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OPERATIONS AND MAINTENANCE MANUAL

D-4800 SERIES

WHITE
ENGINES, INC.
CANTON, OHIO 44707

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PART NO. 205084-B

INTRODUCTION

The White D4800 series of diesel engines consists of three six cylinder models, natural asperated, turbocharged, and turbo-charged with after cooling. All are overhead valve, four cycle, heavy-duty commercial type engines. The engines are built as vertical engines (piston motion in a vertical plane). Extensive tests, both laboratory and field, have proven that these engines are adaptable to purposes for which such sizes and types are required.

All locations given as right-hand (R.H.) or left-hand (L.H.) have reference to the observer's position when facing the flywheel or clutch. The front of the engine is the timing gear end. The flywheel and clutch end is the rear of the engine. Therefore, when reference is made to No. 1 cylinder or front main bearing, it is always the one nearest the timing gears. Cylinders, connecting rod, etc., are numbered from the front or timing gear end of the engine. All dimensions are given in inches and fractions of inches, except as otherwise noted. All weights and measures are in United States avoirdupois or liquid measure standards.

This book is divided into the following sections, which appear in the order named -- Specifications, Operation, Lubrication, Description and Maintenance, Trouble Shooting, Fits and Tolerances.

When necessary to refer to accessories which are not furnished by White Engines, Inc., information and comments given are general and may not apply to the specific accessory used.

As an operator, you owe it to yourself to read this book carefully.

GENERAL INDEX

WHITE ENGINE DATA SHEET : STANDARD POWER UNITS
(Figures Dependent on Engine Speed Relate to 1800 RPM)

ENGINE MODEL	D-4800	D-4800-T	125 KW. D-4800-TA	137.5 KW. D-4800-TA
No. of Cylinders	6	6	6	6
Cu. In. Displacement	478	478	478	478
Lube Oil Capacity: Qts. (w/filter)	22 (dual filters)	22 (dual filters)	22 (dual filters)	22 (dual filters)
Cooling System Capacity (including radiator)	7.5 Gal.	7.5 Gal.	7.5 Gal.	7.5 Gal.
Coolant Flow in G.P.M.	60	60		
Heat Rejection to Coolant BTU/BHP/MIN	30	31	31	31
CFM Air for Cooling	7000	7000	8630	8630
CFM Air for Combustion	195	100KW : 295 90KW : 277 75KW : 252	360	395
^{0}F. Exhaust Temp. at Full Load	1120	1165	1200	1200
CFM Exhaust Gas Flow at Full Load	580	897	1105	1220
Max. Allowable Total Exhaust Back Pressure	2.5" Hg or 35" H_2O		2.5" Hg or 35" H_2O	
Exhaust Outlet:NPTF	3.5" O.D.	3.25" O.D.	3" - 8	3" - 8
Lbs. Weight: Open Power Unit	1925	1900	1920	1920
Lbs. Weight: Closed Power Unit	2050			

SPECIFICATIONS
(Also see "Fits and Tolerances")

MODEL	NO. CYL.	BORE AND STROKE
D-4800 Natural Asperated	6	4.56 X 4.88
D-4800 Turbocharged	6	4.56 X 4.88
D-4800-TA	6	4.56 X 4.88
Firing Order		1-5-3-6-2-4

CRANKSHAFT

Material	Special Steel Hardened Bearings
No. of Bearings	7
Bearing Dia. (Main)	3.62"
Bearing Length (Front)	1.50"
Bearing Length (Center)	2.14"
Bearing Length (Rear)	1.61"
Bearing Length (Inter.)	1.61"

CAMSHAFT

Driven	Helical Gear
No. of Bearings	4
Length (Front)	1.16"
Length (Inter.)	1.06"
Length (Rear)	1.32"

CONNECTING ROD

Material	Heat Treated Steel
Connecting Rod Bearings, Dia.	3.52"
Connecting Rod Bearings, Length	1.45"
Connecting Rod Length c to c	8.75"

GENERAL DATA

Cooling	Belt Driven Centrifugal Pump
Alternator Mounting	Standard Swivel Type Alternators
Water Pump--Fan Assembly	Mounted on Front of Cylinder Block
Method of Suspension	3 or 4 Point
Flywheel	For Any Standard Clutch

GENERAL DESCRIPTION AND FEATURES OF DESIGN

CYLINDER BLOCK AND CRANKCASE

The cylinder block and crankcase are cast in one piece. In order to permit more efficient cooling, the cylinders are water jacketed the full length of the bore. This construction results in a very rigid unit, which provides a sturdy support for the crankshaft.

MAIN BEARINGS

The six cylinder engine has seven main bearings. This places a main bearing on each side of each connecting rod bearing, see Illustration No. 1. This construction helps to eliminate vibration at high speeds. The bearing caps are held in place by two alloy steel capscrews.

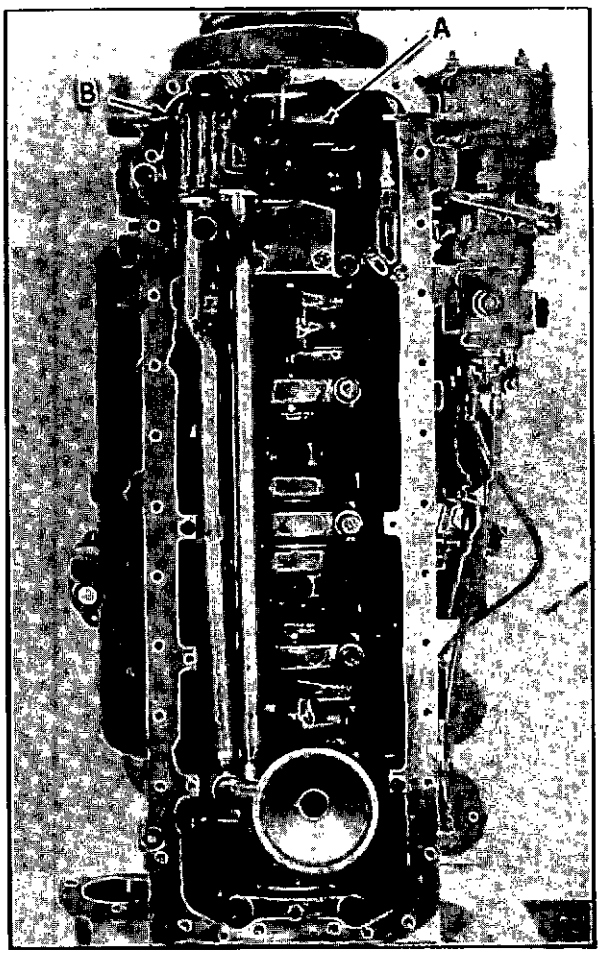


Illustration No. 1

The crankshaft end thrust is controlled by the center main bearing. This shell has suitable flanges on both sides of the bearing, which form a thrust bearing.

Precision or insert type bearings are used. In this construction there is a removable shell in each cap, as well as for the upper part. The upper shell is not interchangeable with the lower shell except for the thrust bearing. These bearing shells are completely finished before being put in place and no line reaming or scraping is required. This allows replacement of the bearings to be easily accomplished. Each bearing shell has a small ear or projection which fits into a recess in the cylinder block or cap, which allows the ear or projection to rest against the adjoining case or cap to prevent the shell from rocking or rotating. These shells are trimetal bearings, steel backed. This permits the use of a hardened crankshaft.

CYLINDER HEAD

The engine has two cylinder heads made from heat treated alloy iron, valve seats and valve guides are replaceable. The head is held to the cylinder block by studs, and nuts; and, in order to insure against leaks the head must be carefully drawn down by means of the stud nuts, which should be progressively tightened, working from the center of the head toward the ends. See Illustration No. 20 for method and sequence for torqueing cylinder head.

CAUTION: -- On a new or reconditioned engine, the cylinder head nuts MUST be retorqued and the valve tappet clearance RESET after two hours of service. See "Fits and Tolerances."

CONNECTING RODS AND PISTONS

Like the main bearings, the connecting rods have the precision or insert type of bearing construction. No shims are used, therefore, bearing adjustment is accomplished by installation of new bearing inserts.

The piston pin is of very large diameter and is of the full floating type. This means that the pin can rotate in either the piston bosses or in the bushing at the top end of the connecting rod, but the fit in the piston is tighter than the fit in the connecting rod bushing. Consequently, the movement in the piston consists of a light, creeping action while the normal rotation of the pin occurs in the bushing in the connecting rod. The piston pin is prevented from moving endwise and making contact with the cylinder wall by means of snap rings, which are located in grooves machined in the bosses of the piston.

CAMSHAFT

The camshaft is supported on removable bearings in the crankcase. The camshaft end thrust is controlled by a thrust plate between the front camshaft bearing and the camshaft gear. This plate is held to the cylinder block by two capscrews.

VALVES

The valves are installed in the cylinder head. The intake valve head is larger in diameter than the exhaust valve head in order to increase the efficiency and insure more power. Both intake and exhaust valves are forged from special alloy steel. The valve tappets are hollow to allow the push rod to properly seat.

OIL SYSTEM

The lubricating system is the pressure type, having gear type oil pump with the suction end in the oil pan oil sump and, therefore, needs no priming. The oil pump is gear driven through a suitable gear arrangement at the front of the engine. The oil tubes and oil pan may be rotated depending on the application.

The oil pump forces the oil under pressure through a full-flow oil filter and oil cooler to the main oil header in the cylinder block. This oil header is a drilled passage extending the length of the cylinder block on the side opposite the camshaft and is closed at both ends with suitable plugs.

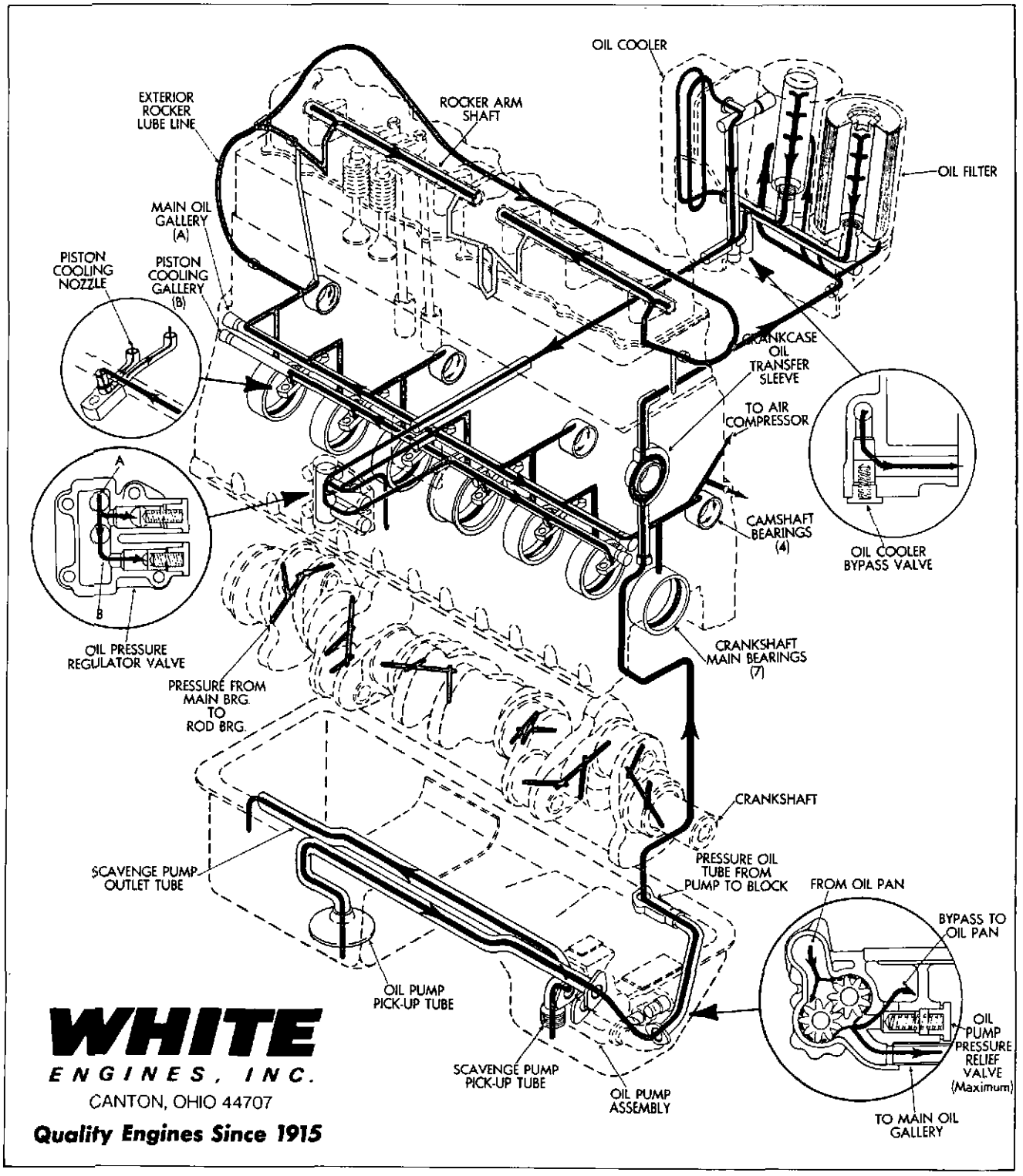
The oil pressure is controlled by a pressure control mechanism assembled on right side of cylinder block, see Illustration No. 35, which connects directly with the oil header. Also, there is a safety pressure relief valve assembled to the oil pump which prevents excessive pressure build-up. See item "A" Illustration No. 1.

From the main header the oil is distributed, under controlled pressure, through drilled passages to all main bearings, camshaft bearings, and rocker arms. From the main bearings, oil is delivered under pressure, through drilled passages in the crankshaft, to all connecting rod bearings. See Illustration.

The cam lobes, valve tappets, and so forth are lubricated by means of oil drain-back and the mist of oil thrown off around the various pressure-lubricated bearings. The pistons are cooled by a spray nozzle located on block. See Illustration No.

External openings are provided for connection of an oil pressure gauge or other accessories requiring pressure lubrication.

LUBRICATION SYSTEM



OPERATION

PRELUDE TO OPERATION

This series of White Diesel Engines consists of one natural asperated, and one turbocharged, both six-cylinder models. See "Specifications."

The book has been compiled for your use in obtaining the maximum efficiency and trouble-free operation which have been built into your diesel engine by White craftmanship.

Should you have a particular problem not covered in this book, we invite you to write to White Engines, Inc., Service Department, P. O. Box 6904, Canton, Ohio 44706, U.S.A., whose experienced personnel will be pleased to assist you.

PRECAUTIONS -- READ BEFORE STARTING THE ENGINE

This section covers those items which are of particular interest to the operator and does not cover such work as might be required of a maintenance crew. This does not mean that an operator should not acquaint himself with the various subjects covered in other sections of this book.

The following precautions, if followed, will help eliminate operating difficulties and abnormal wear:

1. Filters -- Keep them clean -- they are the guardians of your engine. Dirty filters cause rapid wear and low engine power output.

2. Fuel Oil -- Keep it clean -- do not use dirty containers to handle it -- insist on the fuel being clean and acid free when you get it. Procure it from a reputable company -- See "Fuel Oil Specifications."

3. Lubricating Oil -- Keep it clean -- drain the crankcase often. Use the best brands obtainable.

4. Do Not Allow The Oil Level to fall much below the full mark on the bayonet gauge. As the lubricating oil is the medium for removing the friction heat in the bearings, the larger the volume, the more heat can be absorbed. Do not fill above the full mark on the bayonet gauge.

5. Do Not Run the Engine at any time without lubricating oil and cooling solution (water or antifreeze mixture).

6. Do Not Use oil, fuel oil or kerosene in the cooling solution or as a cooling medium, as these will be detrimental to the synthetic rubber hoses, etc.

7. Never Run the Engine with the water or antifreeze solution boiling. This allows lubrication to break down and may seriously damage the engine.

8. Do Not Put Cold Water in an Overheated Engine. It may crack the cylinder head, block, etc.

9. Do Not Allow the Air Cleaners to become clogged or to be operated without all of the connections being tight. These units protect your engine from undue wear only when they are given intelligent care.

10. Never Allow Your Batteries to run low or dry of water. In cold weather, do not fill batteries with water when shutting down as this makes them more subject to freezing.

11. Do Not Attempt starting the engine until the lubricating oil, water, and fuel supplies have been checked.

12. Do Not Run the Engine at high speed without load, as this will cause undue wear and shorten the engine's life.

13. Do Not Idle the Engine for long periods. It is not only detrimental to the engine but also increases operating costs.

14. Do Not Use the Engine as a brake in intermediate or low gear unless the vehicle speed is held to that used in the same gears on the level. The high engine speeds possible when using low or intermediate gear descending a steep grade will turn the engine much faster than the speed for which it is designed, and damage will result.

15. Never Allow the Engine to Run Without Oil Pressure showing on the gauge. Damage from lack of lubrication will result.

16. Do Not Operate the Fuel Injection Pump with one or more lines shut off or blocked. The high pressure will ruin the pump.

17. Do Not Attempt to make repairs or adjustments to the fuel injection equipment unless you are familiar with it. It is far less expensive to take it to the nearest authorized service station.

18. Correct Fuel Nozzle Pressure is essential to efficient operation. Have the nozzles checked often.

19. Do Not Allow the fuel in the tank to run low as it may allow the fuel transfer pump line to uncover long enough to fill the lines with air and cause the engine to stop, resulting in lost time taken for repriming.

20. Loss of power, erratic running and poor performance often result from Air In the Fuel Injection System. Be sure there are no leaks in the fuel lines and filters which will allow this condition to exist. Vent cocks on top of the filters are for bleeding off any air which may accumulate from bubbles in the fuel and very minor leaks; therefore, it is essential to bleed these often until the operator is sure air is not entering the fuel system.

21. Remember, dirt, grit, water, lint or any foreign matter in both the fuel and lubricating oils are detrimental to the engine and it is your duty, as an operator, to see that they do not get into the engine.

22. Do Not Attempt to start the engine in cold weather until you have read "Cold Weather Starting."

23. Some external heat will help starting in cold weather and saves the batteries. Also, ether may be used in extremely cold weather.

24. Never run the starting motor longer than 15 seconds at one time without a rest period of at least one minute before allowing it to run again. Failure to follow this procedure may result in a burned out starting motor.

25. Do Not Attempt to start or operate this engine without first reading the instructions in this book carefully. As an operator, you owe it to yourself.

26. On a new engine or reinstallation of a cylinder head, the cylinder head nuts must be retightened and the valve tappet clearance reset after two hours of service. See Fits and Tolerances.

STOPPING THE ENGINE

1. Stopping is generally effected by moving the stop control to the stop position until the engine stops.

2. If the atmospheric temperature is below freezing and no antifreeze solution is used, the complete water circulating system should be drained. This includes the engine water jackets, water pump, radiator and all water pipes.

3. If an antifreeze solution is used, the solution should be checked with a hydrometer to make sure the solution will not freeze. It is best to have a solution that will not freeze at temperatures far below those then being experienced.

4. Do not fill the batteries with water when shutting down as this makes them more liable to freezing. Fill the batteries just before starting up for the day's run.

INSPECTION OR ADJUSTMENTS

TO BE MADE DAILY

1. Go over the entire engine daily to make sure there are no loose bolts, nuts, screws, electrical connections or parts and, also, stop all fuel, lubricating oil and water leaks. There will probably be very little tightening needed but one loose part may cause serious damage.

2. Check the lubricating oil level in the engine and keep filled to the full mark on the gauge.

3. Remove the pipe plug in the bottom of the lubricating oil filters and drain all water and sediment which may have accumulated.

4. Air cleaners should be inspected and cleaned before starting the day's run. If the engine is working in extreme dusty atmosphere,

it may be necessary to clean these units more often than once a day.

5. See that there is a day's supply of clean fuel in the tanks before starting.

6. Electrical equipment requires very little attention but the batteries should be checked for water which should be kept at a proper level.

7. The water circulating system probably receives less attention and care than any part of the engine installation and yet it is one of the most important units. Water should be added daily to make up for that lost in evaporation. Also, observe if scale or sediment is forming in the cooling system; if it is, obtain water from a supply which will not cause these troubles. If the water pump is leaking, replace the seal.

8. If the air temperature is freezing or likely to go down to freezing, check the antifreeze solution, making sure it will not freeze at temperatures well below those expected.

INSPECTION OR ADJUSTMENTS TO BE MADE AFTER EACH 100 HOURS' OPERATION

1. Inspect and adjust the fan belts, if loose.

2. Inspect the radiator and clean, if clogged or shows scale formation.

3. Inspect the fuel supply tank and, if necessary, wash out thoroughly with clean fuel oil to remove all dirt and sediment. Remove the air from the fuel filters. See "Priming the Fuel System."

LUBRICATION OF ELECTRICAL EQUIPMENT AT EACH 400 HOURS' OPERATION

1. Lubricate the alternator. Three to four drops of the same grade and guality lubricating oil as is used in the engine crankcase is all that is necessary. Too much lubrication is as bad as too little, as too much will flood the alternator with oil and get on the commutator and brushes, causing the brushes to stick in their carrier.

2. Lubricate the starting motor, if equipped with oilers, with the same grade of oil as is used in lubricating the alternator. These motors have absorbing bushings, so fill the cups with oil until the bearings are saturated. Motors not equipped with oilers have oilless bushings and need no lubrication except at the time of overhaul.

STARTING AND OPERATING SUGGESTIONS

1. Always use single viscosity, low ash oil. This oil should be capable of meeting A.P.I. service classification, shown in Lubricating Oil Specifications, Page 19.

2. Use only the best lubricating oil obtainable. See page 19.

3. An SAE 20 oil is a good grade to start with; from this, the proper grade can be determined by observing the pressure gauge and the condition of the oil at change periods.

   It is suggested that a detergent type oil be used. This oil must be changed after each 125 hours of operation and should be drained while the oil is hot.

4. Fill the cooling system with antifreeze solution or clean water (if in a locality where the water has a large percentage of dissolved minerals or is alkaline -- use rain water). Allow sufficient time for the coolant to seek the lowest level, then complete the filling.

NOTE: -- Some manufacturers of permanent type antifreeze also market a cooling system sealer. It is recommended that this sealer be installed when installing the antifreeze solution.

5. Be sure the batteries are hooked up properly before pressing the starter button.

6. Turn the engine over three or four times by hand to be sure there is nothing sticking or water has not seeped into a cylinder, as the starting motor has sufficient power to damage the engine if foreign material or water is in the cylinder.

7. Be sure all fuel line connections are tight and the fuel system properly primed.

BATTERY CABLE RECOMMENDATION

For single 12 volt battery systems, use stranded SAE #0 cable for combined total cable lengths up to 5 ft. For combined total cable lengths of 5 to 7 ft., use #000 stranded cable.

If two (2) 6 volt batteries are used in series, then the next larger cable sizes are required because of the increased voltage loss at the additional connectors. In other words, for lengths up to 5 ft., use stranded SAE #00 cable. Also, if two (2) 12 volt batteries are used in parallel, cable sizes should be the same as for 6 volt batteries in series.

It is also extremely important that contacts are properly made and cables correctly prepared. Cables should be crimped in the terminal and then the terminal filled with solder. The ends of the cables should be tinned prior to assembly.

When the cables are grounded to the equipment frame, the area at the grounding point must be wire brushed to remove rust and paint and bare metal exposed. When the frame is used as a ground, make certain that there are no riveted or bolted joints between the ground location at the battery and the ground location of the starter.

Battery posts also should be wire brushed and the battery top cleaned using a solution of baking soda and water before connecting the cables. In fact, keeping the battery clean with the soda solution is good normal maintenance practice.

All terminal connections must be properly made as poor connections are a frequent cause of poor starting capability. Because of the high current it draws in cranking, voltage drop across poor connections become excessive and the battery will be incapable of bringing the starting motor and engine up to starting speeds.

STARTING THE ENGINE

SAVE YOUR BATTERIES. Two 12 volt batteries in parallel will crank the engine against compression for about six periods of 15 seconds each with a recuperation or rest of one minute between each period of cranking. Electric starter cranking, with the nozzle holders removed during tests for fuel oil delivery to the nozzles, will conserve the battery charge.

If the atmospheric air temperature is 50° F. or over, the following instructions should enable anyone to readily start the engine. If the air temperature is below 32° F., read "Cold Weather Starting."

FIRST TIME THE ENGINE STARTED or starting the engine after a long period of shutdown.

1. Fill the fuel tank with suitable fuel oil. Bleed the air from the fuel lines and filter, see "Priming the Fuel System."

2. Fill the cooling system with clean, pure water, or, if the temperature is below freezing and the engine is to stand or operate in these temperatures, use an antifreeze solution.

3. Fill the crankcase with suitable lubricating oil to the full mark on the oil gauge rod.

4. Turn the engine over by means of the starter three or four times to start oil circulation and distribute the oil already on the surfaces. This cranking also prevents possibilities of damage due to water having accumulated in the cylinders.

PRIMING THE FUEL SYSTEM -- AIR LOCK TROUBLE

1. Air or gas binding or lock in the fuel injection system is the most general cause of failure to start or hard starting if the proper fuel is used. Air binding or lock is caused mainly from leaky fuel valves, check valves or running out of fuel. Gas binding or lock is caused by heating of the fuel to a point higher than that at which the particular fuel used begins to throw off gaseous vapors. To eliminate the air or gas lock caused by either of these difficulties, the following procedure should be followed:

Loosen the fuel filter vent cocks and allow fuel from tank to flow into the filter until solid fuel comes from the vent cocks. Close the vent cocks.

NOTE: -- It may be necessary to crank the engine over (in rare cases) to permit the priming pump to draw fuel from the filters.

2. In addition to the procedure just described, check the lubrication of the alternator, starter, air compressor (if used) and any other accessories. Check the air cleaners to make sure there are no obstructions, that they are properly installed, and are clean.

3. Check the entire electrical system to be sure there are no loose connections and all component parts are properly connected.

4. See that no loose bars, tools, parts, etc., are lying in, or on, any part of the engine as they could cause serious damage to the engine or bodily injury to anyone near.

5. Start the engine by operating the starting button. If the atmospheric temperature is 50° F. or above, and if all of the foregoing instructions have been properly followed and the proper grade and type of fuel oil has been used, the engine will start at once.

6. Allow the engine to run for several minutes before load is applied to enable the engine to properly warm up and insure proper lubrication.

USUAL ROUTINE WAY OF STARTING THE ENGINE. If the engine has been operating recently and nothing has been removed or repaired since it last operated, the following is all that is necessary to start:

1. Check the fuel supply.

2. Check the lubricating oil. Be sure the oil is to the full mark on the bayonet gauge.

3. Check the cooling water or solution.

4. If the atmospheric temperature is 50° F. or above, nothing special need be done in preparation for starting. If below this temperature, see "Cold Weather Starting."

5. Place the governor control lever at half throttle or load position.

6. Be sure the stop control is not in the shut off position.

7. Start the engine by operating the starter button.

8. Check the engine, as under "Operating Instructions After Starting."

COLD WEATHER STARTING SUGGESTIONS

The increased temperature of the air due to compression is the only means of igniting the fuel sprayed into the combustion chamber.

If the metal surrounding this chamber and cylinder is extremely cold and the air entering the cylinder before compression is cold, the resultant temperature may not be sufficient to ignite the mist of fuel. The faster the starter turns the engine the less time is available for the heat of compression to be absorbed by the iron and water.

Three methods are available to increase this temperature.

1. Heat the water or cooling solution.

2. Heat the air before it reaches the cylinder.

3. Use a spray-type starting aid. Many makes are available and these devices can be installed by a competent mechanic.

Starting between 50° F. and 32° F. If the engines are not equipped with a cold starting aid, much time can be saved and excessive drain on the starting battery can be avoided by following these suggestions:

1. Crank the engine over several turns.

2. Place the governor control lever at full throttle or load position.

3. Be sure the stop control is not in the shut-off position.

4. As the operator depresses the starter button, hold the ether spray so that it will be sucked into the air intake manifold.

The above are suggestions for cold weather starting. However, the fuel injection pump on your engine has a built in cold weather starting aid. This consists of a spring loaded piston that allows extra fuel to be pumped to nozzles during the starting cycle. To activate this piston open throttle, at least 3/4 of its stroke, before pressing starting switch. As soon as engine fires and comes up to speed the hydraulic pressure built up in fuel pump overcomes the spring force on excess fuel device and returns it to its full load fuel setting.

Starting Between 32° F. and 0° F. (If the engines are not equipped with cold starting aid). To obtain maximum cranking speed, the oil must not be too heavy. When the temperatures approach freezing, many experienced operators drain all of the crankcase oil from the engine at the end of the day's run and heat it before returning it to the crankcase when ready to start. This is a good practice for the hot oil insures more immediate circulation to the bearings and helps warm the engine. At freezing temperatures, the water or cooling solution should be drained from the engine and radiator and heated to approximately 160°, if water, and as hot as possible if some solution is used. (Beware of fire if an alcohol solution is used). When this is poured into the engine the cold iron parts are heated and the oil on the cylinders thinned down. This operation does not take nearly as long as changing batteries after they are run down and will greatly aid in starting.

Starting 0° F. and Below. If the engines are not equipped with a cold starting aid, heating of the water, oil and air may be found desirable. Battery output is reduced at these low temperatures, so every means should be used to conserve your battery.

OPERATING INSTRUCTIONS AFTER STARTING

After the engine has started, an inspection of the whole engine unit should be made to make sure all parts are functioning properly.

1. Look at the lubricating oil gauge. If no pressure shows after the engine has run 10 or 12 seconds, shut down the engine and ascertain what the trouble may be. With the bearings in good condition and the proper grade of oil, the pressure should be 50 to 65 pounds at full engine speed. If the oil is very cold or heavy, this pressure may be much higher. As the oil heats up, the pressure will reduce.

2. Check the water temperature. If the water temperature is above 200° F., shut down the engine to ascertain what the trouble may be. Never operate with the water boiling, as this heat on the cylinder walls breaks down the oil film and also causes considerable water loss due to steaming.

3. Observe the engine operation for smoothness, quietness and exhaust condition. If the fuel is up to specifications and has the proper ignition and burning qualities, the engine may still run raggedly because a cylinder or two is firing irregularly due to being cold. As the engine begins to warm up, however, all cylinders should fire regularly. If they do not, the nut connecting the fuel line to the nozzle holder should be slightly loosened, one cylinder at a time, and fuel allowed to flow until all air has been expelled. When this nut is loosened, if the engine speed remains the same and the exhaust sounds the same, that cylinder is not firing or is firing irregularly. If, after checking this trouble and allowing fuel to flow from the loosened nut a few times, any cylinder still continues to fire irregularly or not at all, shut down the engine and trace out the trouble, some hints of which will be found in "*Trouble Shooting.*"

4. See that there is an adequate supply of fuel in the tank and that fuel is being delivered to the fuel pump. The delivery can be checked by slightly loosening the nut connecting the supply pipe to the secondary fuel filter; and, if a good quantity of fuel appears, it is an indication that the fuel injection pump is being supplied with sufficient fuel. If no fuel or very little appears, shut down the engine and check the supply tank again. If the fuel supply is adequate, check the fuel lines from the tank to the transfer pump and the transfer pump to the filters for leaks from *loose connections, broken nuts and cracked or broken lines.* Also, check the lines for obstructions inside or having been pinched closed or nearly so. If the lines are found satisfactory, check the transfer pump.

5. Check and see that there are no oil or water leaks.

6. Observe the fan and belt operation. Loose fan belts allow slippage which reduces the efficiency of the fan and wears the belts out rapidly and, also, affects the efficiency of the water pump.

7. See that the radiator, if one is used, is free of obstructions between the fins or tubes as they will obstruct the air flow and reduce the cooling efficiency of the radiator unit.

STORING THE ENGINE FOR LONG PERIODS

If slushing oil is not available, clean crankcase lubricating oil heated to about 180° to 200° may be substituted. However, this does not have the protection qualities of the slushing oil and should be periodically reapplied.

A -- Preparing the Engine

1. Before reinstalling the nozzle holders, take a pump type oil can with a long narrow spout, with a tip that will fit into the 7/32" or larger hole of the spray nozzle sleeve, and give it six or eight squirts per cylinder, then turn the engine over slowly a few times to distribute the oil.

   BEFORE STARTING, remove the spray nozzles and turn the engine over with the starting motor to blow the excess oil out.

2. Drain the entire engine and water circulating system thoroughly.

3. Drain the lubricating oil from the engine and filters.

4. The crankcase should be filled to the FULL mark on the bayonet gauge with an oil similar to the following:

   Gulf No-Rust Engine Oil, Grade 2
   Shell ENSIS 412, Specification 2-126, Grade 2

   This oil should be placed in the engine crankcase at the beginning of the run.

The above oils are graded the same as regular motor oil according to SAE weight. Therefore, the proper weight of oil for the climatic conditions should be chosen to facilitate starting.

5. Disconnect the wires leading to the batteries and remove the batteries, storing them preferably at some place where they can be charged periodically, as batteries lose their charge rapidly if not in use.

6. Cover the ends of the air inlet and exhaust pipe so moisture cannot reach the valve ports and cylinders, store the engine where it will not be exposed to the elements such as sun, rain, snow, hail, etc., and preferably where it can be kept warm and dry.

7. Every month the engine should be cranked over by hand eight or ten revolutions to redistribute the oil film over the wearing surfaces. This will prevent rusting of the wearing surfaces inside the engine.

The above methods have proven successful; however, White Enginges, Inc., cannot assume responsibility for engine storage.

Preparing the Engine For Starting After a Long Shutdown. If the engine has been stored as outlined above, it will be necessary to pursue the following procedure to prepare it for starting again:

1. Drain the entire fuel system of lubricating or special oil. Open the drain on the bottom of the main fuel supply tank and allow all water and sediment in the tank to drain, then reconnect the tube.

2. Check all fuel supply lines from the main supply tank to the filter to make sure the connections are tight and the lines are open with no obstruction or "pinched" places.

3. Remove the nozzle holders and wipe the vaseline from the outside surface of each nozzle. Do not wipe the vaseline off the valve in the valve body. Prime the fuel system, see "Priming the Fuel System."

4. If the nozzles do not function properly, clean as described under "Care of the Fuel Nozzle."

5. Turn the engine by hand three or four revolutions to spread the lubricating oil on the walls and bearings and start oil circulation.

6. Install the fuel or spray nozzles and connect the lines tightly.

7. Drain the lubricating oil filter of all water and sediment.

8. Fill the cooling system with clean water or an antifreeze solution.

9. Follow the instructions as given for "Starting the Engine the First Time."

10. After the engine is running, follow the instructions as given for "Operating Instructions After the Engine is Started."

HIGH ALTITUDE OPERATION

The starting and operation of Diesel engines encounter certain difficulties at higher altitudes. These difficulties are not commonly noticeable until 3000 feet is reached. While the engine has lost only about 10 percent at 3000 feet, at 6000 feet the loss is about 21 percent. From these figures one can readily see that no difficulty will be encountered in the first 3000 feet, but that some consideration must be made in the power requirements at these higher altitudes. This fuel adjustment must be made on turbocharged engines to prevent overspeeding of the turbocharger.

Since air at higher altitudes is much lighter and contains less oxygen than at sea level, the amount of air or oxygen drawn into the cylinders at higher altitudes is much less. This lowers the compression pressures, causing hard starting and poor combustion.

It is necessary to reduce the amount of fuel entering the cylinder, as with the original fuel setting and the smaller amount of oxygen, the combustion is incomplete and a smoky exhaust results, with the naturally asperated engine only.

It is sometimes desirable to follow the starting methods as outlined under "Cold Weather Starting."

For additional information on specific cases, please write to White Engines, Inc., Service Department, P. O. Box 6904, Canton, Ohio 44706, U.S.A., giving as much data as available.

LUBRICATION

LUBRICATION INSTRUCTIONS

Oil Level. The level of the oil in the crankcase is determined by a bayonet or dip stick type of gauge. Wipe off the gauge and reinsert to determine the oil level accurately. The oil level should be maintained at the full mark on the gauge. See Illustration No. 4.

The engine must be stopped for at least two minutes before the oil level is checked. This will allow the oil to drain back into the oil pan and prevent overfilling.

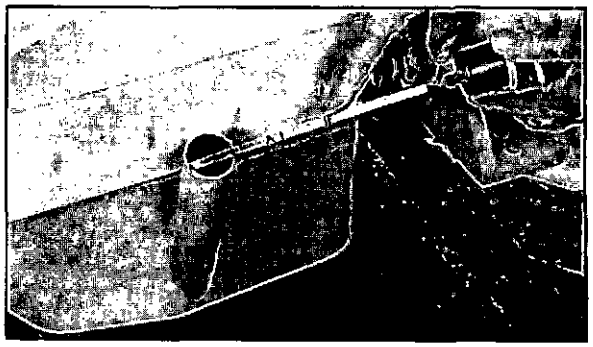


Illustration No. 4

OIL CHANGING

Frequency of oil changes depends upon the application of the engine and the severity of the operation. Under normal operating conditions the oil should be changed every 125 hours. A new or reconditioned engine should have the oil changed more often for the first 100 hours of operation. (Suggest first change each 50 hours).

Lubricating oil recommendations are based on engine design, type of service, and ambient air temperature. High quality oils combined with necessary oil and filter changes are required to assure maximum performance, long engine life, and minimum operating cost.

RECOMMENDED LUBRICATING OIL SPECIFICATIONS

Ambient Air Temperature	Viscosity Grade	Use single viscosity, low ash oil with API Classification as shown below. Select viscosity grade according to ambient temperature.
-10° to 30° F 30° to 60° F 40° and up	10W 20 - 20W 30	
-10° F and up	15W - 40	NOTE: Multigrade oils with CD Classification Only are acceptable for Diesel engines.

API CLASSIFICATION

Naturally Aspirated Diesel (MIL-L-2104B or C) ----- CC (Single Viscosity) or CD

Turbocharged Diesel Engine (MIL-L-2104C) ---------- CD

For breaking in a new engine, we suggest an S.A.E. 20 Detergent oil, Series No. 1, for normal conditions and a lighter oil if cold weather or cold climate conditions prevail. Detergent oil, Series No. 1, should be used for at least 50 hours of operation. Change each 25 hours.

The filter element should be changed at the same time the oil is changed in the crankcase. Recheck the oil level after running the engine approximately five minutes to fill the filters. Use the bayonet gauge when replenishing the oil supply and fill to the full mark on this gauge. See "Oil Level."

ACCESSORIES

Accessories mounted on the engine usually carry their own lubricating instructions, which should be followed.

OIL PRESSURE

Refer to "Oil Pressure." See Engine Name Plate.

SUGGESTED PREVENTIVE MAINTENANCE SCHEDULE
DIESEL

A. DAILY

1. Check air cleaner.
2. Check crankcase oil level.
3. Check coolant level.
4. Check alternator charge.
5. Check oil pressure reading.
6. Check general condition of unit. Tighten, repair, or replace parts as necessary.

B. 125 HOURS OR 3000 MILES IN ADDITION TO "A" SERVICES

1. Change crankcase oil.
2. Clean crankcase breather.
3. Tighten accessory drive belts.

4. Check radiator air passages for air flow restrictions, dirt chaff, etc. Clean, if dirty.

5. Replace primary fuel filter only.

6. Change oil filter.

C. 500 HOURS OR 12000 MILES. IN ADDITION TO "B" SERVICES

MAJOR TUNE-UP

1. Inspect engine for loose connections, leaks in oil, fuel and water system, cracks, and free action of all moving parts.

2. Check valve tappet clearance and reset, if necessary.

3. Adjust governor and throttle linkage.

4. Change air filter.

5. Clean, inspect and set injector nozzles if loss of engine performance is noted or exhaust smoke density indicates a problem.

6. Check fuel pump timing and adjust, if necessary.

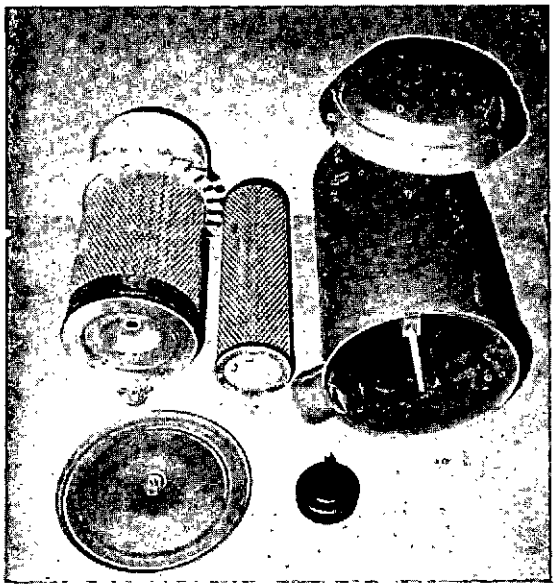


Illustration No. 5

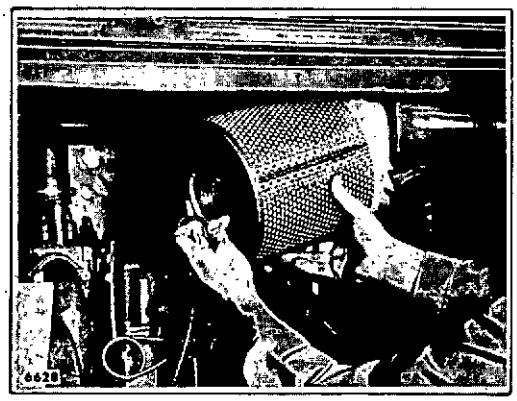


Illustration No. 6

DESCRIPTION AND MAINTENANCE

This section covers a brief description and function of the various parts of the engine along with complete instructions covering the repair, disassembly and reassembly of the various component parts of the "D" 4800 series engines.

This section has the various subjects arranged alphabetically for convenience in locating.

AIR CLEANERS

Dirt is the greatest enemy of any internal combustion engine and it is necessary to take every precaution to prevent it from entering the engine. This is accomplished by using an efficient dry type air cleaner. When dirty, a restriction is created in the air intake, which may cause excessive exhaust smoke, loss of power, excessive fuel consumption, internal engine deposits and result in short engine life. Very little restriciton, due to dirty air filters, is sufficient to create a very rich mixture. Therefore, one of the most essential preventive measures is proper maintenance of the air intake filter. This unit should be checked at least once a day and, if operating in dusty conditions, may require cleaning or servicing of the elements even more often. Single element style cleaners are used in normal applications.

When an Air Restrictor Indicator, either electrical or vacuum type is used, it will flash or show a red signal when the air intake system has become clogged. If the air stack cap, or precleaner screener has been kept clean, indication will be that the air cleaner element should be serviced.

DUEL-STAGE AIR CLEANER

The Heavy Duty type air cleaner has a primary (outer) element and a safety element, (Illustration No. 5). Clean primary element only when restriction indicator light shows red. Replace primary element yearly, or every 1000 hours of operation or after 10 cleanings, whichever comes first. For maximum engine protection, cleaning of safety element is not recommended. Have your dealer replace safety element only after primary element has been cleaned or replaced and restriction indicator again shows red.

Illustrations No. 5 and No. 6 show two of several styles that may be specified. Service and cleaning should follow the manufacturers' instructions printed on the decal located on the outside of the cleaner.

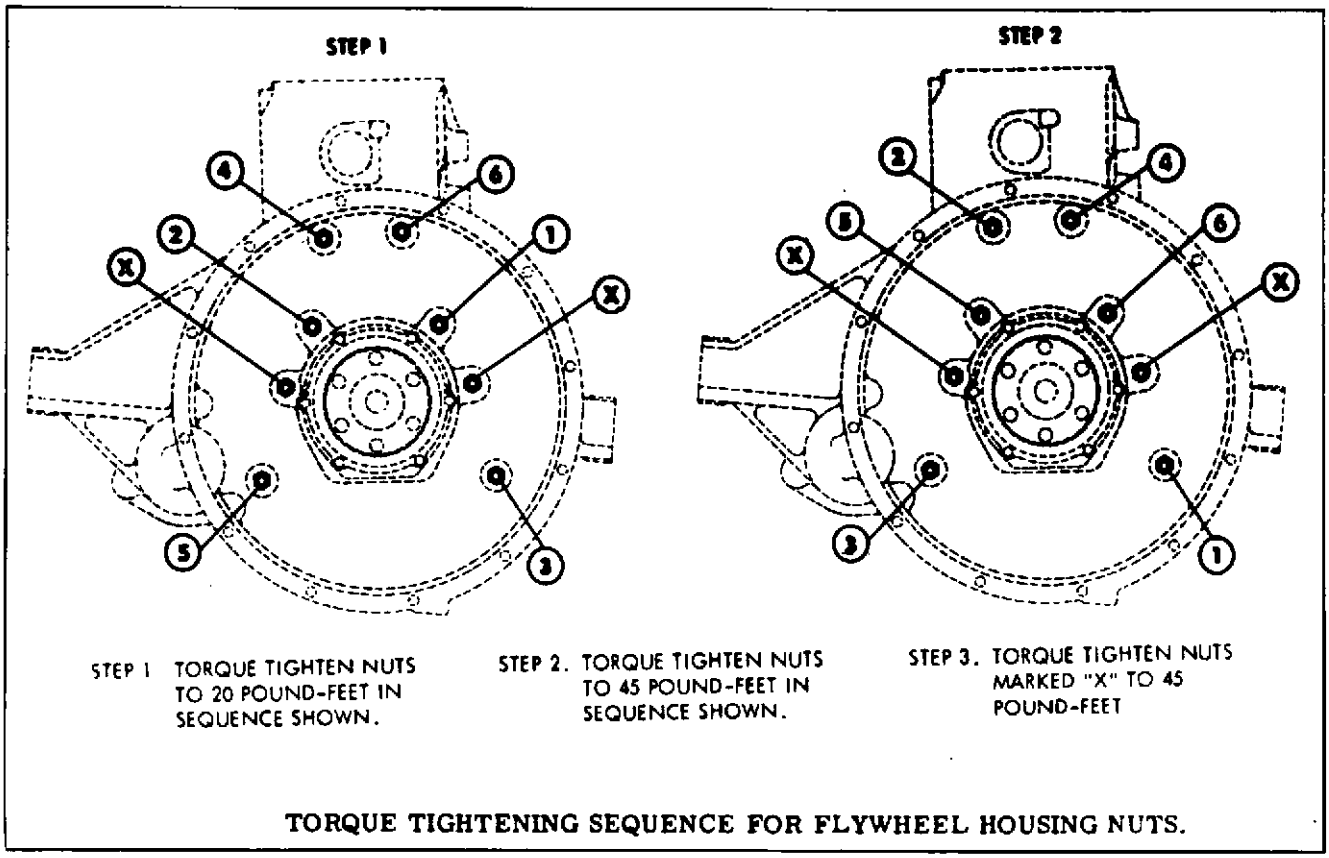
All connections between the air cleaner and manifolds must be absolutely air tight. Abrasive laden air drawn into the engine through a loose connection will cause rapid wear of the pistons, rings and upper cylinder surfaces.

BREATHER

The breather allows accumulated gases to escape from the crankcase, the normal process of engine breathing. The engine is equipped with a draft tube to eliminate these gases.

BELLHOUSING

The bellhousing is an aluminum casting which fastens to the rear end of the cylinder block. The bellhousing forms a complete enclosure for the flywheel and clutch, to which the transmission, torque converter or other drive mechanism is attached. The bellhousing also forms the rear motor support,



TORQUE TIGHTENING SEQUENCE FOR FLYWHEEL HOUSING NUTS.

Illustration No. 7

TO REMOVE THE BELLHOUSING

1. Remove the clutch or power take-off mechanism.
2. Remove the flywheel. See "Flywheel," Illustration No. 21.
3. If the engine is in the unit, place suitable supports under the rear of the crankcase to support the engine.
4. Remove the rear motor support screws.
5. Remove the bellhousing attaching stud nuts. See Illustration No. 7. This also shows torqueing sequence and pounds torque on nuts.
6. Pull the bellhousing away from the engine. It may be necessary to tap the housing with a soft hammer to loosen from the dowels or gaskets sticking to the block.

TO INSTALL THE BELLHOUSING

1. Install a new bellhousing gasket to the cylinder block, as bellhousing locating dowels and studs will hold it in place.

2. Check the bellhousing mounting dowels to be sure that they are tight and in good condition. Install bellhousing and torque, tighten nuts in sequence shown in Illustration No. 7.

3. Install the rear motor support screws and remove the jack or block from under the crankcase.

4. Install the flywheel. See "Flywheel", Illustration No. 21, page 35 and "Indicator", Illustration No. 22.

5. Install the clutch or torque converter.

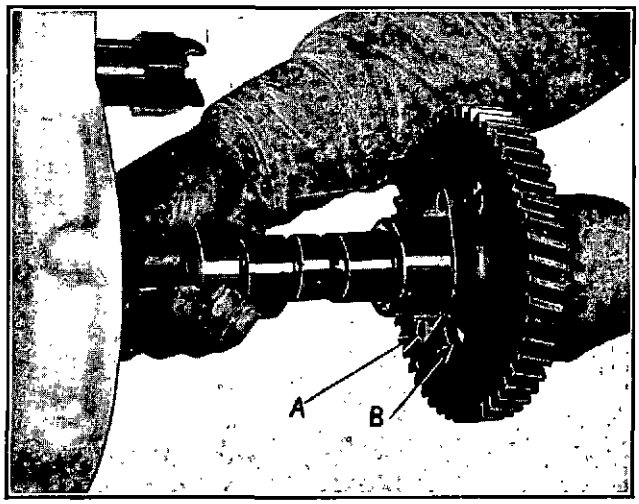


Illustration No. 8

CAMSHAFT

The camshaft is supported on large diameter pressure lubricated removable bearings in the crankcase and is driven by means of a suitable gear which meshes with the crankshaft gear.

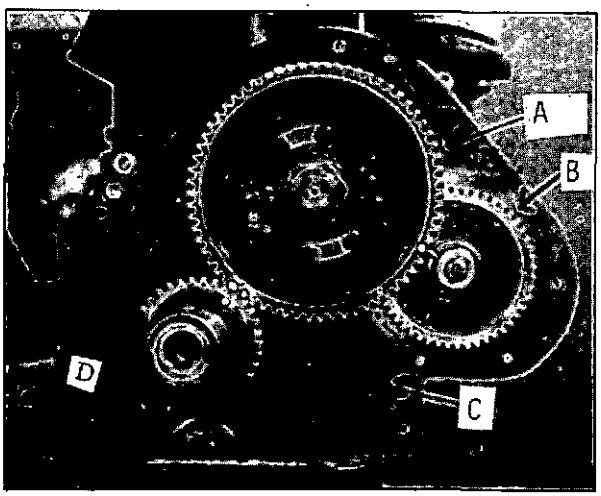


Illustration No. 9

The timing of these two gears requires no check of the valve position. It is only necessary to align the two punch marks on the cam gear with the one mark on the crank gear. This timing procedure applies only when Bosch - Model 100 or Roosa Master DB fuel injection pumps are used.

When the Roosa Master - Model DM pump is used, the timing must be set exact, as shown in Illustration No. 9. The two punch marks on the cam gear (A) and one on the crank gear (B) and the one punch mark on the cam gear (A) and the line on the fuel pump drive gear (C) must be in perfect alignment. (See Fuel Pump Timing.)

The camshaft end play is controlled by a thrust plate (A), Illustration No. 8, located between the front camshaft bearing and the camshaft gear. Correct end play of .006 to .015 is regulated by the thickness of the thrust plate.

To decrease the end play when it is beyond specified limits. Replace thrust plate "A", see Illustration No. 8.

To increase the end play, use a piece of very fine emery or Crocus cloth on a surface plate, polish the thrust plate to the desired thickness to obtain the proper end thrust.

TO REMOVE THE CAMSHAFT.

Assuming that the radiator, and so forth, have been removed, the camshaft may be removed, as follows, without removing the engine from the chassis.

1. Remove the fan blade and belts for easier access to the gear cover and gears.

2. Remove the fan drive pulley nut, fan drive pulley, and vibration damper assembly.

3. Remove the gear cover.

4. Remove the rocker arm covers, rocker arms and push rods.

5. Remove lube oil filters and cooler assembly, also fuel oil filter.

NOTE: Do not disconnect fuel oil lines, just lay filter to one side.

6. Remove side cover plates and lift out tappets keeping them in same order as removed for reassembling in same position.

NOTE: To remove and assemble the camshaft to the engine with the engine out of the chassis, the same procedure is followed, except Item No. 5 and No. 6 are disregarded. With the engine out of the chassis, it is only necessary to set the engine on the bellhousing, push the tappets to the "up" position and remove the camshaft. With the tappets in the raised position, rotate the engine until the two holes in the camshaft gear expose the thrust plate attaching screws.

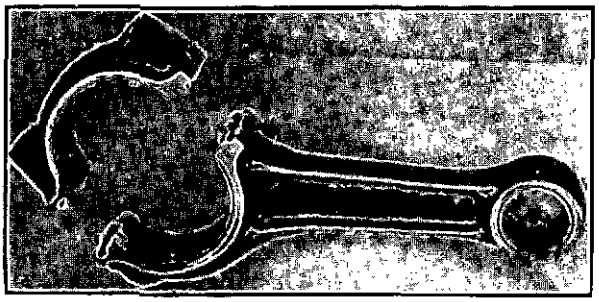
7. Remove the thrust plate attaching screws and pull the camshaft forward out of the engine block.

   Inspect the camshaft lobes, journals, etc., for wear or damage. Also, inspect the thrust plate for clearance.

CONNECTING ROD

The connecting rods are heavy alloy steel forgings with precision type bearings for the shaft and bronze bushings for the piston pin. With this precision or insert shell type bearing, the cam and rod is split at 45° to facilitate removal. No shims are used and, therefore, when reconditioning of the bearings is necessary, only the bearing shells need to be replaced.

CAUTION: Do not file or grind the caps, as new bearings cannot be installed in a connecting rod that has been filed.



Connecting Rod

NOTE: -- As built at the factory, the connecting rods and caps are marked on the camshaft side and to the front of the engine with the cylinder number in which they are used.

TO REMOVE THE CONNECTING RODS

CAUTION: -- Connecting rods and caps are matched -- keep them paired together, as otherwise they cannot be reinstalled.

1. Drain the radiator and engine block.
2. Remove the thermostat housing and thermostat and water manifolds. Also, disconnect the water temperature gauge thermocouple.
3. Disconnect and remove the air cleaner hose from the manifold.
4. Disconnect the exhaust pipe from the manifold.
5. Disconnect the fuel lines and remove from pump and nozzle holders.
6. Remove the front and rear cylinder head covers, rocker arm assemblies and push rods.
7. Remove the cylinder head nuts and lift the cylinder head assembly carefully from the engine (manifolds may be removed with the heads).
8. Remove the oil pan and lubricating oil pump and lines.
9. Remove the piston oil spray nozzle assembly from each cylinder.
10. Carefully scrape the carbon deposit from the top of each cylinder bore so that the pistons can be removed without damage to the rings.
11. Turn the engine so that No. 1 and No. 6 connecting rod caps can be removed and the piston and rod assembly pushed carefully upward with a block of wood or hammer handle, Illustration No. 10, to remove from the engine.

NOTE: -- Keep the rod caps and bearings of each respective rod together -- do not mix.

12. Turn the engine, as required, so that the other rods and pistons may be removed.

TO DISCONNECT THE CONNECTING RODS FROM THE PISTONS.

Remove the piston pin retaining rings and push the pin out of the piston and connecting rod bushing.

Inspect the piston pin and bushing for wear and replace, if necessary. If new parts are used, check the connecting rod alignment on a standard aligning fixture.

TO INSTALL THE CONNECTING RODS.

1. Assemble the connecting rod and piston and insert the retaining rings in piston.

2. Inspect the crankshaft for any rough or scored marks that might damage the connecting rod bearing. If any rough marks are found, use an oil stone, very fine emery cloth or Crocus cloth to polish the shaft. Clean the shaft thoroughly after polishing.

3. Install the piston rings on the pistons. See "Piston Rings."

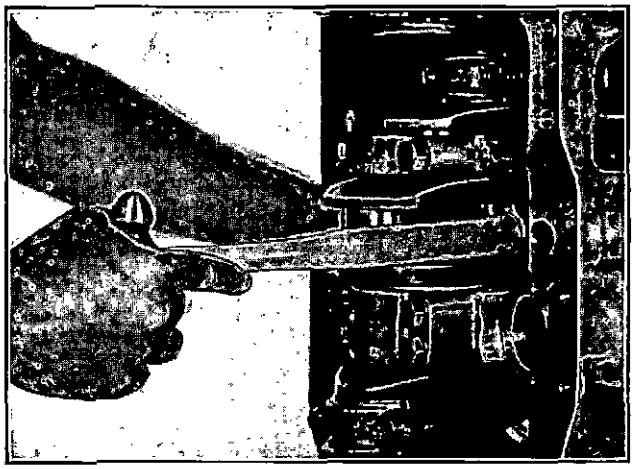


Illustration No. 10

4. Select the proper piston and connecting rod assembly and turn the crankshaft so that it is in the correct position.

5. Apply a liberal coat of lubricating oil to the cylinder bores, pistons, rings, and piston pin. Space the piston rings so that no two slots are in line.

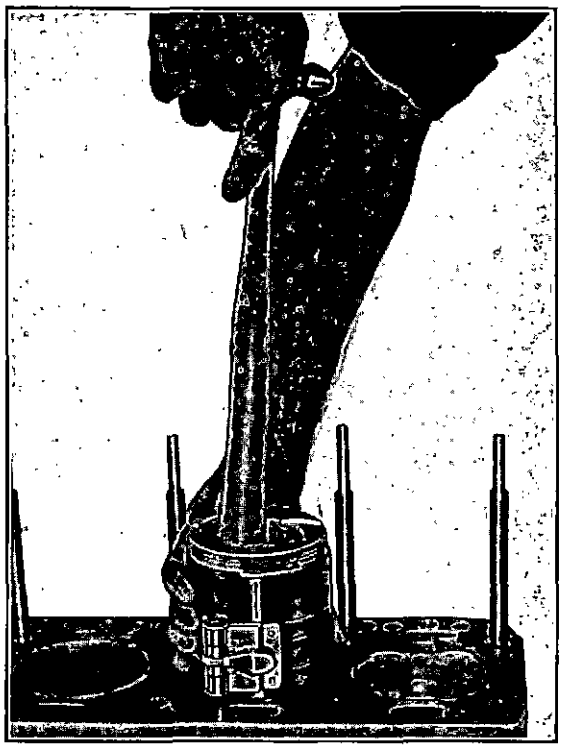


Illustration No. 11

6. With the piston rings compressed as shown in Illustration No. 11, use a hammer handle or block of wood to force the piston and rings into the cylinder bore. At the same time, use care that the connecting rod is in line with the crankshaft journal.

7. With the piston entirely in the cylinder bore, insert the upper bearing shell and pull the connecting rod down to the crankshaft.

8. Place the shells in the cap and assemble. Tighten the cap screws to the proper tension and try the connecting rod for side movement. It should move easily. See "Fits and Tolerances" for proper clearance and proper nut tension.

9. Repeat the above operations for all connecting rods.

10. Install the piston oil spray assembly for each piston.

11. Install oil pump and lines.

12. Inspect the top of the cylinder block and pistons. Be sure no foreign matter is present and install new cylinder head gaskets. Be sure fire ring and grommets are in place.

13. Install the cylinder head. See "Cylinder Head Torque", per Illustration No. 20.

14. Insert the valve push rods and install the rocker arm assemblies.

15. Adjust the tappets to the proper clearance. See "Valves."

16. Install the cylinder head cover, using a new gasket, if necessary. Install the nuts and washers as removed.

17. Install the thermostat, thermostat housing, water pump by-pass hose and connect the water temperature gauge thermocouple and water manifold.

18. Install the fuel lines.

19. Install and connect the air cleaner and connect the exhaust pipe to the manifold.

20. Connect the radiator hoses and fill the radiator with clean water or antifreeze.

21. Install the oil pan, using new gaskets, and fill the crankcase with the proper grade of lubricating oil.

CONNECTING ROD BEARING REPLACEMENT

If excessive clearance develops between the shaft and bearing shells, new bearing shells should be installed. If the clearance is excessive with the new bearings, regrind the shaft and use undersized bearings. Undersized bearings are available in sizes of .010 and .020.

The connecting rod bearings may be replaced as outlined below:

1. Remove the oil pan. See "Oil Pan, Oil Pump & Oil Pump Lines".

2. Locate the crankshaft so the connecting rod cap can be removed.

3. Remove the screws.

4. With a soft hammer, tap the cap to loosen it and remove the cap.

5. Replace the bearing shells as outlined under paragraph No. 8 and No. 9 (Connecting Rod Installing).

6. Reassemble the oil pan, oil pump and lines to the engine. See "Oil Pan".

COOLING SYSTEM

Perhaps the best method for care of the cooling system is to clean and flush the system periodically; also, use some good rust and corrosion preventive between cleaning periods. Almost all natural water contains some mineral salts which stimulate corrosion.

Exhaust gas leaking between the cylinder head and the gasket also results in corrosion if exhaust gases discharge into the water, combining to form a variety of acids such as carbonic, nitrous and sulphurous, all supporting electrolytic corrosion. It is, therefore, important that the cylinder head stud nuts be drawn down at regular and frequent intervals to prevent exhaust gases from leaking into the water jacket.

Air leaks around the hose connections and through the water pump should be carefully guarded against, since oxygen is a major factor in promoting corrosion. Check the hose connections frequently for air leaks.

If the engine or unit is equipped with a pressure type sealed system, it is imperative that the correct type of radiator cap be used. This is determined by the type of system used.

There are two types of sealed cooling systems which are used extensively. One type has a safety relief valve arrangement built into the radiator filler cap, Illustration No. 12. The overflow pipe is also connected to the radiator filler neck above the lower seat of the pressure cap. In this manner, if excessive pressure develops in the cooling system, the lower part of the pressure cap will raise from its seat and allow the vapor to escape through the overflow pipe.

This type of cap should never be removed quickly. Always turn the cap off slowly until the pressure has escaped through the overflow pipe, then remove the cap.

The second type of pressure sealed cooling system has the pressure relief valve and overflow pipe built into the top tank as a separate unit (not connected to the filler neck).

However, if any type of sealed cooling system is used, the proper filler cap, good gaskets and a smooth gasket surface are essential if excessive loss of the coolant is to be prevented.

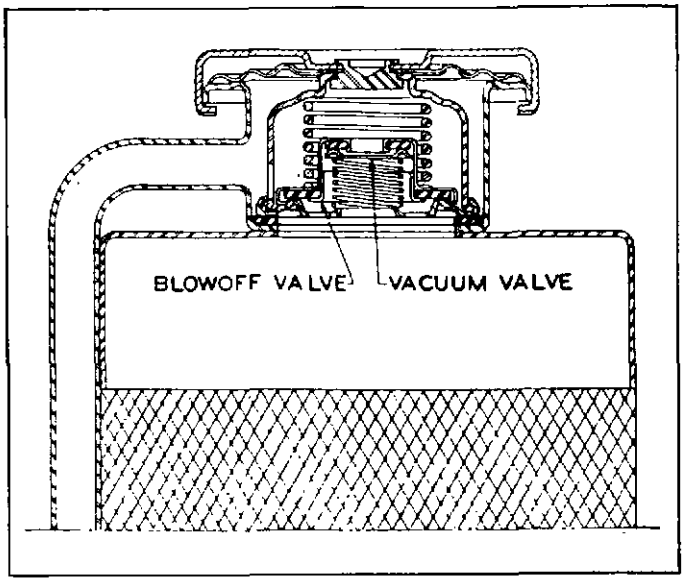


Illustration No. 12

From the above, it can be readily understood why serious overheating of the engine may result from loss of coolant or cooling efficiency when the incorrect filler cap, bad gaskets, or a rough gasket surface is encountered.

Use a good commercial neutralizer in the cooling system. To obtain the best results, follow the instructions of the manufacturer.

CRANKSHAFT

The crankshaft is a machined forging having all bearing journals surface-hardened. The nominal diameter of the main bearings is 3 41/64" while the nominal diameter of the connecting rod journals is 3". The shaft has passages drilled to carry oil, under pressure, to the connecting rod bearings. These passages should be cleaned with a wire brush, see Illustration No. 13, before the shaft is installed in the engine.

The diameters given above are only nominal, see "Fits and Tolerances" for the actual standard sizes.

WARNING! When regrinding a crankshaft, it is imperative that the original 5/32" radius from journal to cheek be maintained. Crankshaft breakage may result from improper grinding of this fillet. The shafts are available in .010, and .020 undersize only.

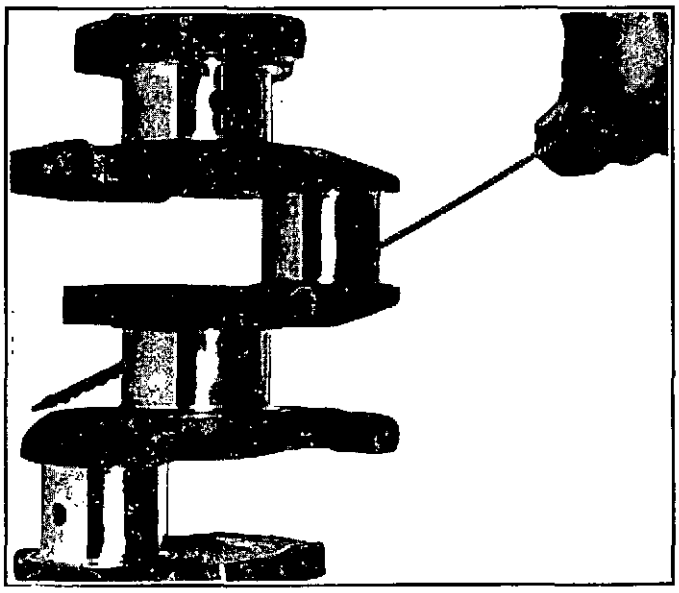


Illustration No. 13

For installation of pilot bushing in crankshaft, see Illustration No. 14. For method of indicating bushing, see Illustration No. 15.

TO REMOVE THE CRANKSHAFT GEAR

If a suitable arbor press is not available, the following method may be used.

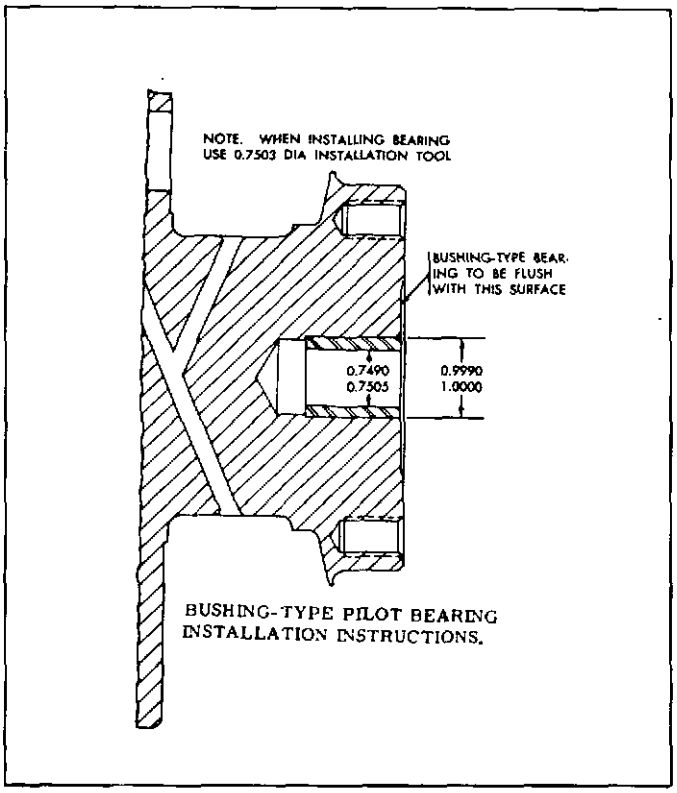


Illustration No. 14

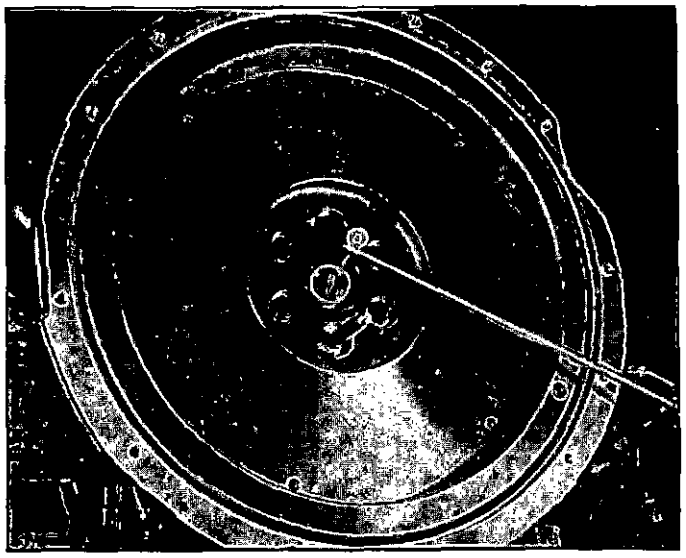


Illustration No. 15

This gear is a snug fit on the crankshaft, and it is possible to pull this gear with any of the commercial pullers. Since replacement of this gear would only be brought about by the gear being badly worn or damaged, making replacement necessary, it will be necessary to replace all gears at the same time.

CRANKSHAFT GEAR, INJECTOR PUMP DRIVEN GEAR AND CAMSHAFT GEAR

a. Removal: Remove crankshaft gear, injector pump driven gear, and camshaft gear.

NOTE: When either crankshaft gear, camshaft gear, or injector pump driven gear need replacement, the three gears must be replaced as a timing gear set.

Remove crankshaft oil deflector from end of crankshaft. Wedge a piece of wood or brass rod between crankshaft gear and camshaft gear to prevent gears from turning while camshaft gear retaining nut is being loosened. Loosen camshaft gear retaining nut and remove wedge or rod.

Align timing marks on crankshaft and camshaft gears. Remove crankshaft gear.

NOTE: Removing injector pump driven gear will disturb fuel injector pump timing in relation to engine valve timing. The fuel injector pump must be retimed when gear is installed.

b. Inspection and Installation: Inspect and install crankshaft gear, injector pump driven gear, and camshaft gear.

1. Check condition of gear keyways. Key must be in proper condition, not worn, and must fit tight in keyway. Check thrust surface of camshaft.

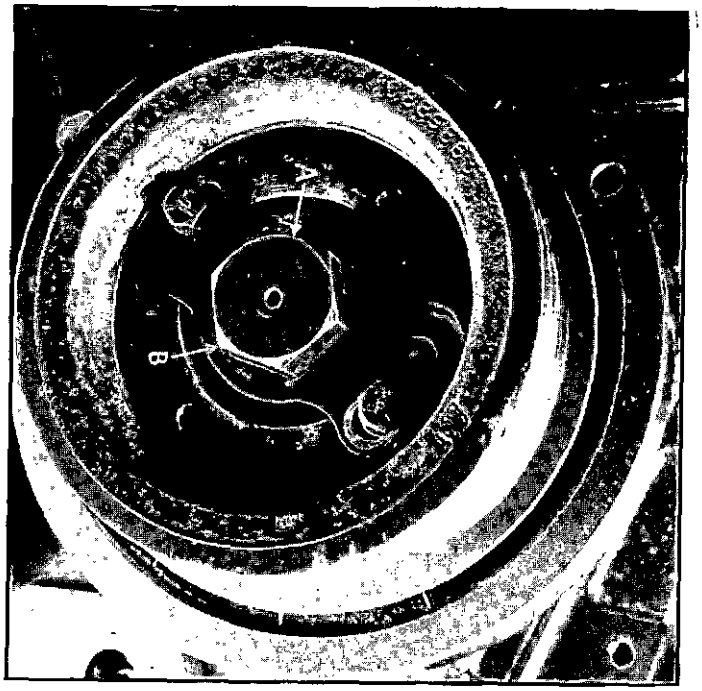


Illustration No. 16

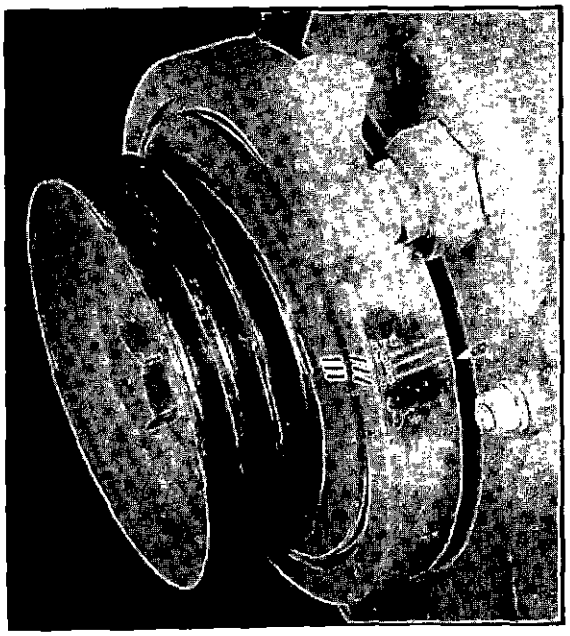


Illustration No. 17

CRANKSHAFT DAMPER AND PULLEY ASSEMBLY

a. General: The crankshaft damper and pulley assembly must be removed from the crankshaft in order to replace the pulley and/or damper.

b. Removal: Remove crankshaft damper and pulley assembly as follows:

1. Remove engine fan from water pump pulley.

2. Remove drive belts.

3. Remove crankshaft damper pulley retaining bolt and lock plate. See Illustration No. 16, Item A & B.

4. Install mechanical puller on hub of pulley. Puller holes are in pulley for this purpose.

c. Disassembly: Disassemble and inspect crankshaft damper and pulley assembly as follows:

1. Remove cap screws securing crankshaft damper to pulley.

2. Separate the crankshaft damper from the crankshaft pulley assembly.

3. Check damper timing mark to be sure they are in perfect alignment with timing marks on edge of pulley. See Illustration No. 17. If they are not, replace damper, as this indicates that rubber in damper is broken or damaged.

4. A viscous damper which has no rubber is sometimes used and should be inspected regularly and replaced if dented.

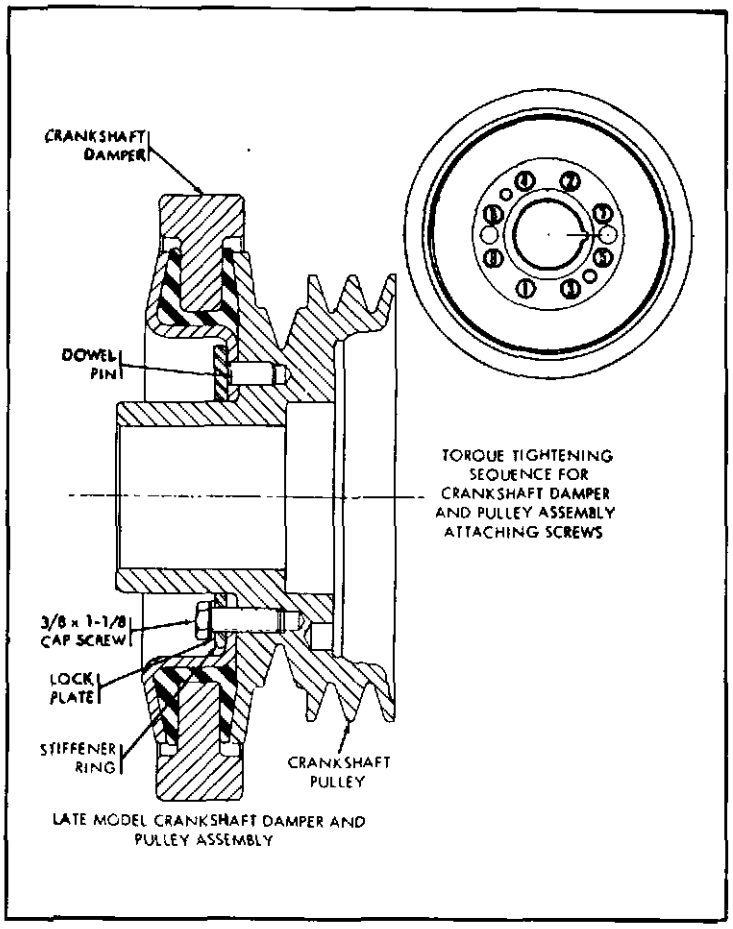


Illustration No. 18

d. Inspection and Repair:

1. Inspect oil seal contact surface for nicks or burs which may damage oil seal. Remove minor damage with Crocus cloth.

2. Check keyway for burs or damage. Check damper and pulley for cracks.

3. Check rubber insert in damper for cracks, cuts, or loose fit. If rubber insert has separated from steel hub or rim, replace damper.

e. Assembly:

1. Tighten the eight cap screws securing the crankshaft damper to the pulley assembly to a torque of 30-35 ft. lbs. following sequence shown in Illustration No. 18.

f. Installation: Before installing crankshaft damper and pulley assembly on crankshaft, coat lip of crankshaft front oil seal and sealing surface on pulley with lubricating oil to prevent damage to oil seal lip when pulley is installed. Hold replacer bolt stationary while turning plain nut to seat damper and pulley assembly. When bolt holes in lock plate do not align with threaded holes in pulley, the plate can be turned over and positioned so the holes are aligned.

CRANKSHAFT FRONT OIL SEAL

a. Removal: Remove crankshaft front oil seal as follows:

1. Remove engine fan and all belts.

2. Remove water pump assembly.

3. Remove crankshaft damper and pulley assembly.

4. Remove oil pan front screws, that hold pan to cover, loosen balance of capscrews so front of pan drops away from gear cover.

5. Remove tachometer adapter, drive shaft, and mounting adapter.

6. Remove crankshaft front oil seal from timing gear cover assembly.

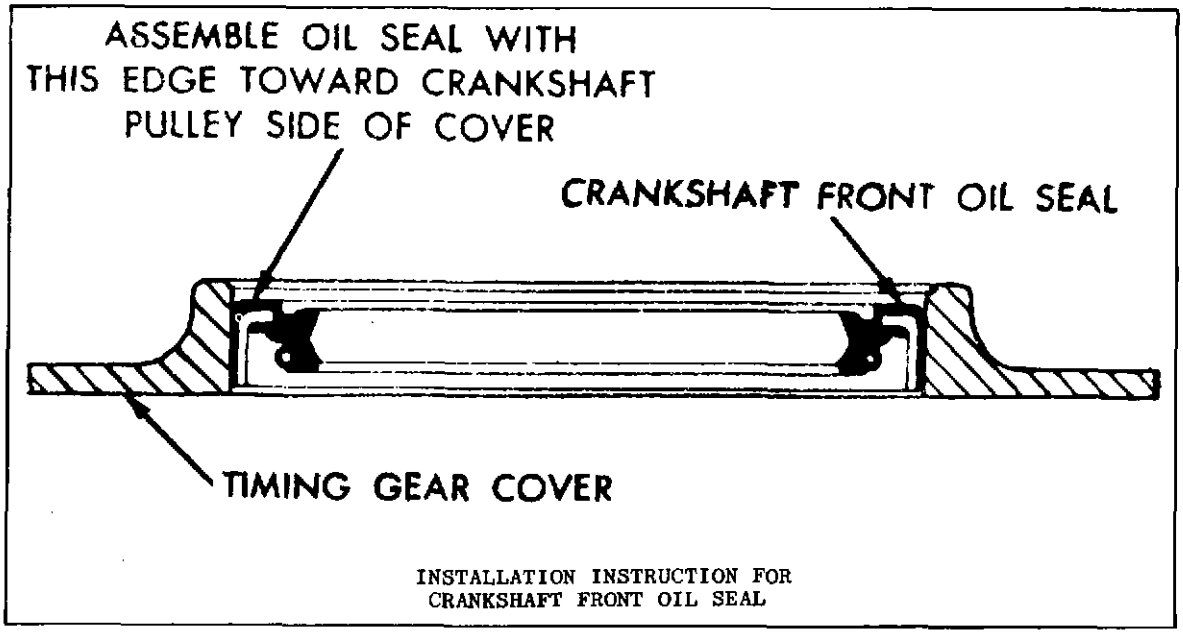


Illustration No. 19

b. Installation: Install crankshaft front oil seal as follows: See Illustration No. 19.

1. The crankshaft front oil seal has a double lip which must be installed in the timing gear cover assembly with flange edge away from cover mounting flange.

2. Position crankshaft front oil seal in bore of timing gear cover assembly. Install seal in bore using arbor press and suitable press plate.

3. The timing gear cover assembly is positioned on two locating dowel pins. When installing cover, cover must be properly positioned on pins before tightening capscrews.

CYLINDER AND CRANKCASE

The cylinders are cast integral with the crankcase and have the water jacket carried the full length of the cylinders. This results in uniform cooling of the piston and cylinder wall.

Material is cast iron with forged bearing caps fastened to the cylinder block with 9/16 capscrews. The most casual inspection of the cylinder block will disclose the very rigid construction provided to support the crankshaft and this rigidity, coupled with the large diameter of the crankshaft, results in a very rugged and smooth running engine. See Illustration No. 1.

All engines are equipped with dry, removable cylinder sleeves. See "Cylinder Sleeve."

The cylinder block has a drilled passageway running the length of the block, known as an oil header, which is closed on the ends with suitable

pipe plugs. From this header, various passages are drilled to carry oil to the main bearings, camshaft bearings and rocker arms. See Illustration No. 2.

All oil passages should be thoroughly cleaned with a wire brush and solvent at overhaul time.

To replace the main bearings, see "Main Bearings".

Core openings are closed by expansion type steel plugs. If any of these should leak, remove and replace with new plugs.

CYLINDER HEAD

The cylinder heads are one piece castings and are interchangeable. The valve seats and the valve guides are removable. The head is held to the cylinder block by studs; and, in order to insure against leaks, the head must be carefully drawn down by means of the stud nuts which should be progressively tightened, working from the center of the head toward the ends, as shown in Illustration No. 20, which shows torque of nuts and sequence for tightening.

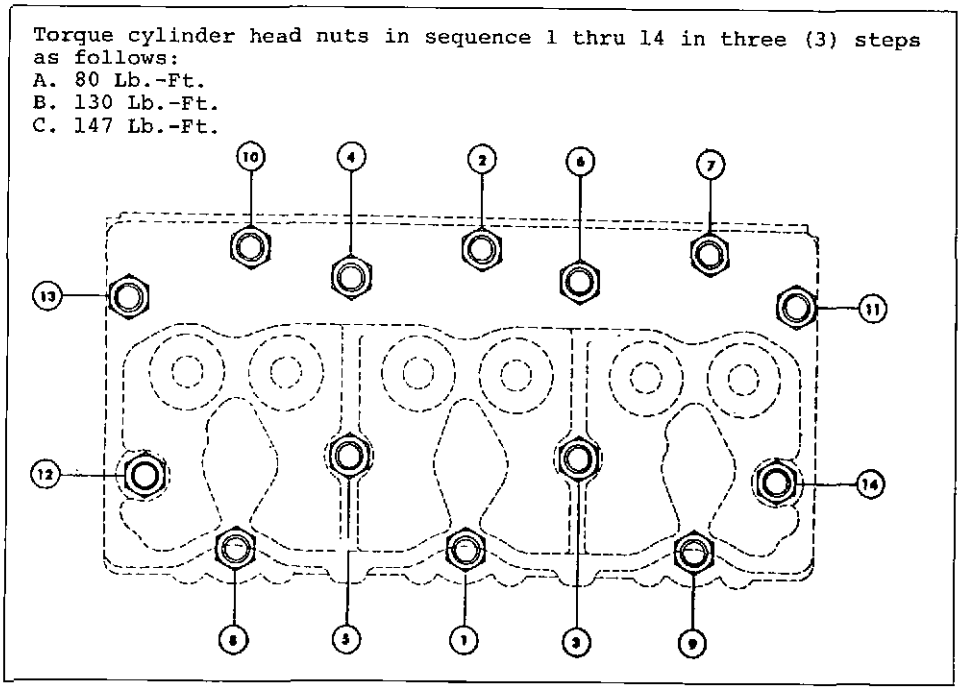


Illustration No. 20

CAUTION: The cylinder head nuts must be retightened and the valve tappet clearance reset after two hours of service.

If cylinder head gasket failure is encountered, a thorough check should be made of contributing factors. Detonation (caused by ignition which is too far advanced), will cause a shock load in the combustion chamber which will damage cylinder head gaskets and, if allowed to continue, may destroy the pins and piston rings. Fuel with a cetane rating too low may also contribute to detonation and corrosion of the gasket to the point where it will start leaking. Cooling solutions, which are contaminated by corrosive combustion gases leaking into the cooling system, are very detrimental to the internal parts of the entire cooling system.

TO REMOVE THE CYLINDER HEAD.

1. Drain the radiator and remove the water thermostat housing and hoses and water manifolds. Also, disconnect the water temperature gauge thermocouple.

2. Disconnect the exhaust pipe from the exhaust manifold.

3. Disconnect the air cleaner or pipe from the intake manifold and remove.

4. Remove the fuel lines from nozzles.

5. Remove the cylinder head covers, rocker arm assemblies and push rods.

6. Remove the cylinder head nuts and lift the cylinder heads from the engine. Tap the heads lightly with a soft hammer, if necessary, to loosen it. Do not pry on the contact surfaces.

   By leaving intake and exhaust manifolds on heads and using a spreader bar, both heads can be removed together.

CYLINDER HEAD INSPECTION.

Cylinder head assembly: Check cylinder head assembly for cracks especially near fillets and around studs and pipe plug openings. Check gasket surfaces for burs or nicks. Replace cracked cylinder head only after making following check:

Pressure test coolant passages of cylinder head at 40 PSI air immersed in 120° F. water, Minimum Time - 5 Min. Reject all cylinder heads with evidence of leakage.

IMPORTANT

Bridge cracks shall not be cause for rejection except when the crack extends below the valve seat insert and/or insert counterbore.

Check the cylinder head for straightness. The maximum permissible out of flat when checking lengthwise is 0.005 inch. The maximum out of flat when checking crosswise is 0.003 inch. Inspect studs for bent condition or damaged threads.

REPAIR

a. Cylinder Head: Replace studs that are stripped or broken, replace complete cylinder head assembly when cracked, warped, or beyond repairs.

1. Cylinder head refacing: When a cylinder head is warped beyond the maximum permissible clearance, the cylinder head can be refaced using a surface grinder. When cylinder head is refaced, grind valve seats as directed in paragraph on valves. Replace the cylinder head when excessive grinding is required to recondition gasket surface.

TO REPLACE THE CYLINDER HEAD

1. Before installing the cylinder heads, clean out the carbon deposits by scraping or brushing. If the valves are to be ground or otherwise serviced, see "Valves".

2. Clean the cylinder block and cylinder head contact surfaces.

3. Install new cylinder head gaskets on the cylinder block. The gaskets must be assembled with the fire ring in place, also, be sure lube oil hole grommet is in place. Use any good commercial cylinder head gasket cement such as Perma Seal or Sure Fire Spray Cement.

4. Place cylinder heads and valve assembly on the block.

5. Start the head nuts and tighten evenly, using a torque wrench. Start at the center of the head and work progressively to the outer ends, see Illustration No. 20 , and "Fits and Tolerances".

6. Install the push rods and rocker arms.

7. Adjust the valve tappets to the proper clearance. See "Valves".

8. Install the cylinder head cover, using a new gasket, if required.

9. Connect the fuel lines.

10. Inspect the thermostat. See "Thermostat", Illustration No. 46.

11. Install the thermostat, housing, hoses, and water manifold. Connect the water temperature gauge thermocouple.

12. Install the air cleaner hose, using new gaskets, if required.

13. Connect the exhaust pipe to the manifold, using new gaskets.

14. Fill the cooling system with the proper solution (water or antifreeze).

CYLINDER SLEEVES

The cylinder sleeves are dry removable type, precision machined to size, and are a slip fit. A puller may be required to remove the sleeves, and dressing of the cylinder bore may be necessary before reinstalling.

FAN ASSEMBLY (Cooling)

The cooling fan is mounted on the water pump driven pulley, which is driven from a drive pulley mounted on the crankshaft by the use of one or more "vee" belts. Various accessories may be mounted on the engine and driven by these belts. Therefore, it is not possible to list the fan belt specifications.

FLYWHEEL

Flywheels used on this series of engines are made of cast iron and may be machined to accommodate different types and sizes of clutches, and other types of couplings. The flywheel is fastened to the crankshaft with six bolts. One of these bolts is off center so that the flywheel can only be installed in one position. This properly locates the flywheel on the crankshaft.

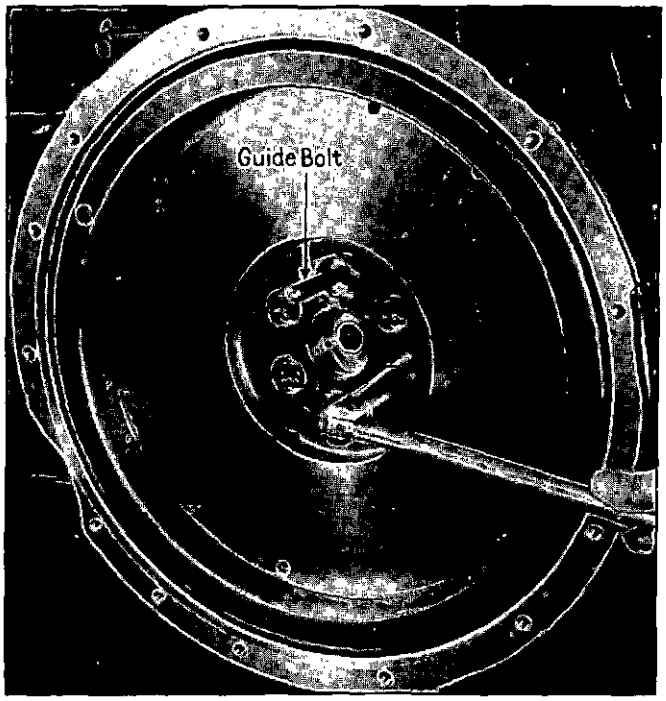


Illustration No. 21

TO REMOVE THE FLYWHEEL.

1. Disconnect and remove the transmission and clutch or torque converter.

2. To assist in the removal of the flywheel, fabricate a 1/2 X 20 X 4" long guide bolt by cutting off the head. See Ill. No. 21.

   Remove one flywheel bolt and install this guide bolt in its place. Then when balance of bolts are removed, there will be a pilot for sliding flywheel on bolt to assist in removal from housing.

3. Using a Lady-Foot pry bar, if necessary, to pull the flywheel from the crankshaft.

TO INSTALL THE FLYWHEEL AND INDICATE.

1. Reverse instructions under heading "To Remove The Flywheel" above.

2. Use an indicator to check the concentricity of the pilot bore. This should not exceed .005 total reading. See Illustration No. 22.

3. Attach the indicator, as shown in Illustration No. 22 to check the face of the flywheel. This should not exceed .008 total reading.

4. Install the starting motor.

5. Install the cluth and transmission as removed.

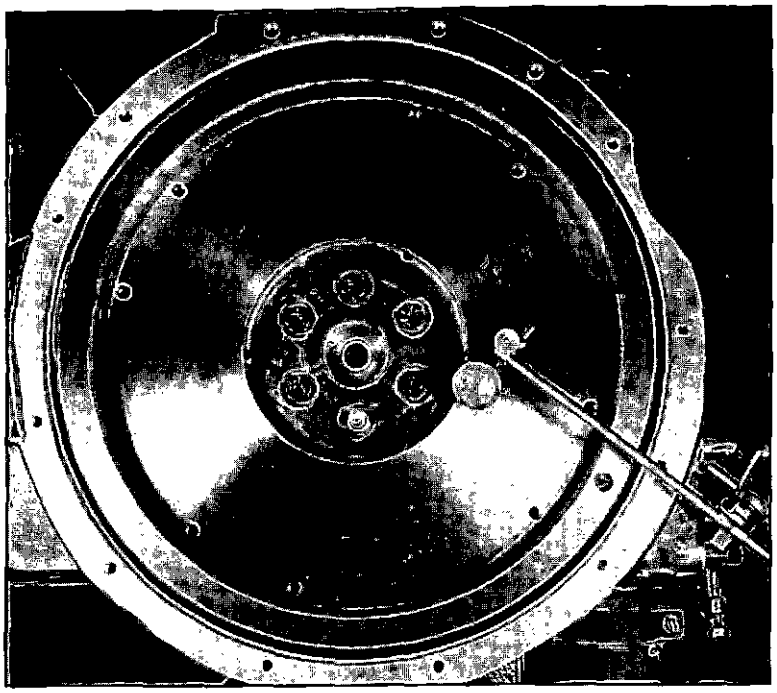


Illustration No. 22

FUEL OIL FILTERS

Extremely close tolerances of the various working parts in the fuel injection system require an efficient fuel filtering arrangement. A spin-on type filter is used to remove all dirt, moisture and foreign materials which may cause wear or corrosion and result in premature and expensive repairs.

CAUTION: A dirty or plugged fuel filter will result in loss of power and may prevent operation of the engine.

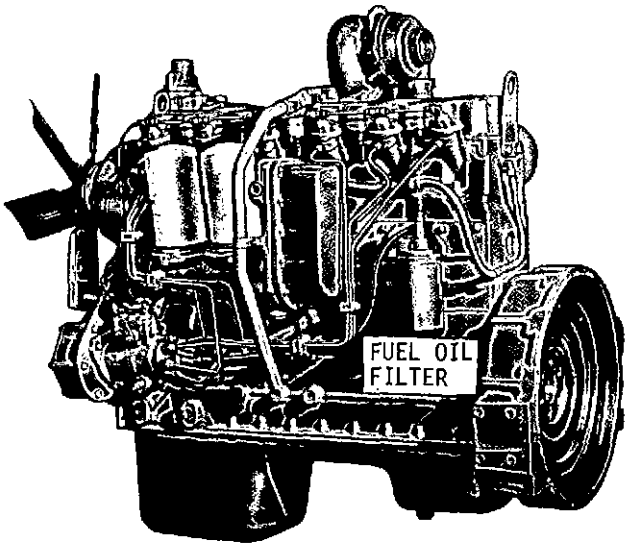


Illustration No. 23

To extend the life of the filters, insist on the fuel oil being clean and then handle it with clean containers. Frequency of changing the filter is determined by the amount of dirt and gum or wax in the fuel oil. Refer to "Preventive Maintenance Schedule".

Before changing filters or doing any work on the fuel system, the adjacent parts and area should be thoroughly cleaned so no dirt will get into the system.

FUEL INJECTION SYSTEM -- SEE "FUEL OIL SPECIFICATIONS", PAGE 66

The fuel injection system consists of a supply tank, primary and secondary fuel filters, fuel transfer pump, fuel injection pump, fuel nozzles, high pressure fuel lines from the injection pump to the fuel nozzles and the necessary low pressure lines and fittings to carry the fuel from the supply tank to the filters and the injection pump; also, a fuel return line to carry by-passed fuel back to the supply tank.

FUEL PUMP TIMING -- BOSCH MODELS PSJ AND 100

The American Bosch injection pumps, Illustration No. 24, are of the constant-stroke, distributing-plunger, sleeve-control type, the plunger being actuated by a cam and tappet arrangement which also carries gearing for the distribution function. The purpose of the pump is to deliver accurately metered quantities of fuel oil under high pressure to the spray nozzles through which the fuel is injected into the engine cylinders, at a definite timing in relation to the engine firing cycle and within the required injection period.

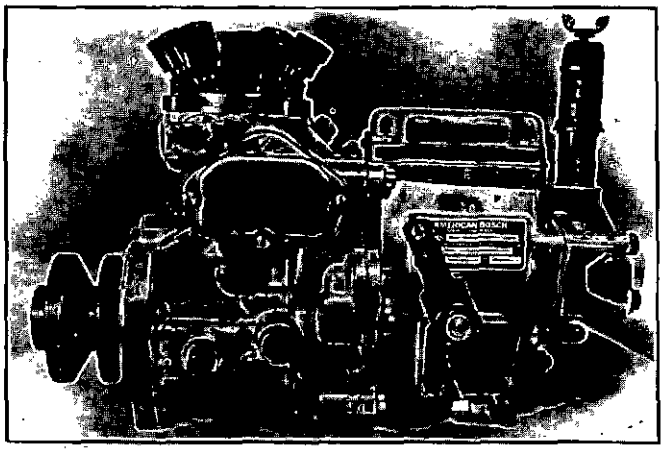


Illustration No. 24

An integral governor, of the machanical-centrifugal type, is used with this pump to control fuel delivery as a function of

speed. It is driven off the rear of the pump camshaft through suitable gearing.

A gear-type fuel supply pump is directly attached to the pump at the rear of governor and driven from the governor drive shaft.

This fuel injection pump is mounted on the timing gear case and driven by the camshaft gear. The pump is pressure lubricated from the engine lubricating system through an auxiliary oil line.

The Bosch injection pumps are installed and timed as outlined below:

TIMING CHART

Engine Model	Injection Pump Model	Timing Setting
D4800	Bosch - PSJ and 100	20° B.T.D.C.
D4800	Roosa Master Model DM	20° B.T.D.C.
D4800	Roosa Master Model DB	9° A.T.D.C.

INSTALLATION AND TIMING - BOSCH PSJ AND 100

1. Spot the engine vibration damper and pulley assembly at the proper degree mark for the engine before Top Dead Center on compression stroke No. 1 cylinder. This can be found by removing No. 1 nozzle and feeling compression against your finger while cranking the engine over by hand. Mark "A" should align with pointer "B", Illustration No. 25.

NOTE: Make sure the timing marks "C" on the vibration damper face are aligned with the marks "D" on the damper flange, Illustration No. 25. If they are not, remove the damper and replace it as misalignment indicates a defective damper and it must not be used.

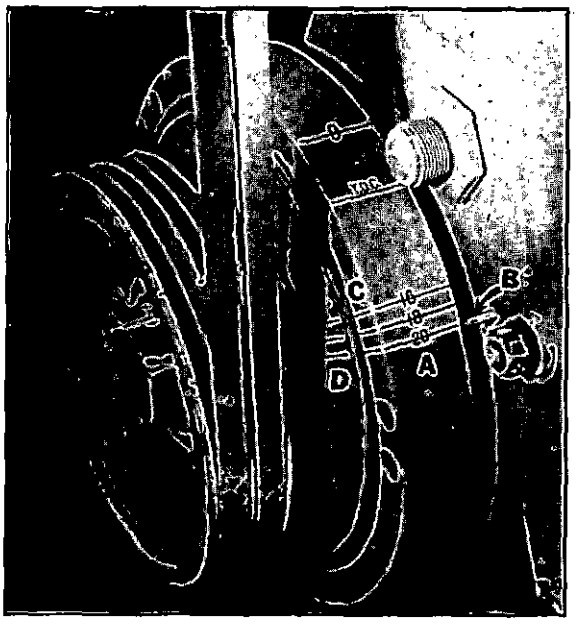


Illustration No. 25

2. Position the fuel injection pump for firing on No. 1 cylinder as follows:

   a. Remove the timing cover from the side of the injection pump.

b. Rotate the injection pump shaft until the mark "A", Illustration No. 26, on the plunger drive "B" is visible through the timing window and is aligned with stationary mark on pump housing. See Item "C", Illustration No. 26.

NOTE: This mark is a machined line on the apex (outside periphery) of plunger drive. When these marks are aligned, pump is timed to fire on No. 1 cylinder. This mark must be visible during the timing procedure.

3. Rotate the drive gear and hub slightly to align the mark on the drive gear hub with the timing pointer in the injection pump housing, shown through hole in fuel pump adapter. See Illustration No. 27. This puts the timing mark "A" to the extreme right and is just visible at edge of pump housing. Due to the pump plunger tappet spring pressure, the timing marks will not stay in the aligned position. However, if the free position of the timing marks is noted in relation to the driven gear teeth (usually two teeth), the engine can be turned backward until the pump drive gear has moved back two teeth. Install the injection pump and turn the engine forward to the correct flywheel degree mark.

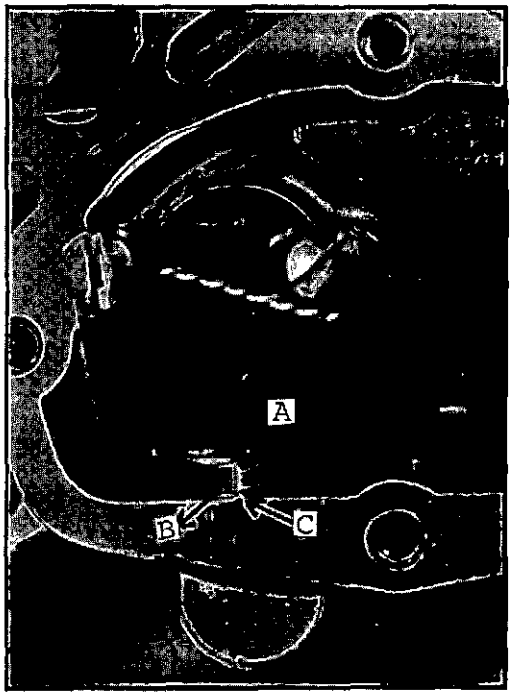


Illustration No. 26

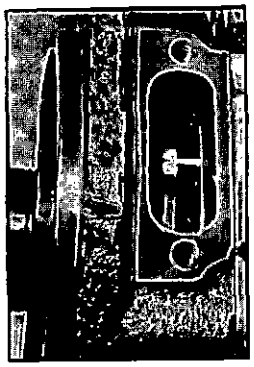


Illustration No. 27

4. Install the drive gear cover plate on gear cover and timing hole cover on pump.

5. Connect the fuel lines, lubricating oil line, and control rods as removed.

CAUTION: Be sure to start and tighten the line nuts finger tight before using a wrench for final tightening to prevent possible damage to these parts.

NOTE: The injection pump is mounted on the LEFT-HAND side of the engine, when standing in a position facing the engine flywheel, the fuel line to No. 1 cylinder is connected to the hydraulic head at the two o'clock position.

BOSCH MODEL 100

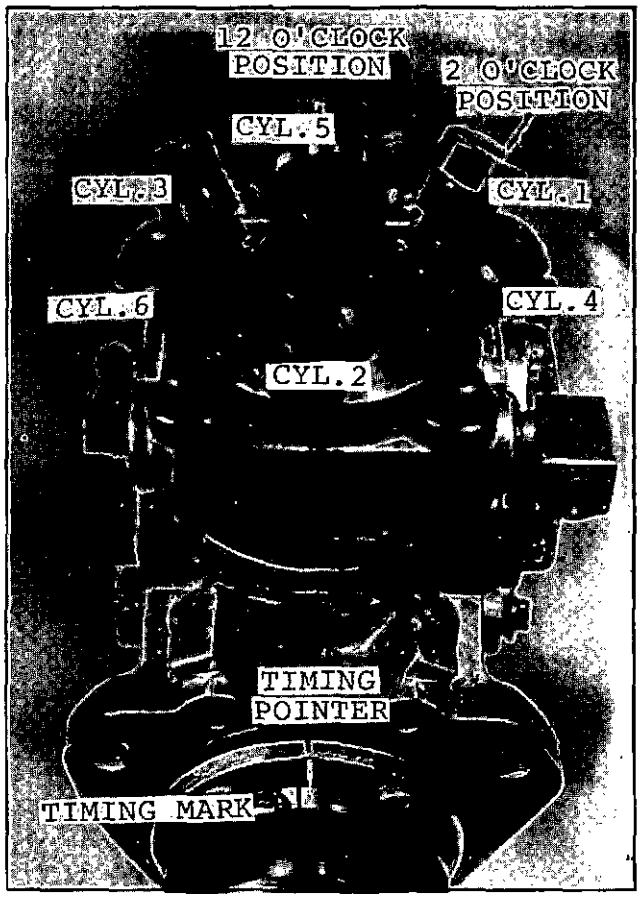


Illustration No. 28

ROOSA MASTER DM

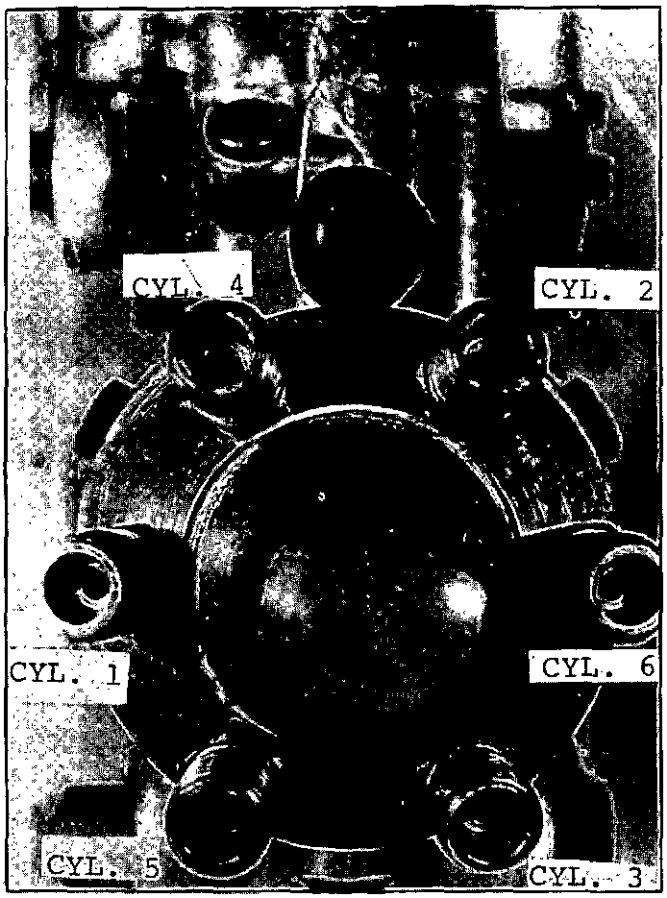


Illustration No. 29

The two o'clock position is located by facing drive end of pump or gear end of engine. The balance of the fuel lines are connected in COUNTER-CLOCKWISE order to their respective cylinders as shown in engine firing order chart. See Illustration No. 28 and No. 29.

Clock time positions are determined from an imaginary line extending from the governor end of the pump across the center of the hydraulic head to the drive gear end of the pump, see Illustration No. 28, as pointing to twelve o'clock. The twelve o'clock position remains the same, regardless of the pump mounting location.

INSTALLATION AND TIMING - ROOSA MASTER DM AND DB

INSTALLING AND TIMING ROOSA DM PUMP.

1. Spot the engine vibration damper and pulley assembly at the proper degree mark for the engine before "Top Dead Center" on compression stroke No. 1 cylinder. This can be found by removing No. 1 nozzle and feeling compression against your finger while cranking the engine over by hand. Mark "A" should align with pointer "B", Illustration No. 25.

2. Install a new O'Ring seal on the pump attaching flange.

3. Remove the timing hole cover on the injection pump and rotate the pump until the timing marks are registered. See Illustration No. 27.

4. Carefully install the fuel pump to drive gear, making certain keyway is aligned with the gear.

5. Install lockwasher and nuts on pump attaching studs.

6. Install flat washer and nut on pump shaft and torque nut to 150 ft. lbs.

7. Recheck timing to make certain pump is in register with correct timing marks on pulley.

8. Install drive gear cover plate on gear housing and timing hole cover on pump.

INSTALLING AND TIMING ROOSA DB PUMP.

1. Caution: Do not remove wires that hold the throttle lever in "wide open" position until after the fuel pump is completely installed.

2. Timing - Follow procedures outlined in paragraphs 1, 2, and 3 in DM timing.

3. Coat the pump shaft liberally with light grease and, using a seal slip (R.M. #13369, carefully install two new cup seals (R.M. #10453) on the shaft. Illustration No. 30.

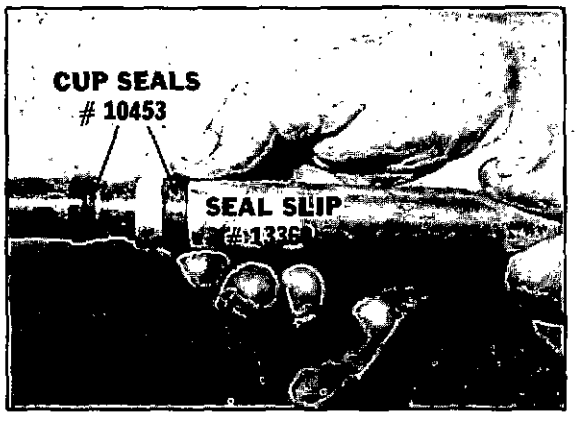


Illustration No. 30

NOTE: NEVER REUSE THESE OIL SEALS.

4. Carefully slide the fuel pump forward over the shaft and seals while using Installing Tool Number R. M. #133371 to hold the first seal lips depressed so that it will not be bent back or ruptured. See Illustration No. 31.

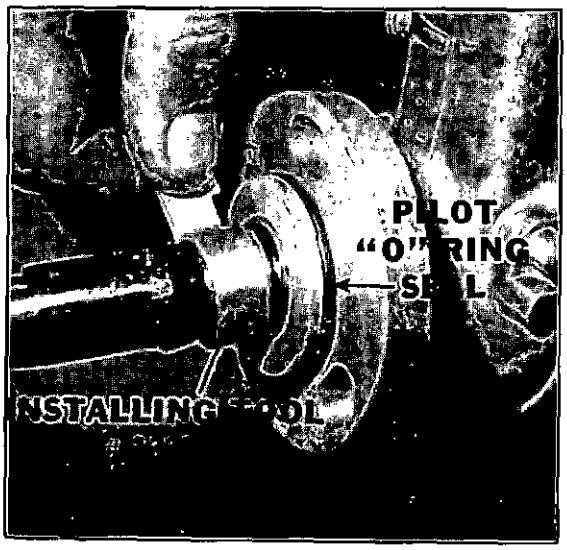


Illustration No. 31

5. With the fuel pump properly engaged on the shaft and the attaching studs, assemble the attaching nuts and washers but only tighten them sufficiently to hold the pump in place.

6. Recheck the timing mark setting on the vibration damper (it should be at 9° A.T.D.C.) and rotate the fuel pump on the attaching studs until the pump timing mark lines up as in Illustration No. 27. Then secure the attaching nuts firmly.

Clean and blow out all fittings and fuel lines. Remove the wire that holds the throttle lever open and install the throttle rod and linkage.

FUEL INJECTION NOZZLES AND LINES

Fuel injection nozzles receive fuel under high pressure from the fuel injection pump. The fuel charge is properly timed to engine operation so that the nozzle introduces a finely atomized spray into the cylinder at the exact instant necessary for the engine power stroke. If fuel nozzles are defective, they must be cleaned, tested, disassembled, and adjusted only by competent fuel system technicians. Handle nozzles with care at all times to prevent damage.

REMOVAL AND DISASSEMBLY.

1. Loosen fuel injection line nuts and disconnect the fuel lines from the injection nozzles. Do not remove nuts or ferrules from the fuel lines.

2. Disconnect the fuel leakoff lines from each of the nozzles. Tag leakoff lines to assure that they'll be assembled to their original nozzles.

3. Remove each fuel injection nozzle and holder assembly from the cylinder head by removing two bolts and lockwashers. Tag each nozzle and holder assembly to identify its position in the cylinder head.

NOTE: The fuel nozzle and holder assemblies must be handled with care at all times. The nozzle and holder assemblies should only be disassembled, cleaned, and adjusted by a competent fuel system technician, using proper fuel nozzle testing equipment.

4. The fuel nozzle and holder assembly can be disassembled by using a twelve point, 3/4-inch box wrench to remove the fuel nozzle retaining nut. Carefully remove the fuel nozzle and washer (if used) from nozzle holder.

CLEANING AND INSPECTION.

DO NOT MIX THESE PARTS -- KEEP THEM IN SETS.

1. Discard all gaskets and seals.

2. Clean the fuel injection nozzles in clean diesel fuel or solvent; dry thoroughly with filtered, dry compressed air. Blow air through the fuel lines to assure that they are clear and unobstructed.

3. Inspect the fuel lines for cracks, dents, kinks, loose or damaged ferrules, and nuts with damaged threads. Replace damaged lines.

4. Visually inspect the fuel nozzle and holder assemblies for damaged threads, cracks, or other visible signs of damage. Replace a damaged fuel nozzle and holder assembly. Fuel nozzle and holder assemblies are to be repaired or serviced only by authorized service centers.

FUEL NOZZLE PRESSURE.

New fuel nozzles should be set for 3100 lbs. per sq. in. pressure on a static fuel nozzle testing fixture and used nozzles at 2850.

INSTALLATION.

1. Insert the assembled fuel nozzle and holder into the cylinder head bore from which it was removed.

2. Install two securing bolts and lockwashers for each nozzle and holder assembly. Tighten the bolts evenly to assure proper alignment of the fuel nozzle and holder assembly. Uneven tightening of the securing bolts may distort the nozzle holder or nozzle tip. This will cause engine misfiring or possible destruction of the complete assembly. Use a torque wrench to progressively tighten the bolts to 25 to 30 ft. lbs. to insure equal tension on both sides of the flange of the nozzle and holder assembly.

3. Install and connect the fuel lines, tighten the nuts securely, but not excessively. If new fuel lines are installed, install new ferrules and nuts on lines during installation.

4. Install and connect the leakoff manifold lines between proper nozzles.

5. If removed, connect the fuel lines and leakoff lines to proper fittings on the fuel injection pump. When installing fuel lines, use new gaskets.

6. The fuel supply line from the secondary and final stage filter to the injection pump must be thoroughly cleaned before installation to insure against metal particles or other foreign material entering the injection pump.

7. The fuel supply line should never be less than 1/2-inch O.D. and fittings no less than 3/8-inch I.D.

8. Open fuel supply to engine; start engine and check for leaks in the fuel system. Correct leaking by tightening fittings. If necessary remove, inspect, and reclean the leaking components.

GEAR HOUSING

The gear housing plate forms the front support for the engine and is doweled to the cylinder block. The gear housing covers the gears. The front oil seal for the crankshaft is also installed in the housing. This housing may be removed for the inspection of the gears, and so forth.

TO REMOVE THE GEAR HOUSING.

Assuming that the radiator has been removed, the gear housing may be removed as follows:

1. Remove the fan blade and belt for easier access to the gear housing and gears.

2. Remove the crank nut and fan drive pulley and vibration damper.

3. Remove the screws from the gear housing and pull the gear housing forward away from the engine.

4. If necessary to remove the gear housing plate, remove the camshaft gear as outlined under "Camshaft", remove the attaching screws and pull the plate forward away from the cylinder block. It may be necessary to tap the plate with a soft hammer to loosen it from the dowels or gasket cement.

INSPECTION.

The gear housing should be carefully inspected for possible cracks, binding, etc. Be sure that the camshaft gear retaining nut is tight. Replace any worn or damaged parts.

ALTERNATOR

A periodic inspection should be made of the charging circuit. The intervals between these checks will vary, depending upon the type of service. Dirt, dust and high speed operation are factors which will contribute to increased wear of the bearings, brushes, etc. Under normal conditions, an inspection of the alternator should be made every 400 hours.

1. Wiring -- A visual inspection should be made of all wiring to insure that there are no broken wires and that all connections are clean and tight. Special attention should be paid to the ground connections at the battery and alternator.

2. If the alternator does not function properly after the above checks, the alternator and the regulator or circuit breaker should be taken to an authorized service station for inspection and repairs.

GOVERNOR

The governor is integral with the fuel injection pump. It is equipped with minimum and maximum speed regulating adjusting screws. The maximum speed should never be increased above that specified in the equipment manual.

To do so may seriously damage the equipment or engine and may cause bodily injury.

FITTING OF THE BEARINGS.

The bearings in these engines are readily accessible after the oil pan and oil pump are removed. The bearings should never be fitted so tight that they bind or drag, see "Fits and Tolerances". A certain minimum clearance is required at all times to provide an adequate oil film between the shaft and bearing and insure a free running engine. The bearings in these engines are of ample proportion and the full pressure lubrication system employed will give long lasting bearings, provided they are properly installed.

Tightening of the main bearing cap screws requires some care to prevent too much strain on the parts. Torque wrenches are on the market which enable the mechanic to measure the force of his pull when tightening such parts. The wrench tension values given under "Fits and Tolerances", show the correct amount of torque to use. No attempt should be made to refit these bearings by filing or grinding the caps, as this will ruin the caps so new shells cannot be installed. See Illustration No. 32.

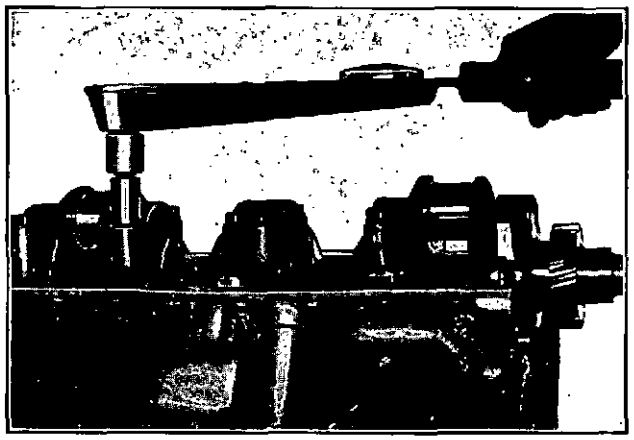


Illustration No. 32

REPLACEMENT OF THE MAIN BEARINGS.

It is not necessary to remove the engine from the unit to replace the main bearings unless, of course, the crankshaft is damaged or worn to the extent that it must be replaced.

The following outline may be used as a guide for replacing the bearings when the engine has not been removed from the unit:

1. Disconnect the battery cable at the battery as a safety measure.

2. If the starter is mounted below the oil pan level and causes interference, disconnect the starter cable and wiring; then remove the starter.

3. Drain the crankcase oil.

4. Remove the oil pan.

5. Remove the oil pump.

6. Loosen all main bearing cap screws.

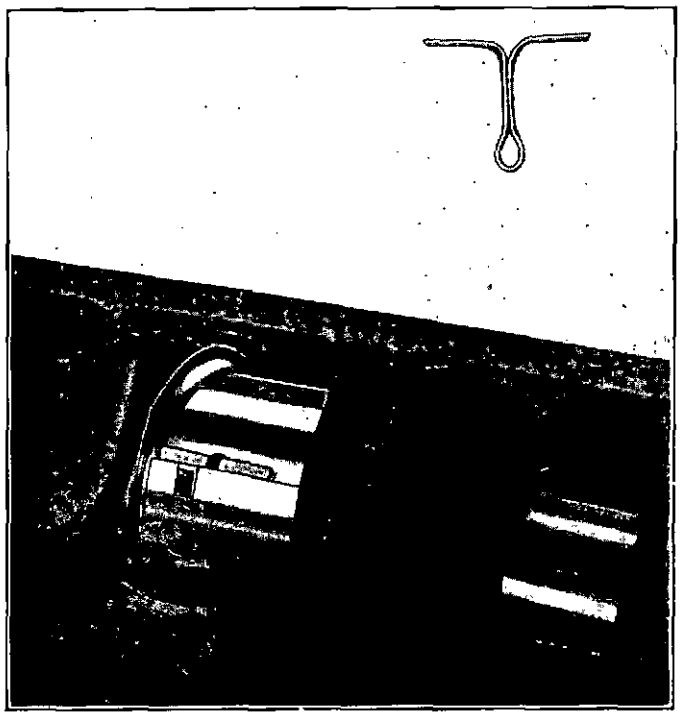


Illustration No. 33

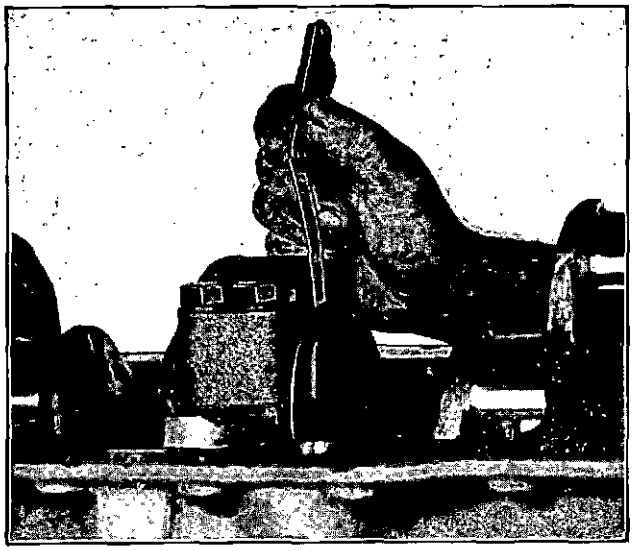


Illustration No. 34

Remove one bearing cap at a time and make bearing replacement. To remove the upper shell, a cotter pin, shaped like Illustration No. 33, may be inserted in the crankshaft oil hole and the shaft rotated so that the pin will push the bearing out. The new bearing may be inserted in the same manner, See Illustration No. 33.

CAUTION: Be sure to remove the pin before assembling the bearing cap.

9. Assemble the bearing cap and lower shell and tighten the screws. See "Wrench Tension".

10. After installing new thrust bearings on the center main bearing, check the end thrust, see Illustration No. 34. See "Fits and Tolerances". It is permissible to dress the thrust bearing to obtain the proper clearance, if necessary. This is done by rubbing thrust flanges on a piece of Crocus cloth on a flat surface until proper clearance is obtained.

11. Thoroughly recheck the inside of the engine for loose screws, nuts, etc.

12. Install the oil pan.

13. Install the starter.

14. Connect the starter cables.

15. Connect the battery cable.

16. Fill the crankcase to the FULL mark on the bayonet gauge, see Illustration No. 4, with the proper grade of oil.

17. Start the engine and immediately check the oil pressure. See "Oil Pressure". If sufficient, allow the engine to run for a few minutes.

while checking for oil leaks, etc.; then stop the engine and recheck the oil level. Add oil, if necessary.

MANIFOLDS (Intake and Exhaust)

There are various types of manifolds used; therefore, it is not practical to discuss them at length in this book. Manifolds differ as to the air cleaner attaching flanges and shape. Different exhaust outlet flanges are used on different installations. From this list of differences, one can readily see the importance of replacing the manifold on the engine with the same type manifold unless the engine is to be applied to a different type of operation.

In installing the manifolds, it is essential to use new gaskets and to be sure that the manifold ports line up with those in the cylinder head. When tightening the manifold studs nuts, a washer should be used under the nut and the manifolds tightened progressively from the center to the end, repeating the operation at least three or four times to make sure that the manifold is tight.

In many instances, a companion flange and gasket are used for the installation of the exhaust pipe. Be sure these are drawn up tight and square with the manifold flange to avoid leaks.

TO REMOVE THE MANIFOLDS.

1. Remove the air cleaner or air cleaner connections from the intake manifold.
2. Disconnect the exhaust pipe from the exhaust manifold.
3. Remove the manifold attaching nuts and washers and remove the manifold. Both manifolds have to be removed together.

TO INSTALL THE MANIFOLDS.

1. Make sure all gasket surfaces are clean, place the manifold gaskets on the attaching studs and assemble both manifolds to the engine with the nuts and washers as removed.
2. Tighten the manifold into place. Tighten all nuts lightly; then, starting from the center, work progressively toward the ends of the manifolds repeating until all nuts are tight.
3. Attach the exhaust pipe and tighten the screws.
4. Install the air cleaner or connect the air inlet tube to the intake manifold.
5. After the engine has been operated a day or more, tighten all manifold attaching nuts.

OIL FILTER

The lubrication system is designed with a full-flow type oil filter and oil cooler.

Filters should receive regular and careful attention. A definite schedule for replacement of the element can be determined from observation of the lubrication oil on the application in which the engine is used. In some applications, the period between changing the filter element may be very short while in others the change period may be extended considerably. Cold engine operation and long idling periods contribute to short filter element life. See "Preventive Maintenance Schedule".

When new filter elements are installed, add sufficient oil to the crankcase so the oil level will be correct after the engine has run long enough to refill the filters. For filter location, see Illustration in front of book.

OIL PAN

The oil pan serves as a cover for the bottom of the crankcase and, also, as an oil reservoir.

Suitable drain plugs are located in the bottom of the oil pan, one in each sump. The bayonet type oil gauge, used to measure the oil level in the pan, is covered under "Bayonet Gauge".

TO REMOVE THE OIL PAN.

1. Drain the crankcase oil from both sumps.
2. Disconnect the starter cable and remove the starter, if mounted below the center line. Tape any "hot" cable terminals.
3. Remove the bayonet gauge assembly.
4. Remove the cap screws from the oil pan and remove the oil pan from the engine.

TO INSTALL THE OIL PAN.

1. Clean the oil pan thoroughly; also, remove the old gaskets from the oil pan and cylinder block.
2. Inspect the inside of the engine for loose nuts, screws, cotter pins, lock wires, etc.; tighten or replace.
3. Cement the new oil pan gasket to the oil pan.
4. Draw up all screws evenly and progressively.
5. Install the drain plugs.
6. Install the starter motor and connect the cables.

7. Refill with oil to the correct level.

8. Reinstall the bayonet gauge assembly.

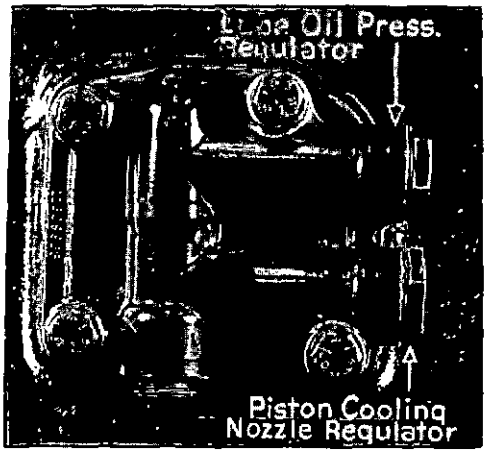


Illustration No. 35

OIL PRESSURE ADJUSTMENT

The oil pressure is automatically controlled or regulated by a compression type spring which controls a relief or by-pass valve. This device is assembled to the cylinder block, see Illustration No. 35. It controls the oil pressure through a predetermined spring pressure and, therefore, no adjustment of the oil pressure is required. There is also a high pressure safety relief valve built into the oil pump which prevents the build-up of excessive oil pressure during engine warm-up time, see Illustration No. 1, Figure "A".

The oil pressure regulator is calibrated to maintain a pressure of 30-65 lbs. in the system. This will vary somewhat with the temperature of the oil and the SAE weight of the oil, also, with the engine speeds.

OIL PUMP

The oil pump is attached to the main bearing cap with suitable screws and is driven by a gear through an idler from the crank gear, see Illustration No. 9 , Figure "D". The oil pump has a suction pipe bolted to the suction side of pump, which extends down into the oil pan, see Illustration No. 36. The oil is drawn into the pump through a large screen, Fig. "A", which prevents coarse dirt from being drawn into the lubricating oil pump. On some engines, the oil pump also has a scavenge pump section to suck oil out of rear sump and deliver it to front sump, regardless of what angle engine may be. This extends into the oil; therefore, the pump needs no priming. After the oil pan is removed, the oil pump is readily removed for inspection or repairs.

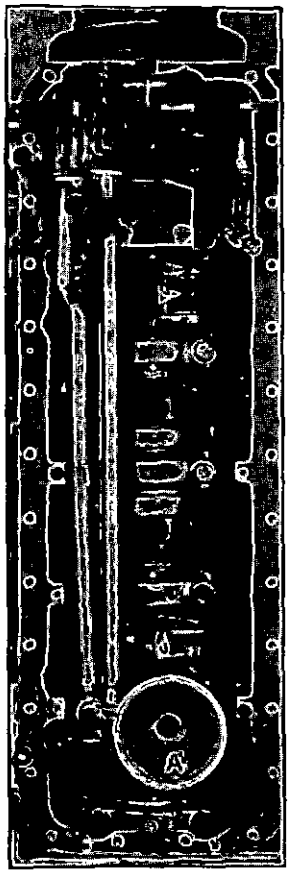


Illustration No. 36

TO REMOVE THE OIL PUMP.

1. Remove the oil pan. See "Oil Pan".

2. Remove oil pump suction and pressure lines.

3. Remove the screws from the oil pump attaching flange and remove the oil pump from the engine.

TO DISASSEMBLE THE OIL PUMP. (See Illustration No. 37).

1. Pull gear from shaft with universal gear puller.
2. Inspect pump carefully and replace any worn or defective parts.

TO REASSEMBLE THE OIL PUMP.

1. Press drive gear on to shaft after pump is assembled.

TO INSTALL THE OIL PUMP.

1. Attach the pump to bearing caps and securely bolt in place.
2. Assemble suction and pressure lines to pump and securely fasten to engine with brackets provided.
3. Install the oil pan. See "Oil Pan".
4. Fill the crankcase to the proper level with the correct grade of lubricating oil.

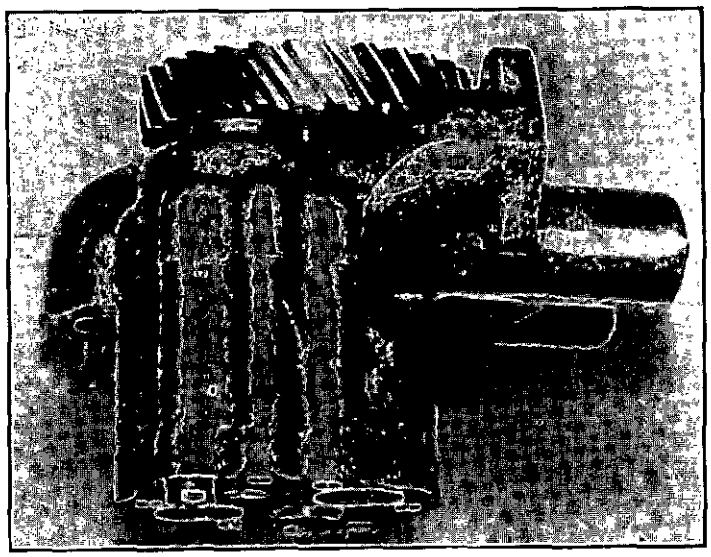


Illustration No. 37

OIL SEAL

The construction of these engines prevents oil leakage when the gaskets are in proper condition and all bolts and screws are properly tightened. Whenever a shaft extends through the engine case and there is a possibility of oil leakage, an oil seal is used, which also acts as a dust seal, preventing dust from entering the engine.

At the flywheel end of the crankshaft, an oil seal is used, Illustration No. 38 and No. 39. As can be seen in the illustrations, the oil seal is mounted on the engine block so that it seals against the flange of the crankshaft.

The crankshaft is prevented from leaking, at the timing gear end, by the use of a seal. This seal is pressed into the timing gear cover. See Illustration No. 19.

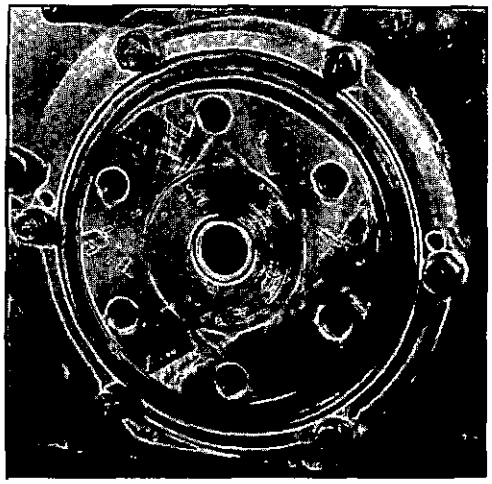


Illustration No. 38

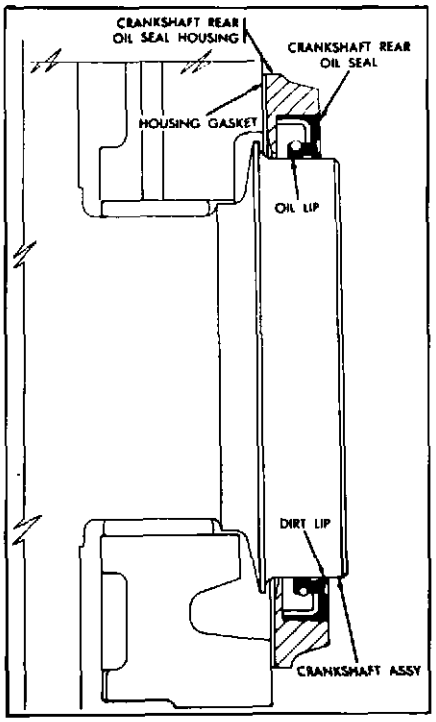


Illustration No. 39

This type of seal requires very little attention; however, at assembly the shaft seal surfaces on which the seal rides must be thoroughly and carefully checked for nicks or scratches which may have a tendency to damage the seal. If any nicks or scratches are found, they should be removed with an oil stone or very fine emery cloth and polished with Crocus cloth. If the shafts have a keyway which might damage the seal during installation, this keyway should be covered with a thin feeler gauge to protect the seal.

No special tools are required to install the seals on the shafts. However, a certain amount of care is required in order not to damage the seals. A coating of oil soap on the seal surfaces of the shafts, and also on the seals themselves, will be found beneficial during the run-in period.

INSTALLATION OF REAR OR #7 MAIN BEARING CAP WITH SEALS.

Install seal, Item "A", Illustration No. 40 in main bearing cap, using Perma Seal No. 2 or its equivalent to hold seals in cap and to make a tight joint between seals and cylinder block. These seals are right to left, so be sure new seals go back in same location as old seals.

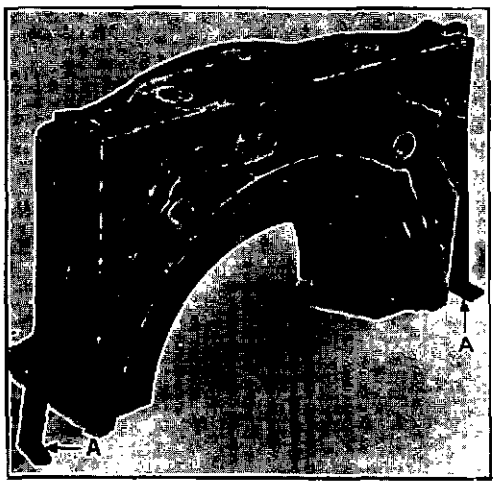


Illustration No. 40

Install main bearing cap along with bearing and snug down in place using a straight edge, as shown in Illustration No. 41. Be sure cap is prefectly square with block. This operation is most important, or otherwise a leak will develop at this point when crankshaft seal is installed if bearing cap and block surfaces are not perfectly square with each other.

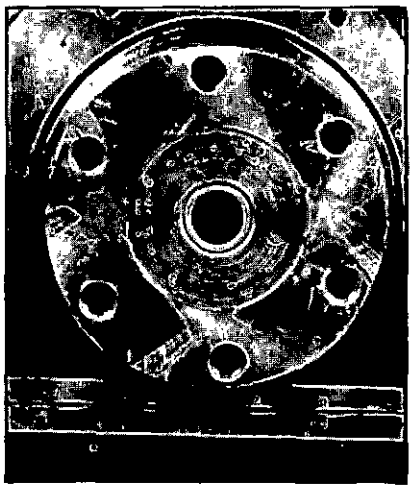


Illustration No. 41

PISTON

The piston is made of an aluminum alloy and is of the solid skirt type. Three piston rings are used, two rings being compression type, while the third ring from the top, which is above the piston pin, is of the oil regulating type. The top of the piston is made thick in order to uniformly transfer the heat from the top of the piston to the rings and to the skirt of the piston. In addition to the above design, a piston spray nozzle is used. See Lubrication System, Page 7. These nozzles are located on the crankcase, next to the main bearing caps and spray oil on the underside of the piston to assist in cooling. The nozzles are located on dowel pins to assure proper alignment with piston.

The pistons should be fitted to the cylinder bores with the proper clearance. See "Fits and Tolerances". If a feeler ribbon is used, this should be a ribbon 1/2" wide.

To remove or install pistons, see "Connecting Rod".

PISTON PIN

The piston pin is a large diameter solid pin of the full floating type. This means that the pin can rotate in either the piston bosses or in the bushing at the top end of the connecting rod. But, the fit in the piston is intended to be much tighter than the fit in the connecting rod; consequently, the movement in the piston consists of a light, creeping action while the normal rotation of the pin occurs in the bushing at the top end of the connecting rod. The piston pin is prevented from moving endwise and making contact with the cylinder wall by means of snap rings, which locate in grooves machined in the bosses of the piston. Piston pins should be fit in the piston bosses with the proper clearance, as indicated in the "Fits and Tolerances Table". See Illustration No. 42.

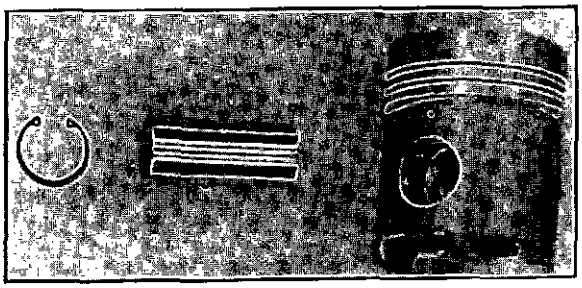


Illustration No. 42

PISTON RINGS

The piston rings, when fitted in the cylinder bore of the engine, should have a gap clearance as indicated in the "Fits and Tolerances Table".

When installing new piston rings, each ring should be tried in the cylinder bore to see if it has the correct gap clearance. If necessary to increase the gap, the ring should be held and filed as shown in Illustration No. 43. If the ring is held in a vise, the vise jaws must be covered with some soft metal. The ends of the rings are squezzed together and the file cuts on both sides. This will insure the ends being parallel. When inserting the ring in the cylinder bore to test the gap clearance, push the ring part way through the bore, using the top of a piston to square the ring in the bore.

Each new ring should be tried for clearance in the piston groove by rolling the ring all the way around the groove. If the piston grooves have been carefully cleaned, the rings will be found to fit correctly; but, if they are tight, they can be lapped slightly on a sheet of emery cloth (No. 000) laid on a flat surface. Use a light uniform pressure when lapping. If rings are loose in groove and clearance is more than that specified in "Fits and Tolerances", replace piston.

When assembling the piston rings to the piston, if a ring spreader tool is not available, the rings can be slipped over thin strips of metal. Whatever method is used, the rings must be handled carefully in order not to distort or break them.

Illustration No. 43

STARTING MOTOR

The starting motor is designed to crank the engine when the switch closes the circuit between the storage battery and the motor. It consists of five main sub-assemblies: the frame and field, the armature, the commutator end head, the pinion housing and the Bendix drive. The frame and field consist of the frame, which supports the components of the starting motor, the pole pieces and the field coils. The coils supply the path for the magnetic field. Illustration No. 44 is an assembly drawing of a typical starting motor

The armature consists of a soft iron core, a commutator and the windings, which are wound in slots in the core and are connected to the commutator. The commutator consists of a number of copper segments insulated from each other and from the armature shaft.

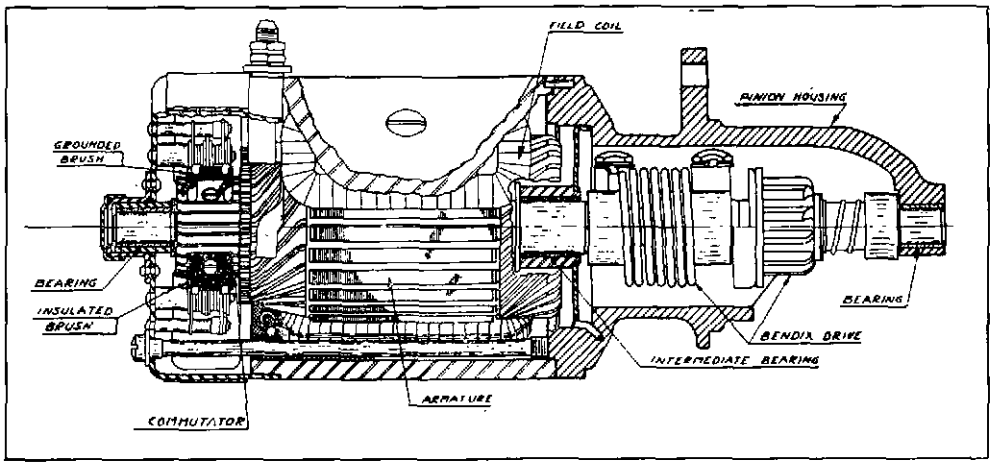


Illustration No. 44

The commutator end head supports a bearing, brush holders and brushes. The pinion housing is a cast iron housing for the Bendix drive, and also provides the motor mounting lugs. The Bendix drive is an automatic clutch that engages the starting motor with the engine flywheel when the motor cranks the engine and disengages when the engine starts. It consists of a threaded sleeve fastened to the armature shaft through a drive spring and a pinion mounted on the threads of the sleeve. When the starting circuit is closed, the armature revolves, turning the sleeve within the pinion and forcing the gear forward, meshing it with the flywheel gear. The sudden shock of meshing is absorbed by the spring. When the engine starts, the pinion is driven faster than the sleeve and is forced back along the threads, automatically de-meshing it from the flywheel.

LUBRICATION.

Some starters are provided with an oil cup which should be filled with lubricating oil when the unit is lubricated.

Other starters have no provision for oiling; these are lubricated at the time of overhaul.

After the starting motor has been in service for an extended period, it should be removed, dismantled and cleaned. Clean the Bendix drive thoroughly and lubricate sparingly with light oil. Inspect the wiring for loose or corroded connections and for broken leads. Make sure the insulation on the wiring has not become frayed.

THERMOSTAT AND BYPASS

The engines are equipped with a thermostat, Illustration No. 46, so designed that it will not allow water from the radiator to circulate through the engine until the water in the engine is at operating temperature, but does bypass a certain amount of water from the cylinder block, which is carried through the bypass tube to the inlet side of the water pump, where it is again circulated through the engine. This is repeated until the water in the engine is heated to operating temperature, when the thermostat begins to open and permits the water from the engine to enter the radiator. This water is, at the same time, replaced in the engine by the water pump drawing from the bottom of the radiator. Thus, the water temperature is constantly maintained in the proper heat range.

A defective thermostat of this type must be replaced as it cannot be repaired. The thermostat should be completely open at temperature marked on the thermostat in the still water test.

The still water test is as follows:

Place approximately 4" of water in a pan or pail. Insert a thermometer of this heat range in the water and set the thermostat in the water with the bellows submerged. Heat the water slowly and carefully observe when the thermostat valve is fully open and note the water temperature. Then compare this temperature with that stamped on the thermostat. See Illustration No. 45.

Five degrees above or under those given are permissible.

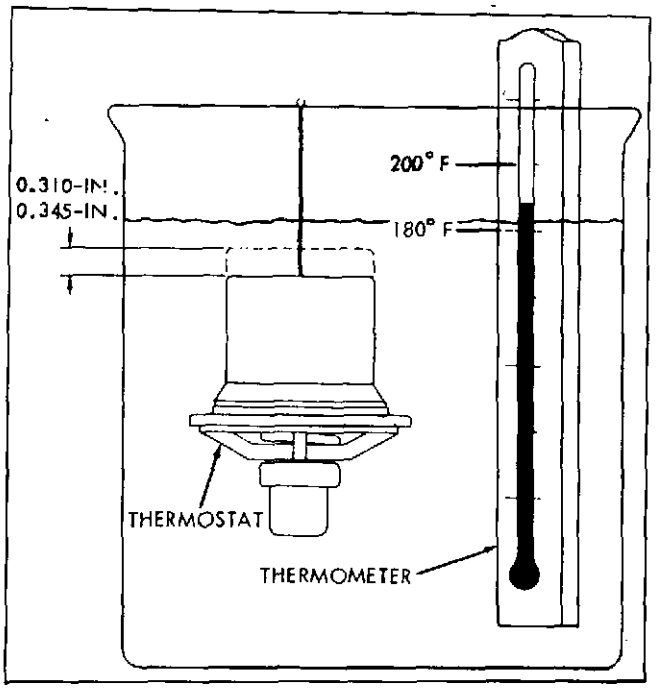


Illustration No. 45

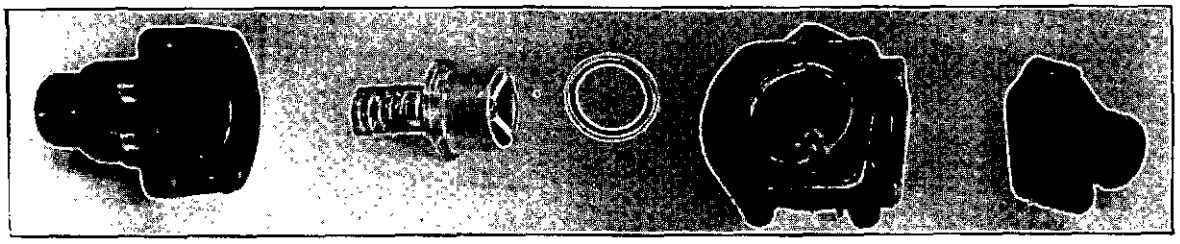


Illustration No. 46

TURBOCHARGER

The turbocharger is a self-contained unit composed of a gas turbine and a centrifugal blower mounted on a common shaft with the necessary surrounding castings. The exhaust gas from the engine is forced into the turbine side of the turbocharger, where the energy of the gas is used to drive the turbine. The blower mounted on the opposite end of the shaft forces air under pressure into the intake system. By providing a greater amount of fresh air, a greater amount of fuel can be burned. This increases power output from the turbocharged engine.

The action of the turbocharger is entirely automatic and requires no control. The speed and output of the turbocharger will vary automatically with variations of engine load or speed, or both.

Turbochargers are ruggedly constructed and have a rotor assembly which is fitted and finely balanced to operate at speeds which may exceed 90,000 rpm. Rotating force is obtained from hot exhaust gases which rotate the turbine rotor. This rotating force is transmitted through a sleeve-bearing supported shaft to a second rotor which draws in fresh, cool air and compresses it in the intake manifold

system from which the cylinders are charged as the intake valves open. The shaft and sleeve bearing are lubricated and cooled by filtered engine lubricating oil.

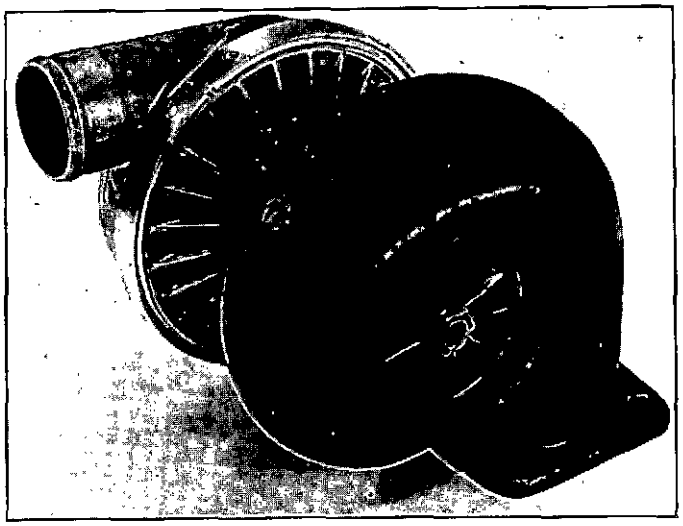


Illustration No. 47

The exhaust system of a turbocharged engine installation must be very carefully designed to eliminate restriction of the free flow of exhaust gases from the turbocharger. The turbocharger exhaust outlet pipe flange is normally shipped with engine equipped with turbochargers. The flange is threaded to accept the recommended size outlet pipe. No reduction in this pipe size is permissible. Bends or turns in the outlet pipe must be limited to a minimum radius of 12 inches. For installation requiring a radius less than 12 inches, write to White Engines, Inc., Engineering Department, Canton, Ohio, U.S.A., for specific recommendations.

NOTE: Back pressure in the exhaust system, measured near the turbocharger, should not exceed 2.5" Hg or 35" H_2O. An increase in exhaust back pressure will result in a corresponding decrease in engine power output.

Mufflers are not recommended for turbocharger-equipped engines. The turbocharger is an efficient muffler due to the speed and design of the turbocharger rotor.

NOTE: Turbocharger repairs should be made only by authorized service centers or competent turbocharger technicians.

BASIC SAFETY PRECAUTIONS

Misuse, misapplication or modification of the turbocharger can result in serious injury and property damage. Basic safety precautions including the following should always be followed:

1. Install turbocharger only on an engine which has been approved for such application. The turbocharger is a precision built product which has been matched and tested for use on specific engines only.

2. Do not modify or substitute any parts of turbocharger. Do not remove metal from any part of the turbocharger.

3. Do not modify or substitute any parts of engine except in accordance with engine owner's manual. Do not modify engine fuel control system or restrict exhaust system or air inlet excessively.

4. Do not operate at excessive altitudes.

5. Do not modify oil supply system or decrease the diameter of the oil drain line.

6. Always warm up the engine to allow warm oil to reach the turbocharger before operating under load.

VALVES

The intake and exhaust valves are made of special steel and operate in valve guides pressed into the cylinder head. They are held on to their seats by strong steel springs, which are fastened to the valves by suitable spring seats and valve lock arrangement. The valves, being located in the cylinder head, are operated by conventional type tappets with hollow push rods running from the tappets to the rocker arms. The rocker arms are lubricated by means of oil forced through a drilled hole in rocker arm support into the shaft on which they rotate. Oil is forced out, through small holes in the rocker arms, over the valve stems and push rods. The replacement of valve tappets will be found under the subject of "Valve Tappets".

In order to continue to get good performance from an engine, it may be necessary to grind or reset the valves at varying intervals. The frequency for doing this depends on the care in the operation of the engine. If the air cleaners have been properly cared for; if all connections between the air cleaner and engine have been kept air tight; if the lubricating oil has been properly maintained; and if the clearance between the valve stem and rocker arm has been properly adjusted, valve grinding will be necessary very infrequently. Their seating should be tested periodically by rocking the engine against compression. When the engine will not rock, compression is leaking through either the valves, cylinder head gasket or past the piston rings. Check the leak by listening for a "hissing" sound, when the engine is cranked by hand, either at the cylinder head gasket area or the breather. If at the cylinder head gasket, remove the head and replace the gasket. If in the breather, dismantle the engine and install new parts for those found worn or scored. If no "hissing" is heard at either of these two places, remove the cylinder head and valves. Clean both thoroughly, removing all carbon and oil. Inspect the valve seats and valves. See "Valve Grinding".

TO REMOVE THE VALVES

1. Remove the cylinder head. See "Cylinder Head".

2. With a clamp type valve spring compressor, compress the valve springs and remove the valve seat locks.

3. Remove the valve springs and seats and lift out the valves. Place the valves in a cardboard or wood block, drilled and numbered so that the valves may be reinstalled in their respective places when grinding or reassembling (do not mark the valves with a file or punch).

4. Clean all carbon from the cylinder head, piston heads, valve seats, valve guides and valves with suitable scraping or buffing tools.

VALVE GRINDING.

Inspect the valve guides for excessive wear. If the valve guides are to be renewed, this should be done before any work is done on the valve seats. This will insure the seat being finished square with respect to the new guide. The exhaust valve guides will usually show the most wear. To drive out the guides, use a drift with a pilot sized to the I.D. of the valve guide. Drive in the new guides to the same depth location as the old guides. See Illustration No. 48, also see "Fits and Tolerances".

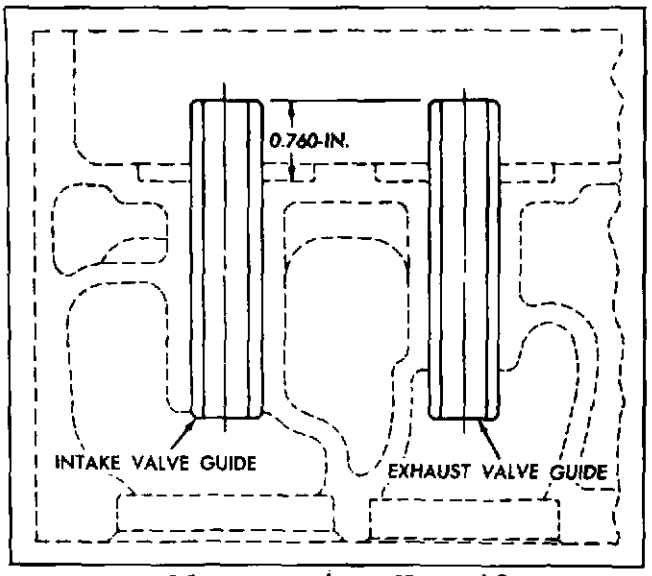
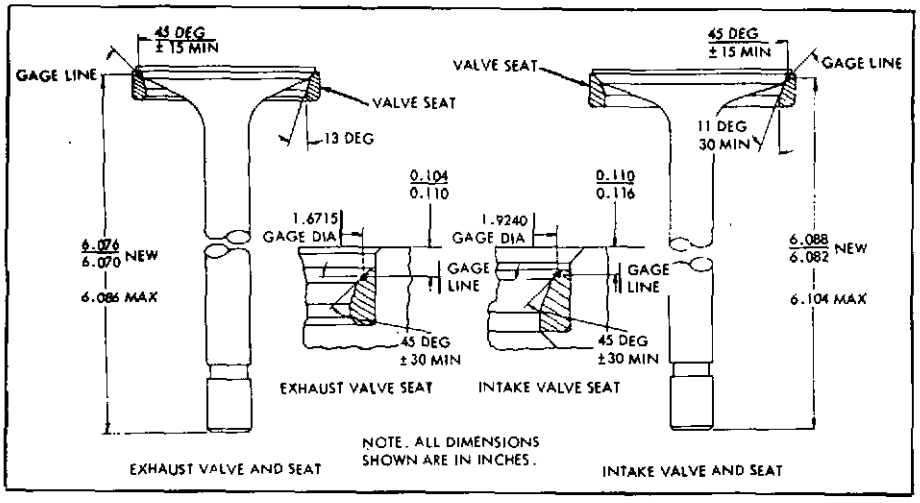


Illustration No. 48

VALVE SEAT GRINDING.



INTAKE AND EXHAUST VALVE FACE AND VALVE SEAT GRINDING DIAGRAM

Illustration No. 49

When valve seats can be repaired by regrinding or when valve seats are replaced, grind as described below:

1. Use a 45° angle grinding stone to grind valve seats.
2. After grinding seat, check valve contact. See Illus. No. 49.
3. Keep valve seat as near as possible to center of valve face.

Narrow seat as necessary, using a 20° grinding stone. Valve should never seat at the top or bottom of the face.

VALVE SEAT REPLACEMENT.

Replace valve seats that cannot be repaired by grinding. Remove seat using any method which will not damage counterbore of cylinder head machined surface. Install new intake valve seat and exhaust valve seat. Grind seat as described in No. 1 above.

Inspect the valve seats; and, if they are pitted or if new guides have been installed, the seats should be refinished. Valve seat tools with proper diameter pilots are required. The exhaust valve seats are round. The intake valve seats are finished on a 45° angle. Reseat the seats with a vibrating angle grinder type reseating tool. Because of the large diameter and surface of the valve seats, it is very difficult to obtain a good reseating job with a reamer type tool. Remove all shoulders and pits from the seat but do not grind any deeper than necessary. Then finish the new or refaced valve to the reseated seat by hand in the usual manner. See Illustration No. 49.

Inspect the valves carefully; and if the stems are badly worn, or are not straight, or if the valves are deeply pitted, the valves should be replaced by new ones. However, valves that are only slightly pitted can be used by refacing them on a valve grinder. Valves must have an accurately finished face of the correct angle. See "Fits and Tolerances" for the seat face width.

If the valves and seats are not deeply pitted or shouldered, or have have been refaced, grind or lap each valve to its seat. Obtain a light coil spring with enough tension to just hold the valve off the seat. Lubricate the valve stem and apply a thin coating of good quality, medium grinding compound on the valve face. Insert the valve in the valve guide and rotate the valve back and forth, about a quarter of a turn, a few times, pressing firmly on the grinding tool. (Avoid continuous round-and-round motion that would cut grooves in the valves or seat). Release the pressure on the tool and the spring should lift the valve from its seat. Rotate the valve 15° or 20° and repeat the grinding process. It will probably be necessary to wipe off and inspect the valve and seat during this process to see what progress is being made; also, the compound may wear off the surface being ground. In either case, reapply another thin coating of compound and continue grinding until inspection shows the surfaces are in contact. Then wipe off all heavy compound and apply a thin coating of "fine" compound and continue the grinding. When the surfaces are "finished" and show a bright, silver-like band of uniform width on both the valve and seat, clean off all traces of the compound. Test each valve for a tight fit by making ten or twelve pencil marks, equally spaced, across the turn and again lift out the valve and observe if all the pencil marks are rubbed out on the contact surface. If not, regrind until this test shows a gas tight mating of the valve and seat.

NOTE: It is imperative that the valves be assembled in the same seats to which they were ground.

TO ASSEMBLE THE VALVES.

1. Thoroughly clean all traces of the grinding compound off the valves, stems, and guides; put a few drops of oil on the valve stems and insert the valves.

2. Using a valve spring compressor, compress the valve springs and insert the valve locks.

3. Turn the head on its side and pour gasoline in the valve openings. If gasoline seeps out around any valve seat in a stream, remove that valve and regrind. Repeat the test.

4. Install the cylinder head and valves on the engine. See "Cylinder Head".

5. Adjust the valve tappets, Illustration No. 50, to the proper setting. See "Fits and Tolerances". This may be readily and systematically accomplished in the following manner. Perusal of the following paragraphs and Illustration No. 50 will point out that the spotting of the crankshaft and rocker arms follows the firing order (1 - 5 - 3 - 6 - 2 - 4) of the engine (starting from the timing gear end). The valve tappet screws have a locknut which must be securely locked.

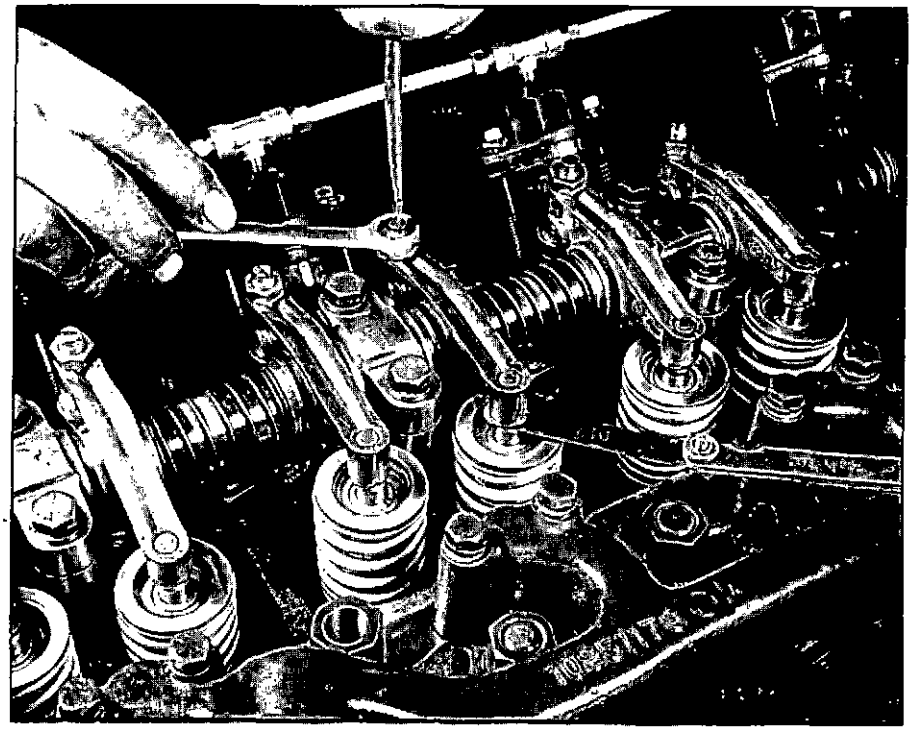


Illustration No. 50

a. Crank the engine over until both the intake and exhaust valve of No. 1 cylinder are closed. Then adjust the tappets on this cylinder. Repeat this on all cylinders following the engine firing order of (1 - 5 - 3 - 6 - 2 - 4) or set the tappets as follows.

For ease of adjustment, note the following:

With cylinder No. 1 intake valve wide open, clearance can be adjusted on cylinder Numbers 2, 3, and 6 intake valves and cylinder Numbers 1, 2, and 4 exhaust valves. With cylinder No. 6 intake valve wide open, clearance can be adjusted on cylinder Numbers 1, 4, and 5 intake valves and cylinder Numbers 3, 5, and 6 exhaust valves.

CAUTION: The cylinder head nuts must be retightened and the valve tappets reset after two hours of service.

The above completes the valve tappet adjustment until after the engine is started and warmed up to operating temperatures, at which time the valve tappets should be readjusted to the correct hot operating clearance.

6. Install the cylinder head cover and any other parts that may have been removed.

7. Fill the cooling system with water or a cooling solution. Start the engine and warm up to operating temperatures.

8. With the engine idling slowly, readjust the tappets to the correct operating clearance.

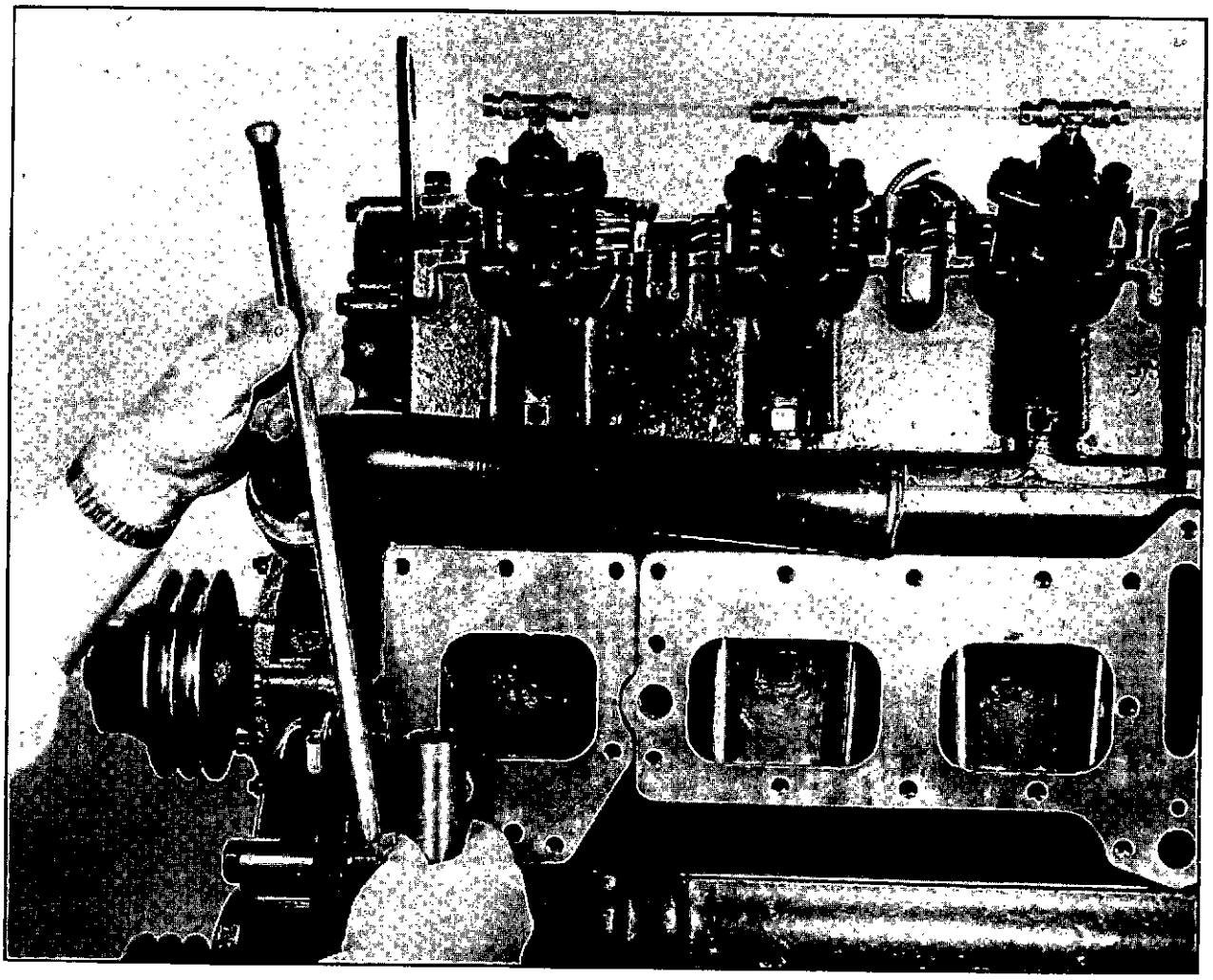


Illustration No. 51

VALVE TAPPETS

The valve tappet is straight and is hollow to receive the push rods.

TO REMOVE THE VALVE TAPPETS.

1. Remove the rocker arms and push rods. See "Camshaft Removal".
2. Remove the tappets from the cylinder block. See Illustration No. 51.
3. Check the tappets for wear and replace any that have excessive clearance.

TO INSTALL THE VALVE TAPPETS.

1. Check each tappet in the cylinder block position to see that it has the correct clearance, see "Fits and Tolerances", and install the tappets.
2. Adjust the valves. See "Valve Grinding".

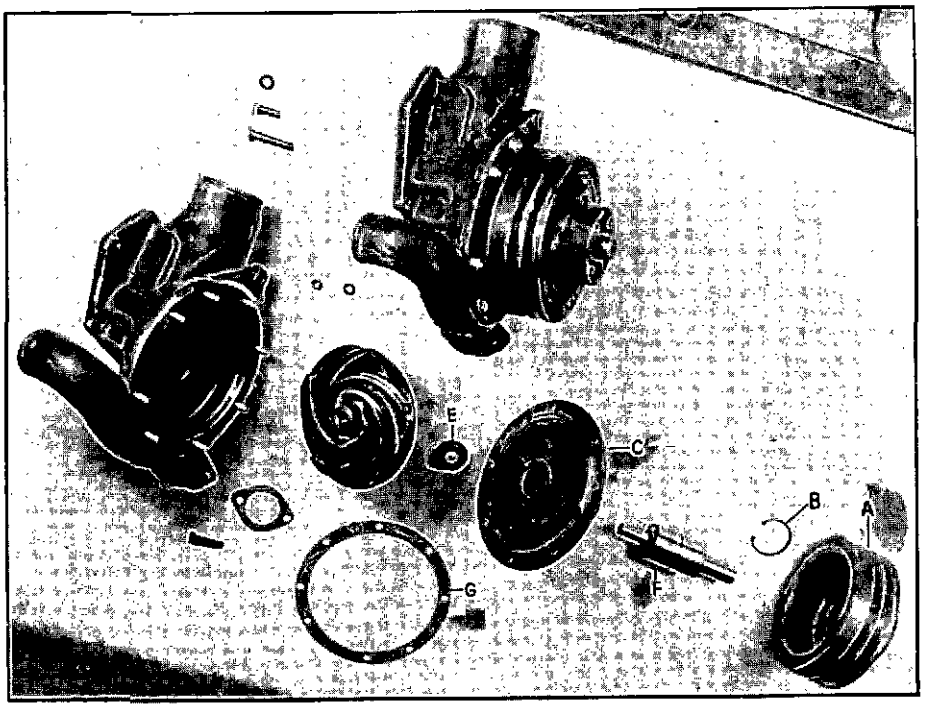


Illustration No. 52

WATER PUMP AND FAN ASSEMBLY

Illustration No. 52 shows a breakdown of the water pump as used on these engines. This pump may be readily removed from the engine after the removal of the water inlet hose, by-pass hose and fan blade. Then remove the water pump to cylinder block attaching screws and lift the pump away from the engine.

TO DISASSEMBLE THE PUMP (Letters refer to Illustration No. 52)

1. Remove the pulley hub (A) from the pump shaft and remove the snap ring (B).

2. Remove the screws from the water pump to cover plate and remove the plate and gasket.

3. Place the front of the pump on a suitable support in an arbor press and press the shaft and bearing assembly out of the pump body (C) and impeller (D).

4. Remove ceramic seal from the pump body.

The shaft and bearing assembly (F) is one unit and no attempt should be made to disassemble these parts.

Wash and clean all parts thoroughly; inspect for wear and damage. It is advisable to reface the seal surface of the impeller if it is grooved or otherwise marked. Put a coating of grease on the seal surface before starting reassembly of the pump.

TO ASSEMBLE THE PUMP.

1. Install new ceramic seal into the pump body (C).

2. Press the shaft and bearing assembly into the body (C).

CAUTION: Press only on the outer bearing face of the bearing and not on the end of the shaft.

3. Install the snap ring (B). Supporting the pump shaft on the outer shaft end, press the impeller (D) on to the shaft.

NOTE: The impeller should be pressed on to a position which permits .010" clearance between a straight edge and the impeller when the straight edge is placed across the rear face of the pump body.

4. Support the pump on the impeller end of the shaft and press the fan drive pulley (A) on to the shaft.

5. Install the new cover gasket (G) and pump cover (C), with the screws as removed.

6. Test the rotation of the pump to see that it does not bind or have any excessive resistance.

When installing a water pump, always use a new gasket and tighten the attaching screws evenly and alternately to prevent possible damage.

WIRING DIAGRAM

Due to many types of electrical equipment and the variety of requirements encountered in different installations, it is impossible to illustrate a typical wiring diagram.

However, the installation of wiring circuits may be more readily understood if the complete system is divided as follows:

1. THE STARTER SYSTEM:

This circuit consists of the battery (electrical energy storage unit), the starting motor and the necessary wiring to connect the battery to the starter switch and from the starter switch to the starter.

In most cases, the ground or return flow of current is carried through the framework of the unit to a point near the battery from where a short cable is connected to the battery to complete the circuit.

When a magnetic type starter switch is used, it is necessary to connect it to a control switch, which may be either a key switch or a simple push botton switch. The key switch has one side connected to the battery side of the ammeter and the other side to the magnetic switch with suitable wires. The magnetic switch may have an external ground post which must be grounded to the unit framework. The push button switch has one side connected to the battery side of the ammeter and the opposite side connected to the magnetic starter switch as outlined above.

2. BATTERY CHARGING SYSTEM:

The battery charging system consists of a generator or alternator, which creates the electrical current, a regulator to control the current, and an ammeter to indicate the amount of current being created or used. (See Chart Below)

3. ACCESSORY SYSTEM:

The accessory system consists of lights, horns, heaters, etc. The current to operate these accessories is usually taken from the ammeter to a suitable switch, which allows the accessories to be operated or turned off as necessary.

FUEL OIL SPECIFICATIONS

Flash point	125°F, minimum
Carbon residue	0.35 percent
Water and sediment . . (see note 3)	0.10 percent by volume, maximum
Ash	0.02 percent by weight, maximum
Distillation, 90 percent . point (see note 4)	640 maximum 540 minimum
Viscosity at 100°F . . .	2.0 centistokes, minimum 4.3 centistokes, maximum
Sulphur (see note 4) . .	1.0 percent, maximum
Cetane number (see . . note 4)	45 minimum

NOTES:

1. The fuel oil must be clean, completely distilled, stable, and noncorrosive.

2. In cold weather, the cloud point (temperature at which wax crystals begin to form in the fuel oil) should be 10°F below the lowest expected fuel temperature to prevent clogging of the fuel filters by wax crystals.

3. The fuel filters are sensitive to water and care should be taken to keep the water content low.

4. Distillation range, sulphur content, and cetane number are three of the most important properties in the selection of fuel for optimum combustion and minimum wear.

BATTERY RECOMMENDATIONS

WHITE ENGINES COMMERCIAL APPLICATIONS

12 VOLT SINGLE BATTERY SYSTEM

ENGINE MODEL	CRANKING REQUIREMENT WATTS @ 0°F.	RECOMMENDED BATTERY SIZE BCI	SAE	PLATES /CELL	COLD CRANK CURRENT - AMPS @ 0°F.	CRANKING POWER - WATTS @ 0°F.	(Former) 20 HR. RATING AMP HRS.	RESERVE CAPACITY MINUTES
D-4800	4200	4D	20T4	19	640	4500	150	285
D-4800-T	4200	4D	20T4	19	640	4500	150	285
D-4800-TA	4200	4D	20T4	19	640	4500	150	285

TROUBLE SHOOTING

ENGINE TROUBLESHOOTING

CAUSE	ENGINE WILL NOT START	HARD STARTING	ENGINE STOPS	ERRACTIC ENGINE PERFORMANCE	BLACK EXHAUST SMOKE	BLUE EXHAUST SMOKE	WHITE EXHAUST SMOKE	LOW POWER	ENGINE OVER-HEATING	ENGINE OVER-COOLING	ENGINE KNOCKING	LOW OIL PRESSURE	BEARING FAILURES
	SYMPTOM												
Air Cleaner Dirty		X		X	X	X		X					
Air Inlet Restricted	X	X		X	X	X		X					
Exhaust System Restricted			X	X	X			X	X				
Battery Weak or Discharged	X	X	X	X									
Battery Cables - Loose Connections	X	X	X	X									
Foreign Matter on Pistons				X				X			X		
Low Cylinder Compression	X	X		X		X		X					
Worn Pistons, Rings, Etc.		X				X		X			X		
Scored Pistons				X		X		X	X		X		X
Valves Leaking		X		X		X		X					
Valves Sticking	X	X		X	X			X			X		
Valves Incorrectly Adjusted	X	X		X				X			X		
Luboil Level Too Low											X	X	X
Luboil Level Too High		X				X		X					
Wrong Type of Luboil		X				X						X	X
Oil Pump Inlet Screen Plugged											X	X	X
Pressure Regulator Not Functioning											X	X	X
Luboil Contaminated											X	X	X
Rocker Arm Shaft Upside Down						X						X	
Oil Header Plug Missing or Loose												X	X
Bearings Failed - Main, Rod, Cam				X		X		X			X	X	X
Excessive Angle Operations						X					X	X	X
Excessive Thrust Pressure On Shafts	X	X	X									X	X
Fuel Tank Empty	X		X										
Fuel Tank Valve Closed	X		X										
Fuel Tank Vent Plugged			X	X									
Fuel Transfer Pump Worn	X	X		X				X					
Fuel Contamination	X	X		X		X		X			X		
Fuel Incorrect For Conditions	X	X	X	X	X	X		X					
Engine Too Cold to Ignite Fuel Properly	X	X		X			X	X					
Stop Control In Stop Position	X		X										
Electric Fuel Shutoff Not Functioning	X		X										
Throttle Linkage Adjustment Incorrect or Sticking				X				X					
Fuel Filters Dirty or Plugged	X	X	X	X				X					
Air Leaks In Fuel System	X	X	X	X				X					
Fuel Pump Incorrectly Timed	X	X		X	X		X	X	X		X		
Sticking or Fouled Nozzle		X		X	X			X			X		
Fuel Return Plugged or Restricted		X	X	X				X			X		
Incorrect Fuel Setting				X	X			X					
Nozzle Opening Pressure Incorrect				X	X			X			X		
Nozzle Incorrectly Torqued				X				X			X		
Fan Belt Loose Or Slipping								X	X				
Radiator Fins or Tubes Dirty or Restricted								X	X				
Water System Piped Incorrectly									X	X			
Low Coolant Level								X	X				
Coolant In Cylinders	X	X		X		X		X	X		X		
Inoperative Thermostat					X	X		X	X	X			
Thermostat Missing					X	X			X				
Engine Overloaded					X			X	X		X		X
Engine Overspeeded					X				X		X		X

FITS AND TOLERANCES

MODEL D-4800 & D-4800-T

CLEARANCES	MIN.	MAX.
CRANK GEAR TO CRANKSHAFT	.0003	- .0013
CRANKSHAFT END CLEARANCE	.010	- .015
CRANKSHAFT MAIN BEARING CLEARANCE	.0018	- .0048
CONNECTING ROD BEARING	.0014	- .0044
CONNECTING ROD SIDE CLEARANCE	.007	- .013
CAMSHAFT BEARING CLEARANCE	.001	- .003
CAMSHAFT END THRUST	.006	- .010
ROCKER ARM TO ROCKER ARM SHAFT	.002	- .004
PISTON TO CYLINDER CLEARANCE		
3 RING PISTON PART #380045		
TOP OF PISTON	.017	- .0215
BOTTOM OF SKIRT	.006	- .0085
PISTON RING GAP AND SIDE CLERANCE		
3 RING PISTON PART #380045		
TOP RING GAP AT 4.5625	.016	- .026
2ND RING GAP AT 4.5625	.016	- .026
OIL CONTROL RING GAP AT 4.562	.016	- .026
SIDE CLEARANCE		
TOP RING	.0035	- .0055
2ND RING	.0035	- .0055
OIL CONTROL RING	.001	- .003
PISTON TO CYLINDER CLEARANCE		
4 RING PISTON PART #380407		
TOP OF PISTON	.039	- .0425
BOTTOM OF SKIRT	.007	- .0095
PISTON RING GAP AND SIDE CLEARANCE		
4 RING PISTON PART #380407		
DOUBLE KEYSTONE RINGS		
TOP RING GAP AT 4.5625	.013	- .023
2ND RING GAP AT 4.5625	.013	- .023
3RD RING GAP AT 4.5625	.013	- .023
OIL CONTROL RING GAP AT 4.562	.016	- .026
SIDE CLEARANCE		
TOP RING	.001	- .0025
2ND RING	.001	- .0025
3RD RING	.0025	- .0035
OIL CONTROL RING	.001	- .003
PISTON PIN TO CONNECTING ROD BUSHING	.0016	- .002
PISTON PIN TO PISTON (See *)	.0002	- .0006
TOP OF CYLINDER BLOCK TO TOP OF PISTON PROTRUSION	.01185	- .02775
TOP OF LINER CYLINDER BLOCK PROTRUSION	.0005	- .004

"*" THE PISTON PIN RETAINING RING SHOULD BE INSTALLED WITH OPENING IN RING FACING DOWN RELATIVE TO BOTTOM OF THE PISTON.

FITS AND TOLERANCES

MODEL D-4800 & D-4800-T

CLEARANCES - CONTINUATION	MIN.	MAX.
PISTON TO CYLINDER CLEARANCES		
3 RING PISTON P/N 40-3810302 (N.A. ENGINE)		
TOP LAND	.0145	- .01675
2ND LAND	.0085	- .01075
3RD LAND	.023	- .02625
TOP OF SKIRT	.00525	- .0065
BOTTOM OF SKIRT (AT CHECK DIA. OF 4.5565 FROM BOTTOM)	.00355	- .00425
PISTON RING GAP AND SIDE CLEARANCES		
3 RING PISTON P/N 40-3810302 (N.A. ENGINE)		
TOP RING GAP AT 4.5625	.016	- .026
2ND RING GAP AT 4.5625	.016	- .026
OIL CONTROL RING GAP AT 4.562	.016	- .026
SIDE CLEARANCE		
TOP RING	.0035	- .0055
2ND RING	.0035	- .0055
OIL CONTROL RING	.001	- .003
PISTON TO CYLINDER CLEARANCE		
3 RING PISTON P/N 40-3810301 (TURBOCHARGED ENGINE)		
TOP LAND	.0295	- .03225
2ND LAND	.0110	- .01375
3RD LAND	.0230	- .02625
TOP OF SKIRT	.00525	- .0065
BOTTOM OF SKIRT (AT CHECK DIA. OF 4.5564 FROM BOTTOM)	.00355	- .00425
PISTON RING GAP AND SIDE CLEARANCE		
3 RING PISTON PART 40-3810301 (TURBOCHARGED ENGINE)		
DOUBLE KEYSTONE RINGS		
TOP RING GAP AT 4.5625	.013	- .023
2ND RING GAP AT 4.5625	.013	- .023
OIL CONTROL RING GAP AT 4.562	.016	- .026
SIDE CLEARANCE		
TOP RING	.001	- .0025
2ND RING	.001	- .0025
OIL CONTROL RING	.001	- .003
PISTON PIN TO CONNECTING ROD BUSHING (LOOSE)	.0016	- .002
PISTON PIN TO PISTON (LOOSE)	.0002	- .0006
TOP OF CYLINDER BLOCK TO TOP OF PISTON PROTRUSION	.0132	- .0348
TOP OF LINER CYLINDER BLOCK PROTRUSION	.0005	- .004

FITS AND TOLERANCES

MODEL D-4800 & D-4800-T

CLEARANCES - CONTINUATION

BACKLASH	MIN.	MAX.
OIL PUMP DRIVE TO IDLER	.004	.006
IDLER TO CRANKSHAFT	.004	.006
CRANKSHAFT TO CAMSHAFT	.002	.004
INJECTION PUMP DRIVE TO CAMSHAFT	.002	.004
VALVE LASH .....Hot and Cold		
Intake	.010	
Exhaust ...	.025	
VALVE STEM TO GUIDE		
Intake	.0021	.0039
Exhaust ...	.0048	.0056
VALVE SEAT RUNOUT	.002 T.I.R.	
TAPPET CLEARANCE IN BLOCK	.0033	.0048
VALVE ARRANGEMENT FRONT TO REAR	I,E,I,E,I,E,I,E,I,E,I,E.	
MINIMUM OIL PRESURE .....15 lb. @ 500 RPM (170°) F		
35 lb. @ 1800 RPM (170°) F		
BELLHOUSING FACE RUNOUT	.008	

TORQUE SPECIFICATIONS

MAIN BEARING CAP BOLTS	135 - 140 ft. lbs.
CONNECTING ROD BOLT	115 - 120 ft. lbs.
CAMSHAFT GEAR TO CAMSHAFT NUT	275 - 300 ft. lbs.
CRANKSHAFT PULLEY ASSEMBLY RETAINING BOLT	225 - 250 ft. lbs.
FLYWHEEL TO CRANKSHAFT BOLT	115 - 120 ft. lbs.
FLYWHEEL HOUSING TO CYLINDER BLOCK NUTS	40 - 45 ft. lbs.
OIL PUMP ATTACHING BOLTS	48 - 54 ft. lbs.
CYLINDER HEAD NUTS (In Four Steps)	
Step 1 - Tighten to	80 ft. lbs.
Step 2 - Tighten to	130 ft. lbs.
Step 3 - Tighten to	147 ft. lbs.
Step 4 - Retorque after Power Pull	147 ft. lbs.
ROCKER ARM SHAFT BRACKET NUT	30 - 35 ft. lbs.
CYLINDER HEAD COVER ATTACHING	3 - 5 ft. lbs.
EXHAUST MANIFOLD NUTS	20 - 25 ft. lbs.
INTAKE MANIFOLD NUTS	20 - 25 ft. lbs.
FUEL PUMP ATTACHING NUT (Injection Pump to Adapter)	35 - 40 ft. lbs.
VIBRATION DAMPER TO CRANKSHAFT PULLEY	30 - 35 ft. lbs.
INJECTION NOZZLE HOLD DOWN	12 - 15 ft. lbs.
FUEL LINE NUTS AT FUEL PUMP (Bosch)	20 - 25 ft. lbs.
CONNECTING SCREW (Fuel Line) (Roosa Master)	235 - 240 in. lbs.
NUT - MODEL "DM" FUEL INJECTION PUMP DRIVE GEAR	150 ft. lbs.
OIL PUMP DRIVE GEAR NUT	50 ft. lbs.

WHITE
ENGINES, INC.
CANTON, OHIO 44707

LIMITED WARRANTY

INDUSTRIAL ENGINE

White Engines, Inc. warrants each new engine or component thereof, sold by it to the original owner-user as follows:

For eighteen (18) months from date of shipment from the factory, or for twelve (12) months of service, or for 1,000 hours of service, whichever shall first occur, (or for such other period of time as may be agreed upon in writing by White Engines, Inc. in respect to the application in which the engine is used) that said engine and component shall be free from defects in material and workmanship.

For any engine or component which is, or becomes defective within the period set forth above, White Engines, Inc. shall furnish to the original owner-user, without charge, parts to replace those parts which upon inspection are determined by White Engines, Inc. to have been defective in material or workmanship.

This warranty does not obligate White Engines, Inc. for the cost of labor or transportation charges in connection with the replacement of defective parts or repair of the engine.

The foregoing warranty does not apply to normal maintenance services or adjustment or to an engine upon which repairs or alterations have been made unless the repairs or alterations were authorized in writing by White Engines, Inc.

White Engines, Inc. makes no warranty in respect to trade accessories. Trade accessories are subject to the warranties of their respective manufacturers.

Other than as set forth above, SELLER MAKES NO WARRANTY OF ANY KIND WHATEVER, EXPRESS OR IMPLIED; AND ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, OTHER THAN AS CONTAINED HEREIN AND HEREBY LIMITED AS TO DURATION IS HEREBY DISCLAIMED.

THIS WARRANTY SUPERSEDES ANY PREVIOUS WARRANTIES AND TAKES EFFECT JULY 1, 1978.