EGR VALVE

Build up of soot (carbon) or contamination of the air filter element is a result of exhaust gases emitted from the EGR valve.

During normal operation of the EGR valve, some soot will occur in the intake manifold below the EGR valve. A soot deposit will also occur on the inner surface of the air cleaner element and housing. This is normal. The air filter element air flow will not be affected, and should last the specified change interval.

Should soot build-up be excessive, and/or evidence of filter deterioration occurring, the following may have occurred:

1. Malfunction of the EGR system (evidenced by excessive black exhaust).
2. Malfunction or setting of the TPS (throttle position switch). Refer to Section 4B.
3. Mode of vehicle operation. If the vehicle is idled for long periods, or long downhill operation with closed throttle, the build-up may be excessive.

To direct the EGR exhaust gas directly into the intake manifold, a baffle, P/N 25042774, has been released for service. The installation of this baffle will prevent the sooting of the filter element. Malfunctions or improper settings of the EGR/TPS system will still cause excessive black smoke and poor performance. Conditions in these areas should be corrected promptly.

To install this baffle, refer to Figure 3-9 below and use the following steps:

1. Remove air filter housing from engine. (Disconnect EGR hose at EGR valve and at solenoid.
2. Clean housing and cover.
3. Inspect air cleaner gasket on manifold. If it is torn or missing, install a new gasket.
4. Install air cleaner housing.
5. Replace element if required.
6. Install baffle and element. Assure proper seating of both. (Attach vacuum hose to EGR valve and solenoid.)
7. Install cover and tighten wing nuts.

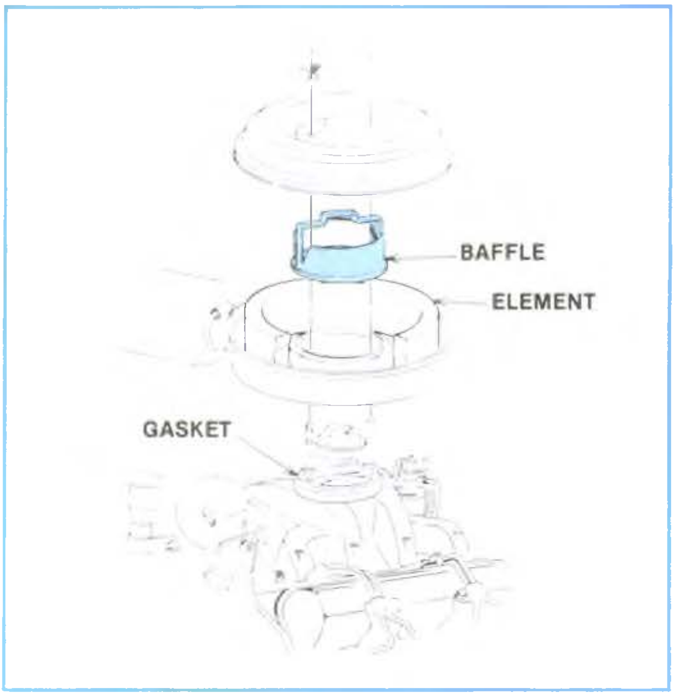


Figure 3-9, **Baffle.**

NOTES

4. Fuel System

4A. Low Pressure Fuel Delivery System
4B. High Pressure Fuel Delivery System

Fuel System Components

The diesel fuel system (see Figure 4-1) consists of the following components:

- Low Pressure: Fuel tank, fuel (lift) pump, fuel filter or filters, fuel lines.

A. Low Pressure Fuel Delivery System.
The system consists of:

- Tank filter sock.
- Mechanical lift pump.
- 1982-83 Primary fuel filter.
- Fuel Line Heater.
- 1982-83 Secondary fuel filter.
- 1983 G-P Truck Secondary fuel filter.
- 1984 Model 80 fuel filter (1984).

B. High Pressure Fuel Delivery System.
The system consists of:

- Fuel injection pump.
- High pressure lines.
- Nozzles.

Fuel is pulled from the fuel tank by the Mechanical pump which is located on the right side of the engine. It is driven by an eccentric lobe on the camshaft through a push rod. Fuel is pulled through the primary filter (1982-83 only), by the Mechanical pump. Fuel is then pumped through the secondary or model 80 filter mounted on the inlet manifold. Both filters remove foreign material which could damage the injection pump or clog the injector nozzle. From the filter, the fuel is pumped to the injection pump.

Fuel Return System

A fuel return system routes excess fuel from the injection pump and leak-off type nozzles.

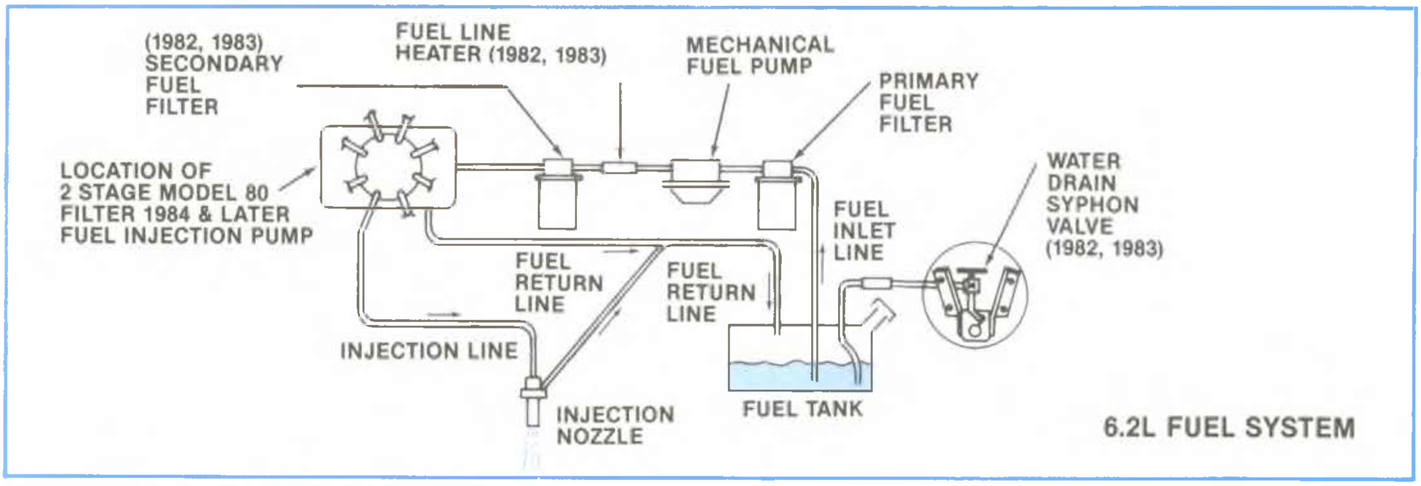


Figure 4-1, Diesel Fuel System.

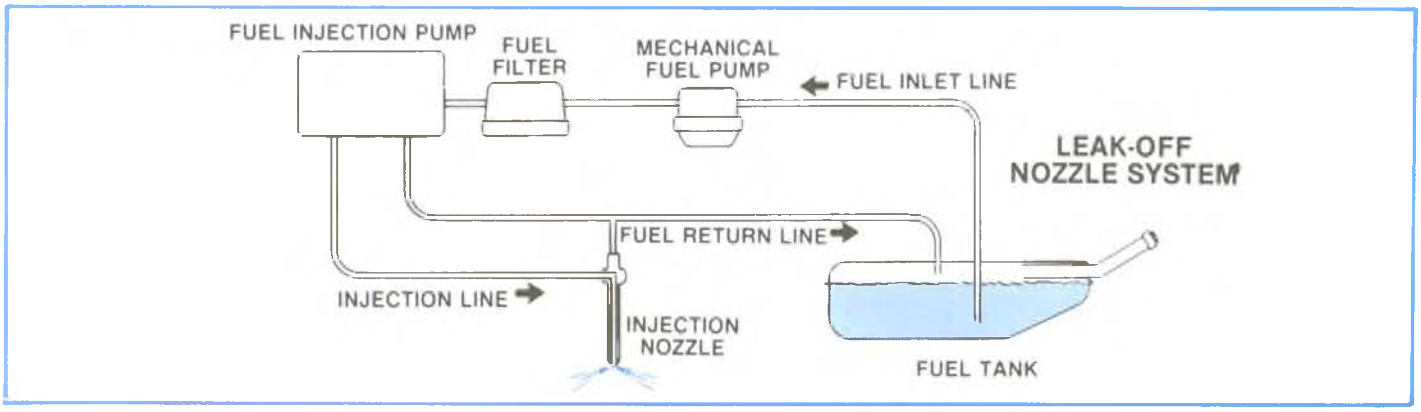


Figure 4-2, Fuel Return Systems.

Fuel Recommendations

General Motors Corporation recommends that owners of 1985 and subsequent Model Year diesel engine vehicles use Number 2-D diesel fuel above 20°F (-7°C) ambient temperature. If the ambient temperature is expected to be below 20°F, Number 1-D diesel fuel is recommended. (Figure 4-3). A "winterized" blend of Number 2-D and Number 1-D fuels may be used if Number 1-D is unavailable.

General Motors will not recommend the use of Number 2-D diesel fuel below 20°F unless it is "winterized". Temperatures below 20°F will cause the "non-winterized" fuel to thicken which may keep the engine from running.

FUEL AND ENGINE OIL RECOMMENDATION

- FUEL TYPE — ABOVE 20°F (-7°C) USE NO. 2-D FUEL. BELOW 20°F (-7°C) USE NO. 1-D (OR WINTERIZED NO. 2-D) FUEL.
- OIL CHANGE INTERVAL AND OIL TYPE — EXTREMELY IMPORTANT
  - CHANGE OIL AND FILTER EVERY 5000 MILES (8000 km)
  - USE ONLY ENGINE OILS LABELED SF/CD (PREFERRED) OR SF/CC.
- OIL VISCOSITY — SELECT THE SAE GRADE OIL BASED ON THE EXPECTED TEMPERATURE RANGE BEFORE NEXT OIL CHANGE.
  - USE SAE 30 GRADE WHENEVER POSSIBLE.
  - DO NOT USE SAE 10W-40 GRADE OIL, OR ANY OTHER GRADE NOT RECOMMENDED.
  - USE SAE 10W-30 or 15W-40 FOR COLD OPERATION ONLY.

Figure 4-3, Fuel Recommendation On Visor.

The colder temperatures will cause number 2 diesel fuel to thicken or cause a wax build-up. This wax build-up could plug the fuel filter and keep the engine from running. However, if the car is towed in and sets in a warm garage, the wax will disappear. On no start complaints in cold weather, ask which grade of diesel fuel is in the tank.

For the best fuel economy, use Number 2-D fuel whenever temperatures will permit.

— NOTE —

Do not try to use home heating oil or gasoline in the diesel engine. Heating oil may cause engine damage. Gasoline may cause engine damage and may keep the engine from running.

— NOTE —

The fuel injection pump, injection nozzles or other parts of the fuel system and engine can be damaged if you use any fuel or fuel additive other than those specifically recommended by DDAD. To help avoid fuel system or engine damage, please heed the following:

- **Some service stations mix used engine oil with diesel fuel. Some manufacturers of large diesel engines allow this; however, for your diesel engine, DO NOT USE DIESEL FUEL WHICH HAS BEEN CONTAMINATED WITH ENGINE OILS. Besides causing engine damage, such fuel will also affect emission control. Before using ANY diesel fuel, check with the service station operator to see if the fuel has been mixed with engine oil.**
- **Do not use any fuel additive (other than as recommended under "Biocide" in this section). At the time this manual was printed, no other fuel additive was recommended.**
- **Take care to not run out of diesel fuel. If you do run out of fuel, you may need to crank the engine longer to re-start it after fuel has been added. To protect the cranking motor (starter), do not crank the engine for more than 10-15 seconds at a time. Allow a one minute cooling off period between crankings. This will allow the cranking motor to cool and any trapped air in the fuel system to bleed off. However, if air is TRAPPED in the system and the engine does not re-start after a total of 30 seconds of cranking air must be purged from the system. See "Fuel Exhaustion" information in this section.**

COLD WEATHER OPERATION (DIESEL ENGINES)

Diesel fuel is sensitive to temperature. All diesel fuel has a certain amount of heavy paraffin-like components, which are high in energy value and help improve fuel economy. But, when temperatures are less than about −7°C (20°F), these heavy paraffin components begin turning into wax flakes. If temperatures are low enough, these flakes can build up on the fuel tank filter or the engine fuel filter and stop fuel from reaching the engine.

At low temperatures, wax flakes are more likely to form in Number 2-D fuel than Number 1-D (or a "winterized" 2-D) fuel. For best operation at temperatures below −7°C (20°F) use Number 1-D, or Number 2-D which has been blended with Number 1-D for winter use.

If you are driving in temperatures less than −18°C (0°F) and do not have Number 1-D or "winterized" Number 2-D fuel in the fuel tank, kerosene can be added to reduce waxing. Kerosene should be added at a ratio of one gallon of kerosene to two gallons of diesel fuel. Because of the lower energy value of kerosene (and reduced fuel economy) it should be added only when anticipated temperatures are less than −18°C (0°F). Once kerosene has been added the engine should be run for several minutes to mix the fuel.

The addition of kerosene will not unplug a filter plugged with wax. Warming a "waxed" filter 0°C to 10°C (32°F to 50°F) will return the wax to solution. Filter replacement is not normally required.

To improve cold weather operation, an engine block heater and fuel heater are on your diesel engine. (See "Cold Weather Starting" under "Starting the Diesel Engine" in Section 1 of this manual for information on the block heater.) The fuel heater is designed to come on when the fuel temperature is less than 4°C (40°F). It warms the fuel and helps stop wax flakes from building up in the fuel filter.

Fuel Tank Components

FILLER CAP

The filler cap contains a 2-way check valve. This will allow air to escape during the day when the tank heats up. In the event of a rollover, the valve will prevent spillage. Under pressure, no greater than 2 psi will exist. The valve must also allow air to enter the tank to replace the fuel used by the engine. A vacuum of no more than about one inch of mercury can accumulate in the tank and a slight hissing sound when removing the cap is normal. The fuel system is calibrated with the cap in place and any alterations will effect performance. Diesel fuel tank caps are specific to Diesels. Gasoline tank caps may fit in the diesel tank filler neck but should not be used.

FUEL PICKUP AND SENDING UNIT

See Figure 4-4. The fuel pick up, commonly known as the "sock" has three functions:

1. Strain out large solids.
2. Act as a strainer to prevent entry of water.
3. Act as a wick to drain fuel down to the bottom of the tank since all pickup pipes do not reach the very bottom of the tank.

The tank filter is a Saran (Polyvinylidene Chloride) sock and is fastened to the fuel inlet line of the in-tank fuel filter and fuel pick-up assembly.

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

Without this sock fuel line heater would be ineffective because the fuel would be trapped in the tank. Since the bypass valve is located at the upper end of the sock, fuel will only be drawn into the waxed sock if the tank contains more than approximately 4 gallons of fuel. Therefore, it is important to maintain a minimum of 1/4 tank of fuel when temperatures are below 20 degrees F.

The Saran sock material has a nominal pore size of 130 microns. In addition to acting as a particle filter for the mechanical lift pump, the Saran tank filter acts as a wick to pick up fuel from the bottom of the tank and as a water filter; water is excluded on the basis of the difference in surface tension between the water and the sock material on the one hand and the fuel and the sock material on the other.

By law in many states, water in fuel should be no more than 1/2 of 1%. That quantity of water will be absorbed by the fuel. Periodically, station operators check for water by putting a special gel on the dip stick. If it turns color, then water is present and it can be pumped out. Unfortunately, not all station operators are responsible and this prompted the use of the Saran sock.

The fuel pickup tube doesn't reach the bottom of the tank. However, since the sock acts as a "wick" the fuel level can actually be lower than the level of the tube and fuel will be drawn out right down to empty. Also, with this design, the level of water in the tank can be much higher before water enters the fuel system. This is about five gallons. Water that gets into the tank will eventually be absorbed by good fuel and will pass harmlessly through the fuel system. Water will be absorbed at a rate of about one gallon per 1000 miles.

— IMPORTANT —

The 6.2L diesel fuel tank sending unit is a 3-pipe assembly (main fuel, fuel syphon, and fuel return). The 4.3L V-6 and 5.7L diesel sending unit is a 2 pipe (main fuel and return). The gasoline fuel tank sending unit is a two pipe assembly (main fuel and canister). The canister pipe has a .055″ orifice in the end of the pipe. It is important that these two units not be interchanged. If the gas unit is installed on a diesel, it will cause intermittent problems with idle and power loss. If the diesel unit is installed on a gas car, the fuel vapors to the canister will be uncontrolled.

The ground wire on a diesel sending unit is a different color than on a gas unit for identification purposes. The tubes are also different sizes: main fuel 3/8 inch, gasoline fuel tank sending unit canister tube is 5/16 inch and the diesel sending unit return tube is 1/4 inch.

WATER IN FUEL WARNING SYSTEM

The 1982-83 units used a tank unit mounted water in fuel (W.I.F.) warning-system. It will detect the presence of water when it reaches the 1-2 gallon level. The water is detected by a capacitive probe. An electronic module provides a ground through a wire to a light in the instrument cluster that reads "water in fuel". The W.I.F. also contains a bulb check. When the ignition is turned on, the bulb will glow from two to five seconds and then fade away.

Owners with water in fuel lights have been instructed to drain the water from the tank if the light comes on immediately after filling. There could be enough water in the system to get into the fuel system and shut the engine down after driving for a short distance. If however it comes on during a cornering or braking maneuver, there is less than a gallon and a shut down will not occur, however, the water should be removed within one or two days. This system will not detect bacteria contained in the water. Figure 4-5 contains diagnostic information on the tank sending unit mounted W.I.F.

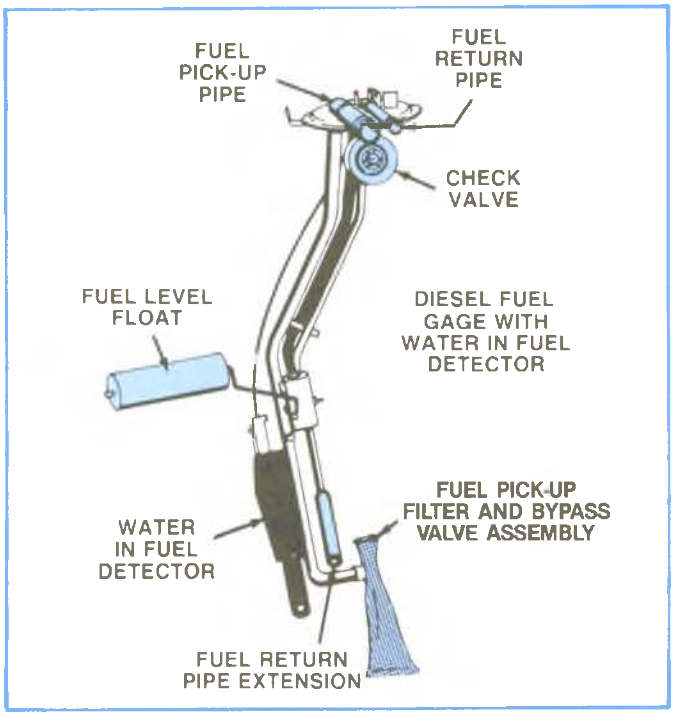


Figure 4-4, Fuel Pickup/Sending Unit With Water-in-Fuel Warning.

A check valve is provided at the upper end of the return pipe to allow fuel to return in the event that frozen water plugs the end of the pipe.

All vehicles using diesel engines have a sock with a bypass valve in the top end. This bypass valve is designed to open up in the event that high cloud point fuels are used in cold weather and the sock gets plugged with wax crystals. The fuel level should be kept at a 1/4 tank, to make sure you do not run out of fuel.

The W.I.F. detector can be serviced separately from the tank unit assembly when it requires replacement. It can be bench checked by using the test setup shown in Figure 4-6.

The module in the detector probe must remain submerged in water for approximately a 15 to 20 second delay period. The indicator lamp will then come on and stay on until the 12V signal is removed. This feature will accommodate large amounts of water.

In 1983, the water in fuel sensitivity was increased to trigger at 1 to 3 liters (.26 to .80 gals.). The time delay was changed from 15-20 seconds to 3-6 seconds.

WATER IN FUEL DETECTOR DIAGNOSIS

OPERATION

The Diesel "Water in Fuel" system uses an electronic water detector mounted inside the fuel tank on the fuel gage sender. The detector will warn the driver when 1 - 2½ gallons of water are present in the fuel tank by lighting a "Water in Fuel" light on the instrument panel. The light will also come on for 2-5 seconds each time the ignition is turned on. This bulb check assures the driver the light is working.

When water is detected it can be drained through the fuel return line without removing the fuel tank.

*TORONADO HAS A 3 WIRE CONNECTOR.

WATER IN FUEL LIGHT ON AT ALL TIMES

With ignition on disconnect 2 wire (yel/blk-pink) connector* at rear of fuel tank and check water in fuel light.

- **LIGHT ON** → Locate and repair short to ground in yel/blk wire from 2 wire connector to IP water in fuel lamp.
- **LIGHT OFF** → Purge fuel tank per purging instructions. Connect 2 wire connector* and check water in fuel light.
  - **LIGHT ON** → Remove tank unit. Check wires for short circuits. If OK, replace detector.
  - **LIGHT OFF** → Normal – fuel had water in it.

WATER IN FUEL LIGHT DOES NOT COME ON DURING BULB CHECK

With ignition on disconnect 2 wire (yel/blk-pink) connector* at rear of fuel tank and ground the yel/blk wire in the body harness. Check water in fuel light.

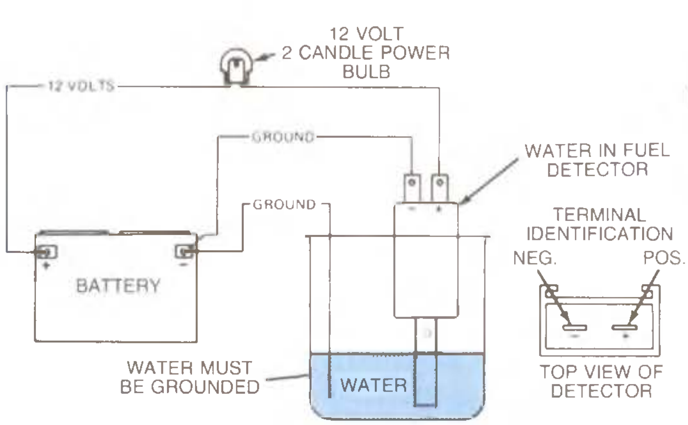
- **LIGHT ON** → Remove fuel gage tank unit and check yel/blk wire for opens. Check connections to water in fuel detector and mounting screw-must be tight. If OK, replace water in fuel detector.
- **LIGHT OFF** → Check water in fuel bulb. If OK, check for open circuit in yel/blk wire from 2 wire connector at rear of tank to IP water in fuel lamp socket.

FUEL TANK PURGE PROCEDURE

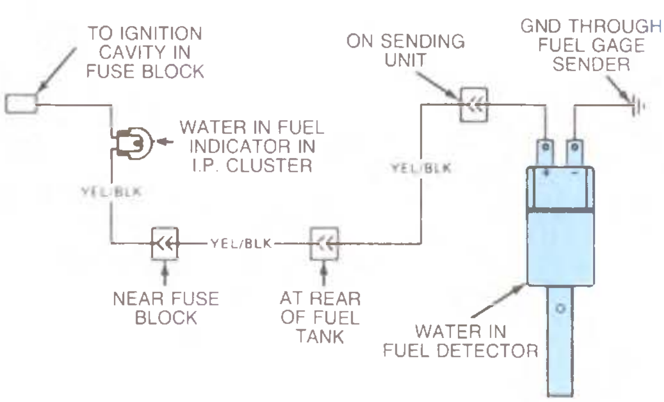
Cars which have a "Water in Fuel" light may have the water removed from the fuel tank with a pump or by siphoning. The pump or siphon hose should be hooked up to the 1/4 inch fuel return hose (smaller of the two fuel hoses) above the rear axle or under the hood near the fuel pump. Siphoning should continue until all water is removed from the fuel tank. Use a clear plastic line or observe filter bowl on draining equipment to determine when clear fuel begins to flow. Be sure to remove the cap on fuel tank while using this purge procedure. Replace the cap when finished. The same precautions for handling gasoline should be observed when purging diesel fuel tanks.

TESTING WATER IN FUEL DETECTOR

Connect water in fuel detector as shown using a 12 V 2 C.P. bulb. There must be a ground circuit to the water for the detector to work. The light will turn on for 2-5 seconds then dim out. It will then turn back on (after 15-20 second delay) when about 3/8" of the detector probe is in the water. Refer to illustration for test set-up.



TEST SET-UP



WATER IN FUEL DETECTOR CIRCUIT

Figure 4-5, **Water In Fuel Detector Diagnosis: 1982-1983.**

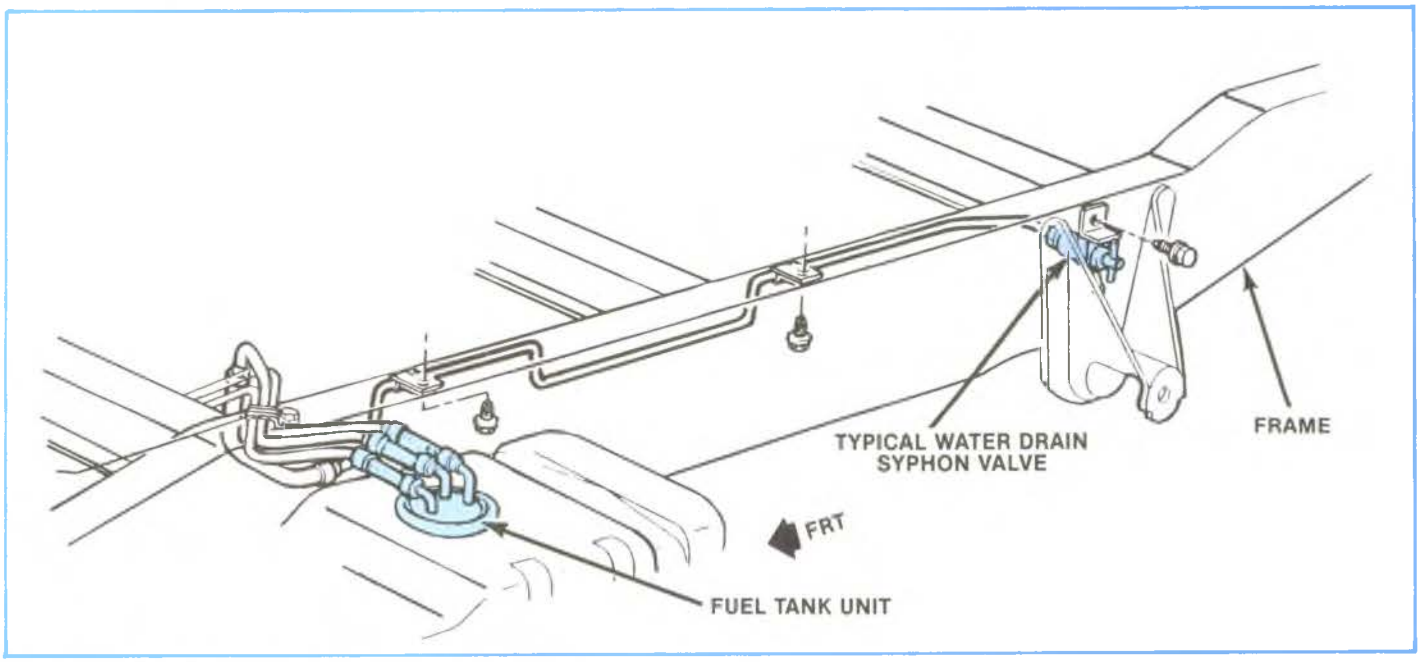


Figure 4-6, **Typical Fuel Syphon Valve.**

1982-1983 Water Drain Syphon Valve (Figure 4-5)

A siphoning system starting at the tank and going to the rear spring hanger, (on some models) and at the midway point of the right frame rail on other models, permits the user to attach a hose at the shut-off and siphon out the water.

> **— NOTE —**
>
> **This system was deleted after 1983.**

Diesel Fuel Contamination

Various malfunctions in diesel engines often lead to injection pump replacement. Before replacing the injection pump, determine if water or an excessive amount of gasoline is the cause of the malfunction. If water or gasoline is found to be the cause of the malfunction, injection pump and injection nozzle replacement may not be necessary. The following procedure should help to eliminate unnecessary pump and nozzle replacement in the event of fuel contamination.

- First, remove the engine fuel filter and inspect the contents for the presence of water or gasoline. If water or gasoline is found, flush the system as outlined on the following page.
- Fuel contamination should be expected if the car stalls, performance is poor or in the case of gasoline, the engine will knock loudly.
- If gasoline is suspected, remove the fuel fill cap and check for the presence of gasoline fumes.
- Gasoline will not harm the injection system. Flush the gasoline out of the system as outlined. Do not remove any injection equipment unless engine operation is unsatisfactory after the system has been flushed.
- For water, remove the engine fuel filter and inspect the contents for the presence of water. If water is found, remove the injection pump cover. If the pump is full of water, flush as outlined on the next page.
- Small quantities of surface rust in the injection pump will not create a problem. If the vehicle stalls as a result of contamination, remove the metering valve and polish it lightly with 600 grit paper to remove the contaminant. If the advance piston is stuck as evident by poor performance, smoke or noise, it may be necessary to remove the pump to free it up.
- Occasionally contamination may enter the system that becomes so severe that physical damage has occurred to the springs and linkage in the pump. These pumps that require part replacement should be returned to a Stanadyne shop for repair.

BIOCIDES

In warm or humid weather, fungi and/or bacteria may form in diesel fuel if there is water in the fuel. Fungi or bacteria can cause fuel system damage by plugging the fuel lines, fuel filters or injection nozzles. They can also cause fuel system corrosion.

If fungi or bacteria have caused your fuel system problems, have your authorized dealer correct these problems. Then, use a diesel fuel biocide to sterilize the fuel system (follow the biocide manufacturer's instructions). Biocides are available from your dealer, service stations, parts stores and other such places. See your authorized dealer for advice on using biocides in your area, and for recommendations on which biocides to use.

DIESEL FUEL QUALITY TEST

The diesel fuel hydrometer J34352 can be used to measure specific gravity of fuel at a nominal temperature (75°F to 95°F). Fuel specific gravity is an indication of the cetane number, and thus, the quality of a fuel. A poor quality fuel can impair diesel engine performance. The following procedure outline how to measure diesel fuel quality:

1. Fill a clean container ¾ full of diesel fuel.
2. Fill the glass hydrometer container with fuel until the hydrometer floats.
3. Gently spin the tool to break the surface tension.
4. Read the scale where the fuel level contacts the hydrometer float.

Scale Code	Approx. Cetane Range	Possible Fuel Quality
Green	46-50 plus	High quality fuel
Yellow	41-45	Medium quality fuel
Red	38-40	Low quality fuel

— NOTE —

The glass hydrometer, including float portion, is very delicate, thus extreme care must be utilized when using this tool.

— NOTE —

You should remove the fuel tank for cleaning when water is detected, because of the current understanding that a small amount of water or slurry is potentially damaging to the fuel system. The syphon does not remove it all.

Diesel Fuel System Cleaning Procedure

— CAUTION —

Never drain or store diesel fuel in an open container due to possibility of fire or explosion.

CLEANING PROCEDURE: WATER IN FUEL SYSTEM

1. Drain the fuel tank.
2. Remove the tank gage unit.
3. Thoroughly clean the fuel tank. If the tank is rusted internally, it should be replaced. Clean or replace the fuel pickup filter and check valve assembly.
4. Re-install the fuel tank but leave the lines disconnected at fuel tank area (above the rear axle).
5. Disconnect the main fuel hose at the fuel pump. Using low air pressure, blow out line towards rear of vehicle. Disconnect the return fuel line at the injection pump, with low air pressure, blow out the line towards the rear of the vehicle.

— NOTE —

If rust is present in these pipes, they must be replaced.

6. Re-connect the main fuel and return line hoses at the tank. Fill the tank at least 1/4 full with clean diesel fuel. Re-install fuel tank cap.
7. Remove and discard the fuel filter.
8. Connect the fuel hose to the fuel pump.
9. Re-connect both battery cables.
10. Purge the fuel pump and pump to filter line by cranking the engine until clean fuel is pumped out, catching the fuel in a closed metal container.
11. Install a new fuel filter.
12. Install a hose from the fuel return line (from the injection pump) to a closed metal container with a capacity of at least two gallons.
13. If the engine temperature is above 125 degrees F (52 degrees C), activate the Injection Pump Housing Pressure Cold Advance (H.P.C.A.). This can be done by disconnecting the two lead connectors at the engine temperature switch (located at the rear of the right cylinder head), and bridging the connector with a jumper.

14. Crank the engine until clean fuel appears at the return line. Do not crank the engine for more than 30 seconds at one time. Repeat cranking if necessary with 3 minute intervals between crankings.
15. Remove the jumper from the engine temperature switch connector and reconnect the connector to the switch.
16. Crack open each high pressure line at the nozzles using two wrenches to prevent nozzle damage.
17. Disconnect the lead to the H.P.C.A. solenoid (on the injection pump).
18. Crank the engine until clean fuel appears at each nozzle. Do not crank for more than 30 seconds at one time. Repeat cranking if necessary, with 3 minute intervals between crankings.

CLEANING PROCEDURE: GASOLINE IN FUEL SYSTEM

1. Drain fuel tank and fill with diesel fuel.
2. Remove fuel line between fuel filter and injection pump.
3. Connect a short pipe and hose to the fuel filter outlet and run it to a closed metal container.
4. Crank the engine to purge gasoline out of the fuel pump and fuel filter. Do not crank engine more than 30 seconds with two minutes between cranking intervals.
5. Remove the short pipe and hose and install fuel line between fuel filter and injection pump.
6. Attempt to start engine. If it does not start, purge the injection pump.
7. Purge the injection pump and lines by cranking the engine with accelerator held to the floor, crank until the gasoline is purged and clear diesel fuel leaks out of the fittings. Tighten fittings. Limit cranking to 30 seconds with two minutes between cranking intervals.
8. Start engine and run at idle for 15 minutes.

— NOTE —

If gasoline is inadvertently pumped into the tank, there will be no damage to the fuel system or the engine. The engine will not run on gasoline. Gasoline has a feature called Octane which defined is the ability of the fuel to resist ignition under high temperatures. Gasoline is a fuel that has high Octane and it resists ignition under high heat, it will only ignite by a spark. Gasoline in the fuel at small percentages, 0-30%, will not be noticeable to the driver. At greater percentages the engine noise will become louder. Gasoline at any percentage will make the engine hard to start hot. In the summer time, this could be a cause of a hot start problem.

Fuel Lines and Lift Pump

Although the injection pump has capabilities to pull fuel from the tank, an engine mounted fuel pump is included in this system as an additional assist in the event of air in the lines such as running out of fuel, fuel line air leaks or air from occasional fuel tank service. (Figure 4-7).

The fuel pump's main job is to supply 5½ lbs. to 6½ lbs. of pressure through the fuel filter to the Injection pump.

Fuel is drawn from the fuel tank through the tank filter by the fuel pump. The fuel pump is driven by an eccentric on the crankshaft. The injection pump drive system uses the end of the camshaft where the fuel pump eccentric is usually located in a gasoline engine.

See figure 4-8. The diesel fuel pump is located on the right side of the engine between the fuel tank and fuel filter. The design of this pump is quite similar to the gasoline engine pump: however, the two components are not interchangeable.

All 1982 and later models will be equipped with GM SPEC. 6031 hoses which are made of "Viton" and contain a non-permeable tube inside.

The hoses will include a yellow stripe and the words "Fluro Elastomer" on the outside. Their purpose is to reduce emissions when hydro-carbons pass through the hose material.

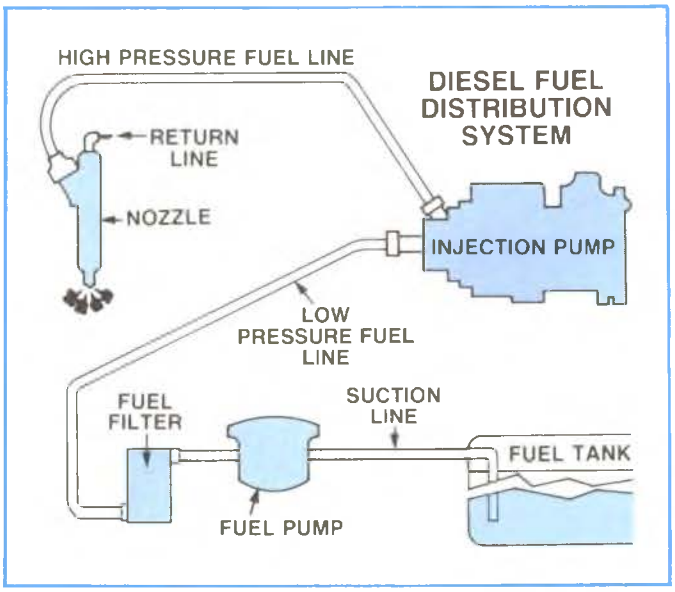


Figure 4-7, Mechanical Lift Pump and Fuel Lines.

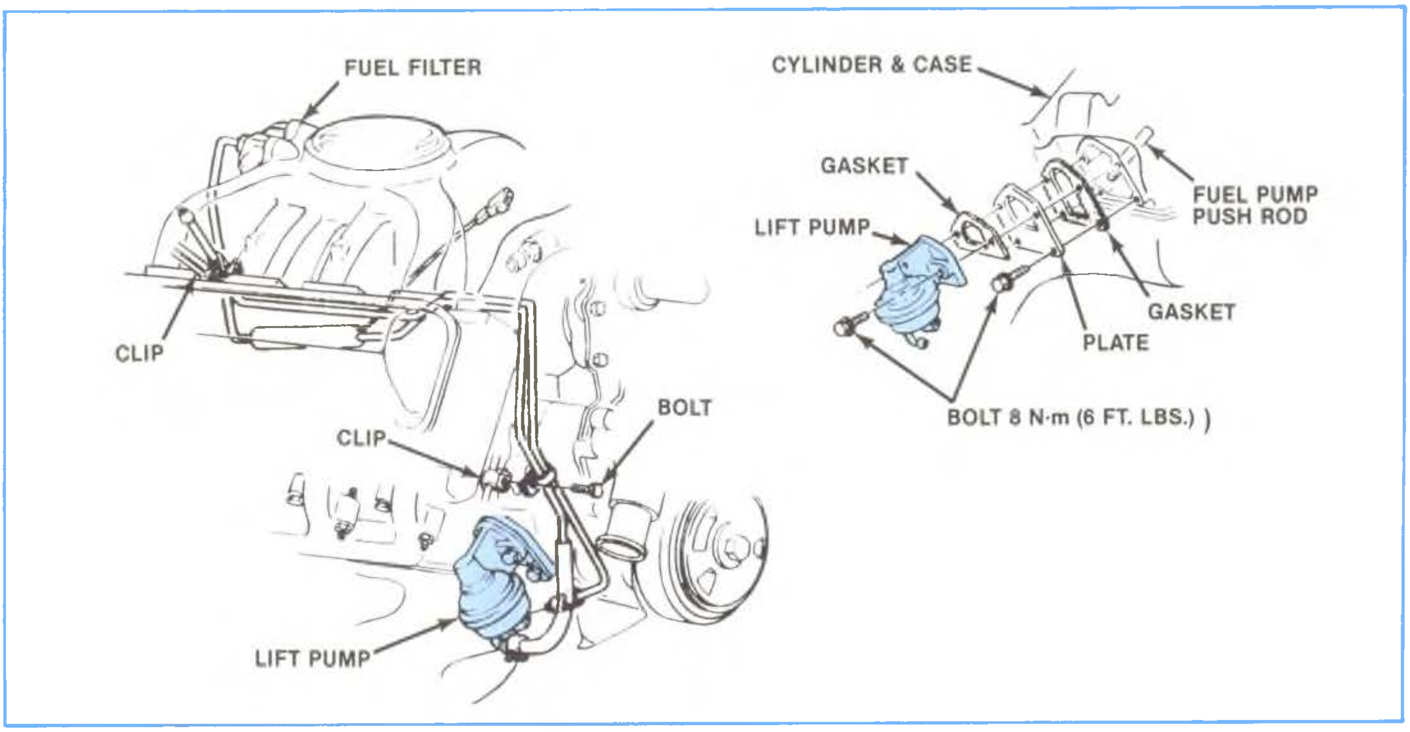


Figure 4-8, Mechanical Lift Pump Location.

Mechanical Fuel Pumps

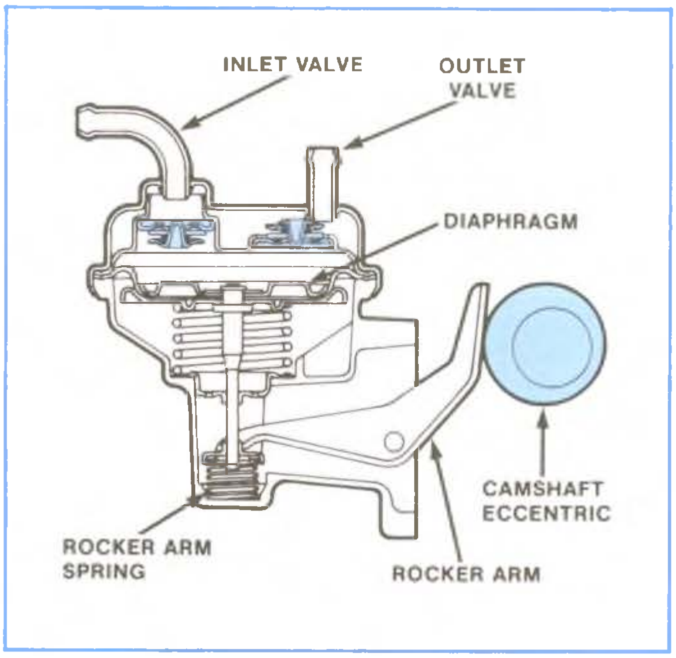


Figure 4-9, **Typical Mechanical Fuel Pump.**

How the Mechanical Fuel Pump Works

A mechanical fuel pump is mechanically actuated by a rocker arm or push rod without electrical assistance. Figure 4-9 shows a typical mechanical fuel pump.

The rocker arm spring holds the rocker arm in constant contact with the camshaft or eccentric.

As the end of the rocker arm moves upward, the other end of the arm pulls the fuel diaphragm downward. The vacuum action of the diaphragm enlarges the fuel chamber drawing fuel from the fuel tank through the inlet valve and into the fuel chamber.

The return stroke starting at the high point of the cam releases the compressed diaphragm spring, expelling fuel through the outlet valve.

When the immediate fuel needs of the engine are satisfied, pressure builds in the fuel line and pump chamber. This pressure forces the diaphragm/piston to make shorter and shorter strokes, until more fuel is needed in the engine.

Fuel Pump Service

Mechanical Fuel Pump Tests

PRELIMINARY INSPECTION

— NOTE —

Perform following tests or inspections before removing pump.

Step 1 Check fittings and connections to insure tightness. If insufficiently tight, leaks of air and/or fuel may occur.

Step 2 Check for fuel line bends or kinks in hoses.

Step 3 With engine idling look for:

a. Leaks at pressure (outlet) side of the pump.

b. A leak on suction (inlet) side will reduce the volume of fuel on the pressure side of the pump and suck in air.

c. Also check for leaks at diaphragm, flange, and at breather holes in pump casting.

d. Check fuel pump steel cover and its fittings for leaks. Tighten or replace fittings as necessary. If fuel pump leaks (diaphragm, flange, steel cover, or pump casting breathing holes), replace pump.

FUEL FLOW TEST

Step 1 Disconnect fuel line at the filter inlet.

Step 2 Disconnect pink wire at the fuel injection pump electric shut-off (ESO) solenoid.

Place a suitable container at end of pipe and crank engine a few revolutions (Figure 4-10). If little or no fuel flows from open end of pipe, then fuel pipe is clogged or pump is inoperative.

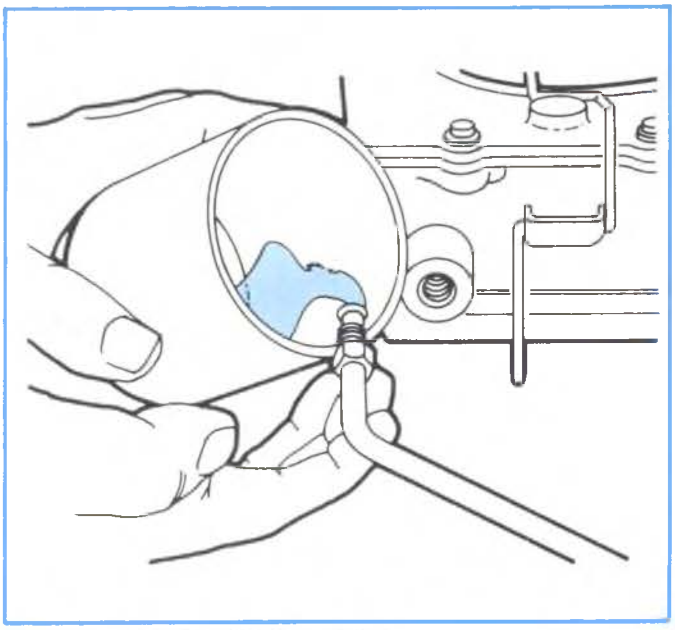


Figure 4-10, **Fuel Flow Test.**

Step 3 Before removing fuel pump, disconnect fuel line at tank and blow through it with air hose. Do not blow through fuel line without disconnecting it becasue it is possible to blow strainer off tank unit or to rupture it. Then reconnect fuel lines to pump and tank. Also, reconnect fuel lines at filter. Start engine and check for leaks.

If fuel flows in a good volume from pipe at filter 1 pint @ 30-45 seconds, fuel delivery pressure may be checked. This test is necessary because a weak pump can still produce an adequate volume of fuel when it is not under pressure. Fuel pressure should be in the 5.5 to 6.5 psi range.

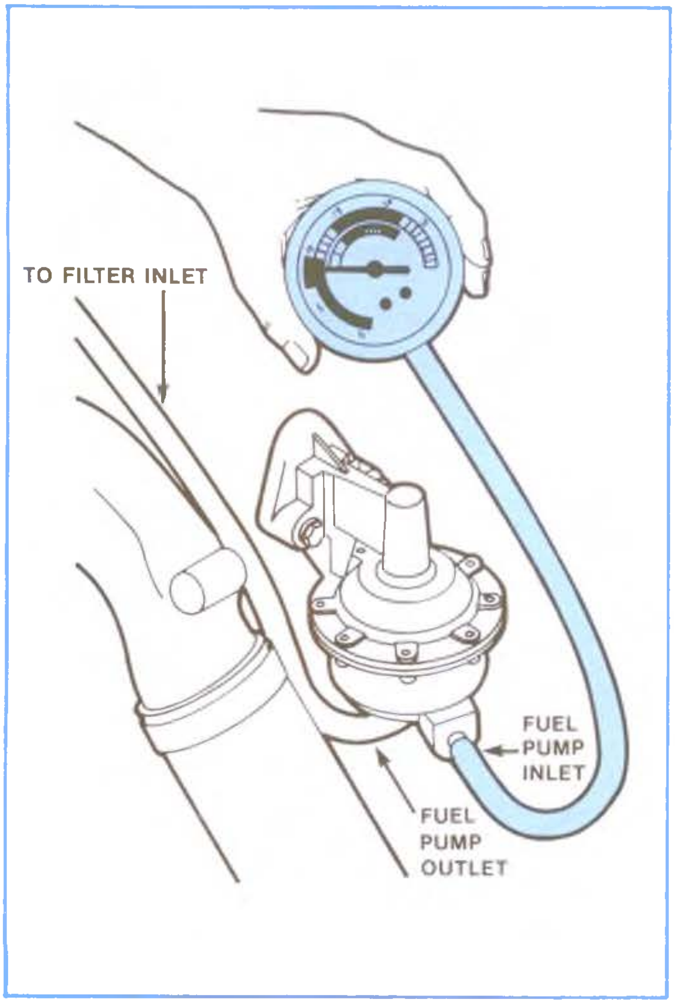


Figure 4-11, Fuel Pump Vacuum Test.

VACUUM TEST, FUEL PUMP INLET (DEAD HEAD)

Low vacuum or complete loss of vacuum provides insufficient fuel to the injection pump to operate the engine throughout normal speed range. The vacuum test will determine if the pump has the ability to pump fuel and is the best indication of the quality performance of the pump (Figure 4-11).

Step 1 Disconnect hose from fuel tank to fuel pump at fuel pump. Plug or position hose to insure no fuel leakage.

Step 2 Connect one end of a short hose to fuel pump inlet and attach a vacuum gage to the other end.

Step 3 Start engine. With engine idling (using fuel in the filter assembly), check vacuum gage. If vacuum is less than 12 inches Hg (2.98 kPa) replace fuel pump.

Avoiding Air Intake

An important function of all hoses, lines and fittings is to carry fuel with maximum absence of air.

When the fuel tank cap is in place and the injection pump and fuel pump are drawing fuel through the lines a low vacuum of 0-1 lb. mercury is created. This occurs because the fuel which the engine uses must be replaced by air. During this vacuum condition, the slightest leak, which may not leak fuel externally, could draw air into the system and depending on the volume of air, a wide variety of engine malfunctions are possible. These may show up as M.P.G. complaints, smoke complaints, performance complaints and hard starting or not starting conditions.

For example, suppose the inlet fitting was slightly loose at the engine fuel filter. This would probably have an external leak and be a complaint of fuel leak or smell of diesel fuel accompanied by a "starts but then dies and can't re-start" complaint. It is possible that when the engine is shut down the fuel could syphon out of the lines and fuel pump and back into the tank. It is then replaced by air which entered at the loose fitting. The fuel system is now empty and as a result the engine must be cranked until the lines are full again.

Diagnosing Air In Fuel Lines

Shop manual diagnosis charts should be referred to when diagnosing for air problems to determine the presence of air. First install a short clear plastic hose into the return line at the top of the injection pump (Figure 4-12). Start the engine and observe for air bubbles or foam in the line. If foam or bubbles are present, proceed as follows:

1. Raise vehicle and disconnect both fuel lines at the tank unit.
2. Plug the smaller disconnected return line.
3. Attach a low pressure (preferably hand operated pump) air pressure source to the larger 3/8 fuel hose and apply 8-12 P.S.I.
   a. Diagnosing trucks equipped with dual tanks will require a check of the right fuel lines with the dash switch in the right tank position and a check of the left fuel lines with the dash switch in the left tank position. The switching valve could be a source.
4. Observe the pressure pump reading of 8-10 P.S.I. A decrease in pressure will indicate the presence of a leak. The pressure will push fuel out at the leak point indicating the location of the leak.
5. Repair as necessary.

In checking for air problems, the proper size clamps on all hoses should be checked. Also, a burr on the edge of a pipe could rip the inside of a line and create air ingestion. Particular attention should be given to improper installation or defective auxiliary filters or water separators.

Since operation of the hydraulic advance mechanism is dependent on transfer pump pressure and pump housing pressure, any deviation from pre-set tolerances can affect the advance mechanism and therefore, the injection timing. Fuel pump delivery less than 5½ lbs. to 6½ lbs. pressure, for example, will reduce total advance directly proportional to pressure loss. Leaks, plugged filters, air ingestion restriced lines etc. will all reduce pressure delivery. Return line restriction can raise housing pressure to as high as transfer pump pressure depending on the degree of restriction and eventually stall the engine by upsetting the balance of transfer pump and housing pressures.

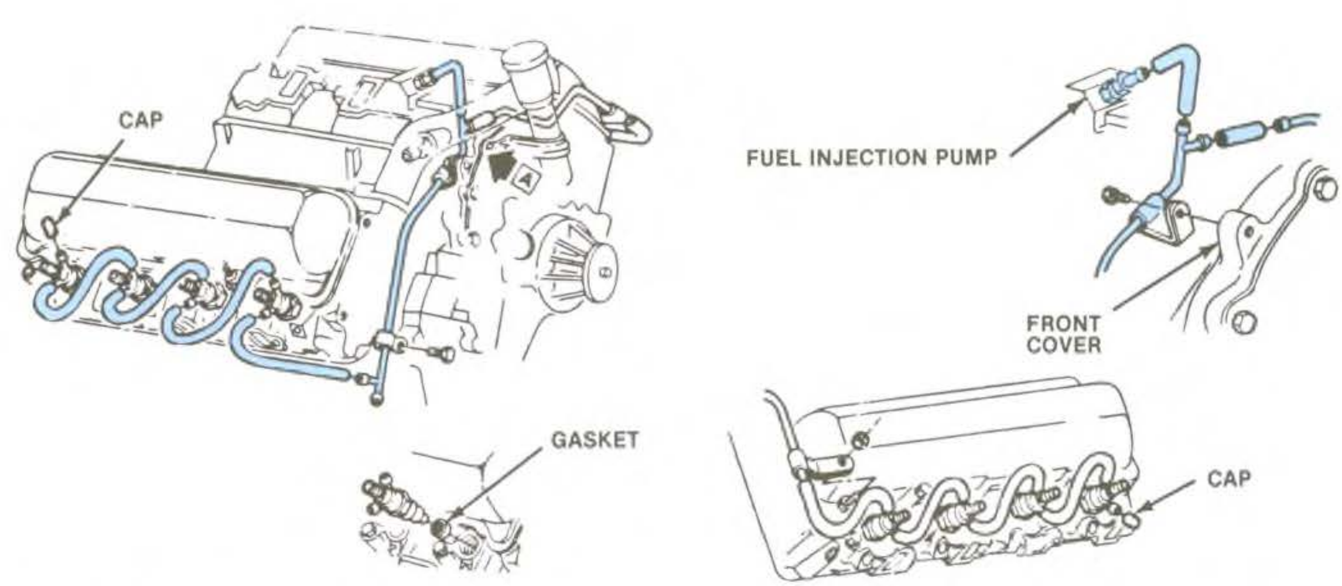


Figure 4-12, **Fuel Return Lines.**

1982-83 Primary Fuel Filter

The primary fuel filter is mounted on the bulkhead in the engine compartment. It is the same type of filter that is used on larger trucks. (Figure 4-13).

At the bottom of the filter, a water drain valve permits draining water that is caught by the filter. This filter is an AC fibrous depth element of the spin-on type. The filter case includes the drain petcock.

PRIMARY FUEL FILTER-WATER DRAIN

See Figure 4-13. If it should become necessary to drain water from the fuel tank, also check the primary fuel filter for water. This can be done as follows:

1. Open the petcock on the top of the primary filter housing.
2. Place a drain pan below the filter and open the petcock on the bottom of the drain assembly. (A length of hose is attached to the petcock to direct drained fluid below the frame.)
3. When all water is drained from the filter, close the petcock lightly.

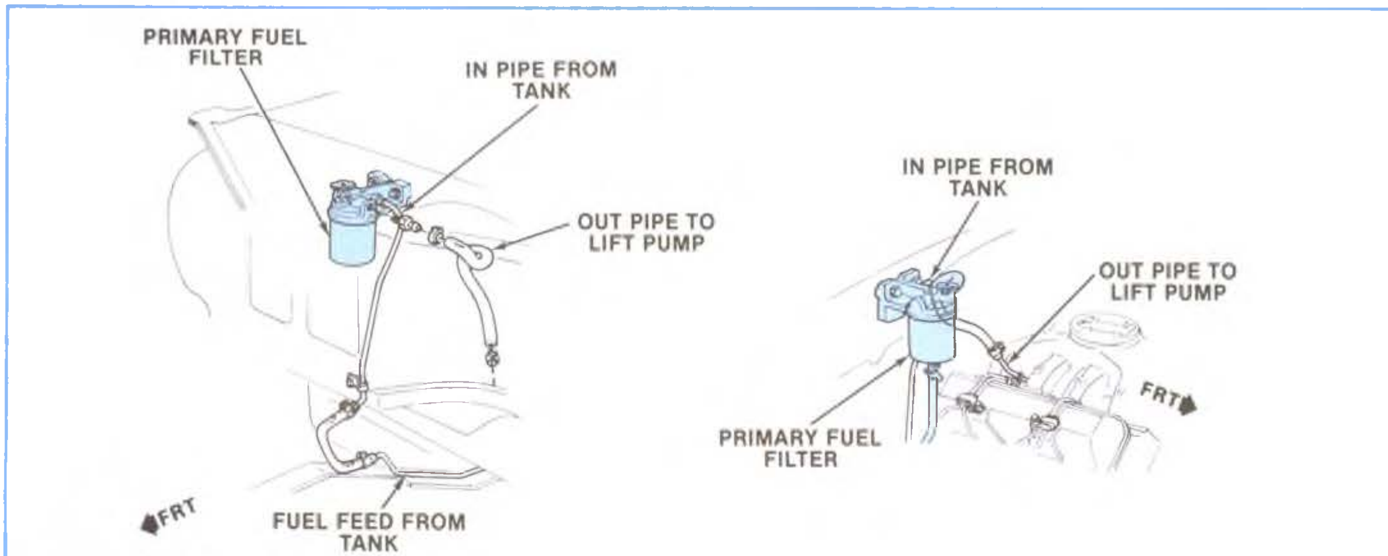


Figure 4-13, **Primary Fuel Filter.**

— NOTE —

If filter is completely drained, remove filter and refill with clean fuel to prevent engine stalling.

4. Close upper petcock tightly.
5. Start the engine and let it run briefly. The engine may run roughly for a short time until the air is purged from the system.
6. If engine continues to run roughly, check that both petcocks at the primary filter are closed tightly.

The primary filter was used in 1982-83 only.

Line Heater

A Diesel cold weather package is used. This package consists of an in-line diesel fuel heater and the engine block heater. (Figure 4-14).

The purpose of the heater is to heat the fuel so that the filter does not plug with paraffin wax crystals. This allows the use of more efficient #2 Diesel fuel at temperatures substantially below its cloud point.

The heater is electrically powered from the ignition circuit and is placed on the fuel filter inlet line a short distance up stream from the filter.

Following are some of the qualities designed into this system:

The heater is in-line, and in fact, a component of fuel pipe assembly between fuel lift pump and filter. It does not have any additional seals or joints that increase the possibility of fuel leaks.

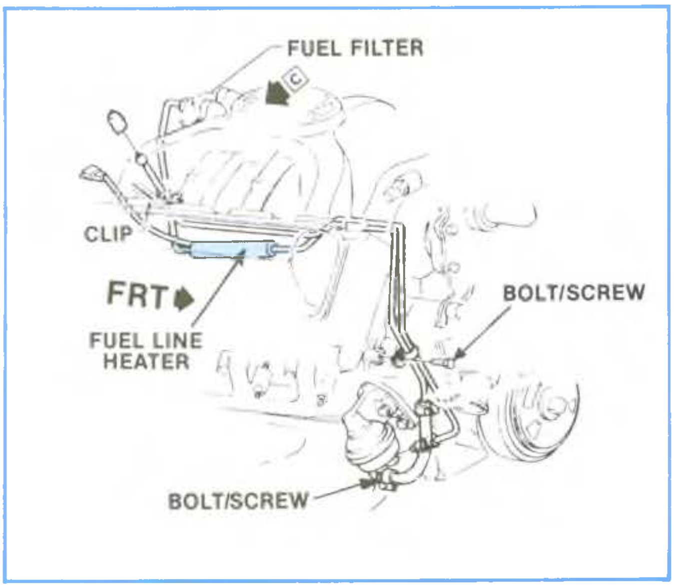


Figure 4-14, **Fuel Line Heater Installation.**

The heater is thermostatically controlled to work when waxing of the fuel is expected. Thermal feedback from the heating element to the bimetal actuator protects the element from burning out if for any reason fuel is not flowing through the fuel heater.

OPERATION

The device can be divided into two major functional components, the heater and the power control assemblies. (Figure 4-15).

The heater is 7/8 inches in diameter and approximately 5½ inches long and consists of an electric resistance strip spiral wound and bonded around the fuel pipe. To minimize the heat loss to the environment, heating element is surrounded by an insulating fiber.

The power control assembly senses fuel temperature and responds by closing an electrical circuit to the heater. The sensing element is a bimetal switch. The internal bimetal switch turns on at 20 degrees F. and shuts off at 50 degrees F. Power consumption is 100 watts. The heat will only be on until the under hood temperature gets hot enough to warm the fuel.

The fuel tank filter sock has a bypass valve which opens when the filter is covered with wax allowing fuel to flow to the heater. Without this bypass valve fuel line heater would be ineffective because the fuel would be trapped in the tank. Since the bypass valve is located at the upper end of the sock, fuel will only be drawn into the waxed sock if the tank contains more than approximately 4 gallons of fuel. Therefore it is important to maintain a minimum level of 1/4 tank of fuel when temperatures are below 20°F.

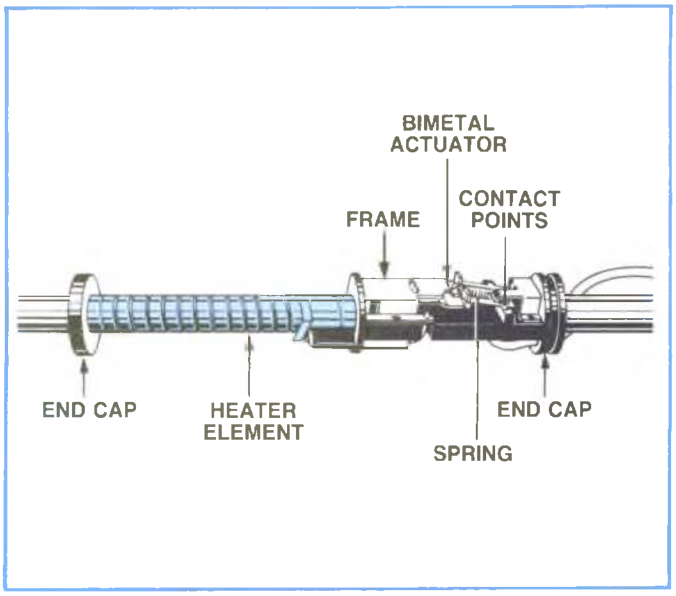


Figure 4-15, **Diesel Fuel Heater Components.**

HEATER SERVICEABILITY/DIAGNOSIS

The heater cannot be serviced. However, it can be checked by using an ammeter connected in series. Checking must take place below 20° ambient temperature. Proper operation will draw approximately 7 amps.

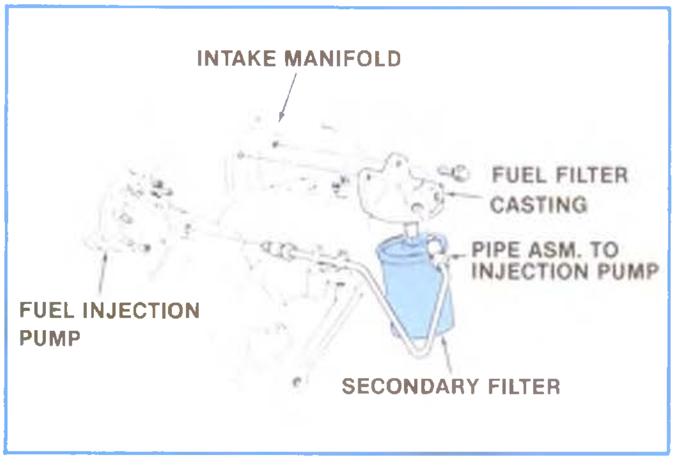


Figure 4-15a, Secondary Fuel Filter (C-K Series).

Secondary Fuel Filters

The 1982 C, K & P, and the 1983 C, K trucks use an intake manifold mounted secondary fuel filter, before the fuel enters the pump. This filter is an AC 10 micron paper replaceable element of the spin-on type. It is mounted to the rear of the intake manifold. See Figure 4-15.

SECONDARY FUEL FILTER C-K SERIES

REMOVAL:

1. Remove fuel filter lines from adapter.
2. Remove fuel filter.
3. Remove filter.

INSTALLATION:

1. Install filter to adapter, tighten 2/3 turn after contacting gasket.
2. Install adapter to intake manifold.
3. Install the fuel filter **inlet line only.**

Anytime the secondary filter is removed or replaced, air must be purged from the filter to prevent engine stalling or excessive cranking time to restart.

4. With the secondary fuel line disconnected, disconnect the pink electrical wire from the fuel injection pump to prevent the engine from starting.
5. Place an absorbent towel under the filter outlet.
6. Crank engine (for 10 seconds max.) until fuel is observed at the outlet port.
7. If fuel is not observed after 10 seconds, wait 15 seconds, repeat Step 6.
8. When fuel is observed at the outlet port, install the outlet line.
9. Reconnect pink wire at injection pump, and reinstall air cleaner.
10. Start engine and allow to idle for several minutes to purge remaining air.
11. Check all fittings and filter for leakage; remove absorbent towel.

1983 G-P TRUCK MODEL 75 FILTER

The G-P series uses a Stanadyne Model 75 secondary fuel filter in 1983. See Figure 4-16. It is fastened using two bail clips. It is particularly important to place absorbent towels under the filter when changing it to improve cylinder and case valley drain and prevent fuel oil contamination of the clutch driven disc.

The Model 75 filter is a two-stage pleated paper type filter. (Figure 4-16). The first stage consists of approximately 400 sq. inches of filtering area and will remove 94% of particles 10 microns and larger. The second stage is made of the same paper material and consists of approximately 200 sq. inches of filtering surface. The second stage is 98% effective in filtering the fuel already filtered by the first stage.

Particles which are larger than 10 microns may damage the pump's internal components. Figure 4-17 will compare various micron sizes and will ultimately show the filter's effectiveness.

1983 G-P TRUCK SECONDARY FUEL FILTER

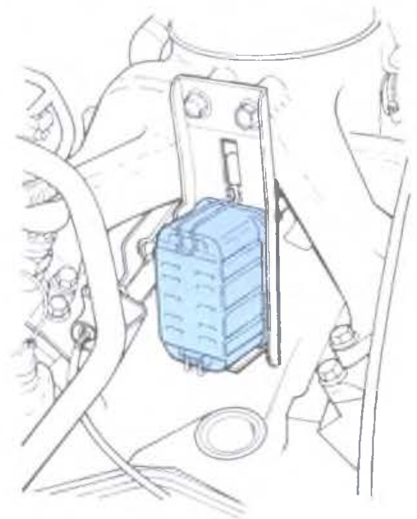


Figure 4-16, G-P Model 75 Secondary Fuel Filter.

SECONDARY FUEL FILTER G-P SERIES

REMOVAL:

1. Engine must be turned off.
2. Remove engine cover.
3. Remove air cleaner.
4. Place absorbent cloth or towel under filter.
5. Unstrap the lower bail first to relieve fuel pressure in the filter.
6. Unstrap the upper bail and remove filter.

INSTALLATION:

1. Insure that both filter mounting plate fittings are free of dirt.
2. Install new filter; snap on the **upper bail clamp only.**

   Anytime the secondary filter is removed or replaced, air must be purged from the filter to prevent engine stalling or excessive cranking time to restart.
3. Disconnect the pink electrical wire from the injection pump to prevent the engine from starting.
4. Crank engine (for 10 seconds max.) until fuel is observed at the lower filter fitting.
5. If fuel is not observed after 10 seconds, wait 15 seconds, repeat Step 4.
6. When fuel is observed at the lower fitting, connect the lower bail clamp.
7. Reconnect the pink wire on injection pump — and install air cleaner.
8. Start engine and allow to idle for several minutes to purge remaining air, — check for fuel leaks.
9. Remove absorbent towel from filter area — reinstall engine cover.

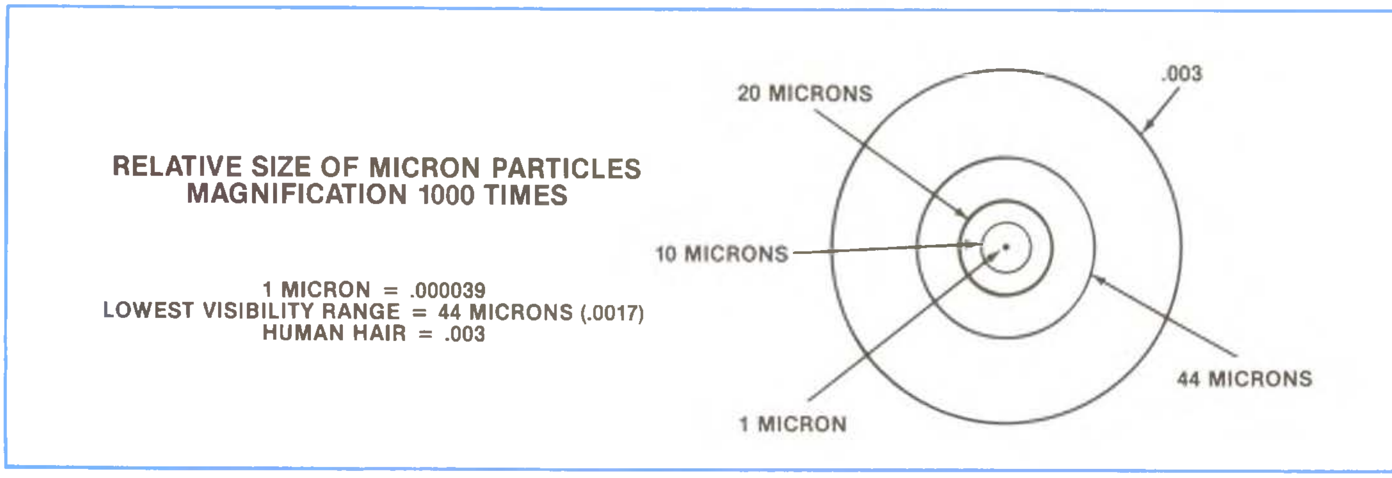


Figure 4-17, **Relative Size of Micron Particles.**

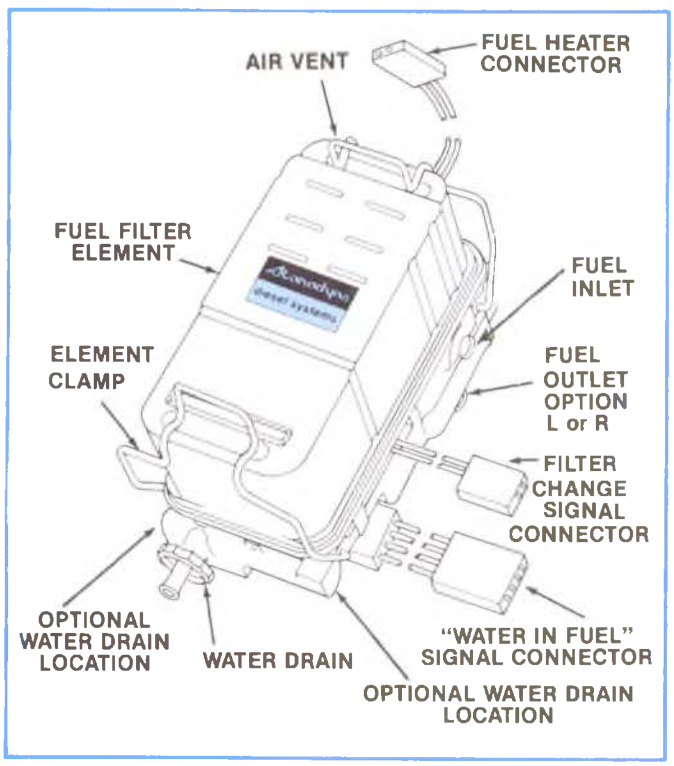


Figure 4-18, **Model 80 Fuel Filter and Base Assembly.**

1984 & LATER MODEL 80 FUEL SENTRY FILTER SYSTEM (FIGURE 4-18)

Combination Fuel Heater
- Fuel Filter
- Water Separator
- Water Sensor
- Filter Change Signal

• FUEL HEATER

See Figure 4-19. The purpose of the heater is to heat fuel, so that the filter does not plug with parafin wax crystals. This will allow the use of fuels at temperatures substantially below the cloud point of the fuel.

The heater is electrically powered from the ignition circuit 39. It is placed in the filter inlet passage in the filter base.

The heater is thermostatically controlled to work when waxing of the fuel is expected. It is self-protected (by thermal feedback from the heating element to the bi-metal actuator) against overheating resulting from the lack of fuel flow. Because it is located within the filter base, it is 50% more heat efficient than a line heater.

The device can be divided into two major functional components, the heater and the power control assemblies.

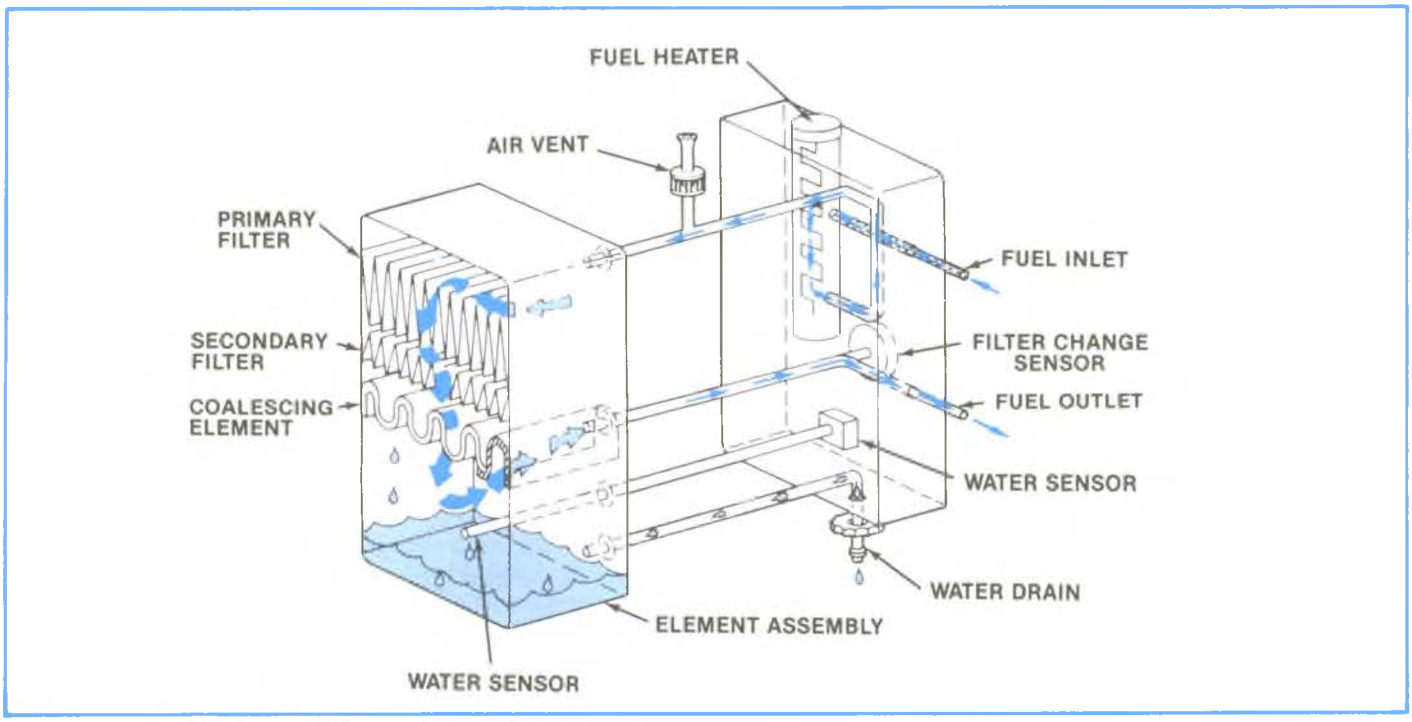


Figure 4-19, **Filter and Base Flow Schematic.**

The heater is 7/8 inches in diameter and consists of an electric resistance strip spiral wound.

The power control assembly senses fuel temperature and responds by closing an electrical circuit to the heater. The sensing element is a bimetal switch. The internal bimetal switch turns on at 20 degrees F and shuts off at 46 degrees F. Power consumption is 110 watts @ 14 volts D.C. The heat will only be on until the under hood temperature gets hot enough to warm the fuel.

The heater can be serviced. However, it is retained in the filter base by the vent valve and an "0" ring. To remove it;

1. Remove the vent valve.
2. Disconnect the electrical connector.
3. Grasp the heater and remove it.

It can be checked by using an ammeter connected in series. Checking must take place below 20 degrees ambient temperature. Proper operation will draw approximately 8.6 amps.

Fuel Filter

The engine fuel filter is a two-stage pleated paper type filter (Figure 4-20). The first stage consists of approximately 350 sq. inches of filtering area and will remove 96% of particles 5-6 microns and larger. The second stage is made of the same paper material with glass particles and consists of approximately 100 sq. inches of filtering surface.

The second stage is 98% effective in filtering the fuel already filtered by the first stage. Particles which are larger than 10 microns may damage pump's internal components. The rectangular design of this filter allows the use of these 2 different elements.

Figure 4-17 compares various micron sizes and will ultimately show the effectiveness of the filter.

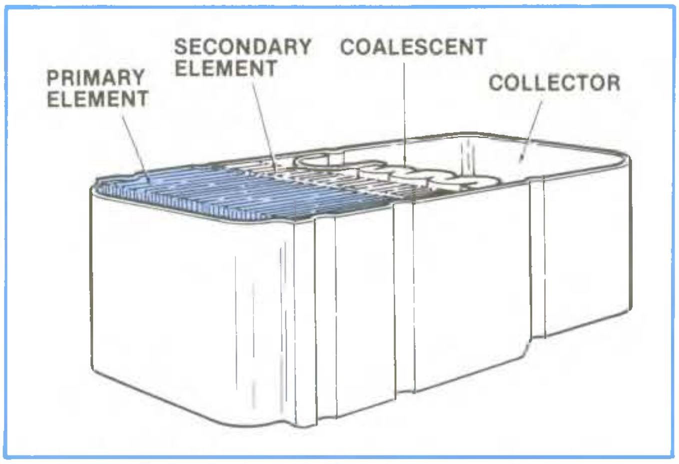


Figure 4-20, **Model 80 Filter Cross-Section.**

WATER SEPARATOR

The bottom of the filter is a hollow water collector. (See Figure 4-19). Because of the greater density of the water, the water droplets will separate from the fuel oil. It will hold approximately 260 cubic centimeters of water (approx. 3-10%).

A nylon fiberglass coalescent is used to blend the small water droplets into larger ones.

"One micron" water droplets collect in the coalescent fibers, and when the droplets get large and heavy enough they drop into the filter bottom.

The coalescing increases the water concentration from 20-30 ppm to 100 ppm. This allows for more efficient water collection.

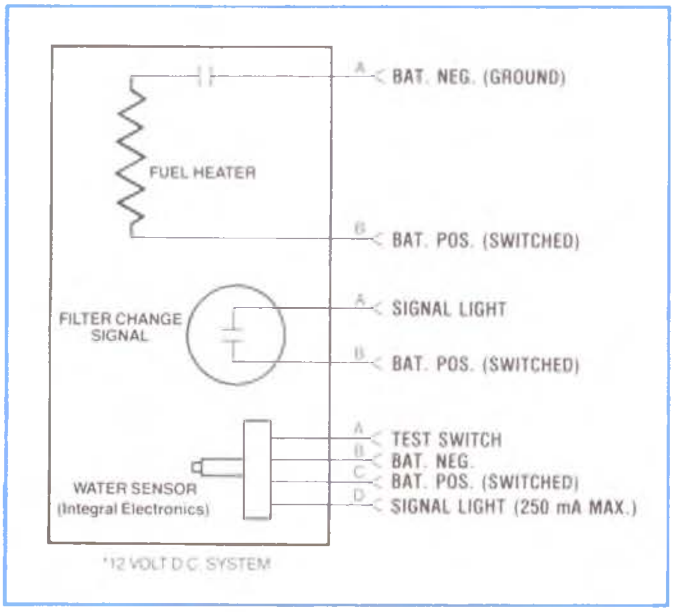


Figure 4-21, 1984 Filter Base Wiring.

WATER SENSOR

The 6.2L uses a water in fuel warning system, which allows the user to guard against water in the fuel.

The water is detected by a capacitive probe located in the filter base. Electronics within the probe will connect a ground (circuit 150) to the ground side of the water in fuel lamp (circuit 508). This lamp is in the center of the instrument panel next to the glow plug lamp. In 1984 (4 wire water sensor module) a bulb check was made any time the ignition switch was in the start position. A B+ signal on the purple wire at the "A" test switch (Figure 4-21) causes pin "D" to pull low, grounding the "water-in-fuel" bulb. In 1984½ and 1985 (3 wire water sensor module) when the ignition is turned on, the lamp will glow from 2 to 5 seconds, and fade away. This is done as a bulb check.

The probe material is iron ferrite, which is not subject to electrolysis. The sensor will turn on at a 50cc level.

— NOTE —

The 1984 water sensor is an IC chip, 4 wire, 4 wire male connector voltage transient module. The 1984½ water sensor has discrete components, 3 wire module, 4 wire male connector. The 1985 and later water sensor has discrete components, 3 wire module and a 3 wire "female" connector.

PRESSURE SWITCH

A pressure will be incorporated in the filter base. It will be used to indicate filter blockage. The pressure differential value is set at 14 in. Hg. ± 2 in.

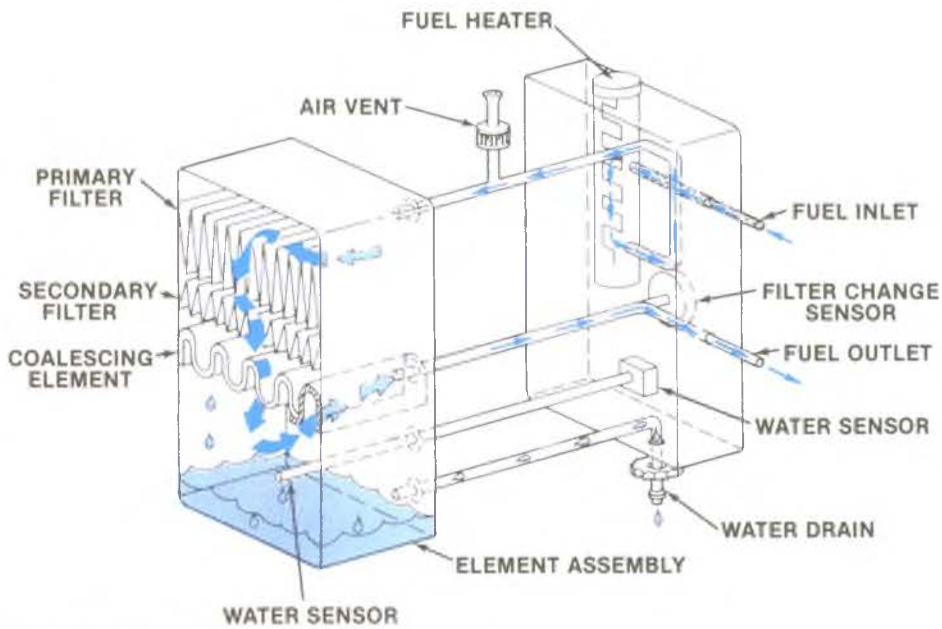


Figure 4-22, **Filter and Base Flow Schematic.**

Fuel Flow

See Figure 4-22. Fuel enters at top right inlet and flows into heating chamber. Heater is activated at 8 degrees C (46 degrees F) and below. Heated fuel enters element at top and flows down thru the two stage fuel filter media pack. While passing through the third stage, water coalesces out and drops to a sump holding area. Clean fuel returns to the base and exits to the fuel injection pump. An electrical signal is obtained from the filter change sensor located in the return path.

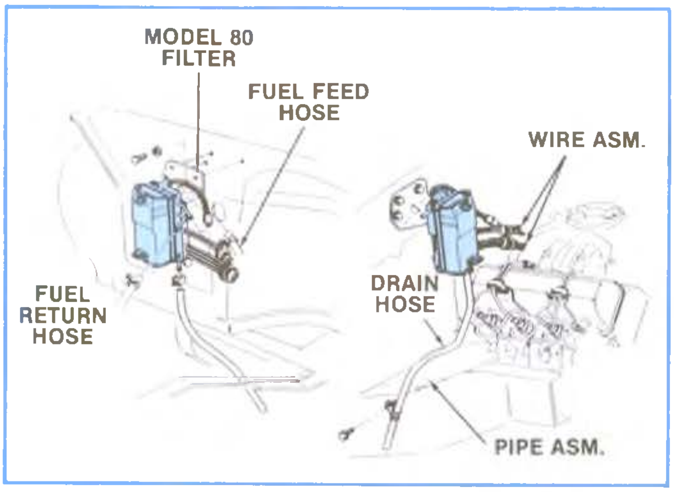


Figure 4-23, C-K Model 80 Mounting.

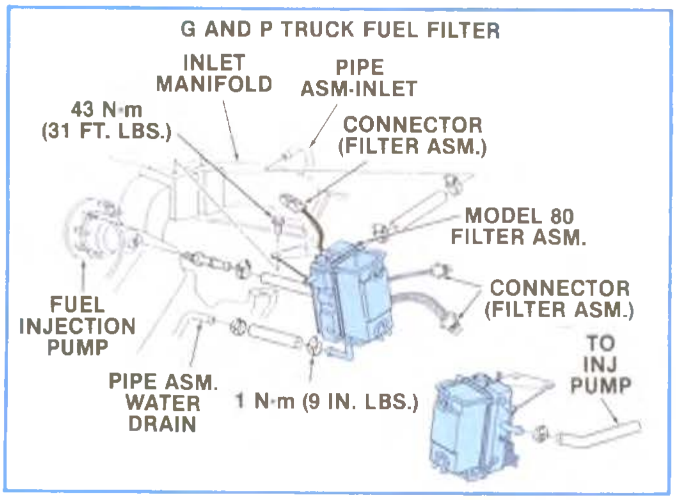


Figure 4-24, G-P Model 80 Mounting.

FUEL FILTER MOUNTING

The Model 80 is cowl mounted on the C-K. See Figure 4-23.

It is mounted at the rear of the intake manifold on a G or P Truck. Also because of space the G & P will use a belt driven vacuum pump. See Figure 4-24.

Water in Fuel

During refueling, it is possible for water to be pumped into your fuel tank along with the diesel fuel. Your vehicle has a water separation system in the fuel filter. It also has a "WATER IN FUEL" light in the instrument cluster which is designed to come on if water has accumulated in the fuel filter and if the fuel filter becomes plugged (a low pressure sensor will activate the light). (The "WATER IN FUEL" light is also designed to come on during engine starting to let you know the bulb is working. If the light does not come on, check the fuse and the bulb.)

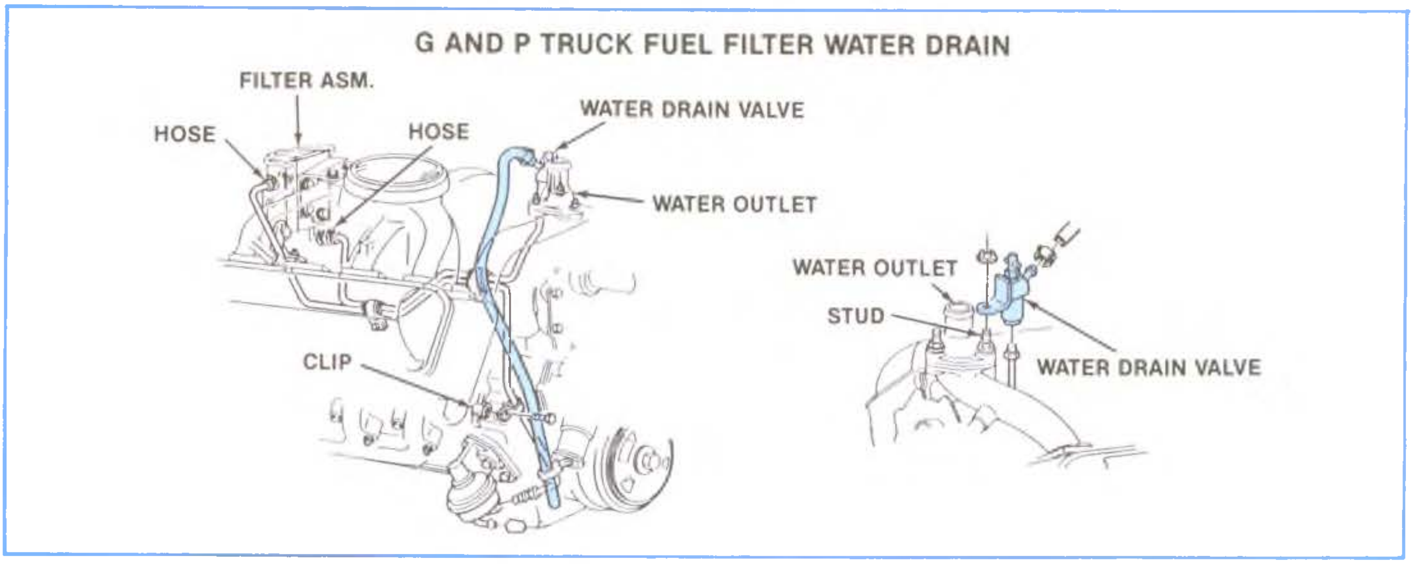


Figure 4-25, G-P Truck Remote Fuel Filter Water Drain.

The G & P Truck have a remote mounted water drain valve near the water outlet.

FUEL FILTER — WATER DRAIN (FIGURE 4-23, 4-24 OR 4-25)

The diesel equipped truck has a multifunction filter for solid contaminants and water. The filter is mounted on the front of the dash.

To drain water:

1. Remove the vehicle fuel tank cap.
2. Place a container below the filter drain hose located below the filter.
3. With the engine off open water drain valve 2-3 turns.
4. Start engine — allow it to idle for about 1-2 minutes or until clear fuel is observed.
5. Stop engine and close water drain valve.
6. Install fuel tank cap.

If the "WATER IN FUEL" light comes on again after driving a short distance or the engine runs rough or stalls — a large amount of water has probably been pumped into the fuel tank. The fuel tank should be purged.

FUEL TANK PURGE PROCEDURE

An authorized dealer can remove (purge) water from the fuel tank. However, you can purge the fuel tank by using the following procedure.

— CAUTION —

If you choose to purge the fuel tank yourself, use caution when working on or near the fuel tank or other parts of the fuel system. Use the same safety precautions you would normally use with gasoline when handling and disposing of the purged mixture. (To dispose of purged fuel, contact a waste oil facility, your dealer or a service station.)

Remember that improper or incomplete service could lead to the vehicle itself not working properly, which may result in personal injury or damage to the vehicle or its equipment. If you have any questions about carrying out this service, have the service done by a skilled technician.

TO PURGE THE FUEL TANK:

1. Park vehicle in a level position. The fuel pick up is in the approximate center of the tank.
2. Place a large container under the filter drain hose. Open the drain 3-4 turns.
3. Disconnect fuel return hose at injection pump.
4. With the fuel tank cap properly installed, apply a low pressure 20.6-34.4 kPa (3-5 psi) maximum air through the fuel return hose. The fuel tank cap is designed to retain 20.6-34.4 kPa (3-5 psi) pressure, allowing water to be forced out of the tank via the filter drain hose.
5. Continue to drain until only clear fuel is observed — the complete contents of the tank may have to be drained.
6. Close drain valve tightly. Reinstall the fuel return hose.

FUEL EXHAUSTION — ENGINE STOPS

Care should be taken not to run out of fuel; however, if the engine stalls and you suspect fuel exhaustion the following procedure will facilitate restarting.

First, determine if engine stall is due to fuel exhaustion. Open the filter air bleed valve — if air is present then the vehicle is probably out of fuel.

To restart the engine:

1. Add at least 2 gallons of fuel if the vehicle is parked on a level surface; as much as 5 gallons may be required if the vehicle is parked on a slope.
2. Disconnect the fuel injection pump shut off solenoid wire (pink wire). (See illustration).

3. With the air bleed open crank the engine 10 to 15 seconds. **Wait one minute for the starter to cool.** Repeat until clear fuel is observed at the air bleed.
4. Close air bleed and reconnect injection pump solenoid wire.
5. Repeat cranking **10-15 seconds** until engine starts.

FUEL FILTER — REPLACEMENT (FIGURE 4-23, 4-24 OR 4-25)

The fuel filter is easily removed and installed with the use of a screwdriver. To prevent fuel spillage — drain fuel from the filter by opening both the air bleed and water drain valve allowing fuel to drain out — into an appropriate container.

To remove the filter:

1. Remove fuel tank cap. This releases any pressure or vacuum in the tank.
2. Disengage both bail wires with a screwdriver.
3. Remove the filter.
4. Clean any dirt off the fuel port sealing surface of the filter adapter and the new filter.
5. Install the new filter — snap into position with bail wires.
6. Close the water drain valve — and open the air bleed. Connect a 1/8″ I.D. hose to the air bleed port and place the other end into a suitable container.
7. Disconnect fuel injection pump shut off solenoid wire. (See illustration).
8. Crank engine for 10-15 seconds and then **wait one minute** for the starter motor to cool. Repeat until clear fuel is observed coming from the air bleed.
9. Close the air bleed, reconnect the injection pump solenoid wire and replace fuel tank cap.
10. Start engine and allow it to idle for 5 minutes.
11. Check fuel filter for leaks.

If the "WATER IN FUEL" light illuminates the following chart (Figure 4-26) may help pinpoint a specific problem.

"WATER IN FUEL" LIGHT CHART	
PROBLEM	**RECOMMENDED ACTION**
• Light comes on intermittently.	Drain water from fuel filter.
• Light stays on — engine running	
1) Temperatures above freezing.	Drain fuel filter immediately. If no water is drained and light stays on — replace fuel filter.
2) Temperatures below freezing.	Drain fuel filter immediately. If no water can be drained — water may be frozen. Open air bleed to check for fuel pressure. If no fuel pressure replace filter.
• Light comes on at high speed or heavy accelerations.	Fuel filter plugged — replace.
• Light stays on continuously — engine stalls, will not restart.	
1) After initial start-up.	Fuel filter or fuel lines may be plugged. See your dealer.
2) Immediately after refueling — Large amounts of water probably pumped into the tank.	Fuel tank purging required. See "Fuel Tank Purge" procedure found in Section 4 of this manual.

Figure 4-26, **"W.I.F." Light Chart.**

Model 80 Fuel Filter Seal Leakage

Leakage of fuel and/or air past the drain and/or vent seal(s) can occur in the base of a Model 80 fuel filter. The two Model 80 assemblies involved are part numbers 14071933 and 14071064. The specific symptoms of this leakage are:

1. External fuel leakage from the vent or drain plugs.
2. A hard starting problem where the engine starts normally, then stalls, and is difficult to re-start.

A new seal (P/N 15529641) has been released to repair fuel and/or air leakage. The new seal has a slightly smaller outside diameter, enabling it to bottom in the bore and seal properly.

Seal replacement can be accomplished with the filter assembly removed from the vehicle as outlined in the following steps:

1. Remove the air vent plug located at the top of the filter base.
2. Loosen the drain plug on C/K model trucks and drain the fuel from the filter. On G and P models, open the remote drain valve to drain the filter.

— NOTE —

G and P model trucks do not have a filter drain plug or seal, and only the air vent plug seal will require replacement.

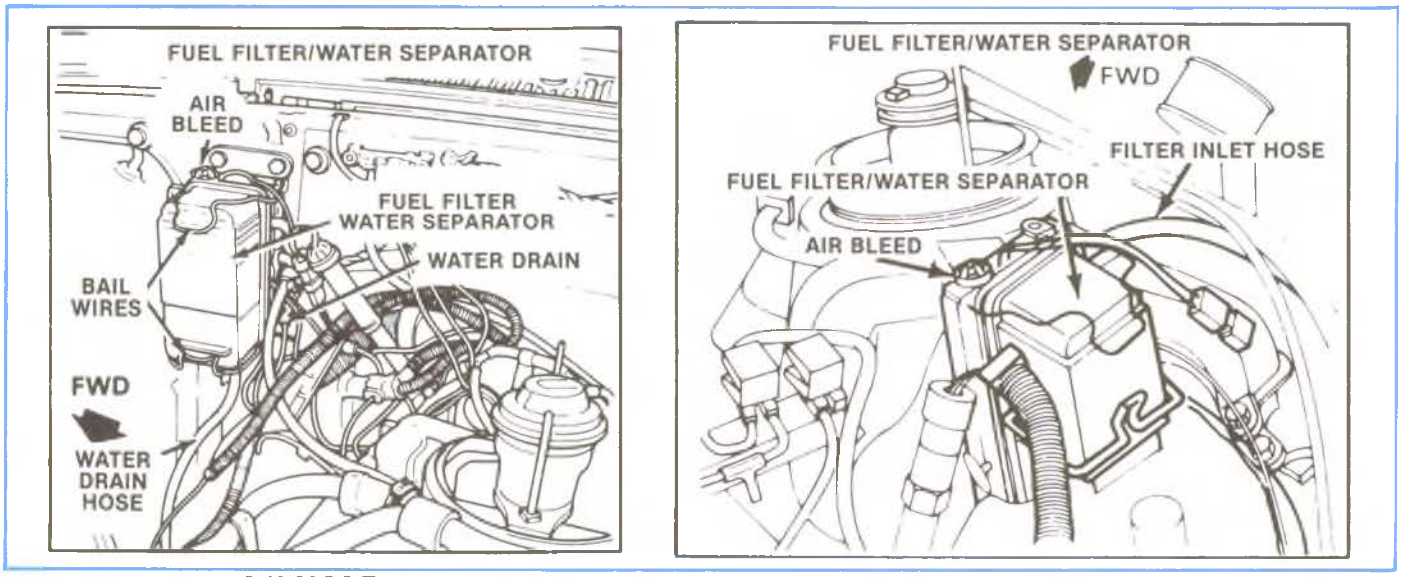
3. Disconnect fuel hoses and wire connections from the filter assembly. Remove the assembly from the vehicle.
4. Unclip and remove the filter/separator element from the base.
5. A paper clip or short length of mechanic's wire can be formed into a tool for seal removal. Using the tool, remove the air vent and drain plug seal (if applicable) from the filter base.
6. Visually inspect the bore(s) for evidence of seal particles. If particles are present, compressed air can be blown into the filter base outlet to remove small particles in the bore(s).
7. A short length of 1/4" bar stock or equivalent with square ends can be used to install the new seals in the base. Apply a small amount of Synkut lubricant or equivalent, such as STP, to one end of the rod. Attach a new seal (P/N 15529641) to the rod's end. Insert the seal into the air vent plug bore until it seats firmly in the bottom of the bore. Visually inspect the seal to ensure it is squarely bottomed. Install the air vent plug.
8. Repeat the above procedure to install a new seal in the drain plug bore, but do not install the drain plug.
9. Prior to installing the drain plug, measure the length of the drain plug bore boss. If the boss is 1/4" long, install the drain plug and tighten until it bottoms. If the boss is 1/8" long, install plain washer (P/N 561890) on the drain plug and then thread the plug in until it bottoms. The drain plug washer prevents threading the drain plug in too far and damaging the seal.
10. Attach the element to the base.
11. The filter assembly can be pressure checked with air by plugging the fuel inlet, outlet, and drain outlet (if applicable). Using a maximum of 10 psi air pressure, open and close the air vent and drain plug (if equipped) several times to ensure the valve(s) are sealing.
12. Reinstall filter assembly on vehicle and attach all fuel hoses and wire connections.
13. Vent and prime the fuel system as outlined in the Service Manual or Owner's and Driver's Guide.

Fuel Filter/Water Separator

SERVICE INSTRUCTIONS TO CORRECT A "WATER IN FUEL" LIGHT INDICATED PROBLEM

When a problem is indicated by the "WATER IN FUEL" signal light, first follow the diagnostic procedure outlined in the vehicle service manual. If this procedure fails to locate the problem and the light continues to stay on, the fault may be in the fuel filter/water separator assembly electrical sensors.

To determine which sensor may be at fault, first disconnect the vacuum sensor. To distinguish the electrical leads, refer to Figure 4-27. The vacuum sensor has two wire leads with a black connector. (The "WATER IN FUEL" sensor has four wire leads with a black connector, and the fuel heater has two wire leads with a white connector.)



C,K MODELS G,P MODELS

Figure 4-27, Electrical Connections, Fuel Filter/Water Separator.

If the indicator light goes off, then the vacuum sensor is probably defective and should be replaced according to the following instructions.

1) Prior to removal of the defective vacuum sensor, obtain a new vacuum sensor and connect to the wire leads in the vehicle. The light should remain off. This is to ensure the new sensor has not been damaged during shipment.
2) Drain the fuel filter/water separator assembly into a container according to the instructions in the vehicle service manual, then disconnect and remove the entire assembly from the vehicle.
3) Remove the filter/separator element from the base assembly.
4) Using a small screwdriver, pry the vacuum sensor retaining clip from the base (Reference Figure 4-27). Take care to prevent damage to the bore. It is suggested that initially prying the clip upwards at the wire lead protective tab will cause the least amount of scoring to the base bore.
5) Remove the vacuum sensor by pulling up on the sensor wire leads and by simultaneously prying under the sensor opposite the leads using a small screwdriver.
6) After the sensor is removed, check the bore by running your finger around the inside of the bore and visually inspect for sharp edges or raised metal burrs caused by removal of the retaining clip.
7) If burrs are present, use a fine (300) grit paper or round stone to remove any sharp metal burrs or scratches in the bore. This is to prevent harm to the sensor "0" ring seal during installation. Take care to prevent debris from entering the hole at the bottom of the bore when performing this service.

— CAUTION —

Do not sand or scratch the lower machined "0" ring sealing surface while deburring.

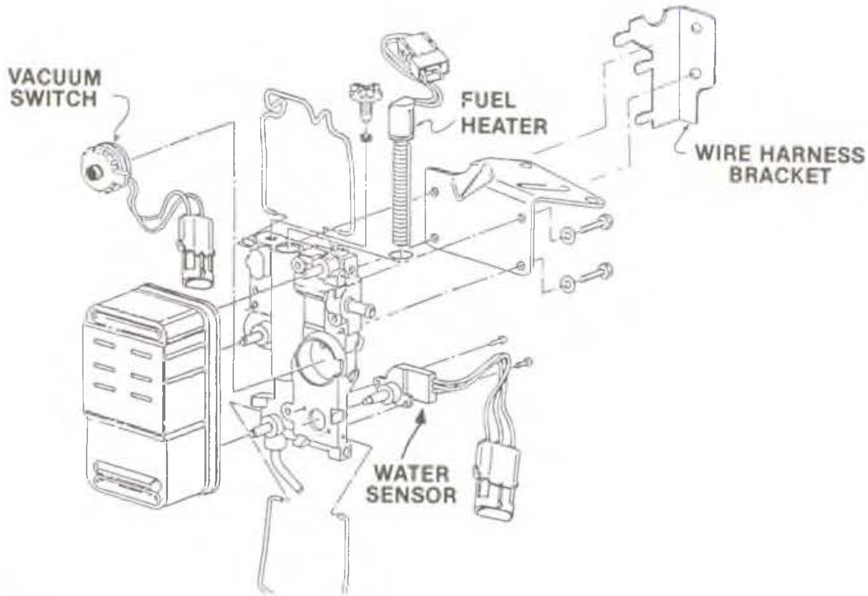


Figure 4-28, 1985 Model 80 Filter, Exploded View.

8) Using a lint-free cloth and solvent, wipe off any debris from the bore area that may have been generated during the deburring process, then blow off the area with compressed air.
9) Remove the sensor retaining clip from the new sensor using a knife blade or screwdriver to pry the clip upward at the wire lead area.
10) Apply a liberal amount of vaseline, grease or STP to the sensor "0" ring seal. Also apply a small amount of lubricant to the base sensor bore.
11) See Figure 4-28 for proper vacuum sensor installation. To prevent cutting of the "0" ring seal, insert the sensor into the bore at an angle with wire lead portion inserted first. Insert the new sensor (less the retaining clip) into the base, using finger pressure until it is seated or nearly seated at the bottom of the bore.
12) Assure the cellular air filter is in place atop the sensor, then place the sensor retaining clip in position with the protective tab over the wire lead. Holding the retaining clip in position with one finger placed at the center of the clip, work the retainer into place by forcing each tab downward uniformly and in small increments using a screwdriver. The retainer will be in proper position when no further downward movement is felt and the top of the retainer is approximately flush with the lip of the bore.

— NOTE —

Current versions of the vacuum sensor have a rubber button at the center of the retaining clip. This button should be in place prior to installation of the sensor retaining clip to the base and prior to installation of the filter/separator element.

13) Install filter/separator element to the base assembly.
14) Reinstall fuel filter/water separator assembly to the vehicle. Connect all electrical leads and the fuel inlet line. Leave the fuel outlet line (smaller) disconnected.
15) Follow the engine startup procedure outlined in the vehicle service manual under "Fuel Filter — Replacement (Diesel Engine)". When clear fuel is observed coming from the outlet fitting, connect the outlet fuel line and complete the engine startup procedure.

Modifications To Model 80 Fuel Sentry For DDA (G & P) Applications

*SDS #	TITLE	DESCRIPTION
		1984
27108	Water Sensor	IC chip, 4 wire, 4 wire male connector, voltage transient module
24831	Vacuum Switch	2 wire male connector
24270	Fuel Heater	2 wire female connector
		1984½
27284	Water Sensor	Discrete components, 3 wire, 4 wire male connector
24831	Vacuum Switch	Same as 1984
24270	Fuel Heater	Same as 1984
		1985
27285	Water Sensor	Discrete components, 3 wire, 3 wire female connector
24290	Vacuum Switch	2 wire female connector
27530	Fuel Heater	2 wire female connector
27517	Wire Harness Bracket	All connectors are attached to this bracket at final assembly

*SDS — Stanadyne Diesel Systems

Functional Difference:

Discrete circuit (1984½ & 1985) water sensor will lamp test for approximately 2-5 seconds each time the key is turned on.

1984 unit lamp tests only during cranking.

14071933 ASSEMBLY C-K TRUCK MODEL 80 PARTS LIST		
DESCRIPTION	**GM PART NUMBER**	**STANADYNE NUMBER**
Bracket, Wiring Harness	15593335	24838
Clip, Vacuum Switch Retainer	15593306	24835
Seal, "0" Ring (Vacuum Switch)	15596608	24275
Switch, Vacuum	15593308	24831
Seal, Drain Plug	15596611	24266
Seal, "0" Ring (Fuel Heater)	15596600	15349
Plug, Vent	15596612	24267
Screw, Thd Forming ½-20	15596607	24437
Bracket, Mtg.	15593336	34522
Clamp, Filter	15596613	24265
Heater Assembly, Fuel	15593337	24870
Screw, Thd Forming	15596603	24322
Sensor, Water	15596610	24269
Base Assembly	15593338	24521
*Element, Filter	14075347	24262

*Part of Filter Element

14071064 ASSEMBLY G-P TRUCK MODEL 80 PARTS LIST		
DESCRIPTION	**GM PART NUMBER**	**STANADYNE NUMBER**
Bumper, Vacuum Switch	15593305	27129
Clip, Vacuum Switch Retainer	15593306	24835
Seal, "0" Ring Vacuum Switch	15593307	24834
Switch, Vacuum	15593308	24831
Screw Thd Forming (¼-20)	15596607	24437
Clamp, Filter	15596613	24265
Bracket, Filter Mtg.	15593309	24527
Seal, Drain Plug	15596611	24266
Plug, Vent	15596612	24267
Seal, "0" Ring	15596600	15349
Heater Assembly, Fuel	15596609	24270
Screw, Thd Forming (8-32)	15596603	24322
Sensor, Water	15593310	27108
*Element, Filter	14075347	24262

*Part of Filter Element

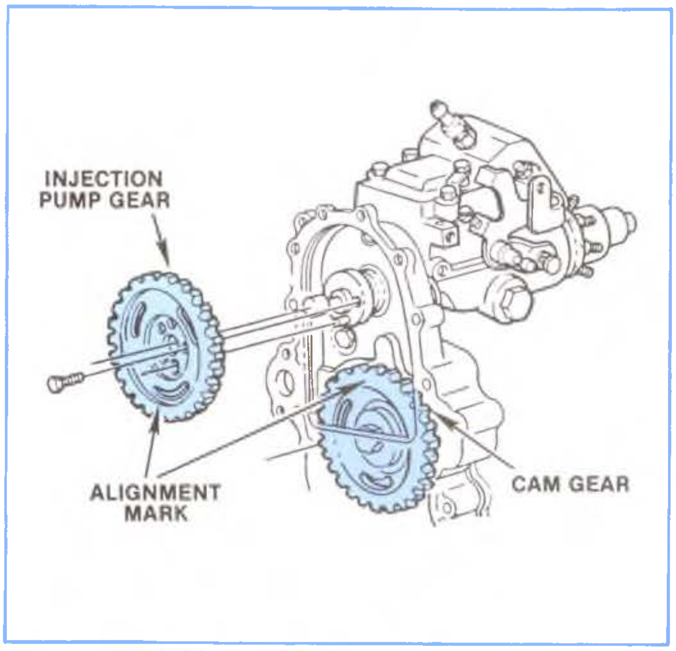


Figure 4-29, **Pump Timing Gears.**

High Pressure Fuel Delivery System

- Injection distributor pump.
- High pressure lines.
- Fuel injection nozzles.

The 6.2 liter injection pump is mounted on top of the engine under the intake manifold. It is gear driven by 2 gears — one attached to the front end of the camshaft which drives the second gear that is attached to the end of the injection pump shaft. These 2 gears are the same size and have the same number of teeth; thus, the injection pump shaft turns at the same rate as the camshaft and one-half the speed of the crankshaft. The pump will turn in the opposite direction to that of the camshaft and crankshaft. See Figure 4-29.

The injection pump is a high pressure rotary type pump that directs a metered pressurized fuel through the high pressure tubes to the eight injector nozzles.

The eight high pressure lines are all the same length although their shape may be different. This prevents any difference in timing, cylinder to cylinder. See Figure 4-30.

The lines are all 600mm long. The I.D. is 2.5mm, and the O.D. is 6.3mm on C, K, and P series. The G-van I.D. is 2mm and the O.D. is 6mm.

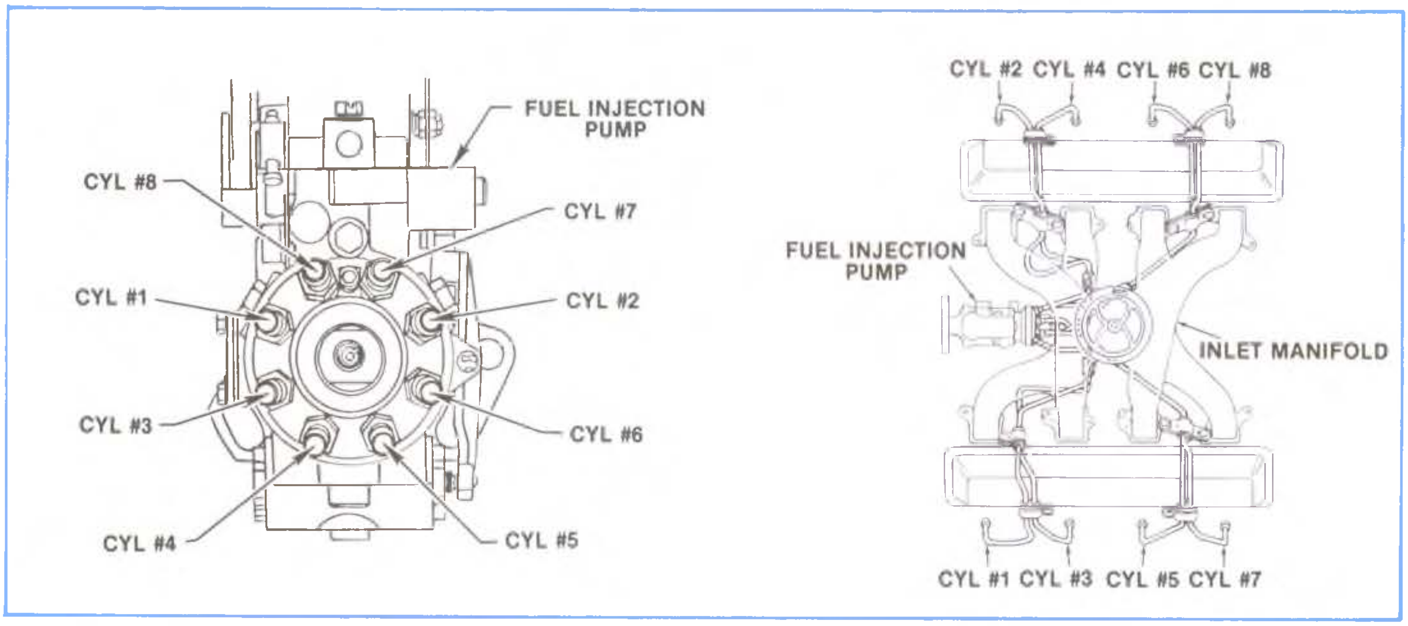


Figure 4-30, **High Pressure Lines.**

Fuel Injection Pump

The 6.2L diesel engine uses the Stanadyne DB2, distributor-type, fuel injection pump (Figure 4-31).

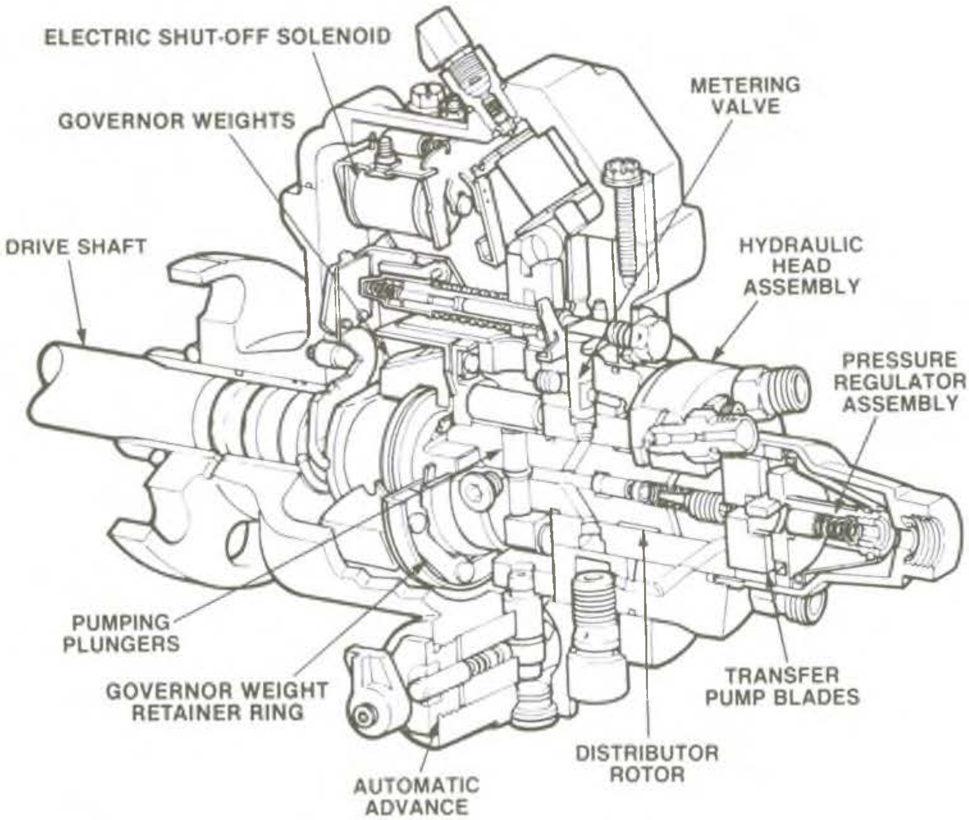


Figure 4-31, **DB2 Distributor-Type Injection Pump Cutaway.**

The function of the fuel injection pump is to meter the fuel according to engine power requirements and to inject it at high pressure through nozzles into the combustion chambers of the engine at the correct timing intervals. The metering calls for careful design and construction, as it has to be carried out at a high speed and with great precision, in order to ensure even fuel distribution with smooth running, and sensitive response to power control. The timing of the injections must also be done with perfect precision, or high efficiency is impossible to achieve, and since the operating pressure may be as high as 6,000 PSI, the pump itself must be constructed with the utmost care, employing high-grade materials and the finest of working tolerances for the pump elements.

The employment of a separate pumping element for each cylinder, together with suitable means of output control, has been the general practice of fuel injection pump manufacture for some time. The idea of using one pump barrel and a set of plungers to supply all cylinders in turn is a natural one, as it offers obvious savings; the pumping element operates more often (according to the number of cylinders), and is provided with a distributor or means of connecting the pump delivery to each of the injectors in turn.

The distributor type pump is thus an attractive proposition, since the number of pumping elements is reduced to one in all cases.

Injection Pump Description

The main rotating components (Figure 4-32) are the drive shaft, the distributor rotor, the transfer pump blades and the governor.

The drive shaft engages the distributor rotor in the hydraulic head. The drive end of the rotor incorporates two pumping plungers.

The plungers are actuated toward each other simultaneously by an internal cam ring through rollers and shoes which are carried in slots at the drive end of the rotor. The number of cam lobes equals the number of engine cylinders.

The hydraulic head contains the bore in which the rotor revolves, the metering valve bore, the charging ports and the head discharge fittings. The high pressure injection lines to the nozzles are fastened to these discharge fittings.

The DB2 Pump is an inlet metering pump. That is, it has a pumping period with a variable beginning, and a constant ending.

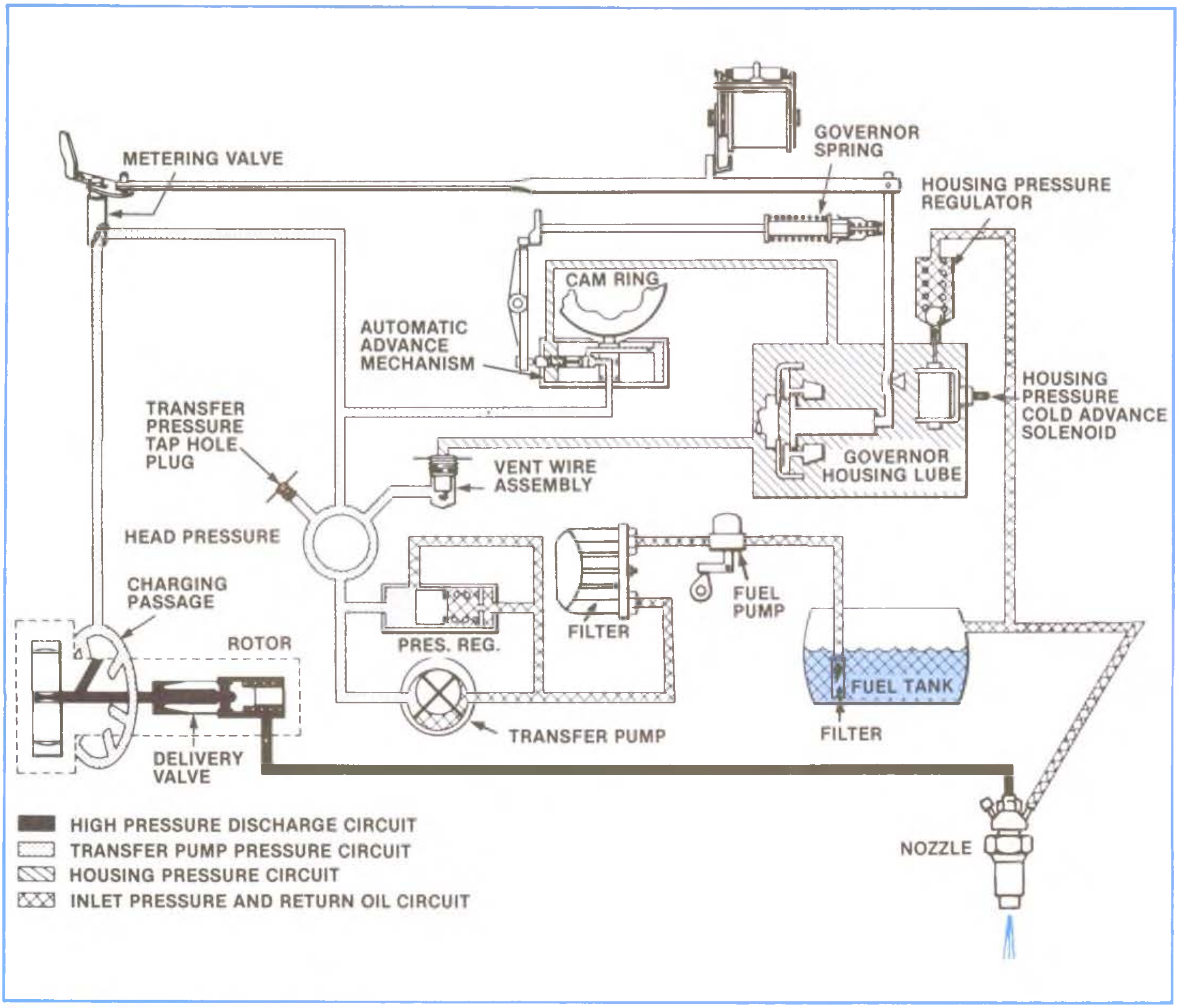


Figure 4-32, Pump Schematic.

Injection Pump Operation

The general operating principal of the pump may be easily understood by following the fuel circuit through the pump.

FUEL FLOW

First, the fuel is drawn into the pump inlet, and through the inlet filter screen by the transfer pump. Excess fuel is bypassed through the pressure regulator assembly, and back through the suction side. The fuel, which is under transfer pump pressure, flows through the rotor and head. (Figure 4-33).

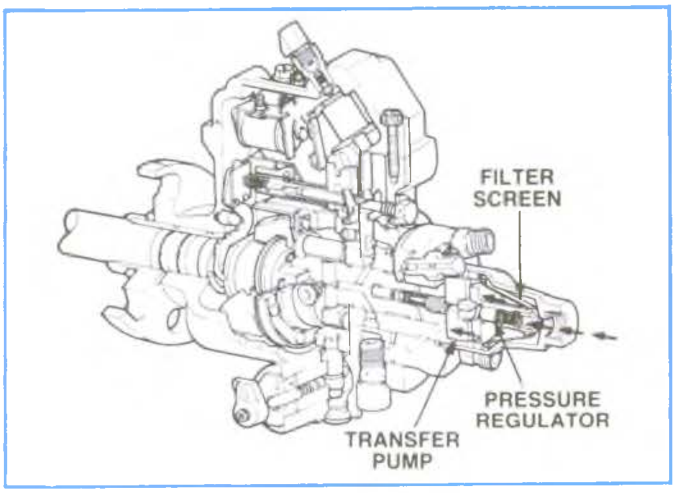


Figure 4-33, Fuel Intake.

From here, the fuel is routed in a number of different directions. Some of the fuel is sent through the head locating screw to the automatic advance. The majority of the fuel is sent into a connecting annulus to the top of the hydraulic head. (Figure 4-34).

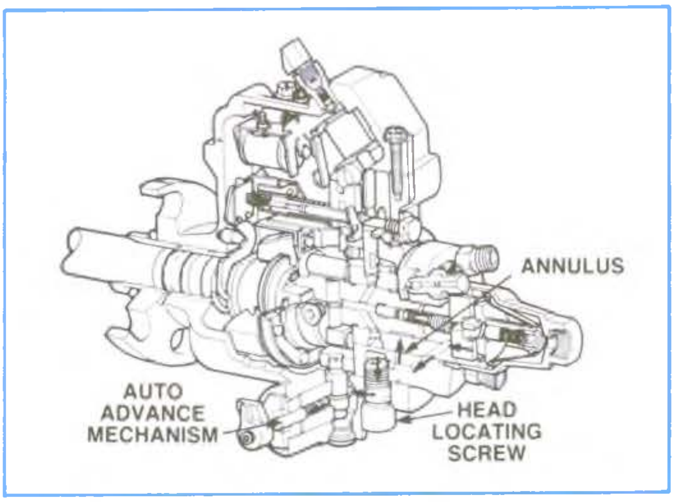


Figure 4-34, Fuel Flow To Hydraulic Head.

From this point fuel is sent to the transfer pump test tap and the vent wire assembly. The remaining fuel is sent through a connecting passage to the metering valve. (Figure 4-35).

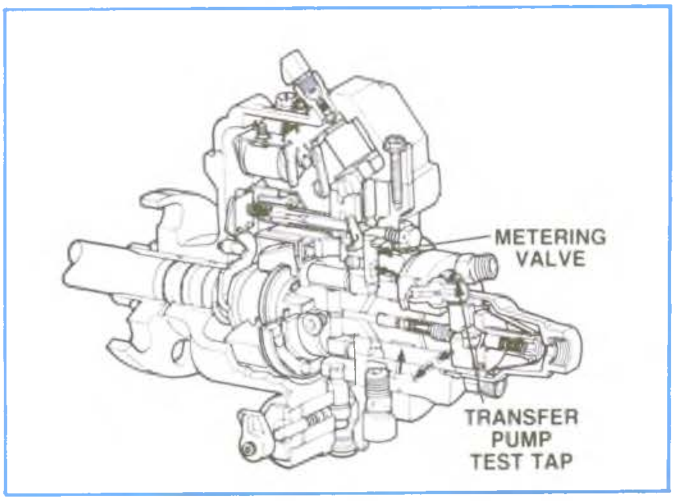


Figure 4-35, Fuel Flow To Transfer Pump and Metering Valve.

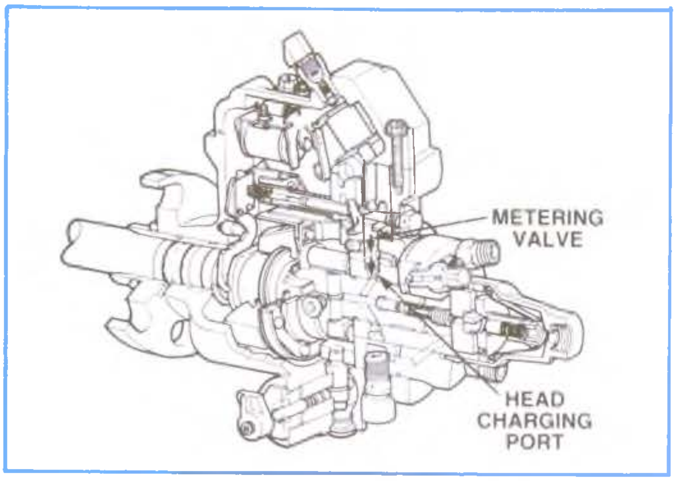


Figure 4-36, Metering Valve.

METERING VALVE

The metering valve, which is controlled by the governor, regulates fuel flow into the head charging ports. (Figure 4-36). It is the equivalent of a throttle plate in a carburetor. It controls the flow area to the pumping plungers. Figure 4-37 shows minimum flow area, and Figure 4-38 shows maximum flow area.

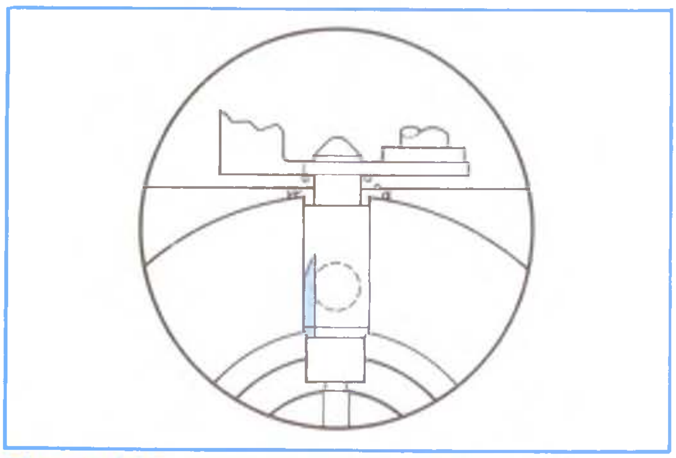


Figure 4-37, Metering Valve Light Load.

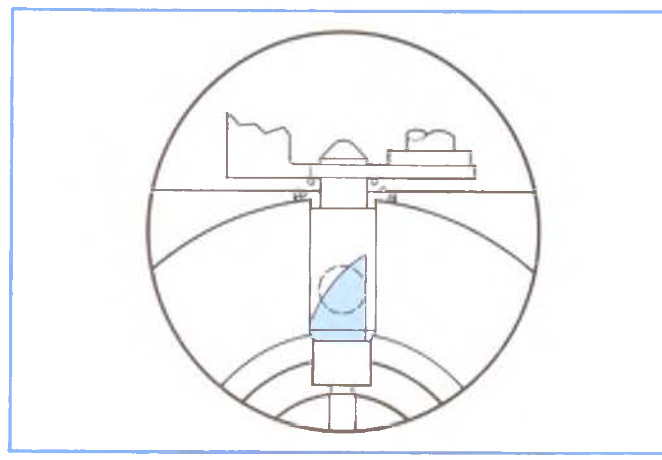


Figure 4-38, Metering Valve Full Load.

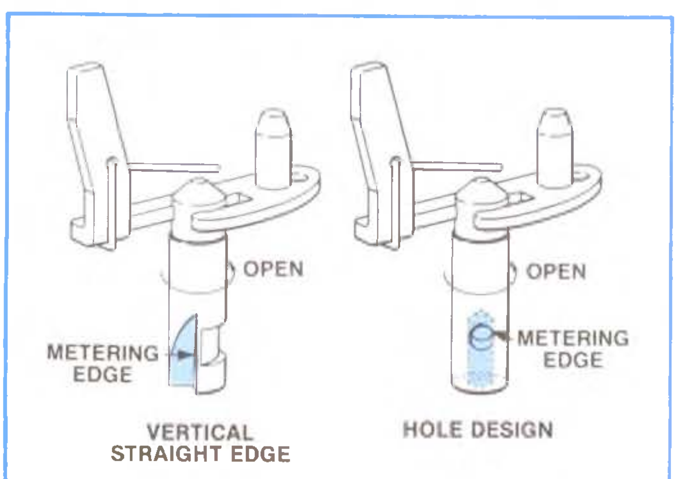


Figure 4-39, Metering Valve Designs.

Figure 4-39 shows the vertical straight edge and hole type metering valves. The 6.2L uses the vertical straight edge type.

PUMPING MECHANISM

As the rotor revolves, the two rotor inlet passages register with charging ports in the hydraulic head. (Figure 4-40).

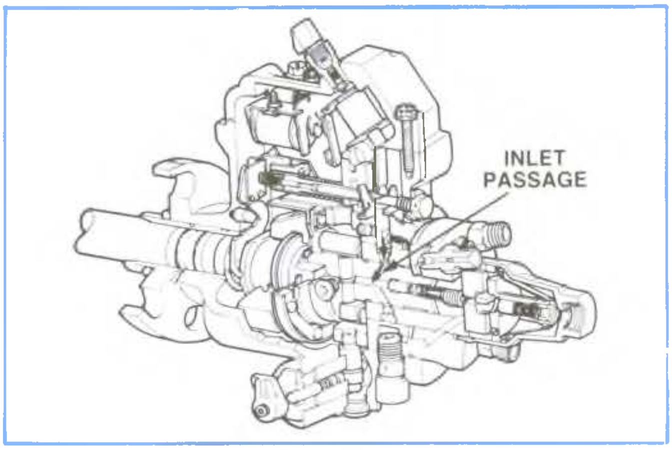


Figure 4-40, **Charging Ports.**

This allows fuel to flow into the pumping chamber. (Figure 4-41). For improved roller retention, the 6.2L engine will use a new roller shoe. It will provide increased shoe wrap-around by positioning the roller deeper into the shoe. Due to the lower profile of these shoes and rollers, the part number of their companion leaf spring has been changed. The shoes are identified by a –10 marking.

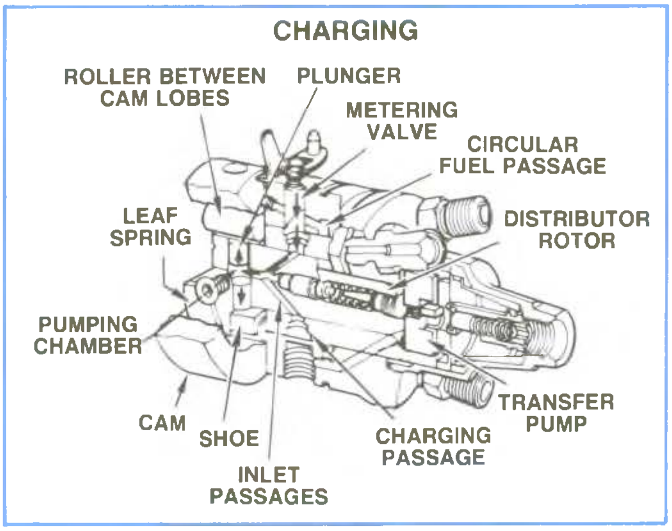


Figure 4-41, **Pumping Chamber.**

As the rotor continues to revolve, the inlet passages move out of registry, ending charging. Discharge begins when the discharge port of the rotor registers with one of the head discharge outlets. (Figure 4-42).

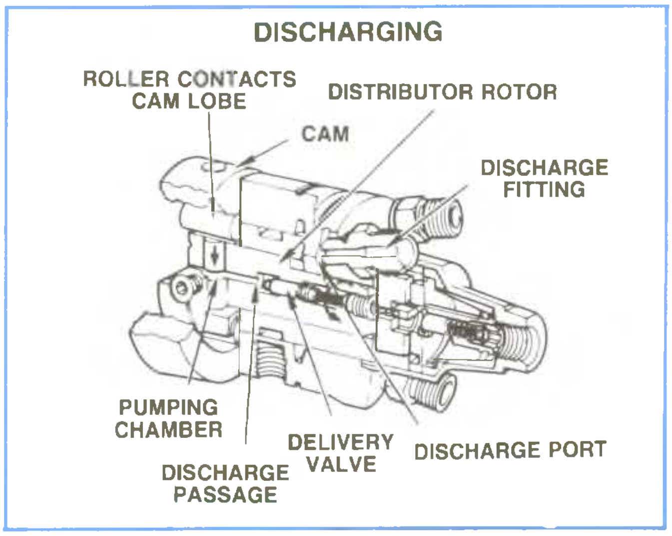


Figure 4-42, **Fuel Discharge.**

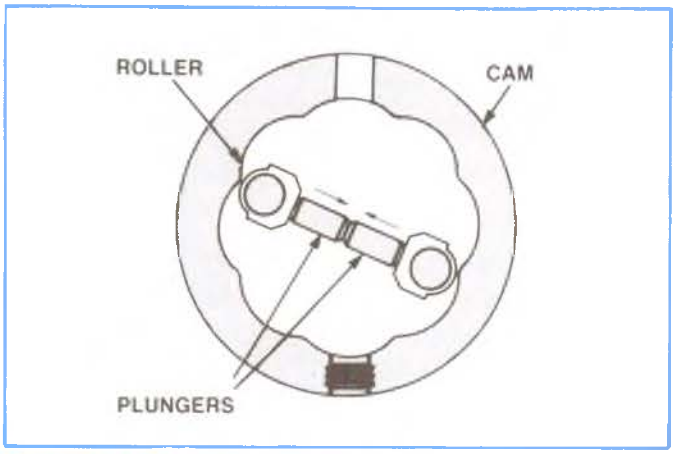


Figure 4-43, **Pressurizing Fuel.**

PUMPING UNDER PRESSURE TO NOZZLE

While the discharge port is open, the movement of the rotor causes the rollers to contact the cam lobes, forcing the plungers together. The fuel is thus pressurized until the rollers pass over the top of the injection cam, when the pressure starts to drop. (Figure 4-43).

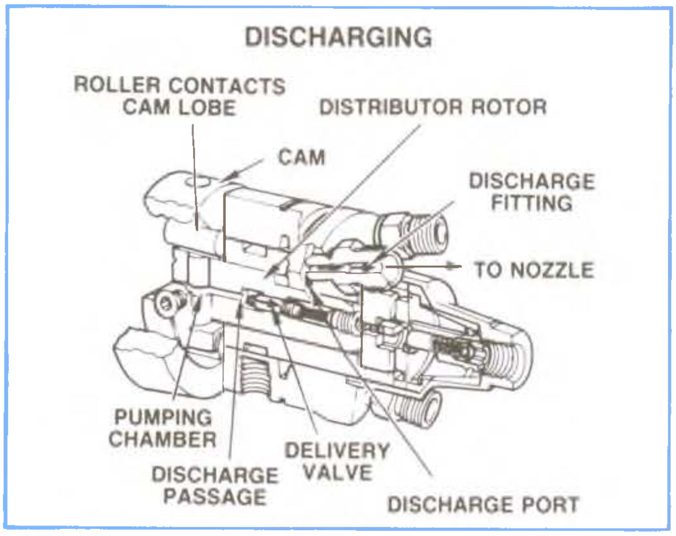


Figure 4-44, **Flow To Nozzle.**

The fuel then flows through the discharge outlet and discharge port to the injection nozzle. (Figure 4-44).

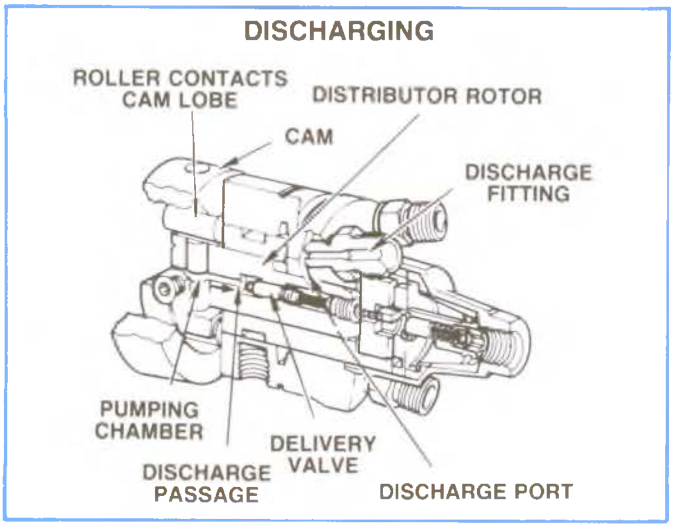


Figure 4-45, **Delivery Valve Control.**

The magnitude of this pressure drop is controlled by the delivery valve which retains a definite residual pressure in the discharge circuit. This pressure is low enough to assure prompt nozzle closing yet high enough to prevent cavitation of the fuel between injections. (Figure 4-45).

TRANSFER PUMP

Now for a closer look at some of the systems and components mentioned earlier in the program. Where model year design differences exist they will also be pointed out.

Let's begin with the component that supplies and pressurizes the fuel: The Transfer Pump.

The positive displacement vane type transfer pump consists of a stationary liner and four spring loaded blades. Since the inside diameter of the liner is eccentric to the rotor axis, inlet and discharge cavities are formed by the blades as they rotate. (Figure 4-46).

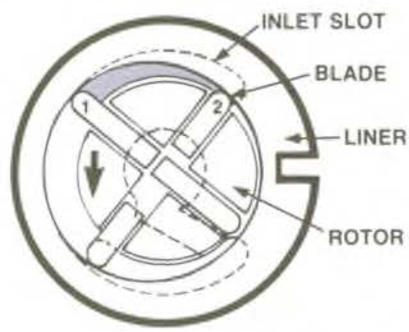


Figure 4-46, Transfer Pump Construction.

— NOTE —

A positive displacement pump discharges a certain amount of liquid for each revolution of the rotating element.

As a blade passes over the inlet slot it enlarges the inlet volume, creating suction. The cavity between this and the second blade fills with fuel until the second blade passes the end of the inlet slot. (Figure 4-47). This volume of fuel is carried around until the leading blade uncovers the end of the discharge slot as shown in the next illustration.

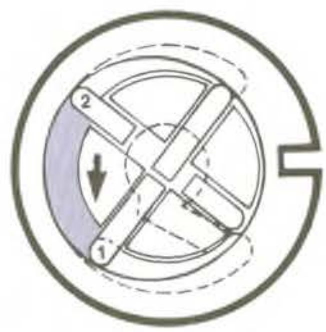


Figure 4-47, Transfer Pump In Mid Position.

As the leading blade continues to pass over the discharge slot it is followed by the second blade which pushes the captive volume of fuel ahead of it. Since the blades are moving into a decreasing volume in the liner, the captive fuel is squeezed out through the discharge slot by the following blade as shown in Figure 4-48.

This sequence takes place four times every revolution of the rotor, producing a continuous discharge.

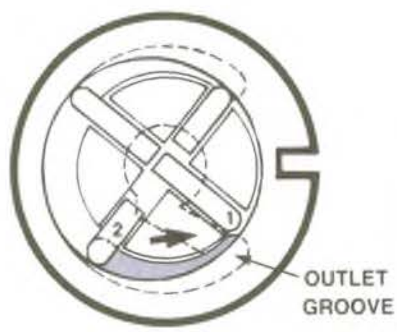


Figure 4-48, Transfer Pump In Lower Position.

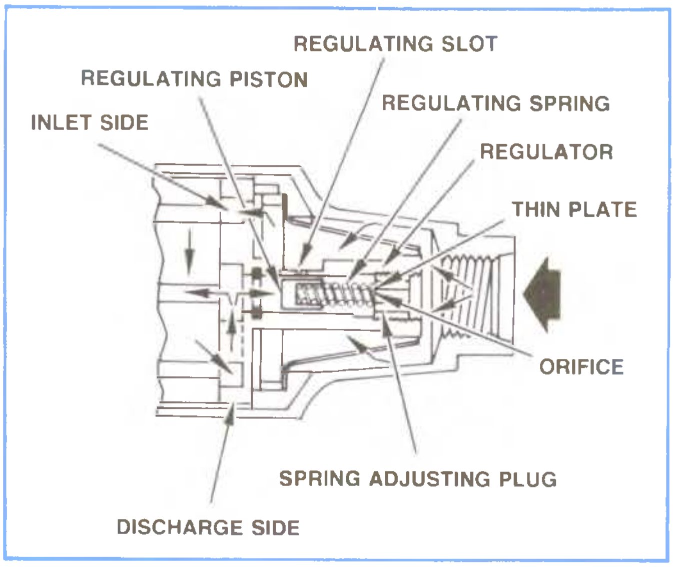


Figure 4-49, Regulator Assembly.

REGULATOR ASSEMBLY OPERATION

In order to understand how designed fuel pressures are maintained over a broad range of conditions we'll now take a closer look at regulator assembly operation.

This illustration shows the operation of the pressure regulator assembly while the pump is running. Fuel output from the discharge side of transfer pump forces the piston in the regulator assembly against the regulating spring. (Figure 4-49).

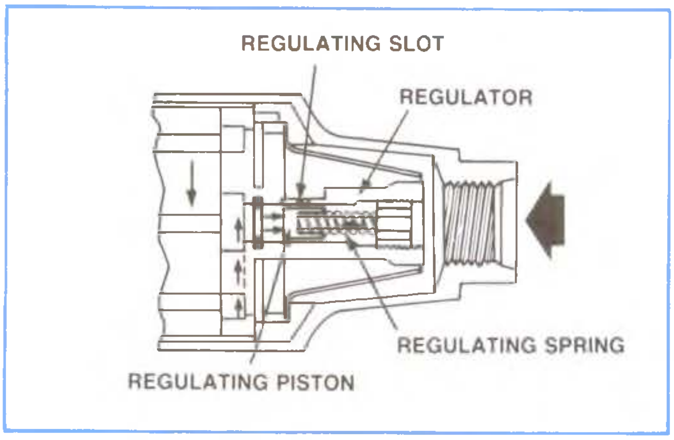


Figure 4-50, Regulator Control.

Since the fuel pressure on the piston is opposed by the regulating spring, the pressure curve of the transfer pump is controlled by the spring rate and the size of the regulating slot. This results in pressure being increased as engine speed increases. (Figure 4-50).

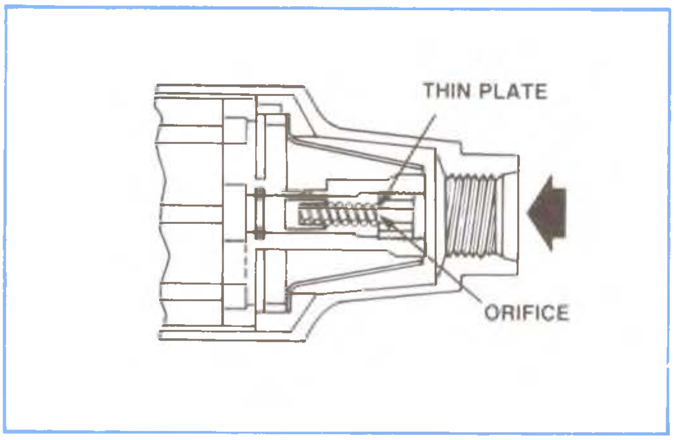


Figure 4-51, Viscosity Compensating Device.

VISCOSITY COMPENSATING DEVICE

Another unique and very simple feature of the DB2 automotive pump is a viscosity compensating device. This component ensures proper transfer pump pressure regardless of the ambient temperature or grade of fuel used. (Figure 4-51).

When fuel "thins" out due to heat, pressure loss will occur. The thin fuel, however, permits increased leakage past a loose fit at the regulating piston causing an increase of pressure in the spring cavity. This aids the spring and moves the piston to restrict spill, thus correcting the pressure. (Figure 4-52).

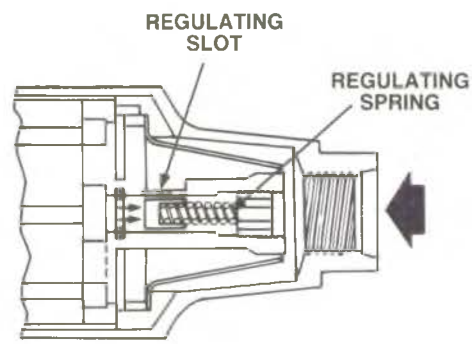


Figure 4-52, **Thin Fuel Correction.**

When fuel is cold it "thickens," and due to the better sealing this affords: fuel pressure increases. Also due to better sealing, leaking past the regulating piston diminishes. This causes a reduction of spring cavity pressure allowing transfer pump pressure to move the regulating piston outward. This increases spill and corrects the pressure. (Figure 4-53).

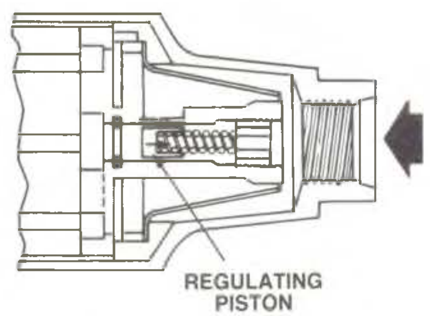


Figure 4-53, **Thick Fuel Correction.**

A short sharp edged orifice in the adjusting plug controls the leakage from the spring cavity.

This orifice is not sensitive to viscosity variation. Consequently, as input to the spring cavity, past the piston, varies with viscosity, pressure in this cavity will also change. This biases the position of the regulating piston over the spill slot and maintains the correct transfer pump pressure. (Figure 4-54).

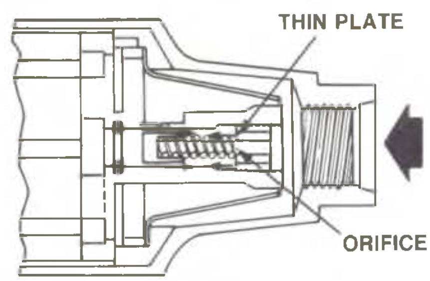


Figure 4-54, **Orifice Control.**

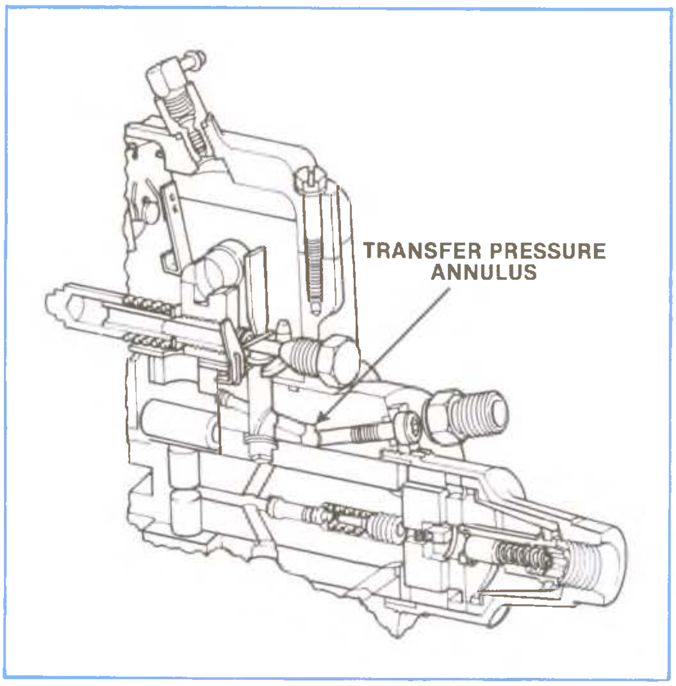


Figure 4-55, Return Oil System.

RETURN OIL SYSTEM

The return oil system (Figure 4-55) performs the following functions. 1.) A controlled flow through the housing maintains stable conditions for the internal parts. 2.) The fuel flow cools and lubricates the pump. 3.) It provides automatic air venting of the system.

The return oil vent passage is fed, from the transfer pressure annulus.

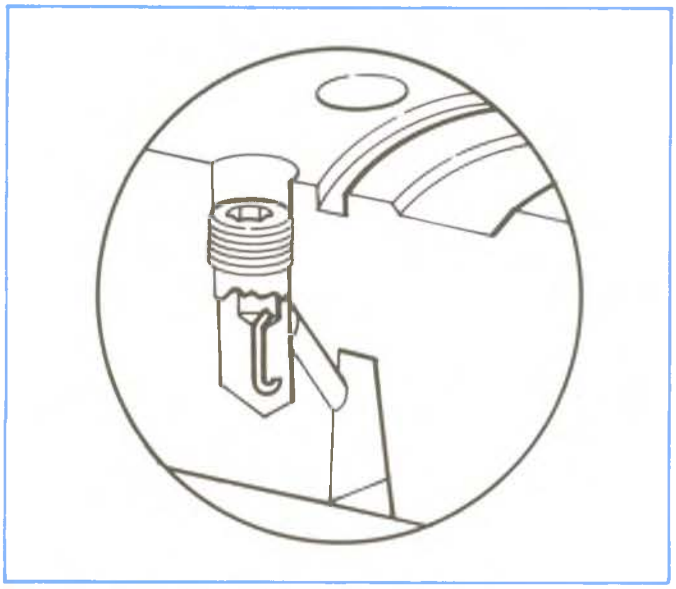


Figure 4-56, Vent Wire Restriction.

Fuel under transfer pump pressure is discharged from the transfer pressure annulus into a vent passage in the hydraulic head (Figure 4-56). Flow through the passage is restricted by a vent wire assembly to prevent excessive return oil and undue pressure loss.

The assembly is made of a hollow screw, into which a "J" wire is installed.

The amount of return oil is controlled by the size of wire used in the vent wire assembly, i.e., the smaller the wire the greater the flow and vice versa. The vent wire assembly is available in several sizes in order to meet the return oil quantities called for on the specification.

Note that this assembly is accessible by removing only the governor cover. The vent passage is located behind the metering valve bore and connects with a short vertical passage containing the vent wire assembly and leads to the governor compartment.

Should a small quantity of air enter the transfer pump, it immediately passes to the vent passage as shown. Air and a small quantity of fuel then flow from the housing to the fuel tank and via the return line.

Housing pressure is maintained by a spring loaded ballcheck return fitting in the governor cover of the pump.

ELECTRIC SHUTOFF SOLENOID

All Stanadyne Diesel Systems DB2 Automotive pumps are equipped with electrical shut-off solenoids. (Figure 4-57).

Illustrated here is an energized to run solenoid. When this is de-energized, an arm on the solenoid is moved out by spring force and physically closes the metering valve. This action interrupts injection, and stops the engine.

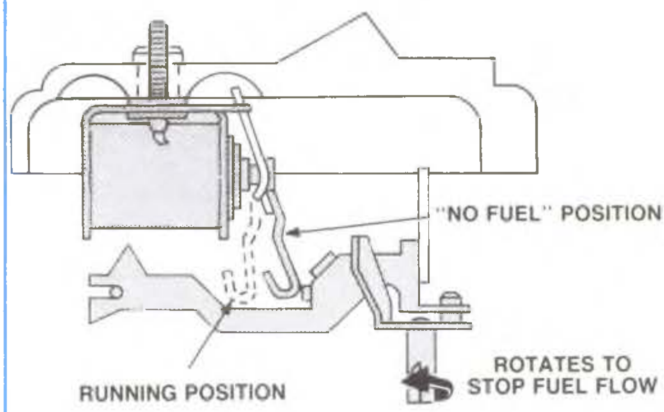


Figure 4-57, **Shutoff Solenoid.**

AUTOMATIC ADVANCE SYSTEMS

The speed advance device (Figure 4-58) is used to achieve best engine performance through the operating speed range of the engine. Timing advance is needed to compensate for the two delay periods: 1) the injection pressure wave traveling the length of the injection line, 2) the ignition delay period.

The injection timing advance system controls the start of injection proportional to pump speed. This is done by moving the cam ring opposite the direction of rotor rotation. The plunger rollers will then come in contact with the lobes on the cam ring earlier in the cycle.

The power advance piston engages the cam ring through the cam advance pin and moves the cam. Fuel under transfer pump pressure is fed through a passage in the hydraulic head, through the cam advance pin to the servo advance piston valve chamber. As transfer pump pressure is increased the servo advance piston valve uncovers a port which is connected to the advance piston, which advance the cam ring.

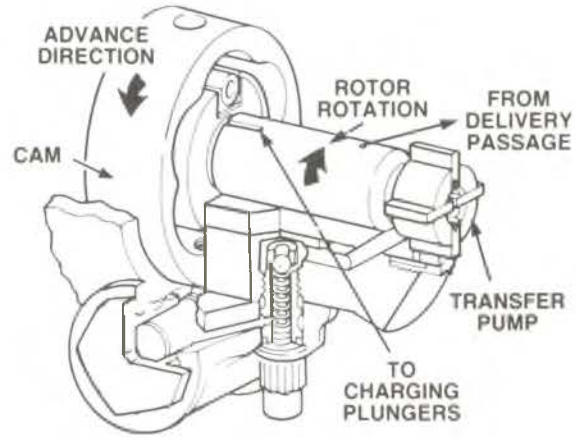


Figure 4-58, **Automatic Advance.**

Secondary control of the cam ring advance is by a mechanical connection from the throttle shaft thru a face cam and rocker lever to the servo advance piston valve spring seat. This secondary timing control results in injection timing better suited to engine demand.

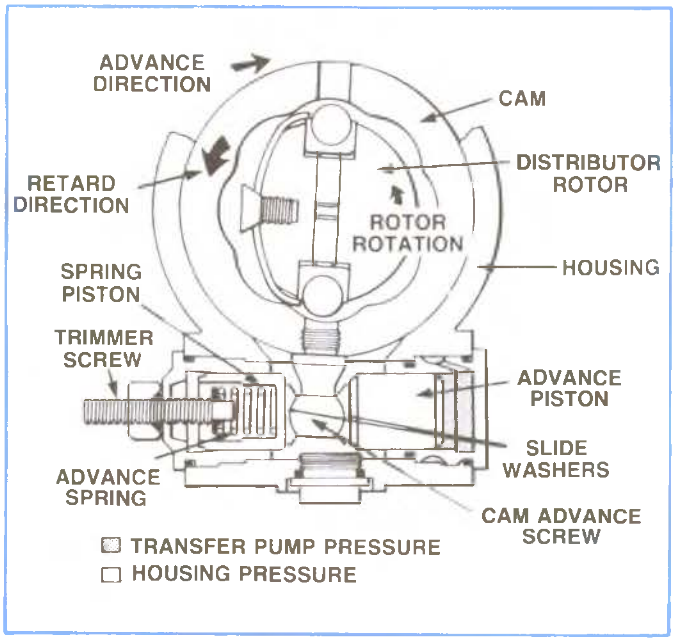


Figure 4-59, Power Side Forces.

AUTOMATIC ADVANCE LOADING FORCES

When the pump is operating, the force required to displace the plungers inward plus the momentum of the rotor assembly transmitted by the rollers, produces the cam loading force. This tends to turn the cam in the direction of rotor rotation. (Figure 4-59). This movement retards the pump's timing.

This cam loading plus spring force is transmitted to and opposes the power side forces. The combination of forces positions the advance mechanism at a definite point for each **full load speed.** At part load the reactive forces diminish and are not as effective in opposing power side forces. As a result the cam assumes a more advanced position.

LIGHT LOAD (PART THROTTLE) TIMING

The inlet metered DB2 pump (Figure 4-60) has a pumping period with a variable beginning and a constant ending. That is, at minimum throttle positions the metering valve is only open a small amount, so the plungers only move a small amount. And the rollers have to ride a great distance up the cam ramp before they can cause the plungers to pressurize the fuel. This causes retarded injection timing as compared to wide open throttle position (maximum metering valve opening). Because at WOT; plunger pressurization begins as the rollers start up the cam ramp, and peaks at the lobe. Therefore, timing must be advanced at light loads (part throttle) to compensate for this injection timing lag. The amount of light load retard is compensated by an inherent light load advance obtained from the mechanical light load advance.

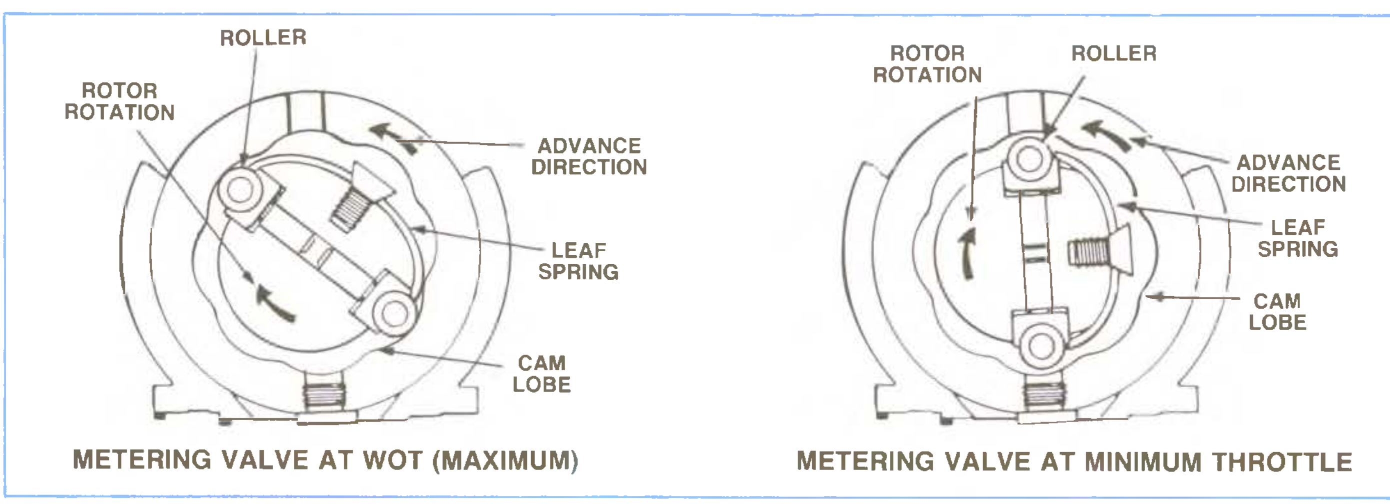


Figure 4-60, Cam Positioning.

SPEED AND LIGHT LOAD ADVANCE SYSTEMS

As noted previously, inlet metered pumps characteristically retard the start of pumping at light loads.

To correct this condition, several forms of light load advance have been developed, two of which are described below.

- The first of these, used in speed advance (used only in the 78-81 5.7L diesel), uses a smaller diameter advance piston to retard the full throttle advance curve with respect to the light load advance curve. The actual advance position at full throttle depends on the difference between the flow into the power piston chamber between pumping events and the reverse flow through the bleed orifice during the pumping event. The smaller diameter advance piston raises advance chamber pressure during the pumping event because of its small area. The flow rate through the bleed orifice is therefore increased. The smaller piston area also increases the advance motion for a given orifice flow change.

MECHANICAL LIGHT LOAD ADVANCE SYSTEM, 6.2L DIESEL

A second light load advance system, shown in Figure 4-61, is available for automotive applications that use min-max governing. In addition to the normal speed advance, light load advance is furnished as a function of throttle angle.

The mechanical light load advance system is used on automotive pumps. It relies on two systems to provide advance. The first system is a servo advance mechanism that is operated by transfer pump pressure and which positions the cam ring in response to throttle setting and engine load.

The second system is composed of a mechanical link between the throttle shaft and the servo plunger. This link is composed of a face cam connected to the end of the throttle shaft and a rocker lever assembly connected to the side of the pump housing by a pivot pin. A roller is attached to the upper end of the lever and rides on the surface of the face cam. The lower end of the lever contacts the protruding end of the servo advance plunger.

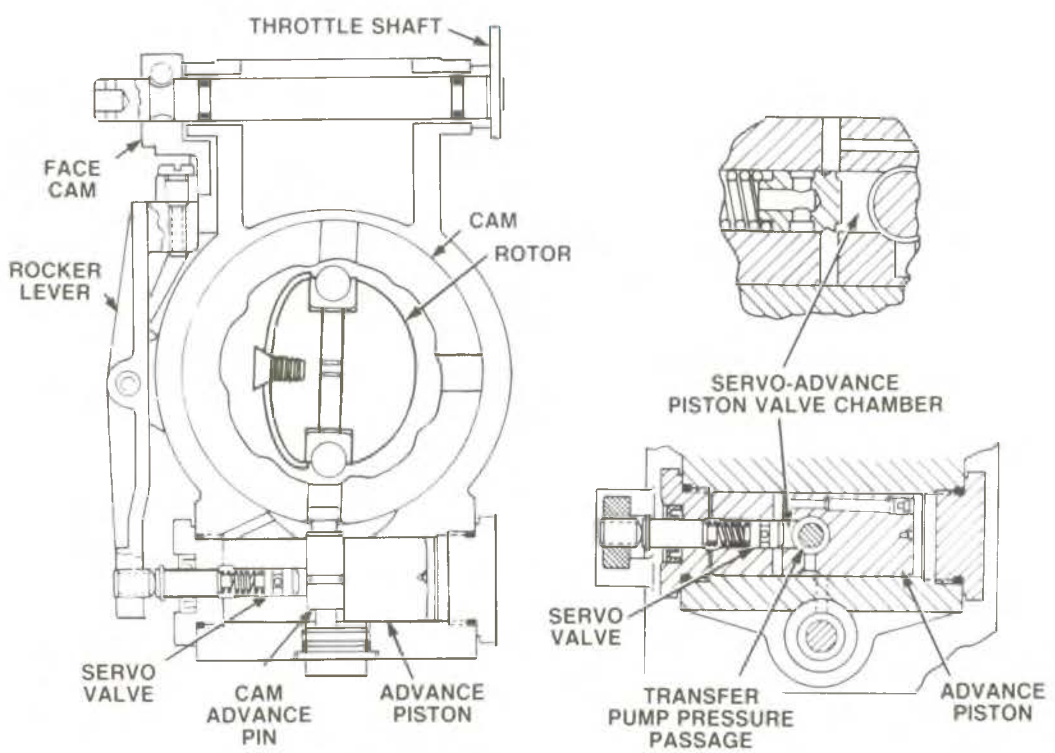


Figure 4-61, **Mechanical Light Load Advance.**

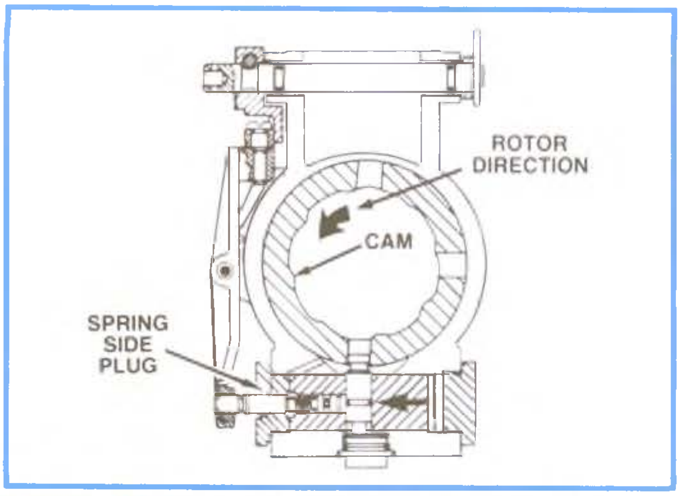


Figure 4-62, **Cam and Rotor Movement.**

MECHANICAL LIGHT LOAD ADVANCE OPERATION

As with the previous advance system, the rotor's force is transferred to the cam ring during injection. This force continually urges the piston toward the retard position. However, an opposing force is supplied by transfer pump pressure acting on one end of the servo advance piston. (Figure 4-62).

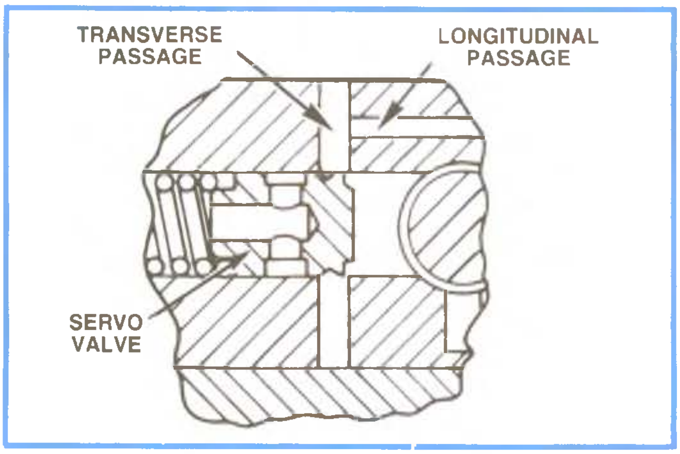


Figure 4-63, **Servo Valve Movement.**

The position of the servo valve in the advance piston bore regulates this force, and determines the degree of advance achieved at any throttle setting or load. (Figure 4-63).

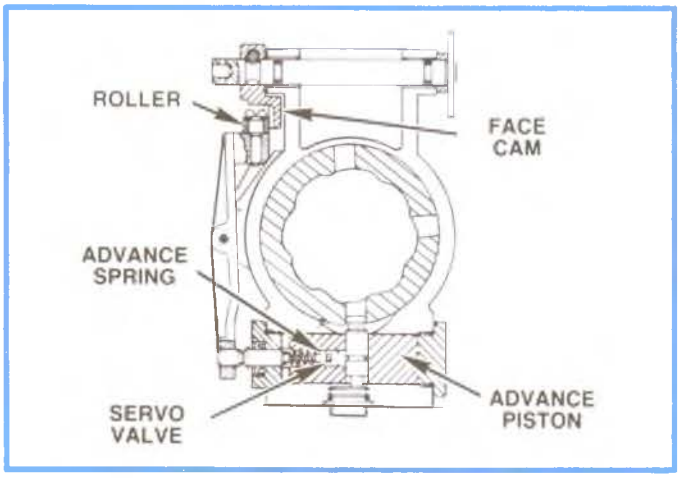


Figure 4-64, **Face Cam To Rocker Lever Action.**

Additional advance at low throttle settings is provided by the face cam to rocker lever action which changes the reference point of the spring. (Figure 4-64).

This allows the servo-advance valve to open further and provide a greater degree of advance at low throttle settings. The end result of both of these advance mechanisms is a vast improvement in the driveability of diesel equipped vehicles.

INTEGRAL ORIFICE ADVANCE PISTON

See Figure 4-65. The advance piston orifice screw has been eliminated, and the orifice is now machined into the piston. The orifice size in 1984 and later is .030 in. 1982-83 orifice size was a .040 in. orifice screw. Stanadyne part #24433 (2443405).

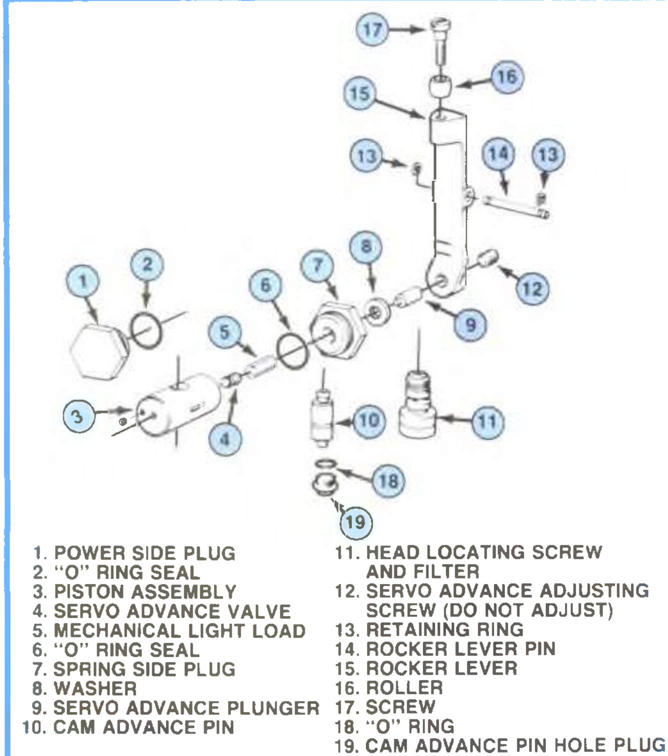


Figure 4-65, Advance Piston.

HEAD LOCATING SCREW AND FILTER ASSEMBLY

A new head locating screw (#24566) with nylon filter has been introduced to prevent contaminants from reaching the advance piston area. See Figure 4-66. The filter is installed into the body of the screw, the end of which is crimped over. The screw is only available as an assembly, as shown on the right, and is identified by a groove around the head of the screw. Suitable for use in all mechanical light load advance-type pumps.

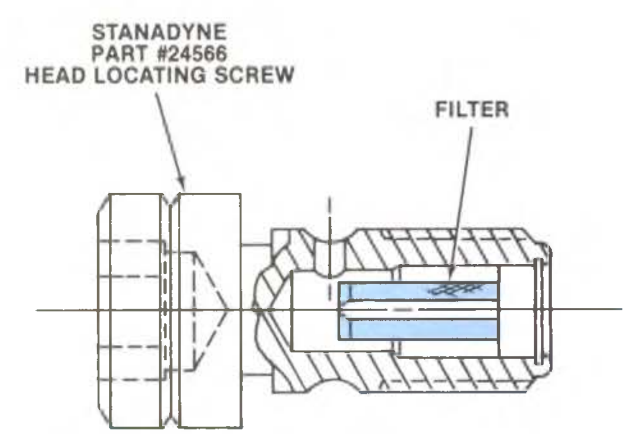


Figure 4-66, Head Locating Screw With Filter.

HOUSING PRESSURE COLD ADVANCE (H.P.C.A.)

All pumps are equipped with a Housing Pressure Cold Advance solenoid. (Figure 4-67).

This component has been designed to allow more advance during engine warm-up. It consists of a solenoid assembly and a ball check return connector, both in a redesigned governor cover. The electrical signal which controls the operation of the solenoid is generated by a sensing unit mounted on the rear of the right cylinder head.

1984 and later H.P.C.A. is controlled by a cold advance circuit (C.A.C.) relay.

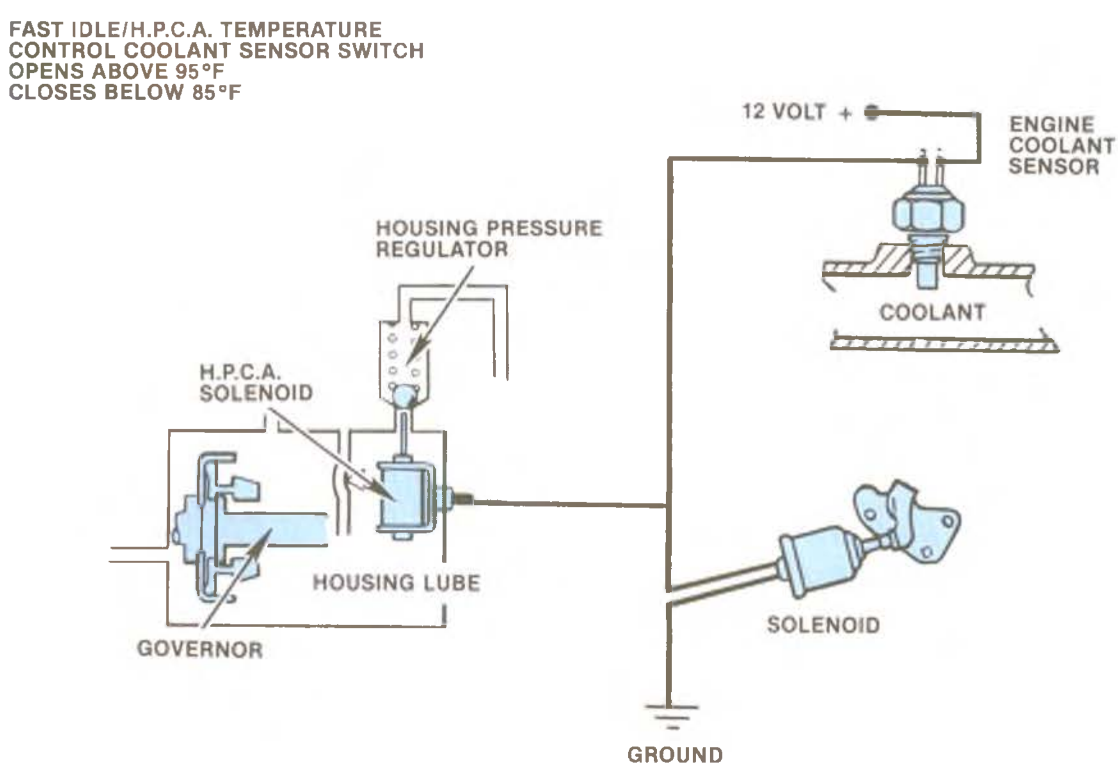


Figure 4-67, H.P.C.A. Solenoid Installation.

The switch is calibrated to open the circuit at 95°F for 83 and later (115° on 1982). Below the switching point, housing pressure is decreased from 8-12 psi to zero which advances the timing 3°. Above, the switch opens de-energizing the solenoid and the housing pressure is returned to 8-12 psi. The fast idle solenoid is energized by the same switch. The switch again closes when the temperature falls below 85°F (95°F on 1982).

PURPOSE:

1. Emission Control device.
2. Better cold starts.
3. Improves idle, reduces white smoke and noise when cold.

H.P.C.A. OPERATION

During cold warm-up conditions, the plunger moves up and the rod contacts the return connector ball. (Figure 4-68). When the ball is moved off of its seat, the housing pressure is reduced due to an increased flow through the connector. Because of lowered housing pressure, the resistance to the advance piston movement is less, and thus the piston can move further in the advance direction.

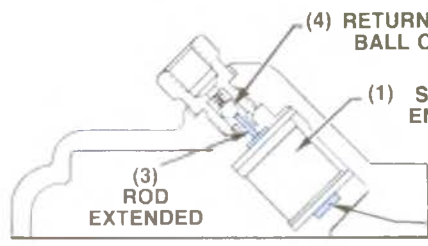


Figure 4-68, Solenoid Energized.

When the engine reaches normal operating temperature the electrical signal to the solenoid ceases, and the plunger is returned to its initial position. (Figure 4-69).

1984 H.P.C.A. Terminal will be changed (24669) because of 84 California System.

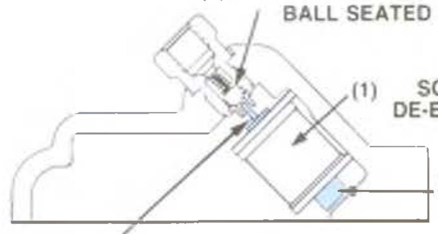


Figure 4-69, Solenoid De-Energized.

— NOTE —

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

MIN-MAX GOVERNOR

Now for a look at the operation of the assembly that controls the engine speed at low idle and high speed. The Min-Max governor.

Illustrated here (Figure 4-70) are the main components of the governor. They are the governor weights, the governor arm, the low idle spring, the idle spring guide, the main governor spring, the main governor spring guide and the guide stud.

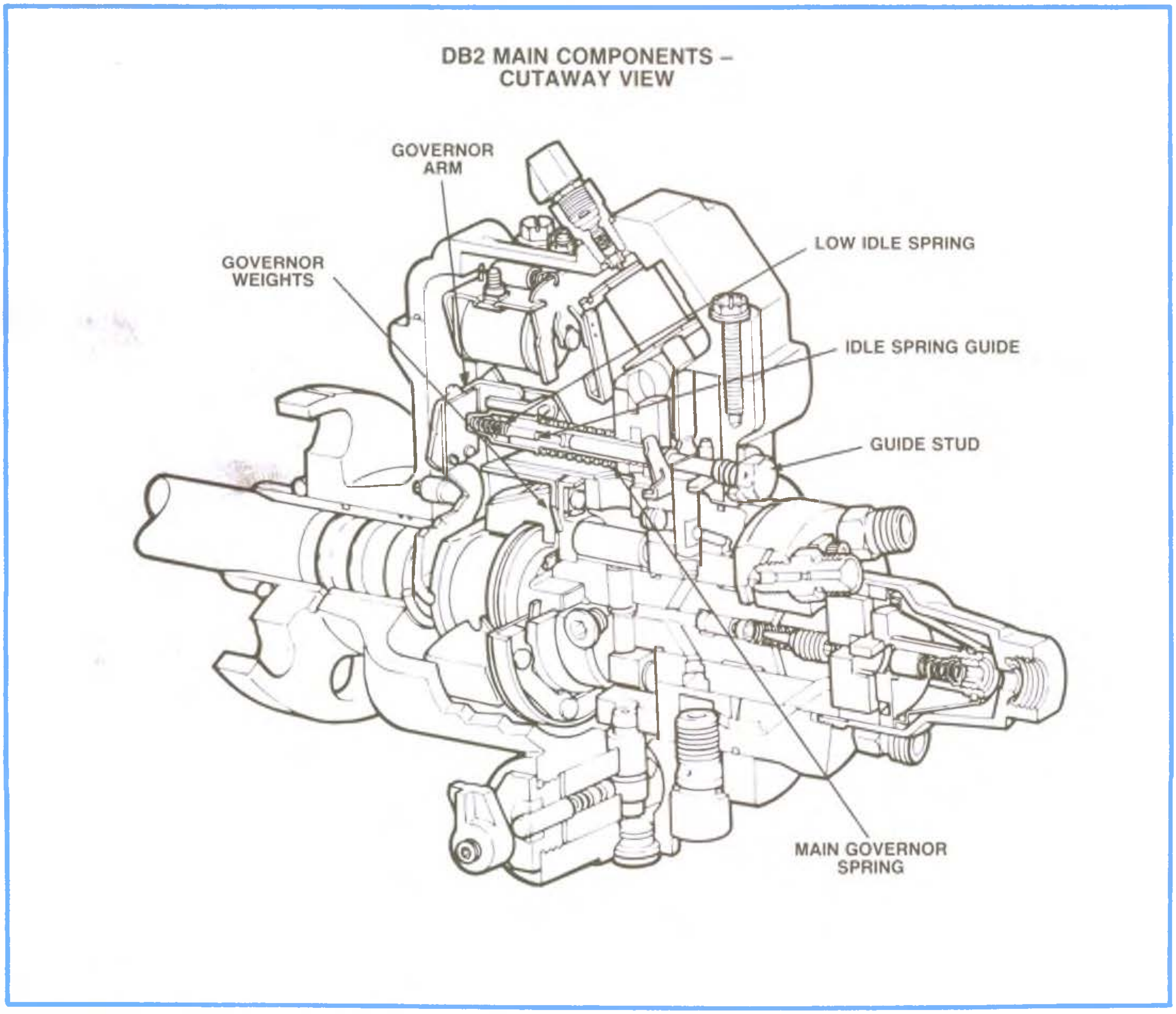


Figure 4-70, Governor Components.

Low Idle

Figure 4-71 shows the relationship of the parts when the pump is running at low idle. The low force developed by the governor weights is balanced by the low idle spring. Thus, only a small amount of fuel is delivered by the metering valve.

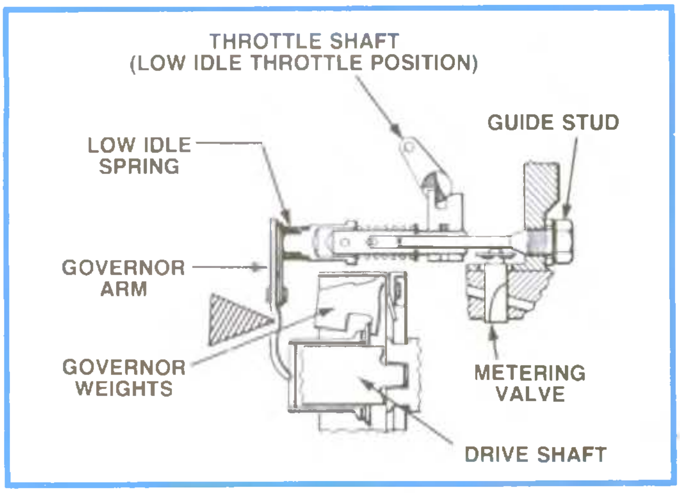


Figure 4-71, Governor at Low Idle.

Mid-Range

In Figure 4-72, the throttle is in a mid-range position. The idle spring is fully collapsed, and the governor weights have moved out partially. The main governor spring is designed such that the governor weight force cannot overcome the spring's preload until the engine reaches the maximum rated speed. Thus, at partial throttle, the assembly acts as a solid link against the governor arm. This permits the driver to control the metering valve position with the throttle over the entire mid-range speed.

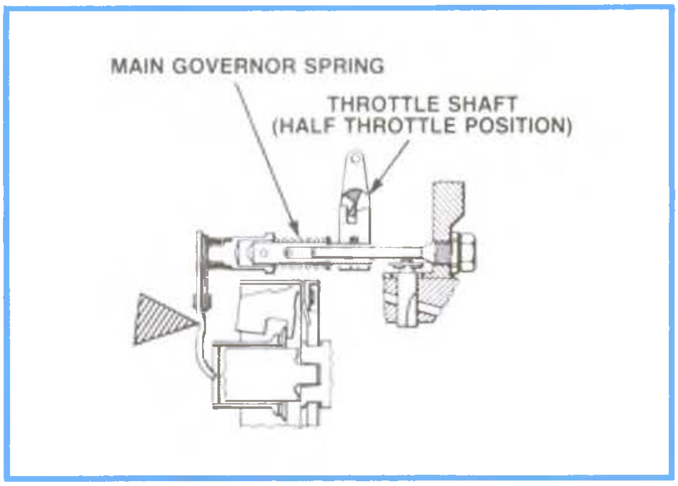


Figure 4-72, Governor at Mid-Range Throttle.

Full Load

With the throttle in the full load position, the engine speed and the pump speed increase until the governor weights have generated enough force to deflect the main governor spring. This movement turns the metering valve to the shut-off position, thereby preventing an engine overspeed condition. (Figure 4-73).

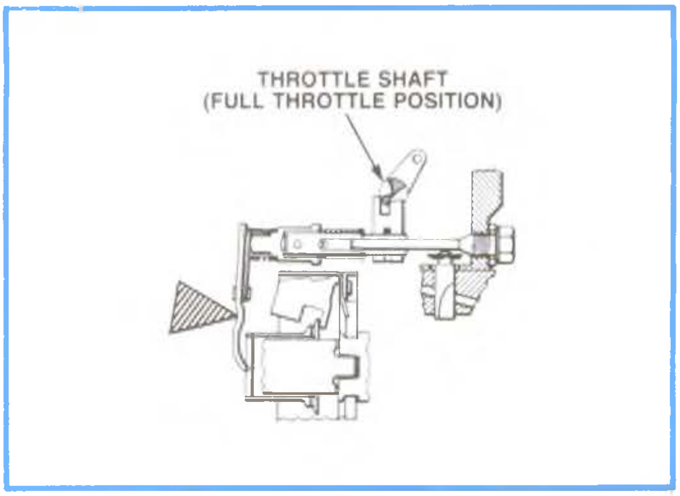


Figure 4-73, Governor at Full Load.

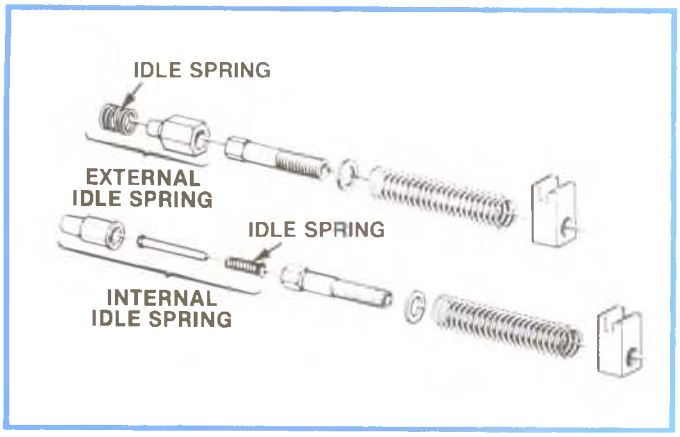


Figure 4-74, Internal Idle Spring Design.

INTERNAL IDLE SPRING

The 1984 and later 6.2L California applications use an internal idle spring, which controls the gap between the sleeve and the washer. (Figure 4-74). The close tolerance will result in a more accurate input to the engine throttle position sensor, which regulates the exhaust gas recirculation and exhaust pressure regulator functions.

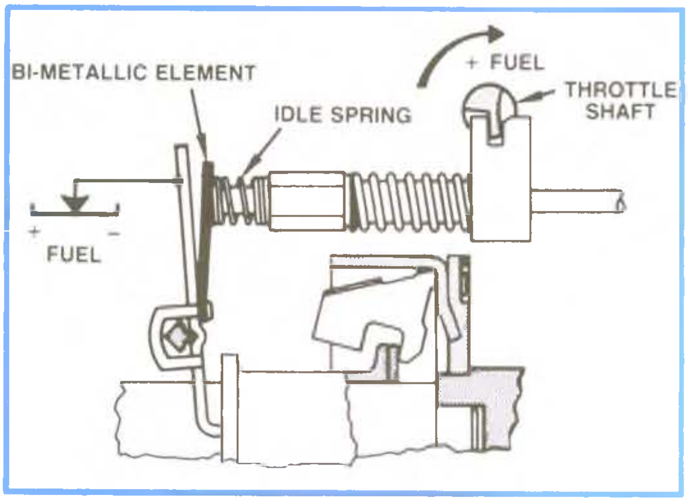


Figure 4-75, Bi-Metal Operation.

HOT FUEL IDLE SPEED DROP

When idle speed drops due to hot fuel, a bi-metal strip on the governor arm deflects. This creates a "spring load" on the governor arm causing it to rotate slightly, thus repositioning the metering valve to pass more fuel and increase speed slightly. (Figure 4-75).

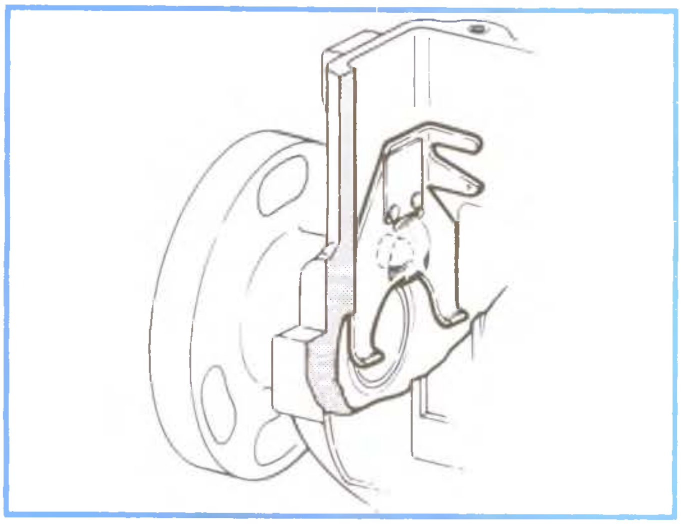


Figure 4-76, Ball Pivot Governor Arm.

GOVERNOR ARM 1982-84

See Figure 4-76. The 6.2L uses a ball-pivot governor arm which has a slot below the bi-metal strip. This prevents interference with the ball pivot conical extrusion. All governor arms of this style now have a tab at the bottom of the conical extrusion, for better retention. The bi-metal strip is covered by a .012" thick back-up leaf for wear resistance.

Injection Pump Rotor

The final component that we will examine is the heart of the diesel injection pump; the rotor. (Figure 4-77).

Due to the extremely close tolerances of the rotor and head assemblies, a thermal relief groove has been incorporated into the rotor design. Thermal shock can cause a head assembly to contract, resulting in the seizure of the head and rotor. To lessen the possibility of this happening, a reduction in the rotor diameter at the area between the ports has been added.

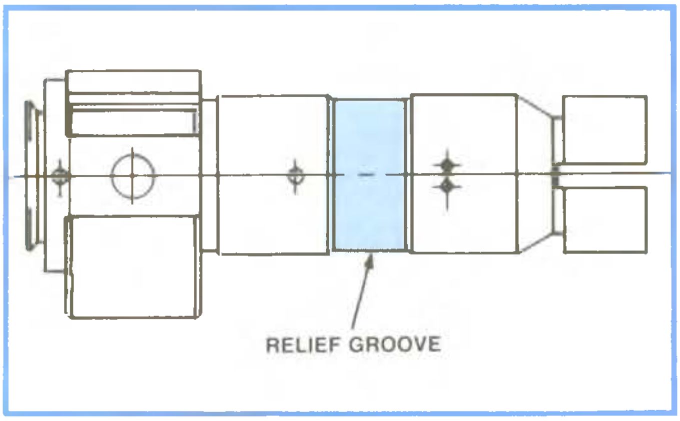


Figure 4-77, **Rotor.**

The rotor in 1980 through 1984 pumps incorporates residual pressure balancing ports. These small vent ports operate by simultaneously registering with the head discharge outlets shortly after each injection. This operation allows a balance of the residual pressures between injection lines and helps smooth out the operation and the sound of the engine.

ROTOR SEIZURES

A rotor seizure can be due to a loss of clearance between the hydraulic head and rotor during the transient (or warm-up) condition. Heat generated by shearing the oil film at the hydraulic head to rotor interface causes heating of the hydraulic head and rotor. Because the mass of the rotor is less than that of the hydraulic head, it heats and expands at a faster rate. The clearance at the interface of the hydraulic head and rotor is thereby reduced and the possibility of rotor seizure is introduced.

The rotor seizures in a test series occurred at the midpoint of the rotor length indicating that the maximum rotor heating and expansion occurred at the midpoint. Therefore, a relief groove was added to the diameter of the rotor, as shown in Figure 4-77 to minimize the potential for rotor seizure following a cold, high speed acceleration.

DELIVERY VALVE

The delivery valve rapidly decreases injection line pressure after injection to a predetermined value lower than that of the nozzle closing pressure. This reduction in pressure permits the nozzle's valve to return rapidly to its seat, achieving sharp delivery cutoff and preventing improperly atomized fuel from entering the combustion chamber.

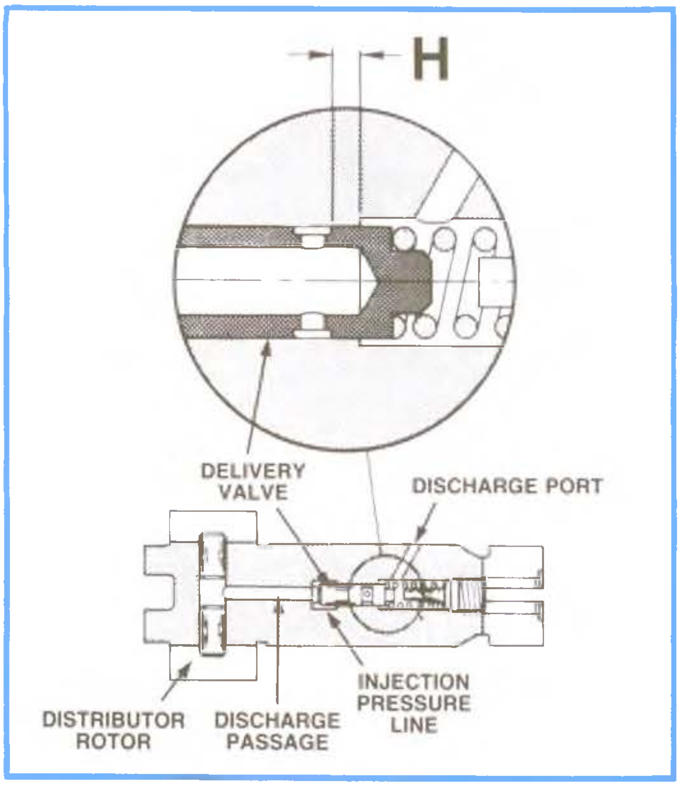


Figure 4-78, Delivery Valve.

DELIVERY VALVE OPERATION

A single, spring loaded, delivery valve (Figure 4-78) is located in the center of the DB2 pump rotor. It serves as a one way check valve to seal the pumping chamber from the injection line and also controls residual line pressure by providing volume unloading.

At the beginning of pumping, the delivery valve is displaced into its spring chamber until, at a valve lift equal to the dimension "H", fuel flows from the plungers to the discharge port. At the end of the pumping cycle, the plungers travel outward allowing the delivery valve to move toward its seat. As the valve closes and the retraction volume (Valve Area H) is removed from the delivery valve spring chamber, a negative pressure wave is propagated toward the nozzle. The negative pressure wave lowers the injection line pressure to allow rapid nozzle closure and prevents secondary injection.

The delivery valve operates in a bore in the center of the distributor rotor. The valve requires no seat — only a stop to limit travel. Sealing is accomplished by the close clearance between the valve and bore into which it fits. Since the same delivery valve performs the function of retraction for each injection line, the result is a smooth running engine at all loads and speed.

When injection starts, fuel pressure moves the delivery valve slightly out of its bore and adds the volume of its displacement to the delivery valve spring chamber. Since the discharge port is already opened to a head outlet, the retraction volume and plunger displacement volume are delivered under high pressure to the nozzle. Delivery ends when the pressure on the plunger side of the delivery valve is quickly reduced, due to the cam rollers passing the highest point on the cam lobe.

Following this, the rotor discharge port closes completely and a residual injection line pressure is maintained. Note that the delivery valve is only required to seal while the discharge port is opened. Once the port is closed, residual line pressures are maintained by the seal of the close fitting head and rotor. It is possible that the residual pressure may vary between injection lines.

TRAILING PORT SNUBBER

A damper orifice is located after the delivery valve. This damper is called a trailing port snubber (Figure 4-79).

The trailing port snubber is used to prevent secondary injections and cavitation errosion of the high pressure system by weakening reflected pressure waves. This port trails the discharge port radially and resonates the fuel back into the delivery valve cavity.

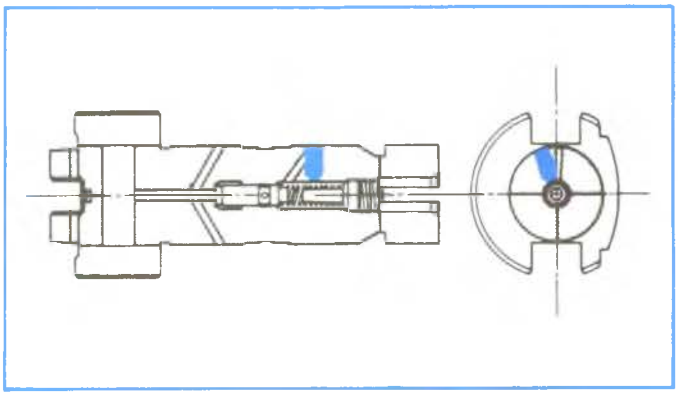


Figure 4-79, Trailing Port Snubber.

The snubber is drilled directly into the rotor bore and is reduced to .018″ in diameter at the bottom of the hole. Since it is located radially behind the discharge port, reflected pressure waves will re-enter the rotor after each injection. The flow rate into the delivery valve bore is then restricted by the .018″ orifice.

Phasing of the rotor snubber port in relation to the other port sequences must be carefully designed. This is especially true for an eight cylinder distributor pump where rotor angular space is at a premium.

The discharge cycle at each port is about 20 degrees. At the 15 degree point in the injection the snubbing begins for approximately 22 degrees.

In the oscilloscope traces (Figure 4-80) the reflected waves cause a needle lift in a system with a standard rotor. With an .018″ snubber port rotor, the pressure waves are reduced and the nozzle valve remains seated between injection.

This reduces the cavitation erosion potential. In addition, pressure waves reflected from the nozzle are partially, rather than totally, reflected as they pass through the snubber orifice.

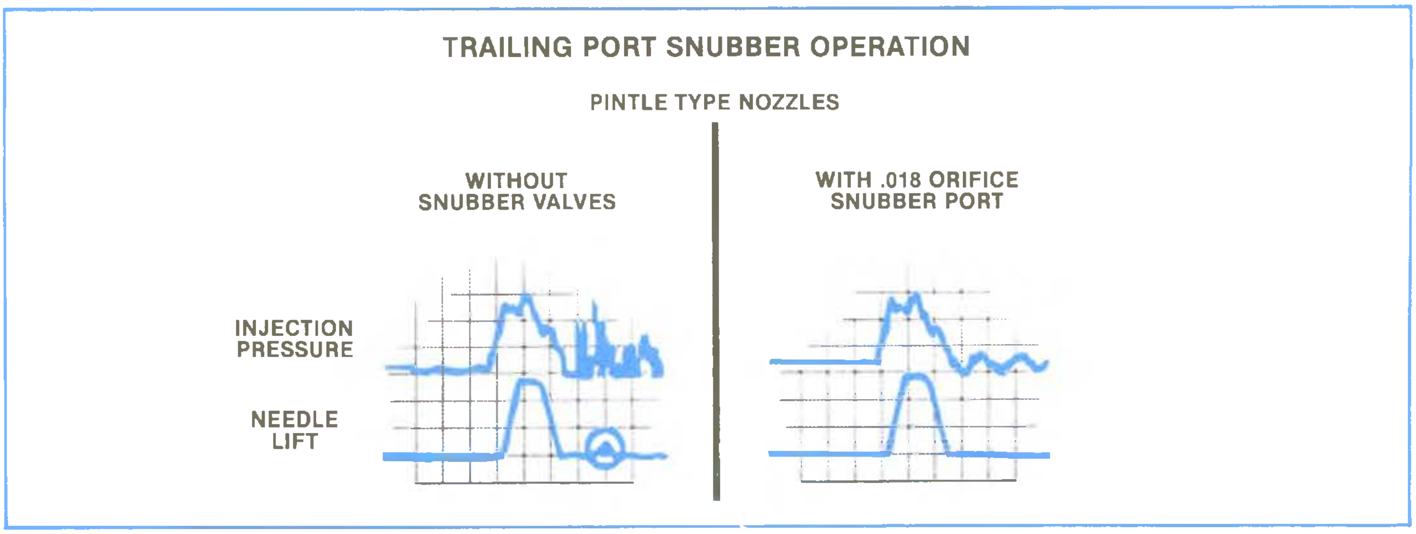


Figure 4-80, Trailing Port Snubber Graph.

Injection Pump Repairs

— NOTE —

The following procedure is not intended as a guide for complete overhaul. It does not include repairs which would involve calibration on a test stand. For operations which require re-calibration, the pump must be sent to an authorized Stanadyne agency.

Figure 4-81 shows a typical test stand installation. The test stand incorporates a 2 to 15 H.P. electric motor, depending on the particular model used, which drives the injection pump. The stand's motor simulates the automotive engine with the rpm controlled on the machine by the operator and not by the throttle opening. Various tests and adjustments are performed. Some are: Electric solenoid pull-in voltage, housing pressure cold advance solenoid operation, face cam position, min-max governor, return oil volume, housing pressure, transfer pump pressure and automatic advance adjustments. Actual calibration of fuel delivery is not adjustable within the head and rotor assembly but is affected directly by some of the above adjustments. Various rpm ranges and throttle openings are used to check output of the pump.

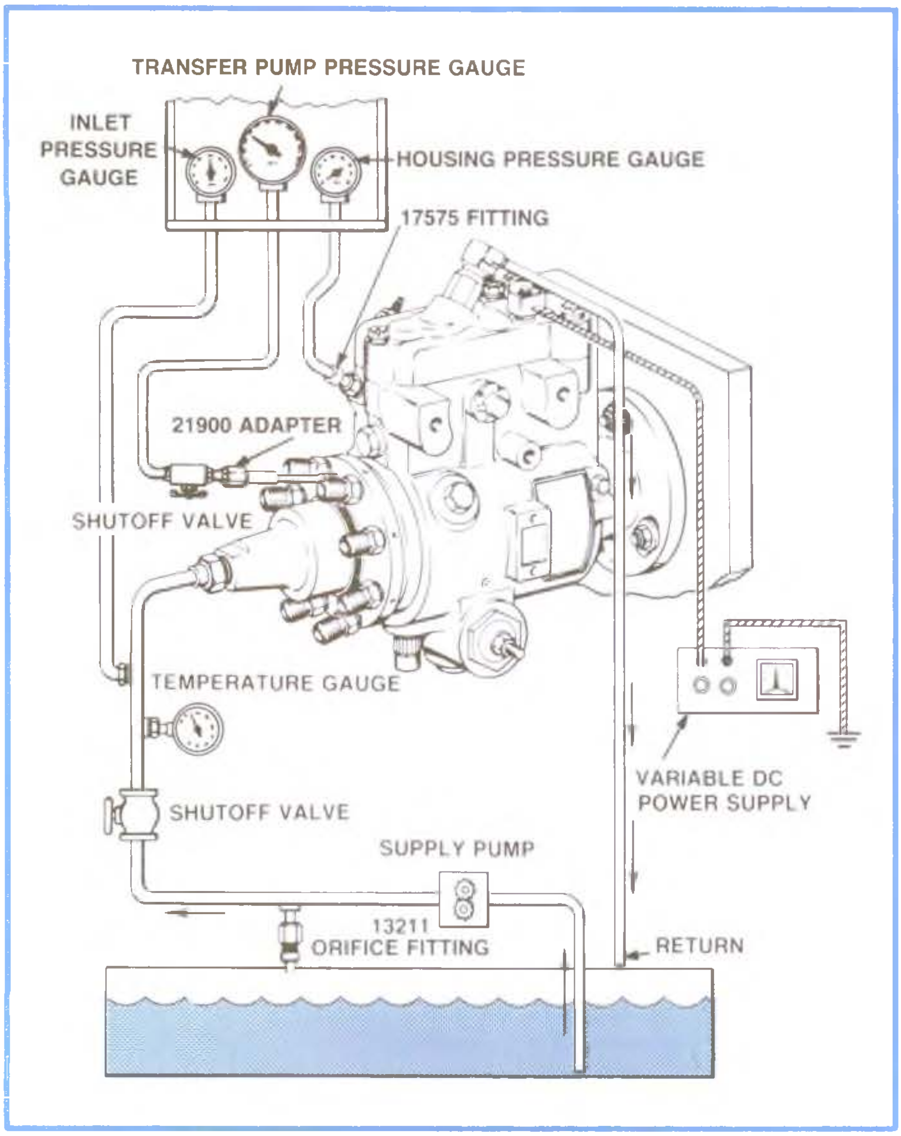


Figure 4-81, Typical Test Stand Installation.

— IMPORTANT —

It should be understood that the injection pump is designed to deliver a metered amount of fuel at the proper time and is therefore incapable of delivering a rich or lean mixture. It should also be understood that other than a failure of the governor weight retainer ring or the correction of the min-max governor, the injection pump will have very little to do with a rough idle condition and therefore generally should not be sent to the local Roosa Master shop for rough idle.

GOVERNOR WEIGHT RETAINER RING FAILURES

Background information of failed governor weight retainer ring: diesel fuel that is contaminated with excessive water or the presence of alcohols found in some additives not normally present in recommended diesel fuels may accelerate failure of the Poly-urethane (Pellethane) governor weight retainer ring in the injection pump. Failure of the ring is heat related and will most likely result in a rough idle condition and, in some instances, the engine may not run. A failed ring will break apart into small black particles plugging the fuel return check valve. Remove the check valve if small particles are observed. Confirm the findings by removing the pump cover and rotating the governor weight retainer in both directions (Figure 4-82) using a suitable tool or screwdriver. If the retainer moves more than 1/16″ and does not return, the retainer ring has failed. Normally a failed ring will allow 1/4″ free movement.

If a failed ring is found, the pump will require removal from the engine. Follow the procedures listed in this manual for replacement.

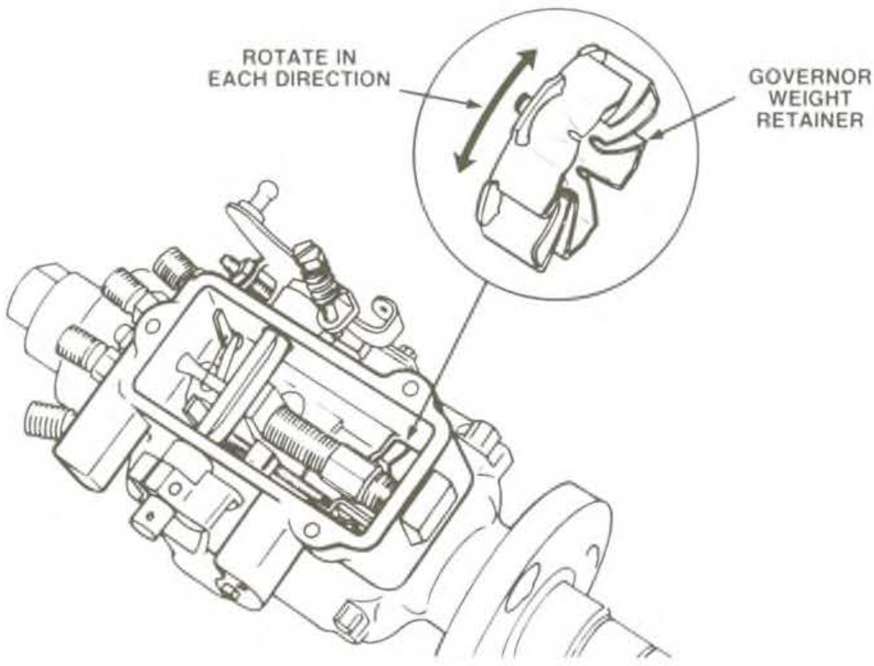


Figure 4-82, **Failed Governor Weight Retainer Ring Checking Procedure.**

SERVICE OPERATIONS ON-VEHICLE

Operations which can be performed individually without removing the pump from the engine are as follows:

- Cover seal replacements
- Guide stud seal replacements
- Throttle shaft seal replacements
- Governor weight retainer ring checking procedure
- Min-Max governor service

The procedure that follows include disassembly, various seal replacements, installation of the pellethane governor weight retainer ring, and a bench leak test.

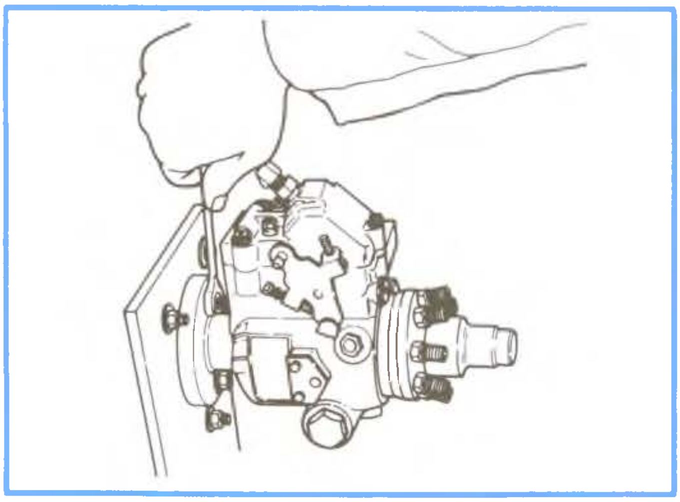


Figure 4-83, **Mounting Pump in Fixture.**

Mounting in Holding Fixture

Mount the pump in the holding fixture, Tool #J-29692B (BT 8046). Always use the fixture to avoid damage to the pump. NEVER MOUNT THE PUMP DIRECTLY IN A VISE. (Figure 4-83).

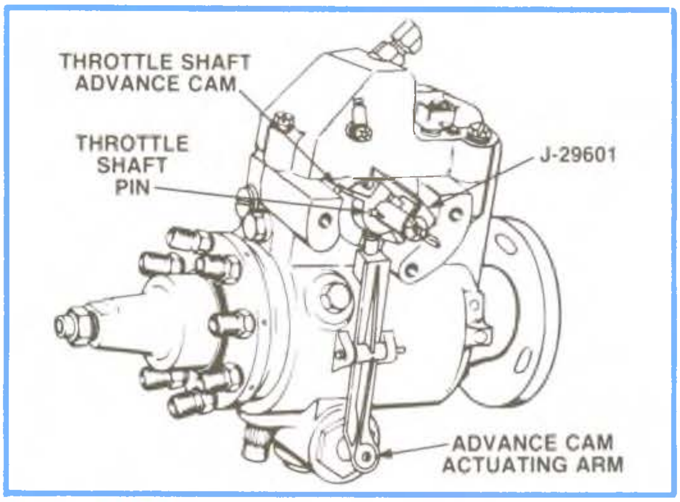


Figure 4-84, **Face Cam Tool J-29601.**

See Figure 4-84. Rotate the throttle lever to the low idle position and install Tool J-29601 over the throttle shaft with slots of tool engaging pin. Put the spring clip over the throttle shaft advance cam and tighten the wing nut. Without loosening the wing nut, pull the tool off the shaft. (This provides the proper alignment on reassembly).

GOVERNOR COVER

Unscrew the three governor cover hold down screws and remove the governor control cover and cover gasket. (Figure 4-85).

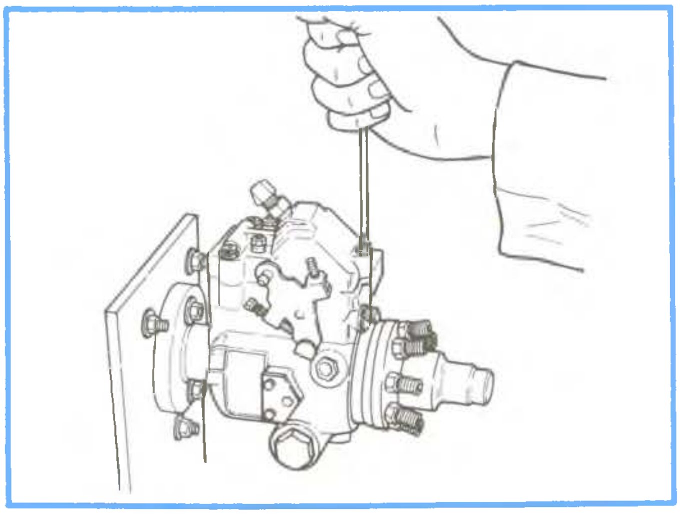


Figure 4-85, **Removing Governor Cover.**

SOLENOIDS

Examine the electric shut off solenoids (Figure 4-86) and the housing pressure cold advance solenoid if so equipped, for damage or debris. Clean the solenoids with compressed air. Solenoid plungers should move freely in their bores.

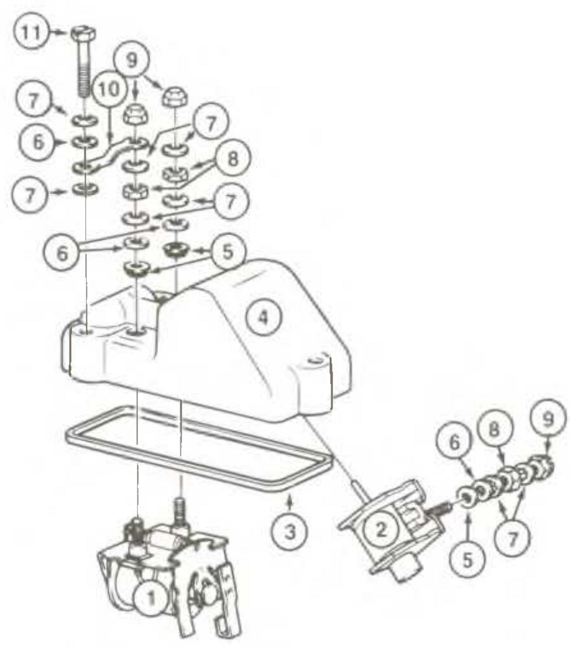


Figure 4-86, **Solenoids.**

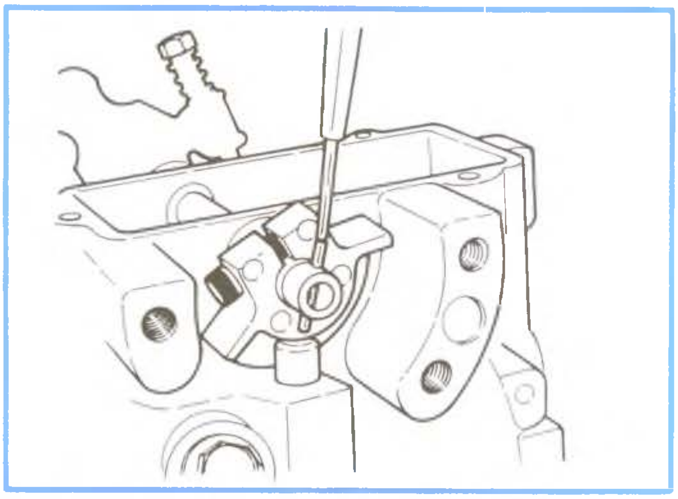


Figure 4-87, Removing Pin From Shaft.

Remove the drive pin from the throttle shaft using the appropriate drift punch. (Figure 4-87).

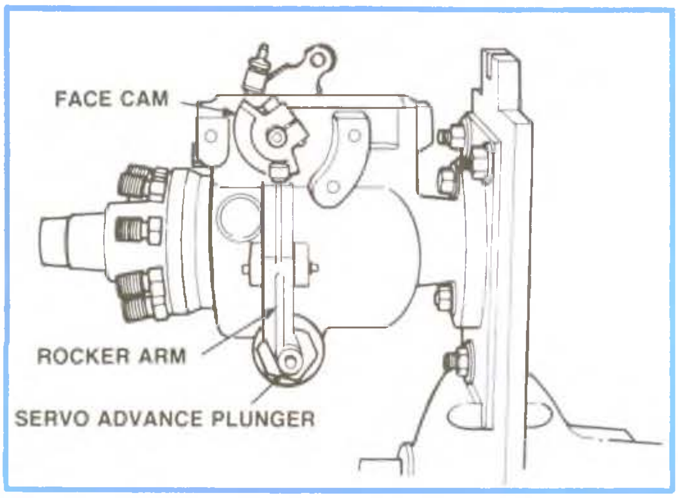


Figure 4-88, Rocker Arm and Face Cam.

LIGHT LOAD ADVANCE ROCKER ARM AND FACE CAM

All mechanical light load advance pumps are equipped with a rocker arm, which contact the servo advance plunger at one end and a face cam which is located on the throttle shaft at the other end. (Figure 4-88).

Pry off the retaining rings from the rocker lever pin and discard the rings. (Figure 4-89).

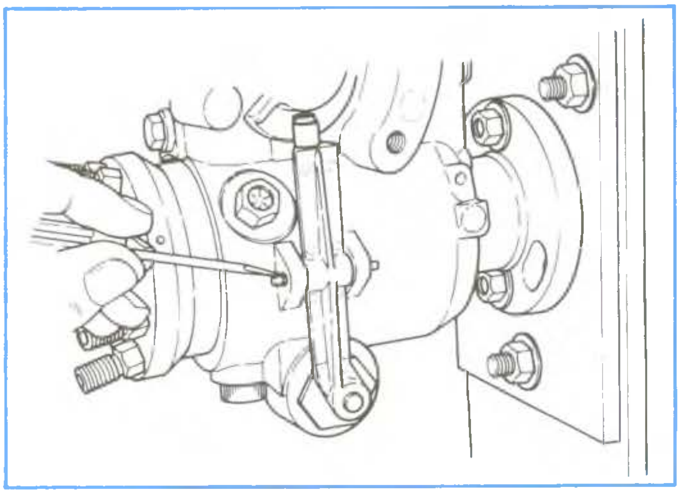


Figure 4-89, **Removing Retaining Rings.**

Push out the pin and remove the lever assembly. (Figure 4-90).

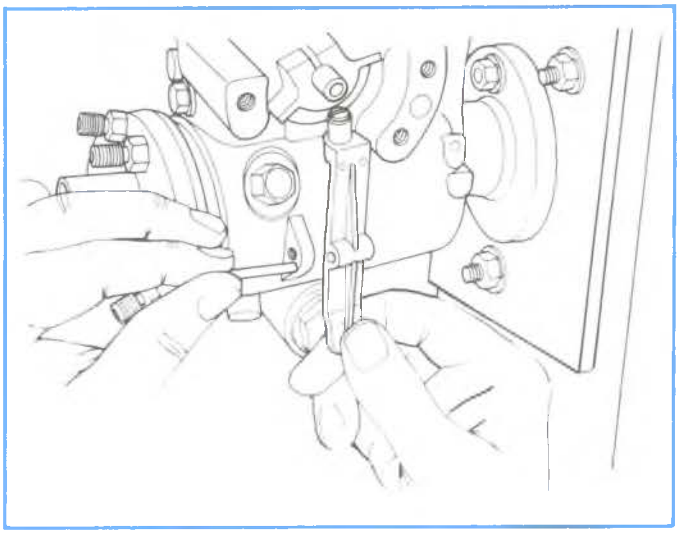


Figure 4-90, **Removing Lever Assembly.**

Face Cam Removal

Loosen the face cam screw, using a 5/32″ hex bit, or #27 Torx bit. The screw must be fully withdrawn to allow for removal of the face cam. (Figure 4-91).

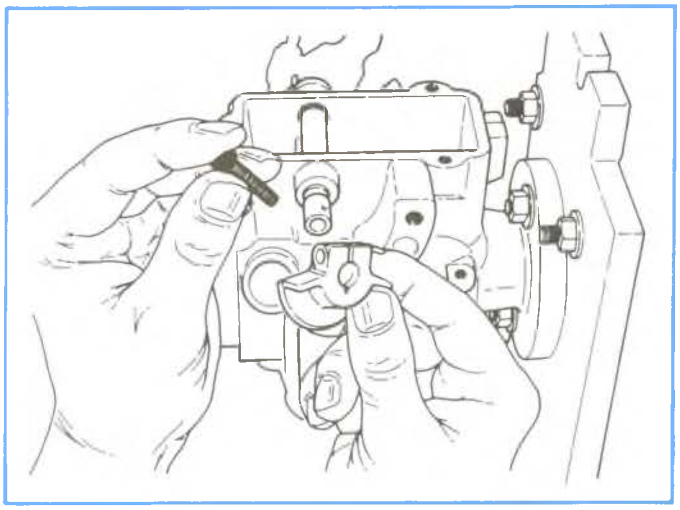


Figure 4-91, **Removing Face Cam.**

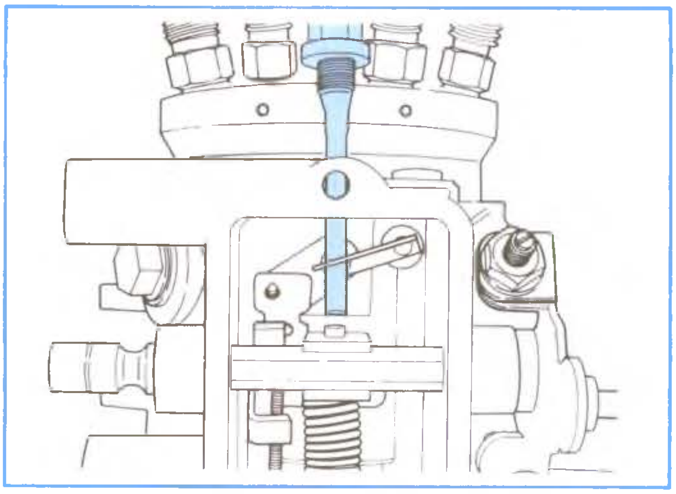


Figure 4-92, Loosening Guide Stud.

Guide Stud

Using a 7/16″ open end wrench or a ¼″ Allen, loosen and withdraw the guide stud. (Figure 4-92).

Observe position of metering valve spring over the top of the guide stud. This position must be exactly duplicated during reassembly. Remove guide stud and washer.

— NOTE —

Two types of guide stud and washer combinations are in use:

- **The current combination is a guide stud with a 1/4 inch internal hex and utilizes a steel washer with trapped elastomer.**
- **The other combination has a 7/16 inch external hex and an aluminum washer. This type of washer must be replaced during reassembly. The correct guide stud and washer combination must be used to prevent fuel leakage.**

Governor Spring Components

While holding the Min-Max assembly between the thumb and forefinger, rotate the throttle and lift out the governor spring components. (Figure 4-93).

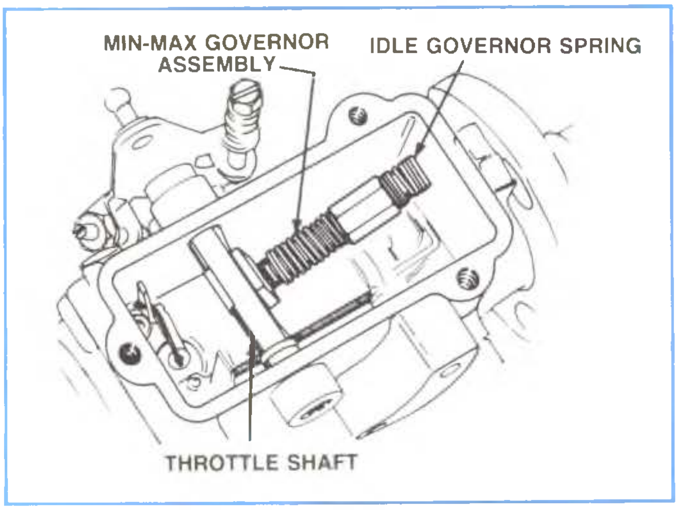


Figure 4-93, **Removing Governor Spring.**

Throttle Assembly

Now, simply pull the throttle shaft assembly through the housing. Remove the mylar washer and O ring seals from the throttle shaft. (Figure 4-94).

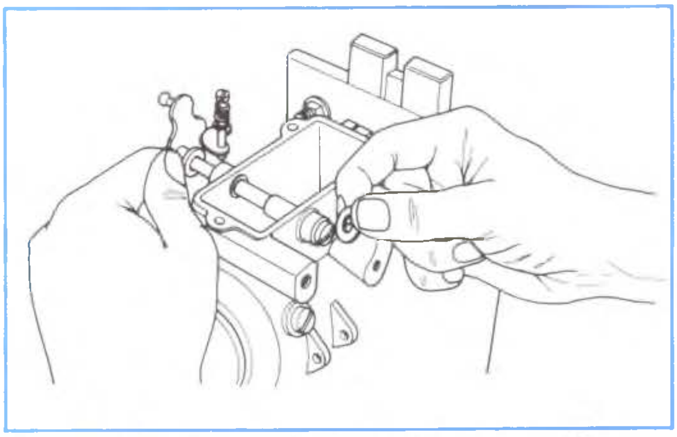


Figure 4-94, **Removing Throttle Assembly.**

Linkage Hook

While depressing the metering valve assembly raise the linkage hook from the metering valve arm. (Figure 4-95).

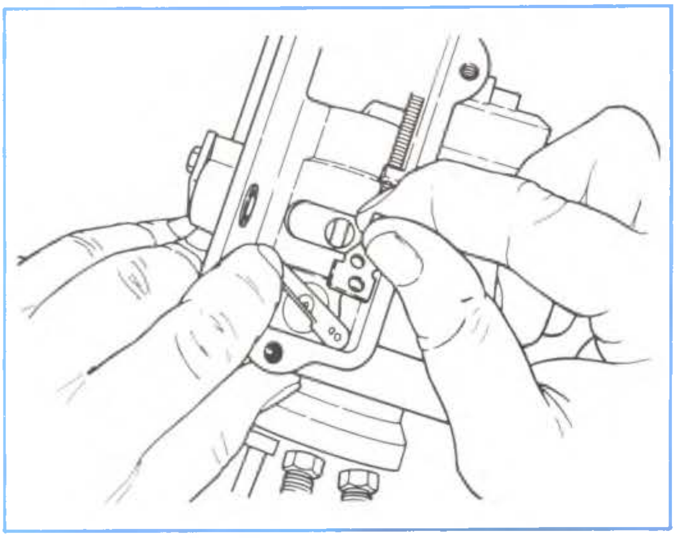


Figure 4-95, **Disengaging Linkage Hook.**

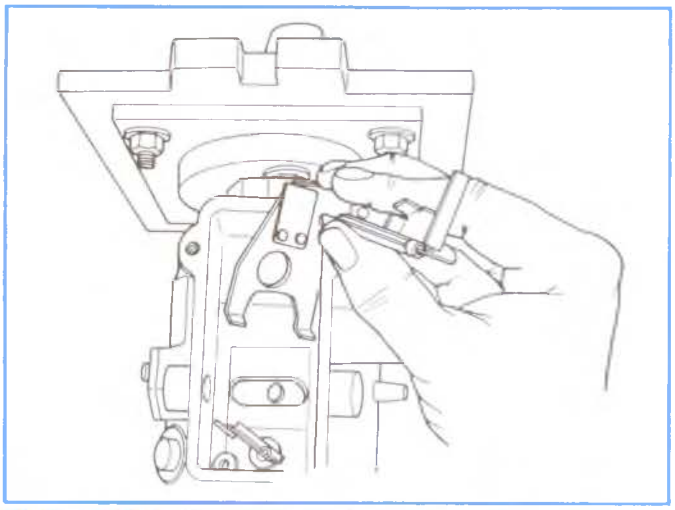


Figure 4-96, **Removing Governor Arm and Linkage (Late Model).**

Governor Arm and Linkage (Late Model)

The governor arm and linkage assembly may be removed as a single unit. (Figure 4-96).

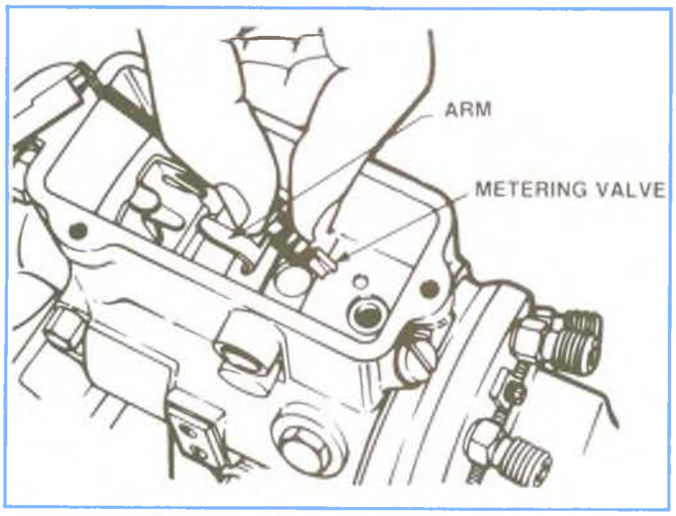


Figure 4-97, **Removing Metering Valve.**

Metering Valve

Remove the metering valve assembly. (Figure 4-97).

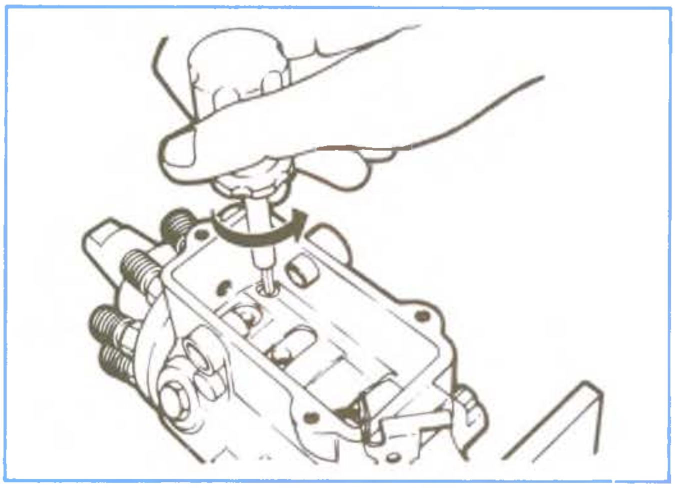


Figure 4-98, **Removing Vent Wire Assembly.**

Vent Wire Assembly

Remove the vent wire screw assembly, using a 1/8″ Allen wrench. (Figure 4-98).

End Cap Locking Screw

Loosen and remove the transfer pump end cap locking screw, plate and seal from the hydraulic head. (Figure 4-99).

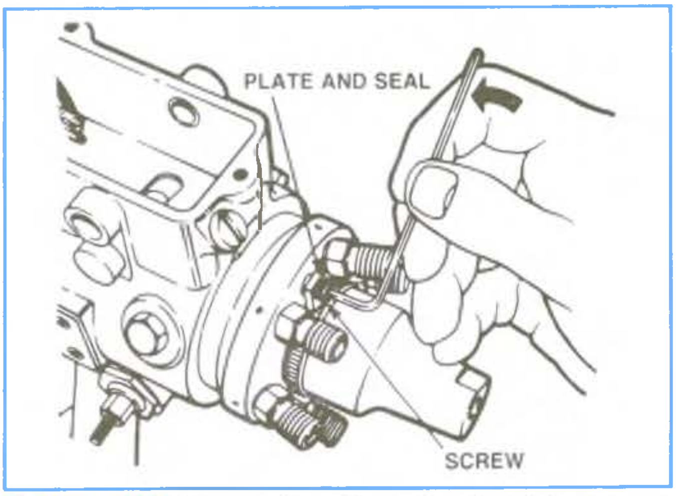


Figure 4-99, Removing End Cap Locking Screw.

> **— NOTE —**
>
> **The following 4 procedures are optional, and are used to replace the end cap seal, if it is found to be leaking.**

Transfer Pump End Cap

In a counterclockwise direction, loosen and remove the transfer pump end cap assembly, using the appropriate end wrench. (Stanadyne Tool #20548, Figure 4-100).

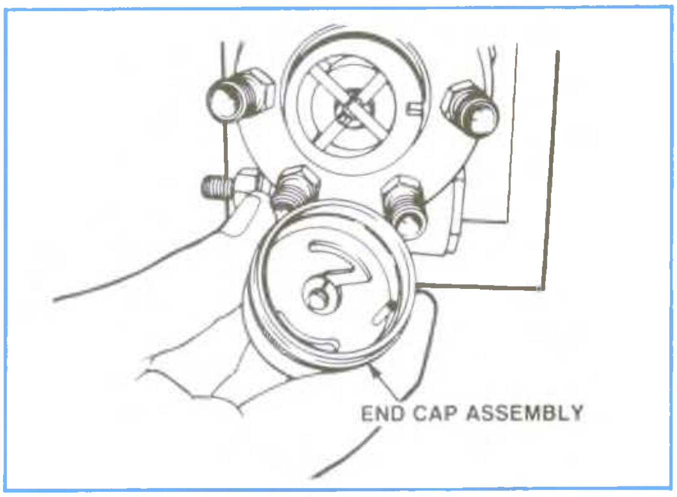


Figure 4-100, Removing End Cap.

Regulator Assembly

See Figure 4-101. With the end cap assembly removed, remove the transfer pump regulator assembly.

> **— NOTE —**
>
> **Do not remove the transfer pump blades and liner, unless they fall out.**

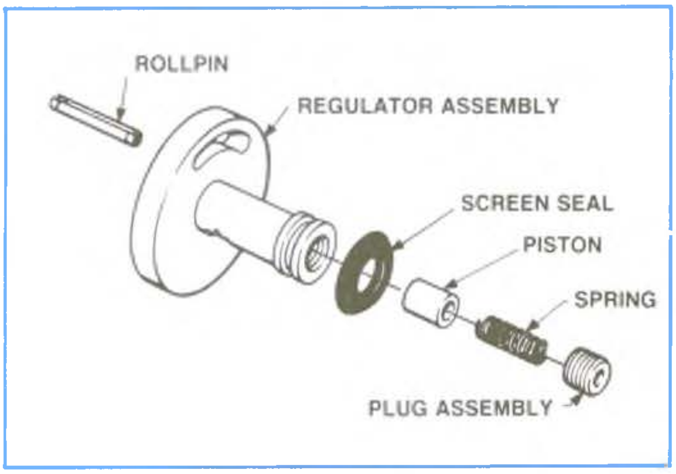


Figure 4-101, Regulator Components.

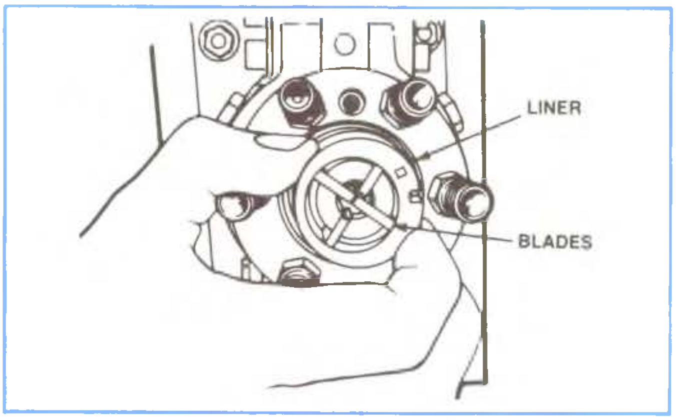


Figure 4-102, **Removing Transfer Pump Blades and Liner.**

Transfer Pump Blades and Liner

See Figure 4-102. If the liner and blades fall out, note on which side the "potmark" is located on the liner.

Also identify which slots in the rotor each blade comes from and mark them with Dykem stain, Stanadyne Part #18836.

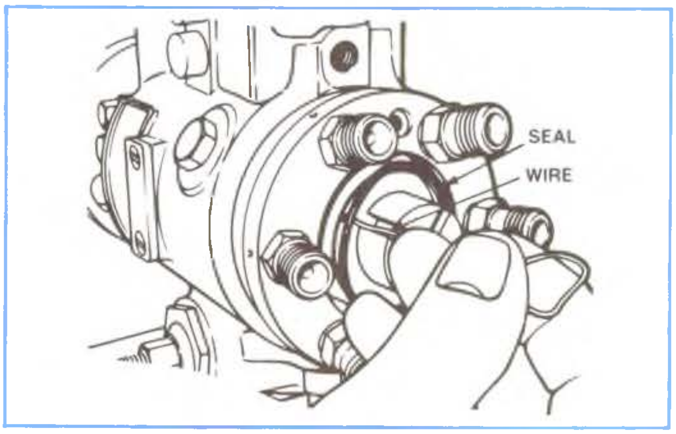


Figure 4-103, **Removing Seal.**

End Cap Seal

Remove the transfer pump end cap seal. (Figure 4-103).

Head Screws

Loosen the head locking screws and remove one screw. (Figure 4-104, left).

Carefully invert the pump and holding fixture in the vise, and remove the head locating screw. (Figure 4-104, right).

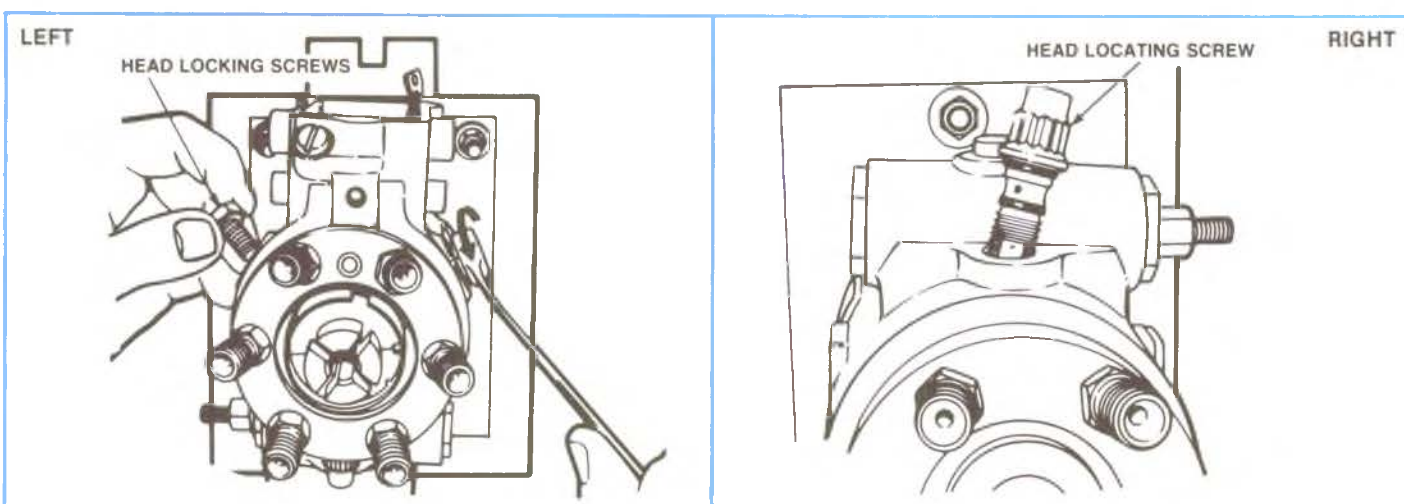


Figure 4-104, **Removing Head Screws.**

Servo Advance Plunger and Piston — Mechanical Light Load Advance

Remove the servo advance plunger. (Figure 4-105, Left).

Using a one inch socket and breaker bar, loosen and remove the spring side piston hole plug. (Figure 4-105, Right).

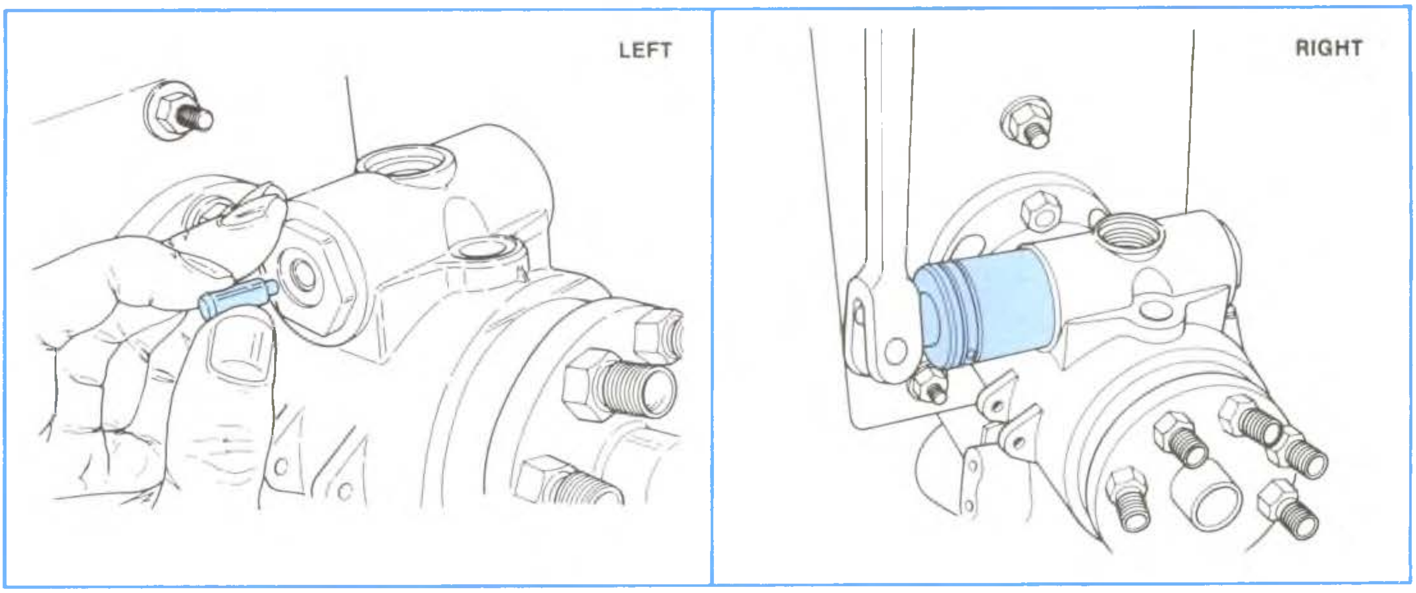


Figure 4-105, Removing Servo Advance Plunger and Piston Hole Plug.

Remove the mechanical light load advance spring and servo advance valve from the advance piston. (Figure 4-106, Left).

Next, remove the power side advance piston hole plug. (Figure 4-106, Right).

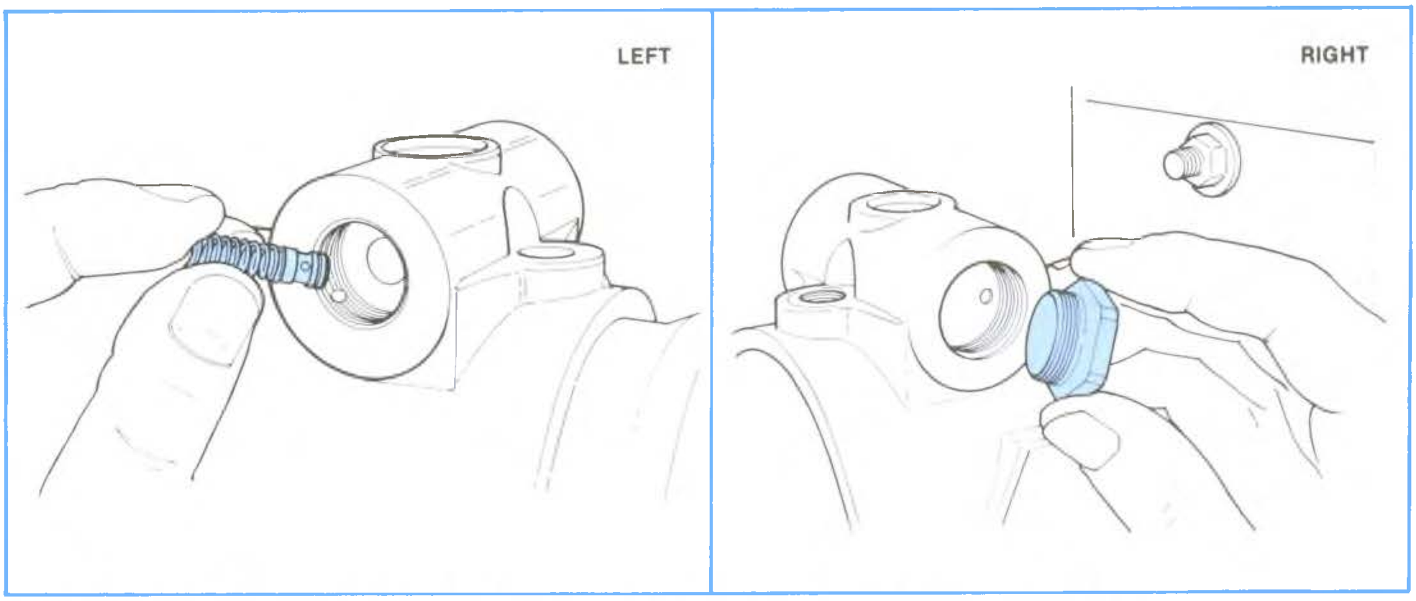


Figure 4-106, Removing Spring and Valve (Left) and Power Side Plug (Right).

Using needle nose pliers, carefully remove the cam advance pin from the advance piston. (Figure 4-107, Left). Now remove the advance piston from its housing bore. (Figure 4-107, Right).

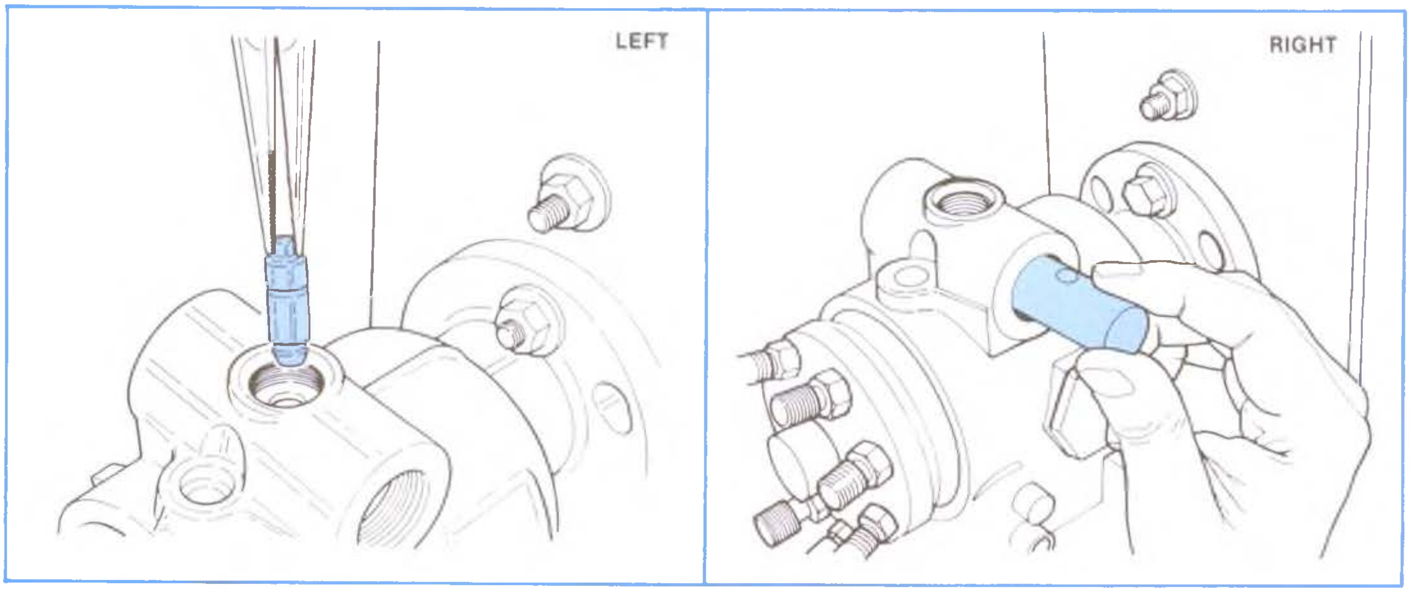


Figure 4-107, Removing Cam Advance Pin and Advance Piston.

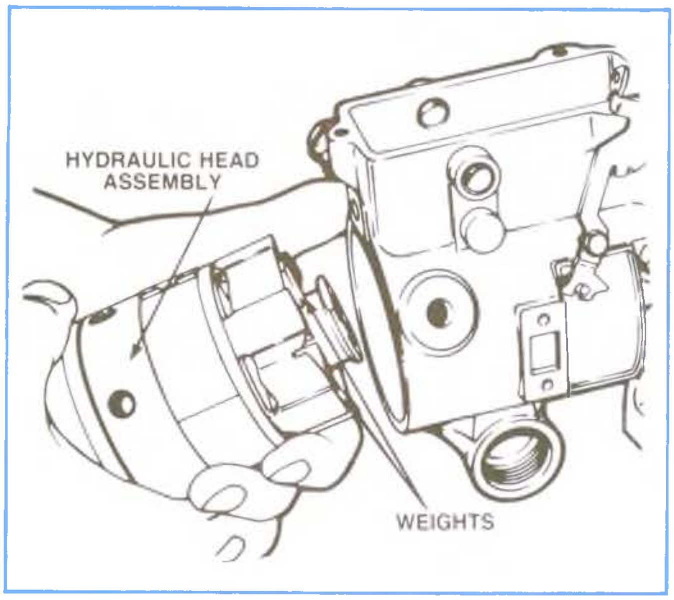


Figure 4-108, Removing Hydraulic Head Assembly.

Hydraulic Head Assembly

Return the pump and holding fixture to its initial position with the rear of the hydraulic head tilted slightly downward, and remove the remaining head locking screw. Remove the hydraulic head assembly by grasping with both hands and withdrawing with a slight rotary motion. (Figure 4-108).

Governor Weights

To disassemble the governor, simply invert the hydraulic head and let the weights, governor thrust sleeve and washer fall into your hand. (Figure 4-109).

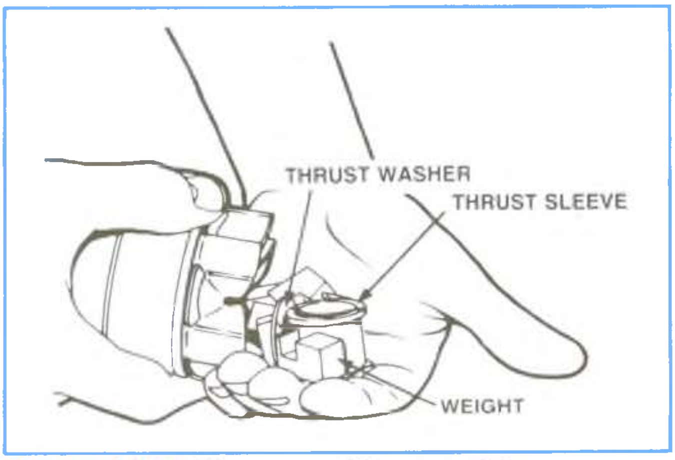


Figure 4-109, Governor Disassembly.

Weight Retainer

Carefully invert the head and rotor assembly, supporting it on the discharge fittings. Use care to avoid dropping the rotor from the hydraulic head. Using Stanadyne tool #13337 07 Tru-Arc Snap Ring Pliers, remove the snap ring holding the retainer assembly to the rotor. (Figure 4-110, Left).

Then remove the weight retainer assembly from the rotor. (Figure 4-110, Right).

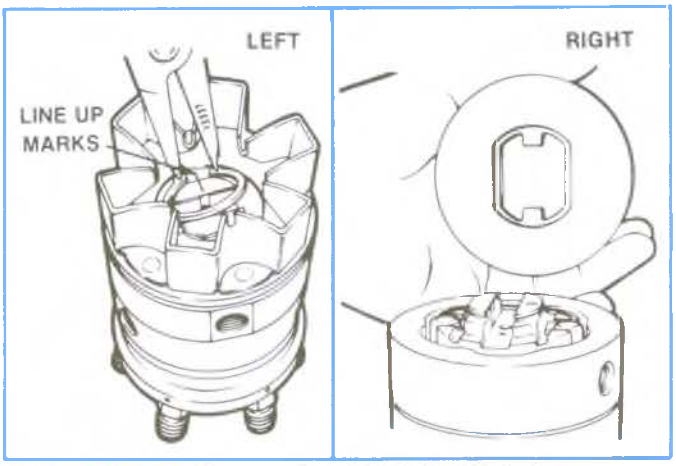


Figure 4-110, Removing Weight Retainer.

— NOTE —

The pump drive shaft is retained with either an "O" ring or a retaining clip (ring). Drive shafts with "O" rings, on late 1984 and later, use a rotating motion and pull out the shaft. Make certain that no pieces of the "O" ring have broken off and still remain in the pump. Remove and discard all drive shaft seals.

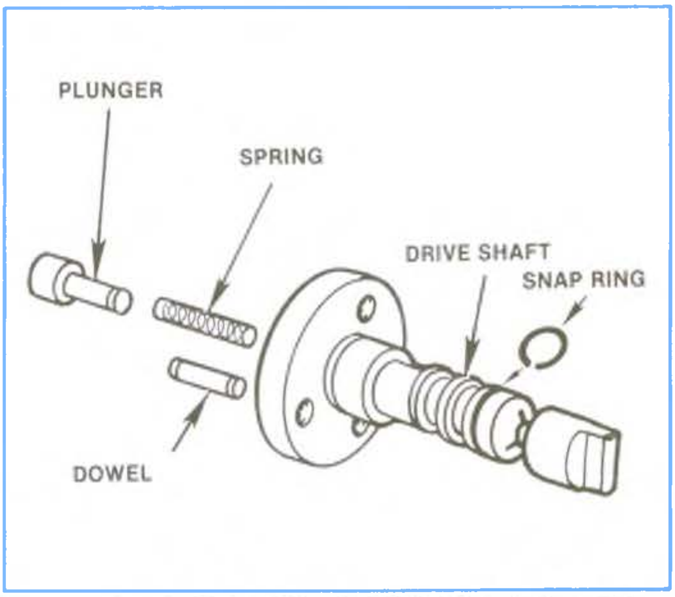


Figure 4-111, Drive Shaft With Retaining Clip.

— NOTE —

The pump drive shaft is retained with either an "O" ring or a retaining clip (ring). Drive shafts with "O" rings, on late 1984 and later, use a rotating motion and pull out the shaft. Make certain that no pieces of the "O" ring have broken off and still remain in the pump. Remove and discard all drive shaft seals.

1982, 1983 And Early 1984 Drive Shafts With A Retaining Clip (Ring).

Rotate drive shaft until one of the raised portions of the retaining ring (immediately below the ball pivot stud), is accessible.

Use a long, thin hook-shaped tool, such as a dental tool, or bent wire, or a snap-on GA467. Reach into the housing through the governor arm opening, hook the ring, and pull it slightly to the rear. Grasp the ring with needle nose pliers and pull it straight up and out of the housing. Discard the ring, it cannot be used again.

— NOTE —

The early drive shaft Stanadyne Part # is 23098. The late drive shaft Part # is 24623. The O-Ring Part # is 22937. The retaining clip (ring) Stanadyne Part # is 23209.

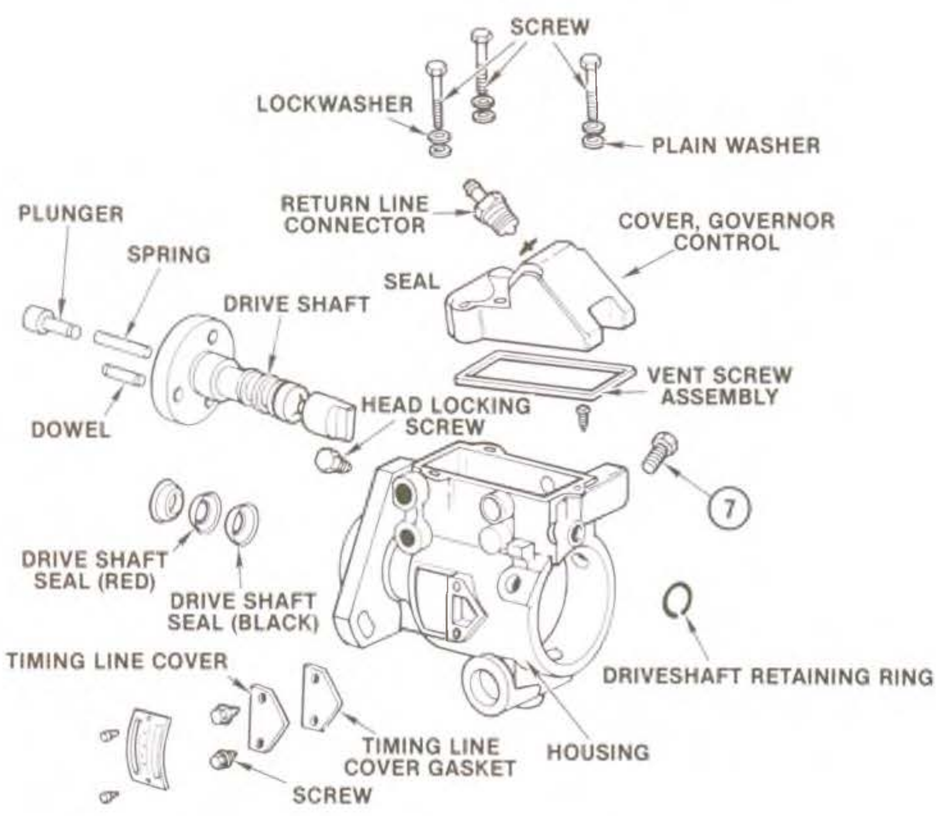


Figure 4-111A, **Drive Shaft With Retaining Clip.**

INSPECTION OF PUMP COMPONENTS

Remember, keep the work area clean. Dirt is the major enemy of the diesel fuel injection pump.

- Discard all "O" rings, seals and gaskets. Replace gaskets and "O" rings during re-assembly.
- Check all springs that you have removed for fretting, wear, corrosion or breakage.
- Check all bores, grooves and seal seats for damage, wear or obstructions of any kind.
- Inspect all components for excessive wear, rust, nicks or scratches.

Drive Shaft Inspection

Measure the distance across the flats of the drive tang. The measurement must not be less than .305″ or 7.75 mm. The drive shaft seal area must be free of nicks and scratches. (Figure 4-112).

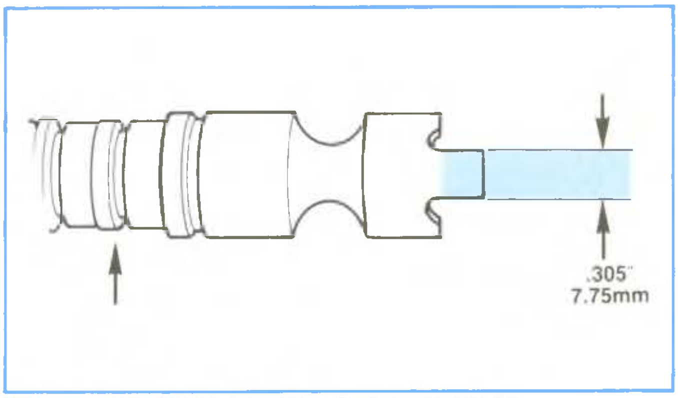


Figure 4-112, **Drive Shaft Inspection.**

Vent Wire Inspection

Next, check the vent wire assembly for freedom of movement. If the vent wire is sticking or damaged, replace the assembly with the same number vent wire. (Figure 4-113).

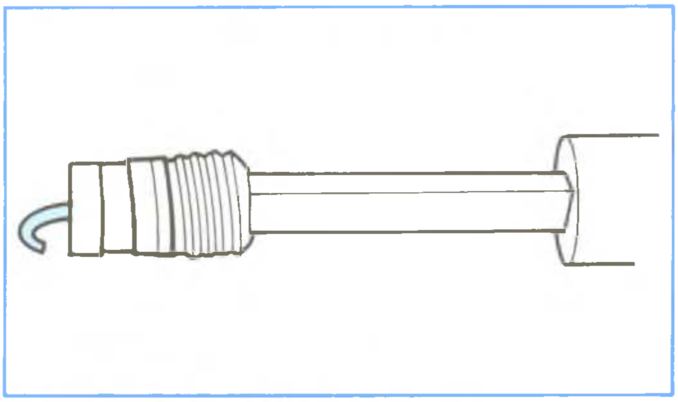


Figure 4-113, **Vent Wire Inspection.**

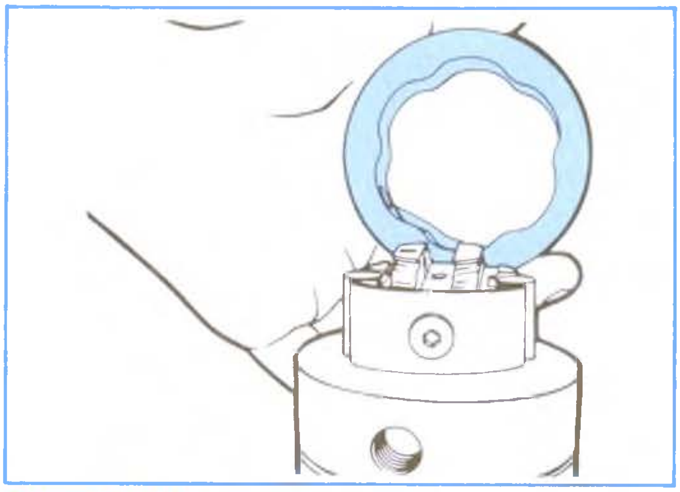


Figure 4-114, Cam Installation.

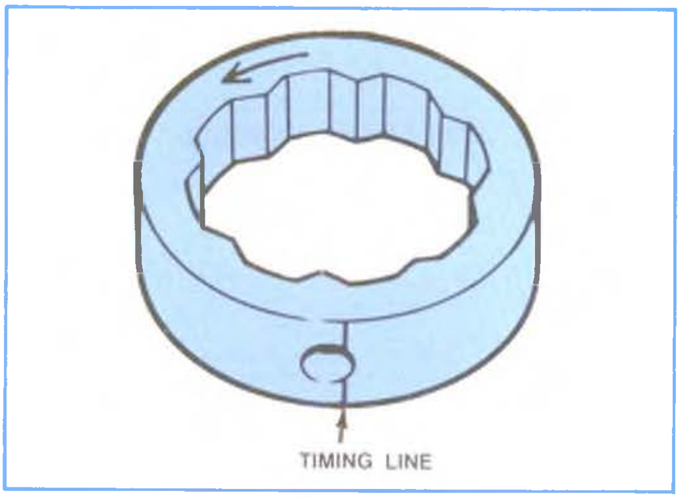


Figure 4-115, Cam Ring Timing Line.

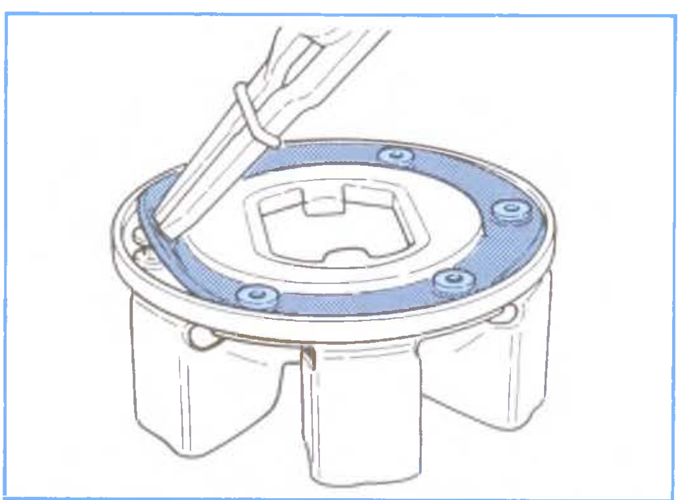


Figure 4-116, Installing Weight Retainer Ring With "Tru-Arcs".

PUMP REPAIR PROCEDURE — ASSEMBLY

Head Seal

Install a new seal onto the hydraulic head.

Cam Ring

If the cam ring was removed, place the cam ring onto the head and rotor assembly, with the arrow indicating the direction of pump rotation showing. (Figure 4-114). Pump rotation is expressed as viewed from the drive end.

Checking Proper Direction of Rotation

If you are servicing a pump in these series, place the cam ring on a table in the same position as Figure 4-115. (Note the hold in relation to the timing line.) Check to be sure the arrow is pointing in the same direction as shown in the illustration.

Weight Retainer Ring (Using Tru-Arc Snap Ring Pliers)

Install a **new** flexible retaining ring onto the weight retainer. Use number 13337 Snap Ring Pliers as shown in Figure 4-116, or use the following procedure with tool BT-8209-A.

Installing Weight Retainer Ring — Using the BT 8209-A

See Figure 4-117.

1. Slide seal over tapered locating pin and into groove on small sleeve.
2. Place indexer ring on bench and insert end of tapered locating pin into hole in top of seal retaining post.
3. Position tool vertically and push down firmly in one continuous motion until it bottoms out.
4. Repeat above operation for all locations.

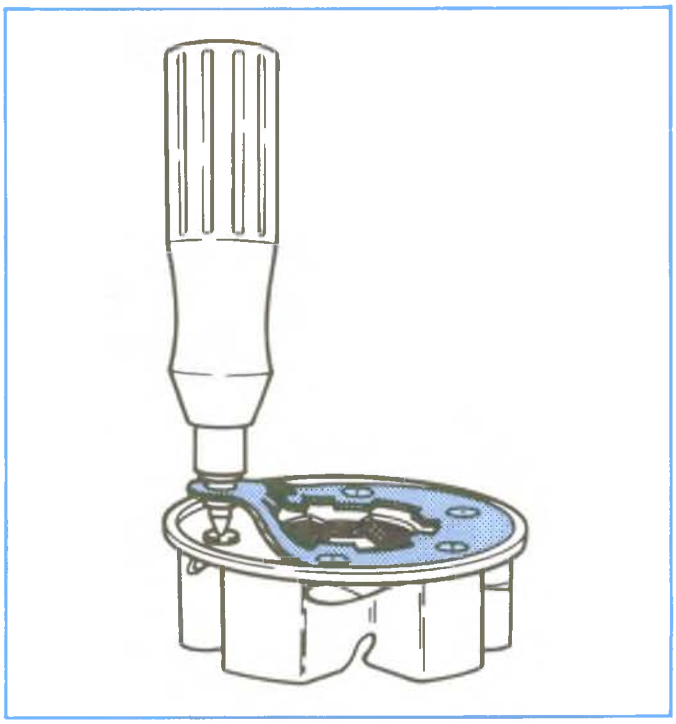


Figure 4-117, Installing Ring With Tool BT 8209-A.

Weight Retainer to Rotor

Assemble the weight retainer onto the rotor. (Figure 4-118).

Next, assemble the snap ring to it's groove using Stanadyne #13337 Pliers 07 Tru-Arc #22 Pliers.

Carefully hold the assembly so the rotor will not fall out. Invert the entire assembly so that it rests on the weight retainer.

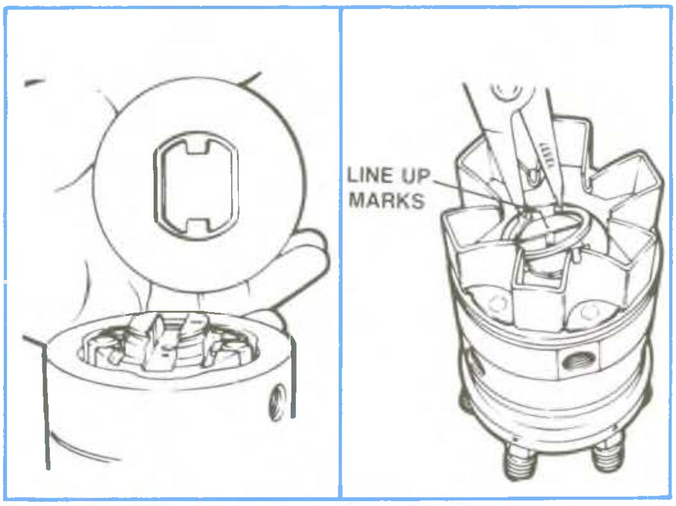


Figure 4-118, Installing Weight Retainer.

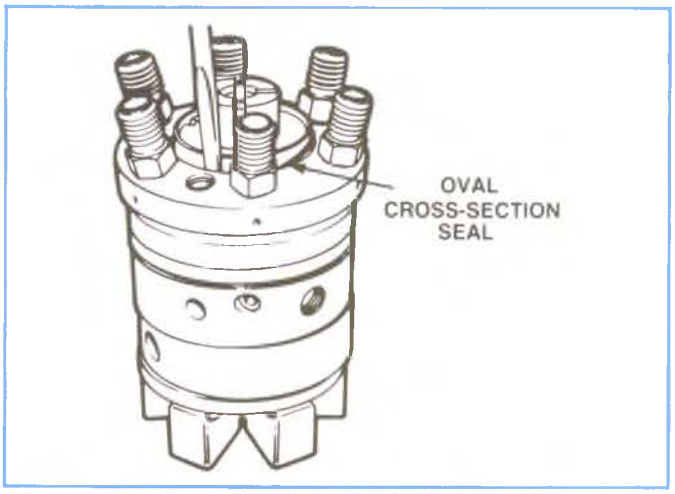


Figure 4-119, **Installing End Cap Seal.**

Transfer Pump End Cap Seal

Install a new transfer pump end cap seal into it's groove in the hydraulic head. This seal has an oval cross section, and can be identified by rolling it between your fingers. (Figure 4-119).

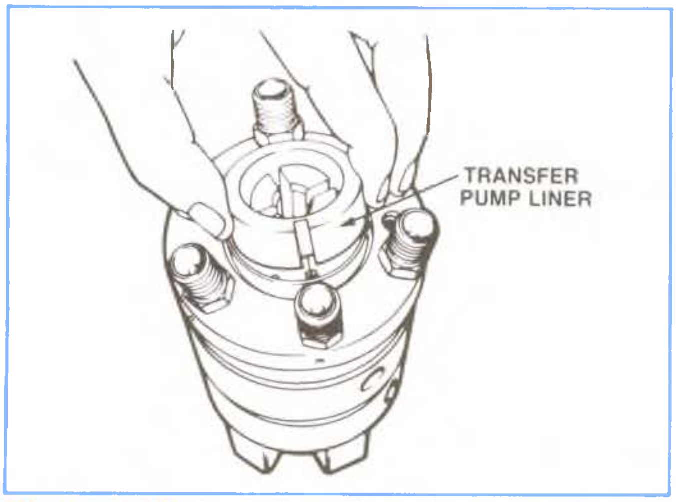


Figure 4-120, **Installing Transfer Pump Liner.**

Transfer Pump Liner

Insert the transfer pump liner with the slot in line with the hole that the regulator roll pin enters. (Figure 4-120).

> **— NOTE —**
>
> **Utmost cleanliness is required during this operation.**

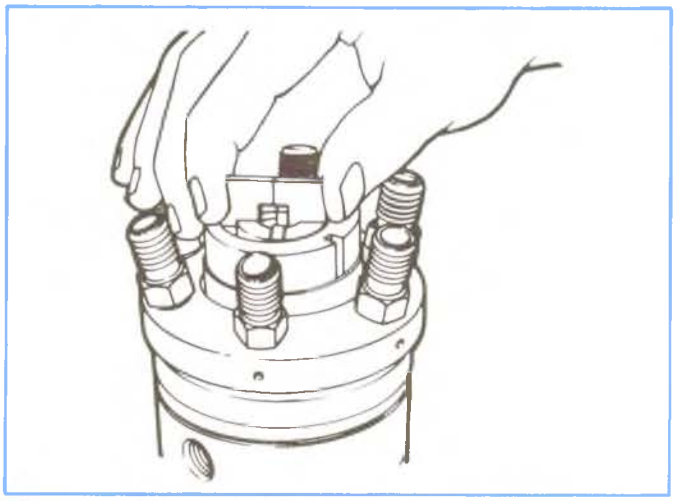


Figure 4-121, **Installing Transfer Pump Blades.**

Transfer Pump Blades

Assemble the springs to the transfer pump blades and install the blade sets in their rotor slots. The blades must be fully compressed, and care must be exercised that the sharp edge of the liner does not score the blade ends. (Figure 4-121).

> **— NOTE —**
>
> **Put the blades in the exact rotor slots, you removed them from, which were marked during disassembly.**

Transfer Pump Regulator

Now, install the transfer pump regulator assembly, beginning with the filter screen seal. (Figure 4-122).

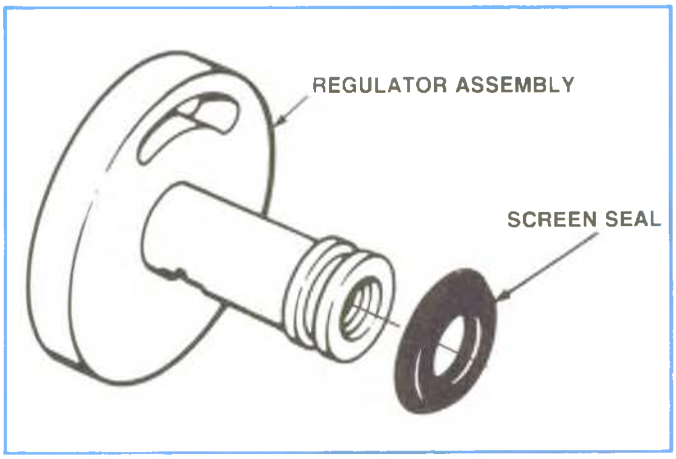


Figure 4-122, **Installing Filter Screen Seal.**

Piston Free Movement Check

Check the movement of the regulating piston by inserting a brass rod through the unthreaded end of the regulator assembly and applying a moderate amount of pressure to the rod. The piston should move in it's bore. (Figure 4-123). If it does not, the pump must be sent to an authorized pump repair station.

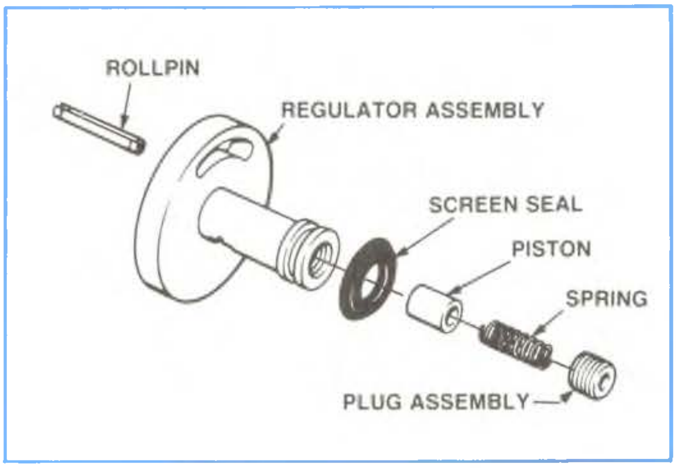


Figure 4-123, **Checking Piston Movement.**

Regulator, Pressure Plate and Screen

Assemble the regulator to the liner. Make certain that the locating pin is in the correct position for proper pump rotation. (Figure 4-124, Left).

Install the assembled pressure plate and screen onto the transfer pump regulator assembly. (Figure 4-124, Right).

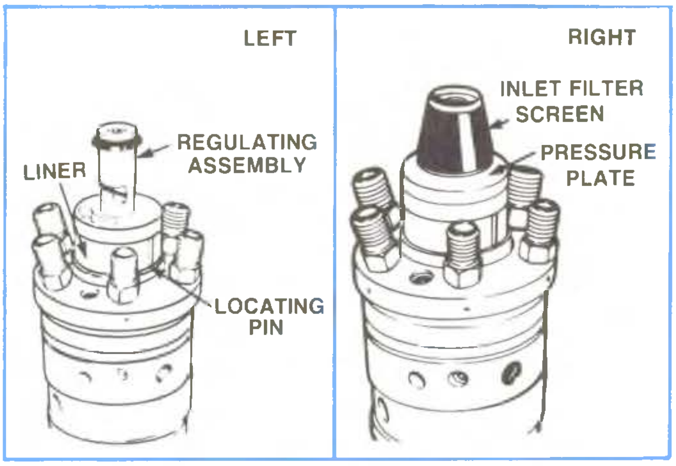


Figure 4-124, **Installing Regulator and Pressure Plate/Screen.**

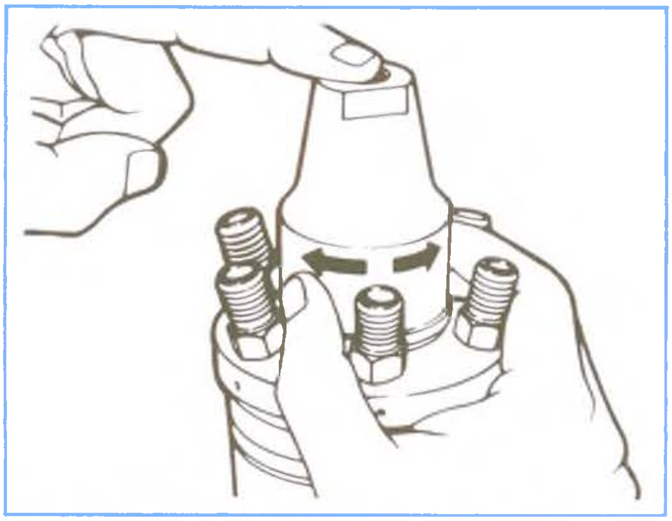


Figure 4-125, Installing Transfer Pump End Cap.

Transfer Pump End Cap

Coat the beveled surface of the pressure plate and the threads on the outside diameter of the end cap with lubriplate or equivalent. (Figure 4-125).

Install the transfer pump end cap by applying slight pressure on the top of the cap. Rotate the cap counter-clockwise until a slight click is heard. Now, turn the cap clockwise by hand until it is tight.

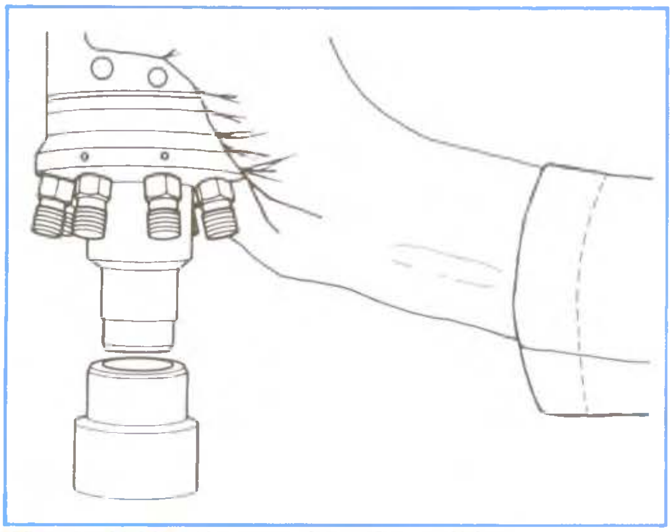


Figure 4-126, Supporting Head For Assembly.

Hydraulic Head and Rotor

Support the head and rotor in Stanadyne Tool #18332 or a used T.H.M. 350 Transmission Sun Gear and Shell. (Figure 4-126).

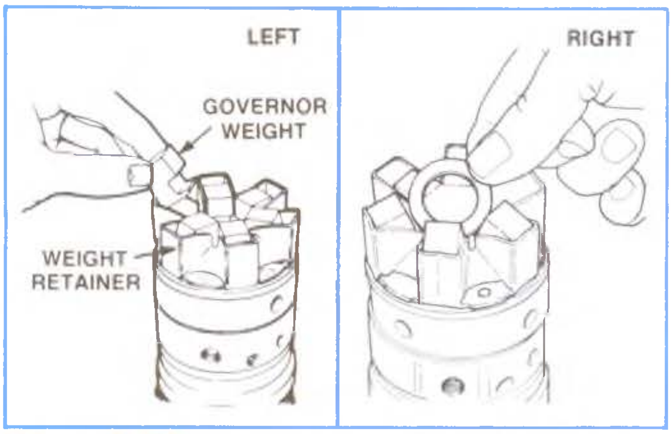


Figure 4-127, Installing Weights and Washer.

GOVERNOR WEIGHTS AND THRUST WASHER

Install the governor weights into the governor weight retainer. (Figure 4-127, Left).

1982 and later pumps do not have a chamfered thrust washer. The washer may be installed either side up. (Figure 4-127, Right).

On 1978-1981 pumps, install the thrust washer with the chamfered side up.

GOVERNOR THRUST SLEEVE

Next, insert the governor thrust sleeve into the lower slots of the governor weights. (Figure 4-128).

Sight across the tops of the assembled weights. All weights should be level and collapsed against the thrust sleeve.

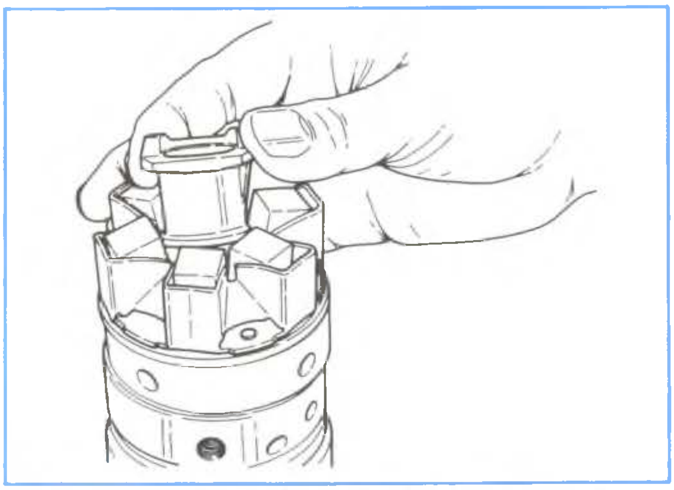


Figure 4-128, **Installing Thrust Sleeve and Checking Weights.**

LUBE HEAD AND HOUSING

The hydraulic head and rotor assembly are now ready to be placed into the housing. First, apply grease onto the hydraulic head, and apply a light film of Synkut (J-33198) lubricant around the inside edge of the housing. In order to aid assembly, tilt the housing slightly downward. (Figure 4-129).

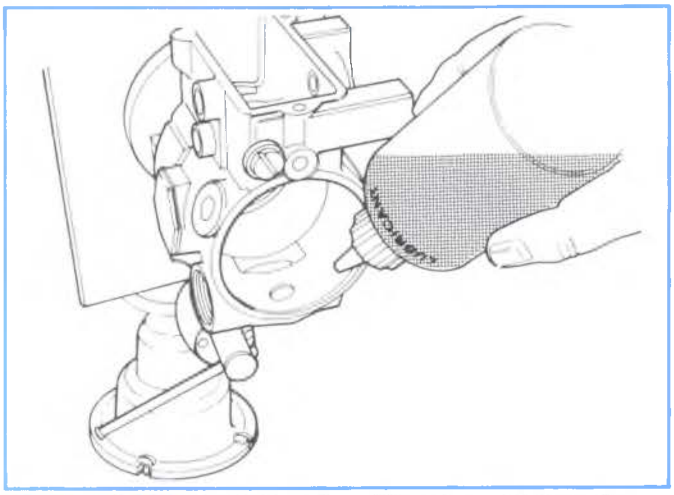


Figure 4-129, **Lubricating Head and Housing.**

CAM POSITIONING

See Figure 4-130. Rotate the cam ring so that the honed hole in the cam is 180 degrees opposite the metering valve bore. This will ensure proper positioning of the cam ring. The smallest hole in the cam ring should be at the bottom. To determine which hole is the smallest, use a head locking screw. The screw will enter the large holes, but not the small one. Position the governor thrust sleeve with the flat edge and two lugs up, and round edge down.

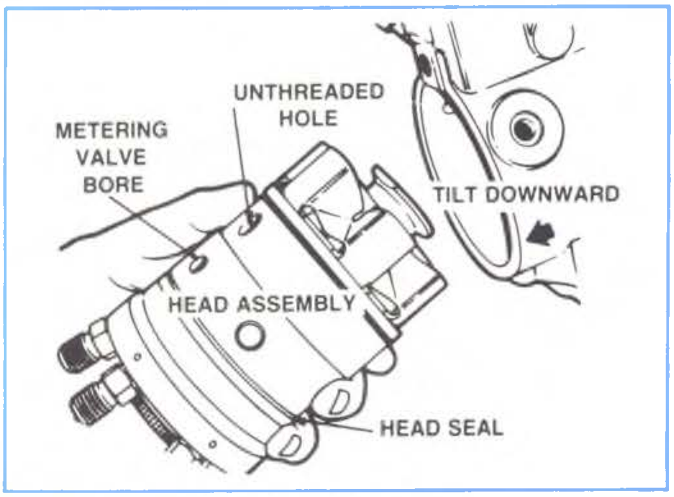


Figure 4-130, **Cam Positioning.**

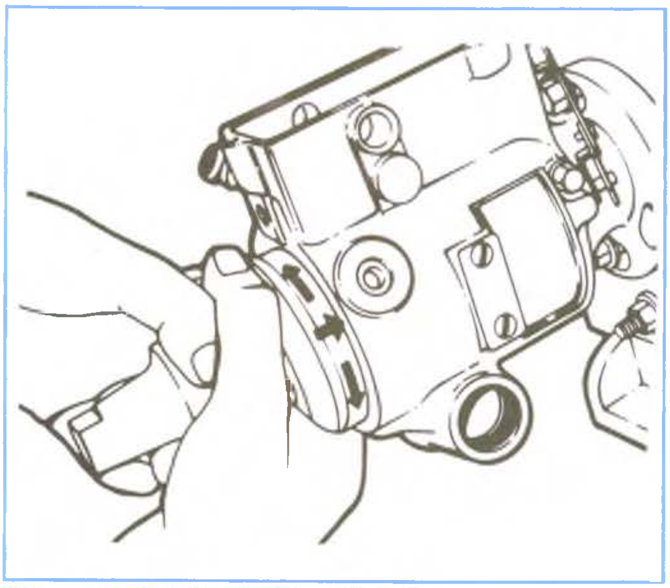


Figure 4-131, Installing Head.

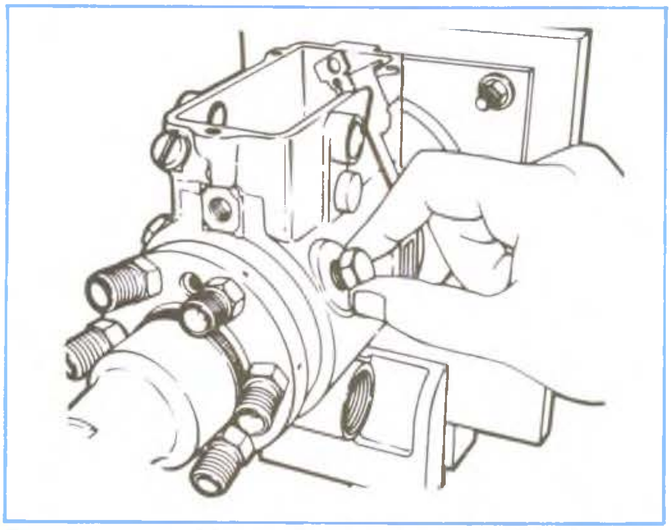


Figure 4-132, Hand Tightening Head Locking Screw.

HEAD INTO BORE

Grasp the hydraulic head firmly in both hands and insert it into the housing bore using a slight rotary motion. (Figure 4-131).

— CAUTION —

Do not force: If the assembly should jam during insertion, withdraw and start over.

— NOTICE —

Be careful not to insert the head assembly too far into the housing. Pushing the head too far will cause the seal to tear in the vent wire opening. It will damage the seal on the hydraulic head and cause leakage.

Rotate the head assembly until the head locking screw holes line up with their corresponding holes in the housing. Insert the two head locking screws, finger tight. (Figure 4-132).

DRIVE SHAFT AND SEALS

Lubricate the seal installer tool. Polish seal tools with #400 grit paper before first use. This will aid installation of seals.

To prevent the governor weights from becoming dislodged from the retainer, the drive shaft should be installed. Begin by installing new seals onto the drive shaft using seal installation tool part #22727 or J-29745A. Apply a liberal coating of Synkut lubricant, part #22204, or J-33198 to the seals and the surface of the tool, to facilitate assembly.

— CAUTION —

Excessive stretching of the center drive shaft seal may cause it to tear. (Figure 4-133)

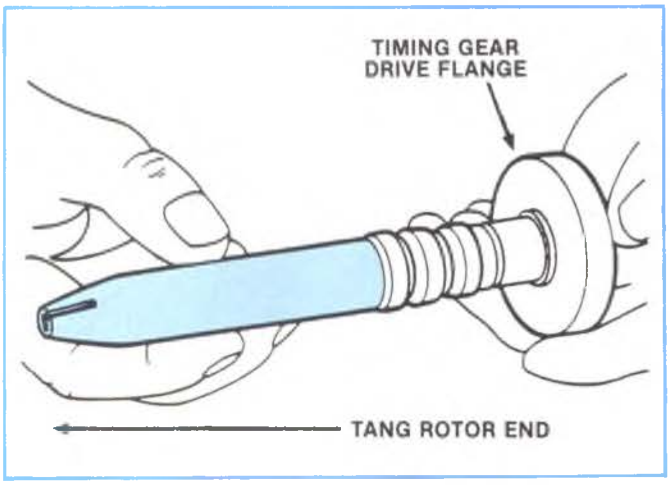


Figure 4-133, **Drive Shaft Seal Installation Tool.**

Install one black seal, cup towards timing gear drive flange.

Relubricate the seal installation tool, and install the red seal, cup towards the tang rotor end.

Install the last black seal, cup towards the tang rotor end.

O-ring retained drive shafts require installation of the O-ring or wire retaining ring onto the shaft at this point. Or install new retaining ring on drive shaft (if so equipped).

— CAUTION —

Do not spread ring far enough so that it becomes loose in the drive shaft retaining slot.

Install the drive shaft to the pump so that the timing spot on the drive shaft tang registers with the timing spot in the rotor tang slot. (Figure 4-134).

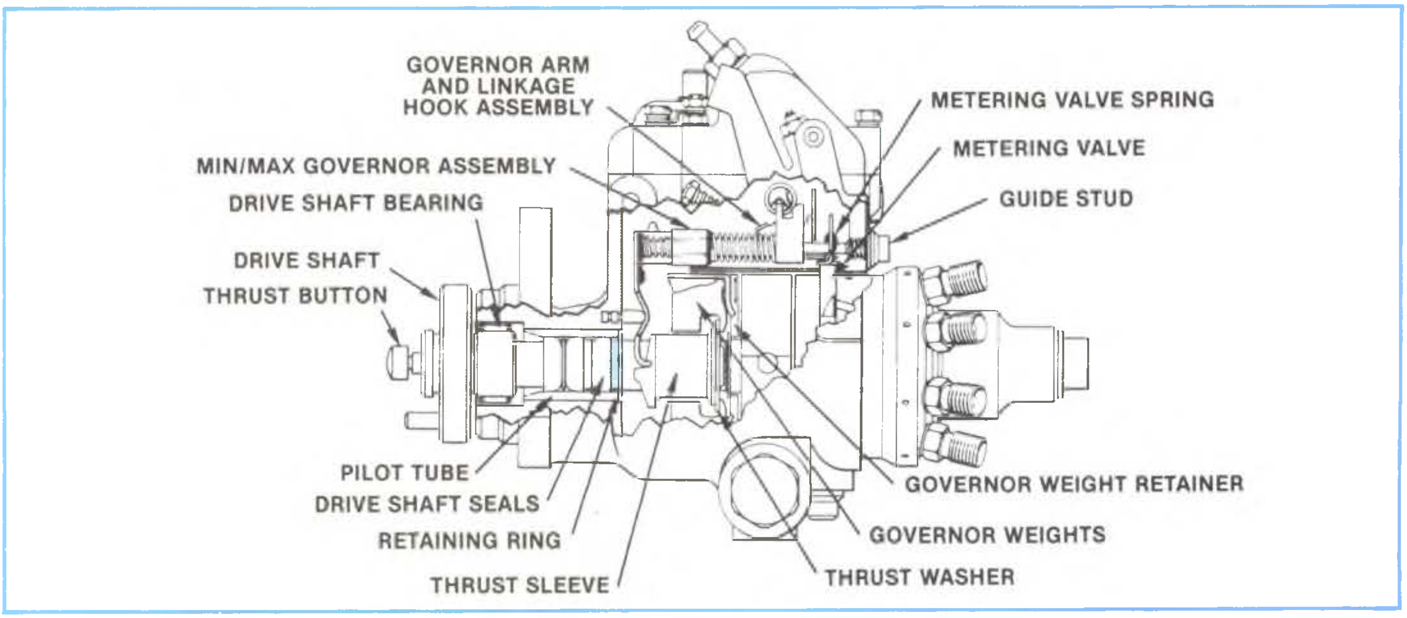


Figure 4-134, **Installing Shaft in Pump.**

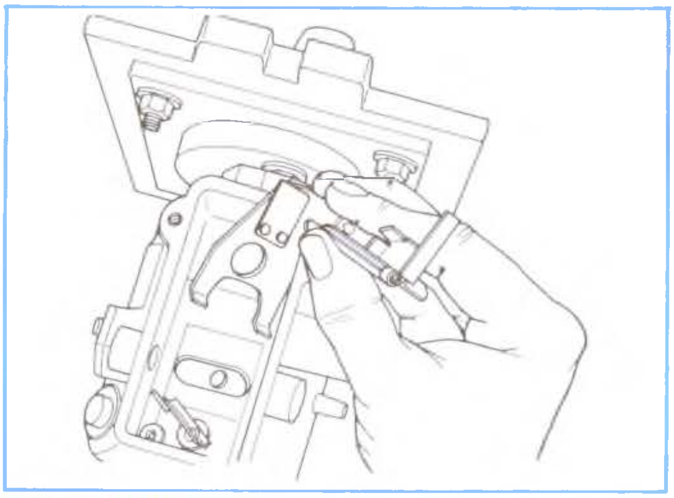


Figure 4-135, **Installing Governor Arm.**

Governor Arm: Late Pump

Next, place the governor arm in position in the housing. In later model pumps, the arm simply rests on a rounded pin cast into the pump housing. Let the linkage hang over the side. (Figure 4-135).

Figure 4-136, **Installing Vent Wire Assembly.**

Vent Wire Assembly

Now, install the vent wire screw assembly (Figure 4-136). 2.8-3.4 N·m (25-30 in. lbs.).

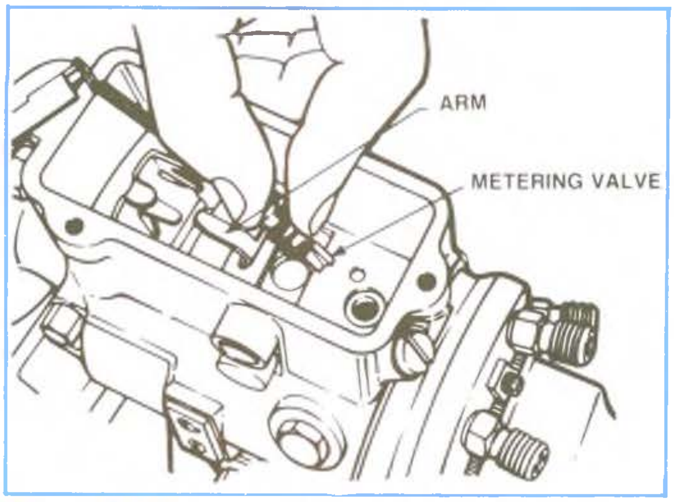


Figure 4-137, **Lubricating Metering Valve.**

Metering Valve

Place the metering valve assembly into it's bore and depress and rotate the valve several times to ensure freedom of movement. If the valve sticks, rinse it off with clean calibrating oil. (Figure 4-137). Never use an abrasive or the specially treated surface will be damaged. However, it may be polished with 600 grid sand paper, but only five turns.

It is possible for the metering valve arm on some injection pumps to contact and bind on the housing after the head and rotor have been removed and reinstalled. If this condition is encountered when checking for metering valve free movement, rotate the head to provide clearance for the metering valve arm.

Then position the opposite end of the linkage assembly onto the metering valve arm, making certain that the spring is not twisted. Remember to check all governor parts for freedom of movement. (Figure 4-138).

— NOTE —

All throttle shaft seals (1984 and later) are made from an improved Viton material, and identified by a green color. This was done to lessen the effects of cold temperatures on the sealing area.

Throttle Shaft (and Clip on Speed Advance Pump)

1. Install the throttle shaft, with throttle shaft spacer, new seals and mylar washer. (Figure 4-139 Left).
   A. Install throttle shaft spacer (22900 if removed).
   B. Install new seals on the throttle shaft.
   C. Install the throttle shaft.
   D. Install mylar washer.

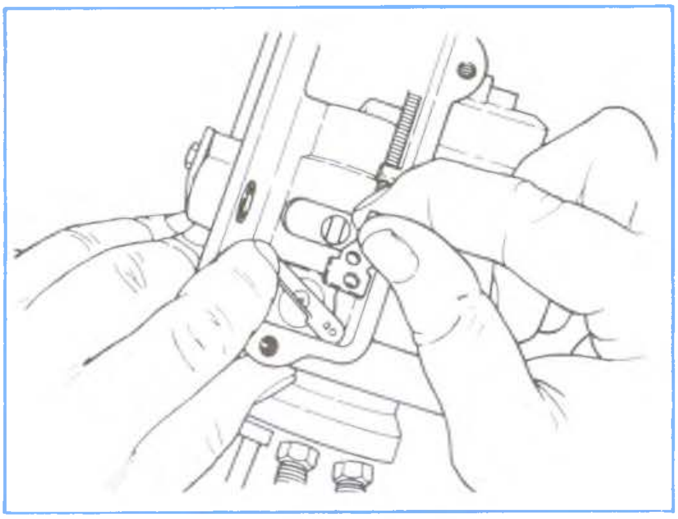


Figure 4-138, Linkage To Metering Valve Arm.

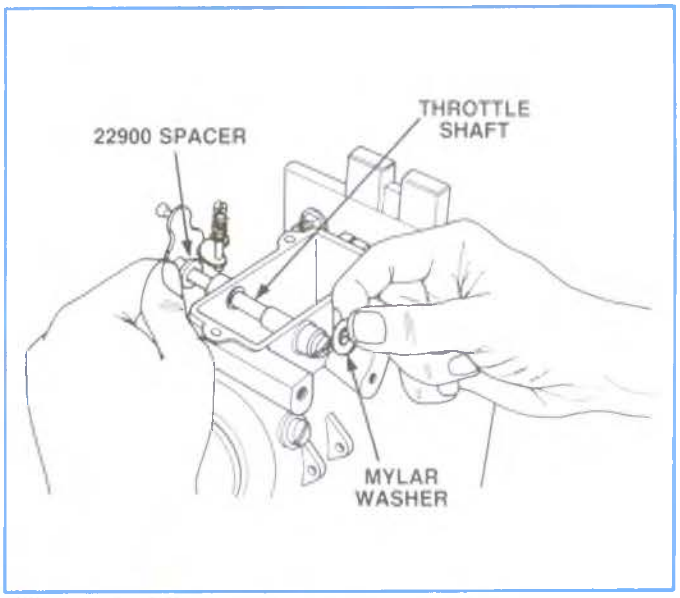


Figure 4-139, Installing Throttle Shaft and Clip.

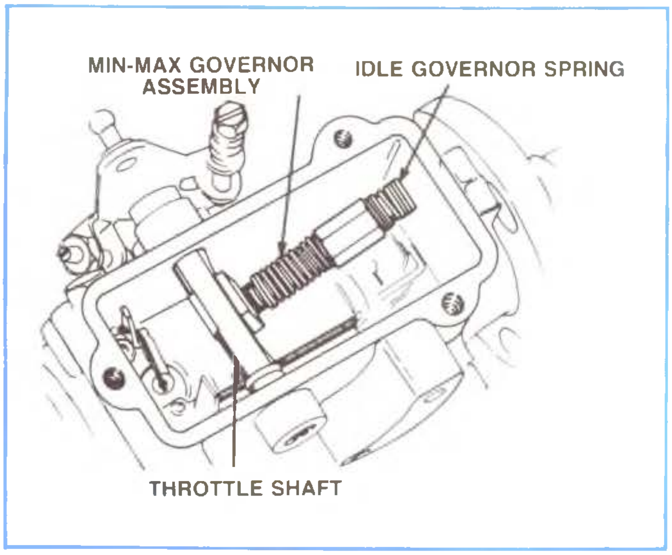


Figure 4-140, Installing Governor Assembly.

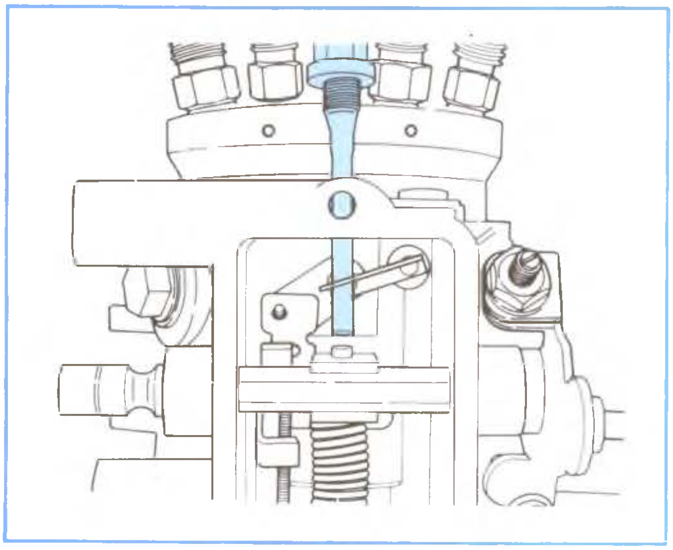


Figure 4-141, Installing Guide Stud.

Governor Assembly

Rotate the throttle to the wide open throttle position, and holding the entire assembly between the thumb and forefinger, fit the block onto the throttle shaft. Hold the assembly in place and rotate the throttle back to the low idle position until the other end of the governor assembly bears against the governor arm. (Figure 4-140).

Install the guide stud, with a new guide stud washer into the housing. (Figure 4-141). The guide stud must be installed beneath the metering valve spring, and engage the min-max assembly without binding. Torque the guide stud to 9-10 N·m (80-90 in.-lbs.).

Check the governor components for proper installation by rotating the throttle shaft assembly to the rear. This should cause compression of the min-max assembly. There should be no evidence of binding.

Head Locating Screw

See Figure 4-142. Invert the pump in the vise, and assemble the seal onto the head locating screw. Apply a light film of grease to the head locating screw. Insert the screw and tighten hand tight. Then using a 5/16″ hex socket, torque to 20-25 N·m (180-220 in.-lbs.).

Make sure that the seal is not sheared during tightening.

> **— NOTE —**
>
> **The head locating screw will contain a filter to reduce advance piston sticking caused by contamination. WDDGM part #14067415 — Stanadyne part #24566.**

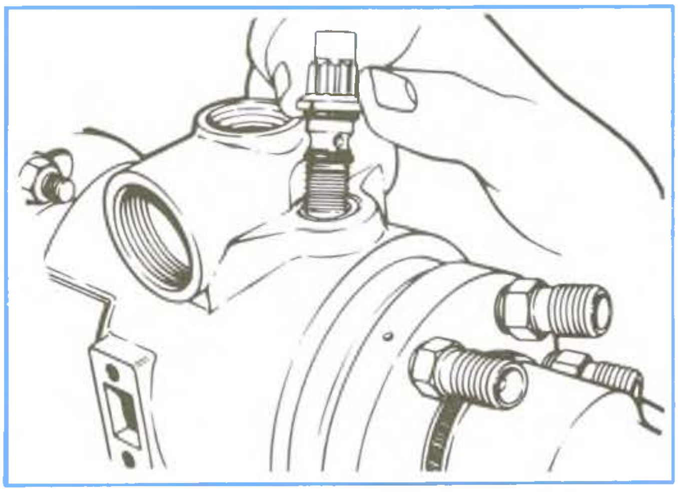


Figure 4-142, **Installing Head Locating Screw.**

Head Locking Screws

See Figure 4-143. At this time, torque the two head locking screws to 20-25 N·m (180-220 in.-lbs.).

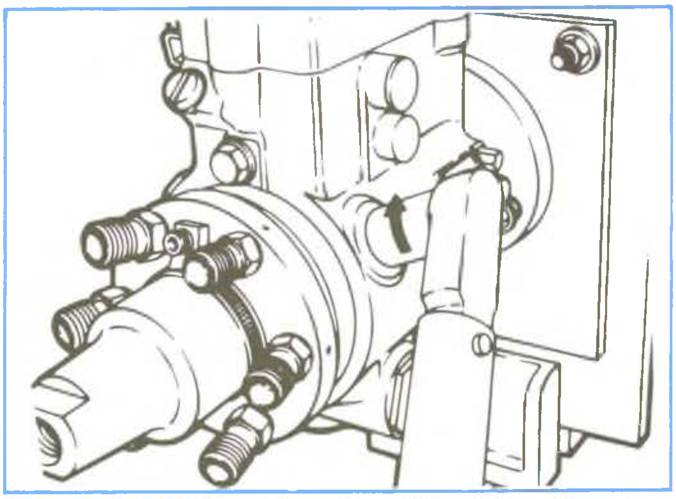


Figure 4-143, **Torquing Head Locking Screws.**

Automatic Advance

Begin the automatic advance assembly of mechanical light load equipped pumps by installing the advance piston. Make certain that the transfer pump pressure port is facing the head locating screw, and that the servo-valve bore faces the rocker arm side of the pump. (Figure 4-144).

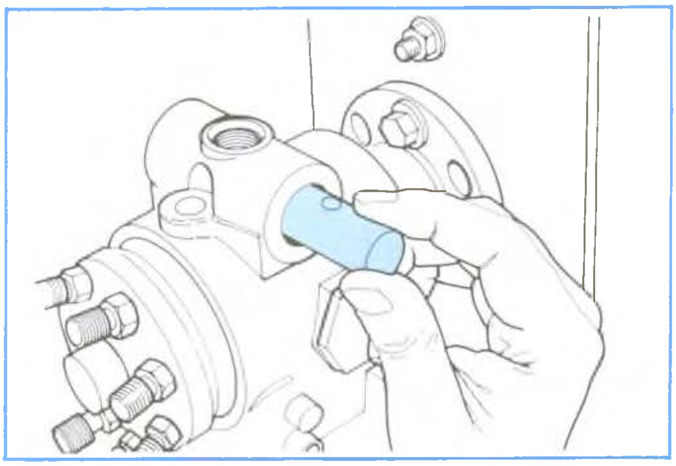


Figure 4-144, **Installing the Advance Piston on Mechanical Light Load Pump.**

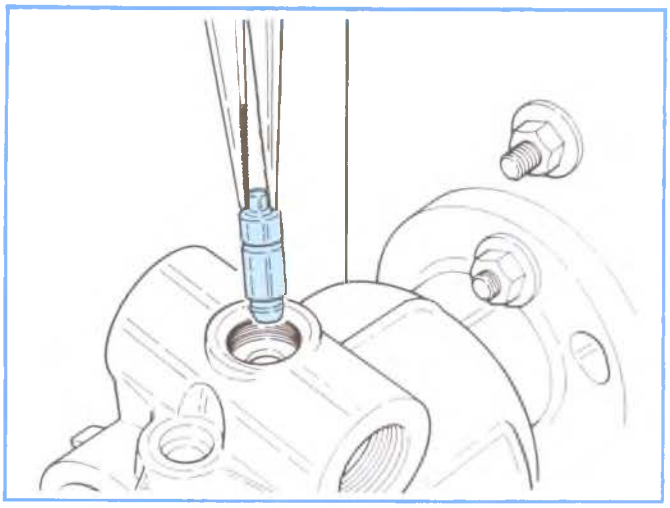


Figure 4-145, **Inserting Cam Pin.**

Then, insert the cam advance pin into its bore, making certain that it properly engages the cam ring. (Figure 4-145).

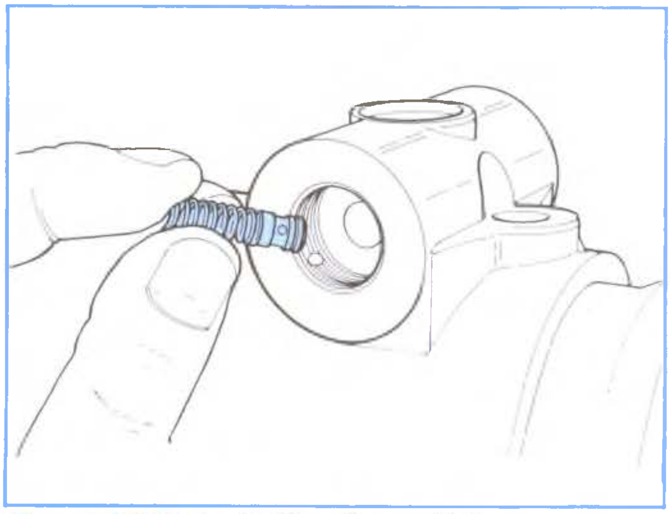


Figure 4-146, **Installing Servo Valve.**

Install the servo valve and spring into the advance piston. (Figure 4-146).

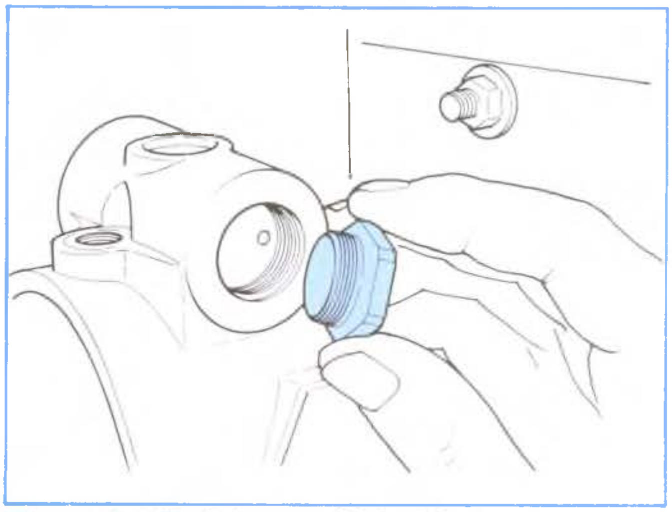


Figure 4-147, **Advance Hole Plugs.**

Install the advance hole plugs. (Figure 4-147).

Now, torque both piston hole plugs to 34.7-42.4 N·m (307-375 in.-lbs.). (Figure 4-148).

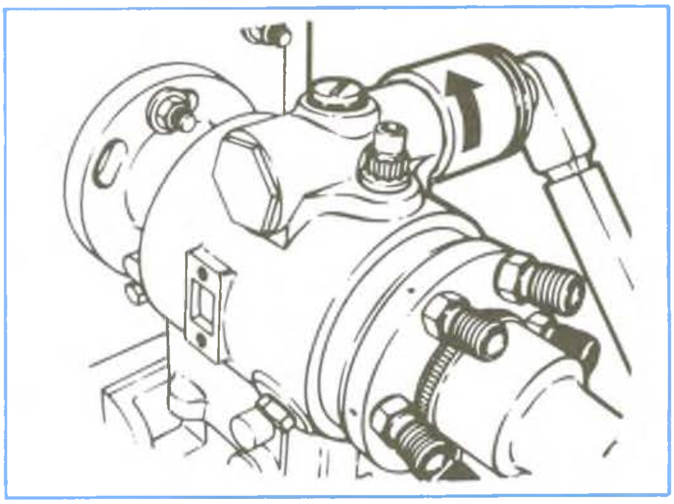


Figure 4-148, **Tightening Piston Hole Plug.**

Complete the assembly of the auto advance mechanism by fitting the advance boss plug with a new seal, and torque to 8.5-11.3 N·m (75-100 in.-lbs.) using a ¼ inch hex socket. (Figure 4-149).

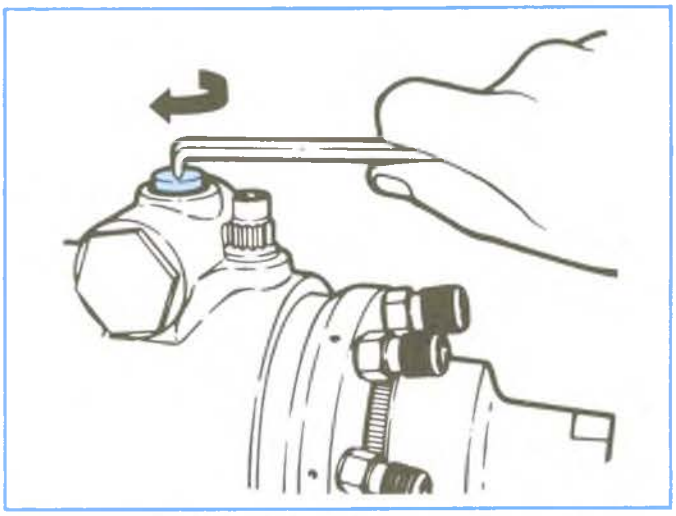


Figure 4-149, **Installing Advance Boss Plug.**

Servo Advance Plunger

In mechanical light load advance pumps, you should now install the servo advance plunger. (Figure 4-150). Then, invert the pump in the vise.

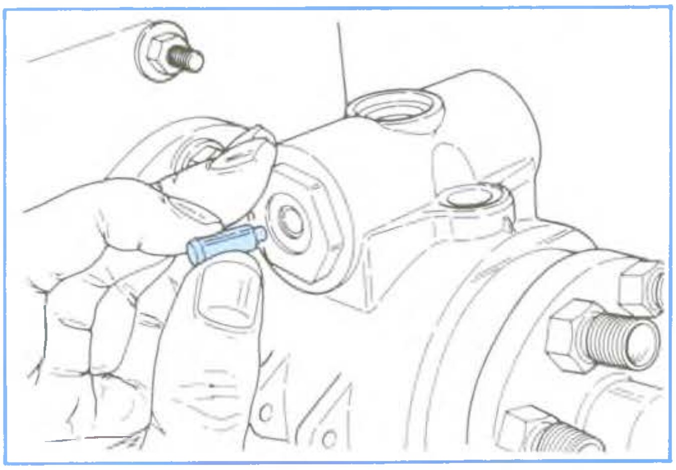


Figure 4-150, **Installing Servo Advance Plunger.**

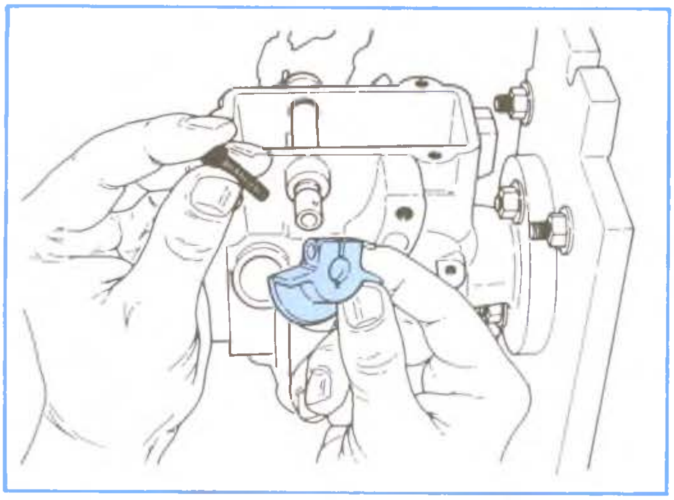


Figure 4-151, **Installing Face Cam Screw.**

Face Cam

Next, install the face cam and a new mylar washer onto the throttle shaft. (Figure 4-151). Secure it by tightening the face cam screw hand tight. Install a new vacuum module drive pin.

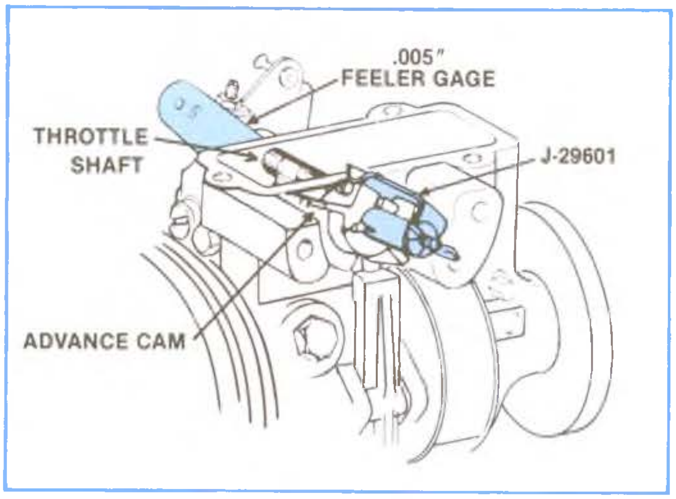


Figure 4-152, **Feeler Gage to Position Cam.**

Install tool J-29601 to position face cam and insert a .005″ feeler gage between throttle shaft washer and housing. (Figure 4-152). Push throttle shaft into housing and squeeze the advance cam to remove clearance. Torque face cam screw to 3-4 N·m (28-32 in.-lbs.).

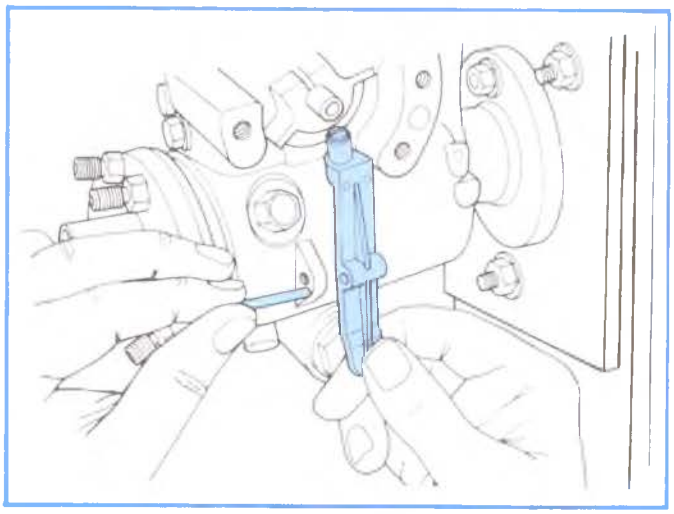


Figure 4-153, **Installing Rocker Arm Pin.**

Rocker Arm

Then, assemble the rocker arm to the housing by installing the rocker arm pin. Secure with the rocker arm pin clips. (Figure 4-153).

Governor Cover Gasket

Complete the governor assembly by placing a new gasket on the governor cover. (Figure 4-154)...

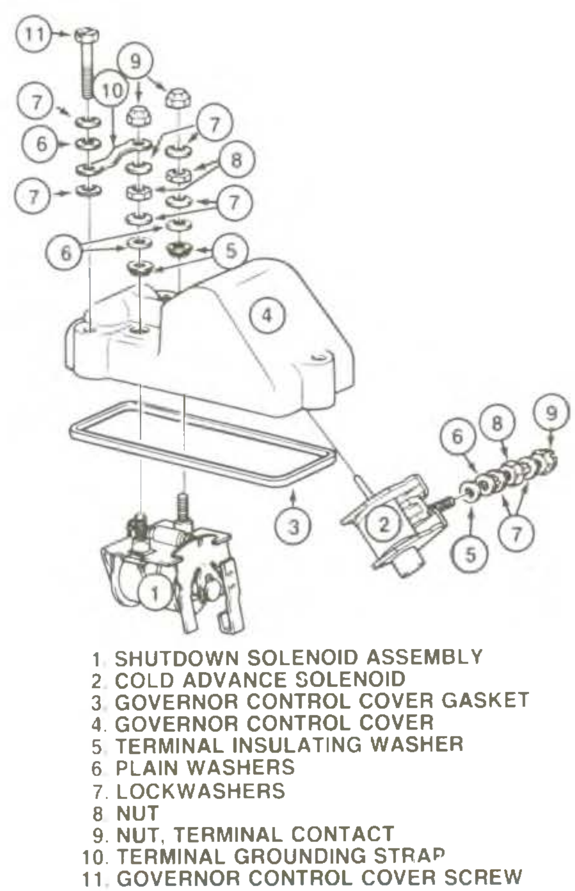


Figure 4-154, Gasket on Governor Cover.

Governor Cover

...and placing the governor cover slightly to the rear of its correct mounting position. (Figure 4-155). Now, slide the cover forward. This prevents the electric shut off solenoid arm from accidently locking the linkage in the run position.

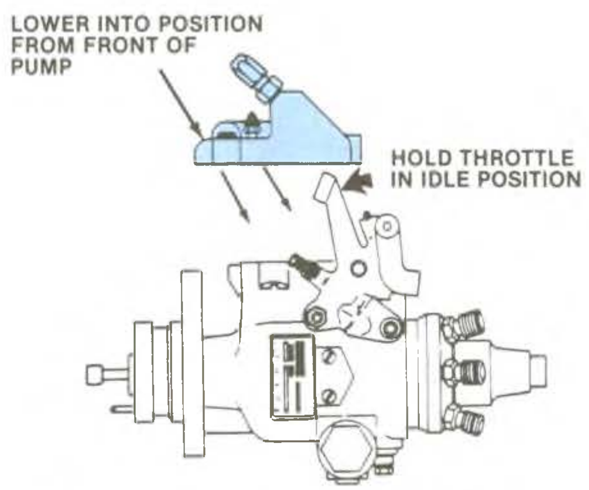


Figure 4-155, Installing Governor Cover.

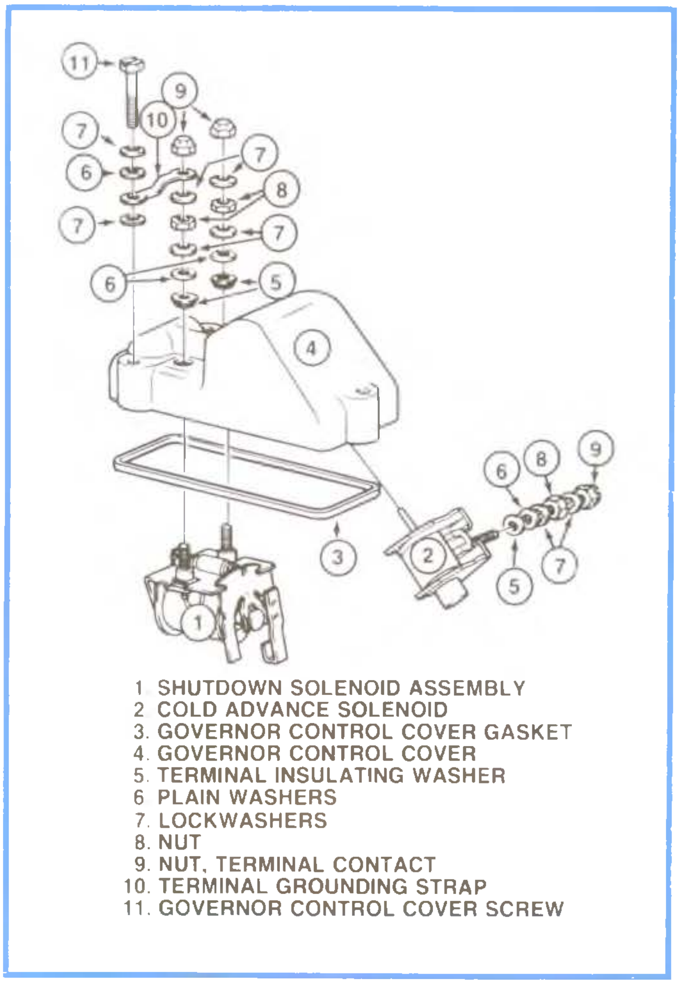


Figure 4-156, installing Governor Cover Screws.

Governor Cover Screws

Install the flat washers, and lock washers onto the cover screws, and torque to 4-5 N·m (35-45 in.-lbs.). (Figure 4-156).

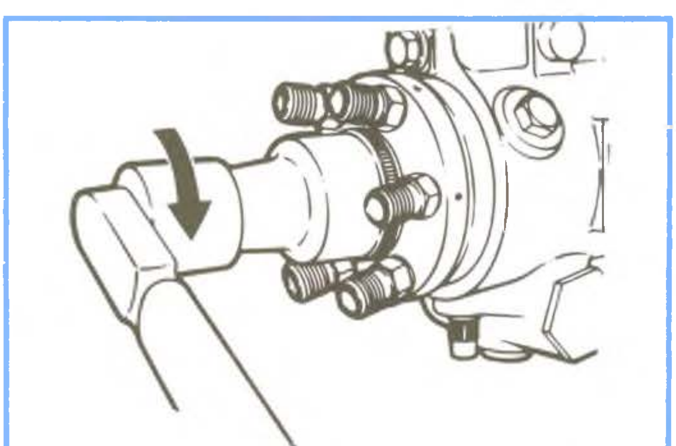


Figure 4-157, Installing the End Cap.

Transfer Pump End Gap

Tighten the transfer pump end cap to 41-50 N·m (360-440 in.-lbs.). (Use Stanadyne Tool #20548, Figure 4-157).

End Cap Locking Plate

Assemble the end cap locking plate, seal and screw to the head and tighten to 8-9 N·m (70-80 in.-lbs.). (Figure 4-158).

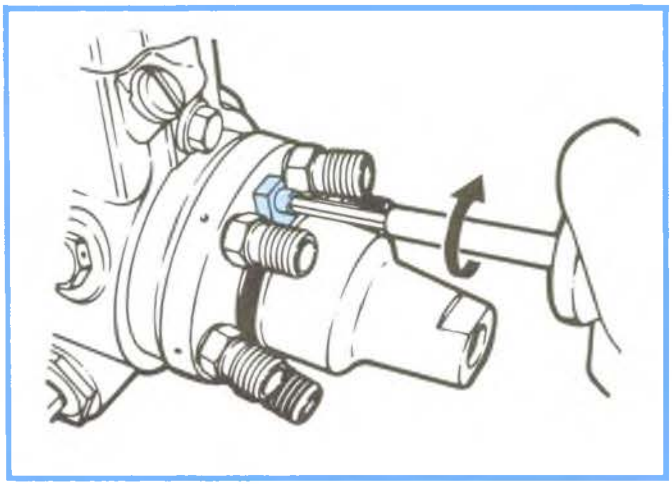


Figure 4-158, **Installing End Cap Locking Plate, Seal and Screw.**

Pressure Testing Of Fuel Injection Pump On the Bench

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

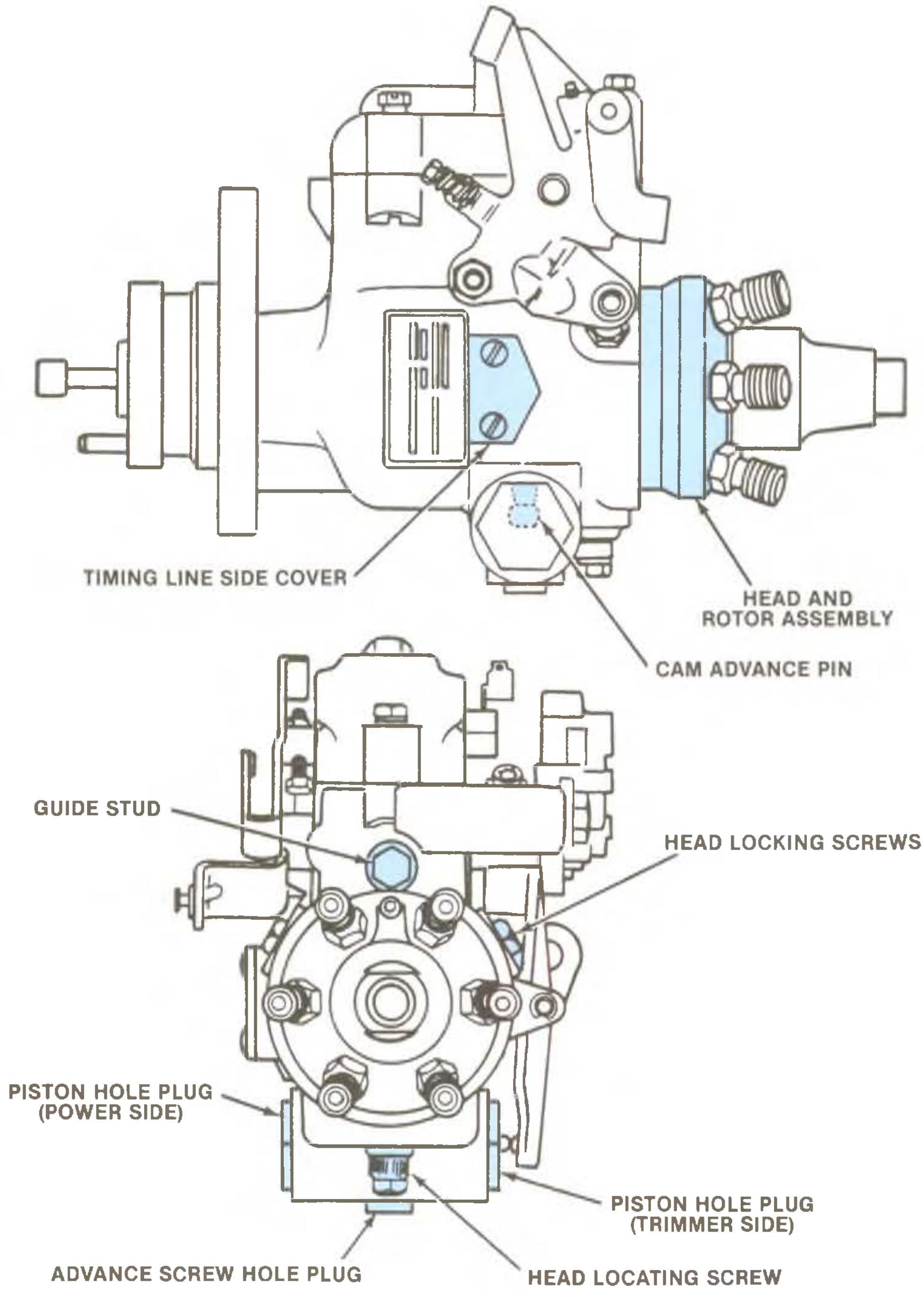


Figure 4-159, **Injection Pump Components Location.**

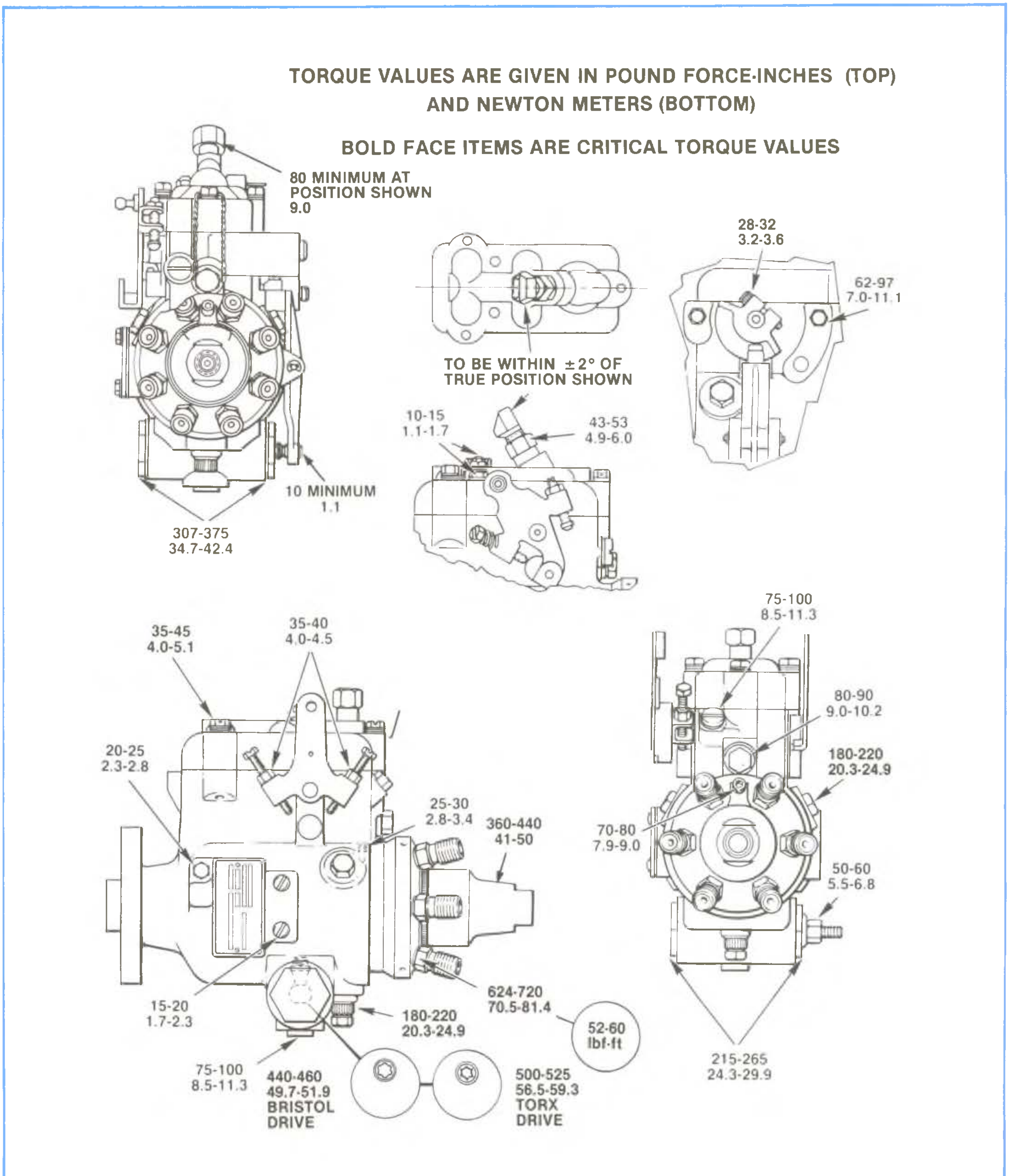


Figure 4-160, Torque Values.

High Altitude Adjustment, 1982 “C-K” Trucks With 6.2L Diesel Engine and LH6 (Light Duty Emissions)

These adjustments are considered altitude performance adjustments and apply only to in-use vehicles. They should not be used to modify vehicles prior to sale.

1982 trucks equipped with the 6.2L diesel engine for low altitude operation may be modified if operation is changed to high altitude for an extended period or permanently. Dealers in high altitude areas should encourage owners who have moved to high altitude counties to purchase the service adjustment procedure outlined below, which is considered an owner maintenance expense. High altitude is defined as 4,000 feet and above. Vehicles designed for principal use at low altitude can be identified by P/N 14050587, injection pump, on light duty emission (LH6) vehicles.

Operation of the 6.2L diesel at high altitudes without modification can result in excessive emission of black exhaust smoke due to low air density. Modification involves the recalibration of the fuel injection pump to a different fuel rate which will compensate for the lower air density at high altitudes.

The injection pump cannot be modified on the vehicle. The following procedure should be used:

1. Remove the injection pump per service manual procedures. Be sure to note the relationship of the timing marks on the pump and front housing. The pump must be reinstalled to its exact previous position.
2. Send the pump to an ADS (Association of Diesel Specialists) Service Center for the altitude performance adjustment. The ADS service centers will be advised by Stanadyne Corporation Bulletin as to injection pump recalibration procedures.
3. Reinstall the pump per service manual procedure. The pump must be installed to its original timing setting. If the original timing relationship was not retained, refer to Bulletin number 82-B-59 detailing the timing procedure.

ALTITUDE ADJUSTMENT LABEL

When LOW ALTITUDE vehicles are adjusted for high altitude operation, a SUPPLEMENTAL emission control information label must be placed **next** to the existing underhood emission control information label. Wash off the area with soap and water, dry thoroughly, and apply the new label, P/N 14057201.

The label should be ordered as regular parts and accessories through the General Motors Warehousing and Distribution Division system. When ordering these labels via rapid entry, use order type CSD. Orders also may be placed on a PC 66 and mailed directly to GMWDD, 6060 West Bristol Road, Flint, Michigan 48554, attention Ship Direct Department.

After performing these adjustments, dealers **should advise** customers that, IF THE VEHICLE IS RETURNED TO CONTINUOUS, LOW ALTITUDE OPERATION, THE PUMP MAY BE RECALIBRATED TO **LOW ALTITUDE** SPECIFICATION PER THE ABOVE PROCEDURE AND THE SUPPLEMENTAL LABEL REMOVED.

Vehicles designed for principal use at high altitude (RPO NA6 — fuel injection pump, P/N 14050526, LH6 engine) perform satisfactorily at low altitude without excessive smoke levels and need not be adjusted for extended operation at low altitude.

HEAVY DUTY DIESEL ENGINE (LL4)

No adjustments are applicable. Engine performs satisfactorily at low and high altitudes.

High Altitude Adjustment, 1983 and Later "C-K-P-G" Trucks With 6.2L Diesel Engine and LL4 (Heavy Duty) or LH6 (Light Duty Emissions)

These adjustments are considered altitude performance adjustments and apply only to in-use vehicles. They should not be used to modify vehicles prior to sale.

1983 trucks equipped with the 6.2L diesel engine for low altitude operation may be modified if operation is changed to high altitude for an extended period or permanently. Dealers in high altitude areas should encourage owners who have moved to high altitude counties to purchase the service adjustment procedure outlined below, which is considered an owner maintenance expense. High altitude is defined as 4,000 feet and above. Vehicles designed for principal use at **high** altitude are identified by option number NA6 on Service Parts Identification label. All other vehicles are designed for principal at **low** altitude.

Operation of the 6.2L diesel at high altitudes without modification can result in excessive emission of black exhaust smoke due to low air density. Modification involves the recalibration of the fuel injection pump to a different fuel rate which will compensate for the lower air density at high altitudes.

The injection pump cannot be modified on the vehicle. The following procedure should be used:

1. Remove the injection pump per Service Manual procedures. Be sure to note the relationship of the timing marks on the pump and front housing. The pump must be reinstalled to its exact previous position.
2. Send the pump to an ADS (Association of Diesel Specialists) Service Center for the altitude performance adjustment. The ADS Service Centers will be advised by Stanadyne Corporation Bulletin as to injection pump recalibration procedures.
3. Reinstall the pump per Service Manual procedure. The pump must be installed to its original timing setting. If the original timing relationship was not retained, refer to bulletins detailing the timing procedure to follow.

ALTITUDE ADJUSTMENT LABEL

When LOW ALTITUDE vehicles are adjusted for high altitude operation, a SUPPLEMENTAL emission control information label must be placed **next** to the existing underhood emission control information label. Wash off the area with soap and water, dry thoroughly, and apply the new label, (P/N 14057201).

The label should be ordered as regular parts and accessories through the General Motors Warehousing and Distribution Division system. When ordering these labels via rapid entry, use order type CSD. Orders also may be placed on a PC 66 and mailed directly to GMWDD, 6060 West Bristol Road, Flint, Michigan 48554, attention Ship Direct Department.

After performing these adjustments, dealers **should advise** customers that, IF THE VEHICLE IS RETURNED TO CONTINUOUS, LOW ALTITUDE OPERATION, THE PUMP MAY BE RECALIBRATED TO **LOW ALTITUDE** SPECIFICATION PER THE ABOVE PROCEDURE AND THE SUPPLEMENTAL LABEL REMOVED.

Vehicles designed for principal use at high altitude (RPO NA6 — fuel injection pump, P/N 14050526, LH6 engine) perform satisfactorily at low altitude without excessive smoke levels and need not be adjusted for extended operation at low altitude.

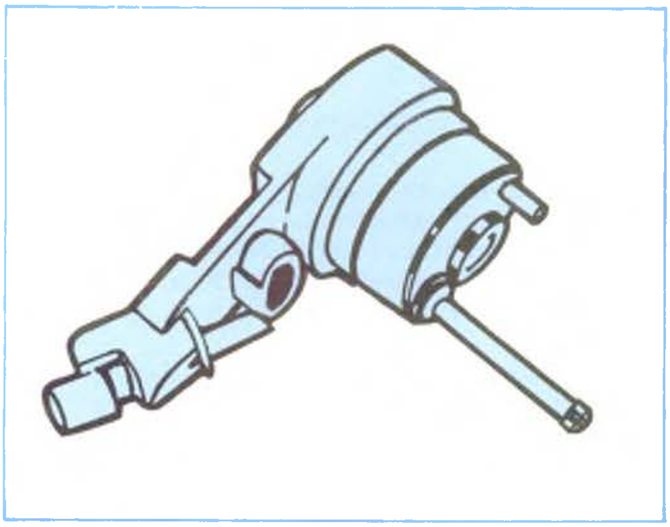


Figure 4-161, Tool #J33042.

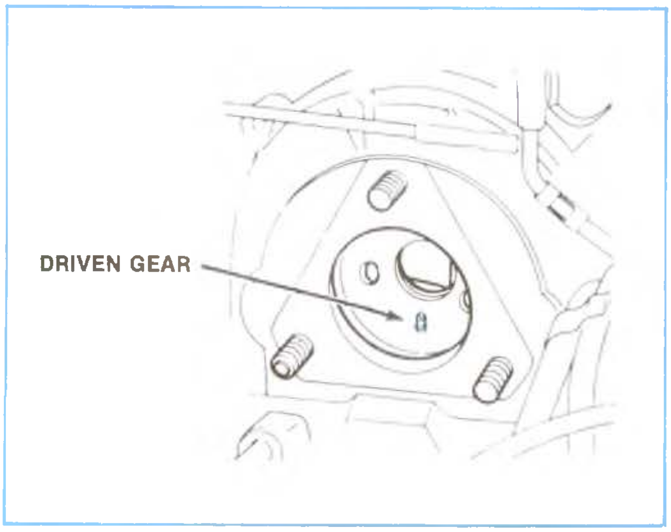


Figure 4-162, Slot of F.I. Pump Gear.

Static Timing

FUEL SYSTEM ADJUSTMENT "MARKING TDC" ON FRONT HOUSING 6.2L DIESEL ENGINE:

1. Turn engine to TDC #1 cylinder (firing).
2. Install timing fixture (J-33042) in F.I. pump location (Figure 4-161). Do not use gasket.
3. Slot of F.I. pump gear to be in vertical 6 o'clock position — (if not, remove fixture and rotate engine crankshaft 360 degrees). The timing marks on gears will be aligned. See Figure 4-162.
4. Fasten gear fixture with one 8mm bolt, and tighten.
5. Install on 10mm nut to housing **upper** stud to hold fixture flange nut to be "finger" tight.
6. Torque large bolt (18mm head) counterclockwise (towards left bank) to 50 ft. lbs. Tighten 10mm nut.
7. Insure crankshaft has not rotated (and fixture did not bind on 10mm nut).
8. Strike scriber with mallet to mark "TDC" on front housing.
9. Remove timing fixture.
10. Install fuel injection pump **with** gasket.
11. Install on 8mm bolt to attach gear to pump hub and tighten to specifications.
12. Align timing mark on F.I. pump to front housing mark. Tighten to specification (3) 10mm attachment nuts.
13. Rotate engine and install remaining (2) pump gear attaching bolt and tighten to specifications.

Checking Probe Holder Alignment For Timing Accuracy

ENGINES DISASSEMBLED

1. Balance #3 and #5 piston positions to establish T.D.C. #1 cylinder firing (Figure 4-163).

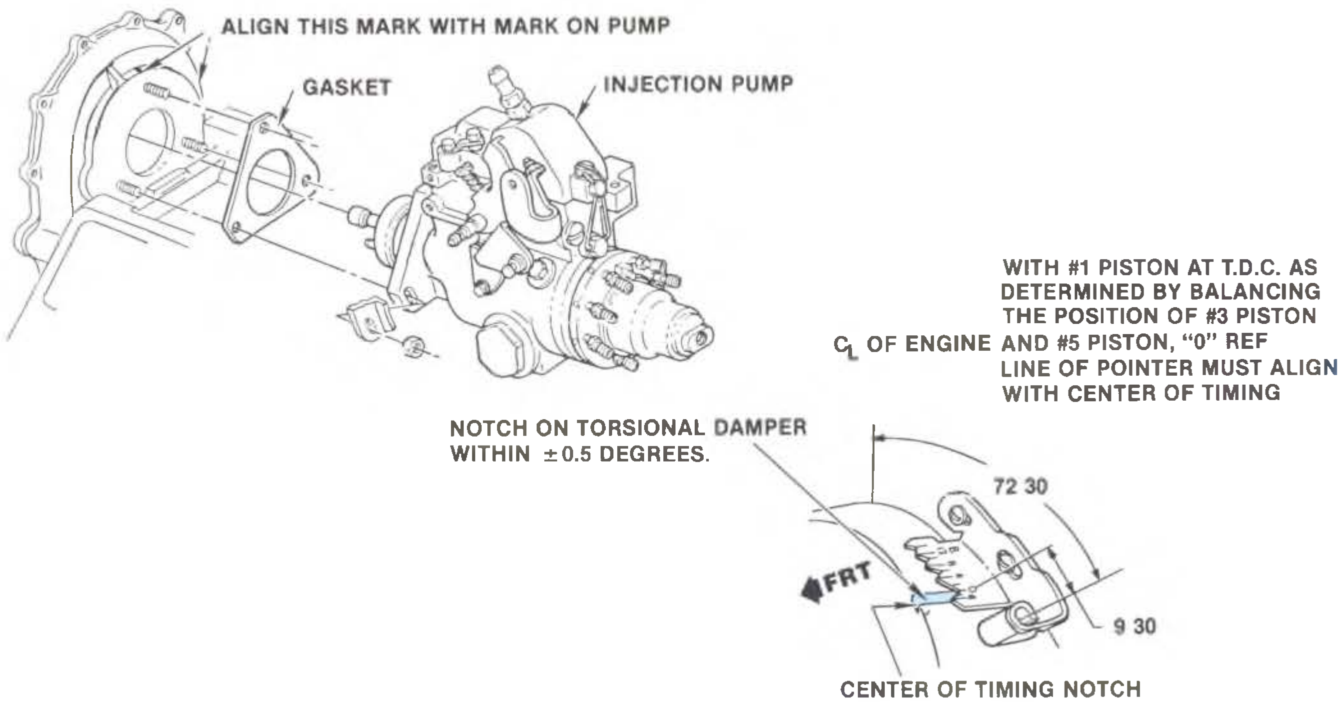


Figure 4-163, T.D.C. Mark.

2. With crankshaft fixed (locked) at T.D.C. #1 cylinder firing:
   A. Install timing pointer at 0 position with respect to mark on torsional damper.
   B. Install timing gear fixture and housing marking fixture. Apply a torque to 50 ft. lbs. to fixture gear in clockwise direction (looking at front of engine, i.e., toward #1 cylinder). Mark timing line on housing. Remove fixtures.
3. Position reference pin on fuel injection pump hub with respect to timing line on pump.
4. Install fuel injection pump through rear of front housing. Align housing and pump timing marks, tighten fasteners.

— NOTE —

Determining cylinder #1 TDC position on an assembled engine for probe holder alignment.

- Remove valve rocker cover.
- Rotate crankshaft until desired cylinder is at or near TDC.
- Remove valve spring retainers, cap, and spring from the inlet valve and allow valve to drop on to head of piston.
- Set up a dial indicator to record the displacement of the valve tip as the crankshaft is rotated.
- Attach a degree wheel to the front of the crankshaft or attach a piece of "calibrated" tape on the damper circumference (.070 inches per degree for an 8 inch diameter damper) to provide accurate reading of at least ±10 degree crankshaft rotation from an assumed TDC reference on a stationary pointer.
- Turn the crankshaft in the direction opposite normal rotation such that the damper mark is approximately 18 degrees BTDC.
- Turn crankshaft in the direction of rotation to 10 degrees BTDC. (To remove any gear/chain lash in timing system). Record dial indicator reading.
- Continue to rotate crankshaft in 2 degree increments and take dial indicator readings thru 10 degrees ATDC.
- Plot the data on a graph. If the assumed TDC was correct, the plot will be symmetrical about that point, i.e., a given valve tip displacement will occur at the same number of degrees before and/or after TDC.
- An alternative to a graph would be to record the number of degrees before TDC and after TDC that a given valve tip displacement occurs; then average those 2 numbers. The resulting number will be the number of degrees thru TDC is from the selected valve tip displacement.

Checking Or Adjusting Pump Timing (Static)

For the engine to be properly timed, the marks on top of the engine front cover and the injection pump flange must be aligned.

— NOTE —

The engine must be off when the timing is reset.

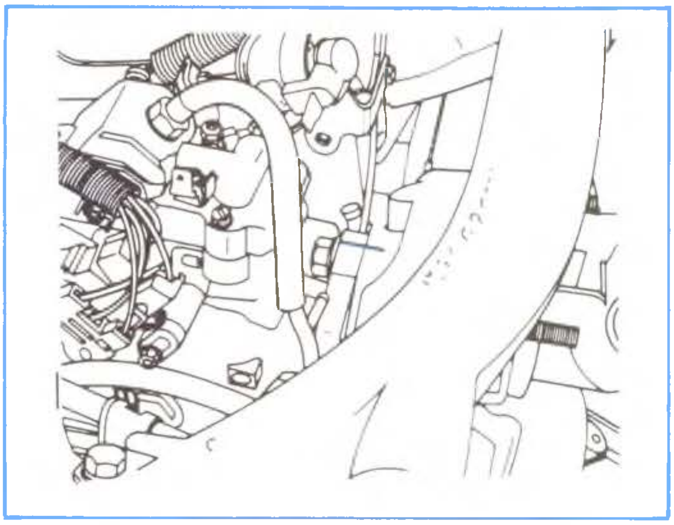


Figure 4-164, Aligned Timing Marks.

ADJUSTING

If marks are not aligned, adjustment is necessary. See Figure 4-164.

1. Loosen the 3-pump retaining nuts **(ENGINE MUST BE OFF).**
2. Align mark on injection pump with mark on front cover and tighten nuts to 40 N·m (30 ft. lbs.). Use Tool J-29872 to aid in rotating the pump to align the marks.

Pump Timing Mark Location And White Smoke At Idle

A condition of white exhaust smoke at idle when the engine is at normal operating temperature may be due to slightly retarded injection timing. The following steps must be adhered to in order to properly diagnose the condition and take corrective action.

1. Determine if retarded timing is the cause of white smoke.
   A. Engine should have a minimum of two hundred (200) miles.
   B. Operate engine to normal temperature (thermostat open).
   C. Check engine RPM and set if required to six hundred and fifty (650) RPM in park (auto) or neutral (manual). Also set fast idle speed to 800 RPM.
   D. With engine at proper idle speed, check for emission of white smoke.
   E. If white smoke is evident, connect a lead from battery plus (+) terminal to the cold advance solenoid terminal on the injection pump (Figure No. 1). A noticeable change in engine sound will be evident. Activating the cold advance solenoid increases the timing approximately three (3) degrees.
   F. Check for white smoke. If no white smoke is evident or has reduced considerably, a change in timing setting is required. If the smoke does not diminish, check for other causes of white smoke. (Assure each cylinder is firing — start with a compression check.)
2. Adjustment of Timing. See Figure 4-165A.
   A. The pump/engine flanges may or may not have a white alignment tape attached, which was used on some early production engines for timing adjustment.
   B. Obtain locally a piece of white tape and draw a 1mm offset line as shown in Figure 4-165B.
   C. To correct the white smoke condition on this engine, add a new tape with a 1mm offset over the old tape (or bare flange(s) if tape is missing). Cut the tape between the flanges. Loosen the three (3) pump attaching bolts and rotate the pump to line up the offset lines. The pump must be rotated clockwise as viewed from the front of the vehicle. Do not exceed 1mm of pump movement. Retighten the three (3) pump attaching nuts to a torque of 25-37 ft. lb. (34-50 N·m).
   D. NOTICE: Do not make timing adjustment with engine running. Do not start engine until pump attaching nuts are torqued securely.

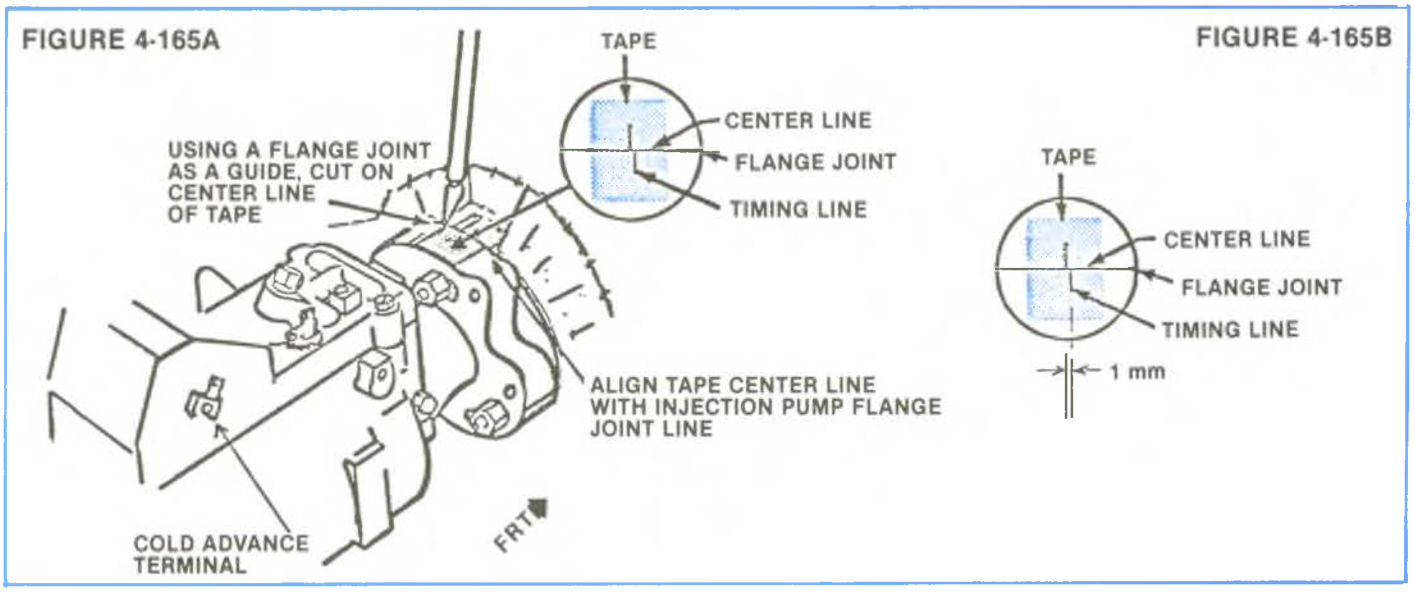


Figure 4-165A-B, Injection Pump Static Timing.

TIMING ADJUSTMENT PROCEDURE

1. Obtain white tape approximately one (1) inch wide by one (1) inch long.
2. Draw a center line.
3. Draw a perpendicular line downward from the center line.
4. Measure from this line 1mm to the left along the center line.
5. Draw a perpendicular line from this point in the other direction.
6. Remove tape backing.
7. Install on pump/flange interface with center line on joint.
8. Cut tape.
9. Loosen pump attaching nuts, move pump to align the offset lines.
10. Retighten pump attaching nuts.

SERVICE INJECTION PUMP STATIC TIMING SETTING

See Figure 4-166. Any service on the 6.2L Diesel engine which requires replacement of the injection pump requires the static timing mark to be at the correct setting.

During the 1982 model year a change to the procedure for marking the pump was made. Injection pumps built during the first half of the 1982 model prior to the change, required the pump timing mark to be offset from the housing flange mark. To facilitate these settings a piece of tape was used which had offset lines. By lining up the tape lines the correct setting was achieved. White tape was used on light duty engines and yellow on heavy duty.

Since service pumps may be of a different vintage than the removed pump, the following must be adhered to for correct timing setting whenever installing a replacement injection pump:

1. All injection pumps have a model identification plate which is attached to the pump housing just below the throttle linkage. The plate includes the (1) model number, (2) serial number and (3) the part number — (Figure 4-166).
2. Remove and install injection pump per service manual procedure.
3. Refer to Figure 4-116 which displays the location of the timing marks which are stamped into the injection pump flange and the front housing.
4. Remove any timing tape that is over the stamped marks.
5. Refer to the model identification plate on the pump that is being installed. Use the following chart to determine the timing mark alignment setting:

MODEL NUMBER	ENGINE/RPO	PUMP PART NUMBER	TIMING MARK OFFSET
DB2-4090	Light Duty (LH6)	14050587	1.5mm (.059″)
DB2-4091	Heavy Duty (LL4)	14050588	2.5mm (.098″)
DB2-4126	Light Duty (LH6)	14050587	Aligned
DB2-4153	Heavy Duty (LL4)	14050588	Aligned

6. If the pump is DB2-4090 or 4091 always have the mark on the pump toward the left side (driver's) of the mark on the housing. This is the advance direction.
7. If an injection pump is to be removed and then reinstalled, it should be first paint marked at the pump to housing flange to allow reinstallation at the original setting.
8. Do not make timing adjustment with the engine running. Do not start engine until pump attaching nuts are torqued securely.

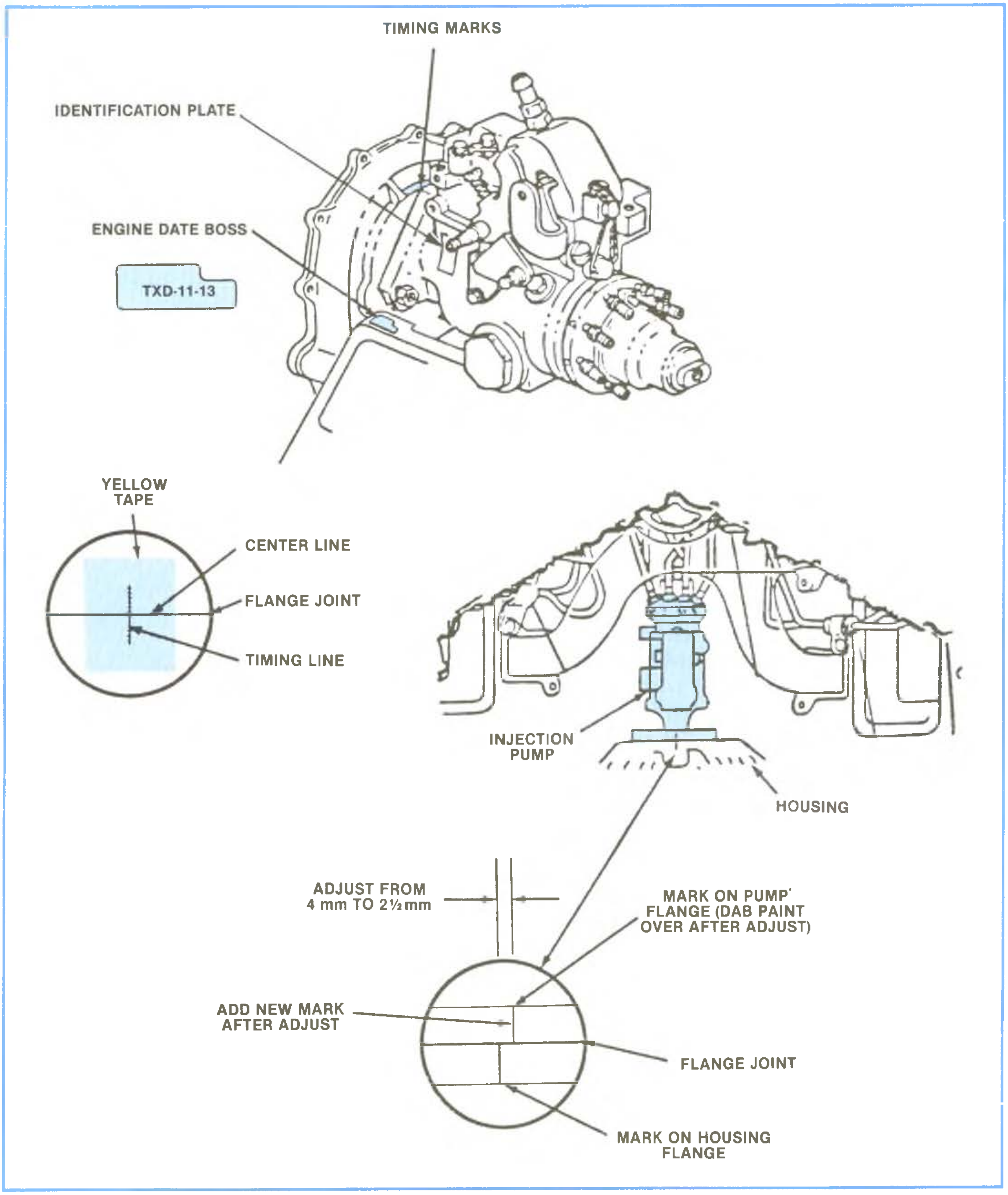


Figure 4-166, **Timing Adjustment, Heavy Duty 6.2L Diesel Engine.**

6.2L Diesel California Engine Timing "C-K" With YF5 California Emissions Light Duty 6.2L Diesel

Any service on the 6.2L light duty diesel engine (built to California specifications) which necessitates removal or replacement of the injection pump, requires a different static timing procedure.

Light duty engines built to California specifications have been timed with a microwave process. After timing with the microwave, an additional mark "O" is stamped over the pump flange/housing interface.

When viewing the California timed engine, the two (2) timing marks (as on Federal engines) will be visible. These may or may not be lined up. In addition, an "O" will be visible, stamped on the flange interface. The "O" should be round. Any deviation of the timing will result in two (2) half circles not matching.

If the pump is removed for service and is replaced on the same engine, be sure to match the "O" for correct timing setting.

If a new pump or a pump that was not previously on the engine is installed, do not use any "O" marks. Instead, use the normal timing marks and align according to the information previously detailed.

Timing Meters

Diesel engine timing meters have the capability of checking engine timing and RPM. These meters can be used to perform diagnostic checks on the 6.2 liter diesel engine. The 6.2 liter engine's injection pump timing **must be** set to static specifications outlined in this manual.

TIMING METERS AND DIAGNOSTIC PROCEDURES

The timing meter's timing capability and tachometer can be used to check the injection pump's housing pressure cold advance and rocker arm mechanical light load advance functions for operation. These checks may indicate if the pump's advance solenoid, advance piston assembly and cam ring are functioning and not binding or seized.

PROCEDURE

1. Place the transmission selector in park, apply the parking brake and block the wheels.
2. Start the engine and let idle until fully warmed up. Then shut off engine.
3. Clean any dirt from the engine probe holder (RPM counter) and crankshaft balancer rim.
4. Using a snap-on MT95 (bracket qualifier) qualify the timing indicator.
5. Attach the timing meter, following manufacturer's instructions.
6. Start engine and adjust idle to 650 RPM. Note engine timing and RPM readings.

HOUSING PRESSURE COLD ADVANCE CHECK

Disconnect advance solenoid's terminal wire at the injection pump. Attach a jumper wire to the battery positive terminal and touch injection pump's advance solenoid terminal. Note engine timing and RPM readings.

When the advance is functioning properly, the engine's timing will **advance** approximately 3 to 5 degrees and RPM will **increase** when the solenoid is energized.

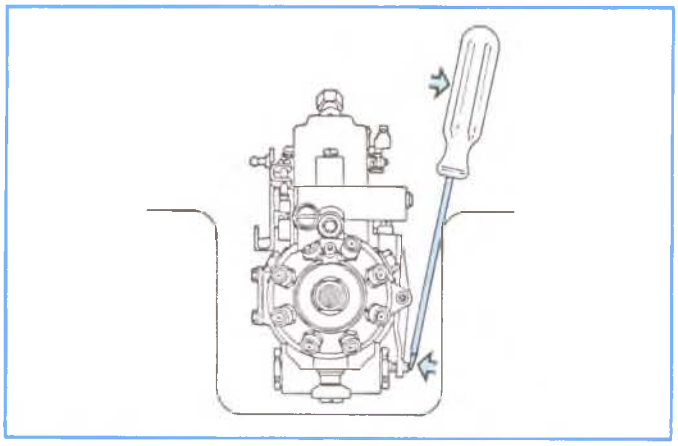


Figure 4-167, Depressing Rocker Lever.

ROCKER ARM MECHANICAL LIGHT LOAD ADVANCE CHECK

See Figure 4-167. Using a ten-inch long screwdriver, push the injection pump's rocker arm (at lower end) towards injection pump. Note engine timing and RPM readings.

When the rocker arm mechanical light load advance is functioning properly, the engine's timing will **retard** approximately 3 to 5 degrees and RPM will **decrease.**

Injection pump removal is normally required to repair the pump's internal mechanical advance.

Engine RPM may require readjustment to emission label specifications when diagnostic procedures are completed.

Injection Nozzles

6.2L NOZZLE AND HIGH PRESSURE FUEL LINES

See Figure 4-168. The fuel from the injection pump is directed through the 8 high pressure lines to the fuel injection nozzles. To a large degree, the successful operation of the engine depends on these eight injection nozzles.

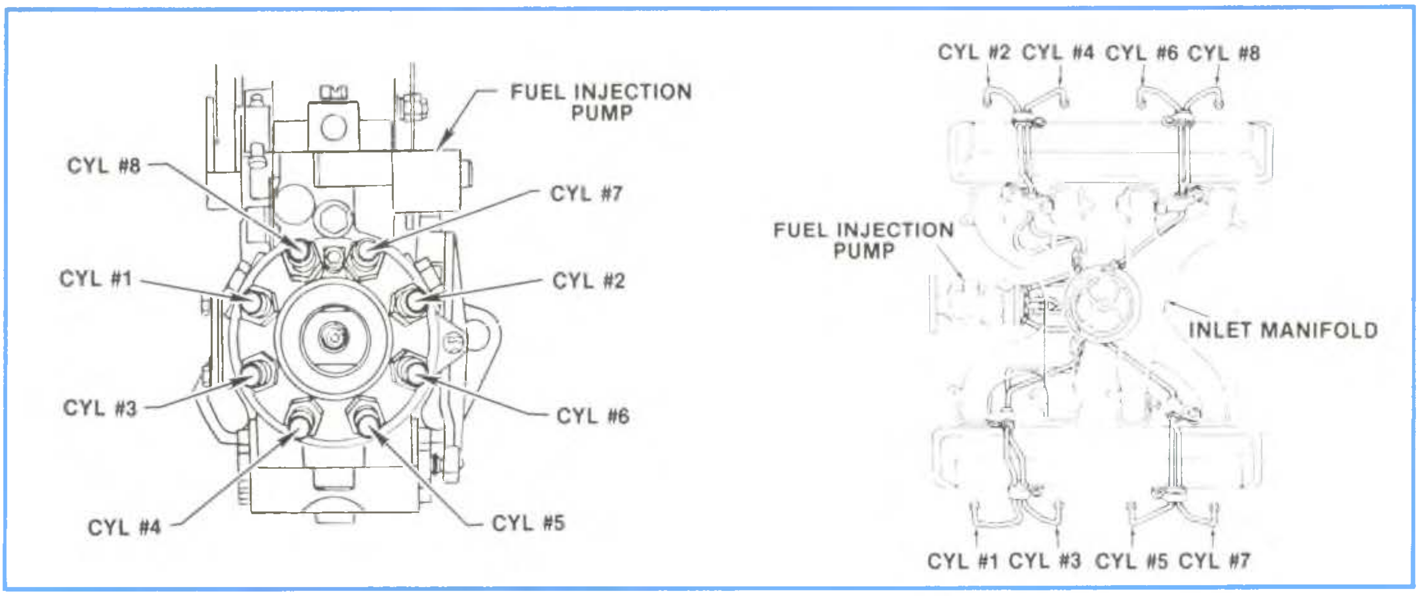


Figure 4-168, **6.2L High Pressure Fuel Lines.**

Metered fuel, under pressure from the injection pump, enters the nozzle and pressurizes the nozzle body (Figure 4-169).

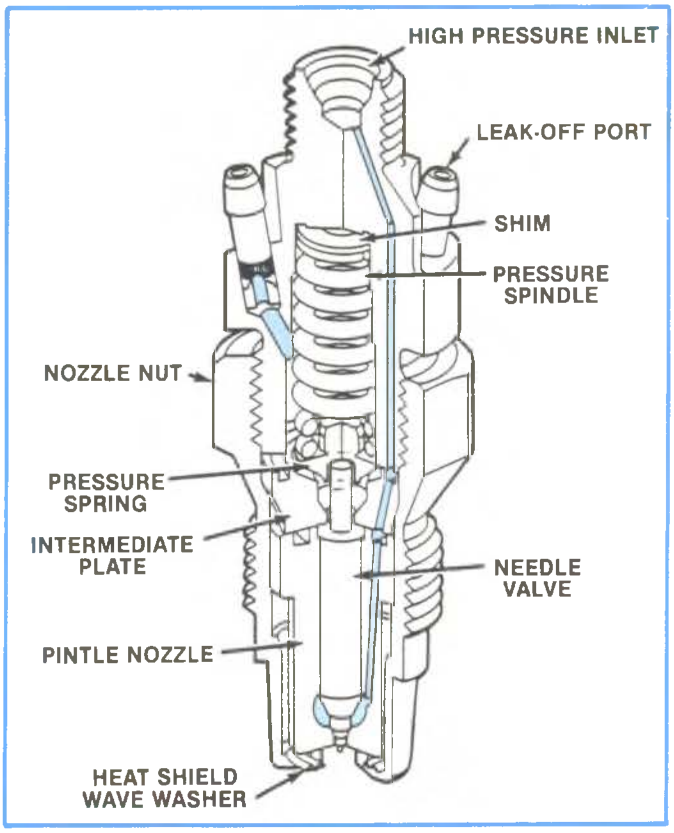


Figure 4-169, **6.2L Nozzle.**

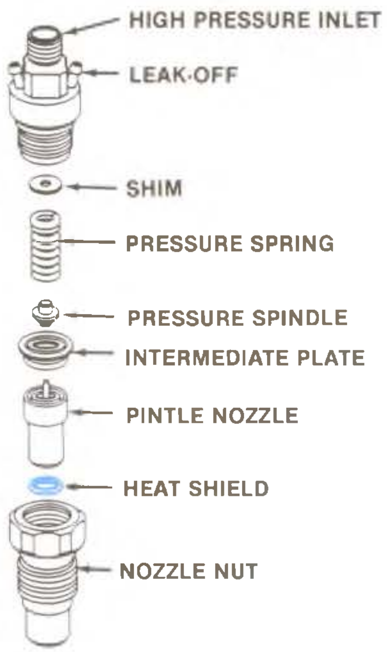


Figure 4-170, **Nozzle Holder Assembly, Exploded View.**

When the pressure in the nozzle body overcomes the spring force, the valve lifts off its seat allowing fuel to spray into the pre-chamber.

During injection a small amount of fuel leaks through the clearance of the valve guide. This fuel flows through the fuel drain back nipple at the top of the nozzle and is returned to the fuel tank through the fuel return line.

The nozzle also has a bleed back path for bleeding excess fuel back to the gas tank. The nozzle allows only the amount of fuel to pass that is needed for engine operation.

Model #KCA18450
Bosch #DNOSD193

See Figure 4-170. The nozzle is a pintle type #DNOSD248 having an initial rota-flow value of 680 cm^3/minute at 0.1mm lift, and overlap length of 0.7mm and a maximum lift of 97mm. The nominal opening pressure is 130 bars (1885 psi).

A pintle nozzle has a special type of a needle valve where in an integral tip from the lower end of the needle is so formed as to influence the flow rate and/or spray. It is a tiny projection at the end of the valve (pintle) which extends through the single large orifice.

The main purpose of the nozzle is to direct and to atomize the metered fuel into the pre-combustion chamber. Fuel from the injection pump enters and pressurizes the supply passages in the injector. When the force on the lift area is greater than the spring pressure on the needle valve spindle, the needle valve is lifted off its seat and rests with its upper shoulder against a stop.

Fuel is forced out into the pre-combustion chamber while the needle valve is lifted. The pressure required to open this injector needle valve is approximately 1700 psi.

As the fuel sprays into the pre-combustion chamber, the pump continues to turn and instantaneously closes off fuel to the nozzle. This action causes a rapid drop in fuel line pressure and spring pressure forces the needle valve to close and seat again, sealing off fuel from the pre-combustion chamber.

The injector nozzle injects fuel once for every 2 revolutions of the crankshaft. This means that under normal driving conditions it will open and close about 1,000 times for every mile driven. In a 10-mile drive to and from work each day, each injector nozzle would open and close approximately 10,000 times. In relation to time if you are driving 60 MPH, each injector nozzle will open and close 1,000 times/minute.

Tool J-29873, a 30mm socket, is used for R & R. There is a copper washer used to seal the outside from the combustion area.

It must be replaced anytime the injector is removed. Maximum pop-off is 135 bars (1960 psi), minimum pop-off 125 bars (1810 psi), leakage 105 bars (1520 psi).

Opening pressure used nozzle; should not fall below 105 bars (1500 psi) on used nozzles.

- Thread size — M24 x 1/5mm fin.
- Length — 84mm
- Needle valve diameter — 6mm
- Line O.D. — 6.3mm
- Line I.D. — 2.5mm
- Line length — 600mm

The G-series has a nozzle which is 10mm shorter than the C-K-P model (Figure 4-171).

Changes in fuel injection nozzle design in the 6.2L diesel from the 1982 to the 1983 and later models require that correct replacement nozzles are used in service.

Attempts to use the incorrect nozzle will damage the cylinder head and nozzle threads. The nozzle used in 1983 and later is similar in appearance to the 1982 nozzle except for a different thread pitch size for the C-K-P Truck only.

When replacing nozzles, reference should be made to the nozzle part number (stamped on the side of the nozzle).

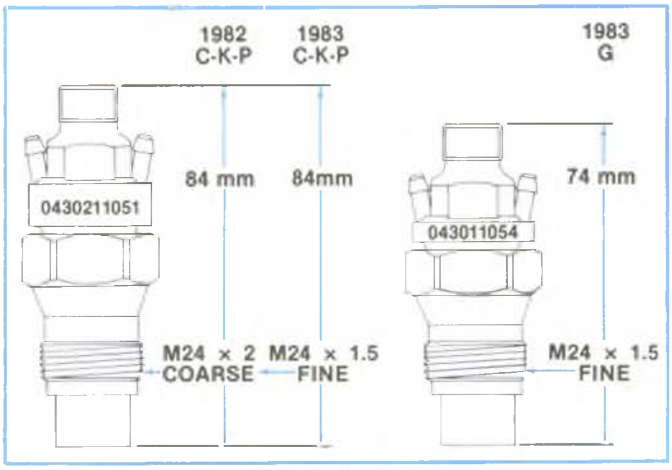


Figure 4-171, G and C-K-P Nozzle Comparison.

— NOTE —

When installing nozzle threads, use Anti-Seize Compound #1052771.

The following chart displays the nozzle applications for 1982 and later models:

	1982			1983 AND LATER		
USAGE	NOZZLE	THREAD	LENGTH	NOZZLE	THREAD	LENGTH
C-K-P	0430211051*	M24 x 2 (coarse)	84mm	0430211058*	M24 x 1.5 (fine)	84mm
G	—	—	—	—	M24 x 1.5 (fine)	74mm

— *NOTE —

The nozzle part numbers shown are vendor part numbers and should not be used for ordering. Use GM part numbers for ordering.

The G-series nozzle also has a 5mm needle valve diameter. The I.D. of the G-series lines are 2mm. The C-K-P needle valve O.D. is 6mm and line I.D. is 2.5mm. Both lines are 600mm in length.

Nozzle Testing

Test is comprised of the following checks:

- Nozzle Opening Pressure
- Chatter
- Leakage
- Spray Pattern

— NOTE —

Each test should be considered a unique test, i.e., when checking opening pressure; do not check for leakage.

If all the above tests are satisfied, the nozzle holder assembly can be again installed in the engine without any changes. If any one of the tests is not satisfied, the complete nozzle holder assembly must be replaced or repaired. Use the following steps.

1. Test Lines — 6 x 2 x 400mm (1.5mm bore).
2. Test fluid per ISO 4113 (example Sheel V1399, Viscor 1487c).
3. Kinetic Viscosity at 40 degrees C per ISO 3104: 2.45-2.75mm 2/second.
4. Test oil temperature during test: 20-25 degrees C (room temperature).
5. Refer to the equipment manufacturers instructions for exact test procedures.

— CAUTION —

When testing nozzles, DO NOT place your hands or arms near the tip of the nozzle. This high pressure atomized fuel spray from a nozzle has sufficient penetration power to puncture flesh and destroy tissue and may result in blood poisoning. The nozzle tip should always be enclosed in a receptacle, preferably transparent, to contain the spray.

TEST SEQUENCE

• PREPARATION

1. Connect the nozzle holder assembly to the test line.
2. Install two clear plastic lines (approximately 1 to 1.5 in. long) over the leak-off connections.
3. Close the shutoff valve to the pressure gauge.
4. **Fill and flush the nozzle holder assembly with test oil by activating the lever repeatedly and briskly. This will apply test oil to all functionally important areas of the nozzle and purge it of air.**

• OBTAINING PRESSURE CHECK

1. Open shutoff valve at pressure ¼ turn.
2. Depress lever of tester slowly. Note at what pressure the needle of the pressure gauge stopped, indicating an increase in pressure (nozzle does not chatter) or at which pressure the pressure dropped substantially (nozzle chatter). The maximum observed pressure is the opening pressure. Some nozzles may drip slightly before they fully open. This is not to be considered a leakage fault, because this is not a leakage test.
3. The opening pressure should not fall below the lower limit of 105 bar (1500 psi) on used nozzles.
4. Replace or adjust nozzles which fall below the lower limit.
5. Adjust the pressure by changing the adjustment shim. The opening pressure is increased by increasing shim thickness and decreased by decreasing shim thickness. It can be changed at the rate of 5 bar (68 psi) for every .04mm (.0016 in.) thickness change.

• LEAKAGE TEST

1. Further open shutoff valve at pressure gauge (½-1½ turns).
2. Blow-dry nozzle tip.
3. Depress lever of manual test stand slowly until gauge reads a pressure of 95 bar (1400 psi). Observe tip of nozzle. A drop may form but not drop off within a period of 10 seconds.
4. Replace the nozzle holder assembly if a droplet drops off the nozzle bottom within the 10 seconds.

• CHATTER TEST

When testing for chatter, it should be noted that the sound (chatter) for new or used nozzles may vary.

On used nozzles, carbonized fuel oil deposited on the pintle and on the nozzle tip produces different sound (chatter) between new and used nozzles on the hand test stand.

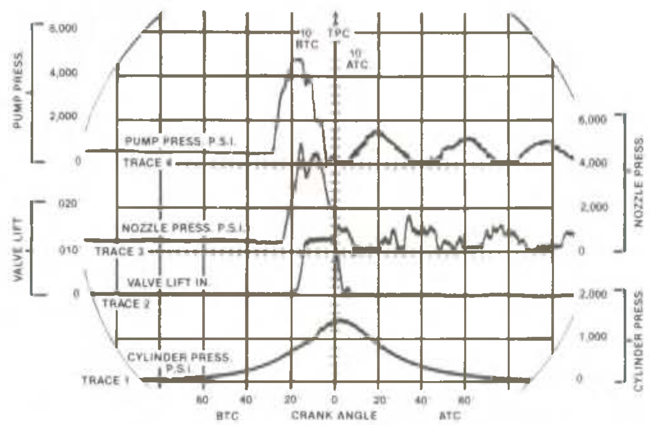
With some used nozzles, the chatter is difficult to detect during slow actuation of the hand test stand lever. As long as there is chatter, the nozzle is acceptable. Use the following steps:

1. Close shutoff lever at pressure gauge.
2. Depress lever of manual test stand slowing noting whether chatter noises can be heard.
3. If no chatter is heard; **increase the speed of lever movement until it reaches a point where the nozzle chatters.**
4. The chatter indicates that the nozzle seat, guide, as well as the pintle, have no mechanical defects.
5. Replace nozzles which do not chatter.

• SPRAY PATTERN

This nozzle features a longer nozzle overlap, greater pintle to body clearance, and greater needle to body clearance. This assembly also features an internal wave washer between the nozzle nut and nozzle. Because of these features, objective testing in the field is difficult. A pop tester will not deliver fuel with the velocity necessary to obtain proper spray pattern analysis.

1. Close shutoff valve at pressure gauge.
2. Depress lever of manual test stand downward abruptly and quickly. The spray should have a tight, evenly shaped conical pattern which is well atomized. This pattern should be concentric to the nozzle axis. Stream-like injections indicate a defect.



TYPICAL OSCILLOSCOPE READING

Figure 4-172, **Oscilloscope Pattern.**

Oscilloscope Pattern, Fuel Injection Pump

Shown in Figure 4-172 is a typical, unretouched, four channel oscilloscope photograph of a Stanadyne fuel injection pump operating at full speed and full load on a 219CID turbocharged diesel engine.

Trace No. 1 represents the cylinder pressure, in pounds per square inch, which reaches approximately 1400 psi during combustion. The preignition pressure of 1000 psi results from the added turbocharger boost which raises the effective compression ratio.

Trace No. 2 represents the nozzle valve lift of .0135 inches (.34mm).

Trace No. 3 shows the nozzle pressure, in pounds per square inch, at the nozzle fitting. A delay in pressure rise occurs around 20° BTDC (engine timing) due to the unseating of the nozzle valve at the preset pressure of 2500 psi. The pressure continues to rise to a peak of approximately 5000 psi after the valve lifts off its seat. This is a result of the resistance generated when the fuel is forced through the tiny spray orifices in the nozzle tip. Note that a small pressure rise, or bounce, occurs after the valve strikes its seat upon closing.

Trace No. 4 represents the injection pump output pressure in pounds per square inch. The peak pressure is approximately the same as nozzle pressure (5000 psi).

The misalignment of traces 3 and 4 indicates the time (lag) it takes for the pump discharge pressure wave to pass through the fuel injection lines and reach the nozzle.

The pump discharge begins at 28° BTDC engine timing. This is 14° pump timing. The advance mechanism was adjusted to produce an 8° pump speed advance (16° engine) with a 12° BTDC static engine timing.

Notice the reflected pressure waves (or afterwaves) which occur after the nozzle is closed. Fluid flow at the nozzle is stopped abruptly when the nozzle closes, but the fuel in the line continues to flow and generates the pressure waves seen in the oscilloscope trace. The pressure waves "echo" back and forth between the nozzle and the pump until they are completely dissipated by fluid friction prior to the next injection cycle. In order to prevent after-injection, the peak pressure of the reflected waves is kept below the nozzle opening pressure.

Also notice that a residual line pressure of approximately 500-600 psi occurs on the left side of the pressure peaks. This pressure is required in order to prevent the valleys of the reflected pressure waves from dropping below atmospheric pressure which could cause cavitation erosion in the pump, fuel line and nozzle.

Cavitation

The injection line is susceptible to a particular kind of corrosion known as cavitation. Cavitation is short of cavitation-erosion-corrosion, indicating the states of the process. First cavitation, second erosion, third corrosion.

The action of the pump creates vapor bubbles in a confined space. These bubbles burst and create shock waves. The shock waves attach nearby metal surfaces, causing them to crumble, or erode. The eroded surface is open to attach by corrosion, which allows the erosion to continue.

Cavitation erosion is actually damage from these pressure waves "echoing" back and forth between the nozzle and pump. It can be compared to the noise or jerk in water pipes which occurs when water is shut off very rapidly.

Fast (Cold) Idle Speed System

See Figure 4-173. The fast idle speed control system consists of a throttle solenoid, engine coolant temperature switch and related control.

During a cold start when the engine coolant temperature is below a prescribed value, the control circuitry energizes (extends) the solenoid and maintains a high engine idle speed by holding the throttle off the low idle stop.

When the engine coolant temperature reaches the prescribed value, the control circuitry de-energizes the solenoid, allowing the throttle to return to the low idle stop.

The fast idle systems work together with the housing pressure cold advance, except on 1984 and later California LH6 systems.

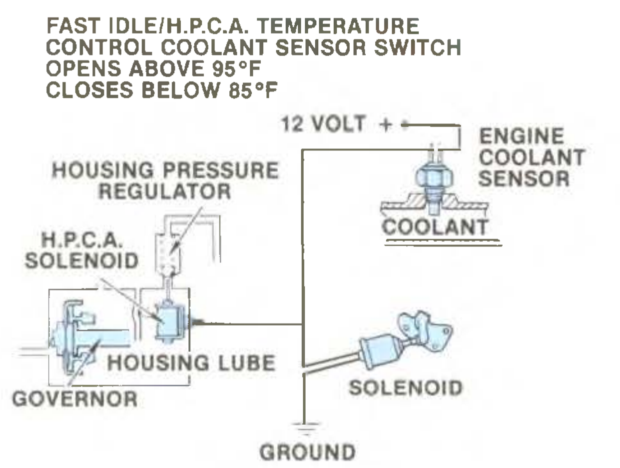


Figure 4-173, **H.P.C.A./Idle Circuit.**

6.2L DIESEL IDLE SPEED SETTING PROCEDURE

1. All idle speeds are to be set within ±25 RPM of specified value.
2. Set parking brake and block drive wheels.
3. Engine must be at normal operating temperature. Air cleaner should be on and all accessories should be turned off.
4. Install a Kent-Moore J-26925 Diesel Tachometer or equivalent per manufacturer's instructions.
5. Adjust low idle speed screw on fuel injection pump to an engine speed of 650 RPM in Neutral for automatic transmissions and 650 RPM in Neutral for manual transmissions.

• **ADJUST FAST IDLE SPEED AS FOLLOWS:**

1. Remove connector from fast idle solenoid. Use an insulated jumper wire from a 12 volt terminal to energize solenoid.

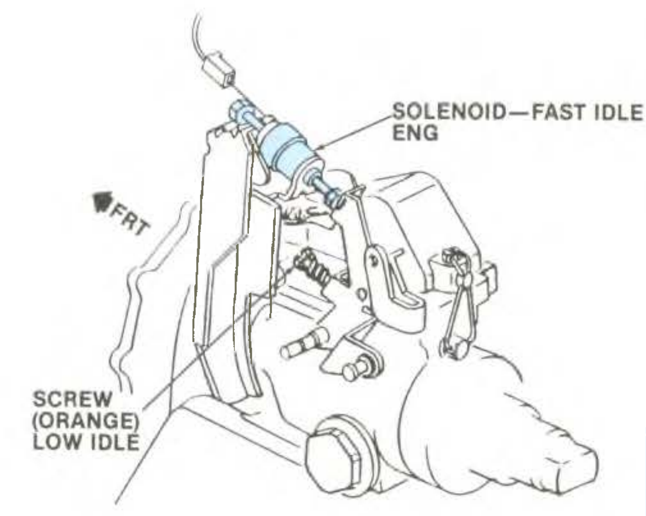


Figure 4-174, **Idle Adjustment.**

— NOTE —

All fast idle solenoids will have the plunger extending through the rear, with a screw head on it. This is for easy access to adjust from the front of the engine.

2. Open throttle momentarily to ensure that the fast idle solenoid plunger is energized and fully extended.
3. Adjust the extended plunger by turning the hex head to an engine fast idle speed of 800 RPM in Neutral.
4. Remove jumper wire and re-install connector to fast idle solenoid.

• **REMOVE TACHOMETER.**

NOTES

5. Emission Systems

5A. General Emission Systems
5B. California Diesel Electronic Control System (DECS)

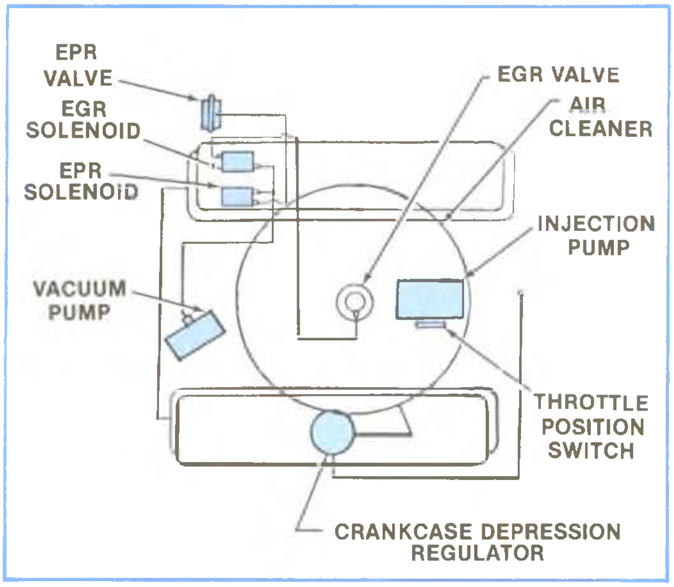


Figure 5-1, **Emission Systems.**

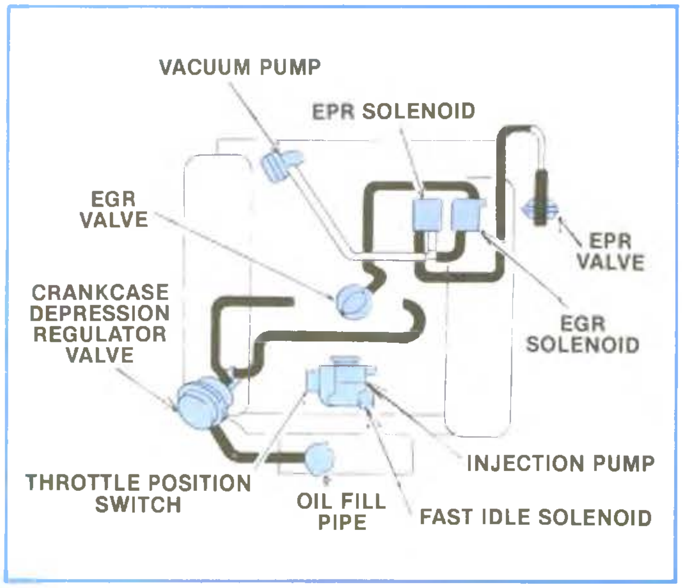


Figure 5-2, **Emission Systems — Federal CK (LH6 Engine).**

5A. General Emission Systems

See Figure 5-1.

1. Crankcase ventilation system (crankcase depression regulator — CDR) LH6 and LL4.
2. Exhaust gas recirculation (EGR) LH6 only.
3. Exhaust pressure regulator (EPR) LH6 only.
4. (LH6) Throttle position switch/(LL4) Vacuum regulator valve.

- Figures 5-2, 5-3 and 5-4 are the Federal Emission schematics for various vehicle applications:

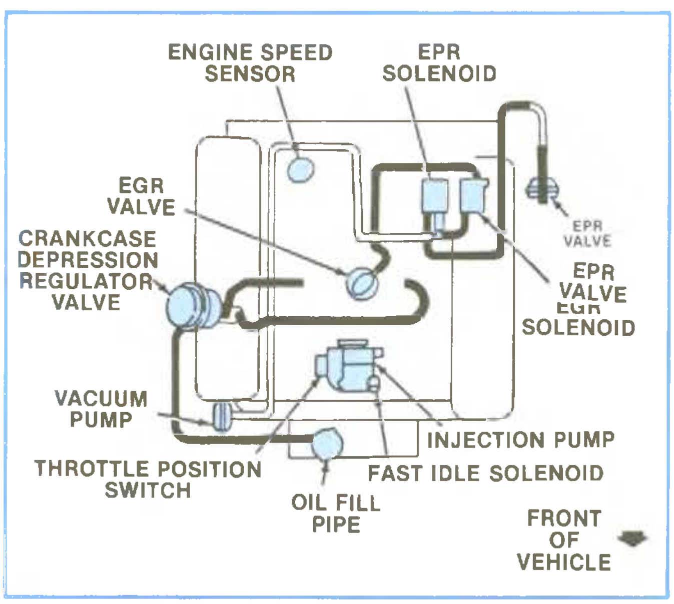


Figure 5-3, **Emission Systems — Federal G (LH6 Engine).**

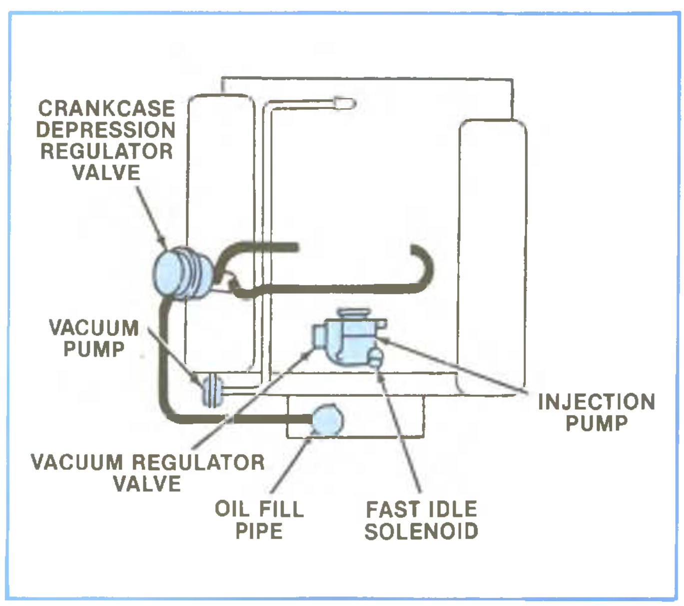


Figure 5-4, **Emission System — LL4 Engine.**

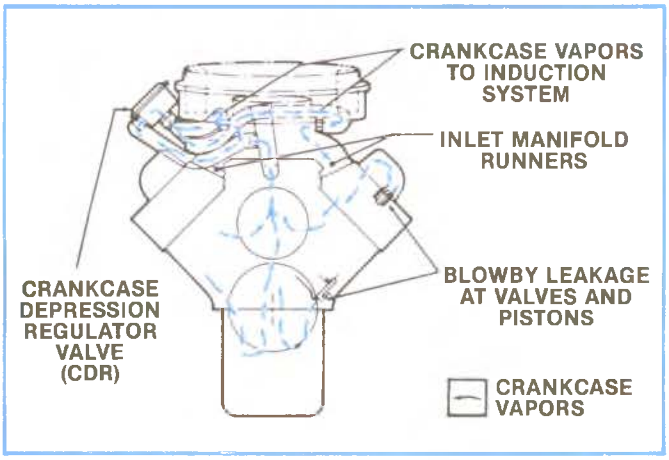


Figure 5-5, Crankcase Ventilation System.

Crankcase Ventilation System

The 6.2L crankcase ventilation system is designed to reduce crankcase pressure at idle (Figure 5-5). It consequently reduces the possibility of engine oil leaks. Crankcase pressure has been highest at idle and, subsequently, the engines have been more susceptible to oil leaks at idle. The regulator is located at the front of the right cylinder head. This, along with the use of large ventilation system tubing will lower crankcase pressure. Crankcase gases now enter the air crossover on each side of the intake manifold.

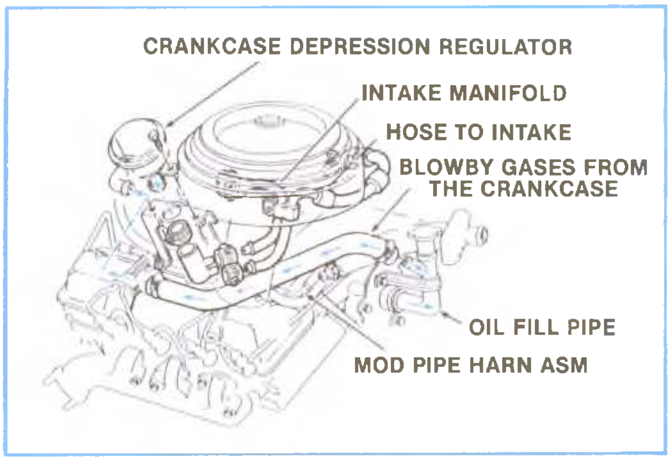


Figure 5-6, CDR Valve Installation.

Crankcase Depression Regulator, CDR

The major component in the ventilation system is the CDR, crankcase depression regulator valve (Figure 5-6). CDR limits crankcase vacuum to a maximum of 3 to 4 inches water. This is done as the gases (blow-by and fresh air) are drawn from the oil fill pipe through the CDR valve and into the intake manifold. 1985 and later CDR plumbing incorporates plastic snap clamp (10019739) for hose retention.

Intake vacuum acts against a spring loaded diaphragm (Figure 5-7) to control the flow of crankcase gases. Higher intake vacuum levels pull the diaphragm closer to the top of the outlet tube. This reduces the amount of gases being drawn from the crankcase and decreases the vacuum level in the crankcase. As the intake vacuum decreases the spring pushes the diaphragm away from the top of the outlet tube allowing more gases to flow to the intake valve.

A diesel engine has little vacuum at idle, because at slow speed there is more time to leak past the rings. And with higher compression the crankcase can be pressurized by blowby.

The purpose of the CDR valve is to maintain 3-4 inches of water (vacuum in the crankcase). Too little vacuum will tend to force oil leaks. Too much vacuum will pull oil into the air crossover.

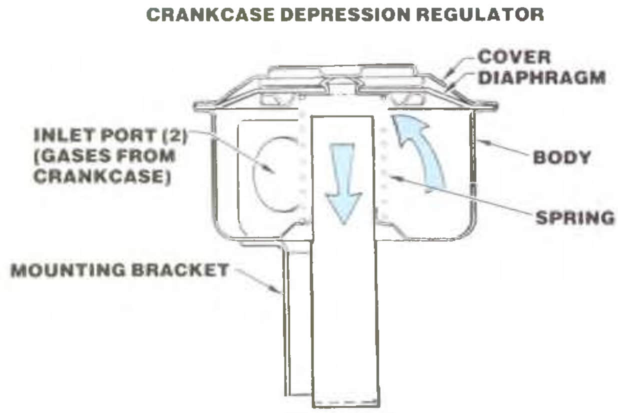


Figure 5-7, **CDR Valve Operation.**

CDR VALVE TEST

The CDR valve is checked with a water manometer (Figure 5-8). The U-tube manometer is a primary measuring device indicating pressure or vacuum by the difference in the height of two columns of fluid. The CDR valve can also be checked with a magnehelic gauge (see Section 7).

Connect one end of the manometer to the oil dipstick hole . . . the other end is vented to the atmosphere. The air cleaner must be installed . . . then run the engine at idle.

•CDR SPECIFICATIONS

1 inch water pressure @ idle to approximately 3-4 inches water vacuum at full load.

NOTE:
Too little vacuum will tend to force oil leaks . . . too much pulls oil into the air crossover.

NOTE:
Add amount column travels up, to amount column travels down, to obtain total. Psi/Vac.

EXAMPLE:
1/2″ + 1/2″ Vac. Reading shown on the manometer is for this **example only.**

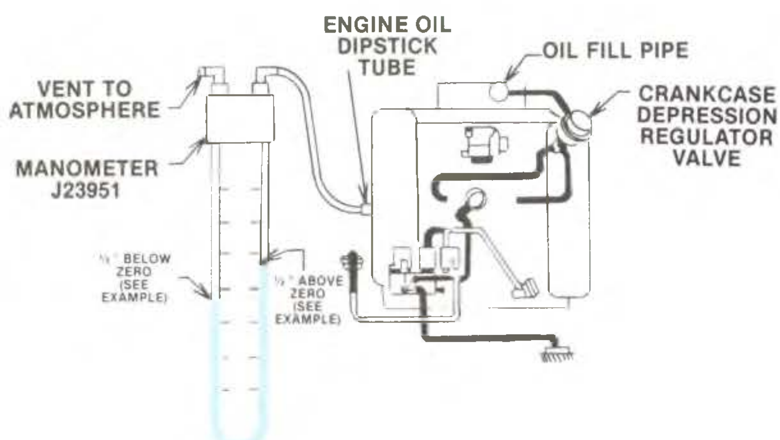


Figure 5-8, **CDR Valve Test with Manometer.**

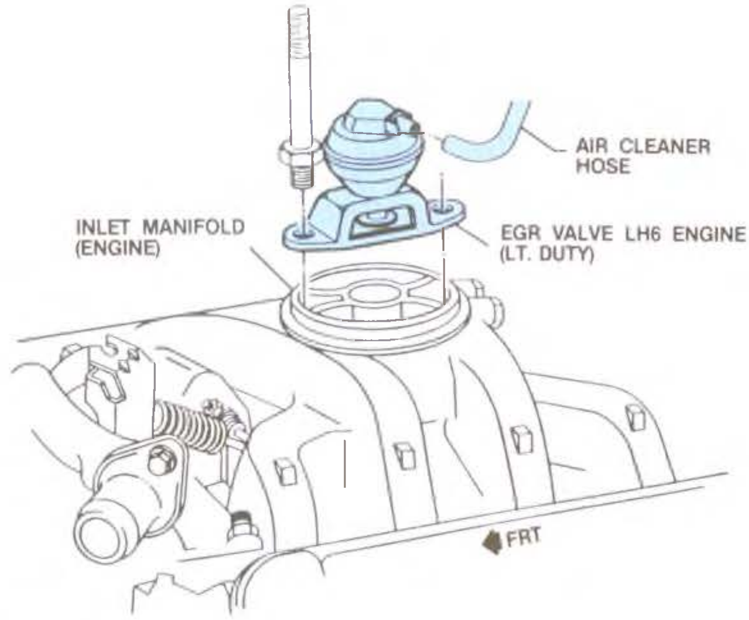


Figure 5-9, **EGR Valve.**

Exhaust Gas Recirculation, EGR

EGR PRINCIPLE

When a vehicle operates for a substantial part of its time at part load — which is the normal condition in town traffic — emissions can be reduced by the use of Exhaust Gas Recirculation. Mixing some of the exhaust gas with the inlet air at part load reduces the concentration of oxygen and lessens the opportunity to produce NO_X. Reduction in NO_X of some 40% can be obtained without increasing HC, CO or specific fuel consumption.

The increase in the temperature and NO_X formation in the main chamber depend upon the amount of incompletely burned compounds discharged from the pre-chamber, the oxygen concentration, and the timing of the discharge.

EGR is designed to control (Oxides of Nitrogen) NO_X. This is done by blending the fuel-air with exhaust gases to reduce the peak temperatures and oxygen concentration. The lack of oxygen lowers the possibility of nitrogen combining with oxygen to form NO_X.

The effect of increasing the EGR on the pollutants shows that as EGR is increased NO_X decreases, while both HC and CO increase. The gradual decrease in NO_X continues as EGR increases but the characteristics of HC and CO change significantly above a value of EGR which varies with speed and load. It is possible to establish an amount of EGR as a function of speed and load. Above 90% fuel no EGR is used. Also since during normal driving in town, very little time is spent above 75% maximum speed, the use of EGR at high speed would have little effect on the pollutants.

Spent gas is run through an EGR valve to the manifold, and then is part of the air intake (Figure 5-9). This is introduced into the combustion chamber. It takes up some of the volume of the incoming charge of air. When ignition takes place, the spent exhaust gases cannot partake in the combustion process, since they have already been used previously, so they add nothing. During the period of "rapid" combustion, the temperature increases quite rapidly. The temperature rise causes the gases to expand. The temperature in the chamber is much higher than the exhaust gases. The spent gases now take part in the process. They cannot add to the process because of lack of oxygen. So the spent or inert gas acts as a sponge and pulls heat into itself causing it to expand. As it does it absorbs heat of combustion and drops the temperature approximately 500°F. Carbon monoxide is not a significant emission factor with diesels. Hydrocarbons are controlled by the injection nozzles, pump timing and combustion chamber design. The EGR valve is used on the LH6 (C) engine only.

VACUUM SWITCHED EGR (FEDERAL EMISSIONS)

With vacuum switched EGR, either full flow or no flow of exhaust gas is admitted to the intake manifold, Figure 5-10. At closed throttle the EGR valve is opened. The EGR valve remains fully open to a calibrated throttle position at which point it closes. The throttle position is sensed by a throttle position switch (TPS) mounted on the throttle shaft. With a TPS, as the throttle is opened, the switch closes at the calibration point and de-energizes a solenoid which shuts the vacuum signal to the EGR valve allowing the valve to close.

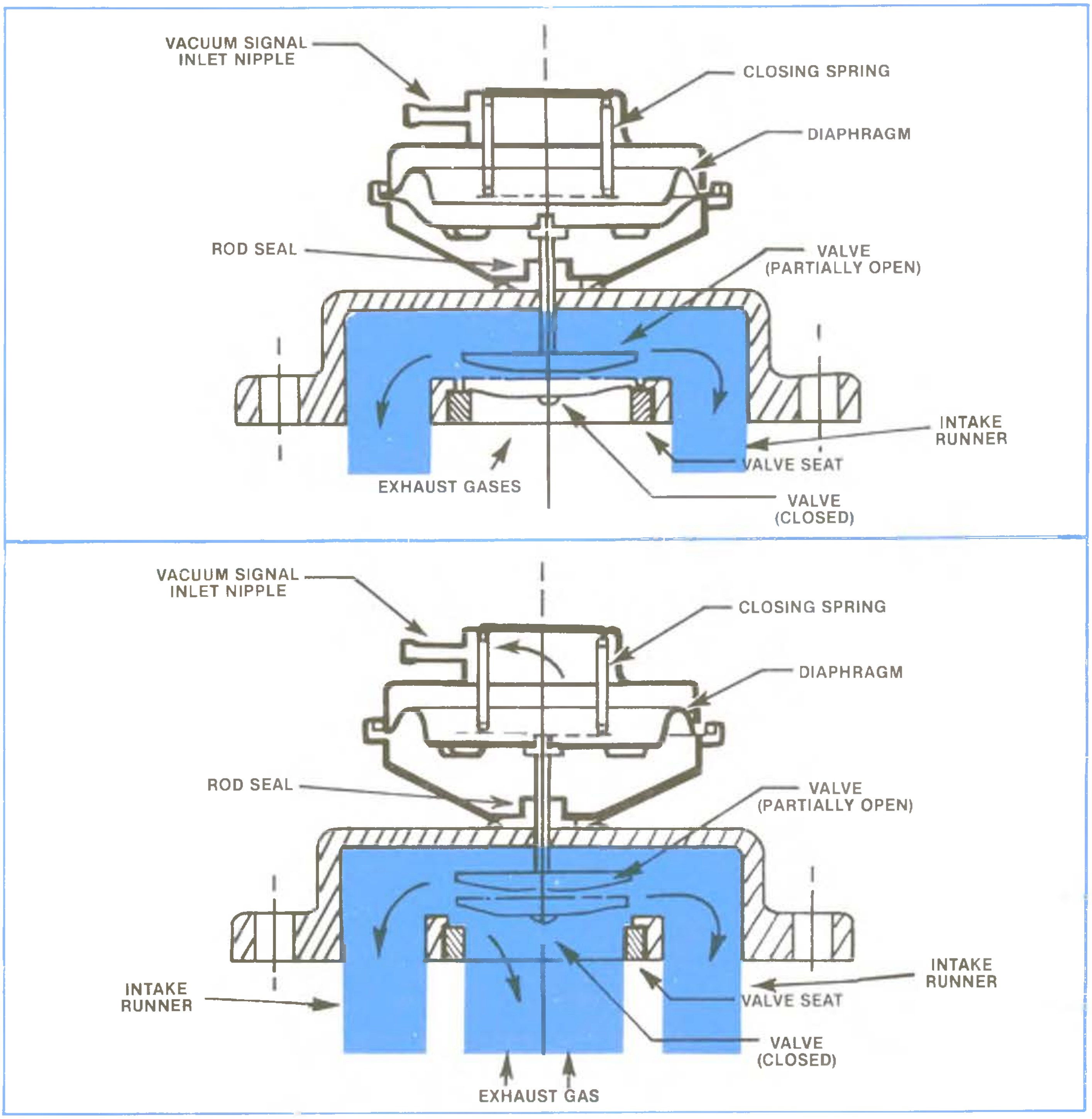


Figure 5-10, Single Diaphragm EGR Valve.

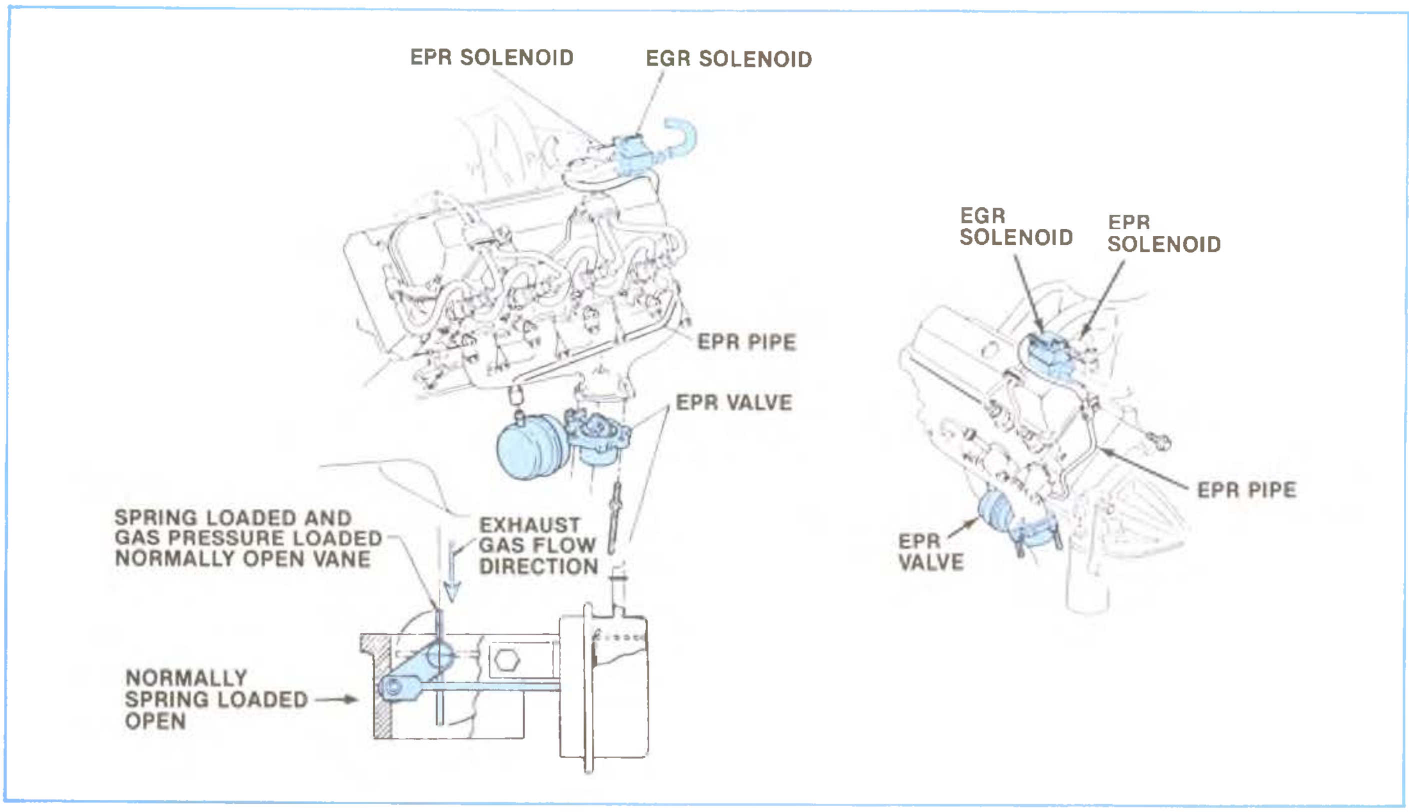


Figure 5-11, EPR Valve and Solenoid Location.

EXHAUST PRESSURE REGULATOR EPR VALVE

An Exhaust Pressure Regulator (EPR) valve is used in the exhaust system to restrict the flow and increase exhaust gas back pressure. (Figure 5-11). This EPR valve is used in conjunction with the vacuum switched EGR valve at the intake manifold. When the throttle is closed, the EPR valve is closed increasing the recirculation of exhaust gas. As the throttle is opened the valve would also open decreasing the amount of exhaust back pressure. The throttle position is sensed by a throttle position switch mounted on the throttle shaft on the injection pump. The throttle position switch de-energizes the EPR solenoid at a calibrated throttle angle.

EPR/EGR Solenoids

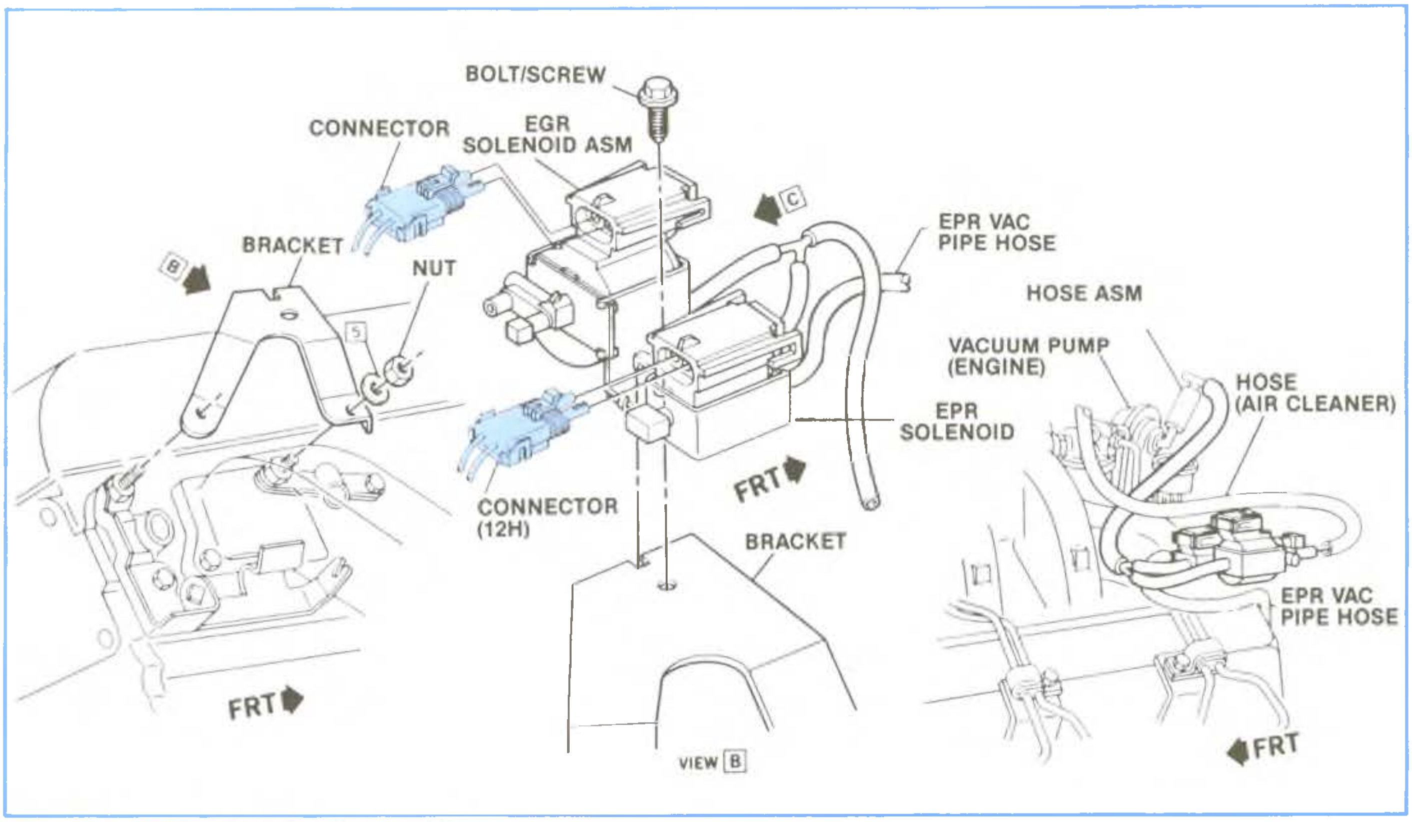


Figure 5-12, **EPR/EGR Solenoids.**

VACUUM SWITCHED EPR

See Figure 5-12. The EPR solenoid is normally closed. When energized by (B+) from the TPS it is open allowing vacuum to the EPR, closing it. This occurs at idle. As the throttle is opened, at a calibrated throttle angle the TPS de-energizes the EPR solenoid, cutting off vacuum to the EPR valve and opening it.

VACUUM SWITCHED EGR

See Figure 5-12. The EGR solenoid is normally open. With vacuum switched EGR, either full flow or no flow of exhaust gas is admitted to the intake manifold. At closed throttle the EGR valve is opened. The EGR valve remains fully open to a calibrated throttle position at which point it closes. The throttle position is sensed by a throttle position switch (TPS) mounted on the throttle shaft on the injection pump.

With TPS, as the throttle is opened the switch closes at the calibration point. It energizes a solenoid which is normally open. This cuts off the vacuum signal to the EGR valve, allowing the valve to close.

— NOTE —

The EPR solenoid is de-energized before, or at the same time, the EGR solenoid is energized.

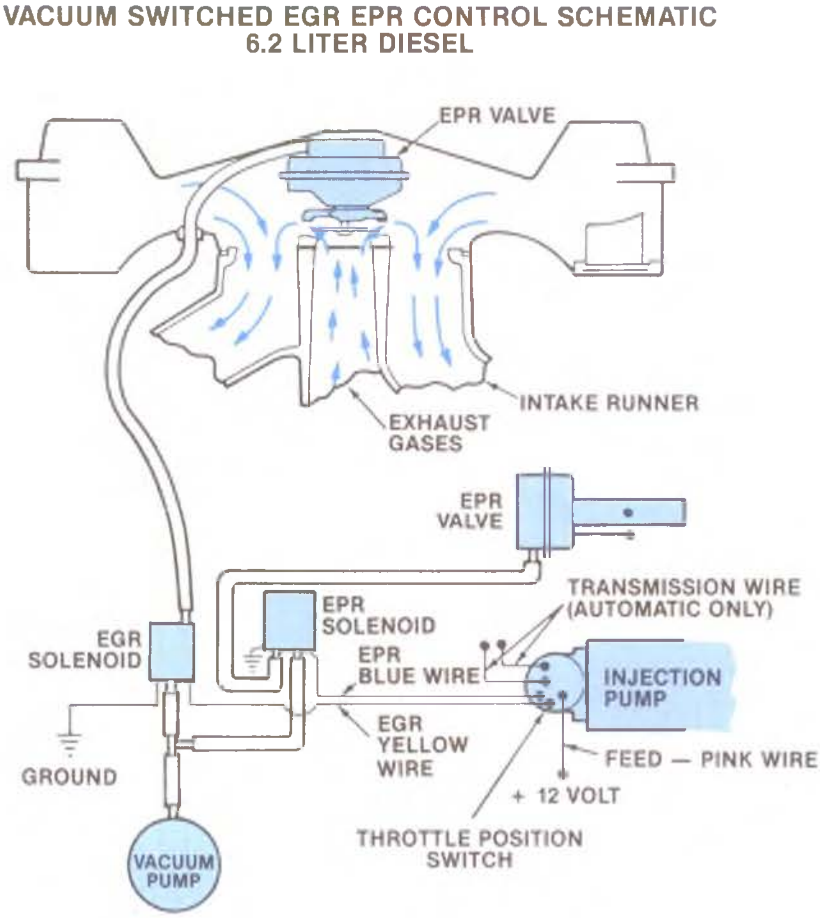


Figure 5-13, Federal EPR/EGR Schematic

Federal EPR/EGR System Operation

Exhaust gas is recycled through the combustion cycle by admitting exhaust gases into the intake manifold. Exhaust gases are routed from both cylinder heads through internal passages in the manifold to the EGR valve (Figure 5-13). Exhaust gas flow is a function of the pressure differential between the exhaust system and the intake manifold. The EGR valve controls the exhaust flow at the point of discharge into the intake manifold.

The EGR valve is operated by vacuum furnished from a mechanically driven vacuum pump (Figure 5-13). The vacuum source signal is routed through an electrically operated open/close solenoid to the EGR valve. EGR is admitted into the intake manifold at idle, and light load fueling rates. The EGR valve remains fully open through a calibrated throttle lever motion. Throttle position is sensed by an electrical switch mounted directly to the R.H. side of the injection pump. As the throttle is opened, the throttle position switch (TPS) electrically closes at the calibration point, energizes the solenoid, and shuts off the vacuum signal, allowing the EGR valve to close.

To increase flow EGR rates an exhaust pressure regulator (EPR) valve is used at the left hand exhaust manifold to increase exhaust back pressure. At closed throttle the EPR valve is closed. With increasing throttle position the throttle position switch electrically opens causing the EPR valve to open by shutting off vacuum to the valve. The EPR valve is controlled by its own switch point within the throttle position switch assembly and its own open/close solenoid. With automatic transmission vehicles, the throttle position switch has an additional function of applying and releasing the transmission converter clutch (TCC), when the throttle is operated to a calibrated point.

THROTTLE POSITION SWITCH

The throttle position switch just has 2 contacts inside it: One to send (B+) at idle on a blue or purple wire to the EPR solenoid which is N.C. and this opens the solenoid valve and vacuum closes the EPR valve. The other contact will send (B+) on a yellow wire to the EGR solenoid, at a specified throttle angle. The EGR solenoid is N.O. This current energizes the EGR solenoid closing it, which cuts off vacuum, closing the EGR valve. There is a delay on some switches in the time when the EPR opens and the EGR closes. There are three different cams used to change EPR/EGR switch points:

- Blue Cam 0° Difference
- Black Cam 5° Difference
- Red Cam 10° Difference

— NOTE —

When DEACTIVATED; the EGR solenoid is normally OPEN, which would allow vacuum to open the EGR valve; and the EPR solenoid is normally CLOSED, cutting off vacuum to the EPR valve, opening it.

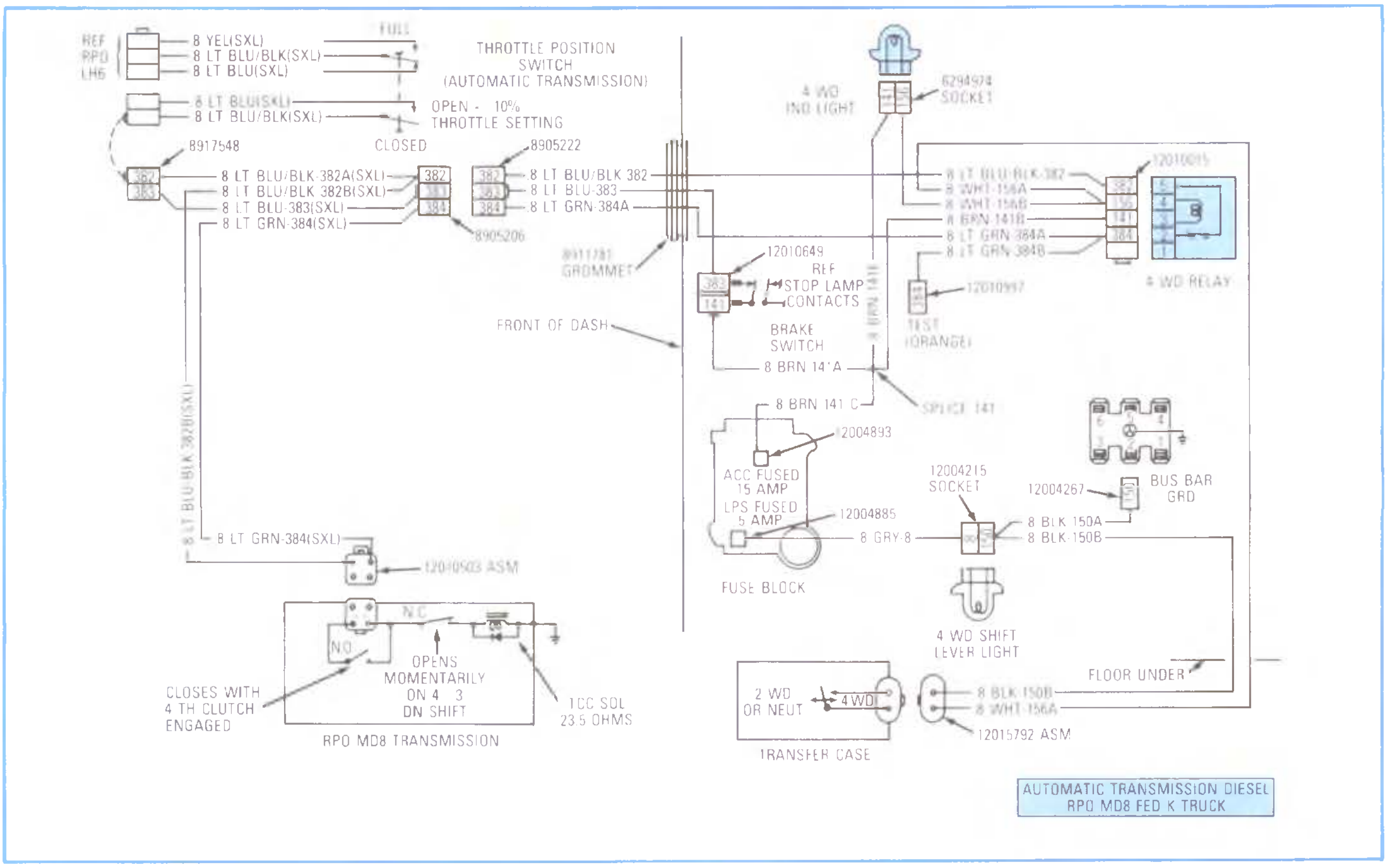


Figure 5-14, Wiring Diagram T.C.C. MD-8 K Truck.

The third switch incorporated in the throttle position switch is used to operate the transmission converter clutch (TCC), in the 700-R4 Transmission (MD8). This switch disengages the converter clutch at a throttle angle of less than 8 degrees.

> **— NOTE —**
>
> **The 1982 models disengaged the converter clutch below, have a 16 degree throttle angle.**

See Figure 5-14, wiring schematic. This switch controls (B+) coming from the brake switch to the T.C.C. solenoid. It prevents converter clutch operation below 8 degrees of throttle opening.

On a 4-wheel drive (Figure 5-14), Diesel Truck, there is a N.C. relay in the parallel path of current to the T.C.C. solenoid, at pin B of the connector at the transmission. It is energized by grounding at pin 4 of the relay.

Pin 4 is grounded through the 4 wheel drive indicator switch in the transfer case. It is grounded in either 4 high or 4 low. When the relay is grounded the N.C. relay is switched to open interrupting the B+ path to pin B of the transmission connector. The only way to have converter clutch operation in 4 wheel drive is, to close the 4th gear switch in the transmission allowing B+ from the other parallel path at pin A to pass through the now closed contacts of the 4th gear switch to the TC.C. solenoid.

Figure 5-15 summarizes the EGR/EPR valve and solenoid operations.

— NOTE —

Heavy black exhaust smoke upon acceleration generally indicates a malfunction in the EGR system.

ENGINE SPEED	EGR VALVE	EGR SOL.	EPR VALVE	EPR SOL.
Idle to 15° Throttle	Open	Not Energized (Vacuum to Valve)	Closed	Energized (Vacuum to Valve)
15° to 20° Throttle	Open	Not Energized (Vacuum to Valve)	Open	Not Energized (No Vacuum to Valve)
20° to Full Throttle	Closed	Energized (No Vacuum to Valve)	Open	Not Energized (No Vacuum to Valve)

Figure 5-15, **EGR Summary.**

EGR/EPR Problem Diagnosis

1. Start engine and operate to open thermostat temperature.
2. Remove air cleaner cover to observe operation of EGR valve.
3. With engine at idle the EGR valve should be open. (Observe valve head in up position and noticeable exhaust noise intake.) If not, check and correct any electrical and hose connection which may be loose and/or disconnected.
4. Remove vacuum hose from EGR valve. The valve head should drop with a noticeable reduction in noise. Reconnect hose.
5. At idle the hose to the EGR valve should have approximately 20 inches of vacuum. If vacuum is not present, check output of the vacuum pump at the pump. The pump should produce a minimum of 20 inches of vacuum.
6. If vacuum is present at the EGR valve but the valve does not open and close as the hose is put on and taken off, the EGR valve is stuck and should be checked and replaced if necessary.
7. Manually operate the throttle lever at the injection pump through approximately 15° to 20° of travel. The EGR valve should close when the TPS reaches the calibrated point.
8. Check the pink wire to the TPS for 12 volts (key on.) If 12 volts is not present, check for any loose connections, open wire, and a blown 20 amp gauge idle fuse.
9. Correct any loose wire connections and change fuse if required. With key on, the blue wire from the TPS switch should also have 12 volts. This blue wire feeds the EPR solenoid. At idle if the pink wire has 12 volts but the blue one doesn't, the TPS is inoperative and should be changed as shown in Section 6CG of the Light Duty Truck Service Manual.
10. With engine off but key on, operate the throttle through 20° travel. At approximately 15°, the TPS will cut out the 12 volts to the blue wire (EPR). At approximately 20°, the TPS will cut in 12 volts to the yellow wire (EGR). If not, the TPS is inoperative.
11. Check to see that the electrical connections are made at the EGR-EPR solenoid assembly and that the hoses are routed correctly and connected to the solenoids.
12. If vacuum is present at the solenoid assembly and the solenoids are receiving an electrical signal as previously mentioned and operation of the TPS through the calibrated points does not operate the EGR and/or EPR valves, the solenoid assembly is inoperative and should be replaced.

DIODE CAUSING EGR SYSTEM (1982 ONLY) MALFUNCTION

A condition exists whereby an excessive electrical feedback load can cause a diode in the EGR and/or EPR solenoids to short. The diodes are for radio noise suppression only. When the diode shorts it usually will blow the 20 amp gauge fuse. A blown fuse will result in no engine electrical accessory feed such as no glow plug operation or light, no cold advance or fast idle, and the EGR system will not operate. When the EGR system becomes inoperative, full vacuum is supplied to the EGR valve at all speeds resulting in heavy black exhaust smoke and low power.

To prevent the diodes from shorting due to heavy feedback loads, a jumper harness unit #14048052 is being made available to install in the EGR-EPR electrical feed circuit at the TPS. This jumper harness has a built in diode to reduce the feedback load.

If a comment of heavy black exhaust smoke is received and the condition can be traced to the EGR/EPR solenoid assembly diode, the following outlines the procedure to follow to install the jumper harness unit.

1. Have engine stopped and key in off position.
2. Disconnect vacuum and electrical connections to the EGR/EPR solenoid assembly.
3. Remove bolt holding assembly, remove and install new assembly.
4. Reconnect vacuum hose and electrical connections.
5. Disconnect (3) wire connector to TPS and install jumper harness between connectors. (NOTE — The wire colors blue, pink and yellow should line up.)
6. Install a new 20 amp gauge idle fuse.

LL4 Model — Vacuum Regulator Valve (VRV)

When using the M40 THM 400 Transmission, with an LL4-Model, a vacuum regulator valve is used (Figure 5-16). This valve supplies an engine load vacuum signal to the transmission vacuum modulator, which is proportional to throttle travel (e.g. at idle maximum vacuum, at W.O.T. minimum or "0" vacuum). This allows the vacuum modulator to regulate transmission shift points and line pressure.

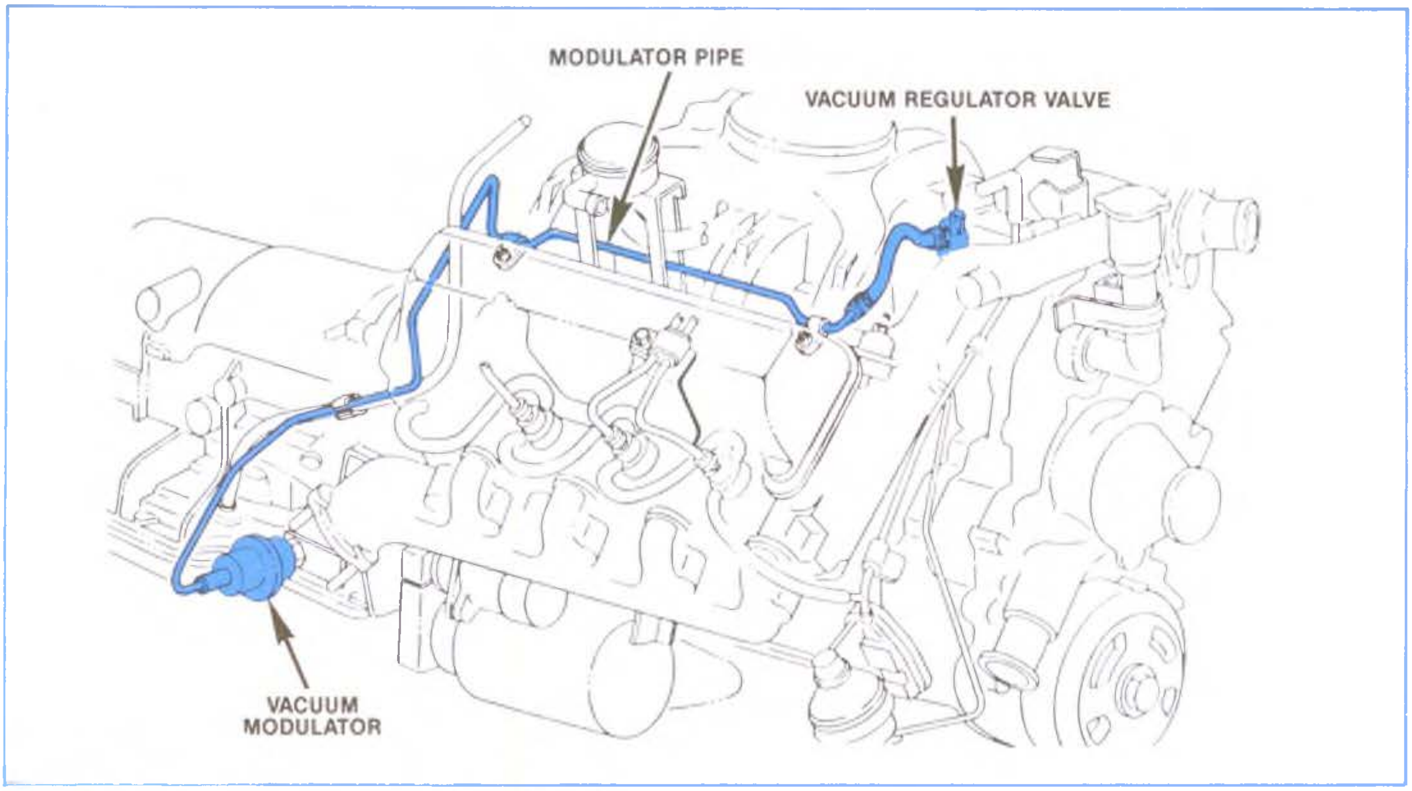


Figure 5-16, Vacuum Regulator Valve (VRV).

— NOTE —

The 1983 and later LL4-Model is also available with the 700-R4 4 speed automatic transmission. This application uses a different throttle position switch, which has only one set of contacts for transmission converter clutch operation. Also a specific adjusting gage bar J33043-5 is necessary.

Throttle Position Switch Adjustment Tool

- **J33043 THROTTLE POSITION SWITCH GAGE BLOCK (6.2L)**

The throttle position switch (Figure 5-16A) is properly adjusted on the throttle shaft using this go-no-go gage and a powered test light or ohmmeter, J33043 enables the technician to check and adjust the throttle position switch on the injection pump.

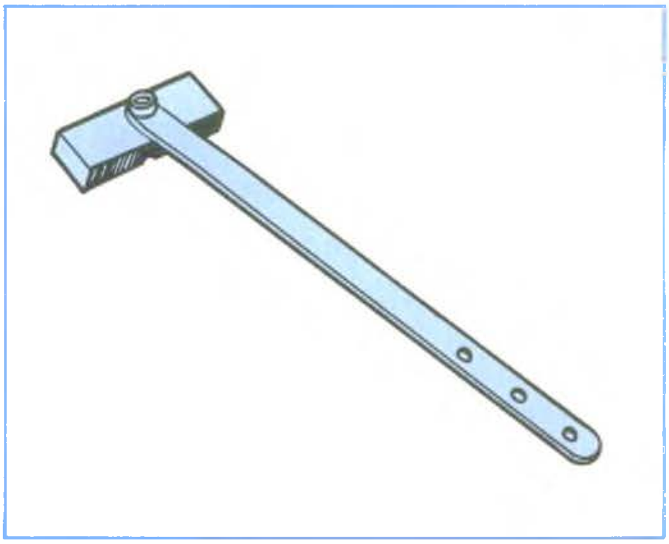


Figure 5-16A, **J33043 Throttle Position Switch Gage Block (6.2L).**

- **THROTTLE POSITION SWITCH GAGE BLOCKS**

New applications for this engine may require new throttle position switch specifications. New gage blocks (Figure 5-16B) can be installed on the handle (J33043-1) of the original gage block:

J33043-2	.646-.668 inch
J33043-4	.602-.624 inch
J33043-5	.771-.773 inch

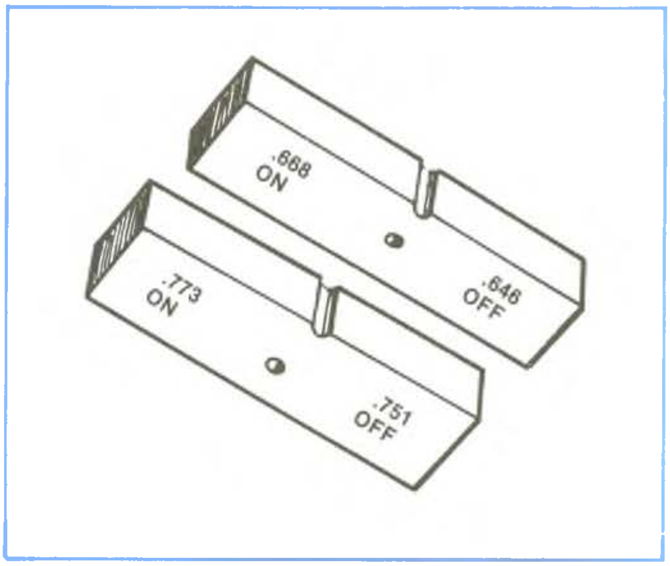


Figure 5-16B, **Throttle Position Switch Gage Blocks**

1982 LH6-MODEL TPS CHART							
				THROTTLE	GAGE BAR		
USAGE	ALTITUDE	TRANS.	MODELS	POSITION SWITCH P/N	SWITCH CLOSED	SWITCH OPEN	GAGE TOOL NUMBER
Nationwide	All	Manual	All	14050405	0.646″	0.668″	J-33043-2
Federal	All	Auto.	All	14033943	0.646″	0.668″	J-33043-2
Calif.	All	Auto.	C/K	14033943	0.646″	0.668″	J-33047-2
Calif.	All	Auto.	C/K	14050408	0.602″	0.624″	J-33043-4

1983 LH6-MODEL TPS CHART					
			GAGE BAR		
ENGINE ASM PART #	BROADCAST B/C CODE	THROTTLE POSITION SWITCH P/N	SWITCH CLOSED	SWITCH OPEN	GAGE TOOL NUMBER
14061529	UHB	14050405	.646	.668	J33043-2
14061531	UHC	14050405	.646	.668	J33043-2
14061545	UHD	14050405	.602	.624	J33043-4
14061549	UHF	14050405	.646	.668	J33043-2
14061550	UHH	14066239	.646	.668	J33043-2
14061552	UHJ	14066238	.602	.624	J33043-4
14061560	UHN	14066239	.646	.668	J33043-2
14050581	UHA	14050405	.646	.668	J33043-2
14061573	UHS	14050405	.646	.668	J33043-2
14066299	UHZ	14050405	.602	.624	J33043-4
14061571	UHR	14050405	.646	.668	J33043-2
14061576	UHT	14066239	.646	.668	J33043-2
14061578	UHU	14066238	.602	.624	J33043-4
14061580	UHW	14066239	.646	.668	J33043-2

1984 LH6 TPS CHART					
			GAGE BAR		
ENGINE ASM PART #	BROADCAST B/C CODE	THROTTLE POSITION SWITCH P/N	SWITCH CLOSED	SWITCH OPEN	GAGE TOOL NUMBER
14071011	FHB	14050405	.602	.624	J33043-4
14071019	FHF	14050405	.602	.624	J33043-4
14071018	FHD	14066239	.646	.668	J33043-2
14071022	FHJ	14066239	.646	.668	J33043-2
14071025	FHK	14050405	.602	.624	J33043-4
14071029	FHN	14050405	.602	.624	J33043-4
14071038	FHW	14066239	.646	.668	J33043-2
14071042	FHY	14066239	.646	.668	J33043-2

— NOTE —
The gage block dimensions were not on the emission label until the 1983 model year. See gage block tool J33043 chart on page 5-14.

1983 & LATER LL4 TPS CHART			
THROTTLE POSITION SWITCH PART NUMBER	GAGE BAR		GAGE TOOL #
	SWITCH CLOSED	SWITCH OPEN	
14066207	.751	.773	J33043-5

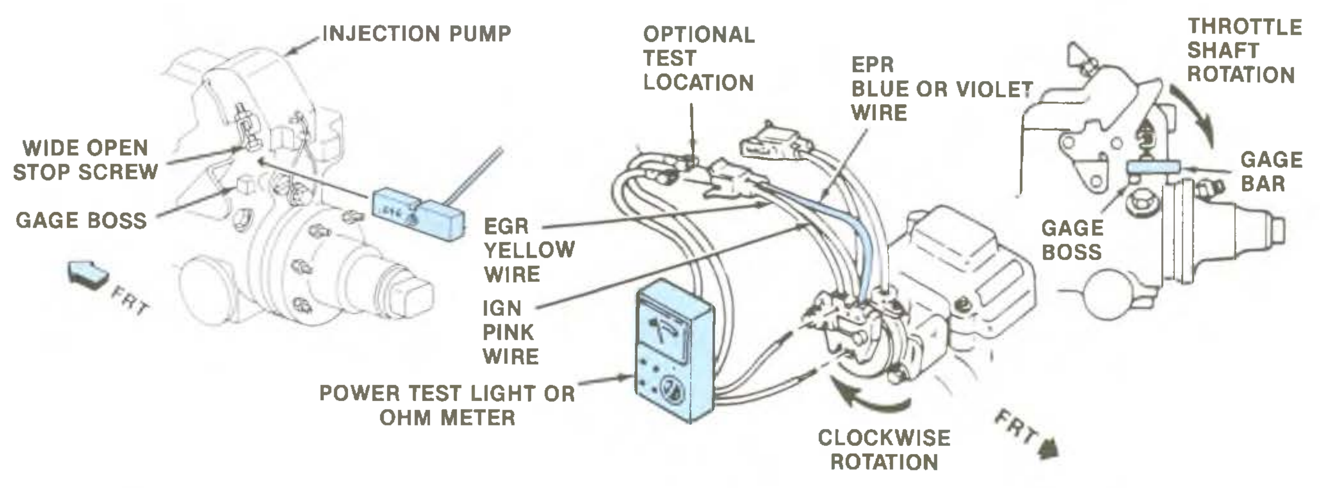


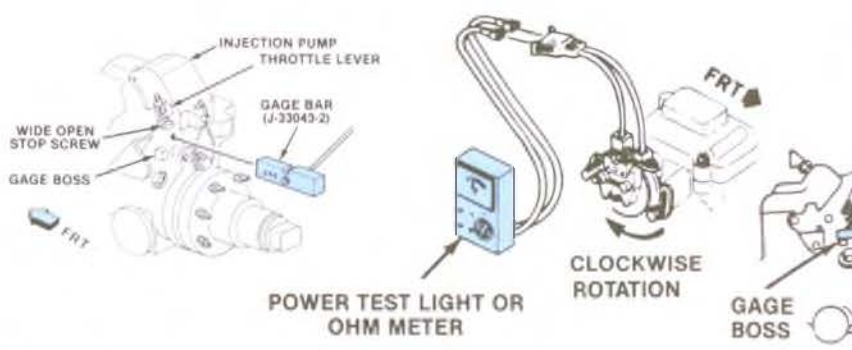
Figure 5-17, **TPS Adjustment LH6-Model.**

DIESEL ENGINE THROTTLE POSITION SWITCH SETTING PROCEDURE

See Figures 5-17 and 5-18.

1. Loose assemble throttle position switch to fuel injection pump with throttle lever in closed position.
2. Attach an ohmmeter or powered test light across the IGN (pink) and EGR (yellow) terminals or wires. (Or on an LL4/710 R4 across the connector terminals.)
3. Insert the proper "switch-on" gage block between the gage boss on the injection pump and the wide open stop screw on the throttle shaft. (Gage block dimension listed on emission label).
4. Rotate and hold the throttle lever against the gage block.
5. Rotate the throttle switch clockwise (facing throttle switch) until continuity pivot occurs (low meter reading) across the IGN and EGR terminals or wires. Hold switch body at this position and tighten mounting screws to 5-7 N·m (4-5 ft. lbs.).
6. Release throttle lever and allow it to return to idle position. Remove the "switch-on" gage bar and insert the "switch-off" gage bar. Rotate throttle lever against "switch-off" gage bar. There should no continuity (meter reads resistance infinity) across the IGN and EGR terminals or wires. If no continuity exists, switch is set properly. However, if there is continuity, then the switch must be reset by returning to Step 1 and repeating the entire procedure.

— NOTE —
The gage block dimensions were not on the emission label until the 1983 model year. See gage block tool J33043 chart on page 5-12.



ENGINE	SWITCH OPEN	SWITCH CLOSED
LL4	0.773	0.751

Figure 5-18, **TPS Adjustment LL4-Model With 700-R4 (MD8) Transmission.**

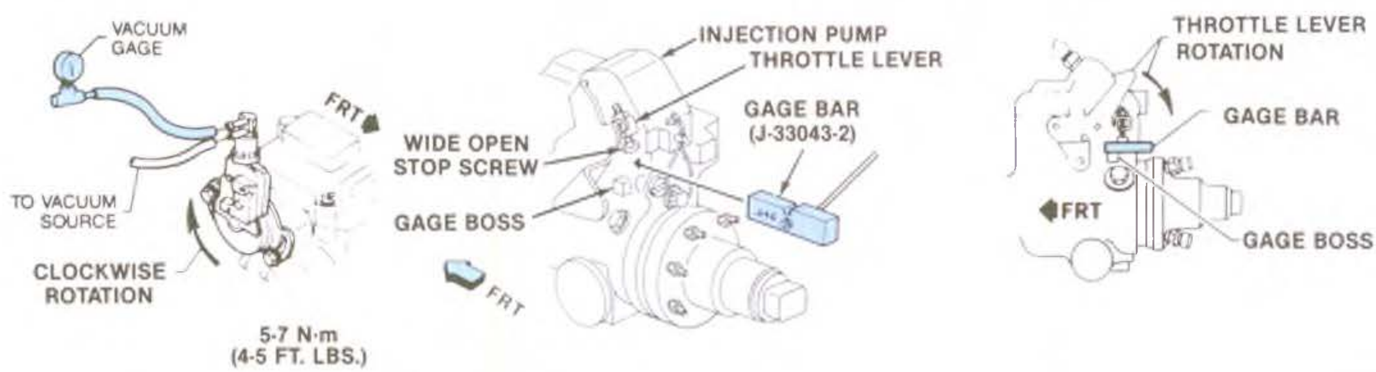


Figure 5-19, **VRV Adjustment LL4-Model With THM 400 (M40) Transmission.**

Transmission Vacuum Regulator Valve Adjustment (LL4)

See Figure 5-19.

1. Attach the vacuum regulator valve snugly, but loosely to the fuel injection pump. The switch body must be free to rotate on the pump.
2. Attach vacuum source of 67 ± 5 kpa (20″ Hg.) to inboard vacuum nipple. Attach vacuum gage to outboard vacuum nipple.
3. Insert vacuum regulator valve gage bar J33043-2 between the gage boss on the injection pump and the wide open stop screw on the throttle lever. (Switch on position).
4. Rotate and hold the throttle shaft against the gage bar.
5. Slowly rotate the vacuum regulator valve body clockwise (facing valve) until vacuum gage reads 27 kpa ± 2 kpa (8″ Hg). Hold valve body at this position and tighten mounting screws to 5-7 N·m (4-5 ft. lbs.).

— NOTE —

Valve must be set while rotating valve body in clockwise direction only.

6. Check by releasing the throttle shaft allowing it to return to the idle stop position. Then rotate throttle shaft back against the gage bar to determine if vacuum gage reads within 27 kpa ± 2 (8″ Hg.). If vacuum is outside limits, reset valve.

VACUUM REGULATOR VALVE, 1982 "C-K-P" WITH 6.2L AND 400 AUTOMATIC TRANSMISSION

Comments regarding high or late upshifts in 1982 "C-K-P" trucks equipped with 6.2L diesel engines and THM 400 automatic transmissions may be the result of the vacuum regulator valve (VRV) calibration. This condition may be corrected by replacing the valve with a new valve, P/N 14057219.

The new valve entered production at the assembly plants in March, 1982.

The VRV should be verified as the cause of this condition using the following procedure:

1. Identify which valve (old or new) is on the engine.
   a. Old valve — rotating CAM is green color. P/N 14033982 is cast into the valve.
   b. New valve — rotating CAM is orange color. P/N 14057219 is white lettered on face of valve.
2. If the valve has a green rotating CAM, remove the valve. If the rotating CAM is orange, go to Step 5.
3. Install a new valve. P/N 14057219.
4. Adjust the new valve, as described on Page 5-16 to 27 kpa (8″ Hg.).
5. If the valve has an orange rotating CAM (P/N 14057219), check for a correct setting of 27 KPA.

— NOTE —

When diagnosing high or late transmission upshifts, be sure to check for a proper vacuum output of approximately 70 kpa (21″ Hg.). Check for the correct modulator pipe. The pipe part #14054204 should be 5/32″ I.D. and be approximately 5″ long.

5B. California (NB2) Diesel Electronic Control System (DECS)

1984-1985 DDAD 6.2L DECS

The 6.2L, LH6 diesel engine will use an electronic controlled EGR emission system for California applications. It is a limited function system, controlling EGR, EPR T.C.C. and system diagnosis.

The 1985 6.2L LH6 DECS is similar, with the addition of on-vehicle self-diagnostics (10 trouble codes) and a vehicle speed sensor.

1984-1985 "California only" (RPO NB2) LH6 Engine less than 8500 lbs. GVWR.

ABBREVIATIONS USED IN THIS SECTION

- **DEC—**
  Diesel Electronic Control System
- **DVM—**
  Digital Volt — OHM Meter With 10 MEG-OHM Impedence
- **CEL—**
  Check Engine Light
- **ECM—**
  Electronic Control Module—Diesel
- **MAP—**
  Manifold Absolute Pressure Sensor
- **EGR—**
  Exhaust Gas Recirculation
- **EPR—**
  Exhaust Pressure Regulator
- **TCC—**
  Transmission Convertor Clutch
- **RPM—**
  Revolutions Per Minute
- **IP—**
  Instrument Panel
- **TPS—**
  Throttle Position Sensor
- **V-REF—**
  ECM Reference Voltage (Approximately 5.3V)
- **WOT—**
  Wide Open Throttle
- **PWM—**
  Pulse Width Modulated
- **CKT—**
  Circuit
- **DDC—**
  Diesel Diagnostic Check Tool
- **ALDL—**
  Assembly Line Diagnostic Link
  or
- **ALCL—**
  Assembly Line Communications Link

1985 DIAGNOSTIC CHARTS

- Diesel system diagnostic check
- DDC tool check
- Code 12
- Code 21
- Code 22
- Code 24
- Code 31
- Code 32
- Code 33
- Code 51
- Code 52
- Code 53
- TCC check
- ECM check (no code 12)
- TPS check

1984 DIAGNOSTIC CHARTS

- Diesel system diagnostic check
- DDC tool check
- ECM check
- Map sensor check
- EGR/EGR vent check
- Engine speed sensor check
- EPR electrical check
- EPR vacuum check
- TPS check
- Transmission convertor clutch (TCC) check

Electronic Vacuum Modulated EGR LH6 6.2L California Diesel

Electronic vacuum modulated EGR is a modulated EGR control system involving digital electronics.

In addition to controlling EGR vacuum signal by throttle position as in a mechanical system, the electronic system also makes use of engine speed and closed loop feedback of EGR control vacuum.

The electronic vacuum modulated EGR system is shown schematically in Figure 5-20. It consists of an electronic control module receiving inputs from throttle position, engine speed and absolute pressure sensors. In 1985 from vehicle speed sensor (VSS).

The electronic control module sends out a pulsed signal which drives a solenoid to control the signal vacuum on the EGR valve, and an "ON/OFF" signal to a solenoid to control vacuum on an exhaust pressure regulator (EPR) valve.

In operation, engine speed and throttle angle define the desired amount of EGR. The electronic control module sends out a pulsed signal to the EGR vacuum control solenoid indicating the vacuum level desired on the EGR valve.

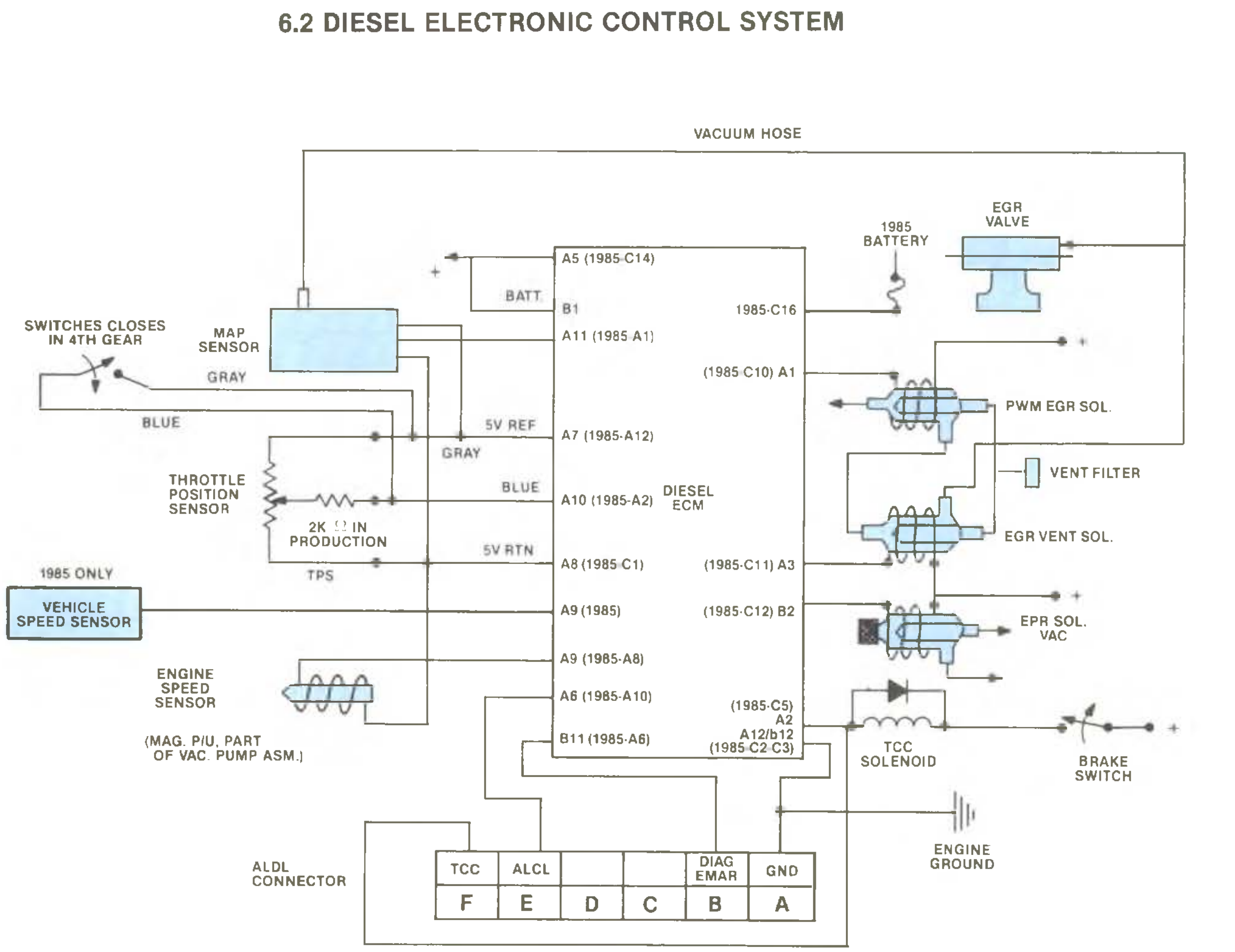


Figure 5-20, Digital Diesel System Schematic.

NOTES

An absolute pressure sensor monitors the vacuum on the EGR valve and feeds this information back to the electronic control module. The electronic control module compares the measured vacuum to the desired vacuum (as defined by throttle angle, engine speed and in 1985 vehicle speed), and then trims the vacuum control solenoid to provide the desired vacuum on the EGR valve. A vacuum control bleed (vent) valve solenoid is also included to quickly relieve vacuum on the EGR valve during accelerations.

In addition, an EPR system is used and the EPR valve is either open or closed. The EPR valve switch point is determined by the electronic control module and is a function of throttle angle and engine speed.

Since the vehicles which use the 6.2L engines are not equipped with a "Check Engine" light, a Diesel Diagnostic Check (DDC Tool J34750) is used whenever the need for service diagnostics (Figure 5-21). This tool J34750 has 4 switch or diagnostic mode positions:

- Normal — Open or resistance infinity to ALCL Pin B.

— NOTE —

In this mode of operation all of the ECM outputs are in control of the ECM.

- ALCL 1 — A 10K ohm resistor to ground from ALCL Pin B.
- ALCL 2 — A 3.9K ohm resistor to ground from ALCL Pin B.
- Diagnostic — 0 ohms resistance to ground from ALCL Pin B.

This allows the ability to quickly recognize that a driveability problem is due to the ECM being in default by either the CEL being "ON" or one of the selectable diagnostic modes indicating a fault is present.

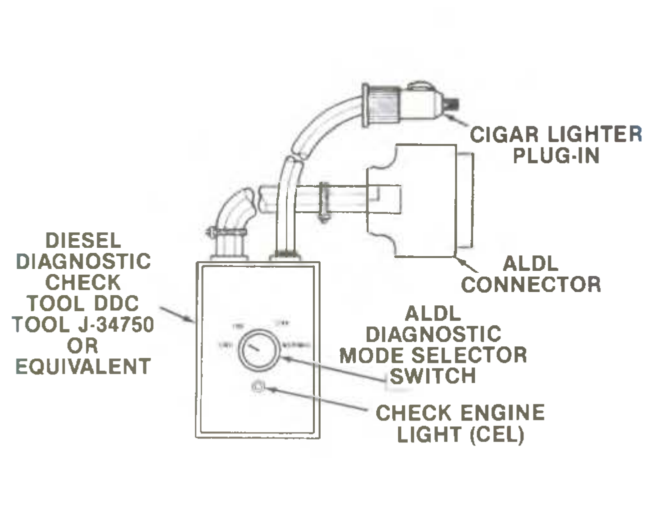


Figure 5-21, **DDC Tool #J34750.**

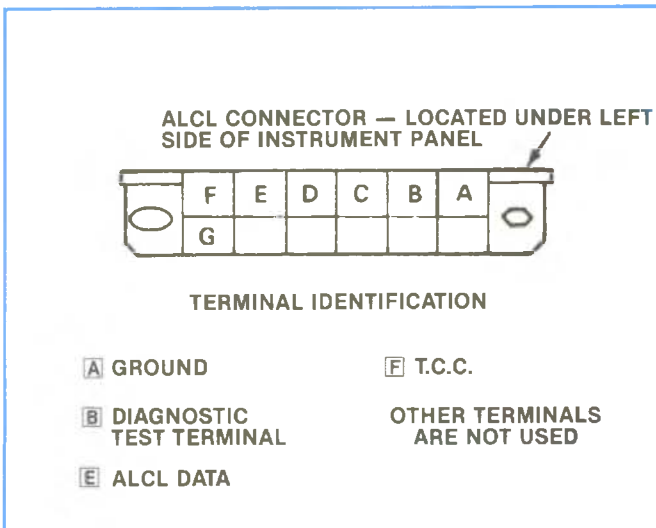


Figure 5-22, **ALCL Connector (CK Series).**

ALCL CONNECTOR

Under the instrument panel on a series CK or under the driver's seat on a series GP is an Assembly Line Communications Link (ALCL) that is used by the assembly plant for a computerized check-out of the system. This connector is also used in service to help diagnose the EGR system and TCC. See Figure 5-22.

1984 6.2L DIAGNOSTIC MODE CHART						
MODE SELECT	ENGINE SPEED	CHECK ENGINE LIGHT	TCC OUTPUT	EPR OUTPUT	EGR OUTPUT	DUMP SOLENOID OUTPUT
Normal No resistor or infinite resistance	N/A	Normal	Normal	Normal	Normal	Normal
ALCL 1	> 600 RPM	Send ALCL Data	Normal	Normal	Normal	Normal
10k to GRD	> 375 RPM < 800 RPM	Send ALCL Data	On	On	10″ Vacuum	Normal
	< 375 RPM	Send ALCL Data	Off	Off	Off	Off
ALCL 2	> 800 RPM	Send ALCL Data	Normal	Normal	Normal	Normal
3.9k to GRD	> 375 RPM < 800 RPM	Send ALCL Data	Off	Off	Off	On
	< 375 RPM	Send ALCL Data	Off	Off	Off	Off
Diagnostic	> 375 RPM	Normal	On	On	10″ Vacuum	Normal
0Ω to GRD	< 375 RPM	Normal	On	On	50% DC	On

ALCL — Assembly Line Communications Link
GRD — Ground
> — Greater Than
< — Less Than
DDC — Diesel Diagnostic Check

— NOTE —

1984 Diagnostic Modes

ALCL 1 Mode is whenever the ALCL Pin B or ECM Pin B11 is grounded by a 10k Ohm resistor.

ALCL 2 Mode is whenever the ALCL Pin B or ECM Pin or ECM Pin B11 is grounded by a 3.9k Ohm resistor.

Diagnostic Mode is whenever the ALCL Pin B or ECM Pin B11 is grounded 0 Ohms resistance.

SPECIAL SOLENOID CONTROL CONDITIONS (1984 DECS SYSTEM)

Under certain conditions the EGR solenoid, the vent solenoid, and the EPR solenoid are controlled independently of the EGR control programming in the ECM.

These conditions include ECM reset, engine not running, engine at idle, engine above idle, diagnostic mode selection, ALCL 1 mode selection and ALCL 2 mode selection.

Engine not running is defined such that engine speed is less than 375 RPM. Engine at idle is defined such that engine speed is greater than 375 RPM but less than 800 RPM. Engine above idle is defined such that engine speed is greater than 800 RPM.

NORMAL MODE

The control functions are operating according to ECM programming.

RESET

The EGR solenoid is de-energized (EGR valve fully open) when the ECM is reset.

The EPR solenoid is de-energized (EPR valve open) when the ECM is reset.

The vent solenoid is de-energized (EGR vent disabled) when the ECM is reset.

ALCL 1 MODE OR ALCL 2 MODE/ENGINE NOT RUNNING

The EGR solenoid is de-energized (EGR valve fully open) if the engine is not running and either ALCL Mode is selected.

The EPR solenoid is de-energized (EPR valve open) if the engine is not running and either ALCL Mode is selected.

The vent solenoid is de-energized (EGR vent disabled) if the engine is not running and either ALCL Mode is selected.

ALCL 1 MODE/ENGINE AT IDLE

The EGR solenoid is controlled by the ECM to deliver a calibrated amount (kPa) of vacuum to the EGR valve whenever the ECM is in the ALCL 1 Mode and the engine is at idle.

The EPR solenoid is energized (EPR valve closed) whenever the ALCL 1 Mode is selected and the engine is at idle.

The vent solenoid is controlled according to the vent determination logic in the ECM whenever the ALCL 1 Mode is selected and the engine is at idle.

ALCL 2 MODE/ENGINE AT IDLE

The EGR solenoid is de-energized (EGR valve fully open) if the ALCL 2 Mode is selected and the engine is at idle.

The EPR solenoid is de-energized (EPR valve open) if the ALCL 2 Mode is selected and the engine is at idle.

The vent solenoid is energized (EGR vent enabled) if the ALCL 2 Mode is selected and the engine is at idle.

DIAGNOSTIC MODE/ENGINE RUNNING

The EGR solenoid is controlled by the ECM to deliver a calibrated amount (kPa) of vacuum to the EGR valve whenever the ECM is in the Diagnostic Mode and the engine is running. In this way, the EGR control can be checked out using a vacuum gauge or a dwell meter test.

The EPR solenoid is energized (EPR valve closed) whenever the Diagnostic Mode is selected and the engine is running.

The vent solenoid is controlled according to the vent determination logic whenever the Diagnostic Mode is selected and the engine is running.

DIAGNOSTIC MODE/ENGINE NOT RUNNING

The EGR solenoid is pulsed at a 50% duty cycle level if the Diagnostic Mode is selected and the engine is not running.

The EPR solenoid is energized (EPR valve closed) if the Diagnostic Mode is selected and the engine is not running.

The vent solenoid is energized (EGR vent enabled) if the Diagnostic Mode is selected and the engine is not running.

5B. California Diesel Electronic Control System (DECS)

1985 6.2L DIAGNOSTIC MODE CHART USING DDC TOOL						
MODE SELECTION	ENGINE SPEED	CHECK ENGINE LIGHT	TCC OUTPUT	EPR OUTPUT	EGR OUTPUT	VENT SOLENOID OUTPUT
Normal ∞ Ω	N/A	Normal	Normal	Normal	Normal	Normal
ALCL 1 10k	$>$ 800 RPM	Send Data	Normal	Normal	Normal	Normal
	$>$ 375 RPM $<$ 800 RPM	Send Data	On	On	10″ Vacuum	Normal
GMAD Test Mode	$\geq$ 375 RPM	Send Data	Off	Off	Off	Off
ALCL 2 3.9k	$>$ 800 RPM	Send Data	Normal	Normal	Normal	Normal
	$\geq$ 375 RPM $<$ 800 RPM	Send Data	Off	Off	Off	On
GMAD Test Mode	$>$ 375 RPM	Send Data	Off	Off	Off	Off
ALCL 3 30k	$>$ 800 RPM	Send Data	Normal	Normal	Normal	Normal
	$>$ 375 RPM $<$ 800 RPM	Send Data	Normal	Normal	Normal	Normal
Diagnostic 0 Ω	$>$ 375 RPM	Send Codes	On	On	10″ Vacuum	Normal
Dealer Test Mode	$>$ 375 RPM	Send Codes	On	On	50% DC	On

PWM — Pulse width modulation
∞ — Resistance infinity
D.C. — Duty cycle

DDC — Diesel Diagnostic Check
$>$ Greater Than
$<$ Less Than

$\geq$ Greater Than or Equal To
$\leq$ Less Than or Equal To

Figure 5-23

1985 Diagnostic Modes

• **NORMAL** ALCL Line Open (Infinite Resistance)

In this mode of operation all of the outputs are in control of the ECM. The diagnostics which have been enabled are operational and can log a malfunction if it occurs and issue a remedial action if appropriate.

• **ALCL 1** ALCL Line Grounded Thru a 10k Ohm Resistor

In this mode of operation, the ALCL data is transmitted via the check engine light output. This list is intended for usage by the GMAD assembly plants.

Additionally, the ECM functions are altered depending upon what engine speed is input to the controller. The ALCL list transmission is not altered by engine speed but the data transmitted is.

• **ENGINE SPEED GREATER THAN 800 RPM**

When the engine is operated at greater than 800 RPM, the ECM functions as it would in the normal mode.

— NOTE —

1985 Diagnostic Modes

ALCL 1 Mode is whenever ALCL Pin B or ECM Pin A6 is grounded by a 10k Ohm resistor.

ALCL 2 Mode is whenever ALCL Pin B or ECM Pin A6 is grounded by a 3.9k Ohm resistor.

ALCL 3 Mode is used only by Delco Electronics during manufacture.

Diagnostic Dealer Test Mode is whenever ALCL Pin B or ECM Pin A6 is grounded with 0 Ohms resistance.

ENGINE SPEED @ IDLE

When the engine speed is between the ECM run decision RPM which is between 375 and 800 RPM, the TCC and EPR outputs are turned on all the time. Also, the EGR loop is forced to run at a constant vacuum, by setting the desired (KPA) vacuum amount equal to the 10″ Hg. EGR vacuum in the diagnostic mode. If this diagnostic mode EGR vacuum of 10 in. Hg. is less than the value in the ECM memory, the vent solenoid will be de-energized. This operation helps verify that the MAP transducer, vacuum plumbing and EGR solenoid are installed and operating properly. The TCC solenoid operation is also checked in this mode.

- **ENGINE NOT RUNNING**

When the engine is not running, all ECM outputs are de-energized.

- **ALCL 2** ALCL Line Grounded Thru 3.9k ohm

In this mode of operation the ECM behaves the same as in the ALCL 1 mode except at engine idle.

- **ENGINE SPEED AT IDLE**

When the engine speed is between 375 and 800 RPM, the TCC, EPR and EGR outputs are de-energized. The vent solenoid output is energized. This state helps verify that the vent solenoid is installed and operating properly.

- **ALCL 3** ALCL Line Grounded Thru 30k ohm

This test mode is intended for usage by Delco Electronics during ECM manufacturing.

- **ENGINE SPEED AT IDLE OR ABOVE**

When the engine speed is above 375 RPM, the ECM functions as if it were in the normal mode.

- **DIAGNOSTIC MODE** ALCL Line Grounded (ALCL Pin B or ECM Pin A6)

This mode is intended to aid field service of the vehicle system. While in this mode the ECM will output diagnostic codes on the check engine light in the typical flash-out three times format. In addition ECM operation will be modified as follows.

1. **ENGINE RUNNING**

   The TCC and EPR outputs will be energized and the EGR loop will be forced to run at 10″ vacuum. The vent solenoid will be de-energized if the calibrated value of 10″ is less than the current value of the EPR switchpoint table. If ALCL Pin B or ECM Pin A6 is grounded with the engine running the system will display any stored trouble codes by flashing the "CHECK ENGINE" light. Each code will be flashed three times. The ignition switch is then turned off, engine is re-started and run to see if the code is a "hard" or "intermittent" failure. If it is a "hard" failure, a Diagnostic Code Chart is used to find the problem. If it is an "intermittent" failure, the charts are not used. A physical inspection of the applicable system is made.

2. **ENGINE NOT RUNNING**

   When the engine is not running, all outputs except the EGR output are energized. The EGR output is forced to run at a 50% duty cycle. If ALCL Pin B or ECM Pin A6 is grounded, with the ignition "ON" and the engine stopped, the system will display a code "12" by flashing the "CHECK ENGINE" light (indicating the system is operating). A code "12" consists of one flash, followed by a short pause, then two flashes in quick succession. Code 12 will continue to flash until the "Test" terminal is ungrounded.

3. **SYSTEM RESET**

   During normal operations the system will only be in reset for the first few milliseconds of operation. During this time the ECM will not process any data flow and all four outputs will be energized.

— NOTE —
All diagnosis should start with the Diesel Diagnostic Circuit Check.

DDC Tool Check 6.2L LH6

See Figures 5-24, 5-25 and 5-26. The Diesel Diagnostic Check (DDC) Tool is a combination "Check Engine" Light (CEL), and diagnostic mode selector. The tool allows a check on the ECM's ability to detect a fault and set a CEL. The mode selector assists diagnostics if a fault is present, even if there was no CEL.

— NOTE —
Prior to any diagnostics, it must be verified that the DDC tool is functioning.

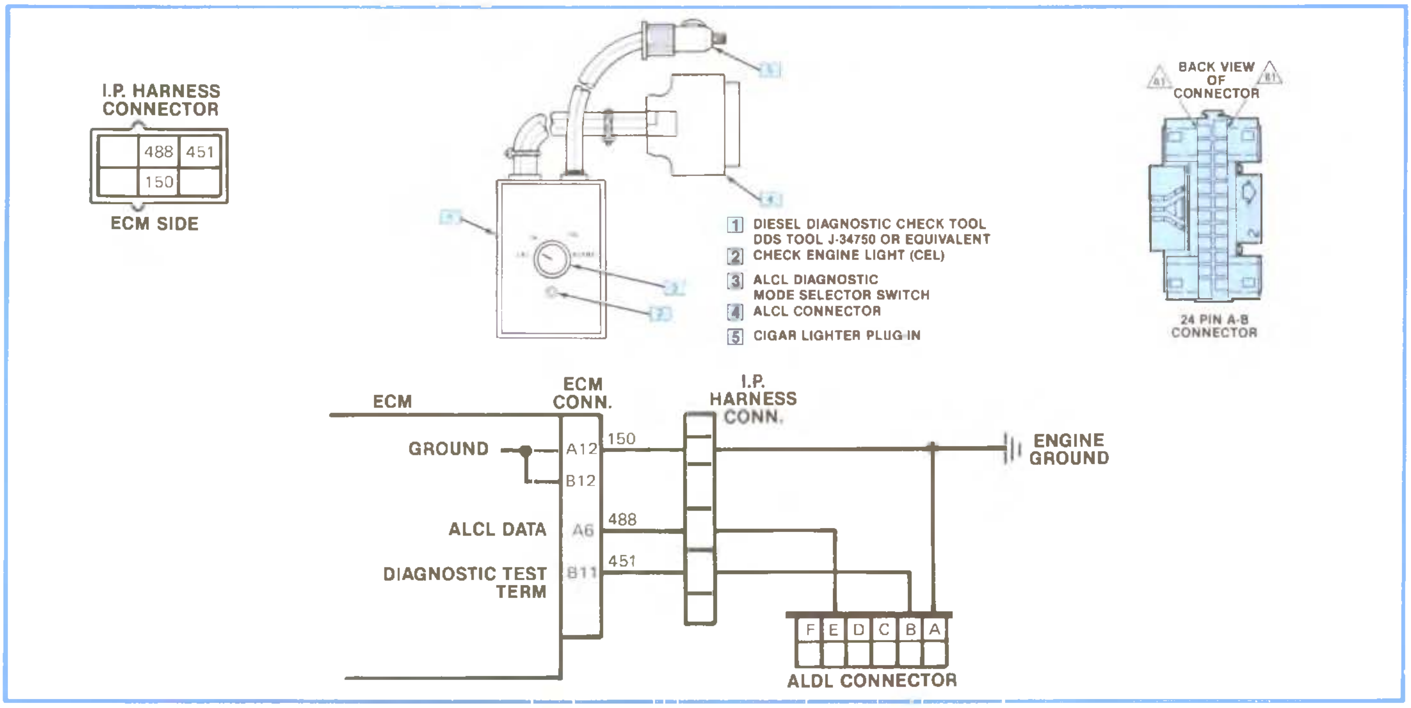


Figure 5-24, 1984 DDC Tool Check Schematic.

1. Check to see if the DDC tool is supplied with 12 volts. Light should be "ON" with only the power cord installed. See Figures 5-24 and 5-25.
2. Check to see if ALCL circuit is grounded or faulty. Normally when connection is made to ALCL, the CEL should remain "ON".
3. When ignition is turned "ON", the CEL should remain "ON". If CEL goes "OFF", ECM may be shorted internally.

— NOTE —
When using the DDC Tool in any of the diagnostic modes (3.9k or 10k), the CEL will flicker. This is normal. Also, when going from any diagnostic mode to either normal or ground, the CEL will come on SOLID for 10 seconds then go "OFF". This is the normal ECM reset.

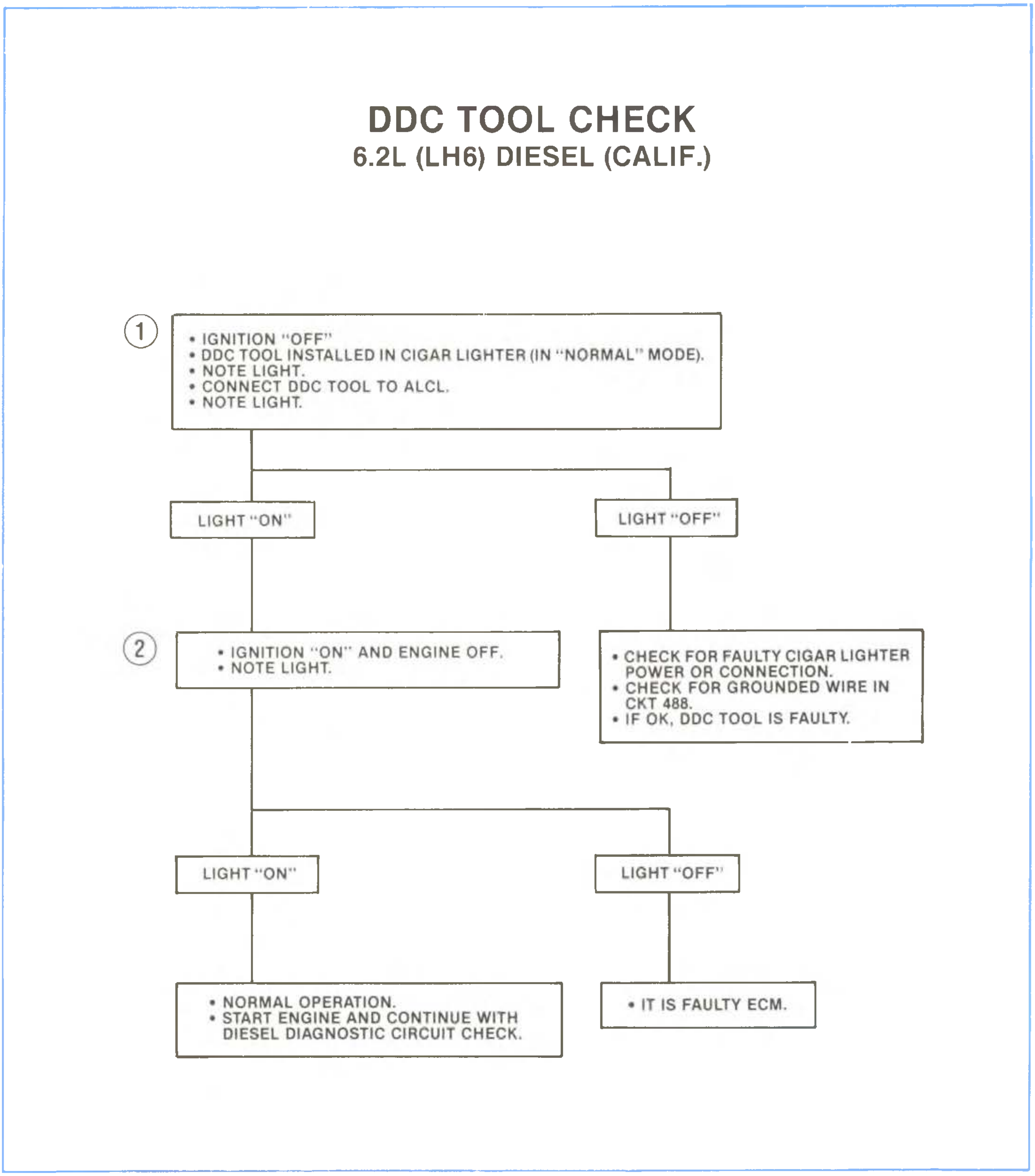


Figure 5-25, DDC Tool Check 1984-85.

5B. California Diesel Electronic Control System (DECS)

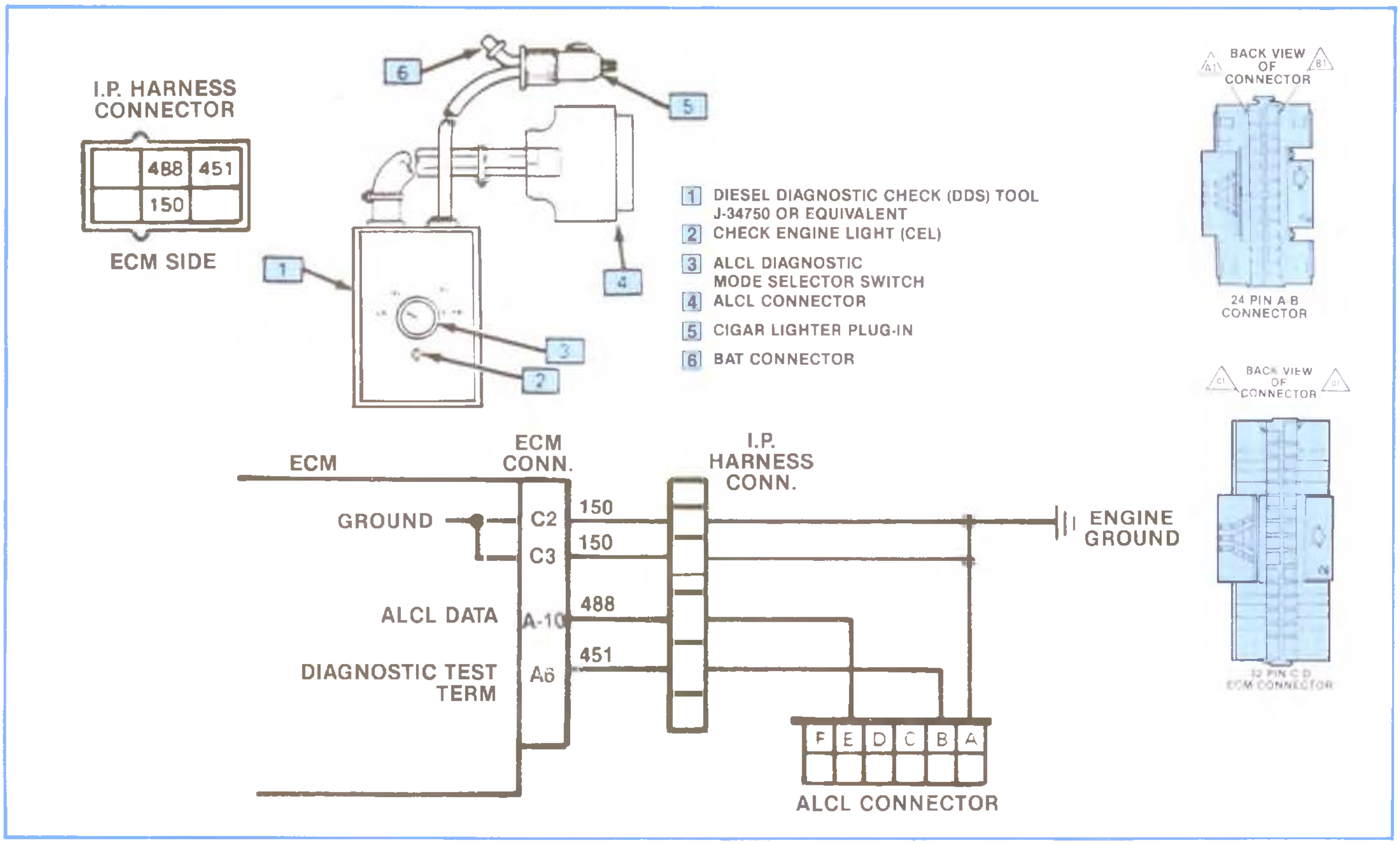


Figure 5-26 1985 DDC Tool Check Schematic.

Pin Condition	Terminal	CEL/Code	Condition	Codes
A10 OPN	ALCL	No CEL	OK	No Light — No Code
A10 GND	ALCL	No CEL	OK	No Light — No Code
A10 OPN	EGR Vent	No CEL	OK	Normal — except vacuum for EGR doesn't go to 0.
A10 GND	Sensor GND	No CEL — No Code	OK	System Normal

1984 Diesel Diagnostic Circuit Check

See Figure 5-27.

The ECM provides the diagnostic logic to detect faults in the systems the ECM monitors or controls. In 1984 the ECM, when it recognizes a fault, has the capability of turning a "Check Engine" Light (CEL) "ON" but does not store or flash a trouble code. Furthermore, if the condition corrects itself, the CEL signal will be turned "OFF" immediately following the correction.

The ECM recognizes errors in Engine Speed, Vacuum errors in the EGR vacuum loop via the MAP sensor, and electrical faults involving the 5-volt reference circuit.

1985 DECS with On-Vehicle Self Diagnostics

PURPOSE

The purpose of the system self diagnostics is to detect faults which may occur and then alert the operator. The self diagnostics also assist service personnel in diagnosing system faults.

The Electronic Control Module (ECM) monitors its own performance and certain system input and output signals to determine if a system fault has occurred.

TROUBLE CODES

Ten "2 digit" trouble codes are used to indicate various system faults.

If the DDC tool J34750 is in the diagnostic mode, that is ALCL Pin B or ECM Pin A6 grounded, with the ignition "ON" and the engine stopped, the system will display a code "12" by flashing the "CHECK ENGINE" light (indicating the system is operating). A code "12" consists of one flash, followed by a short pause, then two flashes in quick succession. Code 12 will continue to flash until the ALCL line (ALCL Pin B or ECM Pin A6) is ungrounded.

If the ALCL line (ALCL Pin B or ECM Pin A6) is grounded with the engine running the system will display any stored trouble codes by flashing the "CHECK ENGINE" light. Each code will be flashed three times. The ignition switch is then turned off, engine is re-started and run to see if the code is a "hard" or "intermittent" failure. If it is a "hard" failure, a Diagnostic Code Chart is used to find the problem. If it is an "intermittent" failure, the charts are not used. A physical inspection of the applicable system is made.

Each trouble code has its own set of conditions that must be met for that code to be detected. Once a code is detected, it will cause the "CHECK ENGINE" light to turn on, and a code may be logged in the nonvolatile memory after meeting the trouble code logging requirements.

The purpose of the trouble code logging requirements is three-fold:

1. To prevent false codes from being logged.
2. To insure that the "CHECK ENGINE" light when illuminated, will remain illuminated for a period of time sufficient to be seen by the technician.
3. To prevent an intermittent code from "flashing" the "CHECK ENGINE" light.

1984 DECS
6.2L (LH6)
DIESEL DIAGNOSTIC CIRCUIT CHECK

- Make physical inspection of engine compartment.
- Make certain all electrical components are correctly attached.
- Check all vacuum lines for hoses off, pinched or burned through.
- Check EGR valve for vacuum leak and free movement.
- Check for plugged EGR vent filter.

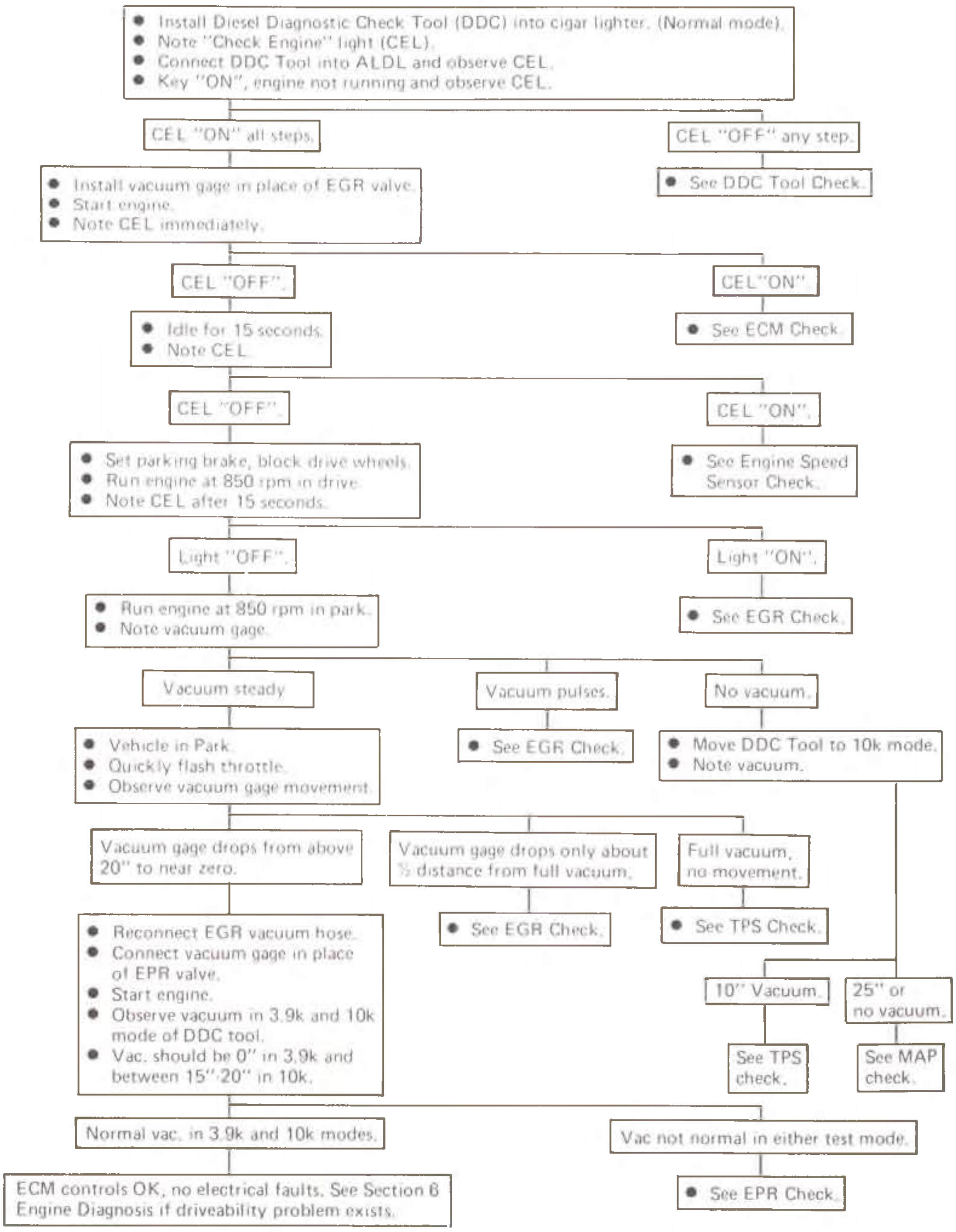


Figure 5-27, 1984 Diagnostic Circuit Check.

The codes are stored in a non-volatile memory, whose storage data is retained if the ignition switch power is turned off. This is commonly known as a long term memory. The trouble codes can be erased by:

1. Disconnecting the large (32 pin) connector for 10 seconds.
2. Disconnecting the battery for 10 seconds.
3. Cycling the ignition switch off and on 50 times.

THE TROUBLE CODES INDICATE FAULTS AS FOLLOWS:

CODE 12	No Engine RPM Reference Pulses. This code is not stored in the memory and will only flash while the fault is present. A normal code with the ignition "ON" engine not running.
CODE 21	Throttle Position Sensor (TPS) circuit 417 sensor signal voltage high on ECM Pin A-2 (open circuit or misadjusted TPS). The engine must run for 2 minutes to set this code.
CODE 22	Throttle Position Sensor (TPS) circuit 417 sensor signal voltage low on ECM A-2 (grounded circuit). The engine must run at 1250 RPM or above before this code will set.
CODE 24	Vehicle Speed Sensor (VSS) is detected when the engine is running. RPM and throttle position indicate the vehicle should be in motion, with inadequate VSS signal (open or grounded circuit). The vehicle must be operating at road speed for 10 seconds before this code will set.
CODE 31	MAP sensor signal voltage too low. Engine must run at idle for 10 seconds before this code will set.
CODE 32	EGR vacuum circuit has seen improper EGR vacuum (closed loop error). The vehicle must be running at a road speed of approximately 30 mph (48 Km/h) for 10 seconds before this code will set.
CODE 33	MAP sensor signal voltage too high. Possible vacuum leak — check for a poor connection at the sensor hose. The engine must run at idle for 10 seconds before this code will set.
CODE 51	PROM fault — (incorrectly installed in socket). It takes 10 seconds to set this code.
CODE 52	ECM fault analog to digital converter fault. It takes 10 seconds to set this code.
CODE 53	5 Volt Reference (V-REF) circuit overloaded (grounded circuit). It takes 10 seconds before this code will set.

1985 Diagnostic Circuit Check

The Diagnostic Circuit Check is the starting point for the diagnostic procedure to be used.

The diagnostic charts are related to the ECM and will determine if the ECM is working properly. This section diagnoses the emissions system controlled by the ECM and has charts to diagnose a circuit when the ECM has displayed a trouble code.

The way to approach a problem is to follow three basic steps:

1. ARE THE ON-VEHICLE DIAGNOSTICS WORKING? — We find this out by performing the "Diagnostic Circuit Check". Since this is the starting point for the diagnostic procedure, always begin here. If the On-Vehicle Diagnostics aren't working, the "Diagnostic Circuit Check" will lead you to a chart to correct the On-Vehicle Diagnostics. If the vehicle will not start, see "Engine Cranks Normally Will Not Start" in Section 7. If the On-Vehicle Diagnostics are OK, the next step is:
2. IS THERE A TROUBLE CODE STORED? If a trouble code is stored, go directly to the numbered code chart. If no trouble code is stored, the third step is:
3. WHAT IS THE DRIVEABILITY SYMPTOM? Section 7 lists various driveability symptoms which may be found, and suggests checks of related components, many of which are found in Section 7.

   This procedure, which takes only a short time, will help lead you to repair the problem in the least amount of time.

1985 DIESEL DIAGNOSTIC CIRCUIT CHECK

6.2L (LH6) DIESEL (CALIF.)

- MAKE PHYSICAL INSPECTION OF ENGINE COMPARTMENT.
- MAKE CERTAIN ALL ELECTRICAL COMPONENTS ARE CORRECTLY CONNECTED.
- CHECK ALL VACUUM HOSES THAT MAY BE DISCONNECTED, PINCHED OR BURNED.
- CHECK EGR VALVE FOR VACUUM LEAK AND FREE MOVEMENT.
- CHECK FOR PLUGGED EGR VENT FILTER AND REPLACE IF REQUIRED.

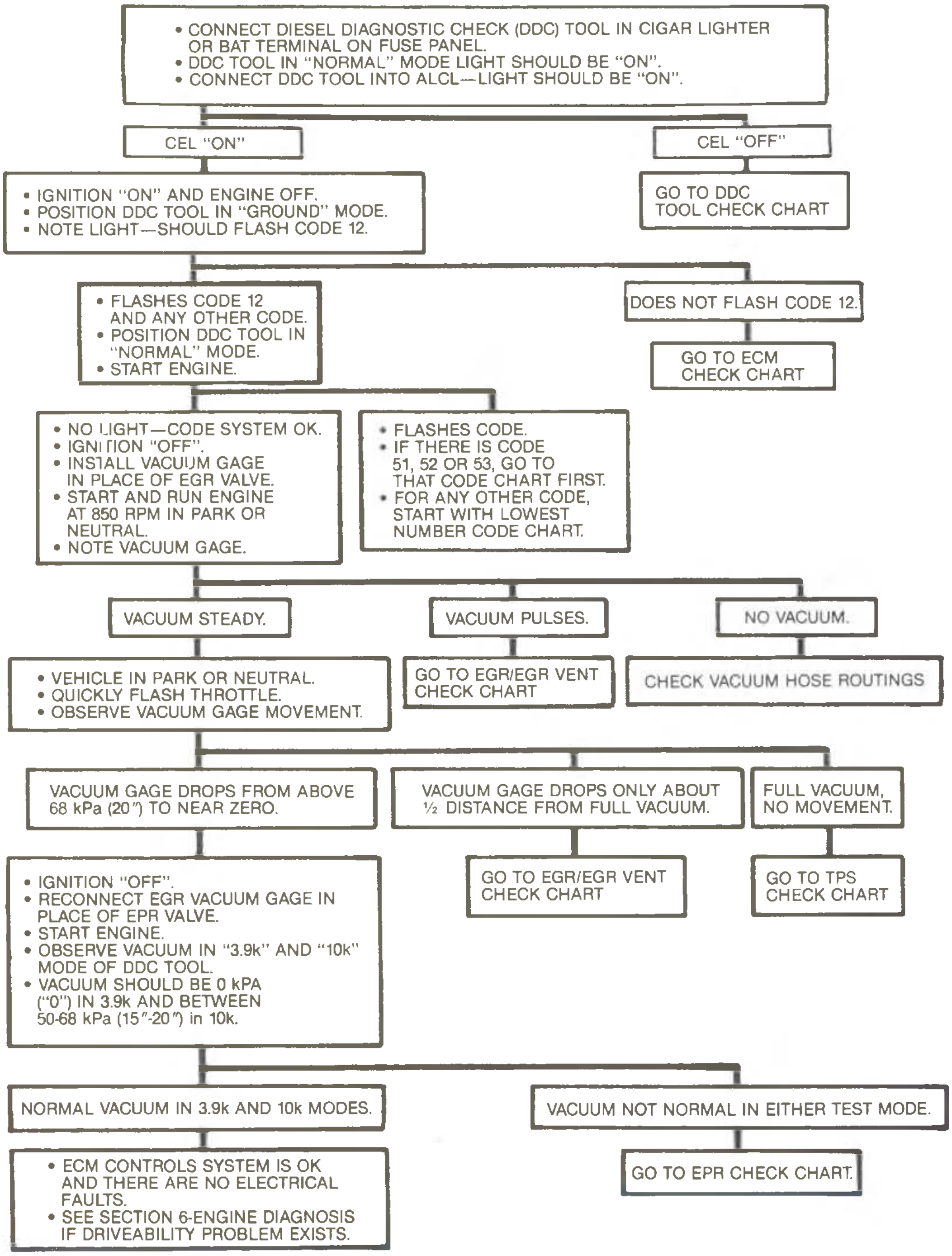


Figure 5-28, 1985 Diesel Diagnostic Circuit Check.

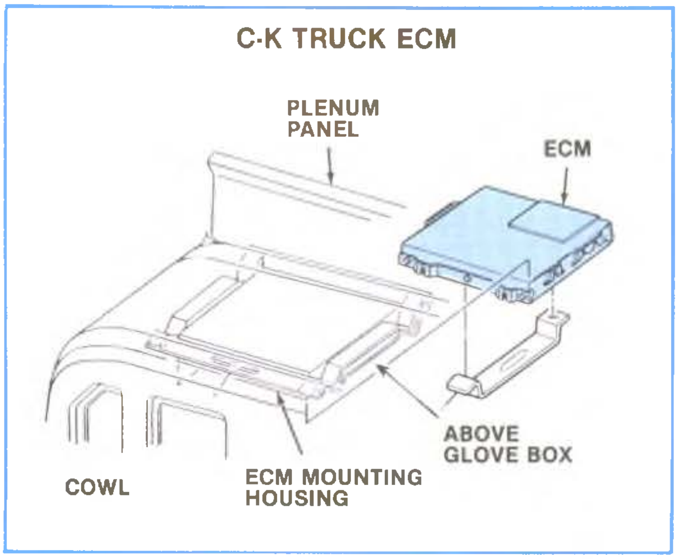


Figure 5-29, C-K Truck ECM Location.

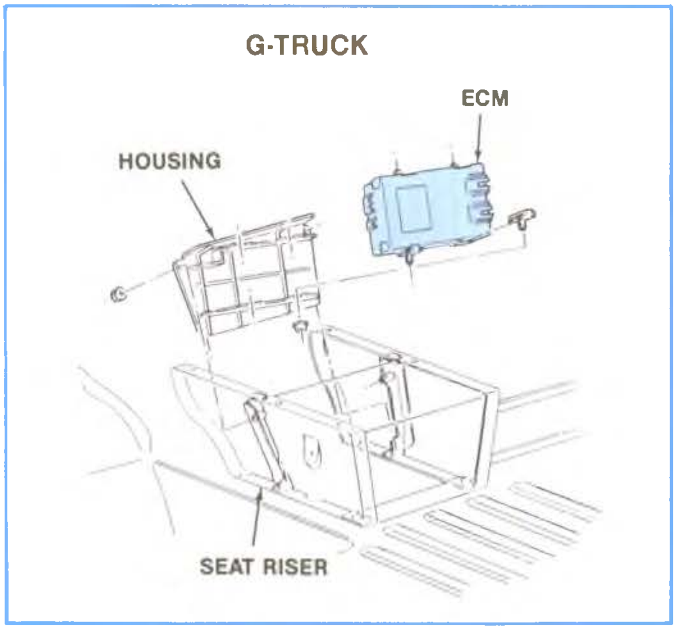


Figure 5-30, G-Truck ECM Location.

Electronic Control Module (ECM)

The system electronic control module (ECM) controls the EGR vacuum signal by modulating a square wave electrical signal to the EGR solenoid.

The solenoid behaves like an "ON/OFF" device responding to the de-energized/energized portion of the square wave. By modulating the de-energized/energized portion of the square wave, the EGR vacuum signal can be controlled. A bleed portion of the solenoid improves the EGR modulation response by bleeding EGR vacuum to atmosphere whenever the solenoid closes the source vacuum port.

THE ECM CONTROLS THE FOLLOWING OUTPUTS:

- Exhaust Gas Recirculation (EGR).
- Exhaust Pressure Regulation Control (EPR).
- Transmission Convertor Clutch Control (TCC).
- System Diagnosis.

THE ECM MONITORS THE FOLLOWING INPUTS:

- Engine RPM.
- Absolute Pressure (MAP) used to monitor EGR vacuum circuit.
- Throttle Position Sensor (TPS).
- 4th Gear Input (1984 only).
- Vehicle Speed via VSS, 1985 and Later.

The ECM is serviced the same as the Delco ECM in gas engine vehicles. In 1984 there is only one service ECM, and 4 different E-PROMS. In 1985, there is one service ECM and 6 different E-PROMS. During service replace either the PROM, ECM or both.

The broadcast code (e.g., BRL) on the E-PROM matches the broadcast code on the ECM.

There is a 4 digit E-PROM code on it for identification, and this code is the last 4 digits in the PROM part number.

E.G. PROM CODE 9564 BRM
PROM part #10039564
Broadcast code — "BRM" will match "BRM" code on the ECM label.

1984 California 6.2L Diesel ECM Usage

- **SERVICE ECM P/N — 1226465**
  - VEHICLE USAGE — C10 Suburban
    K10 Blazer
    C10-20 Pick-up
  - CALIB. — S8H5M
  - BROADCAST CODE — BRL
  - PROM PART #16040980

- **SERVICE ECM P/N — 1226465**
  - VEHICLE USAGE — K10 Suburban
    G20 (Van) Manual Trans.
  - CALIB. — S8H7
  - BROADCAST CODE — BRM
  - PROM PART #16039564

- **SERVICE ECM P/N — 1226465**
  - VEHICLE USAGE — K10 Pick-up
  - CALIB. — S8B14
  - BROADCAST CODE — BRN
  - PROM PART #16039569

- **SERVICE ECM P/N — 1226465**
  - VEHICLE USAGE — G20 (VAN) AUTO TRANS.
  - CALIB. — S8H14
  - BROADCAST CODE — BRR
  - PROM PART #16039580

1985 California 6.2L Diesel ECM Usage

SERVICE ECM PART #1226645 (ALL SERIES)

VEHICLE USAGE

- C-Truck Automatic
- Broadcast Code — DWC
- PROM Part #16044575

- C-Truck Manual
- Broadcast Code — DWD
- PROM Part #16044585

- K-Truck Automatic
- Broadcast Code — DWF
- PROM Part #160144595

- K-Truck Manual
- Broadcast Code — DWH
- PROM Part #16044605

- G-Van Automatic
- Broadcast Code — DWJ
- PROM Part #16044615

- G-Van Manual
- Broadcast Code — DWK
- PROM Part #16044625