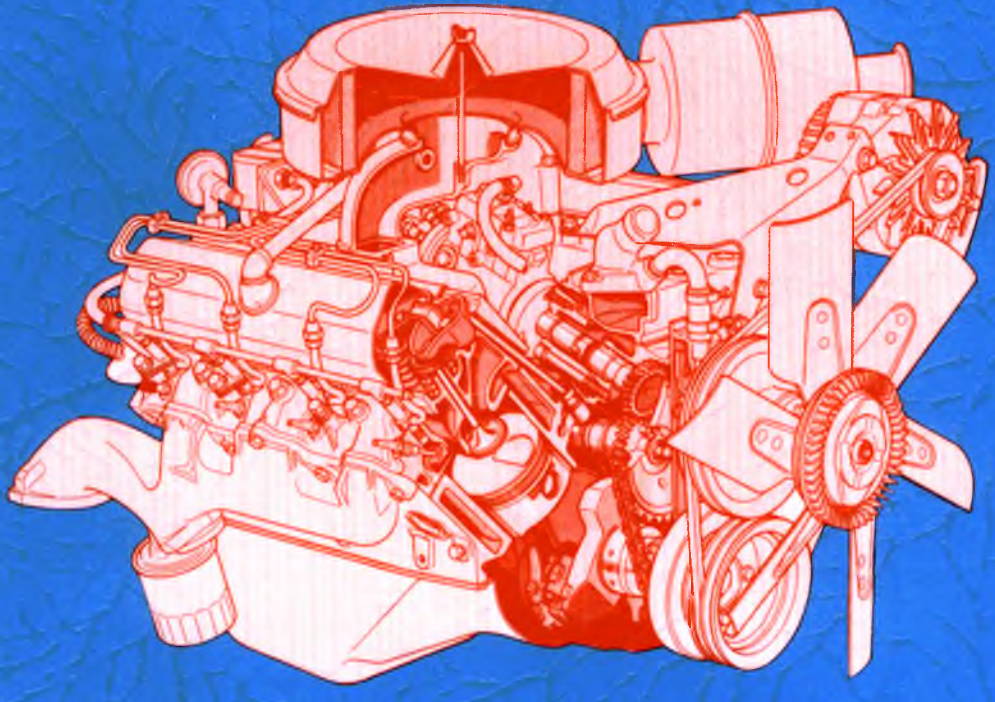
diesel

Oldsmobile



DIESEL ENGINE SERVICE MANUAL

OLDSMOBILE
DIESEL ENGINE SERVICE MANUAL

IMPORTANT SAFETY NOTICE

Proper service and repair is important to the safe, reliable operation of all motor vehicles. The service procedures recommended by Oldsmobile and described in this manual are effective methods of performing service operations. Some of these service operations require the use of tools specially designed for the purpose. The special tools should be used when and as recommended.

It is important to note that this manual contains various Warnings, and Cautions which should be carefully read in order to minimize the risk of personal injury to service personnel or the possibility that improper service methods will be followed which may damage the vehicle or render it unsafe. It also is important to understand that these Warnings, and Cautions are not exhaustive. Oldsmobile could not possibly know, evaluate and advise the service trade of all conceivable ways in which service might be done or of the possible hazardous consequences of each way. Consequently, Oldsmobile has not undertaken any such broad evaluation. Accordingly, anyone who uses a service procedure or tool which is not recommended by Oldsmobile must first satisfy himself thoroughly that neither his safety nor vehicle safety will be jeopardized by the service method he selects.

OLDSMOBILE

DIESEL ENGINE SERVICE MANUAL

FOREWORD

This manual contains service information on the 5.7 ℓ V-8 Diesel Engine manufactured by Oldsmobile Division, GM Corporation. All service procedures and specifications apply to the engine when installed in an Oldsmobile passenger car.

The diesel engine compares in size with the 350 V-8 gasoline engine manufactured by Oldsmobile Division which was the starting point in the engineering of the diesel engine. All of the major parts; block, crankshaft, rods, pistons and lifters have been strengthened to handle the higher compression ratio.

A diesel engine does not have an electrical spark ignition system, emission control devices (except for the crankcase ventilation system) or a catalytic converter. Maintenance normally associated with a gasoline engine such as spark plugs, points and carburetor service are not required on a diesel. Refer to the Maintenance Chart for scheduled maintenance.

No attempt should be made to disassemble the injection pump or nozzles. Illustrations in this manual are to provide information on how they operate and are not intended to be used as service procedures. Service on these parts should only be performed by authorized dealers who have trained personnel and approved testing equipment.

ENGINE CLEANING

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

CAUTION

Oldsmobiles contain many parts dimensioned in the metric system as well as in the customary system. Many fasteners are metric and are very close in dimension to familiar customary fasteners in the inch system. It is important to note that during any maintenance procedures, replacement fasteners must have the same measurements and strength as those removed, whether metric or customary. (Numbers on the heads of metric bolts and on surfaces of metric nuts indicate their strength. Customary bolts use radial lines for this purpose, while most customary nuts do not have strength markings.) Mismatched or incorrect fasteners can result in vehicle damage or malfunction, or possibly personal injury. Therefore, fasteners removed from the car should be saved for re-use in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that matches the original. For information and assistance, see your Oldsmobile dealer.

SERVICE DEPARTMENT

OLDSMOBILE DIVISION

GENERAL MOTORS CORPORATION
LANSING, MICHIGAN

PRICE: TWO DOLLARS

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SECTION A

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GENERAL INFORMATION

The basic engine is similar in construction to the 5.7 Litre (350 C.I.D.) V-8 gasoline engine. It is a 5.7 Litre V-8 four cycle diesel fuel engine. Cylinder numbers 1, 3, 5 and 7 are on the left bank. Cylinder numbers 2, 4, 6 and 8 are on the right bank. The firing order is 1-8-4-3-6-5-7-2. The major difference is in the cylinder heads, combustion chamber, fuel distribution system, air intake manifold and method of ignition. The cylinder block, crankshaft, main bearings, rods, pistons and pins are heavier duty because of the high compression ratio required to ignite diesel fuel. Diesel ignition occurs because of heat developed in the combustion chamber during compression. This eliminates the need for spark plugs and high voltage ignition.

Intake and exhaust valves in the cylinder heads operate the same as in a gasoline engine, but are of a special design and material for diesel operation. The stainless steel pre-chamber inserts in the cylinder head combustion chambers are serviced separately from the head. With the cylinder head removed they can be pushed out after removing the glow plugs and injection nozzles. Glow plugs are threaded, injection nozzles are retained by a bolt and spring clamp. The injection nozzles are spring loaded and calibrated to open at a specified PSI of fuel pressure.

Because the intake manifold is always open to atmospheric pressure, there is no vacuum supply and a vacuum pump is required to operate vacuum operated accessories such as air conditioning door diaphragms and cruise control. Power brake assist pressure is supplied by the power steering pump to a hydraulic booster on the brake master cylinder.

THEORY OF OPERATION

Operation of the four cycle diesel engine manufactured by Oldsmobile Division can be compared with a four cycle gasoline engine. The major difference is the fuel and method of ignition. The four cycles; intake, compression, power and exhaust are the same.

INTAKE STROKE – GASOLINE ENGINE (Fig. A-1)

The intake valve is opened by a lobe on the camshaft, through a pushrod and rocker arm assembly. The piston moves down in the bore due to the rotation of the crankshaft. As the piston moves down in the cylinder it pulls outside air through the air cleaner and into the carburetor, where it is mixed with fuel in the proper proportion for the needs of the engine. The air/fuel mixture then flows through the intake manifold, past the intake valve and into the cylinder.

The power output of a gasoline engine is determined by the amount of air/fuel mixture drawn into the cylinder. The carburetor throttle valve controls engine speed by controlling the air/fuel mixture flow through the carburetor throttle body and into the cylinders.

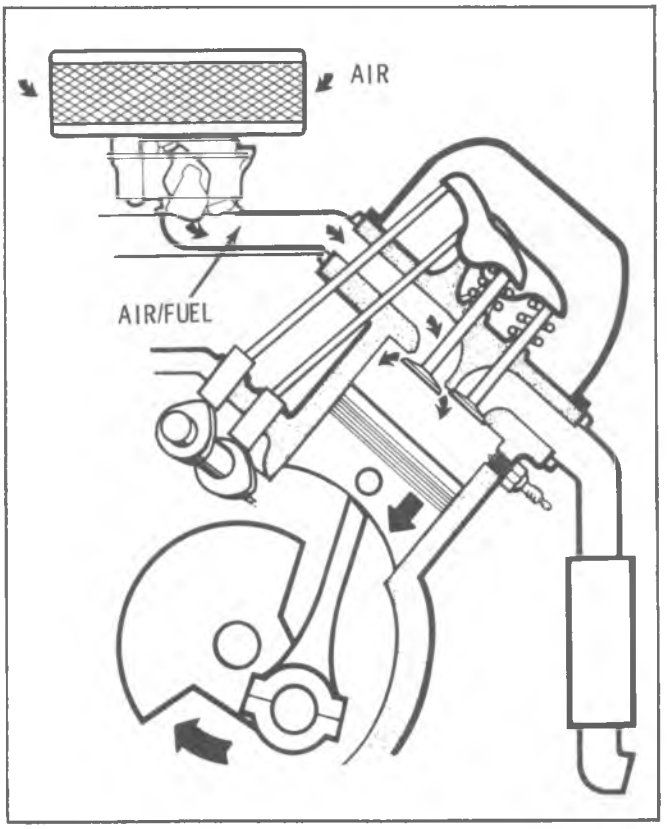


Fig. A-1–Intake Stroke (Gasoline Engine)

COMPRESSION STROKE – GASOLINE ENGINE (Fig. A-2)

After the piston reaches the bottom of its stroke and begins to rise in the cylinder, the compression stroke begins. Camshaft movement allows the intake valve to be closed by spring pressure. The exhaust valve is still being held closed by spring pressure. Since there is no way for the air/fuel mixture to escape, it is compressed. When the piston nears the top of the compression stroke, an electrical spark jumps across the spark plug gap and ignites the air/fuel mixture.

The purpose for the ignition system is to provide voltage to the spark plug to cause a spark across the gap of sufficient intensity to ignite the air/fuel mixture in the combustion chamber. This voltage must arrive at the correct cylinder at the proper moment in the compression stroke. The ignition system also varies the time the spark arrives in the compression stroke in relation to engine speed and load. This is necessary to obtain maximum power and economy from the engine.

Ignition advance is necessary for maximum power output because the air/fuel mixture burns at a constant rate, regardless of engine speed. An air/fuel mixture that takes .003 of a second to burn at 1000 rpm will take the same time to burn at 2000 rpm. At 1000 rpm the engine will rotate 18 degrees in .003 of a second while at 2000 rpm it will rotate 36 degrees. So, to have combustion completed at the same time as it did at 1000 rpm, the mixture will have to be ignited 18 degrees earlier in the compression stroke. If this is not done, much of the heat of combustion will escape out of the exhaust instead of being converted to power to drive the car.

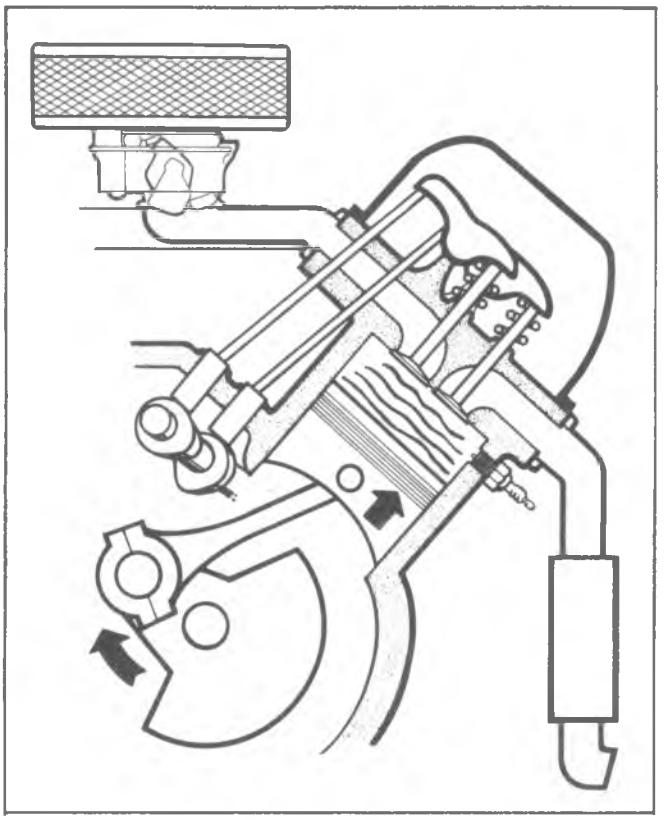


Fig. A-2–Compression Stroke (Gasoline Engine)

POWER STROKE – GASOLINE ENGINE (Fig. A-3)

When the air/fuel mixture is ignited, it burns quickly, causing a rapid pressure rise in the cylinder. This pressure forces the piston down in the bore and causes the crankshaft to rotate. As the piston nears the bottom of its travel, the exhaust valve, operated by a lobe on the camshaft, opens.

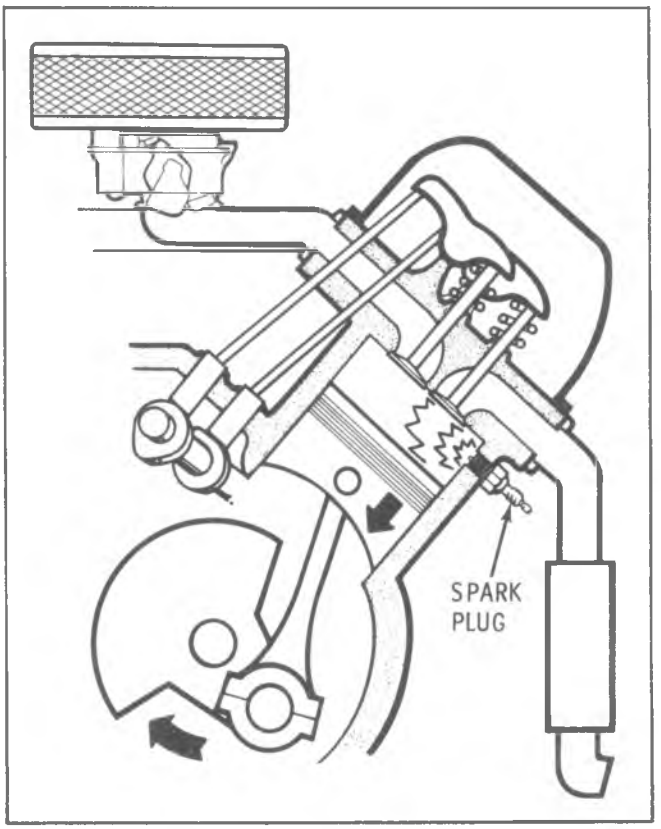


Fig. A-3–Power Stroke (Gasoline Engine)

EXHAUST STROKE – GASOLINE ENGINE (Fig. A-4)

The piston then begins to rise in the cylinder, beginning the exhaust stroke. The upward movement of the piston forces the burned gases past the exhaust valve out of the cylinder. As the piston nears the top of its movement, the camshaft lobe again opens the intake valve and the cycle repeats itself. The exhaust valve is closed by spring pressure shortly after the piston begins its downward movement.

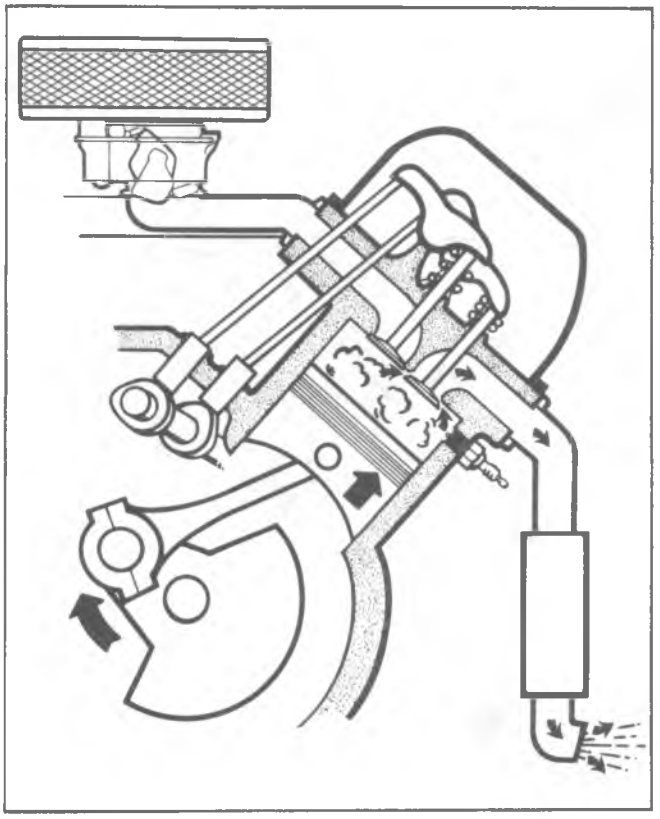


Fig. A-4–Exhaust Stroke (Gasoline Engine)

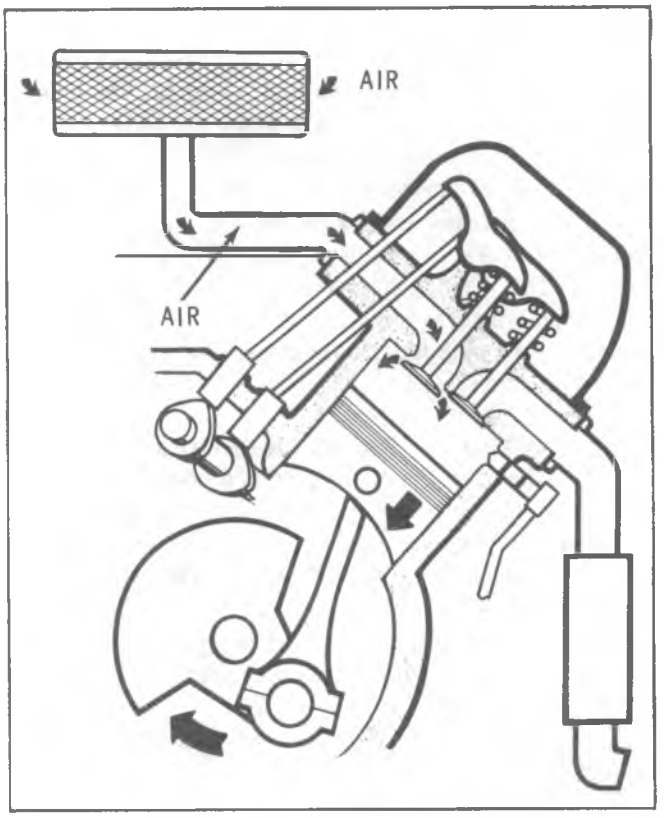


Fig. A-5–Intake Stroke (Diesel Engine)

THEORY OF OPERATION – DIESEL ENGINE

INTAKE STROKE – DIESEL ENGINE (Fig. A-5)

The intake stroke is basically the same as that of the gasoline engine. The intake valve is held open by a lobe on the camshaft, through a push rod-rocker arm arrangement. The piston moves down in the bore due to the rotation of the crankshaft. As the piston moves down in the cylinder, it pulls outside air through the air cleaner and air manifold into the cylinder. There is no carburetor to mix fuel with the air, or throttle valve to limit the amount of air entering the cylinder. The cylinder fills completely with air on every intake stroke. The diesel engine is fuel injected and power output is determined by the amount of fuel injected directly into the cylinder during the compression stroke.

COMPRESSION STROKE – DIESEL ENGINE (Fig. A-6)

When the piston reaches the bottom of its travel, it begins to rise in the cylinder. The rotation of the camshaft allows the intake valve to be closed by spring pressure. Since both valves are closed, the air is compressed by the upward movement of the piston. Another difference between a gasoline and diesel engine is their compression ratios. Current production gasoline engines have a compression ratio of about 8.5:1 while the diesel engine compression ratio is about 22.5:1. This higher compression ratio is made possible by the fact that only air is being compressed. When air is compressed this much its temperature rises above that of the ignition point of the fuel. If fuel were present, it would begin to burn without a spark. (An example of this principle is an air compressor. The cooling fins become quite hot after it has been running a short time.)

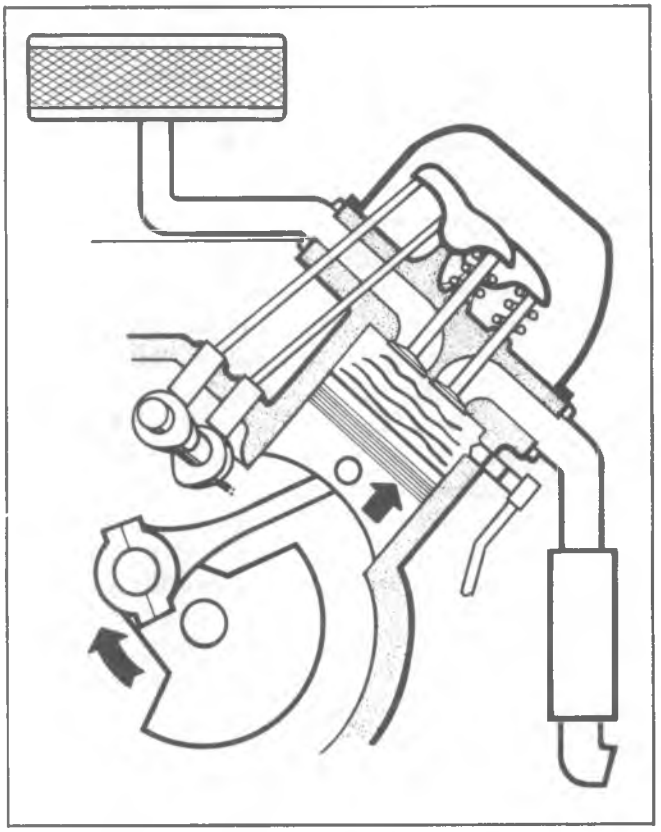


Fig. A-6–Compression Stroke (Diesel Engine)

POWER STROKE – DIESEL ENGINE (Fig. A-7)

The power stroke for a diesel is similar to a gasoline engine except for the way the fuel is ignited. The high air temperature in the cylinder of a diesel eliminates the need for an ignition system. As the piston nears the top of its travel on the compression stroke, fuel is injected into the combustion chamber, igniting immediately. Once ignited, the fuel burns quickly, causing a rapid pressure rise in the cylinder. This pressure increase forces the piston down in the bore which causes the crankshaft to rotate. The exhaust valve is then opened by a lobe on the camshaft as the piston nears the bottom of its travel.

EXHAUST STROKE – DIESEL ENGINE (Fig. A-8)

The exhaust stroke is the same as a gasoline engine. The upward motion of the piston forces the burned gases past the open exhaust valve and out of the cylinder. As the piston nears the top of its travel, the intake valve opens and the cycle repeats.

In comparing the operation of the gasoline and diesel engines, these basic differences were covered:

DIESEL ENGINES –

1. Have no throttle valves to restrict air intake.
2. Compress only air.
3. Have a much higher compression ratio.
4. Do not have an electrical spark ignition system.
5. Inject fuel directly into a pressurized chamber.
6. Control power and speed by the amount of fuel injected.

Most of these differences are made possible through the use of fuel injection. The fuel injection pump also varies engine timing according to engine speed.

FUEL INJECTION SYSTEM (Fig. A-9)

The fuel injection system has one injection pump that meters, pressurizes and distributes fuel to all eight cylinders. Fuel is distributed to the cylinders in the same manner an ignition system distributes high voltage. Instead of two electrical contacts aligning to allow current flow, two fluid passages align to allow fuel flow. The fuel is then carried by a high pressure line to the proper cylinder. The high pressure fuel line is connected to a nozzle, the tip of which is located in the combustion chamber. The nozzle contains a spring loaded check valve that is closed except when high pressure fuel is directed to that nozzle. This pressure lifts the valve off its seat and the fuel is injected into the combustion chamber through holes in the end of the nozzle. These holes are located to aim the fuel at the most desirable points in the combustion chamber. When fuel pressure drops, spring pressure closes the valve, stopping any further fuel delivery. As engine speed increases, engine timing is advanced by aligning the fuel passages in the pump sooner so fuel is injected into the cylinder earlier in the compression stroke.

One advantage of a diesel engine is fuel economy. The greater fuel economy is due to three main factors: air/fuel ratio, compression ratio, and the heating value of the fuel.

The air/fuel ratio in a diesel engine varies from 100:1 at idle to 20:1 at full load. (By comparison, the air/fuel ratio in a gasoline engine varies between 18:1 and 12:1.)

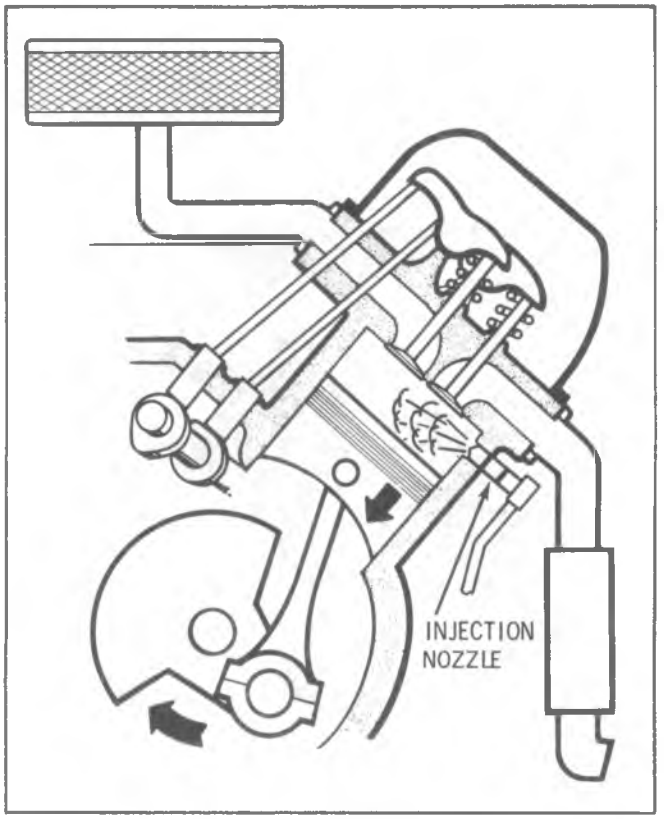


Fig. A-7–Power Stroke (Diesel Engine)

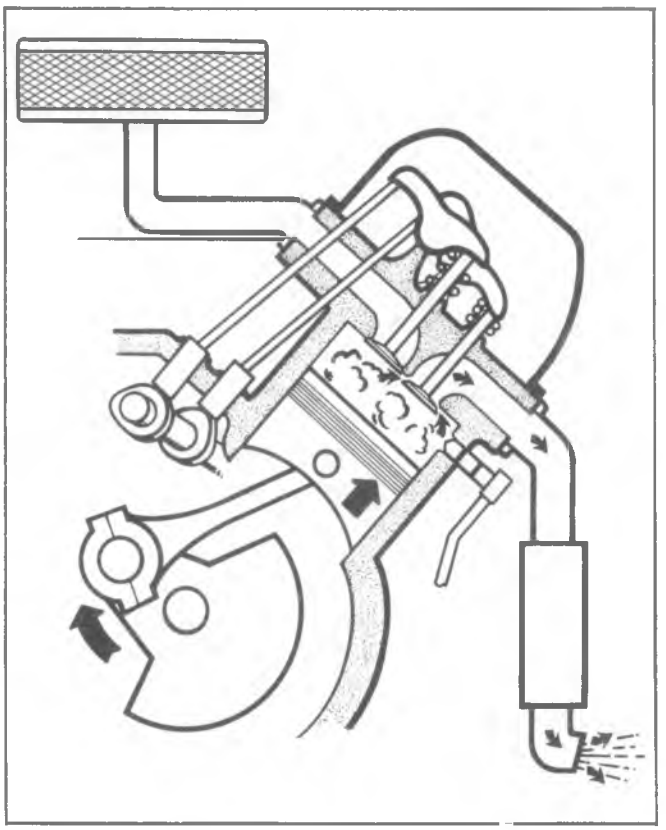


Fig. A-8–Exhaust Stroke (Diesel Engine)

In a gasoline engine, air/fuel mixture is drawn into the

cylinder after being mixed in the proper proportion in the carburetor.

In a diesel engine only air is drawn in, and because air intake is unrestricted, the cylinder fills with air on every intake stroke. The high compression ratio causes the air in the cylinder to be raised above the ignition temperature of diesel fuel. Fuel is not injected into the compressed air until it is time for ignition. The fuel being injected into the cylinder is mixed with the air in the cylinder by turbulence. Since the air temperature is above the ignition point of the fuel, when the fuel comes in contact with the air it ignites and burns.

The second reason for greater fuel economy is that the higher compression ratio of the diesel engine allows the engine to turn more of the fuel heat energy into mechanical energy. This is possible because when fuel is burned, it will expand at the same rate regardless of the area it is contained in. This means that the smaller the area, the higher the pressure will be. It is the pressure in the combustion chamber that forces the piston down in the bore, so the higher the pressure, the greater the power output per stroke.

Another reason for the increased pressure in the diesel engine is that the cylinder fills with air on every intake stroke. The air in the cylinder, not used in the combustion process, absorbs some of the heat from combustion. When air is heated it expands. The resultant increased pressure in the cylinder increases the power output, thus improving economy.

The third reason for greater fuel economy of the diesel engine is the heating value of the fuel. If a fuel gives off more heat per unit, less fuel will be needed to give the same power output. This is true for diesel fuel when compared to gasoline. The heating value of Number 2 diesel fuel is approximately 11% higher than that of gasoline.

Besides the advantage of better fuel economy, the diesel offers an improvement in emissions. A diesel engine, when designed for low emission, can pass current emission requirements with no additional systems such as E.G.R., Catalytic Converter, A.I.R., etc. Hydrocarbons and carbon monoxide output levels are very low, due to the completeness of combustion.

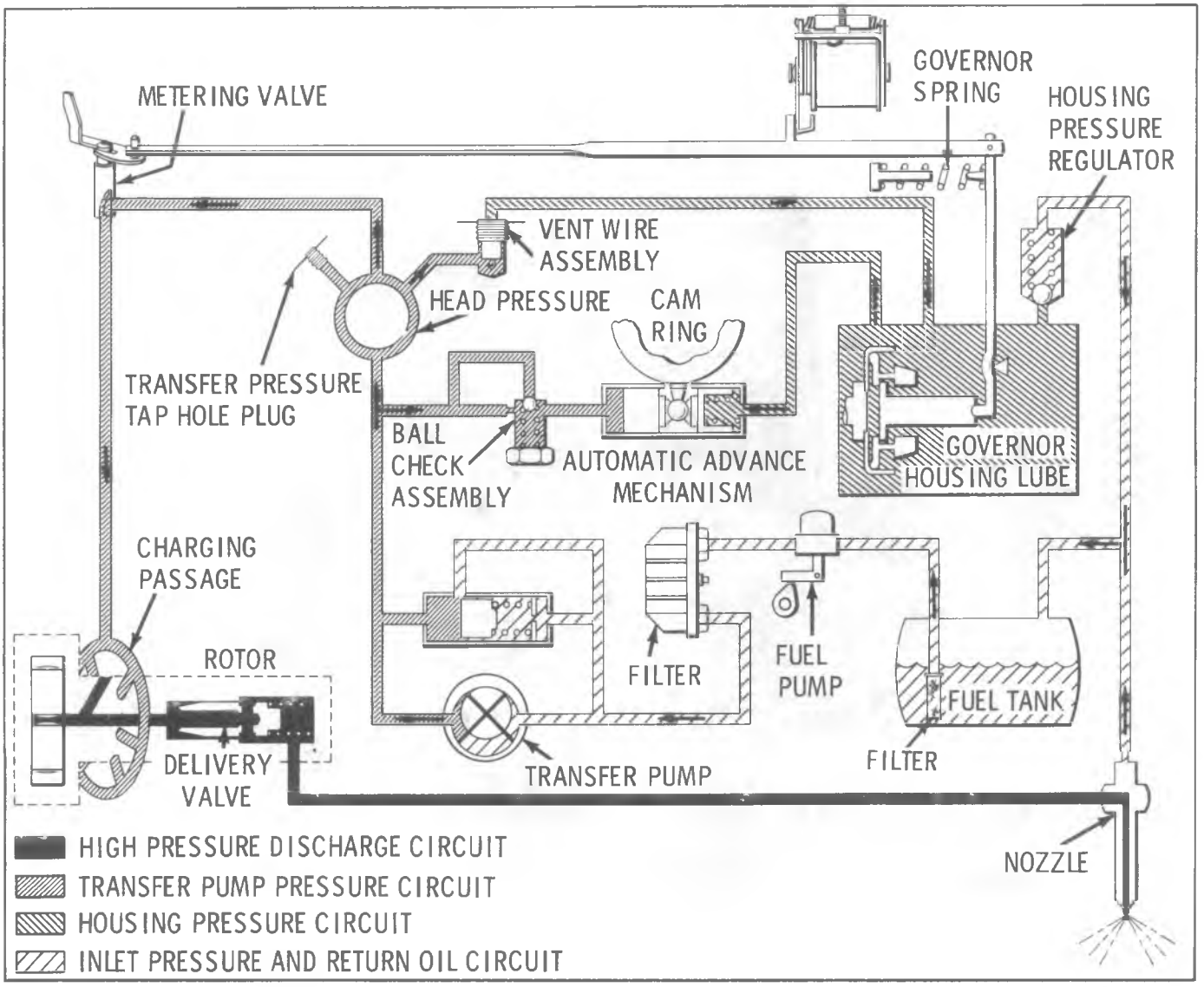


Fig. A-9—Fuel Injection System

INJECTION PUMP OPERATION

PARTS AND FUNCTIONS (Fig. A-10)

It is necessary to become familiar with the function of the main parts to understand the basic operating principles of the fuel injection pump.

MAIN PARTS

1. Drive shaft.
2. Distributor rotor.
3. Transfer pump blades.
4. Pumping plungers.
5. Internal cam ring.
6. Hydraulic head.
7. Pressure regulator assembly.
8. Governor.
9. Automatic advance.
10. Housing.
11. Fuel metering valve.

The main rotating parts are the drive shaft (1), distributor rotor (2), transfer pump blades (3) and governor (8).

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

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

The 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 distributor rotor has two charging ports and a single axial bore with one discharge port to serve all head outlets to the injection lines.

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

The pump has a 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 fuel metering valve. The fuel metering valve can be closed to shut off fuel through a solid linkage by an independently operated shut-off lever.

The automatic advance is a hydraulic mechanism which advances or retards the beginning of fuel delivery from the pump.

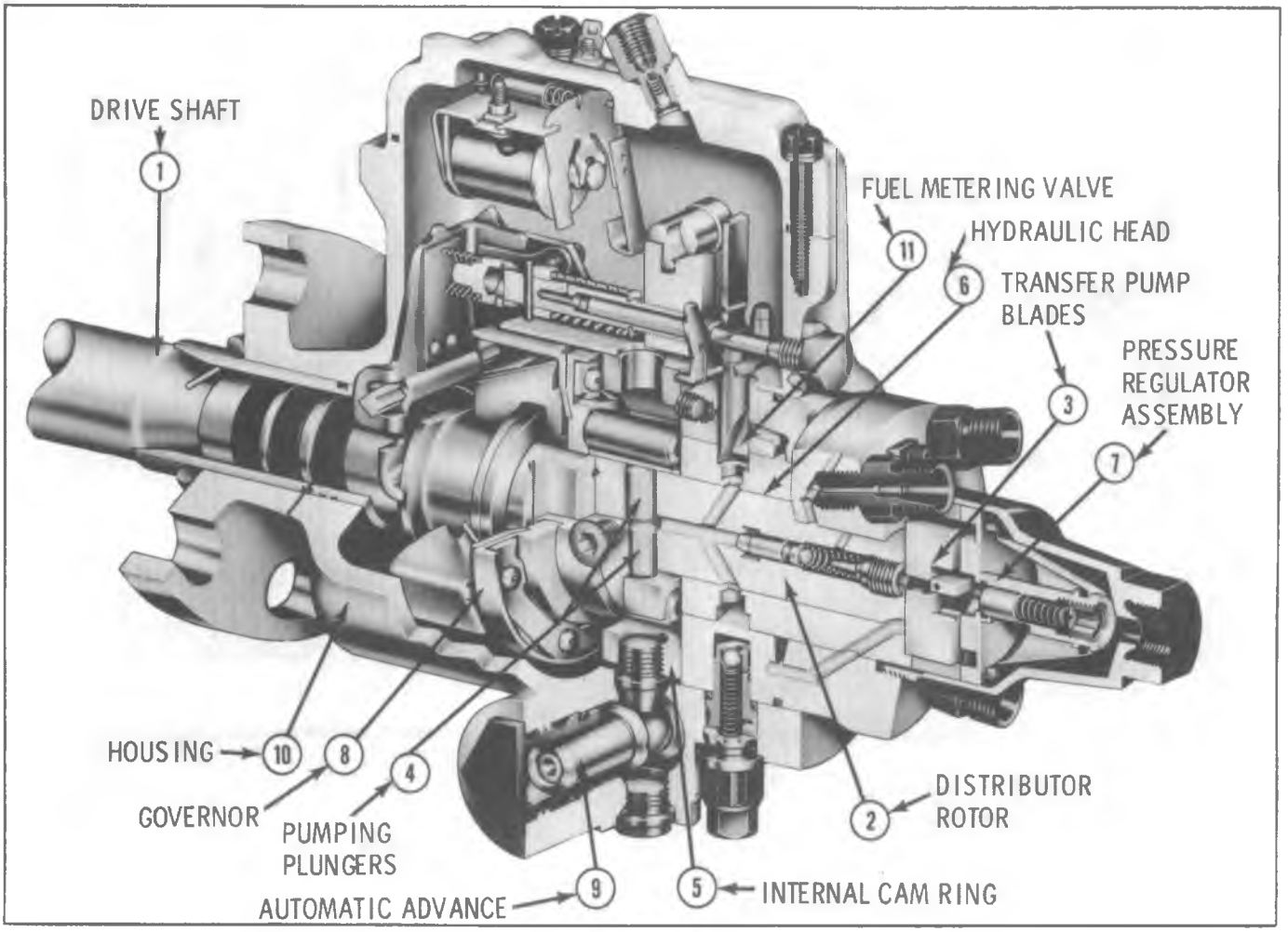


Fig. A-10–Fuel Injection Pump

FUEL FLOW (Fig. A-11)

The operating principles of the pump can be understood more easily by following the fuel circuit during a complete pump cycle. Fuel is supplied from the engine crankshaft operated fuel pump, through filters into the injection pump through the inlet filter screen (1) to the vane type fuel transfer pump (2). Some fuel is by-passed through the pressure regulator assembly (3) back to the suction side.

Fuel under transfer pump pressure flows past the rotor retainers (4) into a connecting passage (5) in the head to the advance (6) and also to the charging circuit (7). The fuel flows through a connecting passage to the fuel metering valve (8). The radial position of the fuel metering valve, controlled by the governor, regulates the flow of fuel into the charging ring which has the charging ports.

As the rotor turns, the two inlet passages (9) 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 (10) 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.

With the exception of the drive shaft bearing, self-lubrication of the pump is a feature of the pump 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 in the hydraulic head connects the outlet side of the transfer pump with the pump housing. This allows air and some fuel to bleed back to the fuel tank through the return line. The fuel thus by-passed fills the housing and lubricates the internal parts.

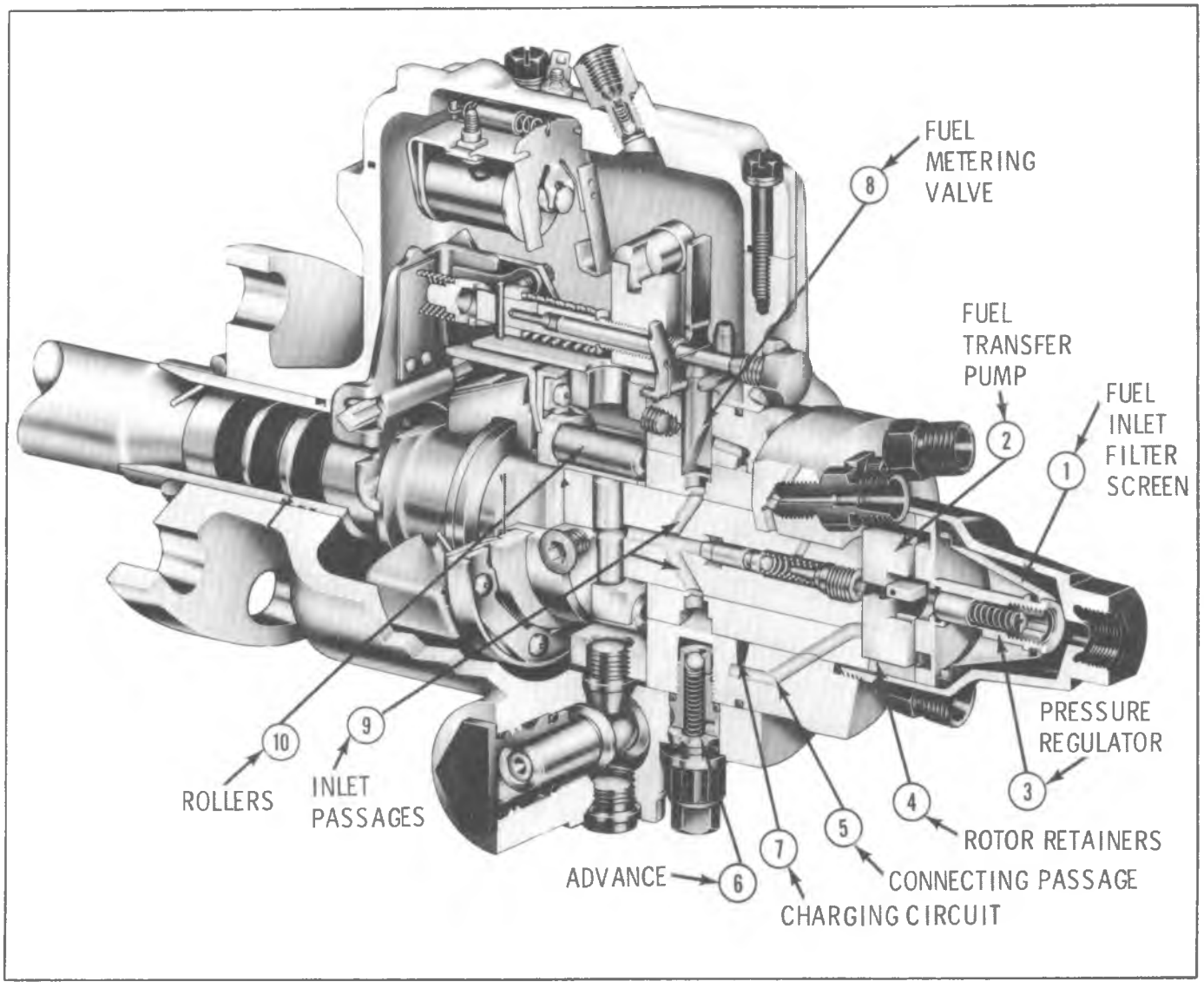


Fig. A-11—Fuel Flow

TRANSFER PUMP PARTS (Fig. A-12)

The positive displacement vane type fuel transfer pump has 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. Blade movement changes the volume of fuel between the blade segments.

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

Fig. A-13 shows the pumping principle. Blade movement causes a volume increase in the space between blade 1 and 2 (View A). At this time, the space is in registry with a 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 movement of blades 1 and 2 is small and volume is not changing (View B). 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 (View C), the liner, whose inside diameter is eccentric to the rotor, pushes blades 1 and 2 in a direction opposite to their previous movement (View A). The volume between the blades is reduced and pressurized fuel is delivered through the groove of the regulator assembly, past the rotor retainers and into an area on the rotor leading to the hydraulic head passages. Volume between the blades continues to decrease, pressurizing the fuel in the quadrant until blade 2 passes the outlet groove in the regulator assembly.

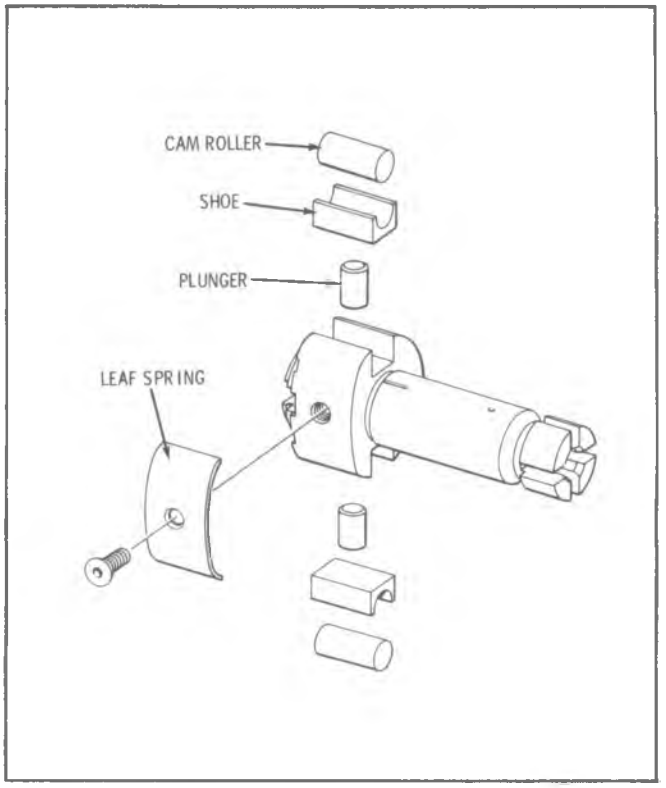


Fig. A-12–Transfer Pump Parts

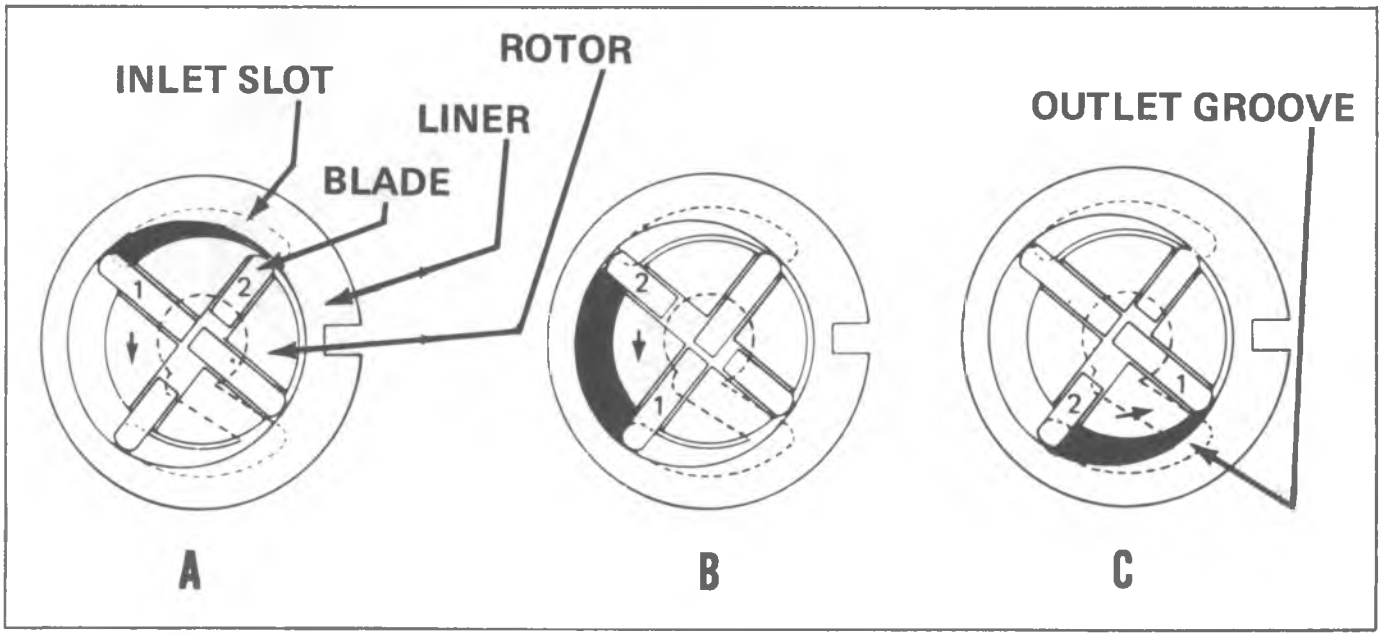


Fig. A-13–Transfer Pump Operation

REGULATOR ASSEMBLY OPERATION (Fig. A-14)

Fig. A-14 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 "A" (View A). 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" in the regulator is part of the pressure regulating slot to prevent excessively high transfer pump pressure.

FUEL VISCOSITY COMPENSATION

The transfer pump works equally well with different grades of diesel fuel and varying temperatures, both of which affect fuel viscosity. A feature of the regulating system offsets pressure changes caused by viscosity difference. Located in the spring adjusting plug is a thin plate which has 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 almost the same when viscosity changes. The pressure exerted against the back side of the piston is determined by the leakage past designed clearance of the piston in the regulator bore and the pressure drop through the sharp-edged orifice. With cold or thicker fuels, very little leakage occurs past the piston. The additional force on the back side of the piston from the thicker fuel pressure is slight. With hot or light fuels, leakage past the piston increases. Fuel pressure in the spring cavity also increases because flow through the orifice remains the same as with cold or thicker fuel. The increased fuel pressure assists the regulating spring and moves the piston, reducing regulating slot area (A). This variation in piston position compensates the leakage which would occur with thin fuels and design pressures are maintained over a broad range of viscosity changes.

CHARGING CYCLE (Fig. A-15)

As the rotor turns the two inlet passages in the rotor align with ports of the charging ring. Fuel under pressure from the transfer pump, controlled by the opening of the fuel metering valve, flows into the pumping chamber forcing the plungers apart.

The plungers move outward a distance equal 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 maximum fuel delivery is limited by a single 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 that while angled inlet passages in the rotor aligned with the ports in the charging ring, the rotor discharge port is not in alignment with a head outlet.

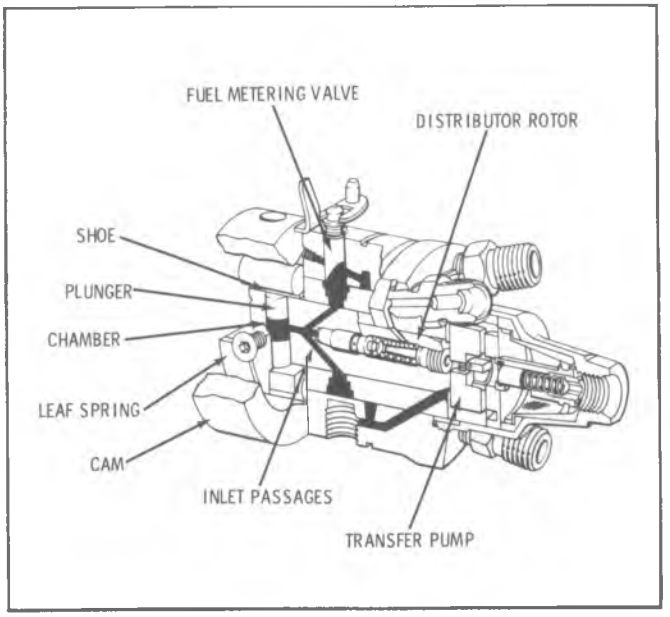


Fig. A-15—Charging Cycle

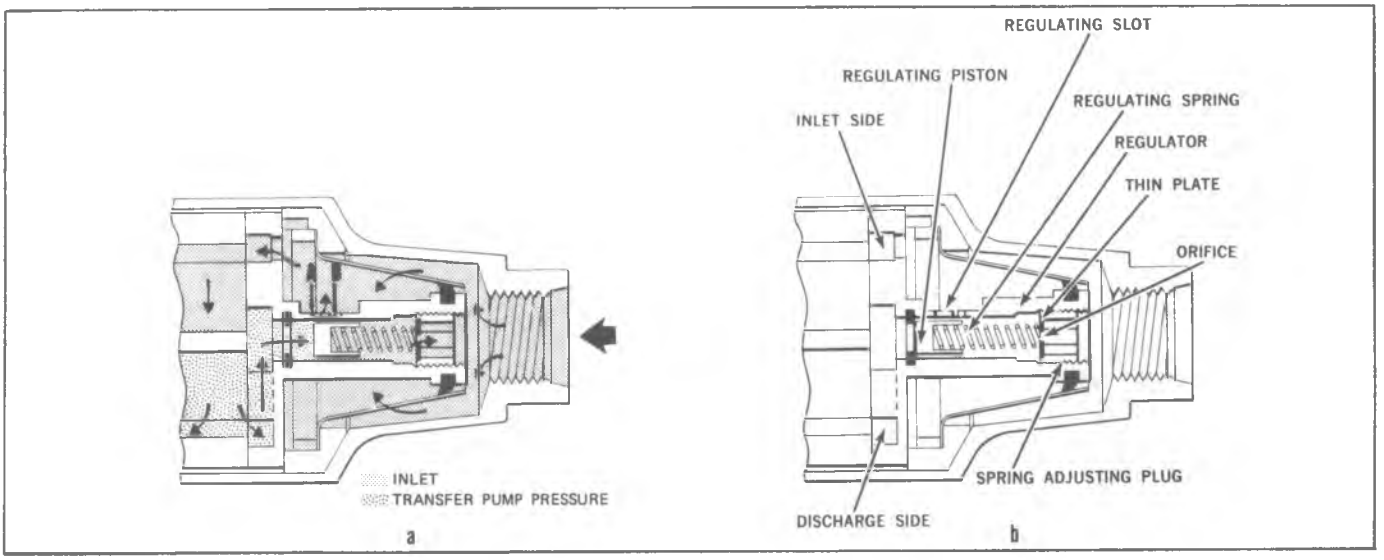


Fig. A-14—Regulator Assembly Operation

DISCHARGE CYCLE (Fig. A-16)

As the rotor continues to turn, the inlet passages move out of alignment with the charging ports. The rotor discharge port opens to one of the head outlets. The rollers then contact the cam lobes and injection begins. Further rotation of the rotor moves the rollers up the cam lobe ramps, pushing the plungers inward. During this 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 injection.

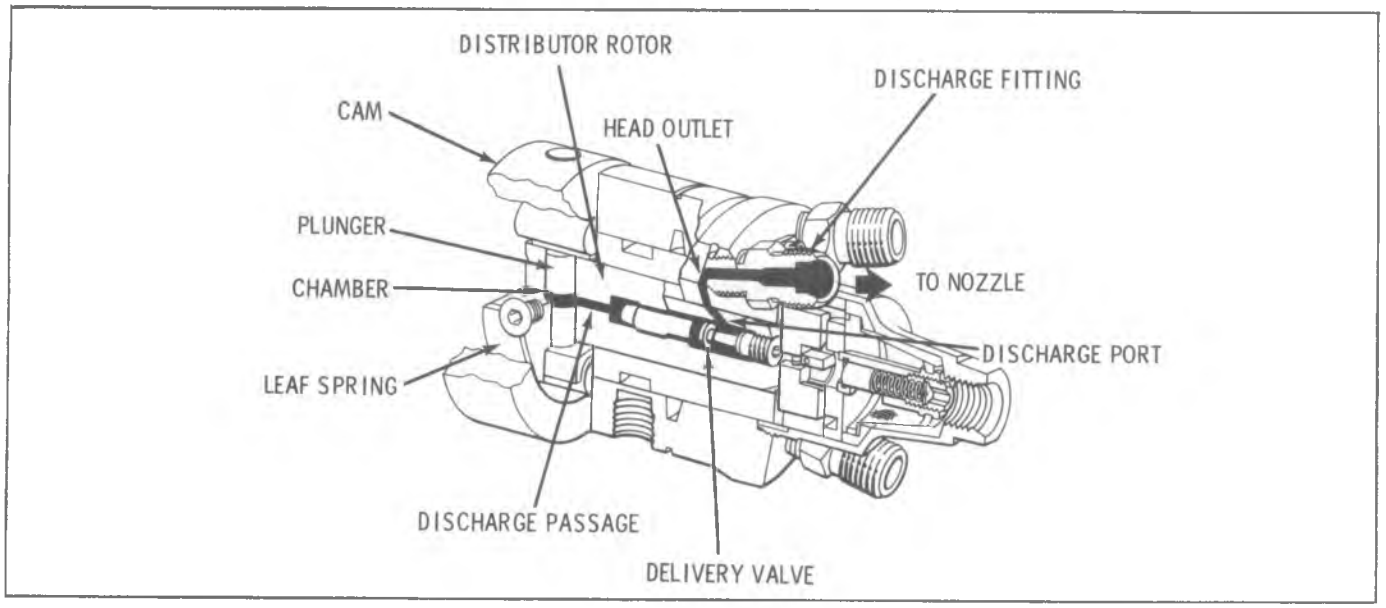


Fig. A-16–Discharge Cycle

DELIVERY VALVE FUNCTION (Fig. A-17)

The delivery valve rapidly decreases injection line pressure after injection to a predetermined value lower than that of the nozzle closing pressure. The reduction in pressure causes the nozzle valve to return rapidly to its seat, causing sharp delivery cut-off and preventing improperly atomized fuel from entering the combustion chamber.

The delivery valve operates in a bore in the center of the distributor rotor. The valve requires no seat, only a stop to limit travel. Sealing is accomplished by the close clearance between 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 which allows the plungers to move outward.

Following this, the rotor port closes completely and a residual injection line pressure is maintained. The delivery valve is only required to seal while the discharge port is open.

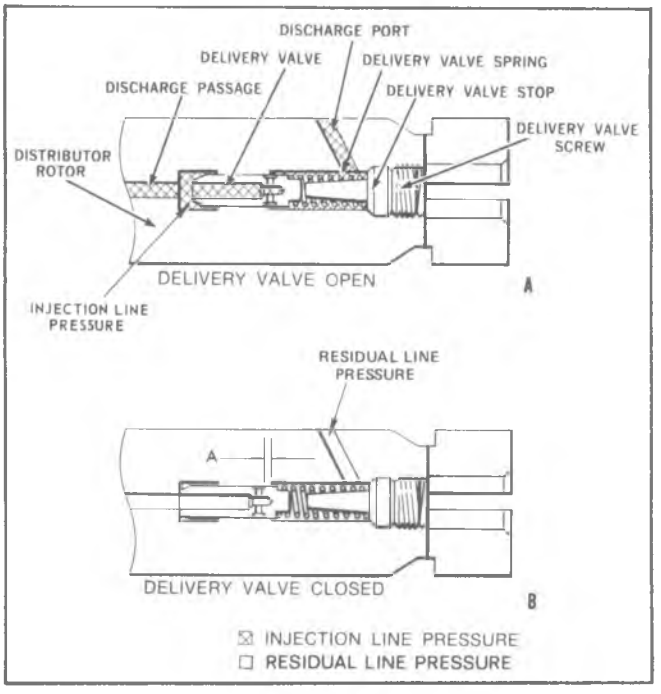


Fig. A-17–Delivery Valve Function

Once the port is closed, line pressures are maintained by the seal of the close fitting head and rotor.

FUEL RETURN CIRCUIT (Fig. A-18)

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

The vent passage is located behind the fuel metering valve bore and connects with a short vertical passage entering the governor linkage compartment.

Should 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 through the return line.

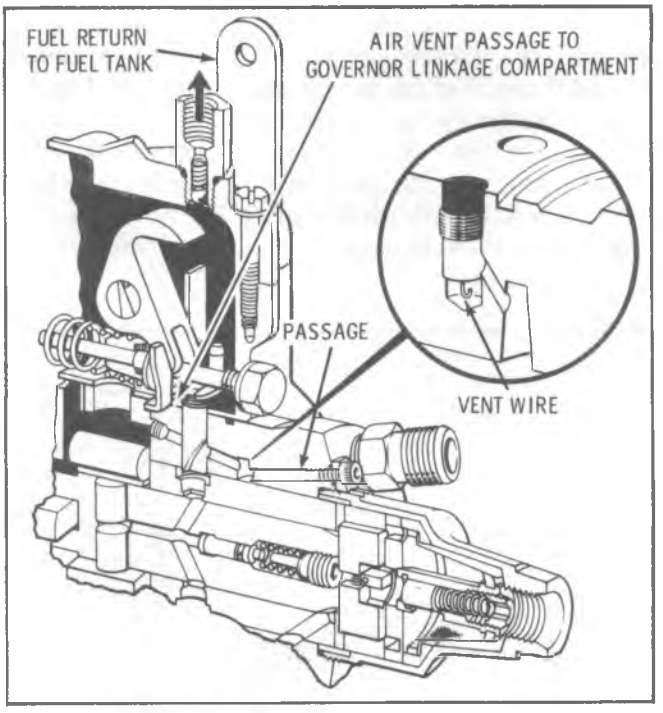


Fig. A-18–Fuel Return Circuit

MECHANICAL GOVERNOR (Fig. A-19)

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

In the mechanical governor, the movement of the weights acting against governor thrust sleeve turns the fuel metering valve by means of the governor arm and linkage hook. This rotation varies the alignment of the fuel metering valve opening to the passage from the transfer pump, thereby controlling the quantity of fuel to the plungers. The governor operates by 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 hook, turns the fuel metering valve. The force on the governor arm caused by the weights is balanced by the governor spring force, which is controlled by the manually positioned throttle lever and throttle linkage for the desired engine speed.

In the event of a speed increase due to a load reduction (such as going downhill), the resultant increase in centrifugal force of the weights rotates the fuel metering valve clockwise to reduce fuel. This limits the speed increase 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 turn the fuel metering valve in a 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 by the throttle position.

A light idle spring is provided for more sensitive regulation when weight energy is low in the low end of the speed range. The limits of throttle travel are set by adjusting screws for proper low idle and high idle positions.

A light tension spring takes up any slack in the linkage joints and also allows the shut-off mechanism to close the fuel metering valve without having to overcome the governor spring force. Only a very light force is required to turn the fuel metering valve to the closed position.

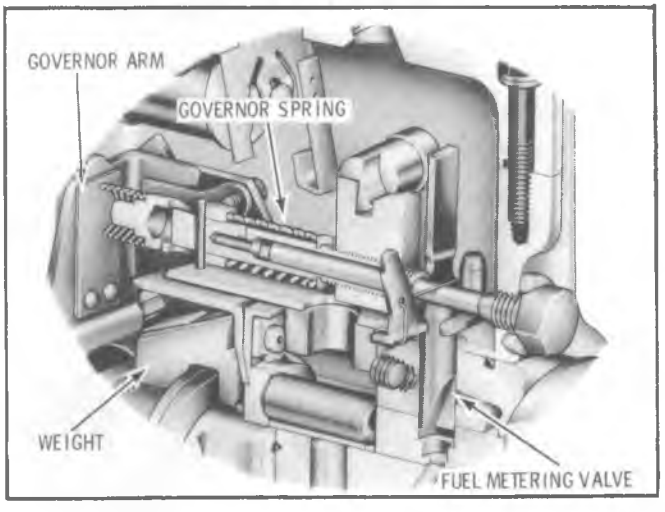


Fig. A-19–Mechanical Governor

AUTOMATIC ADVANCE (Fig. A-20)
(SPEED RESPONSIVE)

The design of the fuel injection pump permits the use of a simple, direct acting hydraulic mechanism, powered by fuel pressure from the transfer pump, to rotate the cam and vary fuel delivery timing. The advance mechanism advances or retards start of fuel delivery in response to engine speed changes.

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 the best power with the least fuel consumption and the least smoke.

The advance piston, located in a bore in the housing, engages the cam through the advance pin and moves the cam

(when fuel pressure moves the piston) opposite to the direction of rotor rotation. A reed check valve 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, hydraulic pressure is reduced and the spring returns the cam to a retarded position in proportion to the reduction of speed. The fuel in the piston chamber is allowed to bleed off through a control orifice in the piston hole plug.

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

A "trimmer screw" provides for a factory adjustment of the advance spring pre-load which controls start of cam movement.

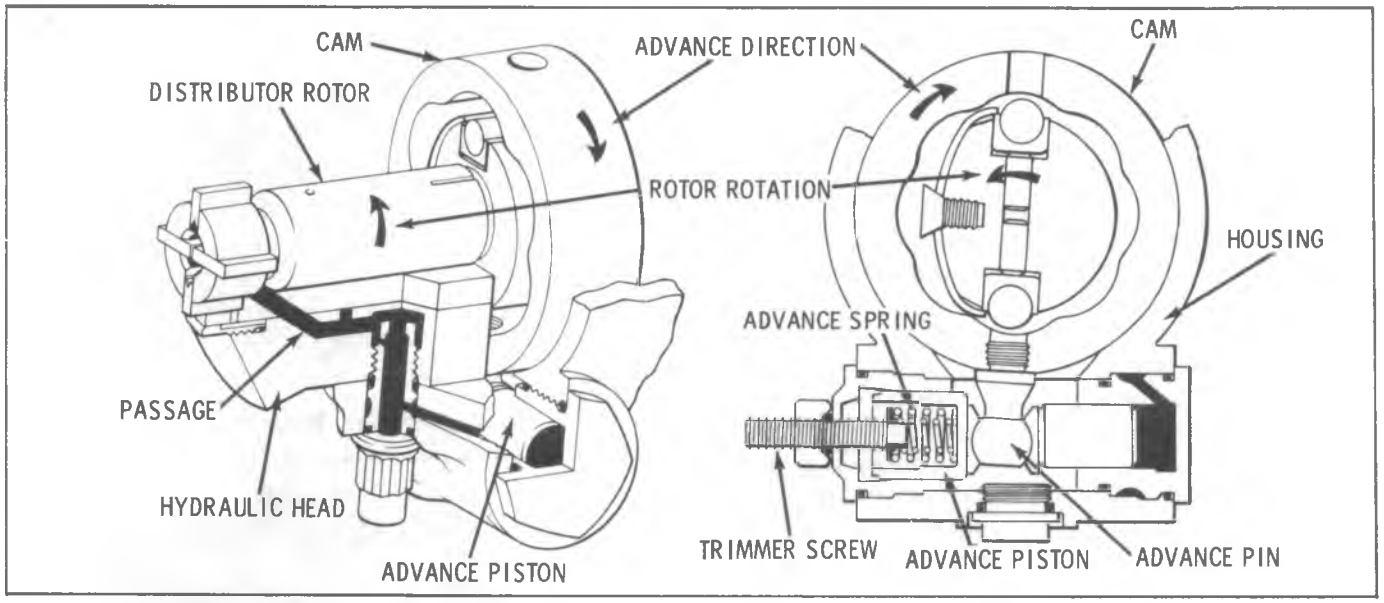


Fig. A-20—Automatic Advance

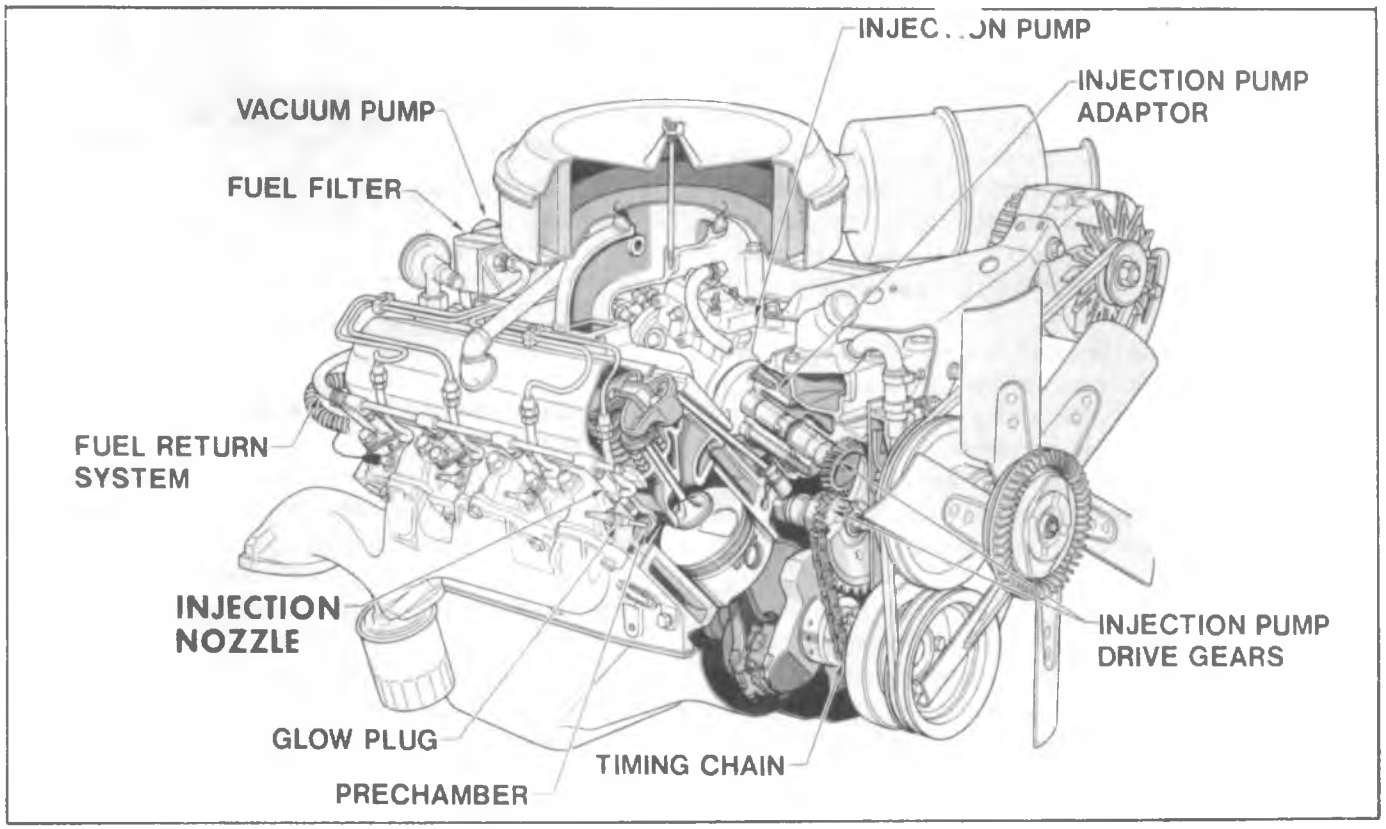


Fig. A-21—Diesel Engine

FUEL SYSTEM (Figs. A-22 through A-25)

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

The fuel filter is located between the mechanical fuel pump and the injection pump. The diaphragm type mechanical fuel pump is mounted on the right side of the engine and driven by a cam on the crankshaft. The fuel tank is at the rear of the car, connected by fuel pipes and hoses to the mechanical fuel pump. Excess fuel returns from the fuel injection pump and injection nozzles to the fuel tank through pipes and hoses. There is also a fuel filter in the fuel tank.

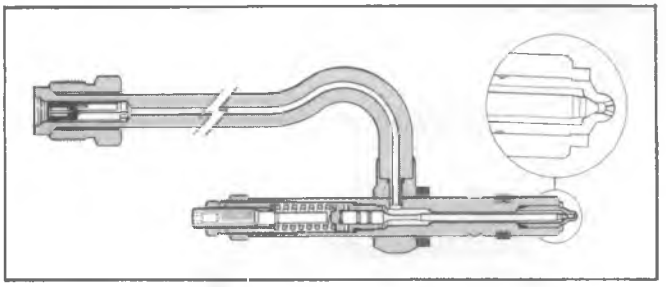


Fig. A-23–Nozzle

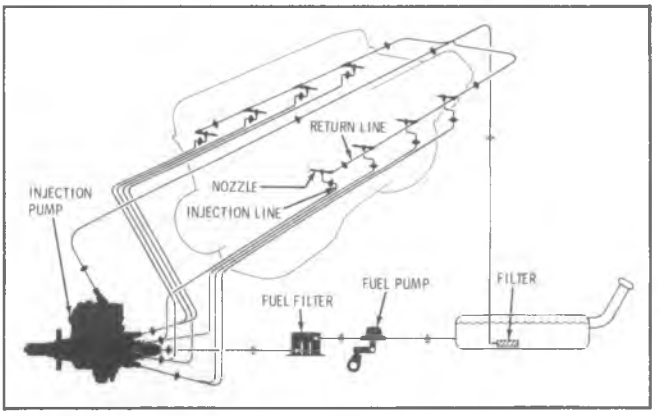


Fig. A-24–Fuel System

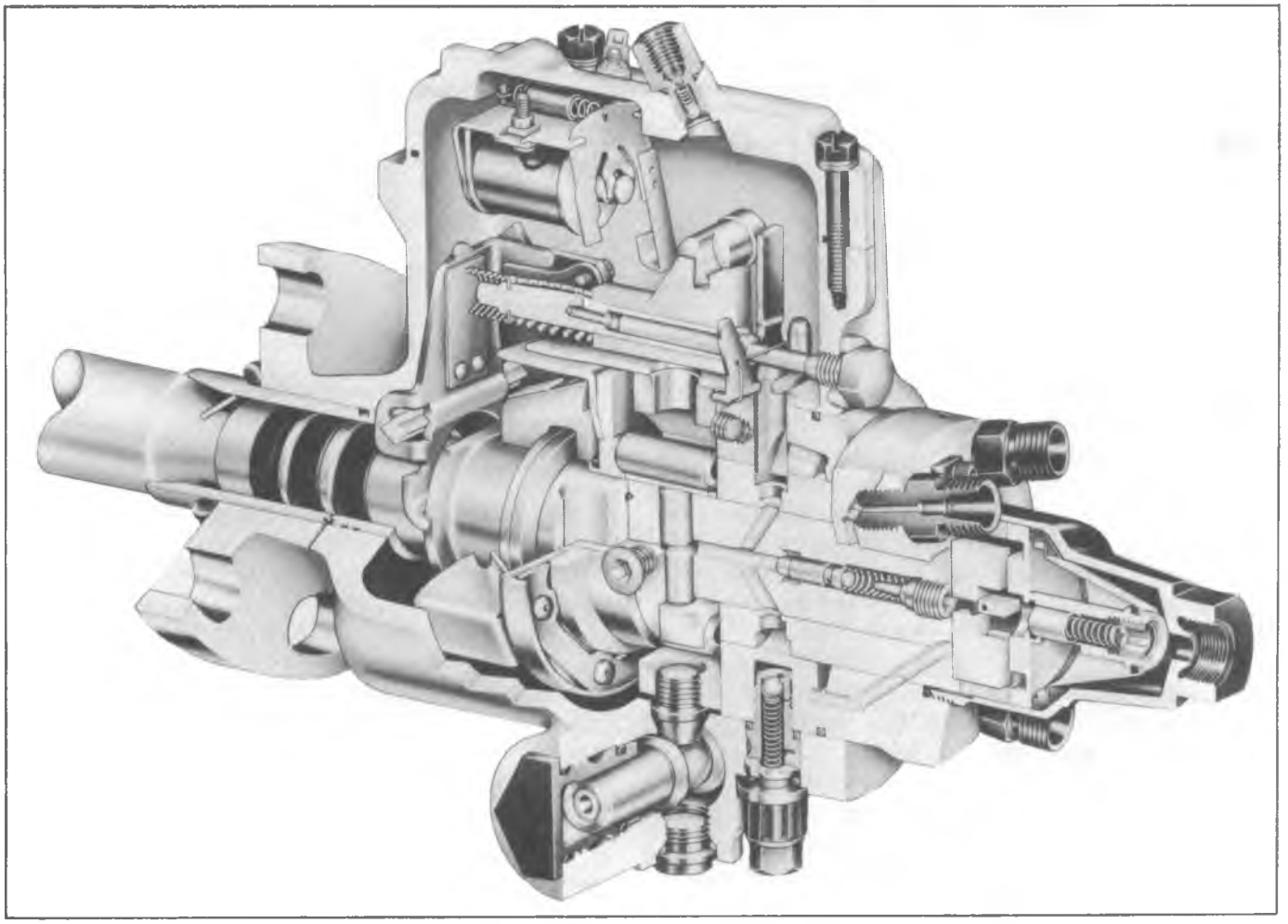


Fig. A-22–Injection Pump

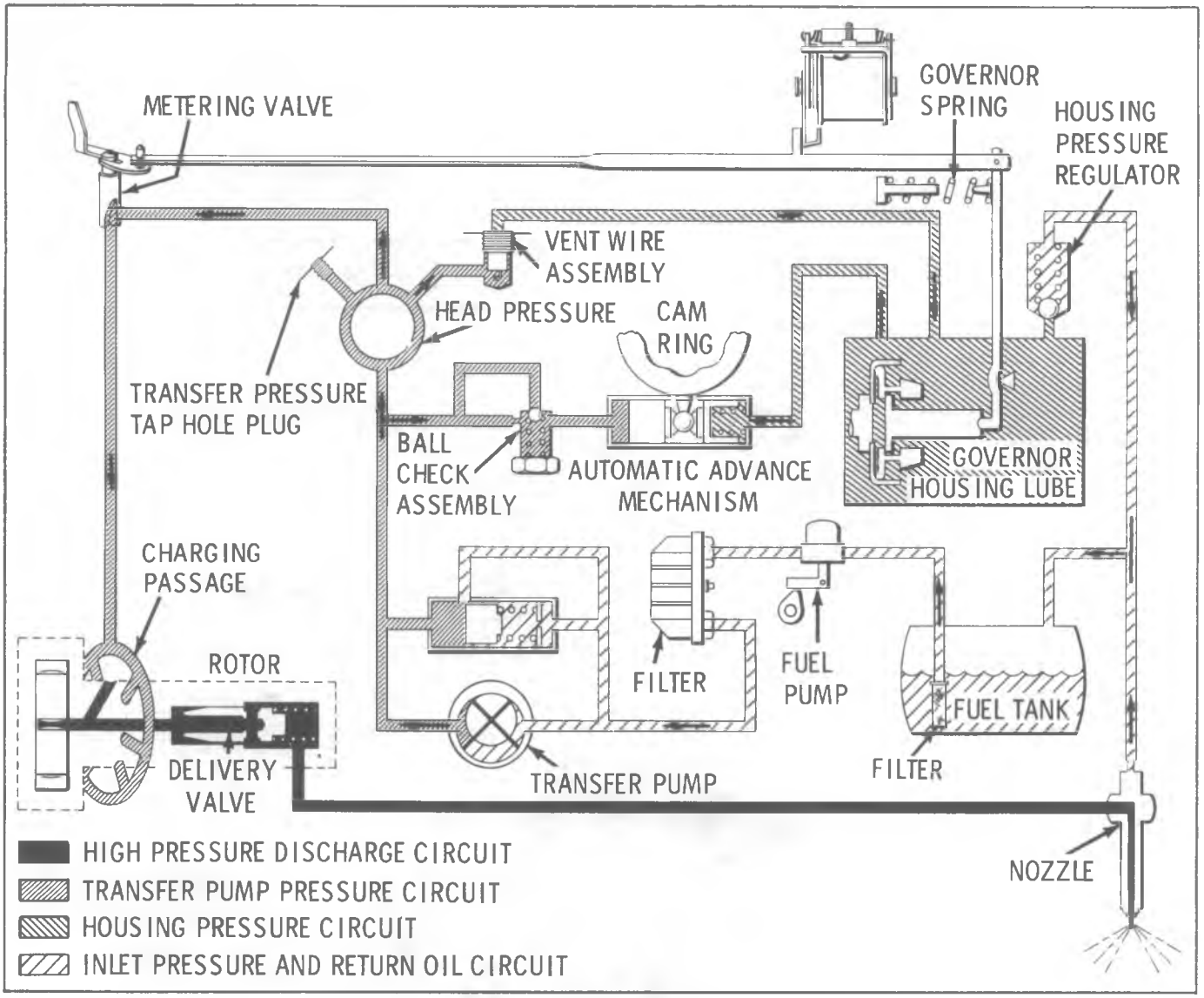


Fig. A-25–Fuel Injection System

LUBRICATION SYSTEM (Fig. A-26)

The engine oil pan forms a reservoir for engine oil to provide lubrication and also hydraulic fluid to operate the valve lifters. Oil pressure for lubrication is furnished by a gear type oil pump that is bolted to the rear main bearing cap and driven by the camshaft gear through a hexagonal drive shaft. The drive shaft is in the vacuum pump drive housing bolted on the top rear of the engine. Do not start the engine with this part removed. (The oil pump will not turn.)

Oil enters the pump through a screened inlet located near the bottom rear of the oil pan. The pressurized oil from the pump passes through the oil filter located on the right rear side of the engine block. (The oil filter base has a by-pass valve which, in the event of filter restriction, will open at 5-1/2 to 6-1/2 psi.) Engine oil is directed to the oil cooler, located in the radiator, then from the cooler to the filter base. The oil then is directed back to the engine oil galleries. A by-pass valve in the filter base allows continuous oil flow to the engine in case of cooler line or cooler restriction. This by-pass valve opens at about 12 psi. Oil then enters the right oil gallery where it is distributed to the five main bearings. The right bank valve lifters receive oil from this gallery from eight feed holes that intersect the gallery.

The five camshaft bearings are lubricated from vertical passages intersecting the main bearing oil passages. At the front main bearing a third passage connects the right main oil gallery to the left gallery which then feeds the left bank of valve lifters.

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

The engine oil pressure warning light switch is connected to the front of the left oil gallery. The switch is calibrated to turn on the instrument panel warning light when engine oil pressure is too low. The switch, normally closed, is set to open at 2-6 psi. The rear oil gallery plug has a .040" orifice to help purge contaminants from the gallery and to lubricate the vacuum pump driven gear.

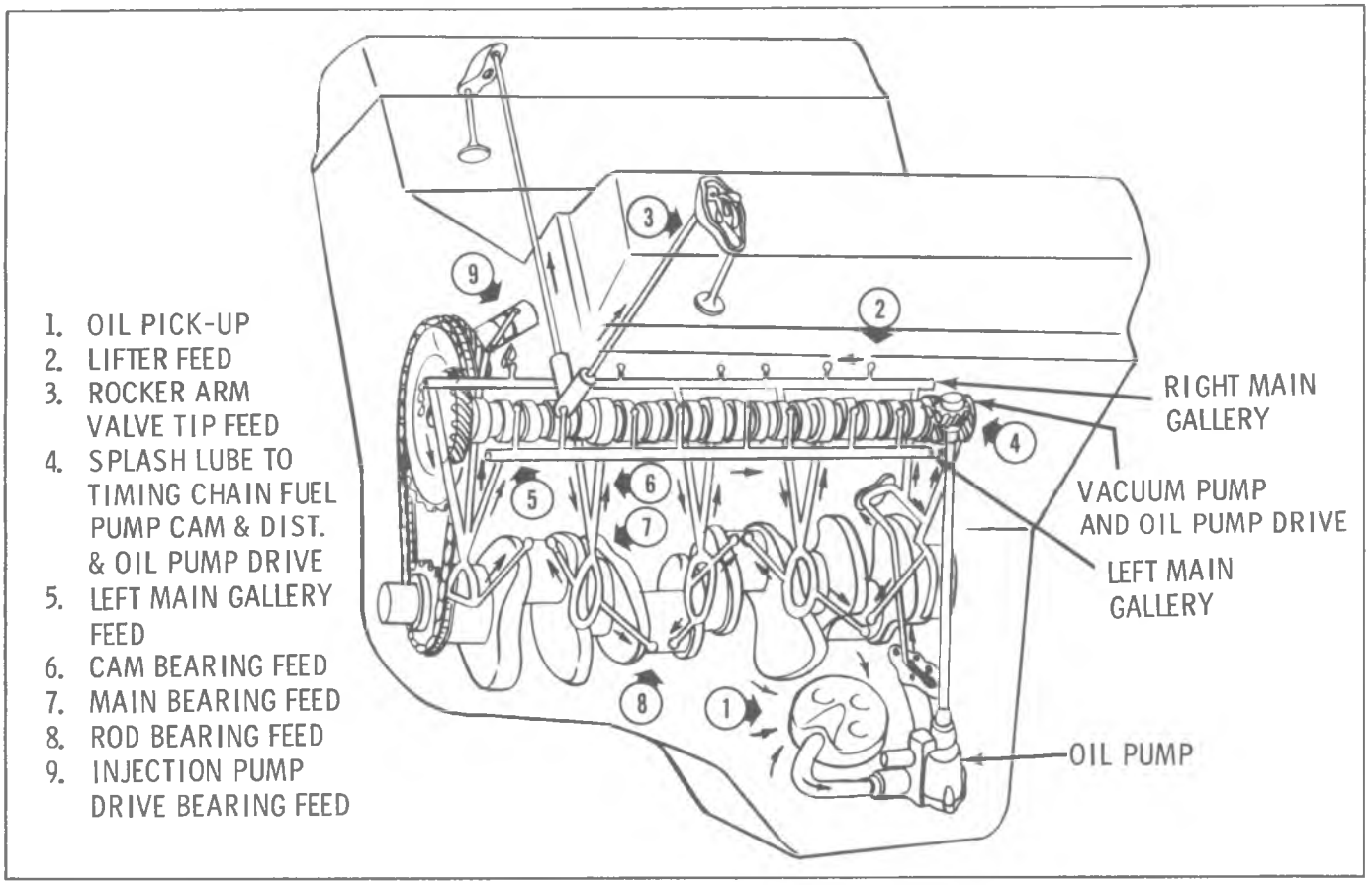


Fig. A-26—Engine Lubrication System

At the front end of the right gallery, a small orifice sprays oil to lubricate the fuel pump eccentric cam on the crankshaft and the timing chain.

The vacuum pump drive gear is lubricated by oil from the left rear oil gallery.

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

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

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

COOLING SYSTEM

Engine cooling is the same as used in the gasoline engine except the radiator tank has two oil coolers. One is connected to the transmission, the other one connects into the oil filter base.

ENGINE ELECTRICAL SYSTEM

Eight glow plugs are used to heat the pre-chamber to aid in starting. (Fig. A-27) They are 12 volt heaters that turn on

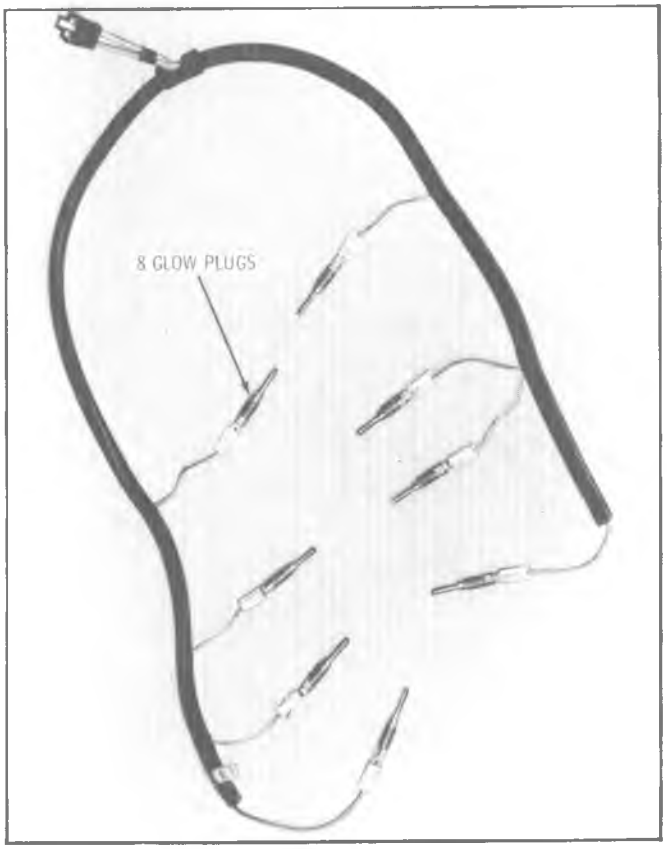


Fig. A-27—Glow Plugs

when the ignition key is turned to the "RUN" position prior to starting the engine. They remain on a short time after starting, then automatically turn off. (The glow plugs get cherry red similar to the heating unit on an electric cook stove.) Two 12-volt sealed top batteries connected in parallel are required for the higher electrical load due to the glow plugs and starter. The starter is larger and designed to crank the engine at least the 100 RPM required for starting a cold engine (240 RPM if engine hot). The two batteries, one on each side in the engine compartment, provide the required capacity and eliminates the need for a single double size special battery. A standard Delcotron generator supplies charging current to both batteries at the same time, there are no switches or relays in the charging circuit.

GLOW PLUG ELECTRONIC CONTROL (Fig. A-29)

The module shown in the lower right corner is the electronic unit inside the car near the fuse panel that controls the glow plug "ON" time. Numbers 1 through 6 on the figure explain what happens before and after starting the engine. Notes 1, 2, 3 and 4 explain other conditions that could happen.

The diode in the generator light circuit prevents generator voltage from feeding back through the two light bulbs and gages–Trans. fuse and into the ignition circuit. If it were not there, the engine would keep running when the key was turned off.

The diagnostic connector is on the left fender inner panel. Only the two terminals and ground (Terminals number 1, 4 and G) are shown connected. A voltmeter or test light connected to G and 1 is a test for battery voltage in the red wire to the ignition switch. Terminal 4 and G is a test for battery voltage in the pink wire from the ignition switch to the fuel solenoid.

The other terminals are: No. 2–Connects to red wire to ignition switch and fuse panel; No. 3–Connects to red wire to headlamp switch and fuse panel; No. 5–Connects to pink wire from ignition switch on the other side of the connector; No. 6 and 7 are not used on diesel engine cars; No. 8–connects to the purple wire to the starter solenoid (12 volts in start position only); No. 9–connects to the purple wire from the solenoid terminal on the ignition switch (12 volts in start position only). These terminals allow a quick check for voltage at important places in the starting circuit.

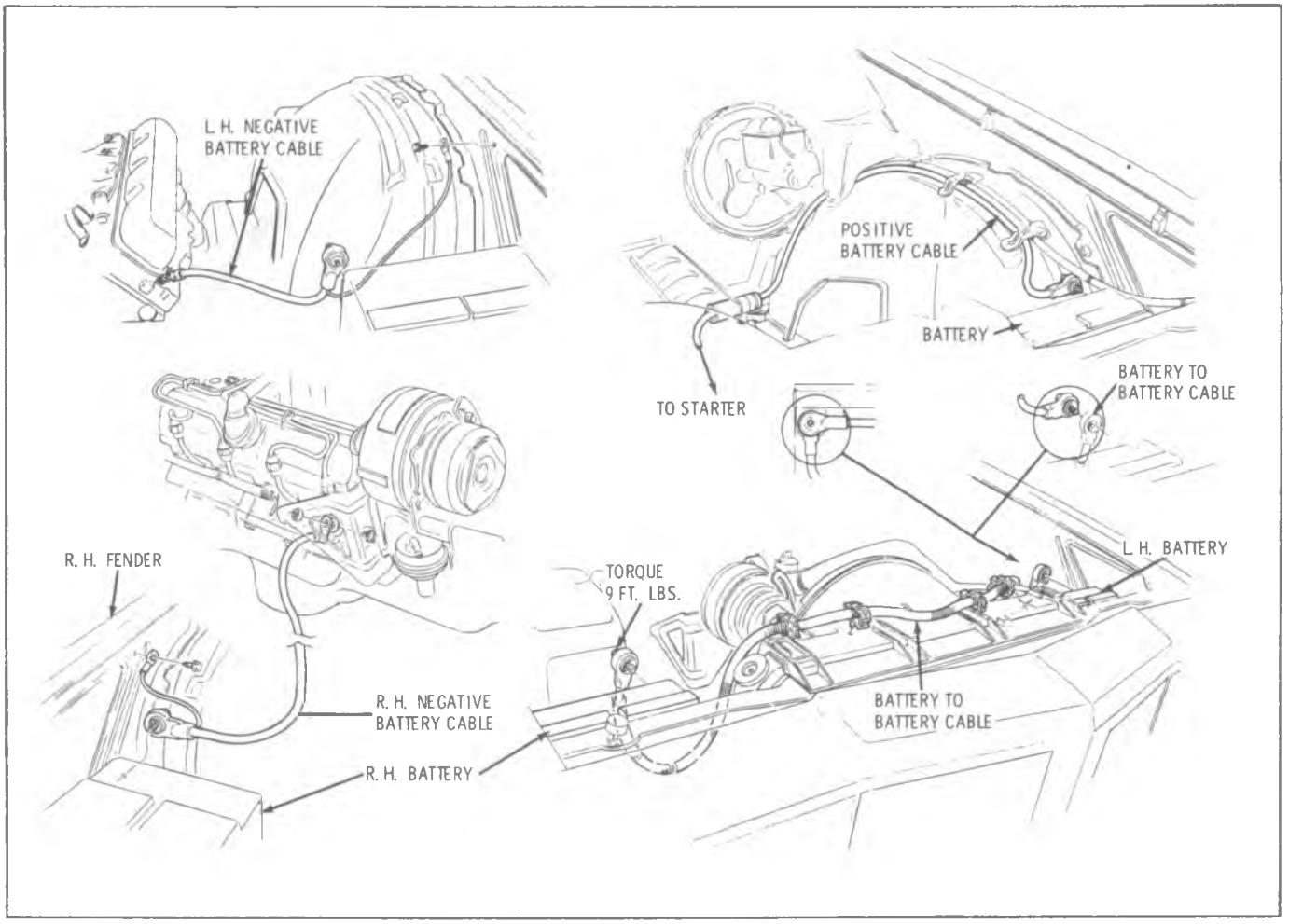


Fig. A-28–Diesel Engine Battery Cable Routing

DIESEL ENGINE GLOW PLUG ELECTRONIC CONTROL

1	2	3	4	5	6
IGN. SWITCH -"OFF"-	IGN. SWITCH -"RUN"-	IGN. SWITCH -"RUN"-	IGN. SWITCH -"START"-	IGN. SWITCH -"RUN"-	IGN. SWITCH -"RUN"-
WAIT LAMP - OFF START LAMP - OFF GLOW PLUGS - OFF	WAIT LAMP - ON START LAMP - OFF GLOW PLUGS - ON	WAIT LAMP - OFF START LAMP - ON GLOW PLUGS - ON ↓ SEE NOTE 1	WAIT LAMP - OFF START LAMP - OFF GLOW PLUGS - ON	WAIT LAMP - OFF START LAMP - OFF GLOW PLUGS - ON ↓ SEE NOTES 2 & 3	WAIT LAMP - OFF START LAMP - OFF GLOW PLUGS - OFF

NOTE 1: If the ignition is left in the "RUN" position 2-5 minutes before turning it to "START", the Glow Plugs and Lamps turn off. This prevents discharging the battery. Turn ignition "OFF" then to "RUN" and wait for Start Lamp. (Voltage to the starter solenoid is also directed to the module and is the signal that the ignition switch was turned to the Start position).

NOTE 2: Engine Running - Generator voltage to turn off the "GEN" lamp is also directed to the module. 9 volts or more indicates the engine is running. Glow plugs remain on the same length of time between No. 5 and 6 as they did between No. 2 and 3.

NOTE 3: Engine did not start. Ign. switch still in "RUN" position. "GEN" lamp on. Electronic control starts over after 2-4 second delay (step 2). Wait lamp on. Start lamp off, and Glow Plugs on.

NOTE 4: The extra light bulb is behind the I. P. and located so it cannot be seen. It's purpose is to provide more current to the generator field coil when starting and idling the engine.

NOTE 5: Diode prevents generator feedback to fuel solenoid when ignition is turned off. The diode is located behind the instrument cluster and may be serviced separately.

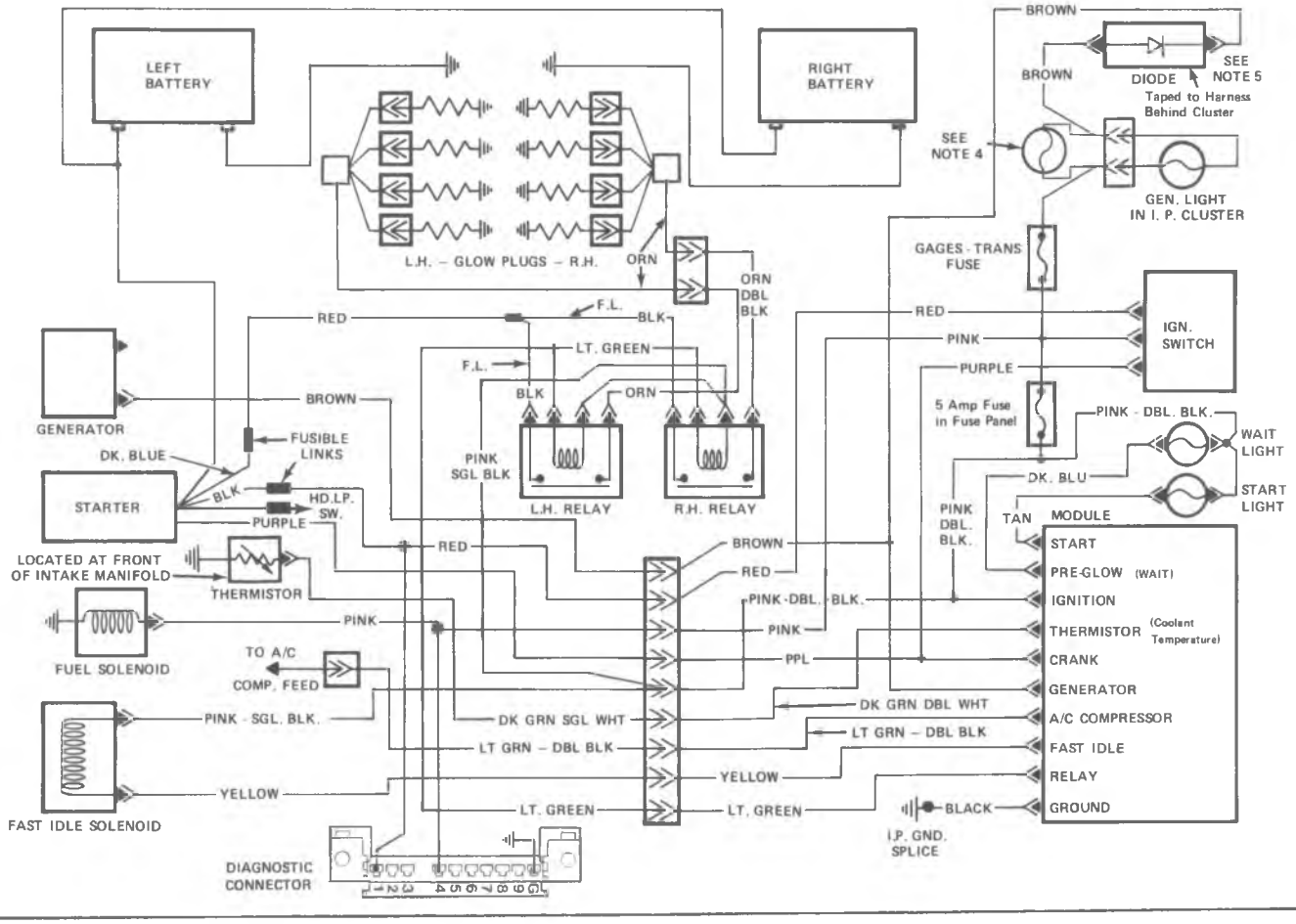


Fig. A-29–Glow Plug Electronic Control

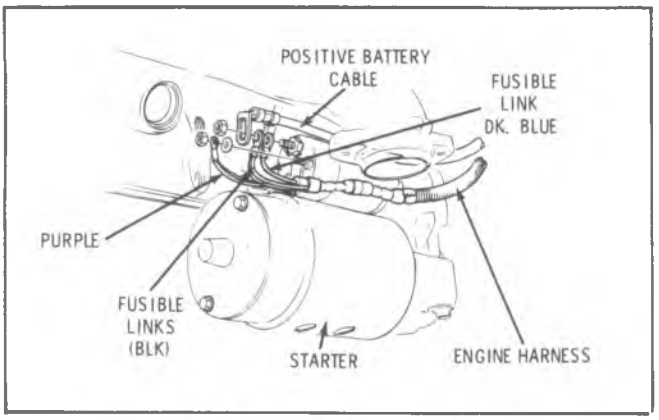


Fig. A-30–Diesel Starter Wiring

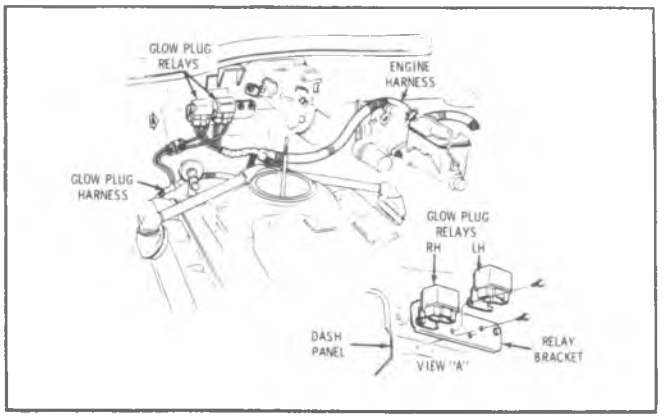


Fig. A-31–Diesel Glow Plug Relays

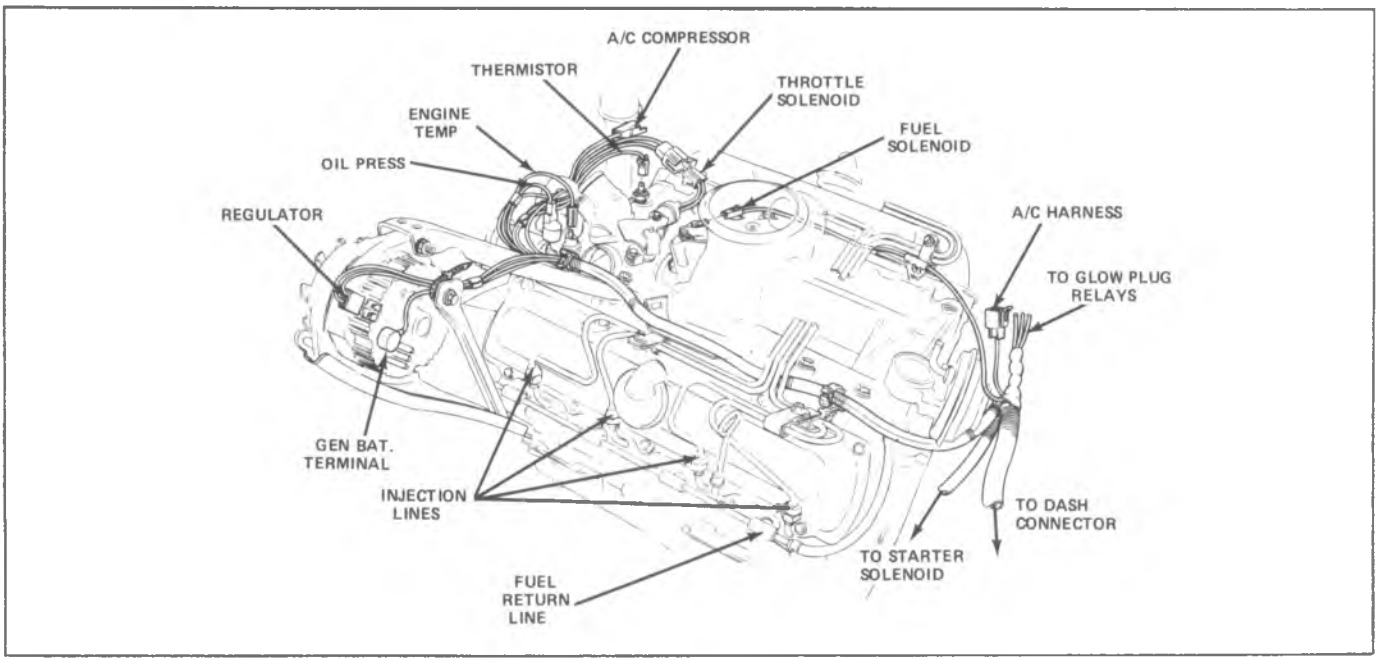


Fig. A-32–Diesel Engine Electrical Harness

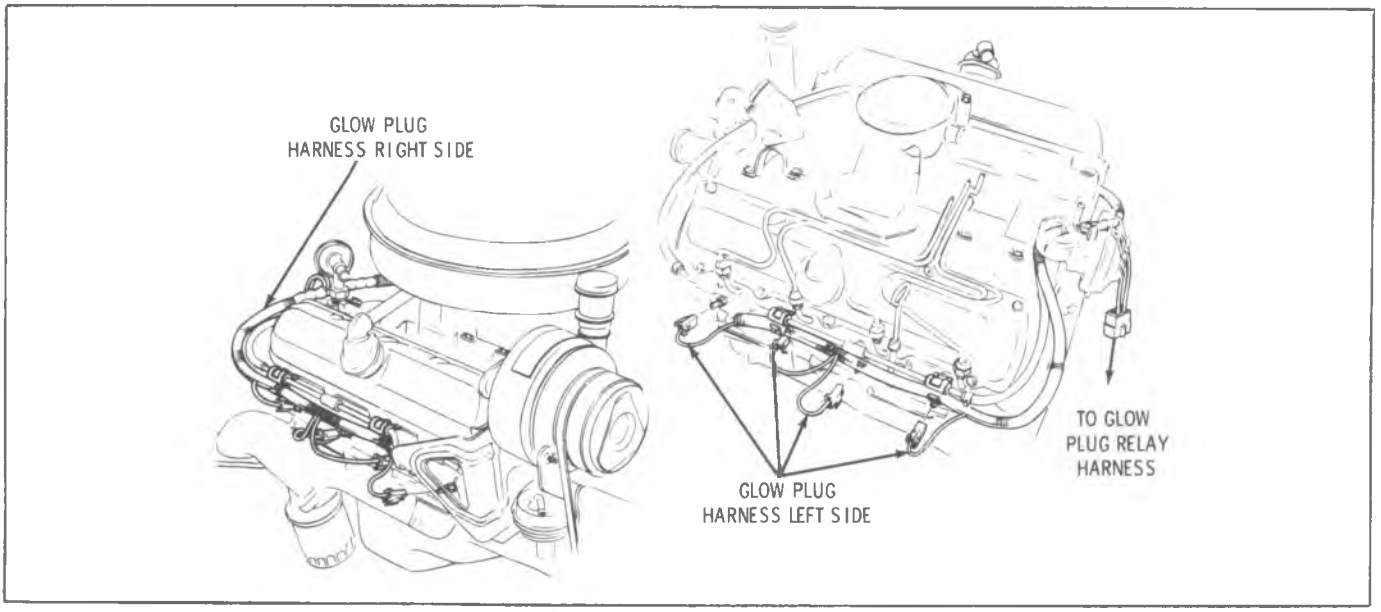


Fig. A-33–Diesel Engine Glow Plug Wiring Harness

SECTION B

DIESEL ENGINE MAINTENANCE FUELS LUBRICANTS

MAINTENANCE

The diesel engine requires very little in maintenance when compared with a gasoline engine. This is mostly due to compression ignition instead of electrical spark ignition. The chart shown in Fig. B-1 is the required Engine Maintenance and does not include other required maintenance on the car such as chassis lubrication, wheel bearing repack, tire rotation, etc. See the Maintenance Schedule furnished with the car for these other services.

ENGINE CLEANING

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

DIESEL ENGINE MAINTENANCE		
	SERVICE	INTERVAL
1.	Engine Oil – Change	3,000 Mile (4 800 km)
2.	Engine Oil Filter - Replace	3,000 Mile (4 800 km)
3.	Cooling System (See Explanation)	See Explanation
4.	Exhaust System – Check Condition	12 Month or 9,000 Mile (14 400 km)
5.	Drive Belts – Check Conditions & Adjustment	12 Month or 15,000 Mile (24 000 km)
6.	Throttle Linkage – Check Operation	12 Month or 15,000 Mile (24 000 km)
7.	Fuel Filter – Replace	24,000 Mile (38 400 km)
8.	Crankcase Ventilation System – Service	6,000 Mile (9 600 km)
9.	Engine Idle Speed - Adjust	At first 3,000 Mile (4 800 km), Then every
10.	Air Cleaner Element – Replace	30,000 Mile (48 000 km) 30,000 Mile (48 000 km)

Fig. B-1–Diesel Engine Maintenance

EXPLANATION OF DIESEL ENGINE MAINTENANCE

1. ENGINE OIL–Change every 3,000 miles (4 800 km). Use only "first line" oils which, according to the label on the can, are intended for service SE/CD.

(NOTE: Do not use engine oils labeled only SE or only CD. These oils will not give the protection and lubrication necessary for a diesel engine. Oils meant for use only in gasoline engines should never be used in a diesel engine; they may cause engine damage.)

Single viscosity grade oils (such as SAE 20W or SAE 30) are more satisfactory than multi-viscosity grade oils (such as SAE 10W-30) for sustained high speed driving.

RECOMMENDED VISCOSITY–Fig. B-2 shows recommended oil viscosity for the temperature range expected before the next oil change. This will help assure good cold and hot starting. Do not use any supplemental oil additives. Engine oil additives may cause engine damage.

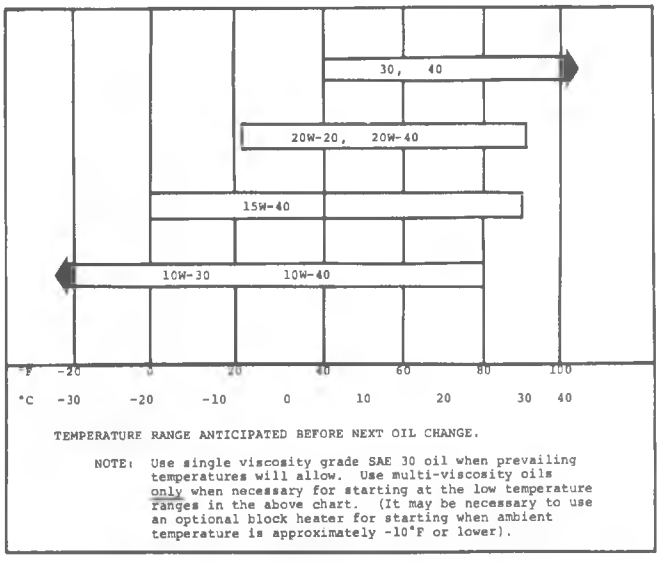


Fig. B-2–Oil Viscosity Chart (Diesel Engine)

2. ENGINE OIL FILTER–Replace at every oil change.

3. COOLING SYSTEM–At 12-month or 15,000 mile (24 000 km) intervals, wash radiator cap and filler neck with clean water, pressure test system and radiator cap for proper pressure holding capacity, tighten hose clamps and inspect condition of all cooling and heater hoses. Replace hoses if checked, swollen or otherwise deteriorated.

Also each 12 months or 15,000 miles (24 000 km), clean exterior of radiator core and air conditioning condenser. Every 24 months or 30,000 miles (48 000 km) drain, flush and refill the cooling system with a new coolant solution.

Coolant level should be checked visually at the see-through coolant reservoir at each engine oil change, while the engine is at normal operating temperature. When level drops to "ADD" mark at normal operating temperature, add one half ethylene glycol and one half water to reservoir (not at radiator cap) to bring to mark. (Level is OK if above "ADD".) Under some conditions, the level may be observed below the "ADD" mark on the reservoir when the system cools and is below normal operating temperature.

4. EXHAUST SYSTEM–Check complete exhaust system and nearby body areas and trunk lid or tailgate for broken, damaged, missing or mispositioned parts, open seams, holes, loose connections or other deterioration which could permit exhaust fumes to seep into the trunk or passenger compartment or cause a heat build-up in the floor pan. Dust or water in the trunk may be an indication of a problem in one of these areas. Any necessary corrections should be made immediately. To help continue integrity, exhaust system pipes rearward of the muffler must be replaced whenever a new muffler is installed.

5. ENGINE DRIVE BELTS–Check belts driving fan, generator, power steering pump and air conditioning compressor for cracks, fraying, wear and tension. Adjust or replace as necessary. Belt tension is shown in Fig. B-3. A belt tension gage should be used to make sure adjustment is correct.

6. THROTTLE LINKAGE–Check for damaged or missing parts, interference or binding. Any deficiencies should be corrected without delay.

7. FUEL FILTER–Replace fuel filter (located at the top rear of engine) at designated intervals or more frequently if clogged.

8. CRANKCASE VENTILATION SYSTEM–Check breather cap and valve assembly and ventilation filter assemblies (both valve covers) each 6,000 miles (9 600 km).

Replace breather cap and valve assembly and flow control valve each 30,000 miles (48 000 km).

Inspect rubber fittings and replace as required, and clean tubes each 30,000 miles (48 000 km).

9. ENGINE IDLE SPEED–Adjust engine idle speed accurately (following specifications shown on label under the hood). Adjustments must be made with test equipment known to be accurate.

10. AIR CLEANER ELEMENT–Replace the engine air cleaner element at designated intervals. Operation in dusty areas will require more frequent replacements.

BELT TENSION		
	3/8" WIDE	15/32" WIDE
NEW USED	150 lbs. MAX 70 lbs. MIN.	165 lbs. MAX 90 lbs. MIN.

Fig. B-3–Belt Tension Chart

FUEL

Some states have restrictions on the purchase of diesel fuel, such as permits or special taxes. Some of these restrictions apply only to residents; others to both residents and non-residents. To find the restrictions in any state, contact an auto club, the state police or other proper state authorities.

This diesel engine is designed to run only on diesel fuel. Usually, Number 2-D is the only diesel fuel available. In some areas, however, Number 1-D diesel fuel is also available. Use Number 2-D if expected temperatures will be above 20° F (–7° C). Use Number 1-D, if available, if expected temperatures wil be below 20° F (–7° C). During the winter months, "winterized" blends of Number 1-D and Number 2-D are available in some areas. This blended fuel is usually called Number 2-D also, but can be used in colder temperatures than Number 2-D fuel that has not been winterized.

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

Do NOT use Number 2-D fuel at temperatures below 20° F (–7° C) unless it is "winterized". The cold temperatures will cause unblended Number 2-D fuel to thicken which may keep the engine from running. Number 1-D fuel may be used year-round, but Number 2-D fuel will give better fuel economy.

FILTERS	TYPE (OR EQUIVALENT)
Engine Oil	PF30
Ventilation Filters (2)	557240
Diesel Fuel	560355
Air Cleaner	A-644C
VALVES	**TYPE (OR EQUIVALENT)**
Flow Control	CV 796
Breather Cap & Valve	FB 72

SECTION C

DIESEL ENGINE STARTING PROCEDURE

STARTING THE DIESEL ENGINE

The diesel engine has a special system to aid in starting. Two lights ("WAIT" and "START") on the instrument panel signal when the engine is ready to start.

Turning the ignition switch to "RUN" starts the system and turns on an amber "WAIT" light. The light may stay on a short time or may go out immediately; waiting time will vary, depending on engine and coolant temperatures.

When the engine is ready to start, the "WAIT" light will go out and a green "START" light will come on.

(NOTE: If the temperature is high enough, the "WAIT" light may not come on and the "START" light will come on immediately. This is normal. The engine is ready to start, with no waiting time needed.)

If the ignition switch is left in "RUN" and not turned to "START", the system will turn off after about 5 minutes. This will prevent discharging the battery. To turn the system on again, turn ignition switch to "OFF", then back to "RUN".

1. Place the transmission shift lever in "PARK" or "N" ("PARK" preferred).

2. Turn ignition switch to "RUN". DO NOT TURN TO "START". With the ignition switch in "RUN", an amber "WAIT" light will come on. This allows time for the glow plugs to heat up the prechamber. When the engine is ready to start, the "WAIT" light will go out and a green "START" light will come on.

(NOTE: Do not try to start the engine with the "WAIT" light on. In most cases, the engine will not start and cold air and fuel entering the prechambers will further delay starting.)

3. With "START" light on, push accelerator pedal HALFWAY to the floor and hold; crank engine by turning ignition switch to "START". Release both ignition switch and accelerator when engine starts. Pumping the accelerator before or during cranking will not aid in starting. (Gasoline engines have an accelerator pump, diesel engines do not need one.)

If the engine does not start after 10 to 15 seconds of cranking, release ignition switch. If the "WAIT" light comes on, leave ignition switch in "RUN" until the "START" Light comes on. Then repeat Step 3. If the "START" Light comes on, repeat Step 3.

IF ENGINE FAILS TO START:

1. Do NOT use starting "aids", such as ether or gasoline, in the air intake. Such aids can delay starting even longer and/or cause damage to engine parts.

2. Turn ignition switch to "RUN". Check to be sure the "WAIT" light is out and the "START" light is on before turning ignition switch to "START". If you crank the engine with the "WAIT" light on, it is not likely to start.

3. If the "START" light is on and the batteries are fully charged, but the engine will not start, use the diagnosis information in Section D to determine the cause.

SECTION D

DIESEL ENGINE DIAGNOSIS

COMPRESSION TEST

To determine if the valves or rings are the cause of low compression, a test should be made to determine the cylinder compression pressure.

When checking compression, the batteries should be at or near full charge. The lowest reading cylinder should not be less than 70% of the highest and no cylinder reading should be less than 275 pounds.

1. Remove air cleaner then install manifold cover J-26996-1.
2. Disconnect the wire from the fuel solenoid terminal of the injection pump.
3. Disconnect wires from glow plugs then remove all glow plugs.
4. Screw the compression gage J-26999 into the glow plug hole of the cylinder that is being checked.
5. Crank engine.

(NOTE: This should be done with six "puffs" per cylinder.)

NORMAL – Compression builds up quickly and evenly to specified compression on each cylinder.

PISTON RINGS LEAKING – Compression low on first stroke tends to build up on following strokes but does not reach normal.

DIESEL ENGINE DIAGNOSIS

Diesel Engine Mechanical Diagnosis such as noisy lifters, rod bearings, main bearings, valves, rings and pistons is the same as for a gasoline engine. This diagnosis covers only those conditions that are different for the diesel engine.

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Will Not Crank	1. Loose or Corroded Battery Cables	Check connections at batteries, engine block and starter solenoid.
	2. Discharged Batteries	Check generator output and generator belt adjustment.
	3. Starter Inoperative	Check voltage to starter and starter solenoid. If OK, remove starter for repair. (Use diagnostic connector terminals shown on circuit drawing in ELECTRICAL DIAGNOSIS.)
Engine Cranks Slowly – Will Not Start (Minimum Engine Cranking Speed – 100 RPM COLD, 240 RPM HOT)	1. Battery Cable Connections Loose or Corroded	Check connections at batteries, engine block and starter.
	2. Batteries Undercharged	Check charging system.
	3. Wrong Engine Oil	Drain and refill with oil of recommended viscosity.
Engine Cranks Normally – Will Not Start	1. Incorrect Starting Procedure	Use recommended starting procedure.
	2. No Voltage To Fuel Solenoid	Connect a 12 volt test lamp from wire at injection pump solenoid to ground. Turn ignition to "ON". Lamp should light.

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Cranks Normally – Will Not Start (Cont'd)		If lamp lights, remove test light. Connect and disconnect solenoid connector and listen for solenoid operation. If OK, go to Step 3. If solenoid does not operate, remove injection pump for repair. If lamp does not light refer to ELECTRICAL DIAGNOSIS for more information.
	3. Glow Plugs Inoperative	Refer to ELECTRICAL DIAGNOSIS.
	4. Glow Plug Control System Inoperative	Refer to ELECTRICAL DIAGNOSIS.
	5. Plugged Fuel Return System	Disconnect fuel return line at injection pump and route hose to a metal container. Connect a hose to the injection pump connection, route it to the metal container. Crank the engine, if it starts and runs, correct restriction in fuel return lines.
	6. No Fuel To Nozzles	Loosen injection line at a nozzle. Do not disconnect. Use care to direct fuel away from sources of ignition. Wipe connection to be sure it is dry. Crank 5 seconds. Fuel should flow from injection line. Tighten connection. (If fuel flows, go to Step 10.)
	7. No Fuel To Injection Pump	Remove line at inlet to injection pump fuel filter. Connect hose from line to metal container. Crank engine. If no fuel is discharged, test the engine fuel pump. (If fuel does not flow from pump outlet, go to Step 8.) If the fuel pump is OK, check the injection pump fuel filter and, if plugged, replace it. If fuel filter and line to injection pump are OK, remove injection pump for repair.
	8. Restricted Fuel Tank Filter	Remove fuel tank and check filter. (Filter for diesel fuel is blue.)
	9. Incorrect or Contaminated Fuel	Flush fuel system and install correct fuel.
	10. Pump Timing Incorrect	Make certain that pump timing mark is aligned with mark on adapter.
	11. Low Compression	Check compression to determine cause.
Engine Starts But Will Not Continue To Run At Idle	1. Slow Idle Incorrectly Adjusted	Adjust idle screw to specification.
	2. Fast Idle Solenoid Inoperative	With engine cold, start engine; solenoid should move to hold injection pump lever in "fast idle position". If solenoid does not move, refer to ELECTRICAL DIAGNOSIS.

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Starts But Will Not Continue To Run At Idle (Cont'd)	3. Restricted Fuel Return System	Disconnect fuel return line at injection pump and route hose to a metal container. Connect a hose to the injection pump connection; route it to the metal container. Crank the engine and allow it to idle. If engine idles normally, correct restriction in fuel return lines.
	4. Glow Plugs Turn Off Too Soon	Refer to ELECTRICAL DIAGNOSIS.
	5. Pump Timing Incorrect	Make certain that timing mark on injection pump is aligned with mark on adapter.
	6. Limited Fuel To Injection Pump	Test the engine fuel pump; check fuel lines. Replace or repair as necessary.
	7. Air In Injection Lines To Nozzles	Loosen injection line at nozzle(s) and bleed air. Use care to direct fuel away from sources of ignition.
	8. Incorrect or Contaminated Fuel	Flush fuel system and install correct fuel.
	9. Low Compression	Check compression to determine cause.
	10. Injection Pump Malfunction	Remove injection pump for repair.
Engine Starts, Idles Rough, WITHOUT Abnormal Noise or Smoke	1. Slow Idle Incorrectly Adjusted	Adjust slow idle screw to specification.
	2. Injection Line Leaks	Wipe off injection lines and connections. Run engine and check for leaks. Correct leaks.
	3. Restricted Fuel Return System	Disconnect fuel return line at injection pump and route hose to a metal container. Connect a hose to the injection pump connection; route it to the metal container. Start the engine and allow it to idle; if engine idles normally, correct restriction in fuel return lines.
	4. Air In Injection Lines To Nozzles	Loosen injection line at nozzle(s) and bleed air. Use care to direct fuel away from sources of ignition.
	5. Internal Fuel Leak at Nozzle(s)	Disconnect fuel return system from nozzles on one bank at a time. With the engine running, watch the normal fuel leakage at the nozzles. Replace any nozzle with excessive fuel leakage.
	6. Nozzle(s) Malfunction	With engine running, loosen injection line fitting at each nozzle in turn. Use care to direct fuel away from sources of ignition. Each

CONDITION	POSSIBLE CAUSE	CORRECTION
Engine Starts, Idles Rough, WITHOUT Abnormal Noise or Smoke (Cont'd)		good nozzle should change engine idle quality when fuel is allowed to leak. If nozzle is found that does not change idle quality, it should be replaced.
	7. Incorrect or Contaminated Fuel	Flush fuel system and install correct fuel.
	8. Uneven Fuel Distribution to Cylinders	Install new or reconditioned nozzles, one at a time, until condition is corrected as indicated by normal idle.
Engine Starts and Idles Rough WITH Excessive Noise and/or Smoke	1. Injection Pump Timing Incorrect	Be sure timing mark on injection pump is aligned with mark on adapter.
	2. Air In Injection Lines To Nozzles	Loosen injection line at nozzle(s) and bleed air. Use care to direct fuel away from sources of ignition.
	3. Nozzle(s) Malfunction	With engine running, loosen injection line at each nozzle, one at a time. Use care to direct fuel away from sources of ignition. Each good nozzle should change engine idle quality when fuel is allowed to leak. If a nozzle is found that does not affect idle quality or changes noise and/or smoke, it should be replaced.
	4. High Pressure Lines Incorrectly Installed	Check routing of each line, Correct as required. (Firing order is 1-8-4-3-6-5-7-2.)
Engine Misfires Above Idle But Idles Correctly	1. Plugged Fuel Filter	Replace filter.
	2. Incorrect Injection Pump Timing	Be sure that timing mark on injection pump and adapter are aligned.
	3. Incorrect or Contaminated Fuel	Flush fuel system and install correct fuel.
Engine Will Not Return To Idle	1. External Linkage Binding Or Misadjusted	Free up linkage. Adjust or replace as required.
	2. Internal Injection Pump Malfunction	Remove injection pump for repair.
Fuel Leaks On Ground – No Engine Malfunction	1. Loose or Broken Fuel Line or Connection	Examine complete fuel system, including tank, lines, injection and fuel return lines. Determine source and cause of leak and repair.
	2. Injection Pump Internal Seal Leak	Remove injection pump for repair.

CONDITION	POSSIBLE CAUSE	CORRECTION
Noticeable Loss Of Power	1. Restricted Air Intake	Check air cleaner element.
	2. Restricted or Damaged Exhaust System	Check system and replace as necessary.
	3. Plugged Fuel Filter	Replace filter.
	4. Plugged Fuel Tank Vacuum Vent.In Fuel Cap	Remove fuel cap. If loud "hissing" noise is heard, vacuum vent in fuel cap is plugged. Replace cap. (Slight hissing sound is normal.)
	5. Pinched or Otherwise Restricted Return System	Examine system for restriction and correct as required.
	6. Restricted Fuel Supply From Fuel Tank To Injection Pump	Examine fuel supply system to determine cause of restriction. Repair as required.
	7. Incorrect or Contaminated Fuel	Flush fuel system and install correct fuel.
	8. Restricted Fuel Tank Filter	Remove fuel tank and check filter. (Filter for diesel fuel is blue.)
	9. External Compression Leaks	Check for compression leaks at all nozzles and glow plugs, using "Leak-Tec" or equivalent. If leak is found, tighten nozzle clamp or glow plug. If leak does not stop at a nozzle, remove it and install a new carbon stop seal and compression seal.
	10. Plugged Nozzle(s)	Remove nozzles. Have them checked for plugging and repair or replace.
	11. Low Compression	Check compression to determine cause.
Noise – "Rap" From One or More Cylinders (Sounds Like Rod Bearing Knock)	1. Air In Fuel System	Check for air leaks in fuel line and correct.
	2. Air in High Pressure Line(s)	Loosen injection line at nozzle(s) and bleed air at each cylinder determined to be causing noise. Use care to direct fuel away from sources of ignition.
	3. Nozzle(s) Sticking Open or with very low Nozzle Opening Pressure	Loosen injection lines at nozzles one at a time. Noise will stop or change when line is loosened at bad nozzle. Remove nozzle for repair.
Noise – Objectionable Overall Combustion Noise Over Normal Noise Level With Excessive Black Smoke	1. Timing Not Set To Specification	Make certain that timing mark on injection pump is aligned with mark on adapter.
	2. Internal Engine Problem	Check for presence of an excessive amount of oil in the air crossover. If present, determine cause and correct.

CONDITION	POSSIBLE CAUSE	CORRECTION
Noise – Objectionable Overall Combustion Noise Over Normal Noise Level With Excessive Black Smoke (Cont'd)	3. Injection Pump Housing Pressure Out Of Specifications	Check housing pressure as described in Section E. If incorrect, replace fuel return line connector assembly.
	4. Injection Pump Internal Problem	Remove injection pump for repair.
Engine Noise – Internal Or External	1. Engine Fuel Pump, Generator, Water Pump, Valve Train, Vacuum Pump, Bearings, Etc.	Repair or replace as necessary. If noise is internal, see Diagnosis For Noise – Rap From One or More Cylinders and Engine Starts and Idles Rough With Excessive Noise and/or Smoke.
Engine Overheats	1. Coolant System Leak, Oil Cooler System Leak or Coolant Recovery System Not Operating	Check for leaks and correct as required. Check coolant recovery jar, hose and radiator cap.
	2. Belt Slipping or Damaged	Replace or adjust as required.
	3. Thermostat Stuck Closed	Check and replace if required.
	4. Head Gasket Leaking	Check and repair as required.
Instrument Panel Oil Warning Lamp "ON" at Idle	1. Oil Cooler or Oil or Cooler Line Restricted	Remove restriction in cooler or cooler line.
	2. Oil Pump Pressure Low	See Section E for oil pump repair procedures.
Engine Will Not Shut Off With Key NOTE: With engine at idle, pinch the fuel return line at the injection pump to shut off engine.	1. Injection Pump Fuel Solenoid Does Not Return Fuel Valve To "OFF" Position.	Refer to ELECTRICAL DIAGNOSIS.

DIESEL ENGINE GLOW PLUG ELECTRONIC CONTROL

1	2	3	4	5	6
IGN. SWITCH -"OFF"-	IGN. SWITCH -"RUN"-	IGN. SWITCH -"RUN"-	IGN. SWITCH -"START"-	IGN. SWITCH -"RUN"-	IGN. SWITCH -"RUN"-
WAIT LAMP - OFF START LAMP - OFF GLOW PLUGS - OFF	WAIT LAMP - ON START LAMP - OFF GLOW PLUGS - ON	WAIT LAMP - OFF START LAMP - ON GLOW PLUGS - ON	WAIT LAMP - OFF START LAMP - OFF GLOW PLUGS - ON	WAIT LAMP - OFF START LAMP - OFF GLOW PLUGS - ON	WAIT LAMP - OFF START LAMP - OFF GLOW PLUGS - OFF
		⬇ SEE NOTE 1		⬇ SEE NOTES 2 & 3	

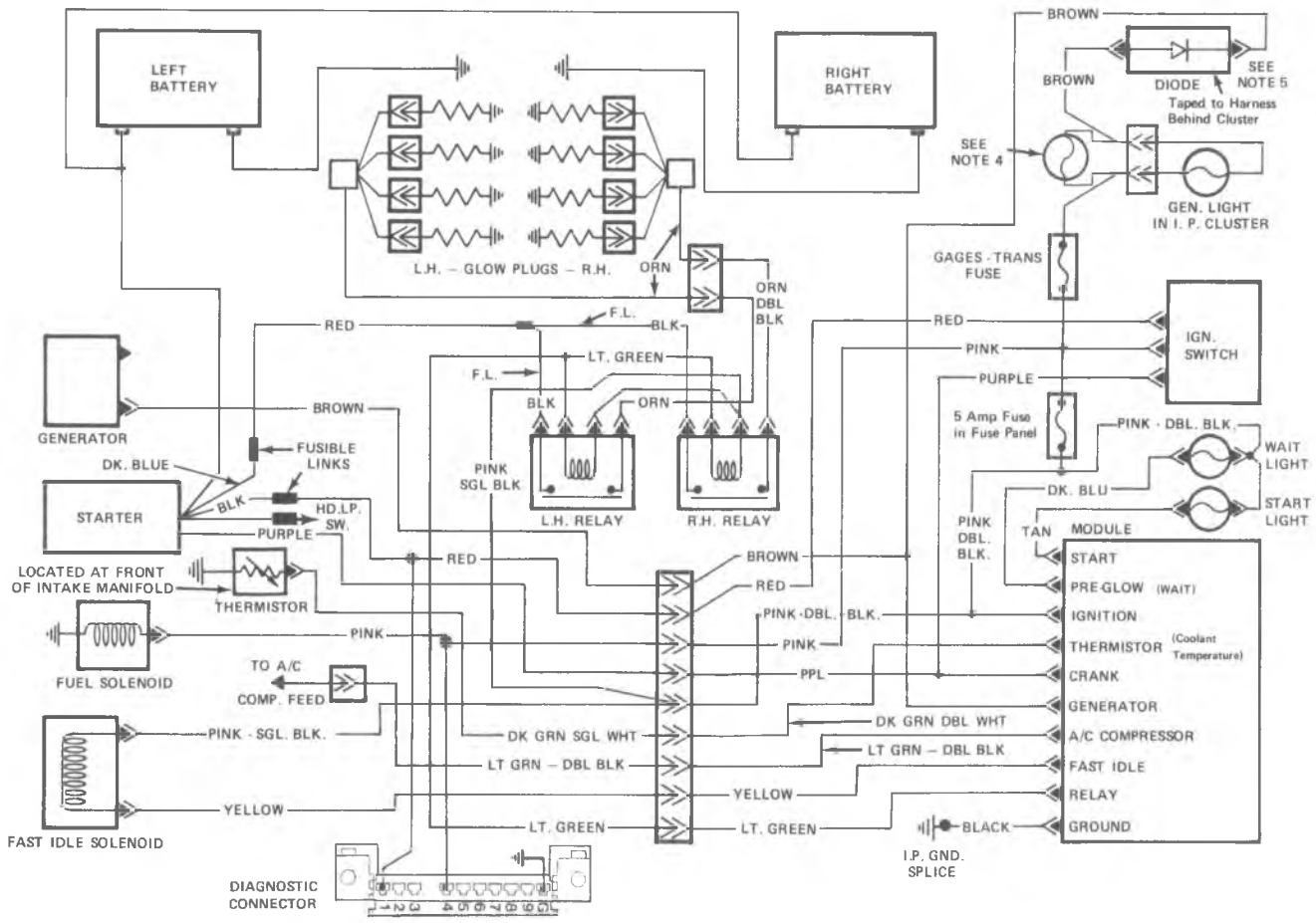
NOTE 1: If the ignition is left in the "RUN" position 2-5 minutes before turning it to "START", the Glow Plugs and Lamps turn off. This prevents discharging the battery. Turn ignition "OFF" then to "RUN" and wait for Start Lamp. (Voltage to the starter solenoid is also directed to the module and is the signal that the ignition switch was turned to the Start position).

NOTE 2: Engine Running - Generator voltage to turn off the "GEN" lamp is also directed to the module. 9 volts or more indicates the engine is running. Glow plugs remain on the same length of time between No. 5 and 6 as they did between No. 2 and 3.

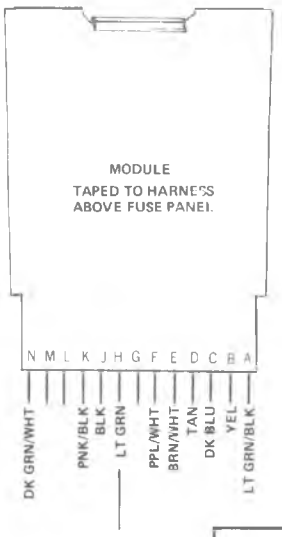
NOTE 3: Engine did not start. Ign. switch still in "RUN" position. "GEN" lamp on. Electronic control starts over after 2-4 second delay (step 2). Wait lamp on. Start lamp off, and Glow Plugs on.

NOTE 4: The extra light bulb is behind the I. P. and located so it cannot be seen. It's purpose is to provide more current to the generator field coil when starting and idling the engine.

NOTE 5: Diode prevents generator feedback to fuel solenoid when ignition is turned off. The diode is located behind the instrument cluster and may be serviced separately.



DIESEL ELECTRICAL SYSTEM DIAGNOSIS



ENGINE DOES NOT START
1. Fuel System checked and is ok.
2. Battery voltage 12.4 or more.
3. Engine cranking speed is ok (100 engine RPM minimum cold, 240 engine RPM minimum hot)
4. WAIT/START lamps operate ok. See note 1.

NOTE 1: If WAIT/START lamps do not come on check 'diesel' 5 amp fuse in fuse panel

NOTE 2: This will allow 2-5 minutes for checking circuits before the emergency shut down occurs. Turning the ignition switch off and back on will reset system. If wait light does not come on, engine is too warm for glow plug operation and thermistor must be disconnected.

Turn ignition switch to "RUN" (see note 2). Connect 12 volt test light to ground and touch test light probe to one glow plug terminal on right bank and one on left bank. Test light should be on in both tests.

TEST LIGHT OFF ONE TEST ONLY (RIGHT OR LEFT)

Connect 12 volt test light to ground and touch probe to orn wire terminal at L. H. relay or orn-dbl-blk wire terminal at R. H. relay.

- **TEST LIGHT OFF** → Touch probe to blk wire terminal of relay.
  - **TEST LIGHT ON** → Replace relay.
  - **TEST LIGHT OFF** → Replace fusible link.
- **TEST LIGHT ON** → Repair open circuit in orn wire circuit to glow plug.

TEST LIGHT OFF BOTH TESTS

Connect 12 volt test light to ground and touch probe to black wire terminal at relays.

- **TEST LIGHT OFF** → Replace fusible link at starter solenoid or repair open in red wire.
- **TEST LIGHT ON** → Touch probe to pink/blk wire terminal of either relay.
  - **TEST LIGHT ON** → Touch probe to lt. green wire term.
    - **TEST LIGHT OFF** → Replace relay.
    - **TEST LIGHT ON** → Connect jumper wire to ground and touch lt. green wire in electronic module connector. If relays operate replace module. If relays don't operate locate and repair open circuit in lt. green wire.
  - **TEST LIGHT OFF** → Repair open in pink/blk wire circuit from relay to ignition switch.

TEST LIGHT ON BOTH TESTS

Connect 12 volt test light to 12 volt source and with plug disconnected touch each glow plug terminal. Replace any glow plug that does not light test light.

ENGINE CRANKS BUT WILL NOT START (GLOW PLUG & LOW PRESSURE FUEL SYSTEMS OK)

Connect a 12 volt test light from wire (pink) at injection pump solenoid to ground. Turn ignition to "ON". Lamp should light.

- **TEST LIGHT ON** → Disconnect and connect pink wire connector and listen for solenoid operation.
  1. If solenoid does not operate, check for good ground and if OK remove injection pump for repair.
  2. If solenoid operates, go to Diesel Engine Diagnosis condition: ENGINE CRANKS NORMALLY WILL NOT START.
- **TEST LIGHT OFF** → Check for open circuit in pink wire from fuel solenoid to ignition switch and repair wire or replace ignition switch.

ENGINE RUNS ROUGH ON COLD START
Glow plugs turn off too soon after engine starts (afterglow time)

Note: If afterglow time period is too long, then batteries will be run down on short trip conditions.

Using a 12 volt test light connected to a good ground probe the ppl/wht wire terminal at the electronic module while cranking the engine. The light should be on and go off when the key is turned to 'Run' position.

- LIGHT ON IN START, OFF IN RUN
  - Check gen. light for normal operation. Repair if necessary. If ok connect 12 volt test light to ground and probe the brown/wht wire terminal in the electronic module while the engine is running.
    - LIGHT ON → Replace electronic module.
    - LIGHT OFF → Locate and repair open in brown/wht wire from electronic module to splice.
- LIGHT OFF IN START → Repair open in ppl/wht wire from electronic module to splice.

ENGINE STARTS HARD OR NOT AT ALL
GLOW PLUGS NOT ON LONG ENOUGH

Glow plugs operate ok but time period incorrect

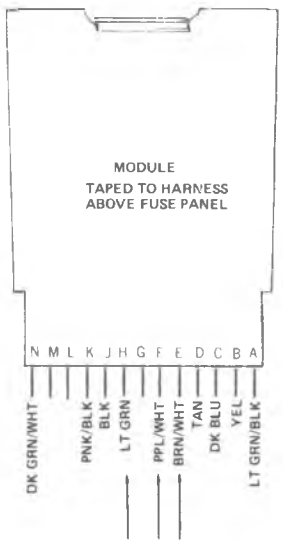
Using an ohmmeter on the 1 X K scale, check the thermistor resistance to ground. Should be 2000 to 5000 ohms at room temperature. 70°F.

- 2000 - 5000 OHMS → Replace electronic module.
- NOT WITHIN RANGE → Replace thermistor

GLOW PLUGS ON AT ALL TIMES
(Causing Rundown Batteries)

Using a grounded 12 volt test light touch probe to term. (Orange wire lh. relay and orn. dbl. blk. rh relay) at each glow plug relay. With ignition off there should be no light.

- LIGHT ON BOTH RELAYS
  - Touch probe to pink/blk. wire term. at relays.
    - LIGHT ON → Locate and repair shorted wire (pink/black) or ignition switch.
    - LIGHT OFF → Replace shorted relays.
- LIGHT ON ONE RELAY → Replace Shorted Relay



BATTERIES RUN DOWN
GLOW PLUGS DO NOT SHUT OFF AFTER 2 - 5 MINUTES.
(Emergency Shut down)

Normal Operation: Glow plugs should shut off after 2 - 5 minutes with the ignition on provided ignition has not been turned to start. This prevents battery run down should ignition be left on.

Using a grounded 12 volt test light, touch the probe to the lt. green wire at the electronic module and turn the ignition on but no to start. Light should stay off for 2 - 5 minutes then come on.

- LIGHT COMES ON → Electronic module ok replace glow plug relays if glow plugs are still on.
- LIGHT STAYS OFF → Turn ignition off. Remove electronic module. Turn ignition on and touch probe to lt. green term. in connector. Test light should come on.
  - LIGHT OFF → Repair grounded lt. green wire between electronic module and glow plug relays.
  - LIGHT ON → Replace electronic module.

DIESEL ELECTRICAL SYSTEM DIAGNOSIS (CONTINUED)

FAST IDLE SOLENOID NORMAL OPERATION

With ignition on, solenoid plunger moves out when throttle is opened to hold fast idle speed as follows:
a. Until engine temperature reaches 140°F
b. For 5 - 8 seconds after each engine start.
c. Whenever A/C is on.

ENGINE STAYS ON FAST IDLE ENGINE WARM OR A/C OFF

Ignition on-disconnect solenoid connector. Solenoid should retract.

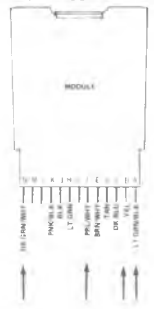
- DOES NOT RETRACT → Check throttle linkage and solenoid plunger for free operation. Correct binding linkage or replace bound up solenoid.
- RETRACTS → Ground thermistor connector.
  - RETRACTS → Replace thermistor
  - DOES NOT RETRACT → Ground dk. green/wht. wire in connector at electronic module.
    - RETRACTS → Locate and repair open circuit in dk. grn/wht wire from thermistor to electronic module.
    - DOES NOT RETRACT → Remove electronic module. Turn ign. key to "RUN".
      - RETRACTS → Replace electronic module.
      - DOES NOT RETRACT → Locate and repair grounded yellow wire from electronic module to solenoid.

NO FAST IDLE WITH COLD ENGINE AND A/C ON OR OFF

Disconnect thermistor
Turn ignition to "RUN"

- SOLENOID OPERATES → Replace thermistor
- SOLENOID DOES NOT OPERATE → Connect thermistor. Connect test light to ground and touch pink wire at fast idle solenoid.
  - LIGHT ON → Connect jumper wire to ground and touch yellow wire at solenoid. Solenoid should operate.
    - SOLENOID DOES NOT OPERATE → Replace and adjust solenoid.
    - SOLENOID OPERATES → Connect 12 volt test light to ground and touch yellow wire at electronic module connector.
      - LIGHT ON → Replace electronic module.
      - LIGHT OFF → Repair open circuit in yellow wire from electronic module connector to solenoid connector.
  - LIGHT OFF → Check pink sgl. blk. wire from fast idle solenoid to splice at dash connector for open circuits. Repair as necessary.

TAPED TO HARNESS ABOVE FUSE PANEL



NO FAST IDLE AFTER EACH ENGINE START (Engine Warm-A/C off)

Fast idle ok with cold engine or a/c on. Use a 12 volt test light and touch the ppl/wht wire terminal at electronic module while cranking engine.

- LIGHT ON → Replace module.
- LIGHT OFF → Locate and repair open in ppl/wht wire from electronic module to splice in harness.

NO FAST IDLE A/C ON (Fast idle ok with cold engine)

Connect 12 volt test light to ground and to lt. grn. dbl blk wire at electronic module.

- LIGHT ON → Replace electronic module.
- LIGHT OFF → Check for open circuit in lt. grn. dbl. blk wire from electronic module to A/C compressor clutch feed wire.

ENGINE CONTINUES TO RUN WITH IGNITION KEY OFF

With ignition turned off and engine still running disconnect 2 wire connector (brown & red) at the generator

- **ENGINE STOPS** → Check diode in brown wire in I. P. harness for a short or installed backward
- **ENGINE CONTINUES TO RUN** → Use a grounded 12 volt test light and touch the pink wire terminal of the fuel solenoid
  - **LIGHT ON** → Check ignition switch adjustment. if ok replace ignition switch
  - **LIGHT OFF** → Remove injection pump for repair

WAIT LIGHT STAYS ON AFTER ENGINE STARTS

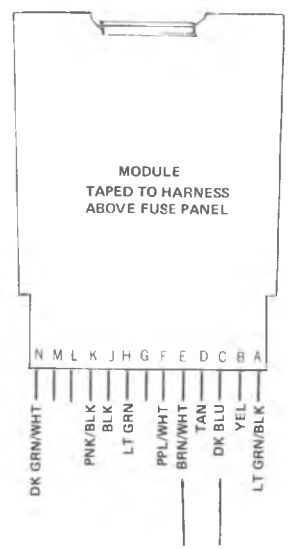
With engine running disconnect electronic module located behind I. P. taped to harness.

- **WAIT LIGHT GOES OUT** → Check brown/wht wire at the electronic module with a grounded 12 volt test light (wire is brown in engine compartment)
  - **TEST LIGHT ON** → Replace electronic module
  - **TEST LIGHT OFF** → Test brown wire at generator 2 wire connector with 12 volt test light.
    - **TEST LIGHT ON** → Locate and repair open circuit in brown/wht wire from generator to electronic module (wire is brown in engine compartment).
    - **TEST LIGHT OFF** → See charging system diagnosis
- **WAIT LIGHT STILL ON** → Locate and repair grounded dk. blue wire between the electronic module and bulb.

WAIT LIGHT DOES NOT COME ON BUT ENGINE STARTS AFTER NORMAL WAITING PERIOD

Check wait light bulb

- **BULB OK** → Test dk. blue wire terminal at electronic module with a grounded 12 volt test light.
  - **TEST LIGHT ON** → Check electronic module ground if ok replace electronic module.
  - **TEST LIGHT OFF** → Repair open circuit in dk. blue wire from electronic module to wait light bulb.
- **BULB OUT** → Replace bulb

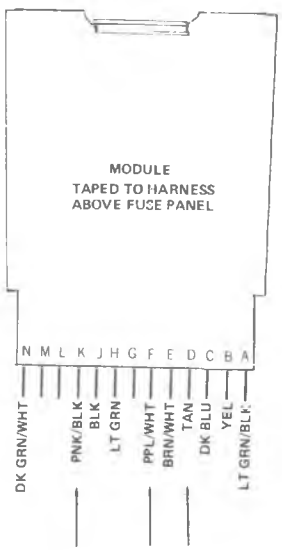


DIESEL ELECTRICAL SYSTEM DIAGNOSIS (CONTINUED)

START LIGHT DOES NOT COME ON BUT WAIT LIGHT TURNS ON AND GOES OFF IN USUAL TIME PERIOD

Connect jumper wire to ground and touch tan wire at electronic module connector. Turn ignition key on.

- START LIGHT ON → Replace electronic module.
- START LIGHT OFF → Check start light bulb. If ok, check pink/black 12 volt feed wire for open circuit. If ok, check tan wire from bulb socket to electronic module.



START LIGHT STAYS ON AFTER ENGINE STARTS OR AFTER 2 - 5 MINUTE EMERGENCY SHUT DOWN

Check the ppl. wire terminal at the electronic module with a 12 volt test light. While cranking the light should be on.

- TEST LIGHT ON → Remove electronic module and observe start light.
  - START LIGHT GOES OUT → Replace electronic module.
  - START LIGHT STAYS ON → Locate and repair short circuit in tan wire from electronic module to START light.
- TEST LIGHT OFF → Repair open in ppl/wht wire from electronic module to splice.

SECTION E

DIESEL ENGINE SERVICE PROCEDURES

INDEX

OIL FILTER BASE (Fig. E-1)

Removal

1. Remove oil cooler lines.
2. Bend exhaust manifold lock tabs away from bolts.
3. Hoist car.
4. Disconnect exhaust system from exhaust manifold. (See EXHAUST CROSSOVER PIPE Removal.)
5. Remove exhaust manifold.
6. Remove oil filter base retaining bolts and remove base.

Installation

If a new oil filter element is installed, add one quart of oil. Clean sealing surfaces and re-bend manifold bolt lock tabs. Start engine, check for leaks and proper oil level. Torque oil filter base attaching bolts to 35 ft. lbs. and exhaust manifold bolts to 25 ft. lbs.

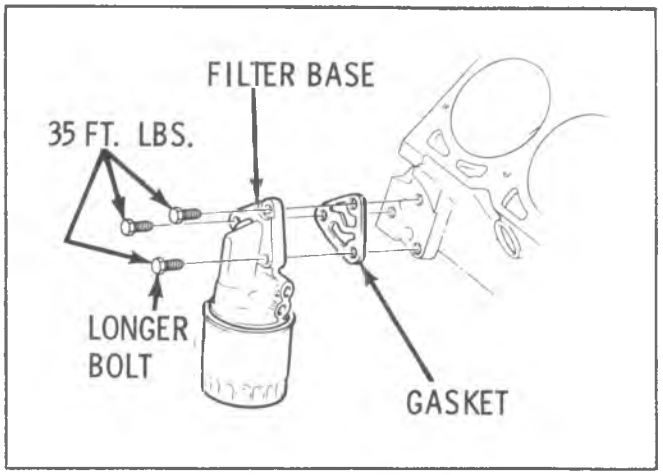


Fig. E-1–Oil Filter Base

ENGINE MOUNTING

Refer to Fig. E-2.

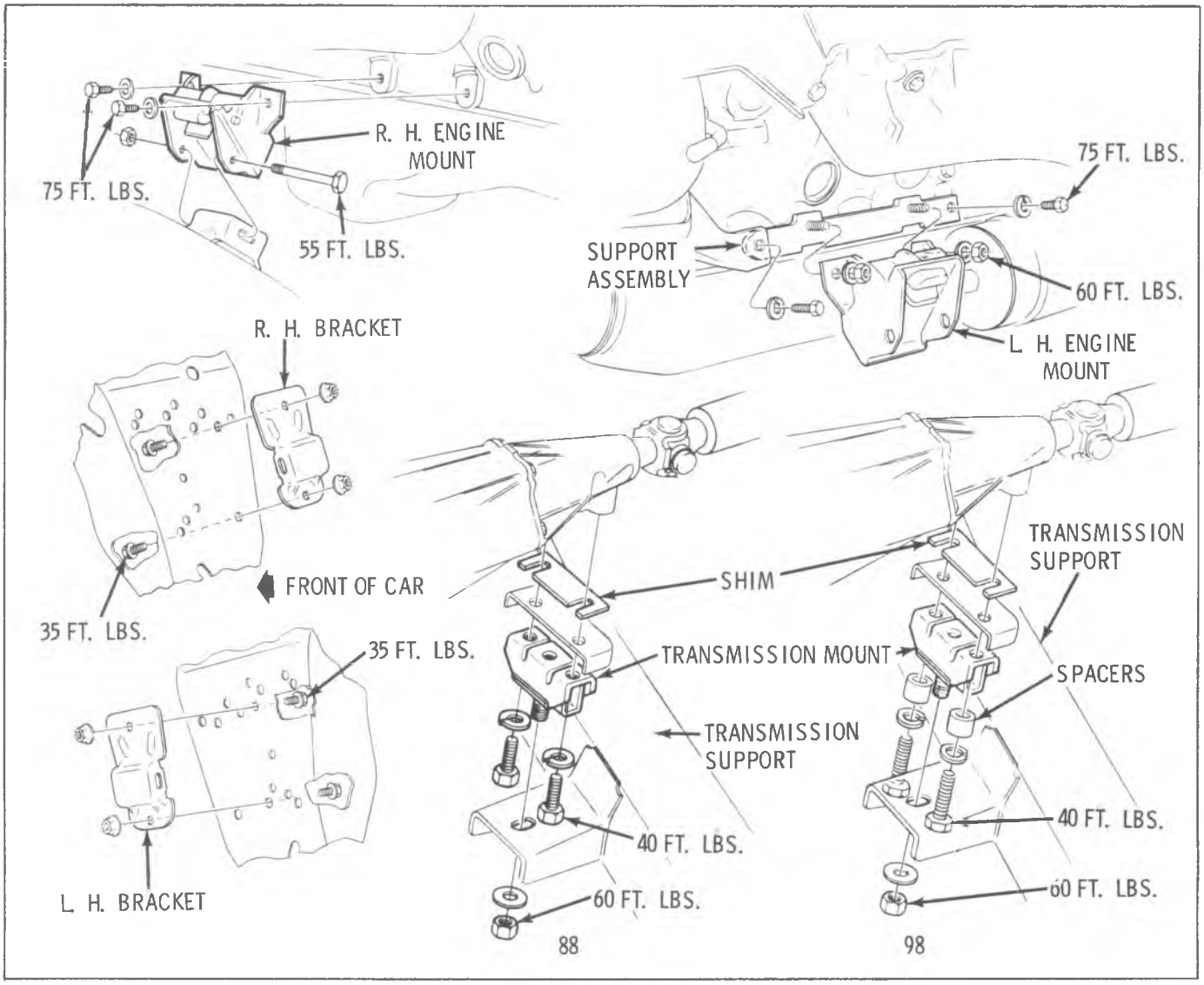


Fig. E-2–88 & 98 Engine Mounts

EXHAUST CROSSOVER PIPE

Removal and Installation

1. Remove bolts from left side of crossover pipe.
2. Remove oil cooler lines from oil filter base.
3. Remove bolts from right side of crossover pipe and remove pipe.

Torque bolts to 14 ft. lbs. when installing.

EXHAUST MANIFOLD

L.H. EXHAUST MANIFOLD

Removal and Installation

1. Remove air cleaner then install air crossover cover J-26996-1.
2. Remove lower generator bracket.
3. Hoist car.
4. Remove crossover pipe.
5. Lower car.
6. Remove exhaust manifold from above.

See Fig. E-3 for bolt torque when installing.

R.H. EXHAUST MANIFOLD

Removal and Installation

1. Hoist car.
2. Remove crossover pipe.
3. Disconnect exhaust pipe.
4. Remove R.F. wheel.
5. Remove exhaust manifold from under car.

See Fig. E-3 for bolt torque when installing.

CHECKING OR ADJUSTING TIMING

Checking (Fig. E-4)

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

(Note: The engine must be stopped when the timing is reset.)

Adjusting

If the marks are not aligned, adjustment is necessary.

1. Loosen the three pump retaining nuts with tool J-26987.
2. Align the mark on the injection pump with the mark on the adapter and tighten nuts. Torque to 35 ft. lbs.

(Note: Use a 3/4" end wrench on the boss at the front of the injection pump to aid in rotating the pump to align the marks.)

3. Adjust throttle rod (See "LINKAGE ADJUSTMENT").

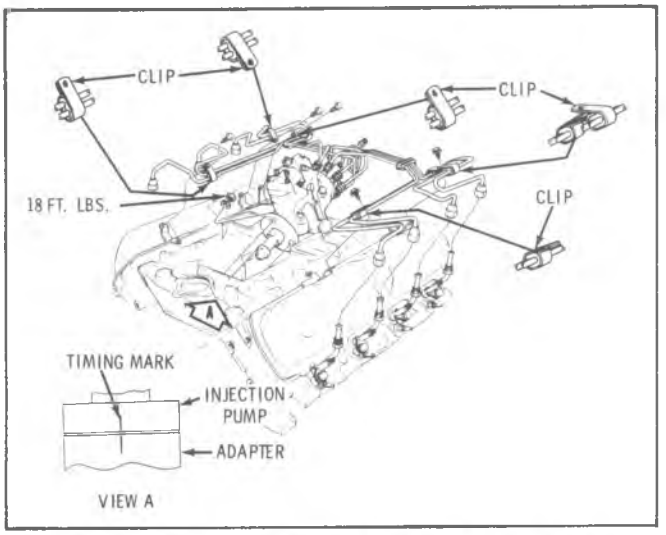


Fig. E-4—Timing Marks and Injection Pump Lines

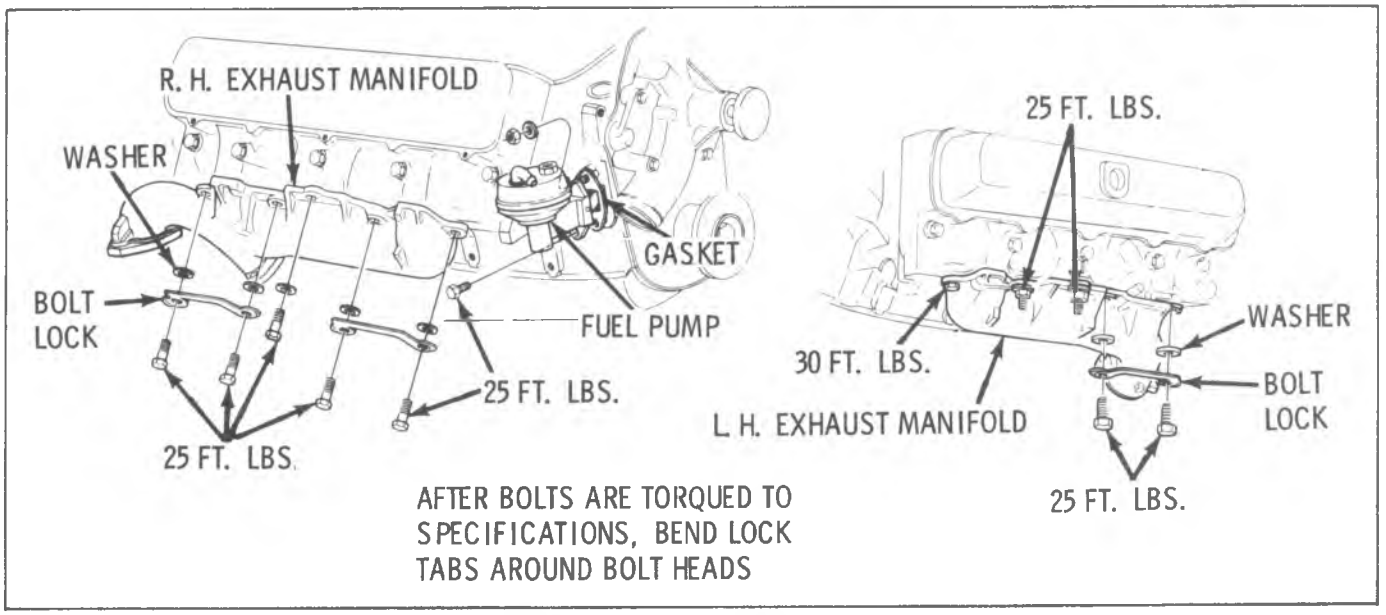


Fig. E-3—Exhaust Manifold Bolts

LINKAGE ADJUSTMENTS (Figs. E-5, E-6 and E-7)

1. TIMING: Check timing, adjust if necessary (engine OFF).

2. THROTTLE ROD ADJUSTMENT: (Engine Stopped)

a. If equipped with cruise control, remove clip from cruise control rod then remove rod from bellcrank.

b. Remove T.V. cable (200 transmission) or detent cable (350 transmission) from bellcrank.

c. Loosen the locknut on the throttle rod, then shorten the rod several turns.

d. Rotate the bellcrank to the full throttle stop, then lengthen the throttle rod until the injection pump lever contacts the injection pump full throttle stop. Release the bellcrank.

e. Tighten the throttle rod locknut.

f. Connect the T.V. or detent cable and cruise control rod to bellcrank then adjust. (Step 3)

3. TRANSMISSION T.V. CABLE (200 Transmission) OR DETENT CABLE (350 Transmission) ADJUSTMENT (Engine Stopped).

a. Remove throttle rod from bellcrank.

b. Push "snap lock" to disengaged position.

c. Rotate the bellcrank to the full throttle stop then hold there.

d. Push in the "snap lock" until it is flush with the cable end fitting. Release the bellcrank.

e. Reconnect the throttle rod.

4. TRANSMISSION VACUUM VALVE ADJUSTMENT (350 Transmission) (Fig. E-8)

a. Remove throttle rod from bellcrank.

b. Loosen the transmission vacuum valve attaching bolts enough to disengage valve from injection pump shaft.

c. Hold injection pump lever against the injection pump full throttle stop.

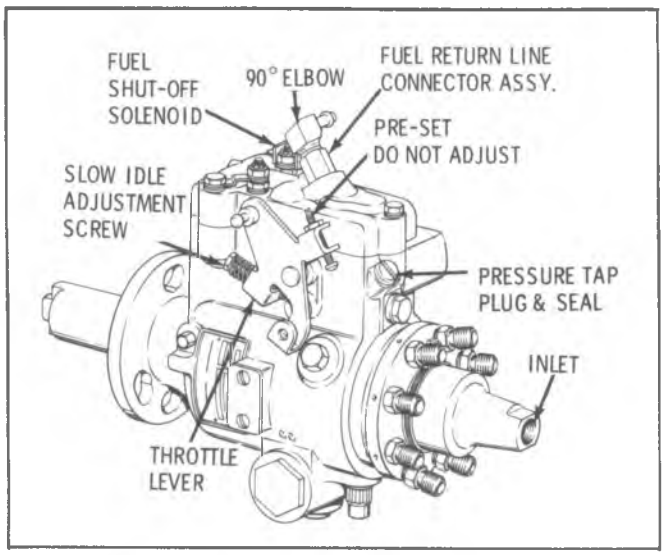


Fig. E-5—Injection Pump Slow Idle Screw

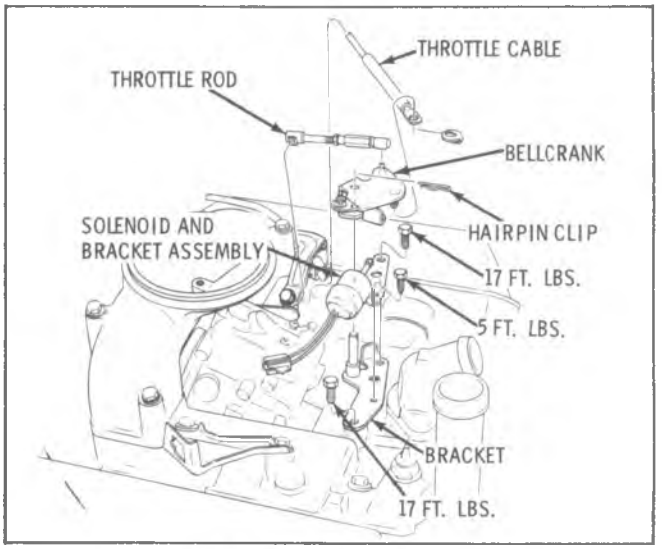


Fig. E-6—Throttle Linkage

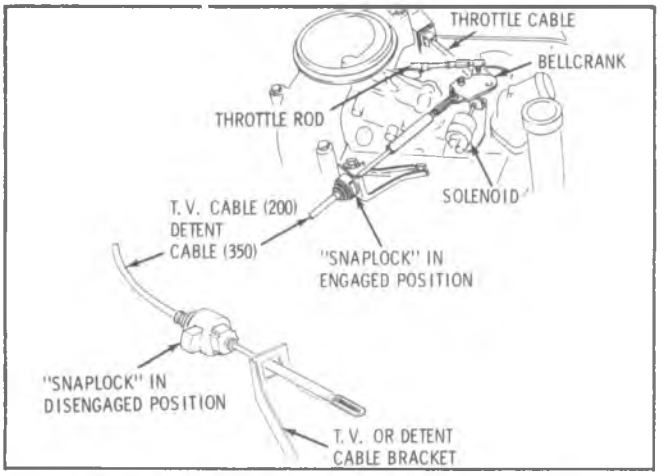


Fig. E-7—Transmission T.V. Cable Adjustment

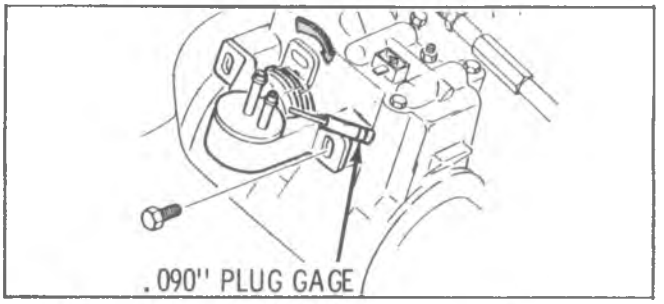


Fig. E-8—Transmission Vacuum Valve Adjustment

d. Rotate the valve to the full throttle position, then insert a .090" pin from BT-3005 carburetor kit to hold the valve in the full throttle position.

e. Rotate the assembly clockwise until the injection pump lever shaft is contacted. Hold in this position. Then:

f. Tighten the two bolts holding the vacuum valve to the injection pump.

g. Remove the pin from the vacuum valve and release the lever.

h. Reconnect the throttle rod to the bellcrank.

5. SLOW IDLE SPEED ADJUSTMENT: (Engine Running)

(Note: To check idle speeds, it will be necessary to insert the probe of the magnetic pickup tach. J-26925 in the timing indicator hole. See Fig. E-9 for location of timing indicator.)

a. With the driving wheels blocked and the parking brake on, adjust the slow idle screw on the injection pump (Fig. E-5) to 575 RPM (Drive range, A/C OFF)

6. FAST IDLE SOLENOID ADJUSTMENT: (Engine Running)

a. With the driving wheels blocked and the parking brake on, adjust the fast idle solenoid plunger to 650 RPM, Drive range, A/C ON and compressor wires disconnected. (Cars WITHOUT A/C, disconnect the solenoid connector. Connect jumper wires to solenoid terminals and ground one jumper wire. Connect the other jumper wire to 12 volts to energize it while making fast idle adjustment.)

7. CRUISE CONTROL SERVO RELAY ROD ADJUSTMENT: (Engine Stopped)

a. Adjust rod to minimum slack (engine off) then put clip in first free hole closest to the bellcrank, but within the servo bail.

TRANSMISSION VACUUM VALVE

Removal

1. Remove the two vacuum hoses from the valve noting the location of the vacuum hoses. (Fig. E-8)
2. Remove the 2 attaching bolts.

Installation

1. Install the valve following the "Transmission Vacuum Valve Adjustment Procedure".
2. Attach the two vacuum hoses to the valve. Put the hose from the vacuum pump to the center port and the hose to the transmission on the outboard port.

CHECKING INJECTION PUMP HOUSING FUEL PRESSURE

1. Remove air crossover and install screened covers, J-26996-2.
2. Remove the fuel return pressure tap plug. (Fig. E-5)
3. Put the seal from the pressure tap plug on the pressure tap adapter J-28526, then screw the adapter into the pump housing.
4. Attach a low pressure gage to the adapter.
5. Install magnetic pick-up tachometer J-26925.
6. Check the pressure with the engine running at 1000 RPM (PARK). The pressure should be 8-12 PSI with not more than 2 PSI fluctuation.
7. If the pressure is incorrect, replace the fuel return line connector assembly and check pressure again. If it is still incorrect, remove the injection pump for repair by an authorized dealer.
8. Remove the tachometer, pressure gage, and adapter J-28526.
9. Put a new pressure tap plug screw seal on the pressure tap plug then screw in the tap plug.
10. Remove screened covers J-26996-2, then install air crossover.

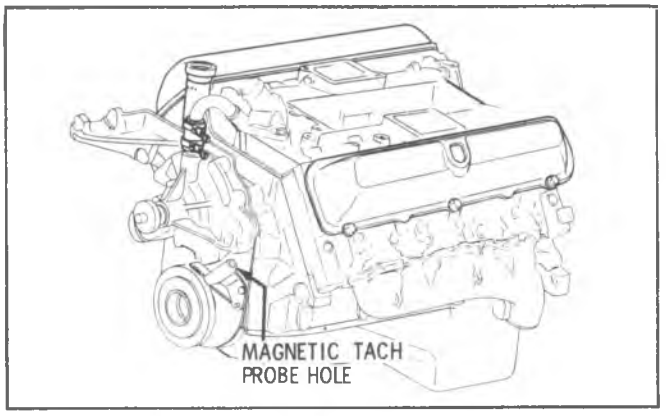


Fig. E-9—Magnetic Tach Probe Hole

INJECTION PUMP FUEL LINES (Fig. E-4)

(Note: When lines are removed, the lines, nozzles and pump fittings must be capped to keep them clean.)

Removal

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

1. Remove air cleaner. (Fig. E-10)
2. Remove filters and pipes from valve covers and air crossover.
3. Remove air crossover and cap intake manifold with J-26996-2 screened covers.
4. Remove injection pump line clamps, then remove the injection pump lines and cap open lines, nozzles, and pump fittings.

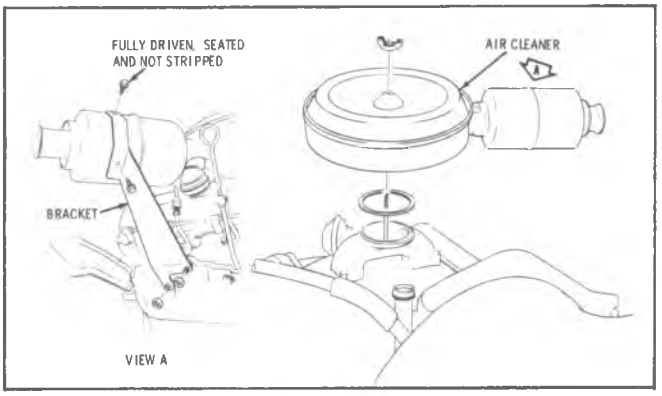


Fig. E-10—Air Cleaner Attachment

Installation

1. Install new injection pump line, install loose then torque both ends. Torque pump end to 35 ft. lbs., and nozzle end to 25 ft. lbs. then install clamps.

(NOTE: If several lines are to be replaced, start with the bottom lines.)

2. Start engine and check for fuel leaks.

3. Remove screened covers J-26996-2 from intake manifold and install air crossover. (Fig. E-11)

4. Connect pipes to flow control valve in air crossover and ventilation filters in the valve covers. (Fig. E-12)

5. Install air cleaner.

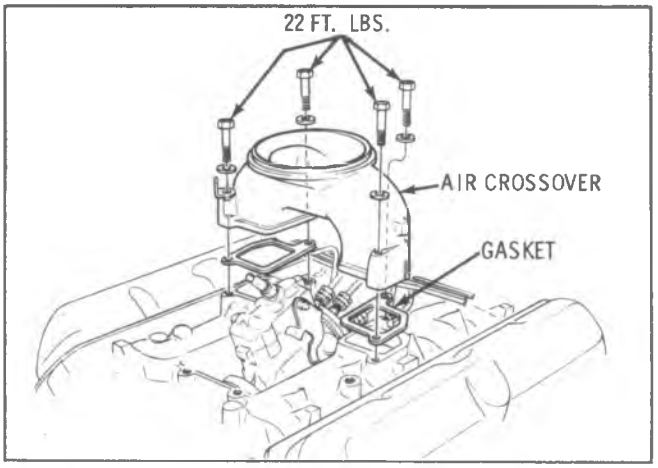


Fig. E-11—Air Crossover

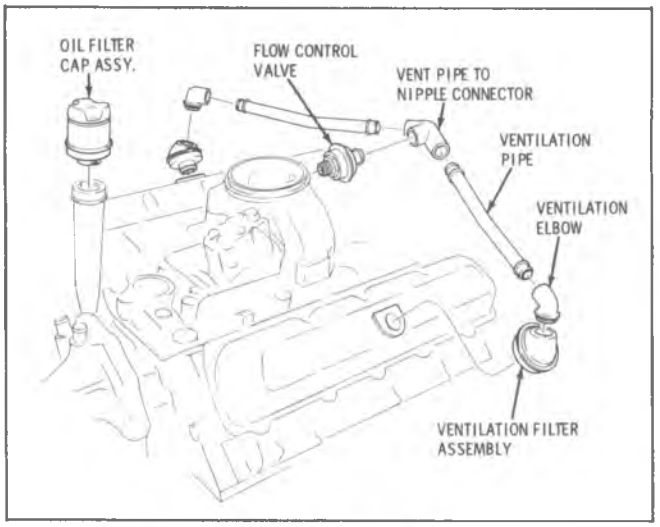


Fig. E-12—Ventilation System

INJECTION PUMP AND LINES

Removal

1. Remove air cleaner.

2. Remove filters and pipes from valve covers and air crossover.

3. Remove air crossover and cap intake manifold with J-26996-2 screened covers.

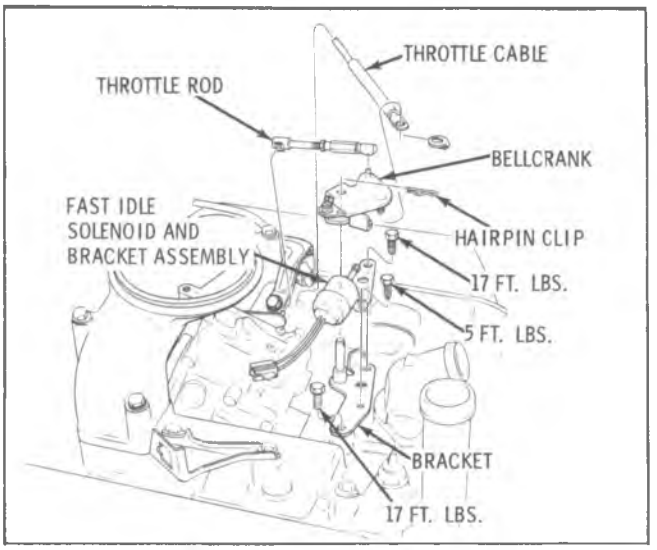


Fig. E-13—Throttle Linkage

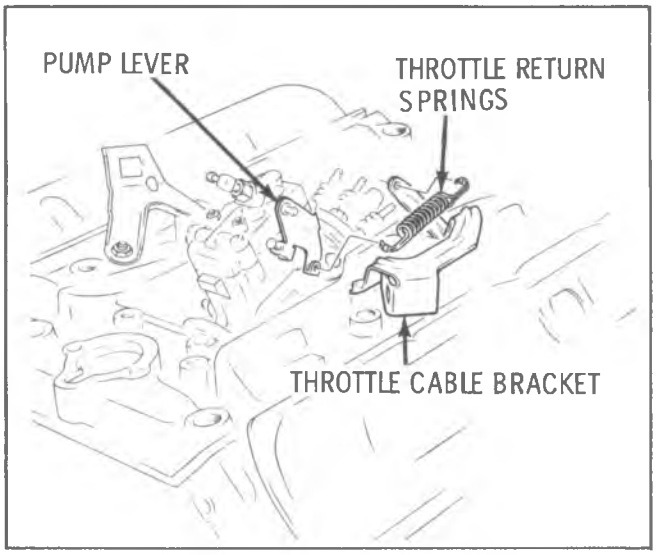


Fig. E-14—Throttle Return Springs

4. Disconnect throttle rod and return spring. (Figs. E-13 and E-14)

5. Remove bellcrank.

6. Remove throttle and T.V. cables from intake manifold brackets. Position cables away from engine.

7. Remove lines to fuel filter, then remove fuel filter. (Fig. E-15)

8. Disconnect fuel line at fuel pump. If A/C equipped, remove rear compressor brace. Remove fuel line.

9. Disconnect the fuel return line from the injection pump.

10. Slide the clamp off the fuel return lines at the nozzles and pull off the fuel return lines from each bank. (Fig. E-16)

11. Using two wrenches, disconnect injection pump lines at the nozzles.

12. Remove 3 nuts retaining injection pump, using tool J-26987.

13. Remove pump and cap all open lines and nozzles.

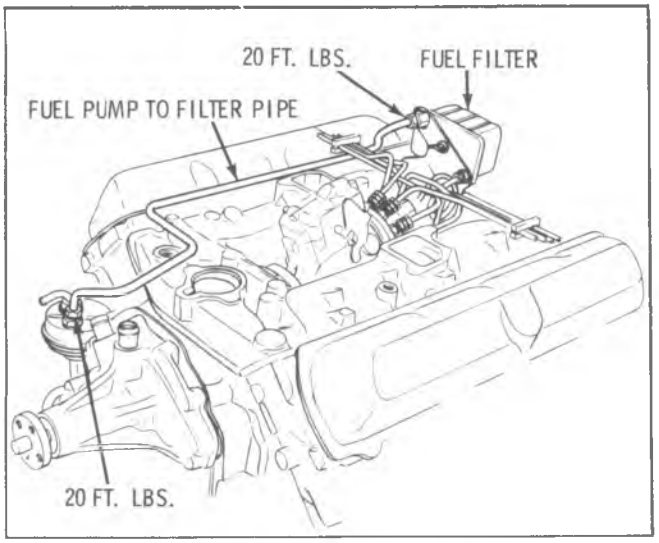


Fig. E-15–Fuel Filter and Lines

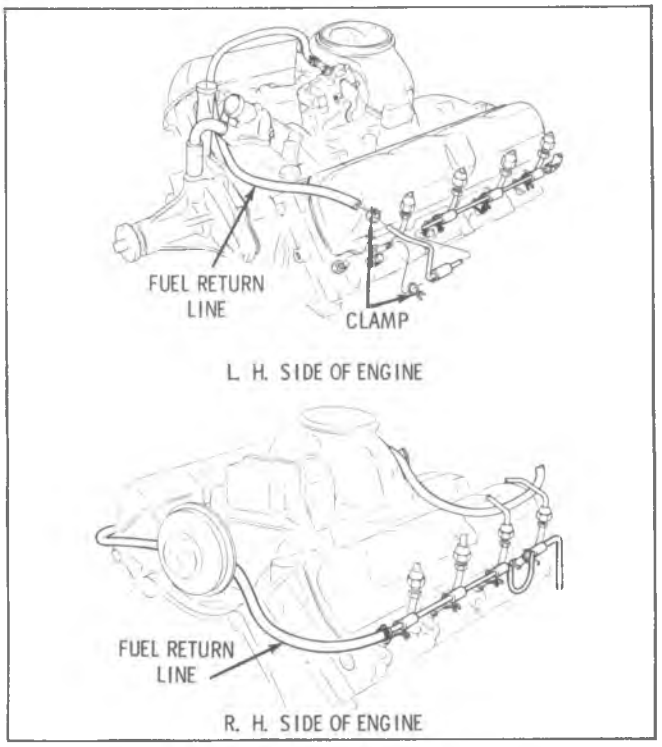


Fig. E-16–Fuel Return Lines

Installation

1. Remove protective caps then line up offset tang on pump driveshaft with the pump driven gear and install pump.

2. Install 3 nuts and lock washers retaining injection pump, do not tighten. Connect injection pump lines at nozzles, then tighten, using two wrenches. Torque to 25 ft. lbs.

3. Connect fuel return lines to the nozzles and injection pump.

4. Align mark on injection pump with mark on adapter and tighten nuts. Torque to 18 ft. lbs.

(NOTE: Use a 3/4" end wrench on the boss at the front of the injection pump to aid in rotating the pump to align the marks.

5. Adjust the throttle rod. (See LINKAGE ADJUSTMENT)

6. Install fuel line from fuel pump to fuel filter. If equipped with A/C, install rear compressor brace.

7. Install bellcrank and hairpin clip.

8. Install throttle and T.V. cables to intake manifold and attach to bellcrank. Adjust the T.V. cable, (See LINKAGE ADJUSTMENT).

9. Connect throttle rod and return spring.

10. Start engine and check for fuel leaks.

11. Remove screened covers J-26996-2 from intake manifold then install air crossover.

12. Install tubes in flow control valve in air crossover and ventilation filters in the valve covers.

13. Install air cleaner.

INJECTION PUMP ADAPTER, ADAPTER SEAL AND NEW ADAPTER TIMING MARK

Removal

1. Refer to "INJECTION PUMP AND LINES" removal.

2. Remove injection pump adapter.

3. Remove seal from injection pump adapter.

Installation

(NOTE: Follow steps 3, 4, 5, 6 and 7 when only the adapter seal is being replaced.)

1. File mark off from injection pump adapter.

(NOTE: Do not file mark from pump.)

2. Position engine on No. 1 cylinder. Align mark on balancer with zero mark on indicator. Refer to Fig. E-17 for position of injection pump driven gear. (The index is offset to the right when number one is at T.D.C.)

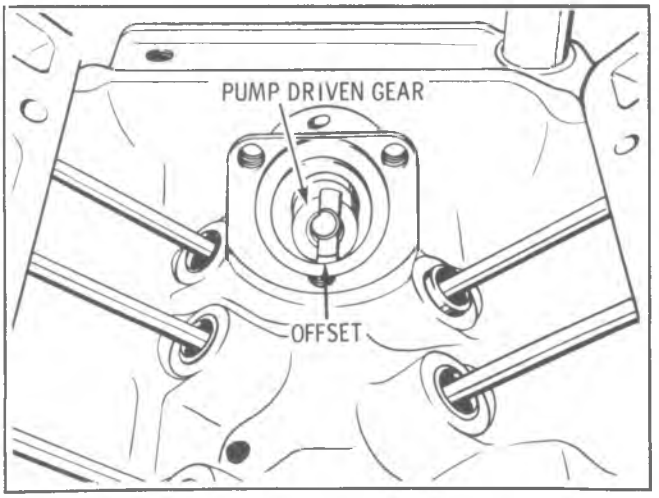


Fig. E-17–Offset on Pump Driven Gear

3. Apply chassis lube to seal area on adapter, taper edge and seal area in manifold. Then install adapter, leave loose.

4. Apply chassis lube to I.D. and O.D. of adapter seal and to seal installing Tool J-28425. Install seal on tool.

5. Push seal on adapter with tool J-28425 (See Fig. E-18).

6. Remove tool and inspect to see if seal is properly positioned.

7. Torque adapter bolts to 25 ft. lbs. (Fig. E-19)

8. Install Timing Tool J-26896 into injection pump adapter. Torque Tool toward cylinder No. 1 to 50 ft. lbs. While holding torque, mark injection pump adapter. Remove tool. (See Fig. E-20)

9. Refer to "INJECTION PUMP AND LINES" installation.

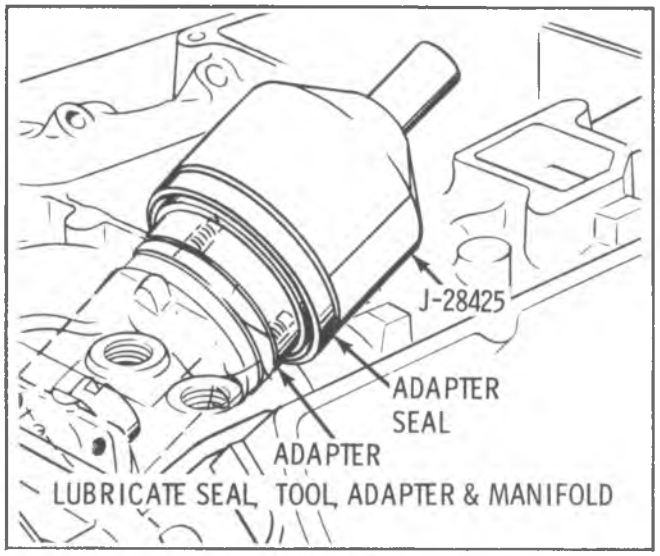


Fig. E-18—Installing Adapter Seal

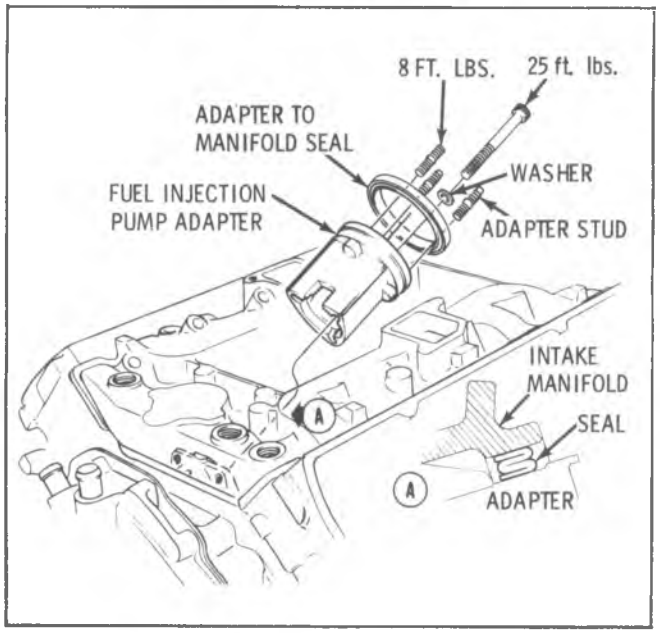


Fig. E-19—Injection Pump Adapter Bolts

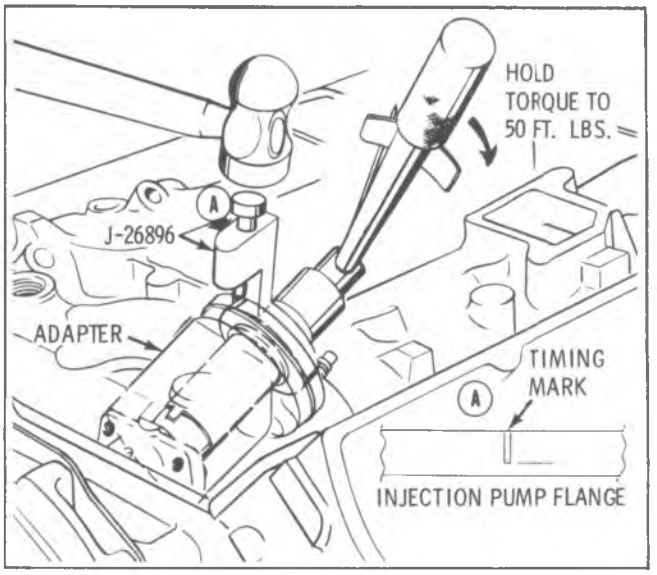


Fig. E-20—Marking Injection Pump Adapter

VALVE COVER

Removal

1. Refer to "INJECTION PUMP AND LINES" for removal.

2. Remove valve cover to cylinder head attaching screws. Remove accessory mounting brackets as necessary and remove valve cover.

Installation

1. Thoroughly clean the head and valve cover gasket surface. Apply 1051435 RTV (Room Temperature Vulcanizing) sealer or equivalent to the valve cover. (Fig. E-21)

2. Install valve cover screws so they are fully seated and not stripped. Install any mounting brackets which were removed. (Fig. E-22)

3. Refer to "INJECTION PUMP AND LINES" for installation.

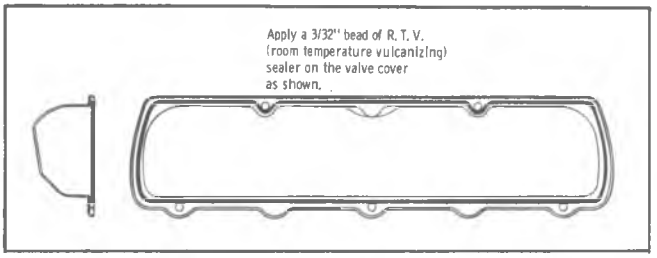


Fig. E-21—Applying Sealer on Valve Cover

INTAKE MANIFOLD

Removal

1. Remove air cleaner assembly.

2. Drain radiator, then disconnect upper radiator hose and thermostat bypass hose from water outlet. Also disconnect heater hose and vacuum hose from water control valve.

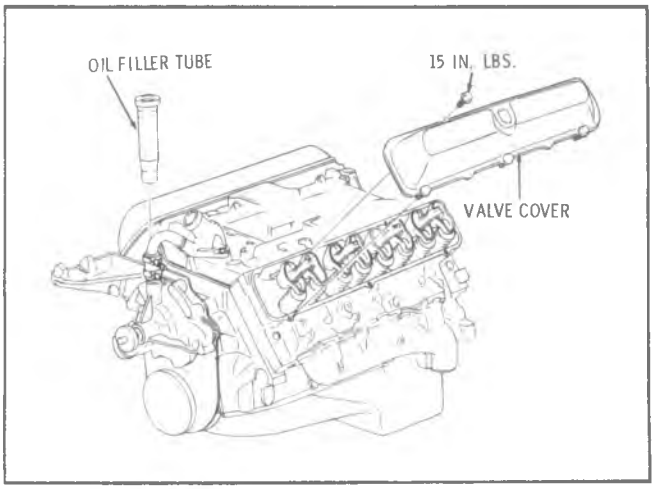


Fig. E-22–Valve Rocker Cover

3. Remove breather pipes from valve covers and air crossover.

4. Remove air crossover and cap intake manifold with J-26996-2 screened covers.

5. Disconnect throttle rod and return spring. If equipped with cruise control, remove servo.

6. Remove hairpin clip at bellcrank and disconnect cables, then remove throttle and T.V. cables from brackets on the intake manifold and position cables away from engine.

7. Disconnect wiring as necessary.

8. Disconnect and/or remove generator and air conditioning compressor brackets as necessary.

(NOTE: The air conditioning lines at the compressor are flexible and should be left attached to the compressor.)

9. Disconnect fuel line from fuel pump and fuel filter and remove fuel filter and bracket.

10. Disconnect line at nozzles and remove injection pump and cap all open lines and fittings on injection pump, filter, fuel lines and nozzles.

(NOTE: Do not bend injection pump lines.)

11. Disconnect fuel return line from injection pump.

12. Disconnect vacuum lines at vacuum pump and remove vacuum pump (with A/C). Remove oil pump drive assembly (non A/C).

13. Remove drain tube.

14. Remove intake manifold bolts, then remove intake manifold. Remove adapter seal.

15. Remove injection pump adapter.

16. Clean machined surfaces of cylinder head and intake manifold with a putty knife. Use care not to gouge or scratch machined surfaces.

Installation

1. Coat both sides of gasket sealing surface that seal the intake manifold to the head with 1050805 sealer or equivalent and position intake manifold gasket. (Fig. E-23)

2. Install end seals, making sure that ends are positioned under cylinder heads.

3. Position intake manifold on engine and connect thermostat bypass hose to water pump.

4. Dip intake manifold bolts in engine oil and torque in sequence shown to 15 ft. lbs. Then re-torque to 40 ft. lbs. (Fig. E-24)

5. Install drain tube. (Fig. E-25)

6. Apply chassis lube to seal area on adapter, taper edge and seal area in manifold. Then install adapter, leave loose.

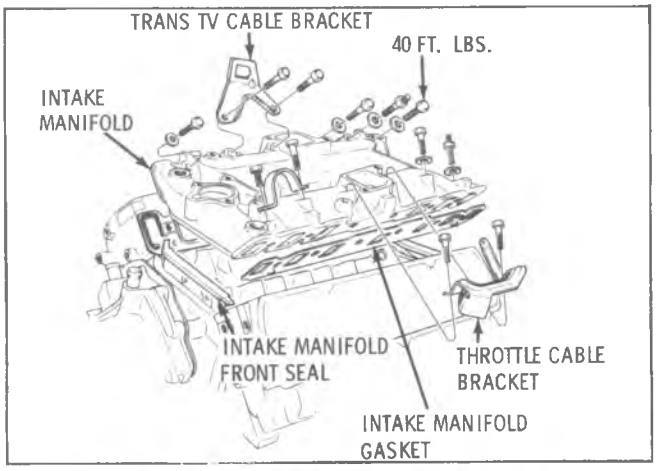


Fig. E-23–Intake Manifold and Gasket

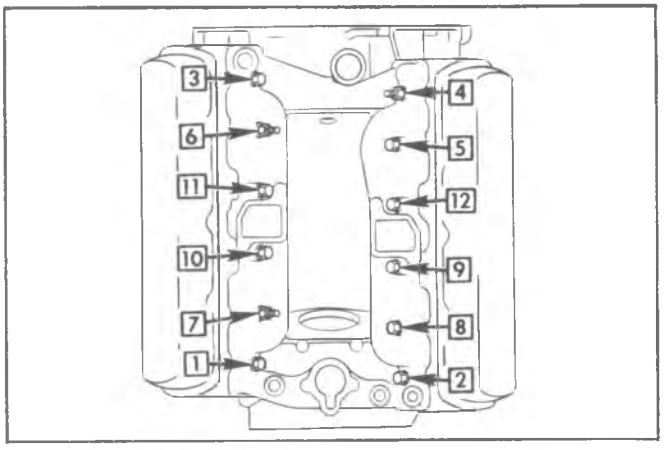


Fig. E-24–Intake Manifold Torque Sequence

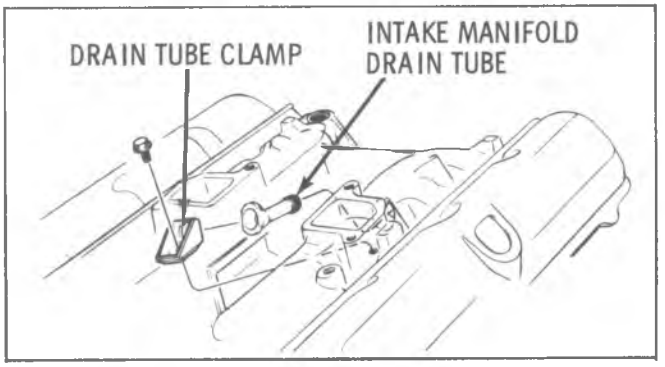


Fig. E-25–Intake Manifold Drain Tube

7. Apply chassis lube to I.D. and O.D. of adapter seal and to seal installing Tool J-28425. Install seal on tool.

8. Push seal on adapter with Tool J-28425. (Fig. E-26)

9. Remove tool and inspect to see if seal is properly positioned.

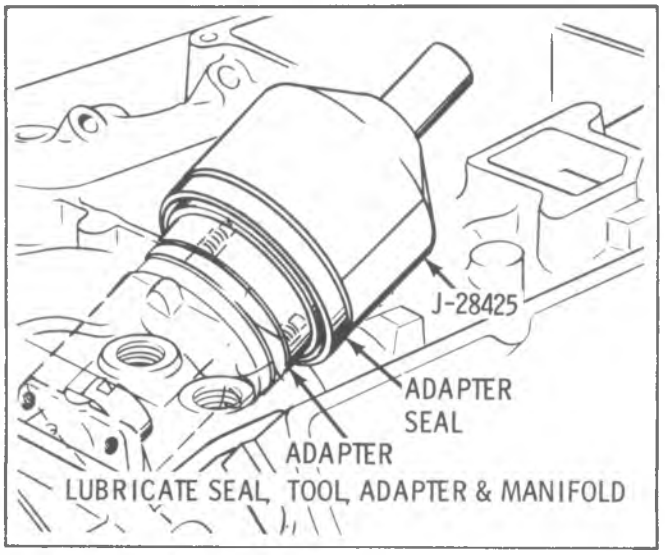


Fig. E-26–Installing Adapter Seal

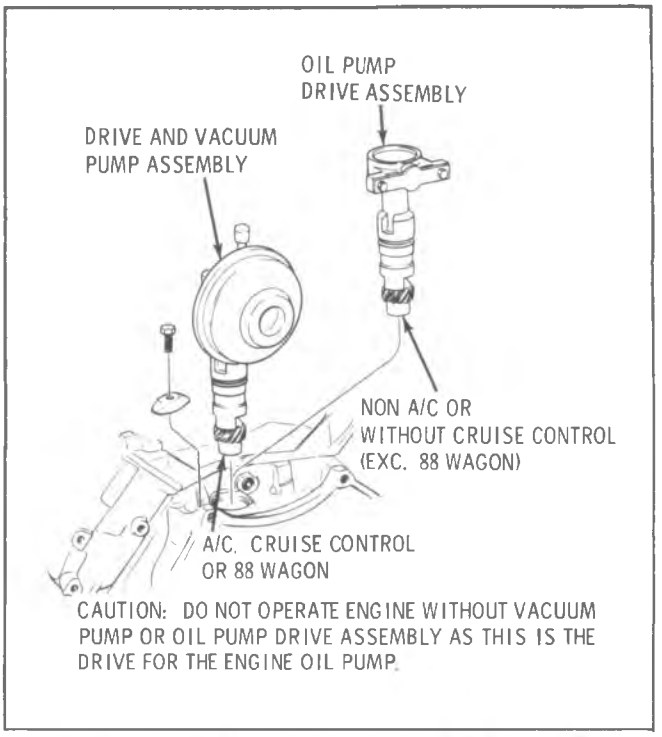


Fig. E-27–Drive and Vacuum Pump/Oil Pump Drive

10. Torque adapter bolts to 25 ft. lbs.

11. Remove caps from injection pump lines. Align offset tang on pump drive shaft with offset in pump driven gear then install injection pump. Connect injection pump lines to nozzles. Align mark on injection pump with mark on adapter.

(NOTE: Use a 3/4" end wrench on the boss at the front of the injection pump to aid in rotating the pump to align the marks.)

12. Install fuel filter bracket and filter, then connect fuel lines.

13. Connect the fuel return line to the injection pump.

14. Install vacuum pump and vacuum lines (with A/C). Install oil pump drive assembly (non A/C) Fig. E-27.

CAUTION: Do not operate the engine without vacuum pump or oil pump drive assembly as this is the drive for the engine oil pump.

15. Connect wiring.

16. Install and/or connect generator and air conditioning compressor brackets as necessary.

17. Install cable, in cable brackets and bellcrank then install bellcrank to intake manifold. Adjust the T.V. cable, (See LINKAGE ADJUSTMENT).

18. Connect throttle rod and return spring.

19. Start engine and check for fuel leaks.

20. Remove screened covers J-26996-1 from intake manifold.

21. Install air crossover.

22. Install breather tubes from valve cover filters and flow control valve at the air crossover.

23. Connect upper radiator hose and heater hose. Connect vacuum hose to water control valve.

24. Fill cooling system.

ROCKER ARMS (Figs. E-28 and E-29)

Removal

1. Remove valve cover.

2. Remove rocker arm flanged bolts, pivot and rocker arms.

(NOTE: Remove each set (one set per cylinder) as a unit.)

Installation

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

(NOTE: Refer to "Valve Lifter Bleed Down" as lifters must be bled down to prevent the piston from hitting the valves.)

2. Lubricate wear points with 1050169 lubricant or equivalent and install the pivots.

3. Install the flanged bolts and tighten alternately. Torque bolts to 25 ft. lbs.

VALVE LIFTERS

Operation

Oil is supplied to the lifter through a hole in the side of

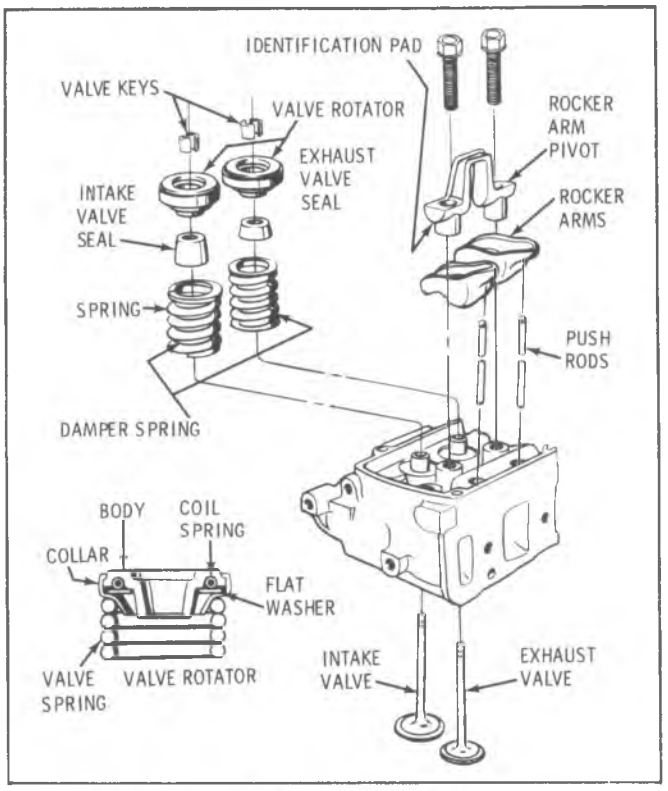


Fig. E-28–Valve Springs and Rocker Arms

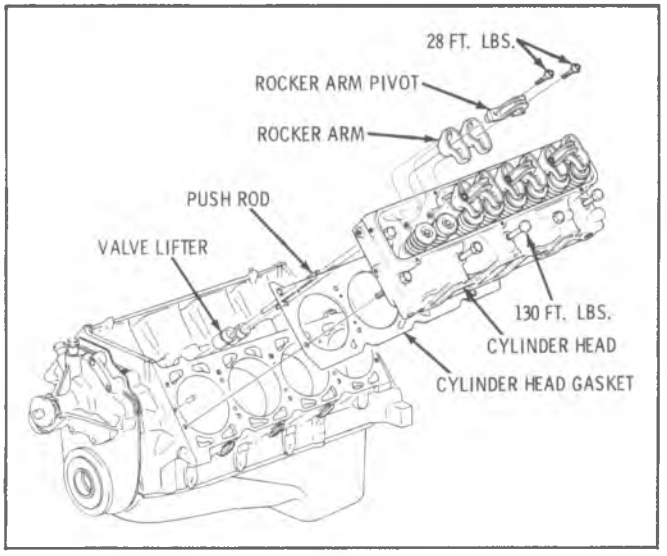


Fig. E-29–Removing Rocker Arms

the lifter body which indexes with a groove and hole in the lifter plunger. Oil is then metered past the oil metering valve in the lifter, through the push-rods to the rocker arms. (Fig. E-30)

When the lifter begins to ride up the cam lobe, the check valve disc is held against its seat in the plunger by the check valve disc spring which traps the oil in the base of the lifter body below the plunger. The plunger and lifter body then raise as a unit, pushing the push-rod up to open the valve. The force of the valve spring which is exerted on the plunger through the rocker arm and push-rod causes a slight amount of leakage between the plunger and lifter body. This

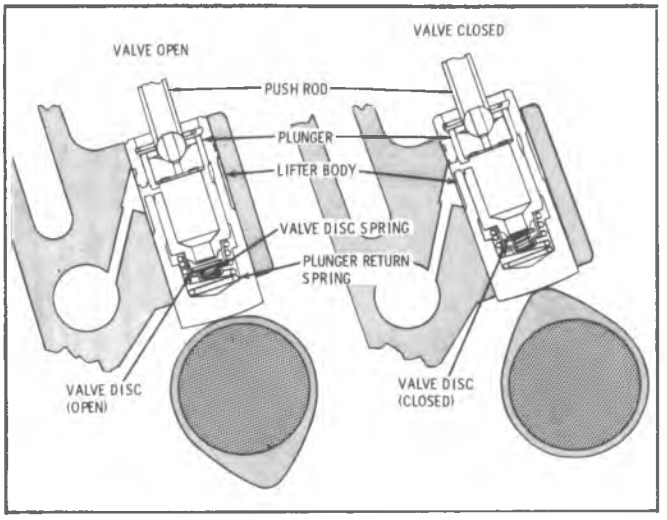


Fig. E-30–Valve Lifter (Cutaway View)

"leak-down" allows a slow escape of trapped oil in the base of the lifter body. As the lifter rides down the other side of the cam lobe and reaches the base circle or "valve closed" position, the plunger spring quickly moves the plunger back (up) to its original position. This movement causes the check valve disc to open against the check valve disc spring and oil from within the plunger is drawn into the base of the lifter. This restores the lifter to zero lash.

(NOTE: Hydraulic valve lifters are not the same as used in gasoline engines.)

Removal

(NOTE: Valve lifters and push-rods should be kept in order so they can be reinstalled in their original position. Some engines will have both standard and .010" oversize valve lifters, the .010" oversize lifter is etched "O" on the side of the lifter. The cylinder block will also be marked if the oversize lifter is used. Fig. E-31)

1. Refer to "INTAKE MANIFOLD" for removal.
2. Remove valve covers, rocker arm assemblies and push-rods.
3. Remove valve lifters.

Disassembly

1. Remove retainer ring with Tool BT-31 or small screwdriver.
2. Remove push-rod seat and oil metering valve.
3. Remove plunger and plunger spring.
4. Remove check valve retainer from plunger, then remove valve and spring.

Cleaning and Inspection

After lifters are disassembled, all parts should be cleaned in clean solvent. A small particle of foreign material under the check valve will cause malfunctioning of the lifter. Close inspection should be made for nicks, burrs or scoring of

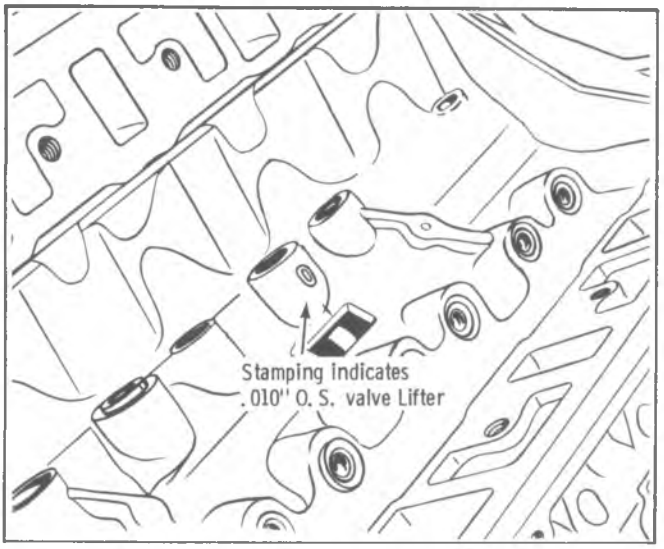


Fig. E-31–O.S. Valve Lifter Identification

parts. If either the body or plunger is defective, replace with a new lifter assembly.

Whenever lifters are removed, check the lifter foot for abnormal wear as follows:

1. Place a straight edge across the lifter foot.

(NOTE: Lifter foot must be clean and dry.)

2. While holding the lifter at eye level, check for light between the straight edge and lifter foot.

3. If light indicates a concave surface of the lifter foot, the lifter should be replaced and the camshaft inspected for wear. Wear at the CENTER of the cam base circle is NORMAL. The camshaft should be replaced ONLY when wear is present across FULL WIDTH of cam base circle. Full wear across the nose of the cam is normal.

(NOTE: Assembly and Valve Lifter Leak Down Test).

4. Assemble valve disc spring and retainer into plunger. (Fig. E-32) Make sure retainer flange is pressed tight against bottom of recess in plunger.

5. Install plunger spring over check retainer.

6. Hold plunger with spring up and insert into lifter body. Hold plunger vertically to prevent cocking spring.

7. Assemble oil metering valve and push rod seat and seat retaining ring in groove.

(NOTE: Lifters must be assembled while submerged in Hydraulic Lifter Test Fluid BT-59 and leak-down tested before placing into service.)

8. Install adapter BT-105-2 in reservoir of Tester BT-60, then fill reservoir with kerosene to 1/2" below top of reservoir.

9. Place assembly into the tester cup, then position oil control valve and push-rod seat onto plunger.

10. Position the 1/4" steel ball on the push-rod seat. Lower tester ram until it contacts the steel ball.

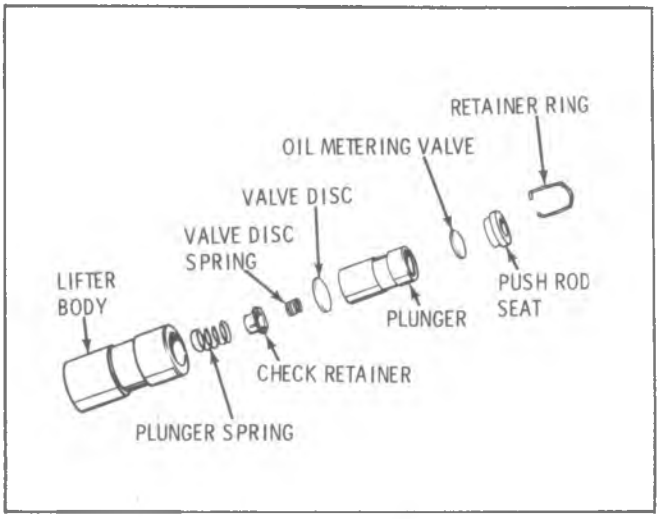


Fig. E-32–Valve Lifter Disassembled

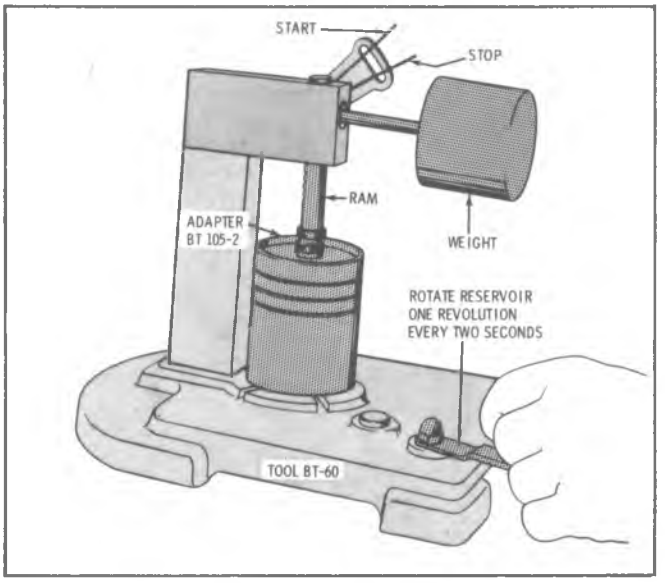


Fig. E-33–Valve Lifter Testing

11. Allow ram to move downward by its own weight until air bubbles disappear.

12. Raise ram, then allow to lower. Repeat this procedure several times or until all air is expelled from lifter.

(NOTE: Do not attempt to expel air from lifter by pumping on ram.)

13. After all air is expelled, allow ram to bleed down lifter until retaining groove is exposed.

14. Install retaining ring.

15. Adjust ram screw so that it contacts the steel ball in the push-rod seat when the pointer is at the start line.

16. Raise arm, then start test by resting ram on steel ball. Rotate reservoir one revolution every two seconds and time the indicator from the start to the stop line. (Fig. E-33) Allowable leak-down rate is six seconds minimum for used lifters and 9 to 60 seconds for new lifters.

17. If leak-down tolerance is within specifications, the lifter can be placed in service without removing test fluid.

VALVE LIFTER BLEED DOWN

If the intake manifold has been removed and if any rocker arms have been loosened or removed; it will be necessary to remove those valve lifters, disassemble to remove the oil. Refill after assembly by working lifter plunger while lifter is submerged in clean fuel oil. See "VALVE LIFTER DISASSEMBLY".

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

(NOTE: The lifters can be bled down for six cylinders at a time in either of the following two positions.)

1. For cylinders number 3, 5, 7, 2, 4 & 8 turn the crankshaft so the saw slot on the harmonic balancer is at 0° on the timing indicator. For cylinders number 1, 3, 7, 2, 4 & 6 turn the crankshaft so the saw slot on the harmonic balancer is at 4 O'Clock position.
2. Tighten the rocker arm pivot bolts to 25 ft. lbs.

(NOTE: It will take up to 45 minutes at each position for the valve lifters to be completely bled down.)

CAUTION: Do not rotate the engine until the valve lifters have been bled down, or damage to the valve train could occur.

3. Finish reassembling the engine as the lifters are being bled.

Valve Lifter Diagnosis

1. Momentarily Noisy When Car Is Started:

This condition is normal. Oil drains from the lifters which are holding the valves open when the engine is not running. It will take a few seconds for the lifter to fill after the engine is started.

2. Intermittently Noisy On Idle Only, Disappearing When Engine Speed Is Increased:

Intermittent clicking may be an indication of a pitted check valve disc, or it may be caused by dirt.

Correction: Clean the lifter and inspect. If check valve disc is defective, replace lifter.

3. Noisy At Slow Idle Or With Hot Oil, Quiet With Cold Oil Or As Engine Speed Is Increased:

Leak check the suspected lifters and replace any lifters that do not meet specifications.

4. Noisy At High Car Speeds And Quiet At Low Speeds:

a. High oil level - Oil level above the "Full" mark allows crankshaft counterweights to churn the oil into foam. When foam is pumped into the lifters, they will become noisy since a solid column of oil is required for proper operation.

Correction: Drain oil until level is correct.

b. Low oil level - Oil level below the "Add" mark allows air to get into the pump at high speeds which results in noisy lifters.

Correction: Fill until oil level is correct.

c. Oil pan bent on bottom or pump screen cocked, replace or repair as necessary.

5. Noisy At Idle Becoming Louder As Engine Speed Is Increased To 1500 rpm:

This noise is not connected with lifter malfunction. It becomes most noticeable in the car at 10 to 15 mph "L" range, or 30 to 35 mph "D" range and is best described as a hashy sound. At slow idle, it may be entirely gone or appear as a light ticking noise in one or more valves. It is caused by one or more of the following:

a. Badly worn or scuffed valve tip and rocker arm pad.
b. Excessive valve stem to guide clearance.
c. Excessive valve seat runout.
d. Off square valve spring.
e. Excessive valve face runout.
f. Valve spring damper clicking on rotator.

To check valve spring and valve guide clearance remove the valve covers:

a. Occasionally this noise can be eliminated by rotating the valve spring and valve. Crank engine until noisy valve is off its seat. Rotate spring. This will also rotate valve. Repeat until valve becomes quiet. If correction is obtained, check for an off square valve spring. If spring is off square more than 1/16" in free position, replace spring. (Fig. E-34)

b. Check for excessive valve stem to guide clearance. If necessary, correct as required.

6. Valves Noisy Regardless Of Engine Speed:

This condition can be caused by foreign particles or excessive valve lash.

Check for valve lash by turning engine so the piston in that cylinder is on top dead center of firing stroke. If valve lash is present, the push-rod can be freely moved up and down a certain amount with rocker arm held against valve. If OK, clean suspected valve lifters.

Valve lash indicates one of the following:

a. Worn push-rod.

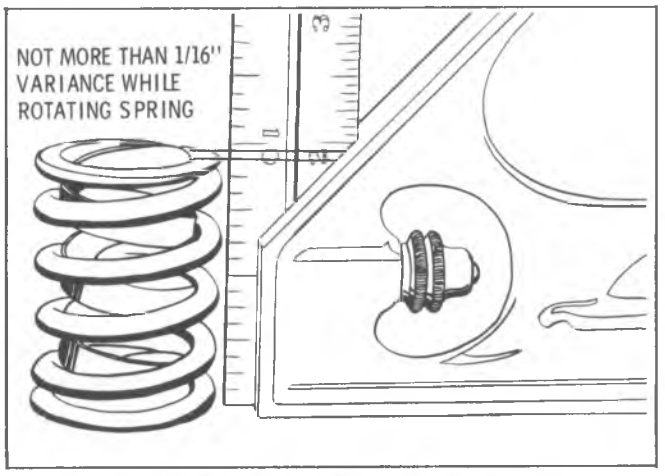


Fig. E-34—Checking Valve Spring

b. Worn rocker arm.

c. Lifter plunger stuck in down position due to dirt or carbon.

d. Defective lifter.

Checking of the above four items:

1. Look at the upper end of push-rod. Excessive wear of the spherical surface indicates one of the following conditions.

a. Improper hardness of the push-rod ball. The push-rod and rocker arm must be replaced.

b. Improper lubrication of the push-rod. The push-rod and rocker arm must be replaced. The oiling system to the push-rod should be checked.

2. If push-rod appears in good condition and has been properly lubricated, replace rocker arm and recheck valve lash.

3. If valve lash exists and push-rod and rocker arm are okay, trouble is in the lifter. Lifter should be replaced.

Installation

(NOTE: Prime new lifters by working lifter plunger while submerged in clean fuel oil. Lifter could be damaged when starting engine if dry.)

1. When a rocker arm is loosened or removed, valve lifter bleed down is required. Refer to "VALVE LIFTER BLEED DOWN". Lifters must be bled down to prevent the piston from hitting the valves.

2. Install lifters and push-rods into original position in cylinder block. See note under Removal.

3. Install manifold gaskets and manifold.

4. Position rocker arms, pivots and bolts on cylinder head as shown in Fig. E-35.

5. Install valve covers.

6. Install intake manifold assembly.

INJECTION NOZZLE (WITH LINES REMOVED)

Removal

1. Remove the fuel return line clamps from all nozzles on the bank where a nozzle is to be removed, then remove that fuel return line.

2. Remove nozzle spring clamp and spacer then remove nozzle using Tool J-26952.

3. Cap the nozzle fuel line and the tip of the nozzle.

(Note: Always protect the tip of the nozzle to prevent damage.)

Installation

1. If a nozzle is to be reinstalled after removal, a new compresson seal and carbon stop seal must be installed after removal of the used seals. See Fig. E-36 for seal installation.

2. Remove protective caps then install injection nozzle and spring clamp and spacer. Torque bolt to 25 ft. lbs. (Fig. E-37)

3. Install fuel return lines and clamps.

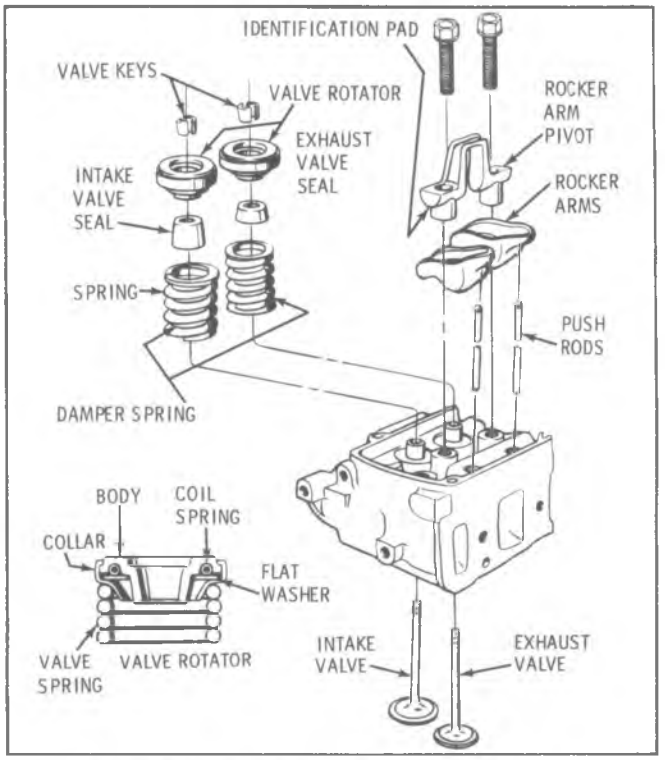


Fig. E-35–Valve Springs and Rocker Arms

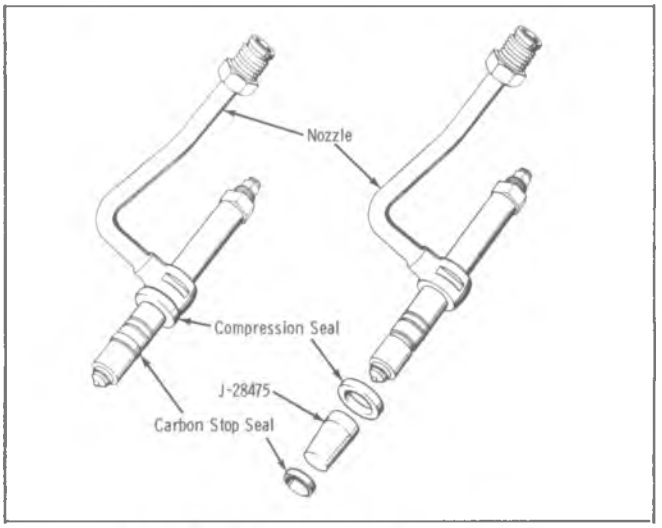


Fig. E-36–Installation of Nozzle Seals

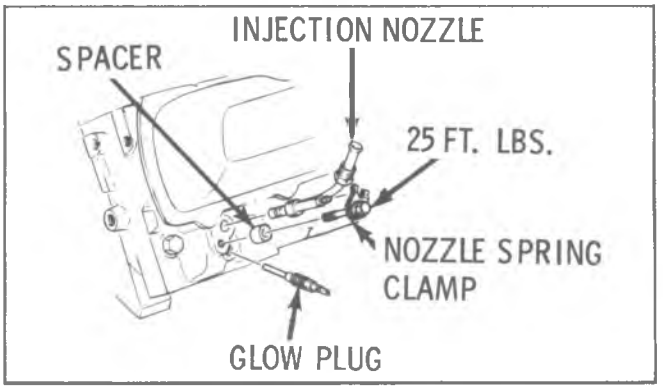


Fig. E-37–Injection Nozzle Installation

CYLINDER HEAD AND GASKET

Removal

1. Remove intake manifold. See "INTAKE MANIFOLD" for removal.
2. Remove valve cover.

(NOTE: Loosen or remove any accessory brackets which interfere.)

3. Disconnect glow plug wiring.
4. Remove ground strap from right cylinder head.
5. Remove rocker arm bolts, pivots, rocker arms and push rods.

(NOTE: Scribe pivots and keep rocker arms separated so they can be installed in their original locations.)

6. Remove fuel return lines from nozzles.
7. Remove exhaust manifold.
8. Remove engine block drain plug on the side of cylinder head removal.
9. Remove cylinder head bolts and remove cylinder head.
10. If necessary to remove pre-chamber, remove the glow plug and nozzle, then tap out with a small blunt drift.

Installation

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

(NOTE: No additional sealer can be used when installing the head gaskets as the passage surfaces are sealed when the gaskets are made using a newly developed method and material. This sealer is accurately printed on the surface of the gasket in the exact quantity required and provides the desired bond between the head and the block. Applying additional sealer would only result in the possiblity of leakage.)

Install pre-chamber, if removed. The pre-chamber can only be installed in one position. (Fig. E-38) Use a small mallet and install in cylinder head. Install glow plug.

(NOTE: The pre-chamber can be .003" below to .003" above the head surface.)

Clean and dip cylinder head bolts in engine oil, torque bolts to 100 ft. lbs. in sequence shown, then re-torque in sequence to 130 ft. lbs. (Figs. E-39 and E-40)

(NOTE: Torque head bolts before installing rocker arms and pivots.)

VALVES AND SPRINGS WITH HEAD REMOVED

Removal

1. Remove valve keys by compressing valve spring with a tool such as BT-6413-2.
2. Remove valve spring rotators or retainers and springs.
3. Remove oil seals from valve stems.
4. Remove valves. Keep valves separated so they can be installed in their original locations. (Fig. E-41)

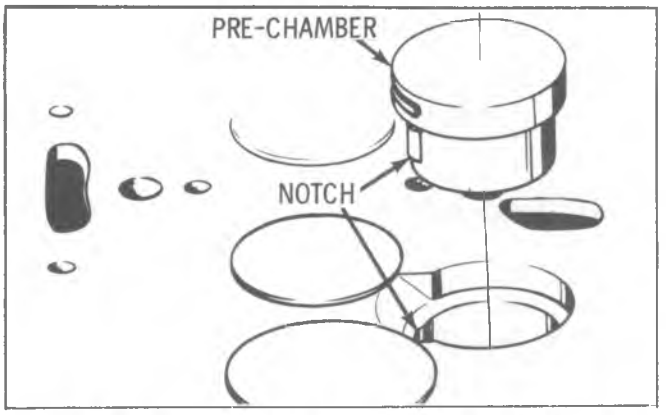


Fig. E-38—Installing Pre-Chamber In Cylinder Head

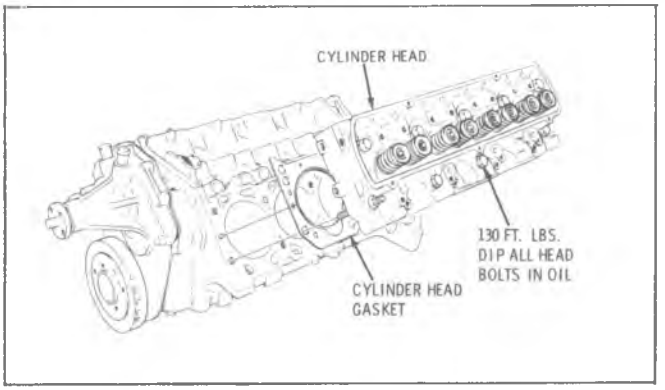


Fig. E-39—Cylinder Head and Gasket

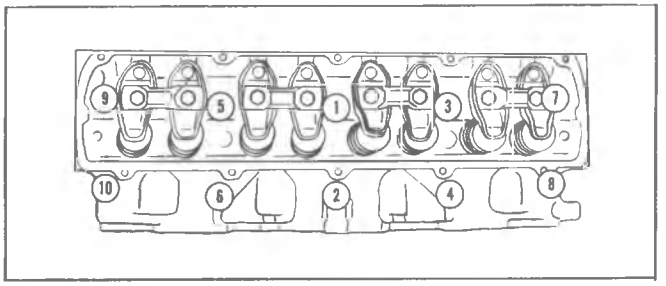


Fig. E-40—Cylinder Head Torque Sequence

Installation

1. Install valves in their respective guides.

VALVE SEAL IDENTIFICATION

Intake	
Std. - .005" O.S.	Gray Colored
.010" - .013" O.S.	Orange Colored
Exhaust	
Std. - .005" O.S.	Ivory Colored
.010" - .013" O.S.	Blue Colored

2. Install new oil seals over valve stem, using Tool BT-6804. (Fig. E-42)

Position seals down as far as possible on valve stem. The seals will correctly position themselves when the engine is started.

(NOTE: Inspect seal for cracks after installation.)

3. Position valve springs over valve stems.

4. Install valve rotators then compress springs with a tool such as BT-6413-2 and install valve stem keys.

5. Check valve springs and keys to be sure they are properly seated.

6. Install exhaust manifold. Torque bolts and nuts to 25 ft. lbs. Bend exhaust manifold bolt lock tabs.

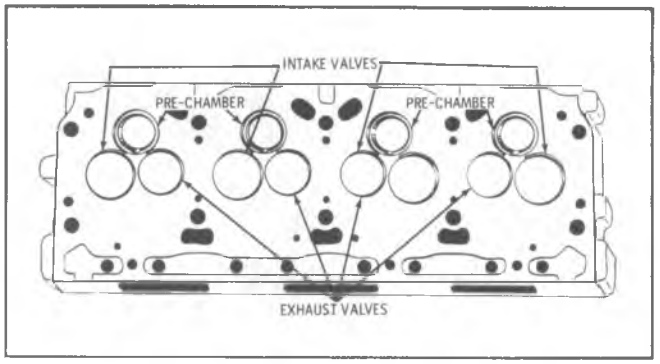


Fig. E-41—Valve Location

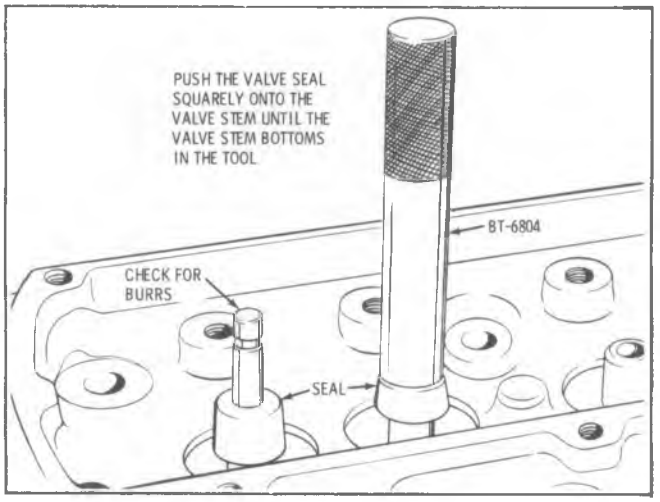


Fig. E-42—Valve Seal Installation

Reconditioning Valves

When reconditioning valves and valve seats, clean carbon from cylinder heads and valves using care not to gouge or scratch machined surfaces. A soft wire brush is suitable for this purpose. Whenever valves are replaced or new valves installed, the valve seats must be reconditioned. (Fig. E-43)

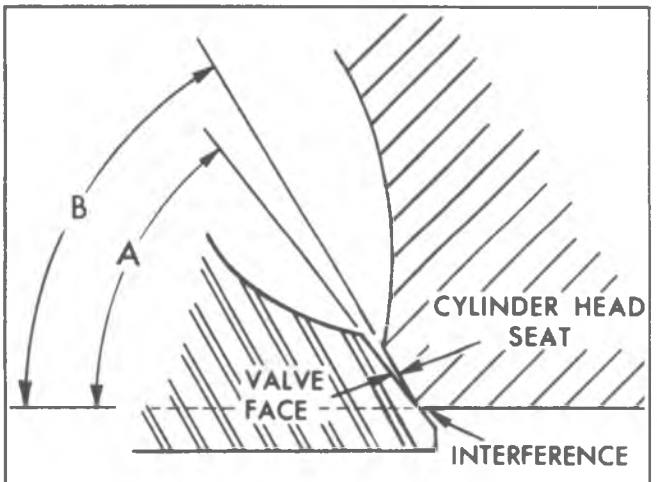
Narrow the valve seats to the specified width.

(NOTE: This operation is done by grinding the portside with a 30° stone to lower the seat and a 60° stone to raise the seat.)

See "ENGINE SPECIFICATION" chart for valve seat width.

(NOTE: Intake valve seats are induction hardened and must be ground, not cut.)

If valve guide bores are worn excessively, they can be reamed oversize. This will require replacement of the valves with oversize valves (stems). The guide bores should be reamed before grinding the valve seats. Valve clearance in guide bore should be .0015" to .0032" (exhaust) or .001" to .0027" for the intake valve.



TYPE	HEAD DIAMETER	VALVE FACE ANGLE	VALVE SPRING DAMPER	VALVE SEAT INSERT	INDUCTION HARDENED VALVE SEAT
Intake	1.875"	44°	Yes	No	Yes
Exhaust	1.625"	30°	Yes	No	No

Fig. E-43—Valve Face and Seat Angles

Measuring Valve Stem Height

Whenever a new valve is installed, or after grinding valves, it will be necessary to measure valve stem height as follows:

Install gage BT-6428 as shown in Fig. E-44.

There should be at least .015" clearance on all valves between gage surface and end of valve stem. (Valve stem can be gaged with or without the valve rotator on the valve.) If clearance is less than .015", remove valve and grind tip of valve stems as required on a valve refacing machine, using the "Vee" block attachment to insure a smooth 90° end. Also be certain to break sharp edge on ground valve tip. Observe an original valve to determine chamfer.

After all valve keys have been installed on valves, tap each valve stem end with a mallet to seat valve rotators and keys. Using gage BT-6428 as shown in Figs. E-44 and E-45, re-gage all valves between valve stem and gage (.015" minimum) and valve rotator and gauge (.030" minimum). If any valve stem end is less than .005" above rotator, the valve is too short and a new valve must be installed.

EXAMPLE:

Valve Rotator to Gage Clearance	.038″
Minus Valve Stem to Gage Clearance	-.035″ – .003″

This is less than .005″ and a new valve should be installed.

(NOTE: There must be a minimum of .030″ clearance between valve rotator and gage. Failure to maintain this clearance will cause rocker arm and valve rotator interference.)

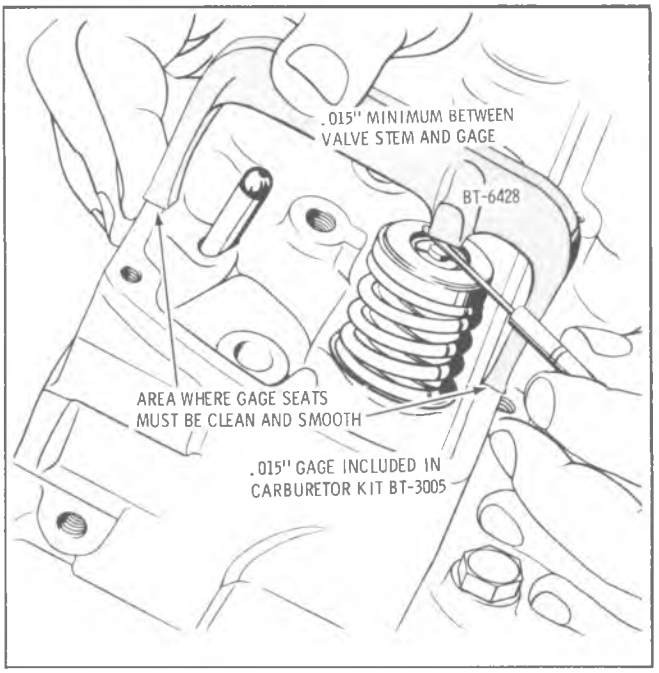


Fig. E-44–Measuring Valve Stem Height

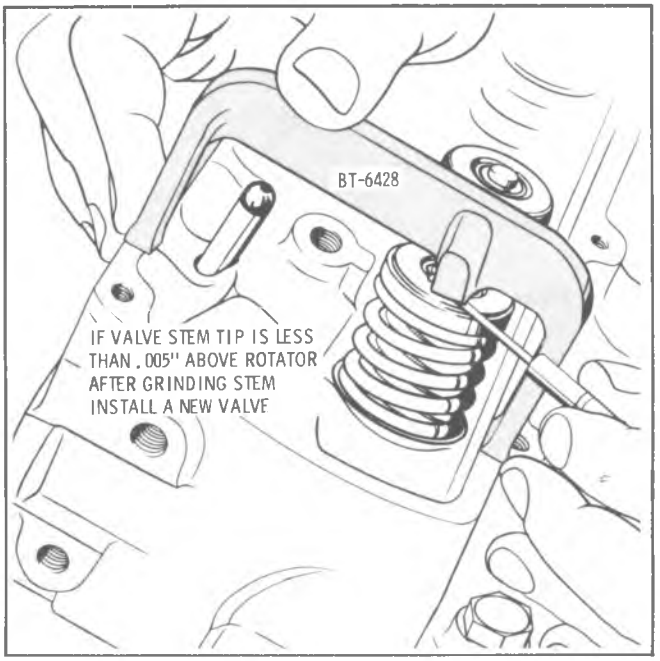


Fig. E-45–Measuring Rotator Height

VALVE GUIDE BORES

If the valve guide bores are worn excessively, they can be reamed oversize. The following reamers are available:

BT-6414-1 . . . . . .003″ Oversize Valve Guide Reamer
BT-6414-4 . . . . . .005″ Oversize Valve Guide Reamer
BT-6414-3 . . . . . .013″ Oversize Valve Guide Reamer

If a standard or .003″ O.S. valve guide bore is being reamed, use the .003″ oversize reamer. For the .005″ oversize valve guide bore, use the .005″ oversize reamer; use the .013″ reamer for the .010″ or .013″ O.S. valve guide bore. If too large a reamer is used and the spiraling is removed, the valve may not receive the proper lubrication.

Occasionally a valve guide bore will be oversize as manufactured. These are marked on the inboard side of the cylinder heads on the machined surface just above the intake manifold surface. (Fig. E-46) These markings are visible without removing any parts other than the air cleaner assembly. Before removing the cylinder heads to perform service to either the valves or valve guide bores, the cylinder heads should be inspected to determine if these markings are present. If no markings are present, the guide bores are standard. If oversize markings are present, any valve replacement will require an oversize valve. If the oversize marking is present, only that particular bore would be oversize, not all bores in that cylinder head. Service valves are available in five different stem diameters: Standard, .003″ oversize, .005″ oversize, .010″ oversize, and .013″ oversize.

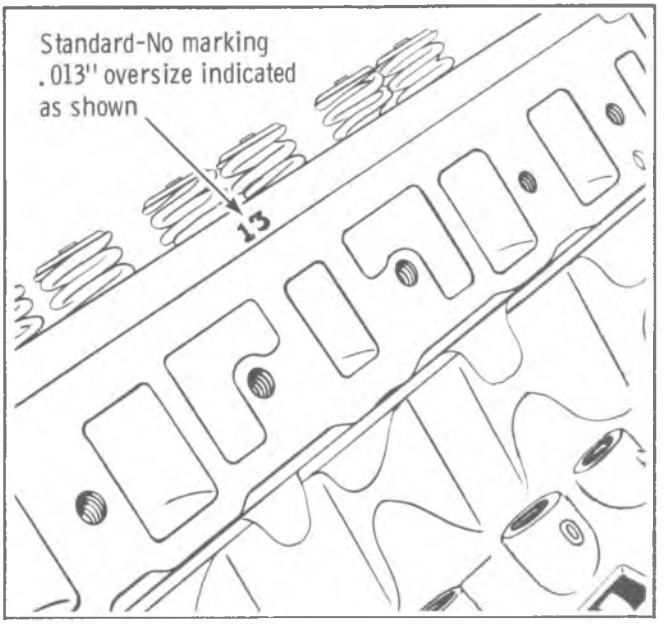


Fig. E-46–Valve Guide Bore Marking

REAMING PROCEDURE

Before attempting to ream the valve guide bores they should be cleaned using Tool BT-6415 as shown in Fig. E-47.

This procedure to ream valve guide bores using Tool BT-6414 is shown in Fig. E-48. Use care to hold reamer straight in valve guide bore.

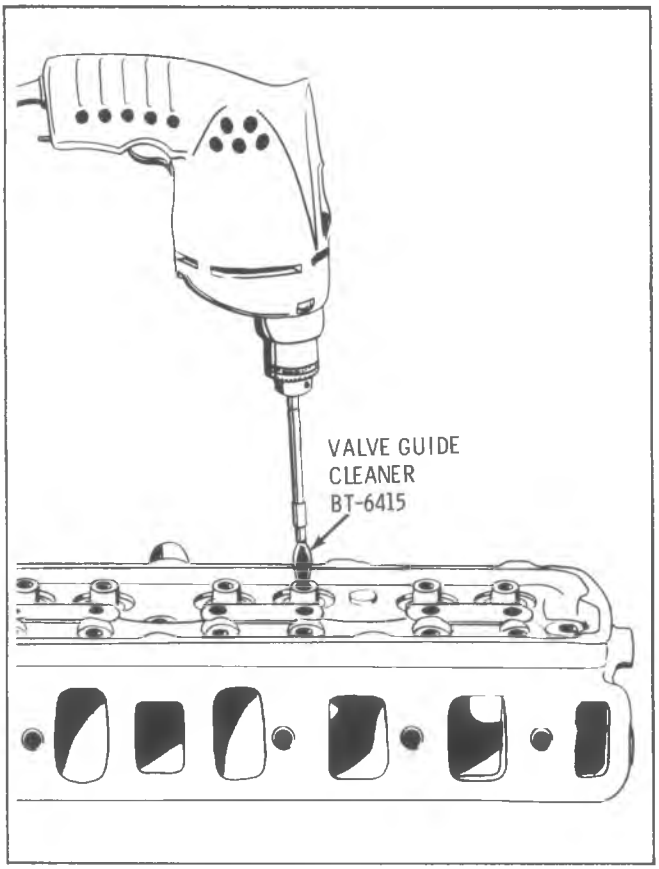


Fig. E-47–Cleaning Valve Guide Bores

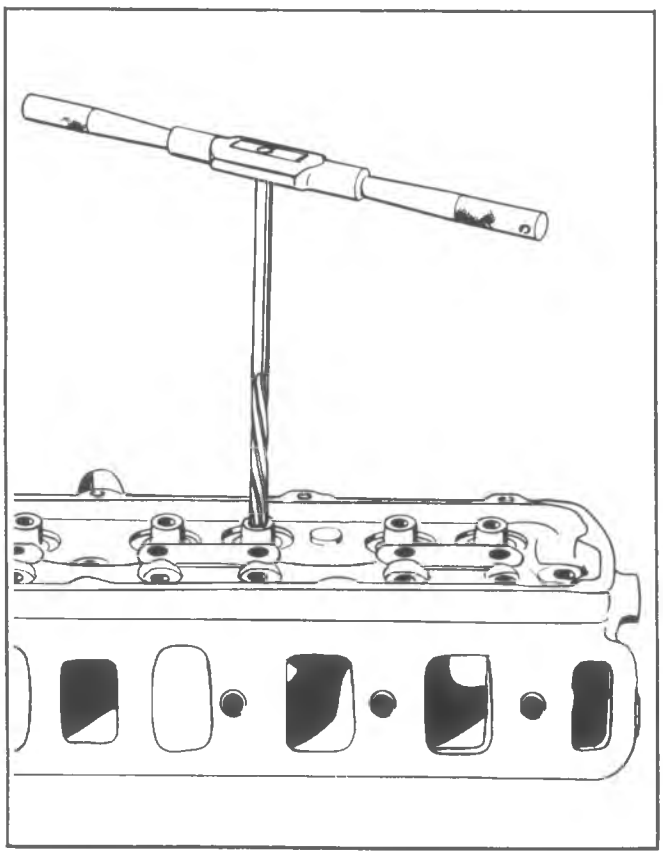


Fig. E-48–Reaming Valve Guide Bores

REPLACING VALVE SPRING (HEAD ON ENGINE)

To replace a worn or broken valve spring without removing the cylinder head proceed as follows:

Removal

1. Remove rocker arm assemblies.
2. Rotate engine so piston is at top dead center for each cylinder.
3. Install Tool BT-6413 (Fig. E-49) and compress the valve spring until valve keys are accessible; then remove keys, valve rotators and springs.

(NOTE: If valve spring does not compress, tap tool with a mallet to break bind at rotator and keys.)

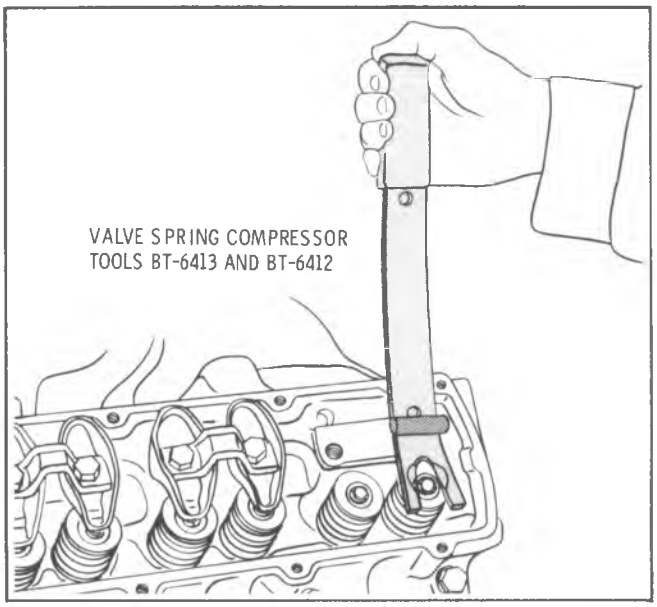


Fig. E-49–Removing Valve Spring

CHECKING ROTATORS

The rotators cannot be disassembled and require replacement only when they fail to rotate the valve.

Rotator action can be checked by applying a daub of paint across the top of the body and down the collar. Run engine approximately 1500 rpm. There should appear to be motion between the body and collar; the body will appear to "walk" around the collar. Rotator action can be either clockwise or counterclockwise. Sometimes on removal and reinstallation, the direction of rotation will change but this does not matter so long at it rotates.

Any time the valves are removed for service the tips should be inspected for improper pattern which could indicate valve rotator malfunction. (Fig. E-50)

Installation

1. Install valve spring and rotator. Using Tool BT-6413, compress the valve spring until the valve keys can be installed.
2. Install rocker arm assemblies.
3. Bleed valve lifters where rocker arm pivots were loosened. Refer to "VALVE LIFTER BLEED DOWN".

2. Remove the cotter pin, spring and the pressure regulator valve.

(NOTE: Position thumb over pressure regulator bore before removing cotter pin, as the spring is under pressure.)

3. Remove the oil pump cover attaching screws and remove the oil pump cover and gasket.

4. Remove the drive gear and idler gear from the pump body.

Inspection

Check the gears for scoring or other damage. If they are damaged, new gears should be installed. During assembly, the gear end clearance should be gauged. Proper end clearance is .0005" to .0075". Also check the pressure regulator valve, valve spring and bore for damage. Proper valve to bore clearance is .0025" to .0050". The checking of gear end clearance will be covered in "Assembly". Check the extension shaft at each end for abnormal wear. The shaft is hardened at both ends and identified by a red dye marking.

Assembly

1. Install the gears and shaft in the oil pump body and check the gear end clearance by placing a straight edge over the gears and measure the clearance between the straight edge and the gasket surface. The clearance should be between .0005" to .0075". If the end clearance is near the excessive reading, check for scores in the cover that would bring the total clearance over the specified amount.

2. Install the cover screws and tighten alternately and evenly. The torque is 8 ft. lbs.

3. Position the pressure regulator valve into the pump cover, closed end first, then install the spring and retaining pin.

(NOTE: When assembling the drive shaft extension to the drive shaft, THE END OF THE EXTENSION NEAREST THE WASHERS MUST BE INSERTED INTO THE DRIVE SHAFT.)

Installation

1. Insert the drive shaft extension through the opening in the main bearing cap and block until the shaft mates into the vacuum pump driven gear.

2. Position pump onto the rear main bearing cap and install attaching bolts. Torque bolts to 35 ft. lbs. (Fig. E-55)

3. Install the oil pan. Refer to OIL PAN Installation.

CONNECTING ROD AND PISTON

Removal

1. Remove intake manifold, head or heads.
2. Remove oil pan.
3. Remove oil pump assembly.

(NOTE: Stamp cylinder number on the machined surfaces of the bolt bosses of the connecting rod and cap for identification when reinstalling. If the pistons are to be removed from the connecting rod, mark cylinder number on piston with a silver pencil or quick drying paint for proper cylinder identification and cap to rod location. The right bank is numbered 2-4-6-8, left bank 1-3-5-7.)

Examine the cylinder bore above ring travel. If ridge exists, remove ridge with ridge reamer before attempting to remove the piston and rod assembly.

4. Remove rod bearing cap and bearing.

5. Install guide hose over threads of rod bolts. This is to prevent damage to bearing journal and rod bolt threads. (Fig. E-56)

6. Remove rod and piston assembly through the top of the cylinder bore.

7. Remove other rod and piston assemblies in the same manner.

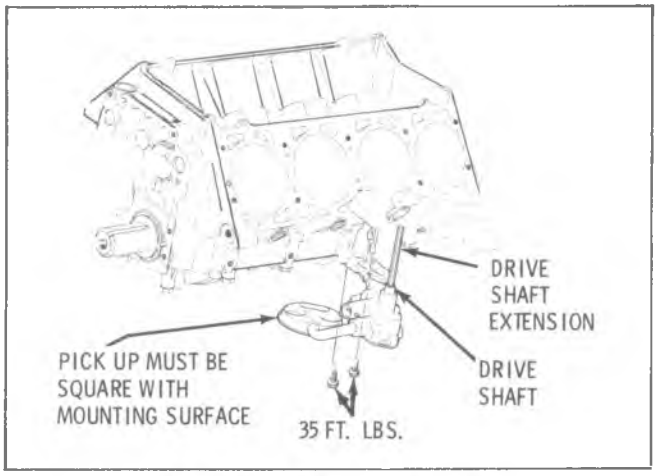


Fig. E-55–Oil Pump Installation

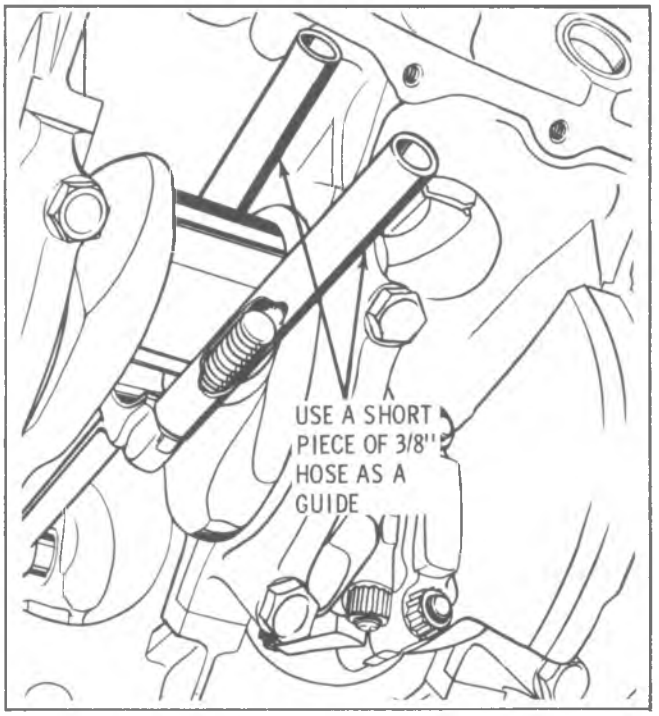


Fig. E-56–Connecting Rod Bolt Guide

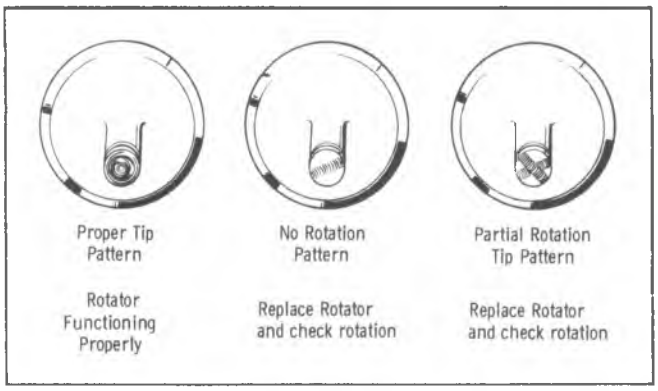


Fig. E-50–Valve Stem Wear

OIL PAN

Removal

1. Remove drive and vacuum pump (with A/C) or oil pump drive (non A/C).
2. Disconnect battery cables. Remove dipstick.
3. Remove upper radiator support and fan shroud attaching screws.
4. Hoist the car and drain oil.
5. Remove flywheel cover.
6. Disconnect exhaust and crossover pipes.
7. Remove oil cooler lines at filter base.
8. Remove starter assembly.
9. Remove engine mounts from engine block, then jack front of engine up, using Engine Support Tool BT-6501. (Fig. E-51)
10. Remove oil pan attaching bolts and remove oil pan.

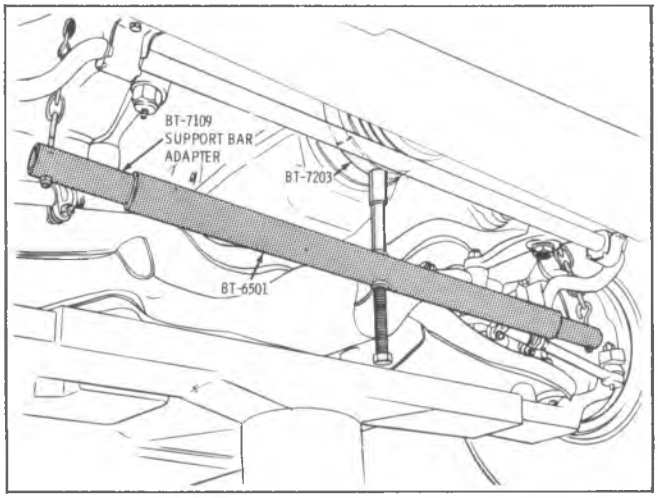


Fig. E-51–Engine Support Tools

Installation (Fig. E-52)

1. Apply 1050805 sealer or equivalent to both sides of pan gaskets and install on block.
2. Install front and rear seal (rubber).
3. Wipe lube, 1050169 or equivalent, on seal area and install pan. Torque bolts to 10 ft. lbs. Install all parts removed, install engine oil.

OIL PUMP

Removal

1. Remove oil pan. (Refer to OIL PAN Removal.)
2. Remove the oil pump to rear main bearing cap attaching bolts, then remove pump and drive shaft extension.

Disassembly (Fig. E-53)

1. Remove the oil pump drive shaft extension.

(NOTE: Do not attempt to remove the washers from the drive shaft extension. The drive shaft extension and washers must be serviced as an assembly. Fig. E-54)

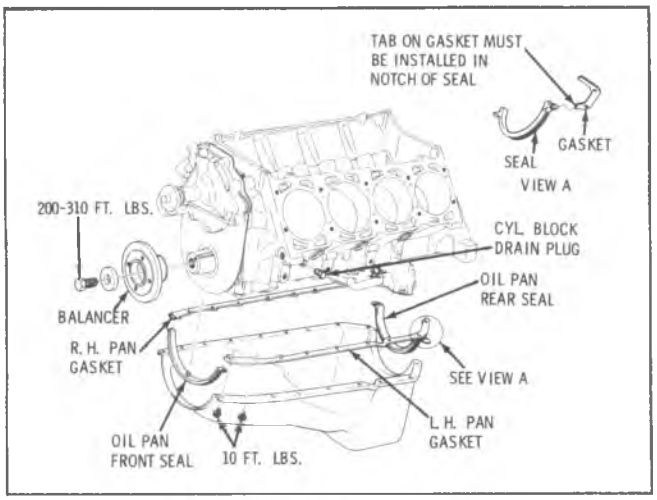


Fig. E-52–Oil Pan Assembly

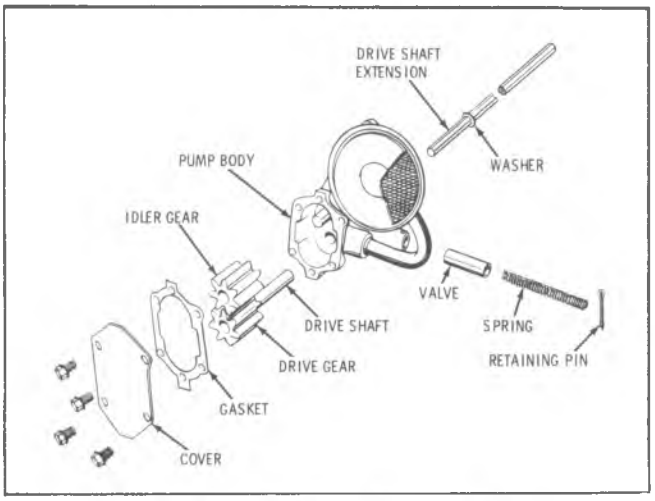


Fig. E-53–Oil Pump Disassembled

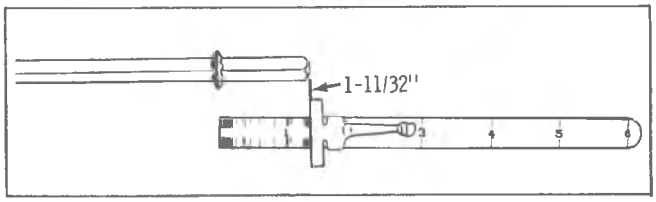


Fig. E-54–Oil Pump Drive Shaft Extension

ROD BEARINGS

The connecting rod bearings are designed to have a slight projection above the rod and cap faces to insure a positive contact.

Connecting rod bearings can be replaced without removing the rod and piston assembly from the engine.

1. Remove oil pan.

(NOTE: It may be necessary to remove oil pump to provide access to rear connecting rod bearings.)

2. With connecting rod journal at the bottom, stamp cylinder number on machined surfaces of connecting rod and cap for identification when reinstalling, then remove caps.

3. Inspect journals for roughness and wear. Slight roughness may be removed with a fine grit polishing cloth saturated with engine oil. Burrs may be removed with a fine oil stone by moving the stone on the journal circumference. Do not move the stone back and forth across the journal. If the journals are scored or ridged, the crankshaft must be replaced.

4. The connecting rod journals should be checked for out-of-round and correct size with a micrometer. Maximum out-of-round must not exceed .0015".

(NOTE: Refer to ENGINE SPECIFICATIONS Chart for more information.)

(NOTE: Crankshaft rod journals will normally be standard size. If any undersized crankshafts are used, all will be .010" U.S. and an "X" will be stamped on the pad at the L.F. upper corner of the block.)

If plastic gaging material is to be used:

5. Clean oil from journal bearing cap, connecting rod and outer and inner surface of bearing inserts. Position insert so that tang is properly aligned with notch in rod and cap. (Fig. E-57)

6. Place a piece of plastic gauging material in the center of lower bearing shell.

7. Remove bearing cap and determine bearing clearances by comparing the width of the flattened plastic gaging material at its widest point with the graduation on the container. The number within the graduation on the envelope indicates the clearance in thousandths of an inch. If this clearance is greater than .0035", replace the bearing and recheck clearance with plastic gaging material.

(NOTE: Lubricate bearing with engine oil before installation. Repeat Steps 2 through 8 on remaining connecting rod bearings. All rods must be connected to their journals when rotating the crankshaft to prevent engine damage.)

(NOTE: Bearings are identified as shown in Fig. E-58.)

8. Measure the rod side clearance as shown in Fig. E-59. Clearance should be .006" to .020".

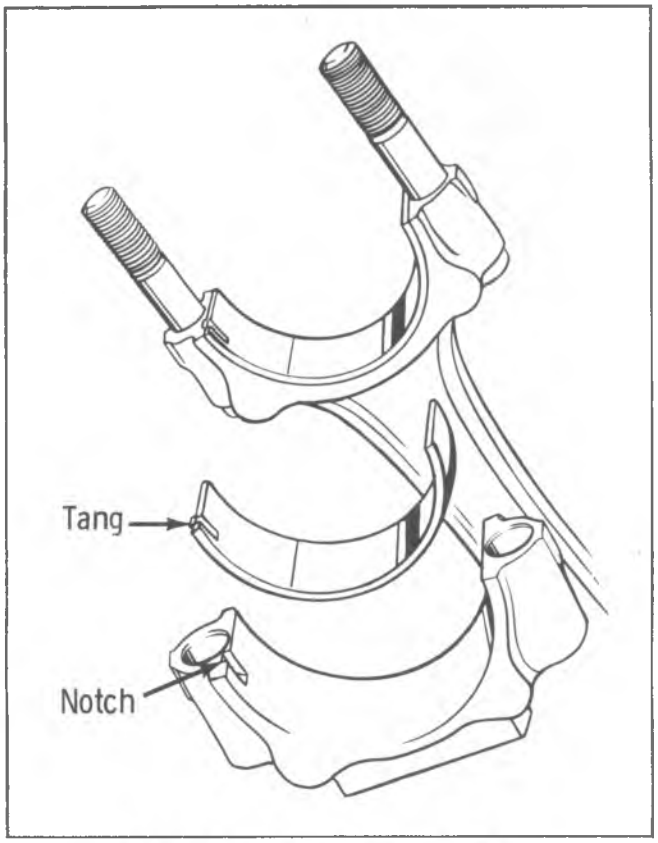


Fig. E-57—Bearing Tang and Notch

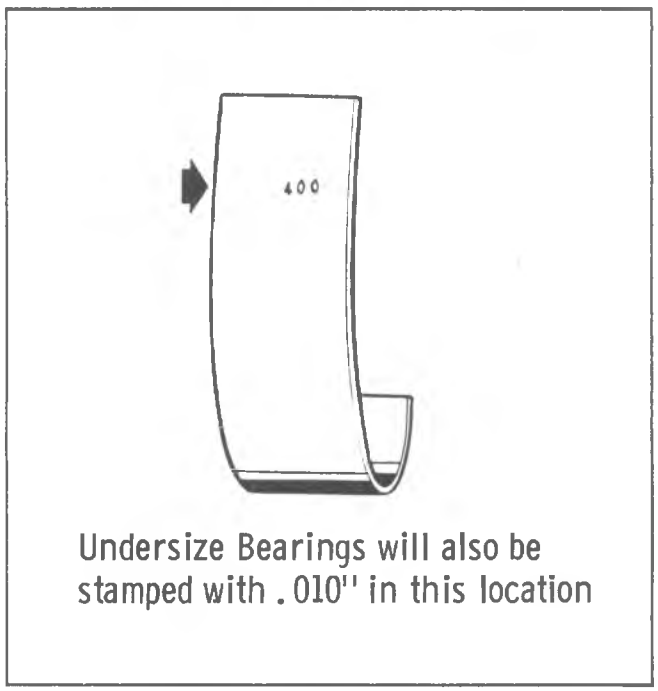


Fig. E-58—Bearing Identification

ROD ASSEMBLY

If a rod is twisted or bent, a new rod must be installed. NO ATTEMPT SHOULD BE MADE TO STRAIGHTEN CONNECTING RODS.

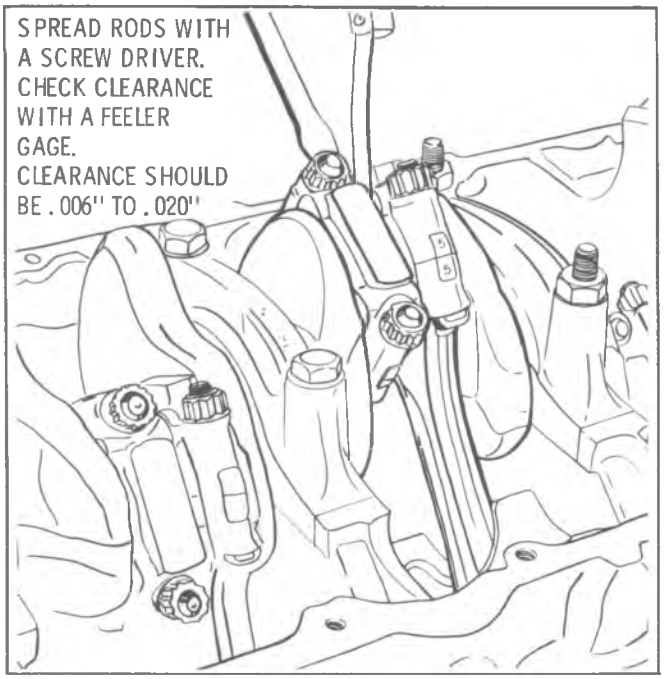


Fig. E-59—Connecting Rod Side Clearance

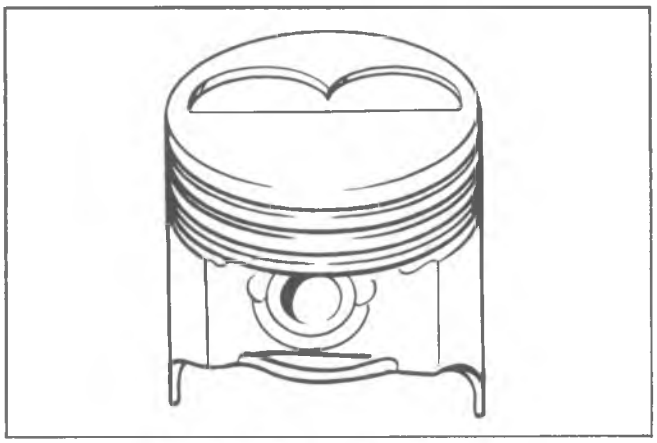


Fig. E-60—Piston Identification

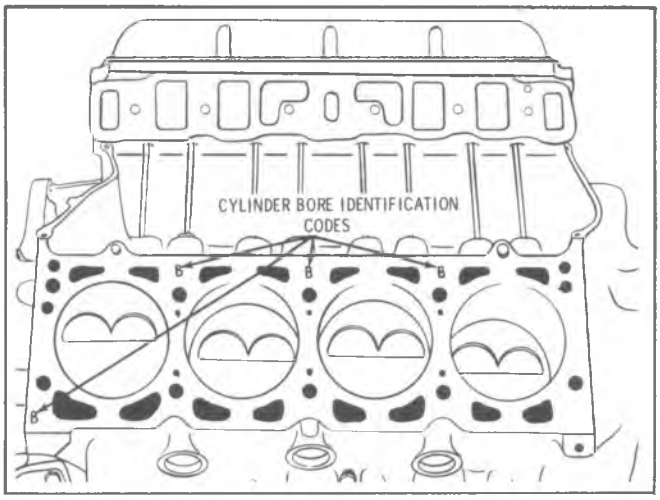


Fig. E-62—Cylinder Bore Marking

MEASURING PISTON

(NOTE: Refer to PISTON INFORMATION CHART FIGURE E-61.)

When replacing pistons, the original cylinder size is stamped with a code letter on the block near each cylinder on the cylinder head surface or on the oil pan rail. (Fig. E-62)

When measuring piston for size or taper, measurement must be made on skirt 90° from piston pin hole (with the piston pin removed). (Fig. E-63)

When measuring taper, measure at the center line of the piston pin hole and at the bottom of the skirt. The largest reading must be at the bottom of the skirt. Allowable taper is .000" to .002".

The piston and cylinder bore must be free of oil and at the same temperature.

(NOTE: On some cars, oversize pistons may be found. These pistons will be .010" oversize.)

Each piston should be fitted to its individual cylinder and marked for that cylinder. Piston to bore clearance is .005" to .006".

BORE DIA.	CYL. BORE SELECTION	BORE SIZES	PISTON SELECTION	PISTON SIZE	PISTON DIA.	PISTON TO CYL. BORE CLEARANCE
4.056-4.058 STD.	A	4.0560-4.0565	A	4.0505 - 4.0510	4.0505 - 4.0525 STD.	.0050 to .0060
	B	4.0565-4.0570	B	4.0510 - 4.0515		
	C	4.0570-4.0575	C	4.0515 - 4.0520		
	D	4.0575-4.0580	D	4.0520 - 4.0525		
4.066-4.068 .010 O.S.	J	4.0660-4.0665	J	4.0605 - 4.0610	4.0605 - 4.0625 .010 O.S.	
	K	4.0665-4.0670	K	4.0610 - 4.0615		
	L	4.0670-4.0675	L	4.0615 - 4.0620		
	M	4.0675-4.0680	M	4.0620 - 4.0625		

Fig. E-61—Piston Information

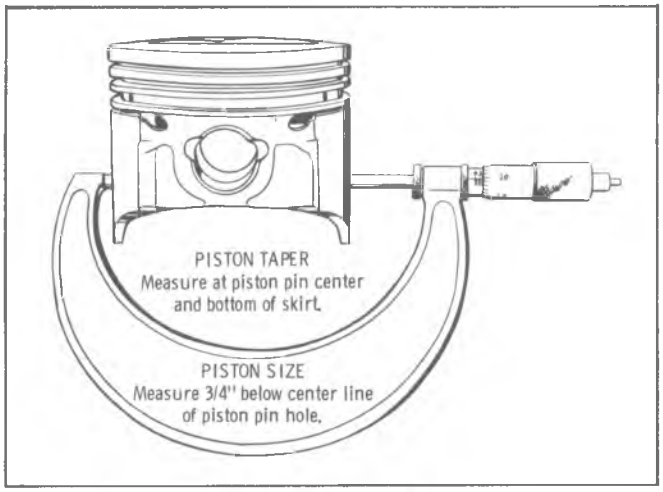


Fig. E-63–Measuring Piston

CHECKING CYLINDER BORE

(NOTE: Refer to PISTON INFORMATION Chart Figure E-61.)

Cylinder bore size can be measured with inside micrometers or a cylinder gauge. Maximum allowable taper of the cylinder bore is .001". The most wear will occur at the top of the ring travel.

Reconditioned cylinder bores should be held to not more than .001" out-of-round and .001" taper.

If the cylinder bores are smooth, the cylinder walls should not be deglazed. If the cylinder walls are scored, the walls may have to be honed before installing new rings. It is important that reconditioned cylinder bores be thoroughly washed with a soap and water solution to remove all traces of abrasive material to eliminate premature wear.

CLEANING PISTON

Clean the pistons by scraping carbon off the top of the piston. Deposits in the ring grooves should be removed with a suitable ring groove cleaning tool. It is important that the ring grooves be completely free of deposits. Pistons do not have oil drain back holes behind the rings.

RINGS (Fig. E-64)

The pistons have three rings (two compression rings and one oil ring). The oil ring consists of two rails and an expander.

Ring Tolerances

When installing new rings, ring gap and side clearance should be checked as follows:

Piston Ring and Rail Gap

Each ring and rail gap must be measured with the ring or rail positioned squarely and at the bottom of the ring-travel area of the bore. (Fig. E-65)

The end gap measurement should be .015" to .025" for compression rings and .015" to .055" for oil rings.

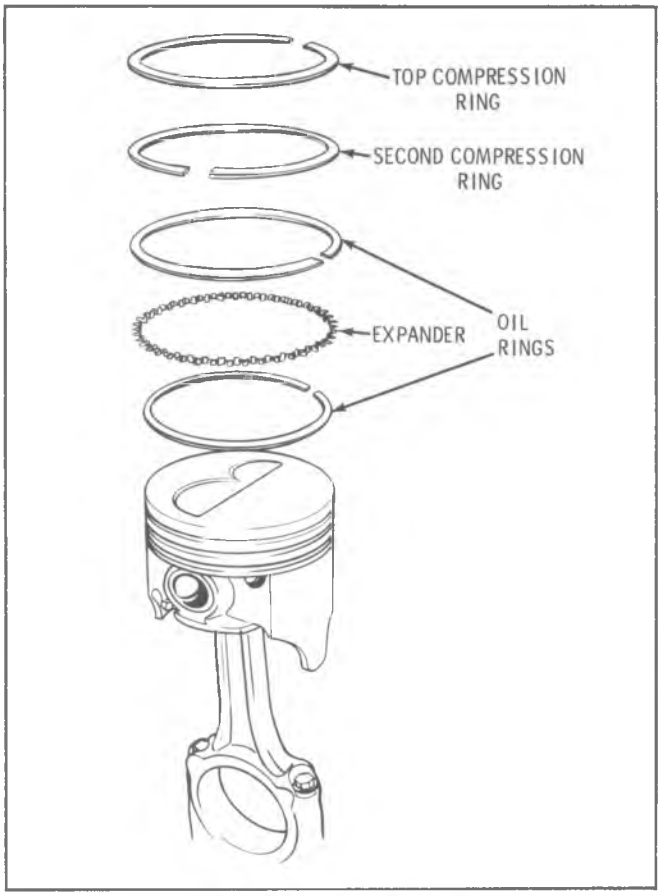


Fig. E-64–Piston Rings

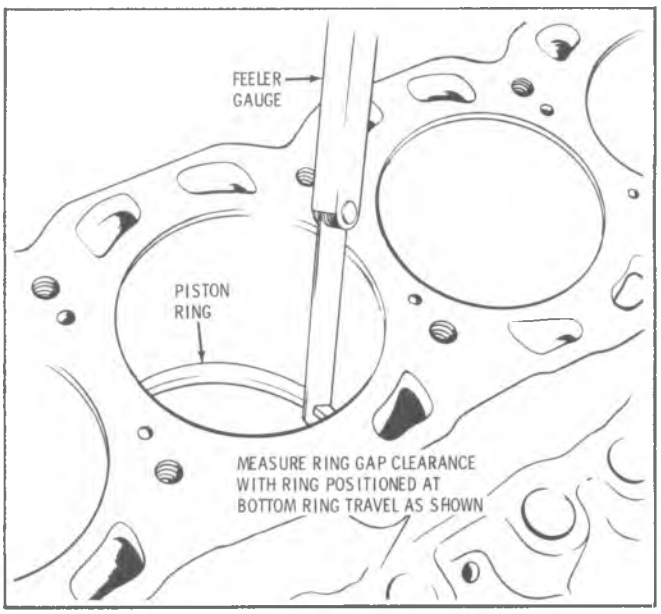


Fig. E-65–Measuring Piston Ring Gap

Side Clearance

Each ring must be checked for side clearance in its respective piston groove by inserting a feeler gage between the ring and its upper land. (Fig. E-66) The piston grooves must be cleaned before checking ring for side clearance.

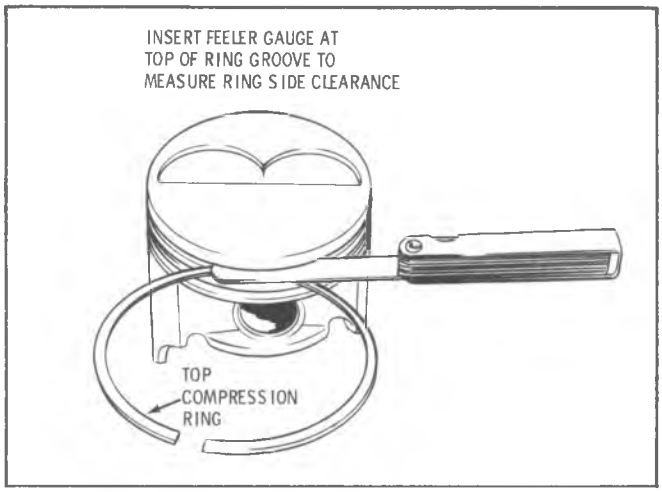


Fig. E-66–Piston Ring Side Clearance

Compression ring top ring clearance is .005″-.007″, lower ring clearance is .0018″-.0038″. Oil ring clearance is .001″ to .005″.

(NOTE: To check oil ring side clearance, the oil rings must be installed on the piston.)

RING INSTALLATION

(NOTE: For service ring specifications and detailed installation instructions, refer to the instructions furnished with the parts package.)

ROD AND PISTON

Installation

1. Install connecting rod bolt guide hose over rod bolt threads. (Fig. E-67)

2. Apply engine oil to rings and piston, then install piston ring compressing tool on piston. (Fig. E-68)

3. Install each piston and rod in its respective cylinder bore so valve depression in top of piston is towards the inner side of engine. (Fig. E-69)

(NOTE: On the forward half of the engine, cylinders 1, 2, 3 and 4, the large valve depression goes to the front. On the rear half of the engine, cylinders 5, 6, 7 and 8, the large valve depression goes to the rear of engine.)

4. Lubricate the crankshaft journal with engine oil and install connecting rod bearing and cap, with bearing index tang in rod and cap on same side.

(NOTE: When more than one rod and piston is being installed, the connecting rod cap attaching nuts should only be tightened enough to keep each rod in position until all have been installed. This will aid in installation of remaining pistons.)

The clearance between the adjacent rods, when checked with a feeler gauge on each crankpin, should be from .006″ to .020″. (Fig. E-70)

5. Torque rod bolt nuts to 42 ft. lbs.

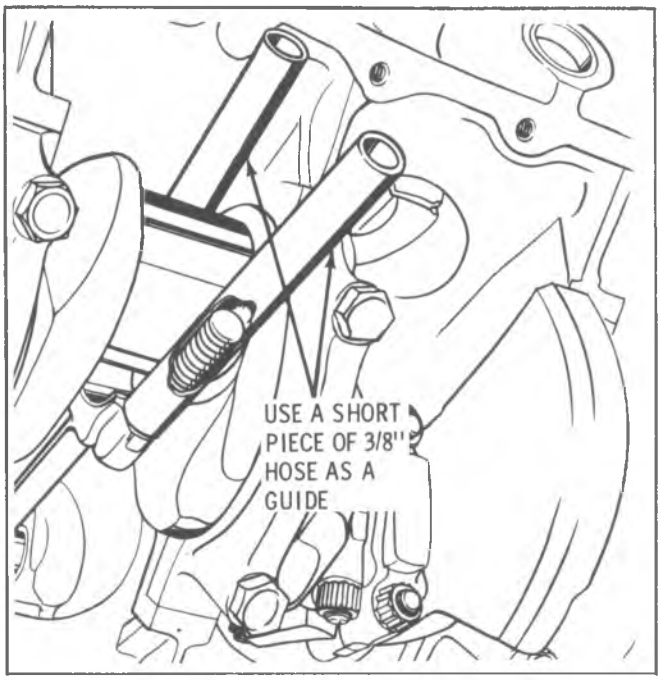


Fig. E-67–Connecting Rod Bolt Guide

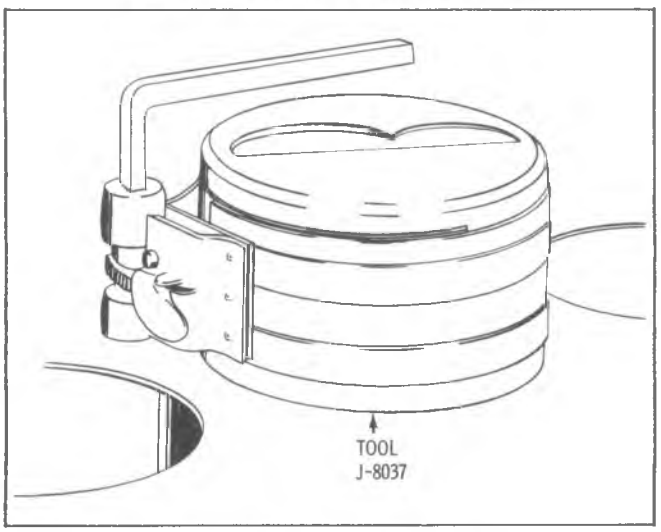


Fig. E-68–Piston Ring Compressor

PISTON PINS

The piston pin is a free floating piston pin and the correct piston pin fit in the piston is .0003″ to .0005″ and rod is .0003″ to .0013″ loose. If the pin to piston clearance is to the high limit (.0005″ piston or .0013″ rod), the pin can be inserted in the piston or rod with very little hand pressure and will fall through the piston or rod by its own weight. If the clearance is .0003″, the pin will not fall through. It is important that the piston and rod pin hole be clean and free of oil when checking pin fit.

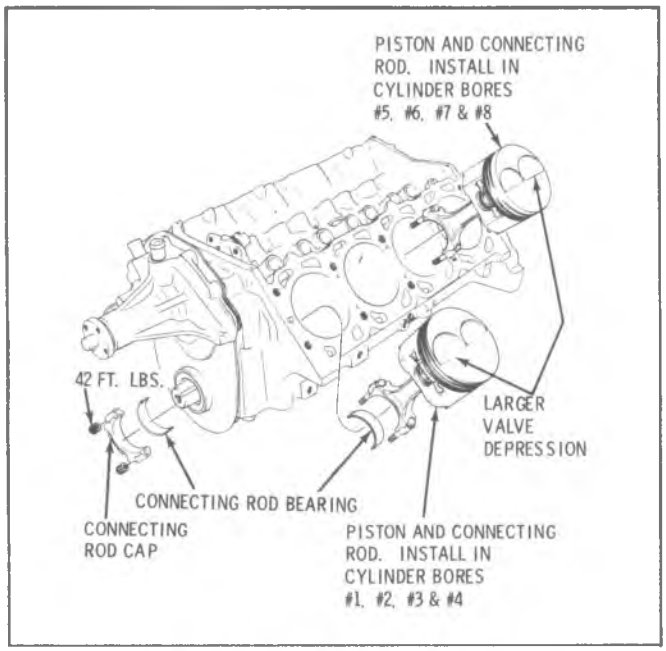


Fig. E-69–Piston Locations In Block

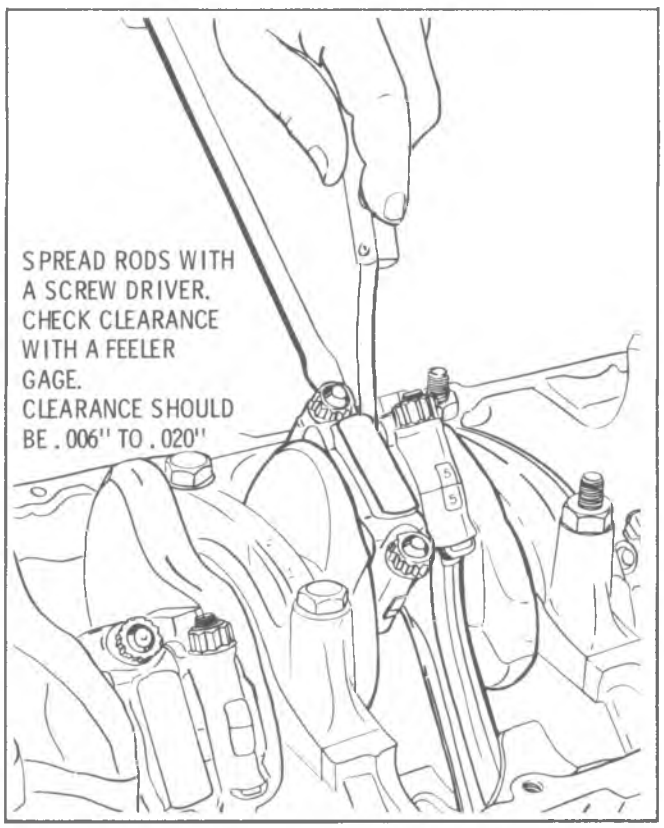


Fig. E-70–Connecting Rod Side Clearance

Whenever the replacement of a piston pin is necessary, remove the snap ring retaining the pin. Then remove pin.

(NOTE: It is very important that after installing the piston pin retaining snap rings that the rings be rotated to make sure they are fully seated in their grooves.)

CRANKSHAFT PULLEY

Removal

1. Remove belt(s).
2. Hoist car.
3. Remove four pulley bolts and pulley.

Installation

1. Install pulley, and four bolts. Torque to 20 ft. lbs.
2. Install belt(s). Adjust belts using Tool BT-7002-3.

BALANCER

Removal

1. Remove belts and crankshaft pulley.
2. Remove balancer hub bolt and washer.
3. Using balancer puller, remove balancer as shown in Fig. E-71.

CAUTION: Use of any other type puller such as a universal claw type which pulls on the outside of the hub can destroy the harmonic balancer. The outside ring of the balancer is bonded in rubber to the hub; by pulling on the outside, rather than the hub, it is possible to break the bond. The T.D.C. is on the outside ring of the balancer; if the bond between the hub and the outside ring is broken, the outside ring could slip which would change the location of the slot.

If it is suspected that the bond between the sections of the harmonic balancer has been broken and the slot position changed, it can be visually checked as shown in Fig. E-72. The center of the keyway should be approximately 16° from the center of the slot. In addition, there are chisel aligning marks between the weight and hub; marks should be together.

Installation

1. Apply sealer 1050805 or equivalent, to inside diameter of pulley hub and to crankshaft key to prevent possible oil leakage. Coat outside area of crankshaft pulley hub which enters seal with Special Seal Lubricant No. 1050169, or equivalent.
2. Install balancer on crankshaft. (Fig. E-73)

(NOTE: Balancer to crankshaft fit is .001" tight to .007" loose.)

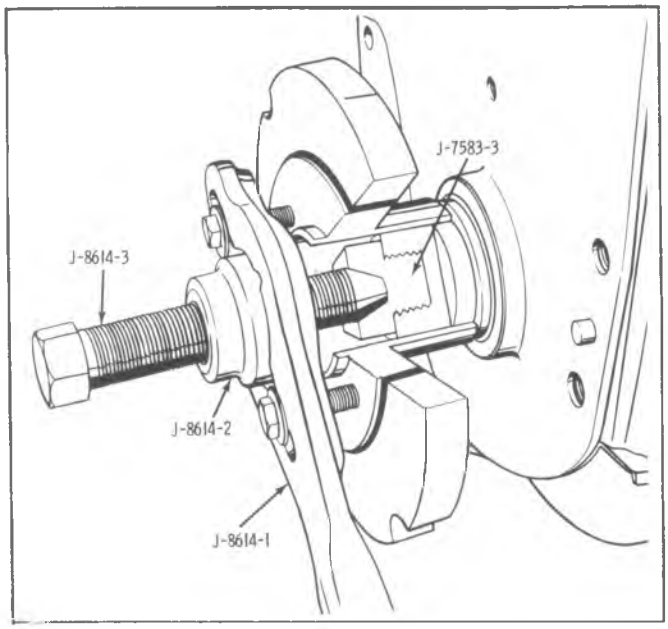


Fig. E-71—Removing Balancer

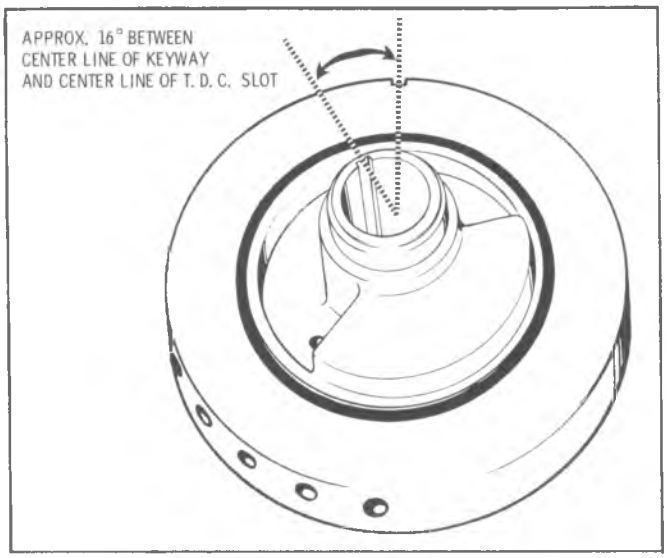


Fig. E-72—Harmonic Balancer

3. Install washer and bolt. Torque 200-310 ft. lbs.

4. Install pulley and belts. Adjust belts using belt adjusting gauge BT-7002-3.

FRONT COVER

Removal

1. Drain cooling system. Disconnect radiator hoses and bypass hose.

2. Remove all belts, fan and fan pulley, crankshaft pulley, harmonic balancer and accessory brackets.

3. Remove cover to block attaching bolts and remove cover, timing indicator and water pump assembly.

4. Remove front cover and both dowel pins. It may be necessary to grind a flat on the pins to get a rough surface for gripping.

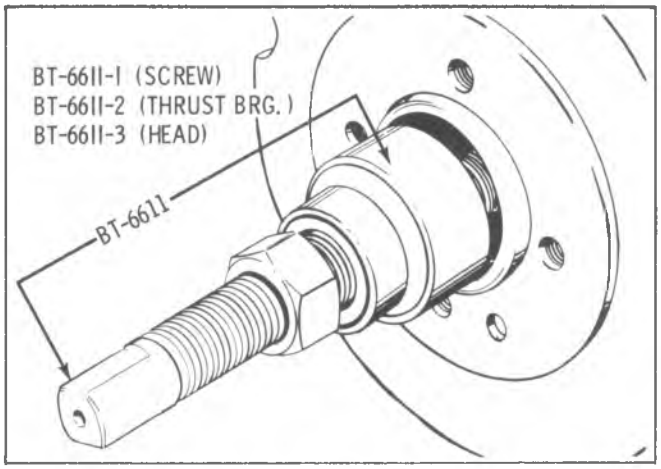


Fig. E-73—Installing Balancer

Installation

1. Grind a chamfer on one end of each dowel pin as shown in Fig. E-74.

2. Cut excess material from front end of oil pan gasket on each side of engine block.

3. Clean block, oil pan and front cover mating surfaces with solvent.

4. Trim about 1/8" from each end of new front pan seal, using a sharp tool as shown in Fig. E-75.

5. Install new front cover gasket on engine block and new front seal on front cover. Apply 1050805 or equivalent sealer to gasket around coolant holes and place on block.

6. Apply R.T.V. sealer at junction of block, pan and front cover as shown in Fig. E-76.

7. Place cover on front of block and press downward to

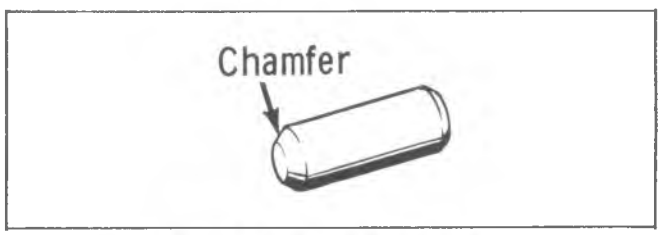


Fig. E-74—Dowel Pin Chamfer

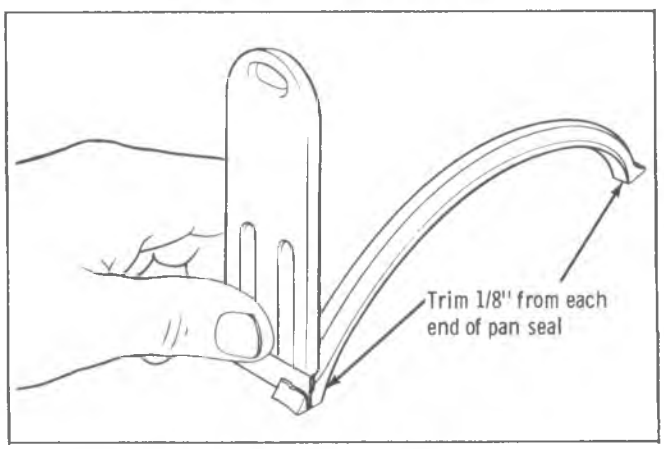


Fig. E-75—Trimming Pan Seals

compress seal. Rotate cover left and right and guide pan seal into cavity using a small screwdriver as shown in Fig. E-77.

8. Apply engine oil to bolts (threads and heads).

9. Install two bolts finger tight to hold cover in place.

10. Install two dowel pins (chamfered end first).

11. Install timing indicator and water pump assembly. Then torque bolts evenly as shown in Fig. E-78.

12. Apply lubricant 1050169 or equivalent on balancer seal surface.

13. Install balancer and balancer bolt. Torque from 200-310 ft. lbs.

14. Install accessory brackets.

15. Connect bypass hose and radiator hoses.

16. Install crankshaft pulley and four attaching bolts. Torque to 20 ft. lbs.

17. Install fan pulley, fan and four attaching bolts. Torque bolts to 20 ft. lbs.

18. Install belts and adjust, using Tool BT-7002-3.

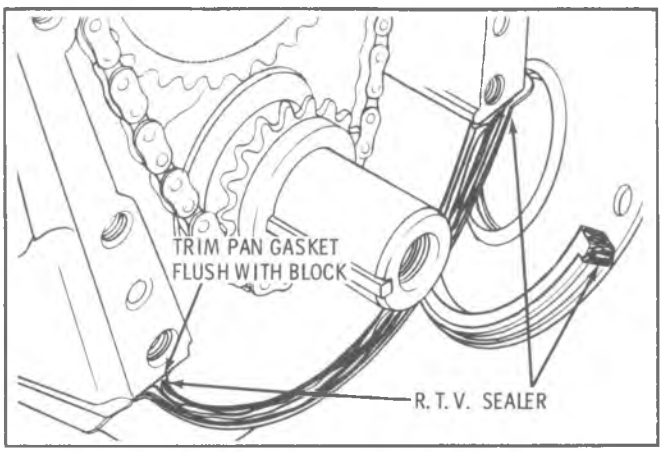


Fig. E-76—Apply Sealer and Trim Pan Gasket

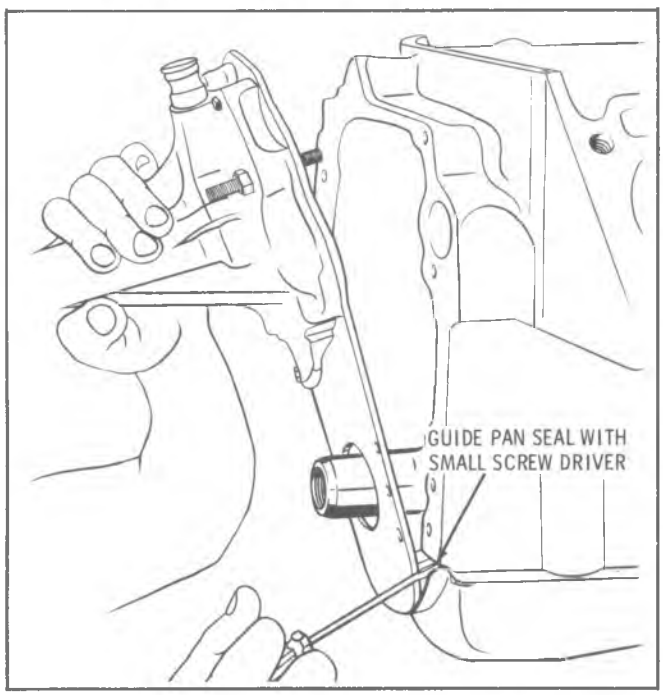


Fig. E-77—Installing Seal

19. Fill radiator.

20. Road test car and check for leaks. Use of spray foot powder or equivalent may aid in detecting leaks.

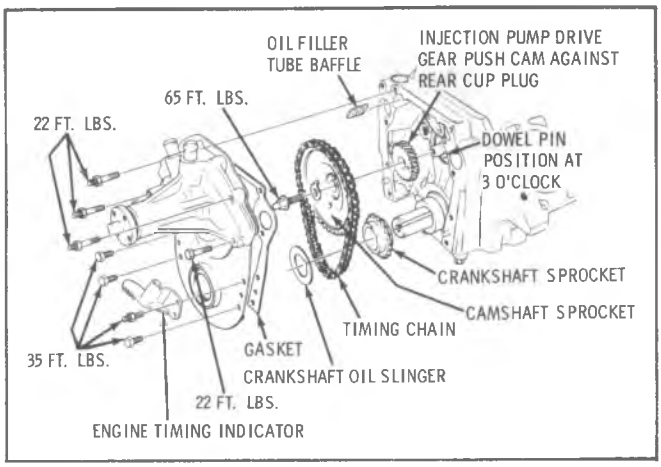


Fig. E-78—Engine Front Cover Bolts

OIL SEAL

Removal (Front Cover Installed)

1. Remove the belts.

2. Remove the crankshaft pulley and pulley hub.

3. Using Tool BT-6406, remove oil seal as shown in Fig. E-79.

Installation

1. Apply 1050805 Sealer or equivalent, to outside diameter of seal.

2. Using Tool BT-6405 and Screw BT-6611, install oil seal as shown in Fig. E-80.

3. Install the pulley hub and crankshaft pulley.

4. Install and adjust belts using Tool Bt-7002-3.

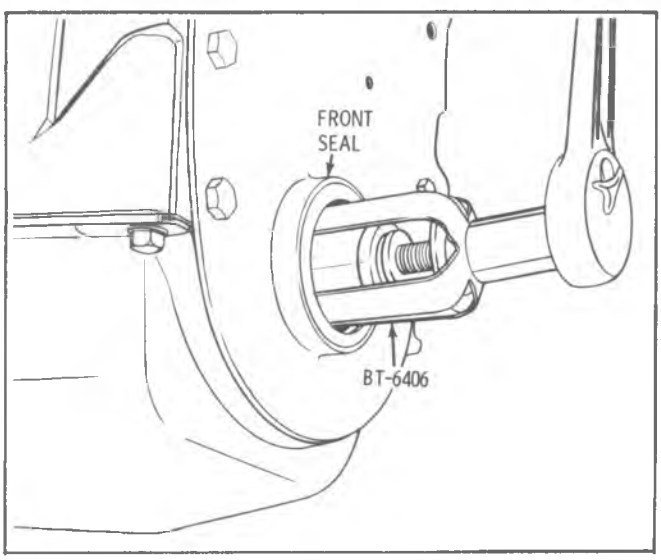


Fig. E-79—Front Oil Seal Removal

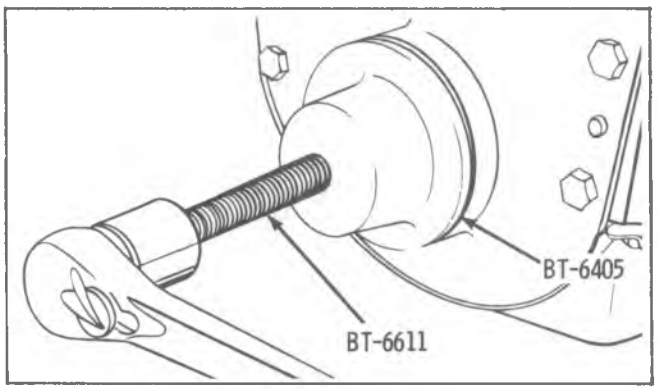


Fig. E-80–Front Oil Seal Installation

TIMING CHAIN AND GEARS (WITH FRONT COVER REMOVED)

Removal

1. Remove oil slinger, cam gear, crank gear and timing chain.
2. Remove fuel pump eccentric from crankshaft if replacement is necessary.

Installation

1. Install key in crankshaft if removed.
2. If removed, install fuel pump eccentric.
3. Install camshaft gear, crankshaft gear and timing chain together, and align timing marks. (Fig. E-81)
4. Torque camshaft sprocket bolt to 65 ft. lbs.

(NOTE: When the two marks are in alignment, number six is at T.D.C. To get T.D.C. for number one cylinder, slowly rotate crankshaft one complete turn. This will bring the cam mark to the top, number one then will be in firing position.)

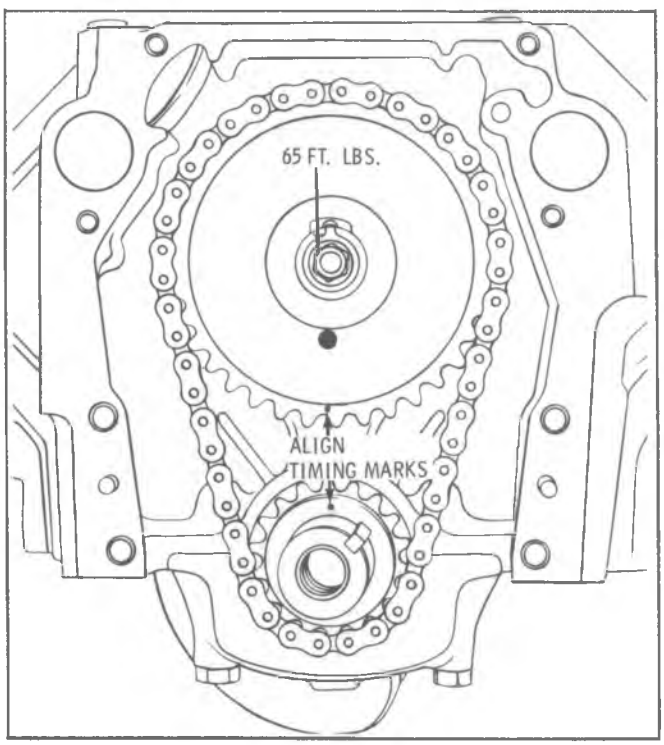


Fig. E-81–Align Timing Marks

5. Install oil slinger.

(NOTE: Any time the timing chain and gears are replaced, it will be necessary to retime the engine. Refer to "INJECTION PUMP ADAPTER".)

CAMSHAFT, INJECTION PUMP DRIVE AND DRIVEN GEARS

Removal

1. Disconnect battery.
2. Drain radiator coolant.
3. Remove upper radiator baffle.
4. Disconnect upper radiator hose at water outlet.
5. Disconnect upper radiator hose support clamp.
6. Disconnect cooler lines at radiator.
7. Remove radiator fan shroud.
8. Remove radiator.
9. Remove intake manifold and gasket, front and rear seal. Refer to INTAKE MANIFOLD, Removal and Installation.
10. Remove balancer pulley.
11. Remove balancer attaching bolt.
12. Remove balancer.
13. Remove engine front cover.
14. Remove both valve covers.
15. Remove rocker arms, push rods and valve lifters.

(NOTE: Parts position should be noted so they will be installed in their original position.)

16. If equipped with air conditioning, discharge A/C system, remove condenser attaching bolts and remove condenser.
17. Remove bolt securing camshaft gear and timing chain, then remove timing gears and chain.
18. Position camshaft dowel pin at the 3 o'clock position.
19. With the camshaft held rearward, remove injection pump drive gear by sliding off the camshaft while rocking the pump driven gear.
20. If necessary to remove pump driven gear, remove injection pump adapter, then remove snap ring and selective washer. Remove the driven gear and spring.
21. Remove camshaft by carefully sliding it out the front of the engine.

(NOTE: Do not force shaft as damage can occur to camshaft bearings. Refer to Fig. E-82 for camshaft identification.)

22. If cam bearings are being replaced, it is necessary to remove oil pan. Refer to "OIL PAN REMOVAL".

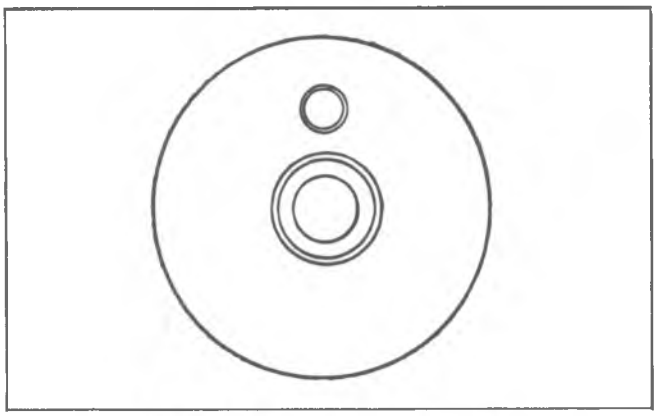


Fig. E-82–Camshaft Identification

Installation

(NOTE: If the injection pump drive or driven gear is to be replaced, both must be replaced.)

(NOTE: Any time the injection pump adapter is replaced or if pump drive or driven gears or timing chain and gears are replaced, it is necessary to retime engine.)

Coat camshaft and bearings with No. 1051396 or equivalent before installing. Camshaft gear and crankshaft gear must be aligned as shown in Fig. E-81.

Check the injection pump driven gear bushing, etc.

Install the injection pump driven gear, spring, shim and snap ring. Check the gear end play. If not within .002″ to .006″, replace the shim to obtain the clearance. (Fig. E-83)

(NOTE: Shims are available from .103″ to .115″ in .003″ increments.)

Position the camshaft dowel pin at 3 o'clock, align the "O" marks on the pump drive and driven gears. Then with the camshaft held in the rearward position, slide the pump drive gear on the camshaft. (Fig. E-84)

Timing indicator attaching stud must be installed and properly torqued before installing power steering pump bracket. Start engine, recharge A/C system, check for possible leaks.

CAMSHAFT AND INJECTION PUMP DRIVEN GEAR BEARINGS

The camshaft bearings must be replaced in complete sets. All bearings must be removed before any can be installed. No. 1 bearing must be removed first, then No. 2, then 3, 4 and 5. When installing the bearings, No. 5 must be installed first, then 4, 3, 2 and 1.

Camshaft Bearing Remover and Installer Set BT-6409 and camshaft bearing pilot spacer, BT-7817 are available tools.

This set can be used to remove cam bearings with the engine either in or out of the car. To replace bearings with

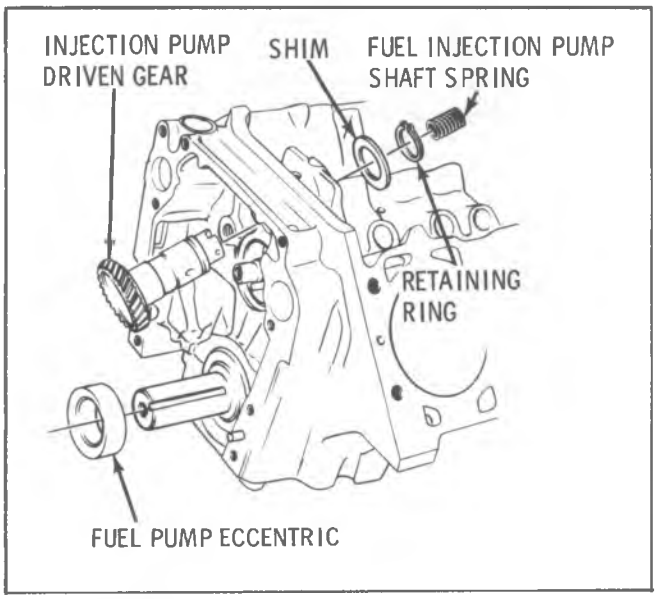


Fig. E-83–Injection Pump Driven Gear End Play Shim

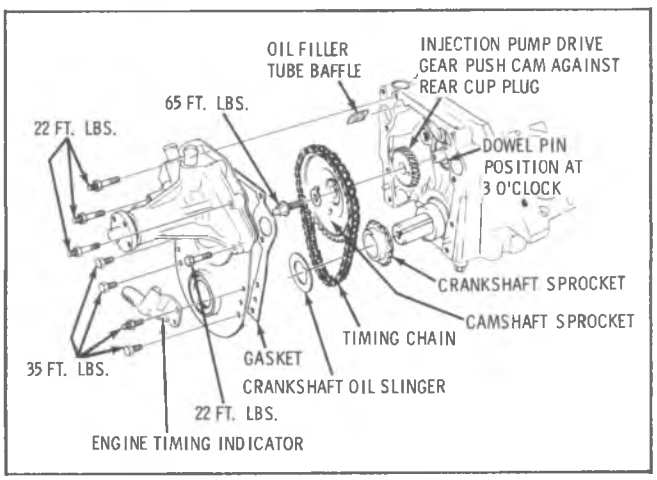


Fig. E-84–Installing Injection Pump Drive Gear

engine in car, proceed as follows:

(NOTE: The number one camshaft bearing is different than used on the gasoline engine.)

Removal

1. Remove engine oil pan.
2. Install No. 1 Cam Bearing Remover and Installer BT-6409-1 on Handle J-8092 and drive out front cam bearing.
3. Place Pilot BT-6409-6 on Driver BT-6409-7 and install No. 2 Cam bearing Tool BT-6409-2 on driver and drive out No. 2 bearing.
4. Remove No. 3 and 4 bearings in the same manner, using BT-6409-3 and BT-6409-4 removers.

(NOTE: Each cam bearing is a different diameter and the correct sequence must be used both for removal and installation.)

5. To remove No. 5 bearing with engine in car, use Puller BT-7409-8.

6. To remove the injection pump drive gear bushings, drive both bushings at the same time from the rear to the front of the block using tool J-28439-2 and driver handle J-8092.

Installation

(NOTE: To aid aligning bearings with oil passages, place each bearing in the front bore with tapered edge toward block and align the oil hole in the bearing with the center of the oil slot in the bore. Mark bottom of bearing. When installing the bearings, the mark will be a guide.)

Slide bearing pilot spacer BT-7817 on bearing pilot BT-6409-6. For bearings 5, 4, 3 and 2 put the driver BT-6409-7 through the pilot BT-6409-6, then screw the installer on the driver. Install the bearings as follows:

1. Place new No. 5 bearing on BT-6409-5 and drive bearing in until the last white line on the driver is flush with the front face of the pilot. (Fig. E-85)

2. Use a piece of 3/32" brass rod with a 90° bend at the end to check the oil hole opening as shown in Fig. E-86.

3. Remove BT-6409-5 Installer and install BT-6409-4. Place No. 4 bearing on installer and drive in until the next to last white line on driver is flush with pilot.

4. Follow the same procedure to install No. 3 and No. 2.

5. Install Tool BT-6409-1 on Handle J-8092 and place No. 1 bearing on installer. Drive bearing in until it is flush with front face of block. (Fig. E-87)

6. To install the injection pump bushings, align the holes in the bushings with the holes in the block. Install both bushings from the front; driving the rear bushing first, using the long end of tool J-28439-1 and driver handle J-8092. Drive the front bushing with the short end of J-28439-1.

7. Use a piece of 3/32" brass rod with a 90° bend at the end to check all oil hole openings. Wire must enter hole or the bearing will not receive sufficient lubrication. (Fig. E-86)

8. Install engine oil pan.

Camshaft and Oil Gallery Plugs (Fig. E-88)

The left hand rear oil gallery plug is not shown. It is a threaded plug in the end of the left gallery just rearward of the distributor. A small hole is provided in the plug for distributor lubrication. The cup plug shown provides access to the threaded plug.

The front oil gallery plugs (not shown) are threaded. The plug on the right side has a small hole which provides lubrication for the timing chain and gears.

To find out if the camshaft plug at the rear of the engine is properly installed, place a straight edge across the machined surface of the rear of the block and measure from the straight edge to the lip of the plug. Dimension should be .250" maximum to .160" minimum.

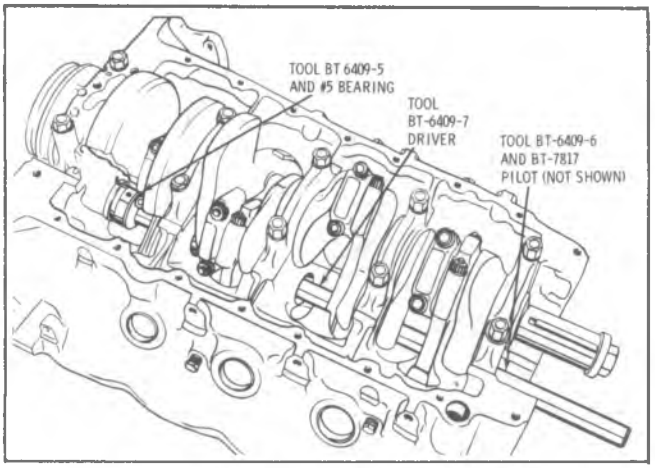


Fig. E-85—Installing Rear Cam Bearing

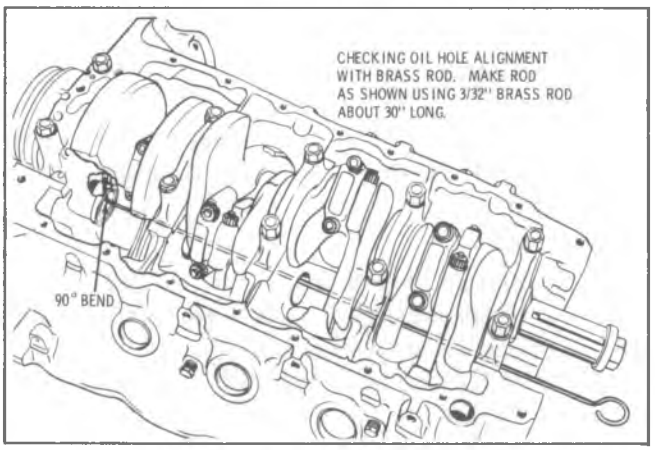


Fig. E-86—Checking No. 5 Oil Hole

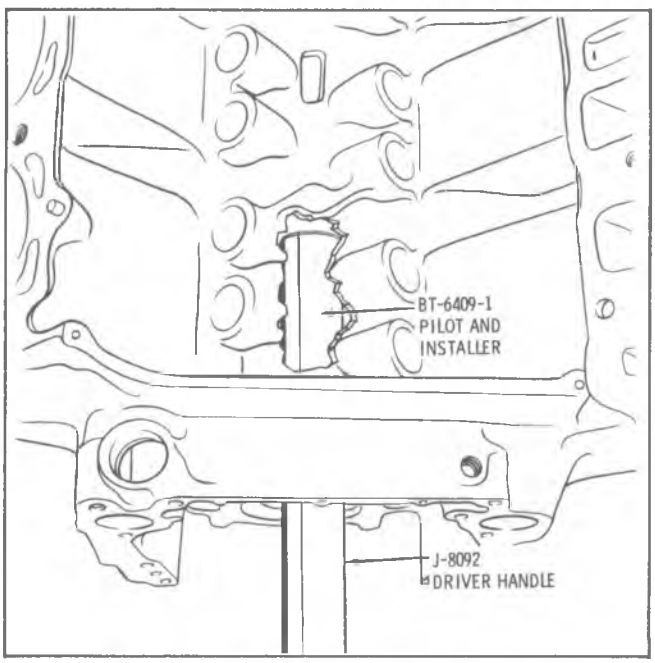


Fig. E-87—Installing No. 1 Cam Bearing

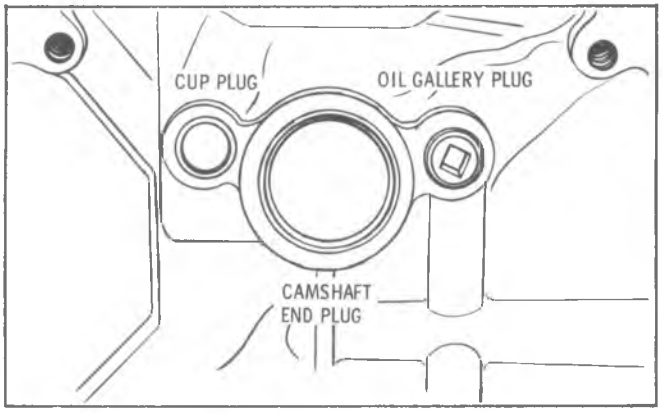


Fig. E-88—Camshaft and Oil Gallery Plugs

UNIT REPAIR

ENGINE

Removal

1. Drain cooling system.
2. Remove air cleaner.
3. Remove hood from hinges, mark hood for reassembly.
4. Disconnect battery negative cables at batteries and ground wires at inner fender panel. Disconnect engine ground strap, right head to cowl.
5. Disconnect radiator hoses, cooler lines, heater hoses, vacuum hoses, power steering pump hoses at power steering gear, air conditioning compressor with brackets and hoses attached, fuel hose from fuel pump and wiring.
6. Remove hairpin clip at bellcrank.
7. Remove throttle and T.V. cables from intake manifold brackets, then position cables away from engine.
8. Remove upper radiator support and radiator.
9. Raise car.
10. Disconnect exhaust pipes at manifold.
11. Remove torque converter cover and three bolts holding converter to flywheel.
12. Remove engine mount bolts or nuts.
13. Remove three bolts, transmission to engine on the right side. Disconnect wires from starter and remove starter.
14. Lower car. Secure lift chain BT-6606 to engine.
15. Place board on top of jack and slightly raise transmission. Remove three left transmission to engine bolts. Remove engine.
16. If car is to be moved, install converter holding tool J-21654 and support transmission with chain support BT-6322.

Installation

1. Fasten chain BT-6606 to engine.
2. Install engine in place. Locate engine dowels into transmission and position through bolts into mounts and tighten. Install three left transmission to engine bolts. Remove support chains and jack.
3. Raise car. Install three bolts, transmission to engine on the right side. Install starter and attaching bolts and attach wires.
4. Install three bolts converter to flywheel and torque converter cover bolts to 40 ft. lbs.
5. Connect exhaust pipes and lower car.
6. Install radiator and upper radiator support.
7. Connect radiator hoses, cooler lines, heater hoses, vacuum hoses, power steering pump hoses at pump, power steering hose bracket to engine, air conditioning compressor, fuel hose to fuel pump and wiring.
8. Position bellcrank and cables to intake manifold. Install bellcrank. Install throttle rod to bellcrank. Connect breather pipes and connect fuel return line to pump.
9. Install air cleaner.
10. Install and align hood with scribe marks.
11. Connect battery cables and ground wires.
12. Add engine oil and coolant.

CRANKSHAFT

Removal (Cylinder Heads On)

1. With engine on stand and oil pan, oil pump and front cover removed, rotate crankshaft to the position where the connecting rod nuts are most accessible. Fig. E-89 shows the engine with the No. 3 and No. 4 rods in the fully extended position.
2. Remove connecting rod caps and install thread protectors. Remove fuel pump eccentric from crankshaft.
3. Remove main bearing caps.
4. Note position of keyway in crankshaft so it can be installed in the same position.
5. Lift crankshaft out of block. Rods will pivot to the center of the engine when the crankshaft is removed.

Do not allow pistons to move in their bore during or after crankshaft removal.

Installation

1. Install enough oil pan bolts in pan rails to align rods with rubber bands. (Fig. E-89)

Align rods so that the inner thread protectors of adjacent rods overlap approximately one inch as shown. Alignment can be adjusted by increasing tension on rubber bands with additional turns around the pan bolts or thread protectors.

2. Measure the crankshaft journals with a micrometer to determine the correct size rod and main bearings to be used.

(NOTE: Whenever a new or reconditioned crankshaft is installed, new connecting rod bearings and main bearings should be installed.)

3. Position crankshaft keyway in the same position as removed and lower into block. The connecting rods will follow the crank pins into the correct position as the crankshaft is lowered.
4. Remove rubber bands, thread protectors and pan bolts and assemble engine.

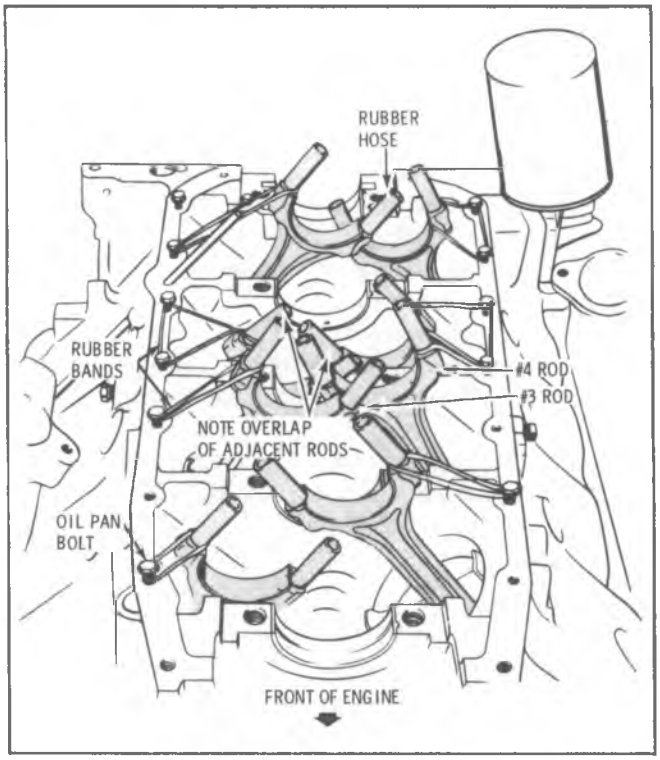


Fig. E-89–Crankshaft Removal

Removal (Cylinder Heads Removed)

1. With engine on stand, remove oil pan, front cover, connecting rods, oil pump and fuel pump eccentric from crankshaft.

2. Remove main bearing caps and lift crankshaft out of block.

Installation

1. Measure the crankshaft journals with a micrometer to determine the correct size rod and main bearings to be used.

(NOTE: Whenever a new or reconditioned crankshaft is installed, new connecting rod bearings and main bearings should be installed.)

2. Position upper half of main bearings in block and lubricate with engine oil.

3. Install a new rear main bearing seal. (Fig. E-90)

(NOTE: Rear bearing must be removed to replace seal.)

4. After oil passages in crankshaft have been checked for being open and shaft is clean, place shaft in block. Lubricate thrust flanges of the center bearing with 1050169 Lubricant or equivalent. Install caps with lower half of bearing lubricated with engine oil. Lubricate cap bolts with engine oil and install, but do not tighten.

5. With a block of wood (Fig. E-91) bump shaft in each direction to align thrust flanges of center main bearing.

(NOTE: After bumping shaft in each direction, wedge the shaft to the front and hold it while torquing No. 3 cap bolts.)

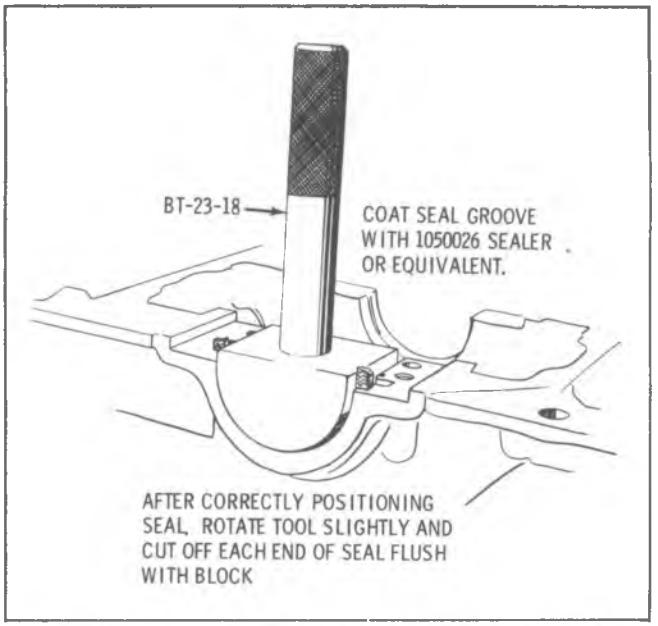


Fig. E-90–Installing Rear Main Oil Seal (Upper Half)

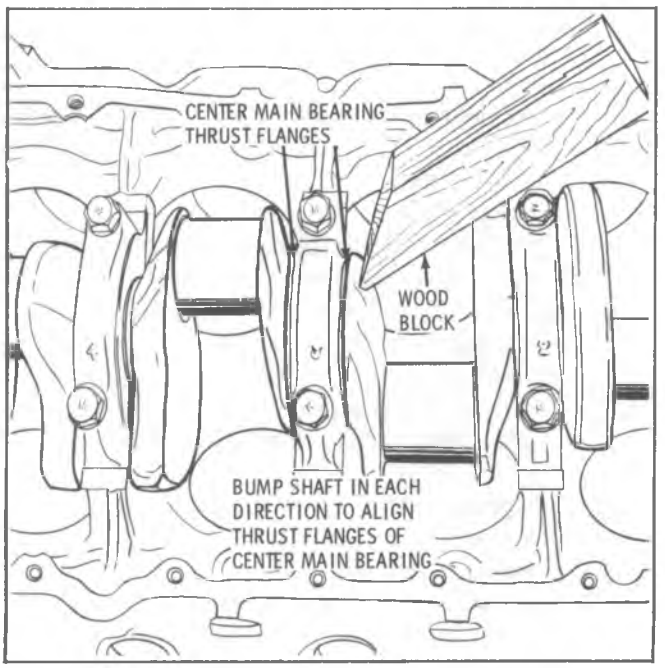


Fig. E-91–Aligning Center Rear Main Bearing Flanges

6. Torque all main bearing bolts to 120 ft. lbs. (Fig. E-92)

7. Reassemble engine and install in chassis.

MAIN BEARINGS

Main bearing clearance must not exceed .0035" on all bearings. The .0035" clearance is permissible only if the engine is disassembled for other than a bearing noise condition. If bearings are noisy or if a visual inspection indicates defective bearings, new bearings must be installed within the specifications outlined under MAIN BEARINGS – REPLACE.

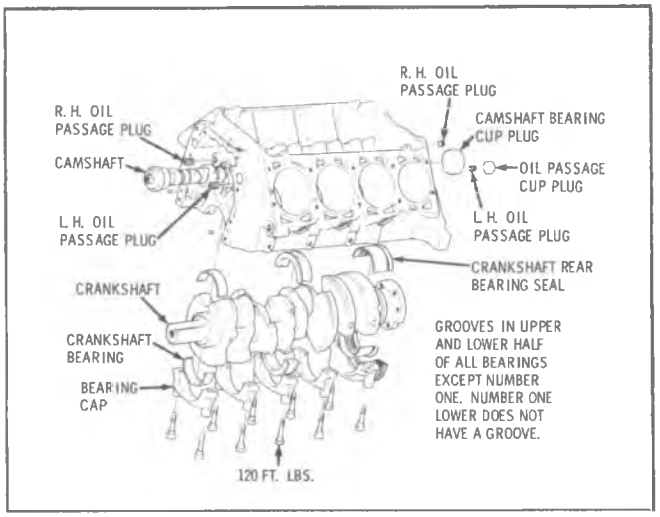


Fig. E-92–Crankshaft, Bearings and Caps

Bearings which fall within the .0035" specifications should not be replaced if the bearings show a normal wear pattern or slight radial grooves.

Checking Bearing Clearances

1. Remove bearing cap and wipe oil from crankshaft journal and outer and inner surfaces of bearing shell.
2. Place a piece of plastic gaging material in the center of bearing.
3. Use a floor jack or other means to hold crankshaft against upper bearing shell. This is necessary to obtain accurate clearance readings when using plastic gaging material.
4. Reinstall bearing cap and bearing. Place engine oil on cap bolts and install.

Torque bolts to 120 ft. lbs.

5. Remove bearing cap and determine bearing clearance by comparing the width of the flattened plastic gaging material at its widest point with graduations on the gaging material container. The number within the graduation on the envelope indicates the clearance in thousandths of an inch. (Fig. E-93) If the clearance is greater than .0035", REPLACE BOTH BEARING SHELLS AS A SET. Recheck clearance after replacing shells. (Refer to MAIN BEARINGS - REPLACE.)

(NOTE: Main bearing end thrust clearance should be .0035" to .0135" as checked with a dial indicator.)

Main Bearings Replacement

Main bearing clearances must be corrected by the use of selective upper and lower shells. UNDER NO CIRCUMSTANCES should the use of shims behind the shells, to compensate for wear, be attempted.

(NOTE: The upper and lower shells must be installed in pairs. Sizes of the bearings are located on the tang. See Fig. E-94. It is possible to have more than one bearing size in the same engine.)

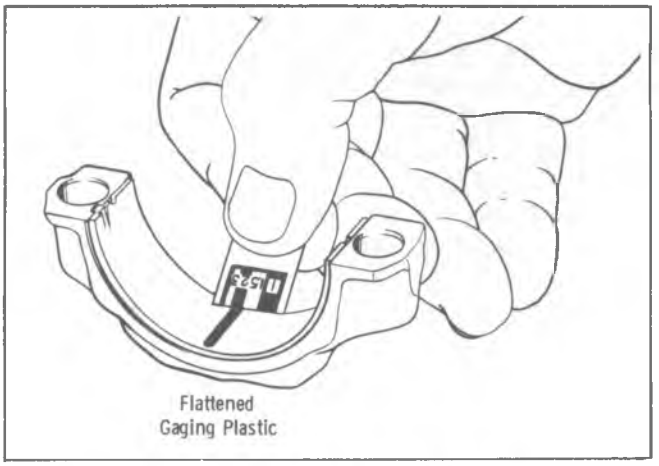


Fig. E-93–Checking Bearing Clearance

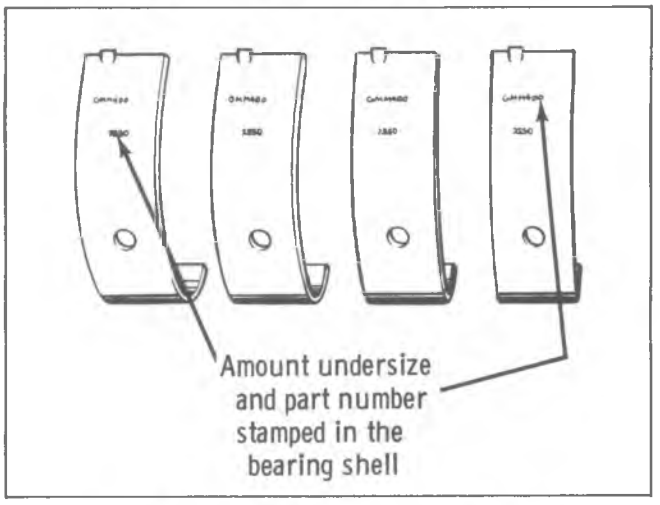


Fig. E-94–Main Bearing Identification

To install main bearing shells, proceed as follows:

1. Loosen all main bearing caps.
2. Remove bearing cap and remove lower shell.
3. Insert a flattened cotter pin or roll out pin in the oil passage hole in the crankshaft, then rotate the crankshaft in the direction opposite to cranking rotation. The pin will contact the upper shell and roll it out.
4. The main bearing journals should be checked for roughness and wear. Slight roughness may be removed with a fine grit polishing cloth saturated with engine oil. Burrs may be removed with a fine oil stone. If the journals are scored or ridged, the crankshaft must be replaced.

(NOTE: The journals can be measured for out-of-round with the crankshaft installed by using a crankshaft caliper and inside micrometer or a main bearing micrometer. The upper bearing shell must be removed when measuring the crankshaft journals. Maximum out-of-round of the crankshaft journals must not exceed .0015".)

5. Clean crankshaft journals and bearing caps thoroughly before installing new main bearings.
6. Apply Special Lubricant, No. 1050169 or equivalent

to the thrust flanges of bearing shells on No. 3 bearing.

7. Place new upper shell on crankshaft journal with locating tang in correct position and rotate shaft to turn it into place using cotter pin or roll out pin as during removal.

8. Place new bearing shell in bearing cap.

9. No. 5 bearing – Install new asbestos oil seal in the rear main bearing cap. (REAR MAIN BEARING OIL SEAL) (Fig. E-95) Install 1050805 or equivalent sealer on cap as shown.

10. Install bearing caps, lubricate bolt threads with engine oil, then install.

Torque bolts to 120 ft. lbs.

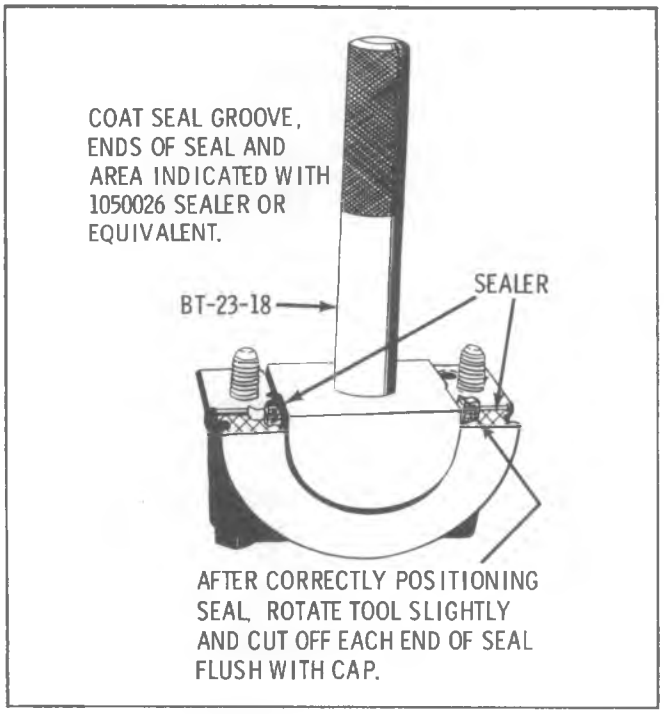


Fig. E-95–Installing Rear Main Oil Seal (Lower Half)

REAR MAIN BEARING UPPER OIL SEAL

Repair

Tools are available to provide a means of installing engine rear main bearing upper seal without removing the crankshaft. The procedure for seal leak correction is listed below.

1. Drain oil and remove oil pan and rear main bearing cap.

2. Insert Packing Tool BT-6433 against one end of seal in cylinder block and drive the old seal gently into the groove until it is packed tight. This varies from 1/4" to 3/4", depending on the amount of pack required. (Fig. E-96)

3. Repeat this on the other end of the seal in the cylinder block.

4. Measure the amount the seal was driven up on one side; add 1/16", then cut this length from the old seal removed from the main bearing cap with a single edge razor blade. Measure the amount the seal was driven up on the other side. Add 1/16" and cut another length from old seal. Use main bearing cap as a holding fixture when cutting seal as shown in Fig. E-97.

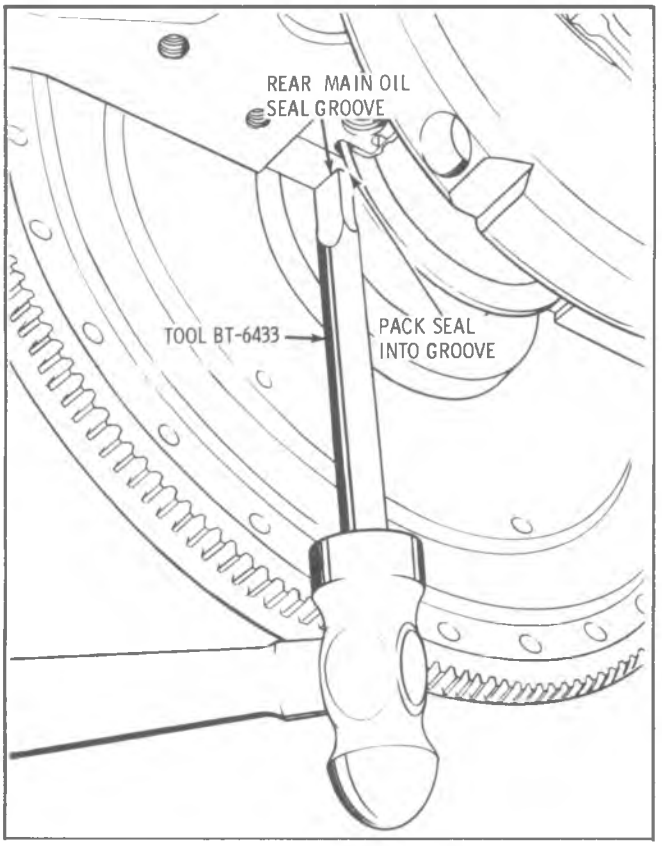


Fig. E-96–Packing Oil Seal

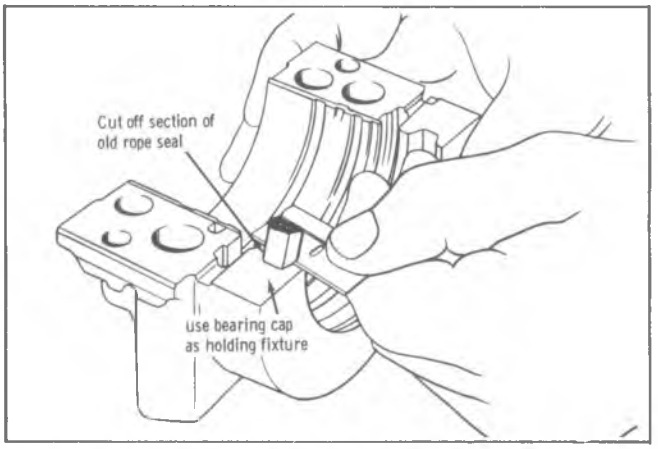


Fig. E-97–Cutting Off Lower Seal Ends

5. Place a drop of 1050805 Sealer or equivalent, on each end of seal and cap as indicated.

6. Work these two pieces of seal into the cylinder block (one piece on each side) with two small screwdrivers. Using Packing Tool, pack these short pieces up into the block. Use Seal Trimming Tool BT-6436 to trim seal flush with block as shown in Fig. E-98.

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

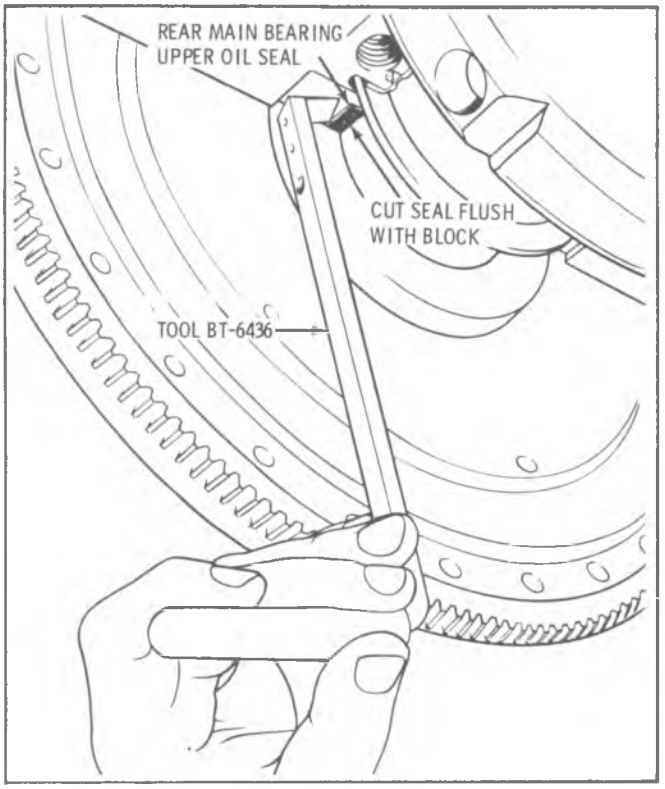


Fig. E-98–Cutting Off Upper Seal Ends

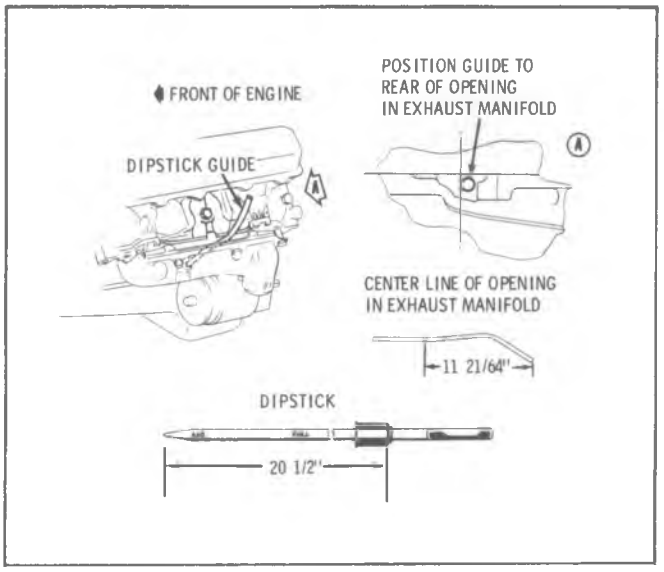


Fig. E-99–Engine Oil Dipstick Identification

7. Form a new rope seal in the rear main bearing cap as outlined.

8. Assemble the cap to the block and torque to specifications.

REAR MAIN LOWER OIL SEAL

Removal

1. Remove oil pan.
2. Remove the rear main bearing cap.
3. Remove rear main bearing insert and old seal.
4. Clean bearing cap and seal grooves and inspect for cracks.

Installation

1. Install seal into bearing cap, packing by hand.
2. Using seal installer, hammer seal into groove. (Fig. E-95)

(NOTE: To check if seal is fully seated in the bearing cap, slide the tool away from seal. With tool fully seated in the bearing cap, slide tool against the seal. If undercut area of tool slides over the seal, the seal is fully seated. If tool butts against the seal, the seal must be driven further into the seal groove. Rotate tool before cutting off excess seal packing.)

3. With tool slightly rotated to prevent damage to tool, cut seal flush with mating surface. With screwdriver, pack seal end fibers towards center, away from edges.

4. Clean bearing insert and install in bearing cap.

5. Clean crankshaft bearing journal and seal contact. Install sealer on cap as shown.

6. Lubricate bearing and seal, install bearing cap, lubricate bolt threads with engine oil and install. Torque bolts to 120 ft. lbs.

7. Install pan with new gaskets.

8. Install lower flywheel cover.

FLYWHEEL

One bolt hole in the flywheel is offset and the flywheel will attach to the crankshaft in only one position.

ENGINE OIL DIPSTICK AND DIPSTICK GUIDES (Fig. E-99)

Removal

Removal of the dipstick guide will assist in easier removal and installation of the left cylinder head.

1. Position the slide hammer from Tool J-2619 on a 1/4" diameter 6" long bolt.
2. Insert the threaded end of the bolt into the oil dipstick guide and clamp with vise grip type pliers.
3. Use slide hammer to tap out tube.

To install, insert a 1/4" diameter x 1/2" long bolt into the tube and tap on the bolt head to drive tube into the block.

SECTION F

DIESEL ENGINE SPECIFICATIONS

FLYWHEEL	
No. of Teeth on Starter Gear	166
No. of Teeth on Starter Pinion	9
LUBRICATION SYSTEM	
Crankcase Capacity Drain and Refill (Including Filter)	7 Qts.
Oil Pump	
Clearance Pressure Relief Valve in Bore	.0025"-.0050"
End Clearance-Gear	.0005"-.0075"
CYLINDER BLOCK	
Engine Type	90° V-Type
No. of Cylinders	8
Bore and Stroke	4.057" x 3.385"
Piston Displacement	5.7 Litre (350 C.I.D.)
Compression Ratio	22.5:1
Firing Order	1-8-4-3-6-5-7-2
Main Bearing Bore In Iron (I.D.)	3.188" - 3.189"
CRANKSHAFT	
Diameter - Main Bearing Journal	3.0003" - 2.9993"
Width - Main Thrust Bearing Journal (No. 3) (with fillets)	1.1985" - 1.2015"
Diameter - Connecting Rod Bearing Journal	2.1248" - 2.1238"
Width - Connecting Rod Bearing (with fillets)	1.877" - 1.887"
Length - Overall Crankshaft	26.470"
Diameter - Oil Holes in Crankshaft	.220" - .250"
Clearance - Crankshaft End	.0035" - .0135"
MAIN BEARINGS	
Bearing Clearance - Crankshaft 1,2,3,& 4	.0005" - .0021"
Bearing Clearance - (Vertical) 5	.0015" - .0031"
Width - Bearing Shell	
No. 1, 2 and 4	.970" - .980"
No. 3	1.193" - 1.195"
No. 5	1.624"
CONNECTING RODS	
Length - Center to Center	5.8835" - 5.8875"
Diameter - Connecting Rod Bore	2.2495" - 2.2500"
Diameter - Pin Bore (Finish Bore in Bushing)	1.0956" - 1.0962"
Bearing Clearance - (Vertical)	.0005" - .0026"
Side Clearance - Big End	.006" - .020"
PISTON	
Diameter Nominal Outside	4.051"
Top of Piston to Center of Pin	1.770"
Clearance to Bore (selective)	.005" - .006"
Weight Less Pin & Rings (all)	796 ± 2 g
Skirt Taper (Piston Pin Centerline to Bottom of Skirt)	.000" - .002" Larger at Bottom
Ring Groove Width (top compression)	.0818" - .0828"
Ring Groove Width (lower compression)	.0798" - .0808"
Ring Groove Width (1 oil)	.1881" - .1891"
PISTON PINS	
Diameter	1.0949" - 1.0953"
Pin to Piston Clearance	.0003" - .0005"
Pin to Rod Clearance	.0003" - .0013"

PISTON RINGS

No. of Compression Rings (per piston)	2
Width of Compression Rings (top & bottom)	.0780" - .0770"
Gap Clearance Compression Rings	.015" - .025"
Clearance in Groove Compression Rings - Upper	.005" - .007"
Clearance in Groove Compression Rings - Lower	.0018" - .0038"
No. of Oil Rings (per piston)	1
Gap Clearance, Oil Ring	.015" - .055"
Clearance in Groove, Oil Rings	.001" - .005"

CAMSHAFT

Bearing Journal Diameters	
No. 1	2.0365" - 2.0357"
No. 2	2.0165" - 2.0157"
No. 3	1.9965" - 1.9957"
No. 4	1.9765" - 1.9757"
No. 5	1.9565" - 1.9557"
Width (including chamfers)	
No. 1	.810"
No. 2, 3 and 4	.741"
No. 5	.788"
Journal Clearance in Bearing (all)	.0020" - .0058"
End Clearance	.011" - .077"
Push Rod - Length	8.265"

VALVE - INTAKE

Diameter Head	1.875"
Diameter - Stem	.3425" - .3432"
Angle - Valve	44°
Angle - Valve Seat	45°
Width - Valve Seat (Cylinder Head)	.075" - .098"
Overall Length	5.120"
Clearance in Guide	.0010" - .0027"
Lash	Hydraulic

VALVE EXHAUST

Diameter - Head	1.625"
Diameter - Stem	.3420" - .3427"
Angle - Valve	30°
Angle - Valve Seat	31°
Width - Valve Seat (Cylinder Head)	.037" - .075"
Overall Length	5.029"
Clearance In Guide	.0015" - .0032"
Lash	Hydraulic

VALVE SPRINGS

Length	2.09"
Diameter - Wire	.177"
Inside Diameter	1.065" - 1.041"
Load	77 - 83 Lbs. @ 1.670"
Load	144 - 158 Lbs. @ 1.300"

VALVE LIFTERS

Diameter - Body	.8422" - .8427"
Length - Overall	2.000"
Clearance in Boss	.0005" - .0022"

Also available in .010" Over Size

CAMSHAFT SPROCKET

Pitch	1/2"
No. of Teeth	36

CRANKSHAFT SPROCKET	
Pitch	1/2"
No. of Teeth	18
TIMING CHAIN	
Width	.570"
No. of Links	48
Pitch	1/2"
Type	Roller

TORQUE SPECIFICATIONS

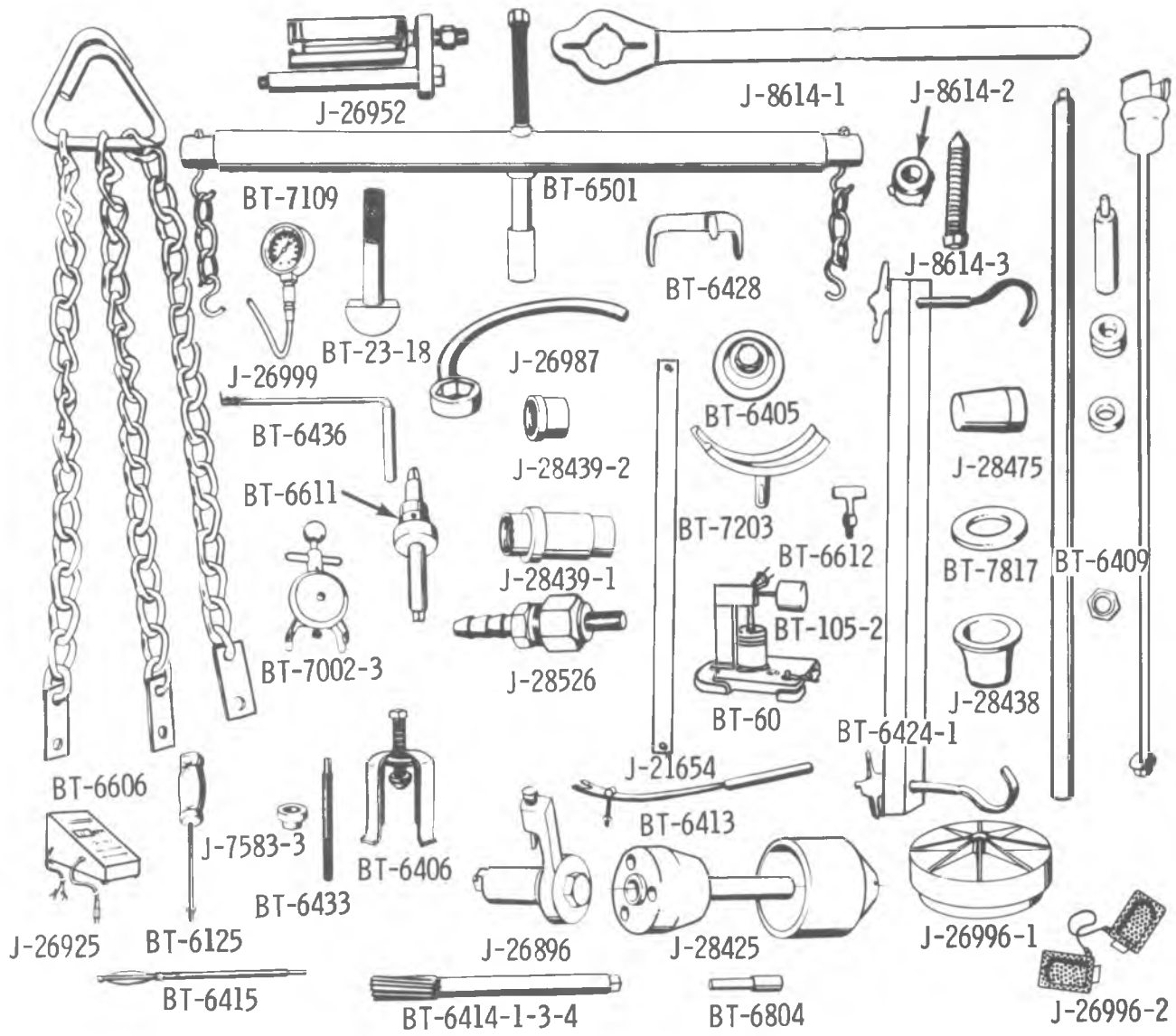
NOTE: Specified torque is for installation of parts only. Checking of torque during inspection may be 10% below specification.

Application	Ft. Lbs.
FUEL PUMP	
Fuel Pump to Block Bolt and Nut	25
EXHAUST SYSTEM	20
ENGINE	
Injection Pump Attaching Nuts	18
Injection Line Nut to Pump	35
Injection Pump Adapter Bolts	25
Injection Line Nut to Nozzle	25
Injection Pump Fuel Filter Inlet Line	20
Injection Pump Fuel Filter Outlet Line	10
Injection Pump Fuel Inlet Line	20
Injection Nozzle Hold-Down Clamp	25
Glow Plug	12
Crankshaft Bearing Cap Bolts	120
Flywheel to Converter	40
Flywheel to Crankshaft	60
Oil Pump to Bearing Cap Bolts	35
Oil Pump Cover to Pump Bolts	8
Rocker Arm Pivot Bolt to Head	25
Valve Cover Bolts	Fully Driven, Seated, Not Stripped
Oil Pan Bolts	10
Oil Pan Drain Plug	30
Crankshaft Balancer to Crankshaft Bolt	200-310
Oil Filter Element to Base	20
Oil Filter Assembly to Cylinder Block Bolts	35
Oil Cooler Lines to Oil Filter Base	12
Oil Cooler Lines to Radiator	25
Support/Front Cover to Cylinder Block Bolts 3/8"	35
Fan Driven Pulley to Hub Bolts	20
Fan Driving Pulley to Balancer Bolts	20
Water Pump to Front Cover Bolts	13
Water Outlet to Manifold Bolts	20

TORQUE SPECIFICATIONS (CONT'D)

*Intake Manifold to Cylinder Head Bolts	40
Exhaust Manifold to Cylinder Head Bolts	25
Engine Mount to Cylinder Block Bolts	75
Engine Mount to Frame Mount	50
Starter to Cylinder Block Bolts	35
Starter Brace to Cylinder Block Bolts	25
Starter Brace to Starter Bolt	15
Vacuum Pump Clamp to Cylinder Block Bolt	17
*Cylinder Head Bolts	130
Connecting Rod Nuts	42
Camshaft Sprocket Bolt	65

*Clean and dip entire bolt in engine oil before tightening to obtain a correct torque reading.



BT-23-18	REAR MAIN BEARING SEAL INSTALLER	BT-7002-3	BELT ADJUSTER GAGE
BT-60	VALVE LIFTER LEAKDOWN TESTER	BT-7109	SUPPORT BAR ADAPTER
BT-105-2	VALVE LIFTER LEAKDOWN TESTER ADAPTER	BT-7203	YOKE
BT-6125	SLIDE HAMMER	BT-7817	CAMSHAFT BEARING PILOT SPACER
BT-6405	FRONT COVER SEAL INSTALLER	J-7583-3	PILOT SCREW (USED WITH J-8614)
BT-6406	FRONT COVER SEAL REMOVER	J-8614	HARMONIC BALANCER REMOVER
BT-6409	CAMSHAFT BEARING SET		-1 HANDLE
BT-6413	VALVE SPRING COMPRESSOR		-2 PLATE
BT-6414-1-3-4	VALVE GUIDE REAMER		-3 SCREW
BT-6415	VALVE GUIDE CLEANER	J-21654	CONVERTER HOLDING TOOL
BT-6424-1	ENGINE SUPPORT BAR	J-26896	STATIC TIMING TOOL
BT-6428	VALVE STEM HEIGHT GAGE	J-26925	TACHOMETER
BT-6433	REAR MAIN BRG. OIL SEAL PUNCH	J-26952	NOZZLE REMOVER
BT-6436	REAR MAIN BRG. SEAL CUT OFF TOOL	J-26987	INJECTION PUMP INTAKE MANIFOLD WRENCH
BT-6501	ENGINE SUPPORT BAR TO REMOVE OIL PAN	J-26996-1	AIR CROSSOVER COVER
	-2 SCREW	J-26996-2	MANIFOLD COVER SCREENS
	-3 TUBE	J-26999	COMPRESSION GAGE
	-4 CHAIN	J-28425	PUMP ADAPTER SEAL INSTALLER
BT-6606	ENGINE LIFT CHAIN	J-28438	PLASTIC PLUGS-PUMP, LINES, NOZZLE
BT-6611	CRANKSHAFT PULLEY INSTALLER	J-28439	PUMP DRIVE SHAFT BUSHING TOOLS
BT-6612	VALVE SPRING COMPRESSOR ADAPTER	J-28475	CARBON STOP SEAL INSTALLER
BT-6804	VALVE SEAL INSTALLER	J-28526	INJECTION PUMP PRESSURE TEST ADAPTER