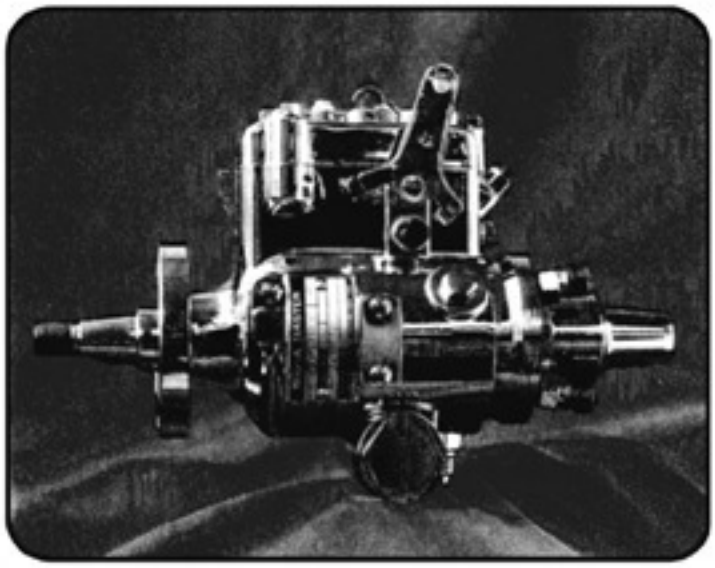
OPERATION AND INSTRUCTION MANUAL
MODEL DB2 PUMP



STANADYNE

CONTENTS

STANADYNE

General

A. PURPOSE OF THE MANUAL

This manual is expressly intended to provide sufficient information for qualified technicians experienced in diesel engines and diesel injection equipment, to disassemble and reassemble the Roosa Master DB2 type fuel injection pump and to make such adjustments and parts replacements as may be needed. It is recommended that an inexperienced person refrain from making adjustments and repairs, as such action may result in very extensive damage to the pump and possibly to the engine.

No service should be performed on the pump before making a careful study of this manual and becoming familiar with the principles and instructions which follow. Since several critical adjustments of the injection pump are required which cannot readily be made on the engine, it is necessary that the service be performed in a facility equipped with the proper special tools and an approved, motorized test stand.

This manual completely describes the operating principles of the pump and most accessories. Only through a thorough knowledge of these principles can the serviceman locate and correct possible operational defects.

B. MODEL NUMBER SYSTEM

It is necessary to understand the model number system for reference to the proper sections of this manual covering operation and maintenance of the pump.

EXAMPLE:

	a	b	c	d	e
Model Number	DB2	6	33	JN	3000

a. DB2-D Series Pump, B-Rotor, 2nd generation
b. 6-Number of cylinders. (Available in 2, 3, 4, 6 and 8 cylinder configurations.)
c. 33-Abbreviation of plunger diameter.
   25 - .250"(6.35mm) 31 - .310"(7.87mm)
   27 - .270"(6.86mm) 33 - .330"(8.38mm)
   29 - .290"(7.37mm) 35 - .350"(8.89mm)
d. JN - Accessory code (See S.B. No. 63)
   The code pertains to combinations of special accessories such as electrical shutoff, automatic advance, variable speed droop adjustment, etc. See the proper service bulletin or manual section for operation and construction of these accessories. Include this in any reference to the pump.
e. 3000 - Specification Number
   Determines selection of parts and adjustments for a given application. Must be included in any reference to the pump.

NOTE: Pump rotation and method of mounting are provided under special notes on individual pump specifications.

C. GENERAL INFORMATION

In a diesel engine, air is drawn into the cylinder through the intake valve and compressed. A metered quantity of fuel is then injected into the cylinder, producing a combustible mixture. This mixture ignites from heat of compression, and the expanding gases force the piston downward.

The function of a diesel fuel injection pump is to accurately meter and deliver fuel to a nozzle in each cylinder and to inject it at high pressure into the combustion chamber at precisely timed intervals. The extreme precision necessary can well be appreciated since this cycle must be repeated thousands of times per minute with virtually no variation in timing or amount of fuel injected. The injection pump is truly the heart of the diesel engine.

ROOSA MASTER
MODEL DB2 DIESEL INJECTION PUMP

The model DB2 injection pump is described as an opposed plunger, inlet metered, positive displacement, distributor type pump. The DB2 pump incorporates a single pumping chamber. Simplicity, the prime advantage of Roosa Master design, contributes to lower initial cost, greater reliability, ease of service and lower maintenance cost.

The necessity for cost reduction is more apparent in the small diesel engine where the injection equipment represents a greater percentage of the cost. Since the basic model has but 100 odd parts, and only four main rotating members, there is less chance of failure. Repairs are generally inexpensive. Today's small high output engines have created a need for improved, yet low cost, injection equipment capable of higher speed operation, quieter running and lower exhaust emissions.

Precise distribution between cylinders, inherent in the pump design, and the ability to preset fuel flow eliminates lengthy periods on the test stand. The pump is self-lubricated, con-

tains essentially the same number of parts regardless of the number of cylinders served, and operates in any position.

IMPROVED DESIGN FEATURES

The addition of the Model DB2 injection pump to the Roosa Master line of fuel injection equipment incorporates many design improvements, and has been durability tested for more than 200,000 hours prior to release for production.

Improved Design Features Include:

1. Housing
   a. Cast-in, hardened throttle bosses.
   b. Larger diameter advance bosses.
   c. Cast-in wrench boss for timing (on some models).
   d. New straight thread return oil fitting.

2. Head and Rotor
   a. Easily accessible vent wire assembly.
   b. Integral angled discharge fittings.

3. Automatic Advance (Optional)
   a. Sintered metal cam standard on light duty applications.

SECTION 1 - CONSTRUCTION AND OPERATION

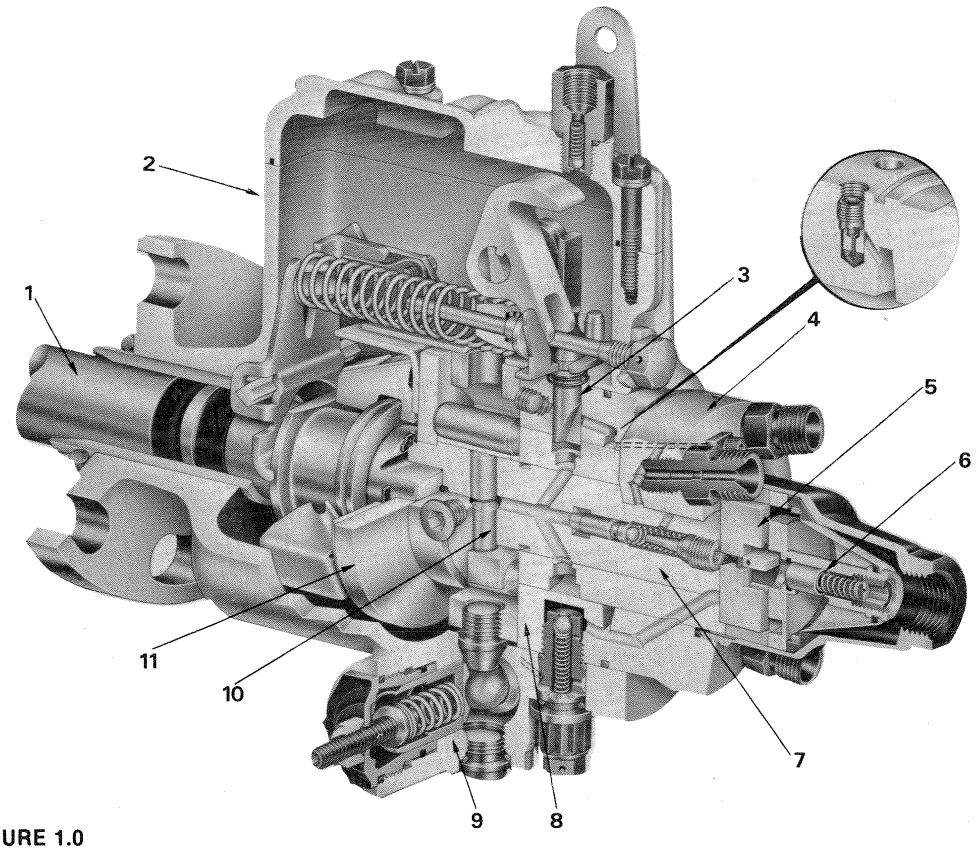


FIGURE 1.0

A. COMPONENTS AND FUNCTIONS

It is necessary to become familiar with the function of the main components to understand the basic operating principles of the Roosa Master Model DB2 pump. See cutaway view (Figure 1.0) for construction details.

MAIN COMPONENTS

1. Drive Shaft
2. Housing
3. Metering Valve
4. Hydraulic Head Assembly
5. Transfer Pump Blades
6. Pressure Regulator Assembly
7. Distributor Rotor
8. Internal Cam Ring
9. Automatic Advance (Optional)
10. Pumping Plungers
11. Governor

The main rotating components are the drive shaft (1), transfer pump blades (5), distributor rotor (7), and governor (11).

With reference to Figure 1.0, the drive shaft engages the distributor rotor in the hydraulic head. The drive end of the DB2 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 normally equals the number of engine cylinders.

The transfer pump at the rear of the rotor is of the positive displacement vane type and is enclosed in the end cap. The end cap also houses the fuel inlet strainer and transfer pump pressure regulator. The face of the regulator assembly is compressed against the liner and distributor rotor and forms an end seal for the transfer pump. The injection pump is designed so that end thrust is against the face of the transfer pump pressure regulator. The distributor rotor incorporates two charging ports and a single axial bore with one discharge port to service all head outlets to the injection lines.

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 contains its own mechanical governor, capable of close speed regulation. The centrifugal force of the weights in their retainer is transmitted through a sleeve to the governor arm and through a positive linkage to the metering valve. The metering valve can be closed to shut off fuel through a solid linkage by an independently operated shutoff lever, or by an electrical solenoid.

The automatic advance is a hydraulic mechanism which advances or retards the pumping cycle.

B. MOUNTING FLANGES

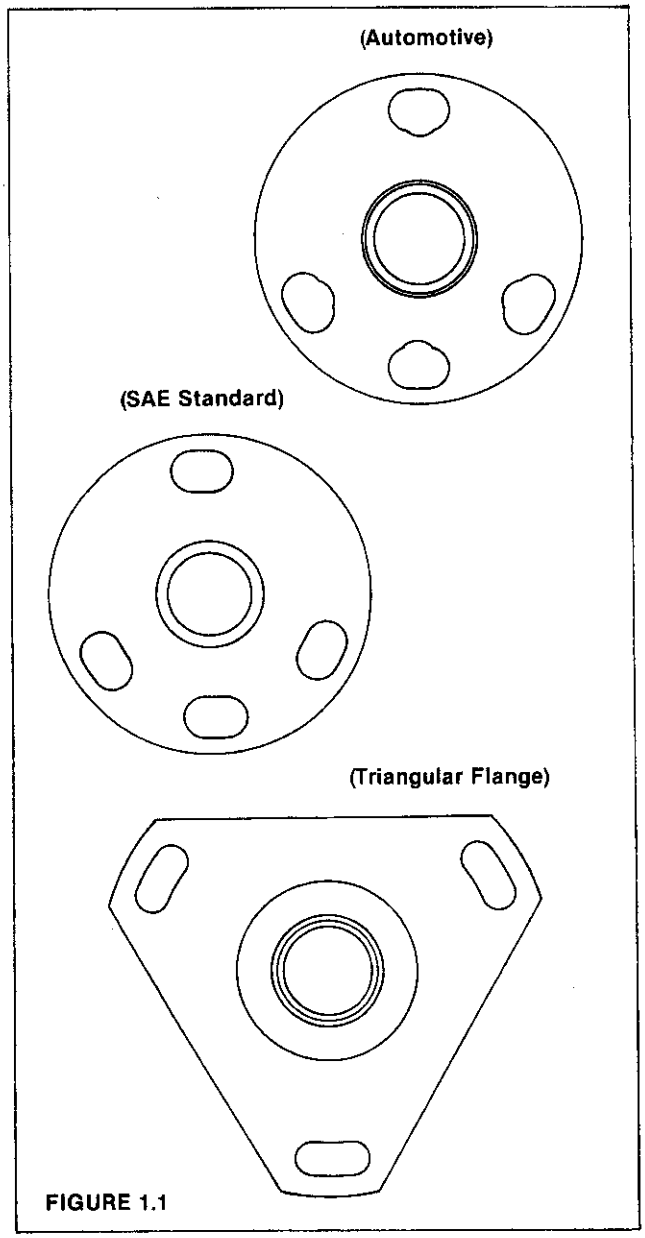


FIGURE 1.1

Shown above are the typical DB2 mounting flange configurations. These are the three most common types. Note that the automotive flange has scalloped slots to enable it to be mounted on a standard pump holding fixture.

C. FUEL FLOW

The operating principles of the pump can be understood more readily by following the fuel circuit during a complete pump cycle, (Figure 1.2), cutaway and, (Figure 1.3), fuel flow schematic. Also, see exploded view of the rotor assembly, (Figure 1.4).

Fuel is drawn from the supply tank through filters into the pump inlet through the inlet filter screen (1) by the vane type fuel transfer pump (2). Some fuel is bypassed through the pressure regulator assembly (3) to the suction side.

Fuel under transfer pump pressure flows through the center of the transfer pump rotor, past the rotor retainers (4) into a circular groove on the rotor. It then flows through a connecting passage (5) in the head to the automatic advance (6) and up through a radial passage (7) and then through a connecting passage (8) to the metering valve. The radial position of the metering valve, controlled by the governor, regulates flow of the fuel into the radial charging passage (9) which incorporates the head charging ports.

As the rotor revolves, the two rotor inlet passages (10) register with the charging ports in the hydraulic head, allowing fuel to flow into the pumping chamber. With further rotation, the inlet passages move out of registry and the discharge port of the rotor registers with one of the head outlets. While the discharge port is opened, the rollers (11) contact the cam lobes forcing the plungers together. Fuel trapped between the plungers is then pressurized and delivered by the nozzle to the combustion chamber.

Self-lubrication of the pump is an inherent feature of the Roosa Master design. As fuel at transfer pump pressure reaches the charging ports, slots on the rotor shank allow fuel and any entrapped air to flow into the pump housing cavity.

In addition, an air vent passage (12) in the hydraulic head connects the outlet side of the transfer pump with the pump housing. This allows air and some fuel to be bled back to the fuel tank via the return line. The fuel thus bypassed fills the housing, lubricates the internal components, cools and carries off any small air bubbles. The pump operates with the housing completely full of fuel; there are no dead air spaces anywhere within the pump.

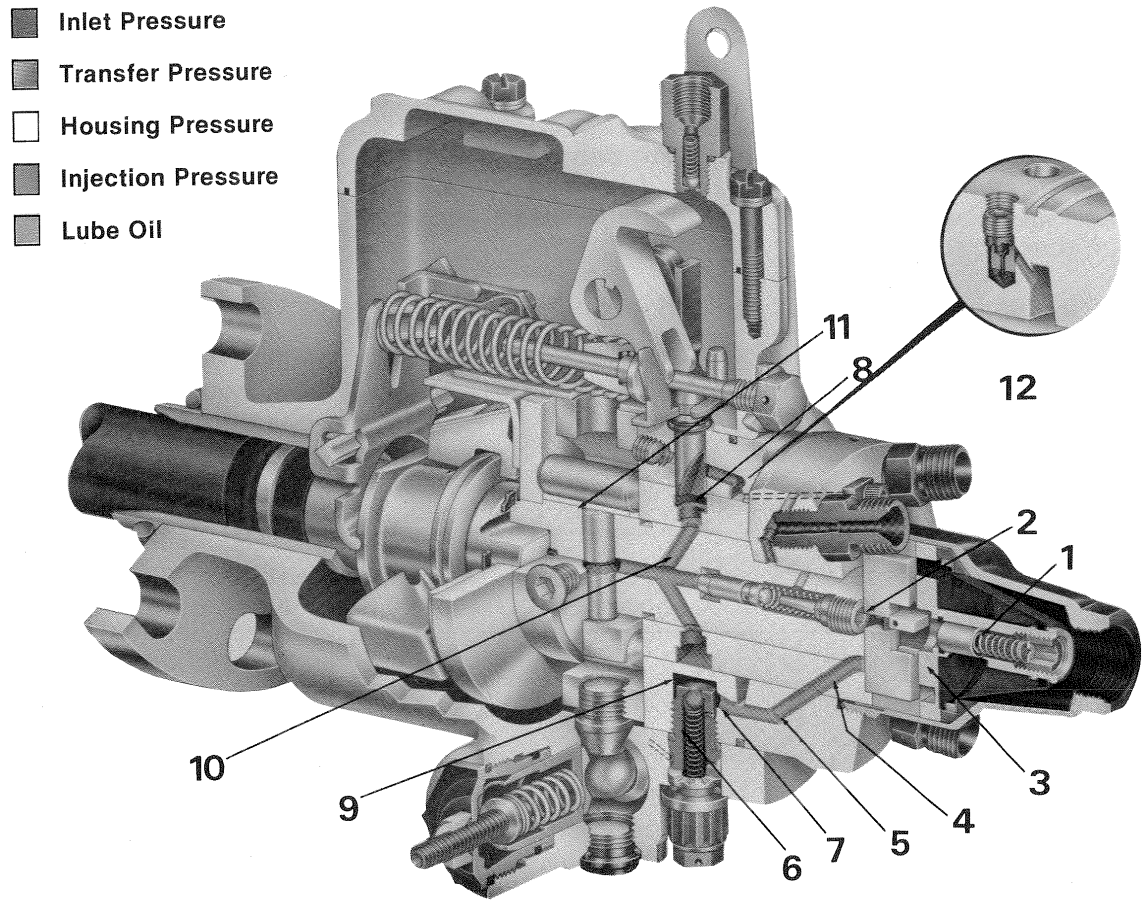


FIGURE 1.2

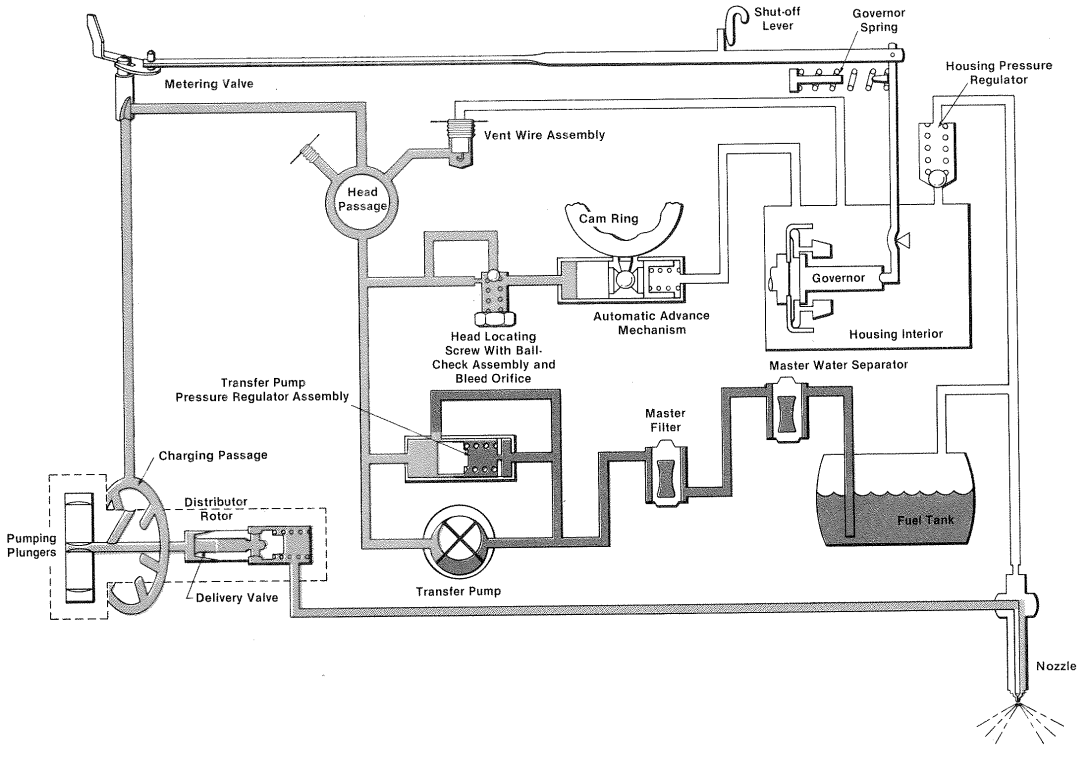


FIGURE 1.3

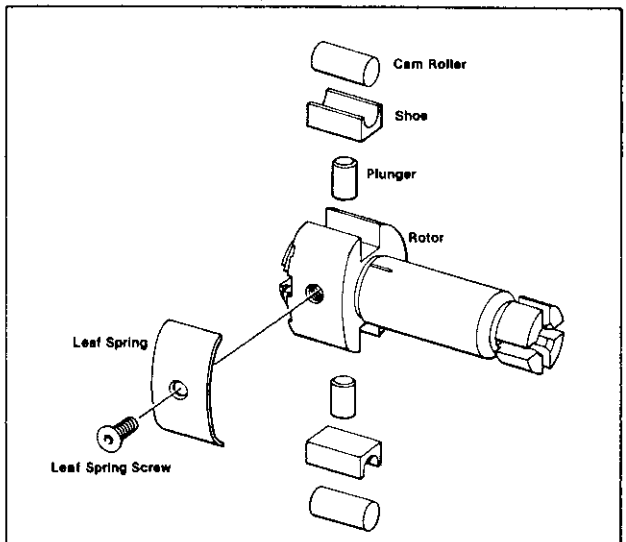


FIGURE 1.4

D. TRANSFER PUMP

The positive displacement vane type fuel transfer pump consists of a stationary liner and spring loaded blades which are carried in slots in the rotor. Since the inside diameter of the liner is eccentric to the rotor axis, rotation causes the blades to move in the rotor slots. This blade movement changes the volume between the blade segments.

Transfer pump output volume and pressure increases as pump speed increases. Since displacement and pressure of the transfer pump can exceed injection requirements, some of the fuel is recirculated by means of the transfer pump regulator to the inlet side of the transfer pump.

Figure 1.5 illustrates the pumping principle. Radial movement causes a volume increase in the quadrant between blades 1 and 2 (Figure 1.5a). In this position, the quadrant is in registry with a kidney shaped inlet slot in the top portion of the regulator assembly. The increasing volume causes fuel to be pulled through the inlet fitting and filter screen into the transfer pump liner. Volume between the two blades continues to increase until blade 2 passes out of registry with the regulator slot. At this point the rotor has reached a position where outward movement of blades 1 and 2 is negligible and volume is not changing (Figure 1.5b). The fuel between the blades is being carried to the bottom of the transfer pump liner.

As blade 1 passes the edge of the kidney shaped groove in the lower portion of the regulator assembly (Figure 1.5c), the liner, whose inside diameter is eccentric to the rotor, compresses blades 1 and 2 in an inward direction (Figure 1.5a). The volume between the blades is reduced and pressurized fuel is delivered through the groove of the regulator assembly, through the transfer pump, through the rotor, past the rotor retainers and into a channel on the rotor leading to the hydraulic head passages. Volume between blades continues to decrease, pressurizing the fuel in the quandrant, until blade 2 passes the groove in the regulator assembly.

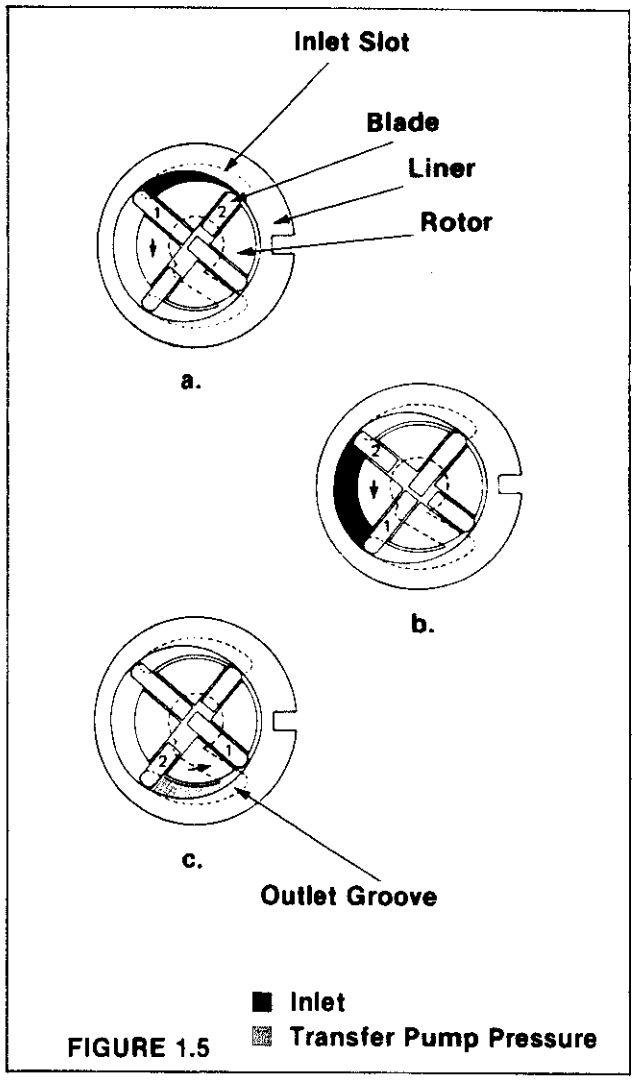
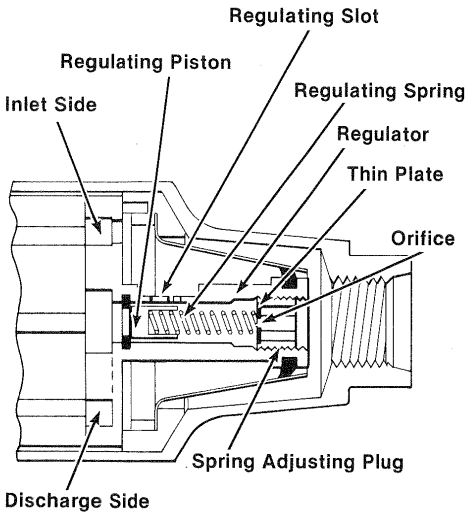


FIGURE 1.5

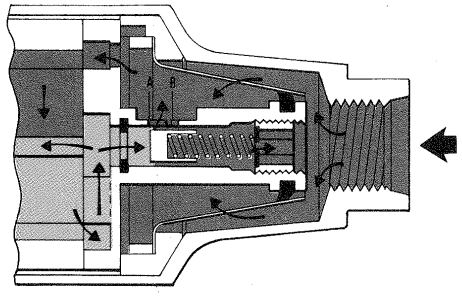
REGULATOR ASSEMBLY OPERATION

Figure 1.6 shows the operation of the pressure regulating piston while the pump is running. Fuel output from the discharge side of the transfer pump forces the piston in the regulator against the regulating spring. As flow increases, the regulating spring is compressed until the edge of the regulating piston starts to uncover the pressure regulating slot "S" (Figure 1.6b). Since fuel pressure on the piston is opposed by the regulating spring, the delivery pressure of the transfer pump is controlled by the spring rate and size of the regulating slot "A". Therefore, pressure increases with speed.

A high pressure relief slot "B" is incorporated in some regulators as part of the pressure regulating slot to prevent excessively high transfer pump pressure, if the engine or pump is accidentally overspeeded.



a.



b.

INLET
TRANSFER PUMP PRESSURE

FIGURE 1.6

VISCOSITY COMPENSATION

The DB2 transfer pump works equally well with different grades of diesel fuel and varying temperatures, both of which affect fuel viscosity. A unique and simple feature of the regulating system offsets pressure changes caused by viscosity difference. Located in the spring adjusting plug is a thin plate incorporating a sharp-edged orifice. The orifice allows fuel leakage past the piston to return to the inlet side of the pump. Flow through a short orifice is virtually unaffected by viscosity changes. The biasing pressure exerted against the back side of the piston is determined by the leakage through the clearance between the piston and the regulator bore and the pressure drop through the sharp edged orifice. With cold or viscous fuels, very little leakage occurs past the piston. The additional force on the back side of the piston from the viscous fuel pressure is slight. With hot or light fuels, leakage past the piston increases. Fuel pressure in the spring cavity increases also, since flow past the piston must equal flow through the orifice. Pressure rises due to increased piston leakage and pressure rises to force more fuel through the orifice. This variation in piston position compensates for the leakage which would occur with thin fuels and design pressures are maintained over a broad range of viscosity changes.

E. CHARGING AND DISCHARGING

Charging Cycle

As the rotor revolves, (Figure 1.7) the two inlet passages in the rotor register with ports of the circular charging passage. Fuel under pressure from the transfer pump, controlled by the opening of the metering valve, flows into the pumping chamber forcing the plungers apart.

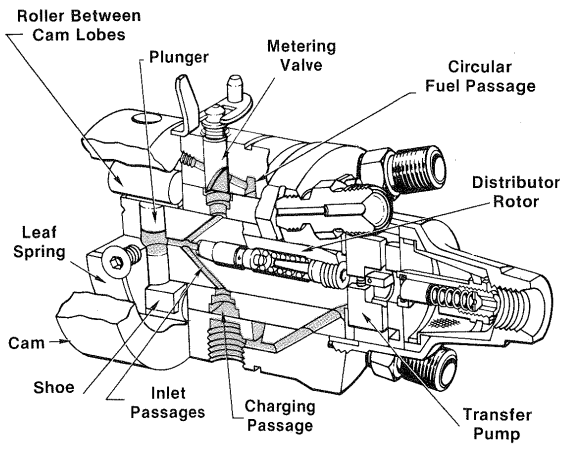


FIGURE 1.7

The plungers move outward a distance proportionate to the amount of fuel required for injection on the following stroke. If only a small quantity of fuel is admitted into the pumping chamber, as at idling, the plungers move out a short distance. Maximum plunger travel and, consequently, maximum fuel delivery is limited by the leaf spring which contacts the edge of the roller shoes. Only when the engine is

operating at full load will the plungers move to the most outward position. Note (Figure 1.7) that while the angled inlet passages in the rotor are in registry with the ports in the circular charging passage, the rotor discharge port is not in registry with a head outlet. Note also that the rollers are off the cam lobes. Compare their relative positions (Figures 1.7 and 1.8).

Discharge Cycle

As the rotor continues to revolve (Figure 1.8), the inlet passages move out of registry with the charging ports. The rotor discharge port opens to one of the head outlets. The rollers then contact the cam lobes forcing the shoes in against the plungers and high pressure pumping begins.

Beginning of injection varies according to load (volume of charging fuel), even though rollers may always strike the cam at the same position. Further rotation of the rotor moves the rollers up the cam lobe ramps pushing the plungers inward. During the discharge stroke the fuel trapped between the plungers flows through the axial passage of the rotor and discharge port to the injection line. Delivery to the injection line continues until the rollers pass the innermost point on the cam lobe and begin to move outward. The pressure in the axial passage is then reduced, allowing the nozzle to close. This is the end of delivery.

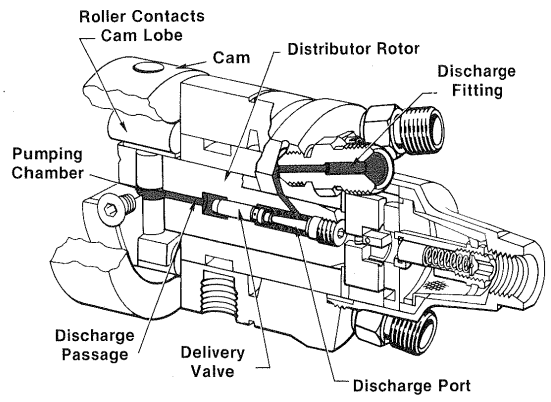


FIGURE 1.8

F. DELIVERY VALVE (Optional)

The delivery valve (Figures 1.9a through 1.9d) 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 valve to return rapidly to its seat, achieving sharp delivery cut-off and preventing improperly atomized fuel from entering the combustion chamber.

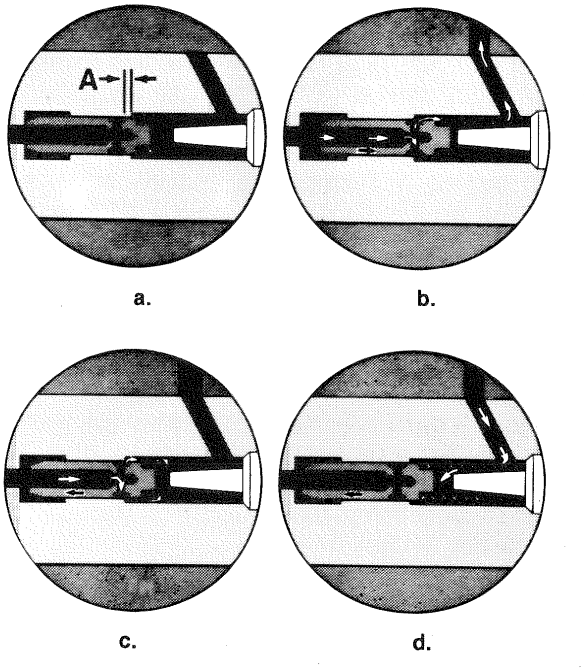


FIGURE 1.9

The delivery valve operates in a bore in the center of the distributor rotor. Note that 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 speeds.

When injection starts, fuel pressure moves the delivery valve slightly out of its bore and adds the volume of its displacement, section "A", 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.

G. RETURN OIL CIRCUIT

Fuel under transfer pump pressure is discharged into a vent passage in the hydraulic head (Figure 1.10). Flow through the passage is restricted by a vent wire assembly to prevent excessive return oil and undue pressure loss. 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.

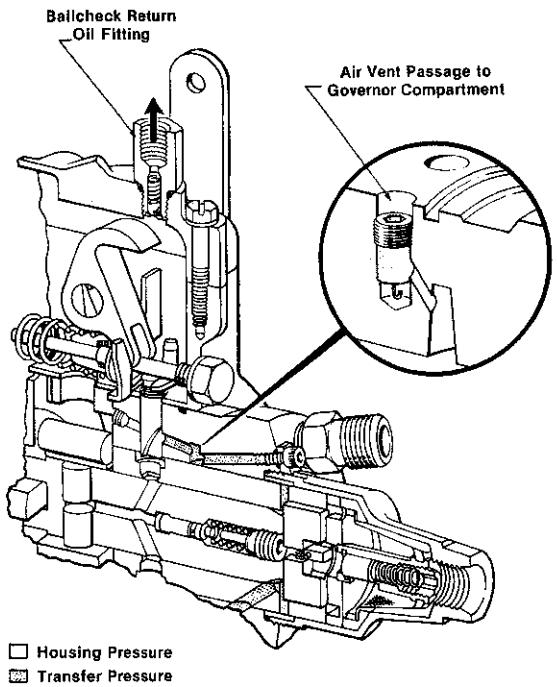


FIGURE 1.10

H. MECHANICAL ALL SPEED GOVERNOR

The governor serves the purpose of maintaining the desired engine speed within the operating range under various load settings.

In the mechanical governor (Figure 1.11), the movement of the weights acting against the governor thrust sleeve rotates the metering valve by means of the governor arm and linkage hook. This rotation varies the registry of the metering valve opening to the passage from the transfer pump, thereby controlling the quantity of fuel to the plungers. The governor derives its energy from weights pivoting in the weight retainer. Centrifugal force tips them outward, moving the governor thrust sleeve against the governor arm, which pivots on the knife edge of the pivot shaft and through a simple, positive linkage, rotates the metering valve. The force of the weights against the governor arm is balanced by the governor spring force, which is controlled by the manually positioned throttle lever and vehicle linkage for the desired engine speed.

In the event of a speed increase due to a load reduction, the resultant increase in centrifugal force of the weights rotates the metering valve clockwise to reduce fuel. This limits the speed increase (within the operating range) to a value determined by governor spring rate and setting of the throttle.

When the load on the engine is increased, the speed tends to reduce. The lower speed reduces the force generated by the weights permitting the spring force to rotate the metering valve in the counterclockwise direction to increase fuel. The speed of the engine at any point within the operating range is dependent upon the combination of load on the engine and the governor spring rate and setting as established by the throttle position. A light idle spring is provided for more sensitive regulation when weight energy is low in the low end of speed range. The limits of throttle travel are set by adjusting screws for proper low idle and high idle positions.

A light tension spring on the linkage assembly takes up any slack in the linkage joints and also allows the shutoff mechanism to close the metering valve without having to overcome the governor springing force. Only a very light force is required to rotate the metering valve to the closed position.

J. AUTOMATIC ADVANCE-SPEED RESPONSIVE (OPTIONAL)

The Roosa Master design permits the use of a

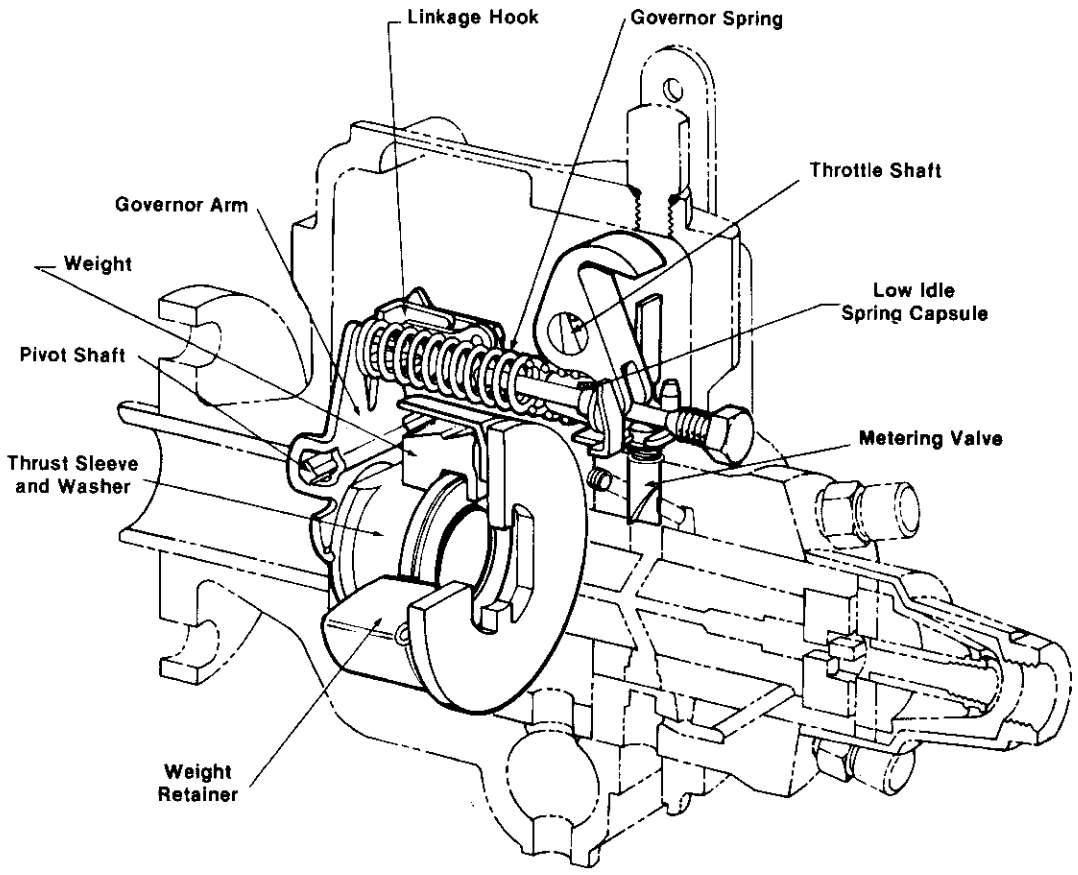


FIGURE 1.11

simple, direct acting hydraulic mechanism, powered by fuel pressure from the transfer pump, to rotate the cam slightly and vary delivery timing. The advance mechanism advances or retards start of fuel delivery in response to engine speed changes. In most injection systems, the actual beginning of delivery of fuel at the nozzle will start later (in engine degrees of rotation) as the speed increases.

Compensating inherent injection lag improves high speed performance of the engine. Starting delivery of fuel to the nozzle earlier when the engine is operating at higher speed insures that combustion takes place when the piston is in its most effective position to produce optimum power with minimum specific fuel consumption and minimum smoke.

The advance pistons located in a bore in the housing engage the cam advance screw and move the cam (when fuel pressure moves the power piston) opposite the direction of rotor rotation (Figures 1.12 and 1.13). Fuel under transfer pump pressure is fed through a drilled passaged in the hydraulic head which registers with the bore of the head locating screw. Fuel is then directed past the spring loaded ballcheck in the bore of the head locating screw. It then enters the groove on the outside diameter of the screw which registers with a drilled passage in the housing leading to the power piston side of the automatic advance assembly.

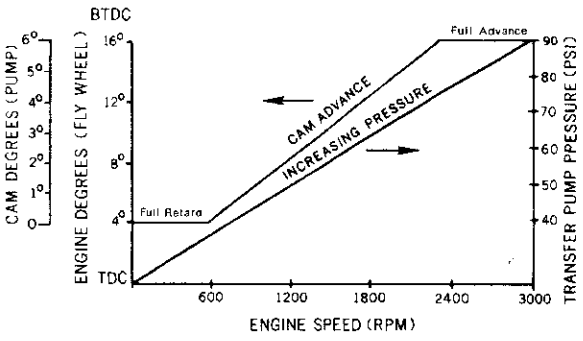
A groove around the power piston plug and a drilled passage allow the fuel to enter the advance piston bore. Fuel pressure against the piston must overcome the opposing spring force plus the dynamic injection loading on the cam in order to change the cam position. The spring loaded ballcheck in the bore of the head locating screw prevents the normal tendency of the cam to return to the retard position during injection by trapping the fuel in the piston chamber. When engine speed decreases, the hydraulic pressure is reduced and the spring returns the cam to a retarded position in proportion to the reduction in speed. The fuel in the piston chamber is allowed to bleed off through a control orifice located below the ballcheck valve in the head locating screw.

At low speeds, because transfer pump pressure is comparatively low, the cam remains in the retarded position. When engine speed increases, transfer pump pressure rises and moves the piston in the advanced direction. Advance piston movement is related to speed. Total movement of the cam is limited by the piston length.

A "trimmer screw" is provided to adjust advance spring preload which controls start of cam movement. It can be incorporated at either side of the advance mechanism and may be adjusted on the test bench while running (Figure 1.13).

SPEED ADVANCE OPERATION

END OF INJECTION TIMING VS. ENGINE SPEED



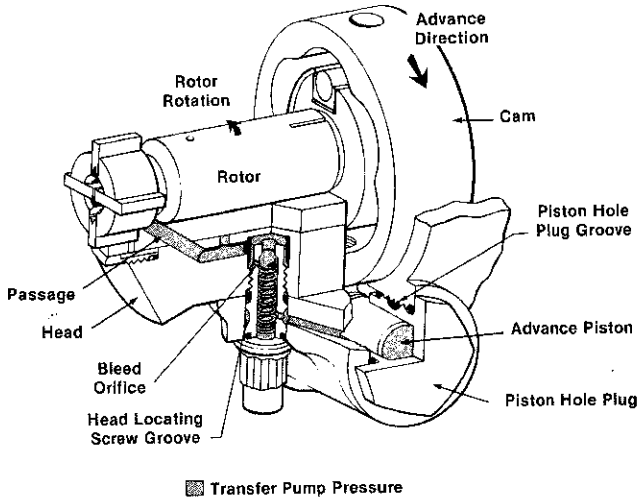


FIGURE 1.12

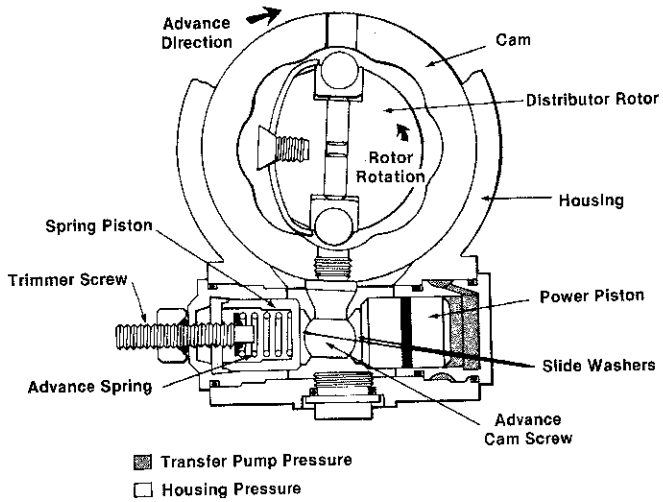
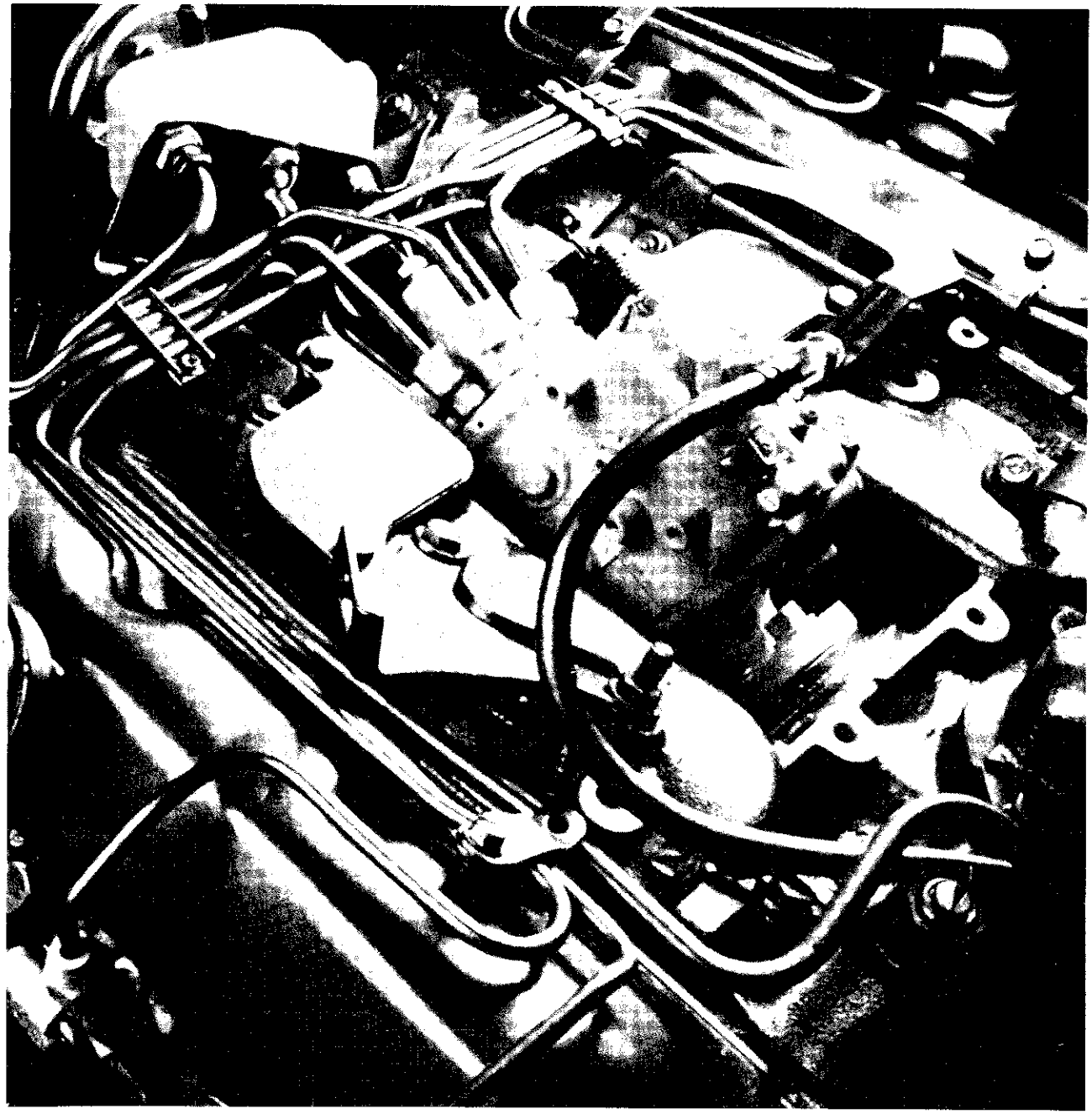


FIGURE 1.13

SECTION 2
REMOVING THE PUMP FROM THE ENGINE



Follow the engine manufacturers' instructions for removal of the pump from the engine. In addition, note the following instructions.

Clean and wash down the pump, fittings, and all connections to eliminate the possibility of contamination entering the system when lines are disconnected.

CAUTION: Do not steam clean or wash pump down while the engine is operating. Severe damage to the pump may occur if its temperature is changed radically while running.

Shut off the fuel supply and disconnect inlet and return lines from their fittings. Loosen injection tubing nuts at the nozzles and pump. Immediately after the lines are removed, all pump, nozzle, and line openings should be capped or plugged.

SECTION 3
DISASSEMBLY

Study the manual first. Before commencing disassembly of the pump, cover inlet and outlet holes, remove all external grease and dirt by washing the unit with diesel fuel and blowing it off with filtered compressed air. It must be constantly kept in mind that dirt, dust, and foreign matter are the greatest enemies of the fuel injection pump. As an added precaution to prevent dirt from entering the fuel system while servicing the pump, it is essential that a clean work space, clean tools, and clean hands be used.

NOTE: All seals and gaskets should be discarded during disassembly. A clean pan should be available in which the parts may be placed during disassembly, and a pan of clean diesel fuel or calibrating oil must be available in which the parts may be flushed. It is recommended that these be deep pans with rounded corners to lessen the chances of dirt pockets.

STEP 1 Remove the pilot tube seal (Figure 3.1).

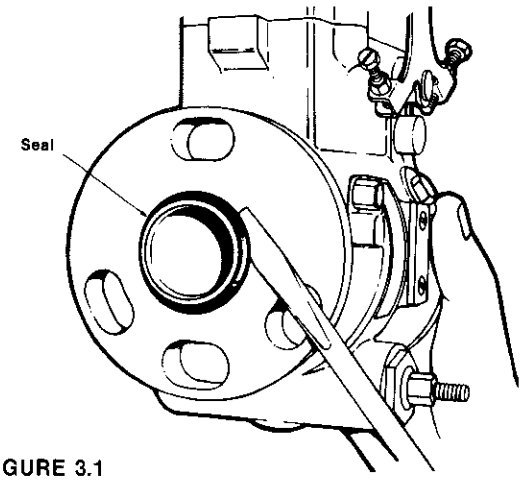


FIGURE 3.1

STEP 2 Mount the pump in a holding fixture, 20029. Always use a fixture to avoid pump sliding out and becoming damaged, never clamp the pump in a vise. Remove all lead plumb sealing wires. Unscrew the three cover hold-down screws (Figure 3.2a).

Remove the governor control cover and cover gasket (Figure 3.2b).

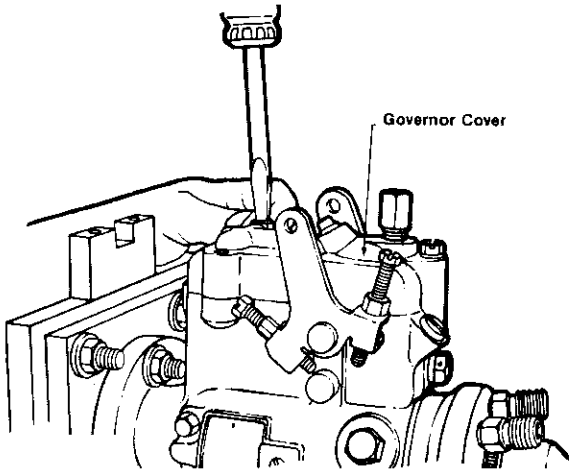


FIGURE 3.2a

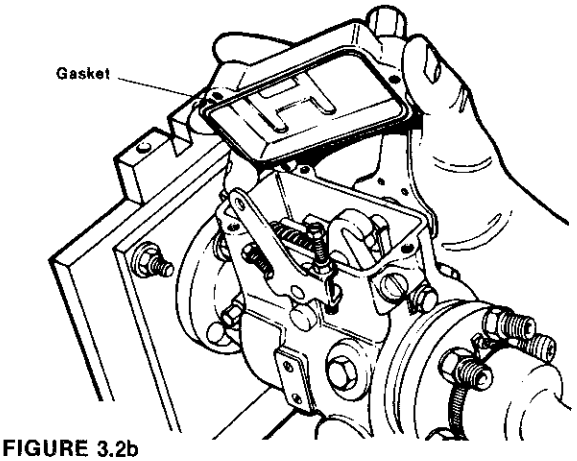


FIGURE 3.2b

STEP 3 Remove the shutoff cam by rotating the shutoff lever to the wide open throttle (WOT) position. Place tool, 20992, with tab beneath the shorter leg of the shutoff cam, on the shutoff shaft and pry gently, sliding the cam off the shaft assembly (Figure 3.3). Discard the shutoff cam.

NOTE: Do not reuse this shutoff cam, use new cam.

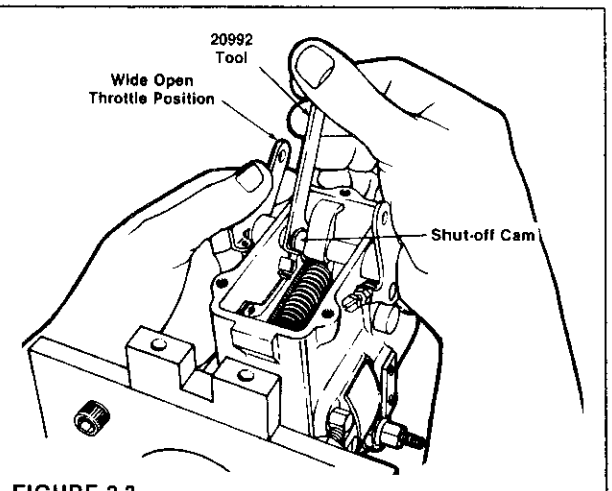


FIGURE 3.3

STEP 4 Withdraw the throttle shaft assembly and throttle shaft lever from the shutoff lever assembly (Figure 3.4). To aid in correct reassembly, note the position of the throttle shaft assembly key in relationship to the groove of the throttle shaft assembly.

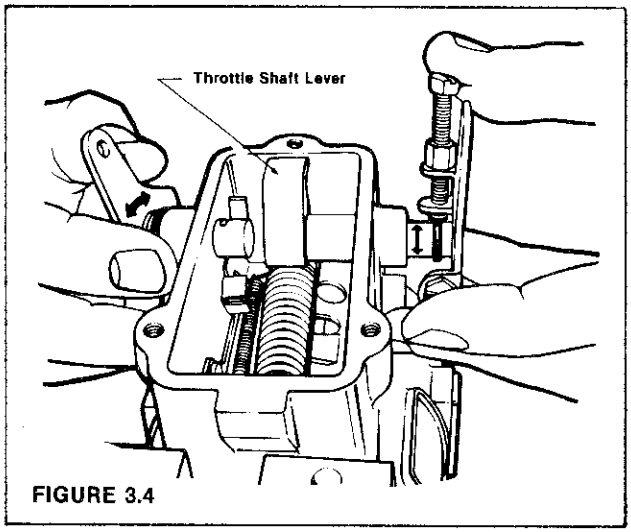


FIGURE 3.4

STEP 5 Loosen the guide stud. (Figure 3.5a)

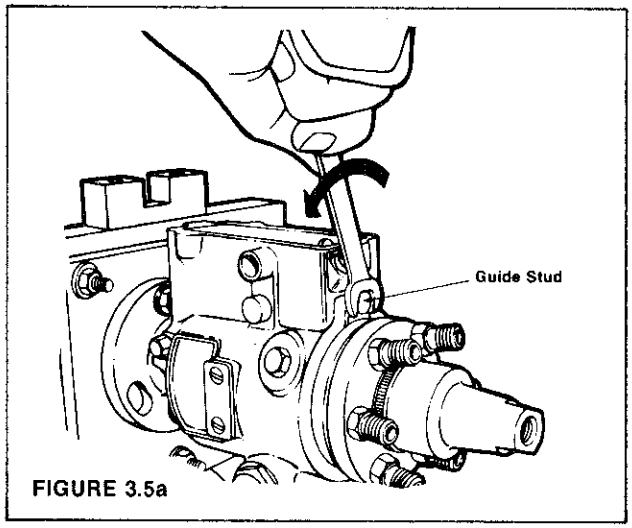


FIGURE 3.5a

While holding the governor spring firmly between the thumb and forefinger, withdraw guide stud and lift out governor spring and components (Figure 3.5b).

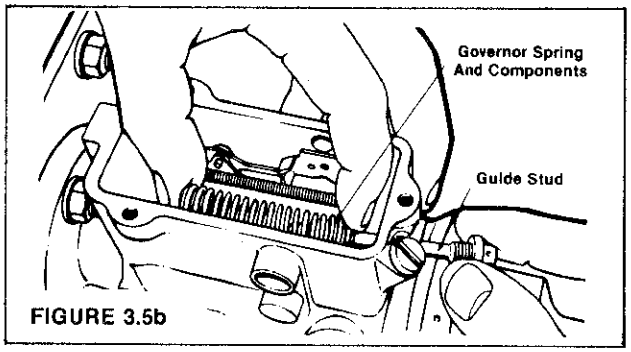


FIGURE 3.5b

STEP 6 While depressing the metering valve assembly, raise the governor linkage hook assembly from the metering valve arm pin. While holding the governor arm forward, pull the linkage hook back slightly to disengage it from the governor arm (Figure 3.6). Place it over the side of the housing. Do not disengage the linkage spring.

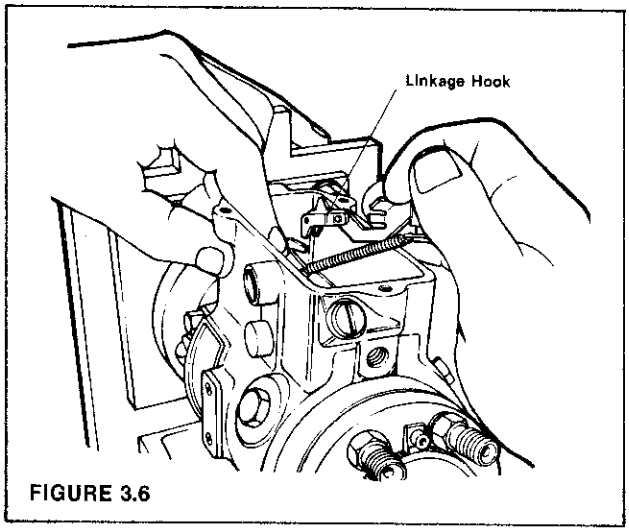


FIGURE 3.6

STEP 7 Remove the metering valve assembly (Figure 3.7).

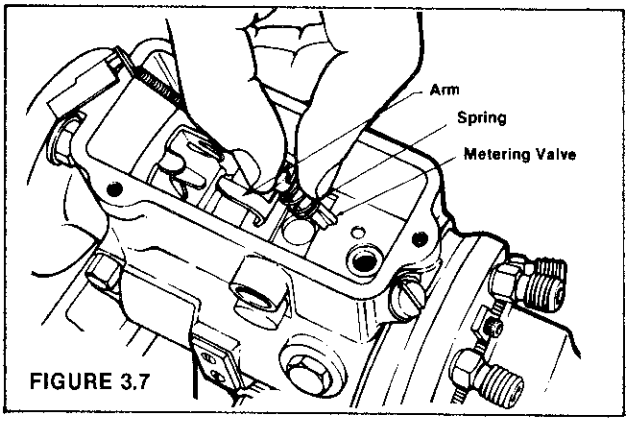


FIGURE 3.7

STEP 8 Loosen and remove the vent wire screw assembly using the 16336 wrench (Figure 3.8).

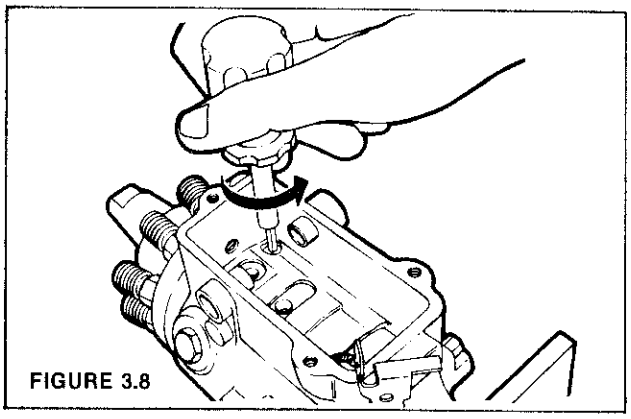


FIGURE 3.8

STEP 9 Loosen and remove transfer pump end cap locking screw, plate and seal from the hydraulic head (Figure 3.9).

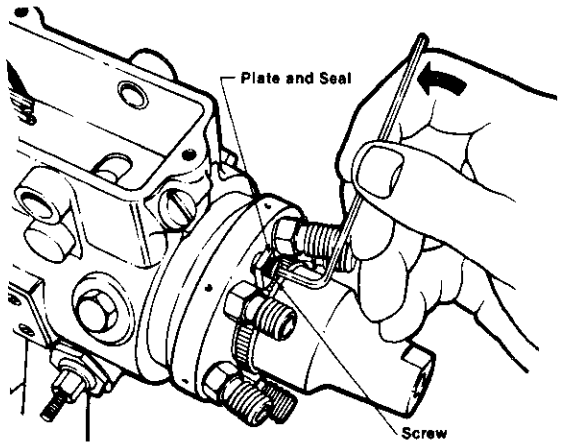


FIGURE 3.9

STEP 10 Loosen and remove the transfer pump end cap assembly, using the appropriate cap wrench (Figures 3.10a and 3.10b).

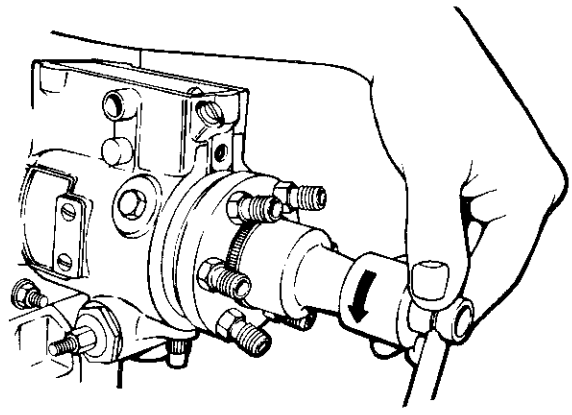


FIGURE 3.10a

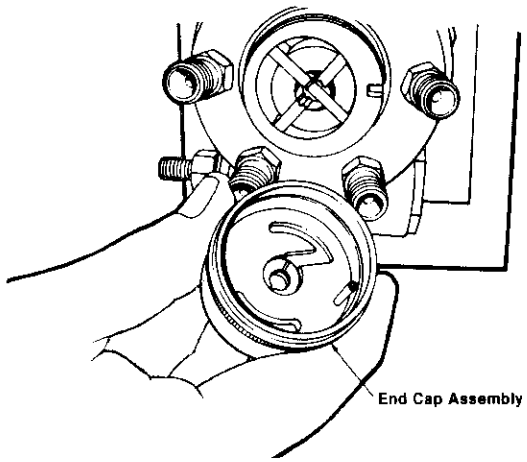


FIGURE 3.10b

STEP 11 Disassemble the transfer pump regulator components (Figure 3.11). Remove the inlet filter screen seal. Remove the end plate adjusting plug assembly with 5/32 inch hex key wrench, 13336. Shake the regulating spring and piston out of the regulating assembly. Using tool 13301, remove the regulating piston seal from the regulator.

NOTE: Some present regulators have metal piston seals and do not have to be removed.

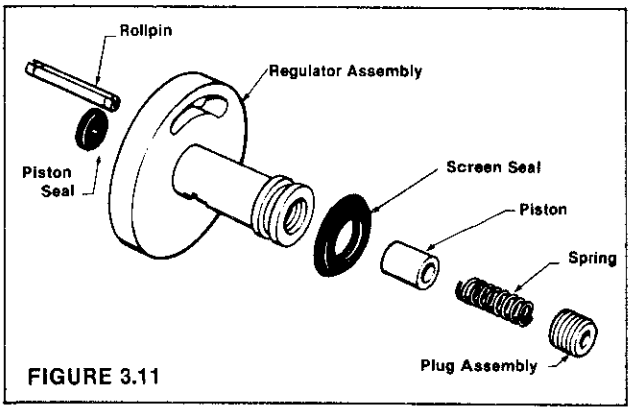


FIGURE 3.11

STEP 12 Remove the transfer pump blades and liner (Figure 3.12).

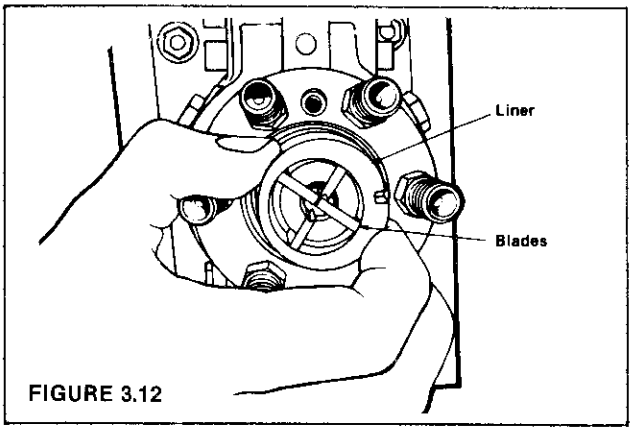


FIGURE 3.12

STEP 13 Remove the transfer pump end cap seal (Figure 3.13).

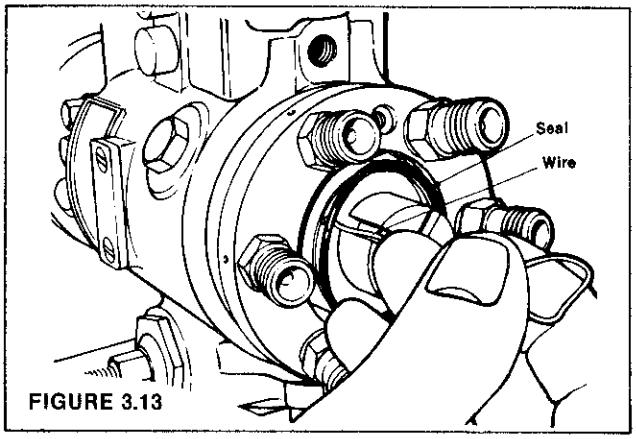


FIGURE 3.13

STEP 14 Loosen the head locking screws and remove one screw (Figure 3.14).

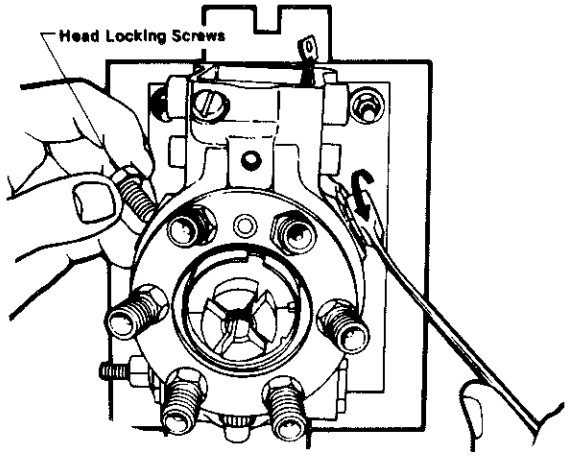


FIGURE 3.14

STEP 15 Invert the pump and holding fixture in the vise. Loosen and remove the head locating screw using a 7/16" deep well socket (Figures 3.15a and 3.15b).

NOTE: On pumps without an advance system, remove the cam locating screw and proceed to STEP 19.

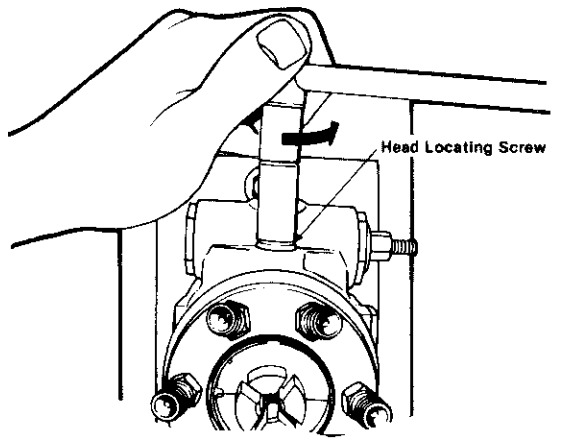


FIGURE 3.15a

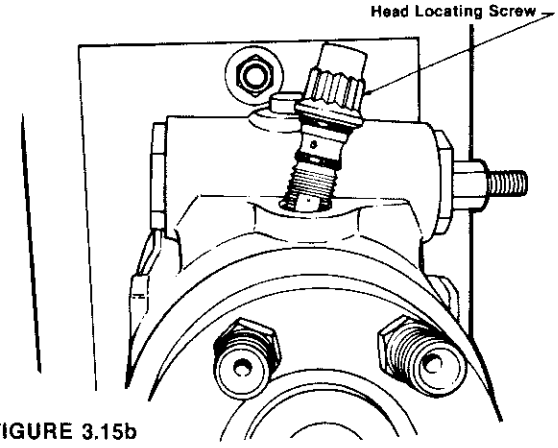


FIGURE 3.15b

STEP 16 Tap the advance screw hole plug lightly with a hammer to loosen (Figure 3.16a).

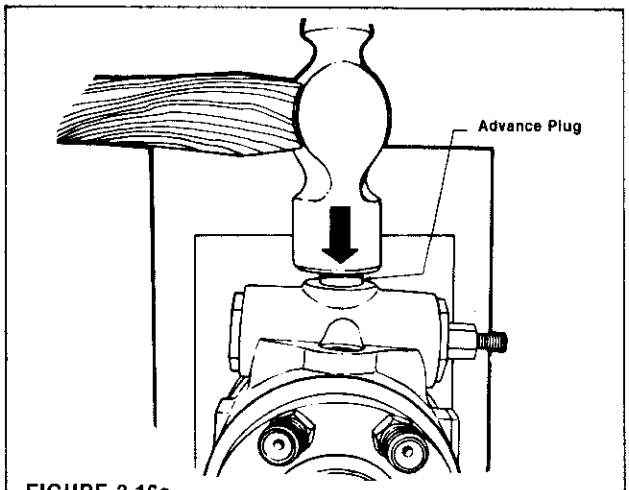


FIGURE 3.16a

Loosen and remove the advance screw hole plug using tool, 14490 (Figures 3.16b and 3.16c).

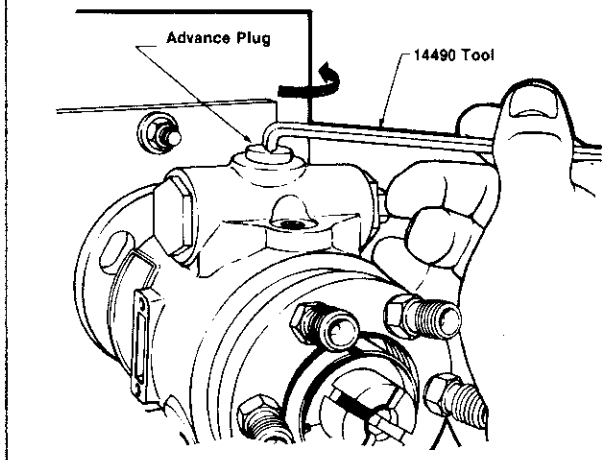


FIGURE 3.16b

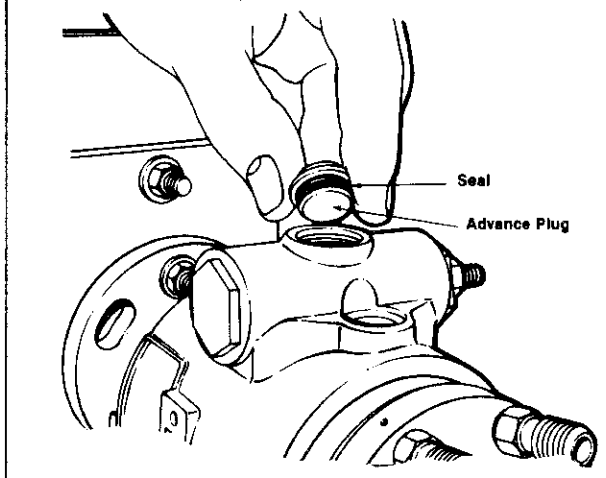


FIGURE 3.16c

STEP 17 Using the 14490 wrench, loosen and remove the spring side advance piston hole plug (Figure 3.17a).

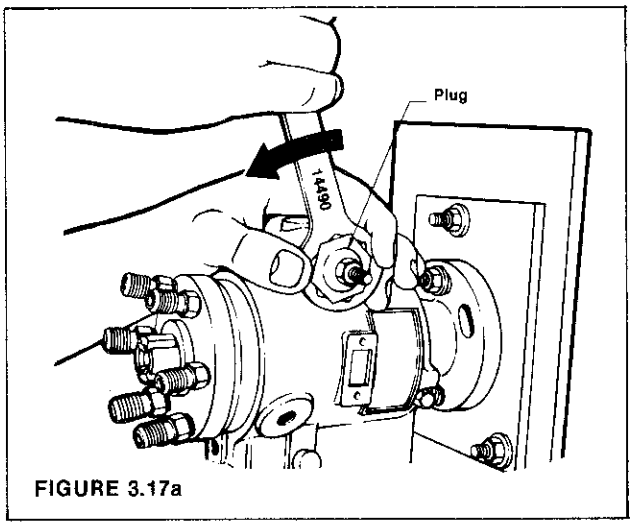


FIGURE 3.17a

Remove the plug, piston, spring, and slide washer (Figure 3.17b).

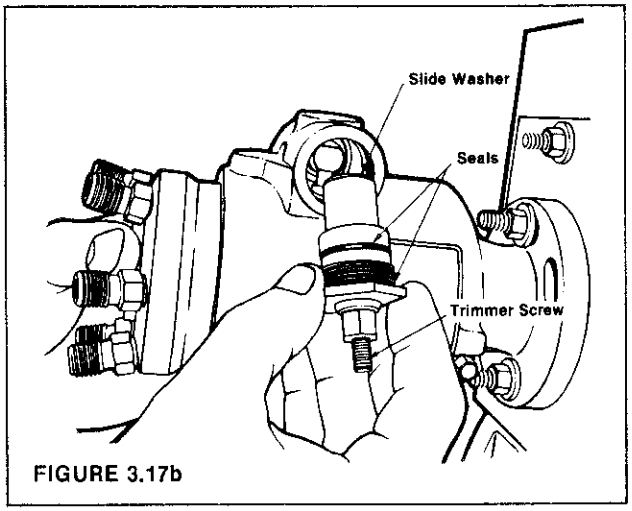


FIGURE 3.17b

STEP 18 Loosen and remove the power side advance piston hole plug (Figure 3.18a).

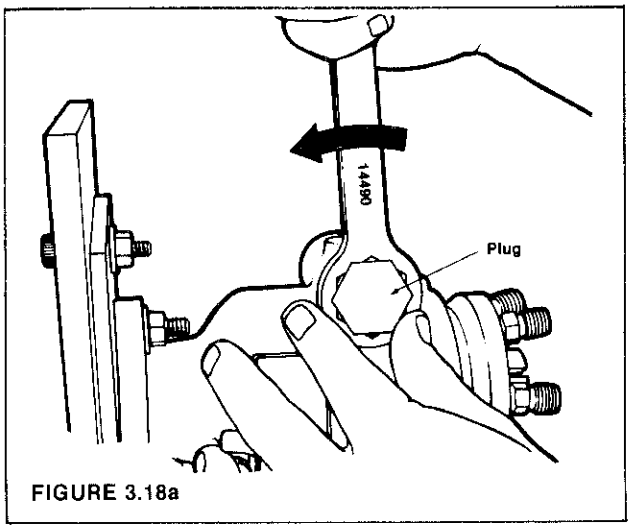


FIGURE 3.18a

Remove the plug, piston, and slide washer (Figure 3.18b).

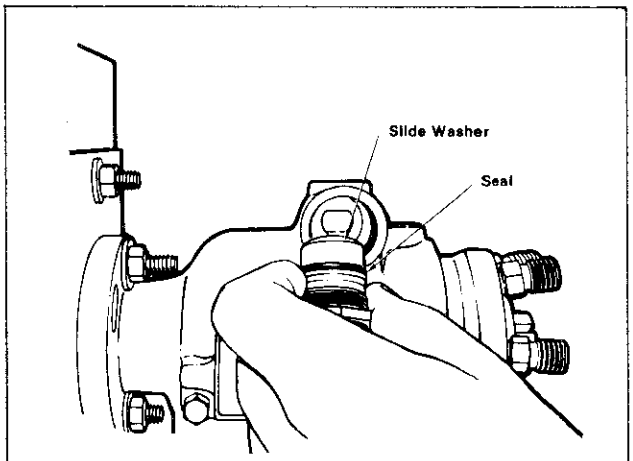


FIGURE 3.18b

NOTE: The sides of the housing, just above the advance boss, bear a "C" or "CC" marking to denote pump rotation. The power side piston is located in the side of the housing which is marked with the letter indicating rotation.

Disassemble the auto advance components (Figure 3.18c). Invert spring side piston hole plug and let the piston, spring and guide fall into your hand.

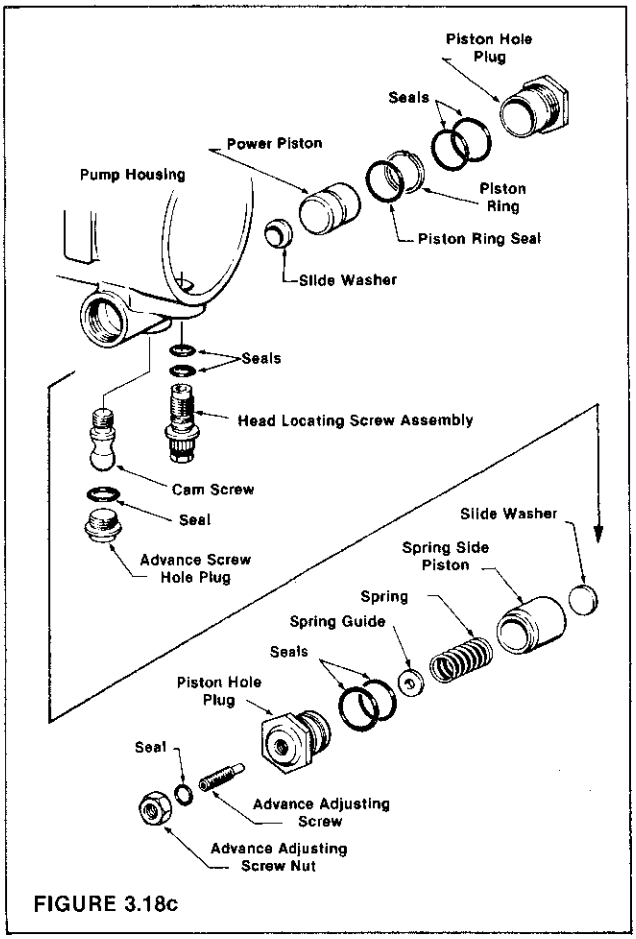


FIGURE 3.18c

To remove the power piston from its plug, hold the plug in one hand and rap it sharply into the palm of your other hand (Figure 3.18d). The piston will slide out. Remove the piston ring and seal from the power piston.

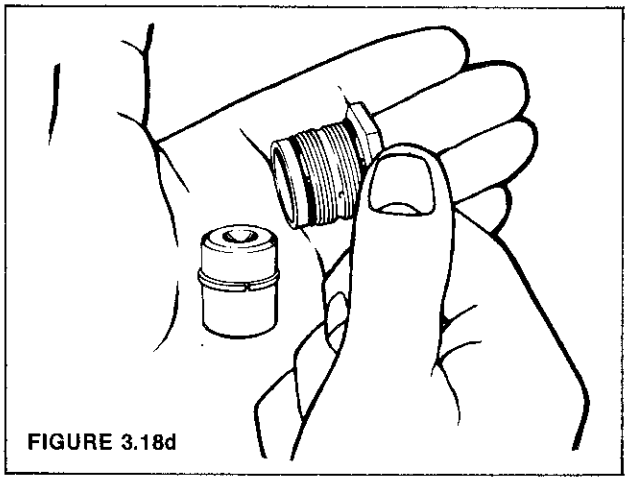


FIGURE 3.18d

Assemble 15499 Bristol Socket Cam Advance Screw Wrench and 15500 Cam Advance Screw Bushing into the advance screw plug hole (Figure 3.18e).

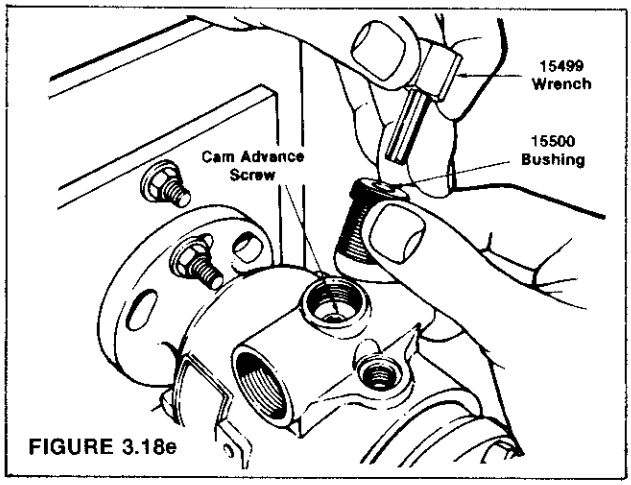


FIGURE 3.18e

Loosen and remove the cam advance screw (Figure 3.18f).

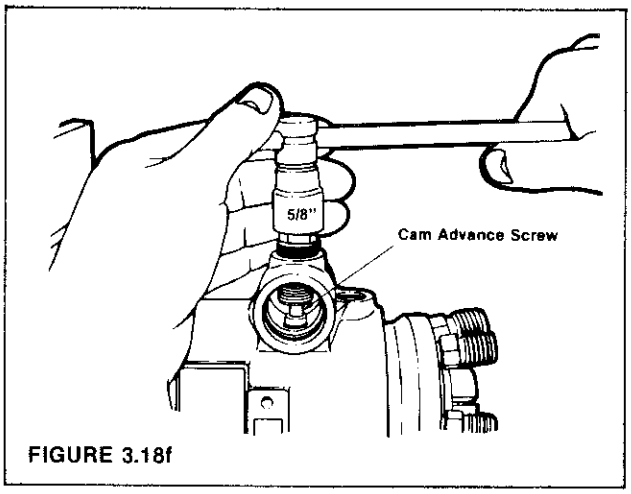


FIGURE 3.18f

STEP 19 Return the pump and holding fixture as a unit to its initial position in the vise with the rear of the hydraulic head tilted slightly downward. Remove the remaining head locking screw and remove the hydraulic head assembly by grasping with both hands and withdrawing with a slight rotary motion (Figures 3.19a and 3.19b).

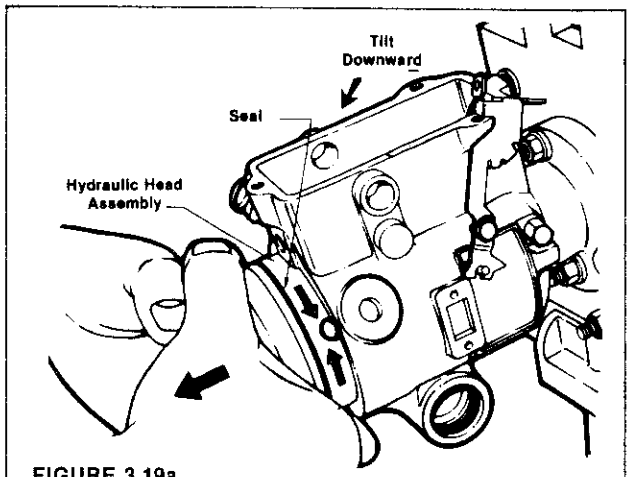


FIGURE 3.19a

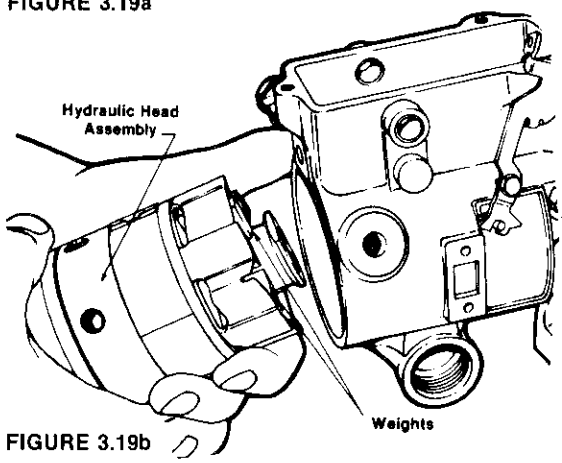


FIGURE 3.19b

STEP 20 To disassemble the governor, invert the hydraulic head and let the weights, governor thrust sleeve and washer fall into your hand (Figure 3.20). Place the head and rotor assembly on top of Fixture 19965.

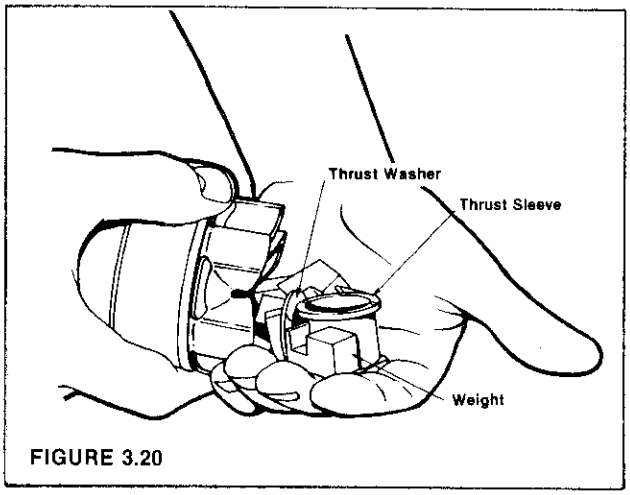


FIGURE 3.20

STEP 21 Loosen and remove one pivot shaft retainer nut and seal (Figure 3.21a).

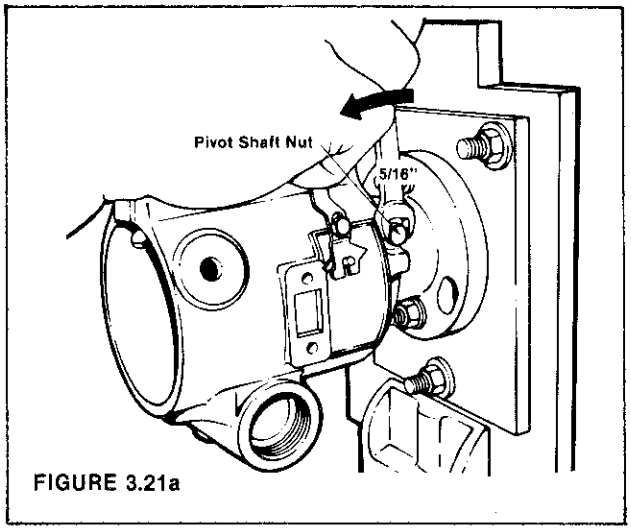


FIGURE 3.21a

The governor arm, pivot shaft, and linkage hook assembly may now be removed (Figure 3.21b).

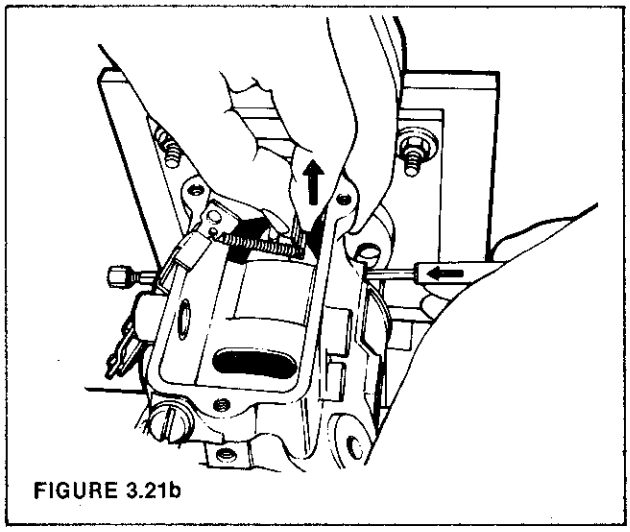


FIGURE 3.21b

STEP 22 Lift the liner locating ring from the rotor retainers (Figure 3.22a).

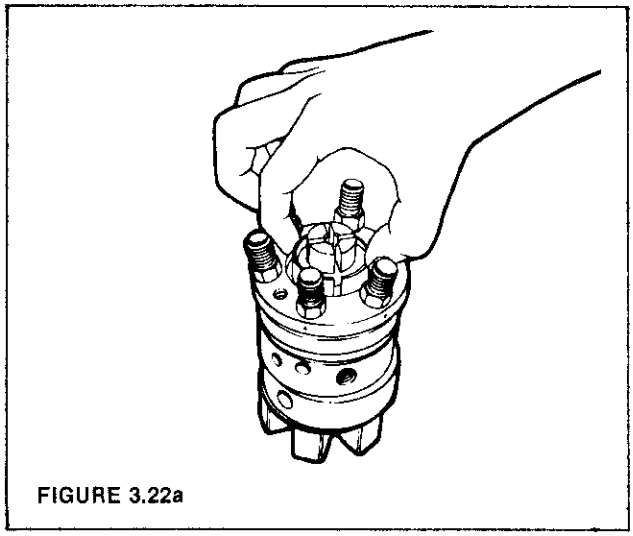


FIGURE 3.22a

Remove the rotor retainers (Figure 3.22b).

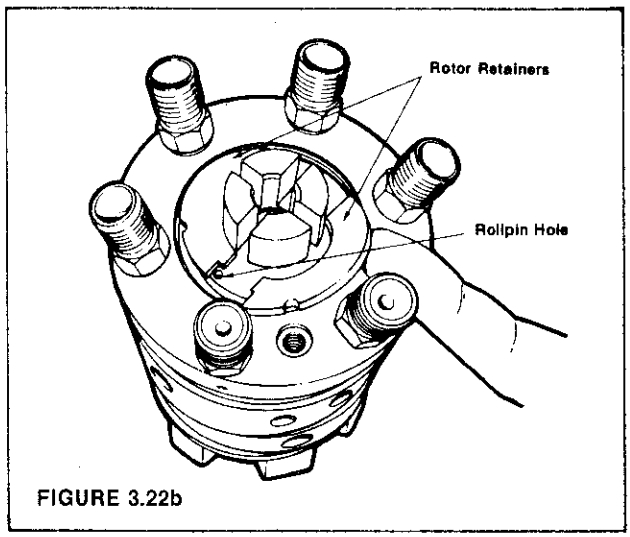


FIGURE 3.22b

STEP 23 Turn the head and rotor assembly over and place it on the discharge fittings. Using the 13337 snap ring pliers, remove the snap ring holding the retainer assembly to the rotor (Figure 3.23a).

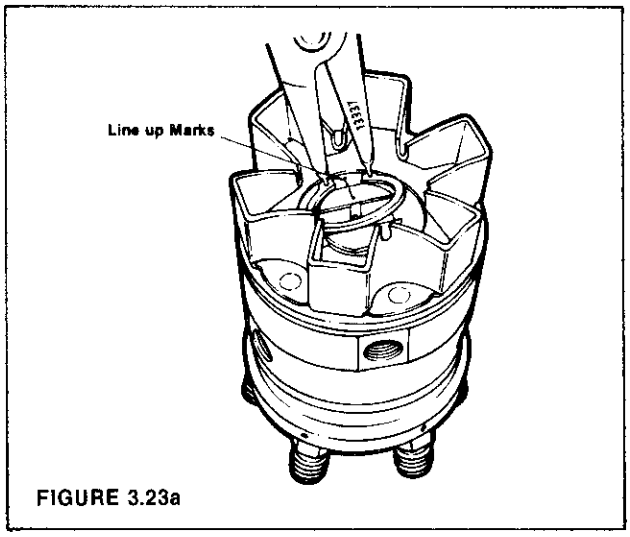


FIGURE 3.23a

Remove the weight retainer assembly from the rotor (Figure 3.23b).

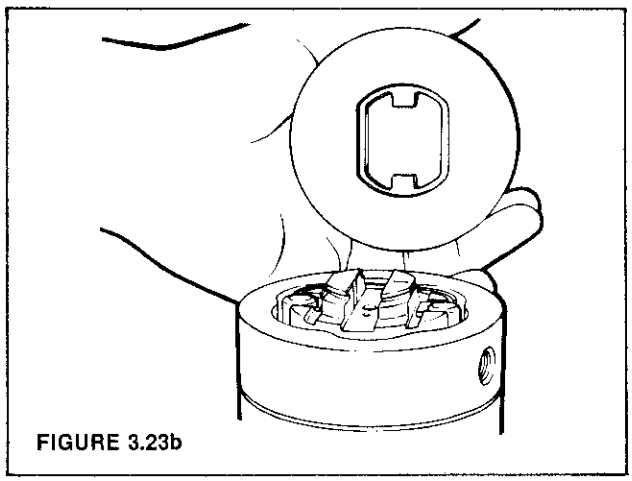


FIGURE 3.23b

STEP 24 Remove the cam ring (Figure 3.24).

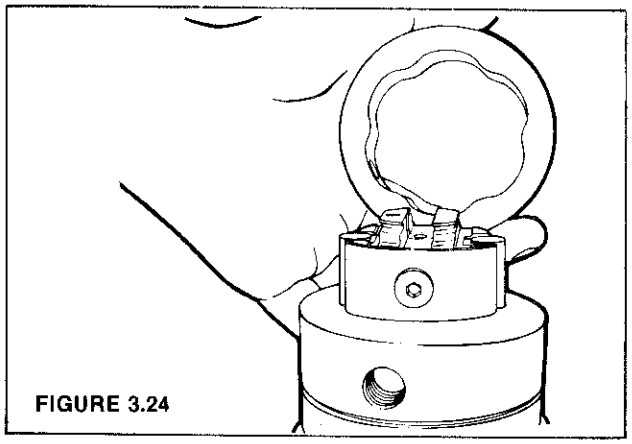


FIGURE 3.24

STEP 25 Check and record the roller to roller dimension as instructed in Step 3 of reassembly, (Figure 5.3). Compare this dimension with that called for on the pump specification (Figure 3.25).

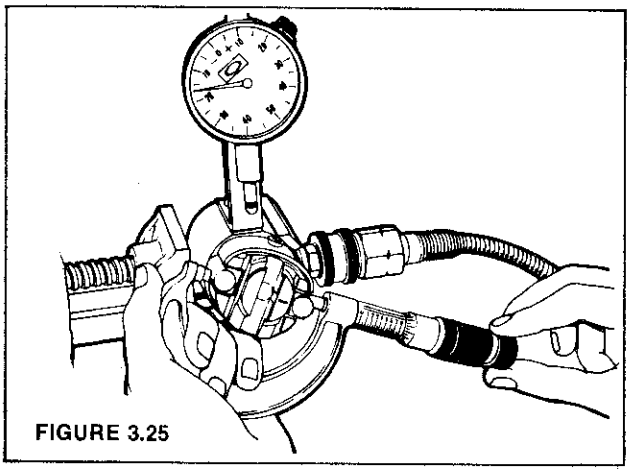


FIGURE 3.25

STEP 26 Use the 13336 hex wrench to remove the leaf spring adjusting screw. Remove the leaf spring (Figure 3.26a). In some cases a shim is used beneath the leaf spring to limit the maximum roller to roller dimension to .005" above the specification. If a shim is present, remove it at this time. Be sure to reinstall the shim during the reassembly.

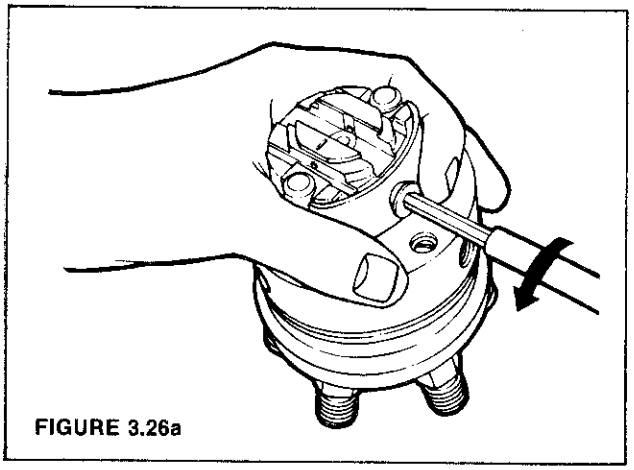


FIGURE 3.26a

Remove the shoes and rollers from the rotor (Figure 3.26b).

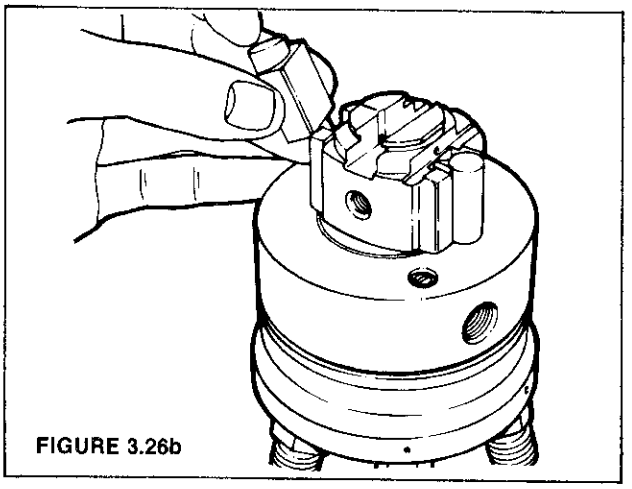


FIGURE 3.26b

Use brass tool 13301 to push the pumping plungers from their bore. Handle all parts carefully with clean hands wet with calibrating fluid (Figure 3.26c).

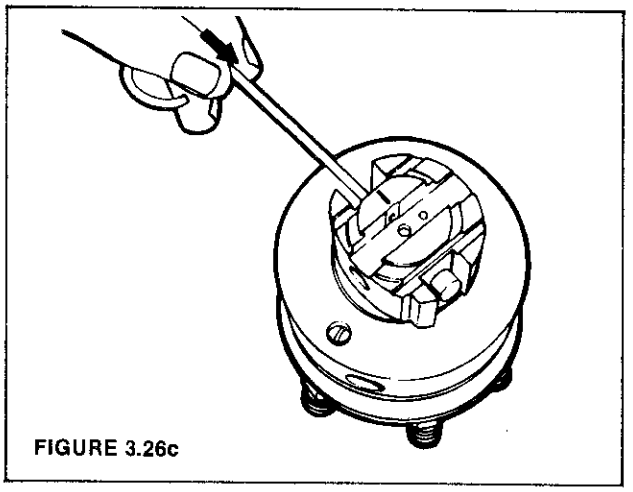


FIGURE 3.26c

STEP 27 Lift the rotor from the head (Figure 3.27).

NOTE: Do not handle the precision ground surface of the rotor.

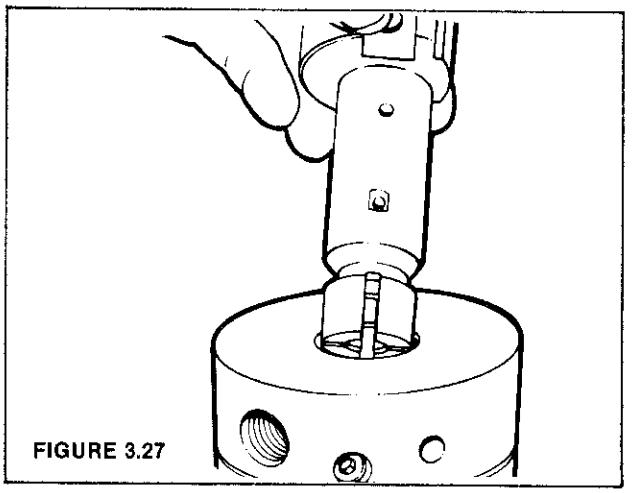
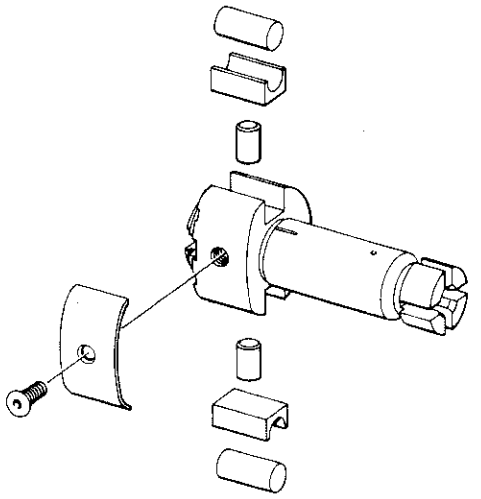


FIGURE 3.27



EXPLODED VIEW OF ROTOR ASSEMBLY

STEP 28 Support the rotor in the 16313 service tool and use a 13336 or 13316 hex wrench to remove the delivery valve stop screw. The delivery valve stop and spring may now be removed (Figure 3.28). Discard the delivery valve stop. If the delivery valve does not slide freely from its bore, use extractor 13383 to remove it.

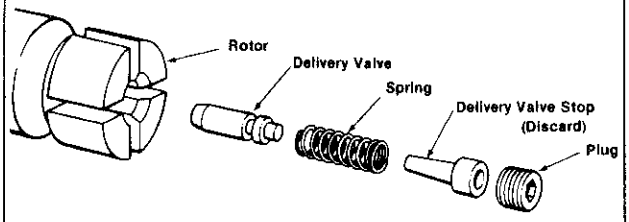


FIGURE 3.28

STEP 29 To remove the arm from the metering valve, place the metering valve in one of the holes provided in the top of the fixture 19965. Use a soft faced mallet to tap the arm off of the valve (Figure 3.29).

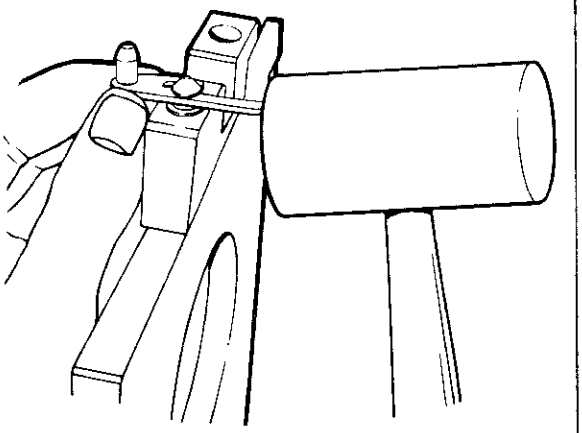


FIGURE 3.29

NOTE: Older style mounting plates may not have holes drilled in the top for inserting and removing the metering valve arm.

Modify the mounting plate by drilling two holes, 17/64" (6.75mm) and 21/64 (8.33mm) as shown.

SECTION 4
PARTS INSPECTION

A. GENERAL INSPECTION

Dirt is the greatest enemy of the fuel injection pump. Keep the work area clean.

Parts must be washed in a suitable solvent and then placed in a clean pan containing fresh fuel or calibrating oil.

Examine all parts in accordance with instructions which follow:

Discard flexible retaining ring, all O-rings, seals and gaskets. Replace with appropriate Roosa Master gasket kits. Examine all springs for fretting, wear, distortion or breakage. Clean and carefully check all bores, grooves, and seal seats for damage or wear of any kind.

Replace damaged or worn parts as necessary.

B. DETAILED INSPECTION

PART GROUP	PART	Examine For: Excessive Wear	Foreign Material or Rust	Nicks or Chipping	Scratches or Scores	Thread Damage	Cracks	Distortion	Freedom of Movement	SPECIFICALLY INSPECT:
Housing & Drive	Housing	X	X	X	X	X	X	X		See Supplementary Inspection 1, Page 4.2
	Drive Shaft	X	X	X	X	X	X	X		
Hydraulic Head & Rotor	Hydraulic Head	X	X	X	X	X	X			
	Vent Wire Assembly		X						X	See Supplementary Inspection 2, Page 4.2
	Discharge Fittings	X	X	X	X	X	X			Inside diameter of discharge fittings, sealing area for wear, nicks & scores
	Distributor Rotor	X	X	X	X	X	X		X	See Supplementary Inspection 3, Page 4.2
	Delivery Valve	X	X	X	X		X		X	See Supplementary Inspection 4, Page 4.2
	Plungers	X	X	X	X				X	See Supplementary Inspection 5, Page 4.2
	Cam Rollers & Shoes	X	X	X	X		X		X	See Supplementary Inspection 6, Page 4.2
	Leaf Spring(s) & Screw(s)	X	X	X		X	X			See Supplementary Inspection 7, Page 4.3
	Cam	X	X	X	X		X	X		See Supplementary Inspection 8, Page 4.3
	Governor Weight Retainer	X	X	X			X	X		Where weights pivot in retainer socket, also "E" ring area for wear, loose pins
	Governor Weights	X	X	X			X		X	See Supplementary Inspection 9, Page 4.3
	Governor Thrust Washer	X	X	X	X		X	X		Contact areas for excessive wear
	Governor Thrust Sleeve	X	X	X			X	X		Points of contact with governor arm for excessive wear
Transfer Pump	End Cap		X			X	X	X		
	Inlet Screen		X				X	X		Screen and soldered area for breakage
	End Plate Adj. Plug		X			X				Tightness in regulator, plugged orifice, loose plate
	Regulating Piston	X	X	X	X				X	
	Regulator		X	X	X	X	X	X		Inside diameter of regulator
	Blades	X	X	X	X		X		X	See Supplementary Inspection 10, Page 4.3
	Liner	X	X	X	X					Inside diameter in high pressure area for wear
	Rotor Retainers	X	X	X	X					
Governor	Pivot Shaft	X	X	X		X		X		Chipped or worn knife edge
	Arm	X	X	X			X	X	X	Points of contact with thrust sleeve & pivot shaft for excessive wear
	Metering Valve	X	X	X	X		X		X	Contact area of body for excessive wear
	Metering Valve Arm	X	X	X	X		X	X		Inspect pin for wear or looseness
Linkage	Linkage Hook	X	X	X	X	X	X	X	X	Metering valve pin hole
Advance	Piston	X	X	X	X				X	
	Cam Advance Screw	X	X	X	X	X	X		X	
	Plugs	X	X	X	X	X	X	X	X	Bore for excessive wear
	Head Locating Screw		X	X	X	X	X			Orifice

C SUPPLEMENTARY INSPECTION

1. Drive Shaft - Measure the distance across the flats of the drive tang which must not be less than .305" (7.75mm). The shaft diameter in the drive shaft seal area must be free of nicks and scratches for the seals to function properly. Moderate shaft wear from the seal lips is normal (Figure 4.1).

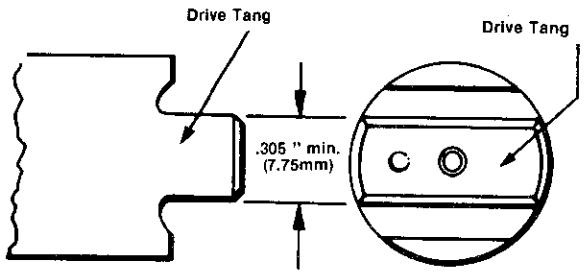


FIGURE 4.1

2. Hydraulic Head - Check the vent wire assembly in the hydraulic head for freedom of movement. If the wire is free, flush the head and blow out all passages with clean, dry air (Figure 4.2). If vent wire is stuck in screw assembly, remove and replace after a thorough cleaning of the assembly and hydraulic head passage.

CAUTION: Do not immerse this head in solvent for extended periods; as sealant damage will result.

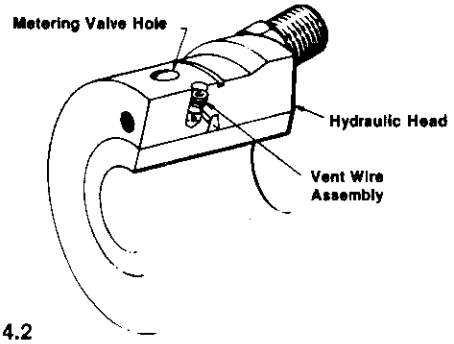


FIGURE 4.2

3. Distributor Rotor - Examine the radii contacted by the leaf spring and the tang slot for excessive wear. Check all slots, charging and discharge ports for chipping of edges or dirt, and the rotor shank for major scratches. Slight erosion on the edge of the discharge port is considered normal. If damage or excessive wear is apparent, the head and rotor must be replaced as a matched unit. Final check for excessive wear on the rotor should be performed on the test stand by checking for minimum cranking delivery.

4. Delivery Valve - Inspect delivery valve retraction cuff for chipping or erosion of edges (Figure 4.4).

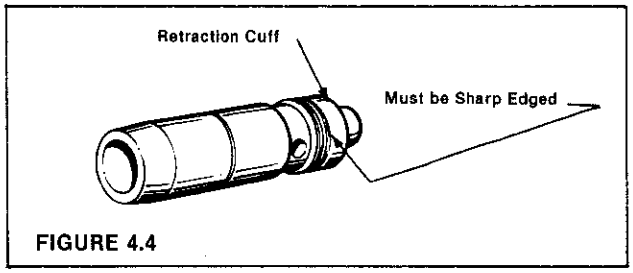


FIGURE 4.4

5. Plungers - While holding the rotor under clean oil, insert the plungers into their bore. With thumb and forefinger over the shoe slots, tilt from side to side several times to determine complete freedom of movement. Interchanging or reversing their initial positions may be necessary, as these are matched parts. If the plungers are sticking, but not visibly damaged, clean both plungers and bore with a soft brush and a solvent such as lacquer thinner or acetone (Do not force plungers into their bore and do not handle rotor shank.) (Figure 4.5).

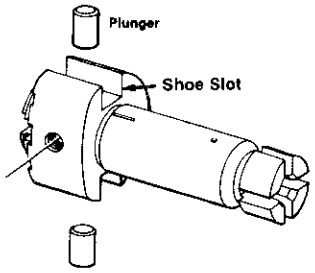


FIGURE 4.5

6. Cam Rollers and Shoes - Check each roller in its shoe for freedom of rotation. Inspect the top edge of each shoe, where retained by the leaf spring, for chipping or excessive wear. Inspect roller and shoe for abrasive wear patterns as illustrated (Figure 4.6).

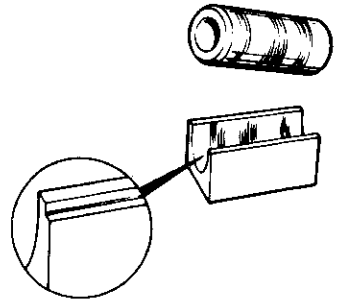


FIGURE 4.6

7. Leaf Spring and Screw - Check for excessive wear at points where the spring contacts the radii on the rotor and along the steps that retain the roller shoes (Figure 4.7). Check the adjusting screw for tightness in the rotor.

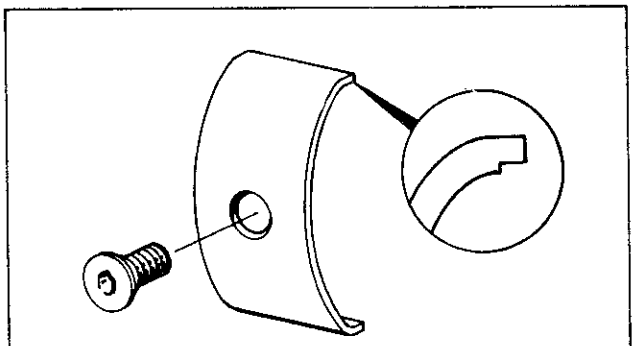


FIGURE 4.7

8. Cam - Since only the working portions of the lobes on the inside diameter are ground, any tool marks between lobes should not be considered as damage. The mottled appearance of the cam is from heat treatment rather than from operation. Carefully inspect the cam lobes and edges of all flat surfaces. If there is evidence of spalling or flaking out, replace with a new cam (Figure 4.8).

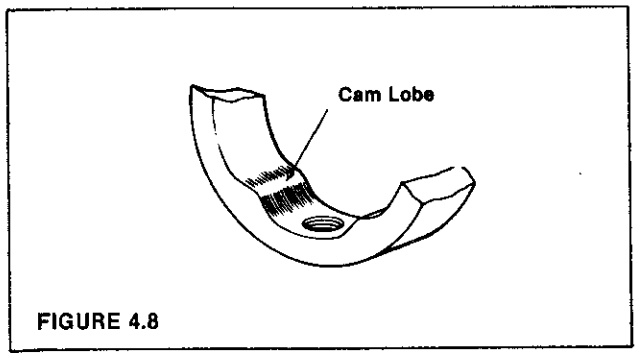


FIGURE 4.8

9. Governor Weights - Check pivot points (heel and toe) of all weights for excessive wear (Figure 4.9).

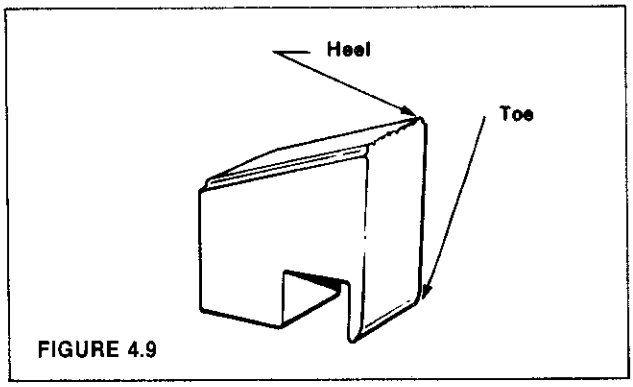


FIGURE 4.9

10. Transfer Pump Blades - Inspect with the utmost care. Check for chipping on any of the edges, including spring bore edges, pitting, imbedded foreign particles or scoring on the rounded edges. Determine blade wear by measuring the length (0.538" min. [13.67mm]). Inspect flat surfaces visually for deep scores (Figure 4.10). If any discrepancies are noted, replace both blade sets and springs.

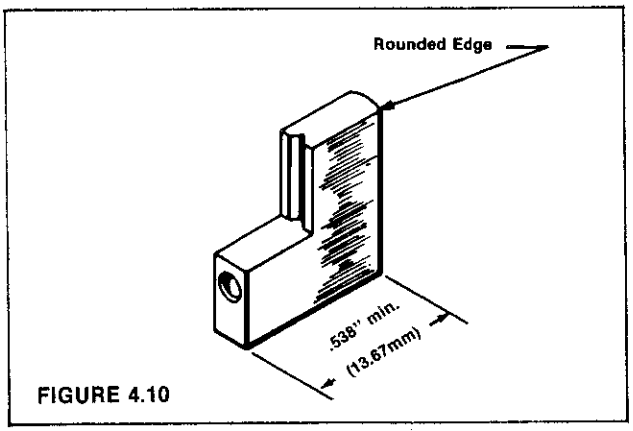


FIGURE 4.10

SECTION 5
REASSEMBLY

STEP 1 Rinse rotor thoroughly in clean fuel or calibrating oil. Place the rotor on holding fixture 16313 and secure fixture in vise. Install the delivery valve to its bore using extractor tool 13383. Make sure it slides freely in its bore.

NOTE: Do not mistake slight interference of the retractor collet in the bore for delivery valve sticking. If the valve is not secured straight and tight in the retractor collet, the collet diameter can drag in the rotor bore.

Install delivery valve spring and a new delivery valve stop to the rotor bore (Figure 5.1). Installation of a used stop can result in leakage and low output at cranking speeds. Start the delivery valve retaining screw into the bore using the hex end of the delivery valve Extractor Tool No. 13383. Tighten the screw to the specified torque.

CAUTION: Excessive tightening of this screw may cause seizure of the hydraulic head and rotor assembly. Insufficient torque may cause leaking and hard starting.

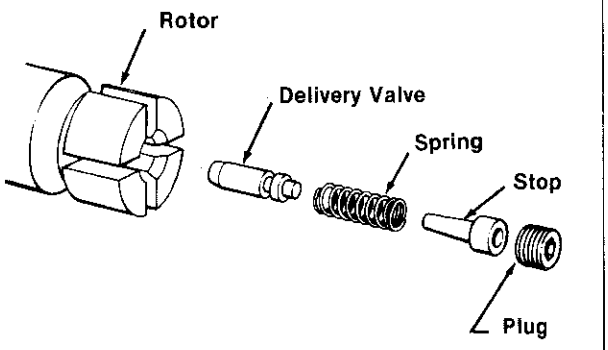


FIGURE 5.1

DELIVERY VALVE REPLACEMENT

Delivery valves of various retraction values are used for different applications. Correct part numbers are found on individual pump specifications. The letters "OV" etched on the base of the rotor indicate a .001" oversize delivery valve bore. A rotor so marked must use a .001" oversize delivery valve. Part numbers for both standard and oversize valves are listed on individual pump specifications. The oversize valve is also identified by blackening on both ends and in the groove on the delivery valve shank (See Service Bulletin No. 143B).

STEP 2 Remove the rotor from the holding fixture and submerge it in clean calibrating oil. Install the pumping plungers and check them for freedom of movement. Assemble the leaf spring, leaf spring adjusting screw and shim (if used) to the rotor (Figure 5.2).

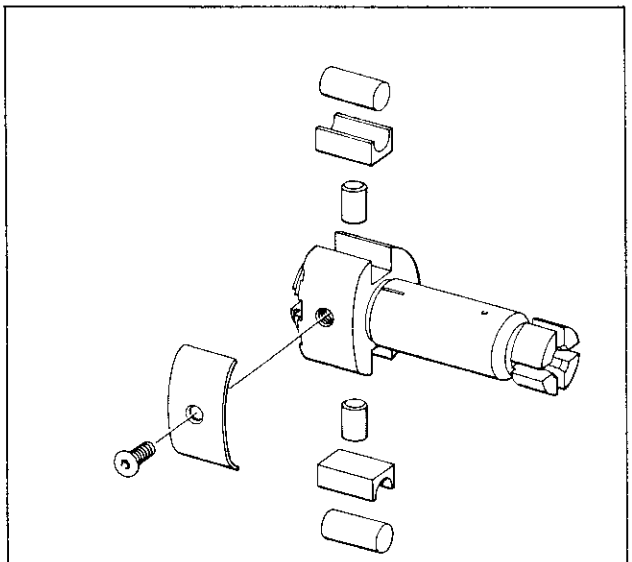


FIGURE 5.2

PLUNGER REPLACEMENT

Since the plungers are positioned centrally in the bore during operation and their travel is extremely short, wear of plungers is negligible. Replacement, however, may be made in instances where rust or damage in handling has occurred. Plungers of any given nominal diameter are graded in four select fit sizes: A, B, C, and D. The rotor is etched with the letter indicating bore size. This mark is found on the base of the rotor.

If plunger replacement is required, check the size designation on the rotor and use the plunger of corresponding part number as indicated on individual specifications. For example: A .330" diameter plunger bears basic part No. 11076 and the graded sizes, A through D, bear part No. 11077 through 11080, respectively. The replacement plungers for a .330" diameter plunger pump with a rotor marked "C" would be part No. 11079. Always refer to correct individual specifications for part numbers.

NOTE: A limited number of pumps will have a "-2" etched on the rotor following the letter grading code. This mark indicates a .002"

(.05mm) oversize plunger bore. Replacement should be ordered according to the oversize plunger group shown on individual specifications. See Service Bulletin No. 60 for further information.

STEP 3 Install Fixture No. 19969 in a vise (clamping on the flat) so that the air inlet hole is not covered by the vise. Assemble a 1.4" - 18 N.P.T. fitting to the air inlet of the fixture. This fitting should be adapted to a supply of clean, filtered, compressed air, regulated to a pressure between 40 and 100 p.s.i. Handle the rotor carefully, holding the rollers and shoes in their slots. Install the rotor assembly to the fixture on the air inlet side. Using a micrometer, measure the roller-to-roller dimension (Figure 5.3)(distance between the outer surfaces of the opposed cam rollers) and compare this with the specification. To set the roller-to-roller dimension to the pump specification, turn the leaf spring adjusting screw inward (clockwise) to increase and outward (counterclockwise) to reduce the roller-to-roller dimension.

NOTE: The roller-to-roller setting provides a completely accurate maximum fuel adjustment and it should not differ from that shown in the applicable specification.

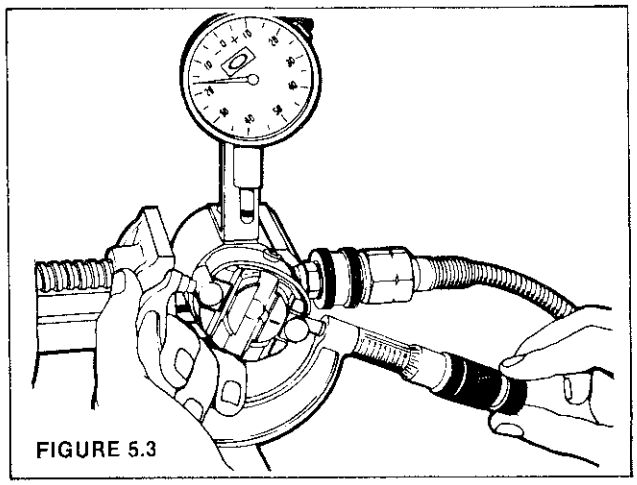


FIGURE 5.3

A centrality check is now required on certain DB2 models. Refer to individual specifications for allowable tolerances and check as follows:

a. After setting the roller-to-roller dimension to the amount indicated on the specification, rotate the rotor until one roller is aligned with the dial indicator plunger. Slide the indicator inward until the plunger depresses it at least .010" (.25mm). Lock the indicator retaining screw. "Zero" the indicator on high point of roller by rotating knurled dial.

b. Rotate rotor (either direction) until the other roller depresses the dial indicator plunger.

c. If roller centrality is beyond specified tolerance (see injection pump specification), roller and/or shoes can be interchanged. Recheck centrality after each change and be sure to recheck the roller-to-roller dimension.

STEP 4 Rinse the hydraulic head assembly in clean calibrating oil. Remove the rotor assembly from the fixture, taking care that the shoes and rollers do not leave their respective slots and rinse in oil. Carefully, insert the rotor assembly into the hydraulic head (Figure 5.4).

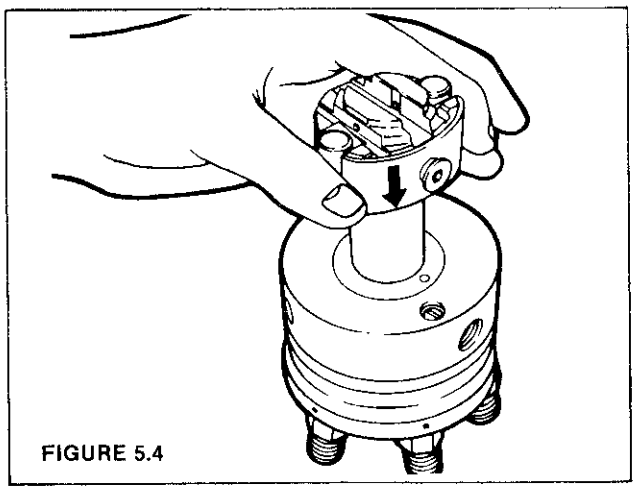


FIGURE 5.4

STEP 5 Place the cam ring onto the head and rotor assembly with directional arrow indicating the direction of rotation of the pump (Figure 5.5). (Pump rotation is expressed as viewed from the drive end.) If the cam ring is installed incorrectly, the pump will not be in time with the engine.

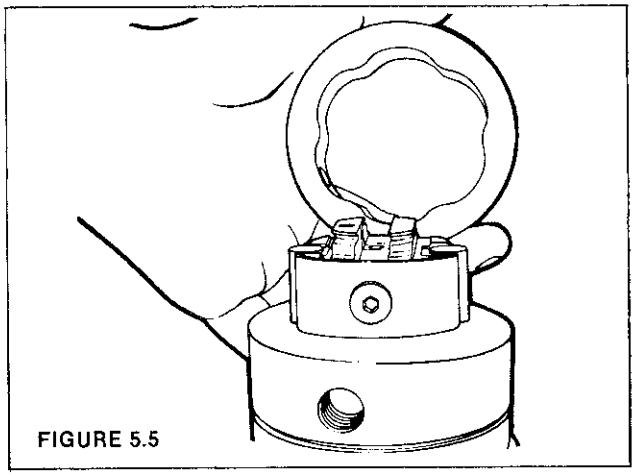


FIGURE 5.5

STEP 6 Place the weight retainer assembly on the rotor (Figure 5.6a).

Make sure the assembly marks on the rotor and the retainer line up with each other. Assemble the snap ring to its groove with the 13337 pliers (Figure 5.6b).

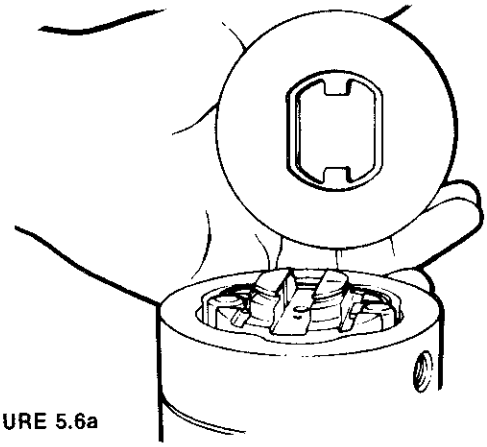


FIGURE 5.6a

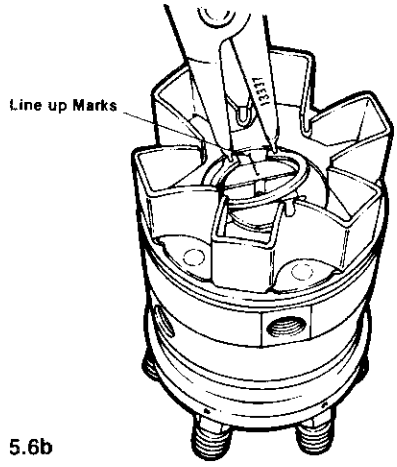


FIGURE 5.6b

STEP 7 While holding the assembly carefully so the rotor will not fall out, invert the entire unit so it rests on the weight retainer. Assemble the rotor retainers to the head and rotor with the cutout portions meeting over the rollpin hole in the hydraulic head (Figure 5.7a).

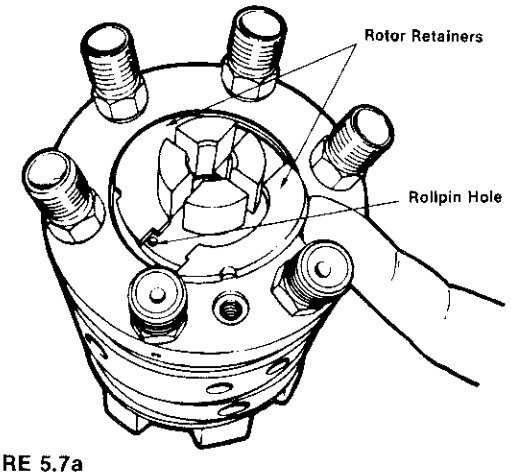


FIGURE 5.7a

Place the liner locating ring over the rotor retainers and bottom it against the head (Figure 5.7b). Position the split in the ring 90° from the split in the retainers.

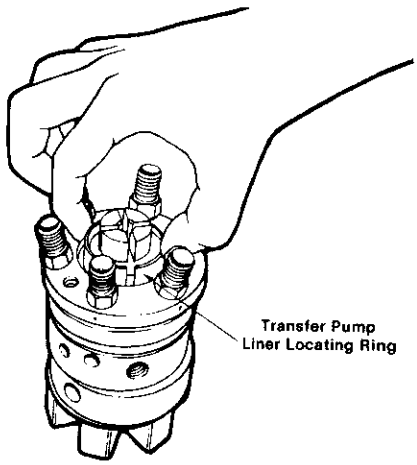


FIGURE 5.7b

STEP 8 Install the new transfer pump end cap seal into the hydraulic head (Figure 5.8). This seal has an oval cross section and can be identified by rolling it between the fingers. Be sure to push the seal all the way into its groove.

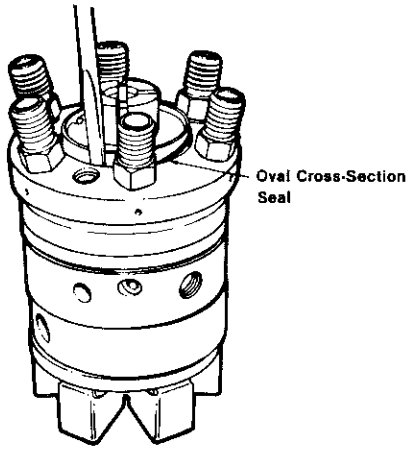


FIGURE 5.8

STEP 9 Insert the transfer pump liner so that the slot is in line with the hole which the regulator assembly rollpin enters (Figure 5.9a).

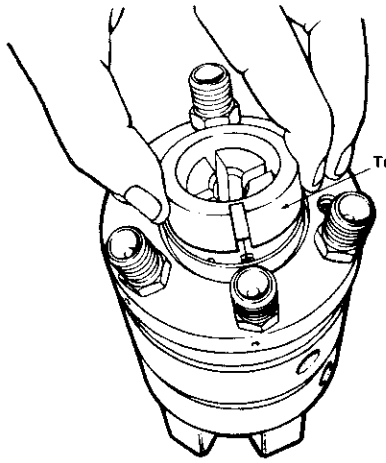


FIGURE 5.9a

Assemble springs to transfer pump blade halves and install the blades in their slots in the rotor (Figure 5.9b). The blade springs must be fully compressed as they are installed and care should be taken not to cock the blades during installation, as the sharp edge of the liner can score the blade ends.

NOTE: A number of rotors have oversized blade slots (.001" [.0254mm] wider than normal). Oversized blade should always be tried first when assembling a pump. If oversized blades fit any of the slots, they should be used in those slots. It is permissible to use both oversize and standard size blades in the same rotor.

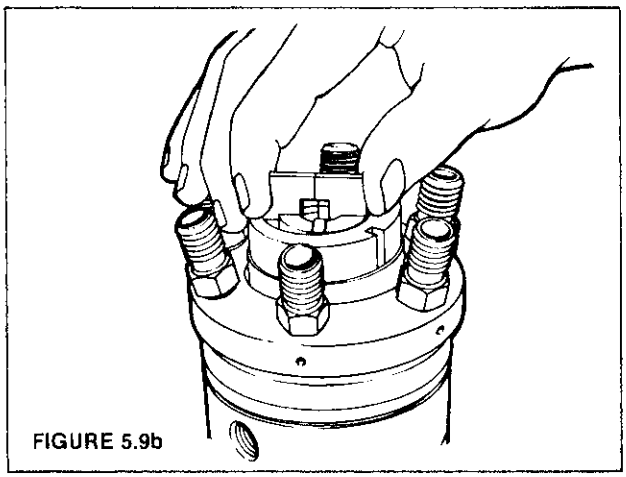


FIGURE 5.9b

STEP 10 Assemble the transfer pump regulator components (Figure 5.10a). Install the inlet filter screen seal on the regulator. Using tool 13301, place the regulating piston seal in the groove of the regulator. Do not roll the seal over when assembling.

NOTE: Some DB2 models no longer use this seal, but instead have a bushing pressed into the regulator in its place. This bushing should not be removed and, when present, no seal is required.

Install the piston to the regulator with the hollow end facing the spring or the threaded end of the bore. Install the regulating spring and adjusting plug. This plug contains the viscosity compensating orifice and should be installed so that the top of the screw is flush with the end of the regulator assembly. Using tool 13301, check the regulating piston for freedom of movement in its bore.

CAUTION: Turn the adjusting plug in until it is flush with end of regulator so damage to the pump will not result from excessive transfer pump pressure when the pump is operated.

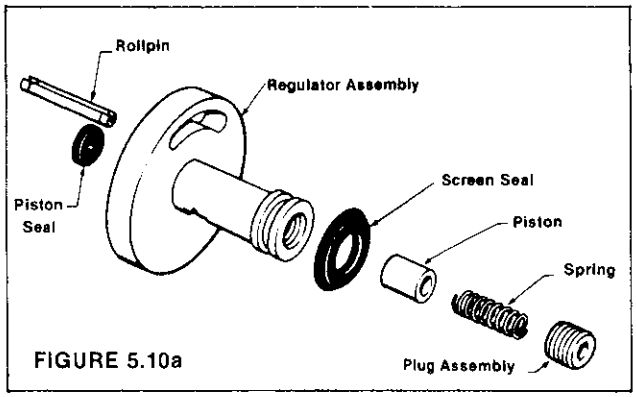


FIGURE 5.10a

Assemble the regulator to the liner (Figure 5.10b). Check that the liner locating pin is in the correct hole in the regulator for proper pump rotation. On the face of the regulator "C" or "CC" is stamped for clockwise or counterclockwise pump rotation.

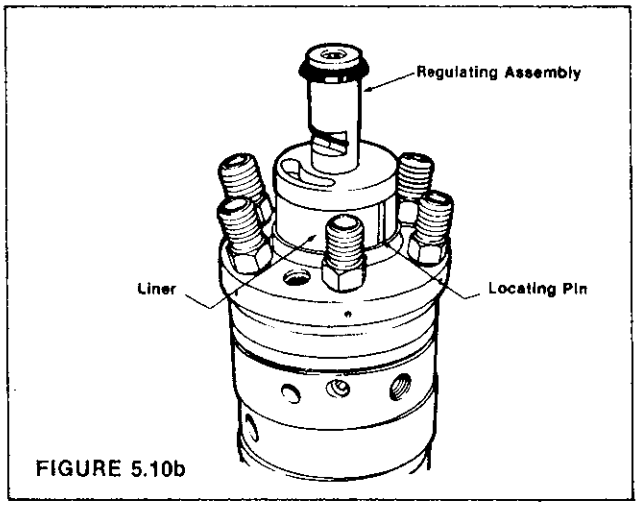


FIGURE 5.10b

Assemble the filter screen to the pressure plate and install the screen retaining ring (Figure 5.10c).

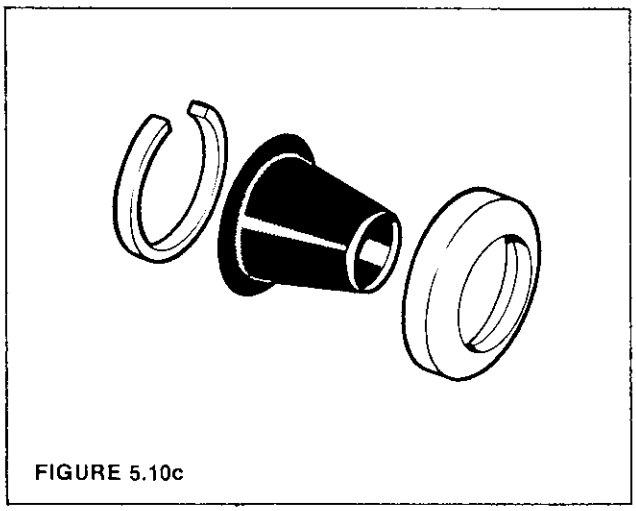


FIGURE 5.10c

Install the assembled pressure plate and screen onto the transfer pump regulator assembly (Figure 5.10d).

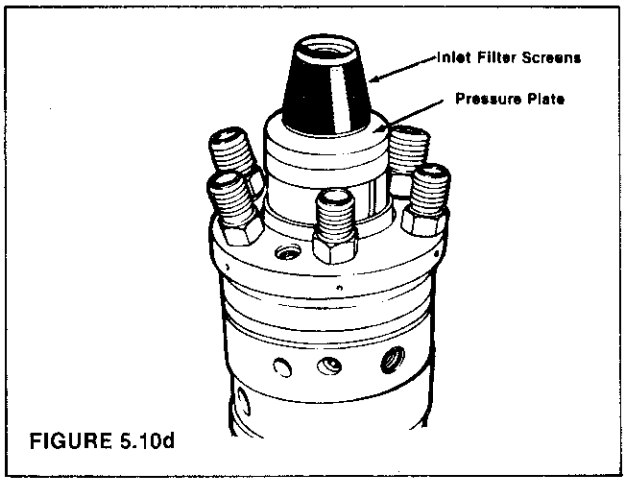


FIGURE 5.10d

Coat the beveled surface of the pressure plate and the threads on the outside diameter of the end cap with clean grease.

Install the transfer pump end cap and thread into the hydraulic head by applying a slight pressure on top of the end cap. Rotate the cap counterclockwise until a slight "click" is heard, now turn the cap clockwise by hand until tight (Figure 5.10e).

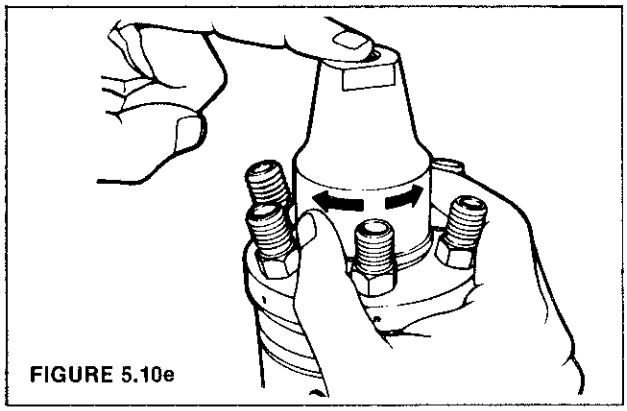


FIGURE 5.10e

STEP 11 Place the governor arm in position in the housing (Figure 5.11a).

NOTE: Insert the pivot shaft, with the knife edge mating with the groove in the governor arm.

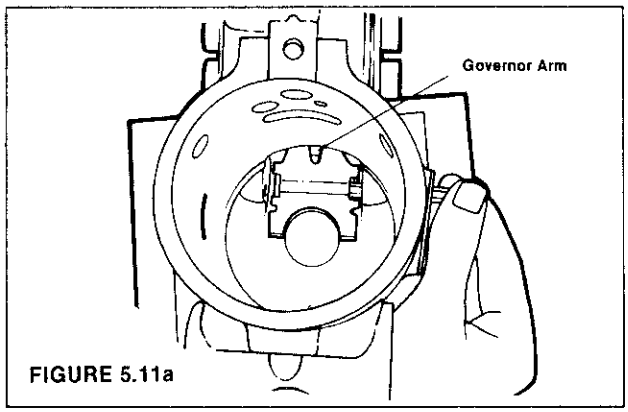


FIGURE 5.11a

Assemble pivot shaft seals and nuts to the shaft and tighten both nuts successively to specified torque (Figure 5.11b).

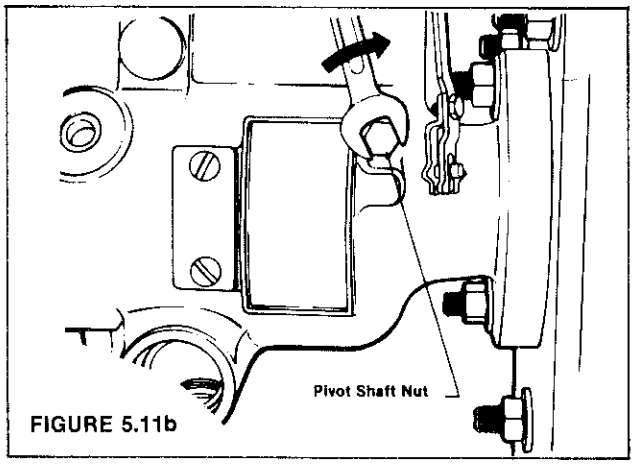


FIGURE 5.11b

STEP 12 Install the governor weights into the governor weight retainer as shown in Figure 5.12a.

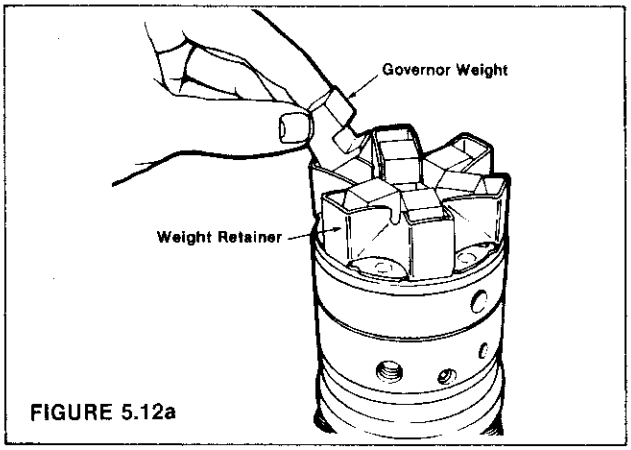


FIGURE 5.12a

Insert the governor thrust washer and thrust sleeve into the lower slots of the governor weights by tilting the weights outward slightly. The two deep grooves of the thrust sleeve should face upward as installed (Figure 5.12b). Sight across the tops to the assembled weights. They should all be level, and collapsed against the thrust sleeve.

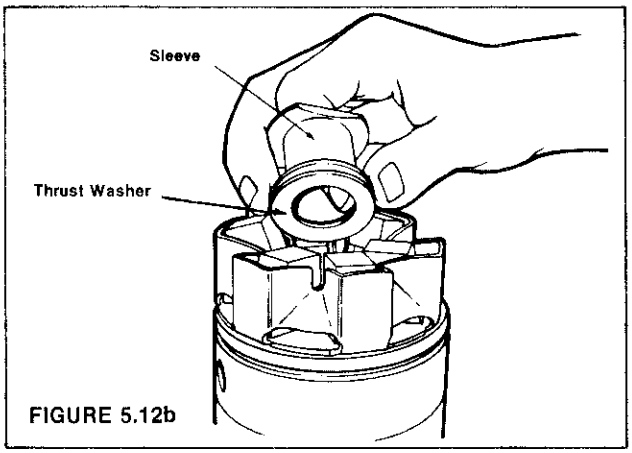


FIGURE 5.12b

STEP 13 The hydraulic head and rotor assembly including the transfer pump assembly, cam ring and governor assembly, are now ready to be put into the housing. Install a new seal on the hydraulic head after first greasing it slightly. Apply a light film of clean grease around the inside edge of the housing and tilt the housing slightly downward at the rear to aid in assembly. Rotate the cam ring so that the unthreaded hole is in line with the metering valve bore. This will insure proper position of the cam ring. Grasp the hydraulic head firmly in both hands and insert it into the housing bore with a slight rotary motion (Figures 5.13a and 5.13b). **Do not force.** If the assembly should jam during insertion, withdraw and start over.

Exercise care not to insert the head assembly too far into the housing. Pushing the head in too far will damage the seal on the hydraulic head and result in leakage.

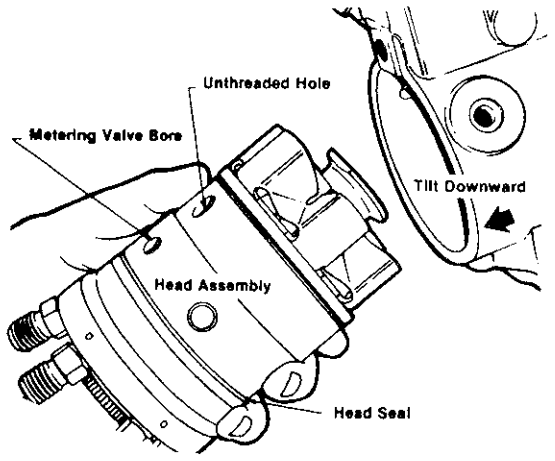


FIGURE 5.13a

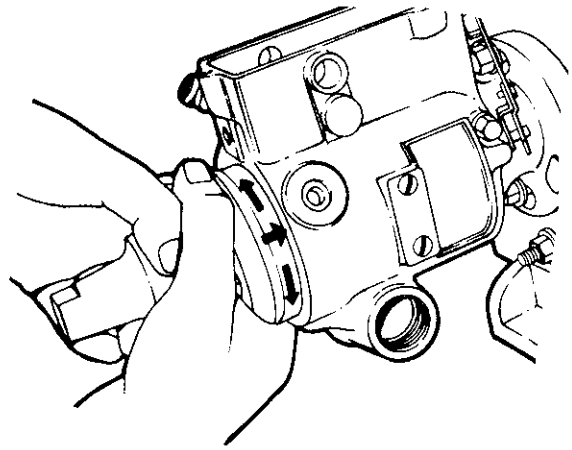


FIGURE 5.13b

STEP 14 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 5.14). Do not tighten with a wrench until STEP 27.

To prevent the governor weights from becoming dislodged from the retainer, a drive shaft should now be installed in the pump. When the pump is fully assembled, the throttle should be wired in the wide open throttle (WOT) position and the shaft may then be removed.

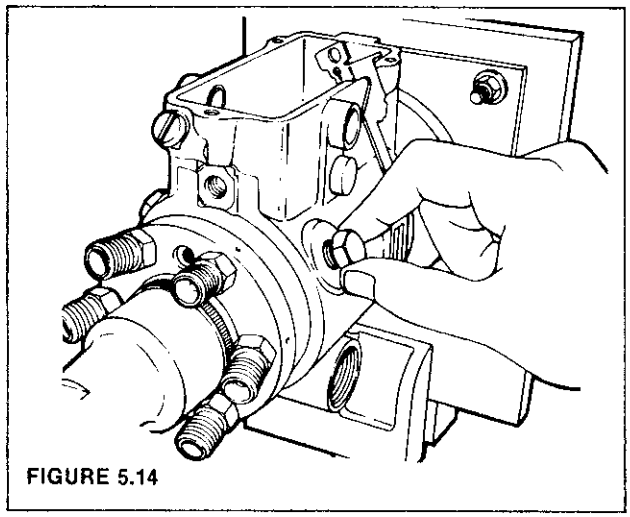


FIGURE 5.14

STEP 15 Install the vent wire screw assembly (Figure 5.15). Tighten to 25 - 30 in.-lbs. (3-3.5 N.m).

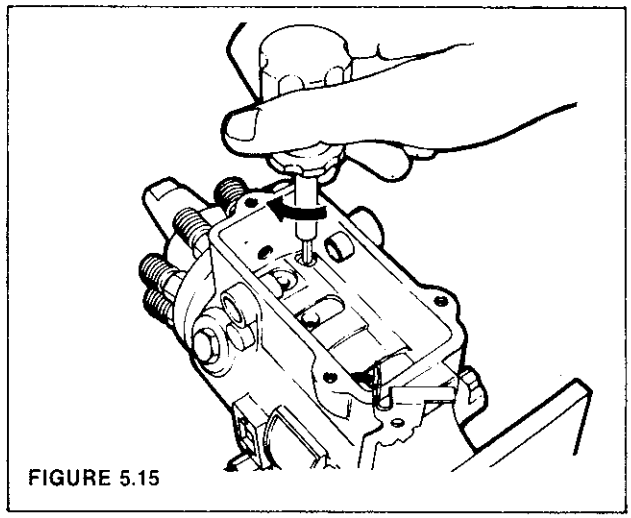


FIGURE 5.15

STEP 16 Assemble the metering valve arm, shim and spring to the metering valve (Figure 5.16a). Exercise care not to distort any of the components.

Place the metering valve assembly into its bore (Figure 5.16b). Depress and rotate the valve several times to insure freedom of movement. If valve sticks, rinse off with clean calibrating

fluid. Never use an abrasive, or the special surface treatment provided will be damaged.

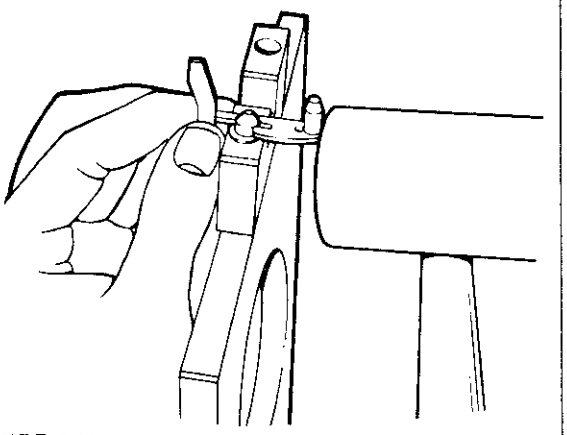


FIGURE 5.16a

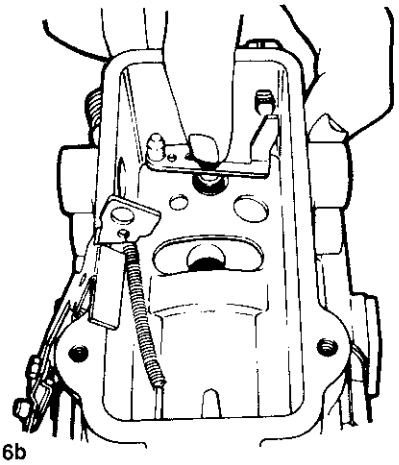


FIGURE 5.16b

STEP 17 Depress the metering valve assembly and install the guide stud and new guide stud washer into the housing and tighten (Figure 5.17a).

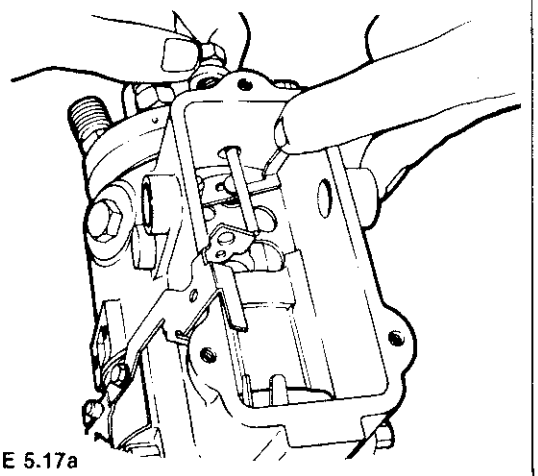


FIGURE 5.17a

* *Use grease sparingly as it can plug the return fitting and pump will not bleed air from housing during start-up.*

Pull back the governor linkage hook, stretching the spring just enough to assemble the hook correctly to the fork on the governor arm. Position the opposite end of the hook over the pin on the metering valve arm (Figure 5.17b). Check all of the governor parts for freedom of movement.

NOTE: Do not twist spring.

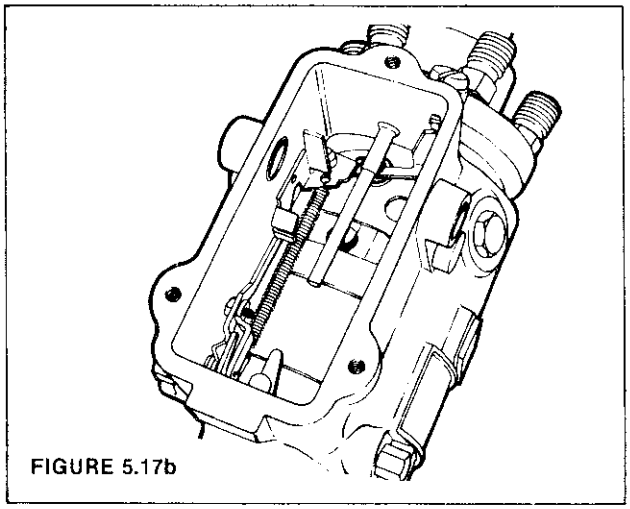


FIGURE 5.17b

Assemble the governor spring, spring retainer, idle spring and idle spring guide on the bench (Figure 5.17c). Apply a light film of grease to the parts in order to keep them in place while assembling.* Install the spring components onto the guide stud as shown.

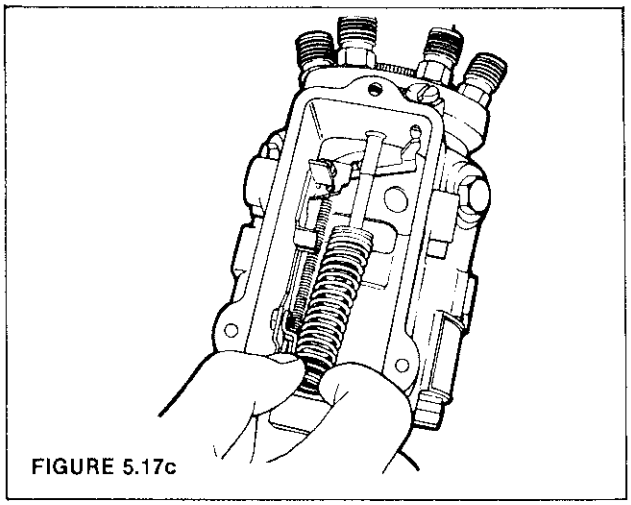


FIGURE 5.17c

STEP 18 Install new Mylar washers and seals to the throttle and shutoff shafts. Apply a light film of grease to each seal.* Assemble the throttle shaft assembly partially through its bore in the housing. Slide the throttle shaft lever over the throttle shaft so that the projection in the throttle shaft lever bore engages the rear key way on the shaft. Position the forked end of the throttle lever so that it straddles the guide stud. Assemble the shutoff shaft

assembly with a slight rotary motion, so as not to damage the seal. If the throttle shaft lever is correctly installed, rotating the throttle shaft assembly to the rear will cause compression of the governor spring (Figure 5.18).

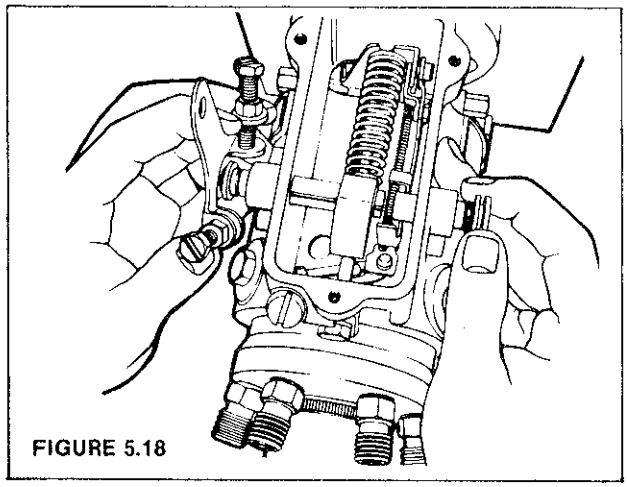


FIGURE 5.18

STEP 19 Invert the pump and holding fixture in the vise. Apply a light film of grease to the head locating screw.* Insert the screw and thread deeply into head hand tight. Using a 7/16" deep well socket and torque wrench, tighten to specification.

NOTE: If screw is not seated properly into the head, the seal may be sheared during tightening (Figures 5.19a and 5.19b).

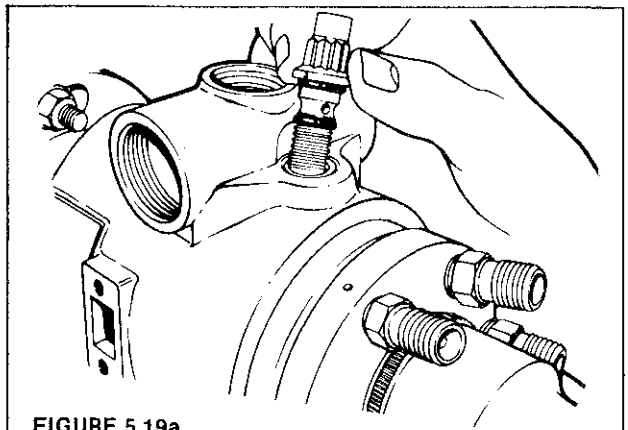


FIGURE 5.19a

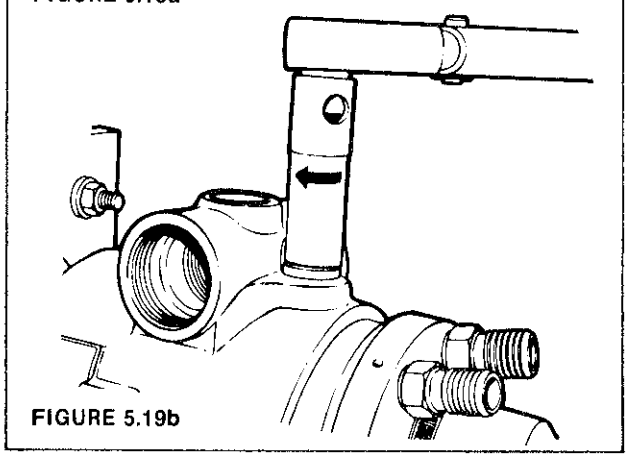


FIGURE 5.19b

STEP 20 Install the cam advance screw (Figure 5.20). Assemble the 15499 bristol socket cam advance screw wrench and 15500 cam advance screw bushing into the advance screw hole plug. Tighten the cam screw to the specified torque. (See Service Bulletin 186). Check cam ring for freedom of movement (locking down the screw can sometimes twist the cam). If cam is not free, tap the screw lightly with a brass rod.

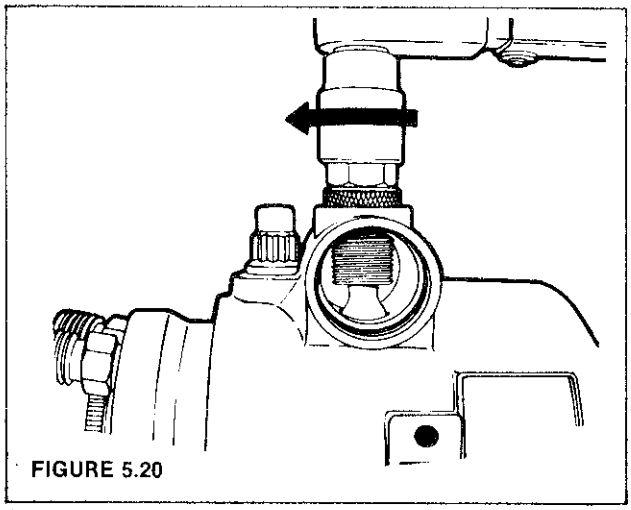


FIGURE 5.20

STEP 21 Assemble the automatic advance components (Figure 5.21a). Install the piston

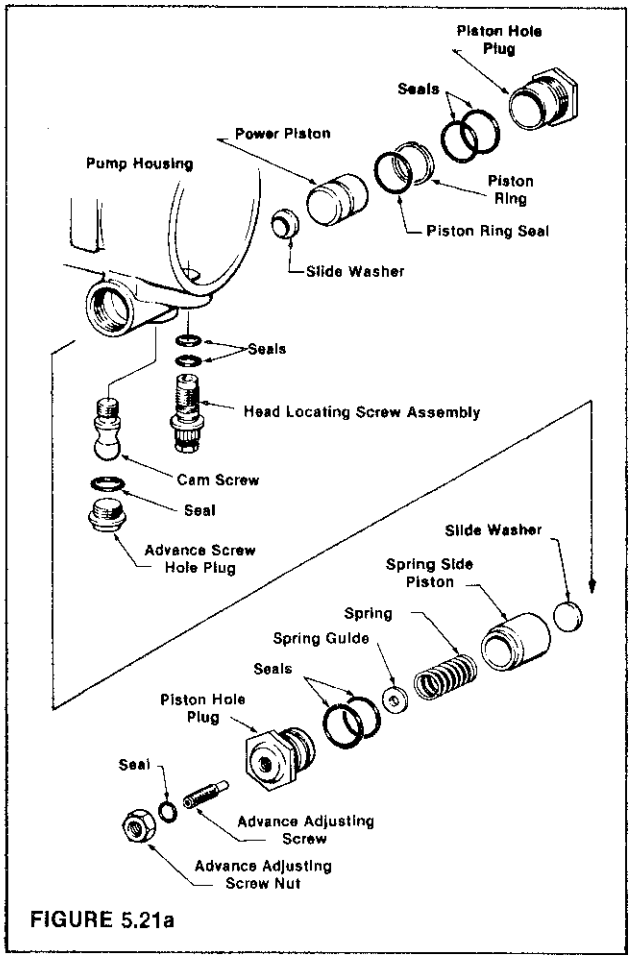


FIGURE 5.21a

* *Use grease sparingly as it can plug the return fitting and pump will not bleed air from housing during start-up.*

ring seal and ring into the groove of the advance power piston. Assemble the advance adjusting screw to the piston hole plug. Install new seals to the piston hole plugs. Assemble the spring guide and spring to the adjusting screw. Install the pistons to the piston hole plugs. Use 16199 piston ring compressor to aid in installing the power piston. Use care not to damage the ring during installation of the assembly to the piston hole plug. Install the adjusting screw nut and a new seal.

Install the advance piston assemblies into the pump housing (Figure 5.21b). A small amount of grease applied to the end of the pistons will keep the slide washers in place during assembly.

NOTE: The sides of the housing near the advance boss bear a "C" or "CC" to denote pump rotation. The power piston is located on the side marked "C" for a clockwise rotating pump and vice versa.

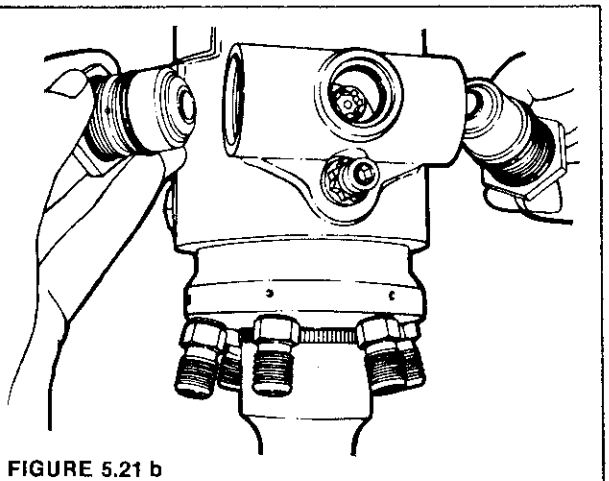


FIGURE 5.21 b

Install the advance screw hole plug and new seal into the housing and tighten using tool 14490 (Figure 5.21c).

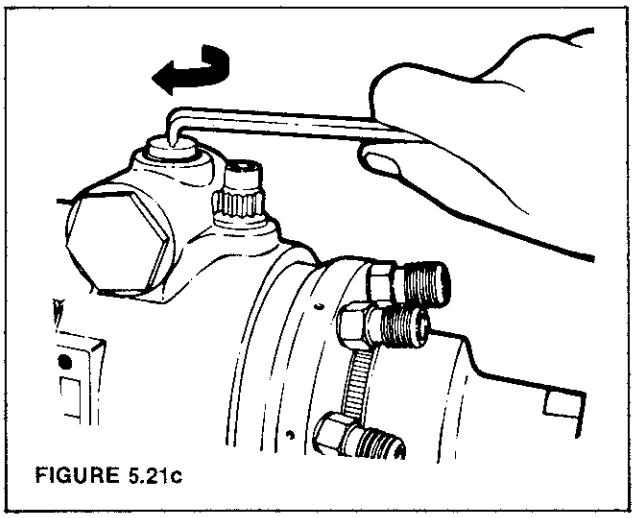


FIGURE 5.21c

Tighten the advance piston hole plugs to the specified torque (Figure 5.21d).

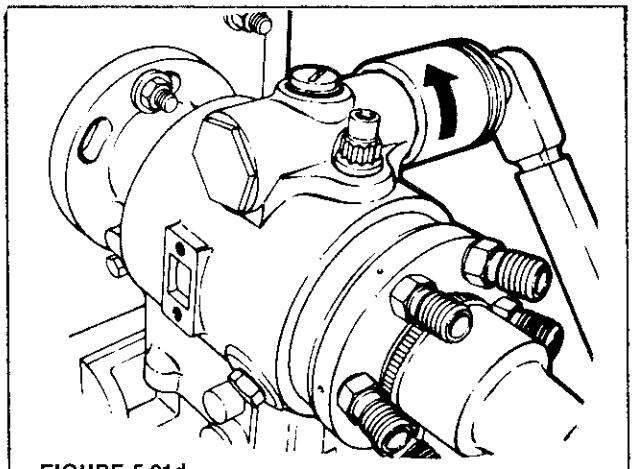


FIGURE 5.21d

STEP 22 Invert the pump and fixture in the vise. Prior to measuring and adjusting the linkage gap, hold throttle lever in wide open position and rotate the drive shaft in the proper direction of rotation until a slight "click" is heard, as the toes of the governor arm engage slots in the thrust sleeve. The torque screw (if used) should be backed out. With the throttle lever held in wide open position, use linkage gauge No. 18914 to check the clearance between the rear of the shutoff shaft and the vertical tab on the linkage hook. (Refer to pump specifications for correct dimension.) Adjustment of this clearance is made by using linkage wrench No. 13379 to change the effective length of the linkage hook. Loosen the adjusting screw and slide linkage to maximum open length. Insert linkage gauge No. 18914 between vertical tab and shutoff shaft, and slide linkage hook together from the rear until face of tab is flush against gauge. Tighten adjusting screw. Check adjustment and reset if required (Figure 5.22).

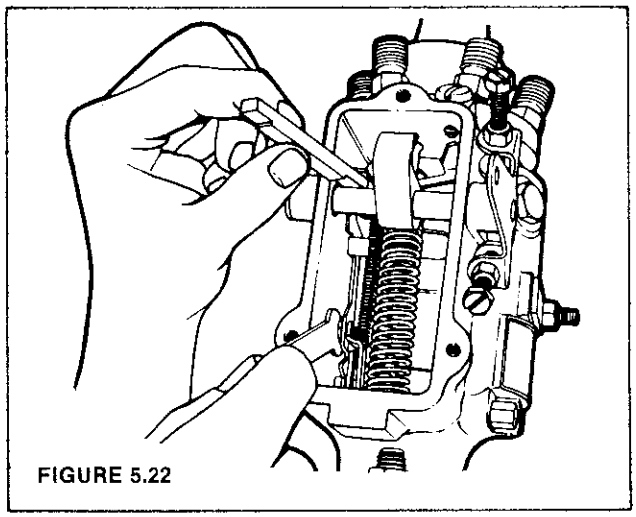


FIGURE 5.22

STEP 23 Compress both sides of the throttle and shutoff shaft and install a new shutoff cam and/or a new throttle shaft retainer clip as needed with the straight inner edge engaging the slot. The cam or clip should snap into position when installed correctly (Figure 5.23).

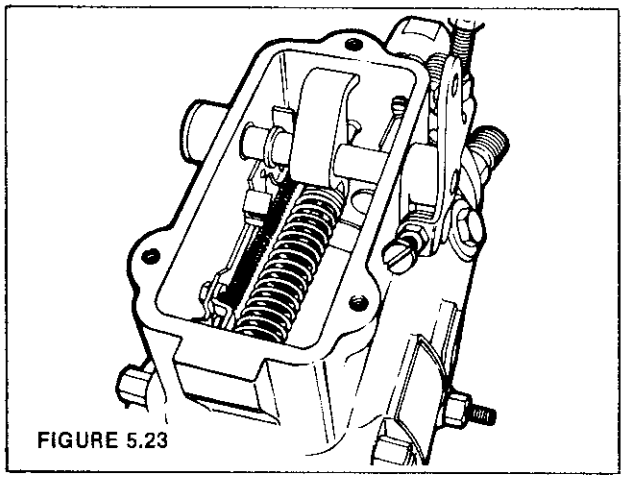


FIGURE 5.23

STEP 24 Assemble a new gasket to governor control cover and install cover on pump. Slip the flat washers and lock washers onto cover screws and tighten to the specified torque (Figure 5.24).

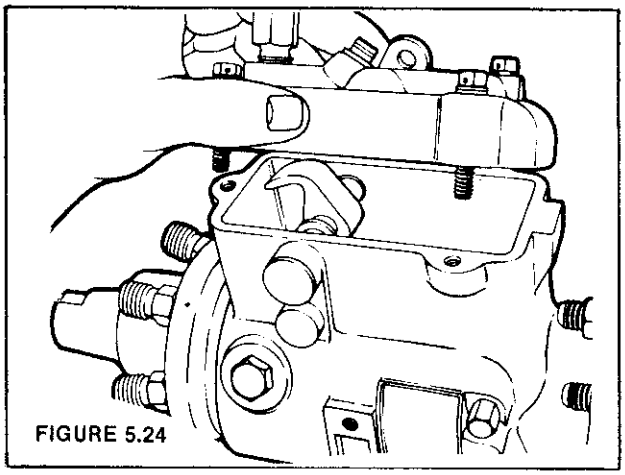


FIGURE 5.24

STEP 25 Insert end cap plug tool in the end cap and tighten the end cap to specified torque, using appropriate end cap wrench (Figure 5.25a).

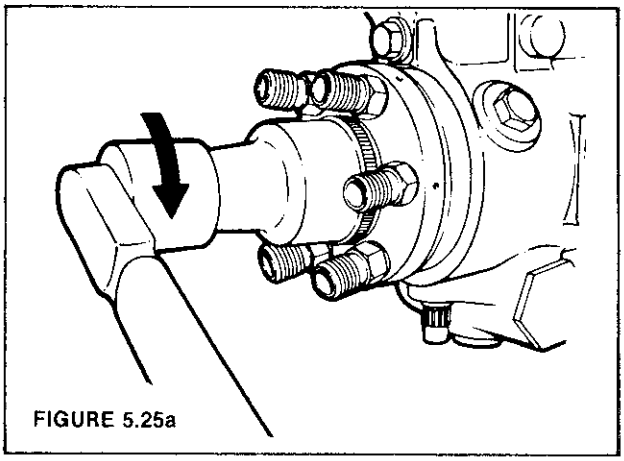


FIGURE 5.25a

CAUTION: The standard transfer pump end cap inlet requires a special inlet fitting with an "O" ring seal (1/2"-20 straight thread). Do not use a tapered pipe thread type fitting as this could bottom and result in seizure of the head and rotor assembly and damage to the end cap threads. Assemble the end cap locking plate, seal and screw, to the head and tighten to the specified torque (Figure 5.25b).

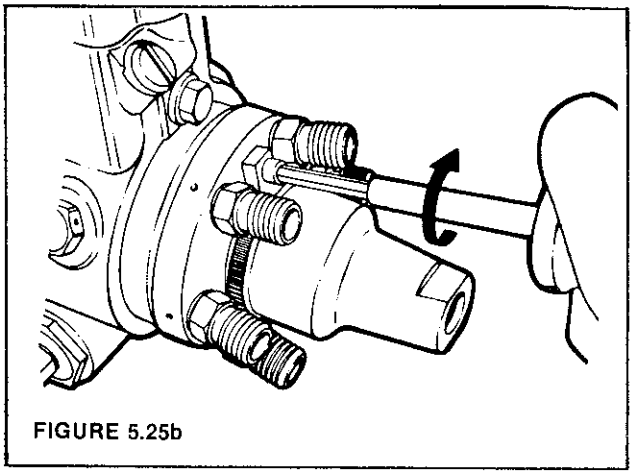


FIGURE 5.25b

STEP 26 Tighten the two head locking screws to the specified torque (Figure 5.26).

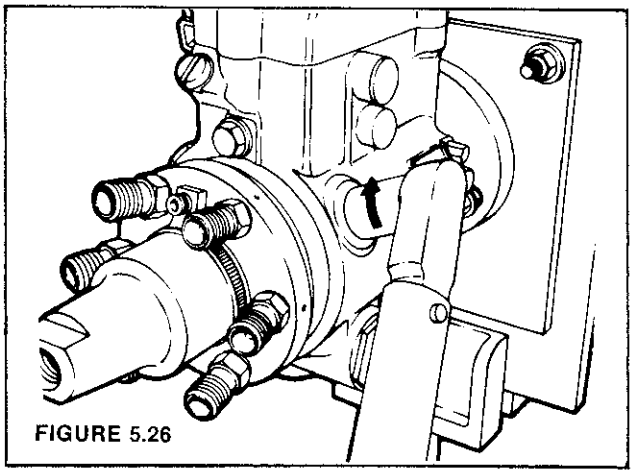


FIGURE 5.26

STEP 27 Remove the pump from holding fixture and install the pump flange seal (Figure 5.27).

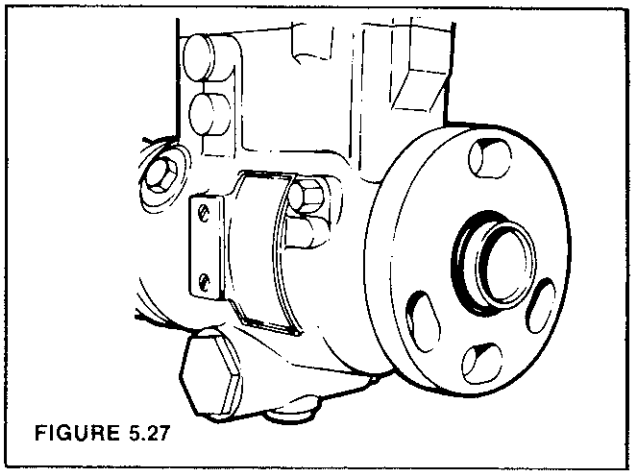


FIGURE 5.27

SECTION 6 - ACCESSORIES

FLEXIBLE GOVERNOR DRIVE

An optional flexible retaining ring (17513) is available in the Model DB2 pump. This ring serves as a cushion between the governor weight retainer and the weight retainer hub. It is designed to absorb torsional loading and vibrations transmitted to the pump from the engine as well as those created within the pump itself. In doing so, it allows for smoother governor operation under all speed and load conditions and reduces wear of the pump drive shaft tang and governor parts. More specific information about this ring is covered in Service Bulletin 180.

ELECTRICAL SHUTOFF

Electrical shutoff devices are available as an option in both Energized to Run (ETR) and Energized to Shutoff (ETSO) models for the DB2 pump. These solenoids are included in various applications to control the run and stop functions of the engine. They accomplish this by positively stopping fuel flow to the plungers, thereby interrupting injection. Operation and service of these devices are covered in detail in Service Bulletin 108.

TORQUE SCREW (Optional)

Torque is commonly defined as the turning moment or "lugging ability" of an engine. Maximum torque varies at each speed in the operating range for two reasons: (1) as engine speed increases, friction losses progressively increase and, (2) combustion chamber efficiency drops due to loss of volumetric efficiency (breathing ability of an engine), and due to reduction of time necessary to completely and cleanly burn the fuel in the cylinder. Since the torque increases with increased load conditions, a predetermined point at which maximum torque is desired may be selected for any engine. Thus, as engine RPM decreases, the torque generally increases toward this preselected point. This desirable feature is called "Torque Back-Up". In the Roosa Master pump three basic factors affect Torque Back-Up. These are:

1. Metering valve opening area.
2. Time allowed for charging.
3. Transfer pump pressure curve.

Of these, the only control between engines for purposes of establishing a desired torque curve is the transfer pump pressure curve and metering valve opening, since the other factors involved are common to all engines. Torque control in Roosa Master fuel injection pumps is accomplished in the following manner:

The manufacturer determines at what speed for a specific application he wants his engine to develop its maximum torque. The maximum fuel setting is then adjusted for required delivery during dynamometer test. This delivery must provide acceptable fuel economy. The engine is then brought to full load governed speed. The fuel delivery is then reduced from that determined by the maximum fuel setting by turning in an adjustment or "torque screw" (Figure 6.0), which moves the metering valve toward the closed position. The engine is now running at full load governed speed. When the engine is operating at high idle speed, no-load, the quantity of fuel delivered is controlled only by governor action through the metering valve. At this point, the torque screw and maximum fuel adjustment have no effect. As load is applied, the quantity of fuel delivered is controlled only by governor action and metering valve position until full-load governed speed is reached. At this point, further opening of the metering valve is prevented by its contact with the previously adjusted torque screw. Thus, the amount of fuel delivered at full-load governed speed is controlled by the torque screw and not by the roller-to-roller dimension. As additional load is applied and engine RPM decreases, a greater quantity of fuel is allowed to pass into the pumping chamber due to the increased time of registration of the charging ports. During this phase of operation the metering valve position remains unchanged, still being held from further rotation by the torque screw. As engine RPM continues to decrease under increasing load, the rotor charging ports remain in registry for a longer time period allowing a larger quantity of fuel into the pumping chamber. Fuel delivery increases until the predetermined point of maximum torque is reached.

At this point, the quantity of fuel is controlled by the roller-to-roller dimension. It must be remembered that torque adjustment on the Roosa Master pump may be properly carried out only during dynamometer or bench test. It should not be attempted on a unit in the field without means of determining actual fuel delivery.

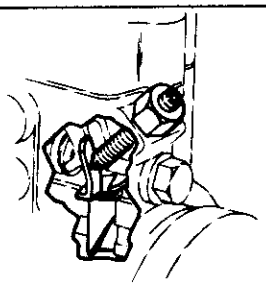


FIGURE 6.0

SECTION 7
TEST BENCH REQUIREMENTS & PROCEDURES

SPECIAL TEST BENCH REQUIREMENTS

Any test is only as good as the testing equipment employed. Incorporation of quality test equipment and adherence to specifications and the following test procedures will reduce testing inaccuracies to a minimum.

a) Calibrating Nozzles: Several different types of calibrating nozzles will be required for testing the various DB2 pump models. Be sure to use only the type of nozzle called for on the individual specification. Some of the permissible types are listed below:

TYPE	OPENING PRESSURE - p.s.i.
DN12SD12	2500 -- (170 ATS)
AMBAC PCU25DO50 .5 Orifice Plate (SAE Std.)	3000 -- (204 ATS)
AMBAC TSE77110 - 5/8 .5 Orifice Plate	1700 -- (116 ATS)

Use of the SAE/150 orifice plate nozzle is described in SAE recommended practices J968c and J969b.

b) Injection Lines: Several injection line sizes (length and I.D.) have been released for service use. Refer to individual specfication for proper size, and see Service Bulletin 330 for preparation and maintenance instructions.

c) Calibrating Oil: Guidelines for calibrating oil are listed in SAE Recommended Practice J969d. Reference Service Bulletin 201 for brands of calibrating oil approved for use with Roosa Master fuel injection equipment. Calibrating oil should be changed every three months or 200 pumps (whichever comes first).

d) Calibrating Oil Temperature: The temperature of the oil in the test bench must be maintained within 110° - 115°F while testing Roosa Master fuel injection equipment.

NOTE: This reading should be taken as close to inlet as possible. The test bench should be equipped with a heater and thermostatic control to maintain this temperature. Reference SAE Recommended Practice J969b.

e) Test Bench: Mount and drive the DB2 pump models according to the test bench manufacturers' instructions. In addition, the test stand coupling should be of the self-aligning, "zero" backlash type; similar to the Thomas Coupling types or Robert Bosch (SAEJ969b).

GENERAL TEST PROCEDURE

a) Install applicable transfer pump inlet connector, using two (2) wrenches so that the pump outlet fitting does not get moved at the same time. Install transfer pressure gauge connector 21900. Install a shutoff valve to isolate the gauge when not in use. Connect a pressure gauge to the 21900 adapter. Some automotive DB2 pumps require 1/4 of one degree setting accuracy. If so specified, remove the timing line cover and replace with the 21734 advance gauge. If the 21734 gauge is not required, replace the timing line cover with the 19918 advance window.

b) Determine proper direction of pump rotation from the specification. Rotation is determined as viewed from the drive end of the pump.

c) If the pump is equipped with an "Energized-to-Run" electric shutoff device, energize it at the lowest speed with the specified voltage (See Service Bulletin 108). Move pump throttle lever to full load position. When transer pump is primed, allow fuel to bleed for several seconds from loosened injection line nuts at the nozzles. Tighten line nuts securely.

NOTE: Roosa Master pump specifications list fuel delivery in cubic millimeters/stroke. Some test benches measure fuel flows in cubic centimeters (milliliters). To convert from mm^3/stroke to CC's use the following formula:

Delivery in CC's =

$$\frac{mm^3/\text{Stroke} \times \text{No. of Strokes}}{1000}$$

EXAMPLE: if the Specification calls for 72 mm^3/stroke and the test stand counter has been set for 500 strokes, simply substitute these numbers into the formula and calculate as follows:

$$\text{Delivery in CC's} = \frac{72 \times 500}{1000} = 36 \text{ CC's}$$

Bear in mind when testing Roosa Master pumps that our specifications refer to engine

RPM (ERPM) and that most test bench tachometers register pump RPM which is 1/2 engine speed for four stroke cycle engines.

d) Operate pump at 1000 ERPM wide open throttle (WOT) for 10 minutes. Dry pump off completely with compressed air. Observe for leaks and correct as necessary. Back out the high idle, low idle, and torque screw (if equipped).

NOTE: Refer to pump specification for correct sequence of test stand adjustments. Pressurize the transfer pump inlet to the amount indicated on specification or to a maximum of 5 p.s.i., if not otherwise indicated.

e) Vacuum Check: Close valve in fuel supply line. At 400 ERPM, the transfer pump must be capable of creating a vacuum of at least 18" of mercury. If it does not, check for air leaks between pump inlet and shutoff valve or deficiency in transfer pump components.

f) Fill graduates to bleed air from test stand and to wet graduates.

g) Check the return oil quantity by directing the return oil flow into an appropriately calibrated graduate for a given time. See individual specifications for allowable quantity and ERPM at which to make the check.

h) Operate at the specified speeds with wide open throttle and observe transfer pump pressure. Adjust pressure regulating spring plug to raise or lower transfer pump pressure.

CAUTION: Under no circumstances should 130 p.s.i. be exceeded.

To adjust pressure, remove the line to the transfer pump inlet connector and use a 5/32" hex key wrench 13316 to adjust the plug. Clockwise adjustment increases pressure. Do not over-adjust.

NOTE: Transfer pump pressure gauge must be isolated by the shutoff valve at the injection pump when checking fuel delivery and advance movement.

j) Check for miminum delivery at cranking speed.

k) Operate at high speed and adjust high idle screw to obtain the specified delivery. Recheck transfer pump pressure upon completion of this adjustment.

m) Adjust the low idle screw to the correct low idle delivery.

n) Automatic Advance: Check the cam position at specified points in the speed range. Adjust trimmer screw, as required, to obtain proper advance operation. Each line on advance gauge 19918 equals two pump degrees. After setting the advance, check to see that the cam returns to its initial position at 0 RPM. Recheck transfer pump pressure after setting advance and correct if necessary.

p) Record fuel delivery at check points shown on the pump specification. ROLLER SETTINGS SHOULD NOT BE READJUSTED ON THE TEST BENCH. Experience has proven that micrometer and dial indicator settings provide more consistent, accurate results in performance. Variations in test bench drives, instrumentation, nozzles lines and fuels in different areas sometimes result in nonconforming flow readings.

q) While operating at full-load governed speed, set torque screw (if employed) to specified delivery. Recheck the transfer pump pressure and advance movement upon completion of this adjustment.

r) Recheck delivery at lowest speed checkpoint.

s) Check governor cutoff at specified speed.

t) Check electric shutoff (if equipped) at speeds indicated on specification.

u) Remove the pump from the test stand and assemble all sealing wires. Pump is now ready for installation to engine.

SECTION 8
FUEL PIPING AND FILTRATION GENERAL RECOMMENDATIONS FOR ALL SYSTEMS

The basic requirements of a diesel engine fuel system are adequate piping, proper selection of filters for the application and completely air-tight joints, with a minimum number of fittings to prevent ingress of air, especially in installations with the fuel tank lower than the pump.

A. PIPING TO THE TANK

Vacuum at the transfer pump inlet must be avoided. If an auxiliary pump is used, pressure at the transfer pump must not be less than 0 p.s.i. nor greater than 5 p.s.i.*. Pressure after the return line connector assembly must not exceed 5 p.s.i. unless called for in specification.

NOTE: The return line must never be piped back to the transfer pump inlet side. Both supply and return line should be connected to standpipes in the tank with the opening for each 2" minimum from the bottom of the tank to allow space for water and sediments to settle and to eliminate siphoning problems. If the inlet standpipe is made as shown in Figure 8.0, it greatly reduces the possibility of air entering when fuel, at low level, is agitated in the tank.

B. FILTER REQUIREMENTS

1. A pleated paper type filter with large area and minimum pressure drop capable of filtering out 75 - 80% of five micron particles should be used. The Master Filter is recommended since it provides sufficient area for long life and two stage filtration for maximum protection (Figure 8.0).

2. Where water in the fuel is known to be a problem, the Master Separator is recommended (Figure 8.0).

C. MAXIMUM PRESSURE DROP

Pressure drop across clean filters should not be more than 2.5" of mercury (1.2 p.s.i.) at full load. Pressure drop in the supply system ex-

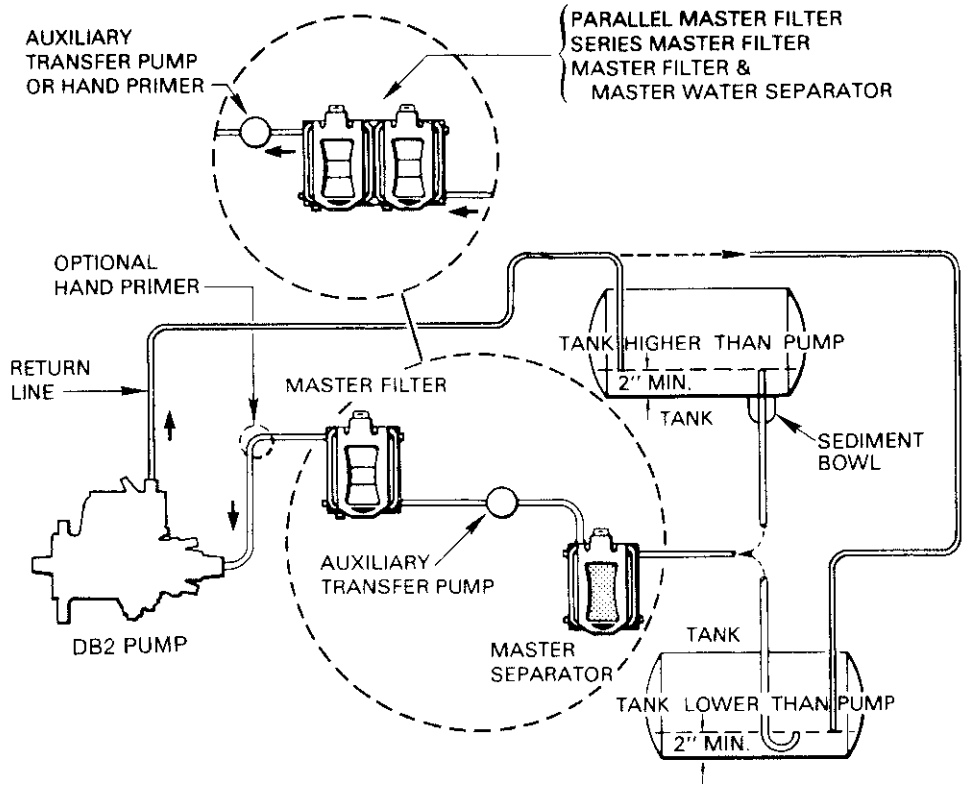


FIGURE 8.0

* *See individual specification for maximum p.s.i.*

ceding 10 in. of mercury (4.9 p.s.i.) because of dirty filters or other restriction usually will affect pump and engine performance, (erratic operation, low power, engine stall). A simple, positive check of the supply system for these defects can be performed readily as outlined in the "Troubleshooting" chart in Section 9.

D. ROOSA MASTER HAND PRIMER

If, due to piping system peculiarities, the system requires a hand primer, it should be accessible from the operator's position during engine cranking. Whenever possible, protect the inlet valves from fouling by installing after the primary filter. In gravity systems a primer is not normally required.

1. Marine & Industrial Engine Applications

Marine and industrial engines may require a different piping arrangement to suit application peculiarities and performance demands. Generator sets, for example, are particularly sensitive to air and usually require a separate electrically or mechanically driven auxiliary supply pump to deliver fuel, at low pressure, to the unit day tank. This places a positive head of fuel at the transfer pump and virtually eliminates entrance of air to the system (Figure 8.0).

Proper selection of piping sizes, filter capacities and layout of the system must be made to prevent undue restriction which would affect pump and engine performance. Of equal importance is the necessity for utmost cleanliness of fuel before and during handling. Admission of minute foreign particles, even in small quantities, will seriously wear and thereby increase the close clearances necessary to seal against internal hydraulic leakage.

Outside storage tanks, as well as vehicle and unit tanks, should be guarded against entrance of dirt. They should have drains to remove water and settlings periodically, be adequately vented and kept as full as possible to prevent condensation. Attendant piping should not be galvanized. Rigid observance of fuel cleanliness standards from time of purchase to ultimate use will do much to assure trouble free operation.

2. Vehicle Applications

Vehicle applications, especially trucks, are subject to unusual vibration and continual agitation of the fuel in the tanks. This causes more than the usual number of loose fittings and air entrainment which can be difficult to remove at the injection pump.

The following recommendations are listed in order of their effectiveness:

a. An electric boost pump as close to the tank outlets as possible is the most desirable system and is highly recommended. It provides a slight positive pressure during operation for proper filter venting and air free supply to the pump inlet.

NOTE: When a Master Separator is incorporated in the system, the electric boost pump must be installed on the fuel outlet side of the separator.

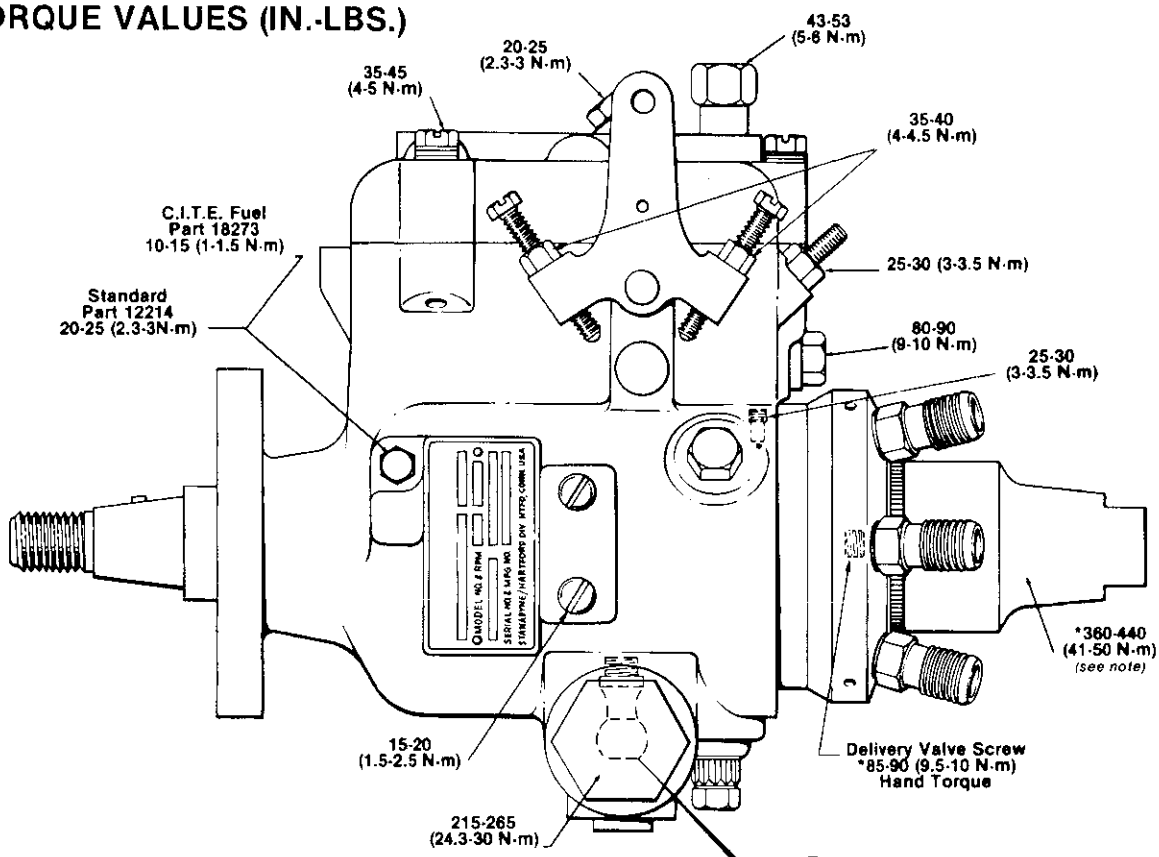
b. An engine-driven diaphragm-type pump can also be used, if mounting provisions are available. Commonly available types do not have hand priming levers and the engine must be cranked to prime the system. Where hand priming levers do exist, the engine must be spotted on the low side of the eccentric cam.

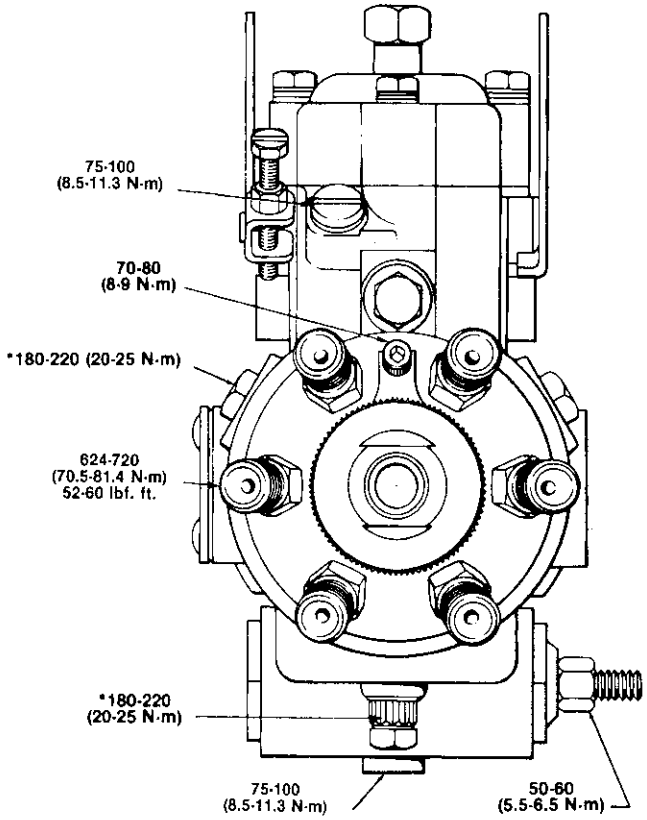
c. A hand primer, mounted as recommended in the piping diagram, can be used if the cost of an auxiliary pump is considered prohibitive. It should be realized, however, that the self-priming advantage will not be present.

Farm and industrial tractors usually have the tank mounted above the engine and the piping arrangement is generally as shown in Figure 8.0.

SECTION 9 - GENERAL DATA

TORQUE VALUES (IN.-LBS.)

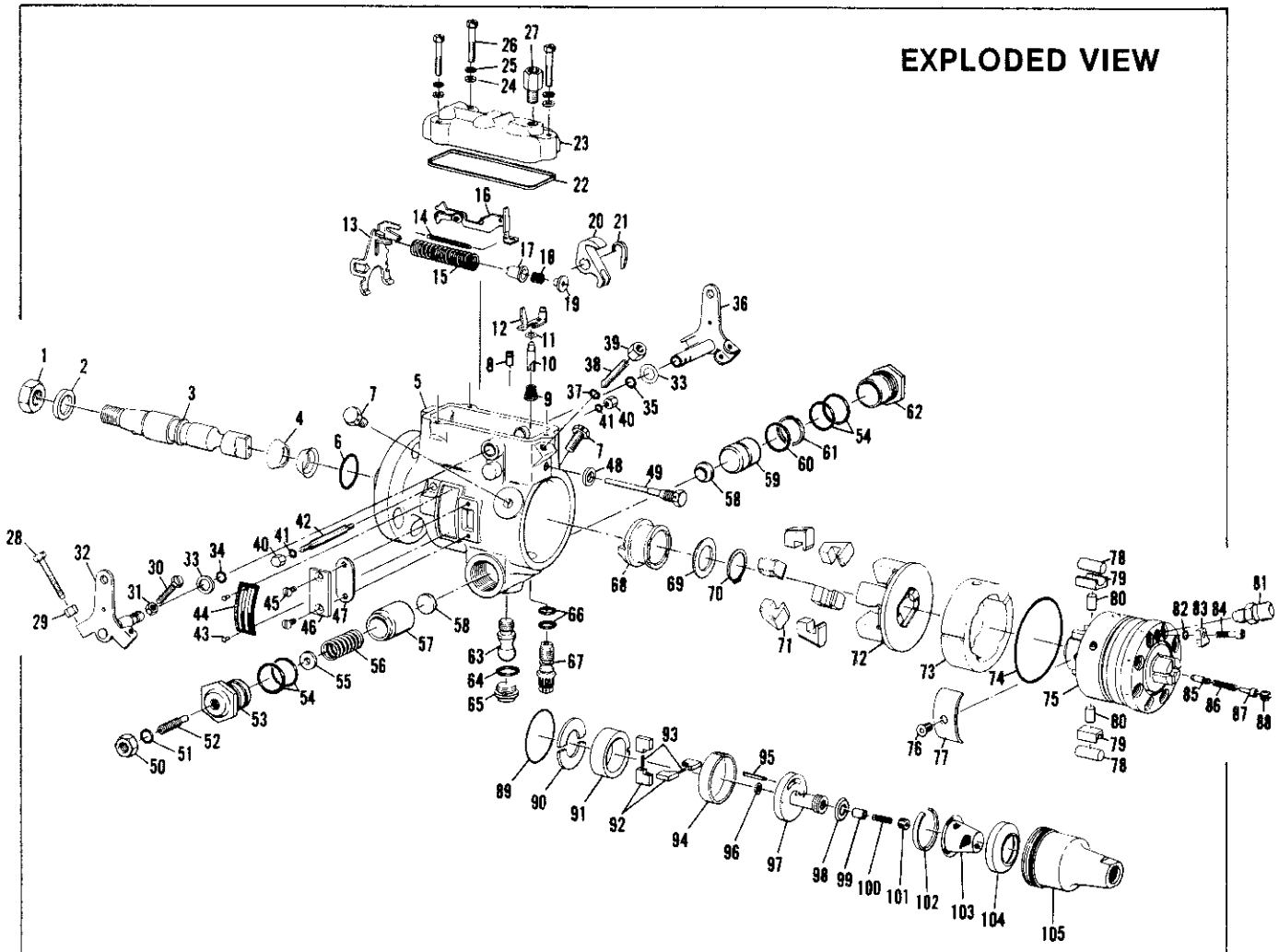




Critical Torque Values

Note: Apply Lubriplate (630AA) to Chamfer of pressure plate and cap threads.

EXPLODED VIEW



1. NUT, drive shaft
2. WASHER, drive shaft
3. SHAFT, drive
4. SEAL, drive shaft
5. HOUSING ASSY., pump
6. SEAL, pump flange
7. SCREW, head locking
8. SCREW ASSY., vent
9. SPRING, metering valve
10. VALVE, metering
11. SHIM, metering valve
12. ARM ASSY., metering valve
13. ARM, governor
14. SPRING, linkage hook
15. SPRING, governor
16. LINKAGE ASSY., gov. hook adj.
17. RETAINER, spring
18. SPRING, idling
19. GUIDE, idling spring
20. LEVER, throttle shaft
21. CAM, shut-off
22. GASKET, governor cover
23. COVER, governor control
24. WASHER, cover screw
25. LOCK WASHER, cover screw
26. SCREW, cover hold-down
27. CONNECTOR ASSY., return line
28. SCREW, low idle adjusting
29. NUT, low idle screw
30. SCREW, high idle adjusting
31. NUT, high idle screw
32. SHAFT ASSY., throttle
33. WASHER, throttle shaft seal
34. SEAL, throttle shaft
35. SEAL, shut-off shaft
36. SHAFT ASSY., shut-off
37. SEAL, torque screw
38. SCREW, torque
39. NUT, torque screw
40. NUT, pivot shaft
41. SEAL, pivot shaft
42. SHAFT, gov. arm pivot
43. SCREWS, nameplate
44. PLATE, name
45. SCREW, timing line cover
46. COVER, timing line
47. GASKET, timing line cover
48. WASHER, guide stud
49. STUD, guide
50. NUT, adv. adj. screw
51. SEAL, adv. adj. screw
52. SCREW, advance adjusting
53. PLUG, piston hole (trimmer side)
54. SEAL, piston hole plug
55. GUIDE, adv. adj. spring
56. SPRING, advance adjusting
57. PISTON, spring
58. WASHER, slide
59. PISTON, power
60. SEAL, piston ring
61. RING, piston
62. PLUG, piston hole (power side)
63. SCREW, cam advance
64. SEAL, advance screw hole plug
65. PLUG, advance screw hole
66. SEAL, head locating screw
67. SCREW, ASSY., head locating
68. SLEEVE, governor thrust
69. WASHER, gov. thrust sleeve
70. RING, gov. cage retaining
71. WEIGHT, governor
72. RETAINER ASSY., gov. weight
73. CAM RING
74. SEAL, hydraulic head
75. HEAD AND ROTOR ASSY.
76. SCREW, leaf spring
77. SPRING, leaf
78. ROLLER, cam
79. SHOE, cam roller
80. PLUNGERS
81. FITTING, discharge
82. SEAL, locking plate
83. PLATE, locking
84. SCREW, locking plate
85. VALVE, delivery
86. SPRING, delivery valve
87. STOP, delivery valve
88. SCREW, delivery valve
89. SEAL, transfer pump
90. RETAINERS, rotor
91. LINER, transfer pump
92. BLADES, transfer pump
93. SPRINGS, transfer pump blade
94. RING, liner locating
95. ROLLPIN, regulator
96. SEAL, inlet filter screen
97. REGULATOR ASSY., transfer pump
98. SEAL, inlet filter screen
99. PISTON, regulating
100. SPRING, regulating
101. PLUG ASSY., end plate adjusting
102. RING, filter screen retaining
103. SCREEN, inlet filter
104. PLATE, transfer pump pressure
105. CAP, transfer pump end

PROBLEM

PROBLEM MAY OCCUR	CAUSE *Numbers in "Problem" Check Chart indicate order in which to check possible "Causes" of Problem.*	A. Fuel not reaching pump	B. Fuel delivered from transfer pump but not to nozzles.	C. Fuel reaching nozzles but engine won't start.	D. Engine starts hard.	E. Engine starts and stops.	F. Erratic engine operation — surge, misfiring, poor governor regulation.	G. Engine idles imperfectly.	H. Engine does not develop full power or speed.	I. Engine smokes black.	J. Engine smokes blue or white.	CORRECTION
ON TEST STAND FOLLOWING OVERHAUL	Transfer Pump liner locating pin in wrong hole for correct rotation.	7										Re-install properly.
	Plunger missing.		9									Assemble new plunger.
	Cam backwards in housing.		8									Reassemble correctly.
	Metering Valve incorrectly assembled to metering valve arm.		6									Reassemble correctly.
	Delivery Valve Sticking, missing or assembled backwards				19		21	17	15			Remove, clean or replace as needed.
	Hydraulic head vent wires missing.		13						24			Install as indicated in reassembly instructions.
	Idling spring missing, or incorrect.						15	8				Assemble as indicated in reassembly instructions.
FOLLOWING INSTALLATION ON ENGINE	Hand primer installed backwards.	3										Re-install properly.
	Seizure of Distributor Rotor.	2										Check for cause of seizure. Replace hydraulic head and distributor rotor assembly.
	Failure of electrical shut-off.		2			8						Remove, inspect and adjust parts. Replace parts as necessary.
DURING OPERATION	Fuel supply lines clogged, restricted, wrong size or poorly located.	9	7	7	5	1	2	13	4			Blow out all fuel lines with filtered air. Replace if damaged. Remove and inspect all flexible lines.
	Air leaks on suction side of system.	11			6	7	8	3	5			Trouble-shooting the system for air leaks. See Supplementary Inspections in manual.
	Transfer Pump Blades worn or broken.	8			12		18	5	13			Replace.
	Delivery Valve Retainer Screw loose and leaking or incorrectly installed.				25		20		21			Inspect Delivery Valve Stop seat for erosion, tighten Retainer Screw, or replace head and rotor assembly as needed.
	Transfer Pump Regulating Piston sticking.	10			13		19	12				Remove piston and regulator assembly and inspect for burrs, corrosion or varnishes. Replace if necessary.
	Shut-off device at "stop" position.		1									Move to "run" position.
	Plungers sticking.		10		21	10		18	17			Disassemble and inspect for burrs, corrosion or varnishes.
	Metering Valve sticking or closed.		3		14	9	12	7	10			Check for governor linkage binding, foreign matter, burrs, missing metering valve shim, etc.
	Passage from Transfer Pump to Metering Valve clogged with foreign matter.		11									Disassemble and flush out Hydraulic Head.
	Tank valve closed.	1										Open valve.
	Fuel too heavy at low temperature.	6			8							Add kerosene as recommended for 0°F, -15°F and -30°F temperatures.
	Cranking speed too low.			1	2						7	Charge or replace batteries.
	Lube oil too heavy at low temperature.			18	9							See engine manual.
	Engine engaged with load.			2	1							Disengage load.
	Nozzles faulty or sticking.			10	17		9	10		5		Replace or correct nozzles.
	Intake air temperature low			5	3							Provide starting aids. See engine manual.
	Engine compression poor.			17	10				25	9	8	Correct compression. See engine manual.
	Pump timed incorrectly to engine			3	4		4	4	7	4	3	Correct timing. See engine manual.
	Excessive fuel leakage past plungers (worn or badly scored).			15	22			16	18			Replace rotor and hydraulic head assembly.
	Filters or Inlet Strainer clogged.	5			7	6	3		6			Remove and replace clogged elements. Clean strainer.
	Cam, Shoes or Rollers worn.			14	20				16			Remove and replace.
	Automatic advance faulty or not operating.			11	24		11	11	12	7	4	Remove, inspect, correct and reassemble.
	Governor linkage out of adjustment or broken.				16		14	9	11			Adjust governor linkage hook.
	Governor not operating; parts or linkage worn, sticking or binding, or incorrectly assembled.		4		26		13	6	9			Disassemble, inspect parts, replace if necessary and reassemble.
	Maximum fuel setting too low.			12	18				14			Reset to pump specifications.
	Engine valves faulty or out of adjustment.				28		10	15		6	9	Correct valves or valve adjustment as in engine manual.

PROBLEM

PROBLEM MAY OCCUR	CAUSE *Numbers in "Problem" Check Chart indicate order in which to check possible "Causes" of Problem.*	A. Fuel not reaching pump.	B. Fuel delivered from transfer pump but not to nozzles.	C. Fuel reaching nozzles but engine won't start.	D. Engine starts hard.	E. Engine starts and stops.	F. Erratic engine operation — surges, misfiring, poor governor regulation.	G. Engine idles imperfectly.	H. Engine does not develop full power or speed.	I. Engine smokes black.	J. Engine smokes blue or white.	CORRECTION
DURING OPERATION	Water in fuel.					2	5	1	23			Drain fuel system and pump housing, provide new fuel, prime system.
	Return oil line or fittings restricted.				29	4	23	19	8			Remove line, blow clean with filtered air and reassemble. Replace if damaged.
	Engine rotation wrong.	4										Check engine rotation. See engine manual.
	Air intake restricted.					3			26	2		Check. See engine manual.
	Wrong Governor spring.						17		27			Remove and replace with proper spring as in pump specifications.
	Pump housing not full of fuel.						7	2				Operate engine for approximately 5 minutes until pump fills with fuel.
	Low cetane fuel.			13	11		6	14	20	8		Provide fuel per engine specifications.
	Fuel lines incorrect, leaking or connected to wrong cylinders.			6			1		28			Relocate fuel lines for correct engine firing sequence.
	Tang Drive excessively worn.						22		19		5	Remove and install new head and rotor assembly and drive shaft as necessary.
	Governor sleeve binding on drive shaft.						16					Remove, inspect for burrs, dirt, etc. Correct and reassemble.
	Shut-off device interfering with Governor linkage.			8	15				2			Check and adjust governor linkage dimension.
	Governor high-idle adjustment incorrect.								3			Adjust to pump specifications.
	Torque Screw incorrectly adjusted.		5	9	23				22	11		Adjust to specification.
	Throttle Arm travel not sufficient.			4					1			Check installation and adjust throttle linkage.
	Rotor excessively worn.		12	16	27							Replace hydraulic head and rotor assembly.
	Maximum fuel setting too high.									10		Reset to pump specifications.
	Engine overheating.					5				3		Correct as in engine manual.
	Exceeding rated load.									1		Reduce load on engine.
	Engine cold.				30						1	Check thermostats or shutter controls, warm to operating temperature. See engine manual.
	Lube oil pumping past valve guides or piston rings in engine.										6	Correct as in engine manual.
	Excess lube oil in engine air cleaner.										2	Correct as in engine manual.

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