GENERAL MOTORS DIESEL FUEL INJECTION

DESCRIPTION

Diesel mechanical fuel injection systems differ greatly from electronic fuel injection systems. In this diesel system, a mechanical high pressure rotary pump, gear driven by the camshaft at camshaft speed, injects a precisely metered amount of fuel to each cylinder at the proper time. The pump is mounted on top of the engine and provides necessary timing advance under all operating conditions.

Eight high pressure fuel pipes carry fuel from pump to an injection nozzle in each cylinder. All eight pipes are exactly the same length to ensure that there is no variance in timing. Engine RPM is controlled by a rotary fuel metering valve. As the accelerator pedal is pushed down, a throttle cable opens the metering valve and allows increased fuel delivery. A built-in low pressure transfer pump delivers fuel to the main injection pump.

A fuel filter is located between the mechanical fuel pump (mounted on the side of the engine block) and the injection pump. Any excess fuel is returned to the tank by a fuel return system.

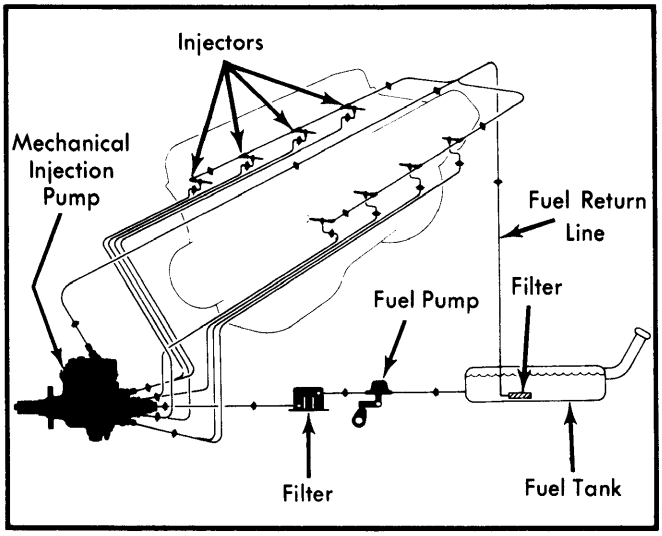

Fig. 1 Diesel Injection System Fuel Circuit

OPERATION

AIR INDUCTION SYSTEM

An air crossover housing is located on top of the engine over the injection pump. It is bolted to the intake manifold with 4 bolts and serves as the only air inlet in the system. No fuel passes through the crossover. It is an open-chambered housing with a single inlet drawing air through an air filter assembly mounted above. The crossover unit has two branches, one leading to each side of the intake manifold. Gaskets are installed between crossover and manifold to prevent vacuum leaks. Federal and California models use different crossovers to accomodate specific EGR systems. Starter fluid should never be used or sprayed into crossover. If crossover is removed, air screens must be installed.

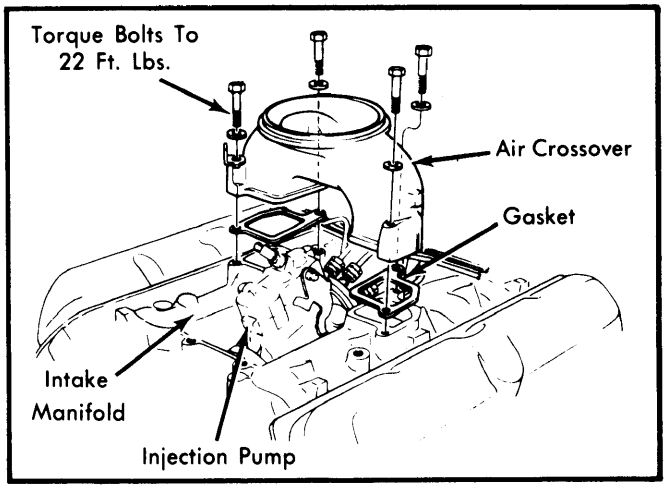

Fig. 2 Air Crossover Assembly (Federal Models)

FUEL TANK-TO-PUMP SYSTEM

Diesel fuel, NOT gasoline, is drawn from the fuel tank by an engine mounted mechanical fuel pump. This pump is driven by an eccentric cam mounted on the crankshaft and puts out about 5½-6½ psi to the main injection pump. A small screen type filter is located in the fuel tank at the pickup. A larger sealed 11-12 micron fuel filter is located on the rear of the engine between fuel pump and main injection pump. Diesel fuel arrives at the center inlet fitting on the injection pump after leaving the filter. A fuel return line is provided to return any excess fuel to the tank.

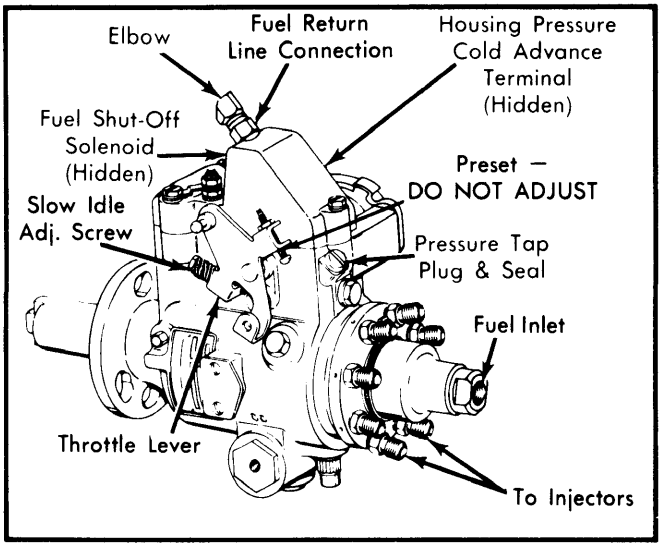

Fig. 3 Diesel Injection Pump

DIESEL INJECTION PUMP

The high pressure diesel injection pump is mounted to the top of the engine below the air crossover. The pump is cam driven at speed equal to the camshaft. Because of this, the pump can precisely govern time and amount of fuel injection.

A built-in fuel pressure regulator and transfer pump picks up fuel at the pump inlet, and pushes it through a passage to the

GENERAL MOTORS DIESEL FUEL INJECTION (Cont.)

pump head. The pump head distributes fuel, still at transfer pump pressure (8-12 psi), to metering valve, governor and automatic advance mechanisms. Fuel then passes to the rotary fuel metering valve and into a charging passage. As the pump shaft rotates, fuel is fired, under high pressure, through each delivery pipe to an injector. The pump is not serviceable and must be exchanged in case of a malfunction.

FUEL DELIVERY PIPES

Eight high pressure pipes are routed from injection pump to an injector in each cylinder. The pipes are of equal length but are bent differently to achieve this equal length. Pipes are not interchangeable and are pre-bent by the manufacturer.

GLOW PLUGS

Glow plugs are small heaters provided to assist in cold starting. The glow plug controller and relay cycle 12 volts to these 6 volt heaters, which causes them to heat rapidly. After the engine starts, the glow plugs remain on for about a minute, then shut off. If the ignition is turned on and the engine is not started, the glow plugs will continue to cycle until the batteries are discharged.

CAUTION — *Do not manually by-pass glow plug relay, or glow plugs will be ruined instantly.*

NOTE — *A burned out FAST GLOW glow plug tip may break off and drop into the pre-chamber when removed. Cylinder head must be removed and pre-chamber removed from head to remove broken tip.*

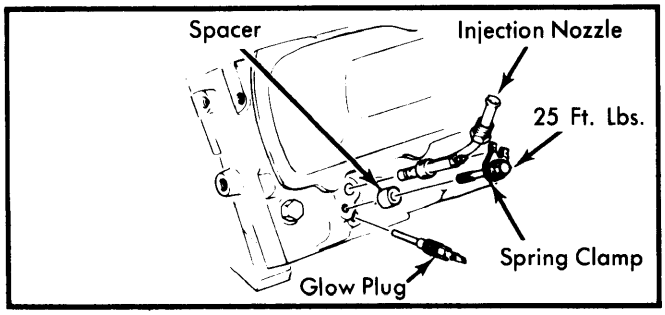

Fig. 5 Glow Plug and Injection Nozzle Location (Federal Model)

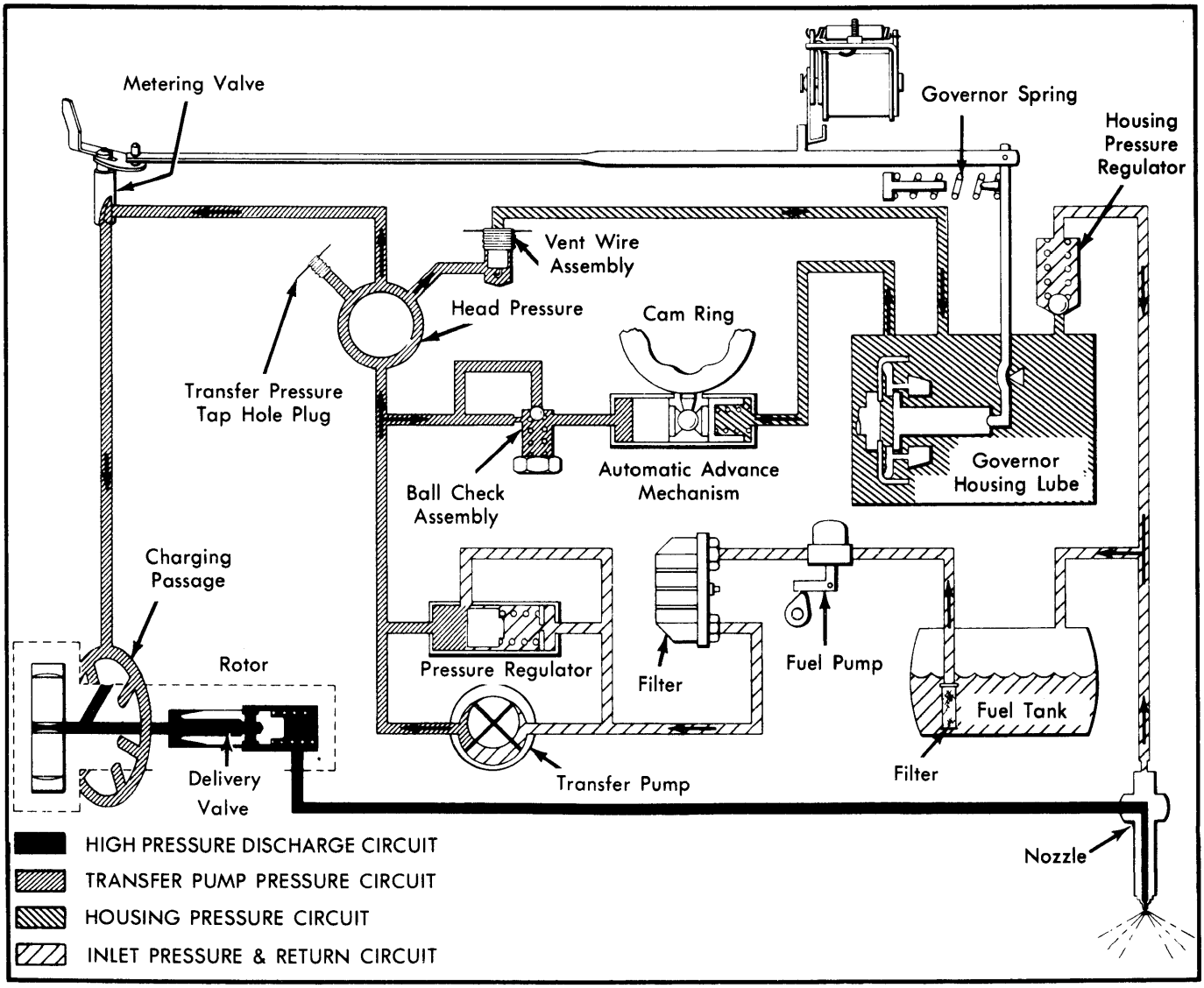

Fig. 4 Diesel Injection Pump Fuel Circuit Diagram

GENERAL MOTORS DIESEL FUEL INJECTION (Cont.)

INJECTION NOZZLES

Diesel Equipment/C.A.V. Lucas – One injection nozzle is located in each combustion chamber. It has a single fuel inlet fitting and is threaded into the cylinder head as are the glow plugs. Injection nozzles are spring loaded and calibrated to open at specified fuel line pressure. The combustion chamber end of the nozzle has a replaceable copper compression seal.

Two types of injection nozzles are used. The inlet fitting in the body of the injector must be tightened to the correct torque when installed or checked.

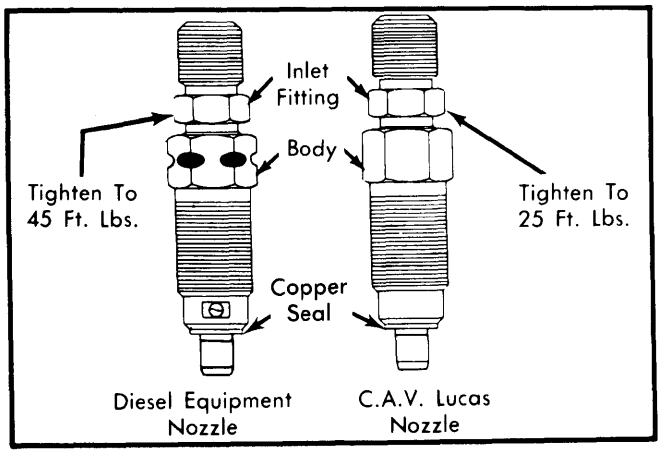

Fig. 6 Diesel Injection Nozzle Identification (California Models)

Roosa-Master – One injection nozzle is located in each combustion chamber. It has a single fuel inlet fitting and a return line for removal of excess fuel. Nozzle is retained in head by a bolt and clamp and is not threaded as glow plugs are. Injection nozzles are spring loaded and calibrated to open at a specified fuel pressure. The engine end of nozzle has a replaceable compression seal and carbon stop seal.

NOTE – *Never try to interchange pickup and passenger car injectors.*

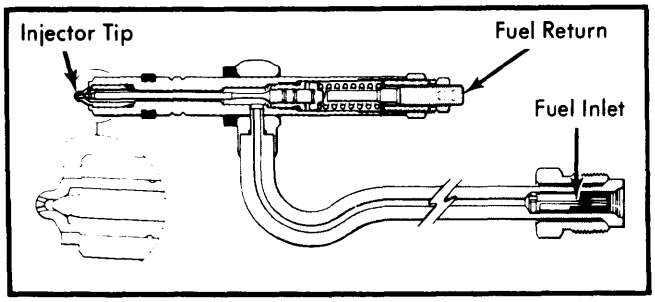

Fig. 7 Cutaway View of Roosa-Master Injection Nozzle (Federal Models)

VACUUM PUMP

Vacuum to operate accessory systems on diesel vehicles is provided by a vacuum pump which is located at the rear of the block and driven by the cam. The engine should never be operated without the vacuum pump in place as it is also the oil pump drive.

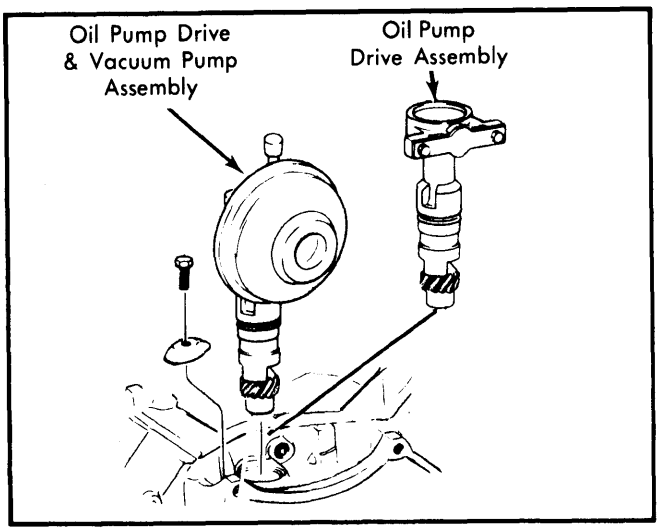

Fig. 8 Vacuum and Oil Pump Drive Units

HOUSING PRESSURE COLD ADVANCE (HPCA)

The HPCA is used to improve cold starting and emission control. The solenoid is controlled by the engine temperature switch and advances injection timing by 3° when the engine is cold. It does this by decreasing the housing pressure from 10 psi to zero. At the same time, the fast idle solenoid is activated. When the temperature switch opens (125° F), the HPCA solenoid is de-energized and housing pressure rises, retarding pump timing.

DIESEL FUEL HEATER (OPTIONAL)

This option is used to heat the fuel during low temperature (below 20° F) operation. This prevents wax crystals from building up and blocking the fuel filters. The filter is located along the right side of the intake manifold and uses a resistance wire spiralled around the fuel line. The filter has a bypass valve which allows fuel to flow to the fuel heater when the filter is covered with wax.

TESTING

GLOW PLUG RESISTANCE TEST

1) Start engine and allow to warm up; then remove all glow plug wires. Using idle speed screw on side of injection pump, adjust idle to roughest speed (but do not exceed 900 RPM). Allow engine to run for 1 minute.

2) Attach jumper wire between voltmeter ground lead and engine lift point on left side of intake manifold. DO NOT use any other point for ground connection. Check resistance by touching positive lead of voltmeter to glow plug terminals (with engine running). Write down values obtained in firing order sequence (1-8-4-3-6-5-7-2).

3) If ohm reading on any cylinder is about 1.2-1.3 ohms, make a compression check on that cylinder before continuing fuel injection diagnosis. Most cylinders should measure between 1.8-3.4 ohms. If more than .3 ohms difference is observed between

GENERAL MOTORS DIESEL FUEL INJECTION (Cont.)

2 consecutive cylinders in firing order, remove injectors and check opening pressure.

4) To improve rough idle, switch nozzles as necessary. Install nozzles with a higher opening pressure to lower ohm reading, and a lower opening pressure to raise ohm reading. A change of about 30 psi will vary ohm reading by .1 ohm.

5) Repeat procedure to confirm idle improvement. Be sure to check glow plug resistance at the same idle speed both times. If no improvement is observed, injection line replacement or injection pump calibration may be necessary.

INJECTION PUMP HOUSING FUEL PRESSURE

1) Remove air crossover assembly. Install screened covers over openings in intake manifold.

2) Remove pressure tap plug from injector pump. See *Fig. 3.*

3) Place seal from pressure tap plug onto pressure tap adapter (J-28526 or equivalent). Screw adapter into pump housing in place of plug.

4) Connect a low pressure gauge to adapter. Install magnetic pickup tachometer.

5) Start engine. Run engine at 1000 RPM with transmission in PARK. Observe gauge.

6) Pressure should be 8-12 psi with no more than 2 psi fluctuation.

7) If equipped with HPCA and pressure is zero, remove electrical connector from HPCA. If pressure remains zero, remove injection pump cover and check advance solenoid for binding and replace parts as needed.

8) If pressure returned to normal with HPCA electrical connector removed, check operation of temperature switch.

9) If pressure is still high, fuel return system may be restricted. Remove fuel return line at injection pump. Install fitting and short piece of hose to allow fuel return to empty into small container.

10) If pressure is lower, correct restriction in fuel line. If pressure still high, replace fuel return line connector assembly.

11) Recheck pressure. If pressure is still not correct, remove injection pump for repair. Pump is not serviceable and must be exchanged for another unit.

12) Remove tachometer, pressure gauge and adapter. Install a NEW pressure tap plug seal on plug. Install tap plug into pump.

13) Remove screened covers from manifold. Install air crossover assembly.

INJECTION NOZZLE

CAUTION — *Do not use a steel brush or a motorized brush to clean nozzles. Damage to nozzle tip may result.*

Spray Pattern Test — **1)** Remove injection nozzles. Clean carbon from tip of nozzle with a soft brass brush. Check torque of inlet fitting to nozzle body and correct as necessary.

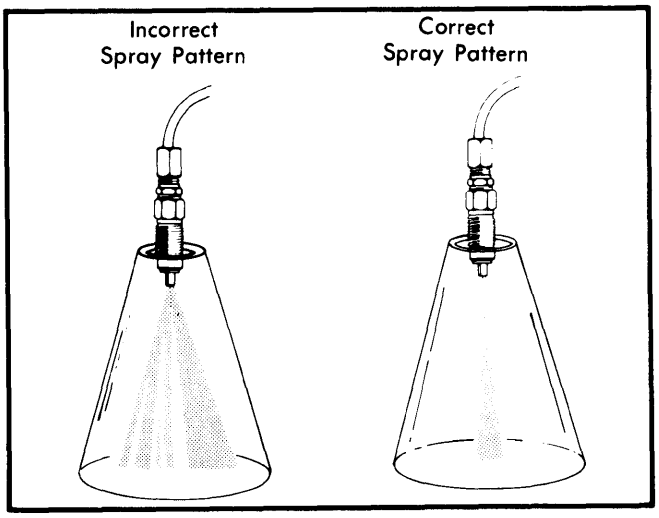

Fig. 9 Nozzle Spray Pattern Test

2) Assemble nozzle to a suitable diesel injection nozzle tester using a connecting line (high pressure) 12" long by ¼" O.D by 1/16" I.D. between nozzle and tester. Refer to test equipment manufacturers' instructions for exact tester operating instructions.

CAUTION — *When testing nozzles, keep spray contained to avoid serious injury. DO NOT allow injector to release line pressure on hands, arms or any part of body. Pressure of atomized test spray has sufficient penetrating power to puncture flesh.*

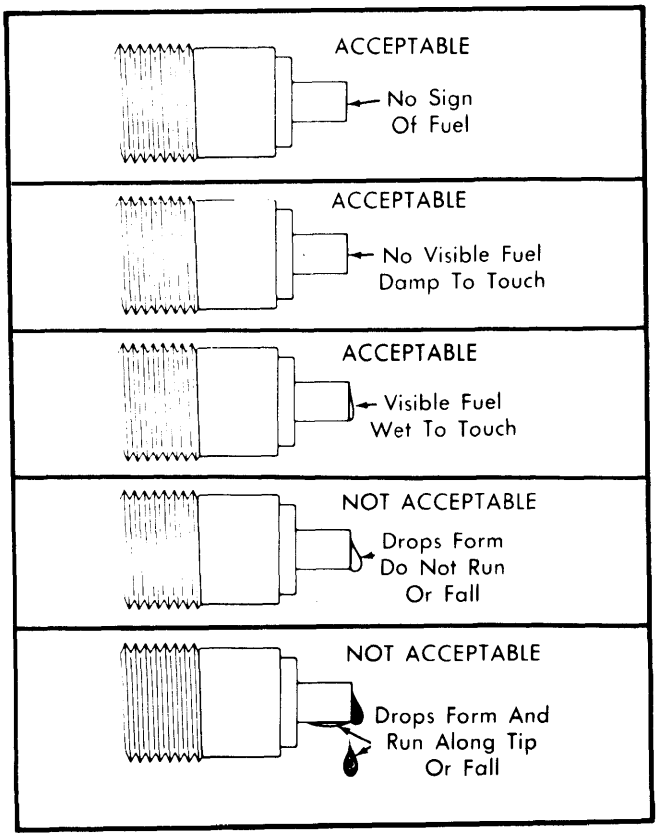

Fig. 10 Injection Nozzle Seat Tightness Test

GENERAL MOTORS DIESEL FUEL INJECTION (Cont.)

3) Build nozzle pressure slow enough to determine exact minimum opening pressure of nozzle. Minimum opening pressure is 1750-1900 psi (Roosa-Master) or 870 psi (Diesel Equipment/C.A.V. Lucas). When nozzle releases pressure, note spray pattern and compare with examples shown. If incorrect, or if a liquid stream, replace nozzle. *See Fig. 9.*

Seat Tightness Test – Decrease pressure to at least 290 psi BELOW actual opening pressure. Dry nozzle tip with compressed air, then increase pressure slowly to 1300-1400 psi (Roosa-Master) or 652 psi (Diesel Equipment/C.A.V. Lucas). Maintain pressure for 5 seconds and compare fuel leakage to examples. *See Fig. 10.*

Chatter Test – Operate tester rapidly to put nozzle under extreme load conditions. Chatter should be audible and should also be felt through handle of tester. Chatter does not occur in engine. It is an indication of valve freedom, proper seat width and interference angle.

Fuel Return Test – **1)** Loosen connector nuts and reposition nozzle tip slightly above horizontal plane. Tighten connector nuts and raise pressure to 1500 psi. Nozzle should not open. Maintain 1500 psi and observe fluid from nozzle return. After first drop forms on fuel return end of nozzle, there should be 3-10 more drops in 30 seconds.

2) Replace defective nozzles or have them serviced by manufacturer. Reinstall all nozzles carefully and tighten to recommended torque.

REMOVAL & INSTALLATION

NOTE – *Manufacturer does not recommend disassembly of pump. However, pump cover, guide stud, and throttle shaft seals may be replaced to eliminate leaks. For all other problems, pump must be removed and taken to an authorized repair station.*

INJECTION PUMP SEAL REPLACEMENT

1) Disconnect ground cables from both batteries, then remove air cleaner and crossover. Install screens over air intakes. Disconnect fuel return line and wiring from injection pump.

2) Clean injection pump cover and area around throttle rod and guide stud. Place rags in engine valley to catch fuel. Remove vacuum regulator valve, throttle rod, and return springs. Remove throttle cable bracket.

3) Install tool (J-29601) over throttle shaft with slots of tool engaging pin. Put spring clip of tool over throttle shaft advance cam and tighten wing nut. Without loosening wing nut, pull tool off shaft. This provides a reference for proper alignment during reassembly.

4) Drive pin from throttle shaft and remove advance cam and fiber washer. Remove any burrs that may have been caused by pin removal. Remove injection pump cover and remove screws from cover.

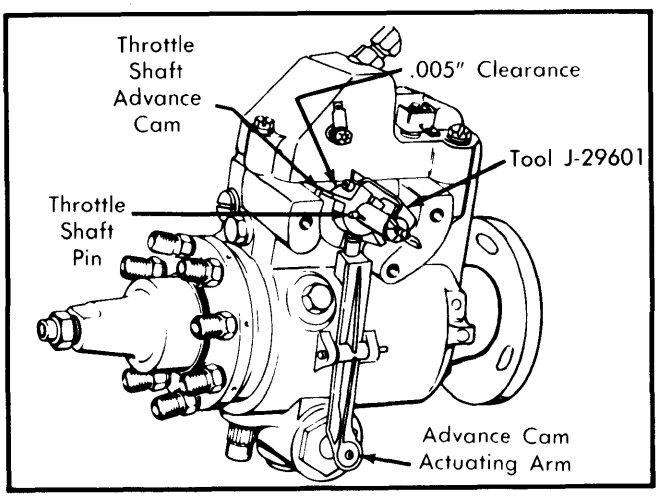

Fig. 11 Injection Pump With Advance Cam Tool Installed

CAUTION – *Do not allow any dirt or foreign objects to drop into injection pump. Engine damage will result.*

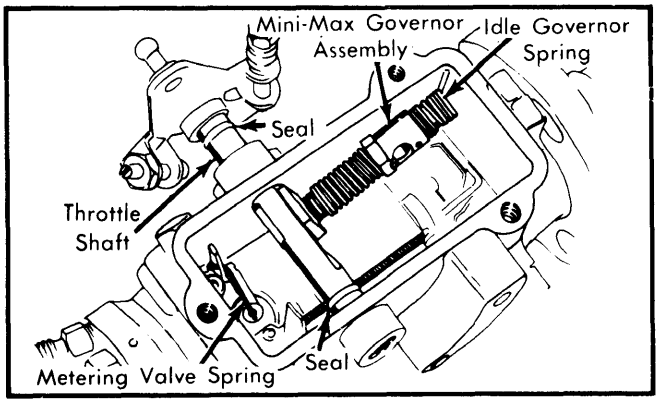

Fig. 12 Injection Pump With Cover Removed

5) Note position of metering valve spring over top of guide stud. This position must be exactly duplicated during reassembly. Remove guide stud and washer, then rotate mini-max governor assembly up and remove from throttle shaft.

6) Remove throttle shaft and inspect. If damaged or worn, replace. It may be necessary to loosen and rotate pump slightly to remove throttle shaft. Inspect shaft bushings. If replacement is necessary, pump must be sent to authorized repair dealer.

7) Remove throttle shaft seals. Do not cut off, as a nick on shaft will cause leakage. Coat new seals lightly with grease and install on shaft.

8) Slide shaft into pump until mini-max governor will slip onto throttle shaft. Rotate governor downward, hold in position, and side shaft and governor cam into place.

9) Install new fiber washer, throttle shaft advance cam (do not tighten screw) and throttle shaft drive pin. Realign advance cam in original position with tool (J-29601), place a .005" feeler gauge between fiber washer and cam, and tighten cam screw.

GENERAL MOTORS DIESEL FUEL INJECTION (Cont.)

10) Reinstall guide stud with new washer. Ensure that metering valve spring extension rides on top of guide stud. Tighten guide stud to 85 INCH Lbs.

11) Hold throttle in idle position and install new pump cover seal. Do not insert screws in cover; position cover slightly forward and above pump. Carefully move cover rearward and downward into position, taking care not to damage seal.

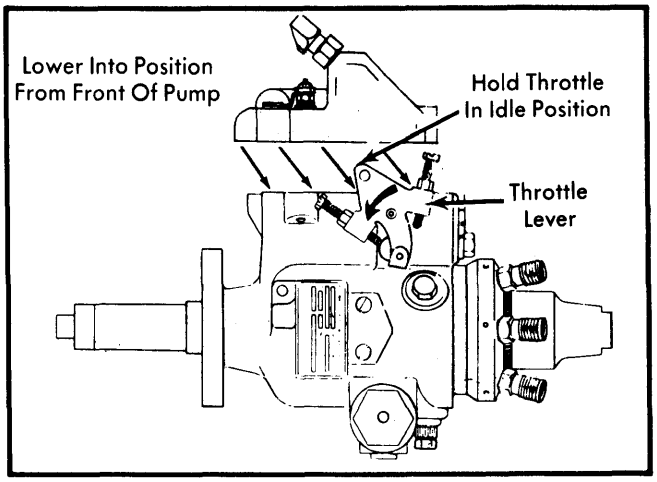

Fig. 13 Installing Injection Pump Cover

12) Insert screws, using flat and lock washers with flat washers against pump cover. Tighten to 33 INCH Lbs., then install vacuum regulator valve.

13) Connect battery ground cables, turn ignition on, and touch pink solenoid wire to solenoid terminal. A clicking sound should be heard as solenoid operates. If not, remove cover and check for solenoid operation.

CAUTION – *If clicking sound is not heard as solenoid wire is connected, DO NOT start engine. Throttle may be stuck in wide-open position.*

14) To check solenoid, ground solenoid lead opposite hot lead and connect pink wire. Turn ignition to "run" position. Solenoid should move linkage. If not, check that voltage across solenoid terminals is at least 12 volts. Replace solenoid if linkage does not move and voltage is 12 volts.

15) Repeat step **14)** and install cover. *See Fig. 13.*

16) If solenoid clicks, connect all wires to pump housing. Reinstall throttle cable bracket and throttle rod. Reinstall throttle cable and return springs.

17) Adjust pump timing and throttle linkage. Install fuel return line and check that all fuel lines are tight. Start engine and check for leaks. Allow engine to idle for several minutes to purge air bubbles and smooth out idle. It may be necessary to stop engine for several minutes to allow air to rise and be purged.

18) Adjust vacuum regulator valve. *See VACUUM REGULATOR VALVE LINKAGE ADJUSTMENT.* Replace air crossover.

AIR CROSSOVER

Removal – Remove air cleaner, then remove filters and pipes from air crossover. Remove bolts and washers and lift crossover from manifold. Place screened covers over intake manifold openings.

Installation – Reverse removal procedure. Torque air crossover bolts to 22 ft. lbs. Be sure to install new gaskets between crossover and intake manifold.

INJECTION PUMP FUEL LINES

Removal – 1) Remove air cleaner and crossover, then install screened covers (J-26996-2 California or J-26996-10 Federal) over openings in intake manifold.

2) Remove injection pump line clamps. It is not necessary to use a back-up wrench when removing lines from pump.

3) Remove injection pump lines and cap open lines.

4) Using a back-up wrench on upper injector nozzle hex, disconnect injection pump lines at nozzle inlet fittings.

5) It is not necessary to remove pump to replace a line(s).

Installation – 1) Install new injection pump line(s) loosely. Position line properly.

2) Torque all high pressure fuel lines to 25 ft. lbs.

NOTE – *Use a back-up wrench when tightening fuel lines to fuel inlet fittings on injector nozzles.*

3) Install line clamps. Start engine and check for fuel leaks.

NOTE – *If several lines are to be replaced, start by connecting lower lines first.*

4) Remove screened covers from intake manifold and install air crossover and air filter assembly.

INJECTION PUMP

Removal – 1) Remove air cleaner and crossover, then install screened covers over openings in intake manifold.

2) Disconnect throttle rod and return spring.

3) Remove bellcrank. Remove throttle and T.V. cables from intake manifold brackets. Position cables away from engine.

4) Remove lines to fuel filter and remove filter.

5) Disconnect fuel line at fuel pump. On models equipped with A/C, remove rear compressor brace.

6) Remove fuel line to injection pump.

7) Disconnect fuel return line at injection pump.

8) Remove injector fuel lines at pump, using 2 wrenches.

9) Use special wrench (J-26987 or equivalent) to remove 3 nuts securing injection pump. Remove pump and cap all open lines and nozzles.

Installation – 1) Position cylinder No. 1 at TDC by lining up crankshaft pulley mark with indicator. Remove caps placed over fittings.

GENERAL MOTORS DIESEL FUEL INJECTION (Cont.)

2) Line up offset tang on pump driveshaft with pump driven gear and install pump.

3) Install 3 nuts and lockwashers securing pump but DO NOT tighten yet.

4) Connect pump lines at nozzles and tighten to 25 ft. lbs. with TWO wrenches.

5) Connect fuel return line to injection pump.

6) Align mark on injection pump with line on adapter. Tighten retaining nuts to 18 ft. lbs.

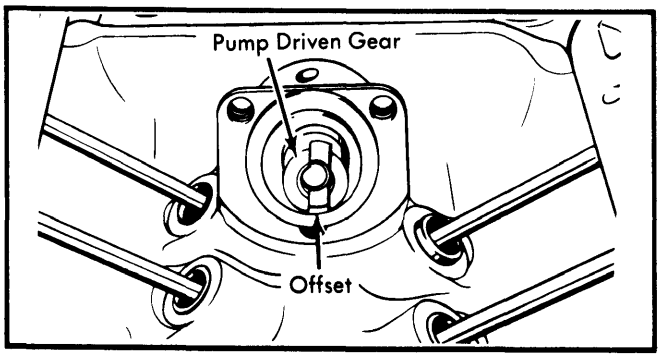

Fig. 14 Pump Driven Gear Offset at TDC (Shown with Intake Manifold Removed)

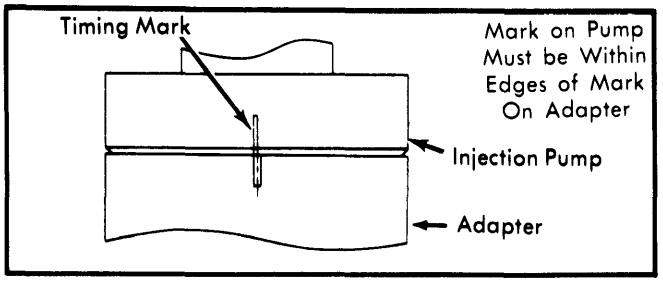

Fig. 15 Aligning Timing Marks on Pump & Adapter

NOTE – *Use a ¾" wrench on boss at front of injection pump to help in rotating pump while aligning marks.*

7) Adjust throttle rod. See *Linkage Adjustment in this article.*

8) Install fuel line from fuel pump to fuel filter. On A/C models, install rear compressor brace.

9) Install bellcrank and clip. Install throttle and T.V. cables to intake manifold. Attach cables to bellcrank.

10) Adjust T.V. cable (See Linkage Adjustment.) Connect throttle rod and return spring, then start engine and check for leaks.

11) Let engine run 2 minutes, then shut-off for 2 minutes to bleed air from pump.

12 Start engine and check for fuel leaks.

13) Remove screened covers and install air crossover and filter assembly.

INJECTION PUMP ADAPTER, SEAL & NEW ADAPTER TIMING MARK

Removal – **1)** Remove air cleaner, air crossover, injection pump and lines.

2) Remove injection pump adapter. Remove seal from pump adapter.

Installation – **1)** File timing mark off of injection pump ADAPTER.

CAUTION – *DO NOT file timing mark off of injection pump.*

2) Rotate engine to place No. 1 piston at TDC. Align mark on balancer with ZERO mark on indicator See *Fig. 14 for position of driven gear.*

NOTE – *Index is offset to the right with No. 1 at TDC.*

3) Apply chassis lube to seal area on adapter, taper edge and seal area in intake manifold. Install adapter and leave loose.

4) Thoroughly lube seal, inside and out, with chassis lube. Install seal on seal installation tool (J-28425).

5) Push seal onto pump adapter using the installation tool.

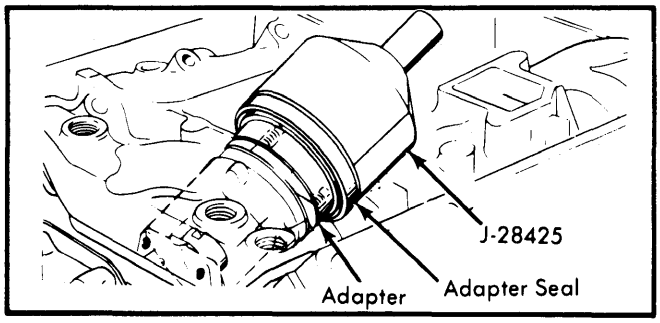

Fig. 16 Installation of New Adapter Seal

6) Remove tool. Observe seal for proper positioning. Torque adapter bolts to 25 ft. lbs.

7) Install timing tool (J-26896) into injection pump adapter. Torque tool in direction of No. 1 cylinder to 50 ft. lbs.

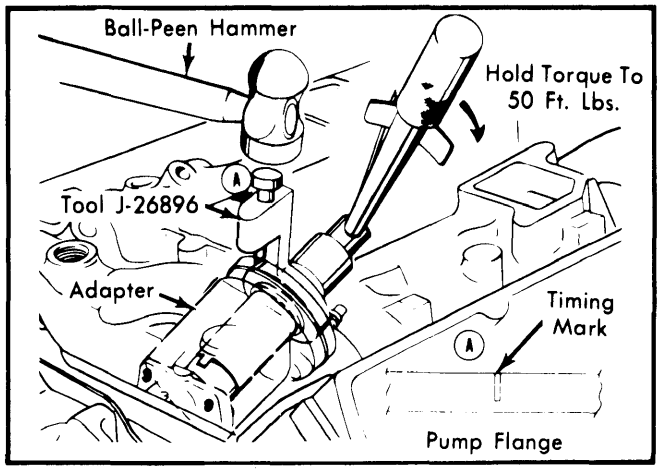

Fig. 17 Stamping Timing Mark on Adapter

GENERAL MOTORS DIESEL FUEL INJECTION (Cont.)

8) While holding torque, stamp timing mark on injection pump adapter. See *Fig. 17.*

9) Remove tool. Install injection pump, lines, and air crossover assembly.

INJECTION NOZZLES

Removal (Diesel Equipment/C.A.V Lucas) – 1) Remove fuel lines from injection pump-to-nozzle on bank of engine where nozzle is to be serviced. Use back-up wrench on nozzle inlet fitting hex. DO NOT bend lines out of way to remove nozzle.

2) Cap open fittings and nozzles. Remove nozzle, using wrench on largest hex of injector nozzle. Make sure copper compression seal is removed with nozzle.

NOTE – *Tip of nozzle must be protected from any damage or dirt.*

Installation – 1) Use new copper compression seal and install nozzle. Tighten to 25 ft. lbs. (C.A.V. Lucas nozzle) or 45 ft. lbs. (Diesel Equipment nozzle). See *Fig. 6.*

2) Install fuel lines to fuel inlet fittings and using a back-up wrench on upper hex of injector, tighten lines to 25 ft. lbs. Start engine and check for leaks.

Removal (Roosa-Master) – 1) Remove fuel lines from injection pump-to-nozzle on bank of engine where nozzle is to be serviced. DO NOT bend lines out of way to remove nozzle.

2) Cap open fittings and nozzles. Remove fuel return line clamps from all nozzles on side of engine where nozzle is to be removed. Remove appropriate fuel return line(s).

3) Remove nozzle spring clamp and spacer. Remove nozzle using removal tool (J-26952). Cap nozzle inlet line and nozzle tip.

NOTE – *Tip of nozzle must be protected from any damage or dirt.*

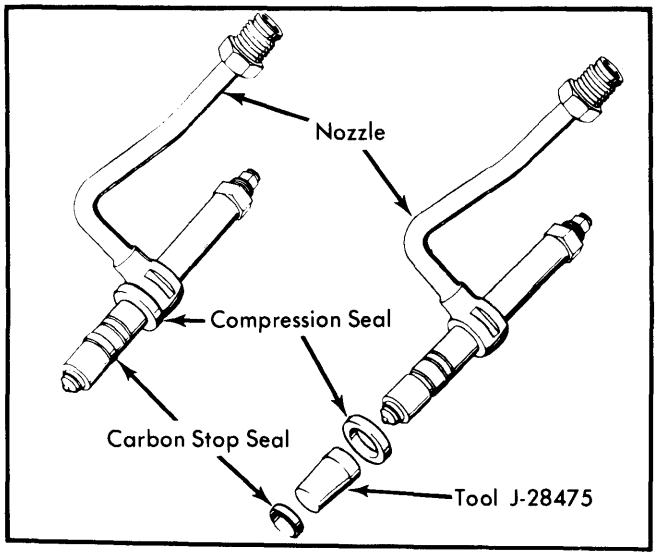

Fig. 18 Roosa-Master Injection Nozzle Seals (Federal Models)

Installation – 1) If old nozzle is to be reinstalled after removal, remove old carbon stop seal and compression seal. Install NEW carbon stop and compression seals.

2) Remove caps from open fittings and lines. Install nozzle, spring clamp and spacer. Torque bolt to 25 ft. lbs.

3) Reinstall fuel return lines and clamps.

4) Install fuel delivery lines from pump-to-nozzles.

5) Start engine and check for leaks.

GLOW PLUGS

Removal – 1) Glow plugs are mounted near each injector nozzle in the cylinder heads. They are threaded and have an electrical wire plugged into the top end.

2) Remove electrical wire from glow plug and remove plug with deep socket. Be sure to engage socket on largest diameter hex surfaces.

Installation – Install glow plug, torque to 12 ft. lbs., and connect electrical wire.

PRE-CHAMBER

NOTE – *Cylinder head must be removed to remove pre-chamber. There is one pre-chamber for each combustion chamber in cylinder head. Pre-chamber is opposite glow plug and can be tapped out with small blunt drift.*

CAUTION – *When removing pre-chamber, be sure to remove injection nozzle and glow plug from head first. If not, glow plug and/or nozzle could be bent and need replacement.*

ADJUSTMENT

HOT (SLOW) IDLE RPM

See *appropriate article in TUNE-UP Section.*

COLD (FAST) IDLE RPM

See *appropriate article in TUNE-UP Section.*

INJECTION TIMING

Engine is properly timed when mark on injection pump is aligned with mark on adapter. See *Fig. 15.* If marks are not aligned, adjustment is necessary. Engine must be off for adjustment.

1) Loosen 3 pump retaining nuts with wrench (J-26987). Align mark on pump with mark on adapter and tighten nuts to 19 ft. lbs.

NOTE – *Use ¾" wrench on boss at front of pump to turn pump while aligning marks.*

2) Adjust throttle rod and linkage.

GENERAL MOTORS DIESEL FUEL INJECTION (Cont.)

LINKAGE ADJUSTMENT

Throttle Rod Adjustment – 1) With engine off, check pump timing. If equipped with cruise control, remove clip from cruise control throttle rod and disconnect rod from throttle lever.

2) Disconnect transmission T.V. or detent cable from throttle assembly. Loosen lock nut on pump rod and shorten by several turns. Rotate lever to full throttle position and hold.

3) Lengthen rod until injection pump lever just contacts full throttle stop. Release lever and tighten lock nut. Remove pump rod from lever assembly.

4) Reconnect transmission T.V. or detent cable. Depress and hold metal lock tab on upper end of cable, then move slider away from lever assembly until it stops against metal fitting.

5) Release metal tab, rotate lever assembly to full throttle stop and release lever assembly. Reconnect pump rod and cruise control rod. Adjust idle speed.

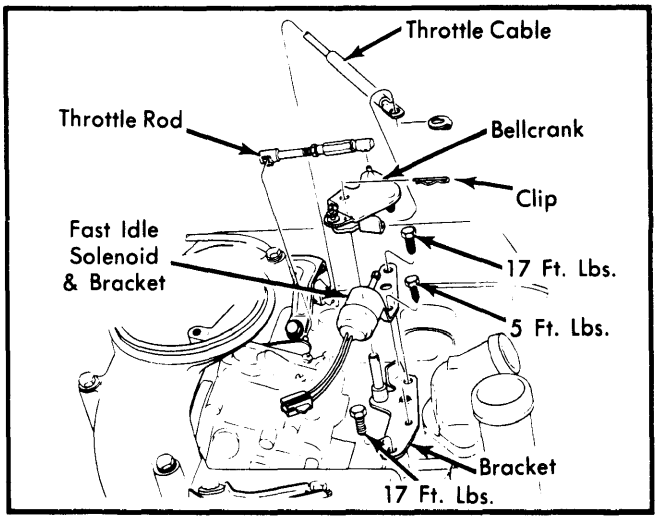

Fig. 19 Disassembled View of Throttle Linkage

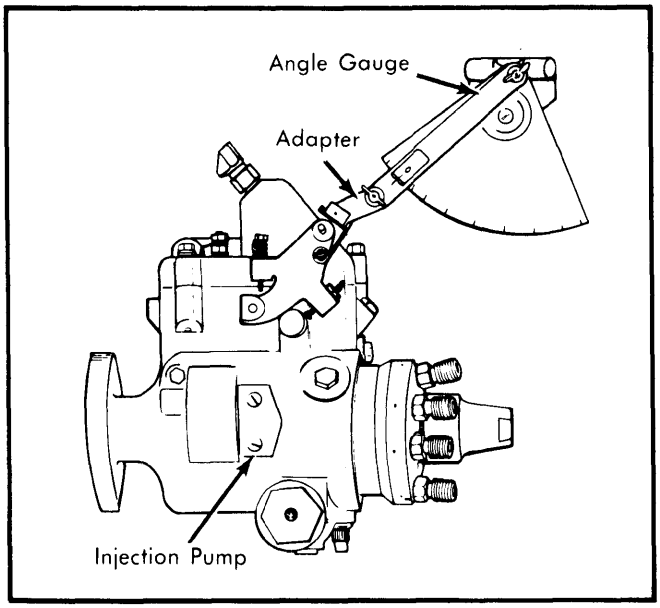

Fig. 20 Vacuum Regulator Valve Adjustment

Vacuum Regulator Valve – 1) Remove air crossover and install screen covers over openings. Remove throttle rod from throttle lever. Loosen vacuum regulator valve-to-pump bolts.

2) Install carburetor angle gauge to injection pump throttle lever. Rotate throttle lever to wide-open throttle position and set angle gauge to zero degrees, then center bubble.

3) Set angle gauge to 58°, then rotate throttle lever until bubble is centered. Attach vacuum pump to port "A" of vacuum regulator valve and vacuum pump to port "B". See *Fig. 21*.

4) Apply 18-22 in. Hg vacuum to port "A", then rotate vacuum valve clockwise to obtain 8.5-9.0 in. Hg. Tighten bolts and connect throttle rod. Remove vacuum pump and angle gauge.

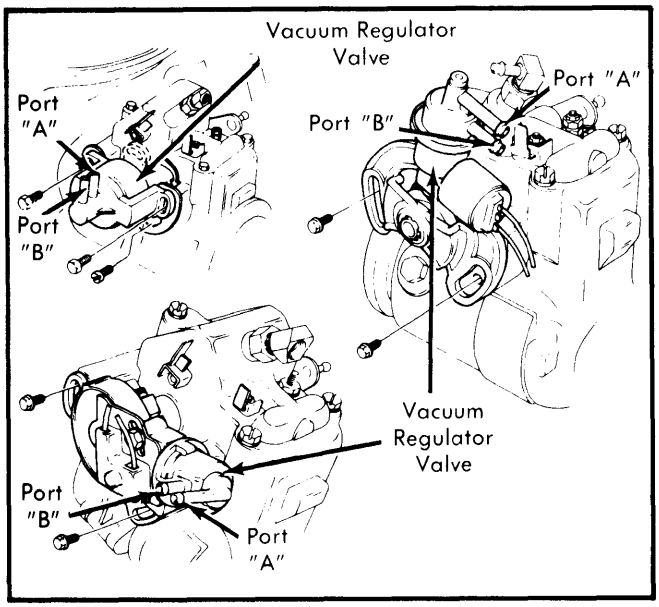

Fig. 21 Vacuum Regulator Valve Port Locations

TIGHTENING SPECIFICATIONS

Application	Ft. Lbs.
Fuel Pump-to-Block Bolt/Nut	25
Injection Pump Attaching Nuts	19
Injection Line Nut-to-Pump	25
Injection Pump Adapter Bolts	25
Injection Line Nut-to-Nozzle	25
Inj. Pump Fuel Filter Inlet	20
Inj. Pump Fuel Filter Outlet	18
Injection Pump Fuel Inlet Line	20
Nozzle Clamp	25
Glow Plug	12
Injection Nozzle (Calif.)	
Diesel Equipment	45
C.A.V. Lucas	25
Glow Plug	12
Air Crossover Bolts	22