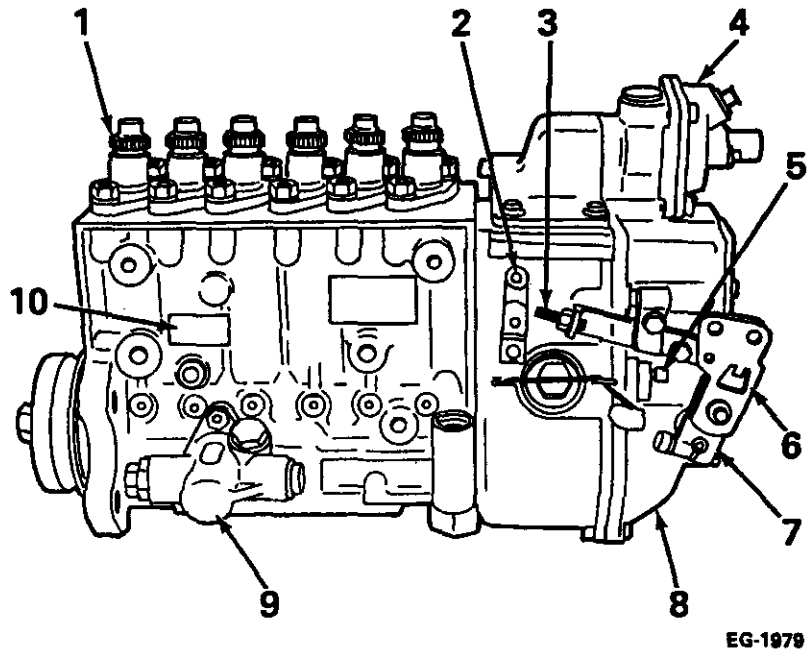
14 FUEL INJECTION PUMP

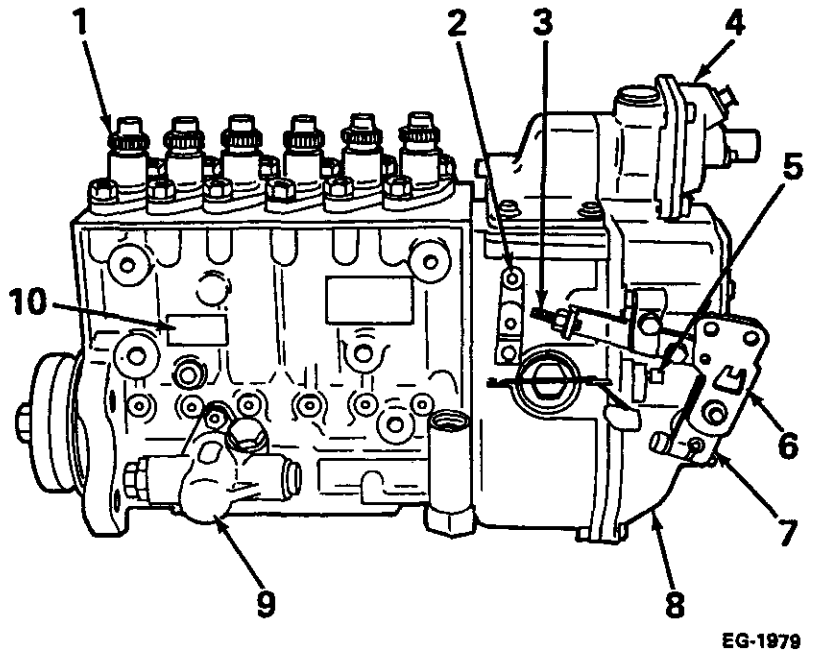
14.1 FUEL INJECTION PUMP EXPLODED VIEW



1. Delivery Valve Holder
2. Shut–Off Lever
3. Shut–Off Stop Screw
4. Aneroid
5. High Idle Stop
6. Control Lever
7. Throttle Lever
8. Governor Housing (RQV–K)
9. Fuel Supply Pump
10. Pump Serial Number Plate

FIGURE 14–1 Bosch Model 3000 Fuel Injection Pump.

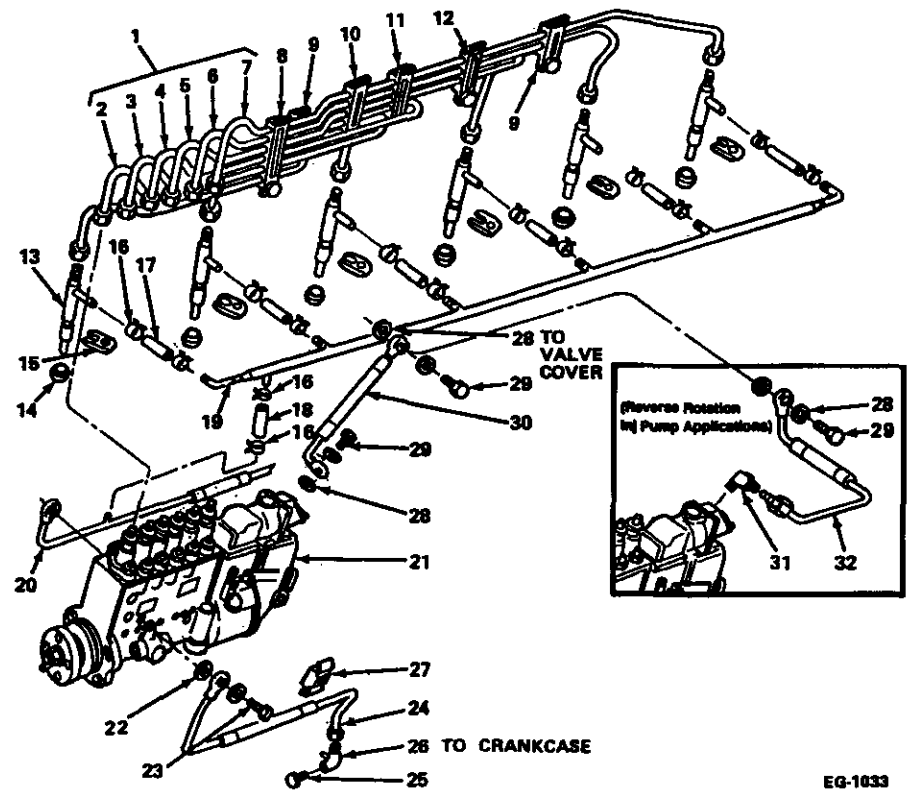
FUEL INJECTION PUMP EXPLODED VIEW



1. Delivery Valve Holder
2. Shut–Off Lever
3. Shut–Off Stop Screw
4. Aneroid
5. High Idle Stop
6. Control Lever
7. Throttle Lever
8. Governor Housing (RQV–K)
9. .Fuel Supply Pump
10. Pump Serial Number Plate

FIGURE 14–2 Bosch Model 7100 Fuel Injection Pump.

FUEL INJECTION PUMP EXPLODED VIEW



1. High Pressure Fuel Lines (6)
2. Fuel Injection Pipe (No. 1 Cylinder)
3. Fuel Injection Pipe (No. 2 Cylinder)
4. Fuel Injection Pipe (No. 3 Cylinder)
5. Fuel Injection Pipe (No. 4 Cylinder)
6. Fuel Injection Pipe (No. 5 Cylinder)
7. Fuel Injection Pipe (No. 6 Cylinder)
8. Fuel Injection Pipe Clamp (6 Pipes)
9. Fuel Injection Pipe Clamp (2 Pipes)
10. Fuel Injection Pipe Clamp (5 Pipes)
11. Fuel Injection Pipe Clamp (4 Pipes)
12. Fuel Injection Pipe Clamp (3 Pipes)
13. Fuel Injector Nozzle (6)
14. Fuel Injector Dust Seal Grommet (6)
15. Fuel Injector Nozzle Crab (6)
16. Leak off Hose Clip (14)
17. Fuel Return Jumper Hose (6)
18. Injector Leak off Manifold to Fuel Return Jumper Hose
19. Fuel Injection Leak off Manifold
20. Fuel Return Tube
21. Fuel Injection Pump Assembly
22. Hollow Screw Gasket (2) +
23. Hollow Screw +
24. Fuel Injection Pump Lube Oil Tube
25. Pipe Plug (For Use Without Air Compressor)
26. Fuel Injection Pump/Air Compressor Elbow
27. Lube Oil Line T–Clip
28. Hollow Screw Gasket (4)
29. Aneroid to Valve Cover/ Intake Manifold Hollow Screw
30. Aneroid Tube
31. Aneroid Tube Elbow (For Reverse Rotation)
32. Aneroid Tube W/Nut (For Reverse Rotation)

\+ Part of Injection Pump

FIGURE 14–3 Fuel Injection Pump, Piping, Nozzles, Drive and Fuel Filter Header.

FUEL INJECTION PUMP EXPLODED VIEW

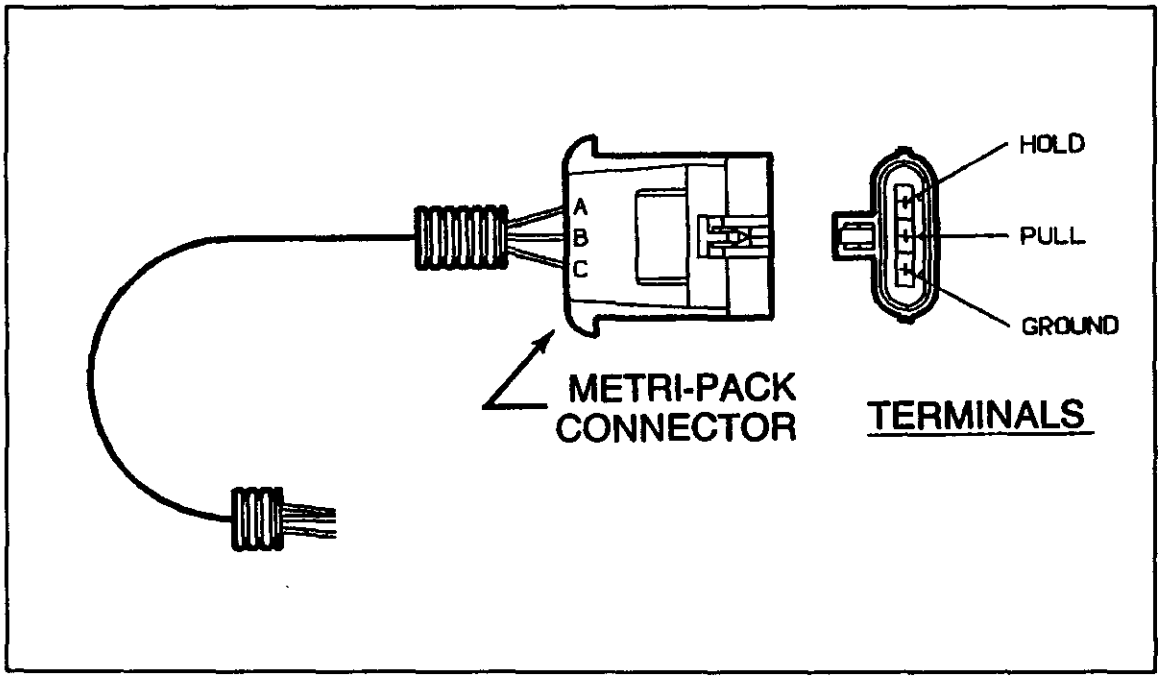
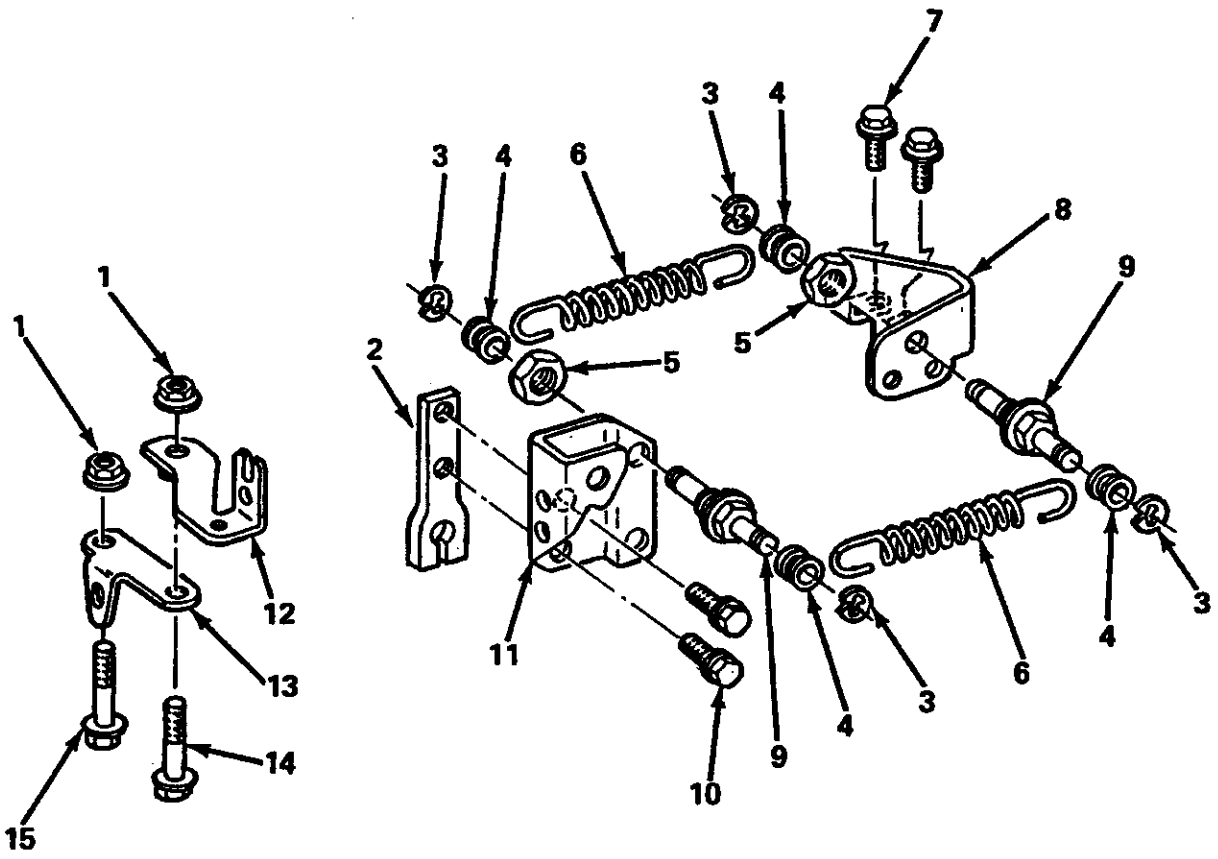


FIGURE 14–4 Electric Shut–Off (ESO) Solenoid.

FUEL INJECTION PUMP EXPLODED VIEW



1. Nut (2)
2. Fuel Injection Pump Throttle Lever
3. Retaining Ring (4)
4. Spring Roller (4)
5. Nut (2)
6. Throttle Control Lever Spring (2)
7. Flange Bolt (2)
8. Return Spring Bracket
9. Double Roller Bolt (2)
10. Flange Bolt (2)
11. Throttle Lever
12. Throttle Cable Bracket
13. Fuel Injection Pump Support Bracket
14. Flange Bolt
15. Flange Bolt

FIGURE 14–5 Typical Fuel Injection Pump Linkage.

14.2 SPECIFICATIONS

DIMENSION	VALUES
INJECTION PUMP:	
Model	Bosch PES6P
Drive	Gear – Steel Forging
Static Timing: (See Emission Label on Engine for Further Data)	
RATED BHP	**STATIC TIMING**
150 HP@ 2600	12 +/– 1 BTDC
175 HP@ 2600	12 +/– 1 BTDC
190 HP@ 2600	12 +/– 1 BTDC
210 HP@ 2600	13 +/– 1 BTDC
230 HP@ 2600	13 +/– 1 BTDC
195 HP@ 2400	12 +/– 1 BTDC
210 HP@ 2400	12 +/– 1 BTDC
230 HP@ 2400	13 +/– 1 BTDC
250 HP@ 2400	13 +/– 1 BTDC
275 HP@ 2400	14 +/– 1 BTDC
250 HP@ 2200	12 +/– 1 BTDC
275 HP@ 2000	11 +/– 1 BTDC
275 HP@ 2200	12 +/– 1 BTDC
300 HP@ 2000	10 +/– 1 BTDC
300 HP@ 2200	12 +/– 1 BTDC
FUEL FILTER:	
Type	Spin–on & Fuel Strainer

SPECIFICATIONS

14.2.1 Special Torques

Injection Pump Drive Gear Bolts	38 lb·ft (51.5 N·m)
Fuel Pump Gear Housing Cover Bolts	66 lb·in. (7.5 N·m)
Fuel Injection Pump Access Cover	66 lb·in. (7.5 N·m)
Nozzle Retainer Bolt (Crab Bolt)	19 lb·ft (228 lb·in) (26 N·m)
Injection High Pressure Line Connector Nut*	30 lb·ft (41 N·m)
Banjo Fuel Oil Connections	26 lb·ft (35 N·m)
Banjo Lube Oil Connections	24 lb·ft (32.5 N·m)
Aneroid Line Banjo Connection	24 lb·ft (32.5 N·m)
Injection Pump Tail Bracket (To Injection Pump)	85 lb·ft (115 N·m)
Injection Pump Tail Bracket (Cylinder Block)	85 lb·ft (115 N·m)
Injection Pump Tail Bracket (Pump)	49 lb·ft (66 N·m)

* Injection line fittings at the pump and nozzle are frequently over tightened due to the fitting size 3/4 inch (19 mm). This swedges the injection line, often partly closing the ends. This alters fuel delivery characteristics, raises injection line pressures and may cause performance problems or injection pump failure. Inspect the ends of the injection lines and discard any with swedged or damaged fittings or holes.

SPECIAL SERVICE TOOLS

TOOLS	DESCRIPTION
J41162	Timing Pin (To Set Timing)
J41162	Plunger Pin (To Check Timing)

14.3 FUEL INJECTION PUMP REMOVAL

NOTICE: **Cleanliness is of utmost importance when servicing fuel injection systems. Always clean engine before injection pump is removed or disconnecting fuel lines. Always plug or cap any opening to prevent dirt, paint chips or other foreign material from entering the fuel system. Do not clean with engine running.**

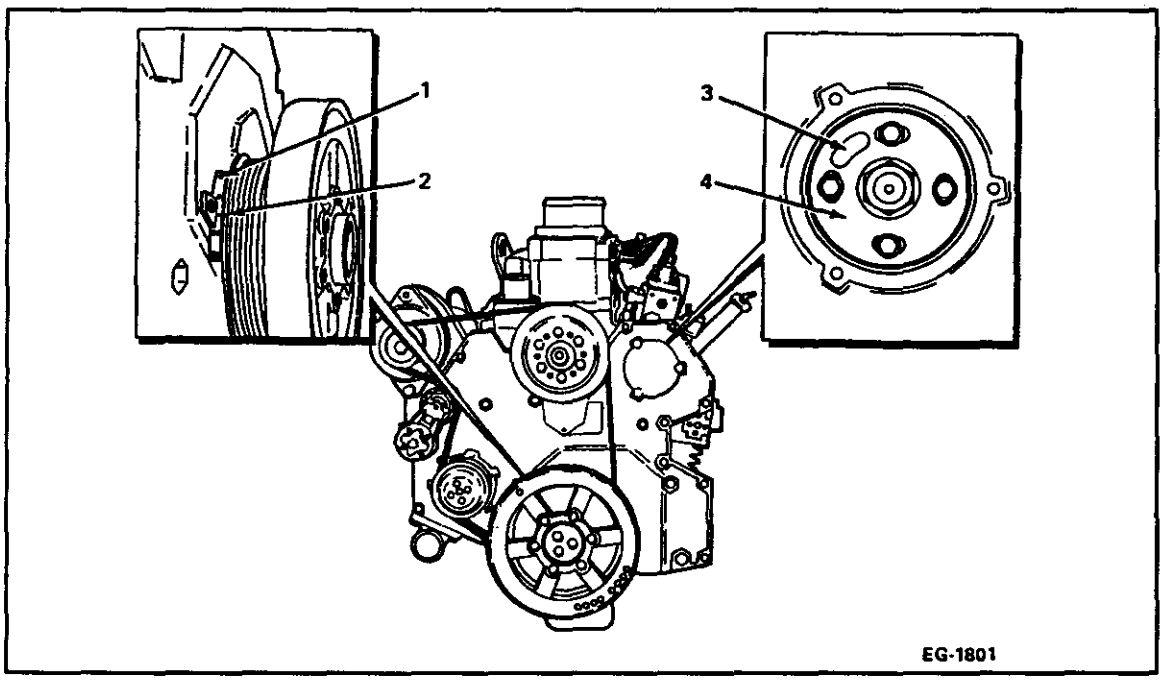
14.3.1 Set Injection Pump to Engine Timing Prior to Pump Removal

1. Disconnect battery cables
2. Disconnect accelerator cable or linkage from outer injection pump control lever.
3. Remove injection pump gear drive access cover from front of engine.

CAUTION

Shut–off must be in no–fuel position before proceeding.

4. Rotate the engine in the normal operating direction until the engine front cover timing pointer is on the degree mark on the damper pulley for the particular application.
5. Verify that small hole in drive gear aligns with lock plate hole behind hub. If aligned, the #1 piston is on the compression stroke. Refer to **FIGURE 14–6.**



1. **Timing Indicator**
2. **Damper Pulley**
3. **Lock Plate (Pointer) Hole**
4. **Drive Gear**

FIGURE 14–6

FUEL INJECTION PUMP REMOVAL

NOTE:

The above procedure establishes the accuracy of the previous timing and avoids the necessity of removing the valve cover to establish the #1 compression stroke during reassembly.

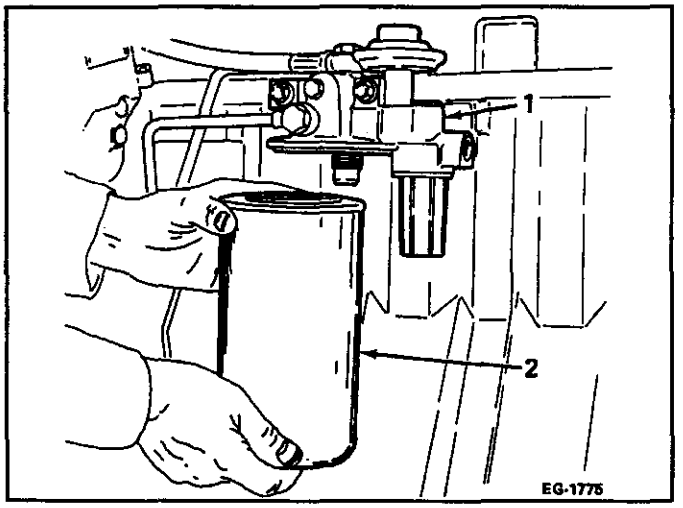
14.3.2 Verify Injection Pump to Engine Timing

If the gear train was disassembled, verify injection pump to engine timing as follows:

1. Verify that the #1 piston is on the compression stroke by:
   a. Removing the valve cover/intake manifold assembly.
   b. Check to see if the #1 cylinder intake and exhaust valve levers are loose by turning the push rods by hand.
   c. If loose, the #1 piston is on the compression stroke and the injection pump may be removed.
   d. If the #1 cylinder valve levers are **NOT** loose, set the pump to engine static timing as described in steps 2–4.
2. Rotate the engine one complete revolution. The engine should now be on the #1 compression stroke.
3. Observe the engine front cover timing indicator and damper pulley degree alignment. Refer to **FIGURE 14–6**.

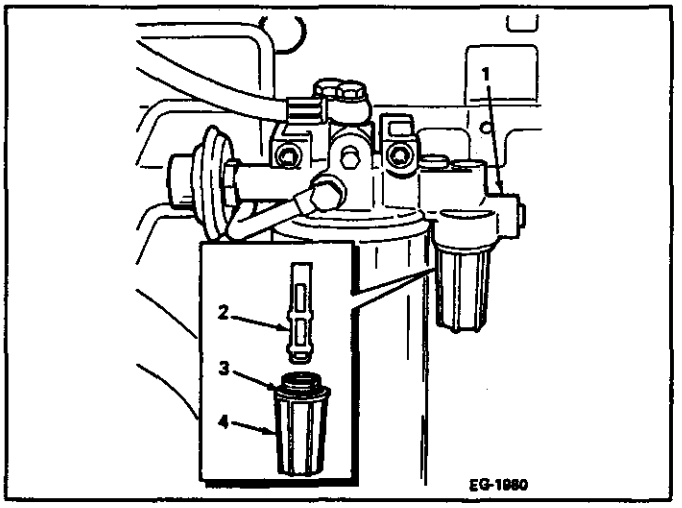
The engine should now be positioned at specified static pump to engine timing. Refer to "Specifications".

FUEL INJECTION PUMP REMOVAL



1. Fuel Filter Header
2. Fuel Filter (Final)

FIGURE 14–7



1. Fuel Filter Header
2. Strainer
3. O–ring
4. Strainer Cover

FIGURE 14–8

NOTE:

If timing is not within specifications, rotate engine to correct crankshaft position (specified degrees before top dead center) before removing injection pump. If necessary to rotate engine in opposite direction of normal rotation to achieve specified timing, rotate engine to 90 degrees before top dead center and then rotate engine to specified timing. This procedure takes up gear backlash.

14.3.3 Removing the Fuel Filter

1. Using an appropriate filter wrench/strap, loosen and remove the fuel filter from the header and discard. Refer to **FIGURE 14–7.**

2. Remove the primary fuel filter/strainer as follows: (Refer to **FIGURE 14–8.**)

   a. Remove plastic strainer cover from filter strainer assembly using an 1–1/8 inch or 29mm socket.

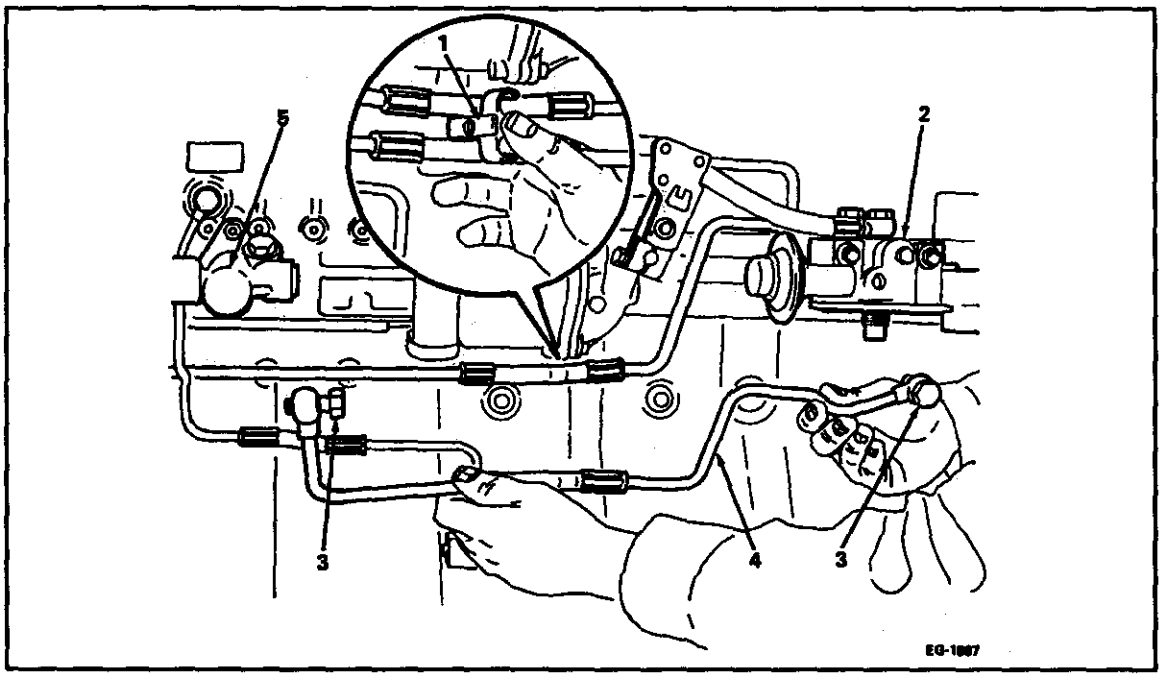
   b. Clean or replace strainer after inspection and reinstall strainer and cover to header assembly.

NOTE:

Install strainer with open end toward filter header.

FUEL INJECTION PUMP REMOVAL

3. Remove the supply pump inlet fuel line as follows (Refer to **FIGURE 14–9**):
   a. Twist and remove the fuel line clamp which connects the supply pump inlet fuel line and the final fuel filter inlet fuel line together.
   b. Twist and remove the fuel line clamp which connects the supply pump inlet fuel line and the lube oil supply line together.
   c. Loosen and remove the hollow screws and copper sealing gaskets at the fuel filter header and supply pump banjo fittings.
   d. Cap the fuel filter header and supply pump openings.



1. **Clamp**
2. **Fuel Filter Header**
3. **Hollow Screw**
4. **Supply Pump Inlet Fuel Line**
5. **Fuel Supply Pump**

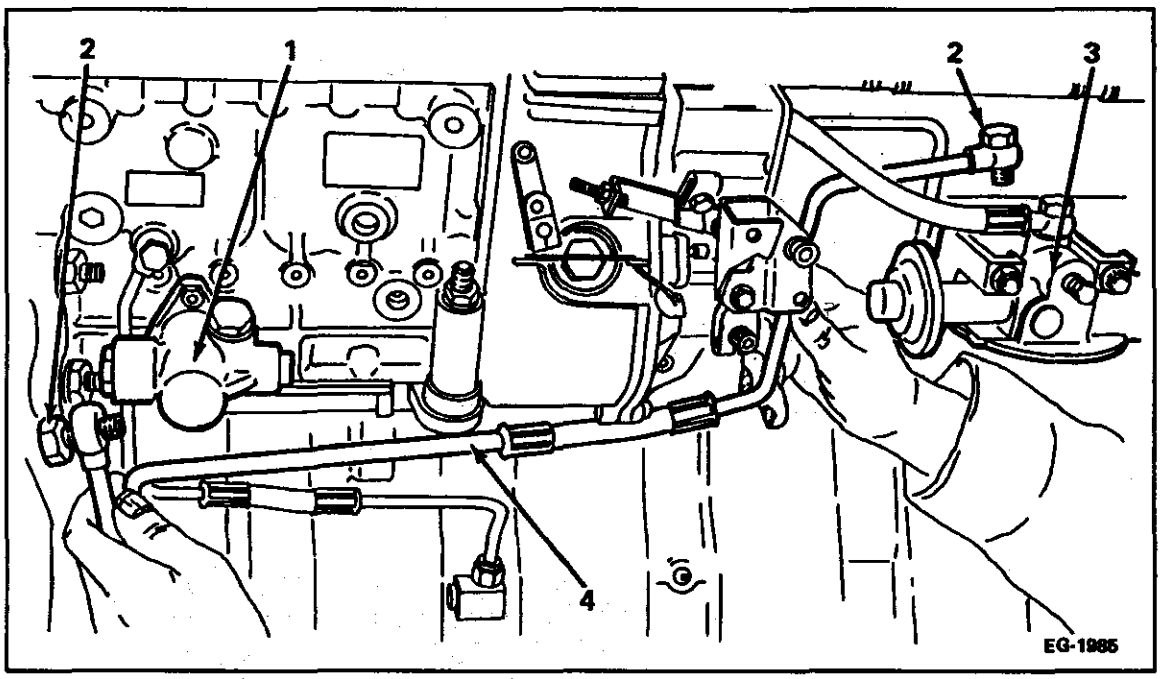
FIGURE 14–9

FUEL INJECTION PUMP REMOVAL

4. Remove the final fuel filter inlet fuel line as follows: (Refer to **FIGURE 14–10**):

   a. Loosen and remove the hollow screws and copper sealing gaskets at fuel filter header and supply pump banjo fittings.

   b. Cap the fuel filter header and supply pump openings.



1. **Fuel Supply Pump**
2. **Hollow Screw**
3. **Fuel Filter Header**
4. **Fuel Filter Inlet Fuel Line**

FIGURE 14–10

FUEL INJECTION PUMP REMOVAL

5. Remove the fuel injection pump inlet hose as follows: (Refer to **FIGURE 14–11**)

   a. Twist and remove the fuel line clamp which connects fuel injection pump inlet hose and fuel return line together.

NOTE:

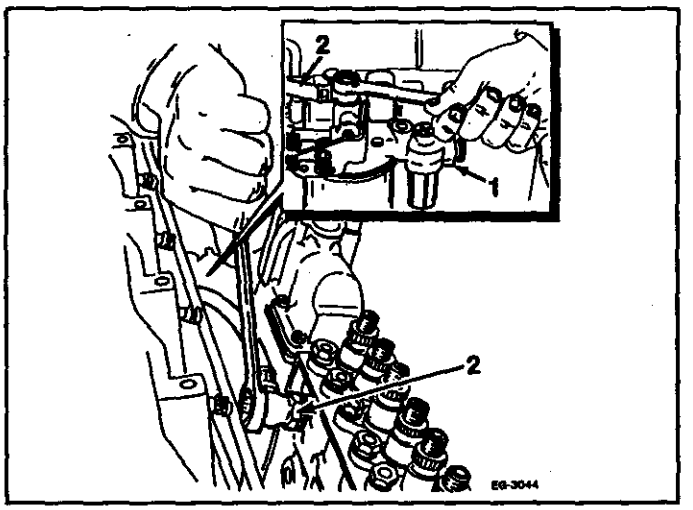
Use two wrenches to loosen the banjo fittings on the injection pump for the fuel inlet and fuel return lines. One to hold the adapter and one to loosen the hollow screw.

   b. Loosen and remove the hollow screws and copper sealing gaskets at fuel filter header and supply pump banjo fitting.

   c. Cap the fuel filter header and supply pump openings.

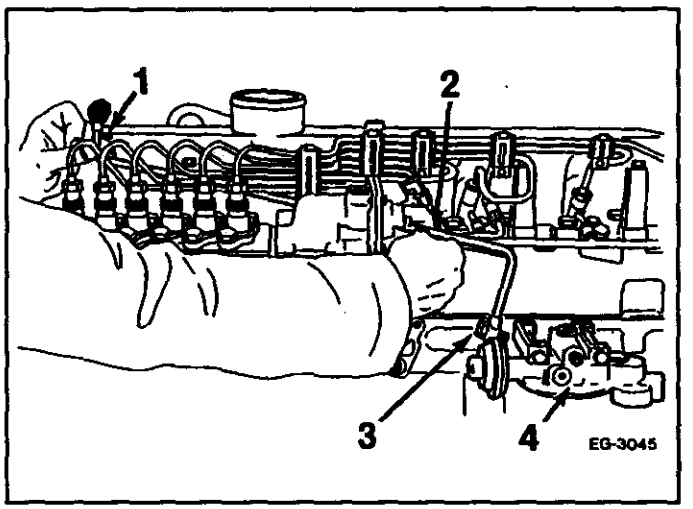
6. Remove the fuel return line as follows: (Refer to **FIGURE 14–12**)

   a. Disconnect the fuel leak–off hose from the return line banjo fitting spud.



1. **Fuel Filter Header**
2. **Fuel Inlet Port**

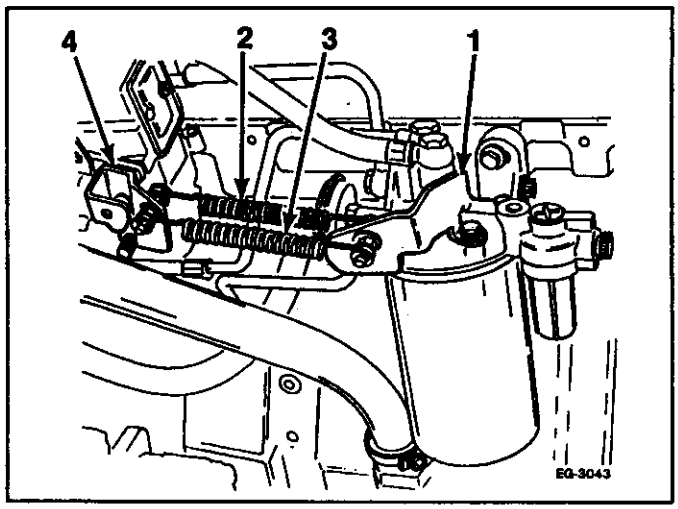
FIGURE 14–11



1. **Valve Cover/Inlet Manifold**
2. **Fuel Return Line**
3. **Crankcase**
4. **Fuel Filter Header**

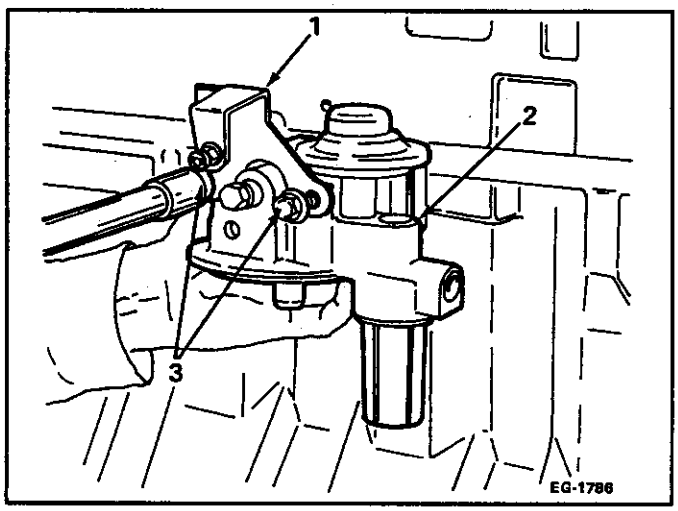
FIGURE 14–12

FUEL INJECTION PUMP REMOVAL



1. Spring Bracket
2. Inner Throttle Spring
3. Outer Throttle Spring
4. Throttle Control Lever

FIGURE 14–13



1. Spring Bracket
2. Fuel filter Header
3. Mounting Bolts

FIGURE 14–14

b. Loosen and remove the hollow screws and copper sealing gaskets at fuel filter header and injection pump banjo fittings.

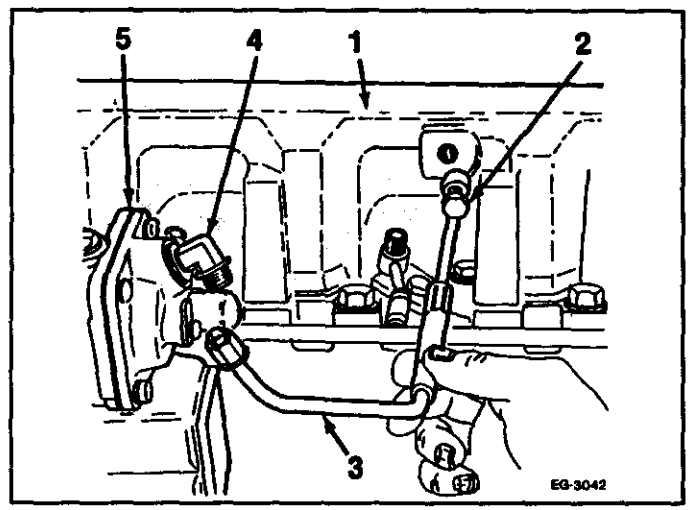
c. Cap the fuel filter header and supply pump openings.

7. Remove the inner and outer throttle springs. (Refer to **FIGURE 14–13**)

8. Loosen and remove the two mounting bolts which secure the fuel filter header to the crankcase then remove the header with spring bracket attached. Refer to **FIGURE 14–14**.

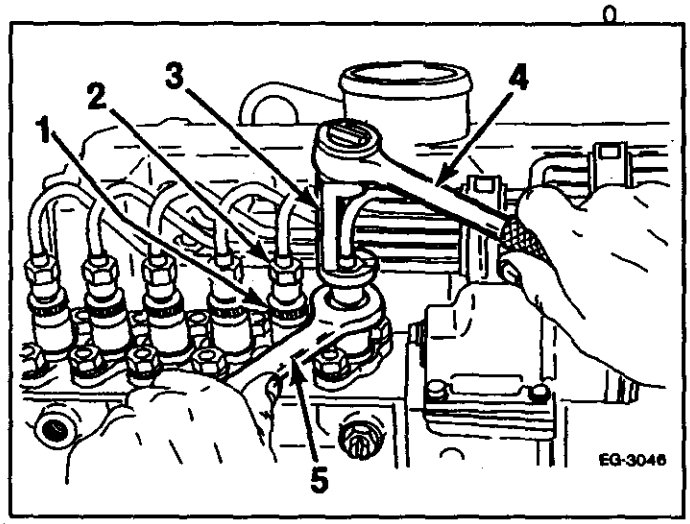
FUEL INJECTION PUMP REMOVAL

9. Remove the aneroid tube as follows: (Refer to **FIGURE 14–15**.
   a. Loosen and remove the hollow screws and copper sealing gaskets at the aneroid and valve cover/intake manifold.
   b. Cap the opening at the aneroid and valve cover/intake manifold.
10. Loosen and remove the fuel injection line nuts at the pump. Hold the delivery valve holder. Deliver Line Wrench to prevent delivery valve movement (which could affect rack travel). Refer to **FIGURE 14–16**.



1. Valve Cover/Intake Manifold
2. Hollow Screw
3. Aneroid Tube
4. Aneroid Elbow
5. Aneroid

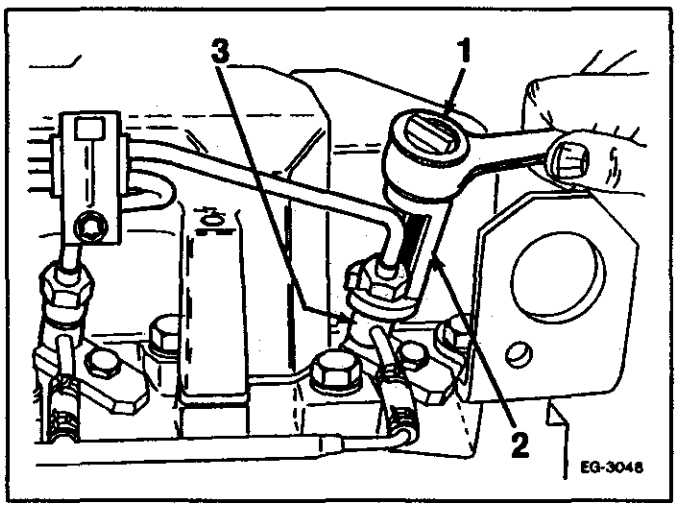
FIGURE 14–15



1. Fuel Injection Pump
2. Injection Pump Line Nut
3. Delivery Valve Socket
4. Ratchet
5. Wrench

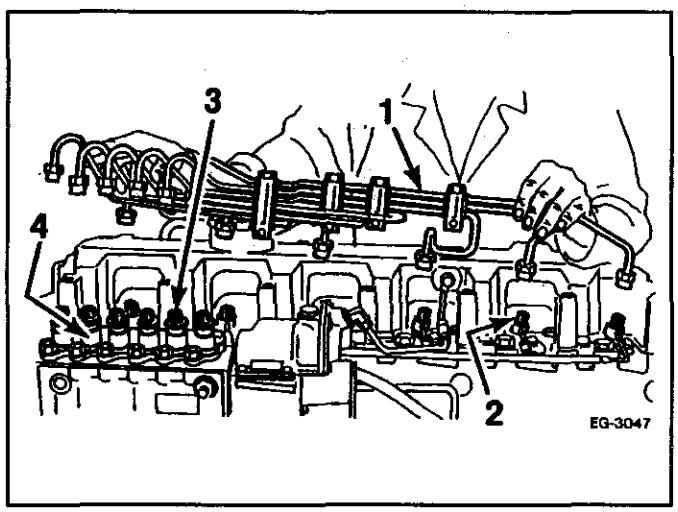
FIGURE 14–16

FUEL INJECTION PUMP REMOVAL



1. Ratchet
2. Delivery Valve Socket
3. Nozzle

FIGURE 14–17



1. Fuel Injection Line Assembly
2. Nozzle
3. Fuel Injection Pump Nozzle
4. Fuel Injection Pump

FIGURE 14–18

11. Loosen and remove the six fuel injection line nuts at the nozzles. Refer to **FIGURE 14–17.**
12. Remove the fuel injection lines as an assembly. Refer to **FIGURE 14–18.**

FUEL INJECTION PUMP REMOVAL

NOTICE: **Cap all fuel injection lines, discharge fitting at the pump and nozzle inlets with plastic caps. Do not use tape. Tape collects dirt and leaves a gummy residue on mating surfaces. Refer to FIGURE 14–18 and FIGURE 14–19.**

13. Remove the lube oil supply line as follows: (Refer to **FIGURE 14–20**)
    a. Loosen and remove the compression nut at the crankcase elbow.
    b. Remove the hex head hollow screw and copper gaskets from the banjo fitting at the fuel injection pump oil inlet.
    c. Remove the tube assembly and discard the sealing sleeve at the compression nut end of the tube.
    d. Cap the pump oil inlet and the elbow at the crankcase.

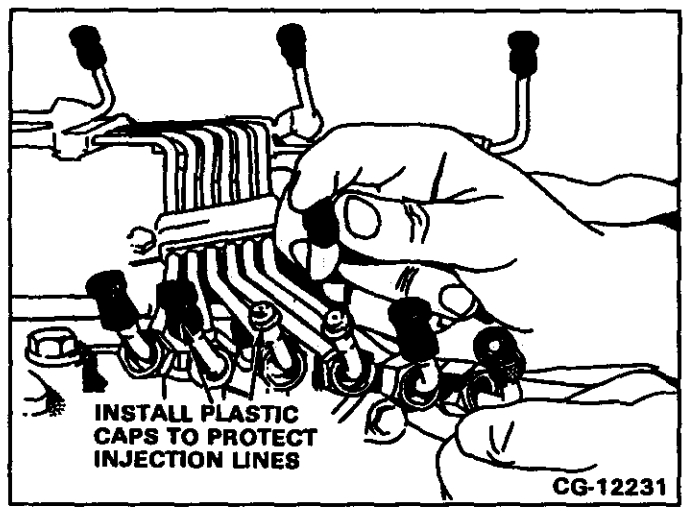
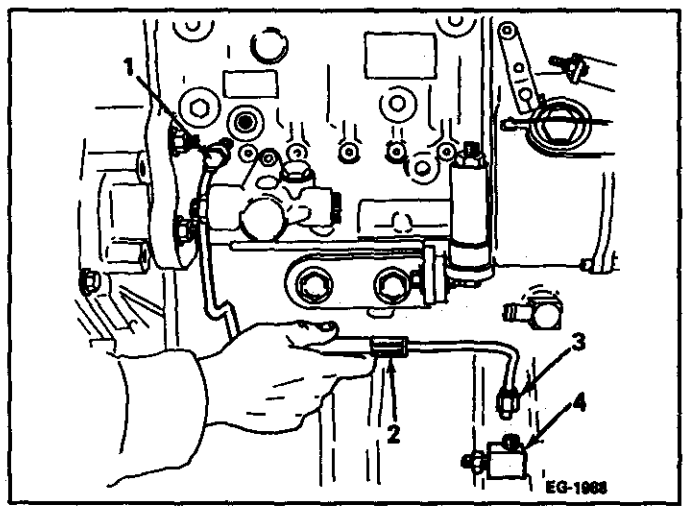


FIGURE 14–19

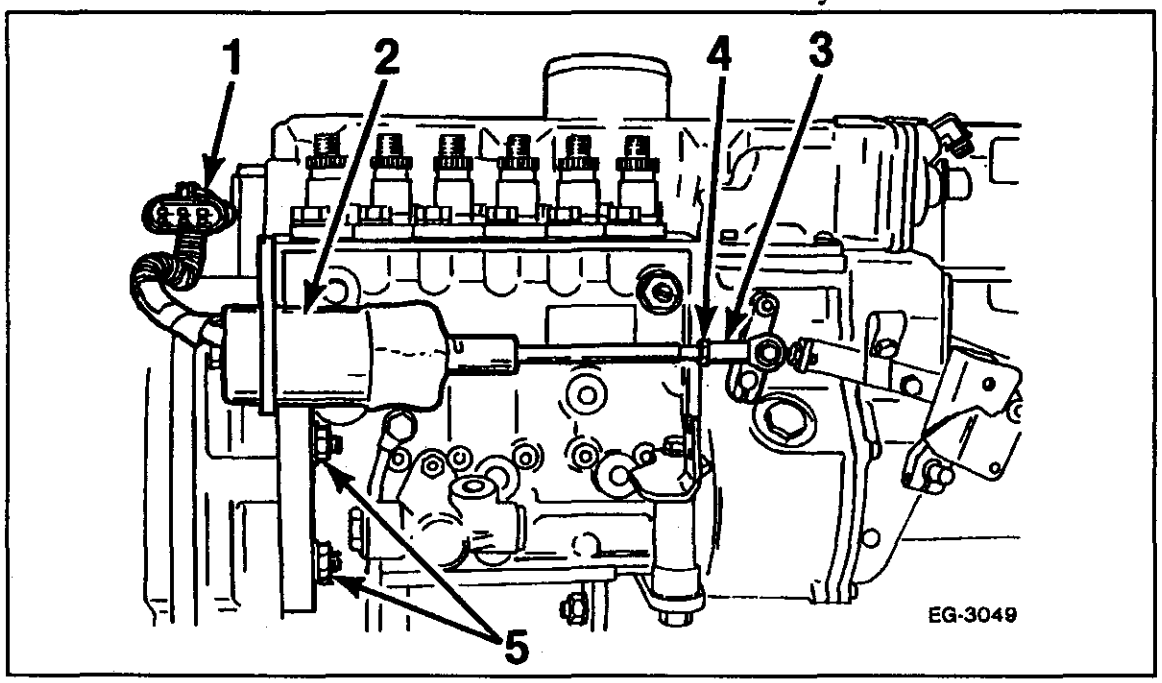


1. **Hollow Screw**
2. **Lube Oil Supply Line**
3. **Compression Nut**
4. **Crankcase Elbow**

FIGURE 14–20

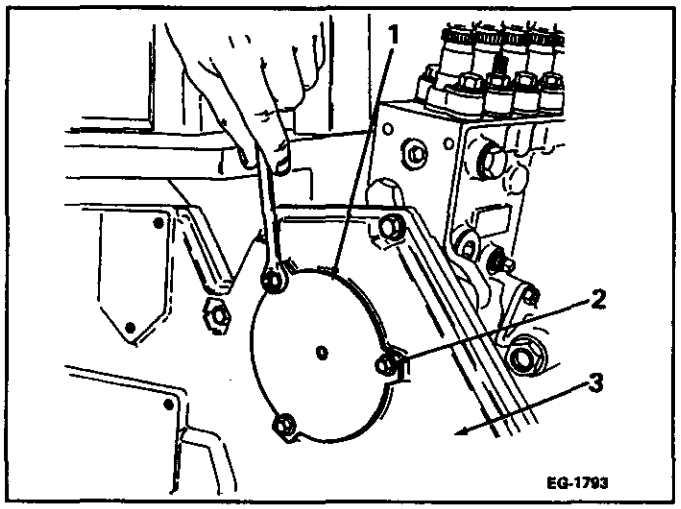
FUEL INJECTION PUMP REMOVAL

14. Remove a fuel injection pump with an electric shut–off solenoid (ESO) as follows: (Refer to **FIGURE 14–21**)
    a. Loosen the jam nut at the female rod end.
    b. Unscrew the swivel from the female rod end.
    c. Disconnect the metri–pack connector from the harness.
    d. Remove the solenoid mounting nuts to remove the solenoid and bracket assembly.



1. Metri–pack Connector
2. Solenoid Assembly
3. Female Rod End
4. Jam Nut
5. Mounting Nuts

FIGURE 14–21



1. Access Cover
2. Mounting Bolt
3. Front Cover

FIGURE 14–22

15. Remove the three fasteners which secure the injection pump drive gear access cover and gasket to front cover. Remove cover and discard the O–ring. (Refer to **FIGURE 14–22**).

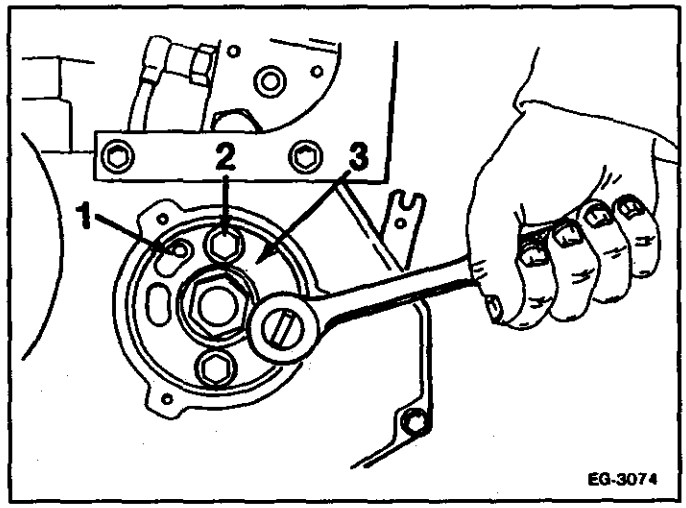
FUEL INJECTION PUMP REMOVAL

16. Remove four (4) injection pump drive gear bolts. (Refer to **FIGURE 14–23**).

17. Remove the four nuts from the retaining studs securing the injection pump to the front cover. (Refer to **FIGURE 14–24**).

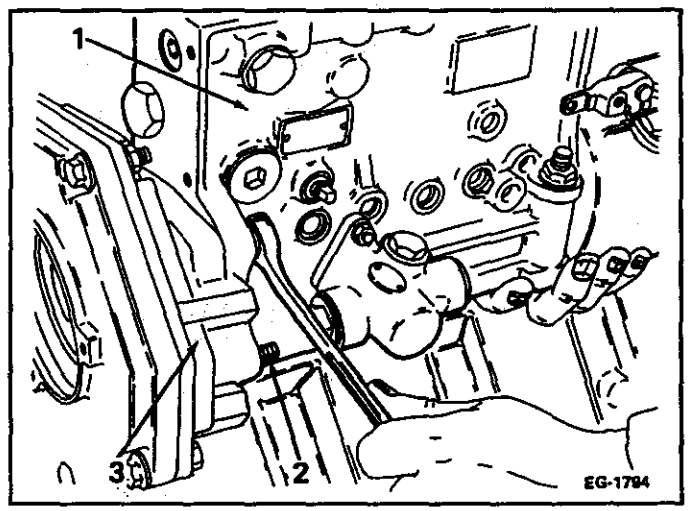
NOTE:

When fuel injection pump is removed, drive gear will remain in front cover.



1. **Timing Pin Tool**
2. **Drive Gear Bolt**
3. **Drive Gear**

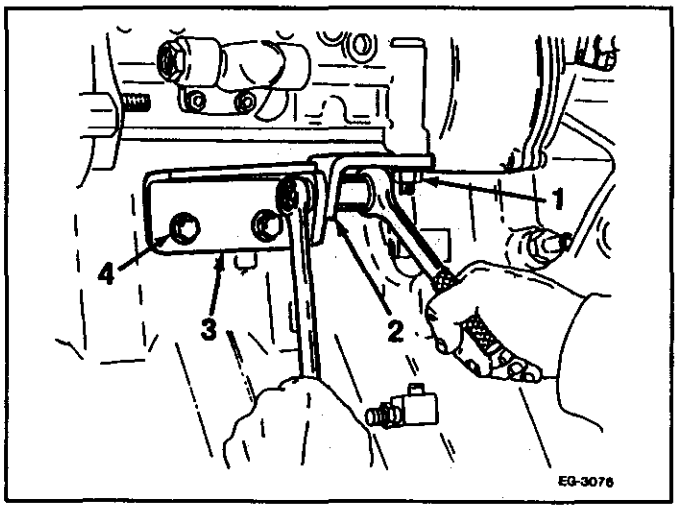
FIGURE 14–23



1. **Fuel Injection Pump**
2. **Mounting Stud**
3. **Front Cover**

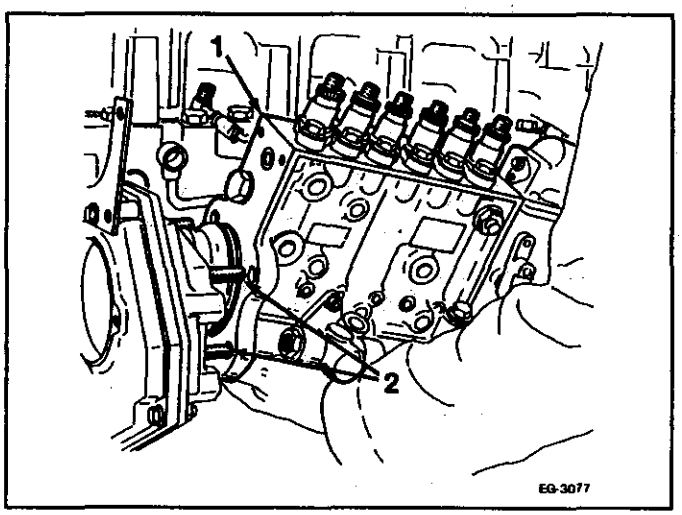
FIGURE 14–24

FUEL INJECTION PUMP REMOVAL



1. Throttle Bracket Bolt
2. Throttle Cable Bracket
3. Mounting Support Bracket
4. Support Bracket Mounting Bolts

FIGURE 14–25



1. Fuel Injection Pump
2. Mounting Studs

FIGURE 14–26

18. Remove injection pump support bracket as follows. (Refer to **FIGURE 14–25**):
    a. Remove bolt, securing pump side bracket to engine side bracket.
    b. Remove the two bolts mounting the support bracket to the crankcase.
19. Remove the injection pump. (Refer to **FIGURE 14–26**).

NOTE: Studs on the front cover plate hold the pump assembly to the front plate.

14.4 FUEL INJECTION PUMP REASSEMBLY

14.4.1 In–Chassis

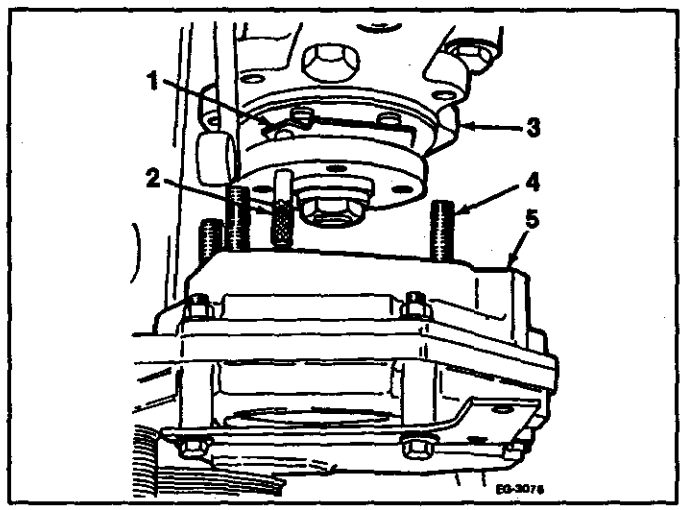
1. Install new O–ring onto injection pump hub. Lubricate O–ring before installing injection pump. Mount the injection pump to the engine front cover plate mounting studs. Refer to **FIGURE 14–27.**

NOTE:

Be sure that the timing pin tool (J41161) is positioned through the hub and into the timing plate. Finger–tighten until timing pin contacts the hub. DO NOT ROTATE ENGINE WITH TIMING PIN INSTALLED. Rotating the engine will damage the timing pin and timing plate.

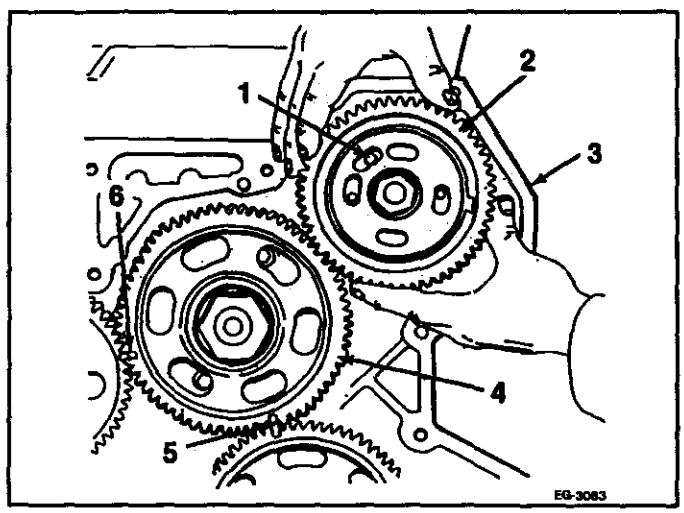
NOTICE: **Verify that the engine #1 cylinder is on the compression stroke (TDC). Also verify static timing by checking the timing mark on pulley and marks on timing plate. Refer to "Set Injection Pump to Engine Timing Prior to Pump Removal" in this section for a detailed procedure.**

2. Position injection pump drive gear slot so that four of the five kidney slotted holes align with mounting holes on the injection pump and timing pin tool is aligned in center of fifth kidney slotted hole. Refer to **FIGURE 14–28.**



1. Timing Pin Tool Bracket
2. Timing Pin Tool
3. Fuel Injection Pump
4. Mounting Stud (4)
5. Front Cover

FIGURE 14–27



1. Timing Pin Tool
2. Drive Gear
3. Front Cover
4. Upper Idler Gear
5. Timing Mark
6. Timing Mark

FIGURE 14–28

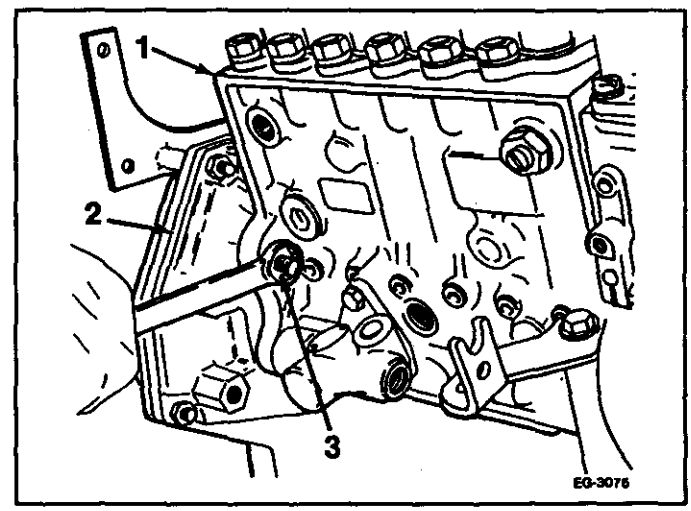
FUEL INJECTION PUMP REASSEMBLY

NOTE:

Position bolts in the center of the kidney slotted holes. The pump drive gear may be rotated by lifting and turning to position.

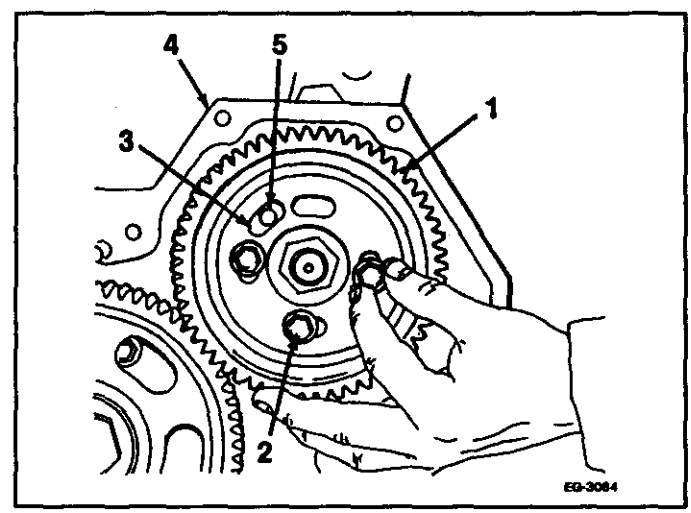
3. Secure injection pump to front cover with four nuts and tighten to the specified special torque (see "Specifications") (**FIGURE 14–29**).

4. Install and tighten the four capscrews securing the injection pump gear to the injection pump at the specified "Special Torque." Refer to **FIGURE 14–30**.



1. **Fuel Injection Pump**
2. **Front Cover**
3. **Mounting Nut (4)**

FIGURE 14–29

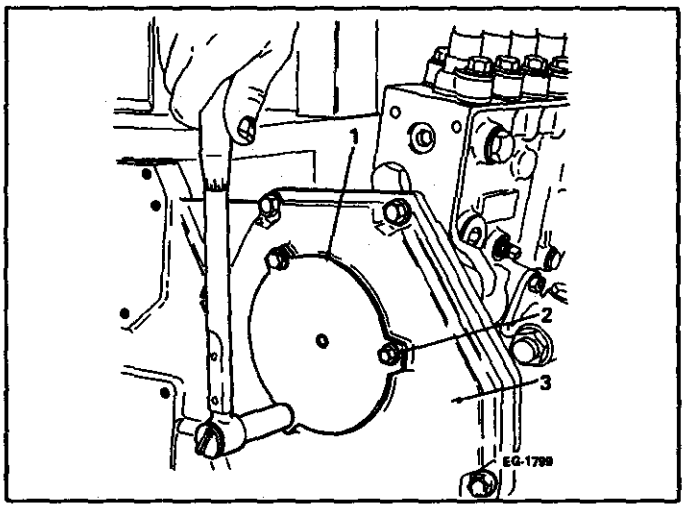


1. **Drive Gear**
2. **Mounting Bolt (4)**
3. **Fifth Kidney Hole**
4. **Front Cover**
5. **Timing Pin Tool**

FIGURE 14–30

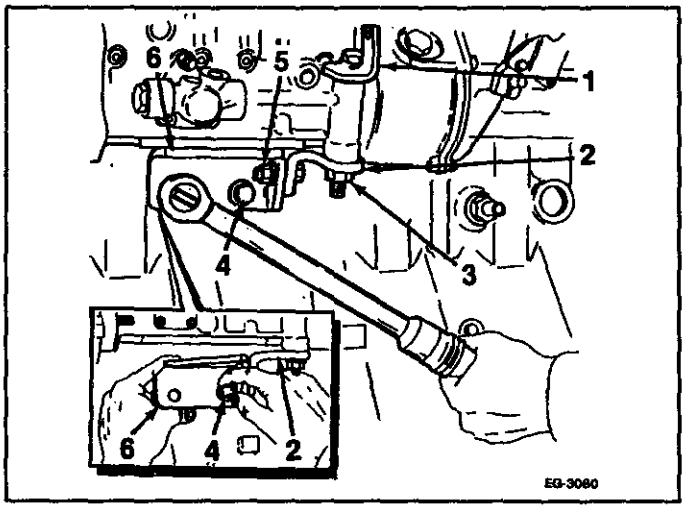
FUEL INJECTION PUMP REASSEMBLY

5. Remove timing pin tool from the gear/hub.
6. Install the injection pump drive gear access cover using a new O–ring as follows: Refer to **FIGURE 14–31.**
   a. Install a new O–ring onto the access cover slot and lubricate.
   b. Secure the access cover to front cover using the three capscrews. Tighten capscrews to special torque. See Appendix.
7. Install the injection pump tail support bracket as follows: (Refer to **FIGURE 14–32**)
   a. Install bolt, washer, nut and throttle cable bracket for the fuel injection pump.
   b. Install the two bolts mounting the throttle bracket to the bottom of the fuel pump and tighten to specified torque.
   c. Install the engine side bracket to cylinder block and snug bolts. Torque bolt between brackets to specified torque.
   d. Tighten the two crankcase bolts to specified torque.
8. If removed, install the electric shut–off solenoid.



1. **Access Cover**
2. **Bolt**
3. **Front Cover**

FIGURE 14–31



1. **Throttle Cable Bracket**
2. **Throttle Bracket**
3. **Throttle Bracket Nut**
4. **Engine Side Bracket Mounting Bolts (2)**
5. **Throttle Bracket Mounting**
6. **Engine Side Bracket**

FIGURE 14–32

FUEL INJECTION PUMP REASSEMBLY

14.4.1.1 Installation Of Electric Shut–off Solenoid

Refer to **FIGURE 14–33.**

1. Install the solenoid and bracket assembly onto the injection pump mounting studs.
2. Assemble the metri–pack connector to the wiring harness.

14.4.1.2 Adjustment Of Electric Shut–off Solenoid Injection Pump

Refer to **FIGURE 14–33.**

NOTE:
The adjustment procedure must be completed as specified to prevent solenoid burn–out or internal damage to the injection pump.

1. Set parking brake, put transmission in neutral and depress clutch, if applicable. **DO NOT PRESS THE ACCELERATOR PEDAL AT THIS TIME!**
2. Turn key switch to **"START"** position to engage starter/pull in E.S.O.
3. After starter is engaged fully, press accelerator pedal to provide starting fuel quantity.
4. Refer to vehicle Operator's Manual for additional starting instructions.

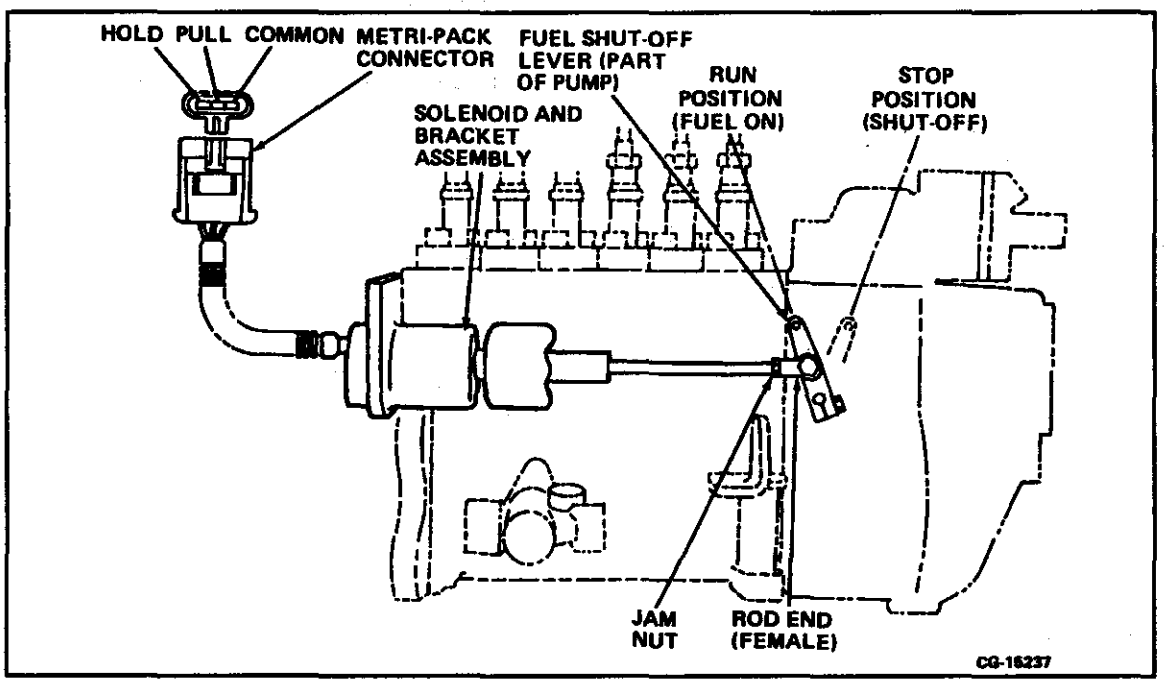


FIGURE 14–33

FUEL INJECTION PUMP REASSEMBLY

14.4.2 In–Chassis (continued)

1. Install the lube oil supply line as follows: (Refer to **FIGURE 14–34**).

   a. Remove the protective cap at the crankcase oil outlet elbow and the pump oil inlet.

   b. Install a new rubber sealing sleeve at the compression nut end of the tube.

   c. Fasten the tube to the crankcase oil outlet tube and tighten the nut.

   d. Using new copper gaskets, fasten the banjo fitting to the pump oil inlet with the hollow screw at the "Specified Torque."

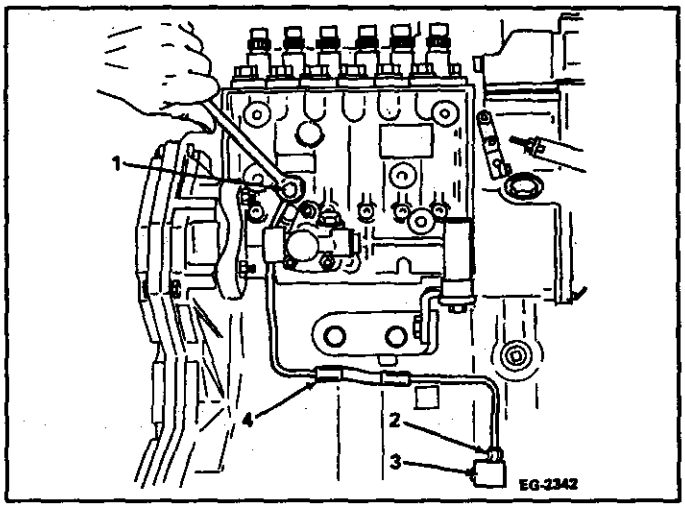
2. Mount the fuel filter header as follows: (Refer to **FIGURE 14–35**)

   a. Insert the header at the crankcase mounting pad. Fasten the header using the two mounting bolts and washers.

   b. Tighten the fasteners to the standard torque (see **Appendix**).

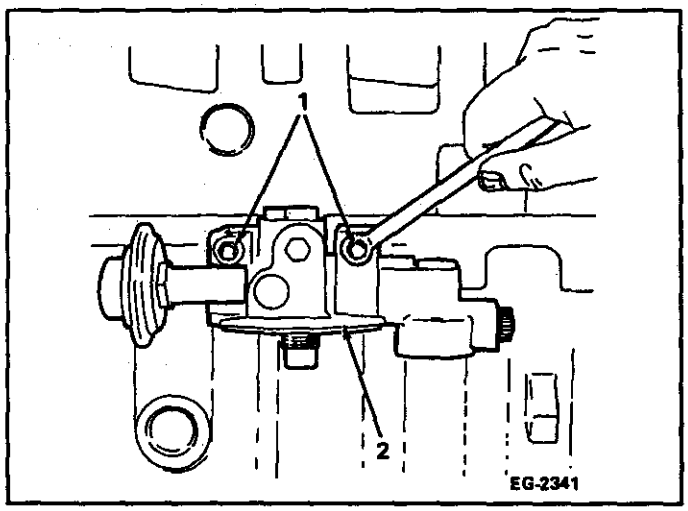
NOTE:
Be sure to install the throttle cable spring bracket on the mounting bolts which attach the filter header.

   c. Remove nylon cap above fuel strainer and observe check ball. If check ball is not in this location, priming pump will not work.



1. **Hollow Screw**
2. **Compression Nut**
3. **Crankcase Elbow**
4. **Lube Oil Supply Line**

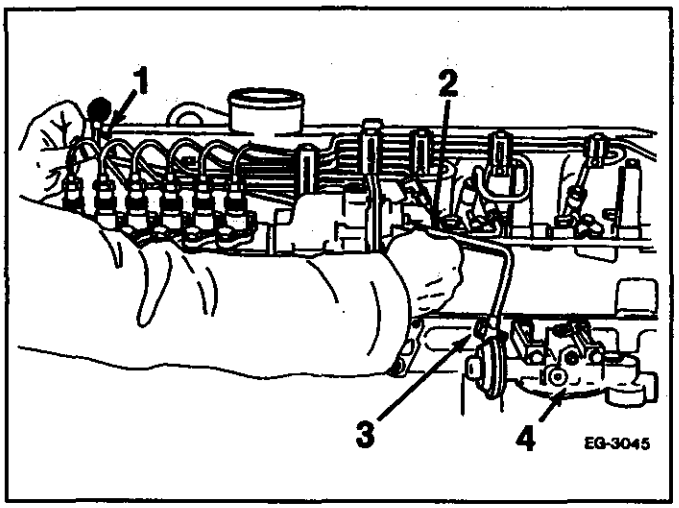
FIGURE 14–34



1. **Mounting Bolts**
2. **Fuel filter Header**

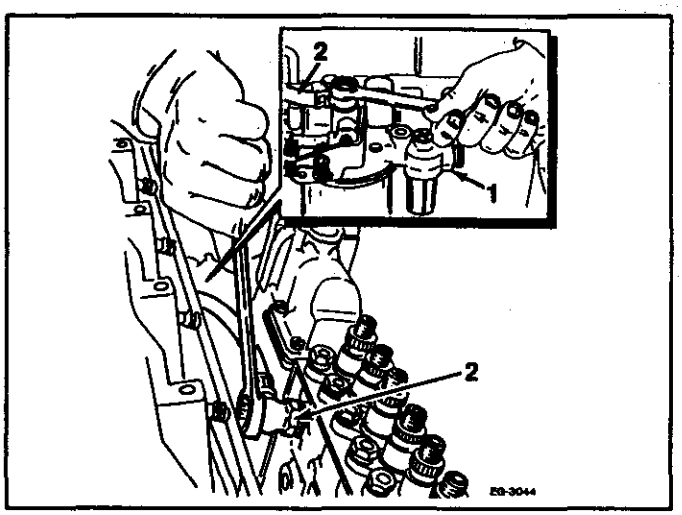
FIGURE 14–35

FUEL INJECTION PUMP REASSEMBLY



1. Valve Cover/Inlet Manifold
2. Fuel Return Line
3. Crankcase
4. Fuel Filter Header

FIGURE 14–36



1. Fuel Filter Header
2. Fuel Inlet Port

FIGURE 14–37

3. Install the fuel injection pump fuel return to filter header line as follows:
   a. Remove protective caps from fuel injection pump return and filter header.
   b. After positioning tube, install with hollow screws and new copper sealing gaskets at pump and header (**FIGURE 14–36**). Tighten to specified torque.
4. Install the fuel injection pump inlet supply hose as follows: (Refer to **FIGURE 14–37**)
   a. Remove protective caps from fuel injection pump inlet and filter header.
   b. After positioning tube, install with hollow screws and new copper sealing gaskets at pump and header. Tighten to specified torque.
   c. Install the fuel line clamp which holds the fuel injection pump inlet hose and fuel return line together.

FUEL INJECTION PUMP REASSEMBLY

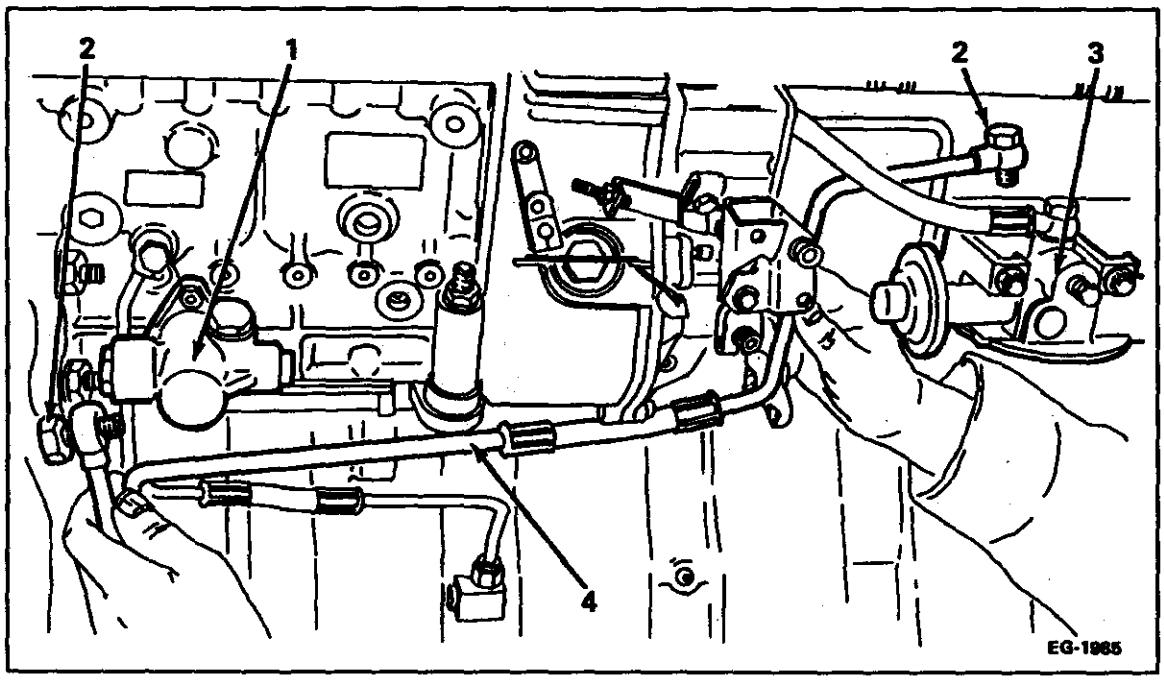
5. Install the final fuel filter inlet fuel line as follows:
   (Refer to **FIGURE 14–38.**)

   a. Remove protective caps from the fuel filter header and supply pump openings.

NOTICE: **Fuel inlet hose must be attached to center port of fuel filter header.**

Reversing the fuel lines will reverse the fuel flow from the fuel filter header to the injector pump.

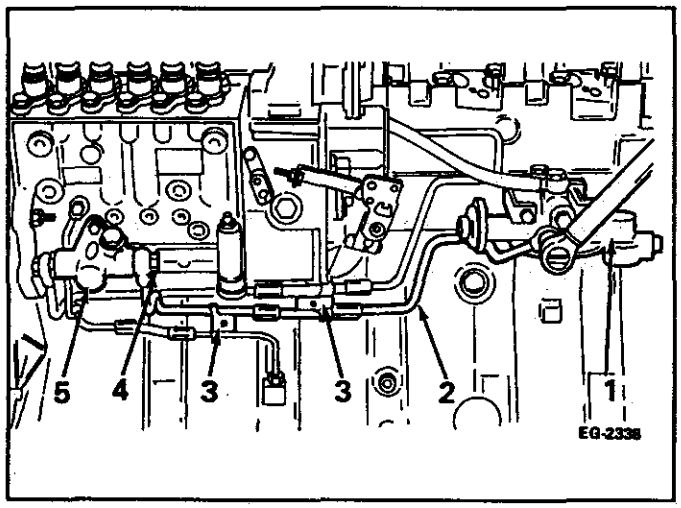
   b. Install the hollow screws and new copper sealing gaskets at fuel filter header and supply pump banjo fittings to connect fuel line. Tighten to specified torque.



1. **Fuel Supply Pump**
2. **Hollow Screw**
3. **Fuel Filter Header**
4. **Fuel Filter Inlet Fuel Line**

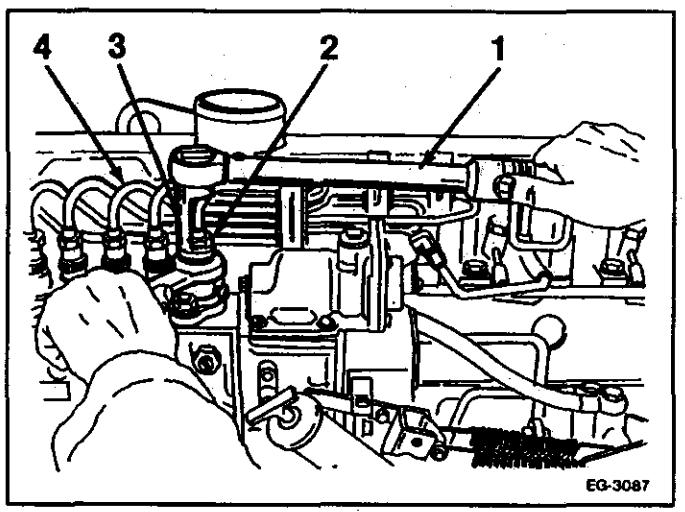
FIGURE 14–38

FUEL INJECTION PUMP REASSEMBLY



1. Fuel Filter Header
2. Supply Pump Inlet Fuel Line
3. Clamp
4. Hollow Screw
5. Fuel Supply Pump

FIGURE 14–39



1. Torque Wrench
2. Nozzle Line Nut
3. Delivery Valve Wrench
4. High Pressure Lines

FIGURE 14–40

6. Install the supply pump inlet fuel line as follows: Refer to **FIGURE 14–39.**

   a. Remove protective caps from fuel filter header and supply pump openings.

   b. Install the hollow screws and new copper sealing gaskets at the fuel filter header and supply pump banjo fittings to connect fuel line. Tighten to specified torque.

   c. Twist to install the fuel line clamp which connects the supply pump inlet fuel line and the final fuel filter inlet fuel line together.

   d. Twist to install the fuel line clamp which connects the supply pump inlet fuel line and the lube oil supply line together.

7. Install the fuel injection line assembly as follows:

NOTICE: **Prior to installing the fuel injection line assembly, clean with filtered compressed air and visually inspect for contamination or damage. Replace as required.**

   a. Remove the protective caps from the lines, nozzles and delivery valve holders at the pump.

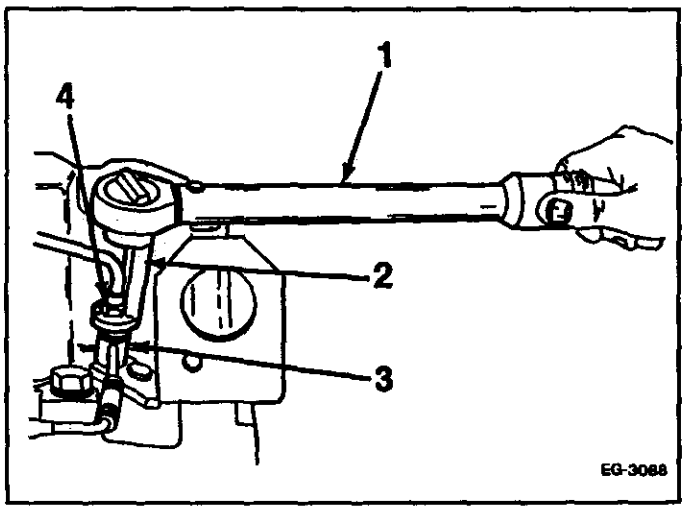
   b. Install the fuel injection line connector nuts at the pump. Tighten to the specified "Special Torque" at the connector nut. Refer to **FIGURE 14–40.**

FUEL INJECTION PUMP REASSEMBLY

c. Install the six fuel injection line nuts at the nozzles. Tighten each nut to the specified "Special Torque." Refer to **FIGURE 14–41.**

NOTE:

Injection line fittings at the pump and nozzle are frequently over tightened due to the size of the fitting. This swedges the injection line, often partly closing the ends. This alters fuel delivery characteristics, raises injection line pressures and may cause performance problems or injection pump failure. Visually inspect the ends of the injection lines and replace any with swedged or damaged fittings or holes.



1. Torque Wrench
2. Delivery Valve Wrench
3. Nozzle
4. High Pressure Line Nut

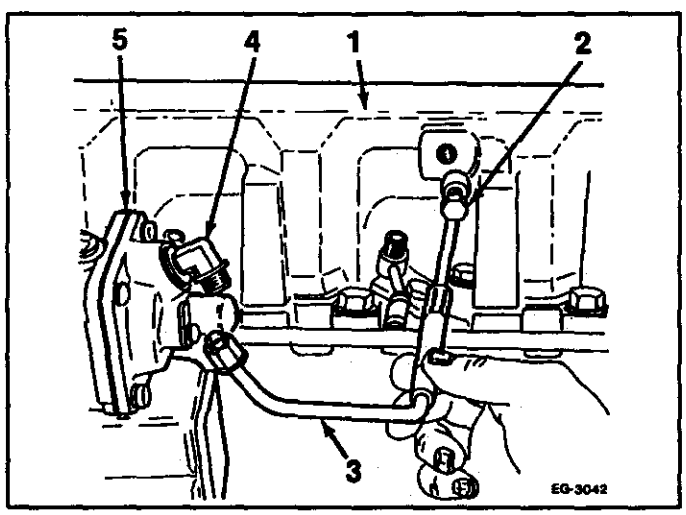
FIGURE 14–41

8. Install the aneroid tube as follows: (Refer to **FIGURE 14–42.**

   a. Remove the protective caps from the intake manifold elbow and the aneroid.

   b. Install the hollow screws and new copper sealing gaskets at the aneroid and intake manifold.

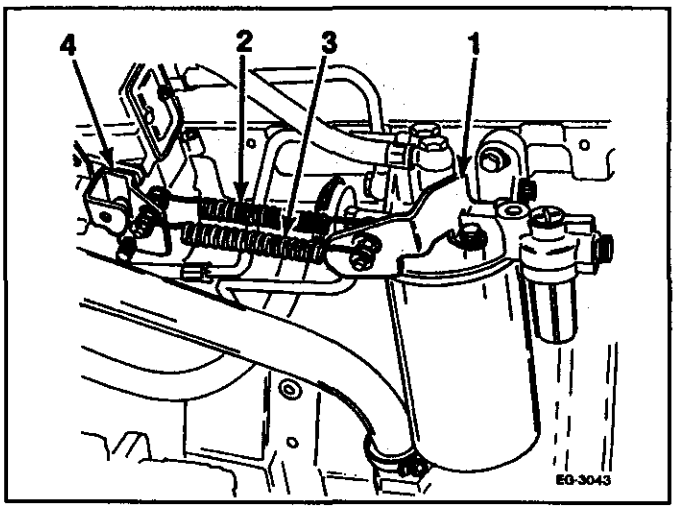
   c. Tighten to the "Specified Torque" the screws at each end of the tube.



1. Valve Cover/Intake Manifold
2. Hollow Screw
3. Aneroid Tube
4. Aneroid Elbow
5. Aneroid

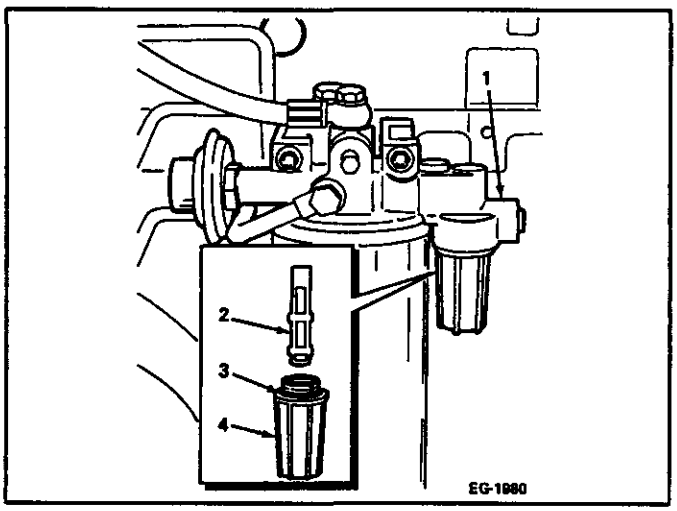
FIGURE 14–42

FUEL INJECTION PUMP REASSEMBLY



1. Inner Throttle Spring
2. Spring Bracket
3. Outer Throttle Spring
4. Throttle Control Lever

FIGURE 14–43



1. Fuel Filter Header
2. Strainer
3. O–ring
4. Strainer Cover

FIGURE 14–44

9. Connect the inner and outer throttle return springs as shown in **FIGURE 14–43.**

10. Install a new primary fuel filter/strainer as follows: Refer to **FIGURE 14–44.**

    a. Lubricate the threads of the strainer cover and install a new O–ring.

    b. Install strainer in cover and hand–tighten into fuel filter header.

NOTE:
Install strainer with open end toward filter header.

FUEL INJECTION PUMP REASSEMBLY

11. Install a new fuel filter as follows: (Refer to **FIGURE 14–45**)

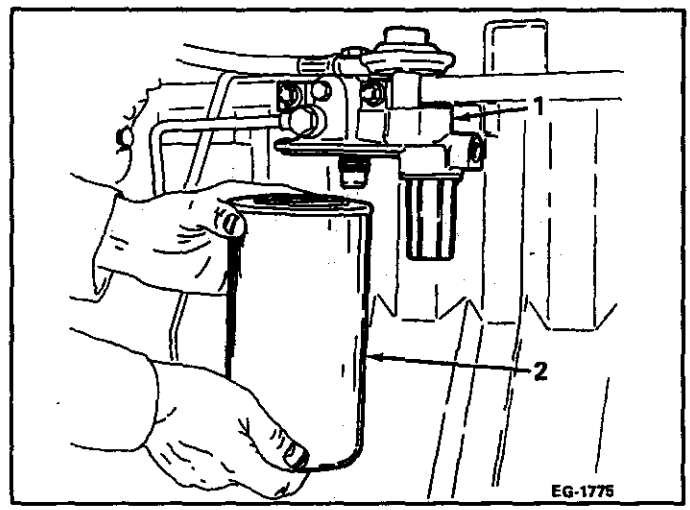
    a. Lubricate the filter gasket with clean diesel fuel.

    b. Tighten until the gasket touches the filter header.

    c. Tighten by hand an additional 1/2 turn.

NOTE:
Do not add fuel to the new filter.

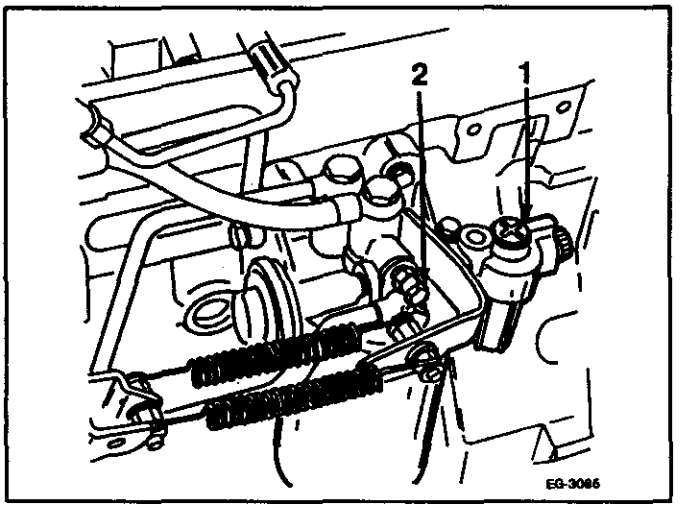
12. Install throttle cable or control rod linkage to the control lever and adjust linkage as specified in the operation and maintenance manual.



1. **Fuel Filter Header**
2. **Fuel Filter**

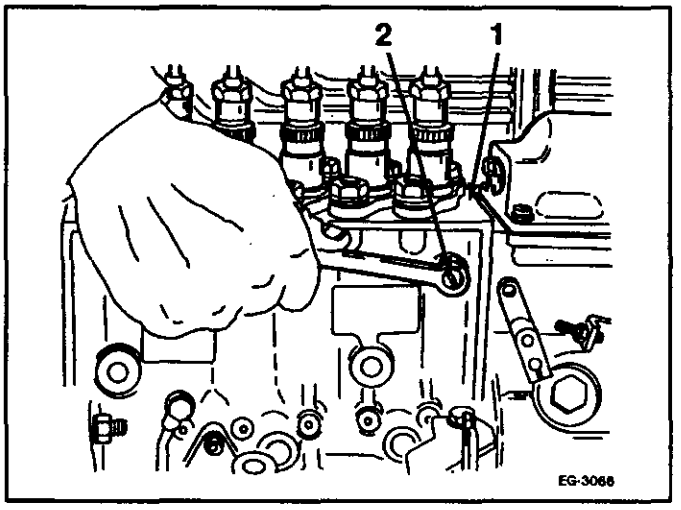
FIGURE 14–45

FUEL INJECTION PUMP REASSEMBLY



1. Fuel Filter Header
2. Bleeder Screw

FIGURE 14–46



1. Fuel Injection Pump
2. Bleeder Screw

FIGURE 14–47

14.4.3 Priming Fuel Injection System

After replacing fuel injection pump or replacing fuel supply lines, prime fuel system using these procedures:

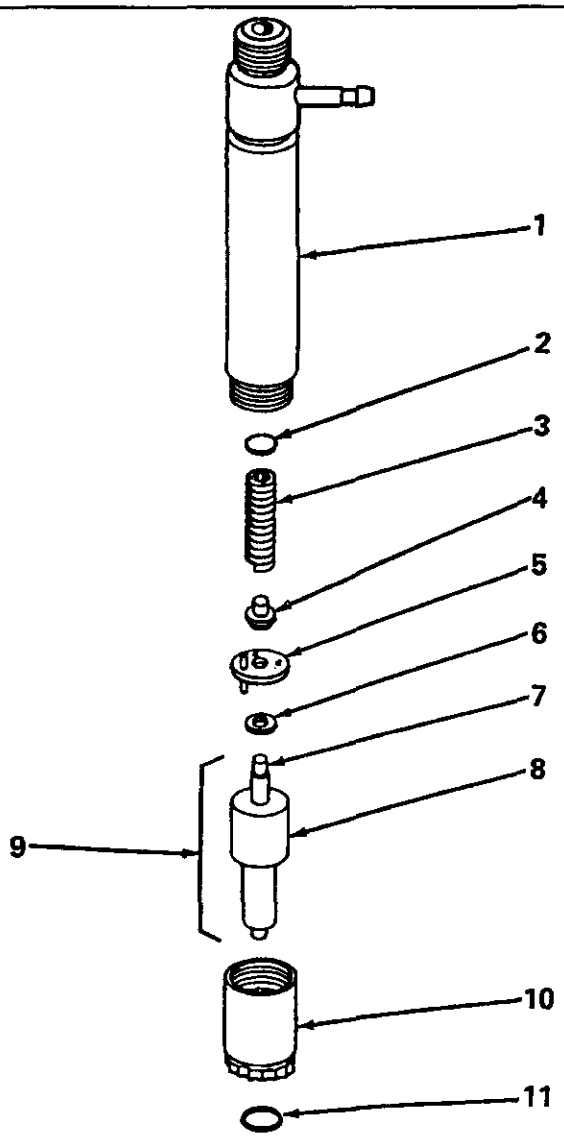
1. Loosen the bleed screws at the fuel filter header (**FIGURE 14–46**) and fuel injection pump (**FIGURE 14–47**).
2. Operate priming pump until pump action provides solid fuel at the bleed screw. Close the screw.
3. Position injection pump shutoff lever in run position with electric shutoff or mechanical cable.
4. Crank engine for fifteen seconds.

NOTE:
Crank engine for no more than 15 second intervals.

5. Start engine and operate until engine runs smoothly.

15 NOZZLES

15.1 FUEL INJECTION NOZZLE EXPLODED VIEW



1. Nozzle Holder Body
2. Spring Spacer
3. Pressure Adjusting Spring
4. Spring Seat Guide
5. Valve Stop Spacer
6. Nozzle Spacer
7. Nozzle Valve
8. Nozzle Valve Body
9. Nozzle Assembly
10. Capnut
11. Copper Gasket

FIGURE 15–1 Fuel Injection Nozzle and Holder Components.

15.2 SPECIFICATIONS

DIMENSION TITLE	VALUES
Type	**Orifice**
Actuation High Pressure Fuel from Injection Pump	
Valve Opening Pressure (V.O.P.)	
New or Reconditioned	3600–3750 lb/in.^{2} (24821–25855 kPa)
Minimum V.O.P. before Reconditioning	2900 lb/in.^{2} (19995 kPa)

15.2.1 Special Torques

Nozzle Cap Nut Torque (with nozzle installed)	33 lb·ft (45 N·m)
Nozzle Retainer Bolt Torque (Crab)	19 lb·ft (228 lb·in.) (26 N·m)
Injection High Pressure Line Connector Torque * ...	30 lb·ft (41 N·m)

* Injection line fittings at the pump and nozzle are frequently over tightened due to the fitting size 3/4 inch (19 mm). This swedges the injection line, often partly closing the ends. This alters fuel delivery characteristics, raises injection line pressures and causes injection pump failures. Inspect the ends of the injection lines and discard any with swedged or damaged fittings or holes.

SPECIAL SERVICE TOOLS

TOOL NO.	DESCRIPTION
J39538	Nozzle Cleaning Kit
J22090A	Lapping Blocks
J39261	Nozzle Sleeve Installer
J39262	Nozzle Sleeve Remover
J39263	Injection Nozzle Holding Fixture
J39264	Holding Fixture Clamping Plate
J29075–150	Nozzle Tester with Adapter
J41165	Nozzle Puller

15.3 TROUBLESHOOTING

1. Where good combustion, specified engine temperature control and clean fuel prevail, nozzles require little attention.

Nozzle trouble is usually indicated by combustion knock. Other symptoms may include:

- ❑ Hard starting or failure to start
- ❑ Engine misses
- ❑ Excessive black smoke at idle
- ❑ Excessive black smoke under load
- ❑ Low power or loss of power
- ❑ Excessive fuel consumption
- ❑ Erratic idle speed
- ❑ Frequent engine stalls
- ❑ Surging at governed RPM

2. While the above symptoms may be caused by defective nozzles, they may also be caused by other engine related problems such as:

- ❑ Incorrect fuel
- ❑ Water in fuel
- ❑ Dirty or damaged fuel filter
- ❑ Incorrect maximum fuel setting
- ❑ Faulty injection pump
- ❑ Insufficient engine lubrication
- ❑ Incorrect pump timing
- ❑ Faulty engine valves
- ❑ Air in fuel

3. Where faulty nozzle operation is suspected on an engine that is knocking, a simple test can be made to determine which cylinder is causing the difficulty.

NOTE:

Keep hands and clothing away from moving items on engine when loosening connections.

4. With the engine running at a speed that makes the defect most pronounced, momentarily loosen the high pressure fuel inlet connection on one nozzle assembly sufficiently to "cut out" the cylinder.

5. Check each cylinder in the same manner. If one is found where loosening causes knocking to cease, the injection nozzle for that cylinder should be tested.

6. Nozzle testing, disassembly, cleaning and reconditioning must be done only by an authorized International Dealer or other diesel service outlet equipped and qualified to perform such services.

NOTE:

When servicing injection nozzle assemblies, the necessity of cleanliness cannot be over–emphasized. A clean workbench, clean washing fluid containers, clean tools and clean hands are all essential to produce satisfactory results. The use of suitable tools for this type of work is equally important.

TROUBLESHOOTING

TROUBLESHOOTING GUIDE		
FAULT	**POSSIBLE CAUSE**	**REMEDY**
Nozzle blueing	1. Faulty installation or tightening	Replace nozzle
	2. Insufficient cooling	Correct cooling system
Spray pattern not well atomized	1. Carbon deposit on tip of valve	Clean nozzle
	2. Nozzle orifice(s) partially blocked	Clean nozzle
	3. Defective nozzle	Replace nozzle
Nozzle opening pressure too high	1. Incorrect shim adjustment	Readjust nozzle shims
	2. Nozzle valve dirty or sticky	Clean nozzle
	3. Seized nozzle	Replace nozzle tip assembly
Nozzle opening pressure too low	1. Shim/spacer wear	Replace worn components and reset opening pressure
	2. Nozzle valve spring broken	
	3. Nozzle seat worn	
Nozzle valve seat leakage	1. Nozzle leaks because of excessive carbon deposit or sticking nozzle valve	Clean nozzle
	2. Defective nozzle	Replace nozzle assembly
Excessive leak–off	1. Dirt between pressure face of nozzle, valve stop spacer and holder body	Clean nozzle
	2. Loose nozzle cap nut	Inspect nozzle body and valve then tighten nut to 33 lb·ft (45 N·m)
	3. Defective nozzle tip	Replace nozzle tip assembly

15.4 IDENTIFICATION

NOZZLE CHART				
Detroit Diesel Nozzle and Holder Assembly +	**Detroit Diesel Nozzle Number**	**Code**	**Vendor Nozzle Identification Number Inscribed on Valve Body (See Note) on page 15–10 just below FIGURE 15–2.**	**Number and Diameter of Spray Holes**
1 820 834 C91	1 820 835 C1	B	30525	5 — 0.240 mm. 5 — 0.0094 in.
1 820 836 C91	1 820 837 C1	C	30526	5 — 0.245 mm. 5 — 0.0096 in.
1 820 838 C91	1 820 839 C1	D	30527	5 — 0.255 mm. 5 — 0.0100 in.
1 820 840 C91	1 820 841 C1	E	30528	5 — 0.260 mm. 5 — 0.0102 in.
1 820 842 C91	1 820 843 C1	F	30529	5 — 0.265 mm. 5 — 0.0104 in.
1 820 844 C91	1 820 845 C1	G	30530	5 — 0.270 mm. 5 — 0.0106 in.
1 820 846 C91	1 820 847 C1	H	30538	4 — 0.295 mm. 4 — 0.0116 in.
1 820 848 C91	1 820 849 C1	J	30539	4 — 0.300 mm. 4 — 0.0118 in.
1 820 890 C91	1 820 891 C1	K	30540	4 — 0.310 mm. 4 — 0.0122 in.
1 820 892 C91	1 820 893 C1	L	30541	4 — 0.325 mm. 4 — 0.0128 in.
1 820 894 C91	1 820 895 C1	M	30542	4 — 0.330 mm. 4 — 0.0130 in.

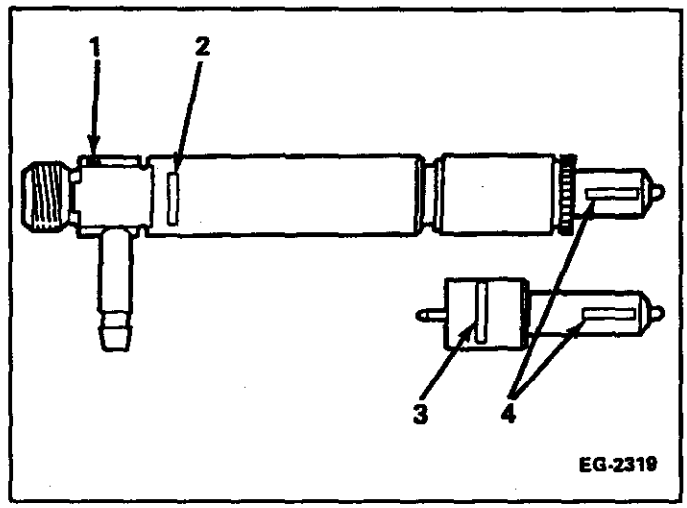
NOTE:
Nozzle Opening Pressure for a New Nozzle is 24825 – 25855 kPa (3600 – 3750 lb/in.^{2}). Recondition or replace the nozzle when opening pressure is below 19,994 kPa (2900 lb/in.^{2}).

IDENTIFICATION

NOTE:
When performing the Nozzle Leakage Test and the nozzle is subjected to 3447 kPa (500 lb/in.²) hydraulic pressure below opening pressure for 5 seconds, wetting of the nozzle tip is permissible without the formation of a droplet.

+ This Detroit Diesel nozzle and holder assembly part number **DOES NOT** appear on the nozzle holder. The manufacturer's nozzle holder part number does appear on the holder. (Refer to **FIGURE 15–2**).

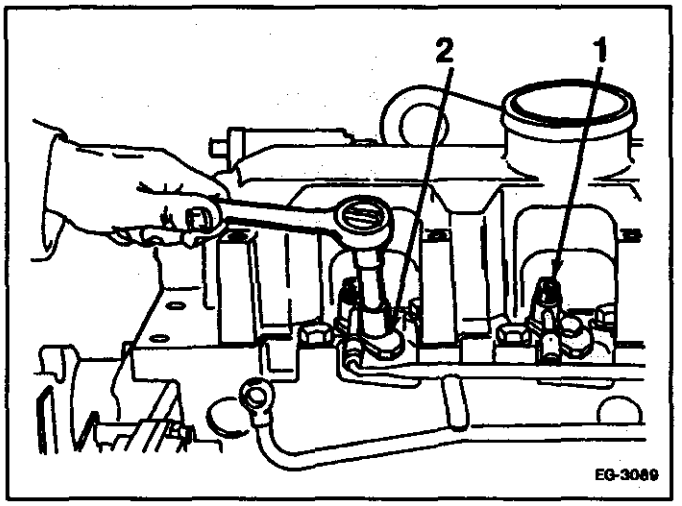
NOTE:
Nozzle identification number cannot be seen with nozzle assembled in the holder. (Refer to FIGURE 15–2).



1. Nozzle Code Location
2. Vendor Nozzle Holder Number
3. Vendor Nozzle Number
4. Nozzle Part Number

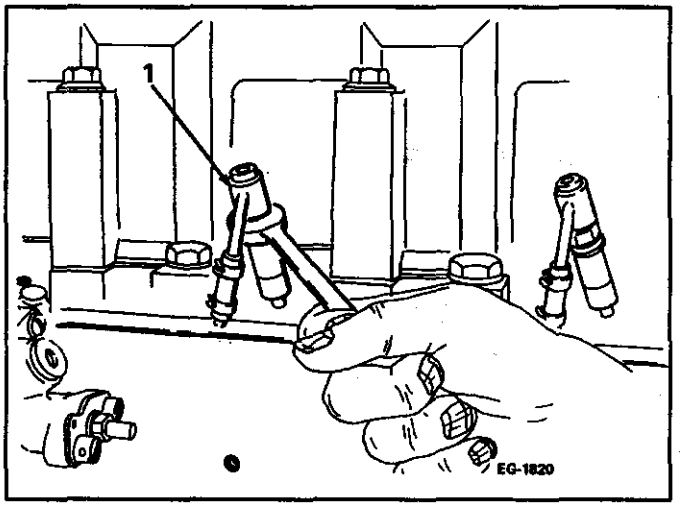
FIGURE 15–2

15.5 REMOVAL



1. Nozzle
2. Clamp (with Bolt)

FIGURE 15–3



1. Nozzle

FIGURE 15–4

1. Clean the top of the engine to prevent dirt from entering any openings.
2. Remove the fuel injection lines as an assembly. Follow the directions in this section under "Fuel Injection Pump Removal".
3. Remove the injection nozzle hold–down bolt and clamp (crab). Refer to **FIGURE 15–3.**

NOTICE: **Be sure to cap all nozzle, pump and fuel line openings to protect the fuel system from contamination.**

4. Remove the nozzle as follows:
   a. Nozzles may be pried or lifted straight out with wrench. Refer to **FIGURE 15–4.**

REMOVAL

b. If necessary, use nozzle puller **J41165** to pull the nozzle straight out. Refer to **FIGURE 15–5.**

NOTICE:

Twisting the holder with a wrench will loosen the nozzle and the copper sealing gasket at the bottom of the nozzle but may also accidentally loosen or remove the nozzle sleeve.

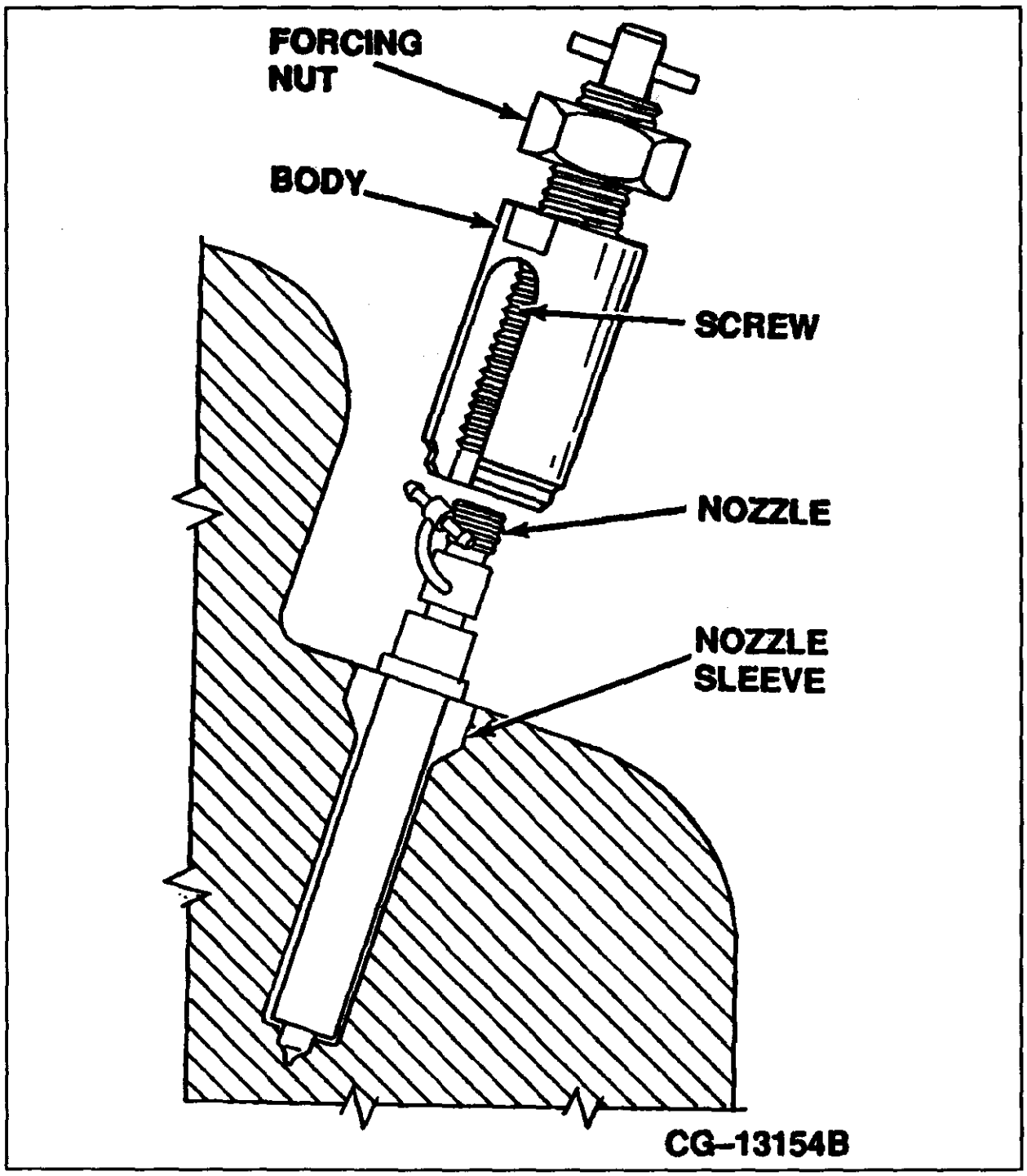
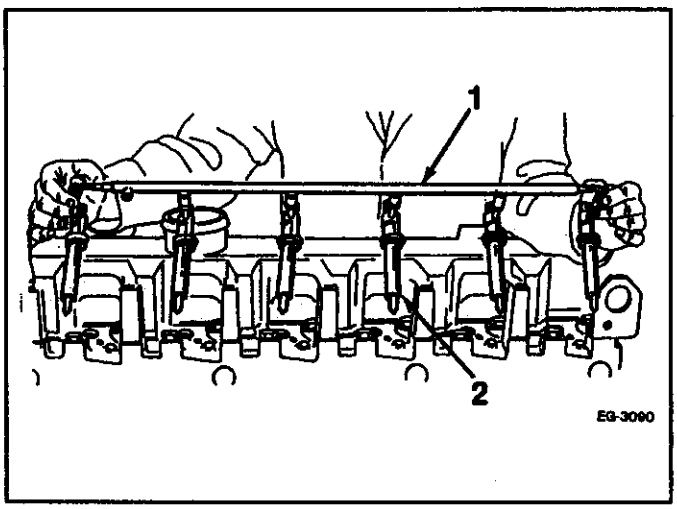


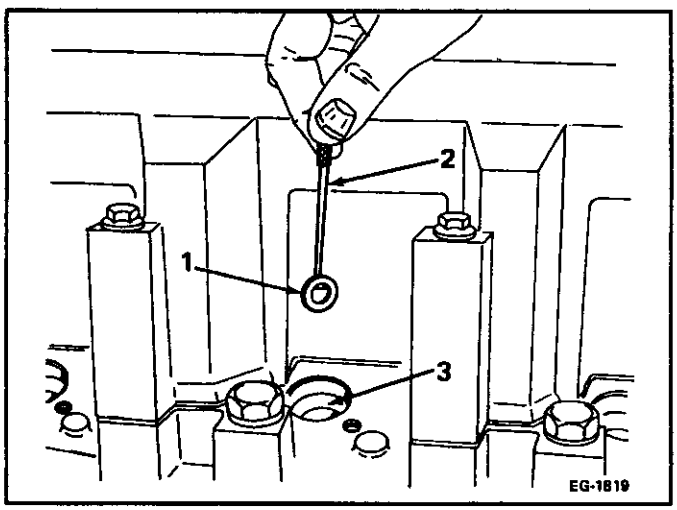
FIGURE 15–5

REMOVAL



1. Fuel Leak–off Line
2. Nozzle

FIGURE 15–6



1. Nozzle Gasket
2. O–ring Pick
3. Nozzle Bore

FIGURE 15–7

5. Remove the nozzles and dust seal grommets from their sleeved bores in the cylinder head. Refer to **FIGURE 15–6.**

NOTE:

The nozzles may be removed as an assembly (with the leak–off lines) or individually. Install plastic caps over the nozzle tips when removed from the cylinder head.

6. Remove the copper nozzle gaskets from the nozzles bores using an O–ring pick. Refer to **FIGURE 15–7.**

NOTE:

The nozzle gasket(s) may adhere to the nozzle(s) when removed.

15.6 PRE–RECONDITIONING INSPECTION

The prime requirements for a satisfactory nozzle assembly are:

- ❑ Pressure tight seats
- ❑ No excessive valve stem leakage
- ❑ Satisfactory spray
- ❑ Atomization characteristics

1. After removal from engine, test nozzles for spray condition, opening pressure and leakage on a hand test pump J29075–150. **FIGURE 15–8** shows an injection nozzle mounted for testing on the hand test pump.

NOTICE: **It is advisable to test nozzles before cleaning them. After testing, place nozzles in a cold decarbonizing solution for at least one hour. After removing nozzles from solution, wash off the outside surfaces.**

2. Prepare pump for making tests. Fill pump reservoir with Viscor 1487C calibration fluid. Open pump valve slightly and operate pump handle to expel air from pump and outlet pipe. Operate pump until solid fluid (without air bubbles) flows from the end of the outlet pipe. Close the pump valve.
3. Connect injection nozzle to test pump. Avoid "cross–threading". Tighten connector nut securely with open end wrench.

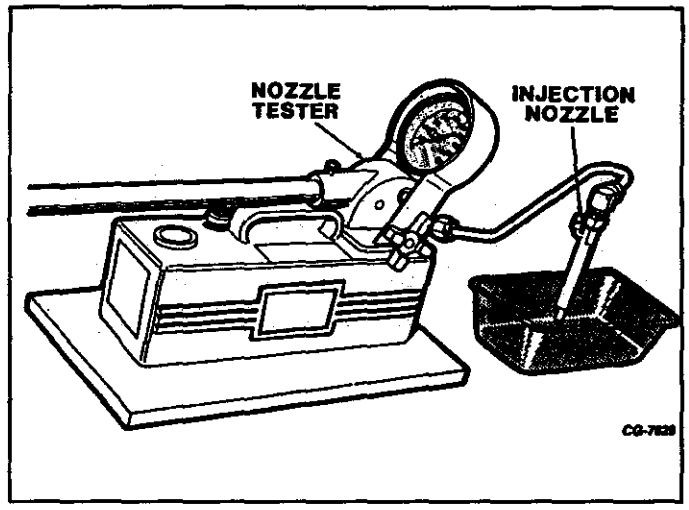


FIGURE 15–8

PRE–RECONDITIONING INSPECTION

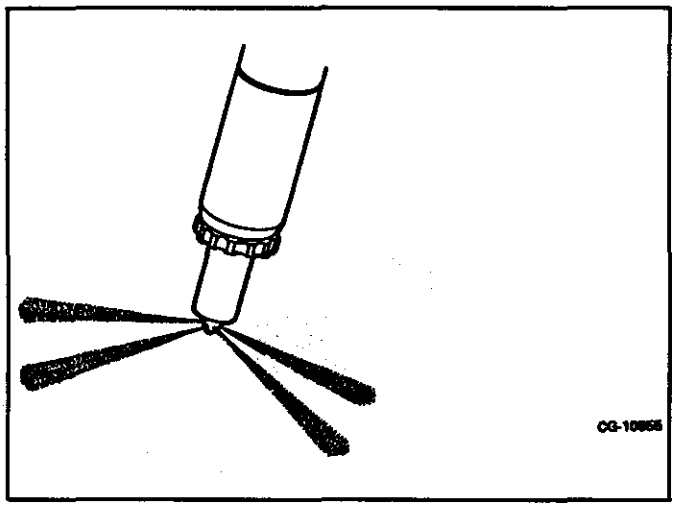


FIGURE 15–9

NOTE:

The gauge valve should be closed. Failure to close the gauge valve will lead to a damaged gauge. The gauge valve should only be opened to check opening pressure and tip leakage. A residual pressure should always be left in the pressure gauge.

4. Bleed air from the nozzle. Open the pump valve and operate the pump for several quick strokes to expel (bleed) air from the injection nozzle. Fluid should discharge from the holes in the nozzle tip.

CAUTION

Keep hands away from nozzle discharge. Fluid discharging from the nozzle under high pressure can penetrate the skin and cause infection. Medical attention should be provided immediately in the event of skin penetration.

the test pump in smooth, even strokes and observe the pattern of fluid discharging from the four (4) five (5) nozzle tip discharge holes. The discharge should be well atomized in an even pattern, free from solid streams and dribbling. Refer to **FIGURE 15–9**.

6. **Check nozzle opening pressure.** Open the gauge valve, operate the test pump in slow, smooth, even strokes and observe gauge pressure to determine pressure at which nozzle opens (discharges fluid). The nozzle should operate within the specified opening pressure range. See "Specifications".

PRE–RECONDITIONING INSPECTION

7. **Check for tip leakage.** Blow nozzle tip dry using filtered compressed air. Operate test pump to maintain pressure at about 500 lb/in.^{2} (3447 kPa) below opening pressure. Nozzle tip should remain dry without an accumulation of fluid drops at spray holes. A slight wetting after about 5 seconds is permissible if no droplets are formed. Refer to **FIGURE 15–10.**

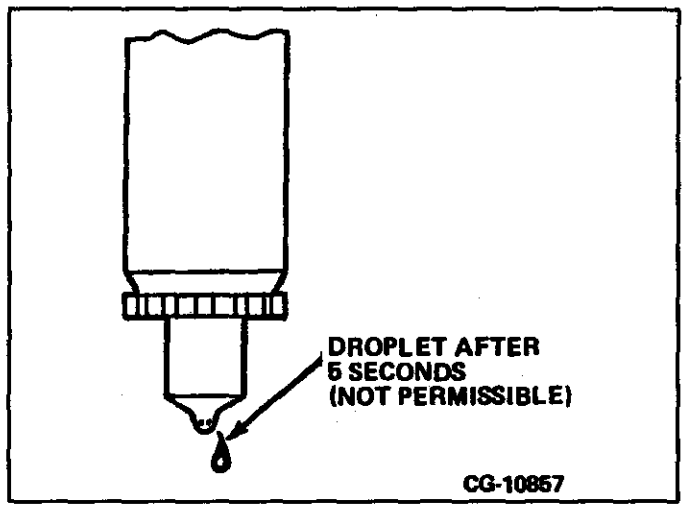


FIGURE 15–10

NOTE:

Do not wipe tip with fingers as this will tend to draw the fluid present in the sac hole through the orifices and falsely indicate a leak and rejection of a good valve/nozzle.

8. **Check fuel leak–off.** Operate test pump in quick strokes and observe for flow of fluid from leak–off part of nozzle. A very slight leak–off is normal. If more than 1.0 cc/minute of fluid is expelled or if fluid surges from leak–off port when nozzle pressure is held @ 500 lb/in.^{2} (3447 kPa) below V.O.P., the nozzle is faulty.
   a. If the nozzle passes the above tests, it is suitable for further service in the engine following cleaning and removal of accumulated carbon.
   b. Nozzles showing irregular spray pattern, leakage at nozzle tip spray holes, excessive fluid leak–off or opening pressure below minimum permissible limit should be replaced or reconditioned (disassembled, cleaned and rebuilt).

15.7 DISASSEMBLY

NOTE:

Disassemble only those nozzle holder assemblies that fail to meet specifications.

When inspecting various components, reference can be made to test performance results as an aid in determining the extent of reconditioning necessary.

NOTE:

Under no circumstances should nozzle valves and bodies be interchanged. To avoid interchanging, use numbered containers to keep nozzle components together.

1. Wash all external dirt, grease and carbon deposits from holder assembly with a suitable cleaning agent.
2. Remove nozzle gasket from nozzle, if not removed earlier.
3. A brass wire hand brush should be used to remove hardened deposits of dirt or carbon. **DO NOT** use a steel wire brush to clean the nozzles. Never use a power operated brush.

NOTICE: **Soak nozzle holder assembly in a carbon removing cleaning agent ("gunk", "bendix cleaner" or equivalent) for at least four hours before removing nozzle cap nut, otherwise, the nozzle plate pins may be damaged.**

DISASSEMBLY

4. An **J39263** injector nozzle holding fixture and **J39264** injector nozzle clamping plate is required when disassembling a nozzle holder assembly; otherwise, the nozzle plate pins may be damaged.

   a. It is recommended that the J39263 holding fixture be bolted to a workbench.

   b. Assemble the clamping plate J39264 to the guide pins on the holding fixture J39263. Refer to **FIGURE 15–11**.

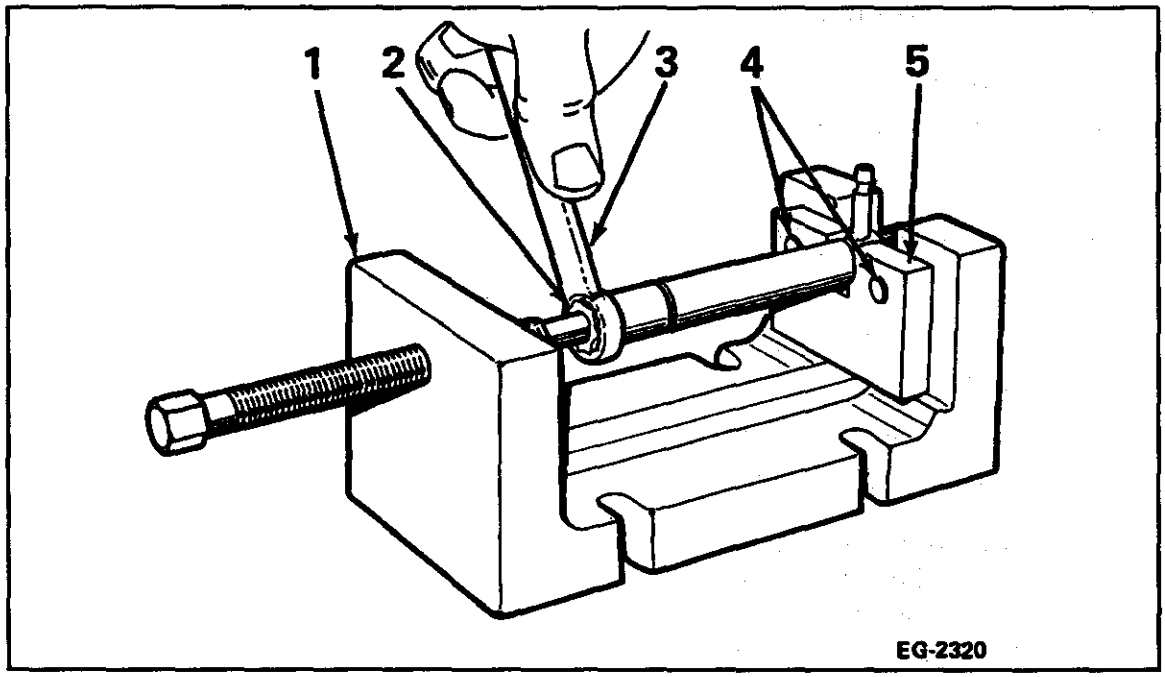
   c. Insert the nozzle and holder assembly into the clamping plate as shown in **FIGURE 15–11.**

   d. Loosen the nozzle cap nut with an appropriate box end wrench until the nut can be turned by hand.

NOTE:
Wrench must be assembled prior to clamping nozzle in fixture.

   e. Remove holder assembly from fixture.

5. The nozzle may now be disassembled. Refer to **FIGURE 15–1** for component parts.



1. **Holding Fixture**
2. **Nozzle Capnut**
3. **Box Wrench**
4. **Pins**
5. **Clamping Plate**

FIGURE 15–11

15.8 CLEANING, COMPONENT INSPECTION AND REPAIR

1. Wash all parts in a suitable cleaning agent.

NOTE:

DO NOT intermix nozzle valves. Keep each valve with its original nozzle body.

2. Soak nozzle valve (tip) in a varnish removing cleaning agent.

3. Probe all nozzle spray holes with the appropriate size cleaning needle J39538.

J39538 Nozzle Cleaning Set Consists of:

Description	Qty.
Honing Stone	1
Pin Vise, 0–.075"	1
Tallow, 1/2 oz. Tube	1
Brass Wire Brush, 1" x 3"	1
Tool Box (Wood, Sliding Lid)	1
Pressure Chamber Scraper	1
Polishing Sticks, 5 mm (60° Seat)	Set of 3
Valve Seat Scraper (60° Seat)	1
Inspection Magnifier (Loupe) 5x	1
Polishing Sticks, 5 mm (90° Seat)	Set of 3
Valve Seat Scraper (90° Seat)	1
Nozzle Sac Reamers .046" (1.17mm)	Set of 2
Nozzle Sac Reamers .050" (1.27mm)	Set of 2
Nozzle Sac Reamers .069" (1.75mm)	Set of 2
Spray Hole	
Cleaning Needles .010" (0.25mm)	Set of 5
Cleaning Needles .011" (0.28mm)	Set of 5
Cleaning Needles .012" (0.30mm)	Set of 5
Cleaning Needles .013" (0.33mm)	Set of 5
Cleaning Needles .014" (0.35mm)	Set of 5
Cleaning Needles .015" (0.38mm)	Set of 5
Cleaning Needles .021" (0.53mm)	Set of 5

NOTE:

The needle used must be smaller in diameter than the nozzle spray hole. See nozzle chart in this section for number and size of orifice holes. Some nozzles will require a smaller cleaning needle then is in Nozzle Cleaning Set J39538 and will have to be purchased separately.

CLEANING, COMPONENT INSPECTION AND REPAIR

4. Clean all ducts and nozzle spray holes with filtered compressed air.
5. Thoroughly clean interior of nozzle cap nut. All carbon deposits must be removed (soak to loosen – brass brush to clean).

NOTE:

Do not be too hasty in judging performance of a nozzle. It has been found that after soaking nozzles in a good carbon cleaner or carburetor cleaner for a day that many will meet specifications for leakage or opening pressure that might otherwise be rejected.

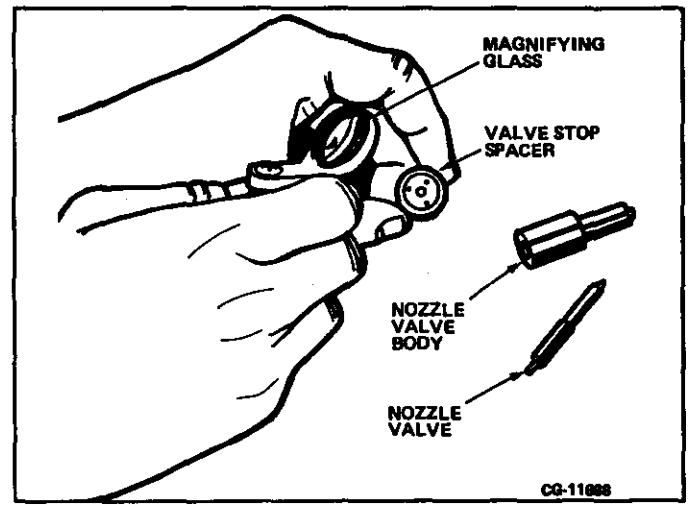


FIGURE 15–12

15.8.1 Component Inspection and Repair

1. Use a magnifying glass (part of **J39538**) to inspect the mating surfaces of the nozzle components, particularly the valve stop spacer, nozzle valve body and valve for nicks, scratches or signs of corrosion. Refer to **FIGURE 15–12.**

NOTE:

Failure of these surfaces to seal properly will result in leakage to the return or to the outside of the nozzle.

2. Recondition the mating surfaces by flat lapping or replace the components as required.

15.9 FLAT LAPPING PROCEDURES

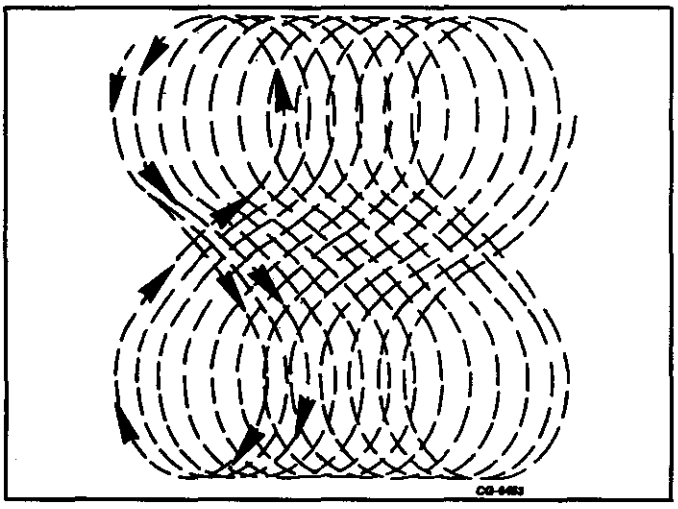


FIGURE 15–13

NOTE:

Use lapping block set J22090–A.

1. Prepare the lapping blocks for use by washing them in fuel oil and using a bristle brush. Dry off with filtered compressed air. **Do not use wiping rags.**
2. Mix a small amount of lapping compound (1000 grit) into a thin paste using diesel fuel.

NOTE:

In some areas, prepared lapping compound can be obtained in small tubes.

3. Apply a very small amount of lapping compound (well spread out) to the lapped side of the blocks. Keep this amount at a minimum to obtain the best results.

NOTE:

Blocks that are grooved on both sides are generally marked to indicate which side is the lapped surface.

4. The part to be lapped should be placed upon the lapping block and moved about in a figure eight pattern. To equalize the wear in the lapping block, the series of figure eight strokes should start at one side and progress across the block as shown in **FIGURE 15–13.**
5. Apply only enough pressure to keep the part flat on the block. After four or five "passes", lift the part off the block and clean the compound off by rubbing the part across a clean sheet of paper placed on a flat surface (avoid excessive lapping).

FLAT LAPPING PROCEDURES

6. If the surface of the lapped part does not appear uniform in reflected light or if there are any depressions around the sealing surfaces, repeat the lapping procedure.

NOTE:

One exception will be for the valve stop spacer. When the lapping process does not remove depressions around the center valve stem hole, the plate may be turned over in "Reassembly", provided good sealing surfaces are present. Otherwise the plate must be replaced with a new one.

7. Perform the last step, **DRY LAPPING**, which produces a mirror–like finish and provides an excellent sealing surface.

15.9.1 Dry Lapping

1. Clean the block in the same manner as described earlier and dry with filtered compressed air. The block used **MUST BE FREE OF ANY LAPPING COMPOUND.**
2. Place the part to be lapped on the block surface and move it about in a figure eight pattern across the whole area of the block (**FIGURE 15–13**). Make four or five passes, then inspect the finish before repeating (if necessary).
3. Apply only enough pressure to keep the part flat on the block.

NOTE:

Do not handle parts on the lapped surfaces as corrosion will appear in the areas touched.

15.10 CARE AND RECONDITIONING LAPPING BLOCKS

NOTICE: **Keep the lapping blocks covered when not being used, to keep dust or other foreign matter from the surface.**

NOTE:

It will be necessary to perform a certain amount of maintenance on the lapping blocks to keep them in top condition. The wear will be gradual but, by continued use, worn or low spots in the block must be removed.

A short time spent each day in hand–lapping the blocks will be an effective way of maintaining the finish necessary for quality lapping.

The lapping blocks must be thoroughly cleaned before any reconditioning is started. Use a stiff bristle brush (not a wire brush) and scrub the blocks in a good solvent and blow dry with filtered compressed air.

All lapping blocks in a set are involved in the reconditioning procedure outlined below:

1. Spread a small amount of 1000 grit lapping compound (prepared in a paste) on block number 1, assuming the blocks to be numbered 1, 2 and 3.
2. Lap number 1 and 2 (face to face) together, using a figure eight pattern (**FIGURE 15–13**). Then take 1 and 3; and finally 2 and 3.
3. After working 1 and 3 together, wipe off number 2 on a clean sheet of paper placed on a flat surface. Low spots, if any, will appear as dark spots and high spots as bright spots. Continue the lapping procedure until the overall appearance is a uniform gray surface.
4. After the blocks have been refinished, clean them thoroughly in a good solvent using a bristle brush, then blow dry with filtered compressed air.

15.10.1 Inspection

1. Visually inspect the valve stop spacer pins for deformity or breakage. Replace as required.
2. Visually inspect the nozzle cap nut for cracks, damaged threads or damaged copper gasket seating face. Replace as necessary.
3. Check the stem and the body of the valve. When both parts are wet with fuel oil, no sticking should be evident. Pull the valve out of the body about one–third of its length. When released, the valve should slide freely back to the seat. Foreign matter or scratches on the valve will cause it to stick. Carefully inspect before installing the valve.
4. **Opening Pressure Adjustment**: The nozzle opening pressure is increased or decreased by the selection of the appropriate sized spacer.

15.11 REASSEMBLY

(Refer to **FIGURE 15–1**)

1. **DO NOT** touch lapped surfaces. To avoid interchanging of nozzle parts, reassemble one nozzle at a time.
2. Dip all parts in clean calibrating fluid.
3. Clamp the nozzle holder body upright in a vise, using the flats on the holder body to clamp onto.
4. Select an appropriate size spacer to achieve the correct opening pressure and insert it into the holder body.
5. Place the pressure adjusting spring and spring seat guide into the nozzle holder body.
6. Align the valve stop spacer with the dowel pin holes in the holder body and assemble to the nozzle holder body.
7. Dip the nozzle valve, located in the nozzle valve body, into clean calibrating fluid.
8. Insert the nozzle valve into the valve body and move the valve up and down several times to insure free movement.
9. Apply a thin, even coat of "Lubriplate 630–AAA" or equivalent to the nozzle valve body seating shoulder.
10. Align the nozzle valve body locating pin holes with the plate pins and assemble to the two components.
11. Assemble the cap nut over the nozzle valve body and tighten the cap by hand to the holder.

(Refer to **FIGURE 15–1**)

12. Tighten the cap nut to the specified special torque.
13. Install a new copper gasket over the nozzle tip.
14. Cap the nozzles with plastic caps until re-testing and adjusting is performed.

15.12 RETESTING AND ADJUSTING CLEAN NOZZLE ASSEMBLIES

CAUTION

Keep hands away from the nozzle discharge. Fluid discharging from the nozzle under high pressure can penetrate the skin and cause infection. Medical attention should be provided immediately in the event of skin penetration.

Using **VISCOR 1487C** (SAE J967 Standard) calibration fluid and a standard hand test pump J24075–150, equipped with a pressure gauge having a capacity of at least 27,600 kPa (4000 lb/in.^{2}), proceed as follows: (Refer to **FIGURE 15–14**).

1. Attach the nozzle tube assembly to the nozzle hand test pump.
2. Attach the 90° adapter to the nozzle tube.
3. Attach nozzle and holder assembly loosely to the test pump. Pump the handle several times to flush out the fittings; then tighten.
4. Test each nozzle for opening pressure as follows:

   Opening Pressure Test: Pump the test pump handle a few strokes to clear the air from the nozzle and then raise the pressure steadily. Observe the gauge pressure at which the valve opens. Refer to the Nozzle Test Chart in this section for the specified opening pressure. If the pressure is incorrect, adjust by selecting a different size spacer.

NOTE:

A .001 inch (.025 mm) change in the spacer will result in an 55 lb/in.^{2} (379 kPa) change in pressure.

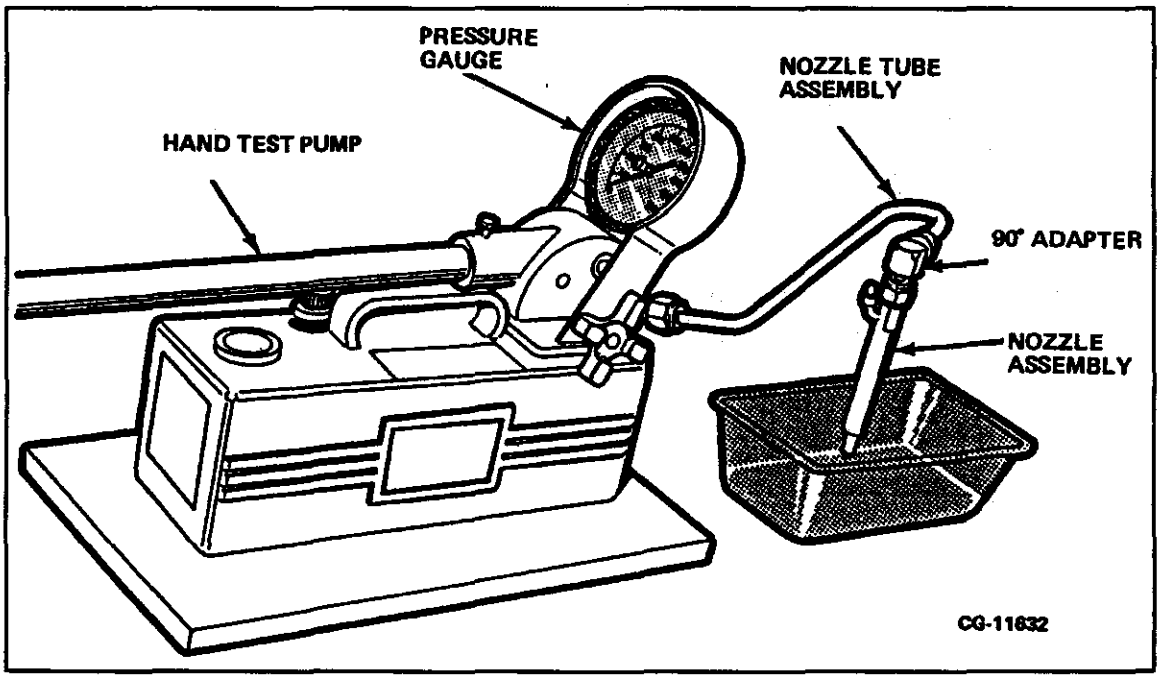


FIGURE 15–14

RETESTING AND ADJUSTING CLEAN NOZZLE ASSEMBLIES

5. Test each nozzle for seat leakage as follows:

   Seat Leakage Test: Wipe the nozzle tip dry. Bring the pressure up slowly to 500 lb/in.^{2} (3447 kPa) below the nozzle opening pressure and maintain this pressure for 5 seconds. If fluid leaks or drips from the nozzle or a visible drop forms, the nozzle is leaking (slight moistening of the nozzle tip is permissible). Recondition or replace a leaking nozzle.

NOTE:

Do not wipe the tip with the fingers as this will tend to draw the fuel present in the sac hole through the orifices and falsely indicate a leak resulting in the rejection of a good valve.

Leakage at the seat may be caused by dirt or foreign material, carbon or gum deposits at the seat area or excessive wear of the seat. If the seat is worn, replace the nozzle body and nozzle valve.

NOTE:

Never lap the valve–to–body seat. This will only widen the seat area and prevent sealing.

6. Test each nozzle for spray pattern as follows:

   Spray Pattern Test: Close pressure gauge valve. Operate test pump at a moderate rate and observe the spray pattern.

   a. All of the fluid should be atomized and each hole should spray approximately the same amount of fuel.

   b. The spray patterns for all holes should be uniform.

NOTE:

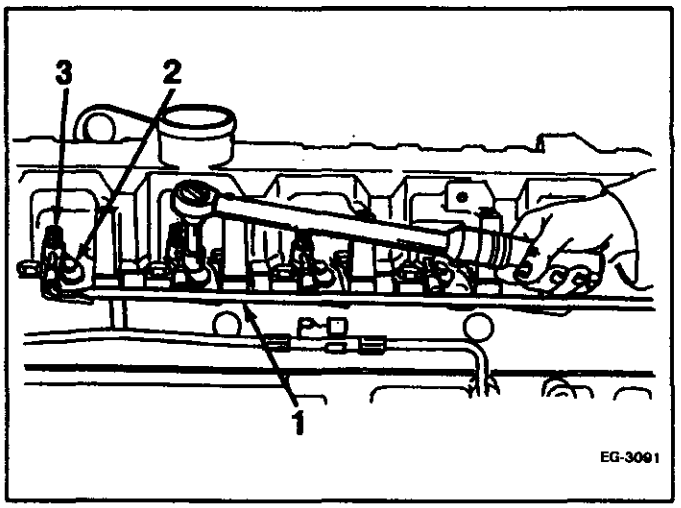
Upon operating the test pump you will note a distinct and relatively regular nozzle chatter. A sharp pitched sound is not mandatory and an occasional skip or variation in sound may occur. In addition, chatter may vary from nozzle to nozzle. Lack of chatter is not a cause for rejection of a nozzle.

7. **Stem Leakage:** Bring the pressure on the nozzle to 1500 lb/in.^{2} (10342 kPa). If there is any leakage from the return, collect it. To conserve time, nozzle may be in inverted position. The maximum allowable leakage is 1.0 cc in one minute at this pressure.

Excessive leakage at this point can be caused by scratches or poor sealing at the flat lapped surfaces of the nozzle body, intermediate plate or valve body. If this possibility has been already eliminated, there is excessive clearance between the valve stem and body. This condition necessitates replacement of the nozzle.

After nozzles meet testing standards and adjustments are made, you may install nozzle assemblies.

15.13 INSTALLATION



1. Fuel Leak–off Line
2. Clamp (with Bolt)
3. Nozzle

FIGURE 15–15

1. Thoroughly clean nozzle bore in cylinder head before reinserting nozzle holder assembly. Pay particular attention to seating surfaces, in order that no small particles or carbon will cause assembly to be cocked or permit blow–by of combustion gases. Don't use hard or sharp tools for cleaning. Blow out with filtered compressed air.

NOTICE: **Be sure to use a nozzle seating brush when cleaning cleaning nozzle bore.**

2. Remove the nozzle tip protective caps and install the nozzle assemblies into each sleeved bore. Be sure a new copper gasket is in place. Use a dab of grease to hold the gasket in place.
3. Install the nozzle retainers (crabs) and tighten the bolts to the specified special torque. Refer to **FIGURE 15–15.**
4. Install the fuel return lines.
5. Remove the protective caps and install the high pressure fuel lines as described previously in this section. Tighten connector nuts to the specified special torque.
6. Prime the fuel injection system as described in Section 14 under "Fuel Injection Pump."