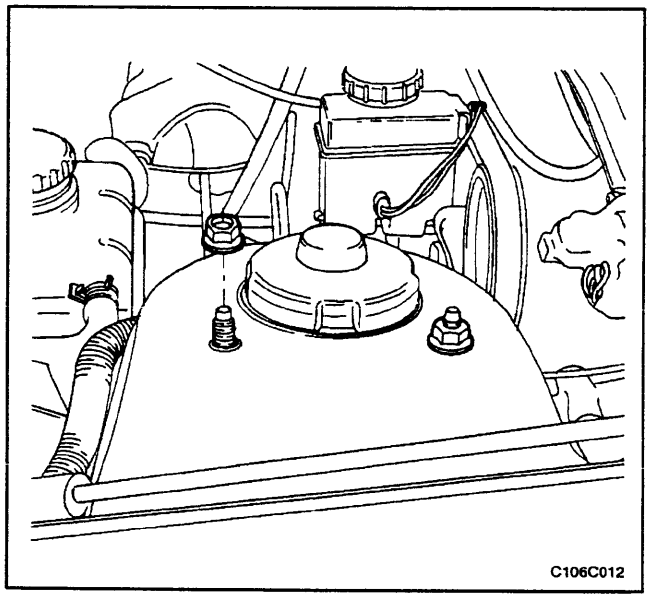
Tighten

Tighten the control arm rear bushing clamp bolts to 75 N•m (55 lb-ft).

Tighten the control arm front bushing nut to 140 N•m (103 lb-ft).

Tighten the stabilizer link-to-control arm nut to 45 N•m (33 lb-ft).

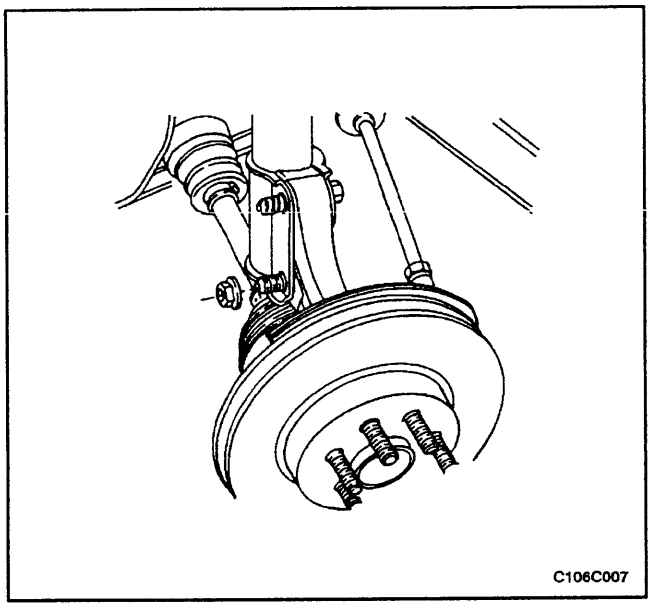
7. Raise the vehicle and install the wheel. Refer to *Section 2E, Tires and Wheels*.
8. Remove the jackstands and lower the vehicle.


C106C012

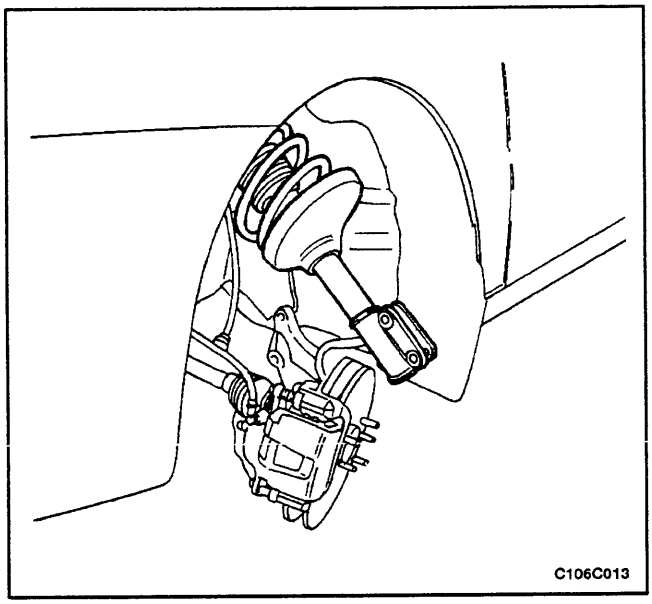
STRUT ASSEMBLY

Removal Procedure

1. Remove the nuts that secure the strut assembly to the body of the vehicle.
2. Raise and suitably support the vehicle.
3. Remove the wheel. Refer to *Section 2E, Tires and Wheels*.
4. On vehicles equipped with an antilock braking system (ABS), disconnect the ABS sensor line from the strut assembly. Refer to *Section 4F, Antilock Brake System and Traction Control System.*
5. Remove the brake line from the securing bracket on the strut assembly. Refer to *Section 4E, Rear Brakes*.



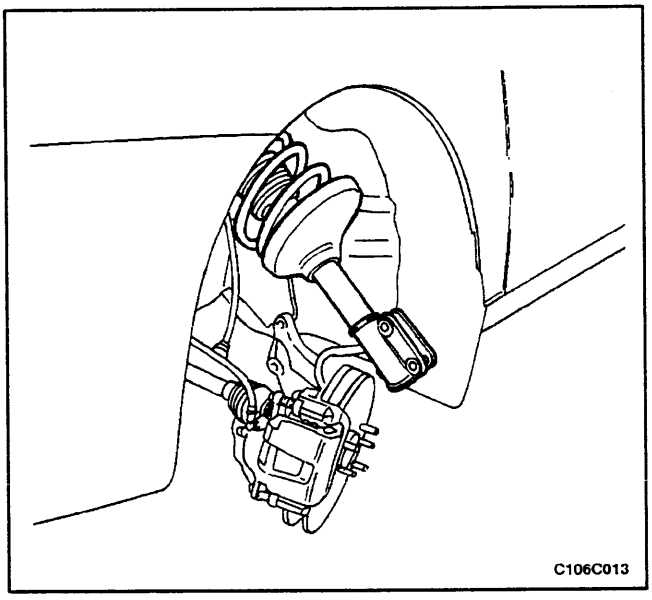
6. Disconnect the steering knuckle by removing the steering knuckle-to-strut assembly nuts and the bolts.

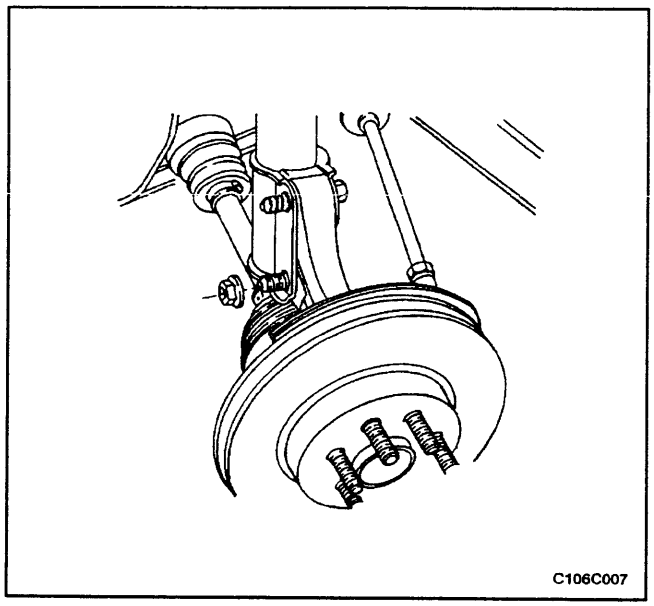


7. Remove the strut assembly.

Installation Procedure

1. Install the strut assembly.

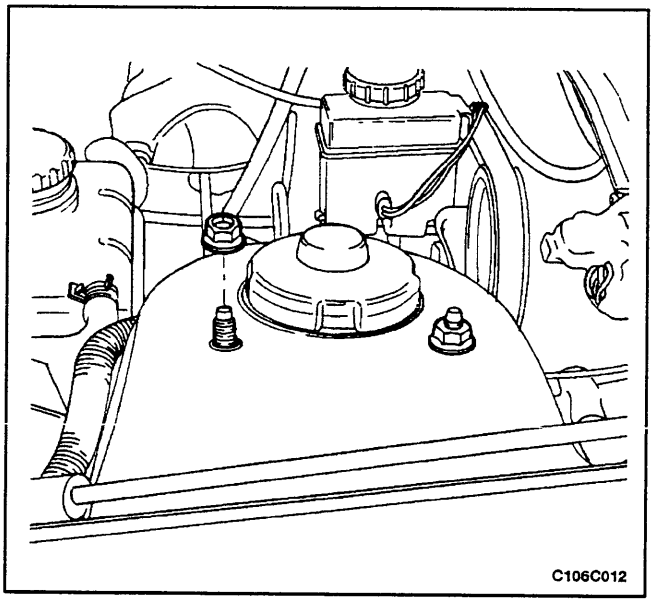



C106C007

2. Connect the strut assembly to the steering knuckle by installing the steering knuckle-to-strut assembly nuts and the bolts.

Tighten

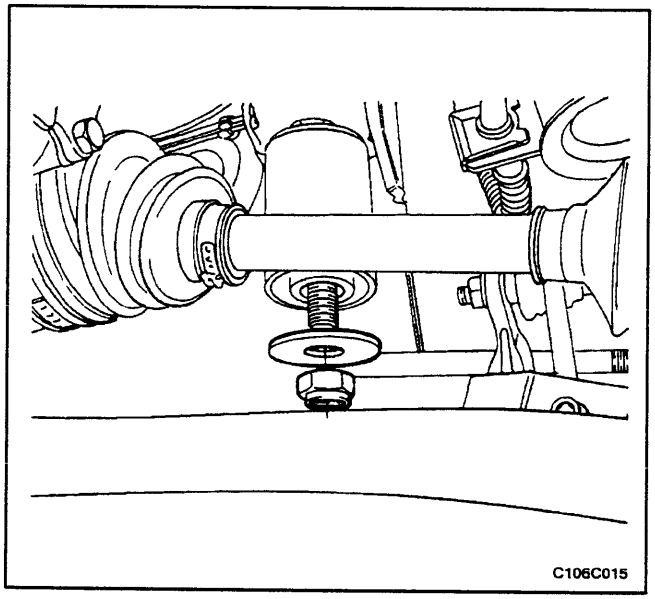
Tighten the steering knuckle-to-strut assembly nuts and the bolts to 135 N•m (100 lb-ft).


C106C012

3. Install the brake line to the securing bracket on the strut assembly. Refer to *Section 4E, Rear Brakes*.
4. On vehicles equipped with the ABS, connect the ABS sensor line to the strut assembly. Refer to *Section 4F, Antilock Brake System and Traction Control System*.
5. Install the wheel. Refer to *Section 2E, Tires and Wheels*.
6. Lower the vehicle.
7. Install the nuts securing the strut assembly to the body of the vehicle.

Tighten

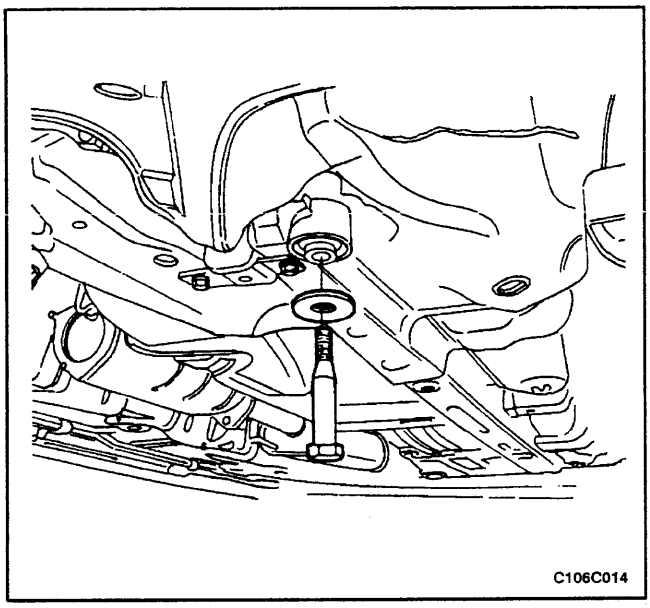
Tighten the strut assembly-to-body nuts to 45 N•m (33 lb-ft).


C106C015

CROSSMEMBER ASSEMBLY

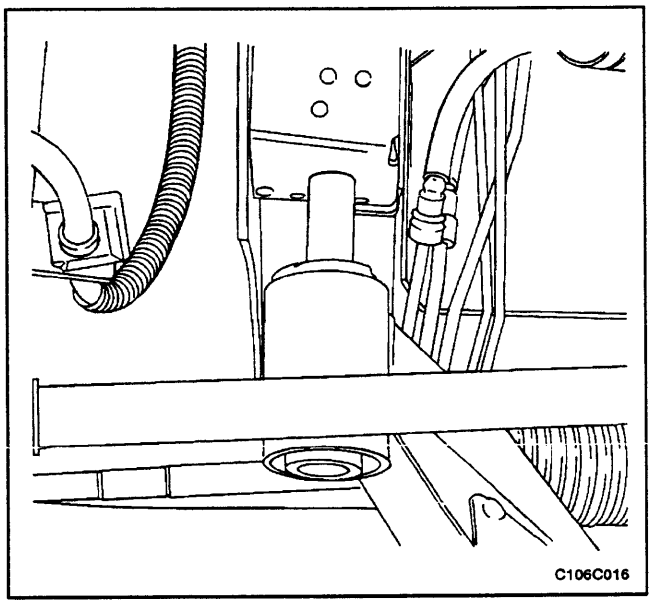
Removal Procedure

1. Raise and suitably support the vehicle.
2. Remove the wheels. Refer to *Section 2E, Tires and Wheels*.
3. Remove the exhaust pipe forward of the catalytic converter. Refer to *Section 1G, Engine Exhaust*.
4. Remove the center member. Refer to *Section 9N, Frame and Underbody*.
5. Disconnect the control arms from the steering knuckle. Refer to "Control Arm" in this section.
6. Disconnect the power steering gear. Refer to *Section 6C, Power Steering Gear*.
7. Remove the crossmember-to-body front nuts and washers.


C106C014

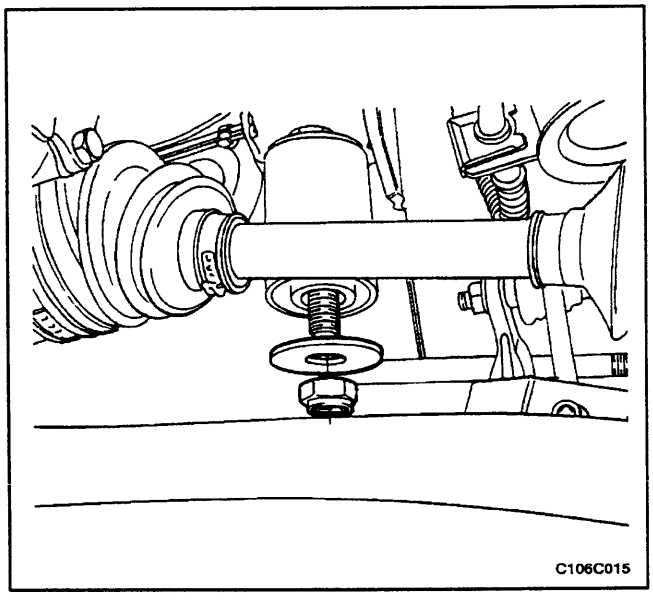
Caution: Two technicians or jackstands must hold the front crossmember assembly during removal of the front attachment bolts. Failure to support the front crossmember properly can result in personal injury.

8. Support the crossmember and remove the crossmember-to-body rear bolts.
9. Remove the crossmember assembly from the vehicle.


C106C016

Installation Procedure

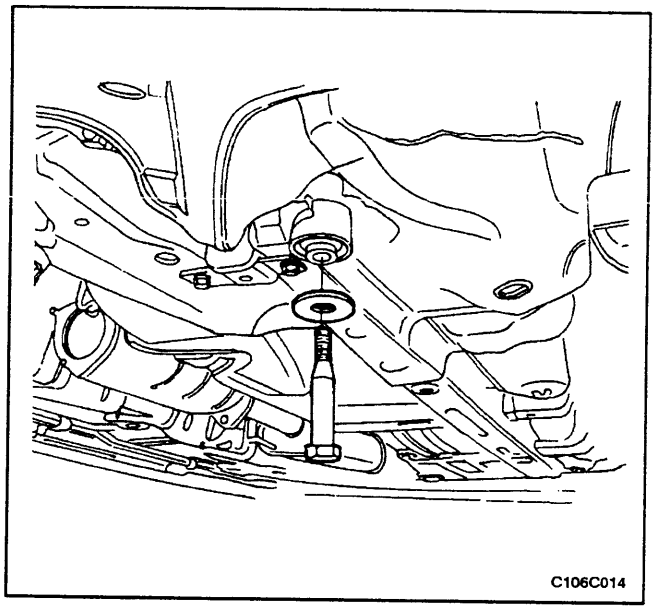
1. Raise the crossmember and align the front attachment points with the body posts of the vehicle. Install the crossmember assembly.


C106C015

2. Install the crossmember-to-body front nuts and washers.

Tighten

Tighten the crossmember-to-body front nuts to 145 N•m (107 lb-ft).



3. Install the crossmember-to-body rear bolts.

Tighten

Tighten the crossmember-to-body rear bolts to 145 N•m (107 lb-ft).

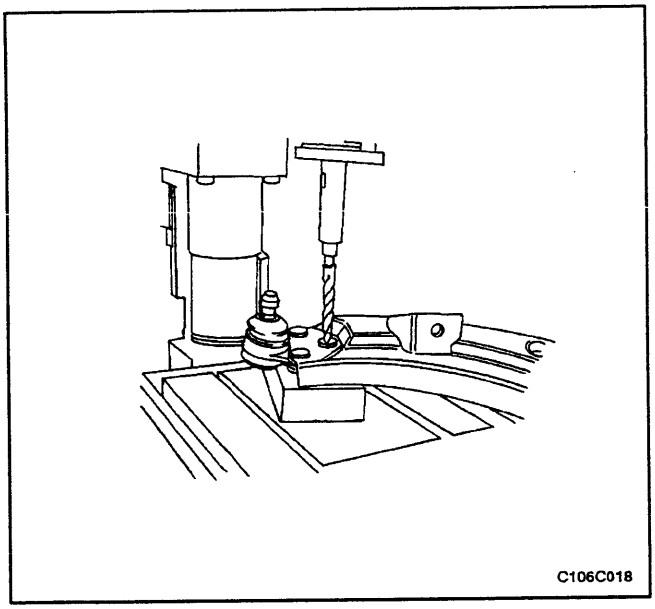
4. Connect the power steering gear. Refer to *Section 6C, Power Steering Gear.*
5. Connect the control arms to the steering knuckle. Refer to "Control Arm" in this section.
6. Install the center member. Refer to *Section 9N, Frame and Underbody.*
7. Install the exhaust pipe into the vehicle. Refer to *Section 1G, Engine Exhaust.*
8. Install the wheels. Refer to *Section 2E, Tires and Wheels.*
9. Lower the vehicle.

UNIT REPAIR

BALL JOINT

Disassembly Procedure

1. Remove the control arm. Refer to "Control Arm" in this section.
2. Drill off the heads of the three rivets with a 12 mm (0.47 inch) drill bit.
3. Punch out the rivets with a drift.



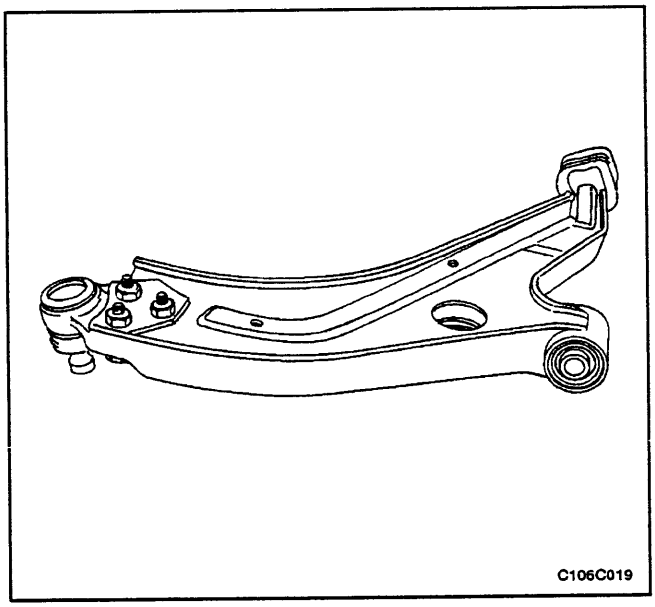
Assembly Procedure

1. Connect the ball joint to the control arm by inserting three ball joint bolts from below the control arm.

Tighten

Tighten the ball joint-to-control arm nuts to 110 N•m (81 lb-ft).

2. Install the control arm. Refer to "Control Arm" in this section.



CONTROL ARM BUSHINGS

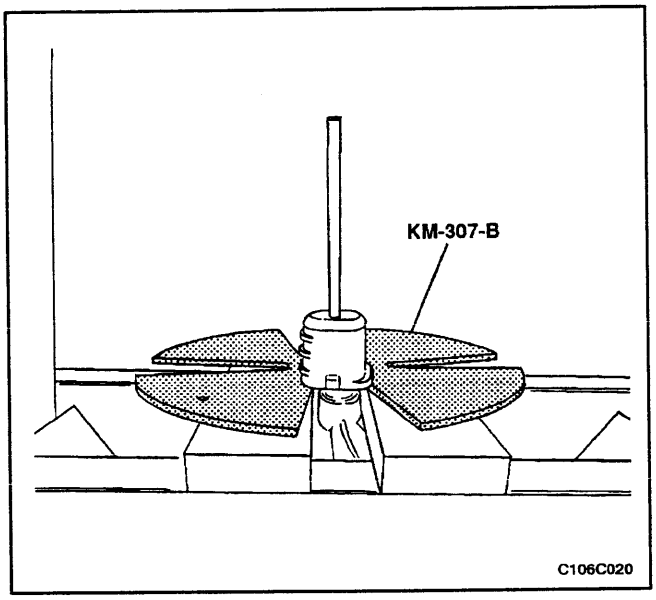
Tools Required

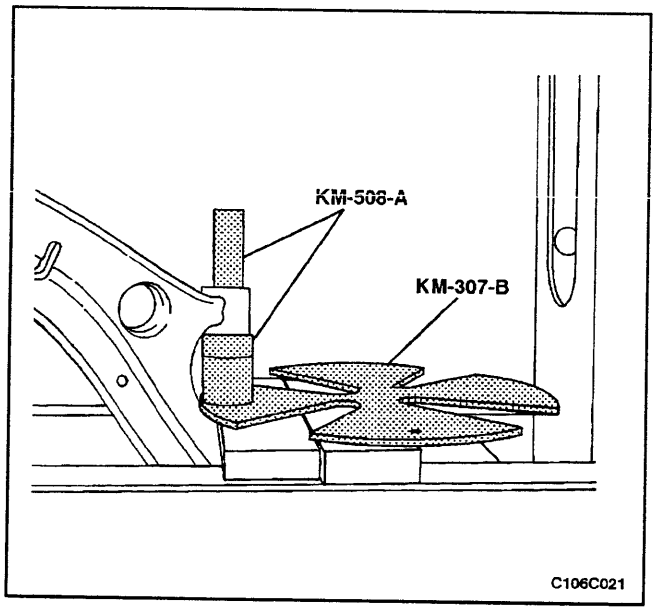
KM-508-A Remover/Installer

KM-307-B Removal Plate

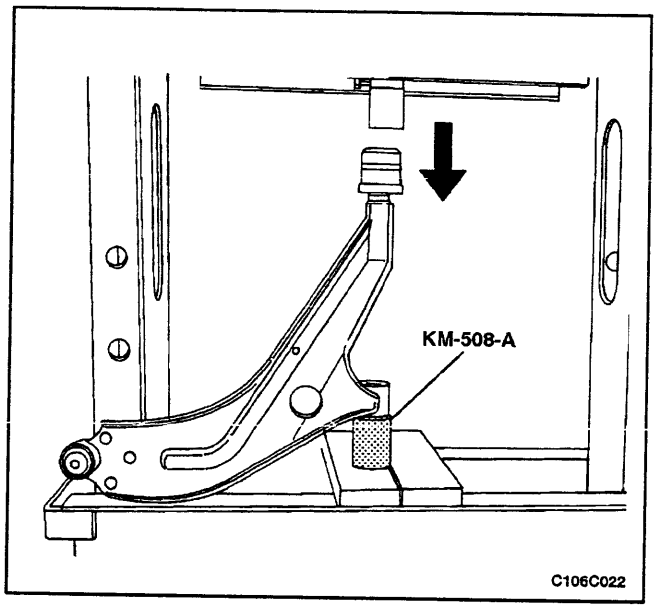
Disassembly Procedure

1. Remove the control arm. Refer to "Control Arm" in this section.
2. Remove the control arm rear bushing using a press, the removal plate KM-307-B, and a drift.



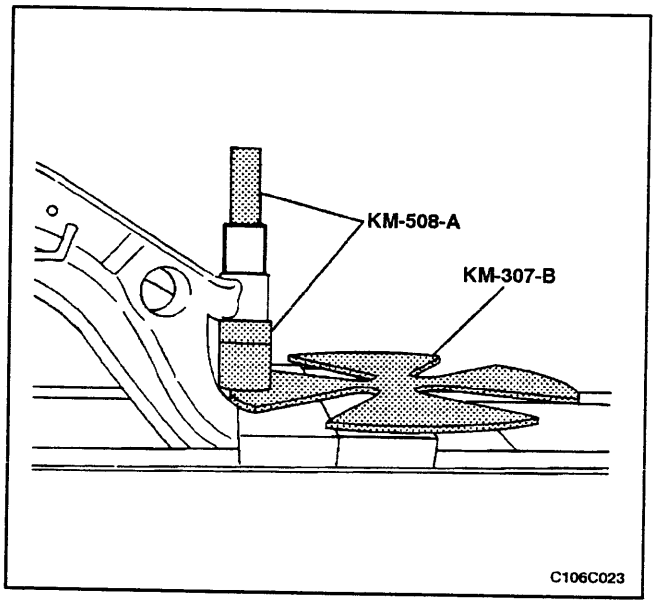


3. Remove the control arm front bushing using a press, the remover/installer KM-508-A, and the removal plate KM-307-B.

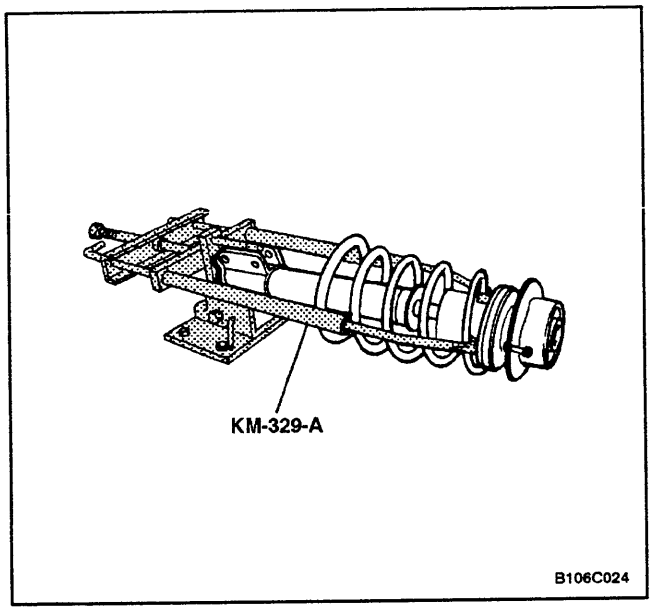


Assembly Procedure

1. Coat the control arm rear shaft with a multipurpose lubricant. Refer to *Section 0B, General Information*.
2. Press the control arm rear bushing onto the shaft. Use the remover/installer KM-508-A to support the control arm.



3. Coat the outside of the control arm front bushing and the inside of the control arm with a multipurpose lubricant. Refer to *Section 0B, General Information*.
4. Press the control arm front bushing into the control arm using a press, the remover/installer KM-508-A and the removal plate KM-307-B. Center the bushing.
5. Install the control arm. Refer to "Control Arm" in this section.



FRONT STRUT ASSEMBLY

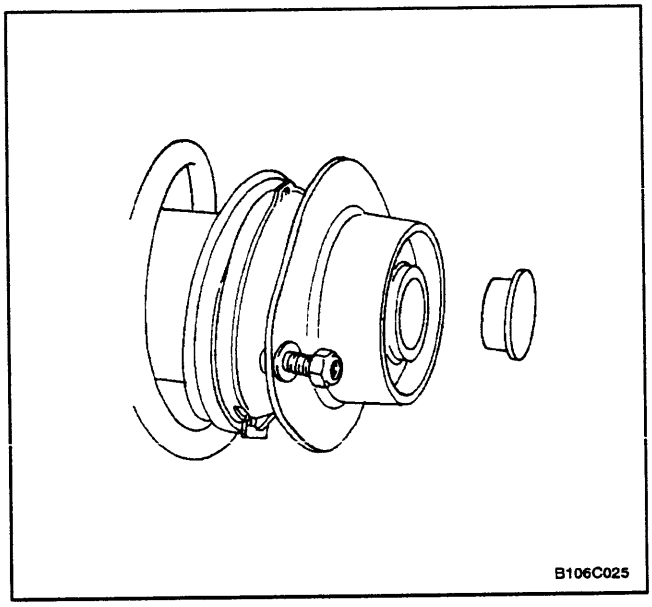
Tools Required

KM-329-A Spring Compressor

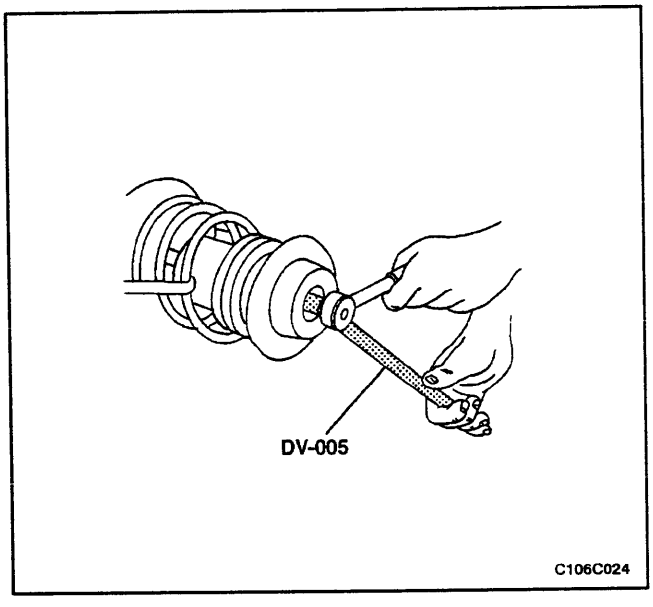
DV-005 Front Strut Mount Nut Wrench

Disassembly Procedure

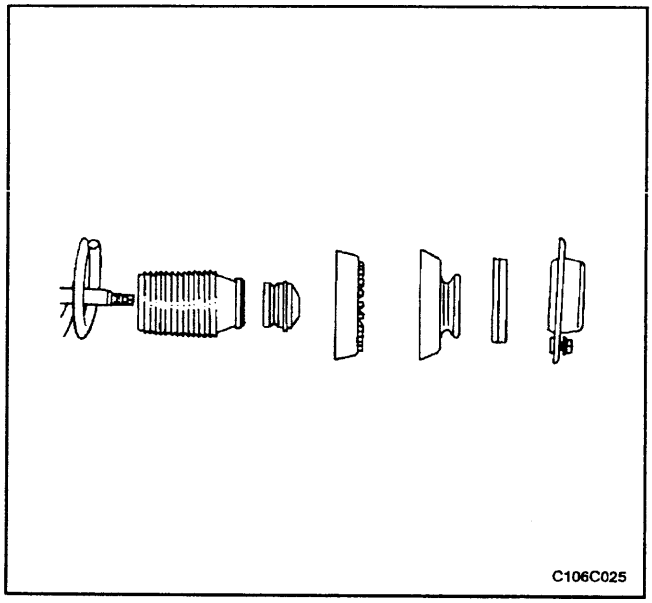
1. Remove the strut assembly. Refer to "Strut Assembly" in this section.
2. Fasten the strut assembly to the spring compressor KM-329-A. Make sure the hooks are seated on the strut spring properly.



3. Compress the front spring with the spring compressor KM-329-A.
4. Remove the dust cover from the bearing assembly.

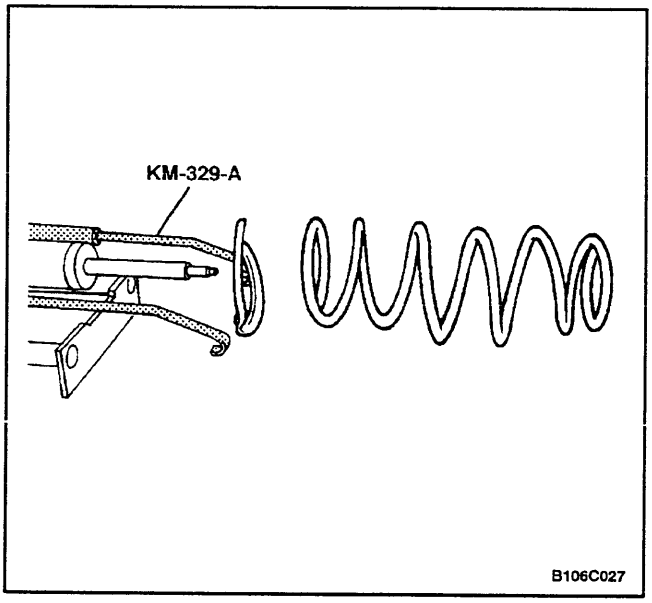


5. Use an open end wrench to hold the threaded piston rod while removing the piston rod nut with the front strut mount nut wrench DV-005.



Important: Record the position of the front spring seat relative to the strut assembly-to-knuckle bracket. Place the front spring locator back in the same position during assembly.

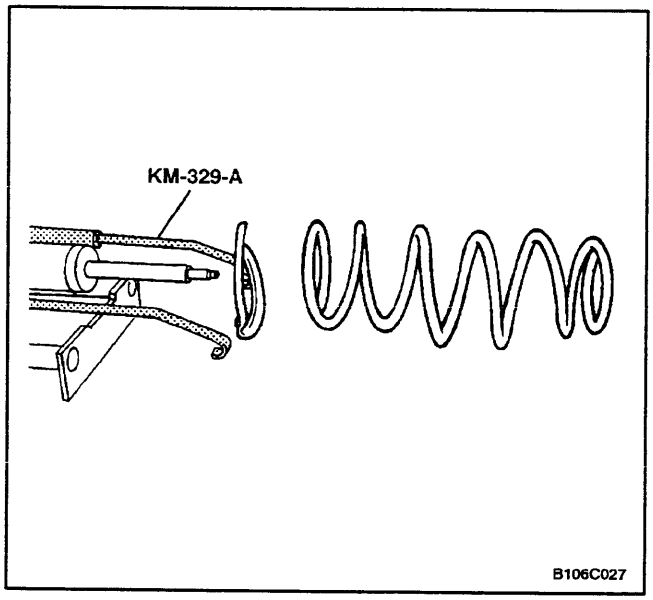
6. Remove the upper strut mount, the mount bearing, the upper spring seat, the upper spring insulator, the hollow bumper and the piston rod boot.

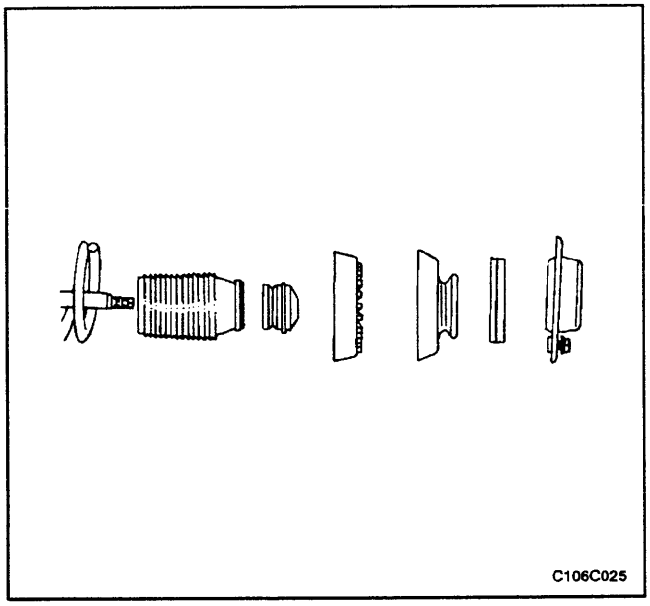


7. Release the spring.
8. Remove the spring and the lower spring insulator.

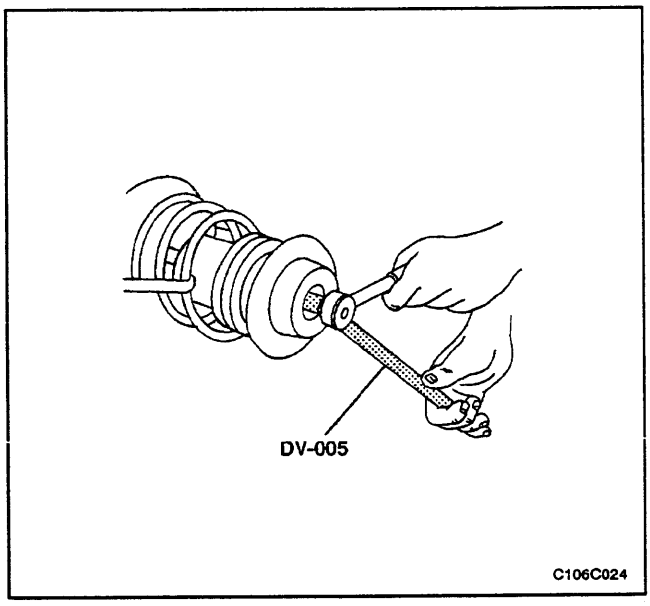
Assembly Procedure

1. Install the lower spring insulator and the spring.
2. Compress the spring using the spring compressor KM-329-A.




C106C025

3. Install the piston rod boot, the hollow bumper, the upper spring insulator, the upper spring seat, the upper strut mount, and the mount bearing. Be sure the front spring seat is positioned correctly.

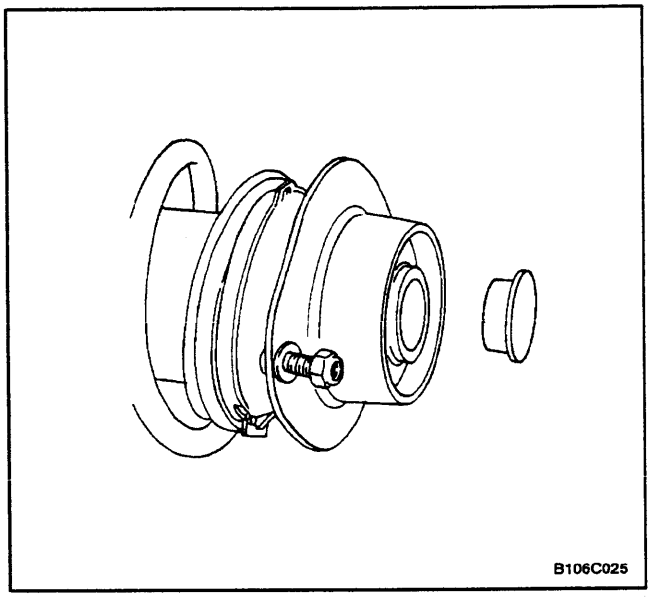


C106C024

4. Install the piston rod nut with the front strut mount nut wrench DV-005.

Tighten

Tighten the piston rod nut to 70 N•m (52 lb-ft).


B106C025

5. Install the dust cover onto the bearing assembly.
6. Release the spring compressor KM-329-A.
7. Remove the strut assembly from the spring compressor KM-329-A.
8. Install the strut assembly onto the vehicle. Refer to "Strut Assembly" in this section.

KNUCKLE

Disassembly Procedure

1. Remove the knuckle assembly from the vehicle. Refer to "Knuckle Assembly" in this section.
2. Remove the rotor. Refer to *Section 4D, Front Disc Brakes*.
3. Remove the hub and bearing assembly. Refer to "Hub and Bearing" in this section.
4. Remove the brake splash shield. Refer to *Section 4D, Front Disc Brakes.*

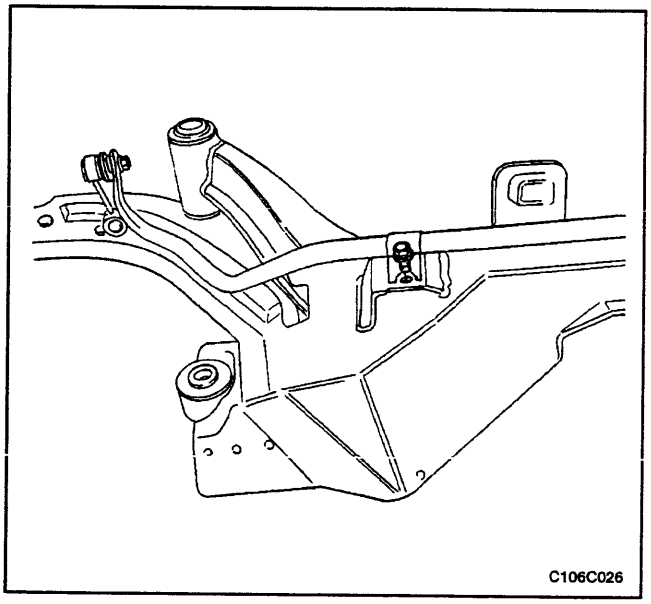
Assembly Procedure

1. Install the brake splash shield. Refer to *Section 4D, Front Disc Brakes.*
2. Install the hub and bearing assembly. Refer to "Hub and Bearing" in this section.
3. Install the rotor. Refer to *Section 4D, Front Disc Brakes*.
4. Install the knuckle assembly onto the vehicle. Refer to "Knuckle Assembly" in this section.

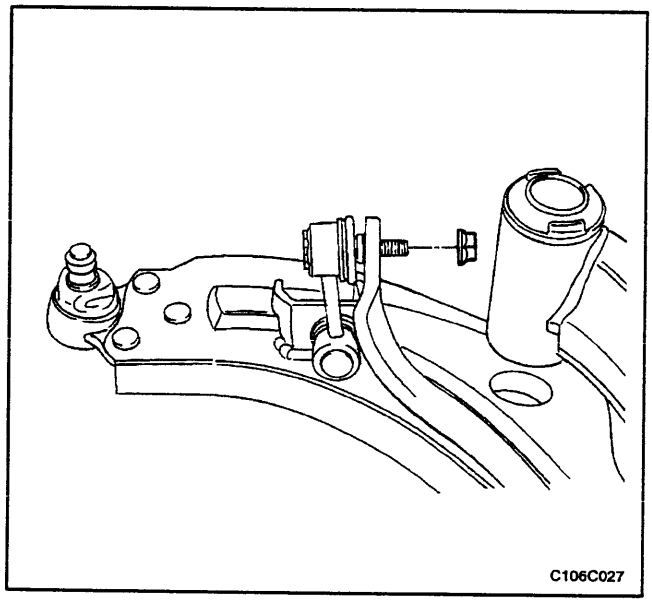
CROSSMEMBER

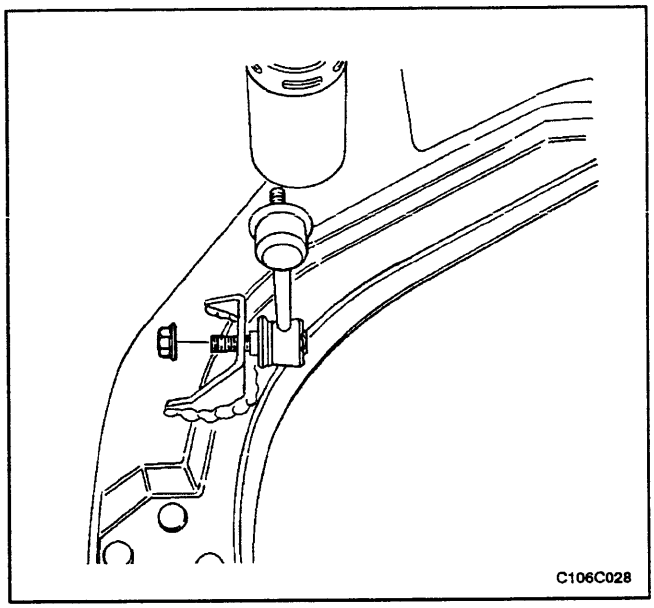
Disassembly Procedure

1. Remove the crossmember assembly from the vehicle. Refer to "Crossmember Assembly" in this section.
2. Remove the stabilizer clamp bolts.

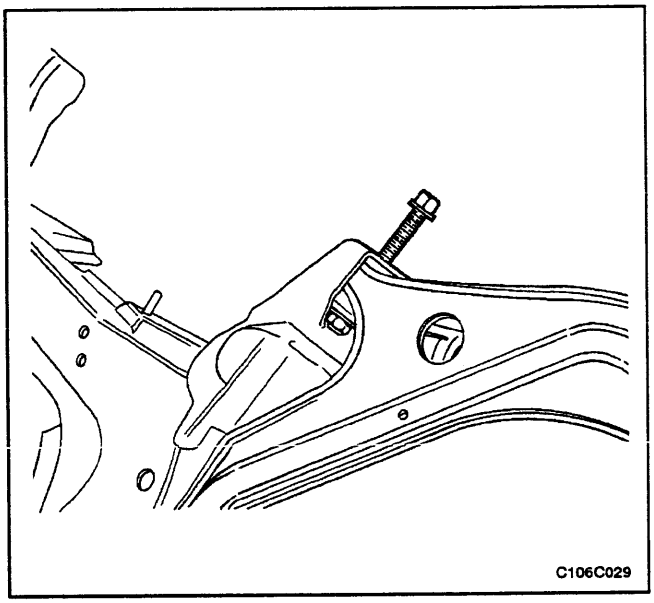

C106C026

3. Remove the stabilizer shaft-to-stabilizer link nuts.
4. Remove the stabilizer shaft clamps, insulators and stabilizer shaft from the crossmember.

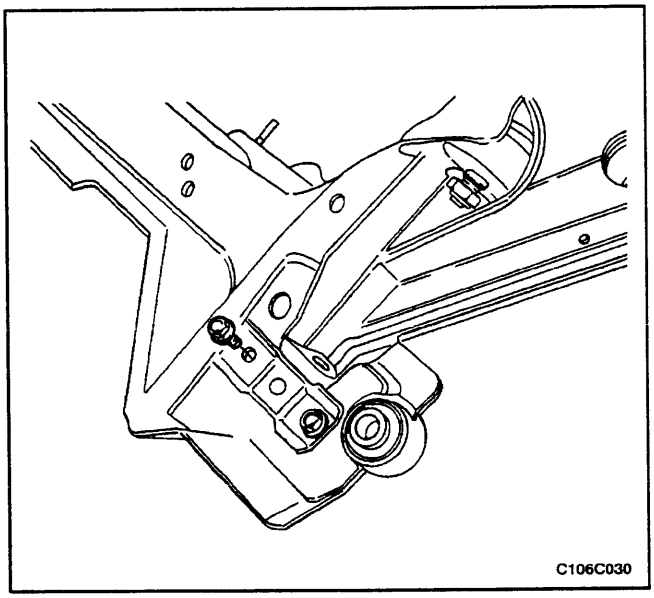

C106C027



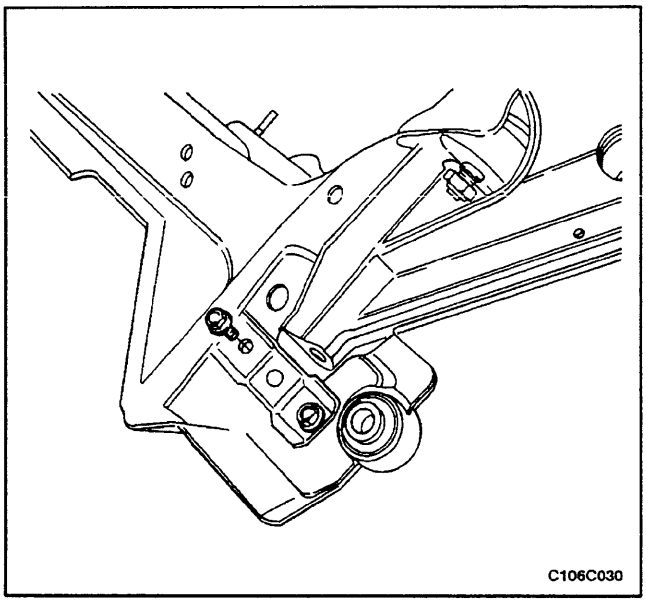
5. Remove the stabilizer link-to-control arm nut.
6. Remove the stabilizer link.



7. Remove the control arm front nuts and bolts.



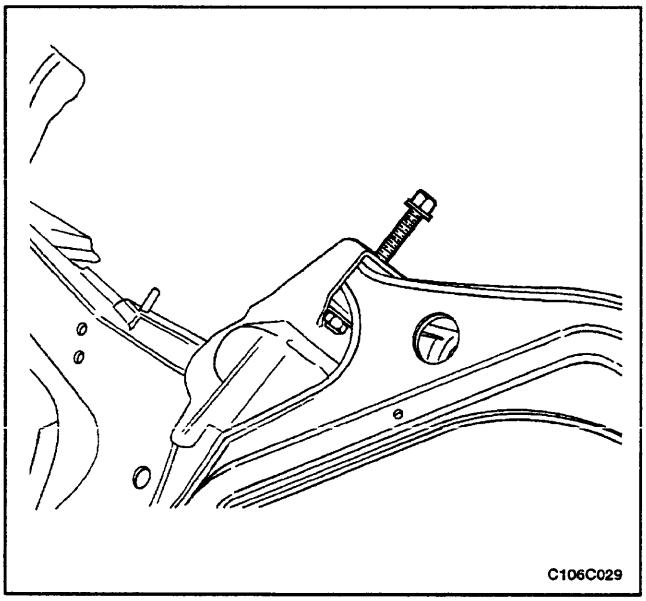
8. Remove the control arm rear bushing clamp bolts and clamps.
9. Remove the control arms.



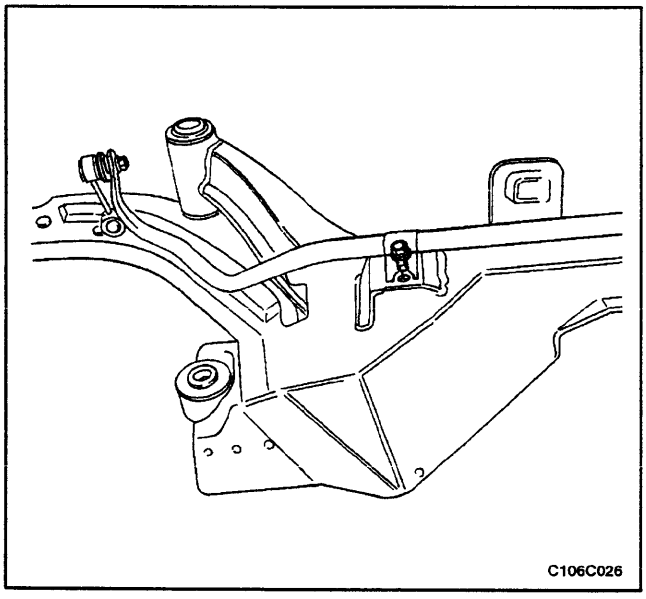
Assembly Procedure

Important: The weight of the vehicle must be supported by the control arms before the stabilizer link-to-control arm nut, the stabilizer shaft-to-stabilizer link nut and the control arm front nut and the rear bolts are tightened. This can be done by lowering the vehicle onto jack-stands under the control arms.

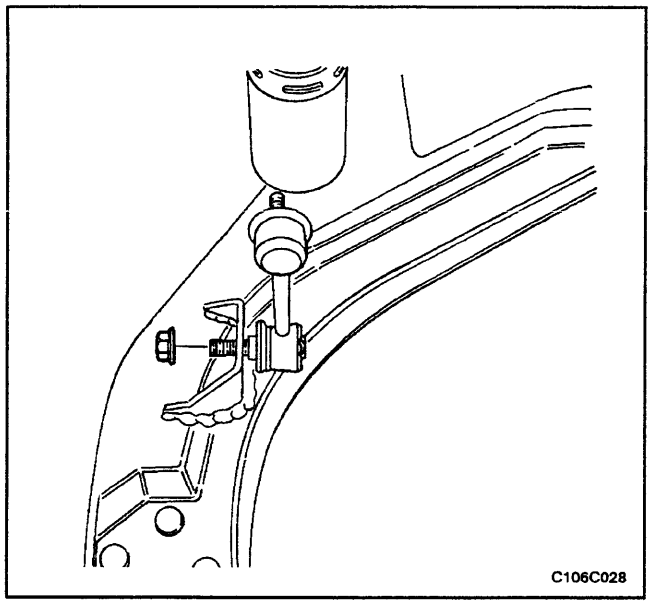
1. Install the control arms.
2. Install the control arm rear bushing clamps and the clamp bolts. Do not tighten.



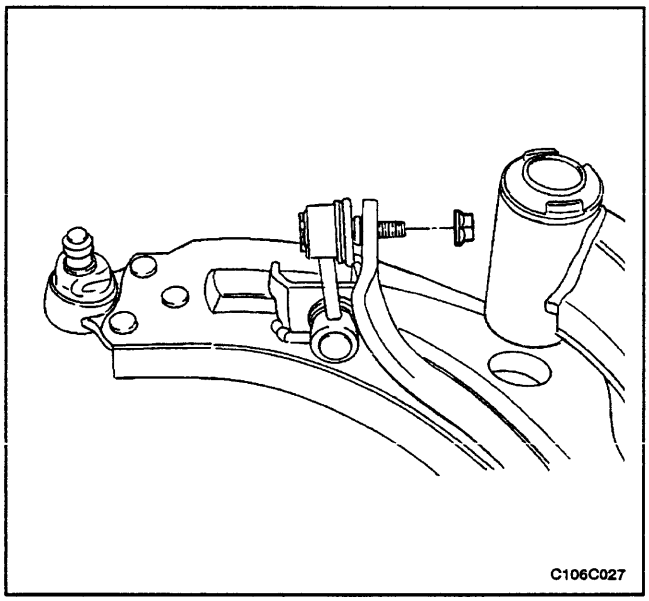
3. Install the control arm front nuts and the bolts. Do not tighten.



4. Install the stabilizer clamps, the stabilizer shaft, and the insulators.
5. Install the stabilizer shaft-to-crossmember clamp bolts.


C106C028

6. Install the stabilizer link.
7. Install the stabilizer link-to-control arm nuts. Do not tighten.


C106C027

8. Install the stabilizer shaft-to-stabilizer link nuts. Do not tighten.

Tighten

Tighten the stabilizer shaft clamp bolts to 37 N•m (27 lb-ft).

9. Install the crossmember assembly into the vehicle. Refer to "Crossmember Assembly" in this section.
10. Lower the vehicle so the control arms are supported by jackstands.

Tighten

Tighten the control arm rear bushing clamp bolts to 75 N•m (55 lb-ft).

Tighten the control arm front bushing nuts to 140 N•m (103 lb-ft).

Tighten the stabilizer link-to-control arm nuts to 45 N•m (33 lb-ft).

Tighten the stabilizer shaft-to-stabilizer link nuts to 45 N•m (33 lb-ft).

11. Remove the jackstands and lower the vehicle.

GENERAL DESCRIPTION AND SYSTEM OPERATION

FRONT SUSPENSION

The front suspension for this vehicle is a combination a strut assembly and a knuckle assembly. The strut assembly combines a strut dampener and spring mounted to the body of the vehicle. The upper end of the strut is isolated by a rubber mount and contains a bearing to allow the strut to turn. The knuckle is attached to the strut assembly and pivots on a ball joint bolted to the control arm. The control arms pivot from the body using rubber bushings.

The ball joint is fastened to the steering knuckle with a pinch bolt and nut, and to the lower control arm with rivets. The stabilizer bar interconnects both strut assemblies of the vehicle through the stabilizer link and is attached to the front suspension crossmember. Jounce and rebound movements affecting one wheel are partially transmitted to the opposite wheel of the vehicle to stabilize body roll.

When servicing the control arm-to-body attachment and the stabilizer shaft-to-body insulators, make sure the attaching bolts are loose until the control arms are moved to the trim height, which is curb height. Trim height is the normal position to which the control arms move when the vehicle is sitting on the ground. Refer to "General Specifications" in this section.

SECTION 2D

REAR SUSPENSION

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

TABLE OF CONTENTS

SPECIFICATIONS

GENERAL SPECIFICATIONS

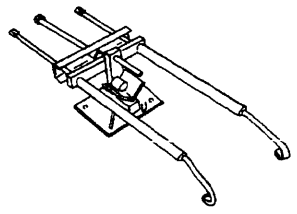
Application	Description
Lubrication	Wheel Bearing Lubricant GM P/N 1051344

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Caulking Nuts	285	210	—
Crossmember-to-Body Bolts	110	81	—
Damper Rod-to-Strut Mount Nuts	80	59	—
Knuckle-to-Strut Assembly Nuts	120	89	—
Parallel Link-to-Crossmember Nuts	120	89	—
Parallel Link-to-Knuckle Nuts	135	100	—
Stabilizer Link-to-Strut Assembly Nuts	45	33	—
Stabilizer Shaft Clamp Bolts	37	27	—
Stabilizer Shaft-to-Stabilizer Link Nuts	45	33	—
Strut Mount-to-Body Nuts	45	33	—
Trailing Link Bracket-to-Body Bolts	90	66	—
Trailing Link-to-Knuckle Bolts	120	89	—
Trailing Link-to-Trailing Link Bracket Nuts	100	73	—

SPECIAL TOOLS

SPECIAL TOOLS TABLE

 A106C031	**KM-329-A Spring Compressor**

DIAGNOSIS

EXCESSIVE FRICTION CHECK

Check excessive friction in the rear suspension as follows:

1. With the aid of a helper, lift up on the rear bumper and raise the vehicle as high as possible. Slowly release the bumper and allow the car to assume normal trim height.
2. Measure the distance from the floor to the center of the bumper.
3. Push down on the bumper, release slowly, and allow the car to assume normal trim height.
4. Measure the distance from the floor to the center of the bumper.

The difference between the two measurements should be less than 12.7 mm (0.50 inch). If the difference exceeds this limit, inspect the control arms for damage or wear.

STRUT DAMPENER

A strut dampener is basically a shock absorber. However, strut dampeners are easier to extend and retract by hand than are shock absorbers.

Struts Seem Weak

Checks	Action
Check the tire pressures.	Adjust the tire pressures to the specifications on the tire placard.
Check the load conditions under which the vehicle is normally driven.	Consult with the owner to confirm the owner's understanding of normal load conditions.
Check the compression and rebound effectiveness of the strut dampener.	Quickly push down and then lift up on the corner of the bumper nearest the strut dampener being tested. Compare the compression and rebound with those of a similar vehicle that has an acceptable ride quality. Replace the strut dampener, if needed.

Struts Are Noisy

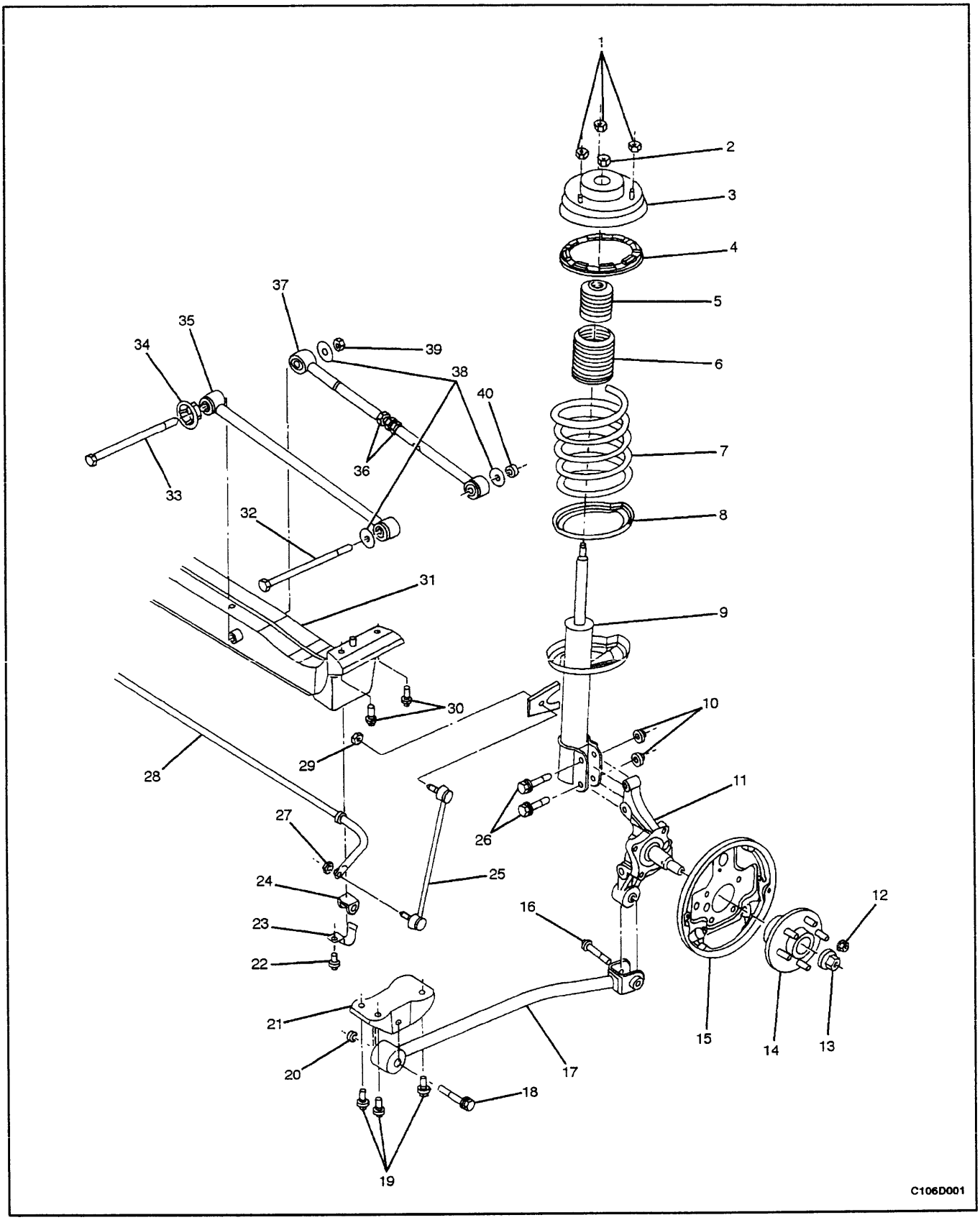
Checks	Action
Check the mountings for looseness or damage.	Tighten the strut dampener. Replace the strut dampener, if needed.
Check the compression and rebound effectiveness of the strut dampener.	Quickly push down and then lift up on the corner of the bumper nearest the strut dampener being tested. Compare the compression and rebound with those of a similar vehicle that has an acceptable ride quality. Replace the strut dampener, if needed.

Leaks

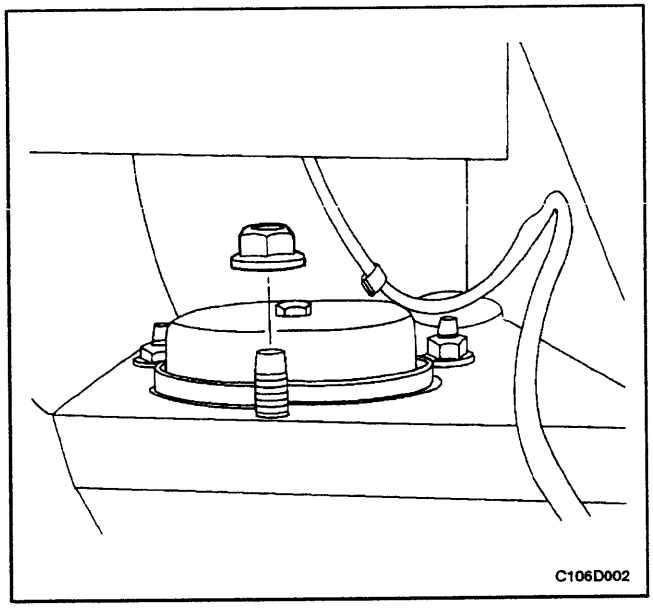
Checks	Action
Check for a slight trace of fluid.	The strut dampener is OK.
Check the seal cover on the fully extended strut.	Replace the strut dampener.
Check for an excessive amount of fluid on the strut dampener.	Replace the strut dampener.

COMPONENT LOCATOR

REAR SUSPENSION



1 Strut Assembly-to-Body Nut
2 Strut Mount Lock Nut
3 Strut Mount
4 Rear Spring Upper Insulator
5 Hollow Bumper
6 Strut Dampener Dust Cover
7 Rear Spring
8 Rear Spring Lower Insulator
9 Strut Dampener
10 Strut Assembly-to-Knuckle Nut
11 Rear Knuckle
12 Wheel Nut
13 Caulking Nut
14 Hub and Bearing Assembly
15 Rear Brake Plate
16 Trailing Link-to-Knuckle Bolt
17 Trailing Link
18 Trailing Link-to-Trailing Link Bracket Bolt
19 Trailing Link Bracket-to-Body Bolts
20 Trailing Link-to-Trailing Link Bracket Nut
21 Trailing Link Bracket
22 Stabilizer Shaft Insulator Clamp Bolt
23 Stabilizer Shaft Insulator Clamp
24 Stabilizer Shaft Insulator
25 Stabilizer Link
26 Strut Assembly-to-Knuckle Bolts
27 Stabilizer Shaft-to-Stabilizer Link Nut
28 Stabilizer Shaft
29 Stabilizer Link-to-Strut Assembly Nut
30 Rear Crossmember-to-Body Bolt
31 Rear Crossmember
32 Parallel Link-to-Knuckle Bolt
33 Parallel Link-to-Crossmember Bolt
34 Parallel Link Cap
35 Front Parallel Link
36 Rear Toe Adjusting Screw Jam Nut
37 Rear Parallel Link
38 Washer
39 Parallel Link-to-Crossmember Nut
40 Parallel Link-to-Knuckle Nut



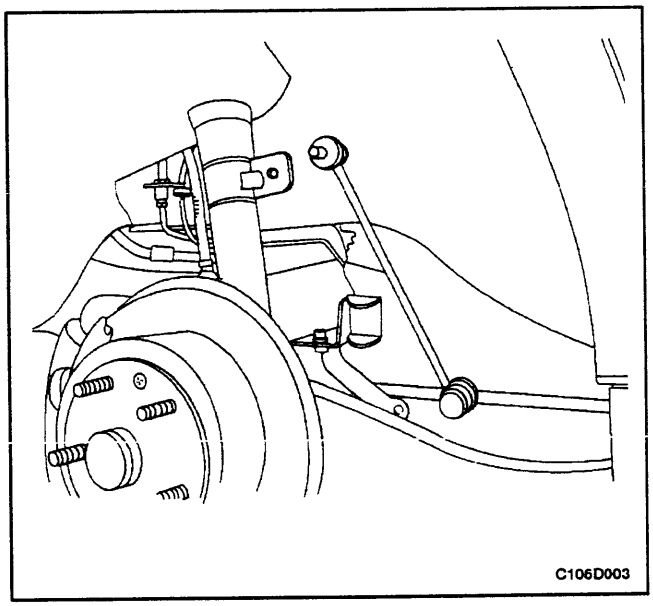
MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

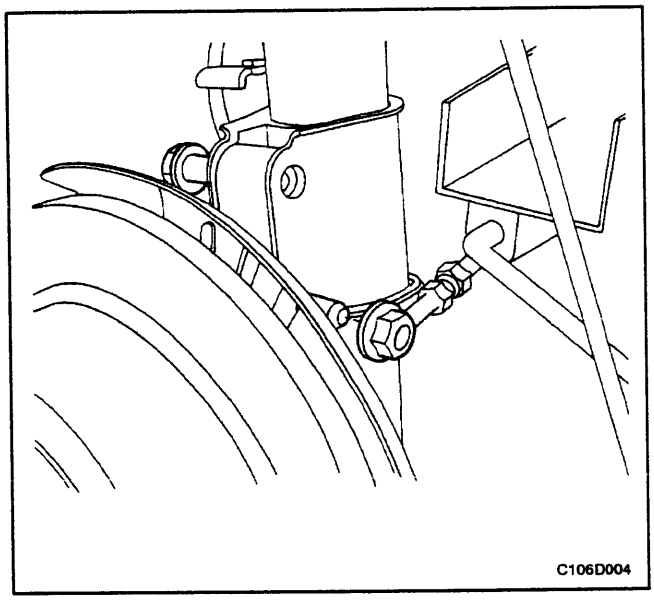
STRUT ASSEMBLY

Removal Procedure

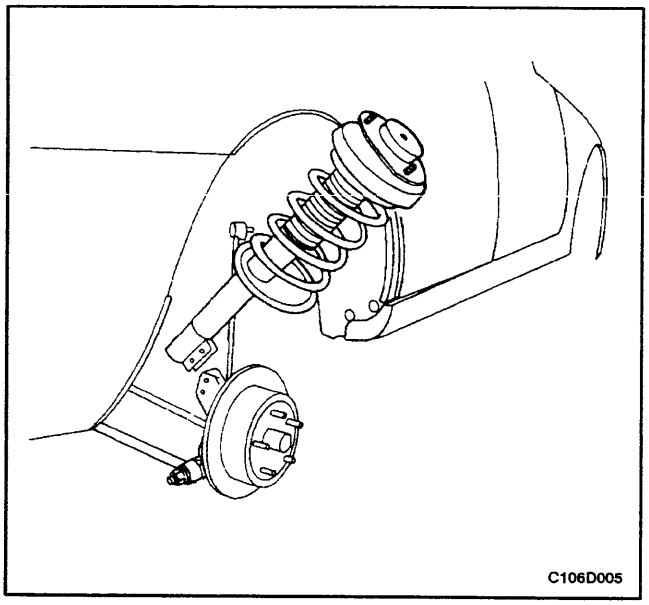
1. Remove the rear seatback. Refer to *Section 9H, Seats*.
2. Remove the rear strut mount-to-body nuts.



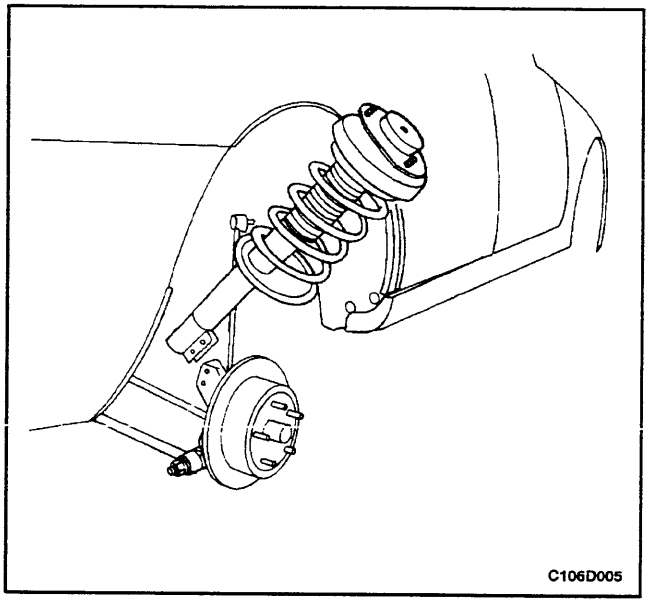
3. Raise and suitably support the vehicle.
4. Remove the wheel. Refer to *Section 2E, Tires and Wheels*.
5. Remove the stabilizer link-to-strut assembly nut and disconnect the stabilizer link from the strut assembly.
6. Remove the clip holding the brake hose and disconnect it from the strut assembly. Refer to *Section 4E, Rear Brakes*.



7. On vehicles equipped with the antilock brake system, disconnect the ABS sensor line from the rear of the strut assembly. Refer to *Section 4F, Antilock Brake System and Traction Control System*.
8. Remove the brake caliper from the rotor. Support the brake caliper. Refer to *Section 4E, Rear Brakes*.
9. Remove the knuckle-to-strut assembly nuts and the bolts.

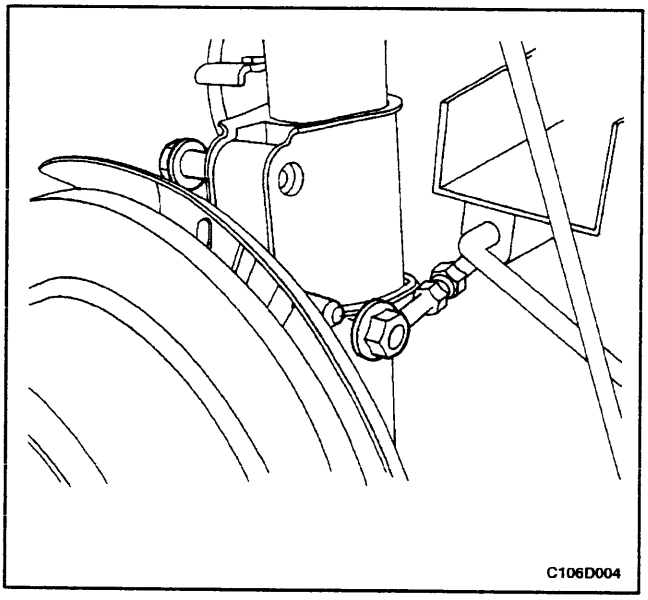


10. Remove the rear strut assembly from the vehicle.



Installation Procedure

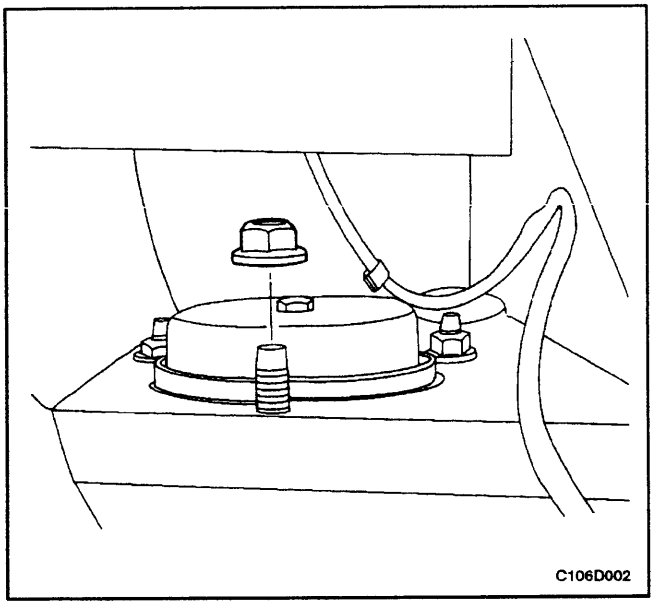
1. Install the rear strut assembly into the vehicle.



2. Install the knuckle-to-strut assembly nuts and bolts.

Tighten

Tighten the knuckle-to-strut assembly nuts to 120 N•m (89 lb-ft).

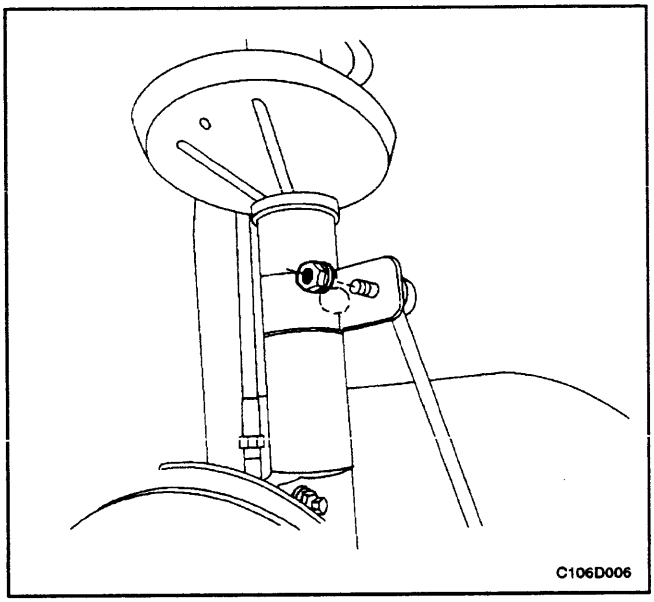

C106D002

3. Lower the vehicle. While a second technician holds the strut assembly in place, attach the strut mount-to-body nuts.

Tighten

Tighten the strut mount-to-body nuts to 45 N•m (33 lb-ft).

4. Install the rear seatback. Refer to *Section 9H, Seats*.
5. Install the brake caliper onto the rotor. Install the brake hose and the clip holding the brake hose to the strut assembly. Refer to *Section 4E, Rear Brakes*.


C106D006

6. On vehicles equipped with the antilock brake system, connect the ABS sensor line to the rear of the strut assembly. Refer to *Section 4F, Antilock Brake System and Traction Control System*.
7. Connect the stabilizer link to the strut assembly and install the stabilizer link-to-strut assembly nut.

Tighten

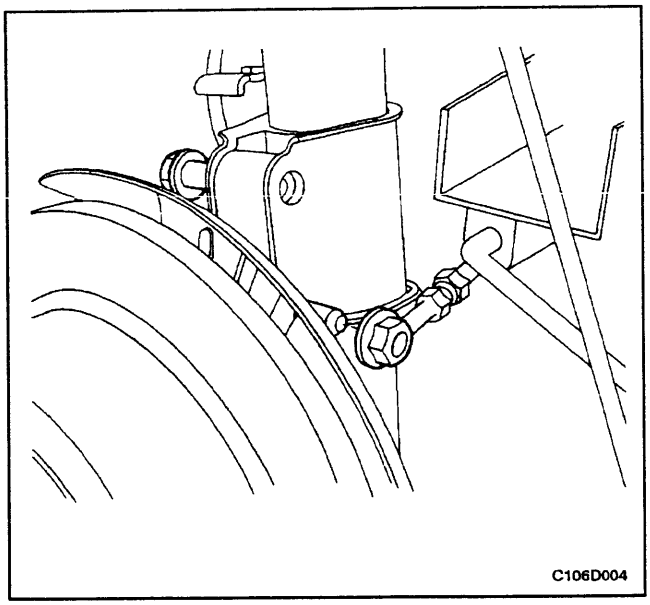
Tighten the stabilizer link-to-strut assembly nut to 45 N•m (33 lb-ft).

8. Install the wheel. Refer to *Section 2E, Tires and Wheels*.
9. Lower the vehicle completely.

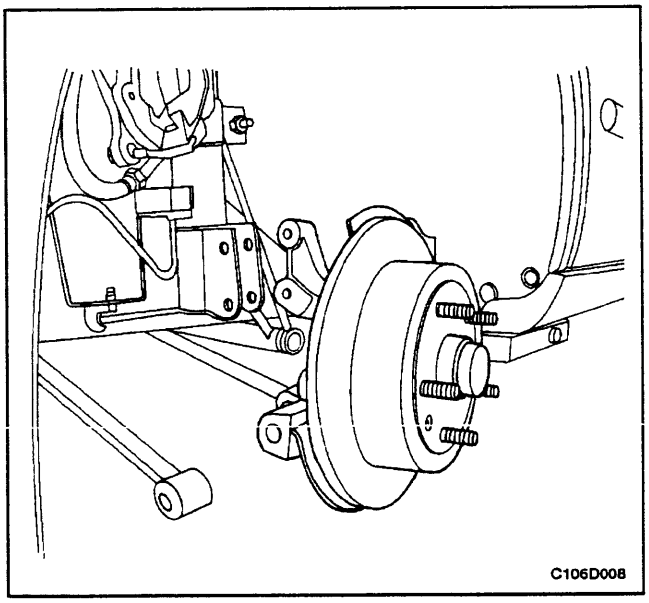
KNUCKLE ASSEMBLY

Removal Procedure

1. Raise and suitably support the vehicle.
2. Remove the wheel. Refer to *Section 2E, Tires and Wheels*.
3. On vehicles equipped with the antilock braking system, remove the ABS speed sensor. Refer to *Section 4F, Antilock Brake System and Traction Control System*.
4. Remove the clip securing the brake line to the strut assembly. Remove the brake caliper from the rotor and support the caliper. Refer to *Section 4E, Rear Brakes*.
5. Disconnect the parking brake from the knuckle assembly. Refer to *Section 4G, Parking Brake.*
6. Disconnect the front and rear parallel links from the knuckle. Refer to "Parallel Links" in this section.
7. Disconnect the rear trailing link from the rear knuckle. Refer to "Rear Trailing Link" in this section.

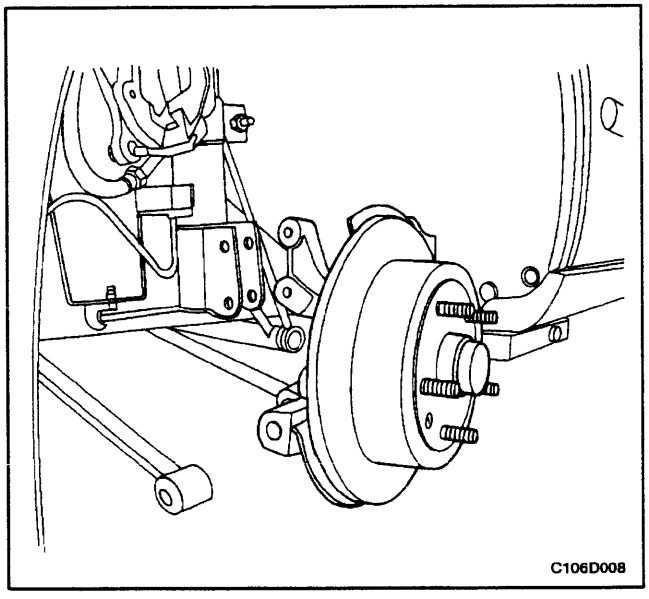


8. Remove the rear knuckle-to-strut assembly nuts and the bolts.

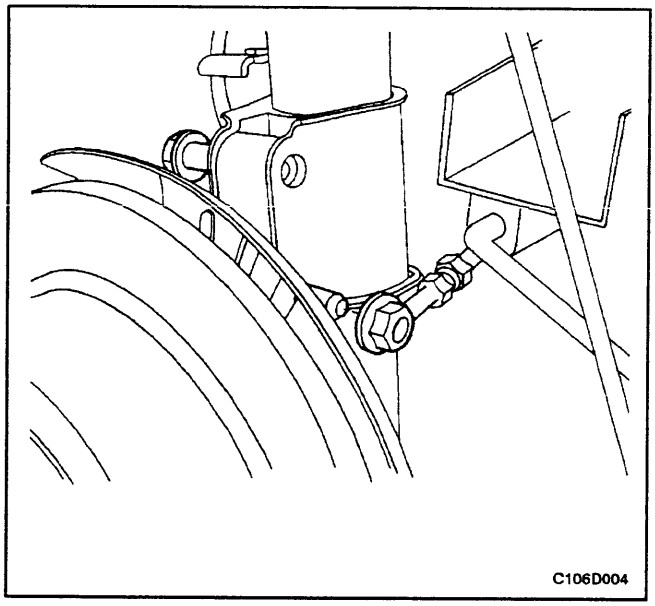


9. Remove the rear knuckle from the strut assembly.

Installation Procedure



1. Install the rear knuckle into the vehicle.

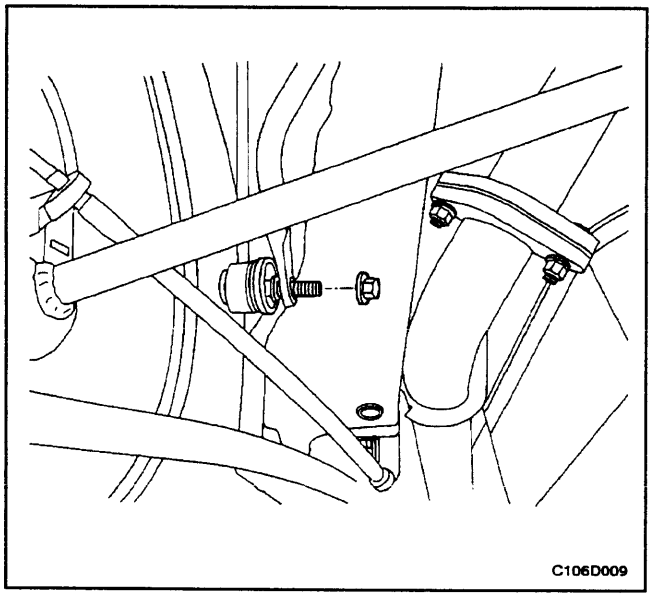

C106D004

2. Install the knuckle-to-strut assembly bolts and nuts.

Tighten

Tighten the knuckle-to-strut assembly nuts to 135 N•m (100 lb-ft).

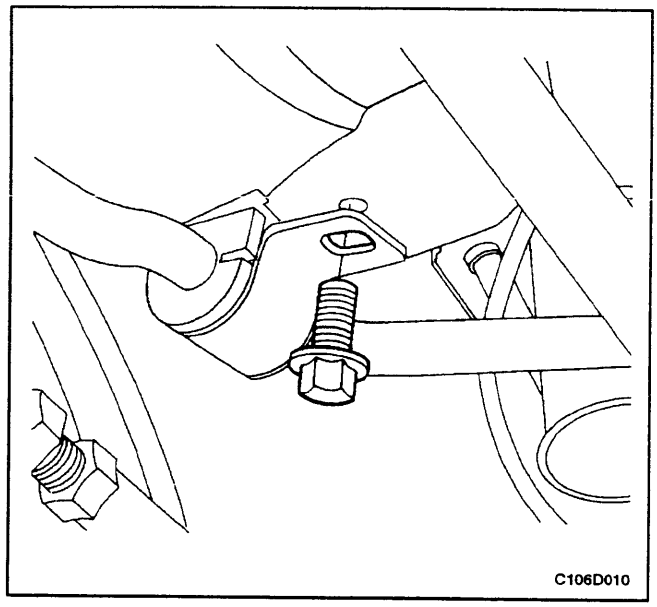
3. Connect the rear trailing link to the rear knuckle. Refer to "Trailing Links and Bracket" in this section.
4. Connect the front and rear parallel links to the knuckle. Refer to "Parallel Links" in this section.
5. Connect the parking brake to the knuckle assembly. Refer to *Section 4G, Parking Brake.*
6. Install the rear brake caliper onto the knuckle assembly. Install the brake line and secure to the strut assembly with the securing clip. Refer to *Section 4E, Rear Brakes.*
7. On vehicles equipped with the antilock braking system, install the ABS speed sensor. Refer to *Section 4F, Antilock Brake System and Traction Control System.*
8. Install the wheel. Refer to *Section 2E, Tires and Wheels.*
9. Lower the vehicle.


C106D009

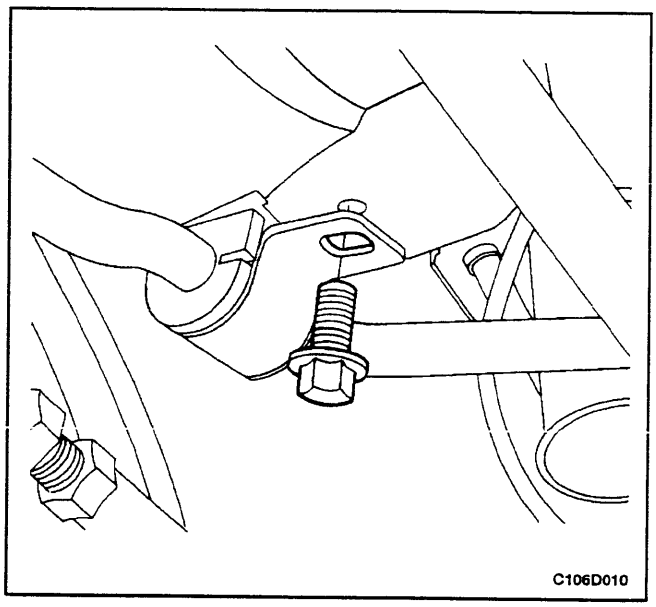
STABILIZER SHAFT AND INSULATORS

Removal Procedure

1. Raise and suitably support the vehicle.
2. Remove the stabilizer shaft-to-stabilizer link nuts.

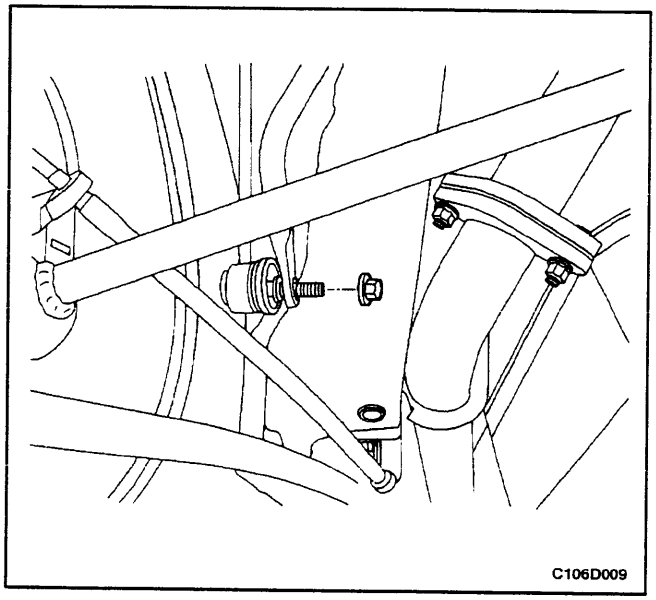


3. Remove the stabilizer shaft clamp bolts and stabilizer shaft clamp.
4. Remove the stabilizer shaft and insulators from the vehicle.



Installation Procedure

1. Install the stabilizer shaft and insulators into the vehicle.
2. Install the stabilizer shaft clamp and the stabilizer shaft clamp bolts. Do not tighten.



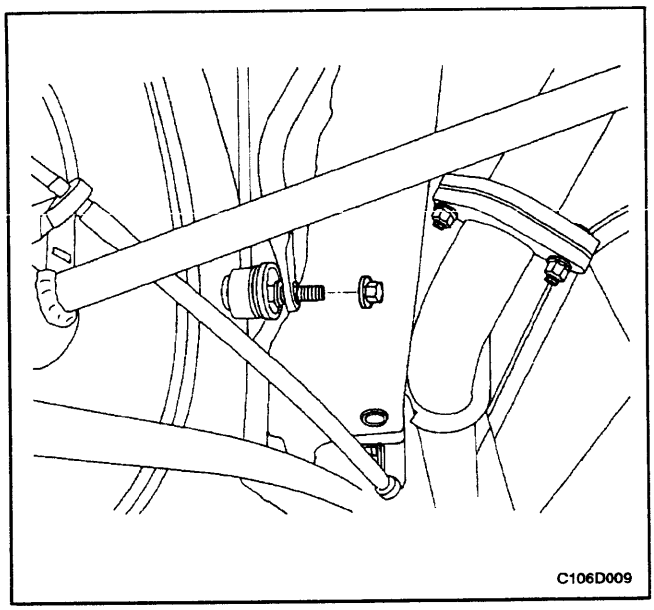
3. Connect the stabilizer shaft to the stabilizer link with the stabilizer shaft-to-stabilizer link nuts.

Tighten

Tighten the stabilizer shaft-to-stabilizer link nuts to 45 N•m (33 lb-ft).

Tighten

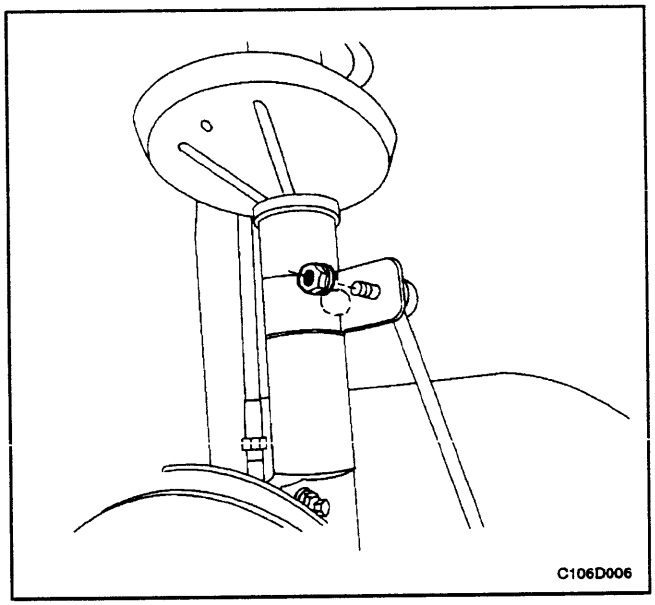
Tighten the stabilizer shaft clamp bolts to 37 N•m (27 lb-ft).



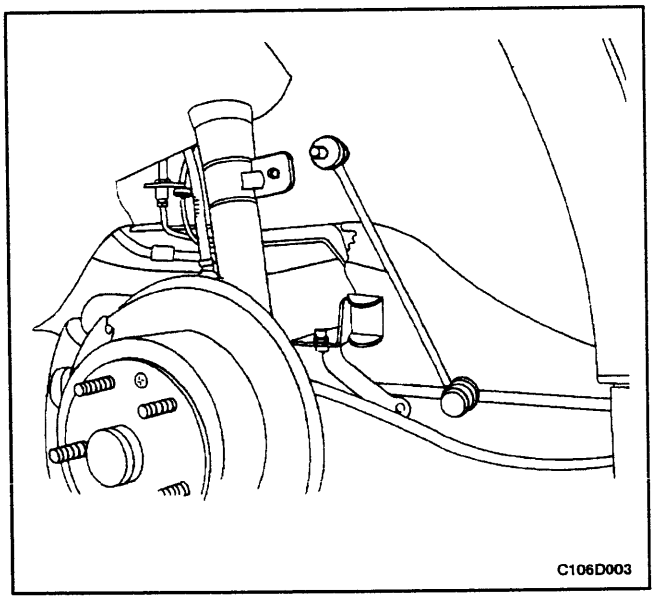
STABILIZER LINK

Removal Procedure

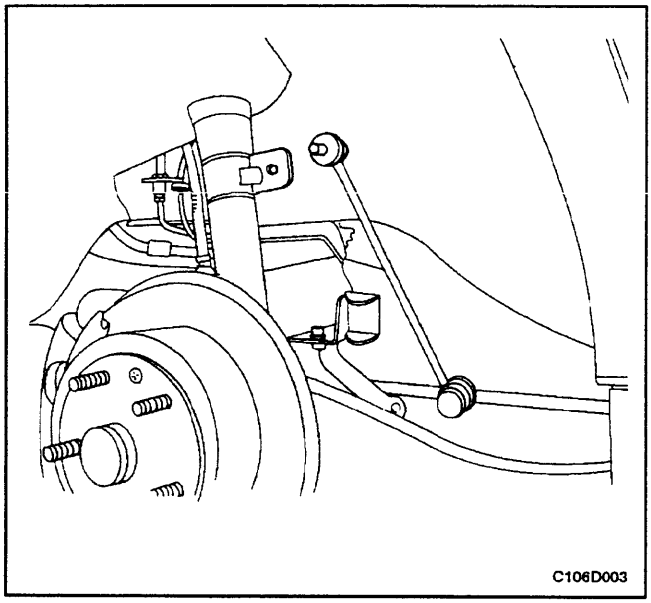
1. Raise and suitably support the vehicle.
2. Remove the stabilizer shaft-to-stabilizer link nut.



3. Remove the stabilizer shaft link-to-strut assembly nut.

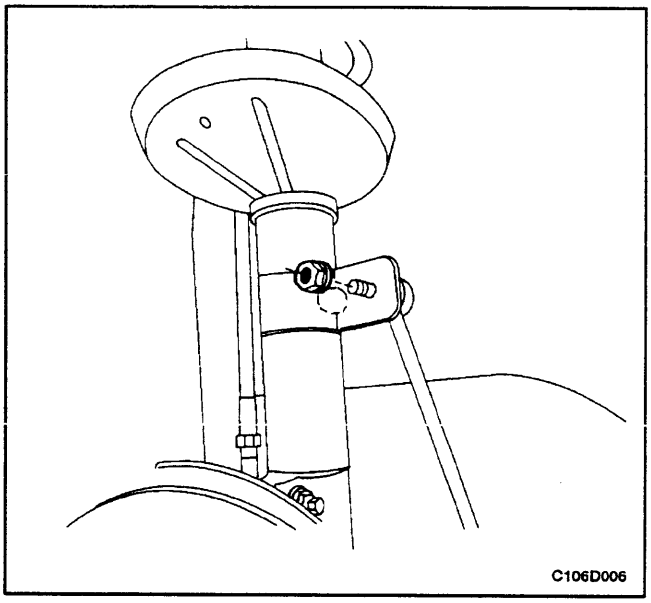


4. Remove the stabilizer link.



Installation Procedure

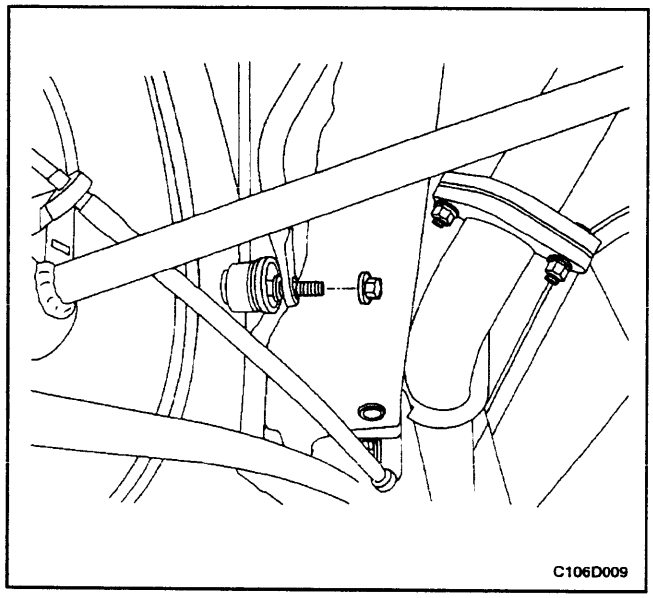
1. Install the stabilizer link.



2. Connect the stabilizer link to the strut assembly with the stabilizer link-to-strut assembly nut. Do not tighten.
3. Connect the stabilizer link to the stabilizer shaft with the stabilizer shaft-to-stabilizer link nut.

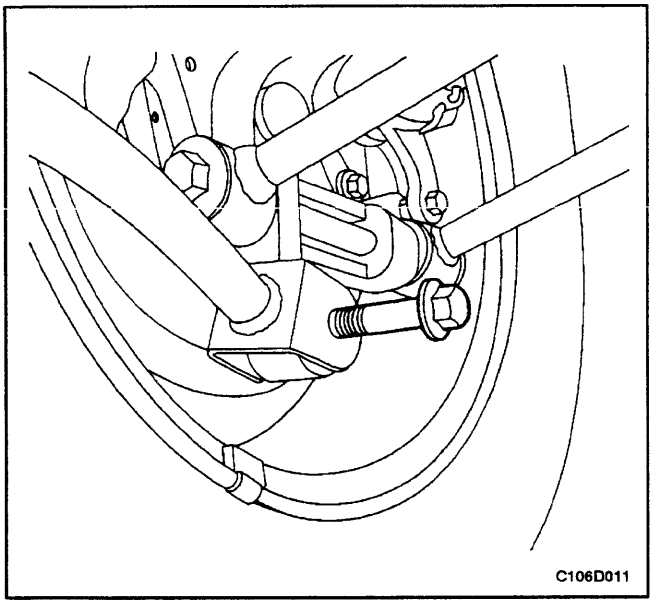
Tighten

Tighten the stabilizer link-to-strut assembly nut to 45 N•m (33 lb-ft).



Tighten

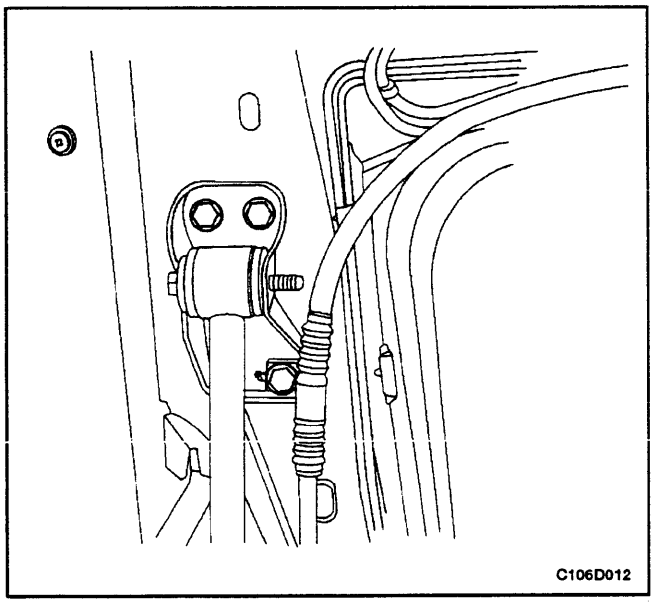
Tighten the stabilizer shaft-to-stabilizer link nut to 45 N•m (33 lb-ft).



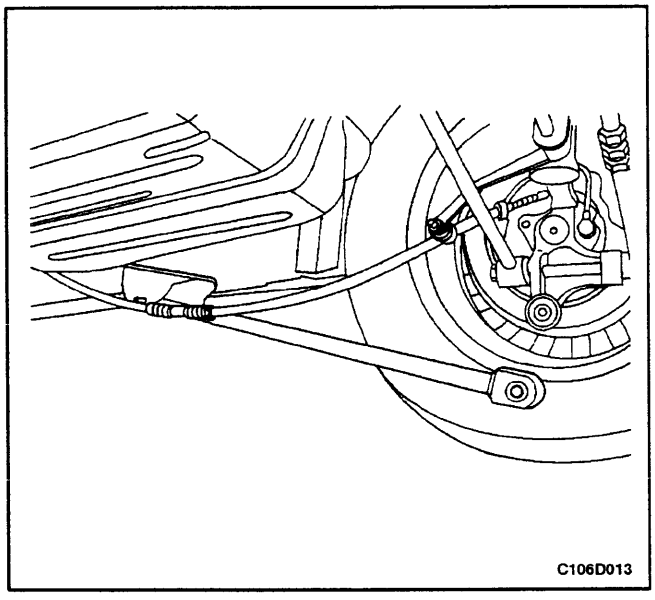
TRAILING LINK AND BRACKET

Removal Procedure

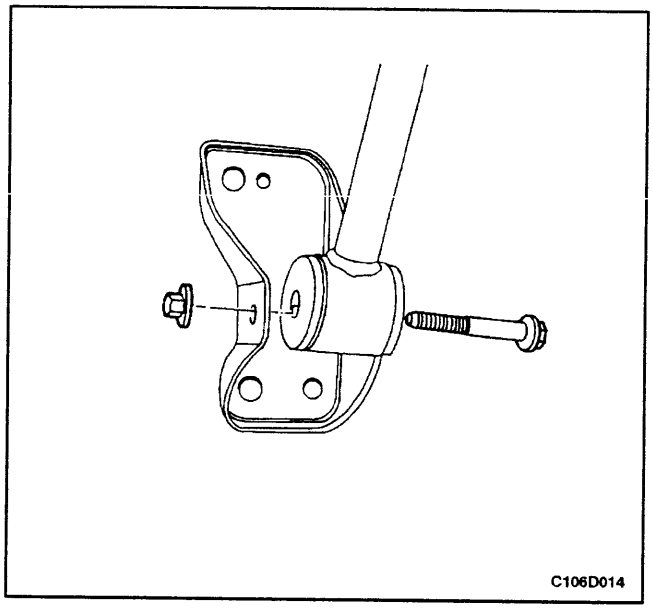
1. Raise and suitably support the vehicle.
2. Remove the rear trailing link-to-rear knuckle bolt.



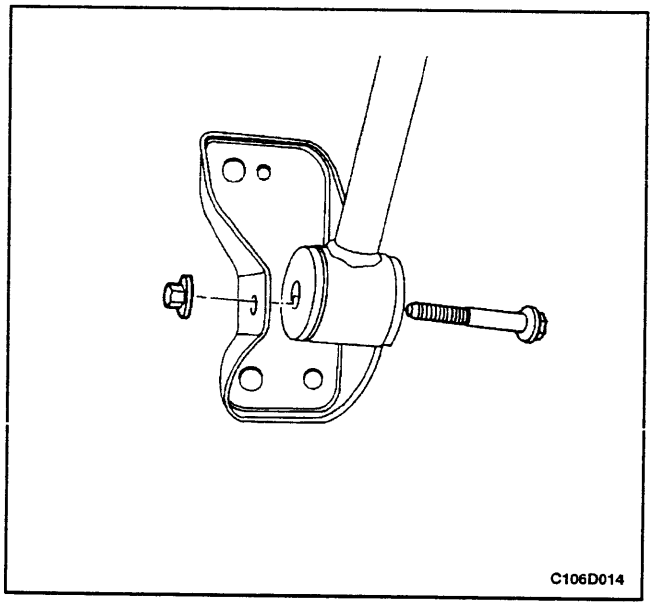
3. Remove the rear trailing link bracket-to-body bolts.



4. Remove the rear trailing link and bracket.



5. Remove the trailing link bracket nut and bolt.
6. Separate the trailing link from the trailing link bracket.

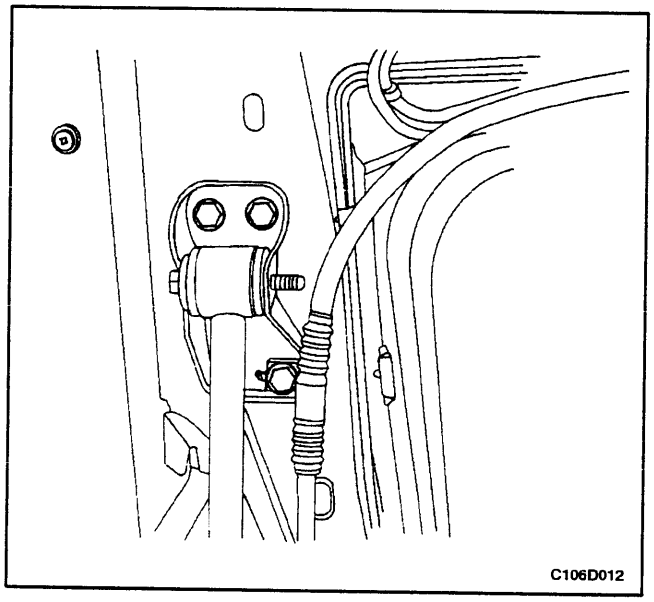


Installation Procedure

1. Connect the trailing link and the trailing link bracket.
2. Install the rear trailing link bracket nut and bolt.

Tighten

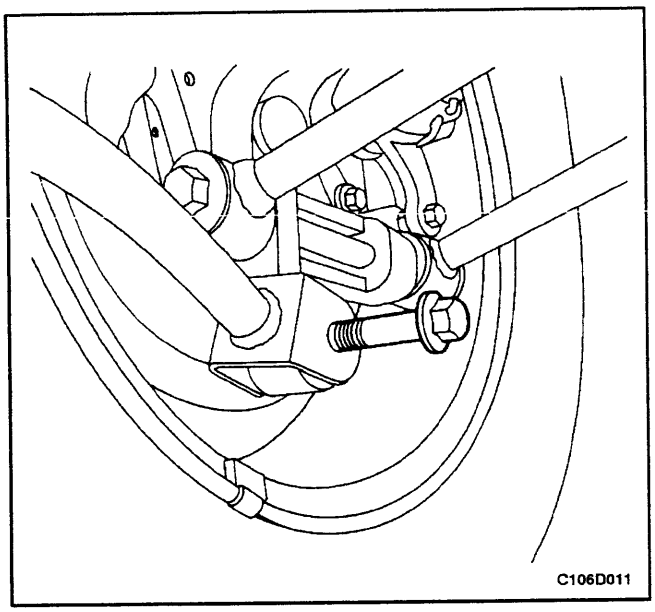
Tighten the trailing link-to-trailing link bracket nut to 100 N•m (73 lb-ft).



3. Install the rear trailing link and bracket into the vehicle.
4. Install the trailing link bracket-to-body bolts.

Tighten

Tighten the rear trailing link bracket-to-body bolts to 90 N•m (66 lb-ft).

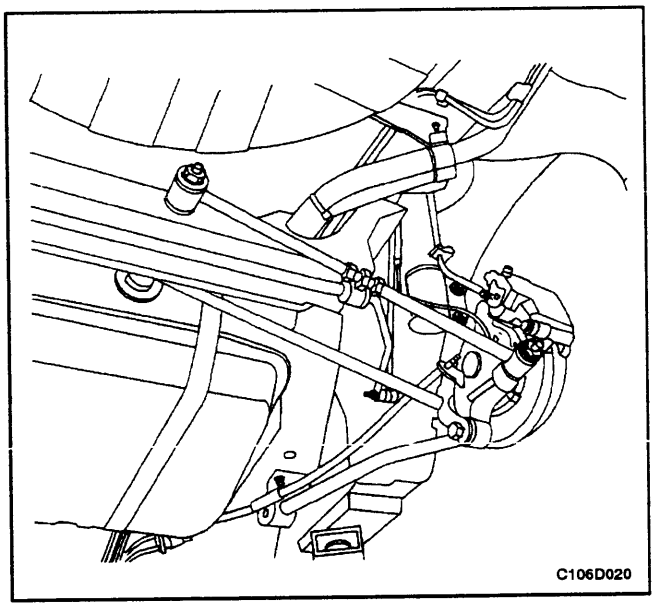


5. Install the trailing link-to-knuckle bolt.

Tighten

Tighten the rear trailing link-to-knuckle bolt to 120 N•m (89 lb-ft).

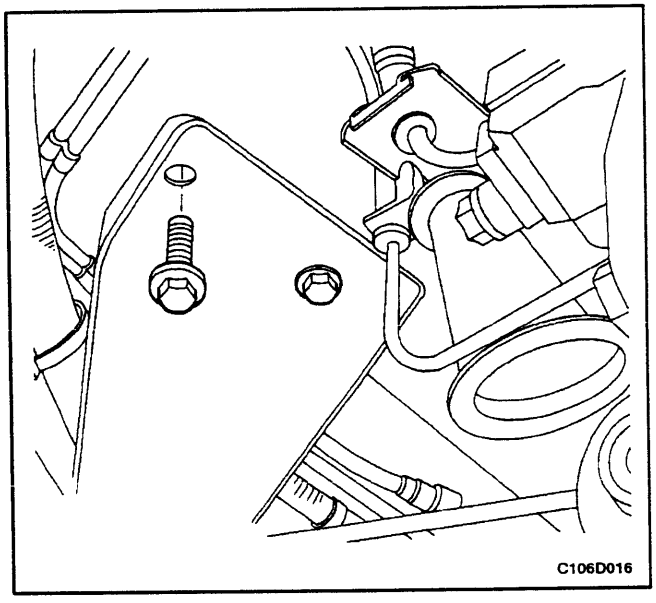
6. Lower the vehicle.



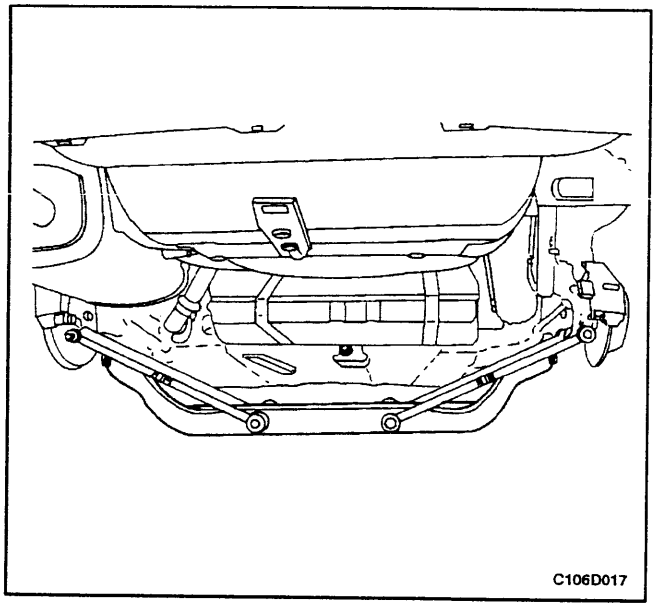
PARALLEL LINKS

Removal Procedure

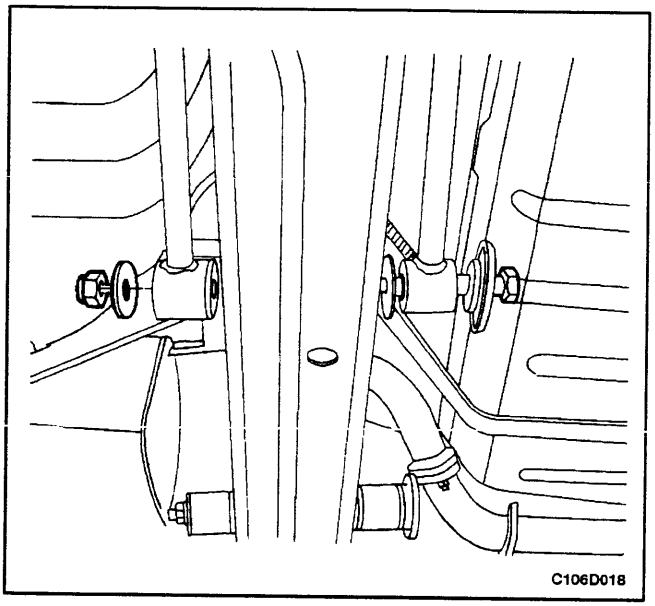
1. Raise and suitably support the vehicle.
2. Remove the wheel. Refer to *Section 2E, Tires and Wheels*.
3. Loosen all of the bolts that connect the front and rear parallel links to the knuckle and the rear crossmember.



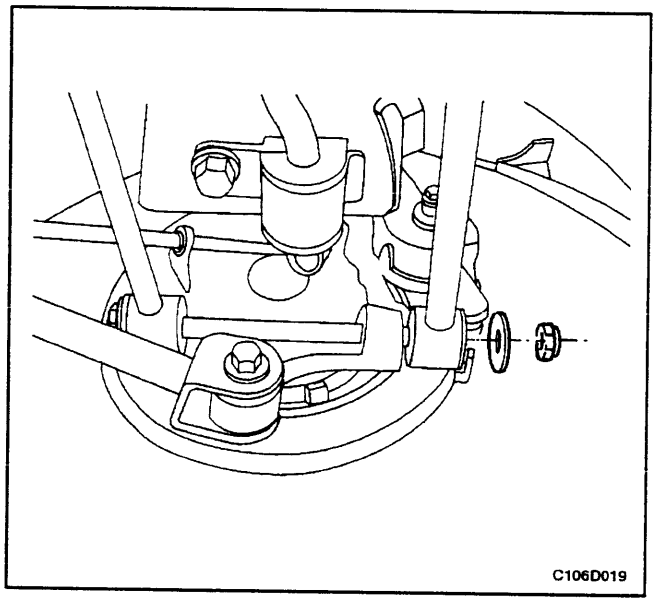
4. Remove the rear crossmember-to-body bolts.


C106D017

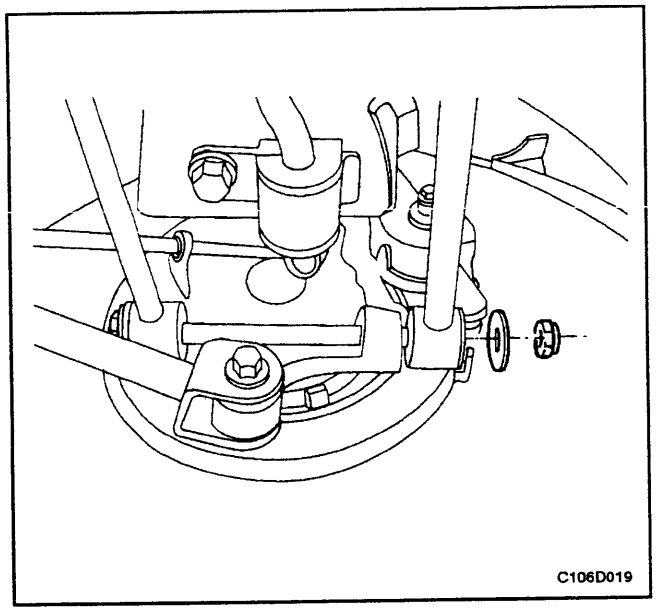
5. Lower the rear crossmember.


C106D018

6. Remove the parallel link bolt from the rear crossmember.

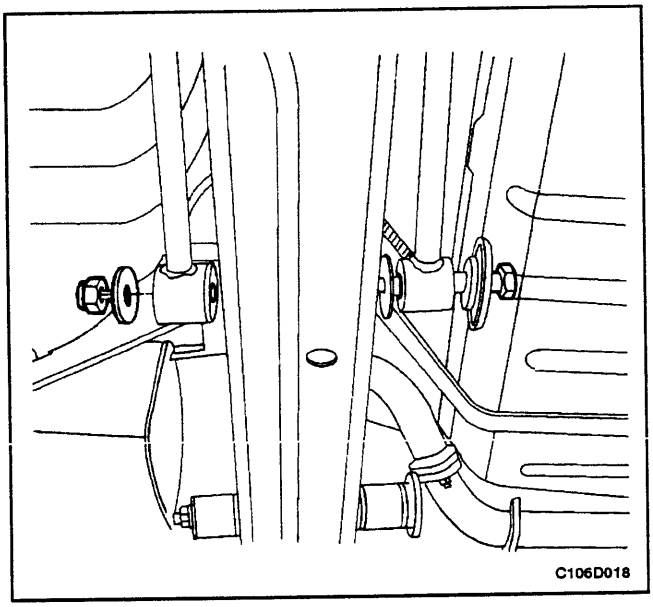

C106D019

7. Remove the parallel link bolt from the rear knuckle.
8. Remove the front and rear parallel links.

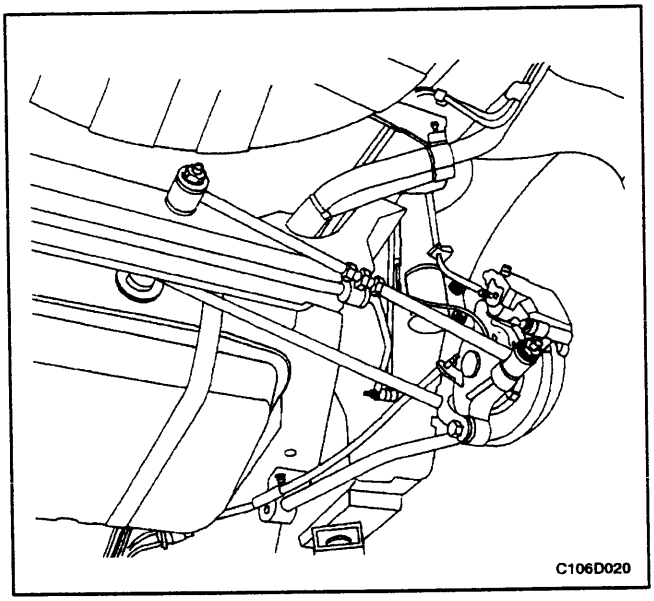


Installation Procedure

1. Install the front and rear parallel links.
2. Install the parallel link bolt onto the rear knuckle.



3. Install the parallel link bolt onto the rear crossmember.

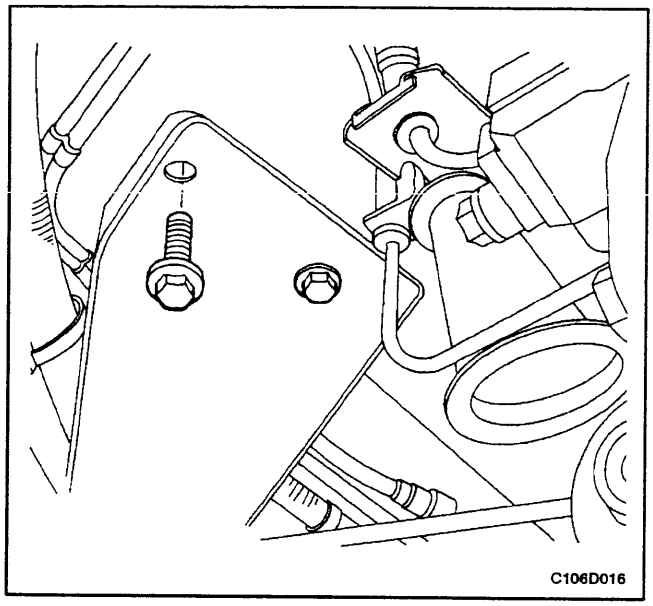


4. Raise the crossmember and install the rear crossmember-to-body bolts.

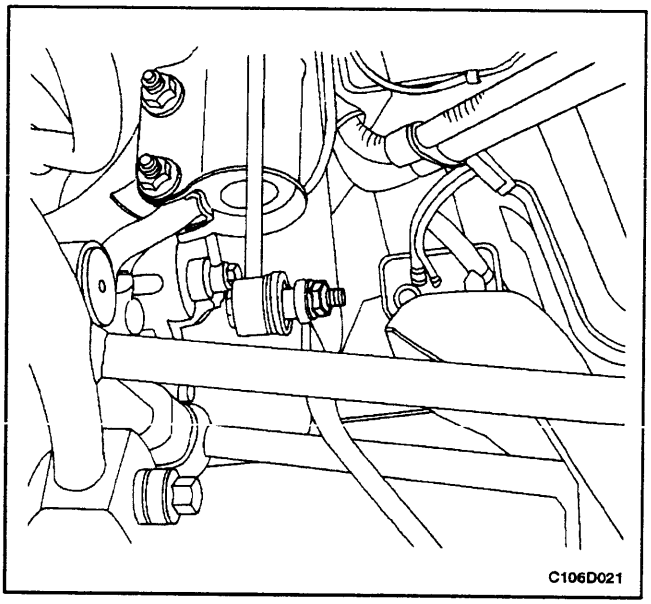
Tighten

Tighten the crossmember-to-body bolts to 110 N•m (81 lb-ft).

Tighten the parallel link-to-cross member nut to 120 N•m (89 lb-ft) and the parallel link-to-knuckle nut to 135 N•m (100 lb-ft).



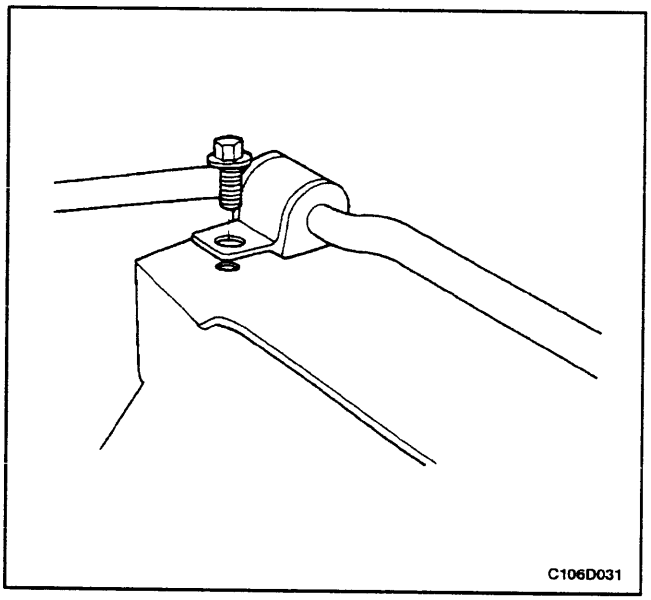
5. Install the wheel. Refer to *Section 2E, Tires and Wheels*.
6. Perform a rear toe adjustment. Refer to *Section 2B, Wheel Alignment*.



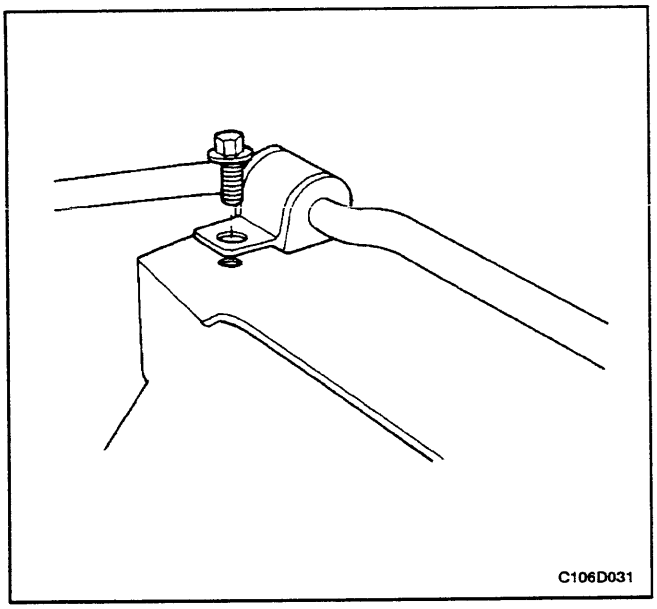
CROSSMEMBER

Removal Procedure

1. Raise and suitably support the vehicle.
2. Remove the parallel links. Refer to "Parallel Links" in this section.
3. Remove the stabilizer shaft-to-stabilizer link nuts and remove the rear crossmember.



4. Remove the stabilizer shaft clamp bolts and remove the stabilizer shaft and insulators from the rear crossmember.

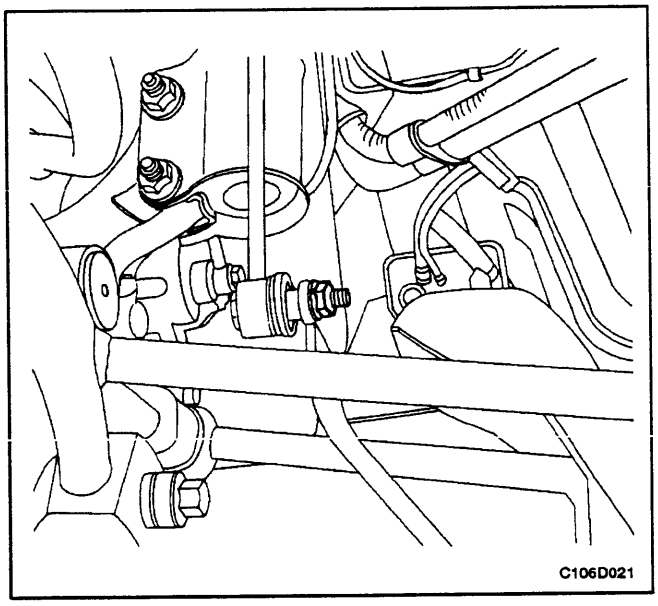


Installation Procedure

1. Install the stabilizer shaft and insulators and secure with the stabilizer shaft clamps and bolts.

Tighten

Tighten the stabilizer shaft clamp bolts to 37 N•m (27 lb-ft).

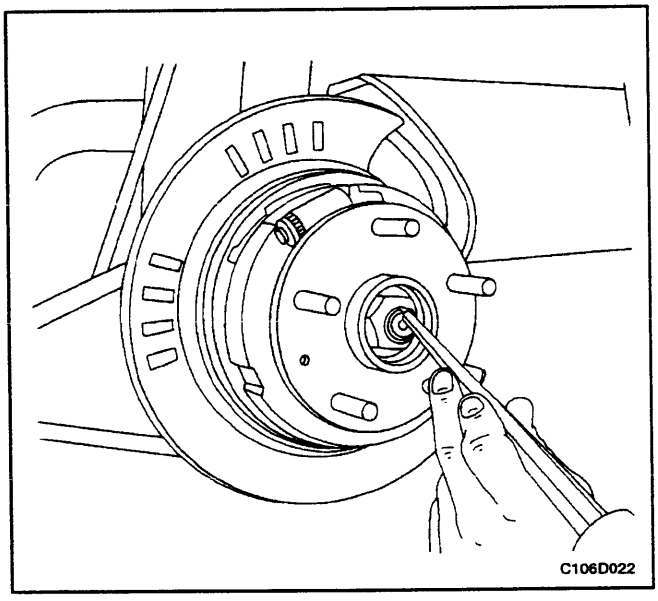


2. Install the rear crossmember and connect the stabilizer shaft to the stabilizer links.
3. Install the stabilizer shaft-to-stabilizer link nuts.

Tighten

Tighten the stabilizer shaft-to-stabilizer link nuts to 45 N•m (33 lb-ft).

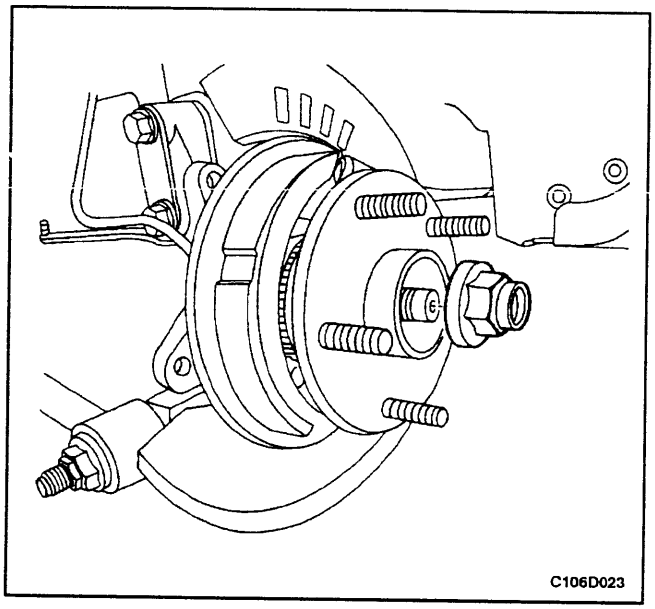
4. Install the parallel links. Refer to "Parallel Links" in this section.
5. Lower the vehicle.



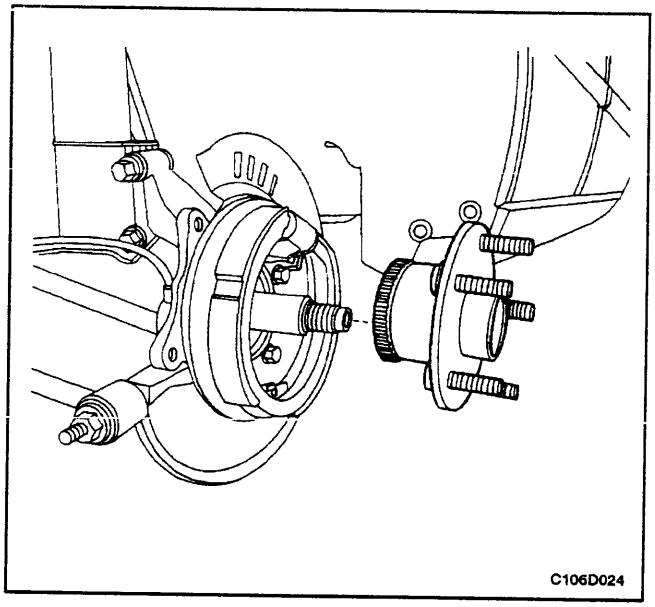
HUB AND BEARING ASSEMBLY

Removal Procedure

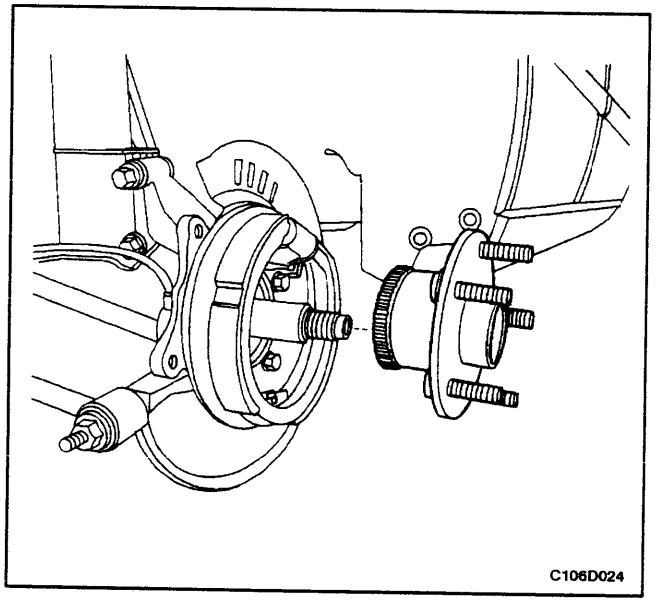
1. Raise and suitably support the vehicle.
2. Remove the wheel. Refer to *Section 2E, Tires and Wheels*.
3. Remove the rear brake caliper and rear brake rotor. Refer to *Section 4E, Rear Brakes*.
4. Remove the dust cap and straighten the indent in the caulking nut with a drift and a hammer.



5. Remove the caulking nut.

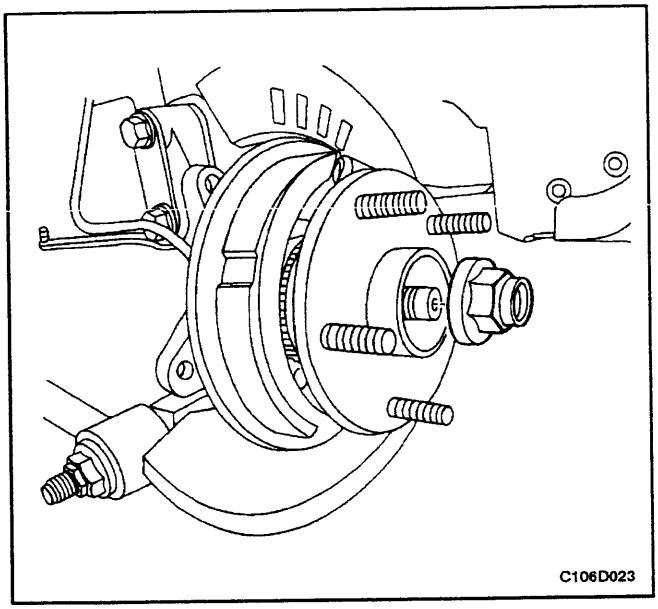


6. Remove the hub and bearing assembly.



Installation Procedure

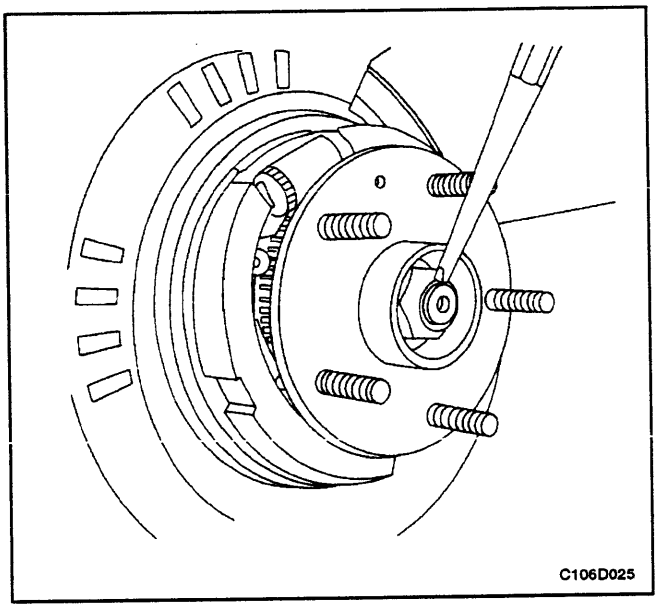
1. Install the hub and bearing assembly.


C106D023

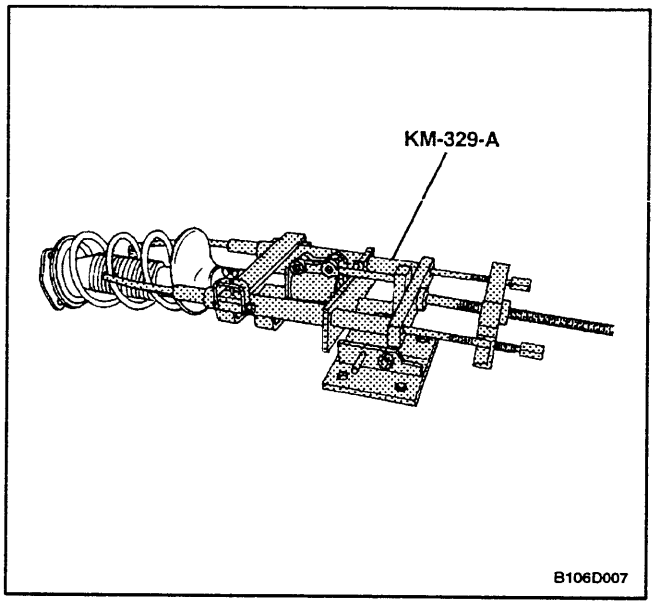
2. Install a new caulking nut.

Tighten

Tighten the caulking nut to 285 N•m (210 lb-ft).


C106D025

3. Indent the caulking nut onto the spindle.
4. Install the rear brake rotor and rear brake caliper. Refer to *Section 4E, Rear Brakes*.
5. Install the wheel. Refer to *Section 2E, Tires and Wheels*.
6. Lower the vehicle.



UNIT REPAIR

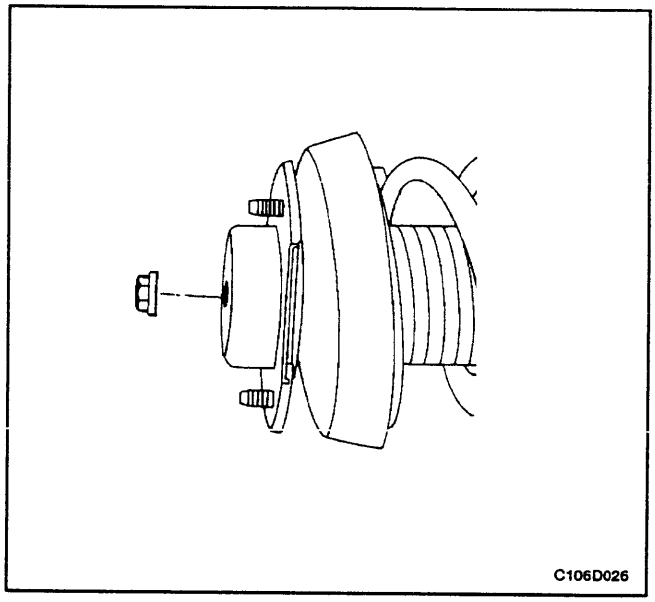
SPRINGS AND INSULATORS

Tools Required

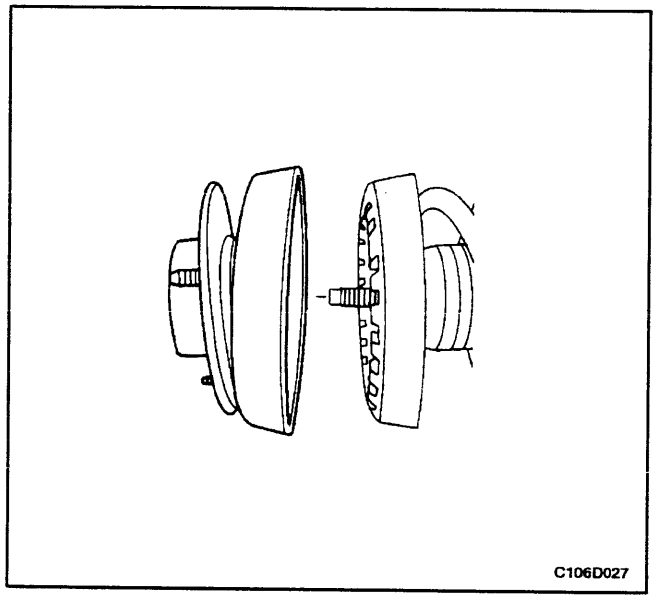
KM-329-A Spring Compressor

Disassembly Procedure

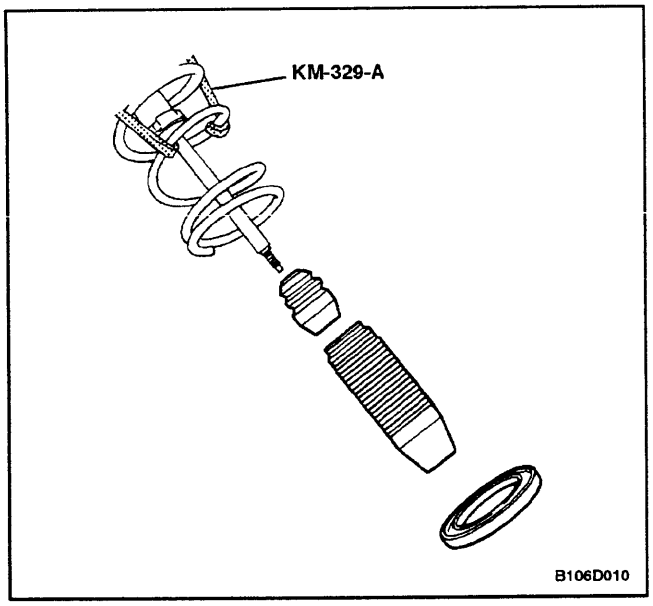
1. Remove the rear strut assembly from the vehicle. Refer to "Strut Assembly" in this section.
2. Mount the rear strut assembly into the spring compressor KM-329-A. Ensure that the hooks are properly seated.



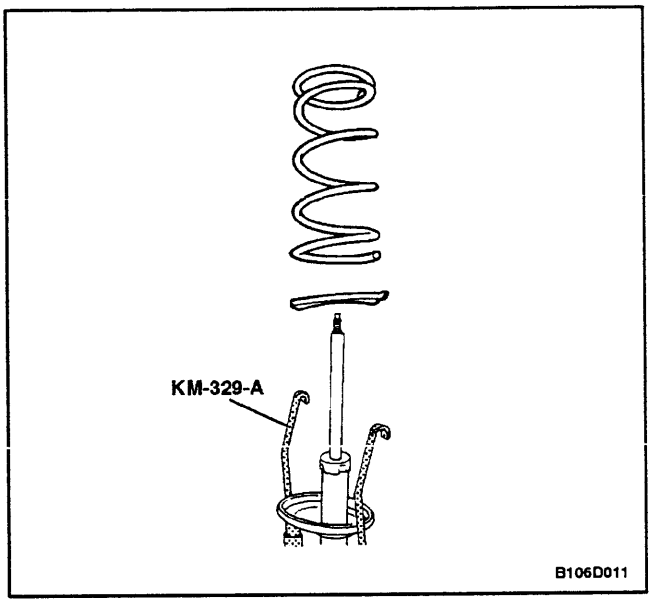
3. Compress the spring.
4. Remove the lock nut from the strut dampener rod.



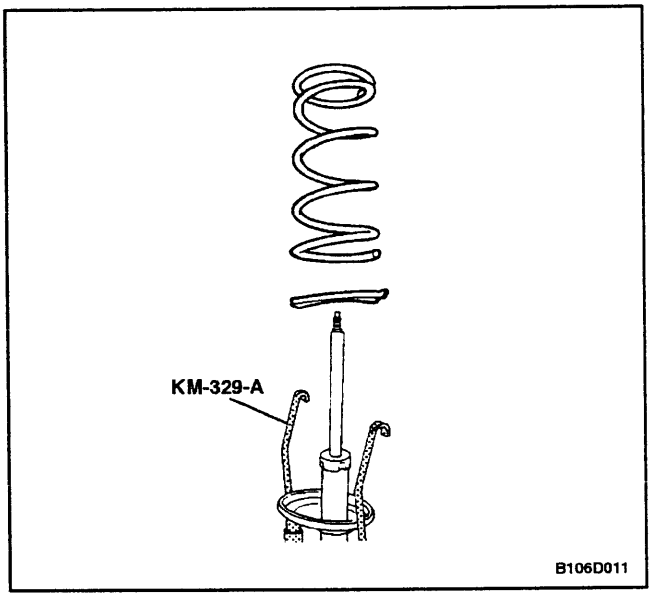
5. Remove the rear strut mount.



6. Remove the rear spring upper insulator, the dust cover, and the hollow bumper.

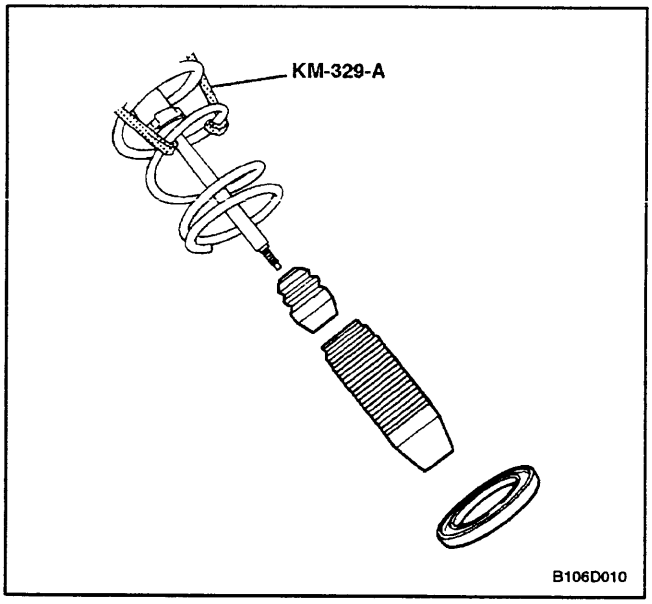


7. Release the spring.
8. Remove the rear spring and the rear spring lower insulator.

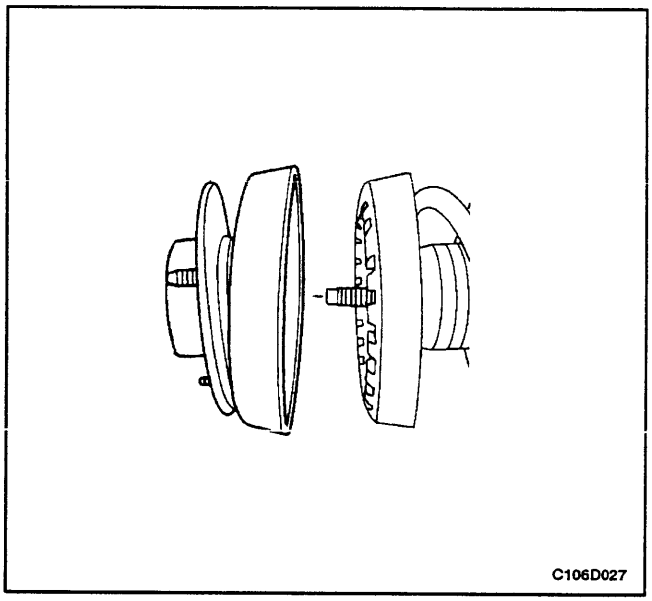


Assembly Procedure

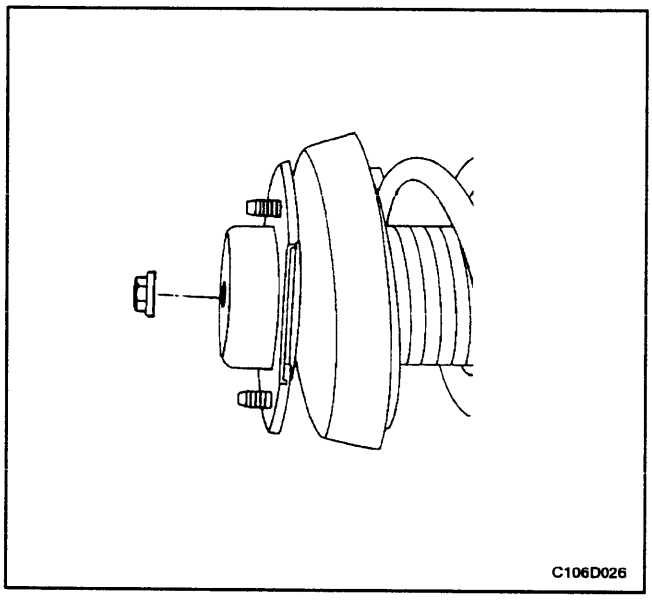
1. Install the rear spring lower insulator and the rear spring.



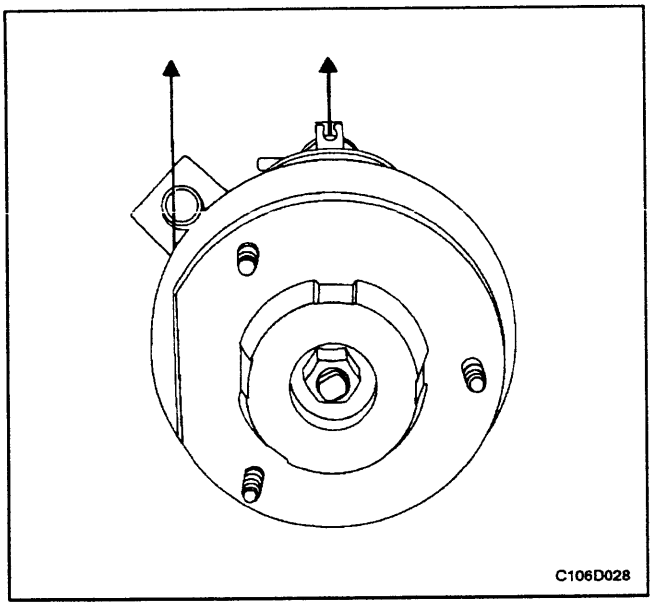
2. Compress the spring.
3. Install the hollow bumper, the dust cover, and the rear spring upper insulator.



4. Install the rear strut mount.



5. Install the lock nut onto the strut dampener rod.



6. Align the flat side of the strut mount with the ABS sensor line bracket on the strut dampener so that the two are parallel to each other.

Tighten

Tighten the damper rod-to-strut mount nut to 80 N•m (59 lb-ft).

7. Release the spring.
8. Remove the strut assembly from the spring compressor and install the strut assembly into the vehicle. Refer to "Strut Assembly" in this section.

KNUCKLE

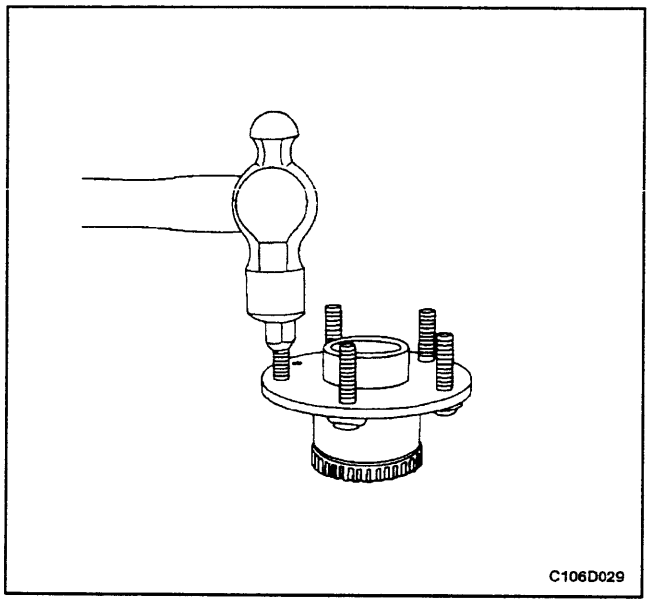
Disassembly Procedure

Important: To facilitate the removal of the caulking nut, it should be loosened before the knuckle is removed from the vehicle. Refer to "Hub and Bearing Assembly" in this section.

1. Remove the knuckle from the vehicle. Refer to "Knuckle Assembly" in this section.
2. Remove the brake caliper and brake rotor or the brake drum. Refer to *Section 4E, Rear Brakes*.
3. Remove the dust cap, the caulking nut, and the hub and bearing assembly. Refer to "Hub and Bearing Assembly" in this section.
4. Remove the rear disc brake assembly. Refer to *Section 4E, Rear Brakes*.
5. Remove the brake splash shield. Refer to *Section 4E, Rear Brakes.*

Assembly Procedure

1. Install the brake splash shield. Refer to *Section 4E, Rear Brakes.*
2. Install the rear disc brake assembly. Refer to *Section 4E, Rear Brakes*.
3. Install the hub and bearing assembly, the caulking nut, and the dust cap. Refer to "Hub and Bearing Assembly" in this section.
4. Install the brake caliper and brake rotor or the brake drum. Refer to *Section 4E, Rear Brakes*.
5. Install the knuckle into the vehicle. Refer to "Knuckle Assembly" in this section.

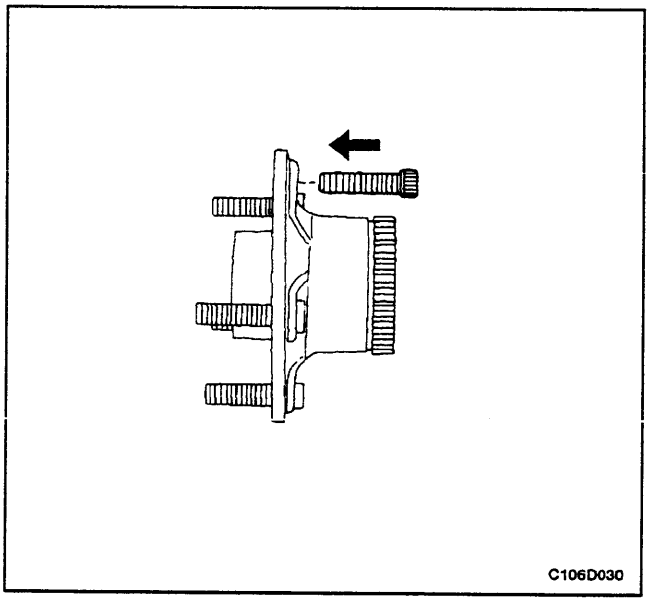

C106D029

HUB AND BEARING

Important: The rear bearings are not serviceable. If the bearings must be replaced, the hub and bearing assembly must be replaced as a unit.

Disassembly Procedure

1. Raise and suitably support the vehicle.
2. Remove the hub and bearing assembly from the vehicle. Refer to "Hub and Bearing Assembly" in this section.
3. Use a hammer to drive out any damaged hub studs.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Assembly Procedure

1. Replace any damaged hub studs with a new hub stud.

GENERAL DESCRIPTION AND SYSTEM OPERATION

REAR SUSPENSION

The rear suspension is fully independent and consists of a crossmember with four parallel links, two trailing links, two strut assemblies with coil springs and insulators, and two knuckles containing the hub and bearing assemblies. The strut assemblies support the weight of the vehicle using coil springs positioned around the strut dampeners. The coil springs are seated on insulators attached to the upper mount and the lower spring seat of the strut assembly. The parallel links and the trailing link bracket have rubber isolator bushings at each end and are attached to the crossmember and the knuckle. The rear parallel link is attached to the crossmember through adjustment cams that are used to adjust rear toe. The trailing links are attached to the body, through the trailing link bracket, and the bottom of the knuckle. A forged knuckle bolts to each strut assembly. Lateral movement of the knuckle is controlled by the parallel links. Fore and aft movement of the knuckle is controlled by the trailing link.

SECTION 2E

TIRES AND WHEELS

TABLE OF CONTENTS

SPECIFICATIONS

TIRE SIZE AND PRESSURE SPECIFICATIONS

Inflation Pressure at Full Load

Engine	Tires	Wheel	Front		Rear	
-	-	-	kPa	psi	kPa	psi
2.0 DOHC	205/60R15	6.0Jx15 (Steel)	200	29	200	29
2.0 DOHC	205/60R15	6.0Jx15 (Alloy)	200	29	200	29

INFLATION PRESSURE CONVERSION SPECIFICATIONS

kPa	psi	kPa	psi	kPa	psi
140	20	185	27	235	34
145	21	190	28	240	35
155	22	200	29	250	36
160	23	205	30	275	40
165	24	215	31	310	45
170	25	220	32	345	50
180	26	230	33	380	55

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Wheel Nut (Alloy Wheel)	100	74	-
Wheel Nut (Steel Wheel)	100	74	-

DIAGNOSIS

WHEEL RUNOUT

Measure wheel runout with an accurate dial indicator. Measurements may be taken with the wheels either on or off the vehicle, using an accurate mounting surface such as a wheel balancer. Measurements may be taken with or without the tire mounted on the wheel.

Measure radial runout and lateral runout on both the inboard and the outboard rim flanges. With the dial indicator firmly seated next to the wheel and tire assembly, slowly rotate the wheel one revolution and record the indicator reading. If any measurement exceeds the following specifications and there is a vibration that wheel balancing will not correct, replace the wheel. Disregard any indicator readings due to welds, paint runs, or scratches.

Steel Wheels

- Radial runout: 0.8 mm (0.03 inch).
- Lateral runout: 1.0 mm (0.04 inch).

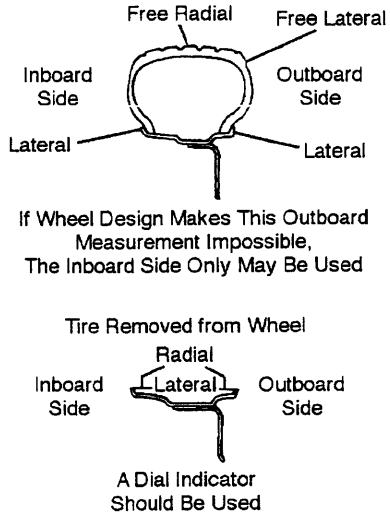
Alloy Wheels

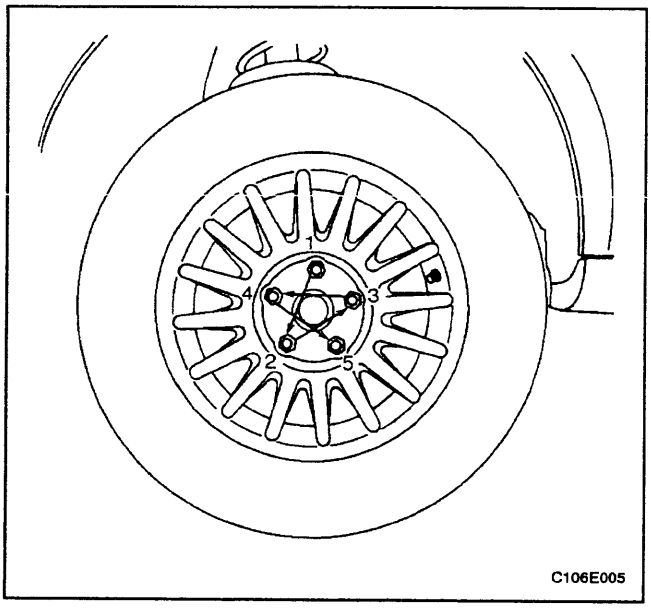
- Radial runout: 0.8 mm (0.03 inch).
- Lateral runout: 1.0 mm (0.04 inch).

Measure free radial runout on the center of the tire tread. The tread can be taped to present a smooth surface. Measure free lateral runout on the outboard side of the tire nearest to the tread.

Steel and Alloy Wheels

- Free radial runout: 1.5 mm (0.06 inch).
- Free lateral runout: 1.5 mm (0.06 inch).





MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

WHEEL

Removal Procedure

1. Remove the wheel cover.
2. Loosen the wheel nuts.
3. Raise and suitably support the vehicle.
4. Remove the wheel nuts.

Notice: Never use heat to loosen a tight wheel. It can shorten the life of the wheel, the wheel nuts, and the wheel bearings. Excessive force, such as hammering the wheel or tire, can also cause damage and is not recommended. Slight tapping of the wheel sidewall with one's hand or with a rubber mallet is acceptable.

5. Remove the wheel and tire assembly.

Difficulty in removing the wheels from the vehicle can be due to foreign material or to a tight fit between the wheel centerhole and the hub or the rotor. These wheels can be removed by

1. Retightening the wheel nuts on the affected wheel and then loosening the wheel nuts by two turns.
2. Lowering the vehicle and rocking it from side to side as hard as possible, using one or more person's body weight to loosen the wheel.
3. Raising the vehicle and removing the wheel.

Caution: Do not allow the penetrating oil to get on the vertical surfaces between the wheel and the drum (or rotor) because penetrating oil in this area could cause the wheel to work loose as the vehicle is driven, resulting in loss of control and an injury accident.

Penetrating oil is not effective in removing tight wheels. If it is used, however, apply it sparingly and only to the wheel's centerhole area.

Installation Procedure

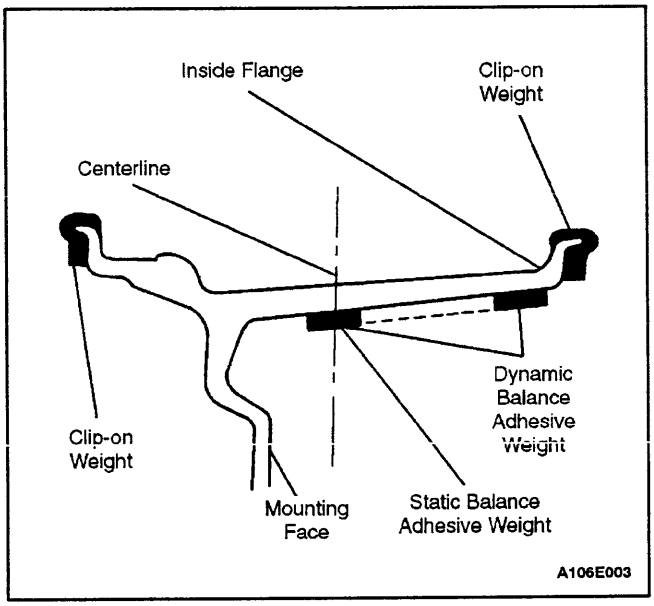
Notice: Before installing the wheels, remove any build-up of corrosion on the wheel mounting surface and the rotor mounting surface by scraping and brushing them with a wire brush. Installing the wheels without good metal-to-metal contact at the mounting surfaces can cause the wheel nuts to loosen, which can later allow a wheel to come off while the vehicle is moving. Wheel bolts must be tightened in sequence and to the proper torque to avoid bending the wheel or the rotor.

1. Mount the wheel and tire assembly.
2. Install the wheel nuts in the sequence shown. Do not tighten the wheel nuts .
3. Lower the vehicle.

Tighten

Tighten the wheel nuts to 100 N•m (74 lb-ft).

4. Install the wheel cover.



ON-VEHICLE BALANCING

On-vehicle balancing will help correct vibrations due to brake drum, rotor, and wheel cover imbalances.

Notice: Do not allow the front suspension to hang free. When the drive axle is run at an extreme angle, extra vibrations can occur, as well as damage to seals and joints.

1. During on-vehicle balancing, do not remove the balance weights from the off-vehicle dynamic balance.
2. If more than 28.4 grams (1 ounce) of additional weight is required, split the weight between the inner and the outer rim flanges.

Caution: Do not spin the drive wheels faster than 55 km/h (35 mph) as indicated by the speedometer. This limit is necessary because the speedometer indicates only one-half of the actual wheel speed when one drive wheel is spinning and the other drive wheel is stopped. Personal injury and damage may result from high-speed spinning.

3. Spin the driven tire and wheel assemblies using the engine.

UNIT REPAIR

ALLOY WHEEL POROSITY

Wheel repairs that use welding, heating or peening are not approved.

1. Raise and suitably support the vehicle.
2. Remove the tire and wheel assembly. Refer to "Wheel" in this section.

Caution: To avoid serious injury, do not stand over the tire when inflating, because the bead may break when it snaps over the safety hump. Do not exceed 275 kPa (40 psi) of air pressure in any tire if the beads are not seated. If 275 kPa (40 psi) of air pressure will not seat the beads, deflate the tire. Relubricate the beads. Reinflate the tire. Overinflation may cause the bead to break and cause serious injury.

3. Locate leaking areas by inflating the tire to 345 kPa (50 psi) and dipping the tire and wheel assembly into a water bath.
4. Mark the leak areas and remove the tire from the wheel.
5. Scuff the inside wheel surface at the leak area with 80-grit sandpaper. Clean the leak area with a general-purpose cleaner.
6. Apply a 3.3 mm (0.13 inch) thick layer of adhesive/sealant to the leak area. Allow it to dry for 12 hours.
7. Install the tire on the wheel. Inflate the tire to 345 kPa (50 psi) and check for leaks as in step 3.
8. Adjust the tire pressure to meet specifications. Refer to "Tire Size and Pressure Specifications" in this section.
9. Balance the tire and wheel assembly. Refer to "Tire and Wheel Balancing" in this section.
10. Install the tire and wheel assembly. Refer to "Wheel" in this section.
11. Lower the vehicle.

ALLOY WHEEL REFINISHING

A protective clear or color coating is applied to the surface of the original equipment cast alloy wheels. Surface degradation can develop if this clear coating is damaged or removed. This can happen at some automatic car wash facilities that use silicon carbide-tipped tire brushes to clean white walls and tires. Once the protective coating is damaged, exposure to caustic cleaners or road salt causes further surface degradation. The following procedure details how to strip, clean and recoat alloy wheels.

Caution: Follow the manufacturer's recommendations and cautions when using these materials.

Required materials:

Amchem Alumi Prep No. 23, stock No. DX533 or equivalent cleaning and conditioning chemical for alloys.

Amchem Alodine No. 101, stock No. DX50T or equivalent coating chemical for alloys.

Ditzler Delclear Acrylic Urethane Clear, Stock No. DAU-75 or equivalent.

Ditzler Delthane Ultra-Urethane Additive, Stock No. DXR-80 or equivalent.

Before repairing the alloy damage or the clear coat damage, prepare the wheels and the tires.

1. Remove the wheel from the vehicle.
2. Mark the location of the outboard weights and remove them.
3. Wash the wheel inside and out with a water-based, all-purpose cleaner. Remove the grease and oil with a solvent cleaner.
4. Mask the tire prior to painting.
5. Using a 400-grit wet or dry sandpaper, sand over the painted areas that will not require recoloring. Sanding will promote the adhesion of the clear coat.

Alloy Damage on Wheel Surface

1. Mount the wheel on a brake lathe and spin the assembly slowly.
2. Sand the wheel with a backing block or pad. Hold the backing block or pad flat to the surface of the wheel and sand slowly back and forth from the center to the outer edge of the tire to remove the damage. Use the following sandpaper grits in the order listed:
   - 80 grit.
   - 150 grit.
   - 240 grit.

Clear Coat Damage on Unpainted Wheels

1. Apply the chemical stripper Amchem Alumi Prep No. 23. Use a 1/4-inch detail brush to apply the stripper around the perimeter and spoke-like areas.
2. Remove the stripper according to the manufacturer's recommendations.

Caution: To avoid serious personal injury, do not use engine power to rotate the wheel while sanding.

3. Sand the wheel with 240-grit sandpaper by rotating the wheel on a slow-spinning brake lathe or by mounting the wheel on the car and spinning it by hand. Sanding restores the machined appearance and promotes adhesion.
4. After repairing the alloy or clear coat damage, the wheels must be recoated.

Recoating Procedure

Caution: To avoid serious personal injury when applying any two-part component paint system, follow the specific precautions provided by the paint manufacturer. Failure to follow these precautions may cause lung irritation and an allergic respiratory reaction.

1. Clean the surface.
2. Soak the wheel with Amchem Alumi Prep No. 23 or equivalent for 1 to 3 minutes. Rinse the wheel with water and blow it dry.
3. Soak the wheel with Amchem Alodine No. 101 or equivalent for 1 to 3 minutes. Rinse the wheel with water and blow it dry.
4. Finish with Ditzler Delclear Acrylic Urethane Clear and Ditzler Delthane Ultra-Urethane Additive or equivalent, using three coats.

   1st coat - spray on a light mist coat; let dry.

   2nd coat - spray or paint on a light coat; let dry.

   3rd coat - spray or paint on a heavy double wet coat; let dry.
5. Let the urethane dry for 24 hours or flash for 30 minutes and force dry at 60°C (140°F) for 30 minutes. Allow the urethane to cool for 5 minutes before mounting the wheel on the vehicle.

OFF-VEHICLE BALANCING

Perform wheel balancing with an electronic off-vehicle balancer. The balancer is easy to use and gives both a static and a dynamic balance. Unlike on-vehicle balancing, the off-vehicle balancer does not correct for drum or rotor imbalance. This drawback is overcome by its accuracy (usually to within 3.54 grams [0.125 ounce]). Secure the wheel on the balancer with a cone through the back side of the centerhole, not through the wheel bolt holes.

CORRECTING NON-UNIFORM TIRES

There are two ways to correct properly balanced tires which still vibrate. One method uses an automatic machine which loads the tire and buffs small amounts of rubber from high spots on the outer two tread rows. Correction by this method is usually permanent and, if it is done properly, does not significantly affect the appearance or the tread life of the tire. Tire truing with a blade-type machine is not recommended because it substantially reduces the tread life and often does not correct the problem permanently.

Another method is to dismount the tire and rotate it 180 degrees on the rim. Do this only on the tire and wheel assemblies which are known to be causing a vibration because this method is just as likely to cause good assemblies to vibrate.

TIRE AND WHEEL MATCH-MOUNTING

The tires and wheels are match-mounted at the assembly plant. Match-mounting aligns the radially stiffest part of the tire, or high spot, to the smallest radius, or low spot, of the wheel.

The high spot of the tire is originally marked by a red paint mark or an adhesive label on the outboard sidewall.

The low spot of the wheel will be at the location of the valve stem.

Before dismounting a tire from its wheel, scribe a line on the tire at the valve stem to assure that it is remounted in the same position.

Replacement tires that are of original equipment quality will have their high and low spot marked in the same manner.

TIRE MOUNTING AND DISMOUNTING

Notice: Use a tire-changing machine to mount or dismount the tires. Follow the equipment manufacturer's instructions. Do not use hand tools or tire irons to change tires. These tools may damage the beads or the wheel rim.

1. Clean the rim bead seats with a wire brush or coarse steel wool to remove lubricants, old rubber, and light rust. Before mounting or dismounting a tire, lubricate the bead area well with an approved tire lubricant.

Caution: To avoid serious injury, do not stand over the tire when inflating it, because the bead may break when it snaps over the safety hump. Do not exceed 275 kPa (40 psi) of air pressure in any tire if the beads are not seated. If 275 kPa (40 psi) of air pressure will not seat the beads, deflate the tire. Relubricate the bead and reinflate the tire. Overinflation may cause the bead to break and cause serious injury.

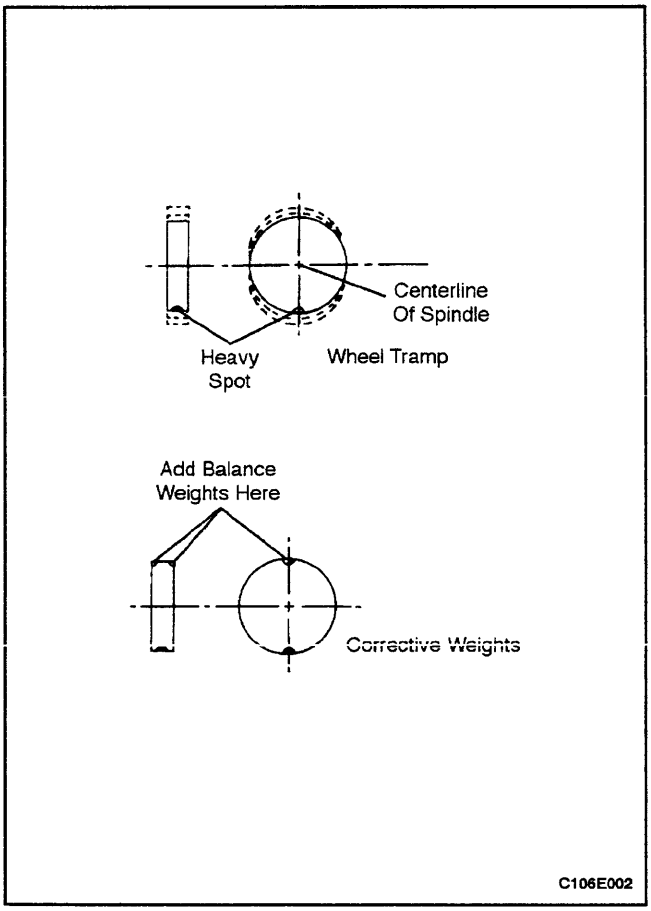
2. After mounting the tire, inflate it until the beads are seated. Never exceed 275 kPa (40 psi) to seat the beads.
3. Install the valve core and inflate the tire to the proper pressure. Make sure the locating ring outside of the bead of the tire shows around the rim flanges of the wheel on both sides. This positioning of the tire will insure that the bead of the tire is seated.

GENERAL DESCRIPTION AND SYSTEM OPERATION

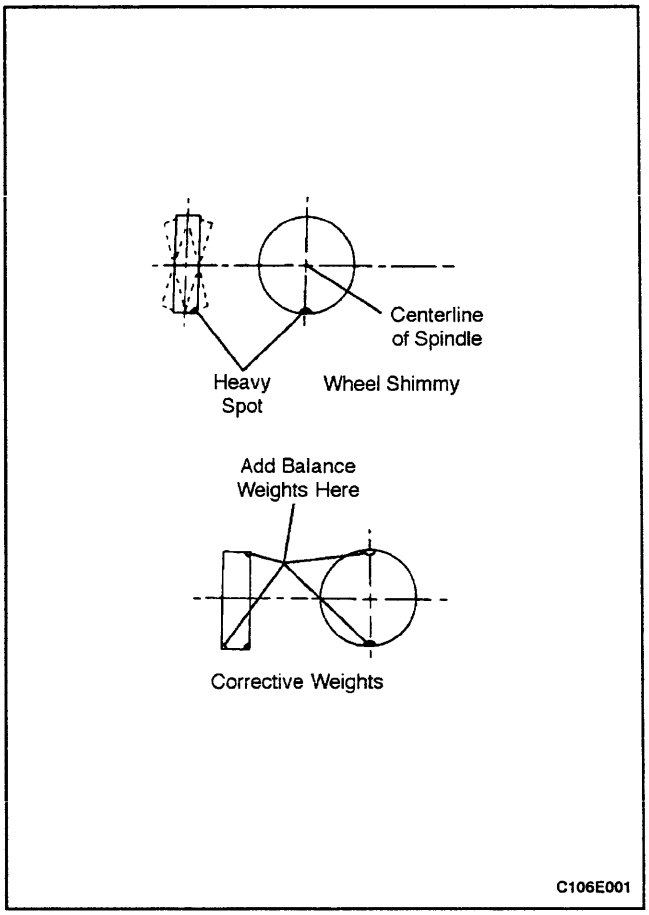
TIRE AND WHEEL BALANCING

There are two types of tire and wheel balancing: static and dynamic.

Static balance is the equal distribution of weight around the wheel. Assemblies that are statically unbalanced cause a bouncing action called wheel tramp. This condition may eventually cause uneven tire wear.



Dynamic balance is the equal distribution of weight on each side of the centerline so that when the assembly spins there is no tendency for it to move from side to side. Assemblies that are dynamically unbalanced may cause wheel shimmy.



General Balance Precautions

Remove all deposits of foreign material from the inside of the wheel.

Caution: Remove stones from the tread in order to avoid operator injury during spin balancing.

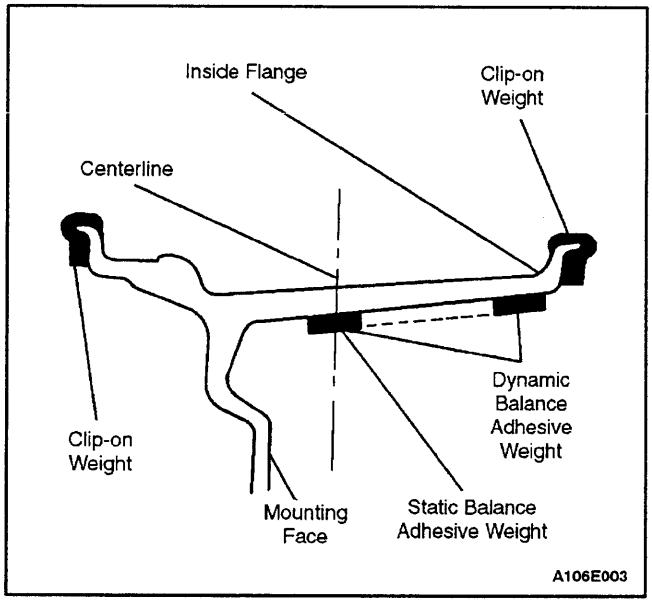
Inspect the tire for any damage. Balance the tire according to the equipment manufacturer's recommendations.

Wheel Weights

If more than 85 grams (3.0 ounces) are needed to static balance the wheel, split the wheel weights as equally as possible between the inboard and the outboard flanges.

Balancing the assemblies with factory alloy wheels requires the use of special nylon-coated, clip-on wheel weights. These weights are designed to fit over the thicker rim flange of the alloy wheel. Install these weights with a plastic-tipped hammer.

Adhesive wheel weights are also available. Use the following procedure to install adhesive wheel weights.



Adhesive Wheel Weight Installation

1. Clean the wheel by sanding it to bare alloy where the wheel weight will be installed.
2. Use a clean cloth or paper towel saturated with a mixture of half isopropyl alcohol and half water to wipe the place where the wheel weight will be installed.
3. Dry the area with hot air. The surface of the wheel should be warm to the touch.
4. Warm the adhesive backing on the wheel weights to room temperature.
5. Remove the tape from the back of the weights. Do not touch the adhesive surface.
6. Apply the the wheel weight and press it on with hand pressure.
7. Secure the wheel weight with a 70-110 N (16-25 lb) force applied with a roller.

TIRE CHAIN USAGE

Due to limited tire-to-body clearance on certain vehicles, recommendations for tire chain use are published in the Owner's Manual. When tire chains need to be used, most current Daewoo vehicles require SAE Class "S" tire chains. These may also be designated as 1100 Series, type PL tire chains. These chains are specifically designed to limit the "fly off" effect which occurs when the wheel rotates.

Be sure that only fine-link chains are used which do not add more than 15 mm (0.590 inch), including the lock, to the tread surface and the inner sides of the tires. Manufacturers of tire chains have a specific chain size for each tire size to ensure a proper fit when the chain is installed. Be sure to purchase the correct chains for the tires on which they are to be used. Use rubber adjusters to take up any slack or clearance in loose chains.

Use of chains may adversely affect vehicle handling.

When tire chains are installed, follow these precautions:

- Adjust speed to road conditions.
- Avoid sharp turns.
- Avoid locked-wheel braking.

To prevent chain damage to the vehicle, install the chains on the front tires as tightly as possible. Tighten them again after driving 0.4 to 0.8 kilometer (0.3 to 0.5 mile). The use of chains on the rear tires is not recommended because they may contact the vehicle and possibly damage it. If chains must be used on the rear tires, be sure there is sufficient clearance between the chains and the body. Do not exceed 70 km/h (45 mph) or the chain manufacturer's speed limit, if lower. Avoid large bumps, potholes, severe turns and any other maneuvers which could cause the tires to bounce. Follow any other instructions of the chain manufacturer which do not disagree with the above instructions.

REPLACEMENT TIRES

A tire performance criteria (TPC) specification number is molded in the sidewall near the tire size of all original equipment tires. This specification number assures that the tire meets performance standards for traction, endurance, dimensions, noise, handling and rolling resistance. Usually a specific TPC number is assigned to each tire size.

Caution: Do not mix different types of tires on the same vehicle such as radial, bias and bias-belted tires except in emergencies, because vehicle handling may be seriously affected and may result in loss of control.

Use only replacement tires with the same size, load range, and construction as the original. The use of any other tire size or construction type may seriously affect ride, handling, speedometer/odometer calibration, vehicle ground clearance, and tire clearance to the body and the chassis. This does not apply to the spare tire furnished with the vehicle.

It is recommended that new tires be installed in pairs on the same axle.

If it is necessary to replace only one tire, pair it with the tire having the most tread to equalize the braking action.

Although they may appear different in tread design, tires built by different manufacturers with identical TPC specifications may be used on the same vehicle.

ALL SEASON TIRES

Most vehicles are now equipped with steel-belted all season radial tires as standard equipment. These tires qualify as snow tires, with a 37 percent higher average rating for snow traction than the non-all season radial tires previously used. Other performance areas, such as wet traction, rolling resistance, tread life, and air retention, have also been improved. This was done by improvements in both tread design and tread compounds. These tires are identified by an "M + S" molded in the tire sidewall following the size number. The suffix "MS" is also molded in the sidewall after the TPC specification number.

The optional handling tires used on some vehicles are not all season tires. These will not have the "MS" marking after the tire size or the TPC specification number.

PASSENGER METRIC SIZED TIRES

All Daewoo vehicles now use passenger (P) metric sized tires. P-metric tires are available in two load ranges: standard load (35 psi maximum) and extra load (41 psi maximum). Most passenger vehicle tires are standard load.

Most P-metric tire sizes do not have exact corresponding alphanumeric tire sizes. For example, a P175/70R13 is not exactly equal in size and load-carrying capacity to an FR70-13. For this reason, replacement tires should be of the same TPC specification number as the originals. If P-metric tires must be replaced with other sizes, consult a tire dealer. Tire companies can best recommend the closest match of alphanumeric to P-metric sizes within their own tire lines.

The metric term for measuring tire inflation pressure is the kilopascal (kPa). Tire pressure may be printed in both kPa and psi. One psi equals 6.895 kPa.

See the tire label or refer to "Tire Size and Pressure Specifications" in this section for tire inflation pressures.

TIRE LABEL

The tire label is permanently located on the rear face of the driver's door and should be referred to for tire information. It lists the maximum vehicle load, the tire size (including the spare tire), and the cold inflation pressure (including the spare tire).

SPARE TIRE

This vehicle comes equipped with a full-sized spare tire and wheel.

WHEELS

Wheels must be replaced if they are bent, dented, have excessive lateral or radial runout, leak air through welds, have elongated bolt holes, or if the wheel bolts won't stay tight or are heavily rusted. Wheels with excessive runout may cause vehicle vibration. Replacement wheels must be equivalent to the original equipment wheels in load capacity, diameter, rim width, offset, and mounting configuration. A wheel of improper size or type may affect wheel and bearing life, brake cooling, speedometer/odometer calibration, vehicle ground clearance, and tire clearance to the body and the chassis. The wheel offset is 49 $\pm$ 1 mm (1.93 $\pm$ 0.04 inches). Steel wheels may be identified by a two- or three-letter code stamped into the rim near the valve stem. Alloy wheels should have the code, the part number, and the manufacturer ID cast into the back side.

INFLATION OF TIRES

The pressure recommended for any vehicle line is carefully calculated to give a satisfactory ride, handling, tread life, and load-carrying capacity.

Tire pressure should be checked monthly or before any extended trip. Check the tires when they are cold, after the vehicle has sat for 3 hours or more or has been driven less than 1 mile. Set the tire pressure to the specifications on the tire label located on the rear face of the driver's door. Tire inflation pressure is also given under "Tire Size and Pressure Specifications" in this section.

Valve caps or extensions should be on the valves to keep dust and water out.

For sustained driving at speeds up to 140 km/h (85 mph), inflate the tires to the pressure recommended on the tire. Sustained driving at speeds faster than 140 km/h (85 mph), even if permitted by law, is not advised unless the vehicle has special high-speed tires available from many tire dealers. Tire pressures may increase as much as 41 kPa (6 psi) when the tires are hot.

Higher than recommended tire pressure can cause

- Hard ride.
- Tire bruising or damage.
- Rapid tread wear at the center of the tire.

Lower than recommended pressure can cause

- Tire squeal on turns.
- Hard steering.
- Rapid and uneven wear on the edges of the tread.
- Tire rim bruises and rupture.
- Tire cord breakage.
- High tire temperatures.

Unequal tire pressures on same axle can cause

- Uneven braking.
- Steering lead.
- Reduced handling.
- Swerve on acceleration.
- Torque steer.

DRIVELINE/AXLE

CONTENTS

SECTION 3A

AUTOMATIC TRANSAXLE DRIVE AXLE

TABLE OF CONTENTS

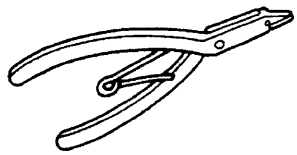
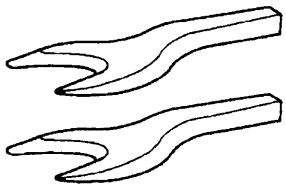
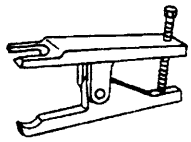
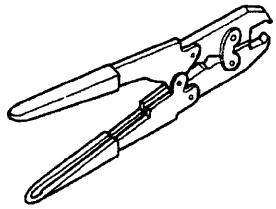
SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Axle Shaft Caulking Nut Initial Torque	180	133	-
Axle Shaft Caulking Nut Final Torque	50 + 60°	37 + 60°	-
Lower Ball Joint Nut and Bolt	90	66	-
Tie Rod Nut	60	44	-
Wheel Bolts	90	66	-

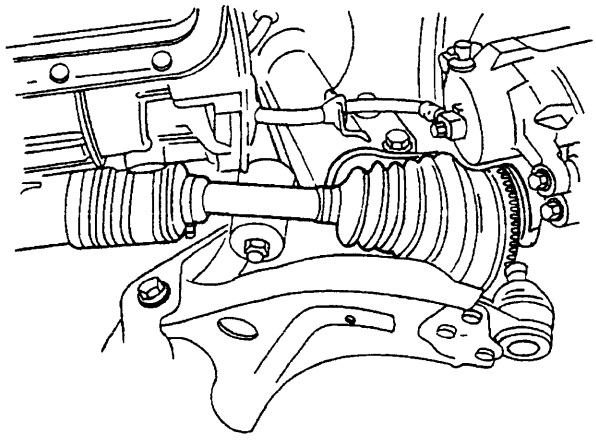
SPECIAL TOOLS

SPECIAL TOOLS TABLE

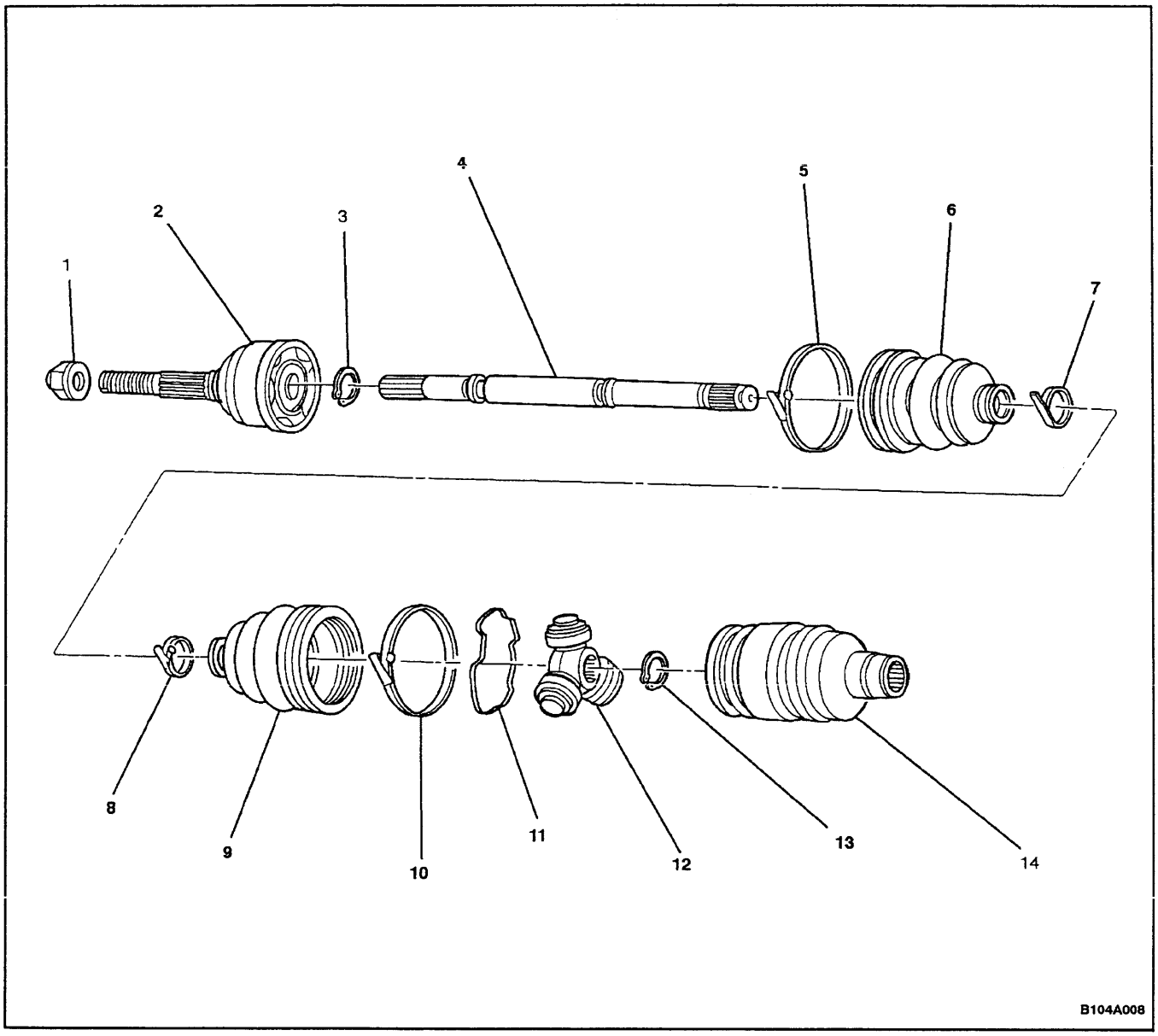
 A104A001	J-8059 Snap Ring Pliers
 A106C032	KM-460-A Axle Shaft Remover
 C106C034	KM-333 Ball Joint Separator
 A104A008	J-35566 Seal Clamp Pliers

COMPONENT LOCATOR

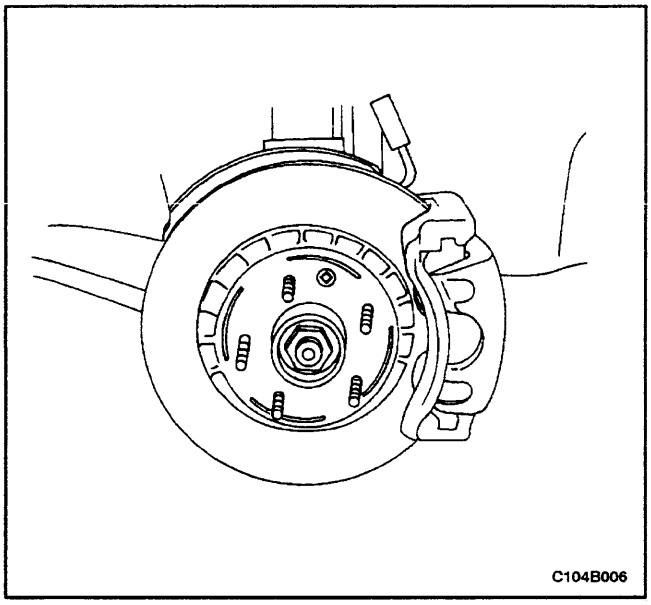
FRONT DRIVE AXLE



C104A002



1 Caulking Nut
2 C/V Joint
3 Snap Ring
4 Axle Shaft (right-hand shown, left-hand similar)
5 Seal Retaining Clamp
6 Drive Axle Outboard Seal
7 Seal Retaining Clamp
8 Seal Retaining Clamp
9 Drive Axle Inboard Seal
10 Seal Retaining Clamp
11 Tripot Joint Retaining Ring
12 Tripot Joint
13 Shaft Retaining Ring
14 Tripot Housing


C104B006

MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

DRIVE AXLE ASSEMBLY

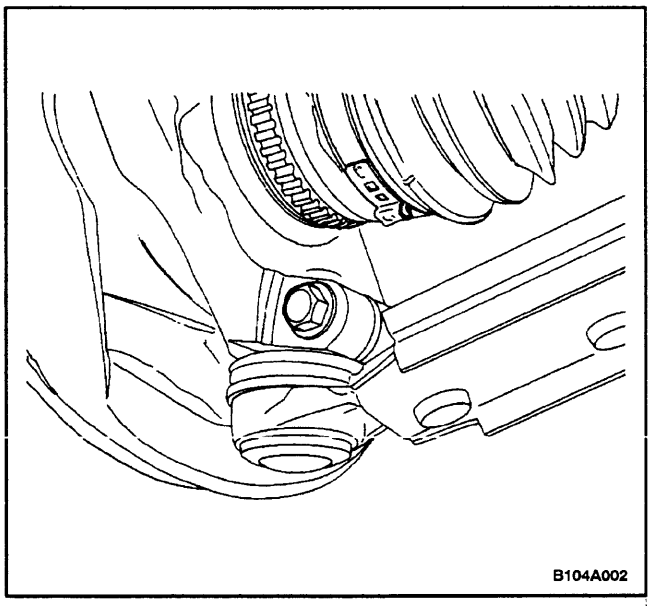
Tools Required

KM-333 Ball Joint Separator

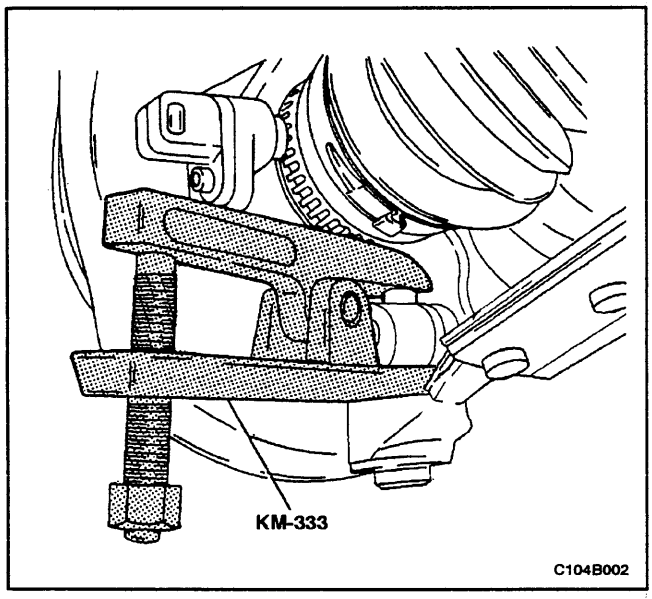
KM-460-A Axle Shaft Remover

Removal Procedure

1. Raise and suitably support the vehicle.
2. Remove the wheels. Refer to *Section 2E, Tires and Wheels*.
3. Remove the engine under covers. Refer to *Section 9N, Frame and Underbody.*
4. Remove the axle shaft caulking nut. Discard the nut.


B104A002

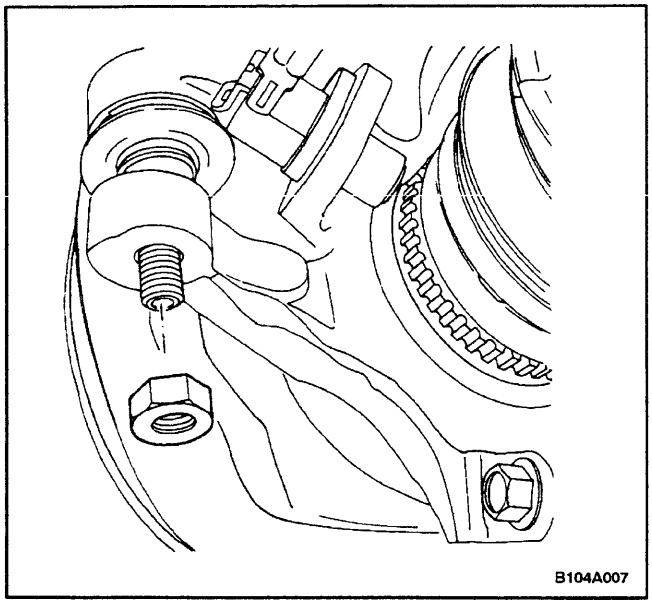
5. Remove the lower ball joint nut and bolt.



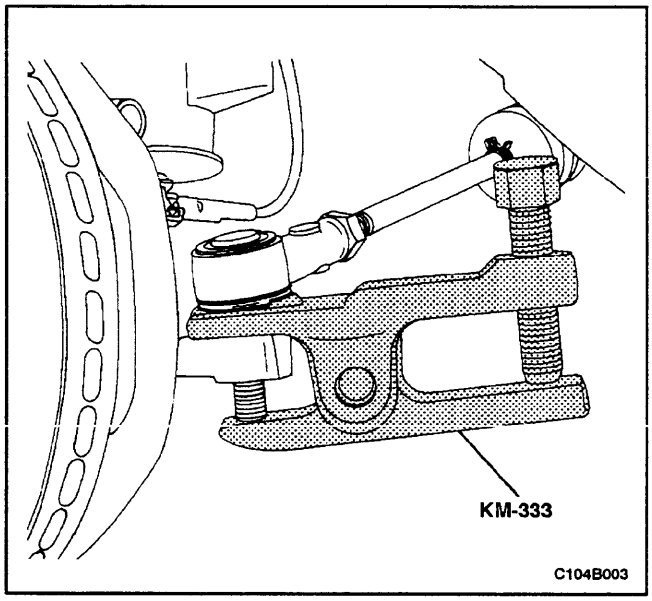
C104B002

Notice: Use only the recommended tool for separating the lower ball joint. Failure to use the recommended tool may cause damage to the ball joint and the seal.

6. Separate the steering knuckle from the lower ball joint using the ball joint separator KM-333.

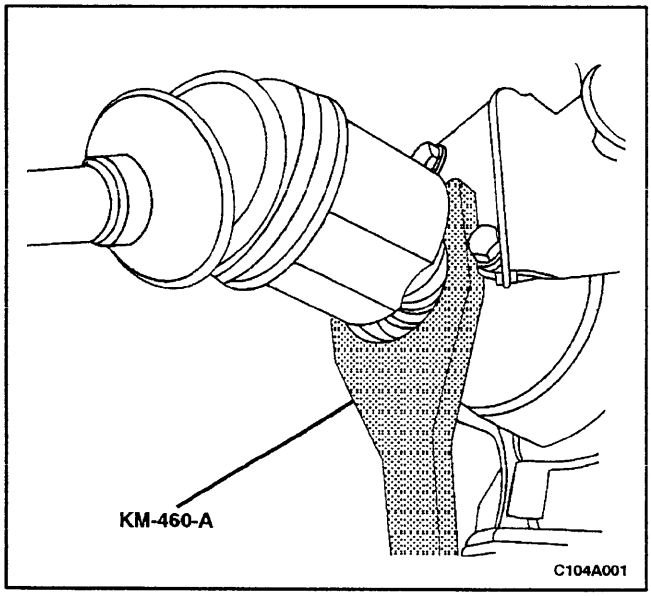


7. Remove the tie rod nut.



Notice: Use only the recommended tool for separating the tie rod from the knuckle/strut assembly. Failure to use the recommended tool may cause damage to the knuckle/strut assembly.

8. Separate the tie rod end using the ball joint separator KM-333.

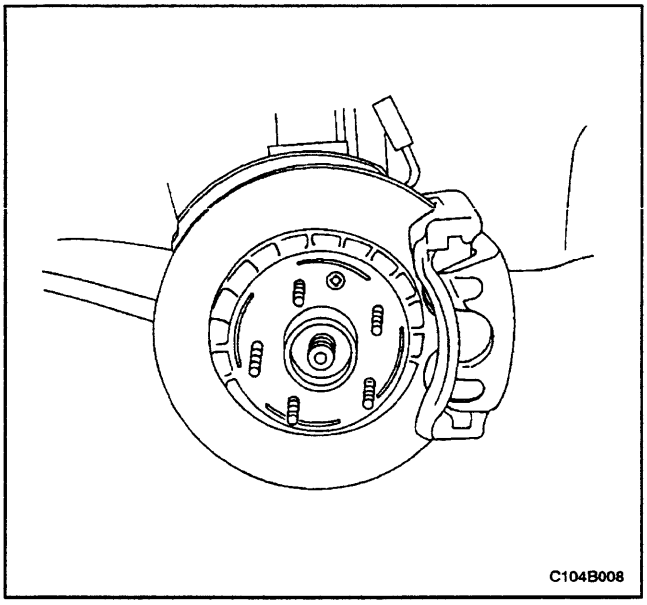


9. Push the drive axle shaft from the wheel hub.

Important: Support the unfastened end of the drive axle. Do not allow the drive axle to dangle freely from the transaxle for any length of time after it has been removed from the wheel hub.

Important: Place a drain pan below the transaxle to catch the escaping fluid. Cap the transaxle drive opening after the drive axle has been removed to keep the fluid in and any contamination out.

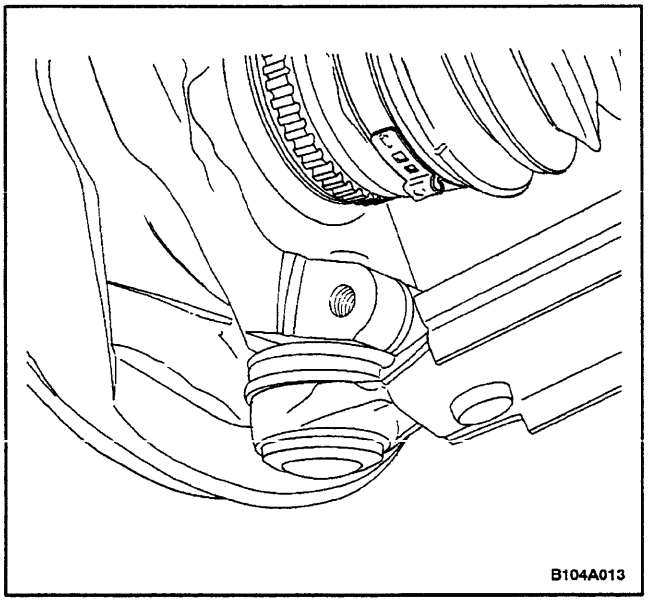
10. Remove the drive axle from the transaxle using the axle shaft remover KM-460-A.


C104B008

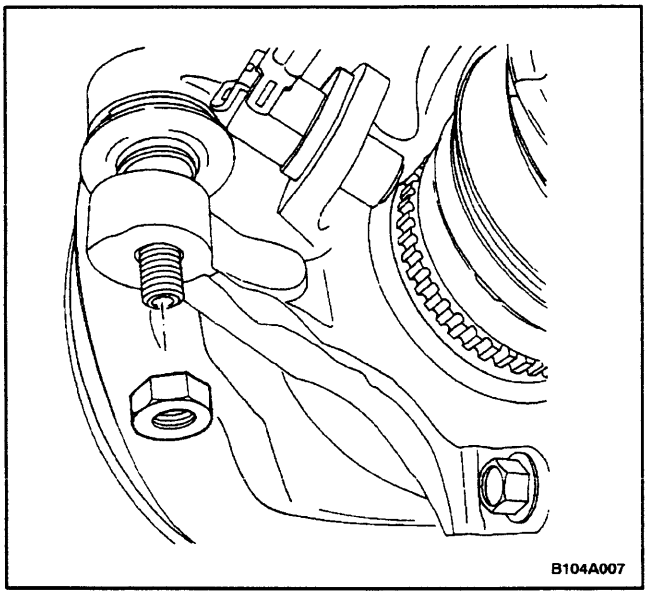
Installation Procedure

Notice: Do not damage the seals.

1. Clean the hub seal and the transaxle seal.
2. Install the drive axle into the transaxle.
3. Install the wheel hub onto the axle shaft.


B104A013

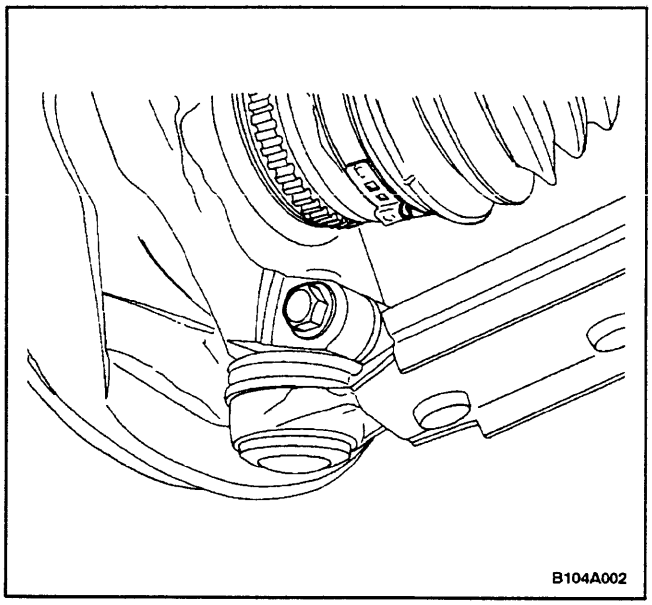
4. Mount the steering knuckle onto the lower ball joint.


B104A007

5. Install the tie rod into the knuckle/strut and install the tie rod nut.

Tighten

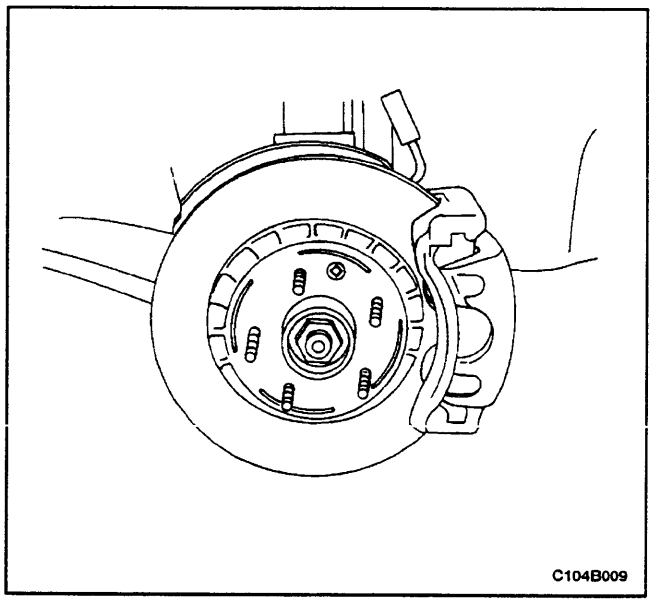
Tighten the tie rod nut to 60 N•m (44 lb-ft).


B104A002

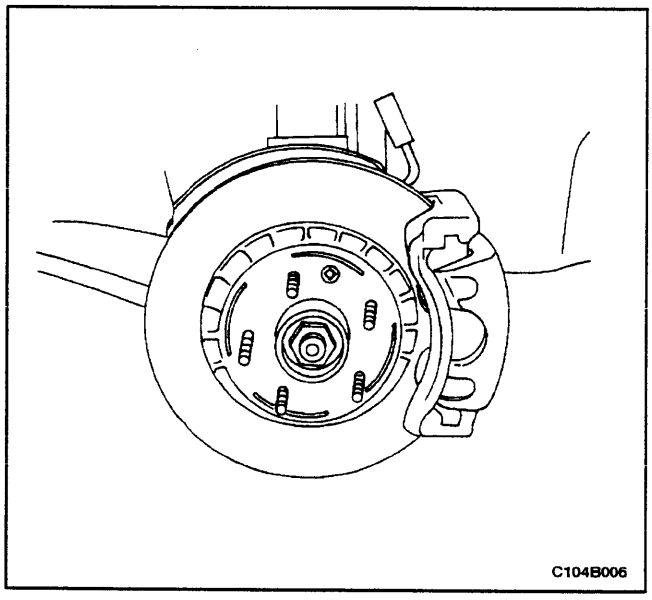
6. Install the lower ball joint bolt and nut.

Tighten

Tighten the lower ball joint bolt and nut to 90 N•m (66 lb-ft).


C104B009

7. Loosely install a new axle shaft caulking nut. Always use a new nut.

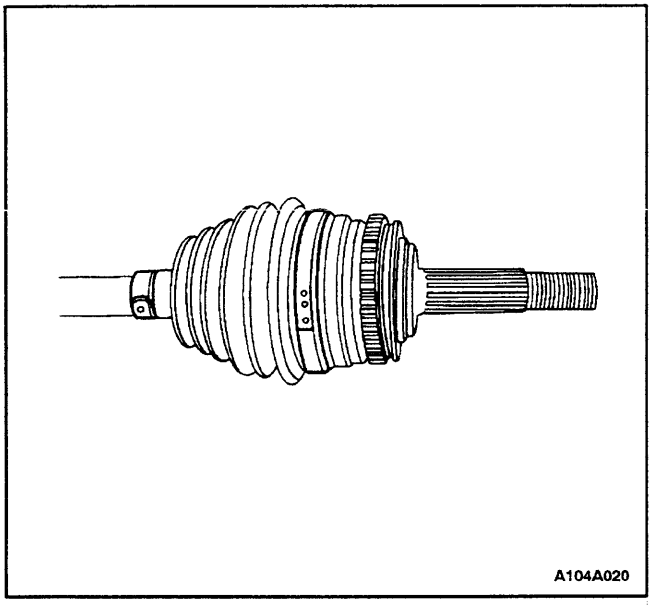

C104B006

8. Install the wheels. Loosely install the bolts. Refer to *Section 2E, Tires and Wheels*.
9. Lower the vehicle to the floor.

Tighten

Tighten the wheel bolts to 90 N•m (66 lb-ft).

10. Peen the caulking nut with a punch and a hammer until the nut is locked into place on the axle shaft hub.
11. Tighten the axle shaft caulking nut to 180 N•m (133 lb-ft). Loosen the nut and re-tighten the nut to 50 N•m (37 lb-ft). Then tighten the nut further by 60 degrees.
12. Install the engine under covers. Refer to *Section 9N, Frame and Underbody.*
13. Refill the transaxle fluid to the proper level. Refer to *Section 5A, 4T40E Automatic Transaxle.*


A104A020

UNIT REPAIR

OUTER JOINT SEAL

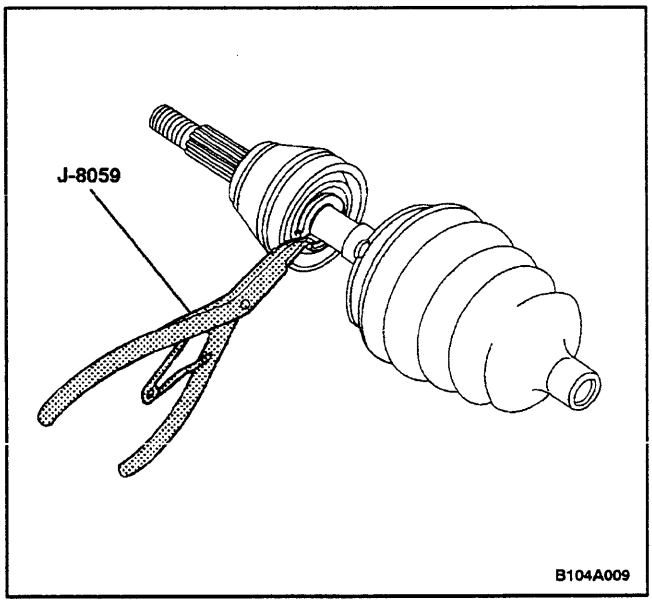
Tools Required

J-8059 Snap Ring Pliers

J-35566 Seal Clamp Pliers

Removal Procedure

1. Remove the drive axle from the vehicle. Refer to "Drive Axle Assembly" in this section.
2. Remove the large seal retaining clamp. Discard the clamp.
3. Remove the small seal retaining clamp. Discard the clamp.

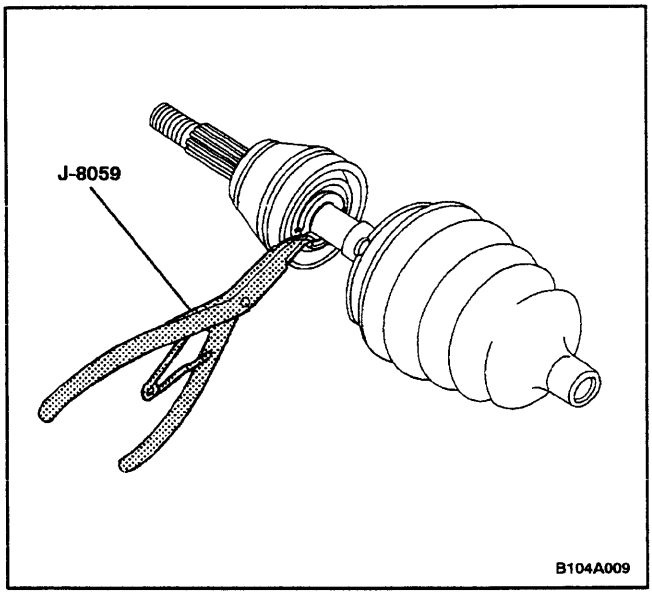


B104A009

4. Degrease the joint.
5. Spread the snap ring using the snap ring pliers J-8059 and remove the outer joint from the axle shaft.

Caution: Do not disassemble the outer joint assembly. Parts are match fit and cannot be serviced separately. Improper reassembly will adversely affect both performance and safety.

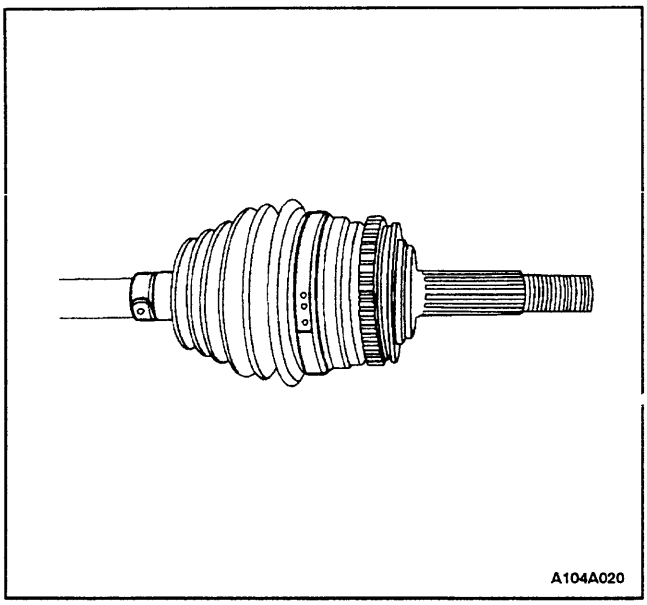
6. Remove the seal from the joint assembly.



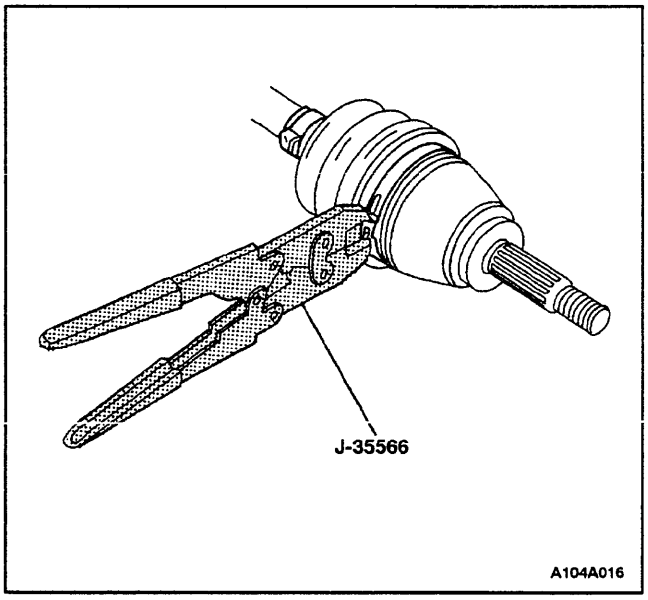
B104A009

Installation Procedure

1. Install the seal onto the axle shaft.
2. Spread the snap ring using the snap ring pliers J-8059 and install the outer joint onto the axle shaft.
3. Fill the joint seal with 175 to 195 g (6.2 to 6.9 ounces) of the recommended grease. Repack the joint with 175 to 195 g (6.2 to 6.9 ounces) of the recommended grease.

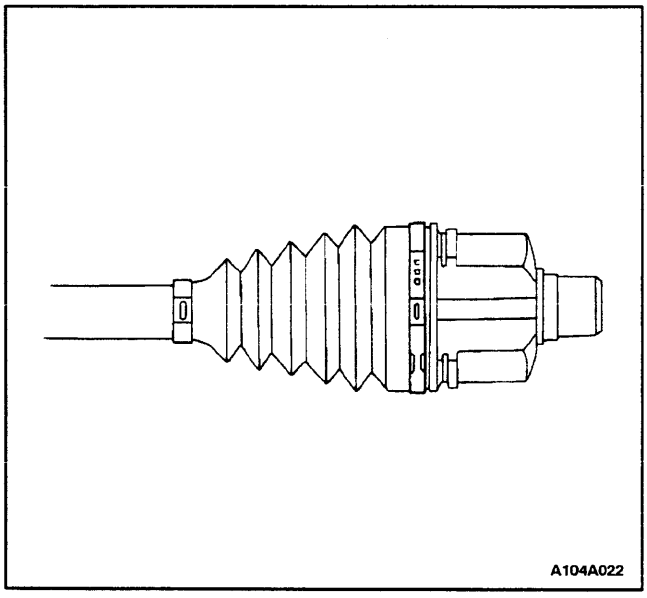

A104A020

4. Install a new large seal retaining clamp and a new small seal retaining clamp.



A104A016

5. Crimp the new small seal retaining clamp and the new large seal retaining clamp using the seal clamp pliers J-35566.
6. Install the drive axle shaft to the vehicle. Refer to "Drive Axle Assembly" in this section.


A104A022

INNER TRIPOT SEAL

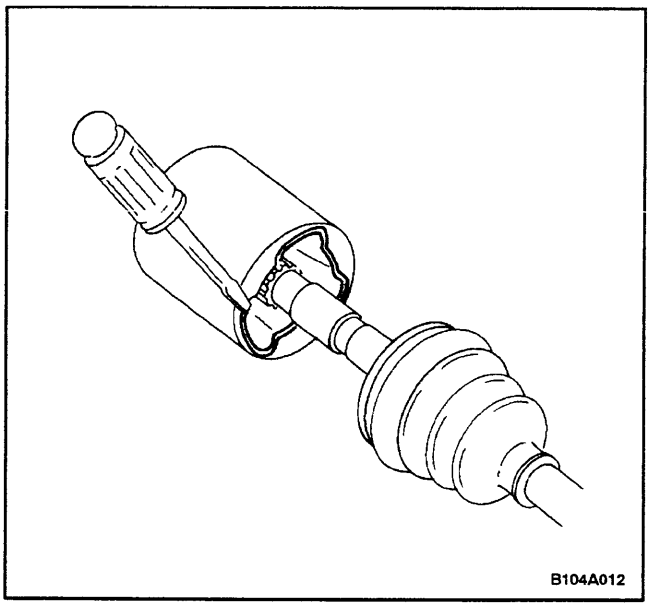
Tools Required

J-8059 Snap Ring Pliers

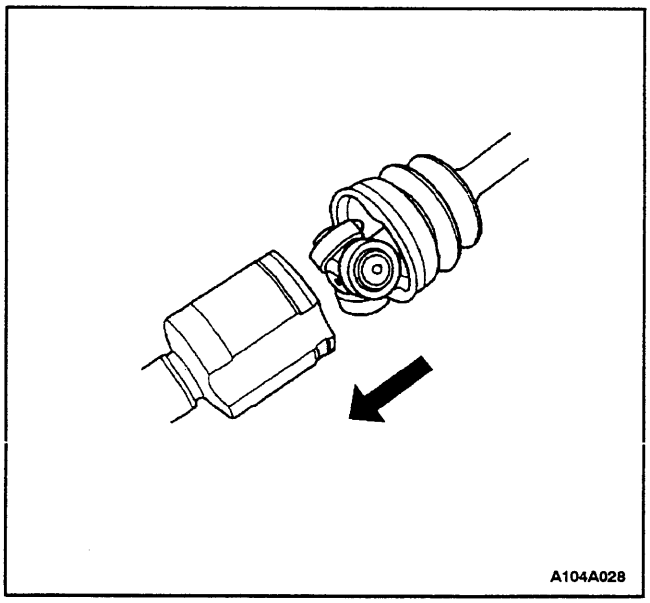
J-35566 Seal Clamp Pliers

Removal Procedure

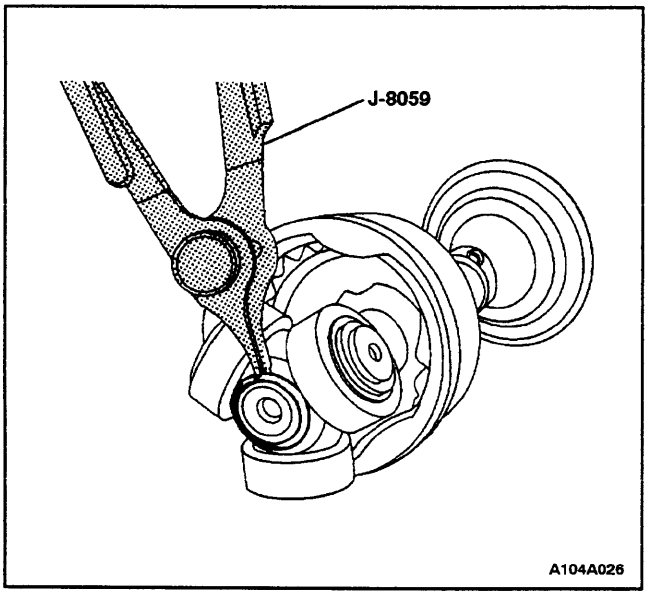
1. Remove the drive axle from the vehicle. Refer to "Drive Axle Assembly" in this section.
2. Remove the large seal retaining clamp. Discard the clamp.
3. Remove the small seal retaining clamp. Discard the clamp.



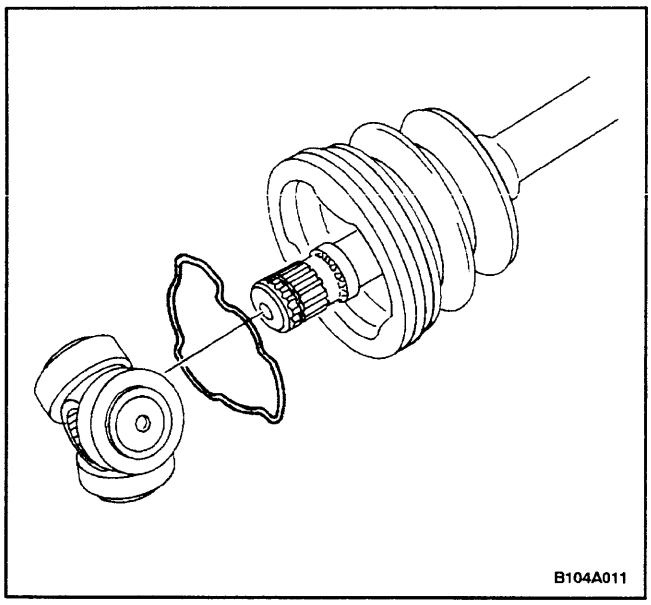
4. Pry the tripot joint retaining ring from the tripot housing.



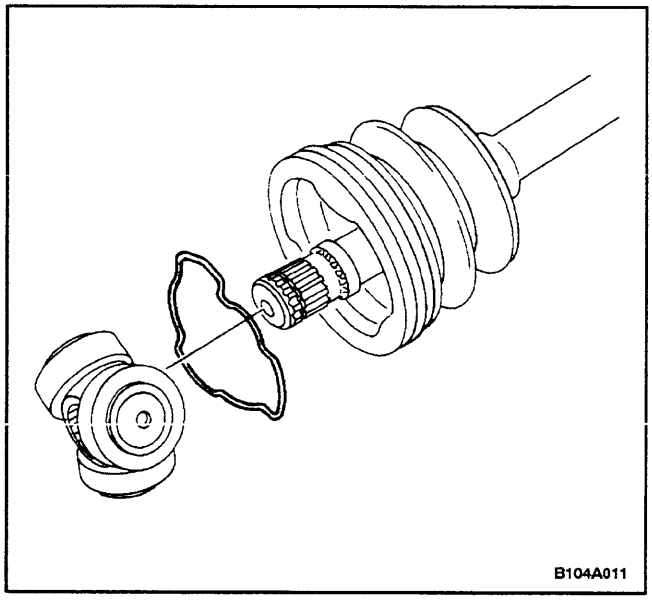
5. Remove the tripot housing from the seal.



6. Degrease the tripot assembly.
7. Remove the shaft retaining ring using the snap ring pliers J-8059.

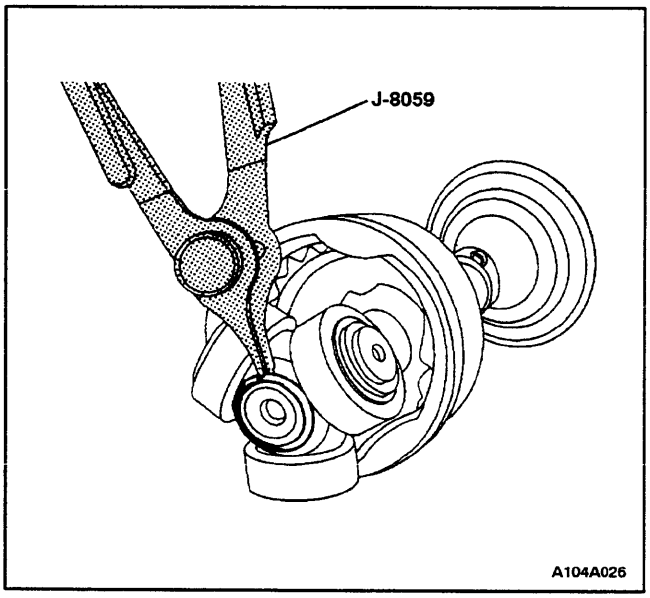


8. Remove the tripot and the tripot joint retaining ring from the axle shaft.
9. Remove the tripot joint seal from the axle shaft.

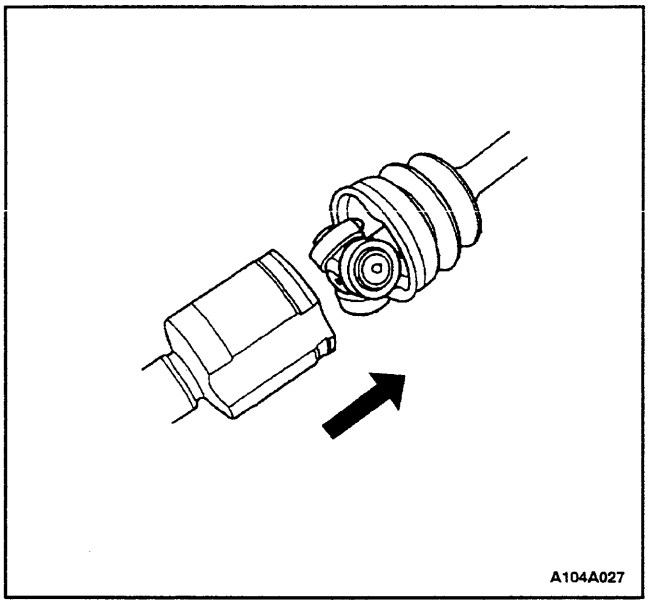


Installation Procedure

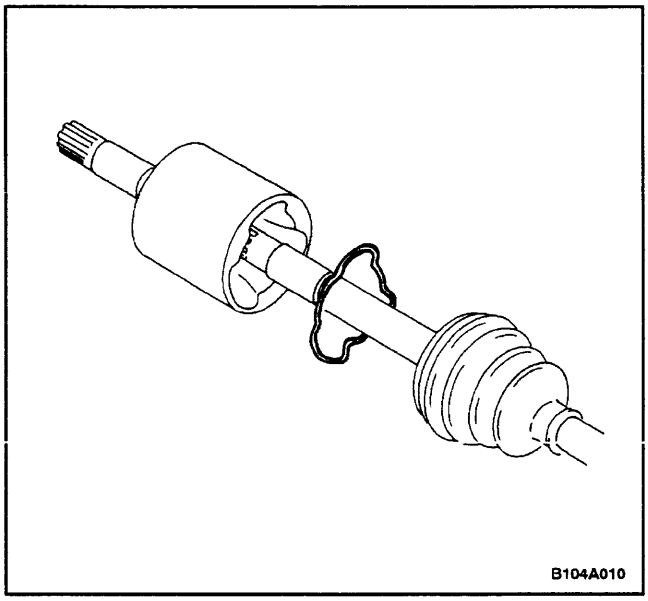
1. Install a new small seal retaining clamp onto the seal. Do not crimp the seal retaining clamp.
2. Install the seal onto the axle shaft.
3. Install the tripot joint retaining ring and the tripot onto the axle shaft.



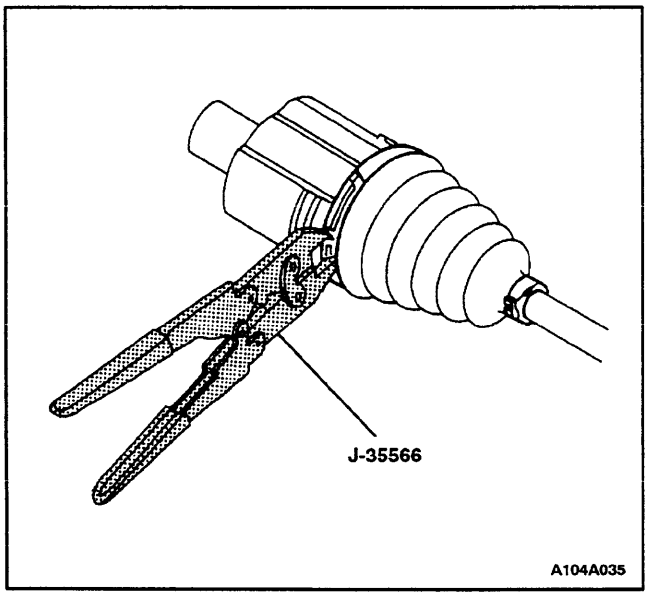
4. Install the shaft retaining ring onto the axle shaft using the snap ring pliers J-8059.


A104A027

5. Fill the tripot housing with 195 to 215 g (6.9 to 7.6 ounces) of the recommended grease. Repack the tripot with 195 to 215 g (6.9 to 7.6 ounces) of the recommended grease.
6. Install the tripot housing onto the tripot assembly.


B104A010

7. Install the tripot joint retaining ring into the tripot housing.



A104A035

8. Install a new large seal retaining clamp. Crimp the large seal retaining clamp using the seal clamp pliers J-35566.
9. Crimp the new small seal retaining clamp using the seal clamp pliers J-35566.
10. Install the drive axle shaft to the vehicle. Refer to "Drive Axle Assembly" in this section.

GENERAL DESCRIPTION AND SYSTEM OPERATION

FRONT DRIVE AXLE

General Description

Drive axles are flexible shaft assemblies that transmit rotational force from the transaxle to the front-wheel assemblies. Each axle assembly consists of an inner and an outer constant-velocity joint connected to an axle shaft. The inner joint is completely flexible and has the ability to move in and out. The outer joint is also flexible, but it cannot move in and out.

The drive axles use one type of outboard joint and one type of inboard joint. The inboard ends of both drive axles incorporate a female spline that installs over a stub shaft protruding from the transaxle.

SECTION 3B

MANUAL TRANSAXLE DRIVE AXLE

TABLE OF CONTENTS

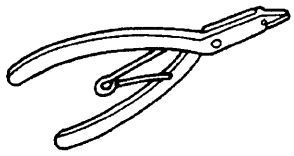
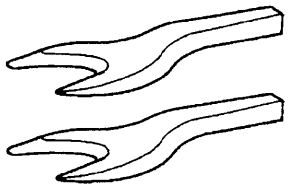
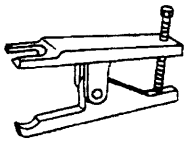
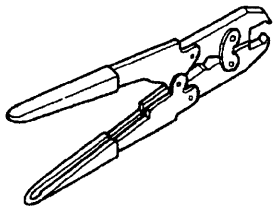
SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Axle Shaft Caulking Nut Initial Torque	180	133	-
Axle Shaft Caulking Nut Final Torque	50 + 60°	37 + 60°	-
Lower Ball Joint Nut and Bolt	90	66	-
Tie Rod Nut	60	44	-
Wheel Bolts	90	66	-

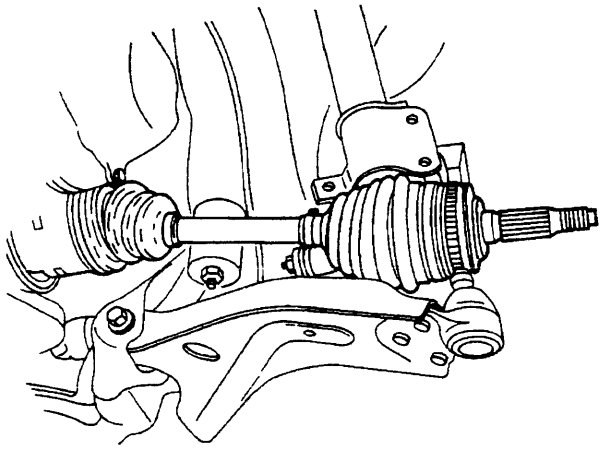
SPECIAL TOOLS

SPECIAL TOOLS TABLE

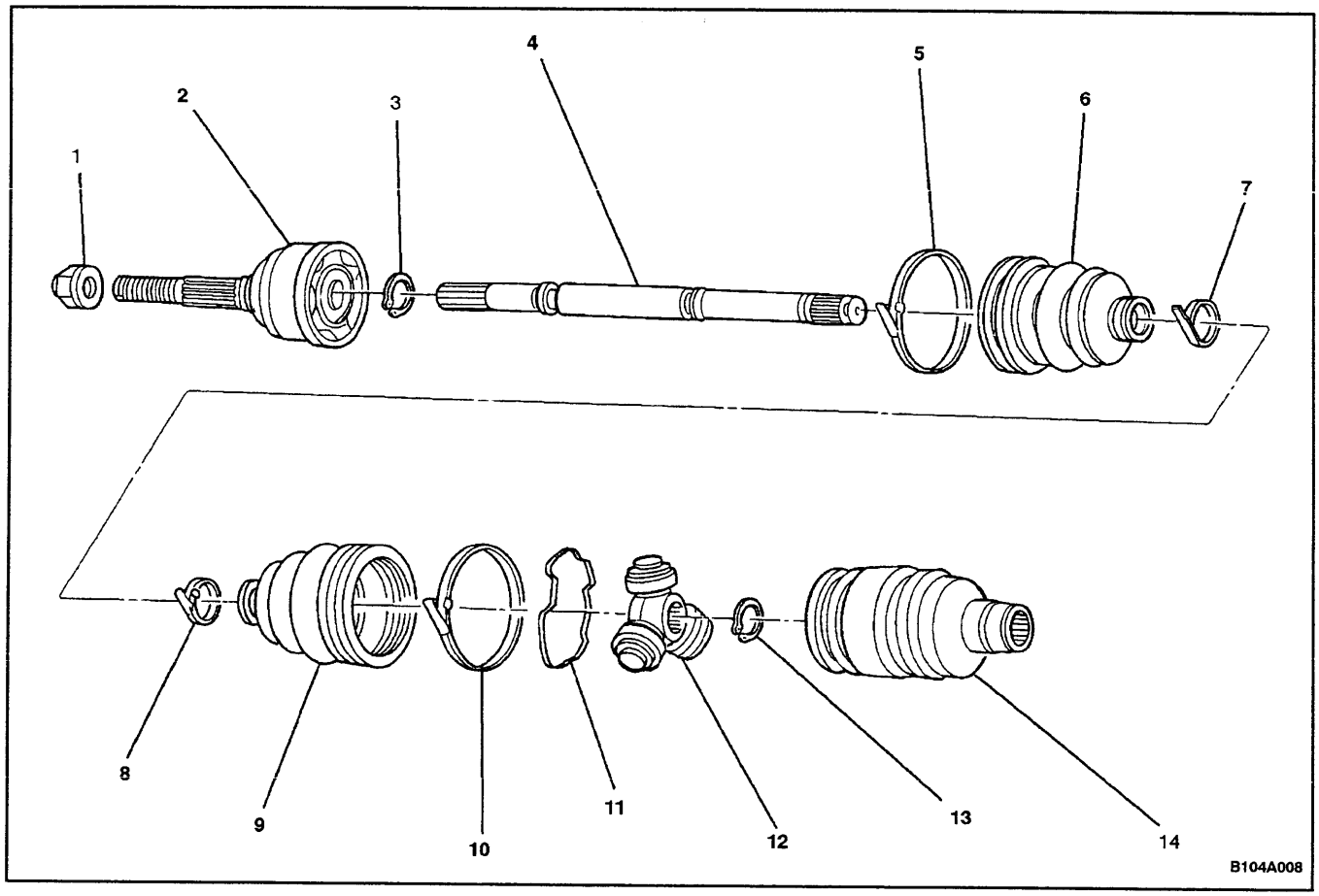
 A104A001	J-8059 Snap Ring Pliers	 A106C032	KM-460-A Axle Shaft Remover
 C106C034	KM-333 Ball Joint Separator	 A104A008	J-35566 Seal Clamp Pliers

COMPONENT LOCATOR

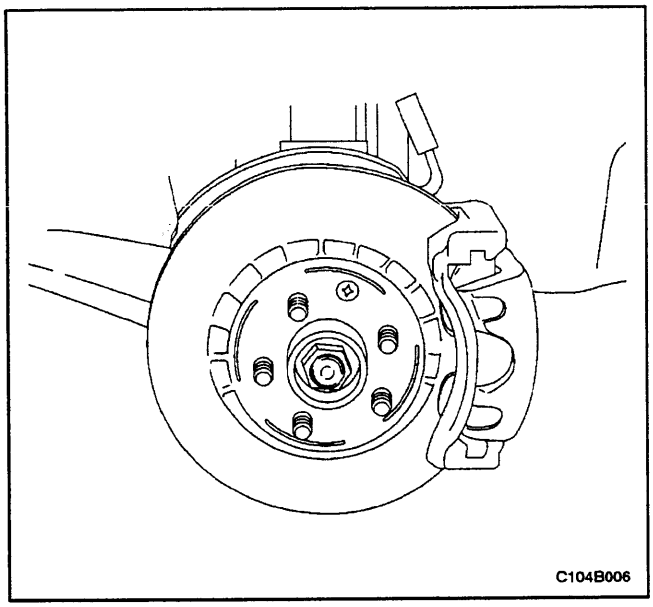
FRONT DRIVE AXLE



C104B001



1 Caulking Nut
2 C/V Joint
3 Snap Ring
4 Axle Shaft (right-hand shown, left-hand similar)
5 Seal Retaining Clamp
6 Drive Axle Outboard Seal
7 Seal Retaining Clamp
8 Seal Retaining Clamp
9 Drive Axle Inboard Seal
10 Seal Retaining Clamp
11 Tripot Joint Retaining Ring
12 Tripot Joint
13 Shaft Retaining Ring
14 Tripot Housing


C104B006

MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

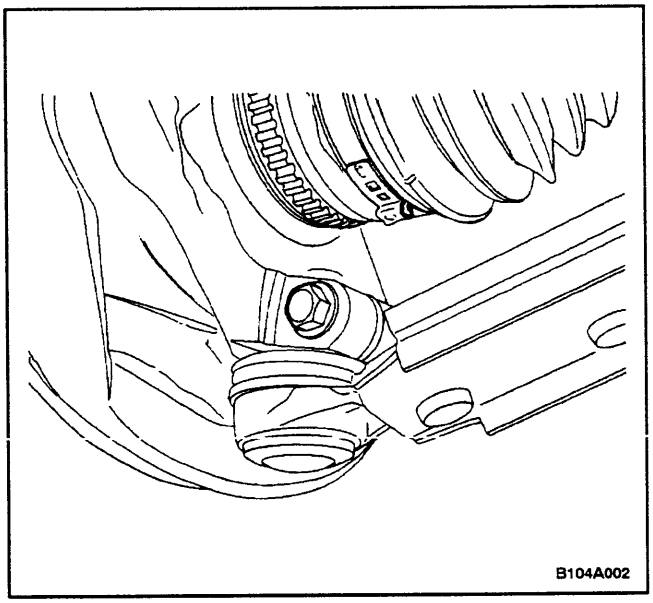
DRIVE AXLE ASSEMBLY

Tools Required

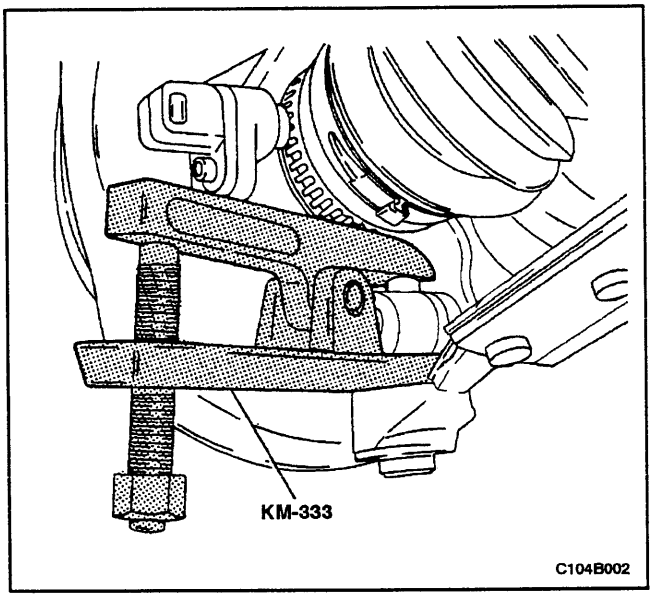
KM-333 Ball Joint Separator
KM-460-A Axle Shaft Remover

Removal Procedure

1. Raise and suitably support the vehicle.
2. Remove the wheels. Refer to *Section 2E, Tires and Wheels*.
3. Remove the engine under covers. Refer to *Section 9N, Frame and Underbody*.
4. Remove the axle shaft caulking nut. Discard the nut.


B104A002

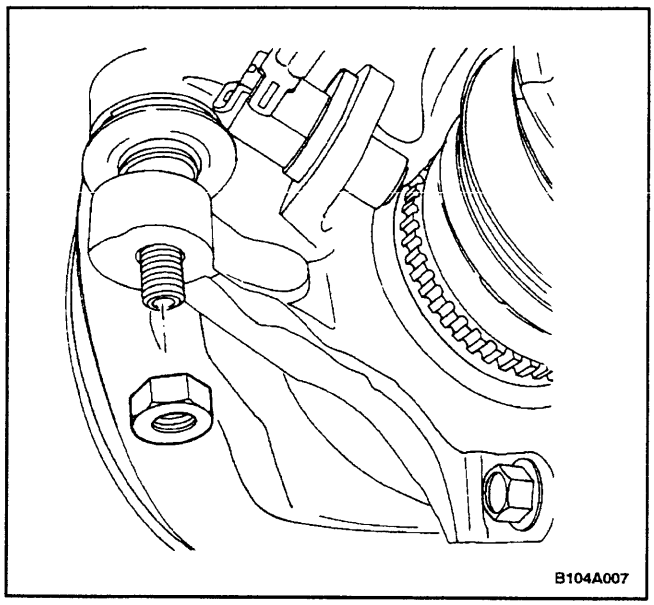
5. Remove the lower ball joint nut and bolt.



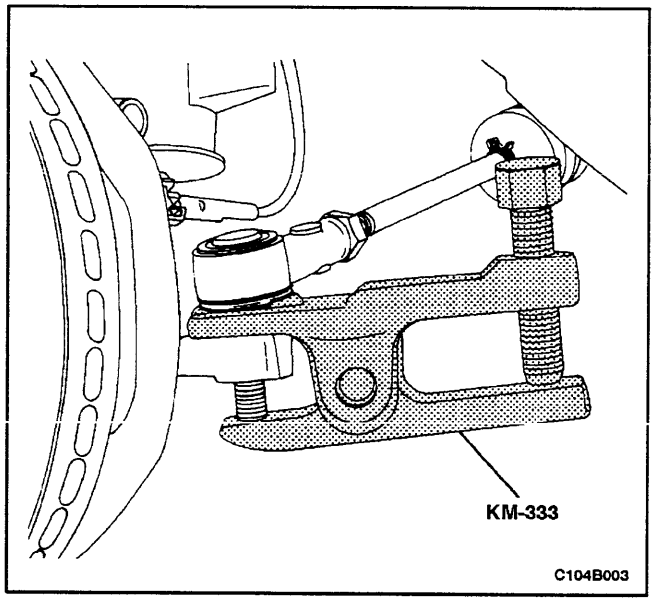
C104B002

Notice: Use only the recommended tool for separating the lower ball joint. Failure to use the recommended tool may damage the ball joint and the seal.

6. Separate the steering knuckle from the lower ball joint using the ball joint separator KM-333.

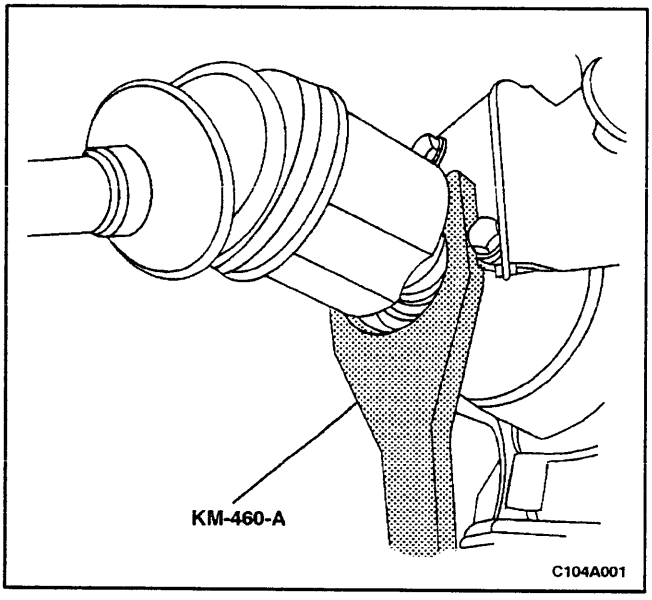


7. Remove the tie rod nut.



Notice: Use only the recommended tool for separating the tie rod from the knuckle/strut assembly. Failure to use the recommended tool may damage the knuckle/strut assembly.

8. Separate the tie rod end using the ball joint separator KM-333.

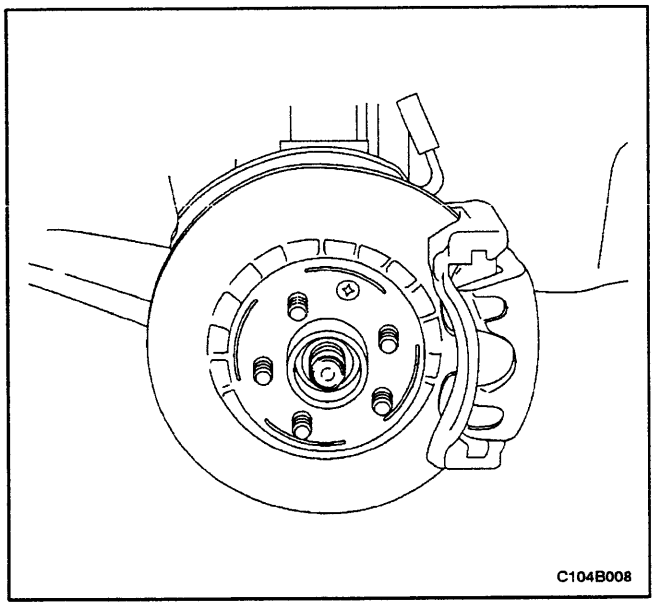


9. Push the drive axle shaft from the wheel hub.

Important: Support the unfastened end of the drive axle. Do not allow the drive axle to dangle freely from the transaxle for any length of time after it has been removed from the wheel hub.

Important: Place a drain pan below the transaxle to catch the escaping fluid. Cap the transaxle drive opening after the drive axle has been removed to keep the fluid in and any contamination out.

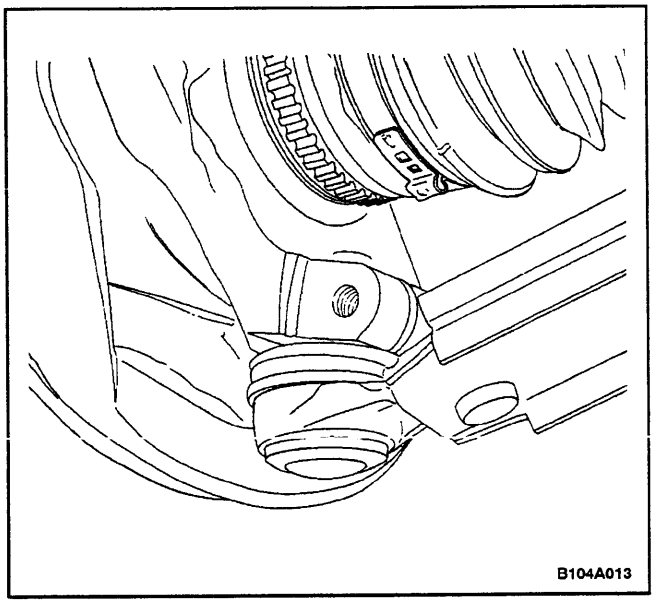
10. Remove the drive axle from the transaxle using the axle shaft remover KM-460-A.


C104B008

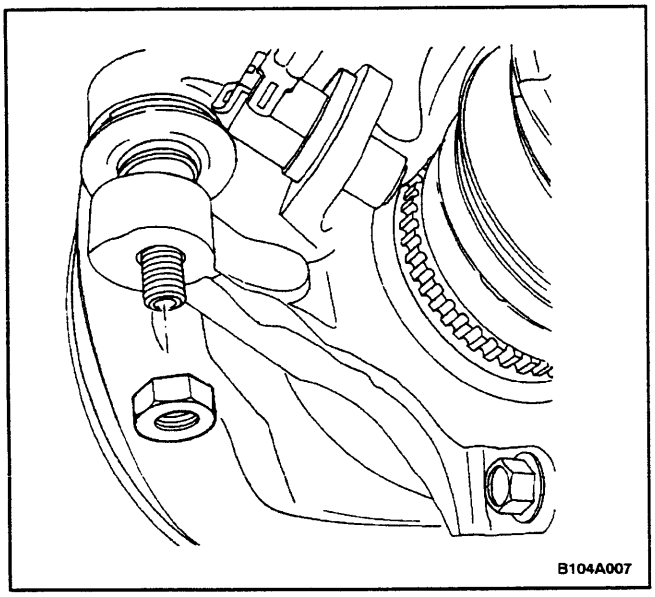
Installation Procedure

Notice: Do not damage the seal.

1. Clean the hub seal and the transaxle seal.
2. Install the drive axle into the transaxle.
3. Install the wheel hub onto the drive axle shaft.


B104A013

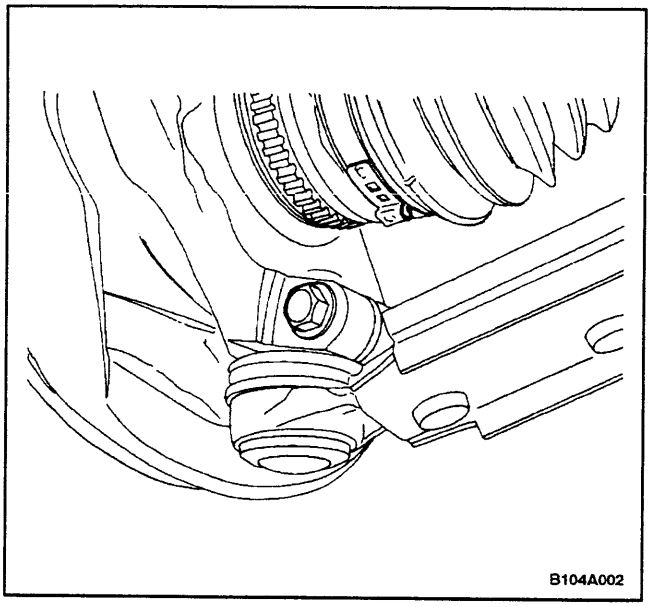
4. Mount the steering knuckle onto the lower ball joint.


B104A007

5. Install the tie rod into the knuckle/strut and install the tie rod nut.

Tighten

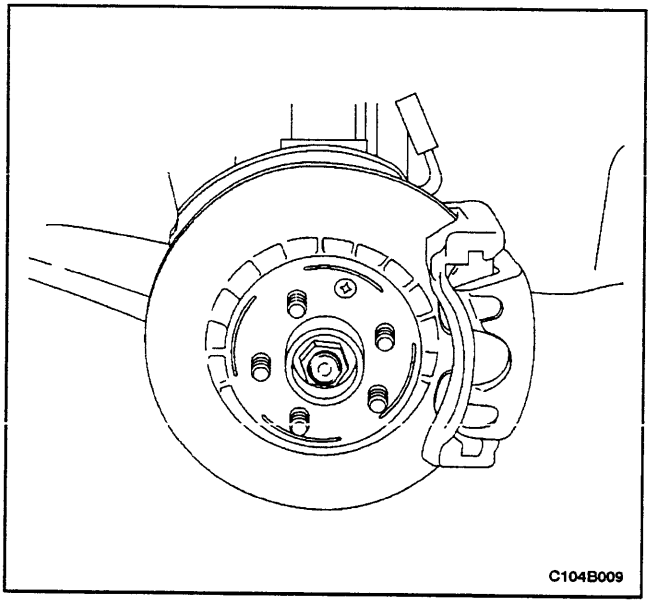
Tighten the tie rod nut to 60 N•m (44 lb-ft).



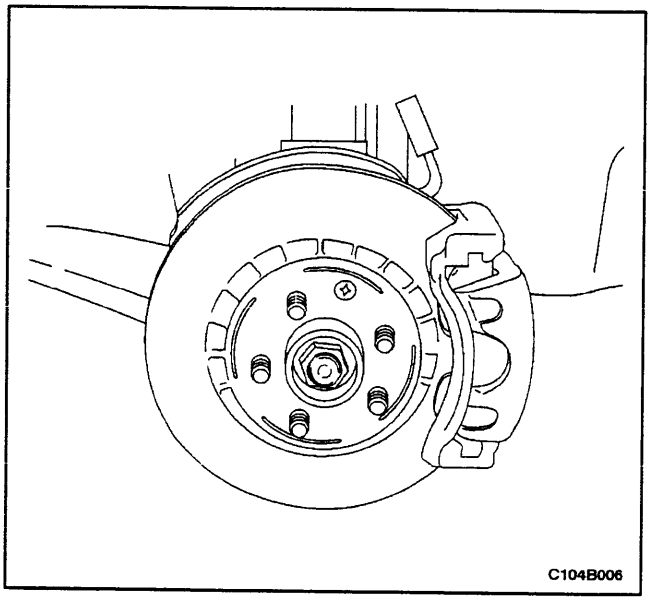
6. Install the lower ball joint nut and bolt.

Tighten

Tighten the lower ball joint nut and bolt to 90 N•m (66 lb-ft).



7. Loosely install a new axle shaft caulking nut. Always use a new nut.
8. Install the wheels. Loosely install the bolts. Refer to *Section 6E, Tires and Wheels.*



9. Lower the vehicle to the floor.

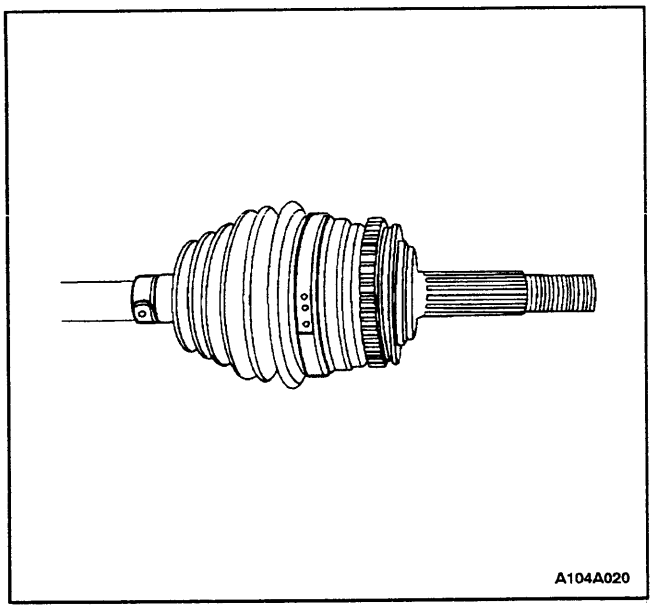
Tighten

Tighten the wheel bolts to 90 N•m (66 lb-ft).

Tighten

Tighten the axle shaft caulking nut to 180 N•m (133 lb-ft). Loosen the nut and re-tighten the nut to 50 N•m (37 lb-ft). Then tighten the nut further by 60 degrees.

10. Peen the caulking nut with a punch and a hammer until the nut is locked into place on the axle shaft hub.
11. Install the engine under covers. Refer to *Section 9N, Frame and Underbody.*
12. Refill the transaxle fluid to the proper level. Refer to *Section 5B, Five-Speed Manual Transaxle.*


A104A020

UNIT REPAIR

OUTER JOINT SEAL

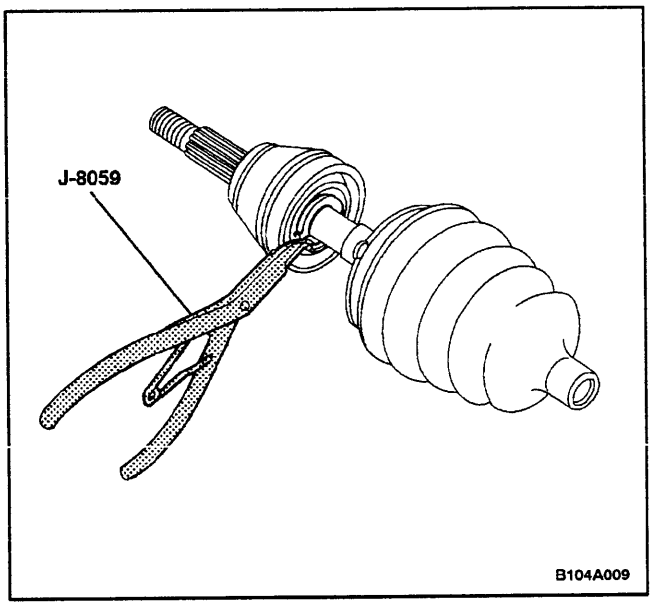
Tools Required

J-8059 Snap Ring Pliers

J-35566 Seal Clamp Pliers

Removal Procedure

1. Remove the drive axle shaft from the vehicle. "Refer to "Drive Axle Assembly" in this section.
2. Remove the large seal retaining clamp. Discard the clamp.
3. Remove the small seal retaining clamp. Discard the clamp.

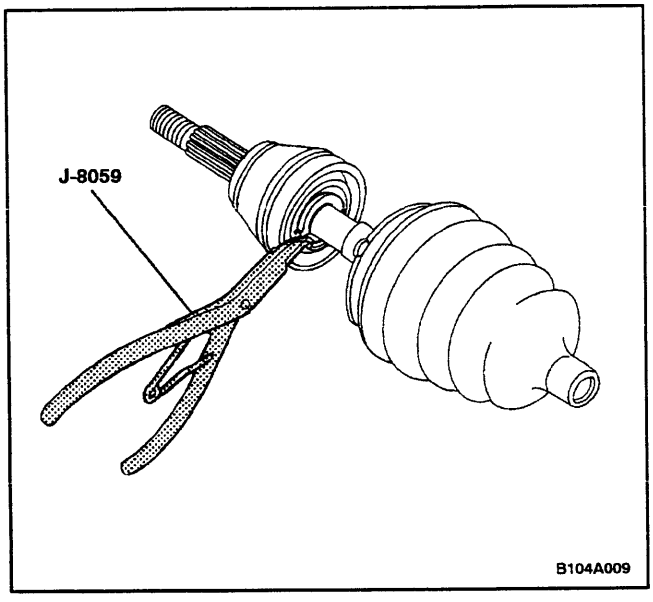


B104A009

4. Degrease the joint.
5. Spread the snap ring using the snap ring pliers J-8059 and remove the outer joint from the axle shaft.

Caution: Do not disassemble the outer joint assembly. Parts are match fit and cannot be serviced separately. Improper reassembly will adversely affect both performance and safety.

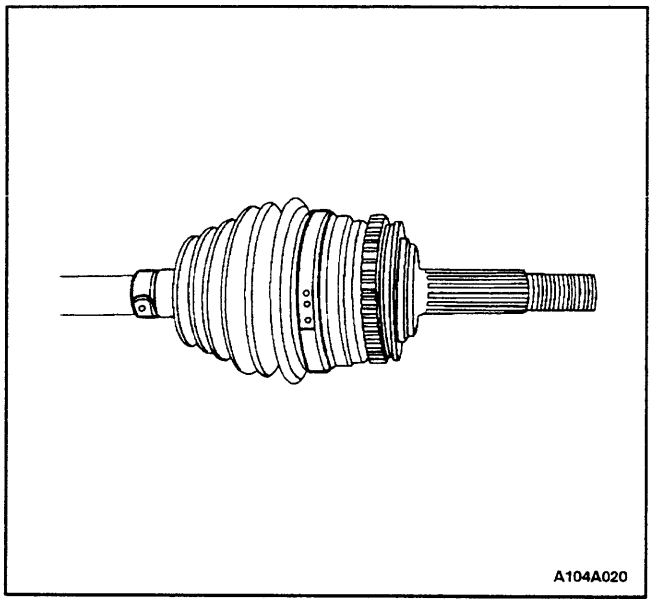
6. Remove the seal from the joint assembly.



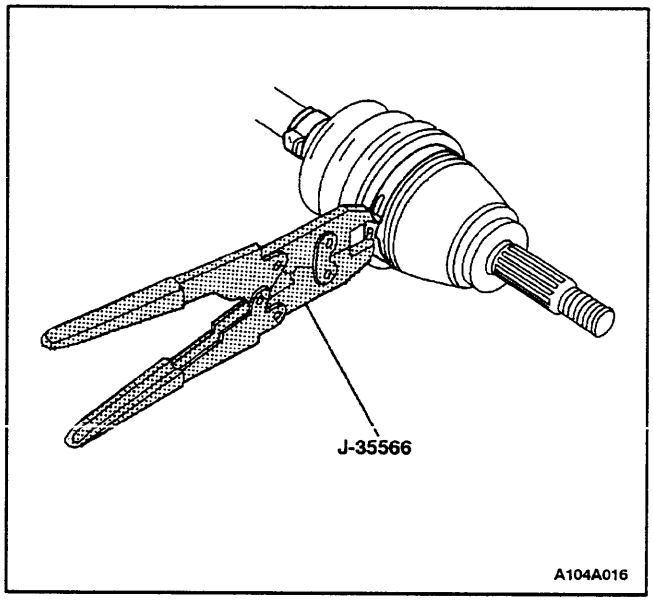
B104A009

Installation Procedure

1. Install the seal onto the axle shaft.
2. Spread the snap ring using the snap ring pliers J-8059 and install the outer joint onto the axle shaft.
3. Fill the joint seal with 175 to 195 g (6.2 to 6.9 ounces) of the recommended grease. Repack the joint with 175 to 195 g (6.2 to 6.9 ounces) of the recommended grease.

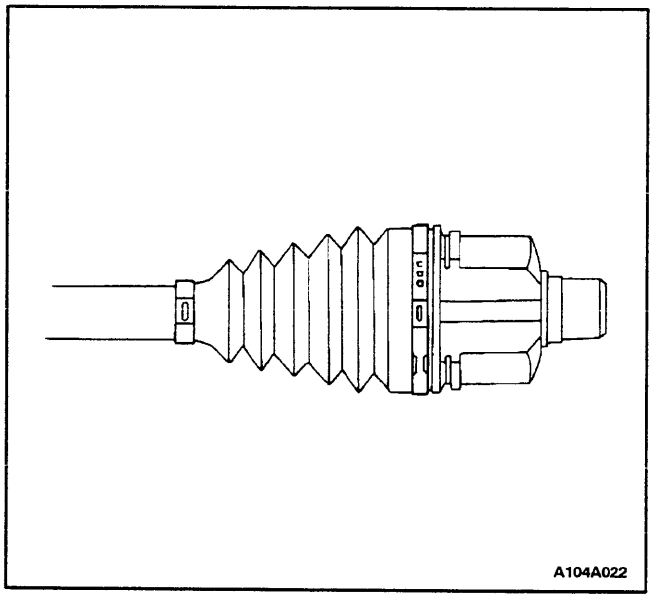

A104A020

4. Install a new large seal retaining clamp and a new small seal retaining clamp.



A104A016

5. Crimp the new small seal retaining clamp and the new large seal retaining clamp using the seal clamp pliers J-35566.
6. Install the drive axle shaft onto the vehicle. Refer to "Drive Axle Assembly" in this section.


A104A022

INNER TRIPOT SEAL

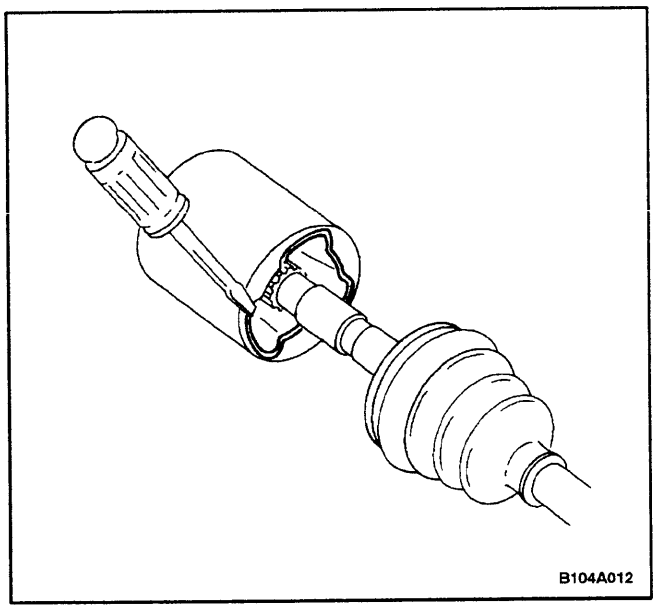
Tools Required

J-8059 Snap Ring Pliers

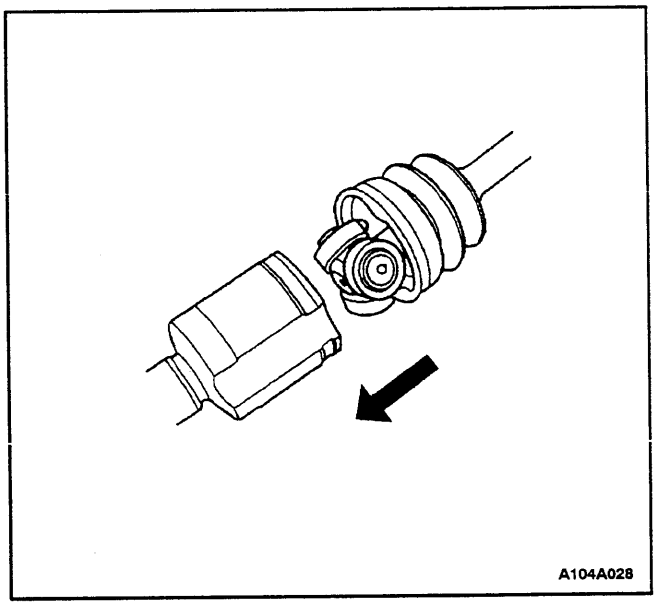
J-35566 Seal Clamp Pliers

Removal Procedure

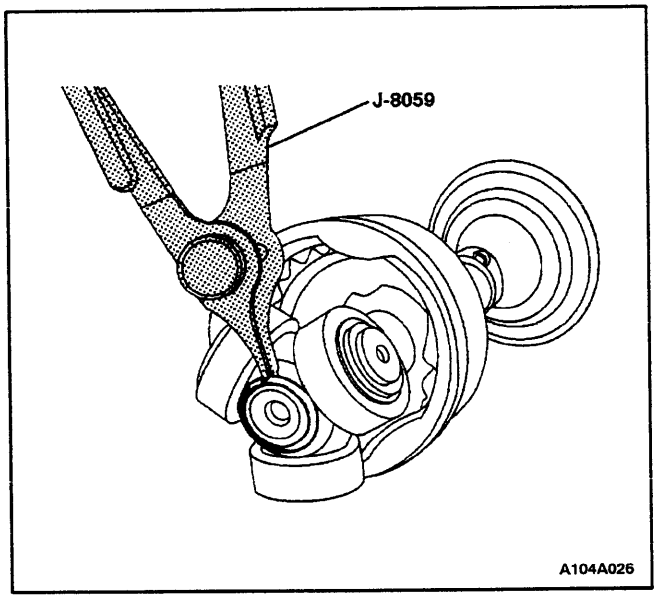
1. Remove the drive axle from the vehicle. Refer to "Drive Axle Assembly" in this section.
2. Remove the large seal retaining clamp. Discard the clamp.
3. Remove the small seal retaining clamp. Discard the clamp.



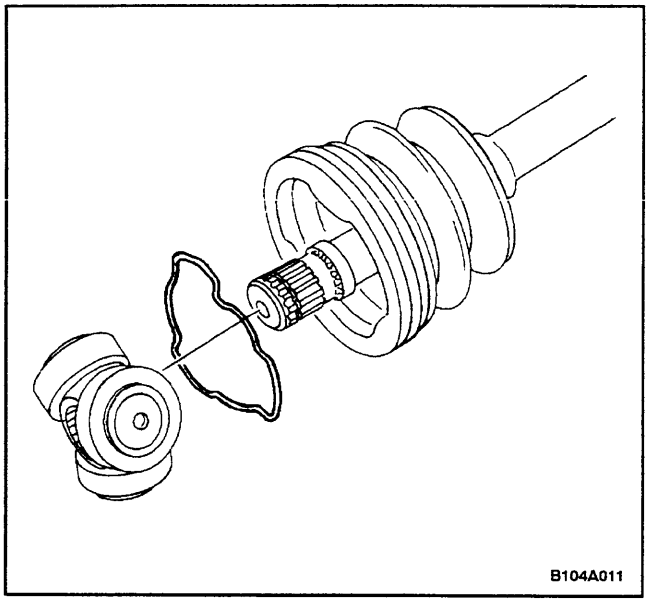
4. Pry the tripot joint retaining ring from the tripot housing.



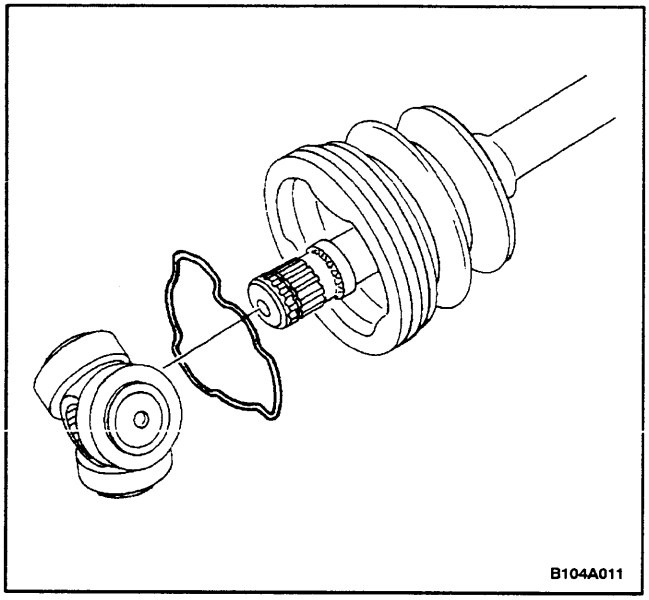
5. Remove the tripot housing from the seal.



6. Degrease the tripot assembly.
7. Remove the shaft retaining ring using the snap ring pliers J-8059.

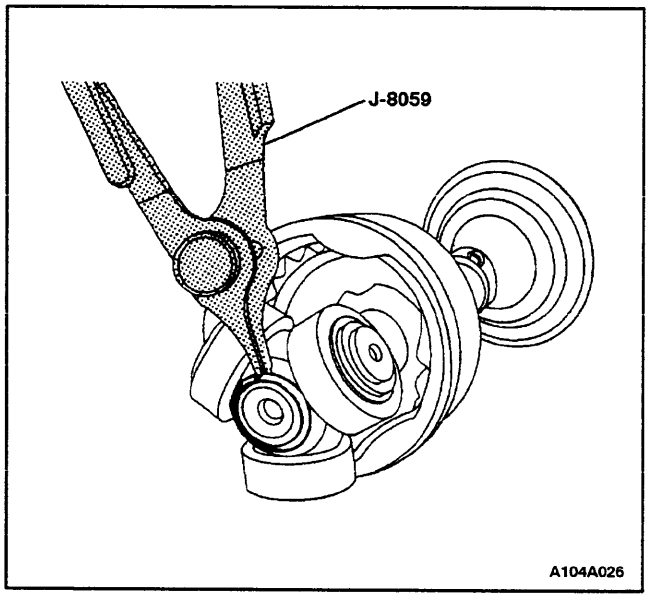


8. Remove the tripot and the tripot joint retaining ring from the axle shaft.
9. Remove the tripot joint seal from the axle shaft.

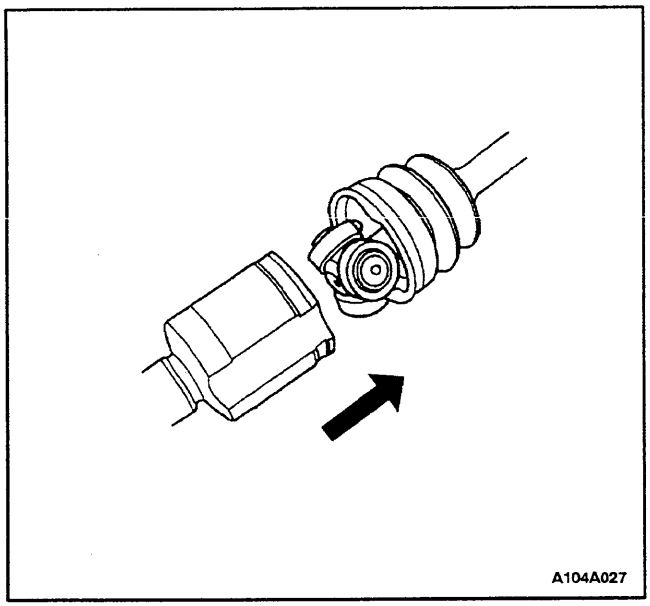


Installation Procedure

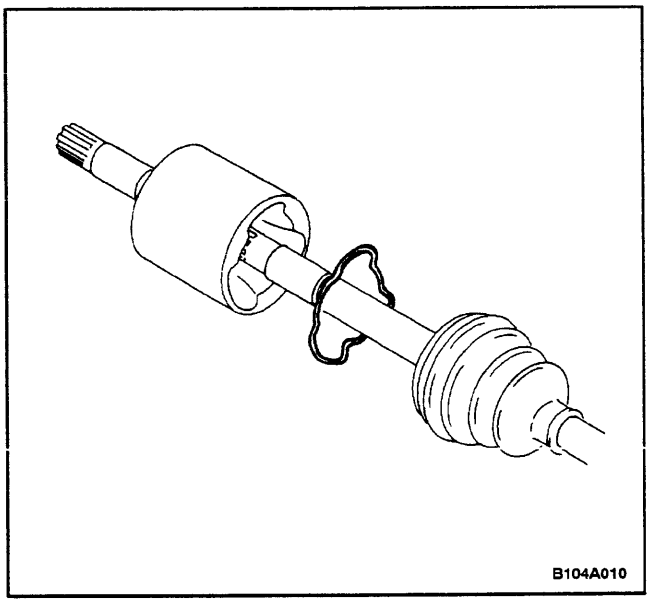
1. Install a new small seal retaining clamp onto the seal. Do not crimp the seal retaining clamp.
2. Install the seal onto the axle shaft.
3. Install the tripot joint retaining ring and the tripot onto the axle shaft.



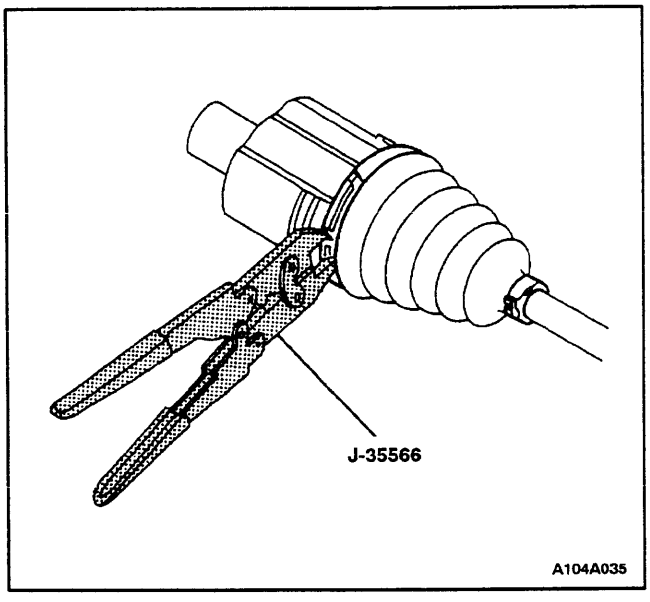
4. Install the shaft retaining ring onto the axle shaft using the snap ring pliers J-8059.



5. Fill the tripot housing with 195 to 215 g (6.9 to 7.6 ounces) of the recommended grease. Repack the tripot with 195 to 215 g (6.9 to 7.6 ounces) of the recommended grease.
6. Install the tripot housing onto the tripot assembly.



7. Install the tripot joint retaining ring into the tripot housing.



8. Install a new large seal retaining clamp. Crimp the large seal retaining clamp using the seal clamp pliers J-35566.
9. Crimp the new small seal retaining clamp using the seal clamp pliers J-35566.
10. Install the drive shaft onto the vehicle. Refer to "Drive Axle Assembly" in this section.

GENERAL DESCRIPTION AND SYSTEM OPERATION

FRONT DRIVE AXLE

General Description

Drive axles are flexible shaft assemblies that transmit a rotational force from the transaxle to the front-wheel assemblies. Each axle assembly consists of an inner constant-velocity joint and an outer constant-velocity joint connected to an axle shaft. The inner joint is completely flexible and has the ability to move in and out. The outer joint is also flexible, but it cannot move in and out. The drive axles use a Rzeppa-style joint on the outboard side and a tripot-style joint on the inboard side.

BRAKES

CONTENTS

SECTION 4A

HYDRAULIC BRAKES

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

TABLE OF CONTENTS

SPECIFICATIONS

GENERAL SPECIFICATIONS

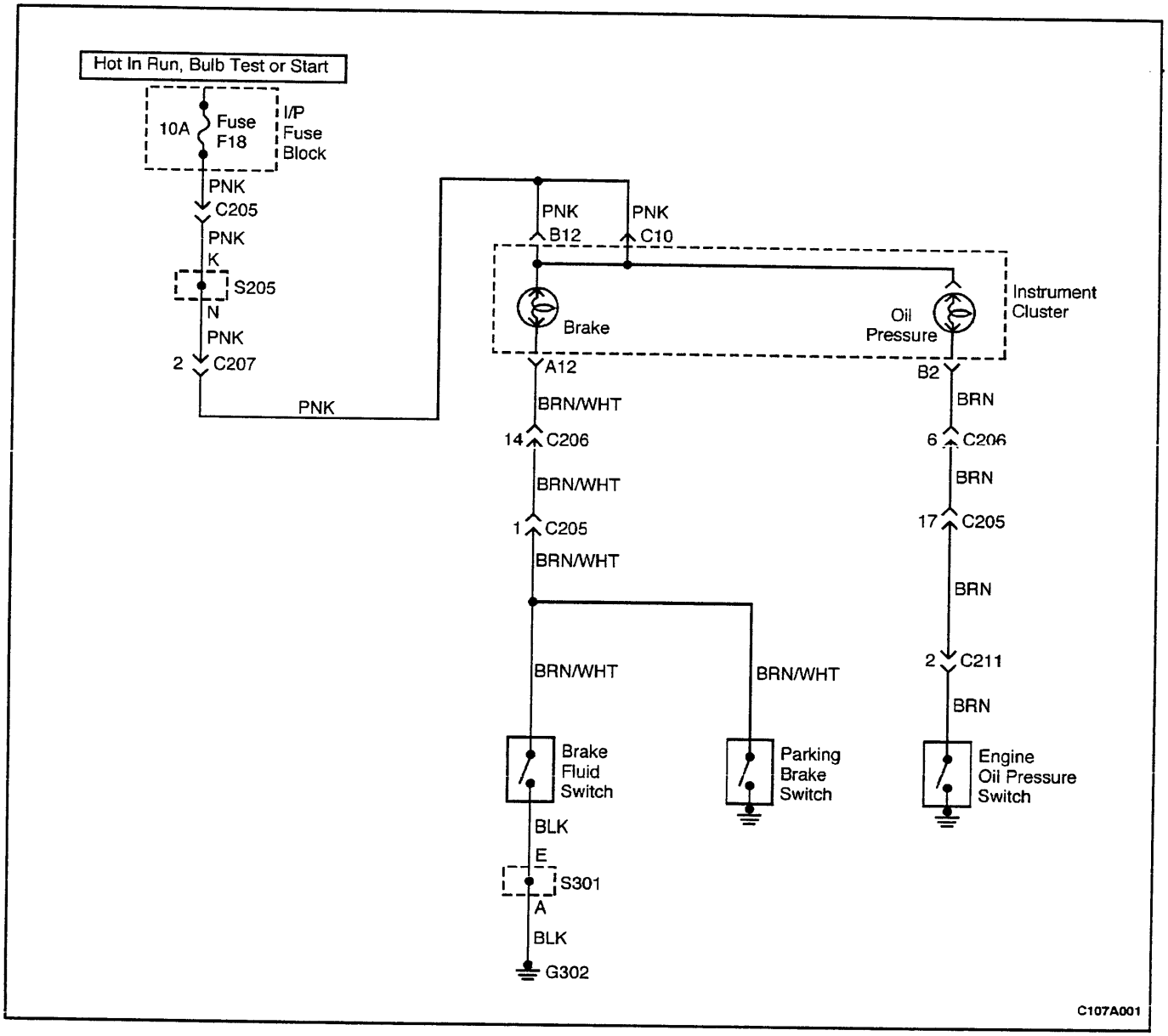
2.0 DOHC Engine		
Application	**Millimeters**	**Inches**
Front Brake Rotors:		
Discard Thickness	22.00	0.87
Lateral Runout (Installed)	0.03	0.001
Rotor Diameter	256.00	10.08
Rotor Thickness (New)	24.00	0.95
Thickness Tolerance	0.0 / -0.30	0.0 / -0.01
Rear Brake Rotors:		
Discard Thickness	8.0	0.314
Lateral Runout (Installed)	0.100	0.004
Rotor Diameter	258.00	10.16
Rotor Thickness (New)	10.40	0.41
Thickness Tolerance	0.0 / -0.20	0.0 / -0.008
Master Cylinder:		
Bore Diameter (Nominal)	23.81	0.94
Bore Diameter (Maximum)	23.862	0.942
Caliper:		
Minimum Piston Diameter (Front)	57.00	2.24
Minimum Piston Diameter (Rear)	35.00	1.38

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Brake Lines	16	12	-
Brake Pedal-to-Pedal Bracket Hex Nut	18	13	-
Front Disc Brake Hose-to-Caliper Bolt	40	30	-
Rear Disc Brake Hose-to-Caliper Bolt	32	24	-
Trim Panel Screws	3	-	27

SCHEMATIC AND ROUTING DIAGRAMS

BRAKE LAMP WARNING CIRCUIT



DIAGNOSIS

BRAKE SYSTEM TESTING

Brakes should be tested on a dry, clean, reasonably smooth and level roadway. A true test of brake performance cannot be made if the roadway is wet, greasy, or covered with loose dirt which can cause all tires not to grip the road equally. Testing also will be adversely affected if the roadway is crowned so as to throw the vehicle's weight so roughly that the wheels tend to bounce.

Test the brakes at different vehicle speeds with both light- and heavy-pedal pressure; however, avoid locking the brakes and sliding the tires. Locked brakes and sliding tires do not indicate brake efficiency since heavily braked but turning wheels will stop the vehicle in less distance than locked brakes. More tire-to-road friction is present with a heavily braked, turning tire than with a sliding tire.

Because of the high deceleration capability, a firmer pedal may be felt at higher deceleration levels.

There are three major external conditions that affect brake performance:

- Tires having unequal contact and grip of the road will cause unequal braking. Tires must be equally inflated, and the tread pattern of the right and the left tires must be approximately equal.
- Unequal loading of the vehicle can affect the brake performance since the most heavily loaded wheels require more braking power, and thus more braking effort, than the others.
- Misalignment of the wheels, particularly conditions of excessive camber and caster, will cause the brakes to pull to one side.

To check for brake fluid leaks, hold constant foot pressure on the pedal with the engine running at idle and the shift lever in NEUTRAL. If the pedal gradually falls away with the constant pressure, the hydraulic system may be leaking. Perform a visual check to confirm any suspected leaks.

Check the master cylinder fluid level. While a slight drop in the reservoir level results from normal lining wear, an abnormally low level indicates a leak in the system. The hydraulic system may be leaking either internally or externally. Refer to the procedure below to check the master cylinder. The system may appear to pass this test while still having a slight leak. If the fluid level is normal, check the vacuum booster pushrod length. If an incorrect pushrod length is found, adjust or replace the rod.

Check the master cylinder using the following procedure:

- Check for a cracked master cylinder casting or a brake fluid leak around the master cylinder. Leaks are indicated only if there is at least one drop of fluid. A damp condition is not abnormal.
- Check for a binding pedal linkage and for an incorrect pushrod length. If both of these parts are in satisfactory condition, disassemble the master cylinder and check for an elongated or swollen primary cylinder or piston seals. If swollen seals are found, substandard or contaminated brake fluid should be suspected. If contaminated brake fluid is found, all the components should be disassembled and cleaned, and all the rubber components should be replaced. All of the pipes must also be flushed.

Improper brake fluid, or mineral oil or water in the fluid, may cause the brake fluid to boil or cause deterioration of the rubber components. If the primary piston cups in the master cylinder are swollen, then the rubber parts have deteriorated.

If deterioration of the rubber is evident, disassemble all the hydraulic parts and wash the parts with alcohol. Dry these parts with compressed air before reassembly to keep the alcohol out of the system. Replace all the rubber parts in the system, including the hoses. When working on the brake mechanisms, check for fluid on the linings. If excessive fluid is found, replace the linings.

If the master cylinder piston seals are in satisfactory condition, check for leaks or excessive heat conditions. If these conditions are not found, drain the fluid, flush the master cylinder with brake fluid, refill the master cylinder, and bleed the system. Refer to *Section 4F, Antilock Brake System and Traction Control System.*

BRAKE HOSE INSPECTION

The hydraulic brake hoses should be inspected at least twice a year. The brake hose assembly should be checked for road hazard damage, cracks, chafing of the outer cover, and for leaks or blisters. Inspect the hoses for proper routing and mounting. A brake hose that rubs on a suspension component will wear and eventually fail. A light and a mirror may be needed for an adequate inspection. If any of the above conditions are observed on the brake hose, adjust or replace the hose as necessary.

BRAKE LAMP WARNING CIRCUIT

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. The BRAKE warning lamp should only illuminate when either the brake fluid reservoir is low or the parking brake is applied.

5. The brake fluid level switch is a normally open switch. If the BRAKE warning lamp is off after disconnecting the switch, the brake fluid level switch is stuck closed.

7. If the BRAKE warning lamp is still on after disconnecting the parking brake switch, there is a short to ground in the wire to the parking brake switch.

12. If the BRAKE warning lamp does not operate while performing any of the functions, the fault should be in the ignition feed to the circuit.
17. This step determines if the problem is in the ignition feed to the circuit or in the instrument cluster.
22. The BRAKE warning lamp should illuminate when jumpering the parking brake connector to ground.
24. If the BRAKE warning lamp is on after jumpering the brake fluid level switch terminals, the switch is faulty.

Brake Lamp Warning Circuit

Step	Action	Value(s)	Yes	No
1	Turn the ignition ON and keep the engine running. Is the BRAKE warning lamp always on?	-	Go to *Step 2*	Go to *Step 11*
2	Release the parking brake fully. Is the BRAKE warning lamp off?	-	System OK	Go to *Step 3*
3	Check the brake fluid level. Is the fluid level OK?	-	Go to *Step 5*	Go to *Step 4*
4	1. Fill the brake fluid reservoir with clean DOT 3 or DOT 4 equivalent hydraulic fluid. 2. Replace the cap on the fluid reservoir. Is the BRAKE warning lamp on?	-	Go to *Step 5*	System OK
5	Disconnect the harness connector from the brake fluid level switch. Is the BRAKE warning lamp on?	-	Go to *Step 7*	Go to *Step 6*
6	Replace the brake fluid level switch. Is the repair complete?	-	System OK	-
7	1. Connect the brake fluid level switch. 2. Disconnect the parking brake switch. Is the BRAKE warning lamp on?	-	Go to *Step 9*	Go to *Step 8*
8	Replace the parking brake switch. Is the repair complete?	-	System OK	-
9	Check for a short to ground in the wiring between the instrument cluster terminal A12 and the parking brake switch. Is there a short?	-	Go to *Step 10*	Go to *Step 11*
10	Repair the wiring as needed. Is the repair complete?	-	System OK	-
11	Check the BRAKE warning lamp after doing each of the following functions: • Apply the parking brake. • Activate the low level switch. Does the BRAKE warning lamp operate for all of these conditions?	-	System OK	Go to *Step 12*
12	Check the BRAKE warning lamp after doing each of the following functions: • Apply the parking brake. • Activate the low level switch. Does the BRAKE warning lamp operate for none of these conditions?	-	Go to *Step 13*	Go to *Step 20*
13	1. Turn the ignition off. 2. Inspect the I/P fuse F18. Is the fuse OK?	-	Go to *Step 15*	*Go to Step 14*
14	Replace the I/P fuse. Is the repair complete?	-	System OK	-

Brake Lamp Warning Circuit (Cont'd)

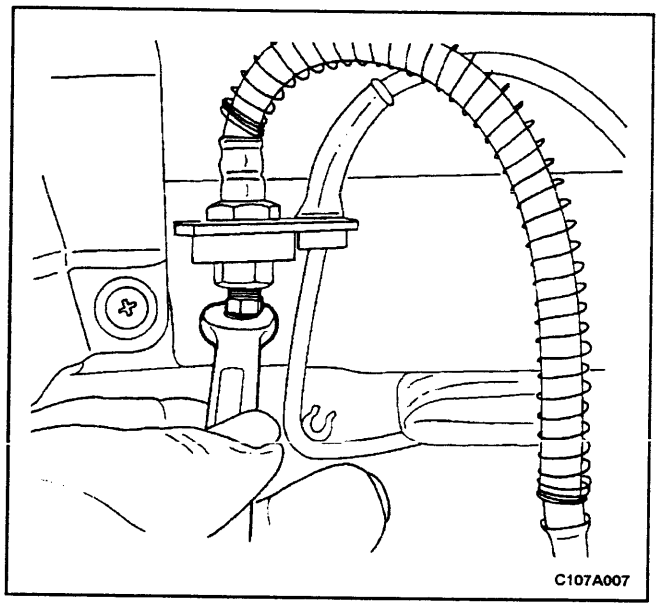
Step	Action	Value(s)	Yes	No
15	Inspect the BRAKE warning lamp bulb. Is the bulb OK?	-	Go to *Step 17*	Go to *Step 16*
16	Replace the bulb. Is the repair complete?	-	System OK	-
17	1. Disconnect the instrument cluster connector. 2. Turn the ignition ON. 3. Measure the voltage at the instrument cluster connector terminal B12. Does the voltage measure within the value specified?	11-14 v	Go to *Step 18*	Go to *Step 19*
18	1. Turn the ignition off. 2. Repair the open in the instrument cluster. Is the repair complete?	-	System OK	-
19	1. Turn the ignition off. 2. Repair the open in the wiring between the instrument cluster connector terminal B12 and the ignition switch. Is the repair complete?	-	System OK	-
20	Apply the parking brake. Does the BRAKE warning lamp operate with the parking brake applied?	-	Go to *Step 21*	Go to *Step 22*
21	Activate the low level switch. Does the BRAKE warning lamp operate with the low level switch activated?	-	System OK	Go to *Step 24*
22	1. Turn the ignition ON. 2. Disconnect the parking brake switch. 3. Jumper the parking brake switch connector terminal to ground. Is the BRAKE warning lamp on?	-	Go to *Step 8*	Go to *Step 23*
23	1. Turn the ignition off. 2. Repair the open in the wire between the instrument cluster connector terminal A12 and the parking brake switch connector terminal. Is the repair complete?	-	System OK	-
24	1. Disconnect the brake fluid level switch. 2. Turn the ignition ON. 3. Jumper the brake fluid level switch connector terminals. Is the BRAKE warning lamp on?	-	Go to *Step 6*	Go to *Step 25*
25	1. Turn the ignition off. 2. Connect a test light between the battery positive and the BRN/WHT wire terminal of the brake fluid level switch. Is the test light on?	-	Go to *Step 26*	Go To *Step 27*
26	Repair the open in the wiring between ground and the brake fluid level switch. Is the repair complete?	-	System OK	-
27	Repair the open in the wiring between the instrument cluster connector terminal A12 and the brake fluid level switch. Is the repair complete?	-	System OK	-

MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

MANUAL BLEEDING THE BRAKES

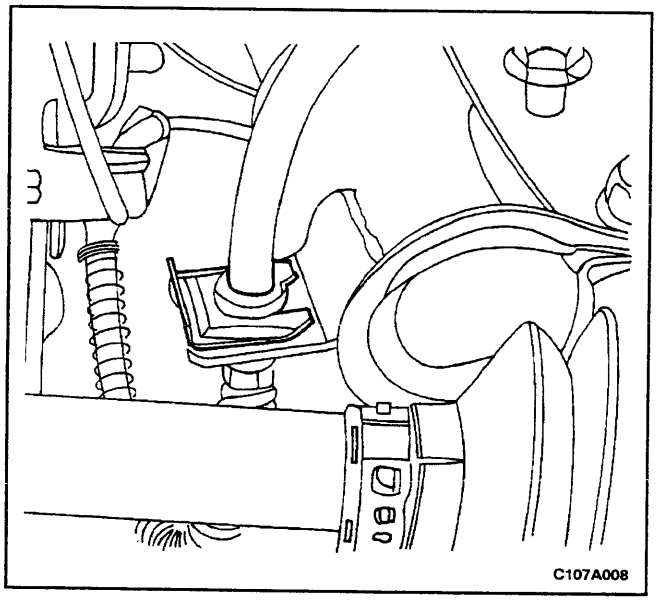
Bleeding of the antilock brake system requires connecting a scan tool to the vehicle. Refer to *Section 4F, Antilock Brake System and Traction Control System.*



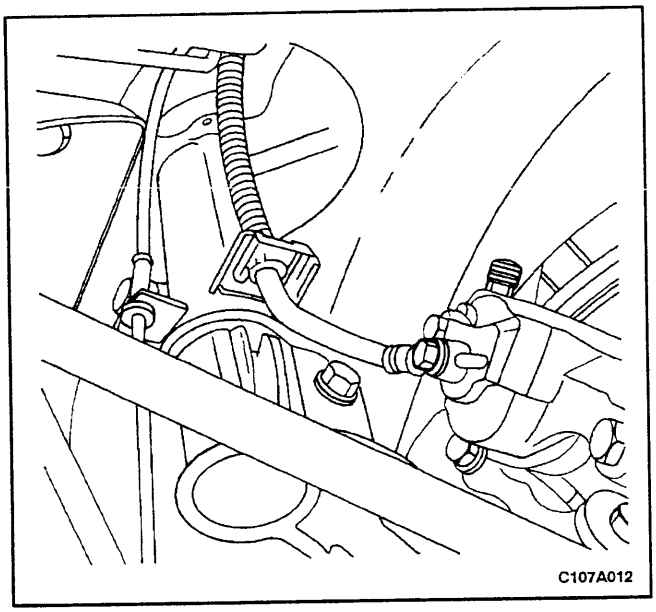
BRAKE HOSE REAR

Removal Procedure

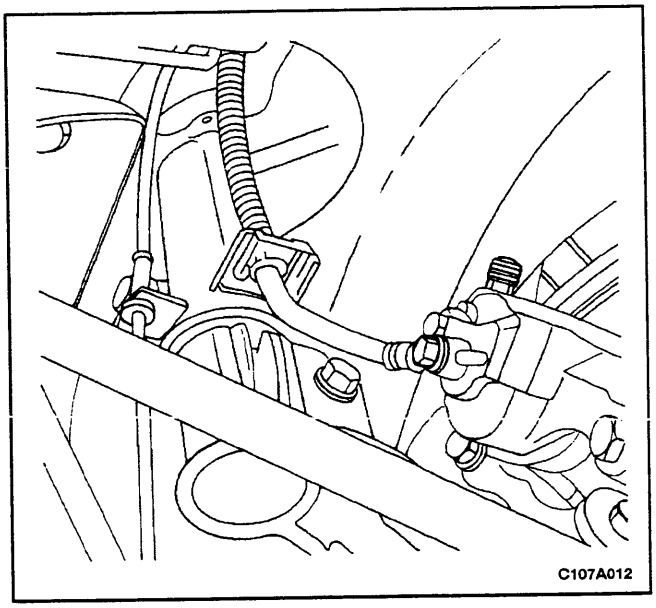
1. Raise and suitably support the vehicle.
2. Disconnect the brake line from the disc brake hose at the wheel housing bracket on each side of the vehicle.
3. Remove the brake hose retainer.



4. Remove the rear disc brake hose retainer and the brake hose from the bracket on the steering knuckle shaft.



5. Remove the rear disc brake hose from the caliper.

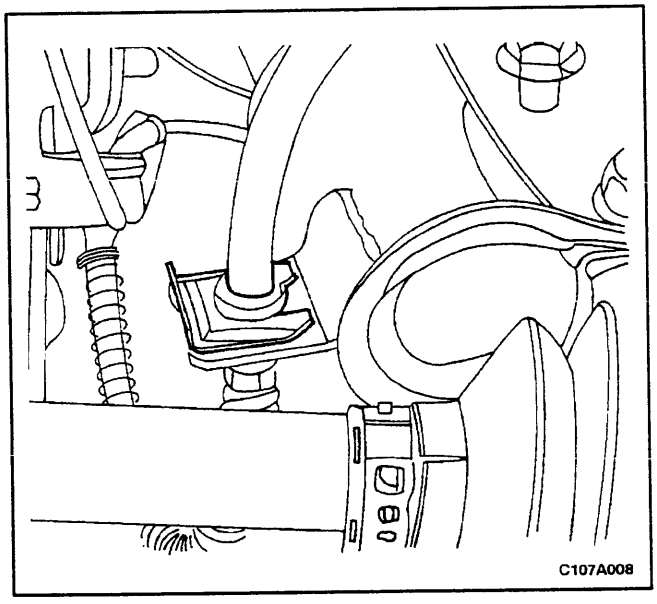


Installation Procedure

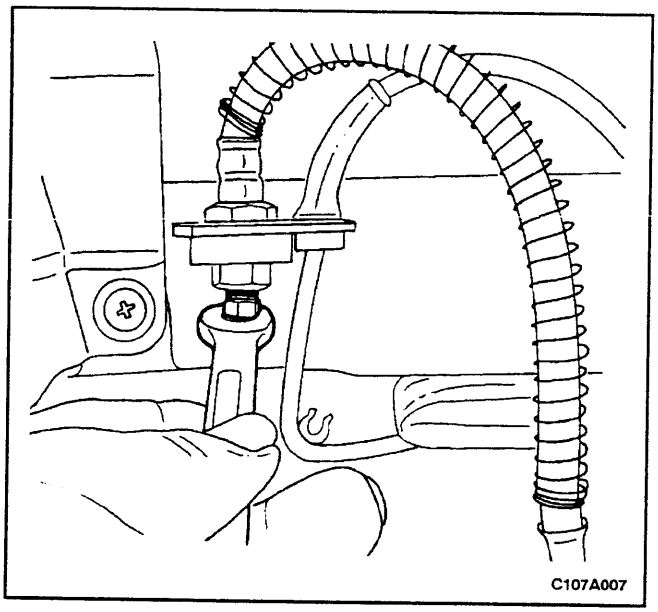
1. Install the rear disc brake hose to the caliper.

Tighten

Tighten the rear disc brake hose-to-caliper bolt to 32 N•m (24 lb-ft).



2 Install the rear disc brake hose and the retainer on the bracket on the steering knuckle shaft.

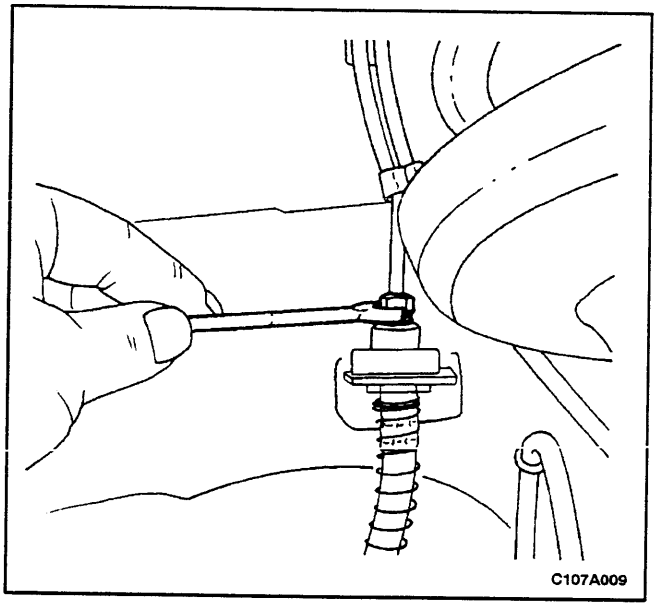


3. Install the rear disc brake line to the brake hose on the wheel housing bracket.

Tighten

Tighten the brake line to 16 N•m (12 lb-ft).

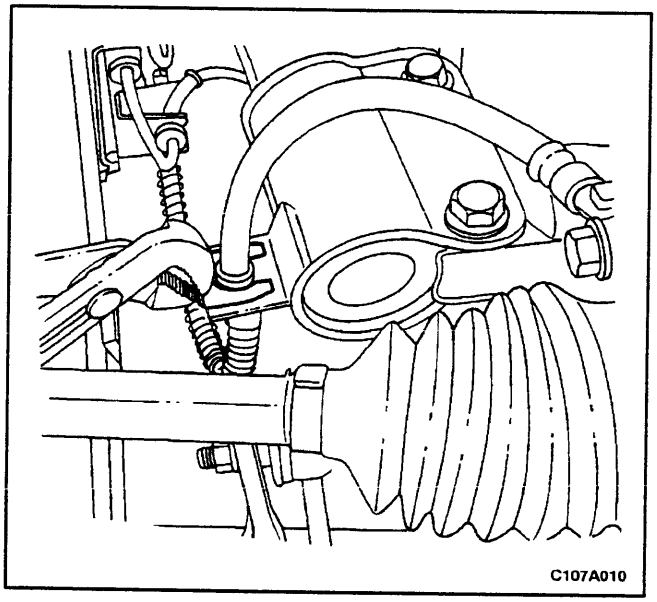
4. Lower the vehicle.
5. Bleed the brake system. Refer to *Section 4F, Antilock Brake System and Traction Control System.*
6. Check the brake system for leaks.



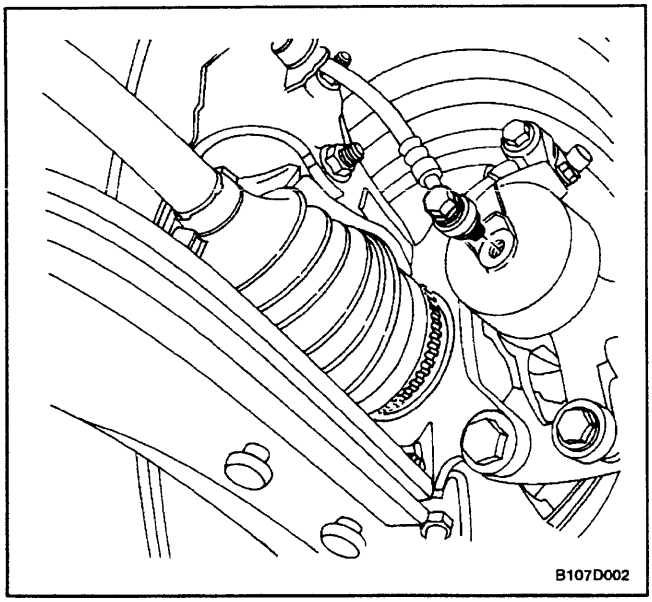
BRAKE HOSE FRONT

Removal Procedure

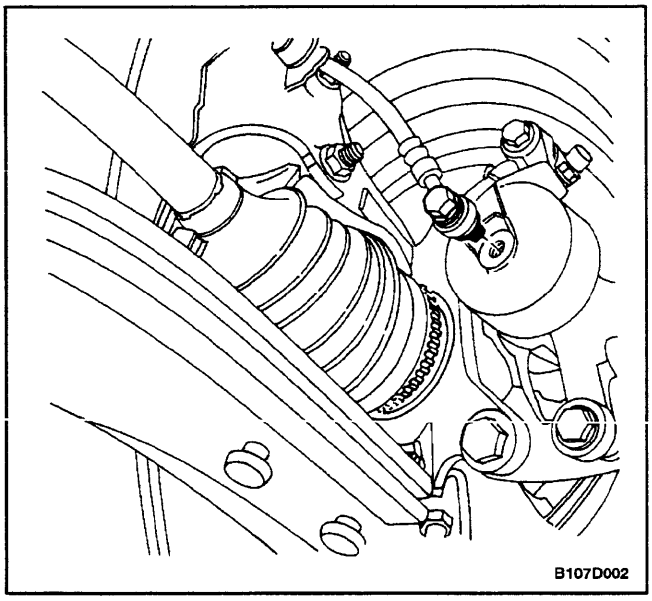
1. Raise and suitably support the vehicle.
2. Disconnect the brake line from the brake hose support bracket on the wheel housing on each side of the vehicle.
3. Remove the retainer.
4. Remove the brake hose from the wheel housing bracket.



5. Remove the retainer and disconnect the brake hose at the steering knuckle shaft bracket.



6. Remove the bolt from the brake caliper.
7. Remove the ring seals and the disc brake hose.

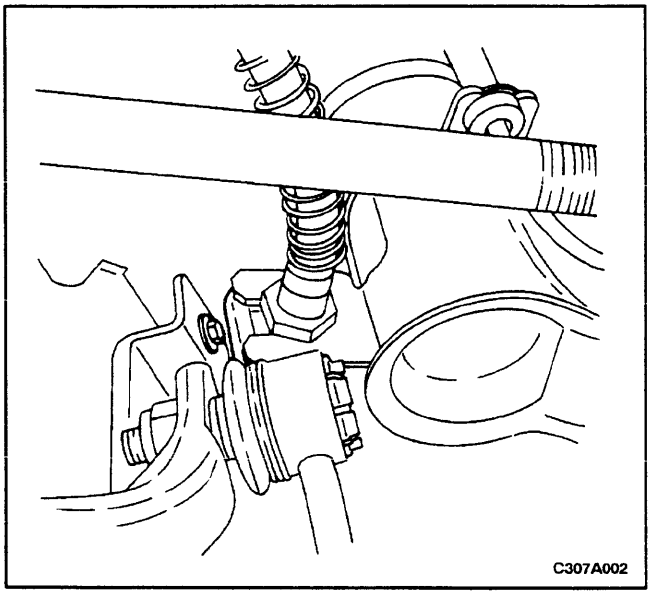


Installation Procedure

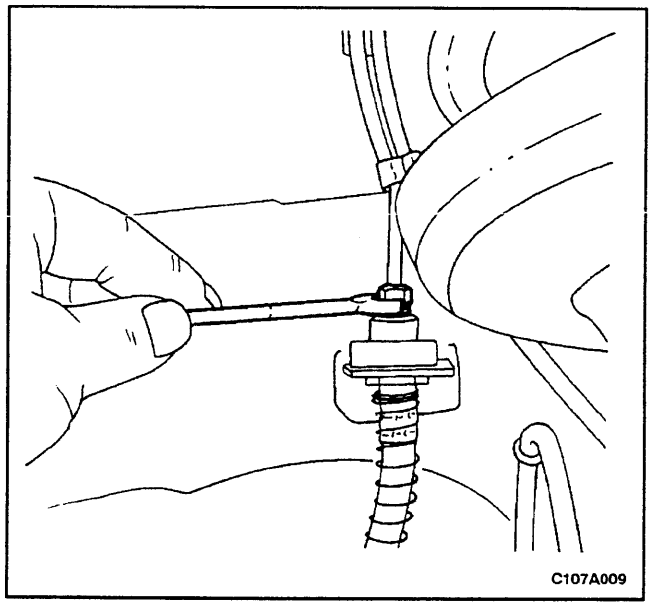
1. Install the new disc brake hose to the caliper with new seal rings and the bolt.

Tighten

Tighten the front disc brake hose-to-caliper bolt to 40 N•m (30 lb-ft).



2. Connect the brake hose at the steering knuckle shaft bracket and install the retainer.

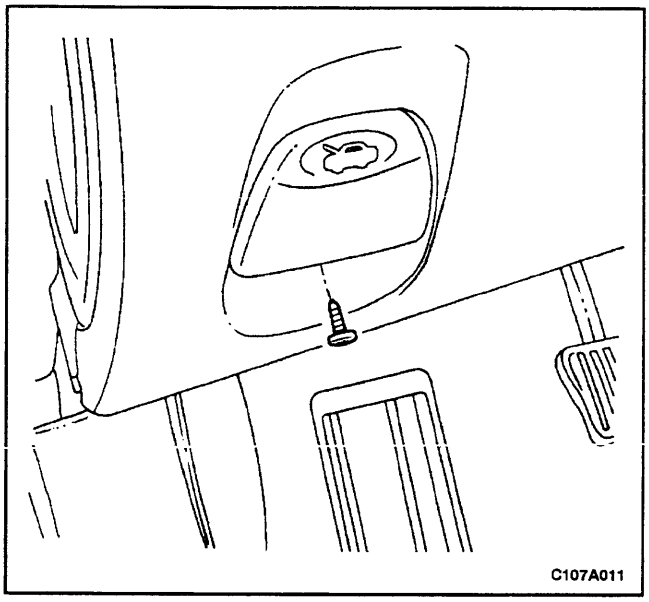


3. Connect the brake line to the brake hose on the wheel housing bracket on each side of the vehicle and install the retainer.

Tighten

Tighten the brake line to 16 N•m (12 lb-ft).

4. Lower the vehicle.
5. Bleed the brake system. Refer to *Section 4F, Antilock Brake System and Traction Control System.*
6. Check the brake system for leaks.

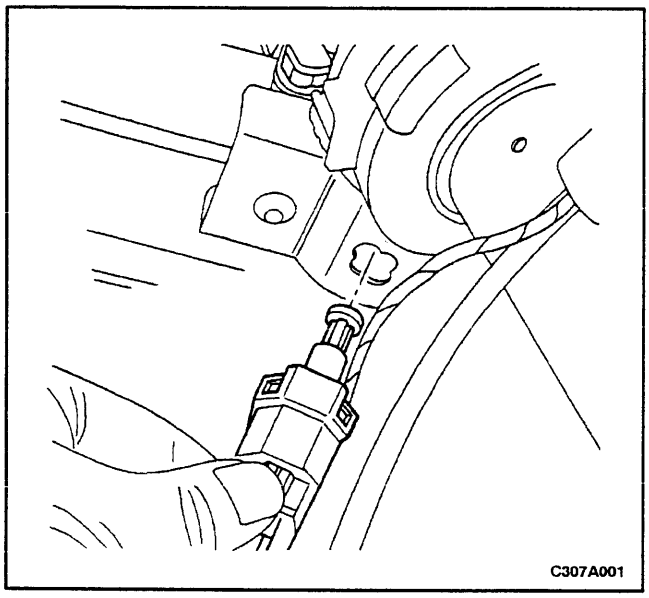


STOPLAMP SWITCH

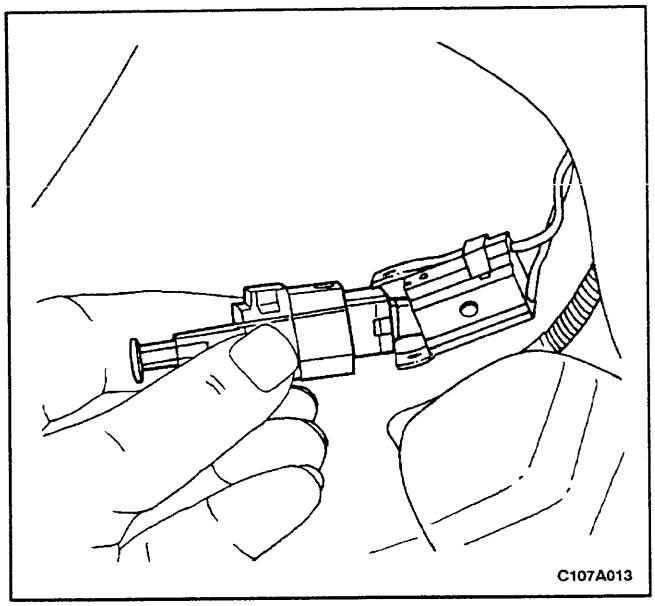
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the trim panel screws.
3. Remove the trim panel.

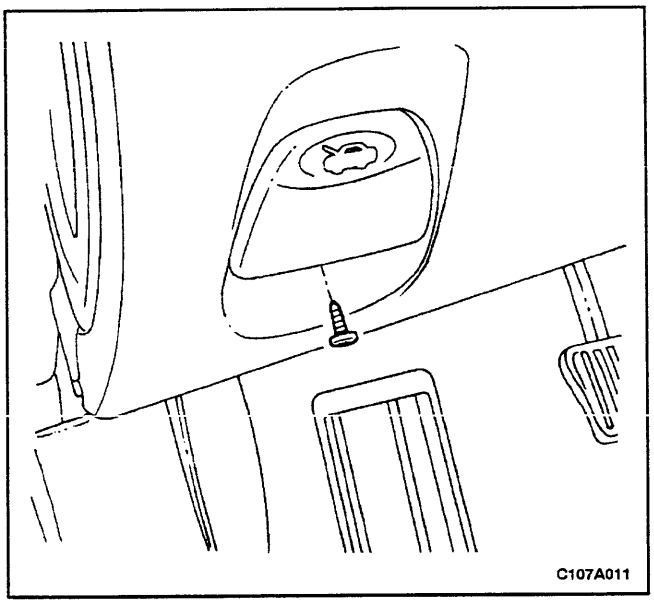


4. Turn the stoplamp switch connector assembly clockwise and remove it from the brake pedal bracket.
5. Separate the stoplamp switch from the connector.



Installation Procedure

1. Place the stoplamp switch into the plug connector.
2. Twist the stoplamp switch connector assembly into the brake pedal bracket hole.

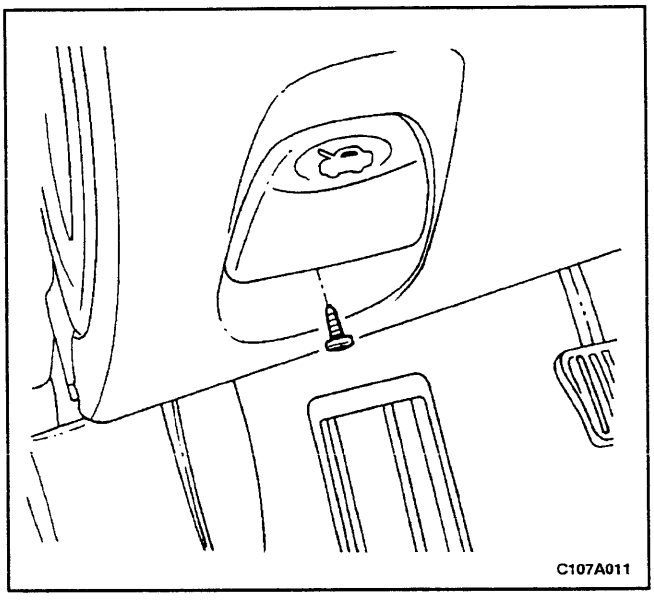


3. Press the brake pedal and pull the switch plunger to its maximum setting to adjust the switch.
4. Release the switch plunger and pull up on the pedal.
5. Install the trim panel with the screws.

Tighten

Tighten the trim panel screws to 3 N•m (27 lb-in).

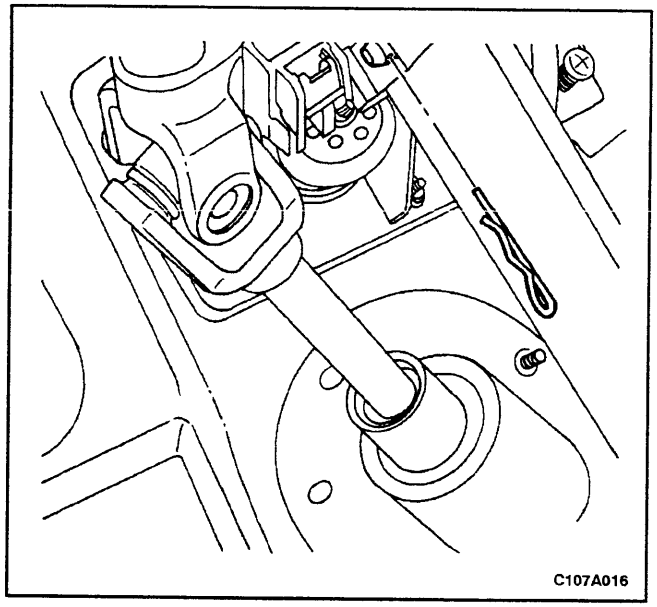
6. Connect the negative battery cable.



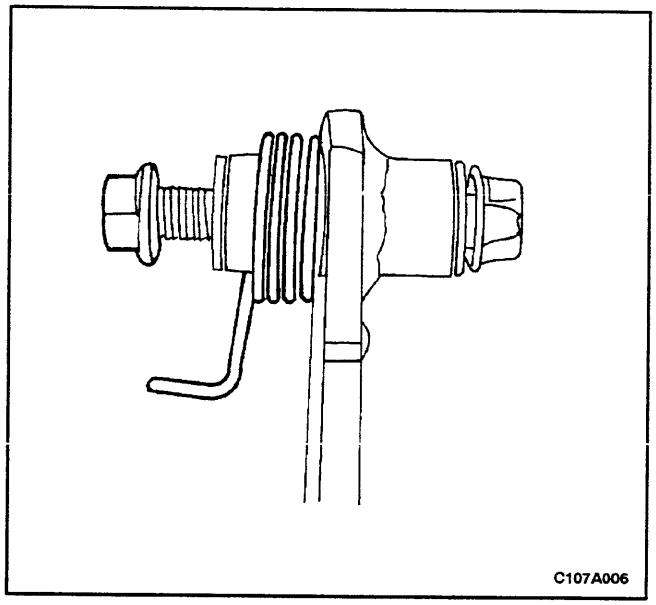
BRAKE PEDAL

Removal Procedure

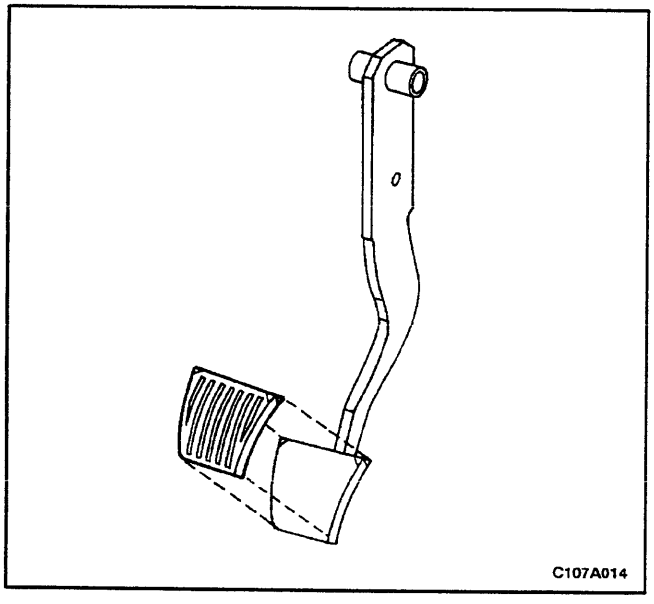
1. Remove the screws holding the trim panel to the instrument panel.
2. Remove the trim panel.



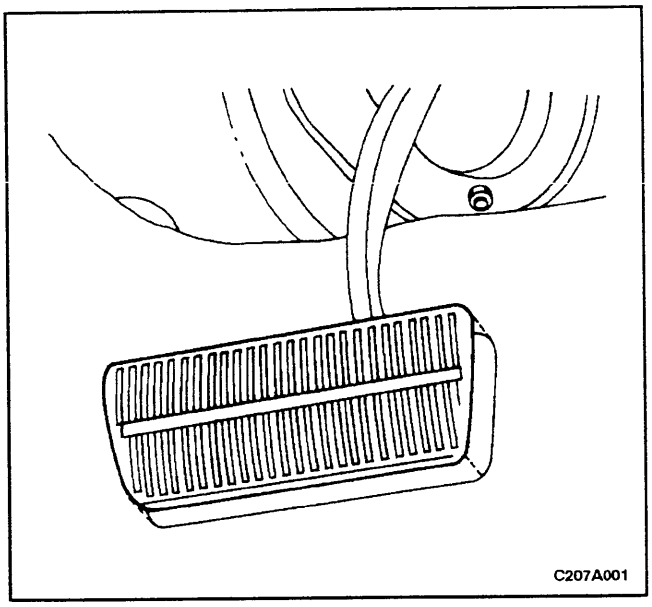
3. Remove the stoplamp switch. Refer to "Stoplamp Switch" in this section.
4. Disconnect the spring retaining clip and the bolt from the pushrod clevis.



5. Remove the hex nut and the spring.
6. Remove the brake pedal and the bolt.

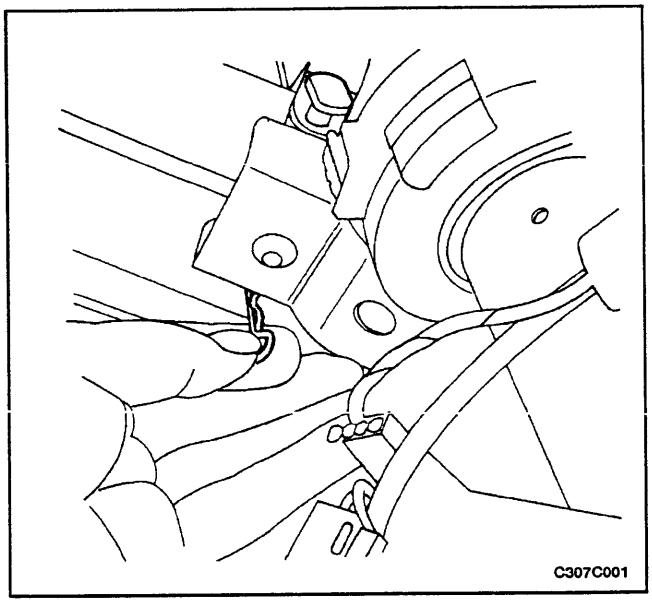


7. Remove the brake pedal cover (manual transaxle pedal shown).



Installation Procedure

1. Install a new pedal cover (automatic transaxle pedal shown), if needed.

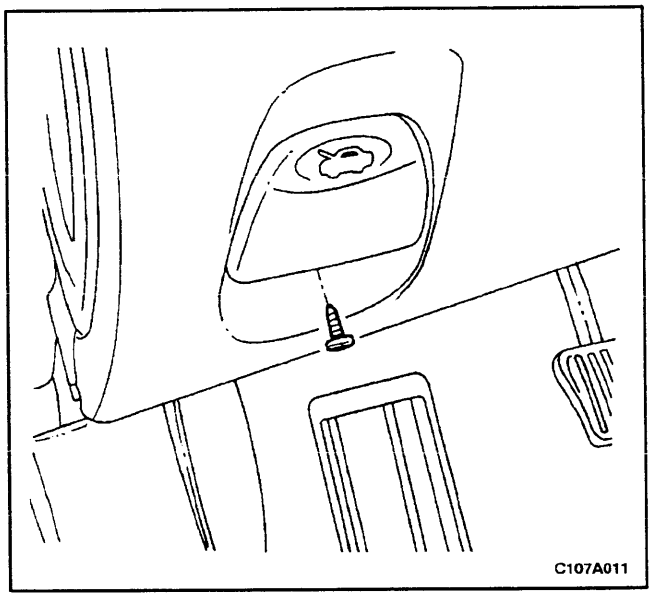


2. Coat the pedal shaft with grease.
3. Position the brake pedal on the pedal-to-dash panel bracket and the pedal bolt.
4. Place the hex nut and the spring on the pedal bolt.

Tighten

Tighten the brake pedal-to-pedal bracket hex nut to 18 N•m (13 lb-ft).

5. Install the push rod clevis to the pedal with the bolt and the spring retaining clip.



6. Connect the stoplamp switch and connector assembly to the pedal bracket. Refer to "Stoplamp Switch" in this section.
7. Install the trim panel with the screws.

Tighten

Tighten the trim panel screws to 3 N•m (27 lb-in).

GENERAL DESCRIPTION AND SYSTEM OPERATION

WARNING LAMP OPERATION

This brake system uses a BRAKE warning lamp located in the instrument panel cluster. When the ignition switch is in the START position, the BRAKE warning lamp should illuminate. It should go off when the ignition switch returns to the ON position.

The following conditions will activate the BRAKE warning lamp:

- The lamp should be on whenever the parking brake is applied and the ignition switch is in the ON position.
- A low fluid level in the master cylinder will turn the BRAKE lamp on.

SECTION 4B

MASTER CYLINDER

TABLE OF CONTENTS

SPECIFICATIONS

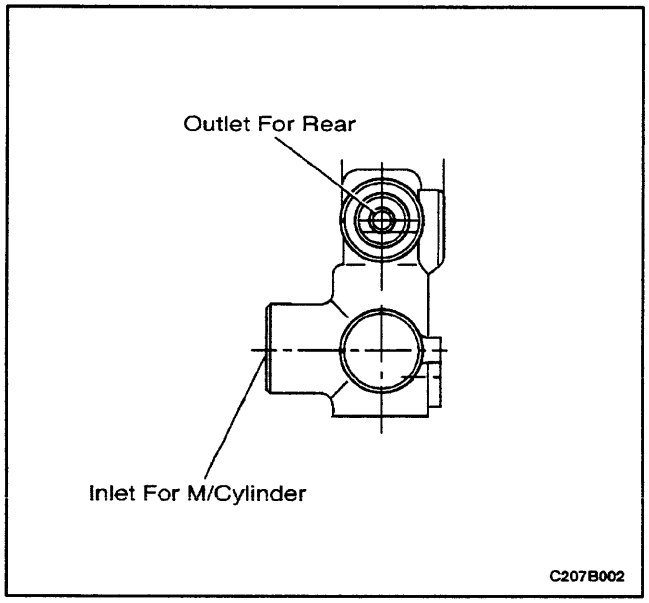
FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Master Cylinder Attaching Nuts	13	-	115
Master Cylinder Brake Lines	16	12	-
Proportioning Valve Brake Lines	10	-	89
Proportioning Valve Nut	10	-	89

DIAGNOSIS

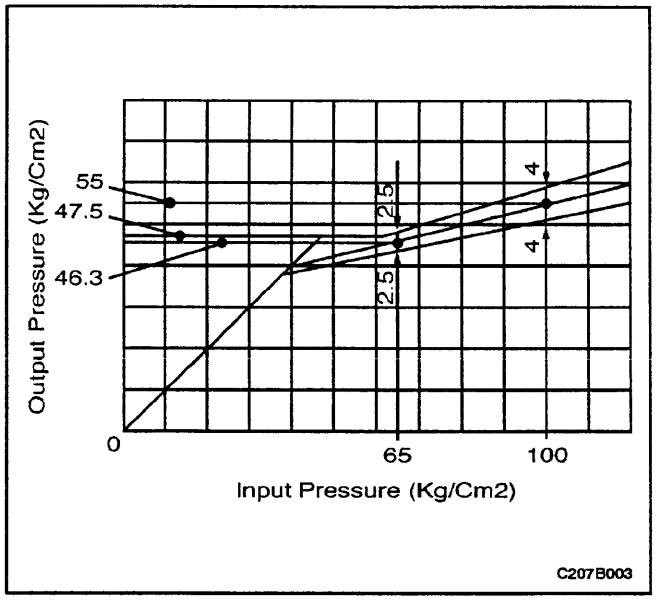
CHECKING BRAKE PROPORTIONING VALVE

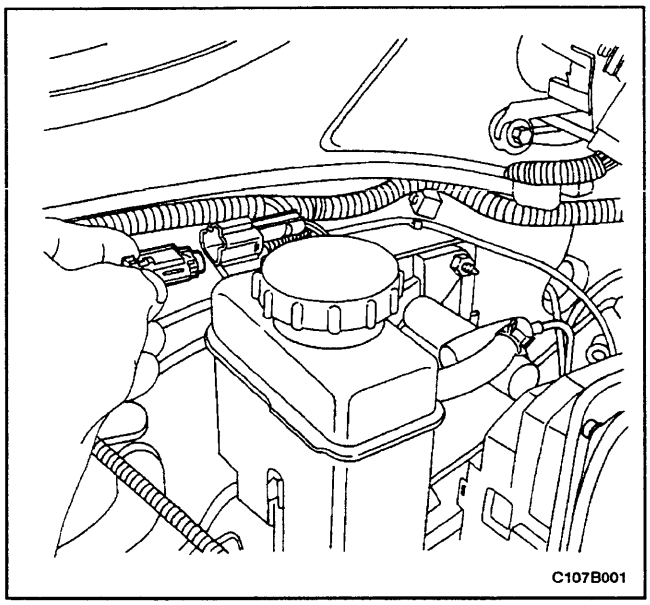
This proportioning valve, designed to work in concert with the ABS unit, is located on the bulkhead, and regulates the distribution of the fluid pressure to the rear brakes.



Using two brake pressure gauges, one on the input side and the other on the output side of the proportioning valve, measure the pressure with the appropriate brake lines disconnected, using the following steps:

1. With the brakes applied, measure the input and output pressure. If the measured pressures are within the ranges as illustrated, the proportioning valve is good.
2. Connect the brake lines in their original positions and bleed the system. Refer to *Section 4F, Antilock Brake System and Traction Control System*.
3. If the proportioning valve requires replacement, refer to "Proportioning Valve" in this section.




C107B001

MAINTENANCE AND REPAIR

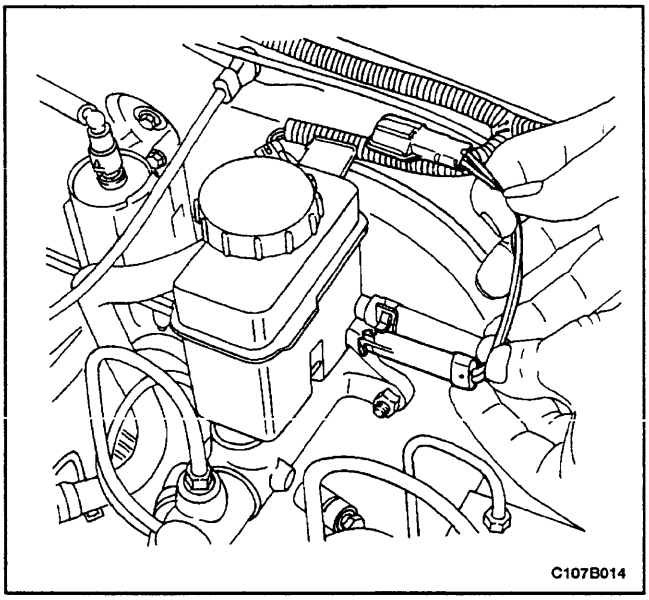
ON-VEHICLE SERVICE

MASTER CYLINDER ASSEMBLY

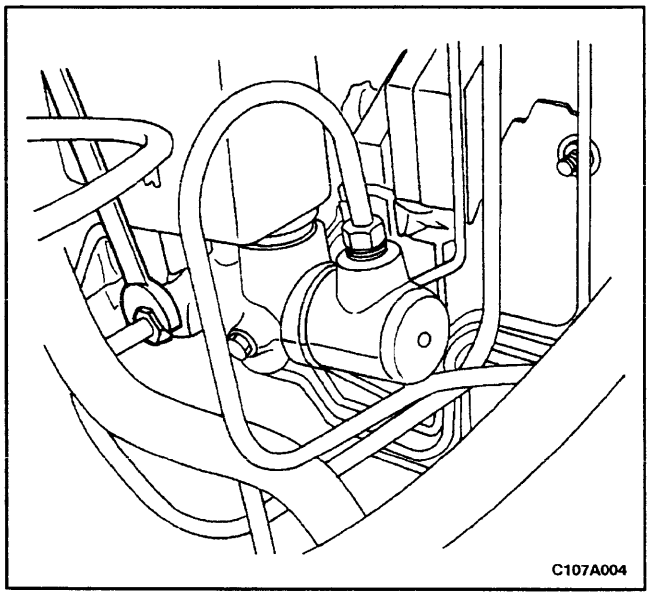
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

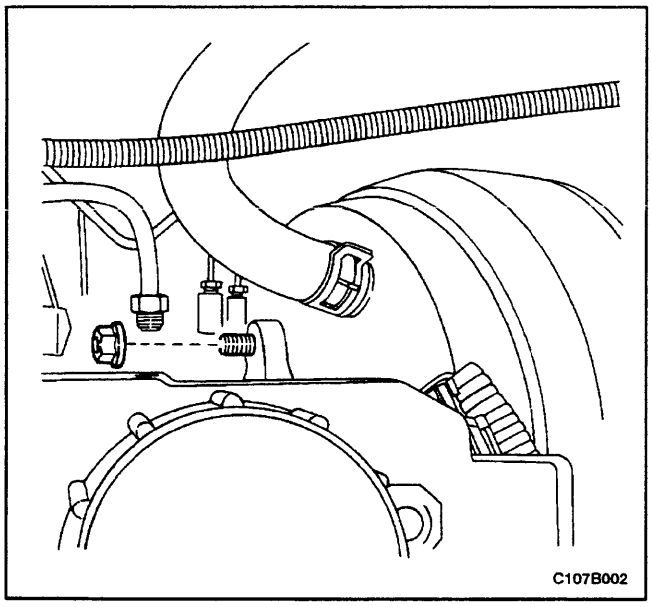
1. For right-hand drive vehicles, remove the air intake tube. Refer to *Section 1C, DOHC Engine Mechanical (2.0L Holdens).*
2. Remove the harness connector from its receptacle that is mounted to the top of the brake fluid reservoir.
3. Remove the receptacle by sliding it off its reservoir mount.


C107B014

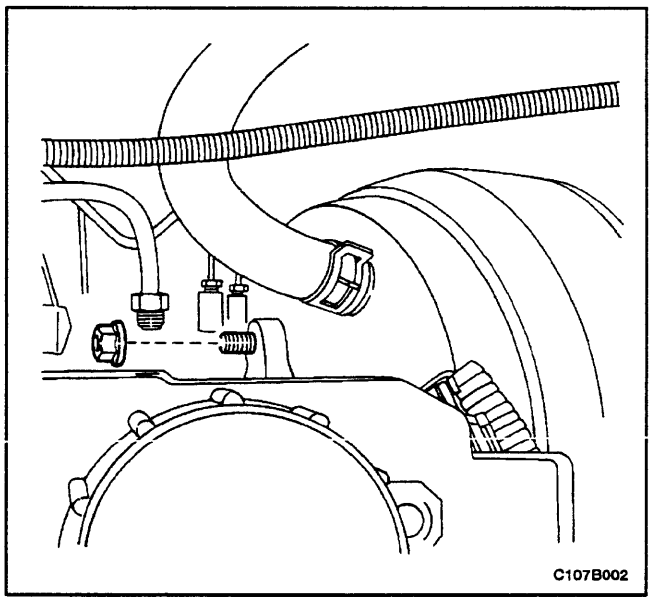
4. Crimp the plastic tabs of the low brake fluid level switch on the engine side of the brake fluid reservoir.
5. While crimping the plastic tabs, pull the switch out from the other side of the reservoir.


C107A004

6. Disconnect the brake lines from the master cylinder body.
7. For vehicles with the manual transaxle, disconnect the clip that secures the clutch hose connection to the master cylinder and move the clip out of the way.
8. Remove the clutch hose from the master cylinder.
9. Plug the opening to the brake lines to prevent the loss and the contamination of the fluid.



10. Remove the master cylinder attaching nuts.
11. Remove the master cylinder assembly.
12. Drain the brake fluid.

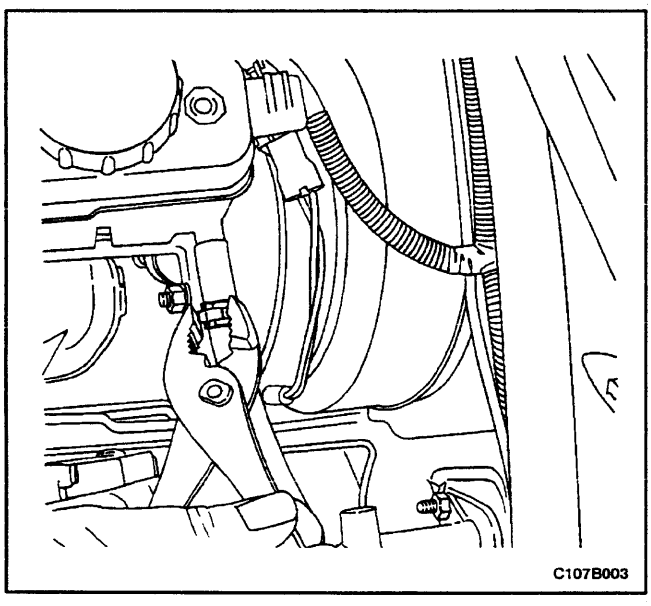


Installation Procedure

1. Install the master cylinder assembly with the new attaching nuts.

Tighten

Tighten the master cylinder attaching nuts to 13 N•m (115 lb-in).

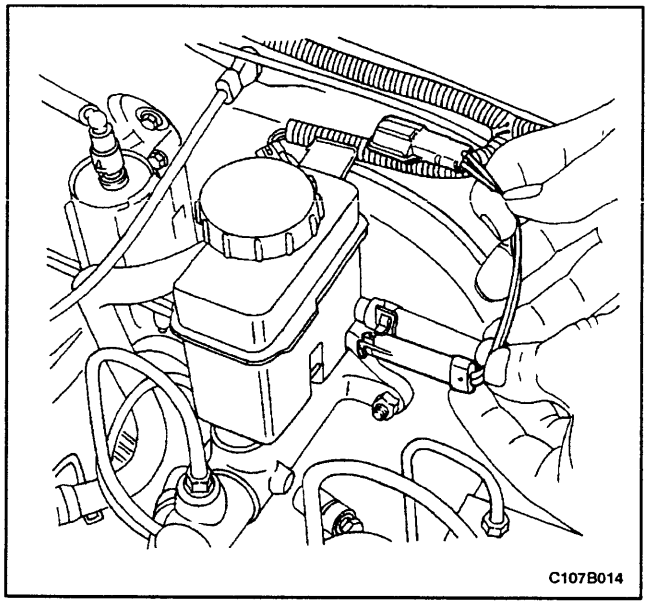


2. Install the brake lines to the master cylinder body.

Tighten

Tighten the master cylinder brake lines to 10 N•m (89 lb-in).

3. For vehicles with the manual transaxle, install the clutch hose connection to the master cylinder with the clip.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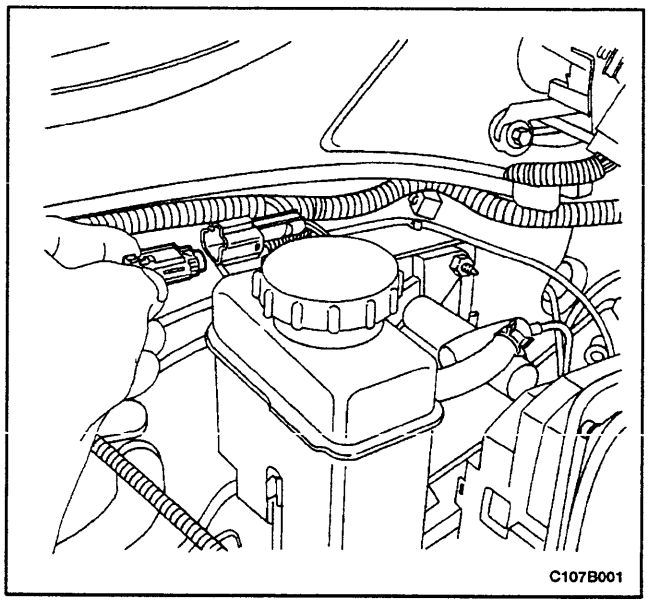
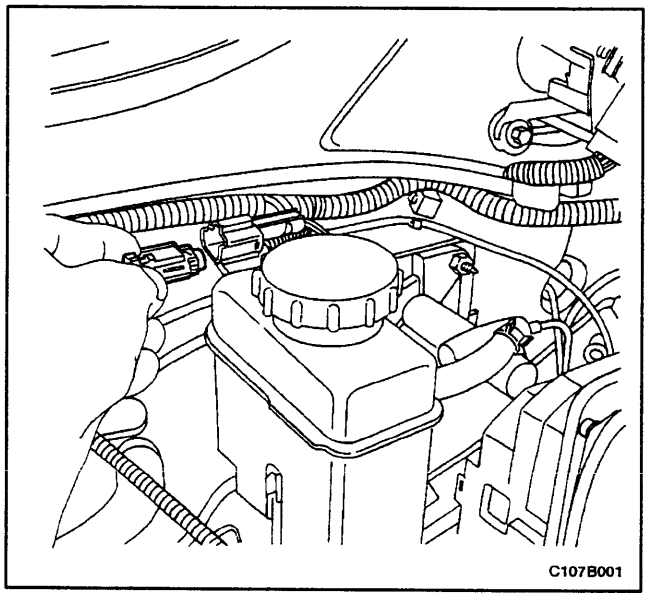
4. Install the low brake fluid level switch by pushing it into the side of the brake fluid reservoir opposite the engine.


C107B001

5. Install the receptacle for the low brake fluid level switch assembly by sliding it into its mount on the top of the brake fluid reservoir.
6. Plug in the harness connector.
7. Add the brake fluid.
8. Check for leaks.
9. Recheck the fluid level.
10. Bleed the brake system. Refer to *Section 4F, Anti-lock Brake System and Traction Control System.*
11. For right-hand drive vehicles, install the air intake tube. Refer to *Section 1C, DOHC Engine Mechanical (2.0L Holdens).*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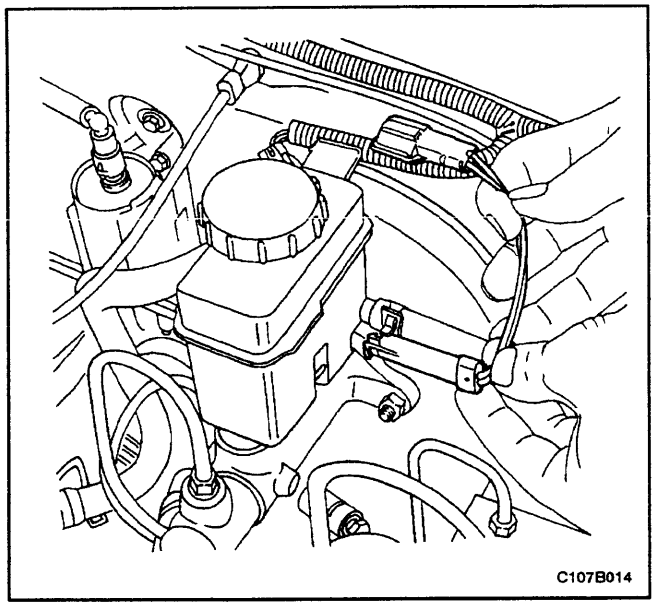
BRAKE FLUID RESERVOIR

(Left-Hand Drive Shown, Right-Hand Drive Similar)

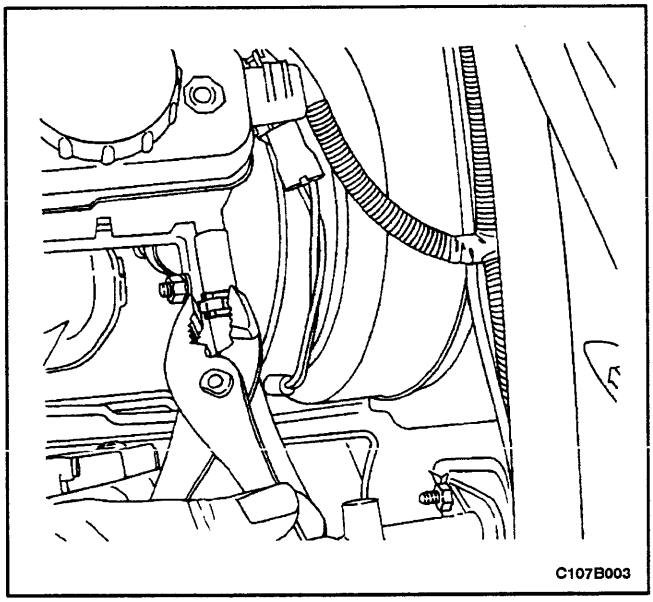
Removal Procedure

important: Remove the brake fluid reservoir only when it must be replaced because of damage or leaks.

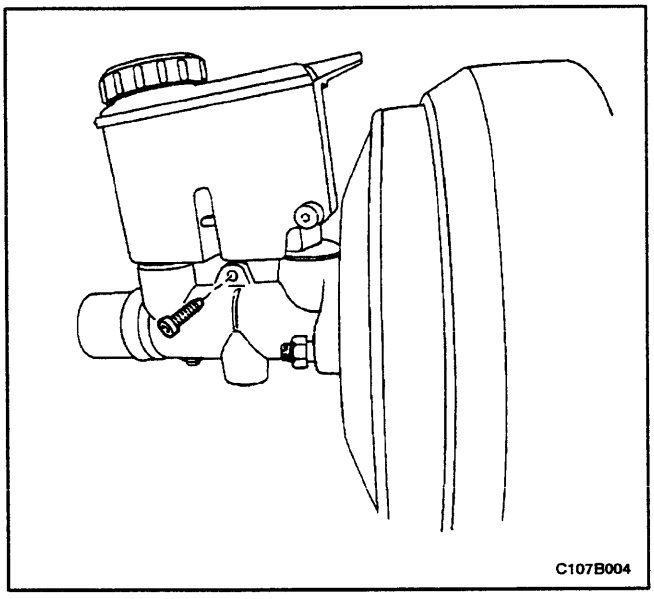
1. Remove the harness connector from its receptacle that is mounted to the top of the brake fluid reservoir.
2. Remove the receptacle by sliding it off its reservoir mount.



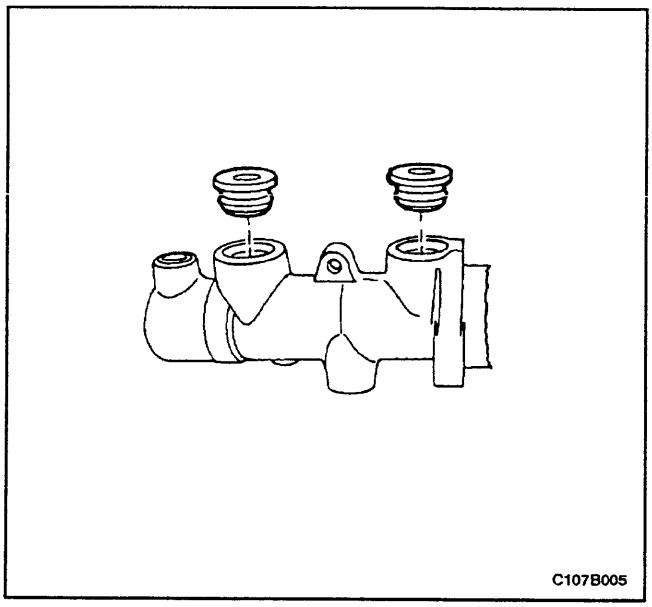
3. Crimp the plastic tabs of the low brake fluid level switch on the engine side of the brake fluid reservoir.
4. While crimping the plastic tabs, pull the switch out from the other side of the reservoir.



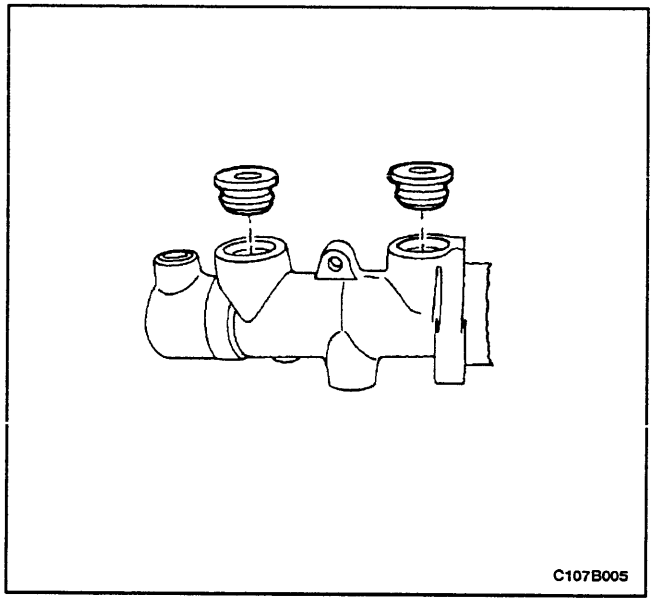
5. For vehicles with the manual transaxle, disconnect the clip that secures the clutch hose connection to the master cylinder and move the clip out of the way.
6. Remove the clutch hose from the master cylinder.



7. Remove the screw that holds the brake fluid reservoir to the master cylinder body.
8. Remove the reservoir from the retaining clamps by gently prying the reservoir upward with a screwdriver.
9. Remove the brake fluid reservoir from the master cylinder body by tilting the reservoir and pulling it upward.

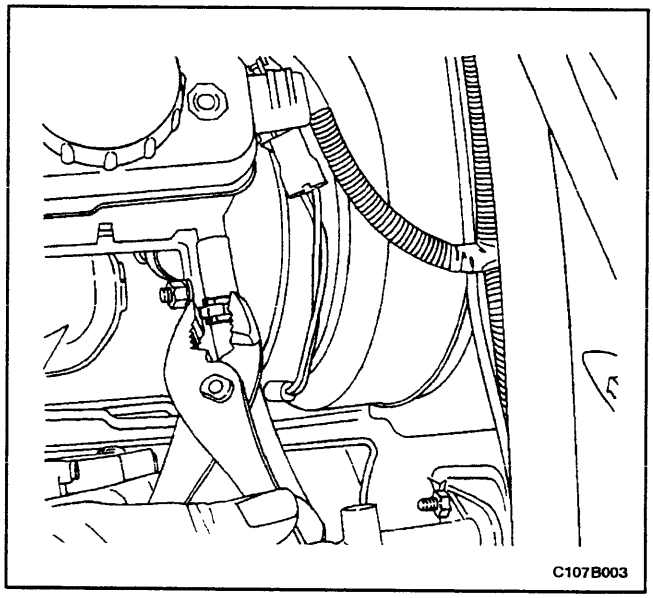

C107B005

10. Remove and discard the brake fluid reservoir seals from the master cylinder body.

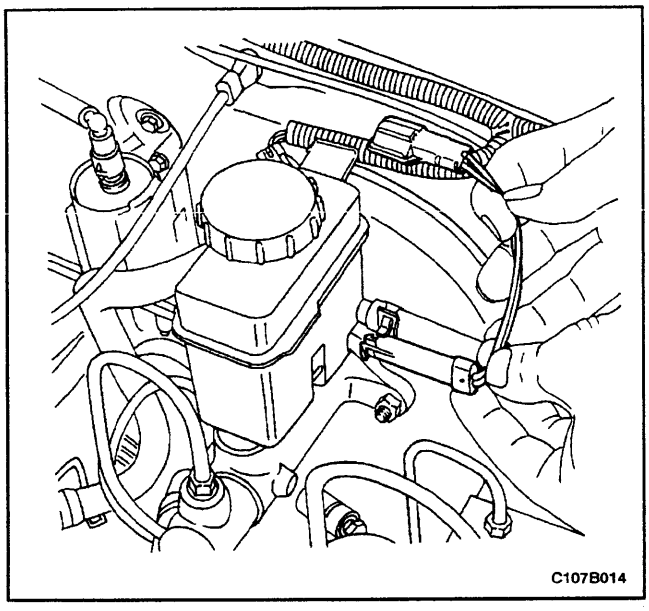

C107B005

Installation Procedure

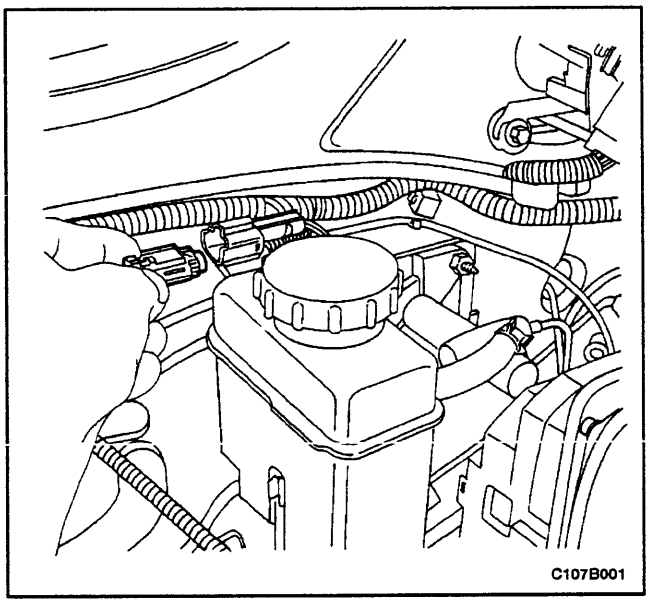
1. Lubricate the new brake fluid reservoir seals with clean brake fluid.
2. Install the brake fluid reservoir seals into the master cylinder body.
3. Install the brake fluid reservoir onto the master cylinder body.


C107B003

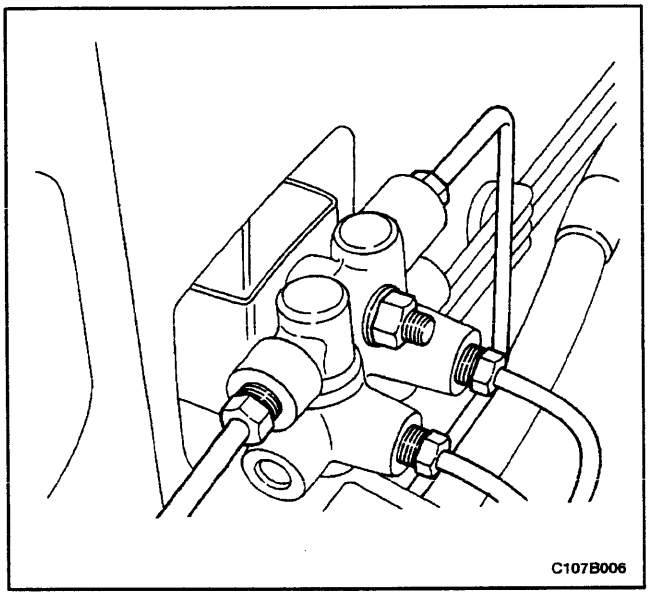
4. For vehicles with the manual transaxle, install the clutch hose connection to the master cylinder with the clip.


C107B014

5. Add the brake fluid.
6. Raise and suitably support the vehicle.
7. Bleed the braking system. Refer to *Section 4F, Anti-lock Brake System and Traction Control System.*
8. Bleed the clutch master cylinder. Refer to *Section 5C, Clutch.*
9. Lower the vehicle.
10. Install the low brake fluid level switch by pushing it into the side of the brake fluid reservoir opposite the engine.


C107B001

11. Install the receptacle for the low brake fluid level switch assembly by sliding it into its mount on the top of the brake fluid reservoir.
12. Plug in the harness connector.

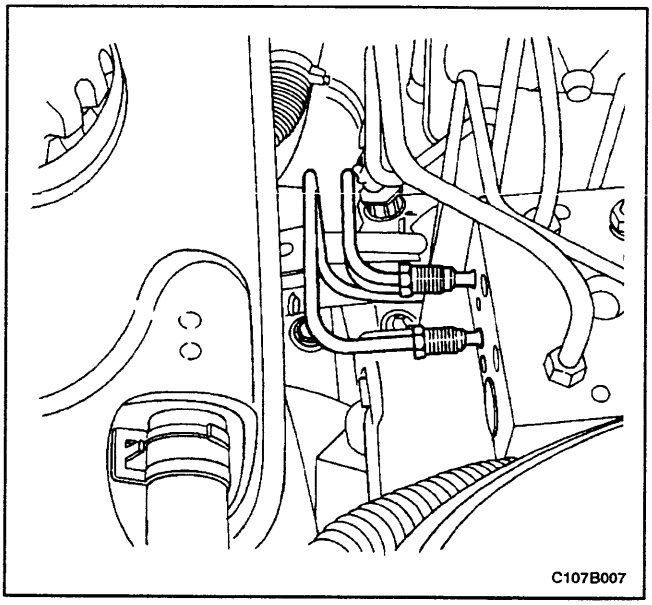

C107B006

PROPORTIONING VALVE

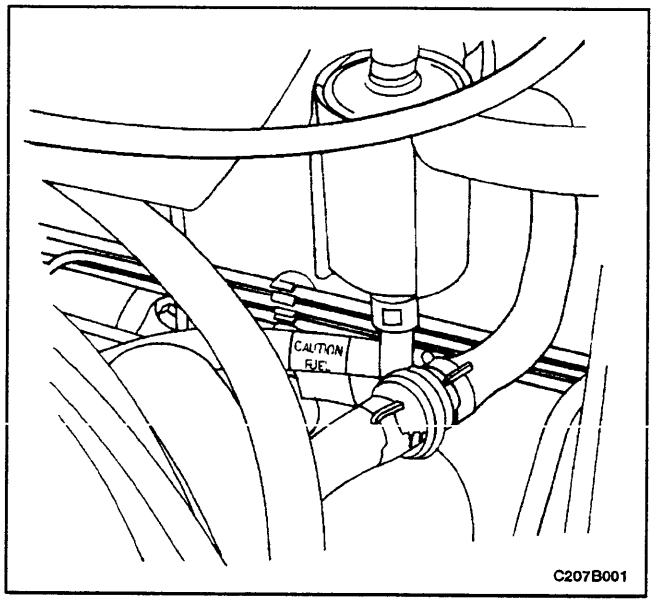
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

1. Disconnect the brake lines from the proportioning valve.
2. Remove the nut that secures the proportioning valve to the bulkhead.

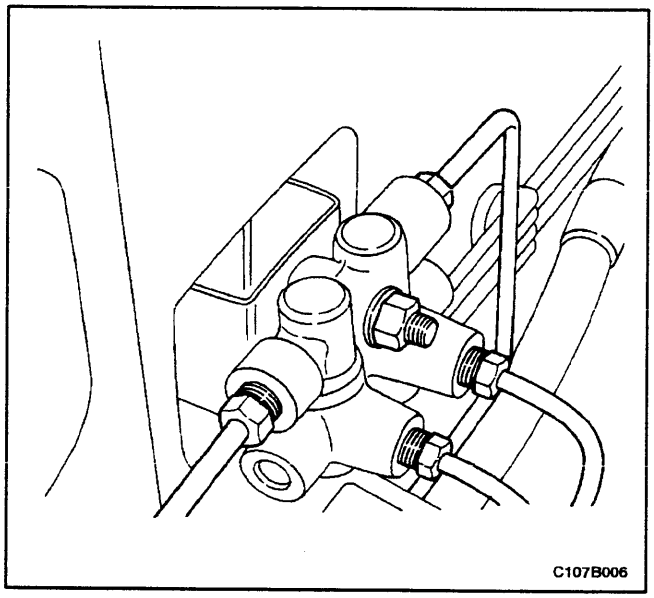

C107B007

3. Remove the brake lines from the hydraulic modulator.



C207B001

4. Unsnap the brake lines from the brackets along the bulkhead.


C107B006

Installation Procedure

1. Install the proportioning valve to the bulkhead.

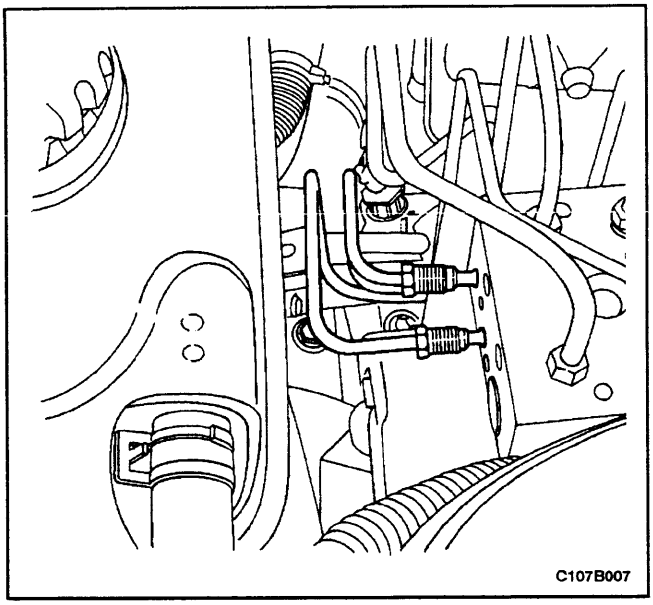
Tighten

Tighten the proportioning valve nut to 10 N•m (89 lb-in).

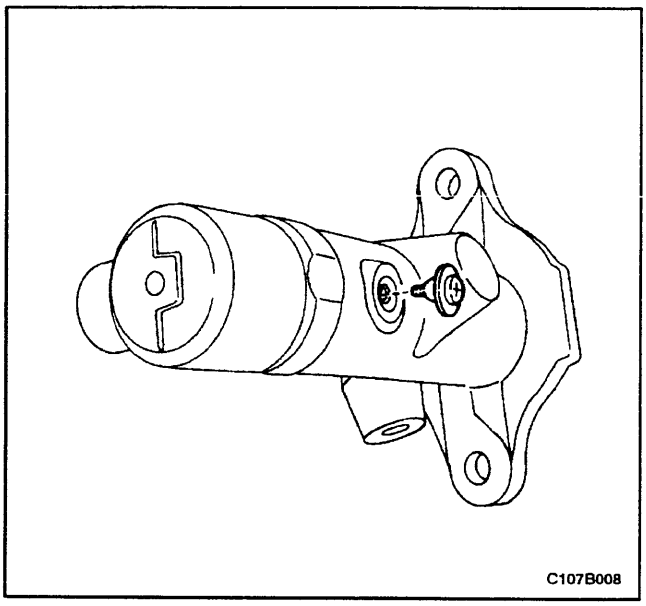
2. Connect the brake lines to the proportioning valve.

Tighten

Tighten the proportioning valve brake lines to 10 N•m (89 lb-in).



3. Install the brake lines to the hydraulic modulator.
4. Raise and suitably support the vehicle.
5. Bleed the braking system. Refer to *Section 4F, Anti-lock Brake System and Traction Control System.*
6. Lower the vehicle.

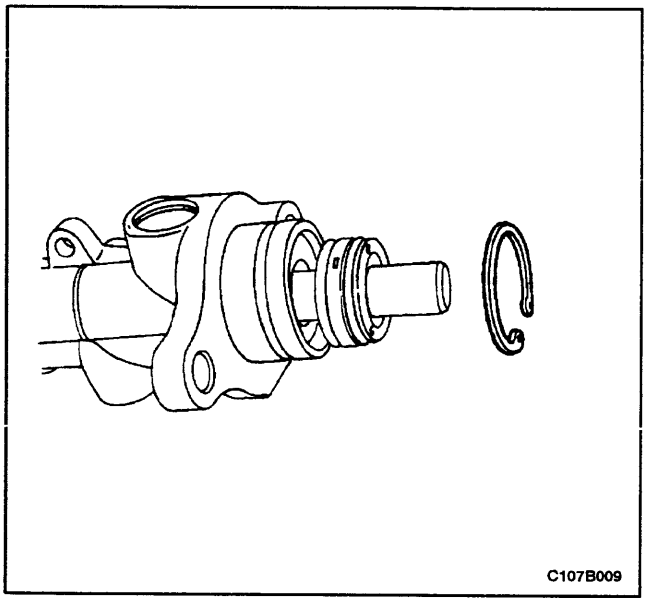

C107B008

UNIT REPAIR

MASTER CYLINDER OVERHAUL

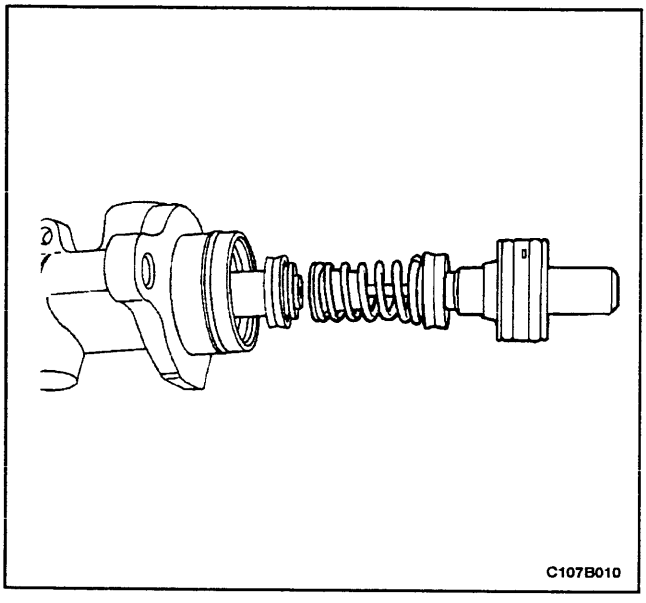
Disassembly Procedure

1. Remove the master cylinder. Refer to "Master Cylinder Assembly" in this section.
2. Remove the brake fluid reservoir. Refer to "Brake Fluid Reservoir" in this section.
3. Remove the screw from the cylinder.

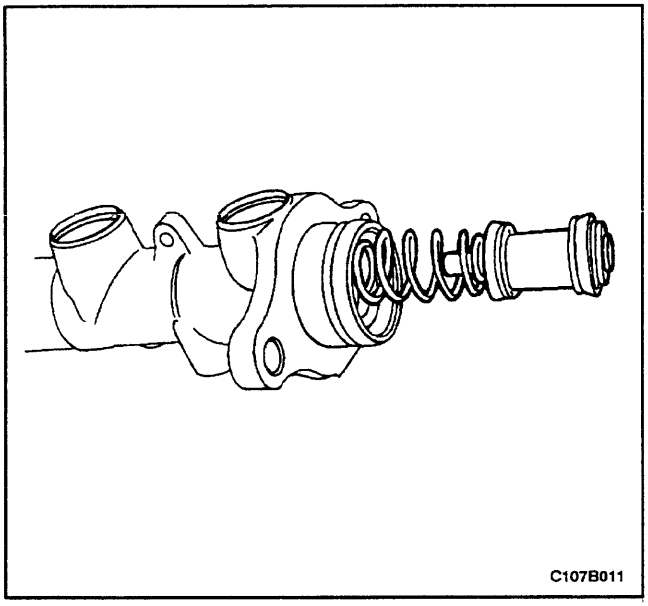

C107B009

Notice: When removing the retaining ring, avoid damaging the piston or the cylinder wall.

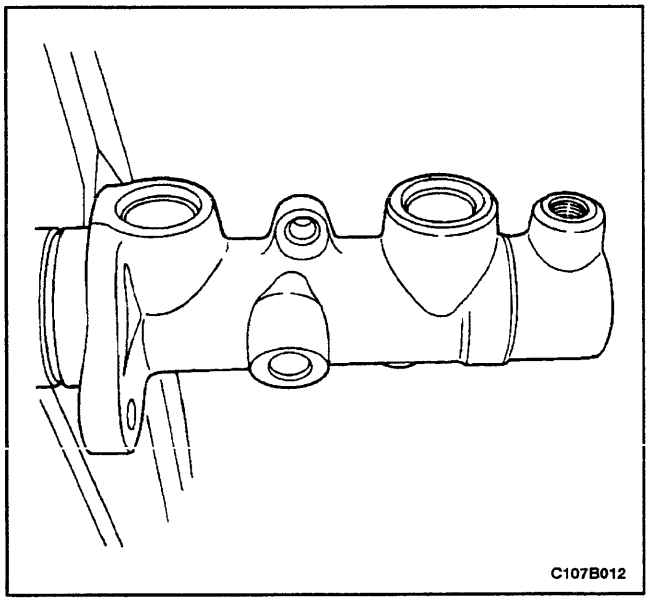
4. Remove and discard the retaining ring from the cylinder body by pressing the hollow shaft and using needle-nosed pliers to grasp and squeeze the retaining ring.


C107B010

5. Remove the washer and the primary piston assembly.


C107B011

6. Carefully remove the secondary piston assembly, including the spring, from the master cylinder bore.

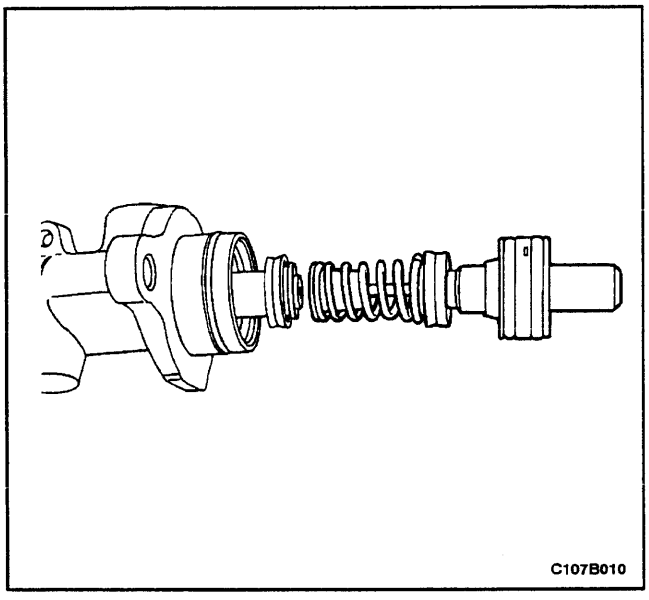

C107B012

Assembly Procedure

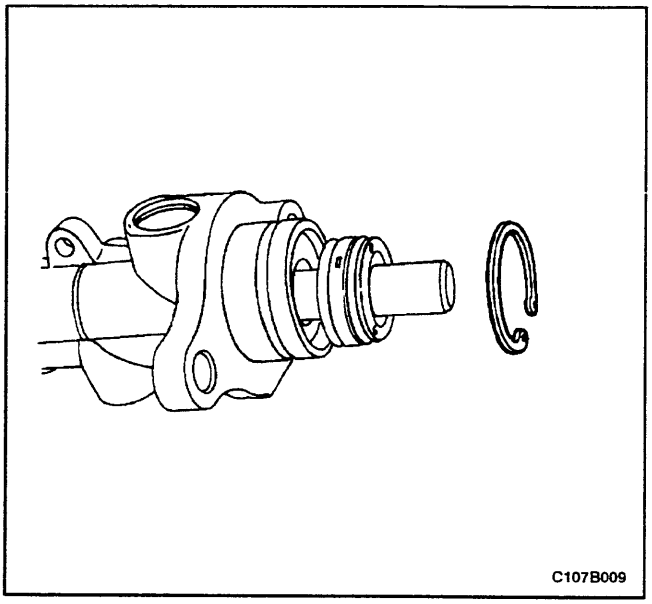
Notice: Do not use abrasives in the master cylinder bore. Abrasives can damage the bore.

Important: Rubber parts and retaining rings must be discarded and replaced with new parts.

1. Clean all the parts with denatured alcohol or clean brake fluid. Dry the parts with compressed air.
2. Inspect the master cylinder bore for scoring or corrosion. If scoring or corrosion is evident, replace the master cylinder body.
3. Lubricate the master cylinder bore with clean brake fluid.

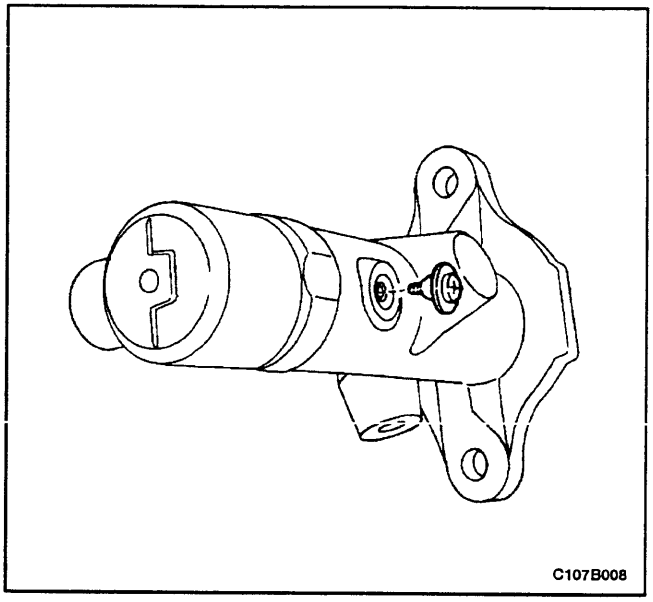

C107B010

4. Carefully insert the secondary piston assembly bore until the secondary piston contacts the base of the cylinder body. Use a wood or a plastic drift, if necessary.
5. Insert the primary piston assembly and the washer.

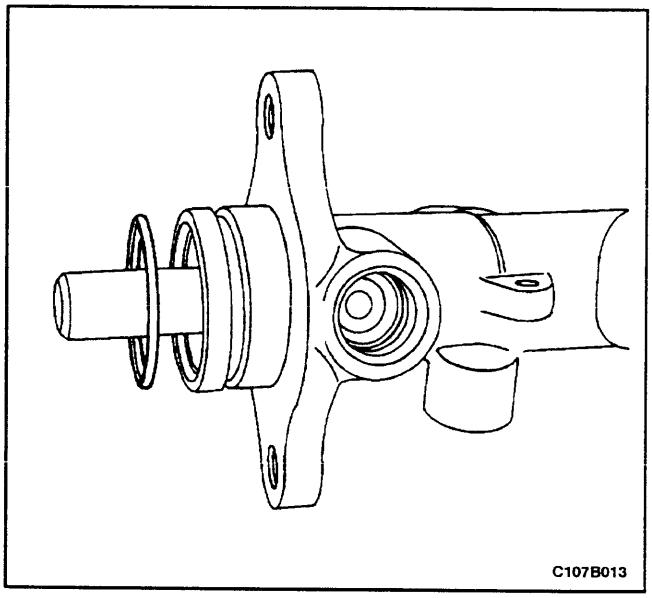

C107B009

Notice: When installing the washer and the new retaining ring, take care not to damage the cylinder bore.

6. Press the pistons into the cylinder bore using a wooden or a plastic drift.
7. Insert the washer and the new retaining ring into the groove in the cylinder bore.


C107B008

8. Install the retaining screw in bottom of the master cylinder and tighten it until it bottoms out on the internal piston assembly.


C107B013

9. Insert a new O-ring over the cylinder body.
10. Install the brake fluid reservoir onto the master cylinder. Refer to "Brake Fluid Reservoir" in this section.
11. Install the master cylinder assembly. Refer to the "Master Cylinder Assembly" in this section.
12. Raise and suitably support the vehicle.
13. Bleed the braking system. Refer to *Section 4F, Anti-lock Brake System and Traction Control System.*
14. Lower the vehicle.

GENERAL DESCRIPTION AND SYSTEM OPERATION

MASTER CYLINDER

The master cylinder is designed for use in a diagonally split system. One front and one diagonally opposite rear brake are served by the primary piston. The opposite front and rear brakes are served by the secondary piston. The master cylinder incorporates the functions of the standard dual master cylinder, plus a low fluid level indicator. The proportioning valve mounted to the bulkhead limits the outlet pressure to the rear brakes after a predetermined master cylinder pressure has been reached.

Notice: Do not use lubricated shop air on the brake parts, as this may damage the rubber components.

Important:

- Replace all the components included in the repair kits used to service this master cylinder.
- Lubricate the rubber parts with clean brake fluid to ease assembly.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- The torque values specified are for dry, unlubricated fasteners.
- Perform all service operations on a clean bench, free from all traces of mineral oil.

PROPORTIONING VALVE

The proportioning valve limits the outlet pressure to the rear brakes after a predetermined master cylinder pressure has been reached. This is used when less rear application force is needed to obtain optimum braking.

FLUID LEVEL SENSOR

The master cylinder is equipped with a fluid level sensor. This sensor will activate the BRAKE light if a low-fluid level condition is detected. Once the fluid level is corrected, the BRAKE light will go out.

SECTION 4C

POWER BOOSTER

TABLE OF CONTENTS

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Booster-to-Dash Panel Nuts	22	16	-
Booster Pushrod Hex Nut	18	13	-
Pushrod Clevis	18	13	-

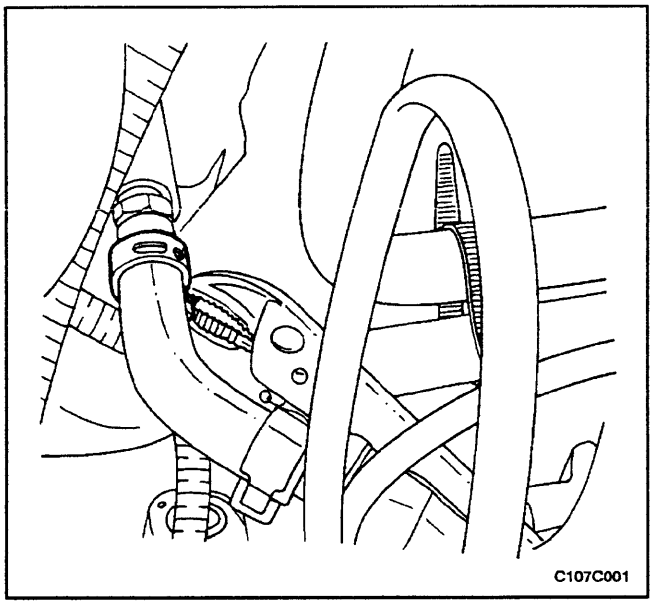
DIAGNOSIS

POWER BOOSTER FUNCTIONAL CHECK

1. With the engine stopped, eliminate vacuum in the booster by pumping the brake pedal several times.
2. Push the pedal down and hold in this position.
3. Start the engine.
4. The booster is OK if the pedal drops further because of extra force produced.

If the brake pedal does not drop, the vacuum system (vacuum hoses, check valve, etc.) is probably defective and should be checked.

If no defect is revealed by checking the vacuum system, the defect is in the booster itself.

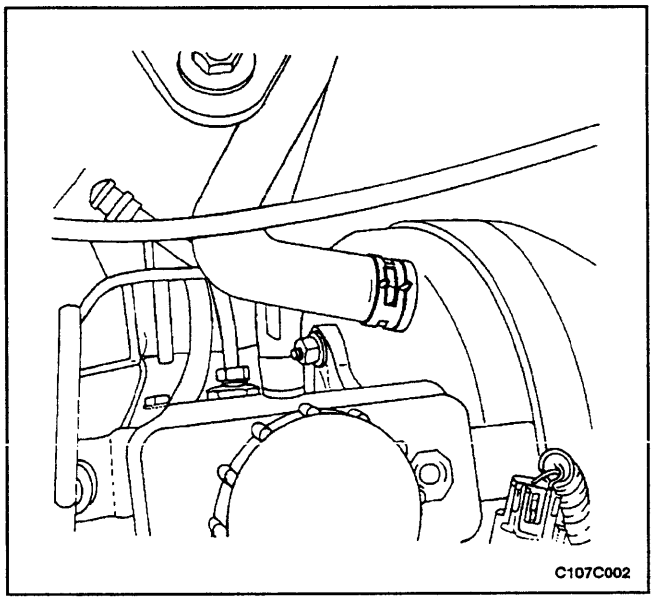


MAINTENANCE AND REPAIR ON-VEHICLE SERVICE

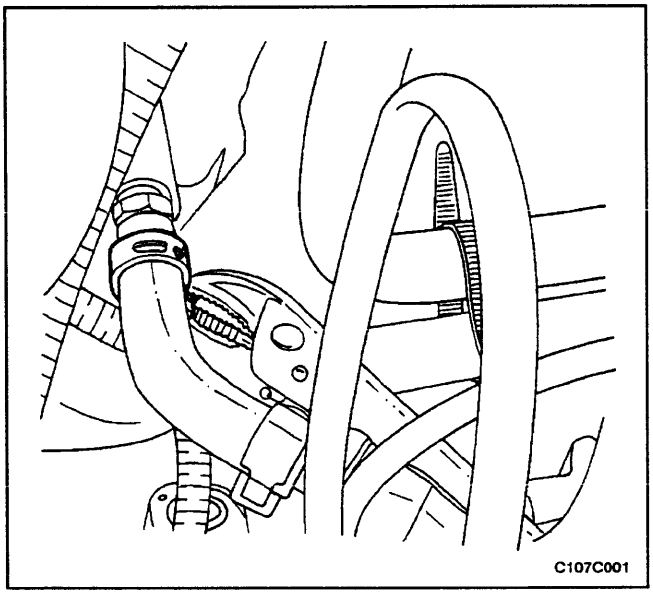
VACUUM HOSE

Removal Procedure

1. Remove the clip on the vacuum hose connection at the intake manifold.
2. Pull the hose from the union nut connection. If the hose does not remove easily or is deteriorated, pry off and discard the hose.

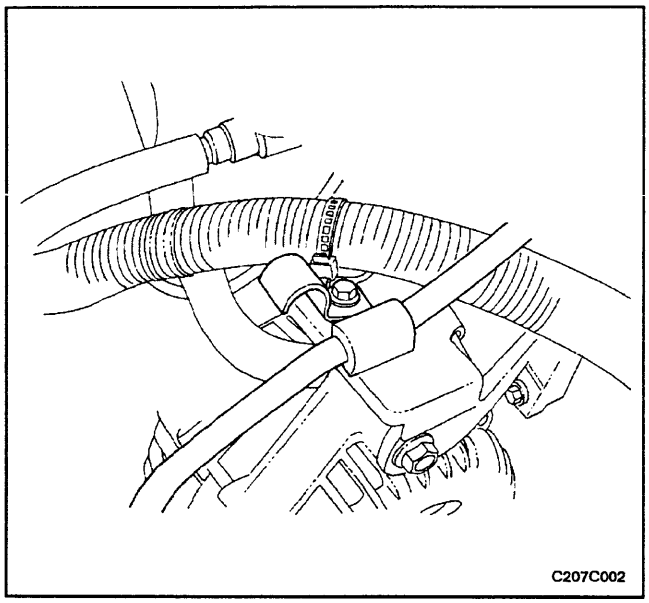


3. Remove the clip on the vacuum hose connection to the brake booster.
4. Remove the vacuum hose.



Installation Procedure

1. Mount the vacuum hose and ensure the connections are tight on each end.
2. Install the vacuum hose clips.
3. Check the function of the booster. Refer to the "Power Booster Functional Check" in this section.

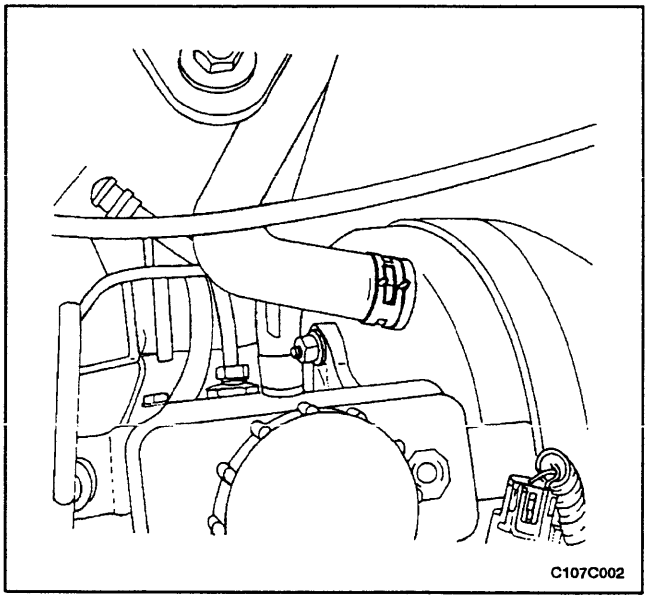

C207C002

POWER BOOSTER ASSEMBLY

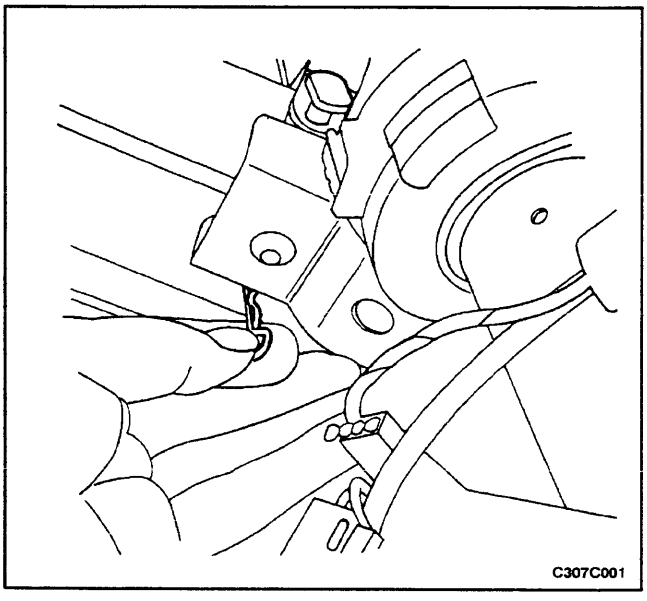
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

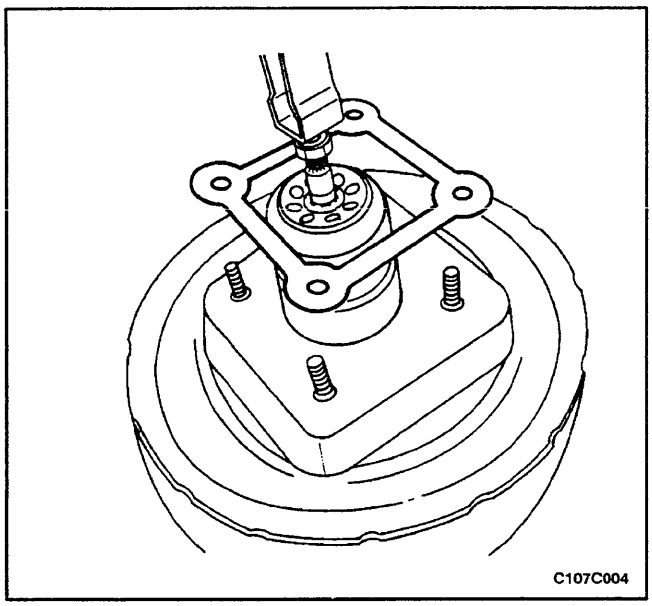
1. For right-hand drive vehicles, remove the air intake tube. Refer to *Section 1C, DOHC Engine Mechanical (2.0L Holdens).*
2. For right-hand drive vehicles, loosen the retaining clip located above the alternator and position it away from the pressure line.


C107C002

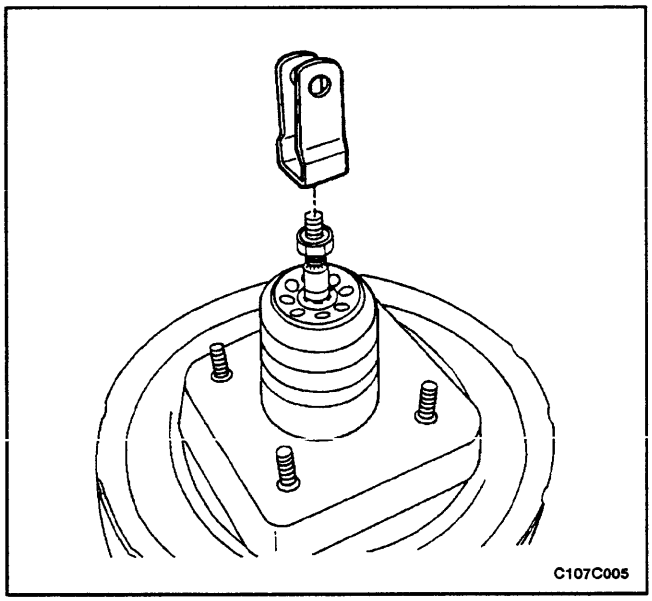
3. Remove the master cylinder. Refer to *Section 4B, Master Cylinder.*
4. Remove the clamp on the vacuum hose connection to the booster.
5. Remove the vacuum hose from the booster. Refer to "Vacuum Hose" in this section.


C307C001

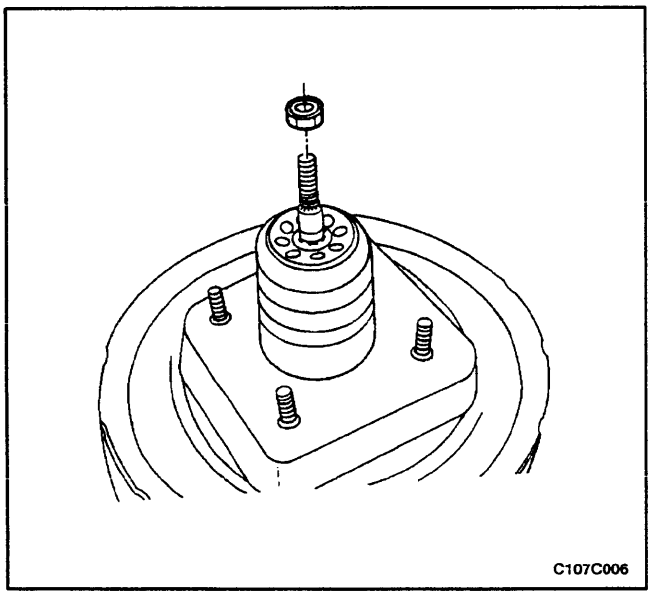
6. Disconnect the brake stoplamp switch. Refer to *Section 4A, Hydraulic Brakes.*
7. Remove the brake pedal spring.
8. Disconnect the clip and remove the pushrod pin from the pedal bracket assembly.



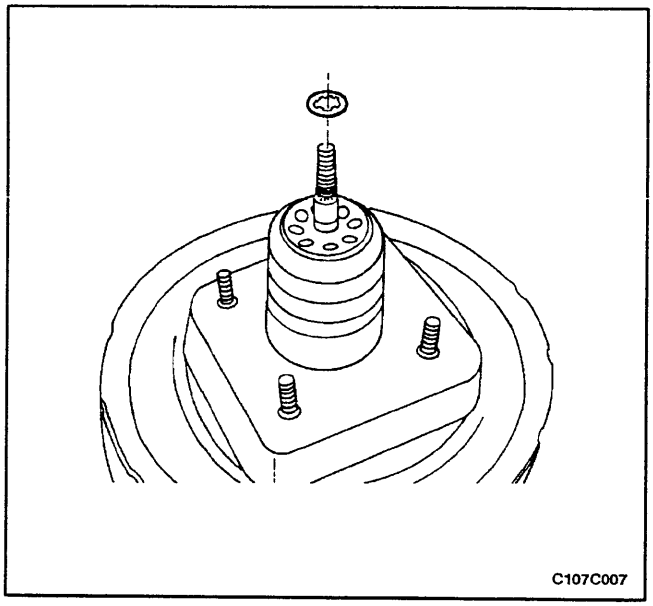
9. Remove the booster mounting nuts from the studs protruding from the dash panel, and remove the booster.
10. Remove and discard the gasket.



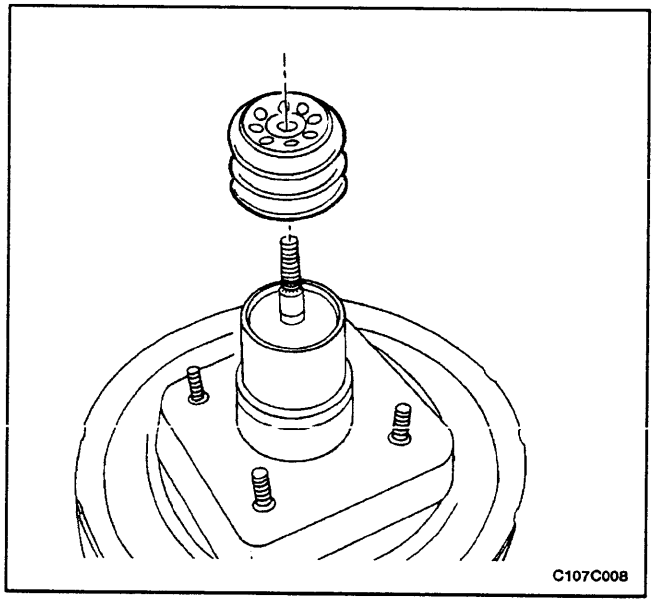
11. Remove the pushrod clevis.



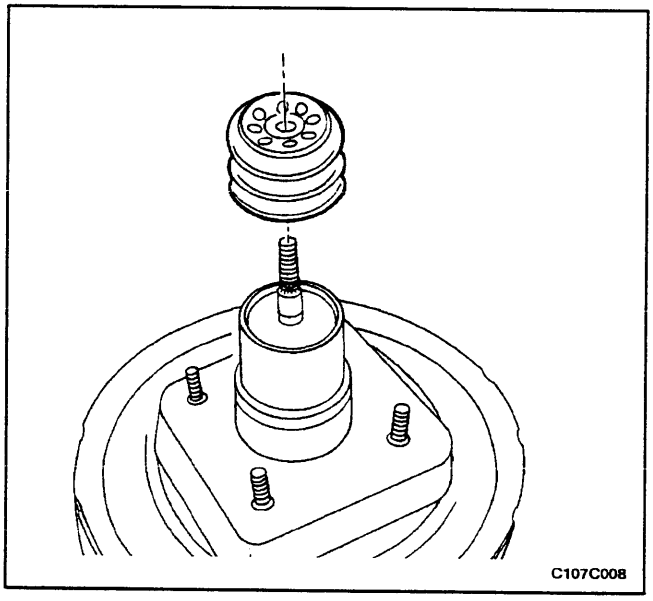
12. Remove the hex nut from the pushrod.



13. Remove the spring clip.

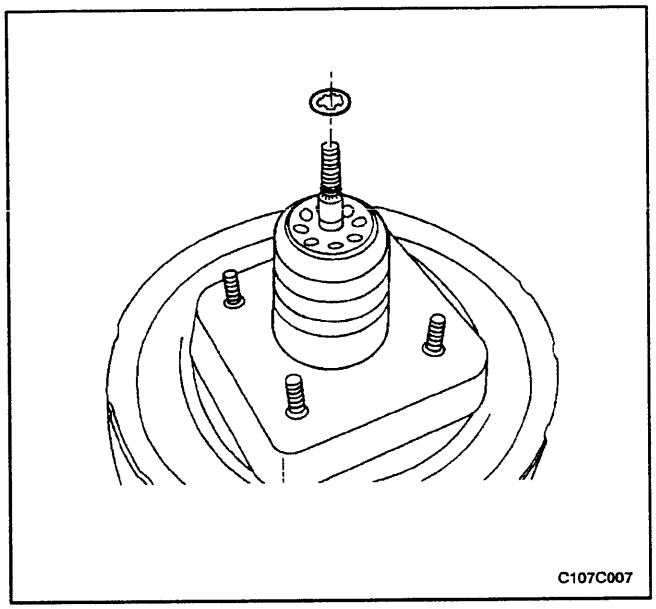


14. Remove the rubber boot and the packings.
15. Discard the rubber boot, if deteriorated, and discard the packings.

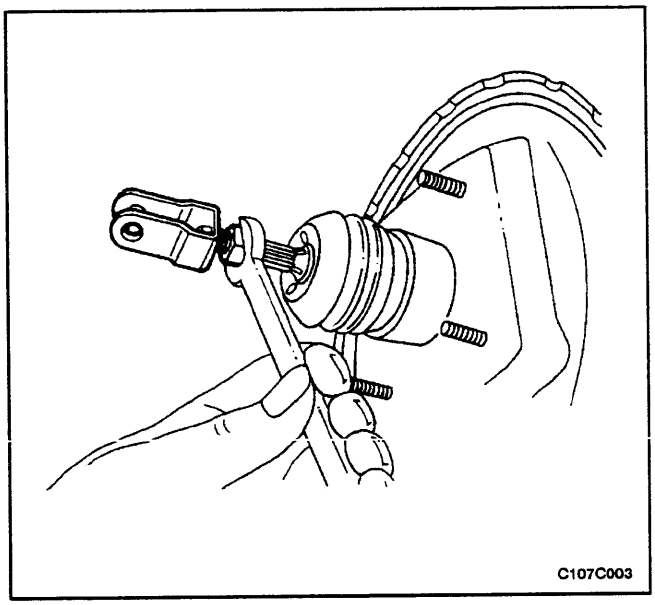


Installation Procedure

1. Check the pushrod and the pushrod clevis for damage and proper fit.
2. Install the new foam rubber and fiber packings, and install the new rubber boot on the booster shaft.



3. Install the spring clip.

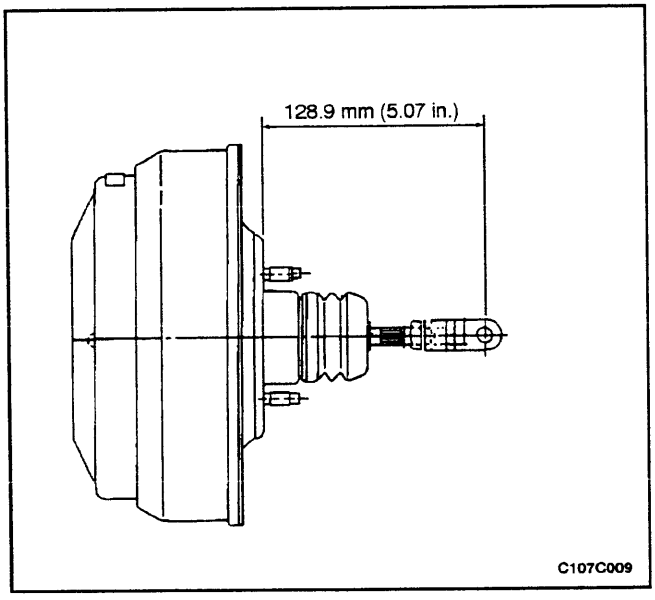


4. Install the hex nut and the pushrod clevis.

Tighten

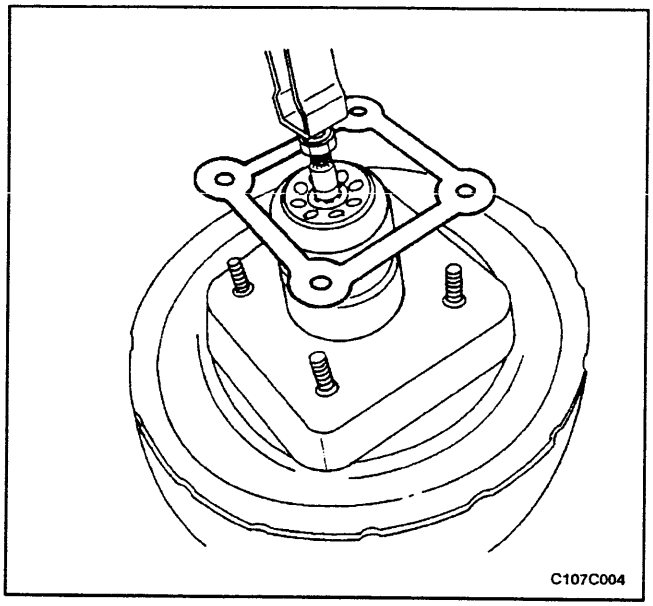
Tighten the booster pushrod hex nut to 18 N•m (13 lb-ft).

Tighten the pushrod clevis to 18 N•m (13 lb-ft).



5. Measure the distance from the booster to the center of the fork bin bore.

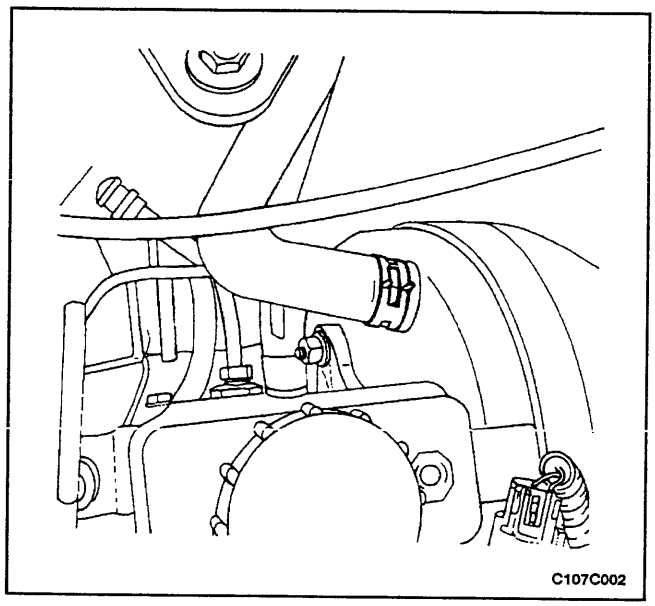
Important: This measurement should be 128.9 mm (5.07 inches).



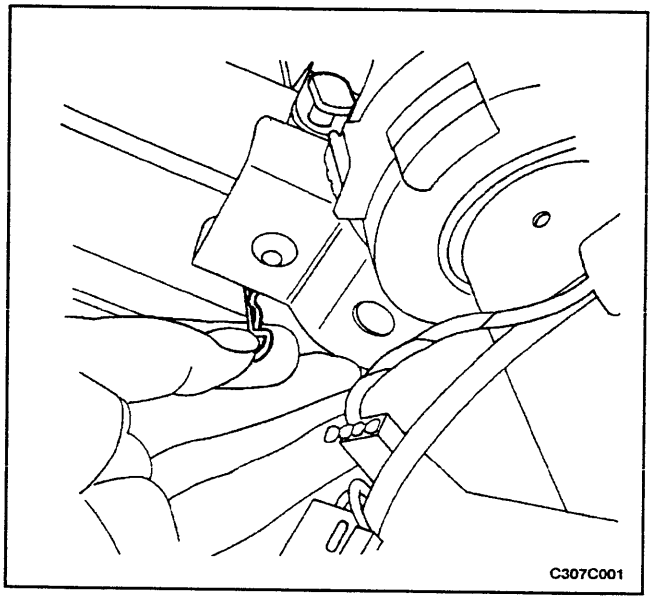
6. Install the new gasket.
7. Install the booster and the mounting nuts to the dash panel.

Tighten

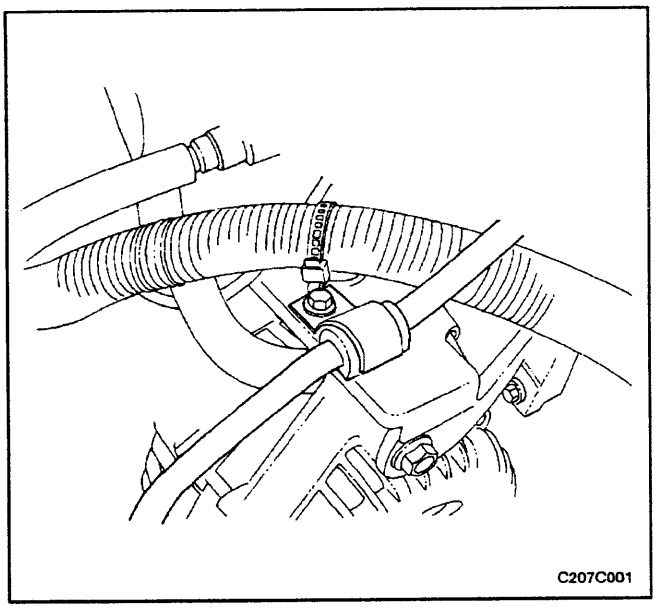
Tighten the booster-to-dash panel nuts to 22 N•m (16 lb-ft).



8. Install the master cylinder onto the booster. Refer to *Section 4B, Master Cylinder*.
9. Install the new vacuum hose to the booster. Refer to "Vacuum Hose" in this section.
10. Install the hose clamp on the vacuum hose.



11. Install the pushrod pin to the brake pedal bracket assembly and connect the clip and the spring.
12. Connect the brake stoplamp switch. Refer to *Section 4A, Hydraulic Brakes*.



13. For right-hand drive vehicles, secure the pressure line with the retaining clip located above the alternator.
14. For right-hand drive vehicles, install the air intake tube. Refer to *Section 1C, DOHC Engine Mechanical (2.0L Holdens)*.

GENERAL DESCRIPTION AND SYSTEM OPERATION

POWER BOOSTER

This booster is a single-diaphragm, vacuum-suspended unit. In a normal operating mode, with the service brakes in the release position, a vacuum-suspended booster operates with a vacuum on both sides of its diaphragm. When the brakes are applied, air at atmospheric pressure is admitted to one side of the diaphragm to provide the power assist. When the brakes are released, atmospheric air is shut off from that side of the diaphragm. The air is then drawn from the booster through the vacuum check valve by the vacuum source.

Important: If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.

SECTION 4D

FRONT DISC BRAKES

TABLE OF CONTENTS

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Brake Hose Inlet Fitting-to-Caliper Bolt	40	30	-
Caliper Bleeder Valve	6	-	53
Caliper-to-Steering Knuckle Mounting Bolts	95	70	-
Retaining Frame-to-Caliper Housing Bolts	27	19	-
Rotor-to-Front Wheel Hub Detent Screw	4	-	35
Splash Shield-to-Steering Knuckle Bolts	25	18	-

DIAGNOSIS

LINING INSPECTION

1. Raise and suitably support the vehicle.
2. Remove the front wheels. Refer to *Section 2E, Tires and Wheels*.
3. Visually check the linings for minimum thickness and wear.
4. Measure the thickness.

Important: The minimum thickness of the inner or outer brake pad is 7 mm (0.28 inch).

5. Install the brake pads in axle sets only.
6. Install the front wheels. Refer to *Section 2E, Tires and Wheels*.
7. Lower the vehicle.

ROTOR INSPECTION

Thickness variation can be checked by measuring the thickness of the rotor at four or more points around the circumference of the rotor. All measurements must be made at the same distance in from the edge of the rotor.

A rotor that varies by more than 0.10 mm (0.004 inch) can cause pedal pulsations and/or front end vibration during brake applications. A rotor that does not meet these specifications should be refinished to specifications or replaced.

During manufacturing, the brake rotor and the tolerances of the braking surface regarding flatness, thickness variation, and lateral runout are held very close. The maintenance of close tolerances on the shape of the braking surfaces is necessary to prevent brake roughness.

In addition to these tolerances, the surface finish must be held to a specified range. The control of the braking surface finish is necessary to avoid pulls and erratic performance and to extend lining life.

Light scoring of the rotor surfaces not exceeding 0.40 mm (0.016 inch) in depth, which may result from normal use, is not detrimental to brake operation.

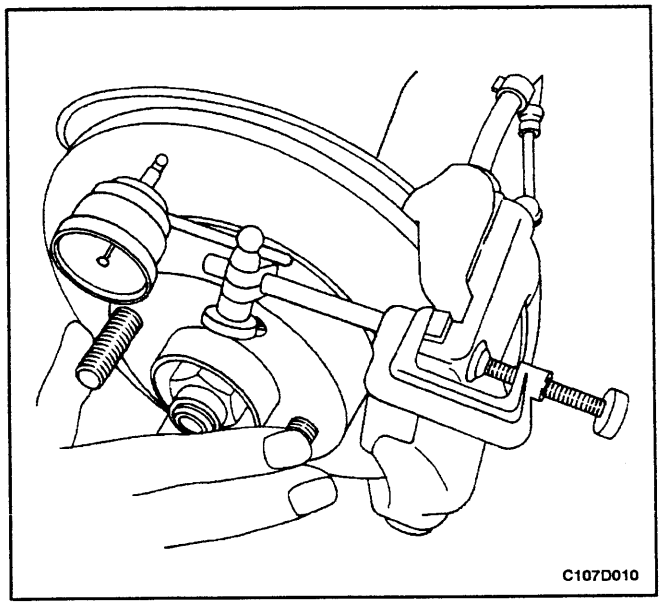
Using a commercially available dial indicator, check lateral runout as follows:

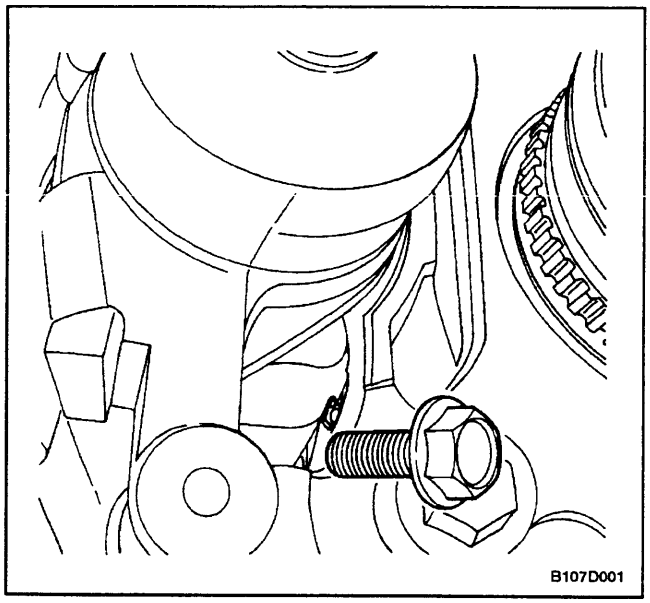
Notice: Permissible lateral runout is a maximum 0.10 mm (0.004 inch). If lateral runout exceeds the specification, ensure that there is no dirt between the rotor and the hub and that contact surfaces are smooth and free from burrs.

1. Position the transaxle in NEUTRAL.
2. Remove the rotor. Refer to "Rotor" in this section.
3. Fasten the brake rotor to the wheel hub with two wheel nuts. Refer to *Section 2E, Tires and Wheels.*
4. Fasten a dial indicator to the brake caliper.
5. Set the gauge probe tip to approximately 10 mm (0.39 inch) from the outer edge of the brake rotor, perpendicular to the disc and under slight preload.
6. Remove the dial indicator and the wheel nuts connecting the rotor to the hub.

Important: Since accurate control of the rotor tolerances is necessary for proper performance of the disc brakes, refinishing of the rotor should be done only with precision equipment.

7. Refinish the rotor, if required, with precision equipment. Discard the rotor if it fails to meet the above specifications after refinishing.
8. Install the rotor. Refer to "Rotor" in this section.




B107D001

MAINTENANCE AND REPAIR

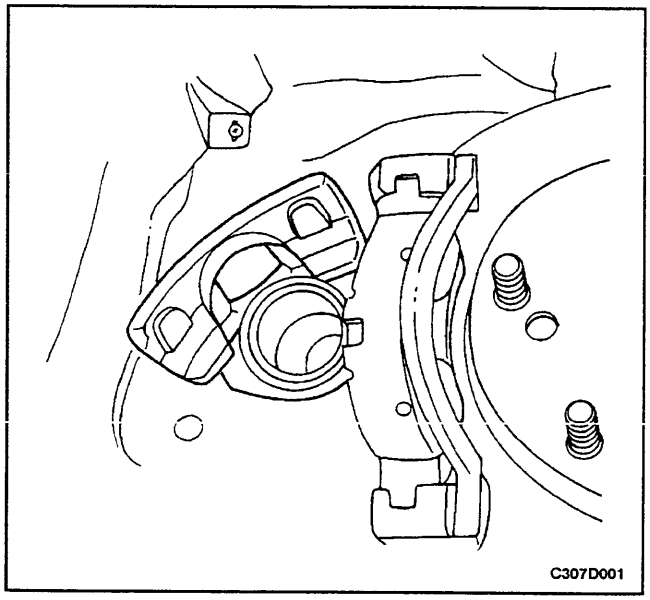
ON-VEHICLE SERVICE

SHOE AND LINING (BRAKE PADS)

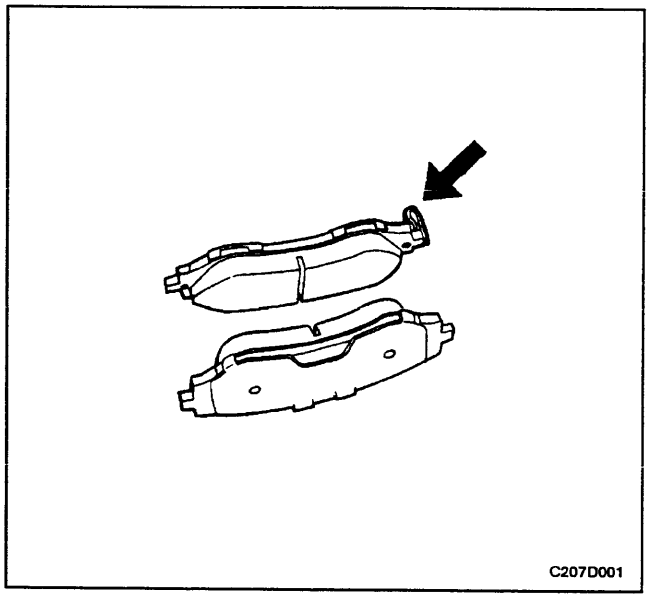
Removal Procedure

1. Raise and suitably support the vehicle.
2. Remove the front wheels. Refer to *Section 2E, Tires and Wheels*.
3. Remove the lower bolt of the caliper assembly retaining frame.

Important: Caliper assembly removal is not necessary to service the brake pads.

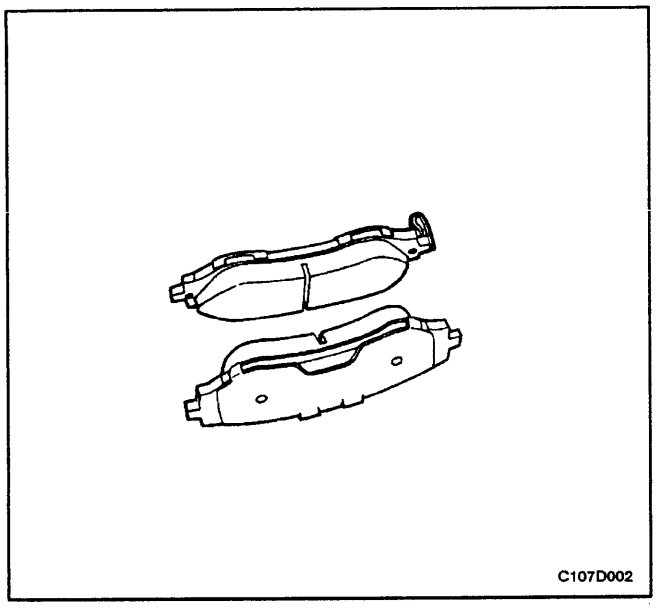

C307D001

4. Pull the caliper piston housing up.


C207D001

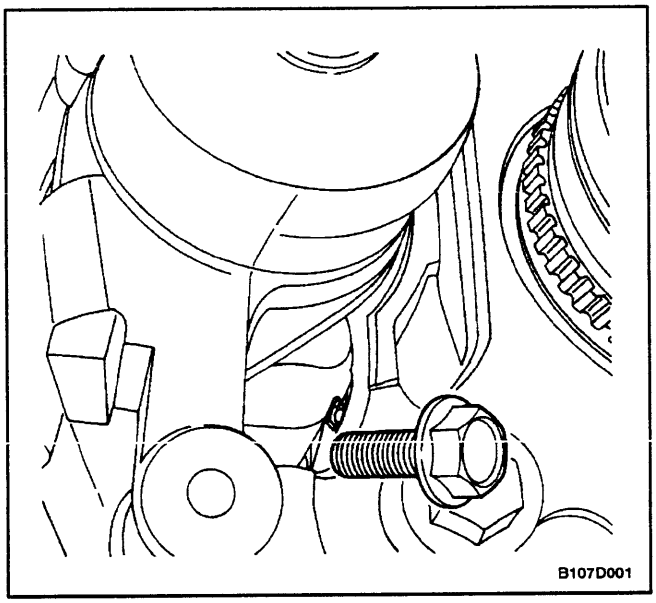
Important: If a squealing noise emanating from the brakes was diagnosed with the vehicle in motion, check the brake pad indicator.

5. Remove the brake pads, noting the position of the pad with the wear indicator clip.


C107D002

Installation Procedure

1. Measure the minimum brake pad thickness. Refer to "Lining Inspection" in this section.
2. Install the brake pads into the caliper.
3. Push the piston inward, if needed.


B107D001

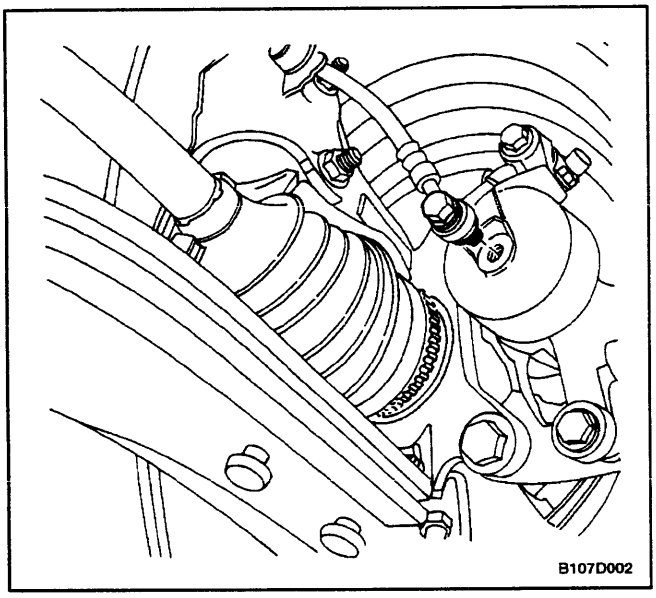
Notice: Take care not to damage the piston seal when the piston housing is pulled down.

4. Pull down the caliper piston housing and secure it to the retaining frame with the lower bolt.

Tighten

Tighten the upper and lower retaining frame-to-caliper housing bolts to 27 N•m (19 lb-ft).

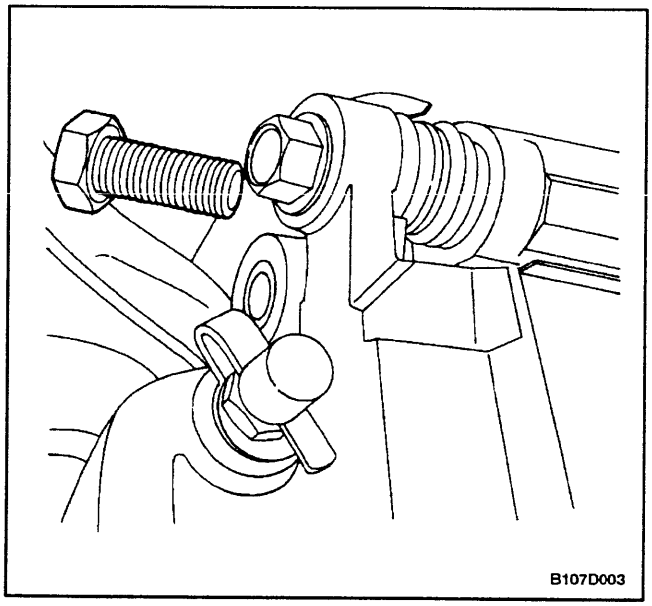
5. Install the front wheels. Refer to *Section 2E, Tires and Wheels*.
6. Lower the vehicle.


B107D002

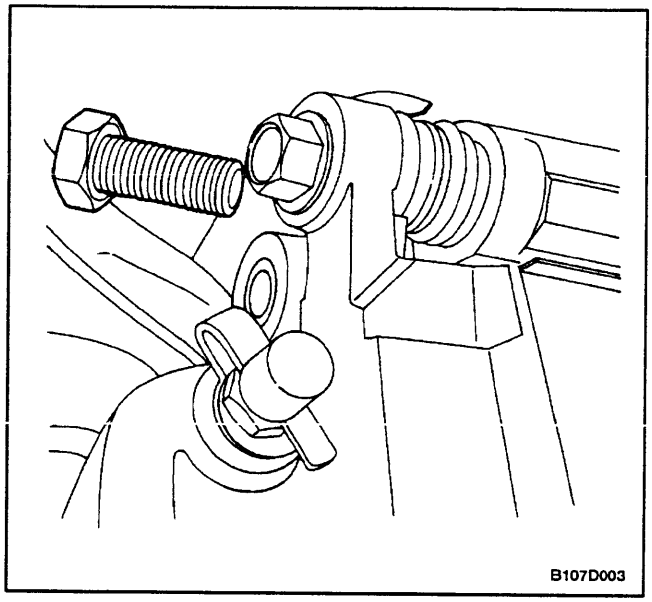
CALIPER ASSEMBLY

Removal Procedure

1. Raise and suitably support the vehicle.
2. Mark the position of the front wheels relative to the wheel hubs and remove the wheels. Refer to *Section 2E, Tires and Wheels*.
3. Remove the bolt and the washers attaching the brake hose to the caliper.



4. Disconnect the brake hose, and plug the openings in the caliper and the brake hose to prevent fluid loss and contamination.
5. Remove the caliper mounting bolts from the steering knuckle, and remove the caliper assembly.

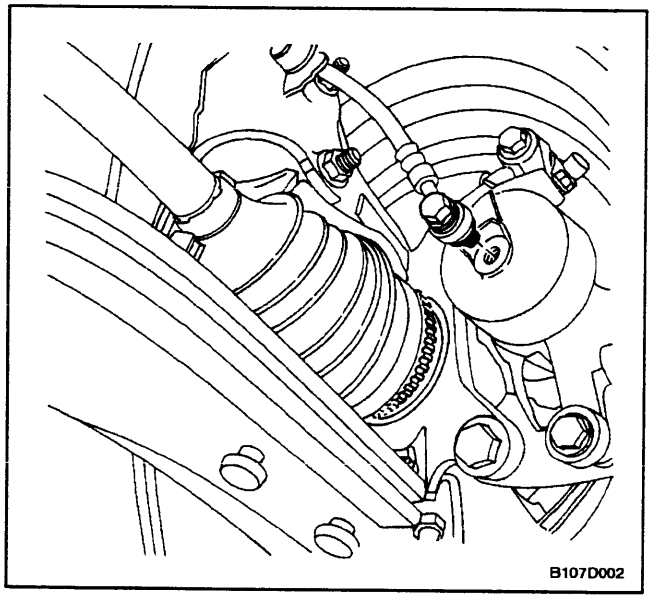


Installation Procedure

1. Install the caliper assembly with the mounting bolts.

Tighten

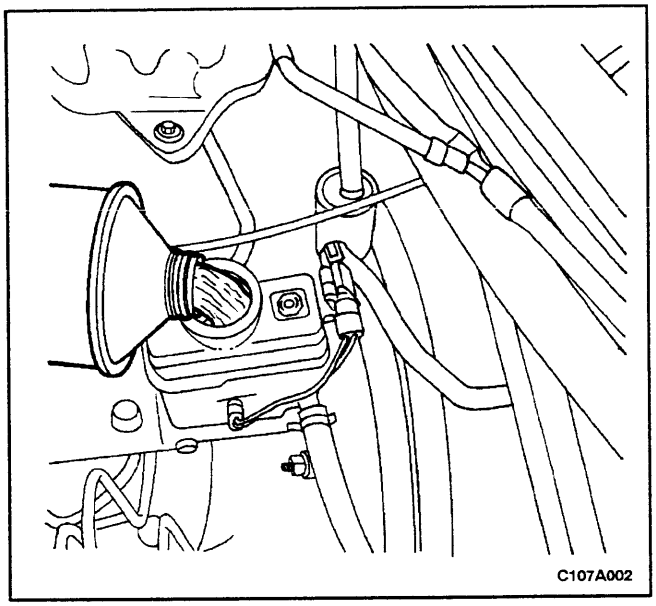
Tighten the caliper-to-steering knuckle mounting bolts to 95 N•m (70 lb-ft).



2. Connect the brake hose.

Tighten

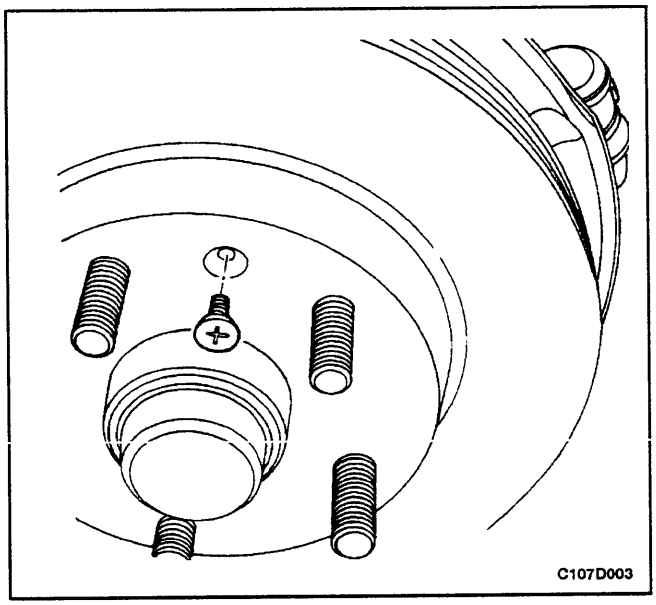
Tighten the brake hose inlet fitting-to-caliper bolt and washers to 40 N•m (30 lb-ft).


C107A002

3. Install the front wheels. Refer to *Section 2E, Tires and Wheels*.
4. Lower the vehicle.
5. Fill the master cylinder to the proper level with clean brake fluid.
6. Bleed the caliper. Refer to *Section 4F, Antilock Brake System and Traction Control System.*
7. Recheck the fluid level.

Notice: Do not move the vehicle until a firm pedal is obtained or improper braking action will result.

8. Repeatedly press the brake pedal to bring the pads in contact with the rotor.


C107D003

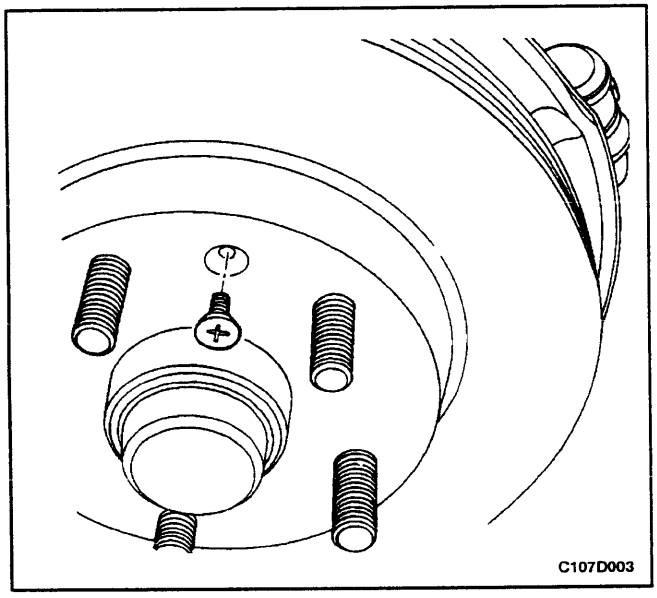
ROTOR

Removal Procedure

Notice: Do not hang the caliper assembly from the brake hose. Any resulting internal hose restriction will impede uniform braking action.

Important: To guarantee uniform braking on both sides, both rotors must have identical surfaces regarding smoothness and scoring depth. For this reason, always replace both rotors.

1. Remove the caliper assembly without disconnecting the brake hoses. Refer to "Caliper Assembly" in this section.
2. Remove the rotor-to-front wheel hub detent screws.
3. Pull off the rotor.


C107D003

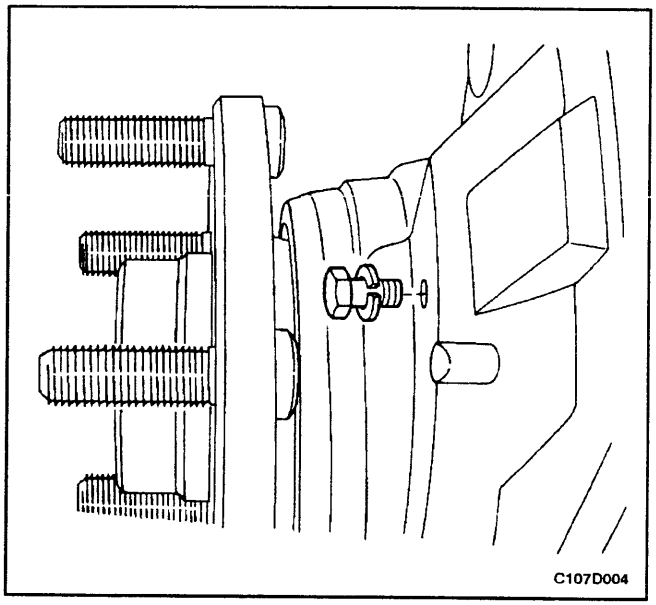
Installation Procedure

1. Inspect the rotor. Refer to "Rotor Inspection" in this section.
2. Install the rotor to the front wheel hub by tightening the detent screw.

Tighten

Tighten the rotor-to-front wheel hub detent screw to 4 N•m (35 lb-in).

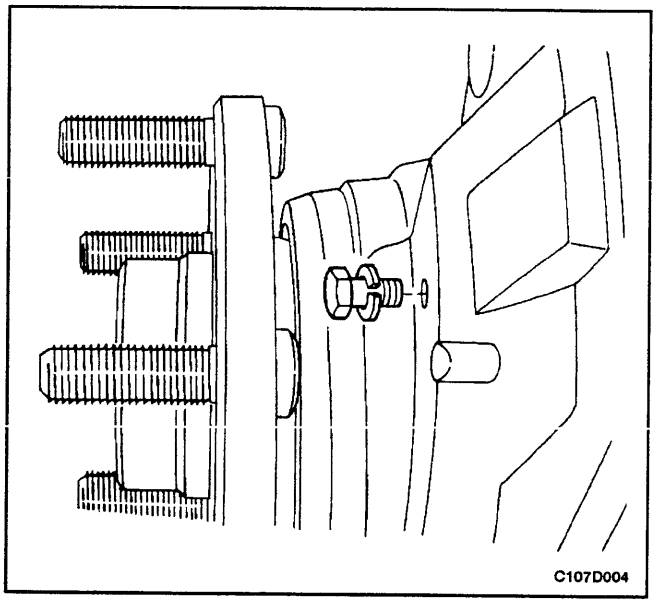
3. Install the caliper assembly. Refer to "Caliper Assembly" in this section.



SPLASH SHIELD

Removal Procedure

1. Remove the rotor. Refer to "Rotor" in this section.
2. Remove the bolts and the lockwashers for the splash shield from the steering knuckle.
3. Remove the splash shield.



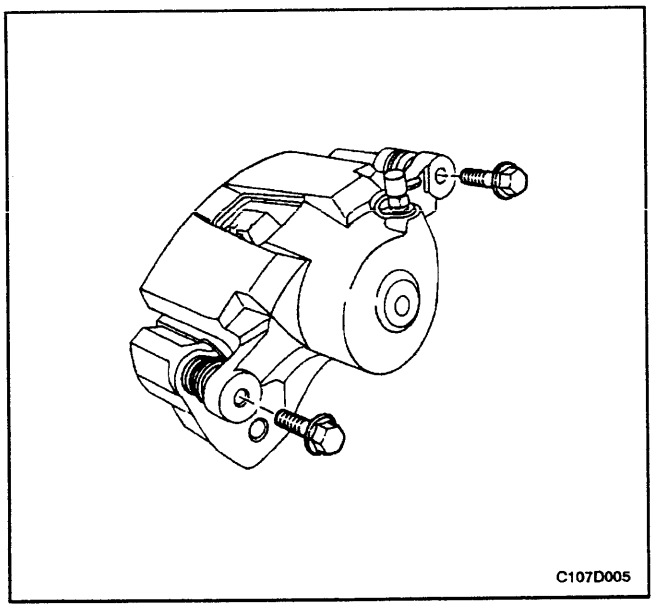
Installation Procedure

1. Install the splash shield.
2. Secure the splash shield to the steering knuckle with the bolts and the lockwashers.

Tighten

Tighten the splash shield-to-steering knuckle bolts to 25 N•m (18 lb-ft).

3. Install the rotor. Refer to "Rotor" in this section.

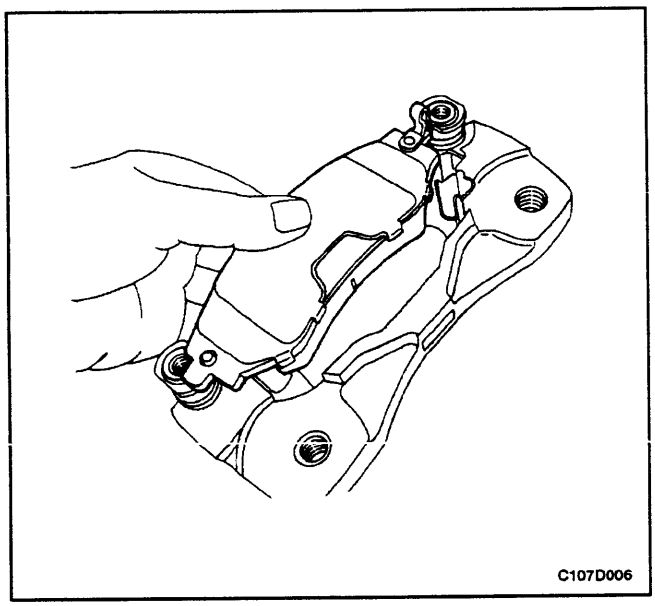

C107D005

UNIT REPAIR

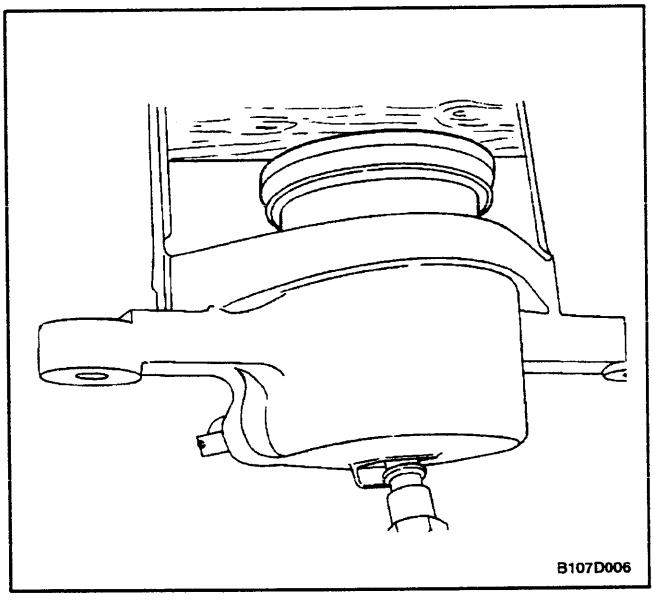
CALIPER OVERHAUL

Disassembly Procedure

1. Remove the caliper assembly. Refer to "Caliper Assembly" in this section.
2. Remove the guide pin bolts connecting the caliper piston housing to the retaining frame.


C107D006

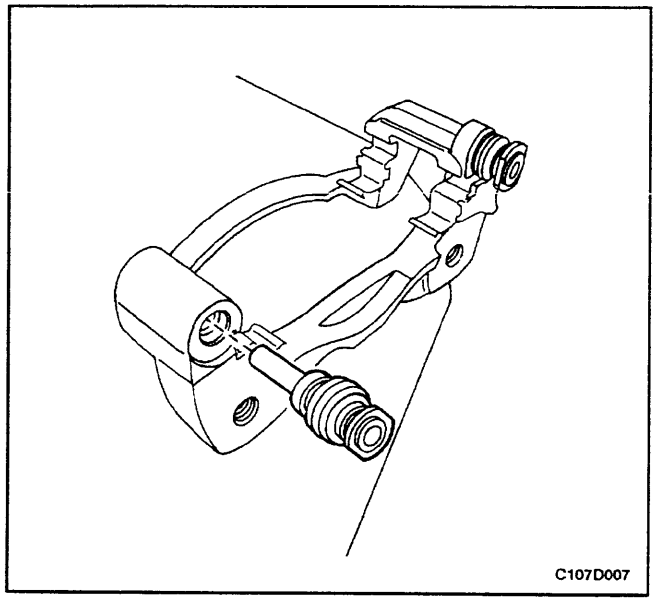
3. Remove the front pad brake set, including the pad springs, from the caliper. Refer to "Shoe and Lining" in this section.


B107D006

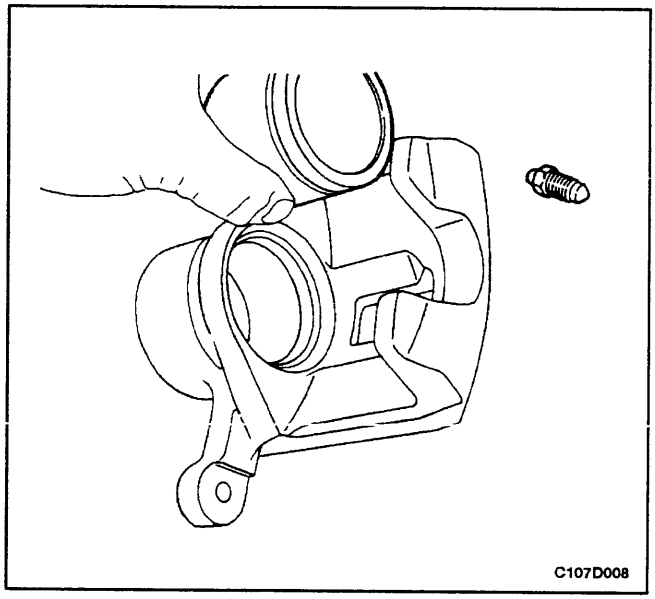
Caution: Do not place fingers in front of the piston in an attempt to catch or protect it when applying compressed air. This could result in serious injury.

Important: Insert a piece of hardwood into the caliper housing interior when removing the piston.

4. Using compressed air, blow out the piston from housing.
5. Remove the outer seal.
6. Remove the inner seal from the caliper piston bore.


C107D007

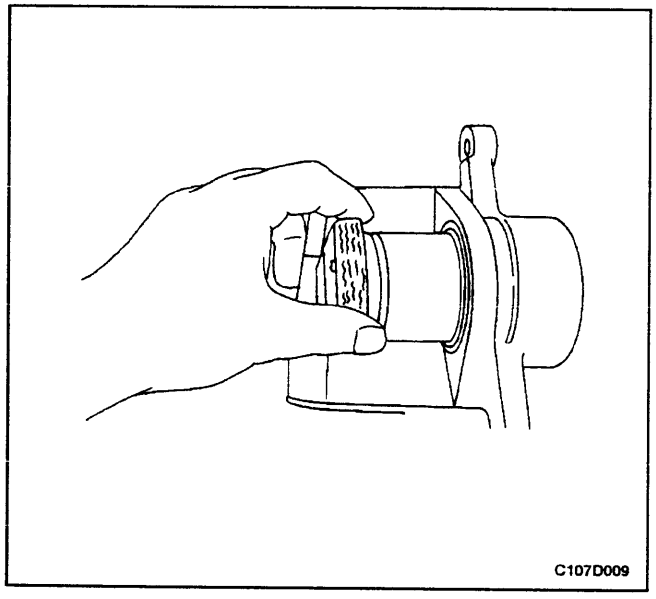
7. Remove the bleeder valve protector and the bleeder valve.
8. Pull out the pins and the rubber boots.


C107D008

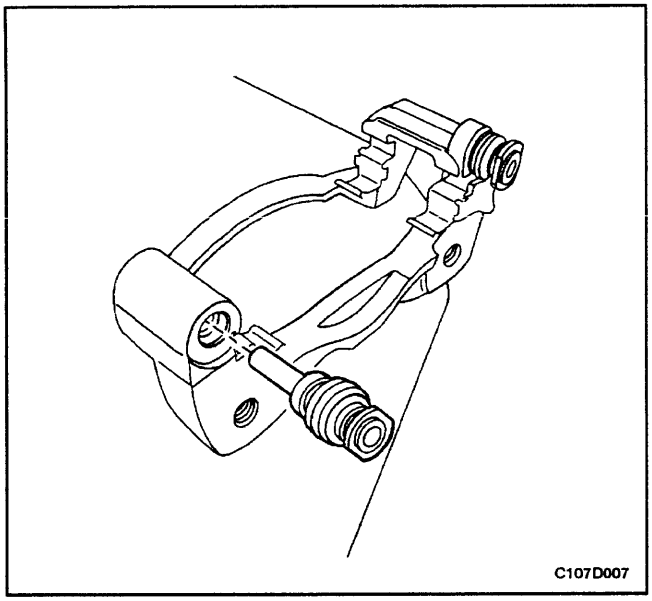
Assembly Procedure

1. Clean all the parts in denatured alcohol or brake fluid. Dry the parts with unlubricated compressed air and blow out all the passages in the housing and the bleeder valve.
2. Inspect the piston and the caliper for scoring, nicks, and corrosion. Replace the components if these elements are found.
3. Inspect the caliper bleeder valve.

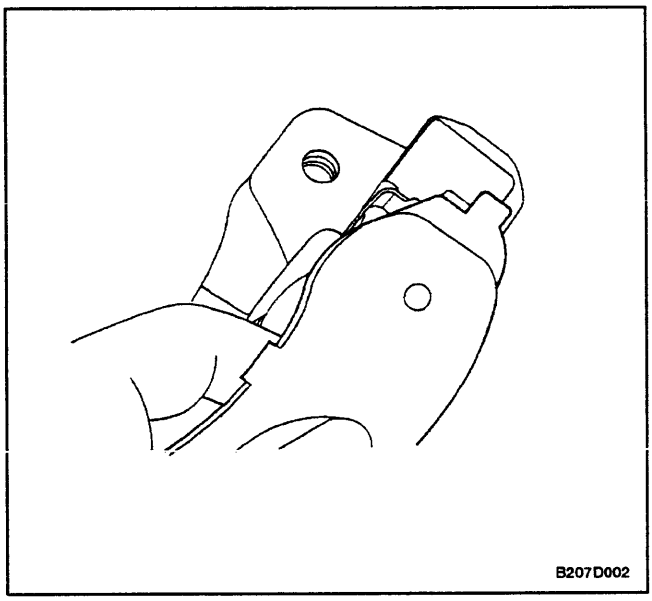
Important: Do not remove material from the piston or the caliper bore.


C107D009

4. Lubricate a new piston inner seal.
5. Install the piston inner seal into the caliper housing groove. Make sure the seal is not twisted.
6. Install the outer piston dust seal in the groove.
7. Lubricate the piston with brake fluid.
8. Push the piston inward until it is properly seated.


C107D007

9. Coat the pins with rubber grease and install the boots.


B207D002

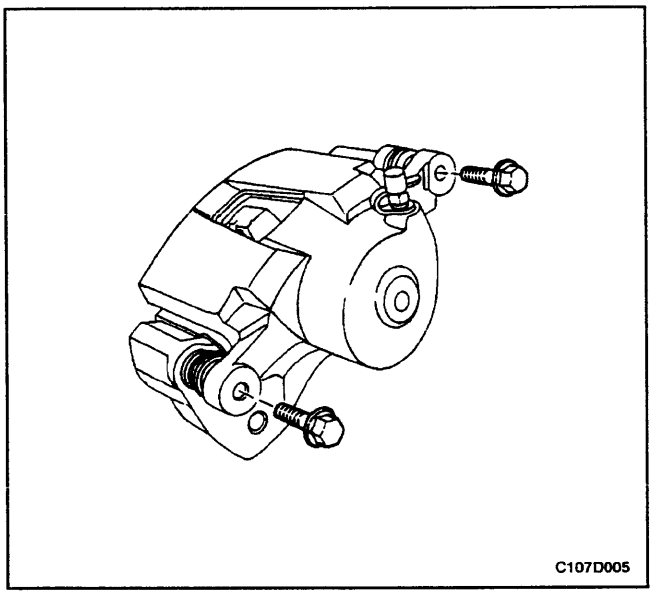
10. Install the caliper bleeder valve and the protector.

Tighten

Tighten the caliper bleeder valve to 6 N•m (53 lb-in).

11. Connect the brake pads and the pad springs.

Important: Make sure the pad springs are properly installed.


C107D005

12. Connect the retaining frame to the caliper housing with the guide pin bolts.

Tighten

Tighten the retaining frame-to-caliper housing bolts to 27 N•m (19 lb-ft).

13. Install the caliper assembly. Refer to "Caliper Assembly" in this section.

GENERAL DESCRIPTION AND SYSTEM OPERATION

DISC BRAKE CALIPER ASSEMBLY

This caliper has a single bore and is mounted to the steering knuckle with two mounting bolts. Hydraulic pressure, created by applying the brake pedal, is converted by the caliper to a stopping force. This force acts equally against the piston and the bottom of the caliper bore to move the piston outward and to slide the caliper inward, resulting in a clamping action on the rotor. This clamping action forces the linings against the rotor, creating friction to stop the vehicle.

Important:

- Replace all components included in the repair kits used to service this caliper.
- Lubricate the rubber parts with clean brake fluid to ease assembly.
- Do not use lubricated shop air on brake parts, as damage to the rubber components may result.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- Replace the pads in axle sets only.
- The torque values specified are for dry, unlubricated fasteners.
- Perform the service operations on a clean bench, free from all mineral oil materials.

SECTION 4E

REAR DISC BRAKES

TABLE OF CONTENTS

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Brake Hose Inlet Fitting-to-Caliper Bolt	32	24	-
Caliper Bleeder Valve	6	-	53
Caliper-to-Steering Knuckle Mounting Bolts	65	48	-
Caliper Guide Pin Bolts	31	23	-
Parking Brake Shoe Hold-Down Spring Assembly Screw	4	-	35
Rotor-to-Rear Wheel Hub Detent Screw	4	-	35
Splash Shield/Backplate-to-Steering Knuckle Bolts	65	48	-
Wheel Hub Assembly-to-Spindle Shaft Caulking Nut	285	210	-

DIAGNOSIS

LINING INSPECTION

1. Raise and suitably support the vehicle.
2. Remove the rear wheels. Refer to *Section 2E, Tires and Wheels*.
3. Visually check the linings for minimum thickness and wear.
4. Measure the thickness.

Important: The minimum discard thickness of the lining is 2 mm (0.08 inch).

5. Install the pads in axle sets only.
6. Install the rear wheels. Refer to *Section 2E, Tires and Wheels*.
7. Lower the vehicle.

ROTOR INSPECTION

Thickness variation can be checked by measuring the thickness of the rotor at four or more points around the circumference of the rotor. All measurements must be made at the same distance in from the edge of the rotor.

A rotor that varies by more than 0.10 mm (0.004 inch) can cause pedal pulsations and/or front end vibration during brake applications. A rotor that does not meet these specifications should be refinished to specifications or replaced.

During manufacturing, the brake rotor and the tolerances of the braking surface regarding flatness, thick-

ness variation, and lateral runout are held very close. The maintenance of close tolerances on the shape of the braking surfaces is necessary to prevent brake roughness.

In addition to these tolerances, the surface finish must be held to a specified range. The control of the braking surface finish is necessary to avoid pulls and erratic performance and to extend lining life.

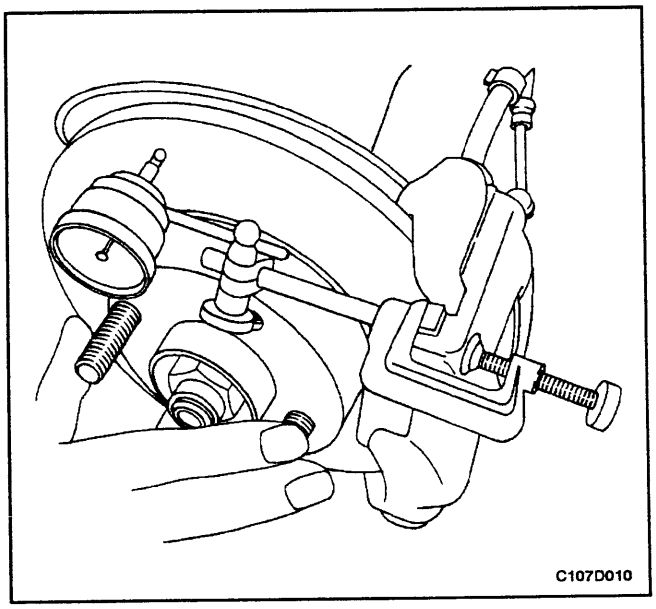
Notice: Permissible lateral runout is a maximum 0.10 mm (0.004 inch). If lateral runout exceeds the specification, make sure there is no dirt between the rotor and the hub and that contact surfaces are smooth and free from burrs in order to avoid premature wear.

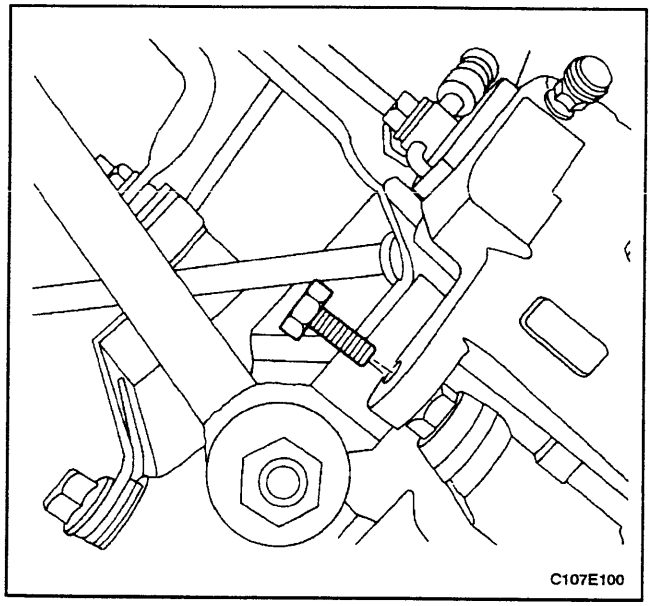
Using a commercially available dial indicator, check the lateral runout as follows:

1. Position the transaxle in neutral.
2. Remove the rotor. Refer to "Rotor" in this section.
3. Fasten the brake rotor to the wheel hub with two wheel bolts.
4. Fasten a dial indicator to the brake caliper.
5. The dial indicator probe tip should measure 234 mm (9.2 inches) from the center of the disc hole.
6. Remove the dial indicator and the wheel bolts.

Important: Since accurate control of the rotor tolerances is necessary for proper performance of the disc brakes, refinishing of the rotor should be done only with precision equipment.

7. Refinish the rotor, if required, with precision equipment. Discard the rotor if it fails to meet the above specifications after refinishing.
8. Install the rotor. Refer to "Rotor" in this section.




C107E100

MAINTENANCE AND REPAIR

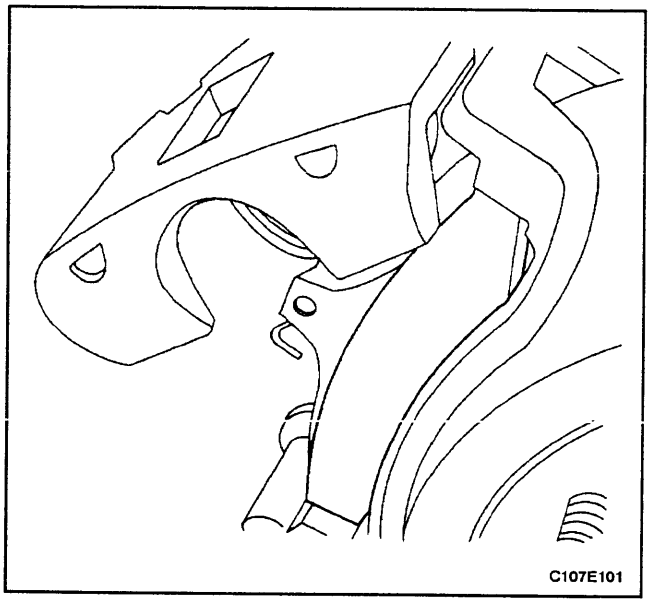
ON-VEHICLE SERVICE

SHOE AND LINING

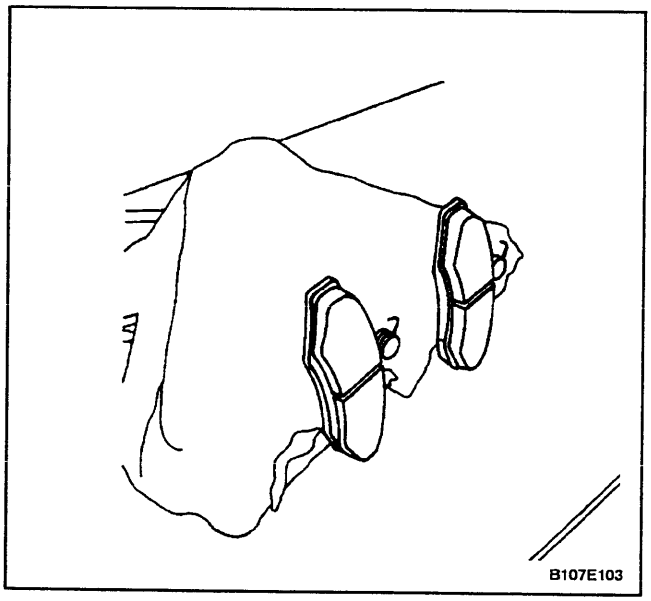
Removal Procedure

1. Raise and suitably support the vehicle.
2. Remove the rear wheels. Refer to *Section 2E, Tires and Wheels*.
3. Remove the lower caliper guide pin bolts.

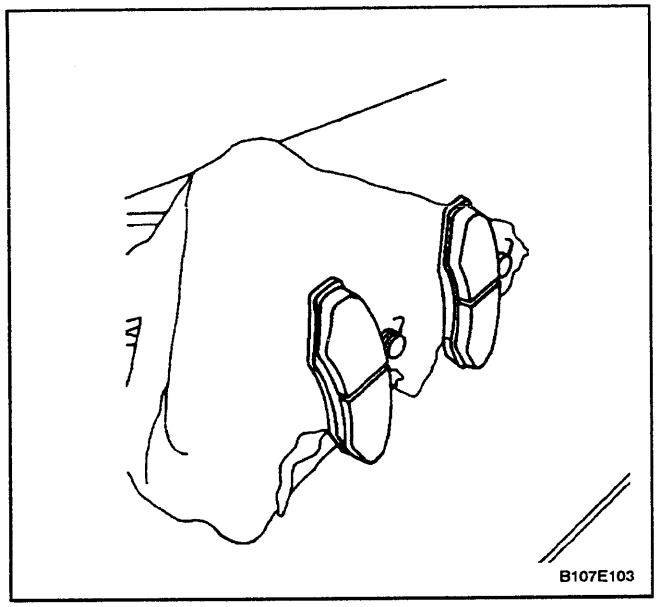
Important: Caliper assembly removal is not necessary to service the brake pads.


C107E101

4. Pull the caliper piston housing up.

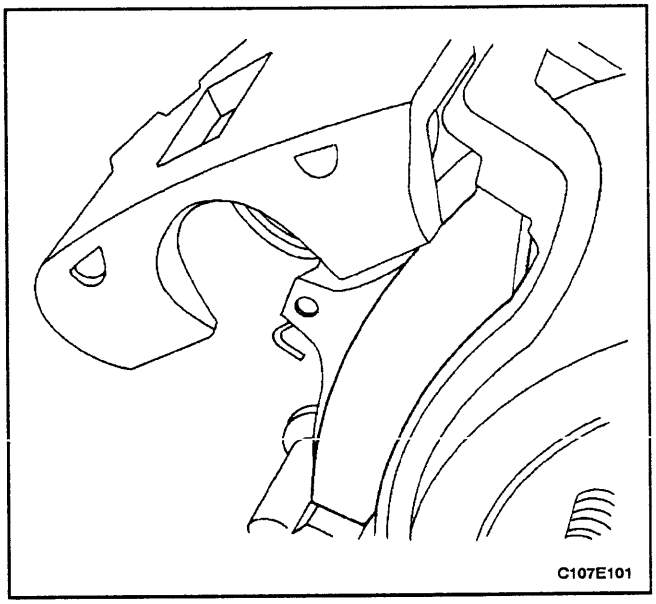

B107E103

5. Remove the brake pads.


B107E103

Installation Procedure

1. Measure the minimum brake pad thickness. Refer to "Lining Inspection" in this section.
2. Install the brake pads into the caliper.
3. Push the piston inward, if needed.


C107E101

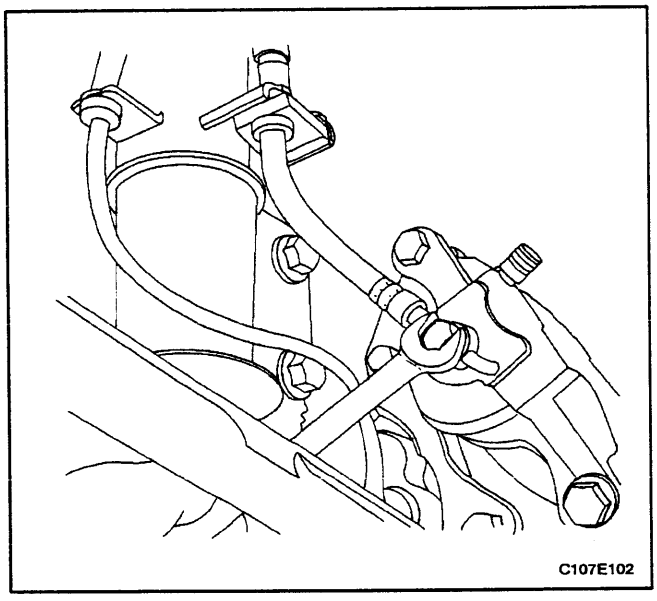
Notice: Take care not to damage the piston seal when the piston housing is pulled down.

4. Pull down the caliper piston housing and secure it with the bolts.

Tighten

Tighten the upper and the lower caliper guide pin bolts to 31 N•m (23 lb-ft).

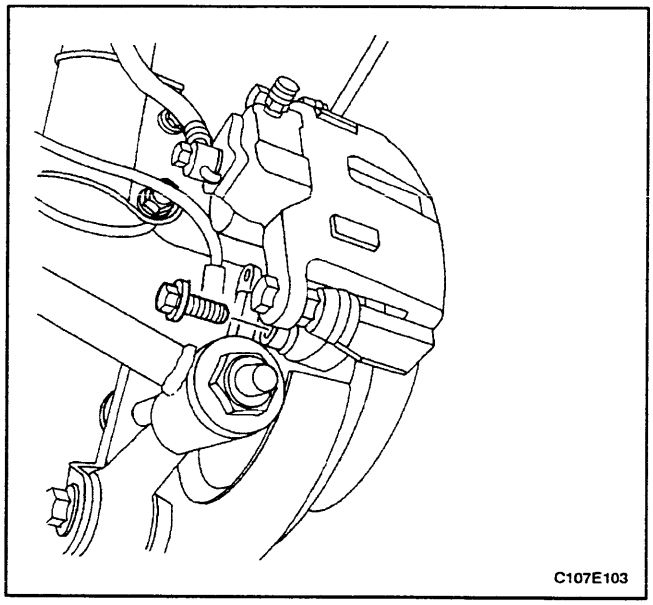
5. Install the rear wheels. Refer to *Section 2E, Tires and Wheels*.
6. Lower the vehicle.


C107E102

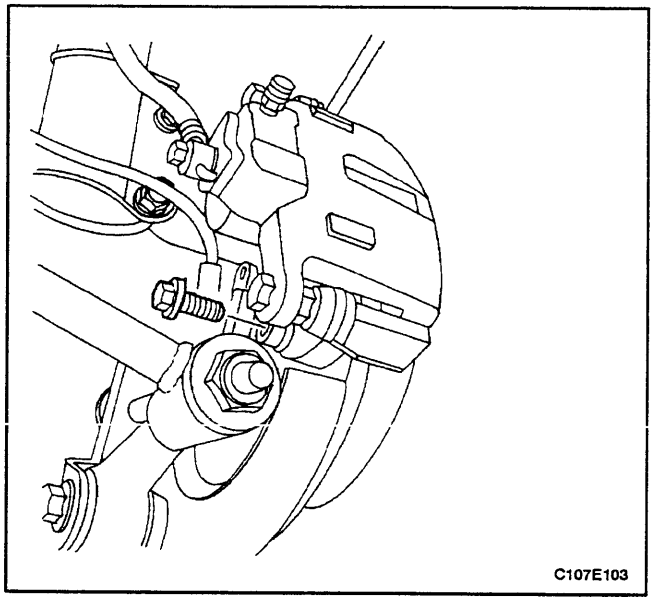
CALIPER ASSEMBLY

Removal Procedure

1. Raise and suitably support the vehicle.
2. Mark the position of the rear wheels relative to the wheel hubs and remove the wheels. Refer to *Section 2E, Tires and Wheels*.
3. Remove the bolt and the washers that attach the brake hose inlet fitting to the caliper.


C107E103

4. Disconnect the brake hose. Plug the openings in the caliper and the brake hose to prevent fluid loss and contamination.
5. Remove the caliper mounting bolts from the steering knuckle.
6. Remove the caliper assembly.

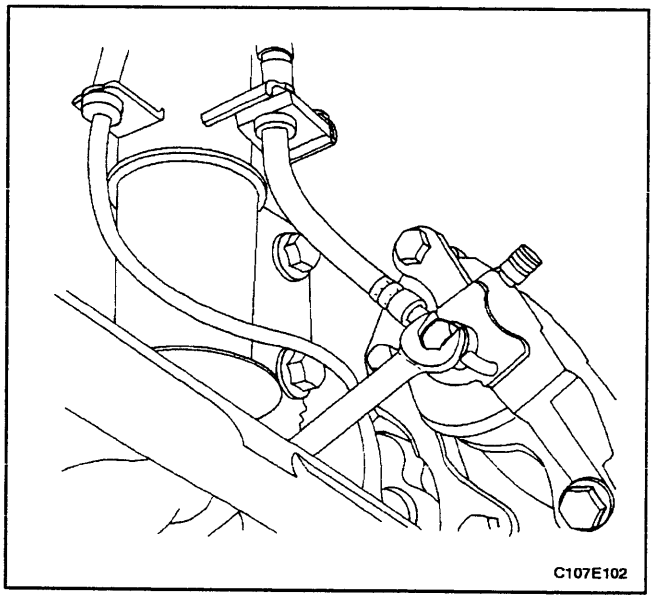

C107E103

Installation Procedure

1. Install the caliper assembly with the mounting bolts.

Tighten

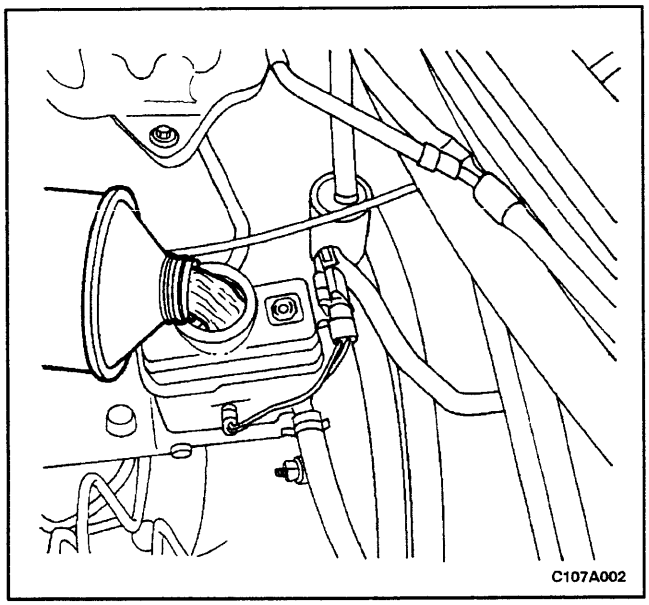
Tighten the caliper-to-steering knuckle mounting bolts to 65 N•m (48 lb-ft).


C107E102

2. Connect the brake hose with the bolt and washers.

Tighten

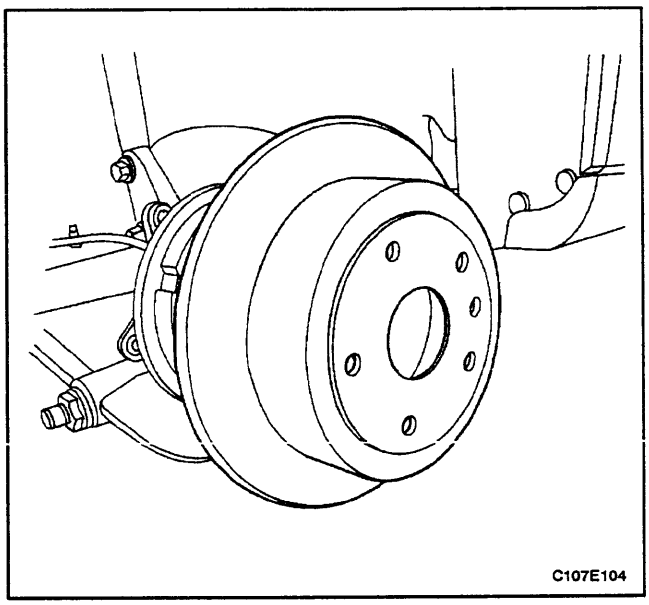
Tighten the brake hose inlet fitting-to-caliper bolt and washers to 32 N•m (24 lb-ft).


C107A002

3. Install the rear wheels. Refer to *Section 2E, Tires and Wheels*.
4. Lower the vehicle.
5. Fill the master cylinder to the proper level with clean brake fluid.
6. Bleed the caliper. Refer to *Section 4F, Antilock Brake System and Traction Control System.*
7. Recheck the fluid level.

Notice: Do not move the vehicle until a firm pedal is obtained, or improper braking action will result.

8. Repeatedly press the brake pedal to bring the pads in contact with the rotor.


C107E104

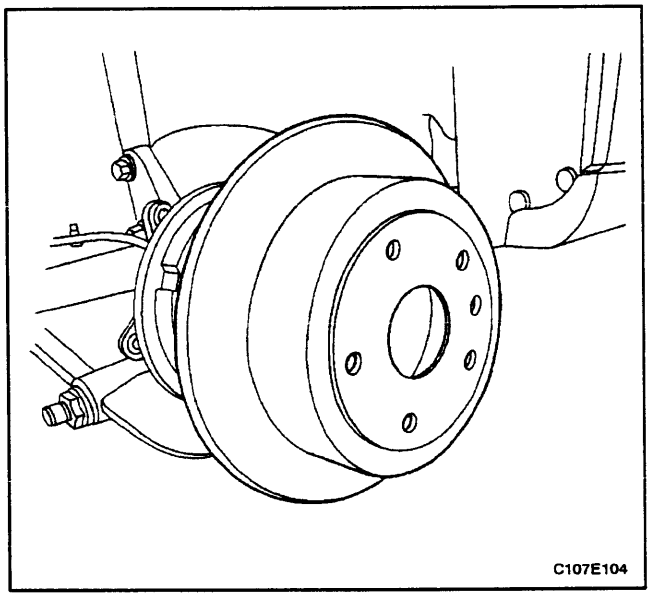
ROTOR

Removal Procedure

Notice: In order to avoid damage to the components, do not hang the caliper assembly from the brake hose.

Important: To guarantee uniform braking on both sides, both rotors must have identical surfaces regarding smoothness and scoring depth. For this reason, always replace both rotors.

1. Remove the caliper assembly without disconnecting the brake hoses. Refer to "Caliper Assembly" in this section.
2. Remove detent screw from the rotor-to-rear wheel hub.
3. Pull off the rotor.


C107E104

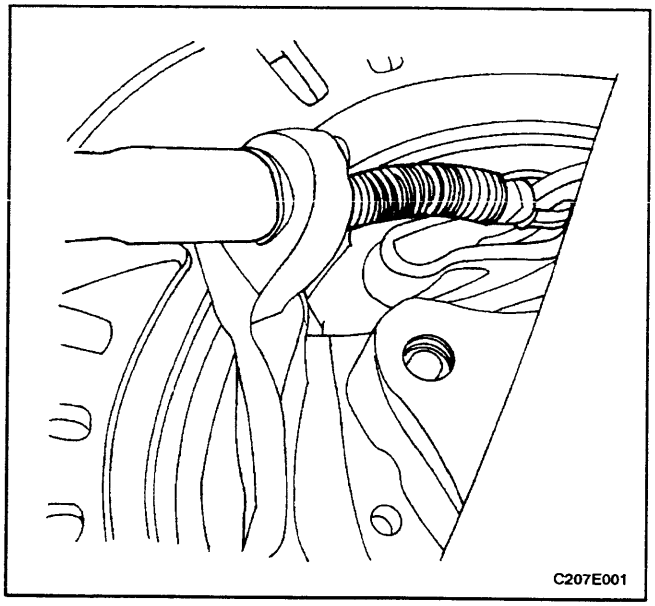
Installation Procedure

1. Inspect the rotor. Refer to "Rotor Inspection" in this section.
2. Install the rotor-to-rear wheel hub with the detent screw.

Tighten

Tighten the rotor-to-rear wheel hub detent screw to 4 N•m (35 lb-in).

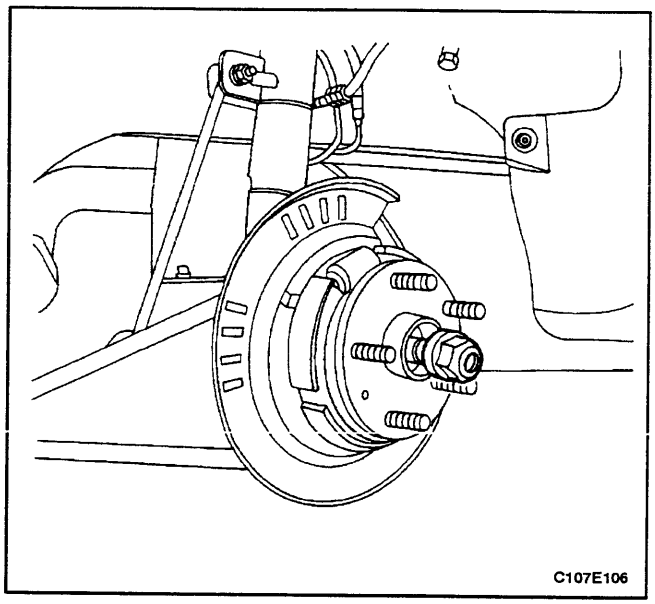
3. Install the caliper assembly. Refer to "Caliper Assembly" in this section.



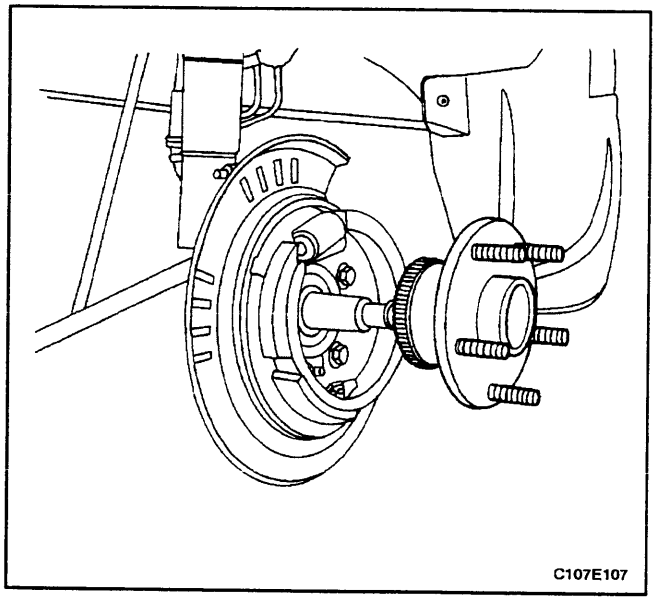
SPLASH SHIELD/BACKPLATE AND PARKING BRAKE LEVER

Removal Procedure

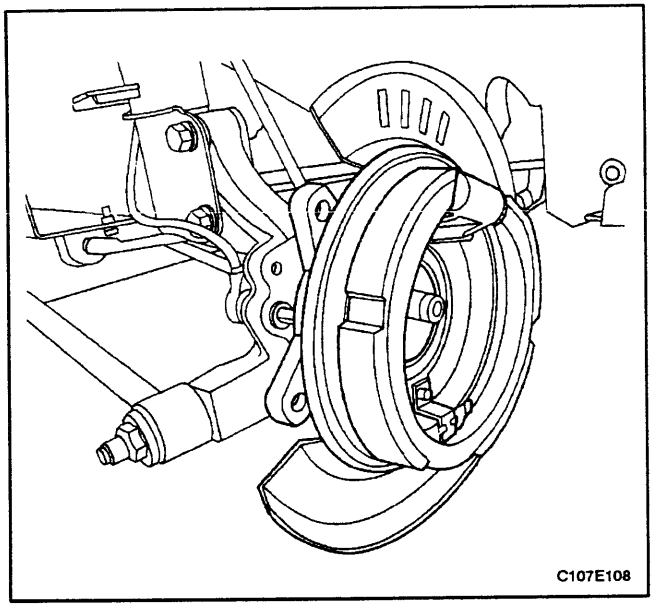
1. Remove the rotor. Refer to "Rotor" in this section.
2. Disconnect the parking brake cable from the brake backplate operating lever.



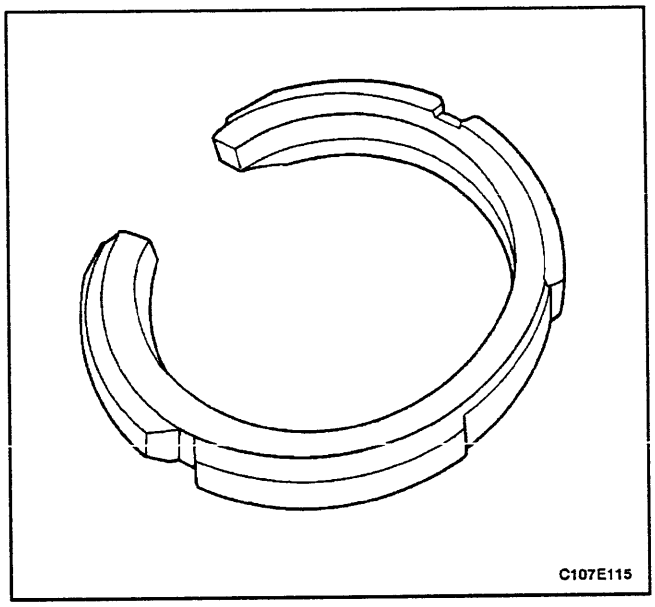
3. Pry off the shaft dust cover.
4. Remove the spindle shaft caulking nut.



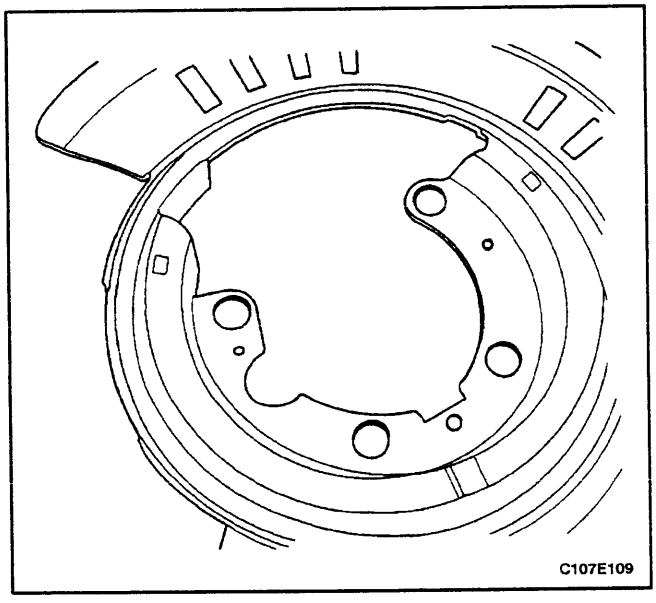
5. Remove the wheel hub assembly from the spindle shaft.



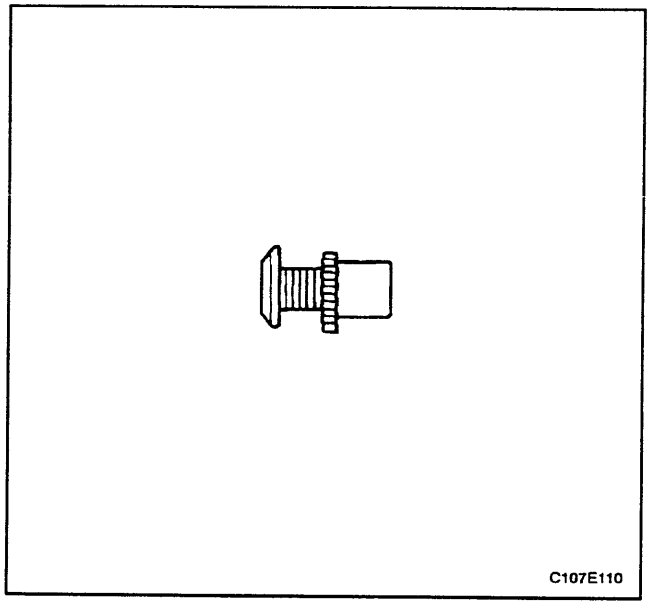
6. Remove the bolts that secure the splash shield/backplate/parking brake shoe assembly to the steering knuckle.
7. Remove the splash shield/backplate/shoe assembly from the steering knuckle.



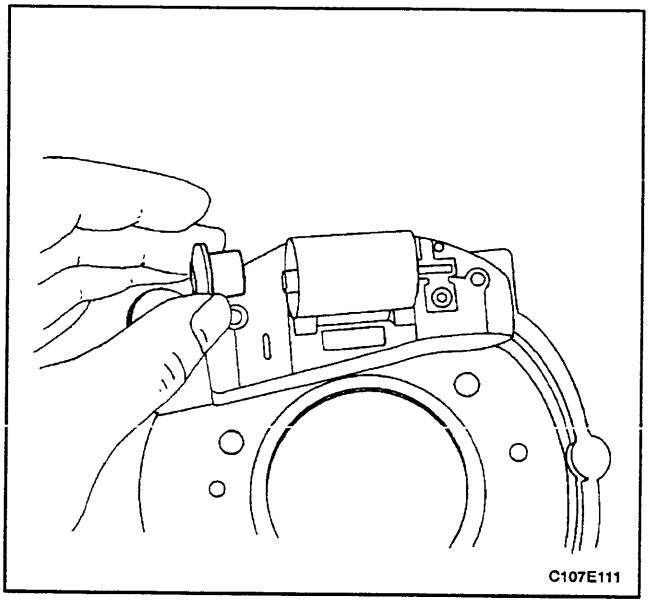
8. Measure the shoe assembly diameter. Refer to *Section 4G, Parking Brake.*
9. Remove the screw that secures the parking brake shoe hold-down spring assembly to the backplate.
10. Remove the parking brake shoe, sliding it away from the actuation mechanism.



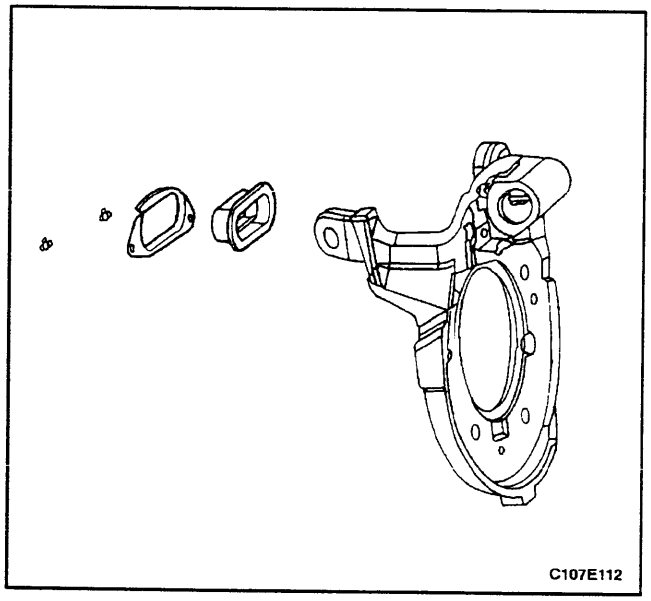
11. Remove the splash shield.


C107E110

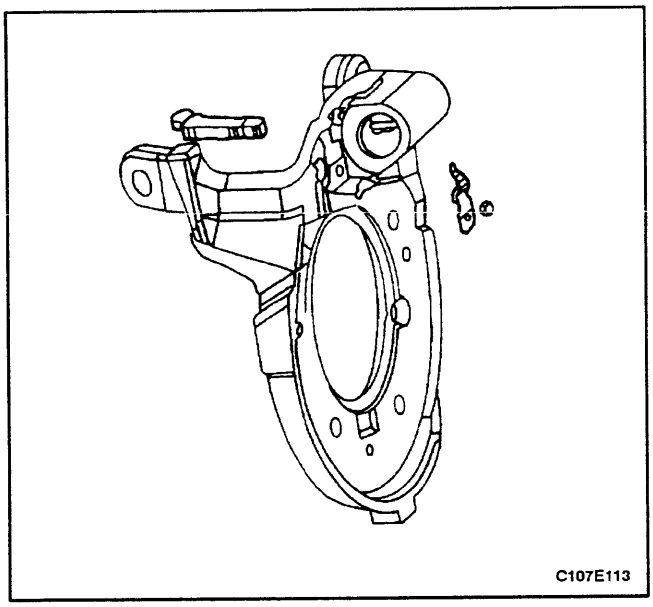
12. Remove and discard the adjuster screw and the nut.


C107E111

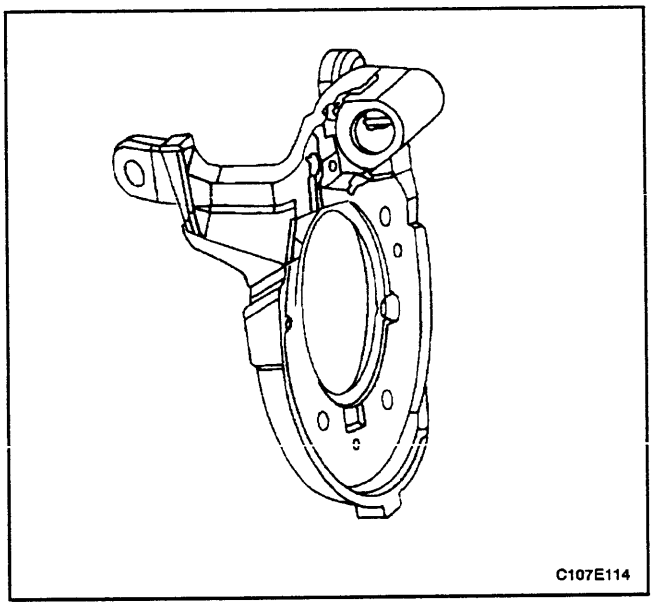
13. Remove and discard the tappet and the pushrod.


C107E112

14. Use a 3.5-mm (0.14-inch) drill to remove the pop rivets that hold the dust cover assembly and the adjuster pawl to the backplate.
15. Remove and discard the dust cover and the dust cover retainer from the backplate.


C107E113

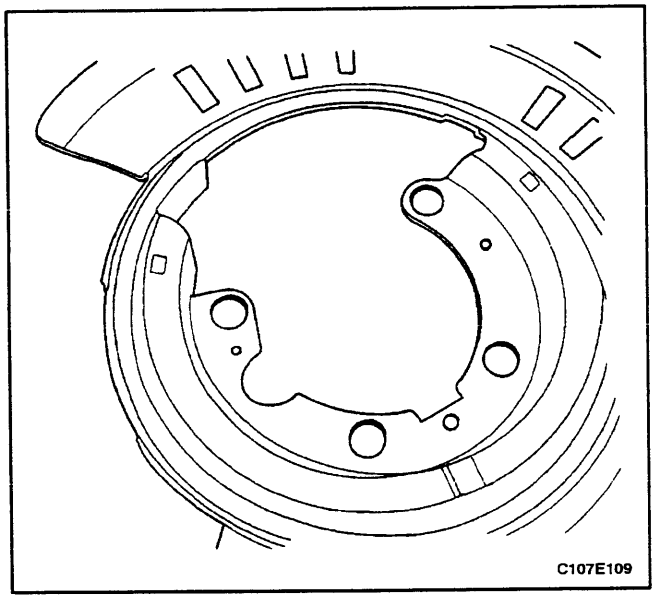
16. Remove and discard the lever and the adjuster pawl.


C107E114

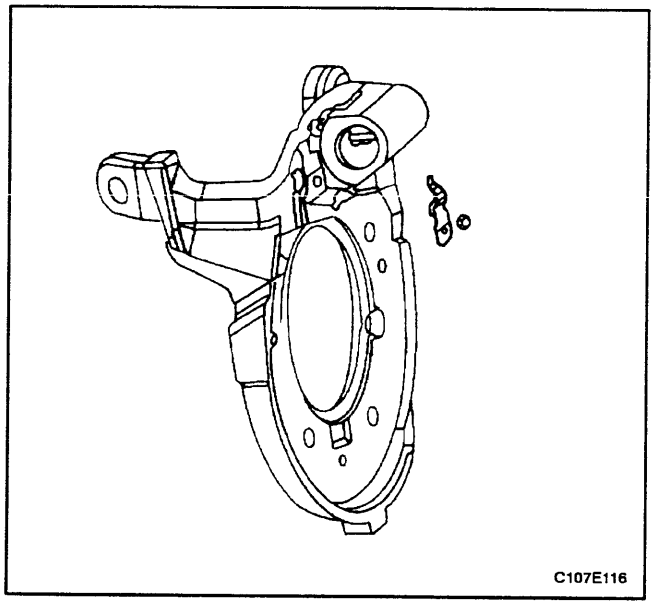
Installation Procedure

Caution: A high flash point oil-free solvent, such as tricloroethylene or acetone, used in cleaning brake components, such as backplates, is usually highly flammable and unhealthy if inhaled for prolonged periods.

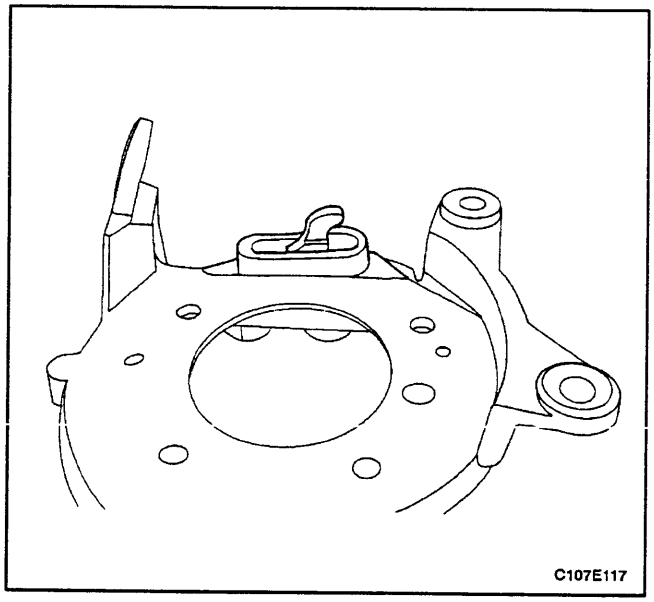
1. Clean the backplate to make sure the actuation cavity is free from grease and any other contamination.
2. Check the shoe assembly position. The shoe will fit centered on the splash shield.


C107E109

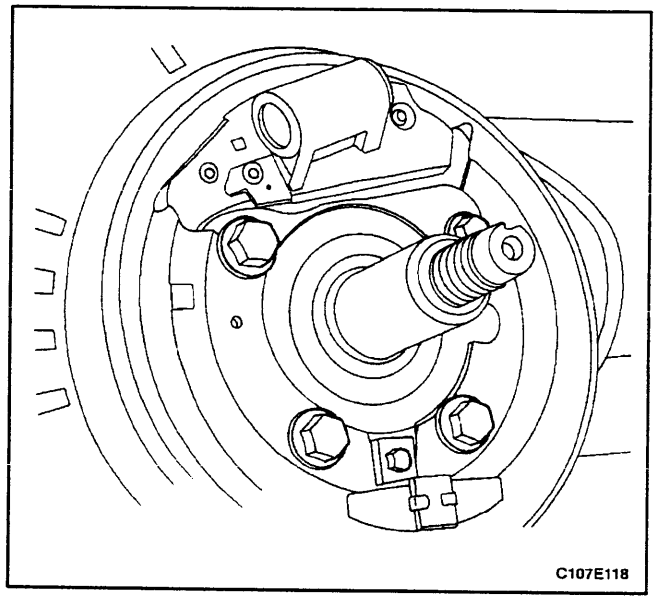
3. Inspect the splash shield for rust or any other damage. Replace the splash shield if necessary.


C107E116

4. Install the new adjuster pawl to the backplate and secure it with a pop rivet.


C107E117

5. Slide the new dust cover onto the dust cover notches.
6. Insert the new lever and the dust cover assembly into the backplate.
7. Secure the new dust cover retainer with pop rivets.


C107E118

8. Lubricate the actuation cavity and the tappet with the grease. Make sure that the internal bore of the cavity is covered with the grease.
9. Secure the splash shield and the backplate to the steering knuckle with the bolts.

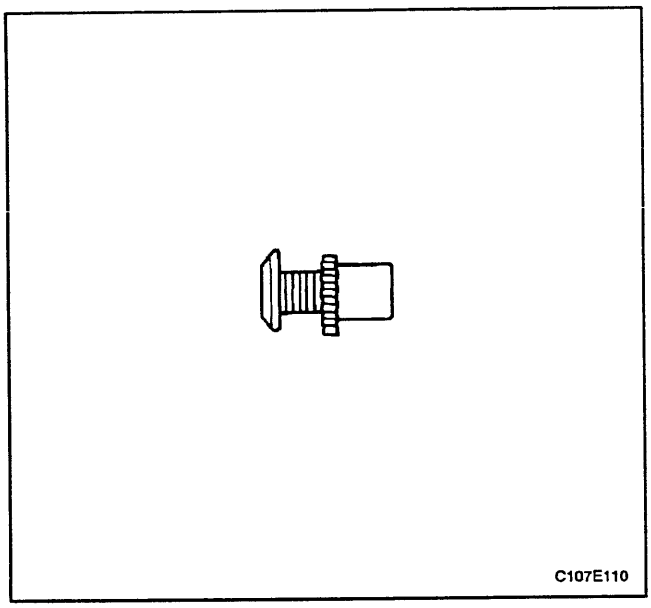
Tighten

Tighten the splash shield/backplate-to-steering knuckle bolts to 65 N•m (48 lb-ft).

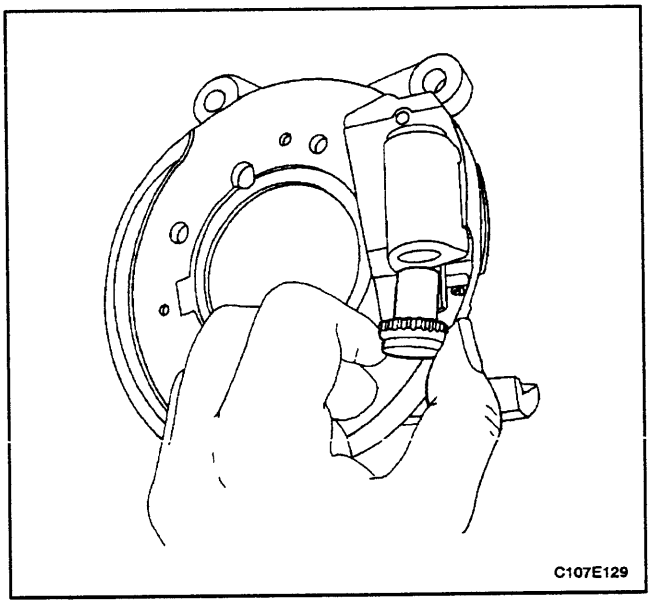
10. Secure the parking brake shoe hold-down spring assembly with the screw.

Tighten

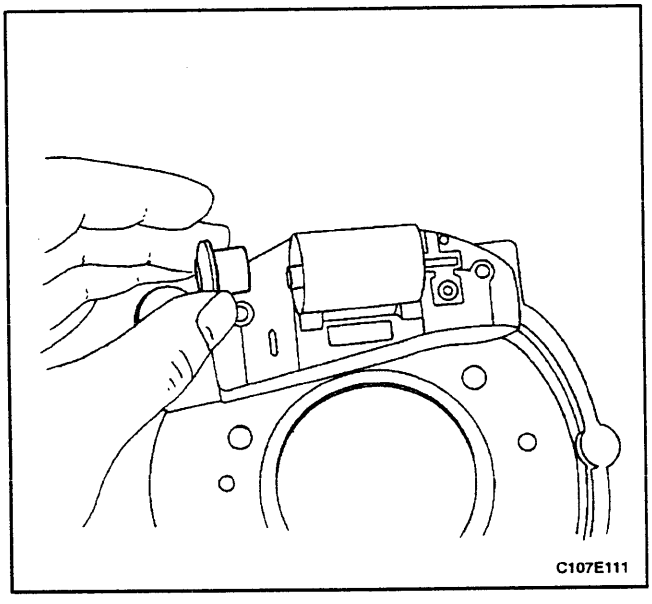
Tighten the parking brake shoe hold-down spring assembly screw to 4 N•m (35 lb-in).


C107E110

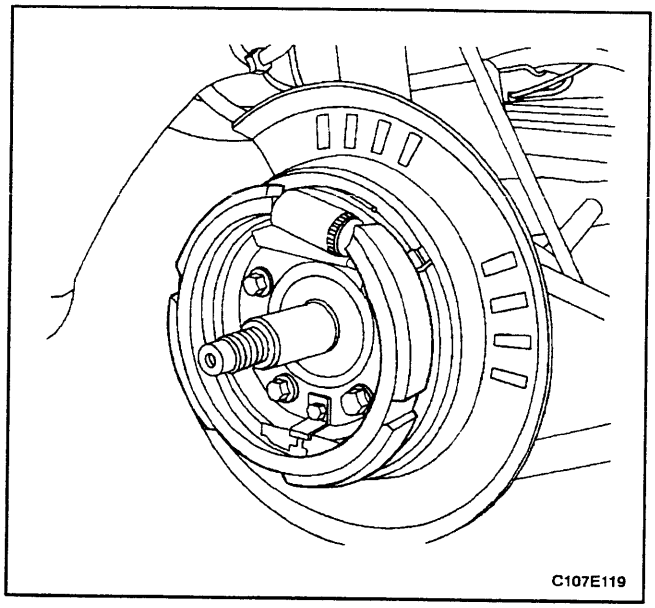
11. Connect the new parking brake adjustment screw to the new adjustment nut.
12. Tighten the adjustment nut to the point at which it meets the screw, and then back off one-quarter turn.


C107E129

13. Install the adjustment screw and the adjustment nut into the backplate actuation mechanism on the adjustment pawl side. Keep the shoe slot parallel with the backplate face.


C107E111

14. Install the new pushrod into the tappet. Make sure the pushrod is set correctly into the lever socket by holding the lever into the backplate while inserting the pushrod and the tappet.

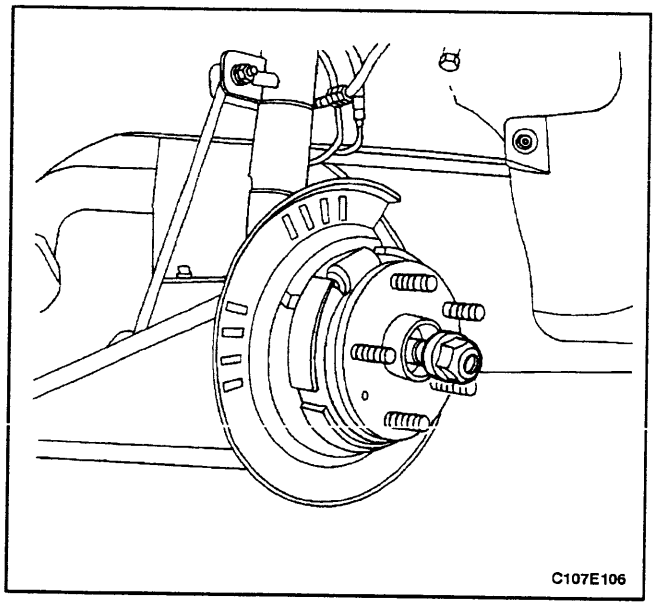

C107E119

15. Clean the excess grease away using a clean rag.

Important: The shoe assembly must be resting on the shield with the brand side up.

Important: Clean hands are required when handling the parking brake shoe.

16. Install the parking brake shoe, engaging the shoe tips in both the adjusting screw and the tappet slots.

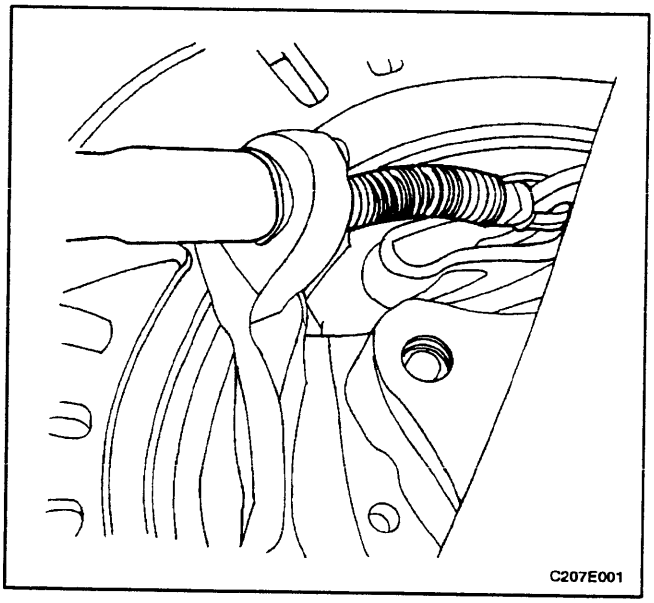

C107E106

17. Install the wheel hub assembly.
18. Secure the wheel hub assembly with the wheel hub assembly-to-spindle shaft caulking nut.

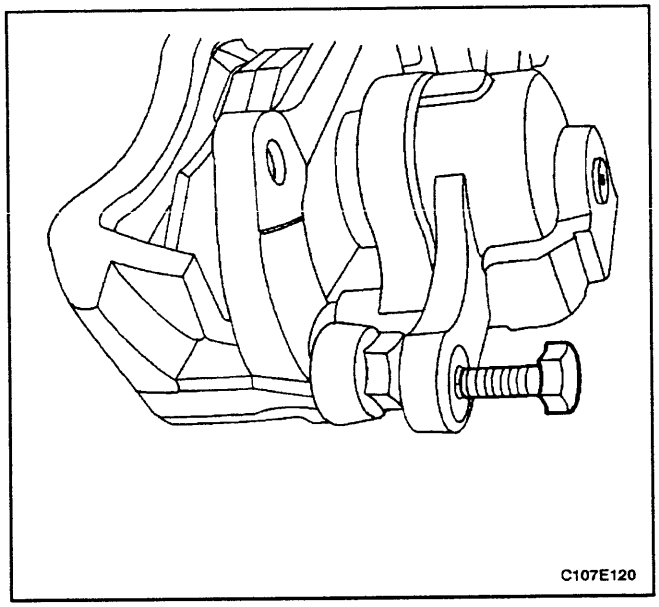
Tighten

Tighten the wheel hub assembly-to-spindle shaft caulking nut to 285 N•m (210 lb-ft).

19. Install the shaft dust cover.


C207E001

20. Install the parking brake cable to the parking brake lever on each side of the vehicle.
21. Adjust the parking brake. Refer to *Section 4G, Parking Brake.*
22. Install the rotor. Refer to "Rotor" in this section.

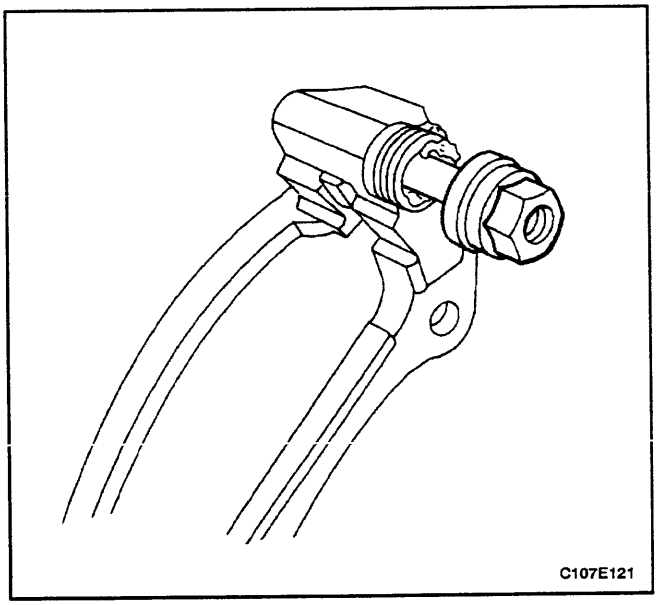

C107E120

UNIT REPAIR

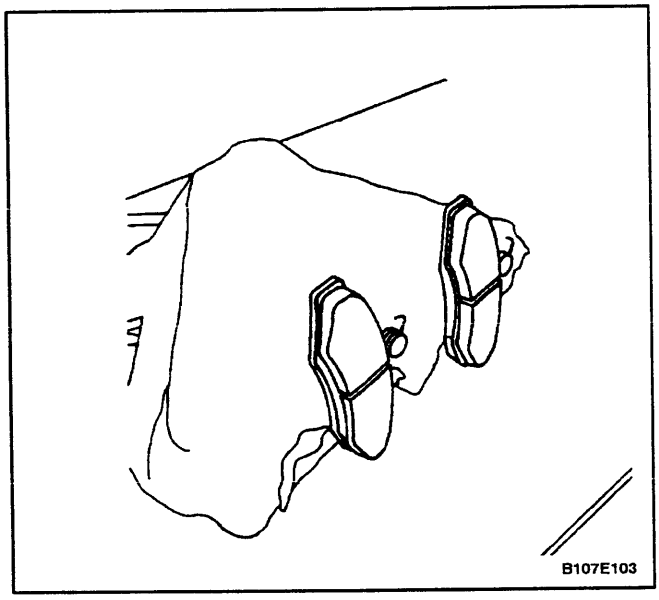
CALIPER OVERHAUL

Disassembly Procedure

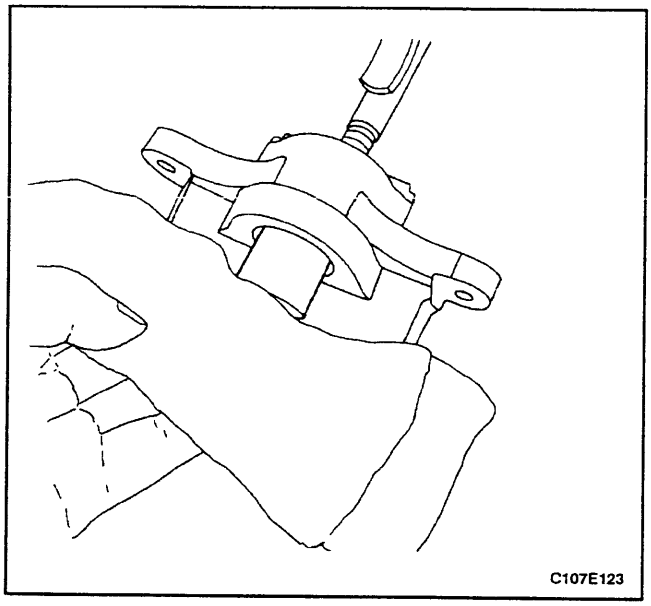
1. Remove the caliper assembly. Refer to "Caliper Assembly" in this section.
2. Plug the caliper housing inlet port and the brake hose end to prevent contamination or fluid loss.
3. Remove and discard the guide pin bolts.


C107E121

4. Remove the caliper piston housing assembly.
5. Remove the guide pins and the boots, plugging the holes of the anchor bracket to prevent contamination. Discard the boots.


B107E103

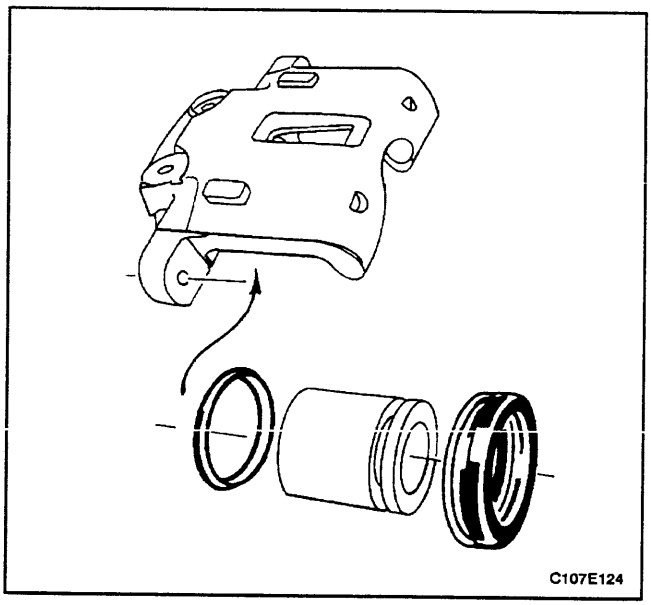
6. Remove the inner and the outer pads of each rear pad brake set from the brake anchor bracket on each side of the vehicle. For the minimum thickness measurement, refer to "Lining Inspection" in this section.


C107E123

7. Clean all residue from the disc pad guide surfaces on the anchor bracket and the caliper housing.
8. Inspect the anchor bracket, and replace it if corroded, worn, or damaged.
9. Place a clean shop towel between the piston and the caliper housing.

Caution: Do not place fingers in front of the piston in an attempt to catch it or protect it when applying compressed air or light air pressure at the housing inlet port. Such action could result in serious injury.

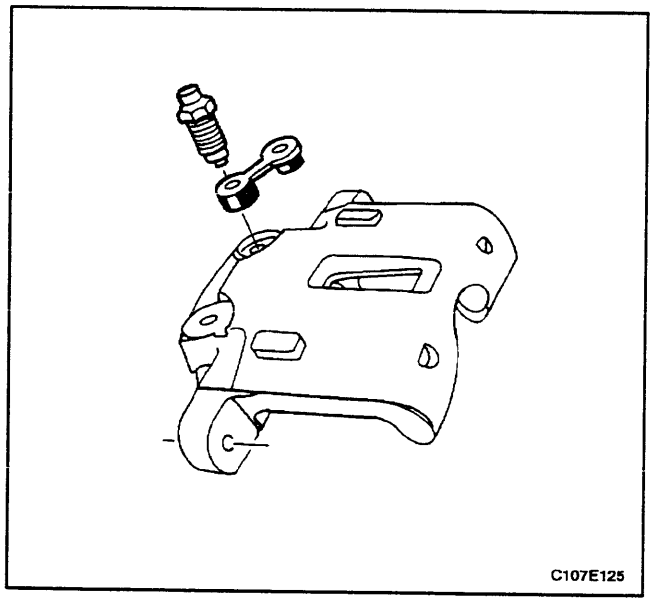
10. Progressively increase the air pressure until the piston is forced out of the bore.


C107E124

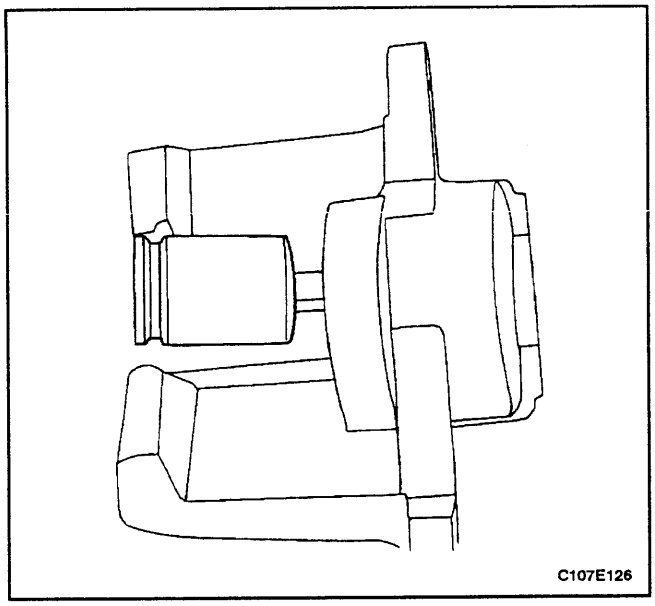
11. Remove and discard the outer boot.

Important: Be careful not to damage the piston bore or the seal groove when removing the inner seal, especially when using a tool, such as a screwdriver.

12. Remove and discard the inner seal.


C107E125

13. Remove and discard the caliper bleeder valve dust cover.
14. Remove the caliper bleeder valve.

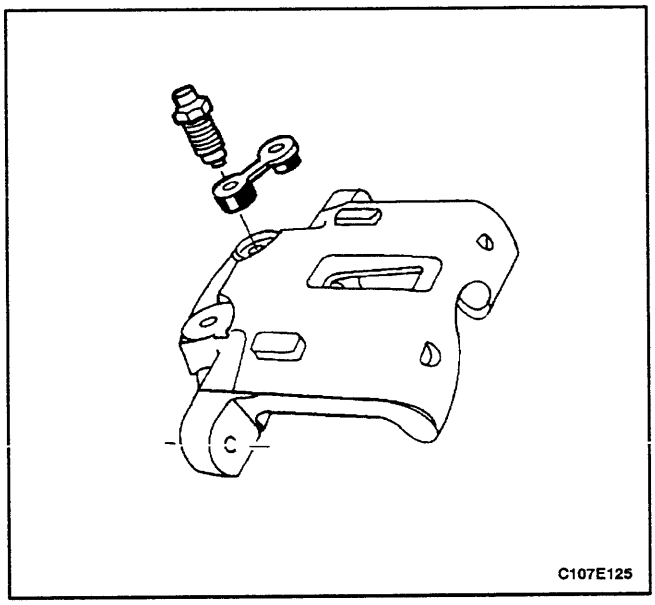

C107E126

Assembly Procedure

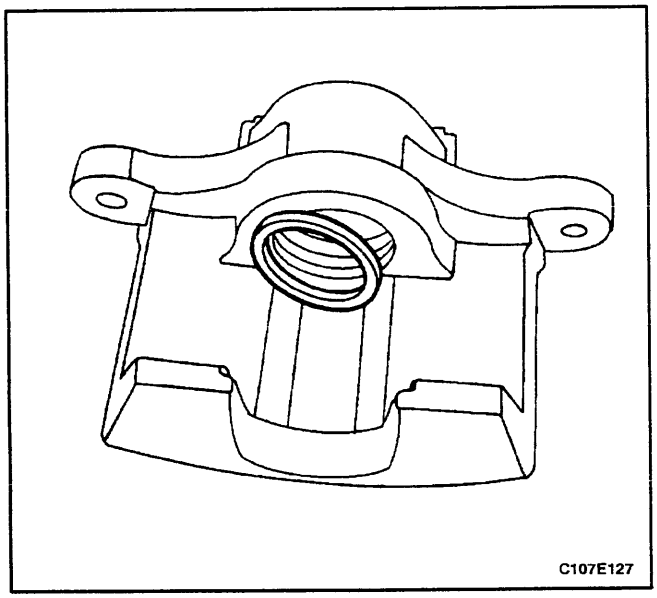
Caution: Be extremely careful to keep the alcohol and any debris away from the eyes to avoid serious injury.

Notice: Keep the rubber components away from the mineral oil to avoid damaging the components.

1. Clean all parts in denatured alcohol or the brake fluid.
2. Dry the parts with unlubricated compressed air.
3. Blow out all passages in the housing and the caliper bleeder valve.
4. Inspect the piston and the housing for scoring, nicks, and corrosion. Replace any components that are scored, nicked, or corroded.

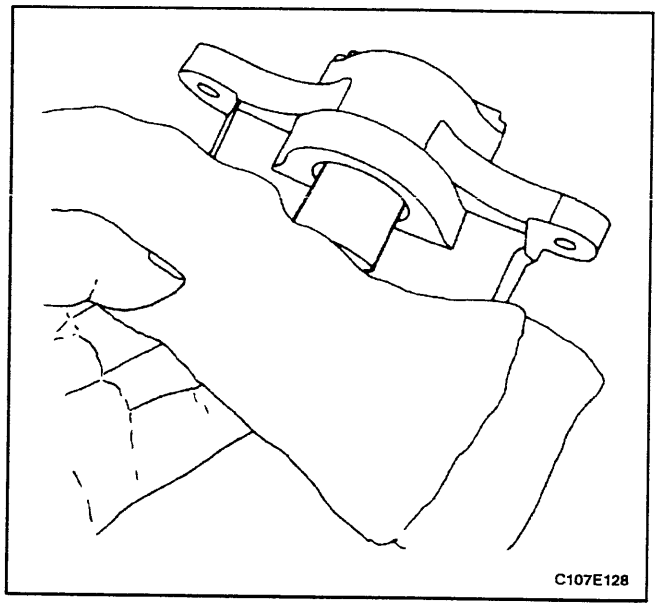

C107E125

5. Inspect the caliper bleeder valve.

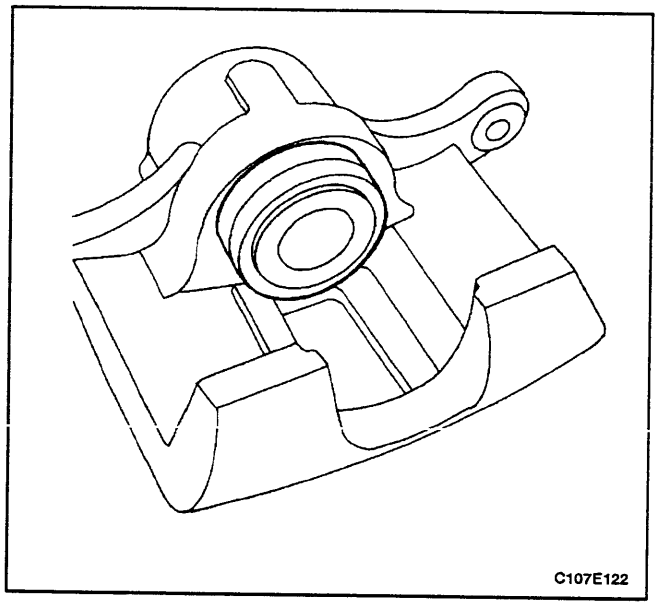

C107E127

Important: Do not remove material from the piston or the caliper bore.

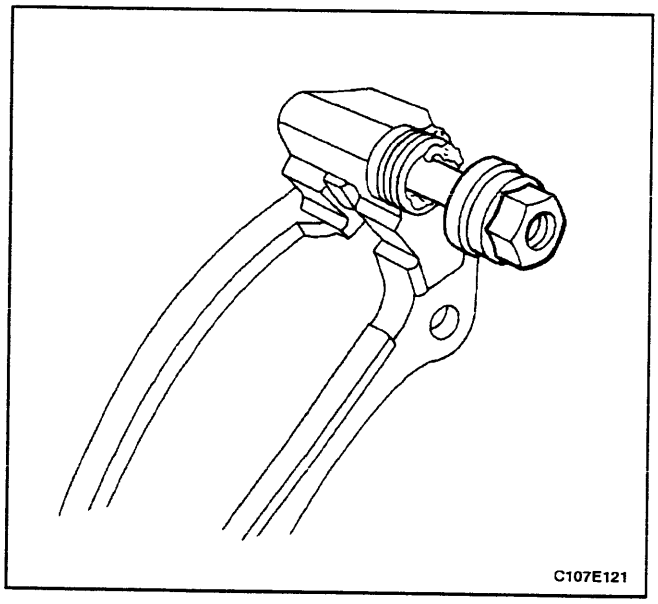
6. Lubricate a new piston inner seal and the housing bore with brake fluid or silicone grease.
7. Lubricate the piston with brake fluid.
8. Install the piston inner seal into the caliper housing groove. Make sure that the seal is not twisted.



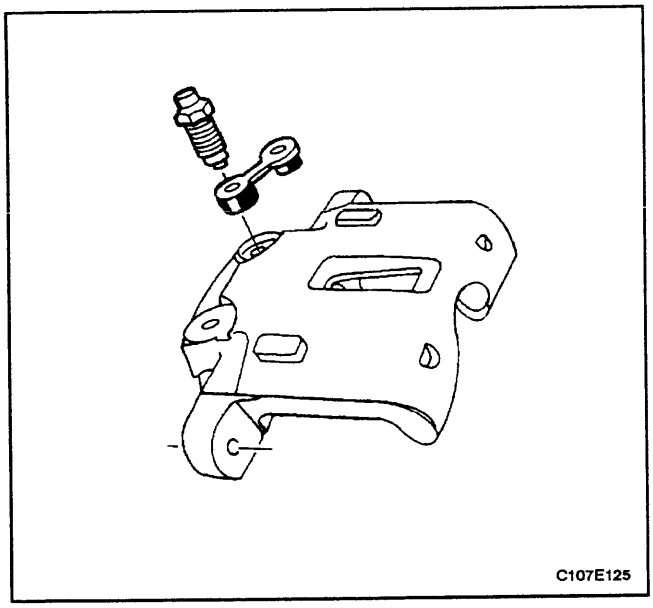
9. Install the boot over the open end of the piston and move the boot toward the closed end.
10. Push the boot away from the piston closed end and install it into the boot groove in the piston bore.
11. Slowly enter the piston into the bore by hand.
12. Apply steady hand pressure until the piston is fully seated in the bore.



13. Inspect the piston and the outer boot, checking to see if the boot is properly engaged in the piston groove.



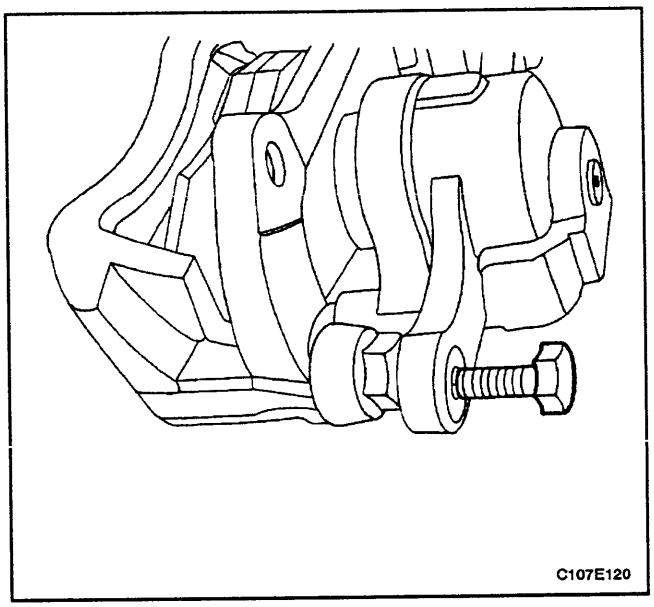
14. Coat the new guide pins with rubber grease and install the pins and the boots into the caliper housing assembly.



15. Assemble the new dust cover on the caliper bleeder valve and screw the caliper bleeder valve into the housing.

Tighten

Tighten the caliper bleeder valve to 6 N•m (53 lb-in).



16. Install the disc pads on the anchor bracket.
17. Place the caliper piston housing assembly into its operating position.
18. If the brake pad springs are sticking through the caliper housing inspection hole, lift the caliper housing and make the necessary corrections to ensure that the springs are fully retained by the housing.
19. Install the new guide pin bolts.

Tighten

Tighten the caliper guide pin bolts to 31 N•m (23 lb-ft).

20. Install the caliper assembly. Refer to "Caliper Assembly" in this section.

GENERAL DESCRIPTION AND SYSTEM OPERATION

DISC BRAKE CALIPER ASSEMBLY

This caliper has a single bore and is mounted to the steering knuckle with two mounting bolts. Hydraulic pressure, created by applying the brake pedal, is converted by the caliper to a stopping force. This force acts equally against the piston and the bottom of the caliper bore to move the piston outward and to slide the caliper inward, resulting in a clamping action on the rotor. This clamping action forces the linings against the rotor, creating friction to stop the vehicle.

Important:

- Replace all components included in the repair kits used to service this caliper.
- Lubricate the rubber parts with clean brake fluid to ease assembly.
- Do not use lubricated shop air on brake parts, as damage to the rubber components may result.
- If any hydraulic component is removed or disconnected, it may be necessary to bleed all or part of the brake system.
- Replace the pads in axle sets only.
- The torque values specified are for dry, unlubricated fasteners.
- Perform the service operations on a clean bench, free from all mineral oil materials.

SECTION 4F

ANTILOCK BRAKE SYSTEM AND TRACTION CONTROL SYSTEM

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

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EBCM Mounting Screws	3	-	27
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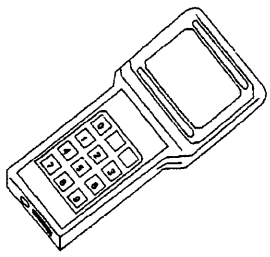
Rear Wheel Speed Sensor Bolt	8	-	71

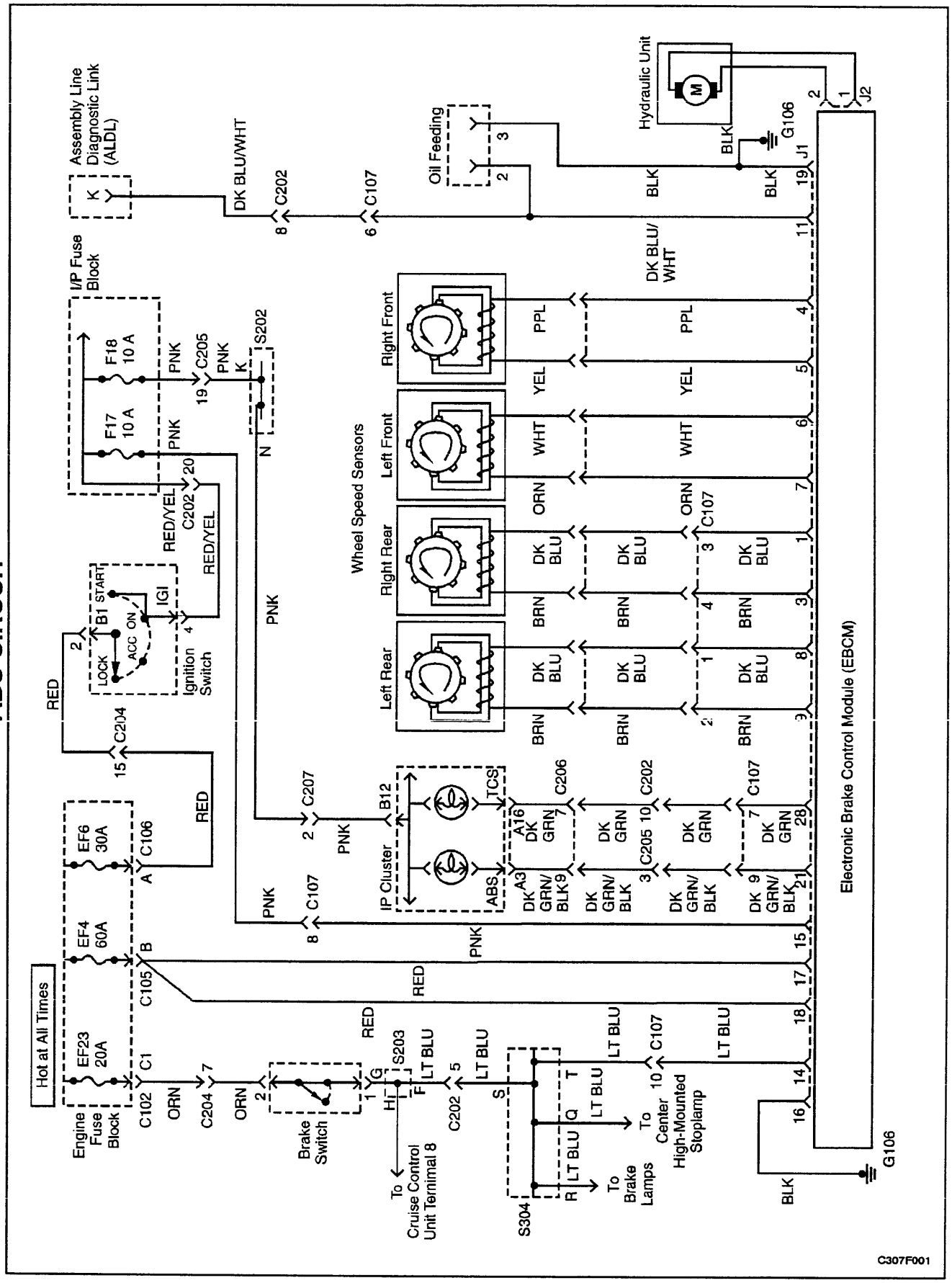
SPECIAL TOOLS

SPECIAL TOOLS TABLE

 A107F057	**Scan Tool**

SCHEMATIC AND ROUTING DIAGRAMS

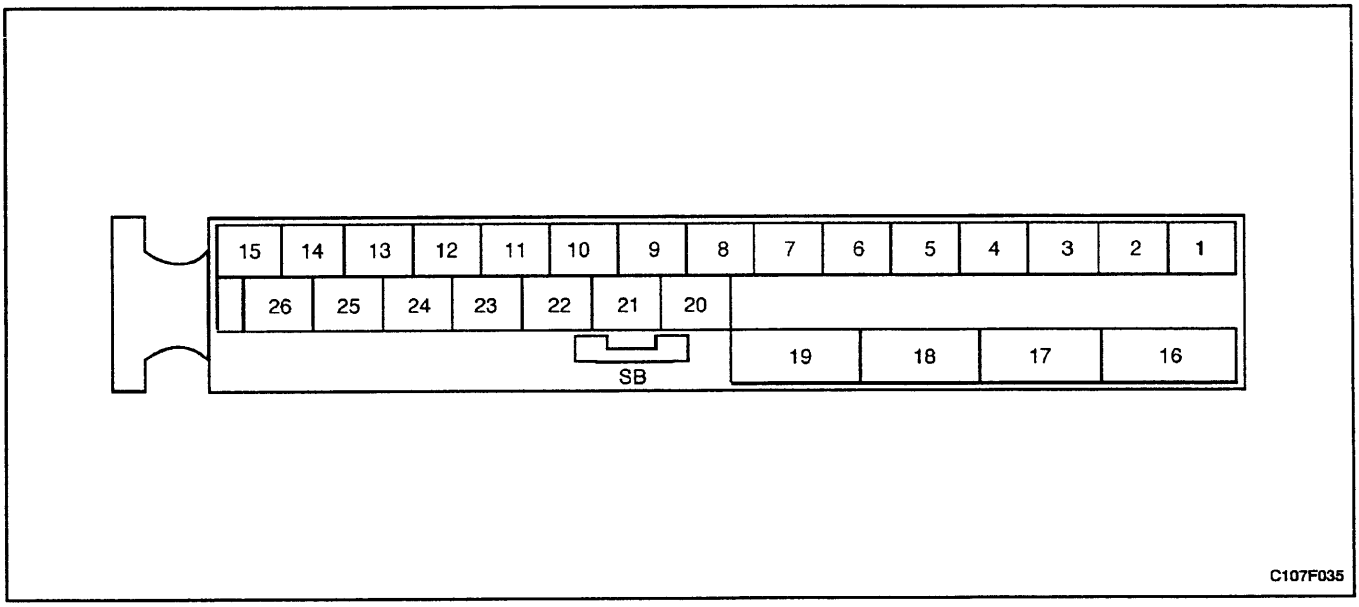
ABS CIRCUIT



C307F001

EBCM CONNECTOR FACE VIEW (WITHOUT TRACTION CONTROL SYSTEM)

EBCM Connector J1

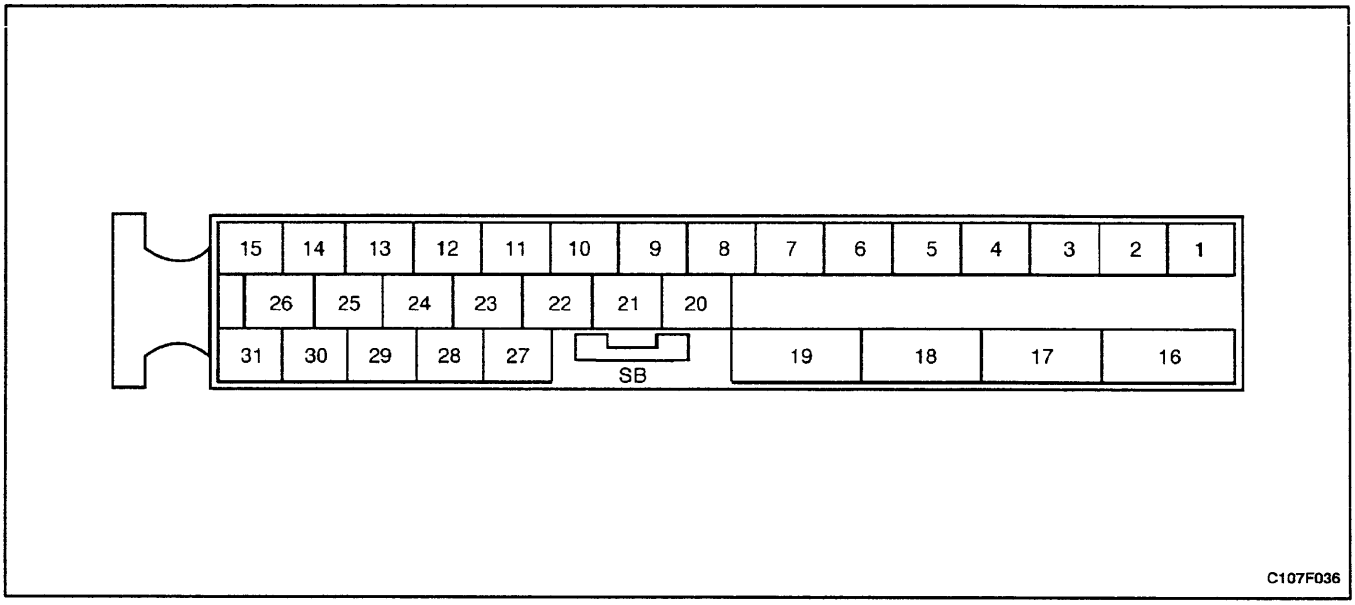


Pin	Color	Circuit
1	DK BLU	Right Rear Ground
2	-	Not Used
3	BRN	Right Rear Sensor
4	PPL	Right Front Ground
5	YEL	Right Front Sensor
6	WHT	Left Front Ground
7	ORN	Left Front Sensor
8	DK BLU	Left Rear Ground
9	BRN	Left Rear Sensor
10	-	Not Used
11	DK BLU/ WHT	Serial Data Link
12	-	Not Used
13	-	Not Used
14	LT BLU	Brake Light Switch

Pin	Color	Circuit
15	PNK	Switched Ignition
16	BLK	Motor Ground
17	RED	Battery
18	RED	Battery
19	BLK	Instrument Ground
20	-	Not Used
21	DK GRN/ BLK	ABS Warning Lamp
22	-	Not Used
23	-	Not Used
24	-	Not Used
25	-	Not Used
26	-	Not Used
SB	-	Shorting Bar

EBCM CONNECTOR FACE VIEW (WITH TRACTION CONTROL SYSTEM)

EBCM Connector J1



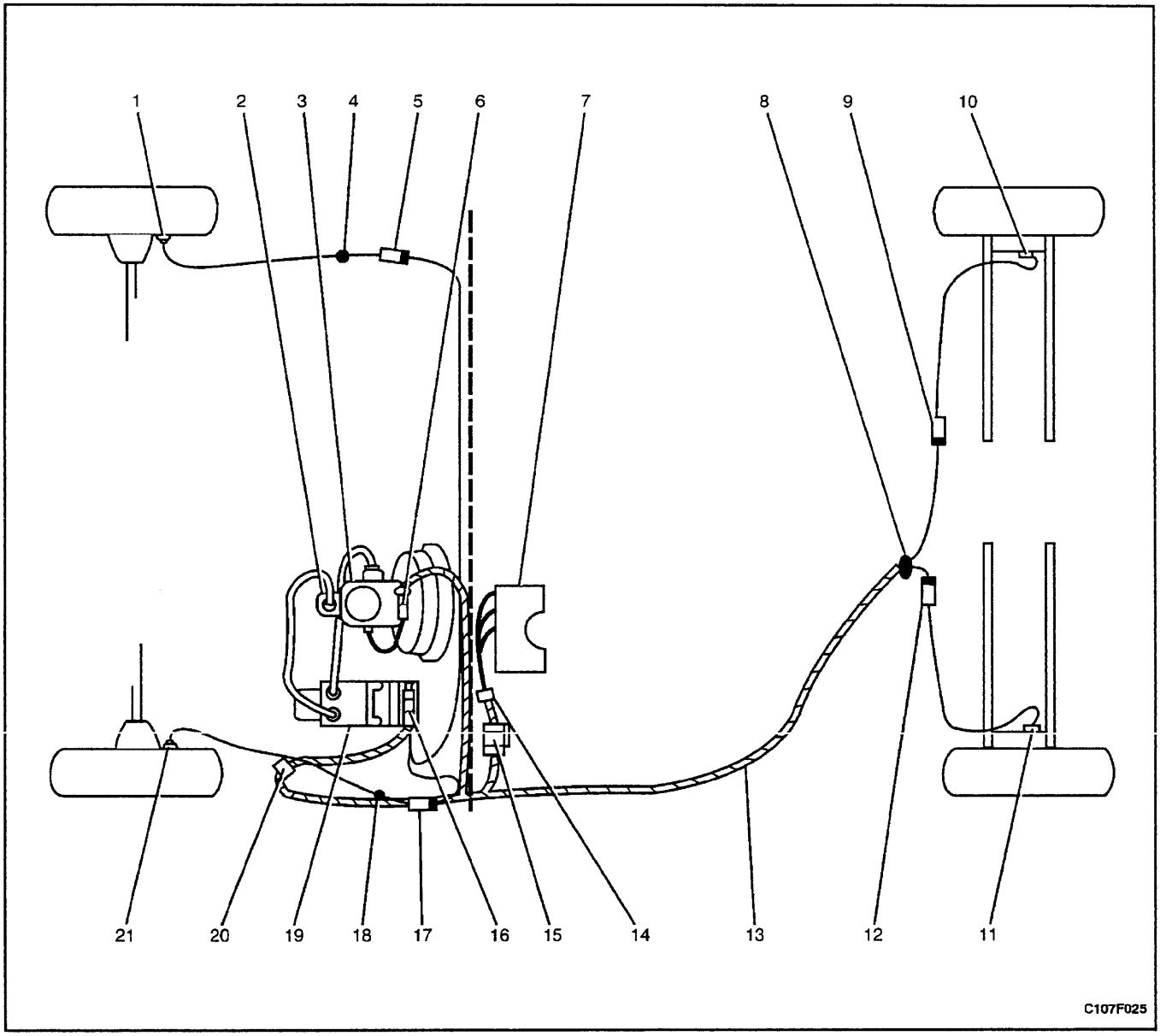
Pin	Color	Circuit
1	DK BLU	Right Rear Ground
2	-	Not Used
3	BRN	Right Rear Sensor
4	PPL	Right Front Ground
5	YEL	Right Front Sensor
6	WHT	Left Front Ground
7	ORN	Left Front Sensor
8	DK BLU	Left Rear Ground
9	BRN	Left Rear Sensor
10	-	Not Used
11	DK BLU/ WHT	Serial Data Link
12	-	Not Used
13	-	Not Used
14	LT BLU	Brake Light Switch
15	PNK	Switched Ignition
16	BLK	Motor Ground

Pin	Color	Circuit
17	RED	Battery
18	RED	Battery
19	BLK	Instrument Ground
20	-	Not Used
21	DK GRN/ BLK	ABS Warning Lamp
22	-	Not Used
23	-	Not Used
24	-	Not Used
25	-	Not Used
26	-	Not Used
27	-	Not Used
28	DK GRN	TCS Warning Lamp
29	-	Not Used
30	-	Not Used
31	-	Not Used
SB	-	Shorting Bar

COMPONENT LOCATOR

ABS AND TCS SYSTEM

(Left-Hand Drive Shown, Right-Hand Drive Similar)



1 Right Front Wheel Speed Sensor
2 Brake Master Cylinder
3 Master Cylinder Reservoir
4 Grommet
5 Right Front Wheel Speed Sensor Connector
6 Brake Fluid Level Switch Connector
7 Instrument Cluster
8 Grommet
9 Right Rear Wheel Speed Sensor Connector
10 Right Rear Wheel Speed Sensor
11 Left Rear Wheel Speed Sensor
12 Left Rear Wheel Speed Sensor Connector
13 Body Wiring Harness
14 Connector C206
15 Connectors C202, C205
16 EBCM Connector J1
17 Left Front Speed Sensor Connector
18 Grommet
19 Hydraulic Modulator with Attached EBCM
20 Connector C107
21 Left Front Wheel Speed Sensor

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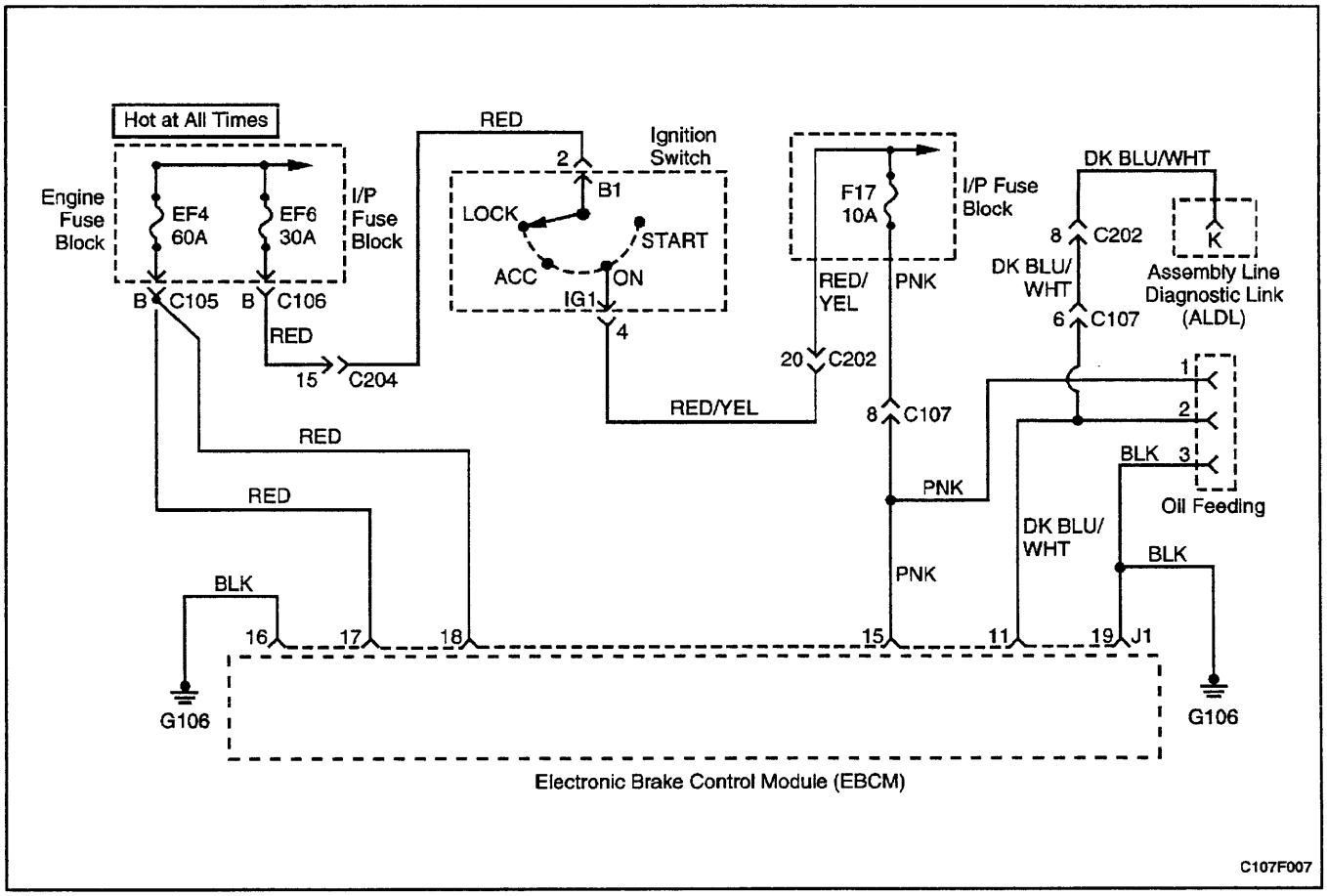
DIAGNOSIS



DIAGNOSTIC CIRCUIT CHECK

The Diagnostic Circuit Check is an organized approach to identifying a problem created by an antilock brake system (ABS) malfunction. It must be the starting point for any ABS complaint diagnosis because it directs the service technician to the next logical step in diagnosing the complaint.

Diagnostic Process

Perform the following steps in order when servicing the ABS/TCS system. Failure to do so may result in the loss of important diagnostic data and may lead to difficulties and time-consuming diagnosis procedures.

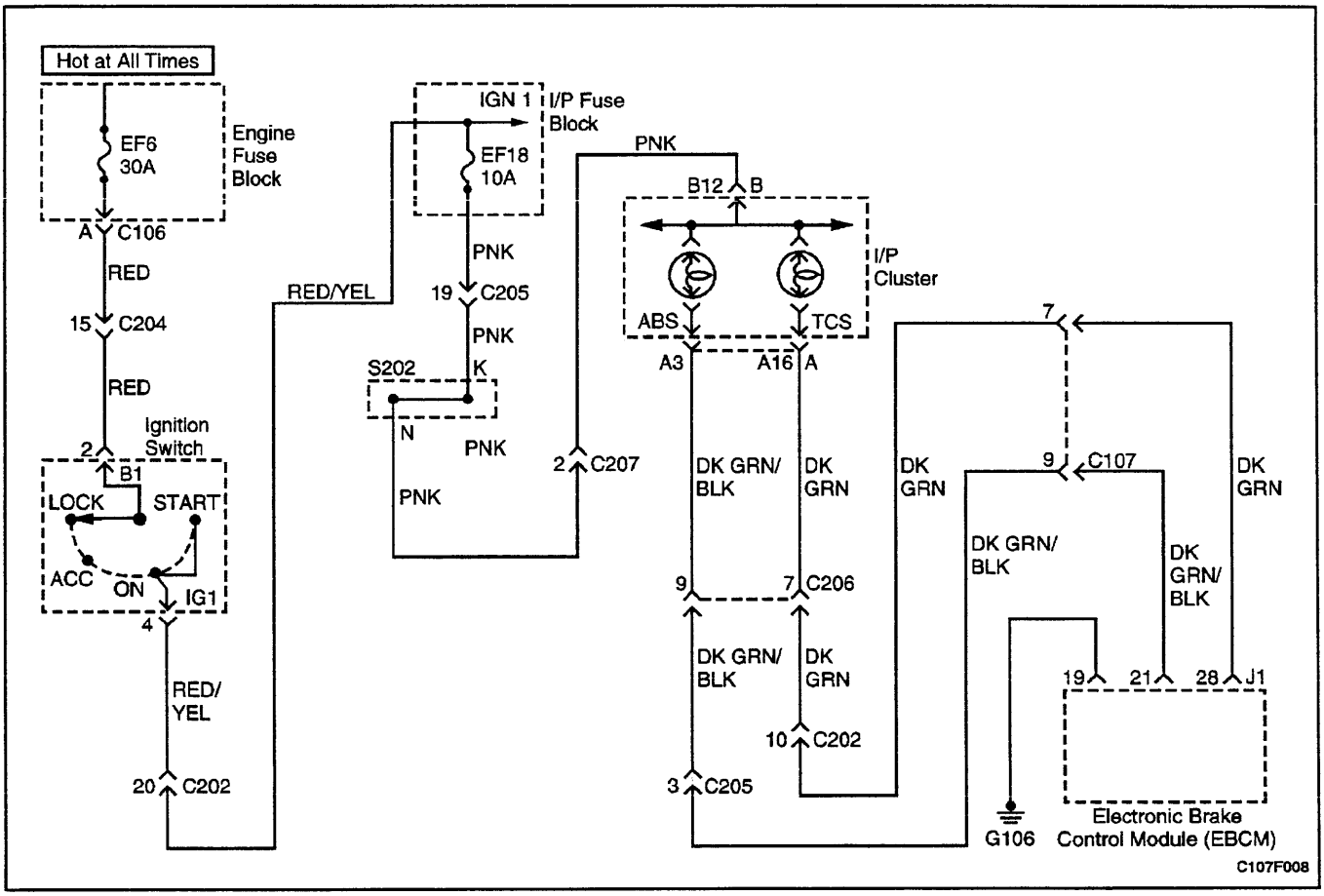
1. Perform the tests of the table below.
2. Perform a road test if directed by the table.
   - Test drive the vehicle while using the snapshot feature of the scan tool.
   - Perform normal acceleration, stopping, and turning maneuvers.
   - If this does not reproduce the malfunction, perform an ABS stop or TCS maneuver on a low friction surface such as gravel.
3. Clear the diagnostic trouble codes (DTCs) after all system malfunctions have been corrected.

Diagnostic Circuit Check

Step	Action	Value	Yes	No
1	1. Install the scan tool. 2. Turn ignition switch to ON. 3. Select the Data List mode. Is the scan tool receiving data from the Electronic Brake Control Module (EBCM)?	-	Go to *Step 2*	Go to *Step 7*

Diagnostic Circuit Check (Cont'd)

Step	Action	Value	Yes	No
2	Check the display. Are there any current DTCs displayed?	-	Refer to the applicable DTC table	Go to *Step 3*
3	1. Turn the ignition switch to LOCK for 10 seconds. 2. Turn the ignition switch to ON and observe the ABS indicator. Does the indicator light for 2 seconds and then go off?	-	Go to *Step 5*	Go to *Step 4*
4	Check the ABS indicator. Did the ABS indicator turn on and stay on?	-	Go to "ABS Indicator Lamp Illuminated Constantly"	Go to "ABS Indicator Lamp Inoperative"
5	Check whether the vehicle is equipped with traction control. Is the vehicle equipped with traction control?	-	Go to *Step 6*	Go to *Step 13*
6	1. Turn the ignition switch to LOCK for 10 seconds. 2. Turn the ignition switch to ON and observe the TCS indicator. Does the indicator light for 2 seconds and then go off?	-	Go to *Step 13*	Go to "Traction Control System Indicator Lamp Inoperative"
7	1. Turn the ignition switch to LOCK. 2. Disconnect the EBCM harness connector J1. 3. Turn the ignition switch to ON. 4. Use a digital voltmeter (DVM) to measure the voltage from ground to terminal 15, 17, and 18 of EBCM harness connector J1. Is the voltage within the specified value on each terminal?	11-14 v	Go to *Step 8*	Go to "Power Supply to Control Module, No DTCs Stored"
8	1. Turn the ignition switch to LOCK. 2. Use a DVM to measure the resistance from the EBCM harness connector J1, terminals 16 and 19 to ground. Is the resistance equal to the specified value?	≈ 0 Ω	Go to *Step 10*	Go to *Step 9*
9	Repair the open in the circuit BLK that failed. Is the repair complete?	-	System OK	-
10	Use a DVM to measure the resistance between terminal 11 of the EBCM harness connector J1 and terminal K of the assembly line diagnostic link (ALDL). Is the resistance below the specified value?	2 Ω	Go to *Step 11*	Go to *Step 12*
11	Replace the ABS unit. Is the repair complete?	-	System OK	-
12	Repair the open or high resistance in circuit DK BLU/WHT between terminal 11 of the EBCM harness connector J1 and terminal K of the ALDL jack. Is the repair complete?	-	Go to *Step 1*	-
13	Perform the road test described above. Are any DTCs set?	-	Go to the table for the DTC	System OK



ABS INDICATOR LAMP INOPERATIVE

Circuit Description

Battery voltage is supplied to the ABS warning lamp with the ignition switch in the ON or START positions. The warning lamp can be activated only by the ABS control module internally supplying ground to terminal 21 or by the shorting bar in the ABS module connector J1 when it is disconnected from the module.

Diagnosis

This procedure checks for a problem in the wiring, a faulty ground, a voltage supply problem, a burned out indicator lamp, or a contact problem in a connector.

Cause(s)

- A fuse has blown.
- The indicator lamp has burned out.
- There is a corroded or broken connector terminal.
- There is a faulty ground connection.
- There is a broken wire in a wiring harness.
- The EBCM is faulty.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This test checks for any DTCs that may cause the ABS indicator lamp to be inoperative.
2. This test verifies an inoperative lamp condition.
3. This test checks for voltage on the lamp circuit.
4. This begins a series of tests of the circuit from the indicator lamp to the EBCM and ground.

19. This begins a series of tests of the voltage supply circuits that power the indicator lamp.

ABS Indicator Lamp Inoperative

Step	Action	Value(s)	Yes	No
1	Install the scan tool and check for any DTCs. Is any DTC set?	-	Go to the chart for the DTC	Go to *Step 2*
2	1. Turn the ignition switch to LOCK. 2. Disconnect the scan tool. 3. Turn the ignition switch to ON. 4. Observe the ABS indicator lamp. Does the lamp illuminate for about 2 seconds, then turn off?	-	Go to "Intermittents and Poor Connections"	Go to *Step 3*
3	With the ignition still ON, observe the oil pressure lamp. Is the oil pressure lamp illuminated?	-	Go to *Step 4*	Go to *Step 19*
4	1. Turn the ignition switch to LOCK. 2. Disconnect connector J1 from the electronic brake control module (EBCM). 3. Turn the ignition switch to ON. Does the ABS indicator illuminate?	-	Go to *Step 5*	Go to *Step 8*
5	1. Turn the ignition switch to LOCK. 2. Examine terminals 19 and 21 at the EBCM connector J1 on both the ABS wiring harness and on the EBCM. Is there a poor connection at any of these terminals?	-	Go to *Step 6*	Go to *Step 7*
6	Repair the faulty terminals or replace the ABS unit as required. Is the repair complete?	-	System OK	-
7	Replace the ABS unit. Is the repair complete?	-	System OK	-
8	1. Turn the ignition switch to LOCK. 2. Disconnect the wire from the negative battery terminal. 3. Measure the resistance between the negative battery wire, which is attached to ground, and the shorting bar in the EBCM connector J1. Does the resistance match the specified value?	0 Ω	Go to *Step 10*	Go to *Step 9*
9	Repair the open or high resistance in the circuit from EBCM connector J1, terminal 19 to ground G106. Is the repair complete?	-	System OK	-
10	1. Remove the I/P cluster. 2. Remove and check the ABS indicator bulb. Is the bulb burned out?	-	Go to *Step 11*	Go to *Step 12*
11	1. Replace the ABS indicator bulb. 2. Install the I/P cluster. Is the repair complete?	-	System OK	-
12	Check the continuity at the I/P cluster connector terminal A3. Does the ohmmeter show the specified value?	0 Ω	Go to *Step 14*	Go to *Step 13*
13	Repair the contact at the I/P cluster connector terminal A3. Is the repair complete?	-	System OK	-

ABS Indicator Lamp Inoperative (Cont'd)

Step	Action	Value(s)	Yes	No
14	Check the wiring harnesses and the connectors in circuit DK GRN/BLK from the I/P cluster terminal A3 to terminal 21 of the EBCM connector J1. Does the ohmmeter show the specified value?	∞	Go to *Step 15*	Go to *Step 16*
15	Repair the open or high resistance found. Is the repair complete?	-	System OK	-
16	Check for continuity between terminal 19 of the ABS connector J1 and ground G106. Does the ground connection match the specified value?	0 Ω	Go to *Step 17*	Go to *Step 18*
17	Replace the ABS unit. Is the repair complete?	-	System OK	-
18	Repair the continuity problem between terminal 19 of the EBCM connector J1 and ground G106. Is the repair complete?	-	System OK	-
19	1. Turn the ignition switch to LOCK. 2. Check fuse F18 in the I/P fuse block. Is this fuse blown?	-	Go to *Step 20*	Go to *Step 21*
20	Replace fuse F18. Is the repair complete?	-	System OK	-
21	Check fuse EF6 in the engine fuse block. Is this fuse blown?	-	Go to *Step 22*	Go to *Step 23*
22	Replace fuse EF6. Is the repair complete?	-	System OK	-
23	Measure the voltage at terminal 2 of the ignition switch connector by backprobing. Does the voltage match the specified value?	11-14 v	Go to *Step 25*	Go to *Step 24*
24	1. Check circuit RED between terminal A of C106 at the engine fuse block and terminal 2 of the ignition switch for continuity. 2. Repair any open or high resistance found. Is the repair complete?	-	System OK	-
25	1. Turn the ignition switch to ON. 2. Backprobe terminal 4 (RED/YEL) of the ignition switch connector. Does the voltage match the specified value?	11-14 v	Go to *Step 27*	Go to *Step 26*
26	Replace the ignition switch. Is the repair complete?	-	System OK	-
27	1. Turn the ignition switch to LOCK. 2. Check circuit RED/YEL from terminal 4 of the ignition switch to fuse F18 in the I/P fuse block. Does the ohmmeter show the specified value?	∞	Go to *Step 28*	Go to *Step 29*
28	Repair the open or the high resistance. Is the repair complete?	-	System OK	-
29	1. Remove the instrument cluster. 2. Check circuit PNK from fuse F18 to terminal B12 of the I/P cluster connector B. 3. Repair any open or high resistance found in a wiring harness, splice pack, or connector. Is the repair complete?	-	System OK	-

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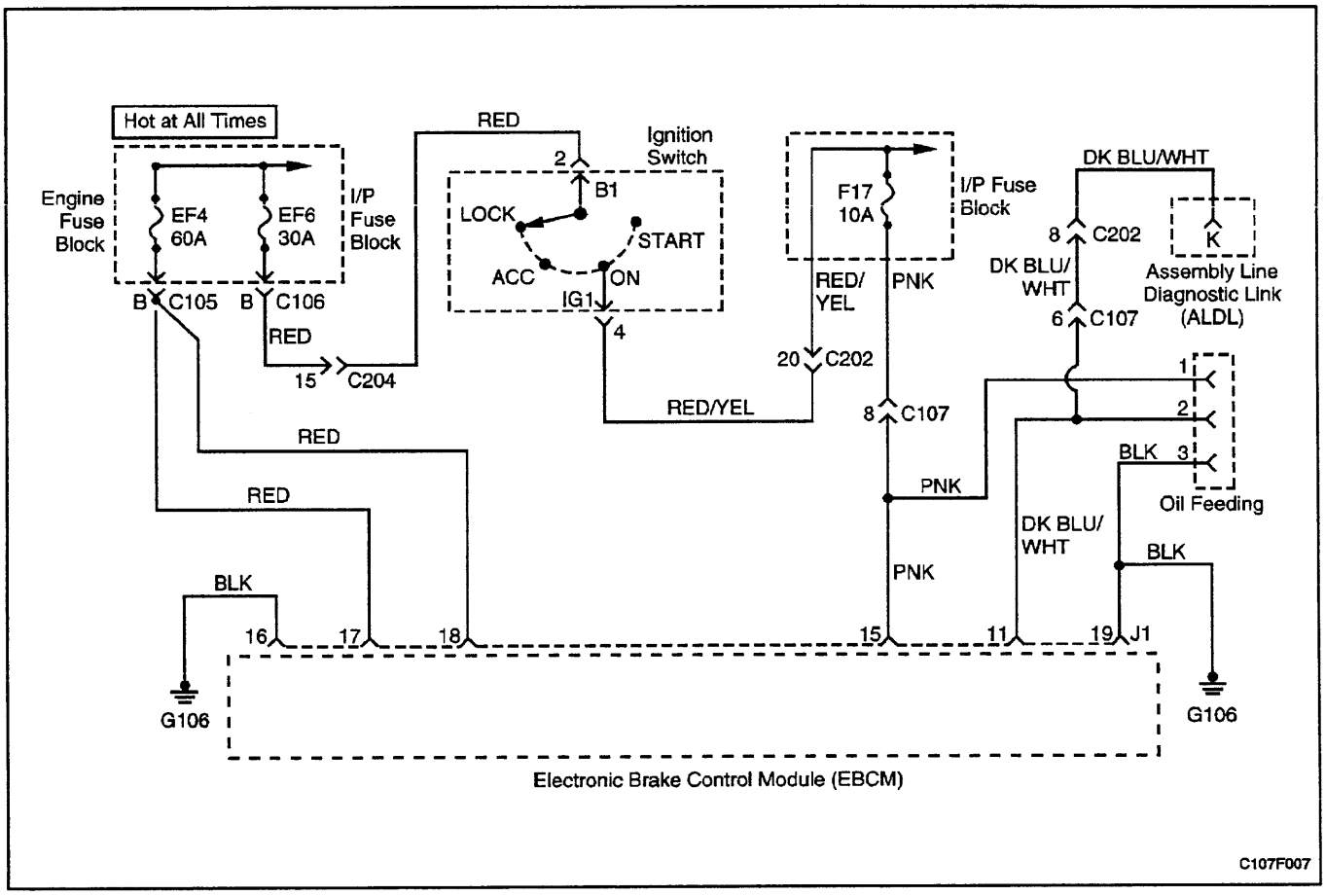


POWER SUPPLY TO CONTROL MODULE, NO DTCs STORED

Circuit Description

Battery voltage is supplied to the electronic brake control module (EBCM) through fuse F17 in the I/P fuse block, to terminal 15 of the EBCM connector J1. The voltage is present when the ignition switch is in the ON or START position.

Diagnosis

This test checks for battery output, proper grounding, blown fuses, a faulty ignition switch, and problems in the circuitry.

Cause(s)

- The battery is defective.
- There is a defective ground connection.
- A connector is damaged.
- A wire is broken or shorted.
- A fuse is blown.
- The ignition switch is malfunctioning.

Fail Action

ABS action is disabled during the period of low voltage, and the ABS warning lamp is ON for the remainder of the ignition cycle.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This step determines whether there is voltage at the battery and the high current source.
7. This step checks for voltage at the ignition 1 source.
11. This step begins the check for voltage at the EBCM end of the ABS harness.
15. This step checks for a defective ground connection.
16. This is a check for a defective EBCM connector.

Diagnostic Aids

It is very important to perform a thorough inspection of the wiring and the connectors. Failure to do so may result in misdiagnosis, causing part replacement with a reappearance of the malfunction.

Power Supply to Control Module, No DTCs Stored

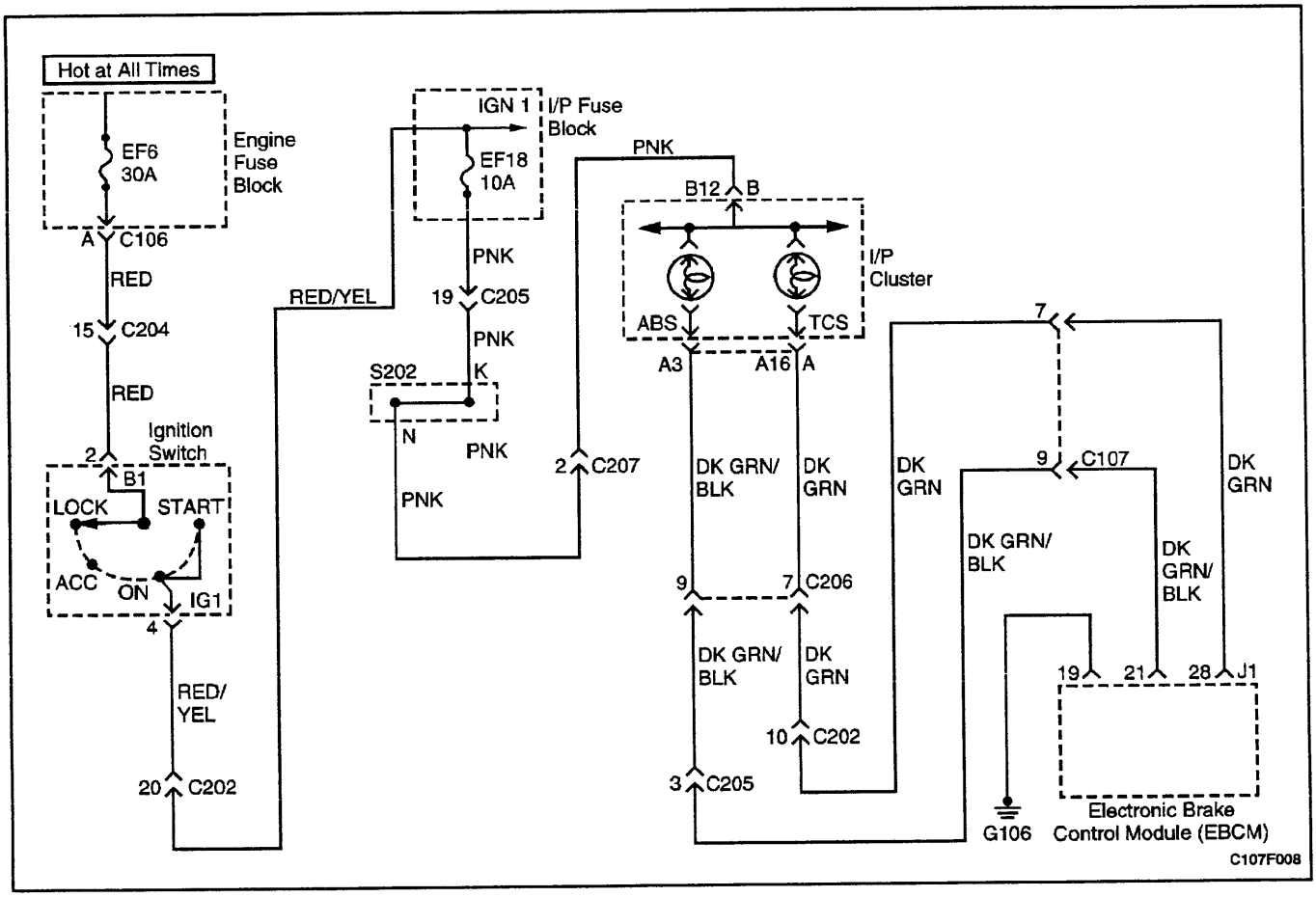
Step	Action	Value(s)	Yes	No
1	Check the voltage at the battery. Is the voltage within the specified value?	11-14 v	Go to *Step 3*	Go to *Step 2*
2	Charge or replace the battery as required. Is the repair complete?	-	System OK	-
3	Check fuse EF4 in the engine fuse block. Is the fuse blown?	-	Go to *Step 4*	Go to *Step 8*
4	1. Replace fuse EF4. 2. Turn the ignition to ON. Does the fuse blow again?	-	Go to *Step 6*	Go to *Step 5*
5	Check the ABS function. Is the repair complete?	-	System OK	-
6	1. Turn the ignition to OFF. 2. Remove fuse EF4. 3. Disconnect the ABS connector J1 from the EBCM. 4. Measure the resistance to ground at terminals 17 and 18. Does the ohmmeter show the specified value?	0 Ω	Go to *Step 7*	Go to *Step 25*
7	Repair the short to ground in circuit RED between terminal B of engine fuse block connector C105 and the ABS harness EBCM connector J1. Is the repair complete?	-	System OK	-
8	Check fuse EF6 in the engine fuse block. Is the fuse blown?	-	Go to *Step 9*	Go to *Step 13*
9	1. Replace fuse EF6. 2. Turn the ignition to ON. Does the fuse blow again?	-	Go to *Step 11*	Go to *Step 10*
10	Check the ABS function. Is the repair complete?	-	System OK	-
11	1. Turn the ignition to OFF. 2. Remove fuse EF6. 3. Disconnect ABS connector J1 from the EBCM. 4. Measure the resistance to ground at terminal 15. Does the ohmmeter show the specified value?	0 Ω	Go to *Step 12*	Go to *Step 25*
12	1. Examine circuit RED between terminal A of engine fuse block connector C106 and terminal 2 of the ignition switch. 2. Examine circuit RED/YEL from terminal 4 of the ignition switch to fuse F17 in the I/P fuse block. 3. Examine circuit PNK from fuse F17 in the I/P fuse block to terminal 15 of the ABS EBCM connector J1. 4. Repair any short to ground found in the wiring or the ignition switch. Is the repair complete?	-	System OK	-
13	Check fuse F17 in the I/P fuse block. Is the fuse blown?	-	Go to *Step 14*	Go to *Step 18*

Power Supply to Control Module, No DTCs Stored (Cont'd)

Step	Action	Value	Yes	No
14	1. Replace fuse F17. 2. Turn the ignition to ON. Does the fuse blow again?	-	Go to *Step 16*	Go to *Step 15*
15	Check the ABS function. Is the repair complete?	-	System OK	-
16	1. Turn the ignition to OFF. 2. Remove fuse F17. 3. Disconnect ABS connector J1 from the EBCM. 4. Measure the resistance to ground at terminal 15. Does the ohmmeter show the specified value?	0 Ω	Go to *Step 17*	Go to *Step 25*
17	Repair the short to ground in circuit PNK fuse F17 of the I/P fuse block and terminal 15 of the ABS harness EBCM connector J1. Is the repair complete?	-	System OK	-
18	1. Disconnect the EBCM connector J1 from the EBCM. 2. Turn the ignition to ON. 3. Check for the presence of battery voltage between ground and terminal 17, and between ground and terminal 18. Is the voltage within the specified value?	11-14 v	Go to *Step 20*	Go to *Step 19*
19	1. Turn the ignition switch to OFF. 2. Trace the RED wires between terminals 17 and 18 of the EBCM connector J1 to terminal B of connector C105 at the engine fuse block. 3. Repair the open in this circuit. Is the repair complete?	-	System OK	-
20	Check the voltage between ground and terminal 15 of the EBCM connector J1. Is the voltage within the specified value?	11-14 v	Go to *Step 22*	Go to *Step 21*
21	1. Turn the ignition switch to OFF. 2. Trace circuit PNK between terminal 15 of the ABS harness EBCM connector to fuse F17 in the I/P fuse block. 3. Trace circuit RED/YEL from fuse F17 of the I/P fuse block to terminal 4 (IG1) of the ignition switch. 4. Trace circuit RED from terminal 2 (B1) of the ignition switch to terminal A of connector C106 at the engine fuse block and to fuse EF6. 5. Repair the open in the wiring or possibly bad connector terminal, defective ignition switch, or blown fuse EF6. Is the repair complete?	-	System OK	-
22	1. Turn the ignition to OFF. 2. Check the resistance between ground and terminals 19 and 16 of the EBCM connector J1. Does the ohmmeter show the specified value?	0 Ω	Go to *Step 23*	Go to *Step 26*
23	Examine terminals 15, 19, 17, 18, and 16 of the EBCM connector. Is there a defective terminal?	-	Go to *Step 24*	Go to *Step 25*

Power Supply to Control Module, No DTCs Stored (Cont'd)

Step	Action	Value	Yes	No
24	Repair the defective terminal or replace the connector or wiring harness as required. Is the repair complete?	-	System OK	-
25	Replace the ABS unit. Is the repair complete?	-	System OK	-
26	Repair the defective ground connection. Is the repair complete?	-	System OK	-



ABS INDICATOR LAMP ILLUMINATED CONTINUOUSLY, NO DTCs STORED

Circuit Description

Battery voltage is supplied to the ABS warning lamp with the ignition switch in the ON or START position. The warning lamp should be activated only by the ABS control module internally supplying ground to terminal 21.

Diagnosis

This procedure checks for a short to ground in the wiring or a defective electronic brake control module (EBCM).

Cause(s)

- There is a short to ground in the circuit between the cluster terminal A3 and the EBCM terminal 21.
- The EBCM is faulty.

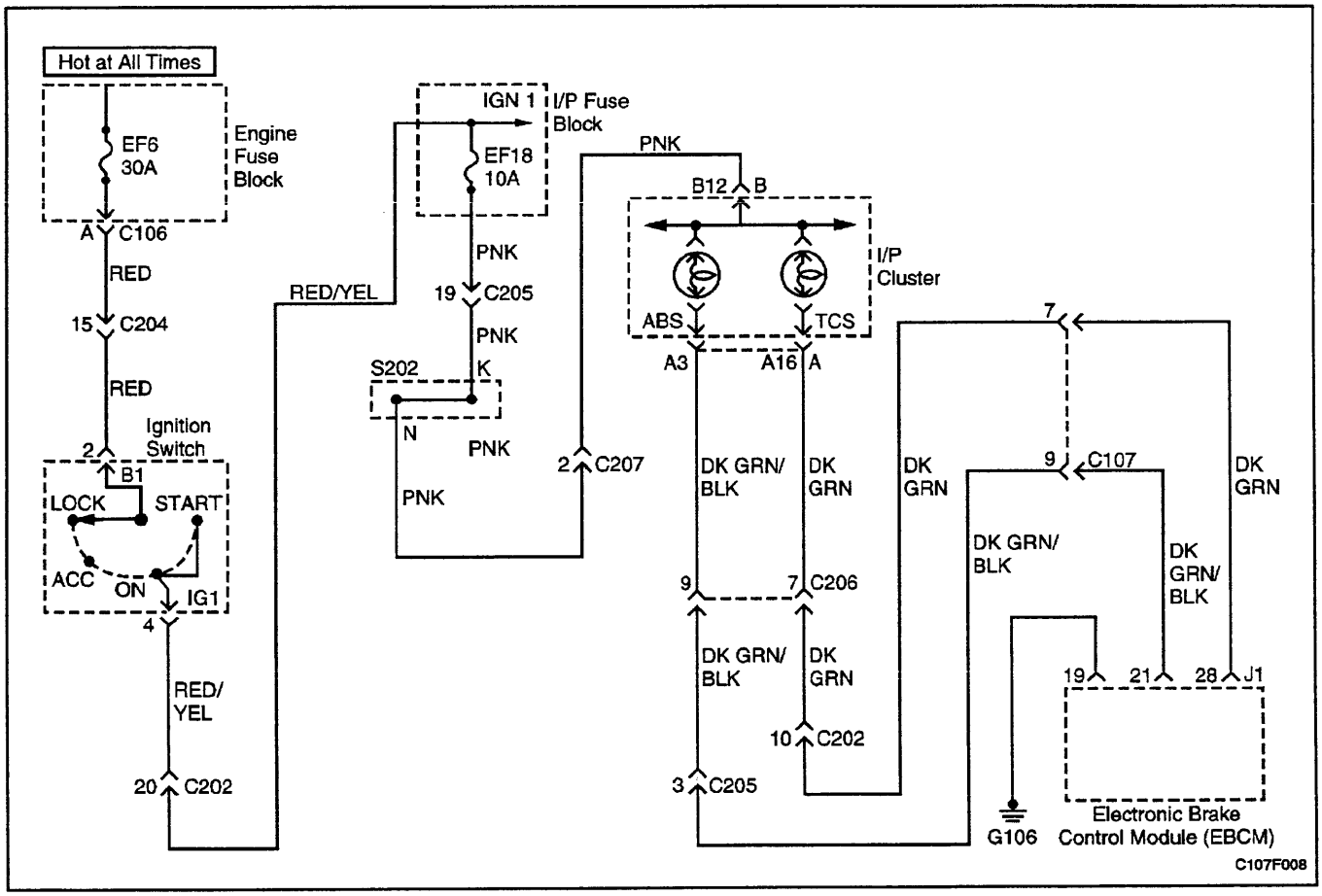
Test Description

The number(s) below refer to step(s) on the diagnostic table.

3. This step determines whether the EBCM is faulty.
5. This begins a search for a short to ground in the circuit between the ABS indicator lamp and the EBCM.

ABS Indicator Lamp Illuminated Continuously, No DTCs Stored

Step	Action	Value(s)	Yes	No
1	Check the EBCM connector J1. Is it connected properly?	-	Go to *Step 3*	Go to *Step 2*
2	Connect the EBCM connector J1. Is the repair complete?	-	System OK	-
3	1. Disconnect the EBCM connector J1. 2. Turn the ignition switch to ON. 3. Use an insulated tool to push the shorting bar in the connector away from terminal 21. Does the ABS indicator lamp go out?	-	Go to *Step 4*	Go to *Step 5*
4	Replace the ABS unit. Is the repair complete?	-	System OK	-
5	1. Turn the ignition switch to OFF. 2. Connect the EBCM connector J1. 3. Disconnect connector C107. 4. Turn the ignition switch to ON. Does the ABS indicator lamp illuminate?	-	Go to *Step 7*	Go to *Step 6*
6	Repair the short to ground in circuit DK GRN/BLK between connector C107 and the EBCM connector J1. Is the repair complete?	-	System OK	-
7	1. Turn the ignition switch to OFF. 2. Connect connector C107. 3. Disconnect connector C205. 4. Turn the ignition switch to ON. Does the ABS indicator lamp illuminate?	-	Go to *Step 9*	Go to *Step 8*
8	Repair the short to ground in circuit DK GRN/BLK between connector C205 and connector C107. Is the repair complete?	-	System OK	-
9	1. Turn the ignition switch to OFF. 2. Connect connector C205. 3. Disconnect connector C206. 4. Turn the ignition switch to ON. Does the ABS indicator lamp illuminate?	-	Go to *Step 10*	Go to *Step 11*
10	Repair the short to ground in circuit DK GRN/BLK between I/P cluster connector A and connector C206. Is the repair complete?	-	System OK	-
11	Repair the short to ground in circuit DK GRN/BLK between connector C206 and connector C205. Is the repair complete?	-	System OK	-



TRACTION CONTROL SYSTEM INDICATOR LAMP INOPERATIVE

Circuit Description

Battery voltage is supplied to the TCS warning lamp with the ignition switch in the ON or START position. The warning lamp can be activated only by the ABS control module internally supplying ground to terminal 28.

Diagnosis

This procedure checks for a problem in the wiring, a faulty ground, a voltage supply problem, a burned out indicator lamp, or a contact problem in a connector.

Cause(s)

- A fuse has blown.
- The indicator lamp has burned out.
- There is a corroded or broken connector terminal.
- There is a faulty ground connection.
- There is a broken wire in a wiring harness.
- The EBCM is faulty.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This test checks for any DTCs that may cause the TCS indicator lamp to be inoperative.
2. This test verifies an inoperative lamp condition.
3. This test checks for voltage on the lamp circuit.
4. This begins a series of tests of the circuit from the indicator lamp to the EBCM and ground.

19. This begins a series of tests of the voltage supply circuits that power the indicator lamp.

Traction Control System Indicator Lamp Inoperative

Step	Action	Value(s)	Yes	No
1	Install the scan tool and check for any DTCs. Is any DTC set?	-	Go to the chart for the DTC	Go to *Step 2*
2	1. Turn the ignition switch to LOCK. 2. Disconnect the scan tool. 3. Turn the ignition switch to ON. 4. Observe the TCS indicator lamp. Does the lamp illuminate for about 2 seconds, then turn off?	-	Go to "Intermittents and Poor Connections"	Go to *Step 3*
3	With the ignition still ON, observe the oil pressure lamp. Is the oil pressure lamp illuminated?	-	Go to *Step 4*	Go to *Step 19*
4	1. Turn the ignition switch to LOCK. 2. Disconnect connector J1 from the EBCM. 3. Connect a jumper from terminal 28 to the grounding bar in the connector. 4. Turn the ignition switch to ON. Does the TCS indicator illuminate?	-	Go to *Step 5*	Go to *Step 8*
5	1. Turn the ignition switch to LOCK. 2. Examine terminals 19 and 28 at the EBCM connector J1 on both the ABS wiring harness and on the EBCM. Is there a poor connection at any of these terminals?	-	Go to *Step 6*	Go to *Step 7*
6	Repair the faulty terminals or replace the ABS unit as required. Is the repair complete?	-	System OK	-
7	Replace the ABS unit. Is the repair complete?	-	System OK	-
8	1. Turn the ignition switch to LOCK. 2. Disconnect the wire from the negative battery terminal. 3. Measure the resistance between the negative battery wire, which is attached to ground, and the shorting bar in the EBCM connector J1. Does the resistance match the specified value?	0 Ω	Go to *Step 10*	Go to *Step 9*
9	Repair the open or high resistance in the circuit from EBCM connector J1, terminal 19 to ground G106. Is the repair complete?	-	System OK	-
10	1. Remove the I/P cluster. 2. Remove and check the TCS indicator bulb. Is the bulb burned out?	-	Go to *Step 11*	Go to *Step 12*
11	1. Replace the TCS indicator bulb. 2. Replace the I/P cluster. Is the repair complete?	-	System OK	-
12	Check continuity at the I/P cluster connector terminal A16. Does the ohmmeter show the specified value?	0 Ω	Go to *Step 14*	Go to *Step 13*
13	Repair the contact at the I/P cluster connector terminal A16. Is the repair complete?	-	System OK	-

Traction Control System Indicator Lamp Inoperative (Cont'd)

Step	Action	Value	Yes	No
14	Check the wiring harnesses and connectors in circuit DK GRN from the I/P cluster terminal A16 to terminal 28 of the EBCM connector J1. Does the ohmmeter show the specified value?	∞	Go to *Step 15*	Go to *Step 16*
15	Repair the open or high resistance found. Is the repair complete?	-	System OK	-
16	Check for continuity between terminal 19 of the ABS connector J1 and ground G106. Does the ground connection match the specified value?	0 Ω	Go to *Step 17*	Go to *Step 18*
17	Replace the ABS unit. Is the repair complete?	-	System OK	-
18	Repair the continuity problem between terminal 19 of the EBCM connector J1 and ground G106. Is the repair complete?	-	System OK	-
19	1. Turn the ignition switch to LOCK. 2. Check fuse F18 in the I/P fuse block. Is this fuse blown?	-	Go to *Step 20*	Go to *Step 21*
20	Replace fuse F18. Is the repair complete?	-	System OK	-
21	Check fuse EF6 in the engine fuse block. Is this fuse blown?	-	Go to *Step 22*	Go to *Step 23*
22	Replace fuse EF6. Is the repair complete?	-	System OK	-
23	Measure the voltage at terminal 2 of the ignition switch connector by backprobing. Is the voltage within the specified value?	11-14 v	Go to *Step 25*	Go to *Step 24*
24	1. Check circuit RED between terminal A of C106 at the engine fuse block and terminal 2 of the ignition switch continuity. 2. Repair any open or high resistance found. Is the repair complete?	-	System OK	-
25	1. Turn the ignition switch to ON. 2. Backprobe terminal 4 (RED/YEL) of the ignition switch connector. Is the voltage within the specified value?	11-14 v	Go to *Step 27*	Go to *Step 26*
26	Replace the ignition switch. Is the repair complete?	-	System OK	-
27	1. Turn the ignition switch to LOCK. 2. Check circuit RED/YEL from terminal 4 of the ignition switch to fuse F18 in the I/P fuse block. Does the ohmmeter show the specified value?	∞	Go to *Step 28*	Go to *Step 29*
28	Repair the open or the high resistance. Is the repair complete?	-	System OK	-
29	1. Remove the I/P cluster. 2. Check circuit PNK from fuse F18 to terminal B12 of the I/P cluster connector B. 3. Repair any open or high resistance found in a wiring harness, a splice pack, or a connector. Is the repair complete?	-	System OK	-

SELF-DIAGNOSTICS

Important: The electronic brake control module (EBCM) turns the valve relay off when a diagnostic trouble code (DTC) is set. The scan tool will indicate that the valve relay is off when it is used to monitor the data list. This is normal and should not be considered a malfunction.

The EBCM performs system self-diagnostics and can detect and often isolate system malfunctions. When it detects a malfunction, the EBCM sets a DTC that represents the malfunction, turns ON the ABS and/or the TCS indicators in most instances, and may disable the ABS and/or the TCS functions as necessary for the duration of the ignition cycle.

Once each ignition cycle, the EBCM performs an automatic test when the vehicle reaches 2.75 km/h (1.7 mph). In the course of this test, the system cycles each valve solenoid and the pump motor, along with the necessary relays, to check component operation. If the EBCM detects any malfunctions, it will set a DTC as described above.

DISPLAYING DTCs

Tools Required

Scan Tool

DTCs can be read through the use of the scan tool.

CLEARING DTCs

Tools Required

Scan Tool

The diagnostic trouble codes (DTCs) in the electronic brake control module (EBCM) memory are erased in one of two ways:

- Use the scan tool "Clear DTCs" selection.
- After 249 DTC-free ignition cycles.

These two methods are detailed below. Be sure to verify proper system operation and absence of DTCs when the clearing procedure is completed.

The EBCM will not permit DTC clearing until all DTCs have been displayed. Also, DTCs cannot be cleared by disconnecting the EBCM, disconnecting the battery cables, or turning the ignition switch to LOCK.

Scan Tool Method

The scan tool can clear ABS/TCS system DTCs using the mass storage cartridge.

1. Install the scan tool and the mass storage cartridge.
2. Select "Fault Memory."
3. Select "Clear Fault Memory."

Clearing the fault memory cannot reset a valve relay which was shut down when the fault was recognized. Changes are possible only after the fault has been eliminated and the next ignition cycle has begun.

Ignition Cycle Default

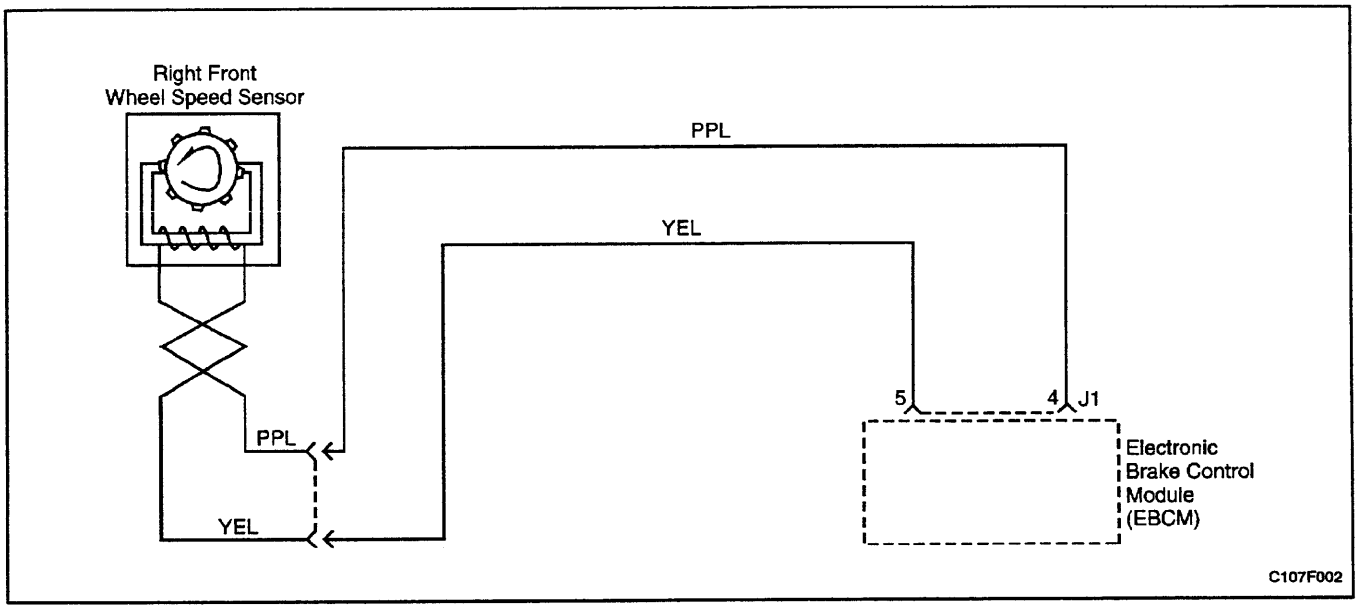
A DTC is erased from memory after 249 ignition cycles without any reappearance of that malfunction.

INTERMITTENTS AND POOR CONNECTIONS

As with most electronic systems, intermittent malfunctions may be difficult to diagnose accurately. The following is a method to try to isolate an intermittent malfunction, especially in wheel speed circuitry.

If an ABS malfunction occurs, the ABS indicator will illuminate during the ignition cycle in which the malfunction was detected. If it is an intermittent problem which seems to have corrected itself (ABS indicator off), a history DTC will be stored. Also stored will be the history data of the DTC at the time the malfunction occurred. Use the scan tool modular diagnostic system to read ABS history data.

Most intermittents are caused by faulty electrical connections or wiring, although a sticking relay or solenoid can occasionally be at fault.



DIAGNOSTIC TROUBLE CODE (DTC) 21
RIGHT FRONT WHEEL SPEED SENSOR FAULT

Circuit Description

The toothed wheel generates a voltage pulse as it moves past the sensor. Each tooth-gap-tooth series on the wheel generates the pulses. The electronic brake control module (EBCM) uses the frequency of these pulses to determine the wheel speed. The voltage generated depends on the air gap between the sensor and the toothed wheel, and on the wheel speed.

Diagnosis

This procedure checks for a malfunctioning wheel speed sensor, a short to ground or to voltage in the wiring, or a contact problem in a connector.

Cause(s)

- The wheel speed sensor is defective or disconnected.
- There is a problem in the wiring.
- There is a problem with a connector.

Fail Action

ABS action is disabled, and the ABS warning lamp is ON.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This step begins an examination for a defective wheel speed sensor.
6. This step tests the wiring for a short to voltage.
8. This step tests the wiring for a short to ground.
10. This step tests for an open or high resistance in the wiring.

Diagnostic Aids

Be sure that the speed sensor wiring is properly routed and retained. This will help to prevent false signals due to the pickup of electrical noise.

It is very important to perform a thorough inspection of the wiring and the connectors. Failure to inspect the wiring and the connectors carefully and completely may result in misdiagnosis, causing part replacement with the reappearance of the malfunction.

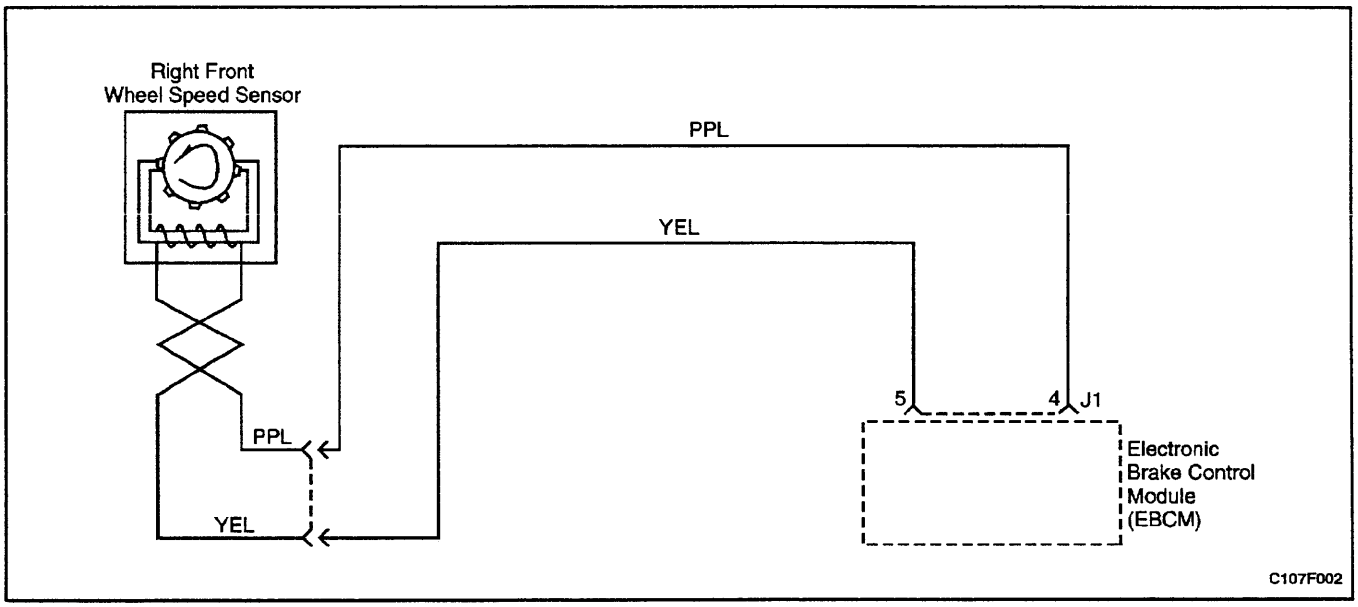
You can use the scan tool to monitor wheel speeds during a road test. Watch the wheel speeds being displayed on the scan tool to see if any of the readings is unusual, such as one sensor varying in speed from the other three, a signal going intermittently high or low, etc. If this does not identify the intermittent, wet the speed sensor harness on the underside of the vehicle and perform a road test, monitoring the wheel speeds with the scan tool.

DTC 21 - Right Front Wheel Speed Sensor Fault

Step	Action	Value(s)	Yes	No
1	Examine the wheel speed sensor. Are there any signs of physical damage?	-	Go to *Step 3*	Go to *Step 2*

DTC 21 - Right Front Wheel Speed Sensor Fault (Cont'd)

Step	Action	Value	Yes	No
2	1. Turn the ignition switch to LOCK. 2. Disconnect the right front wheel speed sensor connector. 3. Use a digital voltmeter (DVM) to measure the resistance between the sensor terminals. Is the resistance within the specified value at approximately 25°C (77°F)?	1280-1920 Ω	Go to *Step 4*	Go to *Step 3*
3	Replace the wheel speed sensor. Is the repair complete?	-	System OK	-
4	1. Switch the DVM to the ac millivolt range. 2. Measure the voltage output of between the wheel speed sensor terminals while rotating the wheel about 1 revolution every 2 seconds. Is the output within the specified value?	≈ 120 mv	Go to *Step 6*	Go to *Step 5*
5	Replace the speed sensor or the toothed wheel as required. Is the repair complete?	-	System OK	-
6	1. Disconnect the harness from the EBCM. 2. Connect a DVM between ground and one terminal of the wheel speed connector. 3. Turn the ignition to ON. 4. Repeat the above test for the other terminal of the wheel speed connector. Is the voltage for either of these terminals within the specified value?	> 1 v	Go to *Step 7*	Go to *Step 8*
7	Repair the short to voltage in the affected circuit. Is the repair complete?	-	System OK	-
8	1. Turn the ignition switch to LOCK. 2. Measure the resistance to ground from terminal 4 at the harness EBCM connector. 3. Measure the resistance to ground from terminal 5 at the harness EBCM connector. Is the resistance at either circuit less than the specified value?	∞	Go to *Step 9*	Go to *Step 10*
9	Repair the short to ground in the affected circuit. Is the repair complete?	-	System OK	-
10	1. Measure the resistance between terminal 4 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the PPL wire. 2. Measure the resistance between terminal 5 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the YEL wire. Is the resistance on either circuit within the specified value?	> 5 Ω	Go to *Step 11*	Go to *Step 12*
11	Repair the open or high resistance in the affected circuit as required. Is the repair complete?	-	System OK	-
12	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 23
RIGHT FRONT WHEEL SPEED SENSOR CONTINUITY FAULT

Circuit Description

The toothed wheel generates a voltage pulse as it moves past the sensor. Each tooth-gap-tooth series on the wheel generates the pulses. The electronic brake control module (EBCM) uses the frequency of these pulses to determine the wheel speed. The voltage generated depends on the air gap between the sensor and the toothed wheel, and on the wheel speed.

Diagnosis

This procedure checks for a malfunctioning wheel speed sensor, a short to ground or to voltage in the wiring, or a contact problem in a connector.

Cause(s)

- The wheel speed sensor is defective or disconnected.
- There is a problem in the wiring.
- There is a problem with a connector.

Fail Action

ABS action is disabled, and the ABS warning lamp is ON.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This step begins an examination for a defective wheel speed sensor.
4. This step tests the wiring for a short to voltage.
6. This step tests the wiring for a short to ground.
8. This step tests for an open or a high resistance in the wiring.

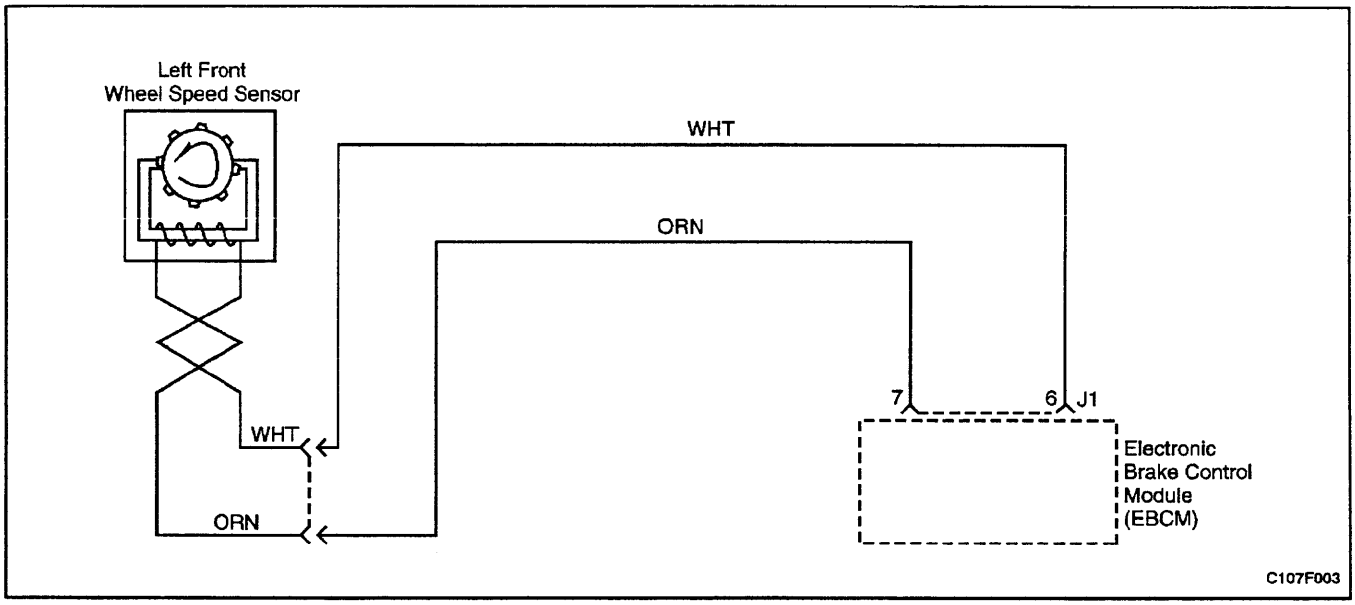
Diagnostic Aids

Be sure that the speed sensor wiring is properly routed and retained. This will help to prevent false signals due to the pickup of electrical noise.

It is very important to perform a thorough inspection of the wiring and connectors. Failure to inspect wiring and connectors carefully and completely may result in misdiagnosis, causing part replacement with the reappearance of the malfunction.

DTC 23 - Right Front Wheel Speed Sensor Continuity Fault

Step	Action	Value(s)	Yes	No
1	Examine the wheel speed sensor. Are there any signs of physical damage?	-	Go to *Step 3*	Go to *Step 2*
2	1. Turn the ignition switch to LOCK. 2. Disconnect the right front wheel speed sensor connector. 3. Use a digital voltmeter (DVM) to measure the resistance between the sensor terminals. Is the resistance within the specified value at approximately 25°C (77°F)?	1280-1920 Ω	Go to *Step 4*	Go to *Step 3*
3	Replace the wheel speed sensor. Is the repair complete?	-	System OK	-
4	1. Disconnect the harness from the EBCM. 2. Connect a DVM between ground and one terminal of the wheel speed connector. 3. Turn the ignition to ON. 4. Repeat the above test for the other terminal of the wheel speed connector. Is the voltage for either of these terminals within the specified value?	> 1 v	Go to *Step 5*	Go to *Step 6*
5	Repair the short to voltage in the affected circuit. Is the repair complete?	-	System OK	-
6	1. Turn the ignition switch to LOCK. 2. Measure the resistance to ground from terminal 4 at the harness EBCM connector. 3. Measure the resistance to ground from terminal 5 at the harness EBCM connector. Is the resistance at either circuit less than the specified value?	∞	Go to *Step 7*	Go to *Step 8*
7	Repair the short to ground in the affected circuit. Is the repair complete?	-	System OK	-
8	1. Measure the resistance between terminal 4 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the PPL wire. 2. Measure the resistance between terminal 5 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the YEL wire. Is the resistance on either circuit within the specified value?	> 5 Ω	Go to *Step 9*	Go to *Step 10*
9	Repair the open or high resistance in the affected circuit as required. Is the repair complete?	-	System OK	-
10	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 25
LEFT FRONT WHEEL SPEED SENSOR FAULT

Circuit Description

The toothed wheel generates a voltage pulse as it moves past the sensor. Each tooth-gap-tooth series on the wheel generates the pulses. The electronic brake control module (EBCM) uses the frequency of these pulses to determine the wheel speed. The voltage generated depends on the air gap between the sensor and the toothed wheel, and on the wheel speed.

Diagnosis

This procedure checks for a malfunctioning wheel speed sensor, a short to ground or to voltage in the wiring, or a contact problem in a connector.

Cause(s)

- The wheel speed sensor is defective or disconnected.
- There is a problem in the wiring.
- There is a problem with a connector.

Fail Action

ABS action is disabled, and the ABS warning lamp is ON.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This step begins an examination for a defective wheel speed sensor.
4. This step tests the wiring for a short to voltage.
6. This step tests the wiring for a short to ground.
8. This step tests for an open or a high resistance in the wiring.

Diagnostic Aids

Be sure that the speed sensor wiring is properly routed and retained. This will help to prevent false signals due to the pickup of electrical noise.

It is very important to perform a thorough inspection of the wiring and the connectors. Failure to inspect the wiring and the connectors carefully and completely may result in misdiagnosis, causing part replacement with the reappearance of the malfunction.

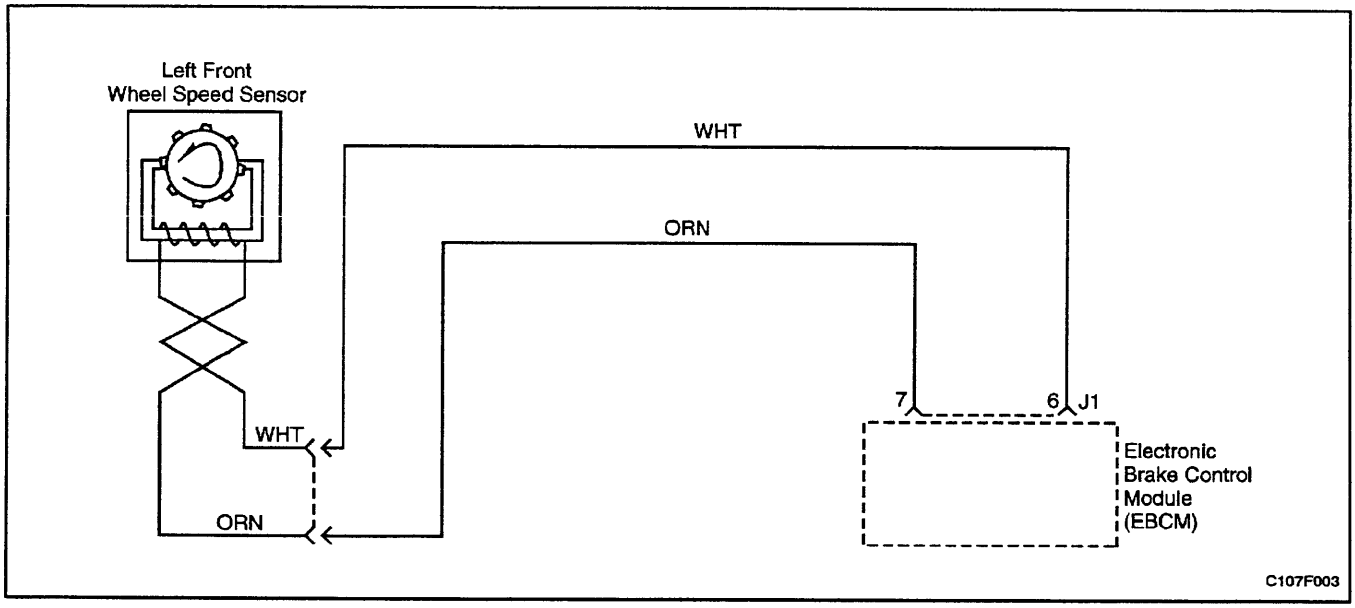
You can use the scan tool to monitor wheel speeds during a road test. Watch the wheel speeds being displayed on the scan tool to see if any of the readings is unusual, such as one sensor varying in speed from the other three, a signal going intermittently high or low, etc. If this does not identify the intermittent, wet the speed sensor harness on the underside of the vehicle and perform a road test, monitoring the wheel speeds with the scan tool.

DTC 25 - Left Front Wheel Speed Sensor Fault

Step	Action	Value(s)	Yes	No
1	Examine the wheel speed sensor. Are there any signs of physical damage?	-	Go to *Step 3*	Go to *Step 2*

DTC 25 - Left Front Wheel Speed Sensor Fault (Cont'd)

Step	Action	Value(s)	Yes	No
2	1. Turn the ignition switch to LOCK. 2. Disconnect the left front wheel speed sensor connector. 3. Use a digital voltmeter (DVM) to measure the resistance between the sensor terminals. Is the resistance within the specified value at approximately 25°C (77°F)?	1280-1920 Ω	Go to *Step 4*	Go to *Step 3*
3	Replace the wheel speed sensor. Is the repair complete?	-	System OK	-
4	1. Switch the DVM to the ac millivolt range. 2. Measure the voltage output of between the wheel speed sensor terminals while rotating the wheel about 1 revolution every 2 seconds. Is the output within the specified value?	≈ 120 mv	Go to *Step 6*	Go to *Step 5*
5	Replace the speed sensor or the toothed wheel as required. Is the repair complete?	-	System OK	-
6	1. Disconnect the harness from the EBCM. 2. Connect a DVM between ground and one terminal of the wheel speed connector. 3. Turn the ignition to ON. 4. Repeat the above test for the other terminal of the wheel speed connector. Is the voltage for either of these terminals within the specified value?	> 1 v	Go to *Step 7*	Go to *Step 8*
7	Repair the short to voltage in the affected circuit. Is the repair complete?	-	System OK	-
8	1. Turn the ignition switch to LOCK. 2. Measure the resistance to ground from terminal 6 at the harness EBCM connector. 3. Measure the resistance to ground from terminal 7 at the harness EBCM connector. Is the resistance at either circuit less than the specified value?	∞	Go to *Step 9*	Go to *Step 10*
9	Repair the short to ground in the affected circuit. Is the repair complete?	-	System OK	-
10	1. Measure the resistance between terminal 6 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the WHT wire. 2. Measure the resistance between terminal 7 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the ORN wire. Is the resistance on either circuit within the specified value?	> 5 Ω	Go to *Step 11*	Go to *Step 12*
11	Repair the open or high resistance in the affected circuit as required. Is the repair complete?	-	System OK	-
12	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 27
LEFT FRONT WHEEL SPEED SENSOR CONTINUITY FAULT

Circuit Description

The toothed wheel generates a voltage pulse as it moves past the sensor. Each tooth-gap-tooth series on the wheel generates the pulses. The electronic brake control module (EBCM) uses the frequency of these pulses to determine the wheel speed. The voltage generated depends on the air gap between the sensor and the toothed wheel, and on the wheel speed.

Diagnosis

This procedure checks for a malfunctioning wheel speed sensor, a short to ground or to voltage in the wiring, or a contact problem in a connector.

Cause(s)

- The wheel speed sensor is defective.
- There is a problem in the wiring.
- There is a problem with a connector.

Fail Action

ABS action is disabled, and the ABS warning lamp is ON.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This step begins an examination for a defective wheel speed sensor.
4. This step tests the wiring for a short to voltage.
6. This step tests the wiring for a short to ground.
8. This step tests for an open or a high resistance in the wiring.

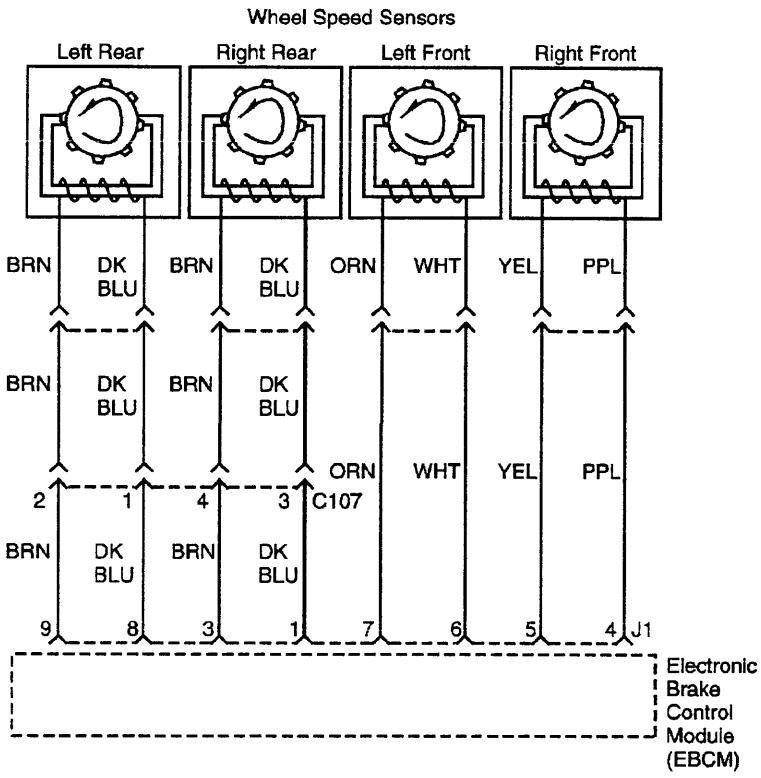
Diagnostic Aids

Be sure that the speed sensor wiring is properly routed and retained. This will help to prevent false signals due to the pickup of electrical noise.

It is very important to perform a thorough inspection of the wiring and the connectors. Failure to inspect the wiring and the connectors carefully and completely may result in misdiagnosis, causing part replacement with the reappearance of the malfunction.

DTC 27 - Left Front Wheel Speed Sensor Continuity Fault

Step	Action	Value(s)	Yes	No
1	Examine the wheel speed sensor. Are there any signs of physical damage?	-	Go to *Step 3*	Go to *Step 2*
2	1. Turn the ignition switch to LOCK. 2. Disconnect the left front wheel speed sensor connector. 3. Use a digital voltmeter (DVM) to measure the resistance between the sensor terminals. Is the resistance within the specified value at approximately 25°C (77°F)?	1280-1920 Ω	Go to *Step 4*	Go to *Step 3*
3	Replace the wheel speed sensor. Is the repair complete?	-	System OK	-
4	1. Disconnect the harness from the EBCM. 2. Connect a DVM between ground and one terminal of the wheel speed connector. 3. Turn the ignition to ON. 4. Repeat the above test for the other terminal of the wheel speed connector. Is the voltage for either of these terminals within the specified value?	> 1 v	Go to *Step 5*	Go to *Step 6*
5	Repair the short to voltage in the affected circuit. Is the repair complete?	-	System OK	-
6	1. Turn the ignition switch to LOCK. 2. Measure the resistance to ground from terminal 6 at the harness EBCM connector. 3. Measure the resistance to ground from terminal 7 at the harness EBCM connector. Is the resistance at either circuit less than the specified value?	∞	Go to *Step 7*	Go to *Step 8*
7	Repair the short to ground in the affected circuit. Is the repair complete?	-	System OK	-
8	1. Measure the resistance between terminal 6 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the WHT wire. 2. Measure the resistance between terminal 7 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the ORN wire. Is the resistance on either circuit within the specified value?	> 5 Ω	Go to *Step 9*	Go to *Step 10*
9	Repair the open or high resistance in the affected circuit as required. Is the repair complete?	-	System OK	-
10	Replace the ABS unit. Is the repair complete?	-	System OK	-



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DIAGNOSTIC TROUBLE CODE (DTC) 28
WHEEL SPEED SENSOR FREQUENCY ERROR

Circuit Description

The toothed wheel generates a voltage pulse as it moves past the wheel speed sensor. Each tooth-gap-tooth series on the wheel generates the pulses. The electronic brake control module (EBCM) uses the frequency of these pulses to determine wheel speed. The voltage generated depends on the air gap between the wheel speed sensor and the toothed wheel, and on the wheel speed.

Diagnosis

This DTC will set when the EBCM cannot identify which wheel speed sensor is causing the malfunction. It is necessary to check all wheel speed sensors and associated wiring to determine the cause of the DTC.

Cause(s)

- Incorrect number of teeth on the toothed wheel.
- Damaged or broken teeth on the toothed wheel.
- Discontinuity or short in speed wheel speed sensor wiring.

Fail Action

Antilock brake system (ABS) action is disabled and the ABS warning lamp is ON.

Test Description

The number(s) below refer to Step(s) on the diagnostic table.

1. This step begins the examination of the front wheel speed sensor sensors.
3. This step checks for a problem with one of the front toothed rings.
5. This step checks the front speed wheel speed sensors.
7. This step checks for shorts in a front wheel speed sensor harness.
9. This step checks for opens in a front wheel speed sensor harness.
11. This step begins a check of the rear wheel speed sensors.
13. This step checks for a problem with one of the rear toothed rings.
15. This step checks the rear wheel speed sensors.
17. This step checks for shorts in a rear wheel speed sensor harness.
19. This step checks for opens in a rear wheel speed sensor harness.

Diagnostic Aids

DTC 28 may be set by running the scan tool auto test if the throttle angle readings are not updating while in the data list mode. If this is the case, clear the DTCs, disconnect the scan tool, and road test the vehicle to at least 25 km/h (15 mph) to see if the DTC resets.

Check the toothed wheels for any large grooves, gouges, marks, etc. that might influence the tooth's signal at the wheel speed sensor. Also check for a buildup of foreign material in the gaps between teeth in the toothed wheel, this material may cause this malfunction.

A badly worn hub/bearing assembly may cause this malfunction. The wheel speed sensor-to-toothed wheel air gap may change excessively due to bearing play.

If an improper rear hub assembly or front outer constant velocity joint is installed, one with a toothed wheel containing the incorrect number of teeth, this DTC can set. Be sure that all the toothed wheels have 48 teeth.

DTC 28 - Wheel Speed Sensor Frequency Error

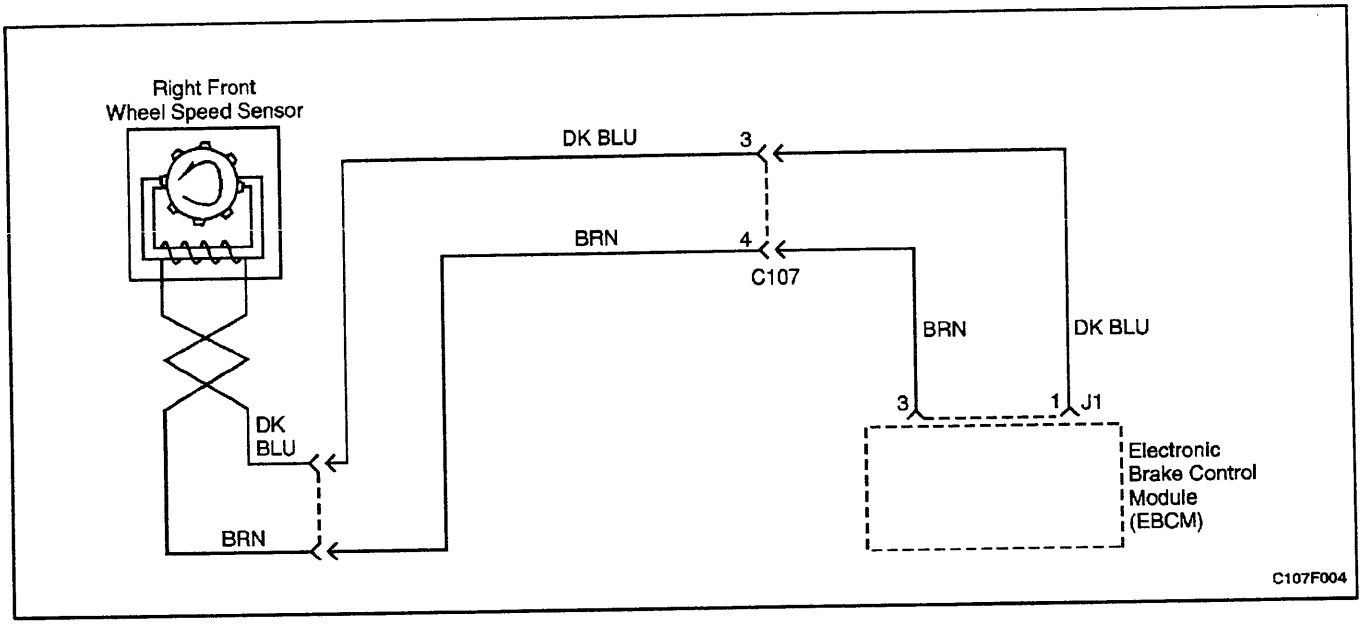
Step	Action	Value(s)	Yes	No
1	Visually inspect the wiring for the front wheel speed sensor sensors. Is there any damage?	-	Go to *Step 2*	Go to *Step 3*
2	Repair or replace components as required. Is the repair complete?	-	System OK	-
3	Check that the correct outer constant velocity (CV) joints are installed on the vehicle. They should have speed rings with 48 teeth. Is one of these incorrect?	-	Go to *Step 4*	Go to *Step 5*
4	Replace the incorrect outer CV joint with the proper unit. Is the repair complete?	-	System OK	-
5	1. Disconnect the wheel speed sensor harnesses from the wheel speed sensor connectors. 2. Measure the wheel speed sensor resistance at the wheel speed sensor connector terminals. Does the resistance fall within the specified values for both wheel speed sensors?	1280-1920 Ω	Go to *Step 7*	Go to *Step 6*
6	Replace the faulty wheel speed sensor. Is the repair complete?	-	System OK	-
7	1. Disconnect ABS control module connector J1. 2. Check each wheel speed sensor harness for a short circuit between its wires with a digital ohmmeter attached to the two terminals at the harness side of the wheel speed sensor connector. 3. Also check each wheel speed sensor harness wire for a short to ground from the connector terminals. Is there any short circuit in either wheel speed sensor harness?	-	Go to *Step 8*	Go to *Step 9*
8	Repair the short circuit in the wiring or from a wiring harness to ground. Is the repair complete?	-	System OK	-
9	Check the continuity of the wiring in both front speed wheel speed sensor circuits between the ABS connector J1 and the wheel speed sensor wheel speed sensor connector on each side of the vehicle. • The left side uses terminals 6 and 7 at the ABS connector J1. • The right side uses terminals 4 and 5 at the ABS connector J1. Is continuity good for both harnesses?	-	Go to *Step 11*	Go to *Step 10*

DTC 28 - Wheel Speed Sensor Frequency Error (Cont'd)

Step	Action	Value(s)	Yes	No
10	Repair the discontinuity found in the front wheel speed sensor harness. Is the repair complete?	-	System OK	-
11	1. Visually inspect the wiring for the rear wheel speed sensor wheel speed sensors. 2. Check that the wheel speed sensors are properly mounted and that the retaining bolts are properly tightened. Is there any damage?	-	Go to *Step 12*	Go to *Step 13*
12	Repair or replace components as required. Is the repair complete?	-	System OK	-
13	Remove each speed wheel speed sensor from the rear knuckles and inspect the toothed ring through the wheel speed sensor mounting holes. • Make sure that the toothed ring has 48 teeth. • Check for any damaged or missing teeth. • Check that the ring is properly positioned under the wheel speed sensor. Is there any damage or other fault with either speed ring?	-	Go to *Step 14*	Go to *Step 15*
14	Replace the rear wheel hub with the proper unit. Is the repair complete?	-	System OK	-
15	1. Disconnect the rear wheel speed sensor harnesses from the wheel speed sensor connectors. 2. Measure the wheel speed sensor resistance at the wheel speed sensor connector terminals. Does the resistance fall within the specified values for both wheel speed sensors?	1280-1920 Ω	Go to *Step 17*	Go to *Step 16*
16	Replace the faulty wheel speed sensor. Is the repair complete?	-	System OK	-
17	1. The ABS control module connector J1 should still be disconnected. Disconnect it now if it is not. 2. Check each wheel speed sensor harness for a short circuit between its wires with a digital ohmmeter attached to the two terminals at the harness side of the wheel speed sensor connector. 3. Also check each wheel speed sensor harness wire for a short to ground from the connector terminals. Is there any short circuit in either wheel speed sensor harness?	-	Go to *Step 18*	Go to *Step 19*
18	Repair the short circuit in the wiring or from a wire to ground. Is the repair complete?	-	System OK	-

DTC 28 - Wheel Speed Sensor Frequency Error (Cont'd)

Step	Action	Value(s)	Yes	No
19	Check the continuity of the wiring in both rear speed wheel speed sensor circuits between the ABS connector J1 and the wheel speed sensor wheel speed sensor connector on each side of the vehicle. • The left side uses terminals 8 and 9 at the ABS connector J1. • The right side uses terminals 1 and 3 at the ABS connector J1. Is continuity good for both harnesses?	-	Go to *Step 21*	Go to *Step 20*
20	Repair the discontinuity found in the rear wheel speed sensor wheel speed sensor harness or connector C107. Is the repair complete?	-	System OK	-
21	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 31
RIGHT REAR WHEEL SPEED SENSOR FAULT

Circuit Description

The toothed wheel generates a voltage pulse as it moves past the sensor. Each tooth-gap-tooth series on the wheel generates the pulses. The electronic brake control module (EBCM) uses the frequency of these pulses to determine the wheel speed. The voltage generated depends on the air gap between the sensor and the toothed wheel, and on the wheel speed.

Diagnosis

This procedure checks for a malfunctioning wheel speed sensor, a short to ground or to voltage in the wiring, or a contact problem in a connector.

Cause(s)

- The wheel speed sensor is defective.
- There is a problem in the wiring.
- There is a problem with a connector.

Fail Action

ABS action is disabled, and the ABS warning lamp is ON.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This step begins an examination for a defective wheel speed sensor.
6. This step tests the wiring for a short to voltage.
8. This step tests the wiring for a short to ground.
10. This step tests for an open or high resistance in the wiring.

Diagnostic Aids

Be sure that the speed sensor wiring is properly routed and retained. This will help to prevent false signals due to the pickup of electrical noise.

It is very important to perform a thorough inspection of the wiring and the connectors. Failure to inspect the wiring and the connectors carefully and completely may result in misdiagnosis, causing part replacement with the reappearance of the malfunction.

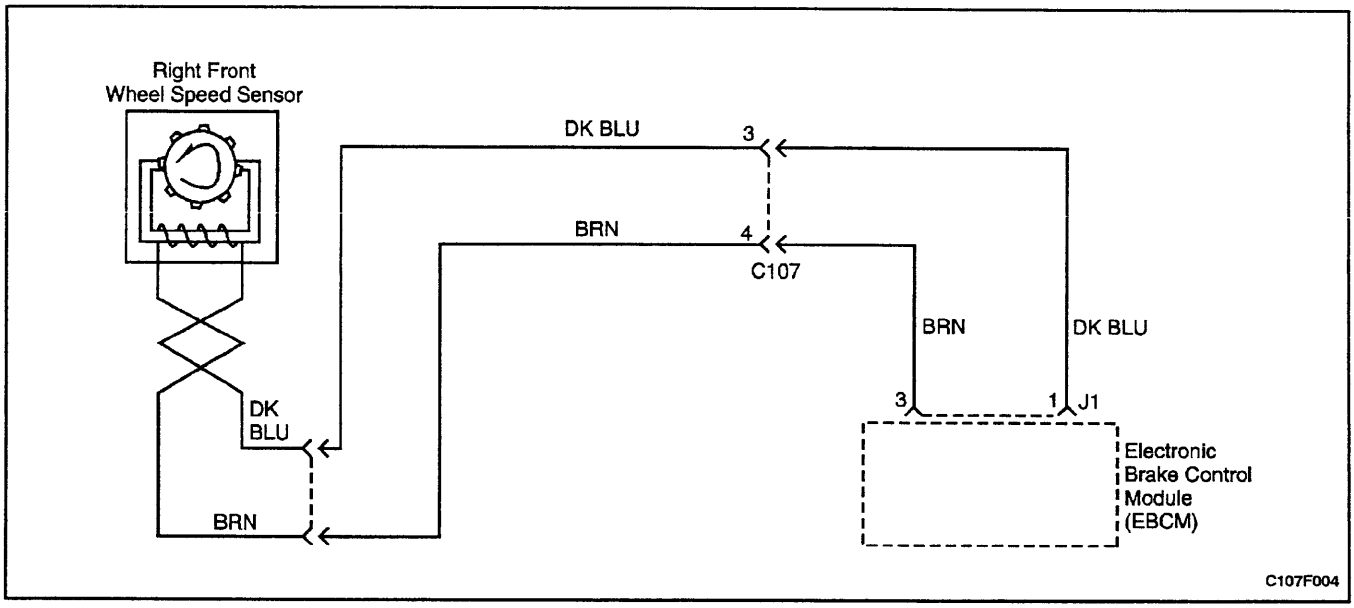
You can use the scan tool to monitor wheel speeds during a road test. Watch the wheel speeds being displayed on the scan tool to see if any of the readings is unusual, such as one sensor varying in speed from the other three, a signal going intermittently high or low, etc. If this does not identify the intermittent, wet the speed sensor harness on the underside of the vehicle and perform a road test, monitoring wheel speeds with the scan tool.

DTC 31 - Right Rear Wheel Speed Sensor Fault

Step	Action	Value(s)	Yes	No
1	Examine the wheel speed sensor. Are there any signs of physical damage?	-	Go to *Step 3*	Go to *Step 2*

DTC 31 - Right Rear Wheel Speed Sensor Fault (Cont'd)

Step	Action	Value(s)	Yes	No
2	1. Turn the ignition switch to LOCK. 2. Disconnect the right rear wheel speed sensor connector. 3. Use a digital voltmeter (DVM) to measure the resistance between the sensor terminals. Is the resistance within the specified value at approximately 25°C (77°F)?	1280-1920 Ω	Go to *Step 4*	Go to *Step 3*
3	Replace the wheel speed sensor. Is the repair complete?	-	System OK	-
4	1. Switch the DVM to the ac millivolt range. 2. Measure the voltage output of between the wheel speed sensor terminals while rotating the wheel about 1 revolution every 2 seconds. Is the output within the specified value?	≈ 120 mv	Go to *Step 6*	Go to *Step 5*
5	Replace the speed sensor or the toothed wheel as required. Is the repair complete?	-	System OK	-
6	1. Disconnect the harness from the EBCM. 2. Connect a DVM between ground and one terminal of the wheel speed connector. 3. Turn the ignition to ON. 4. Repeat the above test for the other terminal of the wheel speed connector. Is the voltage for either of these terminals within the specified value?	> 1 v	Go to *Step 7*	Go to *Step 8*
7	Repair the short to voltage in the affected circuit. Is the repair complete?	-	System OK	-
8	1. Turn the ignition switch to LOCK. 2. Measure the resistance to ground from terminal 1 at the harness EBCM connector. 3. Measure the resistance to ground from terminal 3 at the harness EBCM connector. Is the resistance at either circuit less than the specified value?	∞	Go to *Step 9*	Go to *Step 10*
9	Repair the short to ground in the affected circuit. Is the repair complete?	-	System OK	-
10	1. Measure the resistance between terminal 1 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the DK BLU wire. 2. Measure the resistance between terminal 3 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the BRN wire. Is the resistance on either circuit within the specified value?	> 5 Ω	Go to *Step 11*	Go to *Step 12*
11	Repair the open or high resistance in the affected circuit as required. Be sure to check terminals 3 and 4 of connector C107. Is the repair complete?	-	System OK	-
12	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 33
RIGHT REAR WHEEL SPEED SENSOR CONTINUITY FAULT

Circuit Description

The toothed wheel generates a voltage pulse as it moves past the sensor. Each tooth-gap-tooth series on the wheel generates the pulses. The electronic brake control module (EBCM) uses the frequency of these pulses to determine the wheel speed. The voltage generated depends on the air gap between the sensor and the toothed wheel, and on the wheel speed.

Diagnosis

This procedure checks for a malfunctioning wheel speed sensor, a short to ground or to voltage in the wiring, or a contact problem in a connector.

Cause(s)

- The wheel speed sensor is defective.
- There is a problem in the wiring.
- There is a problem with a connector.

Fail Action

ABS action is disabled, and the ABS warning lamp is ON.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This step begins an examination for a defective wheel speed sensor.
4. This step tests the wiring for a short to voltage.
6. This step tests the wiring for a short to ground.
8. This step tests for an open or a high resistance in the wiring.

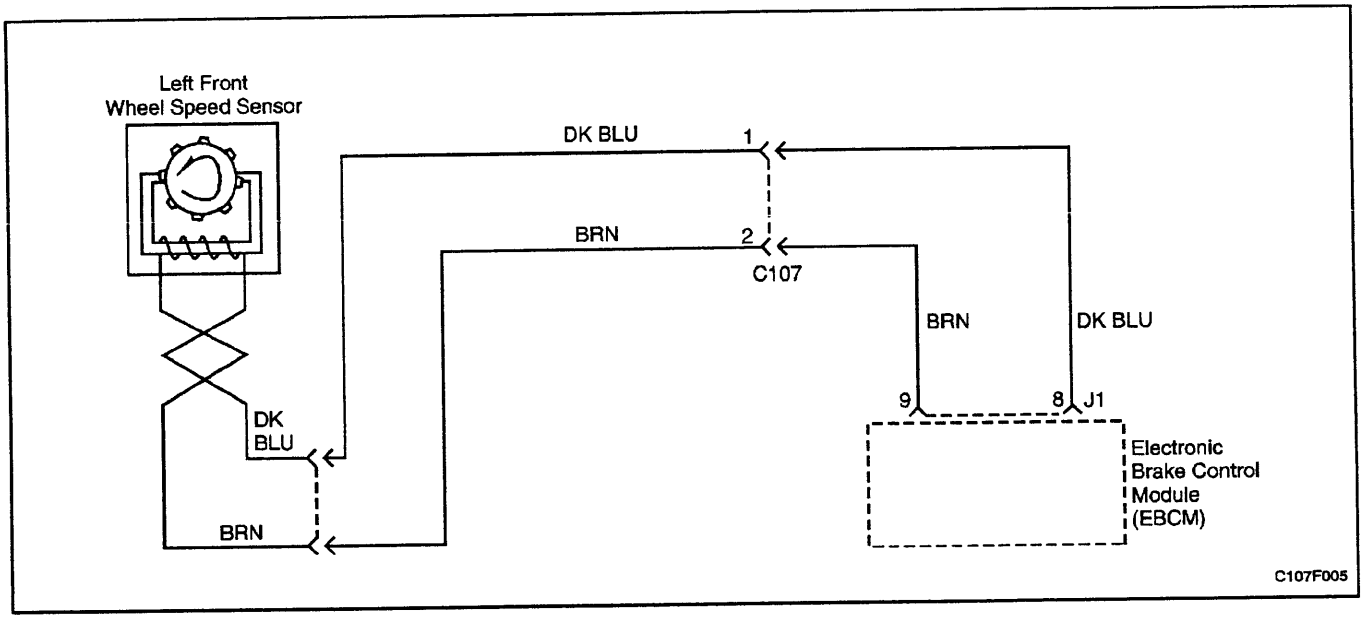
Diagnostic Aids

Be sure that the speed sensor wiring is properly routed and retained. This will help to prevent false signals due to the pickup of electrical noise.

It is very important to perform a thorough inspection of the wiring and the connectors. Failure to inspect the wiring and the connectors carefully and completely may result in misdiagnosis, causing part replacement with the reappearance of the malfunction.

DTC 27 - Right Rear Wheel Speed Sensor Continuity Fault

Step	Action	Value(s)	Yes	No
1	Examine the wheel speed sensor. Are there any signs of physical damage?	-	Go to *Step 3*	Go to *Step 2*
2	1. Turn the ignition switch to LOCK. 2. Disconnect the right rear wheel speed sensor connector. 3. Use a digital voltmeter (DVM) to measure the resistance between the sensor terminals. Is the resistance within the specified value at approximately 25°C (77°F)?	1280-1920 Ω	Go to *Step 4*	Go to *Step 3*
3	Replace the wheel speed sensor. Is the repair complete?	-	System OK	-
4	1. Disconnect the harness from the EBCM. 2. Connect a DVM between ground and one terminal of the wheel speed connector. 3. Turn the ignition to ON. 4. Repeat the above test for the other terminal of the wheel speed connector. Is the voltage for either of these terminals within the specified value?	> 1 v	Go to *Step 5*	Go to *Step 6*
5	Repair the short to voltage in the affected circuit. Is the repair complete?	-	System OK	-
6	1. Turn the ignition switch to LOCK. 2. Measure the resistance to ground from terminal 1 at the harness EBCM connector. 3. Measure the resistance to ground from terminal 3 at the harness EBCM connector. Is the resistance at either circuit less than the specified value?	∞	Go to *Step 7*	Go to *Step 8*
7	Repair the short to ground in the affected circuit. Is the repair complete?	-	System OK	-
8	1. Measure the resistance between terminal 1 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the DK BLU wire. 2. Measure the resistance between terminal 3 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the BRN wire. Is the resistance on either circuit within the specified value?	> 5 Ω	Go to *Step 9*	Go to *Step 10*
9	Repair the open or high resistance in the affected circuit as required. Be sure to check terminals 3 and 4 of connector C107. Is the repair complete?	-	System OK	-
10	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 35
LEFT REAR WHEEL SPEED SENSOR FAULT

Circuit Description

The toothed wheel generates a voltage pulse as it moves past the sensor. Each tooth-gap-tooth series on the wheel generates the pulses. The electronic brake control module (EBCM) uses the frequency of these pulses to determine the wheel speed. The voltage generated depends on the air gap between the sensor and the toothed wheel, and on the wheel speed.

Diagnosis

This procedure checks for a malfunctioning wheel speed sensor, a short to ground or to voltage in the wiring, or a contact problem in a connector.

Cause(s)

- The wheel speed sensor is defective.
- There is a problem in the wiring.
- There is a problem with a connector.

Fail Action

ABS action is disabled, and the ABS warning lamp is ON.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This step begins an examination for a defective wheel speed sensor.
6. This step tests the wiring for a short to voltage.
8. This step tests the wiring for a short to ground.
10. This step tests for an open or a high resistance in the wiring.

Diagnostic Aids

Be sure that the speed sensor wiring is properly routed and retained. This will help to prevent false signals due to the pickup of electrical noise.

It is very important to perform a thorough inspection of the wiring and the connectors. Failure to inspect the wiring and the connectors carefully and completely may result in misdiagnosis, causing part replacement with the reappearance of the malfunction.

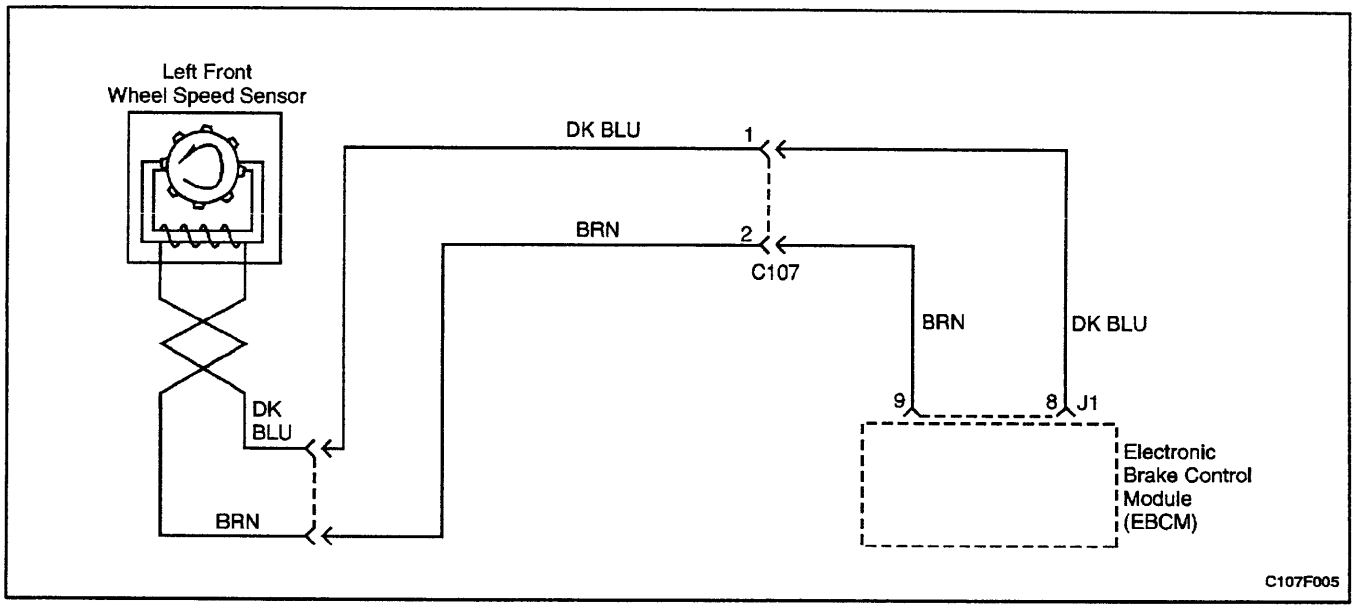
You can use the scan tool to monitor wheel speeds during a road test. Watch the wheel speeds being displayed on the scan tool to see if any of the readings is unusual, such as one sensor varying in speed from the other three, a signal going intermittently high or low, etc. If this does not identify the intermittent, wet the speed sensor harness on the underside of the vehicle and perform a road test, monitoring wheel speeds with the scan tool.

DTC 35 - Left Rear Wheel Speed Sensor Fault

Step	Action	Value(s)	Yes	No
1	Examine the wheel speed sensor. Are there any signs of physical damage?	-	Go to *Step 3*	Go to *Step 2*

DTC 35 - Left Rear Wheel Speed Sensor Fault (Cont'd)

Step	Action	Value(s)	Yes	No
2	1. Turn the ignition switch to LOCK. 2. Disconnect the left rear wheel speed sensor connector. 3. Use a digital voltmeter (DVM) to measure resistance between the sensor terminals. Is the resistance within the specified value at approximately 25°C (77°F)?	1280-1920 Ω	Go to *Step 4*	Go to *Step 3*
3	Replace the wheel speed sensor. Is the repair complete?	-	System OK	-
4	1. Switch the DVM to the ac millivolt range. 2. Measure the voltage output of between the wheel speed sensor terminals while rotating the wheel about 1 revolution every 2 seconds. Is the output within the specified value?	≈ 120 mv	Go to *Step 6*	Go to *Step 5*
5	Replace the speed sensor or the toothed wheel as required. Is the repair complete?	-	System OK	-
6	1. Disconnect the harness from the EBCM. 2. Connect a DVM between ground and one terminal of the wheel speed connector. 3. Turn the ignition to ON. 4. Repeat the above test for the other terminal of the wheel speed connector. Is the voltage for either of these terminals within the specified value?	> 1 v	Go to *Step 7*	Go to *Step 8*
7	Repair the short to voltage in the affected circuit. Is the repair complete?	-	System OK	-
8	1. Turn the ignition switch to LOCK. 2. Measure the resistance to ground from terminal 8 at the harness EBCM connector. 3. Measure the resistance to ground from terminal 9 at the harness EBCM connector. Is the resistance at either circuit less than the specified value?	∞	Go to *Step 9*	Go to *Step 10*
9	Repair the short to ground in the affected circuit. Is the repair complete?	-	System OK	-
10	1. Measure the resistance between terminal 8 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the DK BLU wire. 2. Measure the resistance between terminal 9 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the BRN wire. Is the resistance on either circuit within the specified value?	> 5 Ω	Go to *Step 11*	Go to *Step 12*
11	Repair the open or the high resistance in the affected circuit as required. Be sure to check terminals 1 and 2 of connector C107. Is the repair complete?	-	System OK	-
12	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 37
LEFT REAR WHEEL SPEED SENSOR CONTINUITY FAULT

Circuit Description

The toothed wheel generates a voltage pulse as it moves past the sensor. Each tooth-gap-tooth series on the wheel generates the pulses. The electronic brake control module (EBCM) uses the frequency of these pulses to determine the wheel speed. The voltage generated depends on the air gap between the sensor and the toothed wheel, and on the wheel speed.

Diagnosis

This procedure checks for a malfunctioning wheel speed sensor, a short to ground or to voltage in the wiring, or a contact problem in a connector.

Cause(s)

- The wheel speed sensor is defective.
- There is a problem in the wiring.
- There is a problem with a connector.

Fail Action

ABS action is disabled, and the ABS warning lamp is ON.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This step begins an examination for a defective wheel speed sensor.
4. This step tests the wiring for a short to voltage.
6. This step tests the wiring for a short to ground.
8. This step tests for an open or high resistance in the wiring.

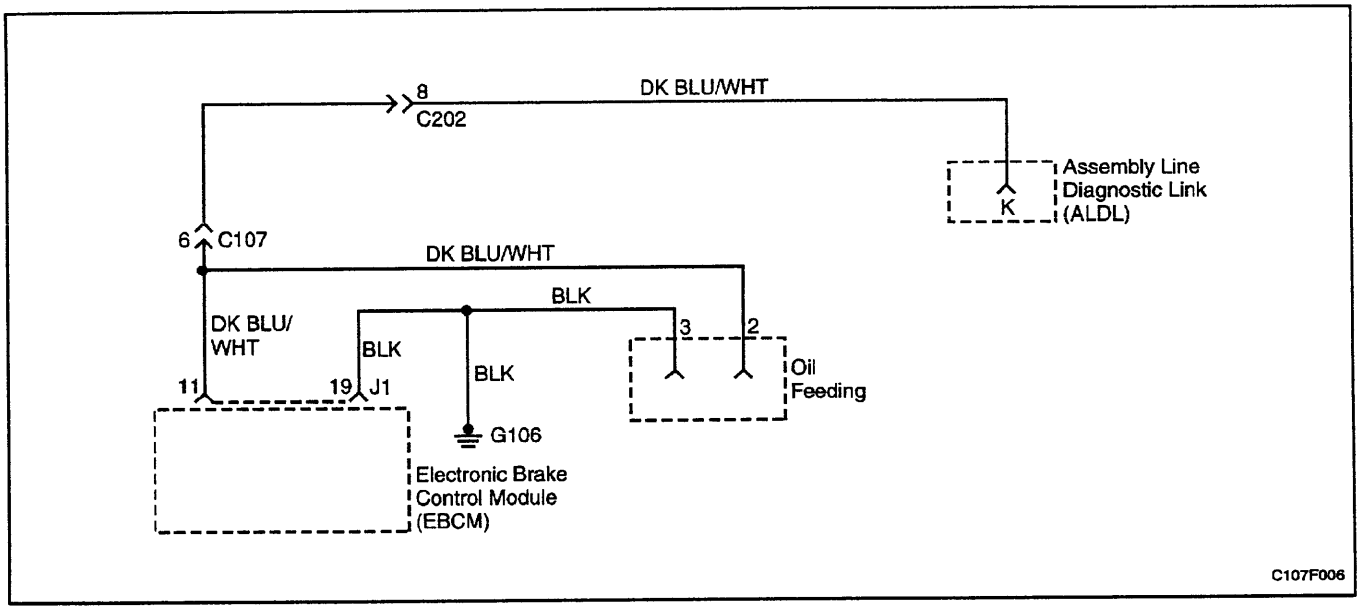
Diagnostic Aids

Be sure that the speed sensor wiring is properly routed and retained. This will help to prevent false signals due to the pickup of electrical noise.

It is very important to perform a thorough inspection of the wiring and the connectors. Failure to inspect the wiring and the connectors carefully and completely may result in misdiagnosis, causing part replacement with the reappearance of the malfunction.

DTC 37 - Left Rear Wheel Speed Sensor Continuity Fault

Step	Action	Value(s)	Yes	No
1	Examine the wheel speed sensor. Are there any signs of physical damage?	-	Go to *Step 3*	Go to *Step 2*
2	1. Turn the ignition switch to LOCK. 2. Disconnect the left rear wheel speed sensor connector. 3. Use a digital voltmeter (DVM) to measure resistance between the sensor terminals. Is the resistance within the specified value at approximately 25°C (77°F)?	1280-1920 Ω	Go to *Step 4*	Go to *Step 3*
3	Replace the wheel speed sensor. Is the repair complete?	-	System OK	-
4	1. Disconnect the harness from the EBCM. 2. Connect a DVM between ground and one terminal of the wheel speed connector. 3. Turn the ignition to ON. 4. Repeat the above test for the other terminal of the wheel speed connector. Is the voltage for either of these terminals within the specified value?	> 1 v	Go to *Step 5*	Go to *Step 6*
5	Repair the short to voltage in the affected circuit. Is the repair complete?	-	System OK	-
6	1. Turn the ignition switch to LOCK. 2. Measure the resistance to ground from terminal 8 at the harness EBCM connector. 3. Measure the resistance to ground from terminal 9 at the harness EBCM connector. Is the resistance at either circuit less than the specified value?	∞	Go to *Step 7*	Go to *Step 8*
7	Repair the short to ground in the affected circuit. Is the repair complete?	-	System OK	-
8	1. Measure the resistance between terminal 8 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the DK BLU wire. 2. Measure the resistance between terminal 9 at the harness EBCM connector and the harness wheel speed sensor connector terminal connected to the BRN wire. Is the resistance on either circuit within the specified value?	> 5 Ω	Go to *Step 9*	Go to *Step 10*
9	Repair the open or high resistance in the affected circuit as required. Be sure to check terminals 1 and 2 of connector C107. Is the repair complete?	-	System OK	-
10	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 41/42
RIGHT FRONT INLET AND OUTLET VALVE SOLENOID FAULT

Circuit Description

The solenoid valve coil circuits are supplied with power from the battery when the valve relay is energized. Switched ground is provided by the electronic brake control module (EBCM) to each coil.

Diagnosis

This procedure checks whether the right front inlet and outlet valves are functioning.

Cause(s)

- A solenoid coil is open or shorted.

Fail Action

ABS is disabled, and the ABS warning lamp is turned ON for the remainder of the ignition cycle. If the failure is intermittent, the EBCM will enable the system at the next ignition cycle and set a history DTC.

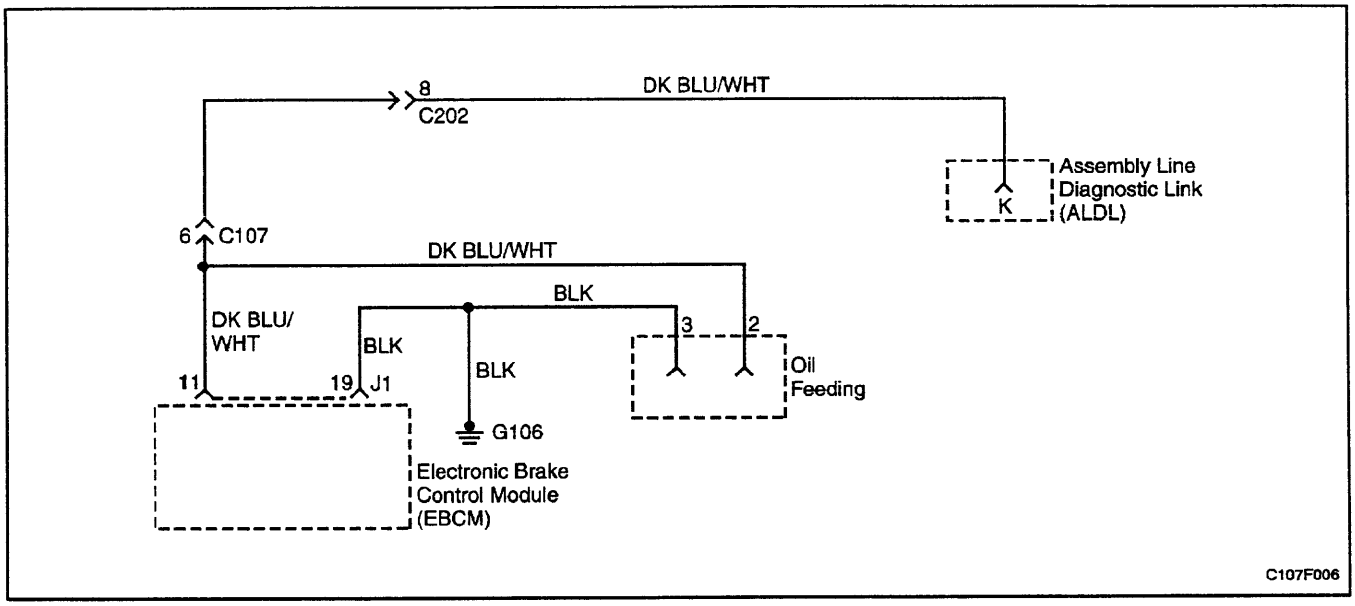
Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This begins the test of the inlet valve.
3. This tests the outlet valve.

DTC 41/42 - Right Front Inlet and Outlet Valve Solenoid Fault

Step	Action	Value(s)	Yes	No
1	1. Raise and suitably support the vehicle at the corner being tested. 2. Turn the ignition switch to ON. 3. Install the scan tool to the assembly line diagnostic link (ALDL) and select "Wheel front right" to begin the solenoid tests at that wheel. This will test both the inlet and the outlet valves. 4. When the scan tool indicates "Pressure hold," depress and hold the brake pedal until the end of the test. 5. Have an assistant attempt to rotate the wheel. Can the wheel be rotated?	-	Go to *Step 2*	Go to *Step 6*
2	1. Maintain pressure on the brake pedal. 2. When the scan tool indicates "Pressure increase," have an assistant attempt to rotate the wheel again. Can the wheel be rotated now?	-	Go to *Step 6*	Go to *Step 3*
3	1. Maintain pressure on the brake pedal. 2. When the scan tool indicates "Pressure release on," have an assistant attempt to rotate the wheel again. Can the wheel be rotated?	-	Go to *Step 4*	Go to *Step 6*
4	1. Release brake pedal pressure when the scan tool indicates "Pressure release off." 2. Clear all DTCs. 3. Road test the vehicle. Does the DTC set again?	-	Go to *Step 6*	Go to *Step 5*
5	1. Check the wiring harness and the connector terminals for an intermittent problem. 2. Repair any problem found. Is the repair complete?	-	System OK	-
6	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 43/44 RIGHT FRONT PRIME LINE AND TRACTION CONTROL SYSTEM (TCS) PILOT VALVE FAULT

Circuit Description

The solenoid valve coil circuits are supplied with power from the battery when the valve relay is energized. Switched ground is provided by the electronic brake control module (EBCM) to each coil.

Diagnosis

This procedure checks whether the right front TCS valves are functioning.

Cause(s)

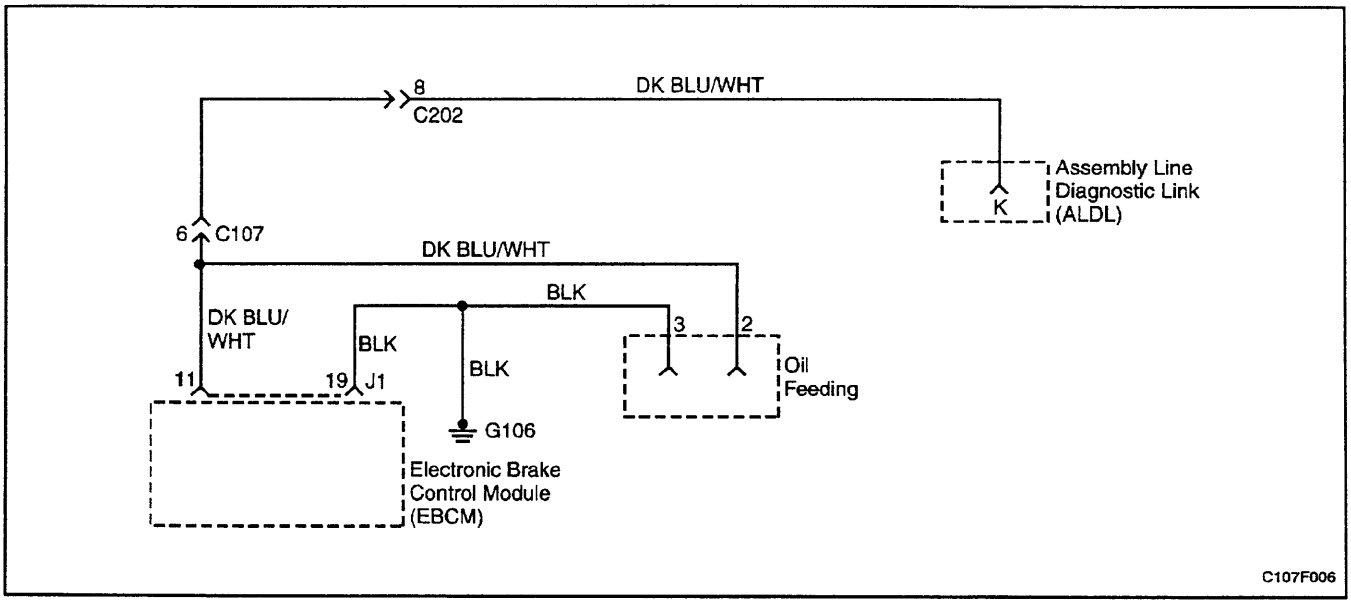
- A solenoid coil is open or shorted.

Fail Action

Antilock brake system (ABS) is disabled, and the ABS warning lamp is turned ON for the remainder of the ignition cycle. If the failure is intermittent, the EBCM will enable the system at the next ignition cycle and set a history DTC.

DTC 43/ 44 - Right Front Prime Line and TCS Pilot Valve Fault

Step	Action	Value(s)	Yes	No
1	1. Raise and suitably support the vehicle at the corner being tested. 2. Turn the ignition switch to ON. **Important:** Do not step on the brake pedal at any time during this test. 3. Install the scan tool to the assembly line diagnostic link (ALDL). 4. Select the ABD function and "Wheel front right" to begin the solenoid tests at that wheel. This will test both the prime and pilot valves. 5. When the scan tool indicates a pressure increase, attempt to rotate the wheel. Can the wheel be rotated?	-	Go to *Step 6*	Go to *Step 2*
2	When the scan tool indicates, that the prime valve was switched OFF, attempt to rotate the wheel again. Can the wheel be rotated now?	-	Go to *Step 6*	Go to *Step 3*
3	When the scan tool indicates that the pilot valve and the pump motor were switched OFF, attempt to rotate the wheel again. Can the wheel be rotated?	-	Go to *Step 4*	Go to *Step 6*



DIAGNOSTIC TROUBLE CODE (DTC) 45/46
LEFT FRONT INLET AND OUTLET VALVE SOLENOID FAULT

Circuit Description

The solenoid valve coil circuits are supplied with power from the battery when the valve relay is energized. Switched ground is provided by the electronic brake control module (EBCM) to each coil.

Diagnosis

This procedure checks whether the left front inlet and outlet valves are functioning.

Cause(s)

- A valve has failed.
- A solenoid coil is open or shorted.

Fail Action

ABS is disabled, and the ABS warning lamp is turned ON for the remainder of the ignition cycle. If the failure is intermittent, the EBCM will enable the system at the next ignition cycle and set a history DTC.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

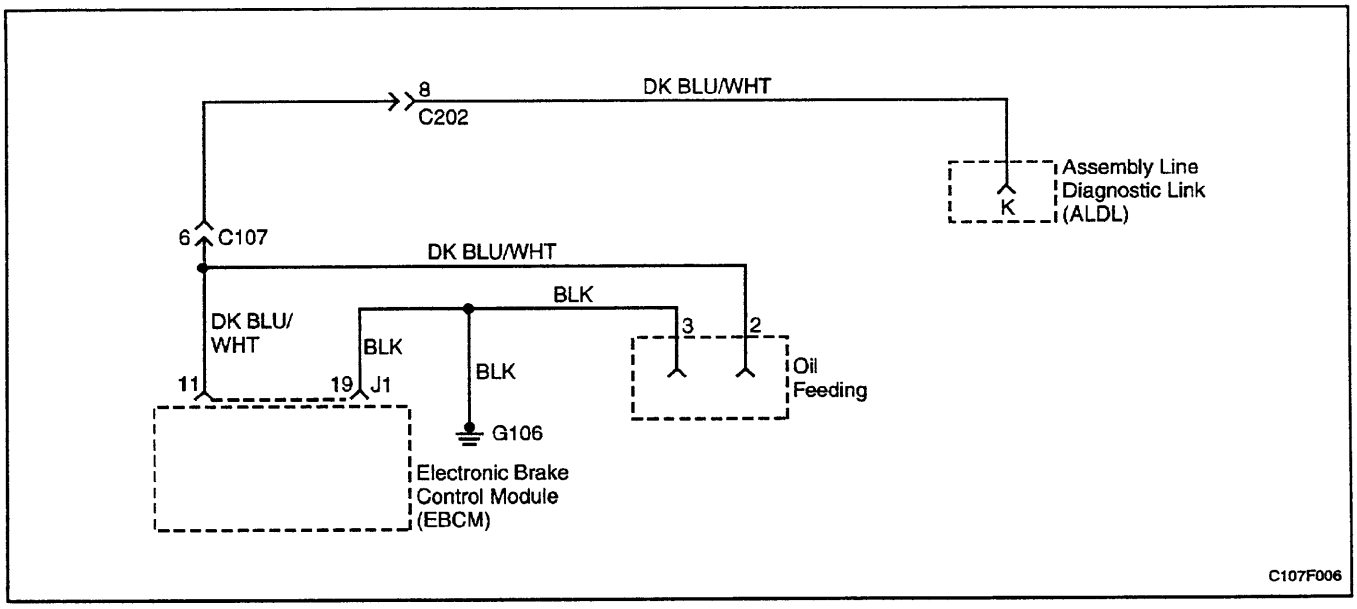
1. This step begins the test of the inlet valve.
3. This step tests the outlet valve.

DTC 43/ 44 - Right Front Prime Line and TCS Pilot Valve Fault (Cont'd)

Step	Action	Value(s)	Yes	No
4	1. Clear all the DTCs. 2. Road test the vehicle. Does the DTC set again?	-	Go to *Step 6*	Go to *Step 5*
5	1. Check the wiring harness and connector terminals for an intermittent problem. 2. Repair any problem found. Is the repair complete?	-	System OK	-
6	Replace the ABS unit. Is the repair complete?	-	System OK	-

DTC 45/46- Left Front Inlet and Outlet Valve Solenoid Fault

Step	Action	Value(s)	Yes	No
1	1. Raise and suitably support the vehicle at the corner being tested. 2. Turn the ignition switch to ON. 3. Install the scan tool to the assembly line diagnostic link (ALDL) and select "Wheel front left" to begin the solenoid tests at that wheel. This will test both the inlet and the outlet valves. 4. When the scan tool indicates "Pressure hold," depress and hold the brake pedal until the end of the test. 5. Have an assistant attempt to rotate the wheel. Can the wheel be rotated?	-	Go to *Step 2*	Go to *Step 6*
2	1. Maintain pressure on the brake pedal. 2. When the scan tool indicates "Pressure increase," have an assistant attempt to rotate the wheel again. Can the wheel be rotated now?	-	Go to *Step 6*	Go to *Step 3*
3	1. Maintain pressure on the brake pedal. 2. When the scan tool indicates "Pressure release on," have an assistant attempt to rotate the wheel again. Can the wheel be rotated?	-	Go to *Step 4*	Go to *Step 6*
4	1. Release brake pedal pressure when the scan tool indicates "Pressure release off." 2. Clear all DTCs. 3. Road test the vehicle. Does the DTC set again?	-	Go to *Step 6*	Go to *Step 5*
5	1. Check the wiring harness and connector terminals for an intermittent problem. 2. Repair any problem found. Is the repair complete?	-	System OK	-
6	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 47/48 LEFT FRONT PRIME LINE AND TRACTION CONTROL SYSTEM (TCS) PILOT VALVE FAULT

Circuit Description

The solenoid valve coil circuits are supplied with power from the battery when the valve relay is energized. Switched ground is provided by the electronic brake control module (EBCM) to each coil.

Diagnosis

This procedure checks whether the left front TCS valves are functioning.

Cause(s)

- A solenoid coil is open or shorted.

Fail Action

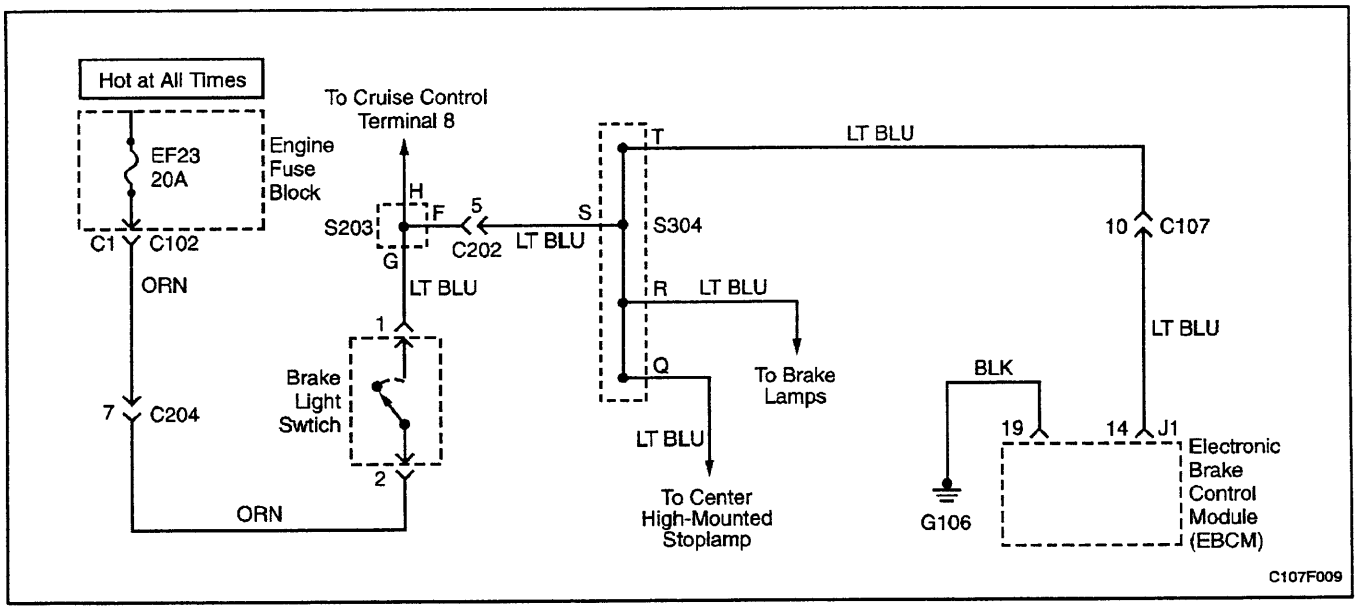
Antilock brake system (ABS) is disabled, and the ABS warning lamp is turned ON for the remainder of the ignition cycle. If the failure is intermittent, the EBCM will enable the system at the next ignition cycle and set a history DTC.

DTC 47/48 - Left Front Prime Line and TCS Pilot Valve Fault

Step	Action	Value(s)	Yes	No
1	1. Raise and suitably support the vehicle at the corner being tested. 2. Turn the ignition switch to ON. **Important:** Do not step on the brake pedal at any time during this test. 3. Install the scan tool to the assembly line diagnostic link (ALDL). 4. Select the TCS function and wheel front left to begin the solenoid tests at that wheel. This will test both the prime and pilot valves. 5. When the scan tool indicates a pressure increase, attempt to rotate the wheel. Can the wheel be rotated?	-	Go to *Step 6*	Go to *Step 2*
2	When the scan tool indicates that the prime valve was switched OFF, attempt to rotate the wheel again. Can the wheel be rotated now?	-	Go to *Step 6*	Go to *Step 3*
3	When the scan tool indicates that the pilot valve and the pump motor were switched OFF, attempt to rotate the wheel again. Can the wheel be rotated?	-	Go to *Step 4*	Go to *Step 6*

DTC 47/48 - Left Front Prime Line and TCS Pilot Valve Fault (Cont'd)

Step	Action	Value(s)	Yes	No
4	1. Clear all the DTCs. 2. Road test the vehicle. Does the DTC set again?	-	Go to *Step 6*	Go to *Step 5*
5	1. Check the wiring harness and connector terminals for an intermittent problem. 2. Repair any problem found. Is the repair complete?	-	System OK	-
6	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 50
BRAKE LIGHT SWITCH (BLS) FAULT

Circuit Description

When the brake pedal is depressed, the contacts on the brake light switch close to illuminate the brake lights. Battery voltage is also applied to terminal 14 of the electronic brake control module (EBCM), which signals the ABS controller that the brakes are applied and ABS may be needed. Without this, signals from a wheel speed sensor that may indicate need for ABS intervention are questionable. When the brake pedal is not depressed, the EBCM terminal 14 is grounded through the brake lights.

Diagnosis

This procedure will check whether there is no output or constant output from the brake light switch and will determine the cause as a faulty switch or a problem in the circuitry.

Cause(s)

- The ground connection or the positive connection at the EBCM has failed.
- There is an open, short to ground, or short to positive in the vehicle wiring.
- The brake light switch has failed.

Fail Action

The system records a DTC 50. ABS operation is not disabled.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This simple test will isolate the problem to the fuse-brake light switch-splice 304 area or the splice 304-EBCM area.
3. This is the first step in identifying an open, a short to ground, a short to voltage, or a faulty brake light switch.
11. This step begins the process of finding an open, a defective connector, or a faulty EBCM.

Diagnostic Aids

Inspect wiring and connectors carefully and thoroughly. Failure to do so could result in misdiagnosis, causing part replacement with reappearance of the malfunction.

DTC 50 - Brake Light Switch (BLS) Fault

Step	Action	Value(s)	Yes	No
1	Step on the brake pedal. Do the brake lights come on at all?	-	Go to *Step 2*	Go to *Step 3*
2	Remove your foot from the brake pedal. Do the lights stay on continuously?	-	Go to *Step 8*	Go to *Step 11*

DTC 50 - Brake Light Switch (BLS) Fault (Cont'd)

Step	Action	Value(s)	Yes	No
3	Check fuse EF23 in the engine compartment fuse block. Is fuse EF23 blown?	-	Go to *Step 4*	Go to *Step 6*
4	1. Replace fuse EF23. 2. Check the new fuse. Does the new fuse blow?	-	Go to *Step 5*	Go to *Step 7*
5	1. Repair the short to ground in the brake light circuitry. 2. Install a new fuse EF23. Is the repair complete?	-	System OK	-
6	Repair the open in the brake light switch circuit ORN from terminal C1 of connector C102 at the engine fuse block to the brake light switch, circuit LT BLU from the brake light switch through splice S203 and terminal 5 of connector C202 to splice S304, or a defective brake light switch. Is the repair complete?	-	System OK	-
7	Check for functioning of the brake lights and the ABS system. Is the repair complete?	-	System OK	-
8	Check the brake light switch on the brake pedal. Is the switch faulty?	-	Go to *Step 9*	Go to *Step 10*
9	Repair the brake light switch. Is the repair complete?	-	System OK	-
10	Repair the short to positive in the circuit LT BLU between the brake light switch, splice S304, the brake lights, the center high-mounted stoplamp, and the ABS wiring harness connector at the EBCM terminal 14. Is the repair complete?	-	System OK	-
11	1. Disconnect the EBCM connector. 2. Use a digital voltmeter (DVM) to measure voltage between pins 14 and 19 of the ABS harness connector at the EBCM. 3. Have an assistant step on the brake pedal. Does the DVM indicate the specified value?	11-14 v	Go to *Step 13*	Go to *Step 12*
12	1. Examine the connection between the ABS harness connector and the EBCM connector terminals 14 and 19. 2. Examine the connection at terminal 10 of connector C107. 3. Examine the wiring of circuit LT BLU between splice S304 and terminal 14 of the ABS EBCM connector for an open condition. 4. Examine the wiring between ground G106 and terminal 19 of the ABS EBCM connector. 5. Repair the broken wire or the defective connector terminal, or replace the connector, the wiring harness, as required. Is the repair complete?	-	System OK	-

DTC 50 - Brake Light Switch (BLS) Fault (Cont'd)

Step	Action	Value(s)	Yes	No
13	Check the interface between the ABS EBCM connector and the EBCM. Is there a poor connection at terminal 14 or 19?	-	Go to *Step 14*	Go to *Step 15*
14	Repair the connector or replace the wiring harness or the ABS unit as required. Is the repair complete?	-	System OK	-
15	Replace the ABS unit. Is the repair complete?	-	System OK	-

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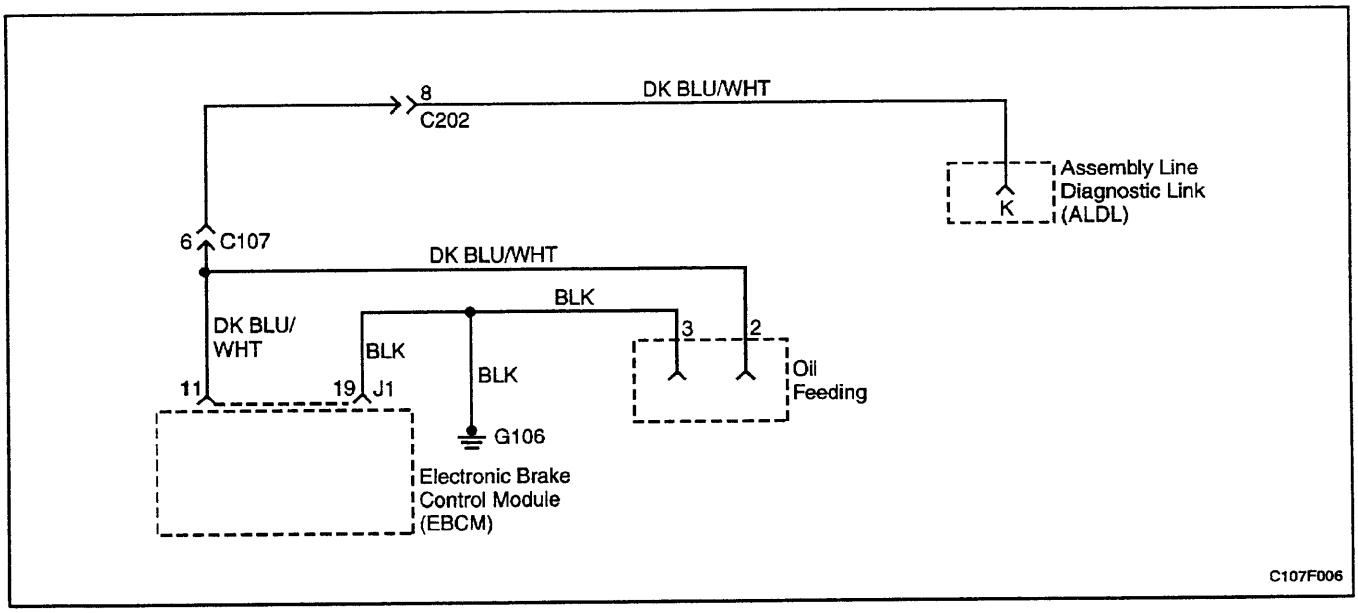


DIAGNOSTIC TROUBLE CODE (DTC) 51/52
RIGHT REAR INLET AND OUTLET VALVE SOLENOID FAULT

Circuit Description

The solenoid valve coil circuits are supplied with power from the battery when the valve relay is energized. Switched ground is provided by the electronic brake control module (EBCM) to each coil.

Diagnosis

This procedure checks whether the right rear inlet and outlet valves are functioning.

Cause(s)

- A valve has failed.
- A solenoid coil is open or shorted.

Fail Action

ABS is disabled, and the ABS warning lamp is turned ON for the remainder of the ignition cycle. If the failure is intermittent, the EBCM will enable the system at the next ignition cycle and set a history DTC.

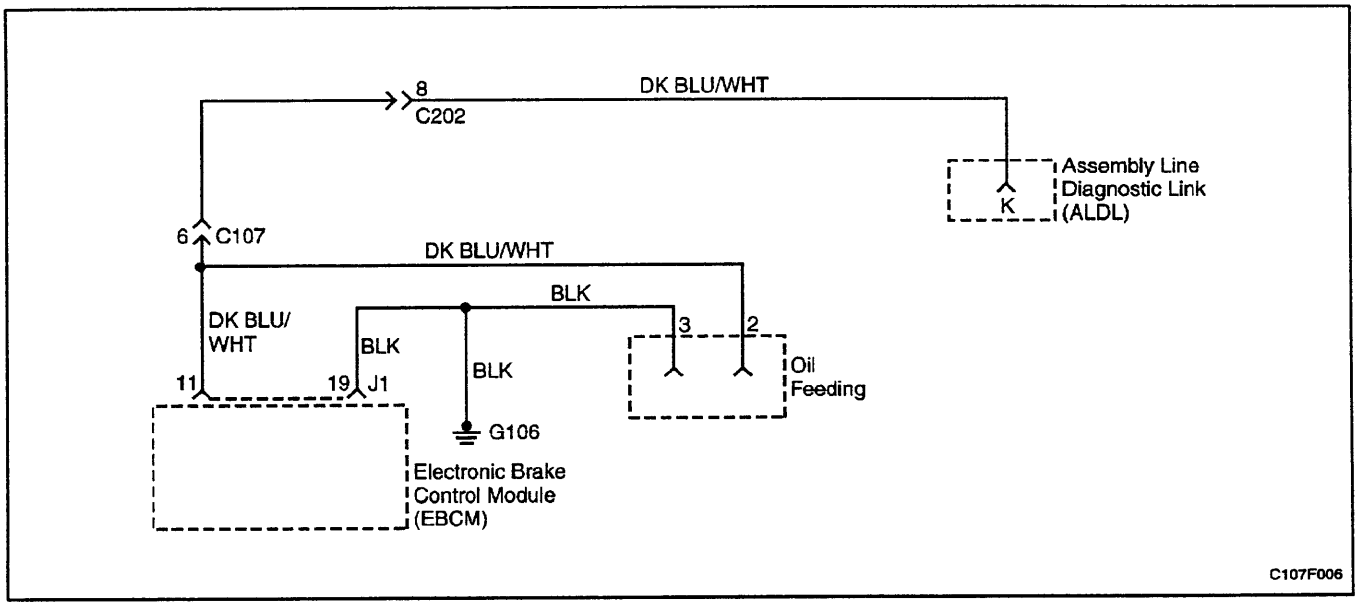
Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This begins the test of the inlet valve.
3. This tests the outlet valve.

DTC 51/52 - Right Rear Inlet and Outlet Valve Solenoid Fault

Step	Action	Value(s)	Yes	No
1	1. Raise and suitably support the vehicle at the corner being tested. 2. Turn the ignition switch to ON. 3. Install the scan tool to the assembly line diagnostic link (ALDL) and select "Wheel rear right" to begin the solenoid tests at that wheel. This will test both the inlet and the outlet valves. 4. When the scan tool indicates "Pressure hold," depress and hold the brake pedal until the end of the test. 5. Have an assistant attempt to rotate the wheel. Can the wheel be rotated?	-	Go to *Step 2*	Go to *Step 6*
2	1. Maintain pressure on the brake pedal. 2. When the scan tool indicates "Pressure increase," have an assistant attempt to rotate the wheel again. Can the wheel be rotated now?	-	Go to *Step 6*	Go to *Step 3*
3	1. Maintain pressure on the brake pedal. 2. When the scan tool indicates "Pressure release on," have an assistant attempt to rotate the wheel again. Can the wheel be rotated?	-	Go to *Step 4*	Go to *Step 6*
4	1. Release brake pedal pressure when the scan tool indicates "Pressure release off." 2. Clear all DTCs. 3. Road test the vehicle. Does the DTC set again?	-	Go to *Step 6*	Go to *Step 5*
5	1. Check the wiring harness and the connector terminals for an intermittent problem. 2. Repair any problem found. Is the repair complete?	-	System OK	-
6	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 55/56
LEFT REAR INLET AND OUTLET VALVE SOLENOID FAULT

Circuit Description

The solenoid valve coil circuits are supplied with power from the battery when the valve relay is energized. Switched ground is provided by the electronic brake control module (EBCM) to each coil.

Diagnosis

This procedure checks whether the left rear inlet and outlet valves are functioning.

Cause(s)

- A valve has failed.
- A solenoid coil is open or shorted.

Fail Action

ABS is disabled, and the ABS warning lamp is turned ON for the remainder of the ignition cycle. If the failure is intermittent, the EBCM will enable the system at the next ignition cycle and set a history DTC.

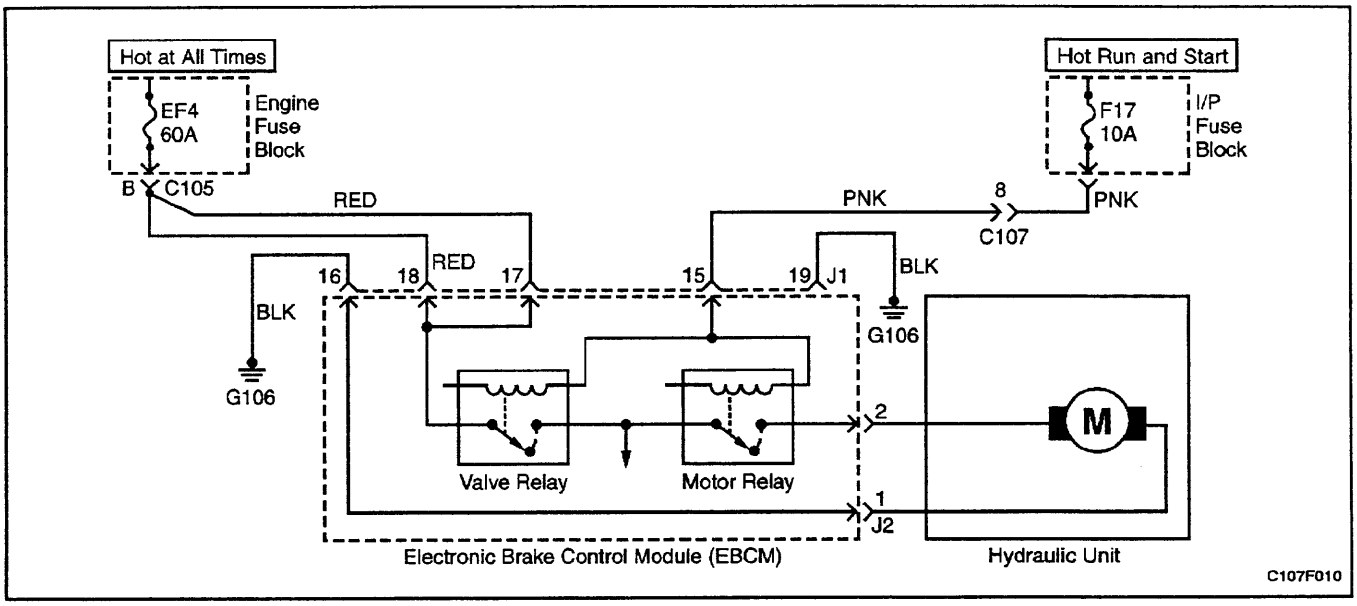
Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This begins the test of the inlet valve.
3. This tests the outlet valve.

DTC 55/56 - Left Rear Inlet and Outlet Valve Solenoid Fault

Step	Action	Value(s)	Yes	No
1	1. Raise and suitably support the vehicle at the corner being tested. 2. Turn the ignition switch to ON. 3. Install the scan tool to the assembly line diagnostic link (ALDL) and select "Wheel rear left" to begin the solenoid tests at that wheel. This will test both the inlet and the outlet valves. 4. When the scan tool indicates "Pressure hold," depress and hold the brake pedal until the end of the test. 5. Have an assistant attempt to rotate the wheel. Can the wheel be rotated?	-	Go to *Step 2*	Go to *Step 6*
2	1. Maintain pressure on the brake pedal. 2. When the scan tool indicates "Pressure increase," have an assistant attempt to rotate the wheel again. Can the wheel be rotated now?	-	Go to *Step 6*	Go to *Step 3*
3	1. Maintain pressure on the brake pedal. 2. When the scan tool indicates "Pressure release on," have an assistant attempt to rotate the wheel again. Can the wheel be rotated?	-	Go to *Step 4*	Go to *Step 6*
4	1. Release brake pedal pressure when the scan tool indicates "Pressure release off." 2. Clear all DTCs. 3. Road test the vehicle. Does the DTC set again?	-	Go to *Step 6*	Go to *Step 5*
5	1. Check the wiring harness and the connector terminals for an intermittent problem. 2. Repair any problem found. Is the repair complete?	-	System OK	-
6	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 61
PUMP MOTOR OR PUMP MOTOR RELAY FAULT

Circuit Description

When the electronic brake control module (EBCM) grounds the pump motor relay, it closes and provides battery voltage to the pump motor if the valve relay is closed. The EBCM senses the voltage applied to the pump motor to verify motor operation.

Diagnosis

This DTC sets when the EBCM detects B+ without motor relay activation or if the EBCM does not detect B+ after motor relay activation.

Cause(s)

- There is a faulty terminal in pump motor connector J2.
- There is a faulty terminal in EBCM connector J1.
- There is a problem in the ABS wiring harness.
- There is high resistance in the chassis ground.
- The EBCM is defective.
- There is a problem in the wiring from pump motor connector J2 to the motor.

Fail Action

ABS is disabled, and the ABS warning lamp is ON.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

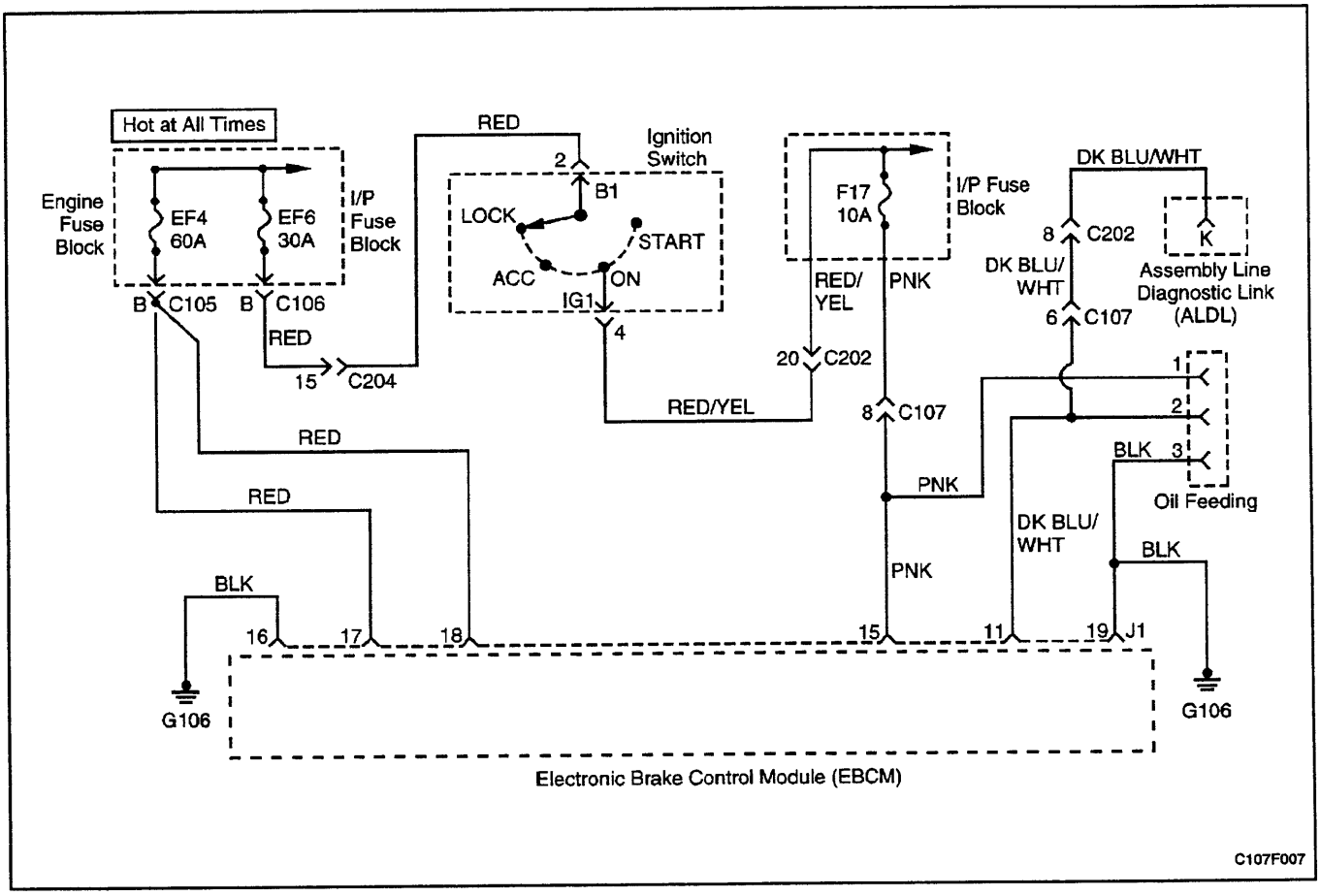
1. This step checks for connector damage.
3. This step checks for a poor ground connection.
7. This step checks for a possible problem with the motor connector at the ABS unit.

Diagnostic Aids

It is very important to perform a thorough inspection of the wiring and the connectors. Failure to do so may result in misdiagnosis, causing part replacement with reappearance of the malfunction.

DTC 61 - Pump Motor or Pump Motor Relay Fault

Step	Action	Value(s)	Yes	No
1	1. Disconnect connector J1 from the EBCM. 2. Examine terminal 16 on the harness connector and on the EBCM connector. Is the terminal damaged or corroded?	-	Go to *Step 2*	Go to *Step 3*
2	Repair or replace the terminal, the connector, the wiring harness, or the EBCM as required. Is the repair complete?	-	System OK	-
3	Measure the resistance from terminal 16 of the harness connector J1 to a good chassis ground. Is the resistance equal to the specified value?	≈0 Ω	Go to *Step 7*	Go to *Step 4*
4	Measure the resistance at the chassis ground connection G106. Is the resistance equal to the specified value?	≈0 Ω	Go to *Step 6*	Go to *Step 5*
5	Repair the connection at chassis ground G106. Is the repair complete?	-	System OK	-
6	Repair the open or the high resistance in the harness between terminal 16 of connector J1 and the ground lug, or replace the ABS wiring harness. Is the repair complete?	-	System OK	-
7	1. Remove the ABS unit from the vehicle. 2. Disconnect connector J2 and examine the terminals. Is there any sign of damage or corrosion that would prevent a good ground contact?	-	Go to *Step 8*	Go to *Step 9*
8	Repair or replace the defective terminal, connector, or ABS unit as required. Is the repair complete?	-	System OK	-
9	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 63
VALVE RELAY CIRCUIT FAULT

Circuit Description

When the ABS is active, the valve relay provides voltage to actuate the solenoid valves. The valves do not use this voltage unless the ABS control module provides the ground for each solenoid coil.

DTC 63 will set if the valve relay voltage is low or if the relay supply line is at 12 volts when the ABS control module is not requesting it. This DTC will also set if the ABS control module detects three or more solenoid valve circuits are open or shorted during the self-test.

Diagnosis

This procedure checks whether there is a poor ground connection for the electronic brake control module (EBCM).

Cause(s)

- A connector terminal is corroded.
- The wiring harness is damaged.
- The ground terminal is not conducting properly.
- The EBCM is defective.

Fail Action

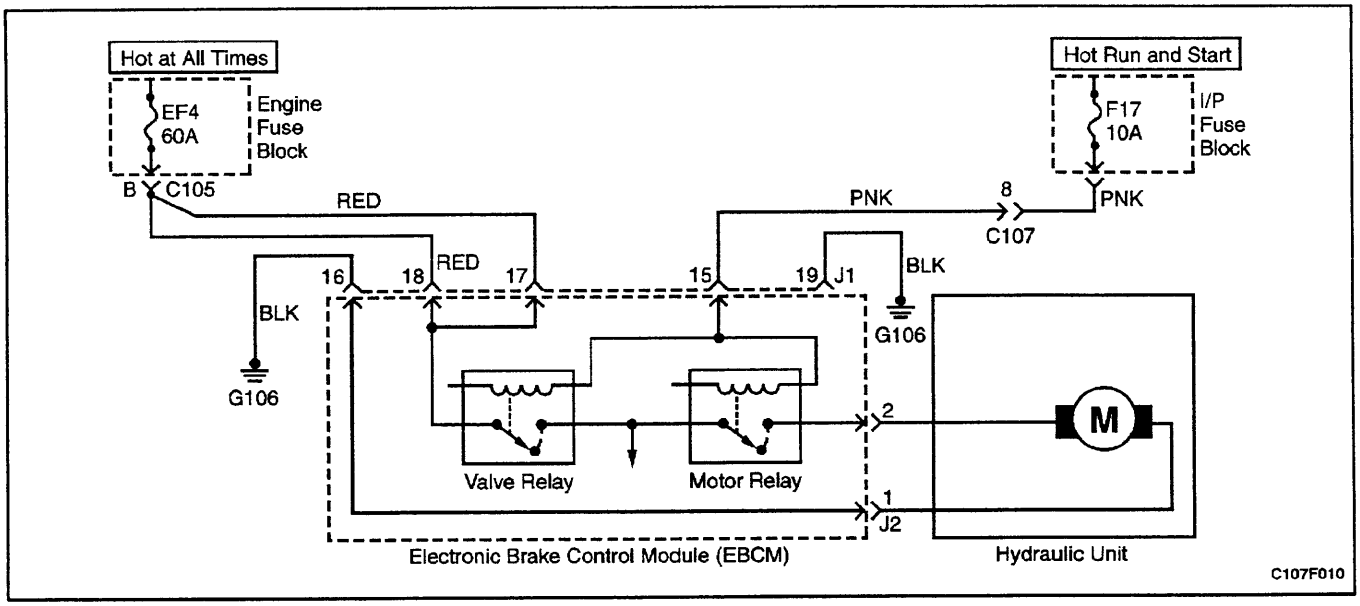
ABS/TCS is disabled, and the ABS warning lamp is turned ON for the remainder of the ignition cycle. If the failure is intermittent, the control module will enable the system at the next ignition cycle and set a history DTC 63.

Diagnostic Aids

It is very important to perform a thorough inspection of the wiring and the connectors. Failure to do so may result in misdiagnosis, causing part replacement with reappearance of the malfunction.

DTC 63 - Valve Relay Circuit Fault

Step	Action	Value(s)	Yes	No
1	1. Use a scan tool to clear all DTCs. 2. Road test the vehicle. Does DTC 63 set again?	-	Go to *Step 3*	Go to *Step 2*
2	1. Check all system wiring harness connectors and terminals, especially the EBCM, for any problem that could cause an intermittent condition. 2. Repair any intermittent problem found. Is the repair complete?	-	System OK	-
3	1. Disconnect ABS harness connector J1 from the EBCM. 2. Examine terminal 19 on the harness connector and the EBCM connector. Is there damage or corrosion at terminal 19?	-	Go to *Step 5*	Go to *Step 4*
4	Repair the terminal or the connector, or replace the ABS harness or ABS unit as required. Is the repair complete?	-	System OK	-
5	Measure the resistance from terminal 19 of the harness connector J1 to a good chassis ground. Is the resistance equal to the specified value?	≈0 Ω	Go to *Step 6*	Go to *Step 7*
6	Replace the ABS unit. Is the repair complete?	-	System OK	-
7	Measure the resistance from terminal 19 of the harness connector J1 to the ground lug at G106. Is the resistance equal to the specified value?	≈0 Ω	Go to *Step 8*	Go to *Step 9*
8	Repair the chassis connection at the ground lug. Is the repair complete?	-	System OK	-
9	Repair the open or the high resistance in the ABS harness, or replace the harness as required. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 65 PUMP FAULT LONG TERM (TCS ONLY)

Fail Action

The antilock brake system (ABS) warning lamp is turned ON and the ABS is disabled for the remainder of the ignition cycle. If the failure is intermittent, the EBCM will enable the system at the next ignition cycle and set a history DTC.

Diagnosis

There is no diagnostic procedure for this problem. If DTC-65 is set, replace the ABS unit.

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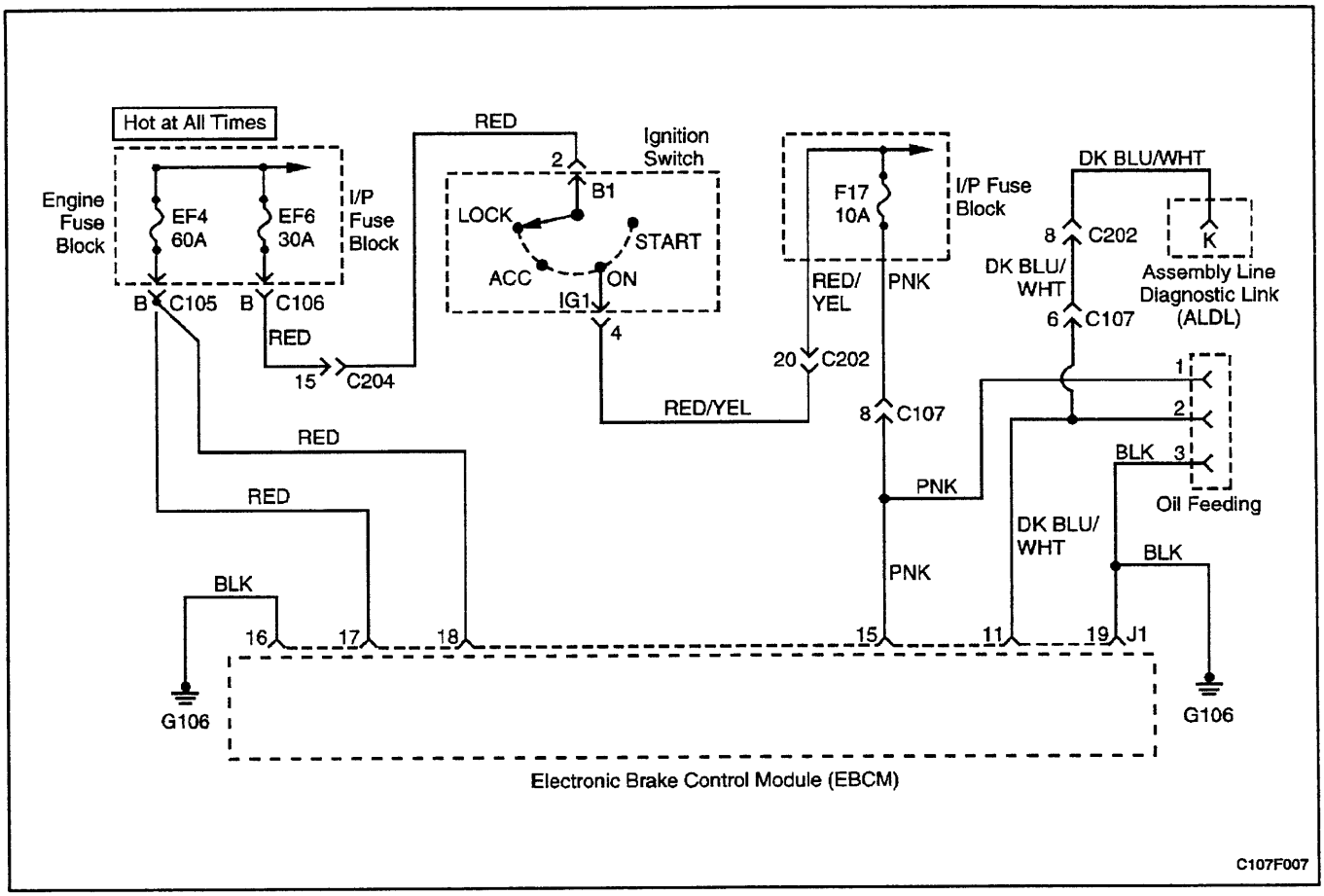


DIAGNOSTIC TROUBLE CODE (DTC) 71
ABS CONTROL MODULE INTERNAL FAULT

Circuit Description

The ABS control module performs various diagnostic checks on itself. If it finds a problem, it sets DTC 71.

Diagnosis

This procedure checks whether there is a poor ground connection for the electronic brake control module (EBCM).

Cause(s)

- A connector terminal is corroded.
- The EBCM is malfunctioning.

Fail Action

ABS is disabled, and the ABS warning lamp is turned ON. If the failure is intermittent, the control module will enable the system at the next ignition cycle and will store a history DTC 71.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

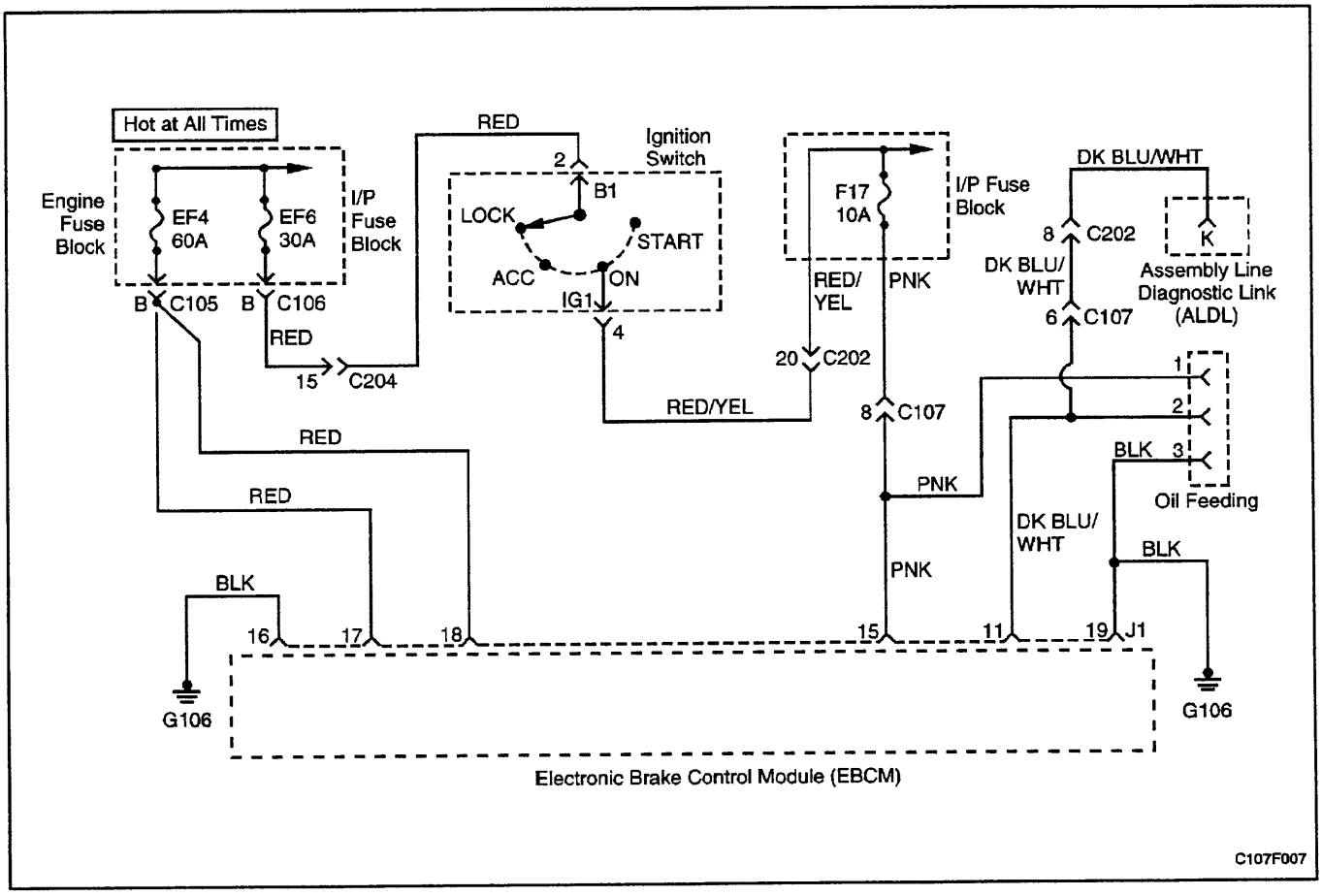
3. This step begins the testing for a poor voltage or ground connection.

Diagnostic Aids

It is very important to perform a thorough inspection of the wiring and the connectors. Failure to inspect the wiring and the connectors carefully and completely may result in misdiagnosis, causing part replacement with the reappearance of the malfunction.

DTC 71 - ABS Control Module Internal Fault

Step	Action	Value(s)	Yes	No
1	Use the scan tool to determine if any other DTCs are set. Are other DTCs set?	-	Go to the tables for the other DTCs	Go to *Step 2*
2	Clear all DTCs and road test the vehicle. Does DTC 71 set again?	-	Go to *Step 4*	Go to *Step 3*
3	1. Check all wiring harness connectors and terminals, especially those at the EBCM, for any condition that could cause an intermittent. 2. Repair any problems found. Is the repair complete?	-	System OK	-
4	1. Turn the ignition switch to OFF. 2. Disconnect EBCM connector J1. 3. Turn the ignition switch to ON. 4. Measure the voltage between ground and terminals 15, 17, and 18 of the EBCM harness connector J1. Is the voltage equal to the specified value?	11-14 v	Go to *Step 6*	Go to *Step 5*
5	1. Check the voltage supply and the ground connections to the EBCM. 2. Repair any open or high resistance found. Is the repair complete?	-	System OK	-
6	Check the EBCM connector J1 for any ineffective terminals. Are there any problems?	-	Go to *Step 7*	Go to *Step 8*
7	Repair any connector problem found. Is the repair complete?	-	System OK	-
8	Clear all DTCs and road test the vehicle. Does DTC 71 set again?	-	Go to *Step 9*	System OK
9	Replace the ABS unit. Is the repair complete?	-	System OK	-



DIAGNOSTIC TROUBLE CODE (DTC) 85
LOW VOLTAGE FAULT

Circuit Description

Proper operation of the electronic brake control module (EBCM) requires a certain minimum voltage. The EBCM monitors the ignition feed circuit to determine if the voltage falls below a minimum level.

Diagnosis

This test checks for battery output, proper grounding, blown fuses, faulty ignition switch, and problems in the circuitry.

Cause(s)

- The battery is defective.
- There is a defective ground connection.
- A connector is damaged.
- A wire is broken or shorted.
- A fuse is blown.
- The ignition switch is malfunctioning.

Fail Action

ABS action is disabled during the period of low voltage, and the ABS warning lamp is ON for the remainder of the ignition cycle. If the failure is intermittent, the EBCM will enable the system at the next ignition cycle and set a history DTC 85.

Test Description

The number(s) below refer to step(s) on the diagnostic table.

1. This step determines whether there is voltage at the battery and at the high current source.
7. This step checks for voltage at the ignition 1 source.
11. This step begins the check for voltage at the EBCM end of the ABS harness.
15. This step checks for a defective ground connection.
16. This is a check for a defective EBCM connector.

Diagnostic Aids

It is very important to perform a thorough inspection of the wiring and the connectors. Failure to do so may result in misdiagnosis, causing part replacement with a reappearance of the malfunction.

DTC 85 - Low Voltage Fault

Step	Action	Value(s)	Yes	No
1	Check the voltage at the battery. Is the voltage within the specified value?	11-14 v	Go to *Step 3*	Go to *Step 2*
2	Charge or replace the battery as required. Is the repair complete?	-	System OK	-
3	Check fuse EF4 in the engine fuse block. Is the fuse blown?	-	Go to *Step 4*	Go to *Step 7*
4	1. Replace fuse EF4. 2. Turn the ignition to ON. Does the fuse blow again?	-	Go to *Step 5*	Go to *Step 6*
5	1. Turn the ignition to OFF. 2. Trace the RED wires in the ABS wiring harness from terminal B of C105 at the engine fuse block to terminals 17 and 18 of the EBCM connector J1. 3. Repair any short circuit found along this path. Is the repair complete?	-	System OK	-
6	1. Turn the ignition switch to OFF. 2. Install the scan tool. 3. Clear all DTCs. 4. Road test the vehicle. Does DTC 85 reset?	-	System OK	-
7	Check fuse F17 in the I/P fuse block. Is the fuse blown?	-	Go to *Step 8*	Go to *Step 11*
8	1. Replace fuse F17. 2. Turn the ignition to ON. Does the fuse blow again?	-	Go to *Step 9*	Go to *Step 10*
9	1. Turn the ignition to OFF. 2. Trace the PNK wire from fuse F17 to terminal 8 of connector C107, and from there to terminal 15 of the EBCM connector J1. 3. Repair any short circuit found along this path. Is the repair complete?	-	System OK	-
10	1. Turn the ignition switch to OFF. 2. Install the scan tool. 3. Clear all DTCs. 4. Road test the vehicle. Does DTC 85 reset?	-	System OK	-
11	1. Disconnect the EBCM connector J1 from the EBCM. 2. Turn the ignition to ON. 3. Check for the presence of battery voltage between ground and terminal 17, and between ground and terminal 18. Is the voltage within the specified value?	11-14 v	Go to *Step 13*	Go to *Step 12*
12	1. Turn the ignition switch to OFF. 2. Trace the orange wires between terminals 17 and 18 of the EBCM connector J1 to terminal B of connector C105 at the engine fuse block. 3. Repair the open in this circuit. Is the repair complete?	-	System OK	-

DTC 85 - Low Voltage Fault (Cont'd)

Step	Action	Value(s)	Yes	No
13	Check the voltage between ground and terminal 15 of the EBCM connector J1. Is the voltage within the specified value?	11-14 v	Go to *Step 17*	Go to *Step 14*
14	1. Turn the ignition switch to OFF. 2. Check fuse EF6 in the engine fuse block. Is the fuse blown?	-	Go to *Step 15*	Go to *Step 16*
15	Replace fuse EF6. Is the repair complete?	-	System OK	-
16	1. Examine circuit PNK between terminal 15 of the EBCM connector J1 to terminal 8 of connector C107, to F17 in the I/P fuse block. 2. Examine the RED/YEL wire from the I/P fuse block to terminal 20 of connector C202, and from there to terminal 4 (IG1) of the ignition switch. 3. Examine the RED wire from terminal 2 (B1) of the ignition switch to terminal 15 of connector C204 to terminal A of connector C106 at the engine fuse block. 4. Repair the open in the wiring or possibly bad connector terminal, or defective ignition switch. Is the repair complete?	-	System OK	-
17	1. Turn the ignition to OFF. 2. Check the resistance between ground and terminals 16 and 19 of the ABS harness EBCM connector. Is the resistance equal to the specified value?	0 Ω	Go to *Step 18*	Go to *Step 20*
18	Examine terminals 15, 16, 17, 18, and 19 of the EBCM connector. Is there a defective terminal?	-	Go to *Step 19*	Go to *Step 21*
19	Repair the defective terminal or replace the connector or wiring harness as required. Is the repair complete?	-	System OK	-
20	Repair the defective ground connection. Is the repair complete?	-	System OK	-
21	1. Install the scan tool. 2. Clear all DTCs. 3. Road test the vehicle. Does DTC 85 set again?	-	Go to *Step 22*	Go to *Step 23*
22	Replace the ABS unit. Is the repair complete?	-	System OK	-
23	1. Examine the wiring harness and connectors for causes of intermittent problems. 2. Repair any intermittent problem found. Is the repair complete?	-	System OK	-

MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

SERVICE PRECAUTIONS

Caution: Brake fluid may irritate eyes and skin. In case of contact, take the following actions:

- ***Eye contact - rinse thoroughly with water.***
- ***Skin contact - wash with soap and water.***
- ***Ingestion - consult a physician immediately.***

Caution: To help avoid personal injury due to poor braking, DO NOT tap into the vehicle's brake system to operate a trailer brake system.

Notice: When fasteners are removed, always reinstall them at the same location from which they were removed. If a fastener needs to be replaced, use the correct part number fastener for that application. If the correct part number fastener is not available, a fastener of equal size and strength (or stronger) may be used. Fasteners that are not reused, and those requiring thread-locking compound will be called out. The correct torque values must be used when installing fasteners that require them. If the above procedures are not followed, parts or system damage could result.

Notice: Use only DOT 3 equivalent hydraulic brake fluid. The use of DOT 5 (silicone) brake fluid is not recommended. Reduced brake performance or durability may result.

Notice: Avoid spilling brake fluid on any of the vehicle's painted surfaces, wiring, cables, or electrical connectors. Brake fluid will damage paint and electrical connections. If any fluid is spilled on the vehicle, flush the area with water to lessen the damage.

Computer System Service Precautions

Take care to avoid electronic brake control module (EBCM) circuit overloading. In testing for opens or shorts, do not ground or apply voltage to any circuit unless instructed to do so by the diagnostic procedure. Test circuits only with a high-impedance multimeter. Never remove or apply power to any control module with the ignition switch in the ON position. Always turn the ignition to the OFF position before removing or connecting battery cables, fuses, or connectors.

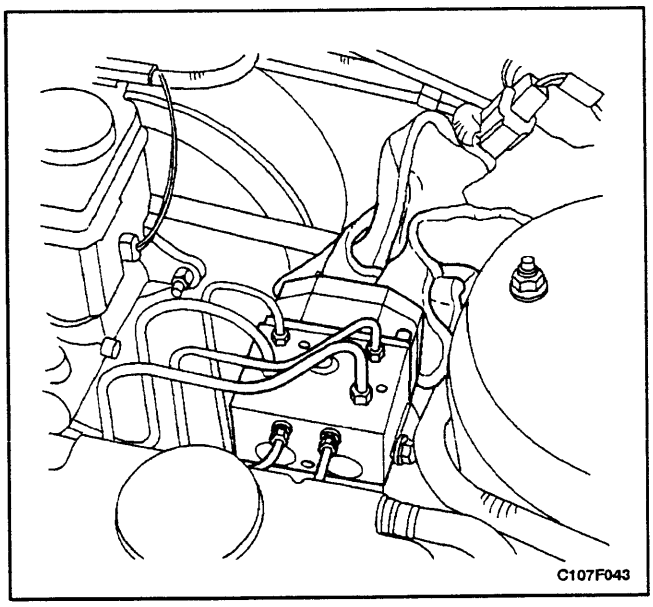
General Service Precautions

- Disconnect the EBCM connector before performing any vehicle welding work using an electric arc welder.
- Do not attempt to disassemble any component designated as nonserviceable. The hydraulic modulator and the EBCM can be separated from each other and replaced separately but cannot be serviced. They have no replaceable parts, and there is no access to the components they contain.

BLEEDING SYSTEM

Replacement modulators are shipped already filled and bled. In normal procedures requiring removal of the modulator, such as to replace the EBCM, air will not enter the modulator, and normal bleeding will be all that is needed. For this procedure, refer to *Section 4A, Hydraulic Brakes.*

If air enters the hydraulic modulator, or if an unfilled modulator is installed, use the brake bleeding program in the scan tool to bleed the modulator. Manual bleeding of the hydraulic modulator is not possible.

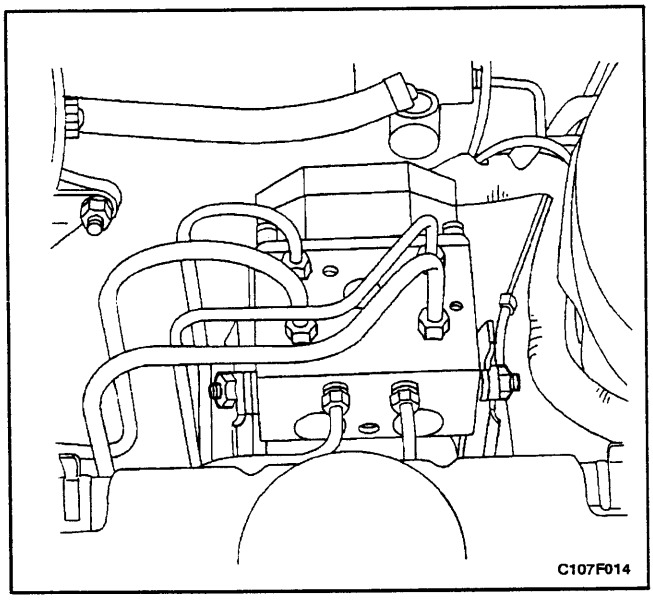

C107F043

ABS 5.3 ASSEMBLY

(Left-Hand Drive Shown, Right-Hand Drive Shown)

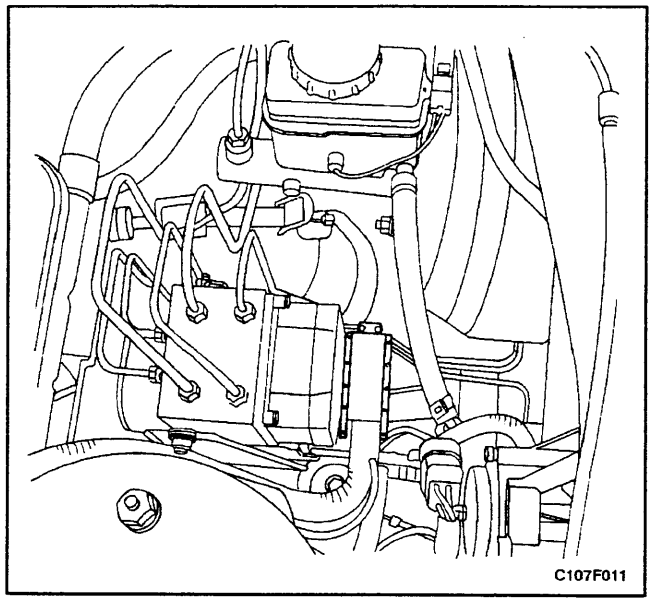
Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the 26- or 31-pin ABS wiring harness connector J1 from its socket on the EBCM.
3. Cover the connector and the socket with shop cloths to protect them from brake fluid.


C107F014

Notice: Take care not to allow air into the hydraulic unit or into the brake pipes from the master cylinder. If air gets into the hydraulic unit, it will require a bleeding procedure using a scan tool programmed for the ABS 5.3 system. As long as no air enters the hydraulic unit, a simple bleeding procedure is all the system will require.

4. Remove the brake pipes from the hydraulic unit. It may be necessary to loosen the brake pipe nuts on the master cylinder to allow for moving those pipes out of the way.
5. Loosen the mounting nuts on the hydraulic unit.
6. Move the brake pipes aside far enough to allow for lifting the ABS 5.3 unit out of the mounting bracket.
7. Tighten the brake pipe nuts on the master cylinder to avoid leaking brake fluid.
8. Cap the brake pipes.


C107F011

Installation Procedure

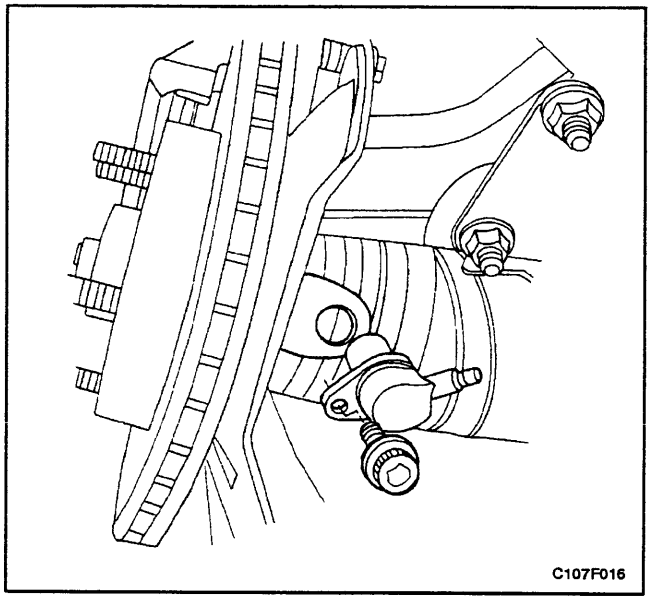
1. Insert the ABS 5.3 hydraulic unit into its mounting bracket and install the nuts.

   Tighten

   Tighten the ABS 5.3 mounting nuts to 9 N•m (80 lb-in).
2. Remove the screw plugs and install all of the hydraulic brake pipes.

   Tighten

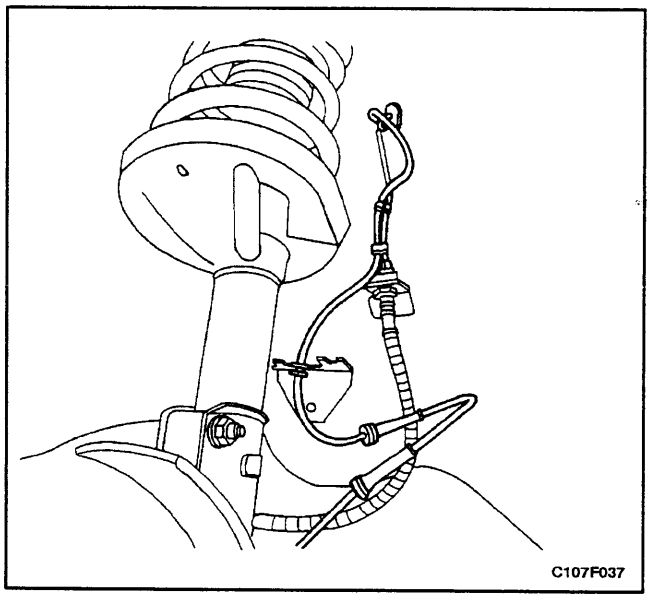
   Tighten the brake pipe nuts to 12 N•m (106 lb-in).
3. Connect the 26- or 31-pin wiring harness connector J1.
4. Connect the negative battery cable.
5. Bleed the hydraulic system. Refer to *Section 4A, Hydraulic Brakes.*


C107F016

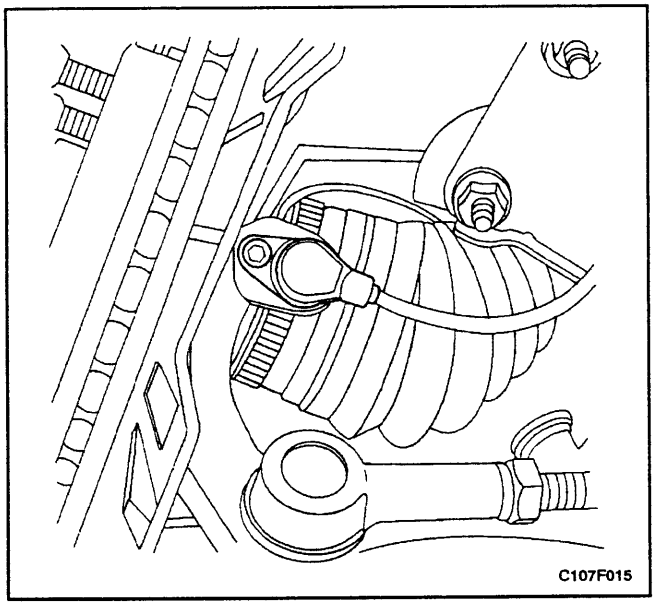
FRONT WHEEL SPEED SENSOR

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the front wheel speed sensor electrical connector.
3. Raise and suitably support the vehicle.
4. Remove the wheel. Refer to *Section 2E, Tires and Wheels*.
5. Turn the steering wheel to expose the speed sensor. It is located at the rear of the steering knuckle near the tie rod end.
6. Remove the bolt and the front wheel speed sensor from the steering knuckle.


C107F037

7. Free the feedthrough grommet for the speed sensor harness and the hydraulic pipe from the strut tower. Remove the speed sensor harness from it so that the connector can pass through the hole in the strut tower.
8. Free the sensor harness from the grommet holders and the clamps and pull it through the fender.

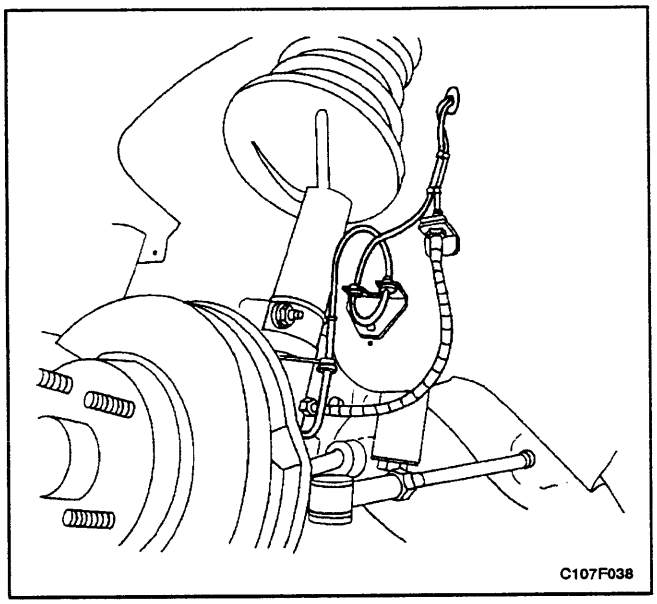


Installation Procedure

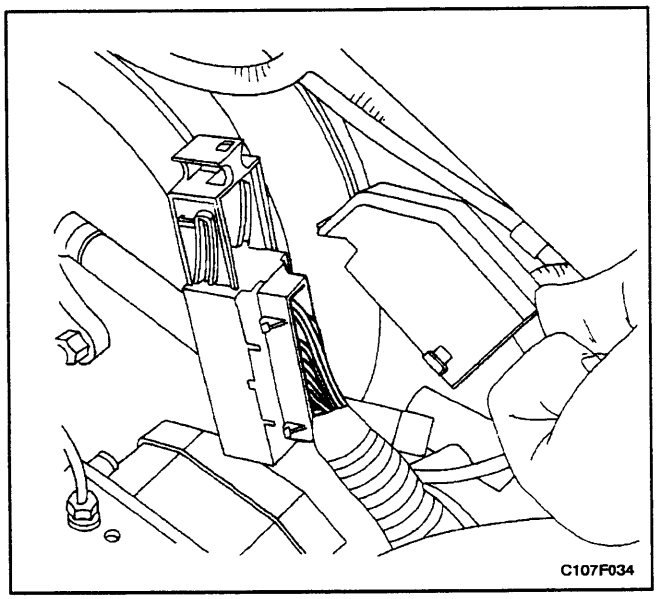
1. Install the front wheel speed sensor to the steering knuckle. Secure it with the bolt.

Tighten

Tighten the front wheel speed sensor bolt to 8 N•m (71 lb-in).



2. Feed the sensor harness into the engine compartment, insert it into the grommet, and secure the grommet into the hole in the strut tower.
3. Secure the harness into the grommet holders and the clamps under the fender.
4. Replace the wheel. Refer to *Section 2E, Tires and Wheels*.
5. Lower the vehicle.
6. Connect the front wheel speed sensor electrical connector.
7. Connect the negative battery cable.

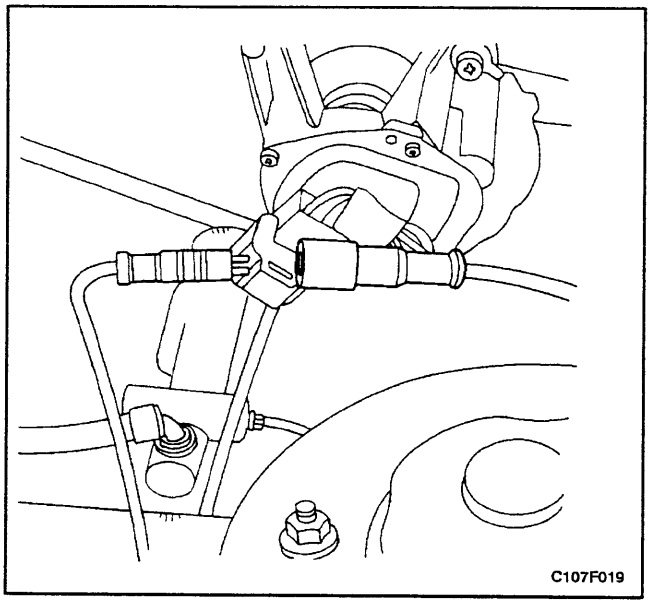


FRONT WHEEL SPEED SENSOR JUMPER HARNESS

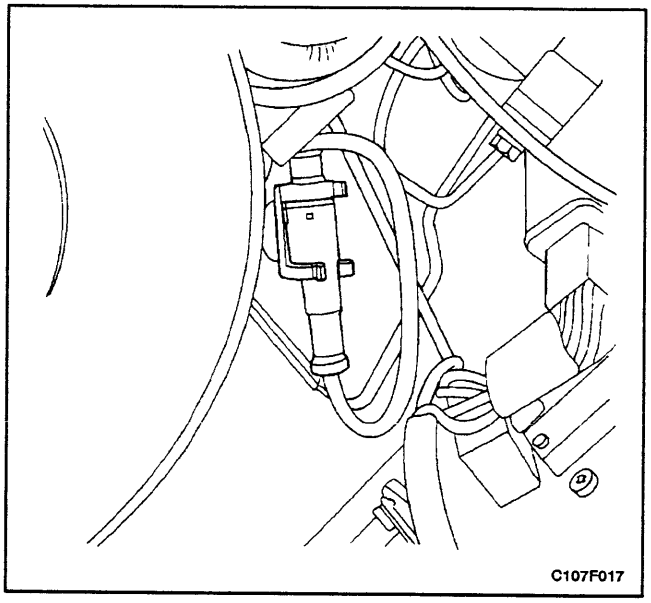
(Left-Hand Drive Shown, Right-Hand Drive Shown)

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect connector J1 from the EBCM.
3. Remove the appropriate terminals from connector J1:
   - Right-side - terminals 4 (PPL) and 5 (YEL).
   - Left-side - terminals 6 (WHT) and 7 (ORN).

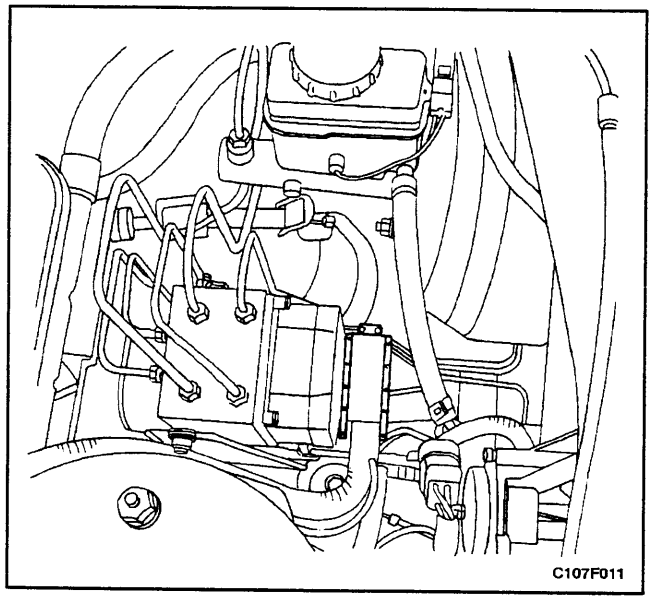

C107F019

4. Both speed sensor harnesses break out of the ABS wiring harness just beyond the ABS connector J1. The right-side speed sensor harness crosses the top of the fire wall to the right-side fender area. The left-side speed sensor harness goes directly to the left-side fender area.
5. Free the speed sensor harness from the wiring harness.
6. Remove the front wheel speed sensor electrical connector from the retaining clamps and disconnect the harness from the sensor connector.

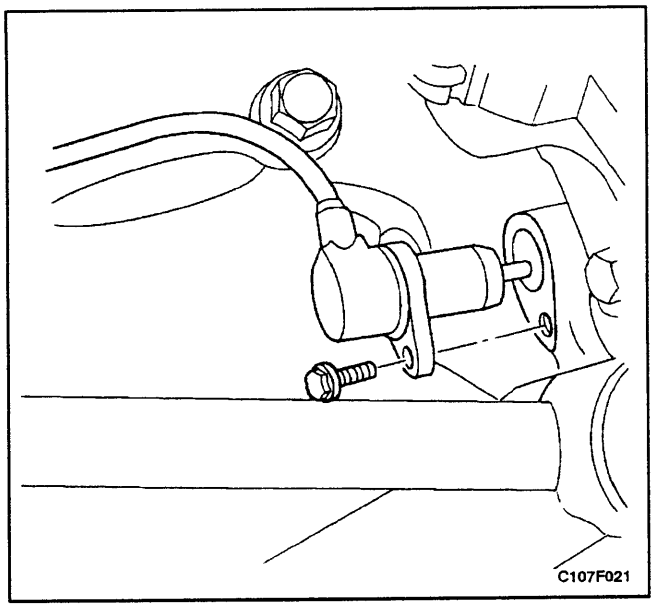

C107F017

Installation Procedure

1. Install the front wheel speed sensor jumper harness.
2. Connect the front wheel speed sensor electrical connector and secure it into the clamps.


C107F011

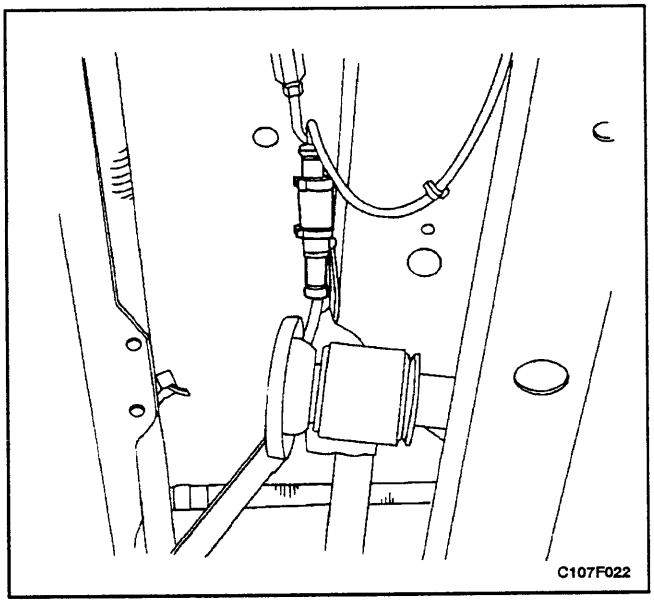
3. Replace the jumper harness into the wiring harness.
4. Insert the terminals into connector J1 as they had been removed:
   - Right-side - terminals 4 (PPL) and 5 (YEL).
   - Left-side - terminals 6 (WHT) and 7 (ORN).
5. Connect EBCM connector J1.
6. Connect the negative battery cable.



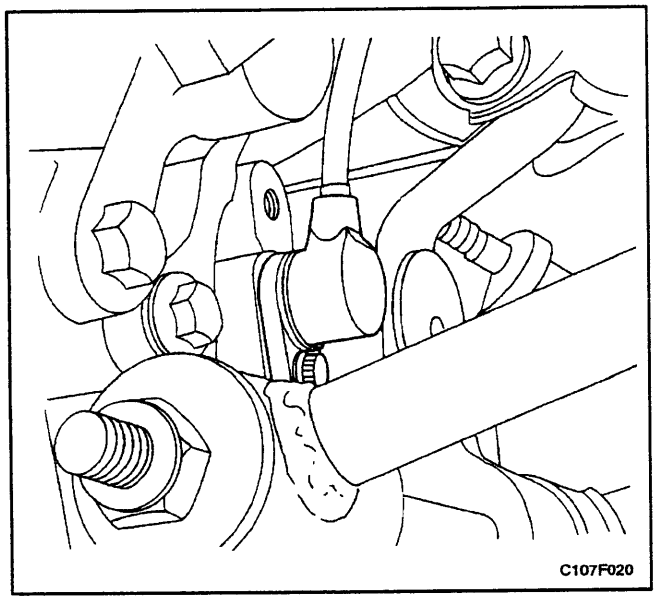
REAR WHEEL SPEED SENSOR

Removal Procedure

1. Disconnect the negative battery cable.
2. Raise and suitably support the vehicle.
3. Remove the bolt and the rear wheel speed sensor from the rear knuckle.



4. Remove the speed sensor cable grommets from their clamps.
5. Remove the speed sensor cable from the clamps securing it to the hydraulic pipe.
6. Remove the speed sensor cable connector from its clamps and disconnect the speed sensor cable from the harness.

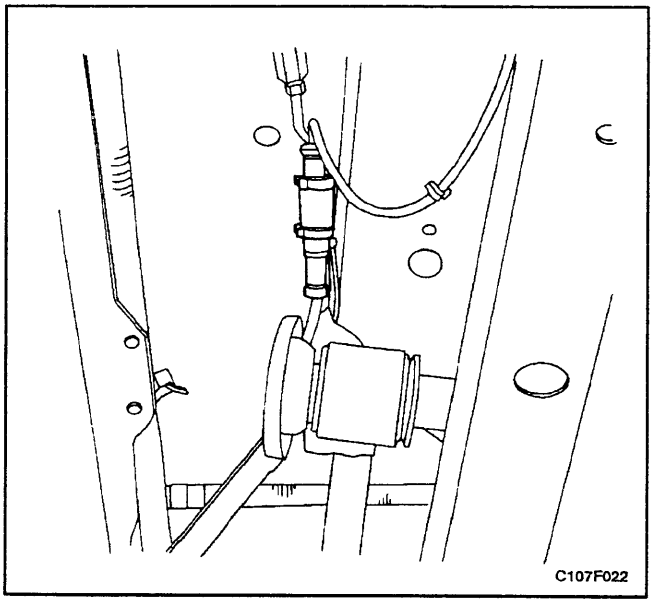


Installation Procedure

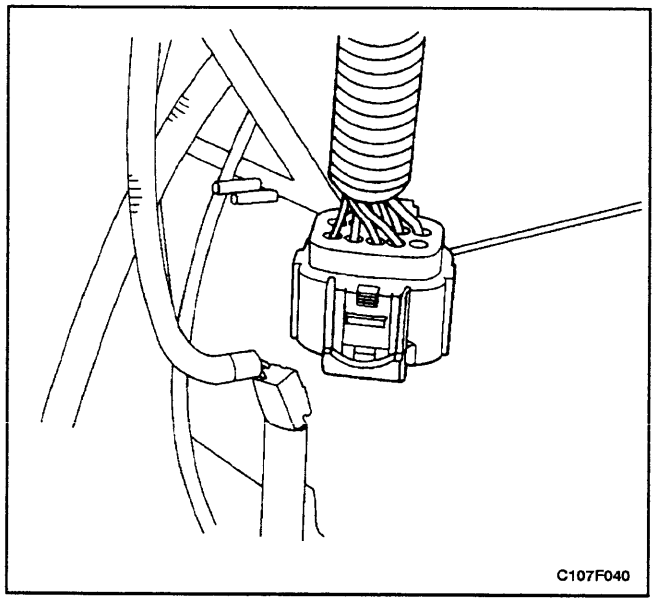
1. Install the rear wheel speed sensor to the rear knuckle. Secure it with the bolt.

Tighten

Tighten the rear wheel speed sensor bolt to 8 N•m (71 lb-in).


C107F022

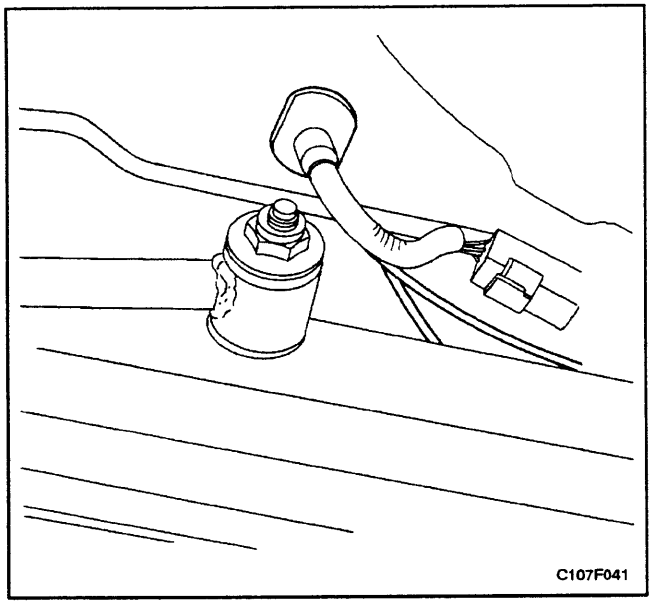
2. Connect the rear wheel speed sensor electrical connector.
3. Secure the speed sensor cable into its clamps on the hydraulic pipe.
4. Secure the speed sensor cable grommets into their clamps inside the fender well.
5. Lower the vehicle.
6. Connect the negative battery cable.

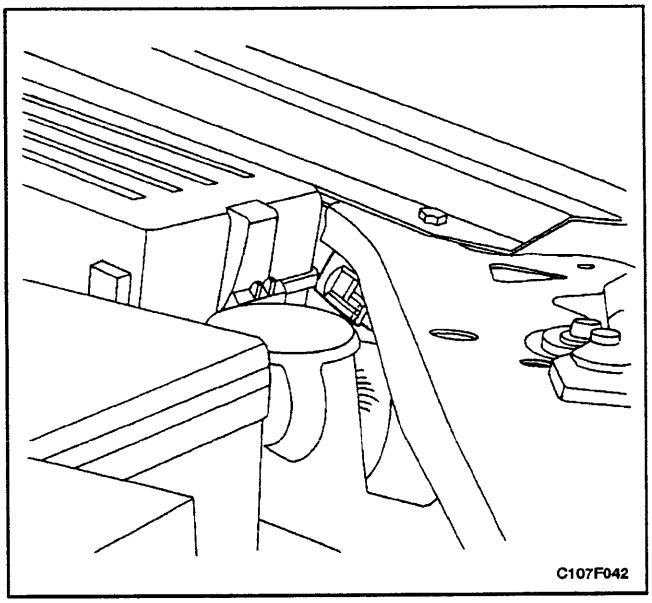

C107F040

REAR WHEEL SPEED SENSOR JUMPER HARNESS

Removal Procedure

1. Remove the negative battery cable.
2. Raise and suitably support the vehicle.
3. Remove the left front wheel. Refer to *Section 2E, Tires and Wheels*.
4. Remove the wheel well splash shield inside the left front wheel arch to expose the body wiring harness where it enters the engine compartment. Refer to *Section 9R, Body Front End*.
5. Disconnect the body harness from the ABS harness at connector C107. This is forward of the left front wheel arch, between the engine fuse block and the wheel arch.
6. Pull the body harness end of C107 into the wheel arch area and remove the DK BLU-BRN pair of speed sensor wires appropriate for the harness being replaced.

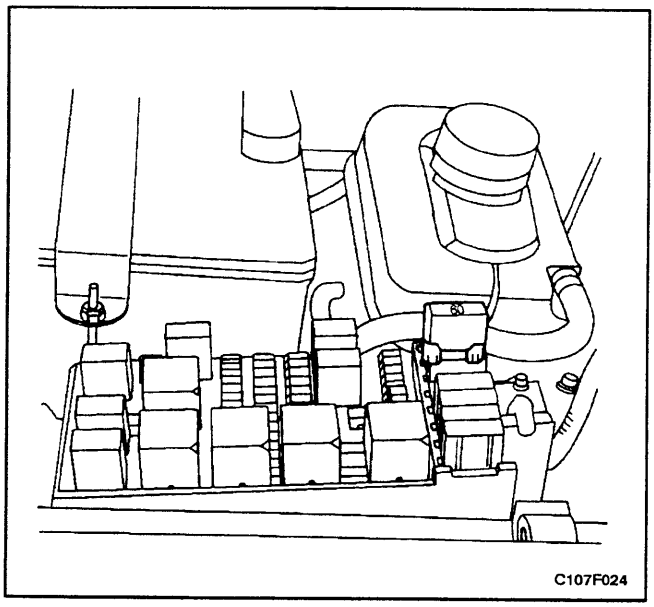




7. Open the body harness cover enough to free the speed sensor harness being replaced.
8. Lower the vehicle.
9. Expose the body harness inside the vehicle body and free the speed sensor harness being replaced.
10. Open the trunk, uncover the spare tire compartment, remove the tape from the feedthrough grommet, and free the speed sensor harness from the body harness.
11. Raise and suitably support the vehicle.
12. Disconnect the speed sensor cable from the sensor harness cable being replaced.
13. Remove the tape sealing the wiring harness and the rear speed sensor harnesses to the grommet passing them through the floor of the vehicle.
14. Pull the harness being replaced through the grommet.

Installation Procedure

1. Pass the harness through the grommet in the floor.
2. Connect the new wheel speed sensor harness to the wheel speed sensor.
3. Secure the connector in its clamp.
4. Adjust the cable length and tape the grommet opening under the vehicle.
5. Lower the vehicle.
6. Tape the grommet opening inside the vehicle.
7. Pass the harness through the grommet and on into the engine compartment.
8. Install terminals onto the harness wires and insert the new terminals into the appropriate cavities of connector C107.
9. Reconnect connector C107 to the ABS harness.
10. Secure the new speed sensor harness into the body wiring harness.
11. Replace the wheel well splash shield. Refer to *Section 9R, Body Front End.*
12. Replace the left front wheel. Refer to *Section 2E, Tires and Wheels.*
13. Lower the vehicle.
14. Connect the negative battery cable.

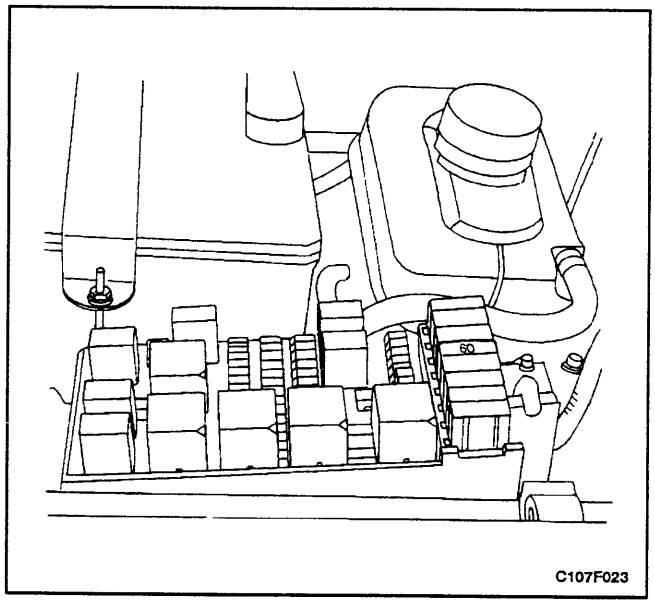


SYSTEM FUSE

Removal Procedure

The ABS system fuse, EF4, is located in the engine fuse block. Counting from the surge tank toward the fender, it is the fourth system fuse in the row at the strut tower end of the fuse block.

1. Disconnect the negative battery cable.
2. Remove the system fuse from its socket.



Installation Procedure

1. Install a new 60-amp system fuse into the socket.
2. Connect the negative battery cable.

INDICATORS

The indicator lamps associated with ABS operation are part of the instrument cluster. Refer to *Section 9E, Instrumentation/Driver Information*, for removal and replacement details.

GENERAL DESCRIPTION AND SYSTEM OPERATION

BASIC KNOWLEDGE REQUIRED

Before using this section, it is important that you have a basic knowledge of the following items. Without this knowledge, it will be difficult to use the diagnostic procedures contained in this section.

- Basic Electrical Circuits—You should understand the basic theory of electricity and know the meaning of voltage, current (amps), and resistance (ohms). You should understand what happens in a circuit with an open or shorted wire. You should be able to read and understand a wiring diagram.
- Use of Circuit Testing Tools—You should know how to use a test light and how to bypass components to test circuits using fused jumper wires. You should be familiar with a digital multimeter. You should be able to measure voltage, resistance, and current, and be familiar with the controls and how to use them correctly.

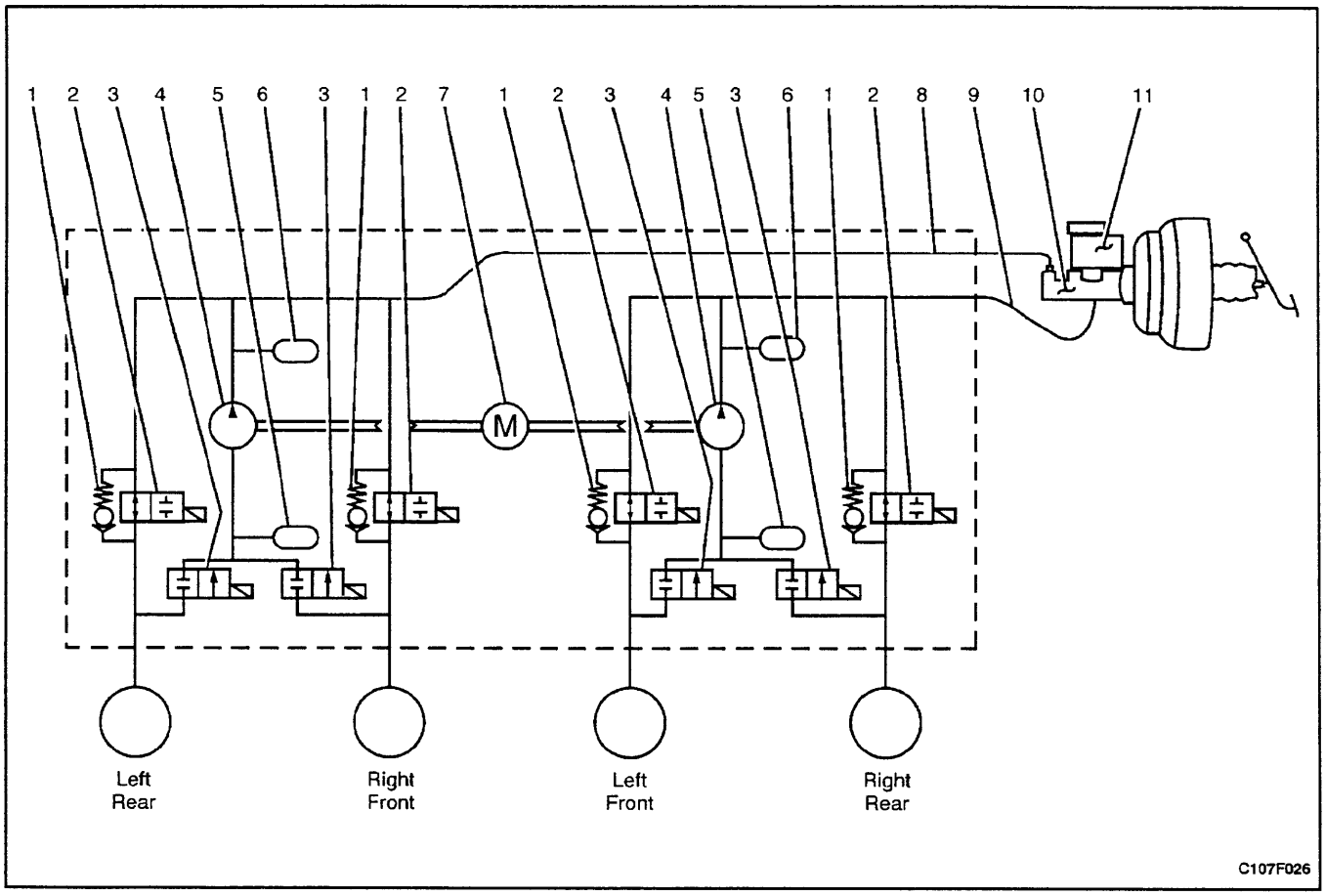
ABS SYSTEM COMPONENTS

The ABS 5.3 Antilock Braking System (ABS) consists of a conventional hydraulic brake system plus antilock components. The conventional brake system includes a vacuum booster, master cylinder, front disc brakes, rear leading/trailing drum brakes, interconnecting hydraulic brake pipes and hoses, brake fluid level sensor and the BRAKE indicator.

The ABS components include a hydraulic unit, an electronic brake control module (EBCM), two system fuses, four wheel speed sensors (one at each wheel), interconnecting wiring, the ABS indicator, and the rear disk brakes. See "ABS Component Locator" in this section for the general layout of this system.

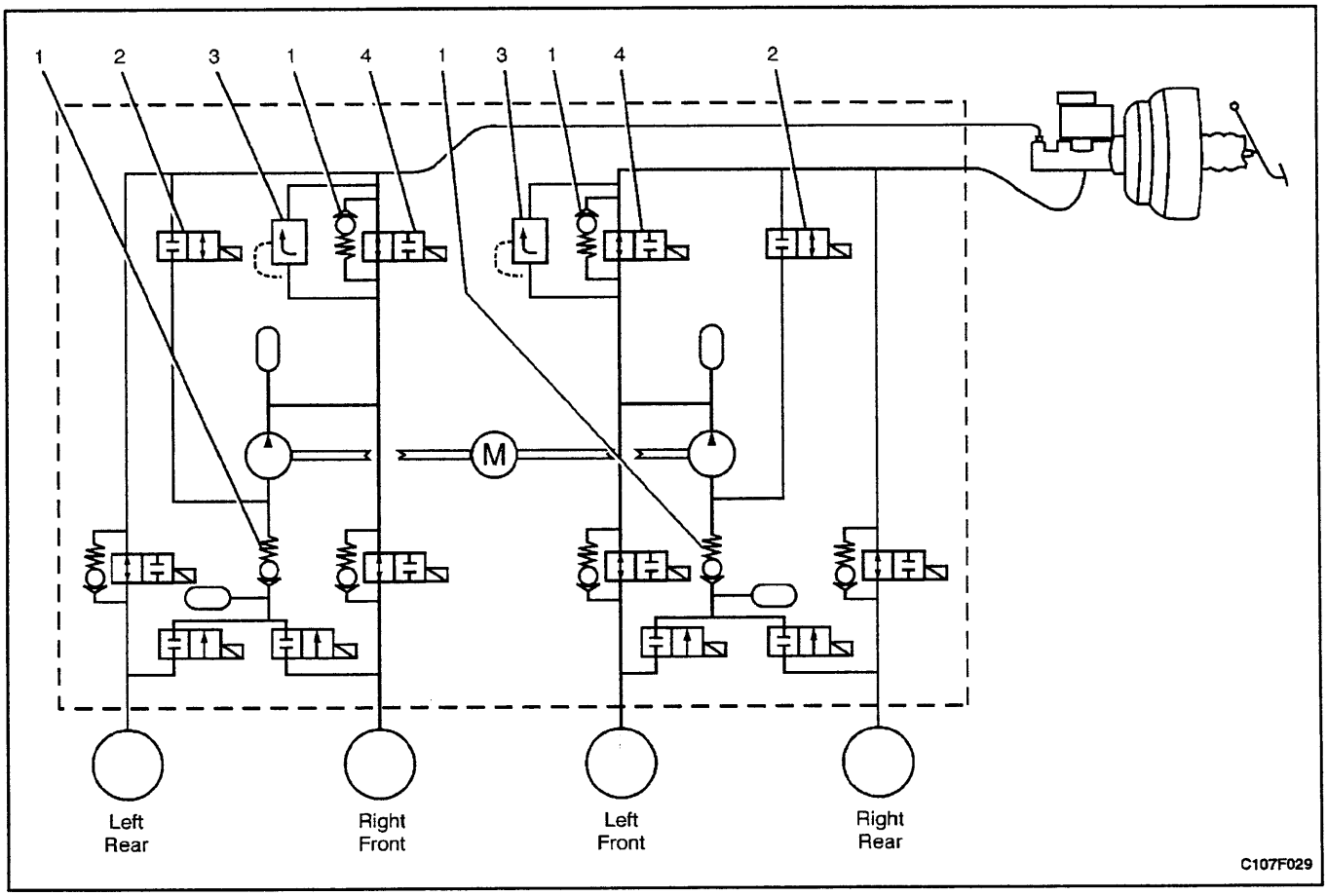
The hydraulic unit with the attached EBCM is located between the surge tank and the fire wall on the left side of the vehicle.

The basic hydraulic unit configuration consists of hydraulic check valves, two solenoid valves for each wheel, a hydraulic pump, and two accumulators. The hydraulic unit controls hydraulic pressure to the front calipers and rear wheel cylinders by modulating hydraulic pressure to prevent wheel lockup.



1 Check Valve
2 Inlet Valve
3 Outlet Valve
4 Pump
5 Accumulator
6 Damper
7 Pump Motor
8 Hydraulic Circuit 2
9 Hydraulic Circuit 1
10 Master Cylinder
11 Master Cylinder Reservoir

Units equipped with TCS add two more valves for each drive wheel for the purpose of applying the brake to a wheel that is slipping. This is done with pressure from the hydraulic pump in the unit. There is also a TCS indicator lamp on the instrument panel to alert the driver to the fact that the TCS system is active. The components identified in the drawing are those added to the basic ABS 5.3 system to provide traction control.

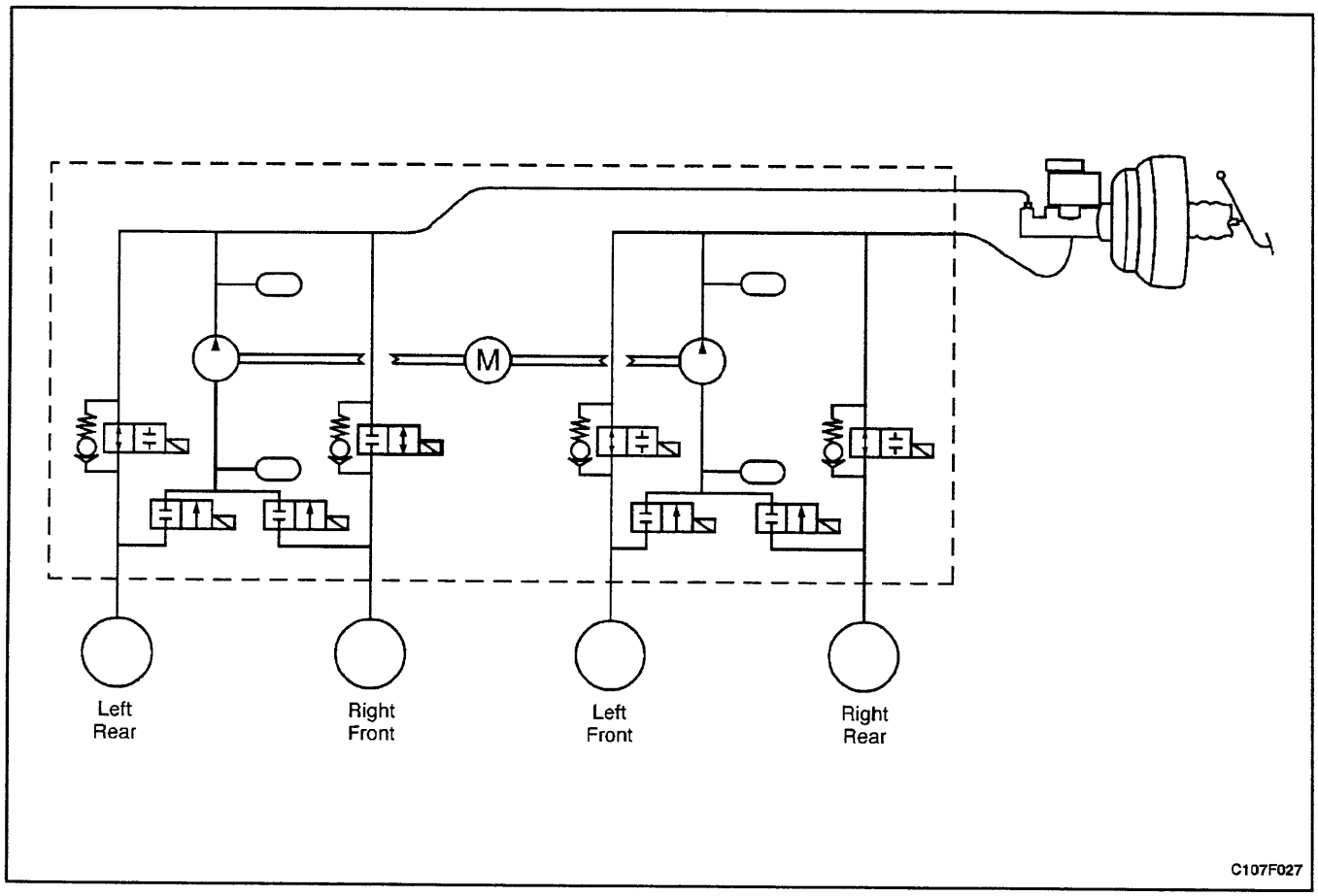


1 Non-return Valve
2 Prime Valve
3 Pressure Relief Valve
4 Pilot Valve

Nothing in the hydraulic unit or the EBCM is serviceable. In the event of any failure, the entire ABS unit with attached EBCM must be replaced. For more information, refer to "Base Braking Mode" and "Antilock Braking Mode" in this section.

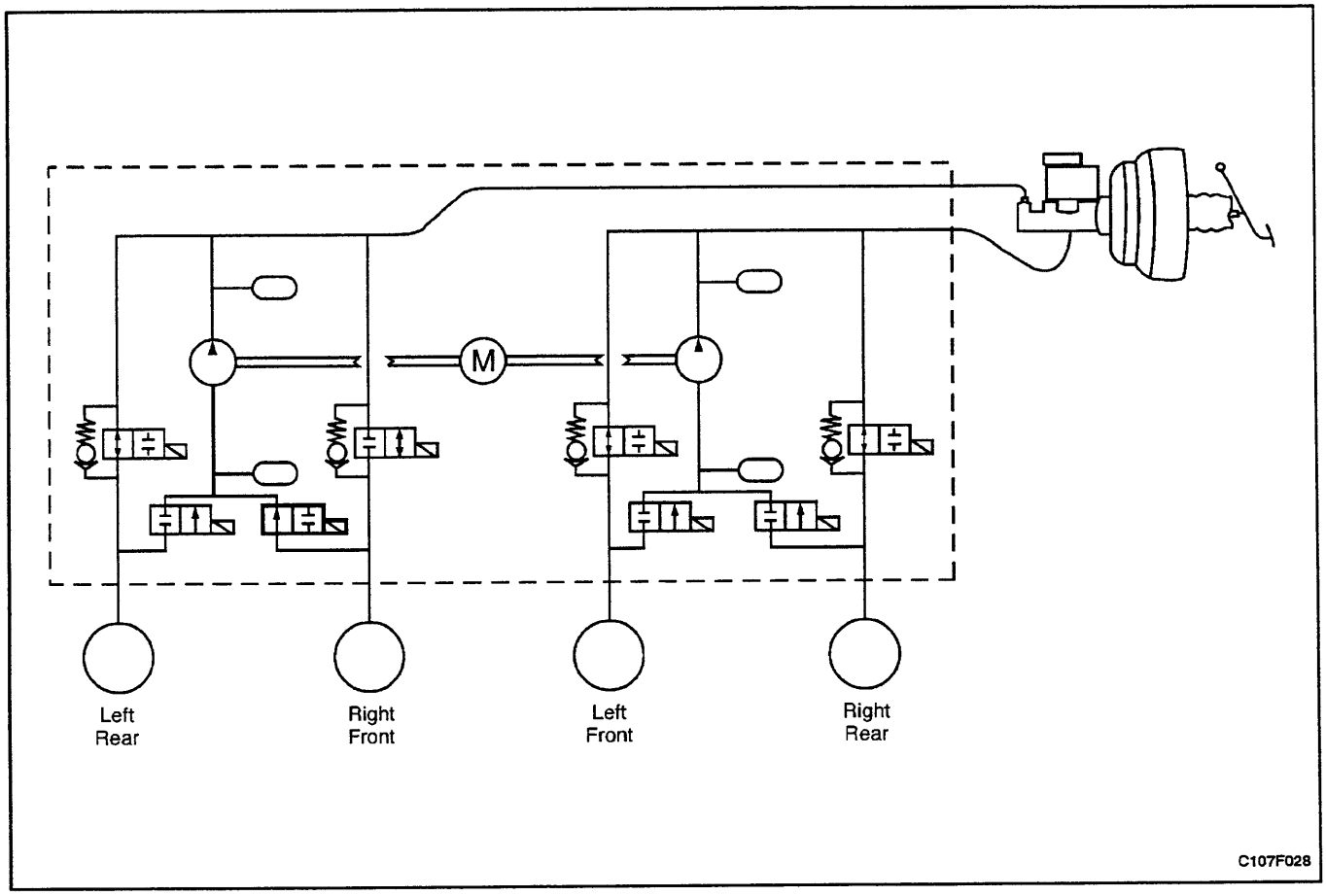
BASE BRAKING MODE

The baseline braking mode of the ABS 5.3 system used in this vehicle is a diagonal split system. In this system, one master cylinder circuit supplies pressure to the right front and the left rear brakes; the other circuit supplies pressure to the left front and the right rear brakes. All valves in the hydraulic modulator are in their normal, non-energized positions as shown in the drawings found in "ABS System Components" in this section.



ANTILOCK BRAKING MODE

If a wheel speed sensor detects a wheel locking up, the electronic brake control module (EBCM) closes the normally open inlet valve for the brake on that wheel to prevent adding more hydraulic pressure to that brake. The illustration shows this for the right front brake.



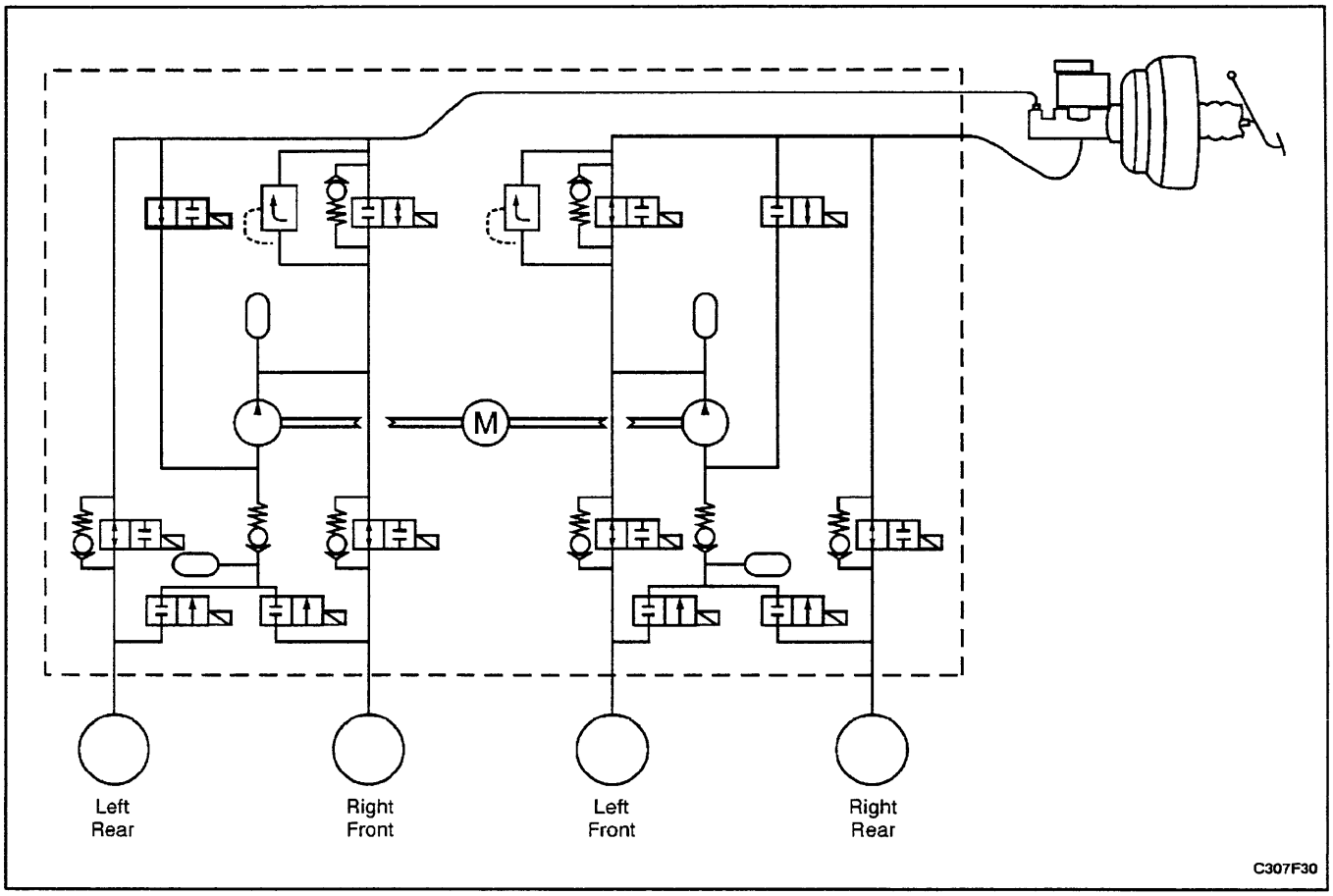
If the wheel locking tendency continues, the EBCM releases the hydraulic pressure at that brake by opening the outlet valve for that wheel.

These inlet and outlet valves at the wheels operate the same way in a TCS system. The additional TCS valves do not operate for the ABS function.

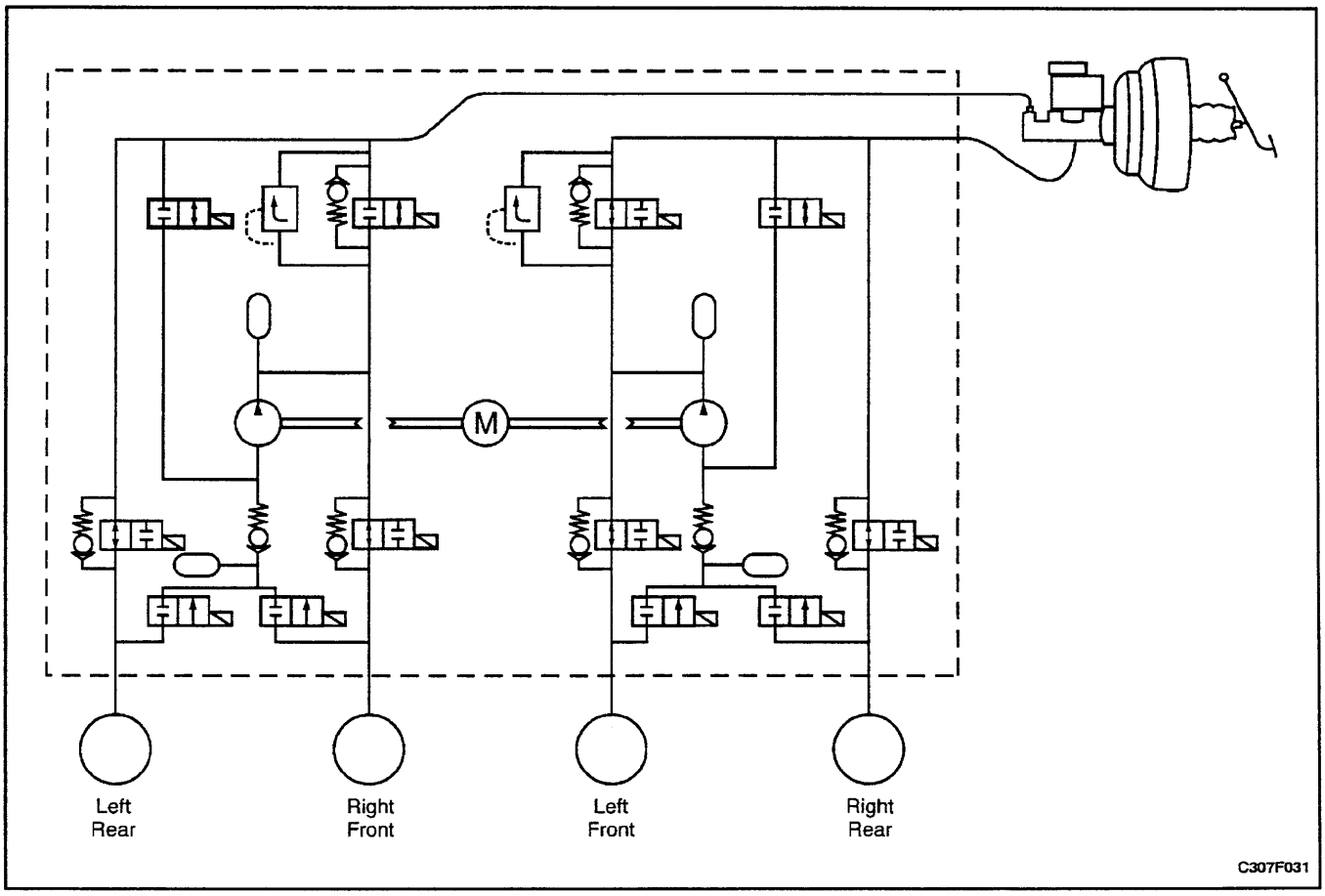
TRACTION CONTROL MODE

The Automatic Brake Differential form of traction control (TCS) used in this system operates by brake application to the drive wheel which is loosing traction. This transfers torque to the wheel that has traction. It is available only at low speed (<40 km/h [25 mph]). When the TCS is active, The TCS indicator lamp in the instrument cluster will be blinking.

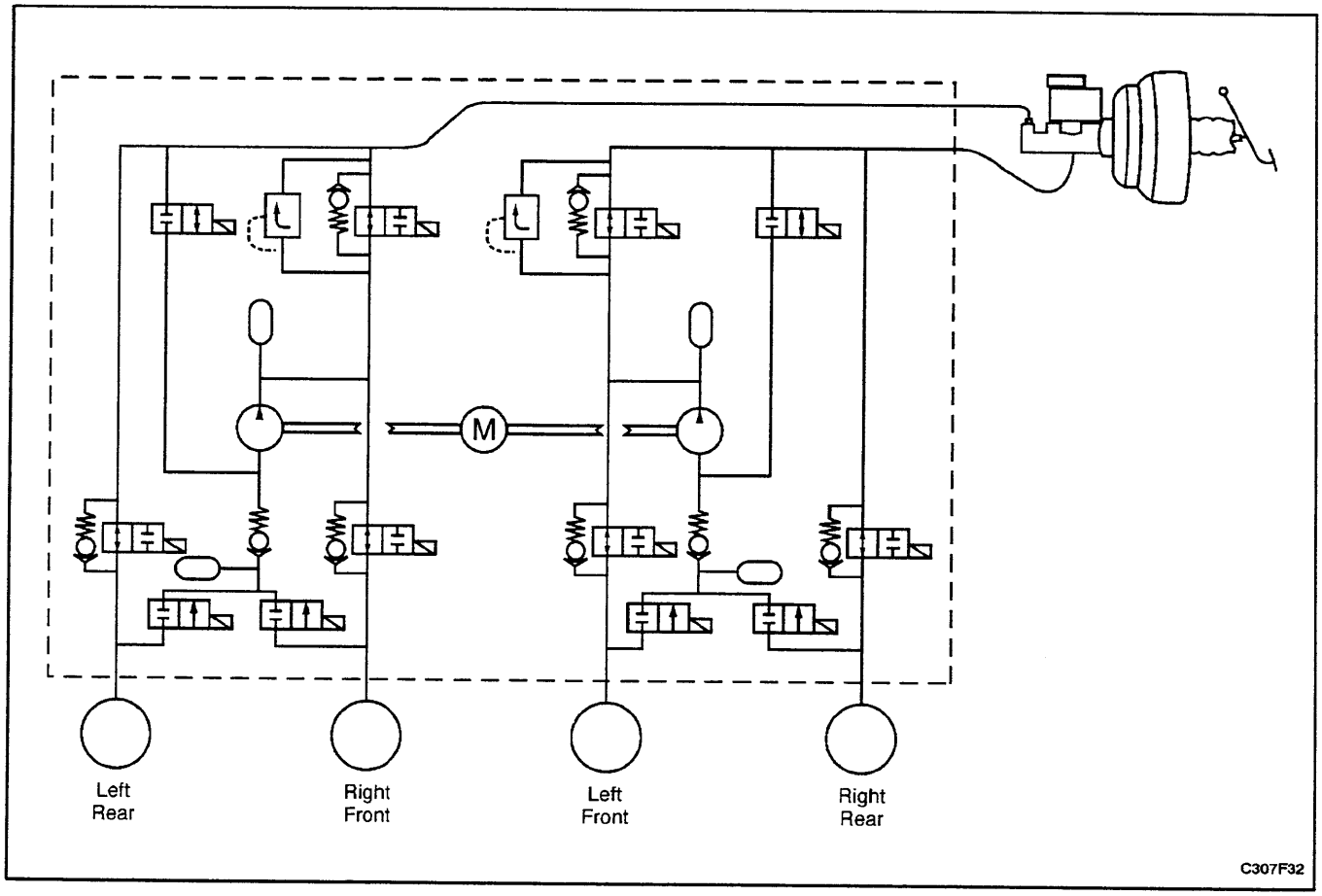
The TCS will operate when a wheel speed sensor detects a wheel spin situation with one of the drive wheels. The electronic brake control module (EBCM) closes the normally open pilot valve to isolate the affected drive wheel brake from the master cylinder and from the rear wheel brake channel. The EBCM also turns on the pump and opens the prime valve to apply pressure to the brake at the wheel that is spinning. The following figures show action at the right front wheel only.



When the wheel spin condition is under control, the EBCM closes the prime valve for the wheel that was spinning to avoid additional braking at that wheel. The pressure relief valves will allow the excess hydraulic fluid being pumped to return to the master cylinder.



When the wheel speed tendency is no longer detected, the EBCM turns off the pump and opens the pilot valve to release the braking pressure, returning the system to its normal configuration.



TIRES AND ABS/TCS

Replacement Tires

Tire size is important for proper performance of the ABS/TCS system. Replacement tires should be the same size, load range, and construction as the original tires. Replace tires in axle sets and only with tires of the same tire performance criteria (TPC) specification number. Use of any other size or type may seriously affect the ABS/TCS operation.

ELECTRONIC BRAKE CONTROL MODULE (EBCM)

Notice: There is no serviceable or removable PROM. The EBCM must be replaced as an assembly.

The EBCM is attached to the hydraulic unit in the engine compartment. The controlling element of ABS 5.3 is a microprocessor-based EBCM. Inputs to the system include the four wheel speed sensors, the stoplamp switch, the ignition switch, and the unswitched battery voltage. There is an output to a bi-directional serial data link, located in pin K of the assembly line diagnostic link (ALDL), for service diagnostic tools and assembly plant testing.

The EBCM monitors the speed of each wheel. If any wheel begins to approach lockup and the brake switch is closed (brake pedal depressed), the EBCM controls the solenoids to reduce brake pressure to the wheel approaching lockup. Once the wheel regains traction, brake pressure is increased until the wheel again begins to approach lockup. This cycle repeats until either the vehicle comes to a stop, the brake pedal is released, or no wheels approach lockup.

Additionally, the EBCM monitors itself, each input (except the serial data link), and each output for proper operation. If it detects any system malfunction, the EBCM will store a DTC in nonvolatile memory (DTCs will not disappear if the battery is disconnected). Refer to "Self Diagnostics" in this section for more detailed information.

FRONT WHEEL SPEED SENSORS

The front wheel speed sensors are of a variable reluctance type. Each sensor is attached to the steering

knuckle, close to a toothed ring. The result, as teeth pass by the sensor, is an ac voltage with a frequency proportional to the speed of the wheel. The magnitude of the voltage and frequency increase with increasing speed. The sensor is not repairable, nor is the air gap adjustable.

FRONT WHEEL SPEED SENSOR RINGS

The toothed ring mentioned above is pressed onto the wheel-side (outer) constant velocity joint. Each ring contains 48 equally spaced teeth. Exercise care during service procedures to avoid prying or contacting this ring. Excessive contact may cause damage to one or more teeth. If the ring is damaged, the wheel-side constant velocity joint must be replaced.

REAR WHEEL SPEED SENSORS AND RINGS

The rear wheel speed sensors operate in the same manner as the front wheel speed sensors. They incorporate a length of flexible harness with the connector attached to the end of the harness. The rear wheel speed rings are incorporated into the hub assemblies and cannot be replaced separately, but require replacement of the rear hub/bearing assembly.

VALVE RELAY AND PUMP MOTOR RELAY

The valve relay and the motor pump relay are located inside the electronic brake control module (EBCM) and are not replaceable. If one should fail, replace the EBCM.

WIRING HARNESS

The wiring harness is the mechanism by which the electronic brake control module (EBCM) is electrically connected to power and to ground, to the wheel speed sensors, the fuses, the switches, the indicators, and the serial communications port. The components, considered part of the wiring harness, are the wires that provide electrical interconnection, and connectors (terminals, pins, contacts, or lugs) that provide an electrical/mechanical interface from the wire to a system component.

INDICATORS

The electronic brake control module (EBCM) continuously monitors itself and the other ABS components. If the EBCM detects a problem with the system, the amber ABS indicator will light continuously to alert the driver to the problem. An illuminated ABS indicator indicates that the ABS system has detected a problem that affects the operation of ABS. No antilock braking will be available. Normal, non-antilock brake performance will remain. In order to regain ABS braking ability, the ABS must be serviced.

The red BRAKE indicator will be illuminated when the system detects a low brake fluid level in the master cylinder or when the parking brake switch is closed (the parking brake is engaged).

When the vehicle is equipped with traction control (TCS), there is also a TCS indicator which the EBCM will illuminate when the traction control system is active.

SECTION 4G

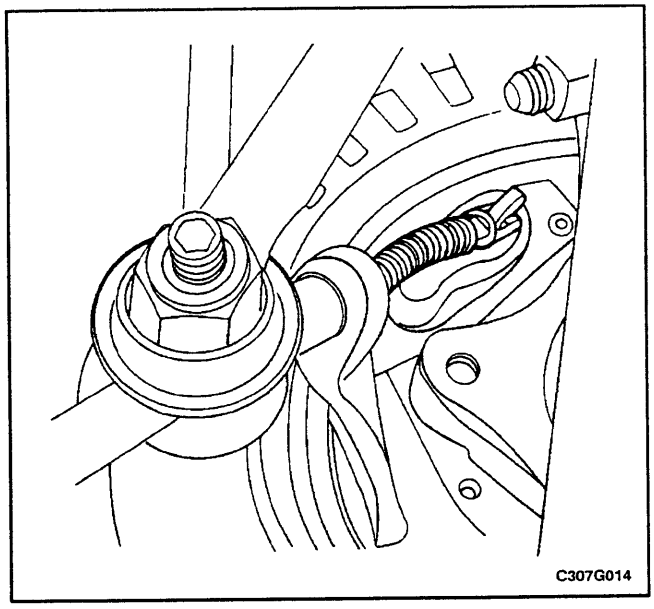
PARKING BRAKE

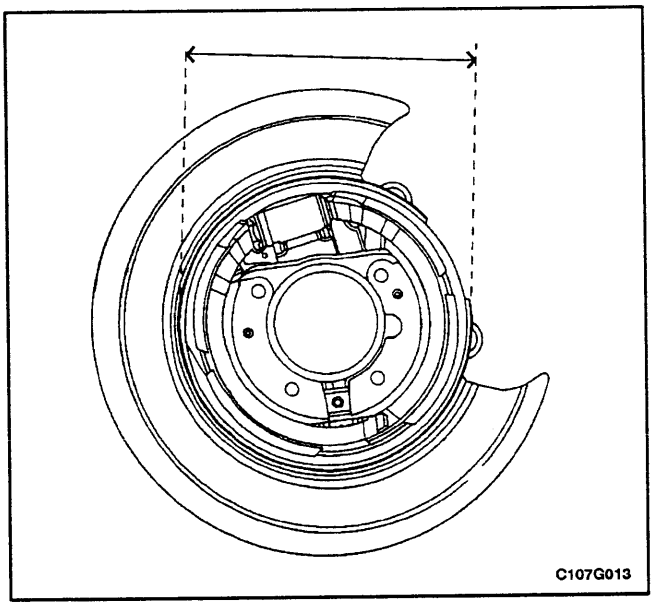
TABLE OF CONTENTS

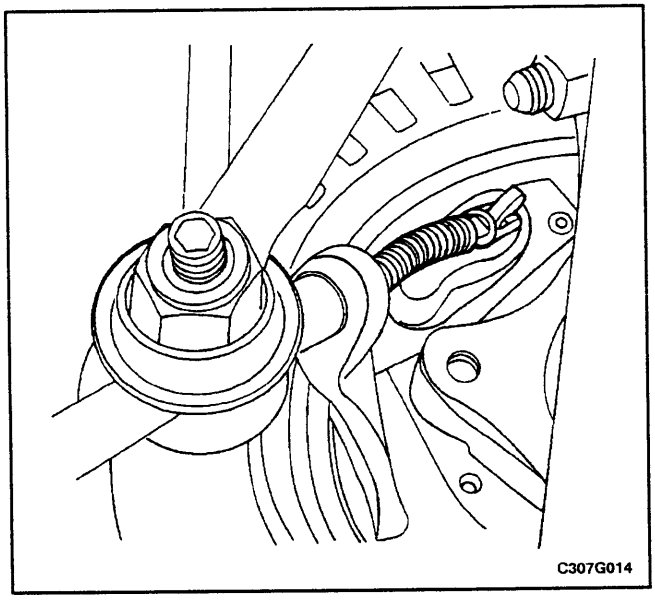
SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Front Muffler Heat Shield Nuts	2.5	-	22
Keyless Entry Receiver Screws	10	-	89
Parking Brake Cable Bracket-to-Trailing Link Bracket Nuts	90	66	-
Parking Brake Cable Console Mounting Bracket Nuts	25	18	-
Parking Brake Cable Nut	12	-	106
Parking Brake Lever Assembly-to-Vehicle Underbody Bolts	20	15	-
Parking Brake Switch-to-Parking Brake Lever Screw	4	-	35







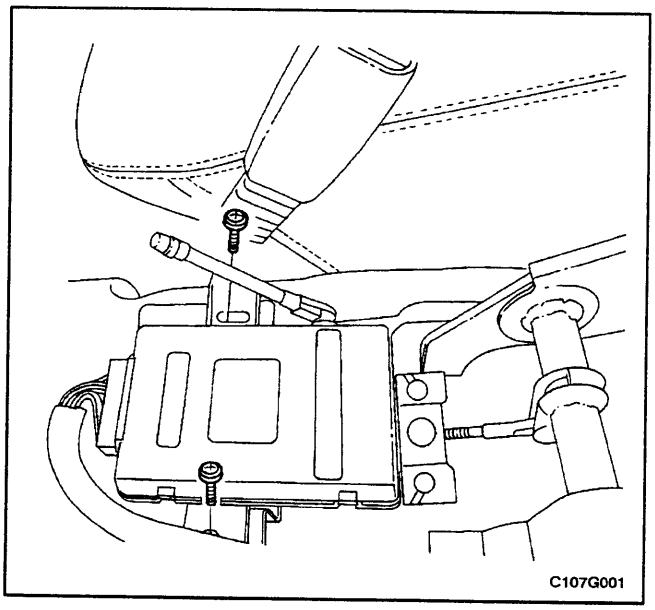
MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

PARKING BRAKE ADJUSTMENT - REAR DISC BRAKES

Adjustment Procedure

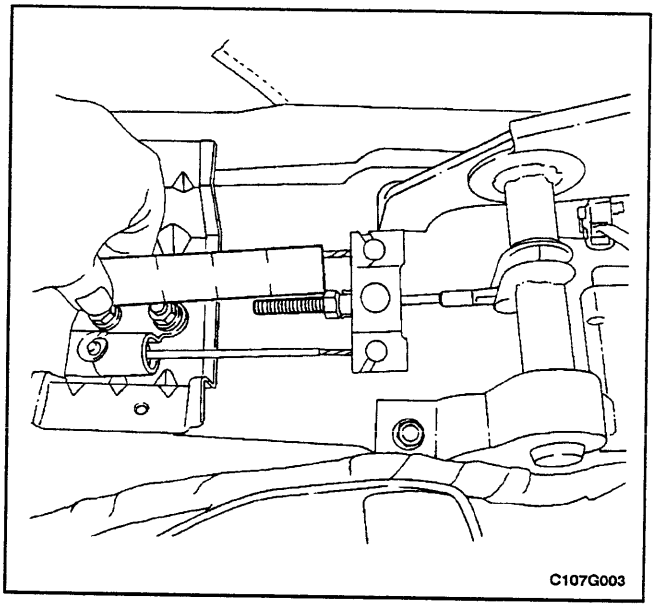
1. Release the parking brake.
2. Raise and suitably support the vehicle.
3. Remove the rear wheels. Refer to *Section 2E, Tires and Wheels*.
4. Remove the caliper and rotor assemblies. Refer to *Section 4E, Rear Disc Brakes*.
5. Disconnect the parking brake cable from the backplate operating lever on each side of the vehicle.
6. Inspect and replace any parts of doubtful strength or quality because of discoloration from heat or stress.
7. Using a vernier caliper, adjust the shoe assembly to 167.6 to 167.8 mm (6.60 to 6.61 inches) by turning the adjuster nut clockwise to increase the diameter.
8. Install the caliper and rotor assemblies. Refer to *Section 4E, Rear Disc Brakes*.
9. Install the rear wheels. Refer to *Section 2E, Tires and Wheels*.
10. Install the parking brake cable to the backplate lever on each side of the vehicle.
11. In the vehicle cabin, pull on the parking brake handle and stop after hearing two clicks.
12. Turn the rear wheel by hand until the wheel begins to drag.
13. Release the parking brake.
14. Turn the rear wheel by hand to check drag and re-adjust the cable, if necessary.
15. Repeat the process for the other rear wheel and lower the vehicle.


C107G001

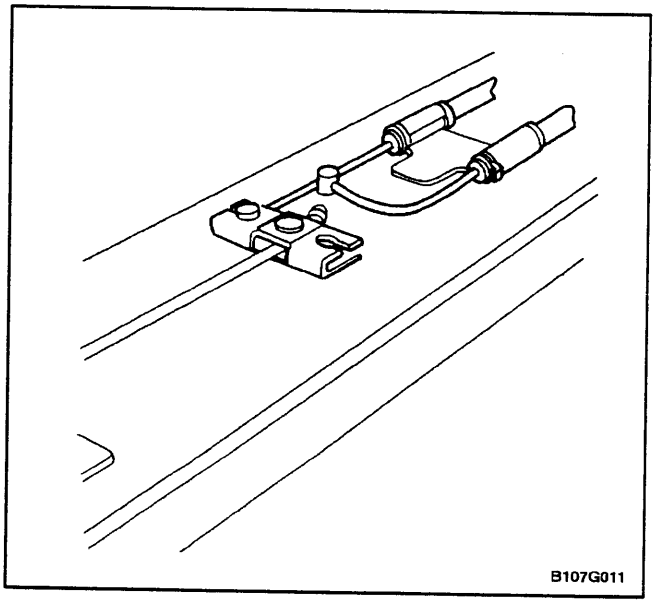
PARKING BRAKE LEVER

Removal Procedure

1. Release the parking brake.
2. Remove the parking brake/gearshift console hood. Refer to *Section 9G, Interior Trim*.
3. If necessary, remove the screws and washers securing the keyless entry receiver to the underbody bracket.


C107G003

4. Measure the thread length from the end of the pull rod to the hex nut.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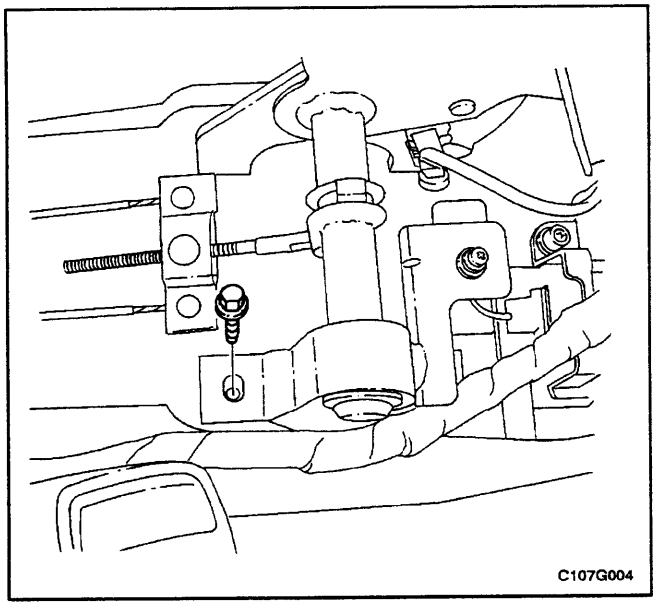
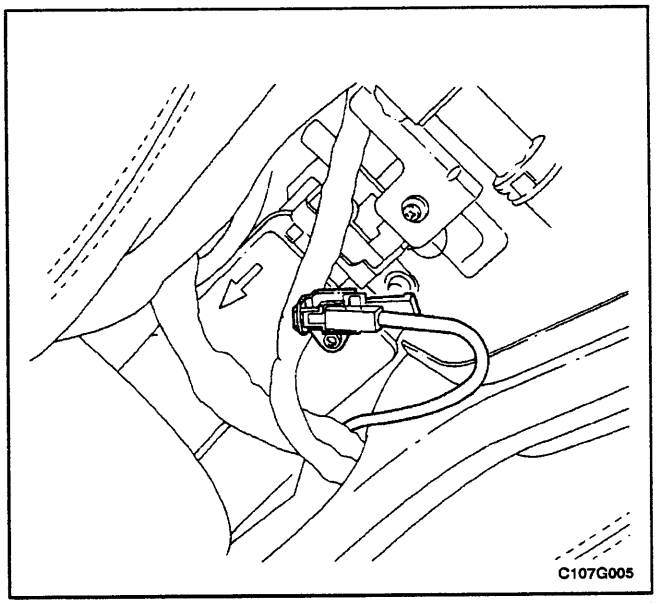
5. Loosen the parking brake adjustment nut from the eye bolt pull rod of the parking brake lever assembly.
6. Remove the parking brake cable ends from the equalizer.

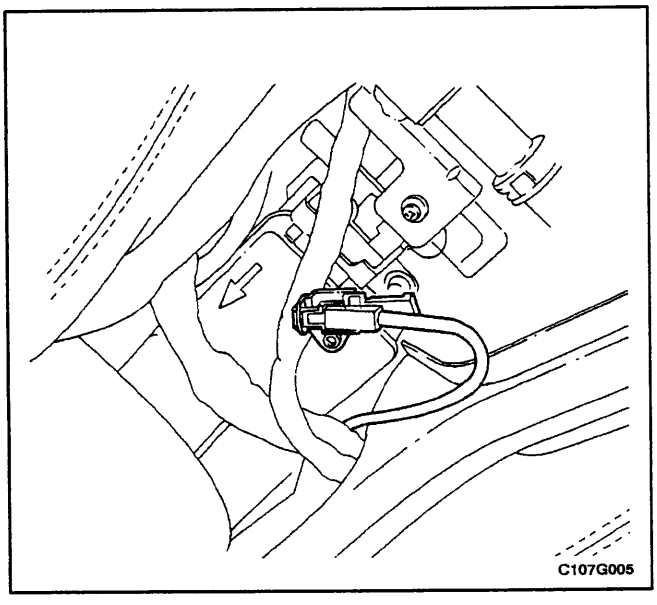


7. Remove the bolts and washers which secure the complete parking brake lever assembly to the underbody.



Notice: The parking brake switch should be replaced if the BRAKE warning light in the instrument panel cluster did not glow when the parking brake was applied with the ignition switch ON.

8. If necessary, remove the parking brake switch attached to the parking brake lever assembly by a small screw, and remove the switch.



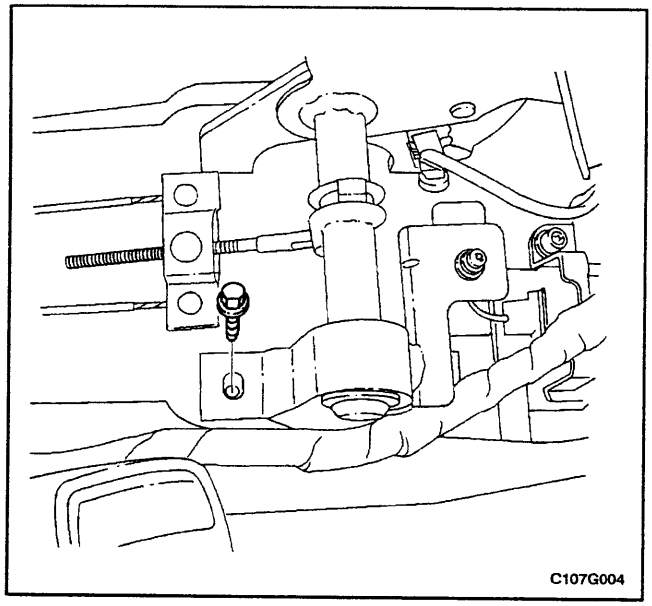
Installation Procedure

Notice: If the parking brake lever is bent or damaged, replace the complete parking brake lever assembly.

1. If necessary, fasten the parking brake switch to the parking brake lever assembly with the screw.

Tighten

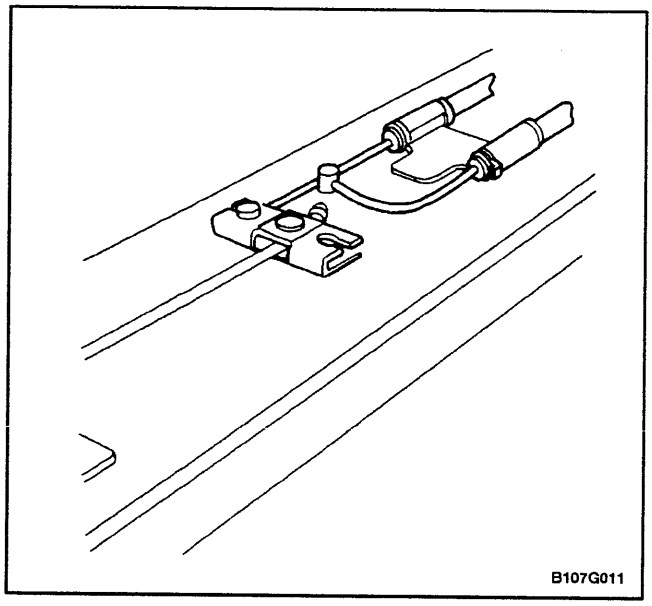
Tighten the parking brake switch-to-parking brake lever screw to 4 N•m (35 lb-in).


C107G004

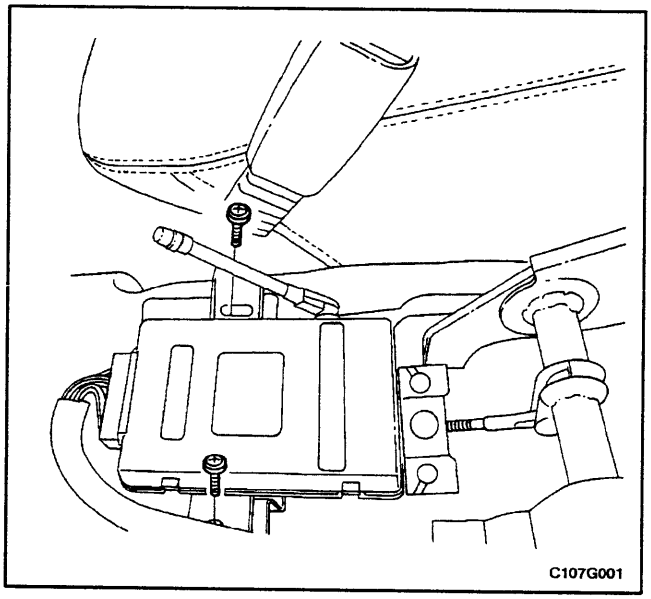
2. Install the parking brake lever bolts, and fasten the parking brake lever assembly to the vehicle underbody.

Tighten

Tighten the parking brake lever assembly-to-vehicle underbody bolts to 20 N•m (15 lb-ft).


B107G011

3. Connect the parking brake cable ends to the equalizer.
4. Check the parking brake adjustment by referring to the original removal adjustment nut measurement taken in the removal procedure. Refer to "Parking Brake Adjustment" in this section.

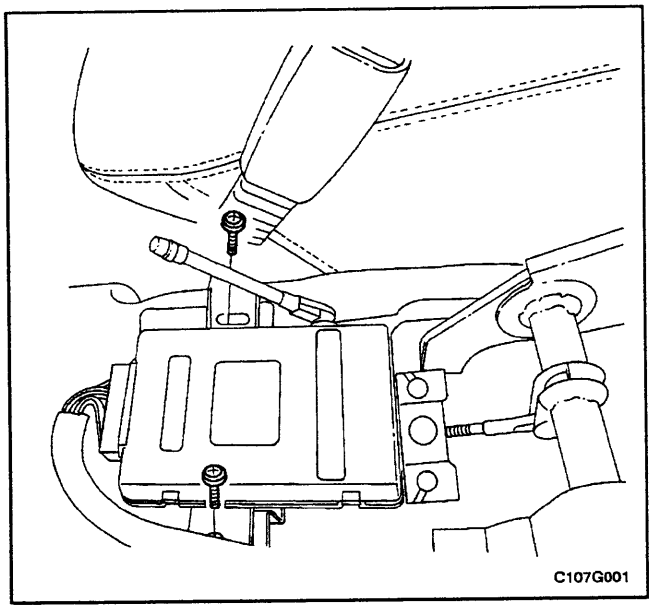

C107G001

5. If necessary, install the screws and washers securing the keyless entry receiver to the underbody bracket.

Tighten

Tighten the screws of the keyless entry receiver to 10 N•m (89 lb-in).

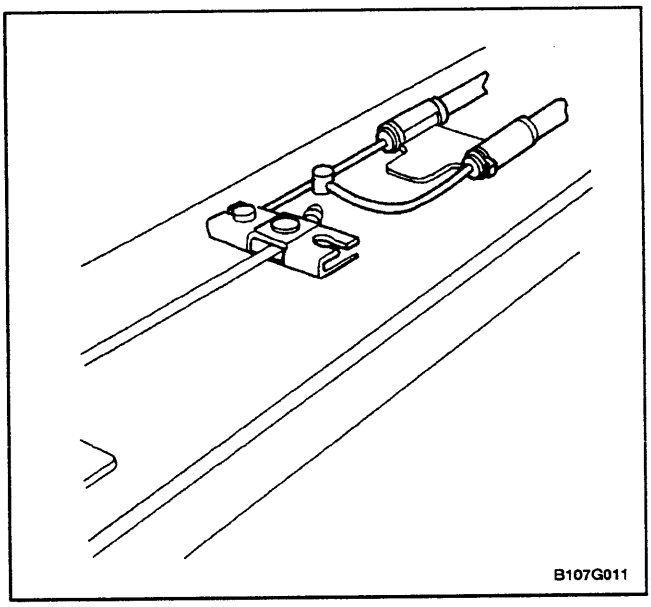
6. Install the parking brake/gearshift console hood. Refer to *Section 9G, Interior Trim*.



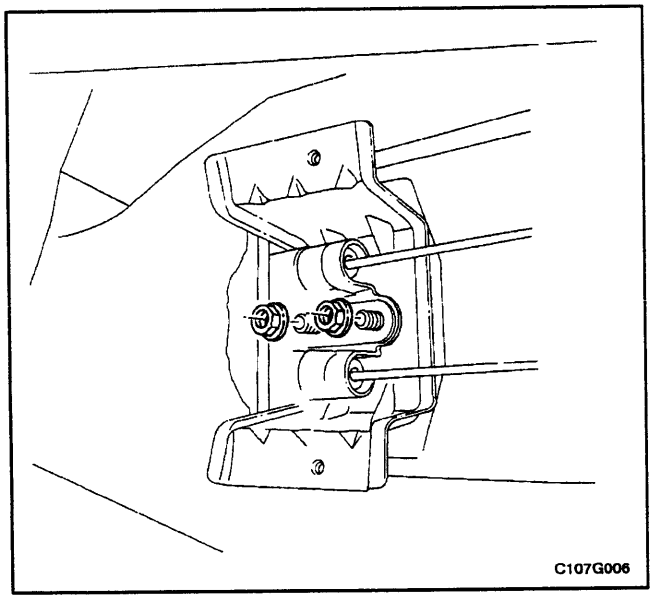
PARKING BRAKE CABLE

Removal Procedure

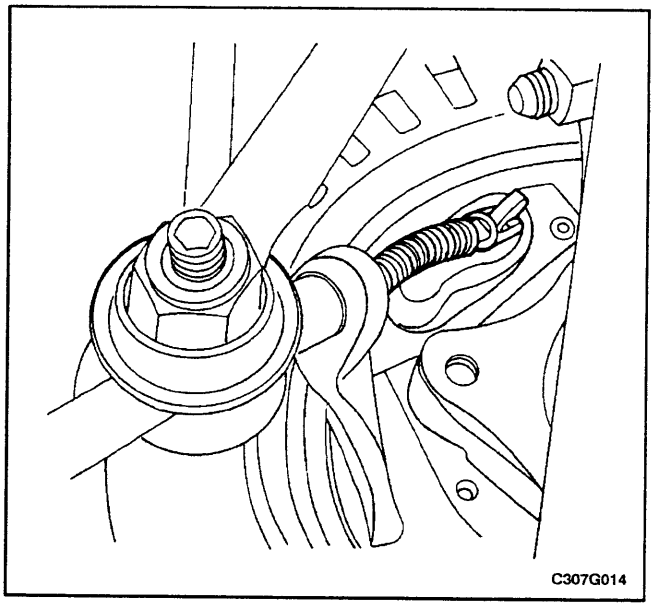
1. Remove the parking brake/gearshift console hood. Refer to *Section 9G, Interior Trim*.
2. If necessary, remove the screws and washers that secure the keyless entry receiver to the body bracket.



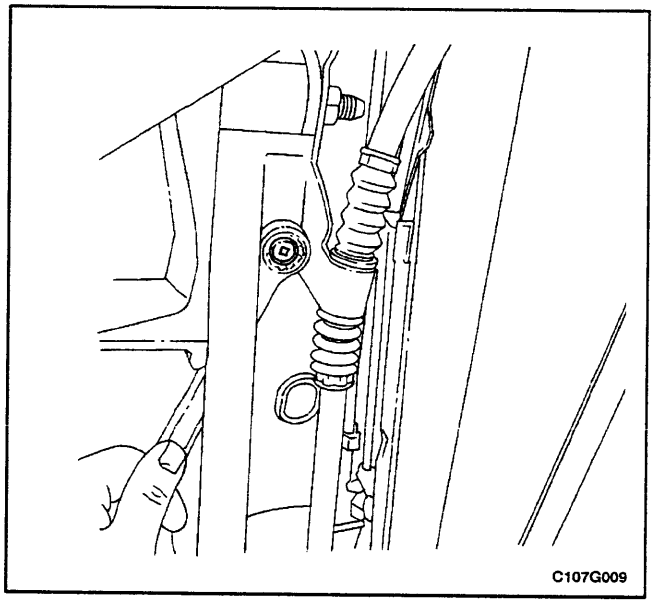
3. Loosen the parking brake adjustment nut from the eyebolt pull rod of the parking brake lever assembly.
4. Remove the parking brake cable ends from the equalizer, and remove the equalizer.



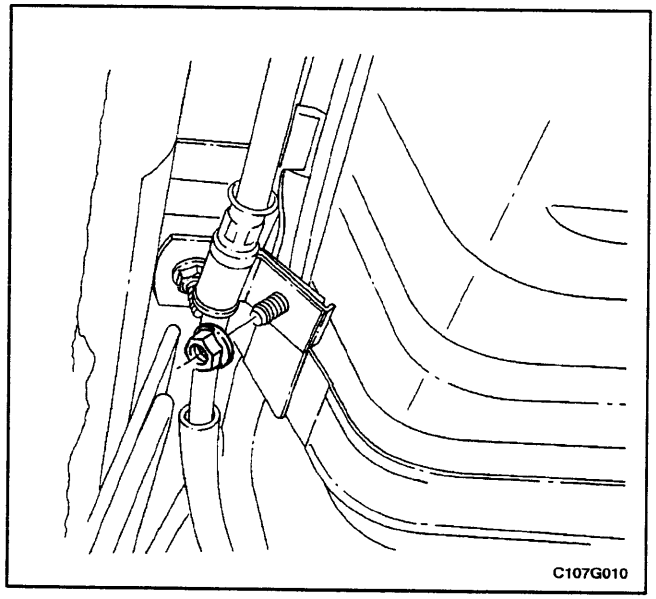
5. Remove the nuts that secure the parking brake cable to the console underbody mounting bracket.
6. Raise and suitably support the vehicle.
7. Remove the rear wheels. Refer to *Section 2E, Tires and Wheels*.



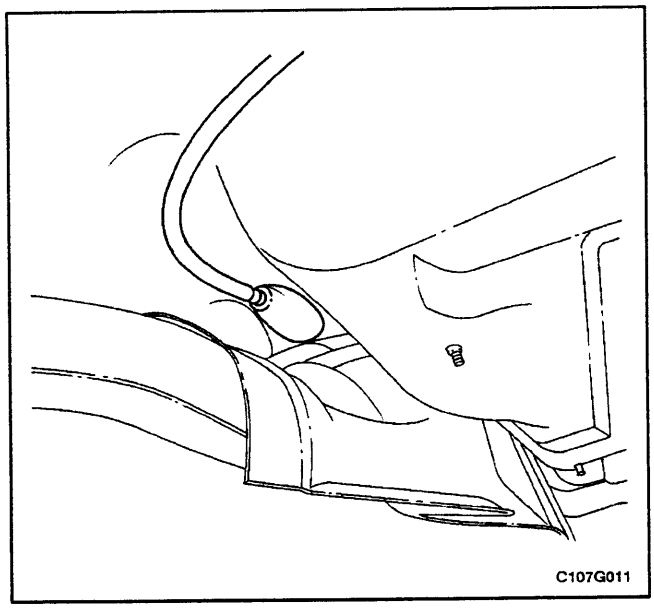
8. Unfasten the parking brake cable from the lever at the rear of the backing plate.
9. Remove the clip that holds the cable into the protruding hole on the rear knuckle assembly.



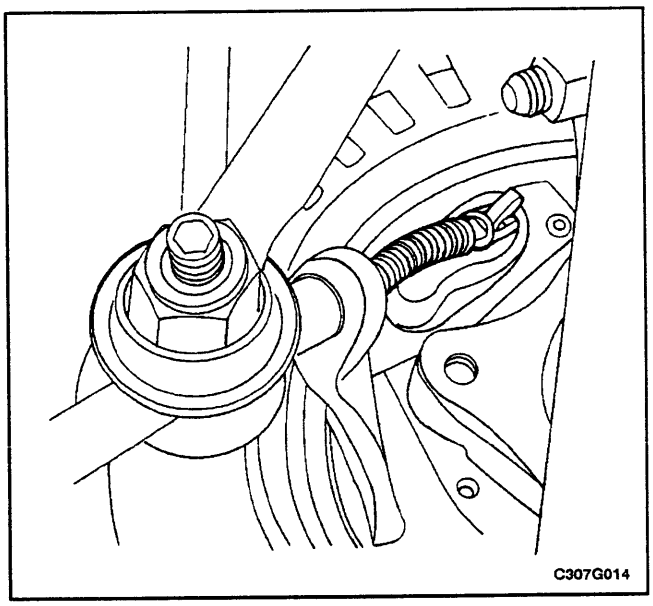
10. Remove the bolt securing the parking brake cable to a holding bracket attached to the trailing link brackets on both the driver and passenger sides of the vehicle.



11. Remove the nut that secures the parking brake cable to the bracket near the fuel tank strap (passenger and driver side).

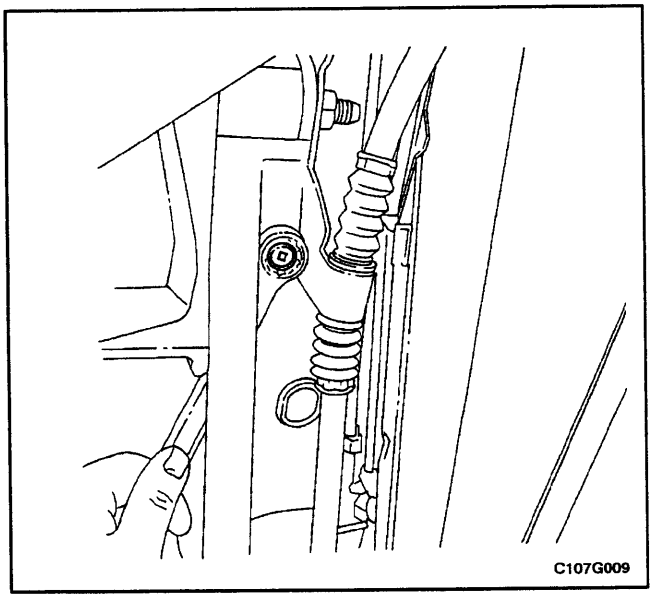


12. Remove the front muffler heat shield nuts, and let the shield rest on the front muffler.
13. Pull out each parking brake cable (and rubber grommet) from its underbody access to the parking brake/gearshift console.



Installation Procedure

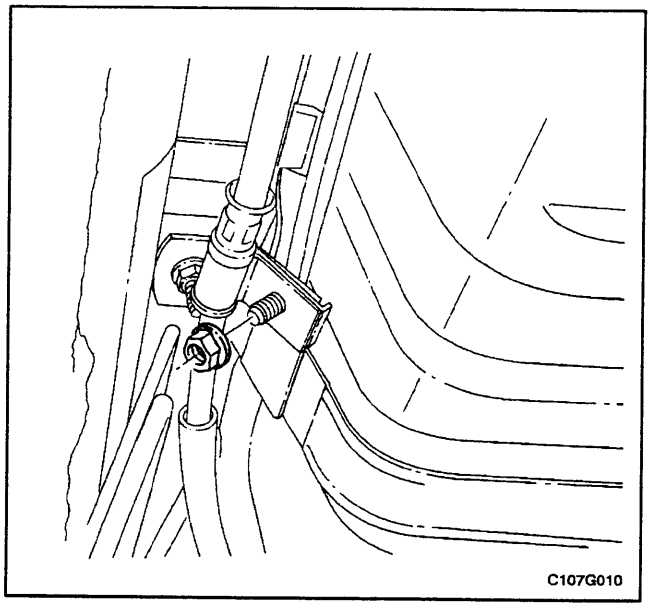
1. Route the parking brake cable to the protruding hole on the rear knuckle assembly.
2. Fasten the parking brake cable to the lever at the rear of the disc brake backing plate.
3. Install the clip that secures the parking brake cable to the protruding hole on the rear knuckle assembly.



4. Install the bolt securing the parking brake cable to a holding bracket attached to the trailing link bracket on both the driver and passenger sides of the vehicle.

Tighten

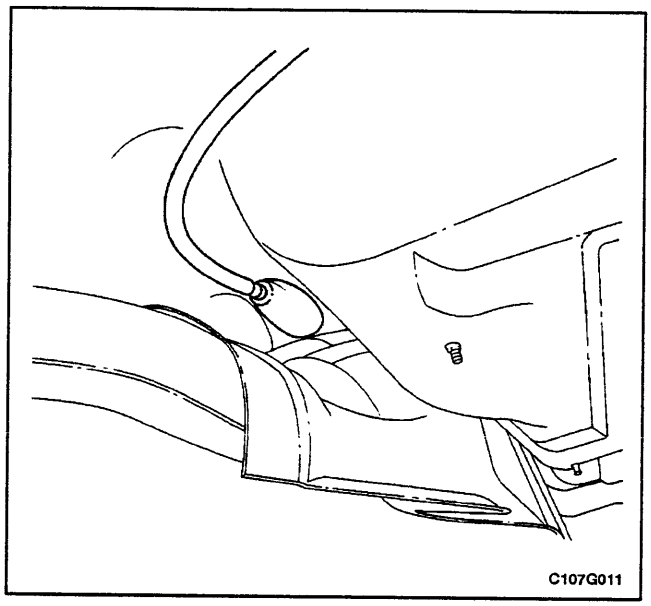
Tighten the parking brake cable bracket-to-trailing link bracket nuts to 90 N•m (66 lb-ft).


C107G010

5. Install the nut that secures the parking brake cable to the bracket near the fuel tank strap (passenger and driver side).

Tighten

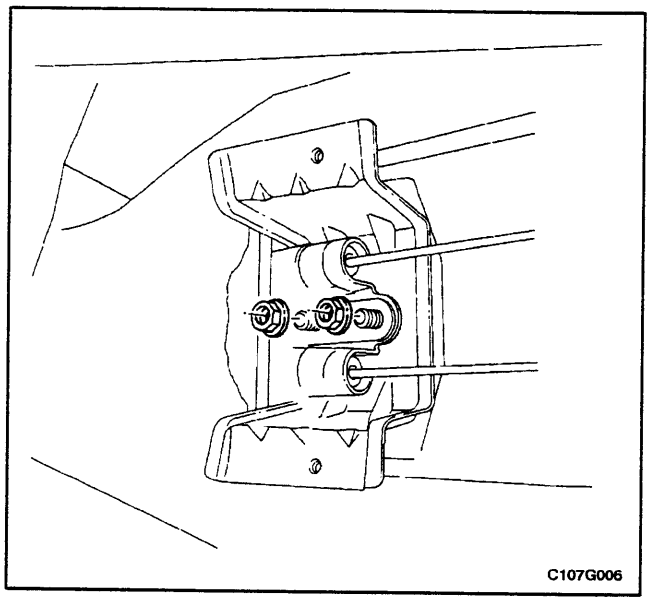
Tighten the parking brake cable nut to 12 N•m (106 lb-in).


C107G011

6. Route the parking brake cables through the access holes to the parking brake/gearshift console.
7. Install the rubber grommet for each cable.
8. Install the front muffler heat shield.

Tighten

Tighten the front muffler heat shield nuts to 2.5 N•m (22 lb-in).

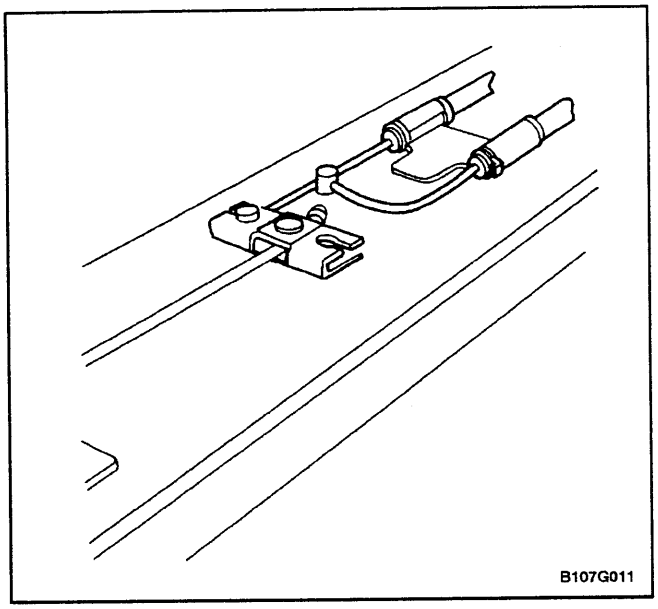

C107G006

9. Route the parking brake cable through the console-to-underbody mounting bracket and secure the bracket with the nuts.

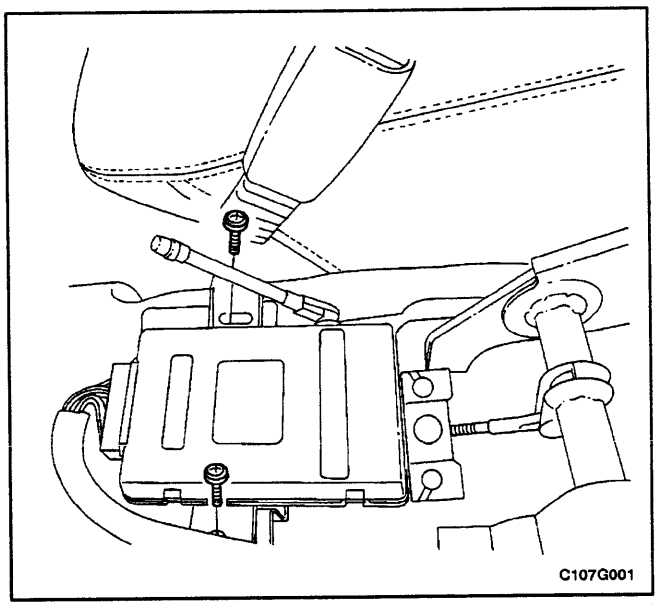
Tighten

Tighten the parking brake cable console mounting bracket nuts to 25 N•m (18 lb-ft).

10. Install the rear wheels. Refer to *Section 2E, Tires and Wheels*.
11. Lower the vehicle.


B107G011

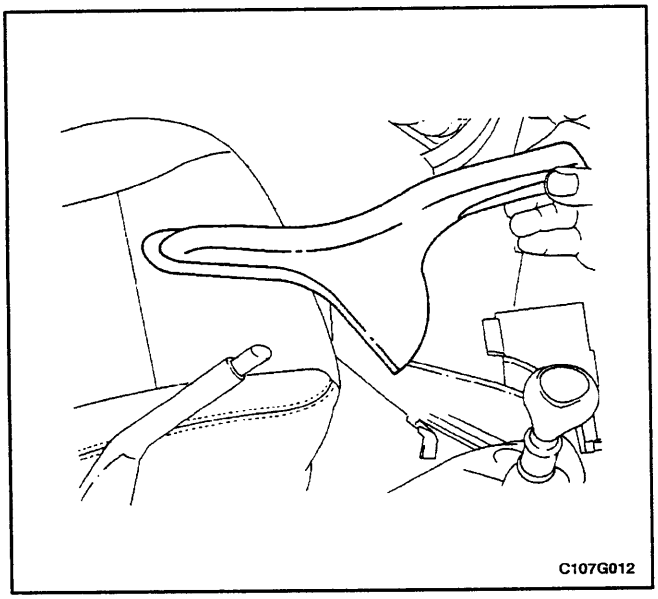
12. Attach the parking brake cable ends to the equalizer.


C107G001

13. Install the parking brake/gearshift console hood. Refer to *Section 9G, Interior Trim*.
14. Adjust the parking brake. Refer to "Parking Brake Adjustment" in this section.
15. Install the screws and washers securing the keyless entry receiver to the underbody bracket.

Tighten

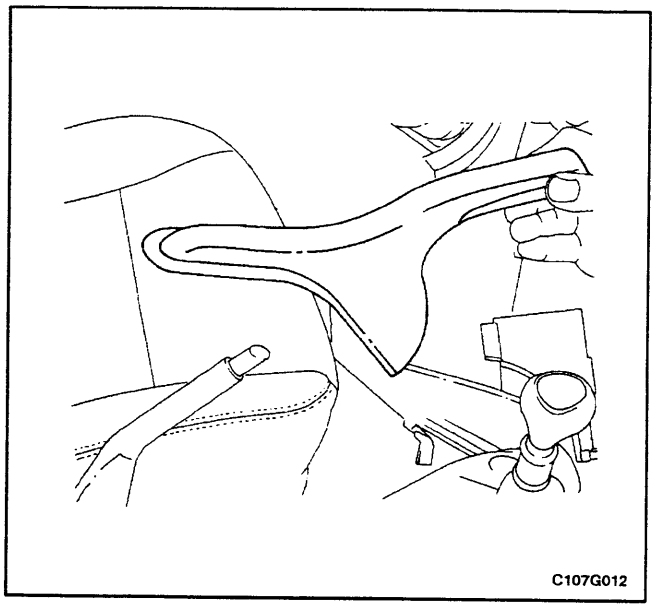
Tighten the keyless entry receiver screws to 10 N•m (89 lb-in).


C107G012

PARKING BRAKE HANDLE

Removal Procedure

1. Remove the parking brake/gearshift console hood. Refer to *Section 9G, Interior Trim*.
2. Slip the parking brake handle off of the parking brake lever.



Installation Procedure

1. Push the parking brake handle as far as it will go on the parking brake lever.
2. Install the parking brake/gearshift console hood. Refer to *Section 9G, Interior Trim*.

GENERAL DESCRIPTION AND SYSTEM OPERATION

PARKING BRAKE

This braking system uses a BRAKE warning light located in the instrument panel cluster. When the ignition switch is in the START position, the BRAKE warning light should glow and go OFF when the the ignition switch returns to the RUN position. Whenever the parking brake is applied and the ignition switch is ON, the BRAKE warning light should glow.

When the brake is firmly applied, the parking brake should hold the vehicle with ample pedal travel remaining. Check for frayed cables, rust, etc. or any condition that many inhibit present (or future) free movement of the parking brake lever assembly.

TRANSMISSION / TRANSAXLE

CONTENTS

SECTION 5A

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

ZF 4 HP 14 AUTOMATIC TRANSAXLE

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SPECIFICATIONS

TRANSAXLE SPECIFICATIONS

Transaxle Capacity	
Input Torque	100-270 N•m (74-199 lb-ft)
Maximum Torque Multiplication of the Different Torque Converters	1.9-2.5
Torque Converter Diameter	260 mm (10.2 in.)
Ratios	
First Gear	2.412:1
Second Gear	1.369:1
Third Gear	1.000:1
Fourth Gear	0.739:1
Reverse	2.828:1
Measurements	
Weight of Transaxle	55 kg (121.3 lb)
Weight of Torque Converter	10.5 kg (23.15 lb)
Fluid Capacity	6.0L (1.98 gal)
Automatic Transaxle Fluid	Dexron®-III or Mercon®-IV

FLUID LEVEL SET AFTER SERVICE

Repair	Amount of Fluid to Add After Repair
Bottom Pan Removal/Installation	4L (1.1 gal)
New Converter Installation	2L (0.5 gal)
Complete Overhaul	5.4L (1.45 gal)

Important: Make sure to maintain the proper fluid level in the transaxle. After each repair or service procedure, add the amount of fluid specified and then check to confirm that the transaxle contains the appropriate fluid level. See "Transaxle Fluid Level Checking Procedure" in this section.

FASTENER TIGHTENING SPECIFICATIONS

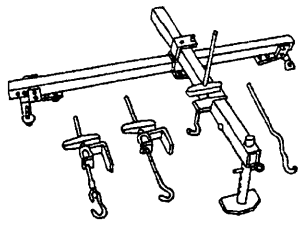
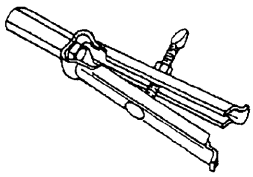
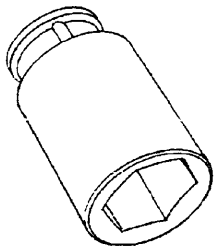
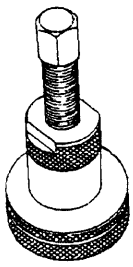
Application	N•m	Lb-Ft	Lb-In
Band C' Adjusting Bolt	10	-	89
Band C' Locking Nut	80	59	-
Bell Housing Bolts	23	17	-
Bell Housing-to-Engine Lower Bolts	75	55	-
Bell Housing-to-Engine Upper Bolts	75	55	-
Case Extension Housing Attachment Bolts	43	32	-
Clutch A and Brake D Housing Attachment Bolts	8	-	71
Cooler Pipe-to-Radiator Fastener Bolt	25	18	-
Cooler Pipe-to-Radiator Nuts	22	16	-
Cooler Pipe-to-Transaxle Case Bolts	22	16	-

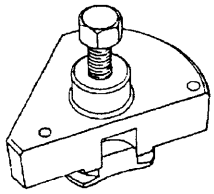
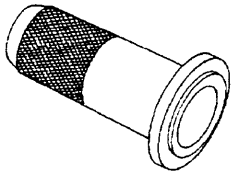
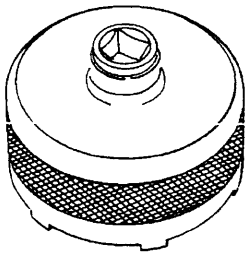
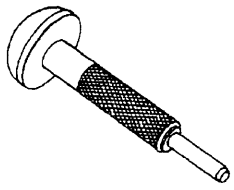
Fastener Tightening Specifications (Cont'd)

Application	N•m	Lb-Ft	Lb-In
Cooler Pipe-to-Transaxle Case Fastener Bolt	25	18	-
Coolant Surge Tank Mounting Bolts	25	18	-
Counterweight Bolt	10	-	89
Differential Adjustment Tool	7	-	62
Fluid Filter Housing Cover Attaching Bolts	8	-	71
Fluid Pan Connecting Bolts	10	-	89
Fluid Pan Drain Plug	15	11	-
Governor Housing Bolts	10	-	89
Grooved Nut	50	37	-
Intermediate Plate-to-Housing Bolts	10	-	89
Intermediate Plate-to-Pump Assembly Connecting Bolts	10	-	89
Large Spur Gear Securing Bolt	150	110	-
Lower Cover Attachment Bolts	8	-	71
Lower Fluid Filler Tube Attachment Nut	15	11	-
Lower Valve Housing Attachment Bolts	8	-	71
Lower Valve Housing Exterior Cover Bolts	8	-	71
Lower Valve Housing Interior Cover Bolts	8	-	71
Neutral Start Switch Connecting Nut	40	30	-
Shift Control Cable Attachment Nut	6	-	53
Shift Control Cable Adjuster Pinch Bolt Nut	8	-	71
Shift Control Cable Mounting Bracket Nuts	6	-	53
Shift Interlock Solenoid Bolts	8	-	71
Shuttle Valve Cover Attachment Bolts	8	-	71
Side Cover Pan Connecting Bolts	10	-	89
Side Shaft Outer Ring Securing Bolts	20	15	-
Small Spur Gear Securing Bolt (First Torque)	10	-	89
Small Spur Gear Securing Bolt (Second Torque)	20	15	-
Spring Plate Detent Screws	10	-	89
Throttle Valve Cable Cam Detent Screw	10	-	89
Torque Converter-to-Flywheel Bolts	60	44	-
Transaxle Center Bracket-to-Engine Bolt	90	66	-
Transaxle Center Bracket-to-Transaxle Bolts	90	66	-
Transaxle Center Mount-to-Center Member Bolts	65	48	-
Transaxle Left Bracket Connecting Bolts	48	35	-
Transaxle Left Mount-to-Body Connecting Bolts	58	43	-
Transaxle Left Mount-to-Transaxle Left Bracket Connecting Bolt	48	35	-
Upper Fluid Filler Tube Attachment Bolt	20	15	-
Valve Body Bolts	8	-	71
Valve Housing Control Valve Side Cover Attachment Bolts	8	-	71
Valve Housing Damper Valve Side Cover Attachment Bolts	8	-	71

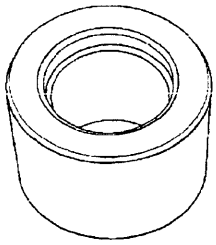
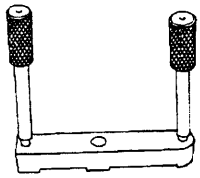
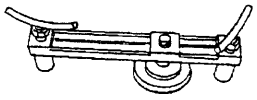
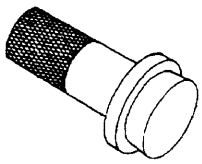
SPECIAL TOOLS

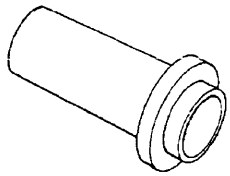
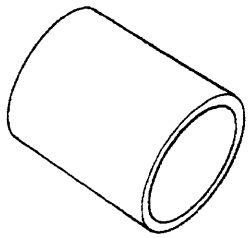
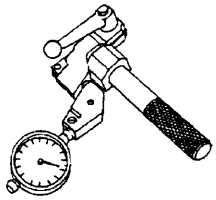
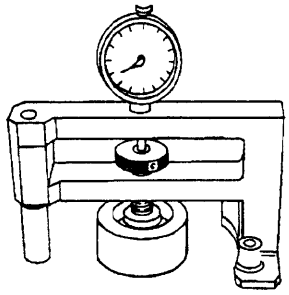
SPECIAL TOOLS TABLE

 A102B152	J-28467-B Engine Support Fixture
 B103A220	J-26941 Ring Puller
 B103A221	KA-001-023 Bolt Remover
 B103A213	KA-001-060 Bearing Remover

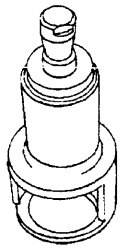
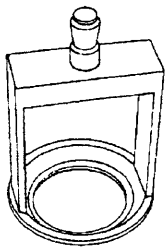
 B103A216	KA-002-088 Differential Adjustment Tool
 B103A207	KA-002-111 Bearing Race Installer
 B103A222	KA-000-155 Grooved Nut Socket
 B103A217	KA-000-187 Seal Ring Punch

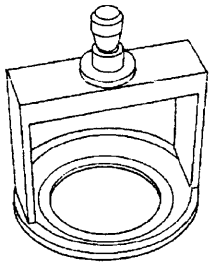
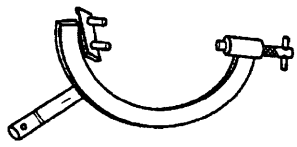
SPECIAL TOOLS TABLE (Cont'd)

 B103A212	KA-000-232 Bearing Remover
 B103A210	KA-000-287 Securing Device
 B103A219	KA-000-288 Side Shaft Retainer
 B103A209	KA-000-298 Bearing Ring Remover/Installer

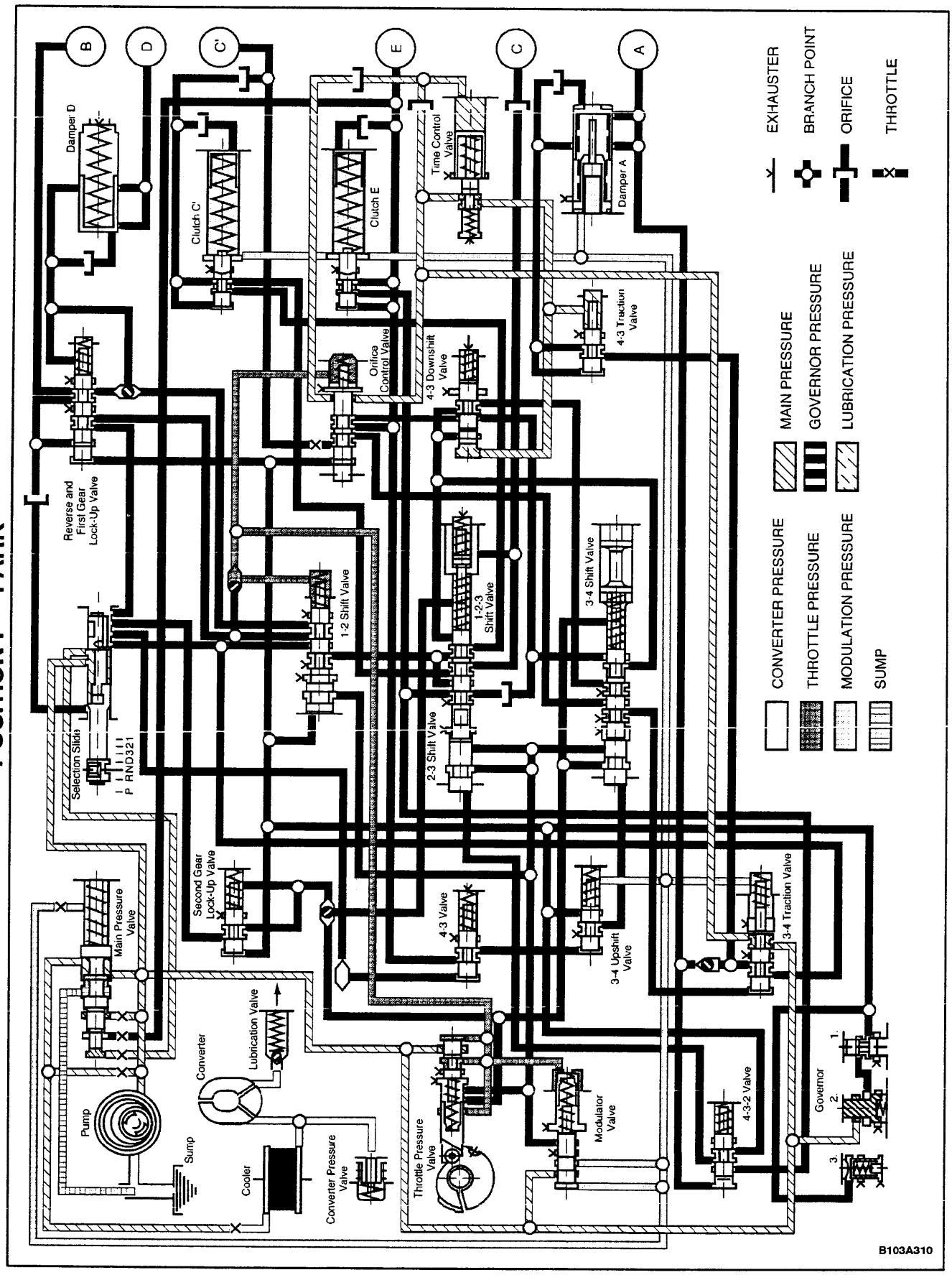
 B103A208	KA-000-299 Seal Ring Installer
 B103A223	KA-000-300 Bearing Installer
 B103A211	KA-001-483 Axial Clearance Measurement Tool
 B103A224	KA-001-655 Spur Gear Clearance Measurement Tool

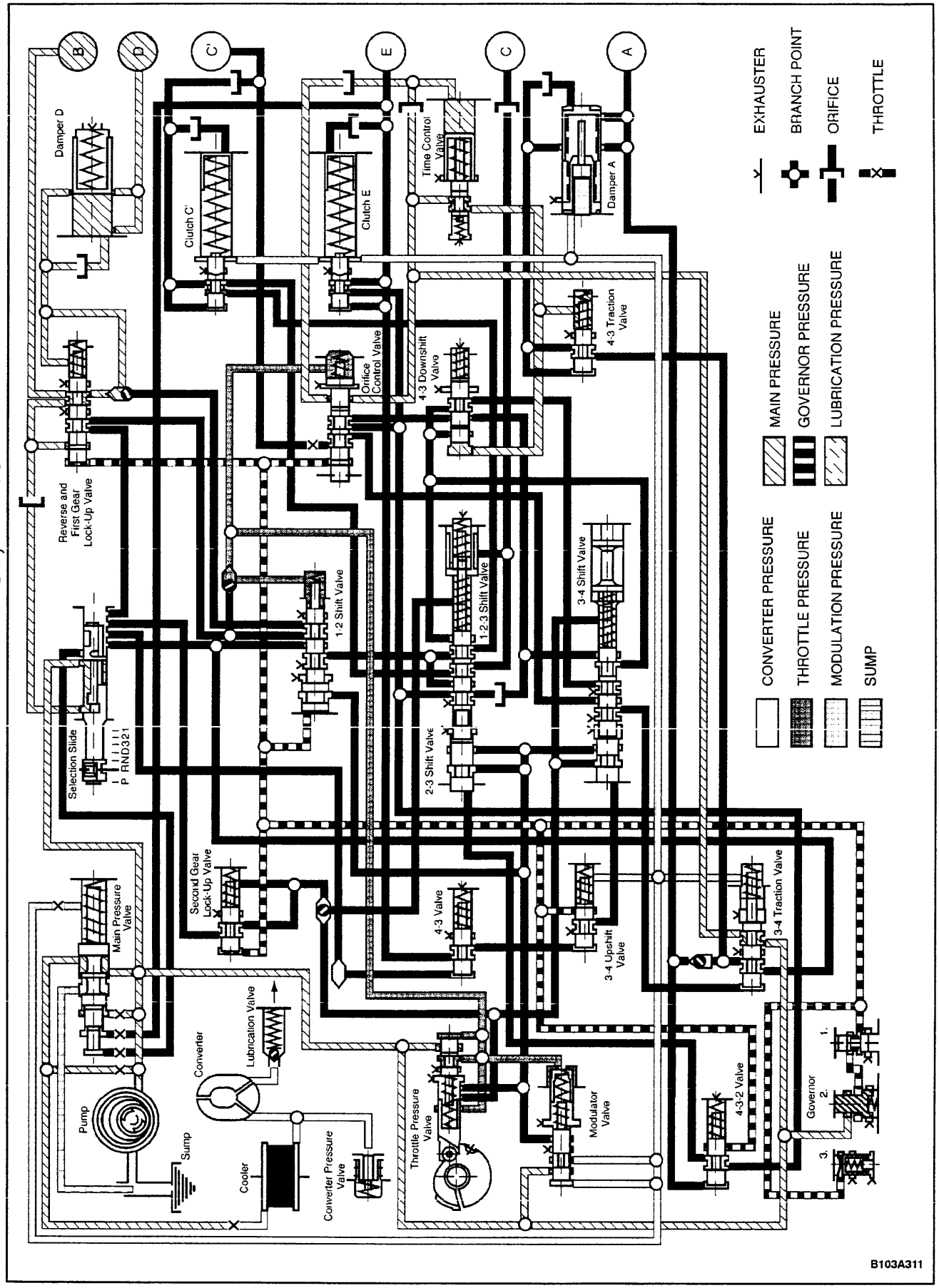
SPECIAL TOOLS TABLE (Cont'd)

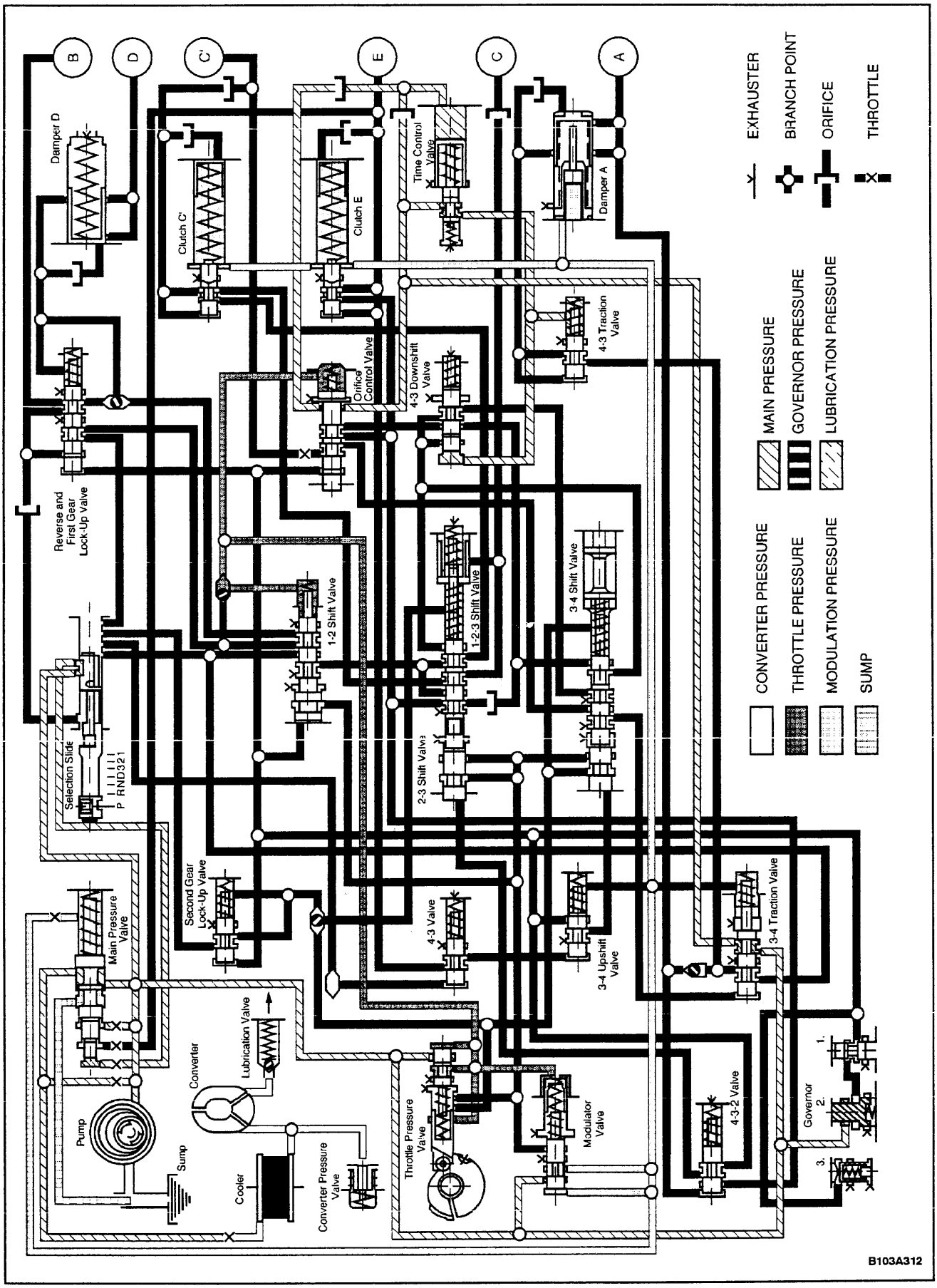
 B103A215	**KA-001-715-04 Bearing Remover**
 B103A214	**KA-000-913 Compression Adapter**

 B103A218	**KA-000-914 Compression Adapter**
 C303A001	**KA-000-914 Compression Adapter**

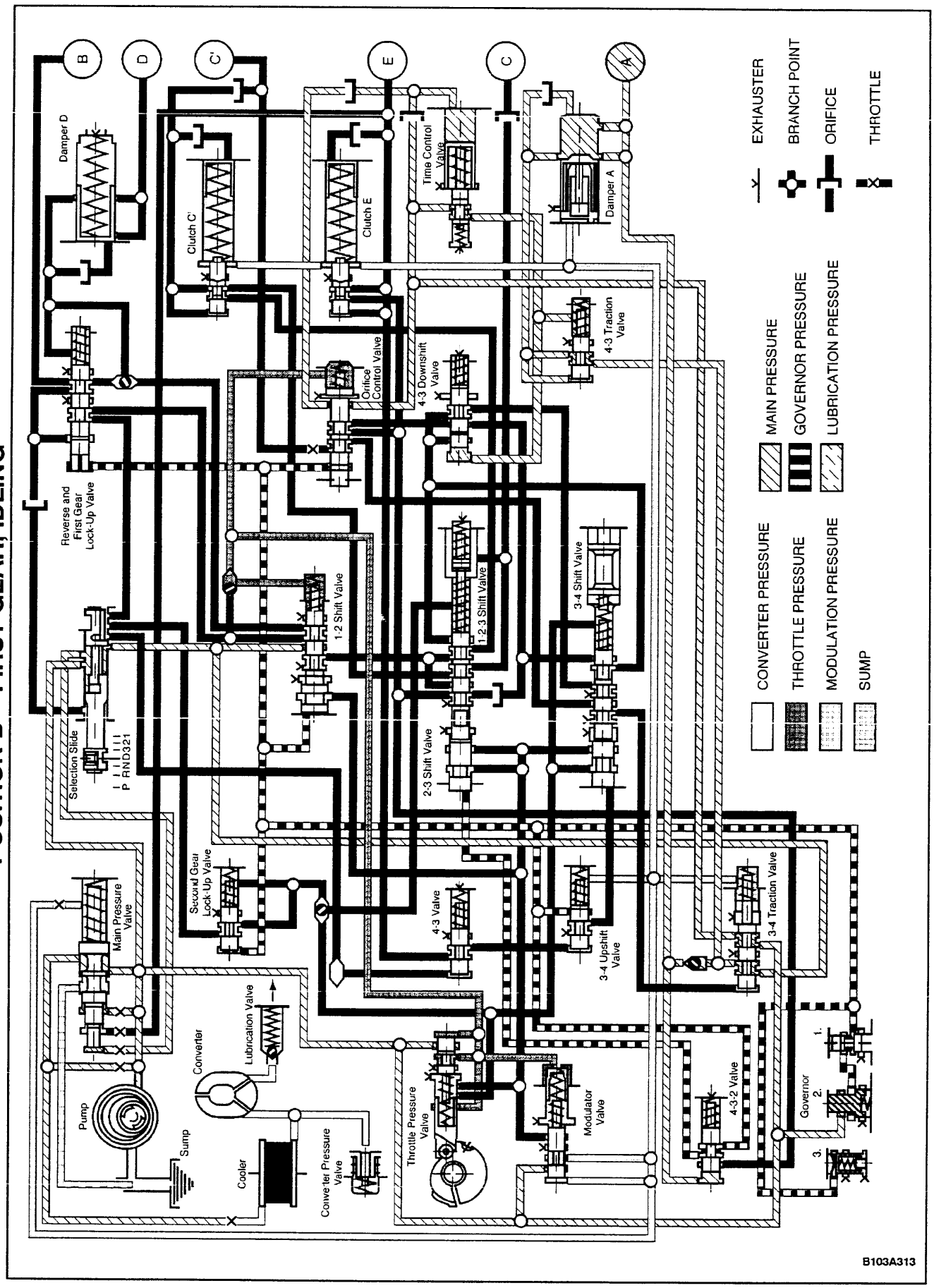
SCHEMATIC AND ROUTING DIAGRAMS

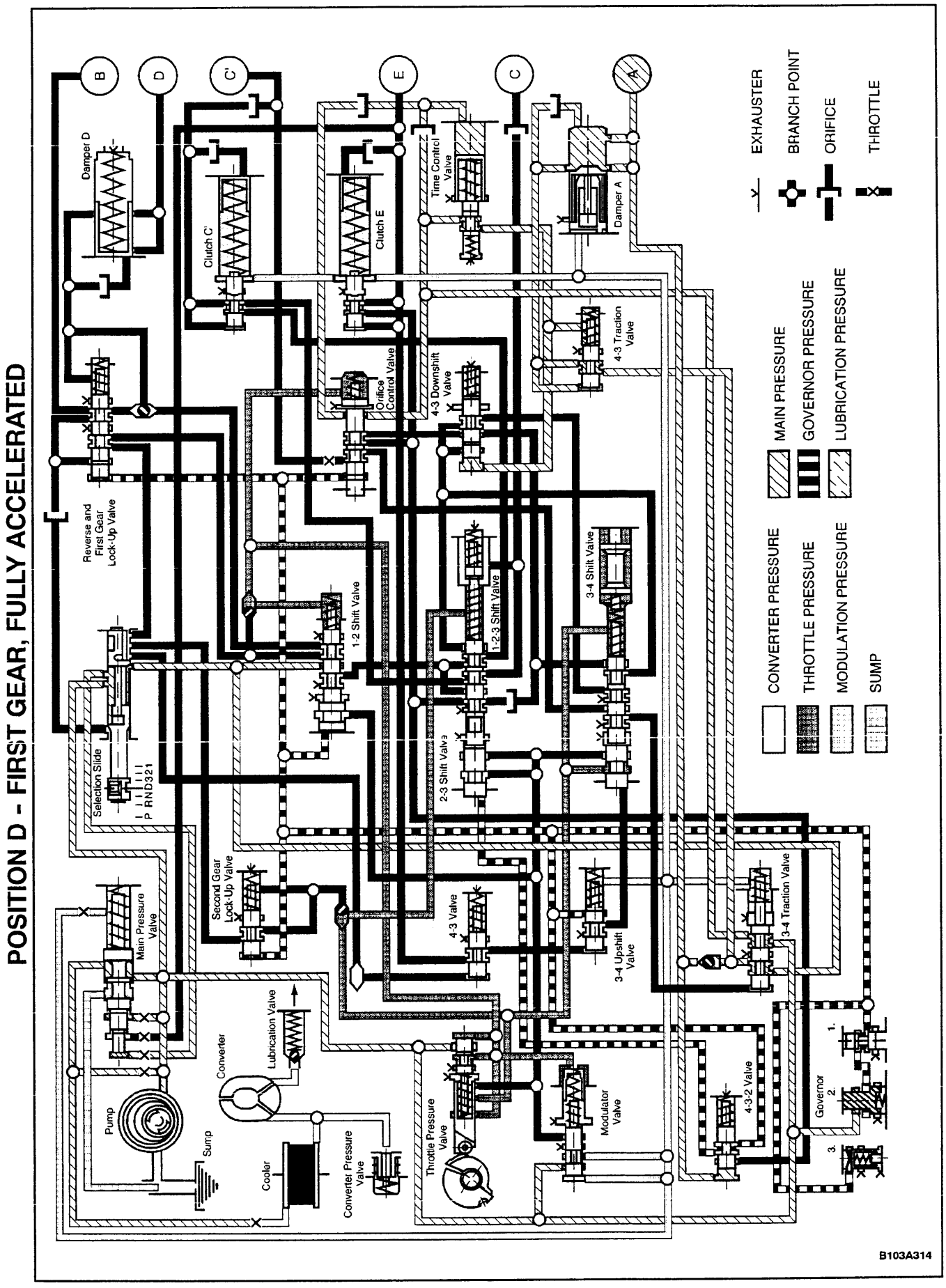



POSITION R - REVERSE, IDLING
B
B
C'
E
C
A
Damper D
Clutch C'
Clutch E
Time Control Valve
Damper A
Reverse and First Gear Lock-Up Valve
Orifice Control Valve
4-3 Downshift Valve
4-3 Traction Valve
1-2 Shift Valve
1-2-3 Shift Valve
3-4 Shift Valve
Selection Slide
P R N D 3 2 1
2-3 Shift Valve
Second Gear Lock-Up Valve
Main Pressure Valve
4-3 Valve
3-4 Upshift Valve
3-4 Traction Valve
Lubrication Valve
Converter
Pump
Sump
Cooler
Converter Pressure Valve
Throttle Pressure Valve
Modulator Valve
4-3-2 Valve
Governor
1.
2.
3.
EXHAUSTER
BRANCH POINT
ORIFICE
THROTTLE
MAIN PRESSURE
GOVERNOR PRESSURE
LUBRICATION PRESSURE
CONVERTER PRESSURE
THROTTLE PRESSURE
MODULATION PRESSURE
SUMP
B103A311

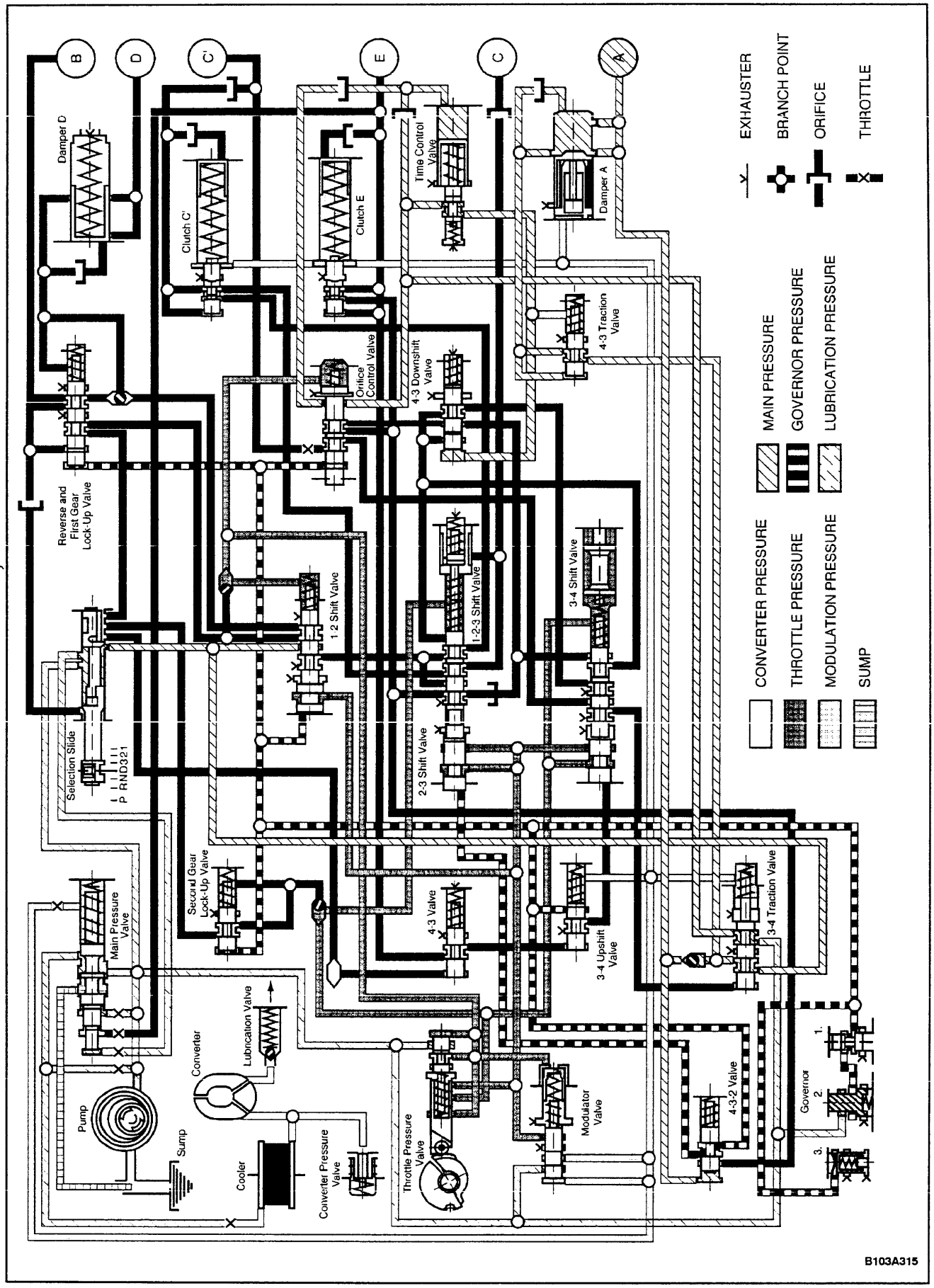

POSITION N - NEUTRAL
B
D
C'
E
C
A
Damper D
Clutch C'
Clutch E
Time Control Valve
Damper A
Reverse and First Gear Lock-Up Valve
Orifice Control Valve
4-3 Downshift Valve
4-3 Traction Valve
1-2 Shift Valve
1-2-3 Shift Valve
3-4 Shift Valve
Selection Slide
P R N D 3 2 1
2-3 Shift Valve
Second Gear Lock-Up Valve
Main Pressure Valve
4-3 Valve
3-4 Upshift Valve
3-4 Traction Valve
Lubrication Valve
Converter
Pump
Sump
Cooler
Converter Pressure Valve
Throttle Pressure Valve
Modulator Valve
4-3-2 Valve
Governor
1.
2.
3.
EXHAUSTER
BRANCH POINT
ORIFICE
THROTTLE
MAIN PRESSURE
GOVERNOR PRESSURE
LUBRICATION PRESSURE
CONVERTER PRESSURE
THROTTLE PRESSURE
MODULATION PRESSURE
SUMP
B103A312

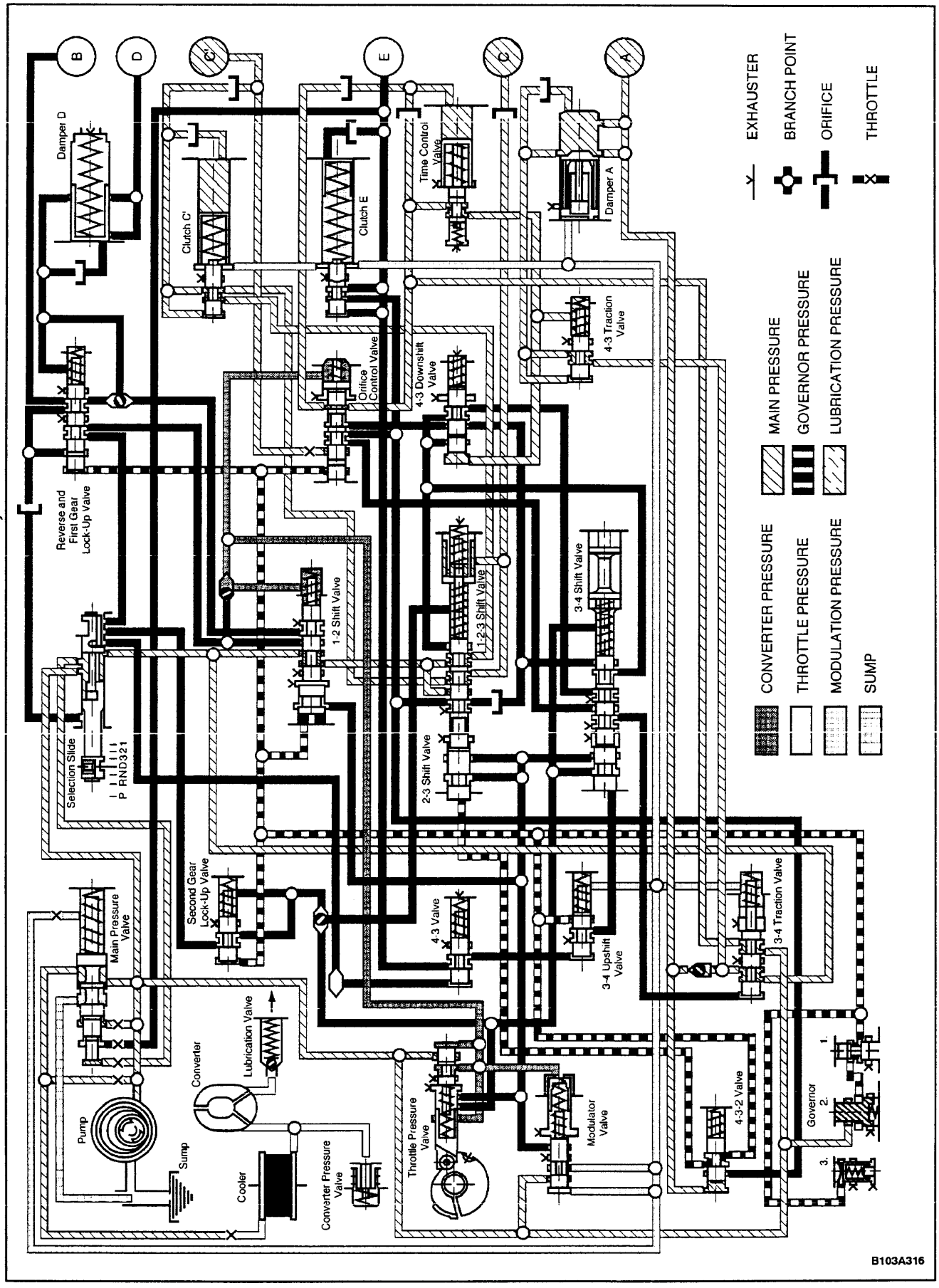
POSITION D - FIRST GEAR, IDLING

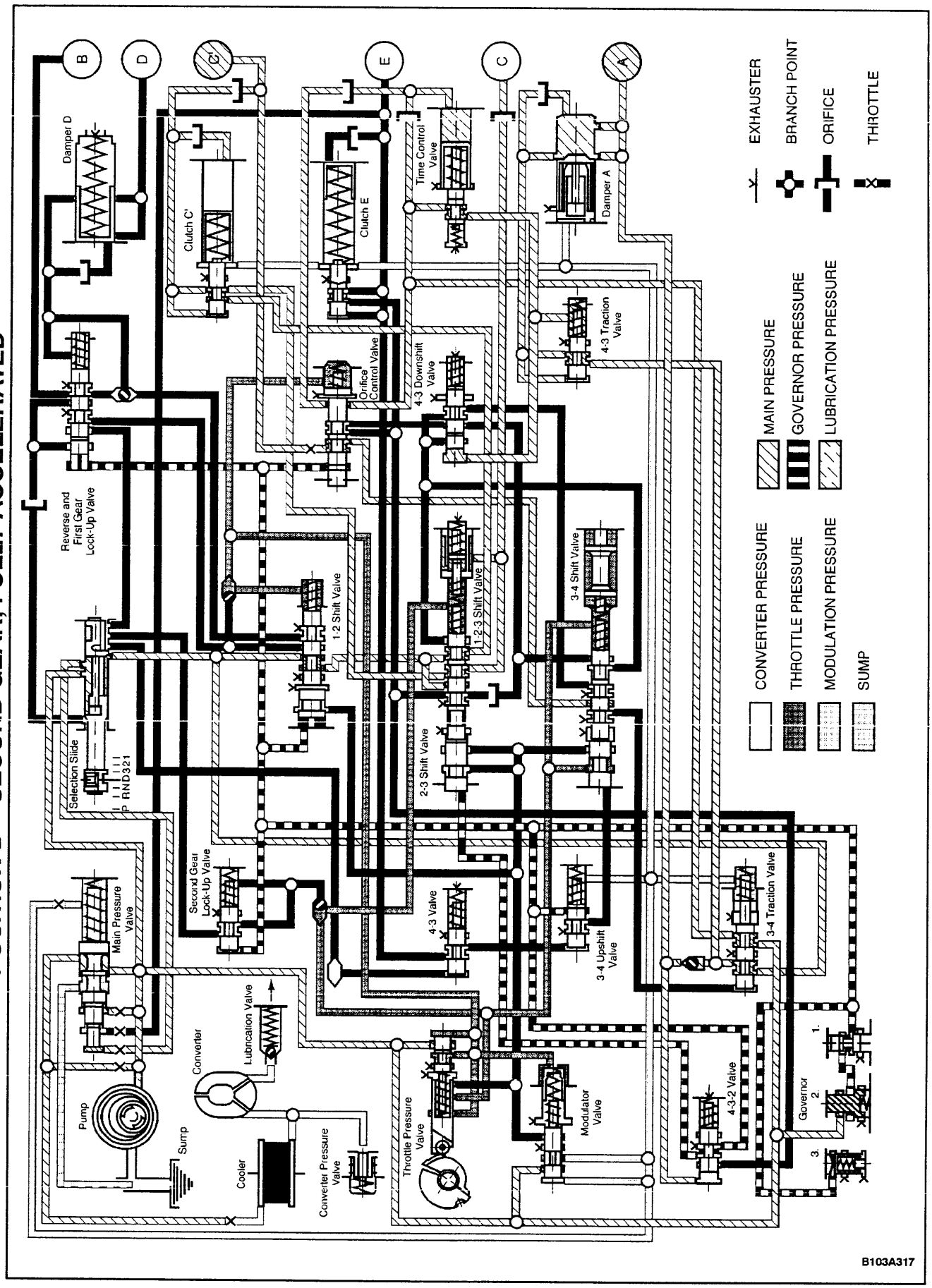



POSITION D - FIRST GEAR, FULLY ACCELERATED
B
D
C'
E
C
A
Damper D
Clutch C'
Clutch E
Time Control Valve
Damper A
Reverse and First Gear Lock-Up Valve
Orifice Control Valve
4-3 Downshift Valve
4-3 Traction Valve
1-2 Shift Valve
1-2-3 Shift Valve
3-4 Shift Valve
Selection Slide
P R N D 3 2 1
2-3 Shift Valve
Second Gear Lock-Up Valve
Main Pressure Valve
4-3 Valve
3-4 Upshift Valve
3-4 Traction Valve
Lubrication Valve
Converter
Pump
Sump
Cooler
Converter Pressure Valve
Throttle Pressure Valve
Modulator Valve
4-3-2 Valve
Governor
1.
2
3.
EXHAUSTER
BRANCH POINT
ORIFICE
THROTTLE
CONVERTER PRESSURE
MAIN PRESSURE
THROTTLE PRESSURE
GOVERNOR PRESSURE
MODULATION PRESSURE
LUBRICATION PRESSURE
SUMP
B103A314

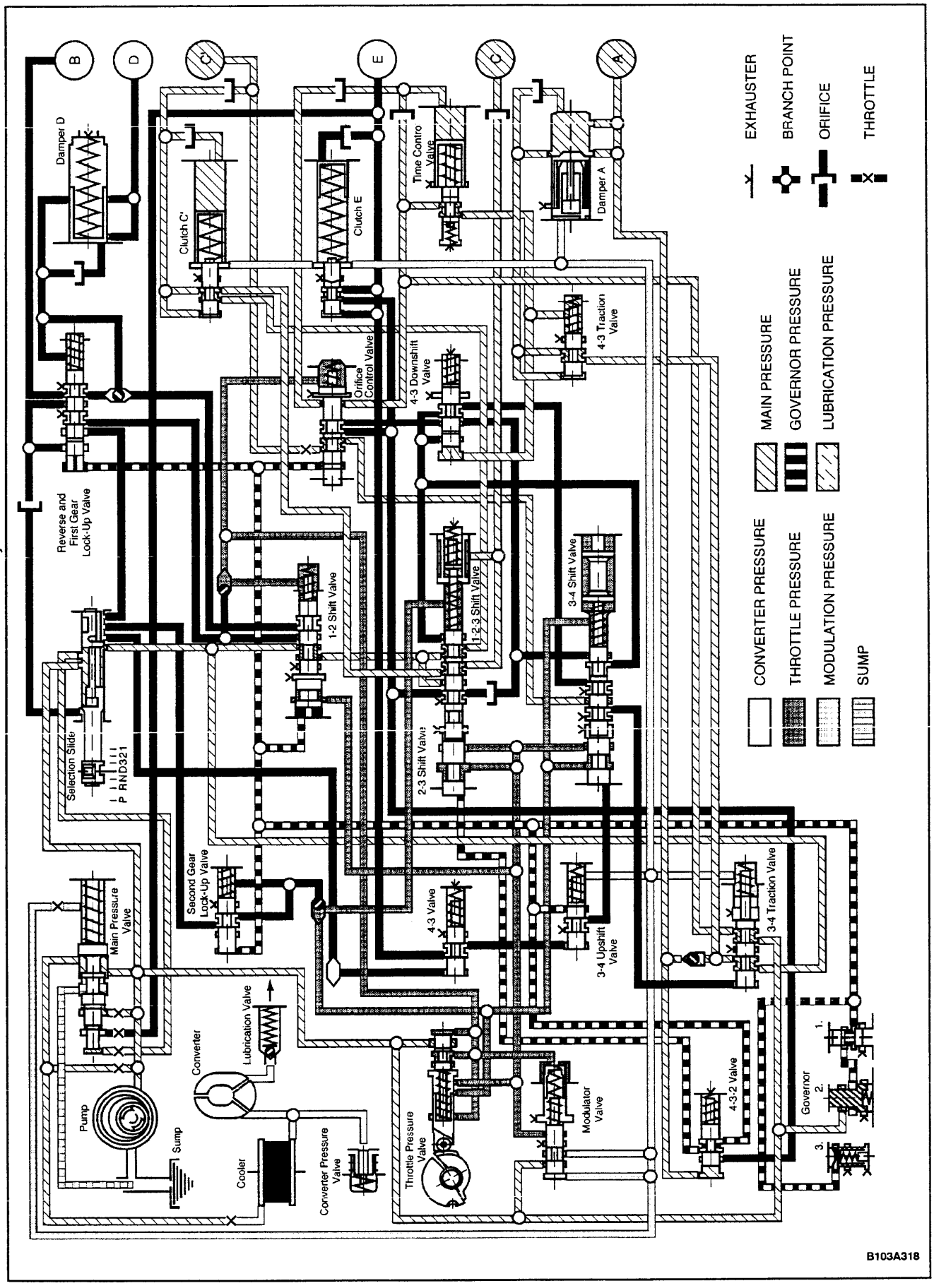
POSITION D - FIRST GEAR, KICKDOWN



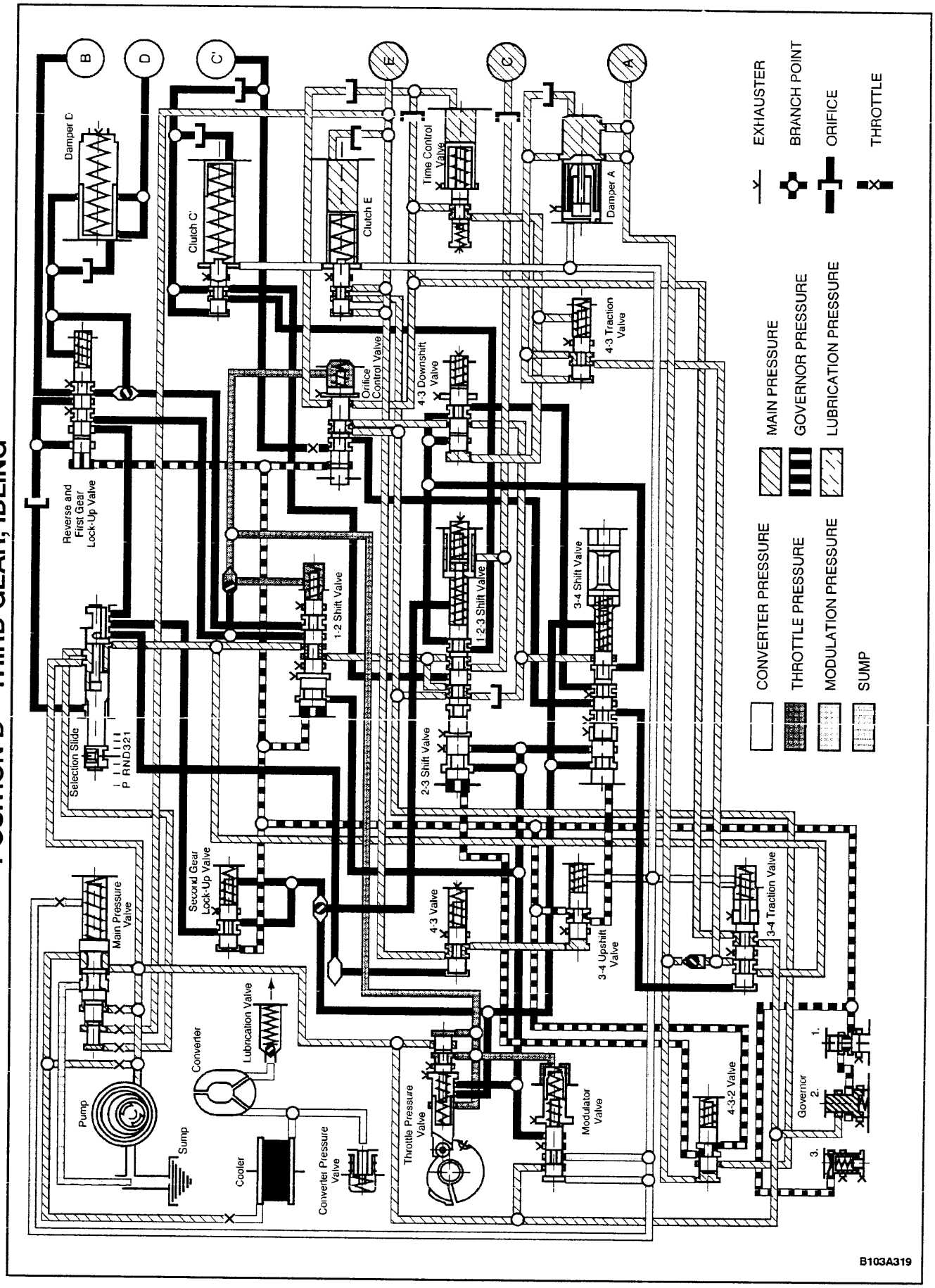

POSITION D - SECOND GEAR, IDLING
B
D
C'
E
C
A
Damper D
Clutch C'
Clutch E
Time Control Valve
Damper A
Orifice Control Valve
4-3 Downshift Valve
4-3 Traction Valve
Reverse and First Gear Lock-Up Valve
1-2 Shift Valve
1-2-3 Shift Valve
3-4 Shift Valve
Selection Slide
P R N D 3 2 1
2-3 Shift Valve
Second Gear Lock-Up Valve
Main Pressure Valve
4-3 Valve
3-4 Upshift Valve
3-4 Traction Valve
Converter
Lubrication Valve
Pump
Sump
Cooler
Converter Pressure Valve
Throttle Pressure Valve
Modulator Valve
4-3-2 Valve
Governor
1.
2.
3.
EXHAUSTER
BRANCH POINT
ORIFICE
THROTTLE
CONVERTER PRESSURE
MAIN PRESSURE
THROTTLE PRESSURE
GOVERNOR PRESSURE
MODULATION PRESSURE
LUBRICATION PRESSURE
SUMP
B103A316

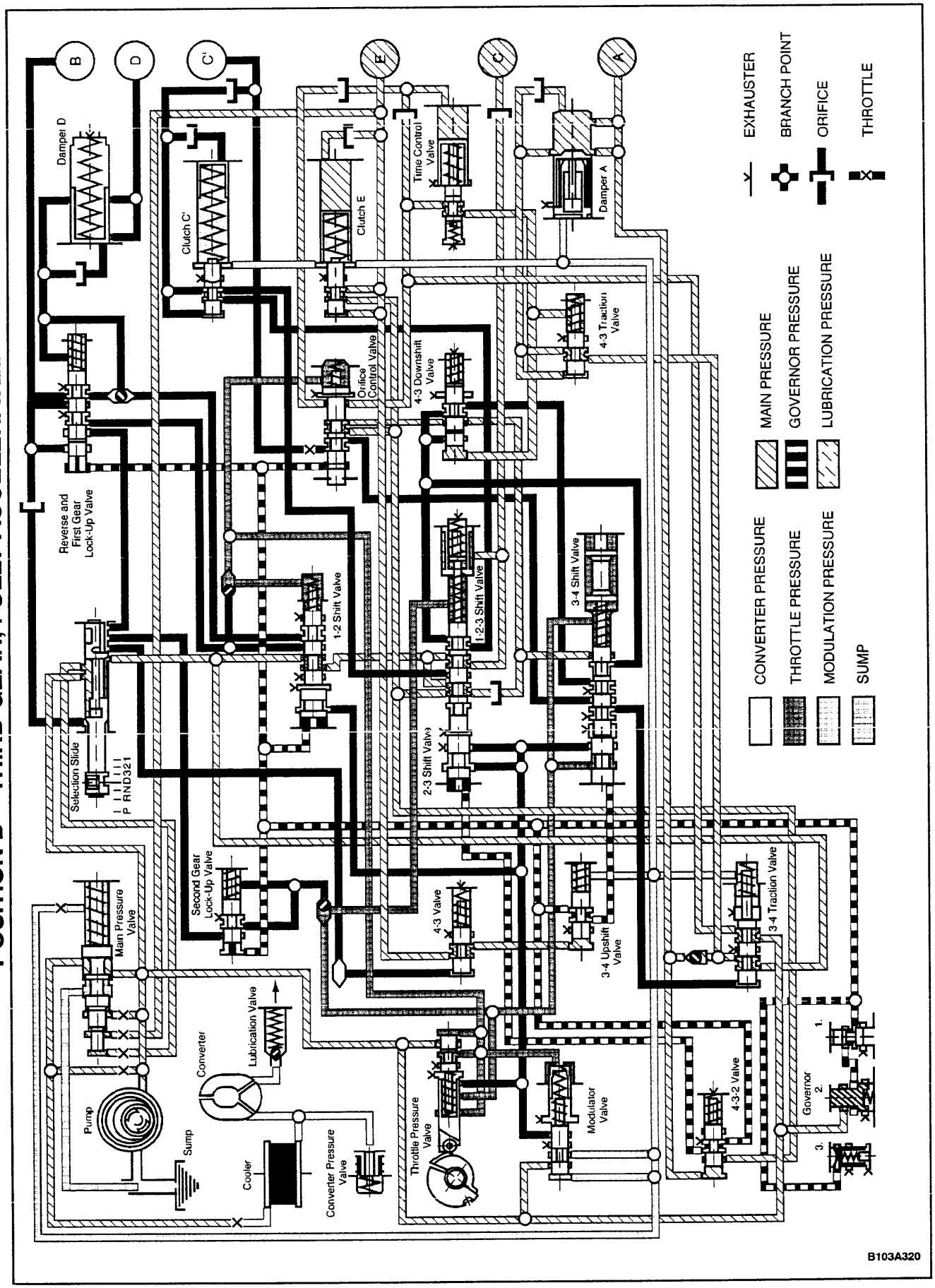

POSITION D - SECOND GEAR, FULLY ACCELERATED
B
D
C'
E
C
A
Damper D
Clutch C'
Clutch E
Time Control Valve
Damper A
Orifice Control Valve
4-3 Downshift Valve
4-3 Traction Valve
Reverse and First Gear Lock-Up Valve
1-2 Shift Valve
1-2-3 Shift Valve
3-4 Shift Valve
Selection Slide
P R N D 3 2 1
2-3 Shift Valve
Second Gear Lock-Up Valve
4-3 Valve
3-4 Upshift Valve
3-4 Traction Valve
Main Pressure Valve
Converter
Lubrication Valve
Pump
Sump
Cooler
Converter Pressure Valve
Throttle Pressure Valve
Modulator Valve
4-3-2 Valve
Governor
1.
2.
3.
EXHAUSTER
BRANCH POINT
ORIFICE
THROTTLE
CONVERTER PRESSURE
MAIN PRESSURE
THROTTLE PRESSURE
GOVERNOR PRESSURE
MODULATION PRESSURE
LUBRICATION PRESSURE
SUMP
B103A317

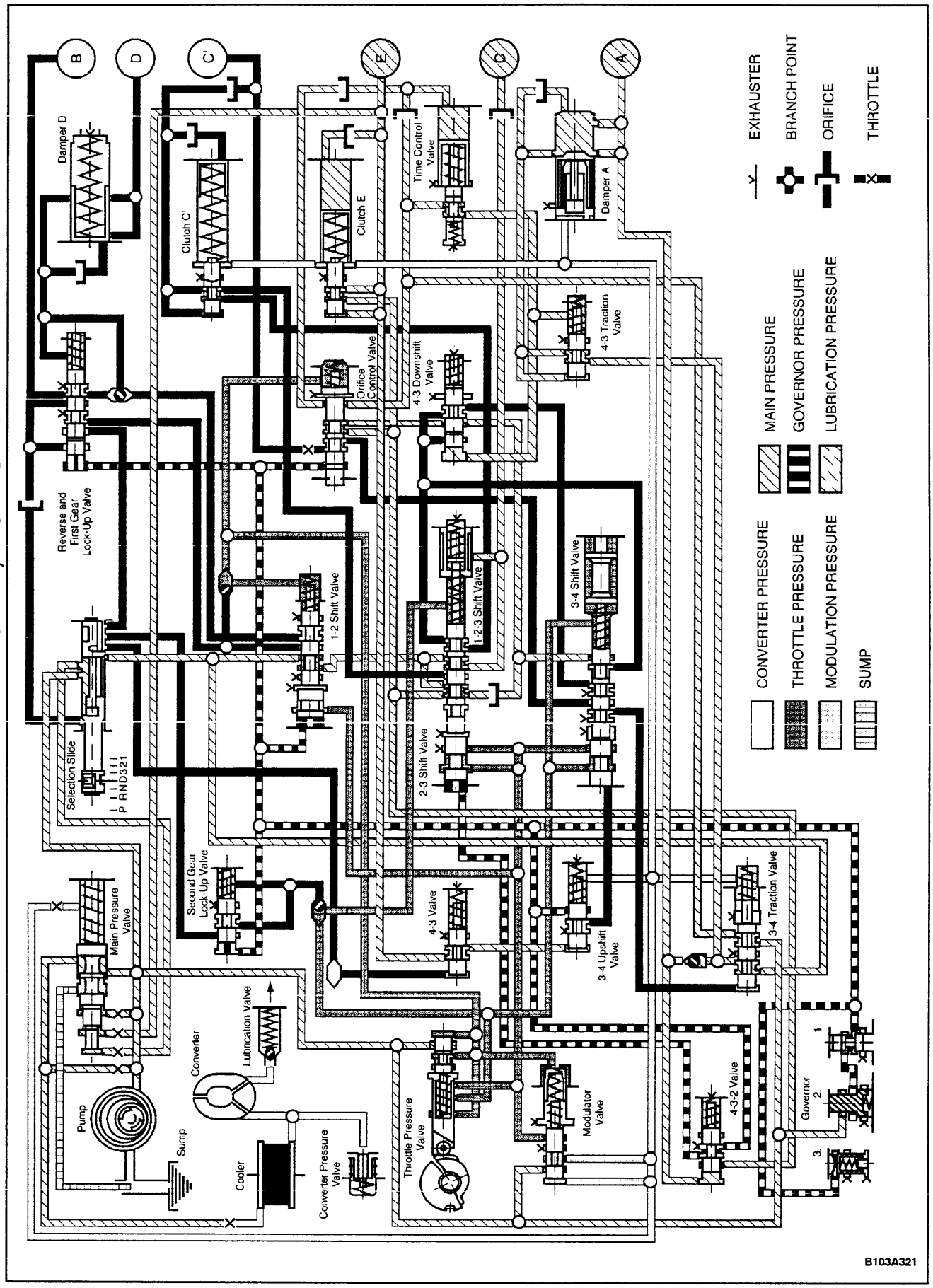
POSITION D - SECOND GEAR, KICKDOWN



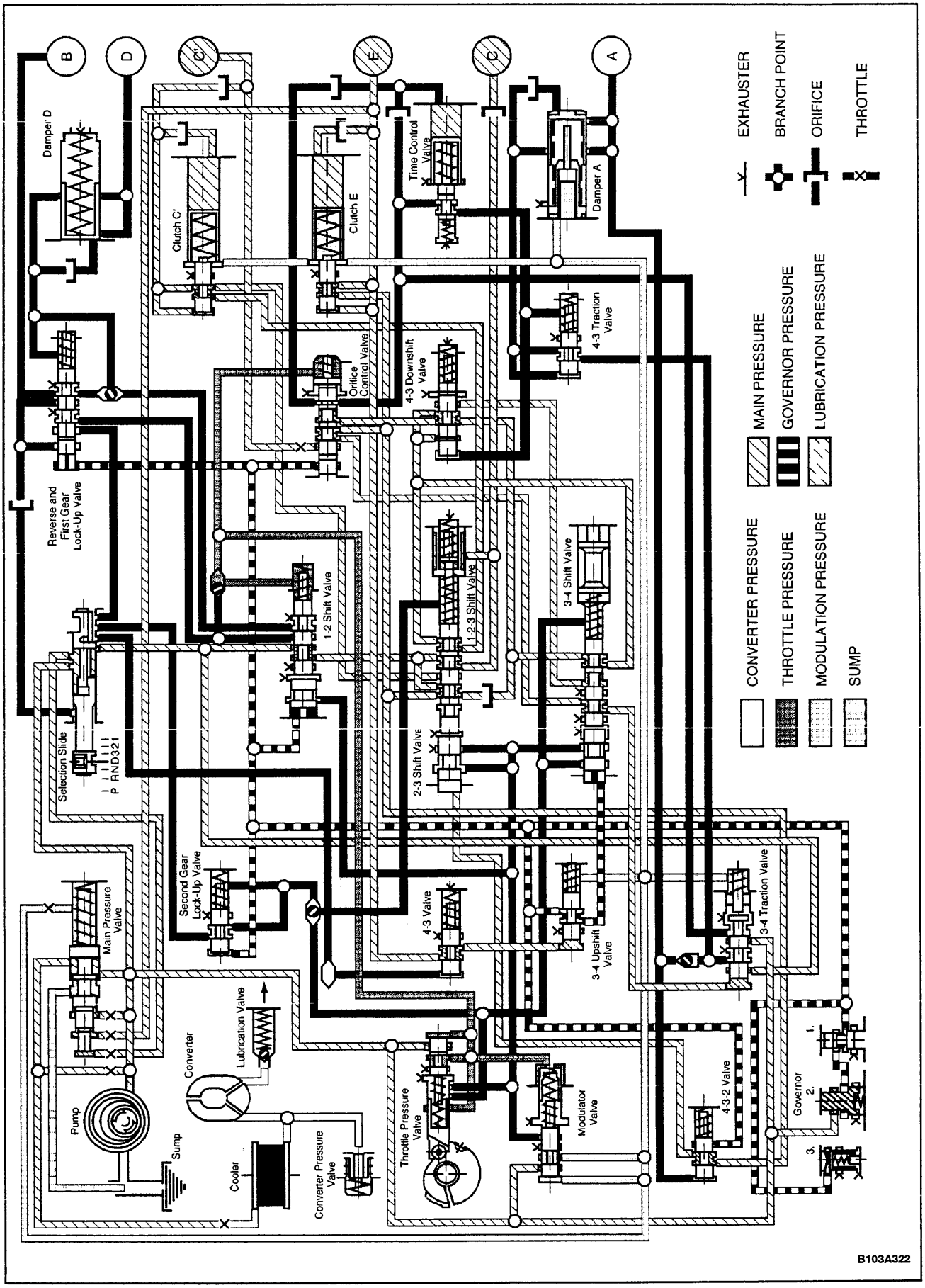
POSITION D - THIRD GEAR, IDLING



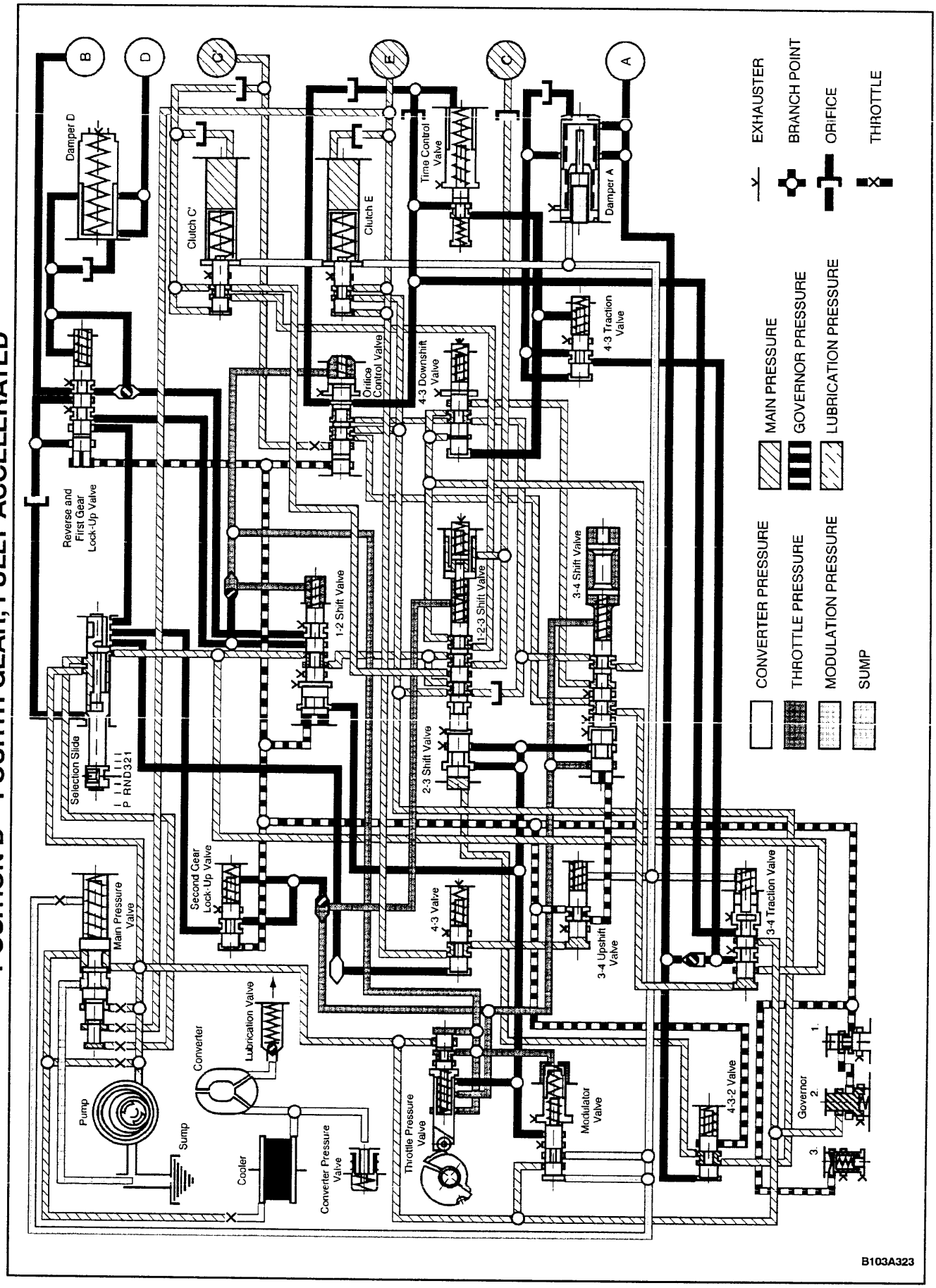

POSITION D - THIRD GEAR, FULLY ACCELERATED
B
D
C'
E
C
A
Damper D
Clutch C'
Clutch E
Time Control Valve
Damper A
4-3 Traction Valve
Orifice Control Valve
4-3 Downshift Valve
Reverse and First Gear Lock-Up Valve
1-2 Shift Valve
1-2-3 Shift Valve
3-4 Shift Valve
Selection Slide
P R N D 3 2 1
2-3 Shift Valve
Second Gear Lock-Up Valve
Main Pressure Valve
4-3 Valve
3-4 Upshift Valve
3-4 Traction Valve
Lubrication Valve
Converter
Pump
Sump
Cooler
Converter Pressure Valve
Throttle Pressure Valve
Modulator Valve
4-3-2 Valve
Governor
1.
2.
3.
EXHAUSTER
BRANCH POINT
ORIFICE
THROTTLE
MAIN PRESSURE
GOVERNOR PRESSURE
LUBRICATION PRESSURE
CONVERTER PRESSURE
THROTTLE PRESSURE
MODULATION PRESSURE
SUMP
B103A320


POSITION D - THIRD GEAR, KICKDOWN
B
D
C'
E
C
A
Damper D
Clutch C'
Clutch E
Time Control Valve
Damper A
Orifice Control Valve
4-3 Downshift Valve
4-3 Traction Valve
Reverse and First Gear Lock-Up Valve
1-2 Shift Valve
1-2-3 Shift Valve
3-4 Shift Valve
Selection Slide
P R N D 3 2 1
2-3 Shift Valve
Second Gear Lock-Up Valve
Main Pressure Valve
4-3 Valve
3-4 Upshift Valve
3-4 Traction Valve
Lubrication Valve
Converter
Pump
Sump
Cooler
Converter Pressure Valve
Throttle Pressure Valve
Modulator Valve
4-3-2 Valve
Governor
1.
2.
3.
EXHAUSTER
BRANCH POINT
ORIFICE
THROTTLE
CONVERTER PRESSURE
MAIN PRESSURE
THROTTLE PRESSURE
GOVERNOR PRESSURE
MODULATION PRESSURE
LUBRICATION PRESSURE
SUMP
B103A321

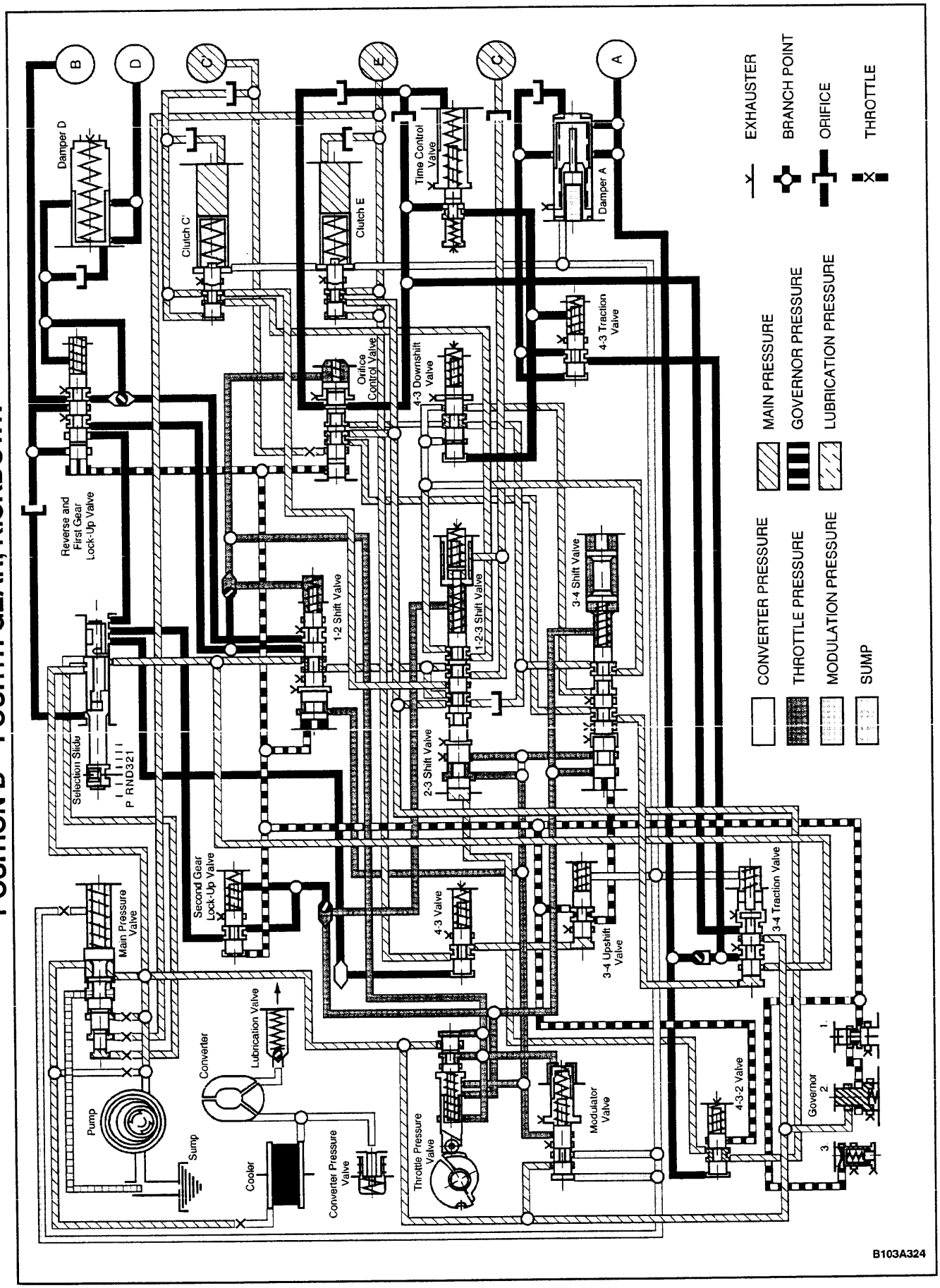
POSITION D - FOURTH GEAR, IDLING



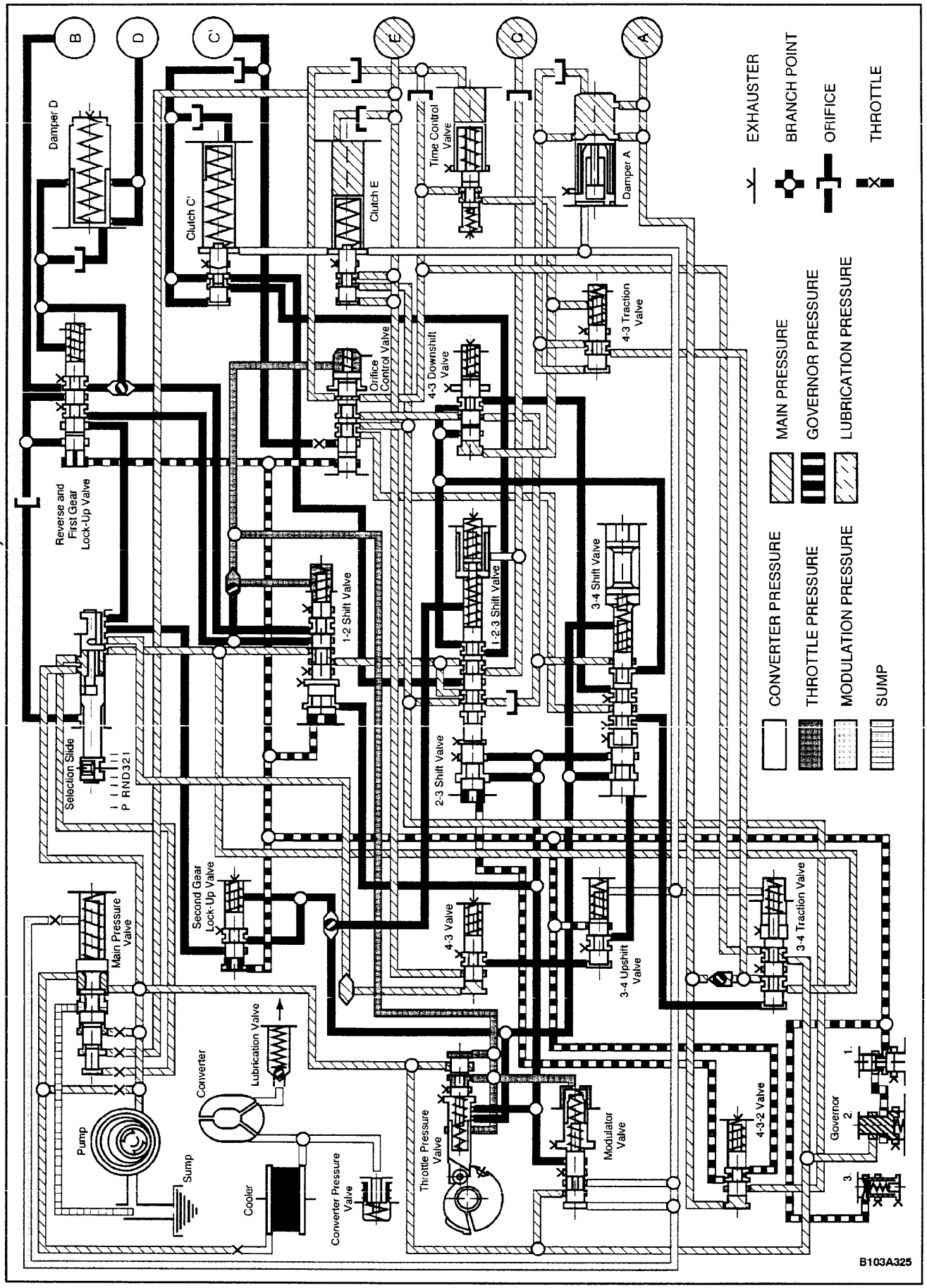
POSITION D - FOURTH GEAR, FULLY ACCELERATED

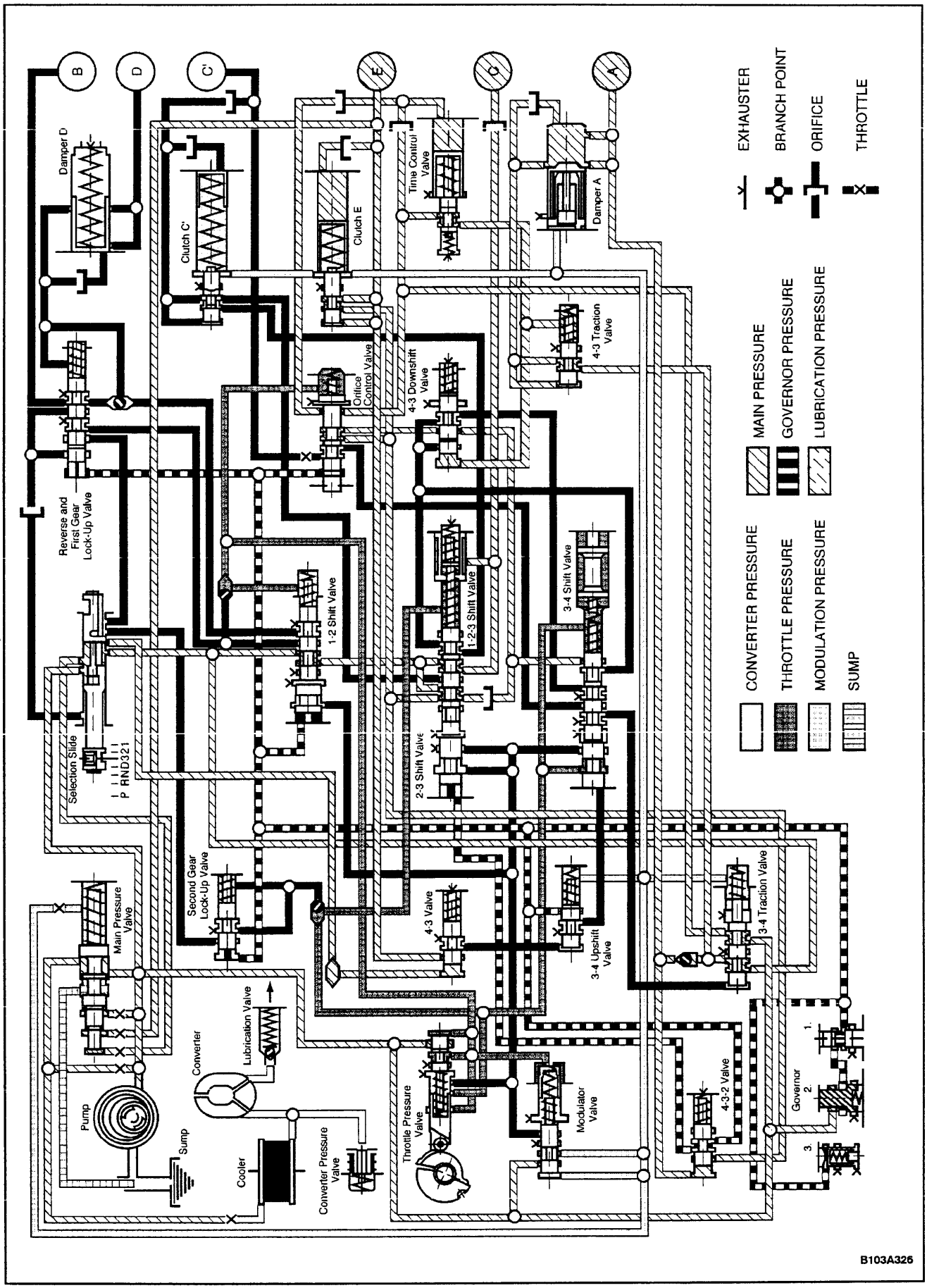


POSITION D - FOURTH GEAR, KICKDOWN

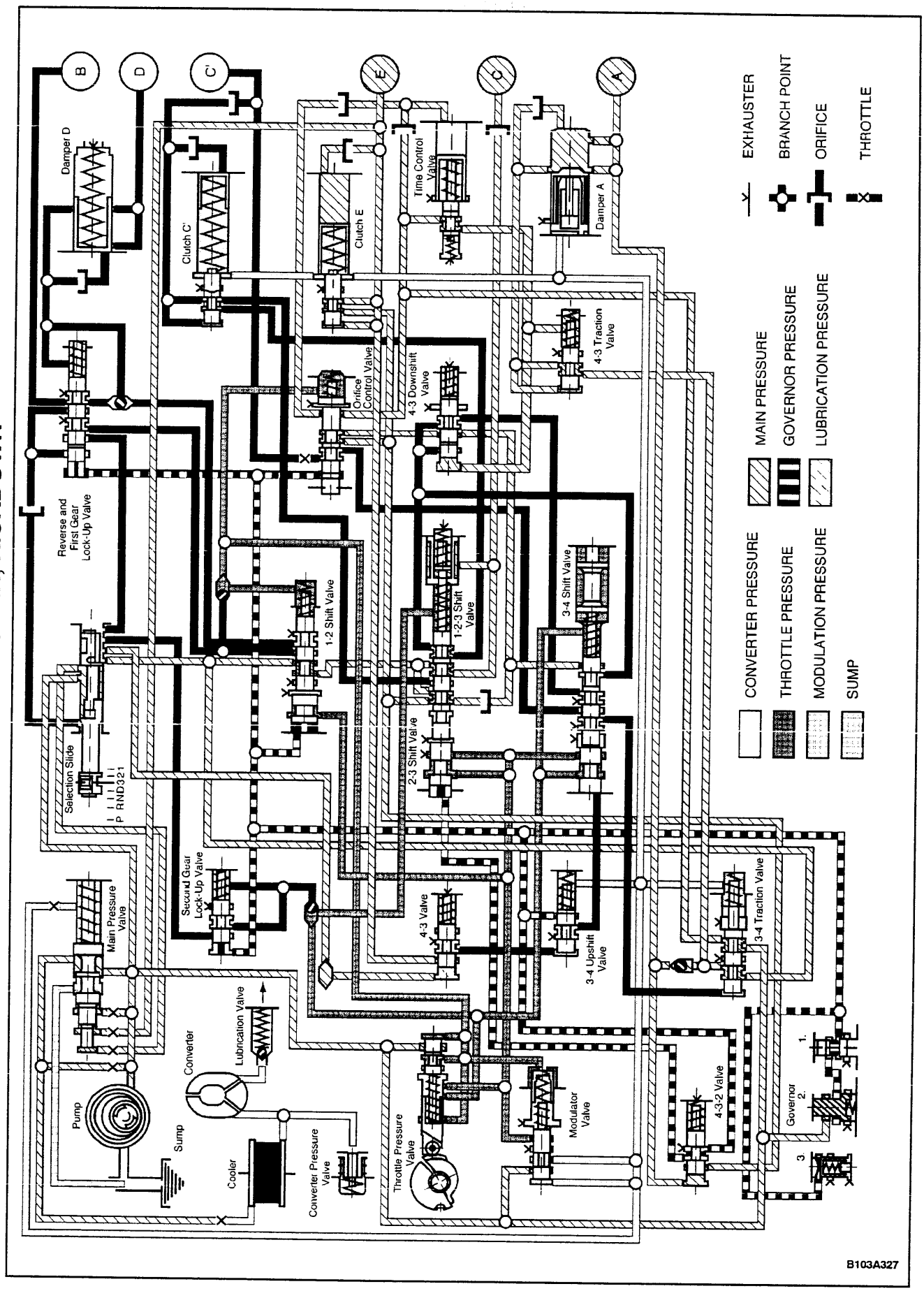


POSITION 3 - THIRD GEAR, IDLING

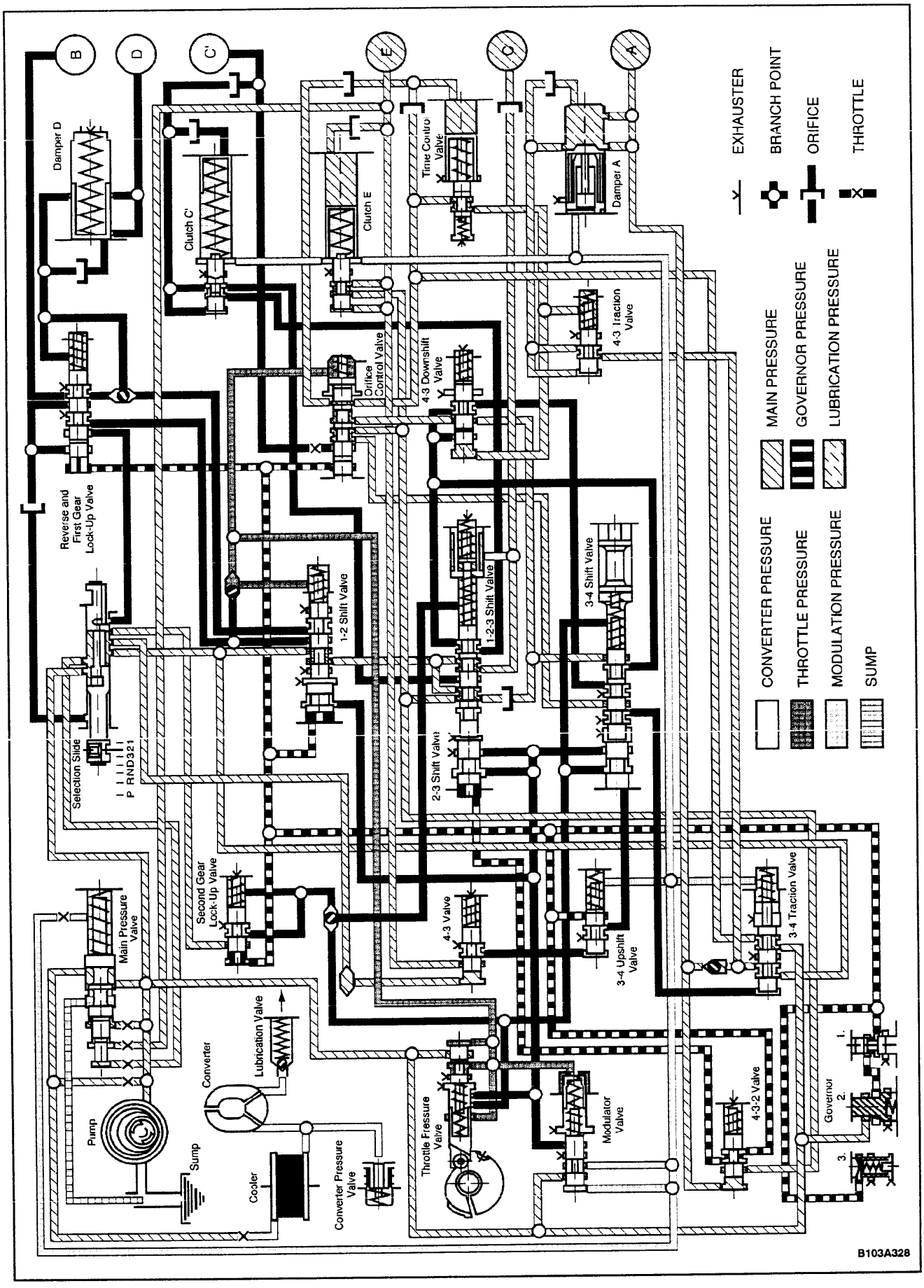



POSITION 3 - THIRD GEAR, FULLY ACCELERATED
B
D
C'
E
Q
A
Damper D
Clutch C'
Clutch E
Time Control Valve
Damper A
Reverse and First Gear Lock-Up Valve
Orifice Control Valve
4-3 Downshift Valve
4-3 Traction Valve
1-2 Shift Valve
1-2-3 Shift Valve
3-4 Shift Valve
Selection Slide
P RND321
2-3 Shift Valve
Second Gear Lock-Up Valve
Main Pressure Valve
4-3 Valve
3-4 Upshift Valve
3-4 Traction Valve
Lubrication Valve
Converter
Pump
Sump
Cooler
Converter Pressure Valve
Throttle Pressure Valve
Modulator Valve
4-3-2 Valve
Governor
1.
2
3
EXHAUSTER
BRANCH POINT
ORIFICE
THROTTLE
CONVERTER PRESSURE
MAIN PRESSURE
THROTTLE PRESSURE
GOVERNOR PRESSURE
MODULATION PRESSURE
LUBRICATION PRESSURE
SUMP
B103A326

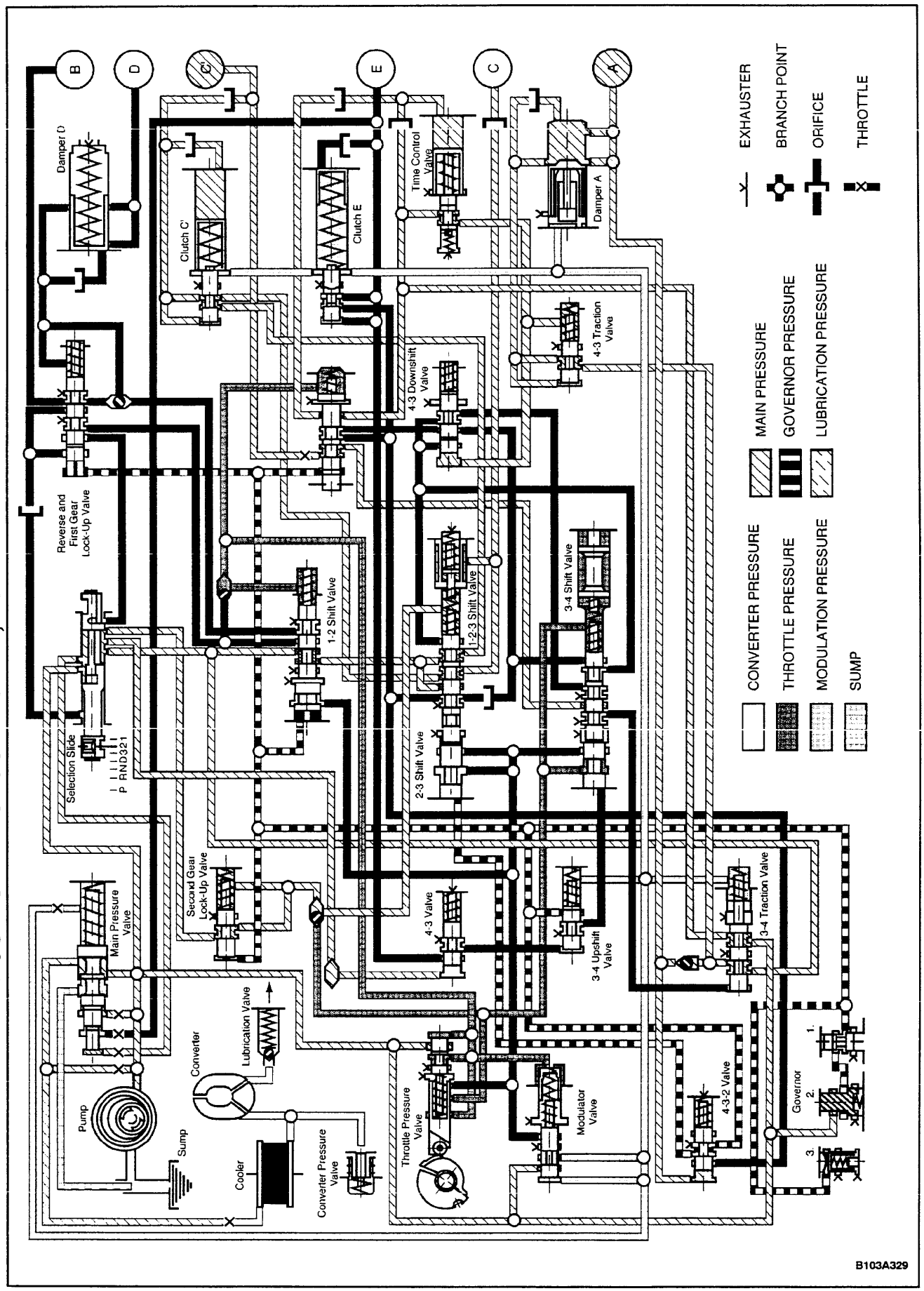
POSITION 3 - THIRD GEAR, KICKDOWN

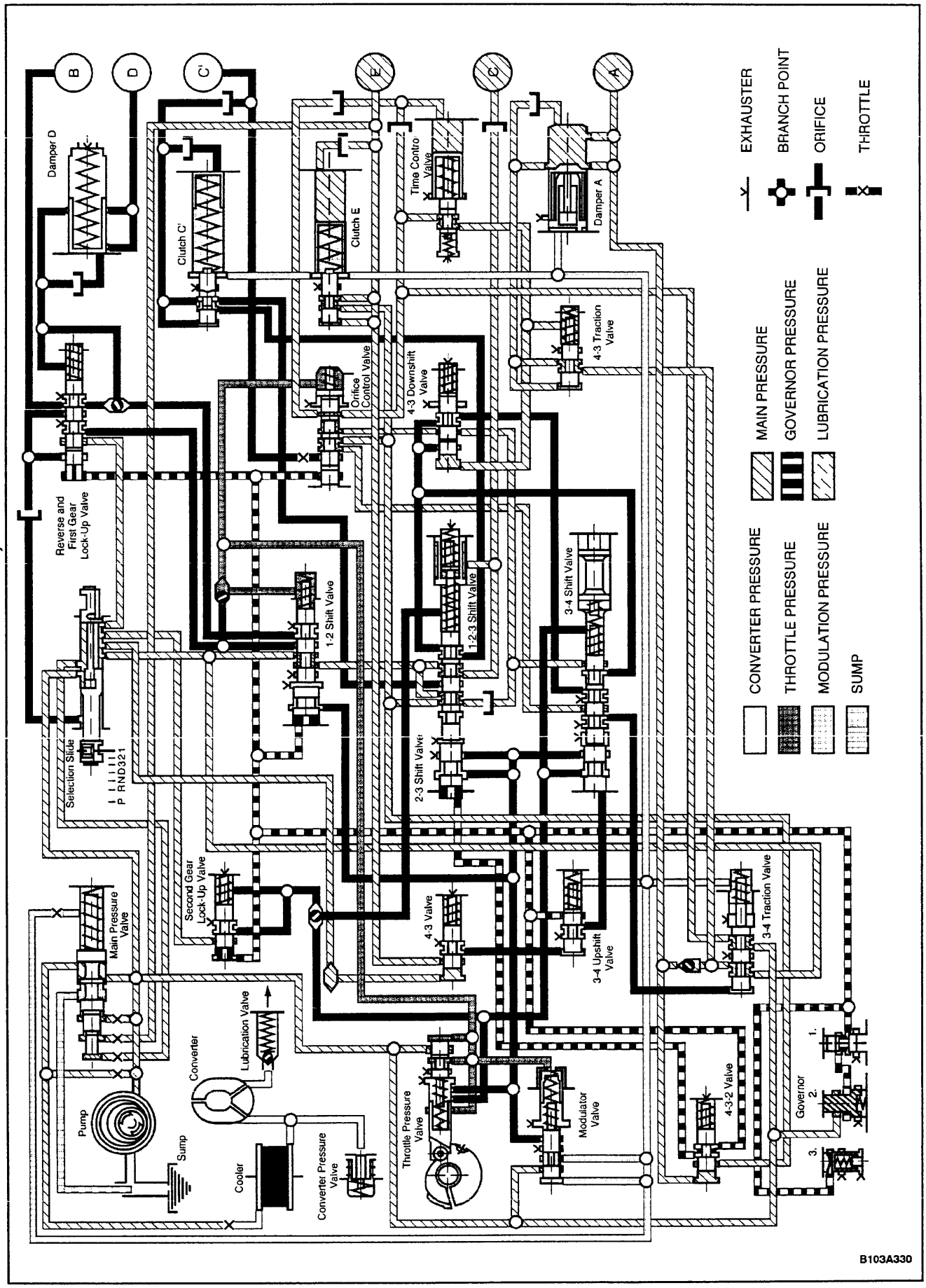


POSITION 2 - THIRD GEAR, IDLING

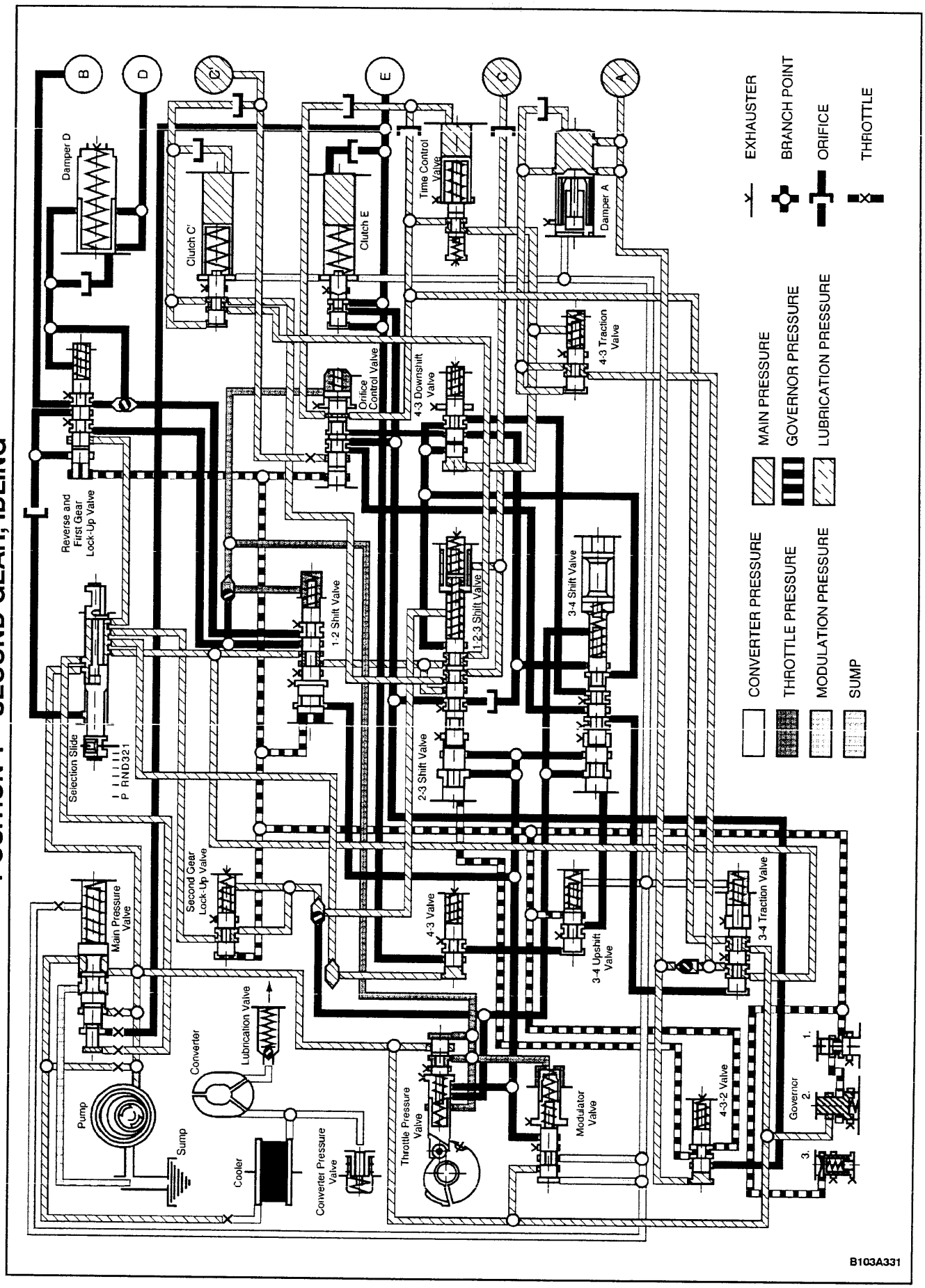


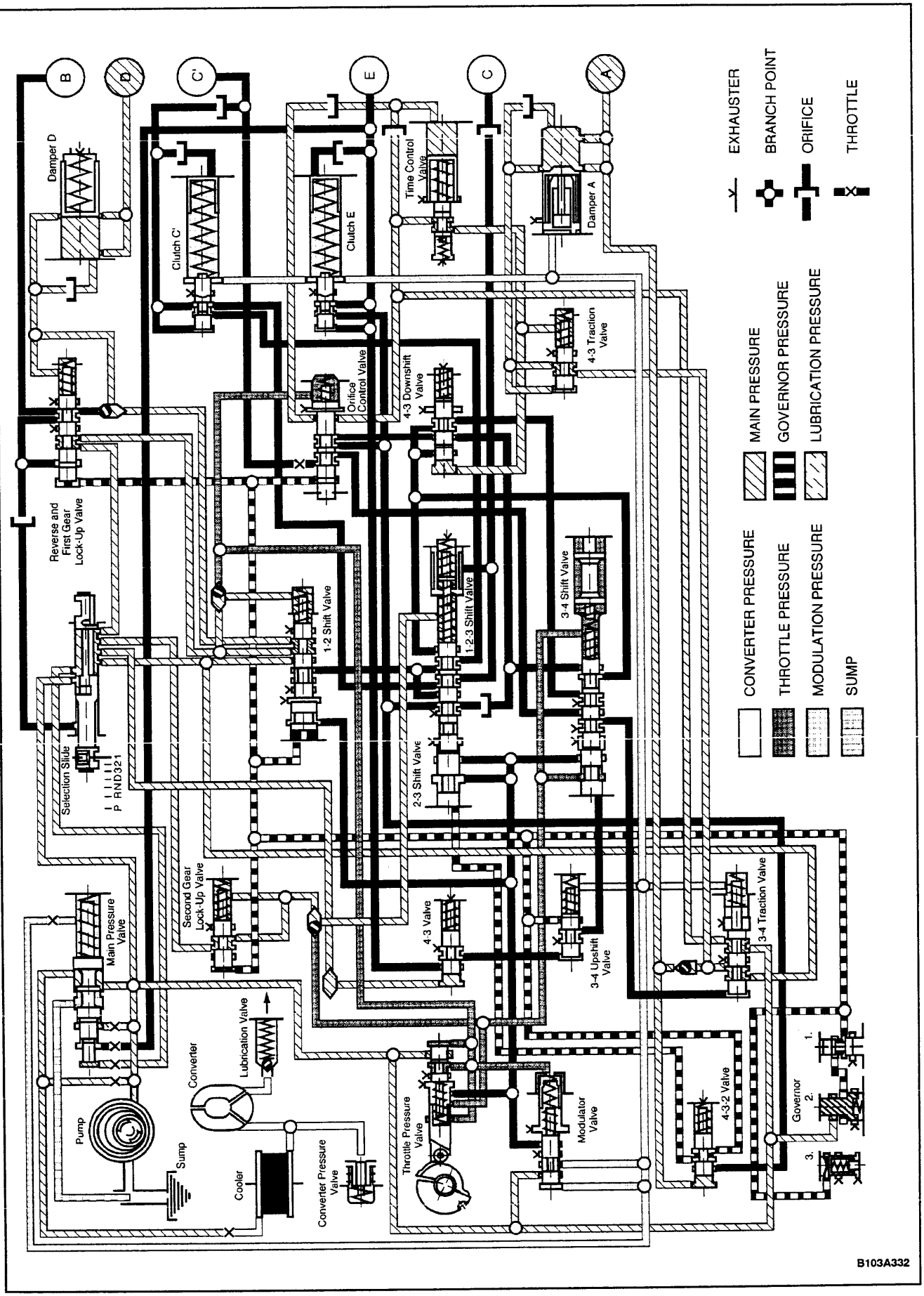
POSITION 2 - SECOND GEAR, FULLY ACCELERATED




POSITION 1 - THIRD GEAR, IDLING
B
D
C'
E
C
A
Damper D
Clutch C'
Clutch E
Time Contro Valve
Damper A
4-3 Traction Valve
Orifice Control Valve
4-3 Downshift Valve
Reverse and First Gear Lock-Up Valve
1-2 Shift Valve
1-2-3 Shift Valve
3-4 Shift Valve
Selection Slide
P R N D 3 2 1
2-3 Shift Valve
Second Gear Lock-Up Valve
Main Pressure Valve
4-3 Valve
3-4 Upshift Valve
3-4 Traction Valve
Lubrication Valve
Converter
Pump
Sump
Cooler
Converter Pressure Valve
Throttle Pressure Valve
Modulator Valve
4-3-2 Valve
Governor
1.
2.
3.
EXHAUSTER
BRANCH POINT
ORIFICE
THROTTLE
MAIN PRESSURE
GOVERNOR PRESSURE
LUBRICATION PRESSURE
CONVERTER PRESSURE
THROTTLE PRESSURE
MODULATION PRESSURE
SUMP
B103A330

POSITION 1 - SECOND GEAR, IDLING

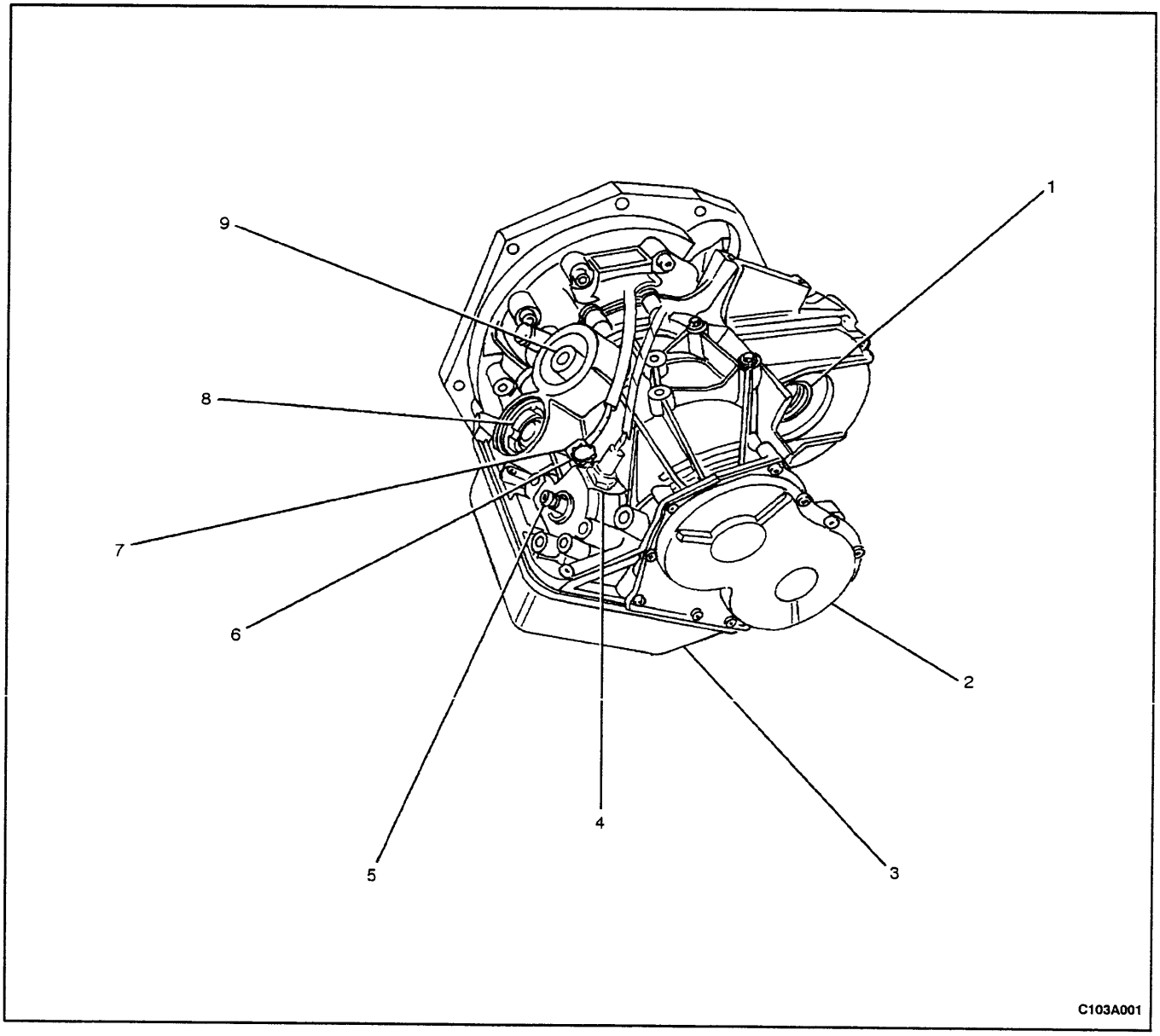



POSITION 1 - FIRST GEAR, FULLY ACCELERATED
B
B'
C'
E
C
A
Damper D
Clutch C'
Clutch E
Time Control Valve
Damper A
Orifice Control Valve
4-3 Downshift Valve
4-3 Traction Valve
Reverse and First Gear Lock-Up Valve
1-2 Shift Valve
1-2-3 Shift Valve
3-4 Shift Valve
Selection Slide
P R N D 3 2 1
2-3 Shift Valve
Second Gear Lock-Up Valve
4-3 Valve
3-4 Upshift Valve
3-4 Traction Valve
Main Pressure Valve
Converter
Lubrication Valve
Pump
Sump
Cooler
Converter Pressure Valve
Throttle Pressure Valve
Modulator Valve
4-3-2 Valve
Governor
1.
2.
3.
EXHAUSTER
BRANCH POINT
ORIFICE
THROTTLE
MAIN PRESSURE
GOVERNOR PRESSURE
LUBRICATION PRESSURE
CONVERTER PRESSURE
THROTTLE PRESSURE
MODULATION PRESSURE
SUMP
B103A332

COMPONENT LOCATOR

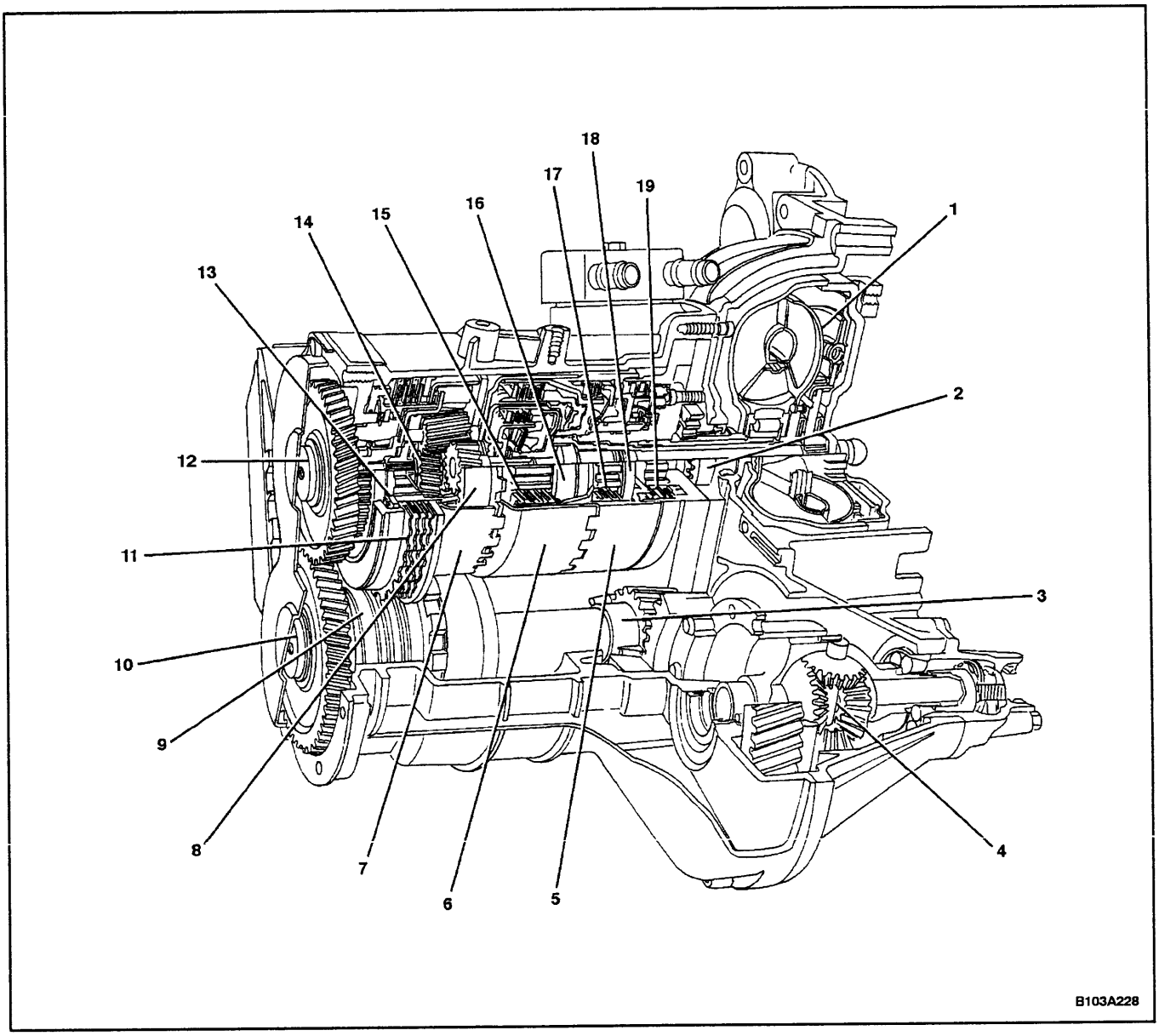
ZF 4 HP 14 AUTOMATIC TRANSAXLE

Exterior Component Locator



1 Differential Output
2 Side Cover
3 Fluid Pan
4 Neutral Start Switch
5 Selector Lever Connection
6 Breather Plug
7 Throttle Valve Cable
8 Brake C'
9 Cooler Pipe Outlet

Interior Component Locator



1 Torque Converter
2 Intermediate Pump/Brake C
3 Output Shaft
4 Differential
5 Clutch B
6 Drive Shell
7 Web Gear
8 Planetary Assembly
9 Governor
10 Large Spur Gear
11 Brake D Assembly
12 Small Spur Gear
13 Piston D
14 Sun Gear
15 Clutch A Assembly
16 Piston A
17 Clutch B Assembly
18 Piston B
19 Brake C Assembly

DIAGNOSIS

SYMPTOM DIAGNOSIS

PRELIMINARY CHECKS

Checks	Action
Check for the engine running at an incorrect idle speed.	Adjust the idle speed.
Check for a noisy transaxle when driving on curvy roads.	Add transaxle fluid.
Check for the engine spinning without providing power flow to the transaxle.	Add transaxle fluid.
Check for foam at the fluid breather.	Remove some transaxle fluid.
Check for large pieces of metal in the fluid pan.	Replace the transaxle.
Check for an incorrect power flow in forward and reverse.	Adjust the selector linkage.

POSITION P - PARK POSITION DOES NOT ENGAGE OR SLIPS

Checks	Action
Check for an incorrectly adjusted selector linkage or cable.	Adjust the selector linkage or the cable. Replace the selector linkage or the cable as needed.
Check for an incorrect clearance at the stop plate.	Measure and adjust the stop plate to the correct clearance.
Check for incorrectly installed park system components.	Correctly install the park system components.
Check for excessive friction in the parking interlock mechanism.	Clean the parking interlock mechanism parts. Replace the parking interlock mechanism parts as needed.
Check for excessive clearance on the spring plate.	Adjust the spring plate. Replace the spring plate as needed.

POSITION P - ENGINE DOES NOT START

Checks	Action
Check for a faulty starter interlock switch.	Replace the starter interlock switch.
Check for a defective neutral safety switch.	Replace the neutral safety switch.
Check for excessive clearance at the selector shaft.	Adjust the clearance at the selector shaft.

POSITION P - NO SHIFT TO REVERSE

Checks	Action
Check for a faulty brake transaxle shift interlock solenoid.	Replace the brake transaxle shift interlock solenoid.

POSITION P - SHIFT OCCURS WITHOUT ENGAGING BRAKE PEDAL

Checks	Action
Check for a faulty brake transaxle shift interlock solenoid.	Replace the brake transaxle shift interlock solenoid.
Check for short in the circuit between the brake switch and the brake transaxle shift interlock solenoid.	Repair the short in the circuit between the brake switch and the brake transaxle shift interlock solenoid.

POSITION R - NO REVERSE

Checks	Action
Check for an incorrectly adjusted shift control cable.	Adjust the shift control cable. Replace the shift control cable as needed.
Check for a clogged fluid filter.	Replace the fluid filter.
Check for a damaged clutch B.	Replace the clutch B. Replace the transaxle as needed.
Check for a damaged brake D. In this case there is no braking action in position 1, first gear.	Replace the brake D. Replace the transaxle as needed.
Check for a jammed governor.	Replace the governor coupling.
Check for a locking valve 1 and a jammed Reverse.	Replace the locking valve 1 in the lower valve housing of the valve body. Replace the valve body as needed.

POSITION R - SLIPPING OR VIBRATION WHEN MOVING OFF

Checks	Action
Check for a damaged clutch B or a damaged brake D.	Replace the clutch B and/or the brake D. Replace the transaxle as needed.
Check for a leak in the fluid feed of the clutch B.	Replace the rectangular rings on the intermediate plate. Replace the intermediate plate and the pump assembly as needed. Replace the transaxle as needed.

POSITION R - HARD ENGAGING JERK OR DOUBLE JERK

Checks	Action
Check for a faulty damper D.	Replace the damper D restrictor in the fluid channel housing of the valve body. Replace the valve body as needed.

POSITION R - REVERSING LAMP DOES NOT COME ON

Checks	Action
Check for a faulty fuse.	Replace the fuse.
Check for a faulty electrical circuit.	Replace the electrical circuit.
Check for a faulty starter interlock switch.	Replace the starter interlock switch.

POSITION N - ENGINE DOES NOT START

Checks	Action
Check for a faulty starter interlock switch.	Replace the starter interlock switch.

POSITION N - VEHICLE MOVES OR CREEPS FORWARD

Checks	Action
Check for an incorrectly adjusted selector linkage or cable between the selector lever and the transaxle case.	Adjust the selector linkage or the cable between the selector lever and the transaxle case. Replace the selector linkage or the cable as needed.

POSITION D - NO POWER

Checks	Action
Check for an open converter relief valve.	Replace the torque converter.
Check for a clogged fluid filter.	Replace the fluid filter.
Check for a faulty clutch A.	Replace the clutch A. Replace the transaxle as needed.
Check for a slipping first gear freewheel.	Replace the first gear freewheel. Replace the transaxle as needed.
Check for an incorrectly adjusted selector linkage or cable between the selector lever and the transaxle case.	Adjust the selector linkage or cable between the selector lever and the transaxle case.
Check for a jammed 3-4 cable valve.	Replace the 3-4 shuttle valve and the spring in the valve housing of the valve body. Replace the valve body as needed.

POSITION D - NO SHIFT FROM EITHER FIRST TO SECOND OR SECOND TO FIRST

Checks	Action
Check for a dirty governor.	Clean the governor coupling. Replace the governor as needed.
Check for a jammed selector valve 1-2.	Replace the 1-2 change valve in the lower valve housing of the valve body. Replace the valve body as needed.

POSITION D - NO SHIFT FROM FIRST TO SECOND ONLY

Checks	Action
Check for a faulty brake C or C′.	Replace the brake C and/or C′. Replace the transaxle as needed.

POSITION D - NO SHIFT FROM EITHER SECOND TO THIRD OR THIRD TO SECOND

Checks	Action
Check for a dirty governor.	Clean the governor coupling. Replace the governor as needed.
Check for a jammed selector valve 2-3.	Replace the 2-3 shuttle valve and the spring in the valve housing of the valve body. Replace the valve body as needed.

POSITION D - NO SHIFT FROM SECOND TO THIRD ONLY

Checks	Action
Check for a faulty clutch E.	Replace the clutch E. Replace the transaxle as needed.
Check for a leak at the fluid feed of the clutch E.	Replace the clutch E. Replace the transaxle as needed.
Check for faulty rectangular rings on the engine shaft or the turbine shaft.	Replace the rectangular rings on the engine or the turbine shaft. Replace the intermediate plate and the pump assembly. Replace the transaxle as needed.
Check for leaks at the protection cap in the intermediate plate.	Replace the intermediate plate and the pump assembly.

POSITION D - NO SHIFT FROM EITHER THIRD TO FOURTH OR FOURTH TO THIRD

Checks	Action
Check for a dirty governor.	Clean the governor coupling. Replace the governor as needed.
Check for a jammed selector valve 3-4.	Replace the 3-4 shuttle valve and the spring in the valve housing of the valve body. Replace the valve body as needed.

POSITION D - NO SHIFT FROM THIRD TO FOURTH ONLY

Checks	Action
Check for a faulty brake C′ when the 1-2 gearshift is OK.	Replace brake C′. Replace the transaxle as needed.
Check for a brake band C′ that has not been pretensioned.	Adjust brake band C′.
Check for a jammed upshift valve 2-3-4.	Replace the 2-3-4 shuttle valve and spring in the lower valve housing of the valve body. Replace the valve body as needed.
Check for a jammed position 3 valve.	Replace the position 3 shuttle valve and spring in the lower valve housing of the valve body. Replace the valve body as needed.

POSITION D - VEHICLE MOVES OFF IN SECOND

Checks	Action
Check for a jammed governor bushing.	Replace the governor coupling.
Check for a jammed selector valve 1-2.	Replace the 1-2 change valve in the lower valve housing of the valve body. Replace the valve body as needed.
Check for an overly tightened brake band.	Adjust the brake band.
Check for a brake band that does not release.	Replace the brake band.

POSITION D - VEHICLE MOVES OFF IN THIRD

Checks	Action
Check for a faulty middle rectangular ring on the governor flange.	Replace the rectangular ring on the governor flange. Replace the governor coupling.
Check for a jammed governor bushing.	Replace the governor coupling.
Check for a jammed selector valve 1-2 and 2-3.	Replace the 1-2 change valve in the lower valve housing and the 2-3 shuttle valve and the spring in the valve housing of the valve body. Replace the valve body.
Check for a leak at the protective cap in the intermediate flange with the clutch B constantly filled.	Replace the seal at the protective cap in the intermediate flange.

POSITION D - VEHICLE SHIFTS FROM FIRST TO THIRD

Checks	Action
Check for a jammed selector valve 2-3.	Replace the 2-3 shuttle valve and the spring in the valve housing of the valve body. Replace the valve body as needed.
Check for a jammed valve 2-3-4.	Replace the 2-3-4 change-up shuttle valve and the spring in the lower valve housing of the valve body. Replace the valve body as needed.
Check for a jammed valve 1-2-3 at the face end of the 1-2 valve.	Replace the 1-2-3 control shuttle valve and the spring in the valve housing of the valve body. Replace the valve body as needed.

POSITION D - VEHICLE SHIFTS FROM FIRST TO FOURTH

Checks	Action
Check for engine cutout.	Replace the valve body.

POSITION D - ZERO LOAD SHIFT NOT OK

Checks	Action
Check for a dirty governor.	Clean the governor. Replace the governor coupling as needed.
Check for a leak in the area of the governor.	Replace the transaxle.
Check for selector valves that do not move freely.	Replace the valve body.

POSITION D - FULL LOAD SHIFT POINTS NOT OK

Checks	Action
Check for an incorrectly adjusted accelerator cable.	Adjust the accelerator cable.

POSITION D - NO KICKDOWN SHIFT FROM SECOND TO FIRST

Checks	Action
Check for an incorrectly adjusted accelerator cable.	Adjust the accelerator cable.

POSITION D - NO KICKDOWN SHIFT FROM THIRD TO SECOND

Checks	Action
Check for an incorrectly adjusted accelerator cable.	Adjust the accelerator cable.

POSITION D - NO KICKDOWN SHIFT FROM FOURTH TO THIRD

Checks	Action
Check for an incorrectly adjusted accelerator cable.	Adjust the accelerator cable.
Check for an imbalance in the governor.	Replace the governor.

POSITION D - ZERO LOAD SHIFTS TOO HARD

Checks	Action
Check for the damper not operating properly.	Replace the valve body.
Check for a modulation pressure that is too high.	Replace the valve body.
Check for damaged discs.	Replace the transaxle.

POSITION D - FULL LOAD AND KICKDOWN SHIFT TAKES TOO LONG

Checks	Action
Check for a damper not operating properly.	Replace the valve body.
Check for a modulation pressure that is too high.	Replace the valve body.
Check for damaged discs.	Replace the transaxle.

POSITION D - FULL LOAD AND KICKDOWN SHIFT IS TOO HARD

Checks	Action
Check for an improper modulation pressure.	Replace the valve body.
Check for a damper not operating properly.	Replace the valve body.

POSITION D - ENGINE SPEED TOO HIGH WHEN SHIFTING FROM THIRD TO FOURTH

Checks	Action
Check for an incorrectly adjusted accelerator cable.	Adjust the accelerator cable.
Check for a jammed diaphragm control valve in the overrun position.	Replace the valve body.
Check for the cable of valve 3-4 not operating freely.	Replace the 3-4 shuttle valve and the spring. Replace the valve body as needed.
Check for an incorrectly adjusted brake band.	Adjust the brake band.
Check for an inaccurate modulation pressure.	Replace the valve body.

POSITION D - ENGINE SPEED TOO HIGH WHEN SHIFTING FROM FOURTH TO THIRD

Checks	Action
Check for an inaccurate operation of the time control valve and the shiftdown valve.	Replace the valve body.
Check for a damaged clutch A.	Replace clutch the A. Replace the transaxle as needed.
Check for inaccurate operation of the clutch A and the cable of valve 4-3.	Replace the 4-3 shuttle valve and the spring in the valve housing of the valve body. Replace the valve body as needed.
Check for an inaccurate air pressure supply in the turbo version only.	Repair the air supply lines as needed.

POSITION 2 - MANUAL DOWNSHIFT NOT OK

Checks	Action
Check for an inoperative locking valve 2.	Replace the valve body.
Check for an inoperative governor.	Replace the governor coupling.

POSITION 2 - NO ENGINE BRAKING ACTION

Checks	Action
Check for a damaged brake C'.	Replace the brake C'. Replace the transaxle as needed.

POSITION 1 - MANUAL DOWNSHIFT FROM SECOND TO FIRST NOT OK

Checks	Action
Check for an inoperative locking valve of the first and the reverse gears.	Replace the first and the reverse shuttle valve and the spring in the valve housing. Replace the valve body as needed.
Check for an inoperative governor.	Replace the governor coupling.

POSITION 1 - NO ENGINE BRAKING ACTION

Checks	Action
Check for a damaged brake D.	Replace the brake D. Replace the transaxle as needed.

ACCELERATOR CABLE JAMS

Checks	Action
Check for a slipped accelerator cable stop.	Insert a cable stop or replace the accelerator cable.
Check for excessive friction in the sleeve of the accelerator cable.	Replace the accelerator cable.
Check for a jammed governor pressure plunger.	Replace the valve body.

SLIPPING OR VIBRATION WHEN MOVING OFF

Checks	Action
Check for a damaged clutch A.	Replace the clutch A. Replace the transaxle as needed.
Check for a damaged rectangular ring or a damaged O-ring on the turbine shaft seal of the fluid feed of the clutch A.	Replace the rectangular ring or the O-ring on the turbine shaft. Replace the transaxle as needed.
Check for damaged O-rings on the piston A.	Replace the O-rings on the piston A. Replace the piston A as needed. Replace the transaxle as needed.

HARD ENGAGING JERK FROM NEUTRAL TO DRIVE

Checks	Action
Check for a damaged damper A.	Replace the valve body.
Check for a broken spring in damper A.	Replace the valve body.
Check for a damaged clutch A.	Replace the clutch A. Replace the transaxle as needed.
Check for a leak at the ball of cable 3-4.	Replace the valve body.

NOISY OPERATION AND SLUGGISH ENGAGEMENT AFTER LONG TRIP

Checks	Action
Check for a clogged fluid filter.	Replace the fluid filter.

NO POSITIVE ENGAGEMENT FORWARD OR REVERSE, LOUD NOISES

Checks	Action
Check for a damaged driver plate between the converter and the engine.	Replace the driver plate. Replace the transaxle as needed.
Check for a damaged pump driver.	Replace the pump driver. Replace the transaxle as needed.

NOISES IN ALL POSITIONS

Checks	Action
Check for a reduced fluid level.	Correct the fluid level.
Check for a leak at the valve body.	Replace the valve body.

INTAKE NOISES FROM FLUID PUMP

Checks	Action
Check for a clogged fluid filter.	Replace the fluid filter.

NOISES VARY ACCORDING TO SPEED

Checks	Action
Check for an altered or an incorrectly adjusted bearing setting of the spur gear drive.	Adjust the bearing setting on the spur gear drive. Replace the transaxle as needed.
Check for an altered or an incorrectly adjusted bearing setting of the differential.	Adjust the bearing setting on the differential. Replace the transaxle as needed.

LEAK DIAGNOSIS

LOCATING FLUID LEAKS

General Method

1. Verify that the material leaking is the transaxle fluid.
2. Thoroughly clean the suspected leak area.
3. Allow the transaxle to reach the normal operating temperature of 88°C (190°F).
4. Park the vehicle over a clean paper or a clean cardboard.
5. Shut the engine OFF and look for fluid spots on the paper.
6. Make the necessary repairs to correct the leak.

Powder Method

1. Thoroughly clean the suspected leak area.
2. Apply an aerosol type powder, such as foot powder, to the suspected leak area.
3. Allow the transaxle to reach the normal operating temperature of 88°C (190°F).
4. Shut the engine OFF.
5. Inspect the suspected leak area and trace the leak path through the powder to find the source of the leak.
6. Make the necessary repairs to correct the leak.

Once the leak point is found, the source of the leak must be determined and repaired. Refer to "Leak Diagnosis" in this section.

FLUID DRIPS OUT OF CONVERTER BELL HOUSING

Checks	Action
Check the gasket in the converter bell housing.	Replace the gasket.
Check for a leak at the weld seam of the torque converter.	Replace the torque converter.

LEAK BETWEEN TRANSAXLE HOUSING AND CONVERTER BELL HOUSING

Checks	Action
Check for loosened fastening bolts on the torque converter bell housing.	Tighten the bolts on the torque converter bell housing.

LEAK BETWEEN TRANSAXLE HOUSING AND FLUID PAN

Checks	Action
Check for loosened fastening bolts on the fluid pan.	Tighten the fluid pan bolts. Replace the fluid pan as needed.
Check for a loose fluid pan gasket.	Repiace the fluid pan gasket.

LEAK BETWEEN TRANSAXLE HOUSING AND SIDE COVER

Checks	Action
Check for loosened bolts connecting the side cover to the housing.	Tighten the side cover bolts.
Check for a damaged side cover gasket.	Replace the side cover gasket.

LEAK AT FLUID COOLER

Checks	Action
Check for a loose cooler pipe bolt connection on the transaxle and/or the radiator.	Tighten the bolts on the transaxle and/or the radiator.
Check for a damaged gasket at the transaxle connection.	Replace the gasket.
Check for a leak in the cooler.	Replace the radiator.

LEAK AT COVER OF BRAKE C′

Checks	Action
Check for a damaged outer O-ring at the cover of the brake C′.	Replace the O-ring.

LEAK AT THE BRAKE BAND C′ ADJUSTING BOLT

Checks	Action
Check for a damaged O-ring at the pin of the brake band C′.	Replace the O-ring.

LEAK AT RETAINING BOLTS FOR SIDE SHAFT BEARING RING

Checks	Action
Check for any loosened bolts.	Tighten the bolts.
Check for a damaged seal.	Replace the seal.

LEAK AT ACCELERATOR CABLE CONNECTOR

Checks	Action
Check for a damaged O-ring on the connector.	Replace the O-ring. Replace the throttle valve cable as needed.

LEAK AT DIFFERENTIAL

Checks	Action
Check for any damaged shaft seals at the input shafts.	Replace the shaft seals.

LEAK AT DIFFERENTIAL EXTENSION

Checks	Action
Check for a damaged O-ring.	Replace the O-ring.
Check for loosened extension housing bolts.	Tighten the extension housing bolts.

LEAK AT SPEEDOMETER DRIVE

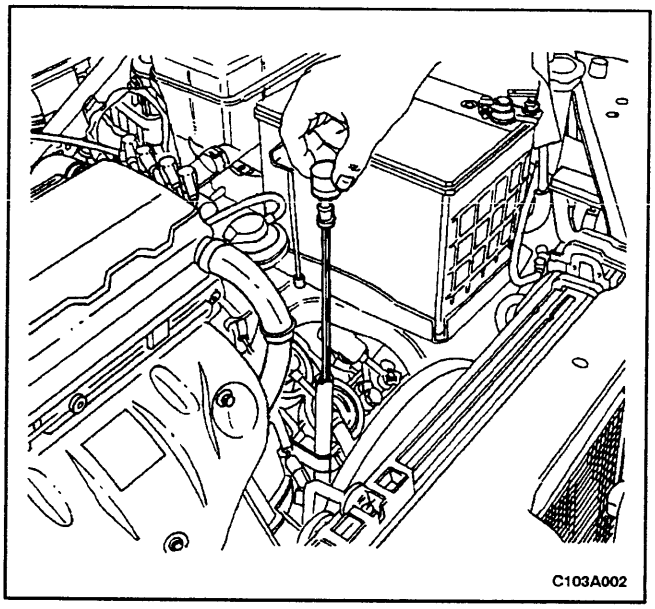
Checks	Action
Check for a damaged O-ring in the speedometer sleeve.	Replace the O-ring.
Check for a damaged shaft seal in the speedometer sleeve.	Replace the speedometer sleeve coupling.

LEAK AT BREATHER

Checks	Action
Check whether the fluid level is too high.	Correct the fluid level.
Check for the wrong grade of transaxle fluid.	Drain the transaxle fluid and replace it with the correct transaxle fluid. Replace the transaxle as needed.

LEAK AT SELECTOR SHAFT

Checks	Action
Check for a damaged selector shaft seal.	Replace the selector shaft seal.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MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

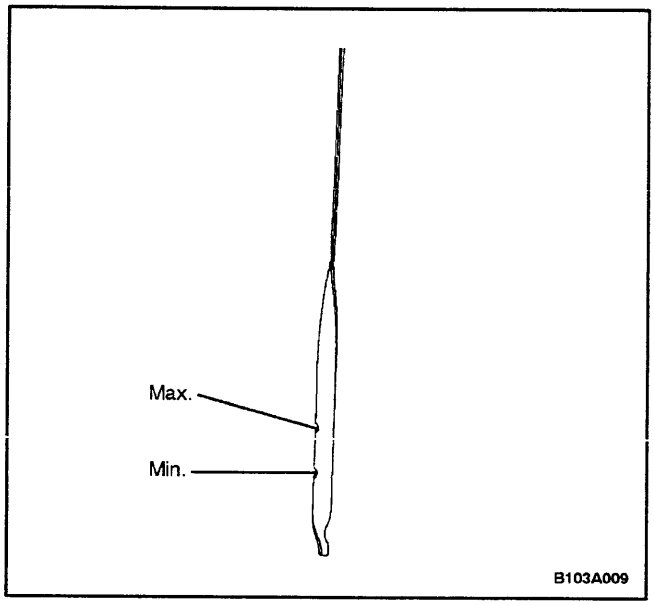
TRANSAXLE FLUID LEVEL CHECKING PROCEDURE

Notice: Check the fluid level when the transaxle temperature is above 80°C (176°F).

1. Make sure the vehicle is level.

Important: During the fluid level check, the selector lever must be in the position P.

2. Place the selector lever in position P.
3. Remove the transaxle fluid dipstick and check the transaxle fluid level.



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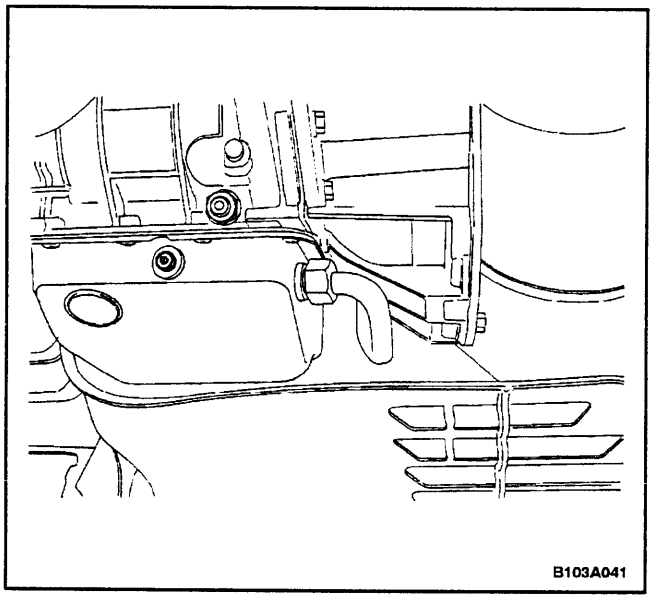
4. The correct fluid level must be between the MIN and the MAX notches on the dipstick.

Notice: When adding fluid or making a complete fluid change, always use Dexron®-III automatic transaxle fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.

5. If the fluid level is below the MIN notch, add transaxle fluid through the fluid filler tube and check for leaks in the transaxle.
6. If the fluid is above the MAX notch, the transaxle is overfilled. Drain some fluid through the fluid pan drain plug. Check the transaxle fluid level.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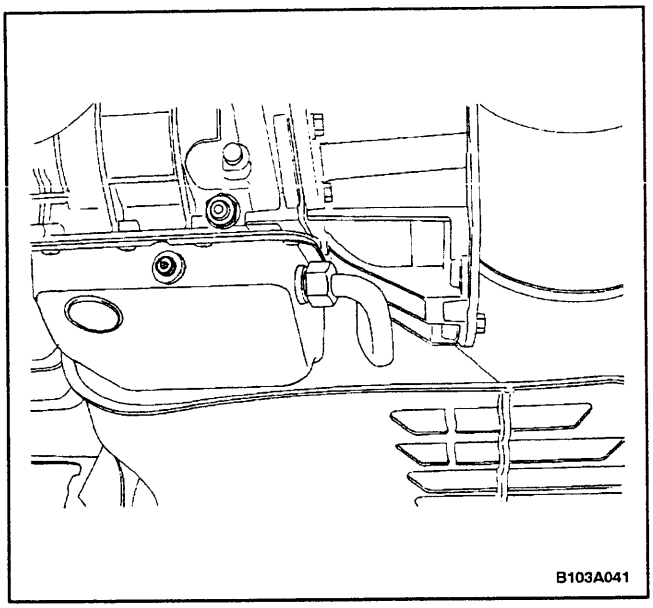
CHANGING FLUID

Removal Procedure

1. Raise and suitably support the vehicle.
2. Place a drain pan under the transaxle.
3. Loosen the fluid pan drain plug. Drain the transaxle fluid.
4. Remove the fluid pan bolts. Remove the fluid pan and the fluid pan gasket. Refer to "Pan and Gasket" in this section.
5. Check the fluid pan flange for distortion. Straighten as needed.
6. Clean the fluid pan, the fluid pan gasket surfaces, and the fluid pan filter with a solvent. All traces of the old gasket material must be removed.
7. Air dry the fluid pan, the fluid pan surfaces that interface with the gasket, and the fluid pan filter.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Installation Procedure

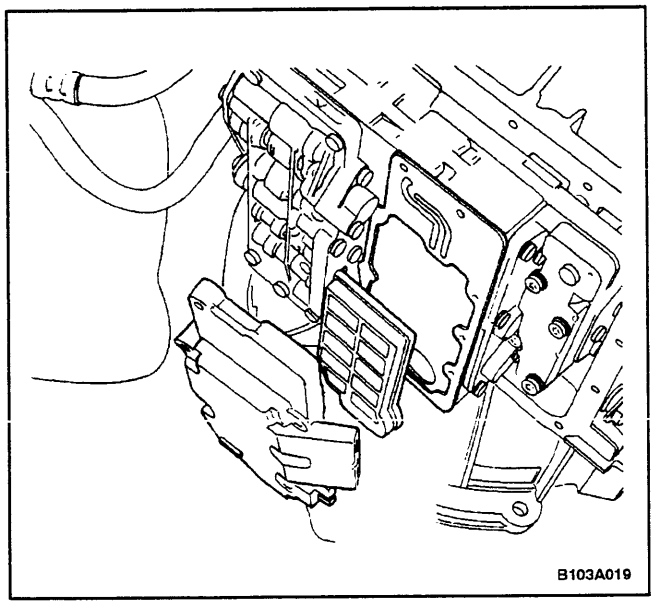
1. Install the fluid pan, using a new gasket. Refer to "Pan and Gasket" in this section.
2. Install the fluid pan drain plug.

Tighten

Tighten the fluid pan drain plug to 15 N•m (11 lb-ft).

3. Lower the vehicle.
4. Fill the transaxle with the proper quantity of automatic transaxle fluid. Refer to "Fluid Level Set After Service" in this section.
5. Check the fluid level. Refer to "Transaxle Fluid Level Checking Procedure" in this section.
6. Check the fluid pan for leaks. Refer to "Locating Fluid Leaks" in this section.

FLUID FILTER AND SEAL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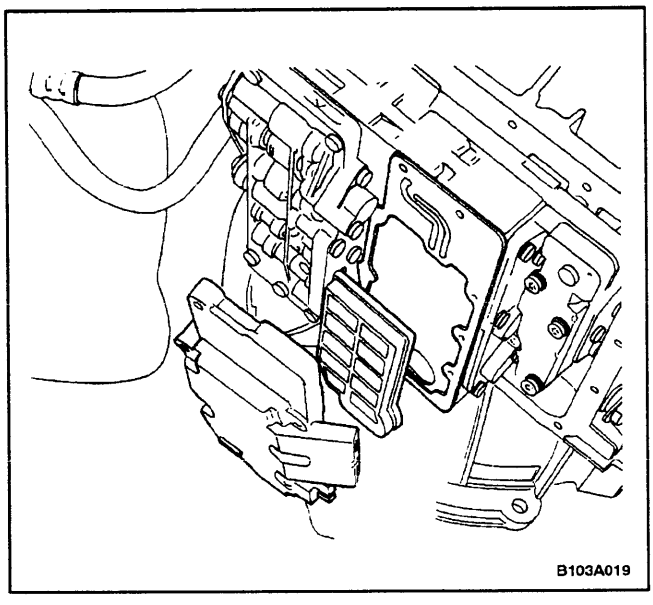
Removal Procedure

1. Raise and suitably support the vehicle.
2. Remove the fluid pan and the gasket. Refer to "Pan and Gasket" in this section.
3. Remove the fluid filter housing cover, the fluid filter, and the fluid filter seal.

Inspection Procedure

Inspect the fluid filter screen and the fluid pan for metal particles, clutch facing material, rubber particles, and engine coolant. If contaminants are found, determine the source and correct it. Refer to "Position R - No Reverse", "Position D - No Power", "Noisy Operation and Sluggish Engagement After Long Trip," and "Intake Noises From Fluid Pump" in this section.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Installation Procedure

1. Install a new fluid filter seal, the fluid filter, and the fluid filter housing cover.
2. Install the fluid filter housing cover attaching bolts.

Tighten

Tighten the fluid filter housing cover attaching bolts to 8 N•m (71 lb-in).

3. Install the fluid pan gasket and the fluid pan. Refer to "Pan and Gasket" in this section.
4. Lower the vehicle.
5. Check the fluid level. Refer to "Transaxle Fluid Level Checking Procedure" in this section.

CASE POROSITY REPAIR

1. Determine the leak area. Refer to "Locating Fluid Leaks" in this section.
2. Clean the leak area with the solvent. Air dry.

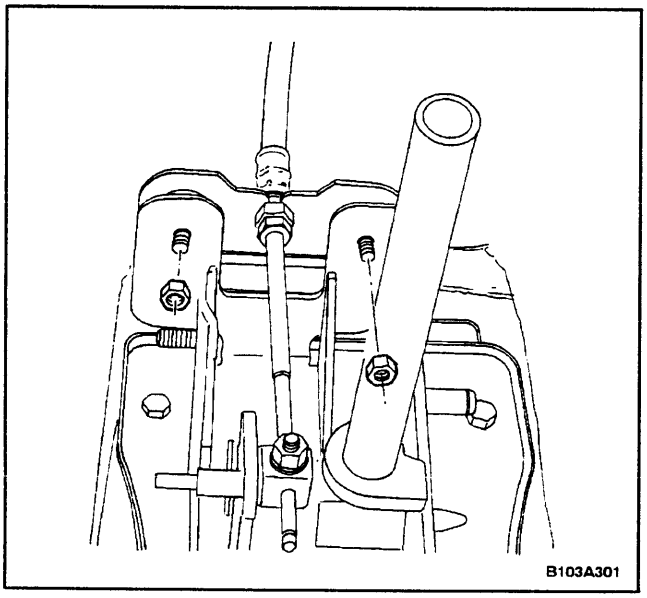
Caution: Epoxy cement may cause skin irritations and eye damage. Read and follow all information on the container label as provided by the manufacturer.

3. Mix a sufficient amount of epoxy cement following the manufacturer's recommendations.
4. While the transaxle case is hot, apply epoxy cement with a with a clean, dry soldering acid brush.
5. Allow the epoxy cement to cure for 3 hours before starting the engine.

FLUID COOLER FLUSHING

Flushing Procedure

1. Drain the fluid from the transaxle and refill the transaxle with the new transaxle fluid. Refer to "Changing Fluid" in this section.
2. Let the engine idle for 5 minutes.
3. Drain the fluid from the transaxle and refill the transaxle with the new transaxle fluid. Refer to "Changing Fluid" in this section.

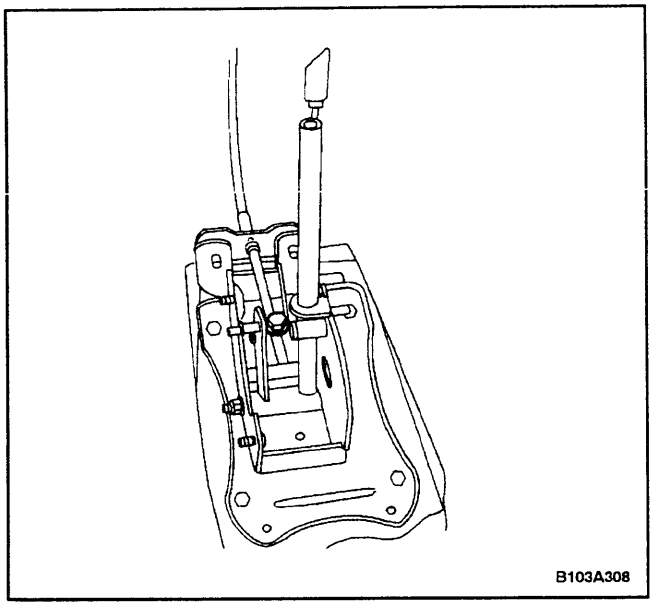


SHIFT CONTROL LEVER

(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the right and the left front lower trim panels, the shift control panel, and the floor console. Refer to *Section 9G, Interior Trim*.
3. Remove the selector position switch.
4. Remove the nuts from the shift control cable mounting bracket at the front of the shift control assembly.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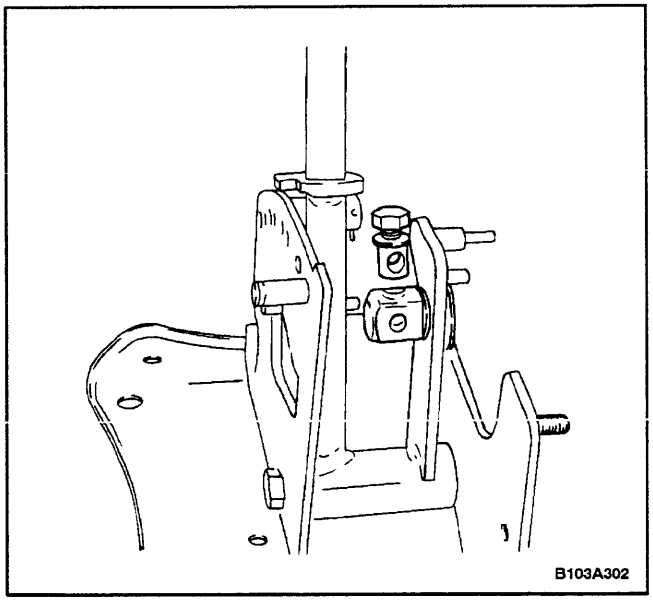
5. Loosen the nut on the shift control cable adjuster pinch bolt.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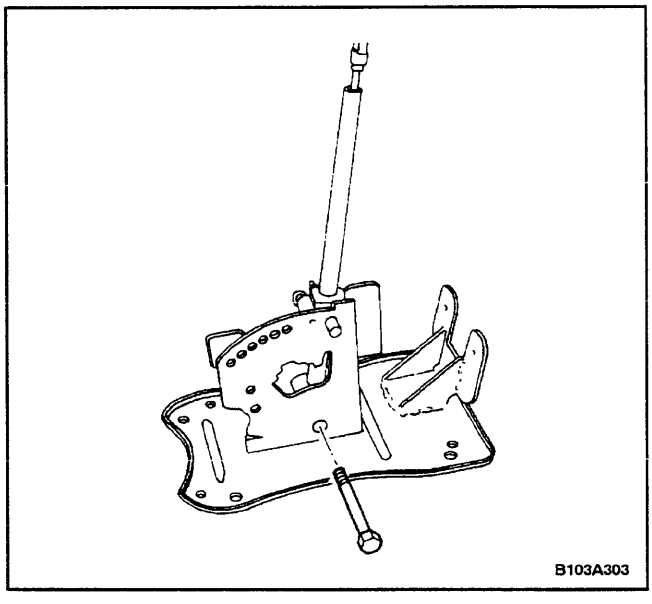
6. Slide the shift control cable out of the shift control cable adjuster and remove the pinch bolt.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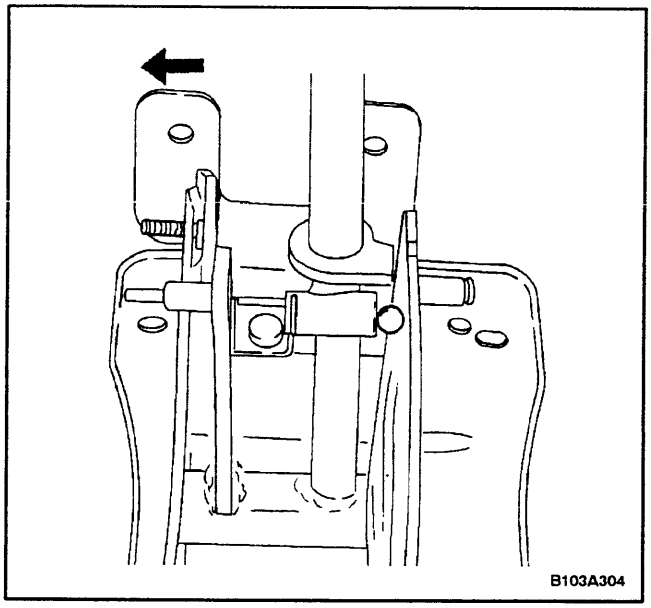
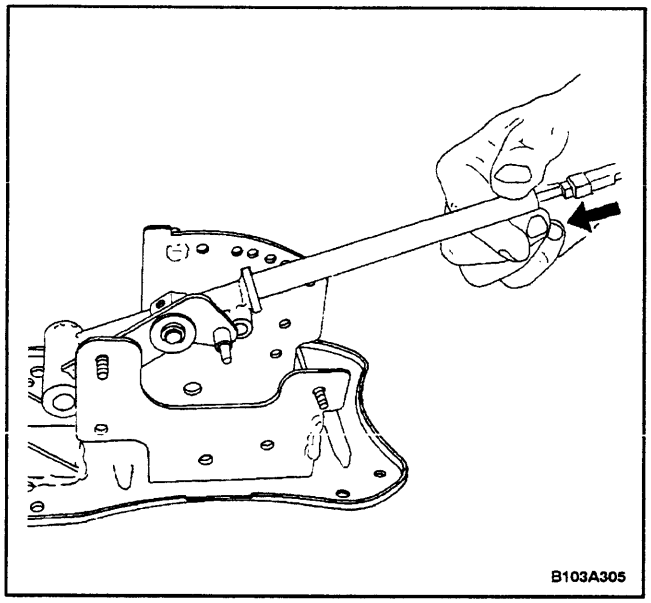
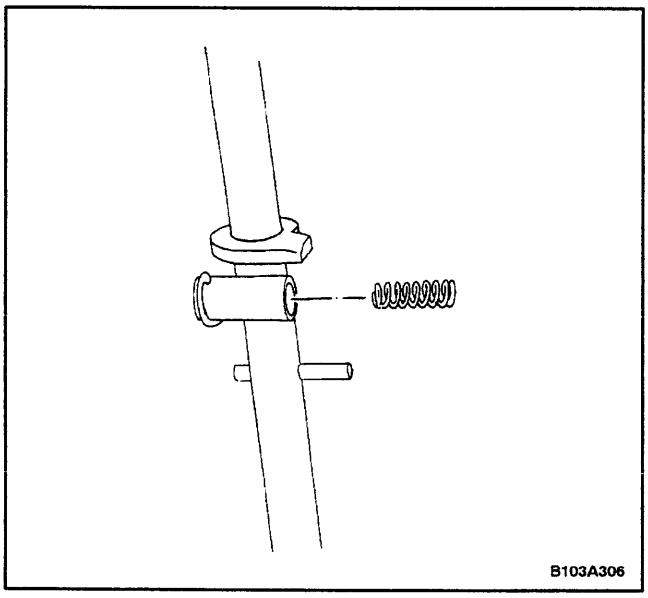
7. Remove the bolt from the bottom of the shift control lever.



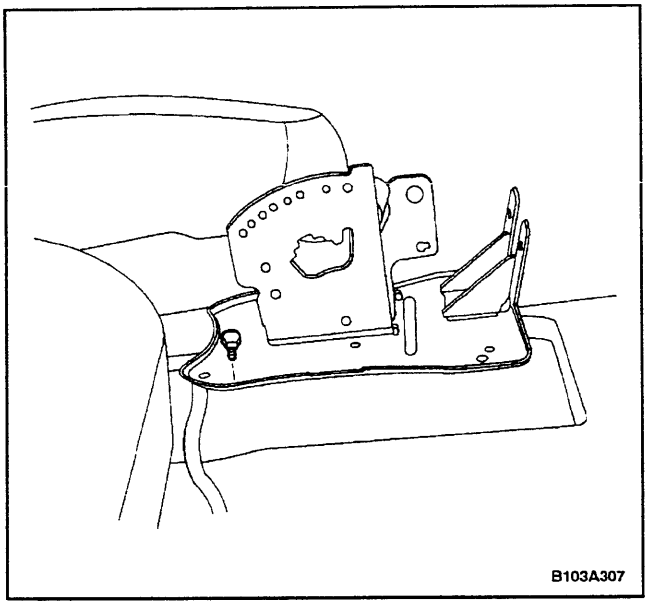
8. Tilt the shift control lever to the left side and remove the spring-loaded detent ball.



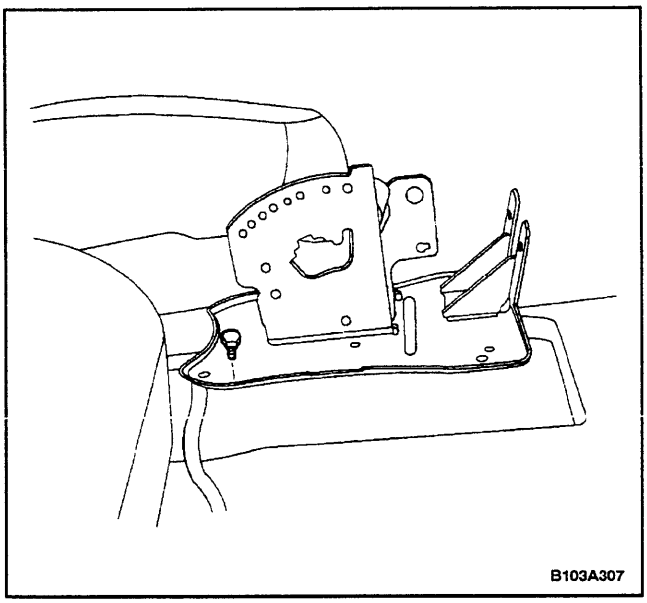
9. Remove the shift control lever by pressing the lock release button while pivoting the bottom of the shift control lever toward the front of the vehicle.



10. Slide the detent spring out of the shift control lever.

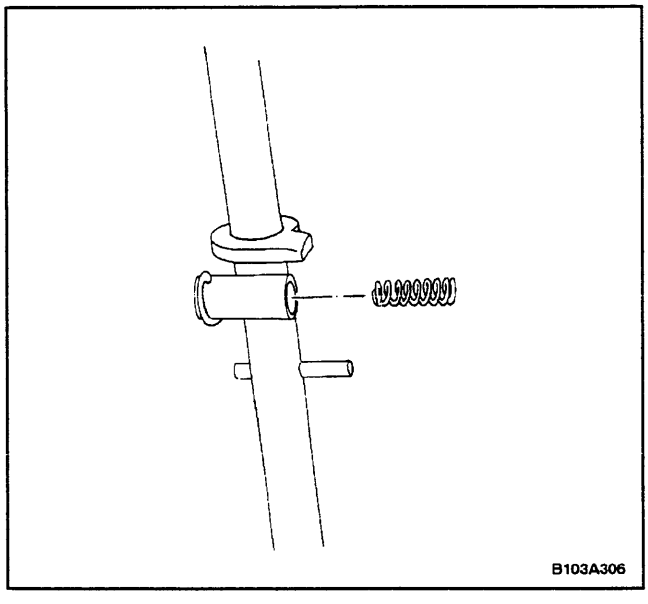


11. Remove the bolts holding the shift control assembly to the floor panel.
12. Remove the shift control assembly.

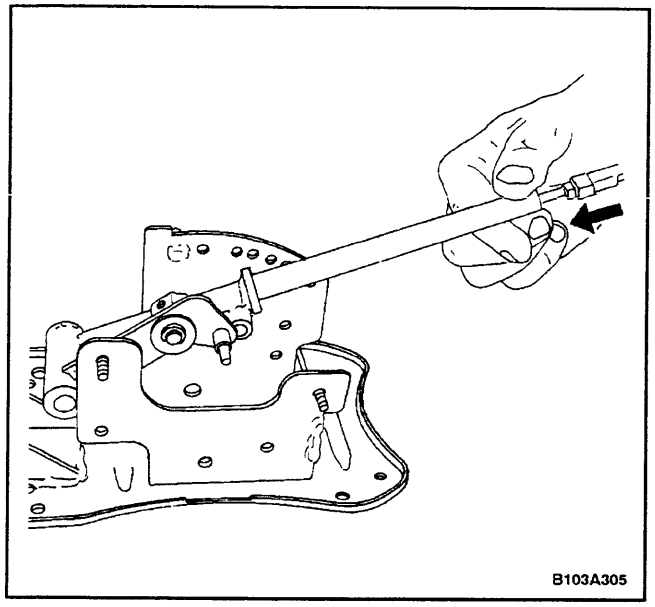


Installation Procedure

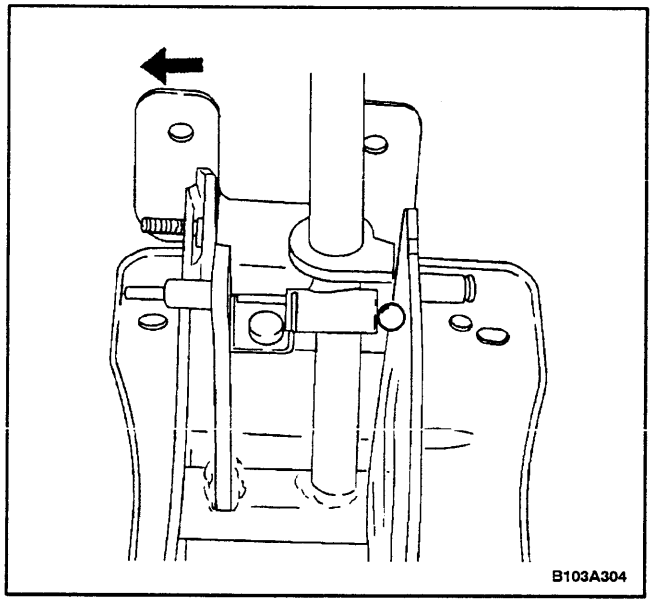
1. Install the shift control assembly in the floor panel with the bolts.



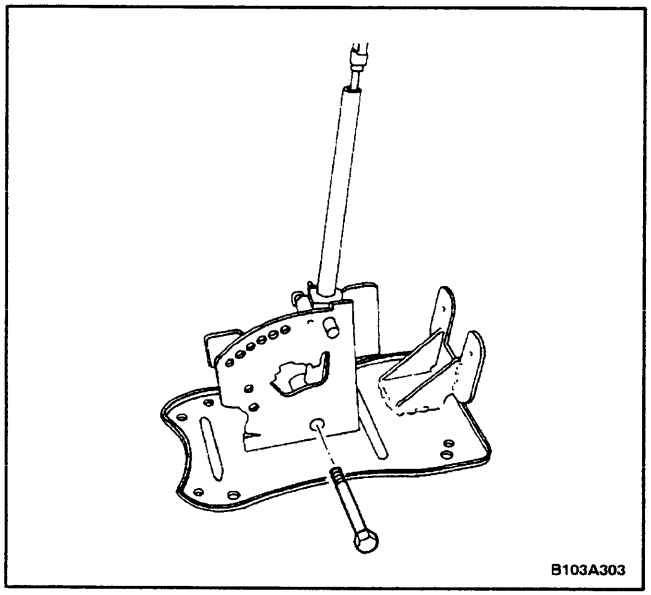
2. Install the detent spring into the shift control lever.



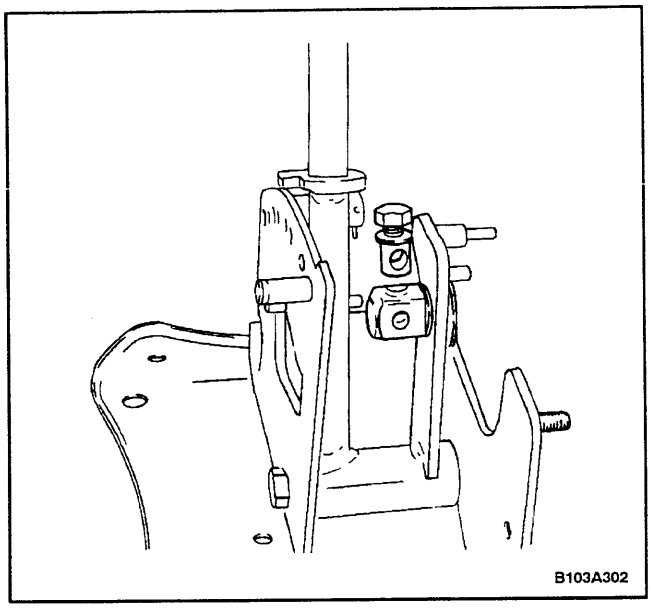
3. Install the shift control lever by pressing the lock release button while pivoting the bottom of the shift control lever toward the rear of the vehicle.



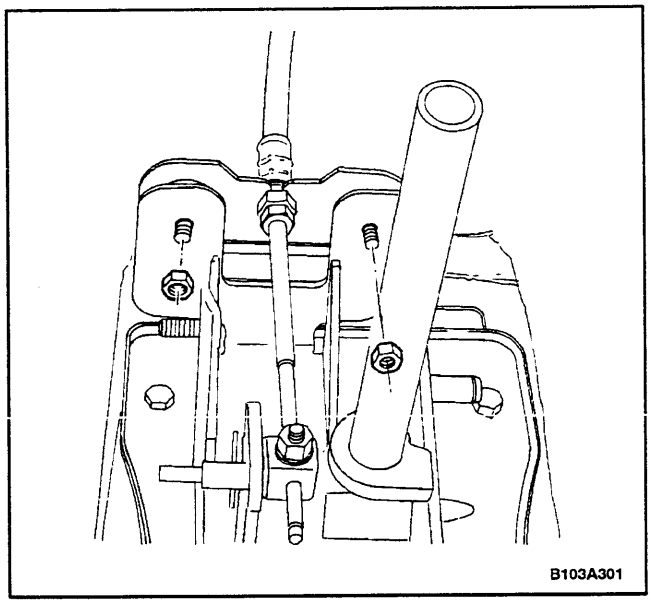
4. Tilt the shift control lever to the left and install the detent ball.



5. Install the bolt in the bottom of the shift control lever.


B103A302

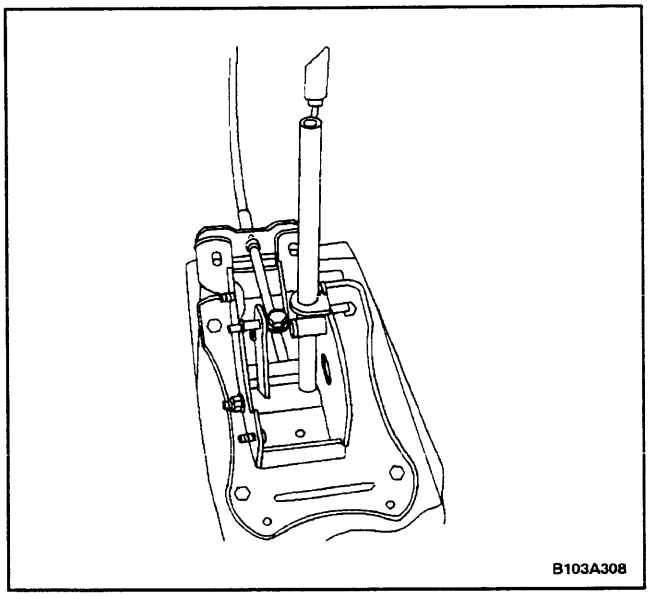
6. Insert the shift control cable adjuster pinch bolt into the shift control assembly and slide the shift control cable into the shift control cable adjuster.


B103A301

7. Attach the shift control cable mounting bracket to the shift control assembly with the nuts.

Tighten

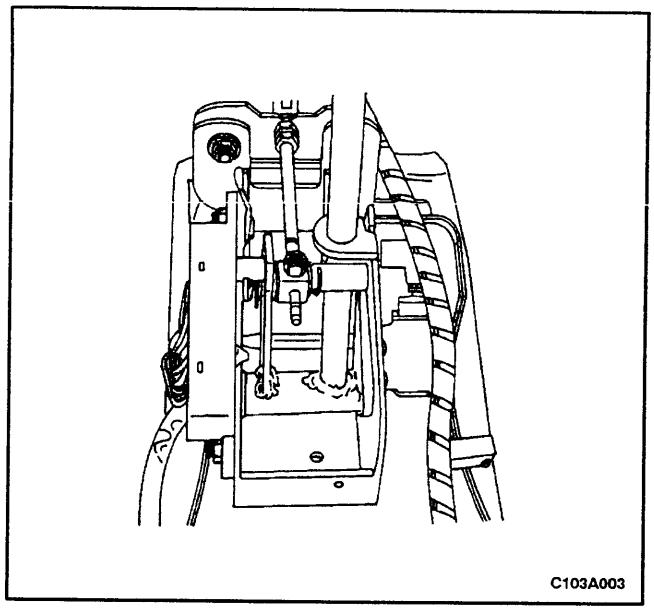
Tighten the shift control cable mounting bracket nuts to 6 N•m (53 lb-in).


B103A308

8. Install the nut on the shift control cable adjuster pinch bolt. Refer to "Control Cable Adjustment" in this section.

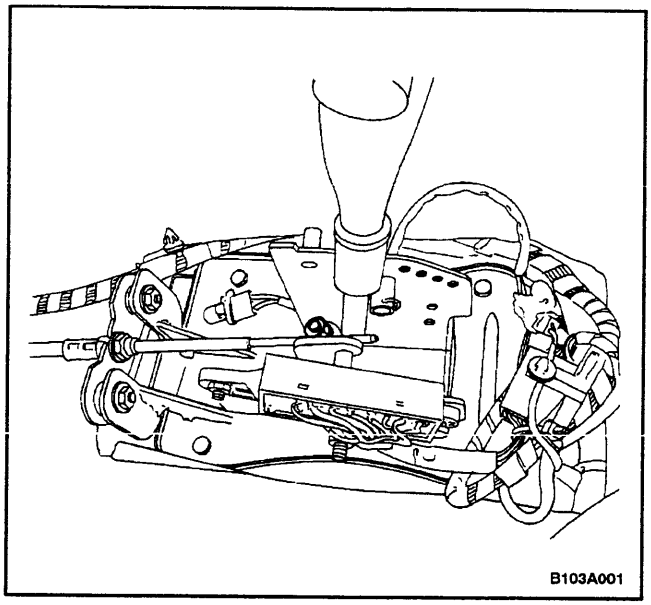
Tighten

Tighten the shift control cable adjuster pinch bolt nut to 8 N•m (71 lb-in).


C103A003

Notice: Make sure the slot in the selector position switch is all the way forward and the shift control lever is in the P position. Failure to do so may damage to the selector position switch and produce a false gear indication.

9. Install the selector position switch on the shift control assembly.
10. Install the floor console, the shift control panel, and the right and the left front lower trim panels. Refer to *Section 9G, Interior Trim*.
11. Connect the negative battery cable.

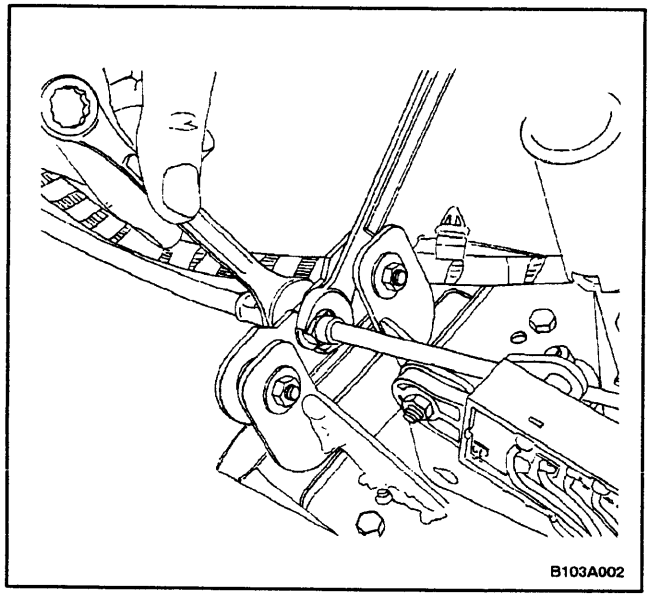

B103A001

SHIFT CONTROL CABLE

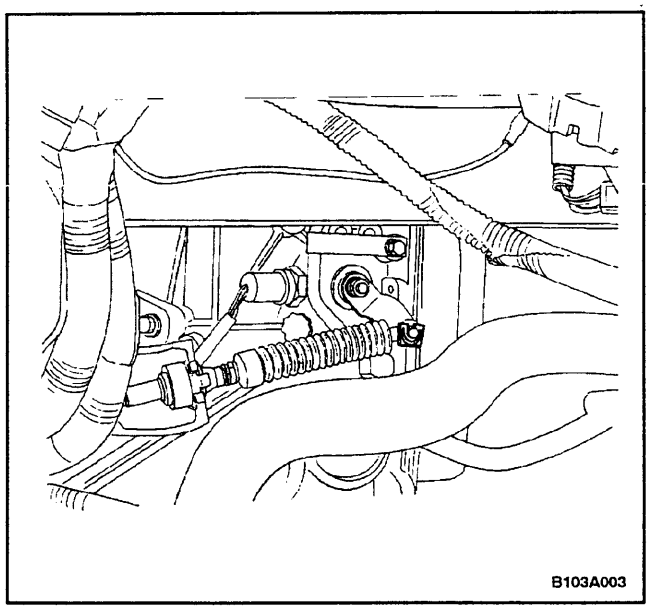
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

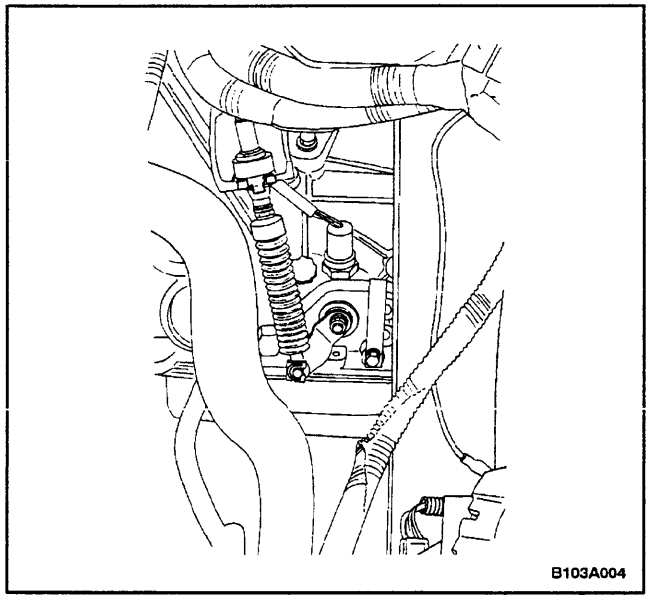
1. Remove the battery and the battery tray.
2. Remove the right and the left front lower trim panels, the shift control panel, and the floor console. Refer to *Section 9G, Interior Trim*.
3. Loosen the pinch bolt nut on the shift control lever.


B103A002

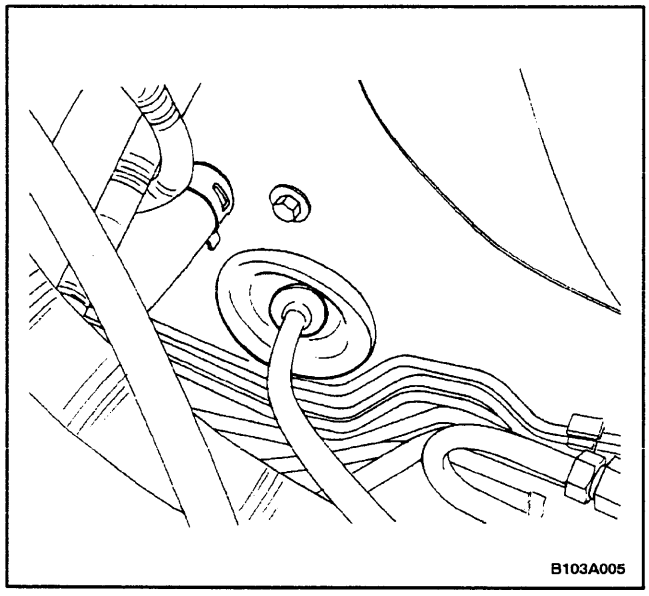
4. Remove the shift control cable from the shift control assembly by holding one nut while loosening the other one.



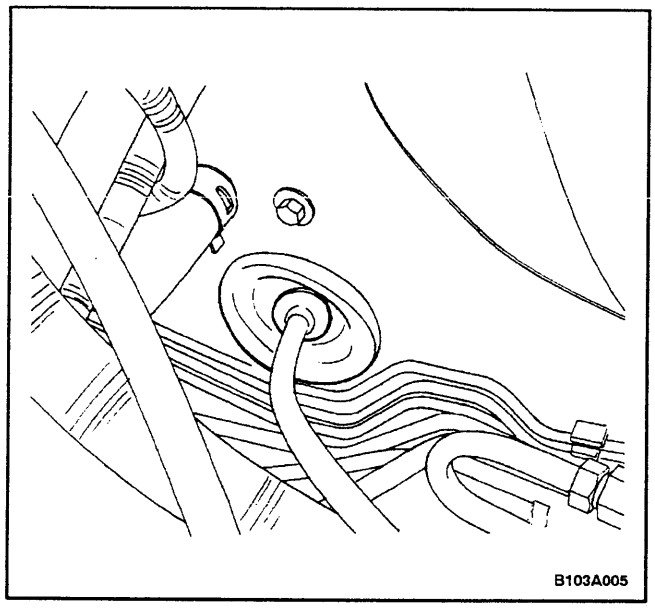
5. Remove the clip from the selector lever connection on the transaxle case and disconnect the shift control cable from the selector lever connection.



6. Remove the clip from the shift control cable at the transaxle mount connection.

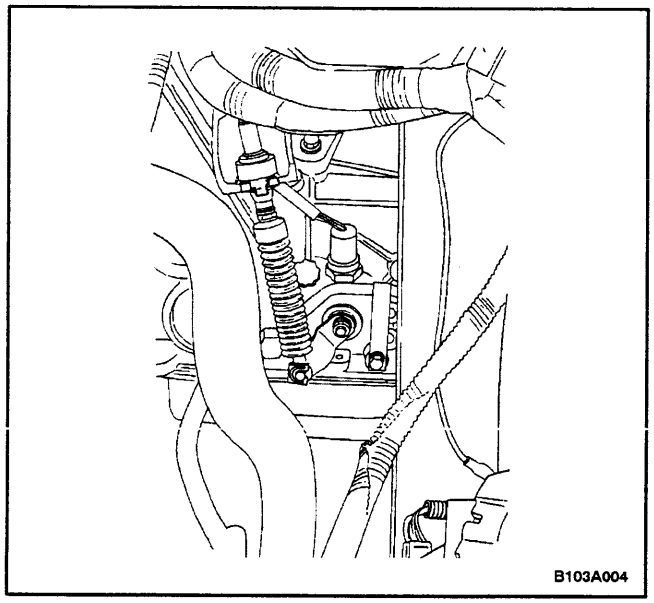


7. Remove the shift control cable from the transaxle mount.
8. Pull the shift control cable through the fire wall of the vehicle, bringing the rubber grommet with it.

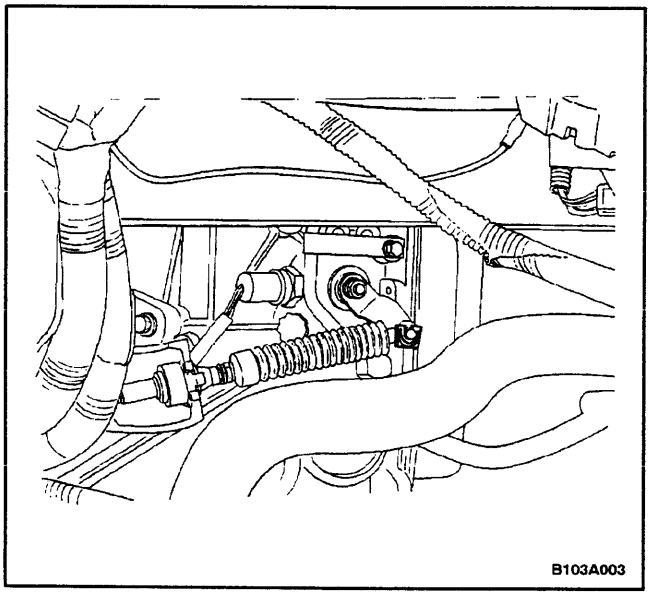


Installation Procedure

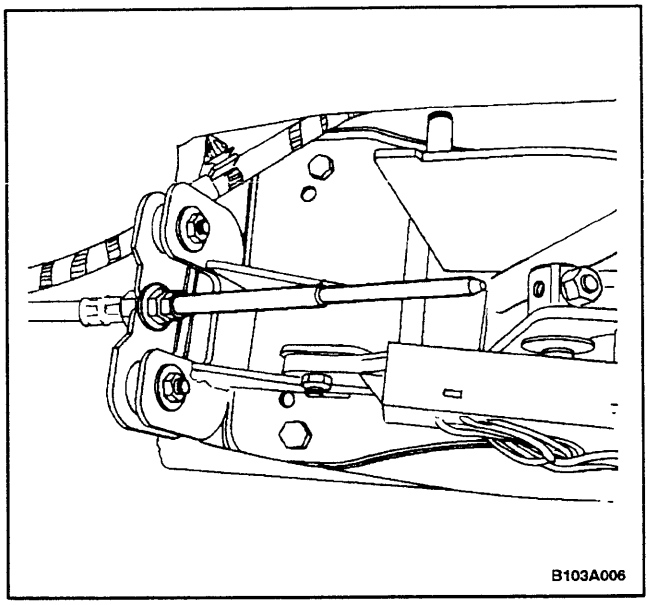
1. Push the shift control cable through the fire wall of the vehicle.
2. Install the rubber grommet into the fire wall.



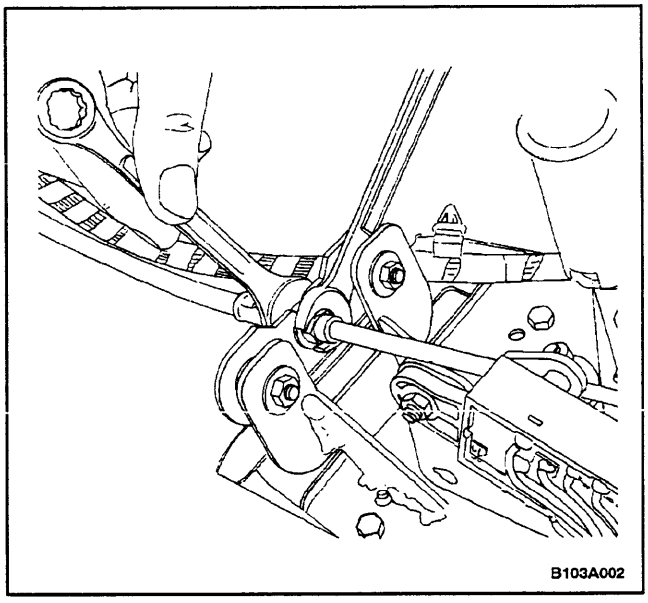
3. Install the shift control cable into the transaxle mount.
4. Install the clip onto the shift control cable at the transaxle mount connection.



5. Connect the shift control cable onto the selector lever connection.


B103A006

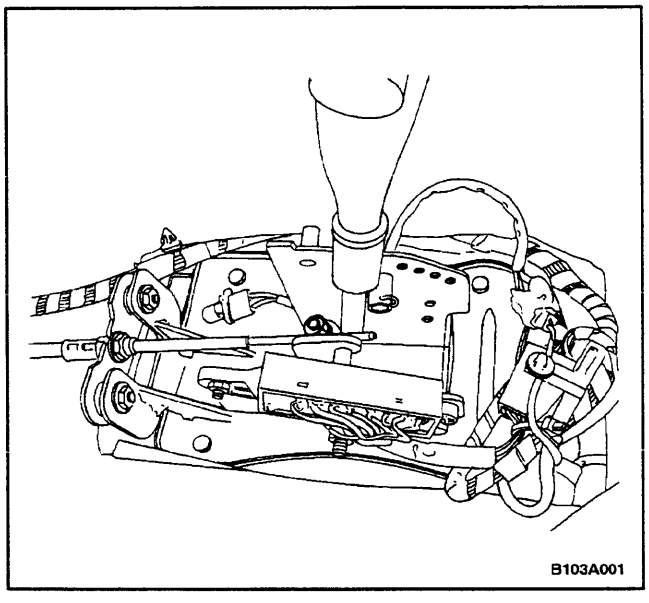
6. Install the clip onto the shift control cable at the selector lever connection on the transaxle case.
7. Install the brass housing and the nut onto the opposite end of the shift control cable.


B103A002

8. Install the shift control cable into the shift control assembly.
9. Install the shift control attachment nut onto the shift control assembly.

Tighten

Tighten the shift control cable attachment nut to 6 N•m (53 lb-in).


B103A001

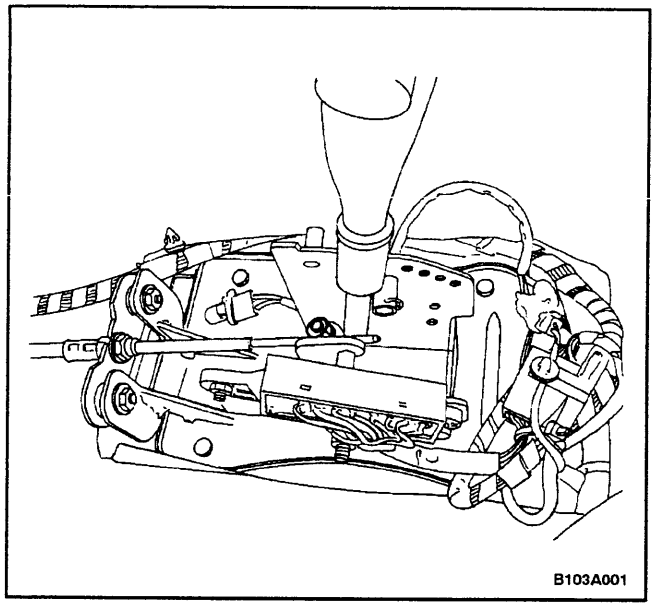
Important: Be sure the shift control lever is in the P position and the selector lever selector is all the way forward before connecting the shift control cable to the shift control lever.

10. Insert the shift control cable into the connecting slot on the shift control lever and secure it with the pinch bolt and nut.

Tighten

Tighten the shift control cable adjustment pinch bolt nut to 8 N•m (71 lb-in).

11. Install the floor console, the shift control panel, and the right and the left front lower trim panels. Refer to *Section 9G, Interior Trim*.
12. Install the battery and the battery tray.


B103A001

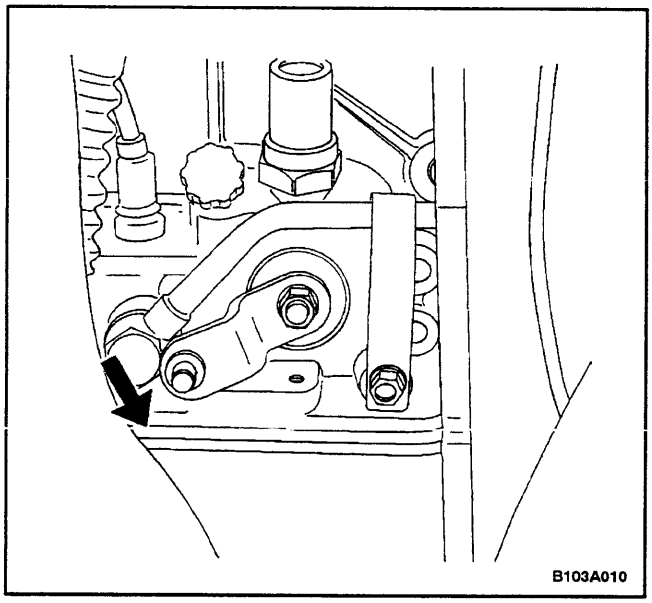
CONTROL CABLE ADJUSTMENT

(Left-Hand Drive Shown, Right-Hand Drive Similar)

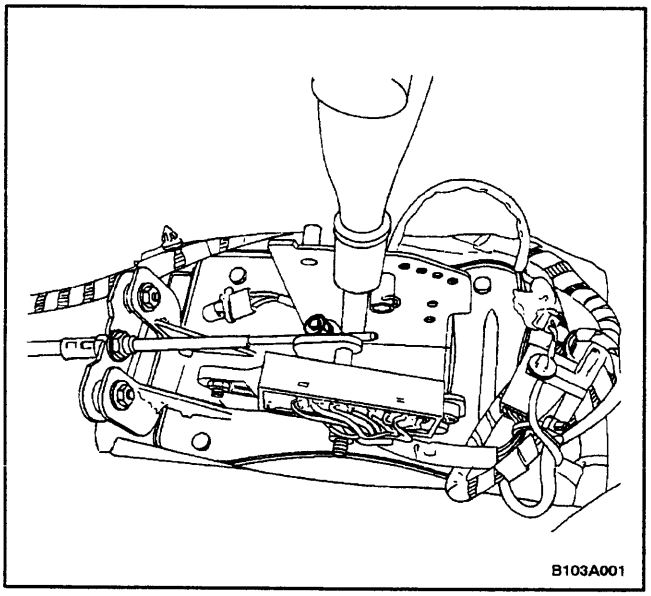
Adjustment Procedure

It is very important to match the shift control lever correctly with the selector lever connection. Place the shift control lever in the P position and check the selector lever connection to see if it is all the way forward. If it is not, proceed with the following adjustment.

1. Remove the battery and the battery tray.
2. Remove the right and the left front lower trim panels, the shift control panel, and the floor console. Refer to *Section 9G, Interior Trim*.
3. Place the shift control lever in the P position.
4. Loosen the pinch bolt nut on the shift control lever.


B103A010

5. Place the selector lever connection all the way forward on the transaxle case.

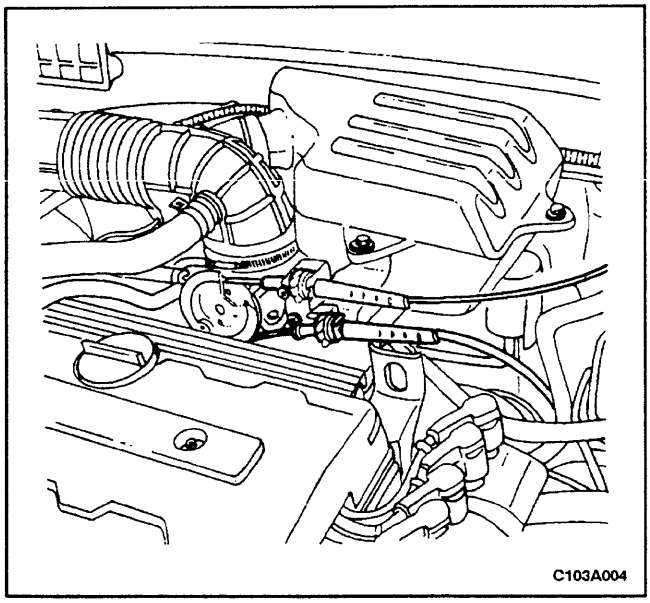

B103A001

6. Insert the shift control cable into the shift control lever tightly.
7. Secure the shift control cable with the shift control cable adjuster pinch bolt and nut.

Tighten

Tighten the shift control cable adjuster pinch bolt nut to 8 N•m (71 lb-in).

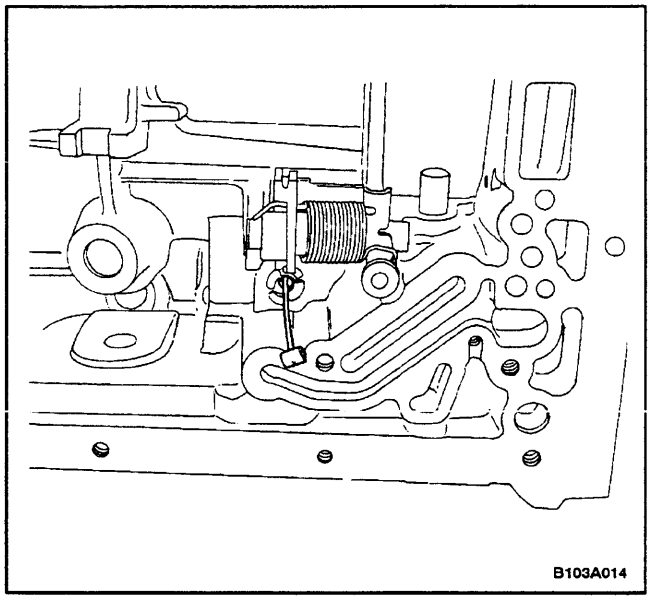
8. Install the floor console, the shift control panel, and the right and the left front lower trim panels. Refer to *Section 9G, Interior Trim*.
9. Install the battery and the battery tray.


C103A004

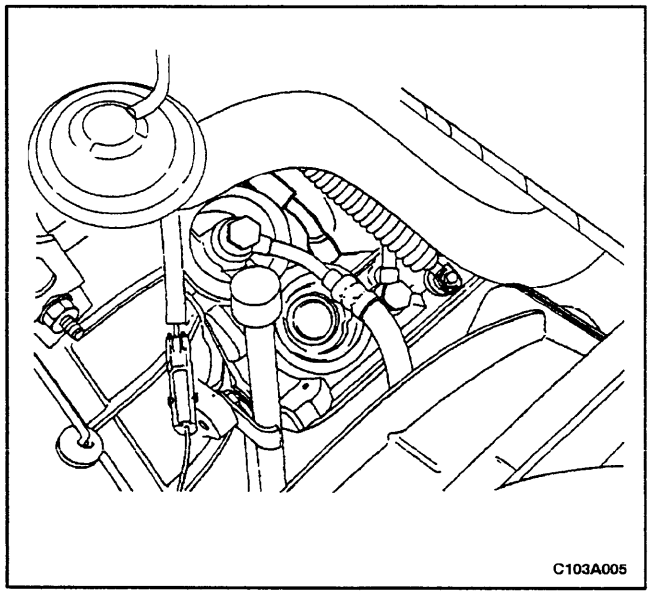
THROTTLE VALVE CABLE

Removal Procedure

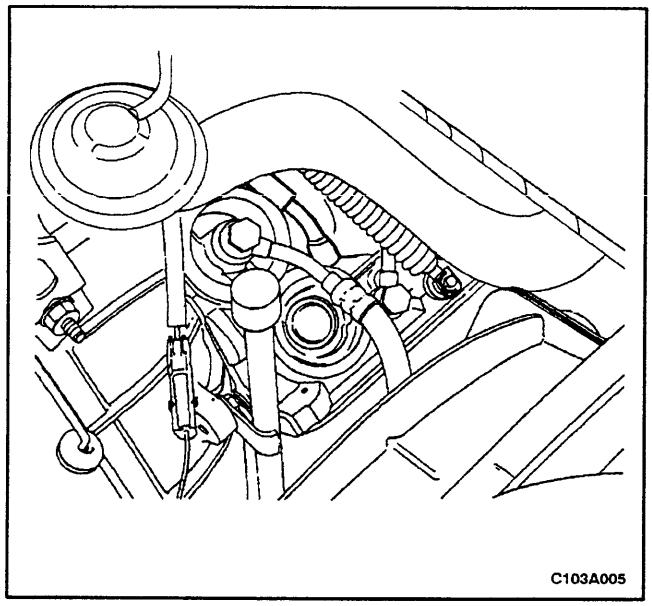
1. Disconnect and remove the battery and the battery tray.
2. Remove the upper cable stop from the throttle cable wheel.


B103A014

3. Raise and suitably support the vehicle.
4. Remove the fluid pan and the gasket. Refer to "Pan and Gasket" in this section.
5. Remove the valve body. Refer to "Valve Body" in this section.
6. Turn the throttle valve cable cam and remove the cable stop from the cam.

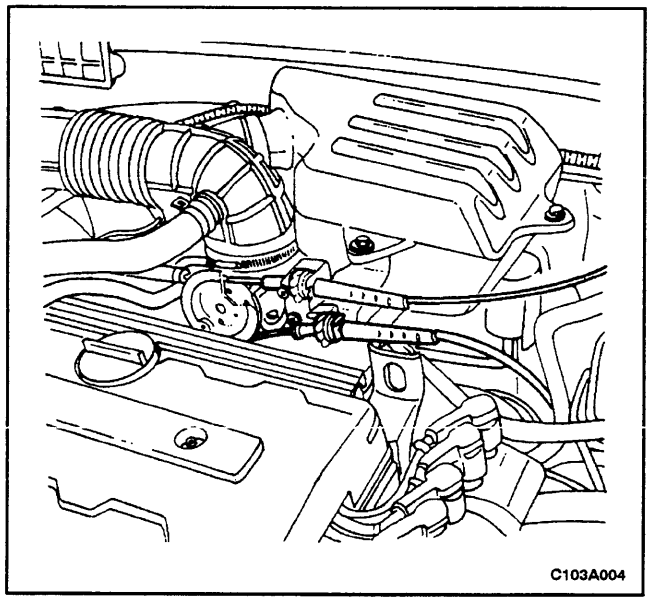

C103A005

7. Lower the vehicle.
8. Remove the throttle valve cable from the transaxle case.

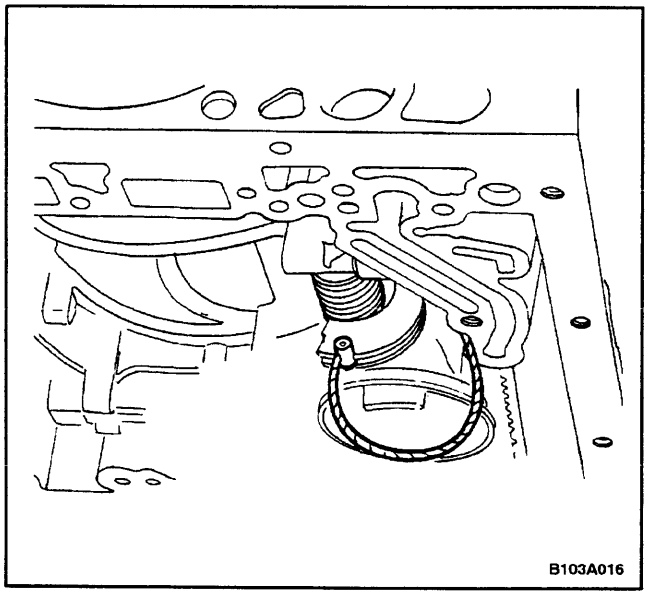

C103A005

Installation Procedure

1. Install the throttle valve cable into the transaxle case.


C103A004

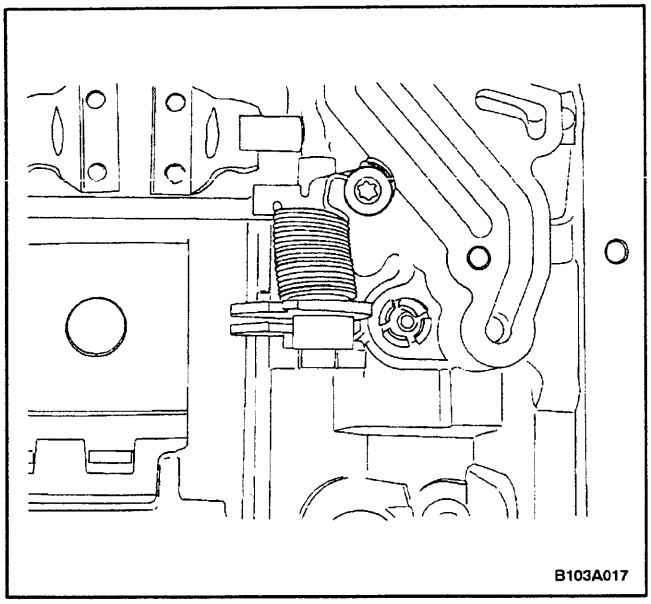
2. Connect the upper cable stop to the throttle cable wheel.


B103A016

3. Raise the vehicle.
4. Turn the cable cam once to allow for a spring load and fit the lower cable stop into the cam seat.
5. Install the valve body. Refer to "Valve Body" in this section.
6. Install the lower fluid pan and the gasket. Refer to "Pan and Gasket" in this section.
7. Lower the vehicle.
8. Install the battery tray and the battery and connect the battery.

Adjustment Procedure

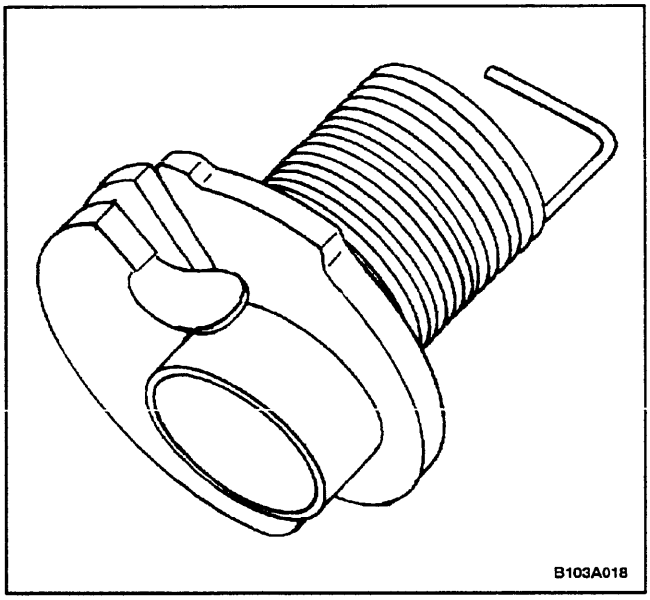
1. Turn the throttle valve wheel counterclockwise to the first stop, then turn it further to open the throttle valve completely.
2. Tighten the cable until the slack is eliminated.


B103A017

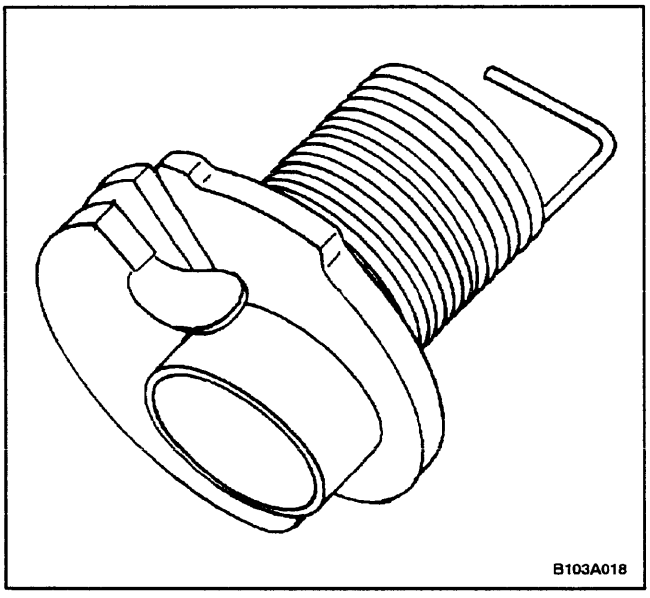
THROTTLE VALVE CABLE CAM

Removal Procedure

1. Raise and suitably support the vehicle.
2. Remove the fluid pan. Refer to "Pan and Gasket" in this section.
3. Remove the valve body. Refer to "Valve Body and Converter" in this section.
4. Remove the throttle valve cable from the cam. Refer to "Throttle Valve Cable" in this section.
5. Remove the detent screw holding the cam onto the transaxle case and remove the throttle valve cable cam.

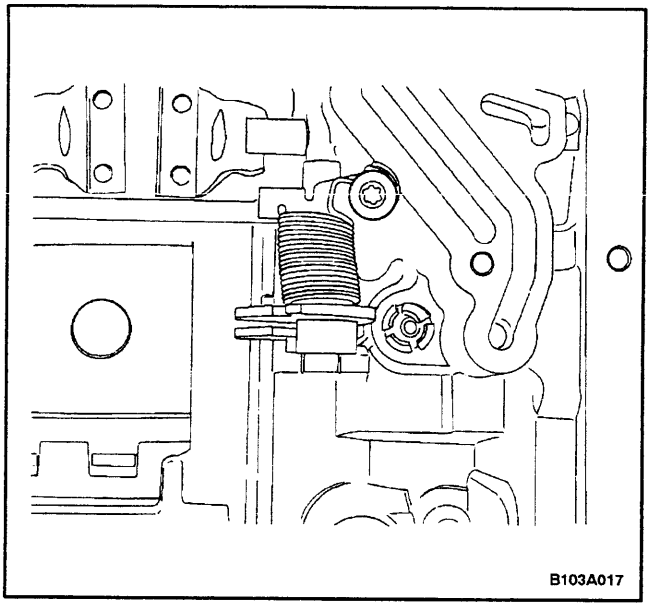

B103A018

6. Remove the spring from the body of the cam.


B103A018

Installation Procedure

1. Install the spring onto the body of the throttle valve cable cam.

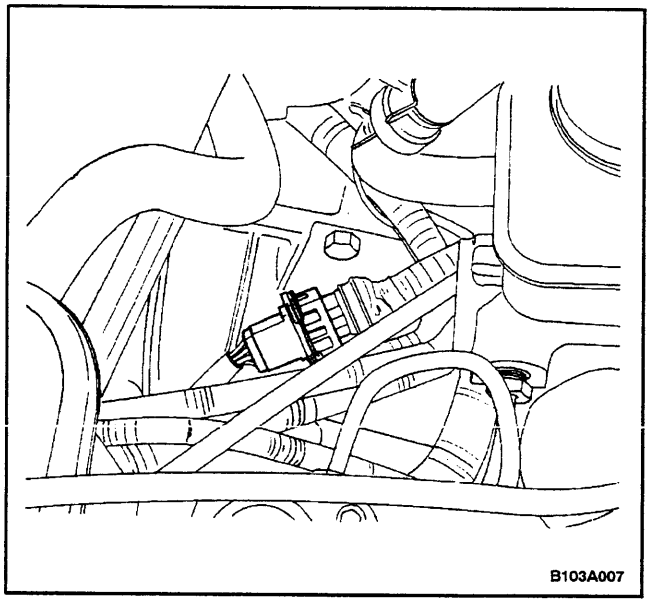

B103A017

2. Install the throttle valve cable cam and secure it to the transaxle case with the detent screw.

Tighten

Tighten the throttle valve cable cam detent screw to 10 N•m (89 lb-in).

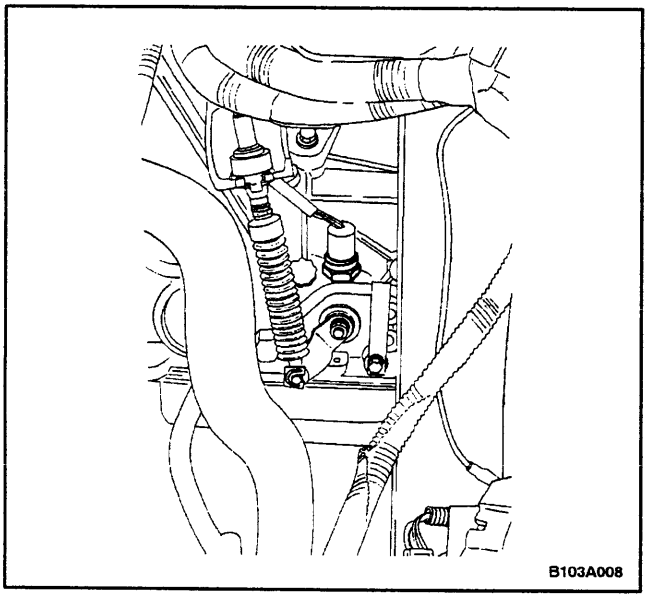
3. Install the throttle valve cable. Refer to "Throttle Valve Cable" in this section.
4. Install the valve body. Refer to "Valve Body and Converter" in this section.
5. Install the fluid pan. Refer to "Pan and Gasket" in this section.
6. Lower the vehicle.


B103A007

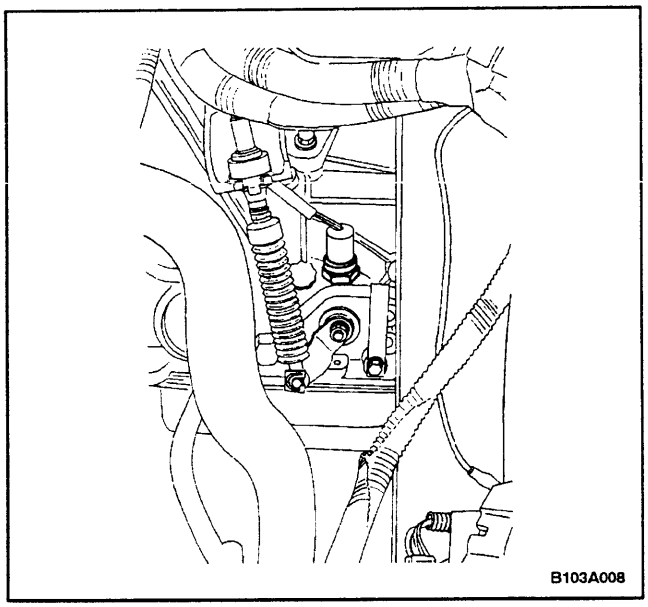
NEUTRAL START SWITCH

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the neutral start switch from the wiring harness.


B103A008

3. Loosen the connecting nut of the neutral start switch on the transaxle case.
4. Remove the neutral start switch.

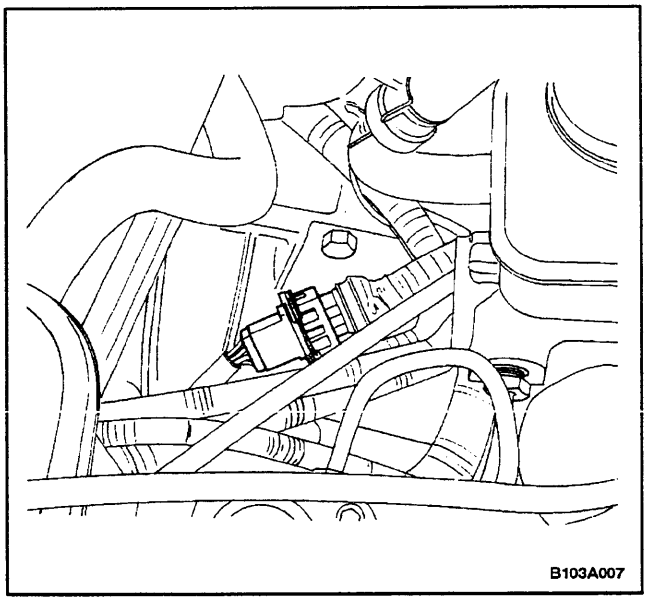

B103A008

Installation Procedure

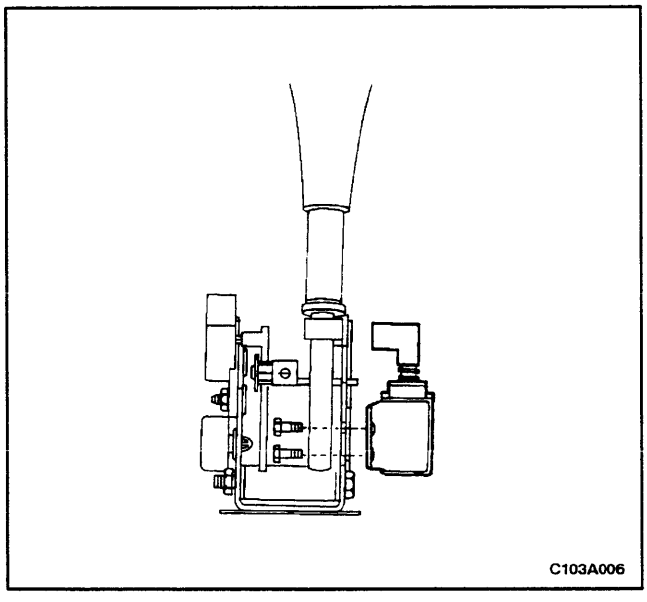
1. Install the neutral start switch and secure it to the transaxle case with the connecting nut.

Tighten

Tighten the neutral start switch connecting nut to 40 N•m (30 lb-ft).


B103A007

2. Connect the neutral start switch to the wiring harness.
3. Connect the negative battery cable.

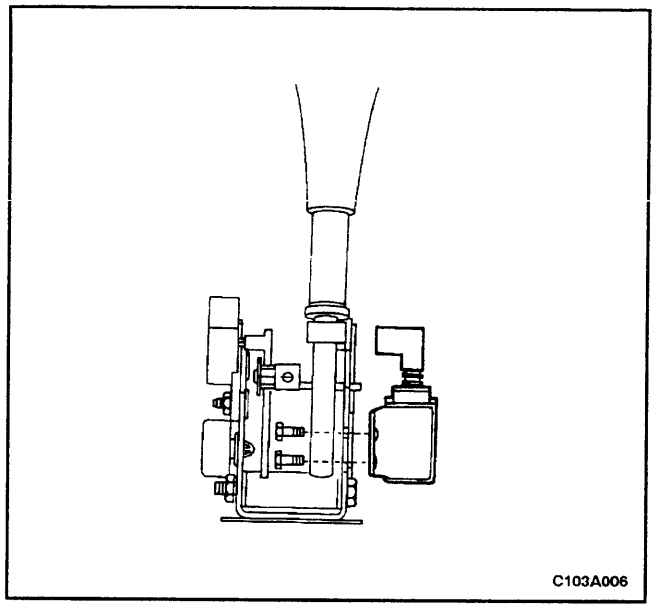

C103A006

BRAKE TRANSAXLE SHIFT INTERLOCK

(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the center console. Refer to *Section 9G, Interior Trim.*
3. Disconnect the electrical connector from the shift interlock solenoid.
4. Remove the shift interlock solenoid bolts and remove the shift interlock solenoid.

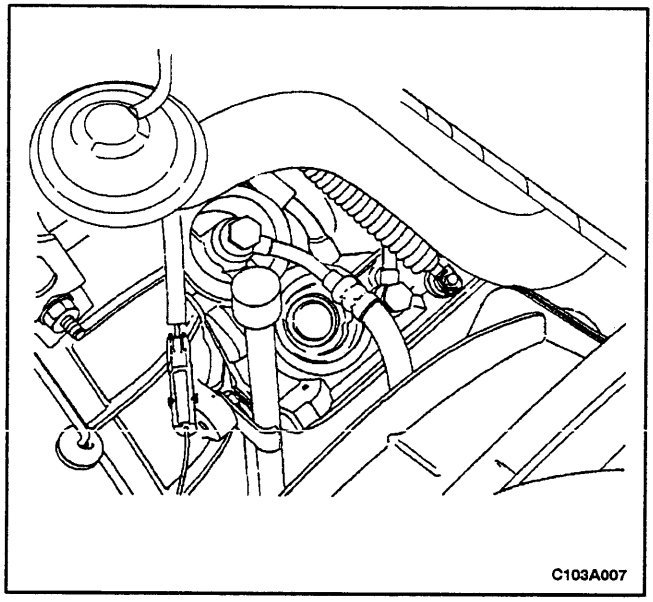

C103A006

Installation Procedure

1. Install the shift interlock solenoid and the shift interlock solenoid bolts.

   Tighten

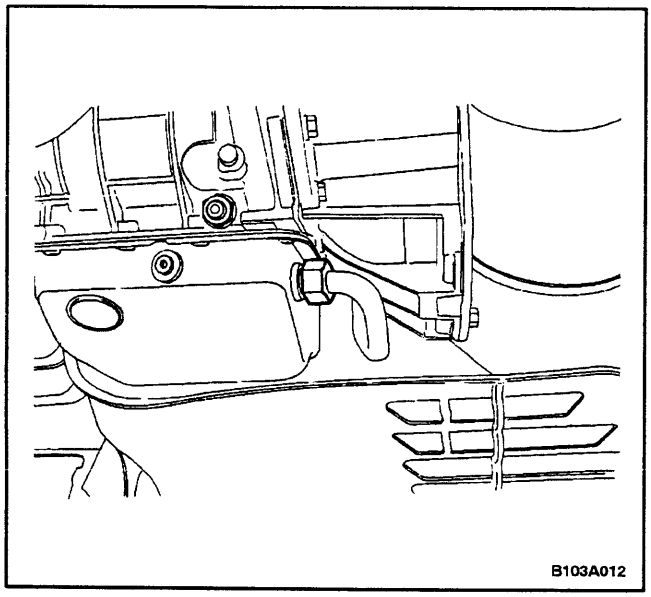
   Tighten the shift interlock solenoid bolts to 8 N•m (71 lb-in).
2. Connect the electrical connector to the shift interlock solenoid.
3. Install the center console. Refer to *Section 9G, Interior Trim.*
4. Connect the negative battery cable.


C103A007

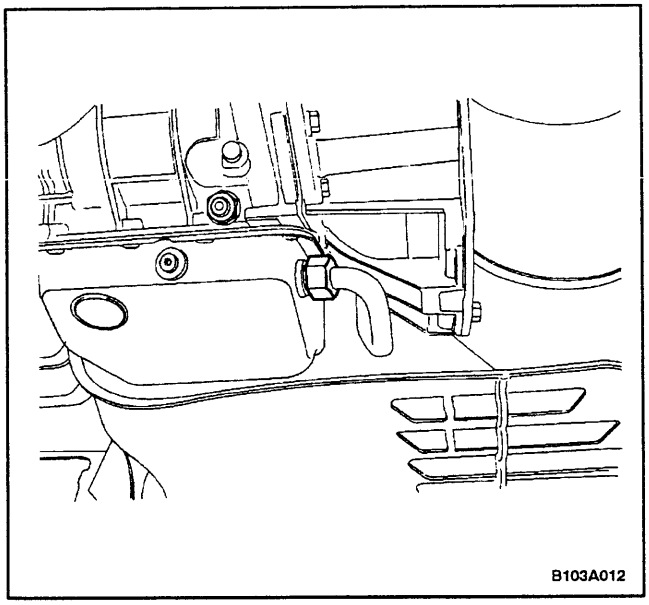
FLUID FILLER TUBE

Removal Procedure

1. Disconnect and remove the battery and the battery tray.
2. Raise and suitably support the vehicle.
3. Drain the fluid out of the transaxle. Refer to "Changing Fluid" in this section.
4. Remove the upper fluid filler tube attachment bolt.


B103A012

5. Remove the lower fluid filler attachment nut and remove the fluid filler tube.

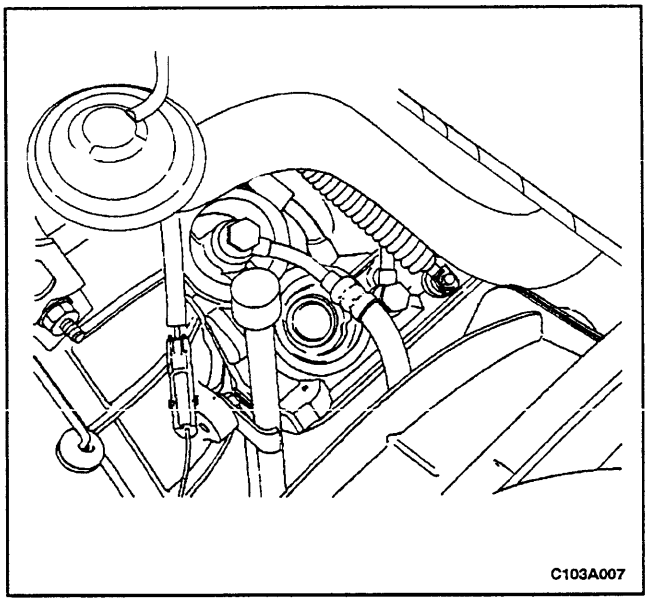

B103A012

Installation Procedure

1. Install the fluid filler tube with the lower fluid filler tube attachment nut.

Tighten

Tighten the lower fluid filler tube attachment nut to 15 N•m (11 lb-ft).

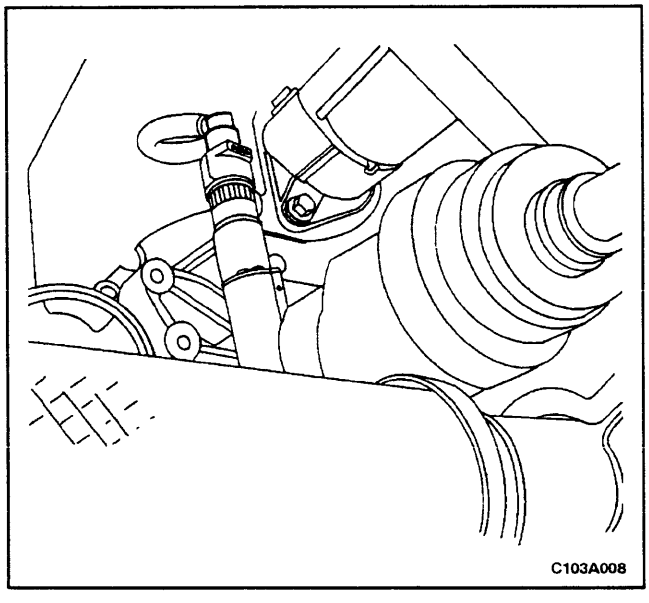

C103A007

2. Install the upper fluid filler tube attachment bolt.

Tighten

Tighten the upper fluid filler tube attachment bolt to 20 N•m (15 lb-ft).

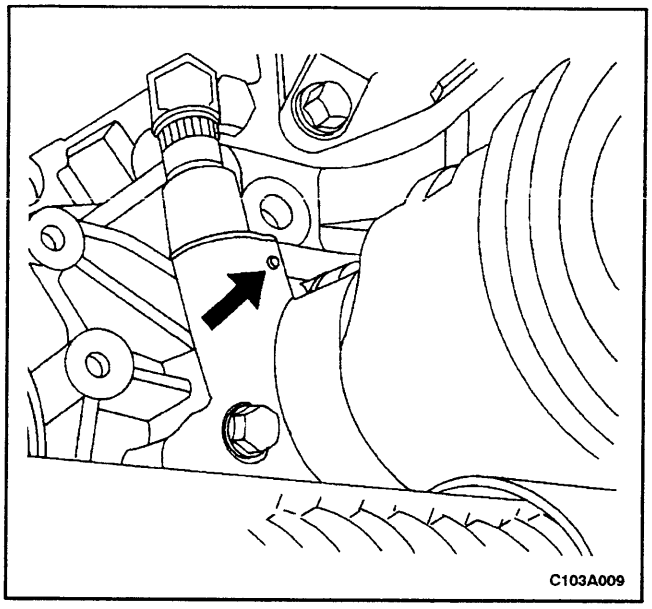
3. Lower the vehicle.
4. Refill the transaxle with the appropriate amount of automatic transaxle fluid. Refer to "Fluid Level Set After Service" in this section.
5. Install the battery tray and the battery.


C103A008

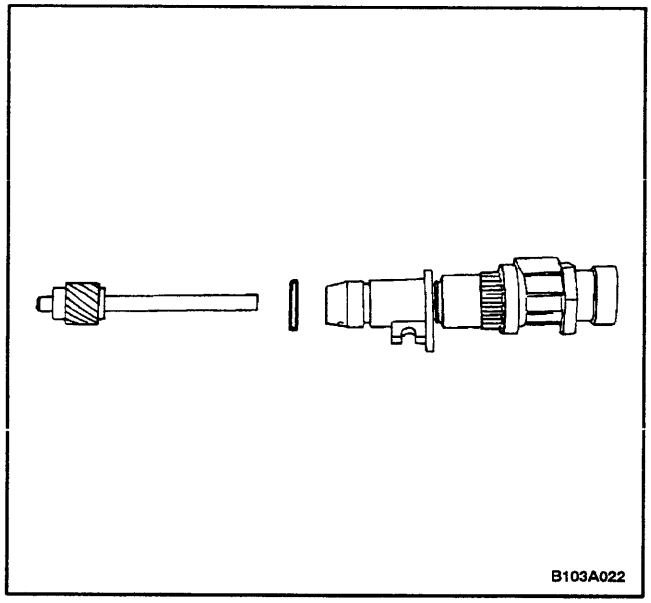
SPEED SENSOR

Removal Procedure

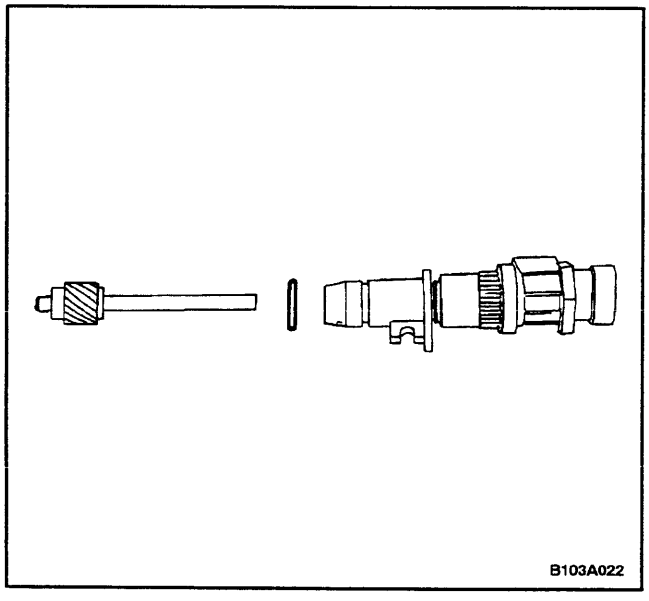
1. Disconnect the negative battery cable.
2. Raise and suitably support the vehicle.
3. Remove the speed sensor electrical connector.



4. Remove the speed sensor from the extension case by removing the roll pin.

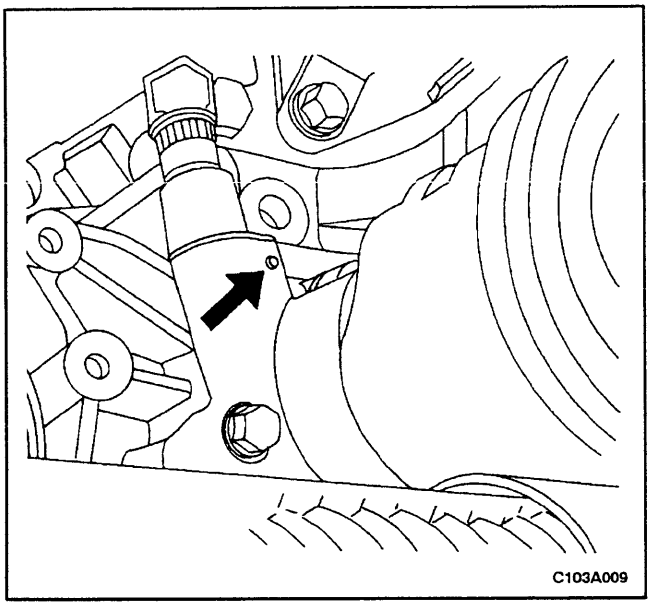


5. Remove the O-ring from the speed sensor.

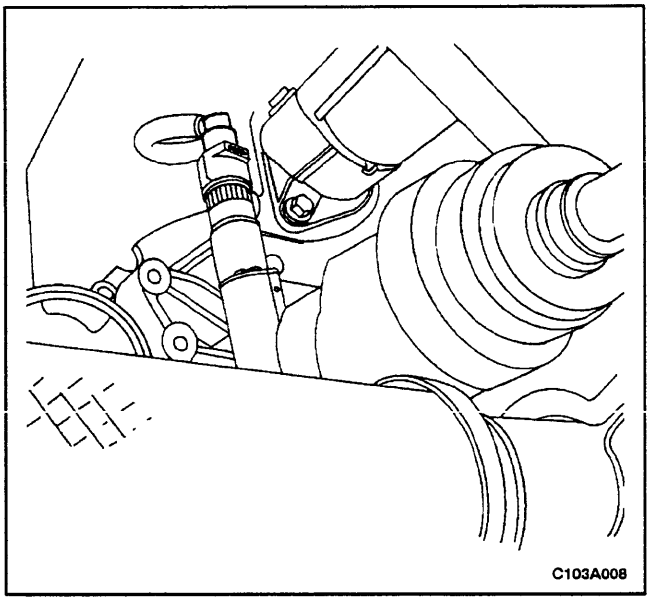


Installation Procedure

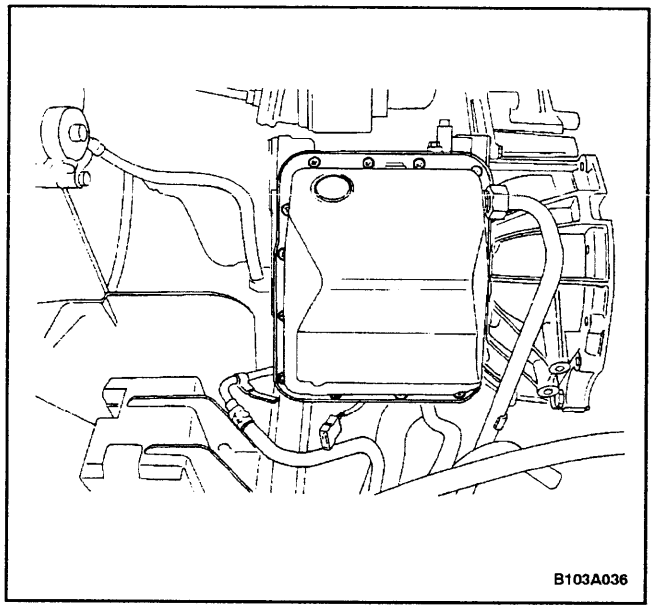
1. Install the O-ring onto the speed sensor.



2. Install the speed sensor into the extension case and secure it with a roll pin.



3. Install the speed sensor electrical connector.
4. Lower the vehicle.
5. Connect the negative battery cable.


B103A036

PAN AND GASKET

Removal Procedure

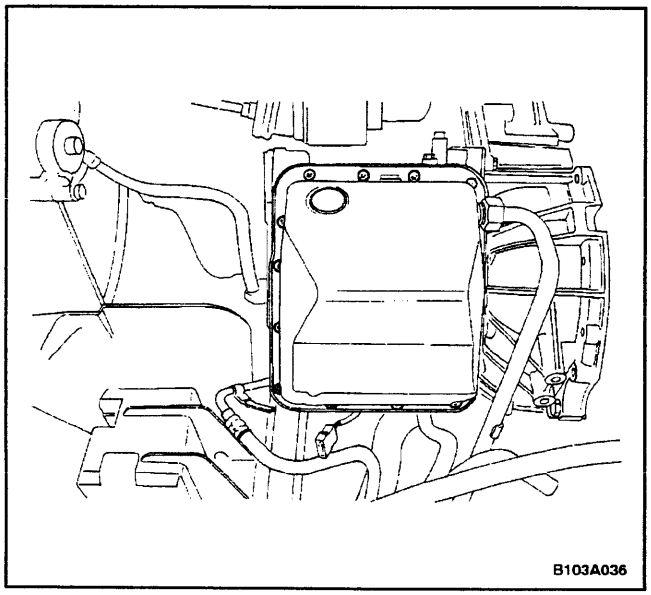
1. Raise and suitably support the vehicle.
2. Remove the engine under covers. Refer to *Section 9N, Frame and Underbody.*
3. Drain the transaxle fluid from the transaxle. Refer to "Changing Fluid" in this section.

Notice: Take care not to damage the mating surfaces of the fluid pan and the case. Such damage can result in fluid leaks in this area.

4. Remove the fluid pan connecting bolts.
5. Remove the fluid pan and gasket.

Inspection Procedure

Inspect the fluid pan for metal particles, clutch facing material, rubber particles, and engine coolant. Inspect the pan flange for distortion. Correct as needed.


B103A036

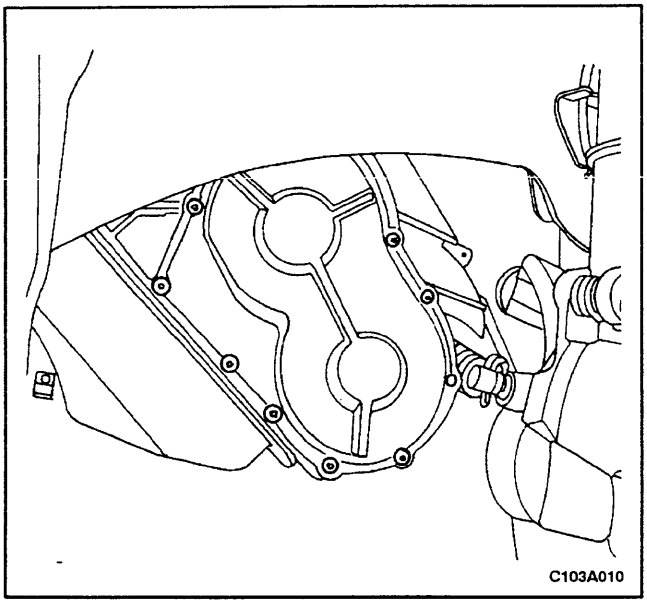
Installation Procedure

1. Install the new transaxle pan gasket.
2. Install the fluid pan with the fluid pan connecting bolts.

Tighten

Tighten the fluid pan connecting bolts to 10 N•m (89 lb-in).

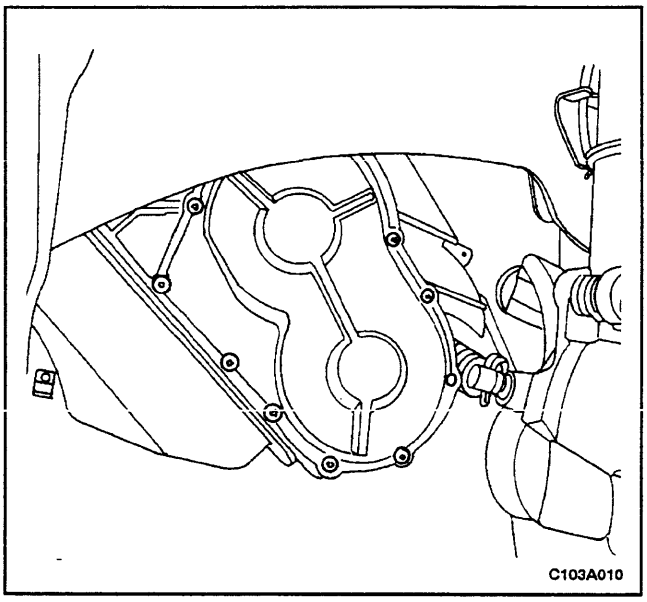
3. Install the engine under covers. Refer to *Section 9N, Frame and Underbody.*
4. Lower the vehicle.
5. Refill the transaxle with the appropriate amount of automatic transaxle fluid. Refer to "Fluid Level Set After Service" in this section.
6. Check the fluid level. Refer to "Transaxle Fluid Level Checking Procedure" in this section.



CASE SIDE COVER PAN AND GASKET

Removal Procedure

1. Raise and suitably support the vehicle.
2. Remove the left tire and wheel assembly. Refer to *Section 2E, Tires and Wheels*.
3. Drain the fluid from the transaxle. Refer to "Changing Fluid" in this section.
4. Remove the side cover pan connecting bolts.
5. Remove the side cover pan and the gasket.



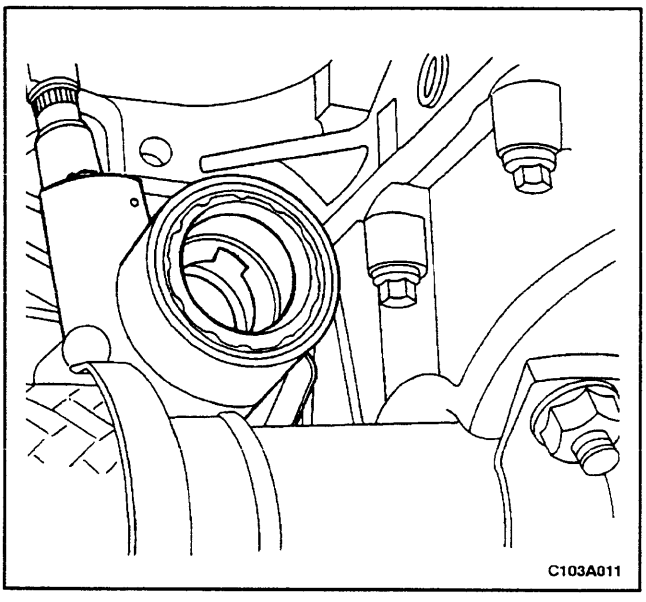
Installation Procedure

1. Install a new side cover pan gasket.
2. Install the side cover pan with the connecting bolts.

Tighten

Tighten the side cover pan connecting bolts to 10 N•m (89 lb-in).

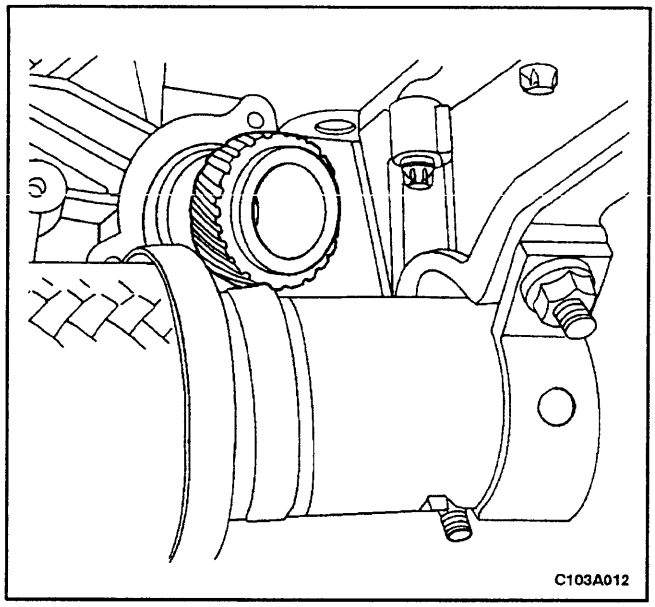
3. Replace the automatic transaxle fluid. Refer to "Fluid Level Set After Service" in this section.
4. Lower the vehicle.



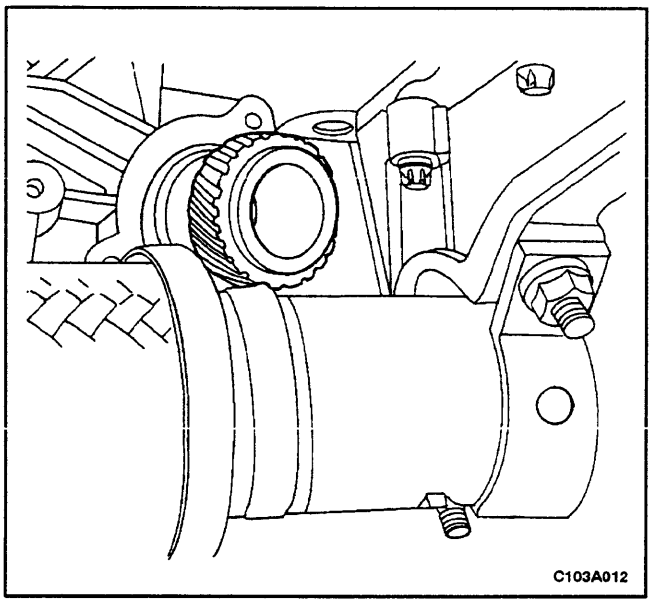
CASE EXTENSION HOUSING

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the vehicle speed sensor connection. Refer to "Speed Sensor" in this section.
3. Remove the case extension housing attachment bolts and the case extension housing.

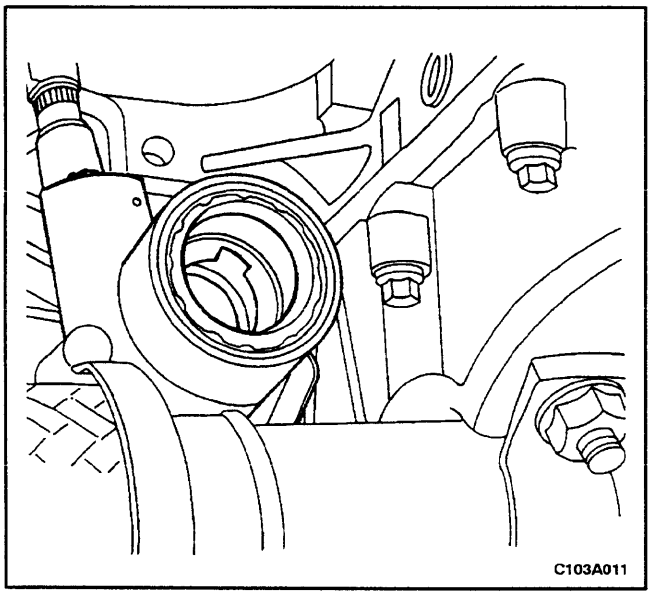


4. Remove speed sensor rotor.



Installation Procedure

1. Install the speed sensor rotor.

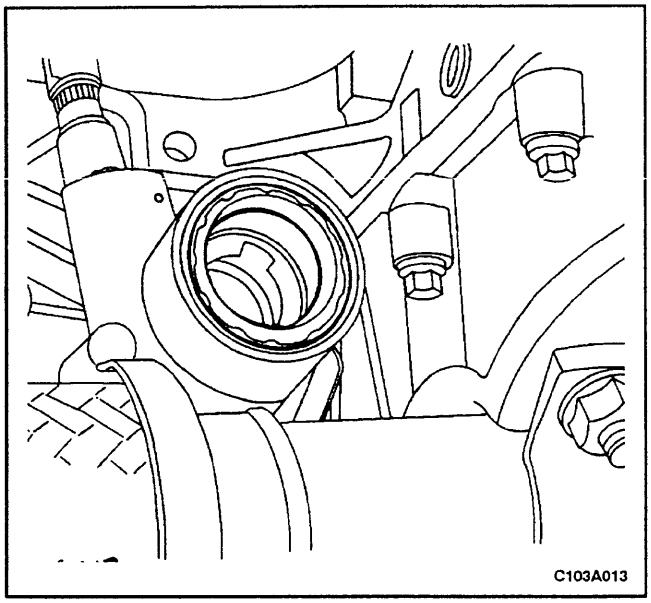


2. Install the case extension housing with the attachment bolts.

Tighten

Tighten the case extension housing attachment bolts to 43 N•m (32 lb-ft).

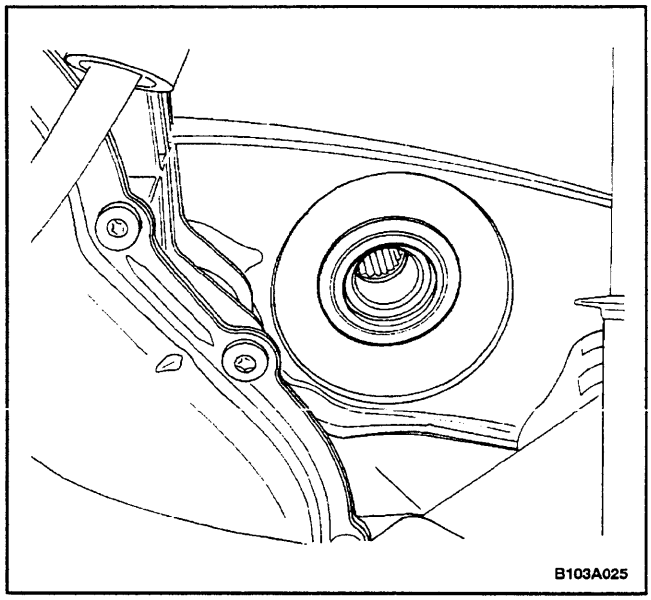
3. Attach the vehicle speed sensor connection. Refer to "Speed Sensor" in this section.
4. Connect the negative battery cable.


C103A013

DRIVE AXLE FLUID SEALS

Removal Procedure

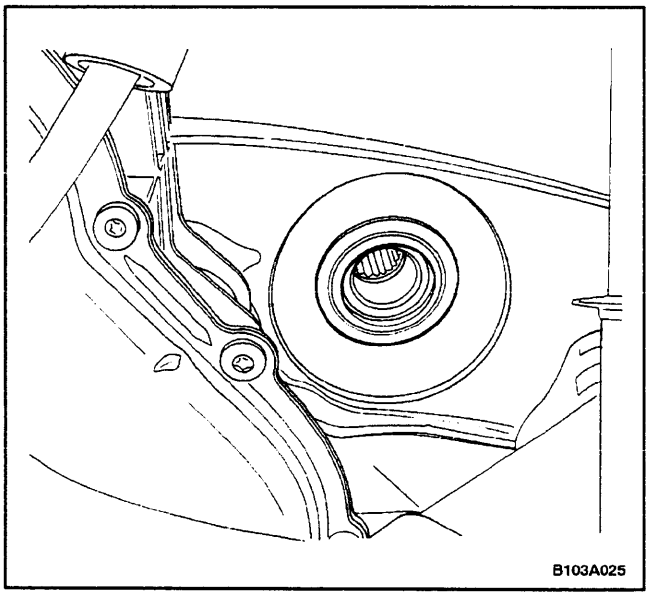
1. Raise and suitably support the vehicle.
2. Remove the wheels. Refer to *Section 2E, Tires and Wheels*.
3. Disconnect the automatic transaxle drive axles from the automatic transaxle. Refer to *Section 3A, Automatic Transaxle Drive Axle*.
4. Remove the right side drive axle fluid seal.

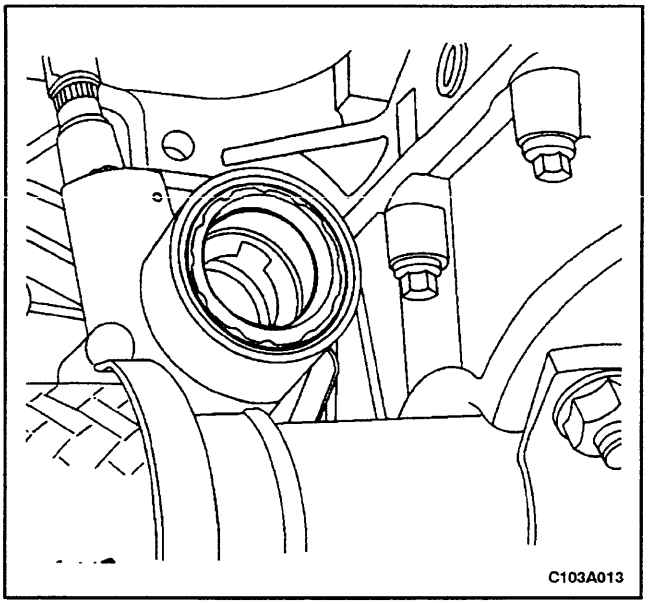

B103A025

5. Remove the left side drive axle fluid seal.

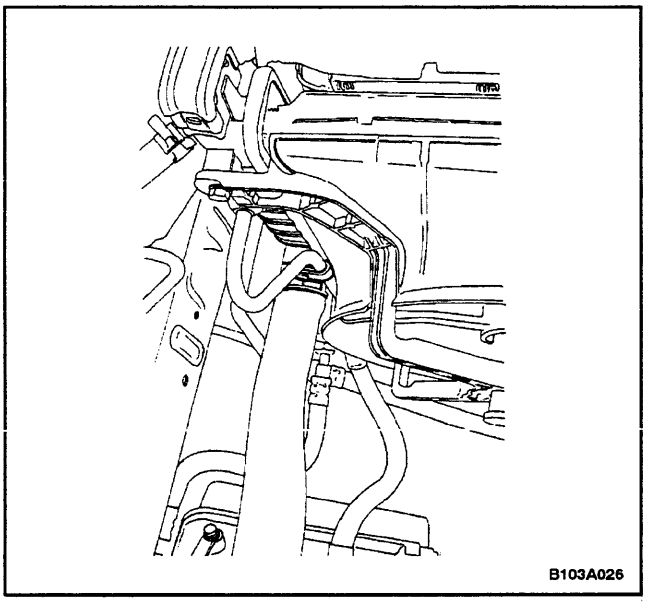
Installation Procedure

1. Install the left side drive axle fluid seal.


B103A025


C103A013

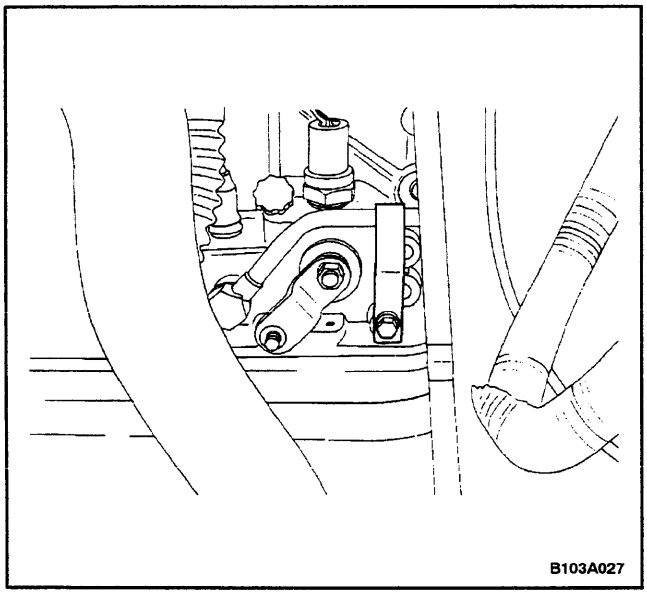
2. Install the right side drive axle fluid seal.
3. Connect the automatic transaxle drive axles to the automatic transaxle. Refer to *Section 3A, Automatic Transaxle Drive Axle.*
4. Install the wheels. Refer to *Section 2E, Tires and Wheels.*
5. Lower the vehicle.


B103A026

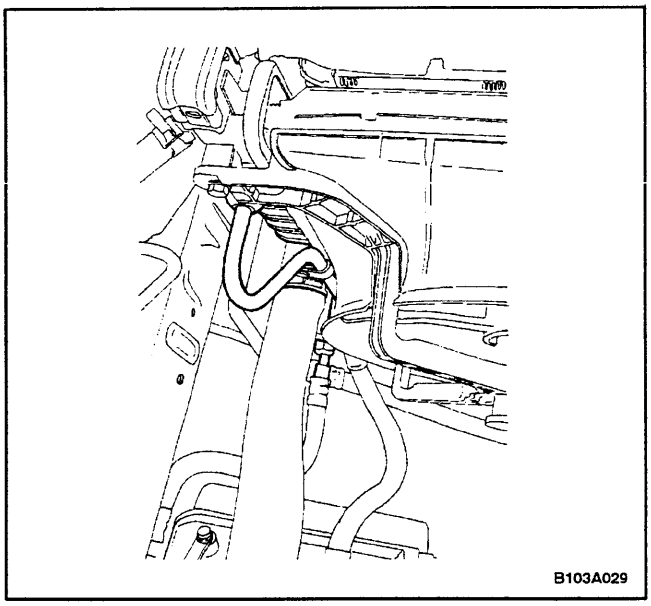
FLUID COOLER PIPES AND HOSES

Removal Procedure

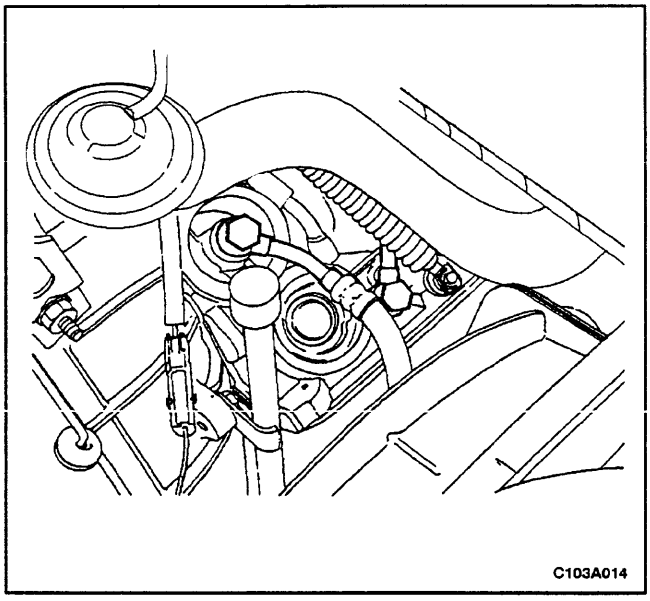
1. Remove the battery and the battery tray.
2. Place a pan under the vehicle to catch any leaking fluid.
3. Remove the securing fastener from the cooler pipe on the radiator.


B103A027

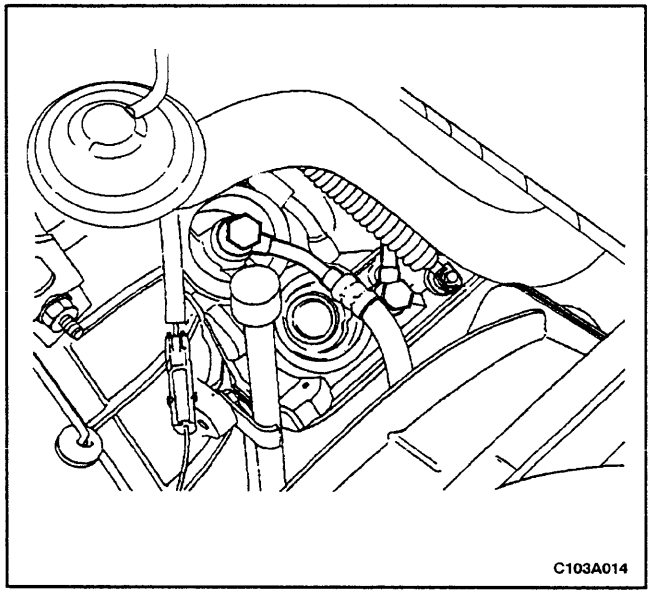
4. Remove the securing fastener from the cooler pipe on the transaxle case.


B103A029

5. Loosen the cooler pipe connections on the radiator.


C103A014

6. Loosen the cooler pipe connections on the transaxle case.
7. Remove the cooler hoses and the cooler pipes.

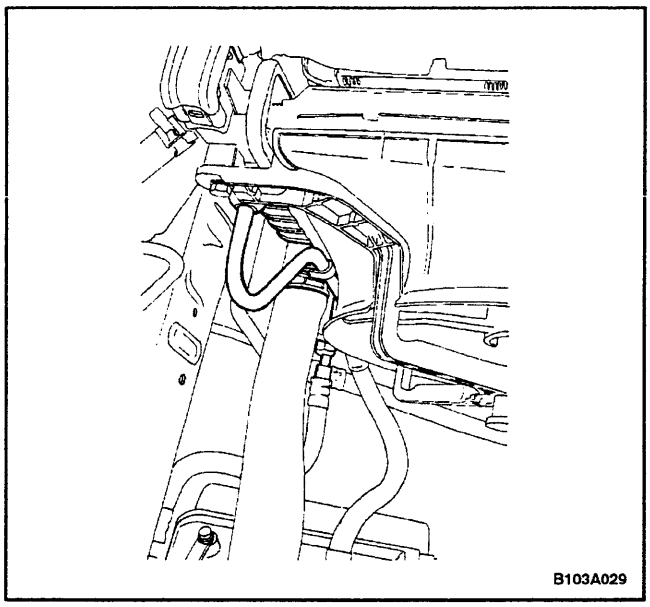

C103A014

Installation Procedure

1. Install the cooler hoses and the cooler pipes.
2. Secure the cooler pipe connections onto the transaxle case with the bolts.

Tighten

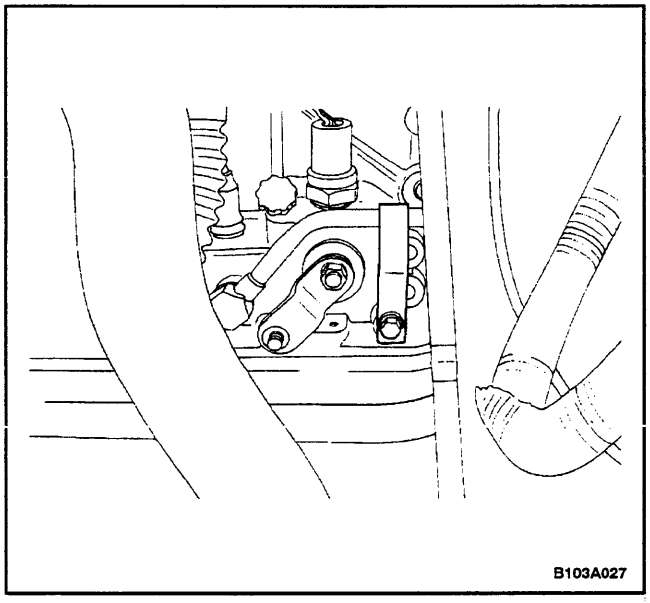
Tighten the cooler pipe-to-transaxle case bolts to 22 N•m (16 lb-ft).


B103A029

3. Secure the pipe connections onto the radiator with the nuts.

Tighten

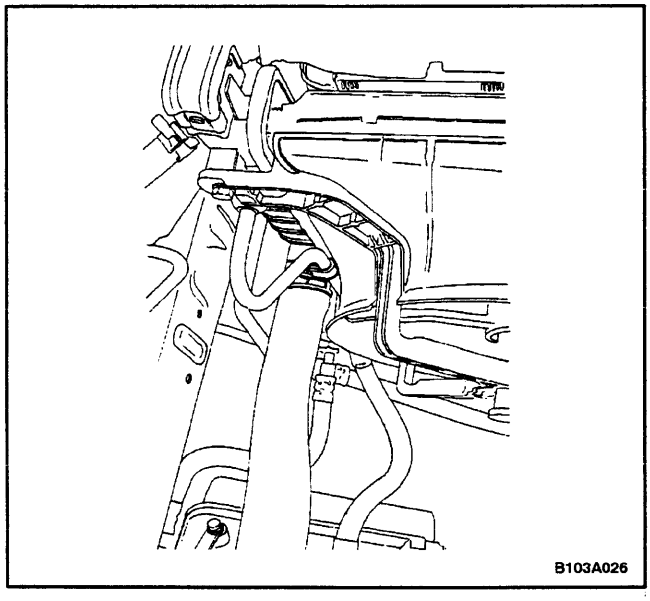
Tighten the cooler pipe-to-radiator nuts to 22 N•m (16 lb-ft).


B103A027

4. Install the cooler pipe securing fastener onto the transaxle case with the fastener bolt.

Tighten

Tighten the cooler pipe-to-transaxle case fastener bolt to 25 N•m (18 lb-ft).

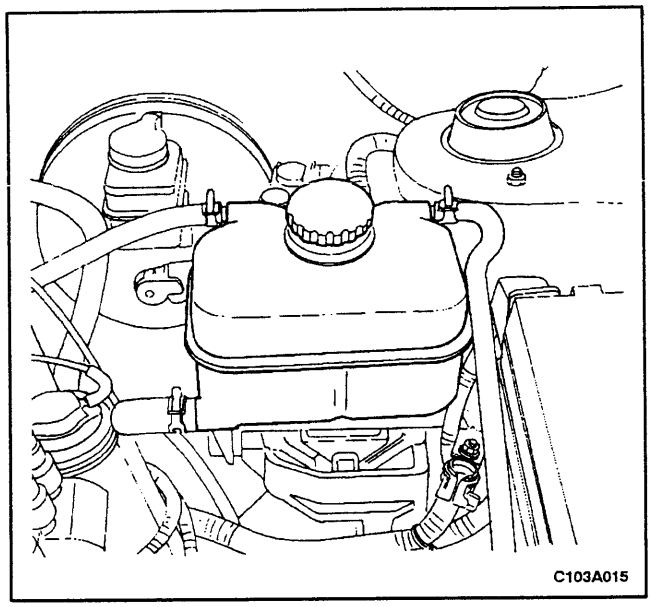

B103A026

5. Install the cooler pipe securing fastener onto the radiator with the fastener bolt.

Tighten

Tighten the cooler pipe-to-radiator fastener bolt to 25 N•m (18 lb-ft).

6. Check the transaxle fluid level. Replace the fluid as needed. Refer to "Fluid Level Set After Service" in this section.
7. Install the battery tray and the battery.


C103A015

TRANSAXLE LEFT MOUNT

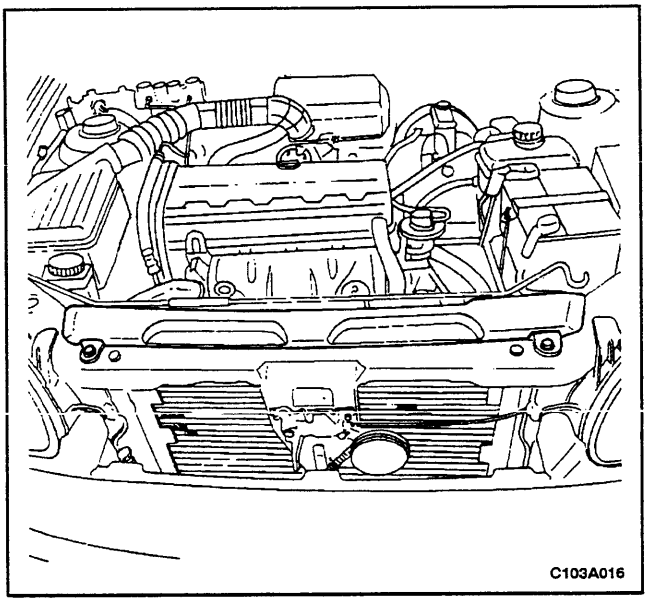
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Tools Required

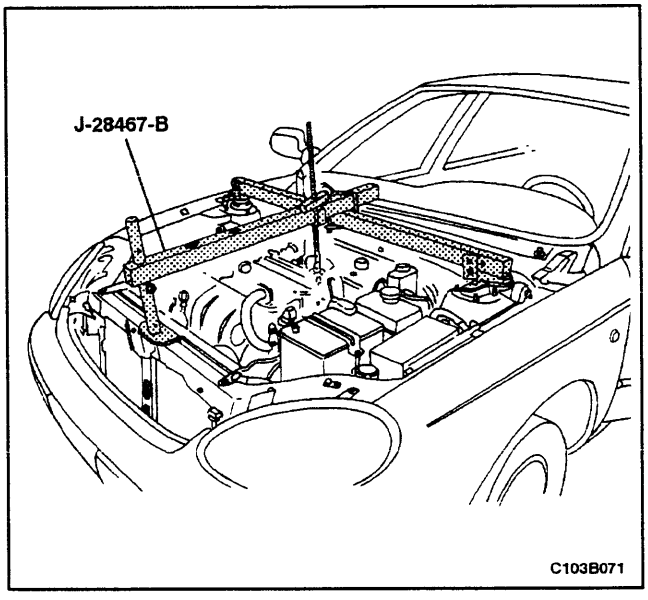
J-28467-B Engine Support Fixture

Removal Procedure

1. Disconnect the battery. Remove the battery and the battery tray.
2. Remove the coolant surge tank.

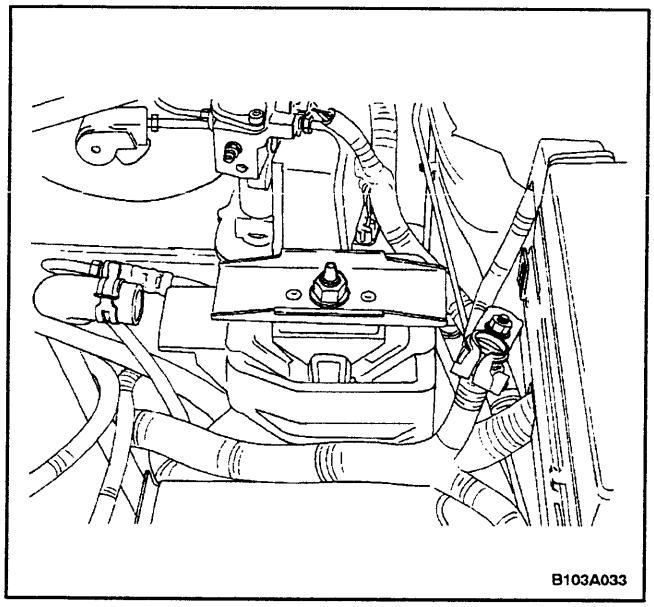

C103A016

3. Remove the upper radiator cover.

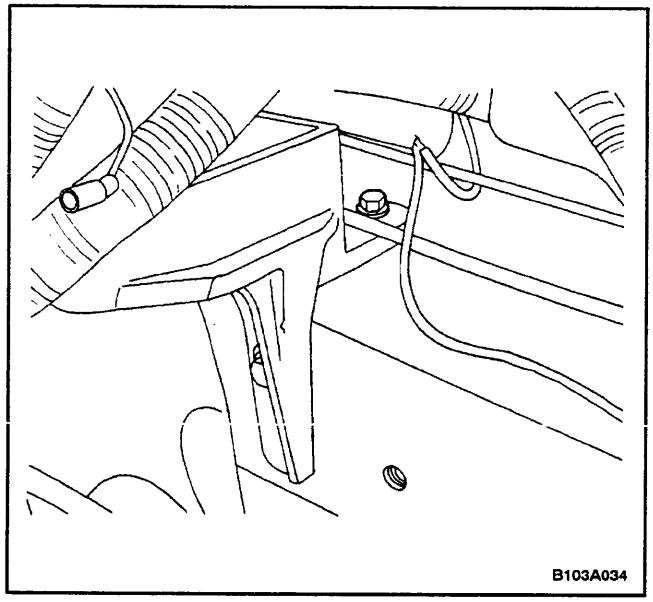


C103B071

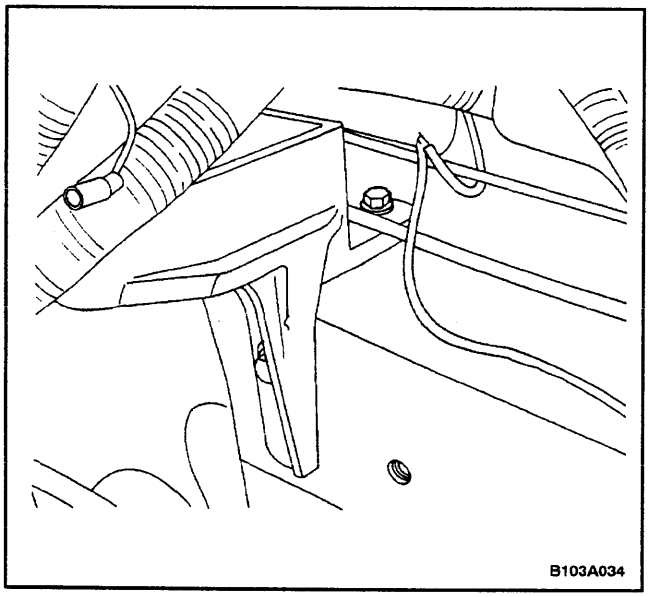
4. Attach the engine support fixture J-28467-B to the right side of the engine. Refer to "Engine Support Fixture" in this section.
5. Support the engine with the engine support fixture J-28467-B.



6. Remove the bolt that connects the transaxle left mount to the left transaxle bracket.



7. Remove the bolts that connect the transaxle left mount to the vehicle. Two bolts are on each side of the mount.
8. Remove the transaxle left mount.

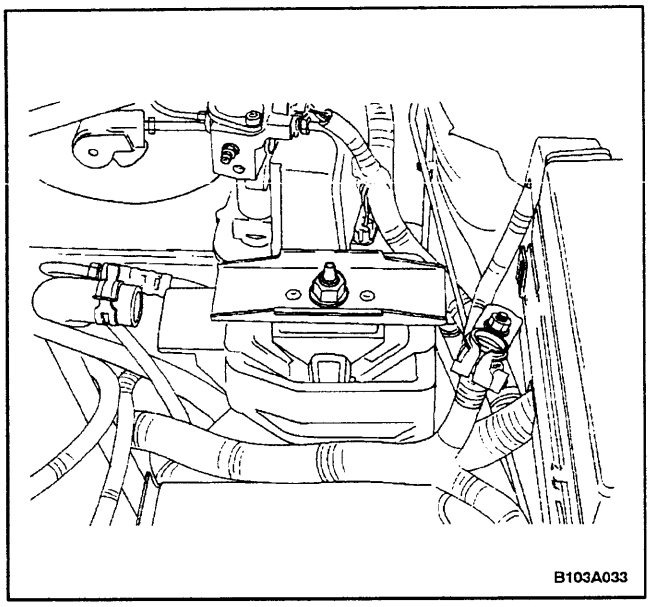


Installation Procedure

1. Install the transaxle left mount.
2. Install the bolts that connect the transaxle left mount to the vehicle.

Tighten

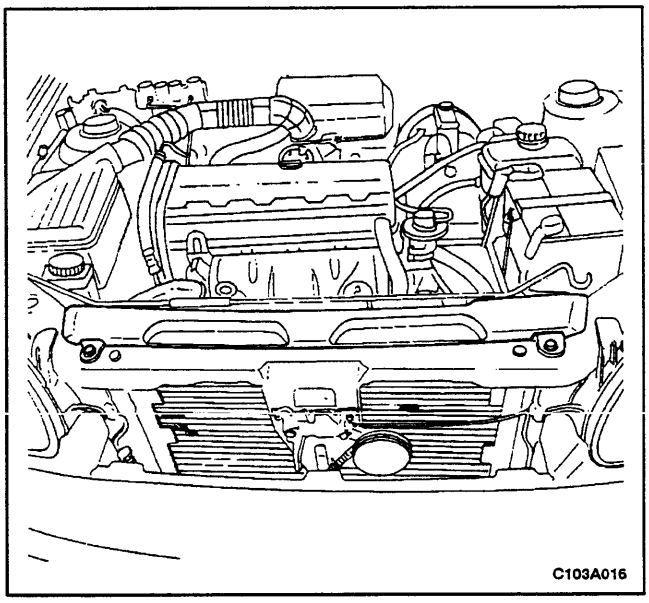
Tighten the transaxle left mount-to-body connecting bolts to 58 N•m (43 lb-ft).


B103A033

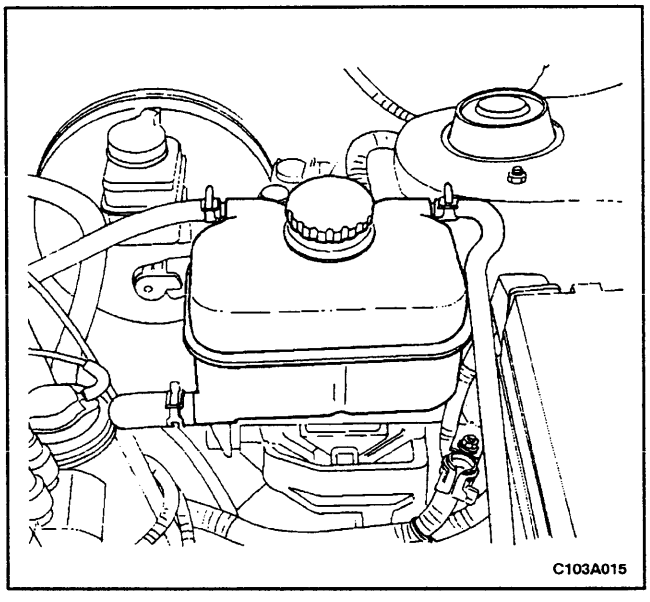
3. Install the bolt that connects the transaxle left mount to the transaxle left bracket.

Tighten

Tighten the transaxle left mount-to-transaxle left bracket connecting bolt to 48 N•m (35 lb-ft).


C103A016

4. Remove the engine support fixture J-28467-B from the engine.
5. Install the upper radiator cover.

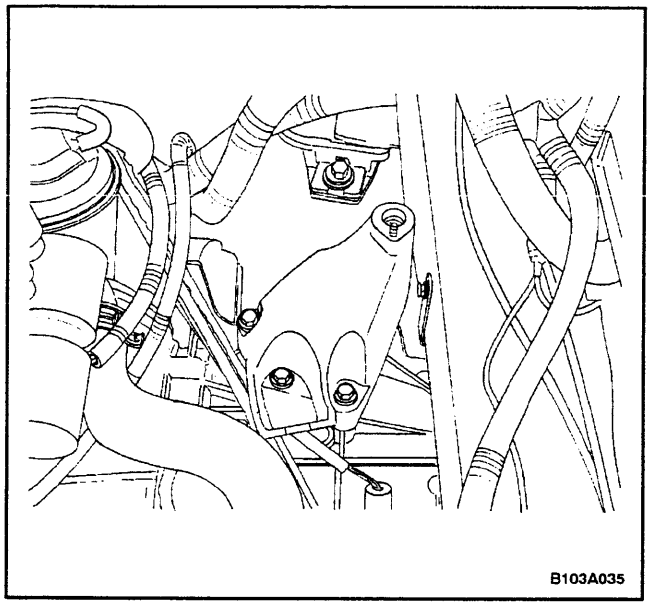

C103A015

6. Install the coolant surge tank with the bolts.

Tighten

Tighten the coolant surge tank mounting bolts to 25 N•m (18 lb-ft).

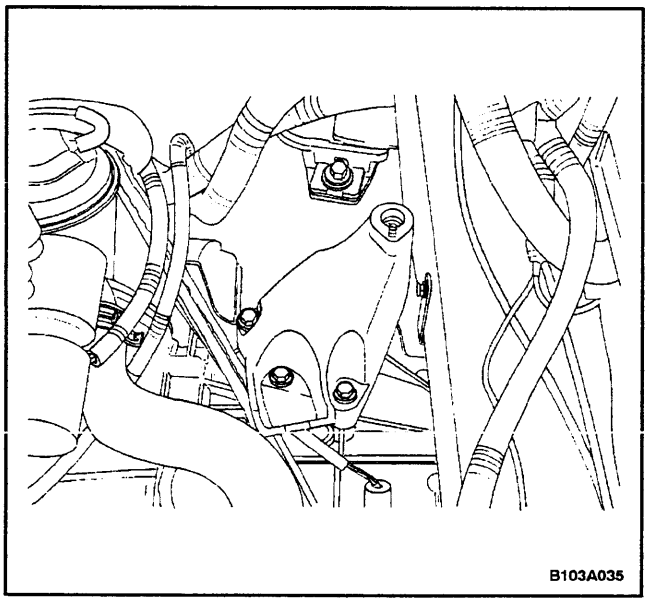
7. Install the battery tray and the battery. Connect the battery.


B103A035

TRANSAXLE LEFT BRACKET

Removal Procedure

1. Remove the battery and the battery tray.
2. Remove the transaxle mount. Refer to "Transaxle Mount" in this section.
3. Disconnect the shift control cable from the transaxle left bracket.
4. Disconnect the shift control cable from the selector lever. Refer to "Shift Control Cable" in this section.
5. Remove the bolts that connect the transaxle to the transaxle left bracket.
6. Remove the transaxle left bracket.


B103A035

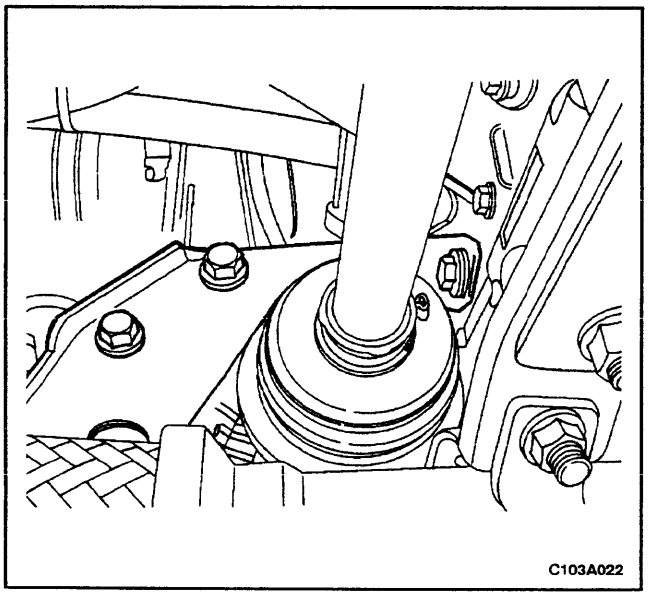
Installation Procedure

1. Install the transaxle left bracket.
2. Install the bolts that connect the transaxle left bracket to the transaxle.

Tighten

Tighten the transaxle left bracket connecting bolts to 48 N•m (35 lb-ft).

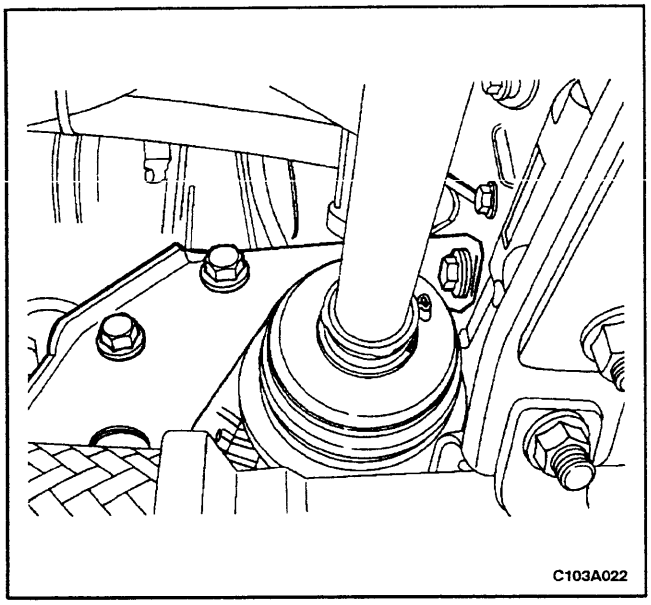
3. Install the transaxle mount. Refer to "Transaxle Mount" in this section.
4. Connect the shift control cable to the selector lever.
5. Connect the shift control cable. Refer to "Shift Control Cable" in this section.
6. Adjust the shift control cable. Refer to "Control Cable Adjustment" in this section.
7. Install the battery tray and the battery.


C103A022

TRANSAXLE CENTER BRACKET

Removal Procedure

1. Remove the center member from the vehicle. Refer to *Section 9N, Frame and Underbody.*
2. Remove the bolts that connect the transaxle center bracket to the transaxle.
3. Remove the bolt that connects the transaxle center bracket to the engine.
4. Remove the transaxle center bracket.


C103A022

Installation Procedure

1. Install the transaxle center bracket to the transaxle with the bolts.

Tighten

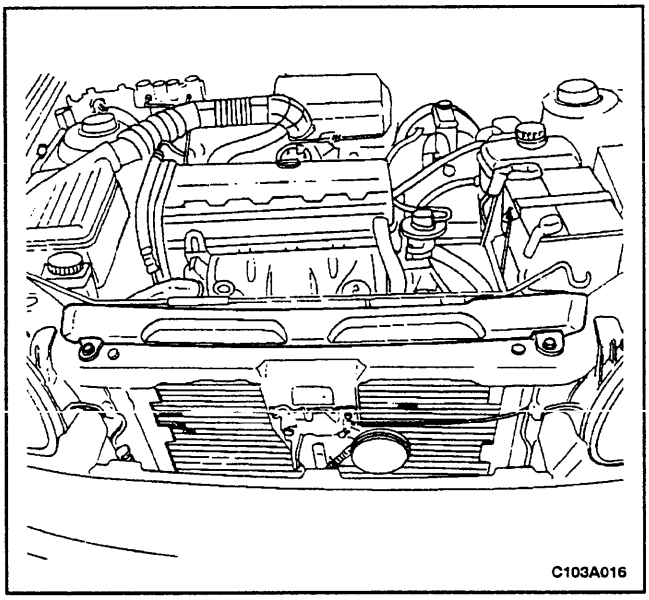
Tighten the transaxle center bracket-to-transaxle bolts to 90 N•m (66 lb-ft).

2. Install the transaxle center bracket to the engine with the bolt.

Tighten

Tighten the transaxle center bracket-to-engine bolt to 90 N•m (66 lb-ft).

3. Install the center member into the vehicle. Refer to *Section 9N, Frame and Underbody.*


C103A016

TRANSAXLE ASSEMBLY

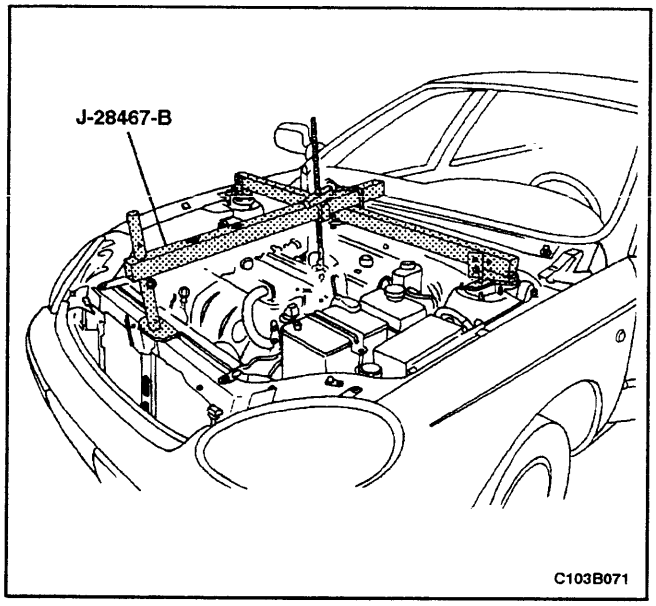
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Tools Required

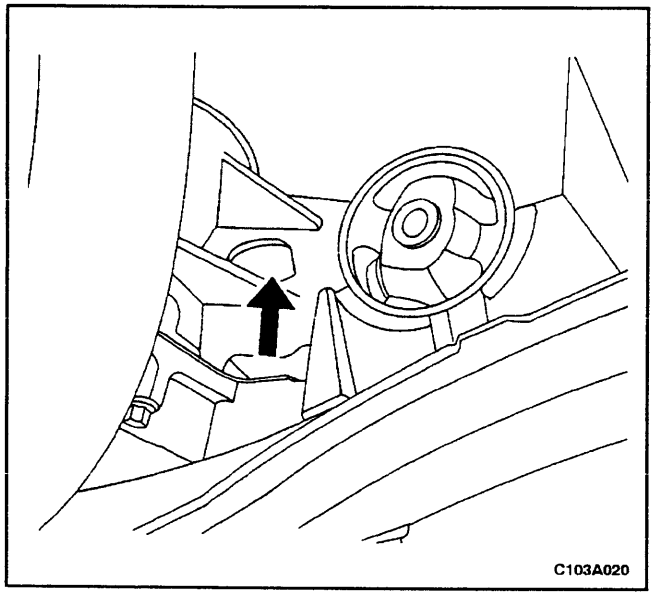
J-28467-B Engine Support Fixture

Removal Procedure

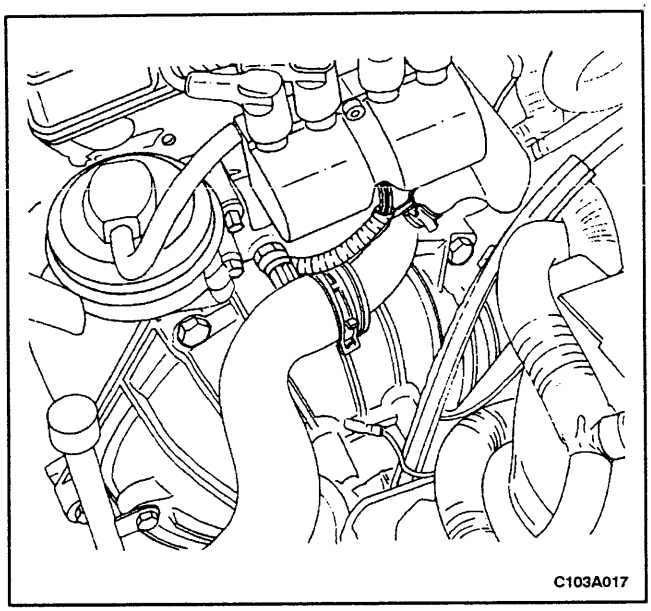
1. Remove the battery and the battery tray.
2. Disconnect the shift control cable from the transaxle bracket.
3. Disconnect the shift control cable from the selector lever. Refer to "Shift Control Cable" in this section.
4. Disconnect the neutral start switch from the wiring harness. Refer to "Neutral Start Switch" in this section.
5. Disconnect the throttle valve cable from the throttle cable wheel. Refer to "Throttle Valve Cable" in this section.
6. Remove the upper radiator cover.



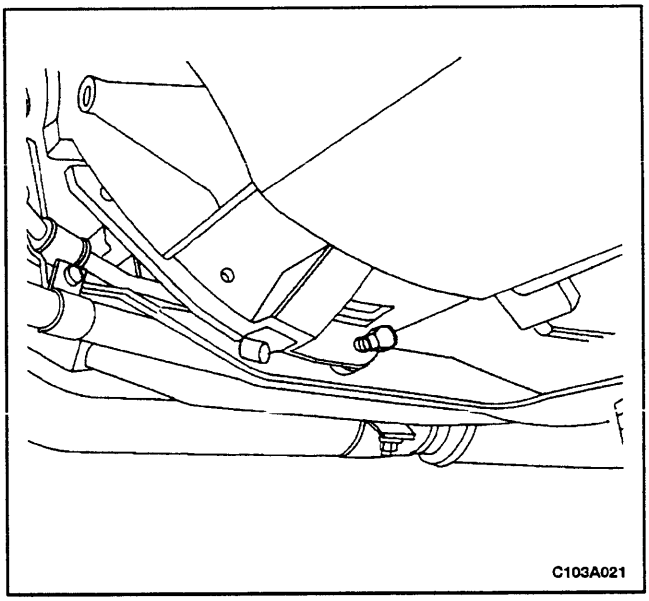
7. Attach the engine support fixture J-28467-B to the right side of the engine. Refer to "Engine Support Fixture" in this section.
8. Support the engine with the engine support fixture J-28467-B.
9. Disconnect the transaxle from the transaxle bracket. Refer to "Transaxle Bracket" in this section.
10. Raise and suitably support the vehicle.
11. Remove the engine under covers. Refer to *Section 9N, Frame and Underbody.*
12. Drain the transaxle fluid. Refer to "Changing Fluid" in this section.
13. Disconnect the vehicle speed sensor electrical connector. Refer to "Speed Sensor" in this section.
14. Lower the vehicle.
15. Remove the fluid cooler hoses and the cooler pipes from the transaxle case. Refer to "Fluid Cooler Pipes" in this section.
16. Remove the bolts that connect the transaxle to the transaxle bracket. Refer to "Transaxle Bracket" in this section.
17. Raise the vehicle.
18. Remove the wheels. Refer to *Section 2E, Tires and Wheels*.
19. Disconnect the automatic transaxle drive axles from the automatic transaxle. Refer to *Section 3A, Automatic Transaxle Drive Axle*.
20. Remove the forward engine mount. Refer to *Section 1B, SOHC Engine Mechanical* or *Section 1C, DOHC Engine Mechanical*.



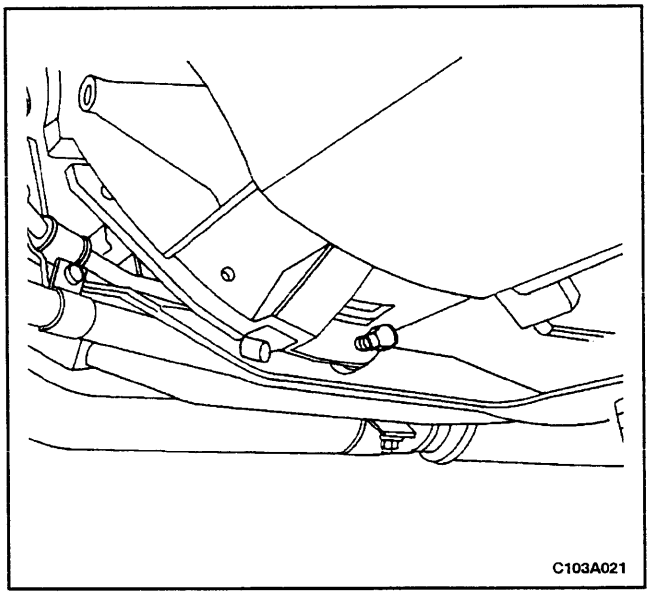
21. Rotate the flex plate through the hole at the bottom of the transaxle to gain access to all the torque converter bolts through the hole at the side of the engine.
22. Remove the torque converter bolts from the flex plate.


C103A017

23. Lower the vehicle.
24. Remove the bell housing upper bolts.


C103A021

25. Raise the vehicle.
26. Support the transaxle from below with a transaxle jack.
27. Remove the bell housing lower bolts.
28. Remove the bolts that connect the transaxle center bracket to the transaxle. Refer to "Transaxle Center Bracket" in this section.
29. Lower the transaxle and remove it from the vehicle.

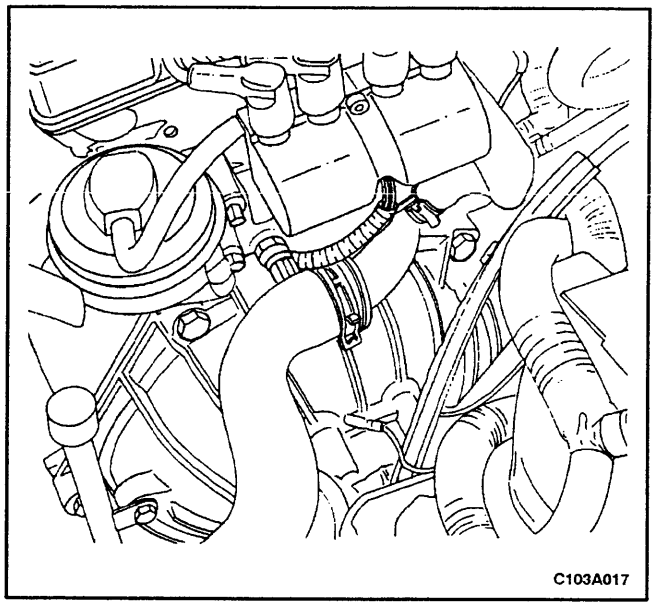

C103A021

Installation Procedure

1. Install the transaxle into the vehicle with the transaxle jack.
2. Install the bell housing lower bolts.

Tighten

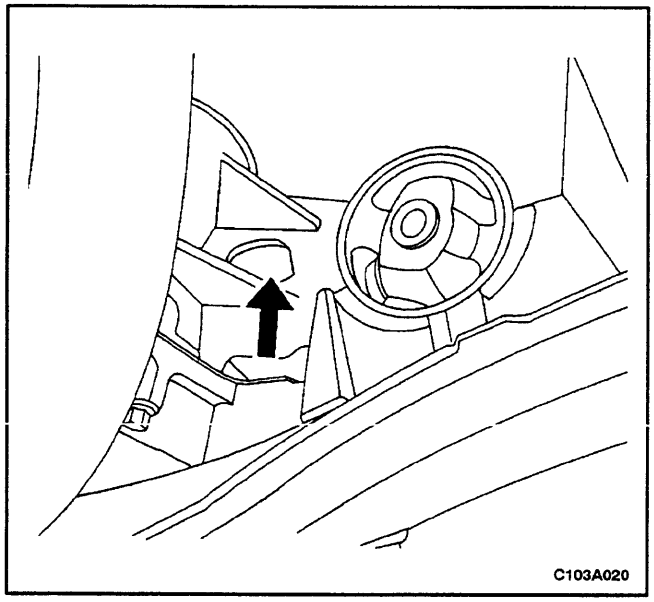
Tighten the bell housing-to-engine lower bolts to 75 N•m (55 lb-ft).


C103A017

3. Remove the transaxle jack and lower the vehicle.
4. Install the bell housing upper bolts.

Tighten

Tighten the bell housing-to-engine upper bolts to 75 N•m (55 lb-ft).

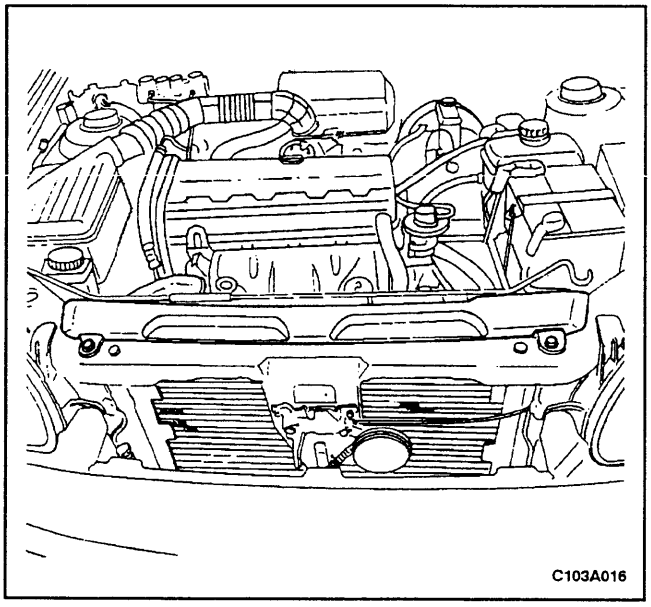

C103A020

5. Raise the vehicle.
6. Install the torque converter bolts that connect the flywheel and the torque converter. Rotate the flywheel to install all the torque converter bolts.

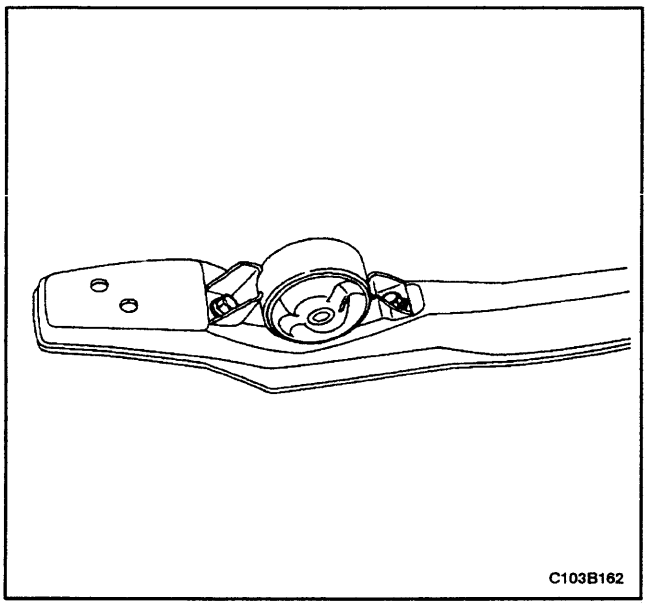
Tighten

Tighten the torque converter-to-flywheel bolts to 60 N•m (44 lb-ft).

7. Install the forward engine mount. Refer to or *Section 1C, DOHC Engine Mechanical*.
8. Install the bolts that connect the transaxle to the transaxle center bracket. Refer to "Transaxle Center Bracket" in this section.


C103A016

9. Connect the speed sensor electrical connector. Refer to "Speed Sensor" in this section.
10. Connect the automatic transaxle drive axles to the automatic transaxle. Refer to *Section 3A, Automatic Transaxle Drive Axle*.
11. Install the wheels. Refer to *Section 2E, Tires and Wheels*.
12. Lower the vehicle.
13. Install the bolts that connect the transaxle bracket to the transaxle. Refer to "Transaxle Bracket" in this section.
14. Remove the engine support fixture J-28467-B from the engine.
15. Install the fluid cooler hoses and the cooler pipes onto the transaxle case. Refer to "Fluid Cooler Pipes" in this section.
16. Install the upper cable stop to the throttle cable wheel. Refer to "Throttle Valve Cable" in this section.
17. Connect the neutral start switch to the wiring harness. Refer to "Neutral Start Switch" in this section.
18. Connect the shift control cable to the transaxle bracket.
19. Connect the shift control cable to the selector lever. Refer to "Shift Control Cable" in this section.
20. Install the upper radiator cover.
21. Install the battery tray and the battery.

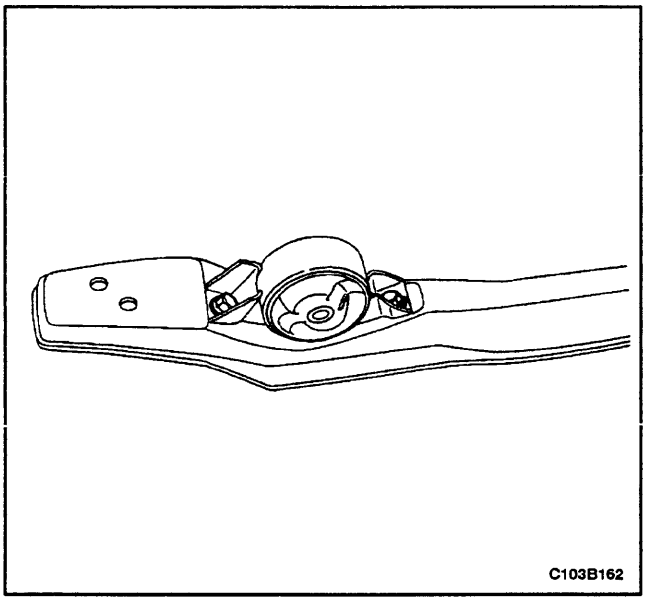

C103B162

UNIT REPAIR

TRANSAXLE CENTER MOUNT

Disassembly Procedure

1. Remove the center member from the vehicle. Refer to *Section 9N, Frame and Underbody.*
2. Remove the transaxle center mount-to-center member bolts.
3. Remove the transaxle center mount.


C103B162

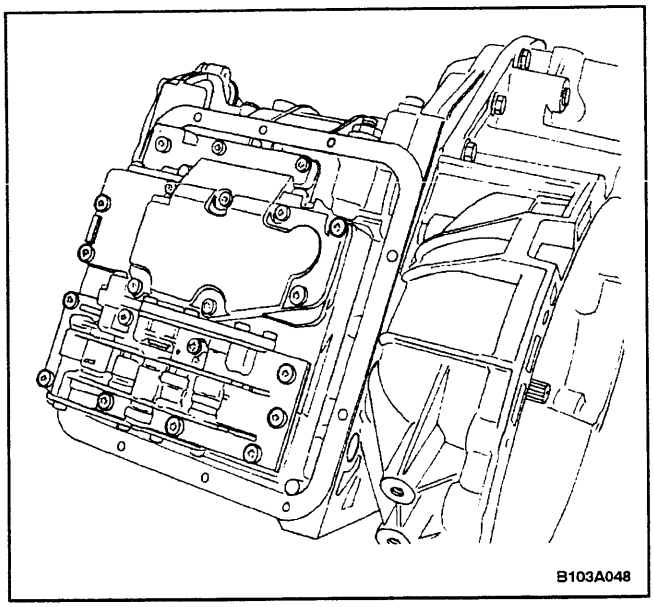
Assembly Procedure

1. Install the transaxle center mount.
2. Install the transaxle center mount-to-center member bolts.

Tighten

Tighten the transaxle center mount-to-center member bolts to 65 N•m (48 lb-ft).

3. Install the center member into the vehicle. Refer to *Section 9N, Frame and Underbody.*


B103A048

MAJOR COMPONENT DISASSEMBLY

Tools Required

J-26941 Outer Ring Puller Ring Remover

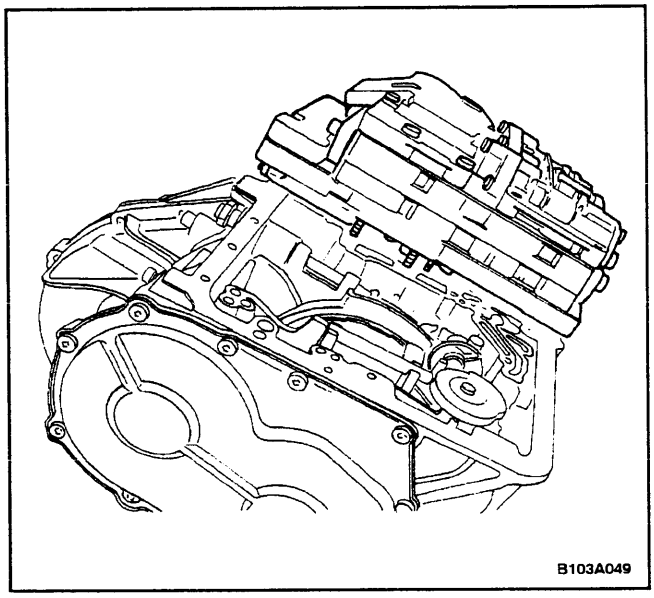
KA-001-023 Bolt Remover

KA-000-155 Grooved Nut Socket

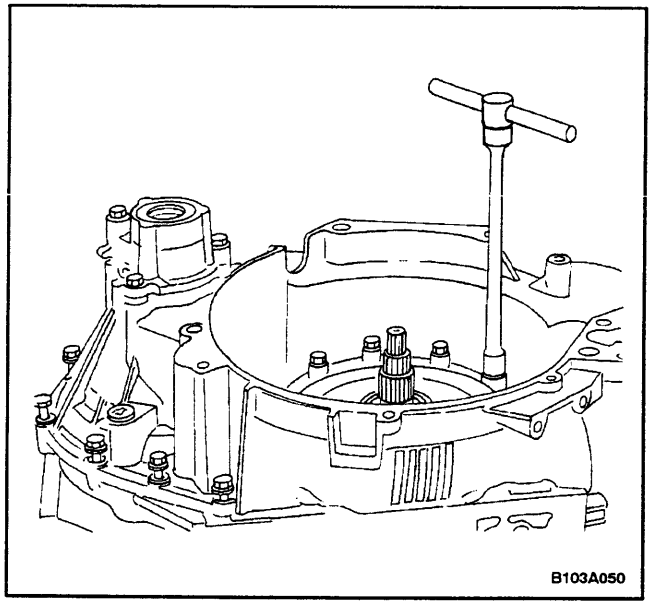
KA-000-288 Side Shaft Retainer

Disassembly Procedure

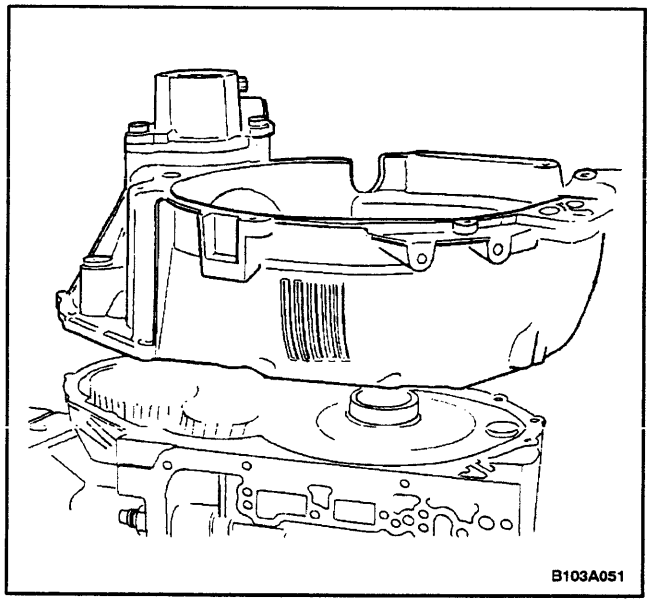
1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the torque converter from the transaxle assembly.
3. Secure the transaxle to a bench holding device so the transaxle can rotate through 180 degrees.
4. Start with the fluid pan in the UP position.
5. Remove the fluid pan and the fluid pan gasket. Refer to "Pan and Gasket" in this section.
6. Remove the largest bolts attaching the valve body to the transaxle.


B103A049

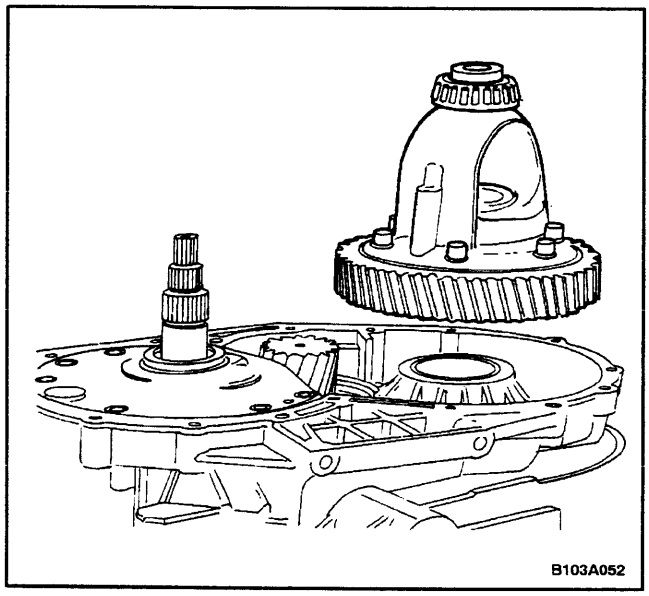
7. Remove the valve body.


B103A050

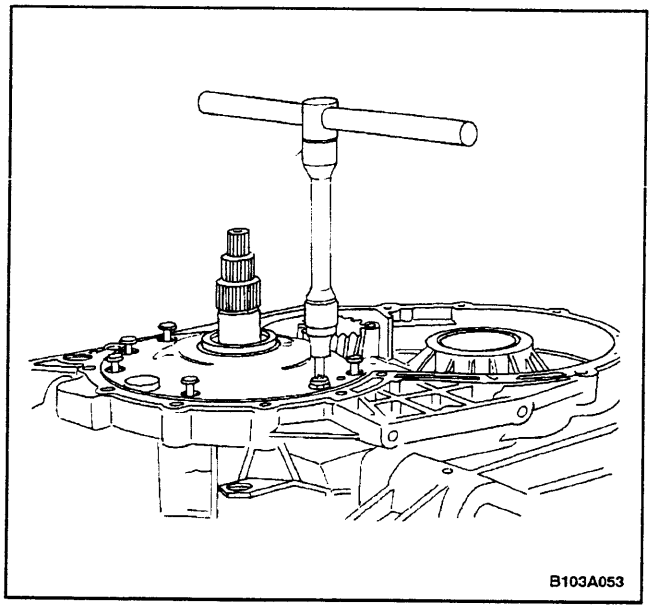
8. Rotate the transaxle 90 degrees so the bell housing is in the UP position.
9. Remove the bolts holding the bell housing to the transaxle case.


B103A051

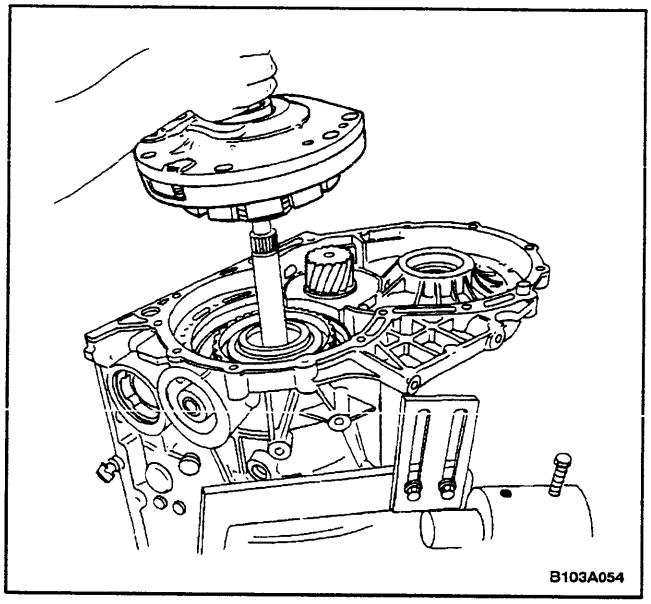
10. Remove the bell housing and the gasket. Remove the speedometer gear from the bell housing.


B103A052

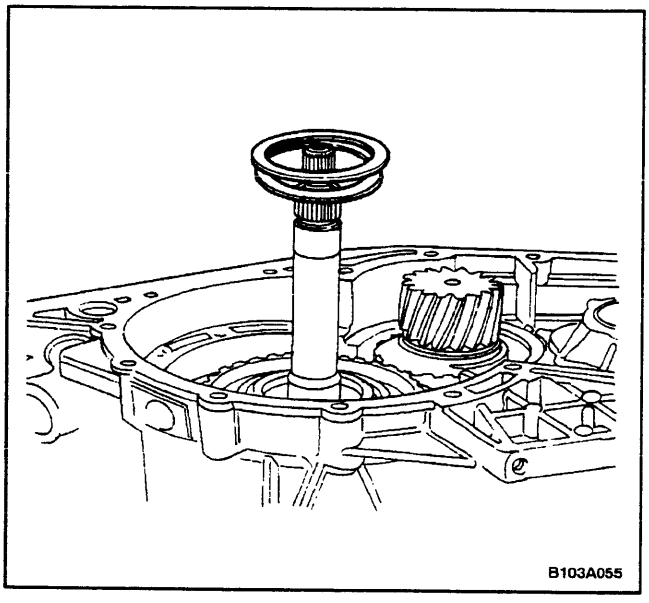
11. Remove the differential gear assembly.


B103A053

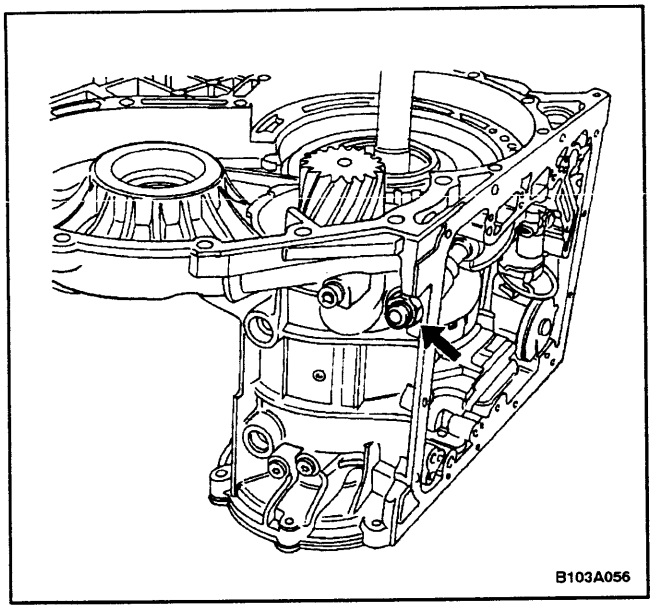
12. Remove the intermediate plate bolts.


B103A054

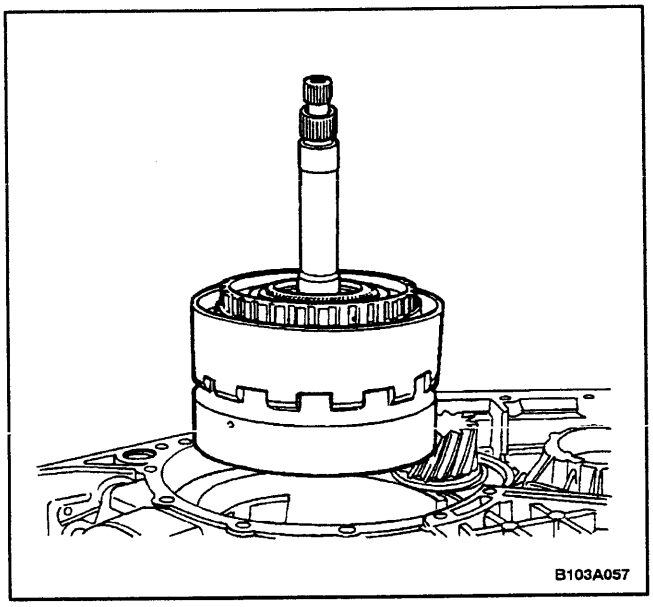
13. Remove the intermediate plate, the pump, and the brake C assembly.


B103A055

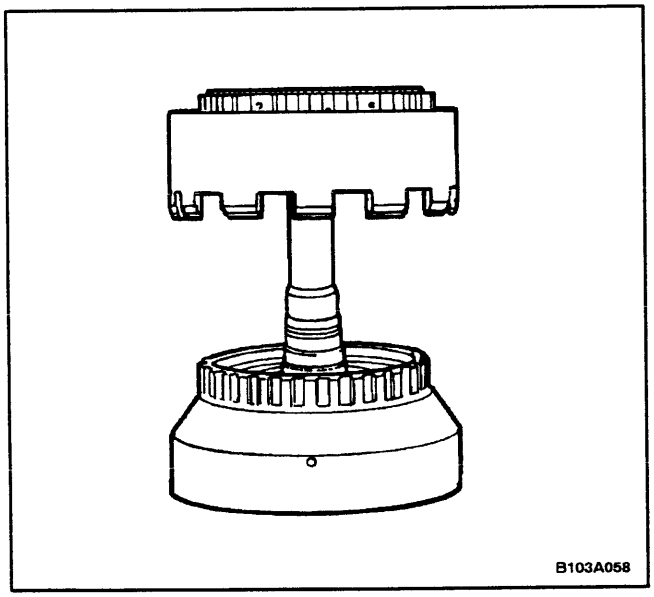
14. Remove the thrust washer and the adjustment washers.



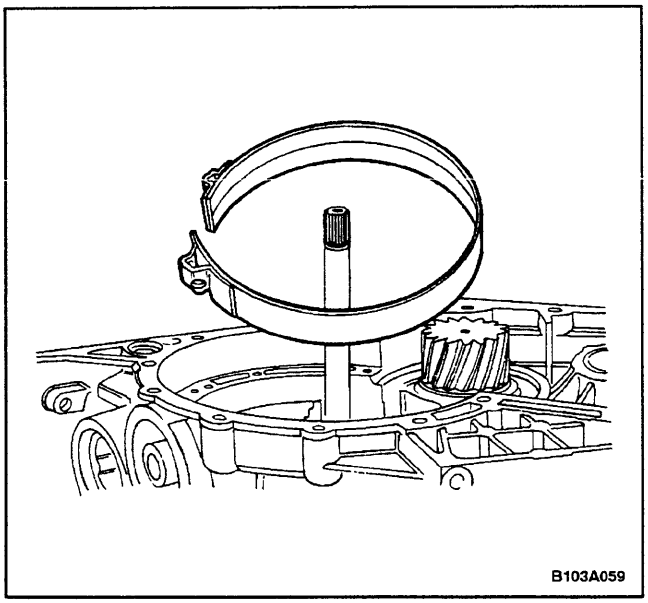
15. Loosen the band C′ by loosening the lock nut and turning the bolt counterclockwise.



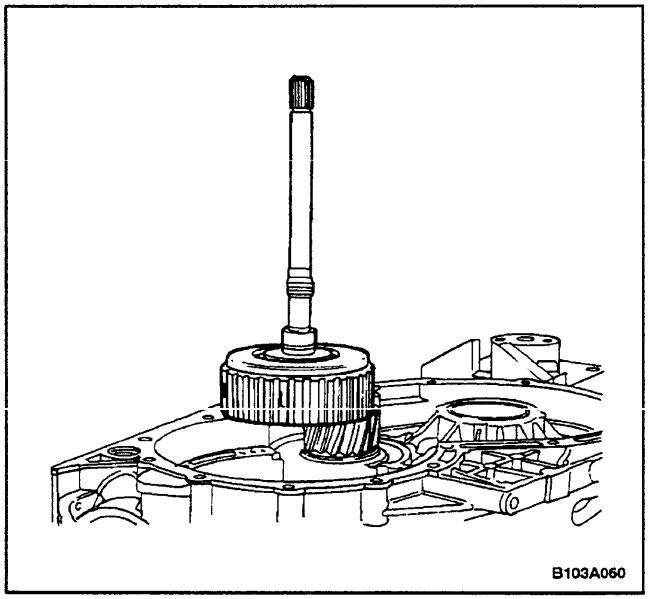
16. Remove the clutch A, the clutch B, and the second freewheel as a unit.



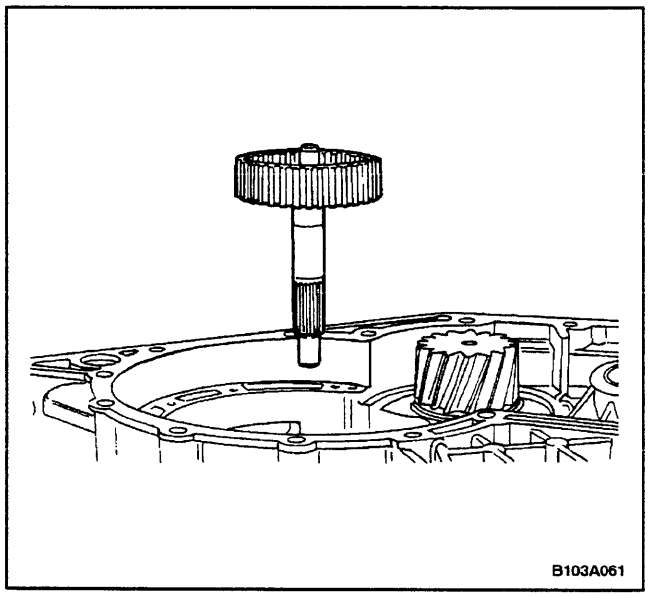
17. Remove the clutch A from the clutch B.


B103A059

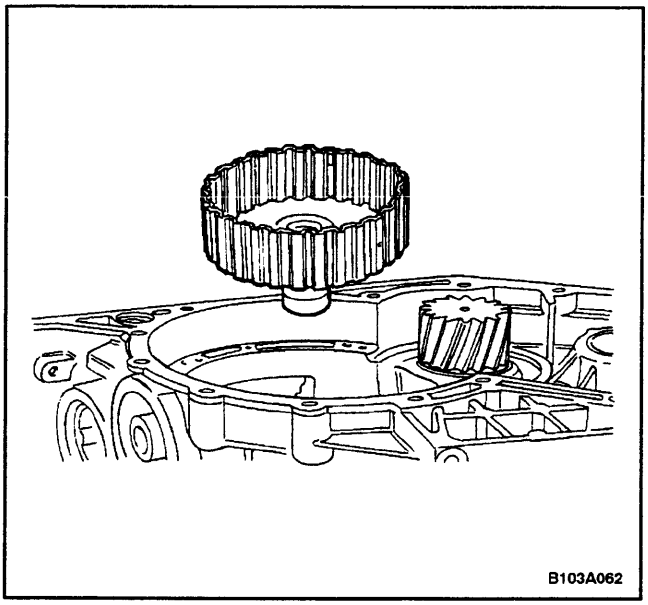
18. Remove the band C'. Do not bend it.


B103A060

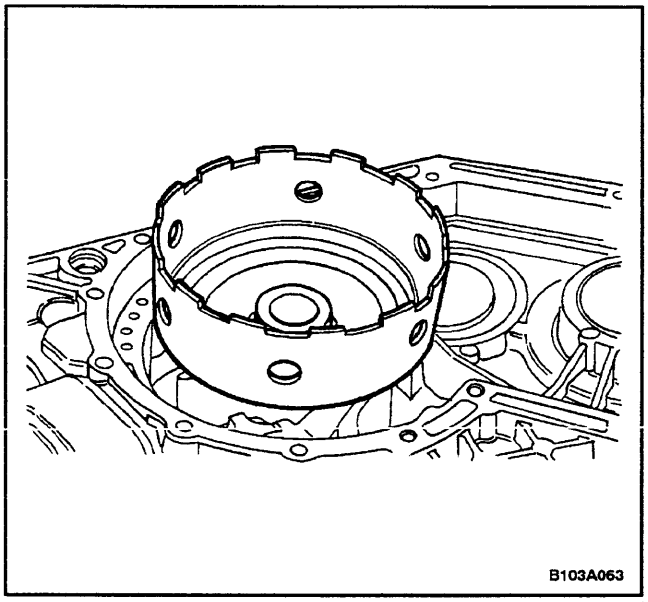
19. Remove the motor shaft together with the clutch E assembly.


B103A061

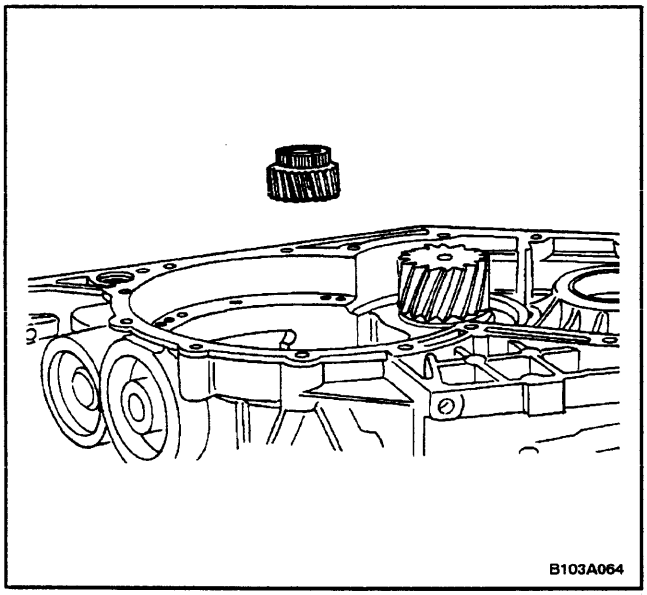
20. Remove the intermediate shaft with the clutch E carrier and the bearing.


B103A062

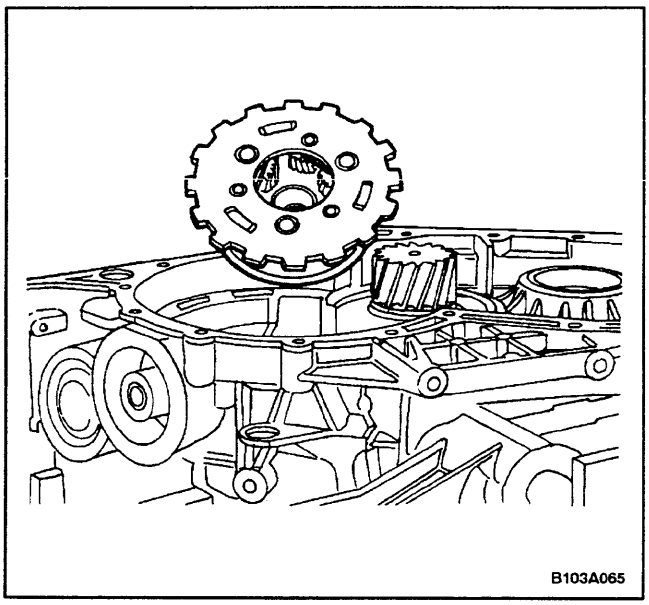
21. Remove the sun shaft with the carrier A, the washer, and the bearing as a complete unit.


B103A063

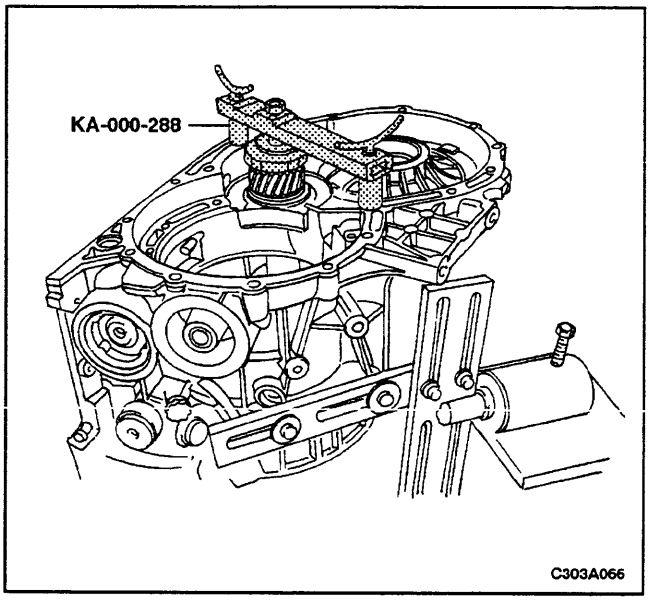
22. Remove the drive shell and the bearing as an assembly.


B103A064

23. Remove the sun gear.

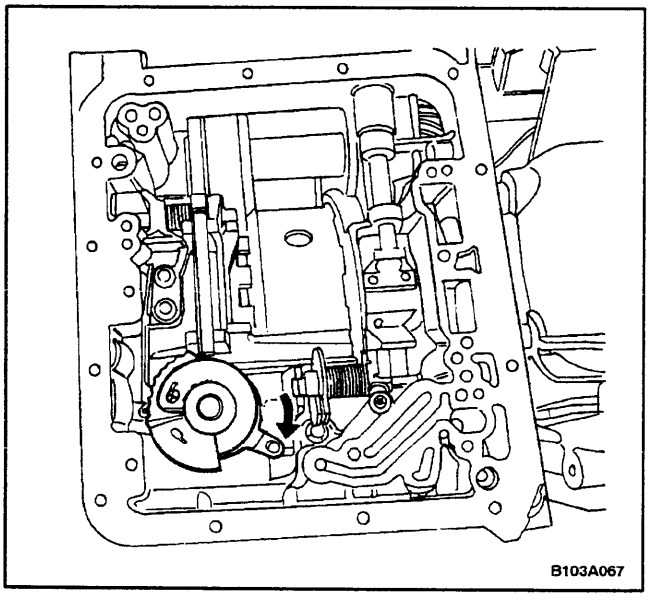

B103A065

24. Remove the planetary assembly and the needle bearing.

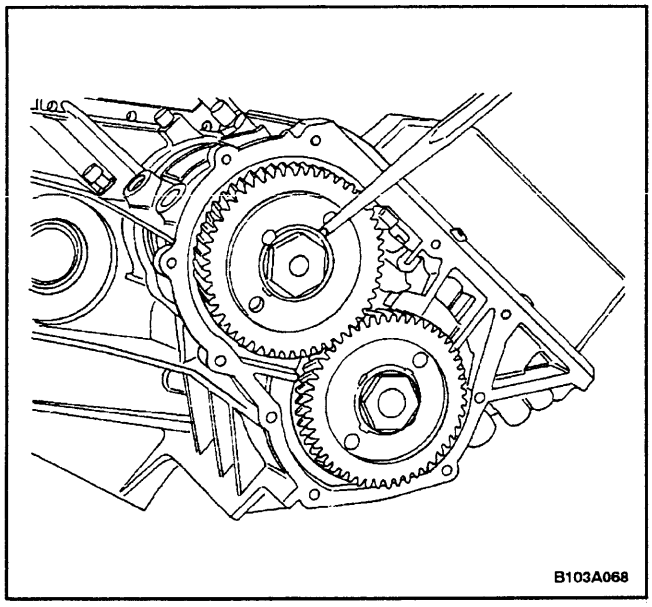


C303A066

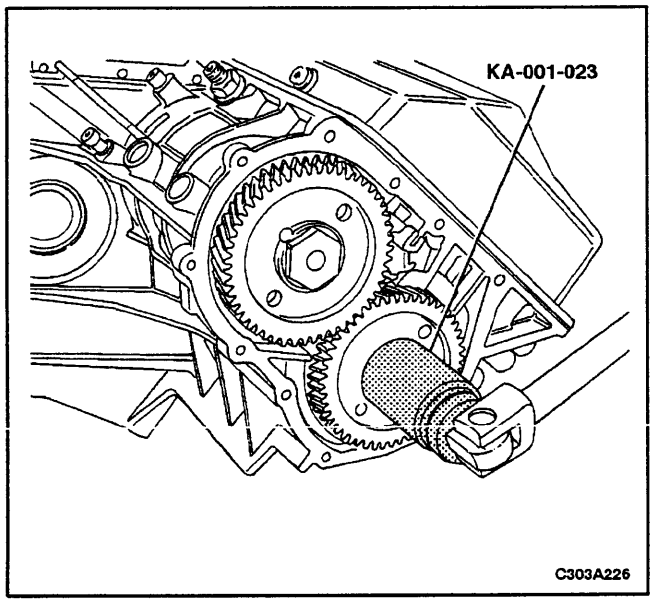
25. Use the side shaft retainer KA-000-288 to hold the side shaft in place.


B103A067

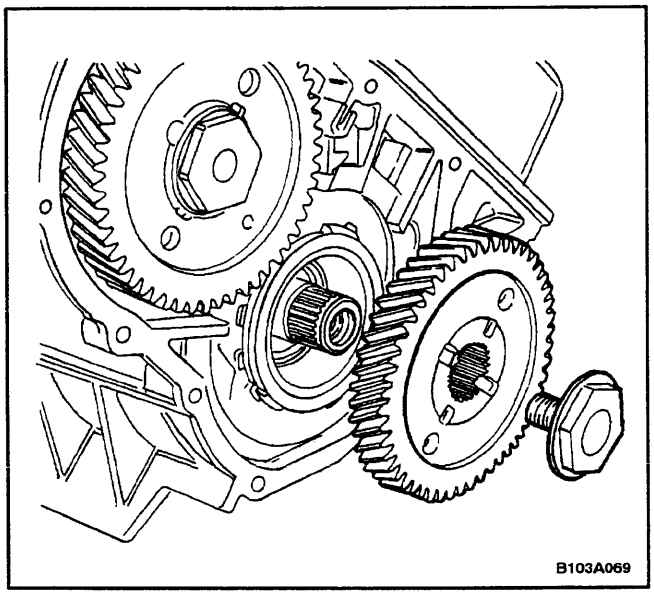
26. Rotate the transaxle 90 degrees so the PARK/ LOCK components are in the UP position.
27. Remove the side cover bolts, the side cover, and the gasket. Refer to "Case Side Cover Pan and Gasket" in this section.
28. Make sure the gear selector is in the PARK position.



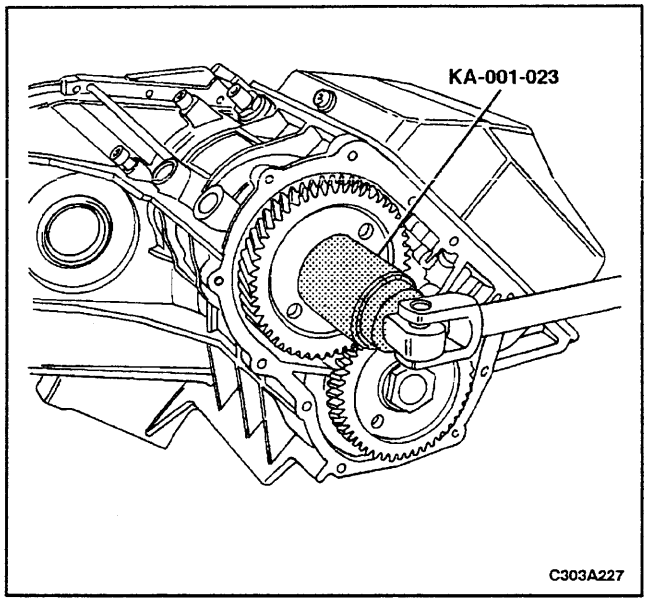
29. Bend the locking tabs on the spur gear securing bolts.



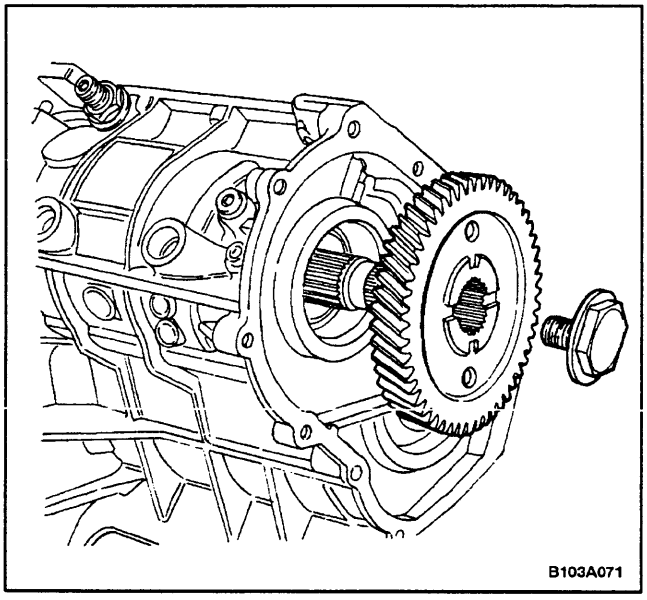
30. Loosen the small spur gear bolt with the bolt remover KA-001-023.



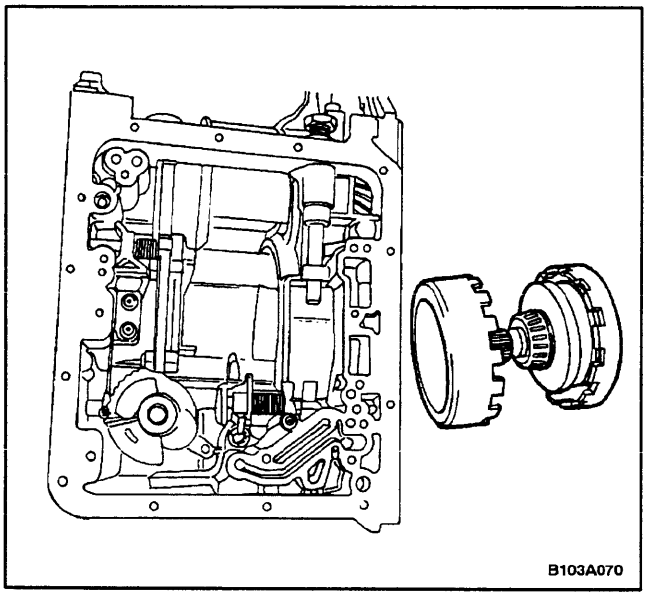
31. Remove the securing bolt on the smaller spur gear and remove the small spur gear.



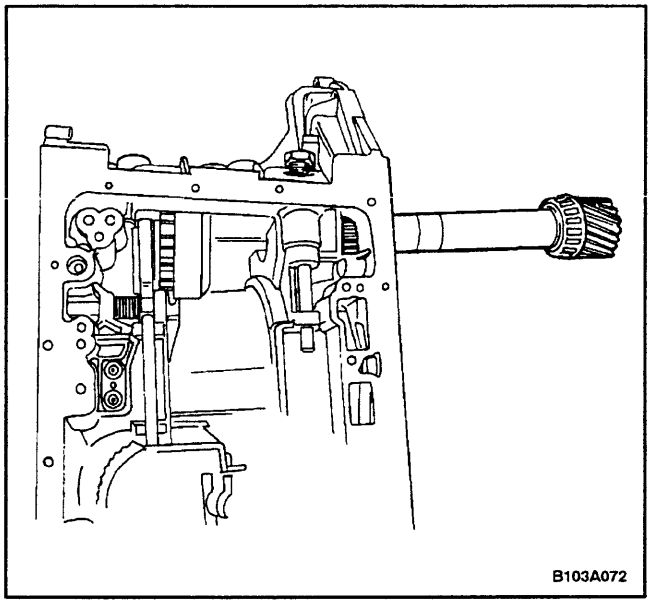
32. Loosen the large spur gear bolt with the bolt remover KA-001-023.



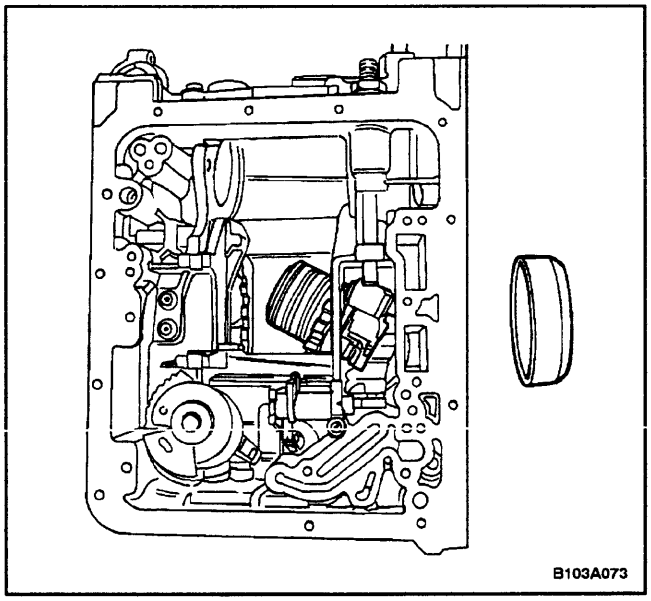
33. Remove the securing bolt on the larger spur gear and remove the large spur gear.



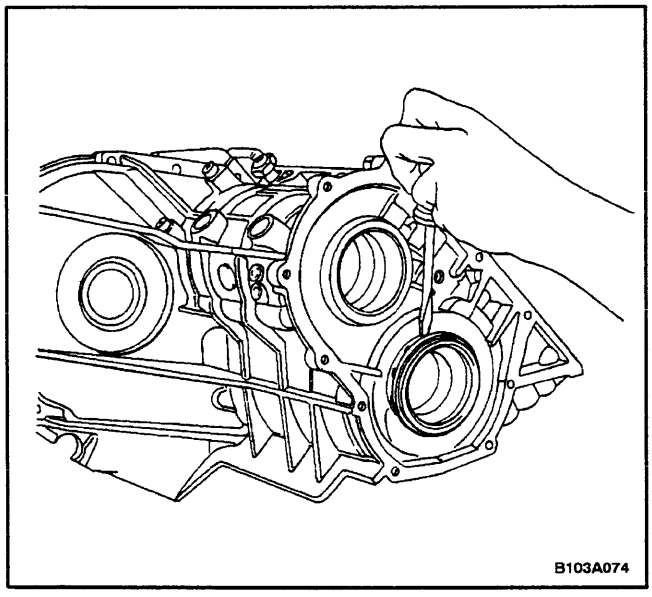
34. Remove the output shaft and the hollow gear together with the web gear.


B103A072

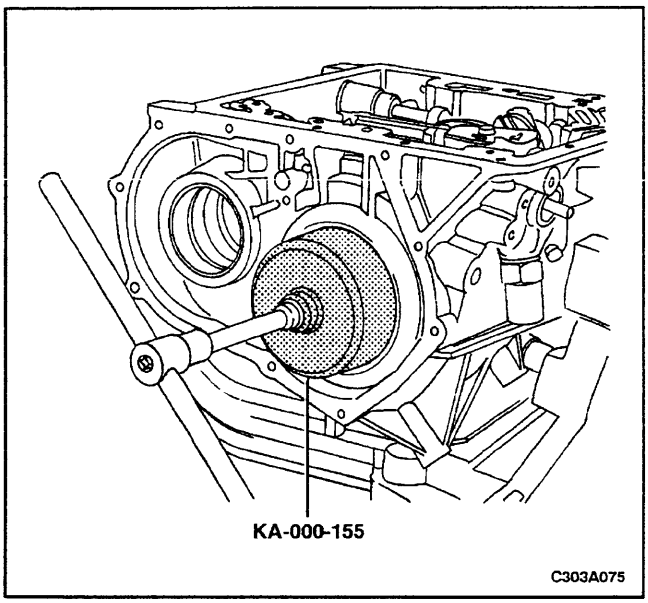
35. Remove the side shaft retainer KA-288 from the side shaft gear.
36. Remove the side shaft.


B103A073

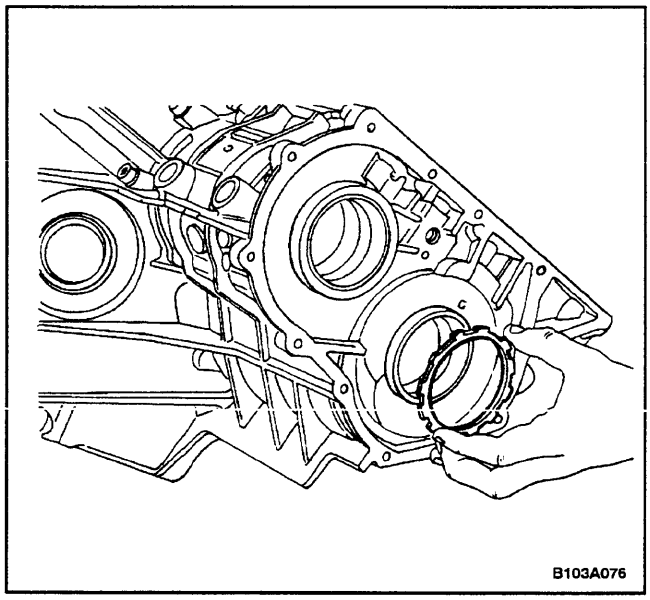
37. Disengage the PARK position and remove the cover plate and the governor assembly.


B103A074

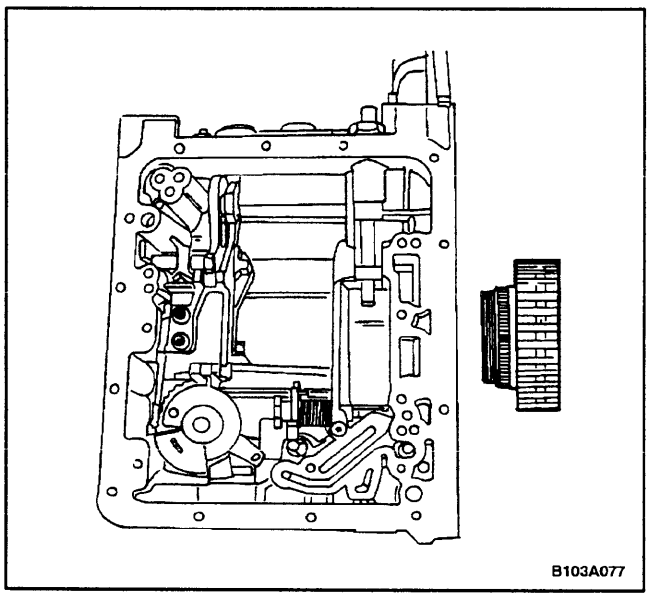
38. Bend the locking tabs on the first freewheel locknut washer.



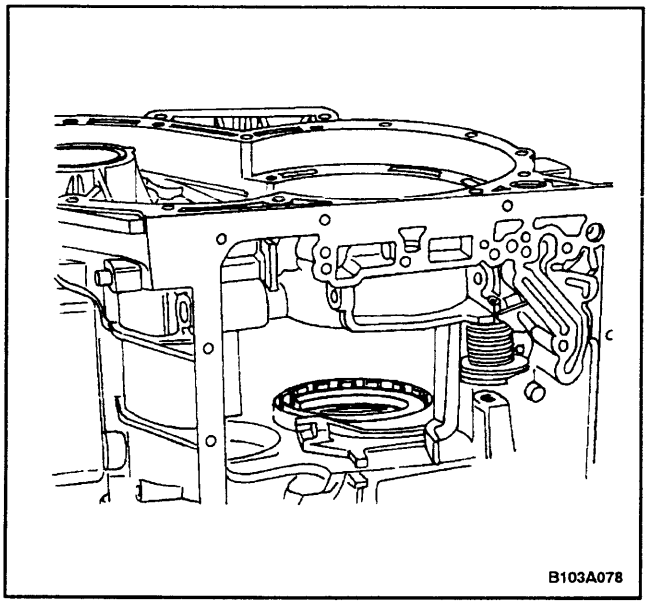
39. Loosen the first freewheel locknut washer using the grooved nut socket KA-000-155.



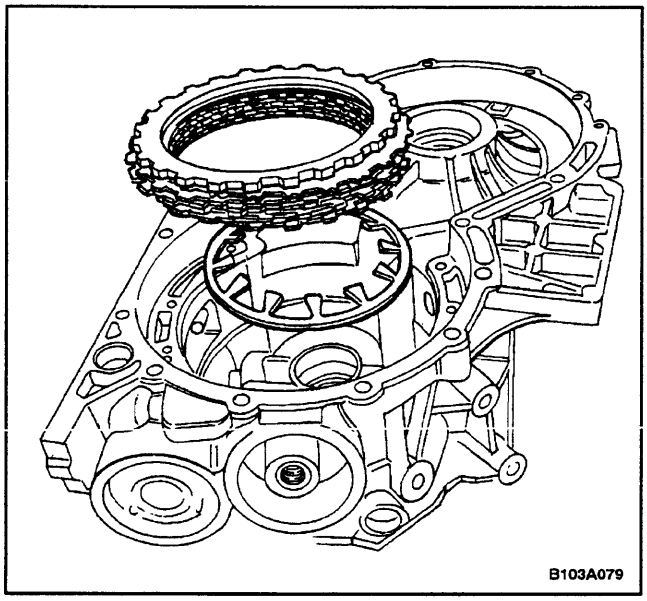
40. Remove the first freewheel locknut washer and the first freewheel ring.



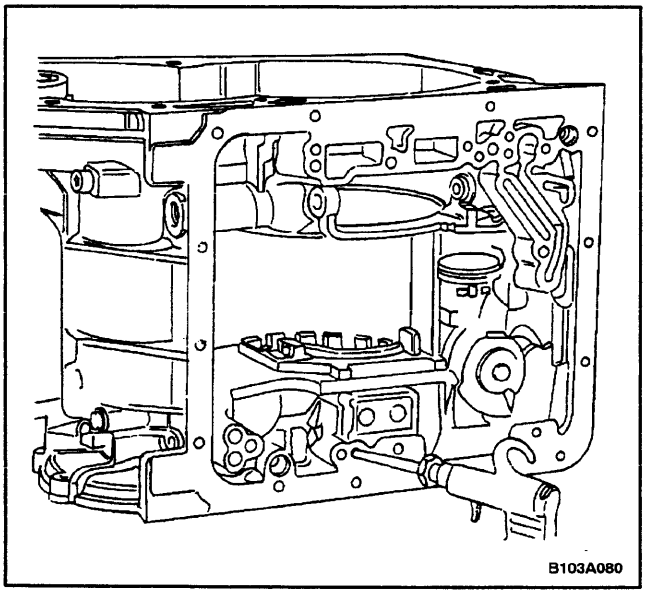
41. Remove the first freewheel.


B103A078

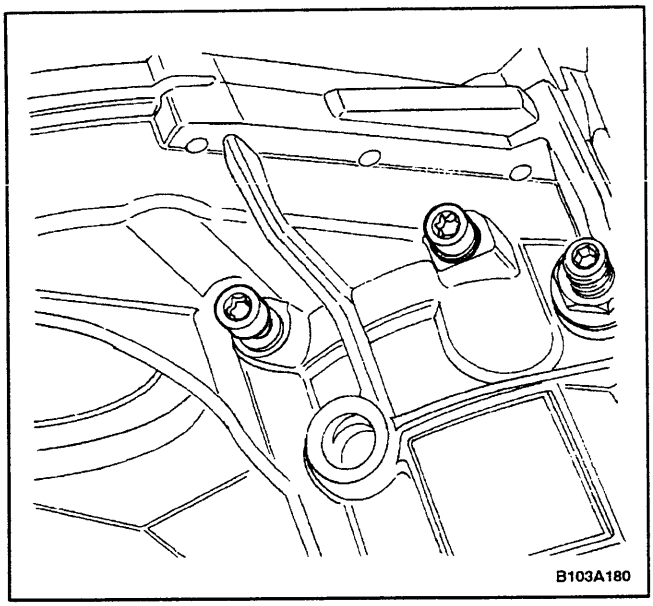
42. Rotate the transaxle 90 degrees so the side shaft outer ring is in the UP position.
43. Remove the brake D snap ring from inside the case.


B103A079

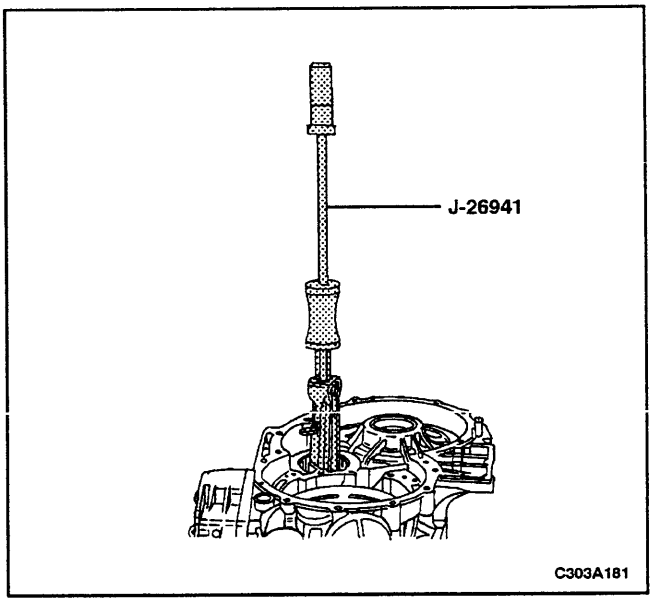
44. Remove the brake D assembly and the plate spring.


B103A080

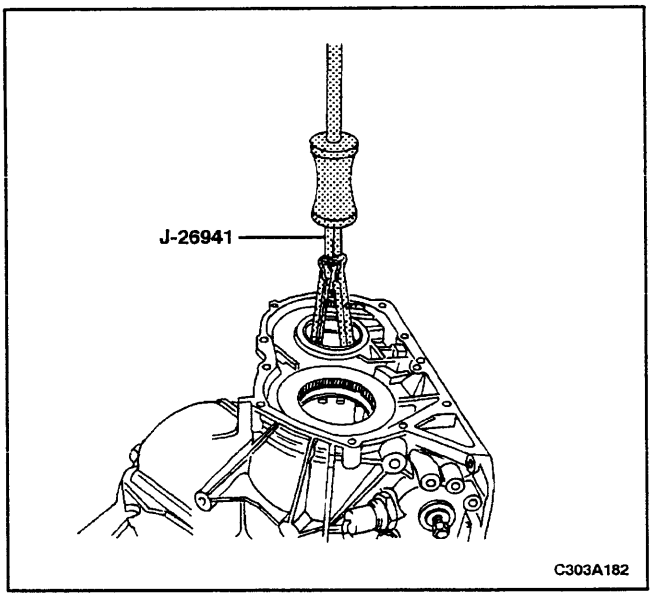
45. Remove the brake D piston by injecting air into the fluid feed hole with an air gun.



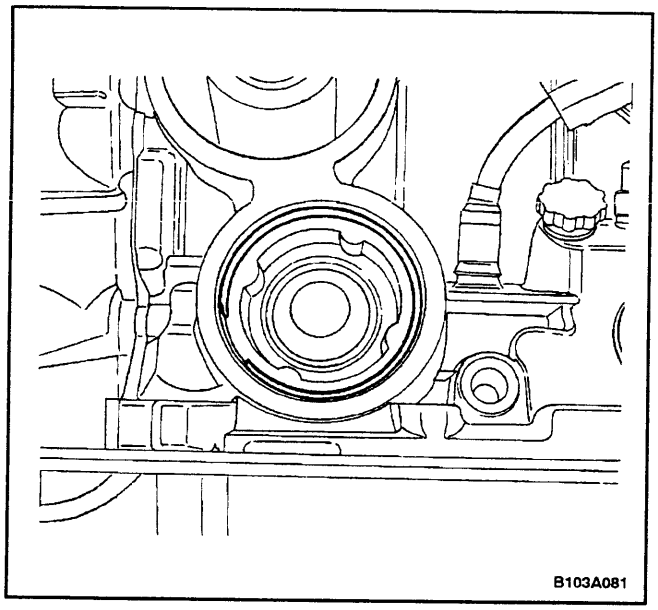
46. Remove the securing bolts from the side shaft outer ring.



47. Remove the side shaft outer ring with the ring puller J-26941.



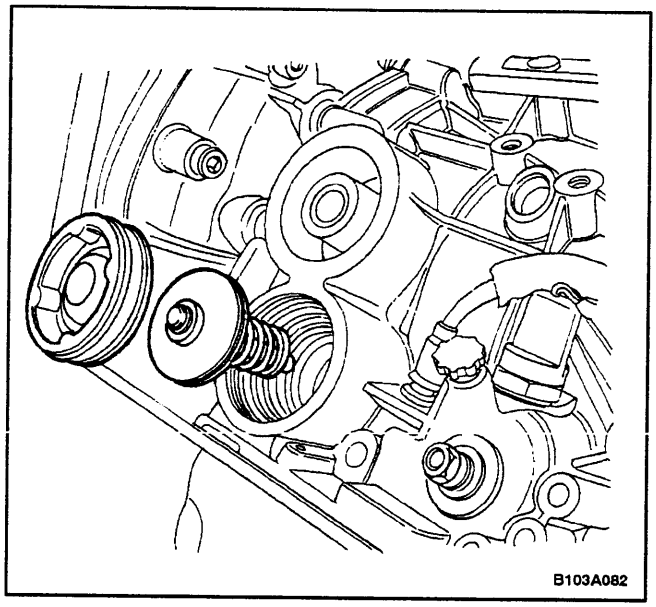
48. Remove the small spur gear con bearing outer ring with the ring puller J-26941.
49. Inspect and clean the transaxle housing.



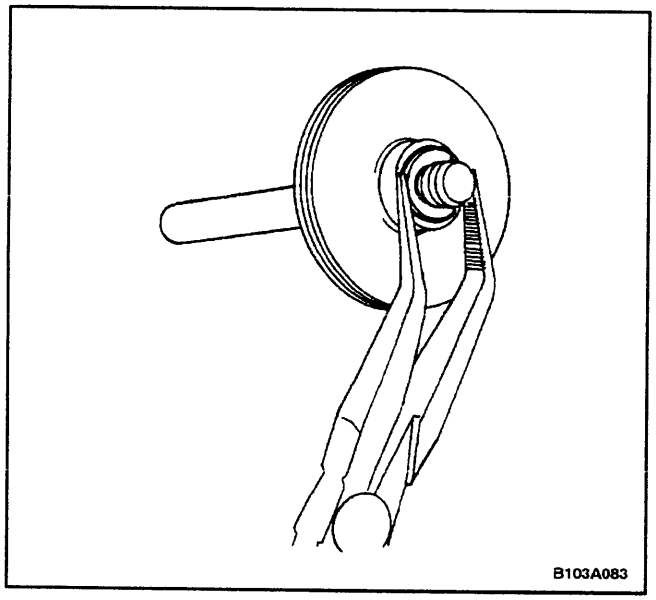
BRAKE C′

Disassembly Procedure

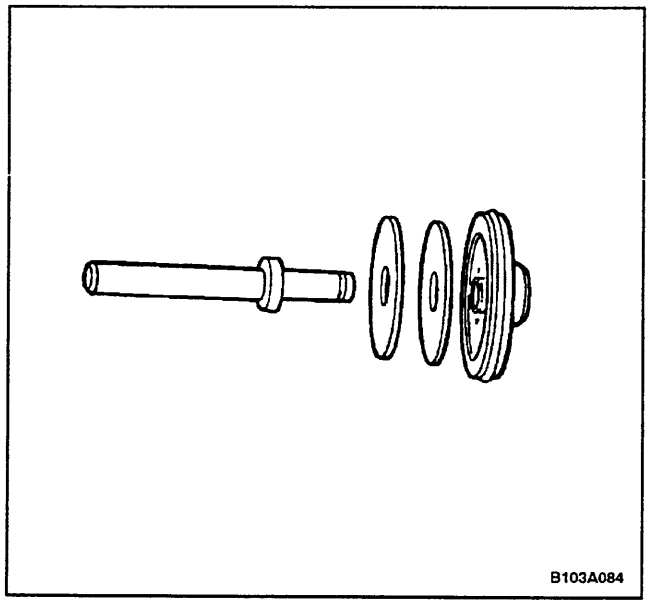
1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the band C′. Refer to "Major Component Disassembly" in this section.
3. Remove the retaining ring holding the piston C′ cover.



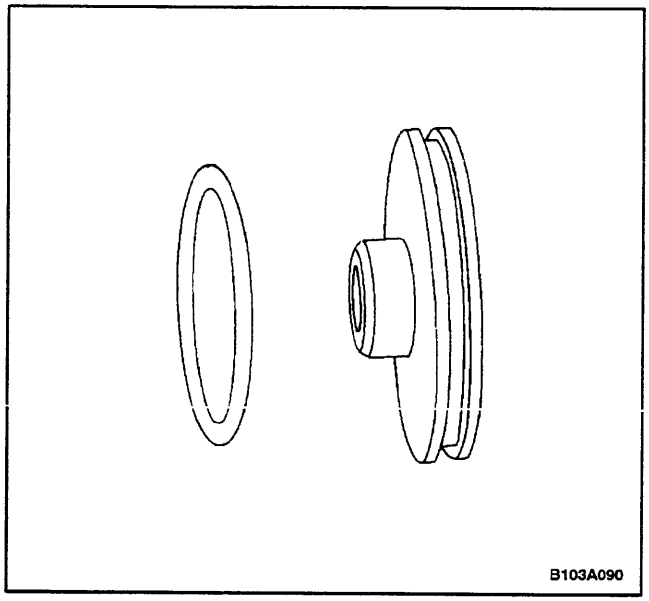
4. Remove the piston C′ cover and the piston C′.



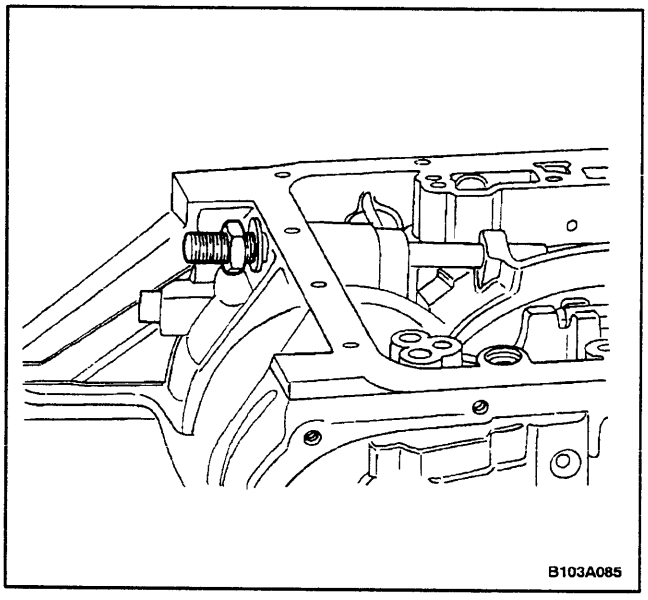
5. Remove the security clip from the piston C′.


B103A084

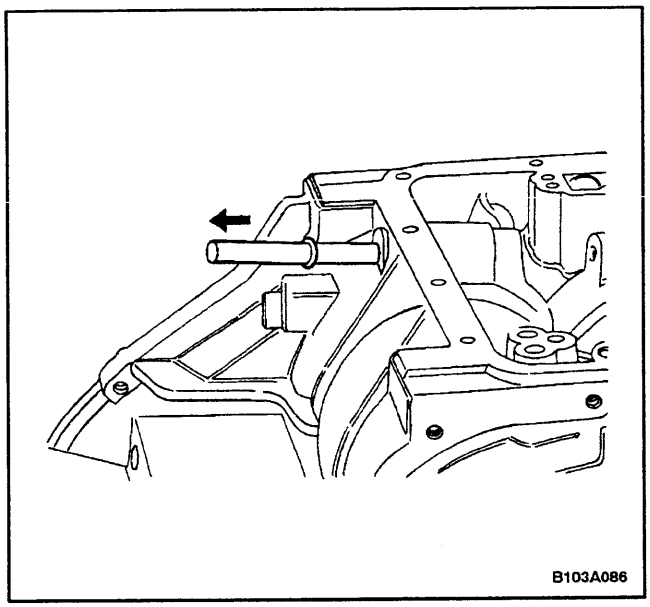
6. Separate the piston C′, the piston rod, and the plate washers.


B103A090

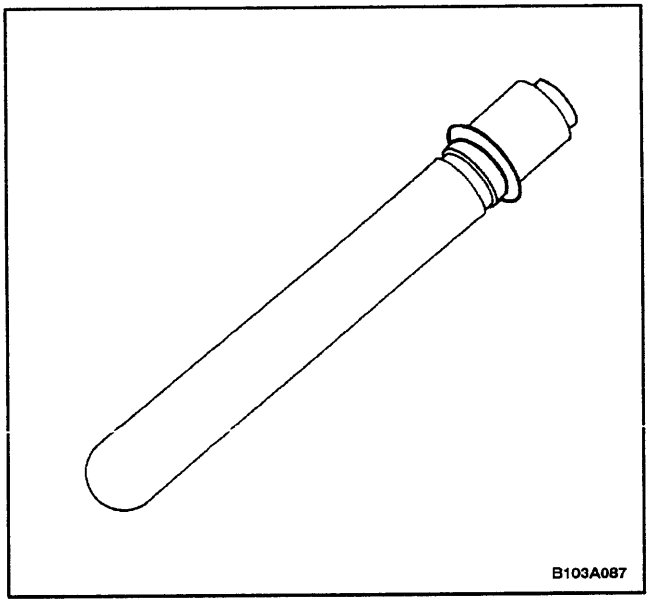
7. Remove the O-ring from the piston C′.


B103A085

8. Loosen the locknut and unscrew the adjusting bolt.



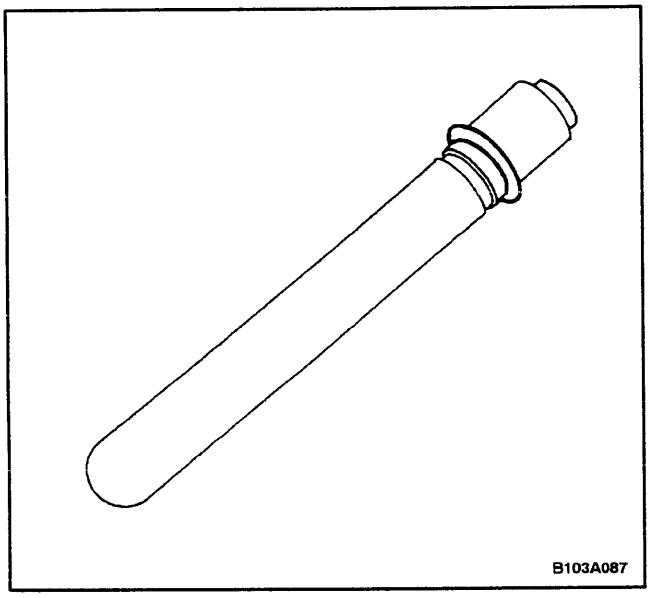
9. Remove the band C′ shaft from the transaxle housing.

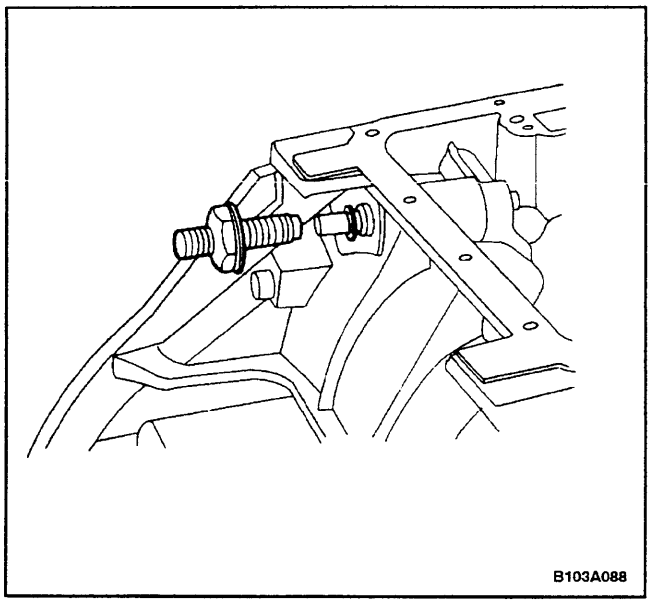


10. Remove the O-ring from the band C′ shaft.

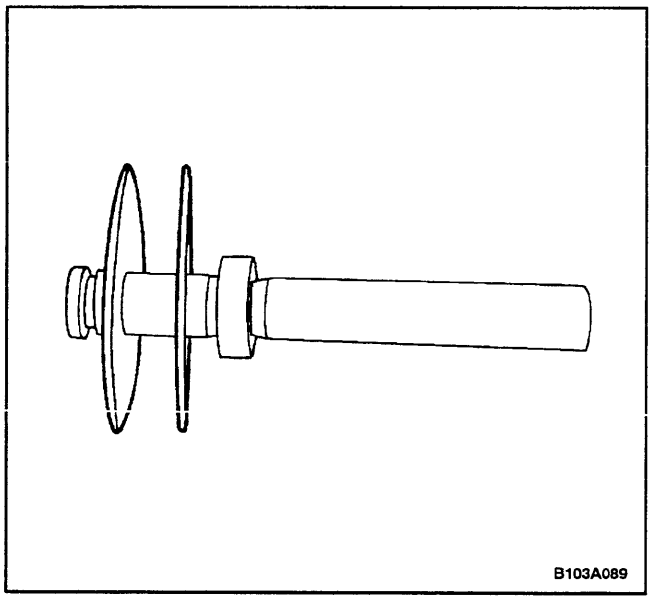
Assembly Procedure

1. Install the O-ring onto the band C′ shaft.



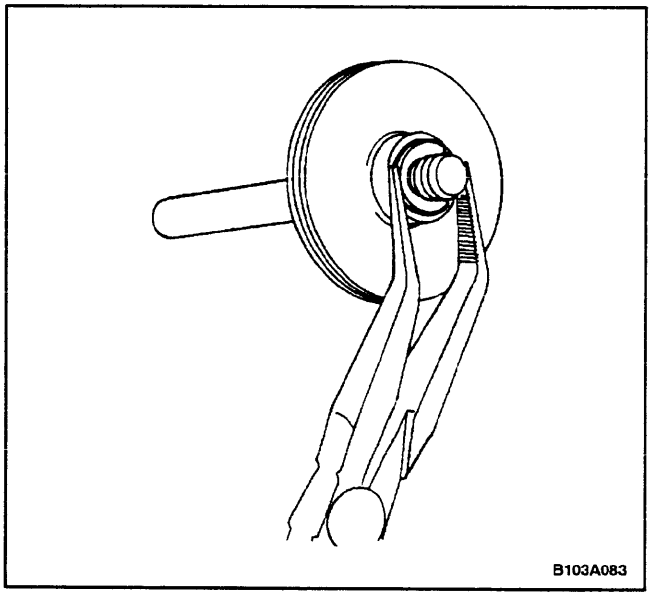

B103A088

2. Insert the band C′ shaft into the transmission housing. Assemble the adjusting bolt, the washer, and the nut. Screw the assembly half of the way into the transmission housing.

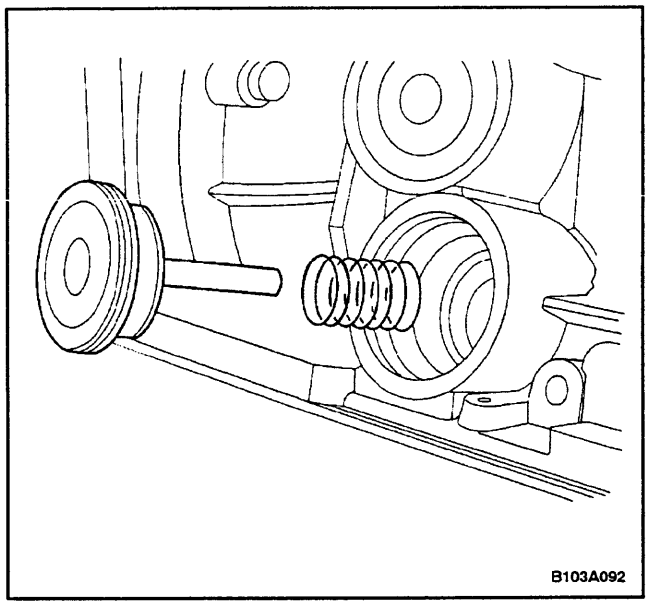

B103A089

Important: Both plate washers are convex. They should face each other as they are assembled on the piston rod, or the brake will not work properly.

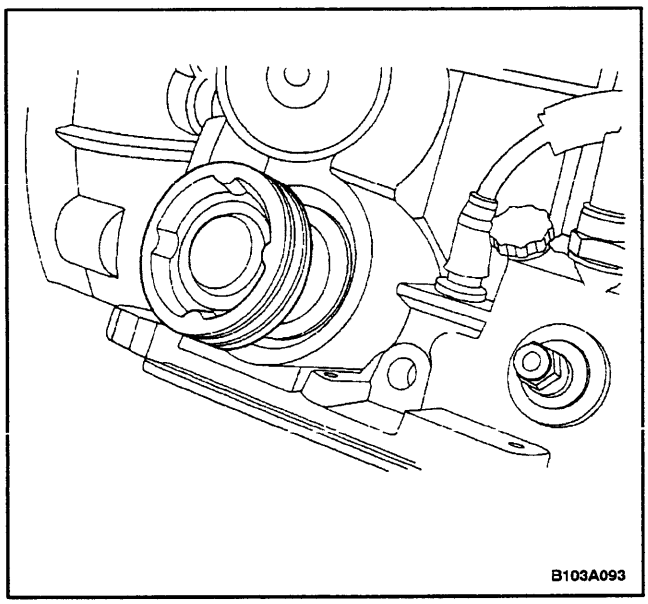
3. Install the plate washers onto the piston rod. The thick one goes on the piston rod before the thin one.


B103A083

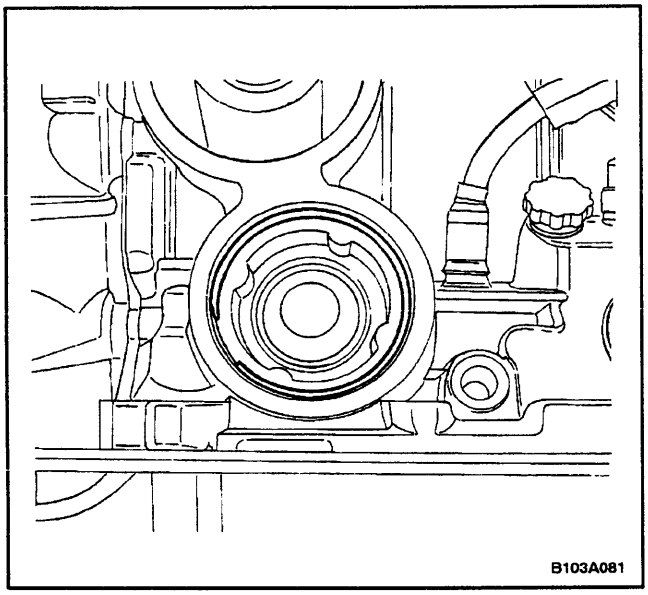
4. Install a new O-ring onto the piston C′ and install the piston C′ onto the piston rod. Install the security clip onto the piston rod.



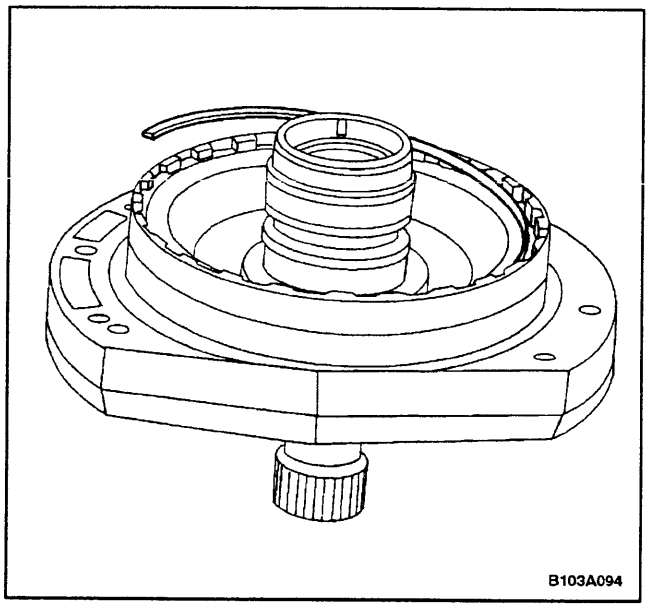
5. Install the spring onto the piston rod and insert the piston C′ into the transaxle housing.



6. Install the piston C′ cover.



7. Install the retaining ring.
8. Install the band C′. Refer to "Major Component Assembly" in this section.
9. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.


B103A094

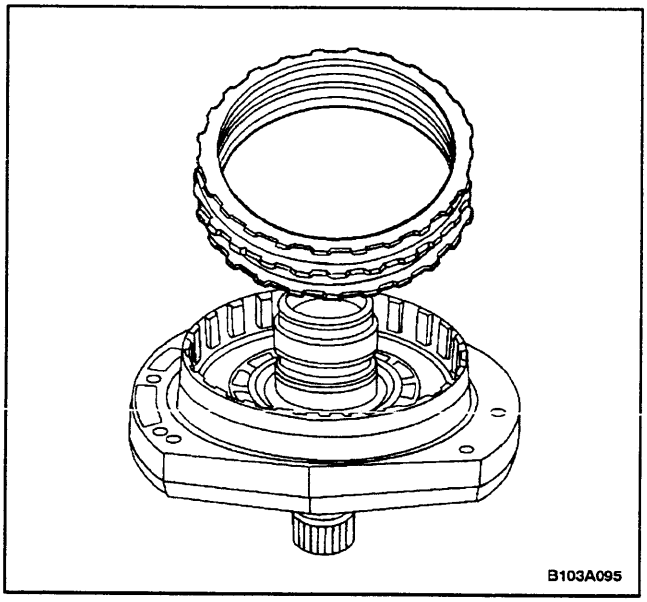
INTERMEDIATE PLATE WITH BRAKE C AND PUMP

Tools Required

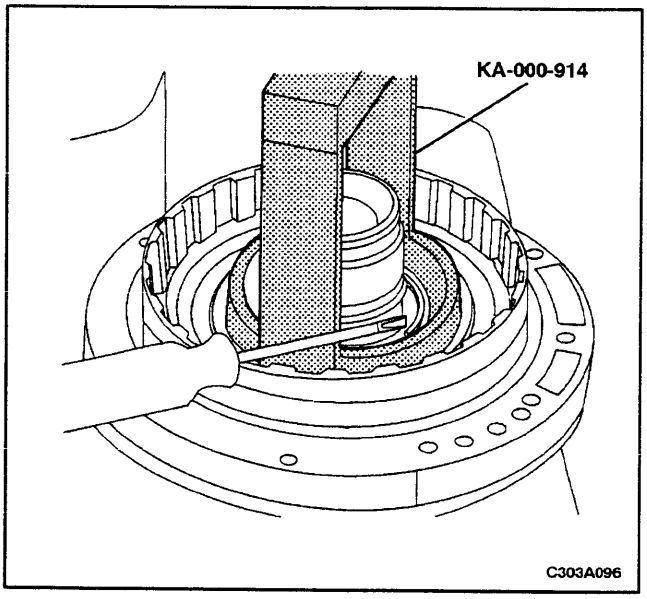
KA-000-914 Compression Adapter

Disassembly Procedure

1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the intermediate plate with the brake C and the pump. Refer to "Major Component Disassembly" in this section.
3. Remove the snap ring that secures the brake C assembly.

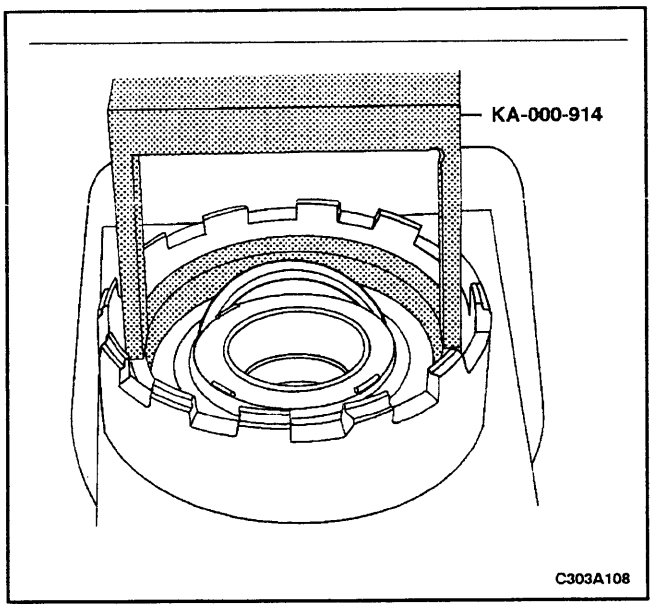

B103A095

4. Remove the brake C assembly.

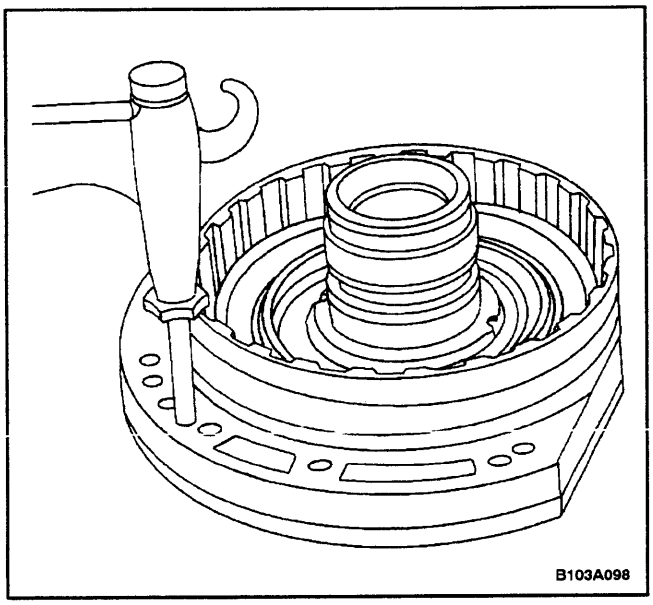


C303A096

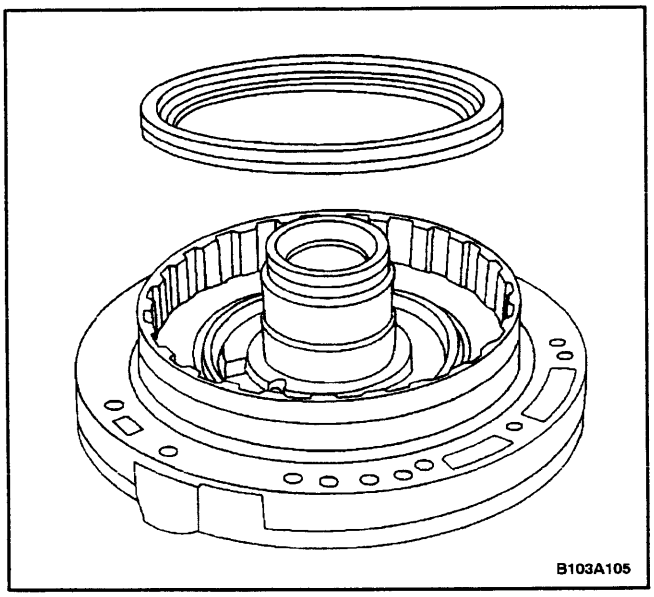
5. Press down the plate spring with the compression adapter KA-000-914 and remove the snap ring with a screwdriver.



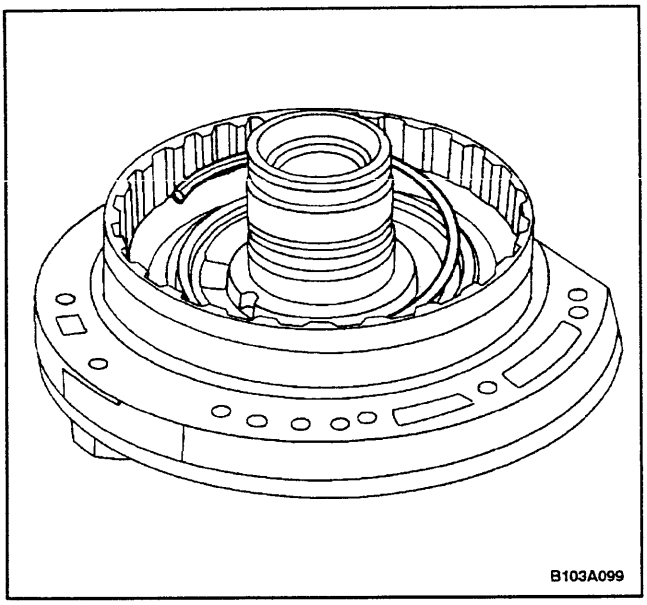
6. Remove the plate spring, the pressure plate, and the retainer ring.



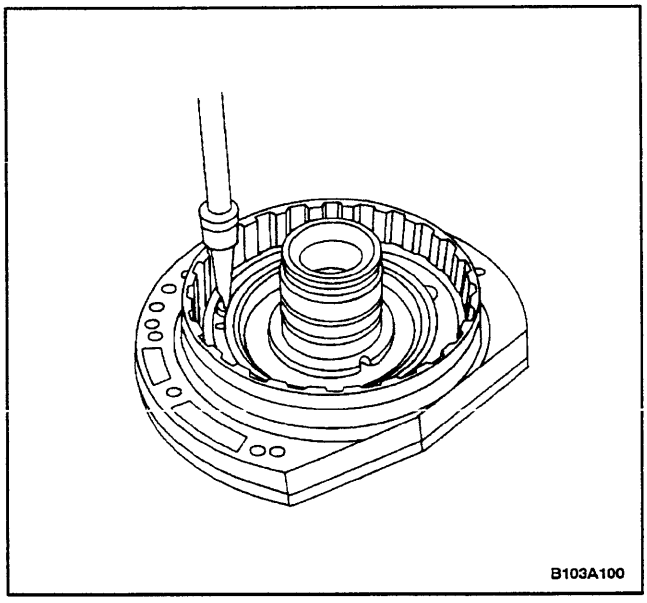
7. Insert an air gun into the fluid feed hole and use air pressure to free the piston C.



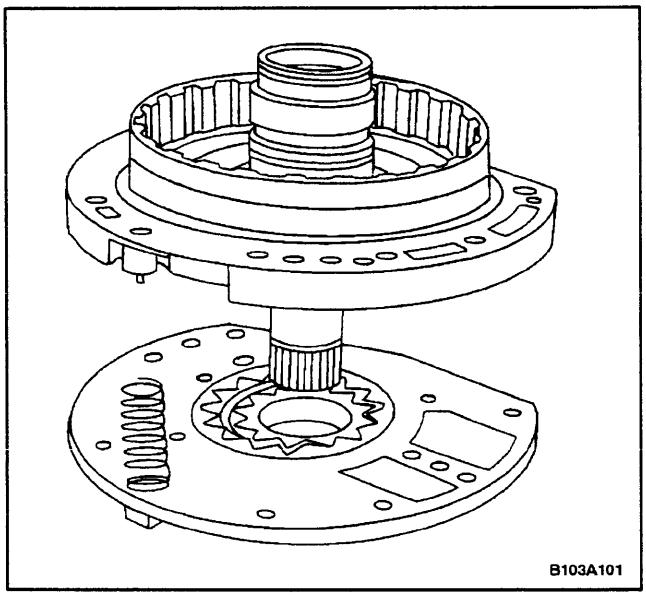
8. Remove the piston C.


B103A099

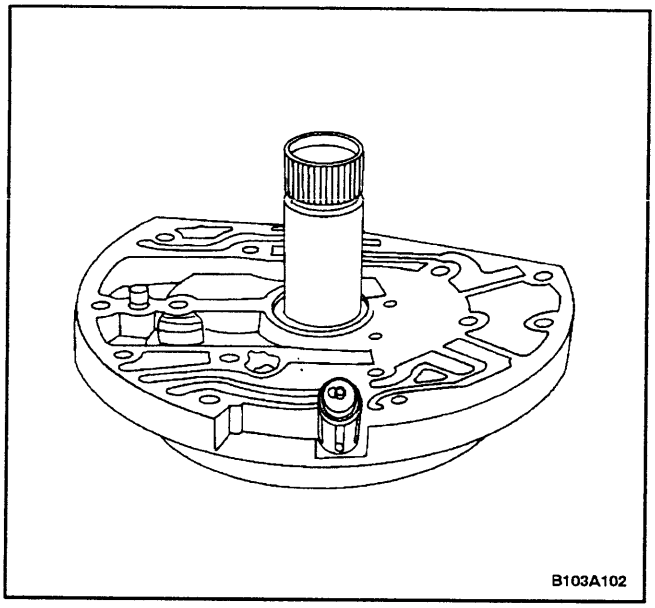
9. Remove the intermediate ring snap ring and the intermediate ring. Replace the O-ring on the intermediate ring as needed.


B103A100

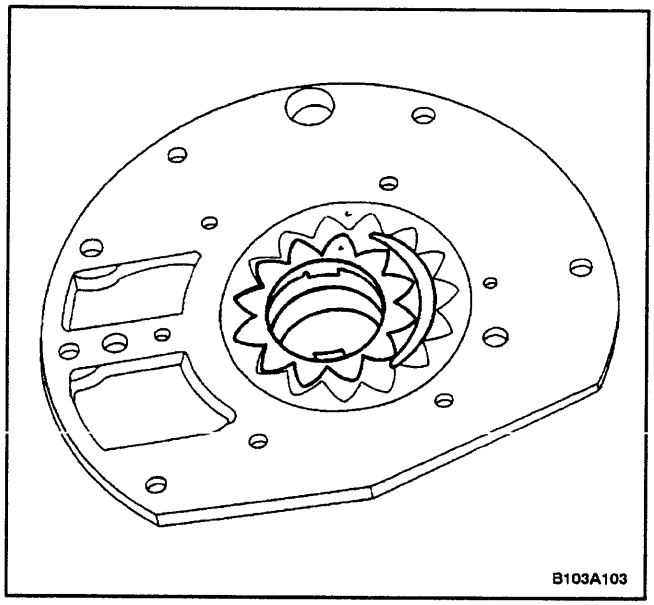
10. Remove the intermediate plate connecting bolts from the pump assembly.


B103A101

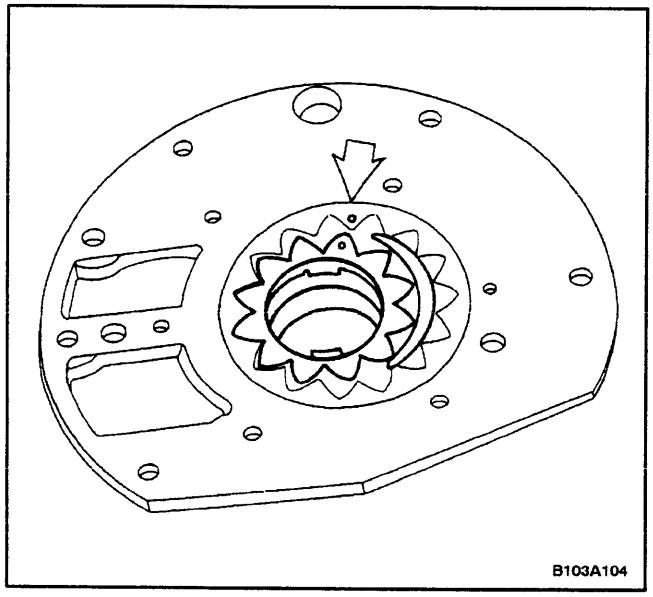
11. Separate the intermediate plate from the pump assembly. Use a plastic hammer for disassembly.


B103A102

12. Remove the spring, the torque converter valve, and the cap.

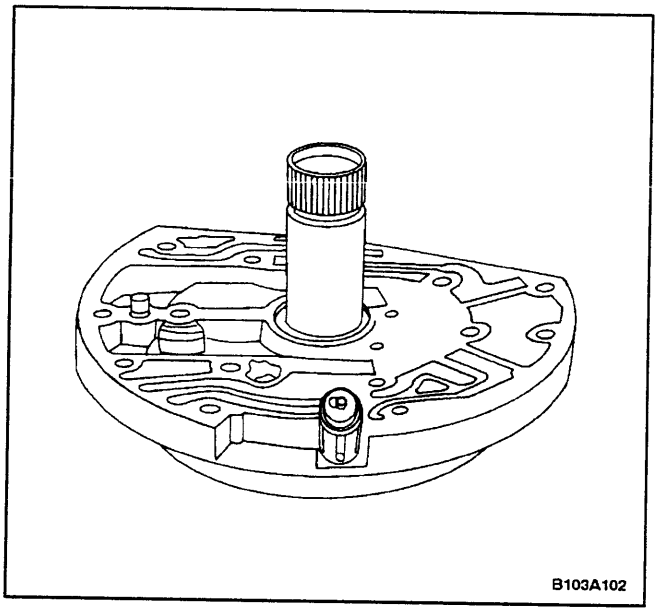

B103A103

13. Remove the pump hollow gear and the pump gear from the pump housing.

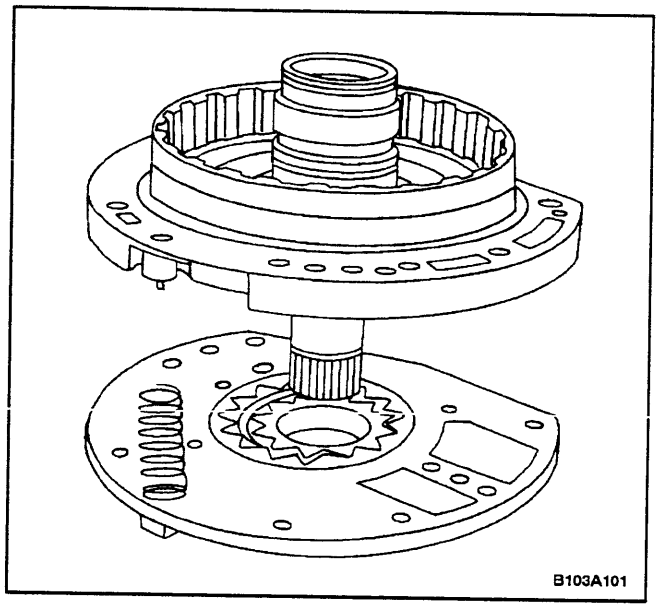

B103A104

Assembly Procedure

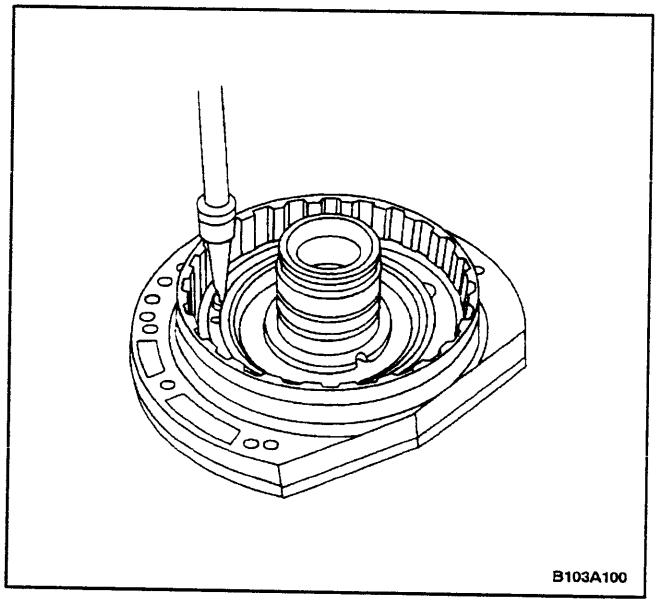
1. Install the pump hollow gear and the pump gear into the pump housing with the marked side of the gears facing upward.


B103A102

2. Install the spring, the torque converter valve, and the cap.


B103A101

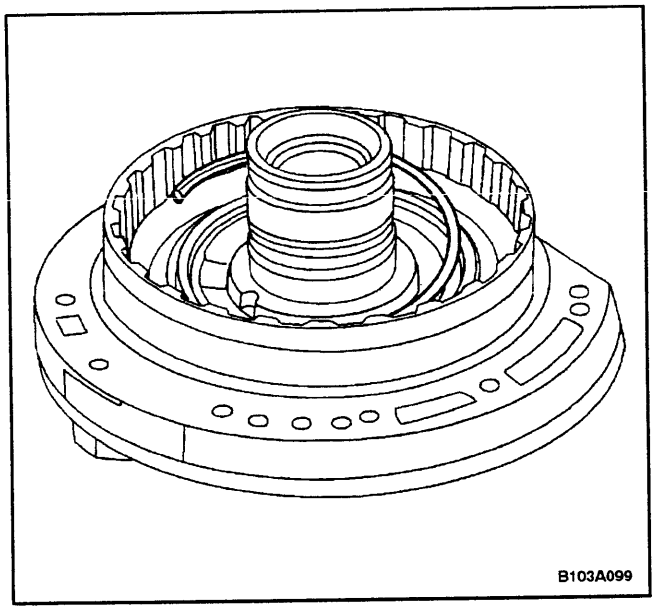
3. Insert the spring into the open gap and align the intermediate plate onto the pump housing.


B103A100

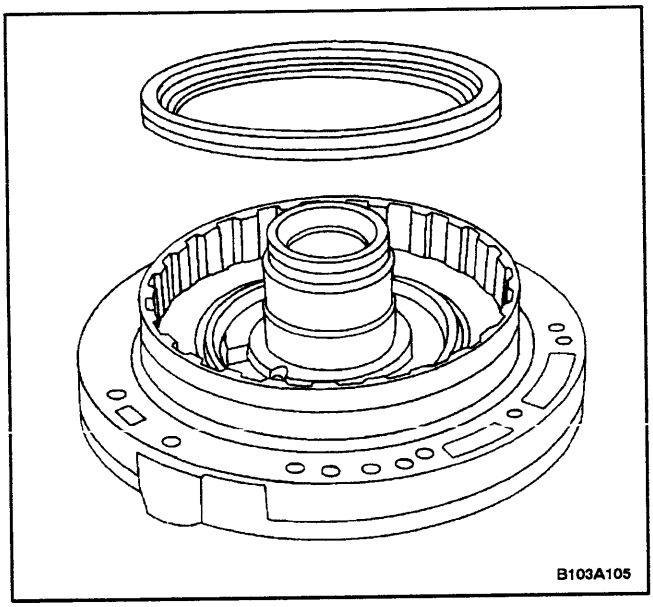
4. Install the intermediate plate connecting bolts into the pump assembly.

Tighten

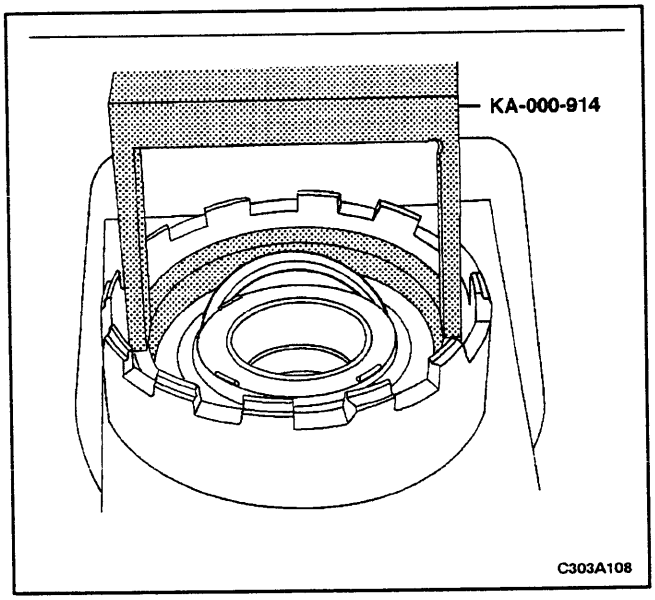
Tighten the intermediate plate-to-pump assembly connecting bolts to 10 N•m (89 lb-in).



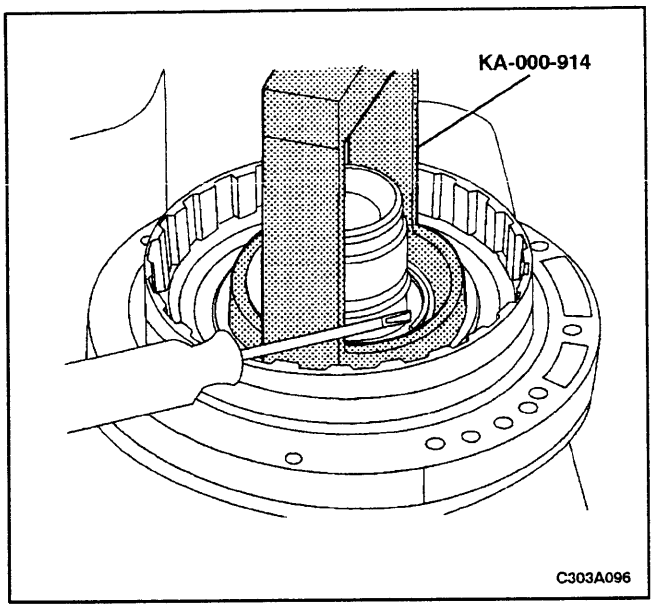
5. Install the intermediate ring and secure it with the intermediate ring snap ring.



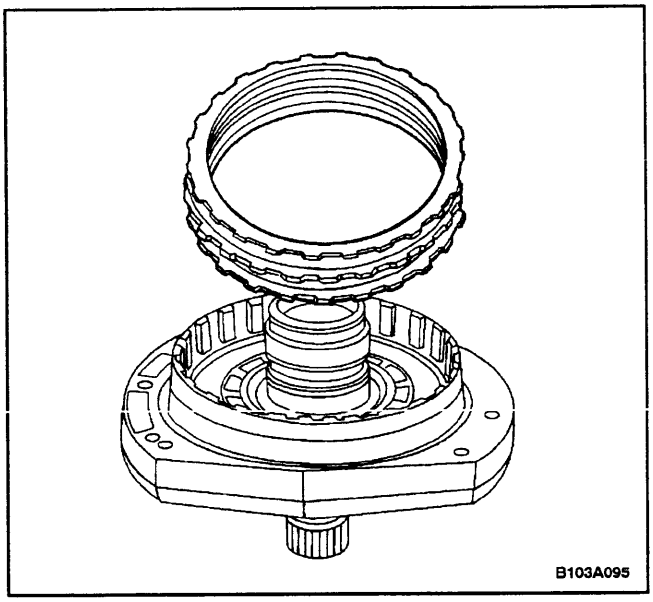
6. Install the piston C.



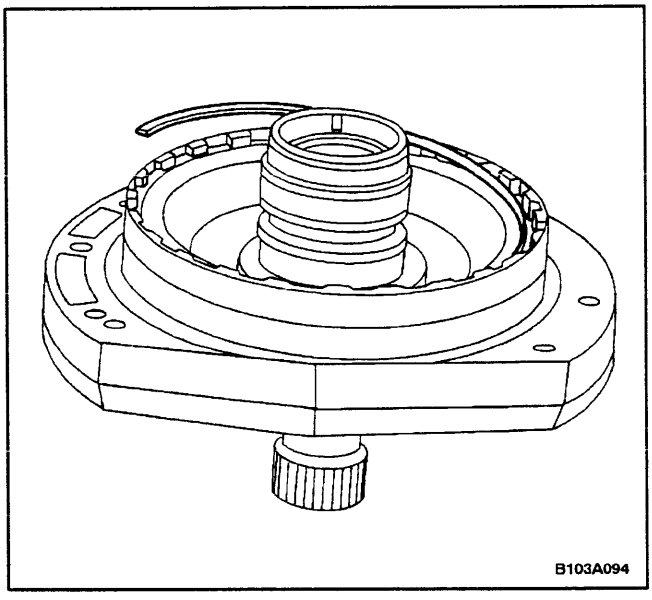
7. Install the plate spring, pressure plate, and the retainer ring.



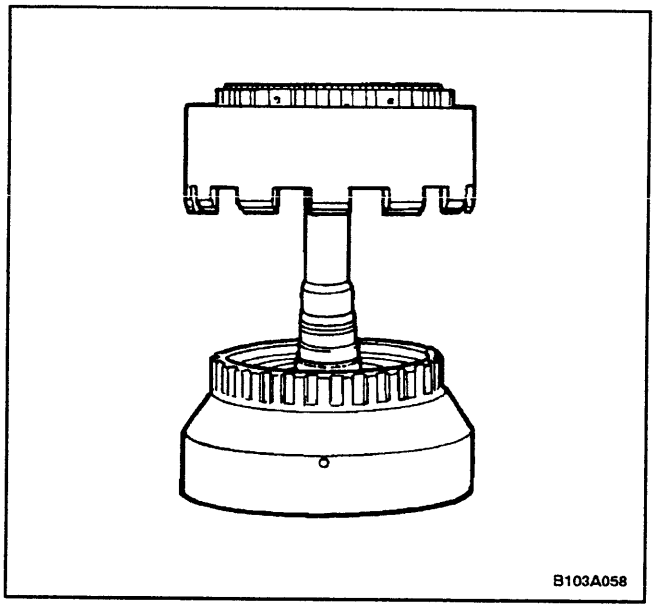
8. Press down the plate spring with the compression adapter KA-000-914 and install the snap ring.



9. Install the brake C assembly.



10. Install the snap ring that secures the brake C assembly.
11. Install the intermediate plate with the brake C and the pump. Refer to "Major Component Assembly" in this section.
12. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.


B103A058

CLUTCH B WITH FREEWHEEL SECOND GEAR

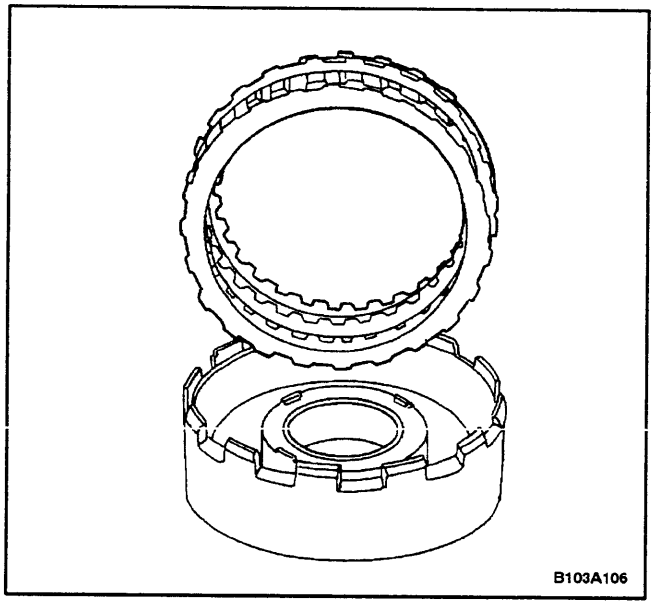
Tools Required

KA-000-914 Compression Adapter

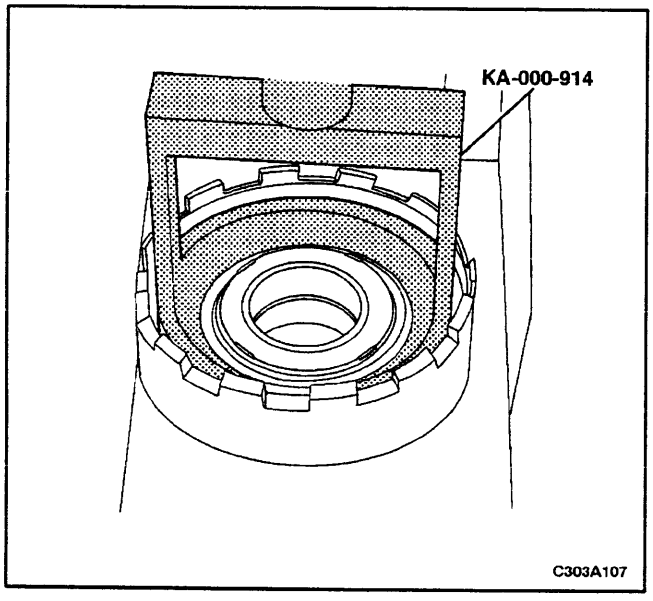
Disassembly Procedure

Important: The freewheel second gear should not be disassembled. Replace this part as a unit.

1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the clutch A, the clutch B and the freewheel second gear assembly from the transaxle housing. Refer to "Major Component Disassembly" in this section.
3. Separate the clutch A from the clutch B and the freewheel second gear assembly.

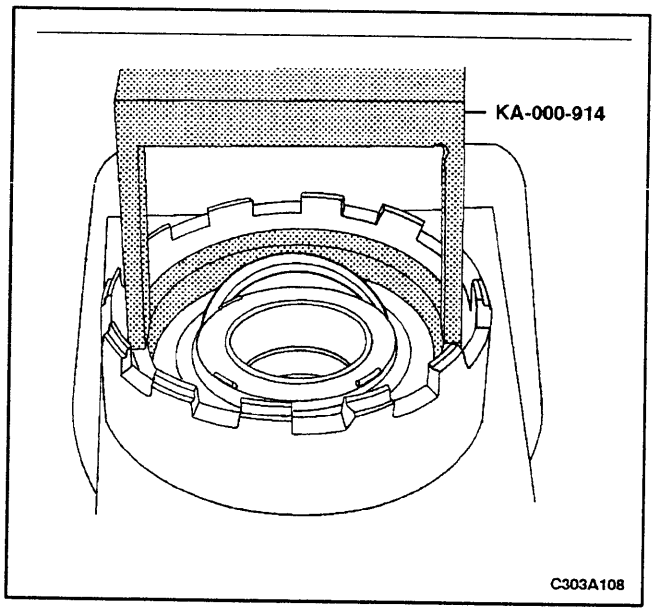

B103A106

4. Remove the snap ring and the clutch B assembly.

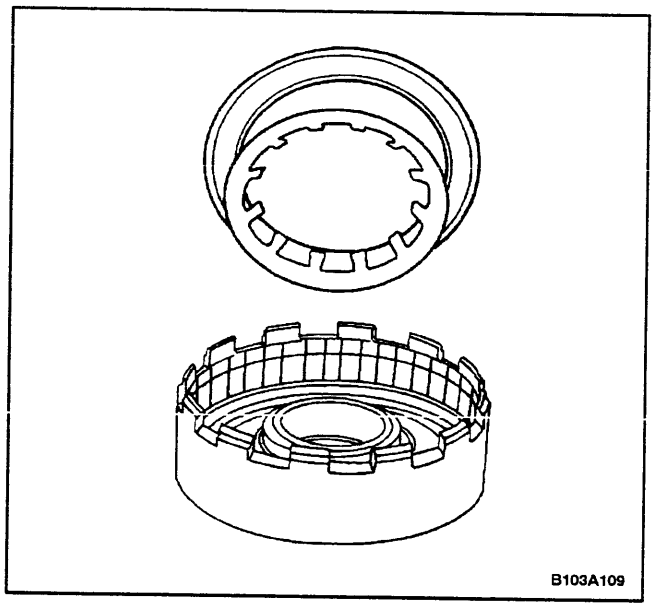


C303A107

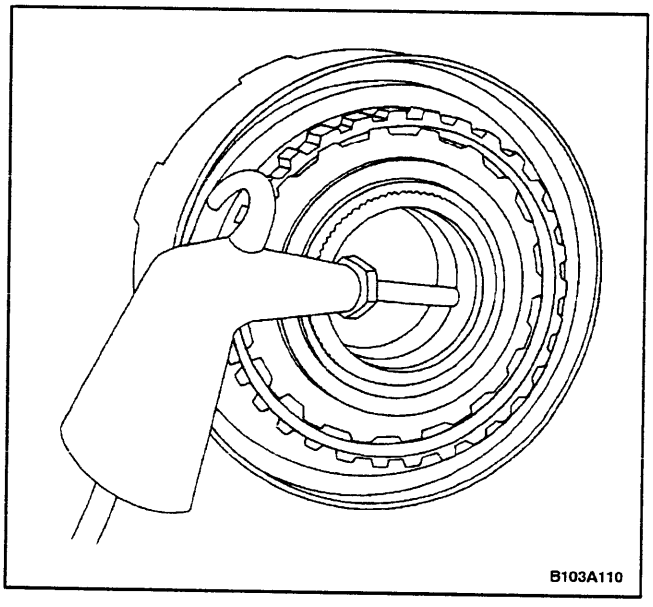
5. Compress the pressure plate using the compression adapter KA-000-914.



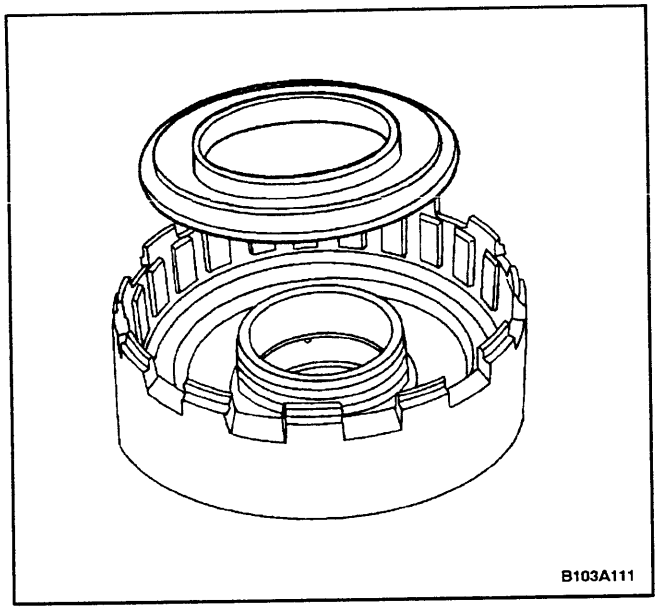
6. Remove the retainer rings and the thrust washers.



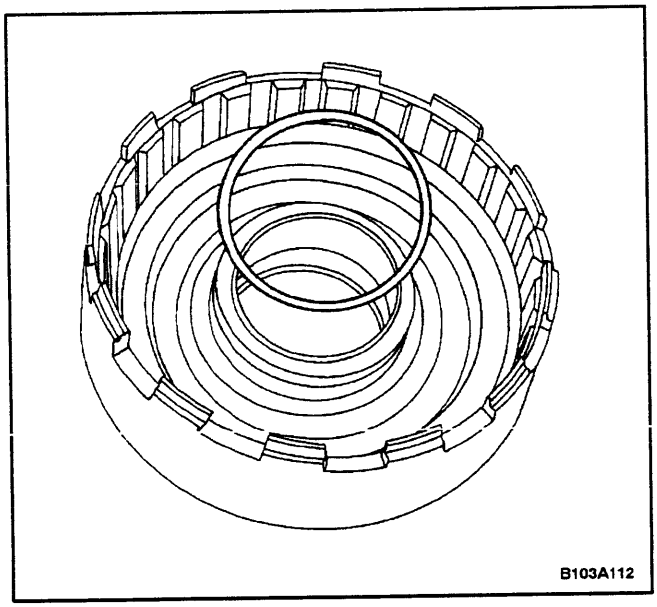
7. Remove the compression adapter KA-000-914.
8. Remove the plate spring and the pressure plate.



9. Insert compressed air into the fluid feed hole for the removal of the piston B.



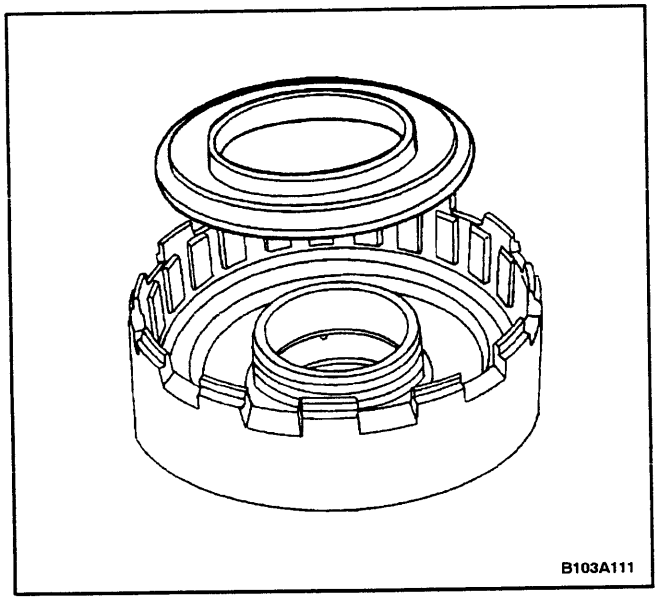
10. Remove the piston B. Replace the O-ring as needed.

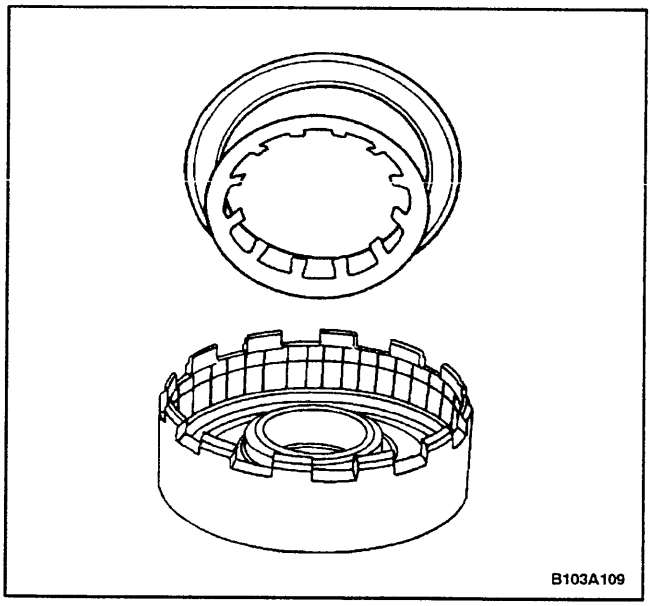


11. Replace the cylinder B O-ring as needed.

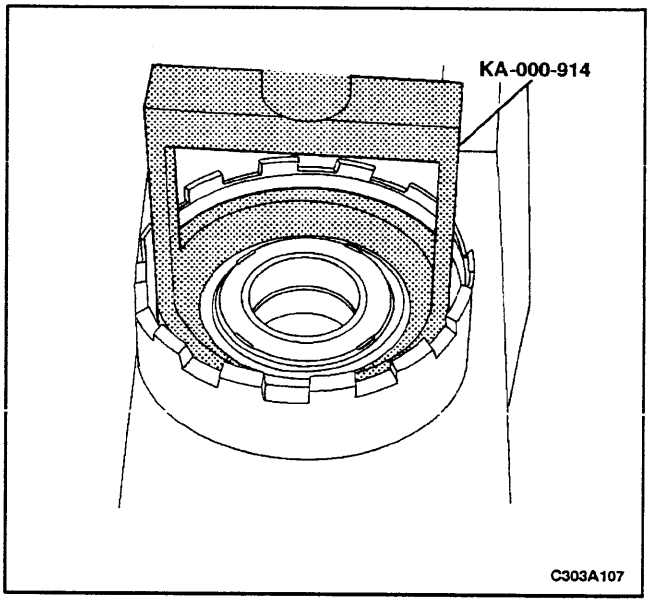
Assembly Procedure

1. Install the piston B.

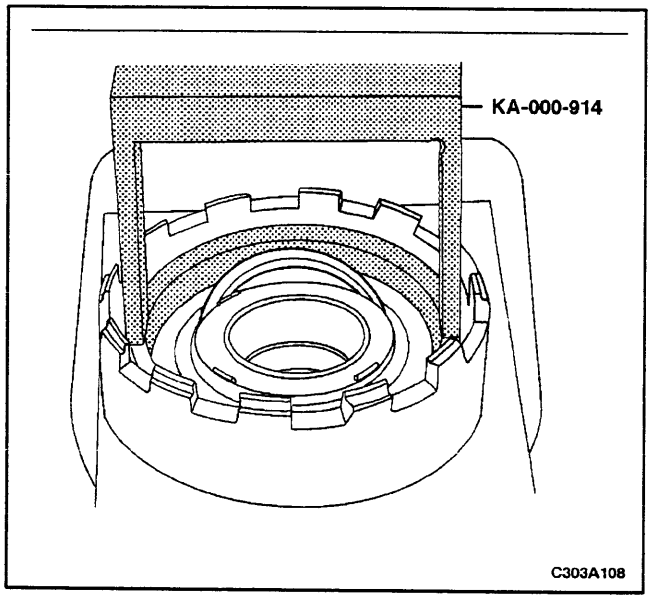




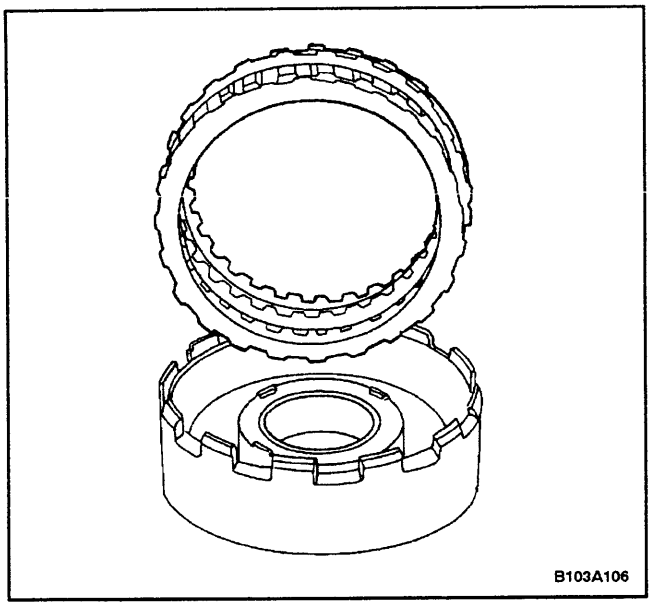
2. Install the plate spring and the pressure plate.



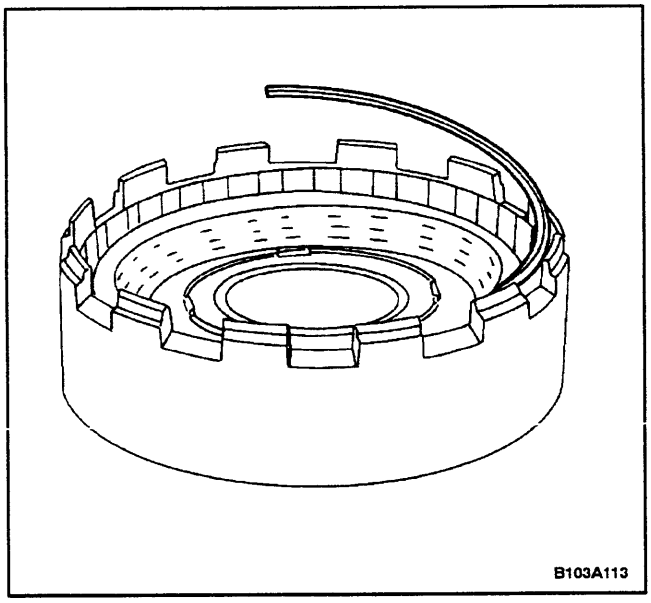
3. Compress the pressure plate using the compression adapter KA-000-914.



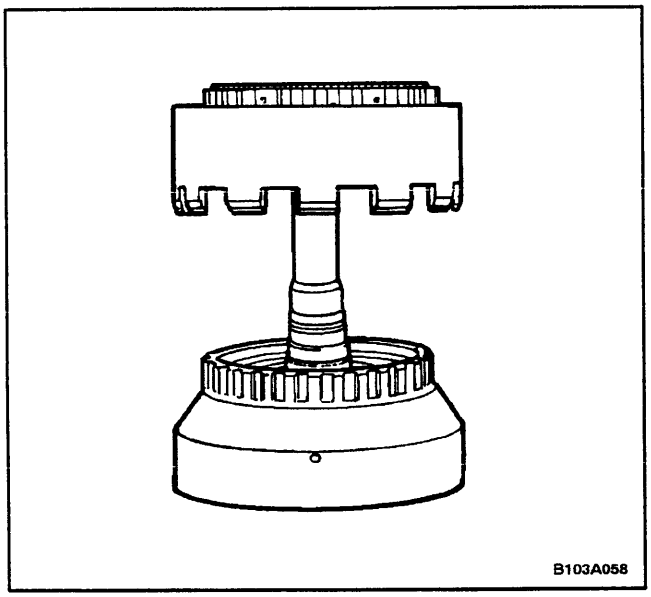
4. Install the retainer rings and the thrust washers.



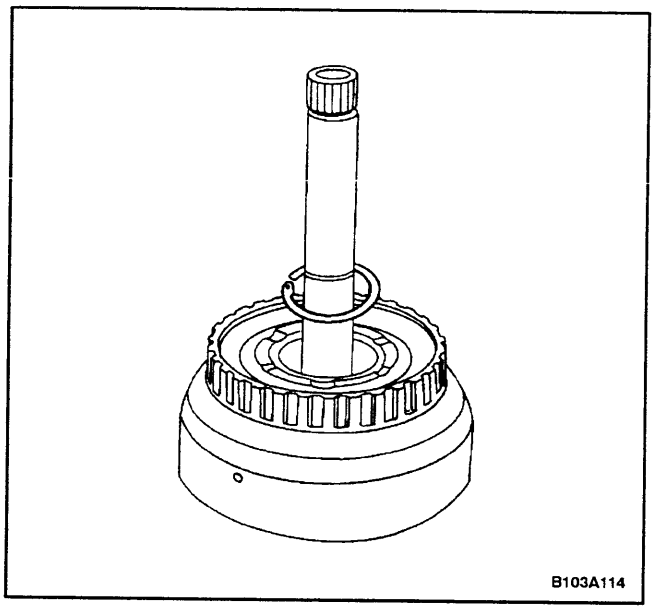
5. Install the clutch B assembly.



6. Install the clutch B assembly snap ring.



7. Join the clutch A, the clutch B, and the freewheel second gear into an assembly.
8. Install the clutch A, the clutch B, and the freewheel second gear assembly into the transaxle housing. Refer to "Major Component Assembly" in this section.
9. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.


B103A114

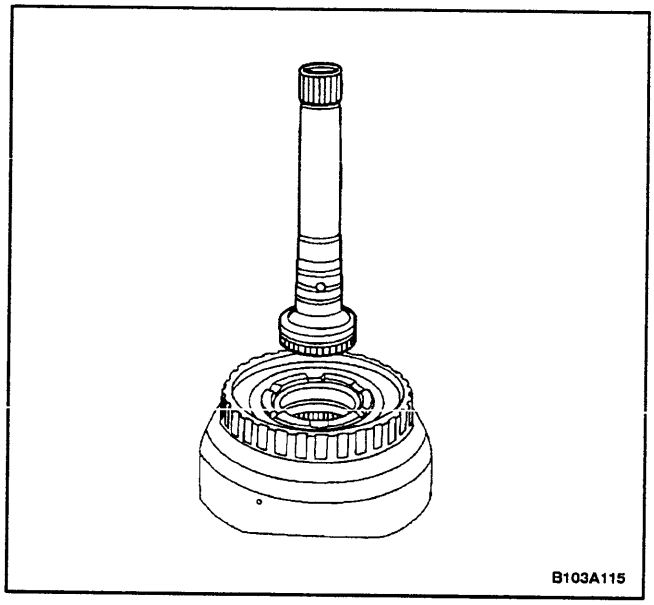
CLUTCH A

Tools Required

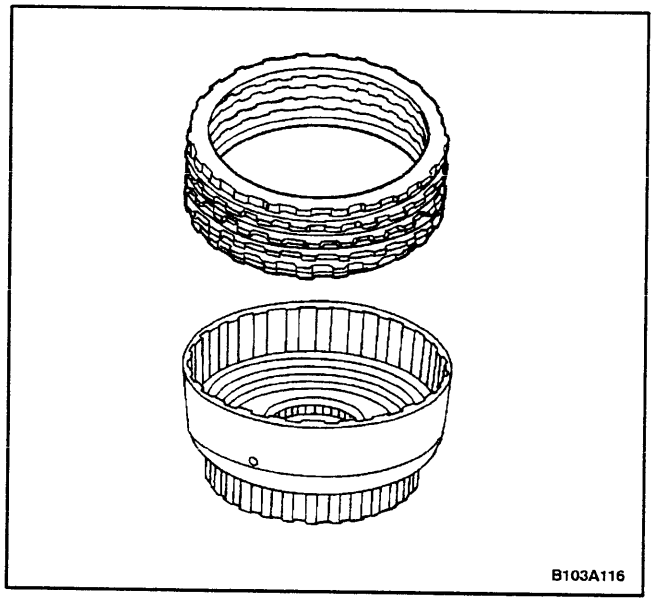
KA-000-913 Compression Adapter

Disassembly Procedure

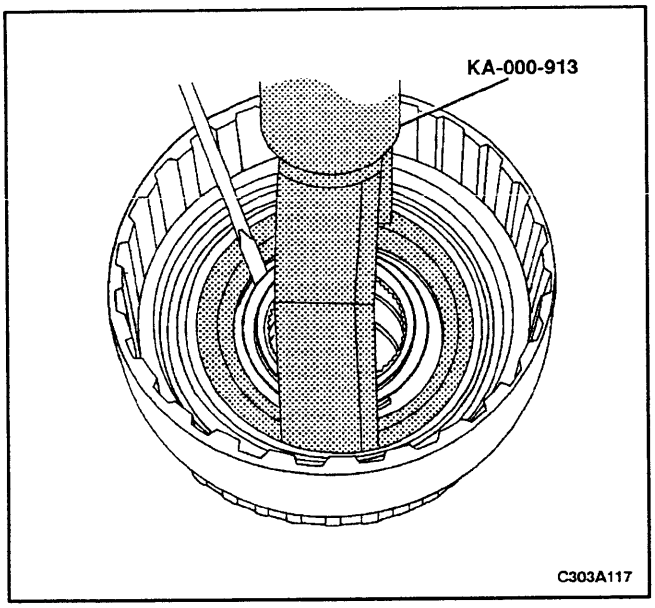
1. Remove the transaxle form the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the clutch A from the transaxle housing. Refer to "Major Component Disassembly" in this section.
3. Remove the clutch A snap ring.


B103A115

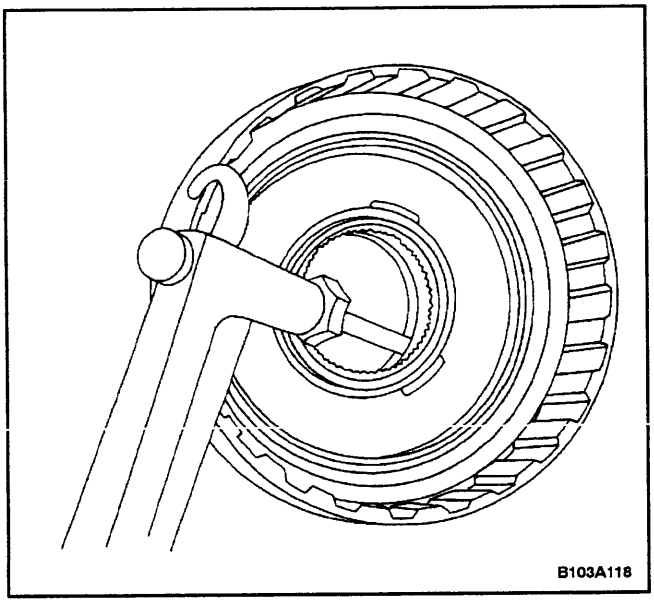
4. Remove the turbine shaft.


B103A116

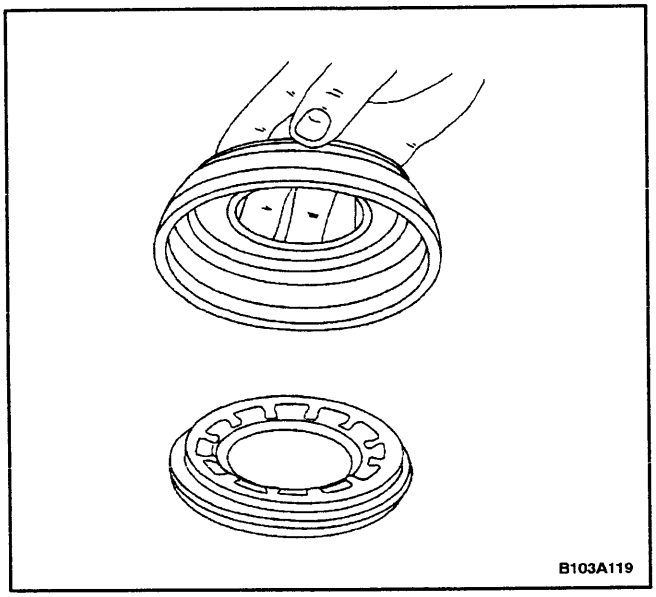
5. Remove the snap ring and the clutch A assembly.



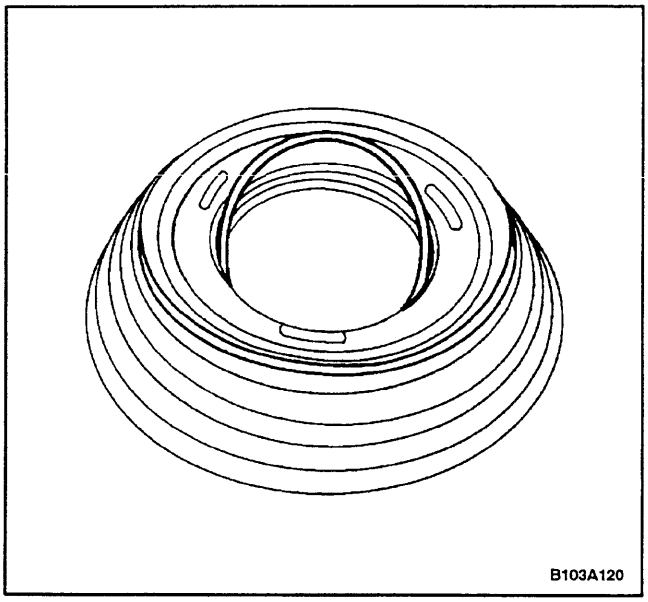
6. Compress the piston with the compression adapter KA-000-913 and remove the snap ring.



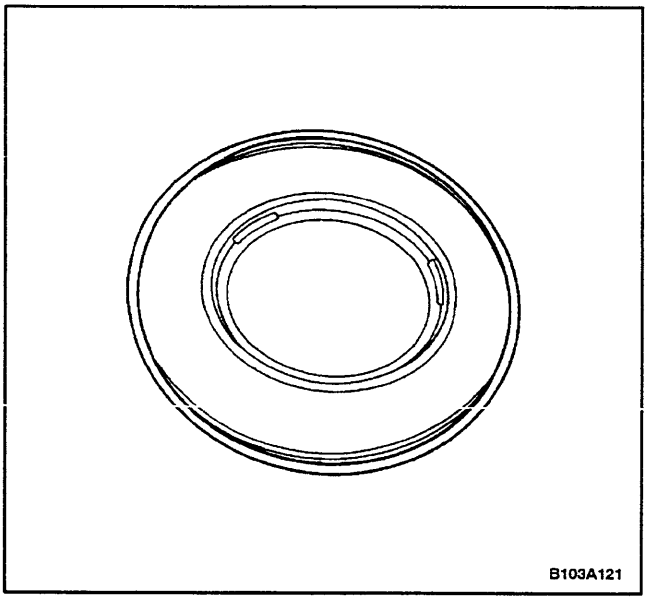
7. Insert compressed air into the fluid feed hole to free the accumulation piston assembly from the clutch A cylinder.



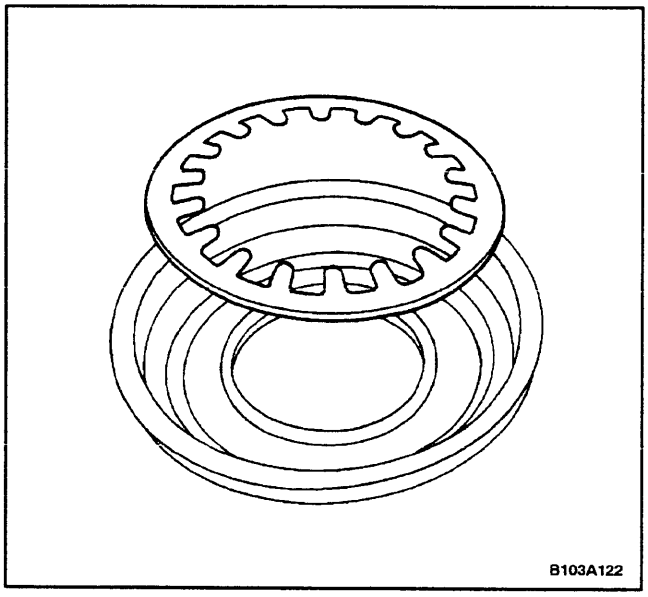
8. Hit the accumulation piston on the work bench lightly to remove the piston A and the plate spring.


B103A120

9. Replace the O-rings on the accumulation piston as needed.

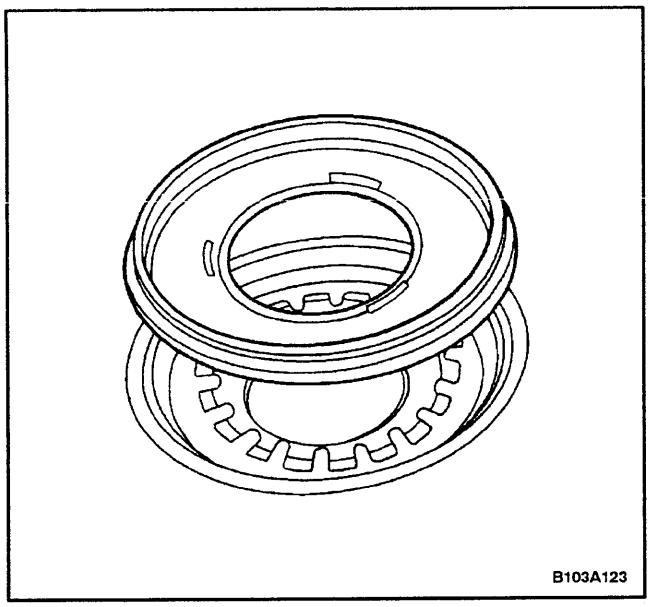

B103A121

10. Replace the O-ring in the piston A as needed.

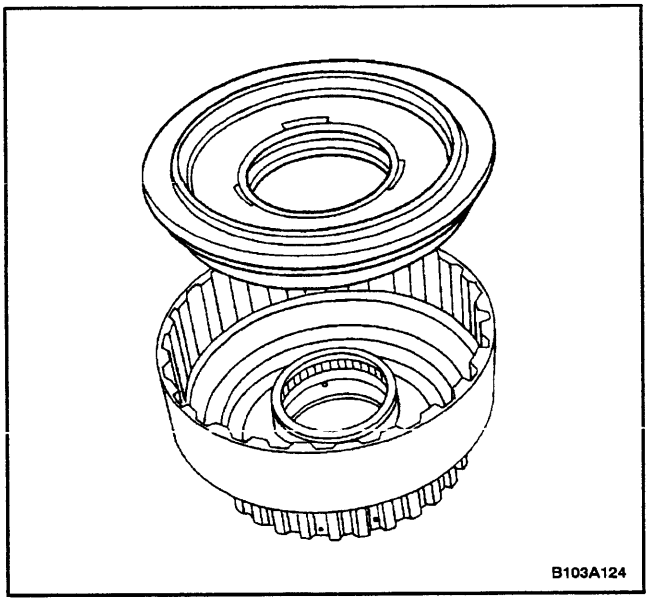

B103A122

Assembly Procedure

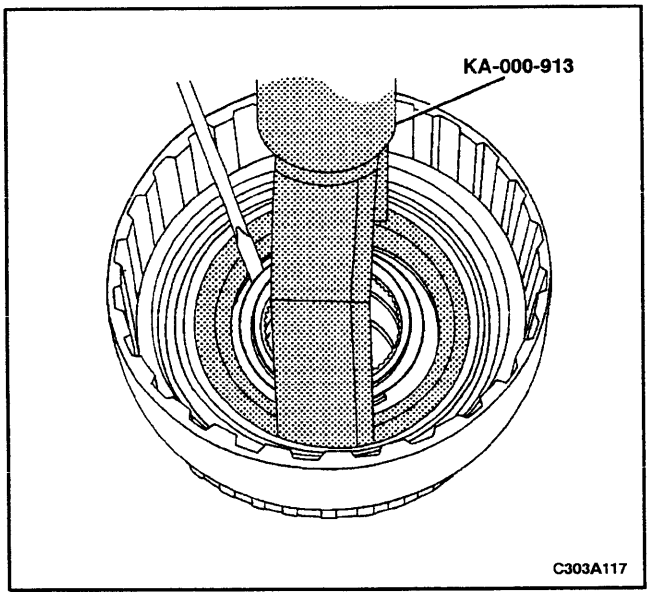
1. Install the plate spring into the accumulation piston.



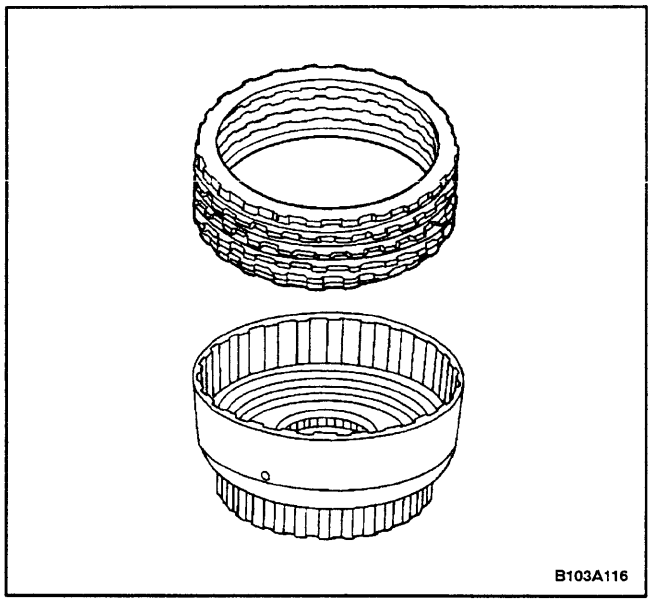
2. Install the piston A into the accumulation piston.



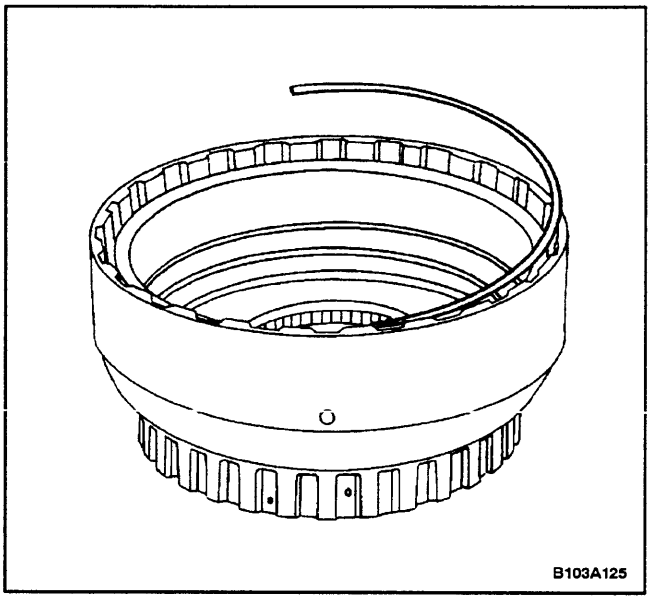
3. Install the accumulation piston into the clutch A cylinder.



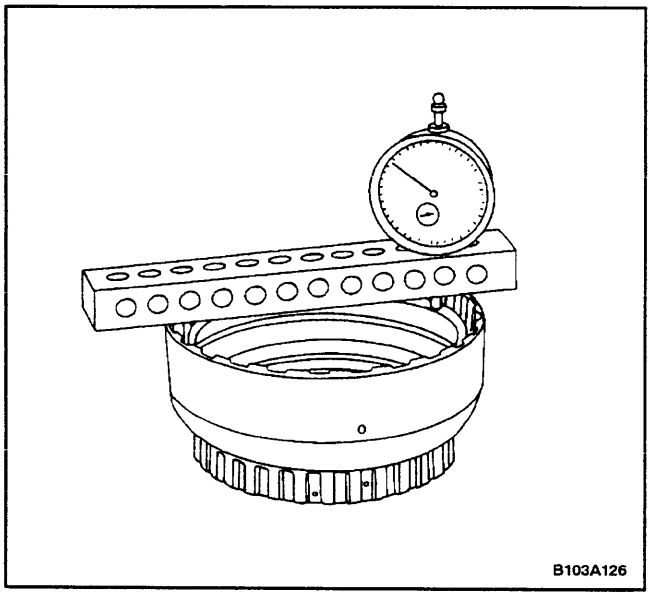
4. Compress the piston with the compression adapter KA-000-913 and install the snap ring.


B103A116

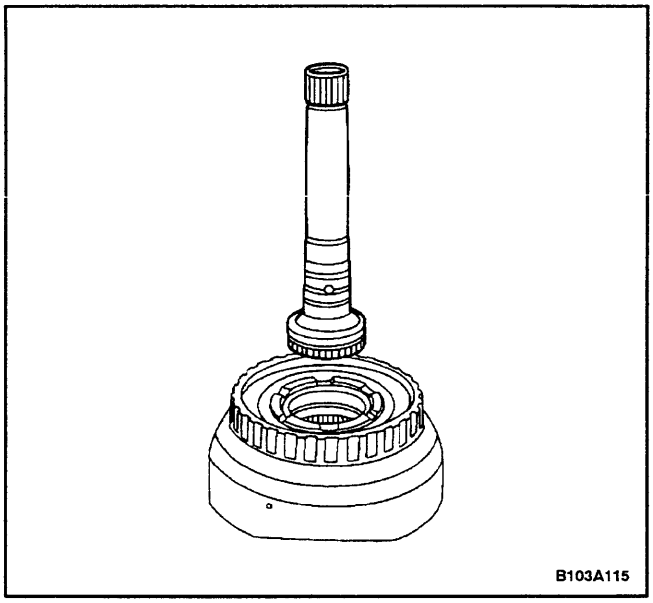
5. Install the clutch A assembly.


B103A125

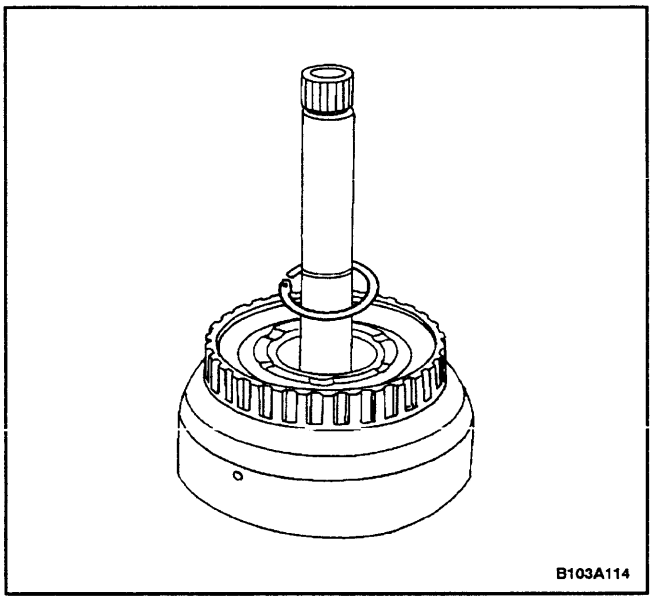
6. Install the clutch A assembly snap ring.


B103A126

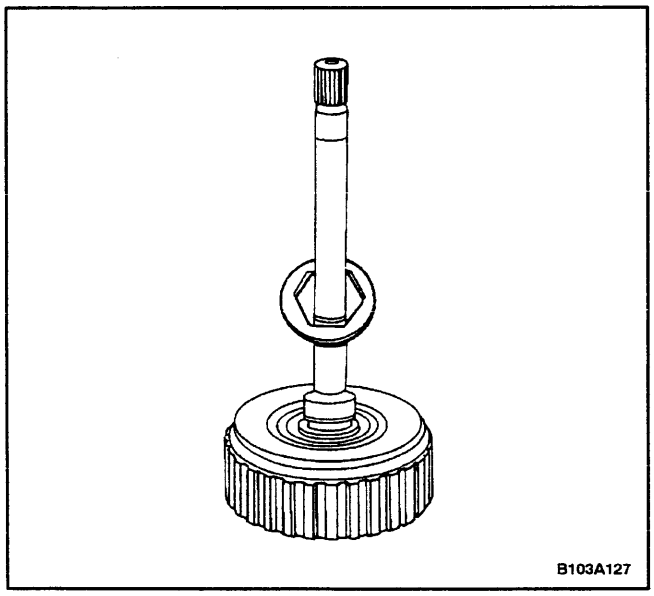
7. Check the clutch A assembly clearance by placing a measuring gauge on top of the clutch A cylinder.
8. Lift the clutch package upward to read the clutch clearance. The clearance should be 1.8-2.0 mm (0.7-0.8 inch).
9. If the measurement does not meet these specifications, replace the snap ring with one that is either thinner or thicker.


B103A115

10. Install the turbine shaft.


B103A114

11. Install the clutch A snap ring.
12. Install the clutch A into the transaxle housing. Refer to "Major Component Assembly" in this section.
13. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.


B103A127

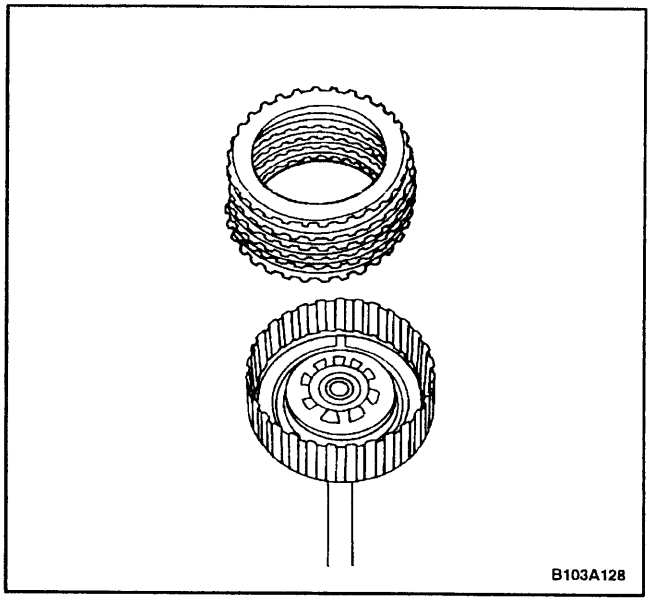
CLUTCH E

Tools Required

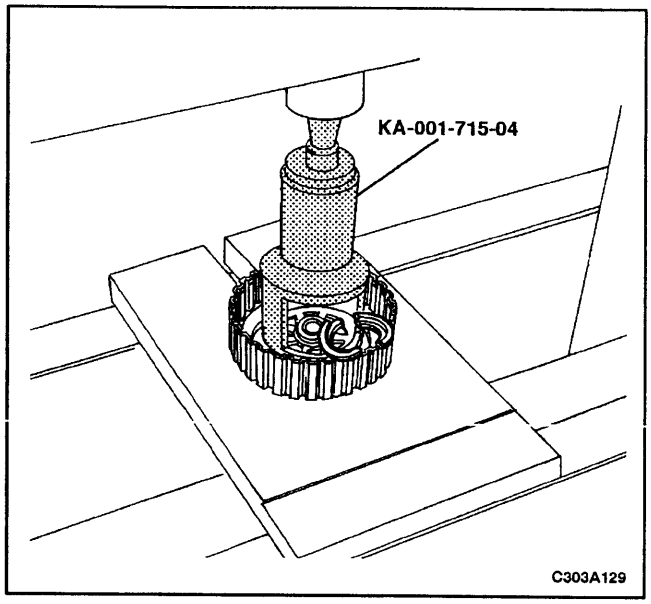
KA-001-715-04 Bearing Remover

Disassembly Procedure

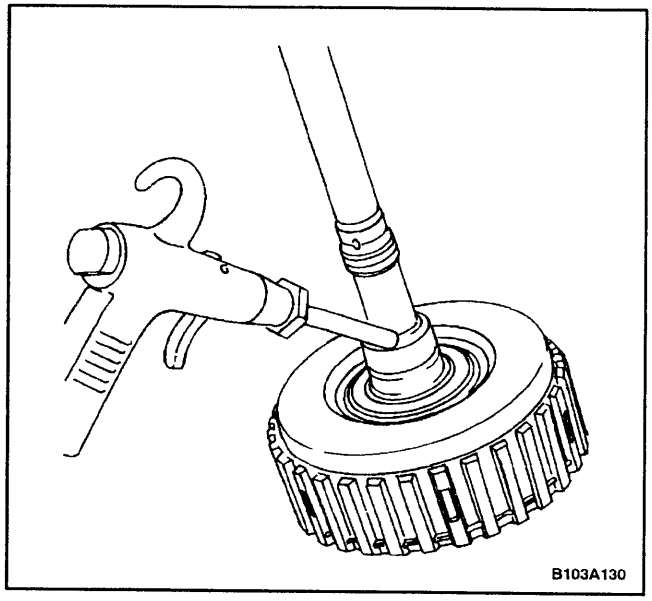
1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the clutch E assembly from the transaxle housing. Refer to "Major Component Disassembly" in this section.
3. Remove the thrust washer from the motor shaft.



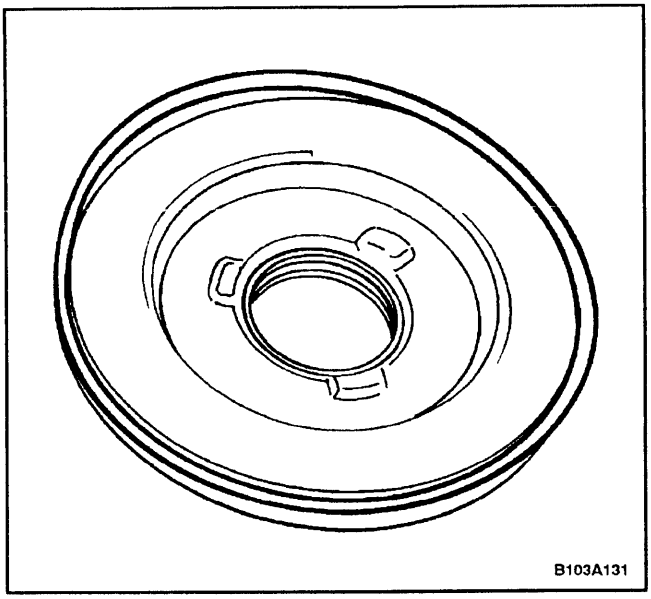
4. Remove the snap ring and the clutch E assembly.



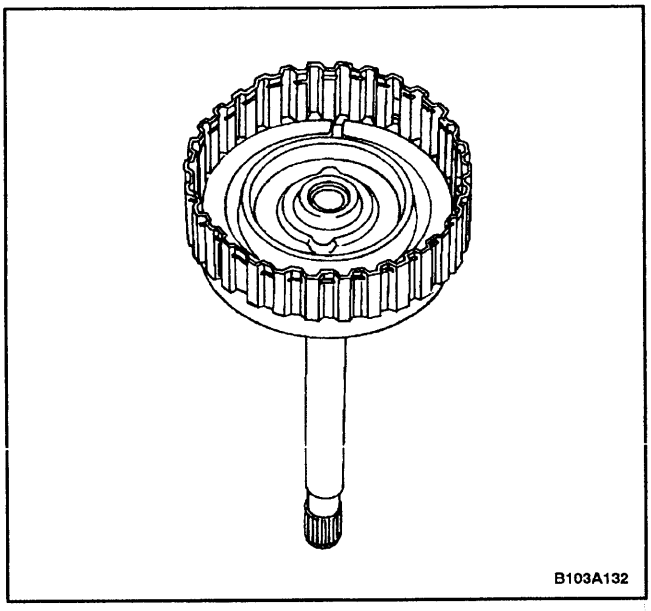
5. Compress the piston E using the bearing remover KA-001-715-04.
6. Remove the retainer rings and the plate spring.



7. Insert compressed air into the fluid feed hole.

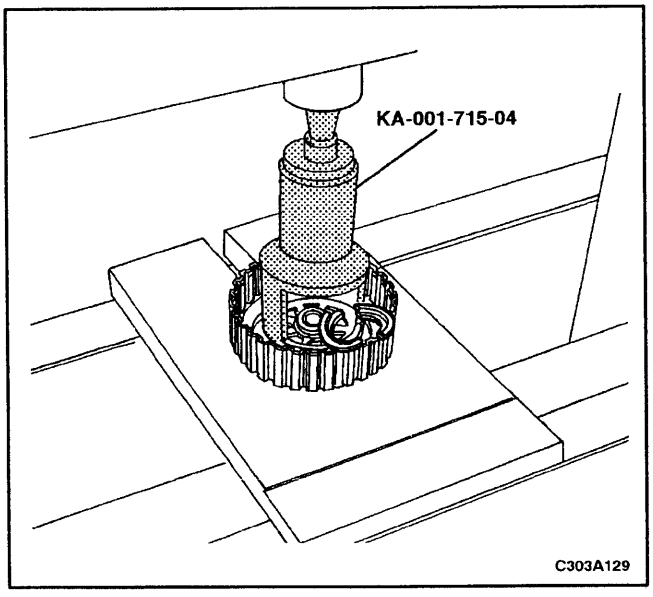


8. Remove the piston E.
9. Replace the O-ring as needed.

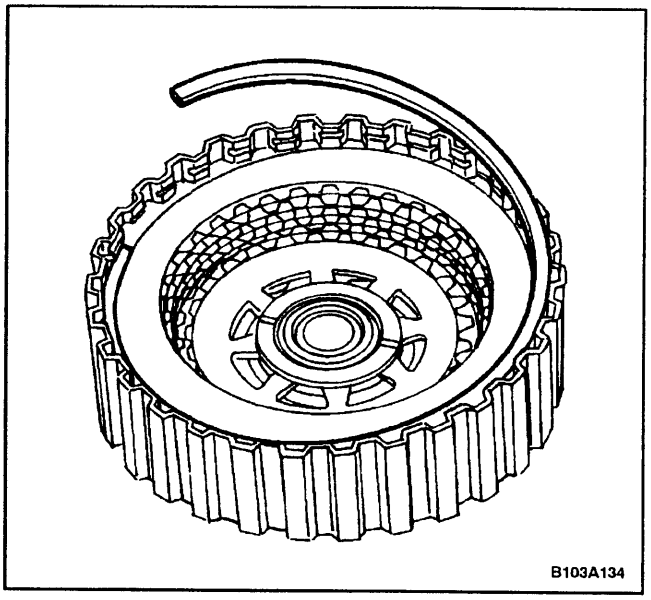


Assembly Procedure

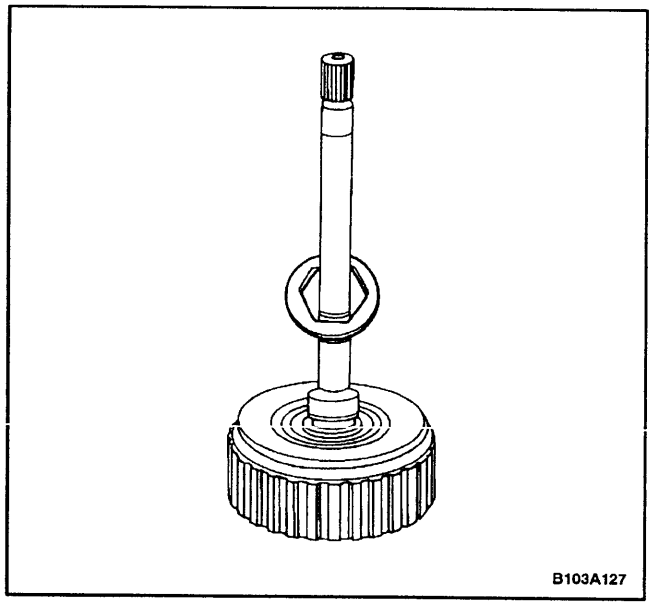
1. Push the piston E into the cylinder of the motor shaft.



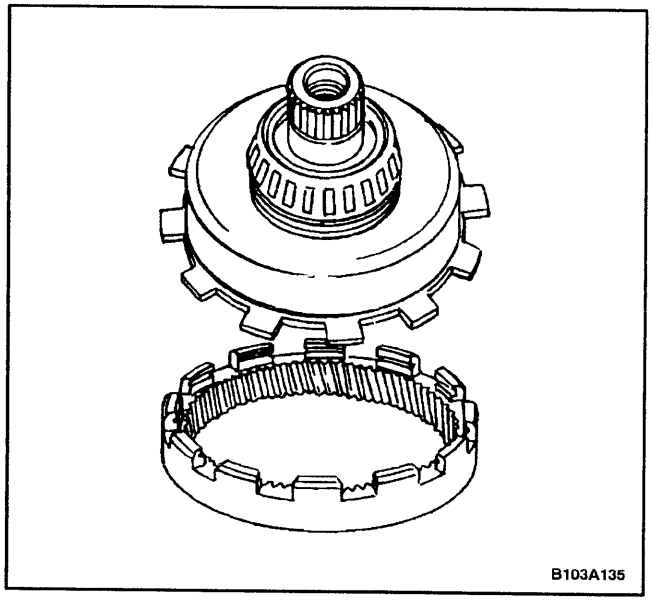
2. Compress the piston E using the bearing remover KA-001-715-04.
3. Install the retainer rings and the plate spring.


B103A134

4. Install the clutch E assembly and the snap ring.


B103A127

5. Install the thrust washer onto the motor shaft.
6. Install the clutch E assembly into the transaxle housing. Refer to "Major Component Assembly" in this section.
7. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.


B103A135

OUTPUT SHAFT AND FREEWHEEL FIRST GEAR

Tools Required

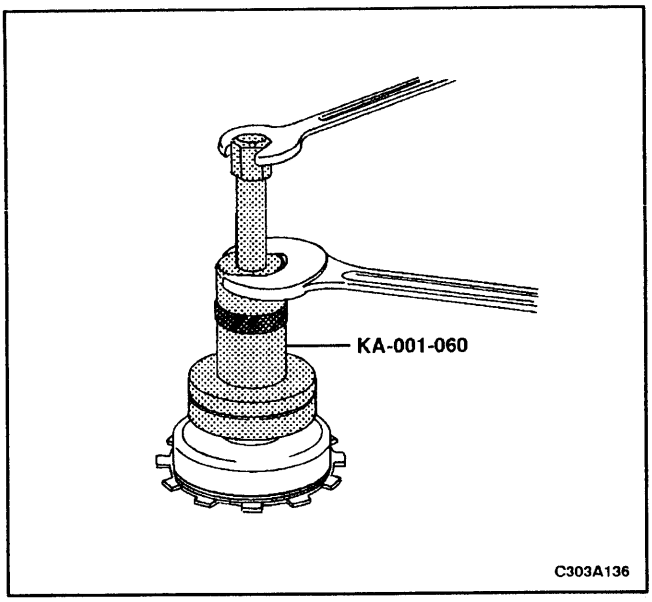
KA-001-060 Bearing Remover

KA-000-232 Bearing Remover

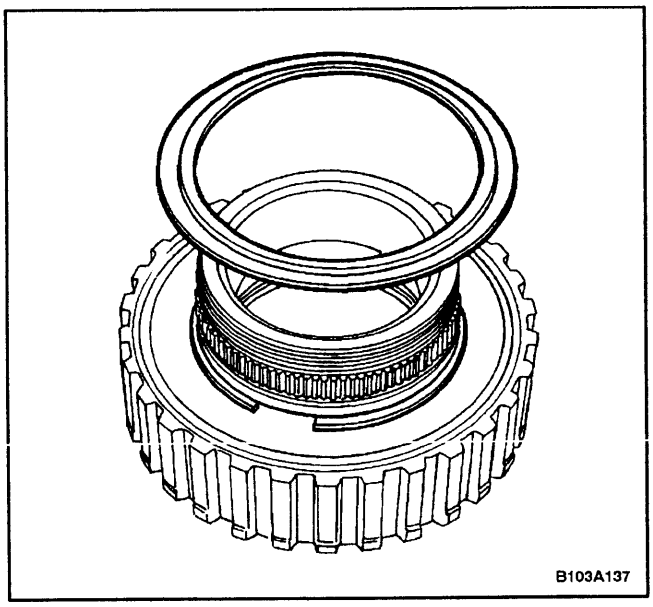
KA-000-300 Bearing Installer

Disassembly Procedure

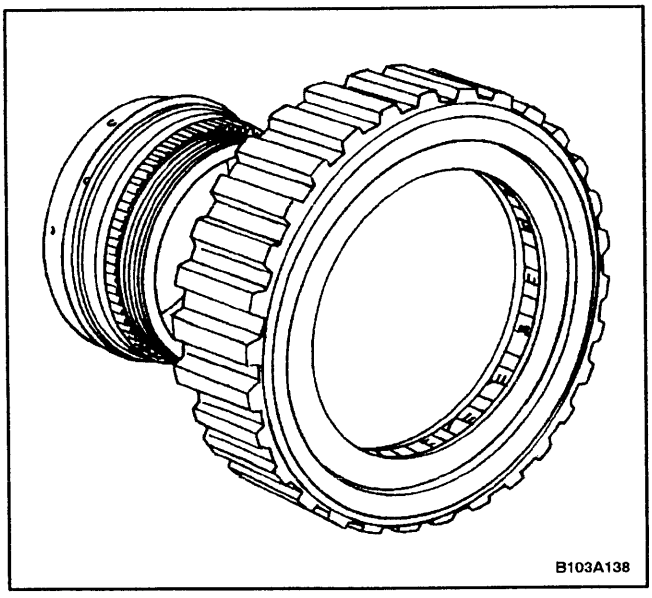
1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the output shaft and the freewheel first gear from the transaxle housing. Refer to "Major Component Disassembly" in this section.
3. Remove the output shaft snap ring.
4. Separate the output shaft and the hollow gear.



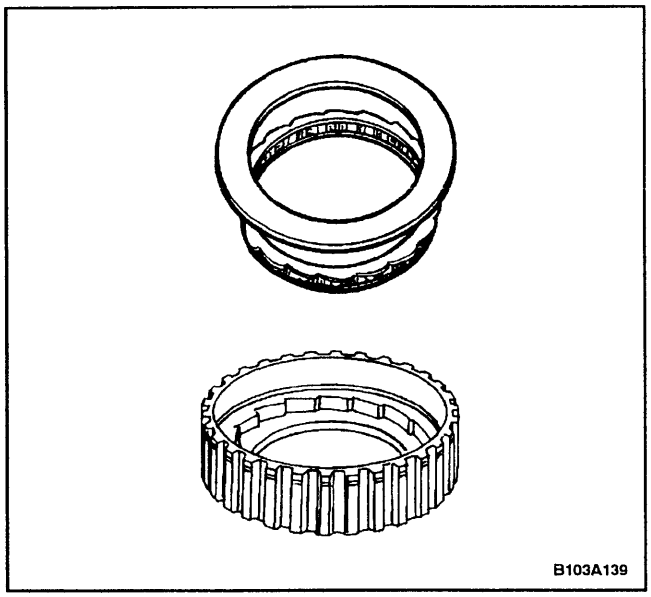
5. Remove the con bearing from the output shaft using the bearing remover KA-001-060.



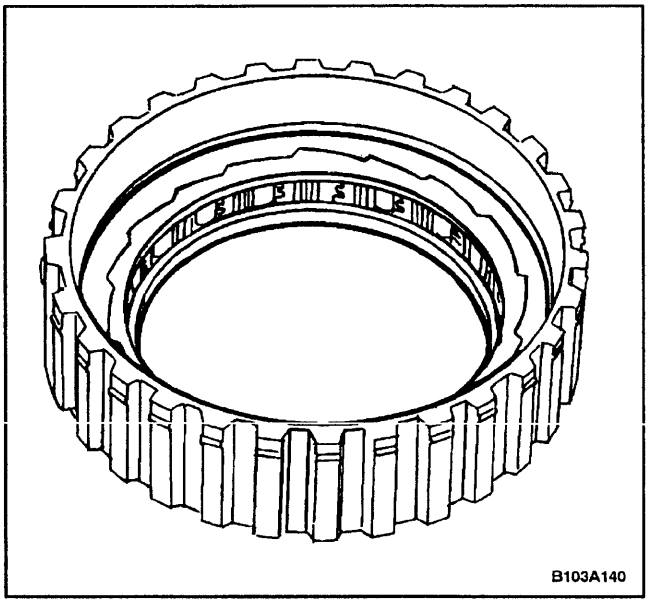
6. Remove the retainer ring and the snap ring.



7. Remove the inner freewheel ring.

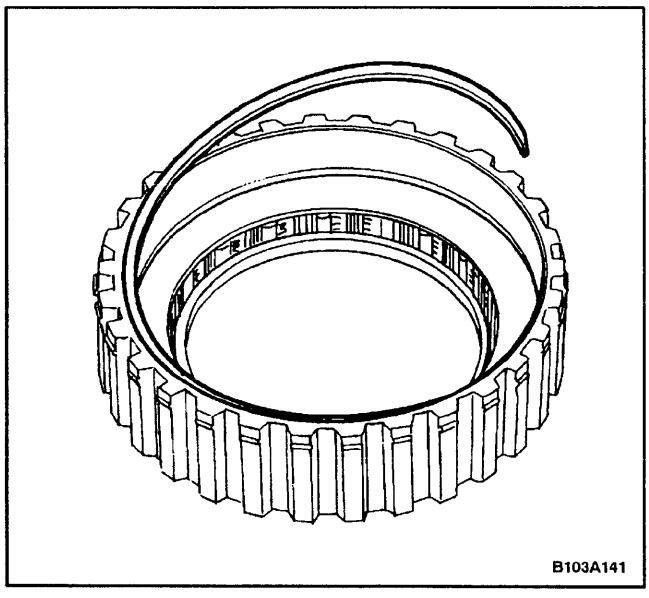

B103A139

8. Remove the snap ring from the freewheel inner ring.
9. Separate the cover plate and the freewheel cage.

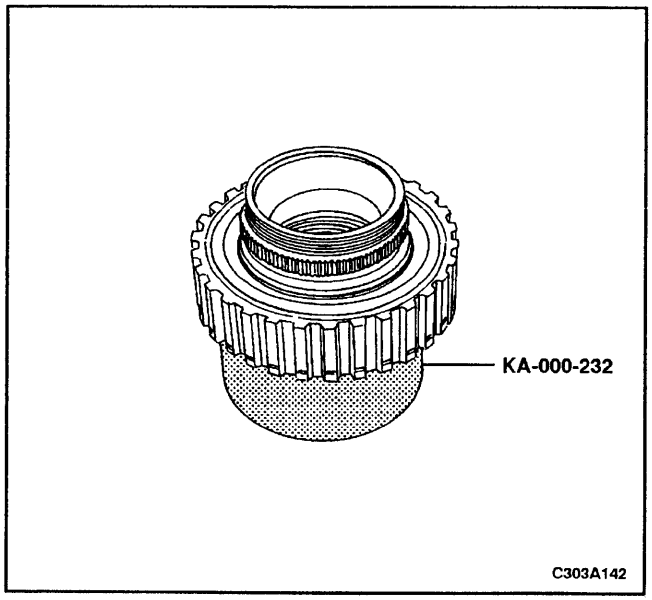

B103A140

Assembly Procedure

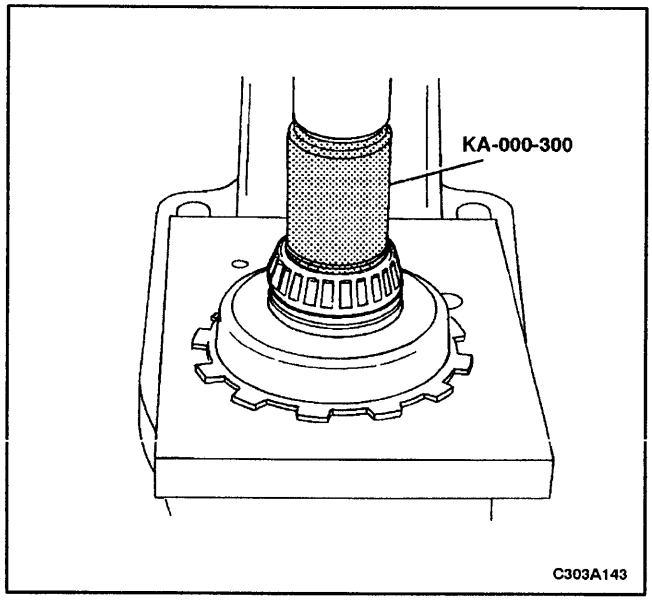
1. Insert the freewheel cage carefully into the freewheel outer ring. For correct assembly, align the teeth of the cage with the openings of the outer ring.
2. Push the freewheel cage downward.


B103A141

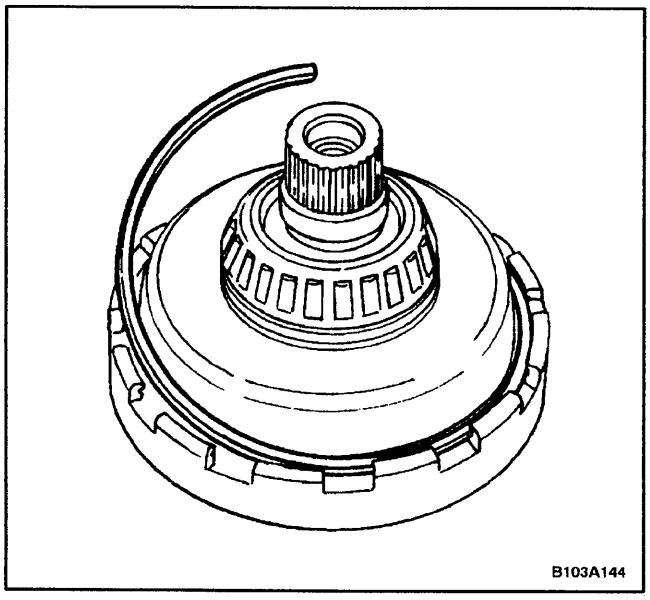
3. Install the freewheel inner ring snap ring.



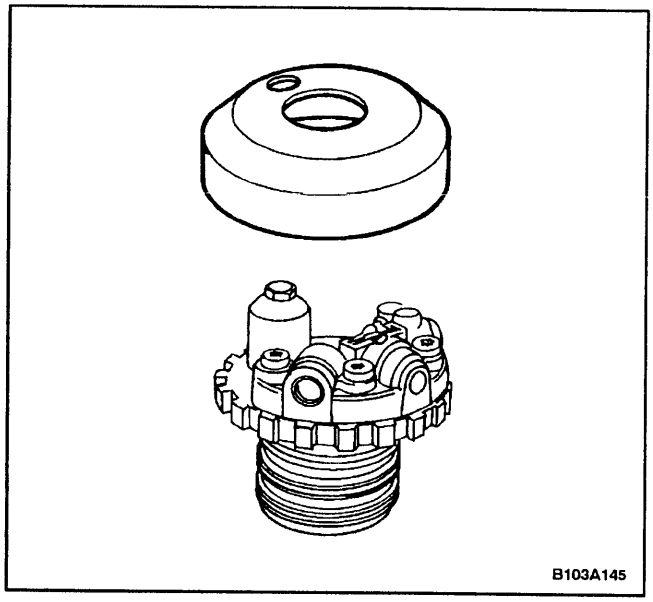
4. Install the bearing ring into the freewheel inner ring and push down to the STOP point.
5. Place the freewheel assembly on the bearing remover KA-000-232 and install the snap ring and the retainer ring.



6. Install the con bearing onto the output shaft using the bearing installer KA-000-300.



7. Join the output shaft and the hollow gear.
8. Install the output shaft snap ring.
9. Install the output shaft and the freewheel first gear into the transaxle housing. Refer to "Major Component Assembly" in this section.
10. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.


B103A145

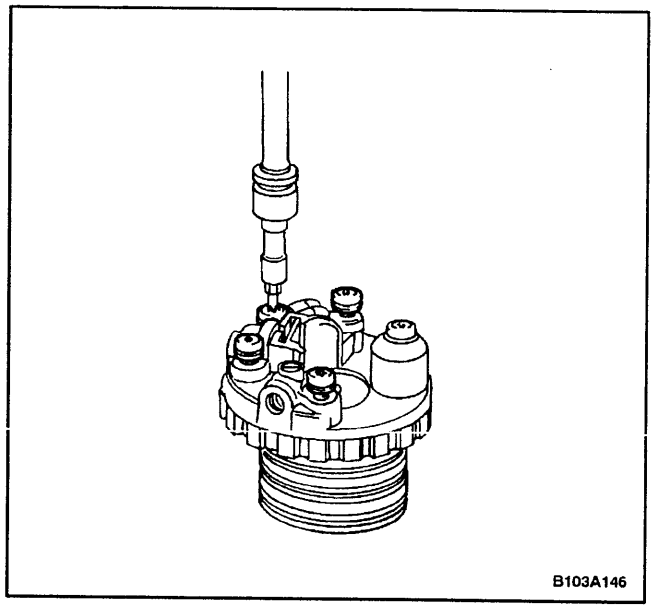
SIDE SHAFT AND GOVERNOR

Tools Required

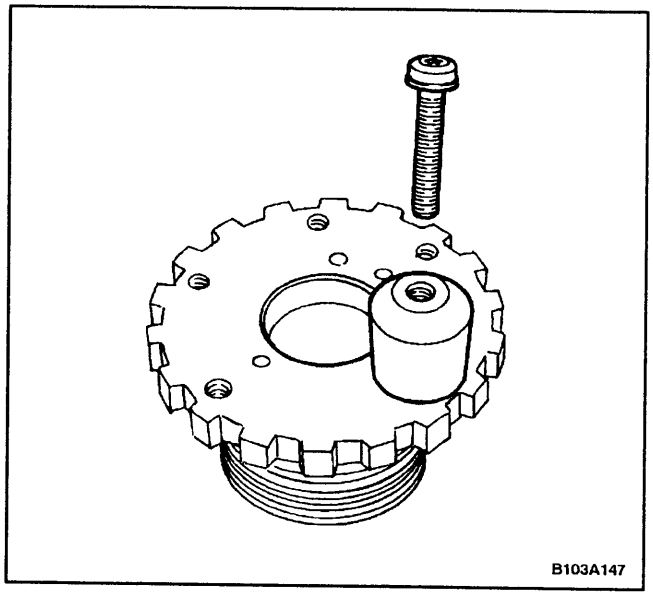
KA-000-232 Bearing Remover

Disassembly Procedure

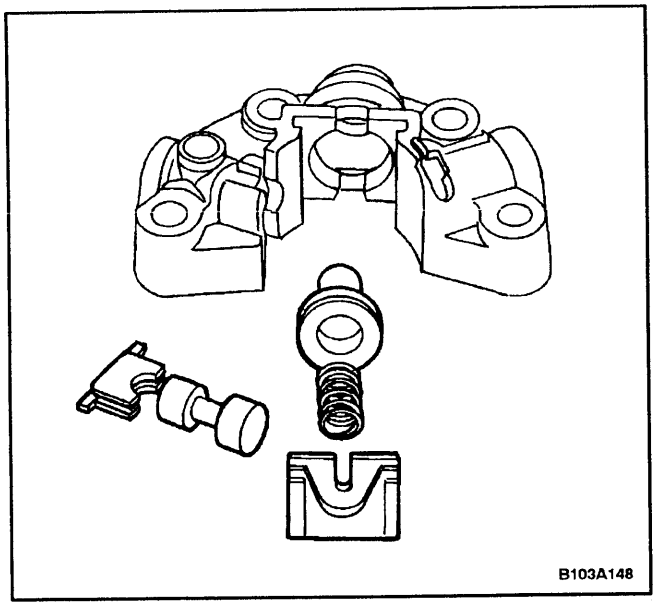
1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the side shaft and the governor assembly from the transaxle housing. Refer to "Major Component Disassembly" in this section.
3. Remove the governor screen sheet.


B103A146

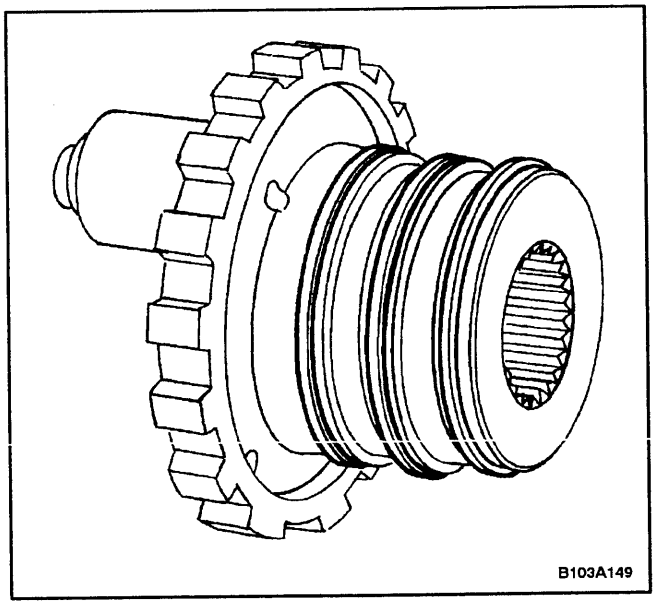
4. Remove the governor housing bolts and the governor housing.


B103A147

5. Remove the governor counterweight bolt and counterweight.

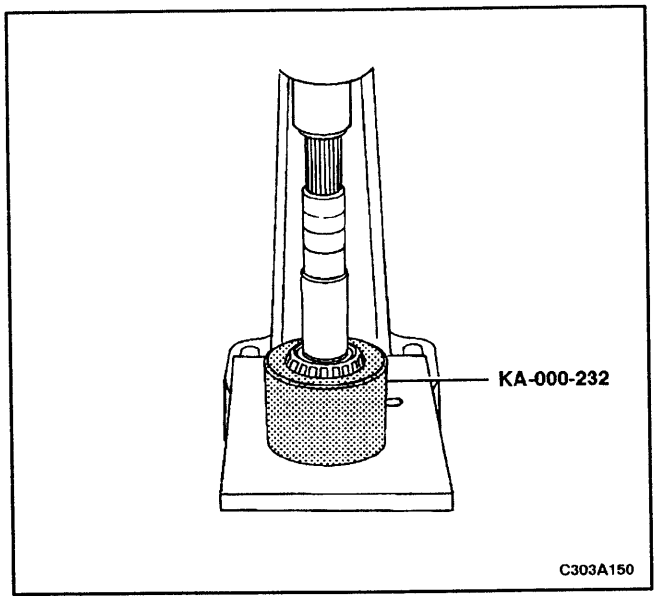

B103A148

6. Remove the stage one push piston and the stage two spring and the piston.


B103A149

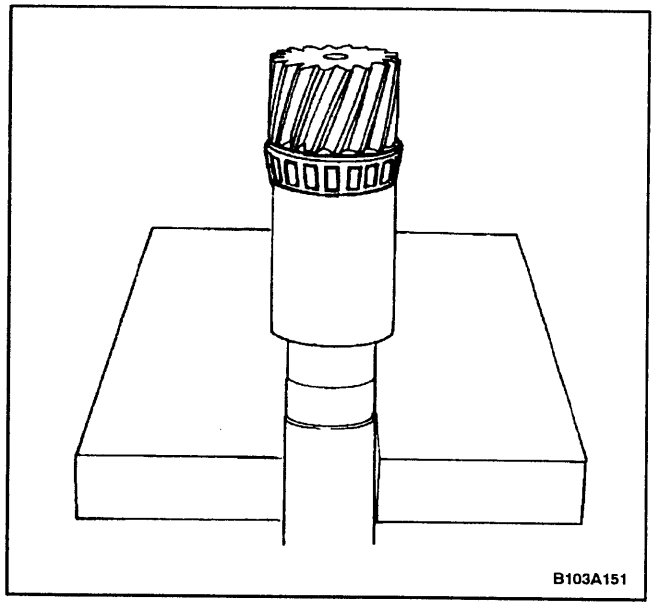
Notice: Inspect the governor housing for damage and replace it if it is damaged.

7. Replace the piston ring and the sealing rings on the governor flange as needed.



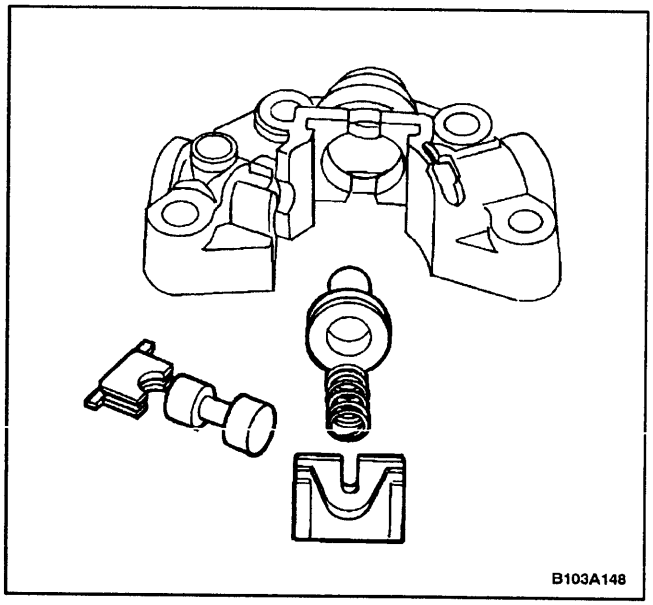
C303A150

8. Remove the con bearing from the side shaft using the bearing remover KA-000-232.

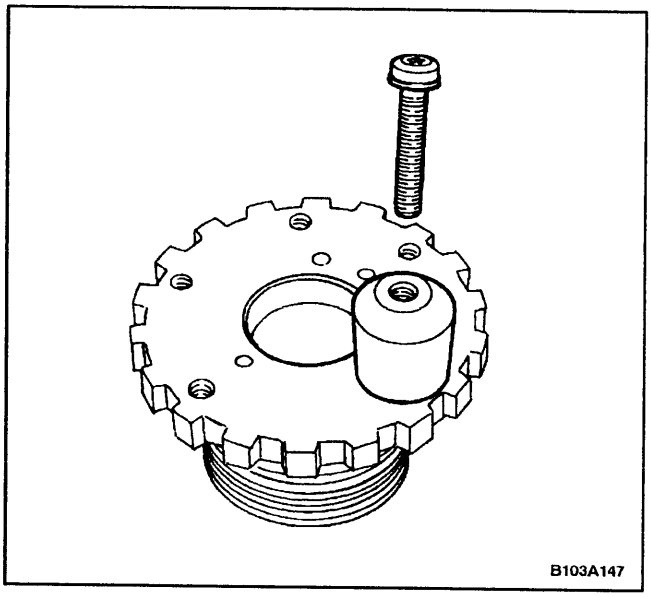

B103A151

Assembly Procedure

1. Press the con bearing onto the side shaft using an arbor press and a 44.5 mm (1.75 inch) outside diameter steel tube with a wall thickness of 3.2 mm (0.13 inch) or a schedule 40 steel pipe, 32 mm (1.3 inch) nominal size.


B103A148

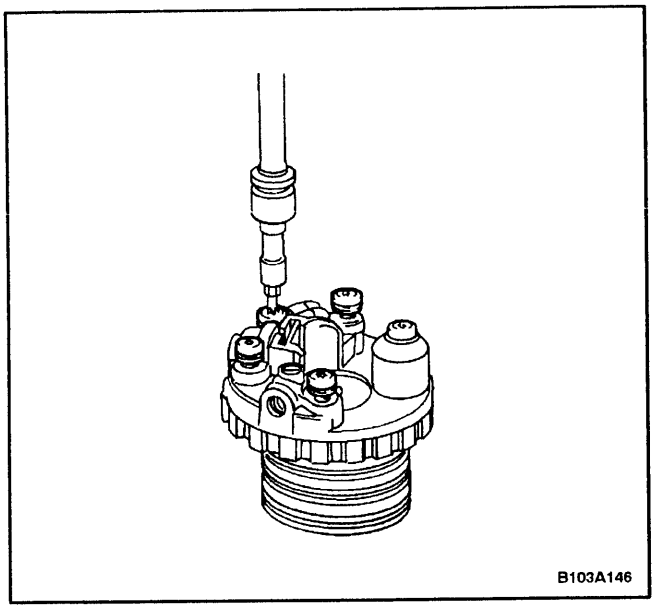
2. Install the stage two spring and the piston and the stage one push piston.


B103A147

3. Install the governor counterweight and the counterweight bolt.

Tighten

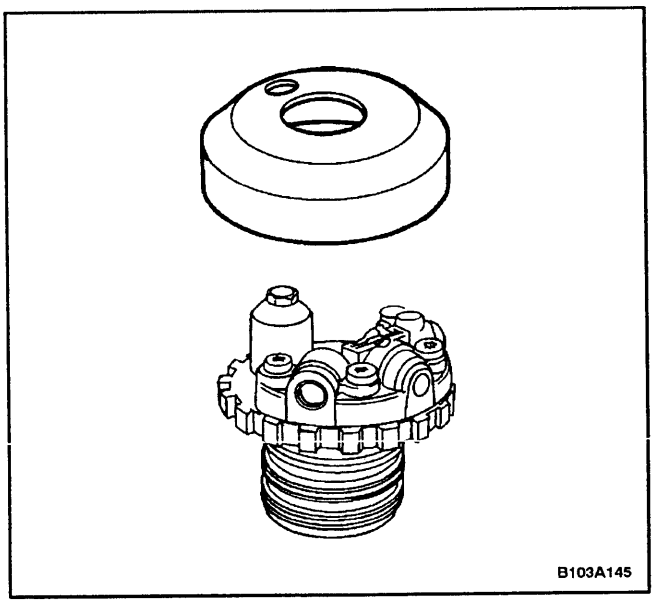
Tighten the counterweight bolt to 10 N•m (89 lb-in).


B103A146

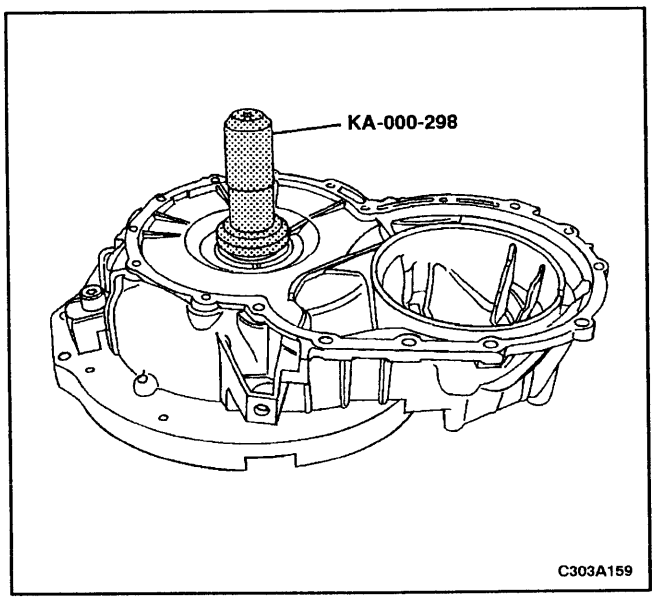
4. Install the governor housing and the governor housing bolts.

Tighten

Tighten the governor housing bolts to 10 N•m (89 lb-in).


B103A145

5. Install the governor screen sheet.
6. Install the side shaft and the governor assembly from the transaxle housing. Refer to "Major Component Assembly" in this section.
7. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.



C303A159

HOUSING

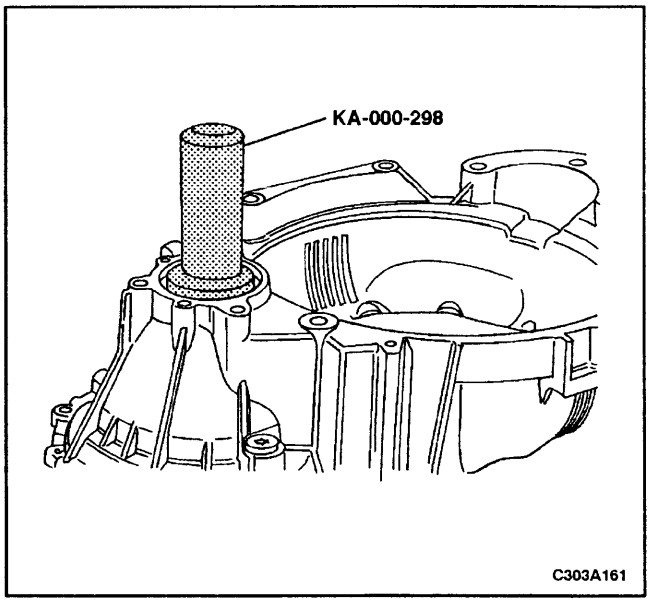
Tools Required

KA-002-111 Bearing Race Installer

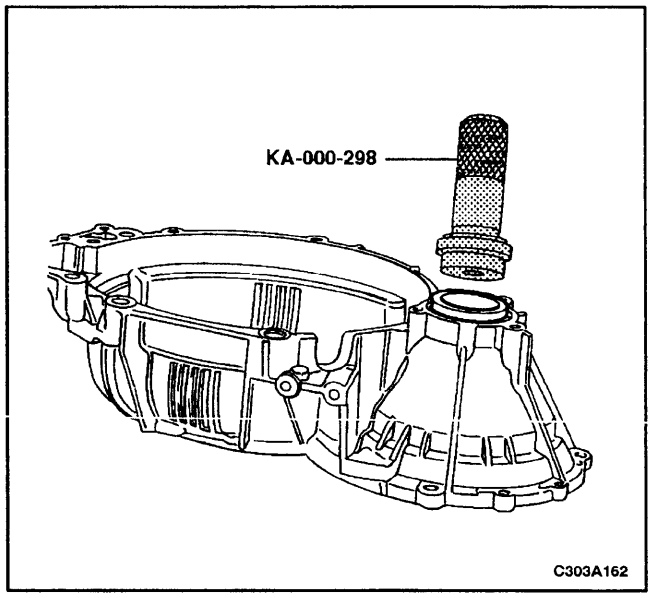
KA-000-298 Bearing Ring Remover/Installer

Disassembly Procedure

1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the bell housing from the transaxle. Refer to "Major Component Disassembly" in this section.
3. Remove the seal ring from the bell housing using the bearing ring remover/installer KA-000-298.

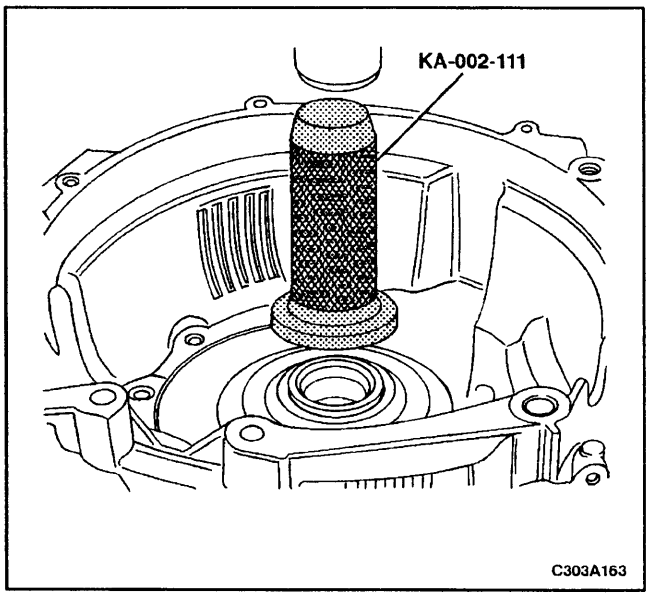


4. Remove the extension housing. Refer to "Case Extension Housing" in this section.
5. Remove the outer ring of the con bearing in the differential area of the housing using the bearing ring remover/installer KA-000-298.

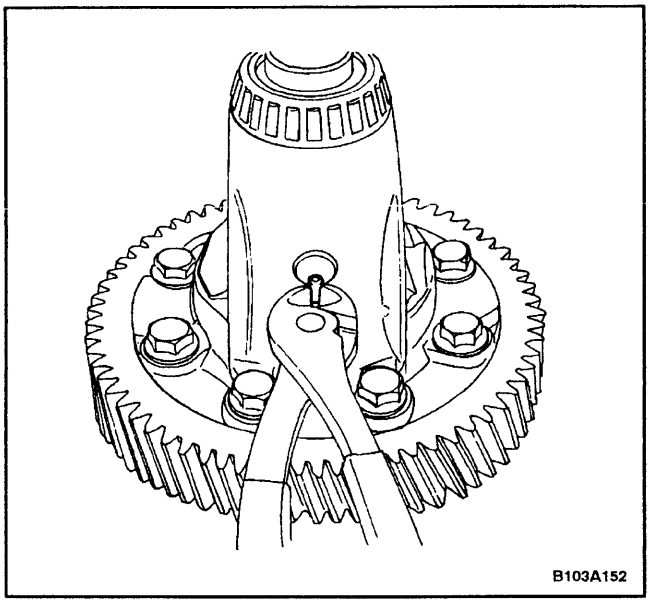


Assembly Procedure

1. Install the outer ring of the con bearing in the differential area of the housing using the bearing ring remover/installer KA-000-298.



2. Install the extension housing. Refer to "Case Extension Housing" in this section.
3. Install the outer ring of the con bearing using the bearing race installer KA-002-111.
4. Install the bell housing into the transaxle. Refer to "Major Component Assembly" in this section.
5. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.


B103A152

DIFFERENTIAL

Tools Required

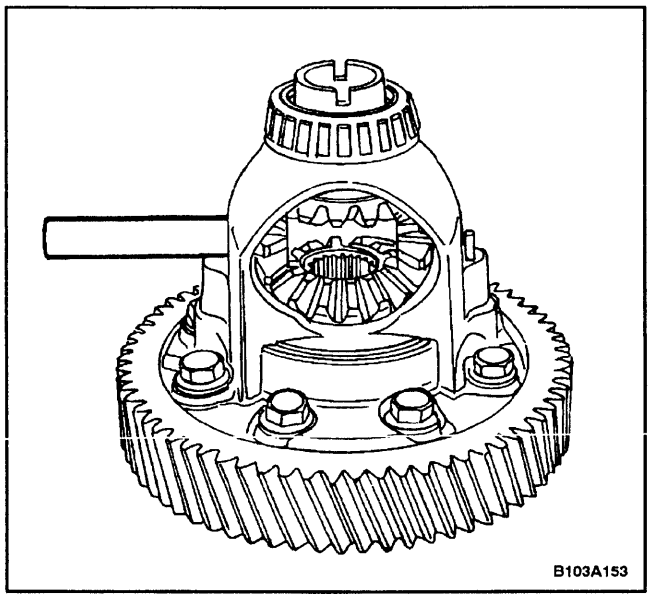
KA-001-060 Bearing Remover

KA-000-299 Seal Ring Installer

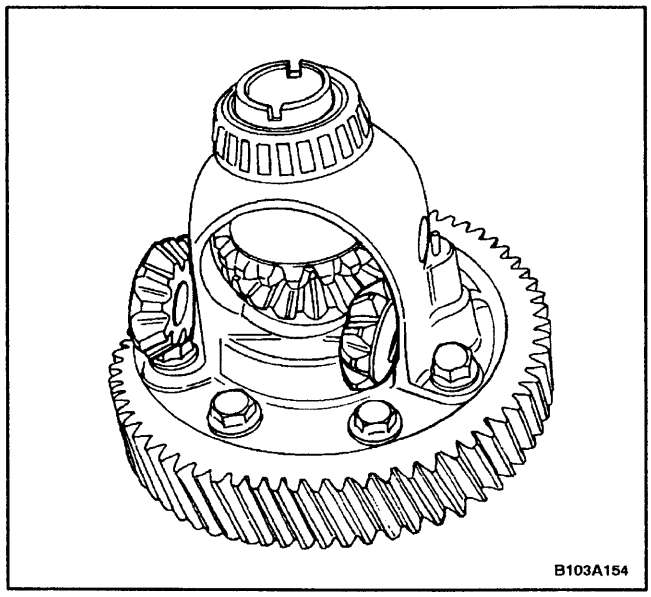
KA-000-300 Bearing Installer

Disassembly Procedure

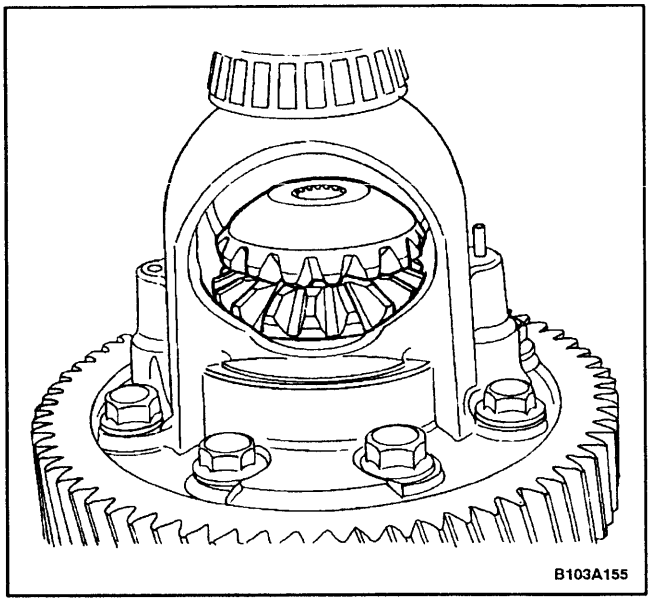
1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the differential from the transaxle. Refer to "Major Component Disassembly" in this section.
3. Remove a roll pin from one side of the differential.


B103A153

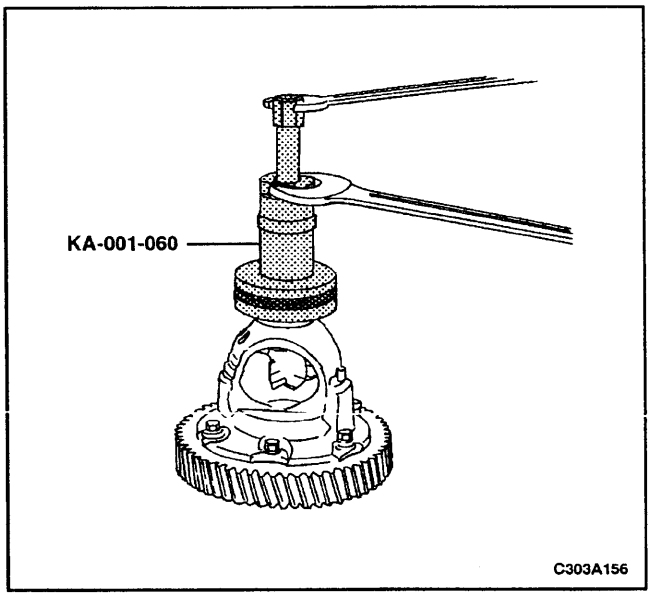
4. Remove the differential push pin.


B103A154

5. Remove the bevel side gears.

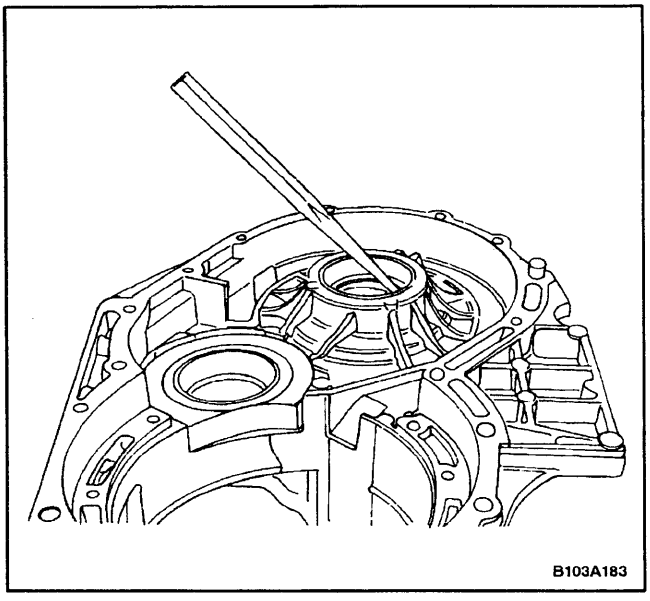

B103A155

6. Remove the bevel upper gear and the bevel lower gear.

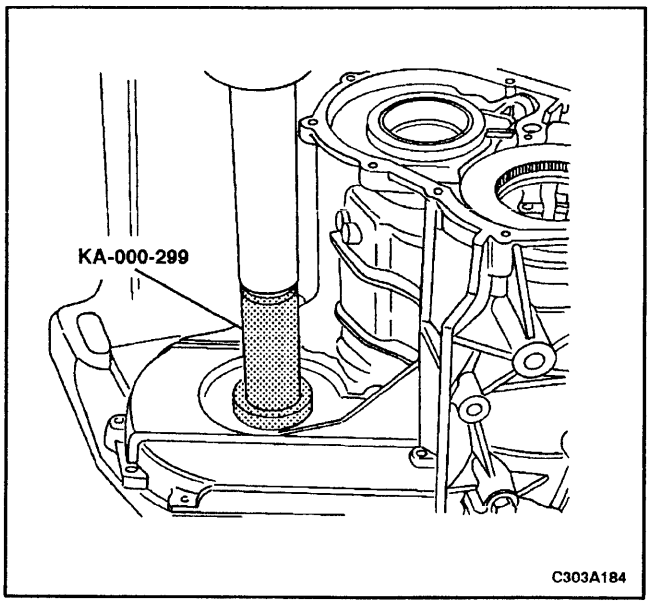


C303A156

7. Remove the upper tapered roller bearing using the bearing remover KA-001-060.

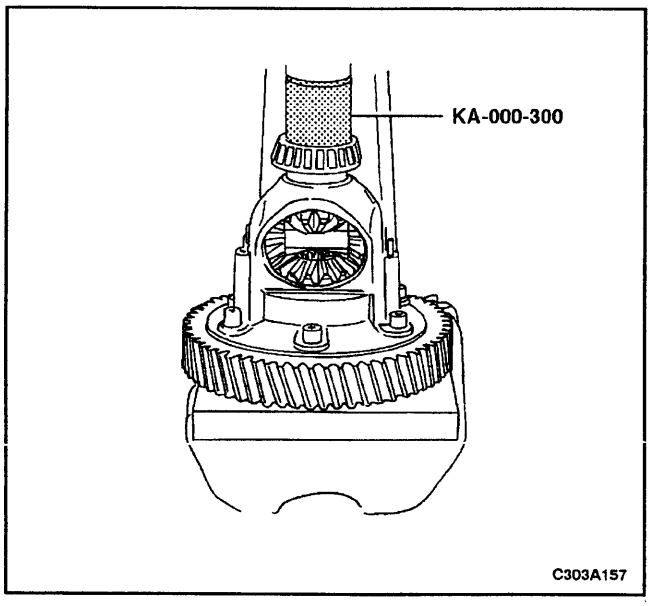

B103A183

8. Remove the housing seal ring in the differential area.

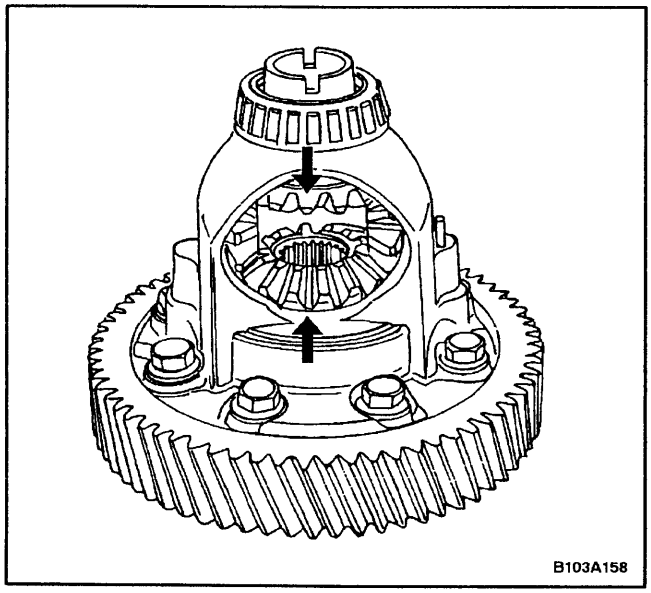


Assembly Procedure

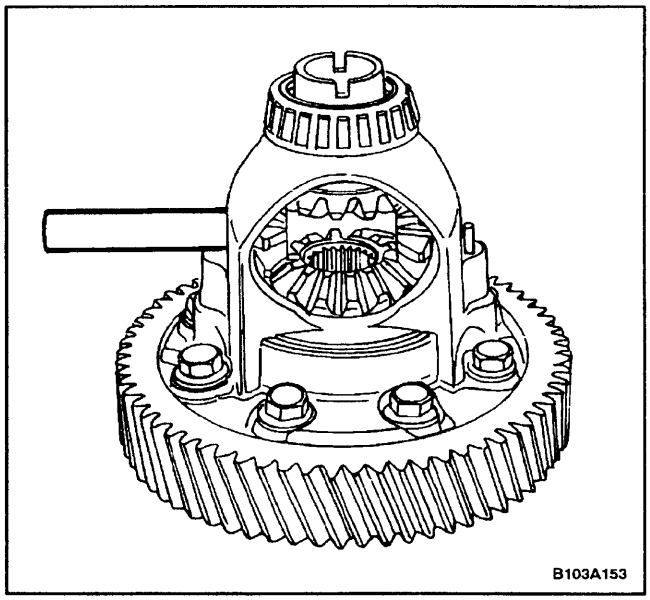
1. Install the housing seal ring in the differential area using the seal ring installer KA-000-299.



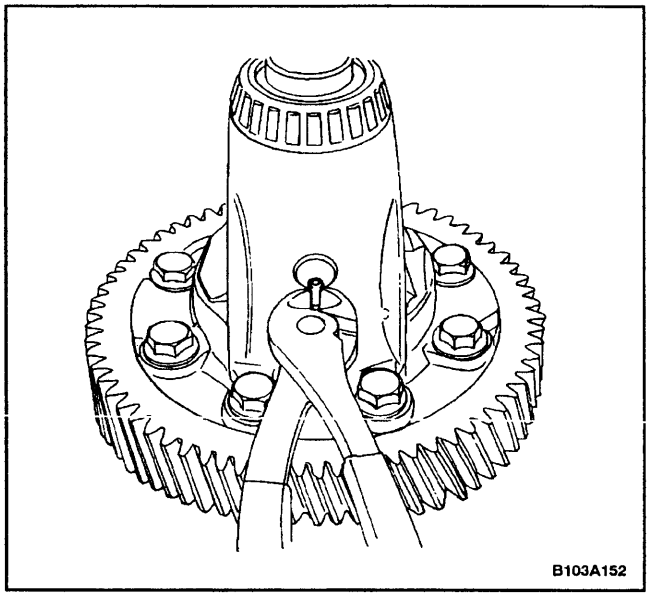
2. Install the upper tapered roller bearing using the bearing installer KA-000-300.



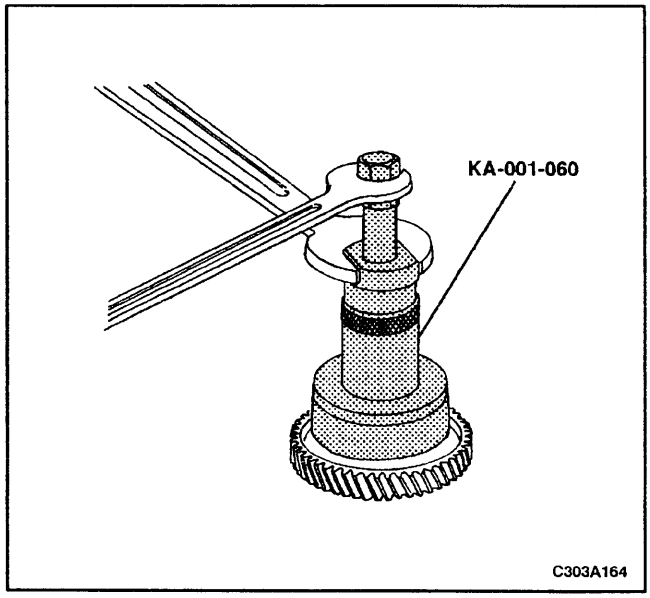
3. Install the upper, the lower, and the side bevel gears. The teeth of the upper gear must align with the spaces in the lower gear in order to install the side, the upper, and the lower bevel gears properly.


B103A153

4. Install the differential push pin.


B103A152

5. Install the roll pin.
6. Install the differential into the transaxle. Refer to "Major Component Assembly" in this section.
7. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.



C303A164

SMALL SPUR GEAR

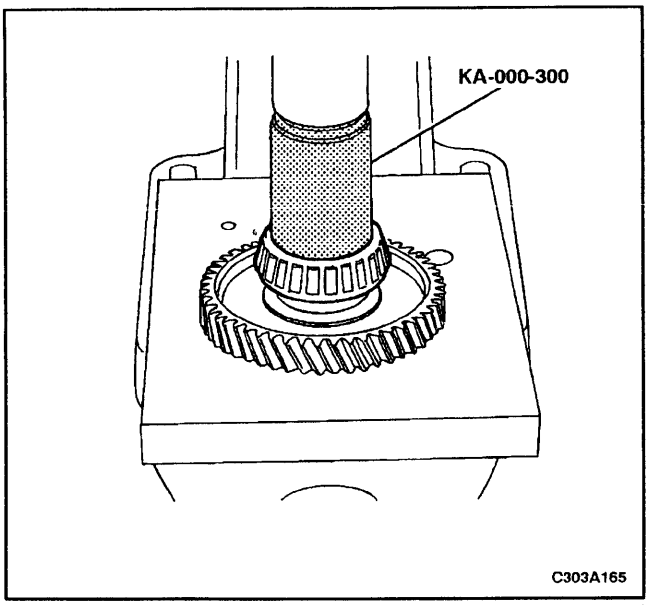
Tools Required

KA-001-060 Bearing Remover

KA-000-300 Bearing Installer

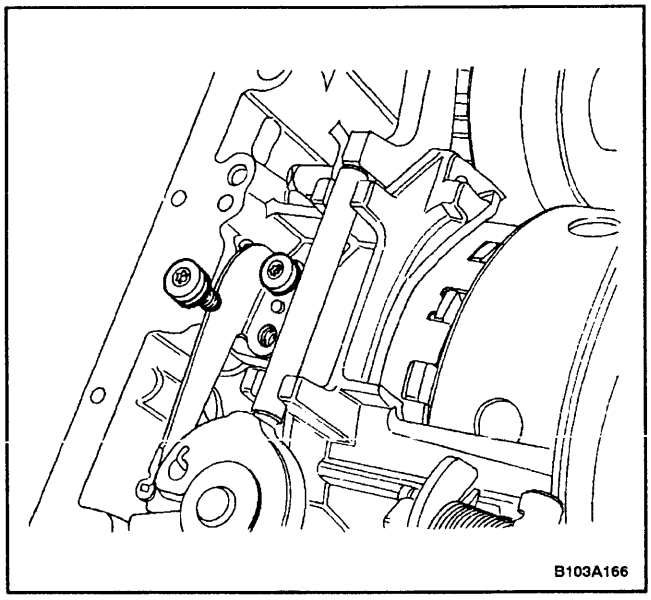
Disassembly Procedure

1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the small spur gear from the transaxle. Refer to "Major Component Disassembly" in this section.
3. Remove the con bearing from the small spur gear using the bearing remover KA-001-060.



Assembly Procedure

1. Install the con bearing onto the small spur gear using the bearing installer KA-000-300.
2. Install the small spur gear into the transaxle. Refer to "Major Component Assembly" in this section.
3. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.



PARK SYSTEM COMPONENTS

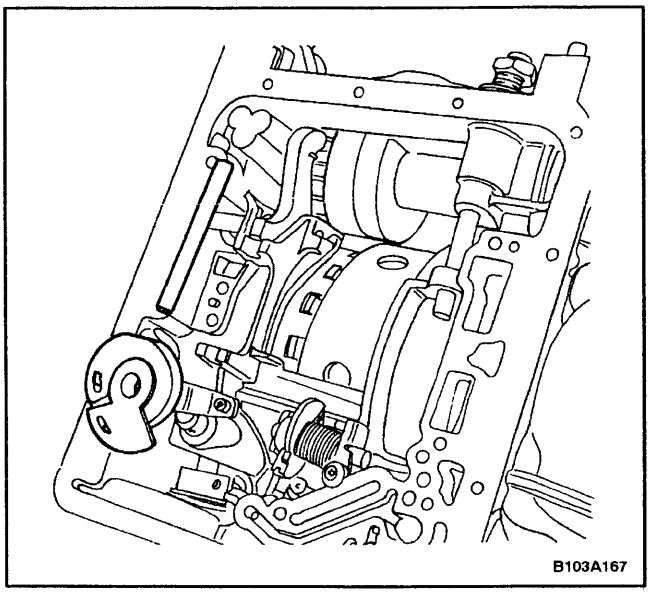
Tools Required

KA-000-187 Seal Ring Punch

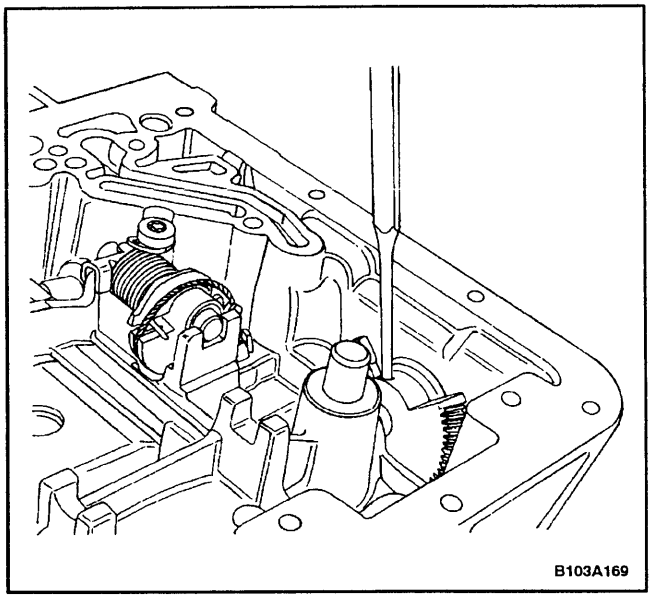
KA-000-287 Securing Device

Disassembly Procedure

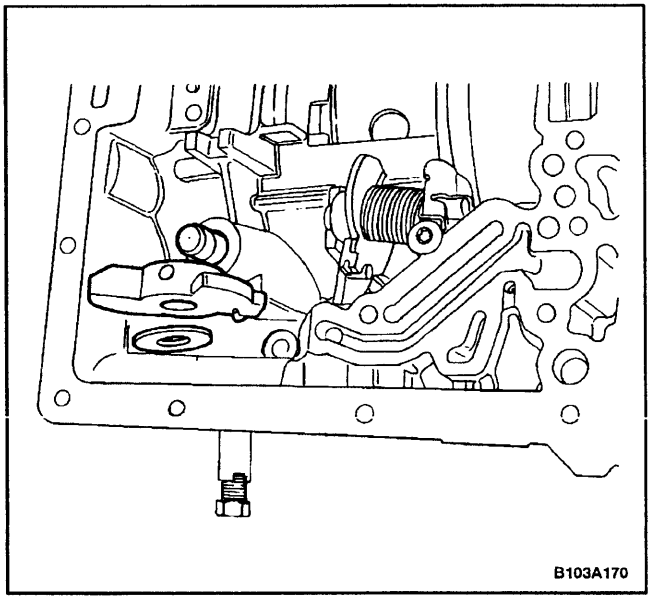
1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the fluid pan cover and the gasket. Refer to "Pan and Gasket" in this section.
3. Remove the valve body. Refer to "Valve Body" in this section.
4. Remove the side cover and the gasket. Refer to "Case Side Cover Pan and Gasket" in this section.
5. Remove the detent screws that secure the spring plate.



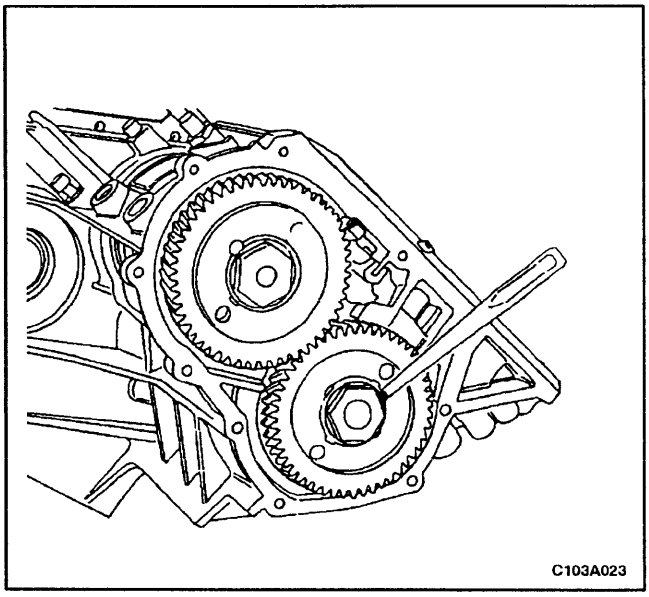
6. Remove the connecting rod and the PARK cam.



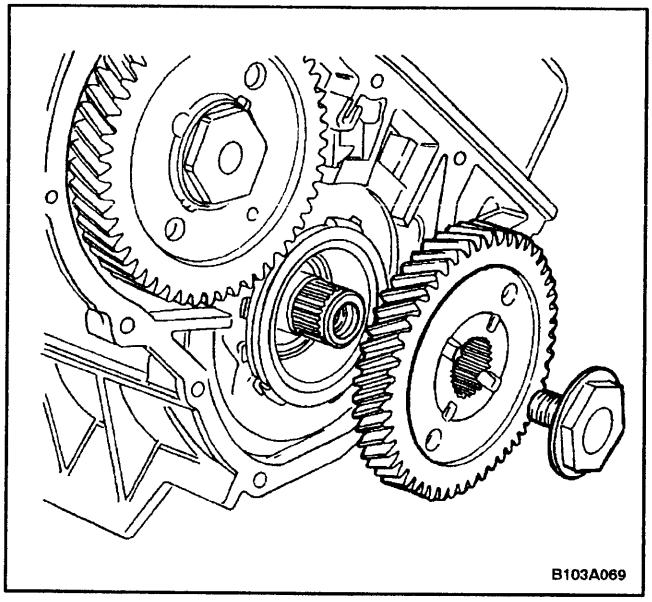
7. Remove the selector shaft roll pin.



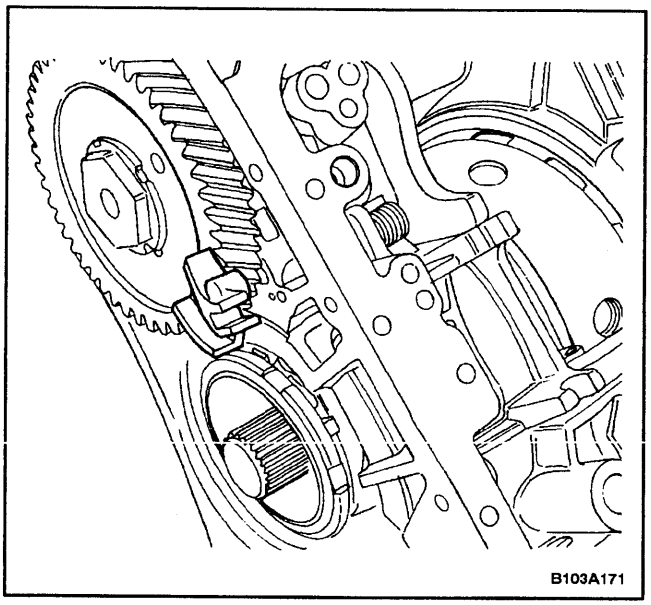
8. Remove the selector shaft, the selector shaft cam, the adjustment washer, and the cam pin.



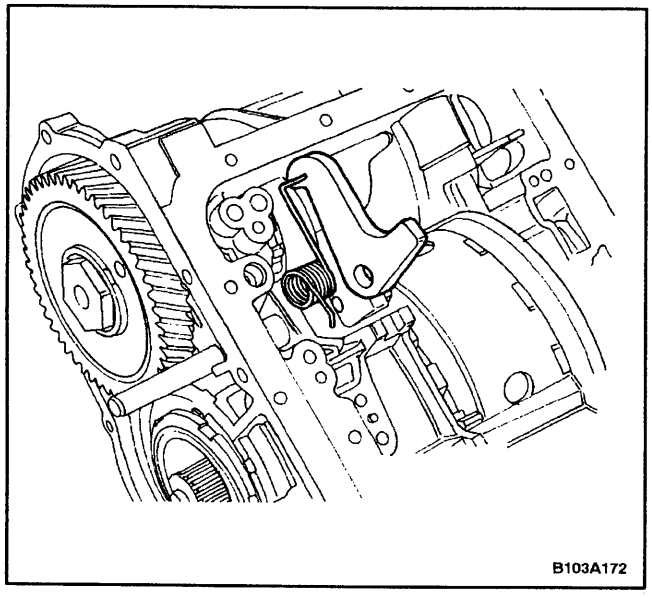
9. Bend the locking tabs on the small spur gear securing nut.



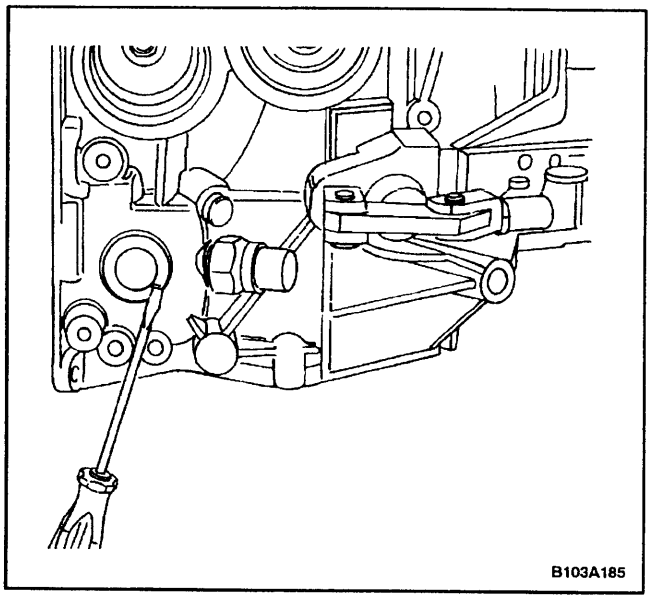
10. Remove the securing bolt on the smaller spur gear and remove the small spur gear.



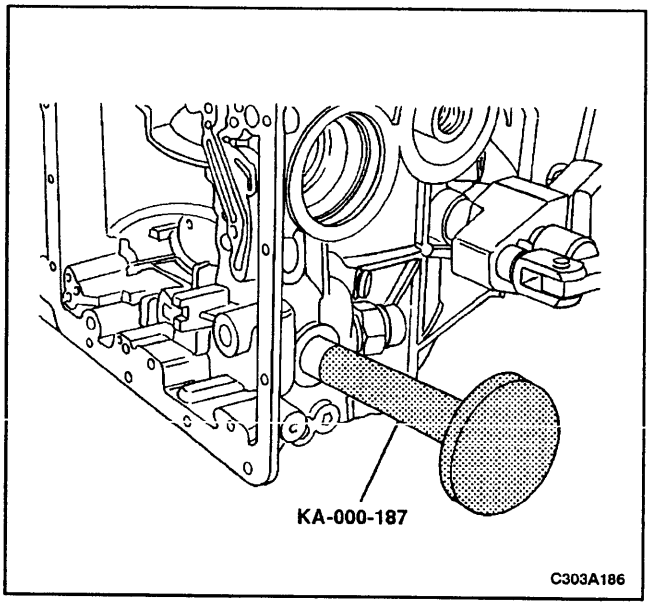
11. Remove the plastic holding fixture.



12. Push the PARK pawl pin out of the housing and remove the BRAKE pawl along with the leg spring.


B103A185

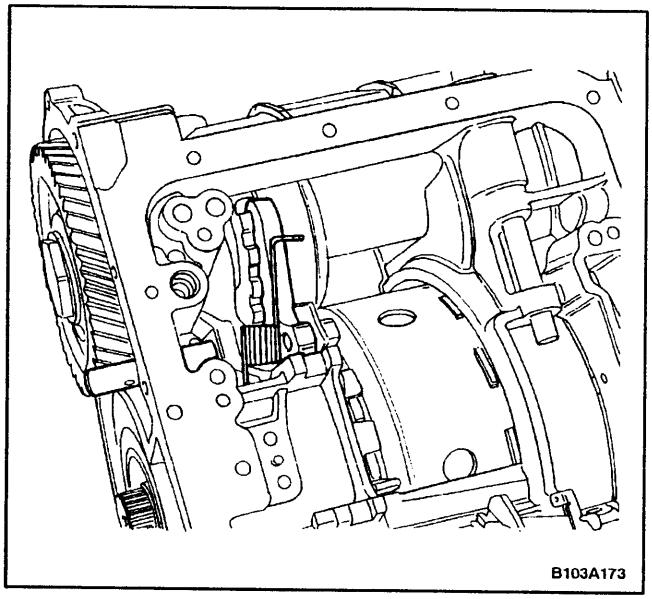
13. Remove the selector shaft seal ring.



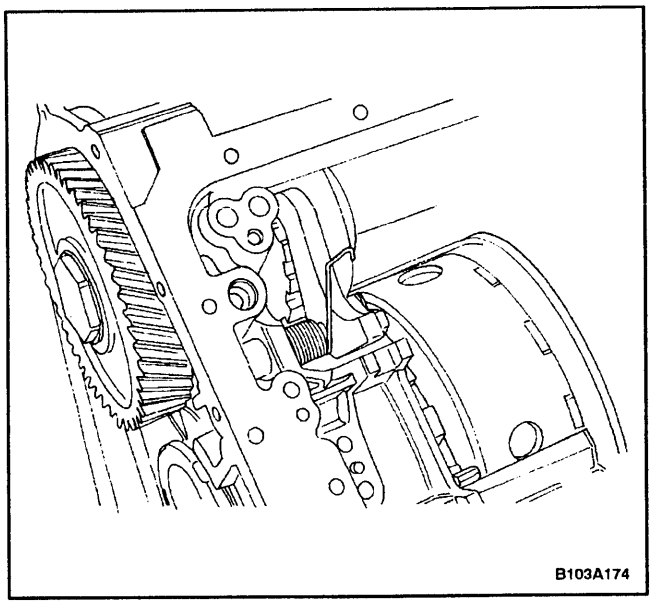
C303A186

Assembly Procedure

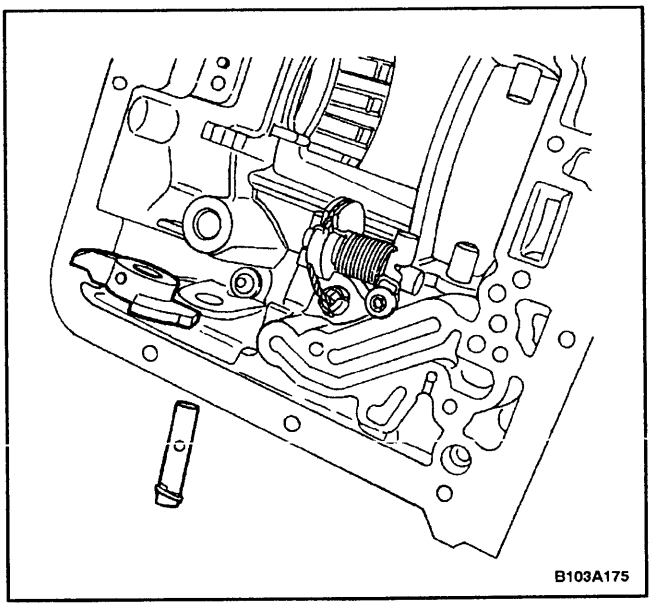
1. Install the selector shaft seal ring using the seal ring punch KA-000-187.


B103A173

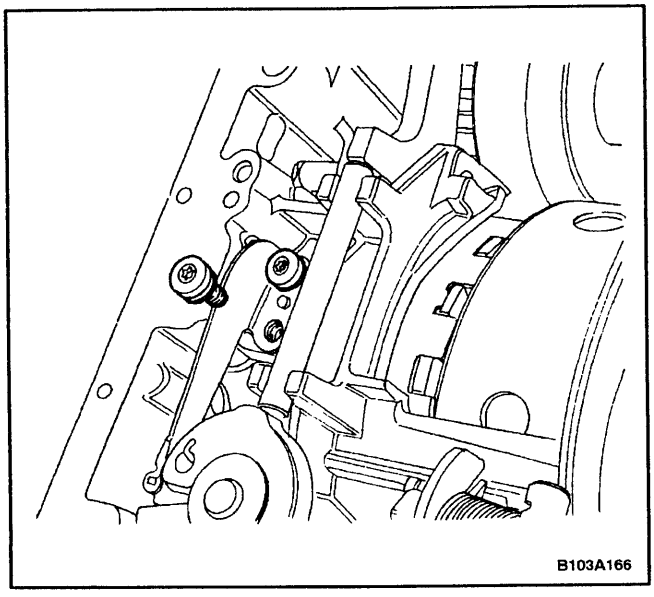
2. Insert the PARK pawl pin approximately half of the way into the transmission case in order to install the leg spring and the PARK pawl.


B103A174

3. Push the shaft to the STOP point and place the leg spring under the PARK pawl.


B103A175

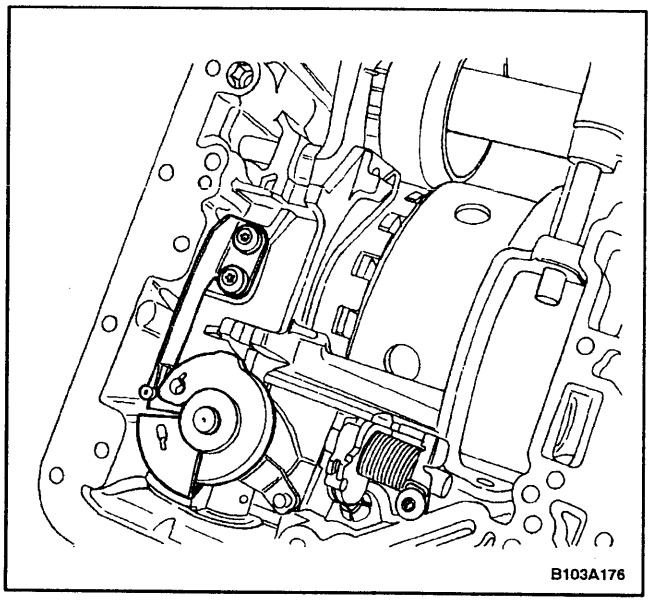
4. Insert the selector shaft half of the way into the transmission case, fit the selector shaft cam onto the shaft, and push the selector shaft to the STOP point.


B103A166

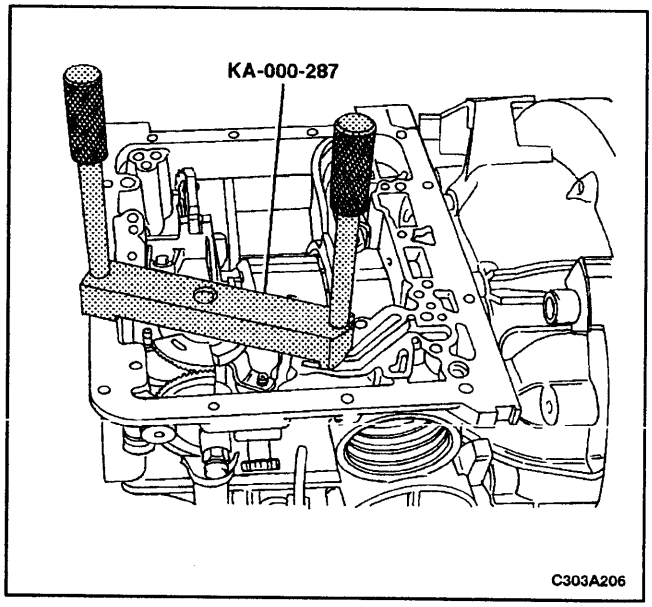
5. Install the spring plate into the housing and secure the spring plate with the detent screws.

Tighten

Tighten the spring plate detent screws to 10 N•m (89 lb-in).

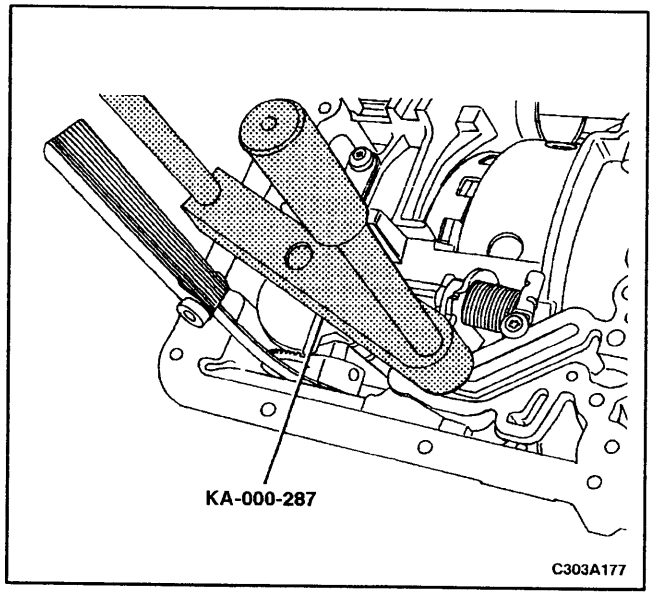

B103A176

6. Install the PARK cam onto the cam pin and connect the spring plate.



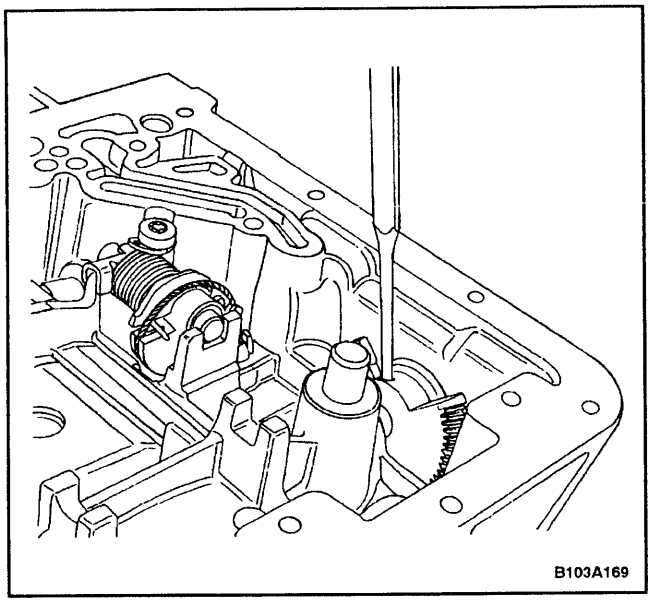
C303A206

7. Push the selector shaft cam up against the PARK cam as tightly as possible. Secure the PARK cam with the securing device KA-000-287.

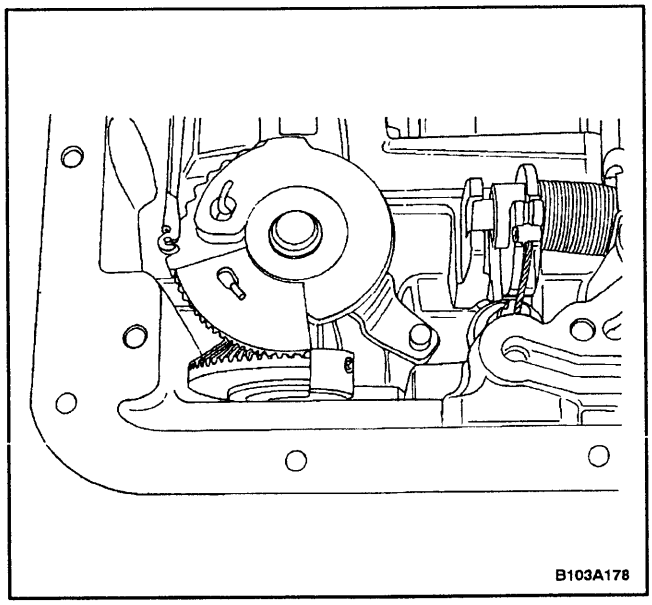


C303A177

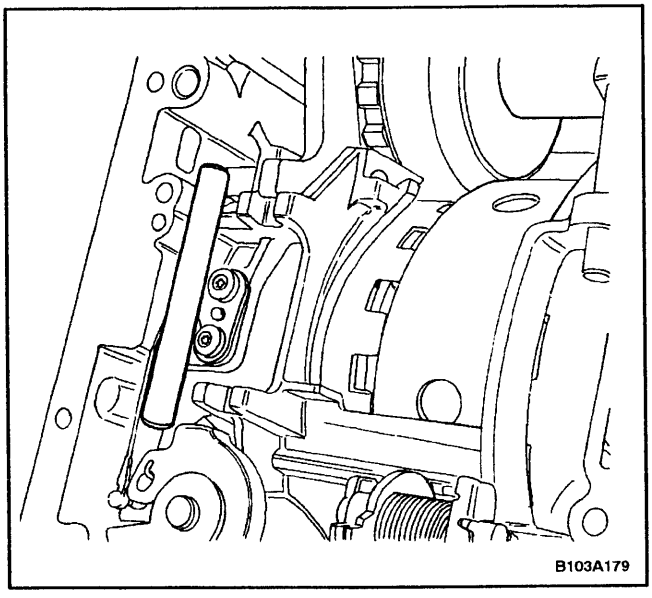
8. Measure the clearance between the selector shaft cam and the transaxle case with a gauge. Determine the size washer to fit into this clearance by subtracting 0.10 mm (0.39 inch) from the clearance measurement.


B103A169

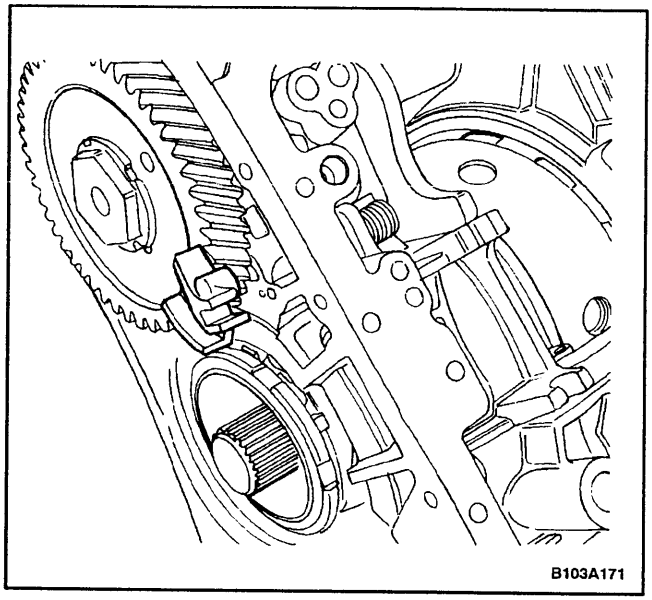
9. Remove the spring plate and pull out the selector shaft as far as needed to insert the washer between the selector shaft cam and the transmission case.
10. Once the selector shaft is back in place, install the roll pin.


B103A178

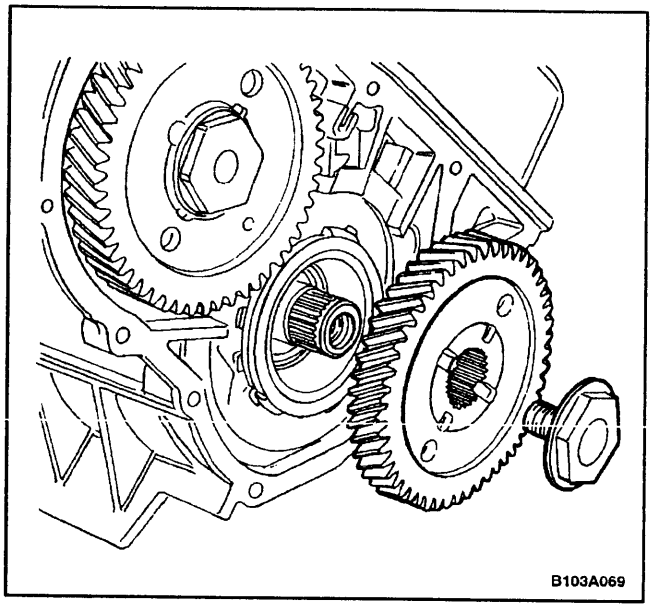
11. The teeth of the PARK cam and the selector shaft cam must be aligned properly.


B103A179

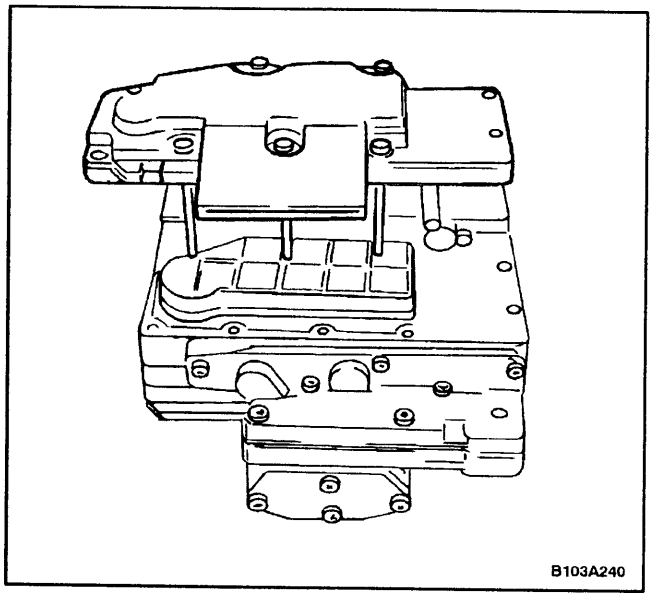
12. Install the connecting rod.


B103A171

13. Install the plastic holding fixture.


B103A069

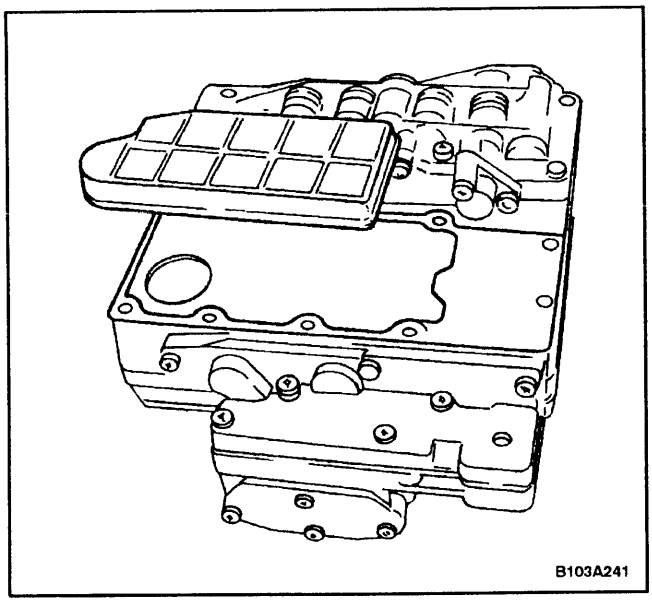
14. Install the small spur gear. Install the securing bolt onto the smaller spur gear.
15. Adjust the clearance on the output shaft. Refer to "Major Component Assembly" in this section.
16. Install the side cover gasket and the side cover. Refer to "Case Side Cover Pan and Gasket" in this section.
17. Install the valve body. Refer to "Valve Body" in this section.
18. Install the fluid pan cover gasket and the fluid pan cover. Refer to "Pan and Gasket" in this section.
19. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.


B103A240

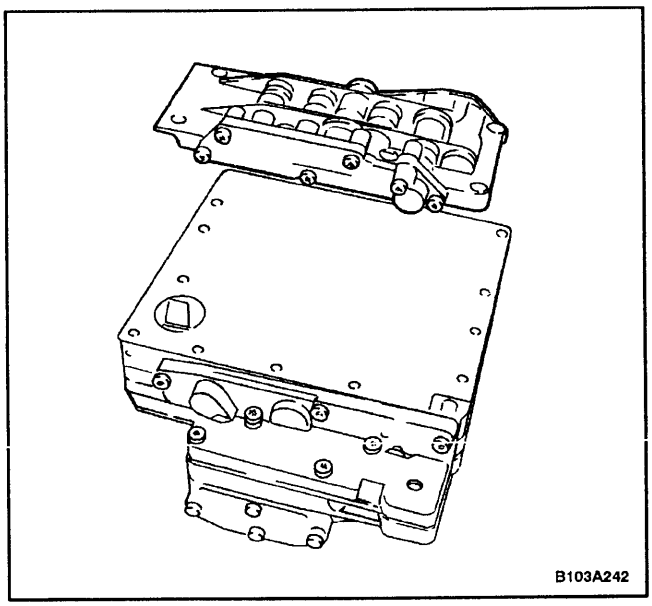
VALVE BODY

Disassembly Procedure

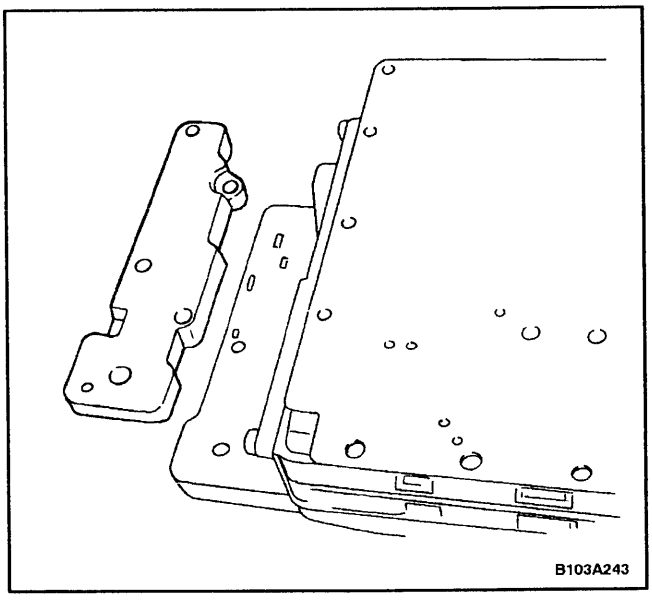
1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the valve body from the transaxle. Refer to "Major Component Disassembly" in this section.
3. Remove the fluid filter housing.



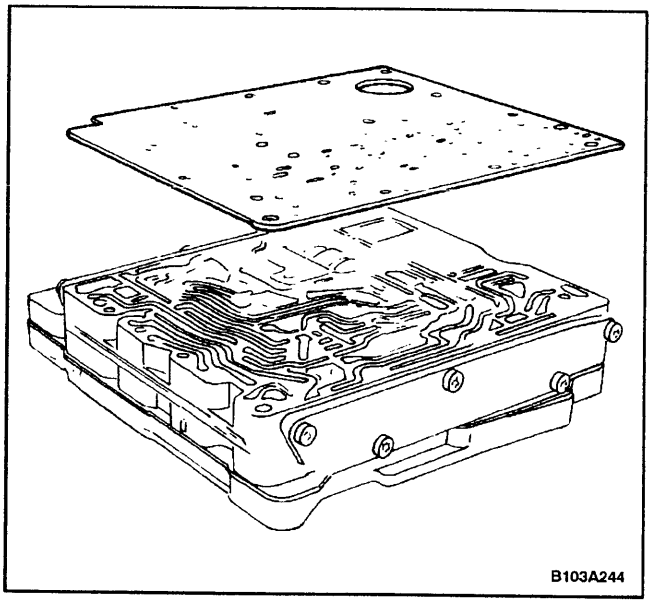
4. Remove the fluid filter and the gasket.



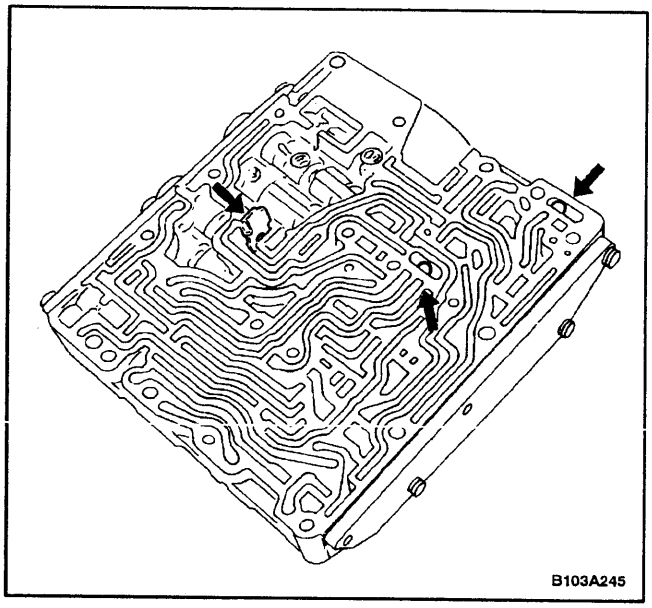
5. Remove the lower valve housing bolts and remove the lower valve housing.



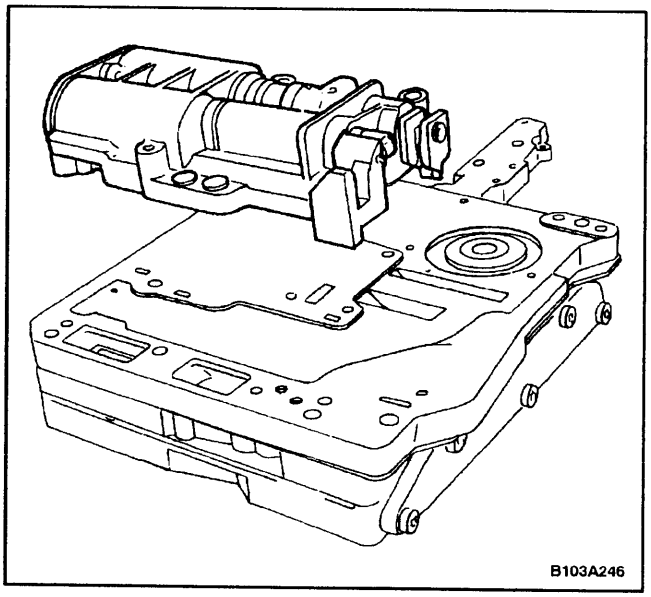
6. Remove the lower cover.



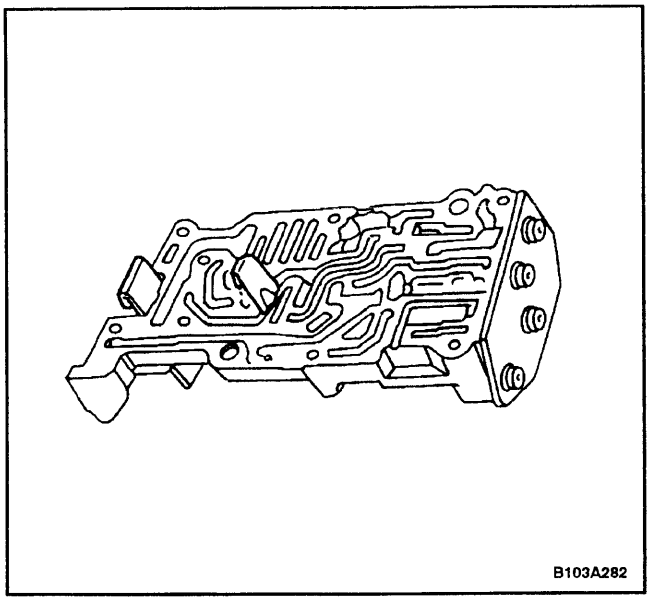
7. Remove the lower intermediate plate.



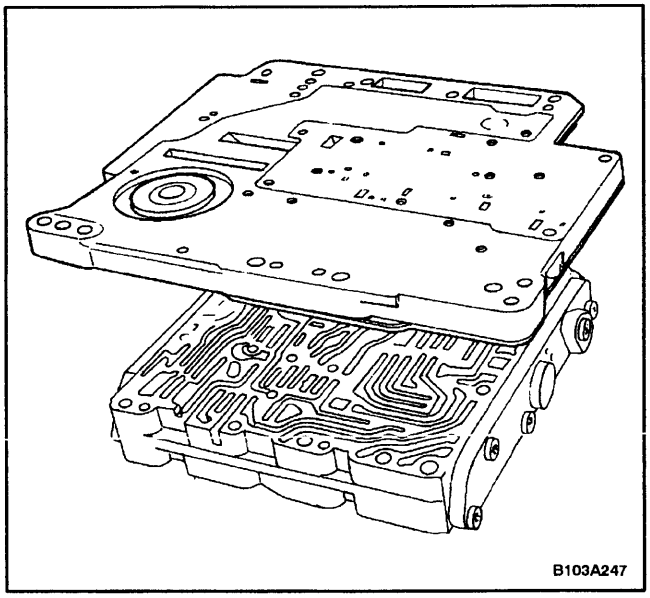
8. Remove the change valve balls and the clip from the lower side of the valve housing.



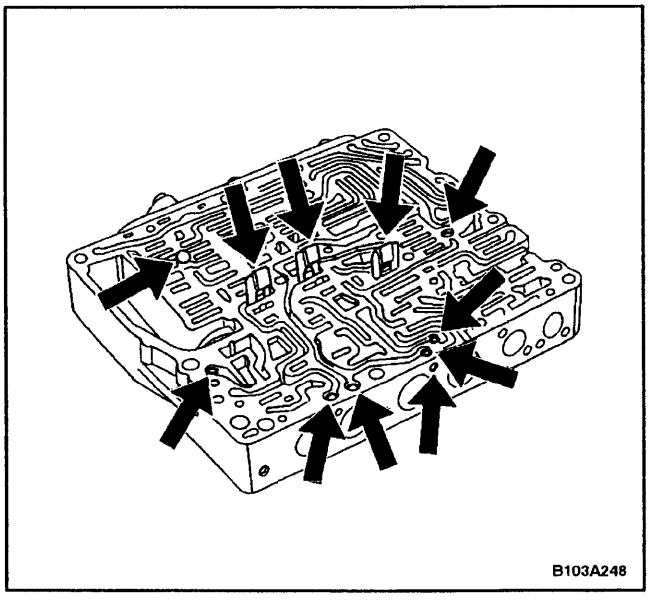
9. Turn the valve body over.
10. Remove the clutch A and the brake D housing.


B103A282

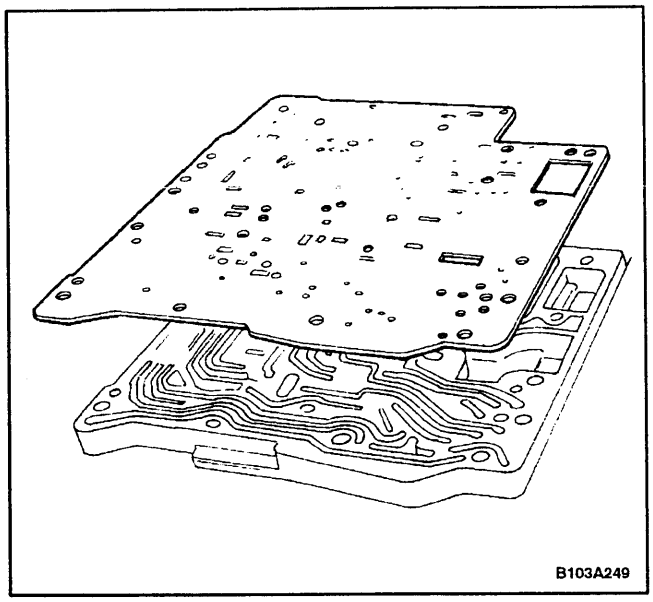
11. Replace the clips on the under side of the housing, if necessary.


B103A247

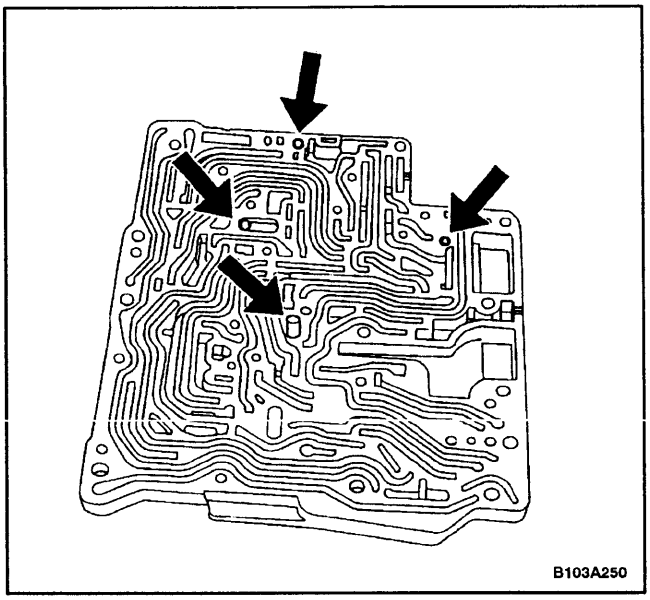
12. Keep the fluid passage plate and the upper intermediate plate together, separating them as a unit from the upper side of the valve housing. Turn them over before placing them on the table.


B103A248

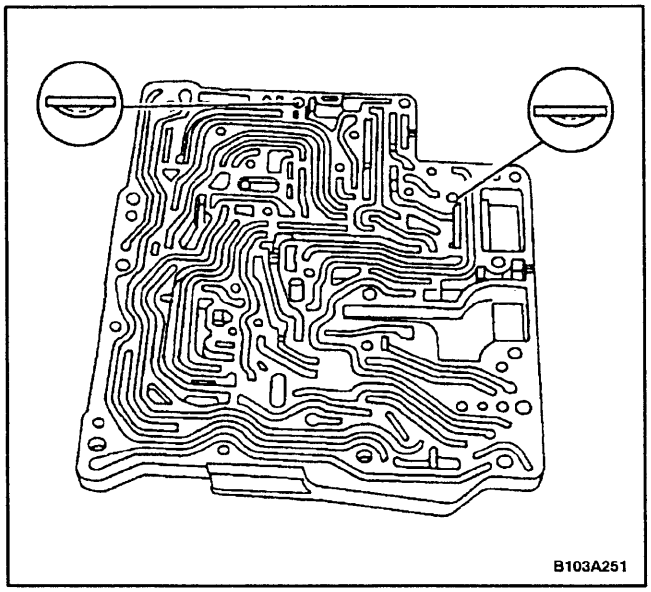
13. Remove the breather ball, the clips, and the restrictors from the upper side of the valve housing.


B103A249

14. Separate the upper intermediate plate from the fluid passage plate.


B103A250

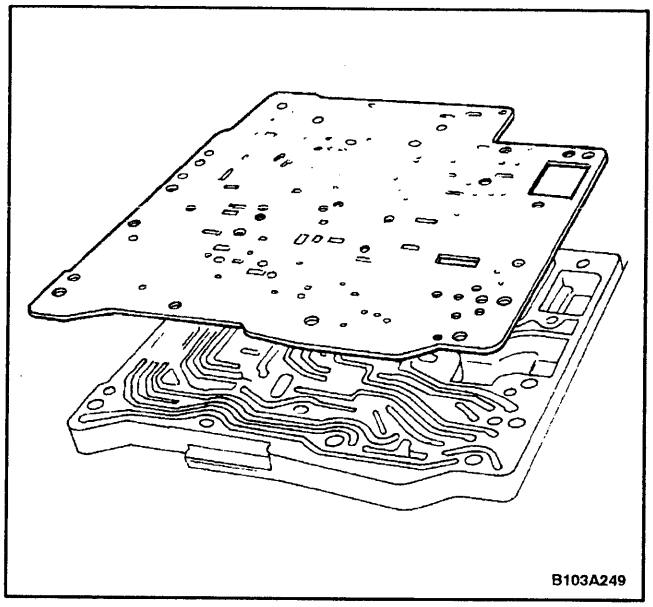
15. Remove the restrictors, the centralizing pin, and the supply ball from the fluid channel housing.


B103A251

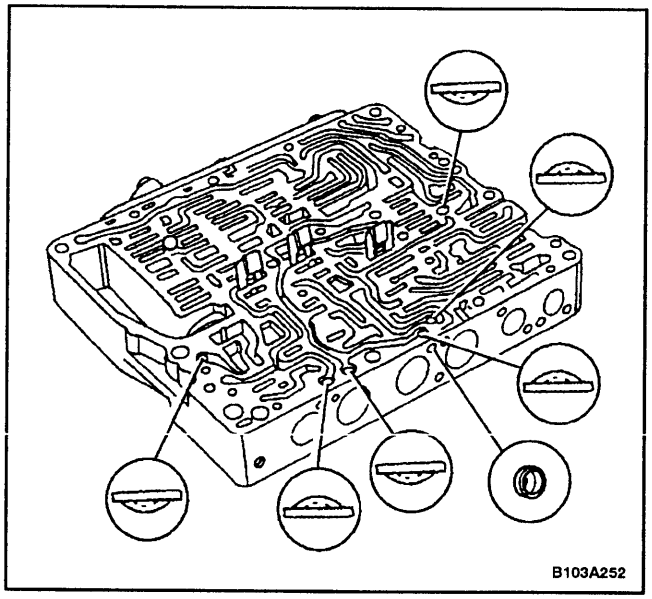
Assembly Procedure

Important: The restrictors go into the housings in a certain orientation. Be sure to seat properly each restrictor.

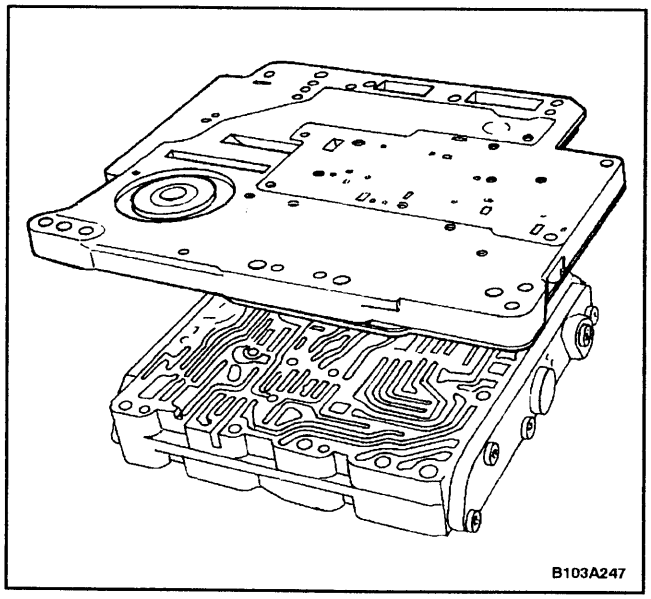
1. Install the centralizing pin, the supply ball, and the damper restrictors into the fluid channel housing.



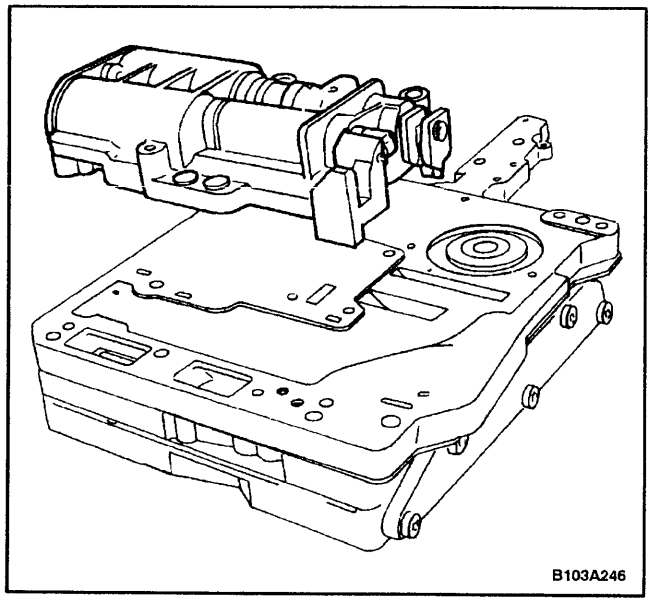
2. Place the upper intermediate plate onto the fluid passage plate.



3. Install the breather ball, the clips, and the restrictors into the upper side of the valve housing.



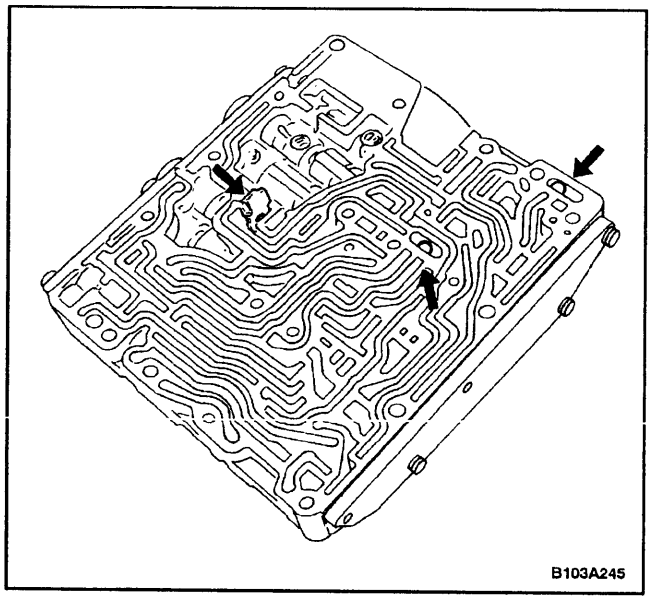
4. Holding the upper intermediate plate to the fluid passage plate, turn them over and place them on the upper side of the valve housing.


B103A246

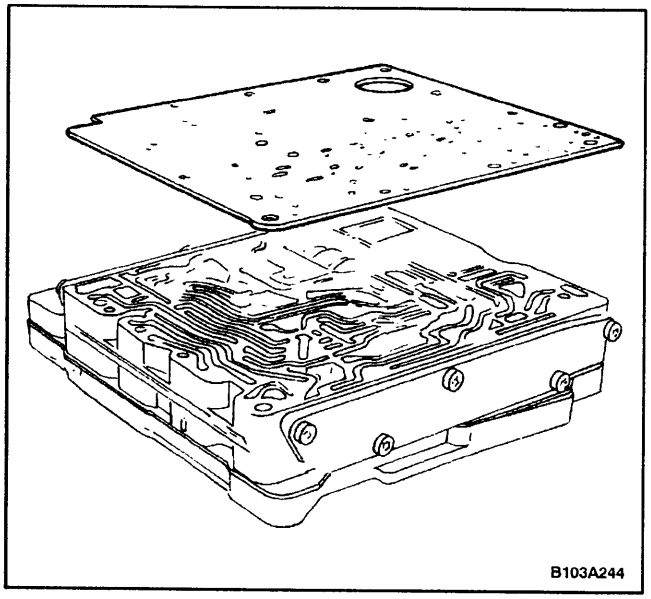
5. Install the clips into the clutch A and the brake D housing.
6. Install the clutch A and the brake D housing with the bolts.

Tighten

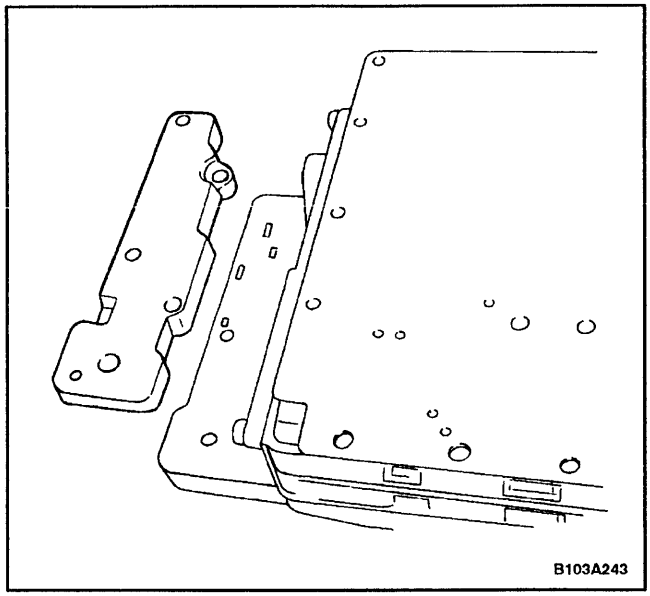
Tighten the clutch A and the brake D housing attachment bolts to 8 N•m (71 lb-in).


B103A245

7. Turn over the valve body.
8. Install the change valve balls and the clip them into the lower side of the valve housing.


B103A244

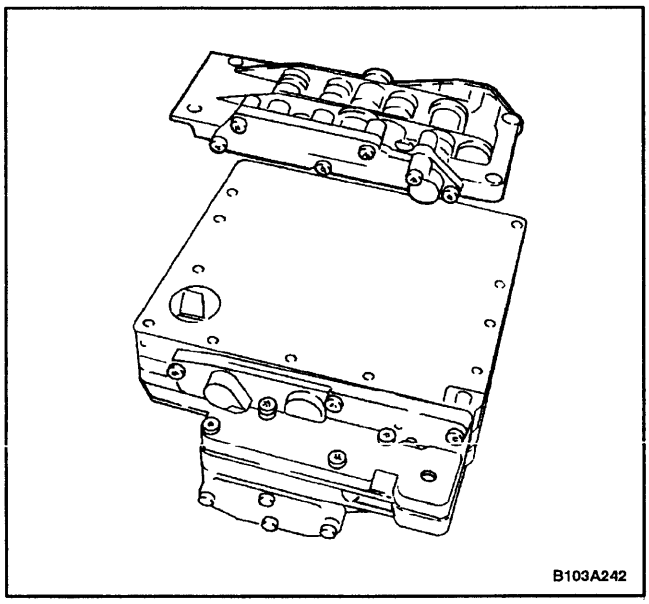
9. Install the lower intermediate plate.



10. Install the lower cover with the bolts.

Tighten

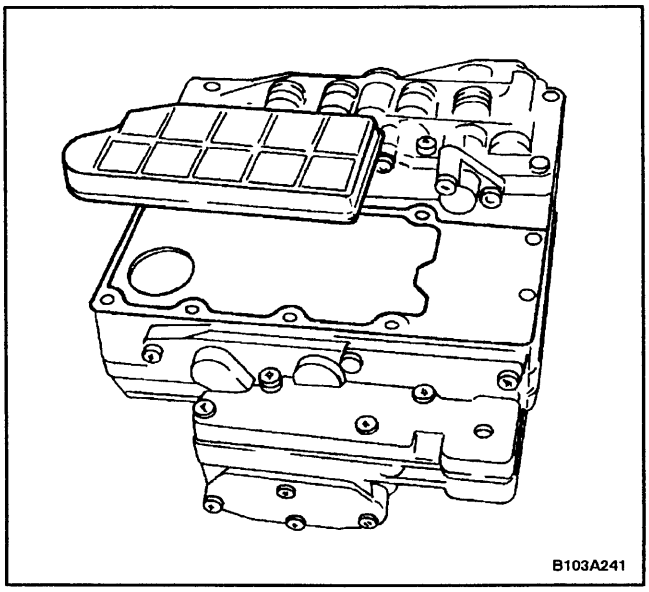
Tighten the lower cover attachment bolts to 8 N•m (71 lb-in).



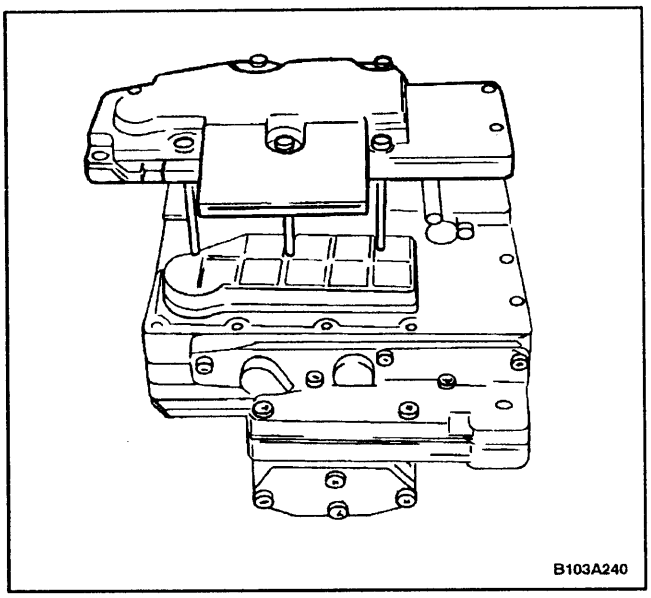
11. Install the lower valve housing with the bolts.

Tighten

Tighten the lower valve housing attachment bolts to 8 N•m (71 lb-in).



12. Install the fluid filter and the gasket.

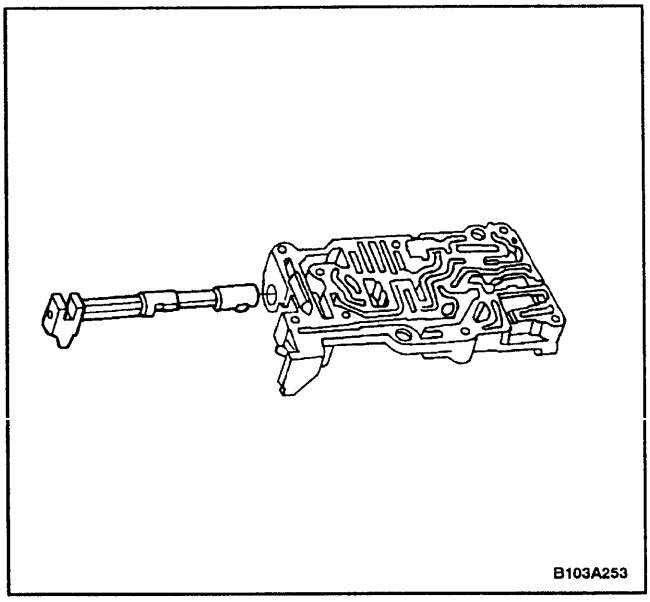

B103A240

13. Install the fluid filter housing with the bolts.

Tighten

Tighten the fluid filter housing cover attaching bolts to 8 N•m (71 lb-in).

14. Install the valve body into the transaxle. Refer to "Major Component Assembly" in this section.
15. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.

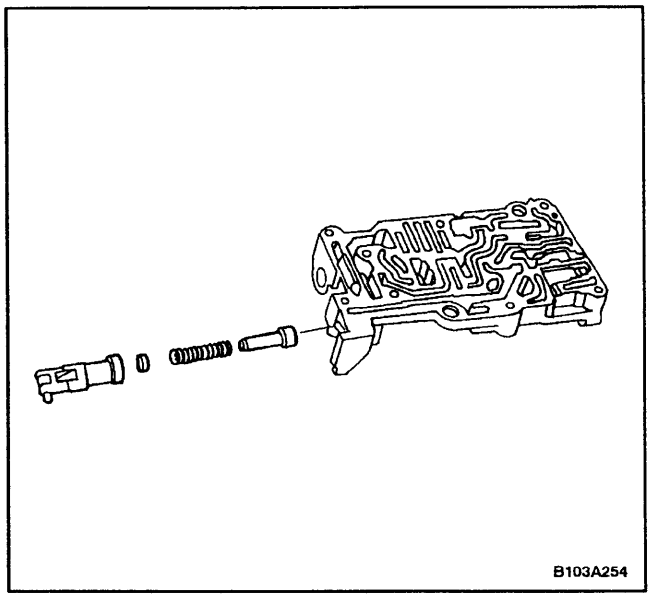

B103A253

CLUTCH A AND BRAKE D HOUSING

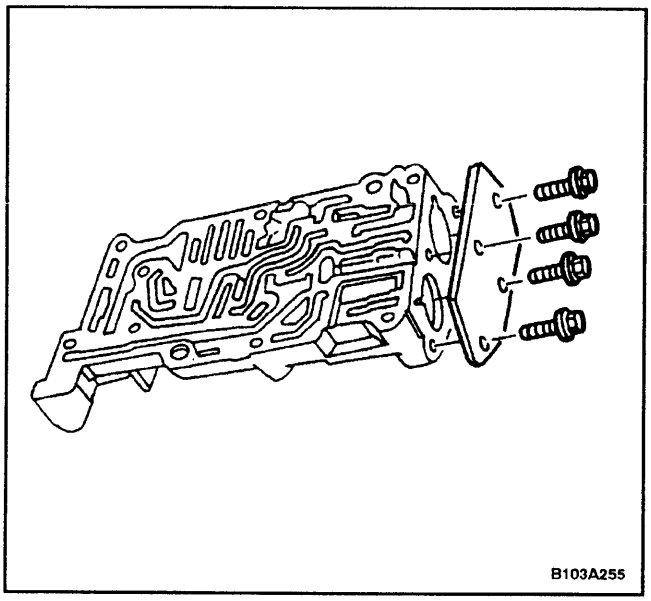
Disassembly Procedure

Important: Use caution when removing the covers from the housing as the valve springs can get lost easily.

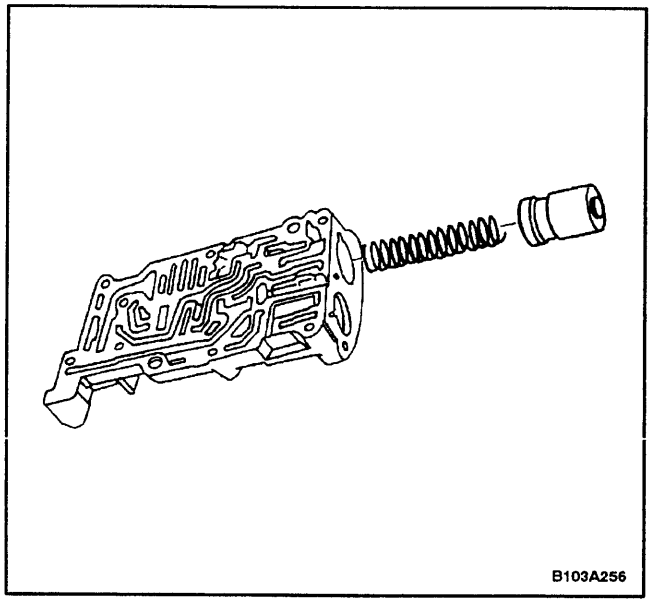
1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the valve body from the transaxle. Refer to "Major Component Disassembly" in this section.
3. Remove the clutch A and the brake D housing from the valve body. Refer to "Valve Body" in this section.
4. Remove the selection shuttle valve.


B103A254

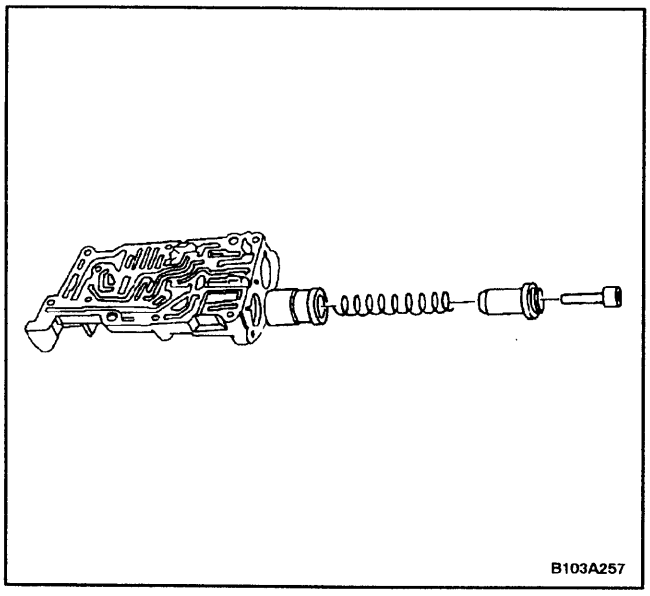
5. Remove the load correction pressure shuttle valve and the spring.



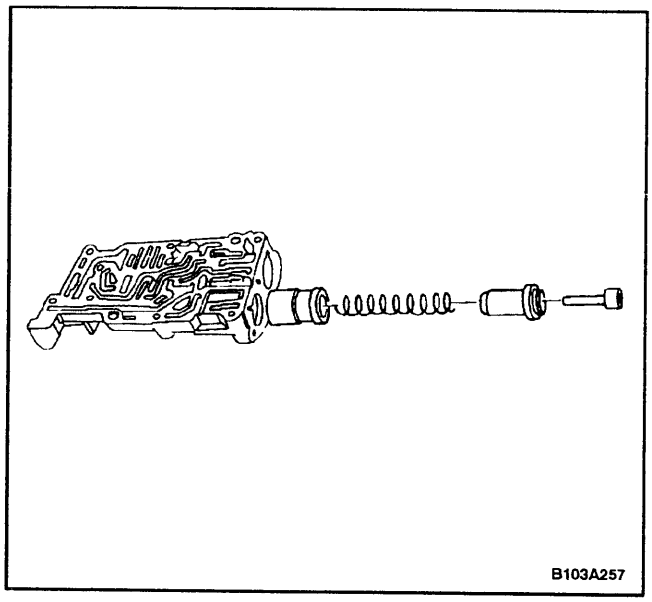
6. Remove the shuttle valve cover from the clutch A and the brake D housing.



7. Remove the brake D shuttle valve and the spring from the housing.

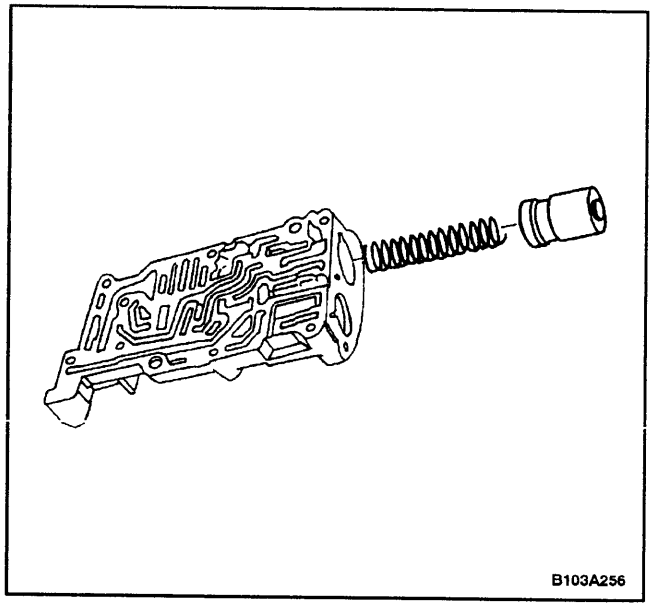


8. Remove the clutch A shuttle valve and the spring from the housing.

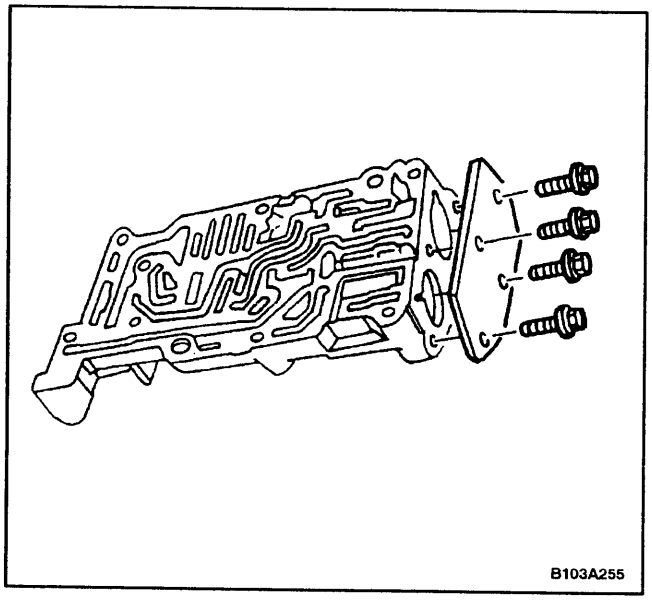


Assembly Procedure

1. Install the clutch A shuttle valve and the spring into the housing.



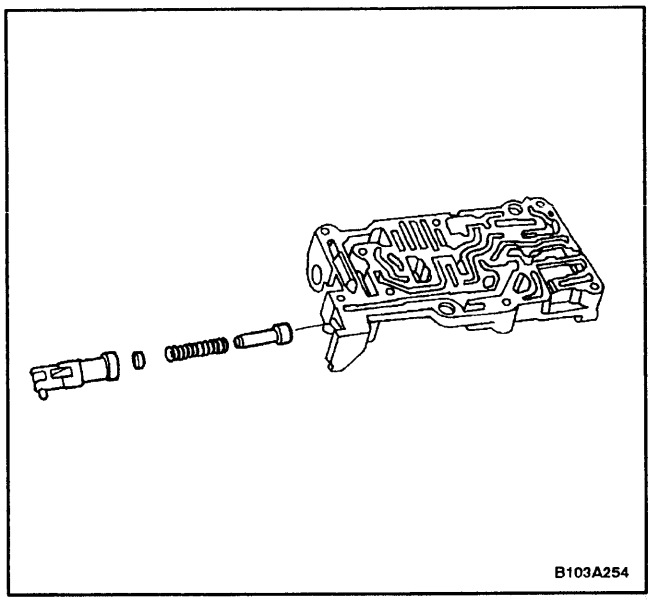
2. Install the brake D shuttle valve and the spring into the housing.



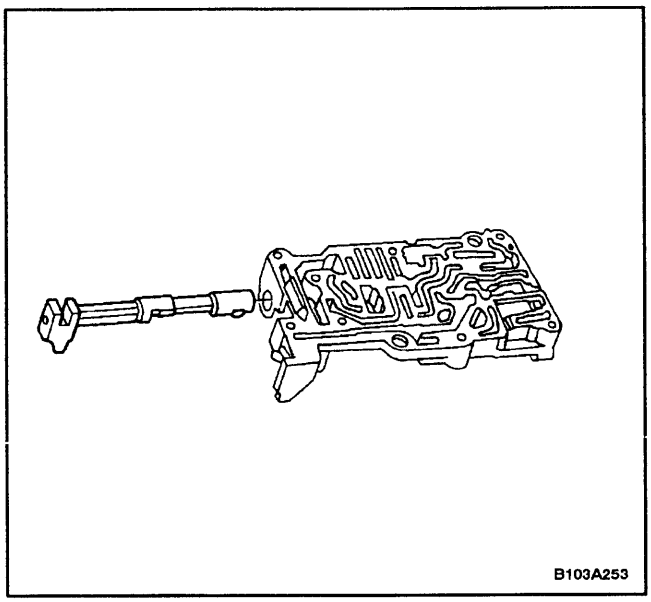
3. Install the shuttle valve cover onto the clutch A and the brake D housing with the bolts.

Tighten

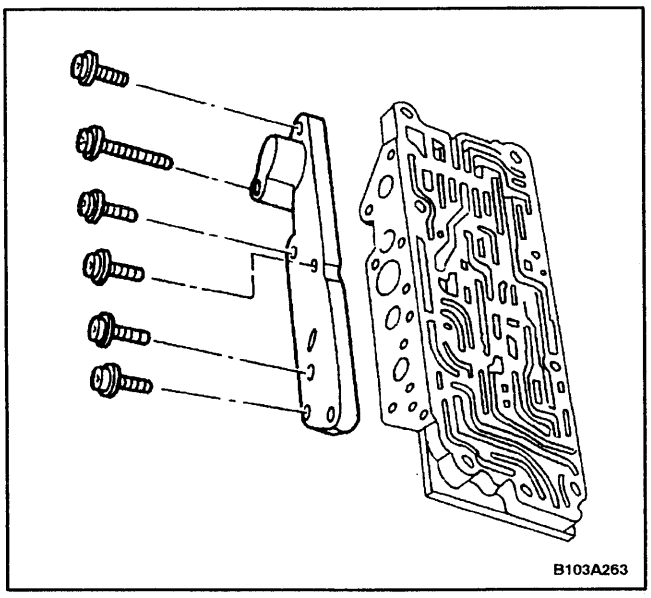
Tighten the shuttle valve cover attachment bolts to 8 N•m (71 lb-in).


B103A254

4. Install the load correction pressure shuttle valve and the spring.


B103A253

5. Install the selection shuttle valve.
6. Install the clutch A and the brake D housing onto the valve body. Refer to "Valve Body" in this section.
7. Install the valve body into the transaxle. Refer to "Major Component Disassembly" in this section.
8. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.

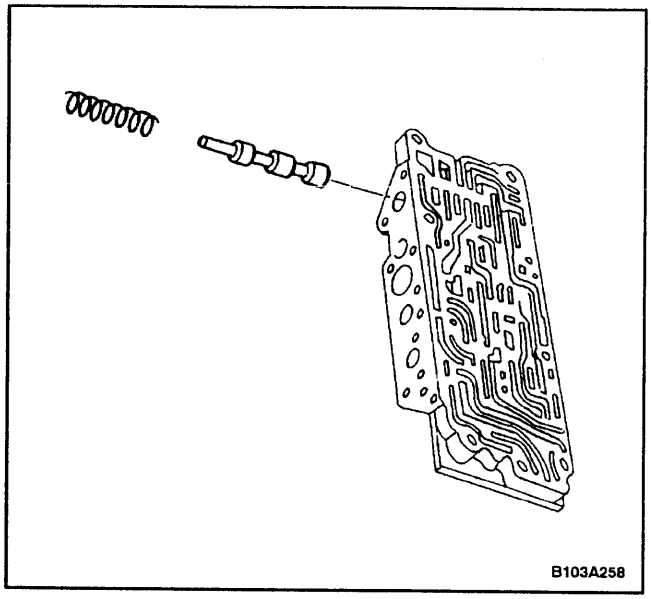

B103A263

LOWER VALVE HOUSING

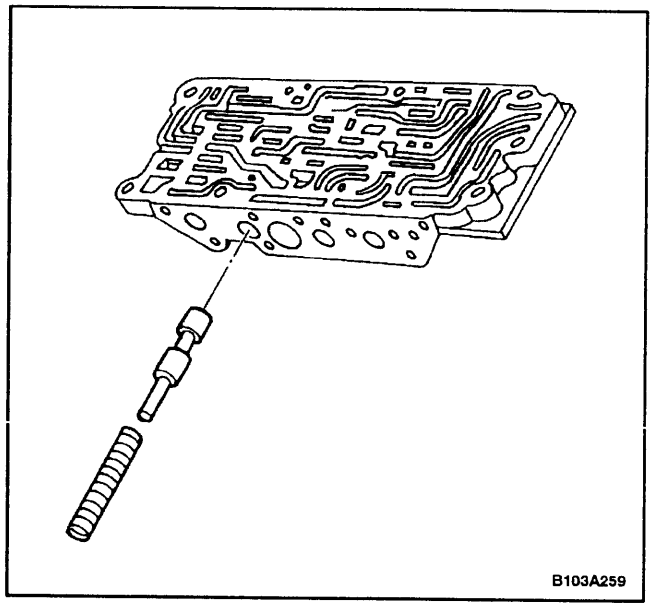
Disassembly Procedure

Important: Use caution when removing the covers from the sides of the housing as the valve springs can get lost easily.

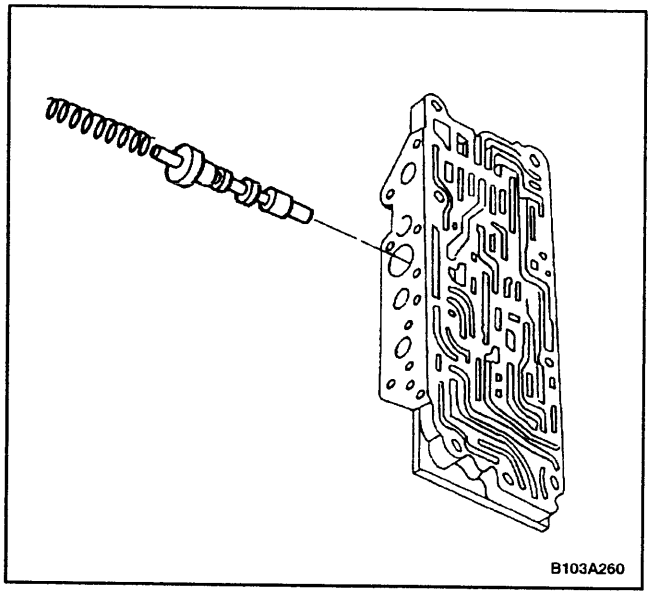
1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the valve body from the transaxle. Refer to "Major Component Disassembly" in this section.
3. Remove the lower valve housing. Refer to "Valve Body" in this section.
4. Remove the lower valve housing exterior cover bolts and the exterior cover.



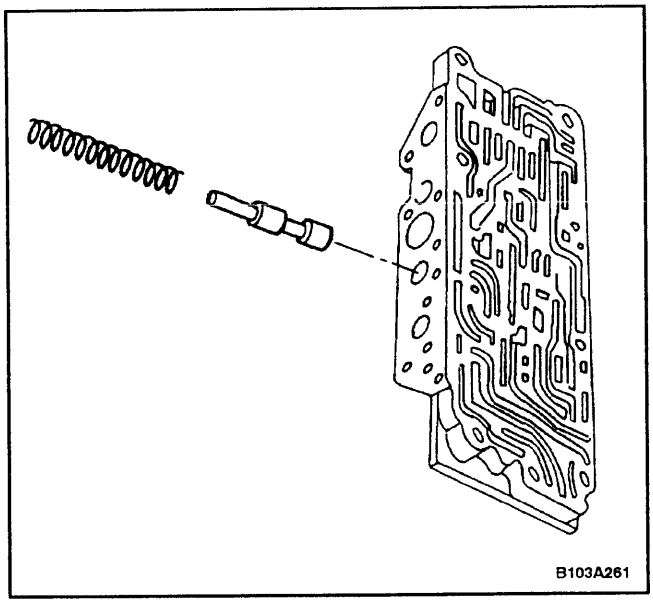
5. Remove the first-second speed change shuttle valve and spring.



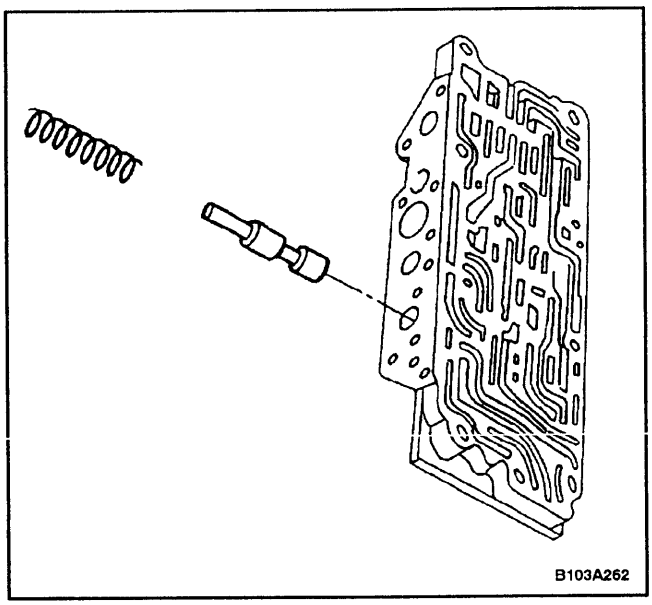
6. Remove the second speed lock shuttle valve and spring.



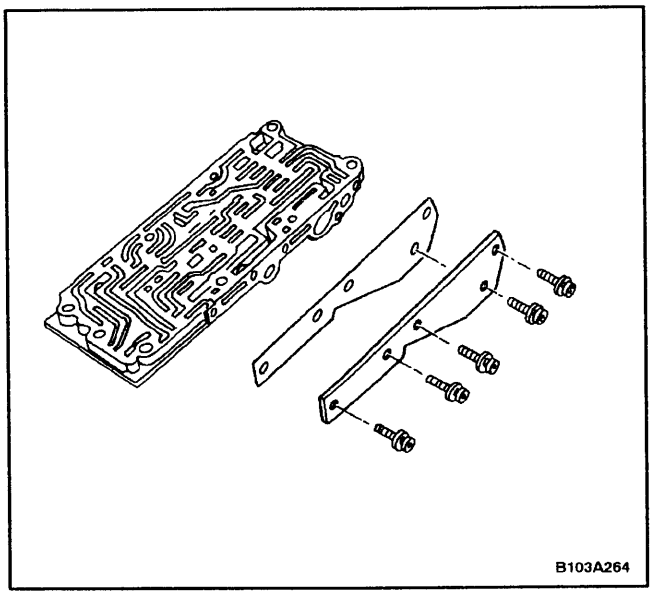
7. Remove the control shuttle valve and the restrictor C' spring.



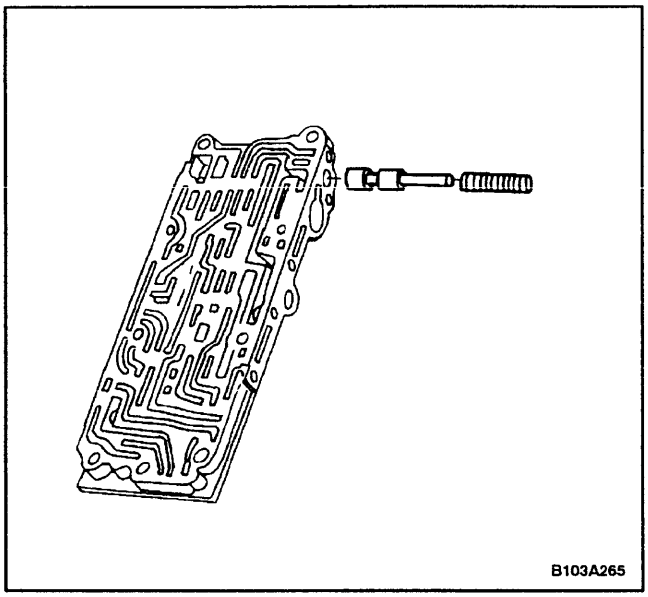
8. Remove the position 3 shuttle valve and the spring.



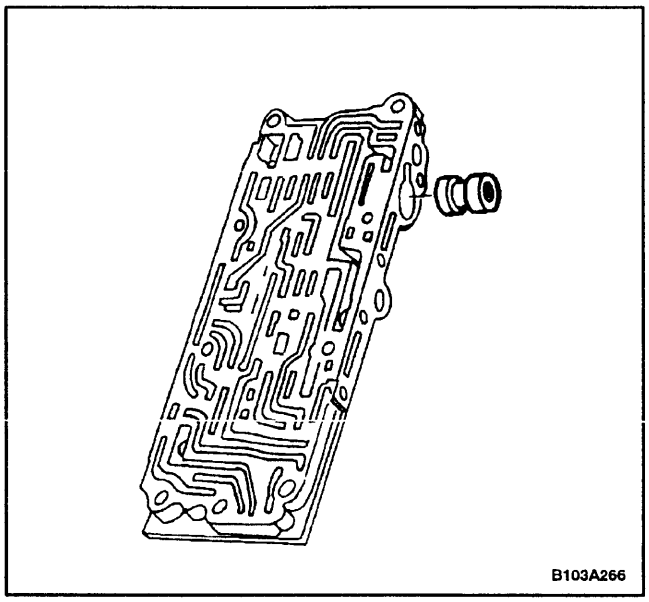
9. Remove the 4-3-2 shuttle valve and the spring.



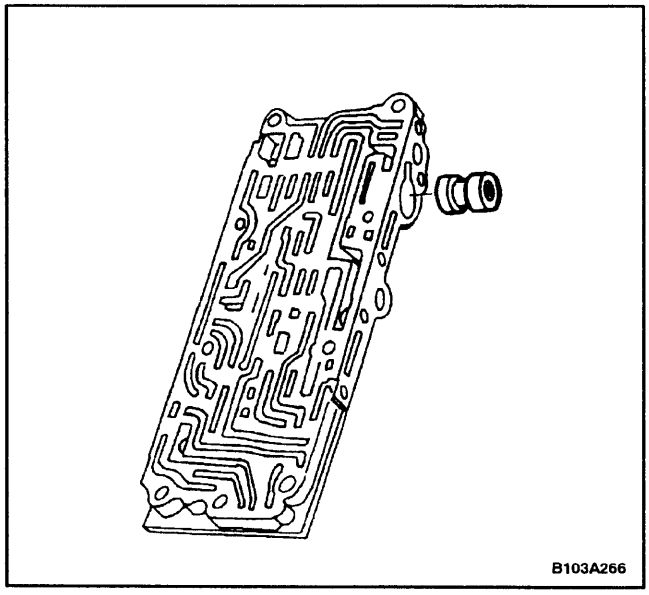
10. Remove the lower valve housing interior cover bolts, the lower valve housing interior cover, and the joint.


B103A265

11. Remove the 2-3-4 change up shuttle valve and the spring.

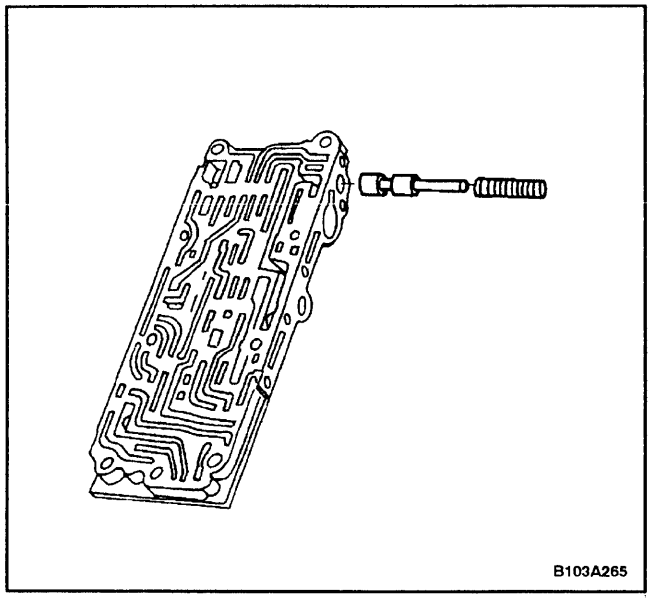

B103A266

12. Remove the 1-2 change valve.

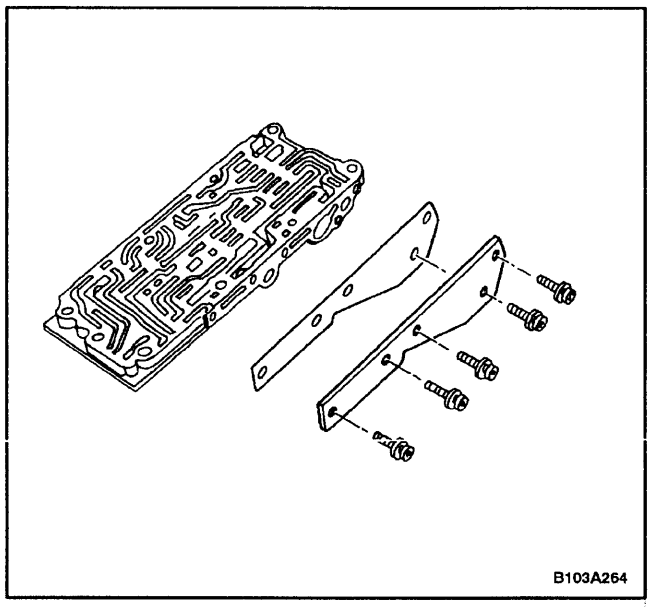

B103A266

Assembly Procedure

1. Install the 1-2 change valve.


B103A265

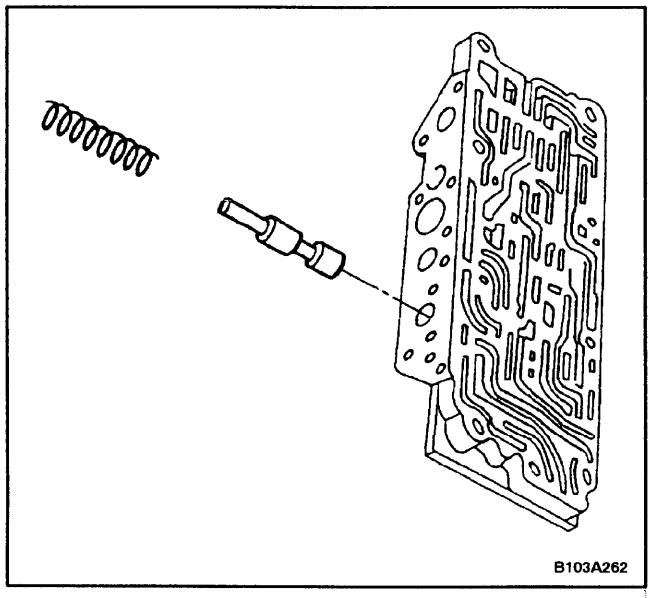
2. Install the 2-3-4 change up shuttle valve and the spring.


B103A264

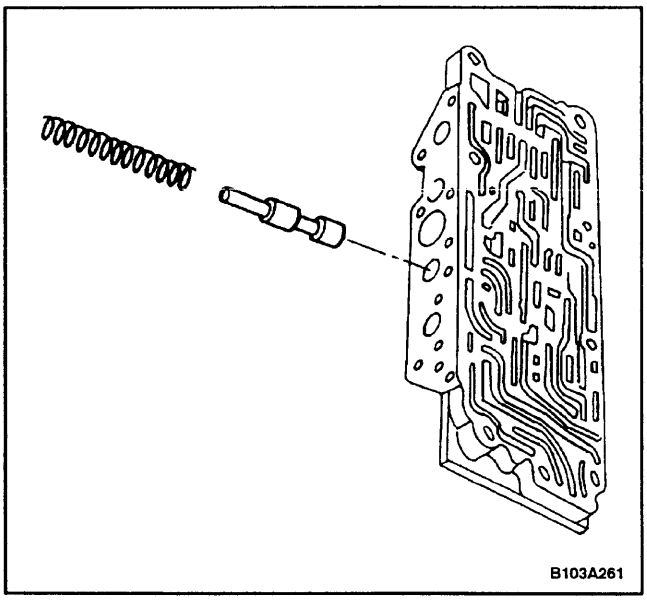
3. Install the lower valve housing interior cover and the joint with the bolts.

Tighten

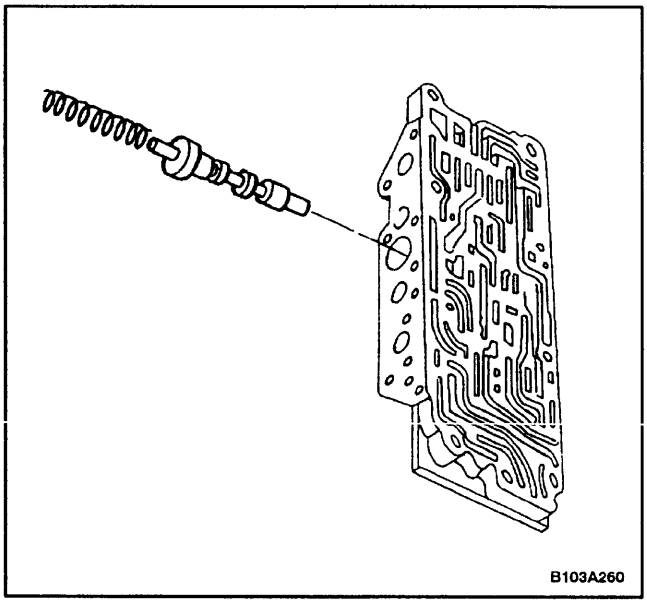
Tighten the lower valve housing interior cover bolts to 8 N•m (71 lb-in).


B103A262

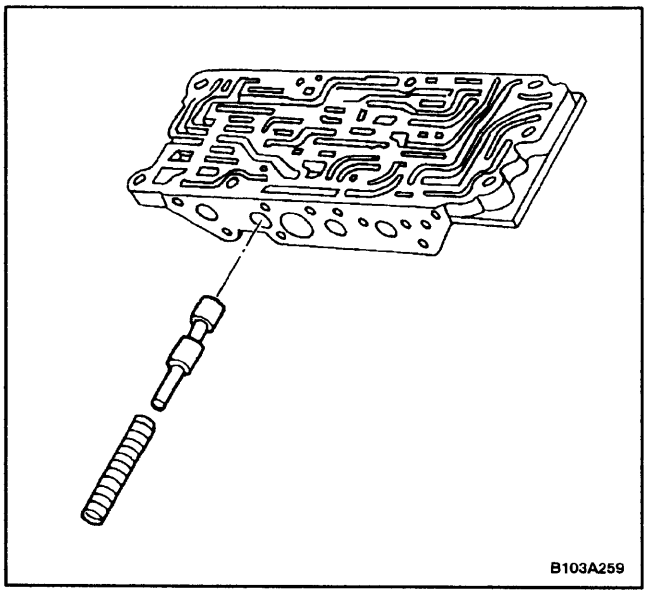
4. Install the 4-3-2 shuttle valve and the spring.



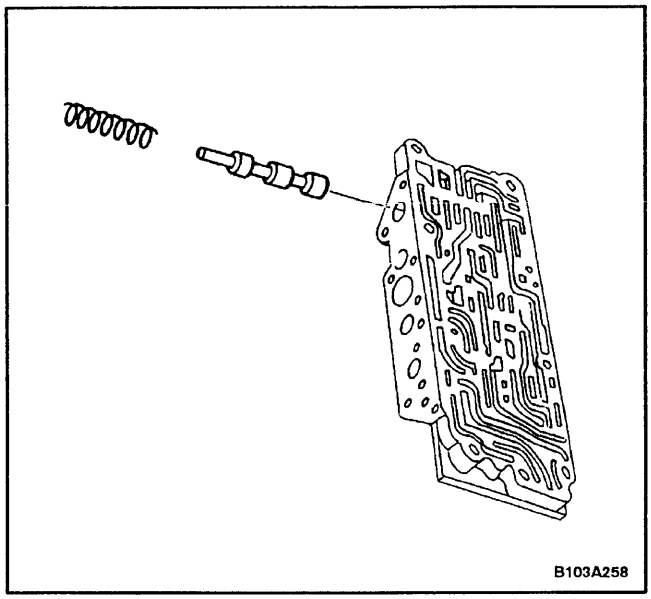
5. Install the position 3 shuttle valve the spring.



6. Install the control shuttle valve and the restrictor C' spring.



7. Install the second speed lock shuttle valve and the spring.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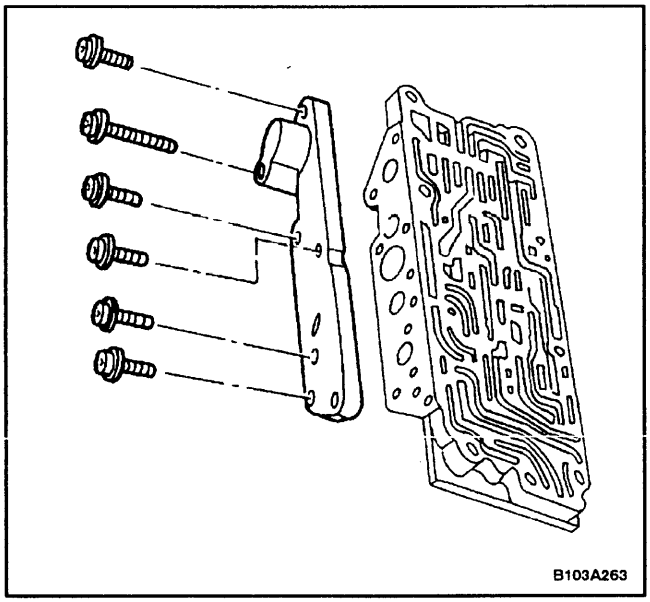
8. Install the first-second speed change shuttle valve and the spring.

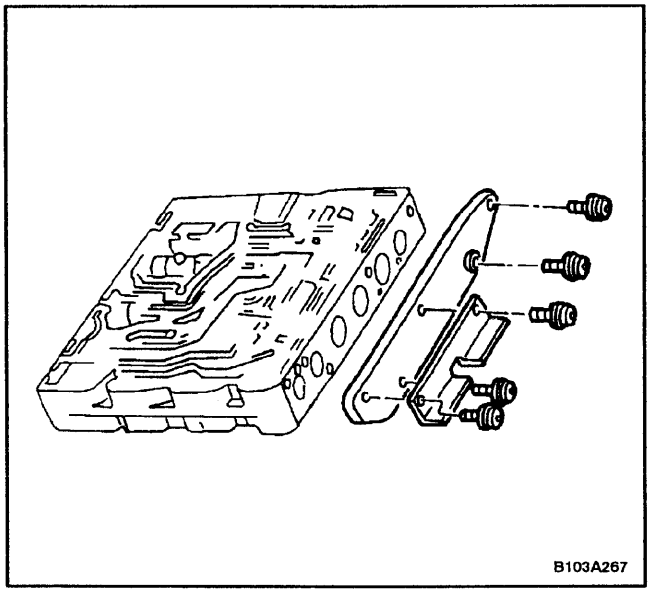

B103A263

9. Install the lower valve housing exterior cover with the bolts.

Tighten

Tighten the lower valve housing exterior cover bolts to 8 N•m (71 lb-in).

10. Install the lower valve housing. Refer to "Valve Body" in this section.
11. Install the valve body onto the transaxle. Refer to "Major Component Assembly" in this section.
12. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.

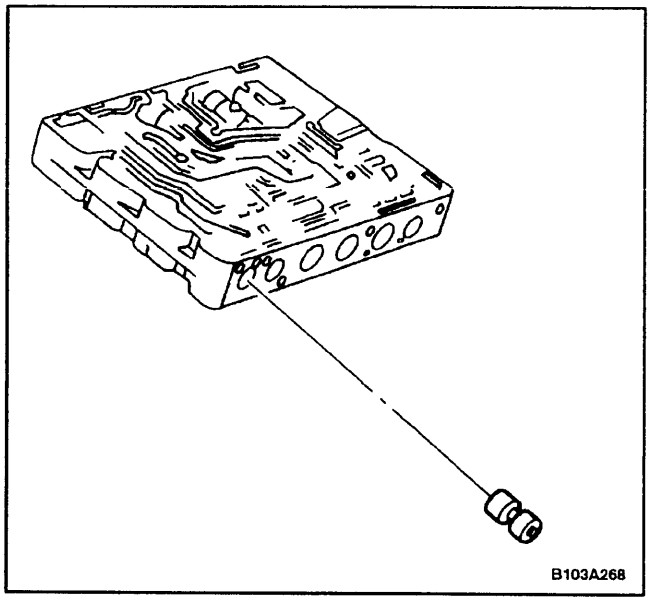

B103A267

VALVE HOUSING

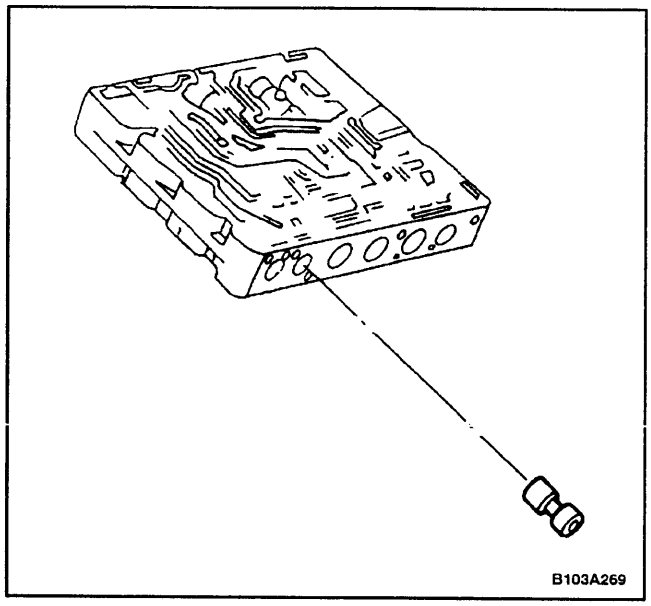
Disassembly Procedure

Important: Use caution when removing the covers from the sides of the housing as the valve springs can get lost easily.

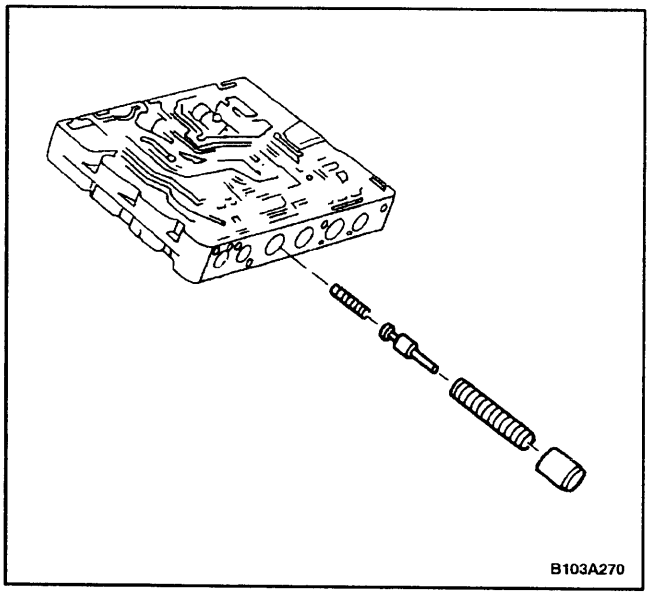
1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the valve body from the transaxle. Refer to "Major Component Disassembly" in this section.
3. Remove the valve housing. Refer to "Valve Body" in this section.
4. Remove the valve housing damper valve side cover bolts and the valve housing damper valve side cover.



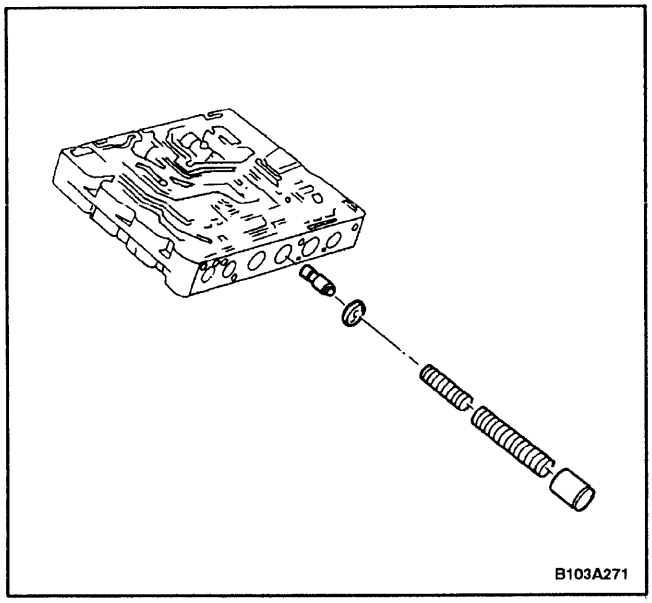
5. Remove the 3-4 change valve.



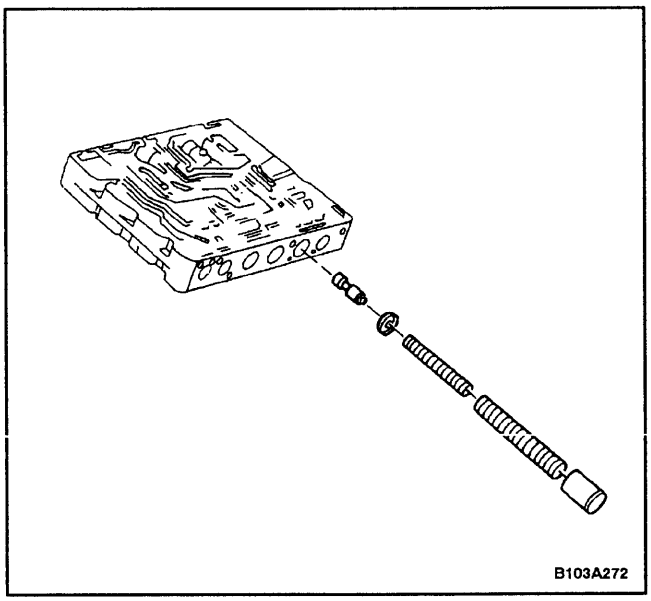
6. Remove the 2-3 change valve.



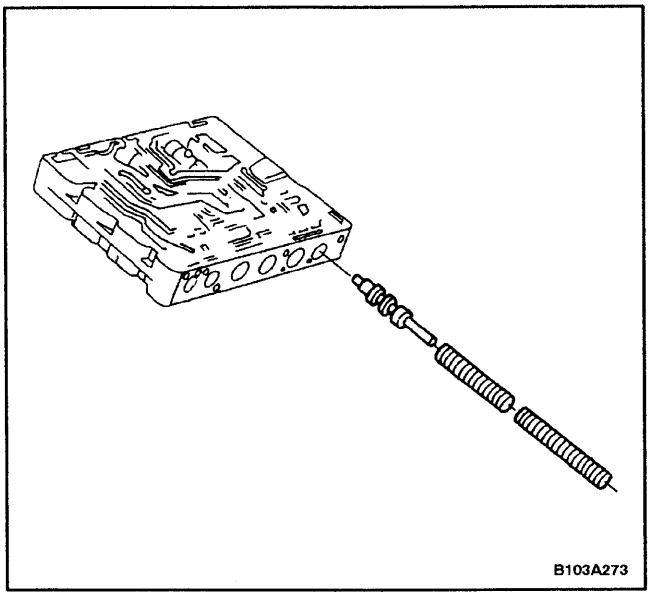
7. Remove the delay shuttle valve and the delay shuttle valve inner and the outer spring.



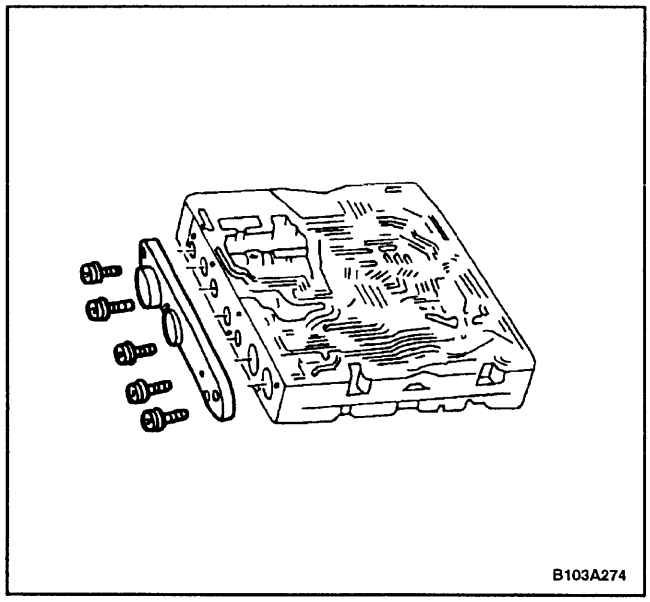
8. Remove the brake C′ damper shuttle valve and the brake C′ damper shuttle valve inner and the outer spring.



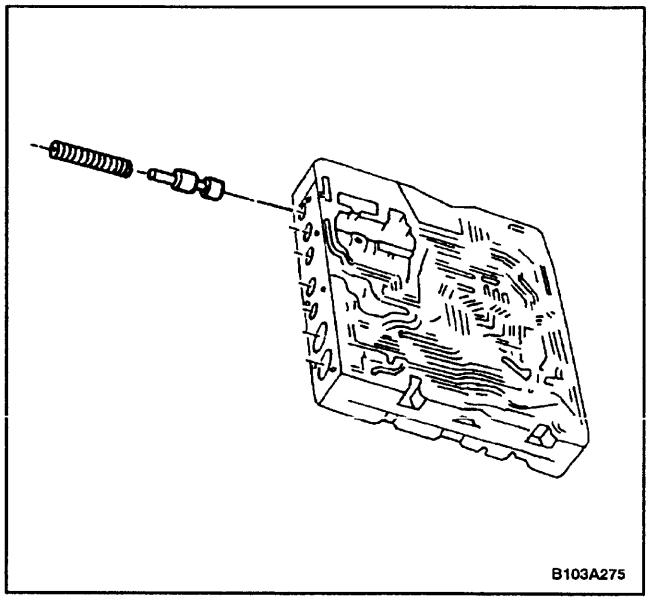
9. Remove the clutch E shuttle valve and the clutch E shuttle valve inner and the outer spring.



10. Remove the main pressure shuttle valve and the main pressure shuttle valve inner and the outer spring.


B103A274

11. Remove the valve housing control valve side cover attachment bolts and the valve housing control valve side cover.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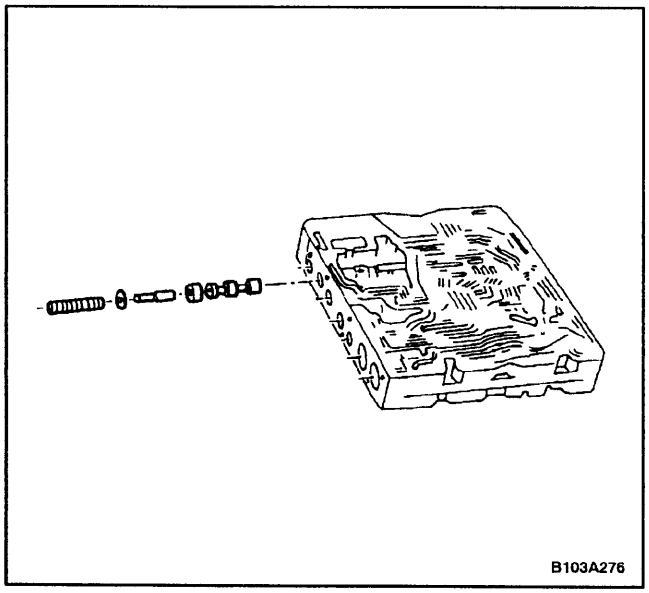
12. Remove the 4-3 change shuttle valve and the spring.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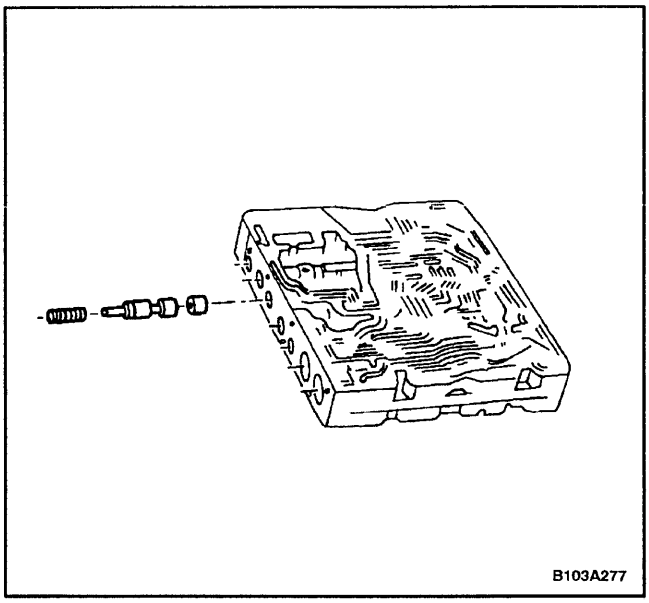
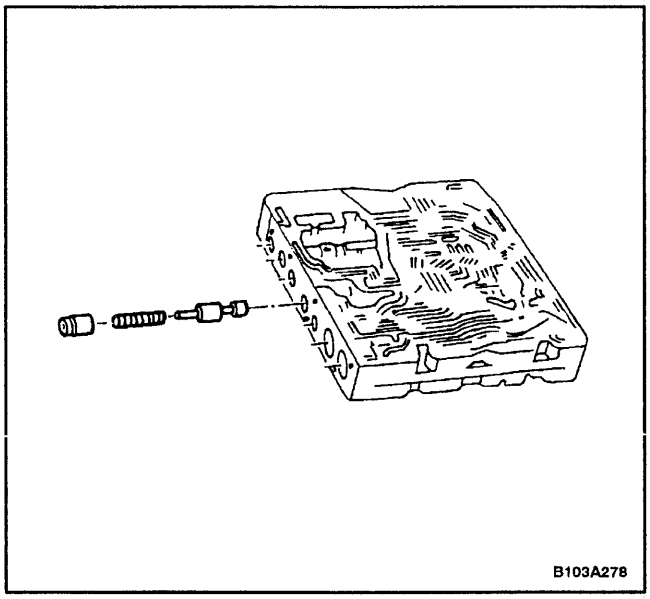
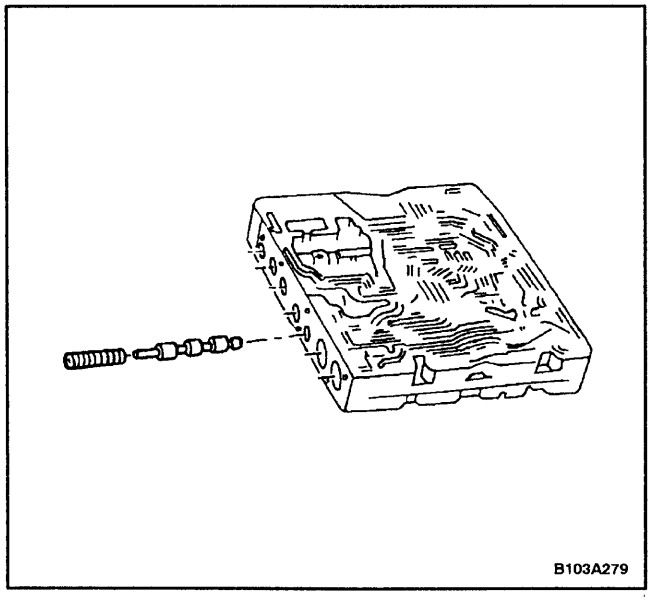
13. Remove the 3-4 change shuttle valve and the spring.



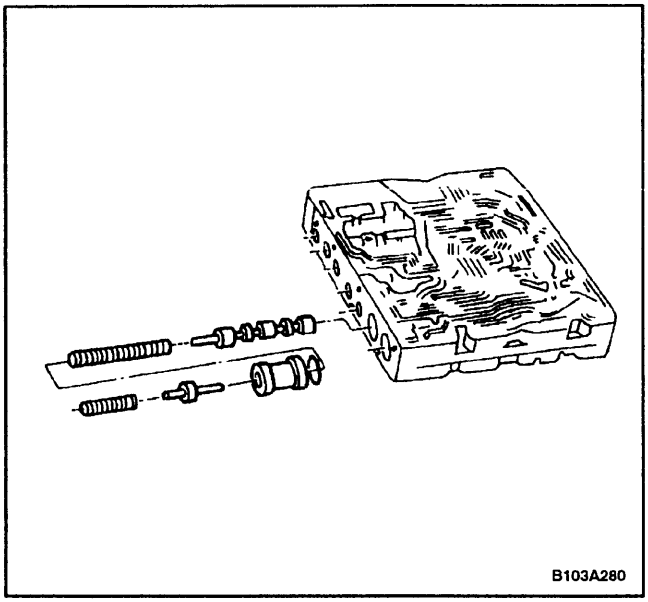
14. Remove the 4-3 kickdown shuttle valve and the spring.



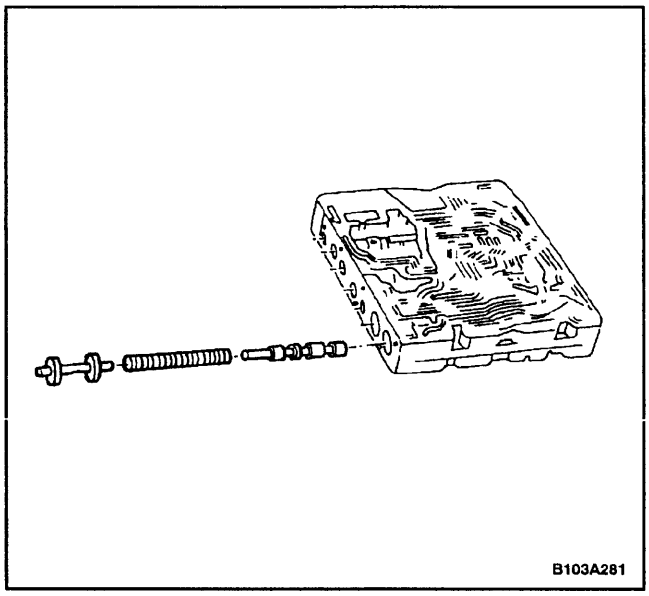
15. Remove the modulation pressure shuttle valve and the spring.



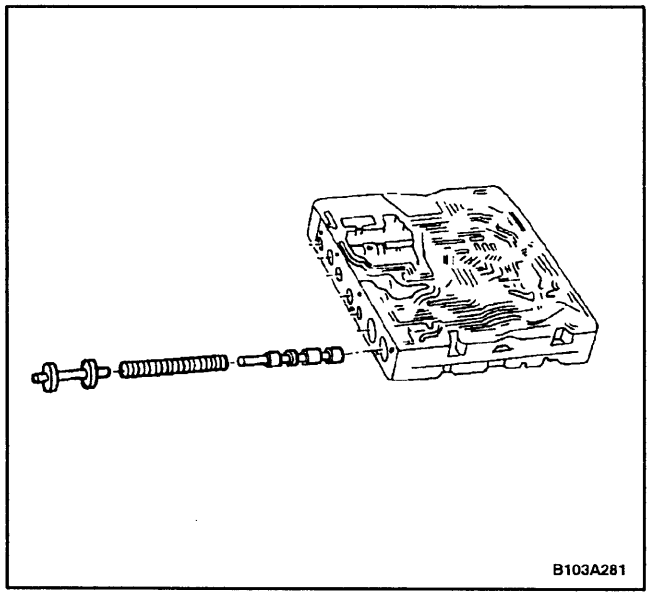
16. Remove the first and the reverse lock shuttle valve and the spring.



17. Remove the 1-2-3 line control shuttle valve and the spring.
18. Remove the 2-3 line change shuttle valve and the spring.

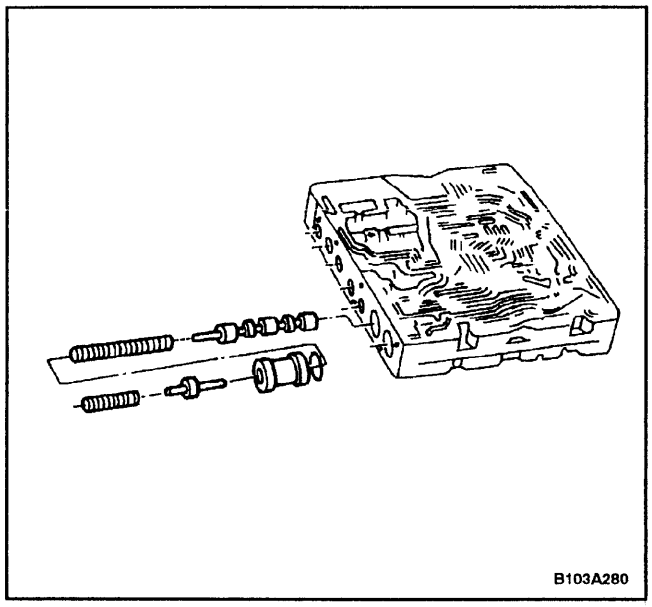


19. Remove the 3-4 change shuttle valve and the spring.

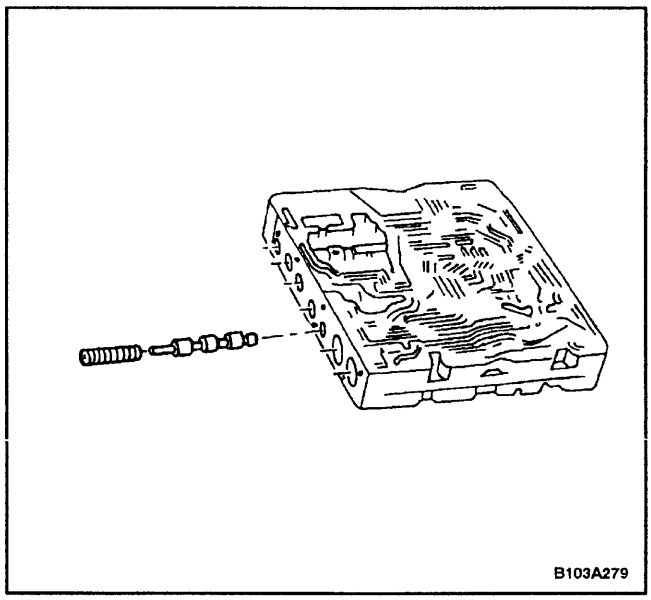


Assembly Procedure

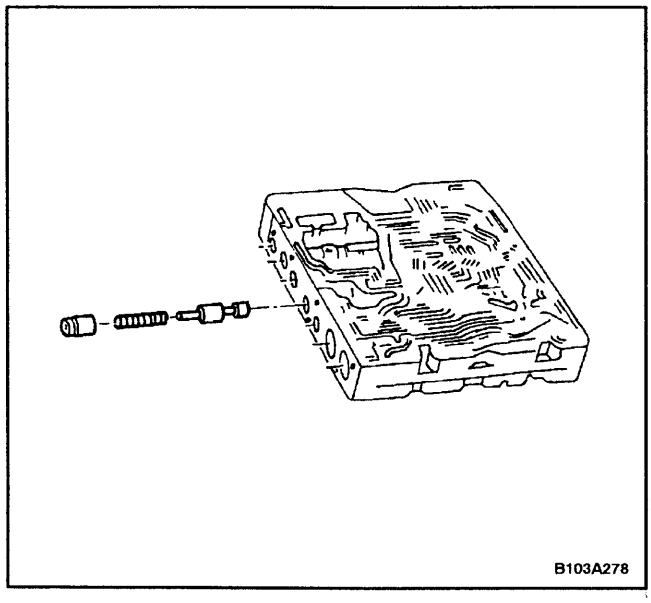
1. Install the 3-4 change shuttle valve and the spring.



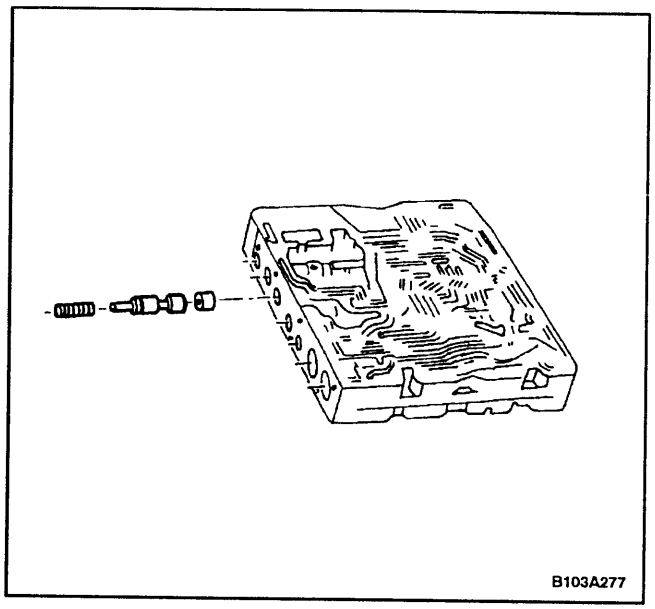
2. Install the 1-2-3 line control shuttle valve and the spring.
3. Remove the 2-3 line change shuttle valve and the spring.



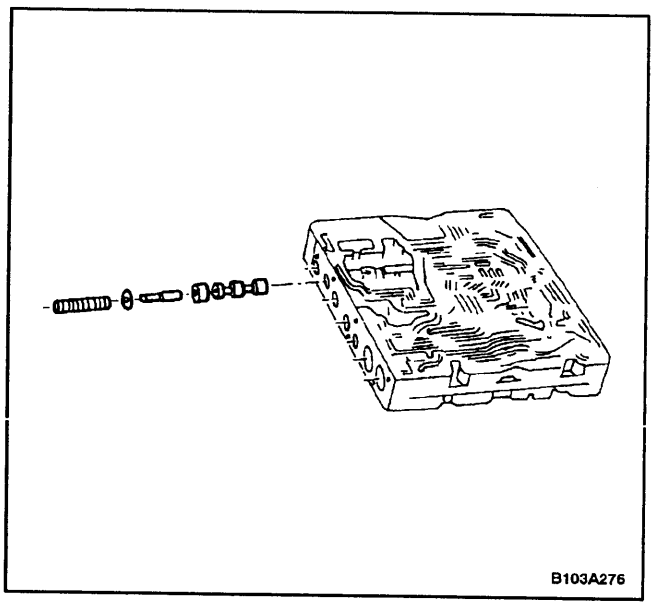
4. Install the first and the reverse lock shuttle valve and the spring.



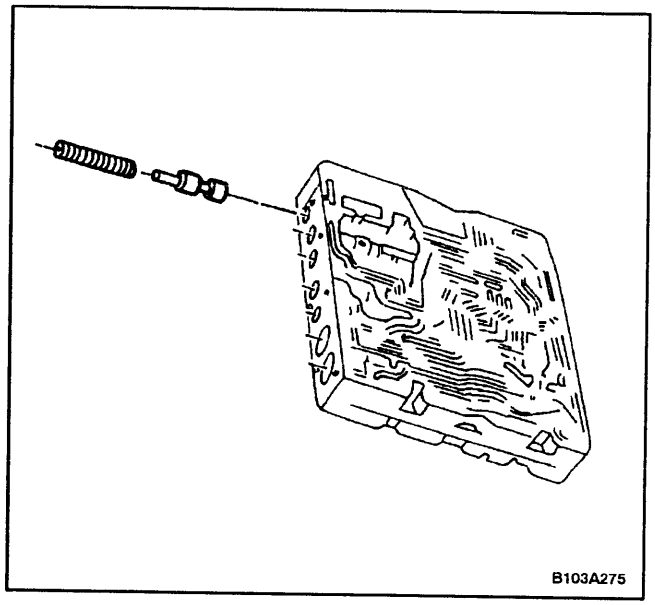
5. Install the modulation pressure shuttle valve and the spring.


B103A277

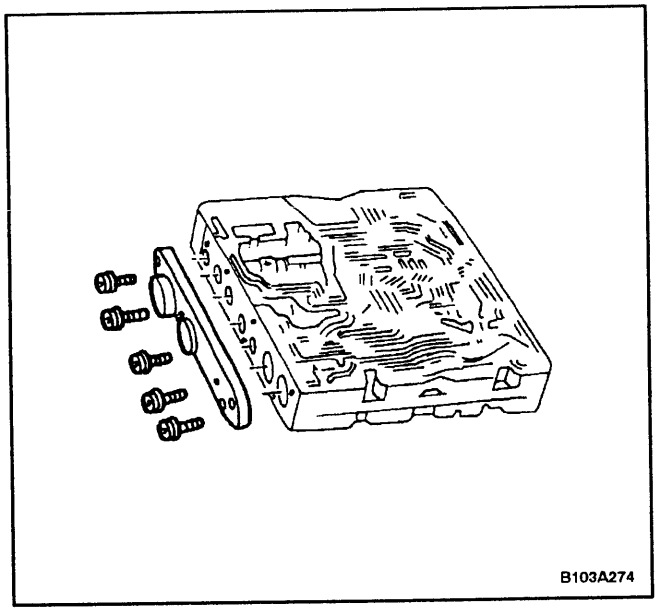
6. Install the 4-3 kickdown shuttle valve and the spring.


B103A276

7. Install the 3-4 change shuttle valve and the spring.


B103A275

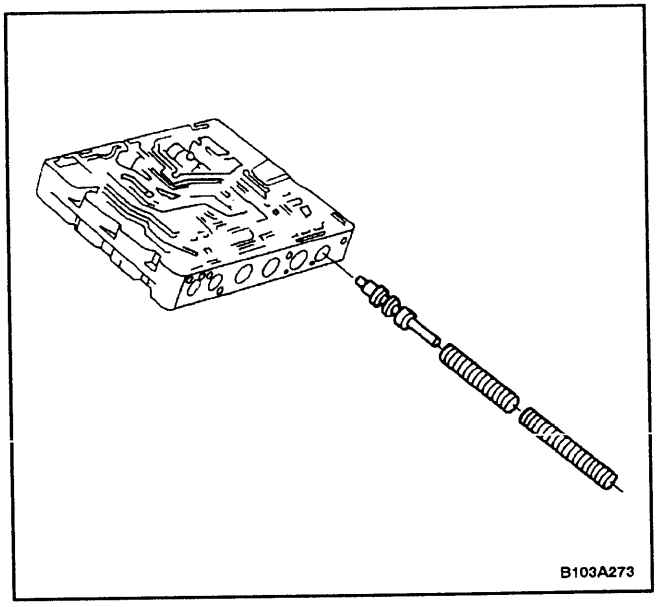
8. Install the 4-3 change shuttle valve and the spring.



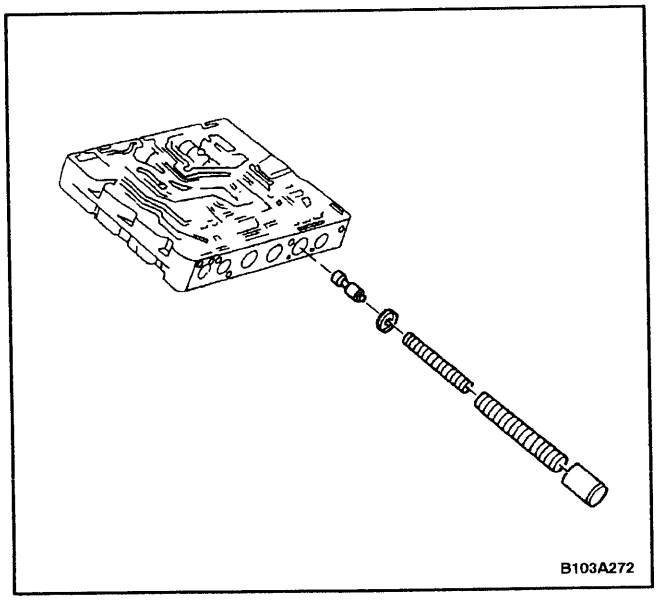
9. Install the valve housing control valve side cover with the bolts.

Tighten

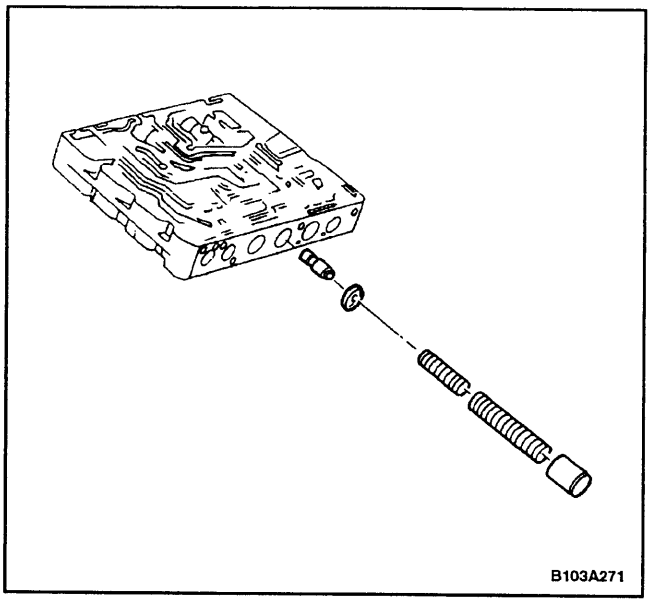
Tighten the valve housing control valve side cover attachment bolts to 8 N•m (71 lb-in).



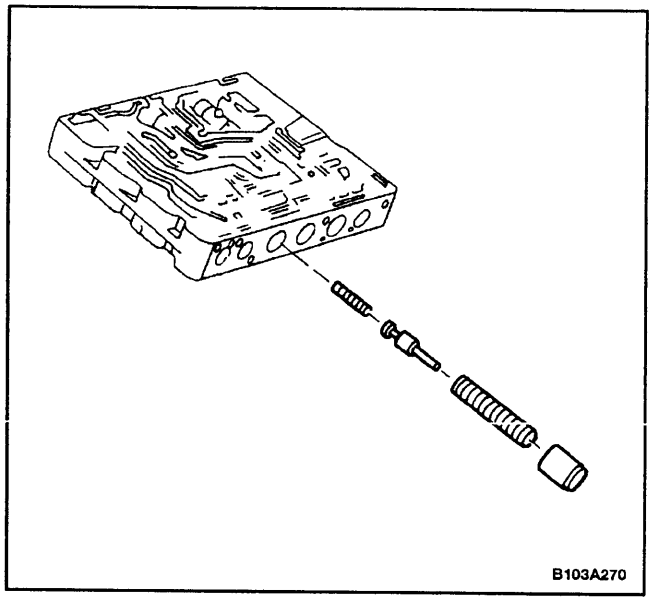
10. Install the main pressure shuttle valve and the main pressure shuttle valve inner and the outer spring.



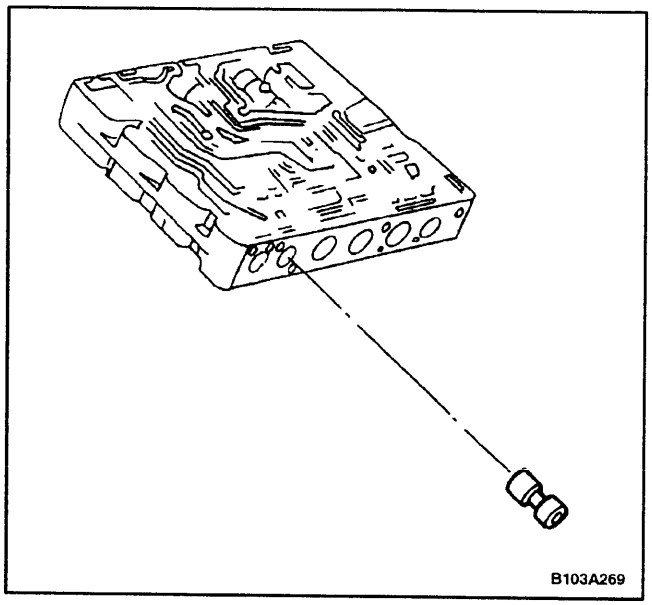
11. Install the clutch E shuttle valve and the clutch E shuttle valve inner and the outer spring.


B103A271

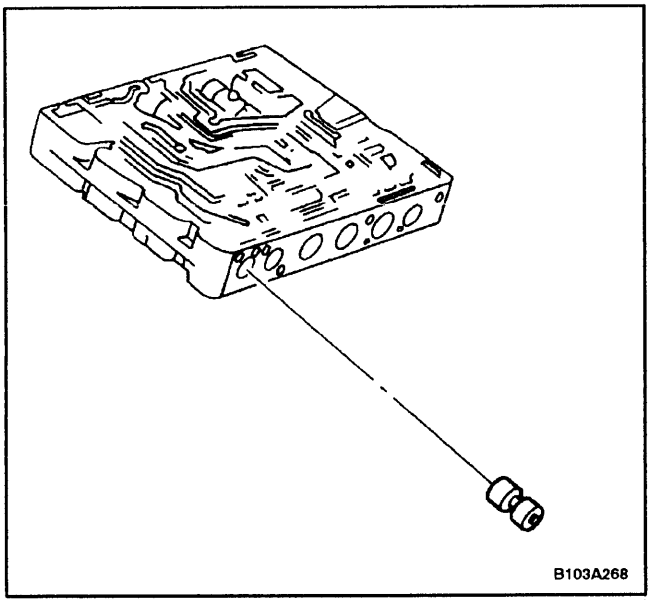
12. Install the brake C′ damper shuttle valve and the brake C′ damper shuttle valve inner and the outer spring.


B103A270

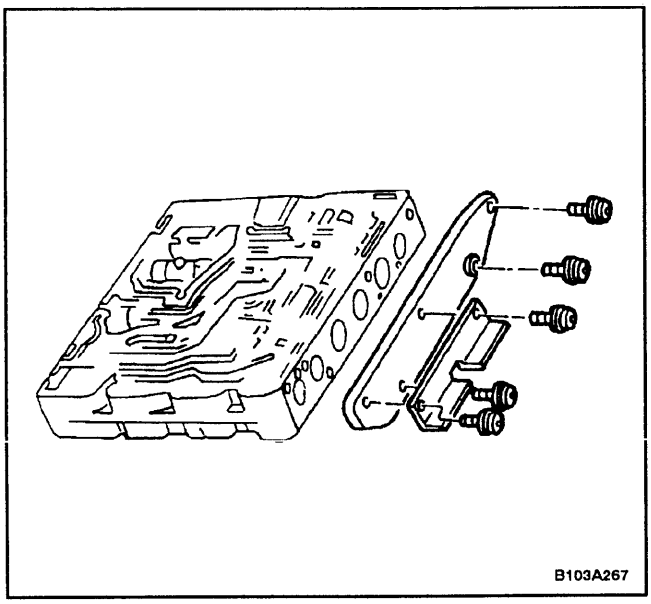
13. Install the delay shuttle valve and the delay shuttle valve inner and the outer spring.


B103A269

14. Install the 2-3 change valve.



15. Install the 3-4 change valve.

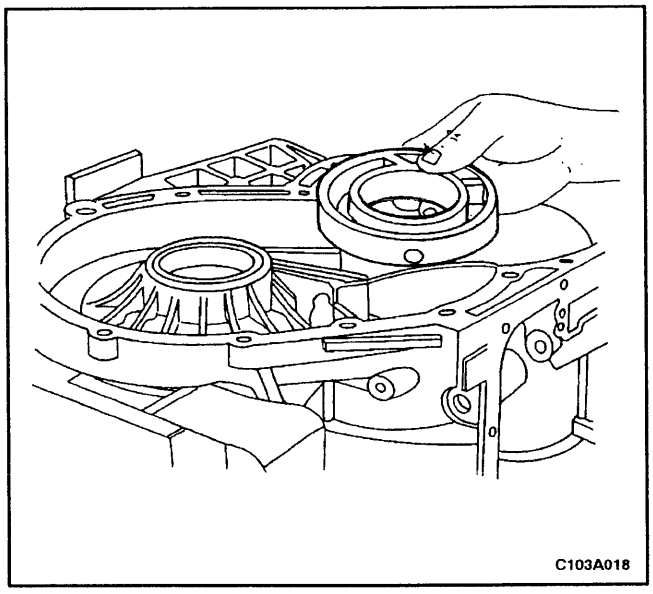


16. Install the valve housing damper valve side cover with the bolts.

Tighten

Tighten the valve housing damper valve side cover attachment bolts to 8 N•m (71 lb-in).

17. Install the valve housing. Refer to "Valve Body" in this section.
18. Install the valve body into the transaxle. Refer to "Major Component Assembly" in this section.
19. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.



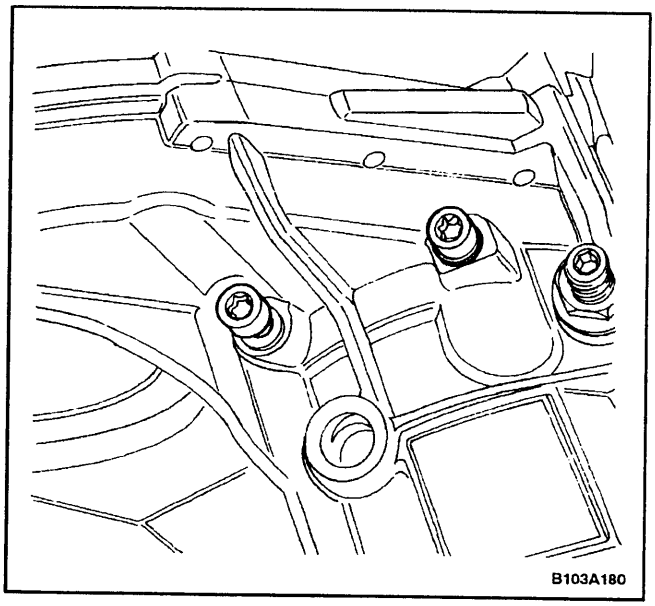
MAJOR COMPONENT ASSEMBLY

Tools Required

KA-002-088 Differential Adjustment Tool
KA-000-155 Grooved Nut Socket
KA-000-288 Side Shaft Retainer
KA-001-483 Axial Clearance Measurement Tool
KA-001-655 Spur Gear Clearance Measurement Tool

Assembly Procedure

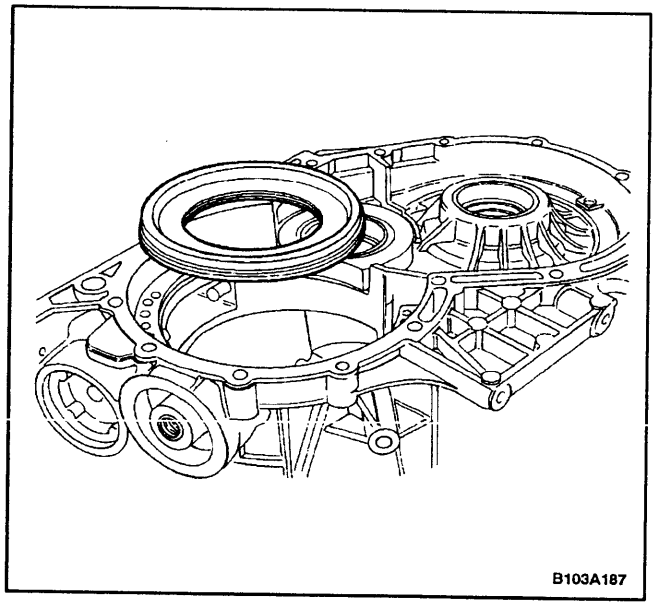
1. Install the side shaft outer ring.


B103A180

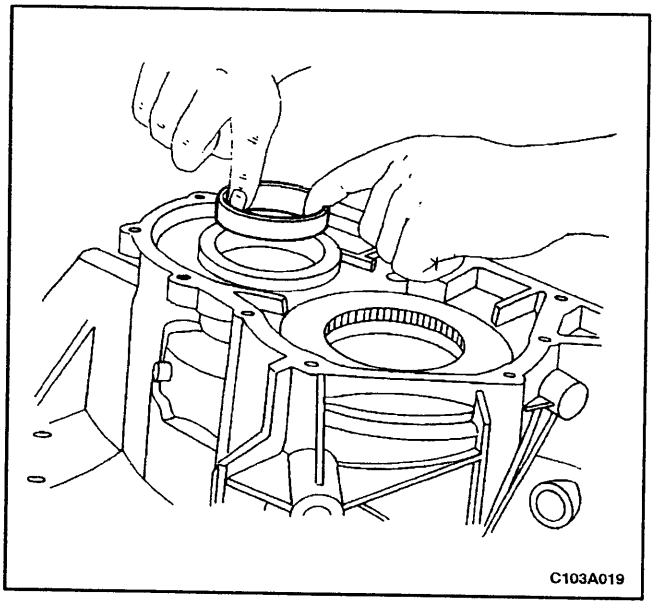
2. Install the side shaft outer ring securing bolts.

Tighten

Tighten the side shaft outer ring securing bolts to 20 N•m (15 lb-ft).


B103A187

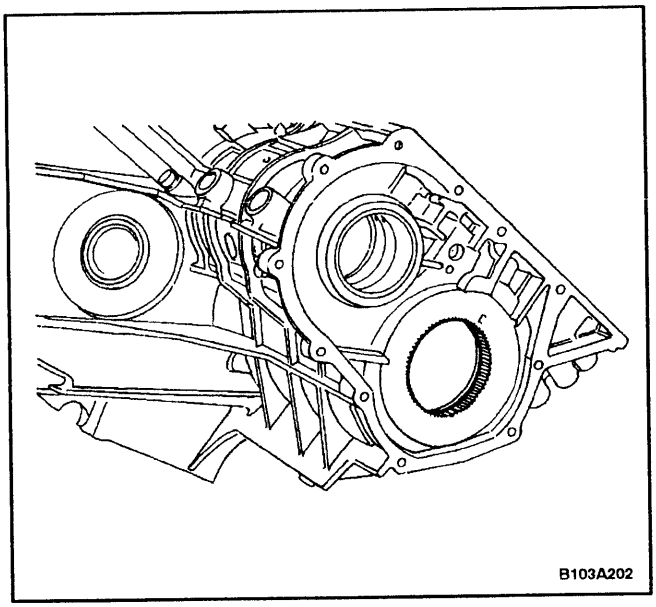
3. Lubricate the piston D seal with the transaxle fluid.
4. Install the piston D into the transaxle case.


C103A019

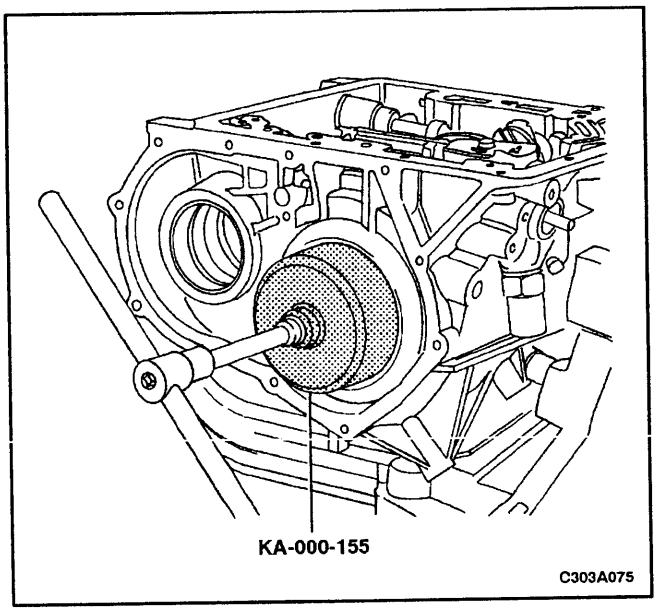
5. Rotate the transaxle 180 degrees so the side shaft access hole is in the UP position.

Important: Preheat the transaxle case to 70°C (158°F) to facilitate the installation of the small spur gear con bearing outer ring.

6. Install the small spur gear con bearing outer ring.


B103A202

7. Rotate the transaxle 90 degrees so the PARK/ LOCK components are in the UP position.
8. Fit the first freewheel into the teeth on the inside of the transaxle case.

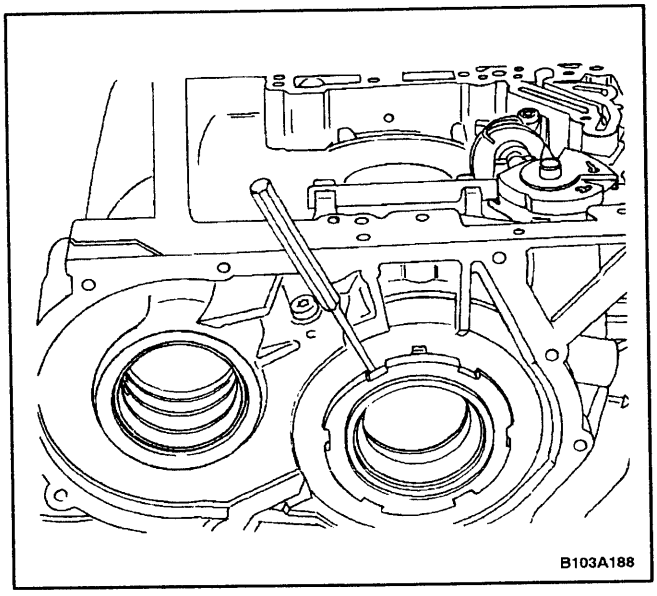


C303A075

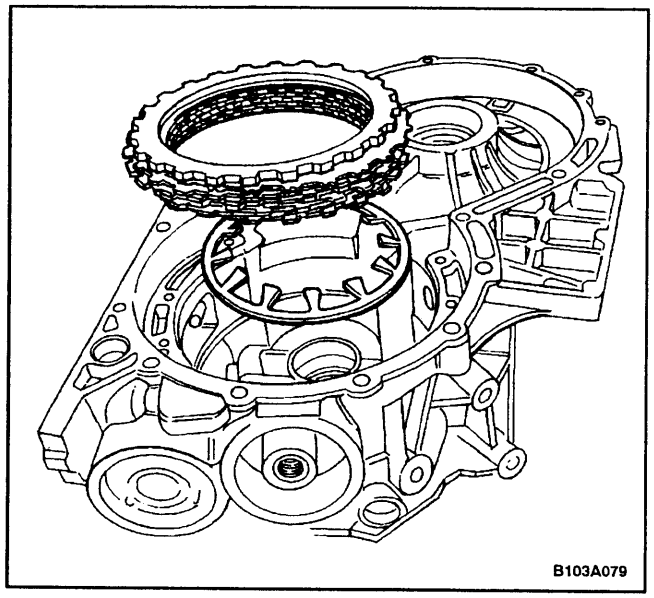
9. Install the security plate and the grooved nut onto the first freewheel using the grooved nut socket KA-000-155.

Tighten

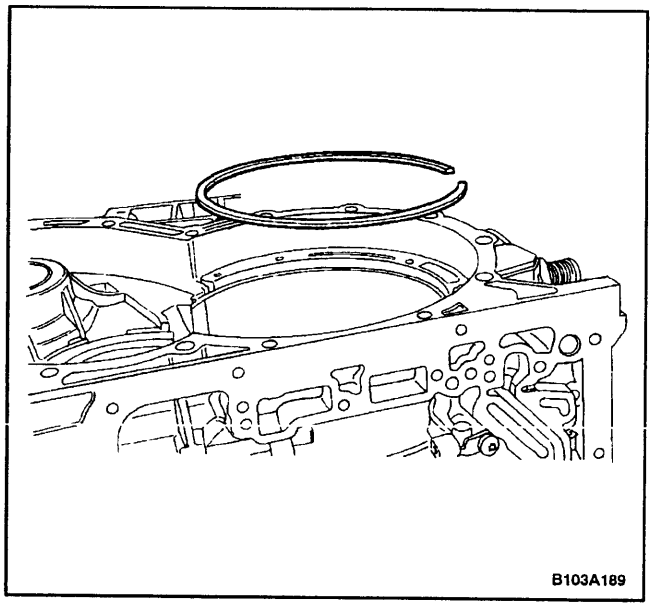
Tighten the grooved nut to 50 N•m (37 ft-lb).


B103A188

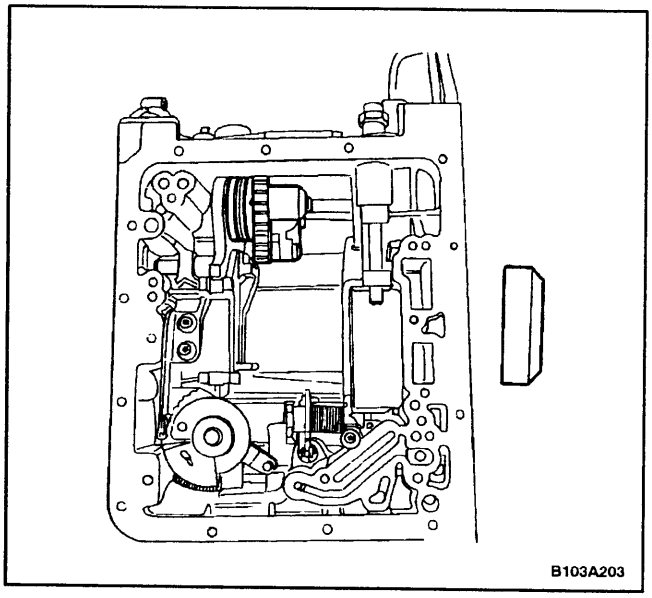
10. Using a punch, bend the tabs on the security plate to lock the grooved nut in place.


B103A079

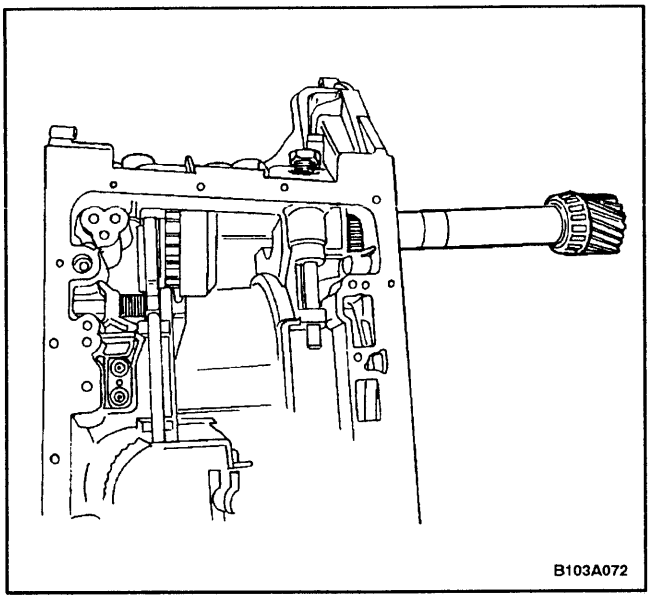
11. Rotate the transaxle 90 degrees so that the bell housing bolt holes are in the UP position.
12. Install the brake D assembly and the plate spring.


B103A189

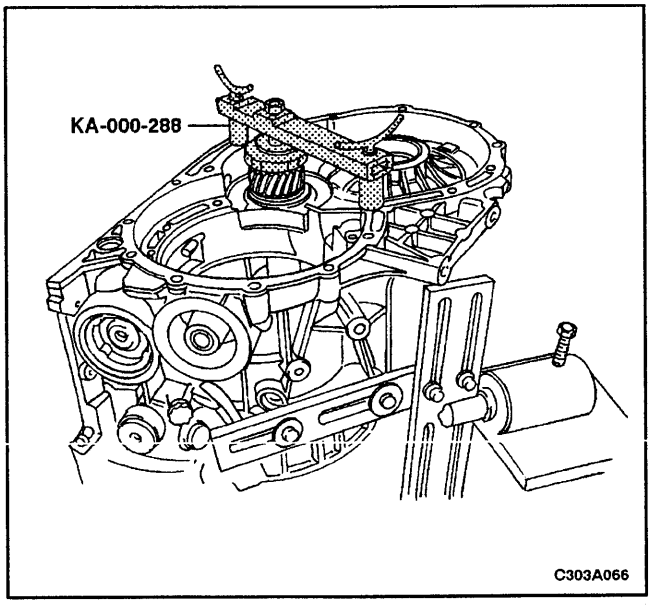
13. Install the snap ring into the case.


B103A203

14. Rotate the transaxle 90 degrees so the PARK/ LOCK components are in the UP position.
15. Install the governor and the cover plate.

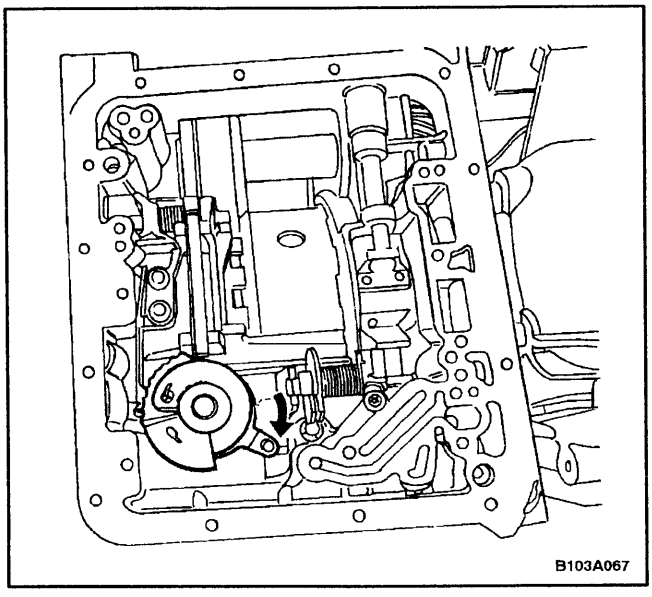

B103A072

16. Install the side shaft.

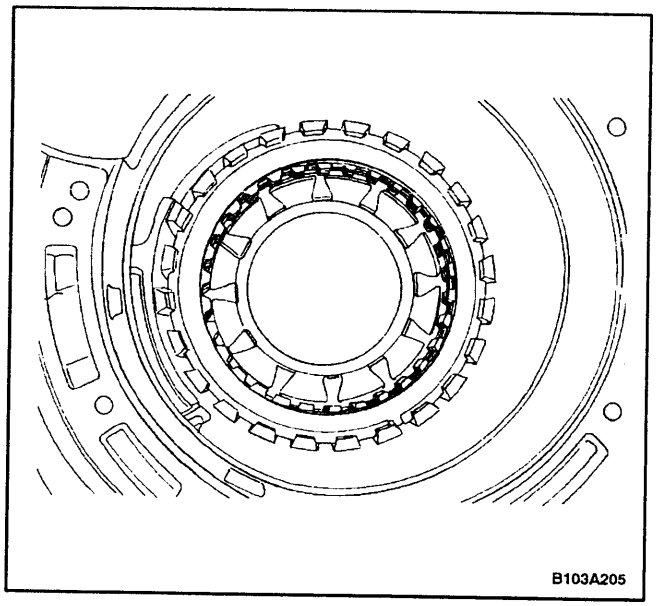


C303A066

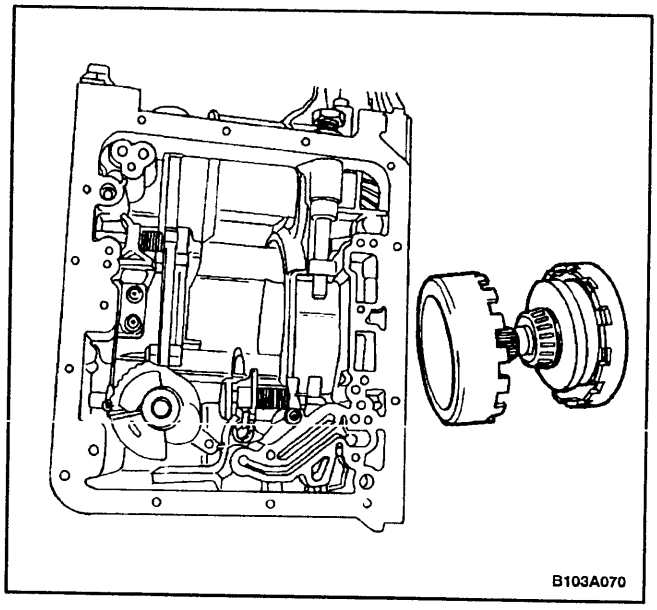
17. Use the side shaft retainer KA-000-288 to hold the side shaft in place.


B103A067

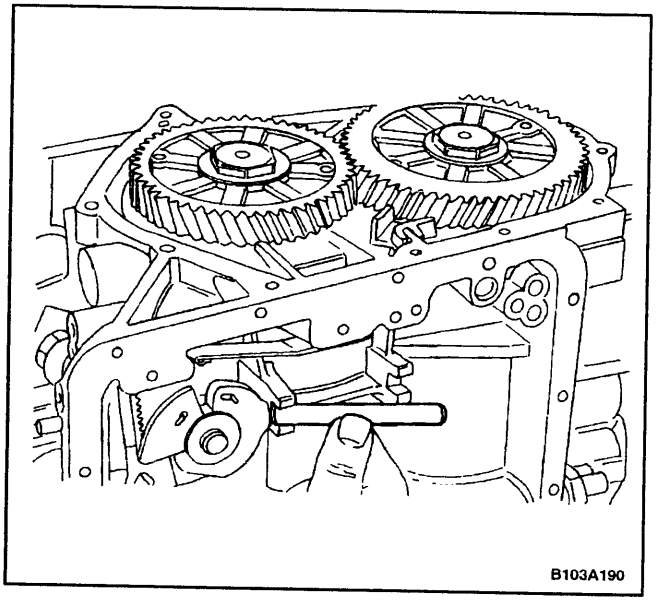
18. Make sure the gear selector is in the PARK position.


B103A205

19. Align the brake D assembly rings.


B103A070

20. Install the web gear onto the outer ring of the free-wheel. Install the output shaft/hollow gear assembly into the transaxle case.

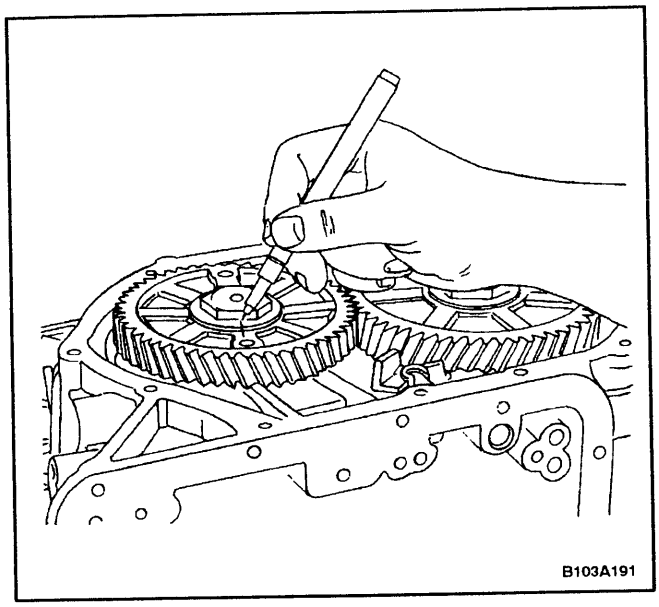

B103A190

21. Install the large spur gear with a 1.75 mm (0.069 inch) washer under it and the securing bolt.
22. Install the small spur gear and the securing bolt.
23. Rotate the transaxle 90 degrees so the spur gears are in the UP position.

Tighten

Tighten the small spur gear securing bolt for its first torque to 10 N•m (89 lb-in).

24. Remove the connecting rod and rotate the gears more than three around.

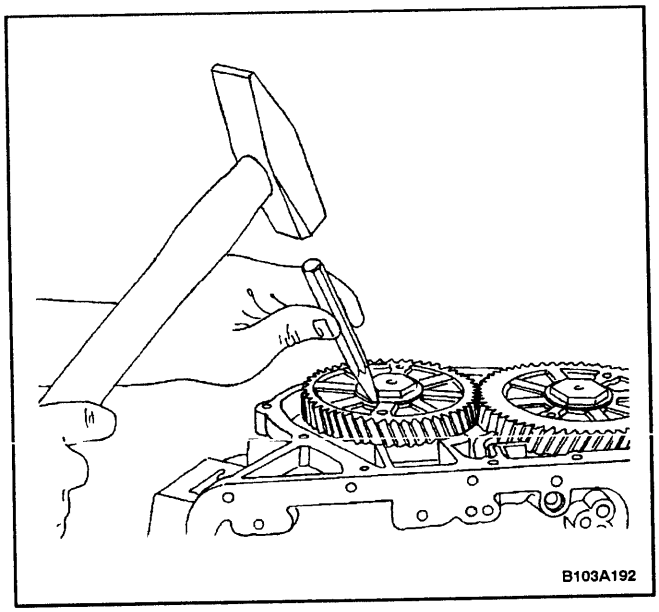

B103A191

25. Insert the connecting rod.

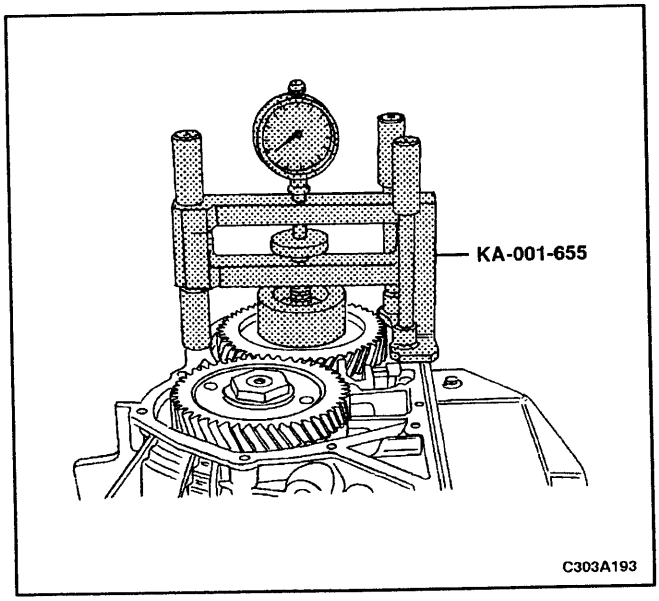
Tighten

Tighten the small spur gear securing bolt for its second torque to 20 N•m (15 lb-ft).

26. Mark the bolt and the gear.


B103A192

27. Turn the bolt 12 mm (0.5 inch) counterclockwise and bend the locking tabs on the securing bolt.

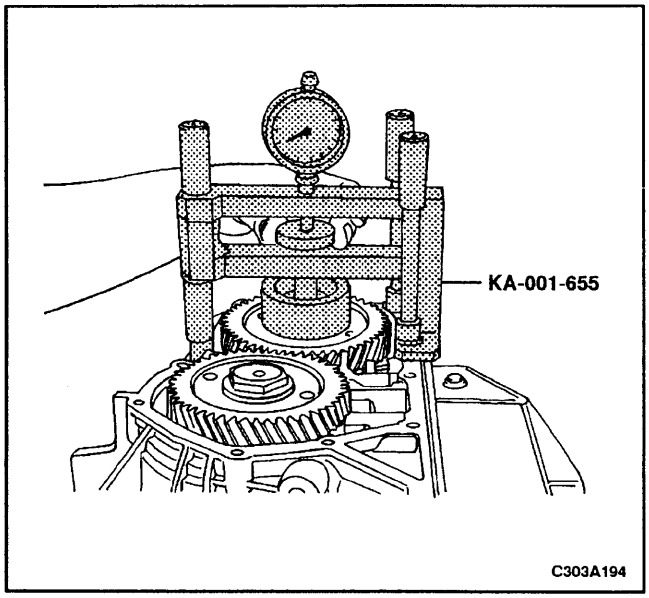


C303A193

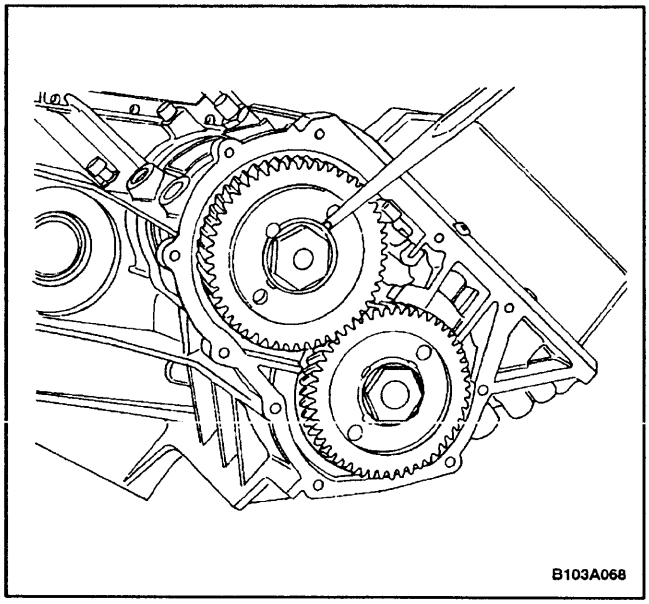
Tighten

Tighten the large spur gear securing bolt to 150 N•m (110 lb-ft).

28. Remove the connecting rod.
29. Install the spur gear clearance measurement tool KA-001-655.



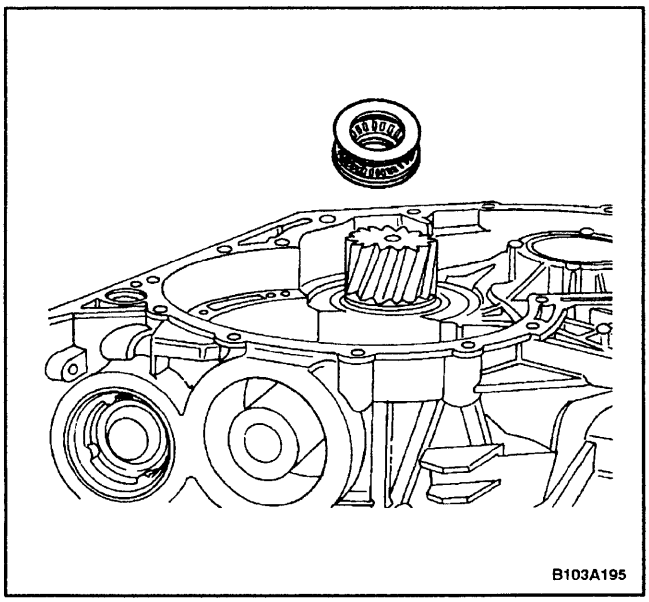
30. Turn the adjusting bolt down until the indicator of the gauge starts to move.



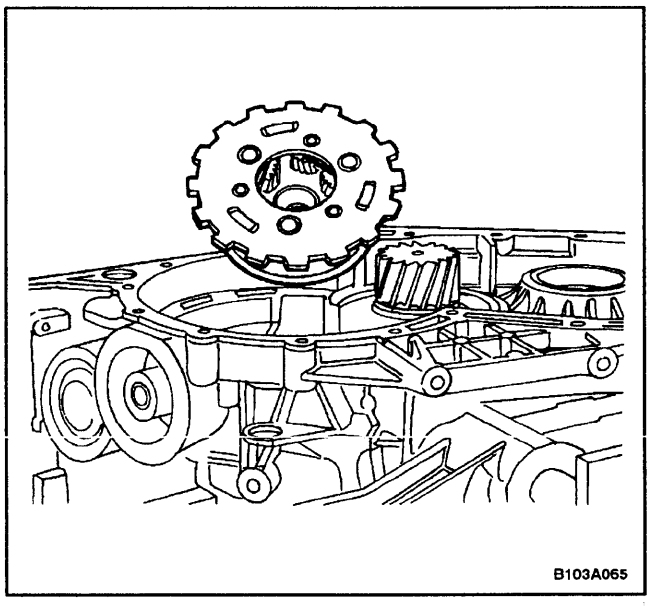
31. Turn the gears to bring the gauge back to point zero.
32. Remove the side shaft retainer KA-000-288 from the side shaft.
33. Turn the adjusting bolt 270 degrees counterclockwise, then turn the gears until the indicator on the gauge has been adjusted. Read the measurement (X) in millimeters.
34. Install the washer under the large spur gear. Determine the thickness of the washer (S) to be inserted under the large spur gear by the formula:
    S = 1.75 mm - (X mm - 0.06 mm), or S = 0.069 inch - (X inch - 0.002 inch).

Exampie: If the dial indicator measurement is 0.46 mm (0.018 inch), determine the washer thickness by subtracting 0.06 mm (0.002 inch) from 0.46 mm (0.018 inch) and then subtracting the difference from 1.75 mm (0.069 inch). In this case, S = 1.75 mm - (0.46 mm - 0.06 mm), i.e. S = 1.35 mm, or S = 0.069 inch - (0.018 inch - 0.002 inch), i.e. S = 0.052 inch. The washer thickness to be placed under the spur gear is equal to 1.35 mm (0.052 inch).

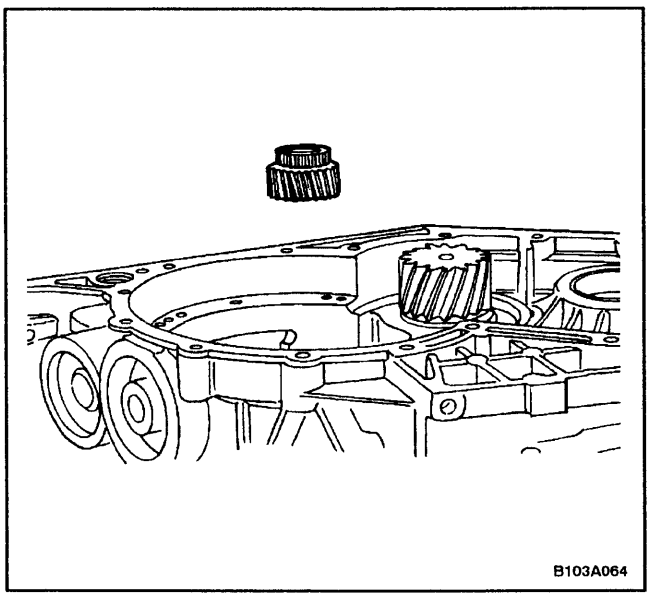
35. Remove the measuring device KA-001-655 and replace the washer under the large spur gear, if necessary.
36. Secure the spur gear bolt by bending the locking tabs.


B103A195

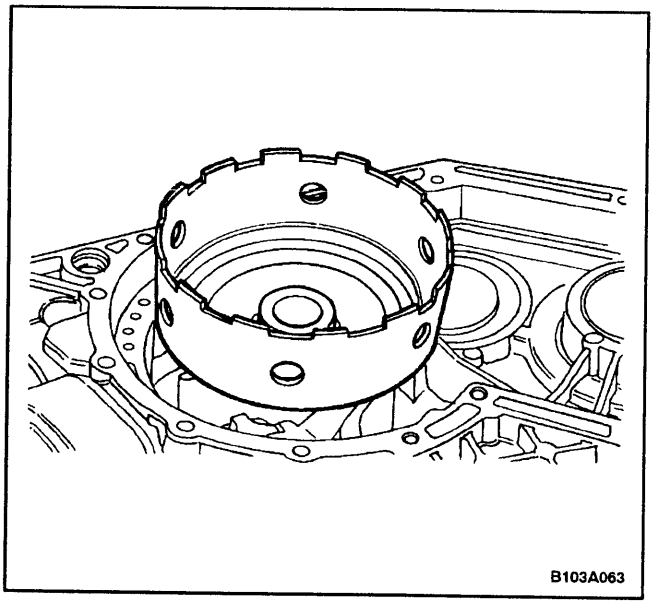
37. Install the side cover. Refer to "Case Side Cover Pan and Gasket" in this section.
38. Rotate the transaxle 180 degrees so the differential bearing race is on the top.
39. Install the washer, the axle cage, and the thrust washer.


B103A065

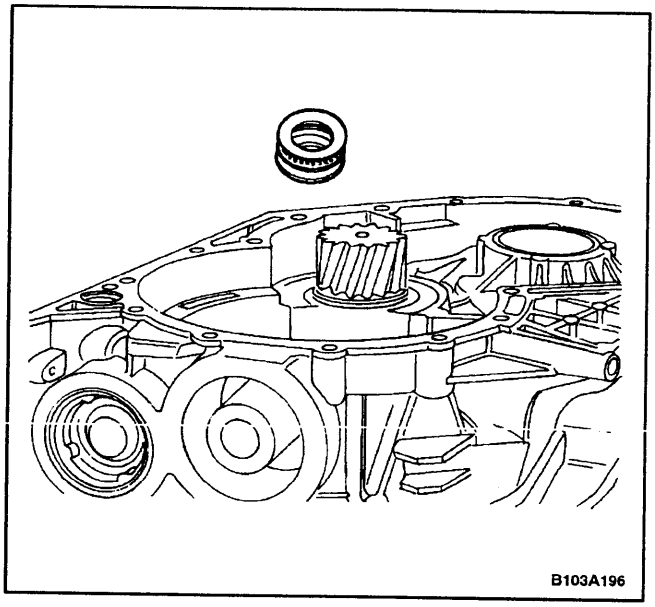
40. Install the planetary assembly into the housing case.


B103A064

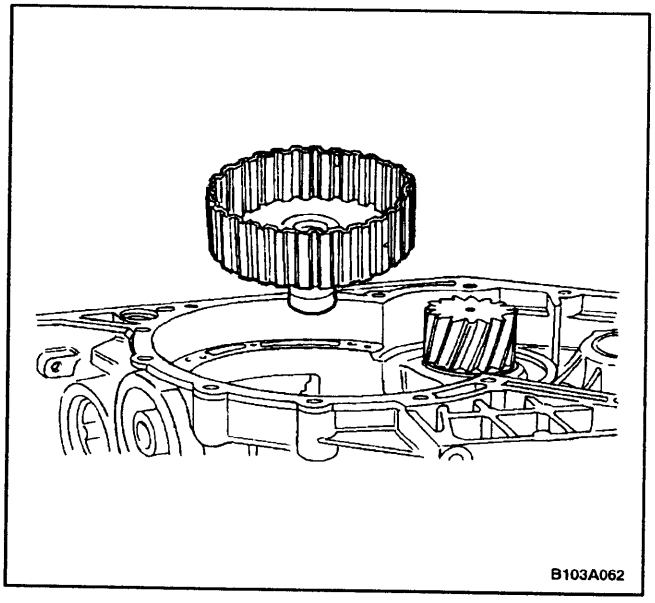
41. Install the sun gear into the planetary assembly.


B103A063

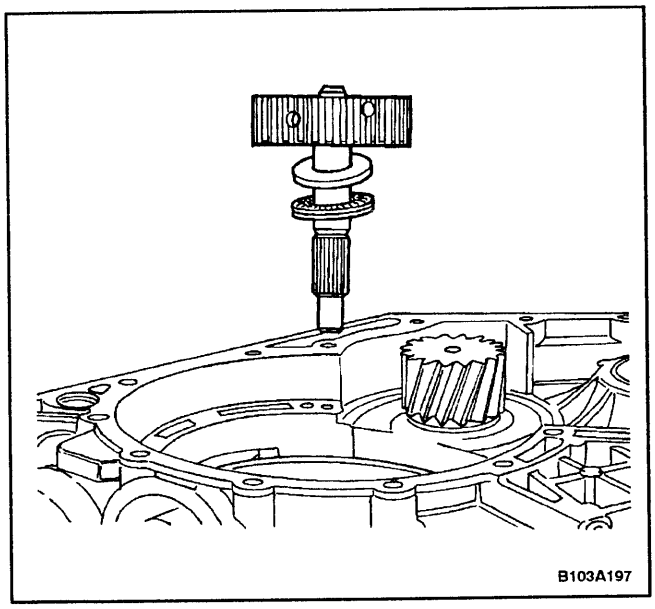
42. Install the inner teeth of the drive shell into the outer teeth of the sun gear.


B103A196

43. Install the washer, the thrust bearing, and the thin axle washer into the drive shell.

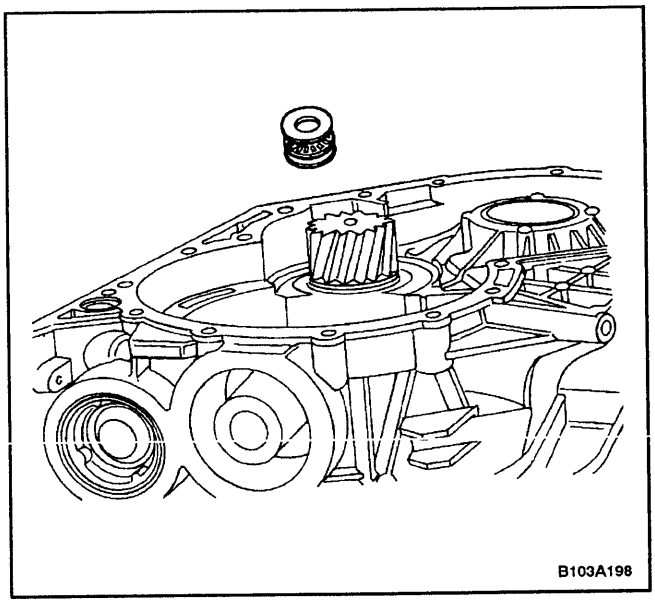

B103A062

44. Install the sun gear shaft into the housing case.

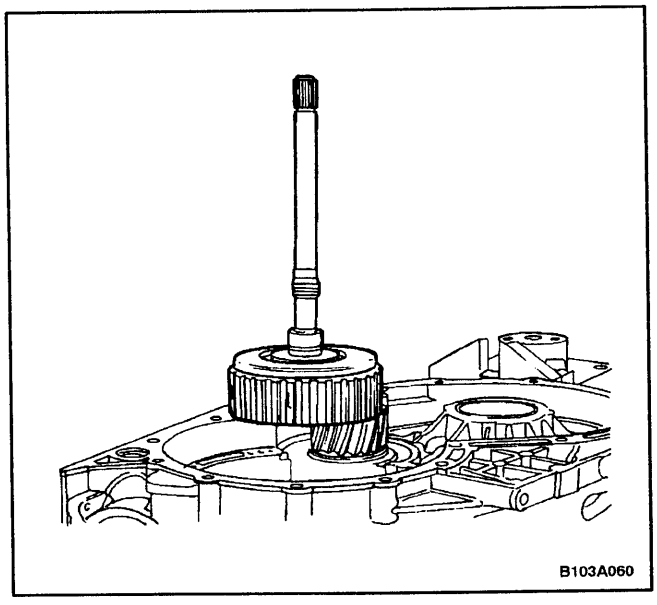

B103A197

Important: If the sun gear assembly has been installed correctly, the drive shell will turn toward the sun gear in one direction only.

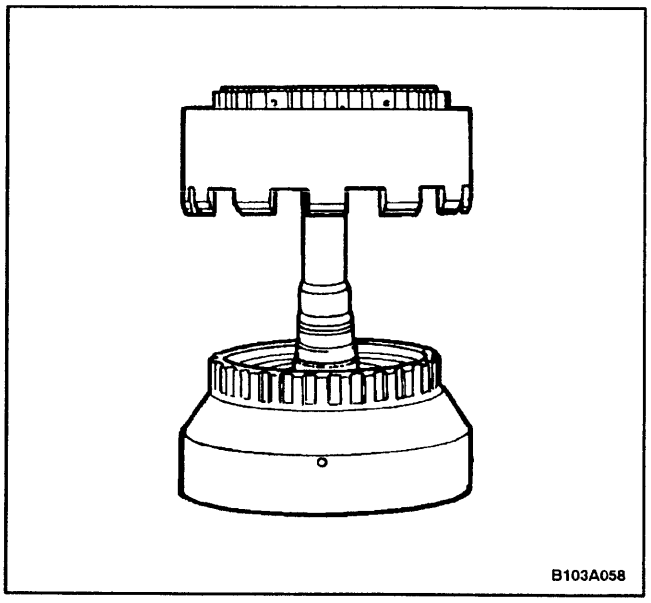
45. Install the washer, the axle cage, and the thrust washer onto the intermediate shaft and install the intermediate shaft assembly into the housing.


B103A198

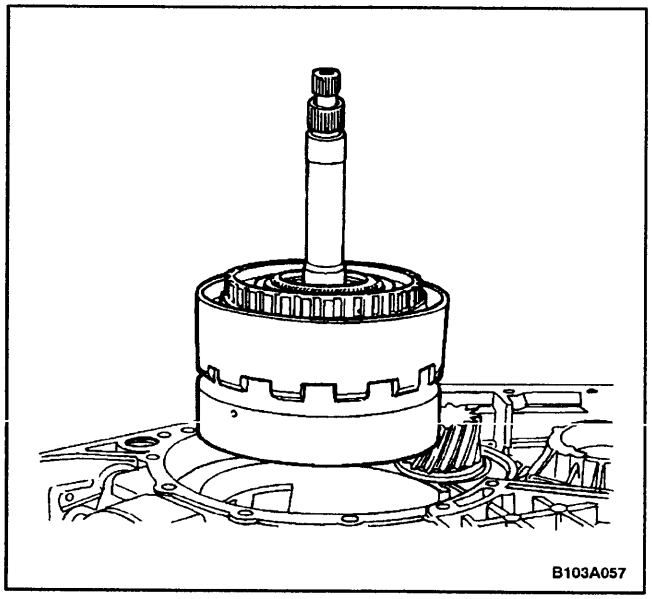
46. Install the washers and the axle cage onto the intermediate shaft.


B103A060

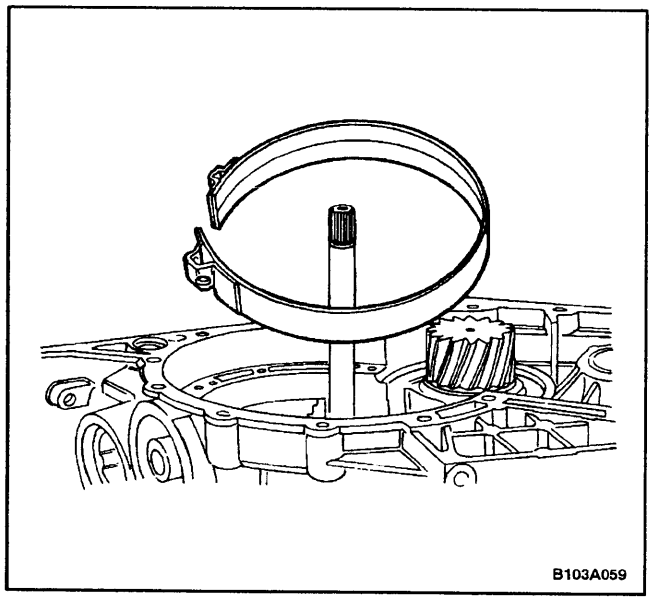
47. Install the motor shaft assembly into the case using a turning motion. The motor shaft is correctly installed when the cylinder E is aligned with the edge of the sun shaft carrier.


B103A058

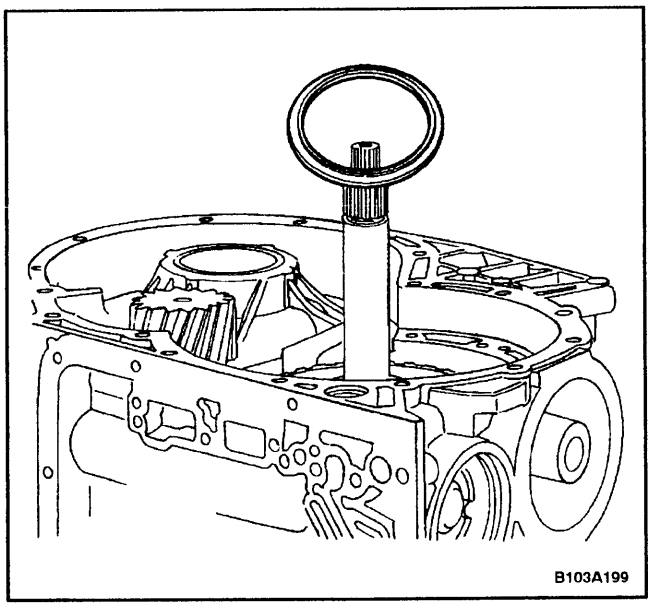
48. Join the clutch A and the clutch B.


B103A057

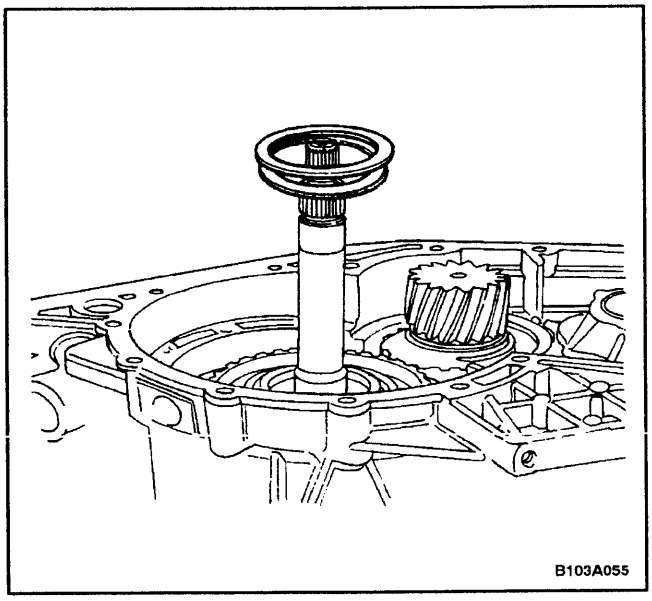
49. Install the clutch A and B assembly into the transaxle case using a twisting motion.


B103A059

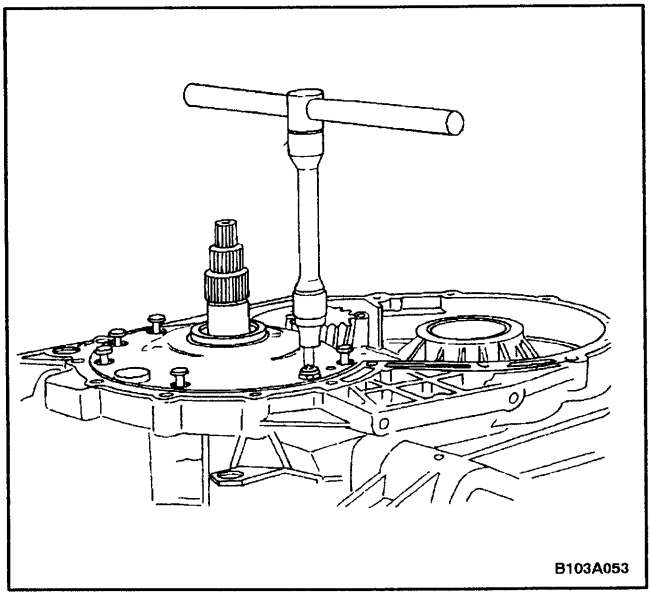
50. Install the band C'.


B103A199

51. Install the holding ring on top of the security washer on the second freewheel.


B103A055

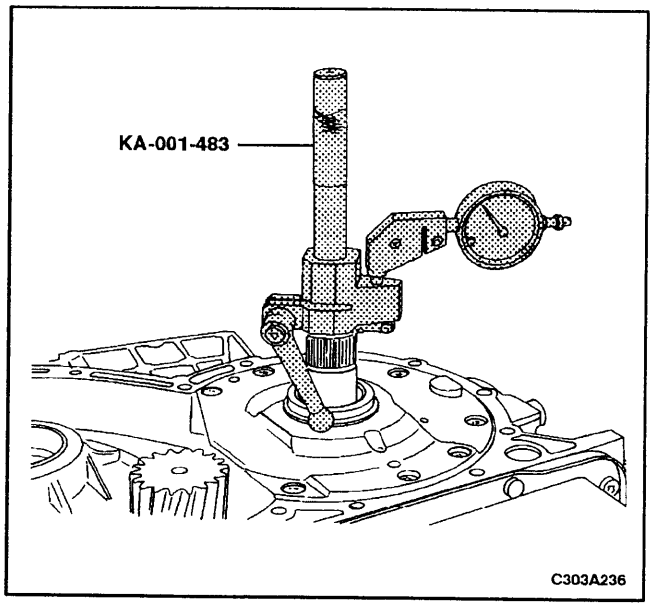
52. Install the adjustment washers and the thrust washer onto the motor shaft.


B103A053

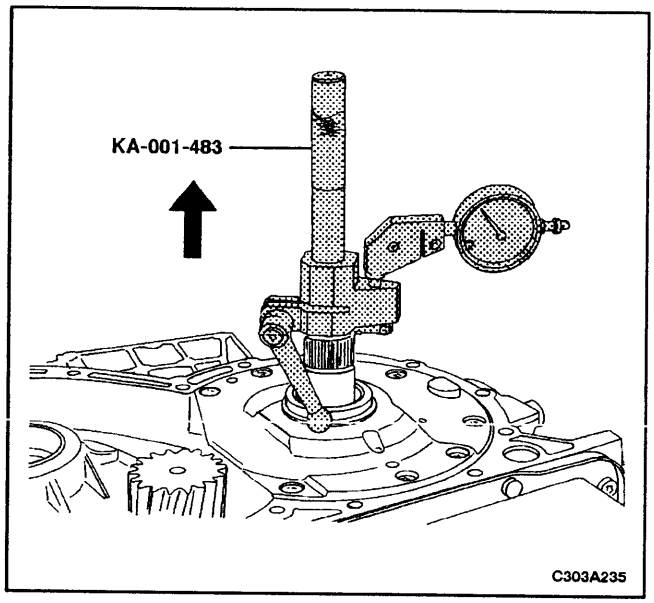
53. Install the pump assembly into the transaxle case with the bolts.

Tighten

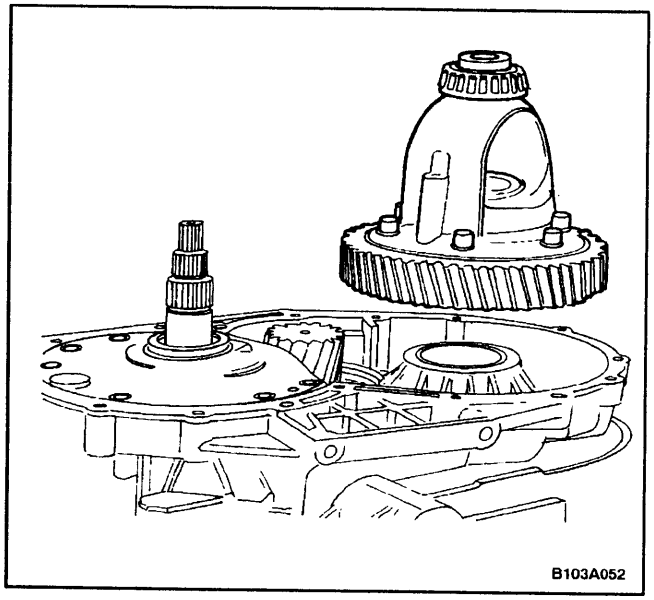
Tighten the intermediate plate-to-housing bolts to 10 N•m (89 lb-in).



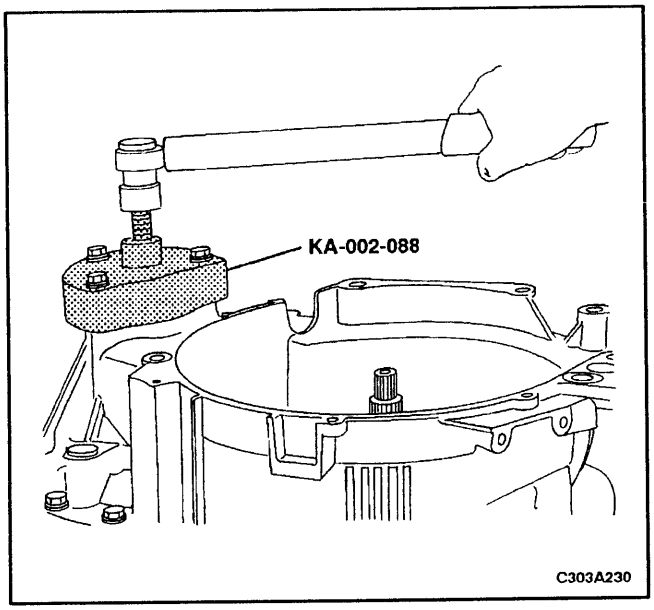
54. Install the axial clearance measurement tool KA-001-483.



55. Place the indicator gauge at zero and pull up on the device.



56. Clearance should be between 0.1 mm (0.004 inch) and 0.3 mm (0.01 inch). A thicker or thinner washer can be used to bring the clearance within tolerance.
57. Install the differential assembly into the transaxle housing.

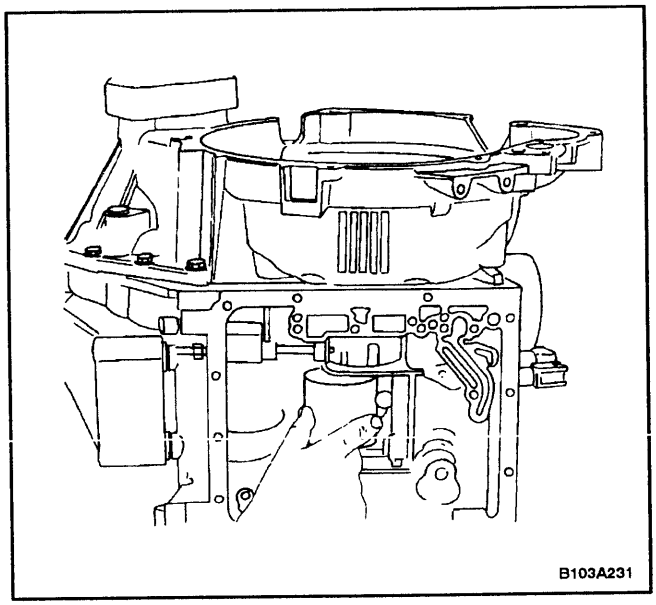


Important: Remove the valve body and the extension housing from the transaxle in order to adjust the differential.

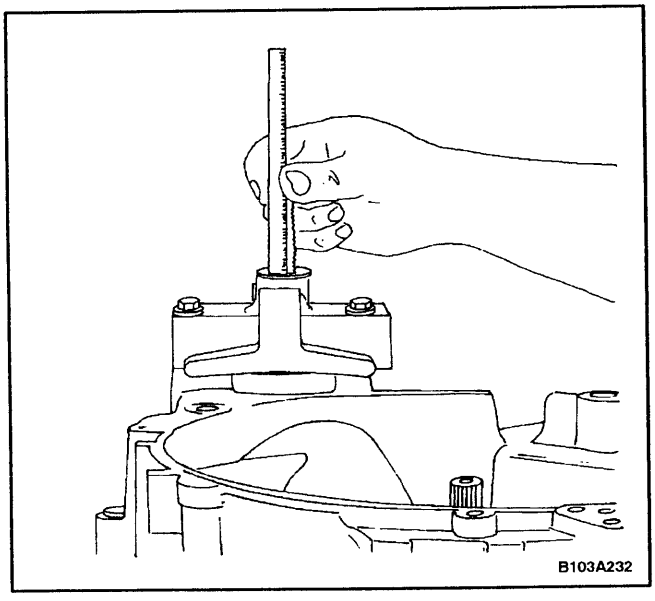
58. Install the differential adjustment tool KA-002-088.

Tighten

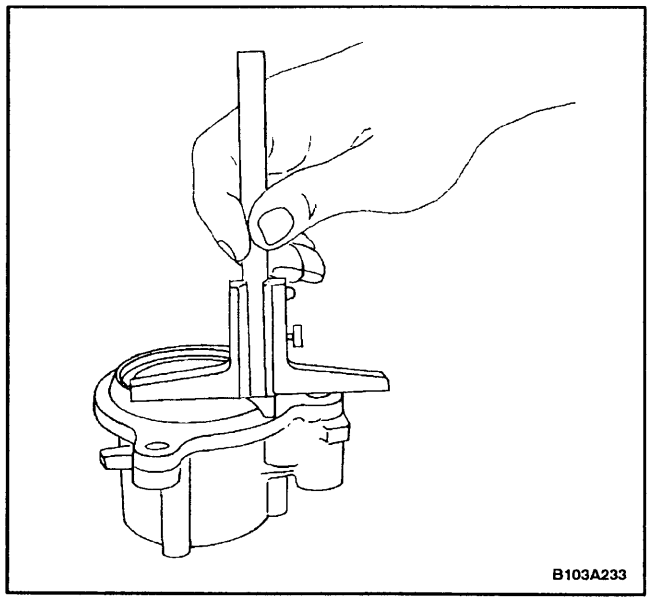
Tighten the differential adjustment tool to 7 N•m (62 lb-in).



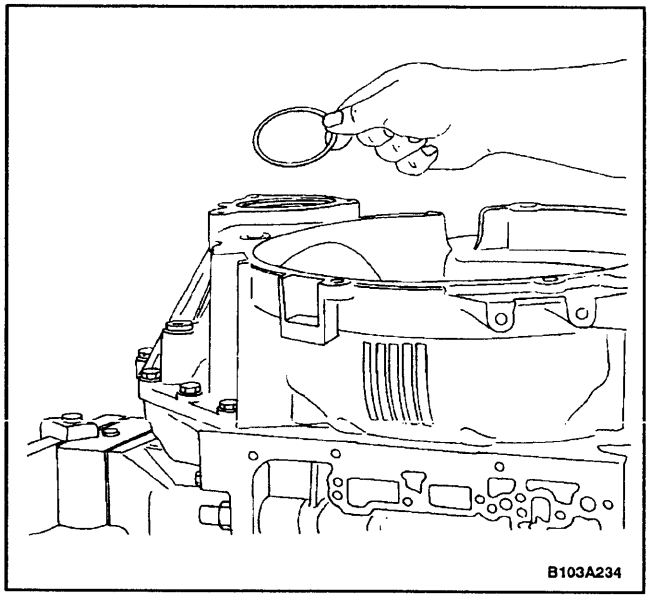
59. Turn the drive shell clockwise to settle the bearings. Check the torque again.



60. Use a depth gauge to determine the distance (A) between the bearing outer ring and the top of the bell housing.

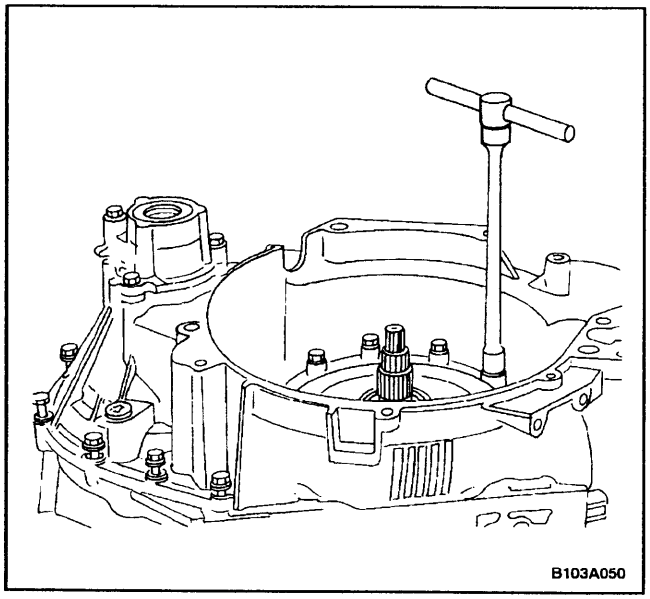

B103A233

61. Use a depth gauge to determine the distance (B) between the top of the extension housing and the bolt flange.


B103A234

62. Depending on the measurement results, insert one or two washers between the top of the differential and the extension housing. Select different washer thicknesses to obtain the best result. The washer thickness (S) can be determined by the formula S=A-B+0.1 mm, or S=A-B+0.004 inch.

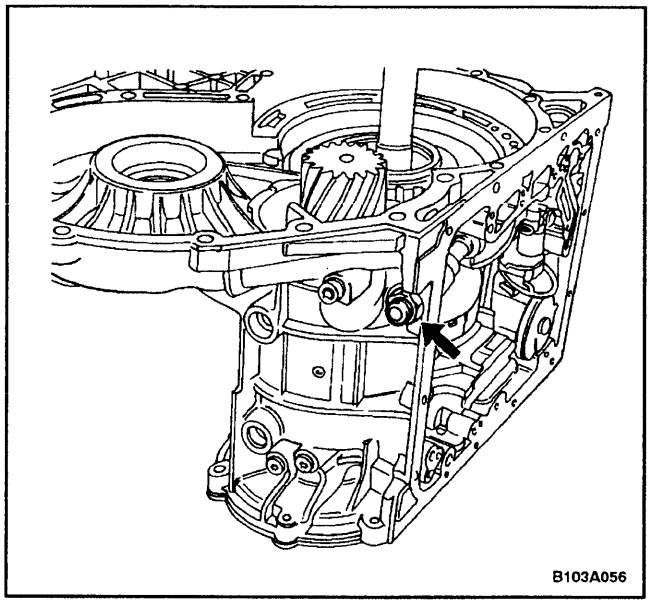
Example: The distance between the bearing outer ring and the top of the bell housing is 10.2 mm (0.40 inch). The distance between the top of the extension housing and the bolt flange is 8.65 mm (0.341 inch). The washer thickness can be determined by subtracting 8.65 mm (0.341 inch) from 10.2 mm (0.40 inch) and then adding 0.1 mm (0.004 inch). In this case, the washer thickness is equal to 1.65 mm (0.039 inch).


B103A050

63. Install the gasket and the bell housing assembly with the bolts.

Tighten

Tighten the bell housing bolts to 23 N•m (17 lb-ft).


B103A056

64. Lubricate the cylinder B with the transaxle fluid.

Tighten

Tighten the band C' adjusting bolt to 10 N•m (89 lb-in).

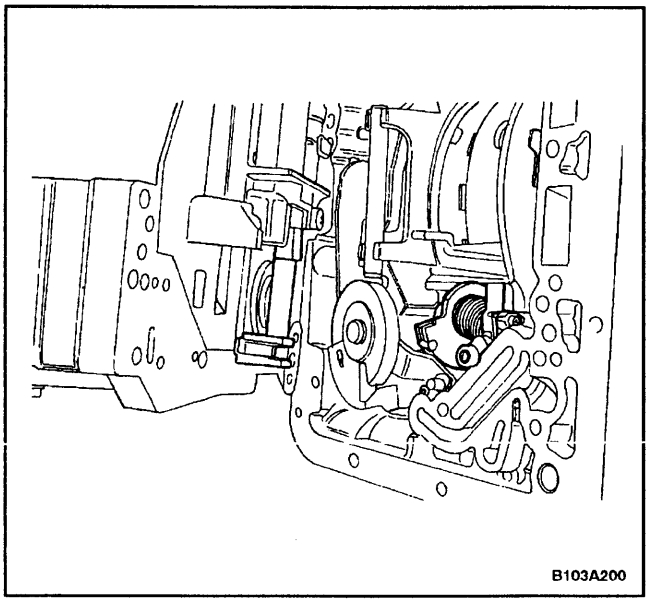
Important: Turn the cylinder B while tightening the band to ensure correct settlement.

65. Turn the adjusting bolt counterclockwise 3 mm (0.1 inch).

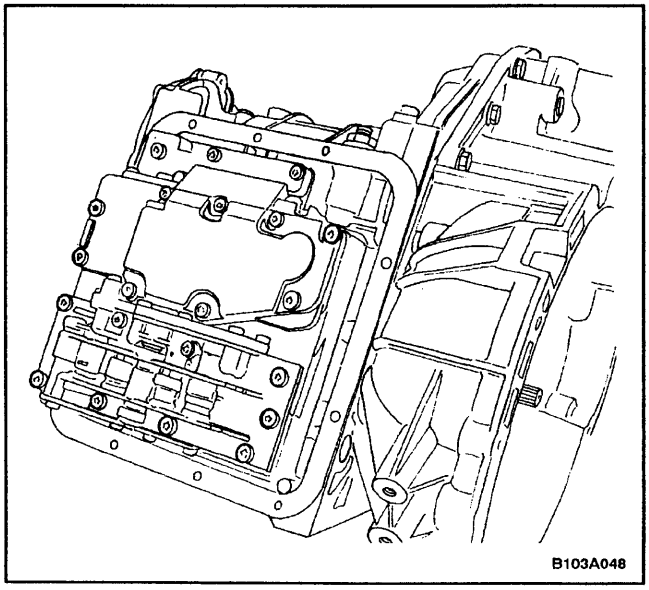
Important: The clearance between the adjusting bolt and band is 0.9~1.2mm.

Tighten

Tighten the band C' locking nut to 80 N•m (59 lb-ft).


B103A200

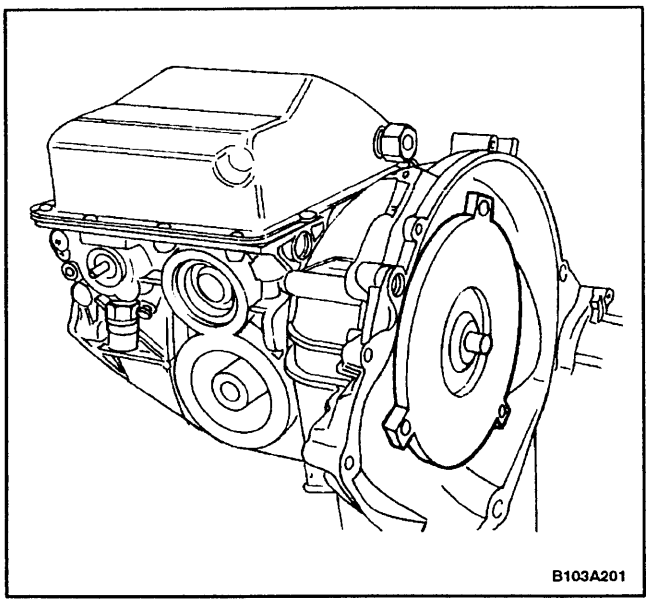
66. Rotate the transaxle 90 degrees so the PARK system components are in the UP position.
67. Install the valve body into the case, making sure the manual and throttle levers are positioned properly.


B103A048

68. Install the valve body bolts.

Tighten

Tighten the valve body bolts to 8 N•m (71 lb-in).



B103A201

69. Install the fluid pan gasket and the fluid pan. Refer to "Pan and Gasket" in this section.
70. Install the torque converter assembly, making sure the converter engages the input shaft, the stator support, and the pump drive gear.
71. Install the transaxle in the vehicle. Refer to "Transaxle Assembly" in this section.

GENERAL DESCRIPTION AND SYSTEM OPERATION

ZF 4 HP 14 AUTOMATIC TRANSAXLE

The ZF 4 HP 14 is a four-speed automatic transaxle designed for cars with front-wheel drive and a transversely mounted engine. The transmission consists of a hydrodynamic, hydrokinetic torque converter with an integrated torsional damper and a four-speed planetary unit. Power transfer is transferred from two spur gear sets and a countershaft to the differential built into the transaxle housing.

In first, second and reverse gear, power is transferred from the engine to the gear box by the use of the torque converter. In third gear, the transaxle works according to the power-splitting principle. Approximately 40 percent of the input power is transmitted hydraulically through the torque converter. Approximately 60 percent of the input power is transmitted mechanically through the converter cover, the integrated torsional damper, and a shaft. In fourth gear, 100 percent of the power is transmitted mechanically through the converter cover, the integrated torsional damper, and a shaft.

The control elements used are hydraulically activated clutches or brakes and freewheel units.

A selector level controls the automatic transaxle. The hydraulically controlled shift points are dependent on the accelerator pedal position and the road speed of the vehicle.

TORQUE CONVERTER

The torque converter transmits power hydraulically from the engine to the transaxle and increases the input torque, particularly when the vehicle is pulling away.

The torque converter is connected to the turbine shaft.

The pump, the turbine, and the stator are contained in an enclosed housing which is completely filled with fluid under pressure. Rotation and power are transmitted by the kinetic energy of the flowing fluid. The torque converter sustains no wear, as there is no mechanical connection between the driving and the driven sections.

The engine-driver impeller induces the fluid to spin. Centrifugal force causes the fluid to flow outward toward the periphery of the impeller, causing the fluid to flow at a higher velocity to the turbine.

In the turbine, the kinetic energy of the fluid is converted to mechanical energy. The fluid then flows through the stator and deflects at an angle which is favorable to the impeller.

The stator is connected to the torque converter housing across the freewheel. By deflecting the fluid, the stators are subjected to torque which, in turn, causes an increase in the turbine torque. The input engine torque is thereby increased approximately twofold as the vehicle pulls away.

The relationship between the turbine torque and the impeller torque is known as the torque multiplication or conversion. The greater the speed difference between the impeller and the turbine, the greater the multiplication or conversion. Maximum torque multiplication is reached when the turbine is stationary. With an increase of the output shaft speed, torque multiplication or conversion decreases until it reaches a ratio of 1:1. The stator then rotates freely in the flowing fluid and the torque converter acts purely as a fluid-coupling device.

The torsional damper which is integrated into the converter minimizes the torsional oscillations and the load change shocks which occur in the third and the fourth gears because of the mechanical power transfer. The torsional damper is connected to the engine shaft which transmits the power mechanically between the engine and the transaxle.

FLUID PUMP

The fluid pump is located between the torque converter and the transaxle case and is driven directly by the torque converter. The pump sucks the fluid through a filter and delivers it to the main pressure regulator valve of the control system. Excess fluid flows back to the pump.

The fluid pump fulfills the following functions:

- Generates line pressure.
- Delivers fluid under pressure to the torque converter, thus preventing air bubbles in the fluid.
- Induces a flow of fluid through the torque converter in order to eliminate heat.
- Supplies fluid pressure to the hydraulic control system.
- Supplies fluid pressure to the shift components.
- Lubricates the transaxle with fluid.

PLANETARY GEARS

The ZF 4 HP 14 automatic transaxle is equipped with a Ravigneaux planetary gear set which consists of the following elements:

- Two sun gears of different sizes, each equipped with three planetary gears.
- One planet carrier.
- One annulus or ring gear.
- Different ratios are obtained by transmitting power through some gears in the planetary gear set while locking other gears.

Power to the drive shafts is always transmitted by means of the annulus, or the ring gear. Refer to "Power Flow" in this section.

CONTROL ELEMENTS

A freewheel consists of an outer ring and an inner ring with rollers or rockers, also known as sprags, fitted between them. A freewheel can transmit torque in one direction only and rotates freely in the opposite direction. The function of the freewheel is to achieve smooth, jerk-free gear shifting.

The ZF 4 HP 14 uses the sprag-type clutch for both the freewheel first gear, associated with the brake D, and the freewheel second gear, associated with the brake C.

Sprag-Type Freewheel

When the sprag type freewheel is in the rotation direction, the sprags are arranged between the inner and the outer rings so that the two rings can turn together easily.

When the sprag-type freewheel is in the locking direction, the asymmetrical sprags are located between the inner and the outer rings which are pushed into an upright position when the rings try to rotate in opposite directions. As a result, they lock between the inner and the outer rings, which prevents the rings from rotating in opposite directions.

The sprags are contained in a special retainer cage.

Plate Clutches and Brakes

These gear-shifting elements consist of the following parts:

- A cylinder.
- A piston.
- A plate set of inner, intermediate, and outer plates.
- The Belleville spring rings.

The gear shifting elements are locked hydraulically by fluid pressure applied between the cylinder and the piston. When the pressure is reduced, the Belleville spring ring pushes the piston back to its original position.

The function of the gear-shifting elements is to carry out gear shifting under load. In this case the plate clutches A, B, and E transmit the engine power to the planetary gear set. The plate disk brakes C and D serve as supports for the planetary gear set elements in the transaxle case.

Because of the hydraulic operation and the continuous lubrication, energy is transmitted virtually without wear. The gear-shifting elements are not subjected to mechanical wear and require no periodic adjustment.

Brake Bands

A hydraulic piston activates Brake band C and acts via the cylinder B and the drum as a brake for sun gear 1.

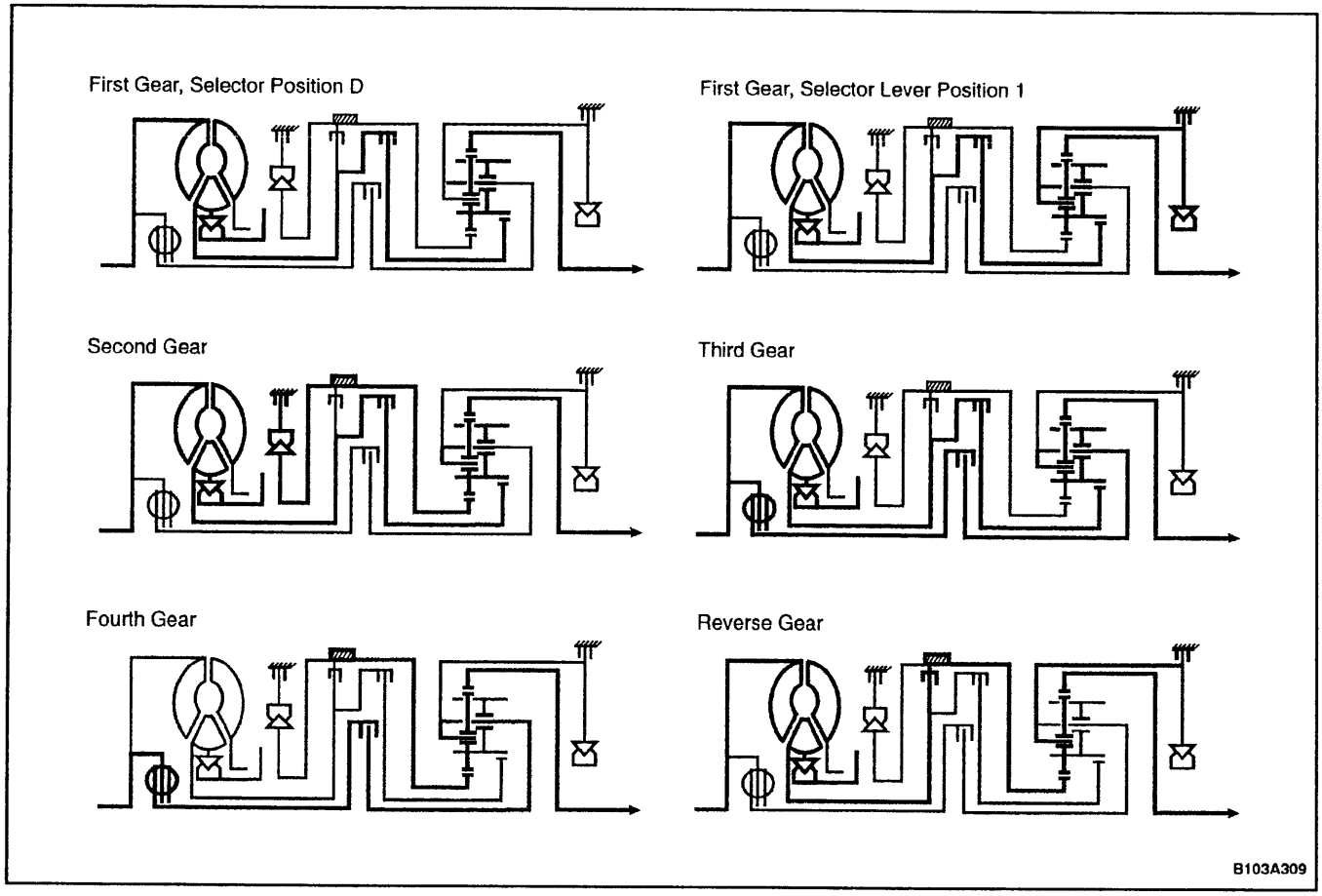
This brake band is unusual in that it sustains no wear and, therefore, needs no periodic adjustment.

Brake Band	First Gear	Second Gear	Third Gear	Fourth Gear	Reverse
Clutch A	a	a	a	-	-
Clutch B	-	-	-	-	a
Brake C	-	a	b	b	-
Brake Band C	-	a	-	a	-
Brake D	a	-	-	-	a
Clutch E	-	-	a	a	-
Freewheel First	a	-	-	-	-
Freewheel Second	-	a	-	-	-

a = Power Transmitting Elements

b = Elements in Waiting Position

POWER FLOW



First Gear, Position D

Power is transmitted through the torque converter turbine and the turbine shaft to the clutch A. This drives the sun gear 2 via the sun gear shaft.

The freewheel first gear locks the planet carrier in counterclockwise rotation.

The sun gear 2 drives the planet gear 2, which drives the planet gear 1. These, in turn, drive the ring gear which is connected to the output shaft.

First Gear, Position 1

The brake D is now also applied. The planet carrier is locked. The overrun braking will be obtained when the accelerator pedal is released.

Second Gear

Power is transmitted through the torque converter turbine and the turbine shaft to the clutch A. This drives the sun gear 2 via the sun gear shaft.

The sun gear 1 is locked by the brake C and the brake band C.

The freewheel second gear is in the traction position.

The planetary gear 2 drives the planetary gear 1, which rolls on the stationary sun gear 1. The power flow then continues, as in the first gear, through the ring gear.

Third Gear

Approximately 40 percent of the power is transmitted hydraulically between the engine and the transaxle.

Power is transmitted through the torque converter turbine and the turbine shaft to the clutch A. This drives the sun gear 2 via the sun gear shaft.

Approximately 60 percent of the power is transmitted mechanically between the engine and the transaxle.

Power is transmitted through the engine shaft to the applied clutch E. The inner clutch plate disk holder E is meshed with the planet carrier.

As the sun gear 2 and the planet carrier are driven simultaneously, the ratio of the planetary gear set is 1:1. The output shaft is driven via the annulus.

Fourth Gear

Power is transmitted through the engine shaft and the clutch E to the planet carrier. The sun gear 1 is locked by the drum of the brake band C. The planet gear 1 thus runs on the sun gear 1 and drives the output shaft via the annulus.

Reverse Gear

The clutch B is applied and transmits power from the turbine shaft, through the drum to the sun gear 1.

The clutch D is applied and locks the planet carrier. As a result, the planet gear 1 reverses the direction of rotation between the sun gear 1 and the annulus, which now drives the output shaft counterclockwise.

PARKING BRAKE

The parking brake is applied when the selector lever is moved to position P. The parking brake acts as a mechanical latch which prevents the vehicle from rolling away.

The parking safety pawl engages the teeth of the parking interlocking gear which is connected to the side shaft of the transaxle. This locks the driving wheels of the vehicle.

When the selector lever is in position P, a pre-loading spring ensures that the parking pawl engages the interlock gear as soon as the car starts to roll.

A locking cone prevents inadvertent release of the parking pawl, even if the vehicle has a heavy trailer hitched to it and is parked on a steep grade.

The parking pawl cannot be engaged inadvertently. At high speeds, it slides over the top of the parking gear teeth. It can be engaged only at lower speeds.

Position P should only be selected when the vehicle is stationary. The parking pawl would be subjected to excessive stress if it were engaged while the vehicle was moving.

HYDRAULIC CONTROL SYSTEM

The hydraulic control system is affected by the following:

- The selector lever position or the line pressure.
- The accelerator pedal position or the throttle pressure.
- The speed of the vehicle or the governor pressure.

Selector Valve

The selector valve routes the fluid flow, depending on the selector lever setting, from the line pressure valve through the shift and the lockup valves, to the clutches, and to the brakes.

Line Pressure Regulator Valve

The line pressure regulator valve opens when the pressure rises to a certain value, thus returning the fluid back to the suction side of the pump. This valve acts as a variable pressure-limiting valve and operates relative to the modulator.

The line pressure controls the system pressure in the valve body. The modulator pressure, the throttle pressure, the governor pressure, and the torque converter pressure are all generated from the line pressure.

Lubrication Valve

Fluid flows from the torque converter through the lubrication valve into the transaxle case.

Torque Converter Pressure Relief Valve

The torque converter pressure relief valve limits the fluid pressure in the torque converter.

Modulator Valve

The modulator pressure simulates the engine torque, to which the gear shifting, carried out by the control elements, must be adjusted.

At low engine torque, the closing pressure for engaging the control elements is low.

At high engine torque, the closing pressure is high. Since the engine torque may be high even at low engine speeds, the function of the modulator pressure is to boost the closing pressure in the control elements during this stage.

The modulator valve operates in three stages.

Stage One

The accelerator pedal is pressed. The modulator valve adjusts the pressure relative to the throttle pressure.

Stage Two

Since pressure boosting is no longer required, the modulator valve serves as a pressure-reducing valve and thus maintains a constant pressure. The modulator valve spring determines the level of this pressure. This stage starts only when the modulator valve piston reaches the STOP in the passage.

Stage Three

At a suitable ignition setting, the modulator pressure can be reduced on kickdown.

Throttle Pressure Valve

The throttle pressure valve is a pressure-reducing valve which adjusts the throttle pressure relative to the following accelerator pedal positions.

Idling Position

The accelerator pedal is not pressed. The throttle pressure valve piston is in its starting position, but there is not yet any throttle pressure.

Part-Throttle Position

The accelerator pedal is slightly pressed. This stage exists from the idling position until the throttle pressure valve piston has reached passage 1 to generate the throttle pressure.

Full-Throttle Position

The accelerator pedal is pressed to the full-throttle position and the throttle cam is moved to the kickdown position. This stage exists from the point at which the passage 1 opens until the throttle pressure valve piston has reached the passage 2.

Kickdown Position

The accelerator pedal is pressed past the full-throttle position and the throttle cam is moved past the kickdown position. The passage 2 is open in this stage.

Shift Valves

There is a shift valve for each gear-shifting stage. These shift valves initiate upshift (1-2, 2-3, 3-4) or downshift (4-3, 3-2, 2-1) by exposing or closing the valve body passages used for routing the fluid pressure to the control elements. This takes place when the valves change over from the position 1 to the position 2 in response to the incoming signals from the line pressure, the governor pressure, or the throttle pressure.

Accumulators

The accumulators prevent the control elements from being subjected to fluid pressure surges. They also ensure a smooth pressure rise which prevents jerky gear shifting.

Accumulators With Clutch Valves

The accelerator pedal position or the engine torque controls the performance of these dampers. They employ the modulated pressure. The clutch valve acts as a variable pressure-reducing valve and controls the clutch pressure during the gear shifting.

Volume Accumulators

These accumulators are operational regardless of the pressure. They are not subjected to the modulated pressure. Damping is carried out only by means of a spring.

First and Reverse Lockup Valve

The first and reverse lockup valve has two functions:

1. It prevents shifting into reverse above a certain speed and blocks the fluid supply to the clutch B and the brake D. The governor pressure and the line pressure control this valve function.
2. In selector lever position 1, it prevents an upshift to the second gear by applying the line pressure to the 1-2 shift valve, which is thus blocked in the first position.

The valve prevents a manual downshift from the position 2 to the position 1 above a certain road speed by blocking the fluid supply to the brake D.

Second Lockup Valve

In the selector lever position 2, the second lockup valve prevents an upshift from the second gear to the third gear by applying the line pressure to the 2-3 shift valve which is thus locked in the position 2.

On a manual downshift from the third gear to the second gear, the second lockup valve prevents a downshift to the second gear above a certain road speed by blocking the fluid supply to the brake C.

2-3-4 Upshift Sequencing Valve

The 2-3-4 valve ensures a sequential 2-3-4 upshift by releasing the governor pressure to the 3-4 valve after the third gear is engaged. An upshift from the second gear to the fourth gear cannot take place because of the clutch A-to-the brake C overlap.

4-3-2 Valve

The 4-3-2 valve ensures a sequential 4-3-2 downshift by applying the line pressure to the 2-3 shift valve and maintaining the 3 position until the third gear has actually been engaged. A downshift from the fourth gear to the second gear cannot take place because of the clutch A-to-the brake C overlap.

3-4 Traction Valve

The 3-4 traction valve operates in the fourth gear as a shift valve for the line pressure supply to the clutch A. On a 3-4 upshift, the clutch A is vented through this valve. The venting takes place only when the brake C is capable of transmitting the engine torque.

4-3 Traction Valve

The 4-3 traction valve serves as the supply valve for the accumulator A. Its function is to prefill the clutch A on a 4-3 downshift.

4-3 Downshift Valve

The 4-3 downshift valve serves as a clutch pressure-retaining valve for the brake C until the clutch A has been filled. The brake C is also vented through the 4-3 downshift valve.

Time Control Valve

On overlap control, the time control valve regulates the delay time between the clutch being released and the clutch being applied. The delay time corresponds to the operating time of the accumulator at the time control valve. The time control valve disconnects the 4-3 traction valve and the 4-3 downshift valve.

Orifice Control

The orifice control valve senses the engine load and controls the pressure supply to the time control valve and to the brake C through a shorter or a longer operating time.

CENTRIFUGAL GOVERNOR

The centrifugal governor is mounted in the side shaft of the gearbox and serves as a sensor for the road speed of the vehicle. The rotation speed is converted to a speed-dependent pressure signal which is supplied to the hydraulic control unit.

Three-Stage Governor

Stage 1

The line pressure is supplied unchanged through the stage 3-2 valve to the stage 1 valve. The valve in the stage 1 is opened by a centrifugal force. The pressure on the differential area of the valve counteracts the centrifugal force, thus reducing the line pressure to the governor pressure.

Stage 2

Above a certain speed, the value for the stage 1 is moved fully outward by the centrifugal force. This provides a free flow path. The line pressure increases with the rotation speed and presses the valve for the stage 2 inward against the centrifugal force and the spring force, thus reducing the line pressure to the governor pressure.

Stage 3

When the centrifugal force has moved the valve for the stage 2 to its STOP, it functions as a free-flow valve. The line pressure presses the valve for the stage 3 inward against the centrifugal force and the spring force, thus reducing the line pressure to the governor pressure.

SECTION 5B

FIVE-SPEED MANUAL TRANSAXLE

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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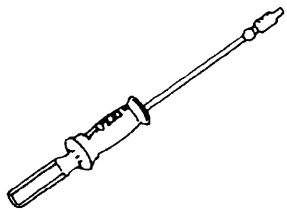
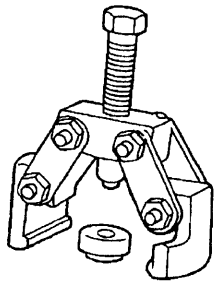
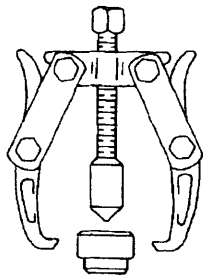
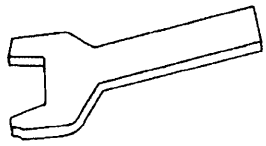
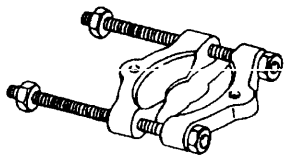
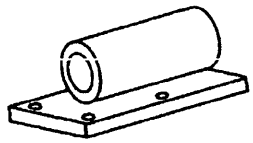
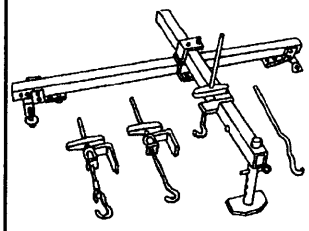
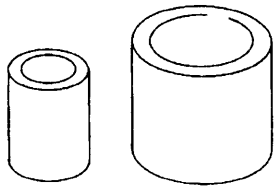
SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

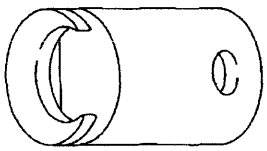
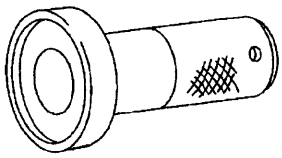
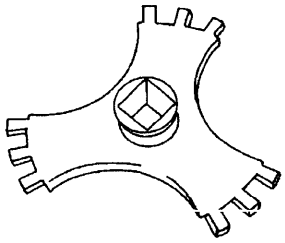
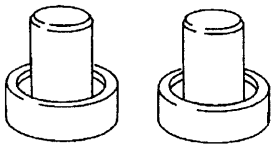
Application	N•m	Lb-Ft	Lb-In
Backup Lamp Switch	20	15	-
Bearing Plate Bolts	22	16	-
Bearing Retainer Bolts, Right Side	25	18	-
Bearing-Adjusting Ring-Retainer Plate Bolt	25	18	-
Center Rear Transaxle Support Bracket Bolts	90	66	-
Clutch-Release Cylinder Bracket Bolts	75	55	-
Differential Cover Bolts	40	30	-
Fifth-Gear Fork Bolts	22	16	-
Fifth-Gearshift Connector Bolts	7	-	62
Gearshift Housing Bolts	6	-	53
Gearshift Lever Cover Bolts	22	16	-
Input Driveshaft Detent Screw	15	11	-
Left Front Transaxle Support Bracket Bolts	60	44	-
Left Rear Transaxle Support Bracket Bolts	60	44	-
Lower Transaxle-to-Engine Bolts	75	55	-
Ring-Gear Bolts	70	52	-
Rod Clamp Bolt	14	-	124
Speedometer-Driven Gear Bolt	5	-	44
Speedometer Housing Retaining Bolt	4	-	35
Support Bracket Bolt	7	-	62
Transaxle Bracket-to-Engine Bolt	90	66	-
Transaxle Bracket-to-Transaxle Bolts	90	66	-
Transaxle Bracket Mount-to-Center Member Bolts	65	48	-
Transaxle Cover Bolts	18	13	-
Transaxle-to-Engine Upper Bolts	75	55	-
Transaxle Upper Brace Bolts	75	55	-

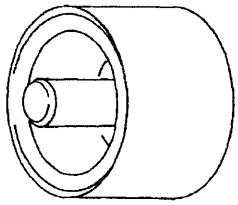
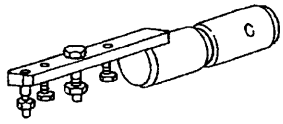
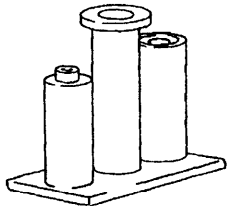
SPECIAL TOOLS

SPECIAL TOOLS TABLE

 A103B110	J-6125-B Slide Hammer	 A103B163	KM-553-A Fifth-Gear Puller
 A103B003	J-22888-20-A Bearing Puller with J-22888-35 Puller Legs	 A103B028	J-36633 Snap Ring Retainer
 A103B112	J-22912-01 Universal Bearing Puller	 A103B002	KM-113-2 Base
 A102B152	J-28467-B Engine-Support Fixture	 A103B025	KM-334 Installer Sleeve

SPECIAL TOOLS TABLE (Cont'd)

 A103B013	**J-42469 Shift Rod Remover**
 A103B007	**KM-519 Ring Installer**
 A103B008	**KM-520 Remover/Installer**
 A103B009	**KM-522 Installer**

 A103B017	**KM-525 Installer**
 A103B019	**KM-552 Fixture**
 A103B021	**KM-554 Installer**

DIAGNOSIS

ISOLATE NOISE

Identify the cause of any noise before attempting to repair the clutch, the transaxle, or their related linkages.

Symptoms of trouble with the clutch or the manual transaxle include

- A great effort required to shift gears.
- The sound of gears clashing and grinding.
- Gear blockout.

Any of these conditions requires a careful analysis. Make the following checks before disassembling the clutch or the transaxle for repairs.

Road Travel Noise

Many noises that appear to come from the transaxle may actually originate with other sources, such as the

- Tires.
- Road surfaces.
- Wheel bearings.
- Engine.
- Exhaust system.

These noises may vary according to the

- Size of the vehicle.
- Type of the vehicle.
- Amount of insulation used in the body of the vehicle.

Transaxle Noise

Transaxle gears, like any mechanical device, are not absolutely quiet and will make some noise during normal operation.

To verify suspected transaxle noises,

1. Select a smooth, level asphalt road to reduce tire and resonant body noise.
2. Drive the vehicle far enough to warm up all the lubricants thoroughly.
3. Record the speed and the gear range of the transaxle when the noise occurs.
4. Check for noises with the vehicle stopped, but with the engine running.
5. Determine if the noise occurs while the vehicle operates in
   - Drive - under a light acceleration or a heavy pull.
   - Float - maintaining a constant speed with a light throttle on a level road.
   - Coast - with the transaxle in gear and the throttle partly or fully closed.
   - All of the above.

Bearing Noise

Differential Side Bearing Noise

Differential side bearing noise and wheel bearing noise can be confused easily. Since side bearings are preloaded, a differential side bearing noise should not diminish much when the differential/transaxle is run with the wheels off the ground.

Wheel Bearing Noise

Wheel bearings produce a rough growl or grating sound that will continue when the vehicle is coasting and the transaxle is in NEUTRAL. Since wheel bearings are not pre-loaded, a wheel bearing noise should diminish considerably when the wheels are off the ground.

Other Noise

Brinelling

A brinelled bearing causes a "knock" or "click" approximately every second revolution of the wheel because the bearing rollers do not travel at the same speed as the wheel. In operation, the effect is characterized by a low-pitched noise.

A brinelled bearing is caused by excessive thrust which pushes the balls up on the pathway and creates a triangular-shaped spot in the bearing race. A brinelled bearing can also be caused from pressing one race into position by applying pressure on the other race.

A false indication of a brinelled bearing occurs as a result of vibration near the area where the bearing is mounted. Brinelling is identified by slight indentations, resulting in a washboard effect in the bearing race.

Lapping

Lapped bearing noise occurs when fine particles of abrasive materials such as scale, sand, or emery circulate through the oil in the vehicle, causing the surfaces of the roller and the race to wear away. Bearings that wear loose but remain smooth, without spalling or pitting, are the result of dirty oil.

Locking

Large particles of foreign material wedged between the roller and the race usually cause one of the races to turn, creating noise from a locked bearing. Pre-loading regular taper roller bearings to a value higher than that specified also can result in locked bearings.

Pitting

Pitting on the rolling surface comes from normal wear and the introduction of foreign materials.

Spalling

Spalled bearings have flaked or pitted rollers or races caused by an overload or an incorrect assembly that results in a misalignment, a cocking of bearings, or adjustments that are too tight.

After completing these checks, refer to the "Diagnosis Chart" in this section.

SYMPTOM DIAGNOSIS

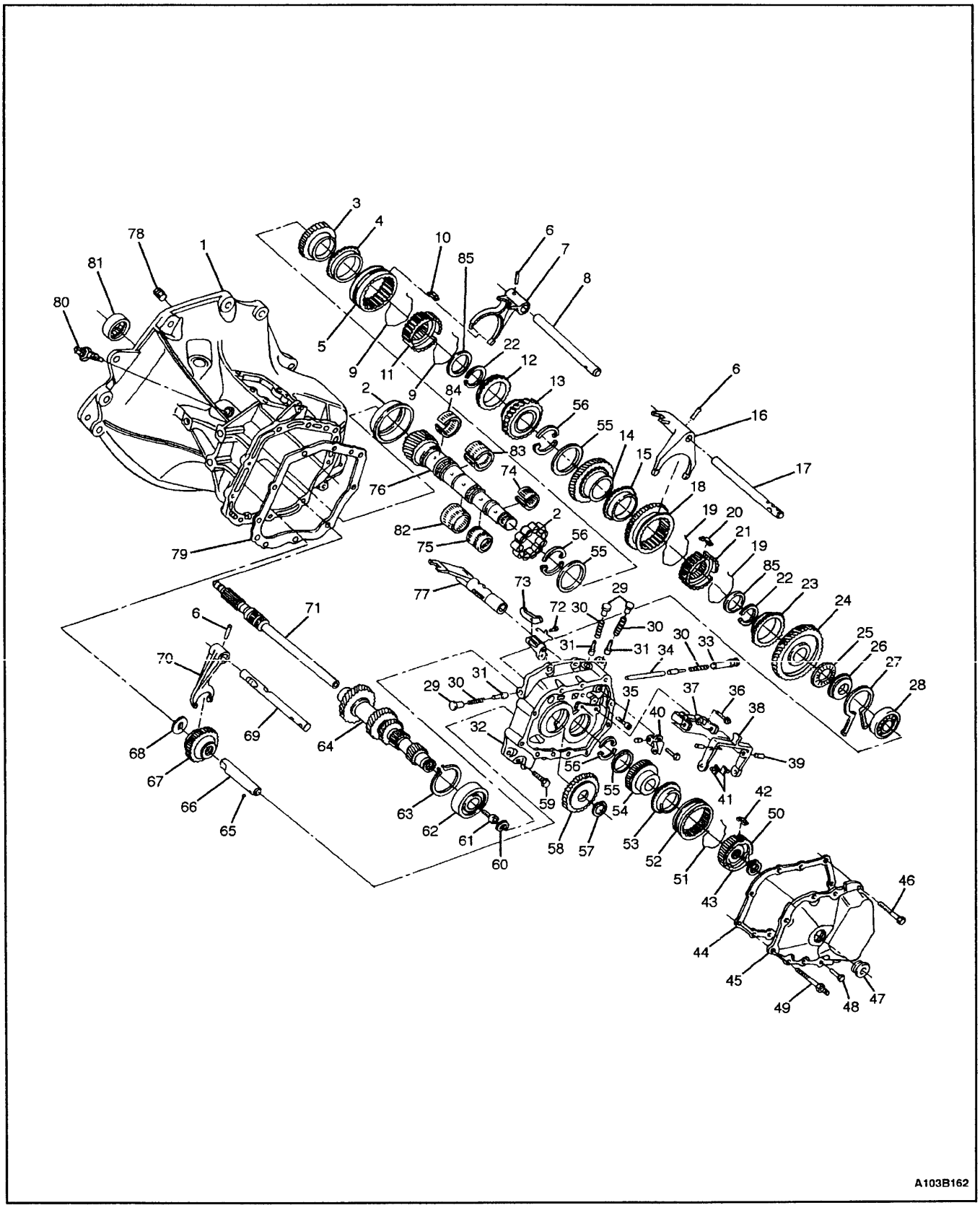
Checks	Action
Check for a knock at low speeds.	• Replace any worn drive axle CV joints. • Replace any worn side gear hub.
Check for a noise most pronounced on turns.	• Correct any abnormalities in the differential gear.
Check for a clunk upon acceleration or deceleration.	• Tighten any loose engine mounts. • Replace any worn drive axle inboard joints. • Replace any worn differential pinion shaft in the case. • Replace any worn side gear hub in the case.
Check for a clunking noise in turns.	• Replace any worn outboard CV joint.
Check for a vibration.	• Replace any rough wheel bearing. • Replace any bent drive axle shaft. • Replace any out-of-round tires. • Balance any unbalanced tire. • Replace any worn CV joint in the drive axle shaft. • Correct an excessive drive axle angle by adjusting the trim height.
Check for a noise in the NEUTRAL gear with the engine running.	• Replace any worn cluster bearing shaft. • Replace any worn clutch-release bearing. • Replace any worn input shaft cluster gears. • Replace any worn first-gear/bearing. • Replace any worn second-gear/bearing. • Replace any worn third-gear/bearing. • Replace any worn fourth-gear/bearing. • Replace any worn fifth-gear/bearing. • Replace any worn mainshaft bearings.
Check for a noise in the first gear (1) only.	• Replace any chipped, scored, or worn first-gear constant mesh gears. • Replace any worn first-second gear synchronizer. • Replace any worn first-gear/bearing. • Replace any worn differential gear/bearing. • Replace any worn ring gear. • Adjust, repair, or replace the shift lever and the rods.
Check for a noise in the second gear (2) only.	• Replace any chipped, scored, or worn second-gear constant mesh gears. • Replace any worn first-second gear synchronizer. • Replace any worn second-gear/bearing. • Replace any worn differential gear/bearing. • Replace any worn ring gear. • Adjust, repair, or replace the shift lever and the rods.
Check for a noise in the third gear (3) only.	• Replace any chipped, scored, or worn third-gear constant mesh gears. • Replace any worn third-fourth gear synchronizer. • Replace any worn third-gear/bearing. • Replace any worn differential gear/bearing. • Replace any worn ring gear. • Adjust, repair, or replace the shift lever and the rods.
Check for a noise in the fourth gear (4) only.	• Replace any chipped, scored, or worn fourth gear or output gear. • Replace any worn third-fourth gear synchronizer. • Replace any worn fourth-gear/bearing. • Replace any worn differential gear/bearing. • Replace any worn ring gear. • Adjust, repair, or replace the shift lever and the rods.

Symptom Diagnosis (Cont'd)

Checks	Action
Check for a noise in the fifth gear (5) only.	• Replace any chipped, scored, or worn fifth gear or output gear. • Repair any worn fifth-gear synchronizer. • Replace any worn fifth-gear/bearing. • Replace any worn differential gear/bearing. • Replace any worn ring gear. • Adjust, repair, or replace the shift lever and the rods.
Check for a noise in the reverse (R) gear only.	• Replace any chipped, scored, or worn reverse idler gear, idler-gear bushing, input gear, or output gear. • Replace any worn first-second gear synchronizer. • Replace any worn output gear. • Replace any worn differential gear/bearings. • Replace any worn ring gear.
Check for a noise in all gears.	• Add sufficient lubricant. • Replace any worn bearings. • Replace any chipped, scored, or worn input-gear shaft or output-gear shaft.
Check for the transaxle slipping out of gear.	• Adjust or replace the linkage as needed. • Adjust, repair, or replace any binding shift linkage. • Tighten or replace the input-gear bearing retainer as needed. • Repair or replace any worn or bent shift fork.
Check for a leak in the area of the clutch.	• Repair the transaxle casing. • Replace any damaged release bearing guide.
Check for a leak at the center of the transaxle.	• Repair the transaxle casing. • Repair the shift mechanism. • Replace the damaged backup lamp switch.
Check for a leak at the differential.	• Adjust or replace the bearing retainers. • Tighten or replace the differential cover. • Adjust or replace the drive axle shaft seals.
Check for a hard shift.	• Replace any damaged release-bearing guide. • Adjust, repair, or replace the shift mechanism. • Adjust, repair, or replace the clutch-release system. • Replace any chipped, scored, or worn fifth-gear synchronizer. • Replace any chipped, scored, or worn first-second gear synchronizer. • Replace any worn third-fourth gear synchronizer. • Adjust, repair, or replace the shift lever and the rods.
Check for a clashing of gears.	• Replace any damaged release-bearing guide. • Adjust, repair, or replace the clutch-release system. • Replace the chipped, scored, or worn input shaft/gear-cluster gears. • Replace any worn fifth-gear synchronizer. • Replace any worn fifth-gear/bearing. • Replace any worn first-gear/bearing. • Replace any worn first-second gear synchronizer. • Replace any worn second-gear/bearing. • Replace any worn third-gear/bearing. • Replace any worn third-fourth synchronizer. • Replace any worn fourth-gear/bearing. • Replace any worn reverse-idler gear.

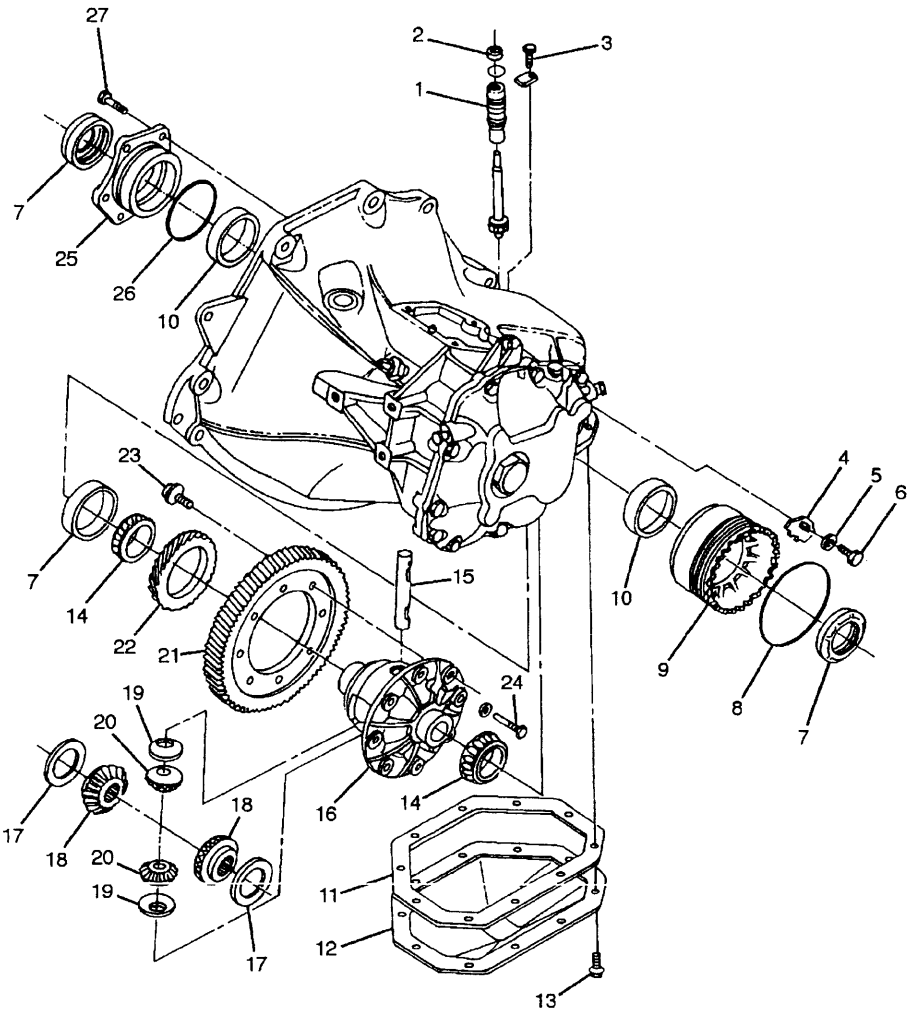
COMPONENT LOCATORS

GEARS AND CASE



1 Case
2 Mainshaft Bearing
3 Fourth Gear
4 Synchronizer Blocking Ring
5 Synchronizer Sleeve
6 Pin
7 Third-Fourth Gearshift Fork
8 Third-Fourth Gearshift Shaft
9 Spring
10 Key
11 Third-Fourth Synchronizer Gear
12 Synchronizer Blocking Ring
13 Third Gear
14 Second Gear
15 First-Second Gear Blocking Ring
16 First-Second Gearshift Fork
17 First-Second Gearshift Shaft
18 Synchronizer Hub Sleeve
19 Synchronizer Spring
20 Key
21 First-Second Synchronizer Gear
22 Snap Ring
23 Outer Blocking Ring
24 First Gear
25 First Gear Needle Bearing
26 Mainshaft Wear Plate
27 Snap Ring
28 Mainshaft Bearing
29 Shift Rod Plug (21.5 mm)
30 Spring
31 Shift Rod Lock Pin
32 Bearing Plate
33 Shift Rod Plug (50.4 mm)
34 Detent Rod Bolt
35 Bolt
36 Bolt
37 Support
38 Fifth Gearshift Fork
39 Pin
40 Fifth Gear Connector
41 Shoe
42 Key
43 Snap Ring
44 Gasket
45 Cover
46 Bolt
47 Plug
48 Bolt
49 Screw
50 Synchronizer Gear
51 Spring
52 Synchronizer Sleeve
53 Synchronizer Blocking Ring
54 Mainshaft Driven Fifth Gear
55 Ring
56 Thrust Washer
57 Ring
58 Input Drive Fifth Gear
59 Bolt
60 Cluster Gear Snap Ring
61 Screw
62 Cluster Shaft Bearing
63 Ring
64 Input Shaft Cluster Gear
65 Ball
66 Reverse Idler Gear Shaft
67 Reverse Idler Gear
68 Washer
69 Reverse Gear Fork Shaft
70 Reverse Gearshift Fork
71 Input Drive Shaft
72 Bolt
73 Fifth-Gear Pawl
74 Fifth-Gear Needle Bearing
75 First-Gear Needle Bearing
76 Main Driven Shaft
77 Fifth Gearshift Lever
78 Hex Plug
79 Gasket
80 Reverse Lamp Switch
81 Input Shaft Bearing
82 Second-Gear Needle Bearing
83 Third-Gear Needle Bearing
84 Fourth-Gear Needle Bearing
85 Washer

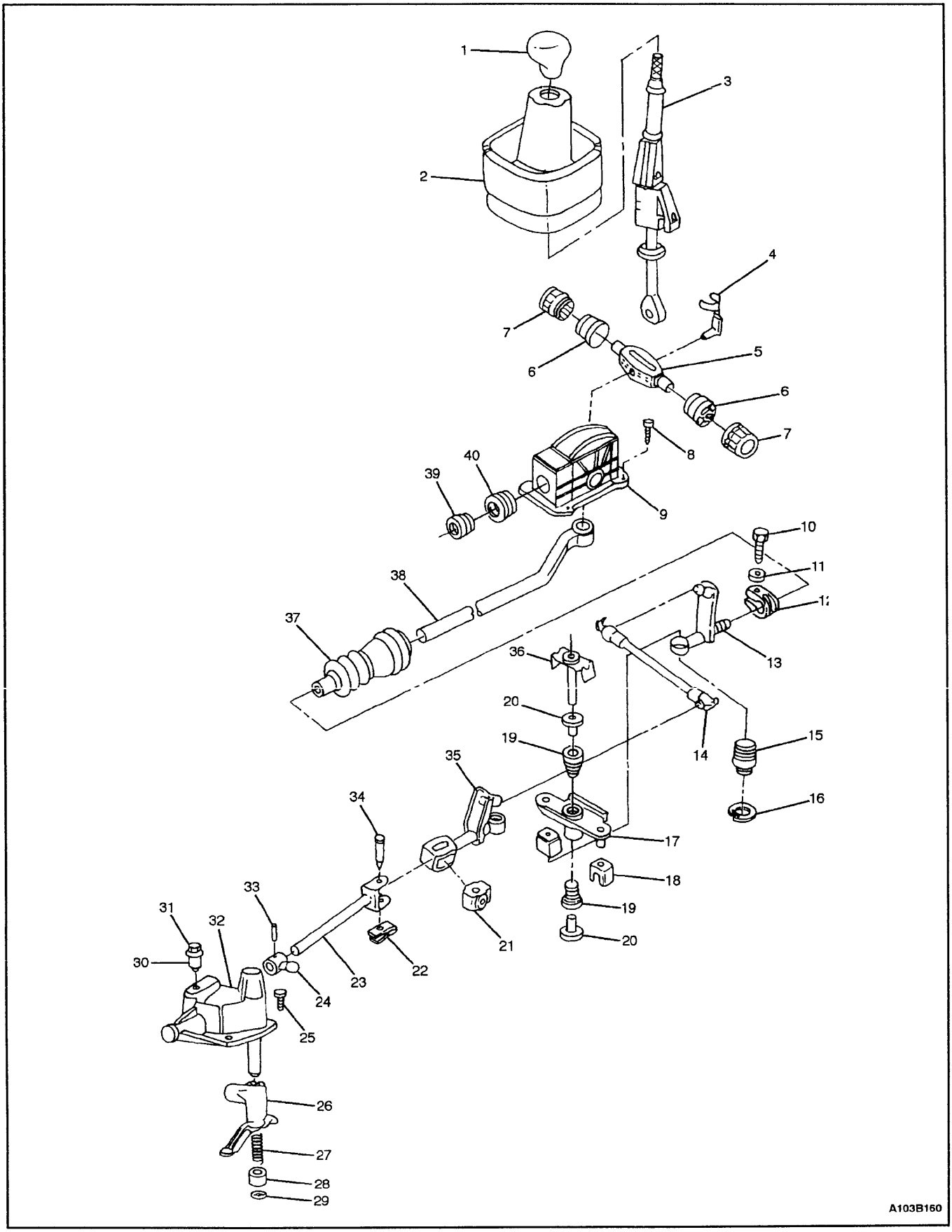
DIFFERENTIAL AND CASE



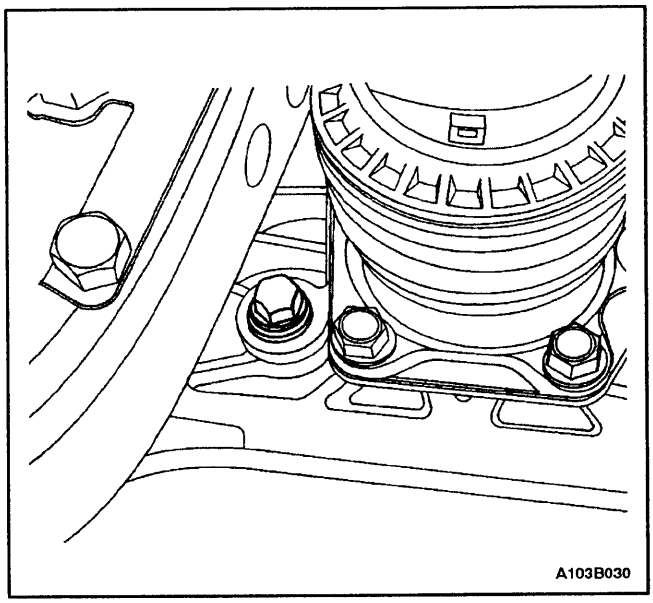
A103B161

1 Speedometer-Driven Gear
2 Seal
3 Hex Bolt
4 Bearing Plate
5 Washer
6 Bolt
7 Seal
8 Seal
9 Bearing Adjusting Ring
10 Side Bearing Race
11 Housing Cover Gasket
12 Differential Cover
13 Bolt
14 Differential Bearing
15 Pinion Gear Shaft
16 Differential Housing
17 Thrust Washer
18 Side Gear
19 Washer
20 Pinion Gear
21 Ring Gear
22 Speedometer Drive Gear
23 Bolt
24 Pinion Shaft Lock Pin
25 Right Side Bearing Retainer
26 Seal
27 Retainer Bolt

SHIFT LINKAGE



1 Gearshift Lever Knob
2 Gearshift Lever Boot
3 Gearshift Lever
4 Gearshift Lever Stop Clamp
5 Gearshift Lever Shaft
6 Gearshift Lever Stop Bushing
7 Gearshift Lever Stop Bushing
8 Bolt
9 Gearshift Housing
10 Shift Rod Clamp Bolt
11 Washer
12 Clamp
13 Linkage Adjuster Bolt
14 Gearshift Control Rod
15 Linkage Ball Socket
16 Circlip Ring
17 Linkage Reverse Lever
18 Gearshift Boot
19 Bushing
20 Bushing
21 Rod U-Joint Bushing
22 Clip
23 Gearshift Rod
24 Shift Finger Lever
25 Cover Bolt
26 Intermediate Lever
27 Shift Lever Thrust Spring
28 Bushing
29 Snap Ring
30 Oil Filler Plug
31 Oil Plug Cap
32 Gearshift Lever Cover
33 Pin
34 Bolt
35 Gearshift Adjuster Linkage
36 Shift Reverse Pivot Bolt
37 Boot
38 Gearshift Tube
39 Bushing
40 Gearshift Tube Bearing

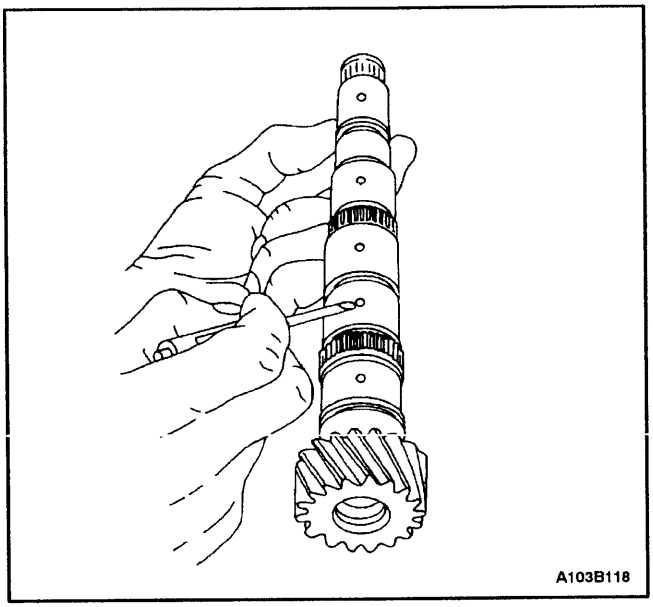

A103B030

MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

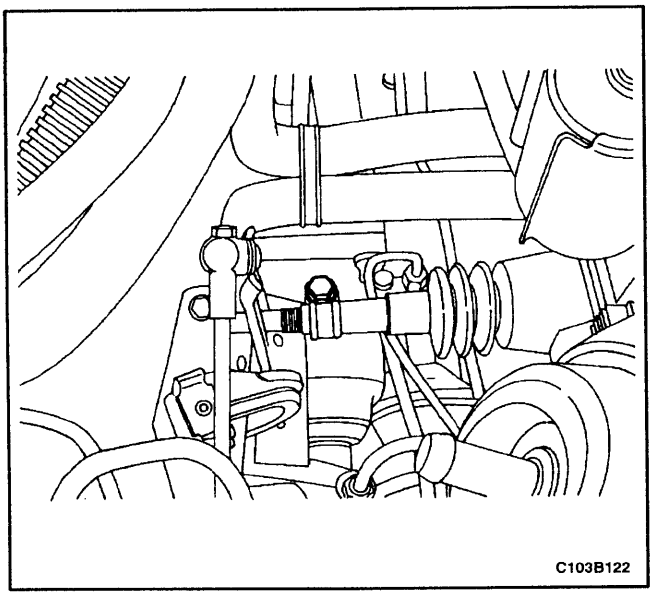
CHECKING FLUID LEVEL

1. With the vehicle on a level surface and the fluid in the transaxle cold, remove the filler plug and check the fluid level. The fluid should come to the bottom edge of the plug hole.
2. If the level is low, add SAE 80 manual transaxle fluid through the filler plug hole until the fluid begins to run out.
3. Reinstall the filler plug and tighten it securely.


A103B118

The speed gears and the synchronizer parts on this vehicle receive lubrication through specific passages in the mainshaft.

It takes 1.8 liters (1.90 quarts) to fill the transaxle completely.

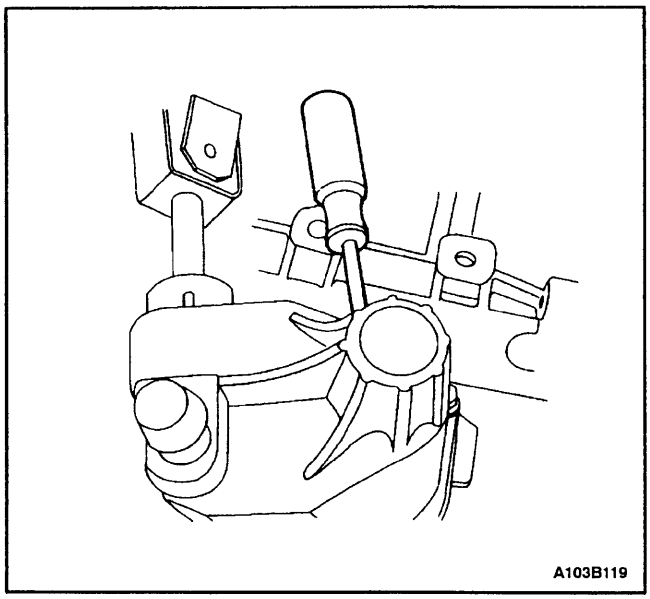

C103B122

SHIFT LINKAGE ADJUSTMENT

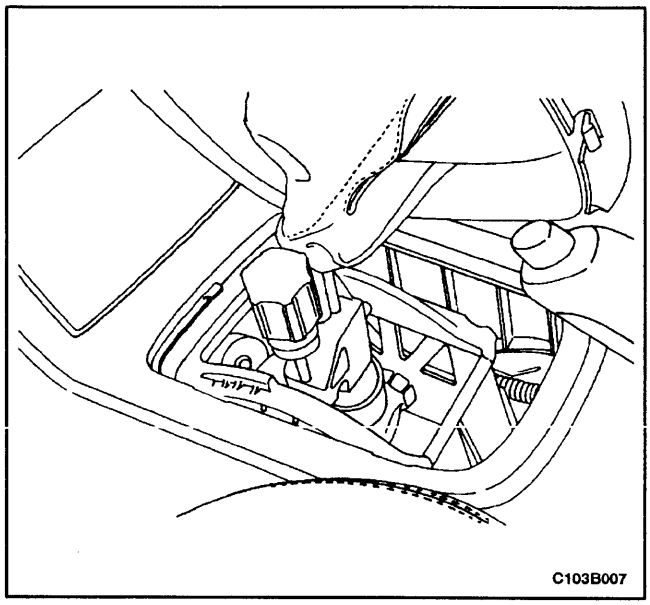
1. Disconnect the negative battery cable.
2. Position the gearshift lever into NEUTRAL.

Important: All the gears must be easy to engage when the vehicle is stationary, the engine is running, and the clutch is disengaged.

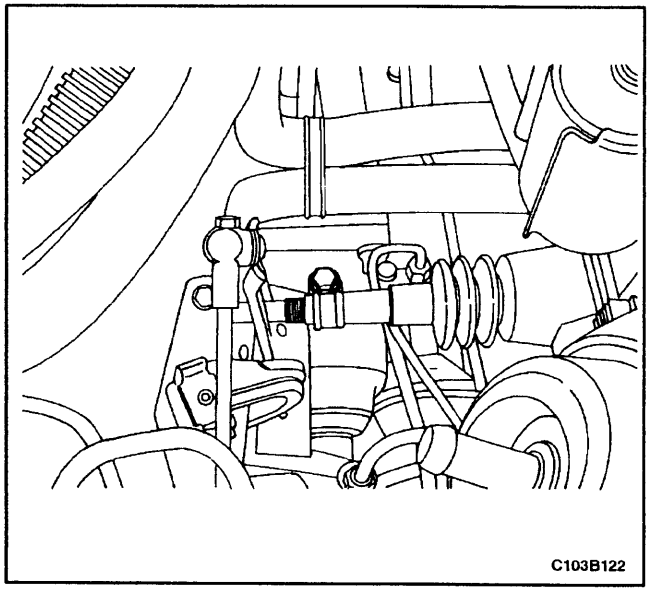
3. Loosen the rod clamp bolt.


A103B119

4. Remove the adjustment hole plug from the shift lever cover.
5. Turn the gearshift rod and fully insert a 5 mm (0.2 inch) gauge pin into the adjustment hole.


C103B007

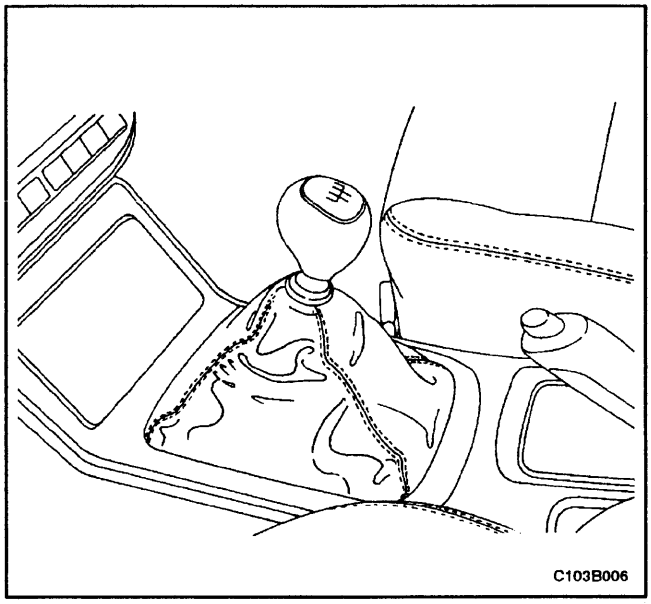
6. Remove the boot from the console.
7. Pull the boot upward to expose the shift control lever mechanism.
8. Position the gearshift lever close to the left side of the NEUTRAL position.
9. Insert a 5 mm (0.2 inch) gauge pin into the holes to align the gearshift lever with the gearshift lever housing.


C103B122

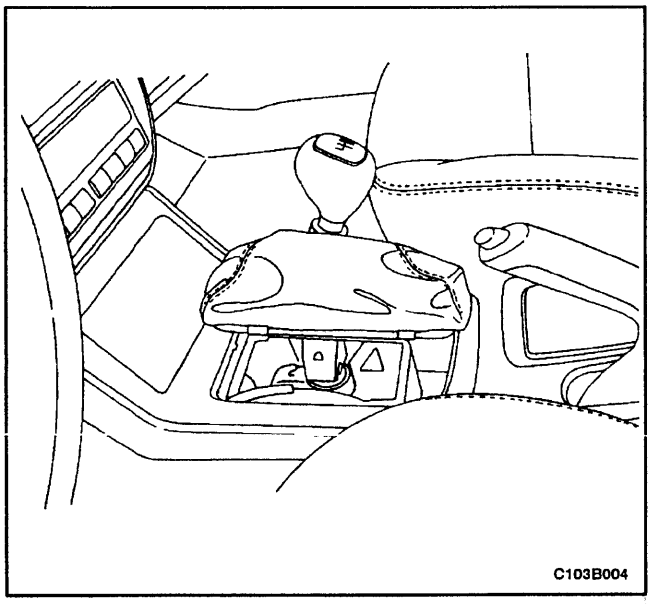
10. Tighten the rod clamp bolt.

Tighten

Tighten the rod clamp bolt to 14 N•m (124 lb-in).



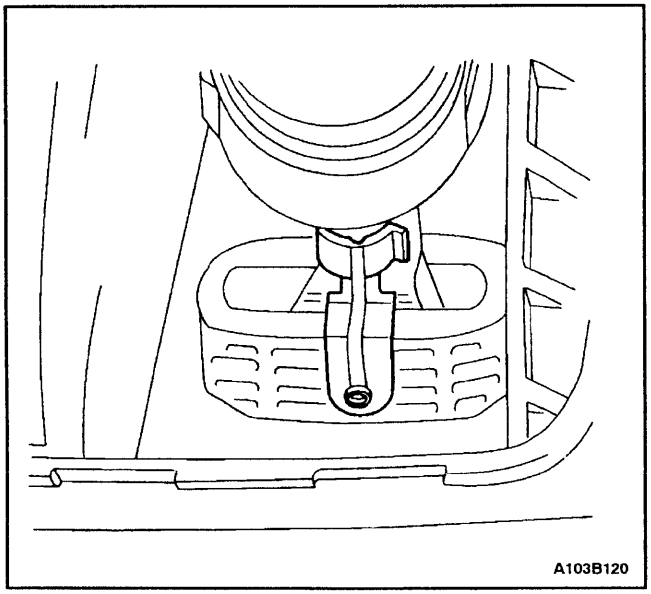
11. Remove the 5 mm (0.2 inch) gauge pin from the adjustment hole.
12. Install the adjustment hole plug.
13. Remove the 5 mm (0.2 inch) gauge pin from the gearshift lever.
14. Install the boot to the console.
15. Connect the negative battery cable.



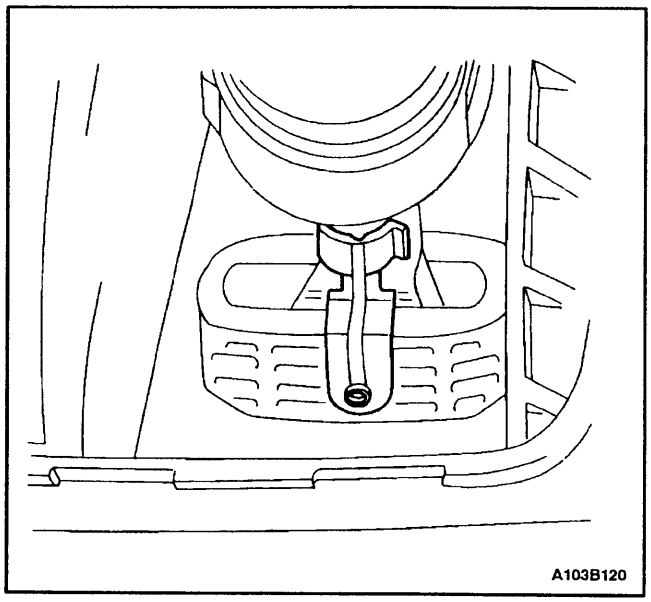
GEARSHIFT LEVER

Removal Procedure

1. Disconnect the negative battery cable.
2. Position the gearshift lever into NEUTRAL.
3. Disconnect the boot from the console cover.
4. Lift the console cover upward to expose the shift control lever mechanism.

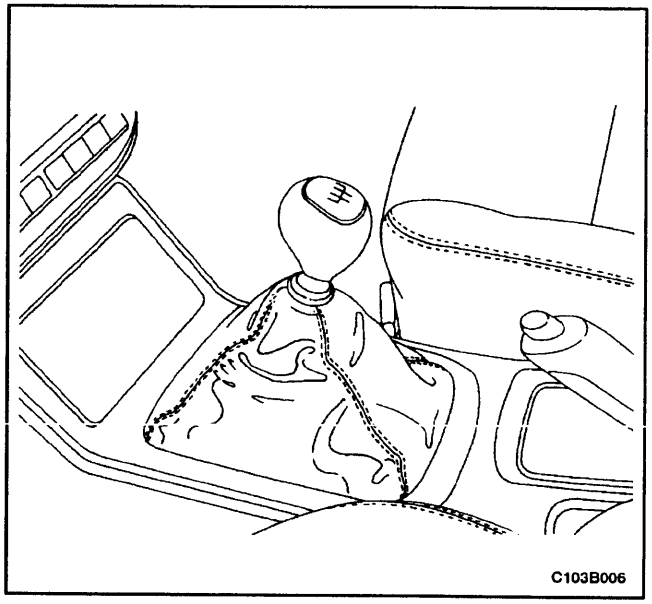


5. Rotate the gearshift lever stop clamp and remove it.
6. Remove the gearshift lever from the gearshift lever shaft.

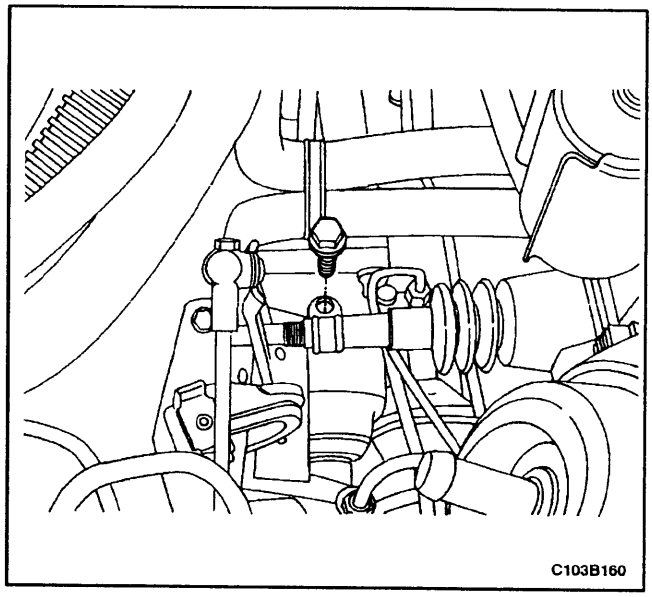

A103B120

Installation Procedure

1. Install the gearshift lever into the gearshift lever shaft.
2. Install the gearshift lever stop clamp.
3. Rotate the gearshift lever stop clamp to secure it.


C103B006

4. Lower the boot and connect it to the console cover.
5. Connect the negative battery cable.

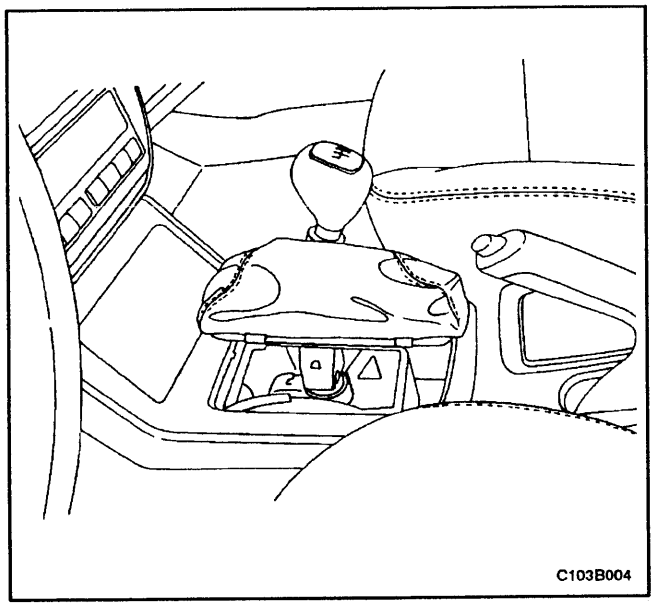

C103B160

GEARSHIFT TUBE, BOOT, BUSHING AND/OR BEARING RING

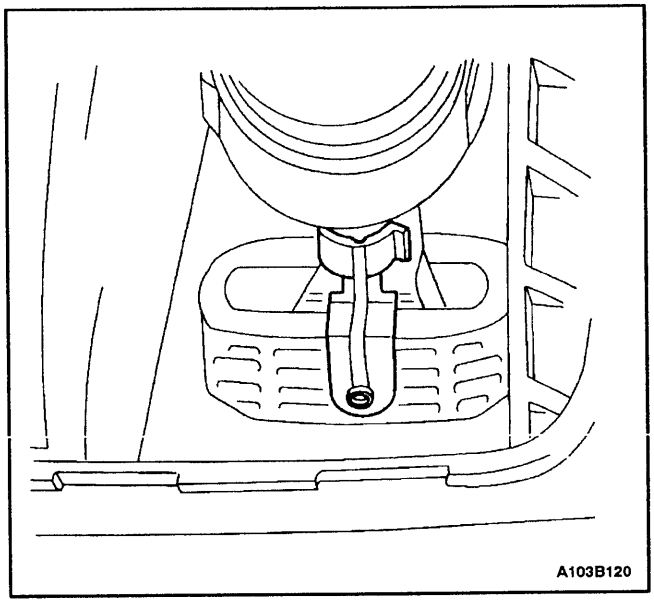
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

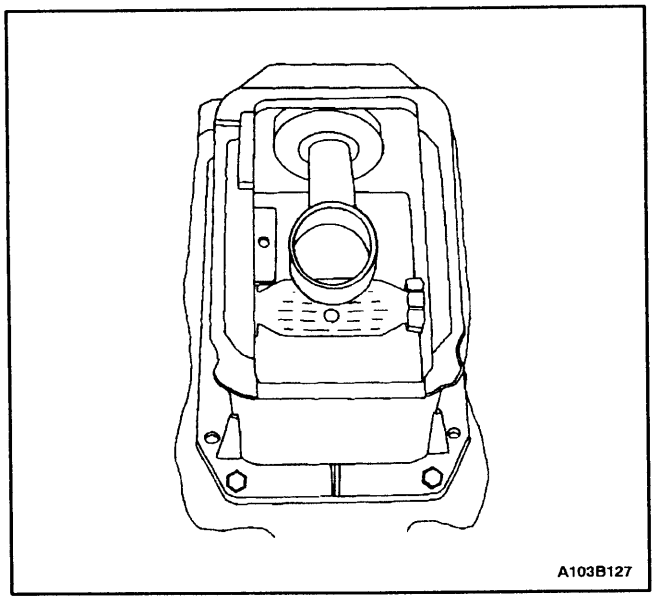
1. Disconnect the negative battery cable.
2. Remove the rod clamp bolt.
3. Separate the linkage bolt from the gearshift tube.
4. Remove the rod clamp from the gearshift tube.


C103B004

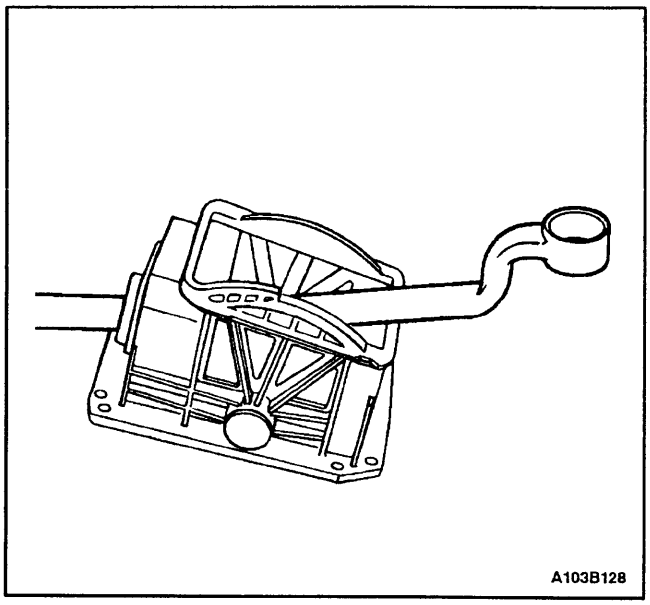
5. Position the shift lever into NEUTRAL.
6. Disconnect the gearshift boot from the front portion of the floor console and lift upward to expose the shift control lever mechanism.


A103B120

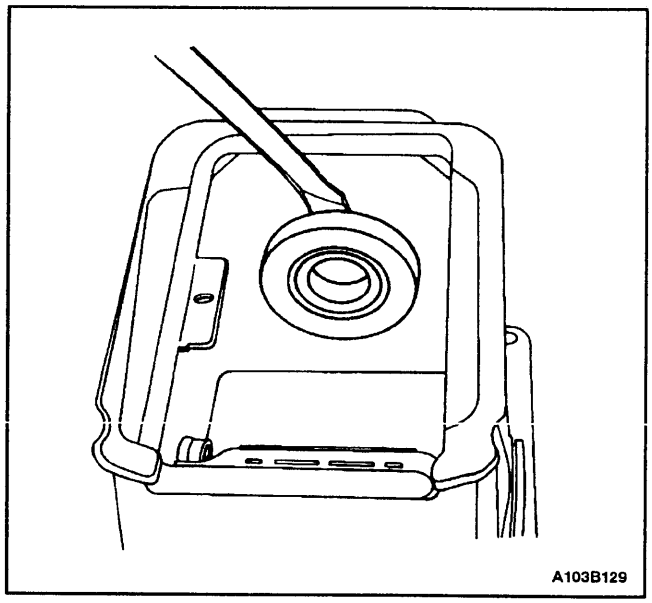
7. Rotate the gearshift lever stop clamp and remove it.
8. Remove the gearshift lever and the boot.
9. Remove the center console. Refer to *Section 9G, Interior Trim.*


A103B127

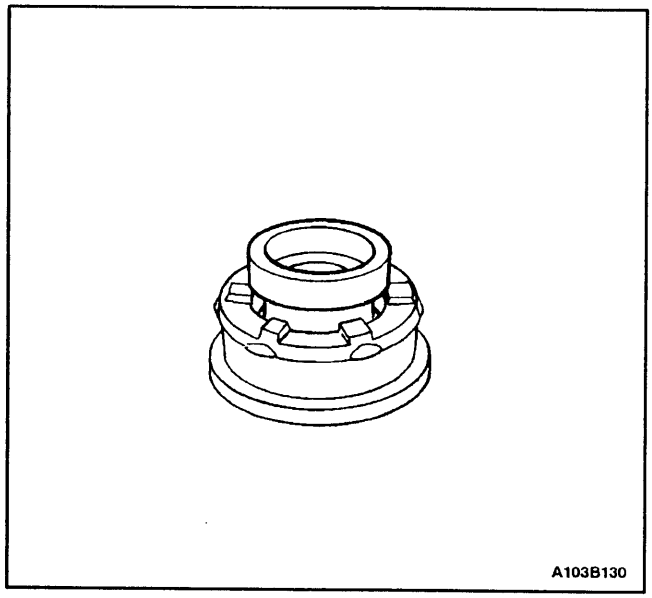
10. Remove the gearshift housing bolts.
11. Remove the gearshift tube with the gearshift housing from the vehicle.



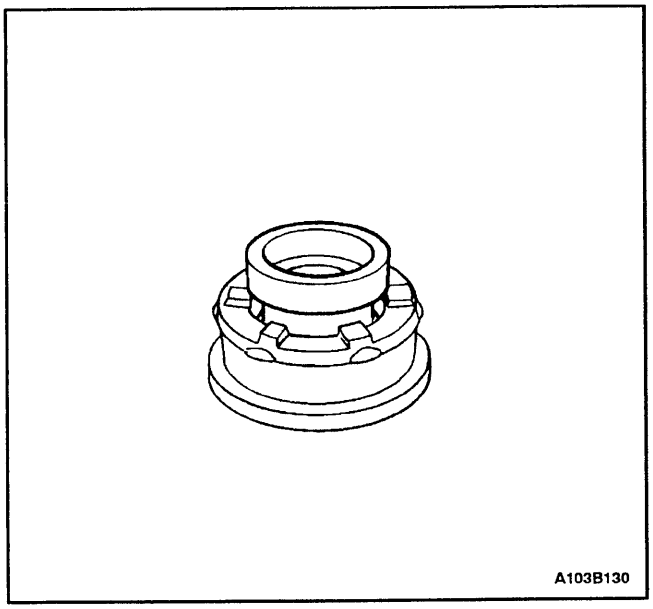
12. Remove the gearshift tube from the gearshift housing.



13. Remove the bushing and the gearshift tube bearing from the gearshift housing.

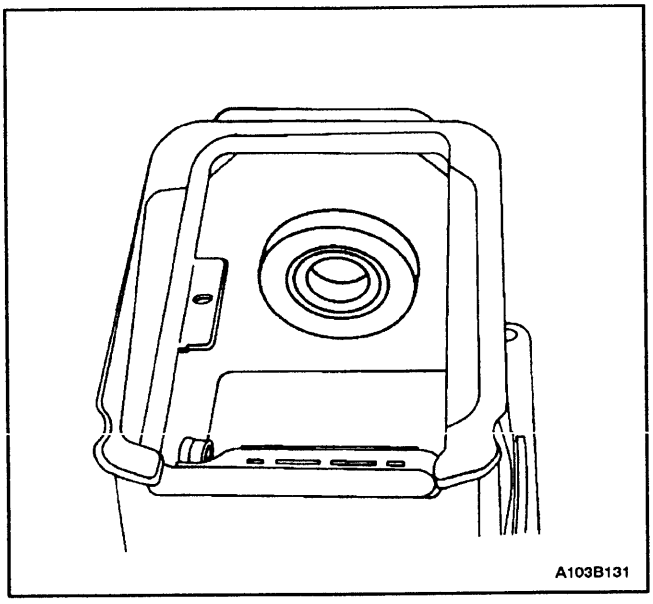


14. Remove the bushing from the gearshift tube bearing.

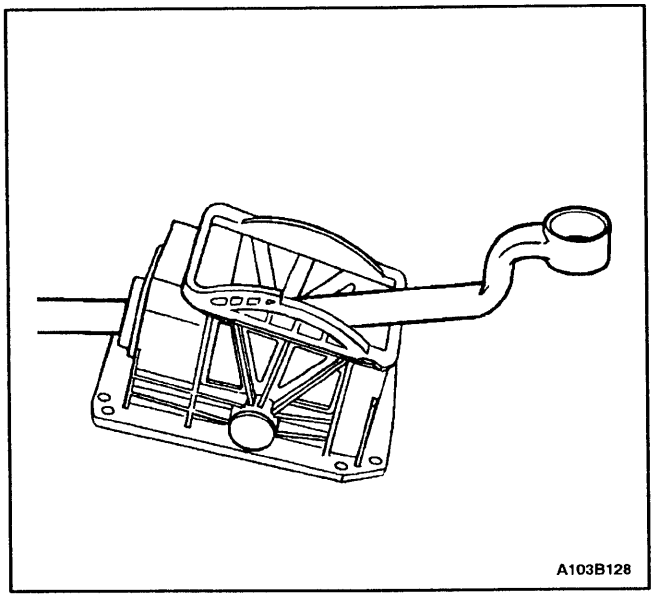


Installation Procedure

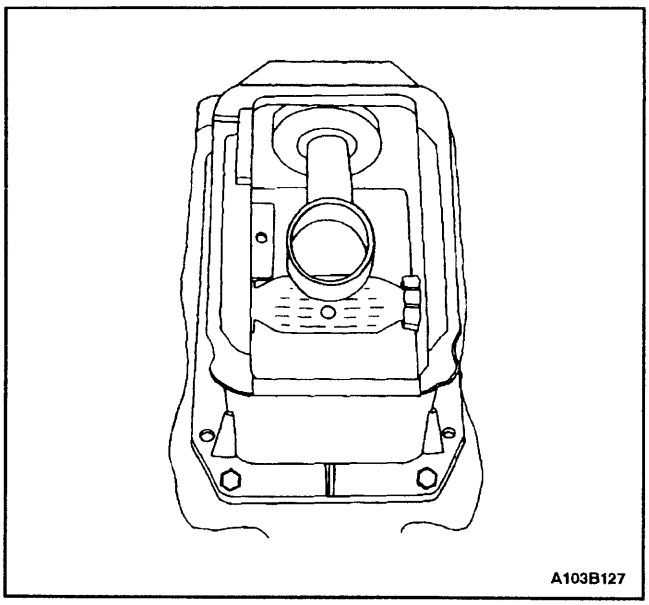
1. Install the bushing into the gearshift tube bearing.



2. Fill the grooves of the bushing with silicone grease.
3. Press the bearing ring into the gearshift housing from the inside.



4. Install the gearshift tube through the bushing into the gearshift housing.

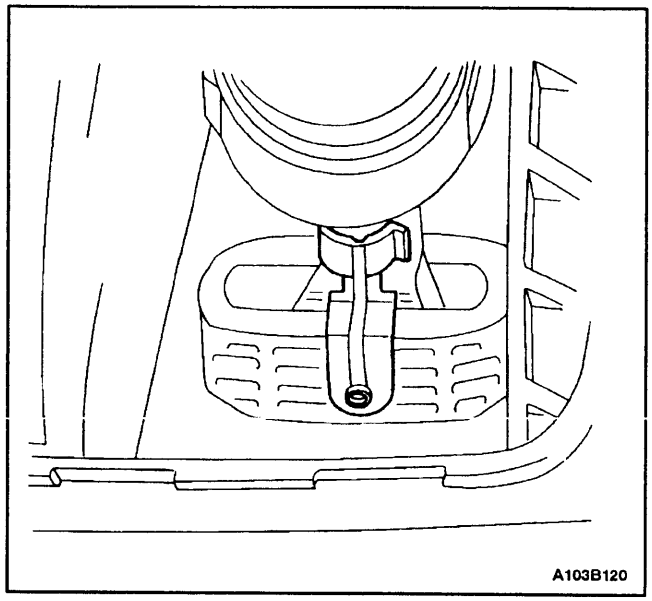

A103B127

5. Install the gearshift housing and the gearshift tube into the vehicle.
6. Install the gearshift housing bolts.

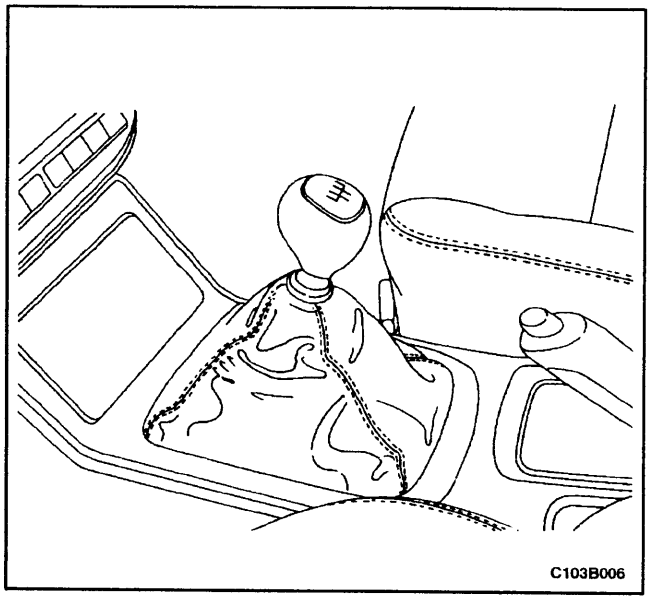
Tighten

Tighten the gearshift housing bolts to 6 N•m (53 lb-in).

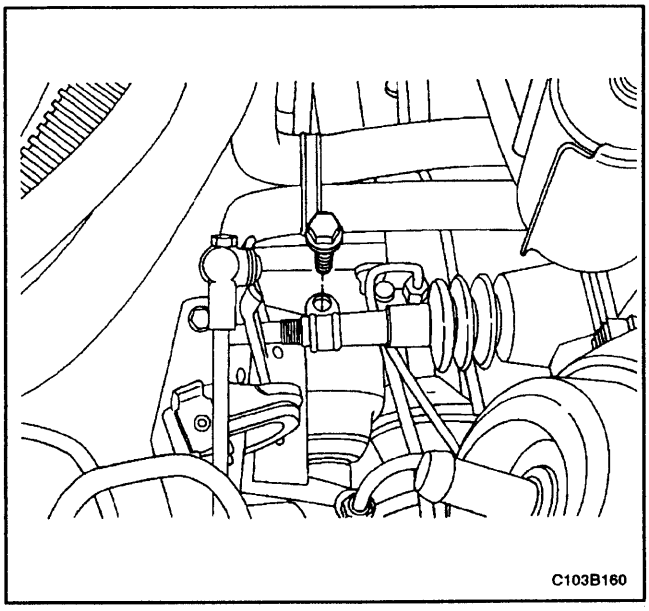
7. Install the center console. Refer to *Section 9G., Interior Trim.*


A103B120

8. Install the shift lever into the shaft.
9. Install the gearshift lever stop clamp and rotate it into position.


C103B006

10. Install the gearshift boot.

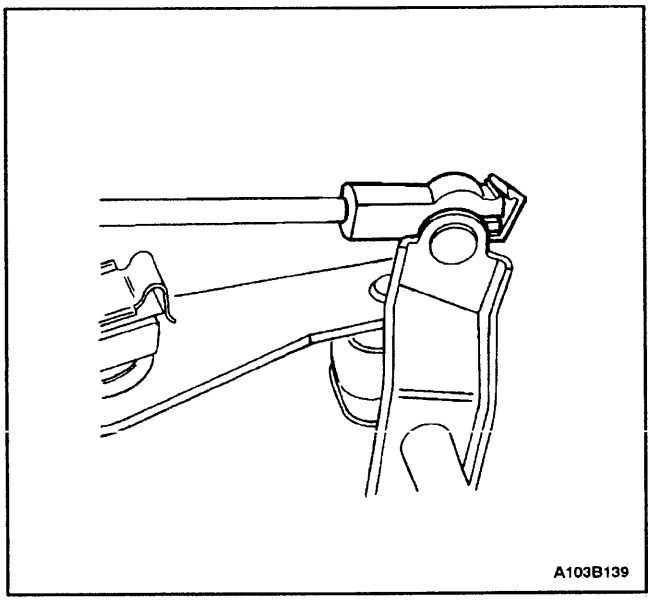

C103B160

11. Install the rod clamp onto the gearshift tube.
12. Connect the linkage bolt to the gearshift tube.
13. Install the rod clamp bolt.
14. Adjust the shift linkage. Refer to "Shift Linkage Adjustment" in this section.
15. Tighten the rod clamp bolt.

Tighten

Tighten the rod clamp bolt to 14 N•m (124 lb-in).

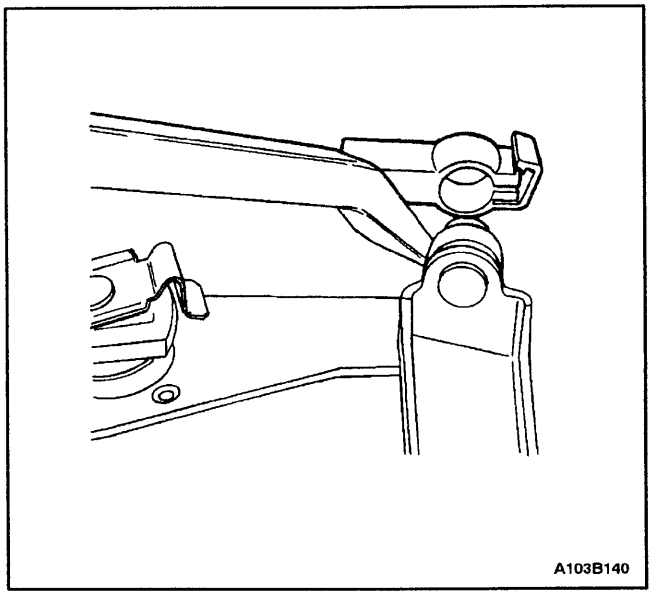
16. Connect the negative battery cable.


A103B139

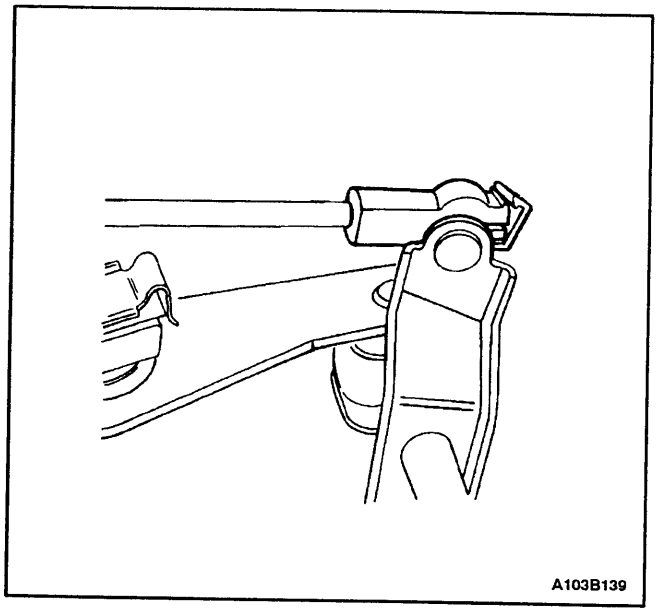
CONTROL SHIFT ROD

Removal Procedure

1. Disconnect the negative battery cable.
2. Separate the plastic clip from the end of each ball socket.

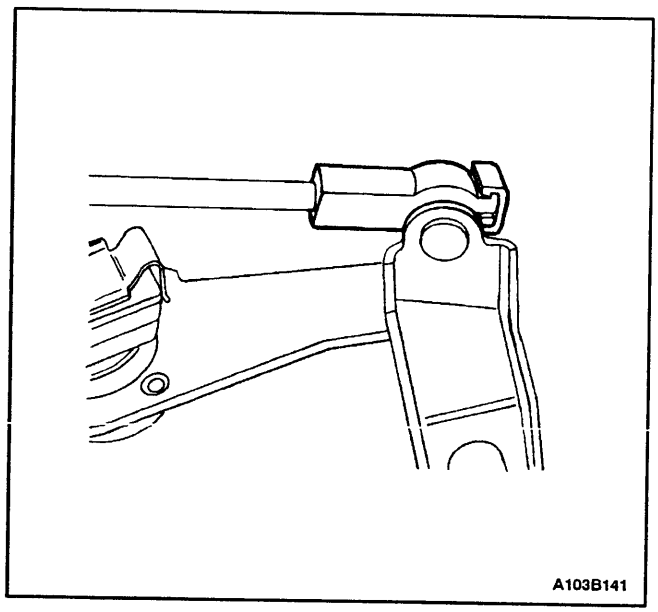

A103B140

3. Separate the ball sockets from the ball studs on the linkage bolts using a pry bar.
4. Remove the control shift rod from the vehicle.



Installation Procedure

1. Install the control shift rod into the vehicle.
2. Press the ball sockets onto the ball studs on the linkage bolts.

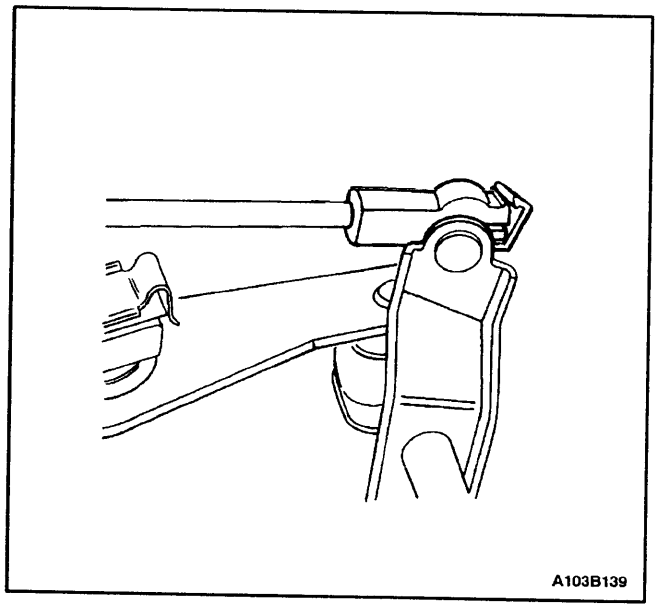


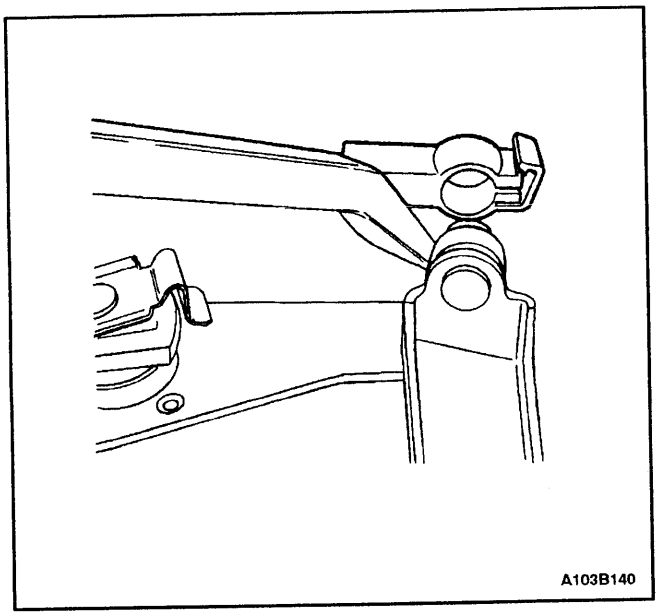
3. Connect the plastic clip on the end of each ball socket.
4. Connect the negative battery cable.

LINKAGE LEVER AND/OR BUSHINGS

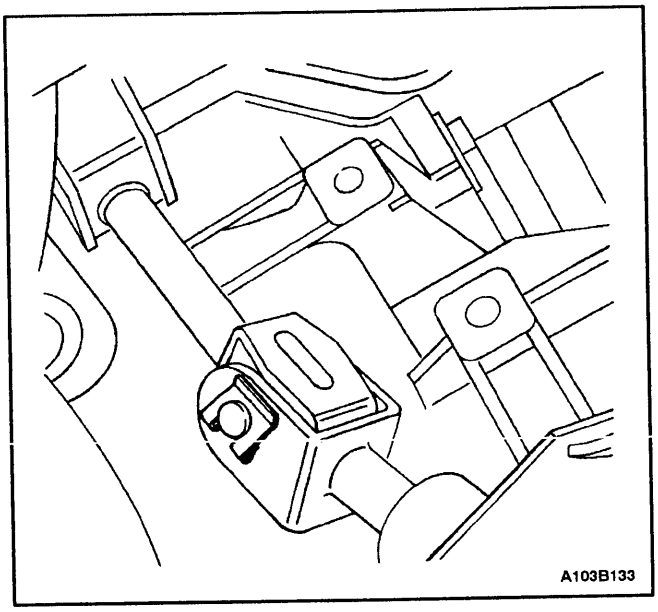
Removal Procedure

1. Disconnect the negative battery cable.
2. Separate the plastic clip from the end of each ball socket.

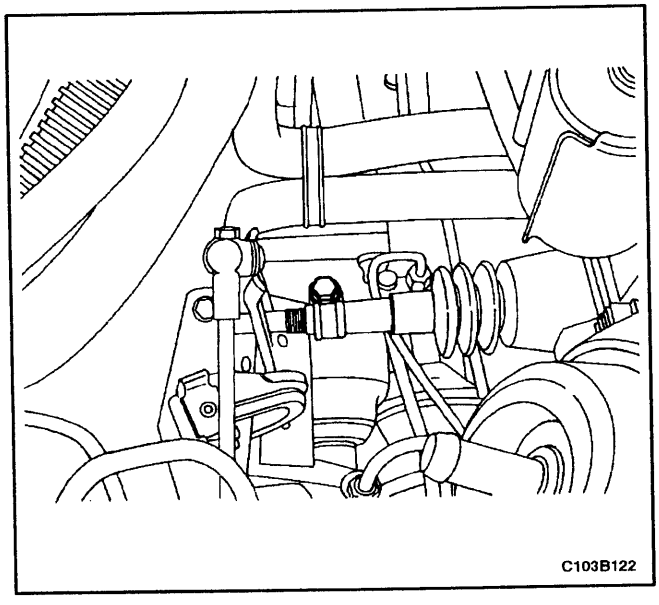




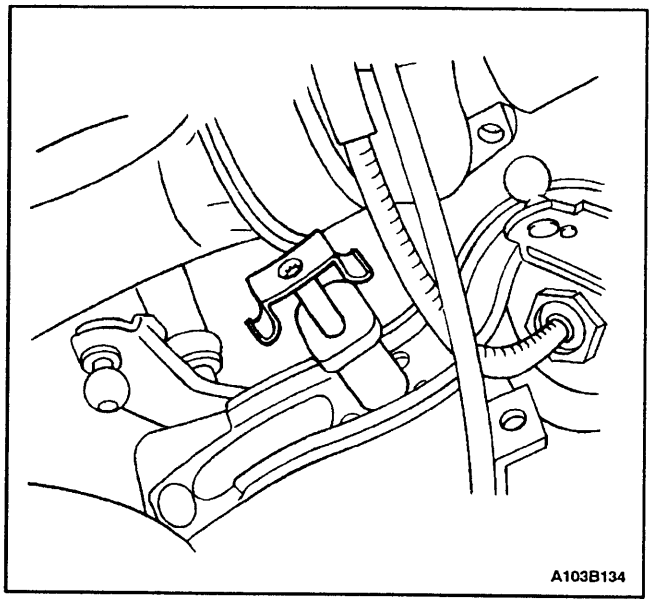
3. Separate the ball sockets from the ball studs on the linkage bolts using a pry bar.
4. Remove the control shift rod.



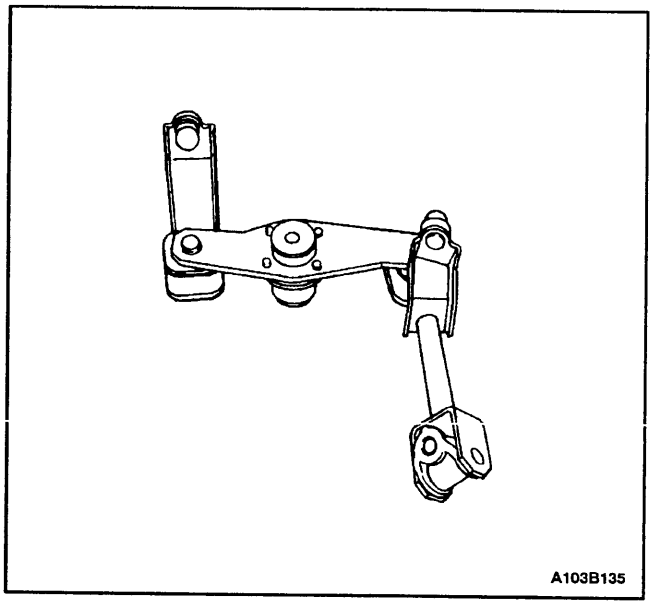
5. Remove the clip and the bolt from the universal joint.



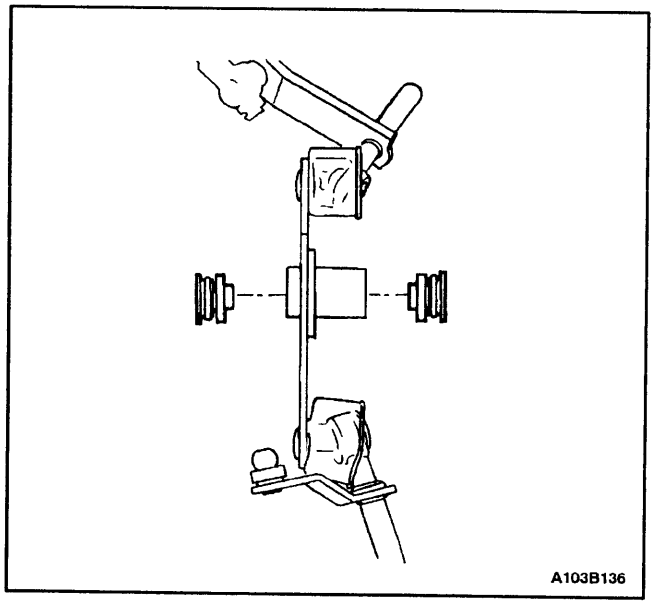
6. Loosen the rod clamp bolt.
7. Separate the linkage bolt from the shift tube.



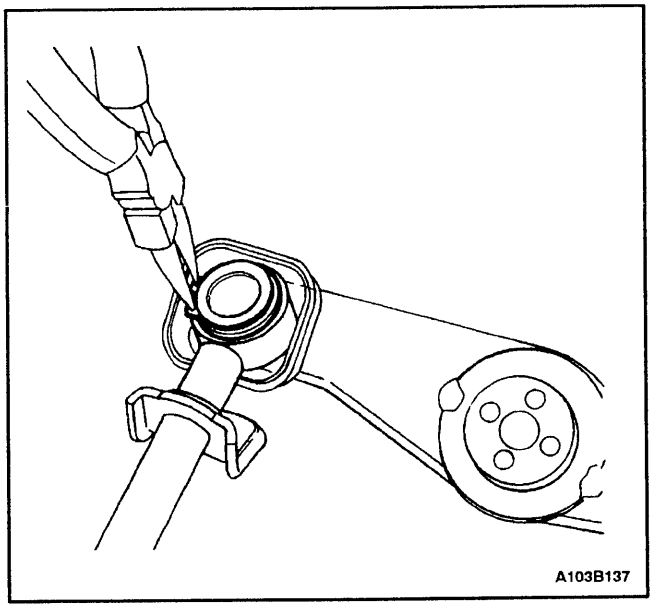
8. Loosen the spring clips and remove the pivot bolt.



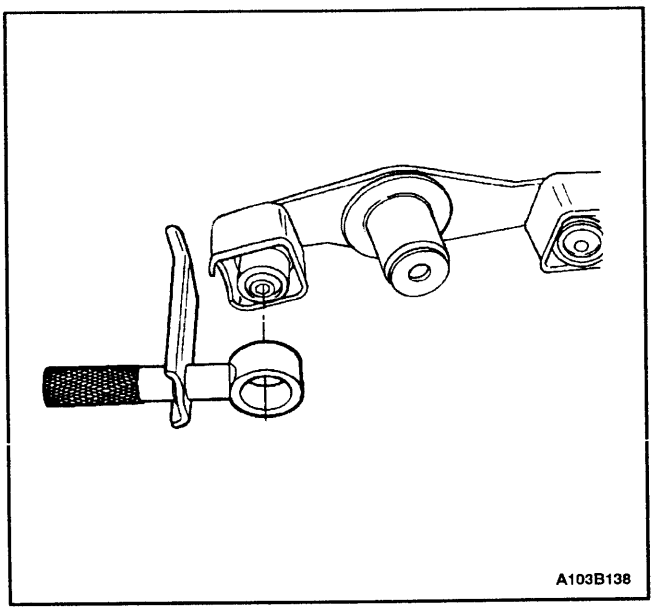
9. Remove the linkage lever assembly from the vehicle.



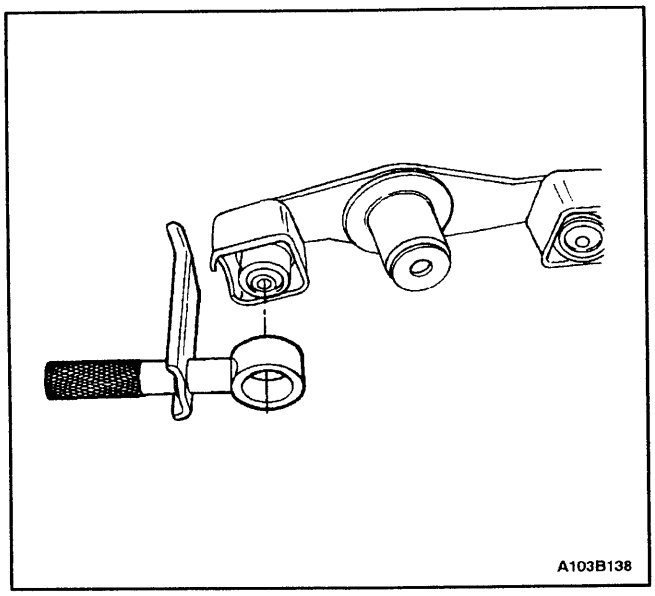
10. Remove both linkage lever bushings from the linkage lever assembly.



11. Remove the snap rings retaining the linkage bolts to the linkage lever assembly.

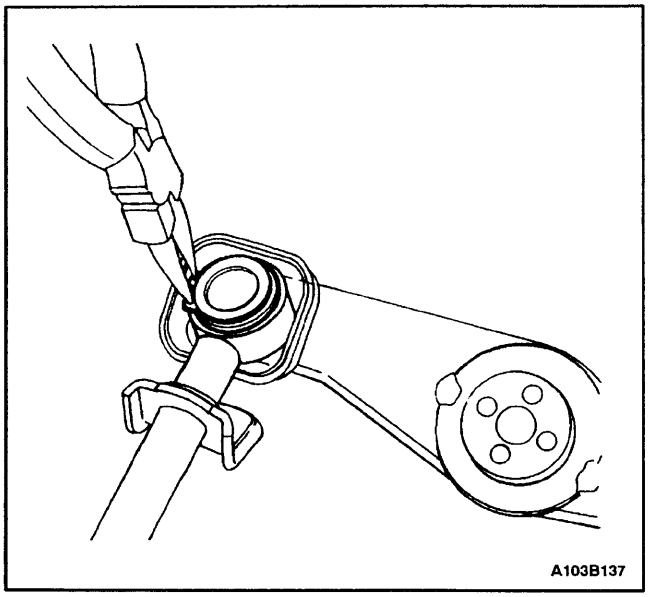


12. Disconnect the linkage bolts from the linkage lever.

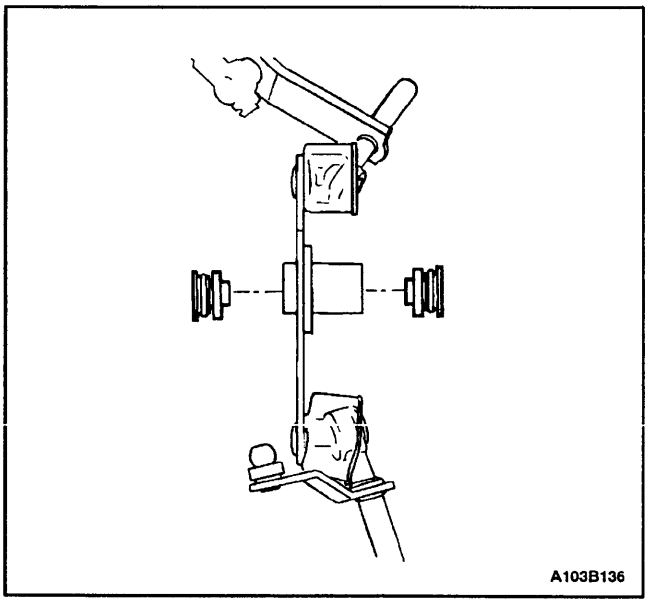


Installation Procedure

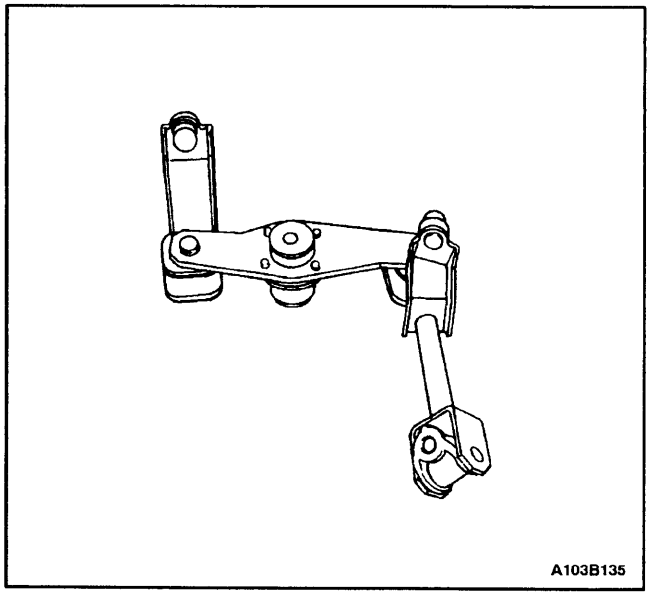
1. Connect the linkage bolts to the linkage lever.


A103B137

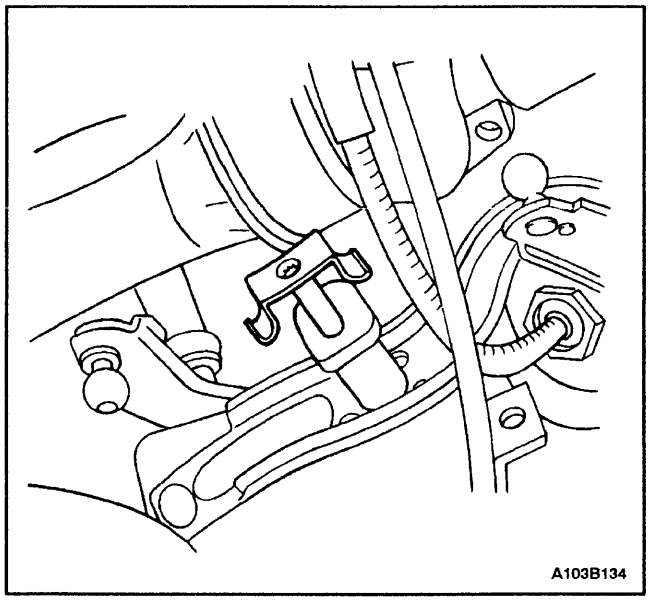
2. Install the snap rings to retain the linkage bolts to the linkage lever assembly.


A103B136

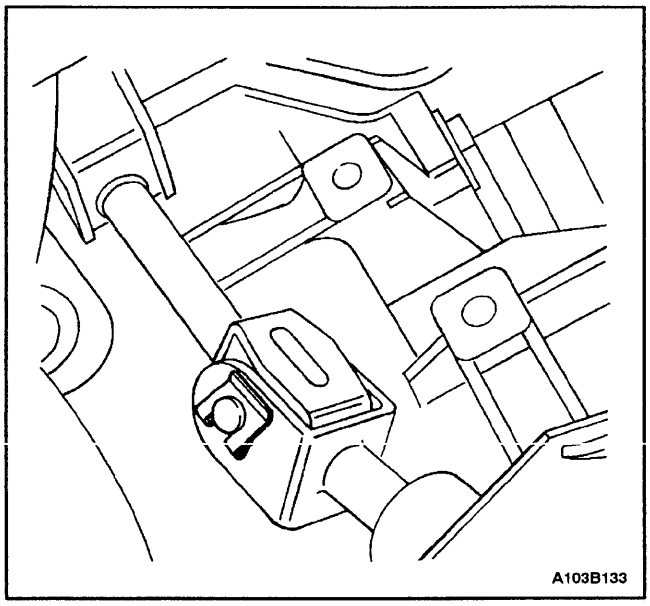
3. Coat the linkage lever bushings with silicone grease.
4. Install both of the linkage lever bushings into the linkage lever assembly.


A103B135

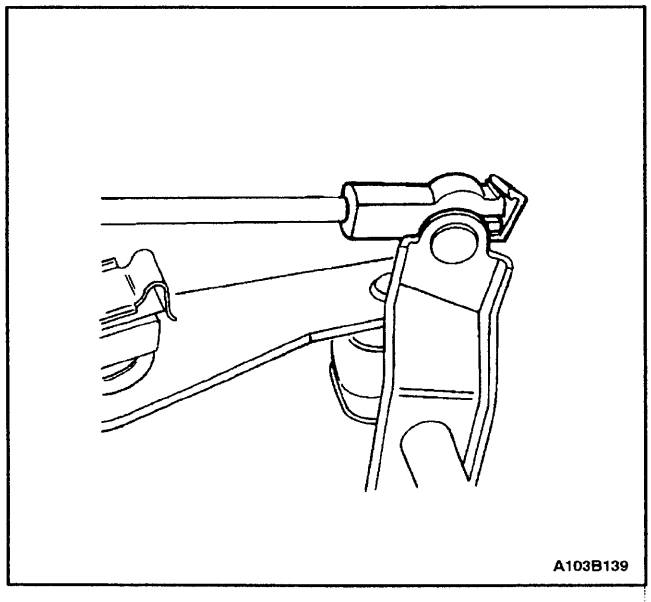
5. Install the linkage lever assembly into the vehicle.



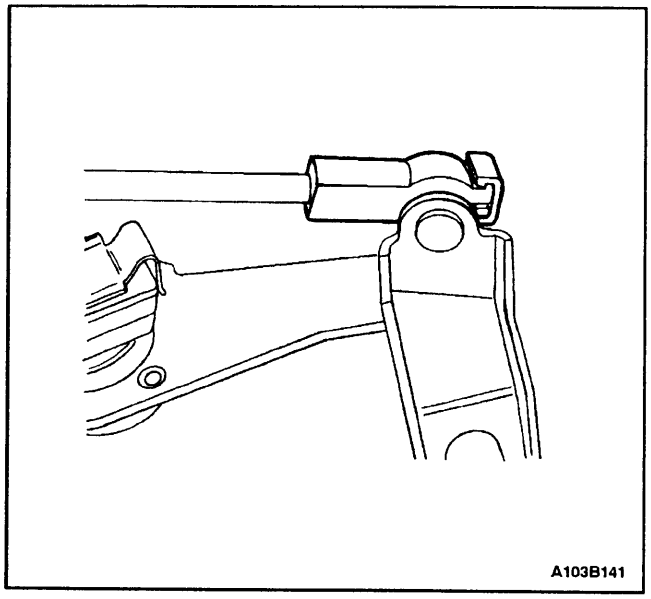
6. Install the pivot bolt. Make sure the spring clips are engaged.



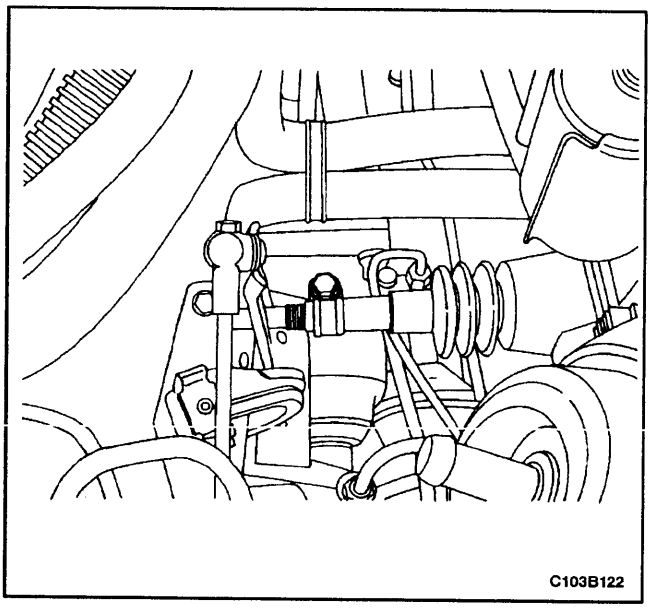
7. Coat the universal joint bolt with silicone grease.
8. Install the universal joint bolt and the clip onto the universal joint.



9. Install the control shift rod.
10. Press the ball sockets onto the ball studs on the linkage bolts.


A103B141

11. Connect the plastic clips on the end of each ball socket.

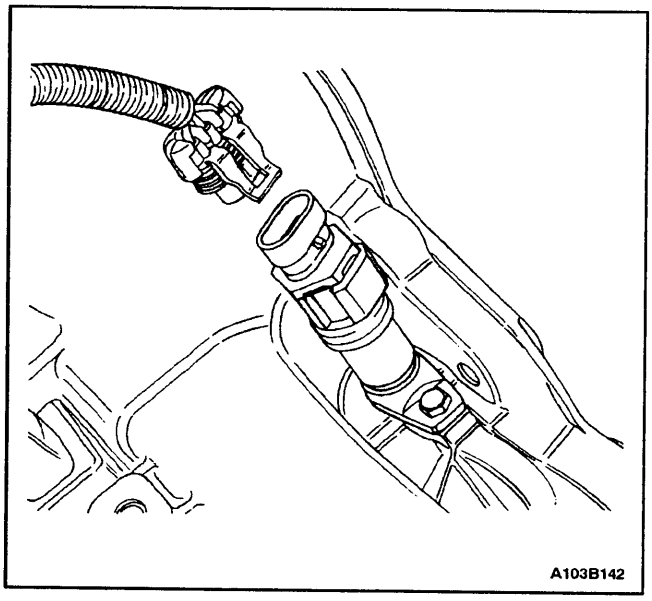

C103B122

12. Connect the linkage bolt to the shift tube.
13. Adjust the shift linkage. Refer to "Shift Linkage Adjustment" in this section.
14. Tighten the rod clamp bolt.

Tighten

Tighten the rod clamp bolt to 14 N•m (124 lb-in).

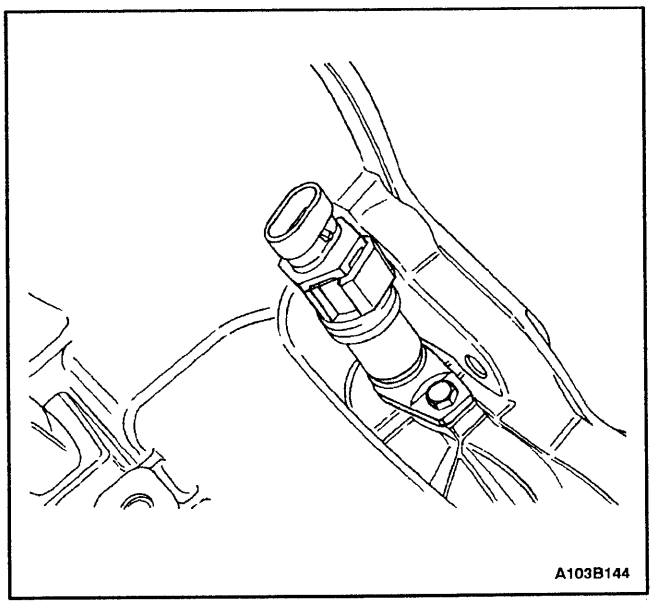
15. Connect the negative battery cable.


A103B142

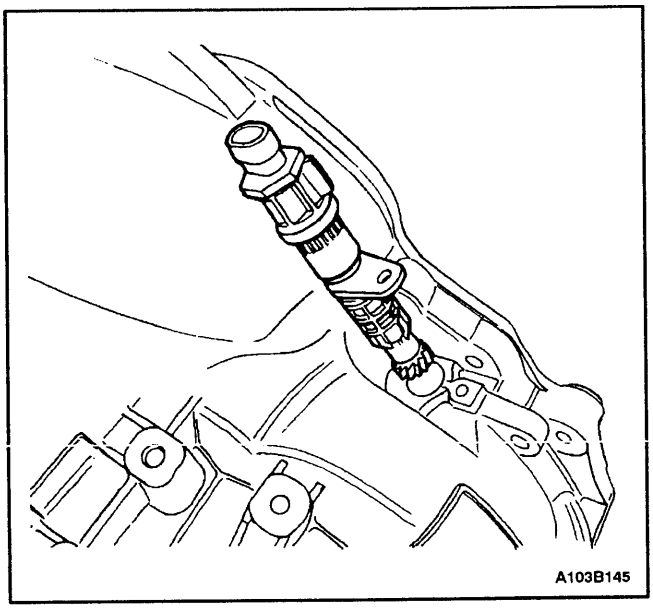
SPEEDOMETER DRIVEN GEAR

Removal Procedure

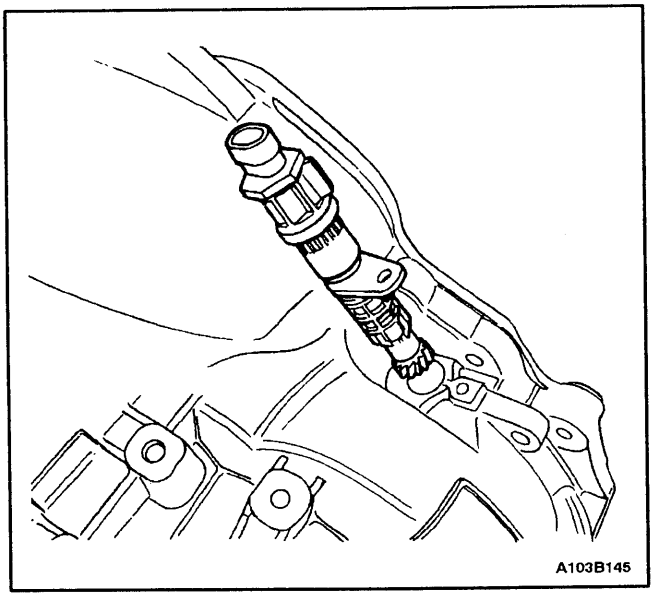
1. Disconnect the speedometer speed sensor electrical connector.



2. Remove the speedometer housing retaining bolt.

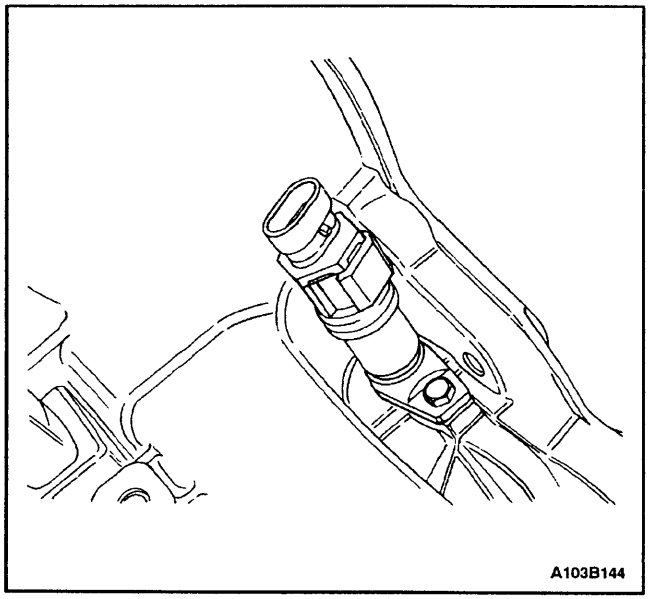


3. Remove the speedometer-driven gear and the speedometer housing.



Installation Procedure

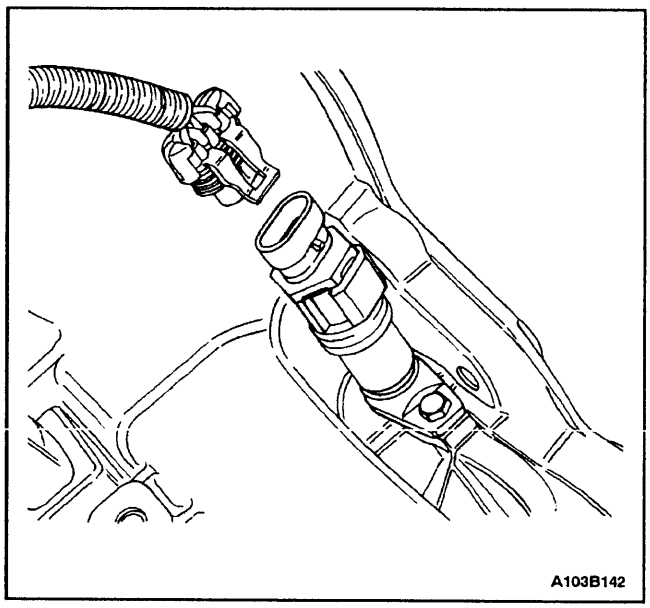
1. Coat the O-ring with petroleum jelly.
2. Install the speedometer-driven gear and the speedometer housing.


A103B144

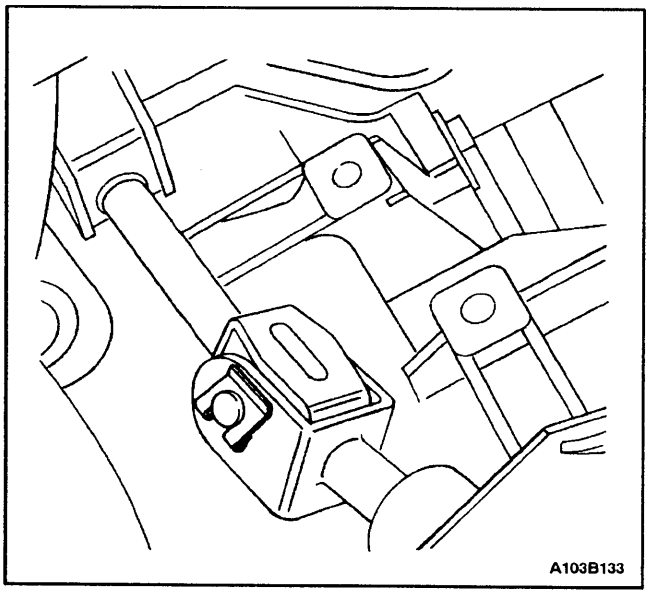
3. Install the speedometer housing retaining bolt.

Tighten

Tighten the speedometer housing retaining bolt to 4 N•m (35 lb-in).


A103B142

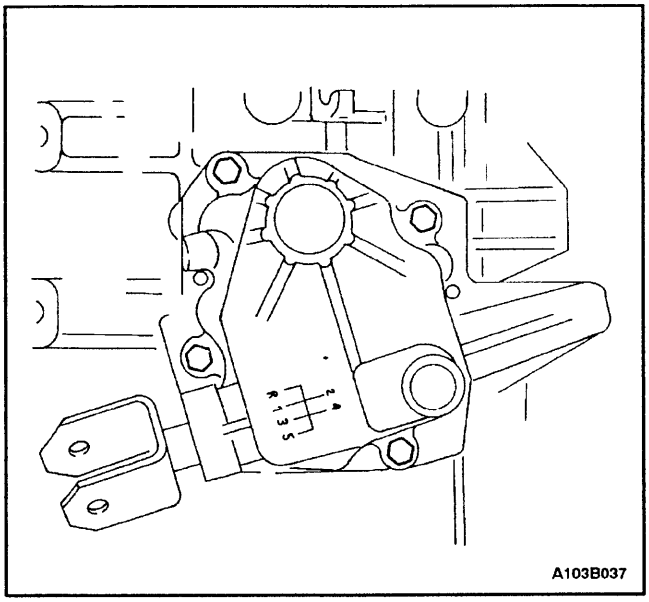
4. Connect the speedometer speed sensor electrical connector.


A103B133

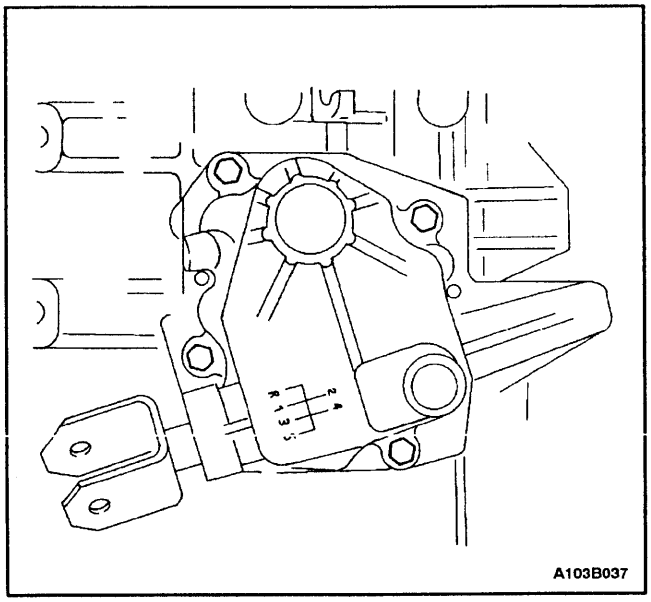
SHIFT LEVER COVER

Removal Procedure

1. Remove the clip and the bolt at the universal joint.



2. Remove the gearshift lever cover bolts.
3. Separate the gearshift lever cover and the gasket from the case.

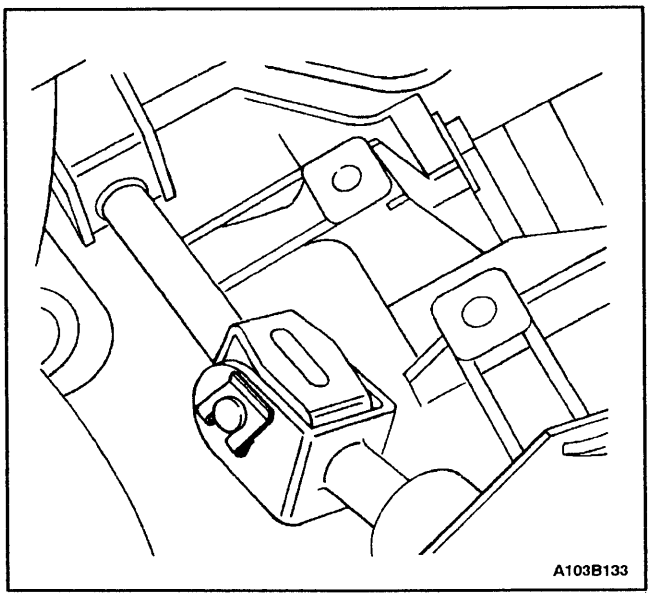


Installation Procedure

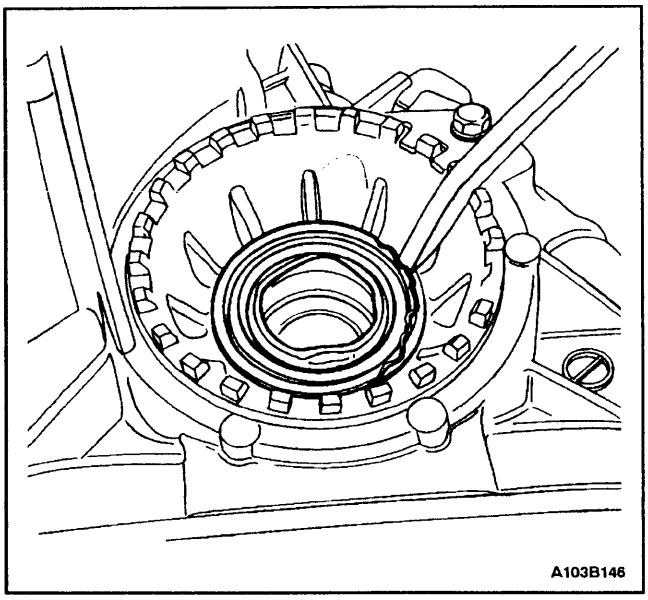
1. Position the gearshift lever cover and the gasket onto the case.
2. Install the gearshift lever cover bolts.

Tighten

Tighten the gearshift lever cover bolts to 22 N•m (16 lb-ft).



3. Install the bolt and the clip at the universal joint.
4. Check and adjust the fluid level. Refer to "Checking Fluid Level" in this section.



DRIVE AXLE SEAL

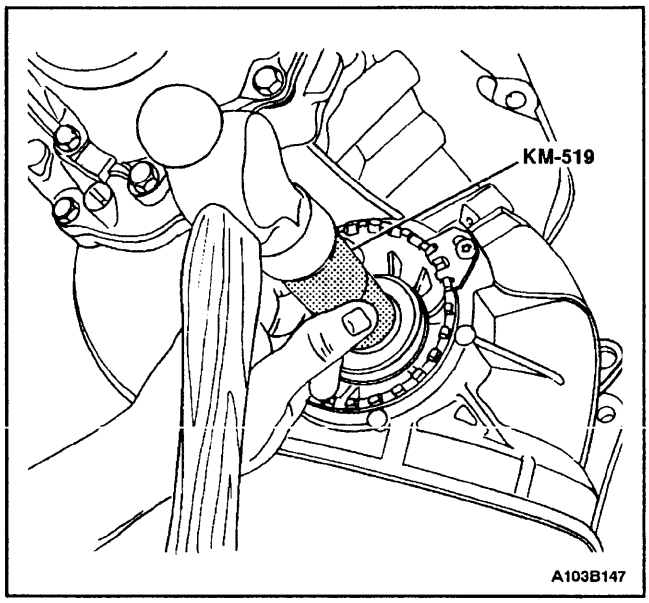
Tools Required

KM-519 Ring Installer

Removal Procedure

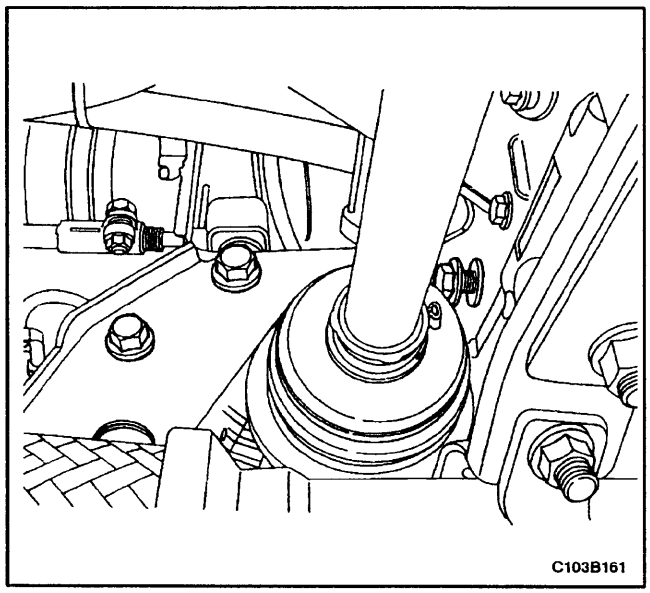
Notice: Do not damage the bearing adjusting ring with the pry bar.

1. Remove the drive axle from the transaxle. Refer to *Section 3B, Manual Transaxle Drive Axle.*
2. Remove the drive axle seal by lifting the outer lip of the seal with a pry bar.



Installation Procedure

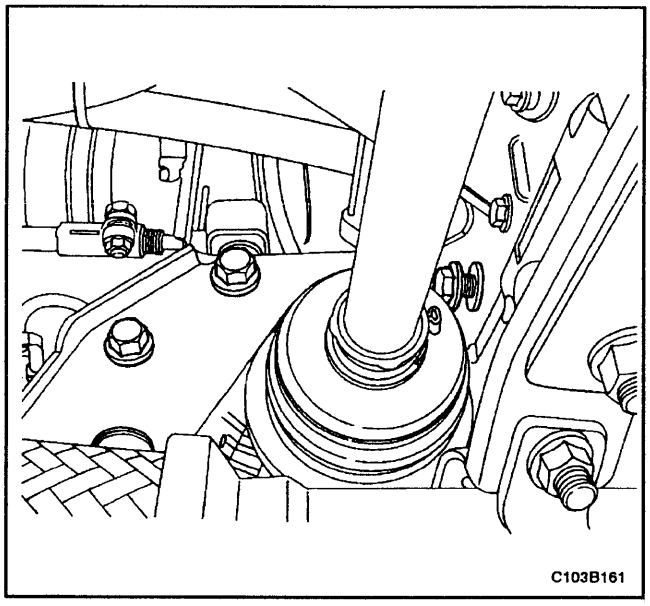
1. Install the new drive axle seal using the ring installer KM-519 and a hammer.
2. Coat the seal lip with the transaxle fluid.
3. Install the drive axle. Refer to *Section 3B, Manual Transaxle Drive Axle.*



TRANSAXLE BRACKET

Removal Procedure

1. Remove the center member from the vehicle. Refer to *Section 9N, Frame and Underbody.*
2. Disconnect the linkage lever from the transaxle bracket. Refer to "Linkage Lever and/or Bushings" in this section.
3. Remove the bolts connectiing the transaxle bracket to the transaxle and the bolt connecting the transaxle bracket to the engine.
4. Remove the transaxle bracket.


C103B161

Installation Procedure

1. Install the transaxle bracket.
2. Install the bolts connecting the transaxle bracket to the transaxle and the bolt connecting the transaxle bracket to the engine.

Tighten

Tighten the transaxle bracket-to-transaxle bolts to 90 N•m (66 lb-ft).

Tighten the transaxle bracket-to-engine bolt to 90 N•m (66 lb-ft).

3. Connect the linkage lever to the transaxle bracket. Refer to "Linkage Lever, and/or Bushings" in this section.
4. Install the center member into the vehicle. Refer to Section 9N, *Frame and Underbody.*

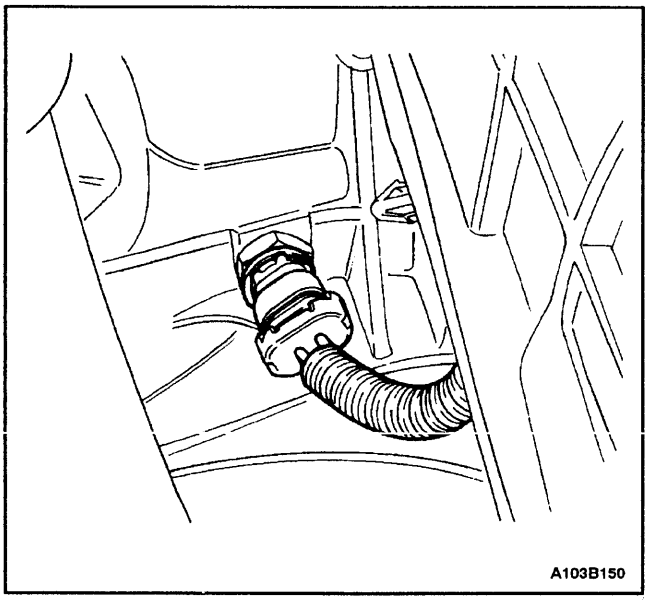
TRANSAXLE ASSEMBLY

Tools Required

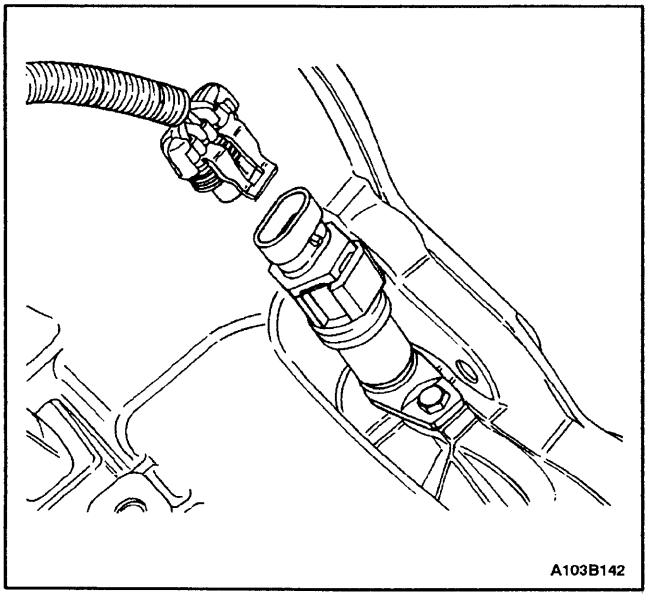
J-28467-B Engine Support Fixture

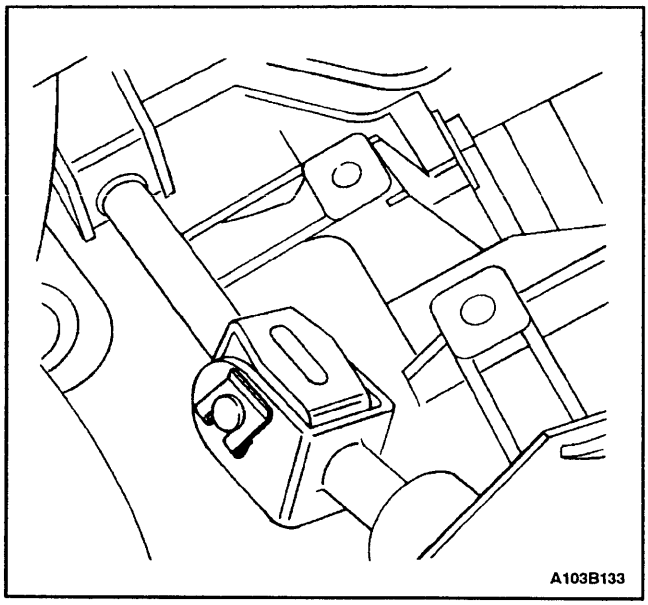
Removal Procedure

1. Disconnect the backup lamp switch electrical connector.

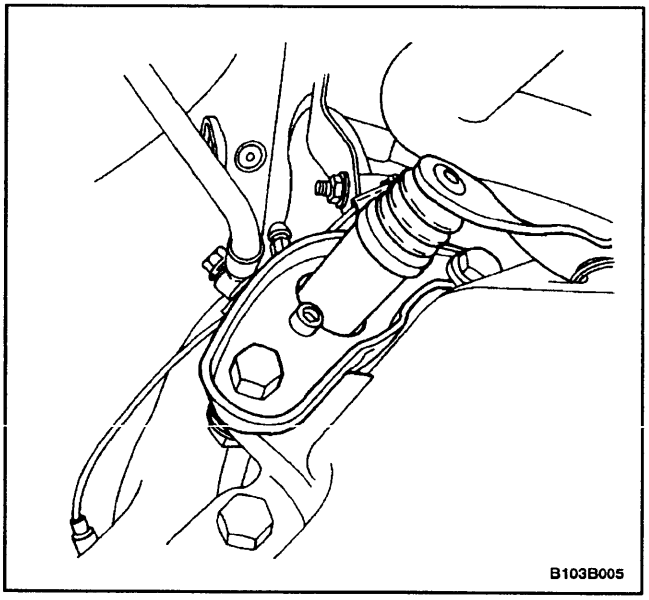

A103B150

2. Disconnect the speedometer speed sensor electrical connector.

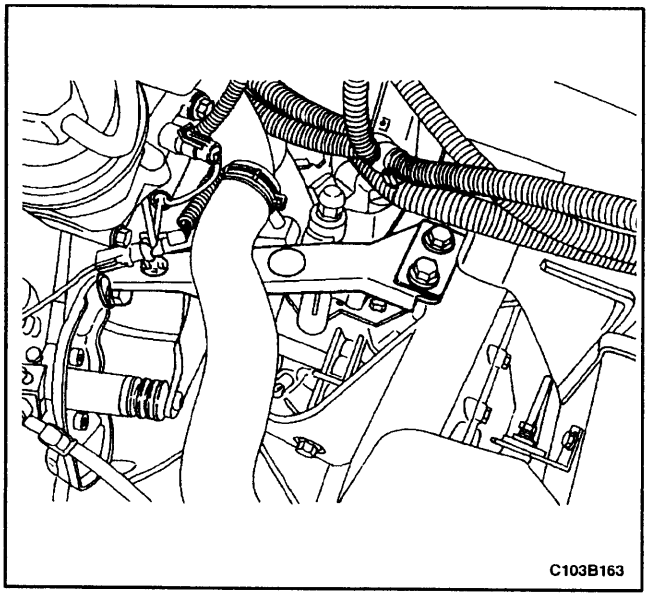

A103B142



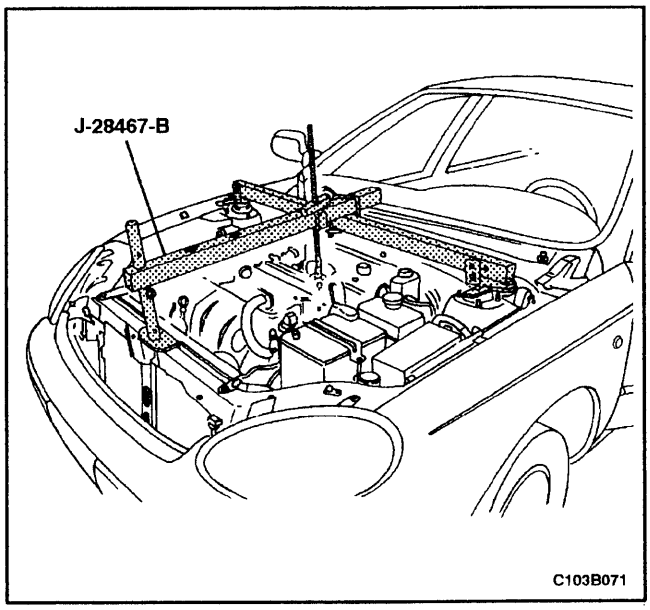
3. Remove the clip and the bolt from the universal joint.



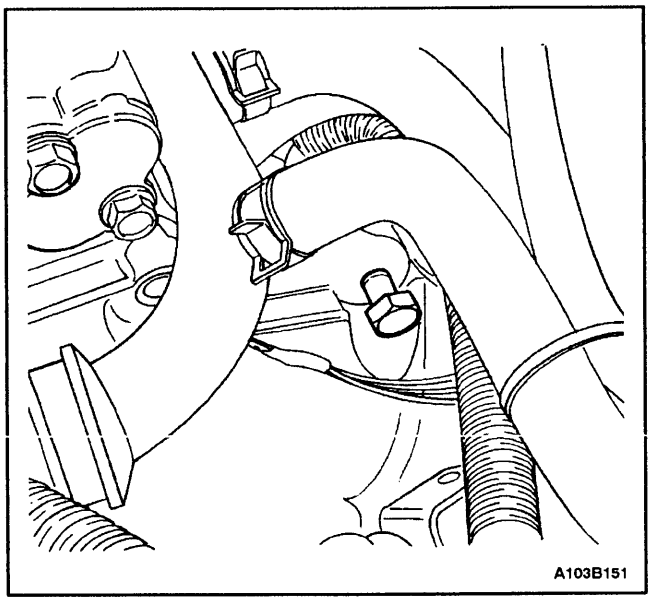
4. Remove the clutch release cylinder bracket bolts and the clutch release cylinder bracket.



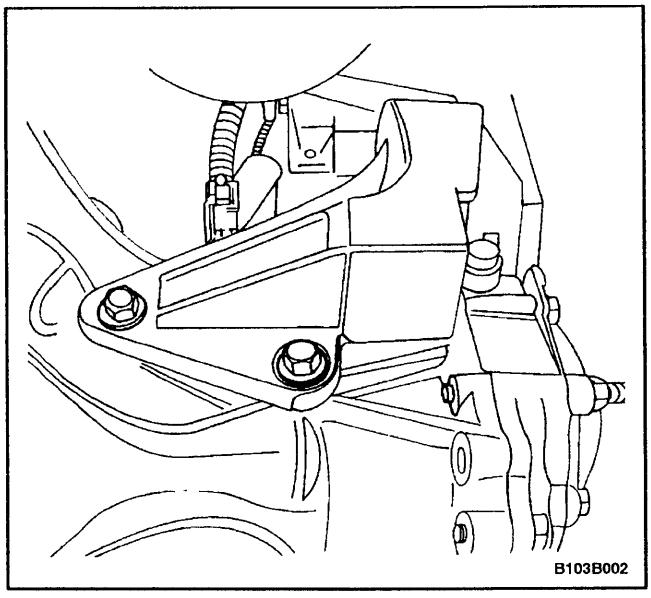
5. Remove the bolts and the transaxle upper brace.



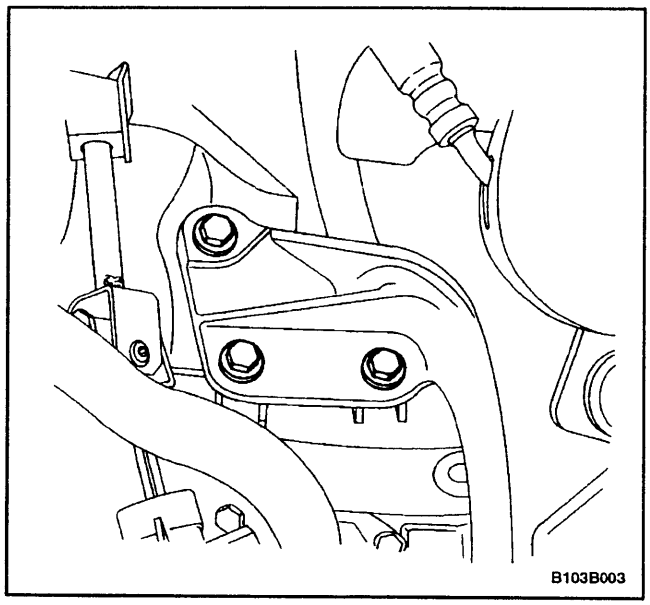
6. Install the engine support fixture J-28467-B.



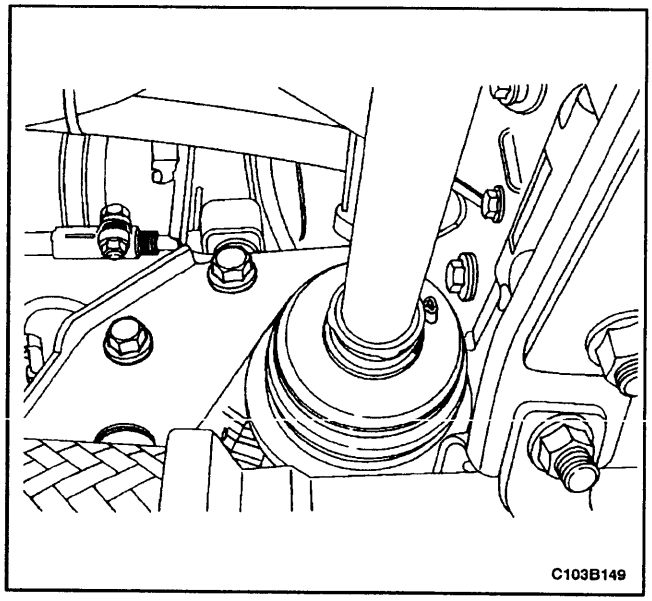
7. Remove the transaxle-to-engine upper bolts.
8. Raise and suitably support the vehicle.
9. Remove both of the drive axle shafts. Refer to *Section 3B, Manual Transaxle Drive Axle*.



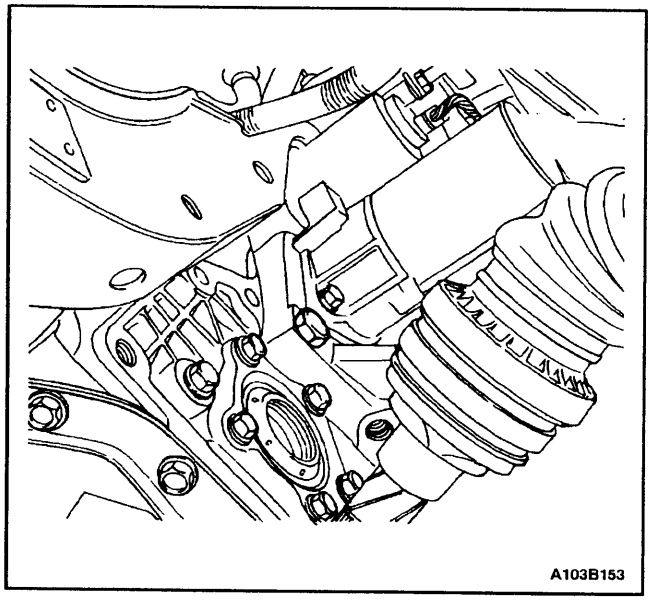
10. Support the transaxle with a transaxle support jack.
11. Remove the left front transaxle support bracket bolts and the left front transaxle support bracket.



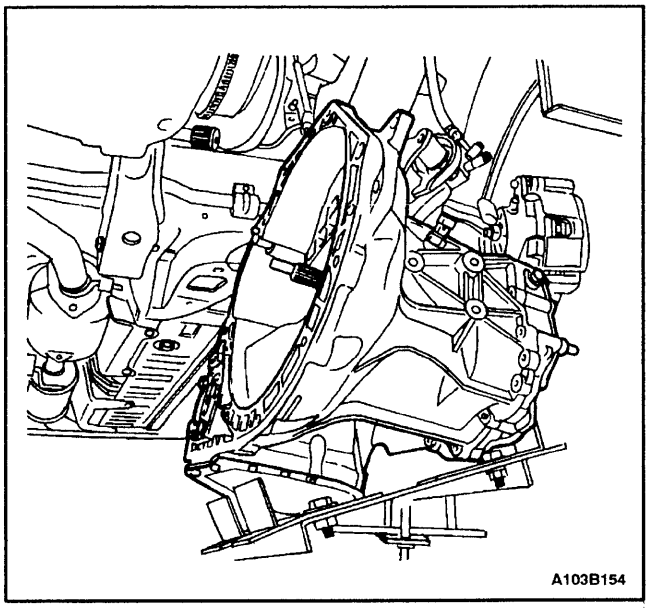
12. Remove the left rear transaxle support bracket bolts and the left rear transaxle support bracket.



13. Remove the center rear transaxle support bracket bolts.



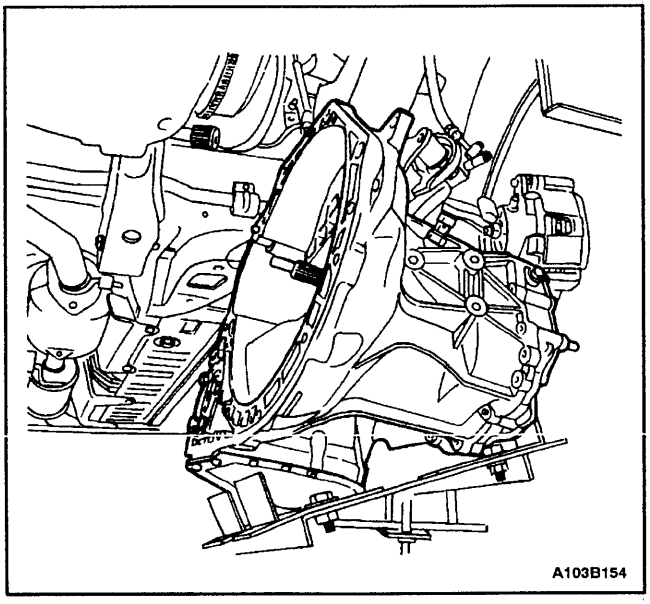
14. Remove the transaxle-to-engine lower bolts.



15. Disconnect the transaxle.

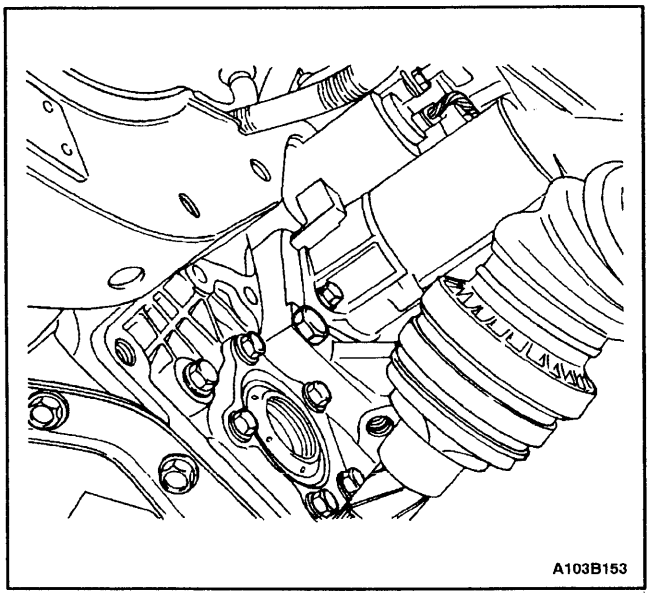
Notice: Rest the transaxle only in an upright position.

16. Slide the transaxle sideways away from the engine block.
17. Lower the transaxle.



Installation Procedure

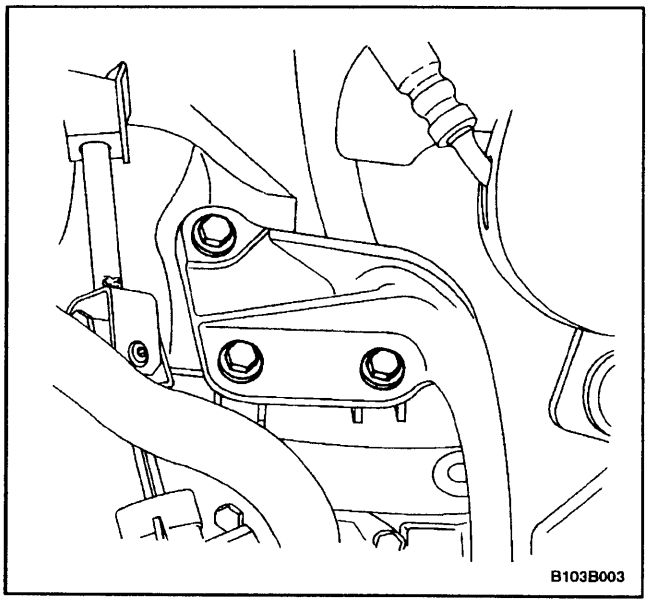
1. Support the transaxle with a transaxle support jack.
2. Install the transaxle by inserting the transaxle input shaft into the clutch disc and sliding the transaxle sideways into the engine block.



3. Install the transaxle-to-engine lower bolts.

Tighten

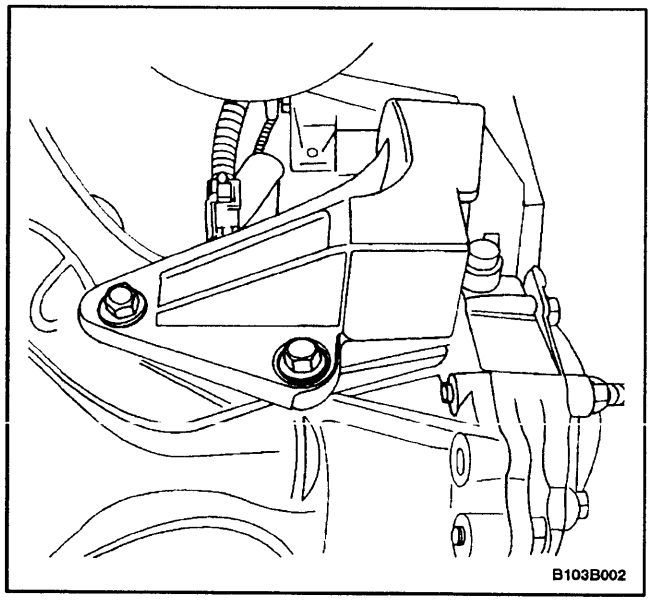
Tighten the transaxle-to-engine lower bolts to 75 N•m (55 lb-ft).



4. Install the left rear transaxle support bracket and the bolts.

Tighten

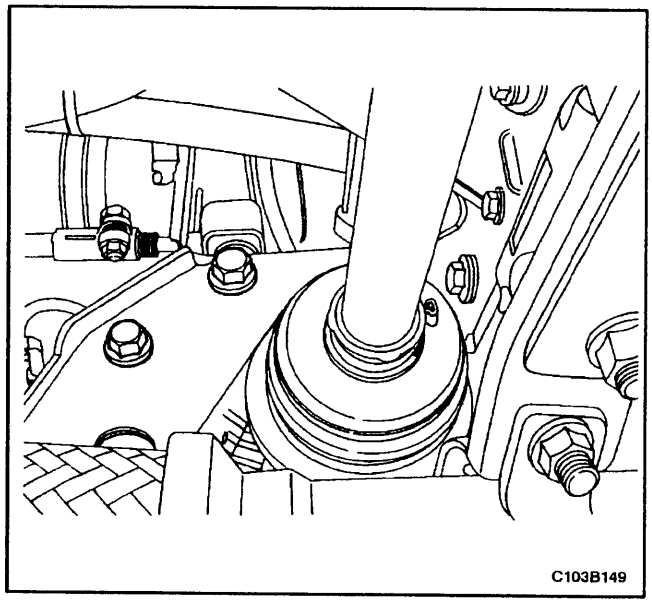
Tighten the left rear transaxle support bracket bolts to 60 N•m (44 lb-ft).



5. Install the left front transaxle support bracket and the bolts.

Tighten

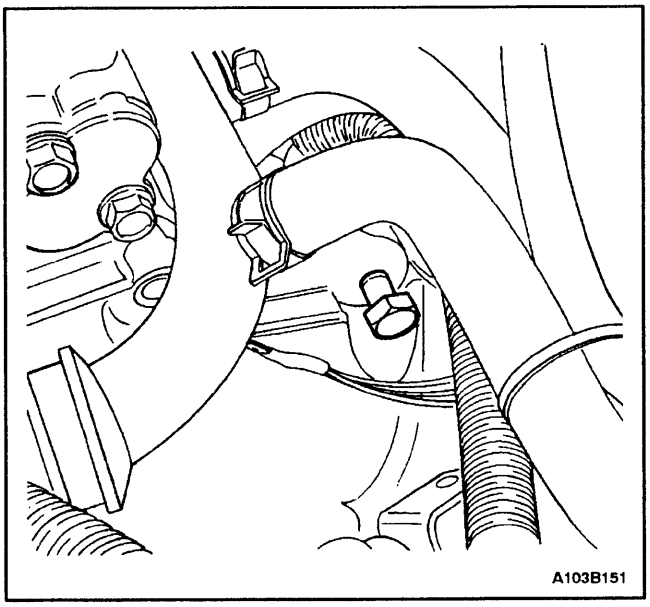
Tighten the left front transaxle support bracket bolts to 60 N•m (44 lb-ft).



6. Install the center rear transaxle support bracket and the transaxle support bracket bolts.

Tighten

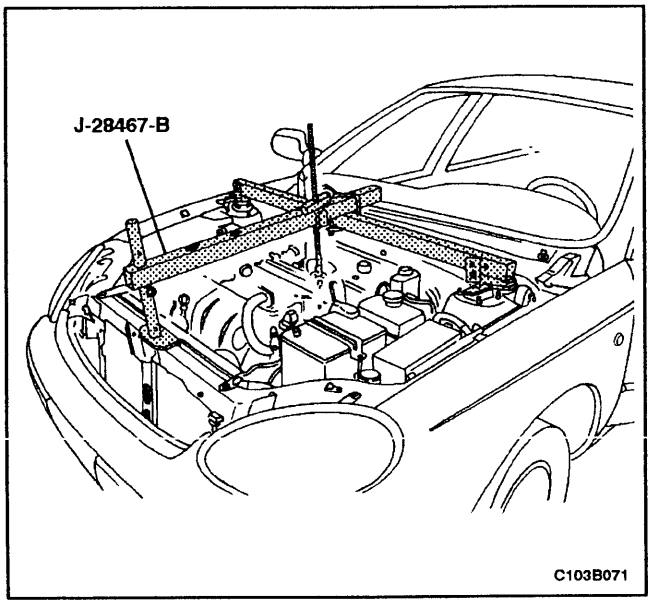
Tighten the center rear transaxle support bracket bolts to 90 N•m (66 lb-ft).



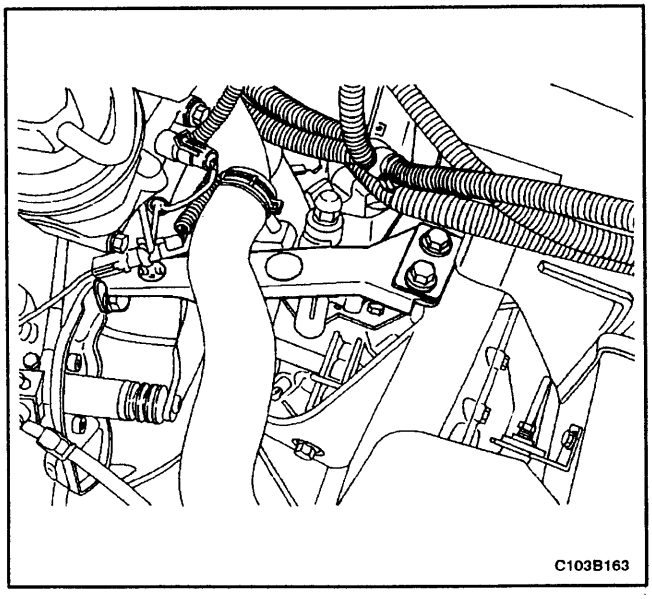
7. Install both of the drive axle shafts. Refer to *Section 3B, Manual Transaxle Drive Axle*.
8. Lower the vehicle.
9. Install the upper transaxle-to-engine bolts.

Tighten

Tighten the transaxle-to-engine upper bolts to 75 N•m (55 lb-ft).



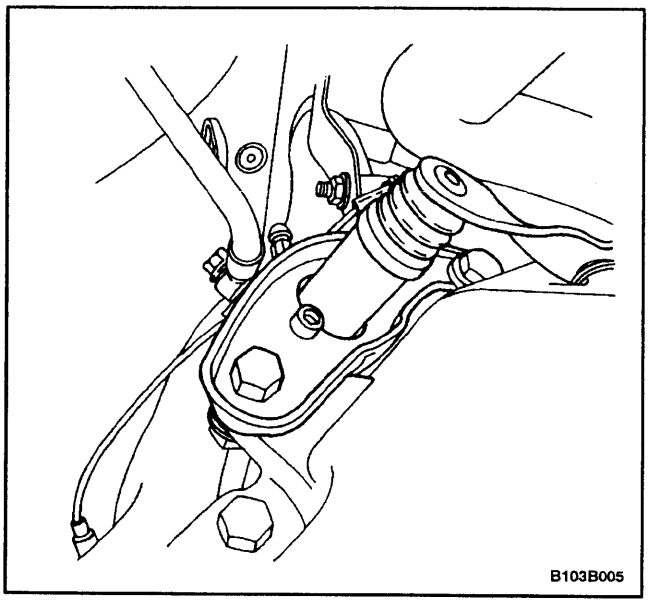
10. Remove the engine support fixture J-28467-B.



11. Install the transaxle upper brace with the bolts.

Tighten

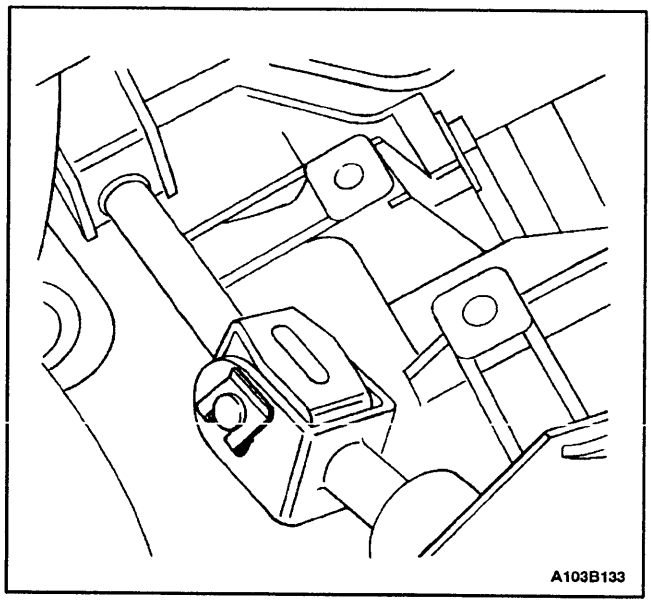
Tighten the transaxle upper brace bolts to 75 N•m (55 lb-ft).



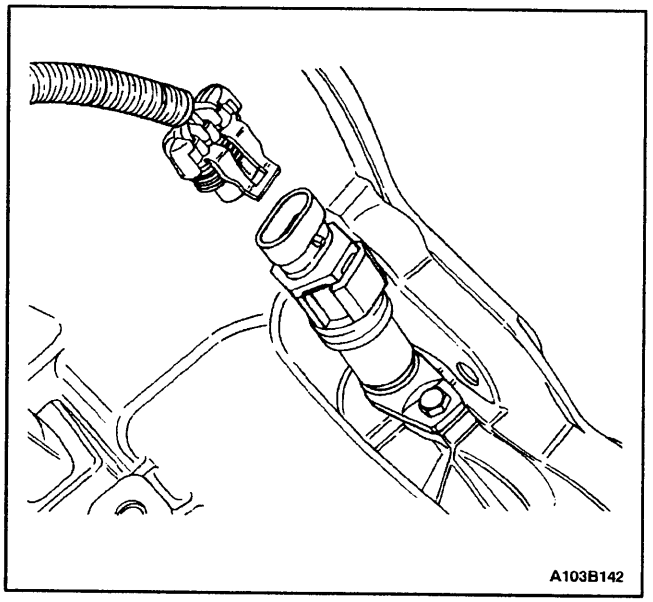
12. Install the clutch release cylinder bracket and the clutch release cylinder bracket bolts.

Tighten

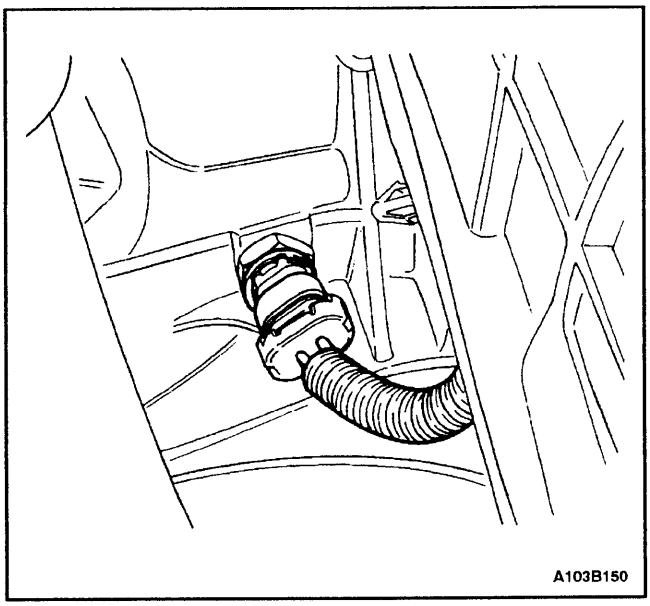
Tighten the clutch release cylinder bracket bolts to 75 N•m (55 lb-ft).



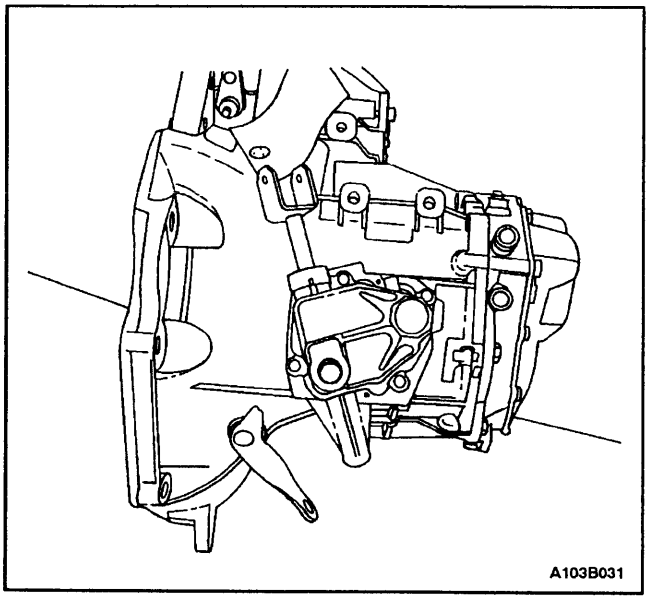
13. Install the bolt and the clip onto the universal joint.

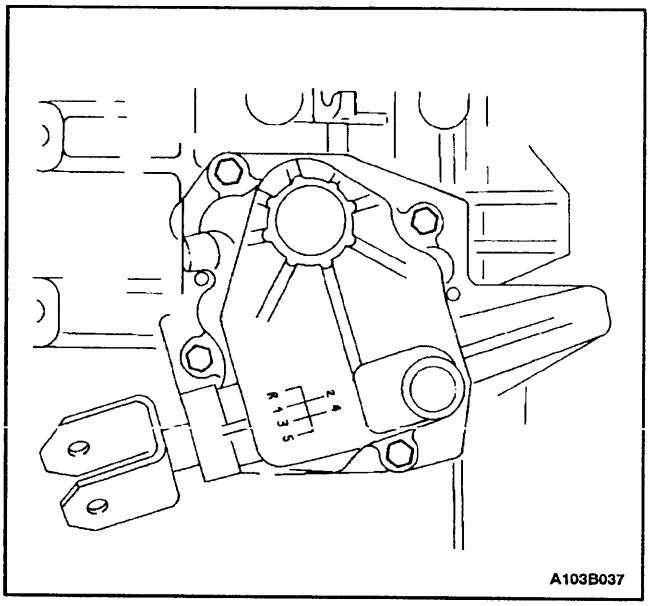


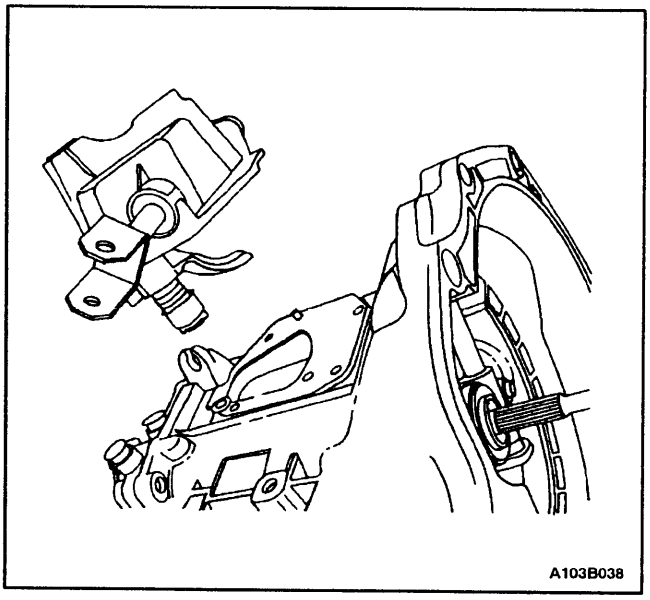
14. Connect the speedometer speed sensor electrical connector.


A103B150

15. Connect the backup lamp switch electrical connector.
16. Inspect the fluid level. Refer to "Checking Fluid Level" in this section.


A103B031


A103B037


A103B038

UNIT REPAIR

MAJOR COMPONENT DISASSEMBLY

Tools Required

J-6125-B Slide Hammer

J-22888-20-A Bearing Puller with J-22888-35 Puller Legs

KM-553-A Fifth Gear Puller

J-36633 Snap Ring Retainer

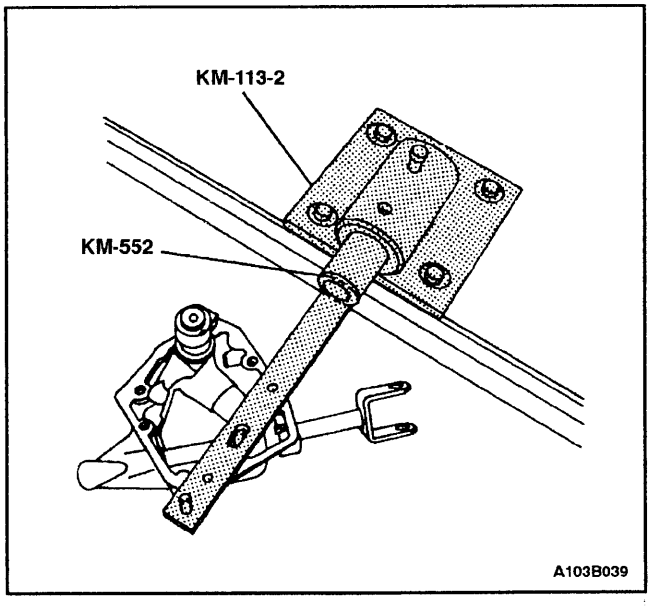
KM-113-2 Base

J-42469 Shift Rod Remover

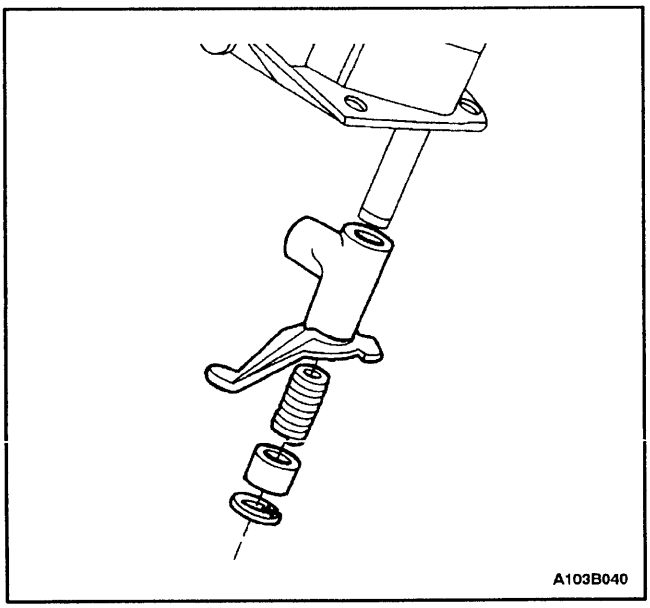
KM-552 Fixture

Disassembly Procedure

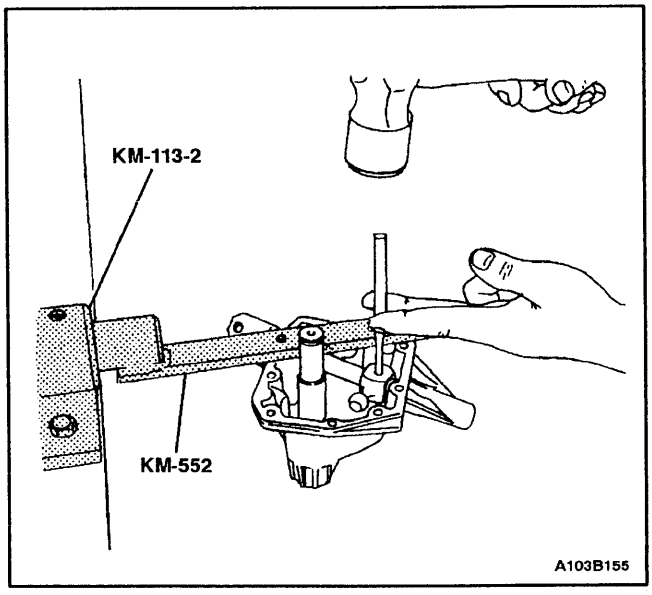
1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the filler plug at the cover.
3. Remove the bolts from the gearshift lever cover.
4. Remove the gearshift lever cover.



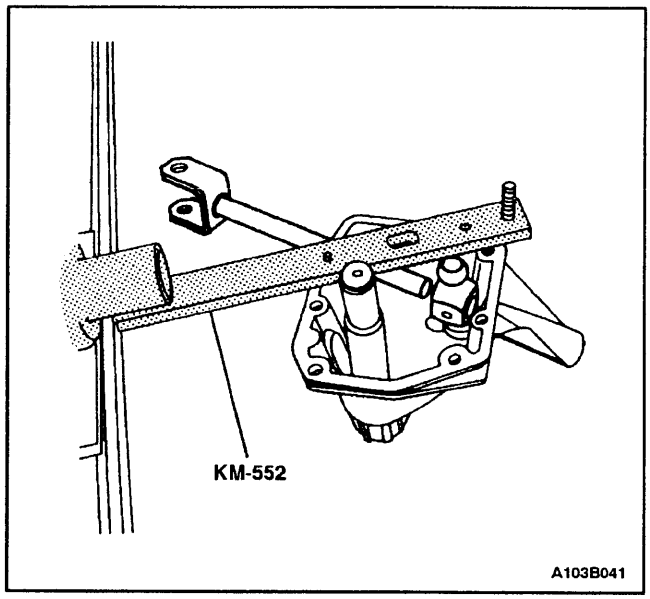
5. Bolt the gearshift lever cover to the fixture KM-552.
6. Position the fixture KM-552 into the base KM-113-2.



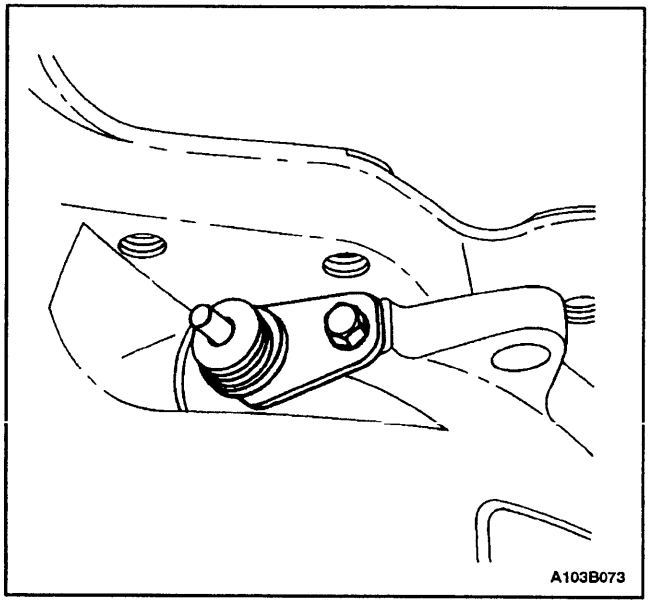
7. Remove the snap ring, the bushing, the spring, and the intermediate lever.



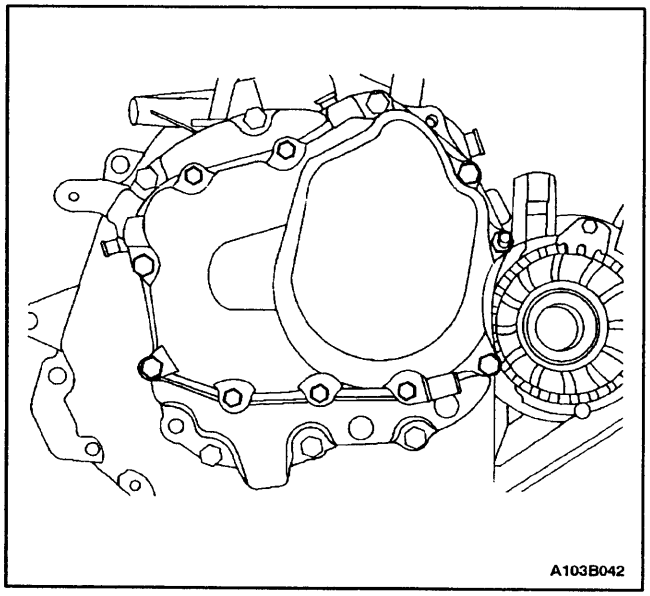
8. Remove the shift finger lever pin.



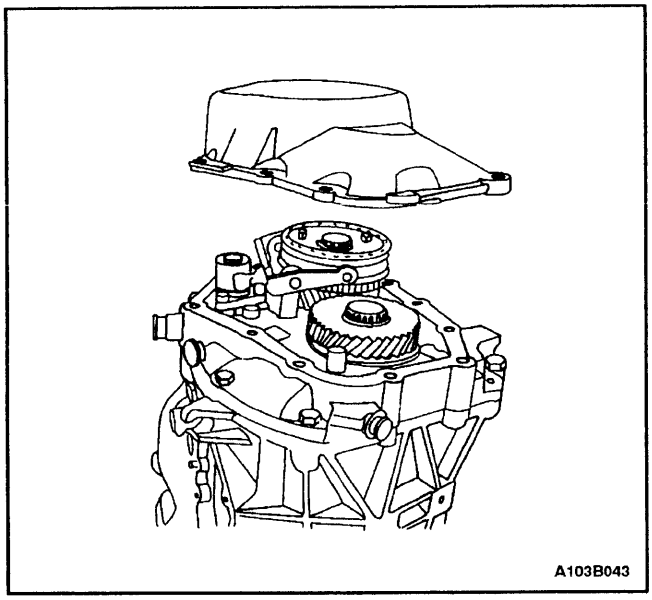
9. Remove the gearshift rod and the shift finger lever.



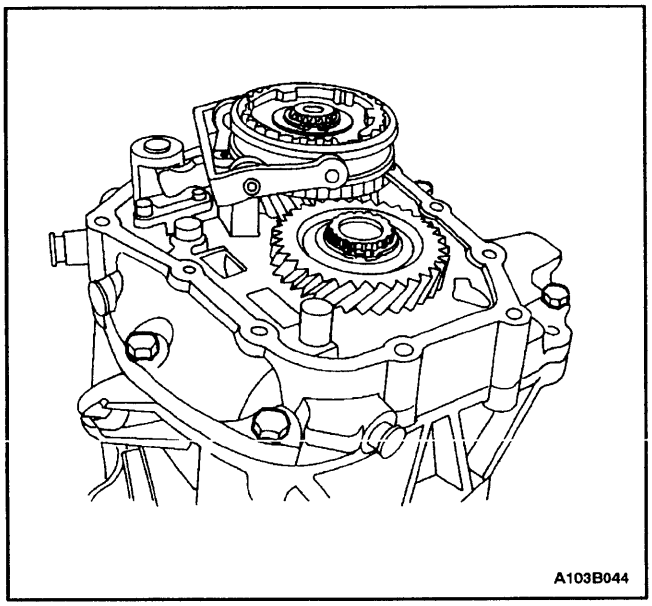
10. Remove the bolt and the speedometer-driven gear from the transaxle housing.



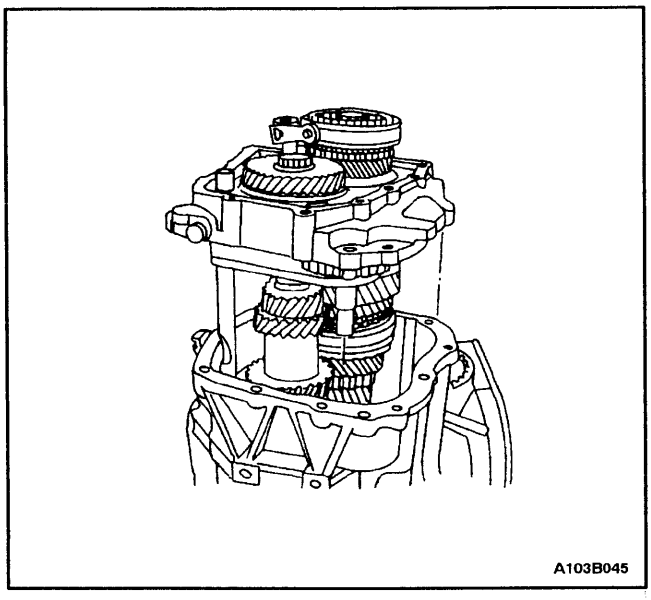
11. Remove the transaxle cover bolts.



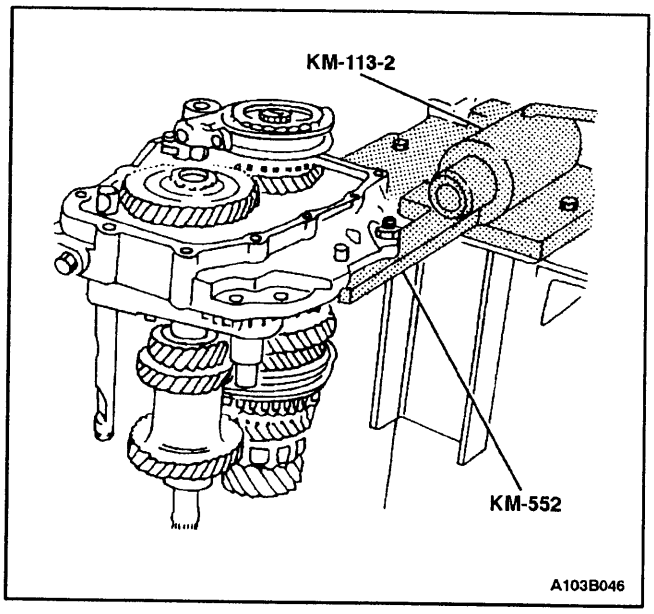
12. Remove the transaxle cover.



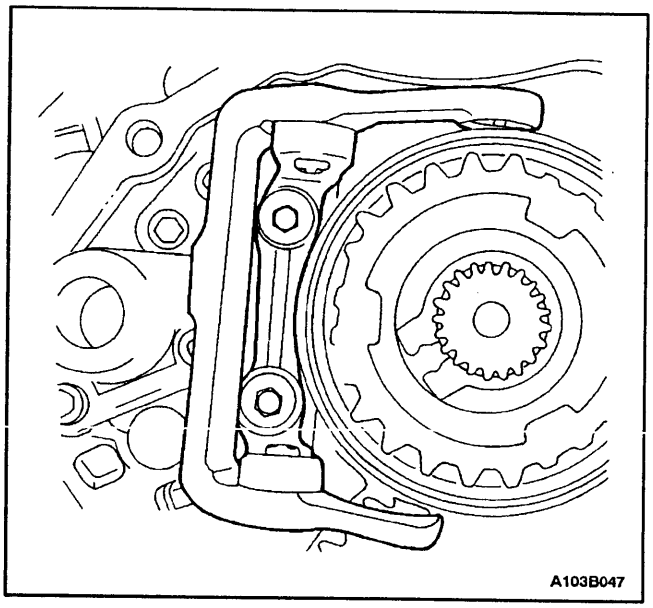
13. Shift the transaxle into second gear.
14. Remove the bearing plate bolts.



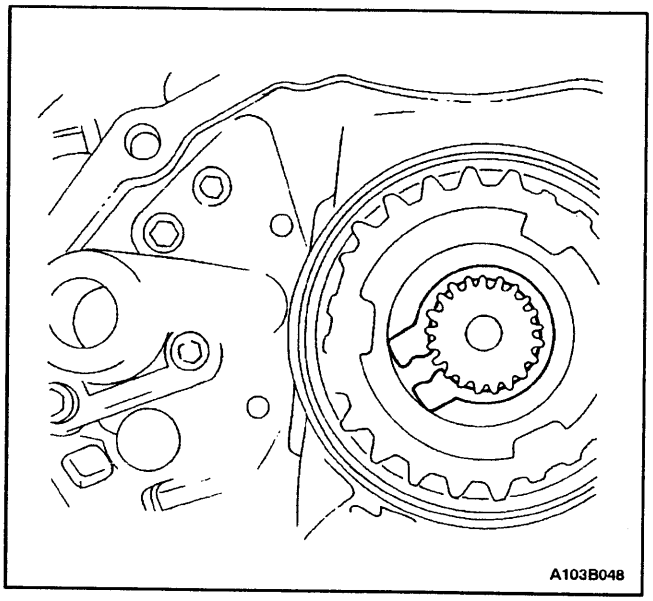
15. Remove the bearing plate from the case with the shafts attached.



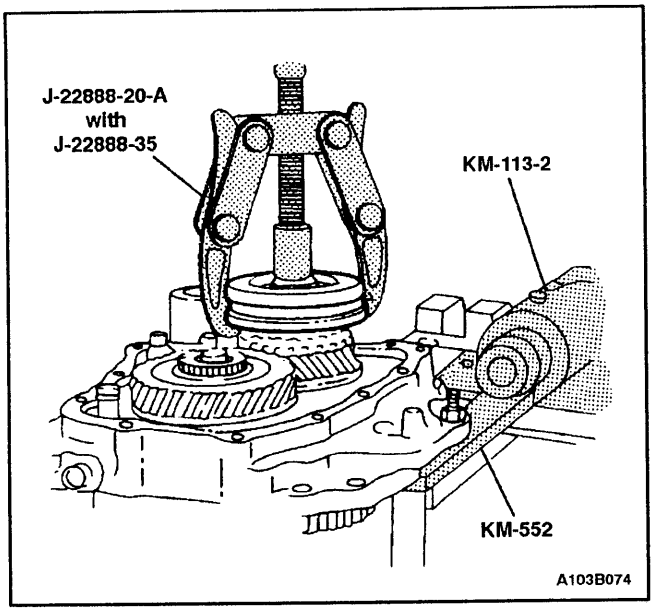
16. Shift the transaxle into reverse (R).
17. Bolt the bearing plate to the fixture KM-552 and install the fixture KM-552 into the base KM-113-2.



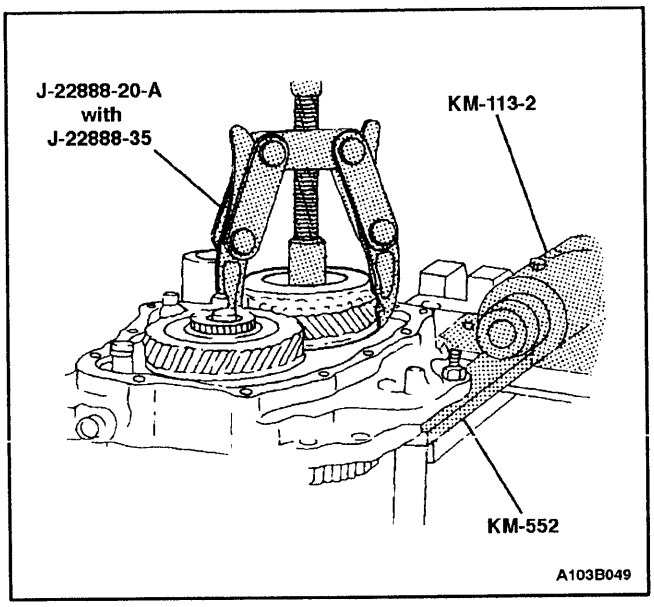
18. Remove the bolts and the fifth-gear fork from the bearing plate.



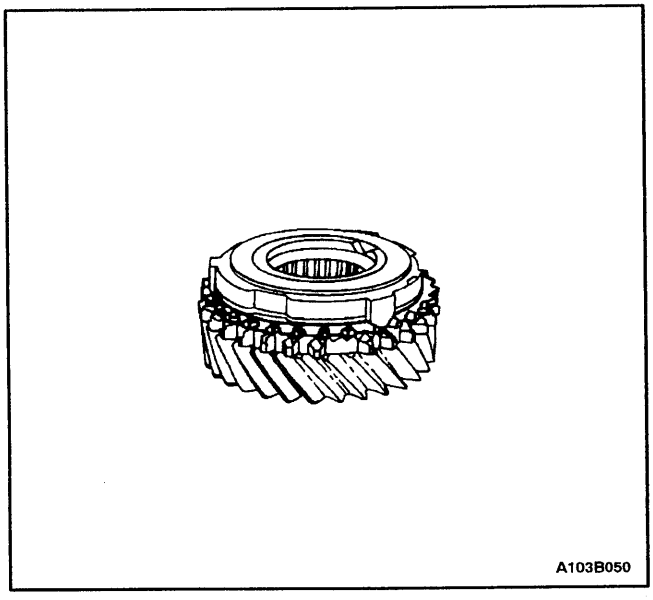
19. Remove the mainshaft-driven fifth-speed assembly snap ring.



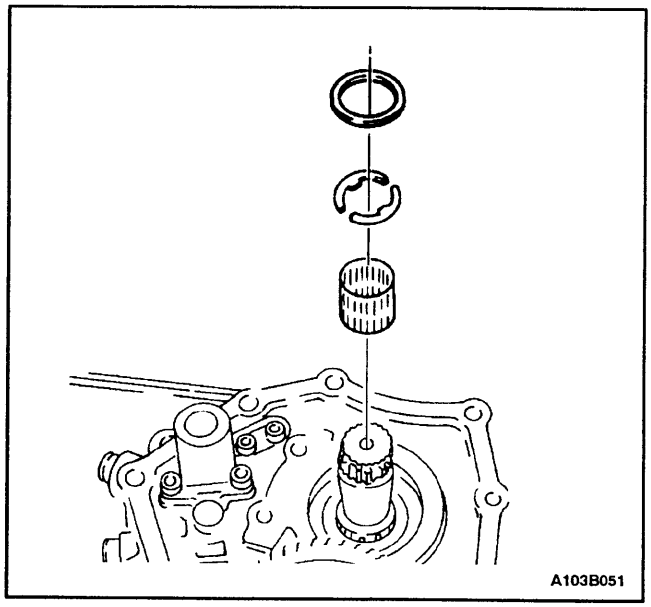
20. Remove the fifth driven gear synchronizer sleeve and the synchronizer gear using the bearing puller J-22888-20-A with the puller legs J-22888-35.



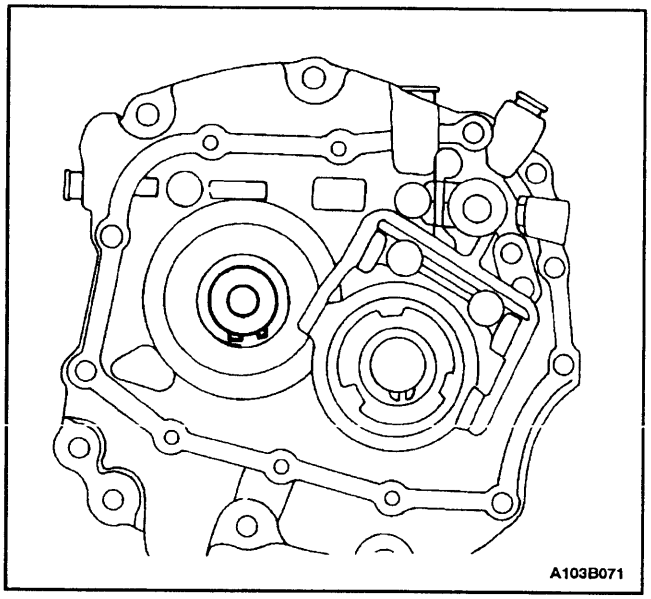
21. Remove the mainshaft-driven fifth-gear assembly.



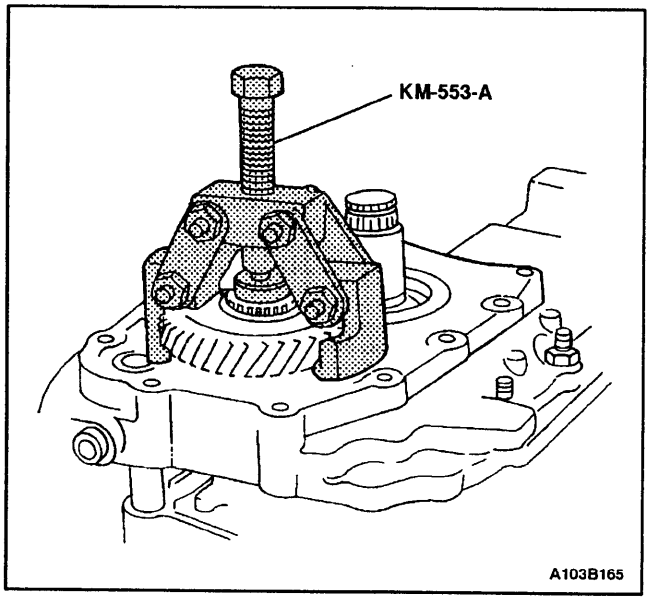
22. Remove the brass synchronizer ring.



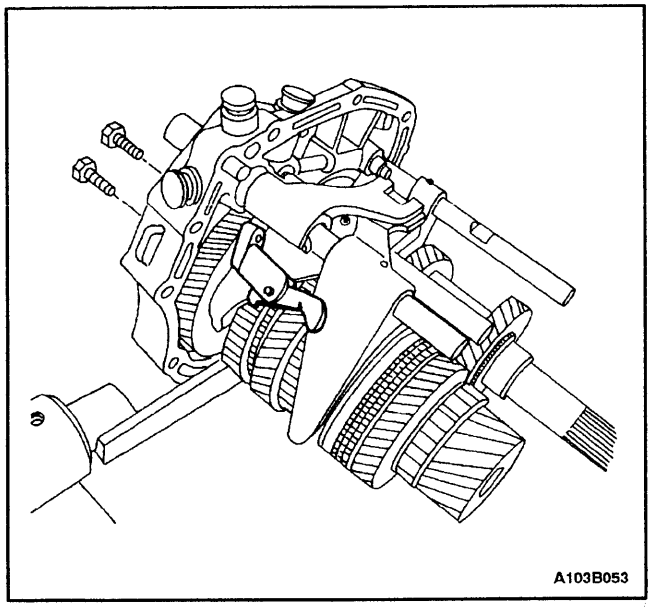
23. Remove the needle bearing, the retaining ring, and the thrust washers.



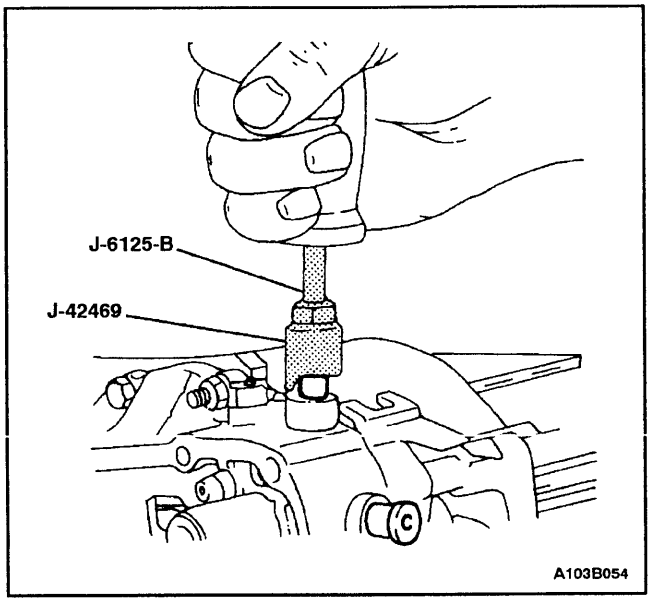
24. Remove the input drive fifth-gear snap ring.



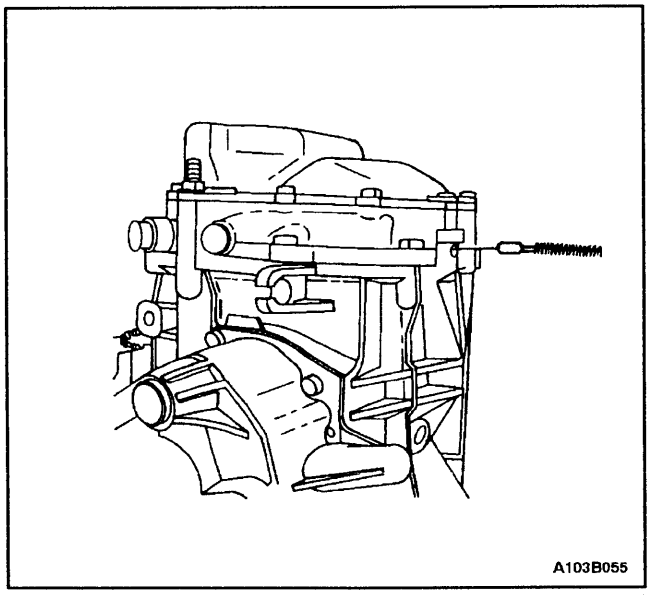
25. Remove the input drive fifth gear using the fifth-gear puller KM-553-A.



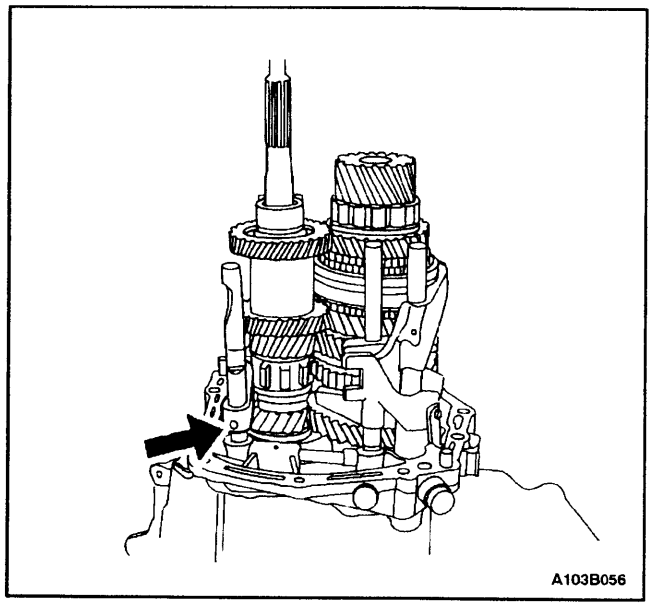
26. Remove the bolts and the fifth-gearshift connector from the bearing plate using the pawl.



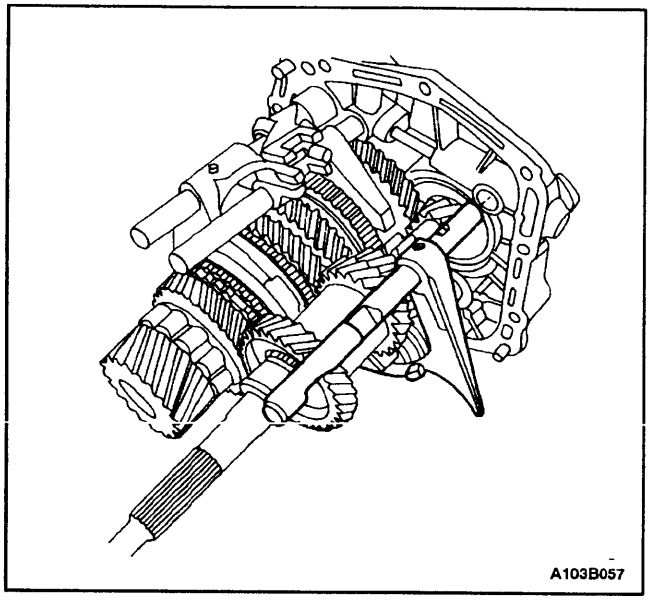
27. Remove the four shift-rod plugs using the shift rod remover J-42469 and the slide hammer J-6125-B.



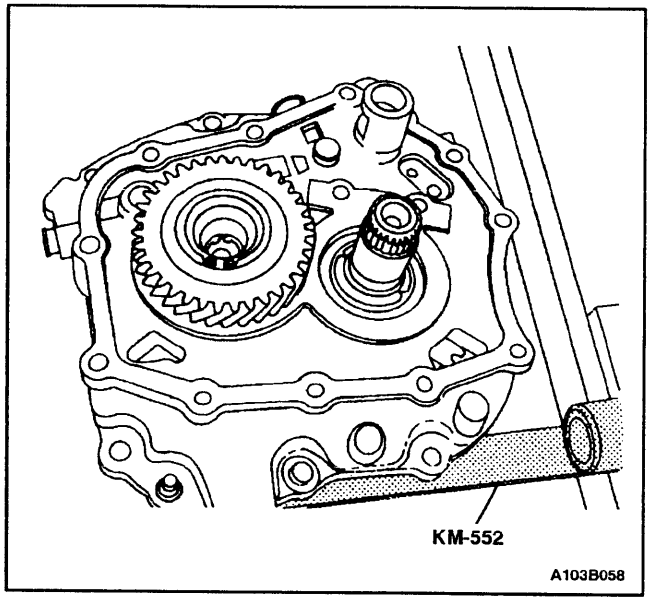
28. Remove the spring and the rod lock pin from the small plug hole.



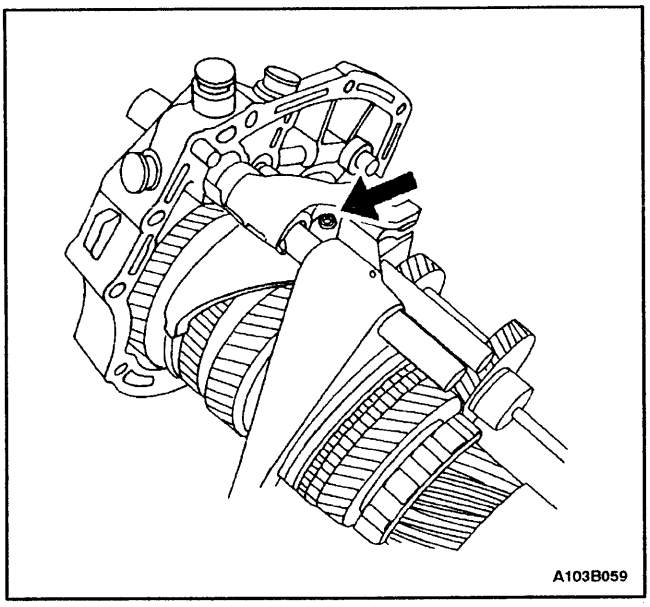
29. Remove the pin from the reverse gearshift rod/fork assembly.



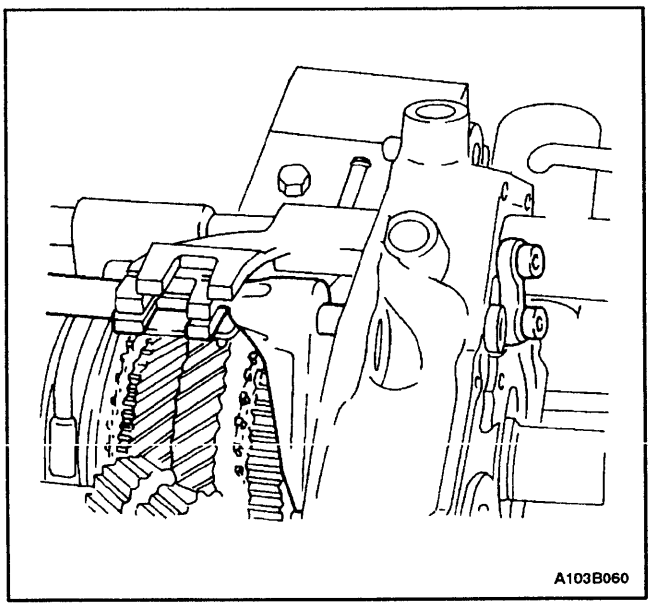
30. Remove the reverse gearshift rod/fork assembly from the bearing plate.



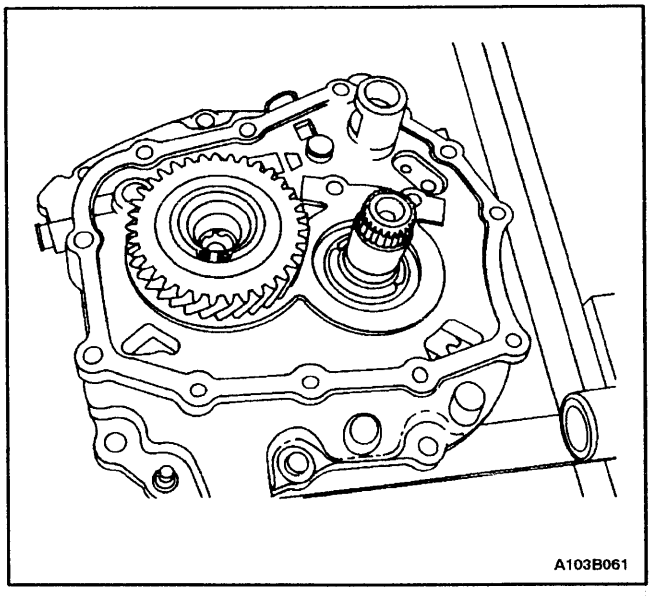
31. Remove the bolts from the support bracket.



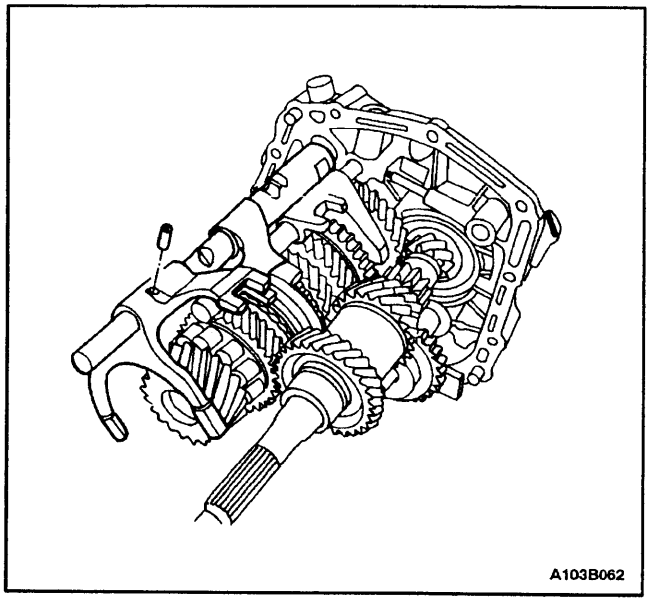
32. Remove the first-second gearshift fork holding pin.



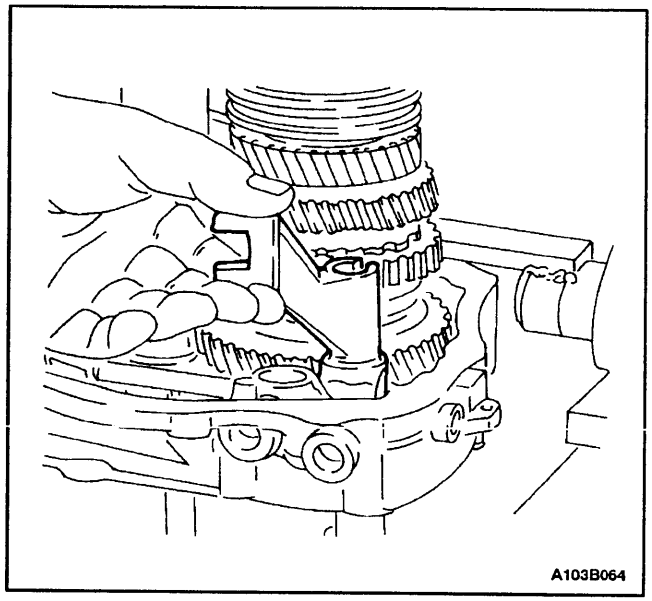
33. Drive the first-second gearshift rod out until it is just free of the bearing plate.



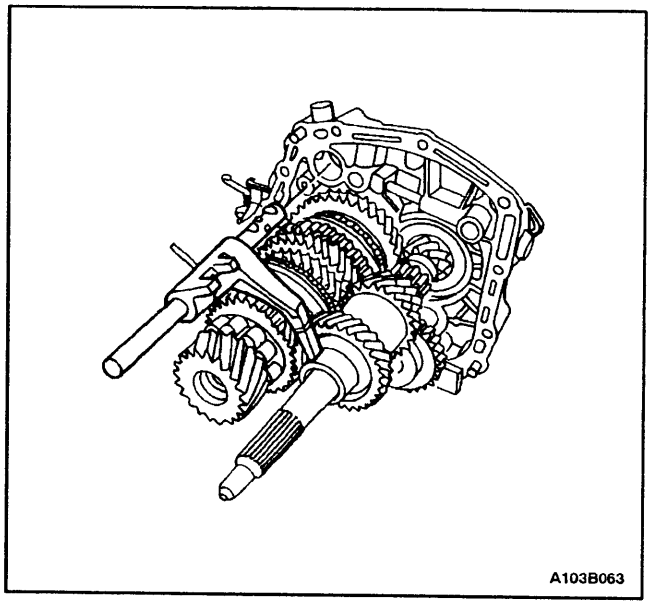
34. Remove the support bracket from the bearing plate.



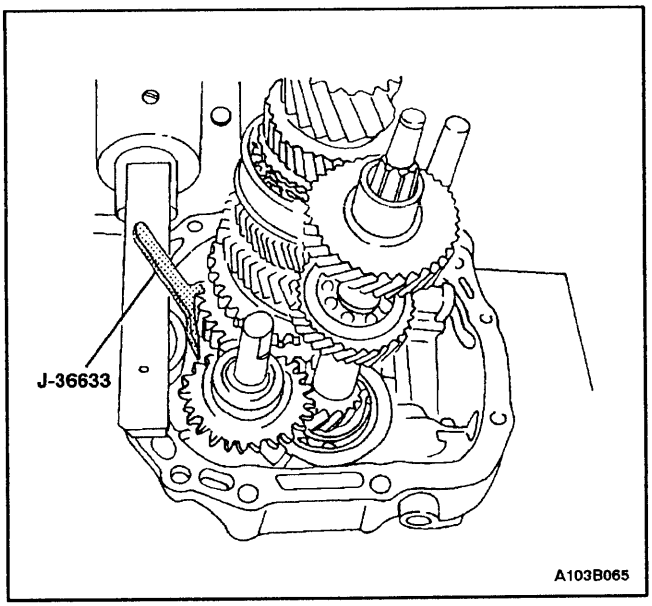
35. Remove the third-fourth gearshift fork holding pin and the third-fourth gearshift rod.



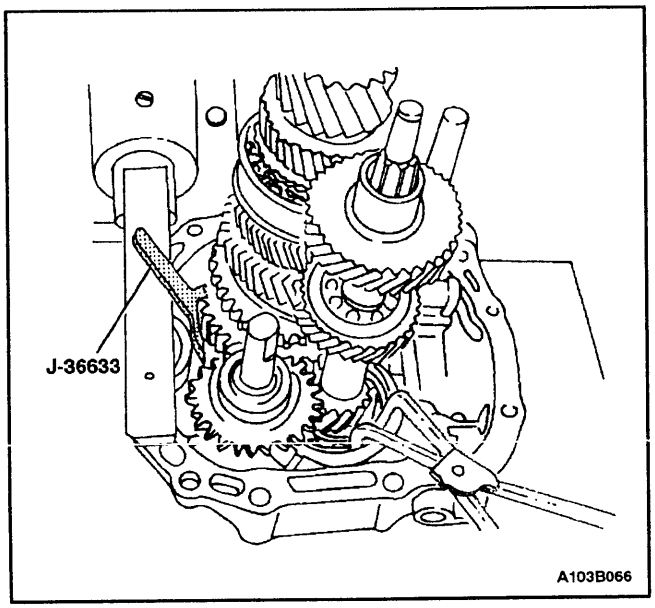
36. Remove the fifth gearshift lever from the bearing plate.



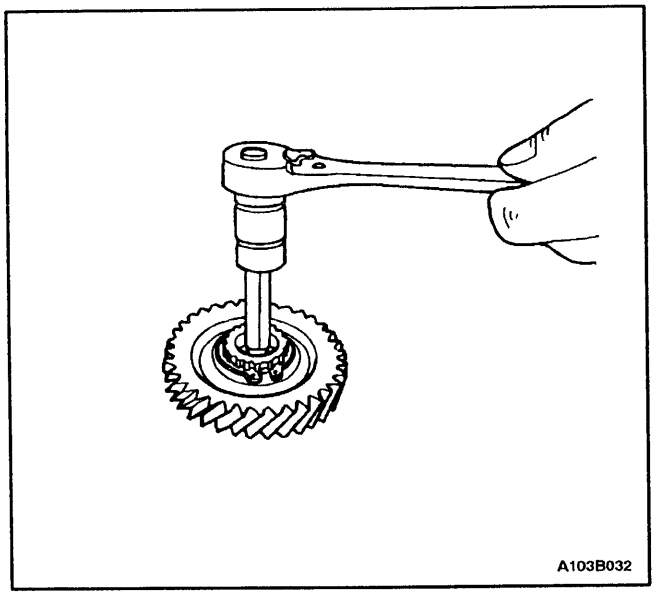
37. Remove the first-second gearshift rod.



38. Compress the snap ring holding the mainshaft and secure it with the snap ring retainer J-36633.



39. Hold the snap ring open at the base of the input shaft using the snap ring pliers.
40. Remove the mainshaft assembly and the input shaft assembly from the bearing plate.



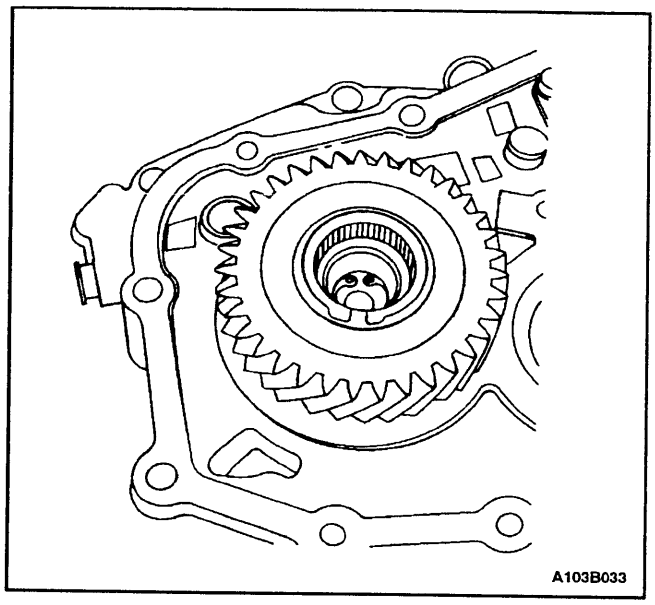
INPUT SHAFT AND CLUSTER GEAR

Tools Required

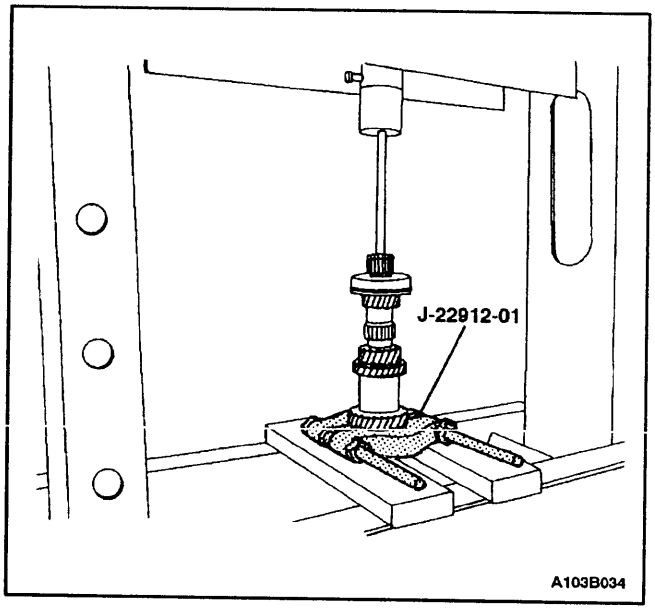
J-22912-01 Universal Bearing Puller

Disassembly Procedure

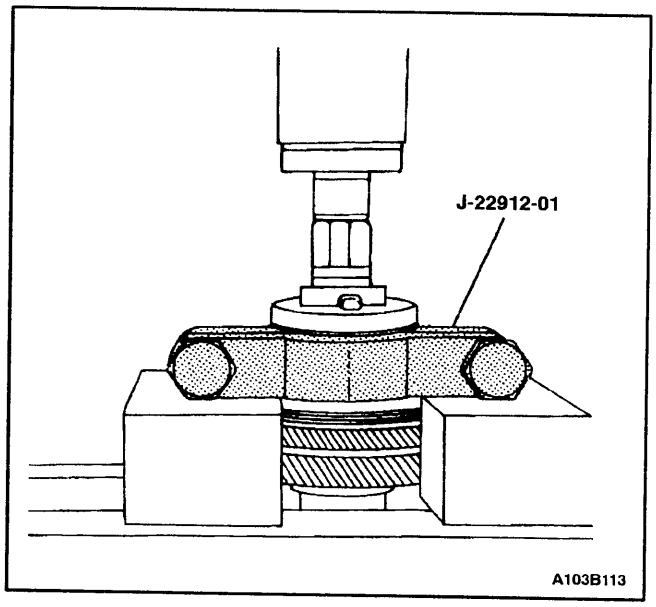
1. Remove the detent screw at the end of the input driveshaft.



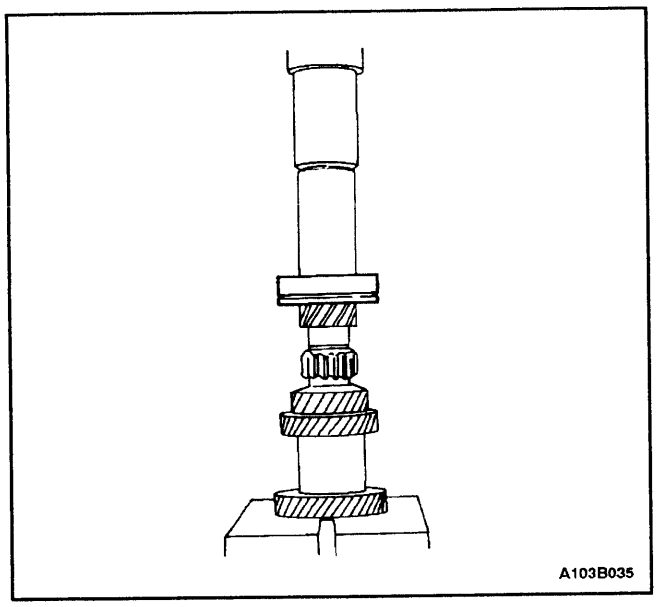
2. Remove the snap ring at the base of the gear cluster.



3. Press the input driveshaft from the input shaft cluster gear using the universal bearing puller J-22912-01.

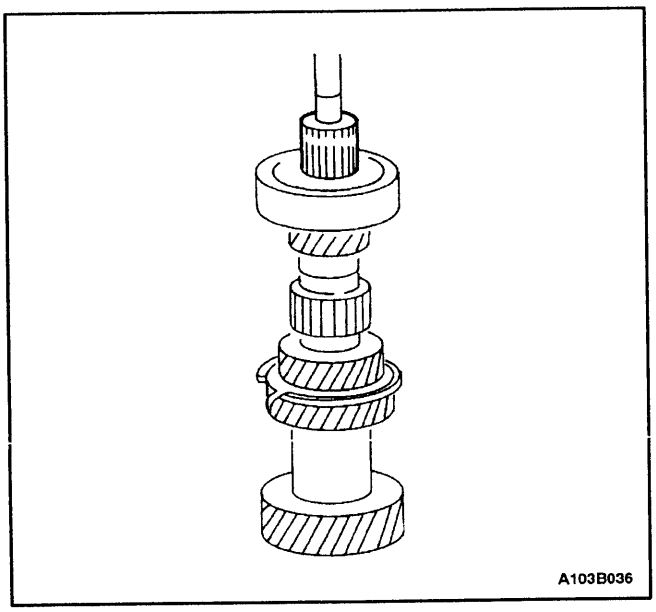


4. Remove the cluster shaft bearing from the input shaft gear cluster using universal bearing puller J-22912-01.

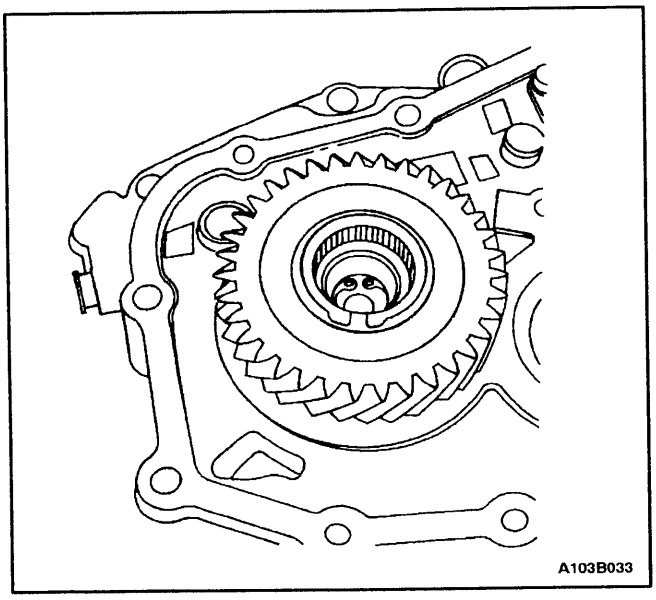


Assembly Procedure

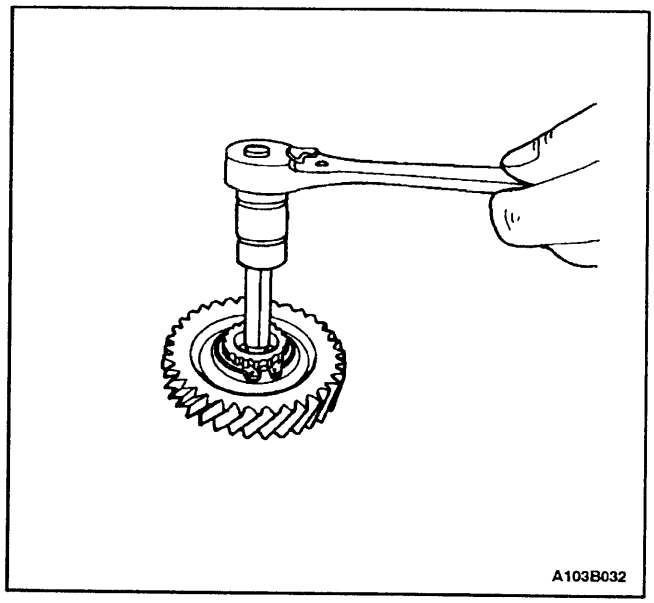
1. Press the cluster shaft bearing onto the input shaft gear cluster.



2. Press the input driveshaft into the input shaft gear cluster assembly.



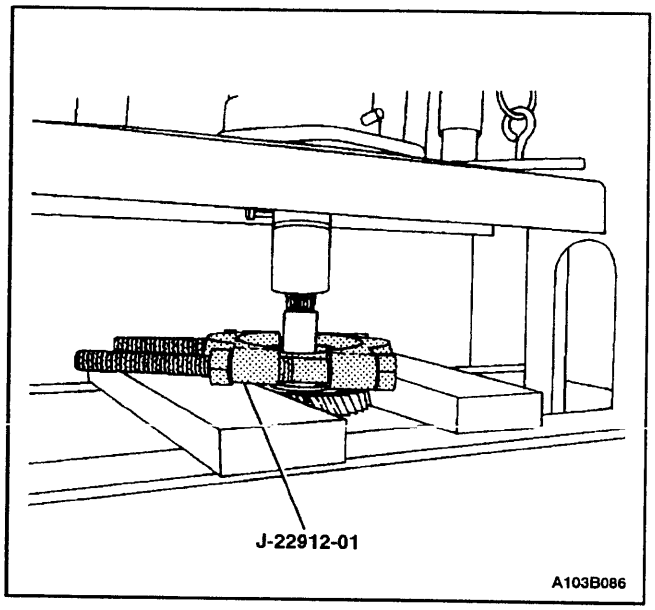
3. Install the snap ring at the base of the gear cluster.


A103B032

4. Install the detent screw at the end of the input driveshaft.

Tighten

Tighten the input driveshaft detent screw to 15 N•m (11 lb-ft).



A103B086

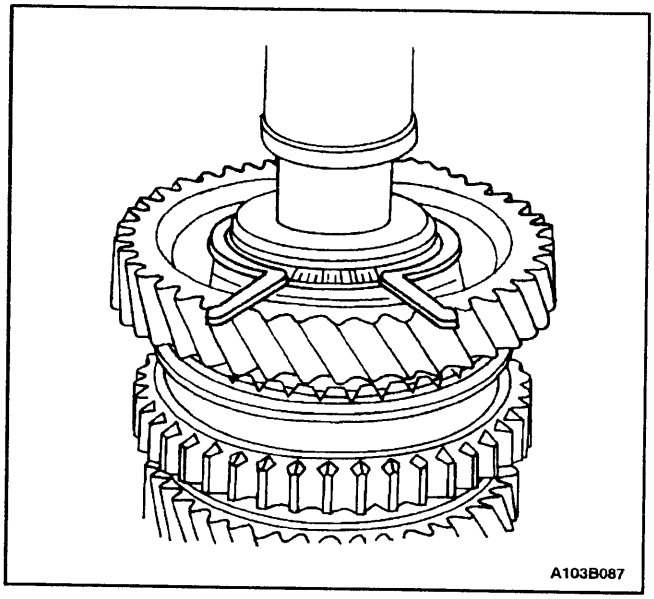
MAINSHAFT

Tools Required

J-22912-01 Universal Bearing Puller

Disassembly Procedure

1. Remove the mainshaft bearing using the universal bearing puller J-22912-01.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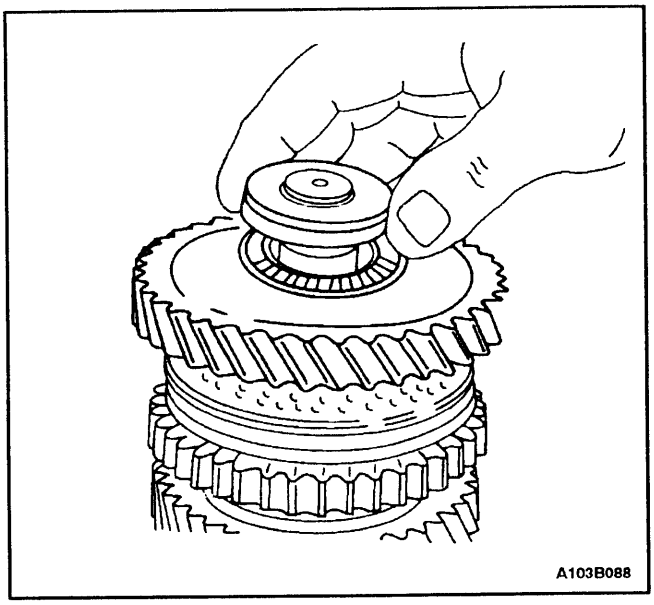
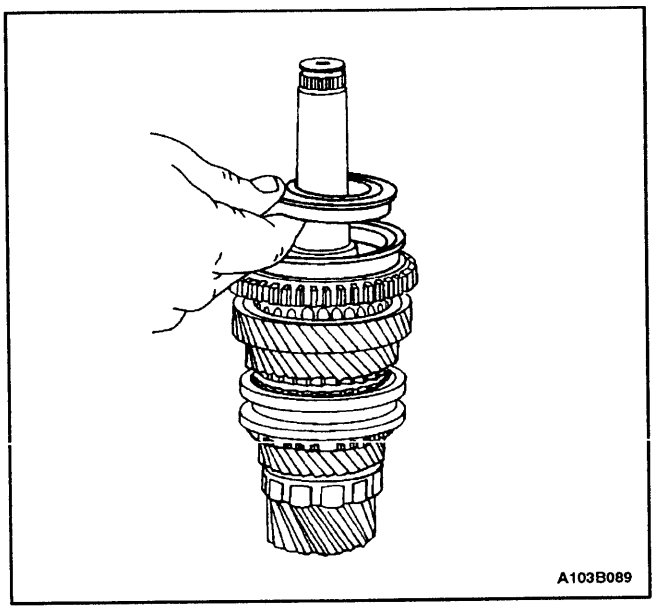
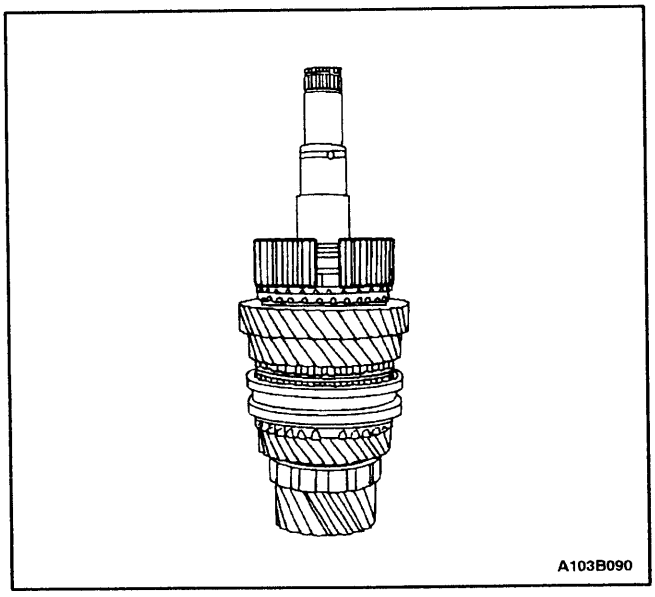
2. Remove the snap ring.



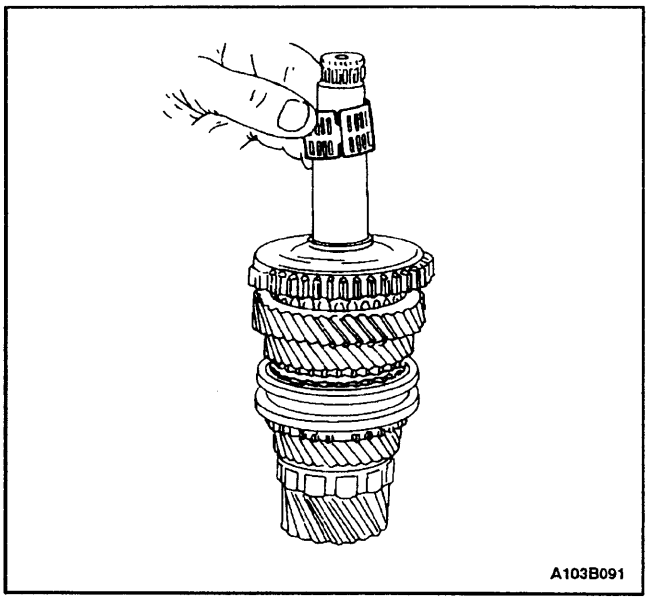
3. Remove the first gear, the flat-type first-gear needle bearing, and the mainshaft wear plate.



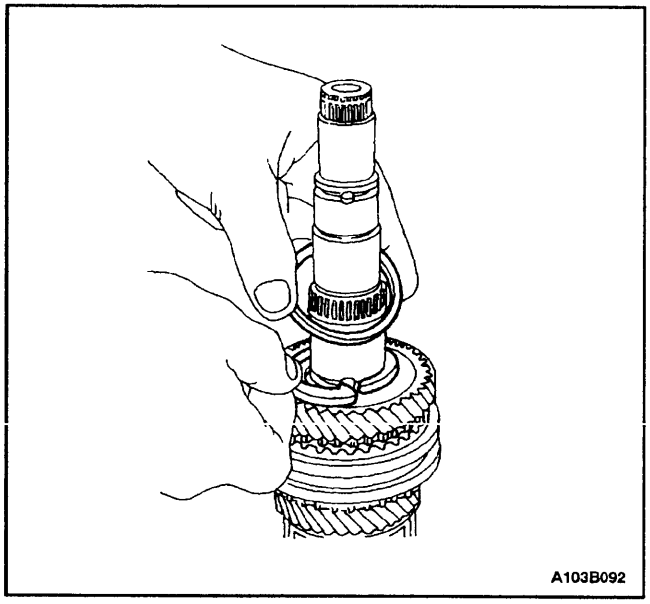
4. Remove the synchronizer hub sleeve that contains the synchronizer spring.
5. Remove the outer blocking ring.



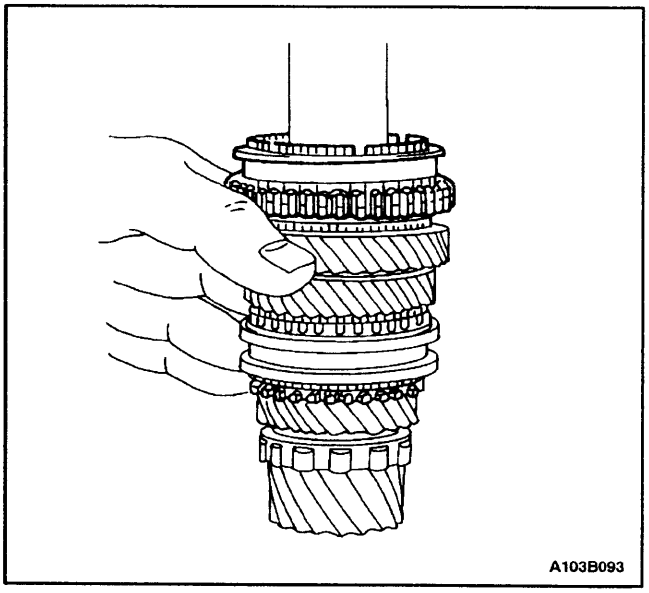
6. Remove the keys from the first-second synchronizer gear.


A103B091

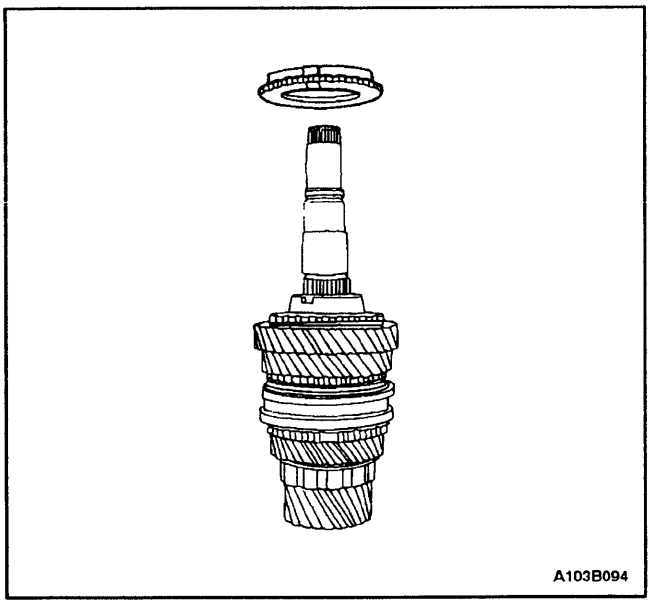
7. Remove the barrel-type first-gear needle bearing.


A103B092

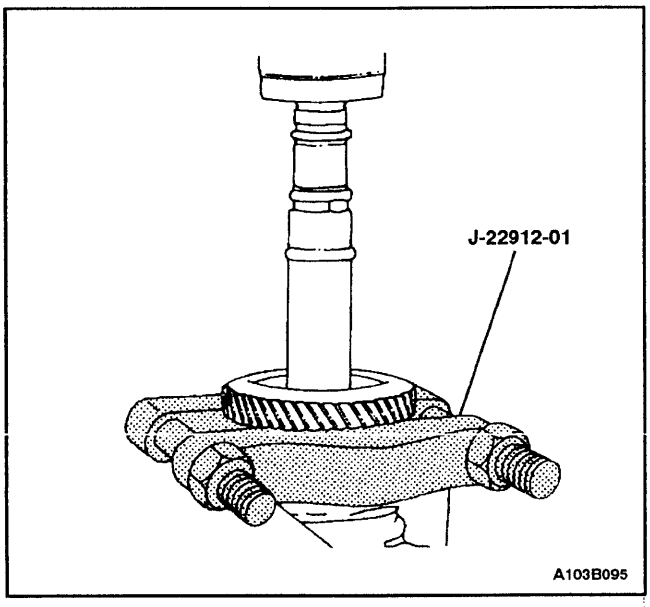
8. Remove the snap ring and the washer.


A103B093

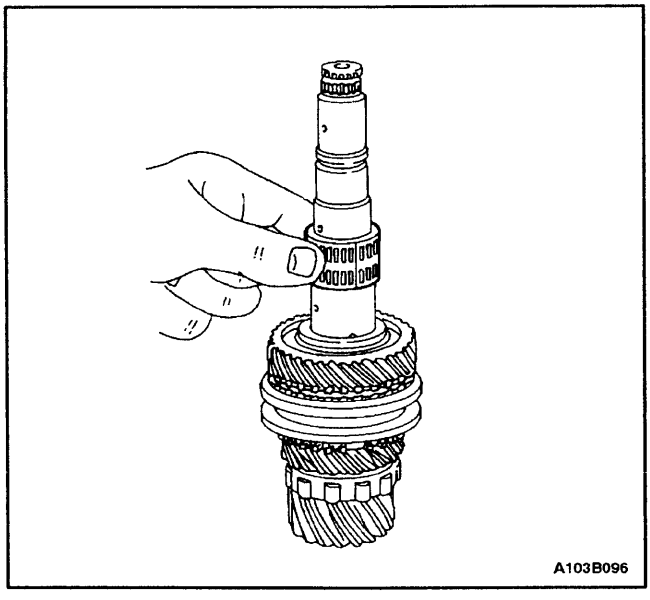
9. Remove the first-second synchronizer gear from the mainshaft.



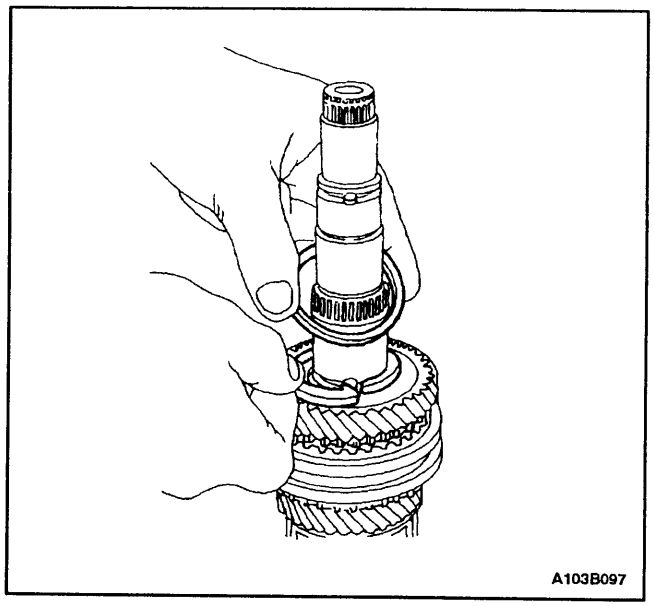
10. Remove the first-second gear blocking ring.



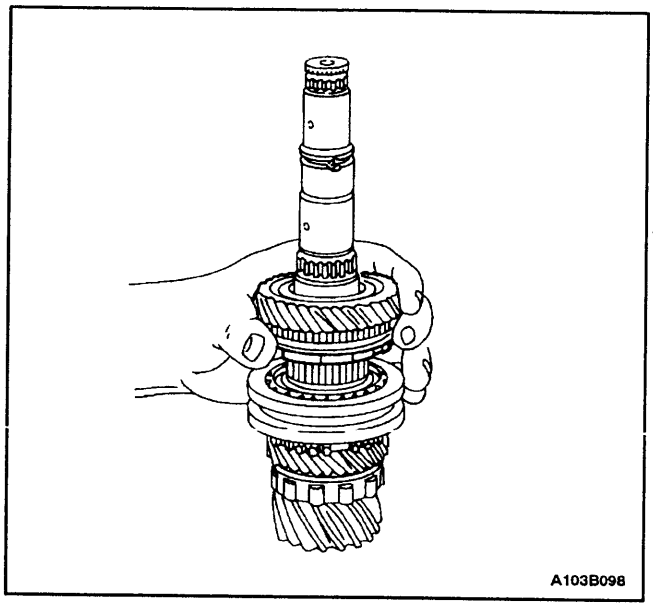
11. Remove the second gear using the universal bearing puller J-22912-01.



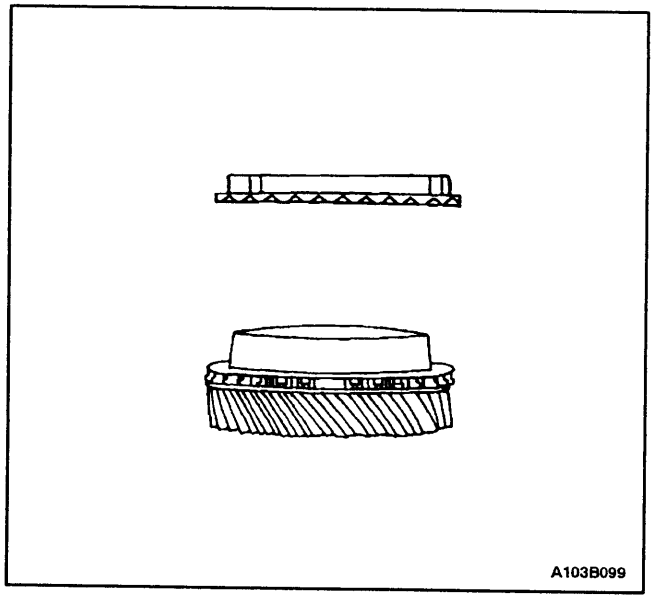
12. Remove the second-gear needle bearing.



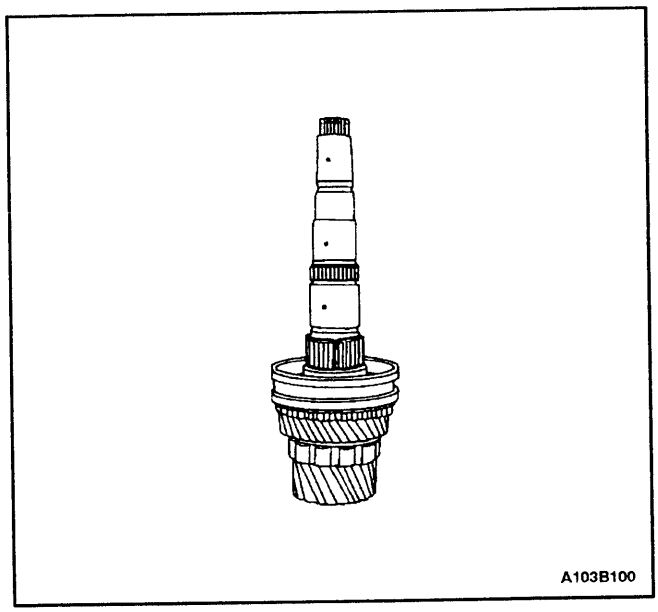
13. Remove the ring and the thrust washer.



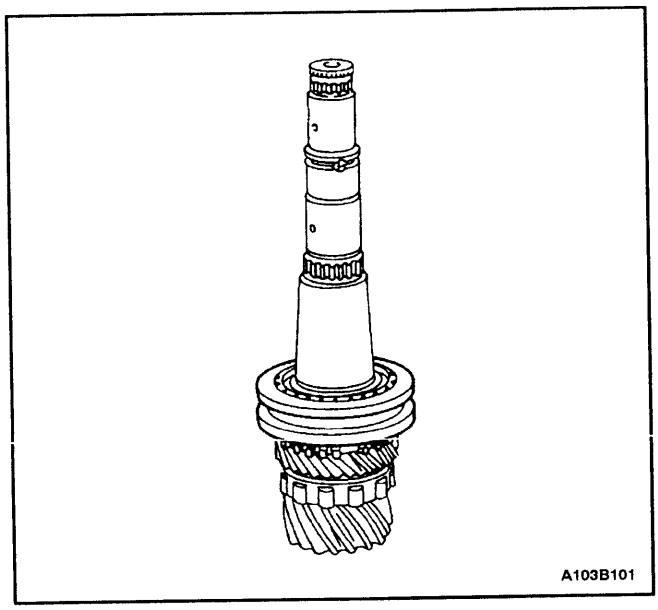
14. Remove the third gear and the synchronizer blocking ring.



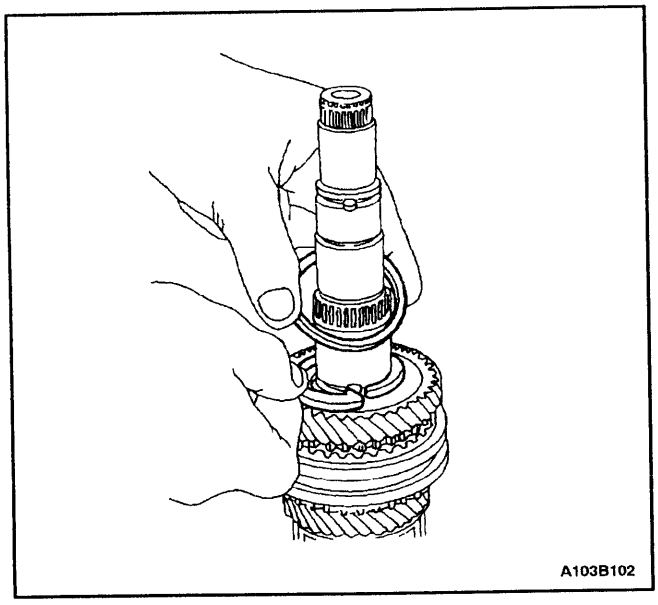
15. Separate the synchronizer blocking ring from the third gear.



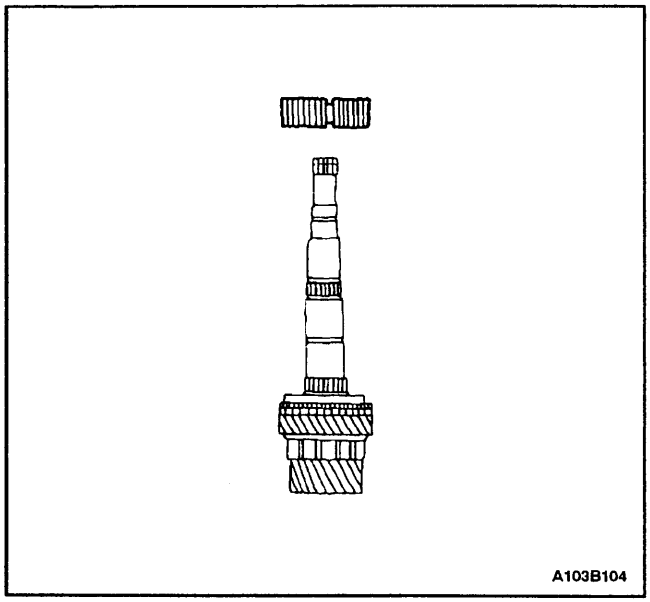
16. Remove the third-gear needle bearing from the mainshaft.



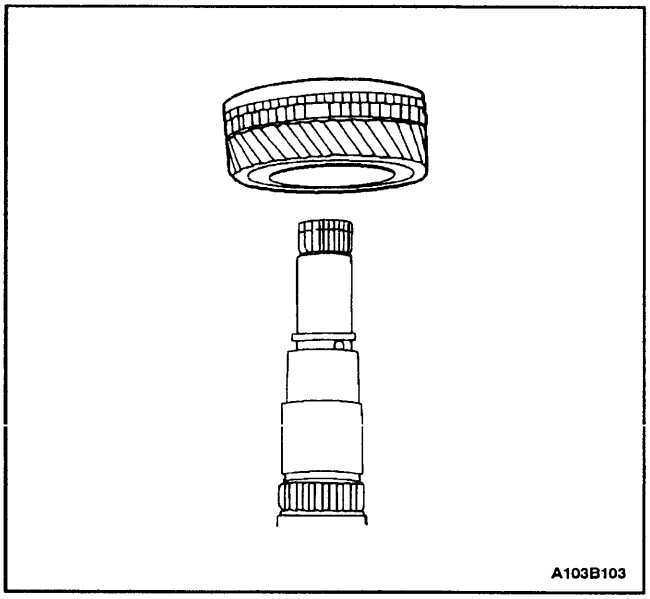
17. Remove the synchronizer sleeve containing the keys and the spring.



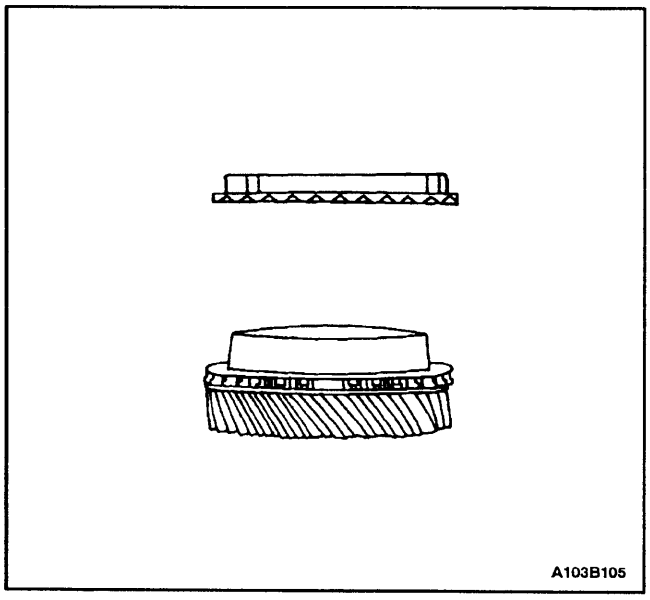
18. Remove the snap ring and the washer from the mainshaft.



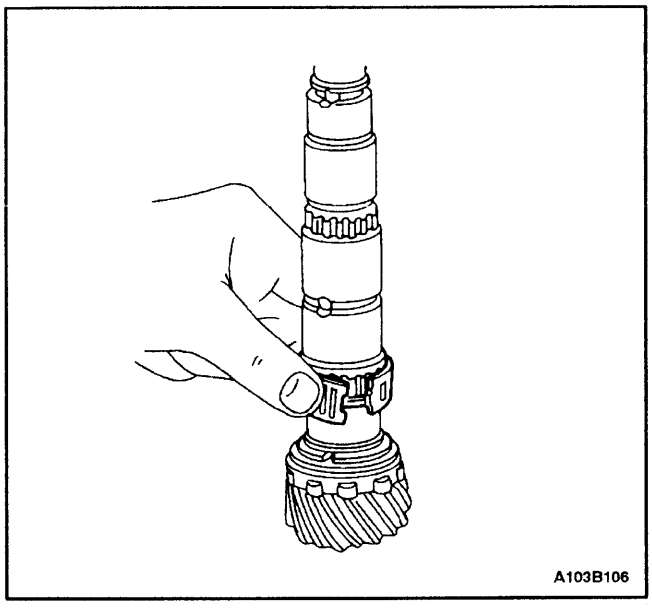
19. Remove the third-fourth synchronizer gear containing the synchronizer spring.



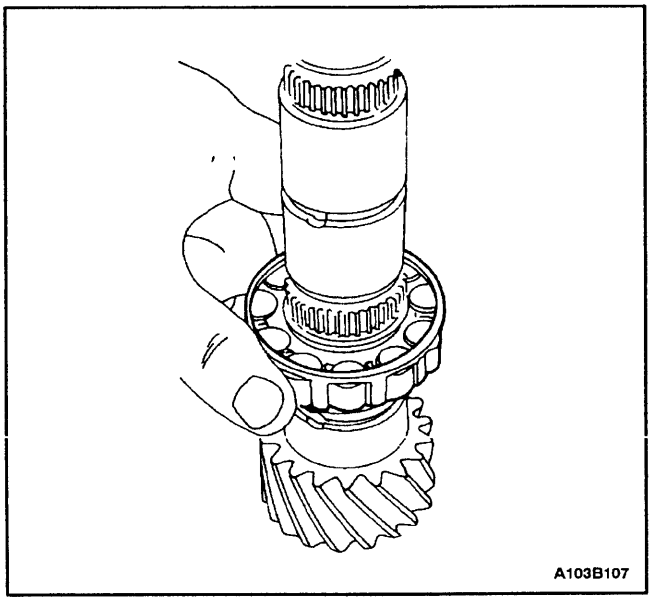
20. Remove the fourth-gear assembly.



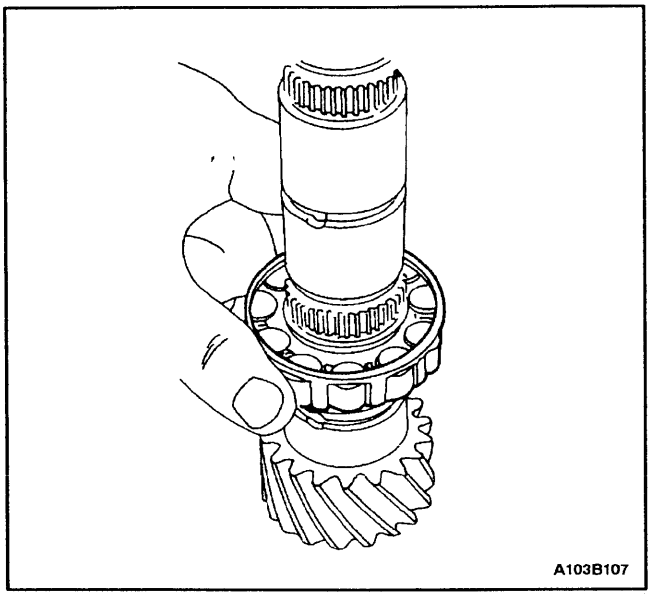
21. Separate the synchronizer blocking ring from the fourth gear.



22. Remove the fourth-gear needle bearing, the ring, and the thrust washer.

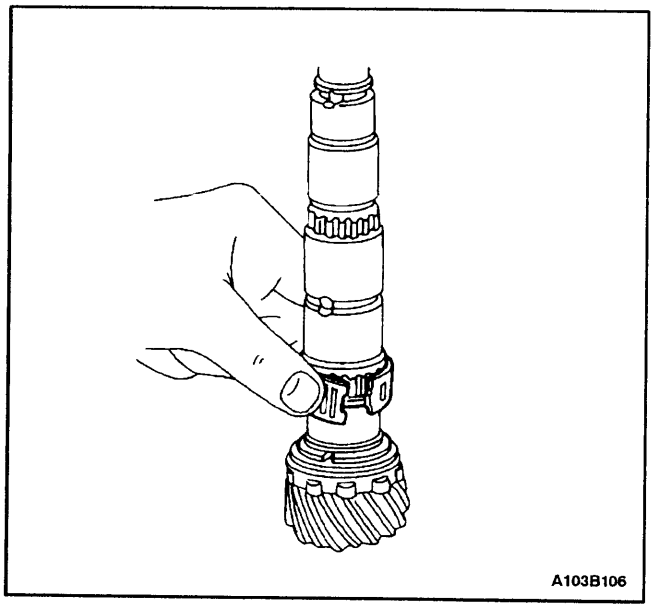


23. Remove the mainshaft bearing.

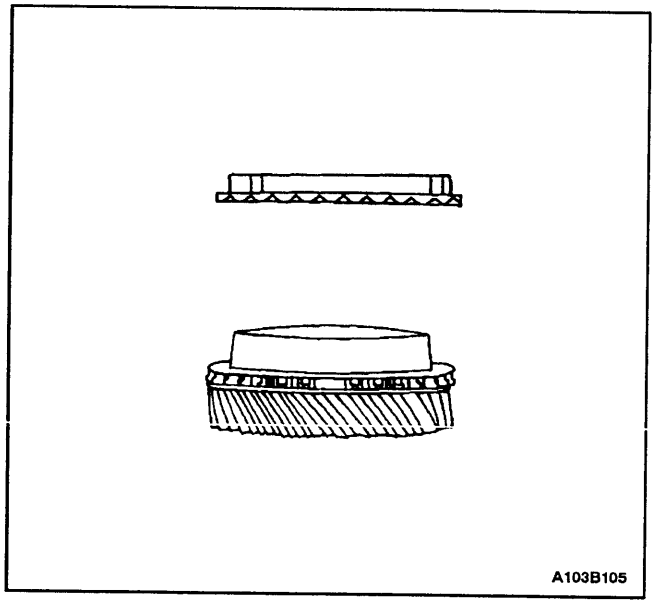


Assembly Procedure

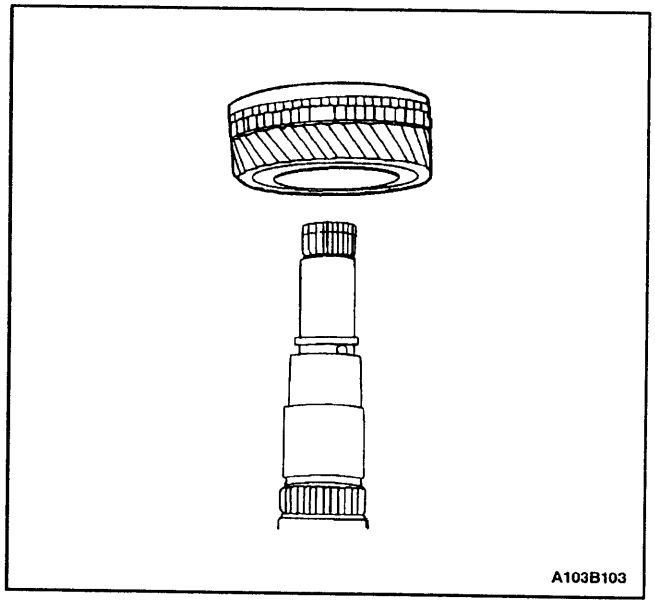
1. Install the mainshaft bearing.



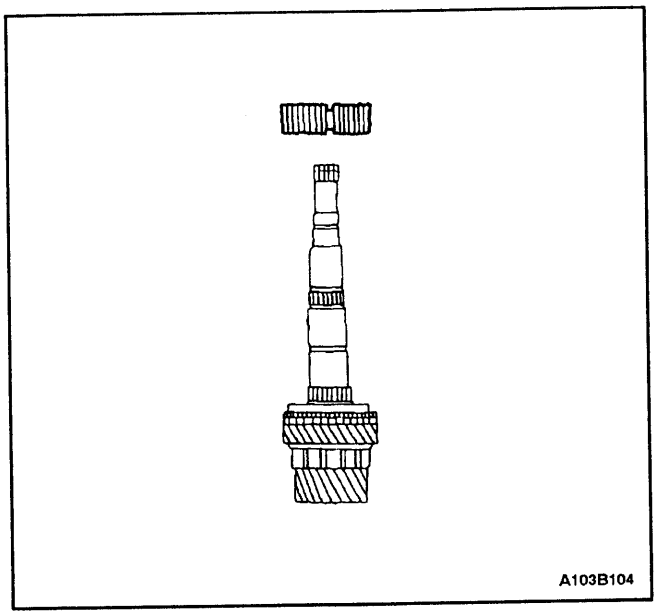
2. Install the ring, the thrust washer, and the fourth-gear needle bearing.



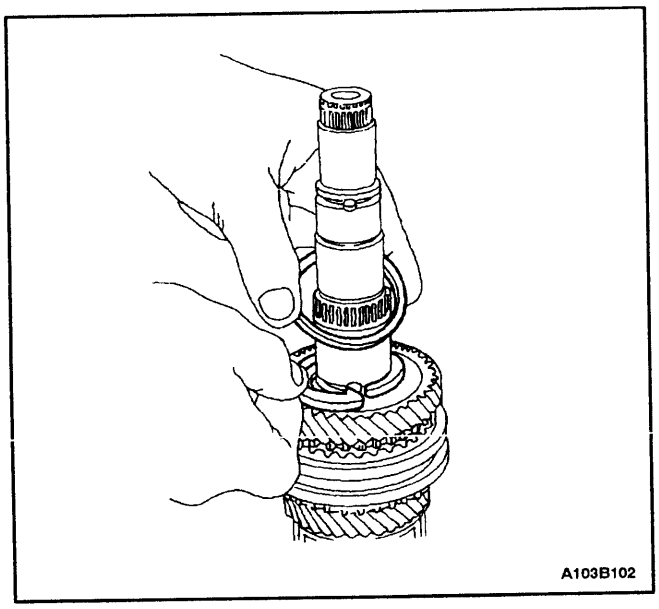
3. Attach the synchronizer blocking ring to the fourth gear.



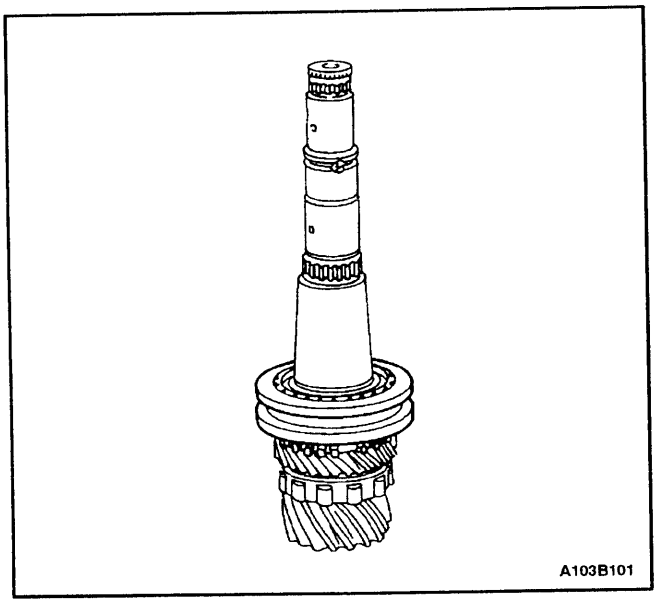
4. Install the fourth-gear assembly.



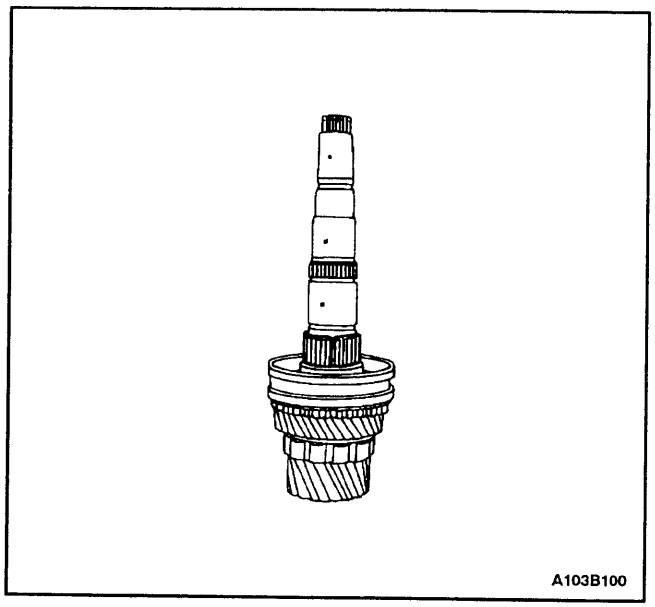
5. Install the third-fourth gear synchronizer containing the synchronizer spring.



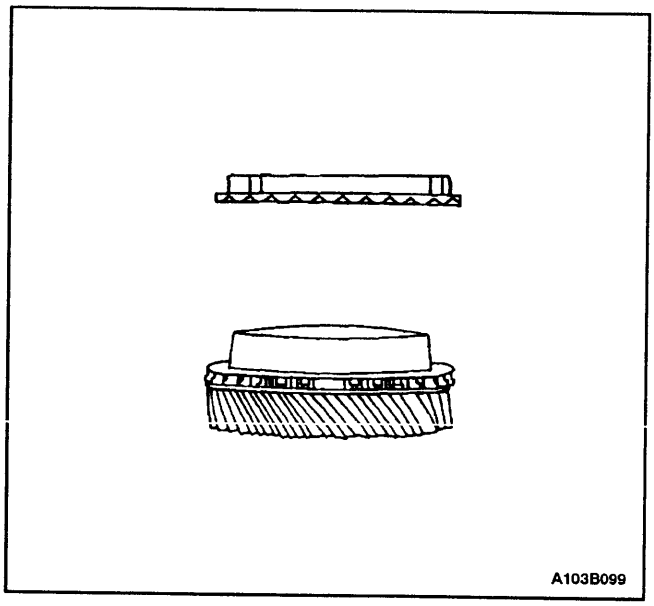
6. Install the snap ring and the washer around the main-shaft.



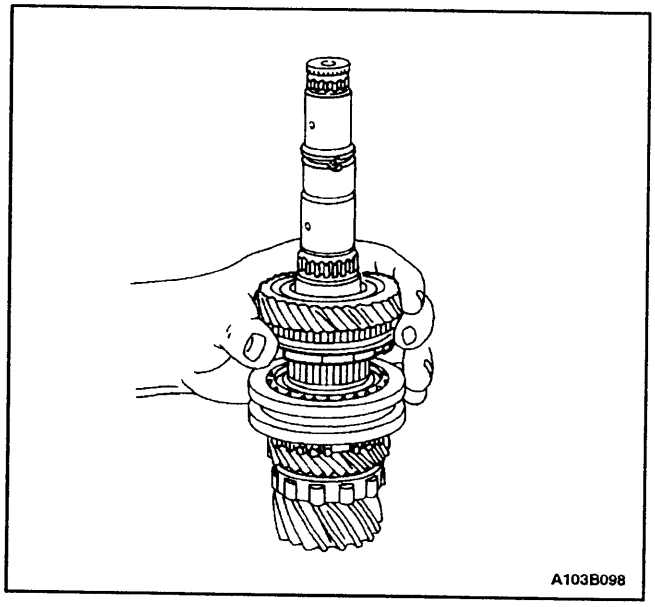
7. Install the synchronizer sleeve containing the keys and the spring.


A103B100

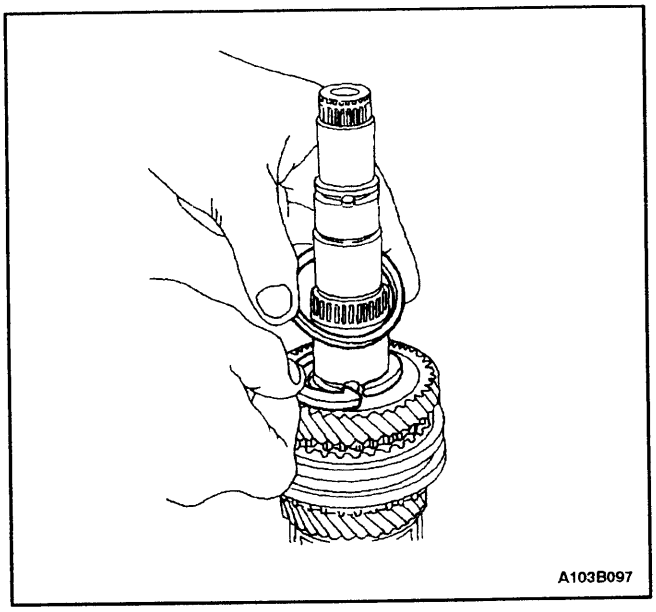
8. Install the third-gear needle bearing.


A103B099

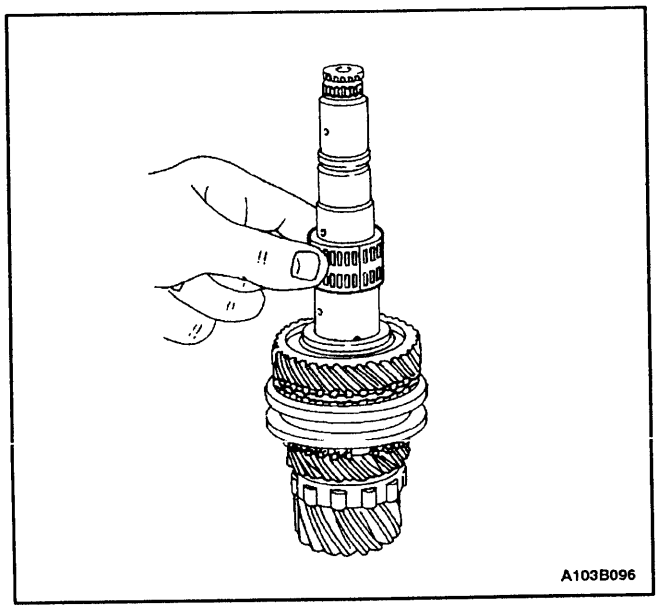
9. Attach the synchronizer blocking ring to the third gear.


A103B098

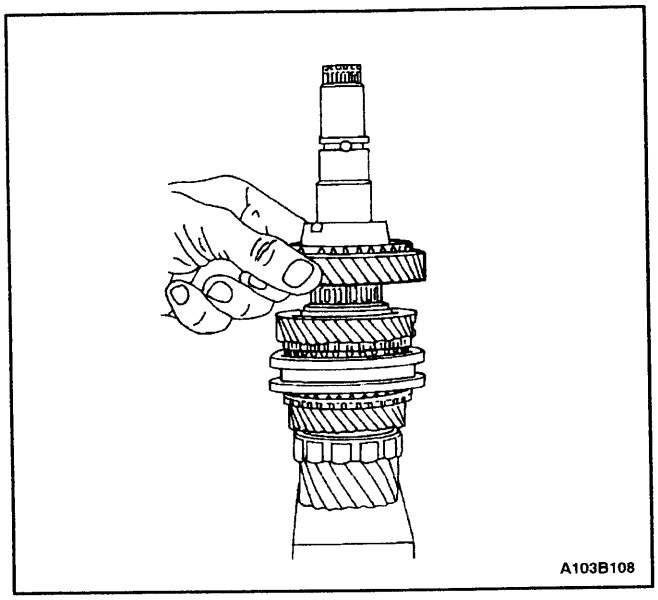
10. Install the third-gear assembly.


A103B097

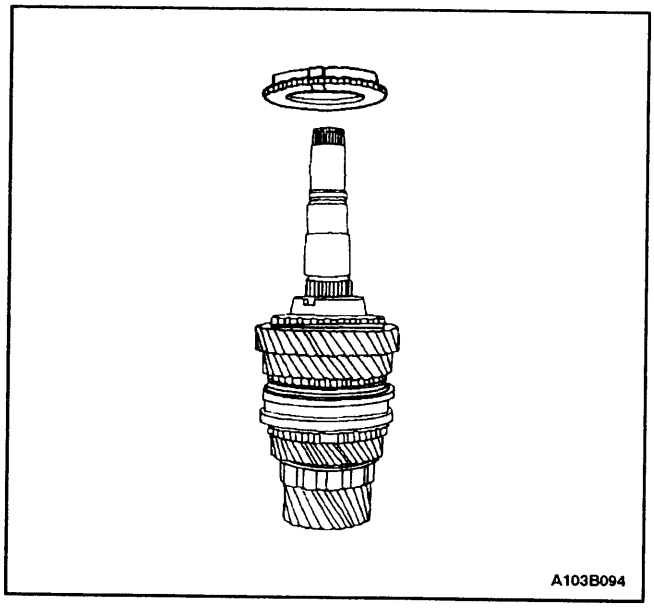
11. Install the thrust washer and the ring.


A103B096

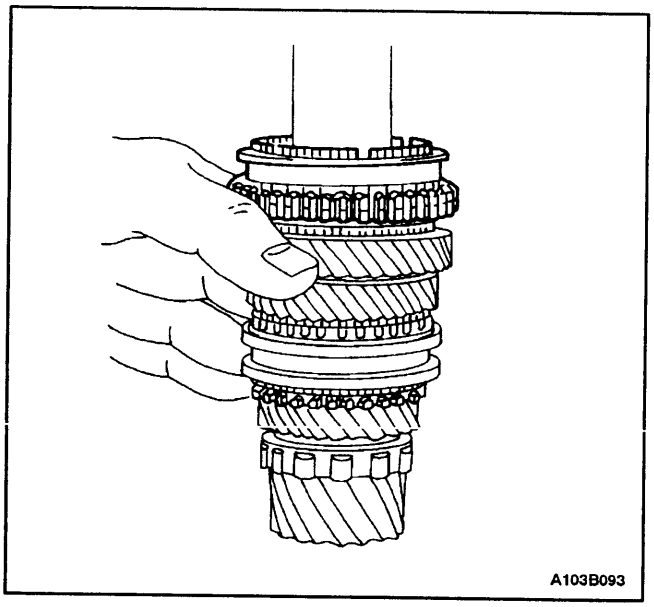
12. Install the second-gear needle bearing.


A103B108

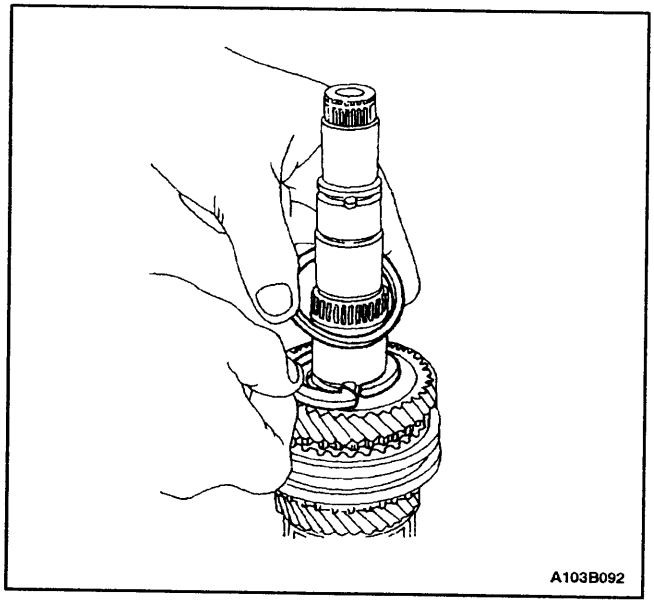
13. Install the second gear.


A103B094

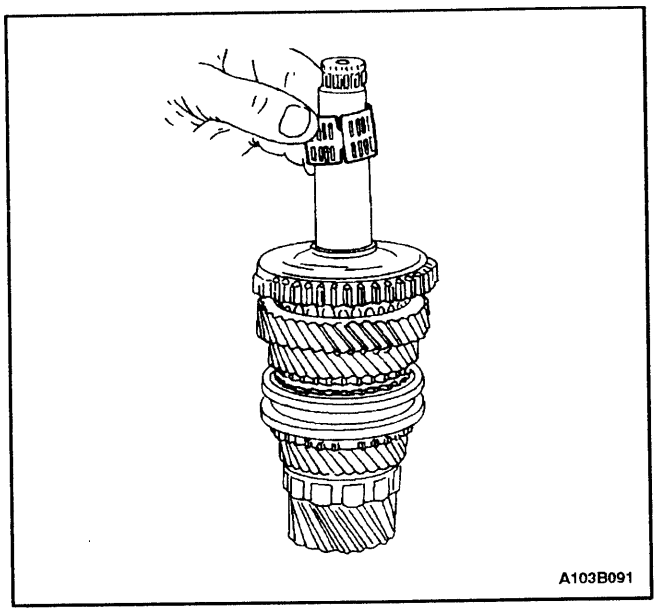
14. Install the first-second gear blocking ring.


A103B093

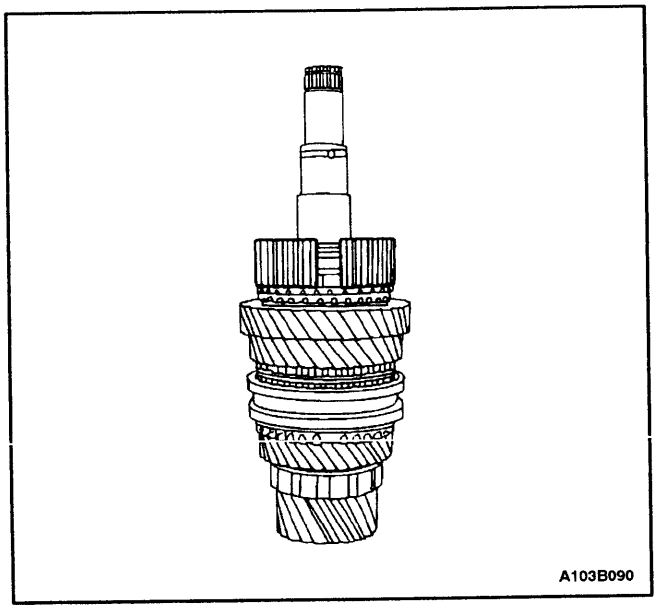
15. Install the first-second synchronizer gear.


A103B092

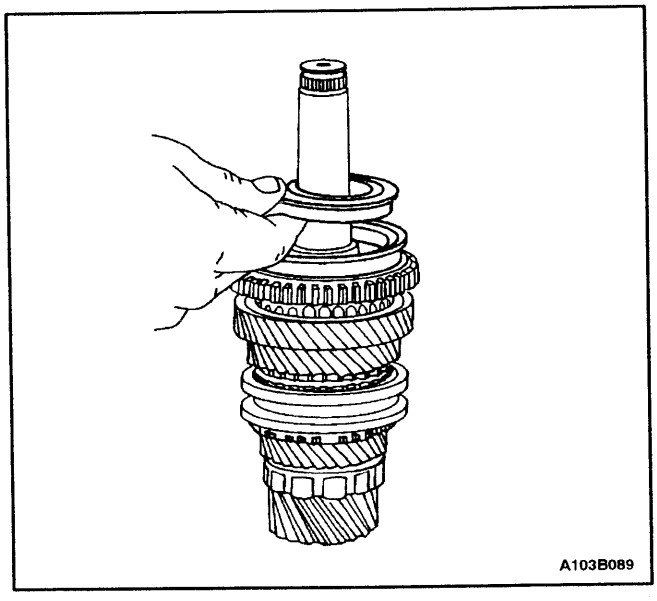
16. Install the washer and the snap ring.



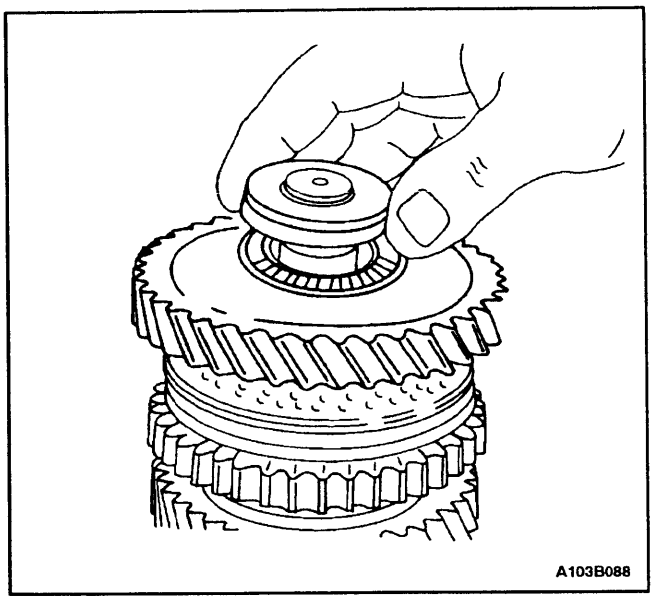
17. Install the first-gear needle bearing.



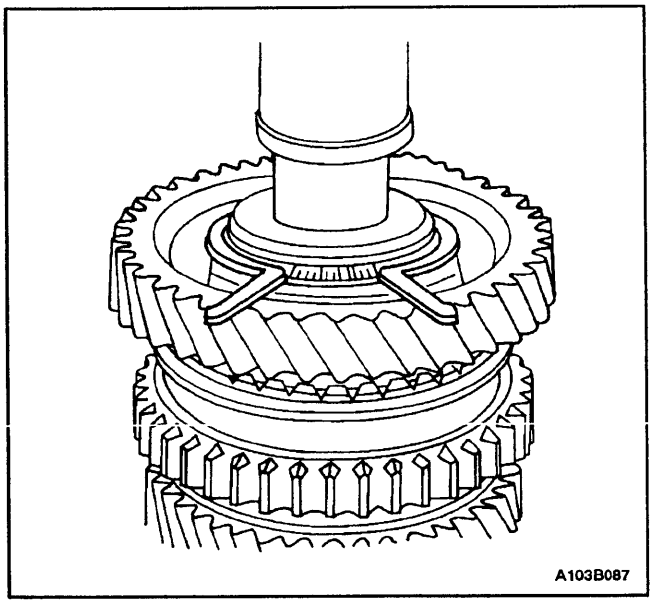
18. Install the keys onto the first-second synchronizer gear.



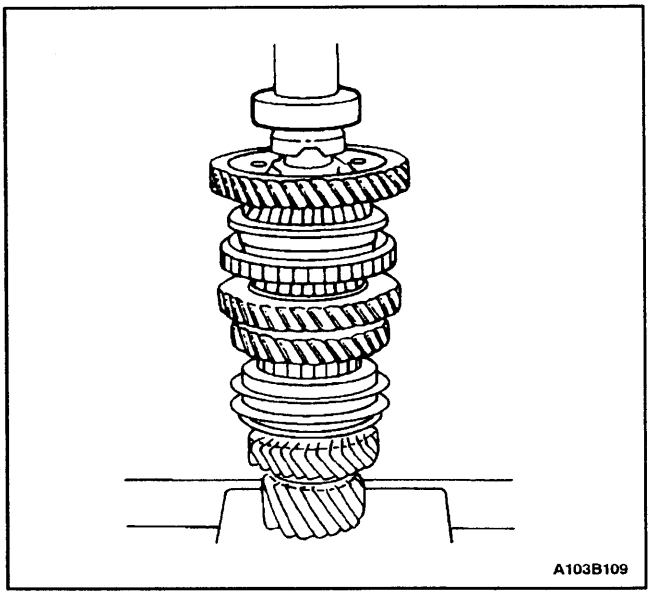
19. Install the synchronizer hub sleeve containing the synchronizer spring.



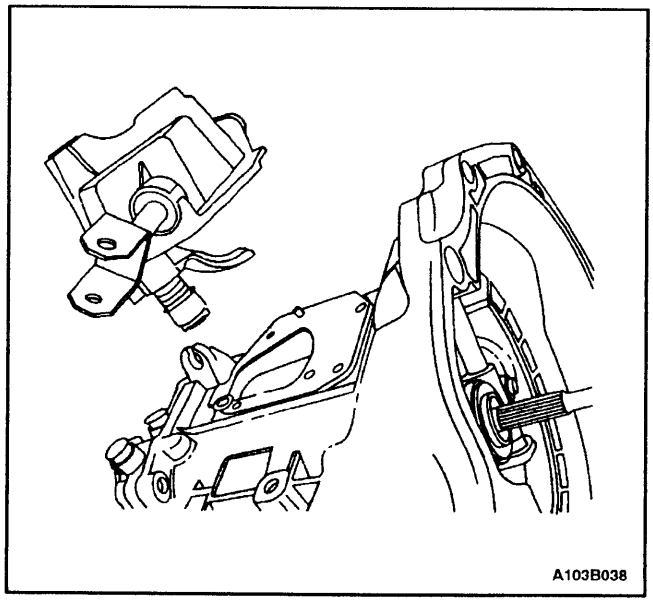
20. Install the outer blocking ring.
21. Install the mainshaft wear plate, the flat-type first-gear needle bearing, and the first gear.



22. Install the snap ring.



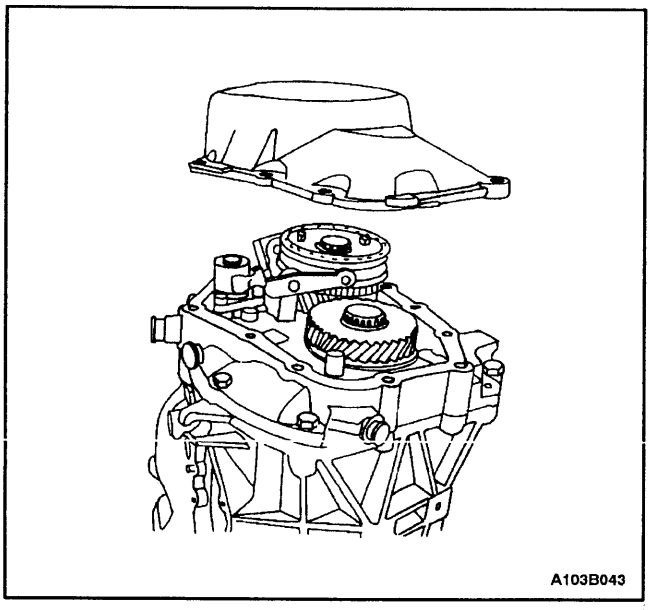
23. Press on the mainshaft bearing.


A103B038

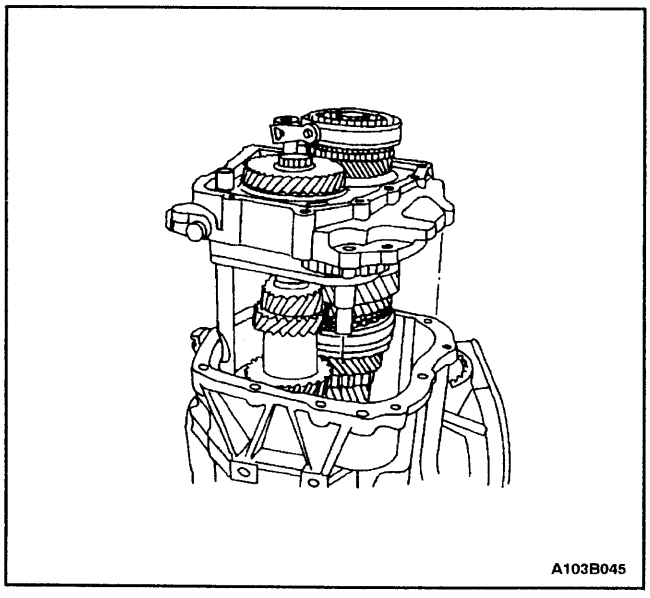
HOUSING CASE

Disassembly Procedure

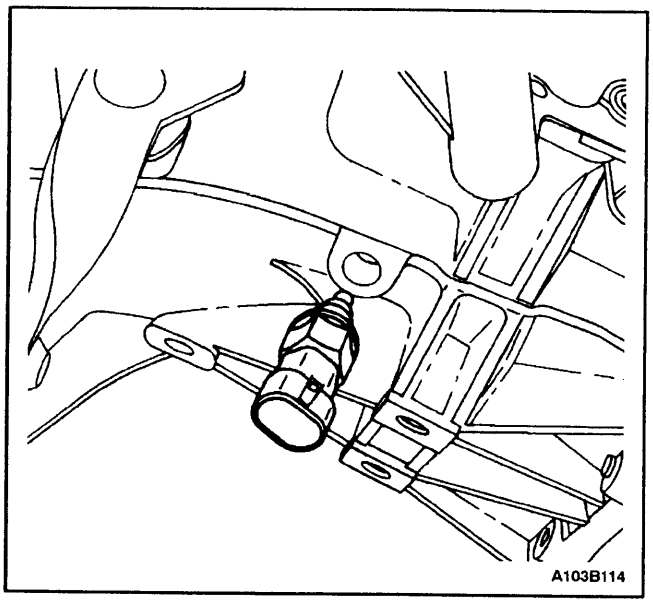
1. Remove the transaxle from the vehicle. Refer to "Transaxle Assembly" in this section.
2. Remove the shift lever cover bolts and the shift lever cover. Do not disassemble the shift lever cover.


A103B043

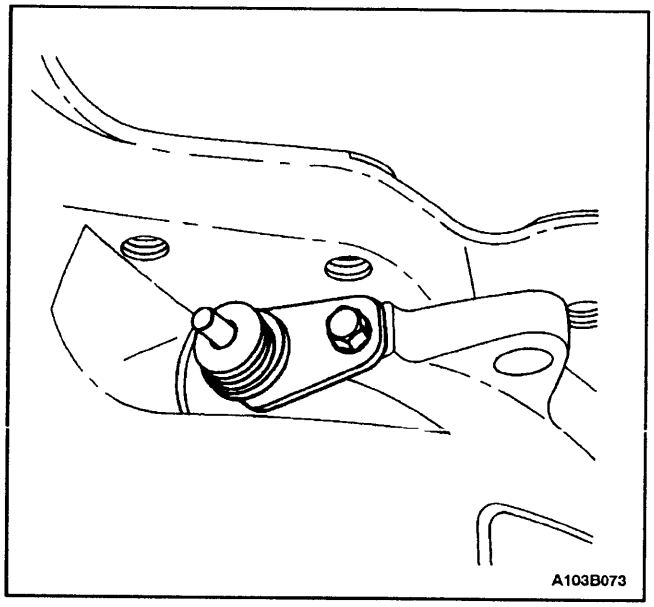
3. Remove the transaxle cover bolts and the transaxle cover.


A103B045

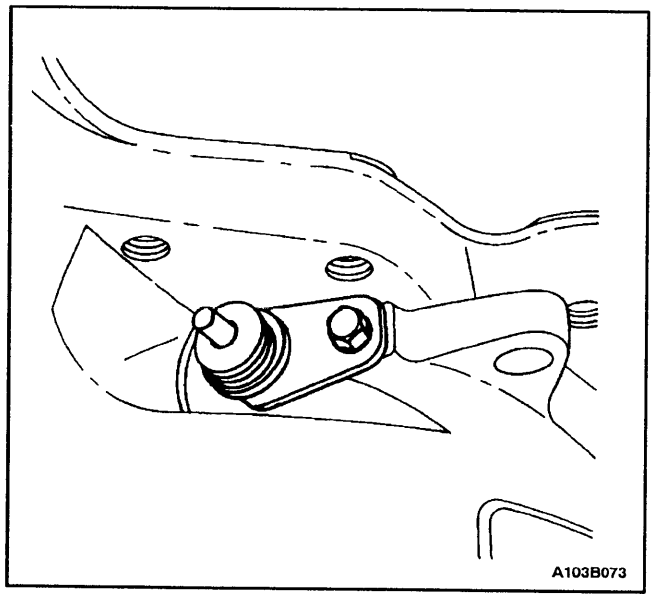
4. Remove the bearing plate bolts and the bearing plate, with the shafts attached. Do not disassemble the shafts.



5. Remove the differential from the transaxle housing. Do not disassemble the differential. Refer to "Differential" in this section.
6. Remove the backup lamp switch from the transaxle housing.



7. Remove the clutch-release bearing and the clutch-release bearing guide. Refer to *Section 5C, Clutch.*
8. Remove the speedometer-driven gear bolt and the speedometer-driven gear from the transaxle housing.

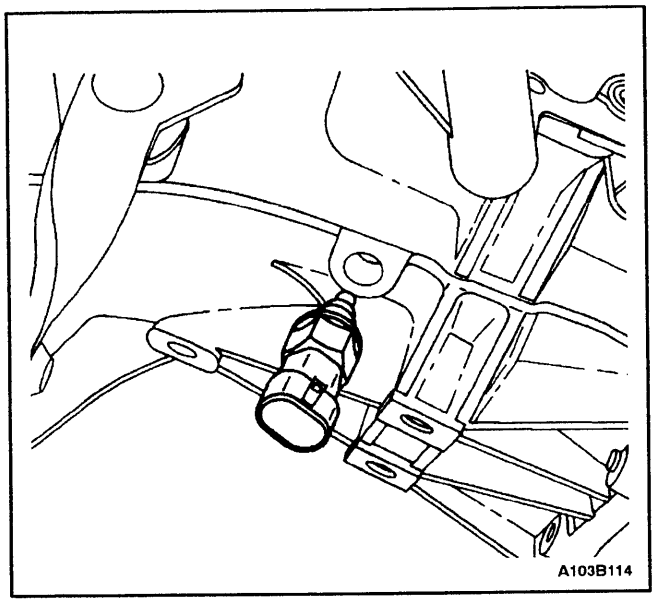


Assembly Procedure

1. Install the speedometer-driven gear bolt and the speedometer-driven gear into the transaxle housing.

Tighten

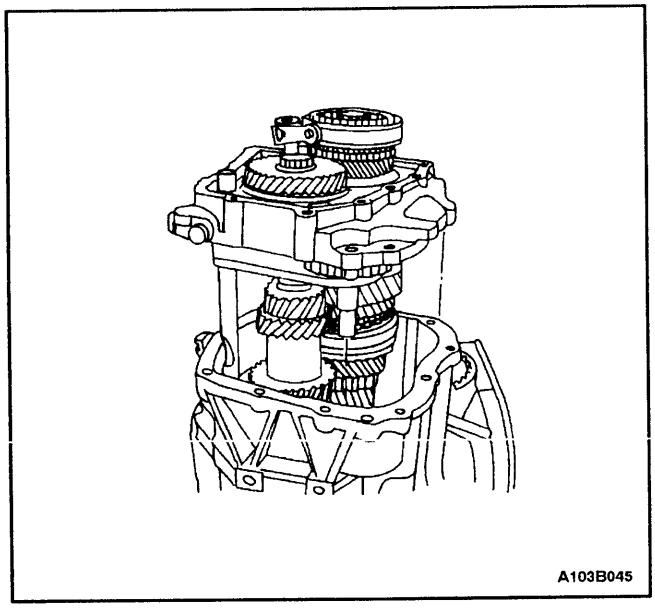
Tighten the speedometer-driven gear bolt to 5 N•m (44 lb-in).


A103B114

2. Install the clutch-release bearing guide and the clutch-release bearing. Refer to *Section 5C, Clutch*.
3. Install the backup lamp switch into the transaxle housing.

Tighten

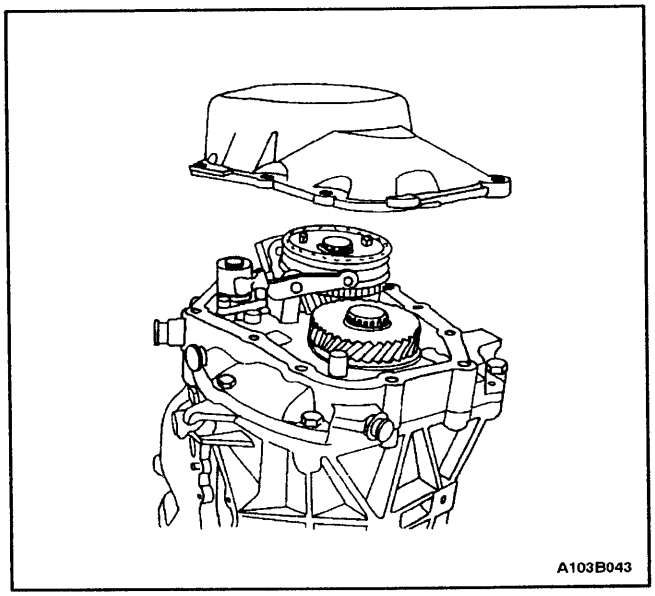
Tighten the backup lamp switch to 20 N•m (15 lb-ft).


A103B045

4. Install the differential into the transaxle housing. Refer to "Differential" in this section.
5. Install the bearing plate, with the shafts attached.
6. Install the bearing plate bolts.

Tighten

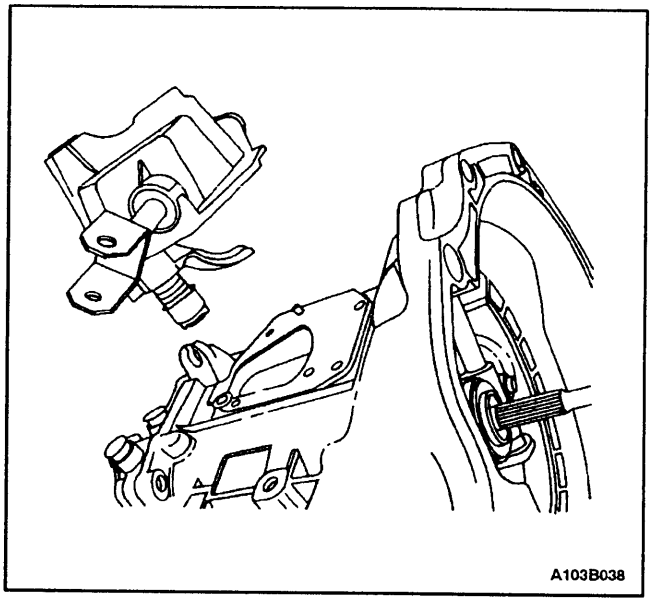
Tighten the bearing plate bolts to 22 N•m (16 lb-ft).


A103B043

7. Install the transaxle cover and the transaxle cover bolts.

Tighten

Tighten the transaxle cover bolts to 18 N•m (13 lb-ft).

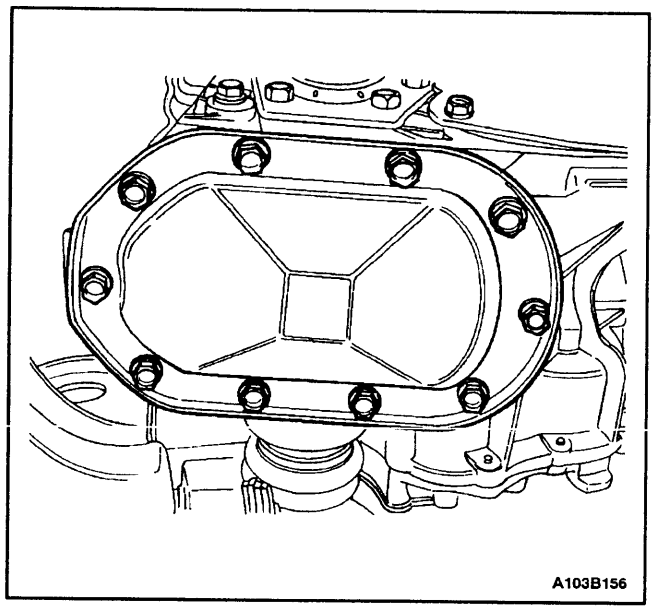


8. Install the gearshift lever cover and the gearshift lever cover bolts.

Tighten

Tighten the gearshift lever cover bolts to 22 N•m (16 lb-ft).

9. Install the transansaxle into the vehicle. Refer to "Transaxle Assembly" in this section.



DIFFERENTIAL

Tools Required

KM-520 Remover/Installer

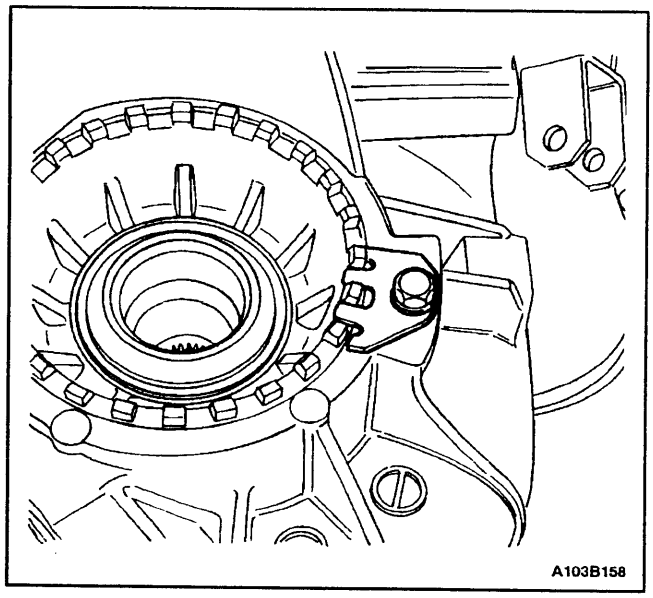
KM-525 Installer

J-22888-20-A Bearing Puller with J-22888-35 Puller Legs

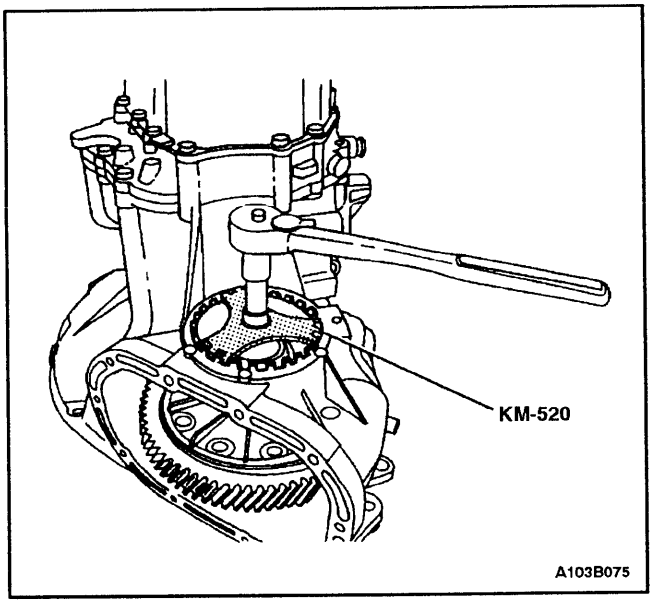
KM-522 Installer

Disassembly Procedure

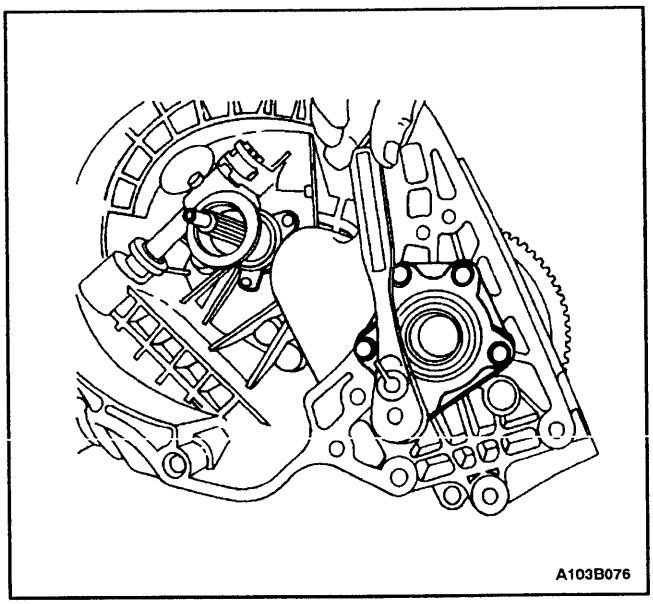
1. Remove the differential cover bolts, the differential cover, and the differential cover gasket.



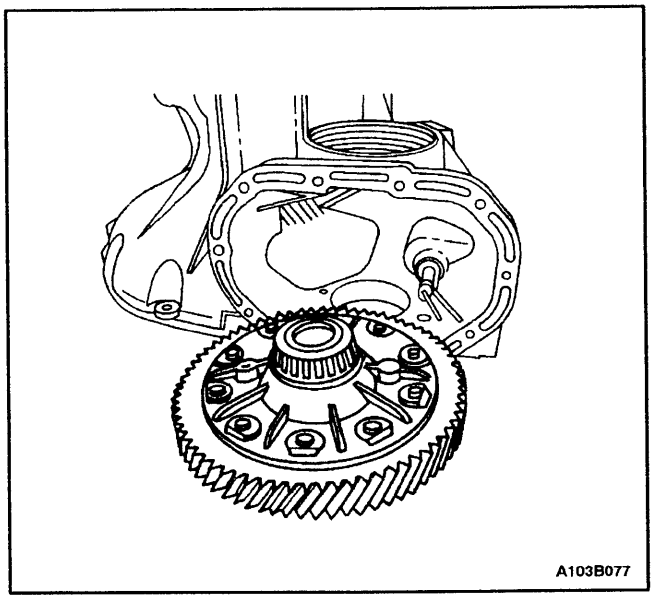
2. Remove the bearing-adjusting ring retainer plate bolt and the bearing-adjusting ring retainer plate.



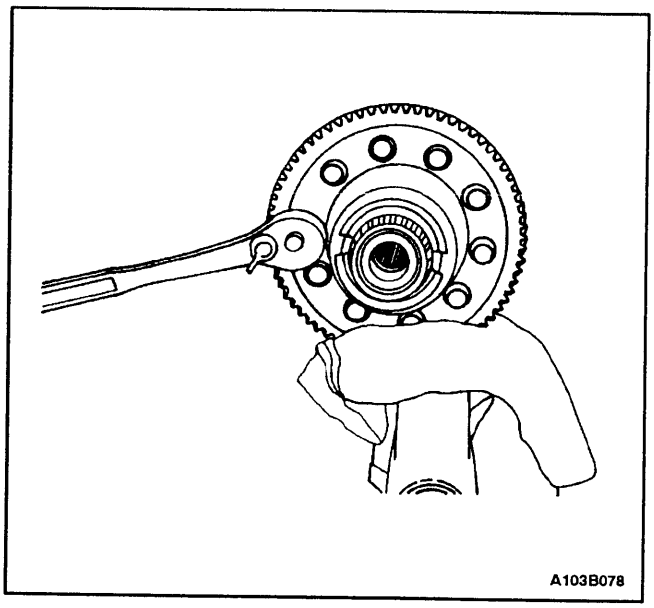
3. Remove the bearing-adjusting ring using the remover/ installer KM-520.



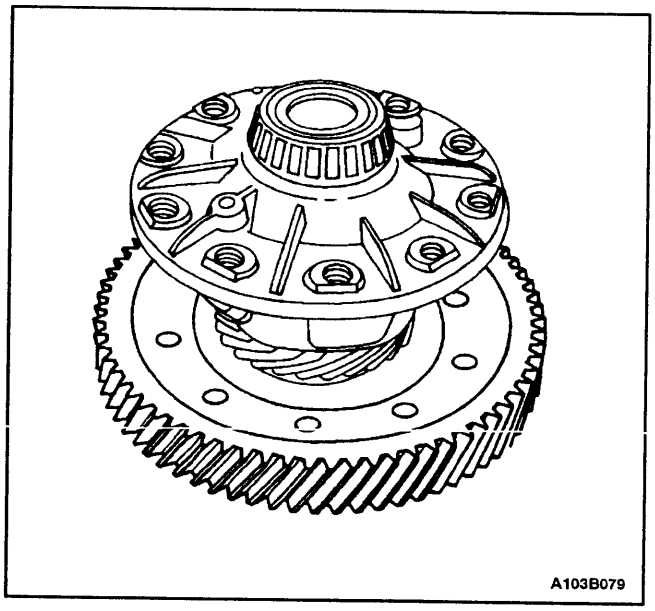
4. Remove the right-side bearing-retainer bolts and the right-side bearing retainer.



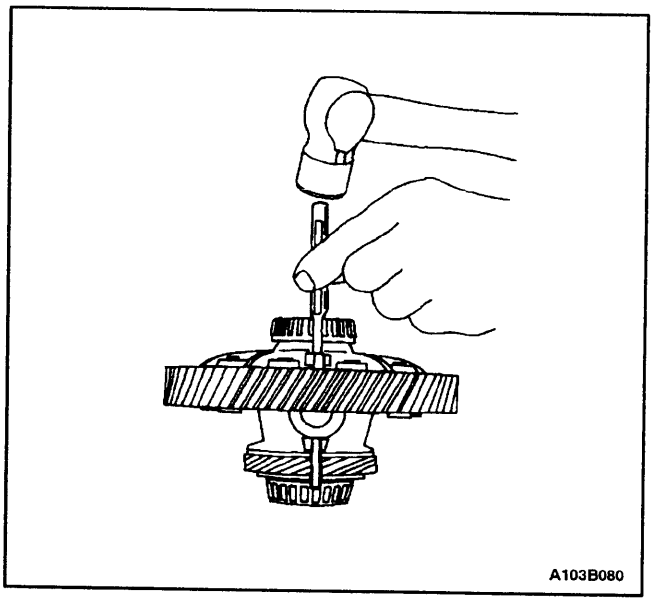
5. Remove the differential assembly from the transaxle case.



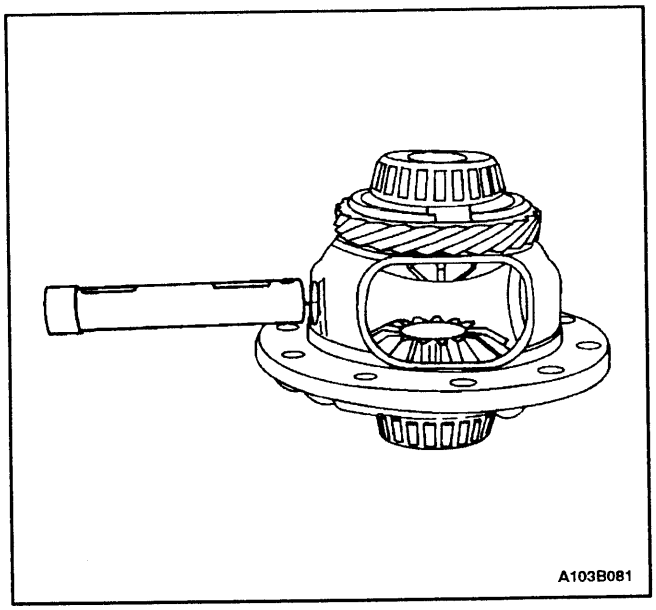
6. Remove the ring gear bolts.



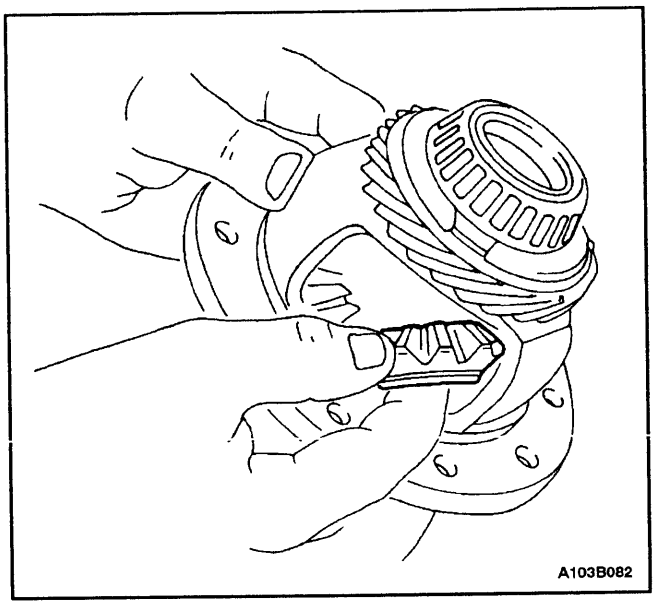
7. Separate the ring gear from the differential housing.



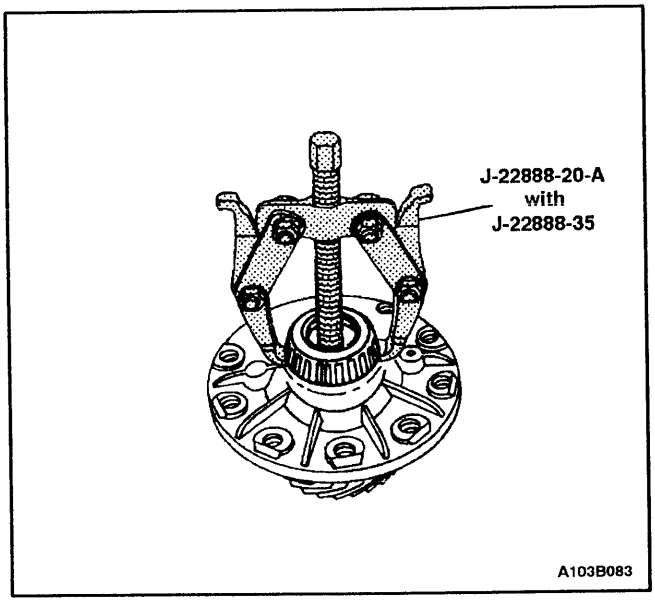
8. Drive the pinion gear shaft lock pin from the differential housing and the pinion gear shaft.



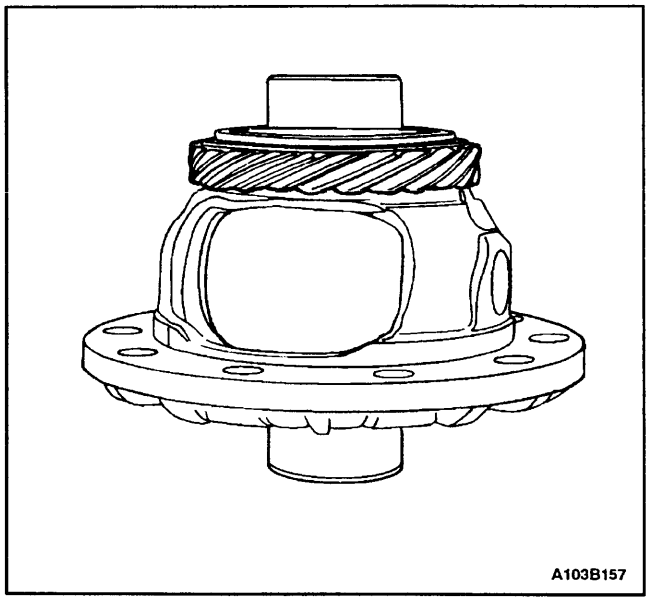
9. Remove the pinion gear shaft.



10. Remove the pinion gears and the washers.
11. Remove the side gears and the side thrust washers.

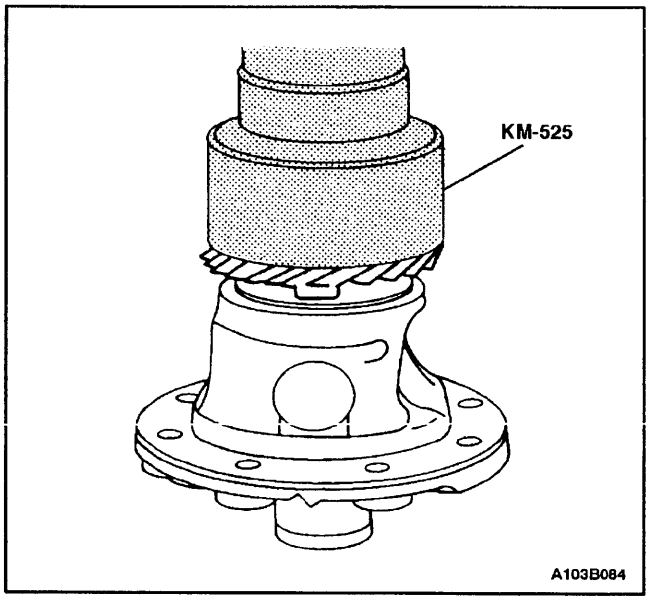


12. Remove both of the differential bearings using the bearing puller J-22888-20-A with the puller legs J-22888-35.

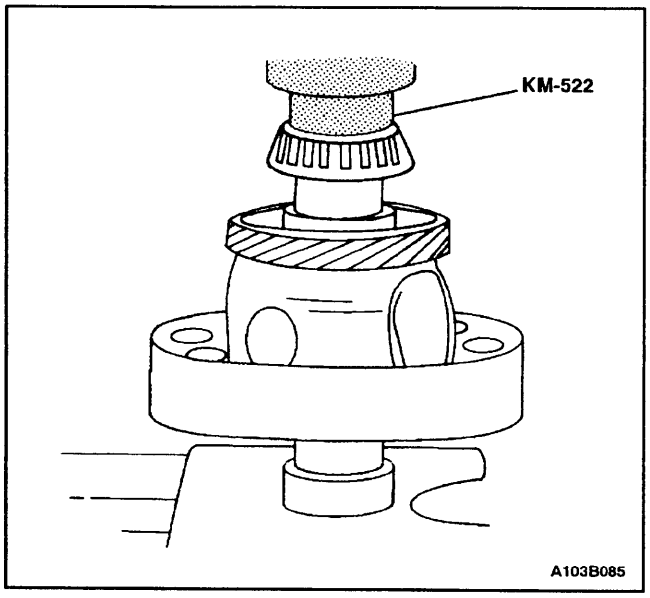


13. Remove the speedometer drive gear from the differential gear housing.

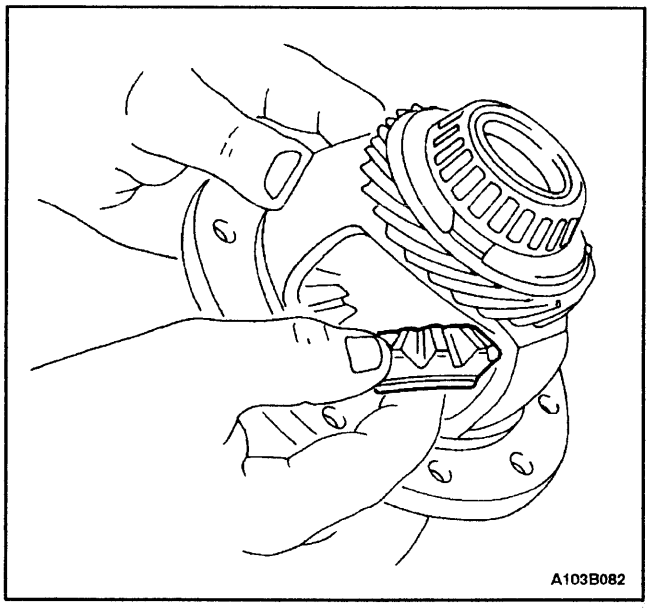
Assembly Procedure



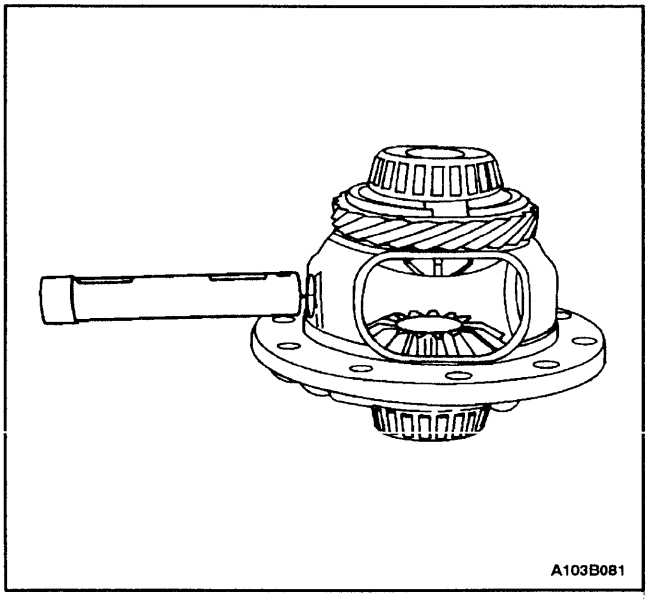
1. Install the speedometer drive gear onto the differential gear housing using the installer KM-525.



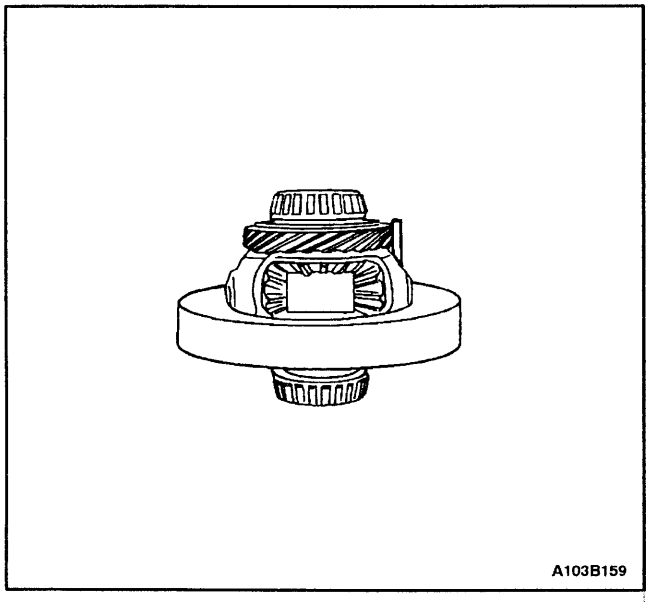
2. Install both of the differential bearings using the installer KM-522.


A103B082

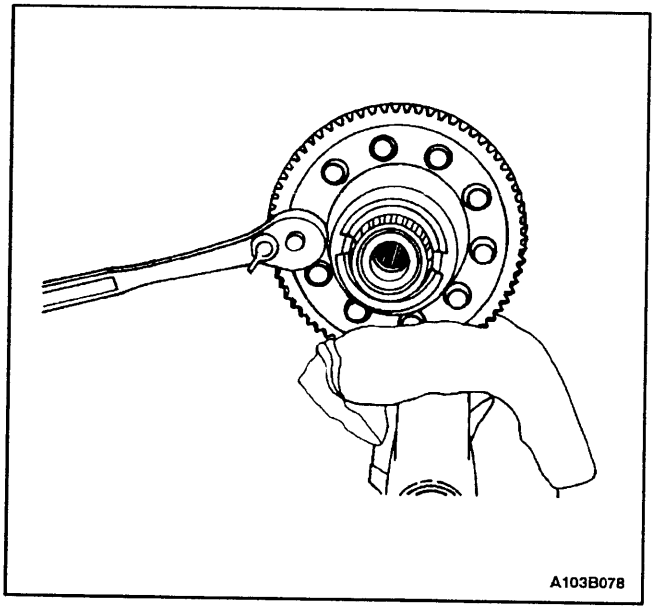
3. Install the side gears and the side thrust washers into the differential housing.
4. Install the differential pinion gears and the differential pinion gear washers into the differential housing.


A103B081

5. Install the pinion gear shaft into the differential housing.


A103B159

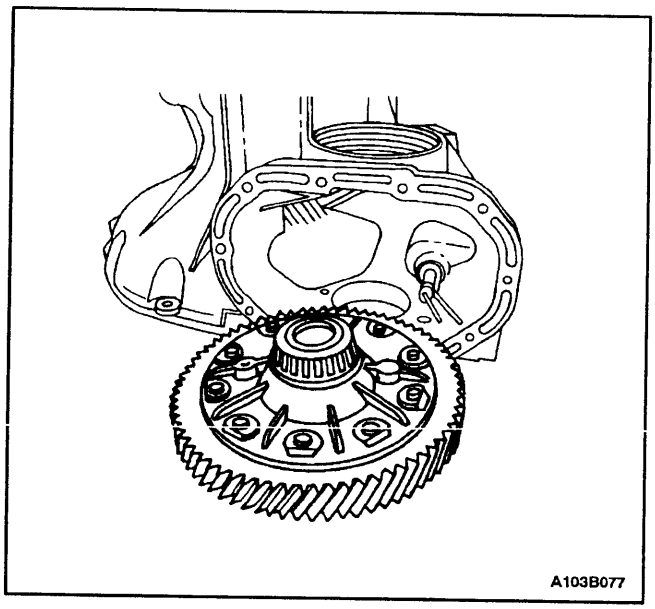
6. Install the pinion gear shaft lock pin into the differential housing and the pinion gear shaft.



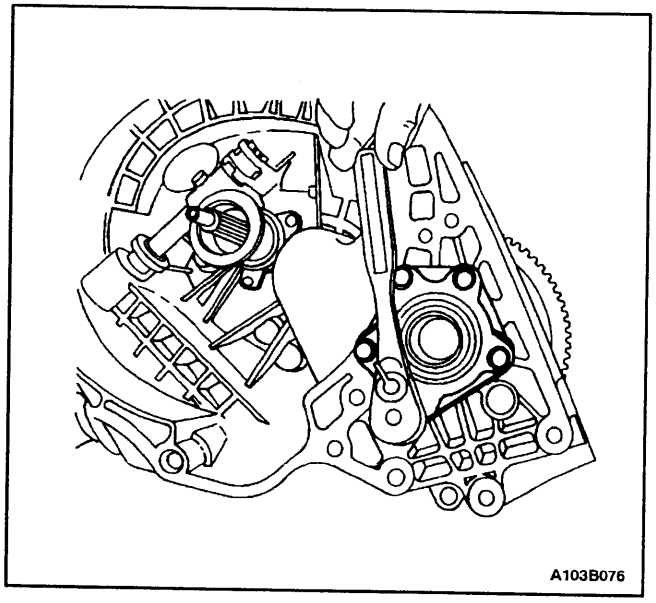
7. Install the ring gear and the ring-gear bolts.

Tighten

Tighten the ring-gear bolts to 70 N•m (52 lb-ft).



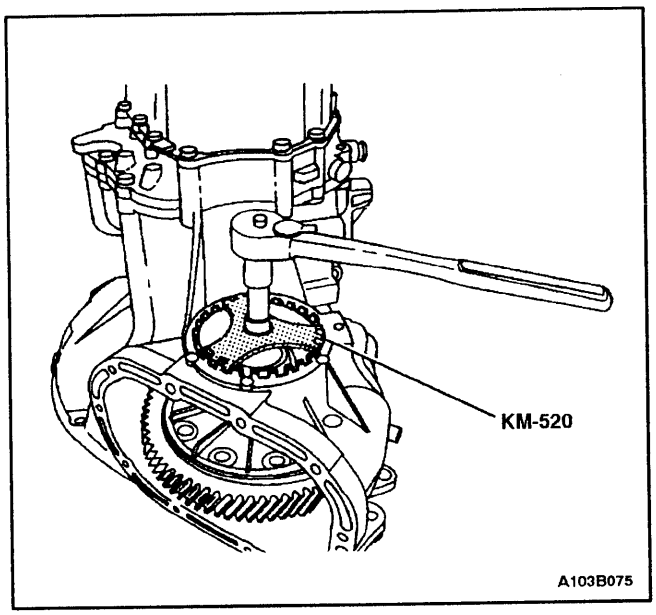
8. Install the differential assembly into the transaxle case.



9. Install the right-side bearing retainer and the right-side bearing retainer bolts.

Tighten

Tighten the right-side bearing retainer bolts to 25 N•m (18 lb-ft).



10. Install the bearing-adjusting ring.
11. Tighten the bearing-adjusting ring using the remover/ installer KM-520.

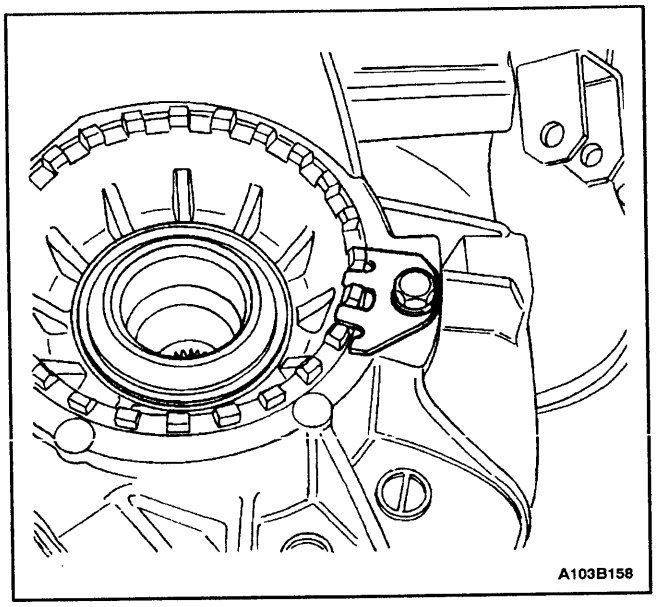
Tighten

Tighten the bearing adjusting ring until there is no end play with the differential.

Adjust the preload on the differential bearings.

Used Bearings:
1 N•m (9 lb-in) required to rotate the differential one revolution per second.

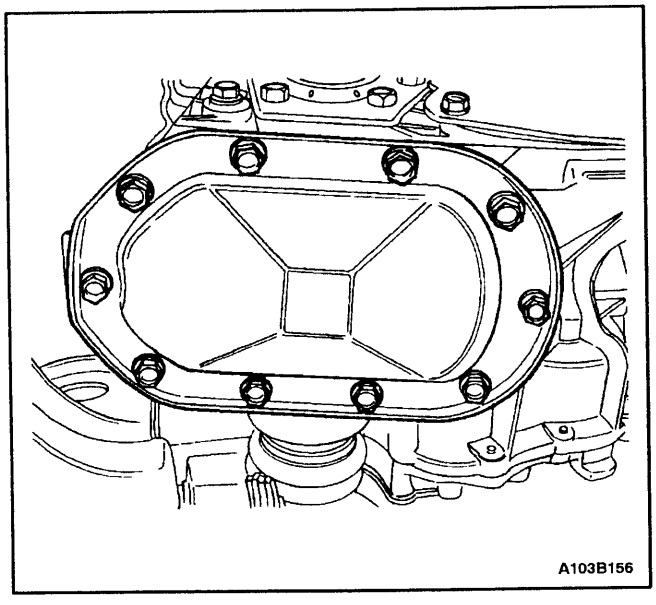
New Bearings:
2 N•m (18 lb-in) required to rotate the differential one revolution per second.
Tighten or loosen the bearing ring adjuster to get the required preload on the bearings.



12. Install the bearing-adjusting ring-retainer plate and the bearing-adjusting ring-retainer plate bolt.

Tighten

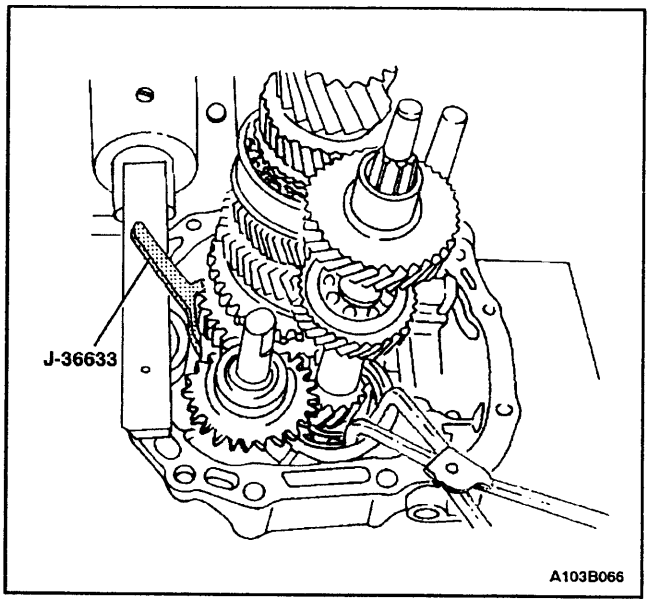
Tighten the bearing-adjusting ring-retainer plate bolt to 25 N•m (18 lb-in).

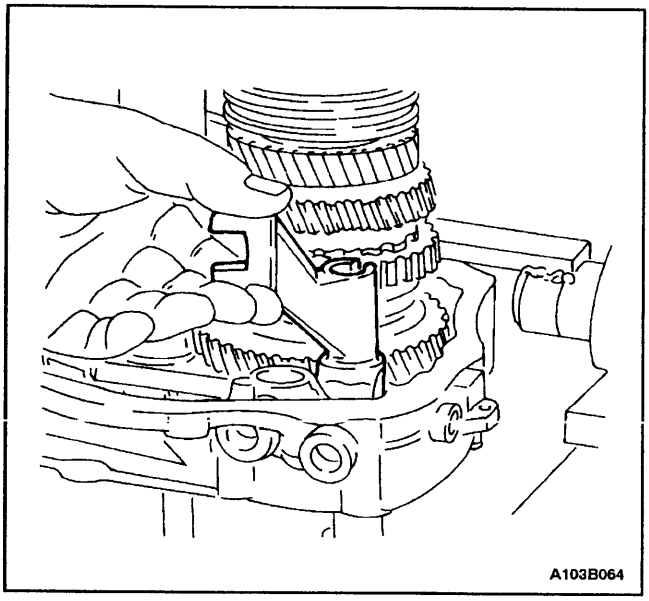


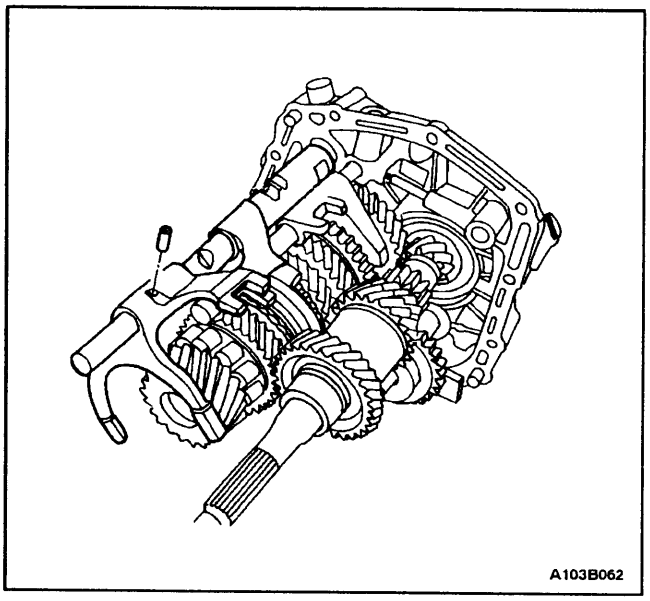
13. Install the differential cover gasket, the differential cover, and the differential cover bolts.

Tighten

Tighten the differential cover bolts to 40 N•m (30 lb-ft).







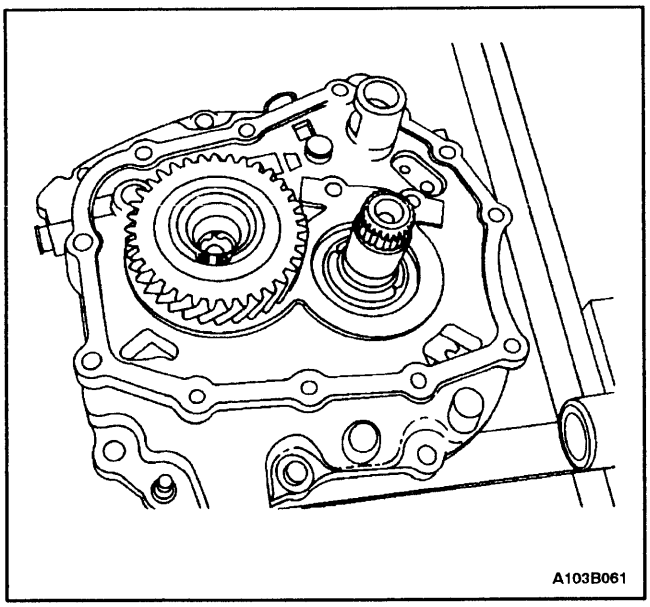
MAJOR COMPONENT ASSEMBLY

Tools Required

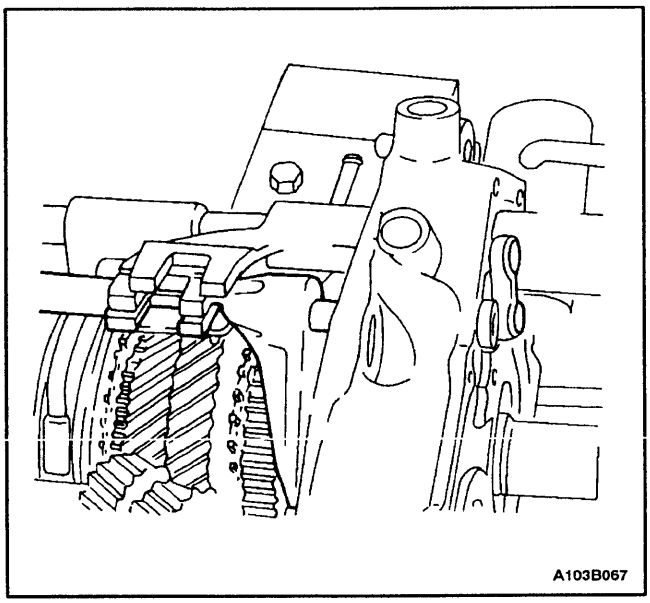
J-36633 Snap Ring Retainer
KM-334 Installer Sleeve
KM-552 Fixture
KM-554 Installer
KM-113-2 Base

Assembly Procedure

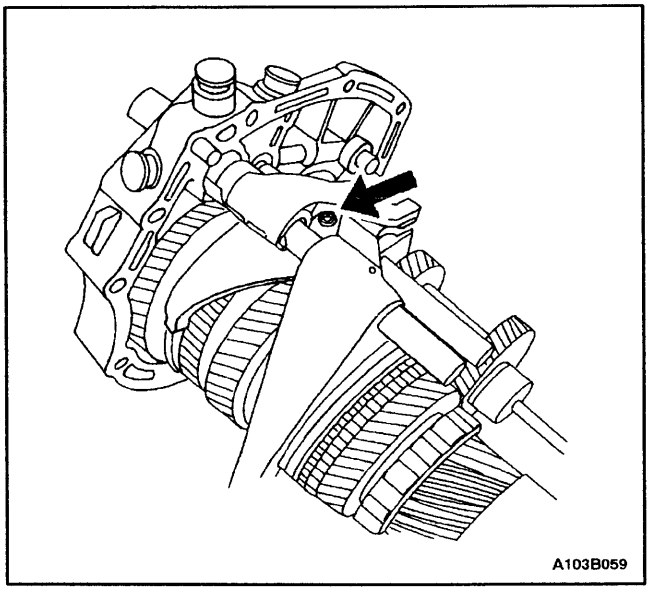
1. Join the mainshaft and the input shaft.
2. Compress the snap ring at the base of the mainshaft and hold with the snap ring retainer J-36633.
3. Hold the snap ring at the base of the input driveshaft with the snap ring pliers.
4. Install the mainshaft/input shaft assembly onto the bearing plate.
5. Release the mainshaft snap ring and the input shaft snap ring.
6. Position the first-second gearshift fork.
7. Install the fifth gearshift lever into the bearing plate.
8. Install the third-fourth gearshift rod/fork holding pin.



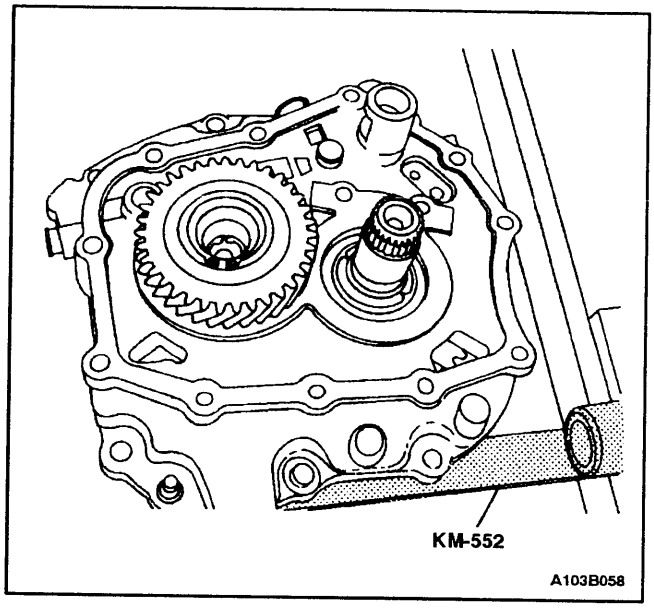
9. Install the support bracket onto the bearing plate.



10. Install the first-second gearshift rod/fork onto the bearing plate.



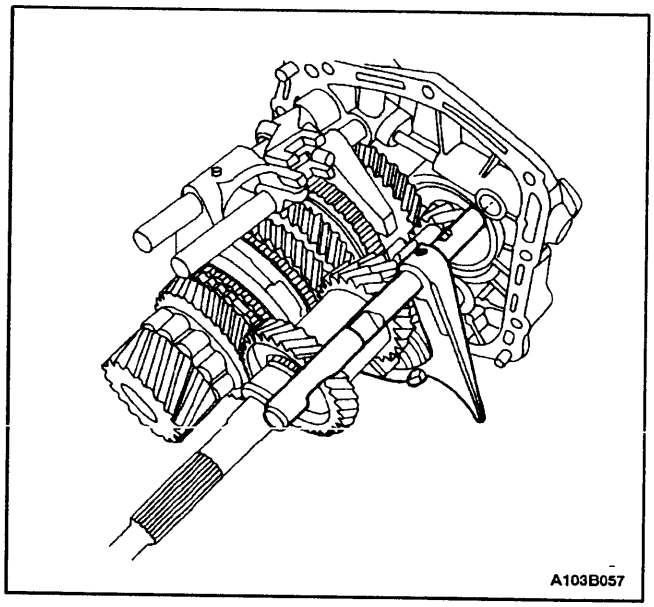
11. Install the first-second gearshift fork holding pin.



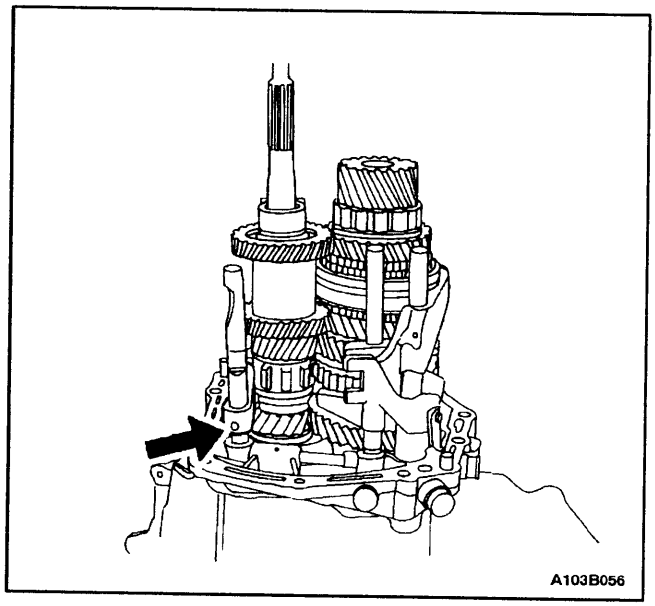
12. Install the support bracket bolts.

Tighten

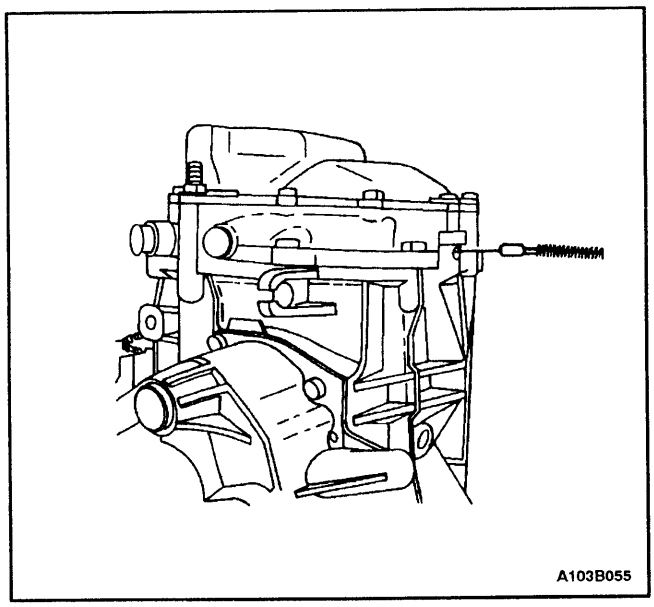
Tighten the support bracket bolts to 7 N•m (62 lb-in).



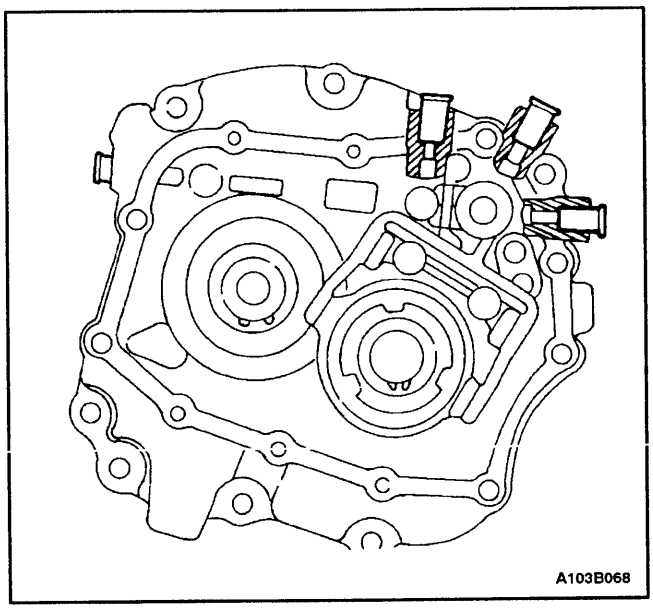
13. Install the reverse gearshift rod/fork onto the bearing plate.



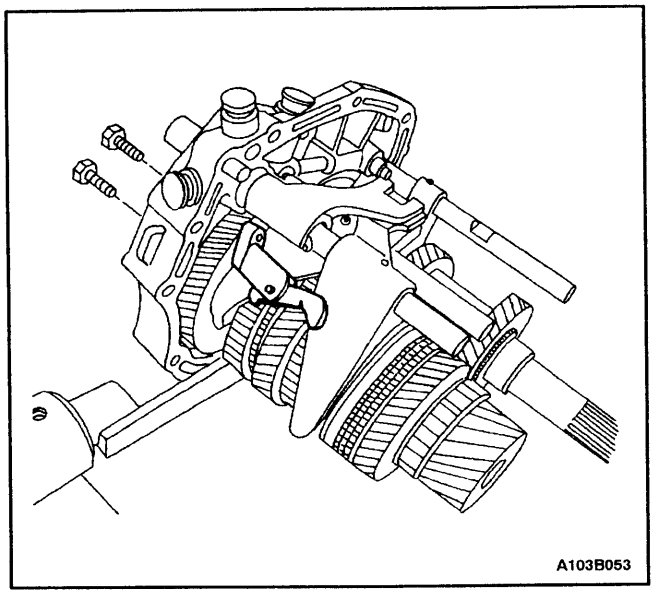
14. Install the reverse gearshift rod/fork holding pin.


A103B055

15. Install the rod lock pin and spring into the small plug hole.


A103B068

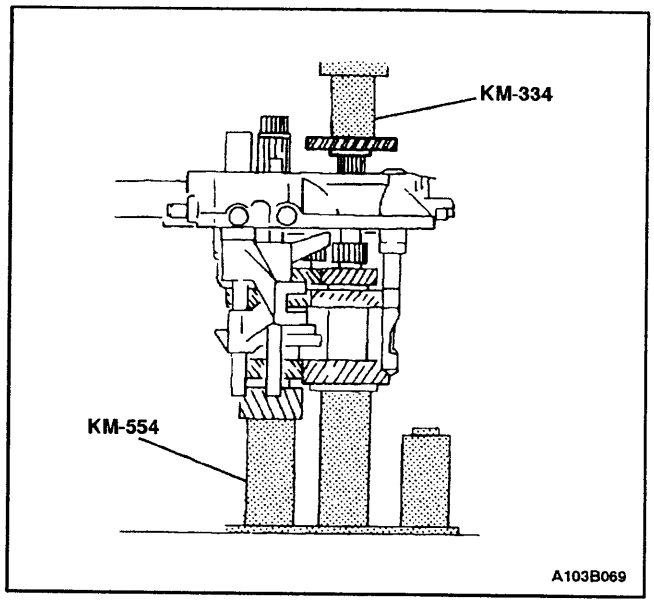
16. Install the fourth-gearshift rod plugs.


A103B053

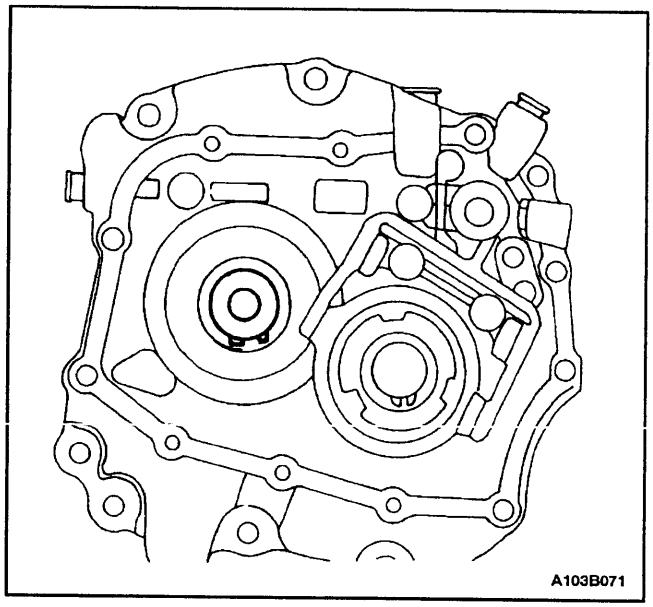
17. Install the bolts and the fifth-gearshift connector onto the bearing plate, using the pawl.

Tighten

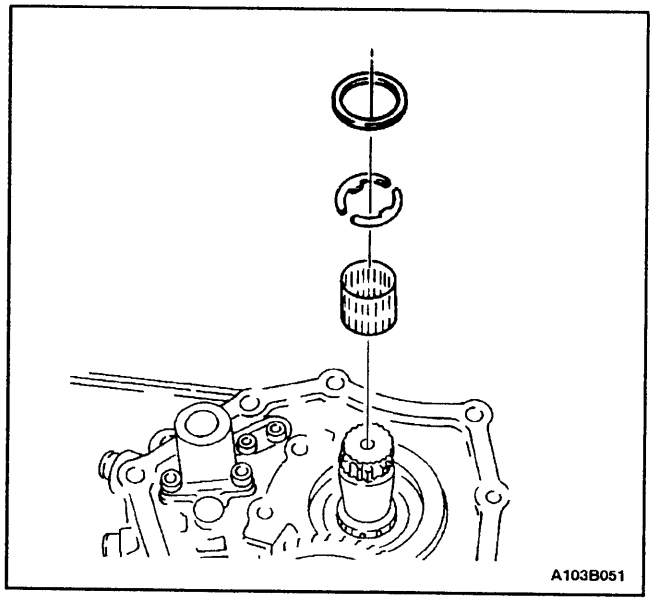
Tighten the fifth-gearshift connector bolts to 7 N•m (62 lb-in).



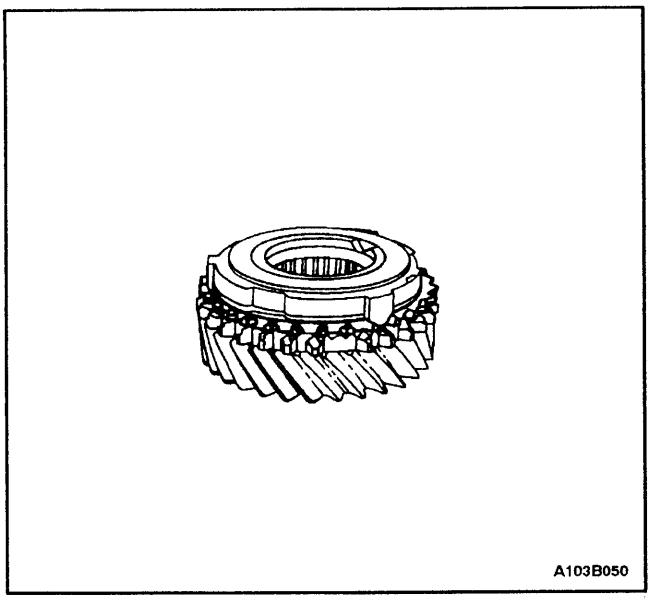
18. Install the input drive fifth gear using the installer KM-554 and the installer sleeve KM-334.



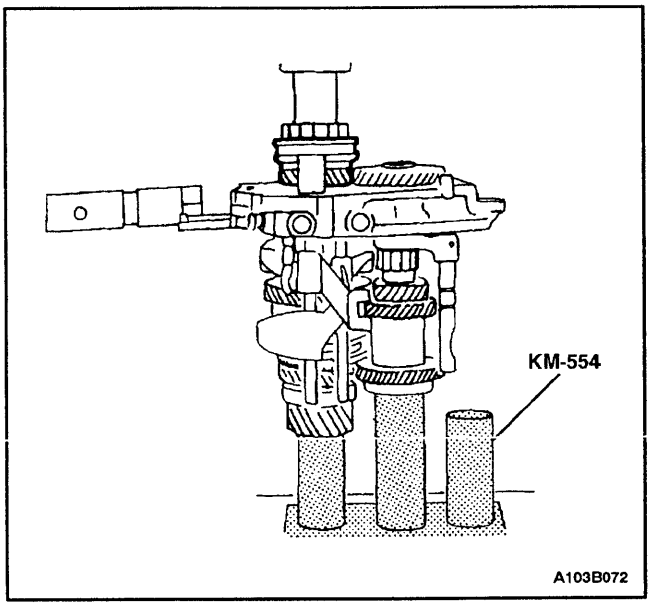
19. Install the snap rings securing the fifth-drive gear.



20. Install the thrust washers, the retaining ring, and the needle bearing into the mainshaft-driven fifth-gear assembly.

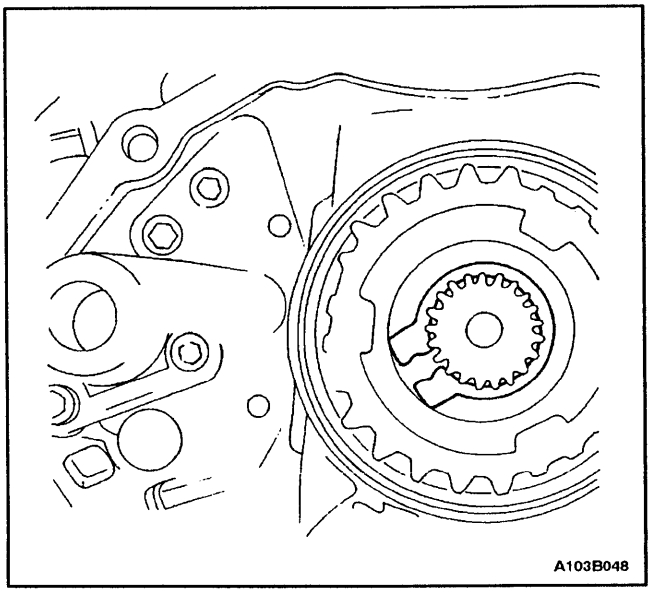

A103B050

21. Install the brass synchronizer ring onto the mainshaft-driven fifth-gear assembly.

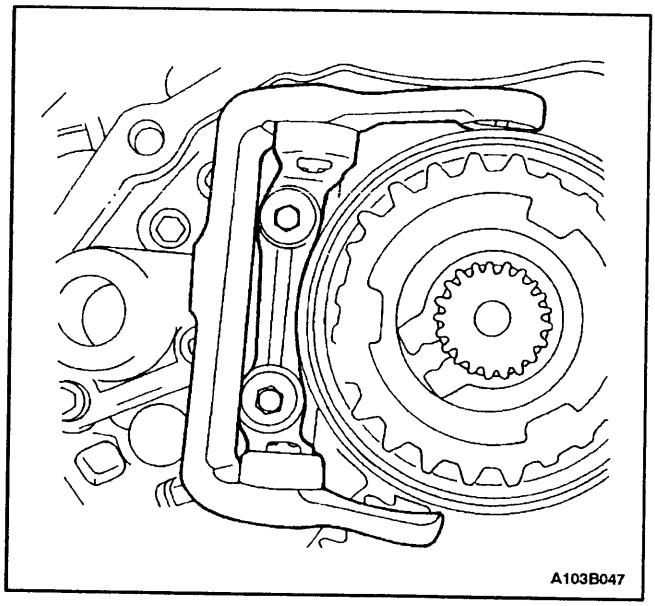


A103B072

22. Install the mainshaft-driven fifth-gear assembly.
23. Install the fifth-drive gear synchronizer gear and the synchronizer sleeve using installer KM-554.


A103B048

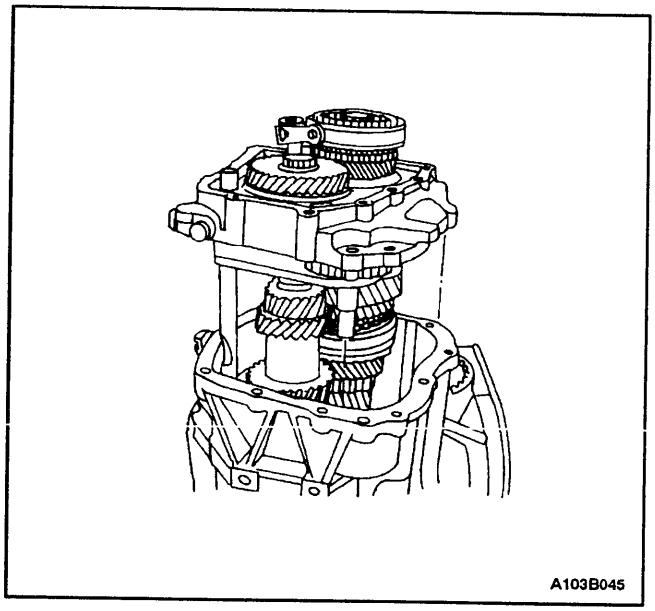
24. Install the snap ring holding the fifth speed-driven assembly.


A103B047

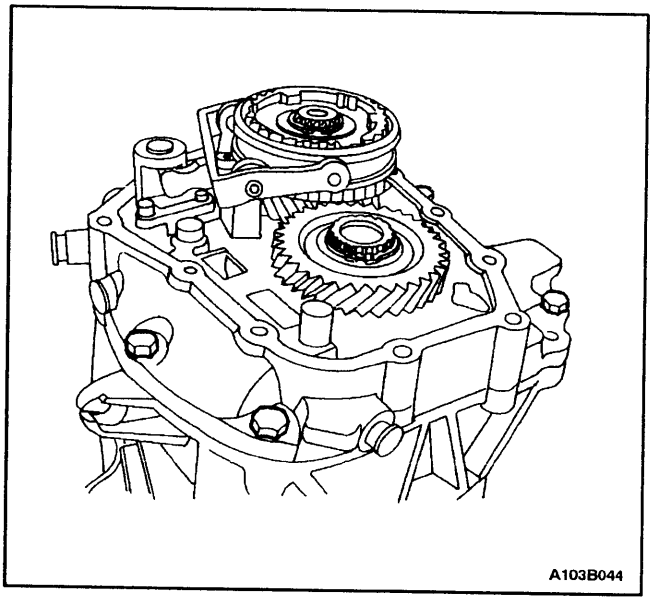
25. Install the bolts and the fifth-gear fork onto the bearing plate.

Tighten

Tighten the fifth-gear fork bolts to 22 N•m (16 lb-ft).


A103B045

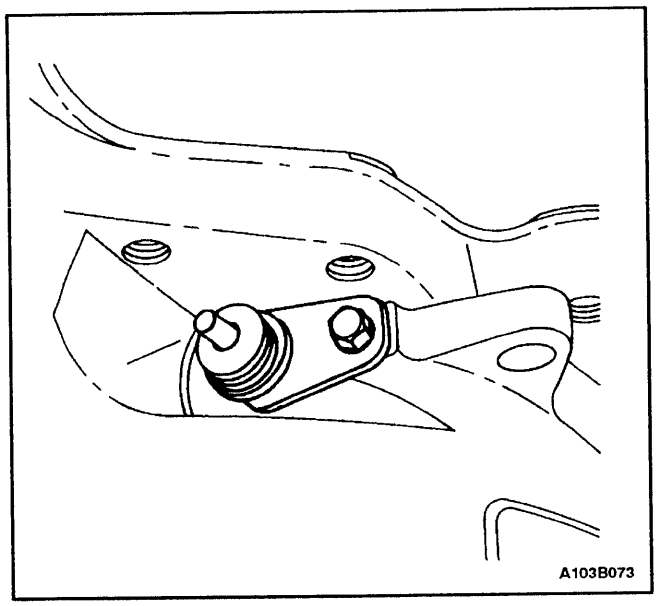
26. Remove the bearing plate from the fixture KM-552.
27. Shift the transaxle into second gear.
28. Install the bearing plate, with the shafts attached, into the case.


A103B044

29. Install the bearing plate bolts.

Tighten

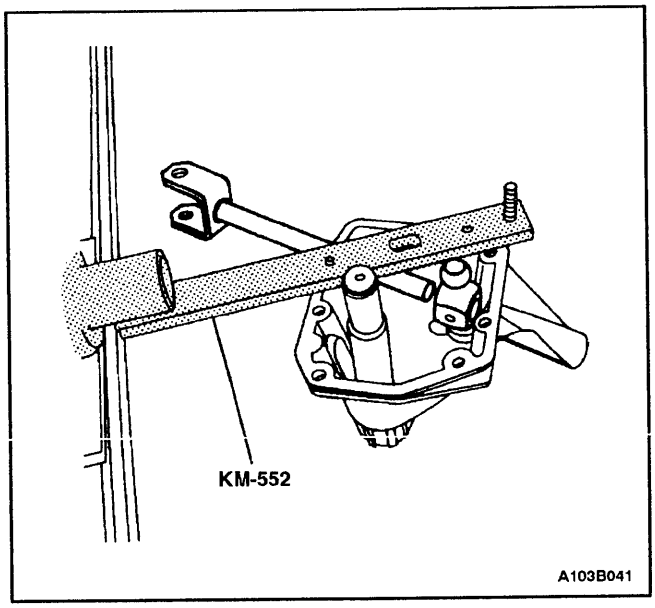
Tighten the bearing plate bolts to 22 N•m (16 lb-ft).


A103B073

30. Install the speedometer-driven gear and the speedometer-housing retaining bolt into the transaxle housing.

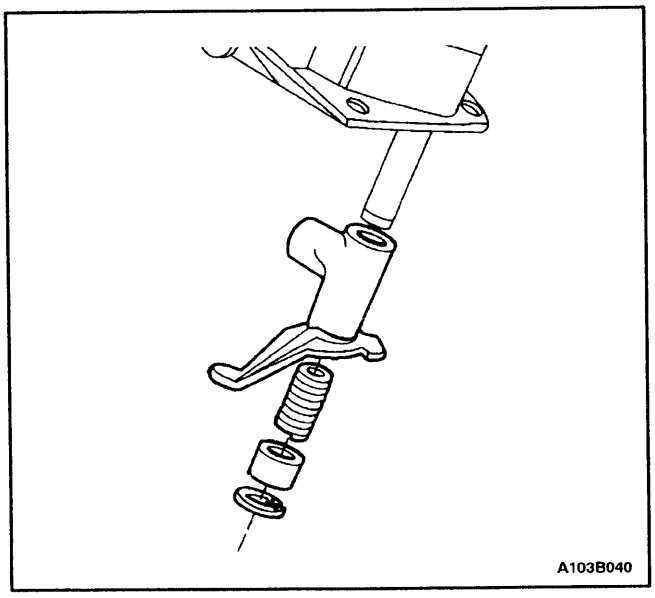
Tighten

Tighten the speedometer housing retaining bolt to 4 N•m (35 lb-in).

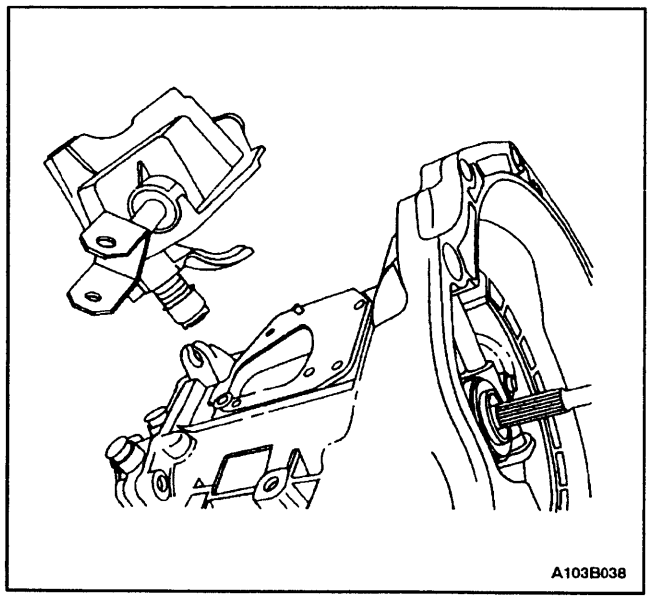


A103B041

31. Bolt the gearshift lever cover to the fixture KM-552.
32. Position the fixture into the base KM-113-2.
33. Install the gearshift rod, the shift finger lever, and the gearshift lever pin.


A103B040

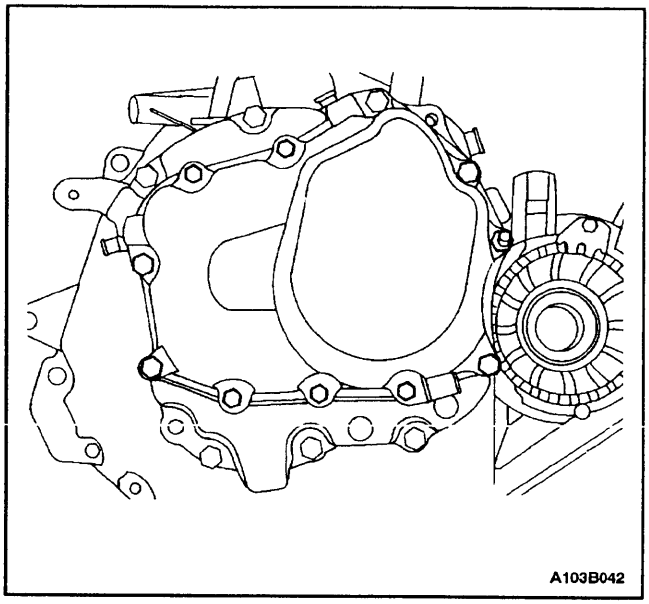
34. Install the snap ring, the bushing, the spring, and the intermediate lever.
35. Remove the gearshift lever cover from the base KM-113-2 and the fixture KM-552.
36. Shift the transaxle into NEUTRAL.


A103B038

37. Install the gearshift lever cover and the gearshift lever cover bolts.

Tighten

Tighten the gearshift lever cover bolts to 22 N•m (16 lb-ft).

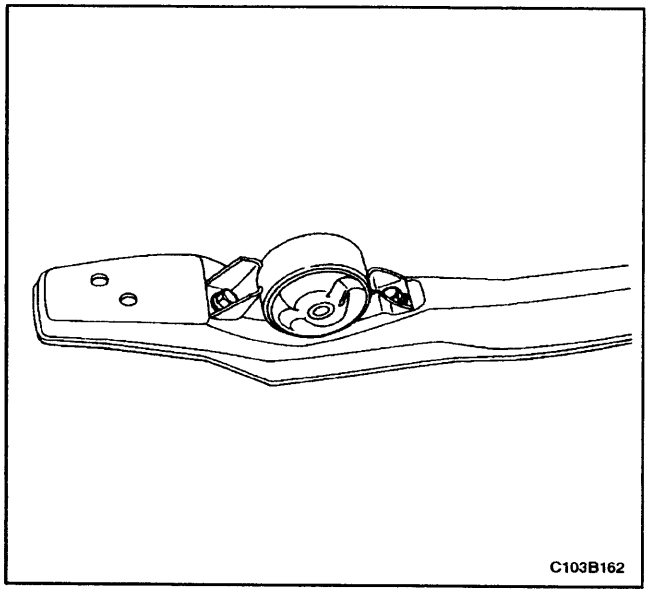

A103B042

38. Install the transaxle cover and the transaxle cover bolts.

Tighten

Tighten the transaxle cover bolts to 18 N•m (13 lb-ft).

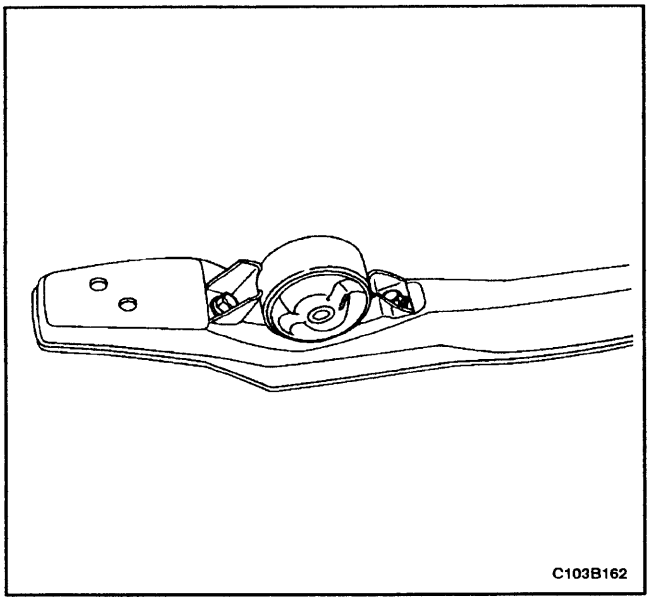
39. Install the transaxle into the vehicle. Refer to "Transaxle Assembly" in this section.


C103B162

TRANSAXLE MOUNT

Disassembly Procedure

1. Remove the center member from the vehicle. Refer to Section 9N, *Frame and Underbody.*
2. Remove the transaxle bracket mount-to-center member bolts.
3. Remove the transaxle bracket mount.



Assembly Procedure

1. Install the transaxle bracket mount.
2. Install the transaxle bracket mount-to-center member bolts.

Tighten

Tighten the transaxle bracket mount-to-center member bolts to 65 N•m (48 lb-ft).

3. Install the center member into the vehicle. Refer to Section 9N, *Frame and Underbody.*

GENERAL DESCRIPTION AND SYSTEM OPERATION

FIVE-SPEED MANUAL TRANSAXLE

This five-speed transaxle assembly is a transmission of constant-mesh design.

Combined in the assembly are

- All forward gears.
- The reverse gear.
- The differential output.

The basic components of the five-speed transaxle assembly units are the

- Transaxle case.
- Input shaft.
- Input shaft gears.
- Output shaft.
- Output shaft gears.
- Ring gear and differential assembly.

Forward Gear

Shifting to a forward gear is accomplished through a combination of synchronizers with blocker rings controlled by sliding shift forks.

Reverse Gear

Reverse gear is not synchronized and uses a sliding idler gear arrangement.

Differential Assembly

The differential is a conventional arrangement of gears that is supported by tapered roller bearings. The final output gear turns the ring gear and differential assembly, which turns the drive axle shafts.

SECTION 5C

CLUTCH

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

TABLE OF CONTENTS

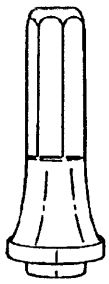
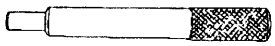
SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	N•m	Lb-Ft	Lb-In
Clutch Fork-to-Release Lever Shaft Bolt	35	26	-
Clutch Master Cylinder Locknuts	22	18	-
Clutch Pedal Nut	18	13	-
Pressure Plate-to-Flywheel Bolts	15	11	-
Release Bearing Guide Sleeve Bolts	5	-	45
Release Cylinder Bolts	60	44	-

SPECIAL TOOLS

SPECIAL TOOLS TABLE

 A103C009	**J-36547 Input Shaft Seal Installer**
 A103C045	**J-42474 Clutch Arbor**

DIAGNOSIS

CLUTCH OPERATION

Fails to Release

Checks	Action
DEFINITION: When the pedal is pressed to the floor, the shift lever does not move freely in and out of reverse gear.	
Check for a loose linkage.	Repair or replace loose linkage, if necessary.
Check for a damaged clutch disc.	Replace the damaged clutch disc.
Check for an improperly installed fork shaft.	Remove and properly reinstall the fork shaft. Very lightly lubricate the fork fingers at the release bearing with wheel bearing grease.
Check for the clutch disc hub binding on the input shaft splines.	Repair or replace the clutch disc hub.
Check for a warped or bent clutch disc.	Replace the warped or bent clutch disc.

Slipping

Checks	Action
Check for the driver improperly operating the vehicle.	Correct the driver's operation of the vehicle as necessary.
Check for an oil-soaked clutch disc.	Correct the leak at its source and install a new clutch disc.
Check for a worn facing or a facing torn from the disc.	Replace the worn disc with a new disc.
Check for a warped pressure plate or a warped flywheel.	Replace the warped pressure plate or the warped flywheel.
Check for a weak diaphragm spring.	Replace the pressure plate.
Check for a driven plate that is not seated.	Start the engine 30 to 40 times. Do not overheat the engine.
Check for a driven plate that is overheated.	Allow the driven plate to cool.

Grabbing (Chattering)

Checks	Action
Check for a burned or a glazed facing caused by oil on the facing.	Correct the leak at its source and install a new clutch disc.
Check for worn splines on the input shaft.	Replace the worn input shaft.
Check for a warped pressure plate or a warped flywheel.	Replace the warped pressure plate or the warped flywheel.
Check for burned or smeared resin on the flywheel or the pressure plate.	Sand off the burned or smeared resin if it is superficial. Replace any burned or heat-checked parts.

Rattling (Transaxle Click)

Checks	Action
Check for weak retracting springs.	Replace the pressure plate.
Check for a loose release fork.	Remove and reinstall the release fork properly.
Check for oil in the driven plate damper.	Correct the cause of the oil leak and replace the driven disc.
Check for a damaged driven plate damper spring.	Replace the driven disc.

Release Bearing Noise with Clutch Fully Engaged

Checks	Action
Check for the driver improperly operating the vehicle.	Correct the driver's operation of the vehicle as necessary.
Check for a binding release bearing.	Clean and re-lubricate the release bearing. Inspect the release bearing for burrs and nicks.
Check for an improperly installed release lever.	Remove and reinstall the release lever properly.
Check for a weak linkage return spring.	Replace the weak linkage return spring.

Noisy

Checks	Action
Check for a worn release bearing.	Replace the worn release bearing.
Check for an improperly installed release lever.	Remove and properly reinstall the fork shaft. Very lightly lubricate the fork fingers at the release bearing with wheel bearing grease.

Pedal Stays on Floor When Disengaged

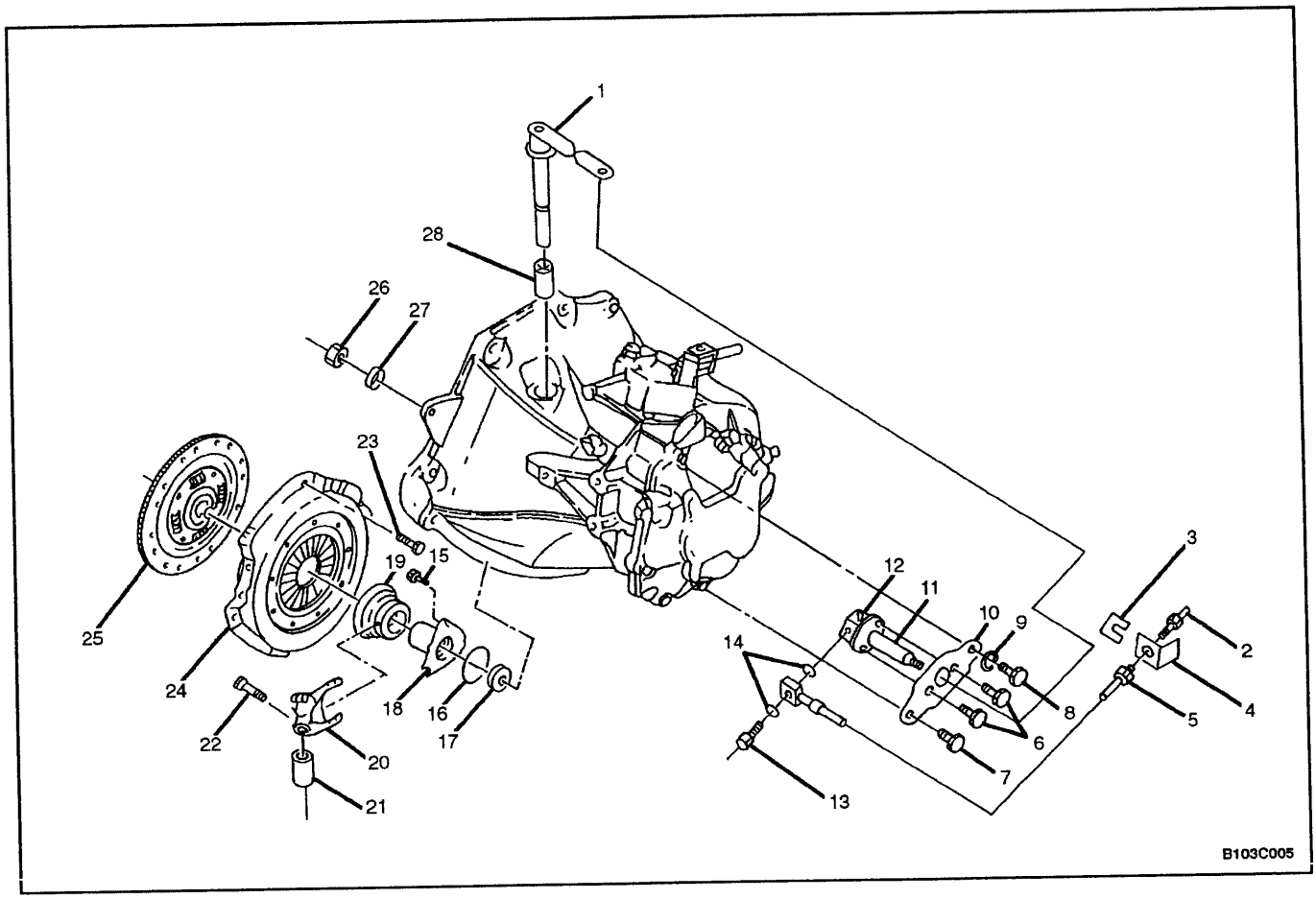
Checks	Action
Check for binding in the linkage or the release bearing.	Lubricate and free-up the binding linkage or the release bearing.
Check for weak pressure plate springs.	Replace the pressure plate.

Hard Pedal Effort

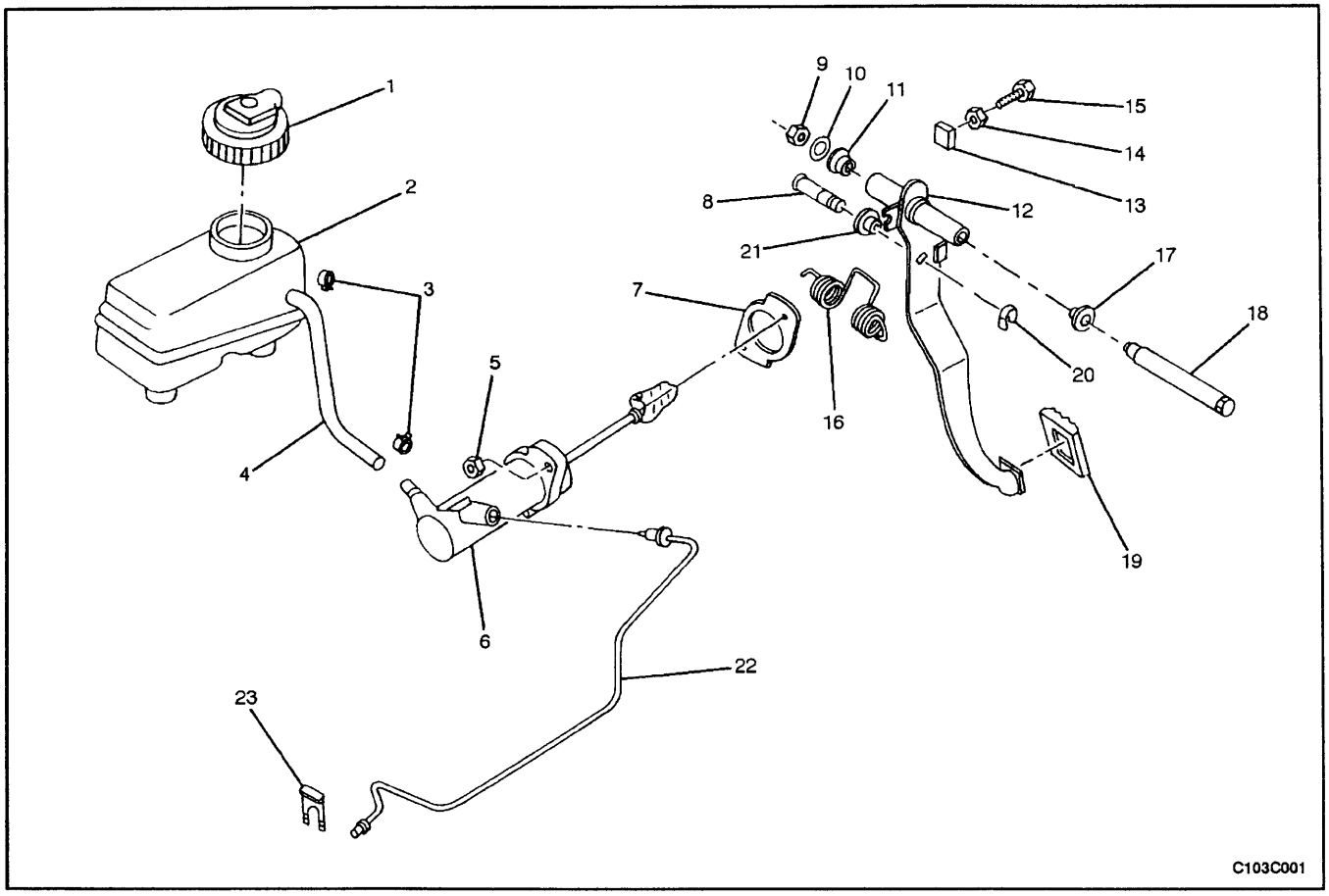
Checks	Action
Check for binding in the linkage.	Lubricate and free-up the binding linkage.
Check for a worn driven plate.	Replace the worn driven plate.

COMPONENT LOCATOR

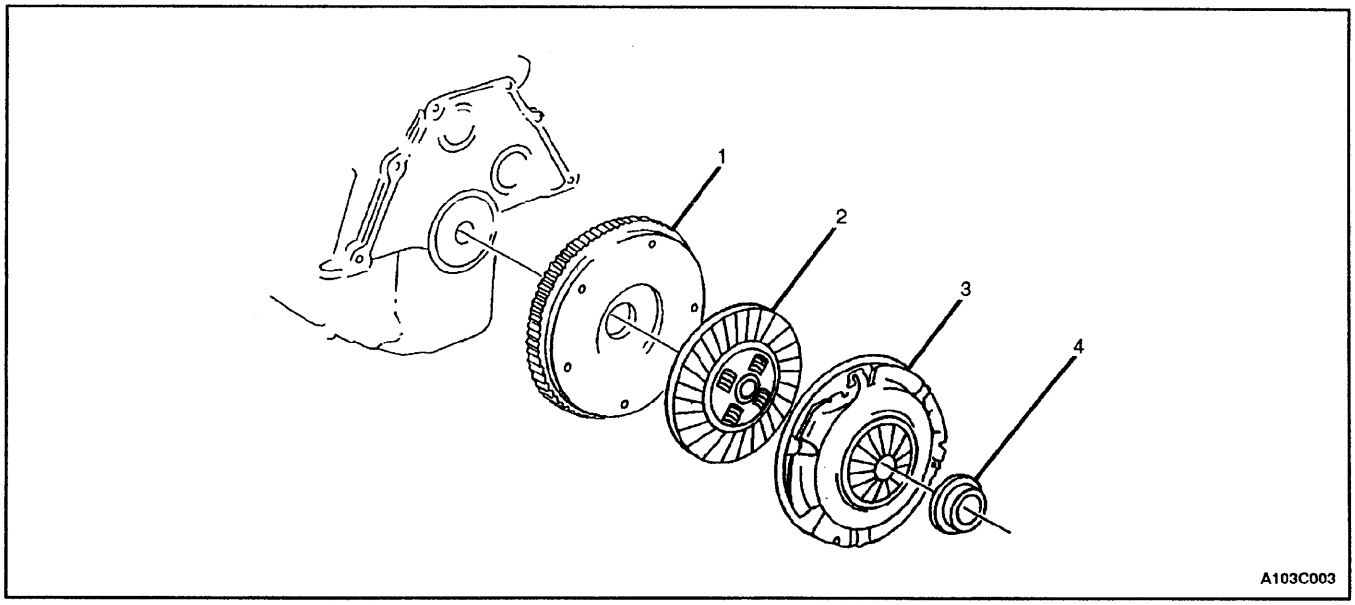
HYDRAULIC CLUTCH COMPONENTS



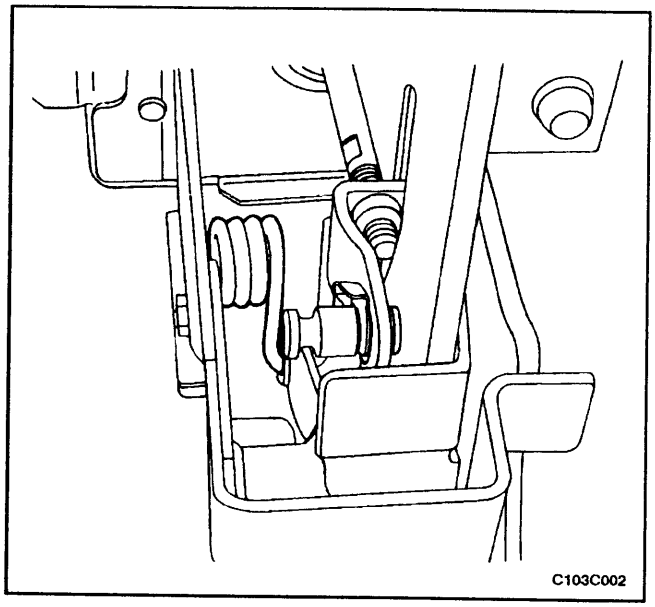
1 Release Lever
2 Pipe
3 Clip
4 Clamp
5 Hose
6 Bolt
7 Bolt
8 Bolt
9 Spring Washer
10 Release Cylinder Bracket
11 Release Cylinder
12 Air Bleeder
13 Bolt
14 Copper Washer
15 Bolt
16 O-ring
17 Input Shaft Seal
18 Bearing Guide Sleeve
19 Release Bearing
20 Fork
21 Bushing
22 Bolt
23 Bolt
24 Pressure Plate
25 Clutch Disc
26 Nut
27 Spring Washer
28 Bushing



1 Reservoir Cap
2 Clutch/Brake Reservoir
3 Spring Clamps
4 Reservoir Hose
5 Nut
6 Master Cylinder
7 Gasket
8 Piston Rod Bolt
9 Nut
10 Washer
11 Clutch Pedal Bushing
12 Clutch Pedal
13 Clutch Pedal Buffer
14 Nut
15 Bolt
16 Return Spring
17 Clutch Pedal Bushing
18 Pedal Mounting Shaft
19 Clutch Pedal Pad
20 Locking Washer
21 Clutch Pedal Bushing
22 Hydraulic Clutch Pipe
23 Clip



1 Flywheel
2 Clutch Disc
3 Pressure Plate
4 Release Bearing


C103C002

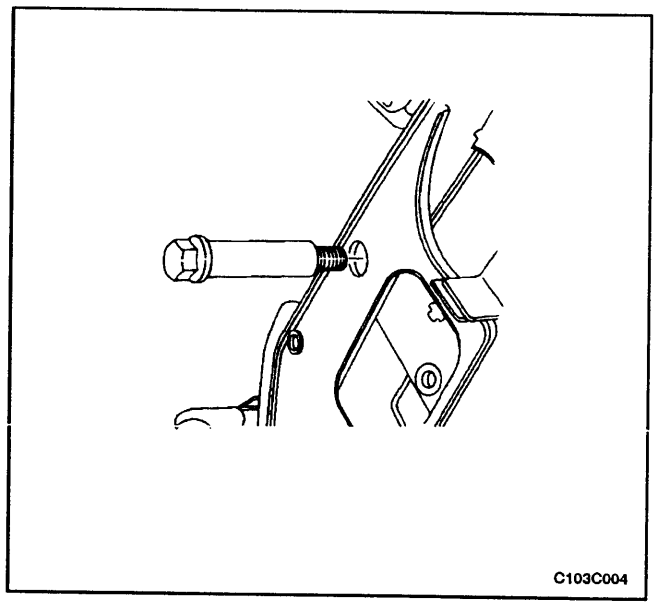
MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

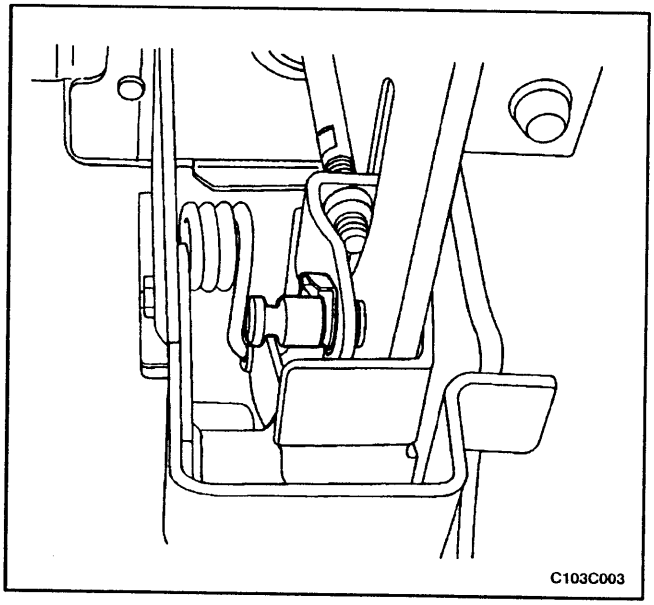
CLUTCH PEDAL

Removal Procedure

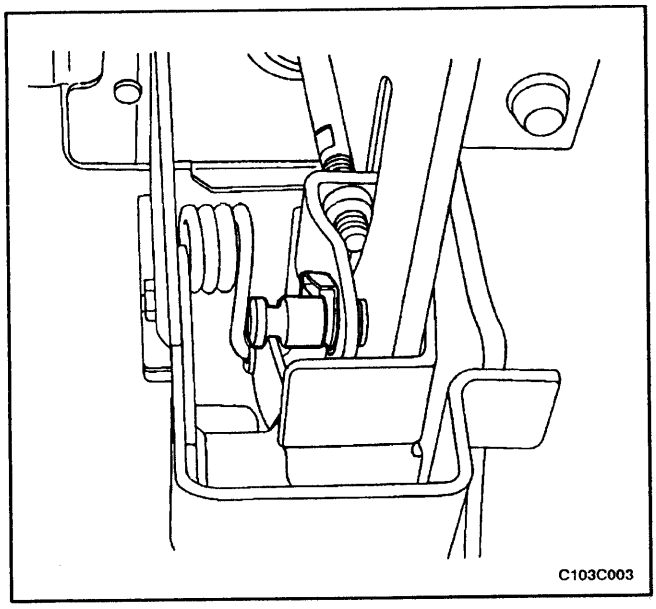
1. Disconnect the negative battery cable.
2. Disconnect the return spring from the mount brace.


C103C004

3. Remove the nut, the washer, and the pedal mounting shaft.

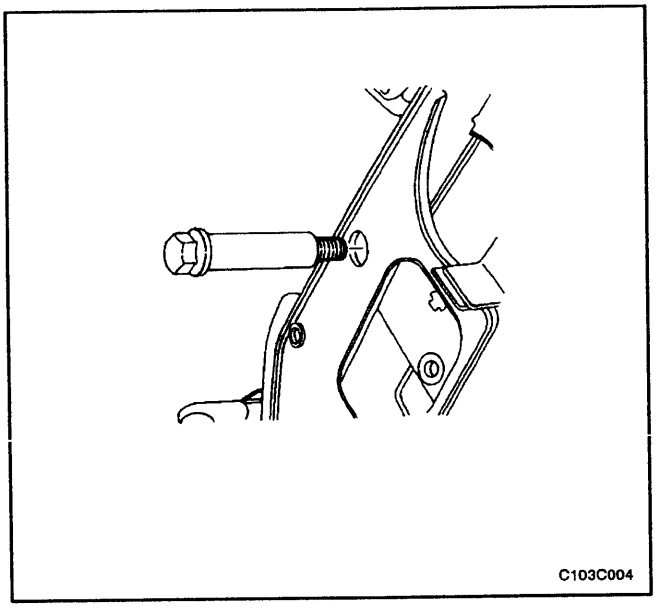

C103C003

4. Remove the locking washer and the piston rod bolt.
5. Remove the clutch pedal from the vehicle.



Installation Procedure

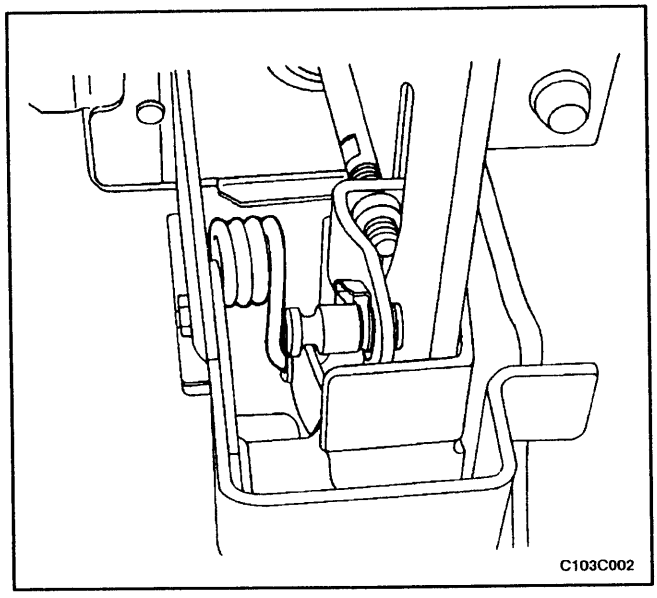
1. Install the clutch pedal to the mount brace. Make sure the return spring engages the notch on the rear of the clutch pedal.
2. Coat the piston rod bolt with multi-purpose grease.
3. Install the piston rod bolt and the locking washer.



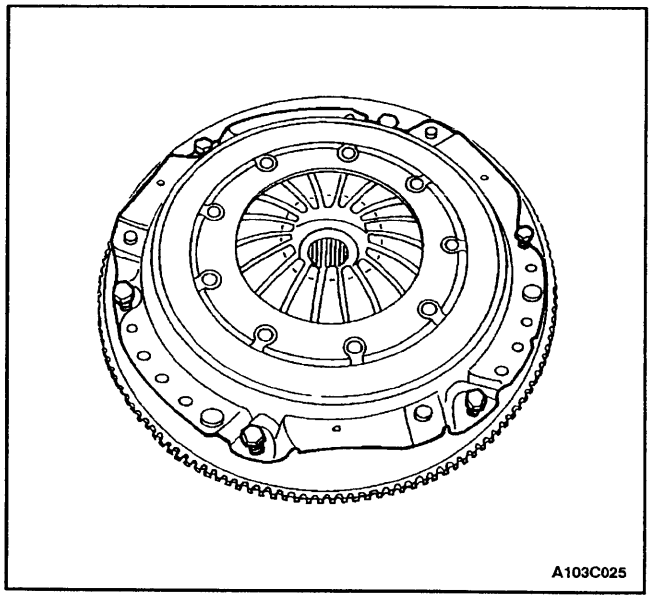
4. Coat the pedal mounting shaft with multi-purpose grease.
5. Install the pedal mounting shaft, the washer, and the nut.

Tighten

Tighten the clutch pedal nut to 18 N•m (13 lb-ft).



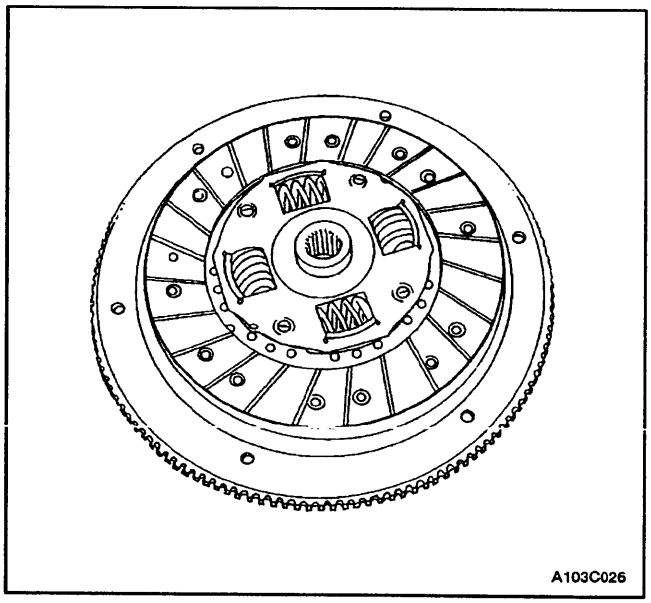
6. Connect the return spring to the mount brace.
7. Connect the negative battery cable.


A103C025

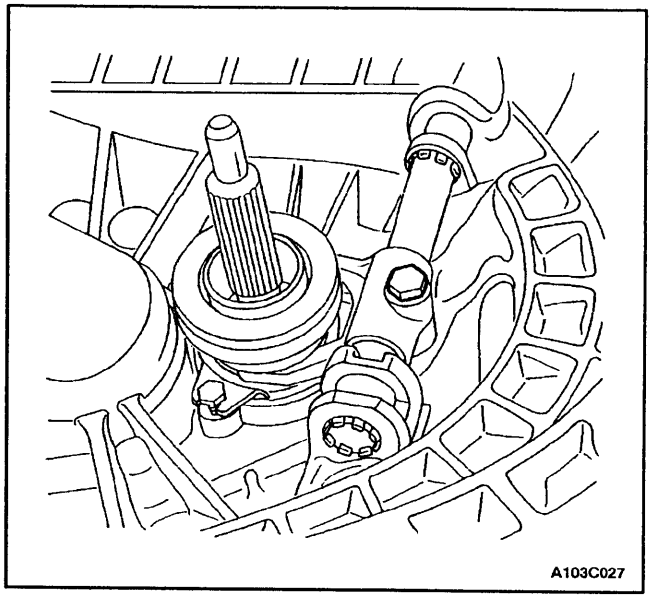
CLUTCH DISC AND RELATED COMPONENTS

Removal Procedure

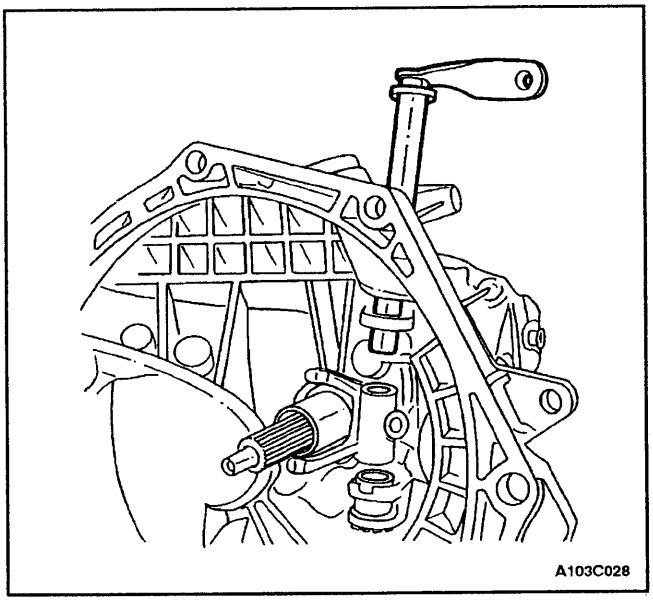
1. Disconnect the negative battery cable.
2. Raise and suitably support the vehicle.
3. Remove the left front wheel. Refer to *Section 2E, Tires and Wheels*.
4. Remove the engine under covers. Refer to *Section 9N, Frame and Underbody.*
5. Remove the transaxle from the vehicle. Refer to *Section 5B, Five-Speed Manual Transaxle*.
6. Remove the pressure plate bolts and the pressure plate. Support the pressure plate when you remove the last bolt.


A103C026

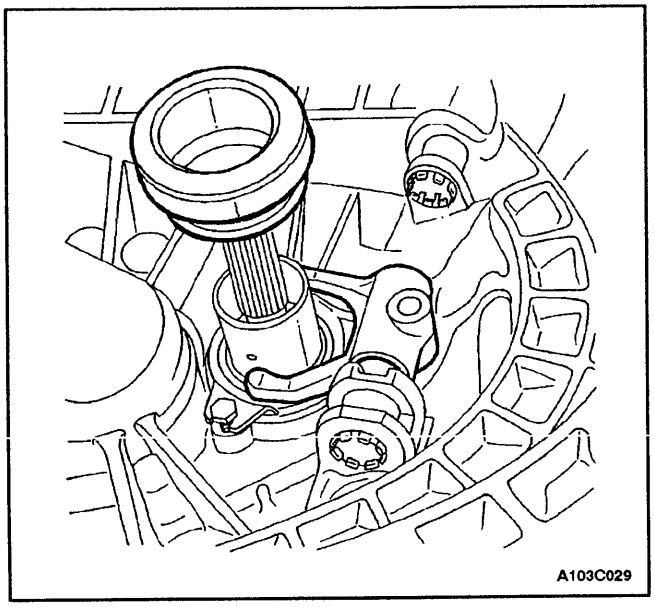
7. Remove the clutch disc.


A103C027

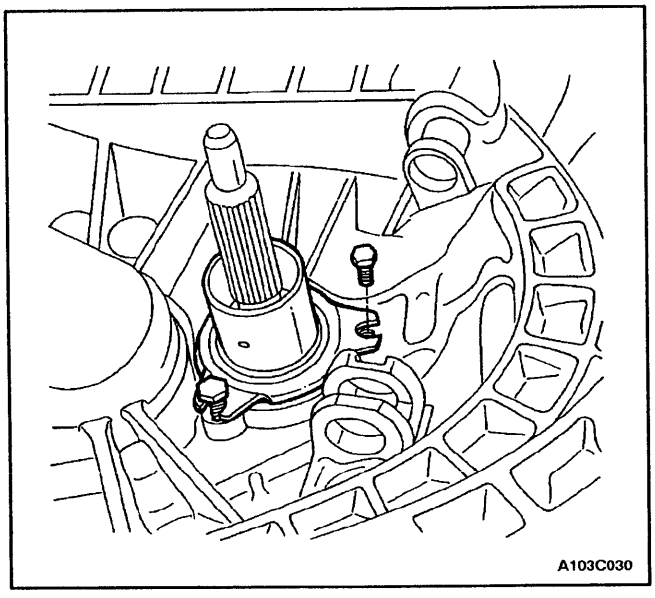
8. Remove the release fork bolt.



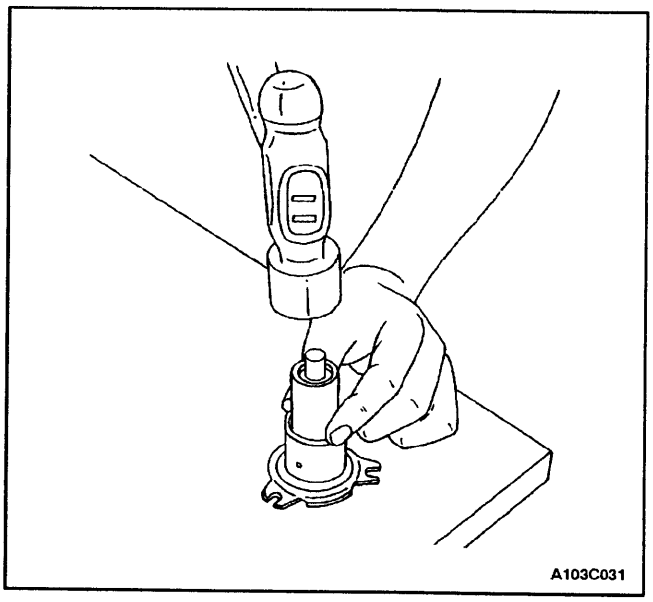
9. Pull the clutch release shaft upward, out of the transaxle.



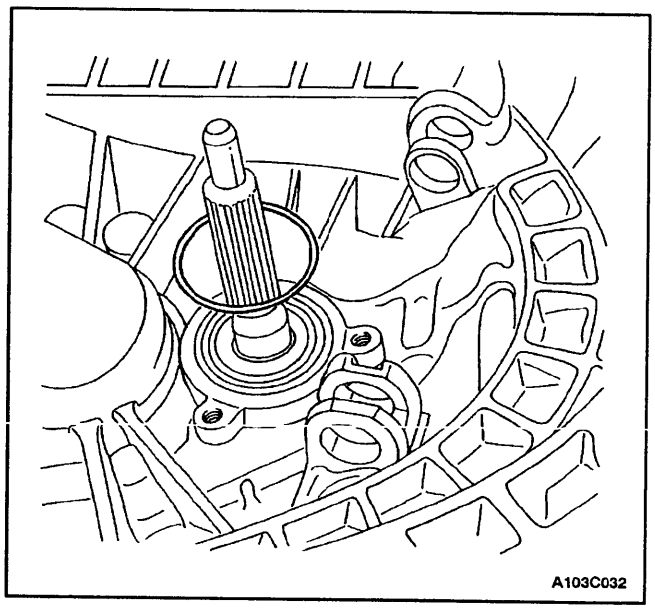
10. Remove the fork and the release bearing from the release bearing guide sleeve.



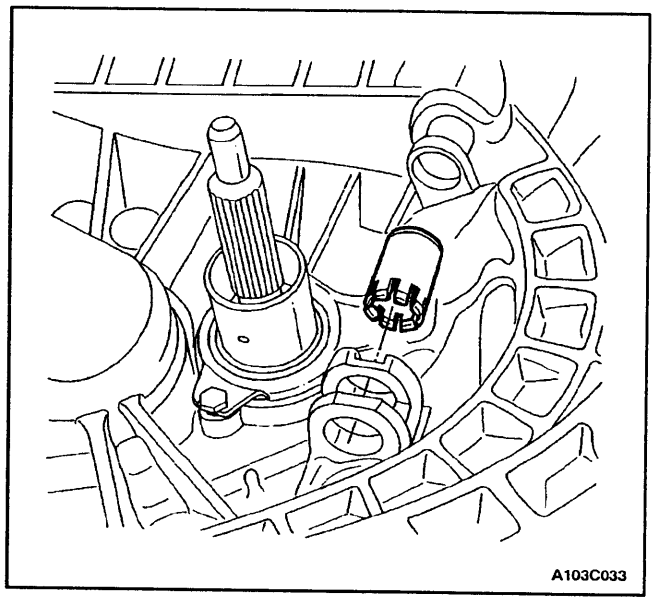
11. Remove the bolts and the release bearing guide sleeve.



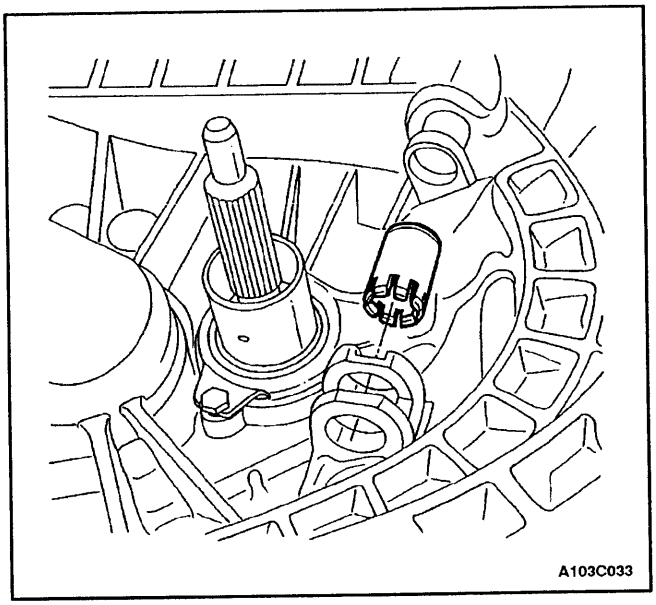
12. Remove the input shaft seal from the release bearing guide sleeve.



13. Remove the O-ring from the groove in the transaxle case.



14. Remove the release lever shaft bushings.


A103C033

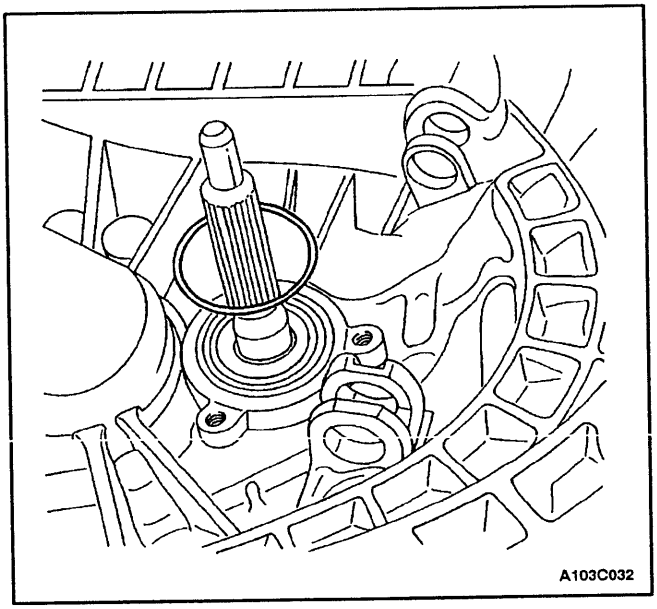
Installation Procedure

Tools Required

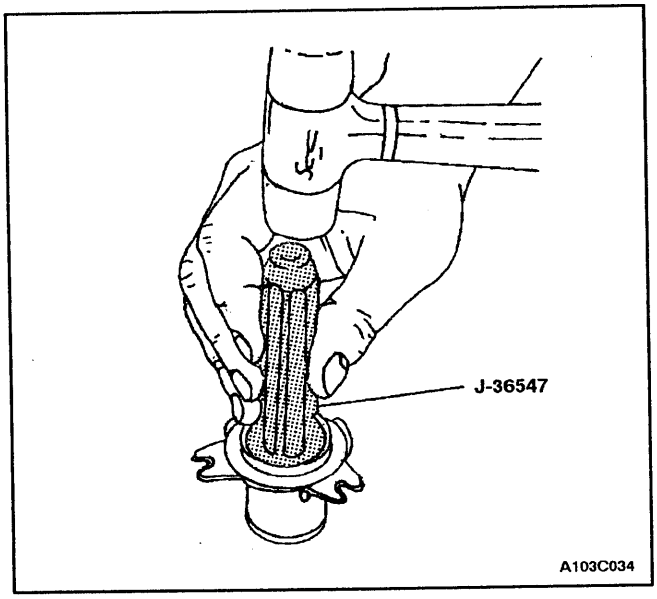
J-36547 Input Shaft Seal Installer

J-42474 Clutch Arbor

1. Install the release lever shaft bushings. Coat the bushing bores with multi-purpose grease.

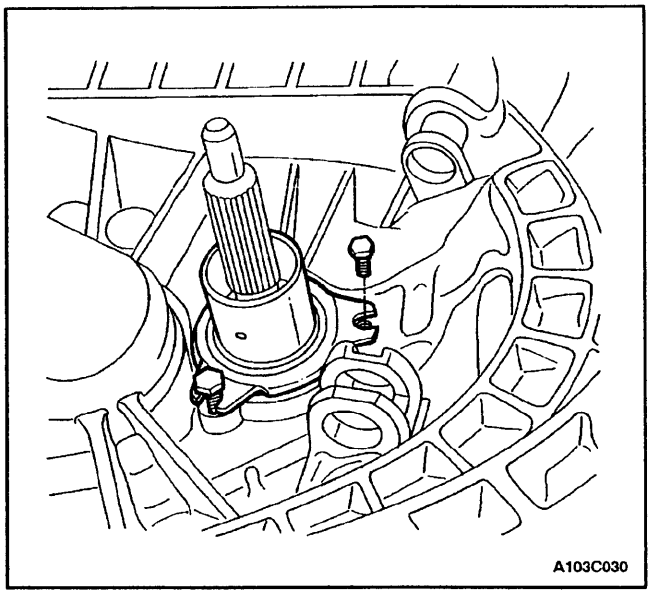

A103C032

2. Install the O-ring into the groove in the case.



A103C034

3. Install the input shaft seal into the release bearing guide sleeve. Use input shaft seal installer J-36547 with a hammer.

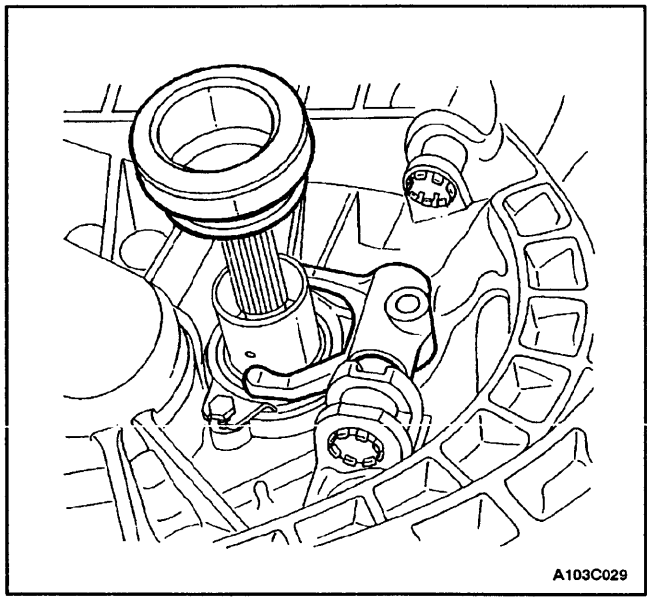


4. Install the release bearing guide sleeve and the bolts.

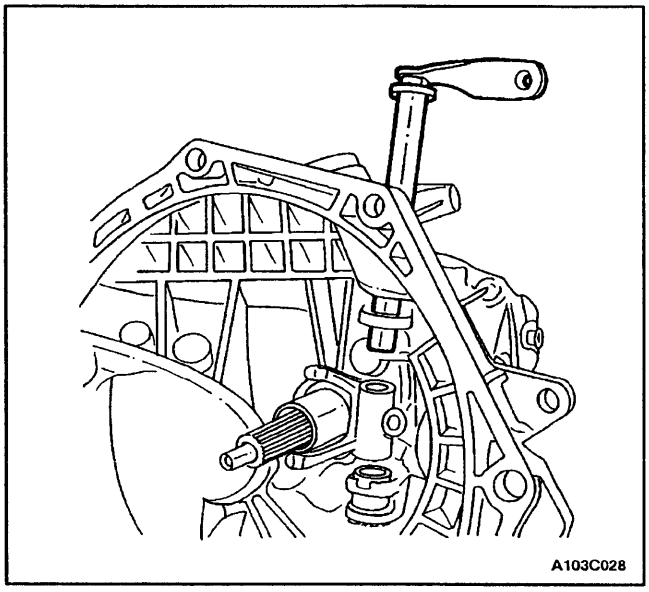
Tighten

Tighten the release bearing guide sleeve bolts to 5 N•m (45 lb-in).

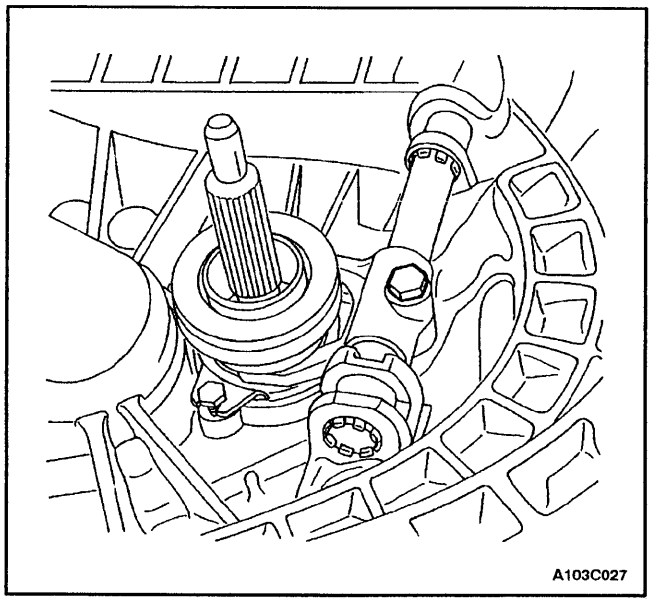
5. Coat the sleeve surface with multi-purpose grease.



6. Coat the release bearing bore with multi-purpose grease.
7. Install the release bearing, with the clutch fork, onto the release bearing guide sleeve.



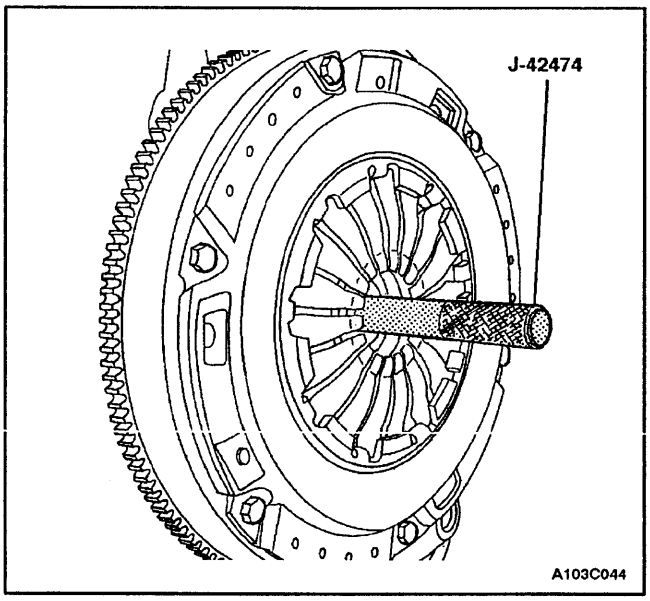
8. Install the release lever shaft from the top of the transaxle. Guide the shaft through the clutch fork.


A103C027

9. Align the shaft to the fork and install the bolt.

Tighten

Tighten the clutch fork-to-release lever shaft bolt to 35 N•m (26 lb-ft).



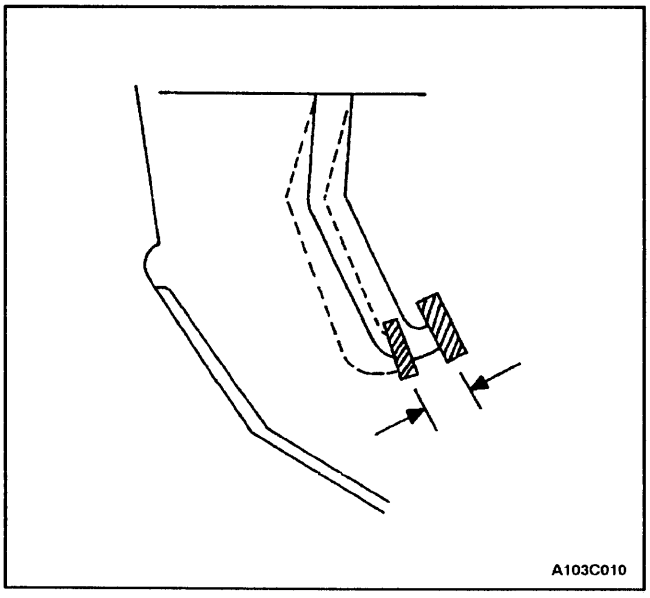
A103C044

10. Coat the spline on the clutch disc with multi-purpose grease.
11. Align the pressure plate and the clutch disc onto the flywheel using the clutch arbor J-42474.
12. Install the pressure plate bolts.

Tighten

Tighten the pressure plate-to-flywheel bolts to 15 N•m (11 lb-ft).

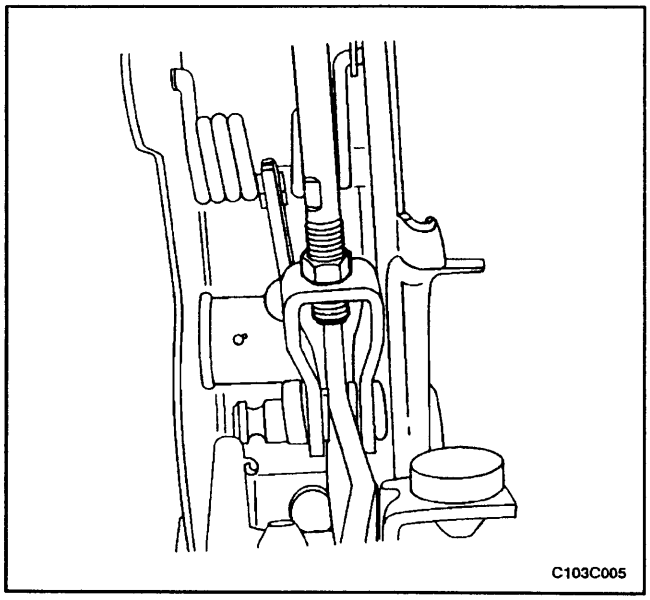
13. Remove the clutch arbor J-42474.
14. Install the transaxle into the vehicle. Refer to *Section 5B, Five-Speed Manual Transaxle*.
15. Install the engine under covers. Refer to *Section 9N, Frame and Underbody*.
16. Install the left front wheel. Refer to *Section 2E, Tires and Wheels*.
17. Lower the vehicle.
18. Connect the negative battery cable.


A103C010

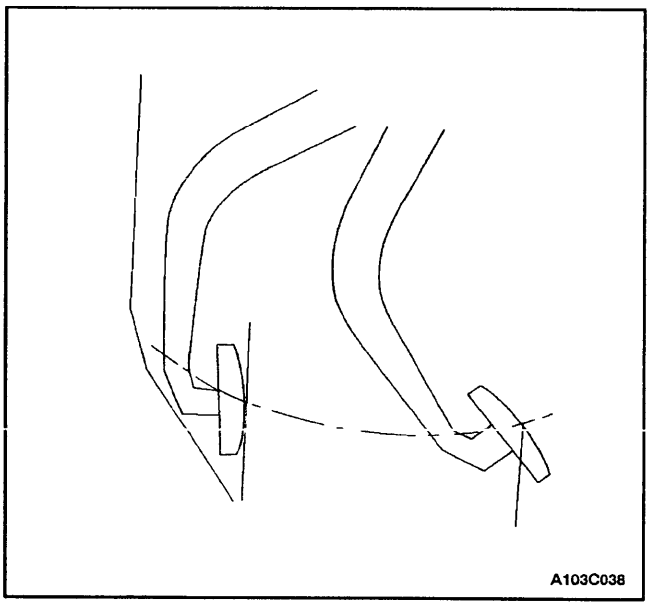
CLUTCH PEDAL ADJUSTMENT (HYDRAULIC)

Adjustment Procedure

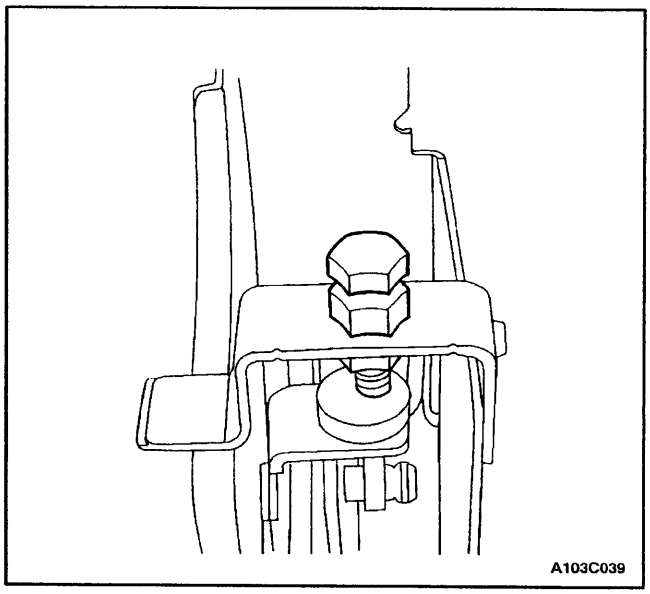
1. Determine the clutch pedal play. Press the clutch pedal lightly with your hand and measure the distance when you feel resistance.


C103C005

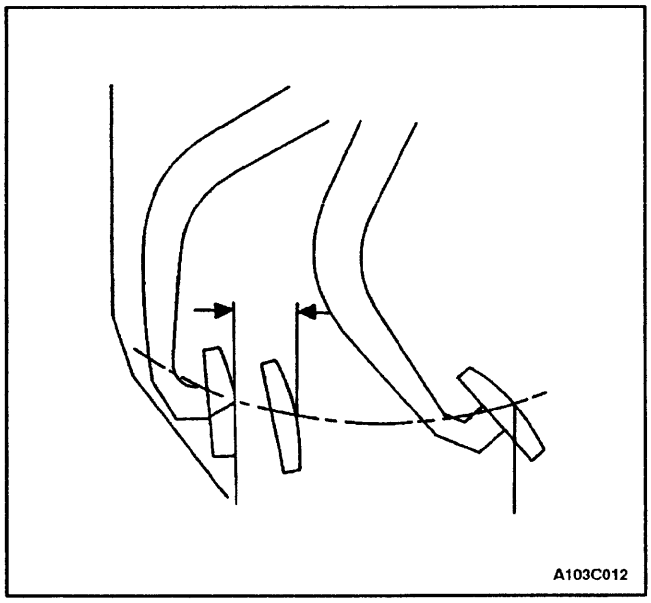
2. Adjust the clutch pedal play. Loosen the locknut and turn the pushrod. Clutch pedal play should measure 6 to12 mm (0.2 to 0.5 inch). Tighten the locknut after adjustment.


A103C038

3. Measure the clutch pedal travel. Press the clutch pedal all the way to the floor. Measure from the starting position to the ending position.


A103C039

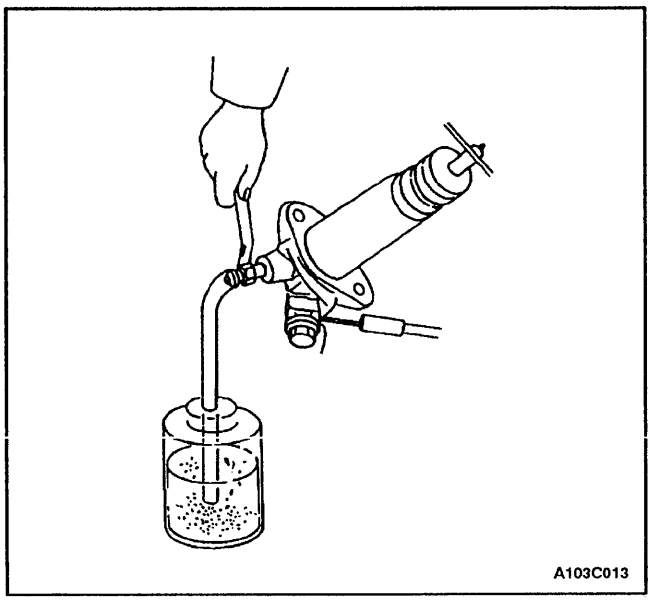
4. Adjust the clutch pedal travel. Loosen the locknut and turn the bolt. Clutch pedal travel should measure more than 140 mm (5.5 inches). Tighten the locknut after adjustment.



CLUTCH RELEASE POINT ADJUSTMENT (HYDRAULIC)

Adjustment Procedure

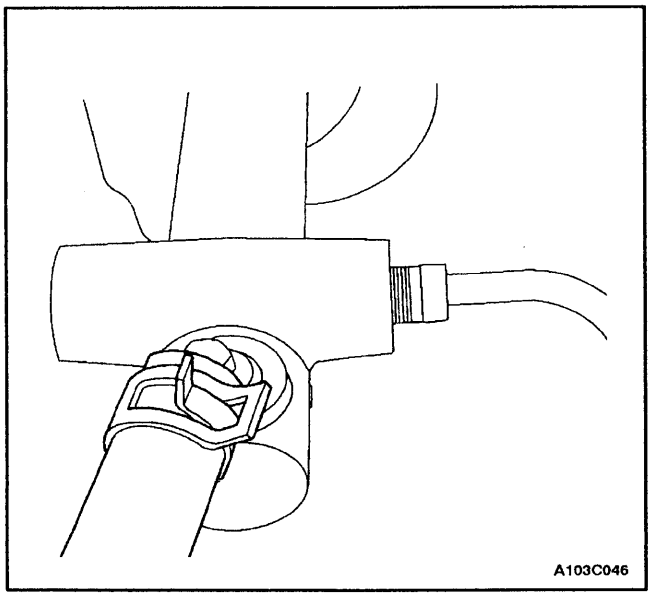
1. Apply the parking brake.
2. Run the engine at idle speed.
3. While you move the shift lever into the reverse position, press the clutch pedal slowly and measure the distance between the point when gear noise is not heard and the point the clutch pedal is completely depressed. The distance should be more than 30 mm (1.2 inches).
4. If the distance is not more than 30 mm (1.2 inches), check the following:
   - Clutch pedal height.
   - Clutch pedal play.
   - Air in the system.
   - Clutch cover and disk.



AIR BLEEDING

Bleed the hydraulic system to remove the air which entered when the pipes were disconnected for repairs. The clutch/brake fluid in the clutch/brake reservoir must be maintained at the MIN level or higher during air bleeding.

1. Attach a vinyl hose to the bleeder plug. Place the other end of the vinyl tube in a glass container half-filled with brake fluid.
2. Slowly pump the clutch pedal several times.
3. While you press the clutch pedal, loosen the bleeder screw until the fluid starts to run out. Close the bleeder screw.
4. Repeat Step 3 until there are no air bubbles in the fluid.
5. Fill the reservoir with brake fluid up to the MAX level.

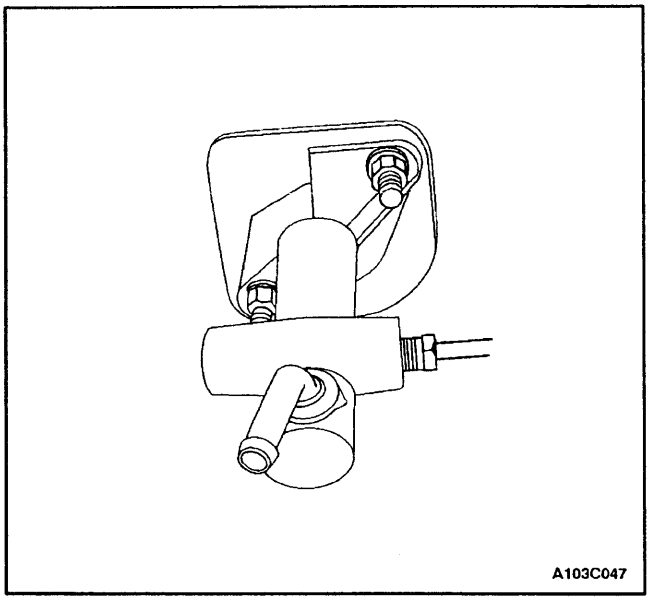


CLUTCH MASTER CYLINDER ASSEMBLY

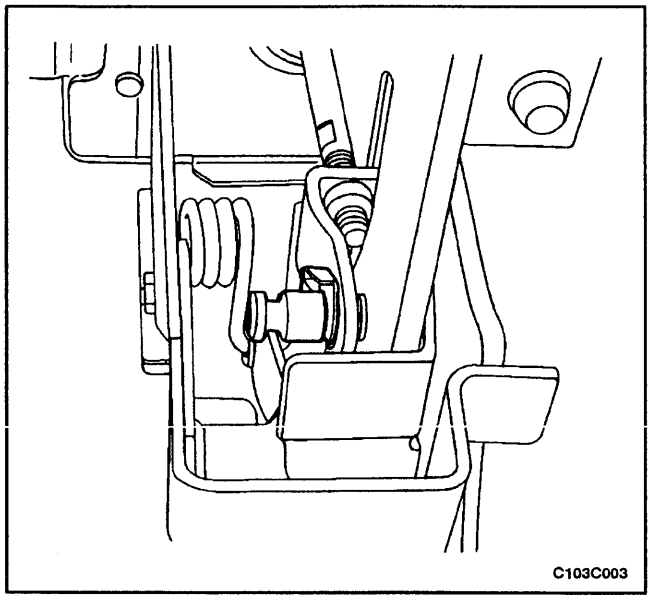
Removal Procedure

Before disconnecting the reservoir tank hose, remove the clutch/brake fluid from the reservoir tank.

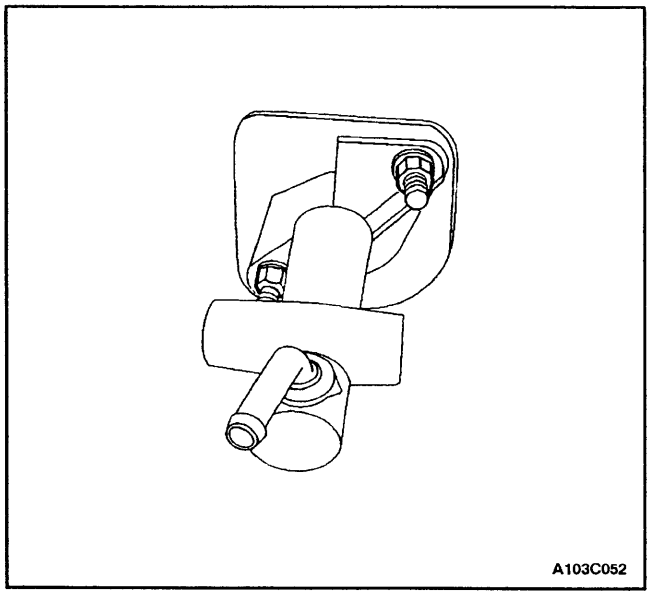
1. Disconnect the negative battery cable.
2. Disconnect the spring clamp on the master cylinder. Remove the reservoir hose.



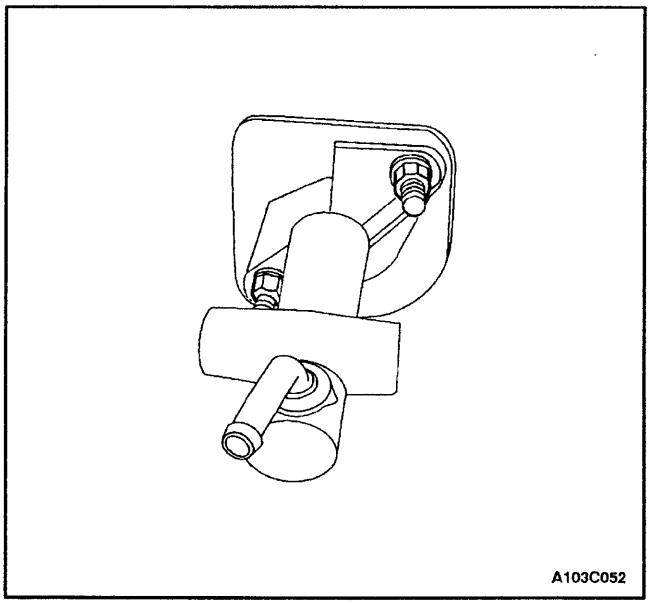
3. Disconnect the pipe connected to the master cylinder.



4. Remove the locking washer and the piston rod bolt from the clutch pedal and piston rod clevis.



5. Remove the locknuts on the master cylinder bracket. Remove the master cylinder in the direction of the engine compartment.

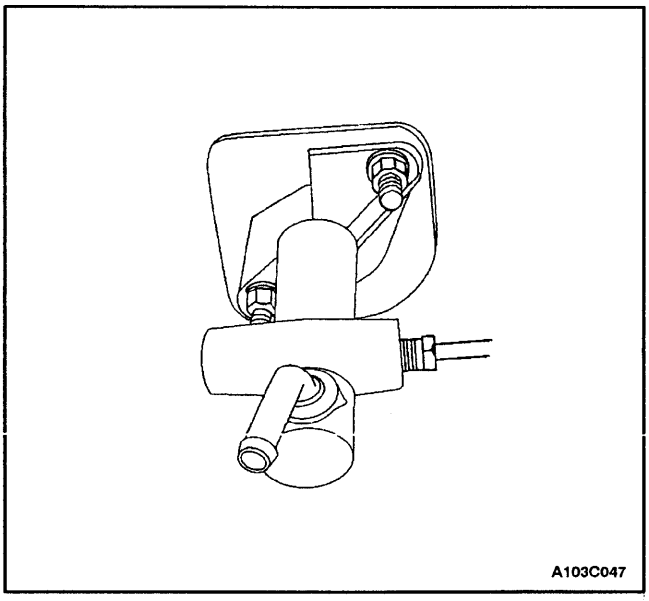


Installation Procedure

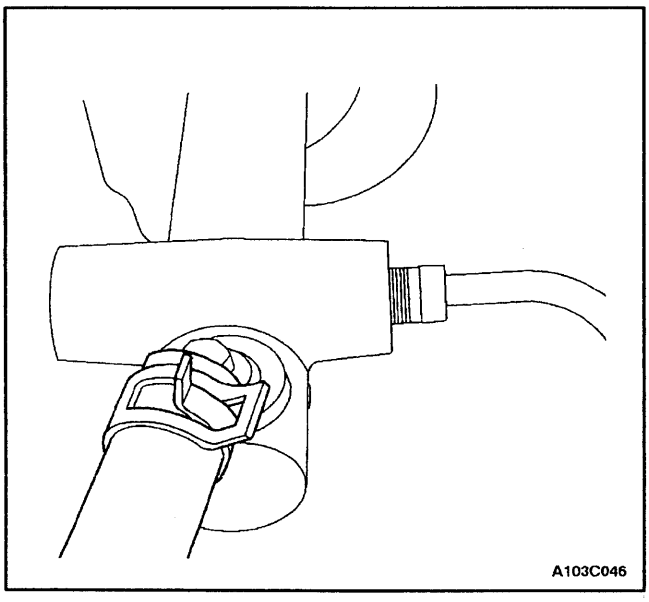
1. Install the master cylinder to the mounting bolts and install the locknuts.

Tighten

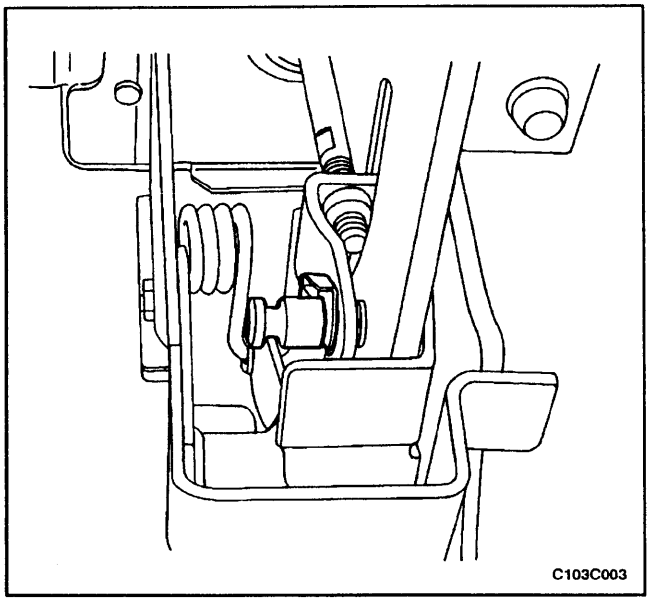
Tighten the clutch master cylinder locknuts to 22 N•m (18 lb-ft).



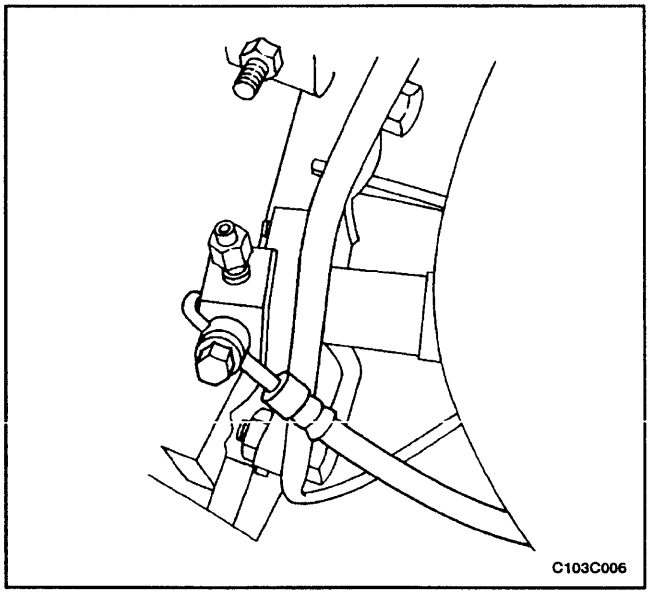
2. Connect the pipe to the master cylinder.



3. Connect the reservoir hose to the master cylinder and tighten the spring clamp.



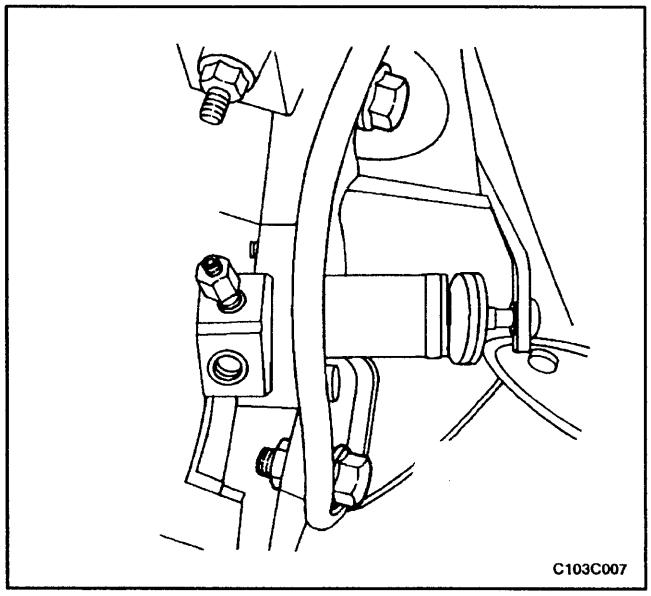
4. Coat the piston rod bolt with multi-purpose grease.
5. Install the piston rod clevis, the piston rod bolt, and the locking washer onto the clutch pedal.
6. Bleed the air. Refer to "Air Bleeding" in this section.
7. Adjust the clutch pedal. Refer to "Clutch Pedal Adjustment (Hydraulic)" in this section.
8. Fill the reservoir with clutch/brake fluid up to the MAX level.
9. Connect the negative battery cable.



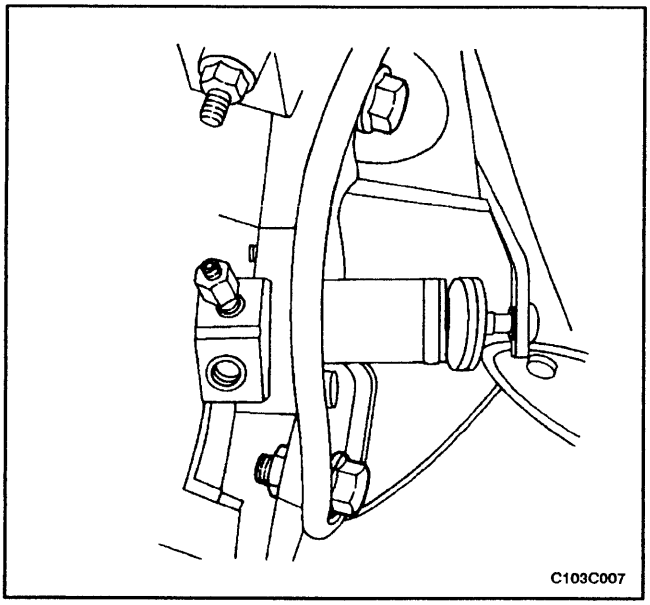
CLUTCH RELEASE CYLINDER ASSEMBLY

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the bolt and disconnect the hose from the clutch release cylinder.



3. Remove the clutch release cylinder bolts and remove the release cylinder from the transaxle.

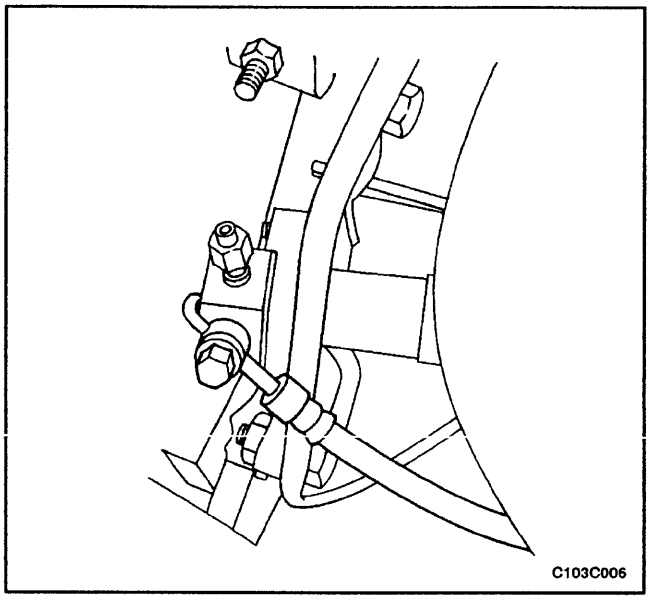


Installation Procedure

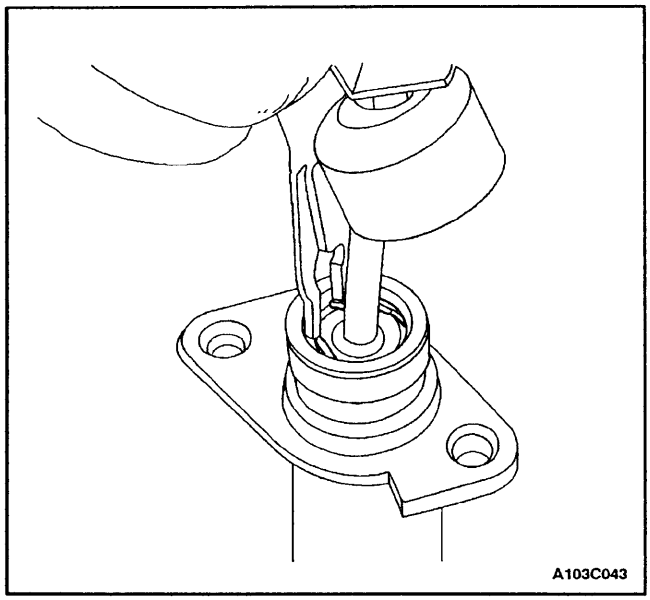
1. Connect the release cylinder to the transaxle and install the bolts.

Tighten

Tighten the release cylinder bolts to 60 N•m (44 lb-ft).



2. Connect the hose assembly to the cylinder body.
3. Apply grease where the pushrod connects to the release lever. Be careful not to stain the boot.
4. Bleed the air. Refer to "Air Bleeding" in this section.
5. Adjust the clutch pedal. Refer to "Clutch Pedal Adjustment (Hydraulic)" in this section.
6. Fill the reservoir with clutch/brake fluid up to the MAX level.
7. Connect the negative battery cable.

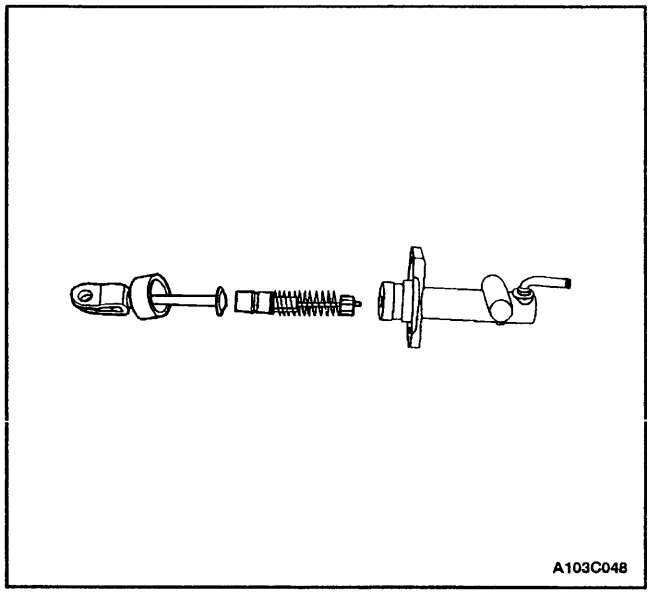

A103C043

UNIT REPAIR

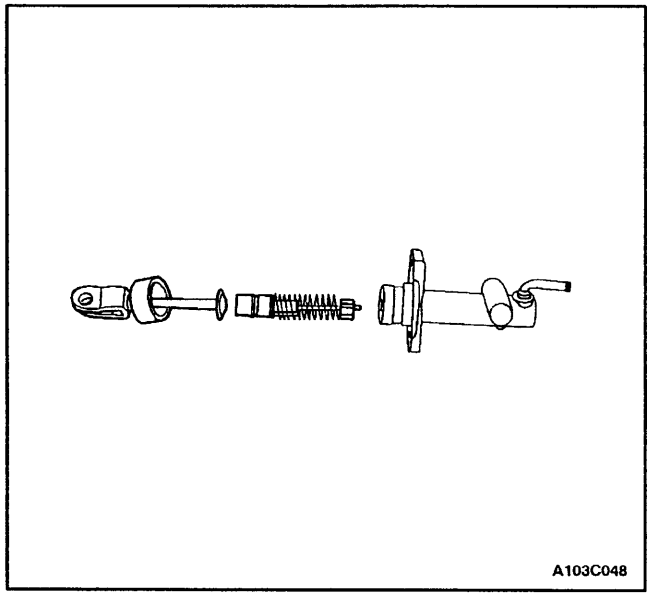
CLUTCH MASTER CYLINDER

Disassembly Procedure

1. Remove the clutch master cylinder assembly from the vehicle. Refer to "Clutch Master Cylinder Assembly" in this section.
2. Remove the boot and disconnect the piston stop ring using ring pliers.

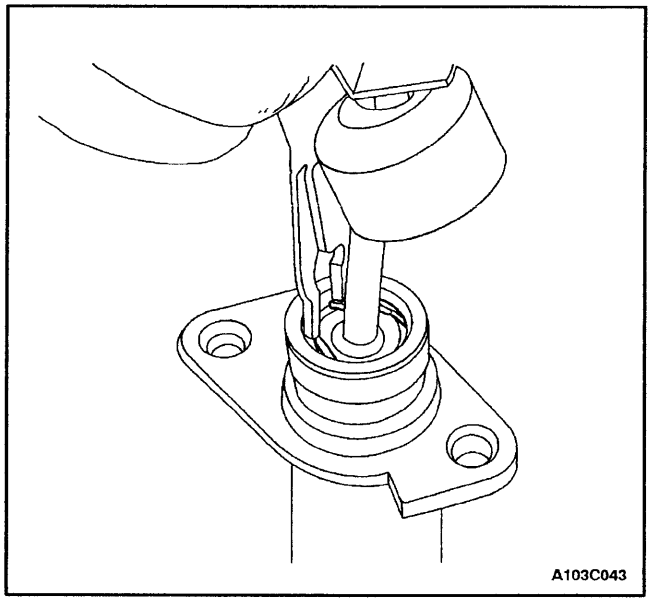

A103C048

3. Remove the pushrod assembly and the piston assembly.
4. Inspect the clutch master cylinder wall and the piston for wear. Replace the piston if necessary.
5. Inspect the cup and the piston for wear. Fluid leaks will show wear on the cup and the piston. Replace the cup and the piston if necessary.
6. Inspect the pushrod for wear. Repair the pushrod if necessary.

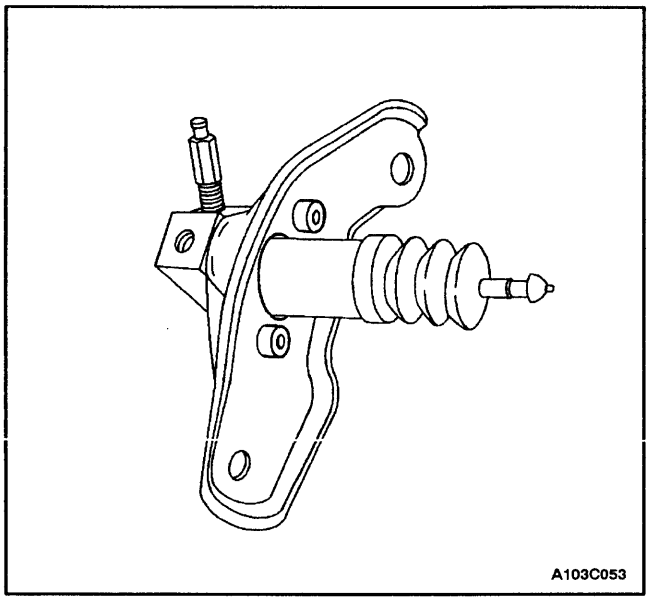

A103C048

Assembly Procedure

1. Apply clean fluid to the piston assembly cup and insert the piston assembly and the pushrod assembly into the master cylinder body.


A103C043

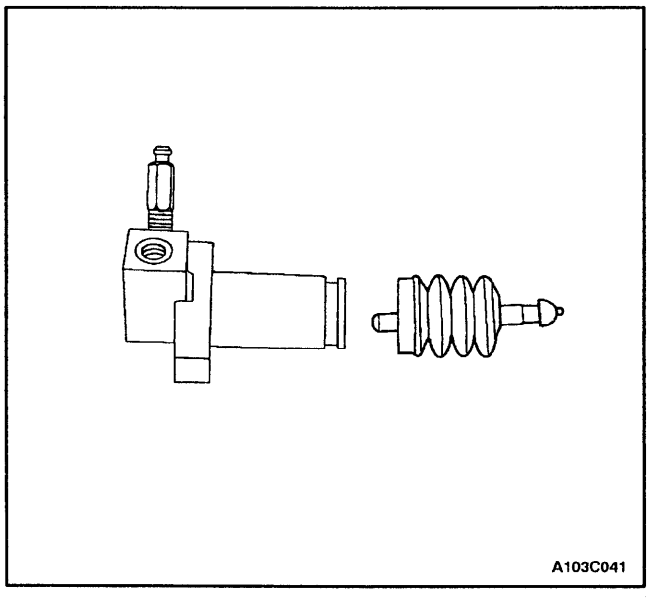
2. Install the piston stop ring using ring pliers. Install the boot.
3. Install the clutch master cylinder assembly into the vehicle. Refer to "Clutch Master Cylinder Assembly" in this section.


A103C053

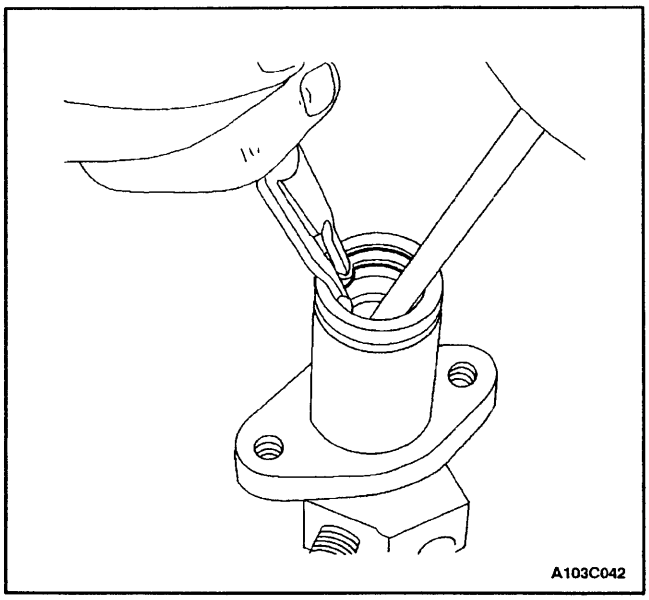
CLUTCH RELEASE CYLINDER

Disassembly Procedure

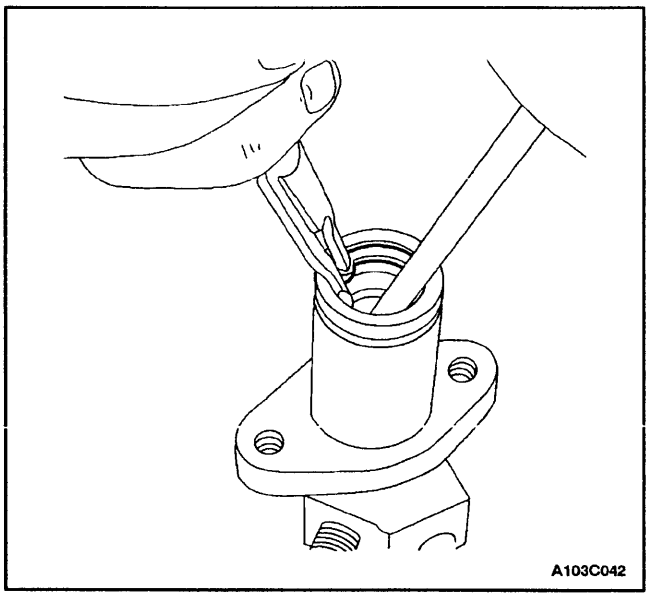
1. Remove the clutch release cylinder assembly from the vehicle. Refer to "Clutch Release Cylinder Assembly" in this section.
2. Remove the bolts and the bracket.


A103C041

3. Remove the boot and the pushrod.

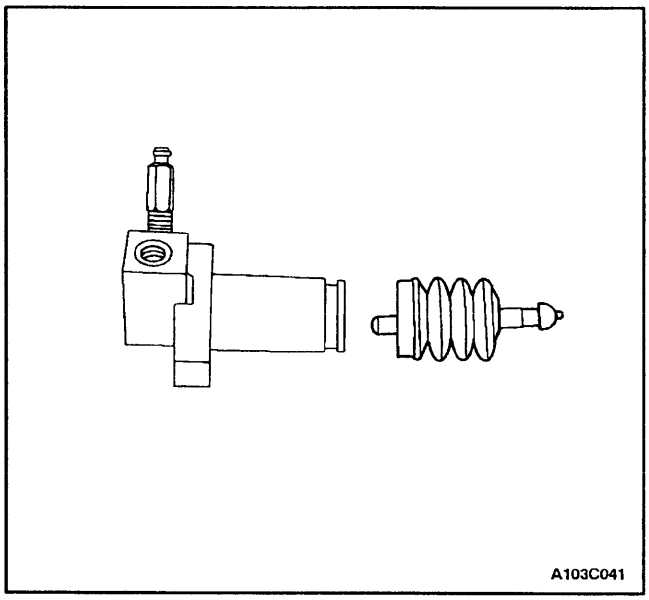


4. Compress the piston with a driver, then remove the snap ring with snap ring pliers.
5. Remove the piston assembly.

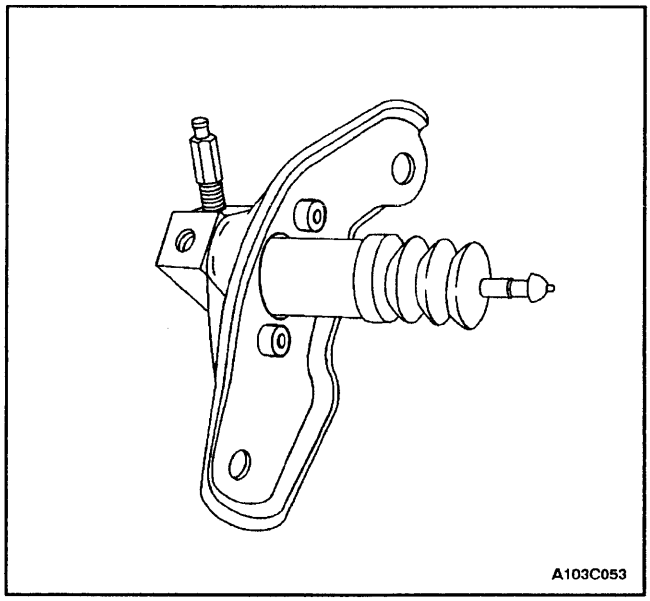


Assembly Procedure

1. Apply clean clutch fluid to the piston and the cup.
2. Install the spring to the piston, and insert the assembly into the cylinder body.
3. Compress the piston with a driver, then install the snap ring with snap ring pliers.



4. Install the push rod and the boot.



5. Install the bracket and the bolts.
6. Install the clutch release cylinder assembly. Refer to "Clutch Release Cylinder Assembly" in this section.

GENERAL DESCRIPTION AND SYSTEM OPERATION

DRIVING MEMBERS

The driving members consist of two flat surfaces machined to a smooth finish. One of these is the rear face of the engine flywheel, and the other is the pressure plate. The pressure plate is fitted into a steel cover, which is bolted to the flywheel.

DRIVEN MEMBERS

The driven member is the clutch disc with a splined hub which is free to slide lengthwise along the splines of the input shaft, but which drives the input shaft through these same splines.

The driving and driven members are held in contact by spring pressure. This pressure is exerted by a diaphragm spring in the pressure plate assembly.

OPERATING MEMBERS

The clutch release system consists of the clutch pedal, the clutch shaft, the fork, and the release bearing. When pressure is applied to the clutch pedal, the fork pivots on its shaft and the inner end pushes against the release bearing. The bearing then pushes against the release levers in the pressure plate assembly, thereby releasing the clutch.

SERVICE MANUAL (I)

LEGANZA

FOREWORD

This manual includes procedure for maintenance, adjustment, service operation and removal and installation of components.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of manual approval.

The right is reserved to make changes at any time without notice.

DAEWOO MOTOR CO., LTD.
INCHON, KOREA

SECTION INDEX

PERSONAL INJURY CAUTION

Appropriate service methods and proper repair procedures are essential for the safe, reliable operation of all motor vehicles, as well as for the personal safety of the person doing the repair. There are many variations in procedures, techniques, tools and parts for servicing vehicles, as well as in the skills of the people doing the work. This manual cannot possibly anticipate all such variations and provide advice or precautions for each. Anyone who deviates from the instructions provided in this manual must ensure their own safety and preserve the safety and integrity of the vehicle. The following list contains general precautions that should always be followed while working on a vehicle.

- *Safety stands are required whenever a procedure calls for underbody work.*
- *Do not smoke when you work on a vehicle.*
- *To prevent serious burns, do not touch any hot metal parts.*
- *Set the parking brake when you work on the vehicle.*
- *Turn the ignition switch OFF unless a procedure states otherwise.*
- *The engine may operate only in a well-ventilated area.*
- *Avoid moving parts when the engine is running.*
- *Safety glasses must be worn for eye protection.*

1997 Daewoo LEGANZA BL2 Service Manual

FOREWORD

This manual includes procedures for maintenance, adjustment, service operations, and removal and installation of components for the LEGANZA BL2 vehicle.

When reference is made in this manual to a brand name, number, or specific tool, an equivalent product may be used in place of the recommended item.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

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Overseas Technical Service Department
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Inchon, Korea

SECTION 0B
GENERAL INFORMATION
TABLE OF CONTENTS

SPECIFICATIONS
TECHNICAL DATA

Performance - Manual Transaxle

Application	2.0L DOHC
Maximum Speed	206km/h (128.0 mph)
Gradeability	0.570 (tan ∅)
Minimum Turning Radius	5.5 m (18.0 ft)

Performance - Automatic Transaxle

Application	2.0L SOHC
Maximum Speed	192 km/h (119.3 mph)
Gradeability	0.650 (tan ∅)
Minimum Turning Radius	5.5 m (18.0 ft)

Engine

Application	2.0L DOHC
Engine Type	Dual Overhead Cam L-4
Bore	86 mm (3.4 in)
Stroke	86 mm (3.4 in)
Total Displacement	1 998 cm^3 (121.9 in^3)
Compression Ratio	9.6:1
Maximum Power	98 kw (131 hp) (at 5,400 rpm)
Maximum Torque	18.8 Kg•m (136 lb-ft) (at 4,600 rpm)

Ignition System

Application	2.0L DOHC
Ignition Type	Direct Ignition System
Ignition Timing	5° BTDC
Ignition Sequence	1-3-4-2
Spark Plug Gap	0.8 mm (0.03 in)
Spark Plug Maker	Bosch
Spark Plug Type	FR8LDC4

Clutch - Manual Transaxle

Application	2.0L DOHC
Type	Single Dry Plate
Outside Diameter	225 mm (8.9 in)
Inside Diameter	150 mm (5.9 in)
Thickness	4 mm (0.16 in)
Fluid Capacity	Common Use; Brake Fluid

Manual Transaxle

Application	2.0L DOHC
Maker	DWMC
Type or Model	D-20
Gear Ratio: 1st	3.545:1
2nd	2.158:1
3rd	1.478:1
4th	1.129:1
5th	0.886:1
Reverse	3.333:1
Final Drive Ratio	3.722:1 (*3.550)
Oil Capacity	1.8L (1.90 qt)

*** France only**

Automatic Transaxle

Application	2.0L DOHC
Maker	ZF
Type or Model	4HP14
Gear Ratio: 1st	2.412:1
2nd	1.369:1
3rd	1.000:1
4th	0.739:1
Reverse	2.828:1
Final Drive Ratio	3.979:1
Oil Capacity	5.35L (5.65 qt)

Brake

Application	2.0L DOHC
Booster Size: Booster 1	7 in. (177.8 mm)
Booster 2	8 in. (203.2 mm)
Master Cylinder Diameter	23.8 mm (0.94 in)
Booster Ratio	5.0:1
Front Brake: Disc Type	Ventilated
Rear Brake: Disc Type	Solid
Fluid Capacity	0.5L (0.527 qt)

Tire and Wheel

Application	2.0L DOHC
Standard Tire Size	205/60R15
Standard Wheel Size	6.0JX15
Inflation Pressure at Full Load: 205/60R15: Front	29
Rear	29

Steering System

Application	2.0L DOHC
Gear Type	Power Rack and Pinion
Wheel Alignment: Front: Total Toe-In (2 Occupants)	- 0.2 ± 0.2° (- 2 ± 2 mm) (0.08 ± 0.08 in)
Caster	3 ± 1°
Camber	- 0.2 ± 1°
Rear: Total Toe-In (2 occupants)	0.1 ± 0.1° (1 ± 1 mm) (0.04 ± 0.04 in)
Camber	- 0.8 ± 1°
Oil Capacity	1.0L (1.06 qt)

Suspension

Application	2.0L DOHC
Front Type	MacPherson Strut
Rear Type	Dual Link Strut

Fuel System

Application	2.0L DOHC
Fuel Delivery	MPI
Fuel Pump Type	Electric Motor Pump
Fuel Filter Type	Cartridge
Fuel Capacity	65L (17.2 gal)

Lubricating System

Application	2.0L DOHC
Lubricating Type	Forced Feed
Oil Pump Type	Duocentric Rotor
Oil Filter Type	Cartridge (Full Flow)
Oil Pan Capacity Including Oil Filter	4.0L (4.22 qt)

Electric System

Application	2.0L DOHC
Battery	610 Cold Cranking Amps
Alternator	95 amps
Starter (No-Load Test Current Draw): 1.4 kW	Minimum 80 Amps Maximum 120 Amps (at 10 Volts)

Cooling System

Application	2.0L DOHC
Cooling Type	Forced Water Circulation
Radiator Type	Cross-flow
Water Pump Type	Centrifugal
Thermostat Type	Pellet Type
Coolant Capacity	7.0L (7.25 qt)

VEHICLE DIMENSIONS AND WEIGHTS

Vehicle Dimensions - Manual and Automatic

Application	2.0L DOHC
Overall Length	4 671 mm (183.9 in)
Overall Width	1 779 mm (70.0 in)
Overall Height	1 437 mm (56.6 in)
Minimum Ground Clearance	167 mm (6.6 in)
Wheel Base	2 670 mm (105.1 in)
Tread: Front	1 515 mm (59.6 in)
Rear (Disc)	1 507 mm (59.3 in)

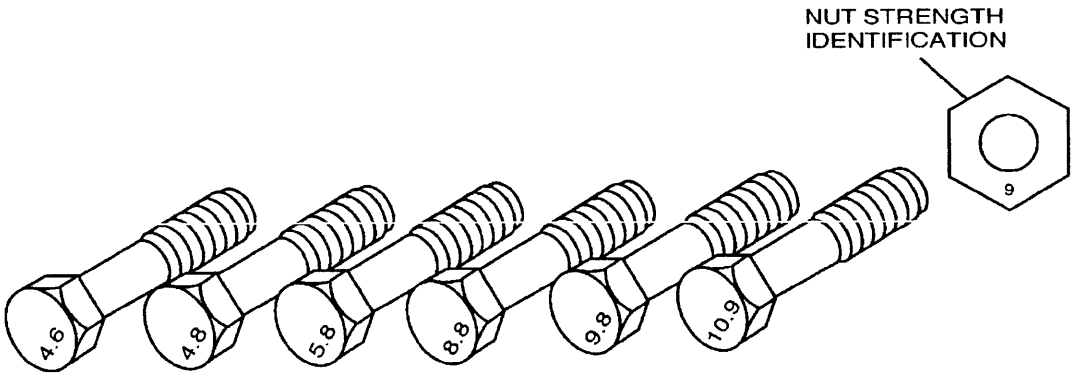
Vehicle Weights - 4 Door Notchback

Application	2.0L DOHC
Manual: Curb Weight	1,325-1,365kg (2,920-3,010 lb)
Gross Vehicle Weight	1,830 kg (4,034 lb)
Automatic: Curb Weight	1,336-1,376 kg (2,884-3,034 lb)
Gross Vehicle Weight	1,830 kg (4,034 lb)
Passenger Capacity	5

STANDARD BOLT SPECIFICATIONS

Bolt*	4T - Low Carbon Steel	7T - High Carbon Steel	7T - Alloy Steel
M6 X 1.0	4.1-8.1 N•m (36-72 lb-in)	4.1-9.5 N•m (48-84 lb-in)	-
M8 X 1.25	8.1-17.6 N•m (72-156 lb-in)	12.2-23.0 N•m (108-204 lb-in)	16-30 N•m (12-22 lb-ft)
M10 X 1.25	20-34 N•m (15-25 lb-ft)	27-46 N•m (20-34 lb-ft)	37-62 N•m (27-46 lb-ft)
M10 X 1.5	19-34 N•m (14-25 lb-ft)	27-45 N•m (20-33 lb-ft)	37-60 N•m (27-44 lb-ft)
M12 X 1.25	49-73 N•m (36-54 lb-ft)	61-91 N•m (45-67 lb-ft)	76-114 N•m (56-84 lb-ft)
M12 X 1.75	45-69 N•m (33-51 lb-ft)	57-84 N•m (42-62 lb-ft)	72-107 N•m (53-79 lb-ft)
M14 X 1.5	76-115 N•m (56-85 lb-ft)	94-140 N•m (69-103 lb-ft)	114-171 N•m (84-126 lb-ft)
M14 X 2.0	72-107 N•m (53-79 lb-ft)	88-132 N•m (65-97 lb-ft)	107-160 N•m (79-118 lb-ft)
M16 X 1.5	104-157 N•m (77-116 lb-ft)	136-203 N•m (100-150 lb-ft)	160-240 N•m (118-177 lb-ft)
M16 X 2.0	100-149 N•m (74-110 lb-ft)	129-194 N•m (95-143 lb-ft)	153-229 N•m (113-169 lb-ft)
M18 X 1.5	151-225 N•m (111-166 lb-ft)	195-293 N•m (144-216 lb-ft)	229-346 N•m (169-255 lb-ft)
M20 X 1.5	206-311 N•m (152-229 lb-ft)	270-405 N•m (199-299 lb-ft)	317-476 N•m (234-351 lb-ft)
M22 X 1.5	251-414 N•m (185-305 lb-ft)	363-544 N•m (268-401 lb-ft)	424-636 N•m (313-469 lb-ft)
M24 X 2.0	359-540 N•m (265-398 lb-ft)	431-710 N•m (318-524 lb-ft)	555-831 N•m (409-613 lb-ft)

* Diameter X pitch in millimeters



METRIC BOLTS - IDENTIFICATION CLASS NUMBERS CORRESPOND TO BOLT STRENGTH - INCREASING NUMBERS REPRESENT INCREASING STRENGTH.

A1010010

MAINTENANCE AND REPAIR

MAINTENANCE AND LUBRICATION

NORMAL VEHICLE USE

The maintenance instructions contained in the maintenance schedule are based on the assumption that the vehicle will be used for the following reasons:

- To carry passengers and cargo within the limitation indicated on the Tire Placard located on the edge of the driver's door.
- To be driven on reasonable road surfaces and within legal operating limits.

EXPLANATION OF SCHEDULED MAINTENANCE SERVICES

The services listed in the maintenance schedule are further explained below. When the following maintenance services are performed, make sure all the parts are replaced and all the necessary repairs are done before driving the vehicle. Always use the proper fluid and lubricants.

Drive Belt Inspection

When a separate belt drives the power steering pump, the air conditioning compressor and the generator, inspect it for cracks, fraying, wear, and proper tension. Adjust or replace the belt as needed.

Engine Oil and Oil Filter Change

Always use above the SH grade engine oil. The SH designation may be shown alone or in combination with other designations such as SH/CC, SH/CD, etc.

Engine Oil Viscosity

Engine oil viscosity (thickness) has an effect on fuel economy and cold weather operation. Lower viscosity engine oils can provide better fuel economy and cold weather performance; however, higher temperature weather conditions require higher viscosity engine oils for satisfactory lubrication. Using oils of any viscosity other than those viscosities recommended could result in engine damage.

Cooling System Service

Drain, flush and refill the system with new coolant. Refer to "Recommended Fluids and Lubricants" in this section.

Fuel Micro-Filter Replacement

Replace the engine fuel filter every 45 000 km (25,000 miles).

The engine fuel filter is located on the center dash panel near the brake booster.

Air Cleaner Element Replacement

Replace the air cleaner element every 30 000 km (18,000 miles).

Replace the air cleaner more often under dusty conditions.

Throttle Body Mounting Bolt Torque

Check the torque of the throttle body mounting bolts.

Tighten the throttle body mounting nuts to 9 N•m (80 lb-in) (DOHC), if necessary.

Spark Plug Replacement

Replace spark plugs with the same type.

- Type: Bosch Type FR8LDC4 (DOHC)
- Gap: 0.8 mm (0.03 in) (DOHC)

Spark Plug Wire Replacement

Clean the wires and inspect them for burns, cracks, or other damage. Check the wire boot fit at the direct ignition system (DIS) module and at the spark plugs. Replace the wires as needed.

Brake System Service

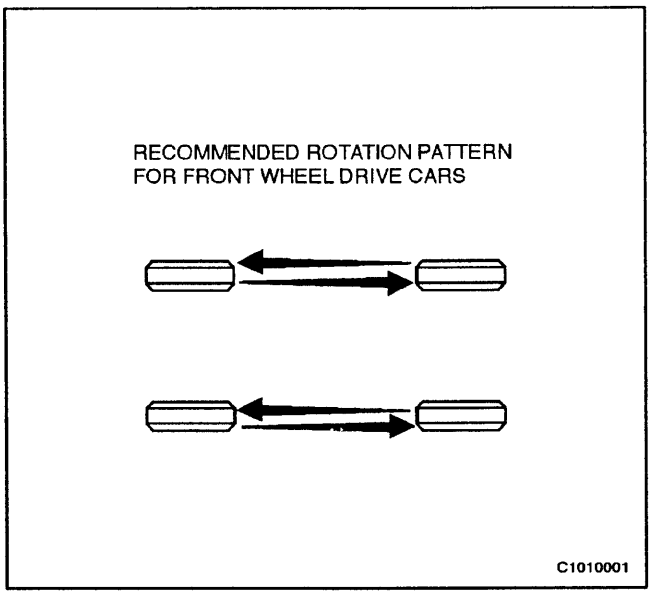
Check the disc brake pads every 10 000 km (6,000 miles) or 12 months. Check the pad and the lining thickness carefully. If the pads or the linings are not expected to last another 10 000 km (6,000 miles), replace the pads or the linings. Check the breather hole in the brake fluid reservoir cap to be sure it is free from dirt and the passage is open.

Transaxle Service

The manual transaxle oil does not require changing. The automatic transaxle fluid should be changed every 30 000 km (19,000 miles).

Tire and Wheel Inspection and Rotation

Check the tires for abnormal wear or damage. To equalize wear and obtain maximum tire life, rotate the tires. If irregular or premature wear exists, check the wheel alignment and check for damaged wheels. While the tires and wheels are removed, inspect the brakes. Refer to "Each Time The Oil Is Changed" in this section.



SCHEDULED MAINTENANCE CHARTS

Engine

Maintenance Item	Maintenance Interval								
	Kilometers (miles) or time in months, whichever comes first								
Kilometers x 1 000	1	15	30	45	60	75	90	105	120
Miles x 1 000	.6	9	18	27	36	45	54	63	72
Months	-	12	24	36	48	60	72	84	96
Drive belts (alternator, power steering)									
DOHC					I				I
Engine oil and oil filter[1, 3]	I	R	R	R	R	R	R	R	R
Cooling system and hose connection		I	I	I	I	I	I	I	I
Engine coolant[3]	I	I	I	R	I	I	R	I	I
Fuel filter				R			R		
Fuel line and connections		I	I	I	I	I	I	I	I
Air cleaner element[2]		I	I	R	I	I	R	I	I
Ignition timing		I	I	I	I	I	I	I	I
Spark plugs			I		R		I		R
DIS Module			I		I		I		I
Charcoal canister and vapor lines				I			I		
PCV System			I		I		I		I
Timing belt (camshaft belt)					I		R		I
Air condition filter*		R	R	R	R	R	R	R	R

Chart Symbols:

I - Inspect, and if necessary correct, clean, replenish or adjust.

R - Replace or change:

[1] If the vehicle is operated under severe conditions: short distance driving, extensive idling or driving in dusty conditions, change the engine oil every 7 500 km (5,000 miles) or six months, whichever comes first.

[2] More frequently if driving in dusty conditions.

[3] Refer to "Recommended Fluids and Lubricants."

Chassis and Body

Maintenance Item	Maintenance Interval								
	Kilometers (miles) or time in months, whichever comes first								
Kilometers x 1 000	1	15	30	45	60	75	90	105	120
Miles x 1 000	.6	9	18	27	36	48	54	63	72
Months	-	12	24	36	48	60	72	84	96
Brake and clutch fluid[1, 4]	I	I	R	I	R	I	R	I	R
Brake pads and discs[3]		I	I	I	I	I	I	I	I
Parking brake		I	I	I	I	I	I	I	I
Brake line and connections (including booster)		I	I	I	I	I	I	I	I
Rear hub bearing and clearance		I	I	I	I	I	I	I	I
Manual transaxle oil[1]		I	I	I	I	I	I	I	I
Clutch and brake pedal free play		I	I	I	I	I	I	I	I
Automatic transaxle fluid[1]	I	I	R	I	R	I	R	I	R
Tighten chassis and underbody bolts and nuts		I	I	I	I	I	I	I	I
Tire condition and inflation pressure	I	I	I	I	I	I	I	I	I
Wheel alignment[2]	Inspect when abnormal condition is noted								
Steering wheel and linkage		I	I	I	I	I	I	I	I
Power steering fluid and lines[1]	I	I	I	I	I	I	I	I	I
Drive shaft boots		I	I	I	I	I	I	I	I
Seat belts, buckles and anchors		I	I	I	I	I	I	I	I
Lubricate locks, hinges and hood latch		I	I	I	I	I	I	I	I

Chart Symbols:

I - Inspect, and if necessary correct, clean, replenish or adjust.

R - Replace or change:

[1] Refer to "Recommended Fluids And Lubricants."

[2] And if necessary, rotate and balance wheels.

[3] More frequently if operated under severe conditions: short distance driving, extensive idling, frequent low-speed operation in stop and go traffic, or driving in dusty conditions.

[4] Change the brake/clutch fluid every 15 000 km (9,000 miles) if the vehicle is mainly driven under severe conditions:
- driving in hilly or mountainous terrain, or
- towing a trailer/caravan frequently.

OWNER INSPECTIONS AND SERVICES

WHILE OPERATING THE VEHICLE

Horn Operation

Blow the horn occasionally to make sure it works. Check all the button locations.

Brake System Operation

Be alert for abnormal sounds, increased brake pedal travel, or repeated pulling to one side when braking. Also, if the brake warning light goes on or flashes, something may be wrong with part of the brake system.

Exhaust System Operation

Be alert to any changes in the sound of the system or the smell of the fumes. These are signs that the system may be leaking or overheating. Have the system inspected and repaired immediately.

Tires, Wheels and Alignment Operation

Be alert to any vibration of the steering wheel or the seats at normal highway speeds. This may mean a wheel needs to be balanced. Also, a pull right or left on a straight, level road may show the need for a tire pressure adjustment or a wheel alignment.

Steering System Operation

Be alert to changes in the steering action. An inspection is needed when the steering wheel is hard to turn or has too much free play, or if unusual sounds are noticed when turning or parking.

Headlamp Aim

Take note of the light pattern occasionally. Adjust the headlamps if the beams seem improperly aimed.

AT EACH FUEL FILL

A fluid loss in any (except windshield washer) system may indicate a problem. Have the system inspected and repaired immediately.

Engine Oil Level

Check the oil level and add oil if necessary. The best time to check the engine oil level is when the oil is warm.

1. After stopping the engine, wait a few minutes for the oil to drain back to the oil pan.
2. Pull out the oil level indicator (dipstick).
3. Wipe it clean, and push the oil level indicator back down all the way.
4. Pull out the oil level indicator and look at the oil level on it.
5. Add oil, if needed, to keep the oil level above the MIN line and within the area labeled "Operating Range." Avoid overfilling the engine, since this may cause engine damage.

6. Push the indicator all the way back down into the engine after taking the reading.

If you check the oil level when the oil is cold, do not run the engine first. The cold oil will not drain back to the pan fast enough to give a true oil level reading.

Engine Coolant Level and Condition

Check the coolant level in the coolant reservoir tank and add coolant if necessary. Inspect the coolant. Replace dirty or rusty coolant.

Windshield Washer Fluid Level

Check the washer fluid level in the reservoir. Add fluid if necessary.

AT LEAST MONTHLY

Tire and Wheel Inspection and Pressure Check

Check the tires for abnormal wear or damage. Also check for damaged wheels. Check the tire pressure when the tires are cold (check the spare also, unless it is a stowaway). Maintain the recommended pressures that are on the tire placard that is on the driver's door.

Lamp Operation

Check the operation of the license plate lamp, the headlamps (including the high beams), the parking lamps, the fog lamps, the taillamp, the brake lamps, the turn signals, the backup lamps, and the hazard warning flasher.

Fluid Leak Check

Periodically inspect the surface beneath the vehicle for water, oil, fuel or other fluids, after the vehicle has been parked for a while. Water dripping from the air conditioning system after use is normal. If you notice fuel leaks or fumes, find the cause and correct it at once.

AT LEAST TWICE A YEAR

Power Steering System Reservoir Level

Check the power steering fluid level. Keep the power steering fluid at the proper level. Refer to *Section 6A, Power Steering System*.

Brake Master Cylinder Reservoir Level

Check the fluid and keep it at the proper level. Refer to *Section 4B, Master Cylinder*. A low fluid level can indicate worn disc brake pads may need to be serviced. Check the breather hole in the reservoir cover to be free from dirt and check for an open passage.

Clutch Pedal Free Travel

Check clutch pedal free travel and adjust as necessary every 15 000 km (9,000 miles). Measure the distance from the center of the clutch pedal to the outer edge of the steering wheel with the clutch pedal not depressed. Then measure the distance from the center of the clutch pedal to the outer edge of the steering wheel with the clutch pedal fully depressed. The difference between the two values must be greater than 140 mm (5.5 in).

Weatherstrip Lubrication

Apply a thin film of silicone grease using a clean cloth.

EACH TIME THE OIL IS CHANGED

Automatic Transaxle Fluid

Refer to *Section 5A, ZF 4HP14 Automatic Transaxle.*

Manual Transaxle

Check the oil level and add oil as required. Refer to *Section 5B, Five-Speed Manual Transaxle.*

Brake System Inspection

This inspection should be done when the wheels are removed for rotation. Inspect the lines and the hoses for proper hookup, binding, leaks, cracks, chafing, etc. Inspect the disc brake pads for wear. Inspect the rotors for surface condition. Inspect other brake parts, including the parking brake, etc., at the same time. Check the parking brake adjustment. Inspect the brakes more often if habit or conditions result in frequent braking.

Steering, Suspension and Front Drive Axle Boot and Seal Inspection

Inspect the front and rear suspension and the steering system for damaged, loose, or missing parts; signs of wear; or lack of lubrication. Inspect the power steering lines and the hoses for proper hookup, binding, leaks, cracks and chafing, etc. Clean and inspect the drive axle boot and seals for damage, tears, or leakage. Replace the seals if necessary.

Exhaust System Inspection

Inspect the complete system (including the catalytic converter, if equipped). Inspect the body near the exhaust system. Look for broken, damaged, missing, or out-of-position parts, as well as open seams, holes, loose connections, or other conditions which could cause heat buildup in the floor pan or could let exhaust fumes seep into the trunk or passenger compartment.

Throttle Linkage Inspection

Inspect the throttle linkage for interference or binding, damaged, or missing parts. Lubricate all linkage joints and throttle cable joints, the intermediate throttle shaft bearing, the return spring at throttle valve assembly, and the accelerator pedal sliding face with suitable grease. Check the throttle cable for free movement.

Engine Drive Belts

Inspect all belts for cracks, fraying, wear, and proper tension. Adjust or replace the belts as needed.

Hood Latch Operation

When opening the hood, note the operation of the secondary latch. It should keep the hood from opening all the way when the primary latch is released. The hood must close firmly.

AT LEAST ANNUALLY

Lap and Shoulder Belt Condition and Operation

Inspect the belt system, including the webbing, the buckles, the latch plates, the retractor, the guide loops and the anchors.

Movable Head Restraint Operation

On vehicles with movable head restraints, the restraints must stay in the desired position.

Spare Tire and Jack Storage

Be alert to rattles in the rear of the vehicle. The spare tire, all the jacking equipment, and the tools must be securely stowed at all times. Oil the jack ratchet or the screw mechanism after each use.

Key Lock Service

Lubricate the key lock cylinder.

Body Lubrication Service

Lubricate all the body door hinges including the hood, the fuel door, the rear compartment hinges and the latches, the glove box and the console doors, and any folding seat hardware.

Transaxle Neutral Switch Operation on Automatic Transaxle

Caution: Take the following precautions because the vehicle could move without warning and possibly cause personal injury or property damage:

- ***Firmly apply the parking brake and the regular brakes.***
- ***Do not use the accelerator pedal.***
- ***Be ready to promptly turn off the ignition if the vehicle starts.***

On automatic transaxle vehicles, try to start the engine in each gear. The starter should crank only in P (PARK) and in N (NEUTRAL).

Parking Brake and Transaxle P (PARK) Mechanism Operation

Caution: In order to reduce the risk of personal injury or property damage, be prepared to apply the regular brakes promptly if the vehicle begins to move.

Park on a fairly steep hill with enough room for movement in the downhill direction. To check the parking brake, with the engine running and the transaxle in N (NEUTRAL), slowly remove foot pressure from the regular brake pedal (until only the parking brake is holding the vehicle).

To check the automatic transaxle P (PARK) mechanism's holding ability, release all brakes after shifting the transaxle to P (PARK).

Underbody Flushing

Flushing the underbody will remove any corrosive materials used for ice and snow removal and dust control. At least every spring, clean the underbody. First, loosen the sediment packed in closed areas of the vehicle. Then flush the underbody with plain water.

Engine Cooling System

Inspect the coolant and freeze protection fluid. If the fluid is dirty or rusty, drain, flush and refill the engine cooling system with new coolant. Keep the coolant at the proper mixture in order to ensure proper freeze protection, corrosion protection and engine operating temperature. Inspect the hoses. Replace the cracked, swollen, or deteriorated hoses. Tighten the clamps. Clean the outside of the radiator and the air conditioning condenser. Wash the filler cap and the neck. Pressure test the cooling system and the cap in order to help ensure proper operation.

RECOMMENDED FLUIDS AND LUBRICANTS

USAGE	CAPACITY	FLUID/LUBRICANT
Engine Oil	4L (4.23 qt)	SOHC - SAE 10W/30, API SH DOHC - SAE 5W/30, API SH
Engine Coolant	7.0L (7.40 qt)	Mixture of water and good quality silicate-base antifreeze (year-round coolant)
Brake and Clutch Fluid	0.5L (0.527 qt)	SSK-221 (DOT-3 Fluid)
Power Steering System Fluid	1.0L (1.06 qt)	DEXRON®-II or III
Automatic Transaxle Fluid	5.4L (5.70qt)	Refer to "Recommended Automatic Transaxle Fluids"
Manual Transaxle Fluid	1.8L (1.90 qt)	CASTROL 80W
Manual Transaxle Shift Linkage	As needed	Grease (M-8122)
Key Lock Cylinders	As needed	Grease (M-8104)
Automatic Transaxle Shift Linkage	As needed	Grease
Clutch Linkage Pivot Points	As needed	Grease
Floor Shift Linkage Points	As needed	Grease
Hood Latch Assembly 1. Pivots and Spring Anchor	As needed	Grease (M-8105)
Hood and door hinges Fuel door hinge Rear compartment lid hinges	As needed	Spray Grease (M-8149) Oil (M-8030)
Weatherstrips	As needed	Wetting Agent (M-8128)

RECOMMENDED AUTOMATIC TRANSAXLE FLUIDS

Manufacturer	Trade name
ADDINOL MINERALÖL GMBH, KRUMPA/D	ADDINOL ATF D III
AGIP PETROLI SPA, ROM/I	AGIP ATF II D
AGIP PETROLI SPA, ROM/I	AGIP DEXRON III
AGIP PETROLI SPA, ROM/I	AGIP ATF D 309
AGIP SCHMIERTECHNIK, WÜRZBURG/D	AUTOL GETRIEBEÖL ATF III D
AGIP SCHMIERTECHNIK, WÜRZBURG/D	AUTOL GETRIEBEÖL ATF-D
ARAL AG, BOCHUM/D	ARAL GETR ÖL ATF 55 F-30589
ARAL AG, BOCHUM/D	ARAL GETRIEBEÖL ATF 22
AVIA MINERALÖL-AG, MÜNCHEN/D	AVIA FLUID ATF 86
BLASER SWISSLUBE, HASLE-RÜEGSAU/CH	BLASOL 229
BP OIL DEUTSCHLAND, HAMBURG/D	FRONTOL UNIVERSAL-ATF 100
BP OIL INTERNATIONAL, LONDON/GB	AUTRAN MBX
BUCHER+CIE AG, LANGENTHAL/CH	MOTOREX ATF SUPER D-22656
BUCHER+CIE AG, LANGENTHAL/CH	MOTOREX ATF DEXRON III MC
C.J.DIEDERICHS SÖHNE, WUPPERTAL/D	CIDISOL-HYDR.-FLUID DEXRON II D
CALPAM GMBH, ASCHAFFENBURG/D	PAMATIC FLUID 289
CALPAM GMBH, ASCHAFFENBURG/D	CALPAMATIC FLUID III F
CALTEX PETROLEUM CORP., LONDON/GB	CALTEX ATF-HDA
CASTROL LTD. SWINDON/GB	CASTROL TQ-D (22765)
CASTROL LTD. SWINDON/GB	CASTROL TRANSMAX Z
CASTROL LTD. SWINDON/GB	CASTROL TQ-D (21289)
CASTROL LTD. SWINDON/GB	CASTROL ATF 21293
CASTROL LTD. SWINDON/GB	CASTROL TQ DEXRON III F-30520
CEPSA, MADRID/E	CEPSA ATF-70
DE OLIEBRON B.V., ZWIJNDRECHT/NL	ATF DMM
DE OLIEBRON B.V., ZWIJNDRECHT/NL	ATF 289
DEA MINERALÖL AG, HAMBURG/D	DEAFLUID 3003
DEA MINERALÖL AG, HAMBURG/D	DEAFLUID 4011
DEA MINERALÖL AG, HAMBURG/D	DEAMATIC
DEUTSCHE SHELL AG, HAMBURG/D	MAC ATF D-21666
DUCKHAMS OIL, BROMLEY/GB	UNIMATIC
ELF LUBRIFIANTS, PARIS/F	TRANSANTAR DF2
ELF LUBRIFIANTS, PARIS/F	ELFMATIC G3
ELF LUBRIFIANTS, PARIS/F	TRANSANTAR DF3
ELF LUBRIFIANTS, PARIS/F	ELFMATIC G2 22329
ELF LUBRIFIANTS, PARIS/F	HUILE RENAULT DIESEL STARMATIC
ELF LUBRIFIANTS, PARIS/F	ANTAR 22329
ELLER-MONTAN-COMP., DUISBURG/D	ELLMO-AUTOMATIK-FLUID 22233
ERTOIL SA, MADRID/E	TRANSMISSIONES AUTOMATICAS D2
ESSO AG, JAMBURG/D	ESSO ATF D (21065)
ESSO AG, JAMBURG/D	ESSO ATF D (21611)
ESSO AG, JAMBURG/D	ESSO ATF F-30320
FINA EUROPE SA, BRÜSSEL/B	FINAMATIC II-D
FUCHS LUBRICANTS (UK), DERBY/GB	SILKTRAN MP-ATF
FUCHS MINERALÖL WERKE, MANNHEIM/D	TITAN ATF 4000
GINOUVES GEORGES SA, LA FARLEDE/F	YORK LT 785
GULF OIL (GB) LTD, CHELTENHAM/GB	ATF 2
HANDEL-MIJNOVIOL B.V., NIJMEGEN/NL	KENDALL ATF DEXRON II D
HOMBERG GMBH+CO KG, WUPPERTAL/D	HOMBERG-GETRIEBE-FLUID D
IGOL FRANCE, PARIS/F	IGOL ATF 420
INA D.D. RAFINERIJA ZAGREB/YU	INA-ATF SUPER
ITALIANA PETROLI, GENOVA/I	TRANSMISSION FLUID DX
KÄPPLER K., STUTTGART/D	SELECTOL FLUID GETR. ÖL II D 23
KLÖCKNER ENERGIEHANDEL GMBH, KÖLN/D	DEUTZ OEL ATF-D
KROON OIL BV, ALMELO/NL	ATF DEXRON II D
KROON OIL BV, ALMELO/NL	ALMIROL ATF
KUWAIT PETROLEUM, HOOGVLIET/NL	Q8 AUTO 15
KUWAIT PETROLEUM, HOOGVLIET/NL	Q8 AUTO 14 (II D-21883)
KUWAIT PETROLEUM, HOOGVLIET/NL	Q8 AUTO 14 (II D-21677)
LEPRINCE+SIVEKE GMBH, HERFORD/D	LEPRINXOL FLUID CN
LIQUIMOLY / MEGUIN, ULM/D	MEGOL ATF II D
MAURAN SA, ODARS/F	INTER OIL INTER MATIC ATF D2
MIN.ÖL-RAFFIN, DOLLBERGEN, UETZE/D	PENNASOL FLUID-GETR. ÖL TYP PCN
MOBIL OIL, WEDEL/D	MOBIL ATF 220 D21412 / D22187
MOBIL OIL, WEDEL/D	MOBIL ATF 220 D20104 / D21685
MOL HUNGARIAN OIL, KOMARON/H	CARRIER ATF
MORRIS LUBRICANTS, SHREWSBURY/GB	LIQUIMATIC D II
NAFTEC, ALGIER/DZ	TASSILIA
NANHAI SUPERIOR LUB-OIL, CHINA	NANHAI ATF (D2)
NIS-RAFINERIJA NAFTE BEOGRAD/YU	GALAX MATIC DAC
OEST G. MIN. ÖLWERK, FREUDENSTADT/D	ATF T 4011
OMV AG, SCHWECHAT/A	OMV ATF D II (D22427)
OMV AG, SCHWECHAT/A	OMV ATF III (F-30580)
OPTIMOL ÖLWERKE, HAMBURG/D	OPTIMOL ATF T 4011
OSWALD KLUTH, BARGFELD-STEGEN/D	UNIVERSAL ATF-D
PAKELO MOTOR OIL, SAN BONIFACIO/I	MULTIPURPOSE TRANSM. FLUID II D
PANOLIN AG, MADETSWIL/CH	PANOLIN ATF MULTI 21996
PRINZ-SCHULTE, FRECHEN/D	AERO-LINE ATF-D
PRINZ-SCHULTE, FRECHEN/D	AERO-LINE ATF-2
REPSOL DISTRUBCION SA, MADRID/E	REPSOL MATIC ATF
S.A.E.L, ALCOBENDAS/E	GULF ATF D II D-22233
SCHMIERSTOFFRAFFINERIE SALZBERGEN/D	WINTERSHALL ATF D
SHELL ASEOL AG, BERN/CH	ASEOL ATF DB UNIVERSAL
SHELL INTERNATIONAL, LONDON/GB	SHELL DONAX TA (D-21666)
SLOVNAFT JS CO, BRATISLAVA/SLO	MADIT AUTOMATIC
SONOL ISRAEL LTD, HAIFA/IL	DEXRON 2 D
SOPROGRASA SA, MADRID/E	SOPRAL 164
STL TECNOL ESCALQUENS/F	TECNOL TECMATIC D2
SUN OIL COMPANY, AARTSELAAR/B	SUNAMATIC 149
SUN OIL COMPANY, AARTSELAAR/B	SUNAMATIC 153
SVENSKA STATOIL AB, NYNÄSHAMM/S	TRANSWAY DX III (F-30373)
TAMOIL LUBES, GENEVA/CH	TAMOIL ATF II D
TEXACO LUBRICANTS COMP., BEACON/USA	ATF MERCON / DEXRON III
TEXACO SERVICES LTD, BRÜSSEL/B	TEXAMATIC 9226
TEXACO SERVICES LTD, BRÜSSEL/B	TEXAMATIC 4291
TEXACO SERVICES LTD, BRÜSSEL/B	TEXAMATIC 4011
TEXACO SERVICES LTD, BRÜSSEL/B	TEXAMATIC 4261
TEXACO SERVICES LTD, BRÜSSEL/B	TEXAMATIC 7080
TOTAL RAFFINAGE DISTR., PARIS/F	TOTAL FLUIDE AT 42
TOTAL RAFFINAGE DISTR., PARIS/F	TOTAL FLUIDE II D
TOTAL RAFFINAGE DISTR., PARIS/F	TOTAL FLUIDE ATX
TOTAL SOUTH AFRICA, JOHANNESBURG/ZA	TOTAL FLUIDE ATD
TURBOTANK BÖSCHE+BÖDEKER, BREMEN/D	TURBO UNIV. ATF MERCON 4011
UFANEFTECHIM REFINERY, UFA/RUS	UFALUB ATF
UNIL DEUTSCHLAND GMBH, BREMEN/D	UNIL MATIC CN T 4011
VOLVOLINE INC., LEXINGTON/USA	VALVOLINE MULTI-PURPOSE ATF
VALVOLINE INTERNAT., DORDRECHT/NL	VALVOLINE ATF TYPE D
VEBA OEL AG, GELSENKIRCHEN/D	MOVARA ATF-GETRIEBEÖL DIID
VEEDOL INTERNATIONAL, SWINDON/GB	VEEDOL ATF-M (22764)
VEEDOL INTERNATIONAL, SWINDON/GB	VEEDOL UNITRANS Z
VEEDOL INTERNATIONAL, SWINDON/GB	VEEDOL ATF DEXRON III F-30521
YACCO SA, PIERRE-LES-ELBEUF/F	YACCO ATF D
ZELLER+GMELIN GMBH & CO, EISLINGEN/D	DIVINOL FLUID 666
ZF FRIEDRICHSHAFEN AG/D	ZF ECOFLUID "A"

GENERAL DESCRIPTION AND SYSTEM OPERATION

GENERAL REPAIR INSTRUCTIONS

If a floor jack is used, the following precautions are recommended:

- Park the vehicle on level ground, "block" the front or rear wheels, set the jack against the frame, raise the vehicle and support it with chassis stands, and then perform the service operation.
- Before performing the service operation, disconnect the negative battery cable in order to reduce the chance of cable damage and burning due to short-circuiting.
- Use a cover on the body, the seats and the floor to protect them against damage and contamination.
- Handle brake fluid and antifreeze solution with care as they can cause paint damage.
- The use of proper tools, and the required special tools where specified, is important for efficient and reliable performance of the service repairs.
- Use genuine DAEWOO parts.
- Discard used cotter pins, gaskets, O-rings, oil seals, lock washers and self-locking nuts. Prepare new ones for installation. Normal functioning of the vehicle's components cannot be maintained if these fasteners and seals are reused.
- Keep the disassembled parts in order to assist in reassembly.
- Keep attaching bolts and nuts separated, as they vary in hardness and design depending on the position of the installation.
- Clean the parts before inspection or reassembly.
- Also clean the oil parts, etc. Use compressed air to make certain they are free of restrictions.
- Lubricate rotating and sliding faces of parts with oil or grease before installation.
- When necessary, use a sealer on gaskets to prevent leakage.
- Carefully observe all specifications for bolt and nut torques.

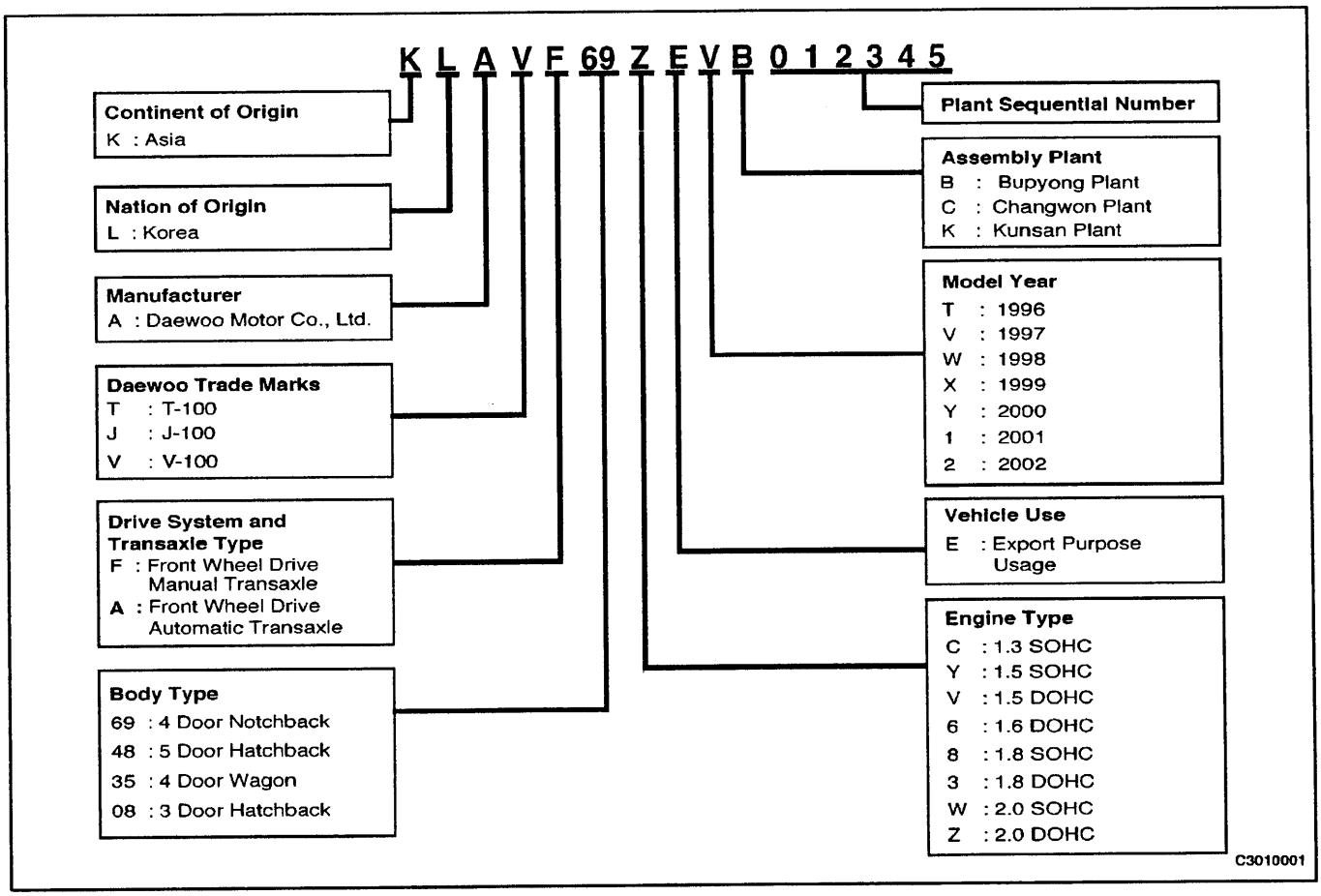
When service operation is complete, make a final check to be sure service was done properly and the problem was corrected.

GENERAL DESCRIPTION

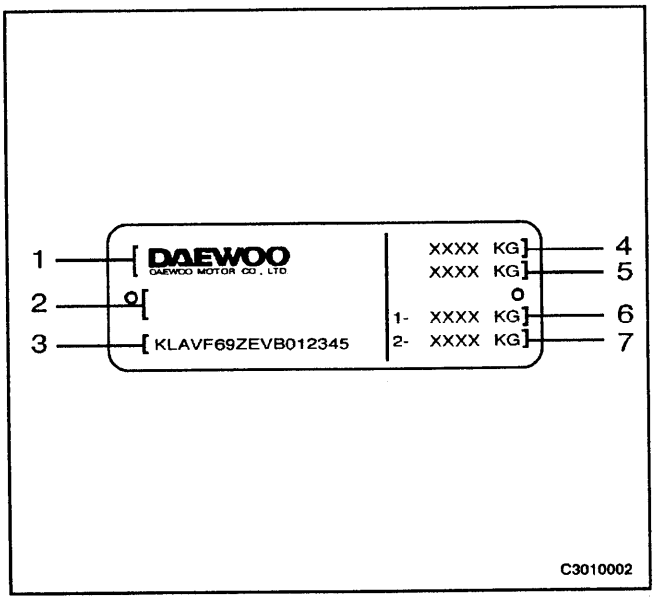
VEHICLE IDENTIFICATIONS

The vehicle identification number (VIN) plate is attached to the top right side of the front panel support. The VIN is also engraved in the top right side of the bulkhead.

Passenger Car VIN



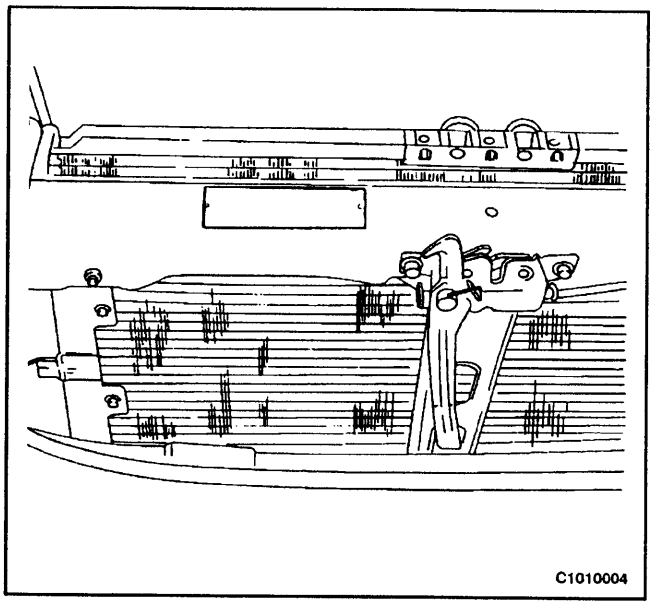
VIN Plate



1 Manufacturer's Name
2 NTA Number or WVTA Number
3 Vehicle Identification Number
4 Gross Vehicle Weight
5 Combination Weight
6 Front Axle Weight
7 Rear Axle Weight

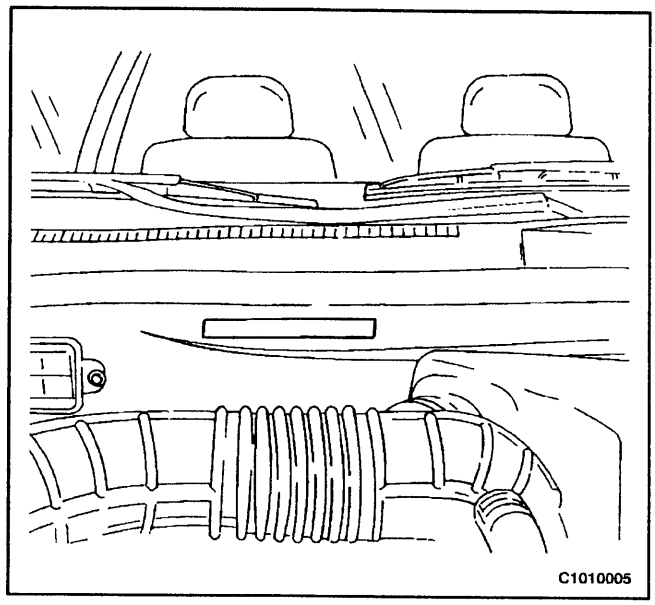
VIN Plate Location

The VIN plate is attached to the top right side of the front panel support.

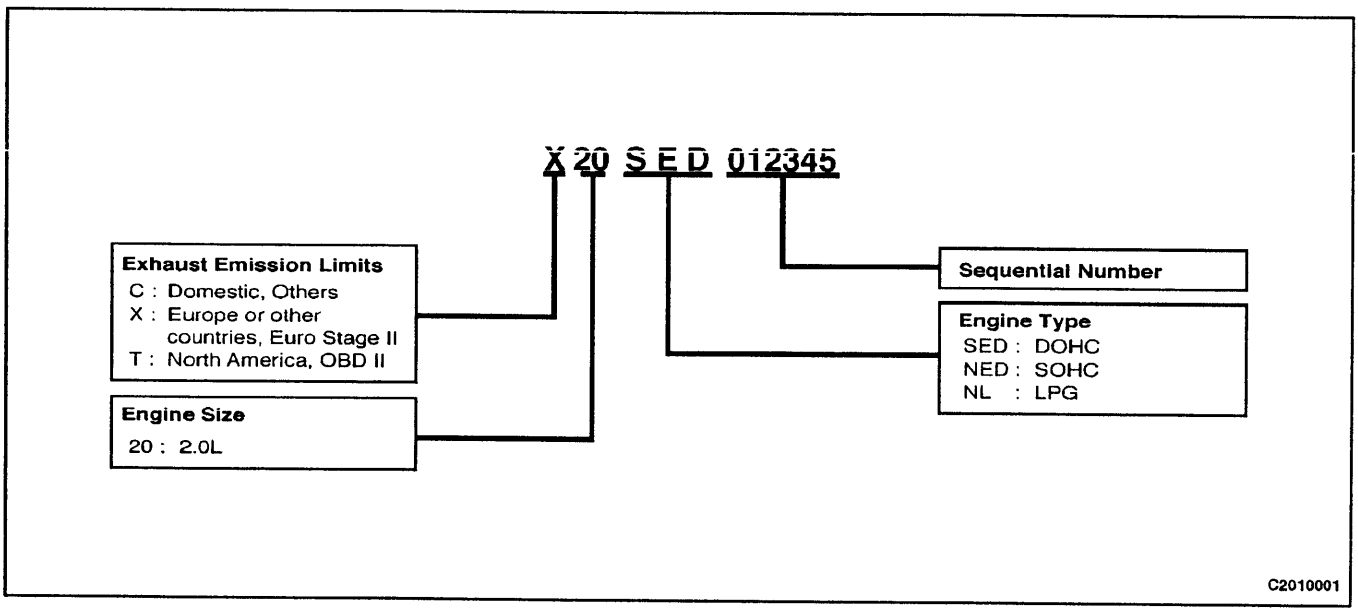


Engraved VIN Location

The engraved VIN is located on the top right side of the bulkhead.

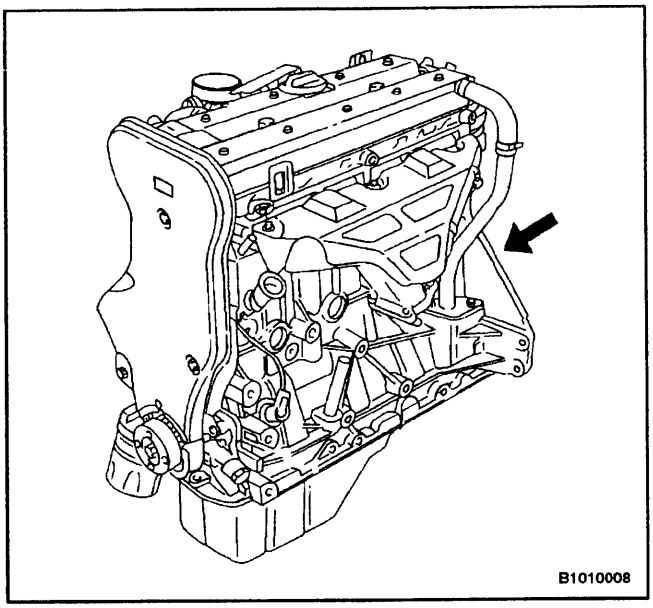


Engine Number



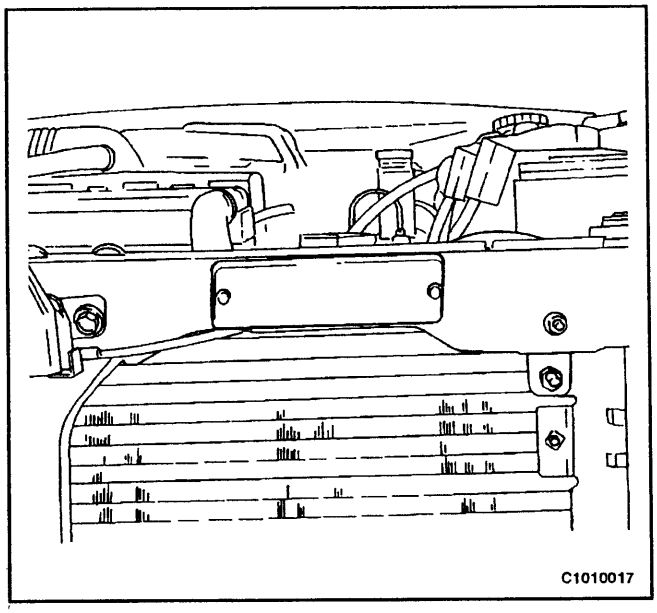
Engraved Engine Number Location

The engraved engine number is located on the engine block beneath the No. 4 exhaust manifold.

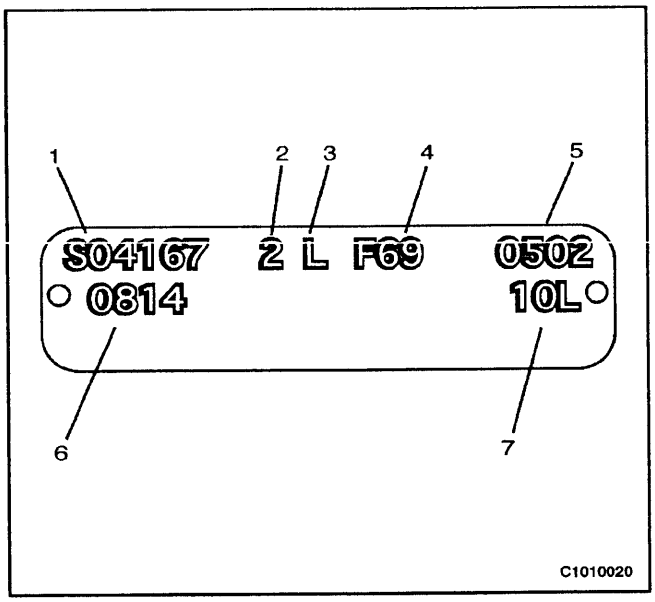


Body Identification Number Plate Location

The body identification number plate is attached to the top left side of the front panel support.

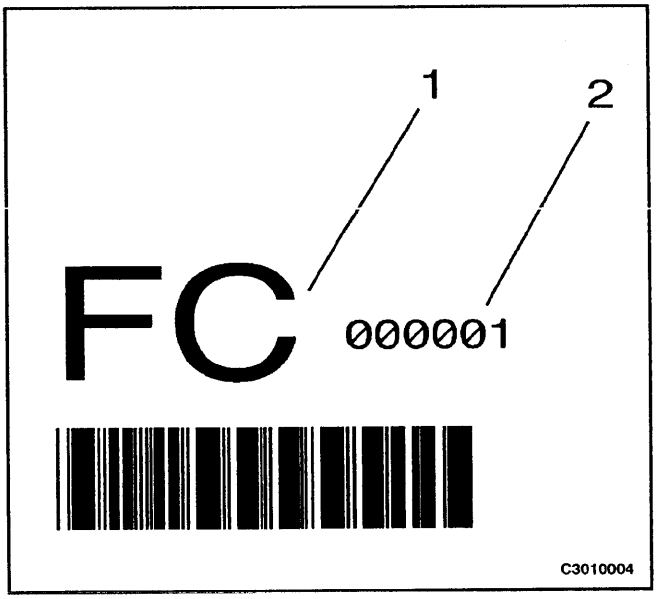


Body Identification Number Plate



1 P/O Number
2 Check Digit
3 Drive
4 Body Type
5 P/O Date
6 Sequential Number
7 Exterior Color

Manual Transaxle Identification Number Plate

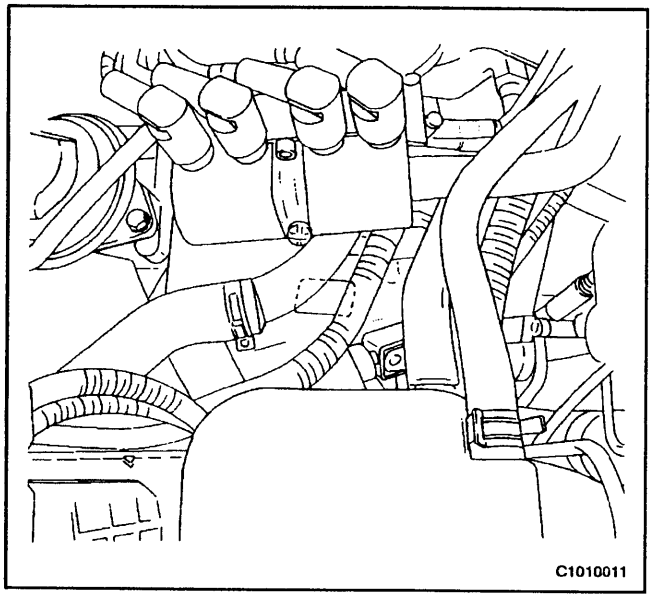


1 Identification Code
2 Sequential Number

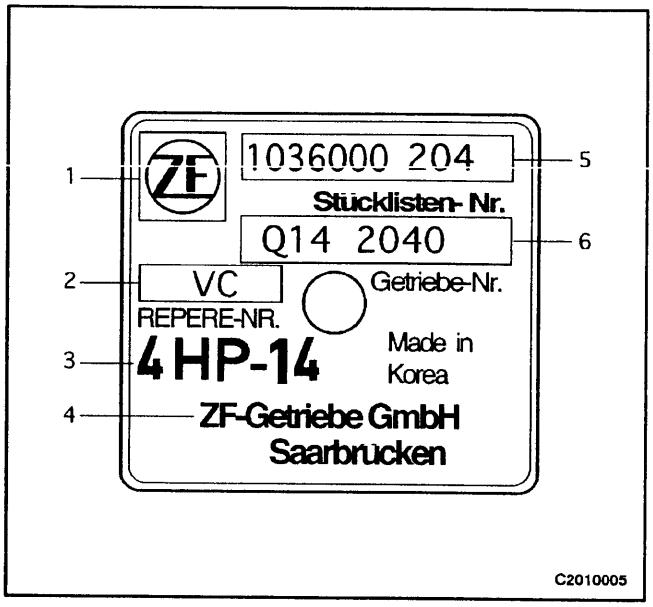
Identification Code	Engine	Gear Ratio
FC	2.0L DOHC	3.722 CR

Manual Transaxle Identification Number Plate Location

The manual transaxle identification number plate is attached to the top of the transaxle case near the engine.



Automatic Transaxle Identification Number Plate

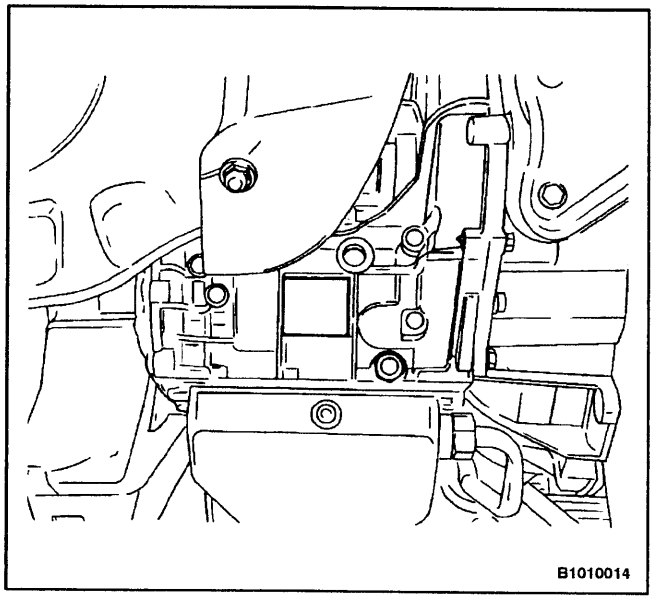


1 Manufacturer's Logo
2 Identification Code
3 Model Name (4HP-14)
4 Manufacturer
5 Part Number
6 Sequential Number

Identification Code	Engine
VC	2.0L DOHC

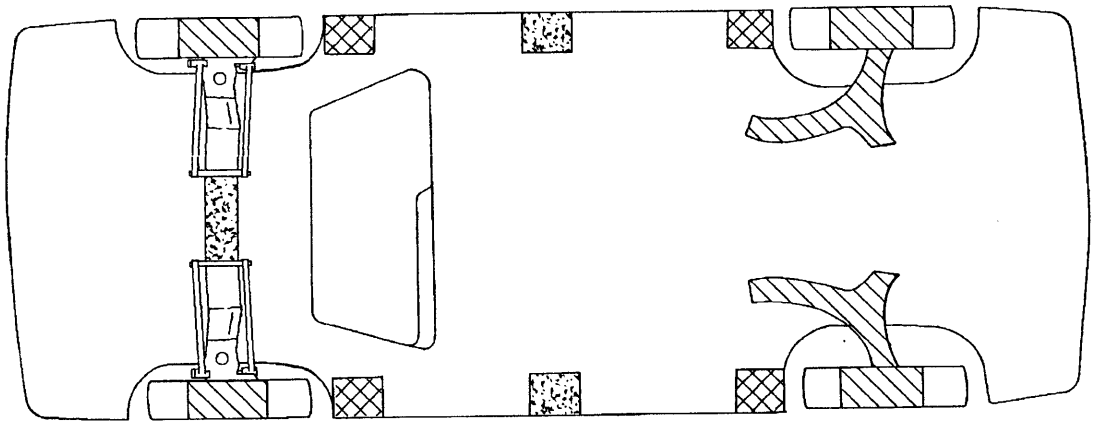
Automatic Transaxle Identification Number Plate Location

The automatic transaxle identification number plate is attached on the rear bottom side of the transaxle case near the bulkhead.

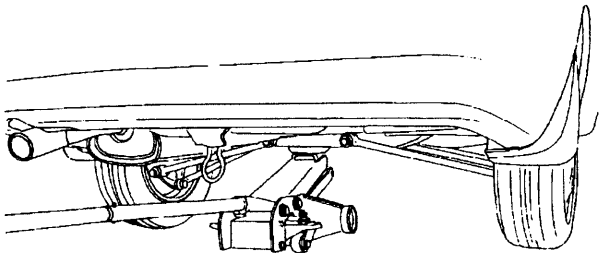


VEHICLE LIFTING PROCEDURES

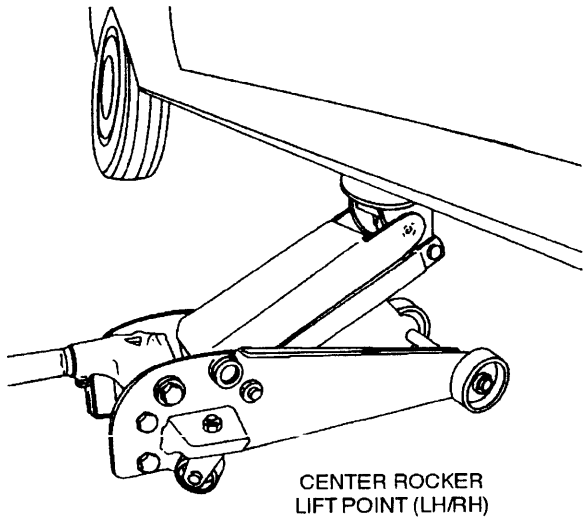
Notice: To raise the vehicle, place the lifting equipment only at the points indicated. Failure to use these precise positions may result in permanent body deformation. Many dealer service facilities and service stations are equipped with automotive hoists that bear upon some parts of the frame in order to lift the vehicle. If any other hoist method is used, use special care to avoid damaging the fuel tank, the filler neck, the exhaust system, or the underbody.



FRAME CONTACT HOIST SUSPENSION CONTACT HOIST FLOOR JACK



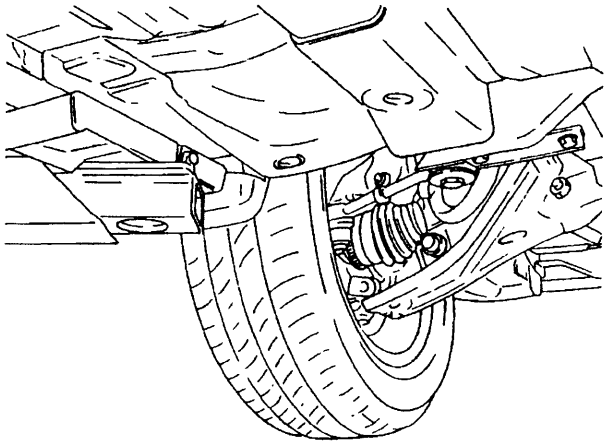
REAR SUSPENSION
AXLE LIFT POINT



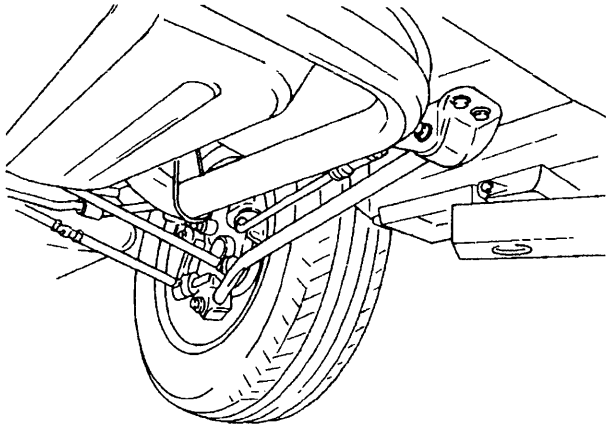
CENTER ROCKER
LIFT POINT (LH/RH)

B1010017

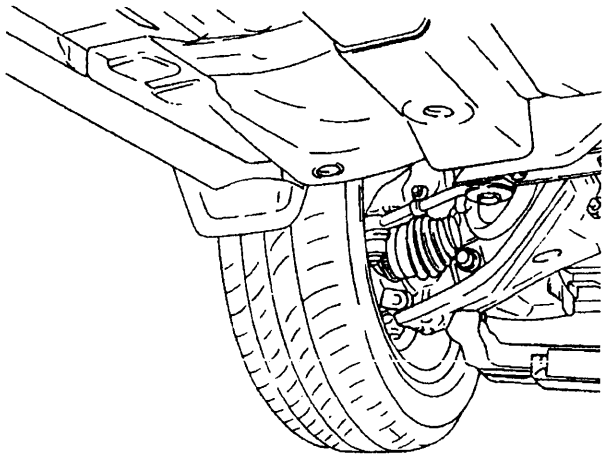
Vehicle Lifting Points



FRAME CONTACT HOIST
REARWARD OF FRONT TIRE



FRAME CONTACT HOIST
FORWARD OF REAR WHEEL



SUSPENSION CONTACT HOIST
UNDER FRONT LOWER CONTROL ARM

C1010014

ENGINE

CONTENTS

SECTION 1

ENGINE

SECTION 1A

GENERAL ENGINE INFORMATION

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DIAGNOSIS

COMPRESSION TEST

Important: Disconnect the Crankshaft Position Sensor (CPS) connector to disable the fuel and the ignition systems.

Test the compression pressure for each cylinder. Low compression pressure may be the fault of the valves or the pistons. The following conditions should be considered when you check the cylinder compression:

- The engine should be at normal operating temperature.
- The throttle must be wide open.
- All the spark plugs should be removed.
- The battery must be at or near full charge.

1. Place approximately three squirts of oil from a plunger type oiler into each spark plug port.
2. Insert the engine compression gauge into each spark plug port.
3. Crank test each cylinder with four to five compression strokes using the starter motor.
4. The lowest reading should not be less than 70% of the highest reading. The compression gauge reading should not be less than 689 kPa (100 psi) for any of the cylinders.
5. Examine the gauge readings obtained after the four "puffs" per cylinder are obtained from cranking the starter motor. The readings are explained in the following descriptions:

- Normal Condition - Compression builds up quickly and evenly to specified compression on each cylinder.
- Piston Rings Faulty - Compression is low on the first stroke and tends to build up on following strokes, but the compression pressure does not reach normal. The compression pressure improves considerably with the addition of oil into the cylinder.
- Valves Faulty - Low compression pressure on the first stroke. The compression pressure does not tend to build up on the following strokes. The compression pressure does not improve much with the addition of oil into the cylinder.

OIL PRESSURE TEST

Step	Action	Value(s)	Yes	No
1	Is low or no oil pressure indicated?	-	Go to *Step 2*	System OK
2	Check the oil level in the crankcase. Is the level low?	-	Go to *Step 3*	Go to *Step 4*
3	Add oil so that the oil level is up to the full mark on the indicator. Is the repair complete?	-	Go to *Step 1*	-
4	Check the idle speed. Is the idle speed below the value specified?	850 rpm	Go to *Step 5*	Go to *Step 6*
5	Increase the idle speed. Is the speed increased?	-	Go to *Step 1*	-
6	Inspect the oil pressure switch. Is the oil pressure switch incorrect or malfunctioning?	-	Go to *Step 7*	Go to *Step 8*
7	Install a new oil pressure switch. Is the repair complete?	-	Go to *Step 1*	-
8	Inspect the oil pressure gauge. Is the oil pressure gauge incorrect or malfunctioning?	-	Go to *Step 9*	Go to *Step 10*
9	Install a new oil pressure gauge. Is the repair complete?	-	Go to *Step 1*	-
10	Inspect the engine oil. Is the engine oil in the crankcase diluted or of the improper viscosity?	-	Go to *Step 11*	Go to *Step 12*
11	Install new engine oil of the proper viscosity for the expected temperatures. Is the repair complete?	-	Go to *Step 1*	-
12	Inspect the oil pump. Is the pump worn or dirty?	-	Go to *Step 13*	Go to *Step 14*
13	Replace the oil pump. Is the repair complete?	-	Go to *Step 1*	-
14	Inspect the oil filter. Is the oil filter plugged?	-	Go to *Step 15*	Go to *Step 16*
15	Install a new oil filter. Is the repair complete?	-	Go to *Step 1*	-
16	Inspect the oil pickup screen. Is the oil pickup screen loose or plugged?	-	Go to *Step 17*	Go to *Step 18*
17	Tighten or replace the oil pickup screen as necessary. Is the repair complete?	-	Go to *Step 1*	-
18	Inspect the oil pickup tube. Are there any holes in the oil pickup tube?	-	Go to *Step 19*	Go to *Step 20*
19	Replace the oil pickup tube. Is the repair complete?	-	Go to *Step 1*	-

OIL PRESSURE TEST (Cont'd)

Step	Action	Value(s)	Yes	No
20	Inspect the bearing clearances. Are the bearing clearances more than the values specified?	Crankshaft 0.040 mm (0.0016 in.) Connecting Rod 0.063 mm (0.0025 in.)	Go to *Step 21*	Go to *Step 22*
21	Replace the bearing if necessary. Is the repair complete?	-	Go to *Step 1*	-
22	Inspect the oil galleries. Are the oil galleries cracked, porous or plugged?	-	Go to *Step 23*	Go to *Step 24*
23	Repair or replace the engine block. Is the repair complete?	-	Go to *Step 1*	-
24	Inspect the gallery plugs. Are any of the gallery plugs missing or not installed properly?	-	Go to *Step 25*	Go to *Step 26*
25	Install plugs or repair as necessary. Is the repair complete?	-	Go to *Step 1*	-
26	Inspect the camshaft. Is the camshaft worn or is there evidence of poor machining?	-	Go to *Step 27*	System OK
27	Replace the camshaft. Is the repair complete?	-	Go to *Step 1*	-

OIL LEAK DIAGNOSIS

Most fluid oil leaks are easily located and repaired by visually finding the leak and replacing or repairing the necessary parts. On some occasions a fluid leak may be difficult to locate or repair. The following procedures may help you in locating and repairing most leaks.

Finding the Leak

1. Identify the fluid. Determine whether it is engine oil, automatic transmission fluid, power steering fluid, etc.
2. Identify where the fluid is leaking from.
   - 2.1. After running the vehicle at normal operating temperature, park the vehicle over a large sheet of paper.
   - 2.2. Wait a few minutes.
   - 2.3. You should be able to find the approximate location of the leak by the drippings on the paper.
3. Visually check around the suspected component. Check around all the gasket mating surfaces for leaks. A mirror is useful for finding leaks in areas that are hard to reach.
4. If the leak still cannot be found, it may be necessary to clean the suspected area with a degreaser, steam or spray solvent.
   - 4.1. Clean the area well.
   - 4.2. Dry the area.
   - 4.3. Operate the vehicle for several miles at normal operating temperature and varying speeds.
   - 4.4. After operating the vehicle, visually check the suspected component.
   - 4.5. If you still cannot locate the leak, try using the powder or black light and dye method.

Powder Method

1. Clean the suspected area.
2. Apply an aerosol-type powder (such as foot powder) to the suspected area.
3. Operate the vehicle under normal operating conditions.
4. Visually inspect the suspected component. You should be able to trace the leak path over the white powder surface to the source.

Black Light and Dye Method

A dye and light kit is available for finding leaks. Refer to the manufacturer's directions when using the kit.

1. Pour the specified amount of dye into the engine oil fill tube.
2. Operate the vehicle under normal operating conditions as directed in the kit.

3. Direct the light toward the suspected area. The dyed fluid will appear as a yellow path leading to the source.

Repairing the Leak

Once the origin of the leak has been pinpointed and traced back to its source, the cause of the leak must be determined in order for it to be repaired properly. If a gasket is replaced, but the sealing flange is bent, the new gasket will not repair the leak. The bent flange must be repaired also. Before attempting to repair a leak, check for the following conditions and correct them as they may cause a leak.

Gaskets

- The fluid level/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The fasteners are tightened improperly or the threads are dirty or damaged.
- The flanges or the sealing surface is warped.
- There are scratches, burrs or other damage to the sealing surface.
- The gasket is damaged or worn.
- There is cracking or porosity of the component.
- An improper seal was used (where applicable).

Seals

- The fluid level/pressure is too high.
- The crankcase ventilation system is malfunctioning.
- The seal bore is damaged (scratched, burred or nicked).
- The seal is damaged or worn.
- Improper installation is evident.
- There are cracks in the component.
- The shaft surface is scratched, nicked or damaged.
- A loose or worn bearing is causing excess seal wear.

KNOCK DIAGNOSIS

Definition for Knock

Engine knock refers to various types of engine noise. Heavy knock is usually very loud and the result of broken or excessively worn internal engine components. Light knock is a noticeable noise, but not as loud. Light knock can be caused by worn internal engine components. Loose or broken external engine components can also cause heavy or light knock.

Engine Knocks Cold and Continues for Two-Three Minutes and/or Knock Increases with Engine Torque

Step	Action	Value(s)	Yes	No
1	Does the engine knock when it is cold and continue for two to three minutes or does the knock increase with torque?	-	Go to *Step 2*	System OK
2	Inspect the flywheel. Is the flywheel contacting the splash shield?	-	Go to *Step 3*	Go to *Step 4*
3	Reposition the splash shield. Is the repair complete?	-	Go to *Step 1*	-
4	Inspect the balancer and the drive pulleys. Is either the balancer or the drive pulleys loose or broken?	-	Go to *Step 5*	Go to *Step 6*
5	Tighten or replace the balancer or the drive pulleys. Is the repair complete?	-	Go to *Step 1*	-
6	Inspect the piston-to-bore clearance. Is the clearance more than the value specified?	0.030 mm (0.001 in.)	Go to *Step 7*	Go to *Step 8*
7	1. Rebore the cylinder and hone to size. 2. Replace the piston. Is the repair complete?*	-	Go to *Step 1*	-
8	Inspect the connecting rod. Is the connecting rod bent?	-	Go to *Step 9*	System OK
9	Replace the connecting rod. Is the repair complete?	-	Go to *Step 1*	-

* Cold engine piston knock usually disappears when the cylinder is grounded out. Cold engine piston knock, which disappears in about 1.5 minutes, is considered acceptable.

Heavy Knock Hot with Torque Applied

Step	Action	Value(s)	Yes	No
1	Is there a heavy knock when the engine is hot and torque is applied?	-	Go to *Step 2*	System OK
2	Inspect the balancer and pulley hub. Is the balancer or pulley hub broken?	-	Go to *Step 3*	Go to *Step 4*
3	Replace the broken balancer or pulley hub. Is the repair complete?	-	Go to *Step 1*	-
4	Inspect the torque converter bolts. Are the bolts tightened to value specified?	60 N•m (44 lb-ft)	Go to *Step 5*	Go to *Step 6*
5	Tighten the torque converter bolts. Is the repair complete?	-	Go to *Step 1*	-
6	Inspect the accessory belts. Are the belts too tight or nicked?	-	Go to *Step 7*	Go to *Step 8*
7	Replace and/or tension the belts to specifications as necessary. Is the repair complete?	-	Go to *Step 1*	-
8	Inspect the exhaust system. Is the system grounded?	-	Go to *Step 9*	Go to *Step 10*
9	Reposition the system as necessary. Is the repair complete?	-	Go to *Step 1*	-
10	Inspect the flywheel. Is the flywheel cracked?	-	Go to *Step 11*	Go to *Step 12*
11	Replace the flywheel. Is the repair complete?	-	Go to *Step 1*	-
12	Inspect the main bearing clearance. Is the clearance more than the value specified?	0.040 mm (0.0016 in.)	Go to *Step 13*	Go to *Step 14*
13	Replace the main bearings as necessary. Is the repair complete?	-	Go to *Step 1*	-
14	Inspect the rod bearing clearance. Is the clearance more than the value specified?	0.063 mm (0.0025 in.)	Go to *Step 15*	System OK
15	Replace the rod bearings as necessary. Is the repair complete?	-	Go to *Step 1*	-

Light Knock Hot

Step	Action	Value(s)	Yes	No
1	Is there a light knock when the engine is hot?	-	Go to *Step 2*	System OK
2	Is detonation or spark knock evident?	-	Go to *Step 3*	Go to *Step 4*
3	Check the engine timing and the fuel quality. Was the problem found?	-	Go to *Step 1*	-
4	Inspect the torque converter bolts. Are the bolts loose?	-	Go to *Step 5*	Go to *Step 6*
5	Tighten the torque converter bolts. Is the repair complete?	-	Go to *Step 1*	-
6	Inspect the manifold. Is there an exhaust leak at the manifold?	-	Go to *Step 7*	Go to *Step 8*
7	Tighten the bolts or replace the gasket. Is the repair complete?	-	Go to *Step 1*	-
8	Check the rod bearing clearance. Is the clearance within the value specified?	0.019-0.063 mm (0.0007-0.0024 in.)	Go to *Step 9*	System OK
9	Replace the rod bearings as necessary. Is the repair complete?	-	Go to *Step 1*	-

Knocks During Initial Start-Up But Lasts Only a Few Seconds

Step	Action	Value(s)	Yes	No
1	Does the engine knock during initial start-up but last only a few seconds?	-	Go to *Step 2*	System OK
2	Check the engine oil. Is the proper viscosity oil used in the crankcase?	-	Go to *Step 4*	Go to *Step 3*
3	Install oil of the proper viscosity for the expected seasonal temperatures. Is the repair complete?	-	Go to *Step 1*	-
4	Inspect the hydraulic lifters. Is there evidence of hydraulic lifter bleed-down?	-	Go to *Step 5*	Go to *Step 6*
5	Clean, test and replace the lifters as necessary. Is the repair complete?*	-	Go to *Step 1*	-
6	Inspect the crankshaft end clearance. Is the clearance more than value specified?	0.302 mm (0.012 in.)	Go to *Step 7*	Go to *Step 8*
7	Replace the crankshaft thrust bearing. Is the repair complete?	-	Go to *Step 1*	-
8	Inspect the front main bearing clearance. Is the clearance more than the value specified?	0.040 mm (0.0016 in.)	Go to *Step 9*	System OK
9	Replace the worn parts of the front main bearing. Is the repair complete?	-	Go to *Step 1*	-

* When the engine is stopped, some valves will be open. Spring pressure against the lifters will tend to bleed the lifter down. Attempts to repair this should be made only if the problem is consistent.

An engine that is operated for only short periods between start-ups may have lifter noise that lasts for a few minutes. This is a normal condition.

Knocks at Idle Hot

Step	Action	Value(s)	Yes	No
1	Does the engine knock at idle when hot?	-	Go to *Step 2*	System OK
2	Inspect the drive belts. Are the belts loose or worn?	-	Go to *Step 3*	Go to *Step 4*
3	Tension or replace the belts as necessary. Is the repair complete?	-	Go to *Step 1*	-
4	Inspect the A/C compressor and the generator. Is either the compressor or the generator faulty?	-	Go to *Step 5*	Go to *Step 6*
5	Replace the faulty A/C compressor or the generator. Is the repair complete?	-	Go to *Step 1*	-
6	Inspect the valve train. Are valve train components faulty?	-	Go to *Step 7*	Go to *Step 8*
7	Replace faulty valve train components. Is the repair complete?	-	Go to *Step 1*	-
8	Check the engine oil. Is the proper viscosity oil used in the crankcase?	-	Go to *Step 10*	Go to *Step 9*
9	Install oil of the proper viscosity for the expected seasonal temperatures. Is the repair complete?	-	Go to *Step 1*	-
10	Inspect the piston pin clearance. Is the clearance more than the value specified?	0.014 mm (0.0005 in.)	Go to *Step 11*	Go to *Step 12*
11	Replace the piston and the pin. Is the repair complete?	-	Go to *Step 1*	-
12	Check the connecting rod alignment. Is the alignment faulty?	-	Go to *Step 13*	Go to *Step 14*
13	Check and replace rods as necessary. Is the repair complete?	-	Go to *Step 1*	-
14	Inspect the piston-to-bore clearance. Is the clearance within the value specified?	0.03 mm (0.0012 in.)	Go to *Step 16*	Go to *Step 15*
15	Hone the bore and fit a new piston. Is the repair complete?	-	Go to *Step 1*	-
16	Inspect the crankshaft balancer. Is the balancer loose?	-	Go to *Step 17*	Go to *Step 18*
17	Torque or replace worn parts. Is the repair complete?	-	Go to *Step 1*	-
18	Check the piston pin offset. Is the offset at the value specified?	0.8 mm (0.031 in.) Toward Thrust Side	Go to *Step 19*	System OK
19	Install the correct piston. Is the repair complete?	-	Go to *Step 1*	-

NOISE DIAGNOSIS

Main Bearing Noise

Step	Action	Value(s)	Yes	No
1	Are dull thuds or knocks heard with every engine revolution?	-	Go to *Step 2*	System OK
2	Check the oil pump pressure. Is the oil pump pressure low?	-	Go to *Oil Pressure Test*	Go to *Step 3*
3	Inspect the crankshaft end play. Is there excessive crankshaft end play?	0.070 ~ 0.302 mm (0.0027 ~ 0.0119 in)	Go to *Crankshaft Replacement Procedure*	Go to *Step 4*
4	Inspect the crankshaft journals. Are the crankshaft journals out-of-round?	-	Go to *Crankshaft Replacement Procedure*	Go to *Step 5*
5	Inspect the belt tension. Is there excessive belt tension?	-	Go to *Timing Belt Replacement Procedure*	Go to *Step 6*
6	Inspect the crankshaft pulley. Is the crankshaft pulley loose?	-	Go to *Crankshaft Replacement Procedure*	System OK

Connecting Rod Bearing Noise Symptom

Step	Action	Value(s)	Yes	No
1	Is a knock noise heard under all engine speeds?	-	Go to *Step 2*	System OK
2	Inspect the crankshaft connecting rod journal. Is the crankshaft connecting rod journal worn?	-	Go to *Crankshaft Replacement Procedure*	Go to *Step 3*
3	Check the oil pump pressure. Is the oil pump pressure low?	-	Go to *Oil Pressure Test*	Go to *Step 4*
4	Inspect the crankshaft connecting rod journals. Are the journals out-of-round?	-	Go to *Crankshaft Replacement Procedure*	Go to *Step 5*
5	Inspect the connecting rods. Is there a misaligned connecting rod?	-	Go to *Pistons and Rods Replacement Procedure*	Go to *Step 6*
6	Inspect the connecting rod bolts. Are the connecting rod bolts torqued properly?	-	System OK	Go to *Pistons and Rods Replacement Procedure*

Piston Noises

Step	Action	Value(s)	Yes	No
1	Are any of the following noises heard: a sharp double knock when the engine is idling, a light ticking with no load on the engine, or a "slapping" noise when the engine is cold?	-	Go to *Step 2*	System OK
2	Inspect the piston pin and bushing. Is the piston pin or the bushing worn or loose?	-	Go to *Pistons and Rods Replacement Procedure*	Go to *Step 3*
3	Inspect the piston. Is the piston broken or cracked?	-	Go to *Pistons and Rods Replacement Procedure*	Go to *Step 4*
4	Inspect the connecting rods. Is there a misaligned connecting rod?	-	Go to *Pistons and Rods Replacement Procedure*	Go to *Step 5*
5	Inspect the piston position. Is the piston 180° out of position?	-	Go to *Pistons and Rods Replacement Procedure*	System OK

Valve Mechanism or Valve Train Noises

Step	Action	Value(s)	Yes	No
1	Is a light tapping sound heard from the engine?	-	Go to *Step 2*	System OK
2	Inspect the valve springs. Are the springs weak or broken?	-	Go to *Cylinder Head and Valve Train Components Replacement Procedure*	Go to *Step 3*
3	Inspect the valves. Are the valves sticking or warped?	-	Go to *Cylinder Head and Valve Train Components Replacement Procedure*	Go to Step 4
4	Inspect the valve lifters. Are the valve lifters dirty, stuck or worn?	-	Go to *Cylinder Head and Valve Train Components Replacement Procedure*	Go to *Step 5*
5	Inspect the camshaft lobes. Are the camshaft lobes damaged or improperly machined?	-	Go to *Camshaft Replacement Procedure*	Go to *Step 6*
6	Check the oil supply to the valve train. Is the oil supply insufficient or poor?	-	Go to *Cylinder Head and Valve Train Components Replacement Procedure*	Go to *Step 7*
7	Inspect the valve guides. Are the valve guides worn?	-	Go to *Cylinder Head and Valve Train Components Replacement Procedure*	Go to *Step 8*
8	Inspect the valve spring seat. Is the valve spring seat incorrect?	-	Go to *Cylinder Head and Valve Train Components Replacement Procedure*	System OK

GENERAL INFORMATION

CLEANLINESS AND CARE

An automobile engine is a combination of many machined, honed, polished and lapped surfaces with tolerances that are measured in the ten-thousandths of an inch. When any internal engine parts are serviced, care and cleanliness are important. A liberal coating of engine oil should be applied to friction areas during assembly, to protect and lubricate the surfaces on initial operation. Proper cleaning and protection of machined surfaces and friction areas is part of the repair procedure. This is considered standard shop practice even if not specifically stated.

Whenever valve train components are removed for service, they should be kept in order. They should be installed in the same locations, and with the same mating surfaces, as when they were removed.

Battery cables should be disconnected before any major work is performed on the engine. Failure to disconnect cables may result in damage to wire harness or other electrical parts.

ON-ENGINE SERVICE

Caution: Disconnect the negative battery cable before removing or installing any electrical unit, or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

Notice: Any time the air cleaner is removed, the intake opening should be covered. This will protect against accidental entrance of foreign material, which could follow the intake passage into the cylinder and cause extensive damage when the engine is started.

SECTION 1C

DOHC ENGINE MECHANICAL

CAUTION: Disconnect the negative battery cable before removing or installing any electrical unit or when a tool or equipment could easily come in contact with exposed electrical terminals. Disconnecting this cable will help prevent personal injury and damage to the vehicle. The ignition must also be in LOCK unless otherwise noted.

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SPECIFICATIONS

ENGINE SPECIFICATIONS

Application	2.0L DOHC
General Data:	
Engine Type	4 Cylinder (In-Line)
Displacement	1 998 cm^3 (121 in^3)
Bore Stroke	86 x 86 mm (3.38 in x 3.38 in.)
Compression Ratio	9.6:1
Firing Order	1-3-4-2
Cylinder Bore:	
Diameter	85.975~86.025 mm (3.384~3.386 in.)
Out of Round (Maximum)	0.013 mm (0.0005 in.)
Cylinder Bore Taper (Maximum)	0.013 mm (0.0005 in.)
Piston Protrusion	0.5 mm Max (0.019 in.)
Oversize (Measure Replacement Piston before Re-boring)	Available in 0.50 mm to suit bore (0.019 in.)
Service Replacement Standard Bore	4 Piston, Pin, and Ring Assemblies Available
Block Face Distortion	0.01 mm Max (0.00039 in.)
Piston:	
Diameter	85.955~86.485 mm (3.384~3.404 in.)
Clearance to Bore	0.0100~0.0300 mm (0.00039~0.0011 in.)
Piston Protrusion	0.5 mm Max (0.019 in.)
Piston Taper	0.013 mm (0.0005 in.)
Piston Rings:	
Ring, End Gap, Top Compression	0.3~0.5 mm (0.011~0.019 in.)
Ring, End Gap, Second Compression	0.3~0.5 mm (0.011~0.019 in.)
Oil	0.4~1.4 mm (0.0015~0.055 in.)
Piston Pin:	
Diameter	20.9970~20.9985 mm (0.82665~0.82671 in.)
Pin Offset	0.8 mm (0.03 in.) Toward Thrust Side

ENGINE SPECIFICATIONS (Cont'd)

Application	2.0L DOHC
Clearance: In Piston	0.0035~0.0140 mm (0.00013~0.00055 in.)
Clearance: In Rod	Interference Fit in Rod
Length	61.5 mm (2.42 in.)
Camshaft:	
Lift - Intake	10.0 mm (0.39 in.)
Lift - Exhaust	10.0 mm (0.39 in.)
Camshaft Cap to Bearing Journal Clearance	0.04~0.144 mm (0.0015~0.0056 in.)
Bearing Journal OD	42.455~43.470 mm (1.6714~1.7114 in.)
Crankshaft:	
Main Journal	-
Diameter (All)	57.982~57.995 mm (2.2827~2.2832 in.)
Radial Runout (Shaft Support on No. 1 and No. 5 Bearings Measured at No. 3 Journal)	0.03 mm (0.001 in.)
Main Bearing Clearance (All)	0.015-0.040 mm (0.00059~0.00157 in.)
End Play	0.070~0.302 mm (0.0027~0.0118 in.)
Service Oversize, Available in 2 sizes	0.25 and 0.5 mm (0.00098~0.019 in.)
Connecting Rod Journal:	
Diameter (All)	48.981~48.987 mm (1.9283~1.9286 in.)
Out of Round (Maximum)	0.004 mm (0.00015 in.)
Rod Bearing Play	0.006~0.031 mm (0.00023~0.00122 in.)
Rod Bearing Clearance	0.019~0.063 mm (0.0007~0.0024 in.) (Production 0.013~0.041 mm (0.0005~0.0016 in.))
Cylinder Head:	
Valve Stem Protrusion	39.8 mm Max (1.566 in.)
Valve Guide Height	13.7~14.0 mm (0.53~0.55 in.)
Overall Height	134.0 ± 0.025 mm (5.275~0.0009 in.)
Minimum Overall Height After Machining	133.9 mm (5.271 in.)

ENGINE SPECIFICATIONS (Cont'd)

Application	2.0L DOHC
Valve System:	
Valve Lash Compensators	Hydraulic
Seat Runout (Maximum, All)	0.03 mm (0.001 in.)
Face Runout (Maximum, All)	0.03 mm (0.001 in.)
Valve Stem Diameter Intake	5.970~5.995 mm (0.235~0.236 in.)
Exhaust	5.960~5.945 mm (0.23464~0.2360 in.)
Valve Diameter Intake	32 ± 0.1 mm (1.2598 ± 0.0039 in.)
Exhaust	29 ± 0.1 mm (1.1417 ± 0.0039 in.)
Valve Seat Width Intake	1.0~1.5 mm (0.039~0.059 in.)
Exhaust	1.7~2.2 mm (0.066~0.086 in.)
Valve Face Angle	44°
Valve Seat Angle	45°
Valve Guide Inside Diameter	7.03~7.05 mm (0.276~0.277 in.)
Oil Pump:	
Gear Lash	0.10-0.20 mm (0.004-0.008 in.)
Outer Gear to Body	0.11-0.19 mm (0.0043-0.0074 in.)
Outer Gear to Crescent	0.11-0.24 mm (0.0043-0.009 in.)
Inner Gear to Crescent	0.18-0.26 mm (0.007-0.010 in.)
End Clearance	0.03-0.10 mm (0.001-0.004 in.)
Sealants and Adhesives:	
Rear Main Bearing Cap	GE p/n RTV 159
Camshaft Carrier-to-Cylinder Head	HN 1581 (Loctite® 515)
Oil Pan Bolts	HN 1256 (Loctite® 242)
Oil Pump Bolts	HN 1256 (Loctite® 242)
Oil Pan Pickup Tube Bolts	HN 1256 (Loctite® 242)
Oil Gallery Plug	HN 1256 (Loctite® 242)
Coolant Jacket Caps and Plugs (Freeze Plugs)	HN 1756 (Loctite® 176)
Exhaust Manifold Studs/Nuts	Anti-seize Compound (HMC Spec HN1325)

FASTENER TIGHTENING SPECIFICATIONS

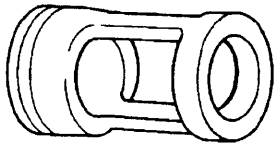
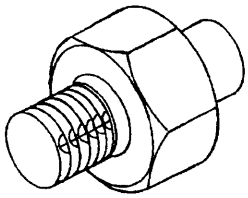
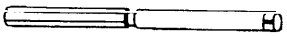
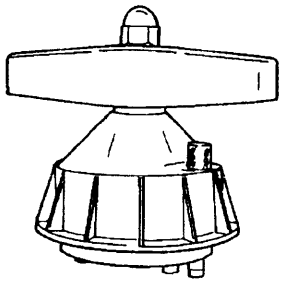
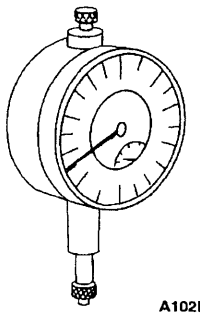
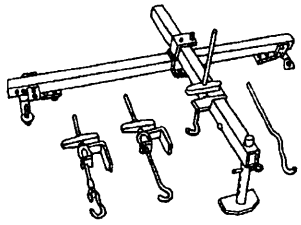
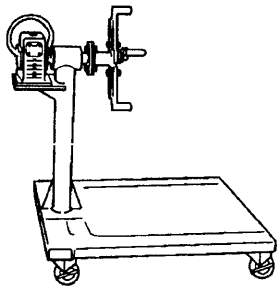
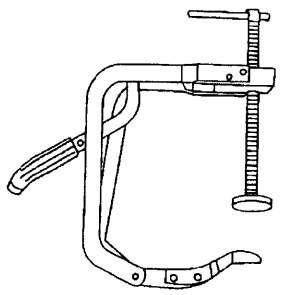
Application	N•m	Lb-Ft	Lb-In
A/C Compressor Hose Assembly Bolt	33	24	-
Air Filter Housing Bolts	8	-	71
Alternator-to-Intake Manifold Strap Bracket Bolts	20	15	-
Alternator-to-Intake Manifold Support Bracket Bolts	35	26	-
Camshaft Bearing Cap Bolts	8	-	71
Canister Purge Solenoid and Exhaust Gas Recirculation Solenoid Bracket Bolt	5	-	44
Connecting Rod Cap Bearing Bolts	35 + 45°	26 + 45°	-
Coolant Bypass Housing Bolts	15	11	-
Coolant Pump Retaining Bolts	20	15	-
Coolant Temperature Sensor	25	18	-
Crankshaft Bearing Cap Bolts	50 + 45° + 15°	37 +45° + 15°	-
Crankshaft Position Sensor Retaining Bolt	13	-	115
Crankshaft Pulley Bolts	20	15	-
Crankshaft Timing Belt Drive Gear Bolt	130 + 40° ~ 50°	96 + 40° ~ 50°	-
Cylinder Head Bolts	25 + 90°+ 90° 90° + 15°	18 + 90°+ 90° + 90° + 15°	-
DIS Ignition Coil and EGR Mounting Bracket Bolts	25	18	-
Engine Block Lower Support Bracket/Splash Shield Bolts	35	26	-
Engine Mount Bolts/Nuts	60	44	-
Engine Mount Bracket-to-Engine Block Nuts/Bolts	90	66	-
Engine to Intake Manifold Support Bracket	20	15	-
Exhaust Camshaft Gear Bolt	50 + 60°+ 15°	37 + 60°+ 15°	-
Exhaust Flex Pipe-to-Catalytic Converter Retaining Nuts	30	22	-
Exhaust Flex Pipe-to-Exhaust Manifold Retaining Nuts	22	16	-
Exhaust Flex Pipe Support Bracket Bolts	30	22	-
Exhaust Gas Recirculation Valve Bolts	20	15	-
Exhaust Manifold Heat Shield Bolts	8	-	71
Exhaust Manifold Retaining Nuts	22	16	-
Exhaust Support Bracket Bolts	30	22	
Flexible Plate Bolts	60	44	-
Flywheel Bolts	65 + 30° + 15°	48 + 30° + 15°	-
Front Timing Belt Cover Bolts	8	-	71
Fuel Rail Retaining Bolts	25	18	-
Ignition Coil Mounting Bolts	10	-	89

FASTENER TIGHTENING SPECIFICATIONS (Cont'd)

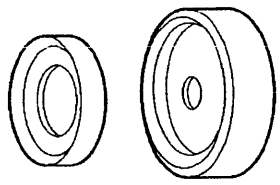
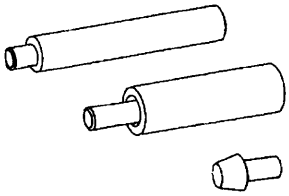
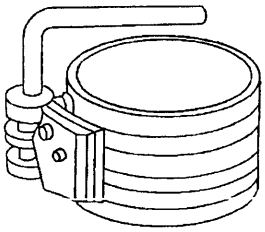
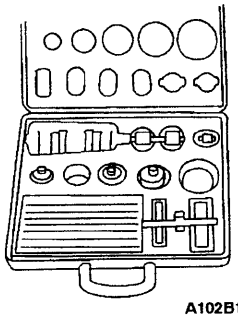
Application	N•m	Lb-Ft	Lb-In
Intake Camshaft Gear Bolt	50 + 60° + 15°	37 + 60° + 15°	-
Intake Manifold Retaining Nuts and Bolts	22	16	-
Intake Manifold Support Bracket Lower Bolts	20	15	-
Intake Manifold Support Bracket Upper Bolts	20	15	-
Oil Pan Drain Plug	35	26	-
Oil Pan Flange-to-Transaxle Retaining Bolts	40	30	-
Oil Pan Retaining Bolts	10	-	89
Oil Pressure Switch	40	30	-
Oil Pump Rear Cover Bolts	6	-	53
Oil Pump Retaining Bolts	10	-	89
Oil Pump Pickup Tube Bolts	8	-	71
Power Steering Hose Clamp Bolt	8	-	71
Pulse Pickup Sensor Disc	13	-	115
Rear Timing Belt Cover Bolts	10	-	89
Resonator Retaining Bolts	8	-	71
Safety Relief Valve Bolt	30	22	-
Spark Plug Cover Bolts	3	-	27
Spark Plugs	20	15	-
Thermostat Housing Mounting Bolts	15	11	-
Throttle Cable Bracket Bolts	8	-	71
Timing Belt Automatic Tensioner Bolt	25	18	-
Timing Belt Idler Pulley Nuts	25	18	-
Transaxle Bell Housing Bolts	75	55	-
Transaxle Torque Converter Bolts	60	44	-
Valve Cover Bolts	8	-	71

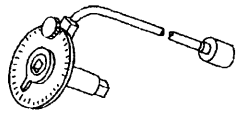
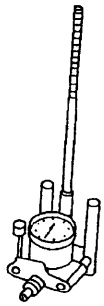
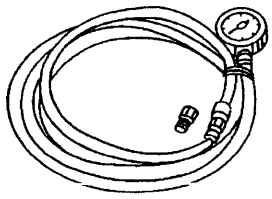
SPECIAL TOOLS

SPECIAL TOOLS TABLE

 A102C153	KM-653 Adapter
 B102C044	KM-135 Adapter
 A102C154	KM-805 Valve Guide Reamer
 A102C155	J-36792 Crankshaft Rear Oil Seal Installer
 A102B154	MKM-571-B Gauge
 A102B152	J-28467-B Engine Assembly Lift Support
 A102B159	KM-412 Engine Overhaul Stand
 A102B157	KM-348 Valve Spring Compressor

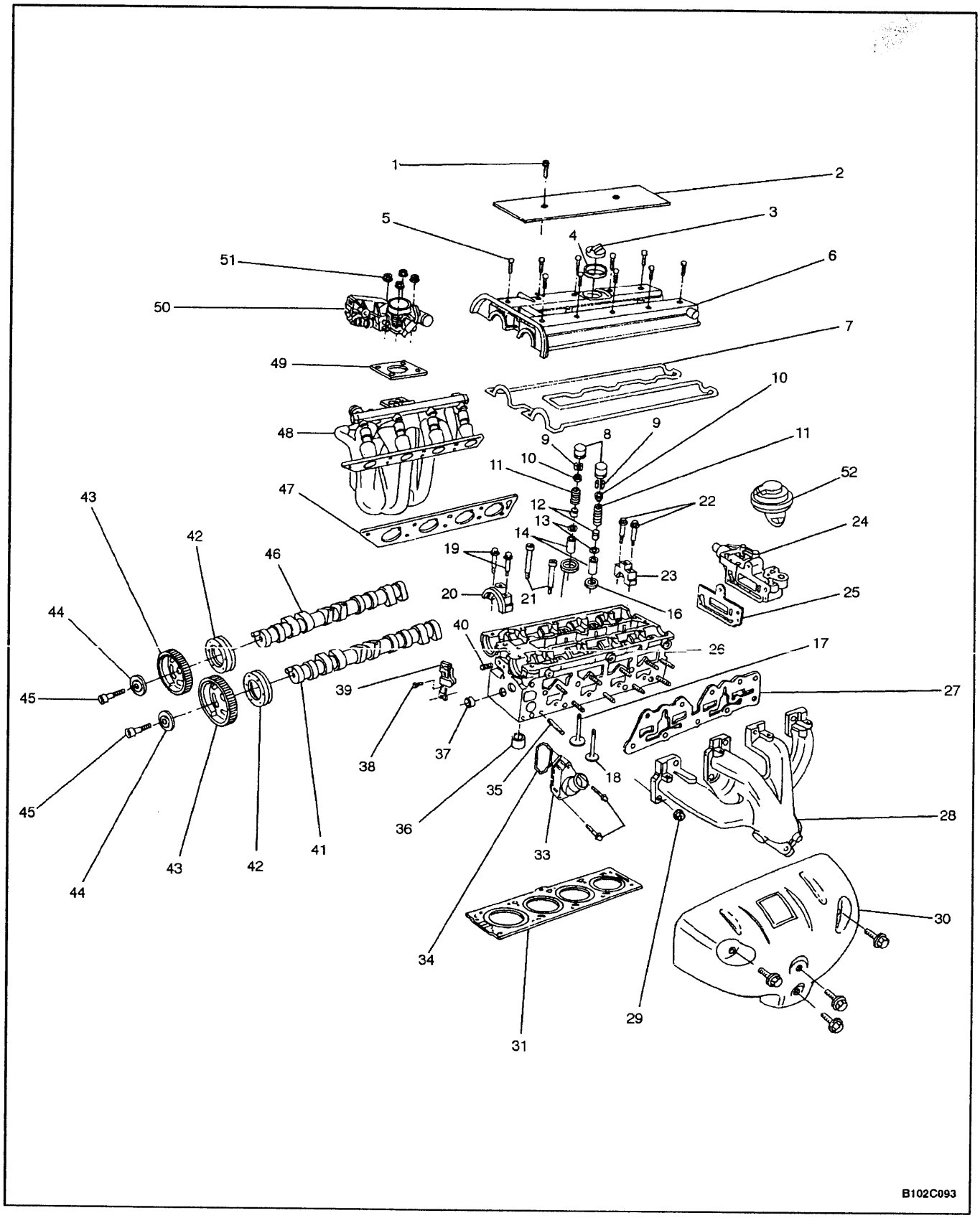
SPECIAL TOOLS TABLE (Cont'd)

 A102B160	KM-635 Crankshaft Rear Oil Seal Installer
 A102B153	KM-427 Piston Pin Service Set
 C102B004	J-8037 Universal Piston Ring Compressor
 A102B156	KM-340-0 Cutter Set Includes: KM-340-7 KM-340-13 KM-340-26

 A102B161	KM-470-B Angular Torque Gauge
 C102B005	J-8087 Cylinder Bore Check Gauge
 A202B005	KM-498-B Pressure Gauge

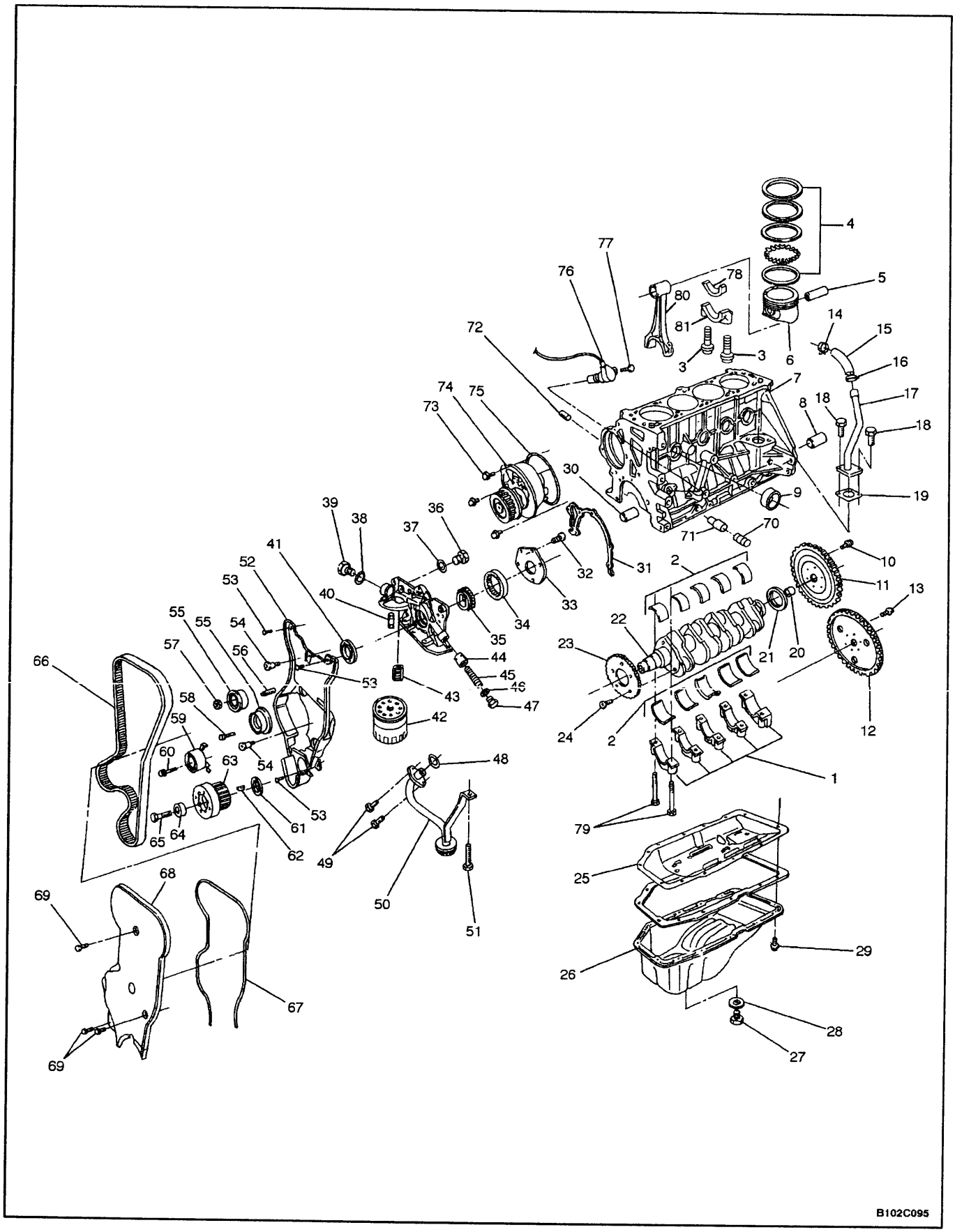
COMPONENT LOCATOR

UPPER END

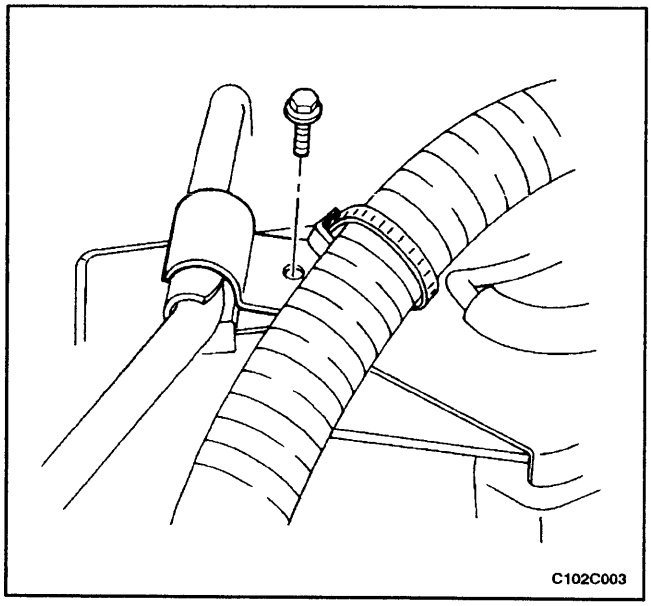


1 Bolt
2 Spark Plug Cover
3 Oil Cap
4 Oil Cap Seal
5 Bolt
6 Valve Cover
7 Valve Cover Gasket
8 Valve Lash Adjuster
9 Retainer
10 Valve Cap
11 Valve Spring
12 Valve Stem Seal
13 Valve Spring Seat
14 Valve Guide
15 Valve Spring Seat
16 Exhaust Seat
17 Inlet Valve
18 Exhaust Valve
19 Bolt
20 Front Bearing Cap
21 Head Bolt
22 Bolt
23 Bearing Cap
24 EGR Adapter
25 EGR Adapter Gasket
26 Cylinder Head
27 Exhaust Manifold Gasket
28 Exhaust Manifold
29 Nut
30 Exhaust Manifold Heat Shield
31 Cylinder Head Gasket
32 Bolt
33 Thermostat Housing
34 Thermostat Housing Gasket
35 Stud
36 Sleeve
37 Plug
38 Bolt
39 Camshaft Position Sensor
40 Oil Gallery Plug
41 Exhaust Camshaft
42 Seal Ring
43 Camshaft Gear
44 Washer
45 Camshaft Gear Bolt
46 Intake Camshaft
47 Intake Manifold Gasket
48 Intake Manifold
49 Throttle Body Gasket
50 Throttle Body
51 Nut
52 EGR Valve

LOWER END



1 Main Bearing Caps
2 Bearings, Main
3 Connecting Rod Bolt
4 Piston Ring Set
5 Piston Pin
6 Piston
7 Engine Block
8 Sleeve
9 Water Jacket Cap
10 Bolt (Manual Transaxle)
11 Flywheel (Manual Transaxle)
12 Flexible Plate (Automatic Transaxle)
13 Bolt (Automatic Transaxle)
14 Clamp
15 Hose
16 Clamp
17 Engine Vent Pipe
18 Bolt
19 Gasket
20 Transaxle Input Shaft Bearing
21 Rear Main Seal
22 Crankshaft
23 Ignition Transmit Disc
24 Bolt
25 Splash Pan and Gasket Assembly
26 Oil Pan
27 Drain Plug
28 Seal Ring
29 Bolt
30 Sleeve
31 Gasket
32 Bolt
33 Oil Pump Gear Cover
34 Ring Gear
35 Gear
36 Plug
37 Washer
38 Washer
39 Bypass Valve Plug
40 Special Screw
41 Seal
42 Oil Filter
43 Bypass Valve
44 Pressure Relief Valve Plunger
45 Pressure Relief Valve Spring
46 Washer
47 Pressure Relief Valve Plug
48 Ring Seal
49 Bolt
50 Oil Suction Pipe
51 Bolt
52 Rear Timing Belt Cover
53 Bolt
54 Special Bolt
55 Idler Pulley
56 Stud
57 Nut
58 Bolt
59 Tensioner
60 Bolt
61 Thrust Inner Washer
62 Woodruff Key
63 Crankshaft Gear
64 Thrust Outer Washer
65 Bolt
66 Camshaft Drive Belt
67 Seal
68 Front Timing Belt Cover
69 Bolt
70 Bushing Plug
71 Bushing
72 Oil Gallery Plug
73 Bolt
74 Water Pump
75 Seal Ring
76 Crankshaft Revolution Sensor
77 Bolt
78 Connecting Rod Bearings
79 Main Bearing Cap Bolts
80 Connecting Rod
81 Connecting Rod Cap


C102C003

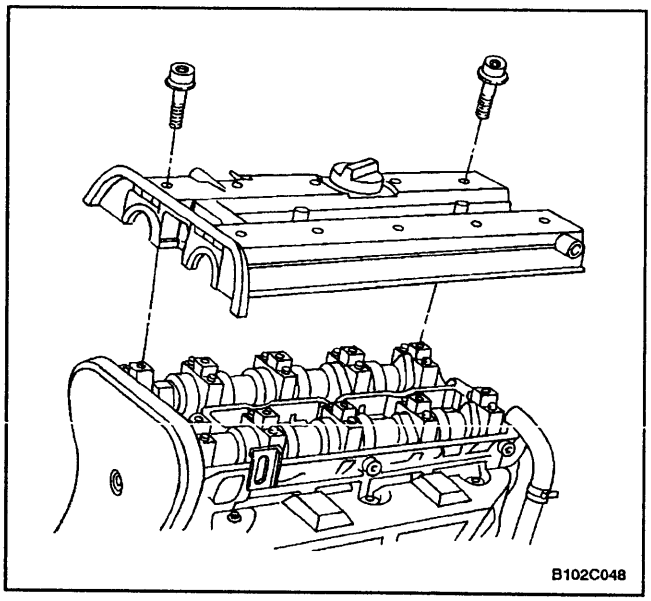
MAINTENANCE AND REPAIR

ON-VEHICLE SERVICE

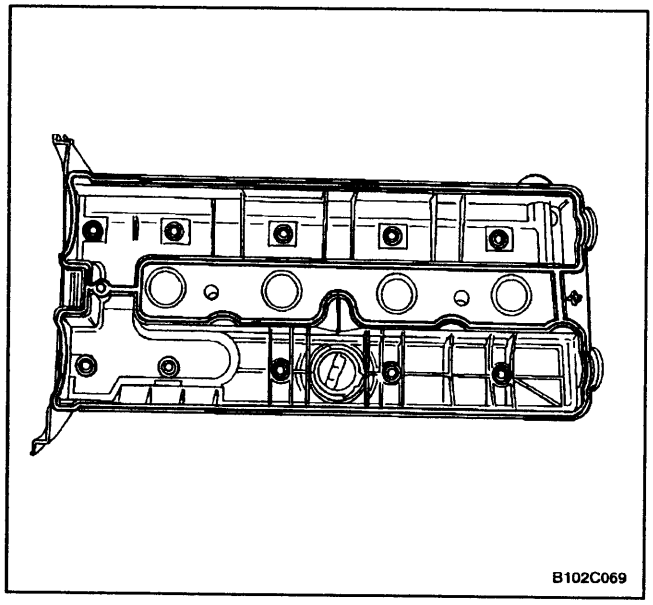
VALVE COVER

Removal Procedure

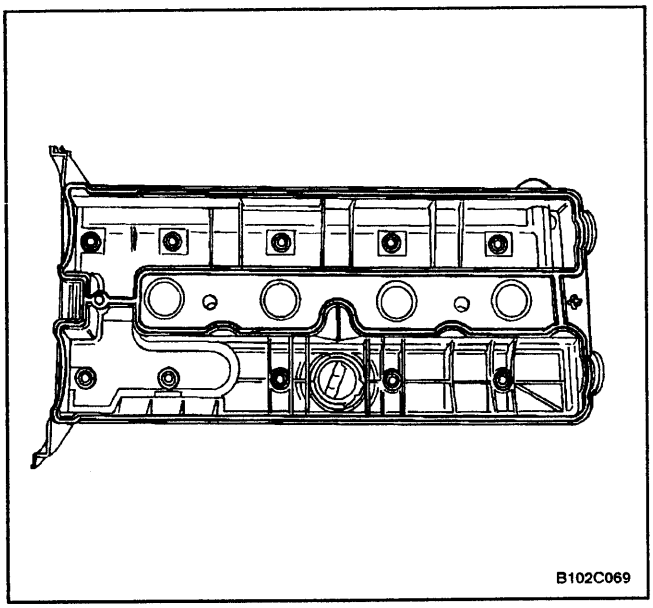
1. Disconnect the negative battery cable.
2. Disconnect the breather tube from the valve cover.
3. Disconnect all of the necessary vacuum lines.
4. Remove the spark plug cover bolts.
5. Remove the spark plug cover.
6. Disconnect the ignition wires from the spark plugs.
7. Remove the power steering hose clamp bolt and position power steering hose clamp clear of the repair area.


B102C048

8. Remove the valve cover bolts.
9. Remove the valve cover washers.
10. Remove the valve cover.

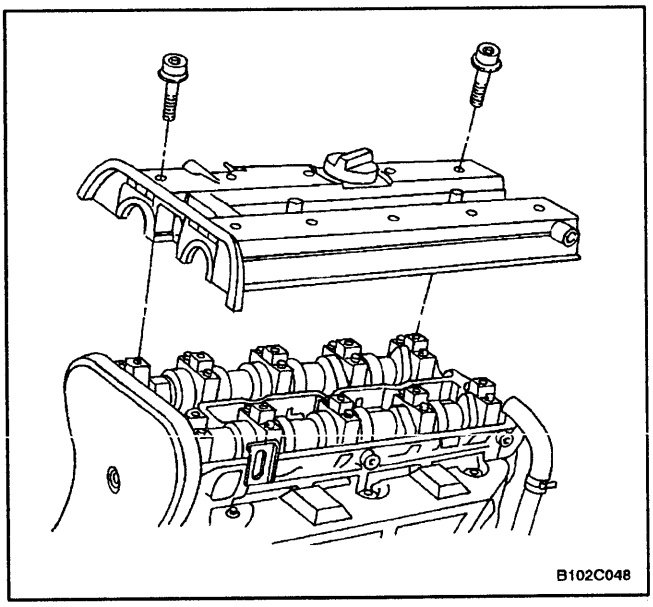

B102C069

11. Remove the valve cover gasket from the valve cover.


B102C069

Installation Procedure

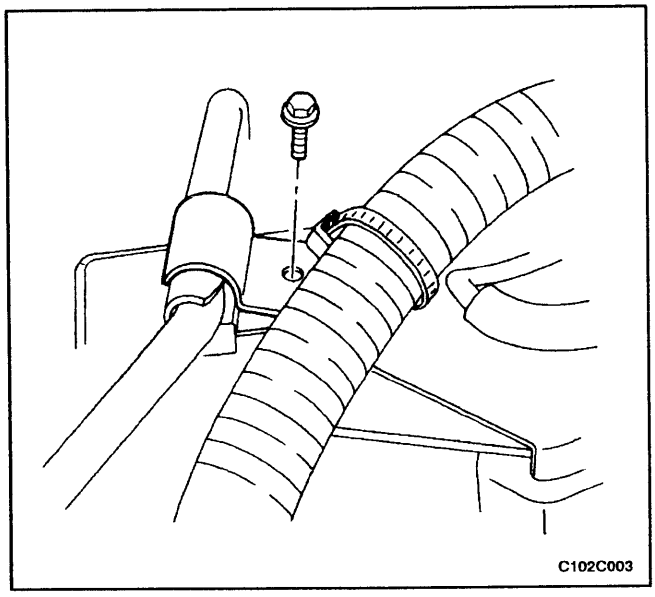
1. Apply a small amount of gasket sealant to the corners of the front camshaft caps and the top of the rear valve cover-to-cylinder head seal.
2. Install the new valve cover gasket to the valve cover.


B102C048

3. Install the valve cover.
4. Install the valve cover washers.
5. Install the valve cover bolts.

Tighten

Tighten the valve cover bolts to 8 N•m (71 lb-in).


C102C003

6. Connect the ignition wires to the spark plugs.
7. Install the spark plug cover.
8. Install the spark plug cover bolts.

Tighten

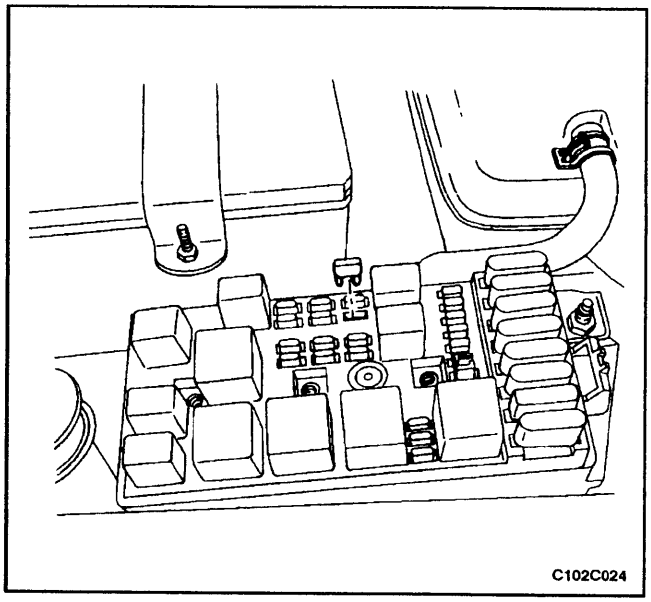
Tighten the spark plug cover bolts to 3 N•m (27 lb-in).

9. Connect all of the necessary vacuum lines.
10. Connect the breather tube to the valve cover.
11. Position the power steering pressure hose in place and install the bolt.

Tighten

Tighten the power steering hose clamp bolt to 8 N•m (71 lb-in).

12. Connect the negative battery cable.


C102C024

CYLINDER HEAD AND GASKET

(Left-Hand Drive Shown, Right-Hand Drive Similar)

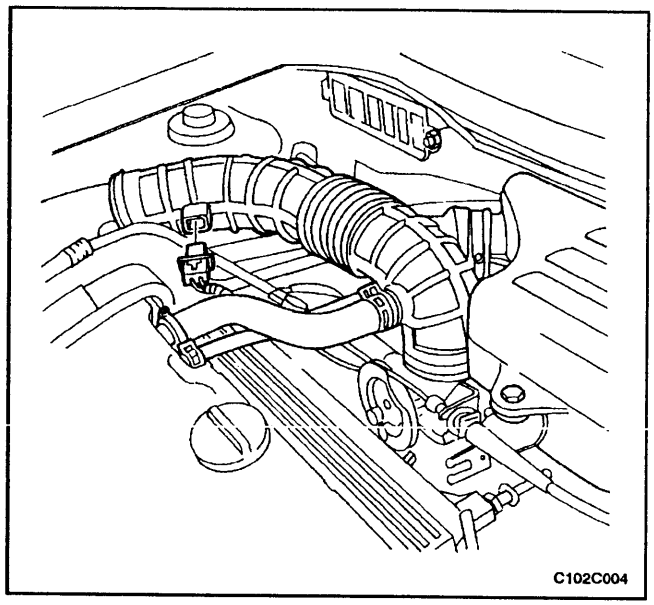
Tools Required

KM-470-B Angular Torque Gauge

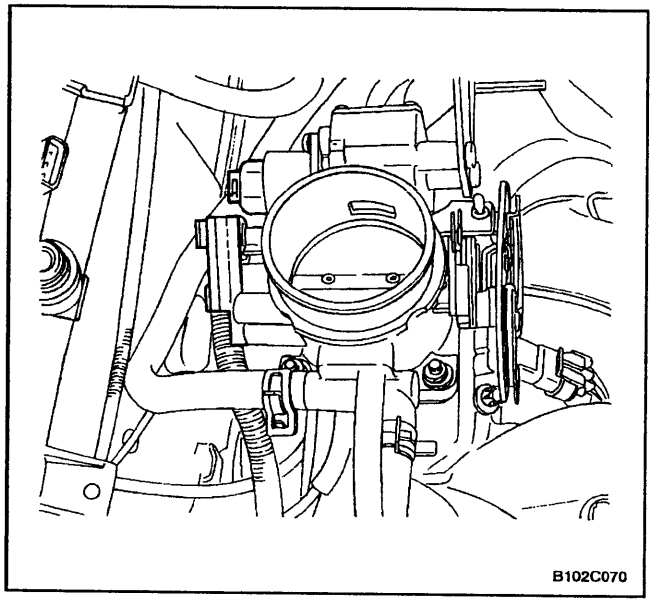
J-28467-B Engine Assembly Lift Support

Removal Procedure

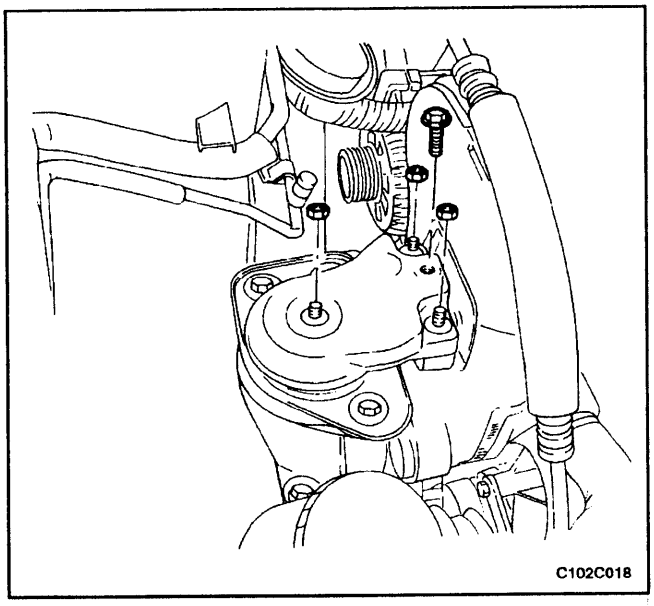
1. Remove the fuel pump fuse.
2. Start the engine. After it stalls, crank the engine for 10 seconds to rid the fuel system of fuel pressure.
3. Disconnect the negative battery cable.
4. Disconnect the electronic control module (ECM) ground terminal
5. Drain the engine coolant. Refer to *Section 1D, Engine Cooling.*


C102C004

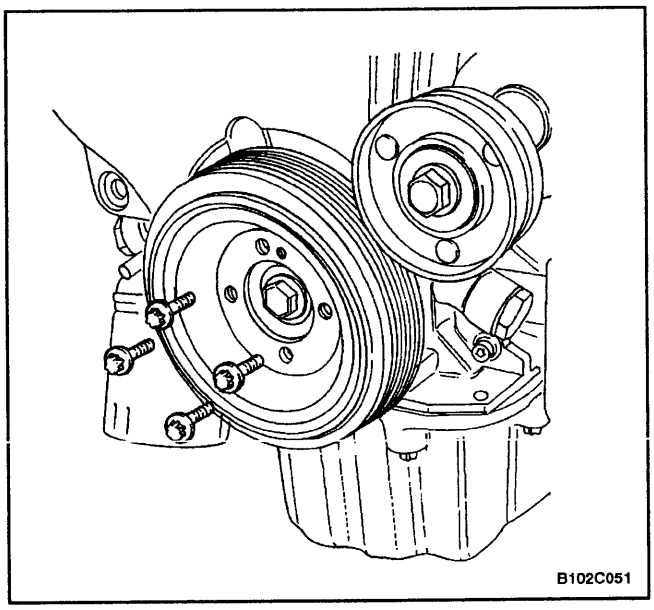
6. Disconnect the manifold air temperature sensor connector.
7. Disconnect the breather tube from the valve cover.
8. Remove the resonator retaining bolts and the resonator.
9. Remove the air intake tube.
10. Remove the canister purge and the exhaust gas recirculation (EGR) solenoids bracket bolt and reposition the cannister purge and the EGR solenoids clear of the repair area.


B102C070

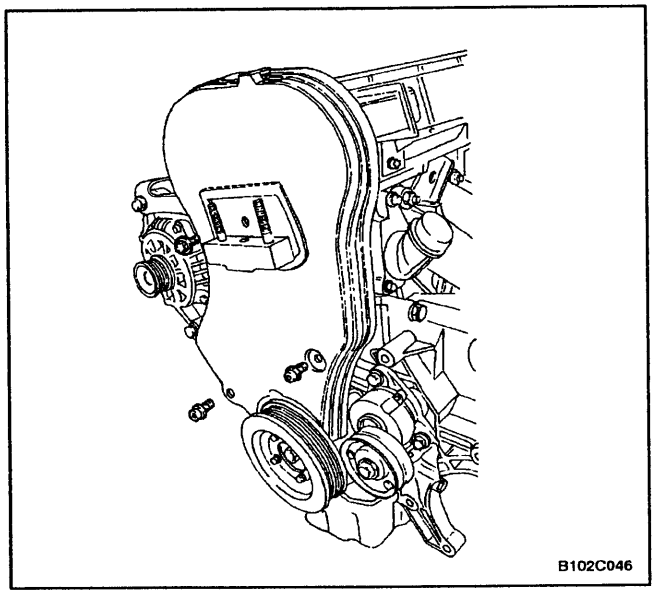
11. Disconnect the direct ignition system (DIS) ignition coil connector.
12. Disconnect the oxygen sensor connector.
13. Disconnect the idle air control valve connector.
14. Disconnect the throttle position sensor connector.
15. Disconnect the engine coolant temperature sensor connector.
16. Disconnect the coolant temperature sensor connector.


C102C018

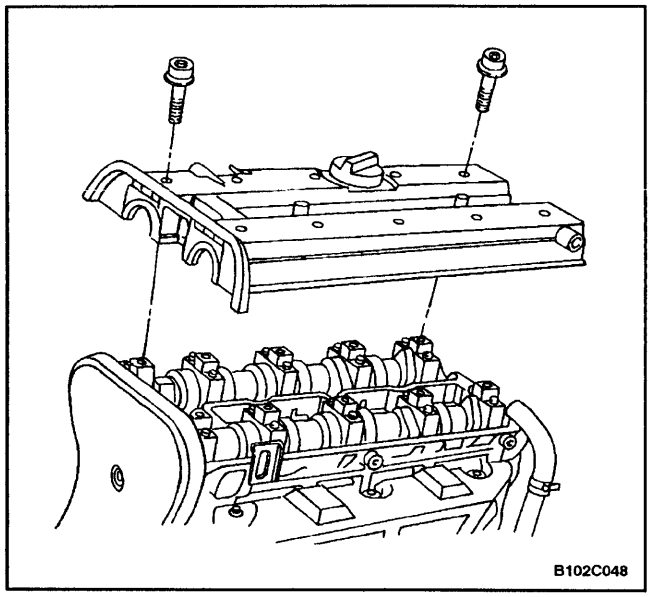
17. Remove the air filter housing bolts.
18. Remove the air filter housing.
19. Remove the right front wheel. Refer to *Section 2E, Tires and Wheels*.
20. Remove the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
21. Install the engine assembly lift support J-28467-B.
22. Remove the right engine mount bracket and the bolts.


B102C051

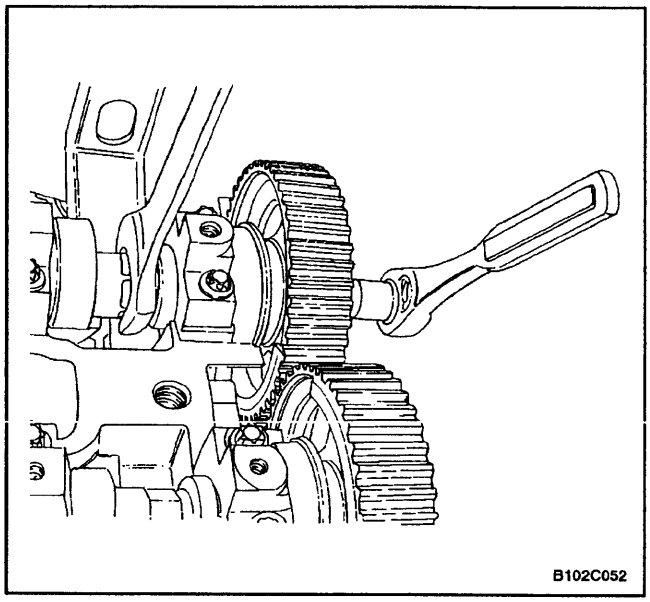
23. Disconnect the upper radiator hose at the thermostat housing.
24. Remove the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*
25. Remove the crankshaft pulley bolts.
26. Remove the crankshaft pulley.


B102C046

27. Remove the front timing belt cover bolts.
28. Remove the front timing belt cover.

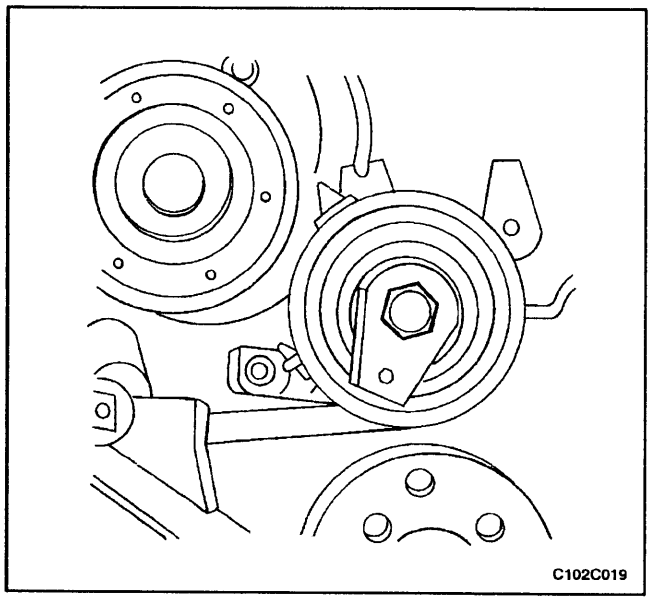

B102C048

29. Remove the timing belt. Refer to "Timing Belt" in this section.
30. Disconnect the breather tube at the valve cover.
31. Remove the spark plug cover bolts.
32. Remove the spark plug cover.
33. Disconnect the ignition wires from the spark plugs.
34. Remove the valve cover bolts.
35. Remove the valve cover washers.
36. Remove the valve cover and the valve cover gasket.

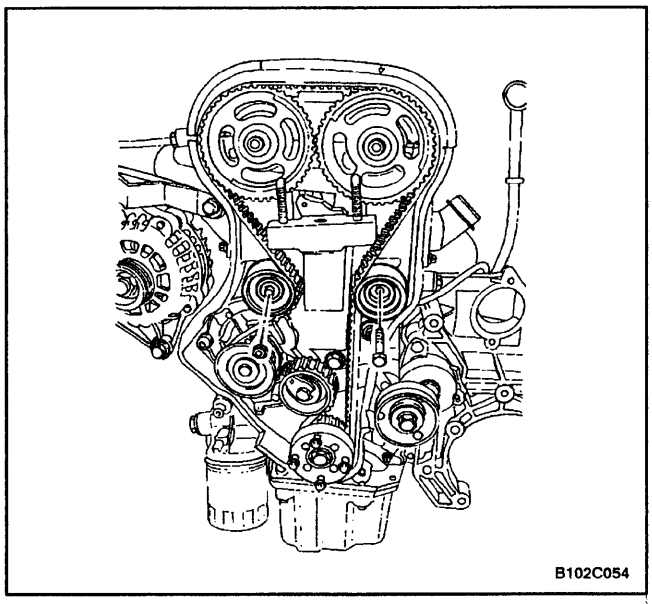

B102C052

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

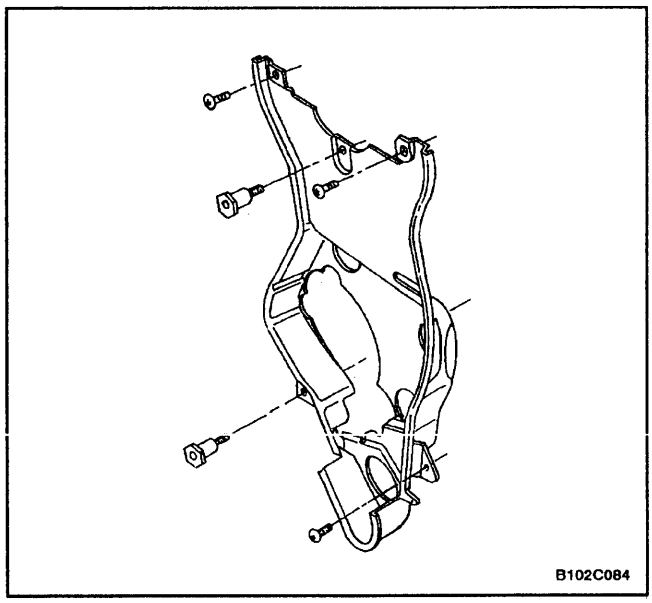
37. While holding the intake camshaft firmly in place, remove the intake camshaft gear bolt.
38. Remove the intake camshaft gear.
39. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft gear bolt.
40. Remove the exhaust camshaft gear.


C102C019

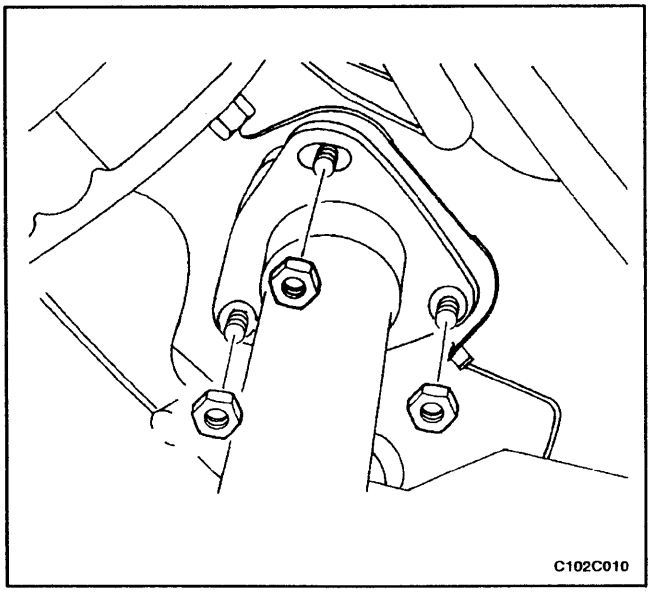
41. Remove the timing belt automatic tensioner bolts.
42. Remove the timing belt automatic tensioner.


B102C054

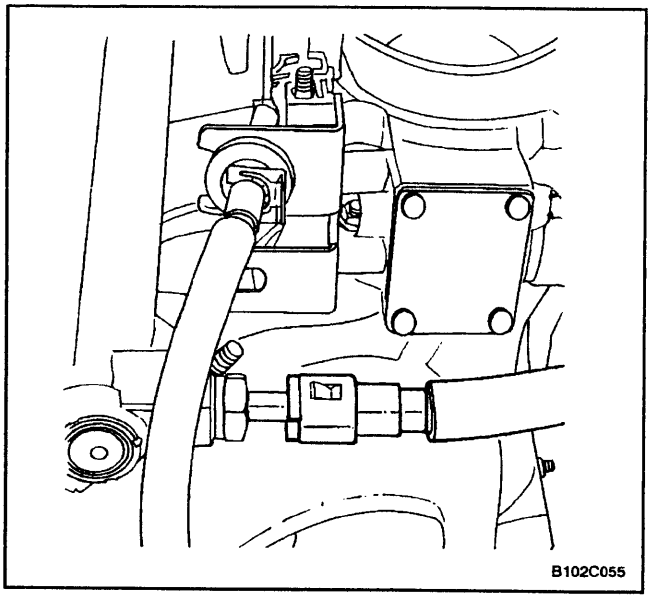
43. Remove the timing belt idler pulley nuts.
44. Remove the timing belt idler pulleys.
45. Remove the engine mount bolts.
46. Remove the engine mount.


B102C084

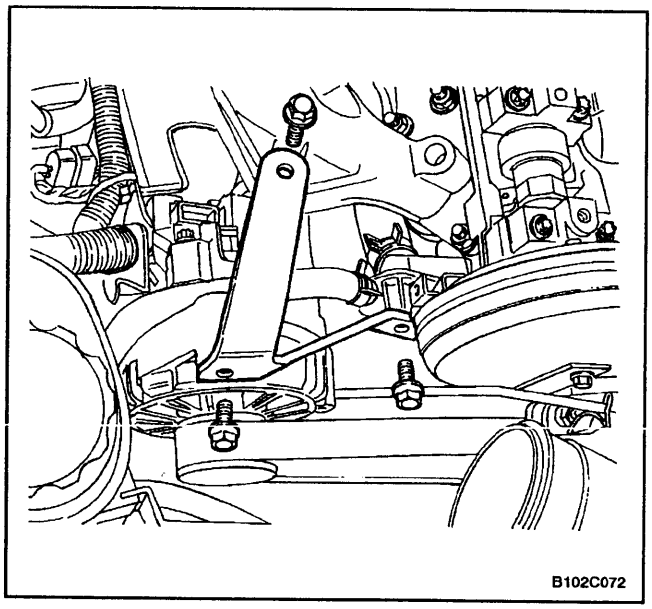
47. Remove the rear timing belt cover bolts.
48. Remove the rear timing belt cover.


C102C010

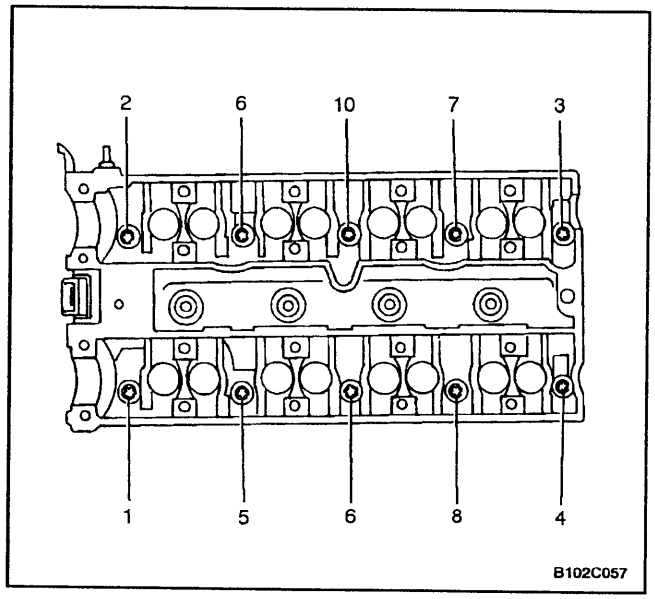
49. Remove the exhaust flex pipe retaining nuts from the exhaust manifold studs.
50. Disconnect all of the necessary vacuum hoses.


B102C055

51. Disconnect the fuel return line at the fuel pressure regulator.
52. Disconnect the fuel feed line at the fuel rail.
53. Disconnect the coolant hose at the rear cylinder head and ignition coil EGR bracket.
54. Disconnect the surge tank coolant hose at the throttle body.
55. Remove the fuel rail assembly. Refer to *Section 1F, Engine Controls.*


B102C072

56. Remove the alternator-to-intake manifold support bracket bolts at the cylinder head coolant bypass and the intake manifold.
57. Remove the alternator support bracket.
58. Remove the intake manifold-to-alternator strap bracket bolt and loosen the bolt on the alternator.
59. Move the strap clear of the intake manifold.

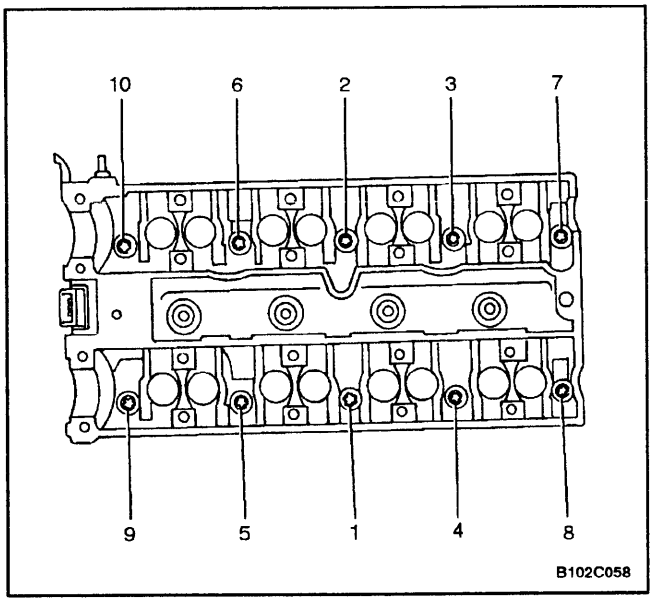


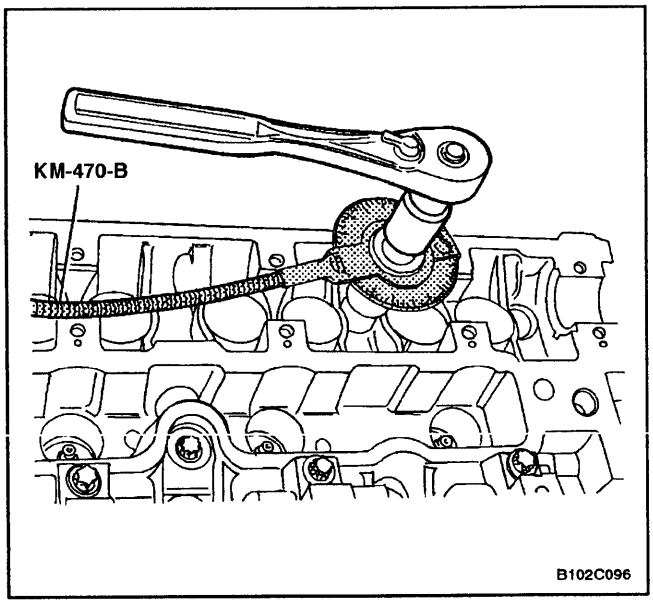
B102C057

60. Disconnect the throttle cable at the throttle body and the intake manifold.
61. Loosen all of the cylinder head bolts gradually and in the sequence shown.
62. Remove the cylinder head bolts.
63. Remove the cylinder head with the intake manifold and the exhaust manifold attached.

Notice: Prevent any engine oil or coolant from entering the cylinders when removing the cylinder head.

64. Remove the cylinder head gasket.





Cleaning Procedure

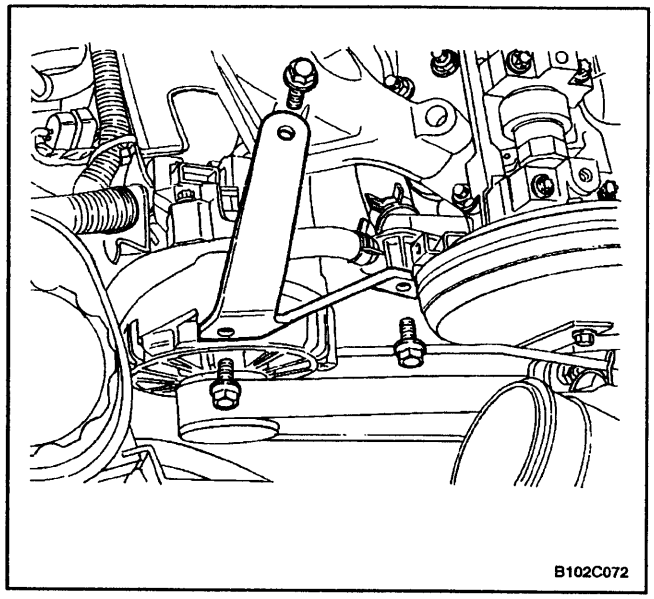
1. Clean the gasket surfaces of the cylinder head and the engine block.
2. Make sure the gasket surfaces of the cylinder head and the engine block are free of nicks and heavy scratches.
3. Clean the cylinder head bolts.
4. Inspect the cylinder head for warpage. Refer to "Cylinder Head and Valve Train Components" in this section.

Installation Procedure

1. Install the cylinder head gasket.
2. Install the cylinder head with the intake manifold and the exhaust manifold attached.
3. Install the cylinder head bolts.
4. Tighten the cylinder head bolts gradually and in the sequence shown.

Tighten

Tighten the cylinder head bolts to 25 N•m (18 lb-ft). After an engine warm-up of 30 to 50 minutes, turn the bolts another 3 turns of 90 degrees and 1 turn of 15 degrees, using the angular torque gauge KM-470-B.


B102C072

5. Connect the throttle cable at the throttle body and the intake manifold.
6. Install the alternator-to-intake manifold support bracket.
7. Install the alternator-to-intake manifold support bracket bolts.

Tighten

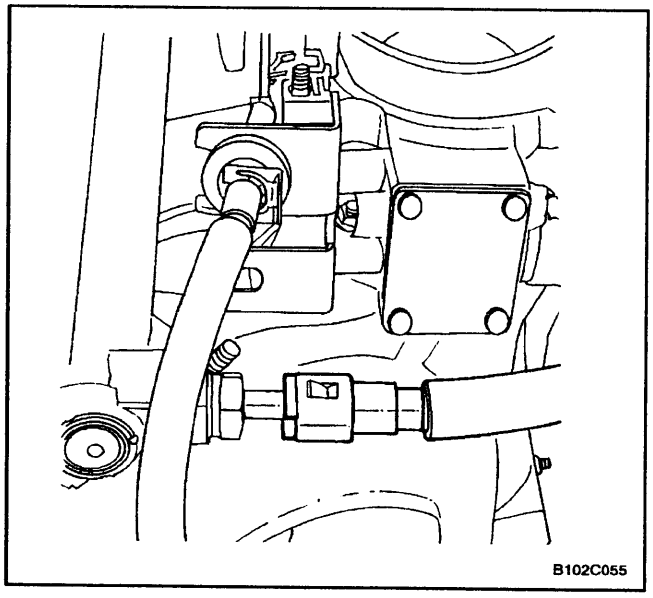
Tighten the alternator-to-intake manifold support bracket bolts to 35 N•m (26 lb-ft).

8. Install the intake manifold strap bracket bolts to the alternator.

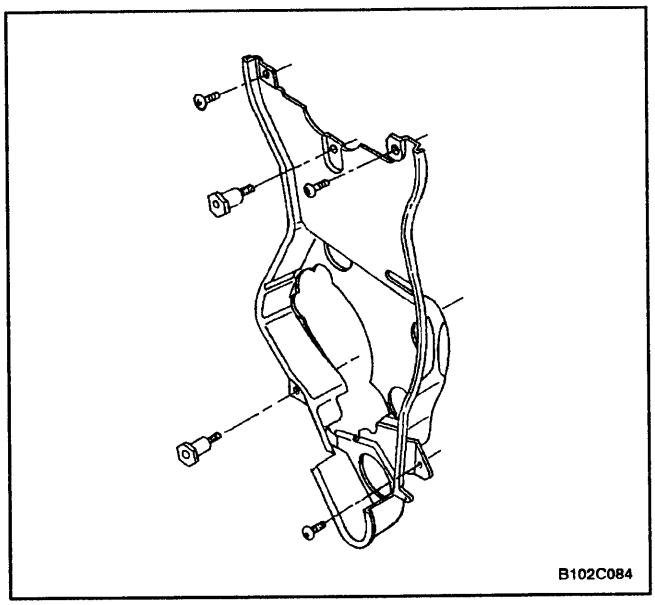
Tighten

Tighten the alternator-to-intake manifold strap bracket bolts to 20 N•m (15 lb-ft).

9. Connect the surge tank coolant hose at the throttle body.
10. Connect the coolant hose to the rear cylinder head and ignition coil EGR bracket.


B102C055

11. Connect the fuel feed line at the fuel rail.
12. Connect the fuel return line at the fuel rail.
13. Connect all of the necessary vacuum hoses.
14. Install the fuel rail assembly. Refer to *Section 1F, Engine Controls.*


B102C084

15. Install the exhaust flex pipe retaining nuts to the exhaust manifold studs.

Tighten

Tighten the exhaust flex pipe-to-exhaust manifold retaining nuts to 22 N•m (16 lb-ft).

16. Install the rear timing belt cover.
17. Install the rear timing belt cover bolts.

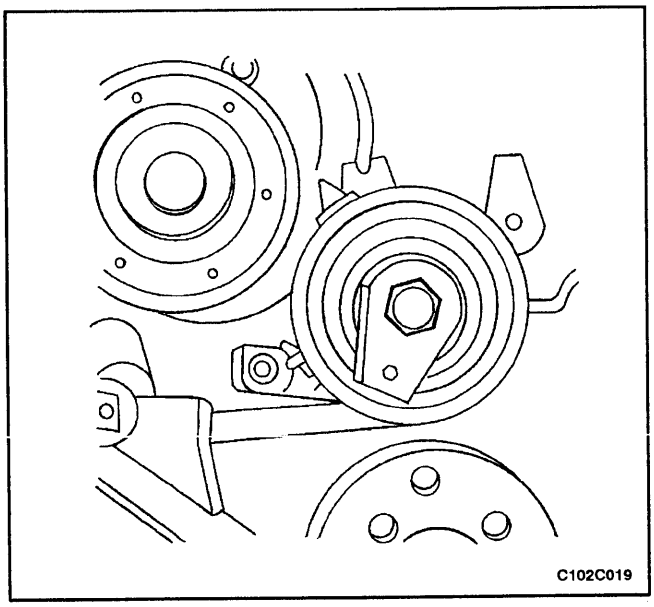
Tighten

Tighten the rear timing belt cover bolts to 10 N•m (89 lb-in).

18. Install the engine mount bolts.

Tighten

Tighten the engine mount bolts to 60 N•m (44 lb-ft).


C102C019

19. Install the timing belt automatic tensioner.
20. Install the timing belt automatic tensioner bolt.

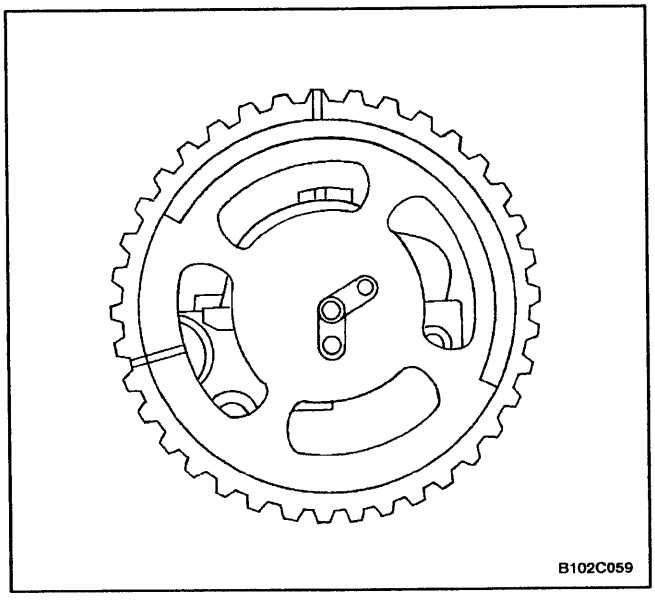
Tighten

Tighten the timing belt automatic tensioner bolt to 25 N•m (18 lb-ft).

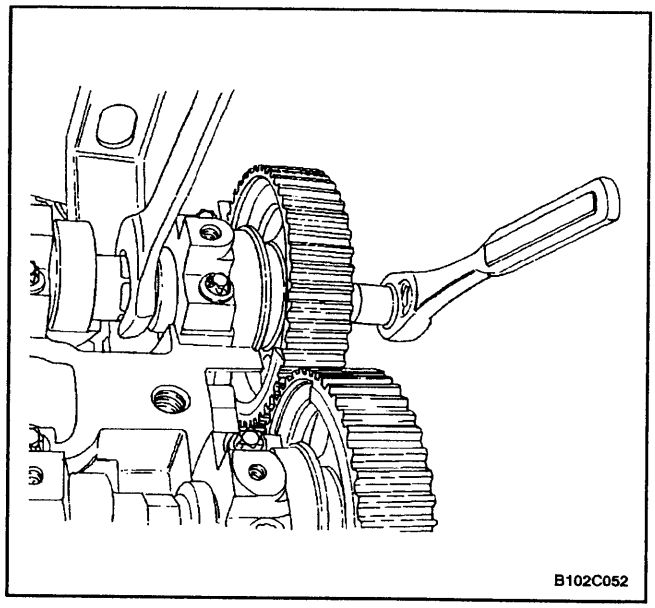
21. Install the timing belt idler pulleys.
22. Install the timing belt idler pulley nuts.

Tighten

Tighten the timing belt idler pulley nuts to 25 N•m (18 lb-ft).


B102C059

23. Install the camshaft gears with the timing marks at the front.
24. Insert the guide pin of the intake camshaft into the "IN" bore.
25. Insert the guide pin of the exhaust camshaft into the "EX" bore.



B102C052

26. Install the camshaft gears by counterholding on the hex of the camshaft with an open end wrench.
27. Install the camshaft gear with a new bolt to the camshaft.

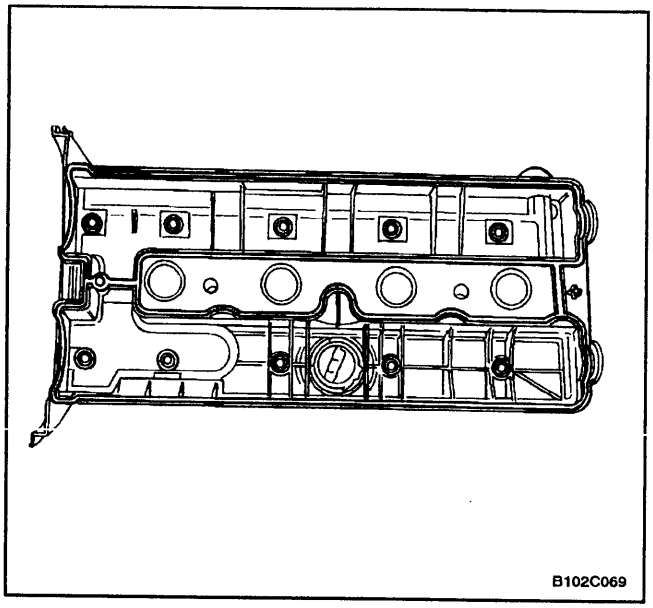
Tighten

Tighten the intake camshaft gear bolt to 50 N•m (37 lb-ft), turn the bolt another 60 degrees and 15 degrees using the angular torque gauge.

28. While holding the exhaust camshaft firmly in place, install the exhaust camshaft gear bolt.

Tighten

Tighten the exhaust camshaft gear bolt to 50 N•m (37 lb-ft), turn the bolt another 60 degrees and 15 degrees using the angular torque gauge.

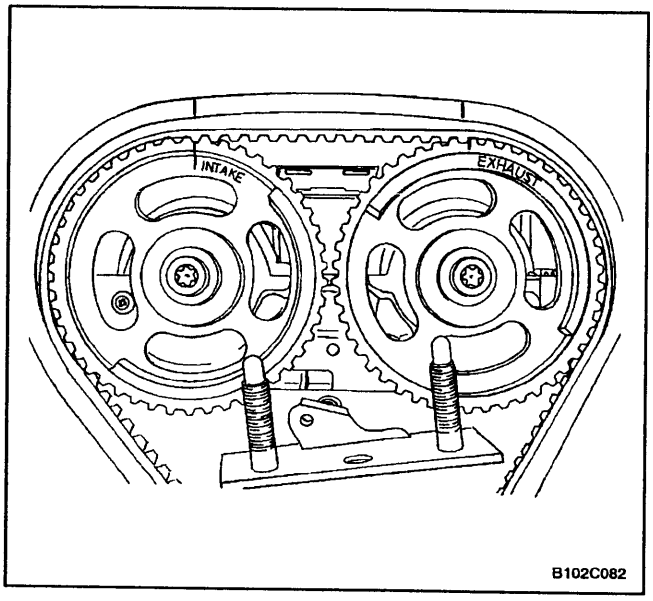


B102C069

29. Apply a small amount of gasket sealant to the corners of the front camshaft caps and to the top of the rear valve cover-to-cylinder head seal.
30. Install the valve cover and the valve cover gasket.
31. Install the valve cover washers.
32. Install the valve cover bolts.

Tighten

Tighten the valve cover bolts to 8 N•m (71 lb-in).



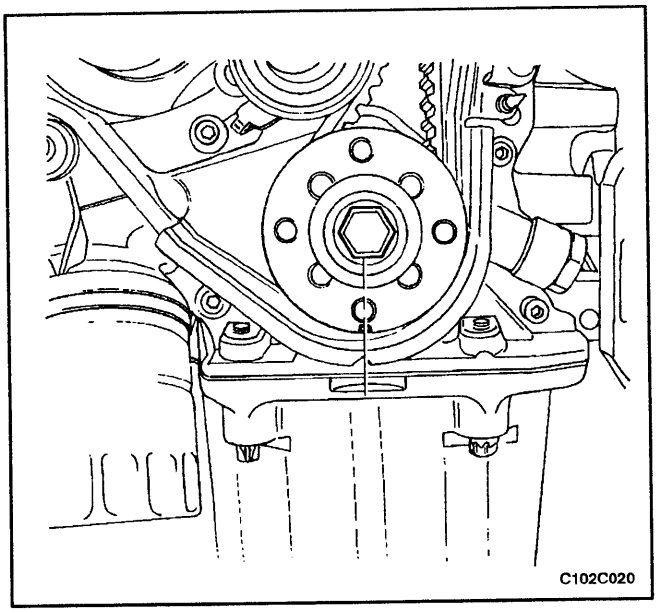
B102C082

33. Connect the ignition wires to the spark plugs.
34. Install the spark plug cover.
35. Install the spark plug cover bolts.

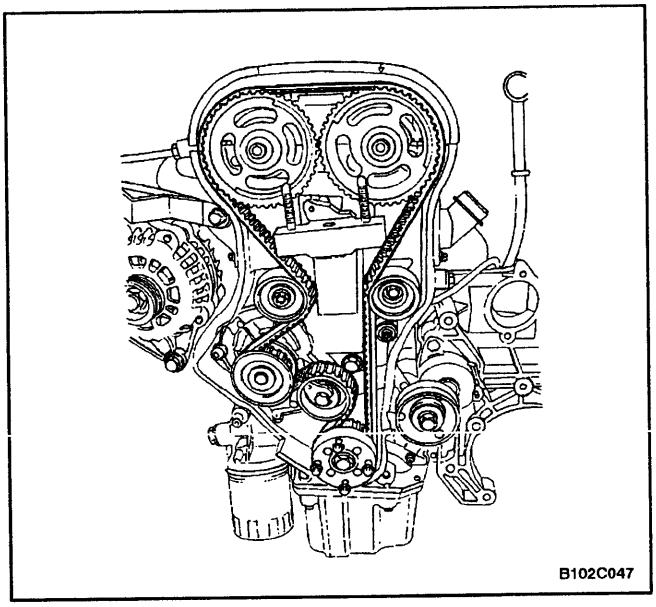
Tighten

Tighten the spark plug cover bolts to 3 N•m (27 lb-in).

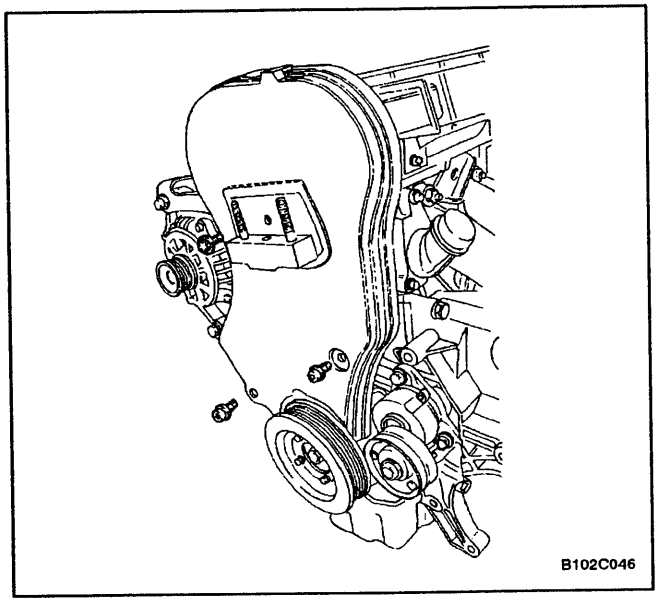
36. Connect the breather tube to the valve cover.
37. Align the timing marks on the camshaft gears to the notches on the valve cover, using the intake gear mark for the intake gear and the exhaust gear mark for the exhaust gear.


C102C020

38. Align the mark on the crankshaft gear with the notch at the bottom of the rear timing belt cover.


B102C047

39. Install the timing belt. Refer to "Timing Belt" in this section.
40. Check and adjust the timing belt tension. Refer to "Timing Belt Check and Adjust" in this section.


B102C046

41. Install the front timing belt cover.
42. Install the front timing belt cover bolts.

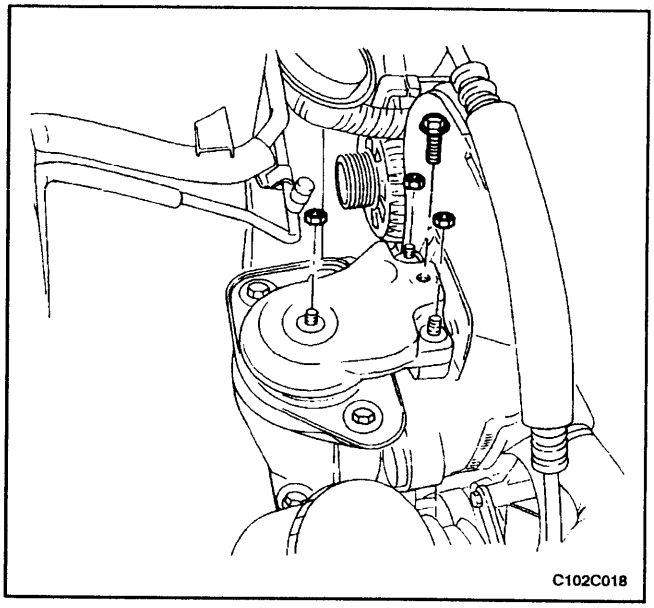
Tighten

Tighten the front timing belt cover bolts to 8 N•m (71 lb-in).

43. Install the crankshaft pulley.
44. Install the crankshaft pulley bolts.

Tighten

Tighten the crankshaft pulley bolts to 20 N•m (15 lb-ft).

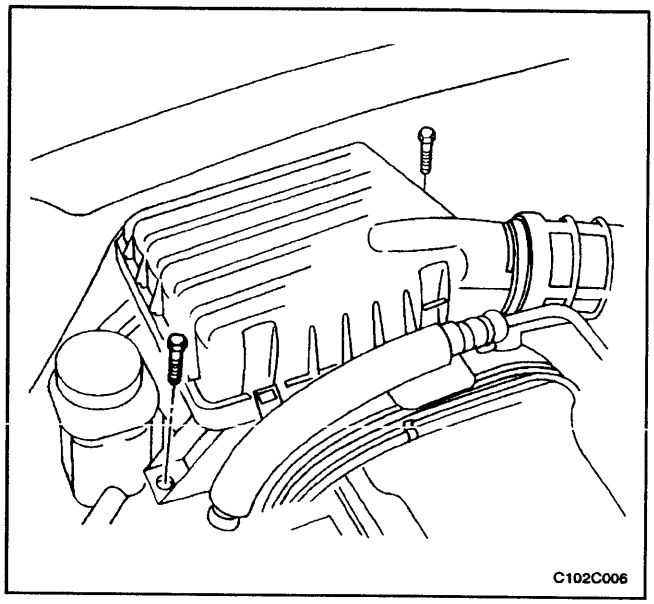

C102C018

45. Install the right engine mount bracket, the retaining bolts, and the nut.

Tighten

Tighten the engine mount bolts to 60 N•m (44 lb-ft).

46. Remove the engine assembly lift support J-28467-B.
47. Install the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*
48. Connect the upper radiator hose to the thermostat housing.
49. Install the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
50. Install the right front wheel. Refer to *Section 2E, Tires and Wheels.*


C102C006

51. Install the air filter housing.
52. Install the air filter housing bolts.

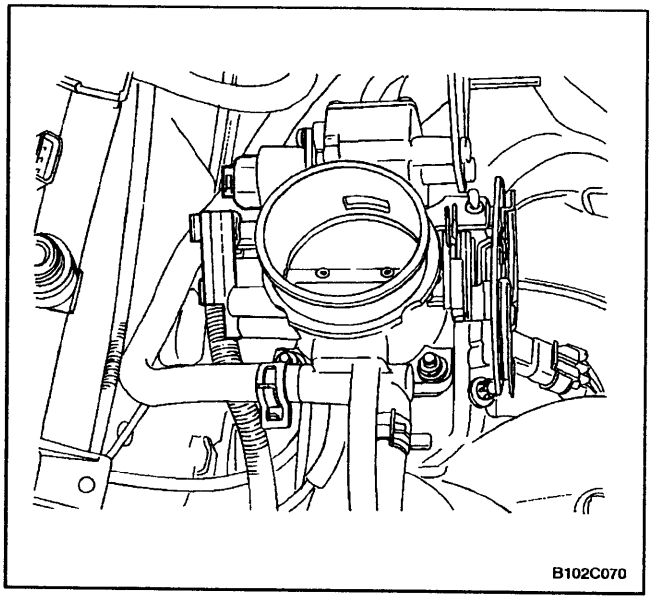
Tighten

Tighten the air filter housing bolts to 8 N•m (71 lb-in).

53. Connect the air intake tube to the throttle body.
54. Connect the breather tube to the valve cover.
55. Connect the manifold air temperature sensor connector.
56. Install the resonator and the retaining bolts.

Tighten

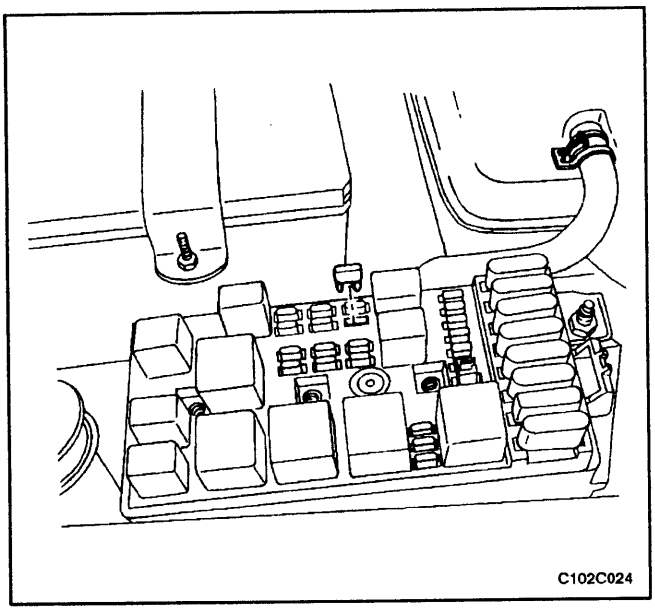
Tighten the resonator retaining bolts to 8 N•m (71 lb-in).


B102C070

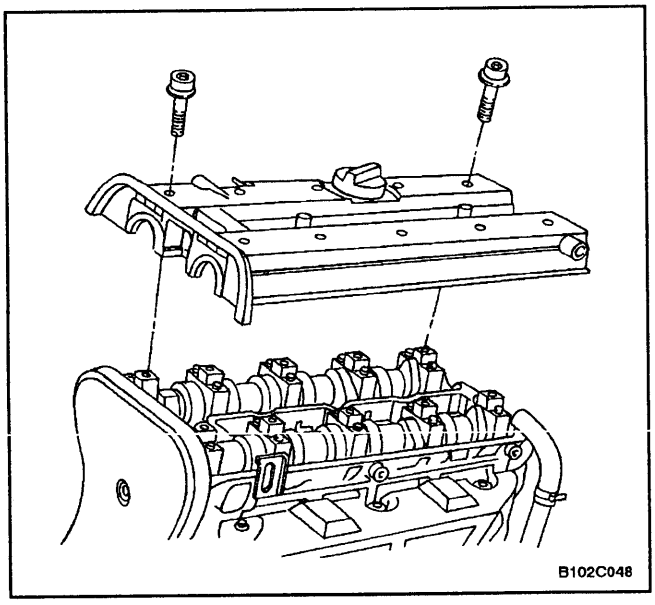
57. Connect the coolant temperature sensor connector.
58. Connect the engine coolant temperature sensor connector.
59. Connect the idle air control valve connector.
60. Connect the throttle position sensor connector.
61. Install the canister purge and the EGR solenoids bracket bolt.

Tighten

Tighten the canister purge and the EGR solenoids bracket bolt to 5 N•m (44 lb-in).


C102C024

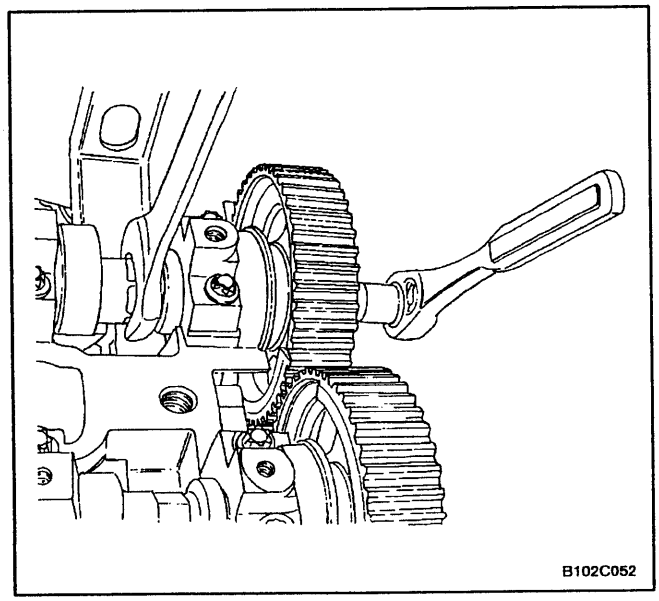
62. Connect the DIS ignition coil connector.
63. Connect the oxygen sensor connector.
64. Connect the ECM ground terminal.
65. Install the fuel pump fuse.
66. Connect the negative battery ground cable.
67. Refill the engine cooling system. Refer to *Section 1D, Engine Cooling.*


B102C048

CAMSHAFTS

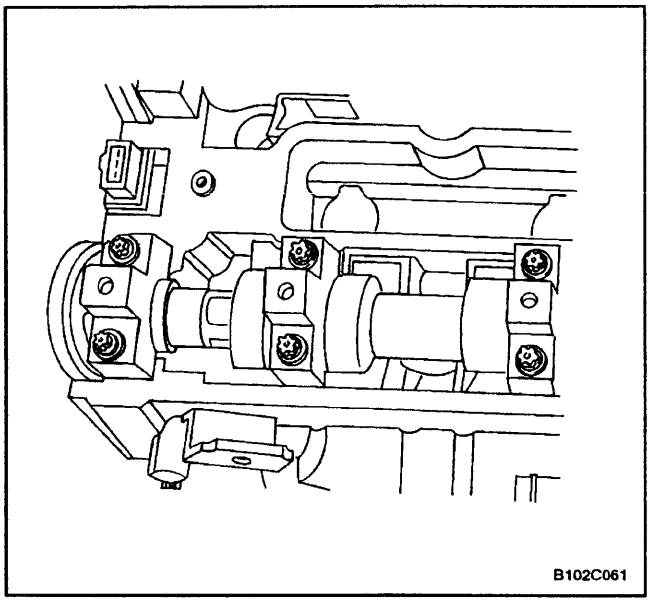
Removal Procedure

1. Remove the timing belt. Refer to "Timing Belt" in this section.
2. Disconnect the breather tube at the valve cover.
3. Disconnect the crankcase ventilation tube at the valve cover.
4. Remove the spark plug cover bolts.
5. Remove the spark plug cover.
6. Disconnect the ignition wires from the spark plugs.
7. Remove the valve cover bolts.
8. Remove the valve cover washers.
9. Remove the valve cover and the valve cover gasket.


B102C052

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

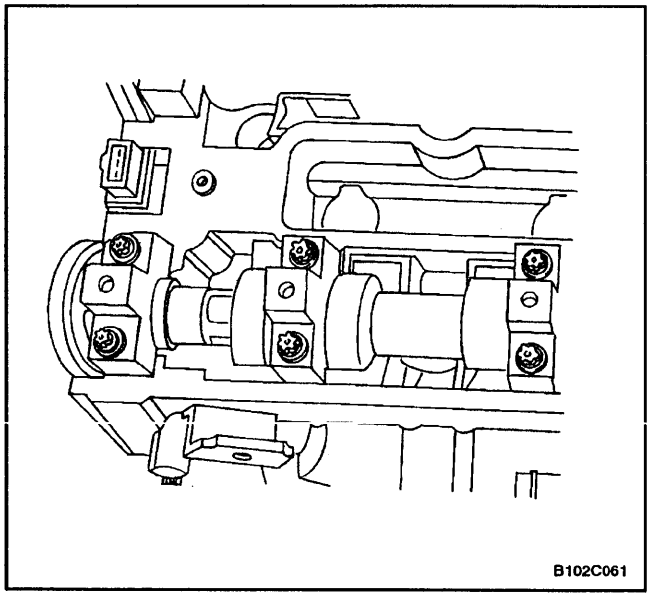
10. While holding the intake camshaft firmly in place, remove the intake camshaft gear bolt.
11. Remove the intake camshaft gear.
12. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft gear bolt.
13. Remove the exhaust camshaft gear.


B102C061

14. Loosen the camshaft bearing cap bolts in stages of one-half to one turn.
15. Remove the camshaft bearing cap bolts from the cylinder head.
16. Remove the camshafts.
17. Remove the seal ring from the camshafts.

Important: The camshaft must detach evenly from the bearing seats in the front guide bearing.

18. Check the camshaft and bearing seats for wear and replace them if necessary.


B102C061

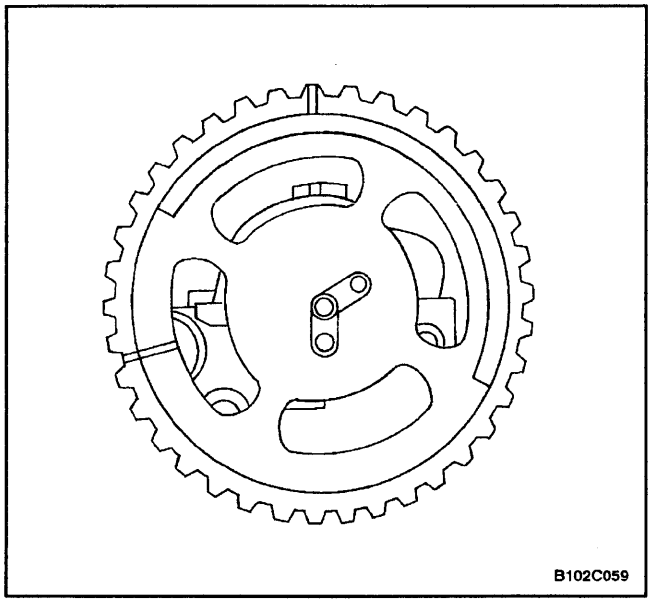
Installation Procedure

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

1. Lubricate the camshaft journals and the camshaft caps with engine oil.
2. Install the intake camshaft.
3. Install the intake camshaft caps in their original positions.
4. Install the intake camshaft cap bolts.
5. Install the exhaust camshaft.
6. Install the exhaust camshaft caps in their original positions.
7. Install the exhaust camshaft cap bolts.
8. Tighten the camshaft cap bolts gradually.

Tighten

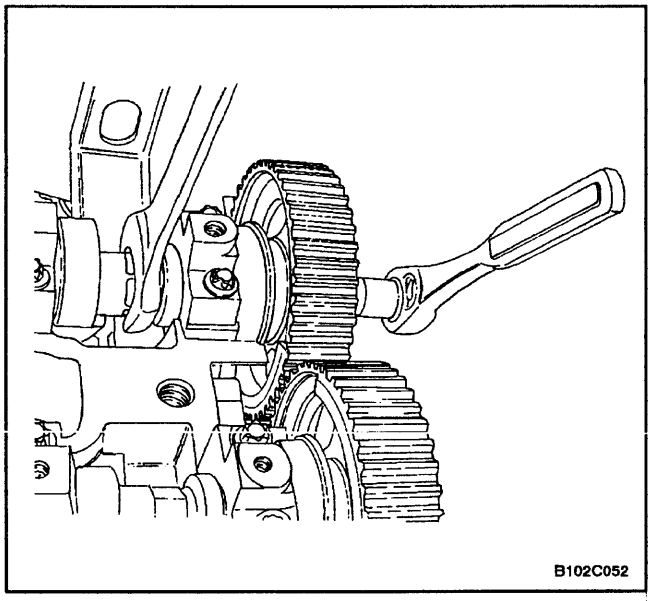
Tighten the camshaft bearing cap bolts to 8 N•m (71 lb-in).


B102C059

9. Measure the intake camshaft end play and the exhaust camshaft end play. Refer to "Engine Specifications" in this section.
10. Install the intake camshaft gear.
11. While holding the intake camshaft firmly in place, install the intake camshaft gear bolt.

Tighten

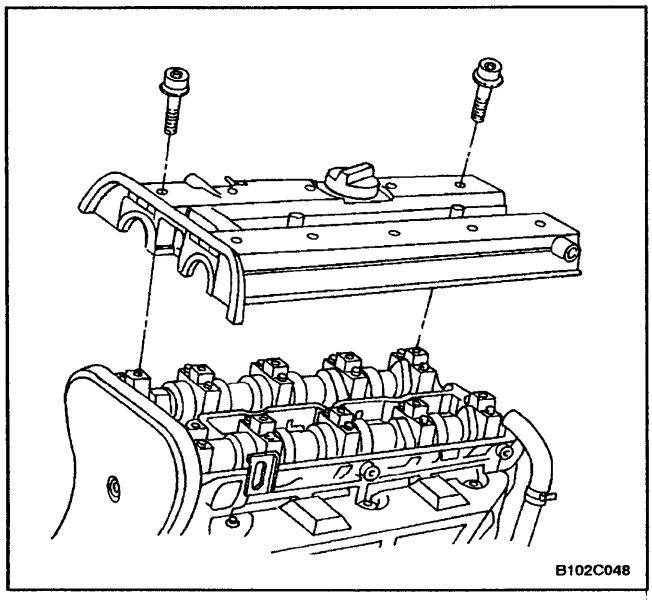
Tighten the intake camshaft gear bolt to 50 N•m (37 lb-ft), turn the bolt another 60 degrees and 15 degrees using the angular torque gauge.


B102C052

12. Install the exhaust camshaft gear.
13. While holding the exhaust camshaft firmly in place, install the exhaust camshaft gear bolt.

Tighten

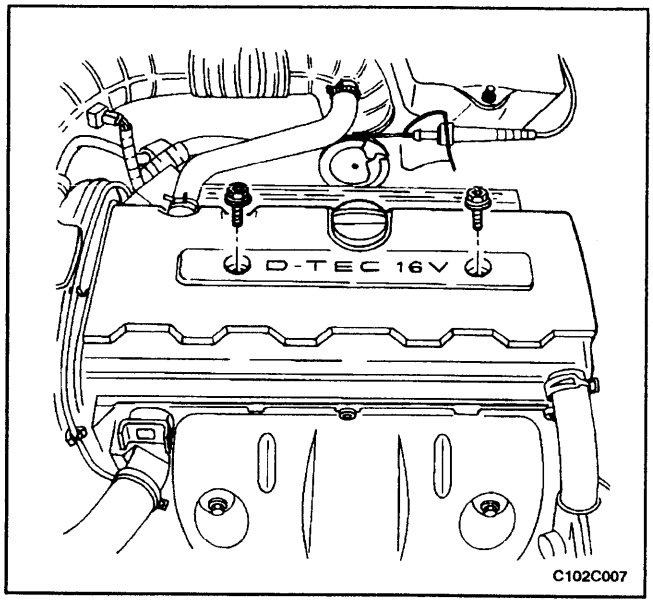
Tighten the exhaust camshaft gear bolt to 50 N•m (37 lb-ft), turn the bolt another 60 degrees and 15 degrees using the angular torque gauge.


B102C048

14. Install the valve cover and the valve cover gasket.
15. Install the valve cover washers.
16. Install the valve cover bolts.

Tighten

Tighten the valve cover bolts to 8 N•m (71 lb-in).

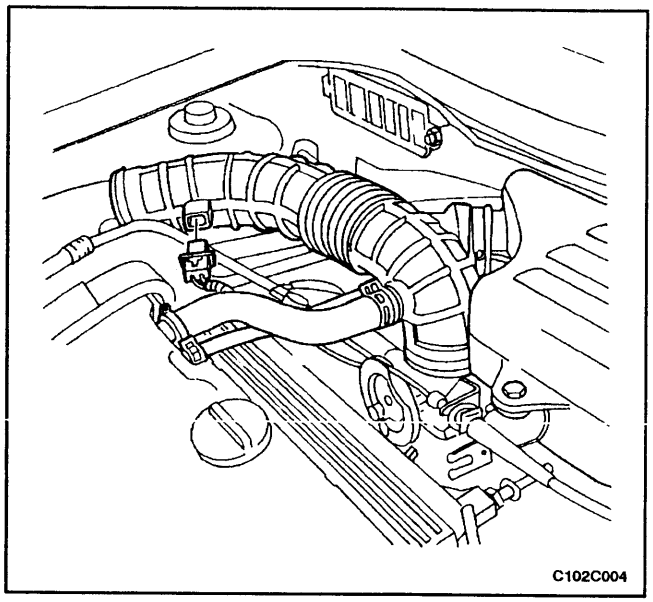


17. Connect the ignition wires to the spark plugs.
18. Install the spark plug cover.
19. Install the spark plug cover bolts.

Tighten

Tighten the spark plug cover bolts to 3 N•m (27 lb-in).

20. Connect the breather tube to the valve cover.
21. Connect the crankcase ventilation tube to the valve cover.
22. Install the timing belt. Refer to "Timing Belt" in this section.

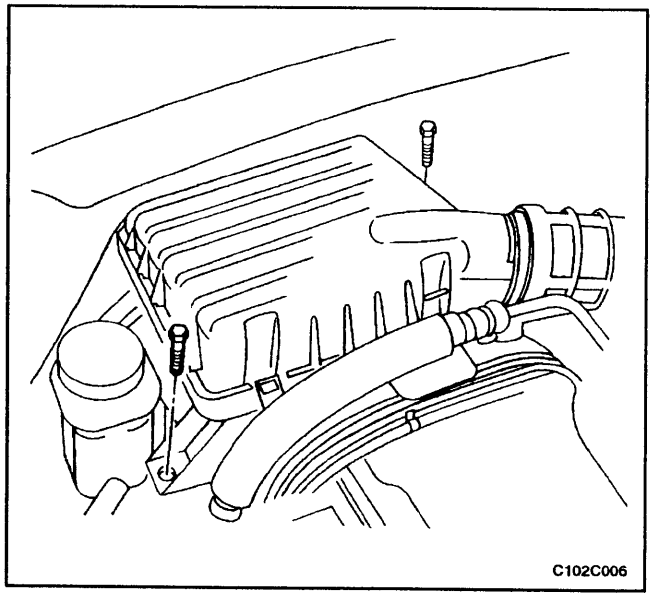


TIMING BELT CHECK AND ADJUST

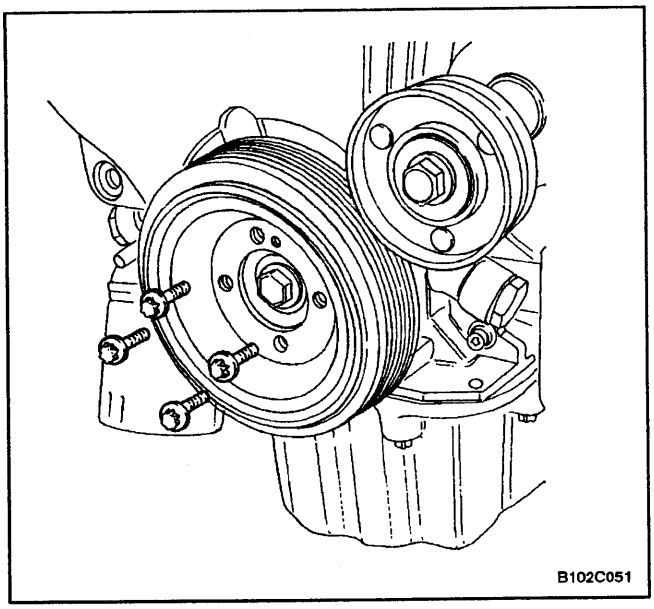
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Adjustment Procedure

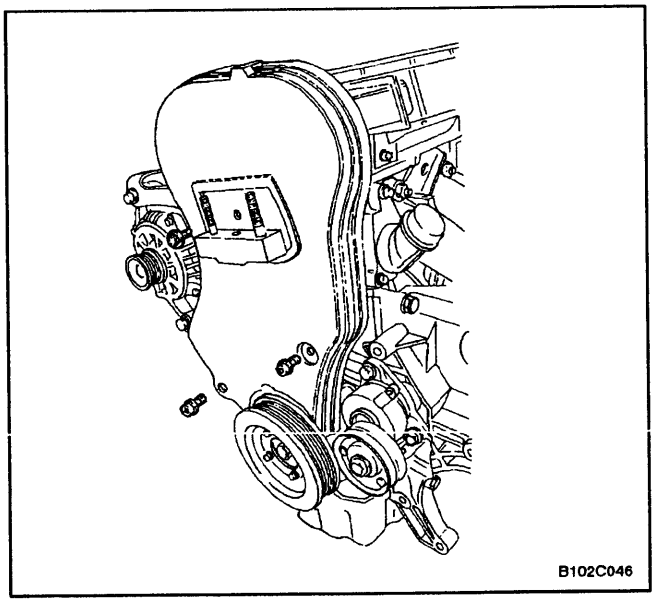
1. Disconnect the negative battery cable.
2. Disconnect the manifold air temperature sensor connector.
3. Remove the air intake tube from the throttle body.
4. Remove the breather tube from the valve cover.



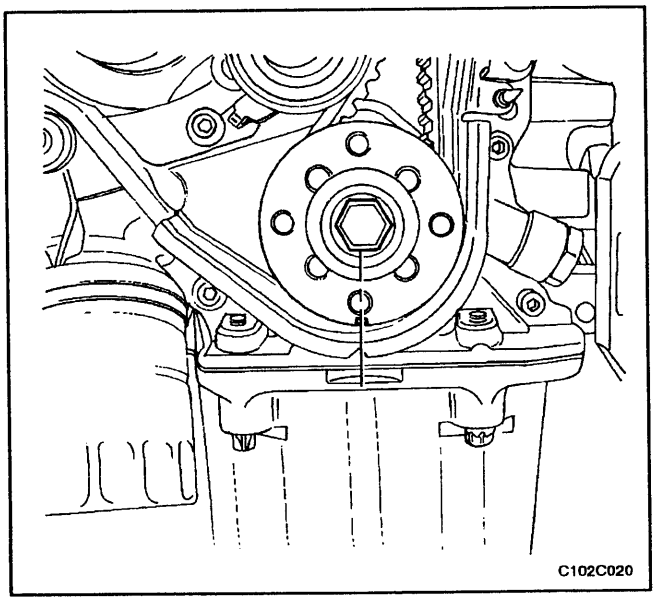
5. Remove the air filter housing bolts.
6. Remove the air filter housing.
7. Remove the right front wheel. Refer to *Section 2E, Tires and Wheels.*
8. Remove the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*


B102C051

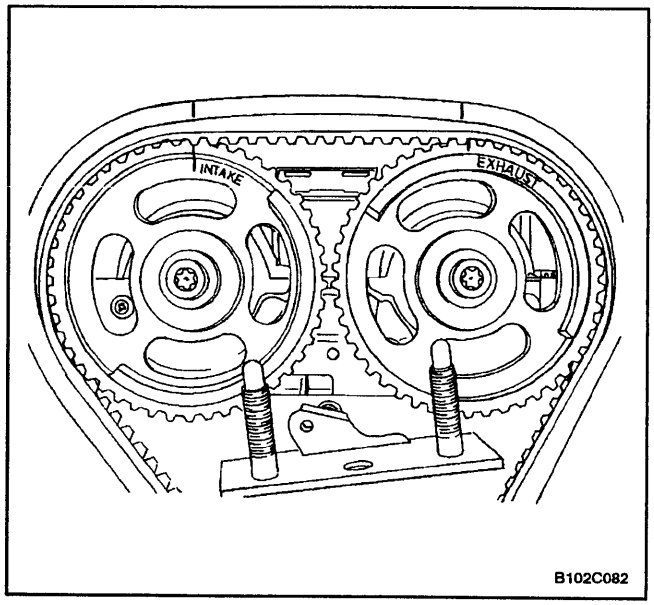
9. Remove the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*
10. Remove the crankshaft pulley bolts.
11. Remove the crankshaft pulley.
12. Remove the right engine mount bracket. Refer to "Engine Mount" in this section.


B102C046

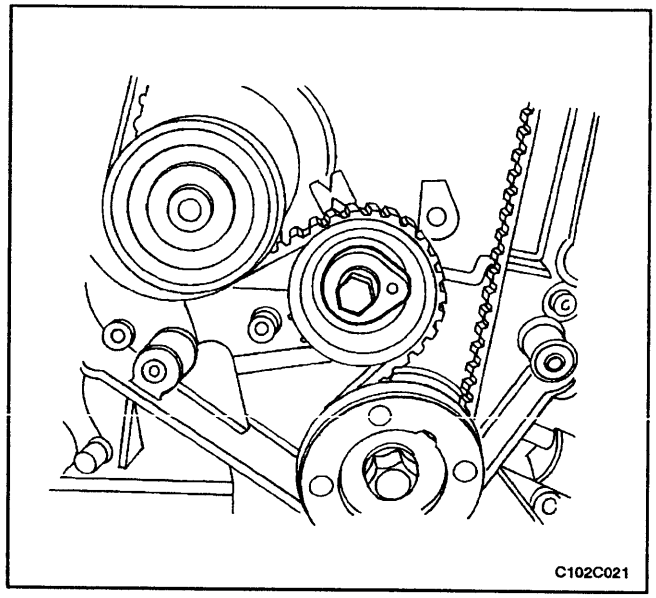
13. Remove the front timing belt cover bolts.
14. Remove the front timing belt cover.


C102C020

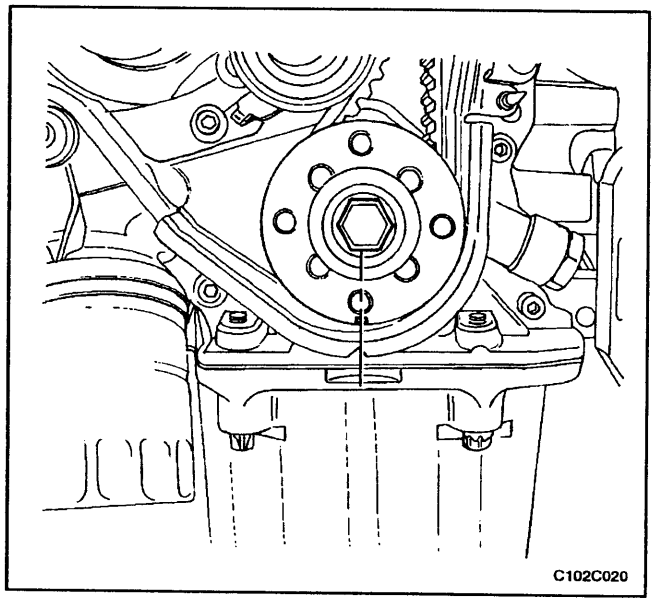
15. Rotate the crankshaft at least one full turn clockwise using the crankshaft gear bolt.
16. Align the mark on the crankshaft gear with the notch at the bottom of the rear timing belt cover.



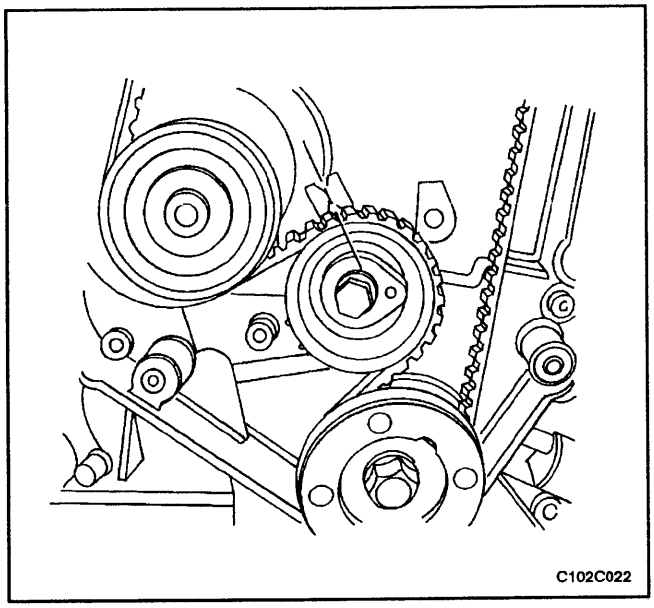
17. Align the camshaft gear timing marks. Use the exhaust gear mark for the exhaust gear and the intake gear mark for the intake gear, since the gears are interchangeable.



18. Loosen the automatic tensioner bolt. To tighten the belt tension, turn the hex-key tab counterclockwise.
19. Rotate the automatic tensioner hex-key tab clockwise until the adjust arm pointer of the timing belt automatic tensioner is aligned with the notch in the timing belt automatic tensioner bracket.



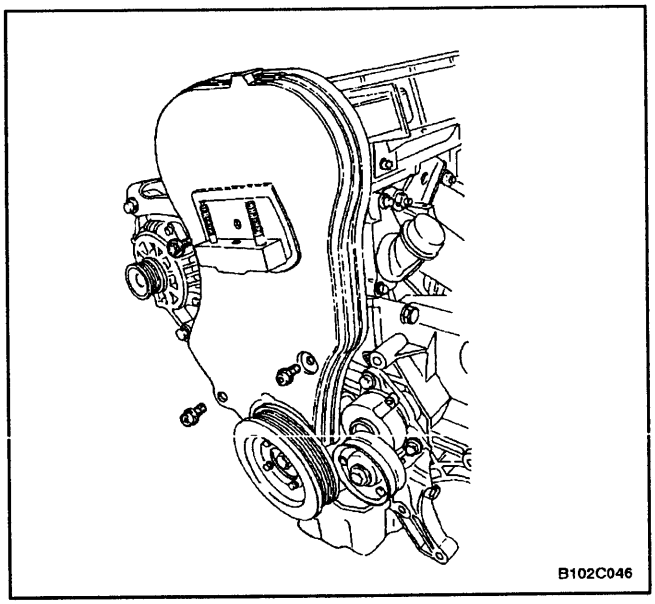
20. Tighten the automatic tensioner bolt.
21. Rotate the crankshaft two full turns clockwise using the crankshaft gear bolt.
22. Check the automatic tensioner pointer.


C102C022

23. When the adjust arm pointer of the timing belt automatic tensioner is aligned with the notch on the timing belt automatic tensioner bracket, the belt is tensioned correctly.

Tighten

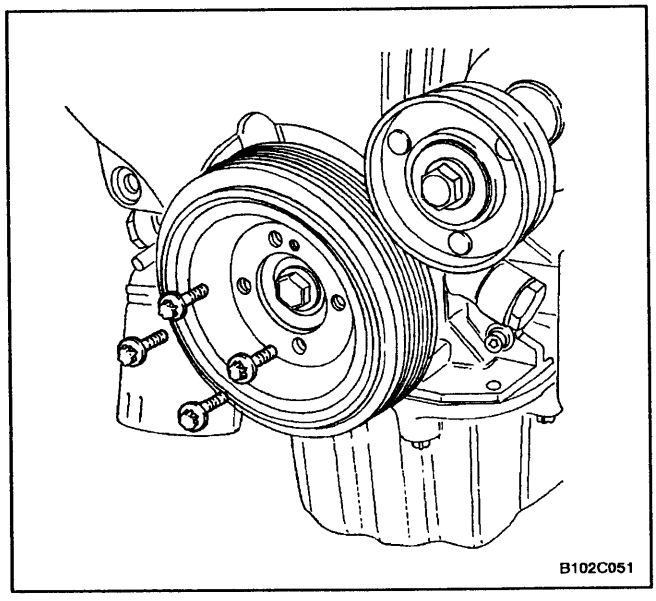
Tighten the timing belt automatic tensioner bolt to 25 N•m (18 lb-ft).


B102C046

24. Install the front timing belt cover.
25. Install the front timing belt cover bolts.

Tighten

Tighten the front timing belt cover bolts to 8 N•m (71 lb-in).

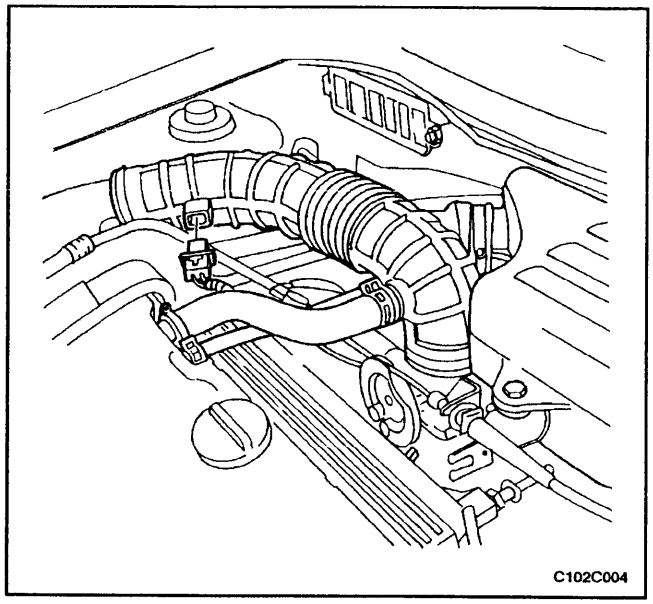

B102C051

26. Install the crankshaft pulley.
27. Install the crankshaft pulley bolts.

Tighten

Tighten the crankshaft pulley bolts to 20 N•m (15 lb-ft).

28. Install the right engine mount bracket. Refer to "Engine Mount" in this section.
29. Install the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*

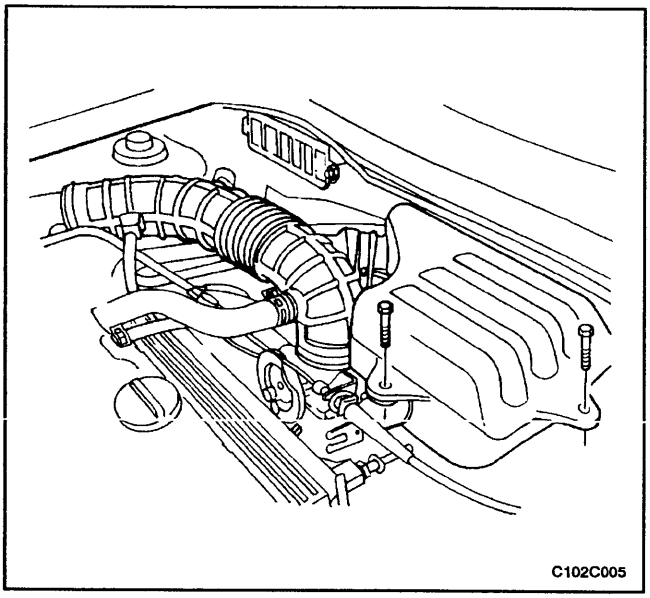

C102C004

30. Install the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
31. Install the right front wheel. Refer to *Section 2E, Tires and Wheels.*
32. Install the air filter housing.
33. Install the air filter housing bolts.

Tighten

Tighten the air filter housing bolts to 8 N•m (71 lb-in).

34. Connect the air intake tube to the throttle body.
35. Connect the breather tube to the valve cover.
36. Connect the manifold air temperature sensor connector.
37. Connect the negative battery cable.

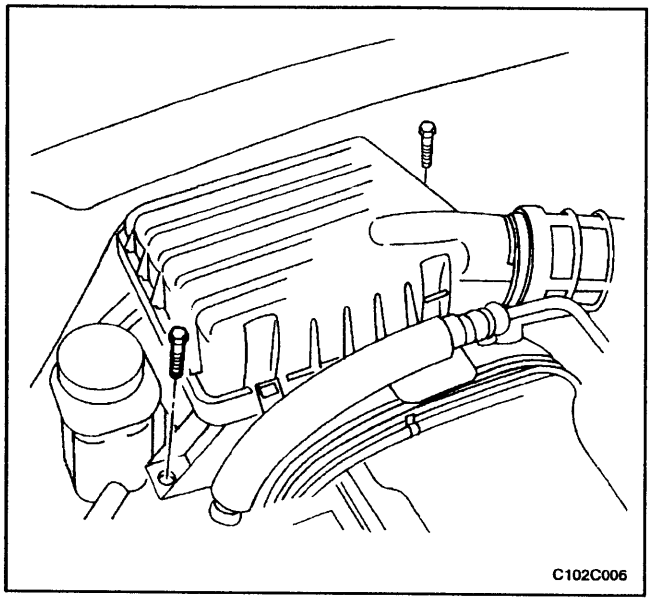

C102C005

TIMING BELT

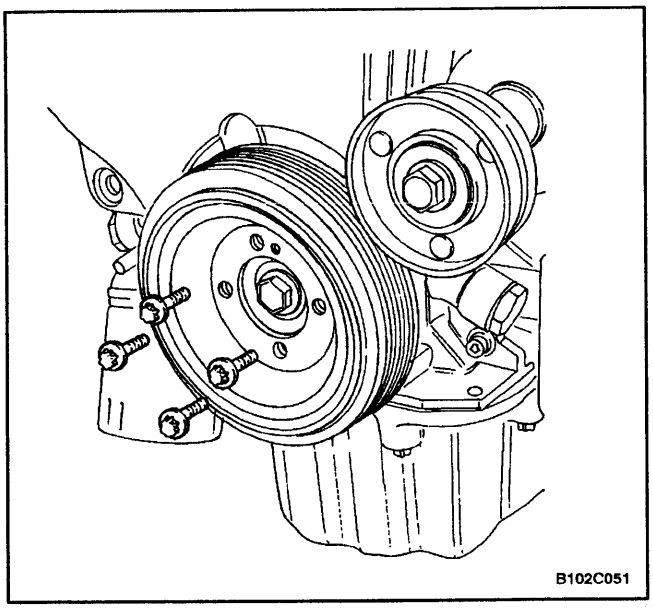
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

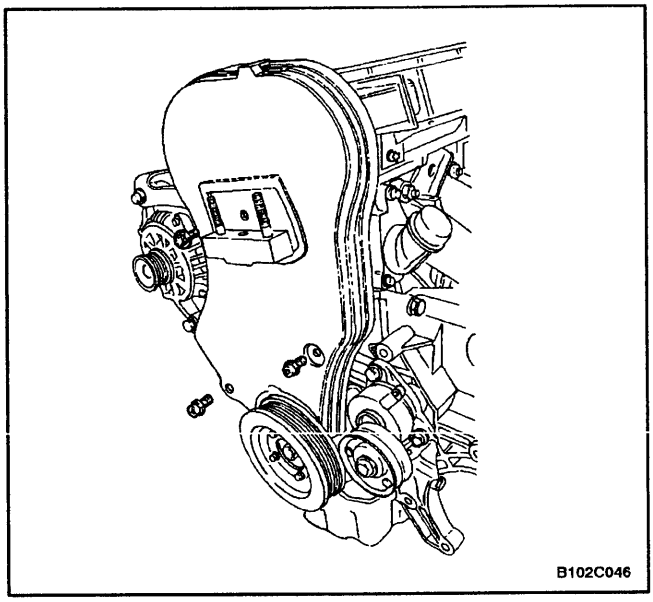
1. Disconnect the negative battery cable.
2. Disconnect the manifold air temperature sensor connector.
3. Disconnect the air intake tube from the throttle body.
4. Remove the resonator retaining bolts and the resonator from the throttle body.
5. Disconnect the breather tube from the valve cover.


C102C006

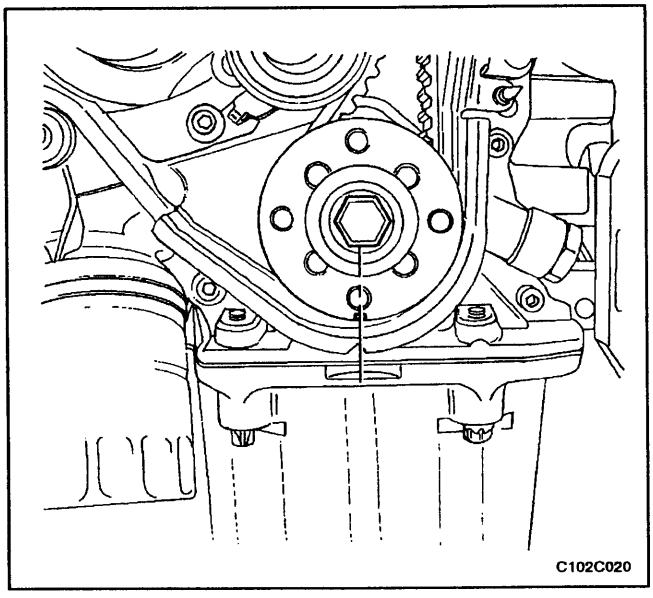
6. Remove the air filter housing bolts.
7. Remove the air filter housing.
8. Remove the right front wheel. Refer to *Section 2E, Tires and Wheels.*
9. Remove the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*


B102C051

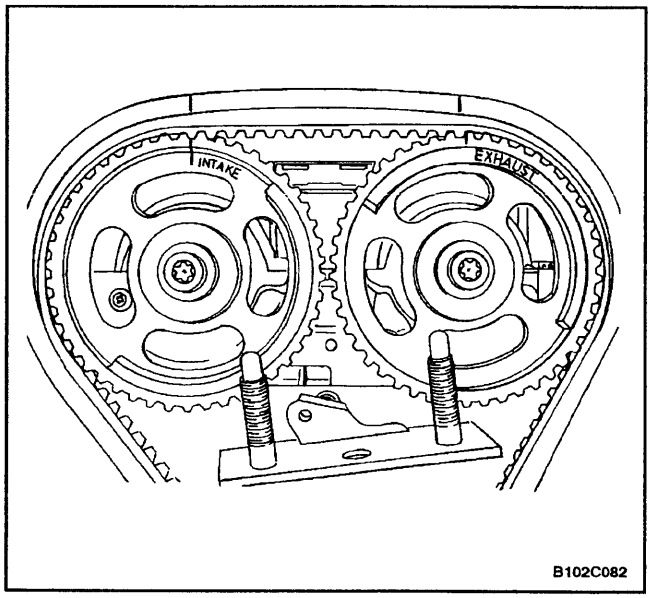
10. Remove the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump*.
11. Remove the crankshaft pulley bolts.
12. Remove the crankshaft pulley.
13. Remove the right engine mount bracket. Refer to "Engine Mount" in this section.


B102C046

14. Remove the power steering hose clamp bolt, and position the hose clear of the repair area.
15. Remove the front timing belt cover bolts.
16. Remove the front timing belt cover.


C102C020

17. Using the crankshaft gear bolt, rotate the crankshaft clockwise until the timing mark on the crankshaft gear is aligned with the notch at the bottom of the rear timing belt cover.

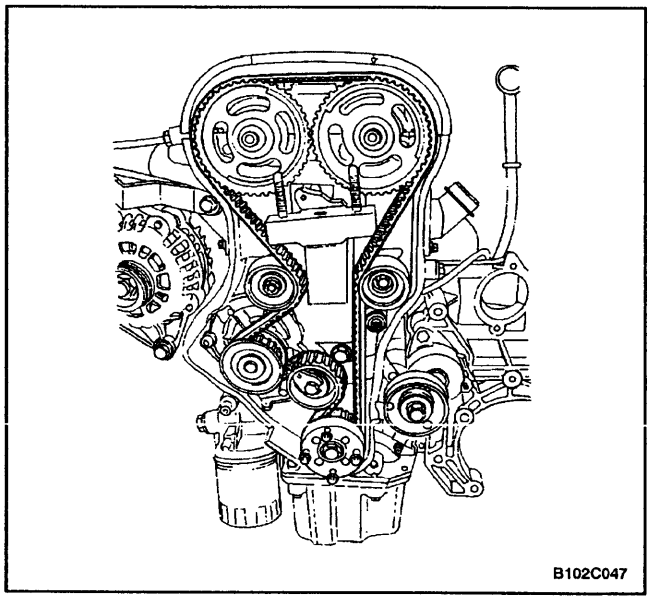


B102C082

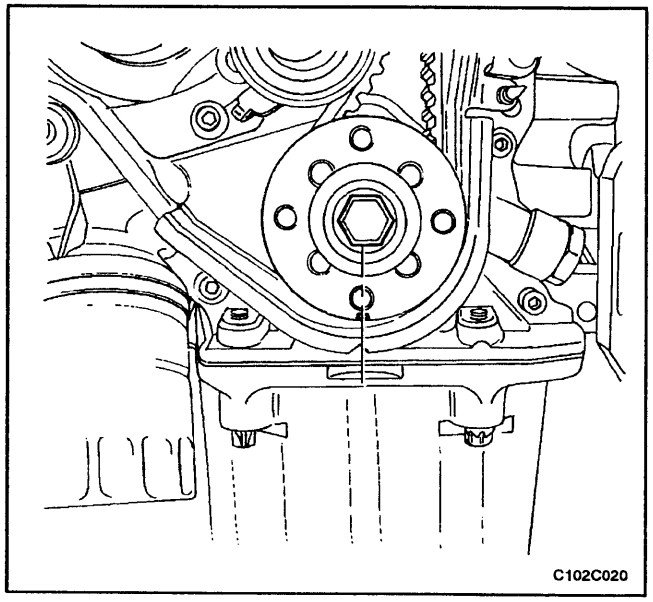
Notice: The camshaft gears must align with the notch on the valve cover or damage to the engine could result.

18. Align the camshaft gears with the notch on the valve cover.

Important: Use the intake gear mark for the intake camshaft gear and the exhaust gear mark for the exhaust camshaft gear since both gears are interchangeable.

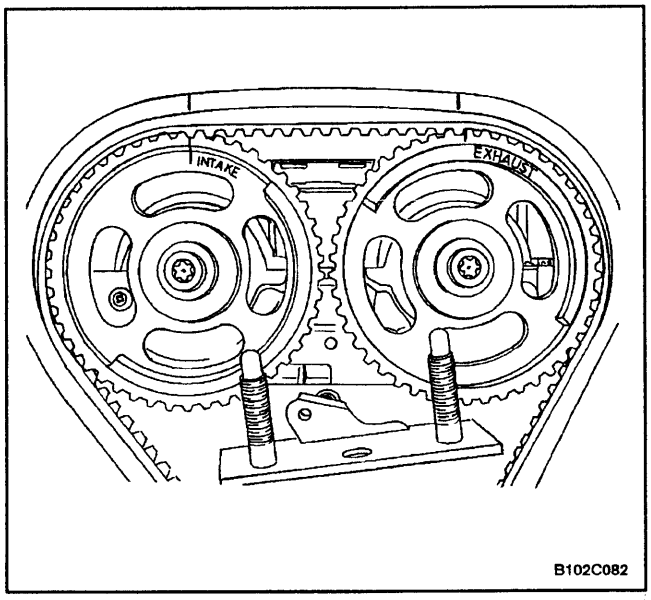

B102C047

19. Loosen the automatic tensioner bolt. Turn the hex-key tab to relieve belt tension.
20. Remove the timing belt.

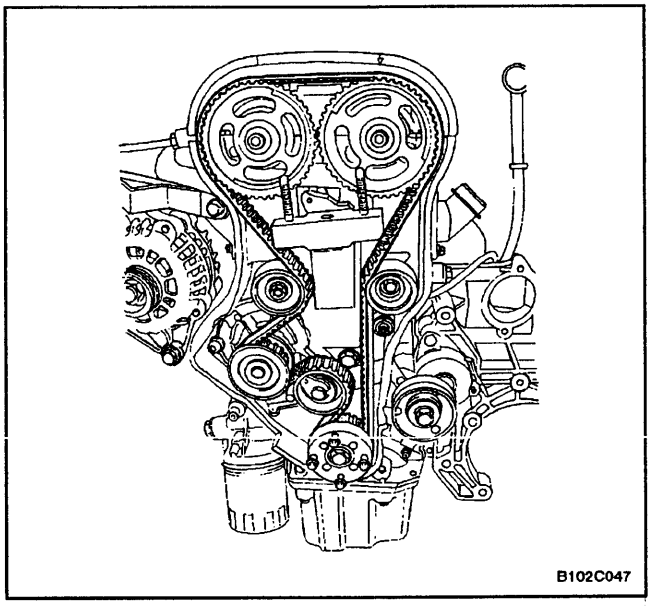

C102C020

Installation Procedure

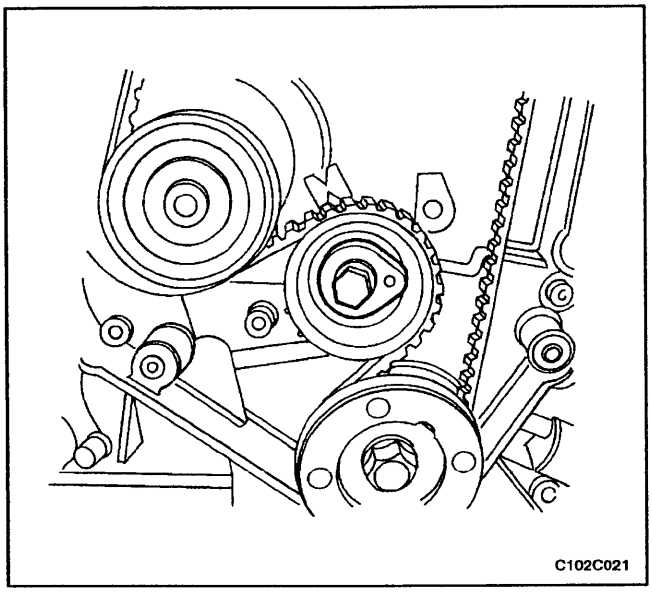
1. Align the timing mark on the crankshaft gear with the notch on the bottom of the rear timing belt cover.



2. Align the timing marks on the camshaft gears, using the intake gear mark for the intake gear and the exhaust gear mark for the exhaust gear.



3. Install the timing belt.

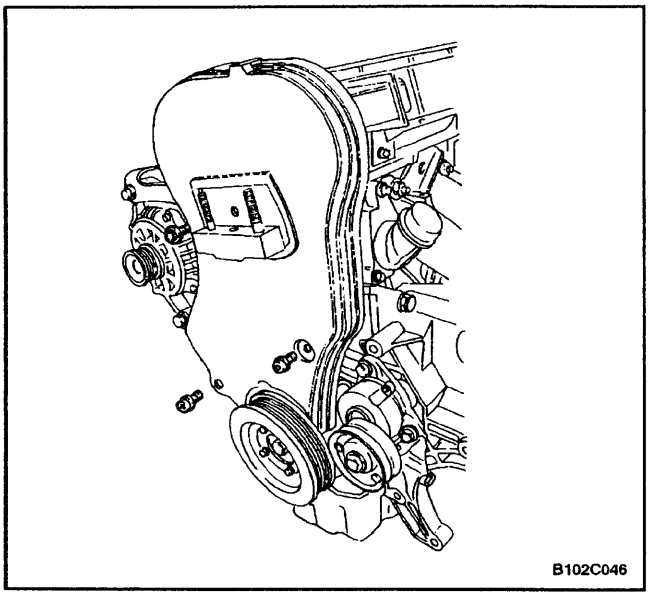


4. Turn the hex-key tab in a counterclockwise direction to tension the belt. Turn until the pointer aligns with the notch.
5. Install the automatic tensioner bolt.

Tighten

Tighten the timing belt automatic tensioner bolt to 25 N•m (18 lb-ft).

6. Rotate the crankshaft two full turns clockwise using the crankshaft gear bolt.
7. Recheck the automatic tensioner pointer.


B102C046

8. Install the front timing belt cover.
9. Install the front timing belt cover bolts.

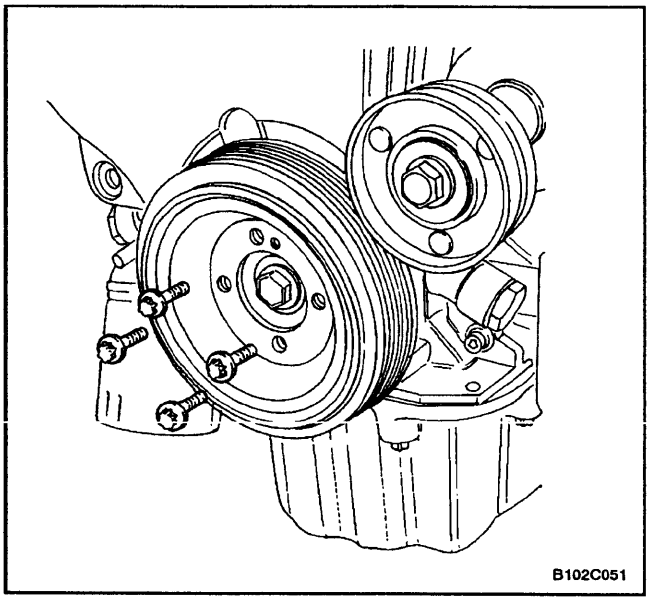
Tighten

Tighten the front timing belt cover bolts to 8 N•m (71 lb-in).

10. Install the right engine mount bracket. Refer to "Engine Mounts" in this section.
11. Position the power steering hose in place and install the clamp bolt.

Tighten

Tighten the power steering hose clamp bolt to 8 N•m (71 lb-in).


B102C051

12. Install the crankshaft pulley.
13. Install the crankshaft pulley bolts.

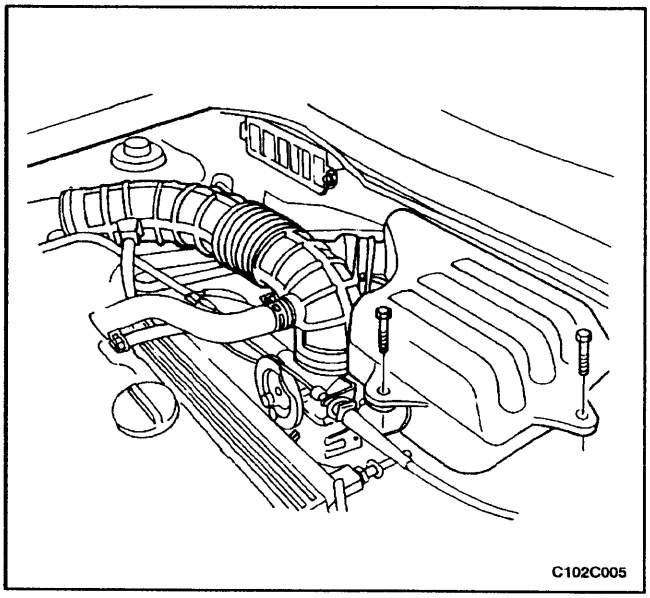
Tighten

Tighten the crankshaft pulley bolts to 20 N•m (15 lb-ft).

14. Install the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*
15. Install the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
16. Install the right front wheel. Refer to *Section 2E, Tires and Wheels.*
17. Install the air filter housing.
18. Install the air filter housing bolts.

Tighten

Tighten the air filter housing bolts to 8 N•m (71 lb-in).

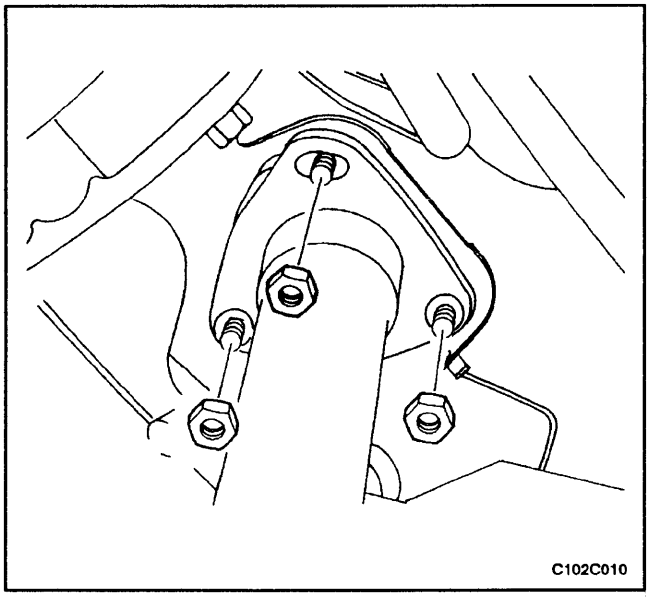

C102C005

19. Install the resonator and the retaining bolts.

Tighten

Tighten the resonator retaining bolts to 8 N•m (71 lb-in).

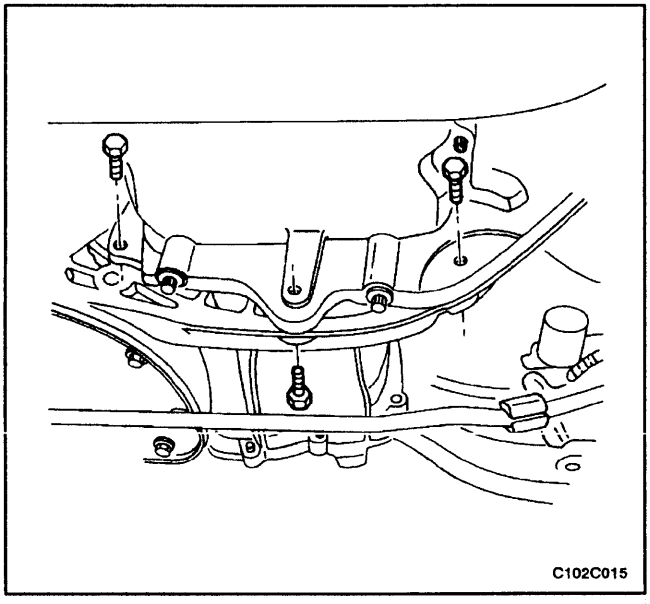
20. Connect the air intake tube to the throttle body.
21. Connect the breather tube to the valve cover.
22. Connect the manifold air temperature sensor connector.
23. Connect the negative battery cable.


C102C010

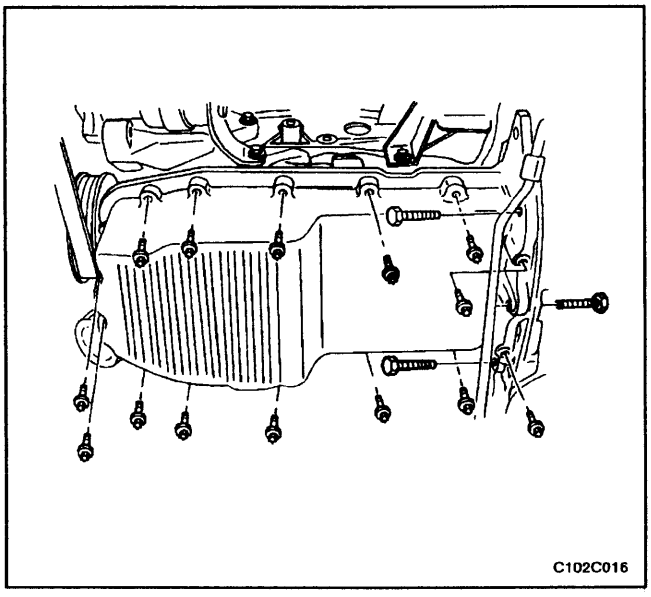
OIL PAN

Removal Procedure

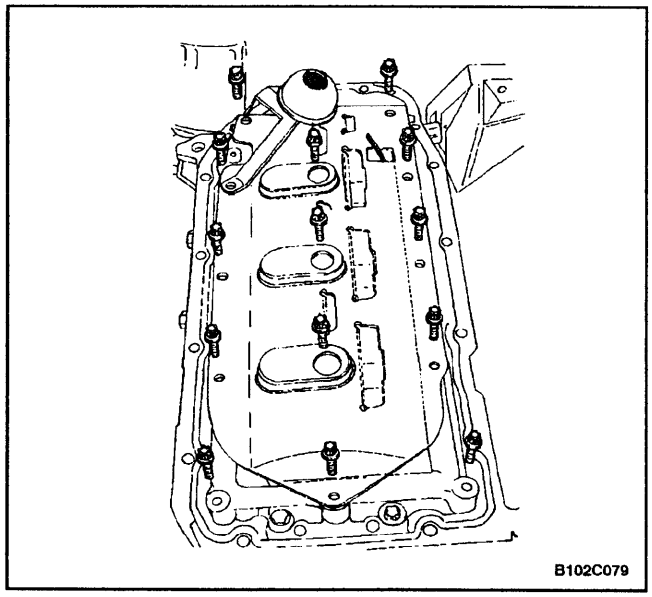
1. Disconnect the negative battery cable.
2. Drain the engine oil from the engine crankcase.
3. Remove the exhaust flex pipe retaining nuts from the exhaust manifold and the support bracket.
4. Remove the exhaust flex pipe retaining nuts from the catalytic converter.
5. Remove the exhaust flex pipe.


C102C015

6. Remove the oil pan flange-to-transaxle retaining bolts.

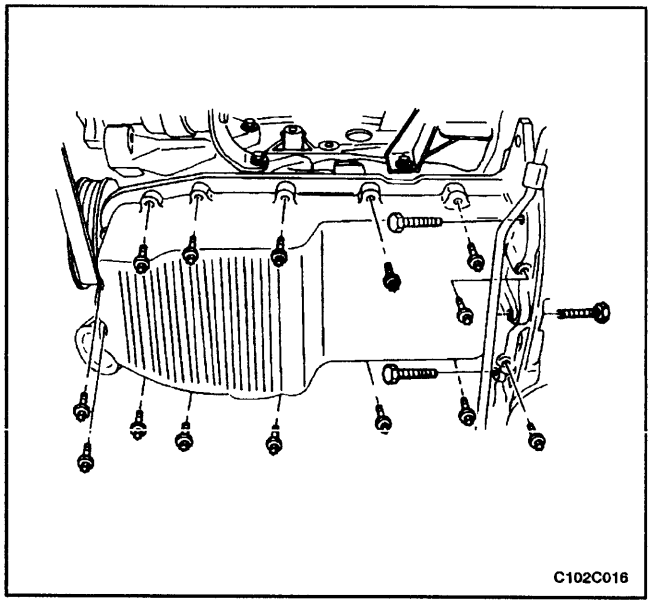

C102C016

7. Remove the oil pan retaining bolts.
8. Remove the oil pan from the engine block.
9. Remove the oil pan gasket from the oil pan.


B102C079

Cleaning Procedure

1. Clean the oil pan sealing surface.
2. Clean the engine block sealing surface.
3. Clean the oil pan retaining bolts.
4. Clean the oil pan attaching bolt holes in the engine block.
5. Clean the oil pan splash shield.

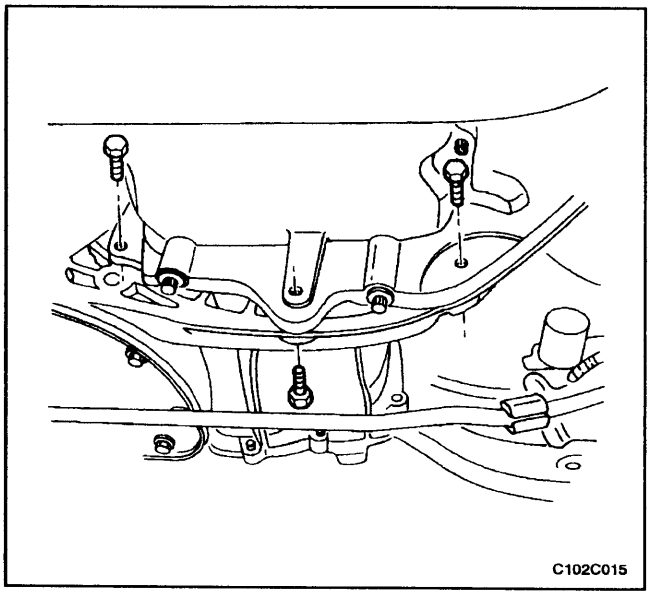

C102C016

Installation Procedure

1. Coat the new oil pan gasket with sealant.
2. Install the oil pan gasket to the oil pan.
3. Install the oil pan to the engine block.
4. Install the oil pan retaining bolts.

Tighten

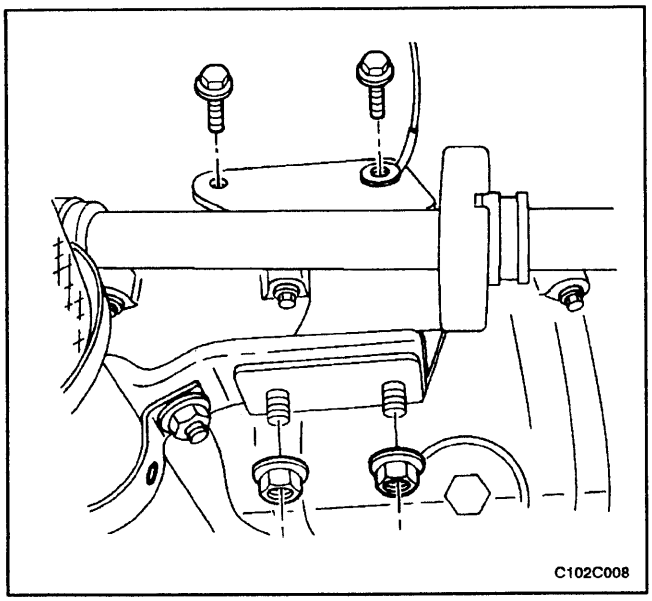
Tighten the oil pan retaining bolts to 10 N•m (89 lb-in).


C102C015

5. Install the oil pan flange-to-transaxle retaining bolts.

Tighten

Tighten the oil pan flange-to-transaxle retaining bolts to 40 N•m (30 lb-ft).



6. Install the exhaust flex pipe.
7. Install the exhaust flex pipe retaining nuts to the exhaust manifold and the support bracket.

Tighten

Tighten the exhaust flex pipe-to-exhaust manifold retaining nuts to 22 N•m (16 lb-ft).

Tighten the exhaust flex pipe support bracket bolts to 30 N•m (22 lb-ft).

8. Install the exhaust flex pipe-to-catalytic converter retaining nuts.

Tighten

Tighten the exhaust flex pipe-to-catalytic converter retaining nuts to 30 N•m (22 lb-ft).

9. Connect the negative battery cable.
10. Refill the engine crankcase with engine oil.

OIL PUMP

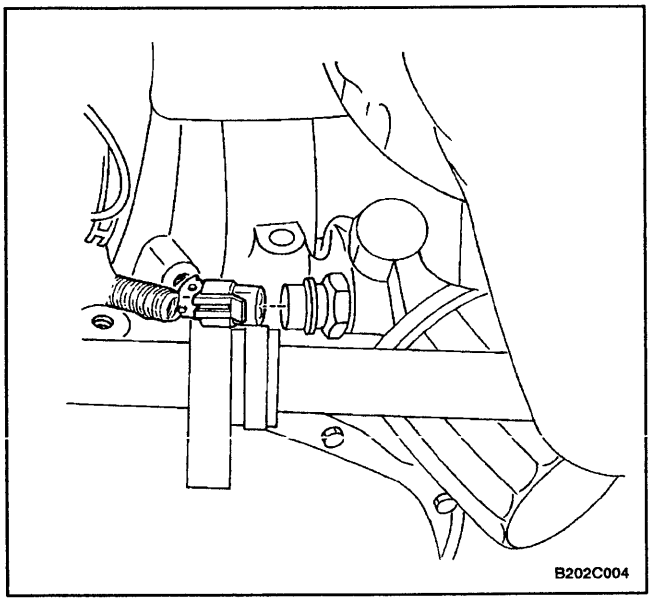
Tools Required

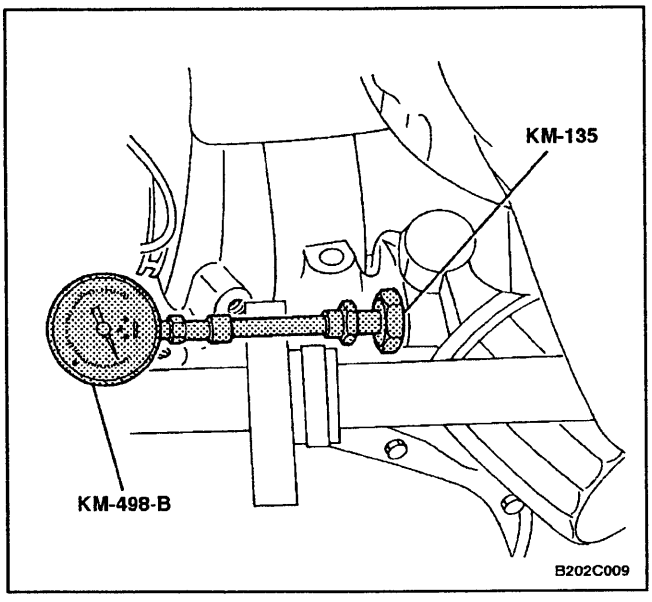
KM-498-B Pressure Gauge

KM-135 Adapter

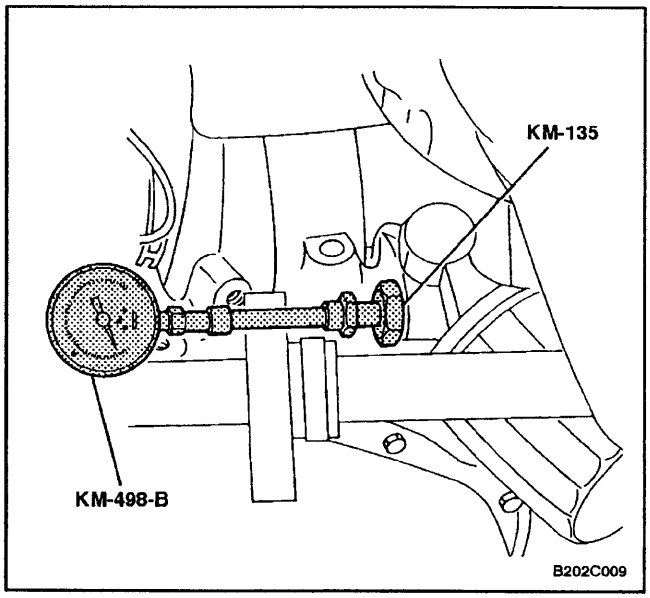
Engine Oil Pressure Inspection Procedure

1. Remove the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
2. Remove the oil pressure switch connector.





3. Install the adapter KM-135 in place of the oil pressure switch.
4. Connect the pressure gauge KM-498-B to the adapter.
5. Start the engine and check the oil pressure at idle speed and engine temperature of 80°C (176° F). The minimum oil pressure should be 30 kPa (4.35 psi).
6. Stop the engine and remove the oil pressure gauge KM-498-B and the adapter KM-135.

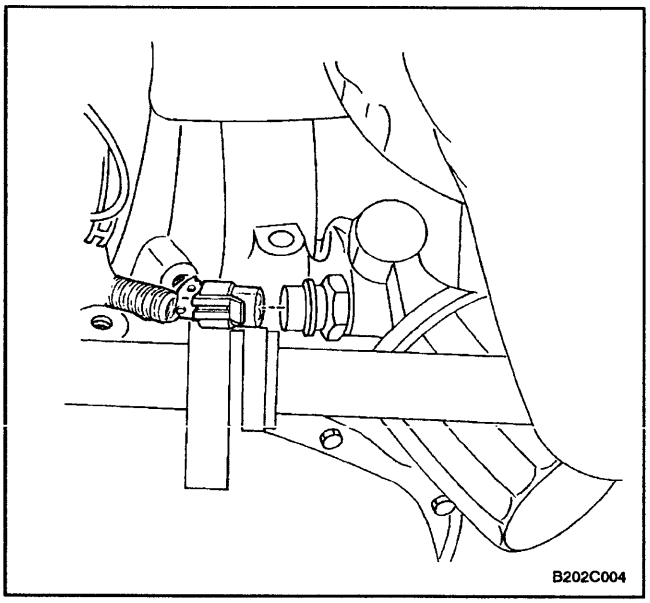


7. Install the oil pressure switch.

Tighten

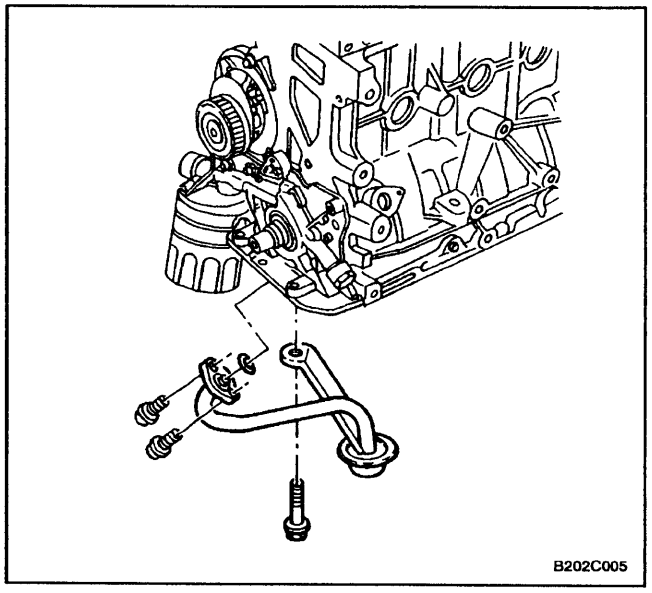
Tighten the oil pressure switch to 40 N•m (30 lb-ft).

8. Connect the electrical connector to the oil pressure switch.
9. Install the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
10. Check the oil level. Fill the oil reservoir to the full mark.

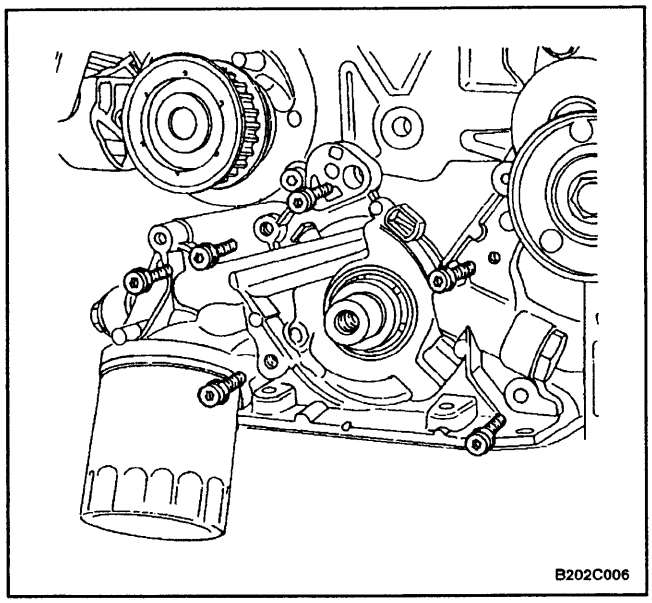


Removal Procedure

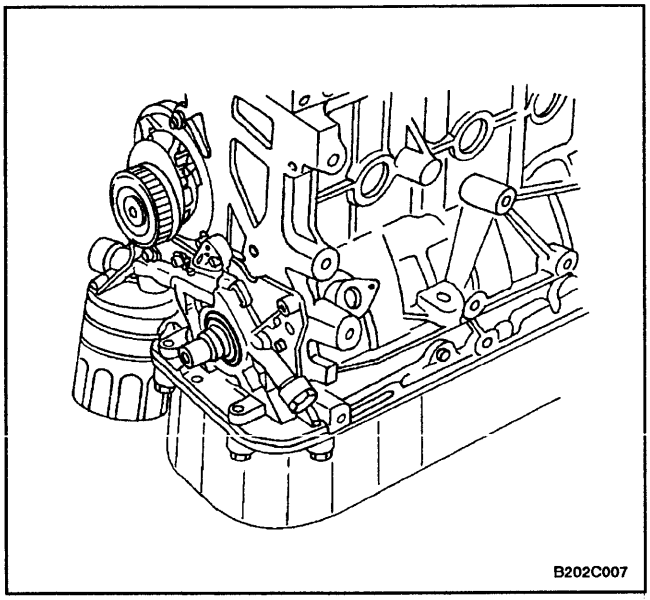
1. Disconnect the negative battery cable.
2. Remove the timing belt. Refer to "Timing Belt" in this section.
3. Remove the rear timing belt cover. Refer to "Rear Timing Belt Cover" in this section.
4. Disconnect the oil pressure switch connector.



5. Remove the oil pan. Refer to "Oil Pan" in this section.
6. Remove the oil pump pickup tube and support bracket bolts.
7. Remove the oil pump pickup tube.

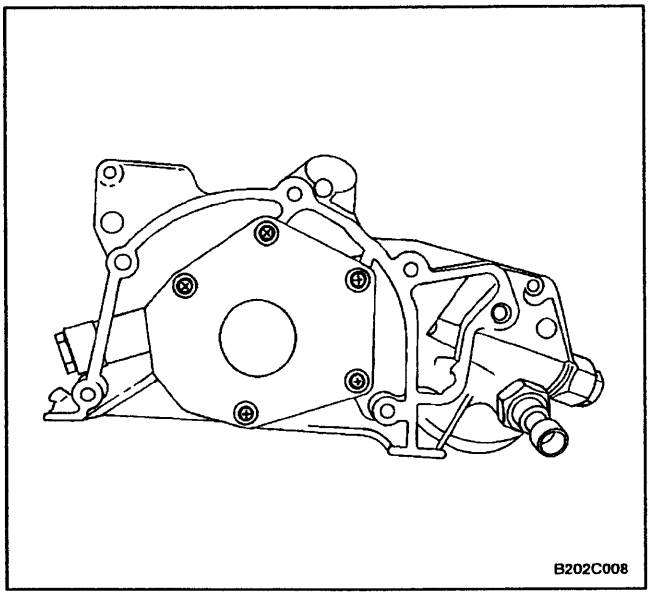

B202C006

8. Remove the oil pump retaining bolts.
9. Carefully separate the oil pump and the gasket from the engine block and the oil pan.
10. Remove the oil pump.

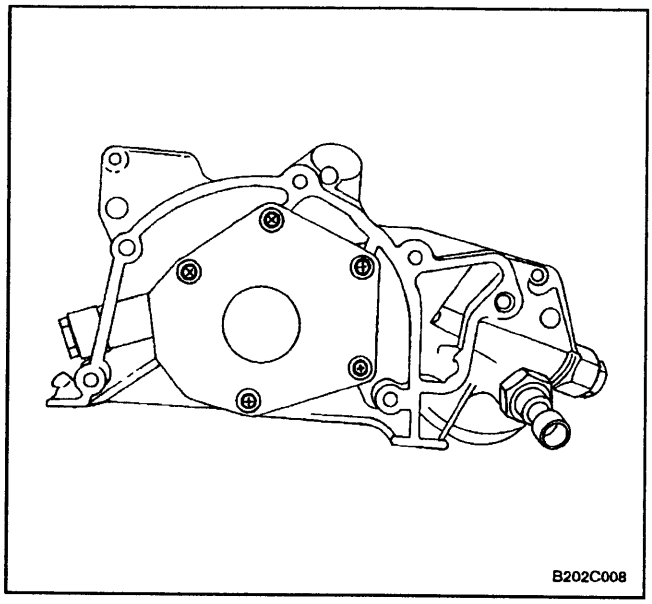

B202C007

Inspection Procedure

1. Clean the oil pump and the engine block gasket mating surfaces.
2. Remove the safety relief valve bolt.
3. Remove the safety relief valve and the spring.
4. Remove the oil pump-to-crankshaft seal.


B202C008

5. Remove the oil pump rear cover bolts.
6. Remove the rear cover.


B202C008

7. Clean the oil pump housing and all the oil pump parts.
8. Inspect all the oil pump parts for signs of wear. Refer to "Engine Specifications" in this section. Replace the worn oil pump parts.

Notice: Pack the oil pump gear cavity with petroleum jelly to ensure an oil pump prime, or engine damage could result.

9. Coat all the oil pump parts with clean engine oil. Install the oil pump parts.
10. Apply Loctite® 242 to the oil pump rear cover bolts and install the rear cover and the bolts.

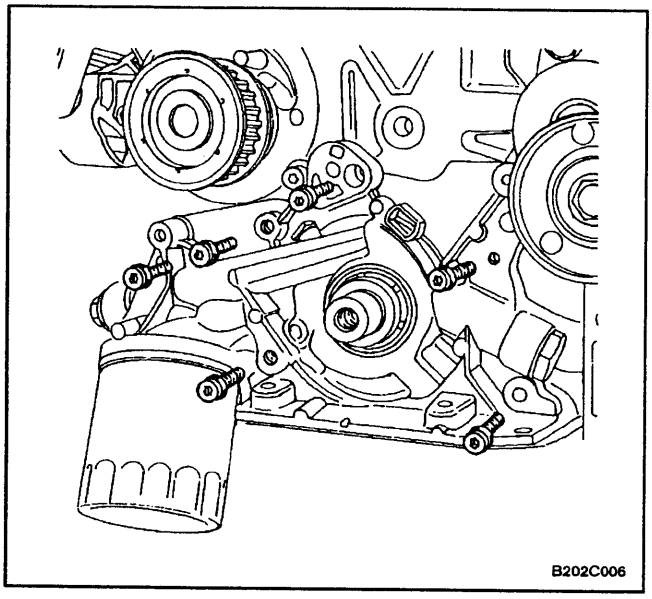
Tighten

Tighten the oil pump rear cover bolts to 6 N•m (53 lb-in).

11. Install the safety relief valve, the spring, the washer, and the bolt.

Tighten

Tighten the safety relief valve bolt to 30 N•m (22 lb-ft).

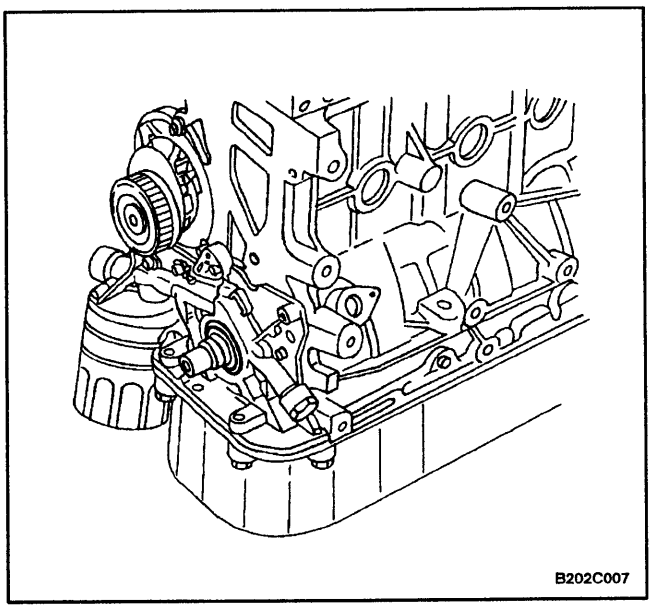

B202C006

Installation Procedure

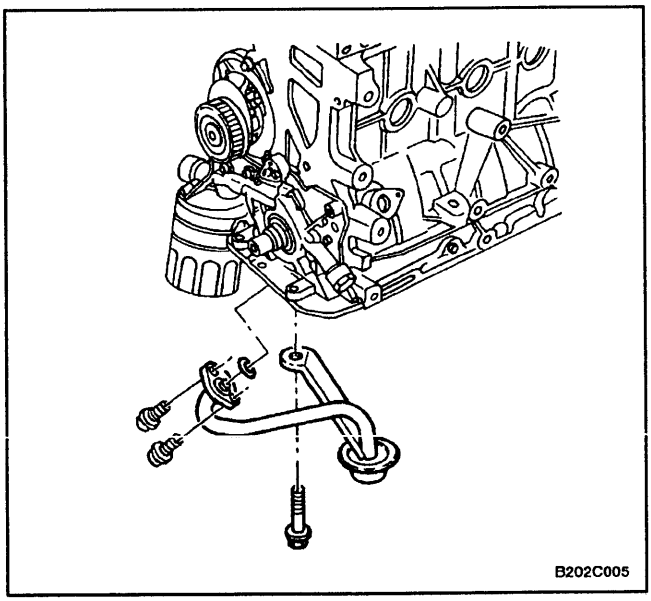
1. Apply Loctite® 242 to the oil pump bolts and room temperature vulcanizing (RTV) sealant to the new oil pump gasket.
2. Install the gasket to the oil pump and install the oil pump to the engine block with the bolts.

Tighten

Tighten the oil pump retaining bolts to 10 N•m (89 lb-in).


B202C007

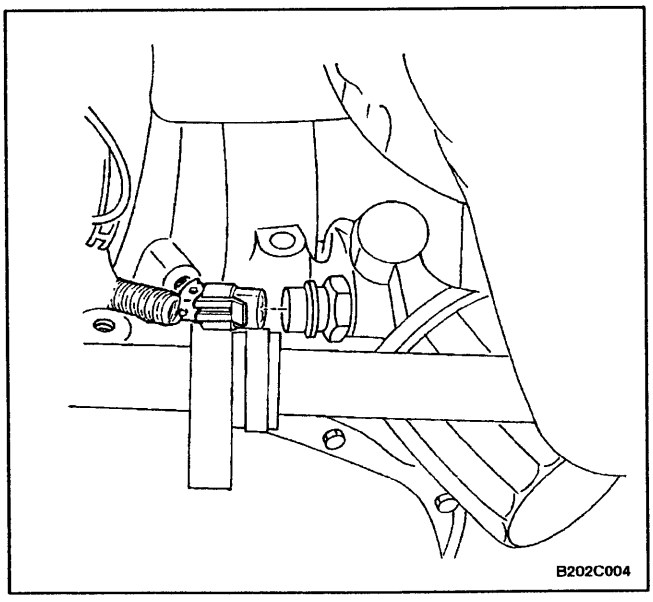
3. Install a new oil pump-to-crankshaft seal. Coat the lip of the seal with a thin coat of grease.


B202C005

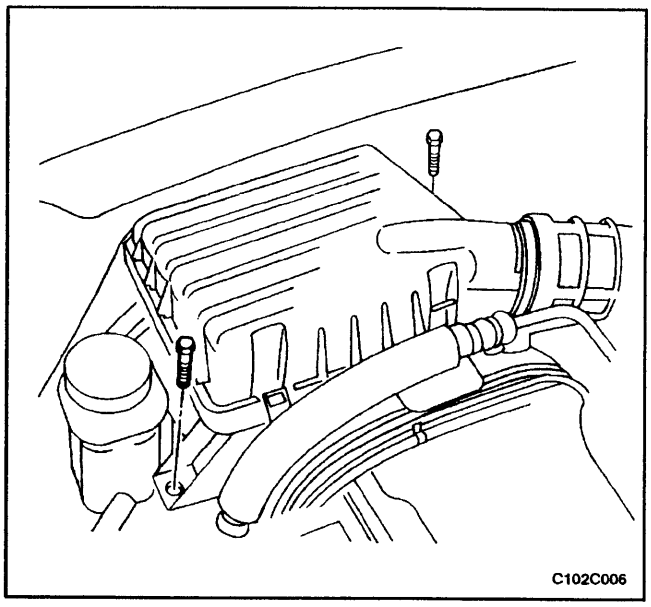
4. Coat the threads of the oil pump pickup tube and the support bracket bolts with Loctite® 242.
5. Install the oil pump pickup tube to the support bracket with the bolts.

Tighten

Tighten the oil pump pickup tube bolts to 8 N•m (71 lb-in).


B202C004

6. Install the oil pan. Refer to "Oil Pan" in this section.
7. Connect the oil pressure switch connector.
8. Install the rear timing belt cover. Refer to "Rear Timing Belt Cover" in this section.
9. Install the timing belt. Refer to "Timing Belt" in this section.
10. Connect the negative battery cable.


C102C006

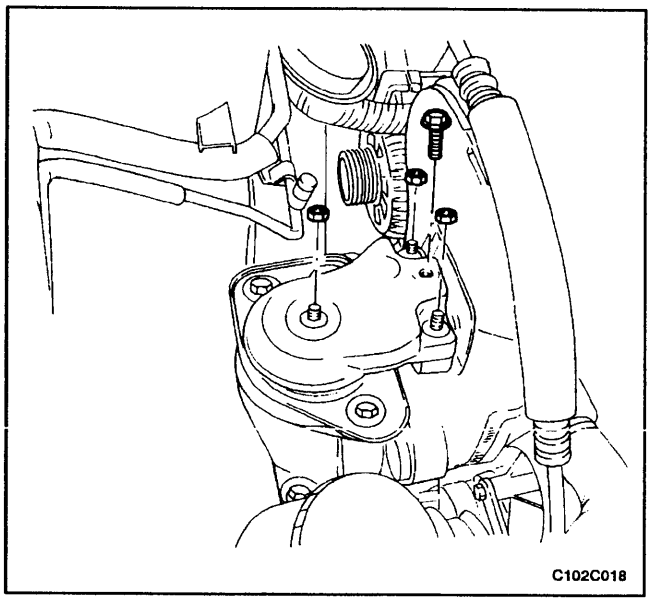
ENGINE MOUNT, RIGHT SIDE

Tools Required

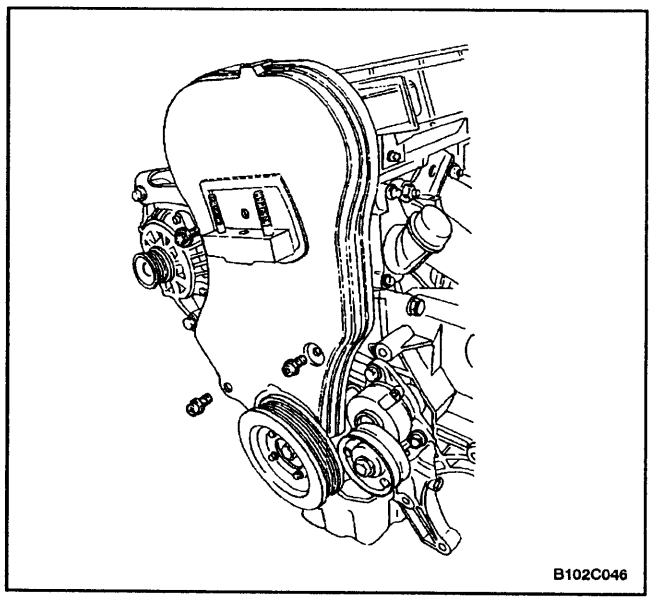
J-28467-B Engine Assembly Lift Support

Removal Procedure

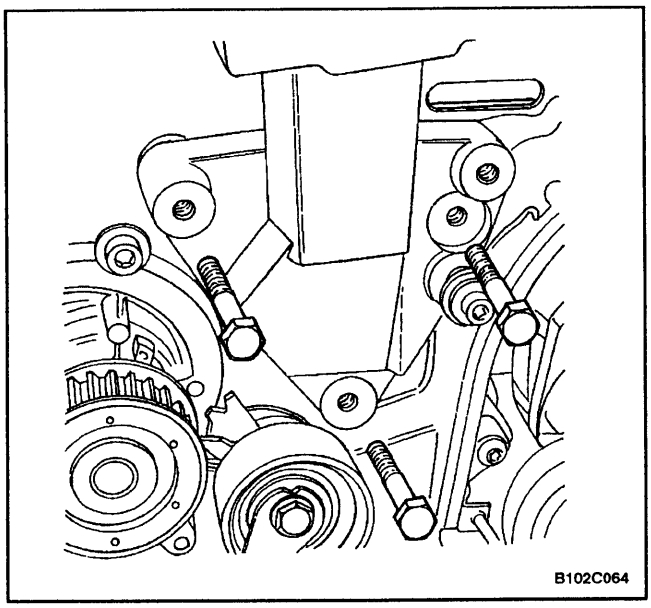
1. Disconnect the negative battery cable.
2. Support the engine assembly using the engine assembly lift support J-28467-B.
3. Remove the right front wheel well splash shield. refer to *Section 9R, Body Front End.*
4. Remove the air filter housing assembly bolts.
5. Remove the air filter housing assembly.


C102C018

6. Remove the engine mount bracket retaining bolts.
7. Remove the engine mount bracket.
8. Remove the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump*.


B102C046

9. Remove the front timing belt cover bolts and the front timing belt cover.
10. Align the crankshaft pulley timing mark with the pointer, and the camshaft gears with the timing marks on the rear cover, by turning the crankshaft gear bolt.
11. Loosen the timing belt automatic tensioner bolt.
12. Turn the hex-key tab to relieve belt tension.
13. Remove the timing belt idler pulley nuts.
14. Remove the timing belt idler pulley.
15. Remove the engine mount retaining bolts.
16. Remove the engine mount.

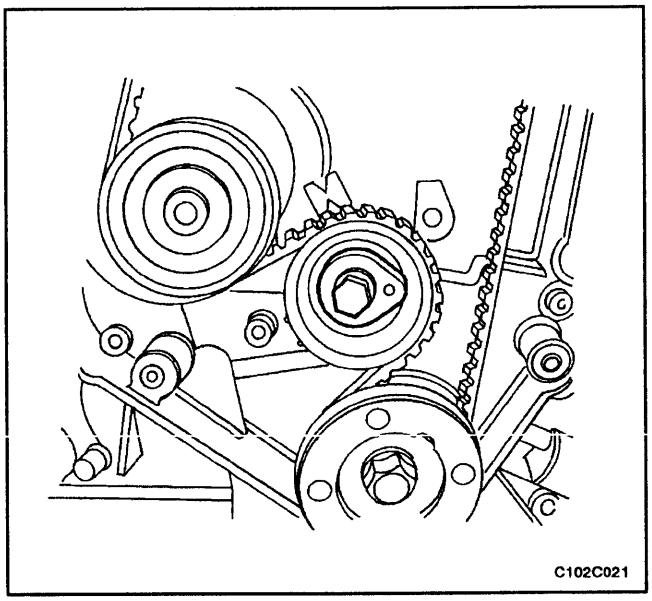


Installation Procedure

1. Install the engine mount.
2. Install the engine mount retaining bolts.

Tighten

Tighten the engine mount bolts to 60 N•m (44 lb-ft).



3. Install the timing belt idler pulleys.
4. Install the timing belt idler pulley nuts.

Tighten

Tighten the timing belt idler pulley nuts to 25 N•m (18 lb-ft).

5. Tension the timing belt by turning the timing belt automatic tensioner hex-key tab counterclockwise until the pointer is aligned to the indicator.

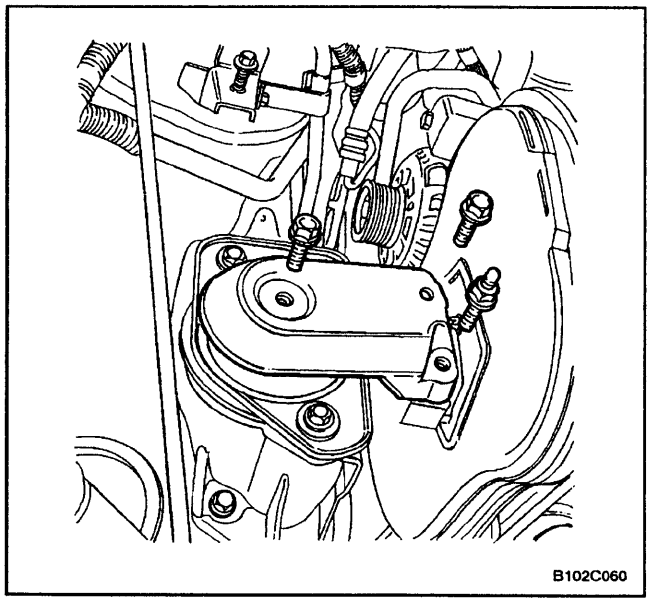
Tighten

Tighten the timing belt automatic tensioner bolt to 25 N•m (18 lb-ft).

6. Install the front timing belt cover.
7. Install the front timing belt cover bolts.

Tighten

Tighten the front timing belt cover bolts to 8 N•m (71 lb-in).


B102C060

8. Install the engine mount bracket and retaining bolts.

Tighten

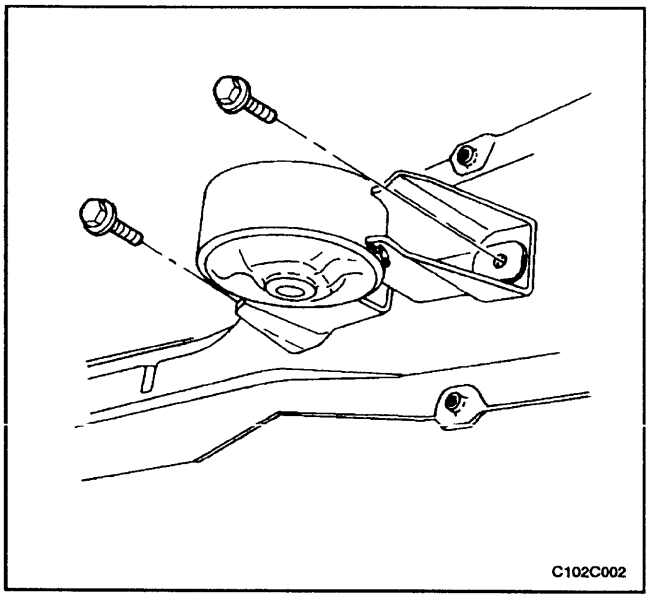
Tighten the engine mount bolts to 60 N•m (44 lb-ft).

9. Remove engine assembly lift support J-28467-B.
10. Install the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump*.
11. Install the air filter housing assembly with the bolts.

Tighten

Tighten the air filter housing assembly bolts to 8 N•m (71 lb-in).

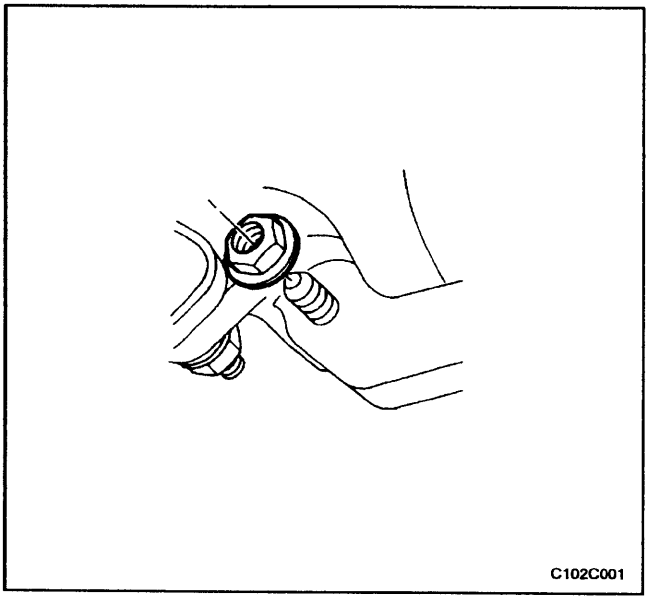
12. Install the right front wheel well splash shield. Refer to *Section 9R, Body Front End*.
13. Connect the negative battery cable.


C102C002

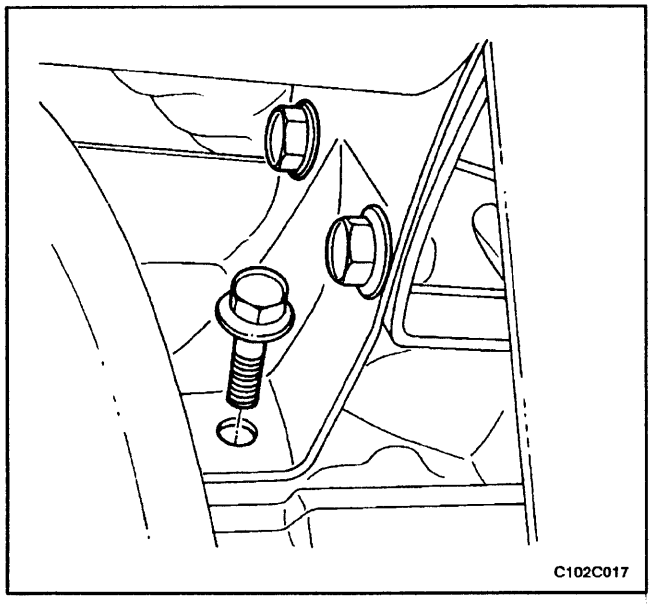
ENGINE MOUNT, FORWARD

Removal Procedure

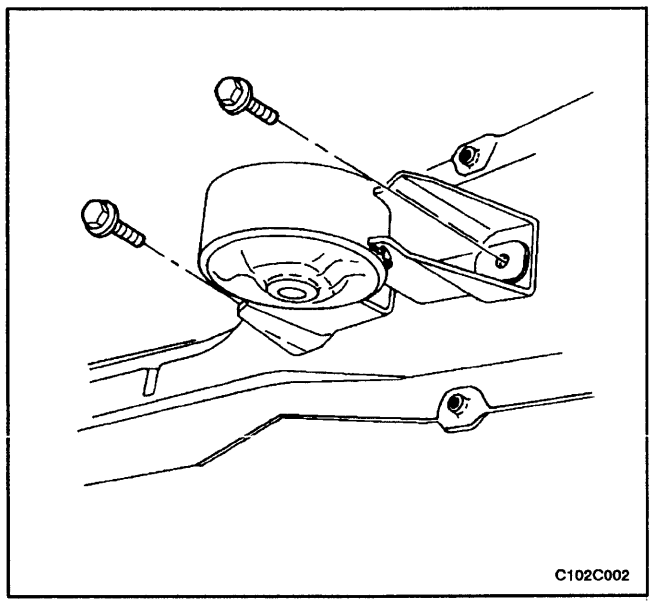
1. Disconnect the negative battery cable.
2. Raise and suitably support the vehicle.
3. Remove the center member. Refer to *Section 9N, Frame and Underbody.*
4. Remove the bolts that secure the engine mount to the center member.
5. Remove the engine mount.


C102C001

6. Remove the engine mount bracket-to-engine block nuts.



7. Remove the engine mount bracket-to-engine block bolts.
8. Remove the engine mount bracket.

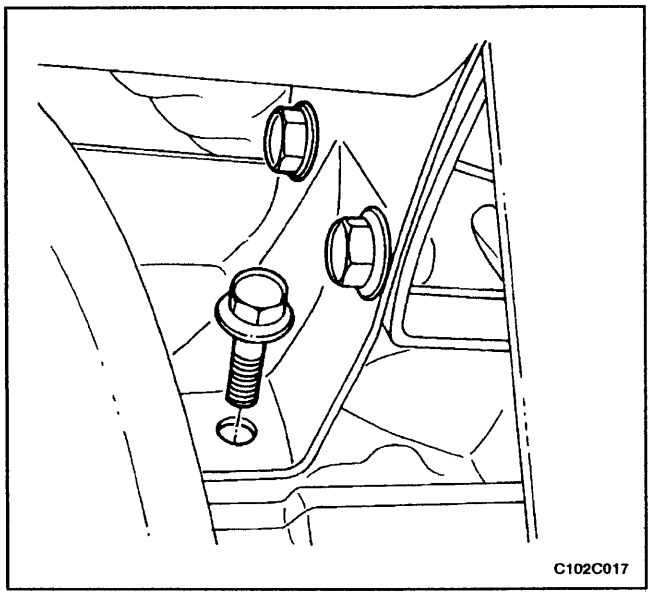


Installation Procedure

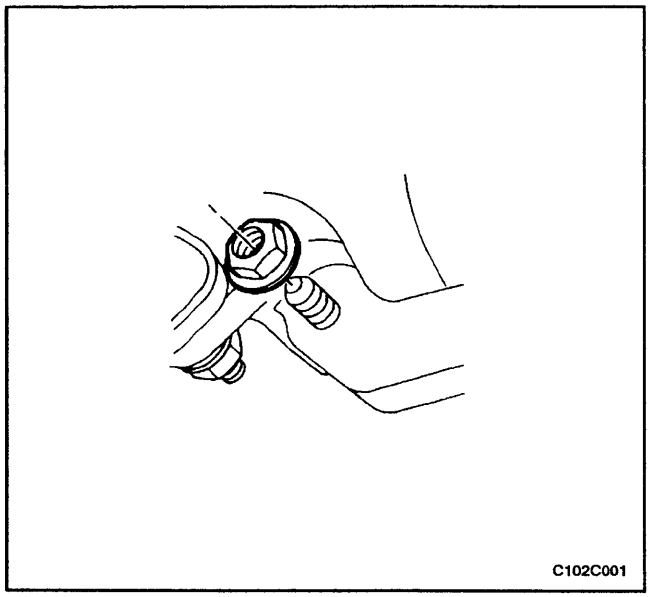
1. Install the engine mount and bolts to the center member.

Tighten

Tighten the engine mount bolts to 60 N•m (44 lb-ft).



2. Install the engine mount bracket-to-engine block bolts.

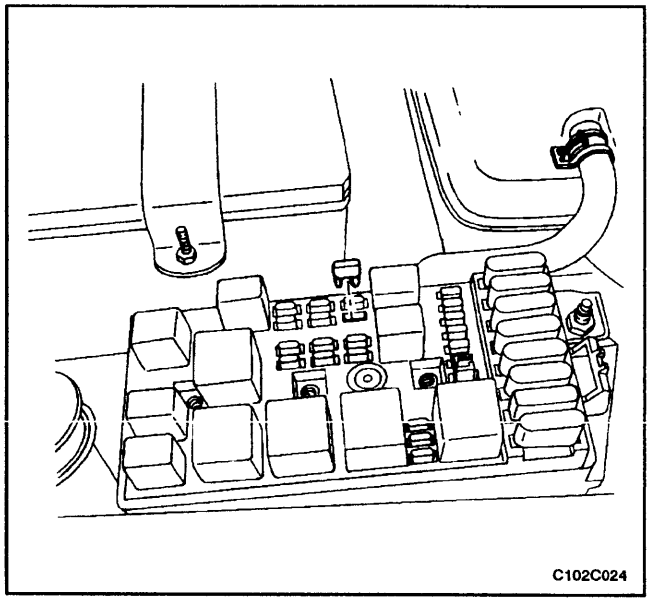

C102C001

3. Install the engine mount bracket-to-engine block nuts.

Tighten

Tighten the engine mount bracket-to-engine block bolts and nuts to 90 N•m (66 lb-ft).

4. Install the center member. Refer to *Section 9N, Frame and Underbody.*
5. Lower the vehicle.
6. Connect the negative battery cable.

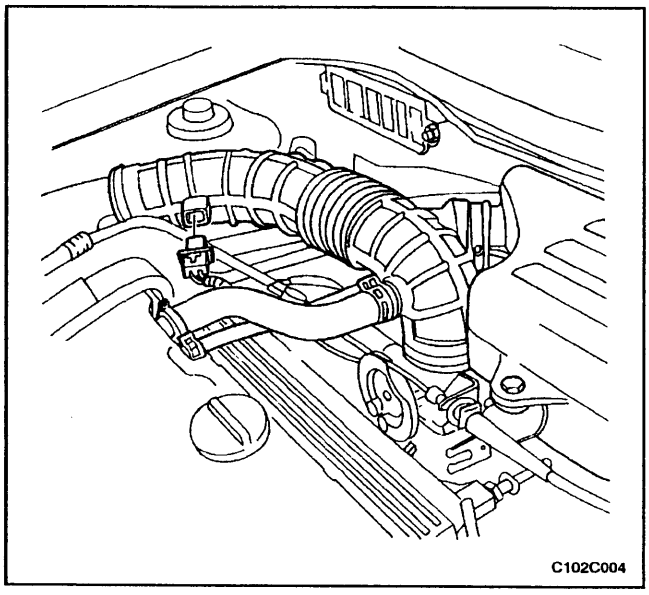

C102C024

INTAKE MANIFOLD

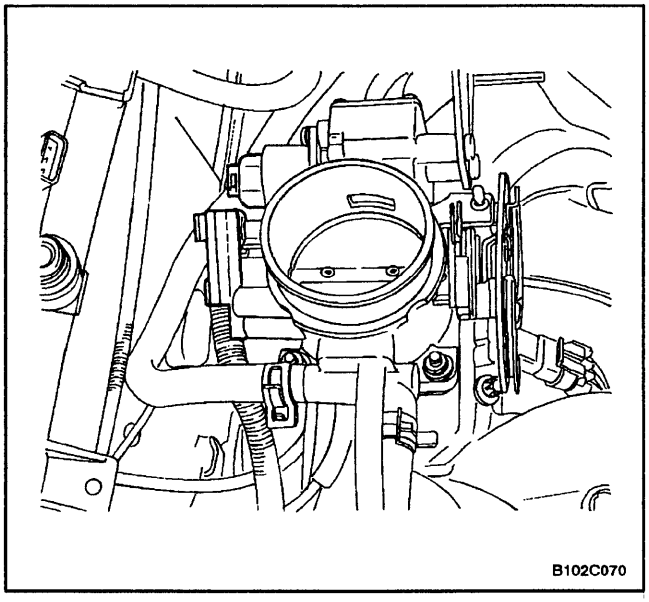
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

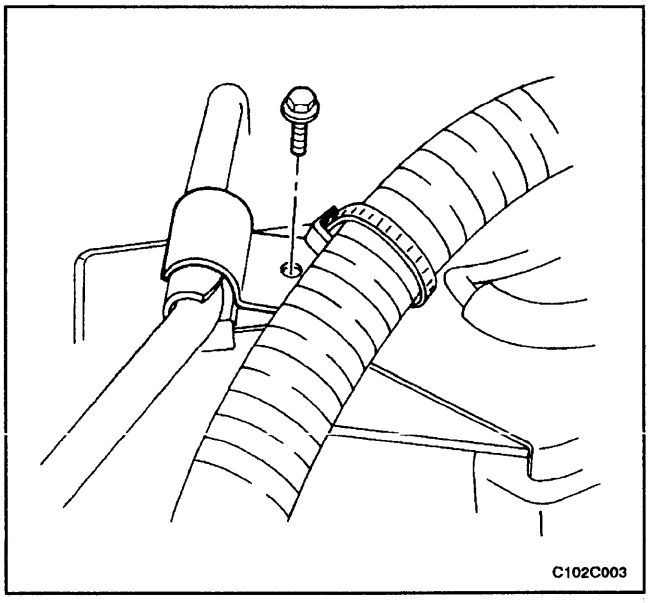
1. Remove the fuel pump fuse.
2. Start the engine. After it stalls, crank the engine for 10 seconds to rid the fuel system of fuel pressure.
3. Disconnect the negative battery cable.
4. Disconnect the canister purge and exhaust gas recirculation (EGR) solenoids from the intake manifold and loosen the bracket bolt.
5. Drain the engine coolant. Refer to *Section 1D, Engine Cooling.*


C102C004

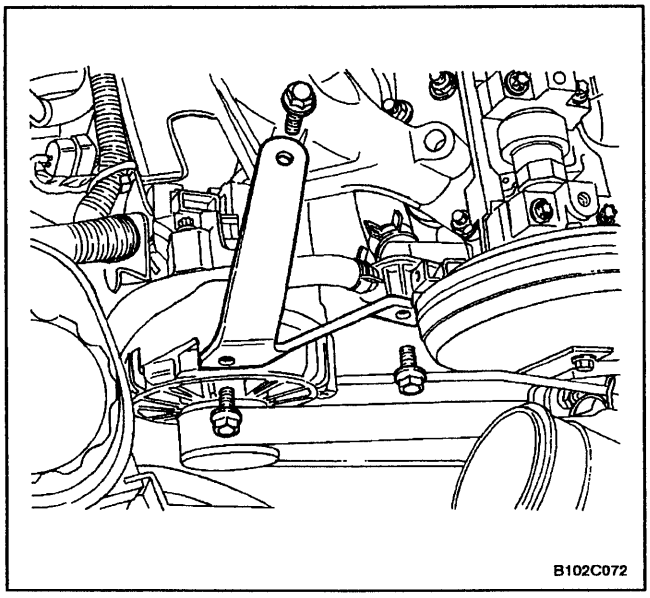
6. Disconnect the manifold air temperature sensor connector.
7. Disconnect the air intake tube from the throttle body.


B102C070

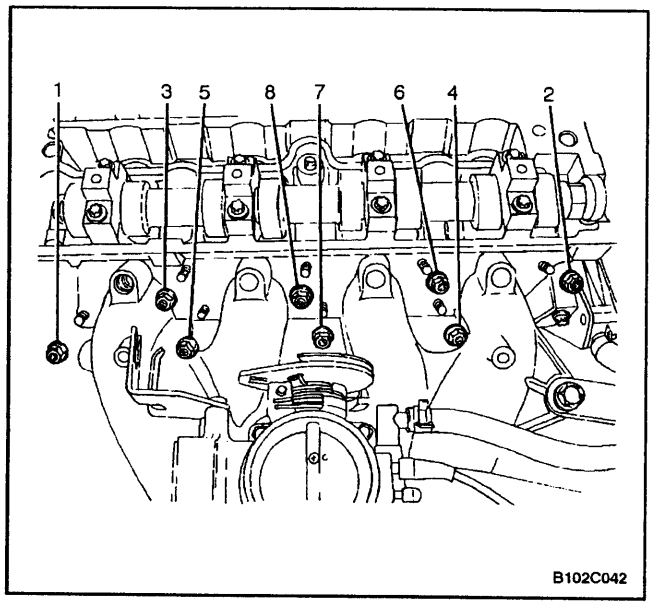
8. Disconnect the idle air control valve connector.
9. Disconnect the throttle position sensor connector.
10. Disconnect the manifold absolute pressure (MAP) sensor connector.
11. Disconnect the coolant hoses at the throttle body.


C102C003

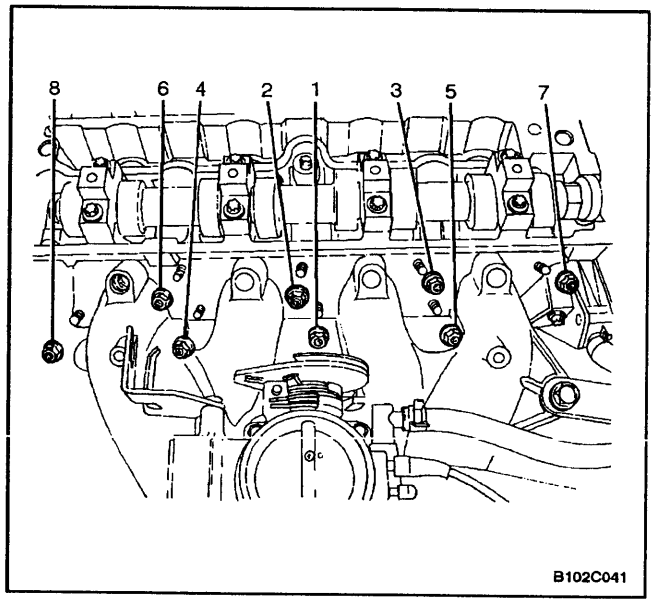
12. Disconnect all of the necessary vacuum hoses, including the vacuum hose at the fuel pressure regulator and the brake booster vacuum hose at the intake manifold.
13. Disconnect the throttle cable from the throttle body and the intake manifold.
14. Remove the throttle cable bracket bolts from the intake manifold.
15. Remove the throttle cable bracket.
16. Remove the alternator-to-intake manifold strap bracket bolts and the strap.
17. Remove the power steering hose clamp bolt, and position the hose clear of the repair area.


B102C072

18. Remove the fuel rail and the injector cover as an assembly. Refer to *Section 1F, Engine Controls.*
19. Remove the alternator-to-intake manifold support bracket bolts.
20. Remove the alternator-to-intake manifold support bracket.
21. Remove the intake manifold support bracket bolt at the engine block and the intake manifold.
22. Remove the intake manifold support bracket.



23. Remove the intake manifold retaining bolts and the nuts in the sequence shown.
24. Remove the intake manifold.
25. Remove the intake manifold gasket.
26. Clean the sealing surfaces of the intake manifold and the cylinder head.



Installation Procedure

1. Install the intake manifold gasket.
2. Install the intake manifold.
3. Install the intake manifold retaining bolts and the nuts in the sequence shown.

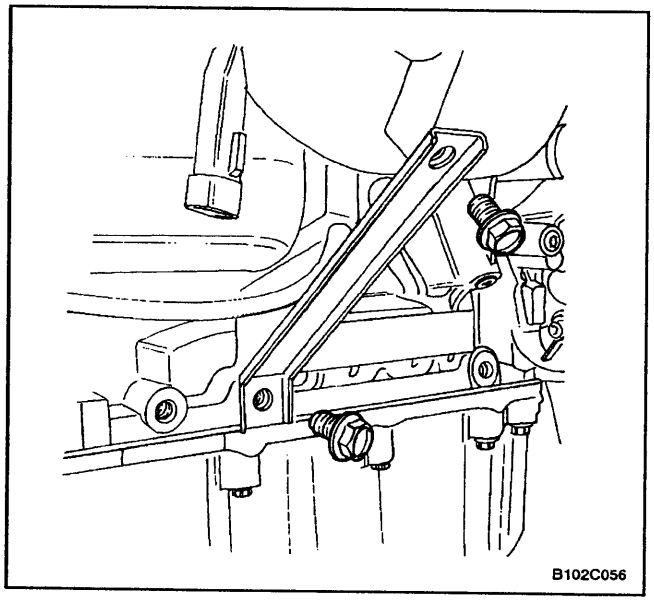
Tighten

Tighten the intake manifold retaining bolts and the nuts to 22 N•m (16 lb-ft).

4. Install the alternator-to-intake manifold strap bracket and bolts.

Tighten

Tighten the alternator-to-intake manifold strap bracket bolts to 20 N•m (15 lb-ft).



5. Install the intake manifold support bracket.
6. Install the intake manifold support bracket upper bolts to the intake manifold.

Tighten

Tighten the intake manifold support bracket upper bolts to the intake manifold to 20 N•m (15 lb-ft).

7. Install the intake manifold support bracket lower bolt to the engine block.

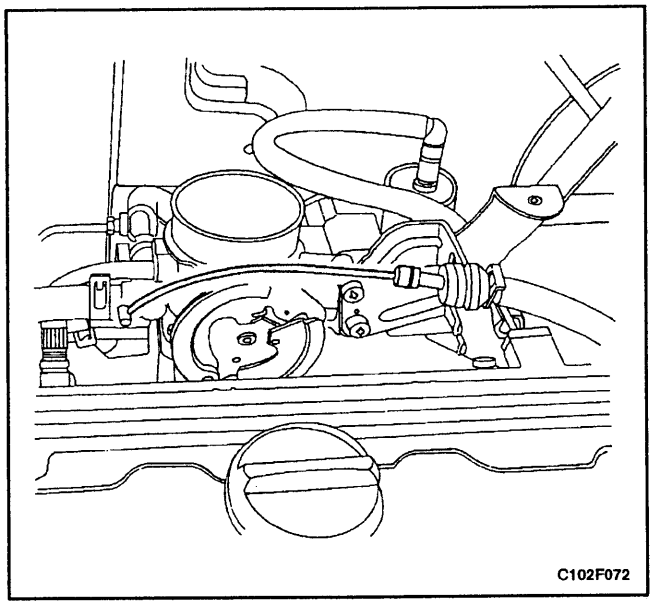
Tighten

Tighten the intake manifold support bracket lower bolt to the engine block to 20 N•m (15 lb-ft).

8. Install the alternator-to-intake manifold support bracket and bolts.

Tighten

Tighten the alternator-to-intake manifold support bracket bolts to 35 N•m (26 lb-ft).

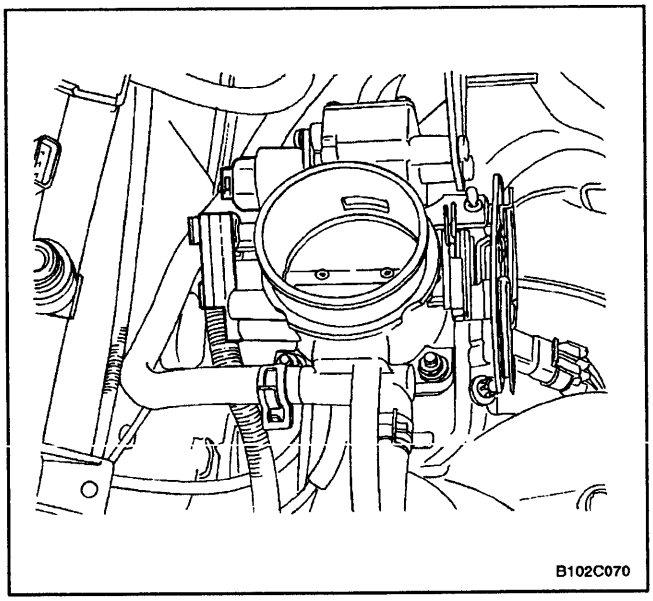

C102F072

9. Install the fuel rail and the injector cover as an assembly. Refer to *Section 1F, Engine Controls.*
10. Install the throttle cable bracket.
11. Install the throttle cable bracket bolts.

Tighten

Tighten the throttle cable bracket bolts to 8 N•m (71 lb-in).

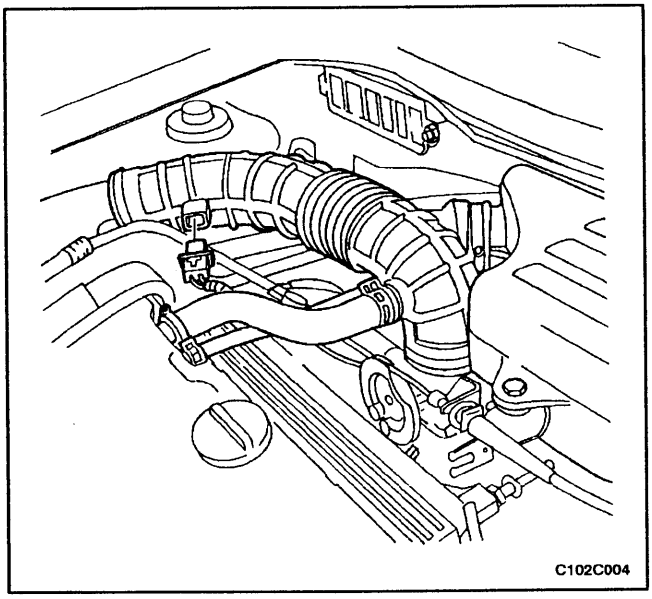
12. Connect the throttle cable to the intake manifold and the throttle body.
13. Connect all of the necessary vacuum lines that were previously disconnected.


B102C070

14. Connect the MAP sensor connector.
15. Connect the coolant hoses to the throttle body.
16. Connect the idle air control valve connector.
17. Connect the throttle position sensor connector.
18. Position the power steering hose in place and install the clamp bolt.

Tighten

Tighten the power steering hose clamp bolt to 8 N•m (71 lb-in).

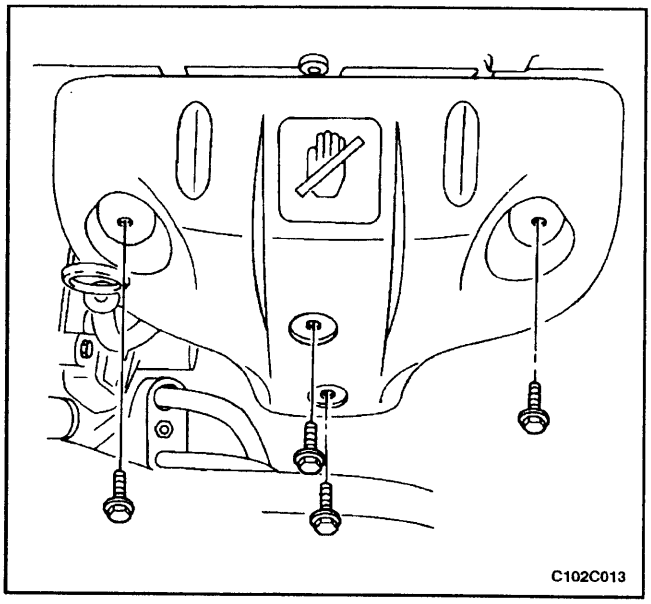

C102C004

19. Connect the air intake tube to the throttle body.
20. Connect the manifold air temperature sensor connector.
21. Connect the canister purge and the EGR solenoids at the intake manifold and tighten the bracket bolt.

Tighten

Tighten the canister purge and the EGR solenoids bracket bolt to 5 N•m (44 lb-in).

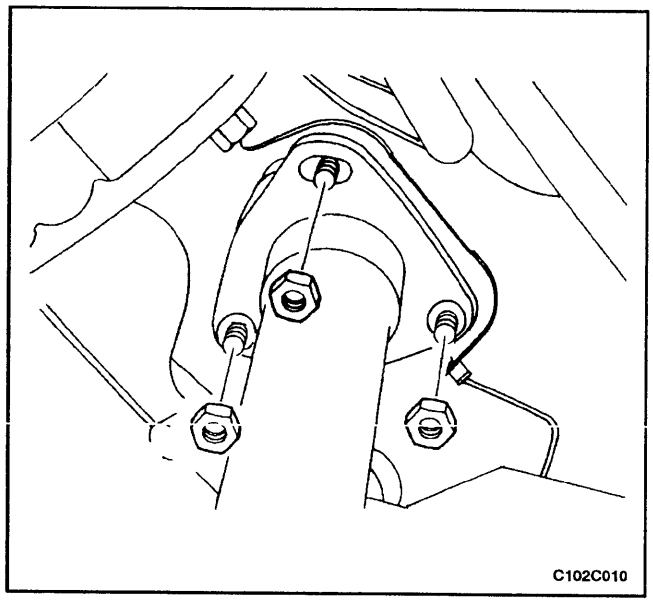
22. Install the fuel pump fuse.
23. Connect the negative battery cable.
24. Refill the engine cooling system. Refer to *Section 1D, Engine Cooling.*



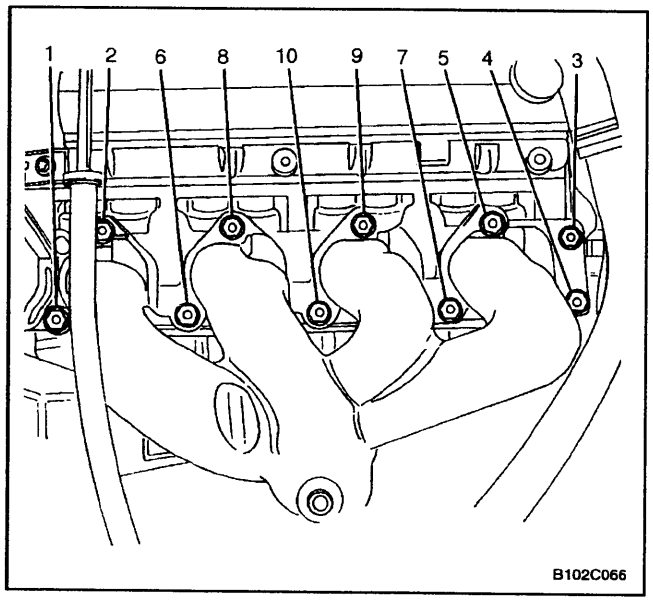
EXHAUST MANIFOLD

Removal Procedure

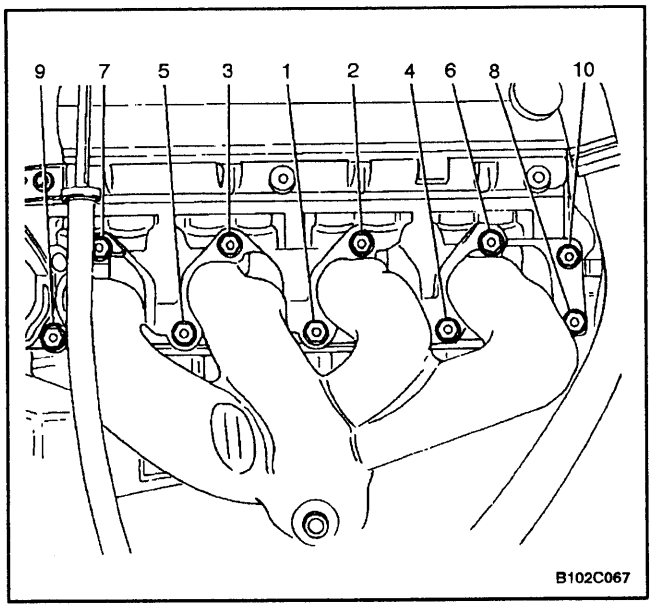
1. Disconnect the negative battery cable.
2. Disconnect the oxygen sensor connector.
3. Remove the exhaust manifold heat shield bolts.
4. Remove the exhaust manifold heat shield.



5. Remove the exhaust flex pipe retaining nuts from the exhaust manifold studs.



6. Remove the exhaust manifold retaining nuts in the sequence shown.
7. Remove the exhaust manifold.
8. Remove the exhaust manifold gasket.
9. Clean the sealing surfaces of the exhaust manifold and the cylinder head.

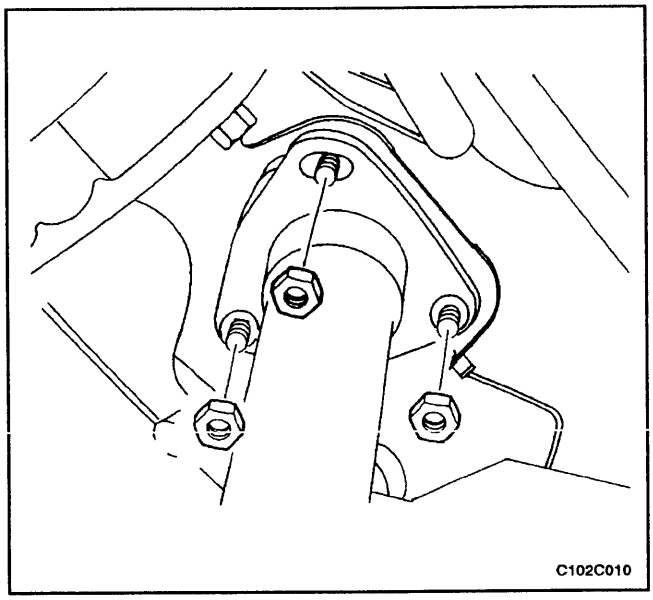


Installation Procedure

1. Install the exhaust manifold gasket.
2. Install the exhaust manifold.
3. Install the exhaust manifold retaining nuts and tighten in the sequence shown.

Tighten

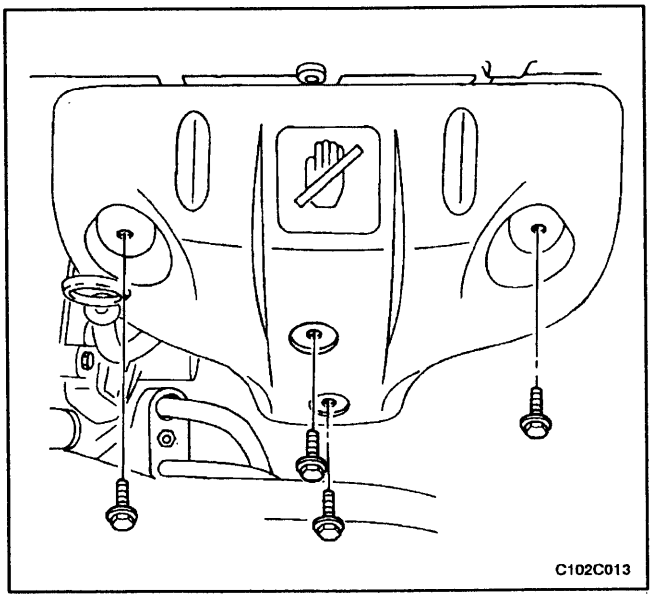
Tighten the exhaust manifold retaining nuts 22 N•m (16 lb-ft).



4. Install the exhaust flex pipe retaining nuts to the exhaust manifold.

Tighten

Tighten the exhaust flex pipe-to-exhaust manifold retaining nuts to 22 N•m (16 lb-ft).

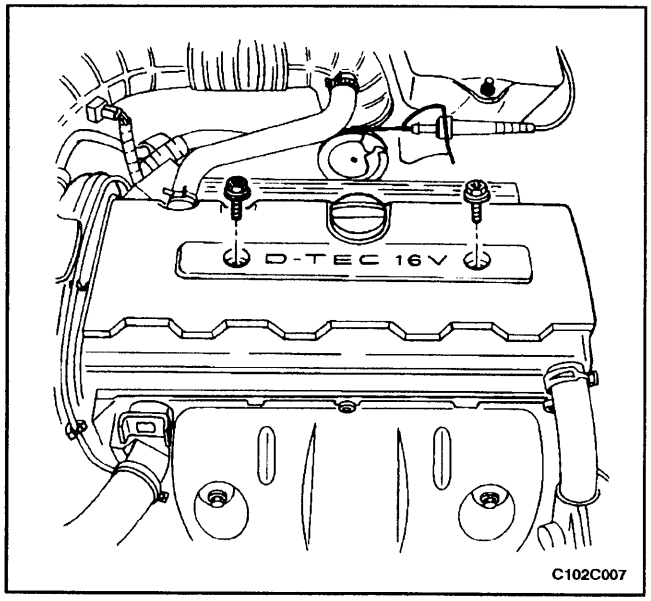


5. Install the exhaust manifold heat shield.
6. Install the exhaust manifold heat shield bolts.

Tighten

Tighten the exhaust manifold heat shield bolts to 8 N•m (71 lb-in).

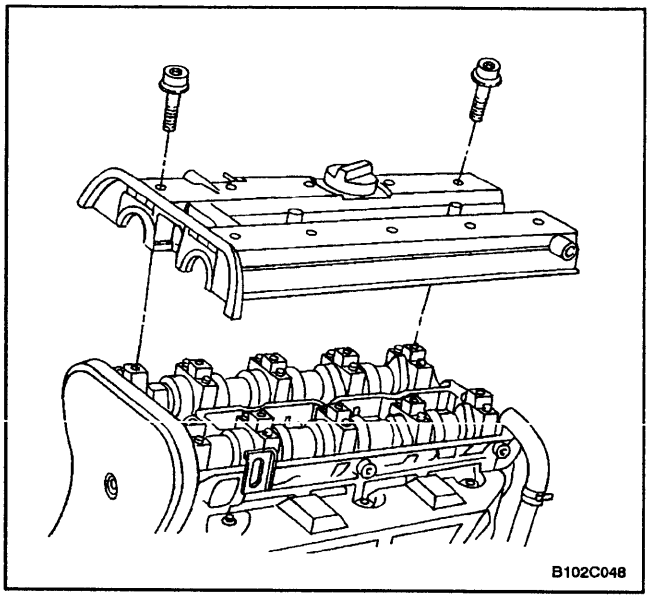
7. Connect the oxygen sensor connector.
8. Connect the negative battery.



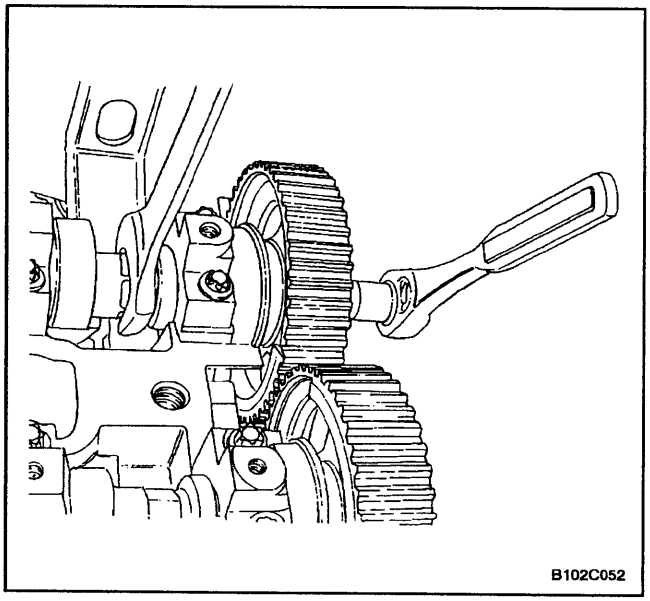
CAMSHAFT GEARS

Removal Procedure

1. Disconnect the negative battery cable.
2. Remove the timing belt. Refer to "Timing Belt" in this section.
3. Remove the spark plug cover bolts.
4. Remove the spark plug cover.
5. Disconnect the ignition wires from the spark plugs.
6. Disconnect the crankcase breather tubes from the valve cover.

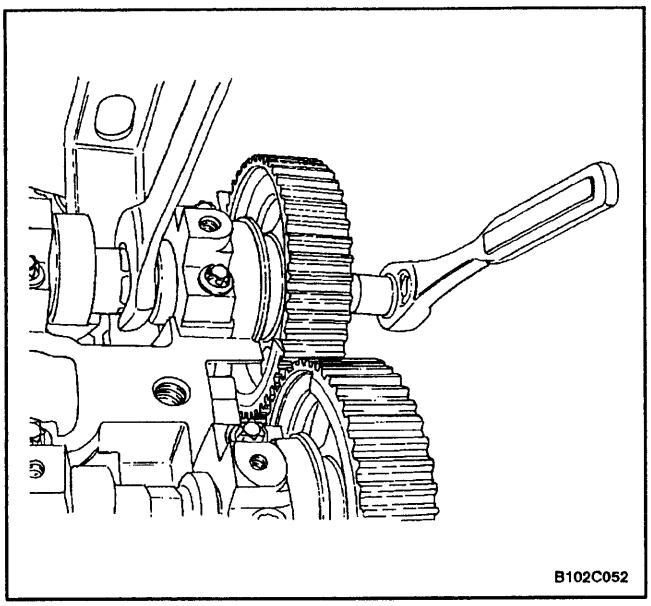


7. Remove the valve cover bolts.
8. Remove the valve cover washers.
9. Remove the valve cover and the valve cover gasket.



Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

10. While holding the intake camshaft firmly in place, remove the intake camshaft gear bolt.
11. Remove the intake camshaft gear.
12. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft gear bolt.
13. Remove the exhaust camshaft gear.


B102C052

Installation Procedure

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

1. Install the intake camshaft gear.
2. While holding the intake camshaft firmly in place, install the intake camshaft gear bolt.

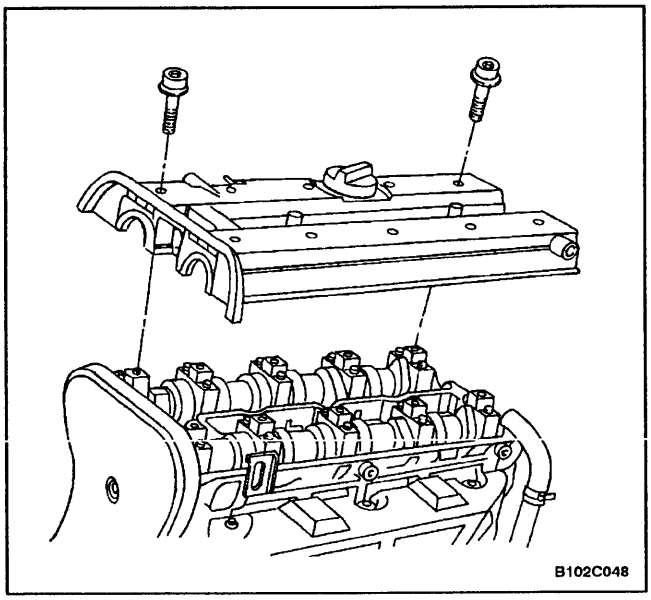
Tighten

Tighten the intake camshaft gear bolt to 50 N•m (37 lb-ft), turn another 60 degrees plus 15 degrees.

3. Install the exhaust camshaft gear.
4. While holding the exhaust camshaft firmly in place, install the exhaust camshaft gear bolt.

Tighten

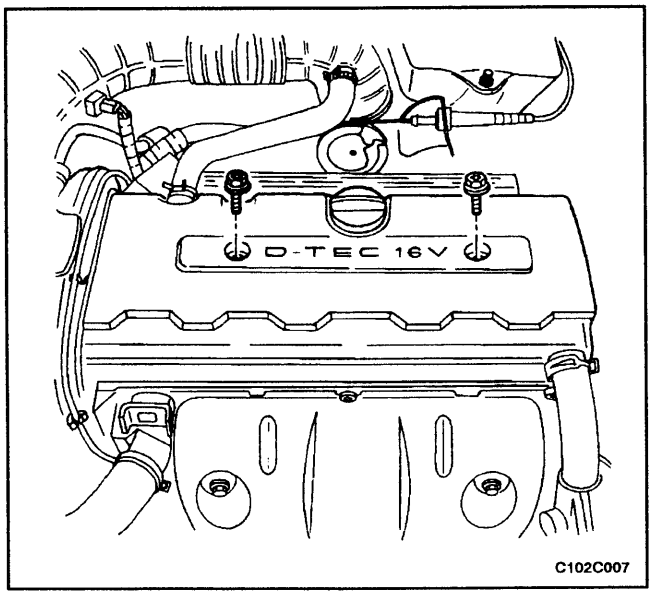
Tighten the exhaust camshaft gear bolt to 50 N•m (37 lb-ft), turn another 60 degrees plus 15 degrees.


B102C048

5. Apply a small amount of gasket sealant to the corners of the front camshaft caps and to the top of the rear valve cover-to-cylinder head seal.
6. Install the valve cover and the valve cover gasket.
7. Install the valve cover washers.
8. Install the valve cover bolts.

Tighten

Tighten the valve cover bolts to 8 N•m (71 lb-in).



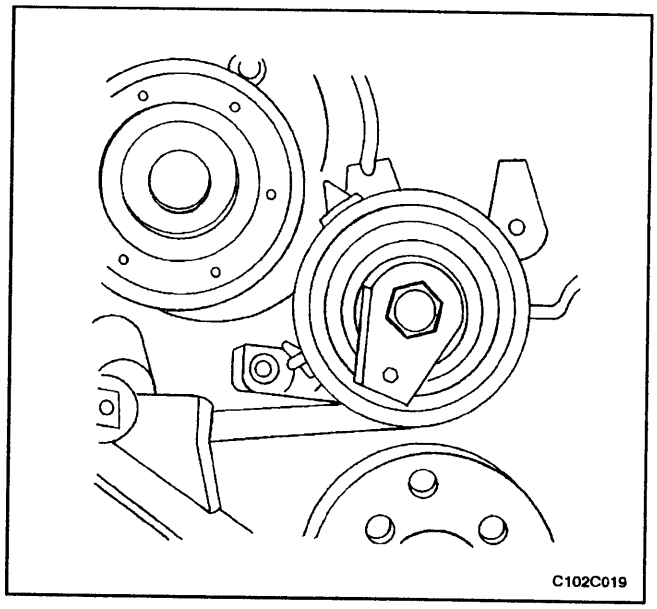
C102C007

9. Connect the crankcase breather tubes to the valve cover.
10. Connect the ignition wires to the spark plugs.
11. Install the spark plug cover.
12. Install the spark plug cover bolts.

Tighten

Tighten the spark plug cover bolts to 3 N•m (27 lb-in).

13. Install the timing belt. Refer to "Timing Belt" in this section.
14. Connect the negative battery cable.


C102C019

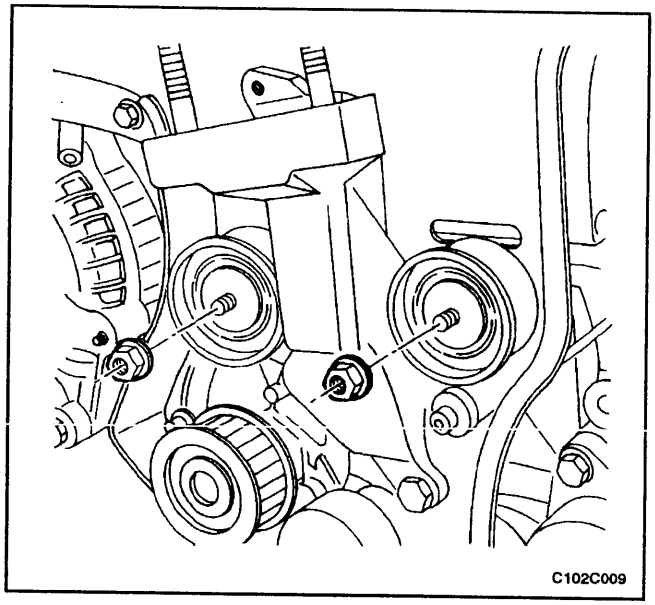
REAR TIMING BELT COVER

Tools Required

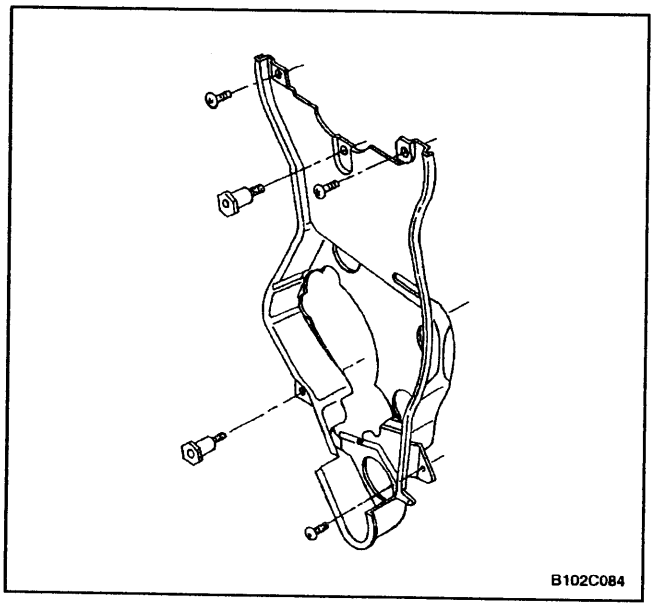
KM-470-B Torque Angular Gauge

Removal Procedure

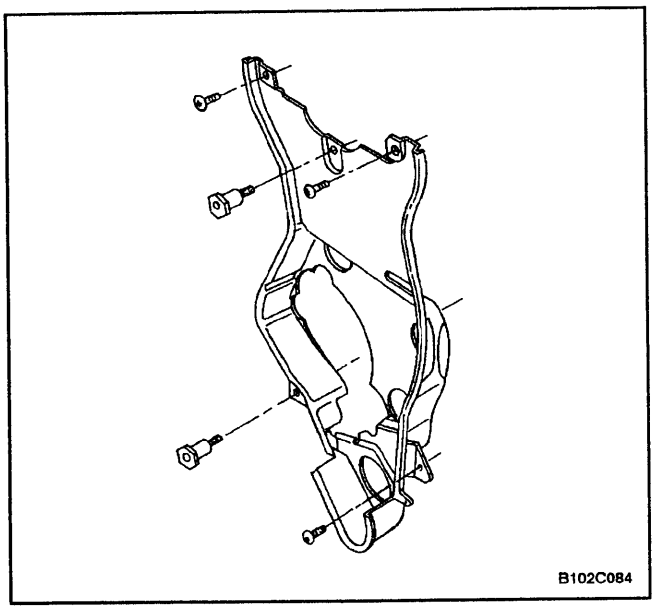
1. Disconnect the negative battery cable.
2. Remove the timing belt. Refer to "Timing Belt" in this section.
3. Remove the camshaft gears. Refer to "Camshaft Gears" in this section.
4. Remove the timing belt automatic tensioner bolt.
5. Remove the timing belt automatic tensioner.


C102C009

6. Remove the timing belt idler pulley nuts.
7. Remove the timing belt idler pulleys.
8. Remove the engine mount retaining bolts.
9. Remove the engine mount.
10. Remove the crankshaft timing belt drive gear bolt.
11. Remove the crankshaft gear.


B102C084

12. Remove the rear timing belt cover bolts.
13. Remove the rear timing belt cover.


B102C084

Installation Procedure

1. Install the rear timing belt cover.
2. Install the rear timing belt cover bolts.

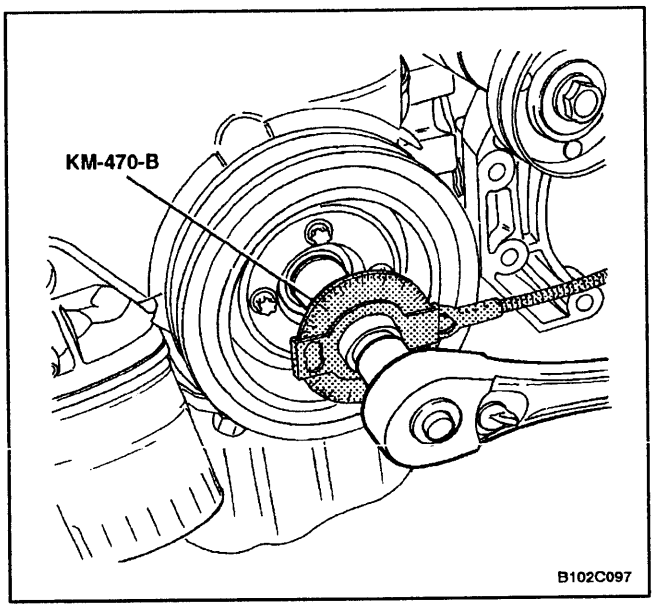
Tighten

Tighten the rear timing belt cover bolts to 10 N•m (89 lb-in).

3. Install the engine mount and the retaining bolts.

Tighten

Tighten the engine mount bolts to 60 N•m (44 lb-ft).



B102C097

4. Install the timing belt idler pulleys.
5. Install the timing belt idler pulley nuts.

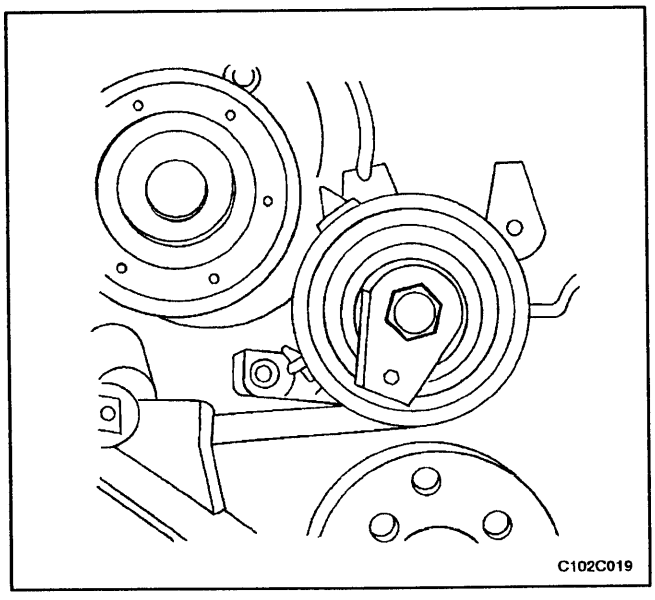
Tighten

Tighten the timing belt idler pulley nuts to 25 N•m (18 lb-ft).

6. Install the crankshaft timing belt drive gear and bolt.

Tighten

Tighten the crankshaft timing belt drive gear bolt to 130 N•m (96 lb-ft) plus 40° plus 50° using the angular torque gauge KM-470-B.

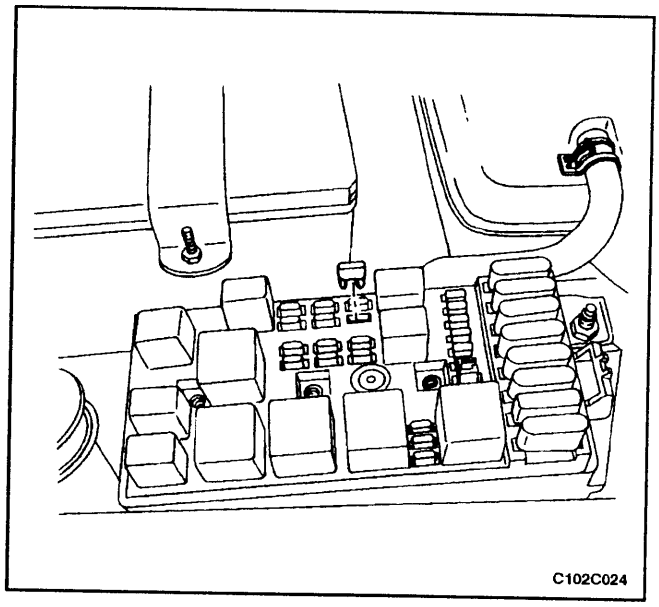

C102C019

7. Install the timing belt automatic tensioner and bolt.

Tighten

Tighten the timing belt automatic tensioner bolt to 25 N•m (18 lb-ft).

8. Install the camshaft gears. Refer to "Camshaft Gears" in this section.
9. Install the timing belt and timing belt cover. Refer to "Timing Belt" in this section.
10. Connect the negative battery cable.

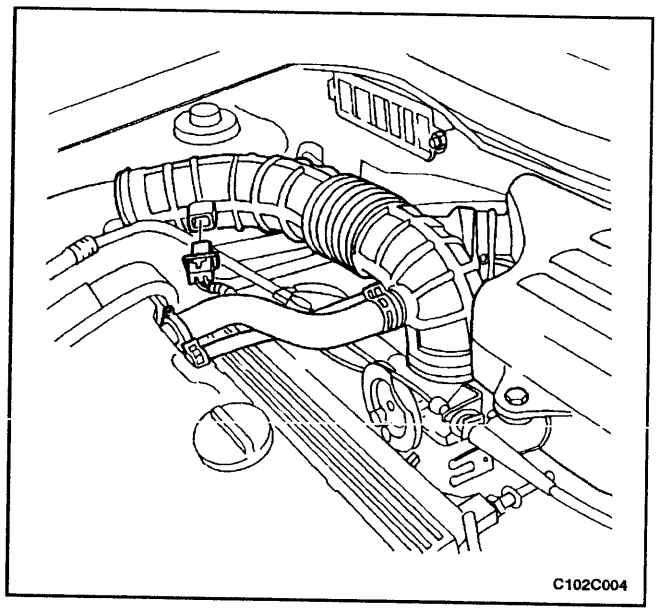

C102C024

ENGINE

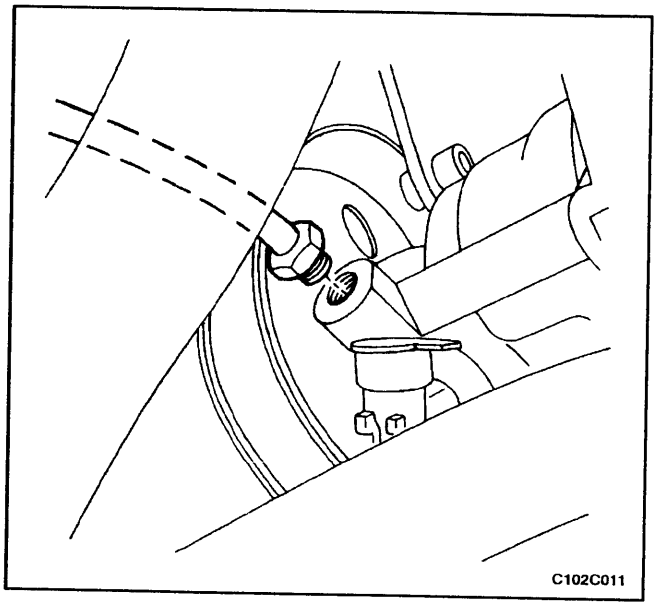
(Left-Hand Drive Shown, Right-Hand Drive Similar)

Removal Procedure

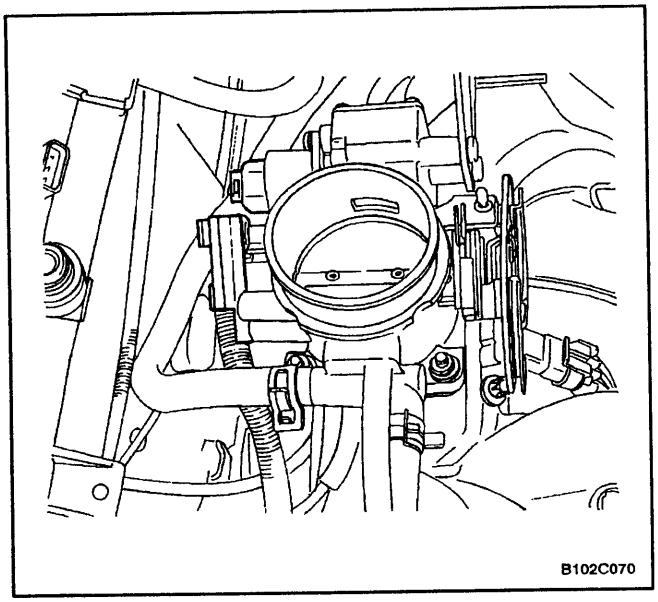
1. Remove the fuel pump fuse.
2. Start the engine. After it stalls, crank the engine for 10 seconds to rid the fuel system of fuel pressure.
3. Remove the hood. Refer to *Section 9R, Body Front End.*
4. Drain the engine oil.
5. Disconnect the negative battery cable.


C102C004

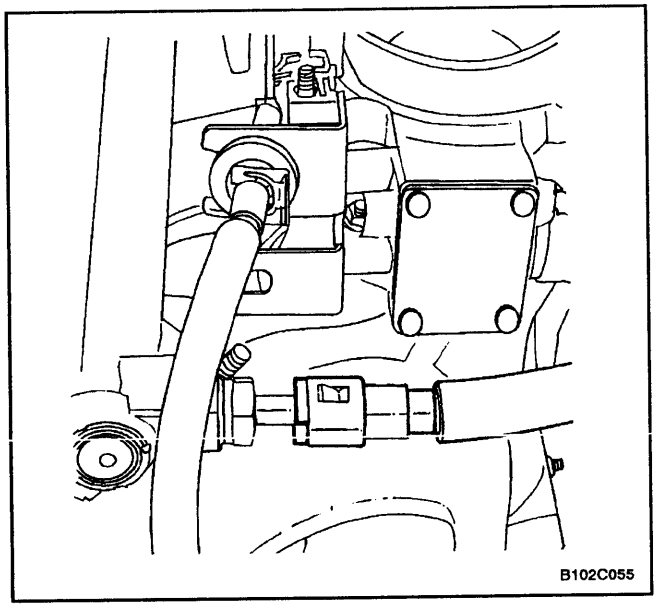
6. Discharge the air conditioning (A/C) system, if equipped. Refer to *Section 7B, Manual Control Heating, Ventilation, and Air Conditioning System.*
7. Disconnect the manifold air temperature sensor connector.
8. Remove the air intake tube.
9. Disconnect the breather tubes from the valve cover.
10. Remove the right front wheel. Refer to *Section 2E, Tires and Wheels.*
11. Remove the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
12. Remove the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*


C102C011

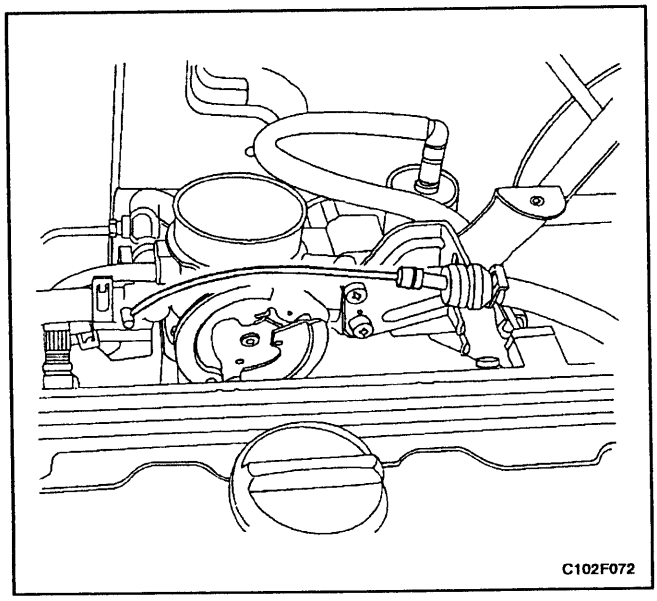
13. Drain the engine coolant. Refer to *Section 1D, Engine Cooling.*
14. Remove the cooling system radiator and the engine cooling fans. Refer to *Section 1D, Engine Cooling.*
15. Disconnect the upper radiator hose from the thermostat housing.
16. Disconnect the power steering return hose from the power steering pump. Collect the oil in a suitable container.
17. Disconnect the power steering pressure hose from the power steering pump. Collect the oil in a suitable container.
18. Disconnect the electrical connector at the direct ignition system (DIS) ignition coil and the electronic control module (ECM) ground terminal.


B102C070

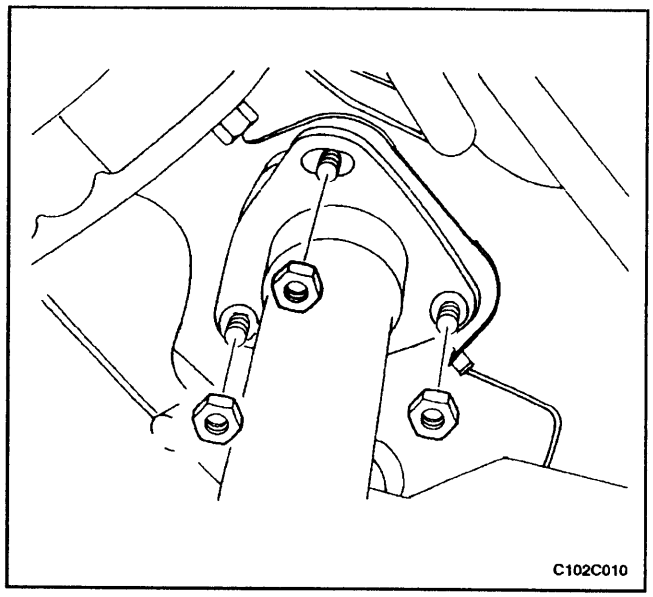
19. Disconnect the oxygen sensor connector.
20. Disconnect the idle air control valve connector and the manifold absolute pressure (MAP) sensor connector.
21. Disconnect the throttle position sensor (TPS) connector.
22. Disconnect the engine coolant temperature sensor (CTS) connector.
23. Disconnect the CTS connector.
24. Disconnect the alternator voltage regulator connector and the power lead.


B102C055

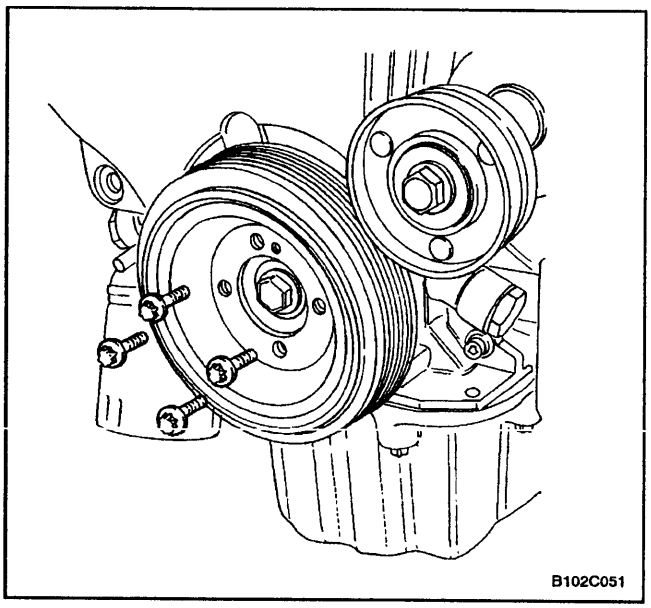
25. Disconnect all of the necessary vacuum lines including the brake booster vacuum hose.
26. Disconnect the fuel return line at the fuel pressure regulator.
27. Disconnect the fuel feed line at the fuel rail.
28. Remove the fuel rail and the injector channel cover as an assembly. Refer to *Section 1F, Engine Controls*.


C102F072

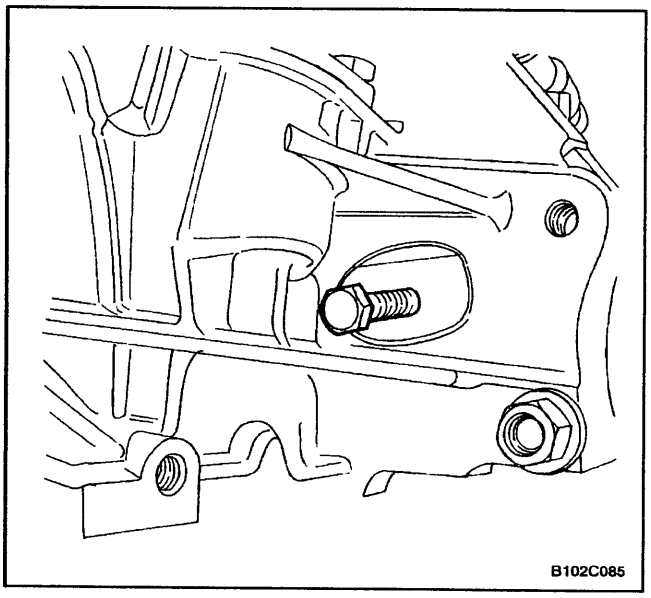
29. Disconnect the throttle cable from the throttle body and the intake manifold bracket.
30. Disconnect the coolant hose at the throttle body.
31. Disconnect the heater outlet hose at the coolant pipe.
32. Disconnect the coolant bypass hose from the cylinder head.
33. Disconnect the surge tank coolant hose from the coolant pipe.
34. Disconnect the lower radiator hose from the coolant pipe.
35. Disconnect the starter solenoid "S" terminal wire and the power lead.
36. Remove the A/C compressor. Refer to *Section 7B, Manual Control Heating, Ventilation, and Air Conditioning System.*



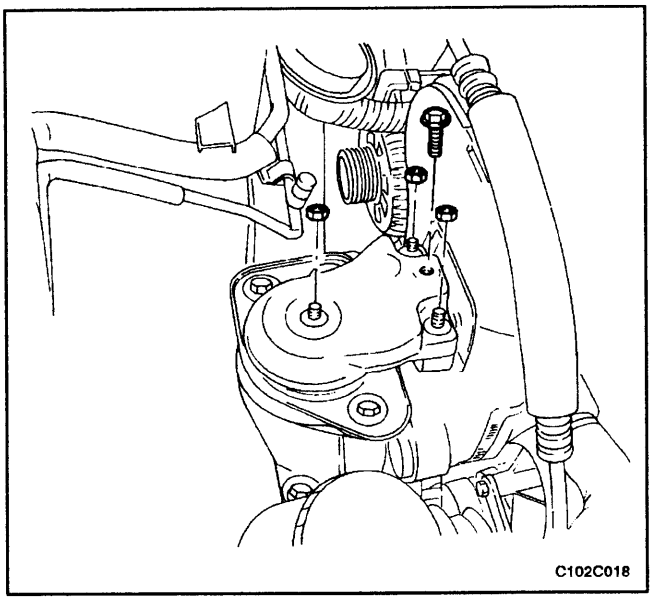
37. Remove the exhaust flex pipe retaining nuts from the exhaust manifold studs and the support bracket.
38. Remove the exhaust flex pipe retaining nuts from the catalytic converter.
39. Remove the exhaust flex pipe.



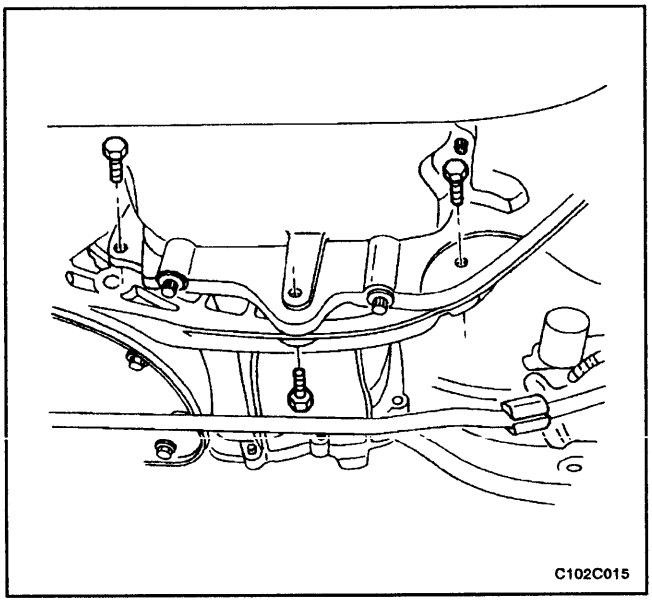
40. Remove the crankshaft pulley bolts.
41. Remove the crankshaft pulley.
42. Disconnect the vacuum lines at the charcoal canister purge (CCP) and the exhaust gas recirculation (EGR) solenoids.
43. Disconnect the electrical connectors at the CCP and the EGR solenoids.
44. Disconnect the electrical connector at the oil pressure switch.
45. Disconnect the crankshaft position and the knock sensor connectors.
46. Support the transaxle with a floor jack.
47. Remove the center member. Refer to *Section 9N, Frame and Underbody.*
48. Install the engine lifting device.



49. Remove the transaxle torque converter bolts from vehicles with an automatic transaxle.
50. Remove the transaxle bell housing bolts and the oil pan flange bolts.
51. Remove the right engine mount bracket. Refer to *Section 5B, Five-Speed Manual Transaxle,* or *Section 5A, ZF 4 HP 14 Automatic Transaxle.*
52. Remove the resonator bolts and the resonator.
53. Remove the air filter housing and the bolts.


C102C018

54. Disconnect the right engine mount bracket from the engine mount and the engine by removing the retaining bolts.
55. Separate the engine block from the transaxle. Remove the engine.


C102C015

Installation Procedure

1. Install the engine into the engine compartment.
2. Align the engine alignment pins to the transaxle.
3. Install the transaxle bell housing bolts.

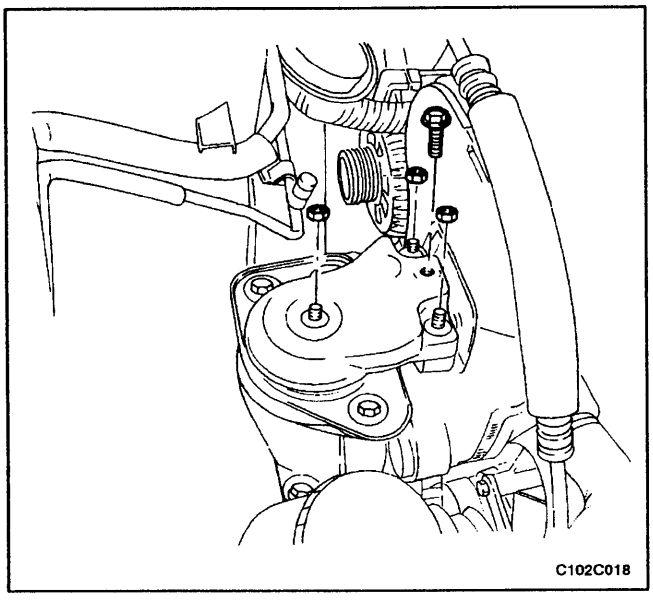
Tighten

Tighten the transaxle bell housing bolts to 75 N•m (55 lb-ft).

4. Install the oil pan flange-to-transaxle retaining bolts.

Tighten

Tighten the oil pan flange-to-transaxle retaining bolts to 40 N•m (30 lb-ft).

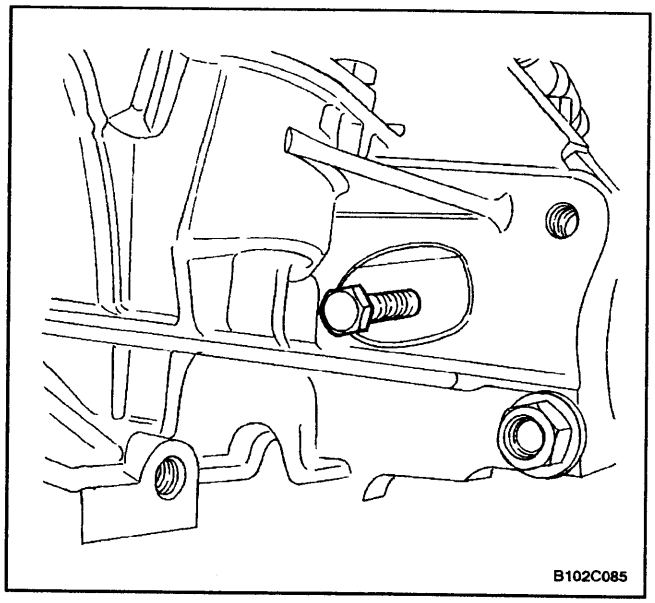

C102C018

5. Install the right engine mount bracket to the engine block mount and the frame mount.
6. Install the right engine mount bracket retaining bolts and the nuts.

Tighten

Tighten the engine mount bolts and the nuts to 60 N•m (44 lb-ft).

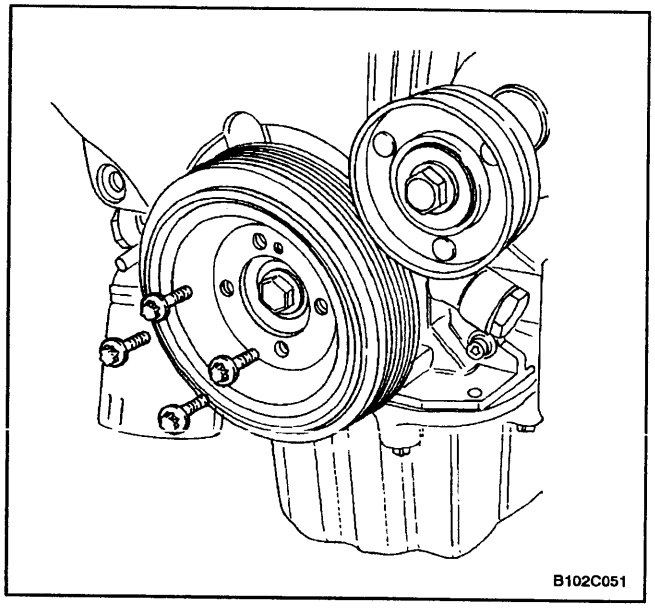
7. Install the rear engine/transaxle mount bracket. Refer to *Section 5A, ZF 4 HP 14 Automatic Transaxle,* or *Section 5B, Five-Speed Manual Transaxle.*
8. Install the center member. Refer to *Section 9N, Frame and Underbody.*



9. Remove the floor jack used for support of the transaxle.
10. Remove the engine lifting device.
11. Install the transaxle torque converter bolts on vehicles with an automatic transaxle.

Tighten

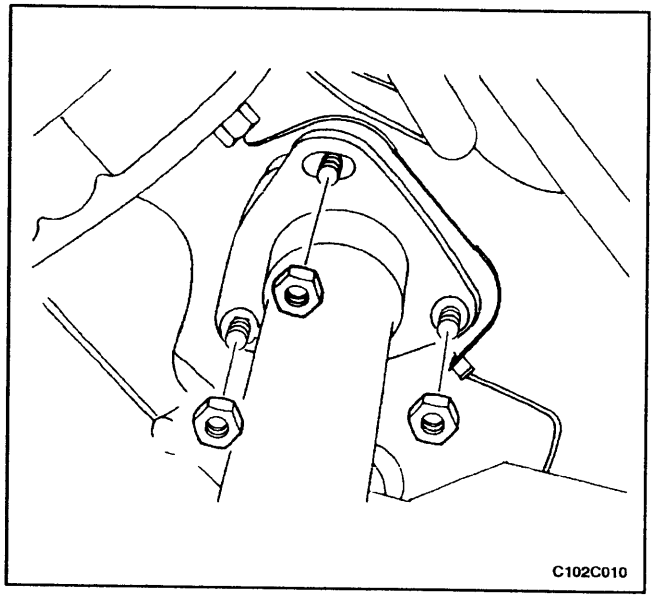
Tighten the transaxle torque converter bolts to 60 N•m (44 lb-ft).



12. Connect the vacuum lines at the charcoal canister purge and the EGR solenoids.
13. Connect the electrical connectors to the charcoal canister purge and the EGR solenoids.
14. Connect the oil pressure switch connector.
15. Install the crankshaft pulley.
16. Install the crankshaft pulley bolts.

Tighten

Tighten the crankshaft pulley bolts to 20 N•m (15 lb-ft) using a torque wrench.



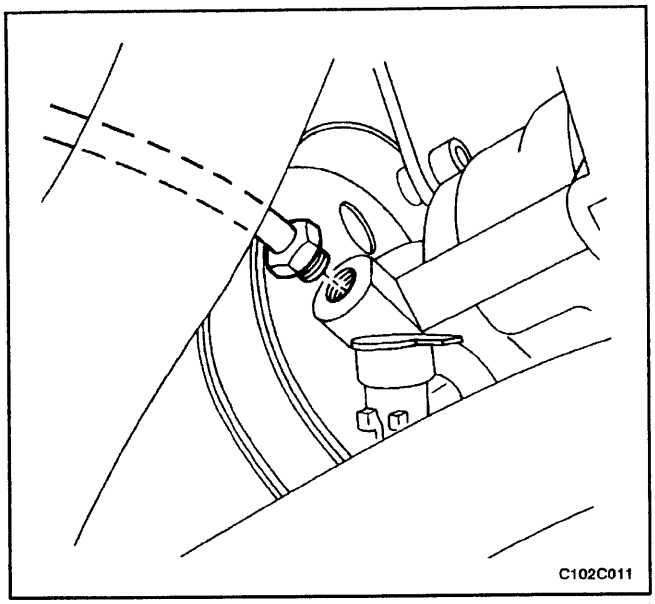
17. Connect the crankshaft position and the knock sensor connectors.
18. Install the exhaust flex pipe.
19. Install the exhaust flex pipe retaining nuts to the exhaust manifold studs and the support bracket.

Tighten

Tighten the exhaust flex pipe-to-exhaust manifold retaining nuts to 22 N•m (16 lb-ft).

Tighten

Tighten the exhaust flex pipe support bracket bolts to 30 N•m (22 lb-ft).

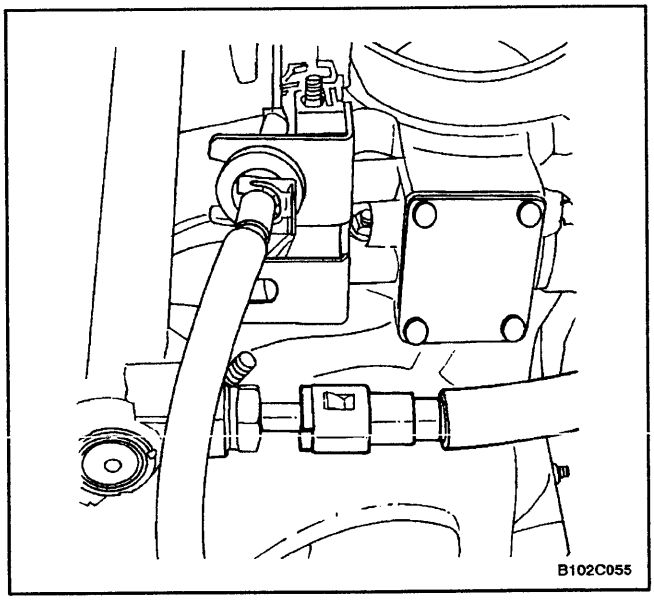


20. Install the exhaust flex pipe retaining nuts to the catalytic converter.

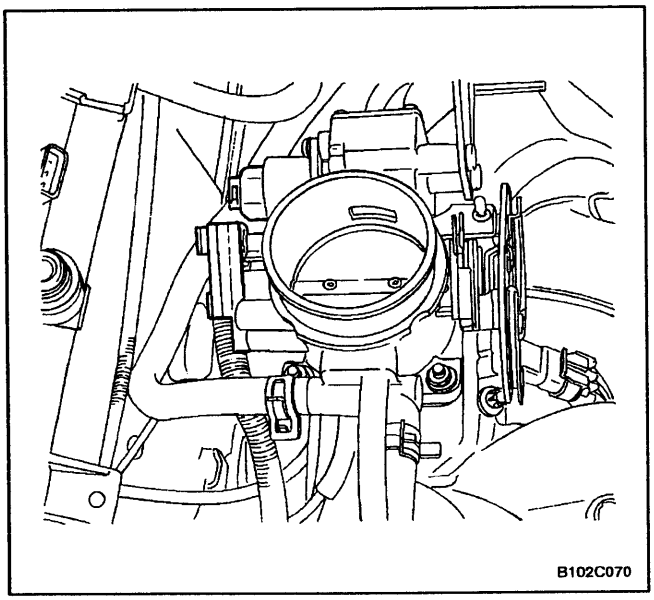
Tighten

Tighten the exhaust flex pipe-to-catalytic converter retaining nuts to 30 N•m (22 lb-ft).

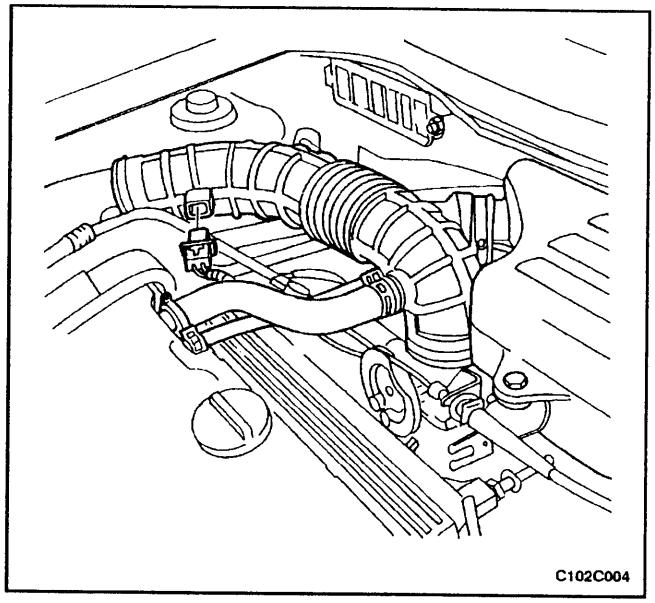
21. Connect the power steering pressure hose.
22. Connect the power steering return hose.
23. Install the A/C compressor, if equipped. Refer to *Section 7B, Manual Control Heating, Ventilation, and Air Conditioning System*.



24. Install the serpentine accessory drive belt. Refer to *Section 6B, Power Steering Pump.*
25. Install the right front wheel well splash shield. Refer to *Section 9R, Body Front End.*
26. Install the right front wheel. Refer to *Section 2E, Tires and Wheels*.
27. Connect the fuel feed line to the fuel rail.
28. Connect the fuel return line to the fuel pressure regulator.
29. Install the fuel rail and the injector channel cover as an assembly. Refer to *Section 1F, Engine Controls.*



30. Connect all of the necessary vacuum lines including the brake booster vacuum hose.
31. Connect the oxygen sensor connector.
32. Connect the starter solenoid "S" terminal wire and the power lead.
33. Connect the alternator voltage regulator connector.
34. Connect the coolant temperature sensor connector.
35. Connect the engine coolant temperature sensor connector.
36. Connect the TPS connector.
37. Connect the IAC valve connector.
38. Connect the MAP sensor connector.


C102C004

39. Connect the electrical connector at the DIS ignition coil and the ECM ground terminal.
40. Install the air intake tube.
41. Install the air filter housing and the bolts.

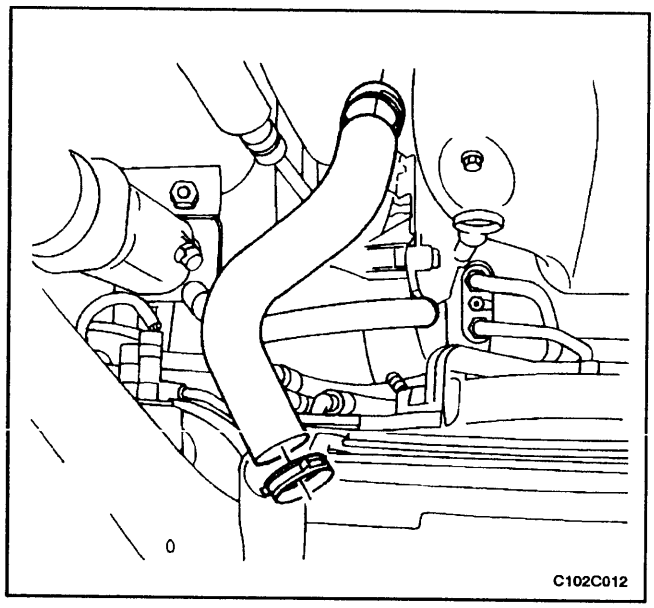
Tighten

Tighten the air filter housing bolts to 8 N•m (71 lb-in).

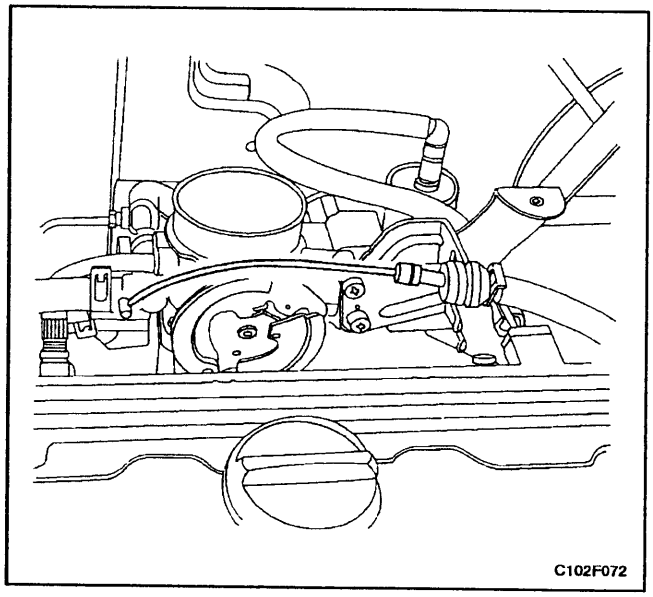
42. Connect the breather tubes to the valve cover.
43. Connect the manifold air temperature sensor connector.
44. Install the cooling system radiator and the engine cooling fans. Refer to *Section 1D, Engine Cooling.*
45. Install the resonator and the retaining bolts.

Tighten

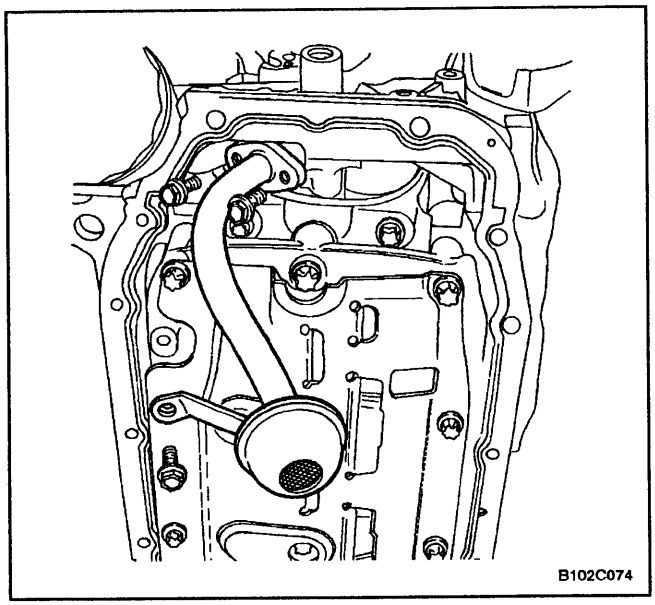
Tighten the resonator retaining bolts to 8 N•m (71 lb-in).


C102C012

46. Connect the lower radiator hose to the coolant pipe.
47. Connect the upper radiator hose to the thermostat housing.
48. Connect the heater inlet hose to the cylinder head.
49. Connect the heater outlet hose to the coolant pipe.
50. Connect the coolant surge tank hose to the coolant pipe.
51. Connect the coolant hose to the throttle body.


C102F072

52. Connect the throttle cable to the throttle body and the intake manifold bracket.
53. Install the fuel pump fuse.
54. Connect the negative battery cable.
55. Refill the engine crankcase with engine oil.
56. Refill the engine coolant system. Refer to *Section 1D, Engine Cooling.*
57. Fill and bleed the power steering system. Refer to *Section 6A, Power Steering System.*
58. Refill the A/C refrigerant system, if equipped. Refer to *Section 7B, Manual Control Heating, Ventilation, and Air Conditioning System.*
59. Install the hood. Refer to *Section 9R, Body Front End.*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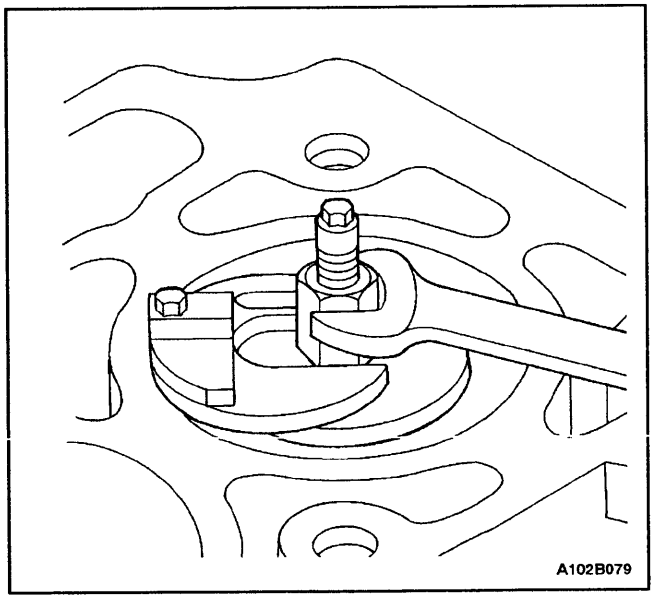
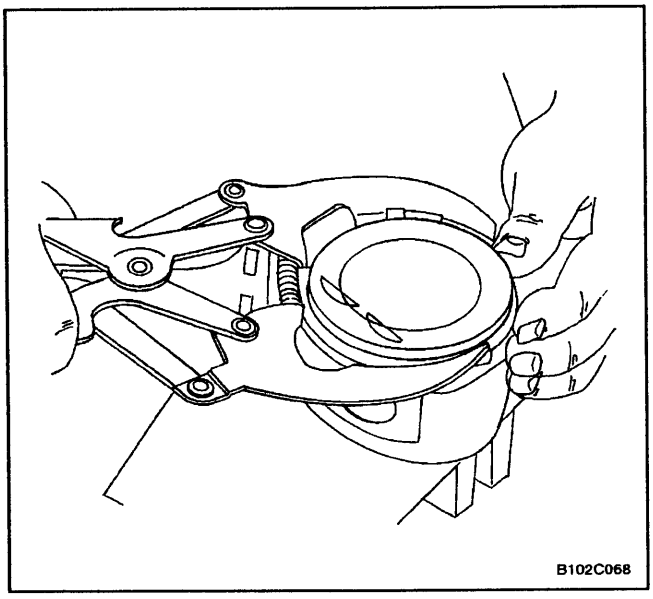

A102B079


B102C068

PISTONS AND CONNECTING RODS

Tools Required

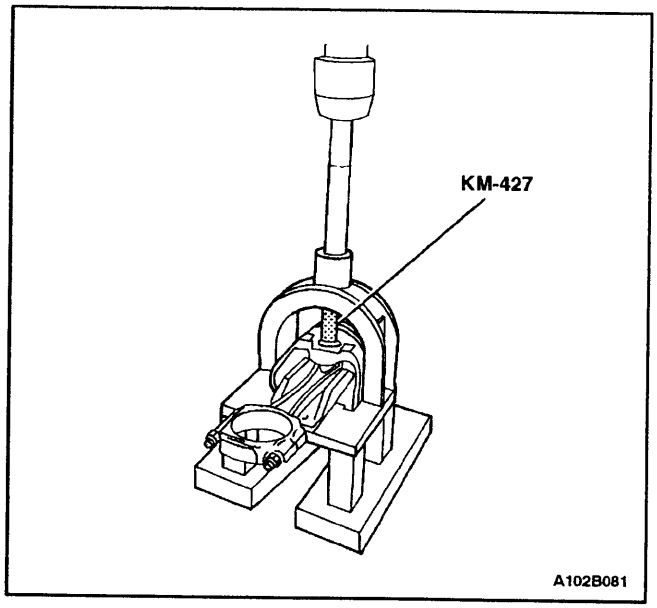
J-8037 Universal Piston Ring Compressor
J-8087 Cylinder Bore Check Gauge
KM-427 Piston Pin Service Set
KM-470-B Angular Torque Gauge

Removal Procedure

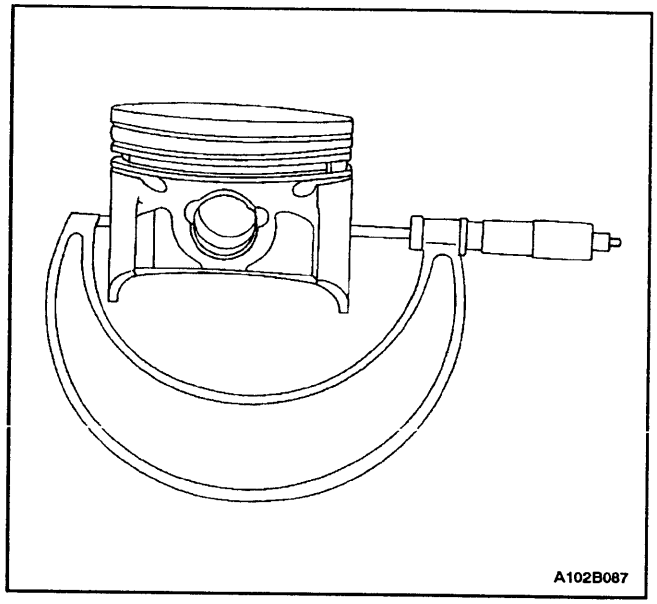
1. Remove the cylinder head with the intake manifold and the exhaust manifold attached. Refer to "Cylinder Head and Gasket" in this section.
2. Remove the oil pan. Refer to "Oil Pan" in this section.
3. Remove the oil pump pickup tube bolts.
4. Remove the oil pump pickup tube.
5. Remove the engine block lower support and the splash shield bolts.
6. Remove the engine block lower support and the splash shield.
7. Move the piston to the bottom of the piston stroke.
8. Mark the connecting rod cap for position.
9. Remove the connecting rod cap bolts.
10. Remove the connecting rod cap and the lower connecting rod bearing.
11. Remove the upper piston connecting rod bearing.
12. Ridge ream the cylinder wall.

Caution: Use care when handling the piston. Worn piston rings are sharp and may cause injury.

13. Remove the piston.
14. Use a piston ring expander tool to expand the piston rings.
15. Remove the piston rings.

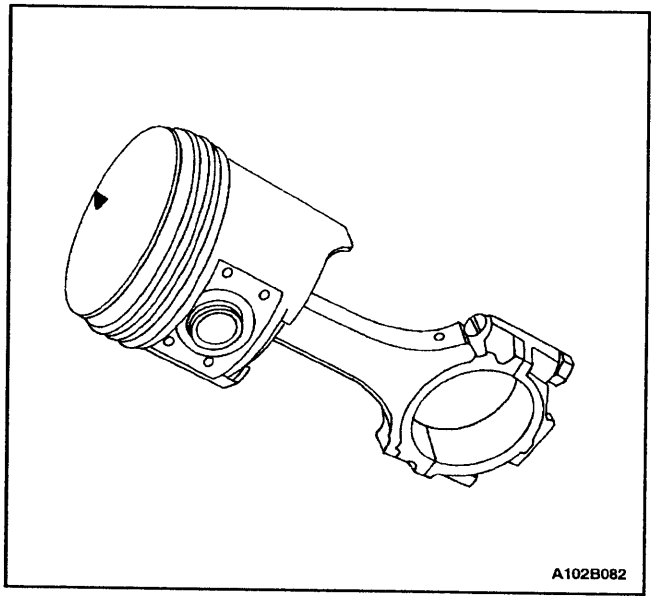


16. Remove the piston pin from the piston and connecting rod assembly using the piston pin service set KM-427.
17. Separate the piston from the connecting rod.

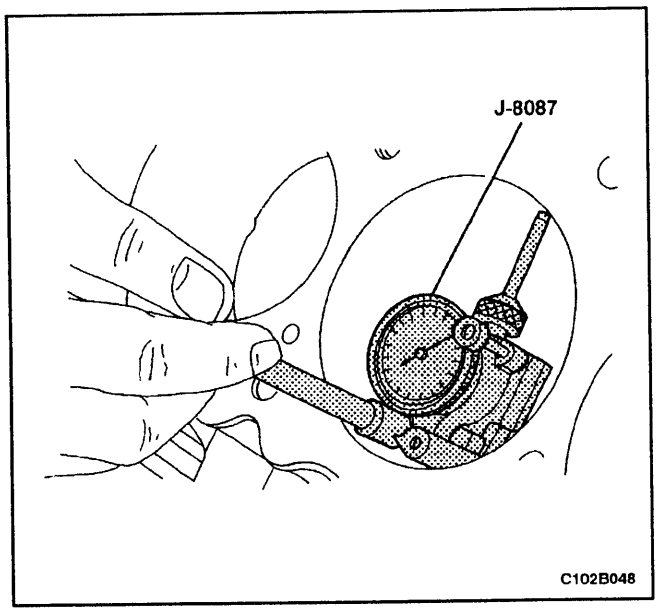


Inspection Procedure

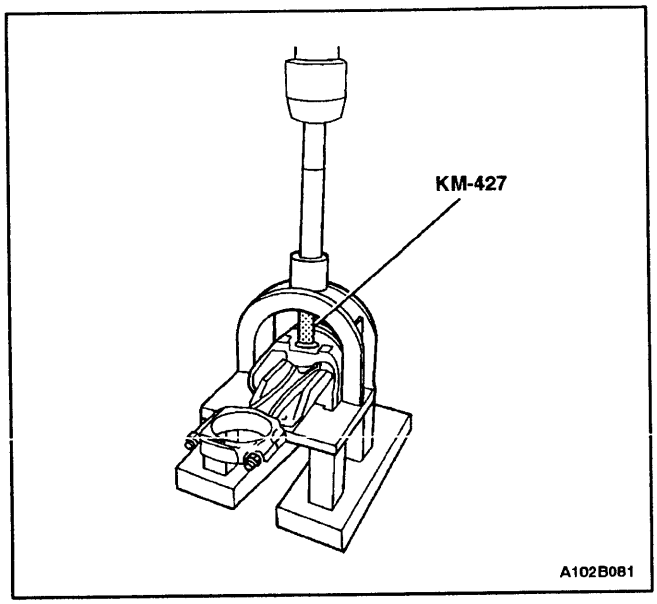
1. Inspect the connecting rod for bending or twisting. If the connecting rod is bent or twisted, replace the connecting rod.
2. Inspect the connecting rod bearings.
3. Inspect the connecting rod lower end for wear.
4. Inspect the connecting rod upper end for scoring.
5. Inspect the crankshaft rod bearing journal for wear. Refer to "Engine Specifications" in this section.
6. Inspect the piston for scoring, cracks, and wear.
7. Inspect the piston for taper using a micrometer.



8. Inspect the piston for fit to the connecting rod.



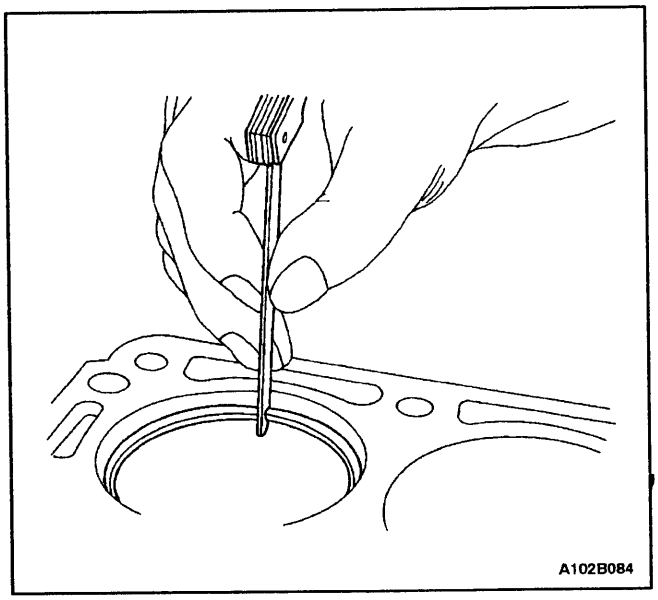
9. Inspect the engine block deck surface for flatness using a straight edge and a feeler gauge. Refer to "Engine Specifications" in this section.
10. Inspect the bearing bore for concentricity and alignment using cylinder bore check gauge J-8087. Refer to "Engine Specifications" in this section. If the bearing bore is beyond specifications, replace the engine block.
11. Inspect the engine block cylinder bore for wear, runout, ridging and taper using a bore gauge. Refer to "Engine Specifications" in this section.
12. Inspect the engine block cylinder bore for glazing. Lightly hone the cylinder bore as necessary.



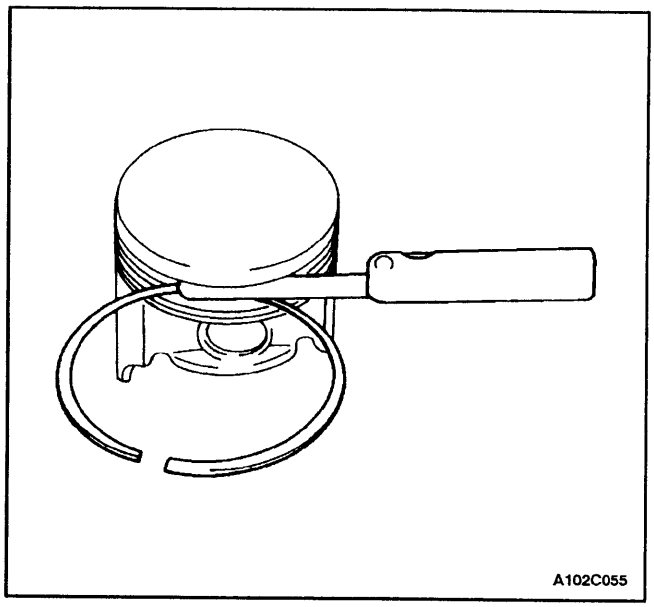
Installation Procedure

Important: For ease of installation of the piston pin, the connecting rod should be heated to 280°C (536°F). Heat the upper connecting rod only. Use commercial thermocolor material to determine the correct temperature. When the thermocolor material changes from black to green, the temperature is correct for installation.

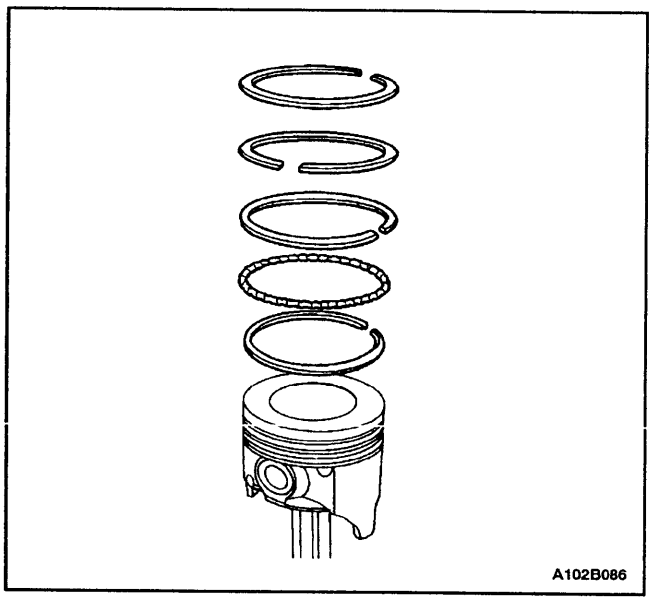
1. Align the notch on the piston and the connecting rod so that the proper sides will be facing the front of the engine.
2. Install the piston pin guide through the piston and the connecting rod.
3. Coat the piston pin with clean oil.
4. Install the piston pin into the opposite side of the piston.
5. Install the piston pin into the piston and the connecting rod assembly using the piston pin service set KM-427.



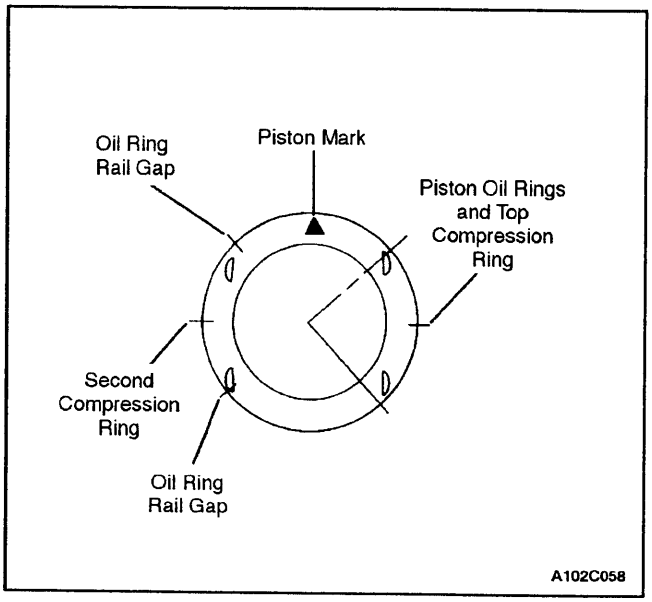
6. Select a set of new piston rings.
7. Measure the piston ring gap using a feeler gauge. Refer to "Engine Specifications" in this section.
8. Increase the piston ring gap by carefully filing off excess material if the piston ring gap is below specifications.


A102C055

9. Measure the piston ring side clearance using a feeler gauge. Refer to "Engine Specifications" in this section.
10. If the piston ring is too thick, try another piston ring.
11. If no piston ring can be found that fits to specifications, the piston ring may be ground to size with emery paper placed on a sheet of glass.

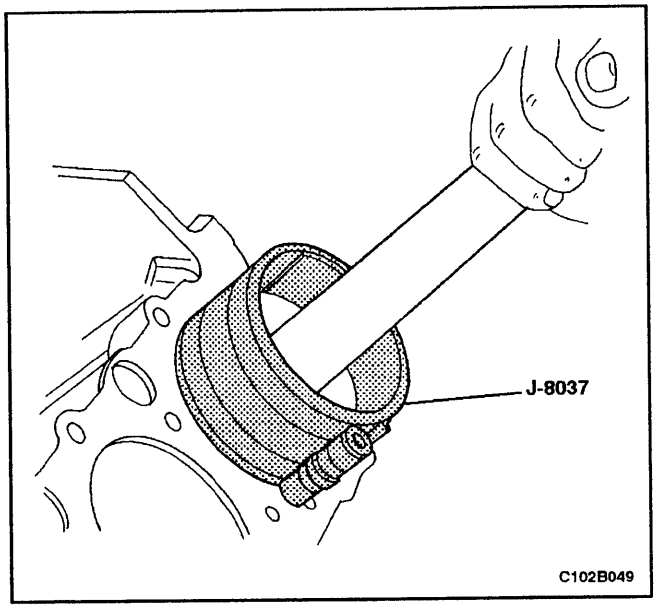

A102B086

12. Install a piston oil ring, the expander, then the second piston oil ring to the bottom ring groove of the piston.
13. Install the second compression ring to the middle ring groove of the piston.
14. Install the top compression ring to the top ring groove of the piston.

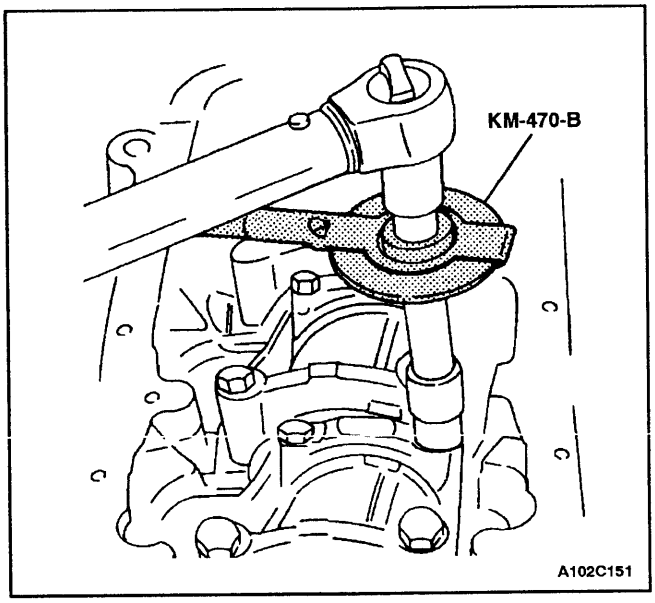


A102C058

15. Use a piston ring expander to install the piston rings. Do not expand the piston rings beyond the expansion necessary for installation.
16. Stagger the piston oil rings, the oil ring rail gaps, the second compression ring, and the top compression ring in relation to the notch on the top of the piston.



17. Lubricate the cylinder wall and the piston rings with clean engine oil.
18. Install the piston using the universal piston ring compressor J-8037 and a wood handle. Guide the lower connecting rod end to prevent damaging the crankshaft journal.
19. Install the connecting rod cap and bearings. Refer to "Crankshaft Bearings and Connecting Rod Bearings - Gauging Plastic" in this section.



20. Install the connecting rod cap bearing bolts.

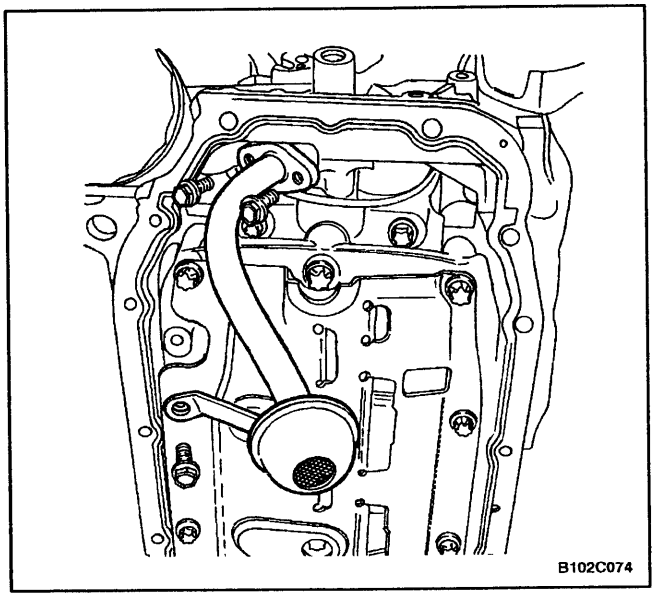
Tighten

Tighten the connecting rod cap bearing bolts to 35 N•m (26 lb-ft). Using the angular torque gauge KM-470-B, tighten the bolts one turn of 45 degrees.

21. Install the engine block lower support bracket/ splash shield bolts.

Tighten

Tighten the engine block lower support bracket/ splash shield bolts to 35 N•m (26 lb-ft).



22. Install the oil pump pickup tube.
23. Install the oil pump pickup tube bolts.

Tighten

Tighten the oil pump pickup tube bolts to 8 N•m (71 lb-in).

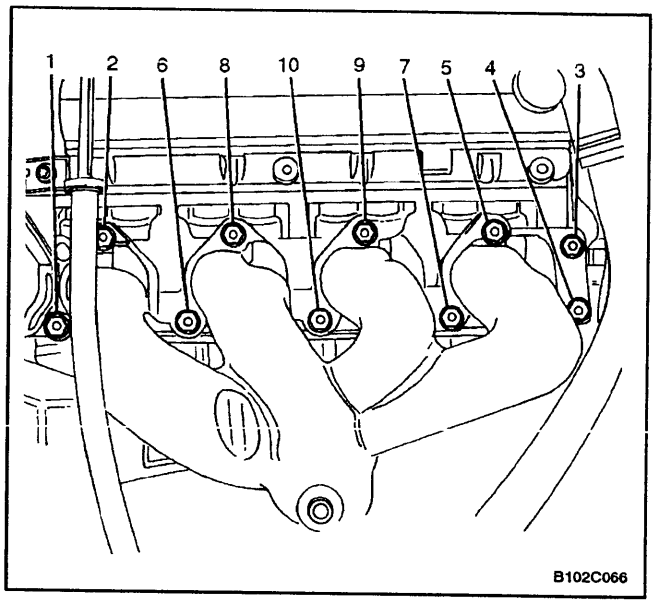
24. Install the oil pan. Refer to "Oil Pan" in this section.
25. Install the cylinder head with the intake manifold and exhaust manifold attached. Refer to "Cylinder Head and Gasket" in this section.

UNIT REPAIR

CYLINDER HEAD AND VALVE TRAIN COMPONENTS

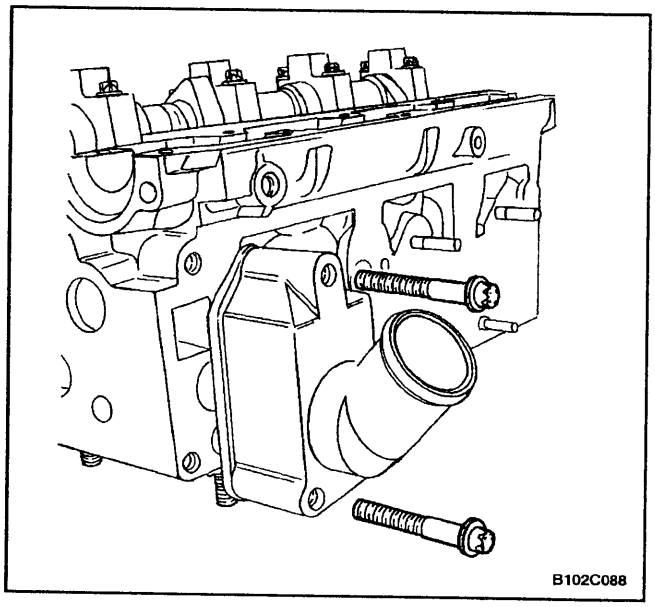
Tools Required

MKM-571-B Gauge
KM-340-0 Cutter Set
  KM-340-7 Guide Drift
  KM-340-13 Cutters
  KM-340-26 Cutters
KM-348 Valve Spring Compressor
KM-653 Adapter
KM-805 Valve Guide Reamer

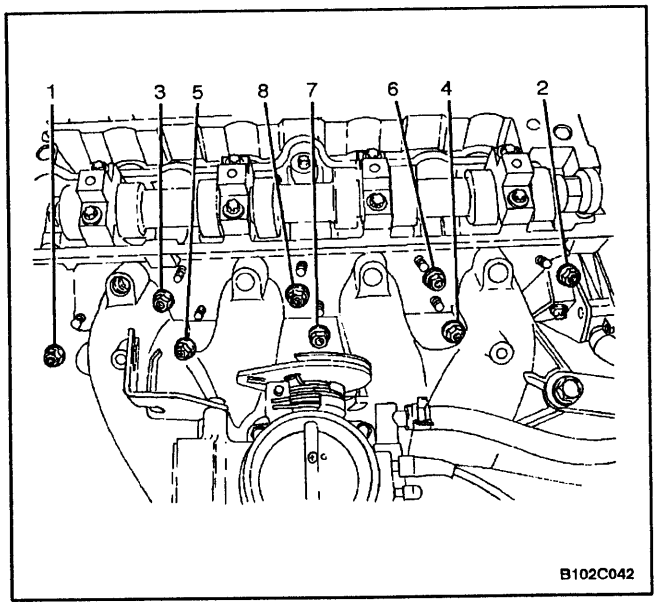


Disassembly Procedure

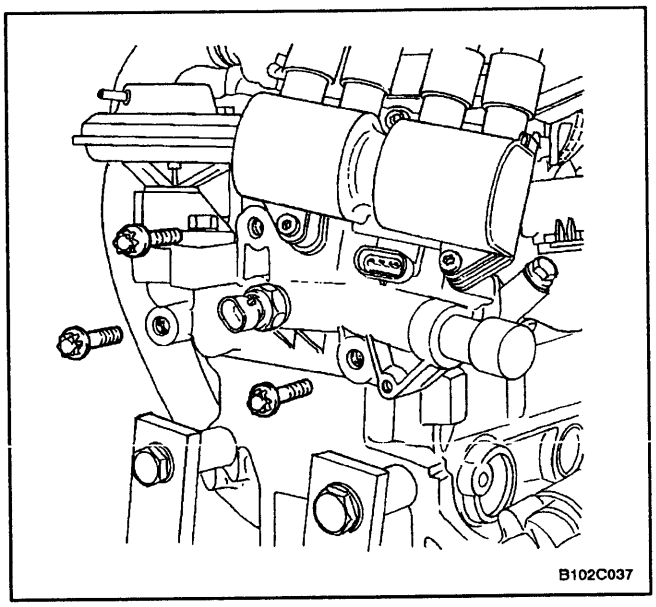
1. Remove the cylinder head with the intake manifold and the exhaust manifold attached. Refer to "Cylinder Head and Gasket" in this section.
2. Remove the coolant temperature sensor.
3. Remove the exhaust manifold heat shield bolts.
4. Remove the exhaust manifold heat shield.
5. Remove the exhaust manifold retaining nuts in the sequence shown.
6. Remove the exhaust manifold.
7. Remove the exhaust manifold gasket.
8. Remove the exhaust manifold studs.



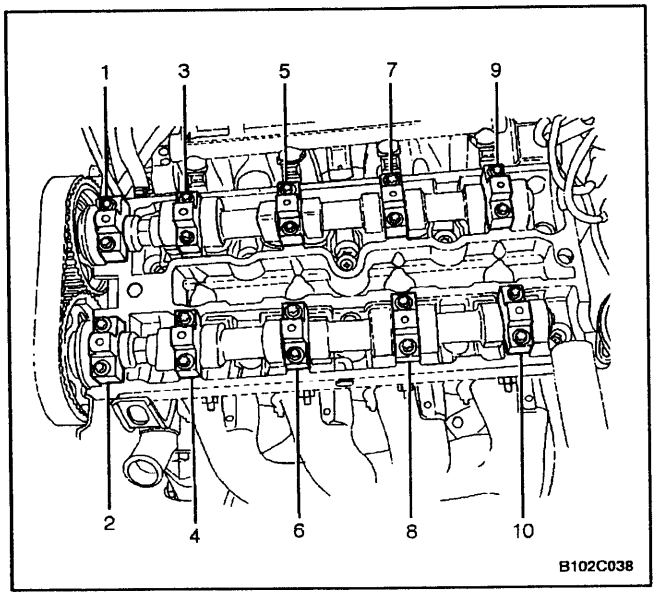
9. Remove the thermostat housing mounting bolts.
10. Remove the thermostat housing assembly.
11. Remove the fuel rail assembly. Refer to *Section 1F, Engine Controls*.
12. Remove the coolant bypass housing mounting bolts and the housing.



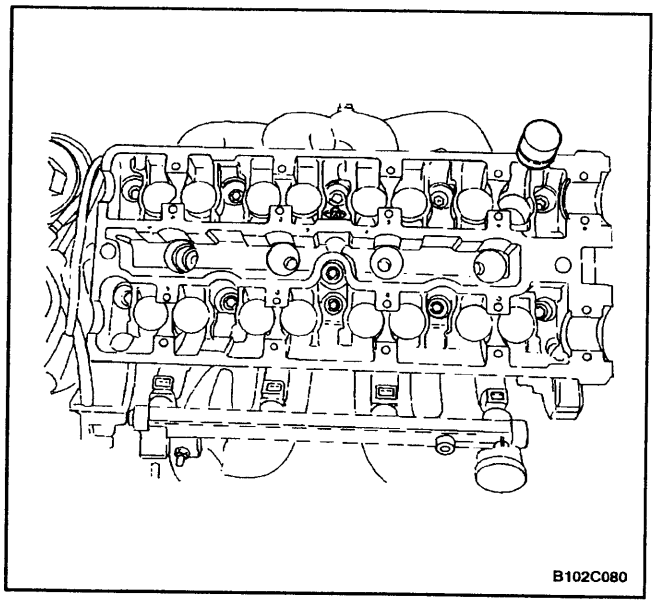
13. Remove the intake manifold retaining nuts and the bolts in the sequence shown.
14. Remove the intake manifold.
15. Remove the intake manifold gasket.



16. Remove the direct ignition system (DIS) ignition coil and exhaust gas recirculation (EGR) mounting bracket bolts.
17. Remove the DIS ignition coil, the EGR mounting bracket, and the ignition wires.
18. Remove the intake manifold studs.
19. Remove the spark plugs.

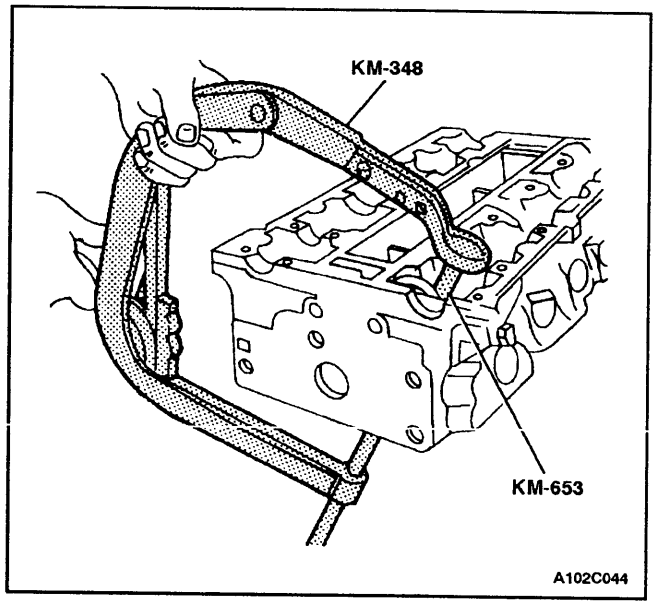


20. Remove the camshaft bearing cap bolts gradually and in the sequence shown for each camshaft cap.



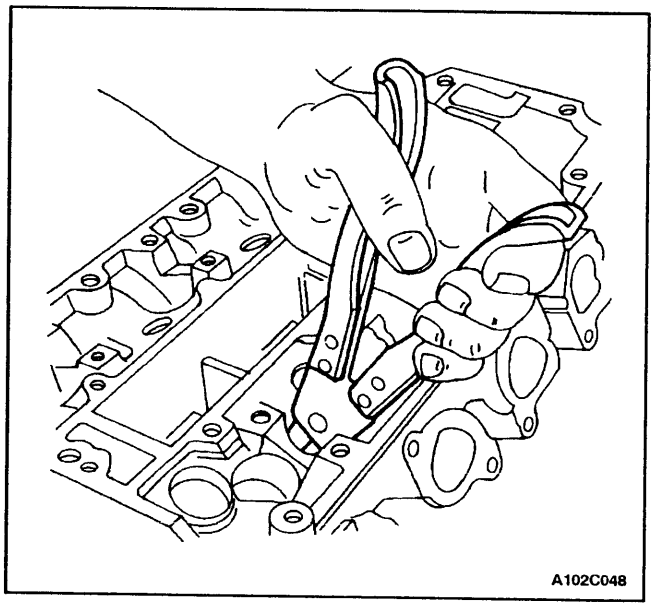
B102C080

21. Remove the intake camshaft caps. Maintain the correct positions for installation.
22. Remove the intake camshaft.
23. Remove the intake valve lash adjusters.
24. Remove the exhaust camshaft caps. Maintain the correct positions for installation.
25. Remove the exhaust camshaft.
26. Remove the exhaust valve lash adjusters.



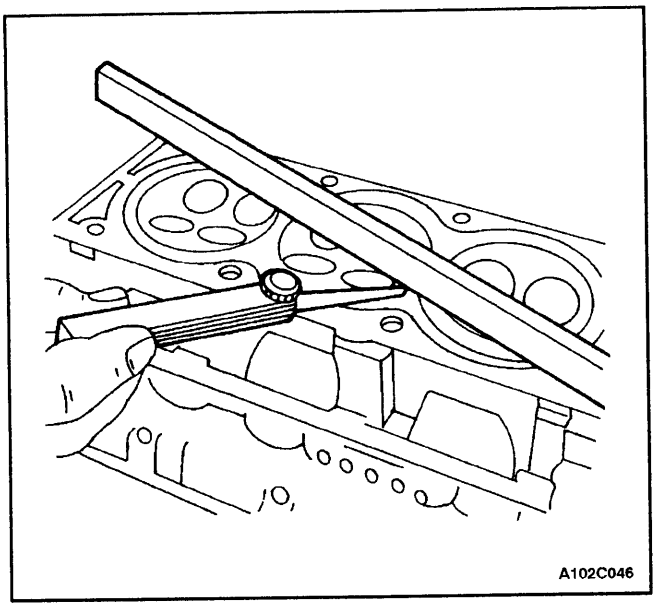
A102C044

27. Compress the valve springs with the valve spring compressor KM-348 and the adapter KM-653.
28. Remove the valve retainers.
29. Remove the valve spring compressor KM-348 and the adapter KM-653.
30. Remove the valve spring caps.
31. Remove the valve springs. Maintain the original position of the valve springs for installation.



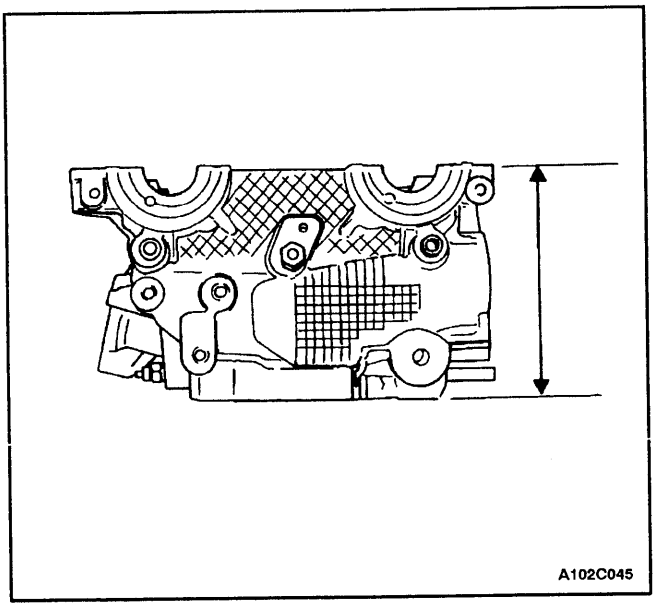
A102C048

32. Remove the valves. Maintain the original position of the valves for installation.
33. Remove the valve stem seals.

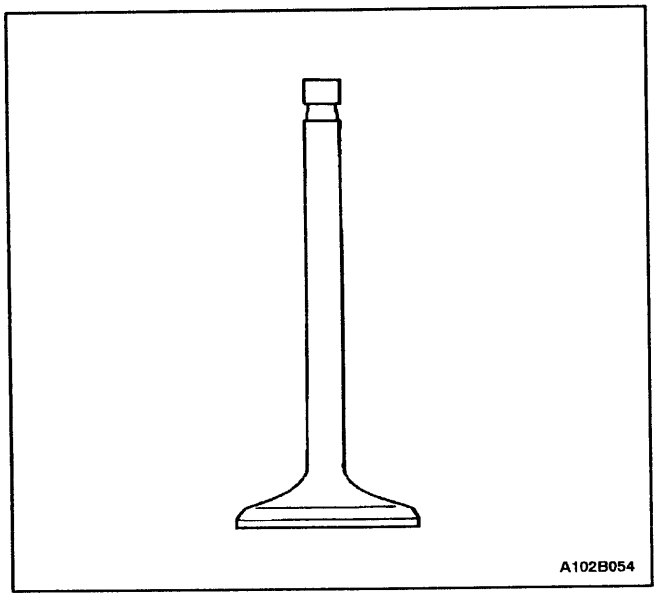

A102C046

Cylinder Head Inspection

1. Clean the sealing surfaces.
2. Inspect the cylinder head gasket and the mating surfaces for leaks, corrosion, and blowby.
3. Inspect the cylinder head for cracks.
4. Inspect the length and the width of the cylinder head using a feeler gauge and a straight edge.
5. Check the sealing surfaces for deformation and warpage. The cylinder head sealing surfaces must be flat within 0.025 mm (0.001 inch) maximum.

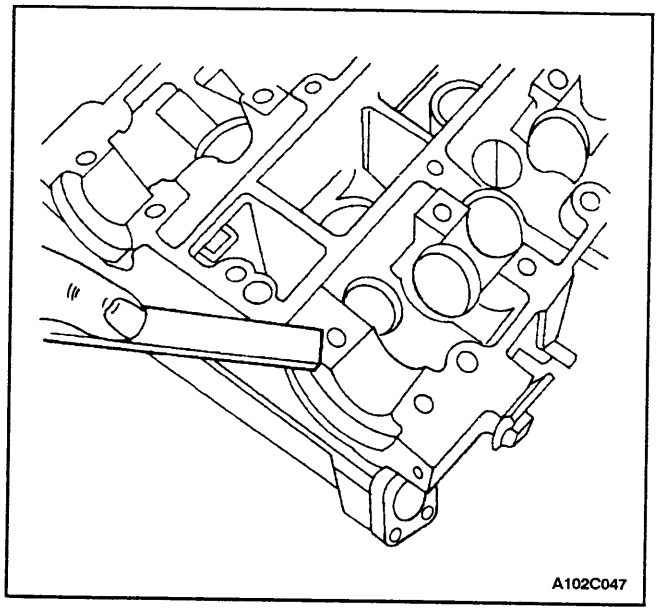

A102C045

6. Measure the height of the cylinder head from sealing surface to sealing surface. The cylinder head height should be 133.975 to 134.025 mm (5.274 to 5.276 inches). If the cylinder head height is less than 133.9 mm (5.271 inches), replace the cylinder head.
7. Inspect all threaded holes for damage.
8. Inspect the valve seats for excessive wear and burned spots.


A102B054

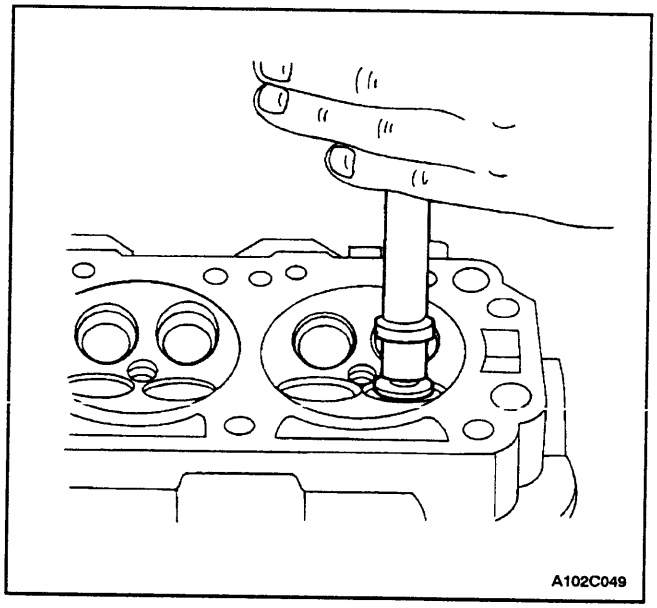
Valve Inspection

1. Inspect the valve stem tip for wear.
2. Inspect the valve retainer grooves and the oil seal grooves for chips and wear.
3. Inspect the valves for burns or cracks.
4. Inspect the valve stem for burrs and scratches.
5. Inspect the valve stem. The valve stem must be straight.
6. Inspect the valve face for grooving. If the groove is so deep that refacing the valve would result in a sharp edge, replace the valve.
7. Inspect the valve spring. If the valve spring ends are not parallel, replace the valve spring.
8. Inspect the valve spring seating surface of the valve rotators for wear or gouges. Replace as required.


A102C047

Cleaning Procedure

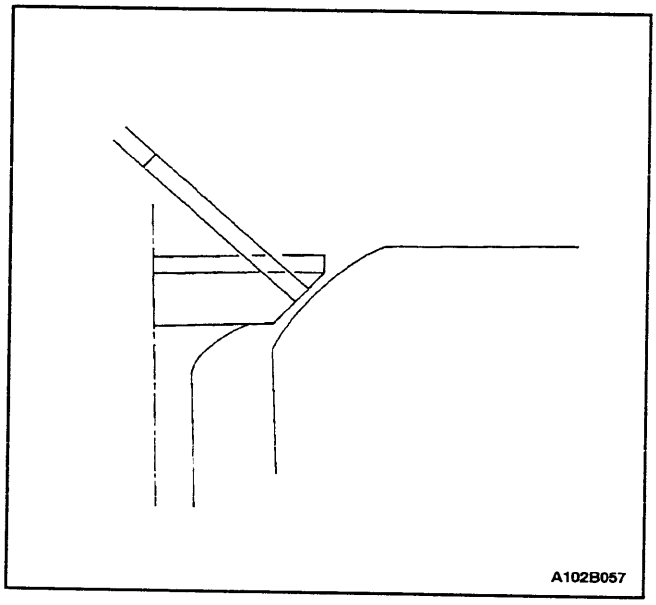
1. Clean the cylinder head.
2. Clean the valve guides.
3. Clean all of the threaded holes.
4. Clean the valves of carbon, oil, and varnish.


A102C049

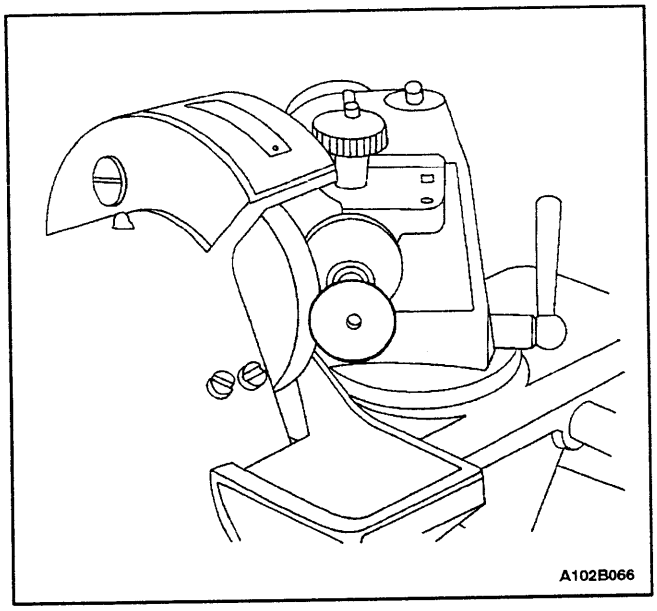
Cylinder Head Overhaul

Valve Grind-in

1. Lubricate the valve seat using a fine-grained paste.
2. Lift the valve rhythmically from the seat with a commercially available valve grinding tool in order to distribute the paste.

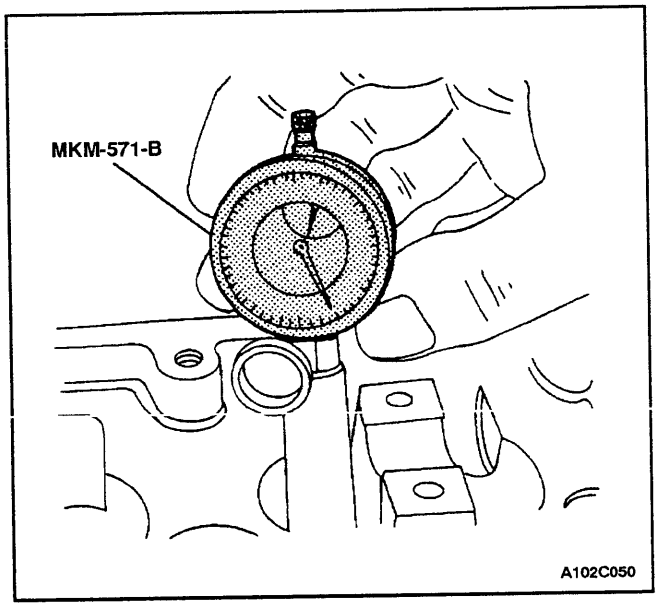

A102B057

3. Check the contact pattern on the valve head and in the cylinder head.
4. Clean the valves, the valve guides, and the cylinder head.



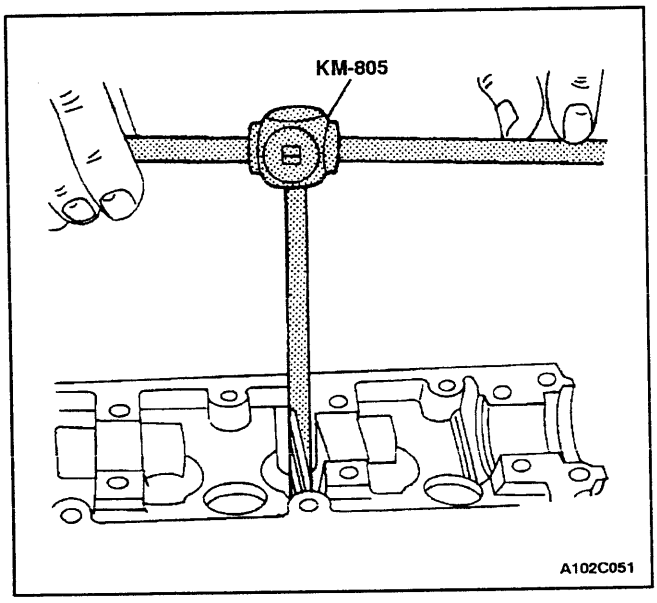
Valve Grind

1. Ensure that there are no crater line burns on the valve cone.
2. The valve may be reground only two times. Do not grind the valve stem end.
3. Ensure that the angle at the valve face is 45 degrees.
4. Inspect the assembly height of the intake valves and the exhaust valves.



Valve Guide - Ream

1. Measure the diameter of the valve guide using gauge MKM-571-B and a commercially available inside micrometer.

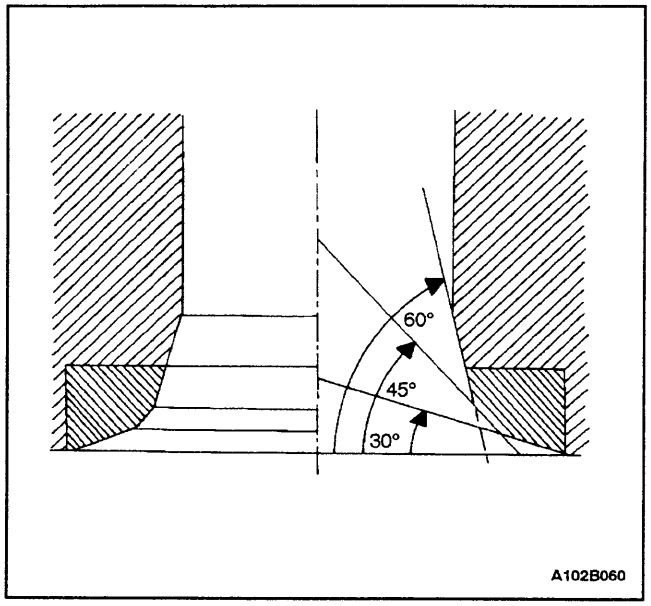


Important: Valve oversizes may already have been fitted in production.

2. An oversize service code is on the valve guide and the valve stem end. The following table gives the correct size, reamer, production code, and service code for each service.

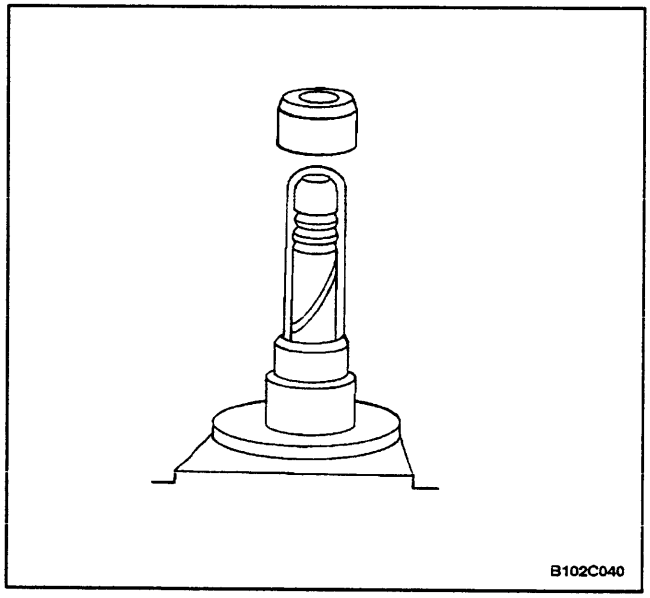
Size	Reamer	Production Code	Service Code
Normal	-	-	K
0.075	KM-805	1	K1
0.150		2	K2

3. Ream the valve guide from the upper side of the cylinder head to the next oversize.
4. After reaming, cross out the code and emboss the valve guide with the new code.



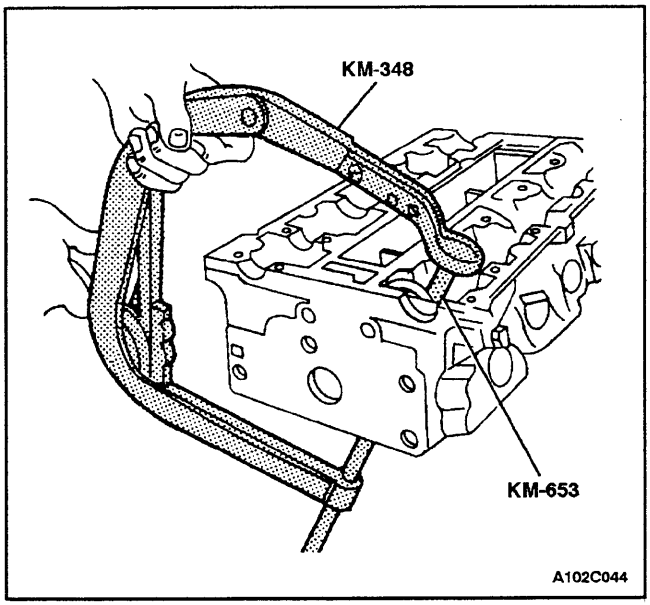
Valve Seat - Cut

1. Place the cylinder head on wooden blocks.
2. Cut the intake and the exhaust valve seats using the guide drift KM-340-7 as follows:
   - Valve seat - A 45-degree surface using the cutter KM-340-13.
   - Upper correction angle - A 30-degree surface using the cutter KM-340-13.
   - Lower correction angle - A 60-degree surface using the cutter KM-340-26.
3. Clean the chippings from the cylinder head.
4. Inspect the dimension for the valve seat width.
   - Intake: 1.2 to 1.4 mm (0.047 to 0.055 inch).
   - Exhaust: 1.4 to 1.8 mm (0.055 to 0.070 inch).
5. Inspect the assembly height of the intake valves and the exhaust valves. If the specified dimension is exceeded, install new valves. Inspect the assembly height of the intake valves and the exhaust valves again. If the valve assembly height is still too large despite replacing the valves, replace the cylinder head.

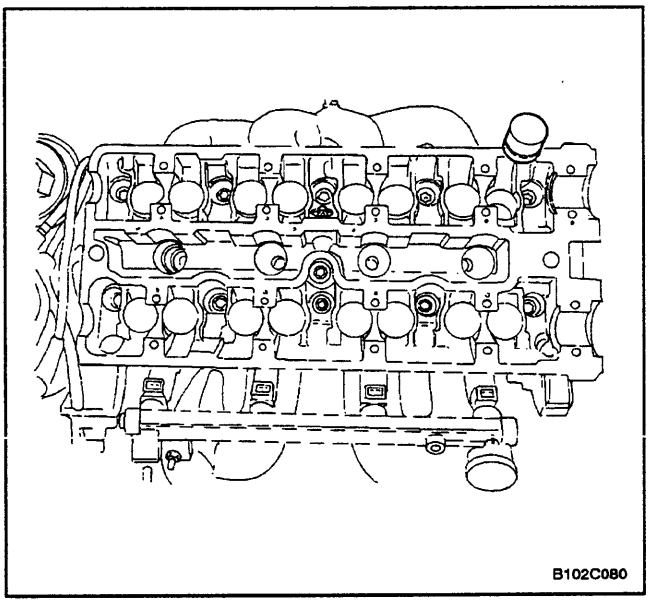


Assembly Procedure

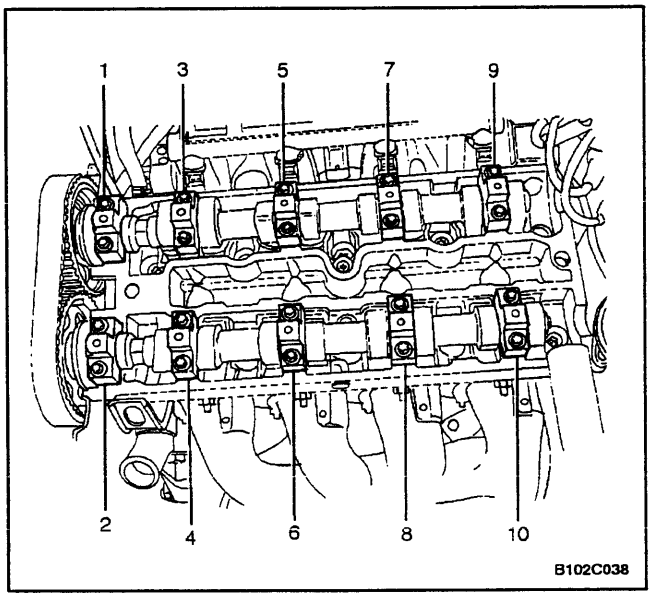
1. Coat the valve stems with engine oil.
2. Insert the valves in the cylinder head in their original positions.
3. Insert the valve spring seats.
4. Push the accompanying assembly sleeve onto the valve stem.
5. Insert the new valve stem seat.
6. Carefully drive the valve stem seal onto the stop with light taps.
7. Install the valve springs in their original positions.
8. Install the valve spring caps.



9. Compress the valve springs with the valve spring compressor KM-348 and adapter KM-653.
10. Install the valve retainers.
11. Remove the valve spring compressor KM-348 and adapter KM-653.



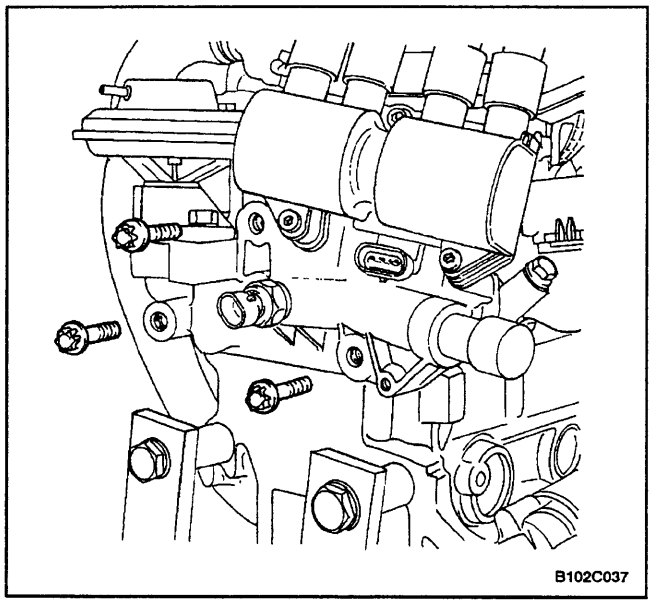
12. Lubricate the valve lash adjusters with engine oil.
13. Install the valve lash adjusters.



14. Install the intake camshaft.
15. Install the intake camshaft bearing caps in their original positions.
16. Install the exhaust camshaft.
17. Install the exhaust camshaft bearing caps in their original positions.
18. Install the camshaft bearing cap bolts.
19. Tighten the camshaft bearing cap bolts gradually and in the sequence shown for each camshaft cap.

Tighten

Tighten the camshaft bearing cap bolts to 8 N•m (71 lb-in).


B102C037

20. Install the spark plugs.

Tighten

Tighten the spark plugs to 20 N•m (15 lb-ft).

21. Install the DIS ignition coil and the EGR mounting bracket, and bolt.

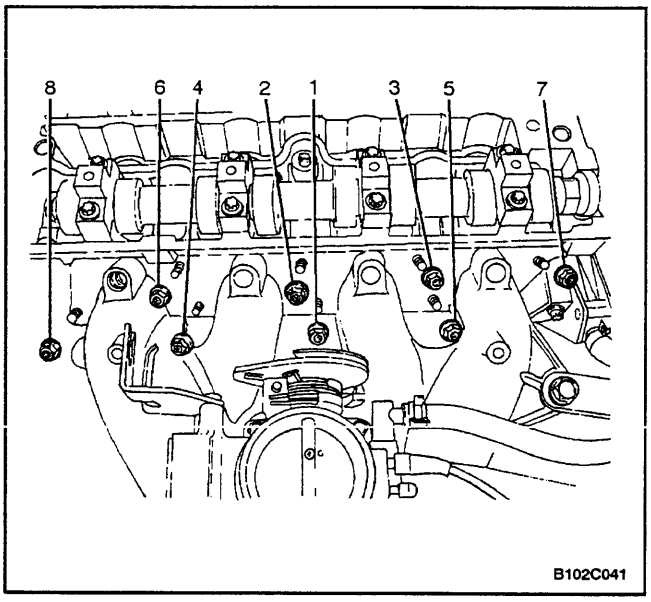
Tighten

Tighten the DIS ignition coil and EGR mounting bracket bolts to 25 N•m (18 lb-ft).

22. Install the DIS ignition coil and EGR.

Tighten

Tighten the DIS ignition coil and EGR to 10 N•m (89 lb-ft).

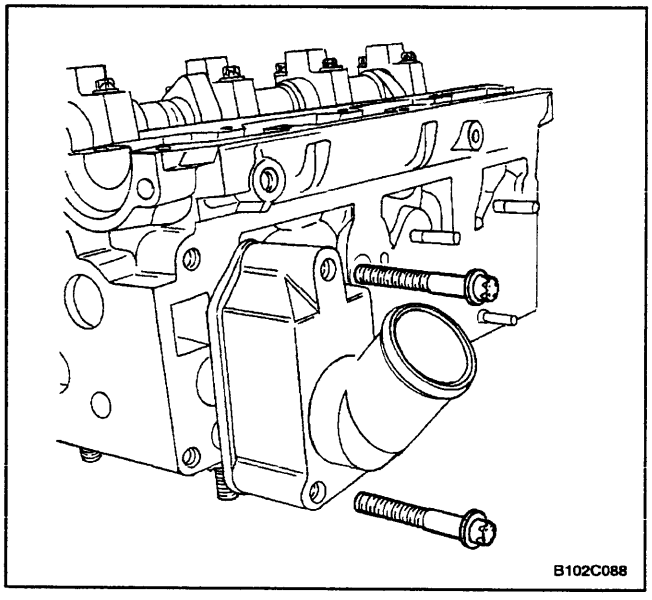


B102C041

23. Install the intake manifold studs.
24. Install the intake manifold gasket.
25. Install the intake manifold.
26. Install the intake manifold retaining nuts and bolts in the sequence shown.

Tighten

Tighten the intake manifold retaining nuts and bolts to 22 N•m (16 lb-ft).


B102C088

27. Install the fuel rail assembly. Refer to *Section 1F, Engine Controls.*
28. Install the thermostat housing assembly.
29. Install the thermostat housing mounting bolts.

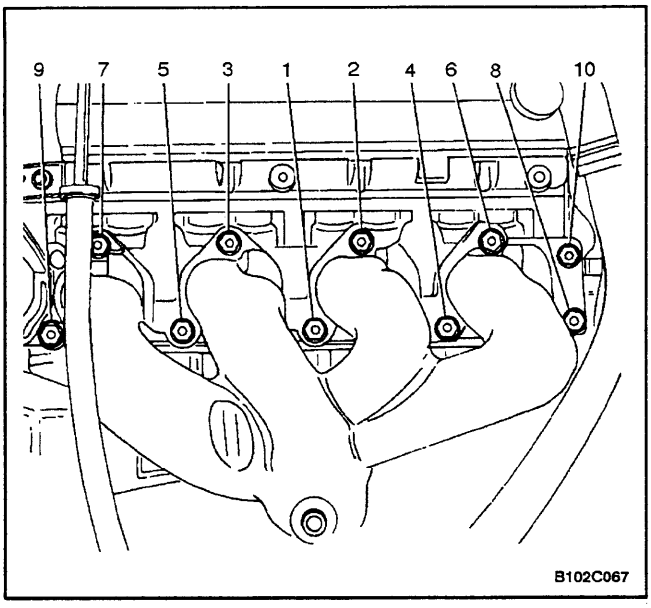
Tighten

Tighten the thermostat housing mounting bolts to 15 N•m (11 lb-ft).

30. Install the coolant bypass housing bolts.

Tighten

Tighten the coolant bypass housing bolts to 15 N•m (11 lb-ft).



31. Install the exhaust manifold studs.
32. Install the exhaust manifold gasket.
33. Install the exhaust manifold.
34. Install the exhaust manifold retaining nuts in the sequence shown.

Tighten

Tighten the exhaust manifold retaining nuts to 22 N•m (16 lb-ft).

35. Install the exhaust manifold heat shield.
36. Install the exhaust manifold heat shield bolts.

Tighten

Tighten the exhaust manifold heat shield bolts to 8 N•m (71 lb-in).

37. Install the cylinder head with the intake manifold and the exhaust manifold attached. Refer to "Cylinder Head and Gasket" in this section.

CRANKSHAFT

Tools Required

KM-412 Engine Overhaul Stand

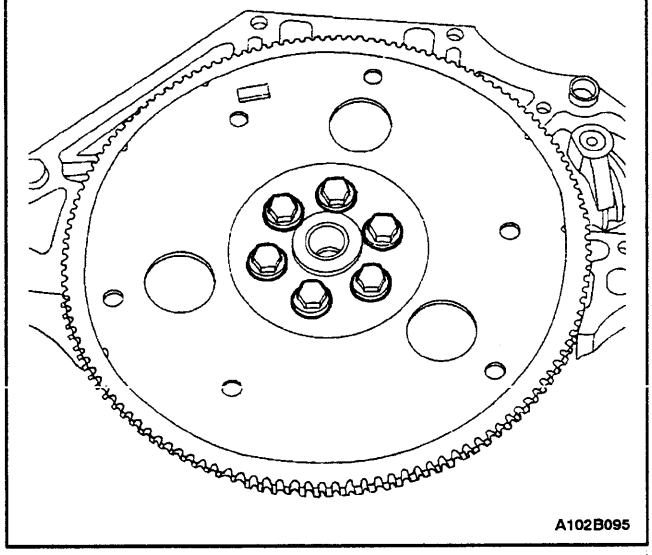
KM-470-B Angular Torque Gauge

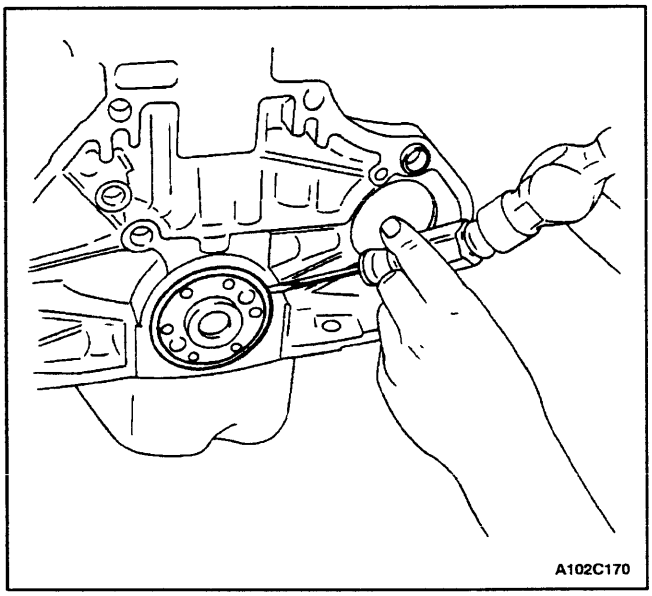
J-36792 or KM-635 Crankshaft Rear Oil Seal Installer

Notice: Take extreme care to prevent any scratches, nicks, or damage to the camshafts.

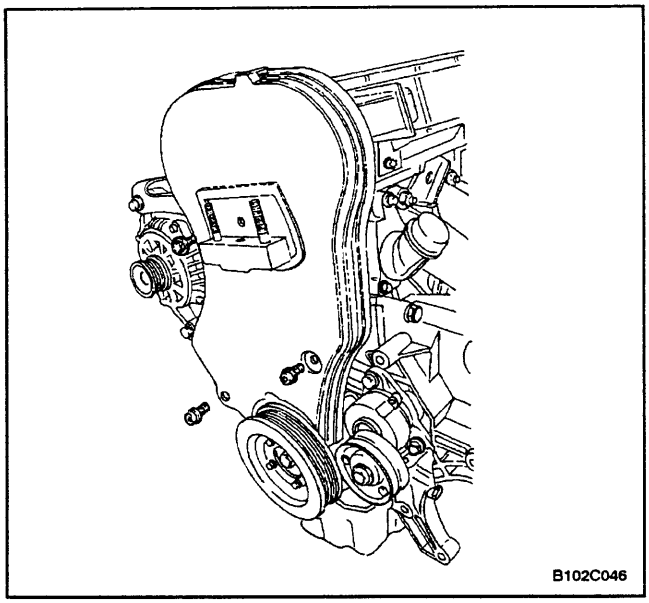
Disassembly Procedure

1. Remove the engine. Refer to "Engine" in this section.
2. Remove the flywheel, or the flexible plate bolts for the automatic transaxle.
3. Remove the flywheel, or the flexible plate for the automatic transaxle.

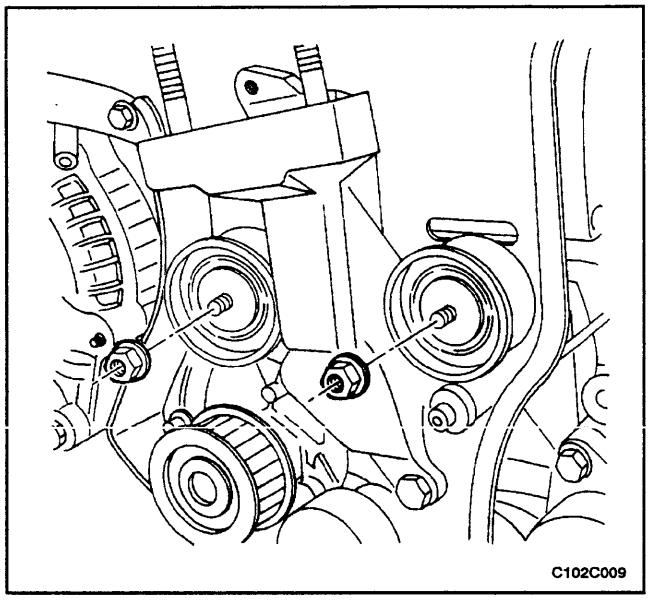




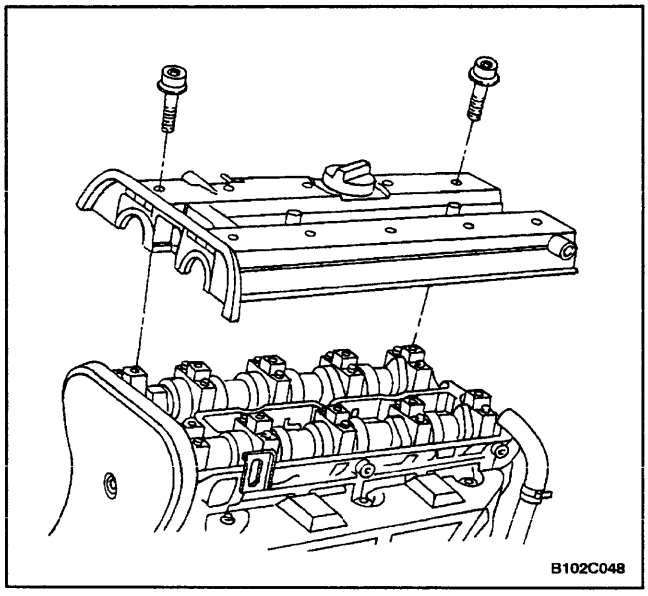
4. Remove the crankshaft rear oil seal.
5. Mount the engine assembly on the engine overhaul stand KM-412.


B102C046

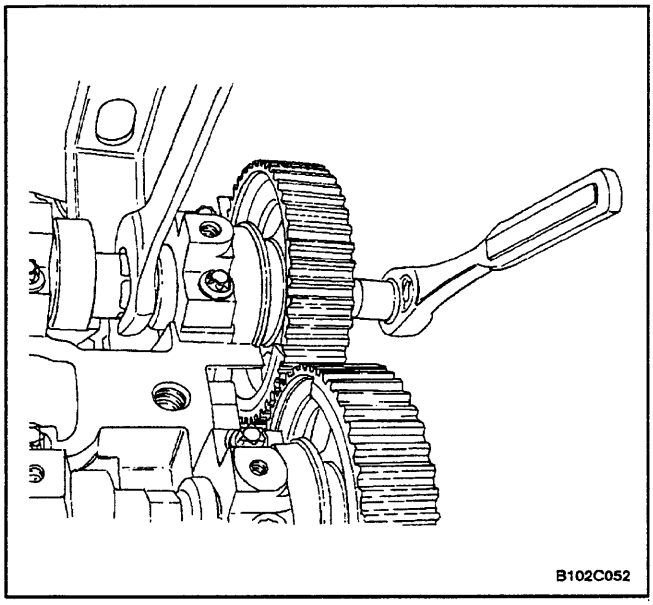
6. Remove the front timing belt cover bolts.
7. Remove the front timing belt cover.
8. Remove the crankshaft pulley bolts.
9. Remove the crankshaft pulley.


C102C009

10. Loosen the timing belt automatic tensioner bolt.
11. Rotate the timing belt automatic tensioner hex-key clockwise to release the tension.
12. Remove the timing belt idler pulley nuts.
13. Remove the timing belt idler pulleys.
14. Remove the timing belt.
15. Remove the engine mount retaining bolts.
16. Remove the engine mount.

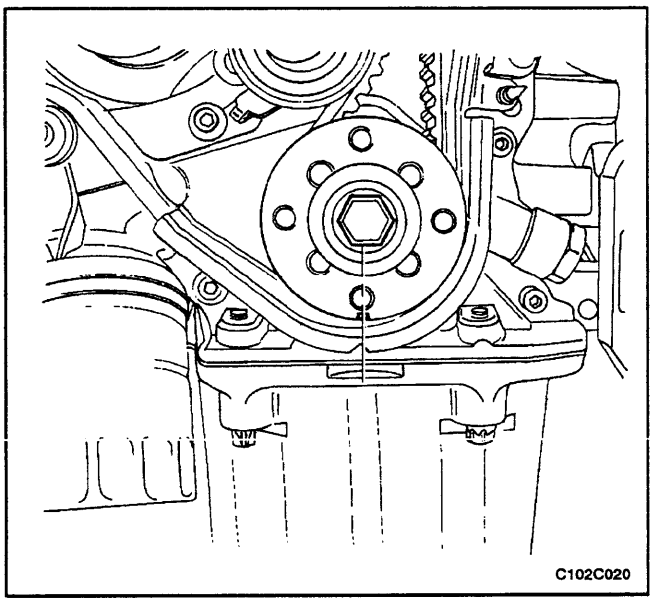

B102C048

17. Disconnect the crankcase breather tubes from the valve cover.
18. Remove the spark plug cover bolts.
19. Remove the spark plug cover.
20. Disconnect the ignition wires from the spark plugs.
21. Remove the valve cover bolts.
22. Remove the valve cover washers.
23. Remove the valve cover and the valve cover gasket.

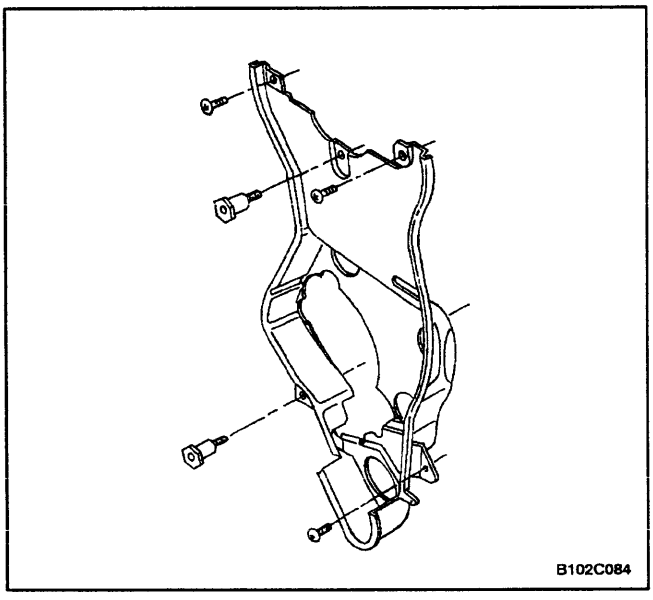

B102C052

Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

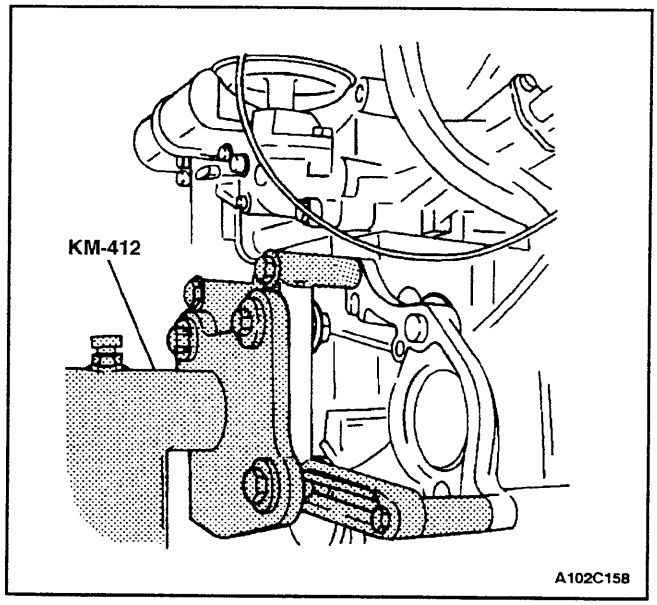
24. While holding the intake camshaft firmly in place, remove the intake camshaft bolt.
25. Remove the intake camshaft gear.
26. While holding the exhaust camshaft firmly in place, remove the exhaust camshaft bolt.
27. Remove the exhaust camshaft gear.


C102C020

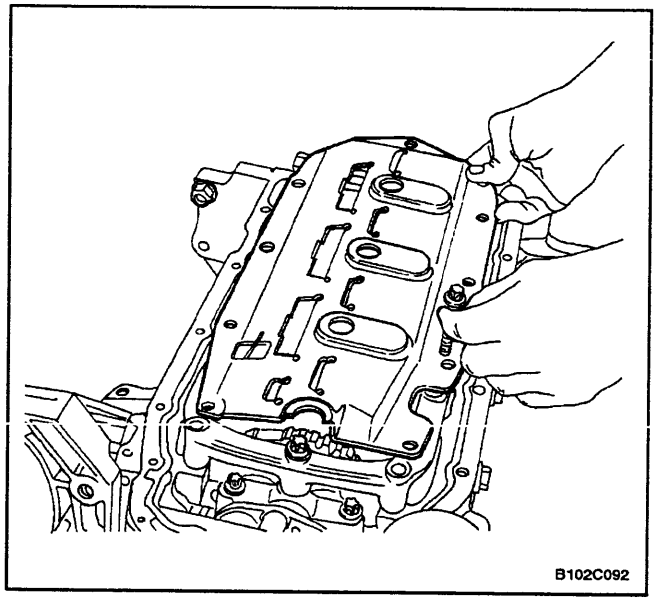
28. Remove the crankshaft timing belt gear.


B102C084

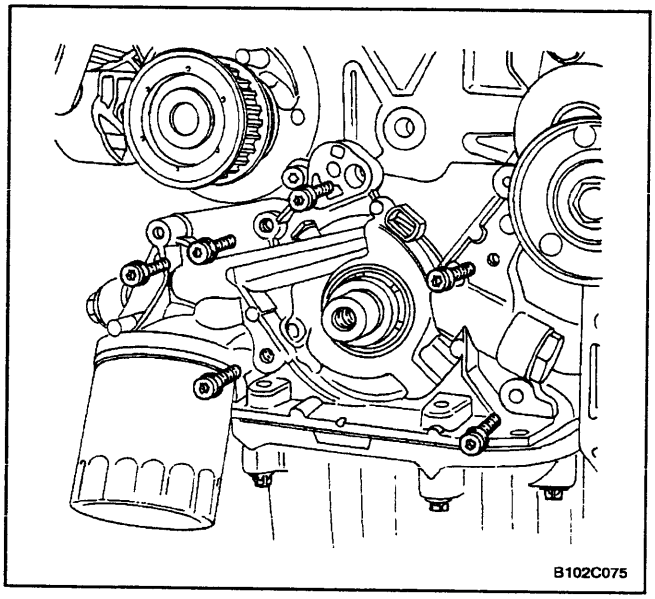
29. Remove the rear timing belt cover bolts and cover.



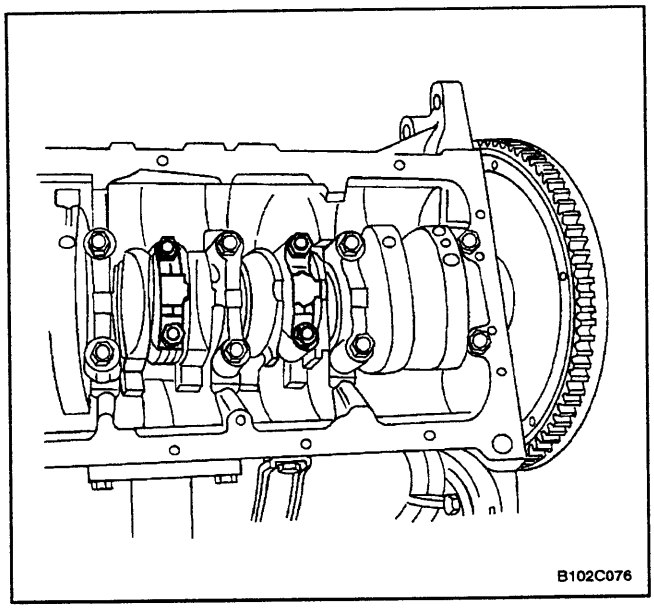
30. Rotate the engine on the engine overhaul stand KM-412.



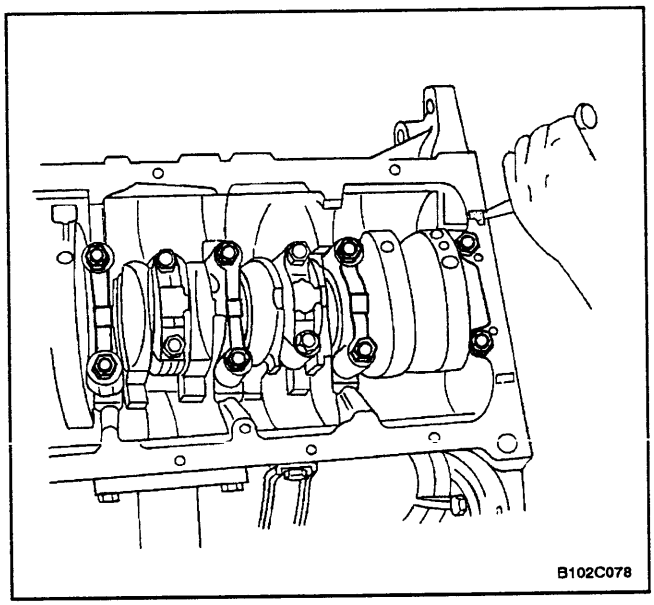
31. Remove the oil pan retaining bolts.
32. Remove the oil pan.
33. Remove the oil pump pickup tube bolts.
34. Remove the oil pump pickup tube.
35. Remove the lower block support bracket/splash shield bolts.
36. Remove the splash shield.
37. Remove the lower block support bracket bolts.
38. Remove the lower block support bracket.



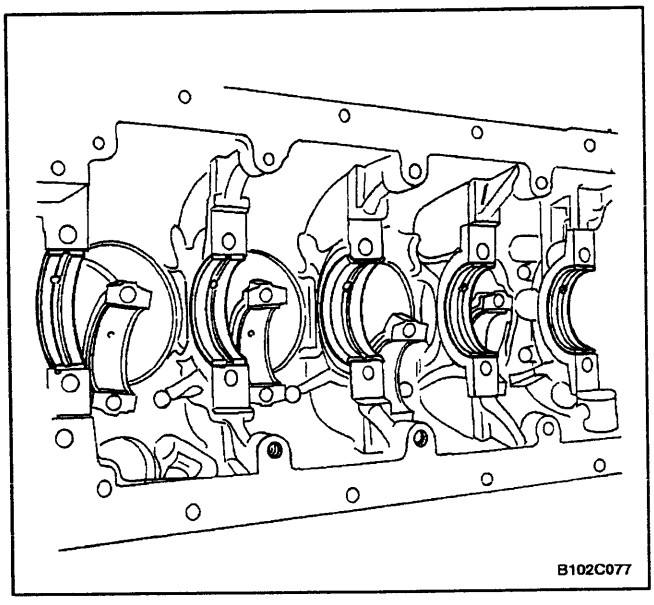
39. Remove the oil pump retaining bolts.
40. Remove the oil pump.


B102C076

41. Mark the order of the connecting rod bearing caps.
42. Remove the connecting rod bearing cap bolts for all of the pistons.
43. Remove the connecting rod bearing caps and the lower connecting rod bearings.

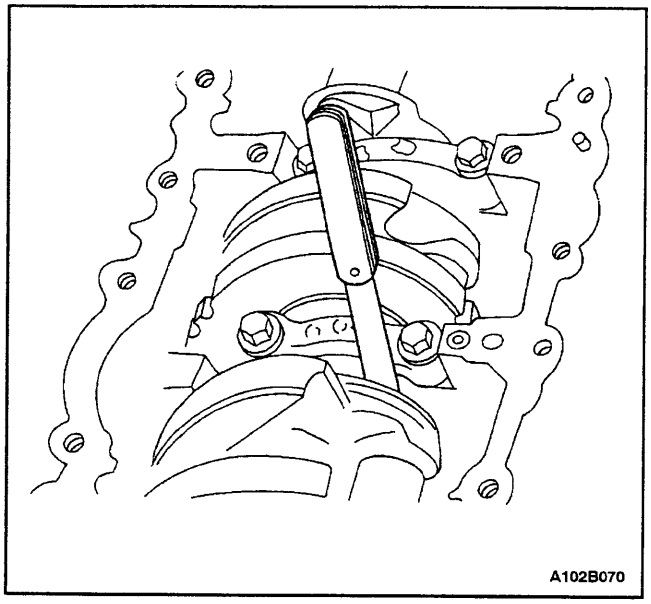

B102C078

44. Mark the order of the crankshaft bearing caps.
45. Remove the crankshaft bearing cap bolts.
46. Remove the crankshaft bearing caps and the lower crankshaft bearings.
47. Remove the crankshaft.
48. Clean those parts that need it.

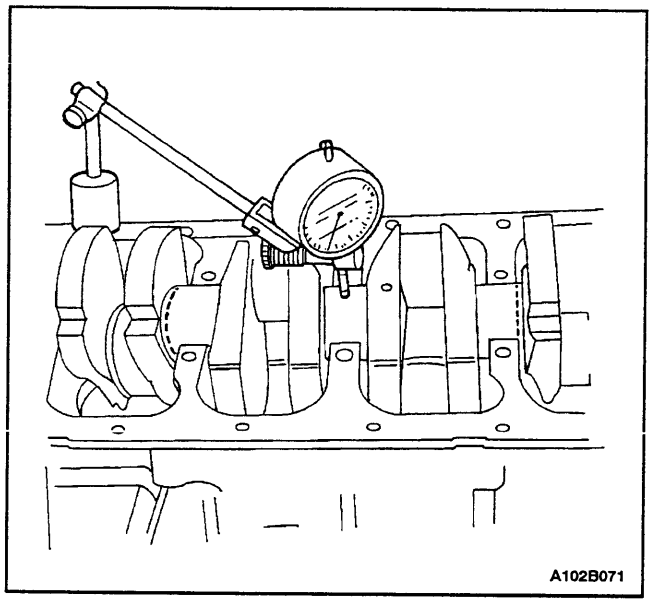

B102C077

Assembly Procedure

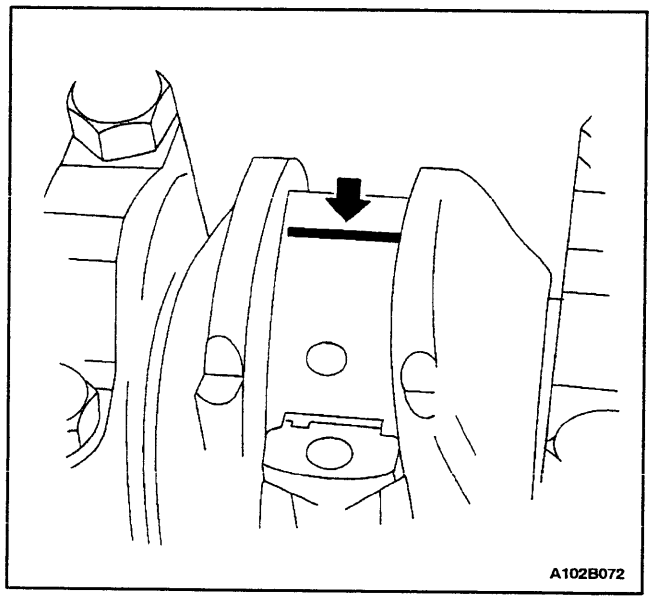
1. Coat the crankshaft bearings with engine oil.
2. If replacing the crankshaft, transfer the pulse pickup sensor disc to the new crankshaft.



3. Install the crankshaft.
4. Install the lower crankshaft bearings in the bearing caps.
5. Inspect the crankshaft end play with the crankshaft bearings installed.
6. Check for permissible crankshaft end play. Refer to "Engine Specifications" in this section.



7. With the crankshaft mounted on the front and rear crankshaft bearings, check the middle crankshaft journal for permissible out-of-round (runout). Refer to "Engine Specifications" in this section.

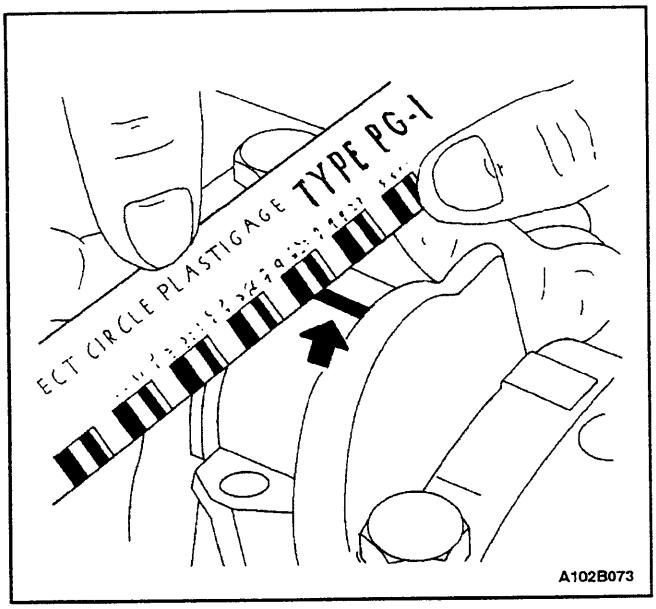


Important: Grease the crankshaft journals and lubricate the crankshaft bearings slightly so that the plastic gauging thread does not tear when the crankshaft bearing caps are removed.

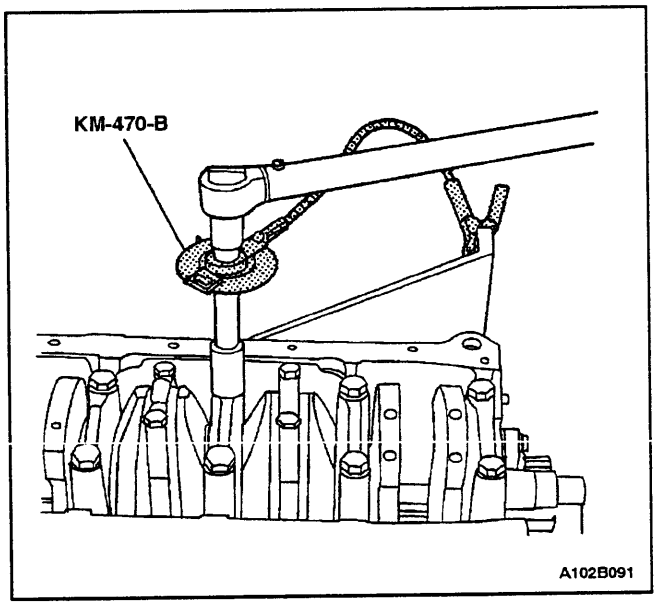
8. Inspect all of the crankshaft bearing clearances using a commercially available plastic gauging (ductile plastic threads).
9. Cut the plastic gauging threads to the length of the bearing width. Lay them axially between the crankshaft journals and the crankshaft bearings.
10. Install the crankshaft bearing caps and the bolts.

Tighten

Tighten the crankshaft bearing cap bolts to 50 N•m (37 lb-ft) plus 45 degrees and 15 degrees.



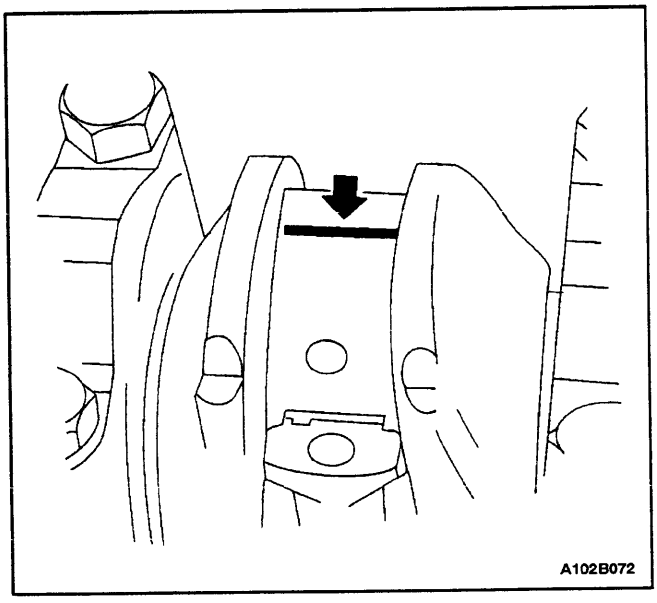
11. Remove the crankshaft bearing cap bolts and the caps.
12. Measure the width of the flattened plastic thread of the plastic gauging using a ruler. (Plastic gauging is available for different tolerance ranges.)
13. Inspect the bearing clearance for permissible tolerance ranges. Refer to "Engine Specifications" in this section.



14. Apply a bead of adhesive sealing compound to the grooves of the crankshaft bearing caps.
15. Install the crankshaft bearing caps to the engine block.
16. Tighten the crankshaft bearing caps using new bolts.

Tighten

Tighten the crankshaft bearing cap bolts to 50 N•m (37 lb-ft) using a torque wrench. Use the angular torque gauge KM-470-B to tighten the crankshaft bearings another 45 degrees plus 15 degrees.

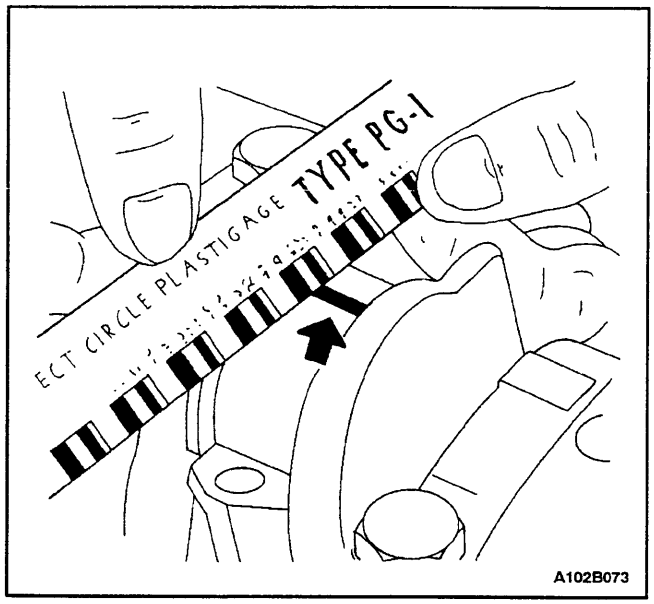


Important: Grease the connecting rod journals and lubricate the connecting rod bearings slightly so that the plastic gauging thread does not tear when the connecting rod bearing caps are removed.

17. Inspect all of the connecting rod bearing clearances using a commercially available plastic gauging (ductile plastic threads).
18. Cut the plastic gauging threads to the length of the connecting rod bearing width. Lay them axially between the connecting rod journals and the connecting rod bearings.
19. Install the connecting rod bearing caps.

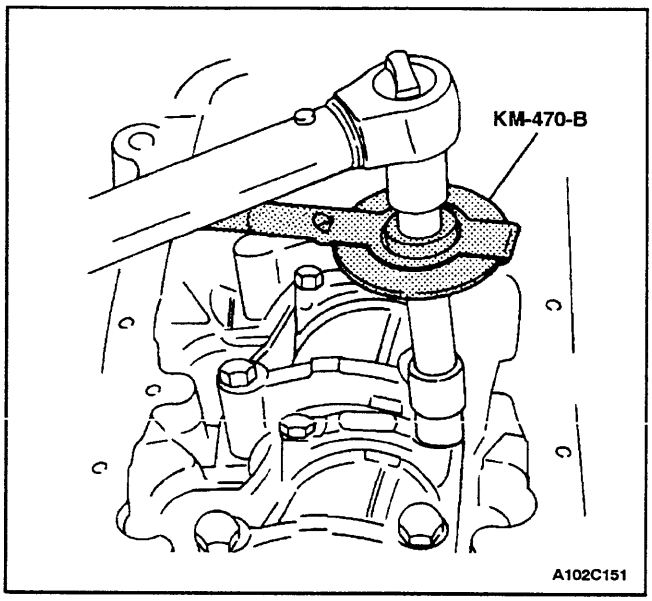
Tighten

Tighten the connecting rod bearing cap bolts to 35 N•m (26 lb-ft) using a torque wrench. Use the angular torque gauge KM-470-B to tighten the connecting rod bearing cap bolts another 45 degrees.



A102B073

20. Remove the connecting rod bearing caps.
21. Measure the width of the flattened plastic thread of the plastic gauging using a ruler. (Plastic gauging is available for different tolerance ranges.)
22. Inspect the bearing clearance for permissible tolerance ranges. Refer to "Engine Specifications" in this section.

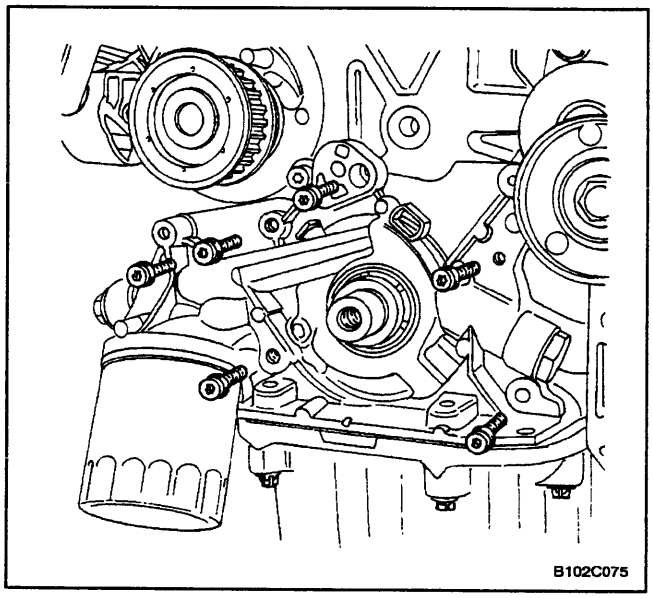


A102C151

23. Install the connecting rod bearing caps to the connecting rods.
24. Tighten the connecting rod bearing caps using new bolts.

Tighten

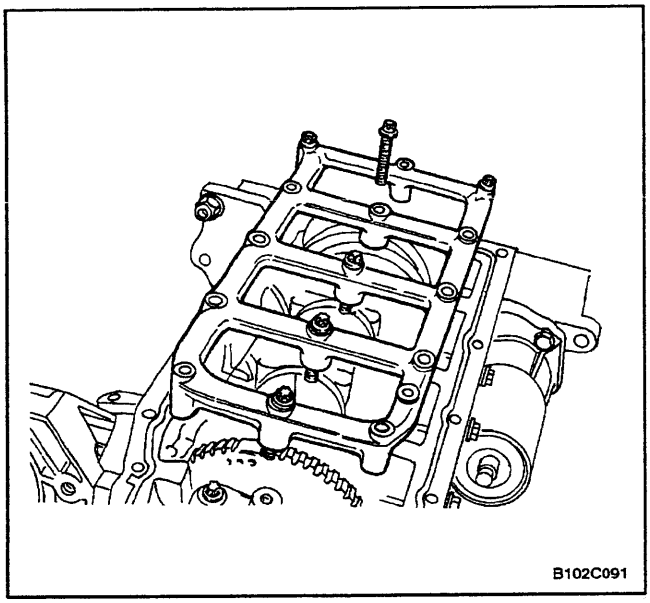
Tighten the connecting rod bearing cap bolts to 35 N•m (26 lb-ft) using a torque wrench. Use the angular torque gauge KM-470-B to tighten the connecting rod cap bolts another 45 degrees.


B102C075

25. Install the oil pump.
26. Install the oil pump retaining bolts.

Tighten

Tighten the oil pump retaining bolts to 10 N•m (89 lb-in).


B102C091

27. Install the engine lower block support bracket and the bolts.

Tighten

Tighten the engine lower block support bracket bolts to 35 N•m (26 lb-in).

28. Install the engine lower block support bracket splash shield and the bolts.

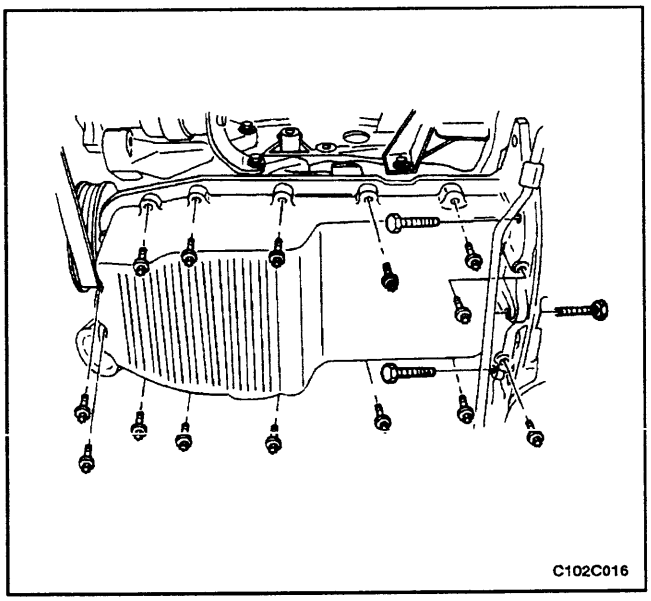
Tighten

Tighten the engine lower block support bracket splash shield bolts to 35 N•m (26 lb-ft).

29. Install the oil pump pickup tube.
30. Install the oil pump pickup tube bolts.

Tighten

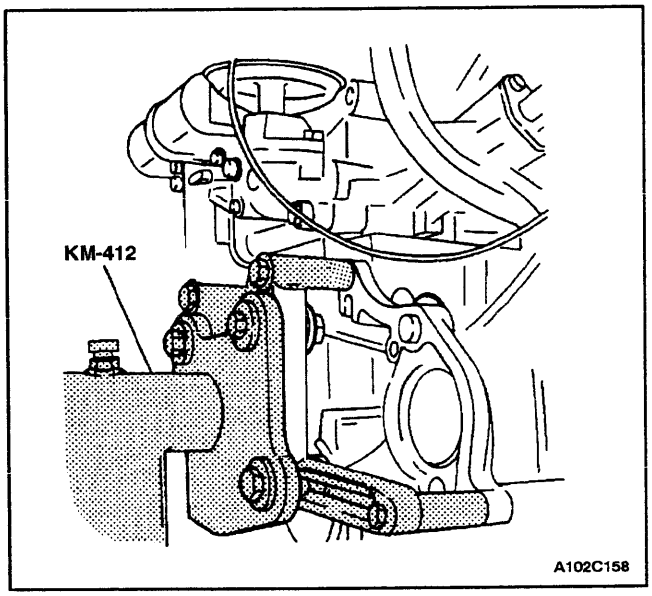
Tighten the oil pump pickup tube bolts to 8 N•m (71 lb-in).


C102C016

31. Coat the new oil pan gasket with the sealant.
32. Install the oil pan gasket to the oil pan.
33. Install the oil pan.
34. Install the oil pan retaining bolts.

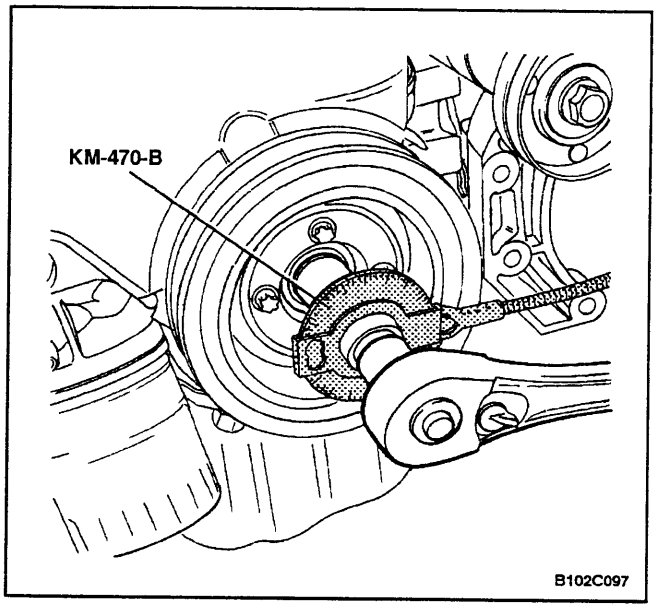
Tighten

Tighten the oil pan retaining bolts to 10 N•m (89 lb-in).



A102C158

35. Rotate the engine on the engine overhaul stand KM-412.



36. Install the rear timing belt cover.
37. Install the rear timing belt cover bolts.

Tighten

Tighten the rear timing belt cover bolts to 10 N•m (89 lb-in).

38. Install the crankshaft timing belt drive gear and the bolt.

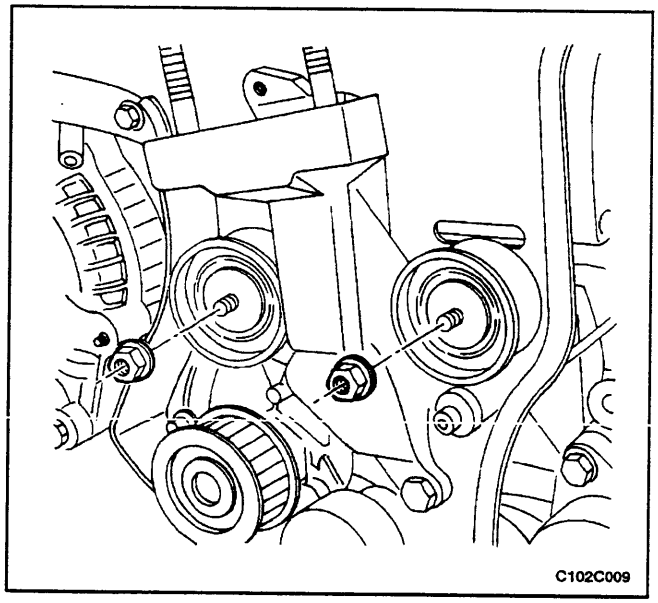
Tighten

Tighten the crankshaft timing belt drive gear bolt to 130 N•m (70 lb-ft) plus 40 degrees to 50 degrees using the torque angular gauge KM-470-B.

39. Install the engine mount and the retaining bolts.

Tighten

Tighten the engine mount bolts to 60 N•m (44 lb-ft).



40. Install the timing belt automatic tensioner.
41. Install the timing belt automatic tensioner bolts.

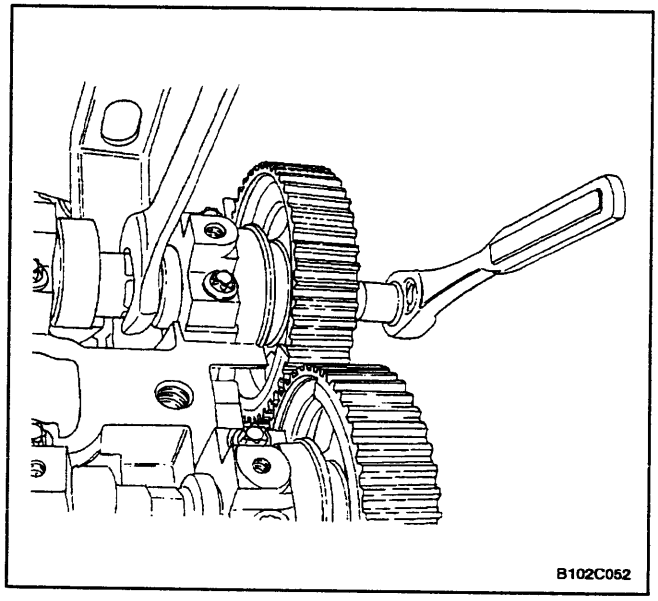
Tighten

Tighten the timing belt automatic tensioner bolts to 25 N•m (18 lb-ft).

42. Install the timing belt idler pulley.
43. Install the timing belt idler pulley nuts.

Tighten

Tighten the timing belt idler pulley nuts to 25 N•m (18 lb-ft).



Notice: Take extreme care to prevent any scratches, nicks or damage to the camshafts.

44. Install the intake camshaft gear.
45. Install the intake camshaft gear bolt while holding the intake camshaft firmly in place.

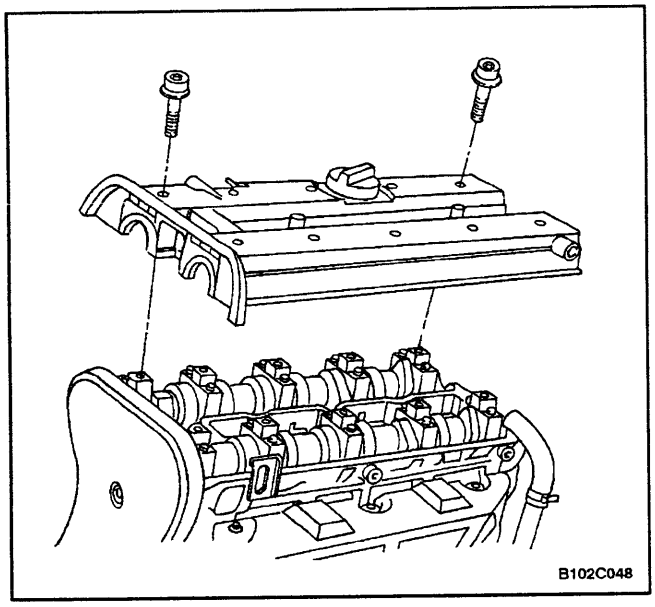
Tighten

Tighten the intake camshaft gear bolt to 50 N•m (37 lb-ft), plus 60 degrees and 15 degrees.

46. Install the exhaust camshaft gear.
47. Install the exhaust camshaft gear bolt while holding the exhaust camshaft firmly in place.

Tighten

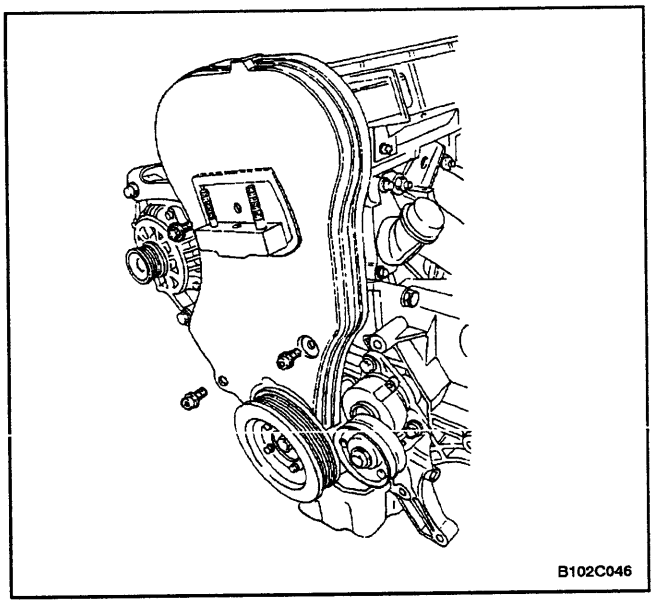
Tighten the exhaust camshaft gear bolt to 50 N•m (37 lb-ft), plus 60 degrees and 15 degrees.



48. Install the timing belt. Refer to "Timing Belt" in this section.
49. Adjust the timing belt tension. Refer to "Timing Belt Check and Adjust" in this section.
50. Apply a small amount of gasket sealant to the corners of the front camshaft caps and to the top of the rear valve cover to the cylinder head seal.
51. Install the valve cover and the valve cover gasket.
52. Install the valve cover washers.
53. Install the valve cover bolts.

Tighten

Tighten the valve cover bolts to 8 N•m (71 lb-in).



54. Connect the ignition wires to the spark plugs.
55. Install the spark plug cover.
56. Install the spark plug cover bolts.

Tighten

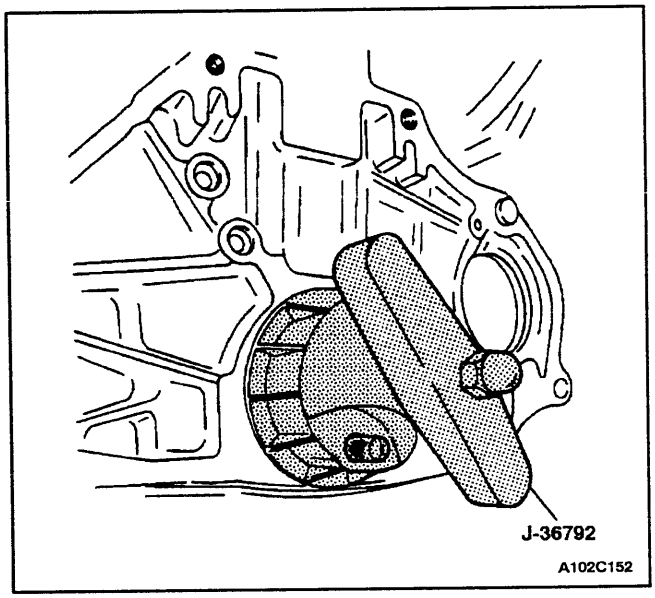
Tighten the spark plug cover bolts to 3 N•m (27 lb-in).

57. Connect the crankcase breather tube to the valve cover.
58. Install the front timing belt cover.
59. Install the front timing belt cover bolts.

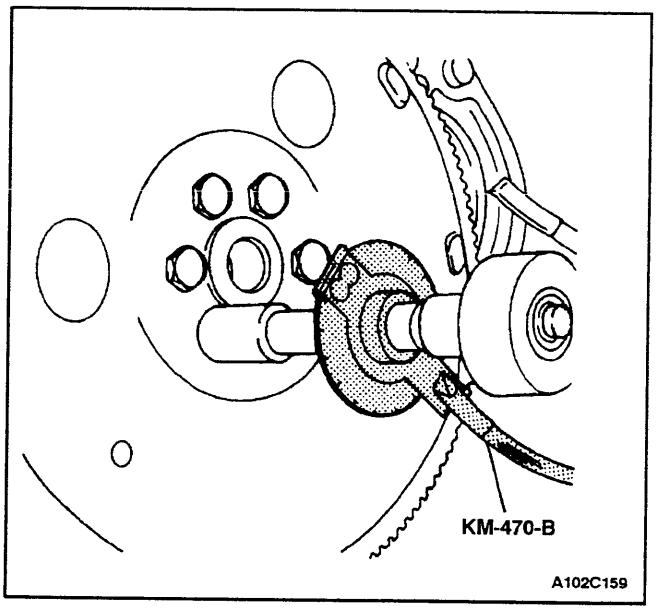
Tighten

Tighten the front timing belt cover bolts to 8 N•m (71 lb-in).

60. Install the engine lifting device.
61. Remove the engine from the engine overhaul stand KM-412.



62. Install a new crankshaft rear oil seal using installer J-36792 or KM-635.

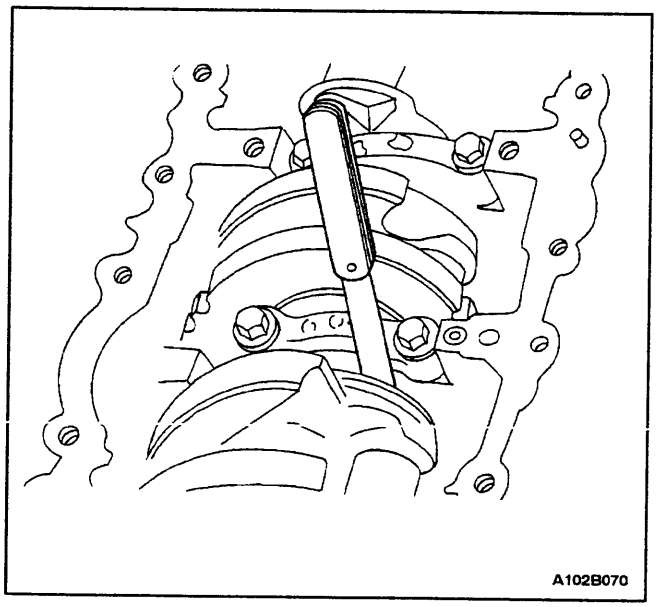


63. Install the flywheel, or flexible plate for vehicles with an automatic transaxle.
64. Install the flywheel, or the flexible plate bolts for vehicles with an automatic transaxle.

Tighten

Tighten the flywheel bolts to 65 N•m (48 lb-ft). Use the angular torque gauge KM-470-B to tighten the flywheel bolts another 30 degrees plus 15 degrees. For the automatic transaxle, tighten the flexible plate bolts to 60 N•m (44 lb-ft).

65. Install the engine. Refer to "Engine" in this section.



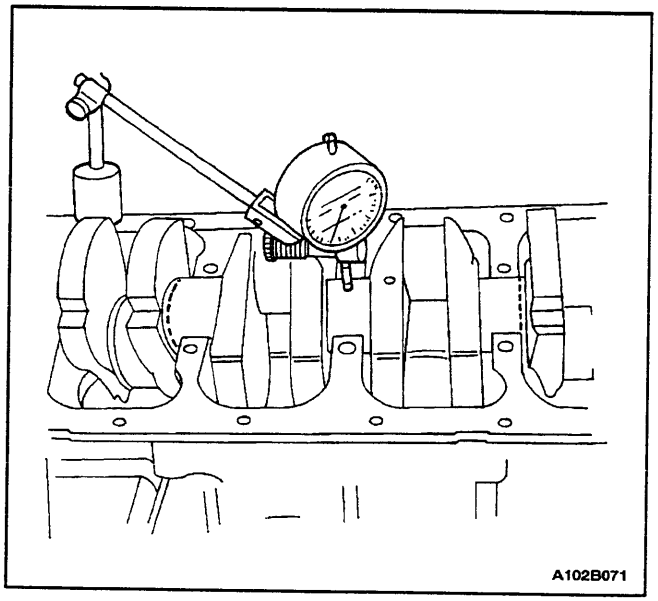
CRANKSHAFT BEARINGS AND CONNECTING ROD BEARINGS — GAUGING PLASTIC

Tools Required

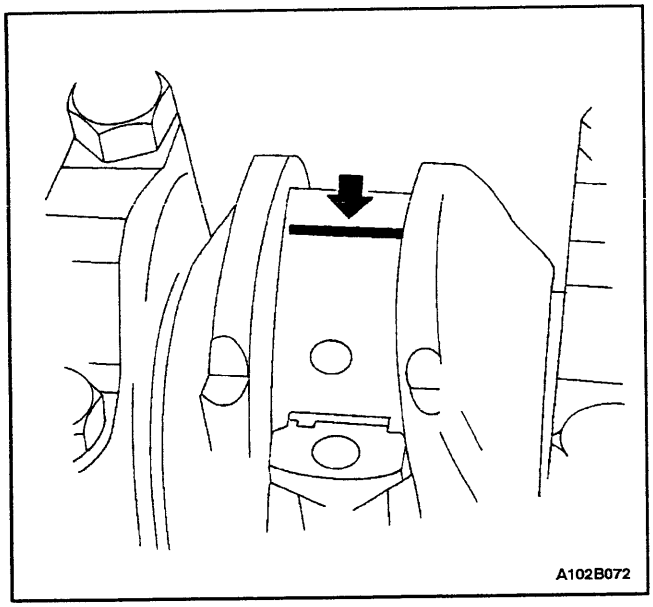
KM-470-B Angular Torque Gauge

Inspection Procedure - Crankshaft

1. Coat the crankshaft bearings with engine oil.
2. Install the upper crankshaft bearings into the engine block crankshaft journals.
3. Install the lower crankshaft bearings into the crankshaft bearing caps.
4. Install the crankshaft.
5. Inspect the crankshaft end play with the crankshaft bearings installed.
6. Check for permissible crankshaft end play. Refer to "Engine Specifications" in this section.

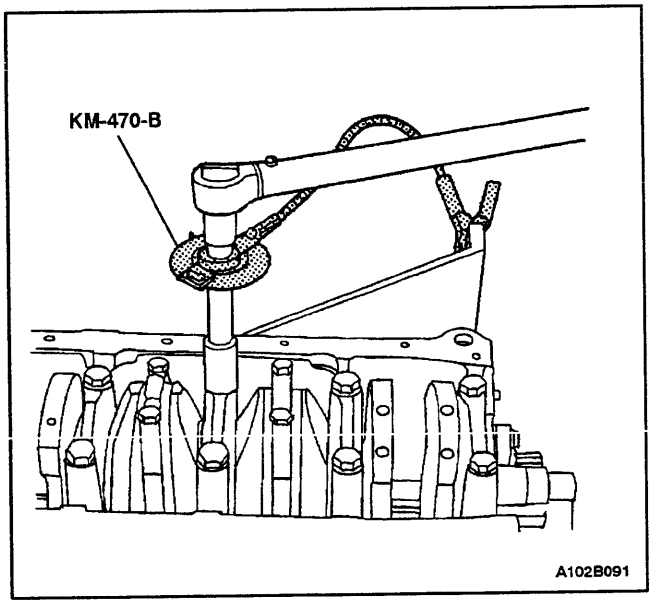


7. With the crankshaft mounted on the front and the rear crankshaft bearings, check the middle crankshaft journal for permissible out-of-round (runout). Refer to "Engine Specifications" in this section.



Important: Grease the crankshaft journals and lubricate the crankshaft bearings slightly so that the plastic gauging thread does not tear when the crankshaft bearing caps are removed.

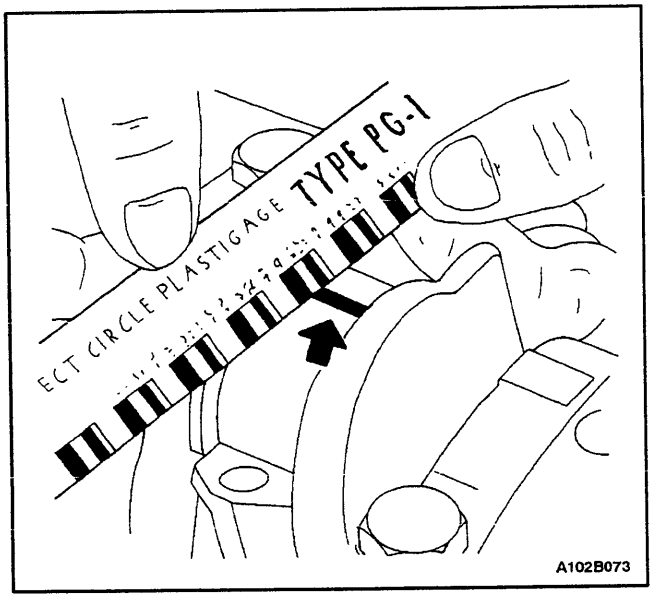
8. Inspect all of the crankshaft bearing clearances using a commercially available plastic gauging (ductile plastic threads).
9. Cut the plastic gauging threads to the length of the bearing width. Lay them axially between the crankshaft journals and the crankshaft bearings.



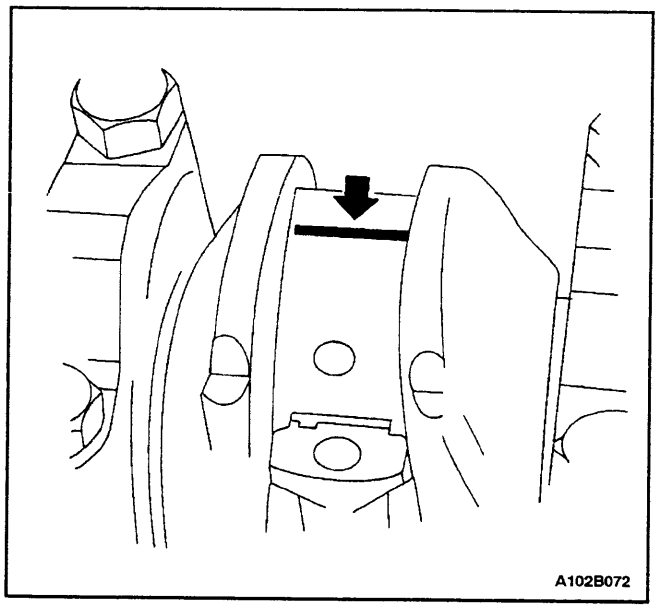
10. Install the crankshaft bearing caps.
11. Install the crankshaft bearing cap bolts.

Tighten

Tighten the crankshaft bearing cap bolts to 50 N•m (37 lb-ft). Using the angular torque gauge KM-470-B, tighten the crankshaft bearing cap bolts another 45 degrees plus 15 degrees.



12. Remove the crankshaft bearing caps.
13. Measure the width of the flattened plastic thread of the plastic gauging using a ruler. (Plastic gauging is available for different tolerance ranges.)
14. Inspect the bearing clearances for permissible tolerance ranges. Refer to "Engine Specifications" in this section.

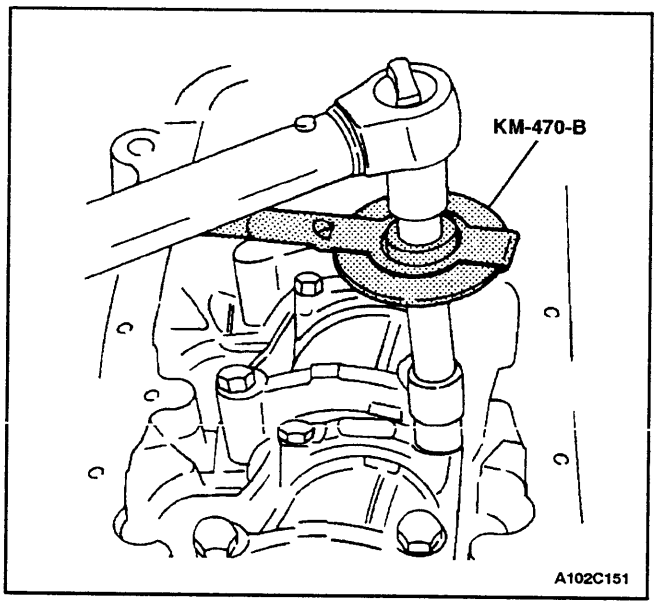

A102B072

Inspection Procedure - Connecting Rods

1. Coat the connecting rod bearings with engine oil.
2. Install the upper connecting rod bearings into the connecting rod journals.
3. Install the lower connecting rod bearings into the connecting rod bearing caps.

Important: Grease the connecting rod journals and lubricate the connecting rod bearings slightly so that the plastic gauging thread does not tear when the connecting rod bearing caps are removed.

4. Inspect all of the connecting rod bearing clearances using a commercially available plastic gauging (ductile plastic threads).
5. Cut the plastic gauging threads to the length of the bearing width. Lay them axially between the connecting rod journals and the connecting rod bearings.



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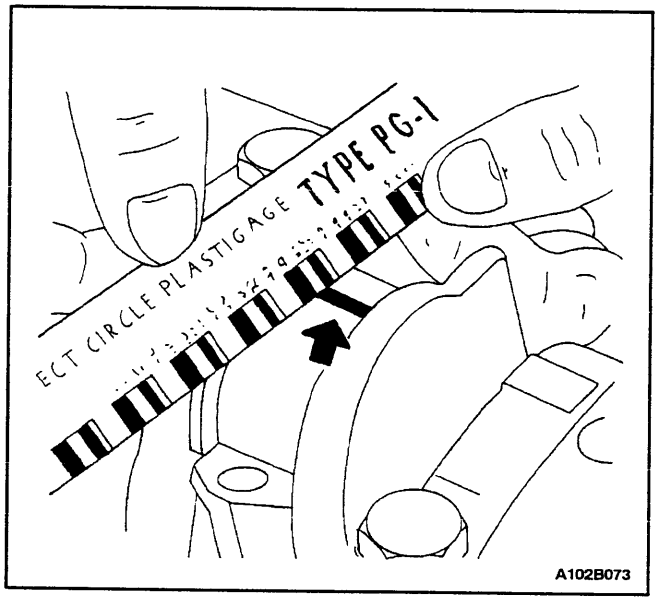
6. Install the connecting rod bearing caps.
7. Install the connecting rod bearing cap bolts.

Tighten

Tighten the connecting rod bearing cap bolts 35 N•m (26 lb-ft). Using the angular torque gauge KM-470-B, tighten the connecting rod cap bolts another 45 degrees.



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8. Remove the connecting rod bearing caps.
9. Measure the width of the flattened plastic thread of the plastic gauging using a ruler. (Plastic gauging is available for different tolerance ranges.)
10. Inspect the bearing clearance for permissible tolerance ranges. Refer to "Engine Specifications" in this section.

GENERAL DESCRIPTION AND SYSTEM OPERATION

CYLINDER HEAD AND GASKET

The cylinder head is made of an aluminum alloy. The cylinder head uses cross-flow intake and exhaust ports. A spark plug is located in the center of each combustion chamber. The cylinder head houses the dual camshafts.

CRANKSHAFT

The crankshaft has eight integral weights which are cast with it for balancing. Oil holes run through the center of the crankshaft to supply oil to the connecting rods, the bearings, the pistons, and the other components. The end thrust load is taken by the thrust washers installed at the center journal.

TIMING BELT

The timing belt coordinates the crankshaft and the dual overhead camshafts and keeps them synchronized. The timing belt also turns the coolant pump. The timing belt and the pulleys are toothed so that there is no slippage between them. There are two idler pulleys. An automatic tensioner pulley maintains the timing belt's correct tension. The timing belt is made of a tough reinforced rubber similar to that used on the serpentine accessory drive belt. The timing belt requires no lubrication.

OIL PUMP

The oil pump draws engine oil from the oil pan and feeds it under pressure to the various parts of the engine. An oil strainer is mounted before the inlet of the oil pump to remove impurities which could clog or damage the oil pump or other engine components. When the crankshaft rotates, the oil pump driven gear rotates. This causes the space between the gears to open and narrow continually, pulling oil in from the oil pan when the space opens, and pumping the oil out to the engine as the space narrows.

At high engine speeds, the oil pump supplies a much higher amount of oil than required for lubrication of the engine. The oil pressure regulator prevents too much oil from entering the engine lubrication passages. During normal oil supply, a coil spring and a valve keep the bypass closed, directing all of the pumped oil to the engine. When the amount of oil being pumped increases, the pressure becomes high enough to overcome the force of the spring. This opens the valve of the oil pressure regulator, allowing the excess oil to flow through the valve and drain back to the oil pan.

OIL PAN

The engine oil pan is mounted to the bottom of the cylinder block. The engine oil pan houses the crankcase and is made of cast aluminum.

Engine oil is pumped from the oil pan by the oil pump. After it passes through the oil filter, it is fed through two paths to lubricate the cylinder block and the cylinder head. In one path, the oil is pumped through the oil passages in the crankshaft to the connecting rods, then to the pistons and the cylinders. It then drains back to the oil pan. In the second path, the oil is pumped through the oil passages to the camshaft. The oil passes through the internal passageways in the camshafts to lubricate the valve assemblies before draining back to the oil pan.

EXHAUST MANIFOLD

A single four-port, rear-takedown manifold is used with this engine. The manifold is designed to direct escaping exhaust gases out of the combustion chambers with a minimum of back pressure. The oxygen sensor is mounted to the exhaust manifold.

INTAKE MANIFOLD

The intake manifold has four independent long ports and utilizes an inertial supercharging effect to improve engine torque at low and moderate speeds.

CAMSHAFTS

This engine is a dual overhead camshaft (DOHC) type, which means there are two camshafts. One camshaft operates the intake valves, and the other camshaft operates the exhaust valves. The camshafts sit in journals on the top of the engine (in the cylinder head) and are held in place by camshaft caps. The camshaft journals of the cylinder head are drilled for oil passages. Engine oil travels to the camshafts under pressure where it lubricates each camshaft journal. The oil returns to the oil pan through drain holes in the cylinder head. The camshaft lobes are machined into the solid camshaft to open and close the intake and the exhaust valves the precisely correct amount at the precisely correct time. The camshaft lobes are oiled by the splash action from pressurized oil escaping from the camshaft journals.

EXHAUST GAS RECIRCULATION VALVE

The exhaust gas recirculation (EGR) system is used to lower oxides of nitrogen (NOX) emission levels caused by high combustion temperatures. The main element of the system is the EGR valve which is operated by vacuum and controlled by the ECM through the electrically actuated EGR solenoid.

The EGR valve feeds small amounts of exhaust gas into the intake manifold to decrease the combustion temperature. The amount of exhaust gas recirculated is controlled by variations in vacuum and exhaust back pressure. If too much exhaust gas enters, combustion will not take place. For this reason, very little exhaust gas is allowed to pass through the valve, especially at idle.

The EGR valve is usually open under the following conditions:

- Warm engine operation.
- Above idle speed.