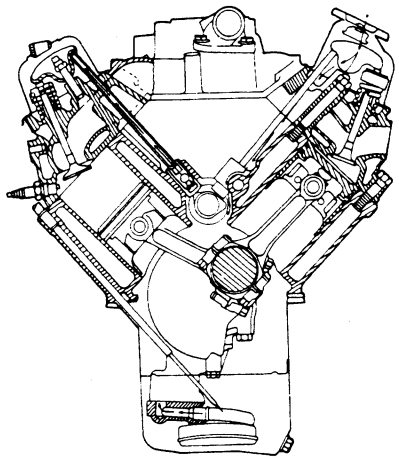
Manual Part No. 93863



SERVICE Manual

4.3 Liter

V-6 DIESEL ENGINE

GENERAC
CORPORATION

P. O. Box 8
PHONE: (414) 544-4811

Waukesha, WI 53187
FAX: (414) 544-4851

Issued- 04/30/94

Printed in U.S.A.

SECTION 6A6

V-6 DIESEL ENGINE

4.3 LITER - VIN V

CAUTION: To help avoid personal injury when a vehicle is on a hoist, provide additional support for the vehicle at the opposite end from which components are being removed. This will reduce the possibility of the vehicle falling off of the hoist.

NOTICE: DO NOT USE STARTING FLUIDS. SUCH AIDS CAN CAUSE IMMEDIATE ENGINE DAMAGE.

CONTENTS

GENERAL DESCRIPTION 6A6-1
Engine Lubrication 6A6-1
ON CAR SERVICE
Engine Assembly 6A6-3
Belt 6A6-3
Engine Mounting 6A6-4
Engine Oil Level Indicator and Tube 6A6-4
Oil Filter Adapter 6A6-5
Oil Cooler Lines 6A6-5
Exhaust Manifold 6A6-5
Injection Pump Adapter and Adapter Seal 6A6-6
Valve Cover 6A6-6
Intake Manifold 6A6-7
Rocker Arms 6A6-8
Valve Lifters 6A6-9
Valve Lifter Bleed Down 6A6-9
Glow Plug 6A6-10
Cylinder Head and Gasket 6A6-10
Checking Rotators 6A6-11
Replacing Valve Spring or Stem Seal (Head On Engine) 6A6-11
Oil Pan 6A6-12
Oil Pump 6A6-13
Oil Pump Drive and Drive Shaft Extension 6A6-13
Crankshaft Pulley Assembly 6A6-14
Crankshaft Balancer 6A6-15
Front Cover 6A6-15
Front Cover Oil Seal 6A6-17
Timing Chain and Sprockets 6A6-17
Injection Pump Drive and Driven Gears 6A6-19
Camshaft 6A6-19
Camshaft and Oil Gallery Plugs 6A6-20
Rear Main Bearing Oil Seal Repair 6A6-20
Flywheel 6A6-21
Crankshaft 6A6-21
TORQUE SPECIFICATIONS 6A6-22
ENGINE SPECIFICATIONS 6A6-23
TOOLS 6A6-27

GENERAL DESCRIPTION

The 4.3 V6 Diesel is a four stroke cycle diesel fuel engine. Cylinder numbers 1, 3 and 5 are on the left bank. Cylinders 2, 4 and 6 are on the right bank. The firing order is 1-6-5-4-3-2.

The required engine maintenance, engine unit numbers and engine identification is outlined in Sections 0A and 0B of this manual. The engine specifications are listed at the back of this section.

Intake and exhaust valves in the cylinder heads operate the same as in a gasoline engine, but are of a special design and material for diesel operation. Electric glow plugs are used to aid starting of a cold engine. The glow plugs and injection nozzles are located in each cylinder. The nozzles open at a specified kPa (psi) of fuel pressure and are not adjustable. (For nozzle service see Section 6C5).

ENGINE LUBRICATION SYSTEM

Fig. 1

The engine oil pan forms a reservoir for engine oil to provide lubrication and also hydraulic fluid to operate the valve lifters. Oil pressure for lubrication is furnished by a gear type oil pump that is bolted to the rear main bearing cap and driven by the camshaft gear through a hexagonal drive shaft.

Oil enters the pump through a screened inlet located near the bottom rear of the oil pan. The pressurized oil from the pump passes through the oil filter located on the right rear side of the engie block. The oil filter adapter has a by-pass valve which will open in the event of filter restriction. Engine oil is directed to the oil cooler, located in the radiator, then from the cooler to the filter adapter. The oil then is directed back to the engine oil galleries. A by-pass valve in the filter adapter allows continuous oil flow to the engine in case of cooler line or cooler restriction. This by-pass valve opens at about 83 kPa (12 psi). Oil then enters the oil galleries where it is distributed to the

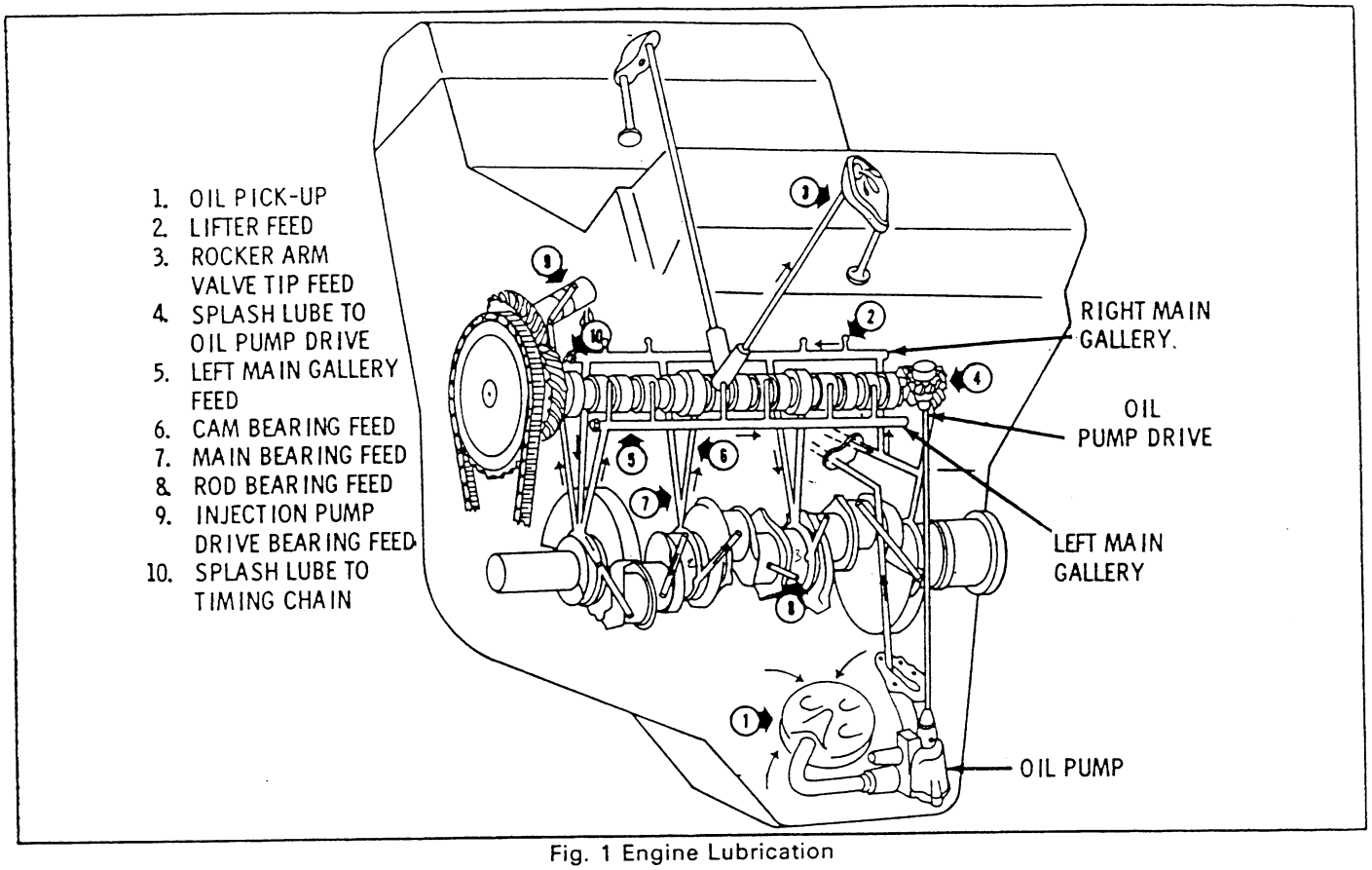


Fig. 1 Engine Lubrication

four main bearings. The valve lifters receive oil from these galleries from twelve feed holes that intersect the gallery.

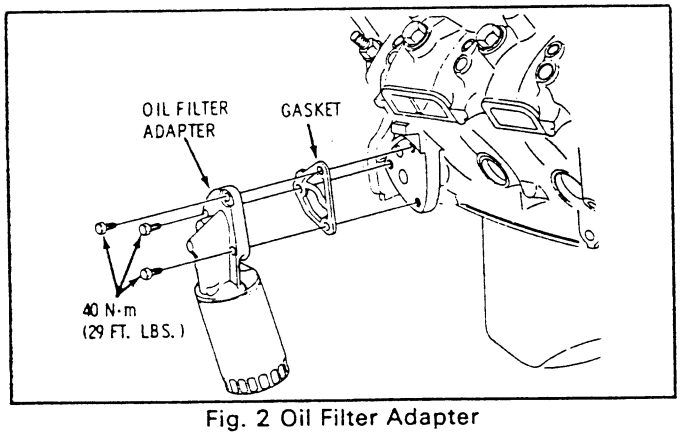


Fig. 2 Oil Filter Adapter

The four camshaft bearings are lubricated from vertical passages intersecting the main bearing oil passages. The injection pump driven gear is lubricated by oil directed through a passage from the top of the front camshaft bearing. An angled passage in the shaft portion of the driven gear then directs the oil to the rear driven gear bearing.

The engine oil pressure warning light switch or sender is connected to the rear of the right oil gallery. The switch is calibrated to turn on the instrument panel warning light when engine oil pressure is too low. The left (front side) rear oil gallery plug has an orifice to help purge contaminants from the gallery and to lubricate the oil pump drive assembly.

At the front end of the right gallery, a small orifice sprays oil to lubricate the timing chain.

The rocker arms and valve tips are lubricated by oil furnished through the hydraulic lifters and hollow push-rods. A disc valve in the lifter meters oil to the push rods.

The connecting rod bearings are oiled by constant oil flow from passages drilled through the crankshaft connecting the main journals to the rod journals. A groove around each main bearing furnishes oil to the drilled crankshaft passages.

Oil returns to the oil pan reservoir from the rocker arms through passages at each end of the cylinder heads. Oil from the valve lifter compartment returns through clearance holes in the lower portion of the compartment near the camshaft. The timing chain compartment drains directly into the oil pan.

Engine Oil Pressure Test

1. Engine at operating temperature.
2. Transmission in **"PARK"** , parking brake applied and drive wheels blocked.
3. Oil pressure should be:
   At slow idle - 48.26 kPa (7 PSI) Min.
   1500 RPM - 206.85 kPa (30 PSI) Min.

ENGINE CLEANING

Do not clean the engine until it has cooled down to surrounding temperature. Spraying water or engine cleaning fluid on the diesel injection pump when it is warm or hot will damage the pump.

ON CAR SERVICE

ENGINE ASSEMBLY

Remove or Disconnect

Tools Required:
J-26996-1 Air Crossover Screen Cover
J-21654 Converter Holding Tool
BT-6322 Transmission Chain Support

1. ...in cooling system.
2. Air cleaner. Install cover J-26996-1.
3. Hood. Mark hood hinges for reassembly.
4. Negative battery cables
5. Ground wires at inner fender panel
6. Engine ground strap
7. Radiator hoses
8. Cooler lines
9. Heater hoses
10. Power steering hoses at gear
11. (Air conditioning) A/C compressor with brackets and hoses attached
12. Fuel hoses from pump, inlet line and injection pump return line
13. Engine attached wiring except at starter
14. Throttle cable
15. Transmission TV cable at the injection pump and engine brackets
16. Upper radiator support and radiator
17. Raise and support car. See "CAUTION" on page 6A6-1.
18. Exhaust pipes at manifolds
19. Torque converter (flywheel) cover
20. Three torque converter to flywheel bolts
21. Starter motor
22. Engine mount through bolts
23. Three engine to transmission bolts on right side
24. Lower car.
25. Secure engine lift chain to engine, such as BT-6606.
26. Place a board on top of a jack and slightly raise transmission. Remove three left transmission engine bolts.
27. Engine

Important

- If vehicle is to be moved, install converter holding tool J-21654 and support transmission with a suitable chain support such as BT-6322.

Install or Connect

1. Fasten chain to engine.
2. Locating engine dowels into transmission, install and tighten through bolts in engine mounts. Torque to specification.
3. Three transmission to engine bolts on left side
4. Remove support chains and jack.
5. Raise and support car. See "CAUTION" on page 6A6-1.
6. Three transmission to engine bolts on right side
7. Starter and wires
8. Three torque converter to flywheel bolts and torque converter cover

   Before installing the flywheel to converter bolts, make certain that the weld nuts on the converter are flush with the flex plate and the converter rotates freely by hand in this position. Hand start the three bolts and tighten finger tight, then torque to specifications. This will insure proper converter alignment.

9. Exhaust pipes
10. Lower car.
11. Radiator and upper radiator support
12. Radiator hoses
13. Cooler lines
14. Heater hoses
15. Vacuum hoses
16. Power steering pump hoses
17. Power steering hose bracket
18. (Air conditioning) A/C compressor
19. Fuel hoses to fuel pump inlet line and injection pump return line
20. Wiring
21. Throttle cable. Fully seat the grommet in the bracket.
22. Transmission T.V. cable. See Section 7A for cable adjustment.
23. Air cleaner
24. Align hood with scribe marks and fasten.
25. Battery cables and ground wires
26. Coolant
27. Engine oil.

Inspect

- For leaks

BELT

Fig. 3, 4 and 5

A single (serpentine) wide belt is used to drive all engine accessories formerly driven by multiple drive belts. All belt driven accessories are rigidly mounted with belt tension maintained by a spring loaded tensioner. To remove and install the belt, lift (rotate) the tensioner idler pulley as shown in Figs. 3 and 4. To check the tensioner, use belt tension gage BT-7825 or J-23600. Belt tension should be 440-620 Newtons (100-140 lbs.).

Important

To get maximum life from the belt, it is important that all pulleys be in alignment to each other. Use a straight edge to check that the pulleys are "in-line". Reposition and/or shim brackets as necessary.

A belt squeak when the engine is started or stopped is normal. It happens because the engine starts and stops so quickly. The has no effect on belt durability.

The drive belt tensioner has the ability to control belt tension over a fairly broad range of belt lengths. However there are limits to the tensioner's ability to

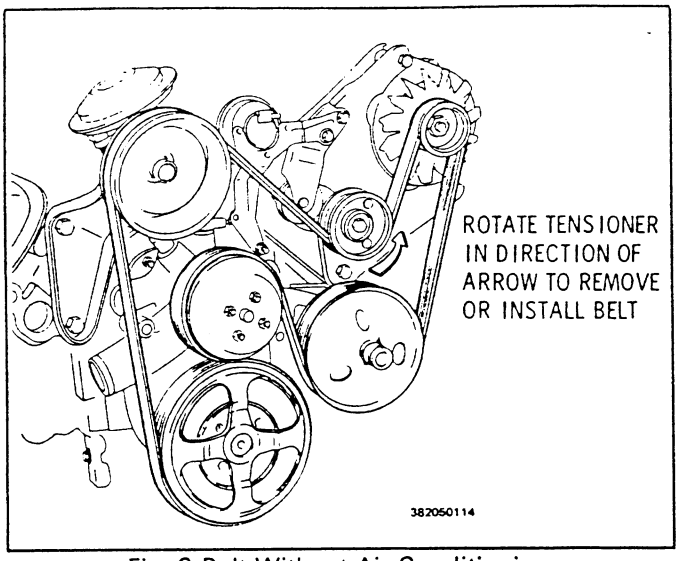


Fig. 3 Belt Without Air Conditioning

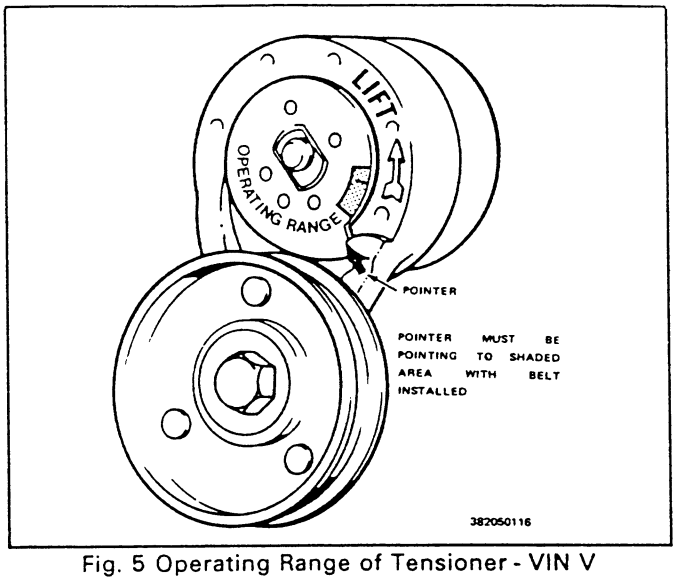


Fig. 5 Operating Range of Tensioner - VIN V

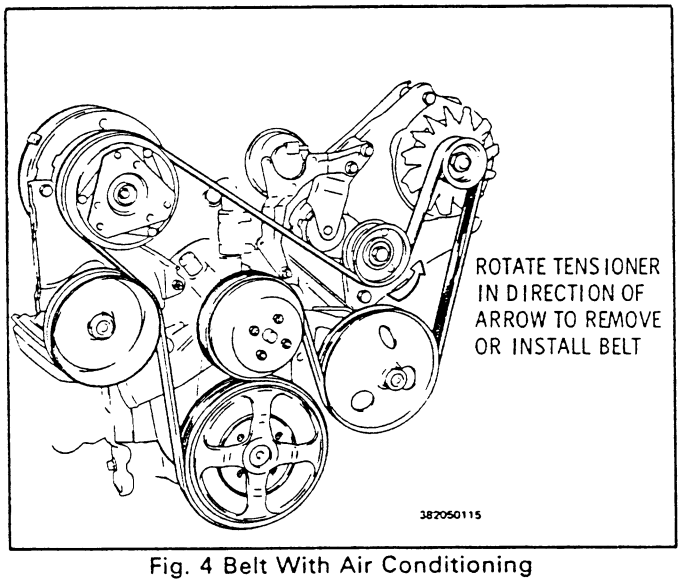


Fig. 4 Belt With Air Conditioning

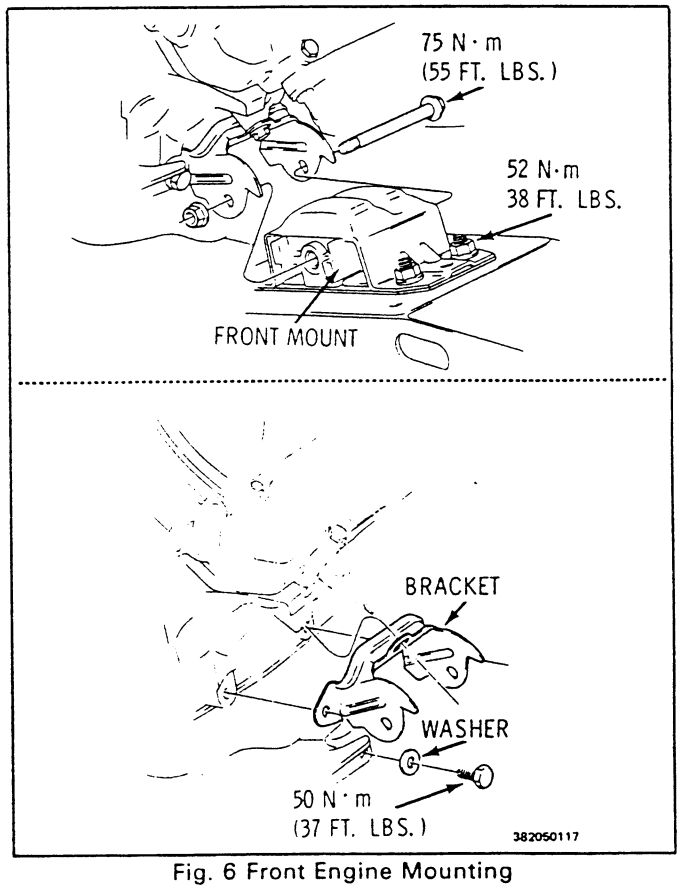


Fig. 6 Front Engine Mounting

compensate for varying lengths of belts. Using the tensioner outside of its operating range can result in poor tension control and/or damage to the tensioner.

The tensioner has provisions for a visual check to verify that it is in the "Operating Range". (Fig. 5)

If the tensioner is outside of its operating range, check the following;

1. Belt incorrect or worn. New belt specifications can be found in "Engine Specifications" at the end of this section.
2. Tensioner improperly installed - dowel pin on bracket not indexed with hole in tensioner.

ENGINE MOUNTING

See Figs. 6 and 7

ENGINE OIL LEVEL INDICATOR AND TUBE

Remove or Disconnect

Tool Required:
J-2619 Slide Hammer.

(Removal of the oil level indicator tube will assist in easier removal and installation of the left cylinder head.)

1. Attach the slide hammer from Tool J-2619 on a 6.3 x 20 mm (1/4" diameter 6" long) bolt.
2. Thread bolt into the oil level indicator tube and clamp with vise grip type pliers or equivalent.
3. Tap out tube.

Install or Connect

1. Insert a 6.3 x 20 mm (1/4" diameter x 1/2" long) bolt into the tube.

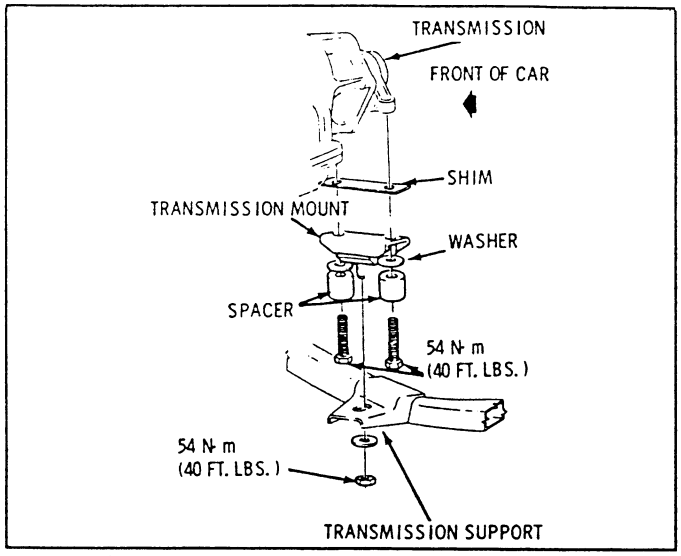


Fig. 7 Rear Engine (Transmission) Mount

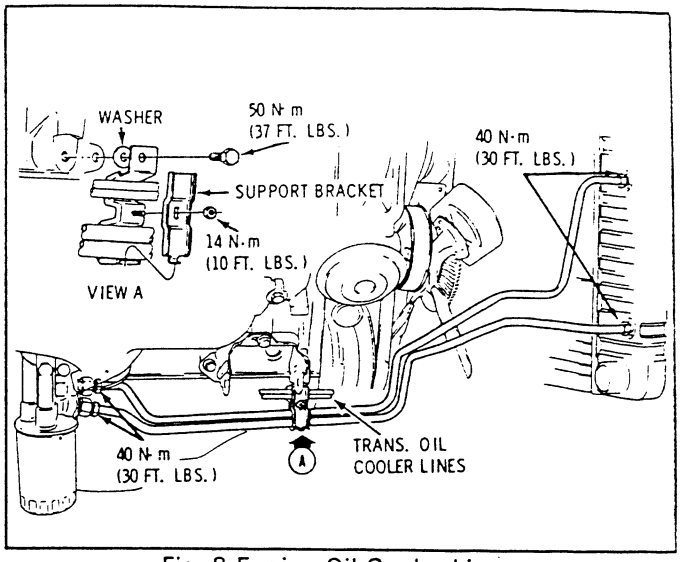


Fig. 8 Engine Oil Cooler Lines

2. Tap on the bolt head to drive tube into the block.

OIL FILTER ADAPTER

Fig. 2

Remove or Disconnect

1. Oil cooler lines
2. R.H. exhaust manifold
3. Oil filter adapter retaining bolts
4. Oil filter adapter

Clean

- Sealing surfaces

Install or Connect

1. Use a new gasket. Torque adapter bolts to 40 N·m (29 lbs. ft.).
2. R.H. exhaust manifold.Torque to specification.
3. Oil cooler lines. See Fig. 8 for routing and torques.

OIL COOLER LINES

Fig. 8

Lines are serviced pre-assembled.

L.H. Exhaust Manifold

Fig. 9

Remove or Disconnect

Tool Required:
J-26996-1 Air Crossover Cover.

1. Air cleaner. Install air crossover cover J-26996-1. (Drill two holes in the cover to avoid air cleaner studs).
2. Lower generator bracket
3. Raise and support car. See "CAUTION" on page 6A6-1.
4. Crossover pipe
5. Lower car.
6. Exhaust manifold from above

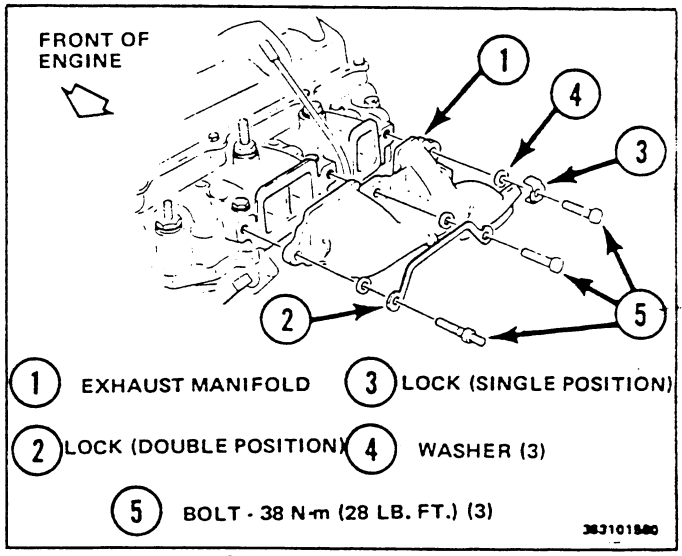


Fig. 9 Left Exhaust Manifold

Install or Connect

1. Exhaust manifold from above. Dip entire attaching bolt(s) into 1052080 lubricant or equivalent. Torque bolts to 39 N·m (29 lbs. ft.).
2. Bend lock tabs over bolt heads.
3. Raise and support car. See "CAUTION" on page 6A6-1.
4. Crossover pipe
5. Lower car.
6. Lower generator bracket
7. Remove air crossover cover and install air cleaner.

R.H. Exhaust Manifold

Fig. 10

Remove or Disconnect

1. Raise and support car. See "CAUTION" on page 6A6-1.
2. Crossover pipe
3. Exhaust pipe
4. R.F. wheel
5. Exhaust manifold from under car

Install or Connect

1. Raise and support car. See "CAUTION" on page 6A6-1.
2. Exhaust manifold from under car. Dip the entire attaching bolt(s) into 1052080 lubricant or equivalent. Torque bolts to 39 N·m (29 lbs. ft.).
3. R.F. wheel
4. Exhaust pipe
5. Crossover pipe
6. Lower car.

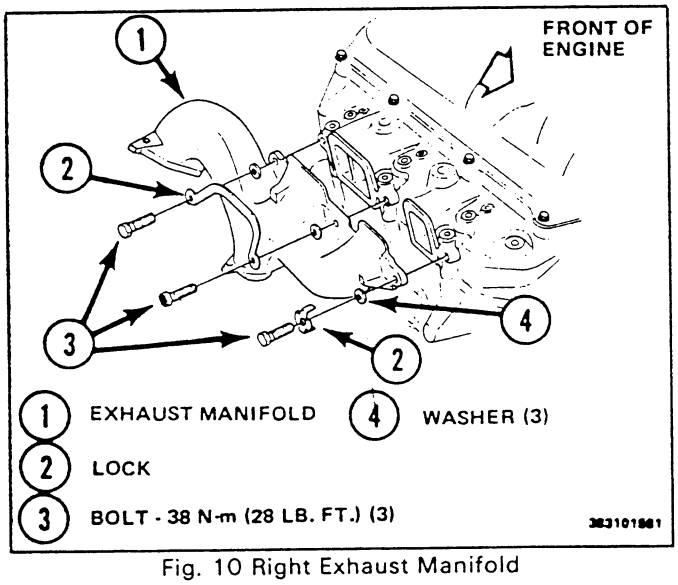


Fig. 10 Right Exhaust Manifold

INJECTION PUMP ADAPTER AND ADAPTER SEAL

Figs. 11 and 12

Tool Required:
J-28425 Seal Installer

Remove or Disconnect

1. Injection Pump, see Section 6C5.
2. Intermediate pump adapter
3. Using a probe, pry out the adapter seal without nicking the adapter.

Install or Connect

1. Lubricate the new seal with chassis lube on both the inside and outside diameters of the seal. Also lubricate tool J-28425 adapter and intake manifold.
2. Place seal on the tool.
3. Insert seal into the adapter and intake manifold.
4. Intermediate pump adapter. Torque bolts to 47 N·m (35 lbs. ft.)

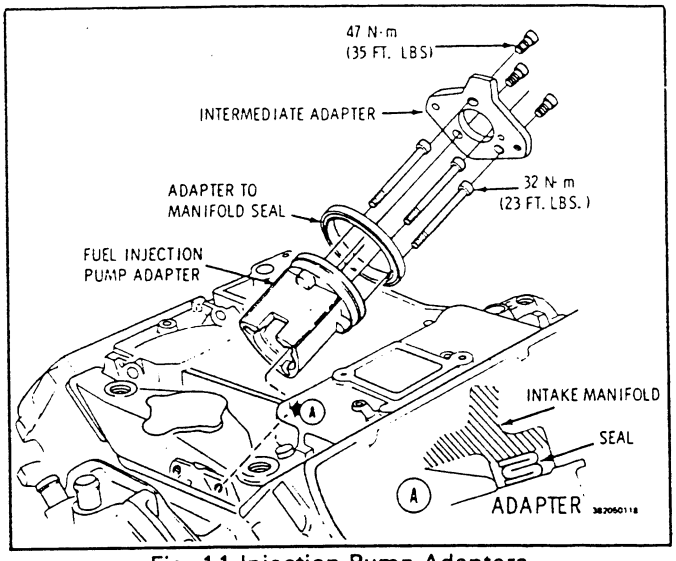


Fig. 11 Injection Pump Adapters

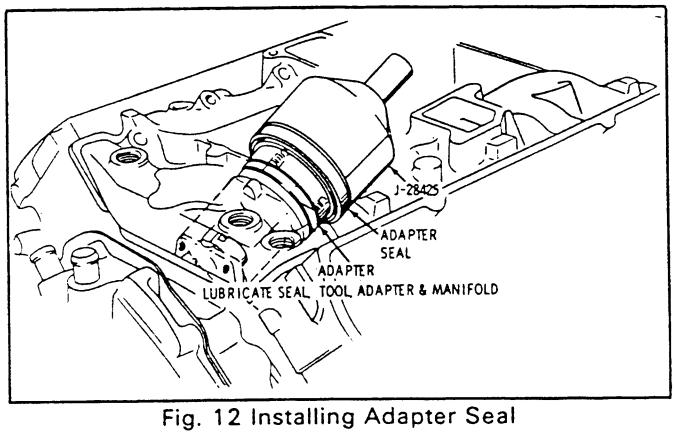


Fig. 12 Installing Adapter Seal

5. Injection pump assembly and reset pump timing, see Section 6C5.

VALVE COVER

Remove or Disconnect

Tool Required:
BT-8315 or J-34144 Seal Breaker

1. Injection lines, see Section 6C5.
2. (R.H. valve cover):
   - Crankcase ventilation system pipes
   - Grommets
   - Filter
   - Crankcase depression regulator valve (Fig. 13)
3. Accessory mounting brackets as necessary.
4. Place tool BT-8315 or J-34144, midway between the ends of the valve cover on the upper side.
5. Tighten the screw to apply a load on the cover (Fig. 14).

Using a rubber mallot, stike on the side of the valve cover, above where the tool is installed.

NOTICE: Use a cloth to absorb the blow of the mallot. If a cloth is not used, the valve cover will be damaged.

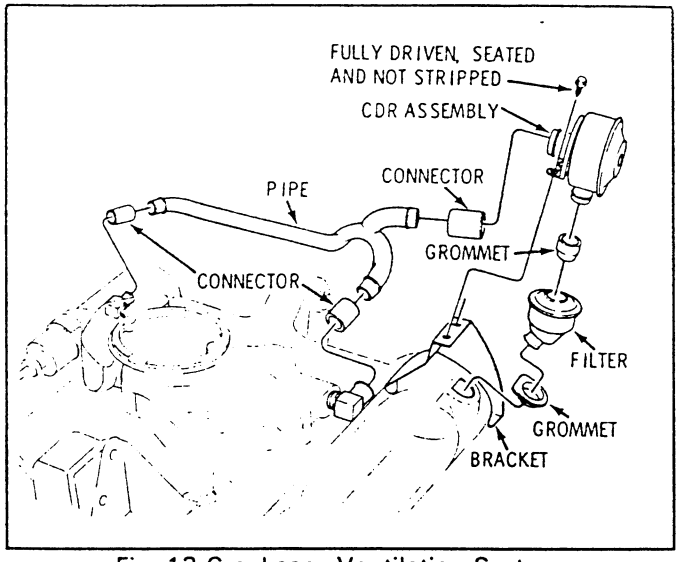


Fig. 13 Crankcase Ventilation System

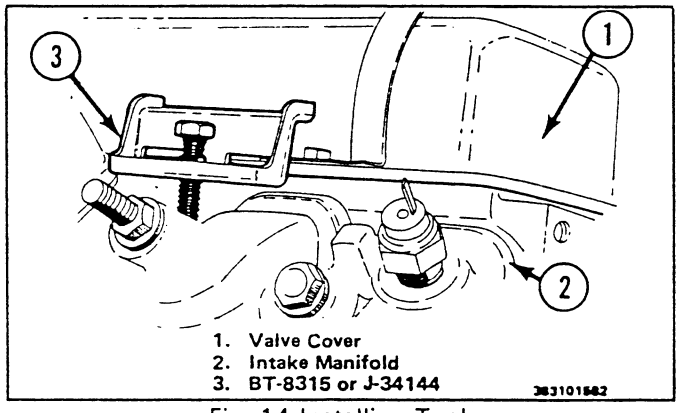


Fig. 14 Installing Tool

7. Valve cover

Clean

- Head and valve cover gasket surface. Apply 1052915, 22521437, G.E. 1673 RTV sealer or equivalent to the valve cover (Fig. 15).

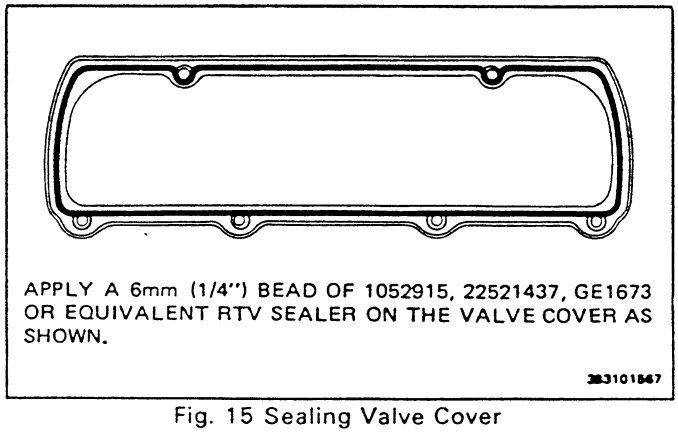


Fig. 15 Sealing Valve Cover

Install or Connect

1. Lubricate the entire valve cover attaching bolt with 1052080 or equivalent.
2. Valve cover and bolts
3. Mounting brackets which were removed
4. If R.H. valve cover was removed:
   - Crankcase depression regulator valve
   - Crankcase ventilation system pipes
   - Grommet
   - Filter
5. Injection lines, see Section 6C5.

Inspect

For Leaks

INTAKE MANIFOLD

Figs. 16, 17 and 18

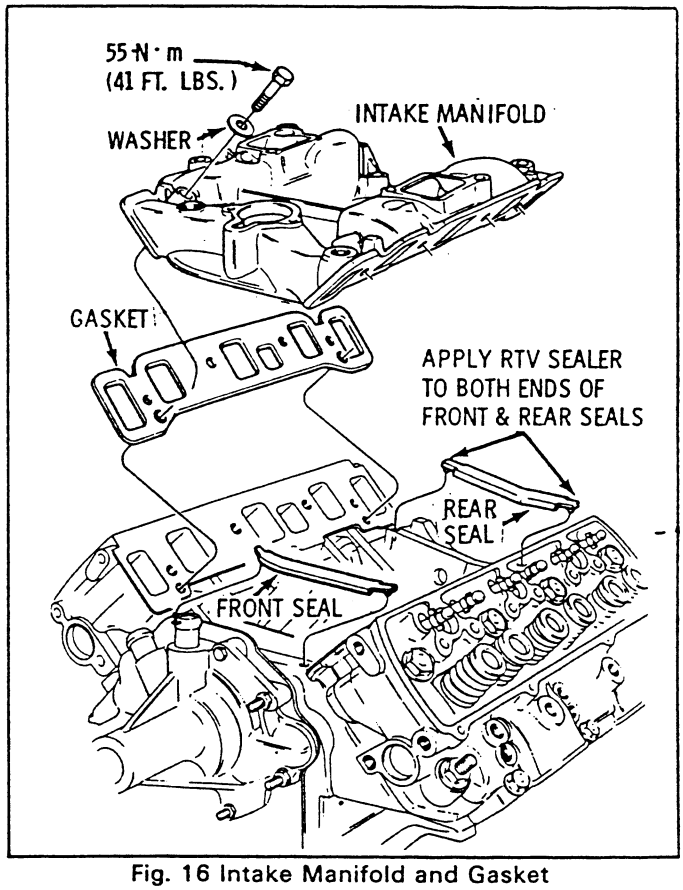


Fig. 16 Intake Manifold and Gasket

Remove or Disconnect

1. Air cleaner
2. Drain cooling system:
   - Radiator hoses
   - Heater hoses
3. Fuel pump. Cap all pump and line openings.
4. Fuel injection pump, see Section 6C5.
5. (Air conditioning) Wiring and switches at generator.
6. Cruise Control Servo
7. (Air conditioning) A/C compressor, loosen and move out of the way.
8. Fuel lines, filter and brackets. Cap all openings.
9. Electrical leads to glow plug control module and sending units

10. Throttle and T.V. cables from the bracket.
11. Drain tube (Fig. 17)

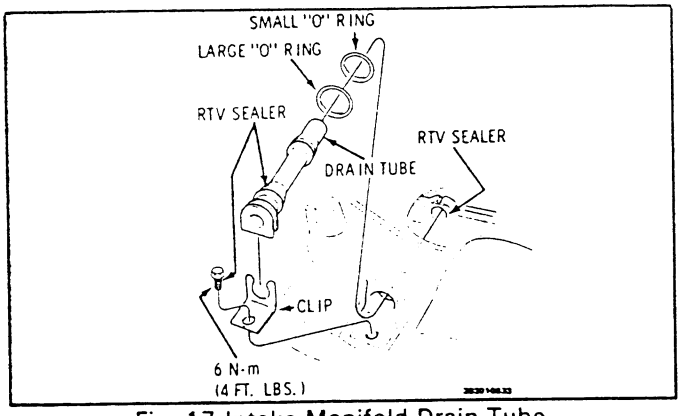


Fig. 17 Intake Manifold Drain Tube

12. Intermediate pump adapter (Figure 11)
13. Pump adapter and seal (Figure 12)
14. Intake manifold

Clean

- Machined surfaces of cylinder head and intake manifold with a putty knife. Use care not to gouge or scratch the machined surfaces. Clean all bolts and bolt holes.

Install or Connect

1. Position the intake manifold gasket. (Fig. 16).
2. End seals. Make sure that ends are positioned under the cylinder heads. The seals and mating surfaces must be dry. Any liquid, including sealer will act as a lubricant and cause the seal to move during assembly. Use 1052915, 22521437, G.E. 1673 RTV sealer or equivalent only on each end of the seal.
3. Position intake manifold on engine.
4. Connect thermostat by-pass hose to water pump.
5. Dip intake manifold bolts in oil.

Tighten

- Torque in sequence (Fig. 18) to 20 N·m (15 lbs. ft.). Then retorque to 55 N·m (41 lbs. ft.).

6. Drain tube (Fig. 17)
7. Pump adapter (Fig. 11)
8. Throttle and TV cables
9. Electrical leads to glow plug control module and sending units
10. Fuel lines, filter and brackets
11. (Air conditioning) A/C compressor
12. Injection pump (See Section 6C5)
13. Lines, hoses, and electrical leads
14. Upper radiator and heater hoses (and vacuum hose at water valve if so equipped)
15. Fill cooling system.

Inspect

Tool Required:
J-24657 manifold screen cover

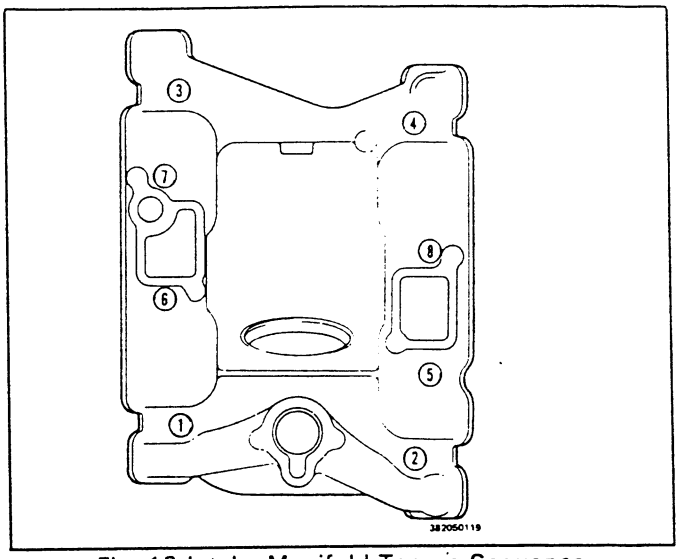


Fig. 18 Intake Manifold Torque Sequence

- Install J-29657 manifold screen cover
- For leaks
- Injection pump timing, see Section 6C5
- Remove J-24657 manifold screen cover.

16. Air crossover
17. Air cleaner

ROCKER ARMS

Fig. 19

Remove or Disconnect

1. Valve cover.

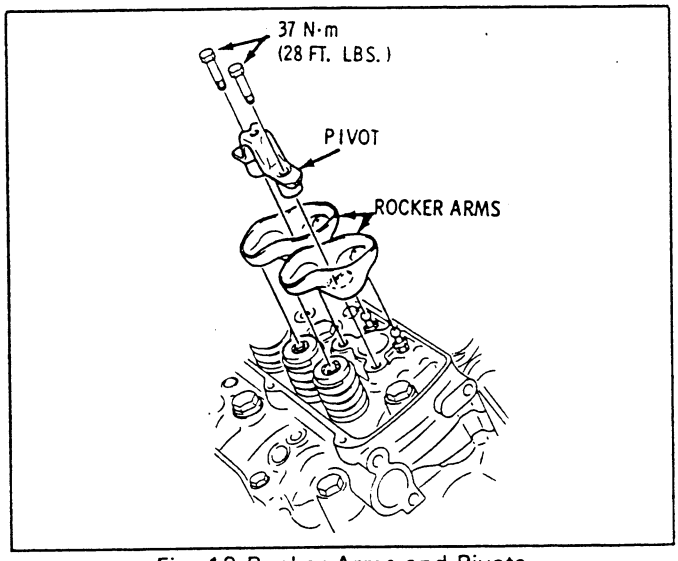


Fig. 19 Rocker Arms and Pivots

2. Rocker arm flanged bolts
   - Pivot
   - Rocker arms
     - Remove each set (one set per cylinder) as a unit.

1. Position a set of rocker arms (for one cylinder) in the proper location.

NOTICE: Refer to " **Valve Lifter Bleed Down**" since the lifters must be bled down, as possible valve to piston interference due to the close tolerances could exist.

3. Lubricate wear points with 1050169 lubricant or equivalent and install the pivots.
4. Flanged bolts and tighten alternately. Torque bolts to 37 N·m (28 lbs. ft.).

VALVE LIFTERS

Important

- Valve lifters and push-rods should be kept in order so they can be reinstalled in their original position. The push rods have a "wing" at the upper end so the push rod can only be installed one way. This is necessary as the ball hardness is not the same on both ends.
- Some engines will have both standard and .010" oversize valve lifters. The indicator is a stamping **".010"** on the side of the cylinder block, above the lifter bore that is oversize. (Fig. 20)

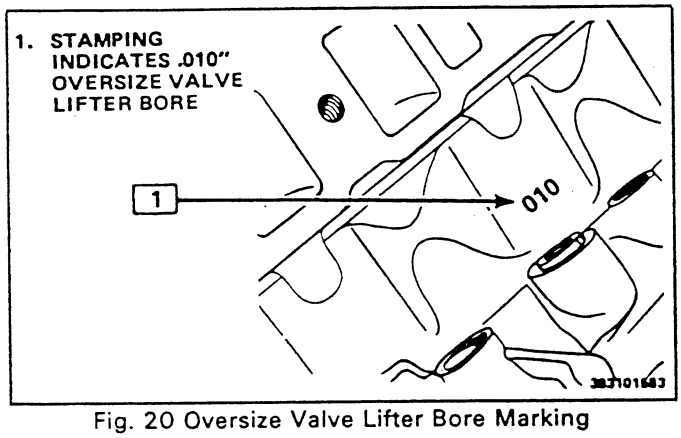


Fig. 20 Oversize Valve Lifter Bore Marking

Remove or Disconnect

1. Intake manifold
2. Valve covers
3. Rocker arm assemblies
4. Push rods
5. Valve lifter guide (Fig. 21)
6. Valve lifters

Install or Connect

Important

- Prime new lifters by working lifter plunger while submerged in clean kerosene or diesel fuel. Lifter could be damaged when starting engine if dry.

NOTICE: When a rocker arm is loosened or removed, valve lifter bleed down is required. Refer to **"VALVE LIFTER BLEED DOWN."** Lifters must be bled down as possible valve to piston interference due to the close tolerances could exist.

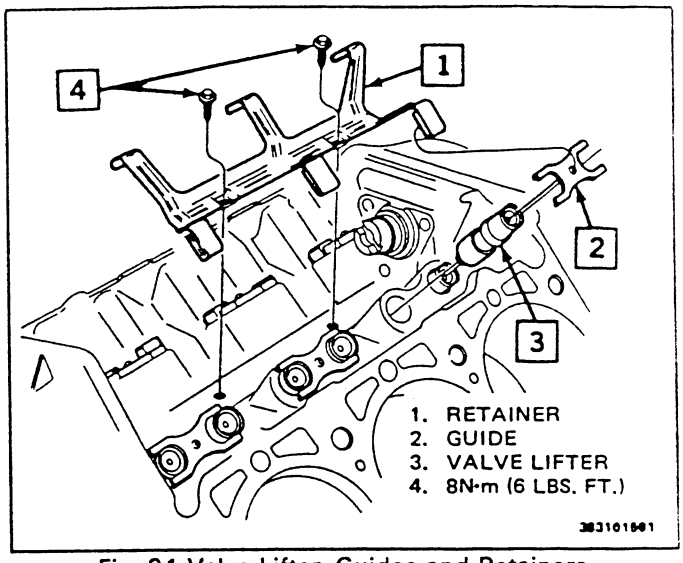


Fig. 21 Valve Lifter, Guides and Retainers

Before installing a new or used lifter in the engine, lubricate the roller and bearings of the lifter with 1052365 lubricant or equivalent.

1. Lifters and push-rods into original position in cylinder block
2. Intake manifold
3. Rocker arms
   - Pivots
   - Bolts (Fig. 19)
4. Valve covers

VALVE LIFTER BLEED DOWN

If the intake manifold has been removed and if any rocker arms have been loosened or removed; remove those valve lifters, disassemble, drain, then reassemble them. See Section 6A Engine General Mechanical.

If the intake manifold has not been removed but rocker arms have been loosened or removed, valve lifters can be bled down by the following procedure;

1. Before re-installing rocker arms, rotate the crankshaft until number 1 cylinder is at 32° before top dead center. This is 50 mm (2") counter-clockwise from the 0° pointer. If only the right valve cover was removed, remove No. 1 glow plug to determine if the position of the piston is the correct one. The compression pressure will tell you that you are in the right position.

   If the left valve cover was removed, rotate the crankshaft until the number 5 cylinder intake valve push rod ball is 7.0 mm (.28") above the number 5 cylinder exhaust valve pushrod ball.

   NOTICE: Use only hand wrenches to torque the rocker arm pivot nuts or bolts to avoid engine damage.

2. If removed, install the No. 5 cylinder pivot and rocker arms. Torque the nuts or bolts alternately between the intake and exhaust valves until the intake valve begins to open, then stop.

3. Install remaining rocker arms except No. 3 exhaust valve. (If this rocker arm was removed).
4. If removed, install but do not torque No. 3 valve pivots beyond the point that the valve would be fully open. This is indicated by strong resistance while still turning the pivot retaining nuts or bolts. Going beyond this would bend the push rod. Torque the nuts or bolts SLOWLY allowing the lifter to bleed down.
5. Finish torquing No. 5 cylinder rocker arm pivot nut or bolt SLOWLY. Do not go beyond the point that the valve would be fully open. This is indicated by strong resistance while still turning the pivot retaining nuts or bolts. Going beyond this would bend the push rod.
6. DO NOT turn the engine crankshaft for at least 45 minutes.

NOTICE: Do not rotate the engine until the valve lifters have been bled down, or damage to the engine will occur.

GLOW PLUG

Fig. 22

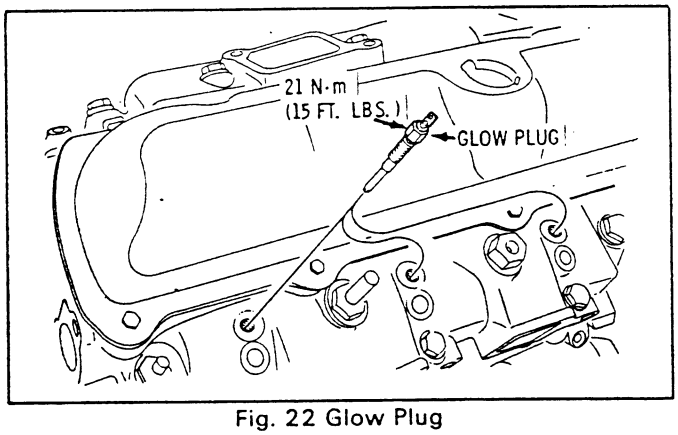


Fig. 22 Glow Plug

A burned out FAST GLOW glow plug tip may bulge then break off and drop into the pre-chamber when the glow plug is removed. When this occurs the cylinder head must be removed and the pre-chamber removed from the head to remove the broken tip.

NOTICE: It is important that the pre-chamber be fully installed flush to the surface of the cylinder head. If this is not done, cylinder head gasket or piston damage can occur.

CYLINDER HEAD AND GASKET

Remove or Disconnect

1. Intake manifold
2. Valve cover
   Loosen or remove any accessory brackets or pipe clamps which interfere.
   If removing the left cylinder head, remove the oil level indicator tube.
3. Fuel lines at injection nozzles
4. Glow plug wiring
5. Ground strap from cylinder head
6. Rocker arms
7. Push rods
   Scribe pivots and keep rocker arms separated so they can be installed in their original locations.
8. Exhaust manifold from the head. Leave attached to the exhaust pipe.
9. Engine coolant drain plug
10. Pipe plugs covering the upper cylinder head bolts (Fig. 23)

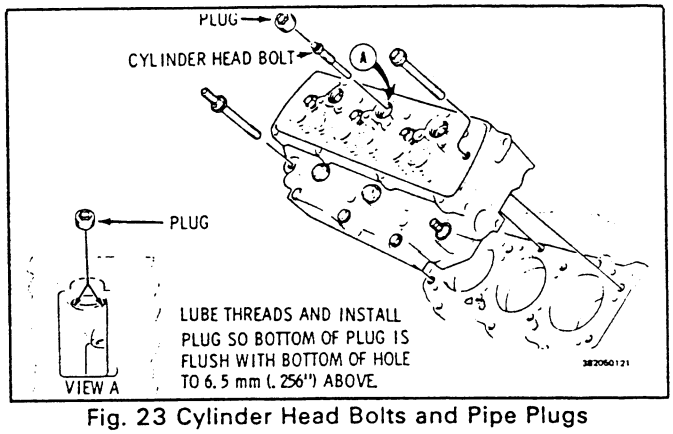


Fig. 23 Cylinder Head Bolts and Pipe Plugs

11. Cylinder head

Inspect

- For inspection and overhaul procedures, refer to Section 6A General Engine Mechanical.

Clean

- Cylinder head bolt holes in the block

Install or Connect

Fig. 24

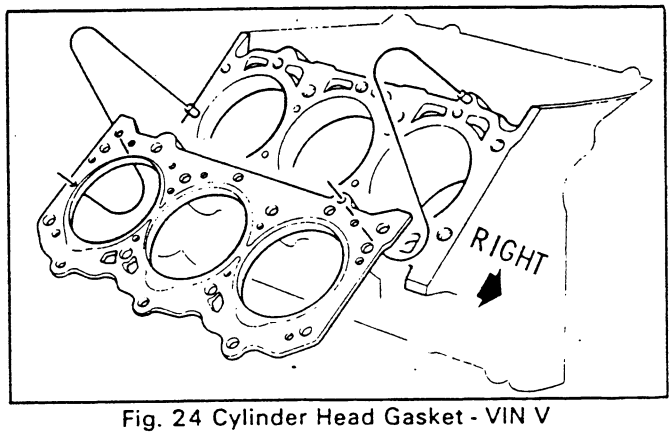


Fig. 24 Cylinder Head Gasket - VIN V

Head gaskets use a special composition gasket that must be used WITHOUT a sealer.

1. Cylinder head
   - Cylinder head bolts
   - Pipe-thread plugs

- Coat the plug threads, bolt threads and the area under the bolt heads with 1052080 sealer or equivalent.

NOTICE: Failure to coat the bolts with the correct sealer will result in coolant leaks and loss of clamping force on the cylinder head gasket due to thread and bolt to head friction, causing cylinder head damage.

Tighten

- Torque all cylinder head bolts in sequence (Fig. 25) except number 5, 6, 11, 12, 13 and 14 to 135 N·m (100 lbs. ft.). Torque number 5, 6, 11, 12, 13 and 14 to 55 N·m (41 lbs. ft.).

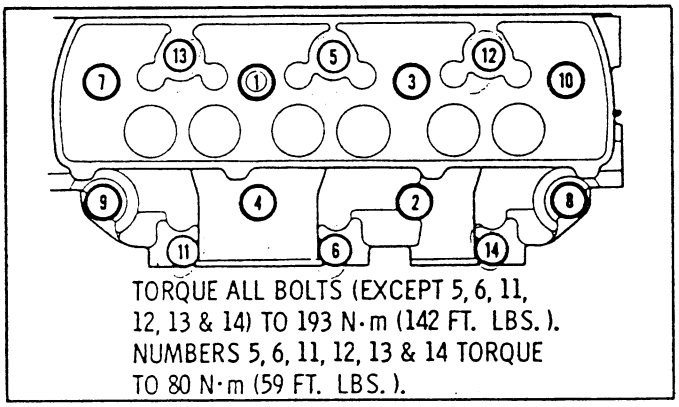


Fig. 25 Cylinder Head Torque Sequence

- Retorque in sequence all cylinder head bolts except number 5, 6, 11, 12, 13 and 14 to 193 N·m (142 lbs. ft.). Retorque number 5, 6, 11, 12, 13 and 14 to 80 N·m (59 lbs. ft.).

2. Install the pipe thread plugs (Fig. 23).

NOTICE: Coat all bolts that enter the cylinder head with 1052080 lubricant or equivalent. Failure to use the correct lubricant can result in cylinder head damage.

3. Engine coolant drain plug
4. Exhaust manifold
5. Push rods
6. Rocker arms
7. Bleed valve lifters
8. Ground strap
9. Glow plug wiring
10. Fuel lines to injection nozzles
11. Fluid level indicator tube
12. Valve cover
13. Intake manifold
14. Fill cooling system.

Inspect

- For leaks

CHECKING ROTATORS

See Section 6A, General Engine Mechanical.

REPLACING VALVE SPRING OR STEM SEAL (HEAD ON ENGINE)

Figs. 26, 27 and 28

Remove or Disconnect

Tool Required:
BT-6413 or
J-26220 valve spring compressor
BT-6804 or J-22315 valve stem oil seal installer

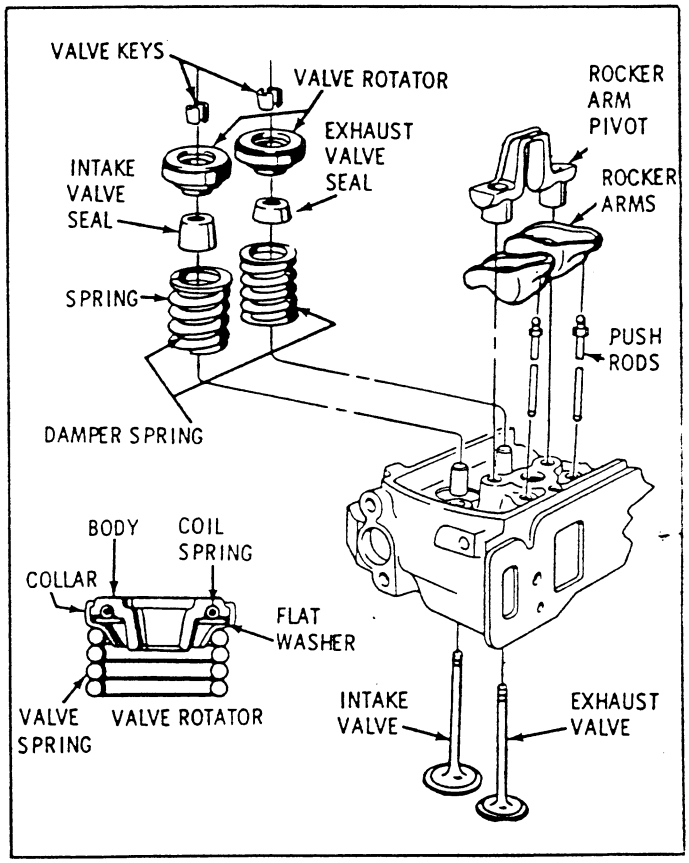


Fig. 26 Cylinder Head Disassembled

1. Valve cover
2. Rocker arms
3. Rotate engine so the piston is at top dead center.
4. With tool BT-6413 or J-26220, compress the valve spring until the valve keys are accessible, then remove the keys, valve rotator and spring. If valve spring does not compress, tap tool with a mallet to break bind at rotator and keys.
5. Valve stem seal. Note color of sealing material. Replace with seal of the same color. (Fig. 26) Push seal down as far as it will go.

Intake Std. - .005" O.S. = Grey
.010 - .013"O.S. = Orange
Exhaust Std. - .005" O.S. = Ivory
.010 - .013" O.S. = Blue

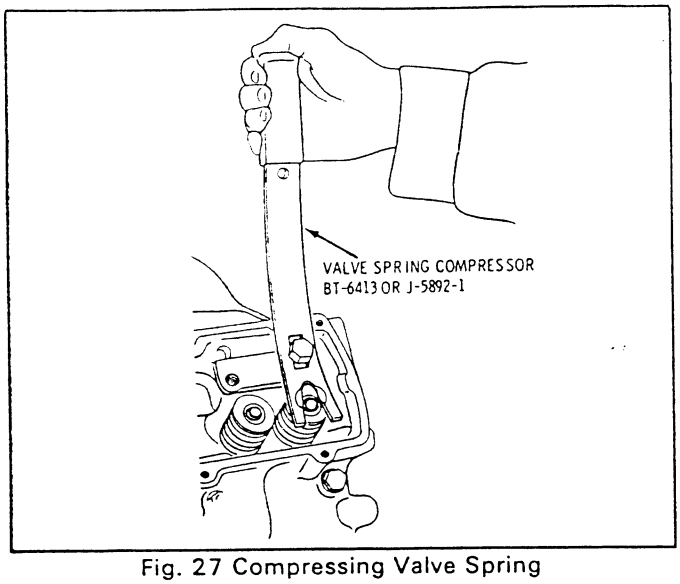


Fig. 27 Compressing Valve Spring

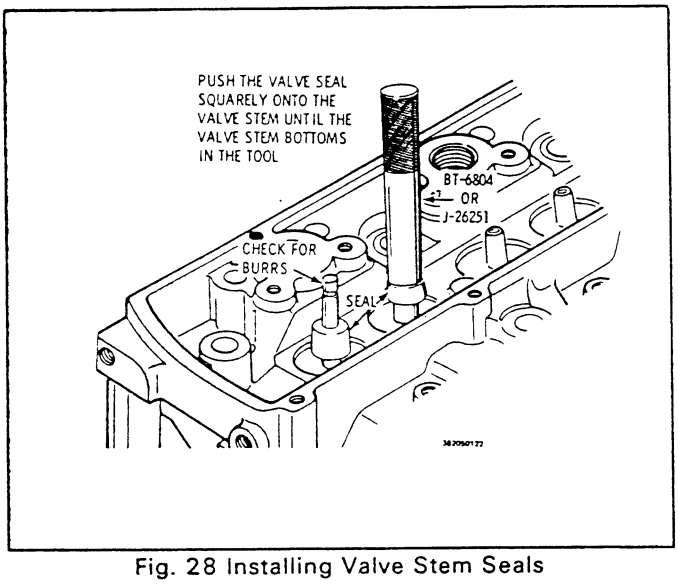


Fig. 28 Installing Valve Stem Seals

Install or Connect

1. Valve spring and rotator. Compress valve spring with tool BT-6413 or J-26220 until the valve keys can be installed.

   Inspect

   - Valve keyes are properly seated
   - Valve stem seals for cracks

2. Rocker arm assemblies
3. Bleed valve lifters.
4. Valve cover

OIL PAN DRAIN SCREW GASKET

Refer to Fig. 29 for the correct installation of a new gasket.

OIL PAN

Remove or Disconnect

Tool Required:
BT-6501 Engine Support

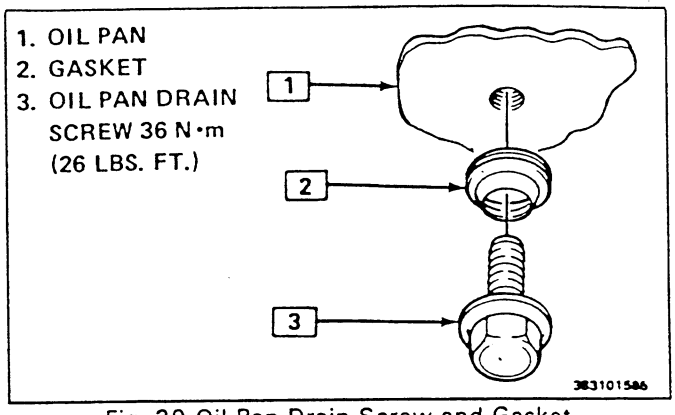


Fig. 29 Oil Pan Drain Screw and Gasket

1. Negative battery cable(s)
2. Fluid Level Indicator
3. Upper radiator support and fan shroud attaching screws
4. Raise and support car. See "CAUTION" on page 6A6-1.
5. Drain engine oil.
6. Flywheel cover
7. Exhaust and crossover pipes
8. Oil cooler lines at filter adapter
9. Starter
10. Mounts from engine block
11. Install engine support BT-6501 and raise engine (Fig. 30).

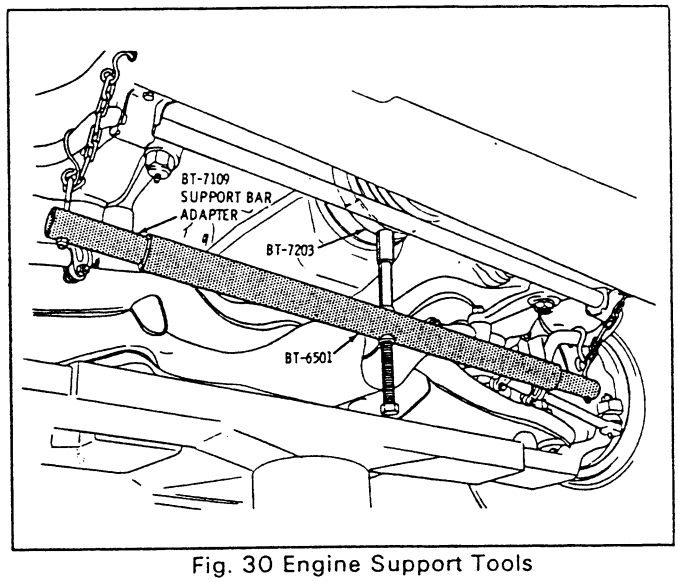


Fig. 30 Engine Support Tools

12. Oil pan

Install or Connect

1. Apply 1050026 sealer or equivalent to both sides of pan gaskets and install on block. Be certain that the tabs on the gaskets are installed in the notches of the seals. (Fig. 31)
2. Apply 1052915, 22521437, G.E. 1673 R.T.V. sealer or equivalent on the front cover oil pan seal retainer (Fig. 32).

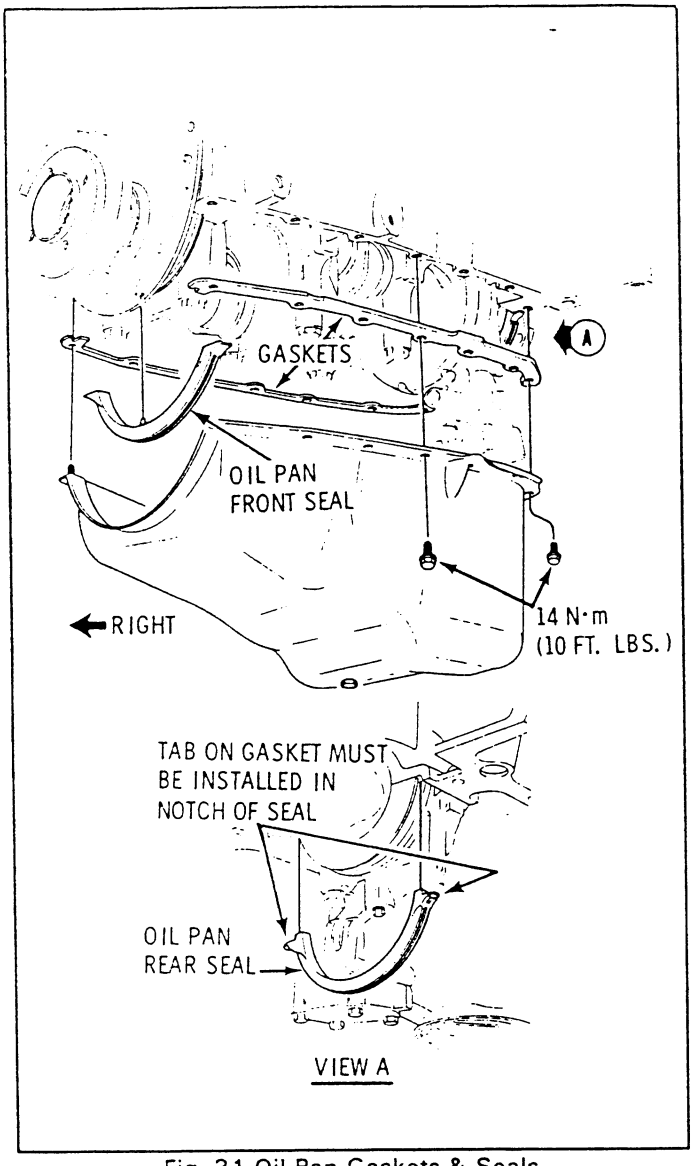


Fig. 31 Oil Pan Gaskets & Seals

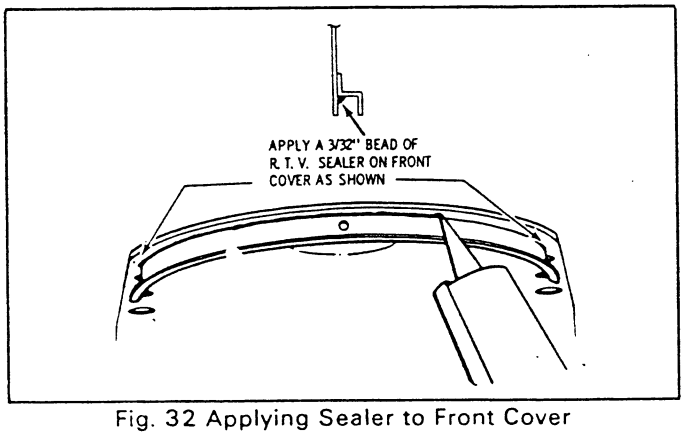


Fig. 32 Applying Sealer to Front Cover

3. Front and rear seals (rubber). Apply 1052915, 22521437, G.E. 1673 R.T.V. sealer or equivalent to each end of the seal where it contacts the cylinder block.
4. Wipe the seal area of the oil pan with engine oil, then install the pan. Torque bolts to 14 N·m (10 lbs. ft.).
5. Lower engine and remove support fixture.
6. Mount to engine block bolts and torque to specification.
7. Starter
8. Oil cooler lines at filter adapter
9. Exhaust and crossover pipes
10. Flywheel cover
11. Lower car.
12. Upper radiator support and fan shroud attaching screws
13. Fluid Level Indicator
14. Negative battery cable(s)
15. Fill crankcase.

Inspect

- For leaks

OIL PUMP

Fig. 33

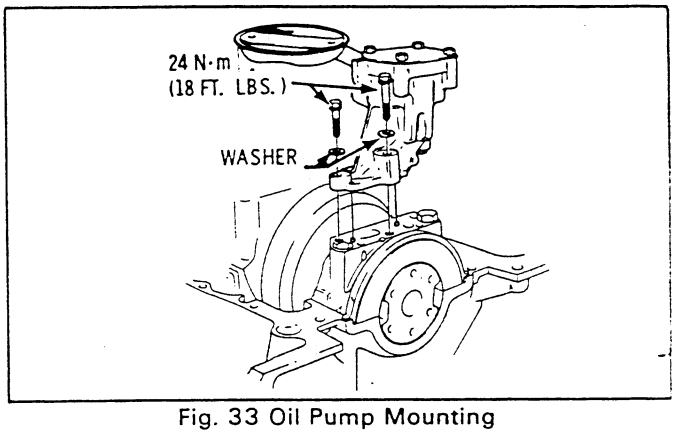


Fig. 33 Oil Pump Mounting

Remove or Disconnect

1. Oil pan
2. Oil pump to rear main bearing cap attaching bolts, then remove the pump and drive shaft extension.

Install or Connect

1. Insert the drive shaft extension through the opening in the main bearing cap and block until the shaft mates into the oil pump drive gear.
2. Position the pump onto the rear main bearing cap and install the attaching bolts. Torque bolts to 24 N·m (18 lbs. ft.).
3. Oil pan

OIL PUMP DRIVE AND DRIVE SHAFT EXTENSION

The oil pump drive is serviced as an assembly with the exception of the drive to block seal. The oil pump drive shaft extension can be removed after the oil pump drive assembly is removed (Fig. 34).

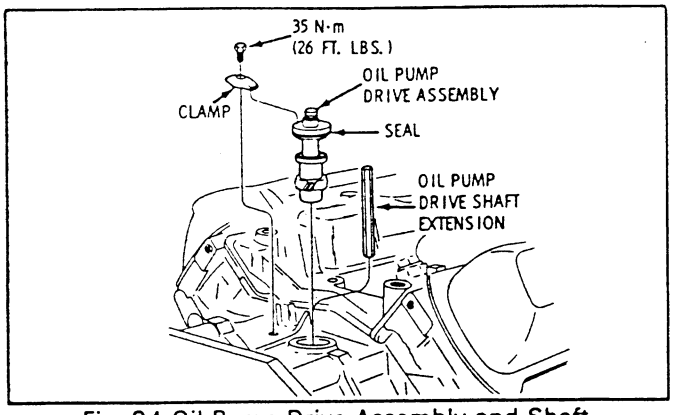


Fig. 34 Oil Pump Drive Assembly and Shaft

Important

- Remove the oil pump drive assembly carefully so that the oil pump drive shaft extension does not become disengaged and falls into the oil pan.

CONNECTING ROD AND PISTON

Fig. 35 and 36

Tool Required
J-8037

Remove or Disconnect

1. Cylinder Head
2. Oil Pan

Important

- Mark Connecting Rod and Cap

3. Connecting Rod Nuts
4. Connecting Rod Cap
5. Install Guide Hose on Connecting Rod Bolts (Fig. 35)

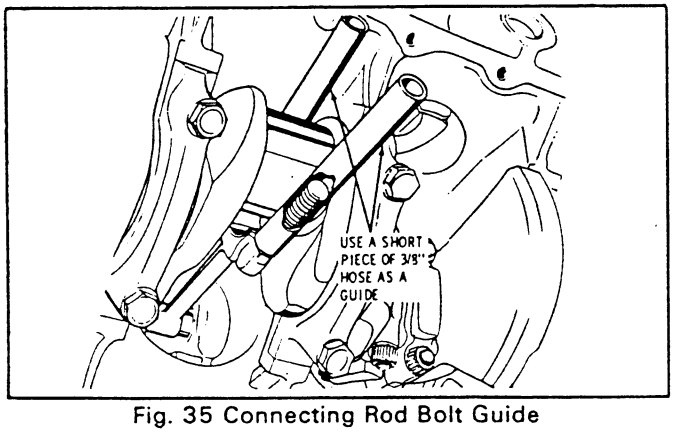


Fig. 35 Connecting Rod Bolt Guide

6. Piston and Connecting Rod Assembly

Inspect

- Cylinder Bore
- Crankshaft Journal

For inspection, fitting of piston, rings and connecting rod bearings, refer to Section 6A, General Engine Mechanical.

Install or Connect

1. Piston and Connecting Rod Assembly, (Fig. 36).

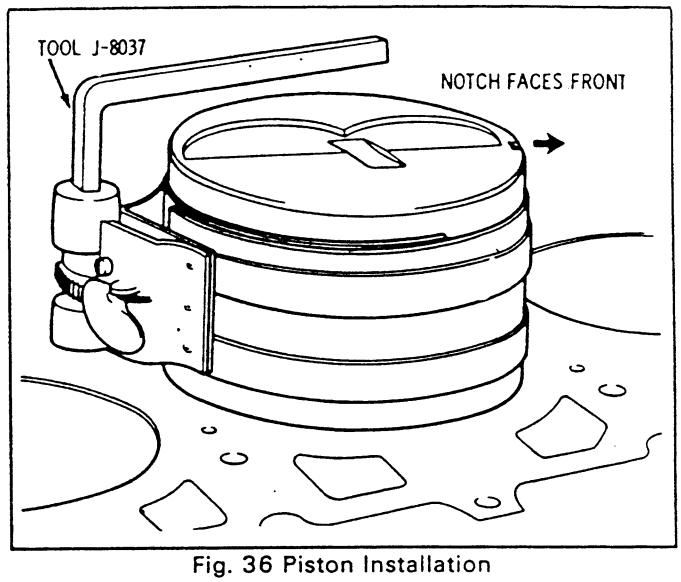


Fig. 36 Piston Installation

2. Rod Bearing Inserts
3. Connecting Rod Caps
4. Connecting Rod Nuts

Tighten

- Connecting Rod Nuts Alternately to 57 N·m (42 lbs.-ft.)

5. Oil Pan
6. Cylinder Head

Inspect

- For correct completion of repair
- For proper oil pressure
- For leaks

CRANKSHAFT PULLEY ASSEMBLY

Fig. 37 and 38

If a crankshaft pulley assembly is suspected of having internal slippage, it can be checked "On Car" by inspecting the position of the attaching bolts. The bolts should be centered between the spokes.

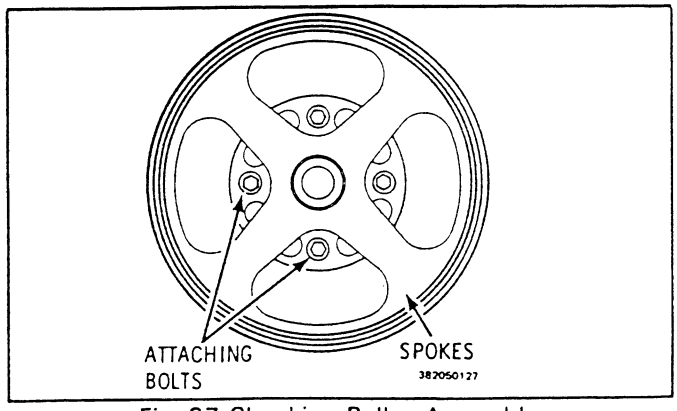


Fig. 37 Checking Pulley Assembly

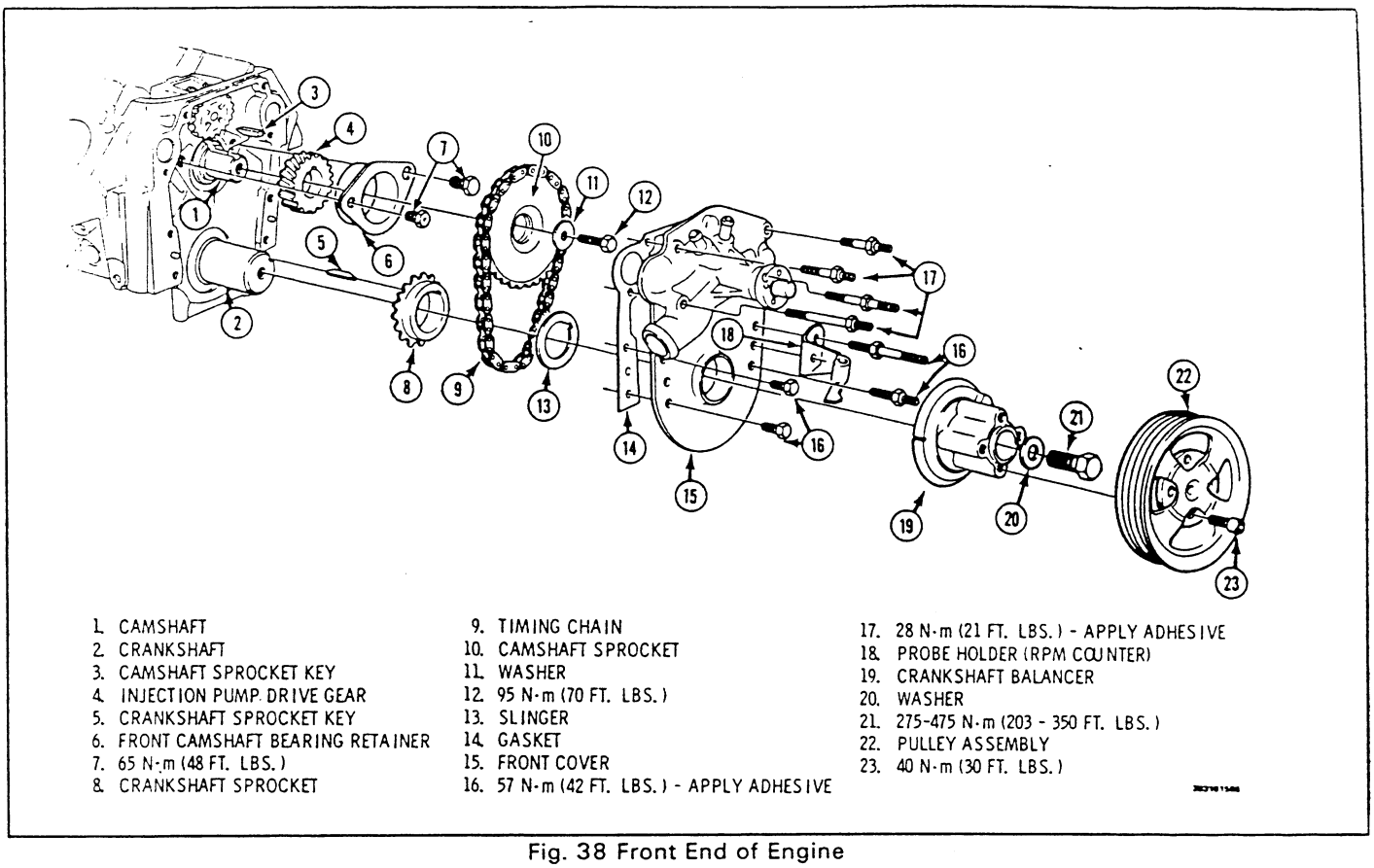


Fig. 38 Front End of Engine

Remove or Disconnect

1. Serpentine belt
2. Pulley assembly

Install or Connect

1. Pulley assembly torque bolts to 40 N·m (29 lbs. ft.).
2. Serpentine belt

CRANKSHAFT BALANCER (HUB)

Fig. 38 and 39

Remove or Disconnect

1. Pulley assembly
2. Balancer. If necessary, use a General Purpose Puller.

Install or Connect

1. Apply 1050026 sealer equivalent to inside diameter of pulley hub and to crankshaft key.
2. Coat outside sealing area of pulley hub with 1050169 lubricant or equivalent.
3. Balancer. If it will not slip on with hand pressure, remove burrs on balancer, key or crankshaft and lightly tap into place with a rawhide hammer. Torque bolt to 275 - 475 N·m (203 - 350 lbs. ft.)
4. Pulley assembly.
5. Serpentine belt.

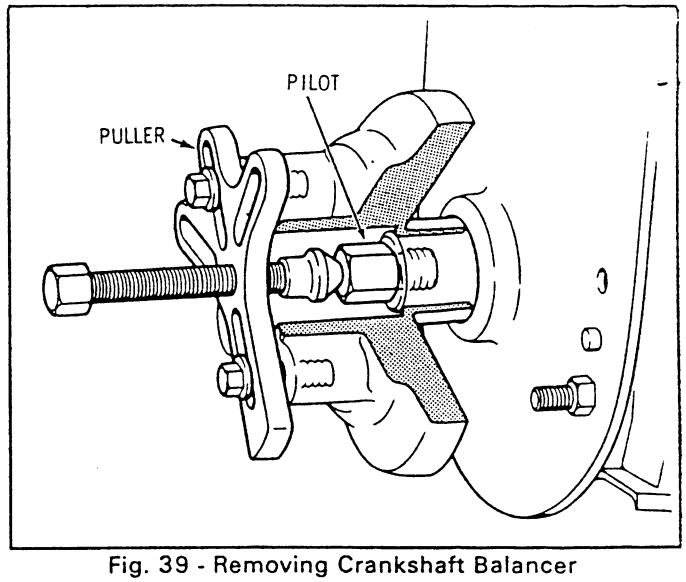


Fig. 39 - Removing Crankshaft Balancer

FRONT COVER

Fig. 38 through 44

Remove or Disconnect

1. Drain cooling system.
2. Radiator hoses
3. Heater hoses
4. Cooling fan and fan clutch
5. Water pump pulley
6. Generator brackets

7. (Air conditioning) A/C compressor
8. Power steering pump
9. Vacuum pump
10. Belt tensioner
11. Front cover to block bolts and probe holder (RPM counter)
12. Front cover and both dowel pins. It may be necessary to grind a flat on the pins to get a rough surface for gripping.

Clean

- With solvent, clean mating surfaces:
  - Engine block
  - Oil pan
  - Front cover

Install or Connect

1. Grind a chamfer on one end of each dowel pin (Fig. 40).

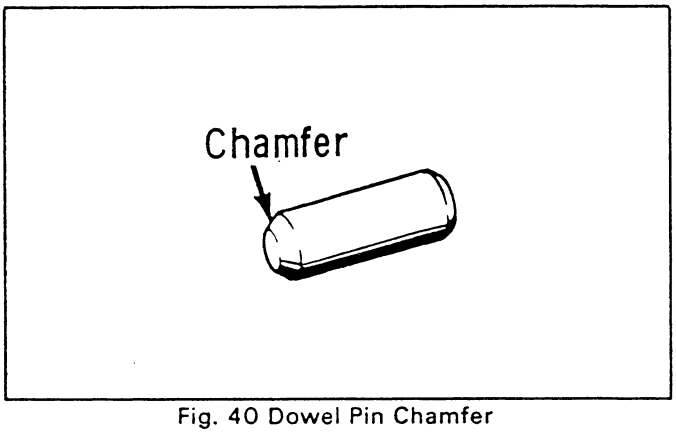


Fig. 40 Dowel Pin Chamfer

2. Cut excess material from front end of oil pan gasket on each side of engine block.
3. Trim about 3 mm (1/8") from each end of new front pan seal (Fig. 41).

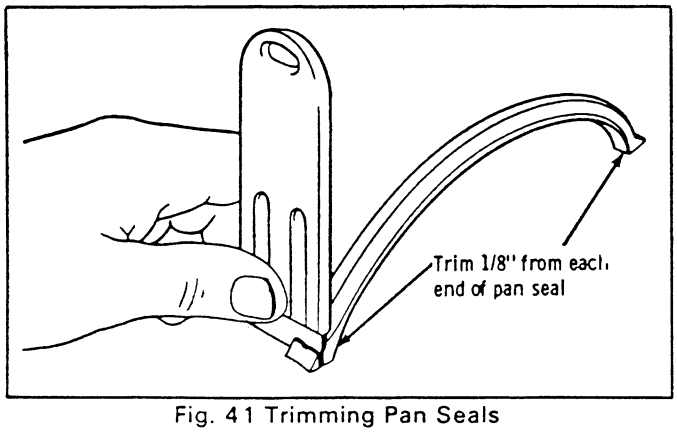


Fig. 41 Trimming Pan Seals

4. Apply 1052915, 22521437, G.E. 1673 R.T.V. sealer or equivalent on the front cover oil pan seal retainer (Fig. 42).

5. Install a new front cover gasket on the engine block and a new front seal on the front cover.

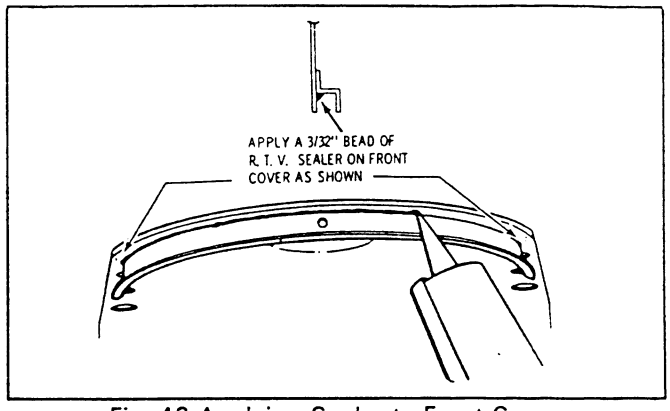


Fig. 42 Applying Sealer to Front Cover

Apply 1050026 sealer or equivalent to the gasket around coolant holes and place on block.

6. Apply 1052915, 22521437, G.E. 1673 R.T.V. sealer or equivalent at junction of block, pan and frontcover (Fig. 43).

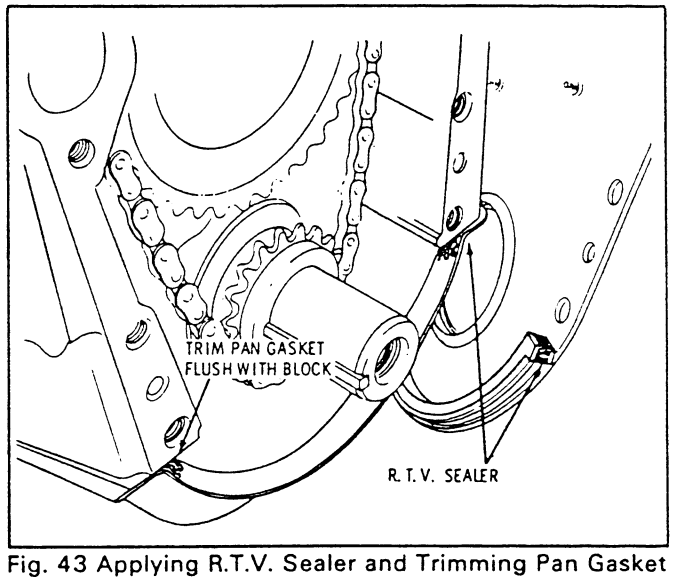


Fig. 43 Applying R.T.V. Sealer and Trimming Pan Gasket

7. Apply 1052624 primer and adhesive kit or equivalent to front cover bolt threads (#16 and 17, Fig. 38).
8. Place cover on front of block and press downward to compress seal. Rotate cover left and right and guide pan seal into cavity using a small screwdriver (Fig. 44).
9. Two bolts finger tight to hold cover in place.
10. Dowel pins, chamfered end first.
11. Probe holder and all front cover to block bolts. Torque bolts (Fig. 38).

NOTICE: The water pump and front cover to block bolts must be coated with 1052624 primer and adhesive or equivalent to avoid coolant leaks and loss of bolt torque.

12. Crankshaft balancer and pulley assembly.
13. Belt tensioner
14. Vacuum pump
15. Power steering pump

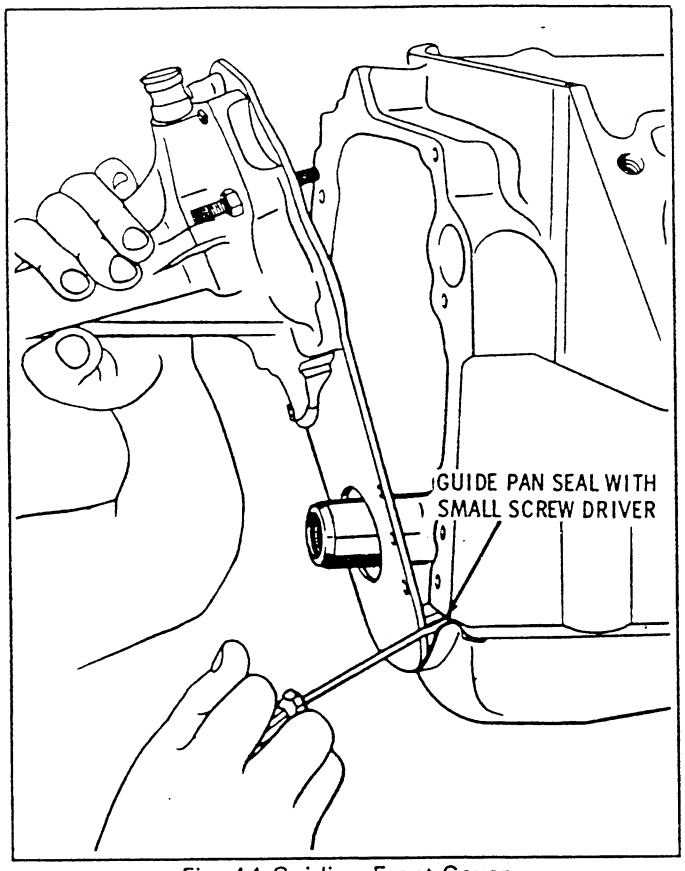


Fig. 44 Guiding Front Cover

16. (Air conditioning) A/C compressor
17. Generator brackets
18. Water pump pulley
19. Cooling fan and clutch
20. Heater hoses
21. Radiator hoses
22. Fill cooling system.

Inspect

- For leaks

FRONT COVER OIL SEAL

Front Cover Installed

Remove or Disconnect

Tools required:
BT-6406 or J-1859-03 and J-23129 oil seal remover
J-29659 oil seal installer

1. Crankshaft balancer.
2. Seal, with tool BT-6406 or J-1859-03 and J-23129 (Fig. 45).

Inspect

- Remove the burrs on the front cover with a tapered reamer or bearing scraper so that when the seal is installed the seal's outside diameter is not scratched and also to form a chamfer at the opening so that the seal will enter the front cover square.

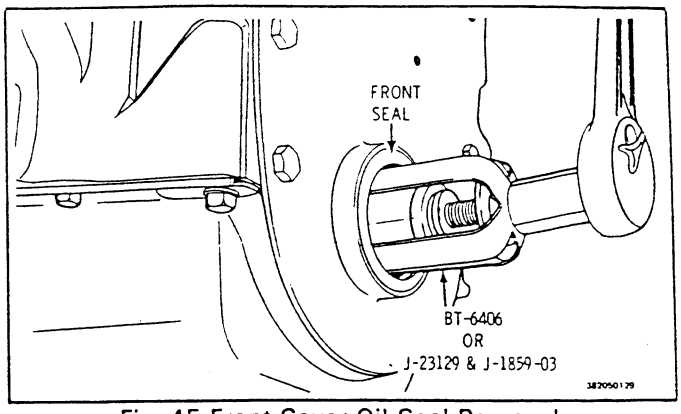


Fig. 45 Front Cover Oil Seal Removal

Install or Connect

1. Apply 1050026 sealer or equivalent to outside diameter of the seal.
2. Using tool J-29659 (with the crankshaft balancer bolt and washer), install the seal **squarely** until strong resistance is felt (Fig. 46). The tool will touch the front cover when the seal is correctly installed.

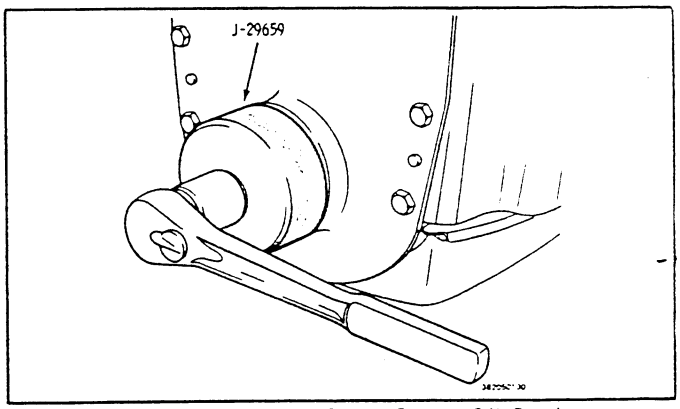


Fig. 46 Installing Front Cover Oil Seal

3. Crankshaft balancer
4. Pulley assembly
5. Serpentine belt

Inspect

- Leaks

TIMING CHAIN AND SPROCKETS

Remove or Disconnect

With Front Cover Removed

Fig. 47

1. Loosen all rocker arm pivot bolts evenly.
2. Crankshaft oil slinger
3. Camshaft sprocket and timing chain
4. Crankshaft sprocket

If the crankshaft sprocket should be a tight fit on the crankshaft, use the tools shown in Fig. 47 to free the sprocket.

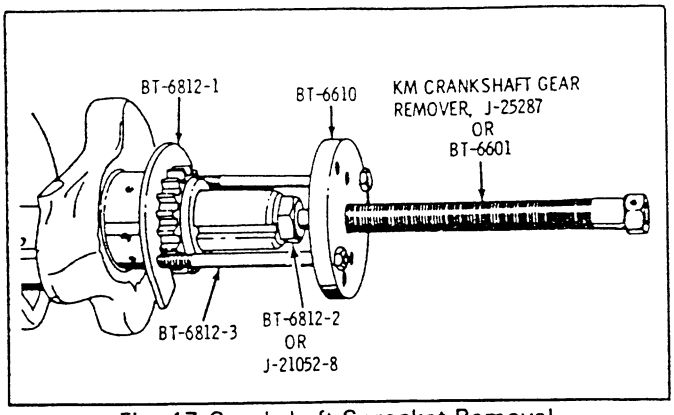


Fig. 47 Crankshaft Sprocket Removal

Install or Connect

1. If the camshaft sprocket key has been removed:
   a. Remove front camshaft bearing retainer.
   b. Install key into the injection pump drive gear.
   c. Assemble bearing retainer and bolts loose on the block.
   d. Install camshaft sprocket.
   e. Rotate camshaft at least 4 turns to center the retainer.
   f. Torque bearing retainer bolts evenly to 65 N·m (48 lbs. ft.).
   g. Remove the camshaft sprocket.

Important

- Rotate the camshaft to be sure it is free, if not repeat steps c through g

2. Crankshaft sprocket key.

Assemble

- On a flat surface, place camshaft and crankshaft sprockets into the timing chain with timing marks aligned (Fig. 49).
- Grasp both sprockets and timing chain.
- Slip crankshaft sprocket onto crankshaft nose and engage key in the sprocket.
- Rotate crankshaft until camshaft sprocket is properly aligned for mounting on the camshaft. Torque camshaft sprocket bolt to 95 N·m (70 lbs. ft.).

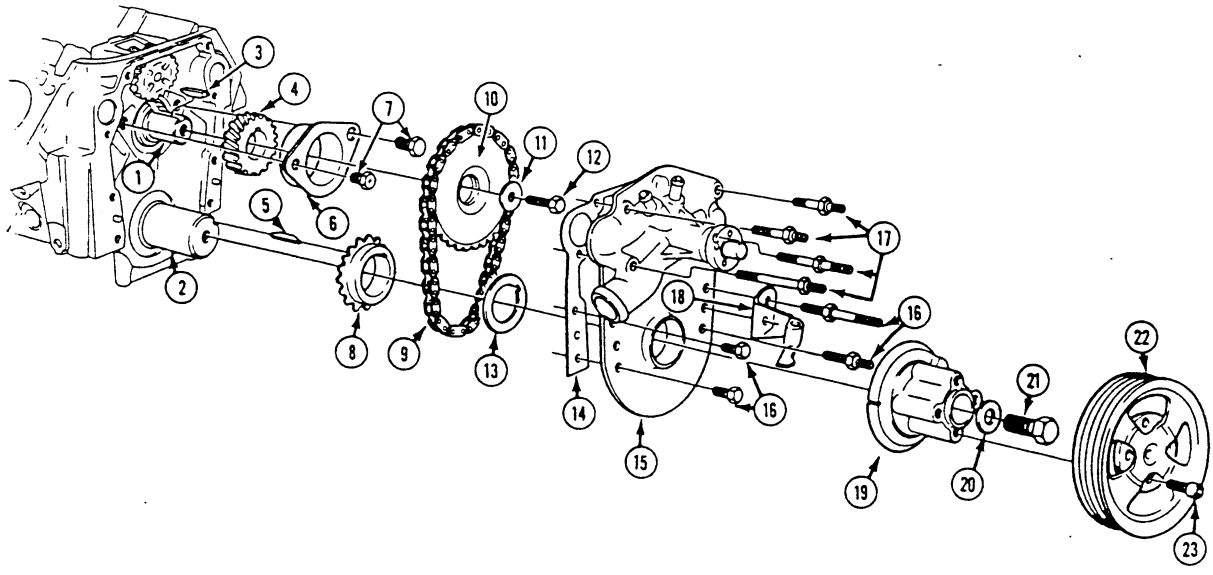
Inspect

- Rotate crankshaft until timing marks are lined up.
- Check timing mark alignment.

Install or Connect

1. Oil slinger
2. Front cover
3. Bleed down valve lifters.
4. Valve covers

Inspect



1. CAMSHAFT
2. CRANKSHAFT
3. CAMSHAFT SPROCKET KEY
4. INJECTION PUMP DRIVE GEAR
5. CRANKSHAFT SPROCKET KEY
6. FRONT CAMSHAFT BEARING RETAINER
7. 65 N·m (48 FT. LBS.)
8. CRANKSHAFT SPROCKET
9. TIMING CHAIN
10. CAMSHAFT SPROCKET
11. WASHER
12. 95 N·m (70 FT. LBS.)
13. SLINGER
14. GASKET
15. FRONT COVER
16. 57 N·m (42 FT. LBS.) - APPLY ADHESIVE
17. 28 N·m (21 FT. LBS.) - APPLY ADHESIVE
18. PROBE HOLDER (RPM COUNTER)
19. CRANKSHAFT BALANCER
20. WASHER
21. 275-475 N·m (203 - 350 FT. LBS.)
22. PULLEY ASSEMBLY
23. 40 N·m (30 FT. LBS.)

Fig. 48 - Front End of Engine

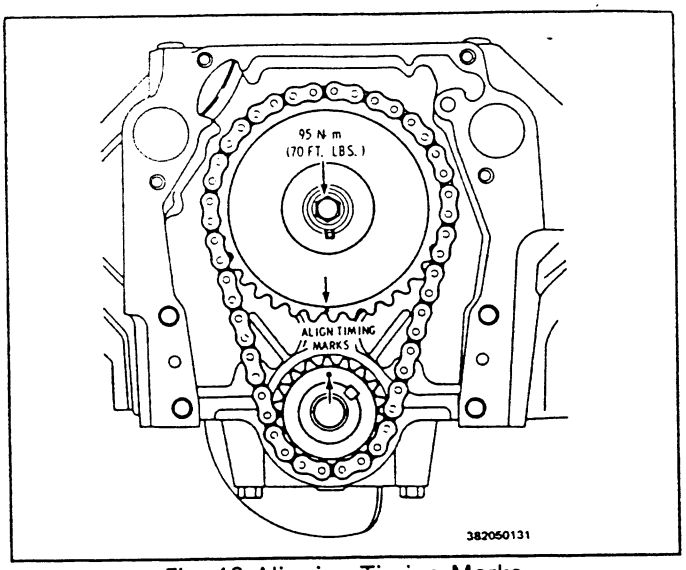


Fig. 49 Aligning Timing Marks

- Injection pump timing - See Section 6C5.

INJECTION PUMP DRIVE AND DRIVEN GEARS

(Timing chain, camshaft sprocket key and front camshaft bearing retainer removed.)

Remove or Disconnect

1. Injection Pump -See Section 6C5.
2. Intermediate pump adapter
3. Pump adapter
4. Snap ring and selective washer
5. Injection pump drive and driven gears and spring (Fig. 50)

Important

- If either the pump drive or driven gears are to be replaced, replace both gears.
- Make certain the marks (o) are in alignment on both gears before inserting the cam gear key.

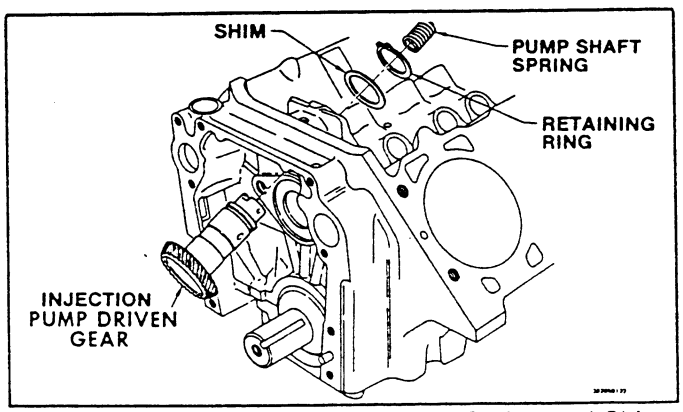


Fig. 50 - Injection Pump Driven Gear, Spring and Shim

Install or Connect

1. Lubricate camshaft and bearings liberally with 1052365 or equivalent.
2. Injection pump driven gear with spring, shim and snap ring

Measure

- Gear end play. If not within .05 - .15 mm (.002" to .006"), select an appropriate shim to obtain the clearance. (Fig. 50)
- Shims are available from 2.03 - 2.92 mm (.080" to .115") in .076 mm (.003") increments.

Injection Pump Driven Gear Bearing Bushings (Driven Gear Removed)

Remove or Disconnect

Tools Required:

J-28439-1 Bushing Remover/Installer

J-8092 Driver Handle

- Drive both bushings out together rear to front of engine using tool J-28439-1 with handle J-8092.

Install or Connect

1. Align the holes in the bushings with the holes in the block.
2. Rear bushing, using the long end of tool J-28439-1.
3. Front bushing with the short end of J-28439-1.

CAMSHAFT

Remove or Disconnect

1. Negative battery cable
2. Radiator fan shroud
3. Radiator
4. Intake manifold
5. Oil pump drive
6. Front cover
7. Rotate the crankshaft and align timing marks (Fig. 49).
8. Valve mechanism

Important

- Store valve mechanism components and valve lifters so that they can be re-installed in their original position.

9. Valve lifters
10. Timing chain and sprockets (Fig. 48)
11. Front camshaft bearing retainer
12. Camshaft sprocket key
13. Injection pump drive gear (Fig. 50)
14. Install a suitable bolt into the camshaft and carefully slide the camshaft out of the block. Refer to 6A General Mechanical Section.

NOTICE: Support the camshaft to avoid damage to camshaft bearings.

Install or Connect

1. Lubricate camshaft and bearings with 1052365 lubricant or equivalent.
2. Camshaft, using a suitable bolt threaded into the front of the camshaft for support.
3. Injection pump drive and driven gears
4. Front camshaft bearing retainer and bolts loosely in the block.
   a. Install the camshaft sprocket and key.
   b. Rotate the camshaft at least 4 turns to center the retainer.
   c. Torque the retainer bolts evenly to 65 N·m (48 lbs. ft.).
   d. Remove the camshaft sprocket.

Important

- Rotate camshaft to be sure it is free if not, repeat steps 4b through 4d.

5. Timing chain and sprockets

Inspect

- Timing mark alignment

6. Front cover
7. Crankshaft balancer and pulley
8. Valve lifters
9. Valve Mechanism

NOTICE: Bleed valve lifters to avoid damage to the engine.

10. Oil pump drive
11. Intake manifold
12. Radiator and fan shroud
13. Fill cooling system

Inspect

- Injection pump timing
- For leaks

CAMSHAFT AND OIL GALLERY PLUGS

Fig. 51 and 52

Rear Camshaft Plug

Remove or Disconnect

1. Transmission
2. Flywheel
3. Punch a hole in the center of the plug. Make the size of the hole just large enough to install the sheet-metal screw that is attached to a "dent-puller."
4. Remove the plug using the "dent-puller."

Clean

- Metal particles.
- Traces of old sealer.

NOTICE: Failure to remove the metal particles will result in engine damage.

Install or Connect

1. Apply 1050026 sealer or equivalent.
2. Drive the plug into the block until flush or .5 mm (.020") concave.
3. Flywheel
4. Transmission

Rear Oil Galley Plugs

The rear oil galley plugs are shown in Fig. 52. Both the pipe plugs and cup plug must be coated with sealer 1050026 or equivalent. Install the cup plug until it is flush or within .5 mm (.020"). Pipe plugs must be fully driven, seated and not stripped. Road test the car and inspect for leaks.

REAR MAIN BEARING UPPER OIL SEAL (ENGINE IN CAR)

Fig. 53 and 54

Remove or Disconnect

Tools Required:
BT-6433 or J-29368 Packing Tool
BT-8407 or J-34749 Seal Installer
BT-6436 Oil Seal Trimmer

1. Oil pan
2. Rear main bearing cap

Assemble

1. With Packing Tool BT-6433 or J-29368, drive both sides of the old seal gently into the groove until it is packed tight (Fig. 53).
2. Measure the amount the seal was driven up on one side; add 1/16", then cut this length from the old seal removed from the main bearing cap with a single edge razor blade. Measure the amount the seal was driven up on the other side. Add 1/16" and cut another length from old seal. Use main bearing cap as a holding fixture when cutting seal (Fig. 54).
3. Place a drop of 1050026 sealer or equivalent, on each end of seal and cap.
4. Work these two pieces of seal into the cylinder block (one piece on each side) with two small screwdrivers. Using Packing Tool, pack these short pieces up into the block and trim seal flush with block using BT-6436 or a sharp blade.

Place a piece of shim stock between seal and crankshaft to protect bearing surface before trimming.

5. Form a new rope seal in the rear main bearing cap. See Section 6A, General Engine Mechanical.
6. Install main bearing cap.

NOTICE: Do not use attaching bolts to pull down the bearing cap. Tap gently into place with a suitable tool. Refer to section 6A General Engine Mechanical.

Inspect

- Leaks

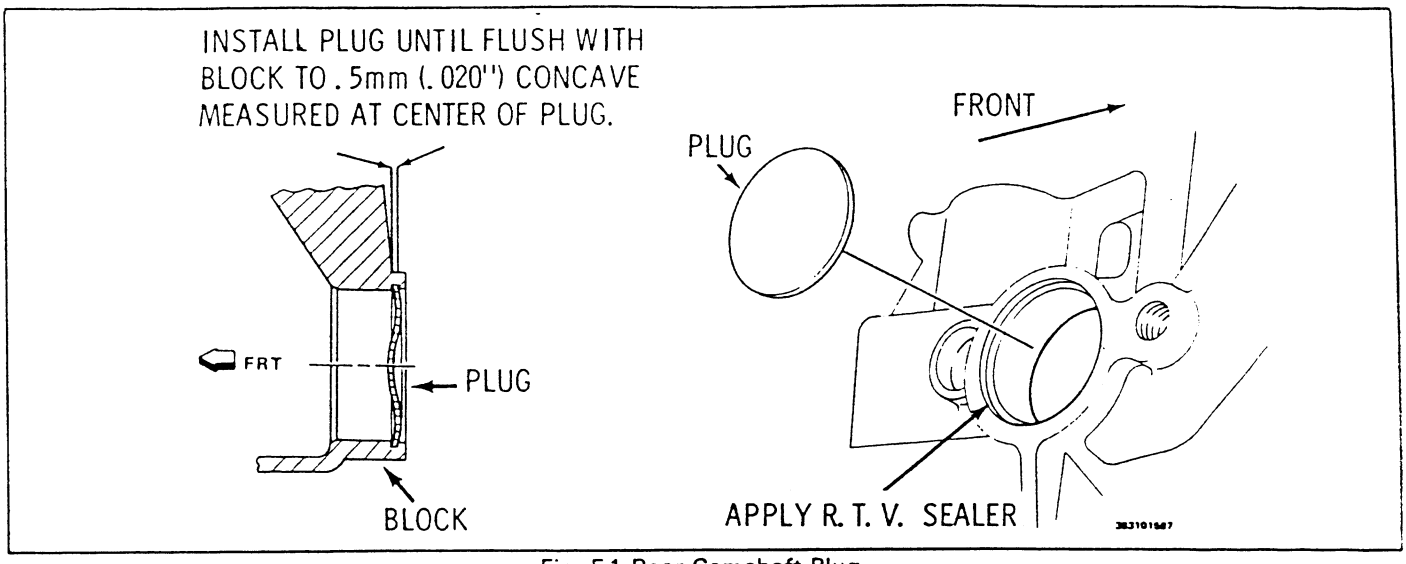


Fig. 51 Rear Camshaft Plug

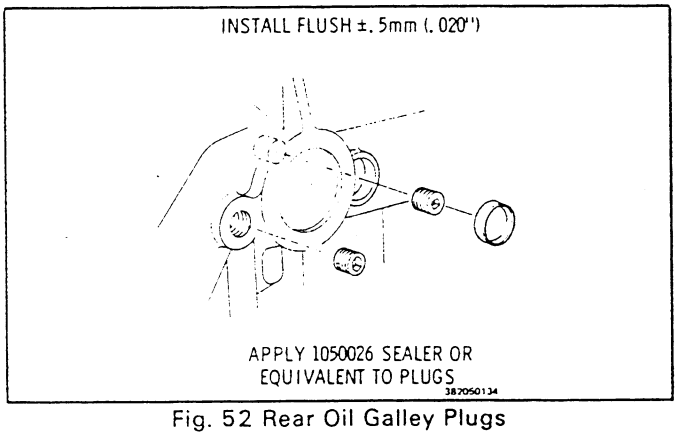


Fig. 52 Rear Oil Galley Plugs

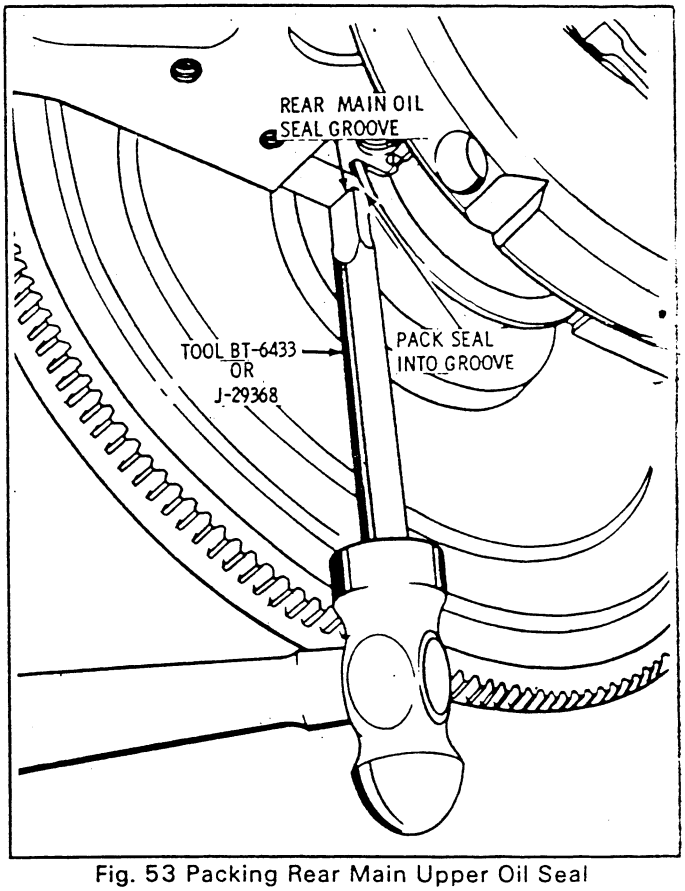


Fig. 53 Packing Rear Main Upper Oil Seal

FLYWHEEL

Fig. 55

One bolt in the flywheel is offset and the flywheel will attach to the crankshaft in only one position. The flywheel ring gear is not replaceable.

CRANKSHAFT

Refer to Section 6A General Engine Mechanical.

Important

When installing cap bolts at #2 or #3 main bearing, it is normal for the bolt to tighten up slightly during the last few turns. The thread interference spreads the load.

Do not attempt to "CLEAN-UP" #2 or #3 main bearing cap block threads with a standard metric tap. The tap used, M12-1.76, is not a standard tap size.

Two different length main bearing cap-to-block bolts will be found. An engine will have only one length cap bolt, there is no mixing of bolt types. Bolt length is measured from the bottom of the bolt head to the end of the threaded part of the bolt.

One type of cap bolt is 100 mm (3 15/16") long. It is used on engines that have main bearing caps that have their location in the engine cast into the cap, 1.E., 2 = number two main bearing cap.

The other type of cap bolt is 110 mm (4 11/32") long. It is used on engines that have main bearing caps that have their location in the engine identified by the number of raised ribs cast into the cap.

Using a long bolt where a shorter length is required will cause the bolt to bottom out before the bolt is contacting the main bearing cap. Using a shorter main bearing cap bolt than required will reduce the amount of thread engagement. This will cause the block threads to strip.

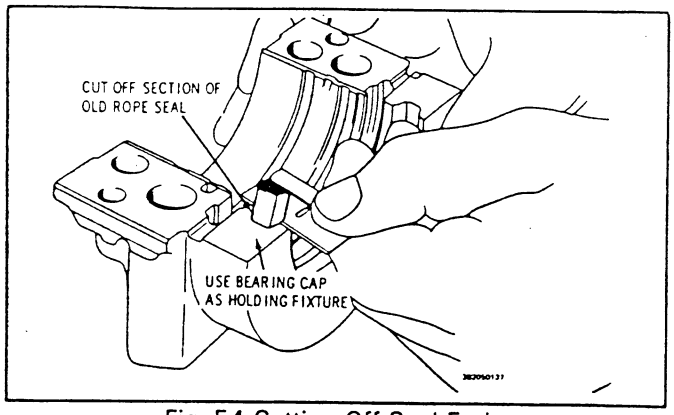


Fig. 54 Cutting Off Seal Ends

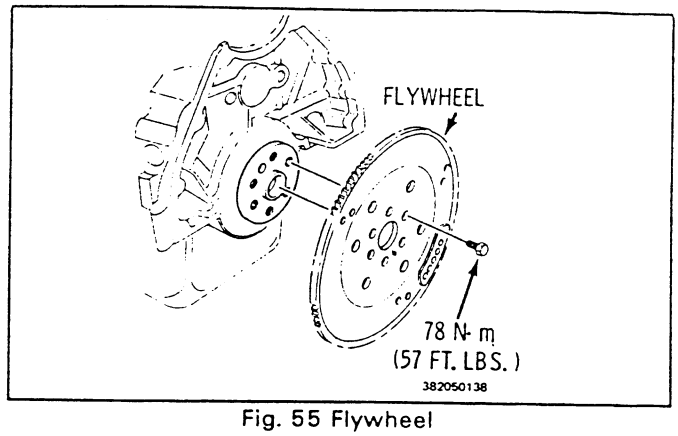


Fig. 55 Flywheel

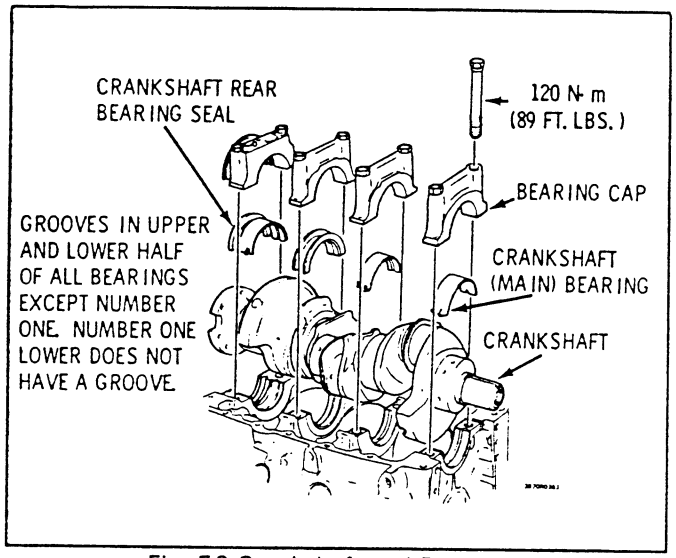


Fig. 56 Crankshaft and Bearings

TORQUE SPECIFICATIONS

NOTE: Specified torque is for installation of parts only. Checking of torque during inspection may be 10% below specification.

Application	N·m (Lbs. Ft.)
Air Crossover to Intake Manifold	38 - (28)
Camshaft Bearing Retainer Bolts	65 - (48)
Camshaft Sprocket to Camshaft Bolt	95 - (70)
Cylinder Head to Block Except No. 5, 6, 11, 12, 13 & 14	193 - (142)
No. 5, 6, 11, 12, 13 & 14	80 - (59)
Connecting Rod Cap Bolts	57 - (42)
Crankshaft (Main) Bearing Cap Bolts	120 - (89)
Crankshaft Balancer to Crankshaft Bolt	275-475 - (203 - 350)
Crankshaft Pulley to Balancer Bolts	40 - (30)
Crossover and Exhaust Pipe to Exhaust Manifold Bolts	31 - (23)
Exhaust Manifold to Cylinder Head Bolts	42 - (31)
Flywheel to Crankshaft Bolts - VIN V	78 - (57)
Flywheel to Torque Converter Bolts	47 - (35)
Front Cover to Cylinder Block Bolts - Apply 1052624 or Equivalent	57 - (42)
Fuel Pump Mounting Nut	24 - (18)
Glow Plug	21 - (15)
Injection Pump Adapter to Block Bolts	32 - (23)
Injection Pump Intermediate Adapter to Adapter Bolts	47 - (35)
Intake Manifold to Cylinder Head Bolts	55 - (41)

Mount (Engine) to Cylinder Block Bolts ..... 50 - (37)
Mount (Engine) to Frame Bolt Nuts ..... 52 - (38)
Mount (Engine) to Bracket through Bolt ..... 75 - (55)
Oil Cooler Lines to Oil Filter Adapter ..... 40 - (29)
Oil Cooler Lines to Radiator - VIN V ..... 40 - (30)
Oil Filter Adapter to Cylinder Block ..... 40 - (29)
Oil Filter Element to Base ..... 2/3 Turn after Gasket Contact
Oil Pan Drain Screw ..... 36 - (26)
Oil Pan to Block Bolts ..... 14 - (10)
Oil Pump Cover or Screen to Pump Body Screws ..... 10 - (7)
Oil Pump Drive Assembly Clamp Bolt ..... 35 - (26)
Oil Pump to Bearing Cap Bolts ..... 24 - (18)
Rocker Arm Pivot to Cylinder Head Bolts ..... 37 - (28)
Starter Brace to Cylinder Block Bolt ..... 27 - (20)
Starter Brace to Starter Stud ..... 25 - (18)
Starter Motor to Cylinder Block Bolts ..... 43 - (32)
Valve Cover to Cylinder Head Screws or Nuts- Fully Driven,
--Seated and Not Stripped
Water Outlet to Intake Manifold Bolts ..... 24 - (18)
Water Pump & Front Cover to Block Bolts
  Apply 1052624 or equivalent ..... 28 - (21)
Water Pump to Front Cover Screws
  Dip Screws in Sealer ..... 18 - (13)
Water Pump Hub Studs ..... 9 - (7)
Water Pump Pulley and Fan Clutch to Water Pump Hub Nuts ..... 27 - (20)

ENGINE SPECIFICATIONS

Cylinder Block

Engine Type ..... 90° V-Type
Number of Cylinders 6
Bore ..... 103.05 mm (4.057")
Stroke ..... 85.98 mm (3.385")
Piston Displacement ..... 4.3 Liter (262 C.I.D.)
Compression Ratio 22.5:1
Firing Order 1-6-5-4-3-2

Lubrication System

Crankcase Capacity, Drain and Refill
  Including Oil Filter ..... 5.6L (6 Qts.)
Oil Filter Type or Equivalent PF-51
Oil Pump
  Relief Valve Clearance in Body ..... .089 mm - .102 mm (.0025"-.0050")
  Gear End Clearance ..... .013 mm to .190 mm (.0005"-.0075")
  Gear Lash ..... .013 mm - .190 mm (.0005" - .0075")
  Gear Pocket
    Depth ..... 35.25 mm - 38.125 mm (1.50" 1.509")
    Diameter ..... 38.960 mm - 39.096 mm (1.534" - 1.539")
  Gear
    Length ..... 38.29 mm - 38.341 mm (1.575" - 1.5095")
    Diameter ..... 38.887 mm - 38.836 mm (1.529" - 1.531")
    Side Clearance ..... .04 mm - .12 mm (.0015" - .0045")

Crankshaft

Diameter - Main Bearing Journal	76.182 mm - 76.207 mm (2.9993"-3.0003")
Width - Main Thrust Bearing Journal, No. 3 with Fillets	30.442 mm - 30.518 mm (1.1985"-1.2015")
Diameter - Connecting Rod Bearing Journal	57.124 mm - 57.150 mm (2.2490"-2.250")
Width - Connecting Rod Bearing (with Fillets)	25.14 mm - 25.40 mm (.9897"-1.0)
Diameter - Oil Holes in Crankshaft	5.588 mm - 6.350 mm (.220-.250")
Clearance - Crankshaft End	.0871 mm - .3429 mm (.0035"-.0135")
Out of Round - Max.	.013 mm (.0005")

Main Bearings

Bearing Clearance	No. 1, 2 & 3 .013-.05 mm (.0005"-.002")
Bearing Clearance	No. 4 (Rear) .051-.086 mm (.0020"-.0034")
Width - Bearing Shell	
No. 1 & 2	24.638 mm - 24.892 mm (.970"-.980")
No. 3	30.302 mm - 30.353 mm (1.193-1.195)
No. 4	32.26 mm (1.27")

Connecting Rods

Length - Center to Center	149.4409 mm - 149.5425 mm (5.8835"-5.8875")
Diameter - Connecting Rod Bore	60.307 mm - 60.325 mm (2.3742"-2.375")
Diameter - Pin Bore (Finish Bore in Bushing)	27.825 mm - 27.845 mm (1.0954"-1.0962")
Bearing Clearance - (Vertical)	.013 mm - .063 mm (.0005" - .0025") max.
Side Clearance - Big End	.21 mm - 45 mm (.008"-.0215") max.

Piston

Diameter (Nominal Outside)	102.8954 mm (4.051")
Top of Piston to Center of Pin	44.958 mm (1.770")
Piston Pin Offset to Thrust Side	1.016 mm - 1.27 mm (.040" - .050")
Clearance to Bore (Selective)	.08 mm -.10 mm (.0035"-.0045")
Weight less Pin & Rings	793 to 798
Skirt Taper (Piston Pin Center Line to Bottom of Skirt) Larger at Bottom	.038 mm - .063 mm (.0015" - .0025")
Ring Groove Width (Top Compression)	2.1082 mm-2.1366 mm (.083"-.084")
Ring Groove Width (Lower Compression)	2.0574 mm - 2.0828 mm (.081"-.082")
Ring Groove Width (Oil)	4.790 mm - 4.8158 mm (.1886"-.1896")

Piston Pins

Diameter	27.81 mm - 27.82 mm (1.0949"-1.0952")
Pin to Piston Clearance	.008 mm - .013 mm (.0003"-.0005")
Pin to Rod Clearance	.008 mm - .033 mm (.0003"-.0013")

Piston Rings

Number of Compression Rings (Per Piston)	2
Width of Compression Rings	1.958 mm - 1.981 mm (.078"-.077")
Gap Clearance - Top Compression Ring	.4 mm - .6 mm (.019"-.027")
Gap Clearance - 2nd Compression Ring	.4 mm - .6 mm (.013"-.021")
Side Clearance in Groove, Compression Ring-Top	.12 mm - .18 mm (.005"-.007")
Side Clearance in Groove, Compression Ring-2nd	.08 mm - .13 mm (.003"-.005")
Number of Oil Rings (Per Piston)	1
Gap Clearance	.254 mm - .558 mm (.010"-.022")
Clearance in Groove, Oil Rings	.025 mm -.127 mm (.001"-.005")

Camshaft

Bearing Journal Diameters	
No. 2	51.219 mm - 51.199 (2.015" - 2.016")
No. 3	50.71 mm - 50.60 mm (1.996" - 1.995")
No. 4	50.20 mm - 50.18 mm (1.976" - 1.975")
Width (Including Chamfers)	
No. 1	17.74 mm (.688")
No. 2, 3 & 4	22.0 mm (.8661")
Journal Clearance in Bearing (All)	.05 mm - .15 mm (.0020"-.0059")
End Clearance	.02 mm - .58 mm (.0008"-.0228")
Lobe Lift	
Intake	6.401 mm (.252")
Exhaust	7.086 mm (.279")
Push Rod Length	196.0372 mm (7.718")

Valve Intake

Diameter Head	47.01 mm (1.875")
Diameter - Stem	8.6995 mm - 8.7376 mm (.3425" - .3432")
Angle - Valve Face	44°
Angle - Valve Seat	45°
Width - Valve Seat (Cylinder Head)	.91 mm - 1.87 mm (.036" - .076")
Overall Length	130.048 mm (5.120")
Clearance in Guide	.025 mm - .068 mm (.0010" - .0027")
Lash	Hydraulic

Valve Exhaust

Diameter - Head	41.275 mm (1.625")
Diameter - Stem	8.687 mm - 8.707 mm (.3420" - .3428")
Angle - Valve Face	30°
Angle - Valve Seat	31°
Width - Valve Seat (Cylinder Head)	1.17 mm - 2.13 mm (.045" - .085")
Overall Length	127.7366 mm (5.029")
Clearance In Guide	.038 mm - .081 mm (.0015" - .0032")
Lash	Hydraulic

Valve Springs

Length	53.086 mm (2.09")
Diameter - Wire	4.4958 mm (.177")
Inside Diameter	26.441 mm - 27.051 mm (1.065" - 1.041")
Load (Closed)	39 - 43N @ 42.4 mm (85 - 95 Lbs. @ 1.670")
Load (Open)	92 - 98N @ 31.0 mm (203 - 217 Lbs. @ 1.220")

Valve Lifters

Diameter - Body	23.39 mm - 23.41 mm (.920" - .922")
Length - Overall	68.73 mm (2.706")
Clearance in Boss	.0127 mm - .054 mm (.0005" - .002")
Also available in .010" Over Size	

Camshaft Sprocket

Pitch	12.70 mm (1/2")
No. of Teeth	36
Bearing Journal Diameter	51.707 mm - 51.727 mm (2.035" - 2.0364")

Crankshaft Sprocket

Pitch	12.70 mm (1/2")
No. of Teeth	18

Timing Chain

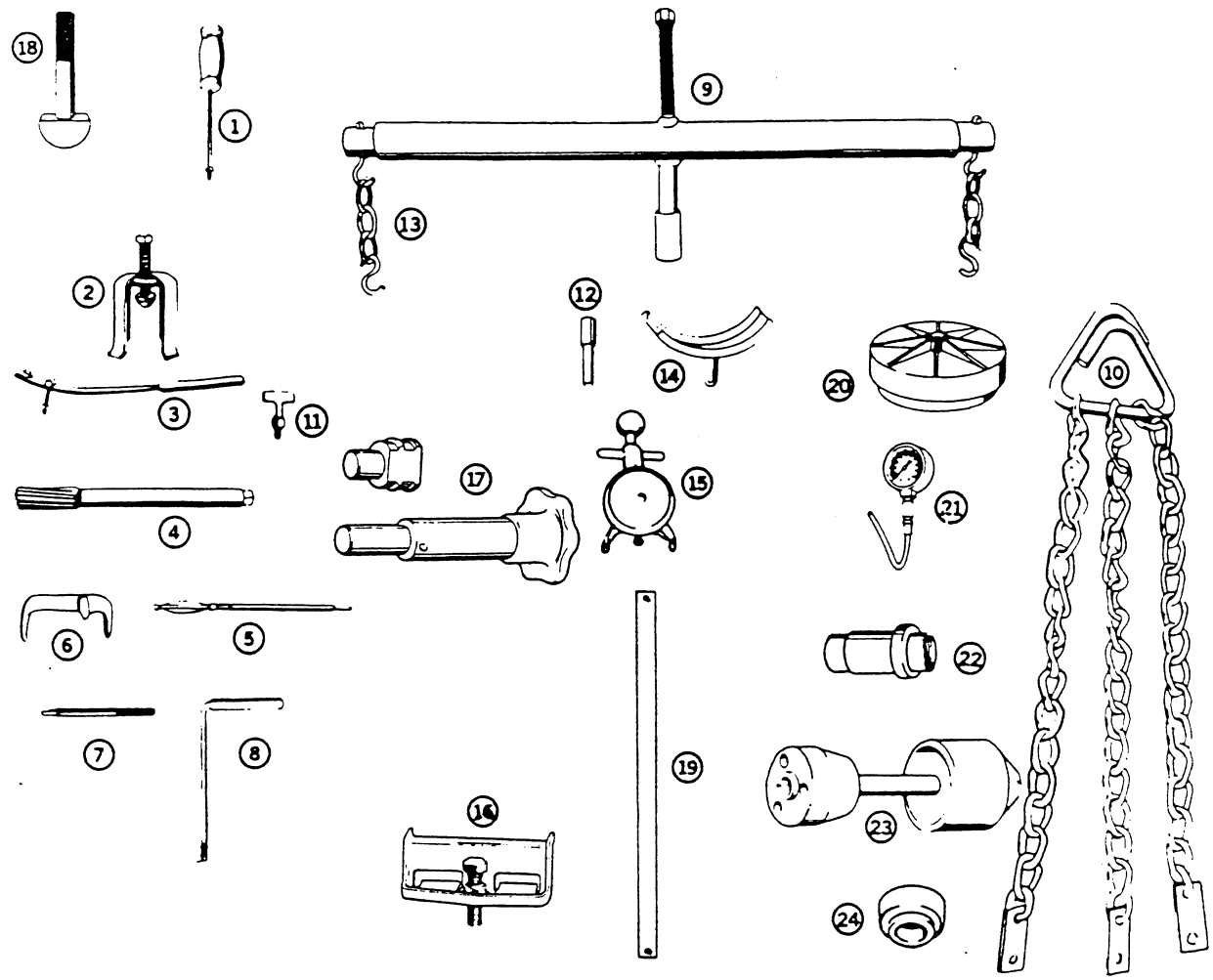
Width	14.50 mm (.570")
No. of Links	48
Pitch	12.70 mm (1/2")
Type	Roller

Flywheel

Number of Teeth on Flywhel Gear	166
Number of Teeth on Starter Gear	9

Serpentine Belt

Belt Length-New Belt without A/C	2490 mm $\pm$ 12.8mm (98.031" $\pm$ .053")
With A/C	2595 mm $\pm$ 12.8 mm (102.165" $\pm$ .503")



1.	BT-6125	SLIDE HAMMER
2.	BT-6406	FRONT COVER OIL SEAL REMOVER
3.	BT-6413 or J-26220	VALVE SPRING COMPRESSOR
4.	BT-6414 or J-5830	VALVE GUIDE REAMER
5.	BT-6415 or J-8108	VALVE GUIDE CLEANER
6.	BT-6328 or J-25289	VALVE STEM HEIGHT GAGE
7.	BT-6433 or J-29368	REAR MAIN OIL SEAL PUNCH
8.	BT-6436	REAR MAIN OIL SEAL TRIMMER
9.	BT-6501	ENGINE SUPPORT
10.	BT-6606	ENGINE LIFT CHAIN
11.	BT-6612	(USE WITH BT-6413) VALVE SPRING COMPRESSOR ADAPTER
12.	BT-6804 or J-26251	VALVE SEAL INSTALLER
13.	BT-7109	(USE WITH BT-6501) SUPPORT BAR ADAPTER
14.	BT-7203	(USE WITH BT-6501) YOKE
15.	BT-7825 or J-23600	BELT TENSION GAGE
16.	BT-8315 or J-34144	VALVE COVER SEAL BREAKER
17.	BT-8346 or J-34594	PISTON PIN RETAINER INSTALLER
18.	BT-8407 or J-34749 WITH J-8092	REAR MAIN SEAL INSTALLER
19.	J-21654	TORQUE CONVERTER HOLDING TOOL
20.	J-26996-1	AIR CROSSOVER COVER
21.	J-26999	COMPRESSION GAGE
22.	J-28439	PUMP DRIVE SHAFT BUSHING TOOLS
23.	J-28425	PUMP ADAPTER SEAL INSTALLER
24.	J-29659	FRONT COVER OIL SEAL INSTALLER

383101588

Tools are available from General Motors Dealers

Fig. 57 Tools - VIN V

SECTION 6C5

DIESEL FUEL INJECTION

ALL NEW GENERAL MOTORS CARS ARE CERTIFIED BY THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY AS CONFORMING TO THE REQUIREMENTS OF THE REGULATIONS FOR THE CONTROL OF AIR POLLUTION FROM NEW MOTOR VEHICLES. THIS CERTIFICATION IS CONTINGENT ON CERTAIN ADJUSTMENTS BEING SET TO FACTORY STANDARDS. THUS, THESE ADJUSTMENT POINTS EITHER HAVE BEEN PERMANENTLY SEALED AND/OR MADE INACCESSIBLE TO PREVENT INDISCRIMINATE ADJUSTMENT IN THE FIELD. FOR THIS REASON, THE FACTORY PROCEDURE FOR TEMPORARILY REMOVING PLUGS, CAPS, ETC., FOR THE PURPOSE OF SERVICING THE PRODUCT MUST BE STRICTLY FOLLOWED AND, WHEREVER PRACTICABLE, RETURNED TO THE ORIGINAL INTENT OF THE DESIGN.

NOTICE: DO NOT USE STARTING FLUIDS. SUCH AIDS CAN CAUSE IMMEDIATE ENGINE DAMAGE.

See the Electric Troubleshooting manual for more information.

CONTENTS

DESCRIPTION
- Fuel System 6C5-1
- Diesel Fuel Heater 6C5-2
- Checking and/or Adjusting Timing 6C5-2
- Throttle Linkage Adjustments 6C5-3
- Vacuum Regulator Valve Adjustment 6C5-4
- Vacuum Regulator Valve R&R 6C5-5
- Idle Speed Adjustments 6C5-5
- Housing Pressure Cold Advance 6C5-6
- Housing Pressure Altitude Advance 6C5-7
- Checking Injection Pump Housing Fuel Pressure 6C5-8
- Injection Pump Fuel Lines R&R 6C5-9
- Reducing Cranking Time 6C5-9
- Injection Pump R&R 6C5-9

INJECTION PUMP
- Fuel Flow 6C5-11

ON-CAR SERVICE:
- Injection Pump 6C5-12
- Pump Cover Seal and/or Guide Stud Seal R&R 6C5-12
- Throttle Shaft Seal R&R 6C5-13
- Solenoids R&R 6C5-15

OFF-CAR SERVICE:
- Timing Line Cover Gasket R&R 6C5-15
- Advance Pin Hole Plug Seal R&R 6C5-16
- Auto Advance Seals R&R 6C5-16
- Hydraulic Head Seal R&R 6C5-16
- Governor Weight Retainer Ring R & R 6C5-16
- Drive Shaft Seal R&R 6C5-17
- Pressure Testing 6C5-17

INJECTION NOZZLES
- Injection Nozzle R&R 6C5-17
- Injection Nozzle Testing 6C5-18
- Cleaning Poppet Nozzles 6C5-18

Torque Specifications 6C5-20

Tools 6C5-21

NOTICE: Disassembly, testing, inspection and reassembly of the components contained in this section requires the utmost cleanliness. All tools, equipment, work areas and parts must be extremely clean. Also, the technician's hands must be kept clean during any reassembly. Lint free wiping towels must be used. Fasteners are to be tightened using a torque wrench known to be accurate. Failure to follow this "Notice" could result in engine operational difficulties and/or damage.

FUEL SYSTEM

Fig. 6C5-1 and Fig. 6C5-2

The diesel fuel injection pump is mounted on top of the engine. It is gear driven off the camshaft and turns at camshaft speed. It is a high pressure rotary pump that injects a metered amount of fuel to each cylinder at the proper time. The six or eight high pressure delivery pipes from the pump to the injection nozzle in each cylinder are the same length to prevent any difference in timing, cylinder-to-cylinder. The fuel injection pump provides the required timing advance under all operating conditions. Engine RPM (car speed) is controlled by a rotary fuel metering valve. Pushing down on the accelerator pedal moves the throttle cable to open the metering valve and allow more fuel to be delivered. The injection pump also has a low pressure transfer pump to deliver fuel from the fuel line to the high pressure pump.

The fuel filter is located between the electric (V6) or mechanical (V8) fuel pump and the injection pump. The V8 diaphragm type mechanical fuel pump is mounted on the right side of the engine and driven by an eccentric on the crankshaft.

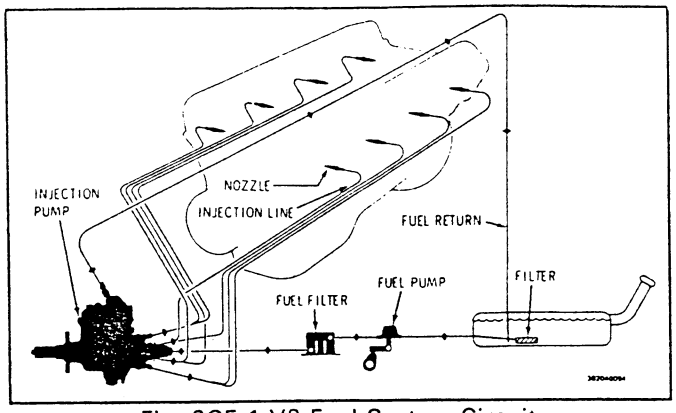


Fig. 6C5-1 V8 Fuel System Circuit

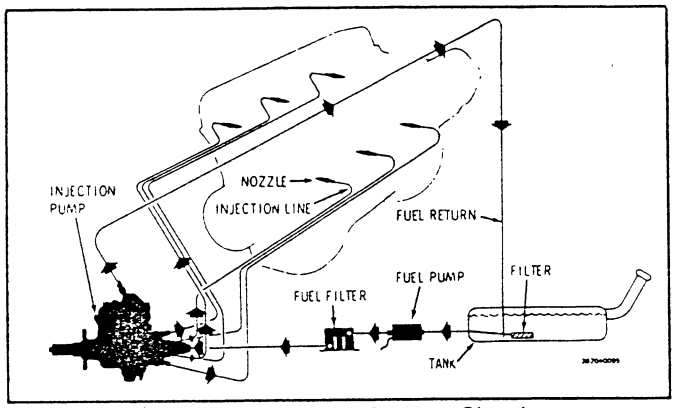


Fig. 6C5-2 V6 Fuel System Circuit

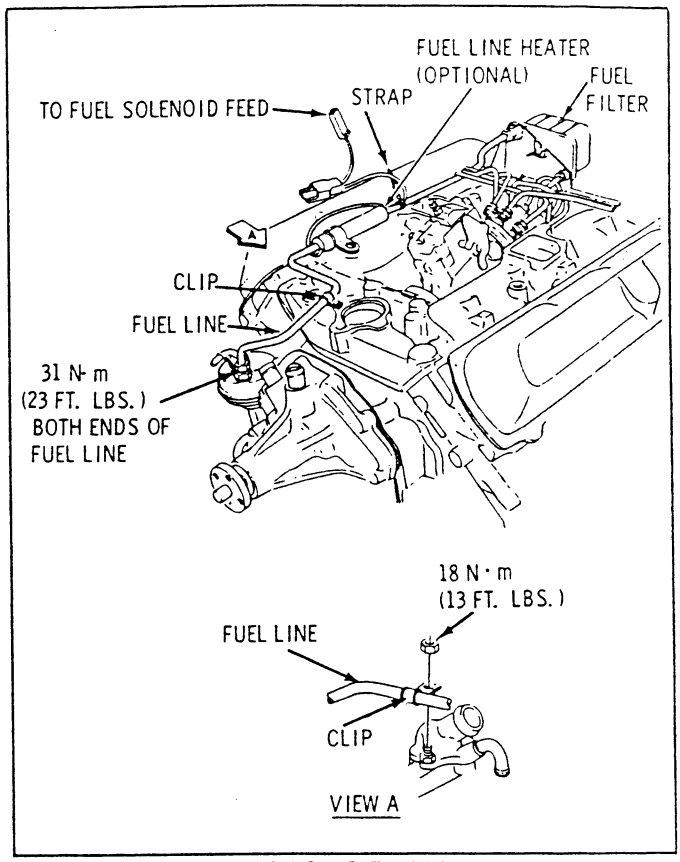


Fig. 6C5-3 V8 Fuel Lines

The V6 uses an electric fuel pump mounted on the engine. For diagnosis of either pump see Section 6C.

The fuel tank is at the rear of the car, connected by fuel pipes and hoses to the fuel pump. Excess fuel returns from the fuel injection pump to the fuel tank through pipes and hoses.

DIESEL FUEL HEATER, OPTION K07

Figs. 6C5-3, 6C5-4 and 6C5-5

This cold weather option consists of an inline diesel fuel heater and an engine coolant heater.

The diesel fuel heater is a thermostatically controlled electrical resistance type heater designed to heat the fuel before it enters the engine mounted fuel filter to reduce the possibility of wax plugging the filter when the fuel temperature is –6° C (20° F) or lower.

Twelve volts are directed to the heater whenever the ignition is in the run position. The heater consists of a strip spiral wound around the fuel pipe. A bimetal thermal switch senses the fuel temperature and closes and electrical circuit when the fuel temperature is about –5° to +5° C (22° F to 41° F). The circuit opens at 12° to 22° C (54° F to 72° F).

Operation of the fuel line heater can only be checked when the fuel is cold, below –6° C (20° F). After several minutes of operation, the oulet pipe will be warmer to the touch than the inlet. It can also be checked with an ohmmeter. You should measure resistance to ground when the thermostatic switch is closed.

NOTICE: Do not test unit without fuel flowing through it otherwise it may burn out.

The fuel tank filter sock has a bypass valve which opens when the filter sock is covered with wax allowing fuel to flow to the heater.

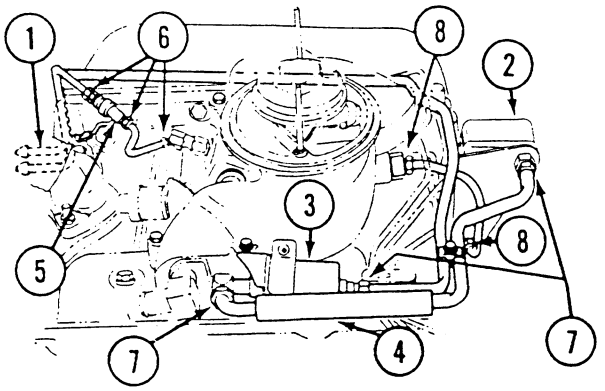
CHECKING AND/OR ADJUSTING TIMING (USING J-33075 TIMING METER)

The timing meter picks up the engine speed and crankshaft position from the crankshaft balancer. It uses a luminosity signal through a glow plug probe to determine combustion timing. Certain engine malfunctions may cause incorrect timing readings. Engine malfunctions should be corrected before a timing adjustment is made. The marks on the pump and adapter flange will normally be aligned within .762 mm (.030 in.) on a V8 and 1.27 mm (.050 in.) on a V6.

1. Place the transmission selector lever in park, apply the parking brake and block the drive wheels.
2. Start the engine and let it run at idle until fully warmed up. Then shut off the engine.

NOTICE: Failure to have the engine fully warmed up will result in sooting of the probe which wil' cause incorrect timing reading and adjustments.

3. Remove the air cleaner assembly and install cover J-26996-1. The EGR valve hose must be disconnected.



1. RETURN LINE
2. FUEL FILTER
3. FUEL PUMP
4. FUEL LINE HEATER (OPTIONAL)
5. HOUSING PRESSURE ALTITUDE ADVANCE
6. 13 N·m (10 LBS. FT.)
7. 26 N·m (19 LBS. FT.)
8. 15 N·m (11 LBS. FT.)

Fig. 6C5-4 V6 Fuel Lines

4. Clean any dirt from the engine probe holder (RPM counter) and crankshaft balancer rim.
5. Clean the lens on both ends of the glow plug probe and clean the lens in the photo-electric pickup. Use a dulled toothpick to scrape the carbon from the combustion chamber side of the glow plug probe. Look through the probe to be sure it's clean. Retarded readings will result if the probe is not clean.
6. Install this RPM probe into the crankshaft RPM counter (probe holder).
7. Remove the glow plug from No. 3 cylinder on a V8 and No. 1 on a V6. Install the glow plug probe in the glow plug opening. Tighten the probe to **11 N·m (8 lbs.-ft.).** Overtightening may crack the lens.
8. On the V8, set the timing meter offset selector to B (99.5); on the V6, set the selector to A (20).
9. Connect the battery leads: red to positive, black to negative.
10. Disconnect the generator to lead connector.
11. Start the engine and adjust the RPM (speed) to the speed specified on the "Vehicle Emission Control Information Label."
12. Observe the timing reading then at 2 minute intervals, again observe the reading. When the readings stabilize over the 2 minute interval readings, compare that reading to one specified on the "Vehicle Emission Control Information Label." The timing reading, when set to specification will be "Negative" (after top dead center).
13. Disconnect the timing meter and install the removed glow plug. Tighten the glow plug to 16 N·m (12 lbs.-ft.).
14. Connect the generator to lead connector.
15. Install the air cleaner being certain to reconnect the EGR valve hose.

Adjusting

1. Shut off the engine.
2. Note the relative position of the marks on the pump flange and pump intermediate adapter (V6) or pump adapter (V8).
3. Loosen the nuts or bolts holding the pump to the adapter to a point where the pump can be rotated. Use a 3/4 in. open end wrench on the boss at the front of the injection pump on a V8 and a 1 in. open end wrench on the V6. (Tool J-25304 has the proper offset on the handle to clear the fuel return line on the V6.)
4. Rotate the pump to the left to advance the timing and to the right to retard the timing. On the V8 engine the width of the mark on the adapter is equal to about one degree. On the V6 the width of the mark on the intermediate adapter is about 2/3 degree. Move the pump the amount that is needed and tighten the pump retaining nuts to 24 N·m (18 lbs.-ft.) on the V8 and 47 N·m (35 lbs. -ft.) on the V6.
5. Start the engine and recheck the timing reading as outlined previously. Reset and recheck the timing if needed.
6. Adjust the pump rod on the V8. On V8 and V6, reset the fast and curb idle speeds. Both procedures are in this section.

   Please note the following:

   a. Sooty or dirty probes will result in retarded readings.
   b. The luminosity probe will soot up very fast when used in a cold engine.
   c. Wild needle fluctuations on the timing meter indicate a cylinder not firing properly. Correction of this condition must be made prior to adjusting the timing.
   d. If after resetting the timing, the timing marks are far apart and the engine still exhibits a problem, the dynamic timing still could be incorrect. It is possible that a malfunctioning cylinder will result in incorrect timing. Whenever this occurs it is essential that timing be checked in the "alternate" cylinder. Timing can be checked in cylinders 2 or 3 on a V8 and 3 or 4 on a V6. If a difference in timing exist between cylinders, try both positions to determine which timing works best.

THROTTLE LINKAGE ADJUSTMENTS - V8

Fig. 6C5-5

1. Disconnect the transmission T.V. (or detent cable from the throttle assembly (and cruise control servo rod, if so equipped).

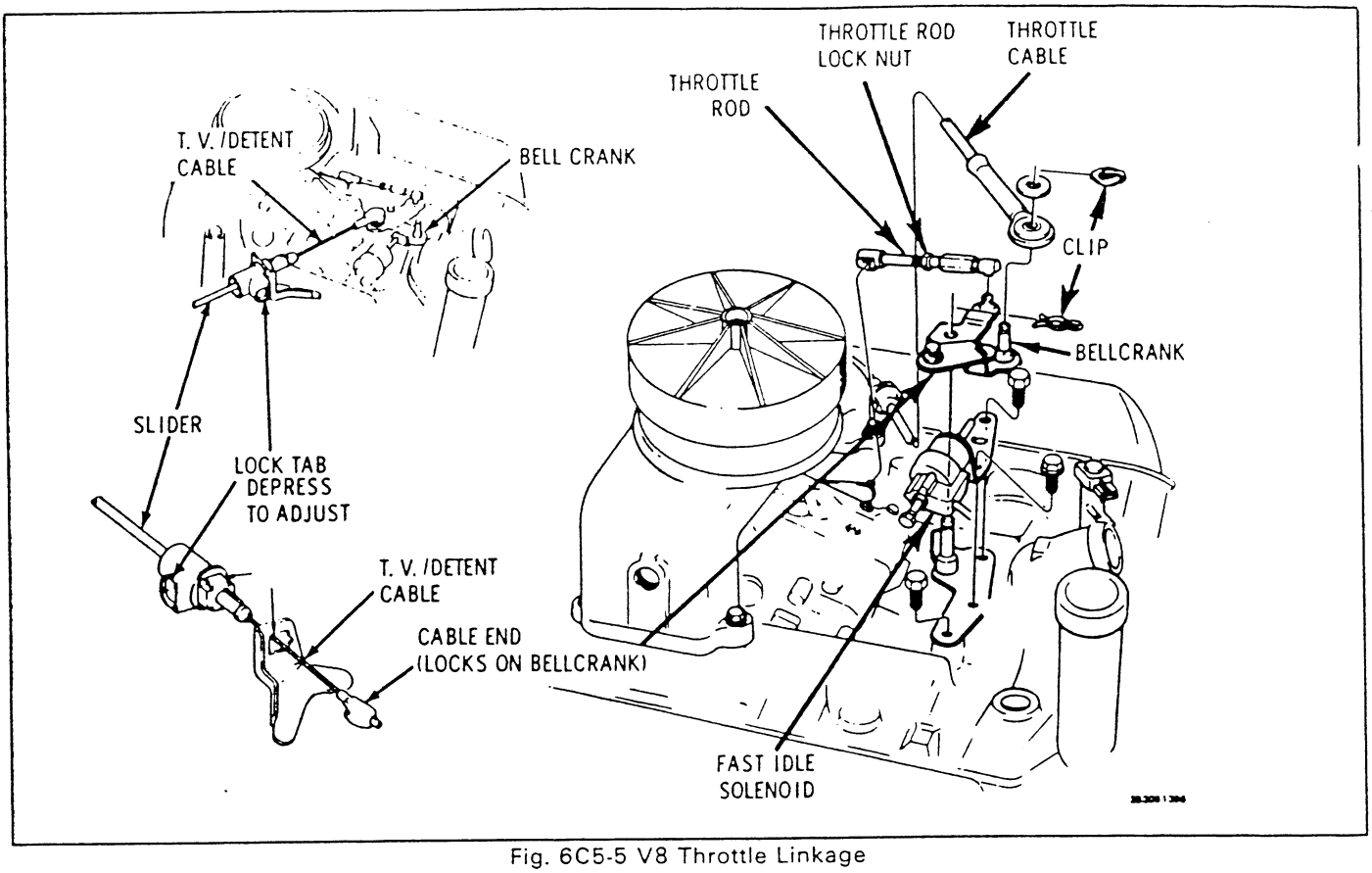


Fig. 6C5-5 V8 Throttle Linkage

2. Loosen the lock nut on the pump rod and shorten several turns.
3. Rotate the bellcrank lever assembly to the full throttle position and hold in that position.
4. Lengthen the pump rod until the injection pump lever just contacts the full throttle stop.
5. Release the bellcrank assembly and tighten the pump rod lock nut.
6. Depress and hold the metal lock tap on the T.V. cable upper end. Move the slider through the fitting in the direction away from the bellcrank lever assembly until the slider stops against the metal fitting. Release the metal tab.
7. Install the cruise control servo rod (if so equipped) and reconnect the transmission T.V. cable.
8. Rotate the bellcrank lever assembly to the full throttle stop and release the lever assembly.
9. Adjust the vacuum regulator valve, see "Vacuum Regulator Adjustment."
10. Reset the idle speeds and adjust the cruise control servo rod, see "Idle Speed Adjustment."

VACUUM REGULATOR VALVE ADJUSTMENT

1. Remove the air crossover (Figs. 6C5-6 or 6C5-7). Install the screened covers in the intake manifold openings; J-26996-10 on V8 and J-29657 on the V6.
2. Disconnect the throttle rod from the pump on the V8 and disconnect the throttle cable and T.V. cable from the pump throttle lever on the V6.

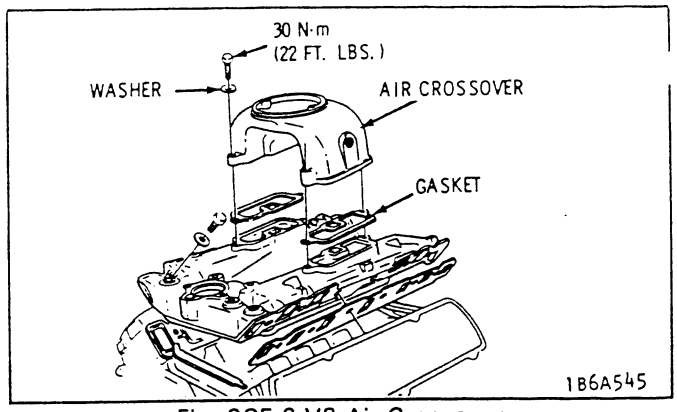


Fig. 6C5-6 V8 Air Crossover

3. Loosen the vacuum regulator valve to injection pump bolts.
4. Install BT-7944 or J-26701-15 carburetor angle gage adapter to the injection pump throttle lever. Place angle gage BT-7704 or J-26701 on adapter.

NOTICE: On the V6 pumps it may be necessary to rework tool BT-7944 or J-26701-15 by filing the tool so that it can fit onto the V6 pump's thicker throttle lever.

5. Rotate throttle lever to the wide open throttl position and set angle gage to zero degrees (Fi 6C5-8).
6. Center bubble in level.
7. Set angle gage to 58 degrees on the V8, and 49 degrees on the V6.

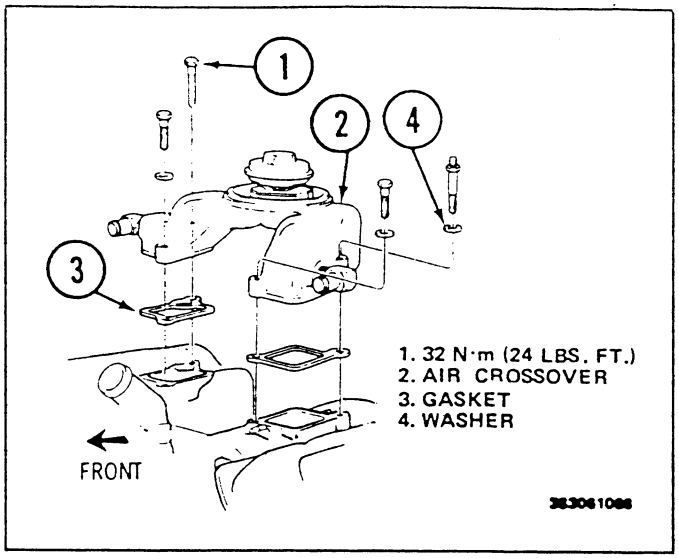


Fig. 6C5-7 V6 Air Crossover

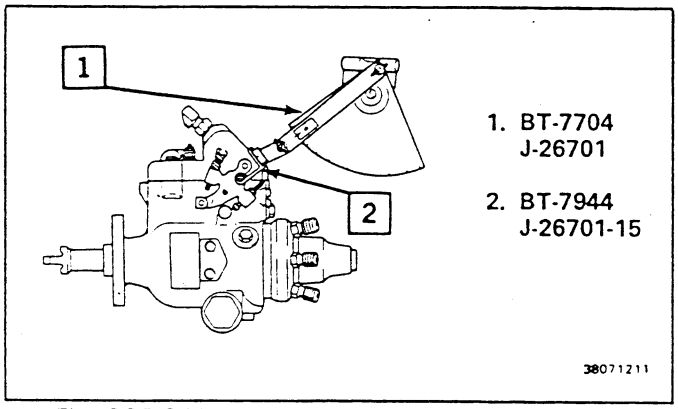


Fig. 6C5-8 Vacuum Regulator Valve Adjustment

8. Rotate throttle lever so lever bubble is centered (Fig. 6C5-9).

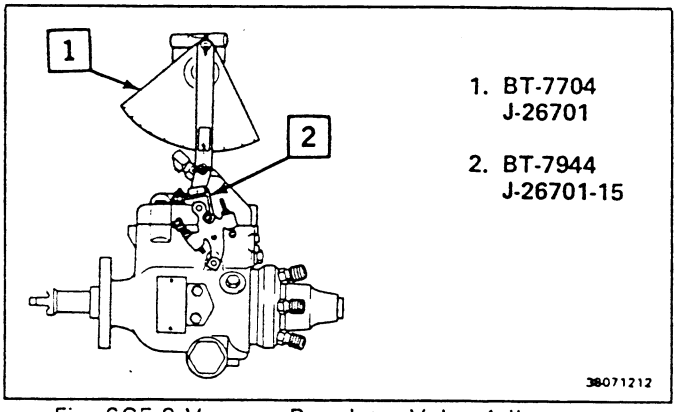


Fig. 6C5-9 Vacuum Regulator Valve Adjustment

9. Attach vacuum source such as BT-7517 or J-23738 vacuum pump to port A. Install vacuum gage to port B. Apply 75 kPa (22" HG) of vacuum to port A, Fig. 6C5-10 or 6C5-11.

10. Rotate vacuum valve clockwise to obtain 36±1 kPa (10.6±.3" HG) of vacuum

11. Tighten vacuum valve bolts. Remove vacuum source and vacuum gage.

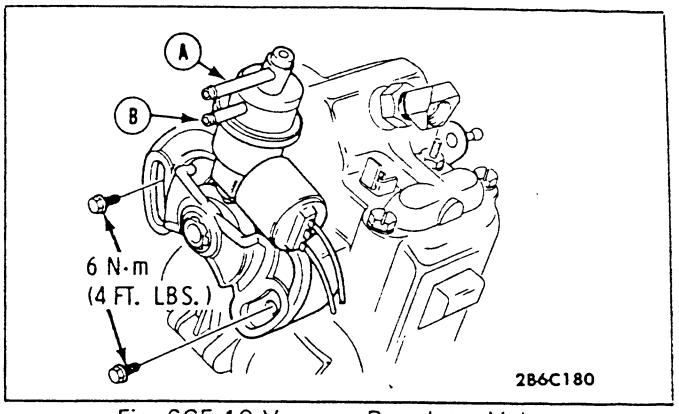


Fig. 6C5-10 Vacuum Regulator Valve

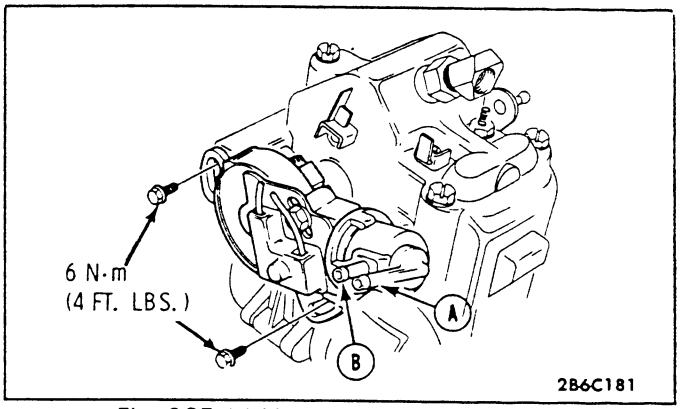


Fig. 6C5-11 Vacuum Regulator Valve

12. Connect the throttle rod to the pump throttle lever on the V8 and connect the throttle cable and T.V. cables to the pump throttle lever on the V6.
13. Remove the intake manifold screened covers.
14. Install the air crossover, Figs. 6C5-6 or 6C5-7.

VACUUM REGULATOR VALVE

Figs. 6C5-10 and 6C5-11

Removal

1. Remove the two vacuum hoses from the valve noting the location of the vacuum hoses.
2. Remove the 2 attaching bolts.

Installation

1. Install the valve following the "Vacuum Regulator Valve Adjustment Procedure."
2. Attach the two vacuum hoses to the valve.

IDLE SPEED ADJUSTMENTS

1. Apply the parking brake, place the transmission selector lever in "**park**" and block the drive wheels.
2. On the V8, perform the throttle linkage adjustment first, if required. See "Throttle Linkage Adjustment."
3. Start engine and allow it to run until warm, usually 10-15 minutes.
4. Shut off the engine, remove the air cleaner assembly.
5. Clean the front cover RPM counter (probe holder) and the crankshaft balancer rim.

6. Install the magnetic pick-up probe of Tool J-26925 fully into the RPM counter. Connect the battery leads; red to positive and black to negative.
7. Disconnect the two lead connector at the generator.
8. On the V6 disconnect the AC compressor clutch lead at the compressor (if so equipped.)
9. Turn off all electrical accessories.
10. Allow no one to touch either the steering wheel or service brake pedal.
11. Start the engine and place the transmission selector lever in "Drive".
12. Check the slow idle speed reading against the one given on the "Vehicle Emission Information Label". Reset if required (Fig. 6C5-12).

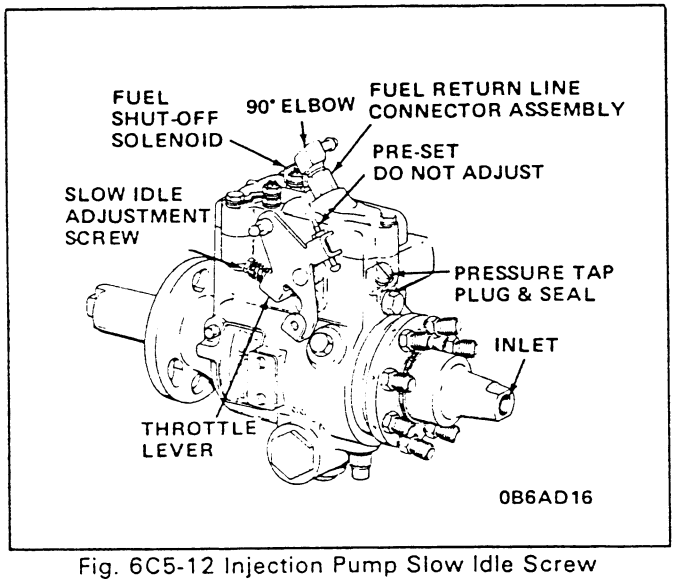


Fig. 6C5-12 Injection Pump Slow Idle Screw

13. Unplug the connector from the EGR-TVS and install a jumper between the connector terminals - do not allow the jumper to touch ground (Fig. 6C5-13 or 6C5-14).

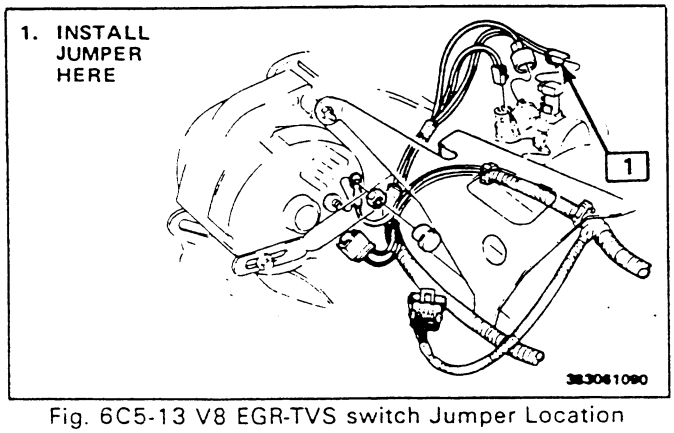


Fig. 6C5-13 V8 EGR-TVS switch Jumper Location

14. Check the fast idle solenoid speed against the one given on the "Vehicle Emission Information Label." Reset if required, see Fig. 6C5-12, V8 and Fig. 6C5-15, V6.
15. Remove the jumper and reconnect it to the EGR-TVS switch.

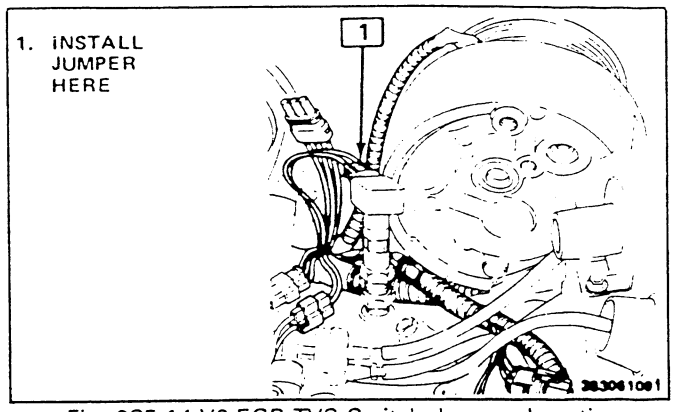


Fig. 6C5-14 V6 EGR-TVS Switch Jumper Location

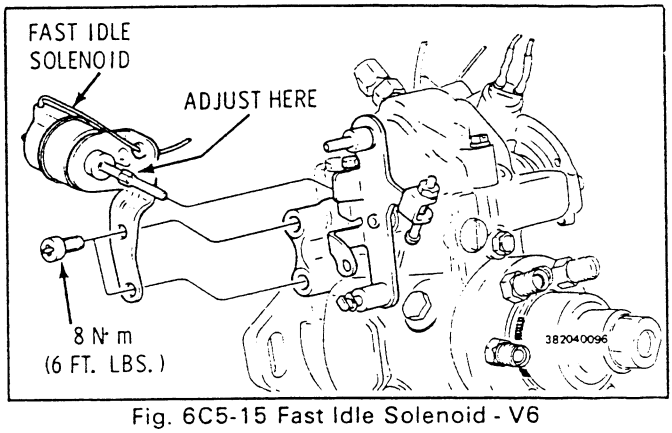


Fig. 6C5-15 Fast Idle Solenoid - V6

16. Recheck and reset the slow idle speed if necessary.
17. Shut off the engine.
18. Reconnect the lead at the generator (and AC compressor, if so equipped).
19. Disconnect and remove the tachometer.
20. If equipped with cruise control adjust the servo throttle rod to minimum slack then put clip in first free hole closest to the bellcrank or throttle lever, but within the servo bail.
21. Install the air cleaner assembly and connect the EGR valve hose.

HOUSING PRESSURE COLD ADVANCE (HPCA) ALL ENGINES

Figs. 6A5-16 and 6C5-17.

The HPCA Feature is designed to advance the injection timing about 4° during cold operation. This circuit is actuated by the EGR-TVS switch. The switch is calibrated to open the circuit at about 41° C (105° F). Below the switching point, housing pressure is decreased from 62-82.7 kPa (9-11 psi) to zero which advances the timing about 4°. Above about 41° C (105° F) the switch opens, de-energizing the solenoid, and the housing pressure is returned to 9-12 psi. The fast idle solenoid is energized by the same switch. The switch again closes when the temperature falls below 95° F.

PURPOSE:

1. Emission Control device.
2. Better cold starts.

3. Improves idle, reduces white smoke and noise when cold.
   When changing the fuel filter or injection pump, or when the car has run out of fuel, disconnect the connector from the temperature switch and jumper connector terminals. This will aid in purging air from the pump by allowing more fuel to pass to the return. (This procedure is necessary only on a hot engine, as the circuit will always be closed when the engine is cold.)

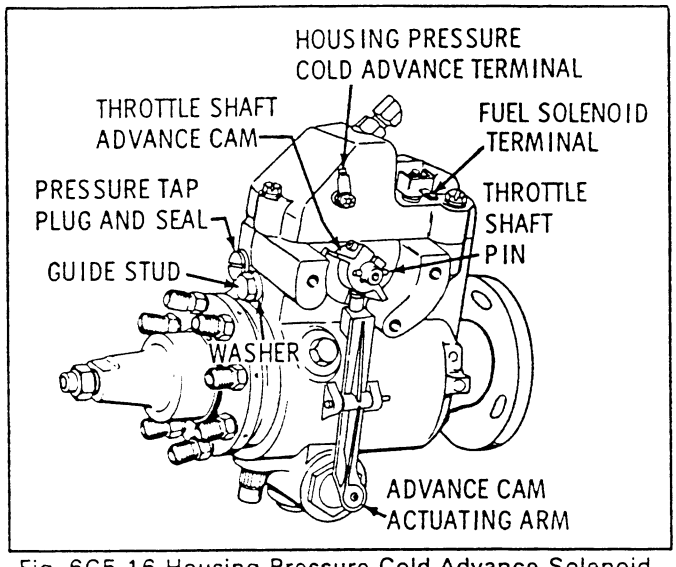


Fig. 6C5-16 Housing Pressure Cold Advance Solenoid, V8

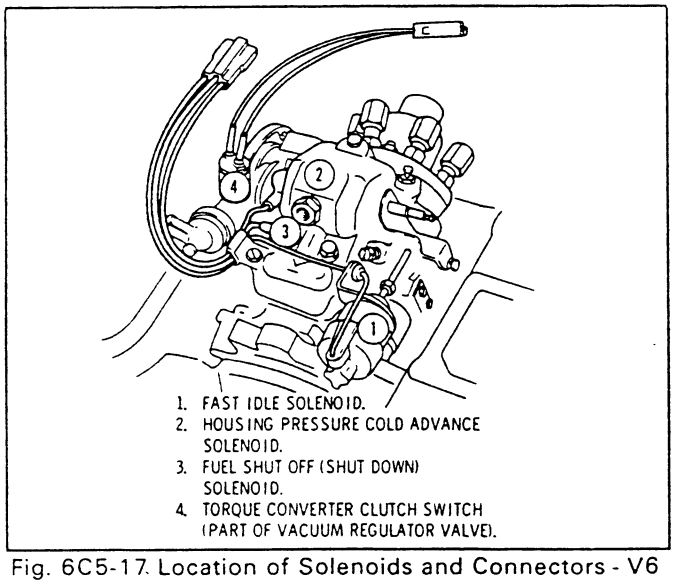


Fig. 6C5-17 Location of Solenoids and Connectors - V6

HOUSING PRESSURE ALTITUDE ADVANCE (HPAA)

The 1984 diesel engine must meet emission standards at both low and high altitudes. Altitude compensation is achieved by timing and EGR modification controlled by an altitude-sensitive switch on non-Calif. cars. Two systems are used: a low-altitude system, and a high-altitude system. A low-altitude car at low altitude, or a high-altitude car at high altitude, has a minumum of activated controls.

Timing is controlled by two pressure regulators. One is the Housing Pressure Cold Advance (HPCA) located in the pump. The other pressure regulator is the Housing Pressure Altitude Advance (HPAA) located in the fuel return line, see Figs. 6C5-18 and 6C5-19. (EGR is controlled with an additional solenoid and a vacuum reducer, see Section 6E4.)

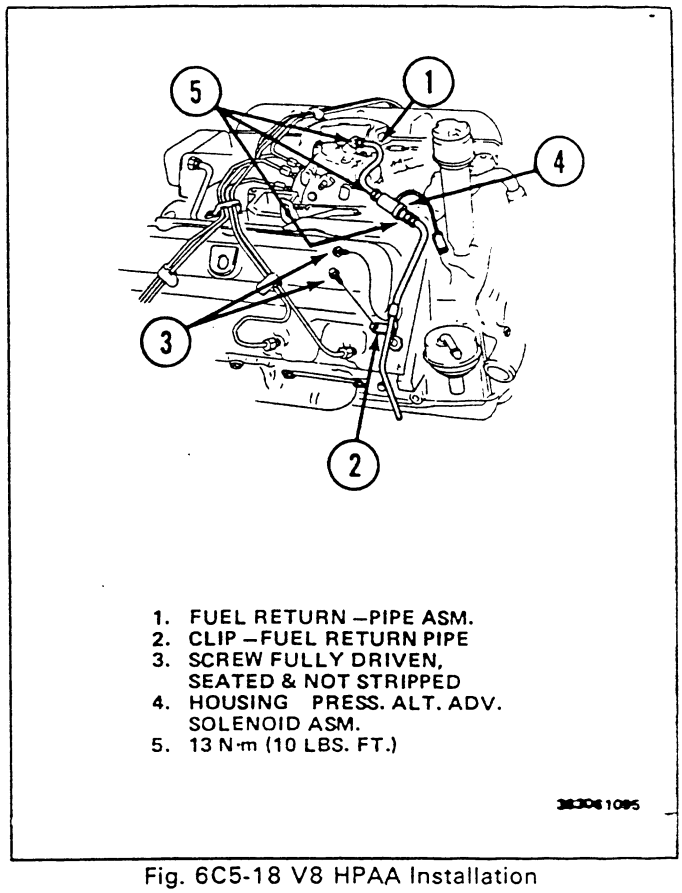


Fig. 6C5-18 V8 HPAA Installation

The altitude control switch, with the appropriate electrical circuity controls HPCA, HPAA, and EGR trim. See the ETM for more information. Fig. 6C5-20 shows a typical location.

The HPAA solenoid will regulate housing pressure according to altitude. When the HPAA solenoid is "ON," the glass check ball is seated, and it will regulate pressure at its calibrated value. When HPAA solenoid is "OFF," the ball is moved off its seat, the return line is open, and there is no regulation. So, it is possible to have both the HPCA (OFF) and the HPAA (ON) regulating the housing pressure at the same time. It is also possible to have just the HPCA (OFF) or just the HPAA (ON) regulating housing pressure. The HPCA must be energized (plunger extended holding the housing pressure regulating check ball off its seat), and not regulating to allow the HPAA solenoid to regulate at its calibrated value. Higher housing pressures retard timing. Fig 6C5-21 shows what happens at different altitudes and engine temperatures on each version.

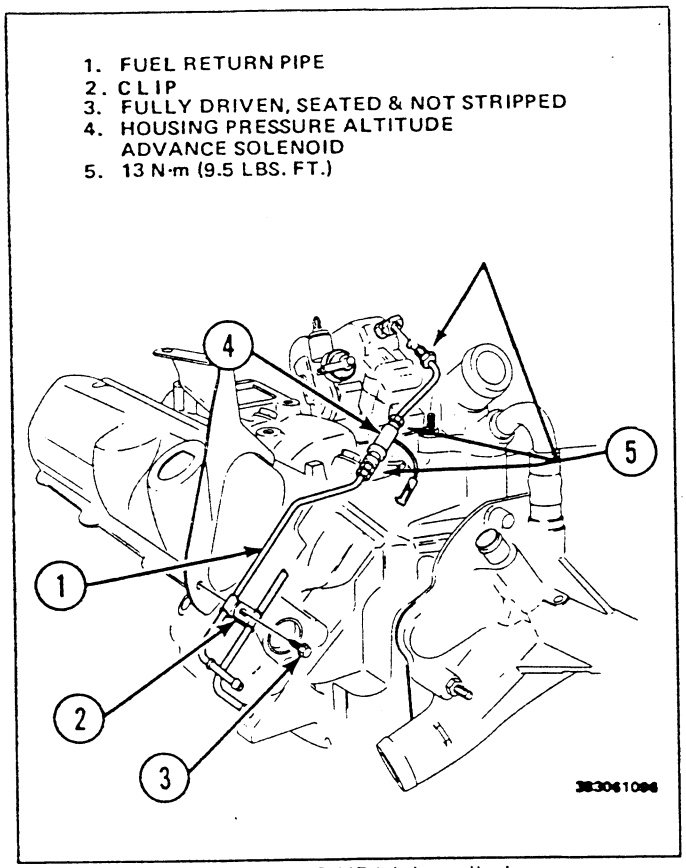


Fig. 6C5-19 V6 HPAA Installation

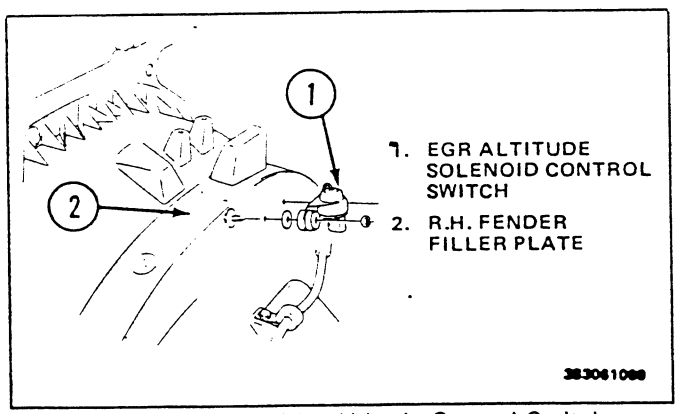


Fig. 6C5-20 EGR/HPAA Altitude Control Switch – Typical

CHECKING INJECTION PUMP HOUSING FUEL PRESSURE – ENGINE WARM

1. Check the operation of the temperature switch on the EGR-TVS. See Section 6E4.
2. Remove the air cleaner and install J-26996-1 cover.
3. Disconnect the fuel return line form the return line connector.
4. Remove the return line connector from the injection pump cover.
5. Push the HPCA solenoid plunger into the solenoid.
6. Remove the electrical connector from the housing pressure cold advance terminal, Figs. 6C5-16 or 6C5-17.
7. With a jumper lead, apply 12V to the HPCA terminal. The HPCA solenoid plunger should fully extend. If not, remove the pump cover and repair or replace the HPCA solenoid. See "Solenoids."
8. Install adapter J-34151 in the pump cover.
9. Install the return line into adapter J-34151.
10. Attach a low pressure gage to adapter J-34151.
11. Install magnetic pick-up tachometer J-26925.
12. Check the pressure with the engine running at 1000 RPM, transmission in Park, parking brake on, drive wheels blocked. The pressure should be 62-82.7 kPa (9-11 psi) with not more than 6.895 kPa (1) psi fluctuation, see Fig. 6C5-21, because pressure will change depending on the system (package) and altitude car is checked at.
13. If the pressure is low, replace the fuel return line connector assembly.
14. If the pressure is too high, the fuel return system or the HPAA may be restricted. Remove the return line at the adapter pump. Install a fitting and short piece of hose to allow the return flow to empty into a small container.
    If the fuel return line connector assembly is replaced, check and if necessary, reset pump timing. See "Checking and/or Adjusting Timing."
15. If the pressure is lower than before, correct the restriction in the fuel line.
16. If still too high, replace the fuel return line connector assembly.

	CONDITION		HPCA	HPAA	NOMINAL HOUSING PRESSURE kPa (psi)
	ALTITUDE	COOLANT			
FEDERAL PACKAGE	BELOW 1219m (4000 FT.)	COLD	ON	OFF	0
	BELOW 1219m (4000 FT.)	HOT	OFF	OFF	68.9 (10)
	ABOVE 1219m (4000 FT.)	COLD	ON	OFF	0
	ABOVE 1219m (4000 FT.)	HOT	ON	ON	48.3 (7)
ALTITUDE PACKAGE	ABOVE 1219m (4000 FT.)	COLD	ON	OFF	0
	ABOVE 1219m (4000 FT.)	HOT	OFF	OFF	68.9 (10)
	BELOW 1219m (4000 FT.)	COLD	ON	OFF	0
	BELOW 1219m (4000 FT.)	HOT	OFF	ON	89.6 (13)

HPCA = HOUSING PRESSURE COLD ADV. HPAA = HOUSING PRESSURE ALTITUDE ADV.
TIMING RETARDS WITH HIGHER HOUSING PRESSURE 383061100

Fig. 6C5-21 Injection Pump Timing Control

17. If it remains too high, remove the injection pump for repair.
18. Remove the tachometer, pressure gage, and adapter.
19. Using a new "O" ring, install the fuel return line connector into the pump cover.
20. Connect the fuel return line to the return line connector.
21. Start the engine and check for leaks.
22. Remove screened covers, then install air crossover.

INJECTION PUMP FUEL LINES

Figs. 6C5-22 and 6C5-23

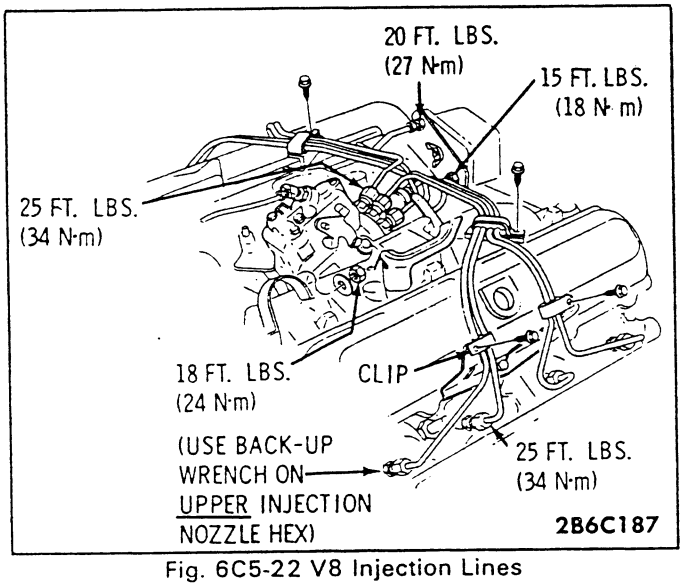


Fig. 6C5-22 V8 Injection Lines

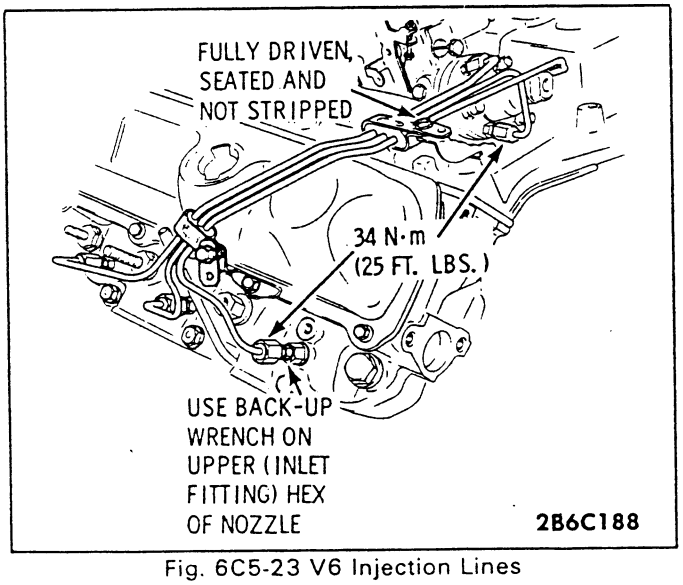


Fig. 6C5-23 V6 Injection Lines

When lines are to be removed, clean all line fittings thoroughly before loosening. Immediately cap the lines, nozzles and pump fittings to maintain cleanliness.

Removal

All lines may be removed without removing injection pump. It is not necessary to use a back-up wrench when removing the lines from pump.

1. Remove air cleaner.
2. Remove filters and pipes from valve covers and air crossover.
3. Remove air crossover (Figs. 6C5-6 or 6C5-7)and cap intake manifold with screened covers J-26996-10, V8 and J-29657, V6.

NOTICE: Always cap the nozzle and lines to prevent damage and contamination.

4. Remove injection pump line clamps, then remove the injection pump lines and cap open lines, nozzles, and pump fittings. Use a back-up wrench on the nozzle upper hex to prevent a fuel leak.

Installation

1. Install new injection pump line, install loose then tighten both ends. See Figs. 6C5-22 and 6C5-23 for the Torque Specifications. Use a back-up wrench on the nozzle upper hex to prevent nozzle damage. Then install clamps.
   If several lines are to be replaced, start with the bottom lines.
2. Start engine and check for fuel leaks.
3. Remove screened covers from intake manifold and install air crossover (Figs. 6C5-6 or 6C5-7).
4. Start the engine and check for leaks.
5. Connect the crankcase ventilation pipes and filter(s) to the valve cover(s) and air crossover.
6. Install the air cleaner.

REDUCING CRANKING TIME

When replacing a fuel filter or injection pump the Housing Pressure Cold Advance should be activated manually if the engine temperature is above 41°C (105°F). Activating the HPCA will reduce cranking time.

To activate the HPCA solenoid, disconnect the two lead connectors at the EGR-TVS switch (Fig 6C5-13 or 6C5-14) and bridge the connector with jumper. After the engine is running, remove the jumper and reconnect the connector to the engine temperature switch.

INJECTION PUMP

Removal

1. Remove the air cleaner assembly.
2. Remove the crankcase ventilation filter(s) and pipes from the valve covers and air crossover.
3. Remove the air crossover (Figs. 6C5-6 or 6C5- and install intake manifold screened cove J-26996-10 on the V8 or J-29657 on the V6. C the V6 disconnect or remove fuel lines and fu pump (Fig. 6C5-4).
   a. On the V8, disconnect the throttle rod (F 6C5-5) and throttle return spring (F 6C5-24). Remove the throttle bellcrank.

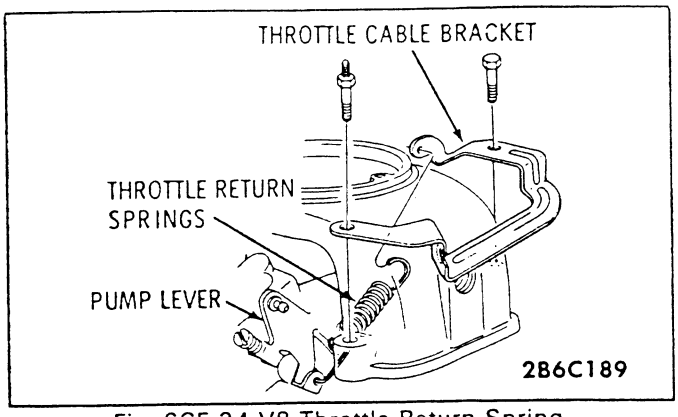


Fig. 6C5-24 V8 Throttle Return Spring

b. On the V6, disconnect the throttle cable (Fig. 6C5-25 and T.V. cable from the pump throttle lever. Disconnect the throttle return spring (Fig. 6C5-26).

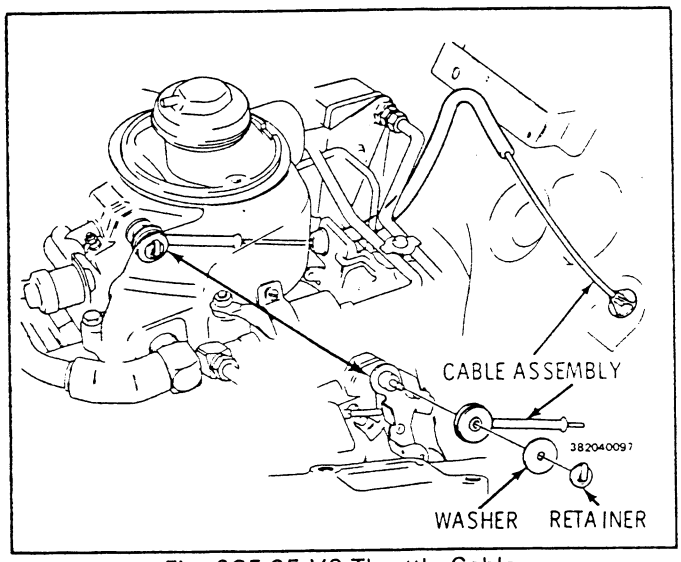


Fig. 6C5-25 V6 Throttle Cable

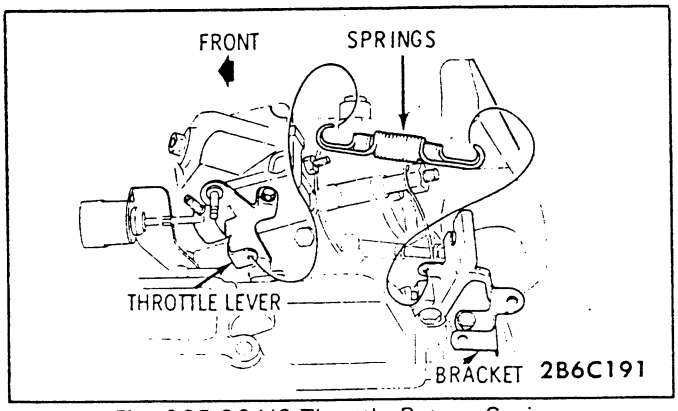


Fig. 6C5-26 V6 Throttle Return Spring

4.

a. If V8 and A/C equipped, disconnect the rear compressor brace.

b. If equipped with a fuel line heater, remove the fasteners that retain the line and heater assembly.

5. Remove the throttle and T.V. cables from the intake manifold brackets. Position the cables away from the engine.
6. On the V8 only, remove the Crankcase Depression Regulator Valve.
7. Remove the fuel filter (with bracket on V8). (See Fig. 6C5-3 for V8, or 6C5-4 for V6).
8. On the V8, disconnect fuel line at the fuel filter.
9. Disconnect the fuel return line from the injection pump.
10. Disconnect the injection line clamps (clips). Disconnect the injection lines from the pump and cap all open lines. Carefully reposition the lines to gain enough clearance for pump removal.
11. On the V8, remove 3 nuts retaining injection pump, using Tool J-26987. On the V6, remove the 2 bolts retaining the injection pump.
12. Remove pump and cap all open lines and nozzles. Discard the pump to adapter "O" ring.

Installation

1. Position engine No. 1 cylinder to firing position by aligning the mark on the balancer with zero mark on the indicator located on the front of the engine. Refer to Fig. 6C5-38 or 6C5-39 for position of injection pump driven gear. (When the number one cylinder is at top dead center, the offset is to the right on the V8, or down on the V6.)

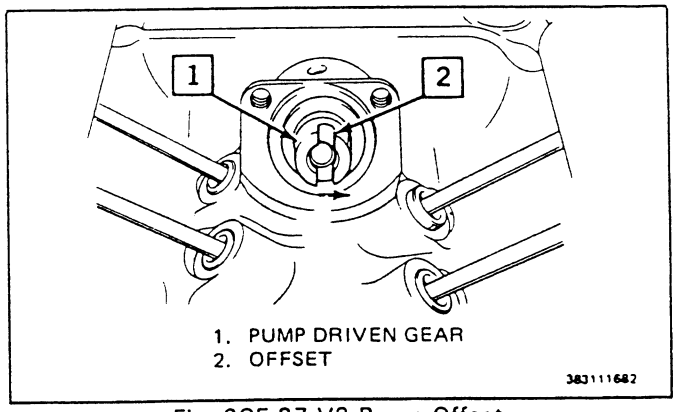


Fig. 6C5-27 V8 Pump Offset

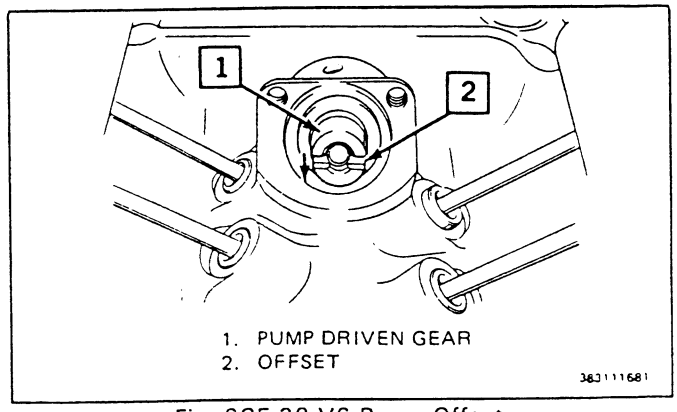


Fig. 6C5-28 V6 Pump Offset

2. Line up the offset tang on pump driveshaft with the pump driven gear. Install a new pump to

adapter "O" ring, then install the pump fully seating pump by hand.

3. If a new adapter (V8) or intermediate adapter (V6) is installed, set the injection pump at the center of slots in the pump mounting flange.

   If the original adapter (V8) or intermediate adapter (V6) is being retained, align the pump timing mark with the mark on the adapter or intermediate adapter. Install the 3 nuts and washers (V8) or 2 bolts and washers (V6) retaining the pump and tighten to 24 N·m (18 lbs.-ft.) V8, and 51 N·m (37 lbs.-ft.) on the V6.
4. Remove the protective caps from the openings and connect the injection lines to the pump.
5. Connect the injection line clamps (Fig. 6C5-22 or 6C5-23).
6. Connect the fuel return line.
7. Install the fuel filter (with bracket, V8). Tighten the line fittings and install the fuel line heater clamps (if so equipped), (Figs. 6C5-3 or 6C5-4).
8. On the V8, install the Crankcase Depression Regulator Valve.
9. If V8 and A/C equipped, connect the rear compressor brace.
10. Install the throttle and T.V. cables into the intake manifold brackets.
    a. On the V8, connect the throttle rod (Fig. 6C5-5) and throttle return spring (Fig. 6C5-24). Adjust the throttle linkage, see "Throttle Linkage Adjustment V8."
    b. On the V6, connect the throttle cable (Fig. 6C5-25) and T.V. cable to the pump throttle lever. Connect the throttle return spring (Fig. 6C5-26). Adjust the T.V. cable, see Section 7A.
11. Start the engine and check for leaks.
12. Check and, if necessary, reset the pump timing (see "Checking and/or Adjusting Pump Timing").
13. Adjust the vacuum regulator valve only if the valve's original position is disturbed or a replacement injection pump is installed see "Vacuum Regulator Valve Adjustment."
14. Adjust the idle speeds, see "Idle Speed Adjustment."
15. Remove screened covers from intake manifold, then install the air crossover.
16. Install tubes and hoses in the air crossover and ventilation filters in the valve covers.
17. Install the air cleaner being certain to reconnect the EGR valve hose.

Injection Pump Seal and "O" Ring Replacement.

Seal and "O" ring replacement damage can be minimized with the use of a thick bodied assembly fluid such as SNYKUT lubricant or equivalent.

INJECTION PUMP

FUEL FLOW

The fuel flow schematic in Fig. 6C5-30 shows the major components and their relationships.

Fuel is drawn through a strainer in the tank by the fuel pump. Fuel at approximately 38 to 45 kPa (5.5 to 6.5 psi) V8, 14 kPa (2 psi) V6, pressure flows through the fuel filter into the transfer pump and pressure regulator suction side.

Fuel under transfer pressure now splits into several directions: to the pressure side of the pressure regulator, to the head passage where three radial passages lead to the vent wire assembly, the pressure tap hole plug, the advance mechanism and to the metering valve.

The metering valve is the equivalent of throttle plates in a carburetor. It controls fuel flow to the pumping plungers.

The vent wire assembly is threaded into the top of the hydraulic head assembly next to the metering valve. It allows air and a controlled amount of fuel to escape to the housing where it will flow back to the fuel tank via the return oil circuit. The vent wire assembly is made up of a screw with a hole through it into which a wire is positioned.

The wire is free to vibrate and resists plugging by debris. Fuel which flows through the vent wire assembly, circulates in the housing to cool and lubricate the internal pump components. A selection of screw assemblies containing different wire sizes is available to obtain the correct amount of return flow.

The housing pressure regulator is a ballcheck fitting in the governor cover which maintains even housing pressure and allows fuel to return to the fuel tank. This recirculation of fuel maintains normal operating temperature. At full load conditions, approximately half of the fuel which enters the pump is injected into the engine cylinders while the other half is returned to the fuel tank.

Fuel in the head passage also flows through a bore leading to the metering valve. The metering valve allows a varying amount of fuel to pass by, depending on its position to charge the pumping plungers.

As the rotor revolves, the rotor inlet passage registers with the charging ports in the hydraulic head, allowing fuel to flow into the pumping chamber. With further rotation, the inlet passages move out of registry and the discharge port of the rotor registers with one of the head outlets. While the discharge port is opened, the rollers contact the cam lobes forcing the plungers together. Fuel trapped between the plungers is then pressurized and delivered by the nozzle to the combustion chamber.

Self-lubrication of the pump is an inherent feature of the pump.

INJECTION PUMP ON CAR SERVICE

There are areas on the injection pump where leaks can be corrected without removing the pump from the engine.

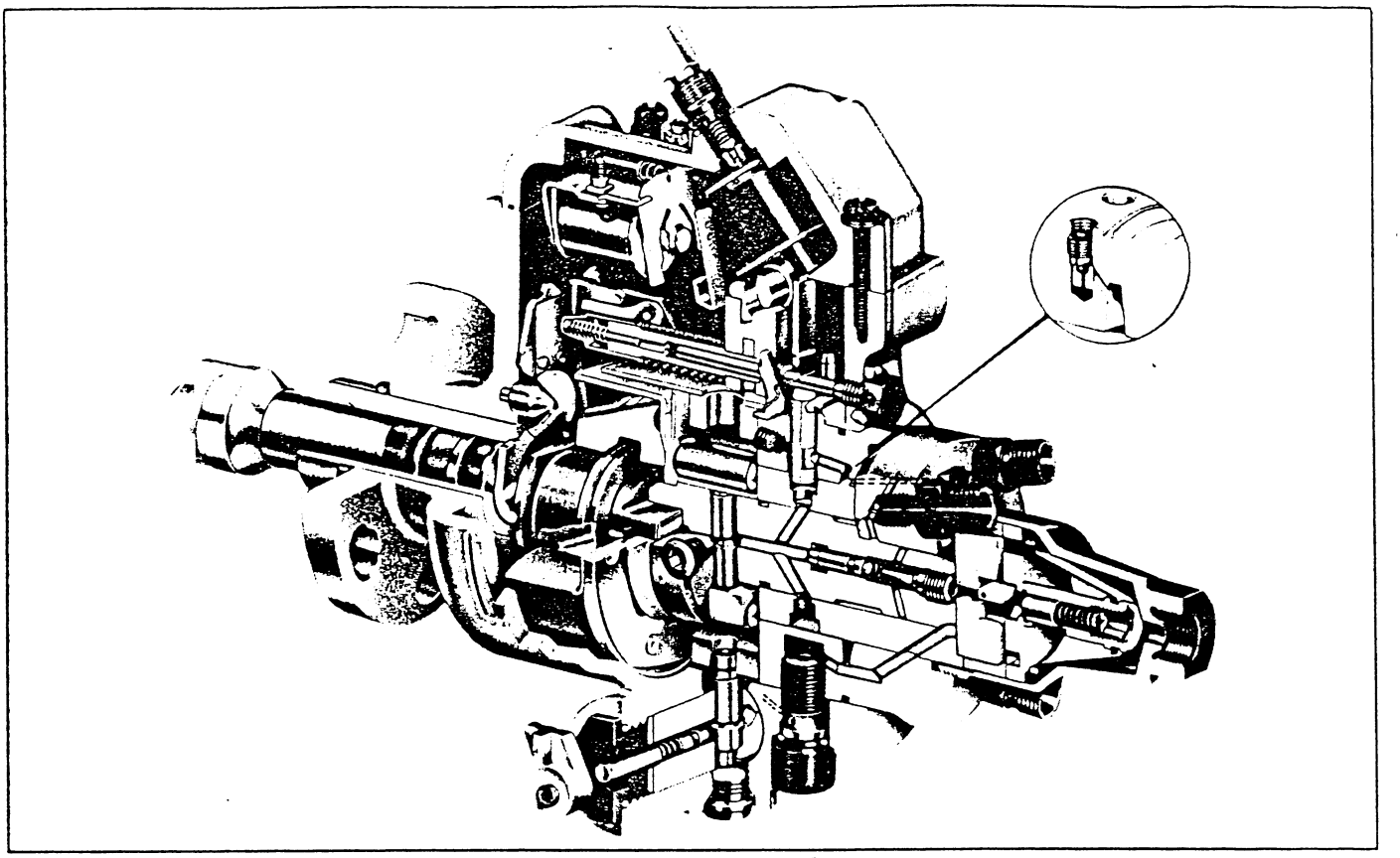


Fig. 6C5-29 Injection Pump Cutaway

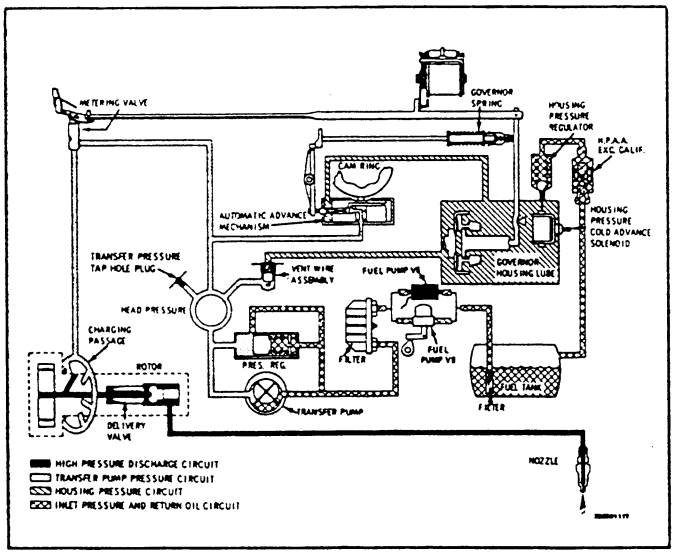
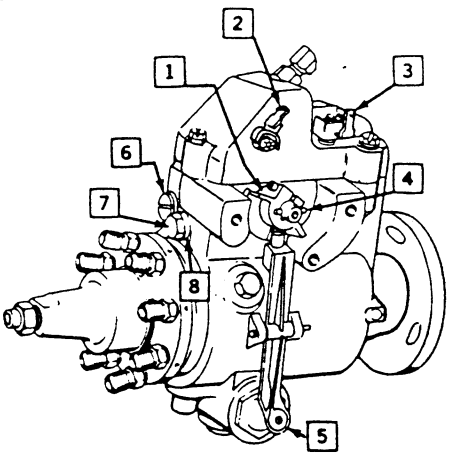


Fig. 6C5-30 Injection Pump Circuit



1. THROTTLE SHAFT ADVANCE CAM
2. HOUSING PRESSURE COLD ADVANCE TERMINAL
3. FUEL SOLENOID TERMINAL
4. THROTTLE SHAFT PIN
5. ADVANCE CAM ACTUATING ARM
6. PRESSURE TAP PLUG AND SEAL
7. GUIDE STUD
8. WASHER

38071213

Fig. 6C5-31 Right Side of Pump

Pump Cover Seal and/or Guide Stud Seal Replacement

1. Remove the air cleaner and air crossover. Install screens J-29657 (V6) or J-26996-10 (V8) in the intake manifold.
2. Disconnect the injection pump fuel solenoid and housing pressure cold advance wires and the fuel return pipe.
3. Clean the injection pump cover, upper portion of the pump and the guide stud area (Fig. 6C5-31). Place several rags in engine valley to catch fuel.
4. Remove the sealing wire (if used), injection pump cover and remove screws from the cover.

NOTICE: Extreme care must be exercised to keep foreign material out of the pump when the cover is off. If any objects are dropped into the pump they must be removed before the engine is started or injection pump damage or engine damage could occur.

STEPS 5, 6 AND 7 ARE FOR GUIDE STUD SEAL REPLACEMENT ONLY.

5. Observe position of metering valve spring over the top of the guide stud. This position must be exactly duplicated during reassembly.
6. Remove the guide stud and washer. Note location of parts prior to removal.
7. Reinstall the guide stud with a new washer making certain that the upper extension of the metering valve spring rides on top of the guide stud. Tighten the guide stud to 9.5 N·m (85 lbs. -in.). Overtightening the guide stud may strip the aluminum threads in the housing.
8. Hold the throttle in the idle position.
9. Install new pump cover seal. Make sure the screws are not in the cover and position the cover about 6mm (1/4 inch) forward (toward shaft end) and about 3mm (1/8 inch) above the pump (Fig. 6C5-32).

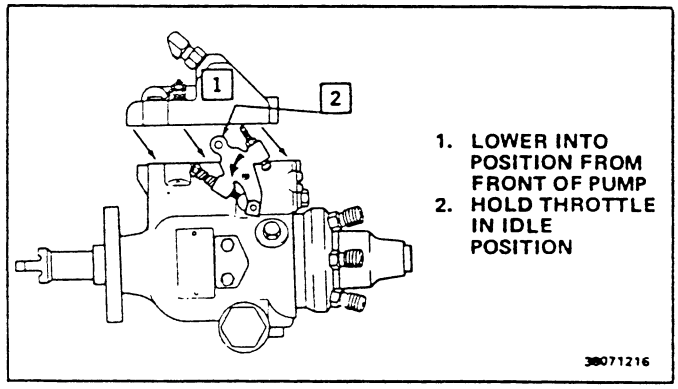


Fig. 6C5-32 Installing Injection Pump Cover

10. Move the cover rearward and downward into position, being careful not to cut the seal and reinstall the cover screws. Be careful not to drop or lose flat washer and internal lock washer with each screw. Flat washer must be against pump cover. Tighten to 4.5 N·m (40 lbs.-in.).
11. Connect the negative cable(s).
12. Turn the ignition switch to the run position and touch the pink solenoid wire to the solenoids. A clicking noise should be heard as the wire is connected and disconnected. If this clicking is not observed, the linkage may be jammed in a wide open throttle position and the engine MUST NOT be started. If clicking is observed, connect the pump solenoid and housing pressure cold advance wires (Fig. 6C5-16 or 6C5-17) then proceed to Step 15.
13. Remove the cover. Ground the solenoid lead (opposite the hot lead) and connect the pink wires. With the ignition switch in the run position, the solenoid in the cover should move the linkage. If not the solenoid must be replaced. Minimum voltage across solenoid terminals must be 12.0.
14. Reinstall the cover and repeat Steps 10, 11, 12, 13.
15. Reinstall the fuel return pipe.
16. Start the engine and check for leaks.
17. Idle roughness may be observed due to the air in the pump, give it plenty of time to purge which it will do by allowing the engine to idle. It may be necessary to shut the engine down for several minutes to allow air bubbles to rise to the top of the pump where they will be purged.
18. Remove the intake manifold screens then reinstall the air crossover and air cleaner.

THROTTLE SHAFT SEAL REPLACEMENT

1. Remove the air cleaner and air crossover. Install screens J-29657 (V6) or J-26996-10 (V8) in the intake manifold.
2. Disconnect the injection pump fuel solenoid and housing pressure cold advance wires and the fuel return pipe (Fig. 6C5-16 or 6C5-17).
3. Scribe a line on the vacuum regulator valve and pump body so the valve can be reinstalled without resetting. Remove the vacuum regulator valve.
4. Remove the throttle rod, V8 or throttle and T.V. /detent cable, V6 and return springs. Remove the throttle cable bracket, V8 only.
5. Install Tool J-29601 over the throttle shaft with slots of tool engaging pin. Put the spring clip of the tool over the throttle shaft advance cam and tighten the wing nut. Without loosening the wing nut, pull the tool off the shaft. (This provides the proper alignment on reassembly.) Fig. 6C5-33.

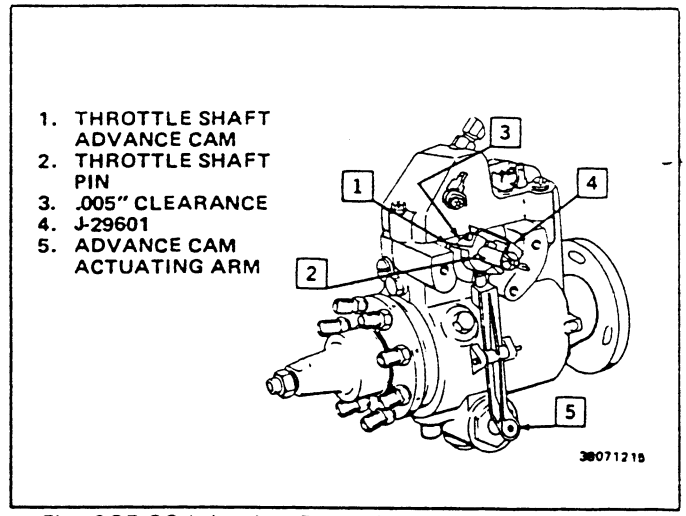


Fig. 6C5-33 Injection Pump Tool J-29601 Installed

6. Remove the pin from the throttle shaft, loosen the clamp screw and remove the throttle shaft advance cam and fiber washer. Remove any burrs from the shaft that may have resulted from pin removal.
7. Clean the injection pump cover, upper portion of the pump, the throttle shaft and the guide stud area (Fig. 6C5-31). Place several rags in the engine valley to catch fuel.
8. Remove injection pump cover and remove screws from the cover.

NOTICE: Extreme care must be exercised to keep foreign material out of the pump when the cover is off. If any objects are dropped into the pump,

they must be removed before the engine is started or injection pump damage or engine damage could occur.

9. Observe position at metering valve spring over the top of the guide stud. This position must be exactly duplicated during reassembly.
10. Remove the guide stud and washer. Note location of parts prior to removal.
11. Rotate the min-max governor assembly up to provide clearance and remove from the throttle shaft (Fig. 6C5-34).

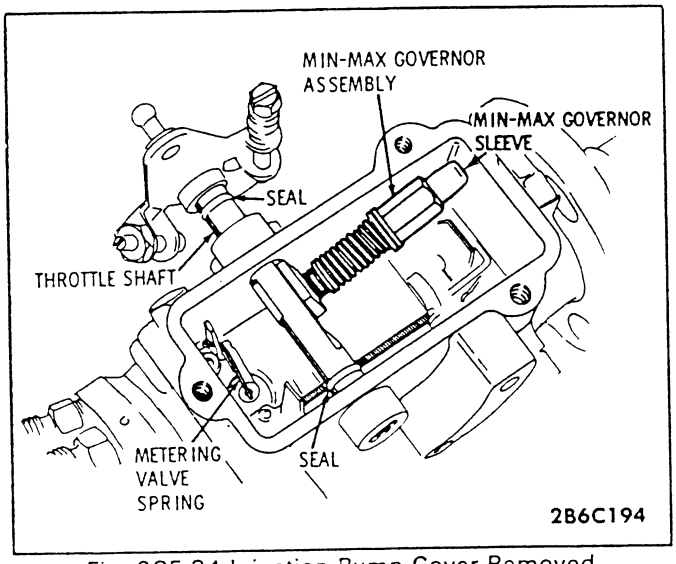


Fig. 6C5-34 Injection Pump Cover Removed

12. Remove the throttle shaft assembly. It may be necessary to loosen the nuts at the injection pump mounting flange and rotate the pump slightly to allow the throttle shaft assembly to clear the intake manifold.
13. Examine the throttle shaft and bushings in the pump housing for any evidence of damage or unusual wear. Remove the pump and send to the local Roosa Master dealer if throttle shaft or bushing replacement is necessary.
14. Remove the throttle shaft seals. Do not attempt to cut the seals to remove, as nicks in the seal seat will cause leakage.
15. Install new shaft seals using care not to cut the seals on the sharp edges of the shaft. Apply a light coating of clean chassis grease on the seals.
16. Carefully slide the throttle shaft back into the pump to the point where the min-max governor assembly will slide back onto the throttle shaft (Fig. 6C5-34).
17. Rotate the min-max governor assembly downward, hold in position and slide the throttle shaft and governor into position.
18. Install a new mylar washer, the throttle shaft advance cam, (do not tighten cam screw at this time), and a new throttle shaft drive pin (Fig. 6C5-31).
19. Align the throttle shaft advance cam so Tool J-29601 can be reinstalled over the throttle shaft, pin in the slots and the spring clip over the advance cam.
20. Insert a .005" feeler gage between the white washer on the throttle shaft and the pump housing. Squeeze the cam and throttle shaft together and tighten the cam screw. Tighten to 3.4 N·m (30 lbs.-in.). Secure with LOCTITE 290 or equivalent. Remove Tool J-29601. Refer to Fig. 6C5-35.

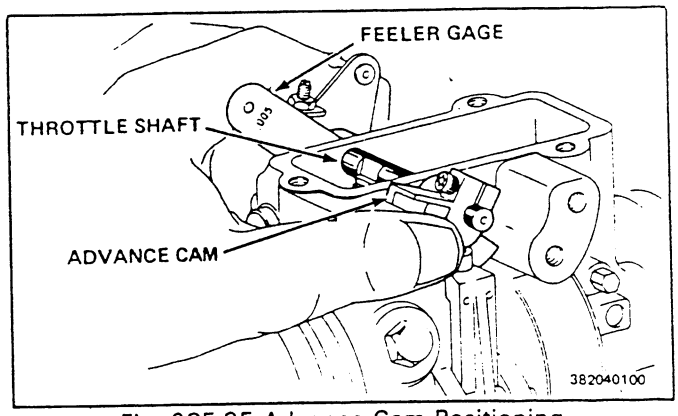


Fig. 6C5-35 Advance Cam Positioning

21. Reinstall the guide stud with a new washer, making certain that the upper extension of the metering valve spring rides on top of the guide stud. Tighten the guide stud to 9.5 N·m (85 lbs. -in.). Overtightening the guide stud may strip the threads in the aluminum housing (Fig. 6C5-31).
22. Hold the throttle in the idle position.
23. Install new pump cover seal. Make sure the screws are not in the cover and position the cover about 1/4 inch forward (toward shaft end) and about 1/8 inch above the pump (Fig. 6C5-32).
24. Move the cover rearward and downward into position, being careful not to cut the seal and reinstall the cover screws. Be careful not to drop and lose flat washer and internal lock washer with each screw. Flat washer must be against pump cover. Tighten to 3.7 N·m (33 lbs.-in.).
25. Install the vacuum regulator valve aligning the marks made previously.
26. Connect the negative cable(s).
27. Turn the ignition switch to the run position and touch the pink solenoid wire to the solenoid. A clicking noise should be heard as the wire is connected and disconnected. If this clicking is not observed, the linkage may be jammed in a wide open throttle position and the engine MUST NOT be started. If clicking is observed, connect the pump solenoid and housing pressure cold advance wires (Fig. 6C5-16 or 17) then proceed to Step 30.
28. Remove the cover. Ground the solenoid lead opposite the hot lead and connect the pink wire With the ignition switch in the run position, th solenoid in the cover should move the linkage. not the solenoid must be replaced. Minimum voltage across solenoid terminals must be 12.0.
29. Reinstall the cover and repeat Step 25.

30. Reinstall throttle cable bracket and throttle rod, V8 only.
31. Reconnect the throttle cable (both) and T.V. /detent cable (V6). Install the throttle return springs.
32. Install the fuel return pipe.
33. Start the engine and check for leaks.
    Idle roughness may be observed due to the air in the pump, give it plenty of time to purge which it will do by allowing the engine to idle. It may be necessary to shut the engine down for several minutes to allow air bubbles to rise to the top of the pump where they will be purged.
34. Remove the intake manifold screens then reinstall the air crossover and air cleaner.

SOLENOIDS

Fig. 6C5-36

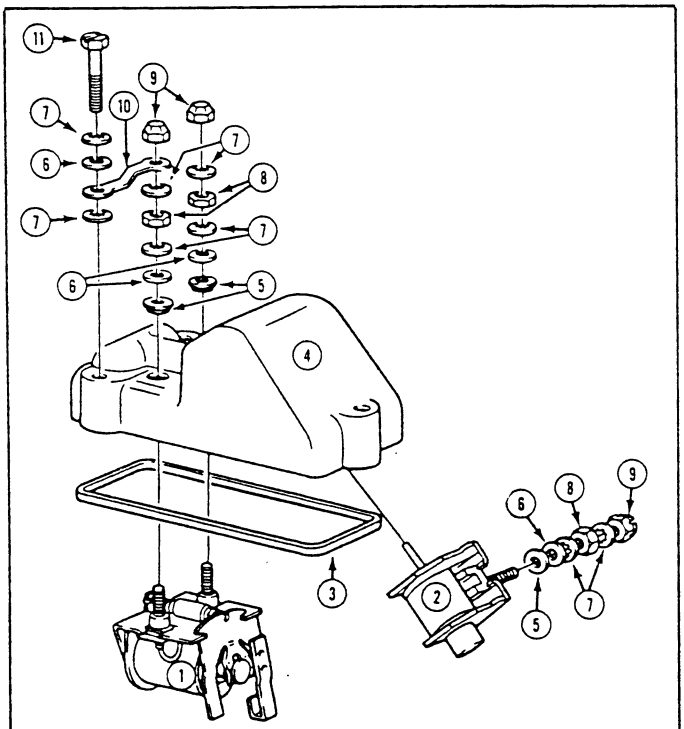


Fig. 6C5-36 Injection Pump Solenoids

1. Remove the pump cover, see "Pump Cover Seal."
2. Remove the terminal contact nut(s) and remove the solenoid from the cover noting the position of any insulating washers.

Installation

1. Place the solenoid in the cover making certain on the shut-off solenoid that the linkage is free, and on the Housing Pressure Cold Advance solenoid that the plunger is centered so that it will contact the fitting check ball.
2. Place the insulating washers on the terminal studs (where used) and install the terminal nuts. Tighten the nuts to 1.13-1.69 N·m (10-15 lbs.-in.).
3. Check the operation of the solenoid prior to installing the pump cover with the use of a 12V (min) DC power source. Make certain that the shut-off linkage is free if that solenoid was replaced.
4. Install the pump cover, see "Pump Cover Seal," Steps 9 through 19.

INJECTION PUMP OFF-CAR SERVICE

For pump removal and installation, see "Injection Pump and Lines," except installation Steps 13 and 14.

Mount the injection pump in a suitable fixture such as BT-8046 or J-29692-B. **DO NOT** clamp the injection pump flange in a vise.

Off-car pump service operations require a leak test after repair, see "Pressure Testing."

TIMING LINE COVER GASKET

Fig. 6C5-37

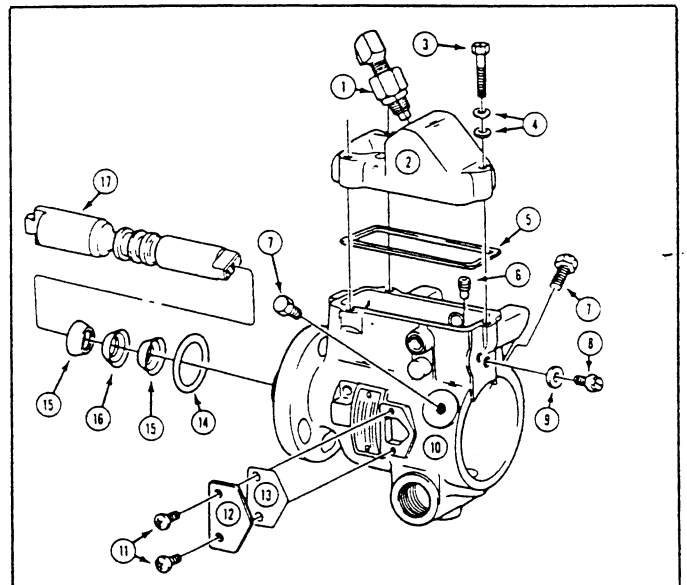


Fig. 6C5-37 Pump Housing and Drive Group

Removal

1. Remove the 2 screws, cover and gasket.

Installation

1. Install the gasket, cover and two screws, tighten the screws to 1.5-2.5 N·m (15-20 lbs.-in.).

ADVANCE PIN HOLE PLUG SEAL

Fig. 6C5-38

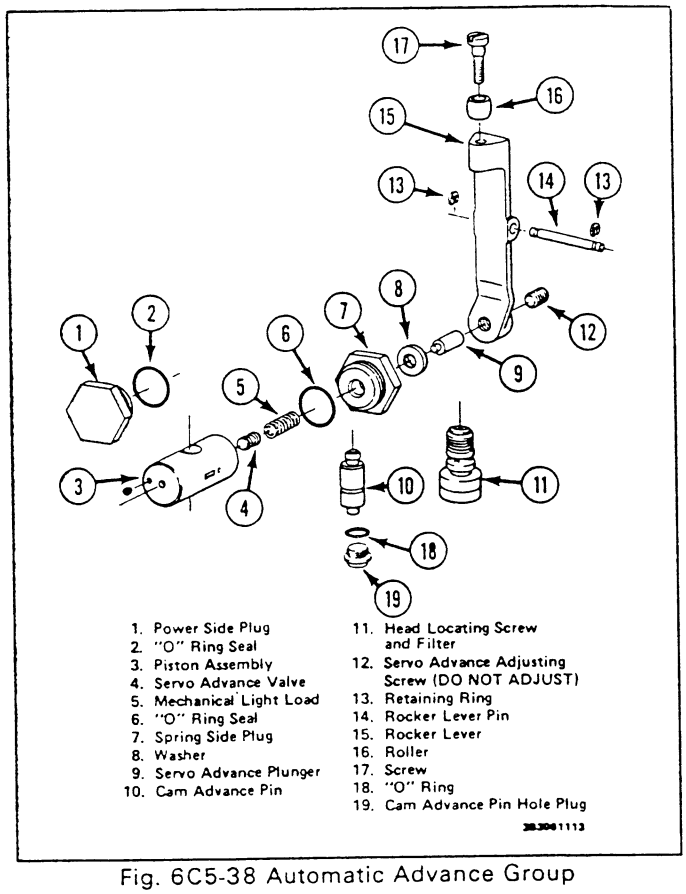


Fig. 6C5-38 Automatic Advance Group

Removal

1. Tap the advance pin hole plug lightly with a hammer to loosen.
2. Loosen and remove the plug, remove the seal and do not reuse it.

Installation

1. Lube a new seal and install it on the plug.
2. Install the plug and tighten it to 8.5-11.0 N·m (75-100 lbs.-in.).

AUTO ADVANCE SEALS

Fig. 6C5-38

Removal

1. Remove the rocker lever by removing the retaining rings and lever pin.
2. Remove the advance pin hole plug as stated in "Advance Pin Hole Plug."
3. Remove the spring side advance piston hole plug.
4. Remove the plug, piston, spring and slide washer.
5. Remove the power side advance piston hole plug.
6. Remove the plug, piston and slide washer.
7. Disassemble both plugs and pistons.
8. Pry the lip seal from the spring side plug.

Installation

1. Lube the new seals and reassemble as shown in Fig. 6C5-38. Use J-33081 to install the lip seal fully.
2. Tighten the plugs to 27 N·m (20 lbs.-ft.).
3. Install the advance screw hole plug using a new seal. Tighten to 8.5-11.0 N·m (75-100 lbs.-in.).
4. Install the rocker lever, lever pin and retaining rings.

HYDRAULIC HEAD SEAL

1. Remove the throttle shaft and seals, see "Throttle Shaft Seal Replacement."
2. Remove the metering valve (Fig. 6C5-45).
3. Remove the housing vent screw assembly (Fig. 6C5-37).
4. Remove the advance pin hole plug, see "Advance Pin Hole Plug."
5. Remove the advance pin (Fig. 6C5-38).
6. Locate the pump assembly and holding fixture so that the rear of the pump is sloping down and remove the head locating screws and seal (Figs. 6C5-36 and 6C5-37).
7. Using a twisting motion, remove the hydraulic head assembly. Remove the "O" ring seal.

Installation

1. Install a new hydraulic head seal and lube it.
2. Locate and line up together the "Dots" on the rotor slot and drive shaft tang.
3. Install the head assembly into the pump housing, lube and install the two head locking screws finger tight. Turn the pump upside down.
4. Clean the advance piston filter screen.
5. Lube and install a new seal on the head locating screw and install the screw tightening it to 20-25 N·m (15-18 lbs.-ft.) (Fig. 6C5-38).
6. Tighten the head locking screws to 20-25 N·m (15-18 lbs.-ft.) (Fig. 6C5-37).
7. Install the advance pin (Fig. 6C5-38).
8. Install the advance pin hole plug and seal, see "Advance Pin Hole Plug."
9. Move the pump so the cover opening is up, and install the metering valve.
10. Install the housing vent screw assembly (Fig. 6C5-37).
11. Install the throttle shaft, seals and pump cover, see "Throttle Shaft and Seals."

GOVERNOR WEIGHT RETAINER RING

A vehicle that suddenly develops a rough running condition especially noticeable at idle or a vehicle that will not start or run may have a broken governor weight retainer ring. A vehicle that will not run may have black particles plugging the fuel return check valve. Remove the check valve. If small particles are observed, proceed to confirm the findings as follows:

1. Remove the injection pump cover, see "Pump Cover Seal and/or Guide Stud Seal Replacement."

2. Rotate the governor weight retainer in both directions with your fingers or a suitable screwdriver. If the weight retainer moves more than 1.6 mm (1/16 inch) and does not return with pressure removed, the governor weight retainer ring has failed. (Failed ring will normally result in about 6.35 mm (1/4 inch) movement.)

   If the ring has failed:

1. Remove the hydraulic head and seal, see "Hydraulic Head Seal."
2. Remove governor cage retaining ring.
3. Remove governor weight retainer assembly. If the pins on the retainer are damaged, replace the retainer to prevent damaged pins from cutting the retainer ring.
4. Flush and clean the pump and all parts (except the head assembly. Examine the shoes and rollers and remove particles.

Assembly

1. Install new governor weight retainer ring.
2. Install the hydraulic head (see "Hydraulic Head Seal Installation").

DRIVE SHAFT SEAL REPLACEMENT

Fig. 6C5-37.

Removal

1. Remove the shaft from the pump with a rotating motion while pulling on the shaft.
2. Remove the shaft and seals.

Installation

1. Clean the shaft.
2. Lubricate the seal installer tool J-29745-A.
3. Install one black seal.
4. Relubricate the seal installation tool, and install the red seal.
5. Relubricate and install the last black seal.
6. Reinstall the shaft, making sure that the drill points on the shaft end and the rotor are matched.
7. Use a rotating motion when installing the shaft to prevent rolling the lip of the seals.
8. Pressure test the pump assembly.

PRESSURE TESTING

1. Drain all fuel from the pump.
2. Connect an air line to the pump inlet connection. Be certain that the air supply is clean and dry.
3. Seal off the return line fitting and completely immerse the pump in a bath of clean test oil.
4. Raise the air pressure in the pump to 137.9 kPa (20 psi). Leave the pump immersed in the oil for 10 minutes to allow any trapped air to escape.
5. *Air may leak from the high pressure outlet fittings, this is normal.* If the pump is not leaking, reduce the air pressure to 13.8 kPa (2 psi) for 30 seconds. If there is still no leak increase the pressure to 137.9 kPa (20 psi). If still no leaks are seen, the pump is ready for use.

INJECTION NOZZLES

INJECTION NOZZLE REMOVAL

Removal

When lines are removed use a back-up wrench on the upper injection nozzle hex.

NOTICE: Always cap the nozzle and lines to prevent damage of contamination.

1. Remove nozzle by applying torque to the largest nozzle hex (Fig. 6C5-39 or 6C5-40).

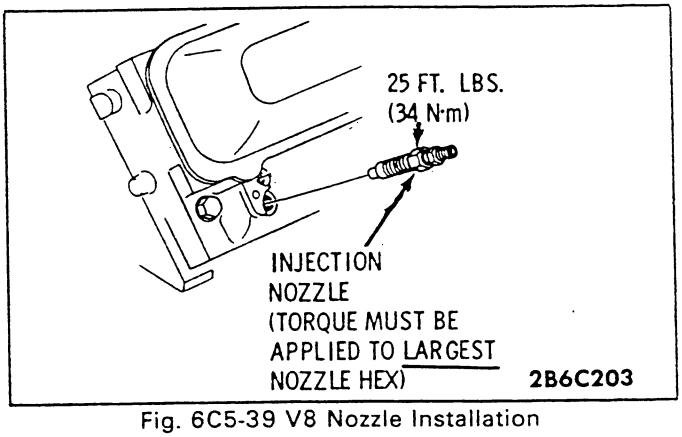


Fig. 6C5-39 V8 Nozzle Installation

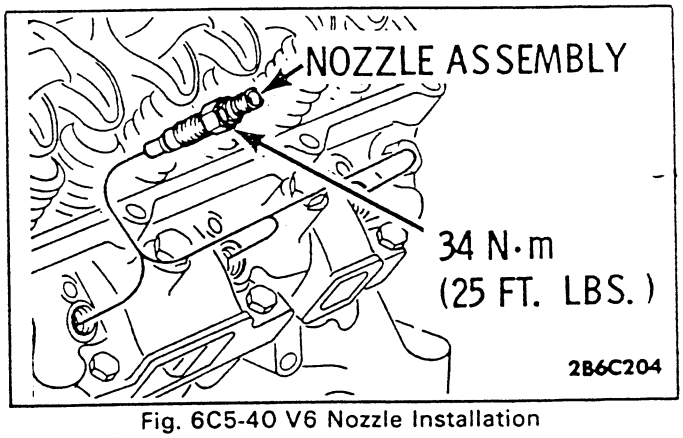


Fig. 6C5-40 V6 Nozzle Installation

2. Remove copper nozzle gasket from the cylinder head if the gasket did not remain on the nozzle.

Installation

The V8 nozzle uses a blue color band and the V6 uses a red color band. Refer to Fig. 6C5-41 If the color band is lost, it is possible to identify a nozzle from the part numbers stamped on the inlet fitting hex. One o the numbers stamped will be a set of three, either 40 or 404. 403 is a V6 and 404 is a V8 nozzle.

1. Remove protective caps from nozzle (if installed after testing).
2. Make sure copper nozzle gasket is installed on th nozzle.
3. Install the nozzle and tighten it to 34 N·m (2 lbs.-ft.). Torque must be applied to the large nozzle hex.

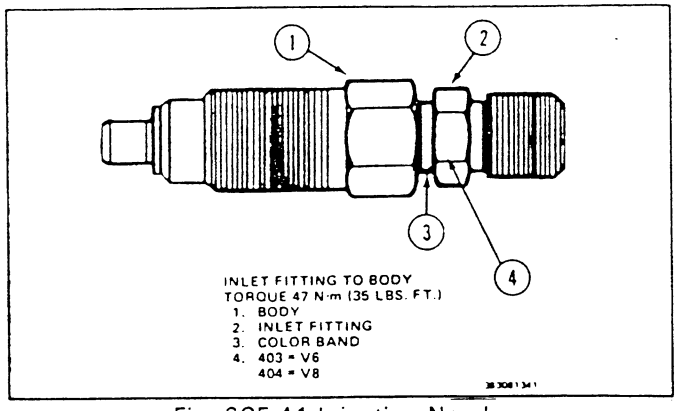


Fig. 6C5-41 Injection Nozzle

4. Attach the lines using a back-up wrench on the upper injection nozzle hex. Tighten the line nut to 34 N·m (25 lbs.-ft.) (Figs. 6C5-22 or 6C5-23.

DIESEL INJECTION NOZZLE TESTING

When a malfunction occurs where the injection nozzles are suspected as the cause, they may be tested as follows.

The most important checks on nozzles are seat tightness and opening pressure. When a nozzle passes these tests the spray pattern with the nozzle in the engine is nearly always satisfactory.

1. Check the torque of the inlet fitting to nozzle body (Fig. 6C5-41).
2. Clean the carbon from the tip of the nozzle with a soft brass wire brush.
3. Assemble nozzle to tester.
   a. Use SAE J967D calibrating oil at room temperature, approximately 70°F (20°C).

   CAUTION: Do not use diesel fuel. Diesel fuel is unstable with respect to corrosion inhibition and may cause skin problems.

   b. Use a connecting line from the nozzle to the tester 12 in. long by 1/4 in. O.D. by 1/16 in. I.D.
   c. Refer to the equipment manufacturers instructions for exact test procedures.
4. TEST SPECIFICATIONS
   a. OPENING PRESSURE – The pressure control valve should be slightly opened and the handle of the test equipment operated at a slow rate (between three and six seconds for one full stroke) to determine the actual opening pressure of the nozzle. The nominal opening pressure on new nozzles is;

      V8 6 895 kPa (1000 psi) blue color band

      V6 5 516 kPa (800 psi) red color band

      The opening pressure on a used nozzle may be about 1034 kPa (150 psi) less.
   b. SPRAY PATTERN –

NOTICE: Close the pressure gage for this test or the gage could be damaged.

CAUTION: Test fuel spray is flammable. Keep vapor away from open flames or personal injury could result.

CAUTION: When testing nozzles, do not place your hands or arms near the tip of the nozzle. The high pressure atomized fuel spray from a nozzle has sufficient penetrating power to puncture flesh and destroy tissue and may result in blood poisoning. The nozzle tip should always be enclosed in a receptacle, preferably transparent, to contain the spray. (Rags in the bottom of the container will reduce chances of splash).

1. Operate the handle of the nozzle tester at a rate of 2 seconds per stroke.
2. The spray pattern should be atomized near the tip. Any solid column of fuel or small droplets forming near the tip make the pattern unacceptable.
   c. SEAT TIGHTNESS – Slightly open the pressure gage for this test. The line pressure should first be allowed to fall to at least 290 psi (2 000 kPa) BELOW the **actual** opening pressure (Step 4a). Dry the nozzle tip with compressed air then increase the line pressure to 150 psi (1 034 kPa) BELOW the **actual** opening pressure (Step 4a). Maintain this pressure for five seconds. After 5 seconds, patterns 1, 2 and 3 are acceptable, patterns 4 and 5 are not acceptable (Fig. 6C5-42).

CLEANING POPPET NOZZLES

Fig. 6C5-43

1. Remove and discard the old copper sealing washer from the tip of the injector using a pair of diagonal cutters as shown in Fig. 6C5-44. Be careful not to damage the nozzle tip when doing this.
2. Flush the exterior of the nozzle, holding the tip up to prevent dirt from entering the inlet. Remove all loose dirt and carbon.
3. Disassemble the injection nozzle as follows:

NOTICE: The parts of each nozzle assembly are preset and calibrated to meet certain specifications. Therefore, DO NOT mix up the parts of each nozzle.

   a. Unscrew the inlet fitting from the body and press the nozzle tip assembly out of the body being careful not to damage nozzle tip (Fig. 6C5-46).
   b. Remove the retainer by sliding the retainer sideways to release the retainer from the valve.
   c. Remove the spring seat and spring and press the valve from the spray tip (see Fig. 6C5-46).

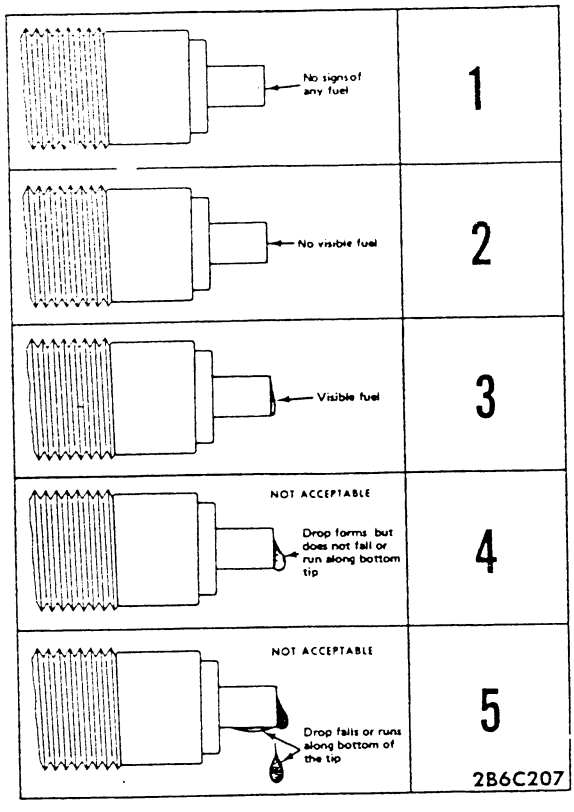


Fig. 6C5-42 Nozzle Seat Tightness Check

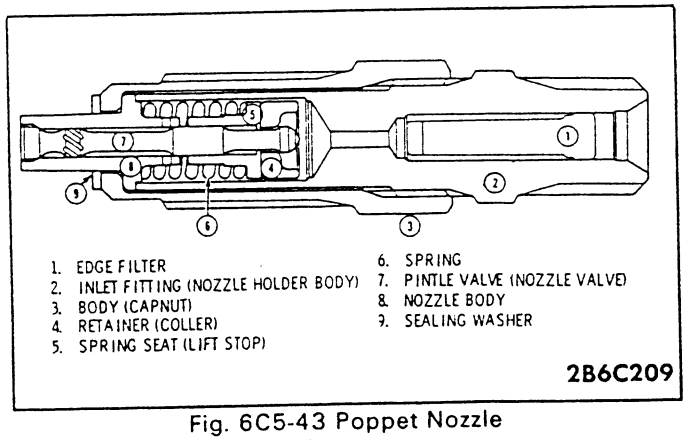


Fig. 6C5-43 Poppet Nozzle

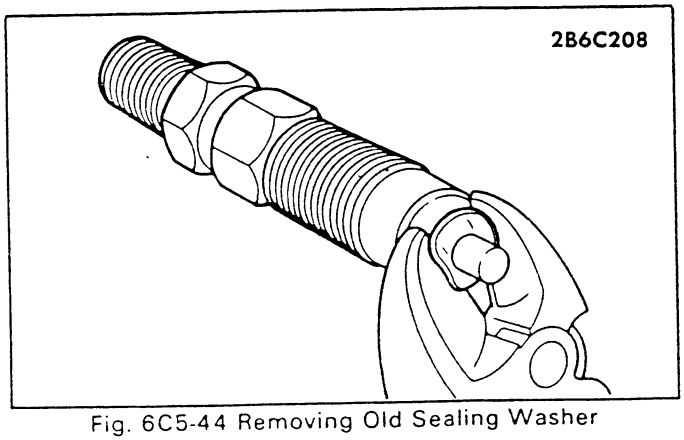


Fig. 6C5-44 Removing Old Sealing Washer

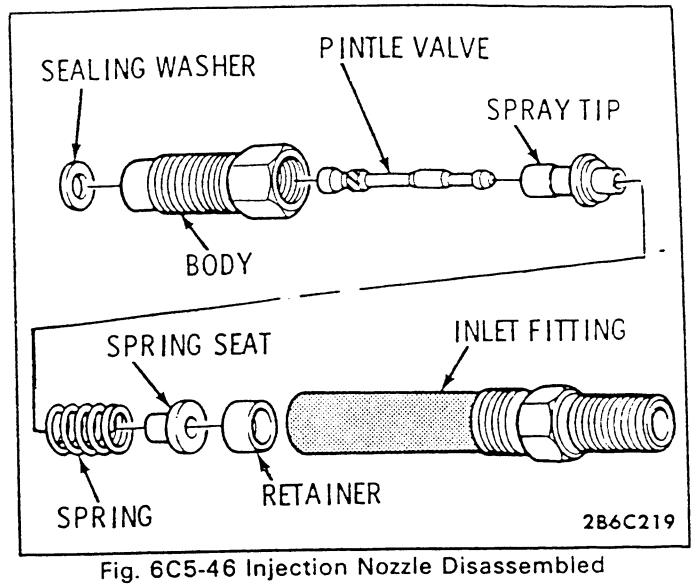


Fig. 6C5-46 Injection Nozzle Disassembled

4. Clean all of the disassembled pieces of the injection nozzle. Use sonic bath cleaner BT-8041, J-29653 or equivalent. If a sonic bath cleaner is used, the parts should remain in the cleaner until they are clean as evidenced by the carbon being removed from the tip of the valve.
5. The components of each injection nozzle are closely matched. DO NOT mix the components of the injection nozzle, keep each nozzle separated (Fig. 6C5-47).

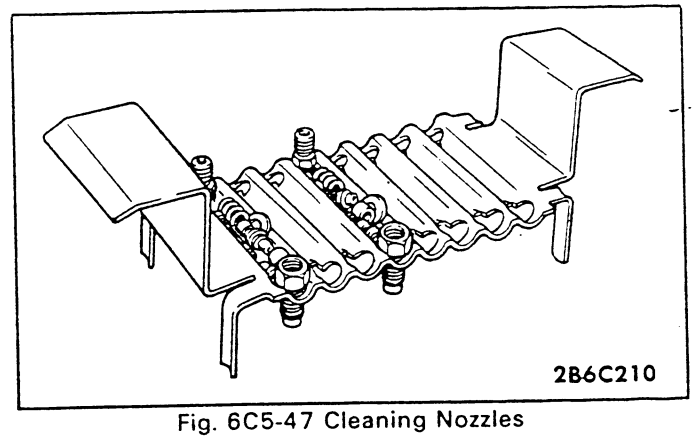


Fig. 6C5-47 Cleaning Nozzles

6. Visually inspect all of the components for cleanliness and damage. The tip of the valve and the interior of the spray tip must be examined very closely. These areas must be completely free of contamination to be satisfactory.
7. If the components are visually satisfactory assemble the injector as follows: (Refer to Figs 6C5-43 and 6C5-46.)
   a. Insert the valve into the spray tip.
   b. Install the spring, spring seat and retainer
   c. Using a clean, unpainted piece of steel as base, compress the spring and lock th retainer by pushing on the retainer an sliding the retainer to a center position afte the spring has been compressed. This can b done either by hand or using assembly too BT-8018 or J-29653-3 (Fig. 6C5-48). Afte

assembly, rotate the retainer with respect to the tip, by hand, to assure proper assembly.

8. Install the nozzle tip assembly into the body. Screw the inlet fitting into the body assembly and tighten to 47 N·m (35 lbs.-ft.).

9. Test the nozzle as outlined in "Nozzle Testing."

10. Install a new copper washer before assembling into the engine. It may be necessary to crimp the washer slightly to create an interference fit so that it will not fall off.

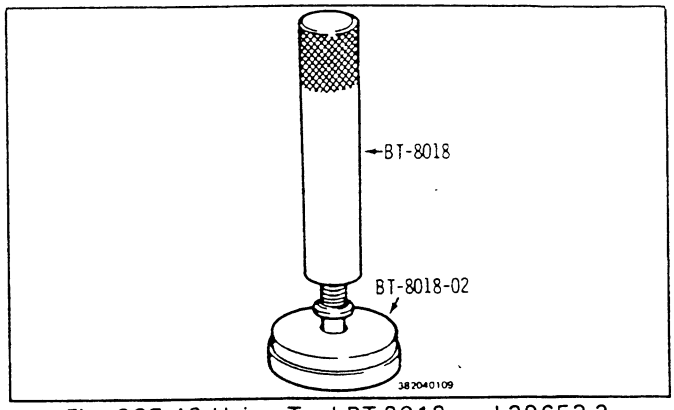
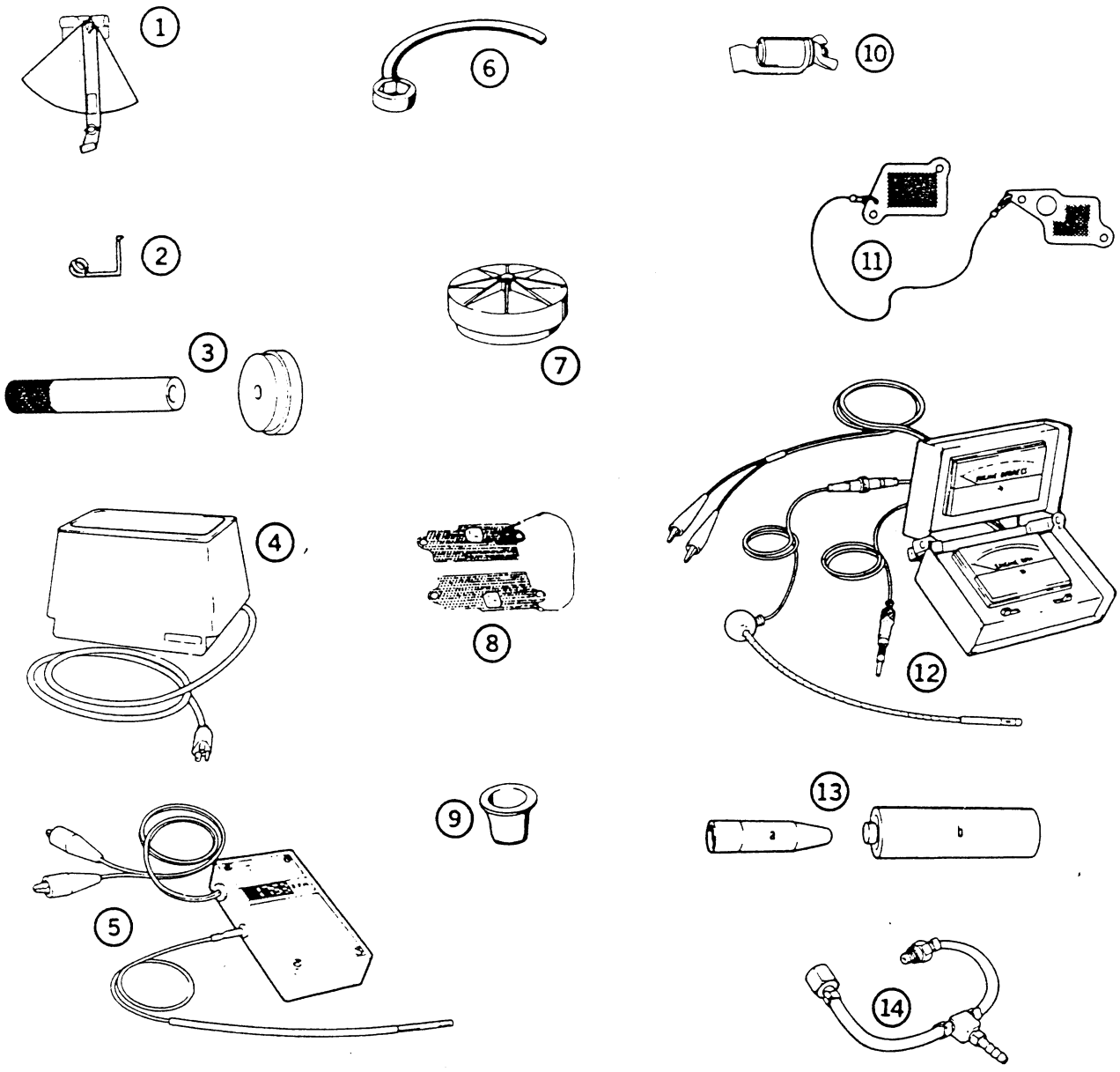


Fig. 6C5-48 Using Tool BT-8018 or J-29653-3

TORQUE SPECIFICATIONS

APPLICATION	N•M (LBS.FT.)
Air Crossover to Intake Manifold	
V8	30 (22)
V6	32 (24)
Fuel Filter	
Inlet Fitting – V8	27 (20)
Outlet Fitting – V8	18 (15)
Inlet Fitting – V6	26 (19)
Outlet Fitting – V6	15 (11)
Fuel Injection Line to Nozzle or Pump	34 (25)
Injection Nozzle to Cylinder Head	34 (25)
Injection Nozzle Inlet Fitting to Body	47 (35)
Injection Pump Inlet Line Fitting	15 (11)
Injection Pump Outlet Line Fitting	13 (10)
Injection Pump	
Advance Pin Hole Plug	11 (100 lbs.-in.)
Advance Side Plugs	27 (20)
Cover Screws	3.7 (33 lbs.-in.)
Fuel Return Line Connector	5 (48 lbs.-in.)
Guide Stud	9.5 (85 lbs.-in.)
Head Locating and Locking Screws	25 (18)
Solenoid Terminal Nuts	1.69 (15 lbs.-in.)
Throttle Shaft Advance Cam Screw	2.5 (20 lbs.-in.)
Timing Line Cover Screws	2.5 (20 lbs.-in.)
Vacuum Regulator to Pump Screws	6 (53 lbs.-in.)



1.	BT-7704 or J-26701	ANGLE GAGE
2.	BT-7944 or J-26701-15	ANGLE GAGE ADAPTER
3.	BT-8018 or J-296523	NOZZLE ASSEMBLY TOOL
4.	BT-8041 or J-29653	ULTRA SONIC NOZZLE CLEANER
5.	J-26925	TACHOMETER
6.	J-26987	INJECTION PUMP WRENCH
7.	J-26996-1	AIR CROSSOVER COVER
8.	J-26996-10	MANIFOLD COVER SCREENS
9.	J-28438	PLASTIC PLUGS - PUMP LINES & NOZZLES
10.	J-29601	INJECTION PUMP THROTTLE SHAFT CAM TIMING ADAPTER
11.	J-29657	MANIFOLD COVER SCREENS -
12.	J-33075	TIMING METER
13.	a. J-29745-A	DRIVE SHAFT SEAL PROTECTOR
	b. J-33081	ADVANCE PLUNGER SEAL INSTALLER
14.	J-34151	INJECTION PUMP HOUSING PRESSURE ADAPTER

Tools are available from General Motors Dealers

383111694

Fig. 6C5-49 Tools – VIN N and V