TM 5-2316

WAR DEPARTMENT TECHNICAL MANUAL

PUMP, CENTRIFUGAL, GASOLINE ENGINE-DRIVEN, BASE-MOUNTED, 4-IN. DISCHARGE, 480-GPM AT 300-FT HEAD, LEFF, MODEL AURORA AD-2

(ENGINE: CHRYSLER T-108-503)

★

OPERATIONS, MAINTENANCE AND REPAIR INSTRUCTIONS

WAR DEPARTMENT • 24 JANUARY 1945

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(ENGINE: CHRYSLER T-108-503)

WAR DEPARTMENT . 30 MARCH 1945

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Washington 25, D. C., (30 March 1945)

TM 5-2316, (Pump, Centrifugal, Gasoline Engine-Driven, Base-Mounted, 4-In. Discharge, 480-GPM at 300-Ft Head, Leff, Model Aurora AD-2 (Engine, Chrysler, T-108-503), is published for the information and guidance of all concerned.

A. G. 300.7 (10 Jul 44).

By order of the Secretary of War:

G. C. MARSHALL,

Chief of Staff.

OFFICIAL:

J. A. ULIO,

Major General,

The Adjutant General.

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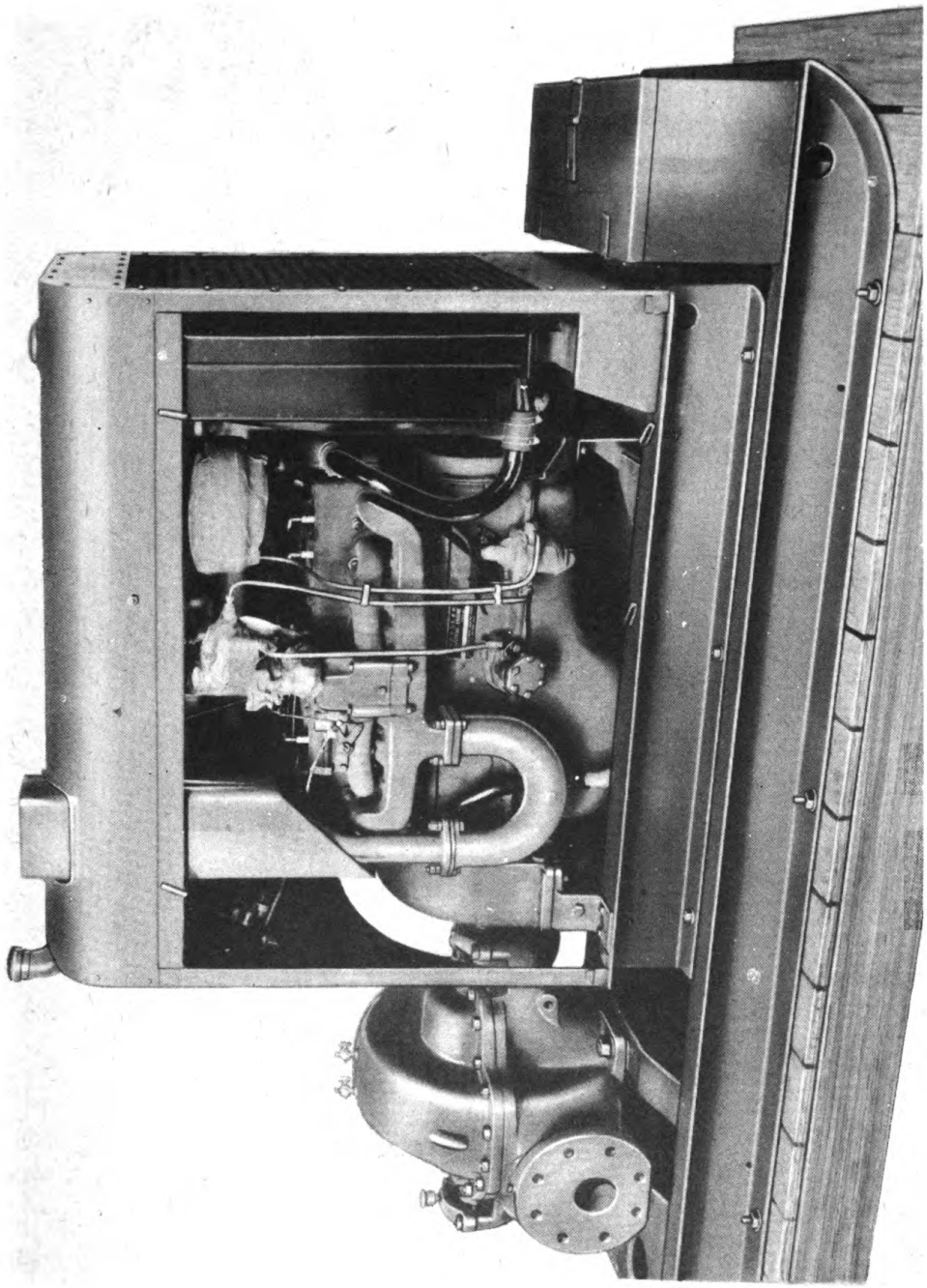


Figure 1—Leff Pump Unit Viewed from Carburetor Side of Engine

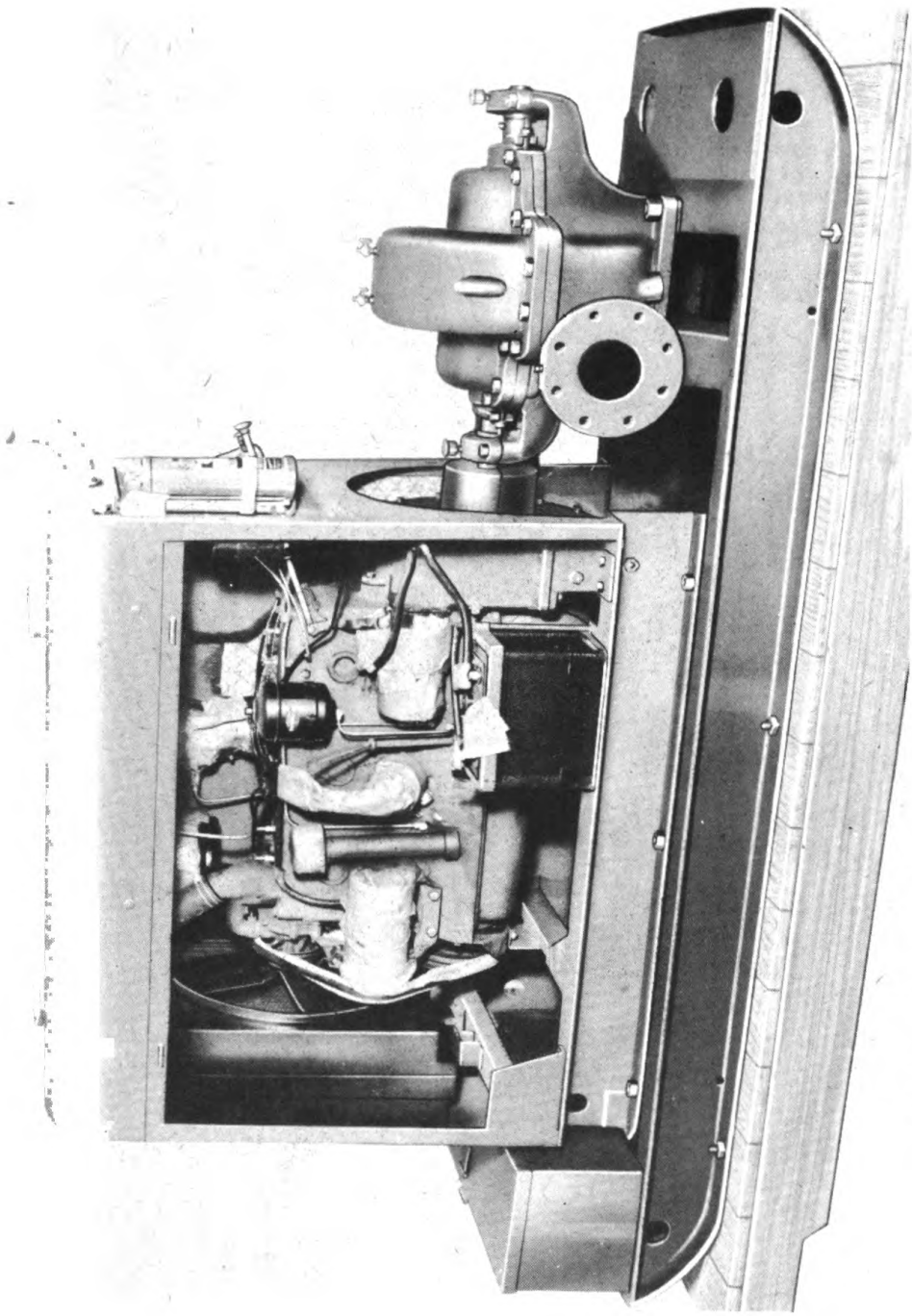


Figure 2—Opposite Side of Left Pump Unit With Engine Panels Removed

PART ONE
INTRODUCTION

SECTION I
GENERAL DESCRIPTION

1. SCOPE.

a. These instructions are published for the information and guidance of the personnel to whom this equipment is assigned. They contain information on the operation and maintenance of the equipment as well as description of the major units and their functions in relation to the other components of the equipment. They apply only to the Leff centrifugal pumping unit and these instructions are arranged in five parts: Part One—Introduction; Part Two—Installation and Operating Instructions; Part Three—Maintenance Instructions; Part Four—Auxiliary Equipment; Part Five—Repair Instructions.

b. Parts Indentification List, Standard Nomenclature List, Technical Bulletins and other publications applicable to the equipment covered by this manual, will be found in the appendix section at the end of this book.

2. RECORDS.

Maintenance instruction forms listed and briefly described in the following subparagraphs will be used in the maintenance of this equipment.

a. WD AGO Form No. 6—Duty Roster. This form slightly modified will be used for recording operation and scheduling lubrication and preventive maintenance services at the proper intervals on individual items of equipment.

b. WD AGO Form No. 48—Driver's Trip Ticket and Preventive Maintenance Service Record. This form will be used by equipment operators for reporting the accomplishment of daily preventive maintenance services and for reporting any deficiencies observed on the equipment during operation.

c. War Department Lubrication Order. This is a maintenance instruction form and is intended to instruct operators and personnel of the using organization as to the proper lubricants to be used and intervals to follow in lubricating individual items of equipment.

d. War Department Preventive Maintenance Services Engineer Equipment. This is a maintenance instruction form and prescribes daily maintenance services to be performed by the operator, as well as the weekly and monthly services to be performed by mechanics of the using organization in providing proper maintenance on individual items of equipment.

e. WD AGO Form No. 464—Preventive Maintenance Services and Technical Inspection Work Sheet for Engineers Equipment. This form is used for personnel of the using organization and higher echelons for reporting the results of preventive maintenance services, command, and technical inspections.

f. WD AGO Form No. 9-70—Spot Check Inspection Report for All Motor Vehicles. This form may be used as a check list for items to be inspected during spot check inspections in lieu of WD AGO Form No. 464.

g. WD AGO Form No. 478—MWO and Major Unit Assembly Replacement Record. Major repairs or rebuilding, the replacement of major unit assemblies and the accomplishment of equipment modifications will be recorded on this form.

SECTION II
DESCRIPTION AND DATA

3. GENERAL.

This manual covers the Leff pumping unit which is composed of an Aurora two-stage horizontally split-case Centrifugal Pump Model AD-2 coupled by means of a Ramsey Coupler to the Chrysler T-108-503 six-cylinder, water-cooled engine mounted on a skid base and capable of pumping 480 gallons per minute at a 300-ft head. Pump and engine may be identified by name plate carrying **model and serial number reference to which is made whenever communication relative to this equipment** becomes necessary. The name plate for the Aurora pump will be found immediately under the outer bearing bracket of the pump while the identification plate of the engine may be found on the carburetor side immediately under the manifold. (Figure 1.)

4. SPECIFICATIONS.

a. **Data**—Specifications and data on the Aurora Centrifugal Pump Model AD-2 and the Chrysler Industrial Engine T-108-503 follow:

b. **Pump Specifications.**—

Suction	four-inch
Discharge	four-inch
Capacity	480 gallons per minute at 300-foot head

(1) CASING split horizontally through center of shaft. Sections bolted and dowel pinned together. Casing is fitted with necessary drainage.

(2) IMPELLERS enclosed, single-suction type one piece bronze casting. Impellers keyed and securely locked with bronze shaft sleeve to shaft. Impellers separated by double wall partition providing for extra long intermediate bronze sleeve bearing.

(3) WEARING RINGS. Bronze cast and locked into position against rotation.

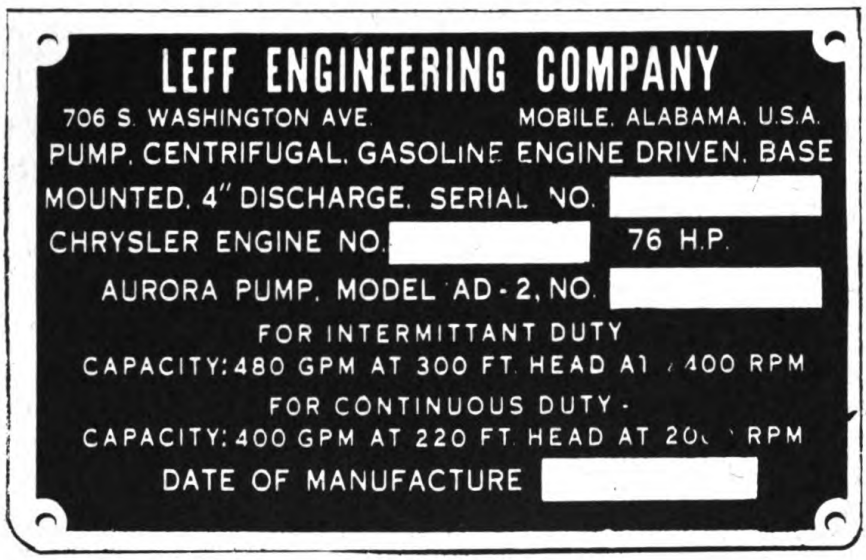
(4) SHAFT. High grade steel made to SAE specification X1335.

(5) SHAFT SLEEVES. Cast bronze.

(6) BEARINGS. Heavy duty ball bearings, grade lubricated.

(7) STUFFING BOXES. Provided with water-seal of lantern ring type on suction side only.

(8) PACKING GLANDS. Bronze.



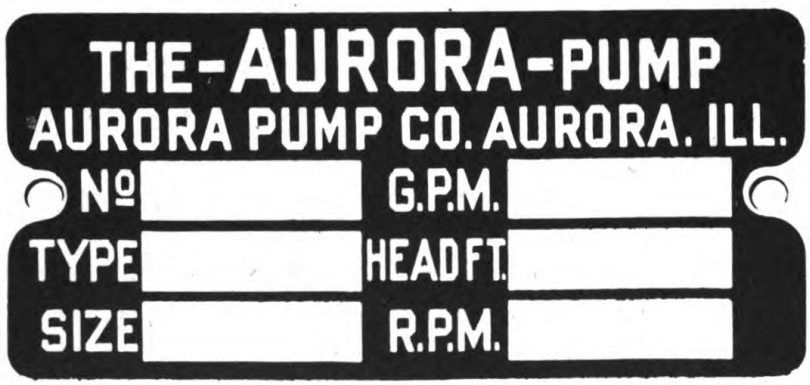


Figure 7—Identification Plates

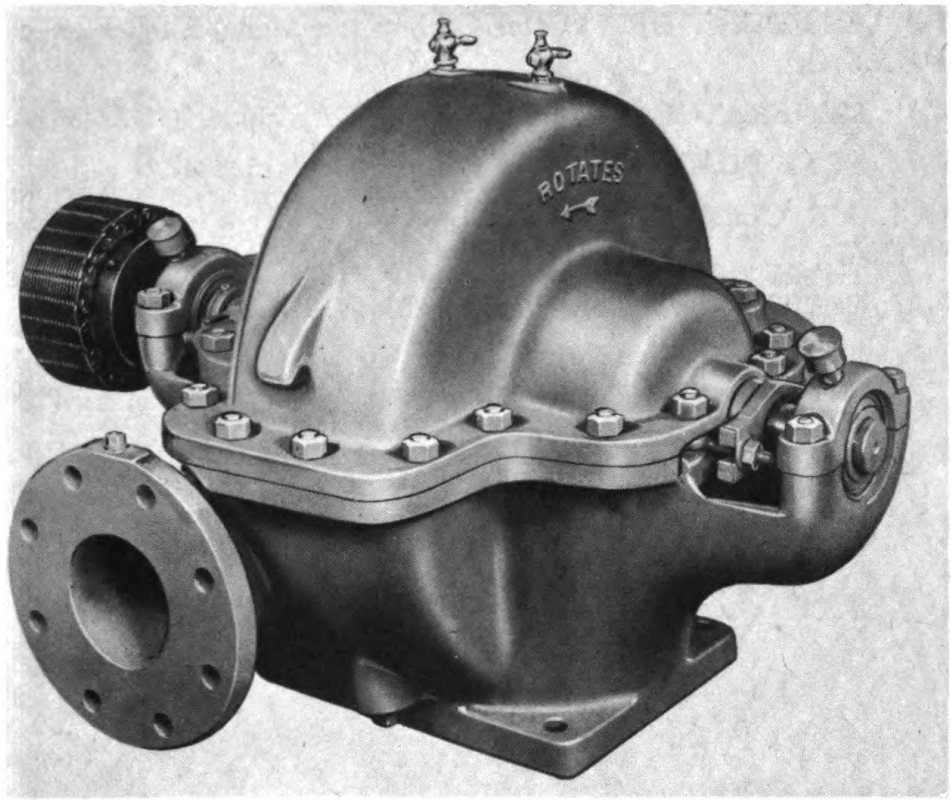


Figure 8—Aurora Pump Viewed from the Discharge Side

(9) COUPLING. Ramsey Flexible Coupling No. 6B.

c. **Engine Specifications.—**

Number of Cylinders	six
Bore	3-7/16 inches
Stroke	4-1/4 inches
Piston Displacement	236.6 cubic inches
Horsepower	28.35
Firing Order	1-5-3-6-2-4
Crankcase Capacity	five quarts
Cooling System Capacity	eighteen quarts
Gasoline Tank Capacity	seventeen gallons

(1) SPARK PLUGS. Auto-Lite Spark Plugs, A-5.

(2) DISTRIBUTOR. Auto-Lite Distributor, IGZ-4001.

(3) STARTING MOTOR. Auto-Lite, Model MAW-4029.

(4) GOVERNOR. King Seely, Model V6S-144.

(5) IGNITION COIL. Auto-Lite Ignition Coil, Model IG-4070-N.

(6) CARBURETOR. Carter Carburetor, Model Ell-1, Flange Size 1½ inches.

(7) GENERATOR. Auto-Lite Generator, Model GDZ-4801.

(8) FUEL PUMP. AC Fuel Pump, Model 1523647.

(9) AIR CLEANER. United Specialties Air Cleaner, Model H-90-11605.

(10) BATTERY. Willard Battery, Model SR-2-105.

SECTION III
TOOLS, PARTS AND ACCESSORIES

5. TOOLS. (See figure 9.).

When shipped from the factory each pump unit is supplied with a tool box containing all necessary tools to effect temporary repairs and replacements. This tool box will be found on the end opposite the pump directly in front of the radiator. This equipment consists of:

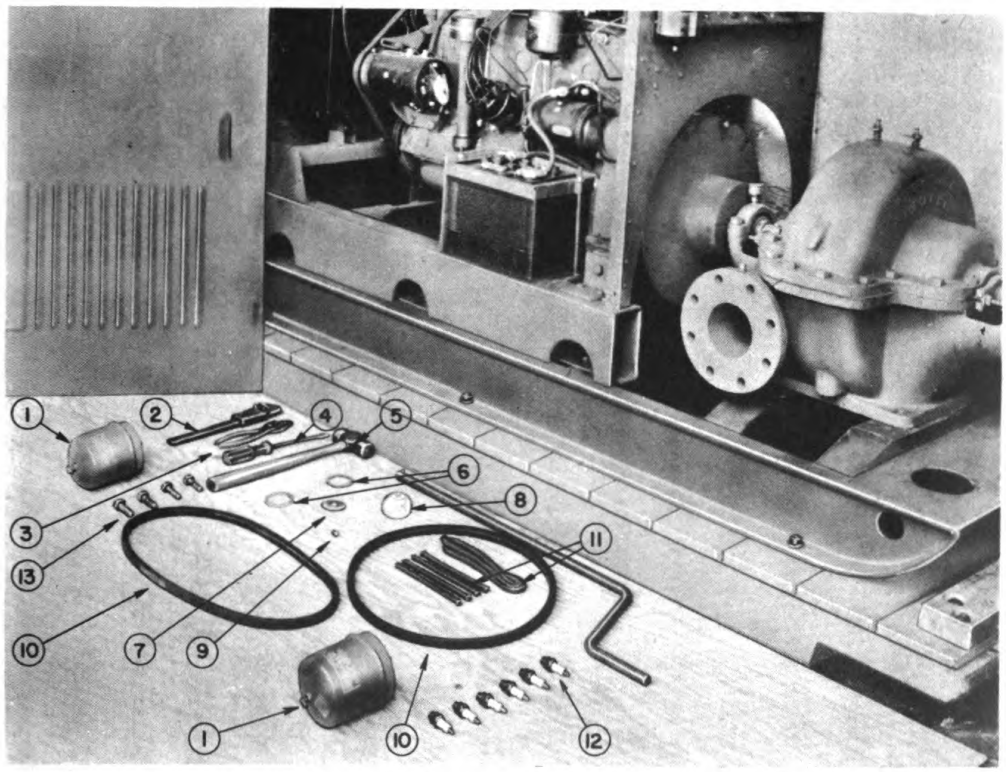


Figure 9—Accessories and Tools Forming Standard Equipment

Identifying Number	Nomenclature	Quantity
9	Setscrew, lock collar	1
13	Studs and Nuts	4
11	Packing, set	1
1	Cartridge, oil filter	2
10	Fan Belt	2
12	Spark Plugs	6
6	Gasket, fuel strainer bowl	2

Identifying Number	Nomenclature	Quantity
7	Screen, fuel strainer	1
8	Bowl, fuel strainer	1
2	Wrench, adjustable, 10 inch	1
3	Pliers, 6 inch	1
4	Screwdriver, 10 inch	1
5	Hammer, ball pein, 1½ pound	1
*	Valve, foot, flanged, 4 inch, with strainer	1
†	Valve, gate, flanged, 4 inch, 150-pound pressure	1
*	Flange, 4 inch, 150-pound pressure	2
*	Flange, 4 inch, for converting United States standard threads to British standard threads	2

* See Figure 10, page 11.
† See Figure 11, page 12.

PART TWO
OPERATING INSTRUCTIONS

SECTION IV
GENERAL INSTRUCTIONS

6. SCOPE.

Part Two contains information for the guidance of the personnel responsible for the installation of this equipment. It also contains information on the installing and operating of the equipment with suggestions for obtaining the best results in pumping efficiency.

7. UNPACKING AND CARE OF PARTS.

a. This equipment is mounted fully assembled and expertly processed and packed as specified by the Corps of Engineers Manual TM5-9711. Crated in one box: length, 8 feet, 8 inches; width, 3 feet, 1 inch; and height, 5 feet, 5 inches. The cubic content of the packing case is 144 cubic feet, net weight 2,250 pounds, gross weight fully crated, processed 3,606 pounds.

b. All parts have been tied with iron bands, bolted or otherwise blocked, end or sidewise, to prevent shifting in shipment. After uncrating, carefully inspect all parts to make certain that they have not been damaged during shipment. Remove bands and bolts as well as partitions and supports. Lay out the component parts on a clean surface and remove the water-proof covers and take care of vital accessory parts. Parts coated with rust preventive lubricant AXS-934, rust preventive compound and insulation compound USA 3-182 can be cleaned by using SOLVENT, dry cleaner, applied with three inch flat paint brush.

c. Inspect all belts to see that they have been properly protected in packing. Remove protection strip of paper and adjust belts to proper tension.

8. STORAGE BATTERY.

a. If this equipment is being unpacked for the first time the storage battery shipped with the unit is bone-dry but fully charged,

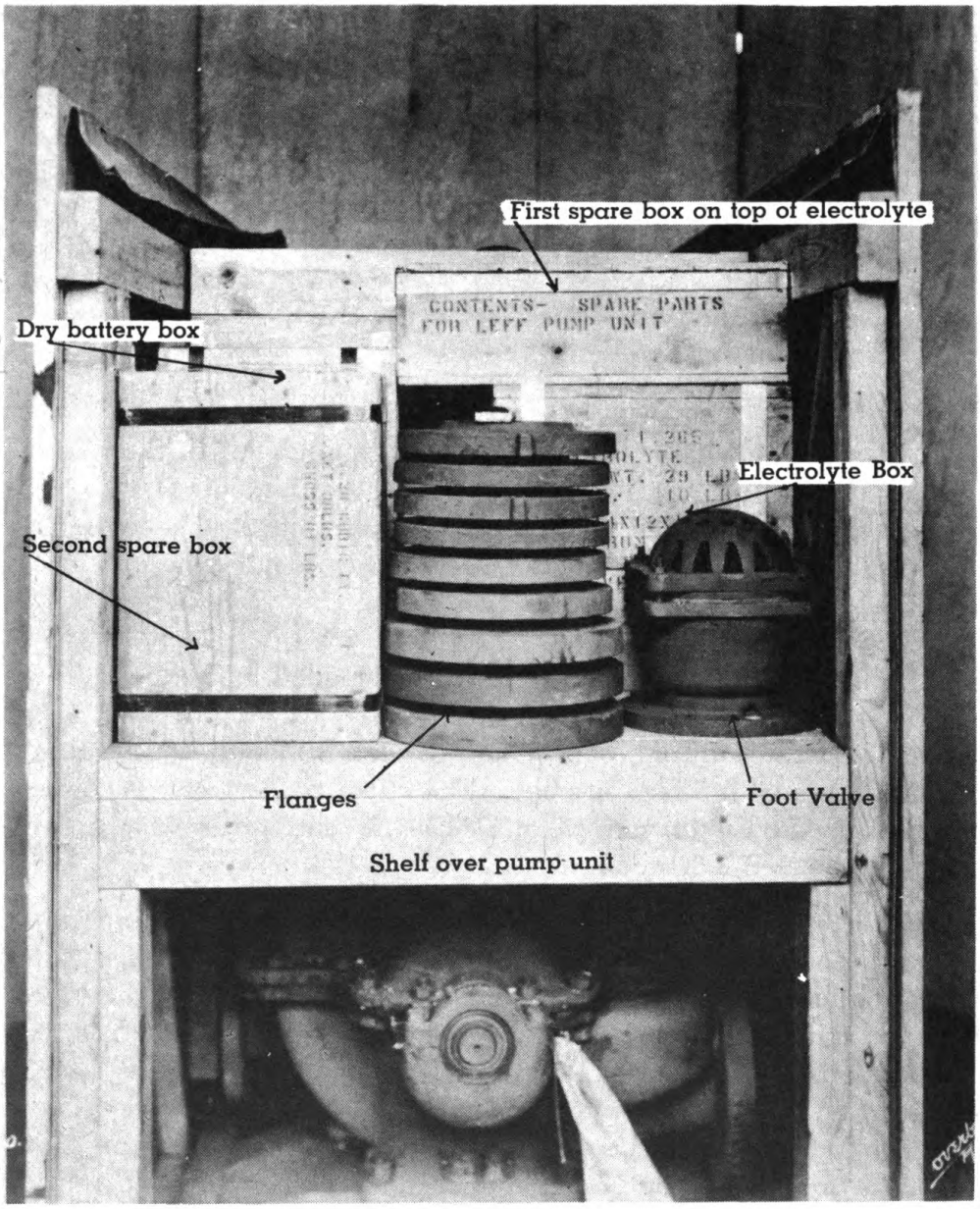


Figure 10—View of Pump with End of Crate Removed Revealing Unit in Partitioned Box

the electrolyte is packed separately as will be found by referring to figure 10. This is not a commercial dry cell but is a fully charged battery with dry plates which will become activated when the electrolyte is added to the battery. No charge will be required if electrolyte is being added to a dry battery.

b. A wet battery is a storage battery containing electrolyte and if the equipment has been unpacked and used previously the chances

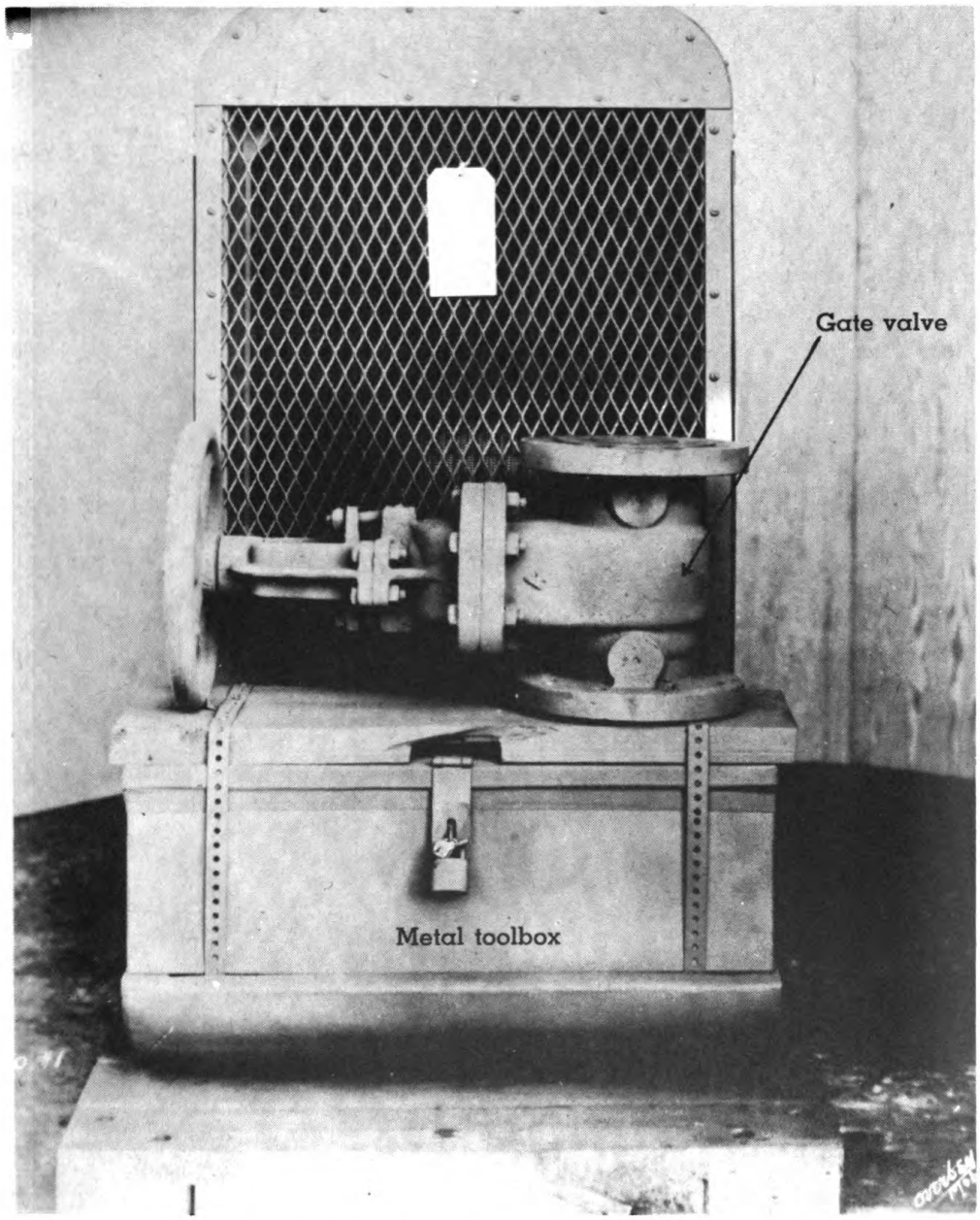


Figure 11—Gate Valve Mounted on Tool Box

are that the storage battery will contain the electrolyte fluid. Wet batteries should be tested with a hydrometer and should show not less than 1.240 specific gravity, with electrolyte level ¼ inch above the plates. If distilled water must be added, charge the battery be-

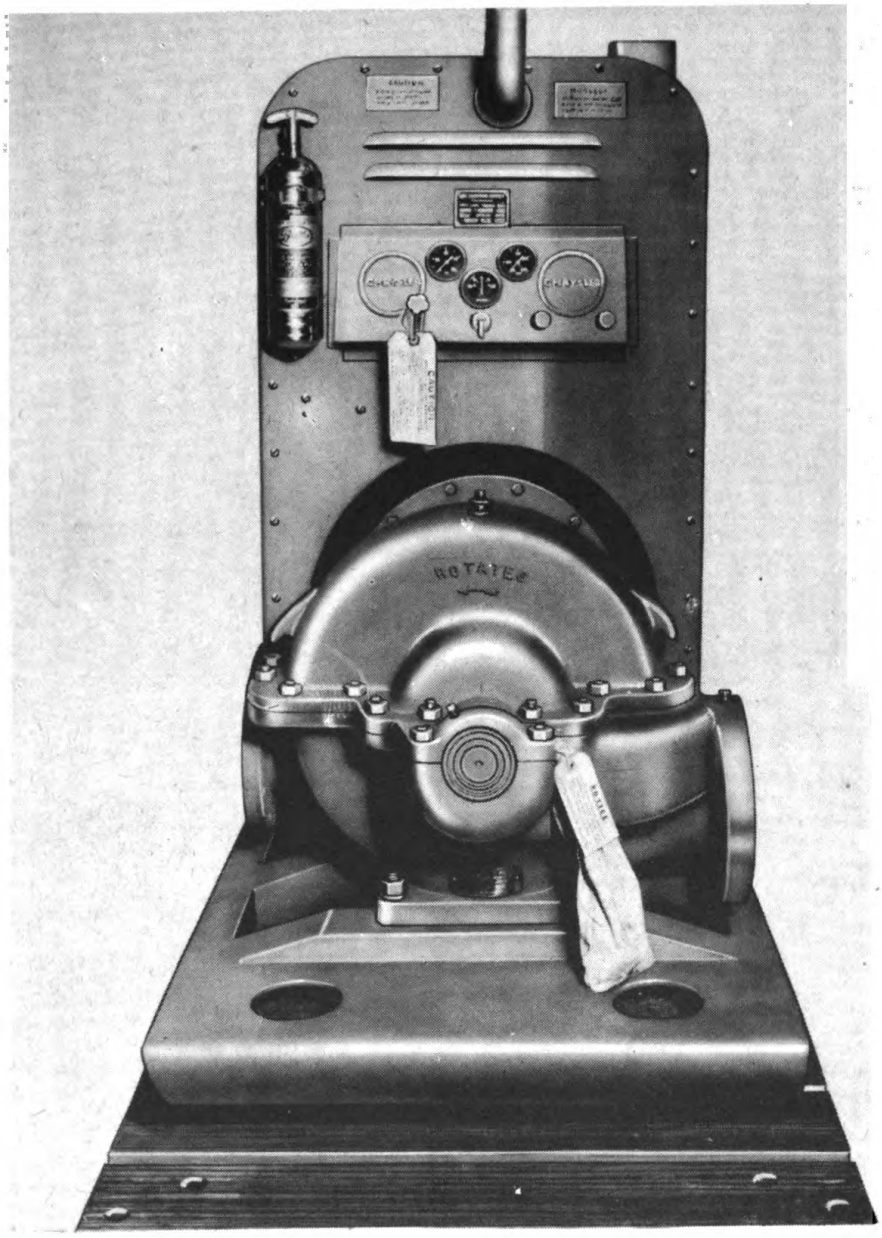


Figure 12—Pump View of Unit

fore testing. Remove the battery from the equipment and neutralize acid spillage by cleaning the case with a solution of eight ounces of soda or one pound of baking soda, per gallon of water. Never use hot water or steam. Make sure that cleaning solution does not enter battery.

SECTION V
INSTALLATION INSTRUCTIONS

9. GENERAL.

a. **Location.**—Locate pump in place that is easily accessible for regular inspection during operation. Pump should be placed as near to liquid supply as possible so as to make suction pipe short and direct. Ample head room should be allowed for a crane, hoist or tackle, if required for servicing. If the unit is placed in a pit, the pump should be safeguarded against floods.

b. **Foundation.**—It is of paramount importance that the unit be placed on good foundation, preferably concrete. Foundation bolts should be placed according to the method shown in figure 13. Pipe sleeves should be about two and one-half diameters larger than the size of the anchor bolts being used.

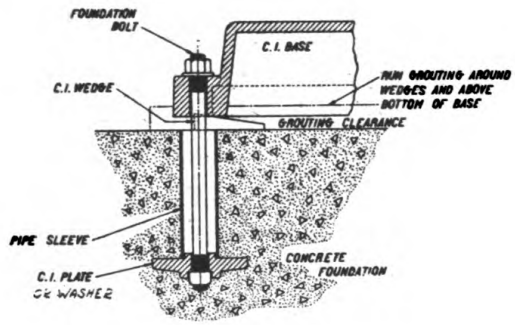


Figure 13—Foundation

c. **Alignment.**—All pumps are properly aligned at the factory by leveling the base, and bringing the pump and driving unit into exact alignment with shims. While not always the case, occasionally bases —no matter how ruggedly constructed—will twist and spring during shipment thus disturbing the original alignment made for the unit. Before starting pump be sure to again check alignment as follows:—

(1) Remove Coupling chain.

(2) Place a straight edge (figure 14) across the face of the teeth of both halves of Coupling Pinions. This should be done at four points on the coupling separated approximately 90 degrees. The distance between the faces of the pinion halves should be checked at four points with a thickness gage.

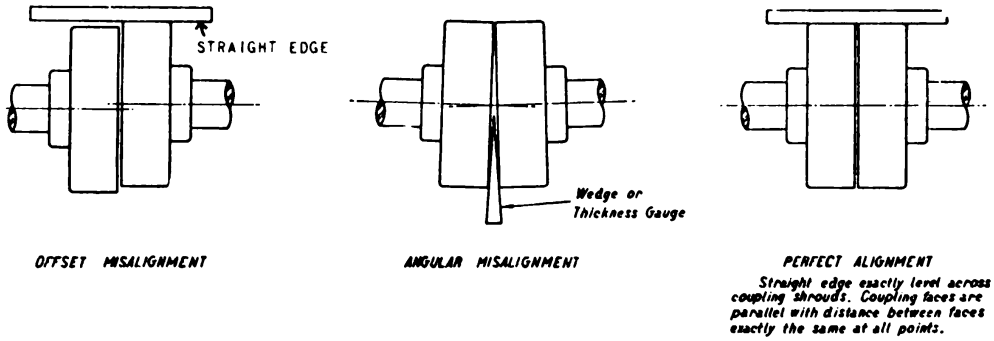


Figure 14—Check Alignment

(3) If unit needs realignment this can be done by placing thin shims under pump or engine as the circumstances require.

(4) After alignment has been accomplished then put on Pinion chain and connect by replacing Chain connecting pins.

d. **Piping.—Connect Pipe Lines.** Pipes must line up naturally. Do not force them into place with flange bolts for this may draw the pump unit out of alignment. Pipe should be supported independently of pump so as not to put any strain on the pump casing. After the piping has been installed alignment of the unit should be checked again and if necessary correction made. For unusually long discharge lines a packed slip joint should be provided to compensate for elongation of the pipe due to pressure. Also, when piping is subject to temperature change it should be arranged so that expansion and contraction does not place a strain on the pump casing.

e. **Discharge Piping.**—To protect pump, the gate valve and check valve should be placed between the pump and the gate valve. If reducers are used on discharge side to increase size of discharge piping, they should be placed between check valve and pump. The discharge pipe should never be smaller than the pump discharge end preferably one or two sizes larger.

f. **Suction Piping.**—The suction pipe should be as direct and short as possible. It should be at least one or two sizes larger than the pump nozzle. If changes from one pipe to another are necessary standard ASME suction reducers should be used. Hot liquids must flow to pump suction by gravity. Pipe should be laid out so that air pockets are eliminated. (See figure 15.) The pipe line should be checked for air pockets. To protect pump from being clogged with foreign material, a strainer should be installed at the base of the suction pipe. A foot valve at the end of suction line will keep

DRAWINGS BELOW SHOW CORRECT AND INCORRECT METHODS OF CONNECTING SUCTION LINE TO PUMP

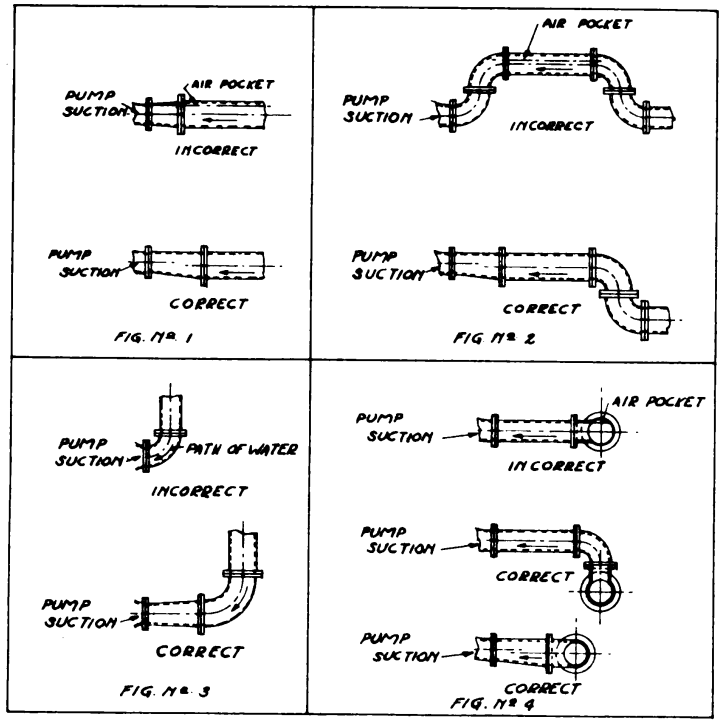


Fig. I shows air pocket formed along upper side of pipe by using concentric increases.
Fig. II shows air pocket caused by overhead loop in suction pipe.
Fig. III shows side connection to pump suction. Use spacer between elbow and pump suction in order that an equal amount of water will enter each side of impeller. Avoids thrust difficulties.
Fig. IV shows proper method of connection pump suction to a suction header in order to avoid air pockets.

Figure 15—Correct and Incorrect Methods of Connecting Suction Line to Pump

the pump primed. Care should be taken with new installation to see that no foreign matter such as chips, cement, rocks, and so forth, are permitted to remain in the pipe or near the entrance as this will cause damage if drawn into the pump.

g. **Final Check on Alignment.**—Check the alignment after the piping has been completed using the straight edge and thickness gage method. As the unit had been aligned before completing the piping, the chances are piping strains are the cause for any misalignment found and changes should be made accordingly. If the stuffing boxes are properly adjusted and the pump and drives properly aligned, the unit can be turned over without difficulty.

h. **Rotation.**—The pump must be run in the direction indicated by the arrow on the casing.

SECTION VI
CONTROLS AND INSTRUMENTS

10. OPERATING CONTROLS.

The operating controls on this unit may be found to the rear of the engine more conveniently called the pump end. They are located on an instrument panel in plain sight and clearly visible. (Figure 16.)

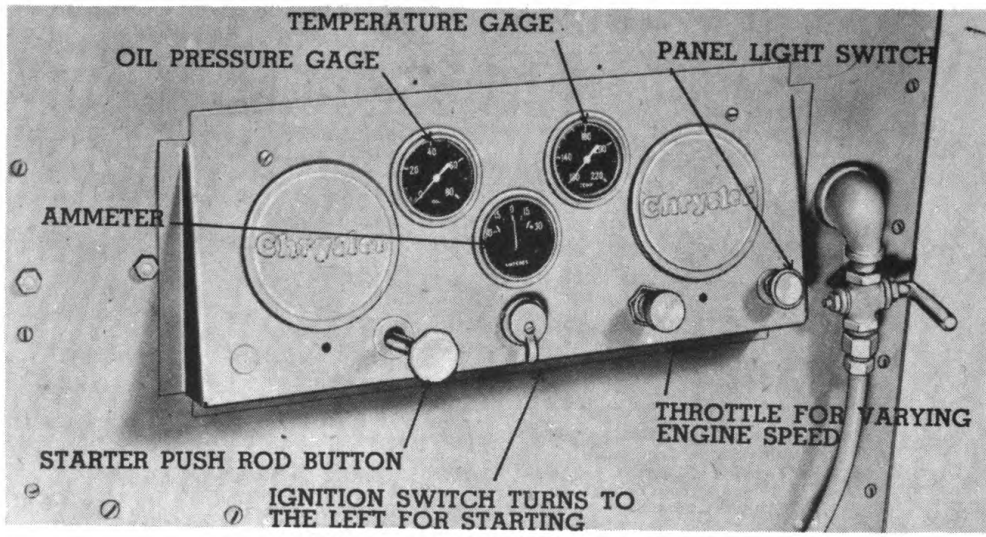


Figure 16—Instrument Panel

In this panel is the temperature gage, oil pressure gage and ammeter. The instrument panel is lit-up with an indirect light and panel light switch will be found in the right hand corner of the panel. The throttle for varying engine speed immediately to the left of the light switch and the ignition switch will be found in the lower center of the panel immediately below the ammeter. The starter push rod button will be found to the left of the ignition switch and is to aid in starting the unit. This engine is equipped with an automatic choke eliminating the necessity for a choke on the instrument panel.

SECTION VII
OPERATION UNDER USUAL CONDITIONS

11. BEFORE STARTING THE PUMP.

a. **Fill the pump with liquid.** (This is called priming.) Before starting the pump the case and suction pipe must be completely filled with liquid for unless this is done the pump will not operate as air will be pumped instead of water. This can be accomplished by filling the casing and suction pipe with liquid. Open the two petcocks (figure 17) at the top of the pump casing in order to release the air which the liquid is displacing in the suction line. After the suction line and pump casing have been filled with liquid no further priming will be necessary and pumping action will be automatic.

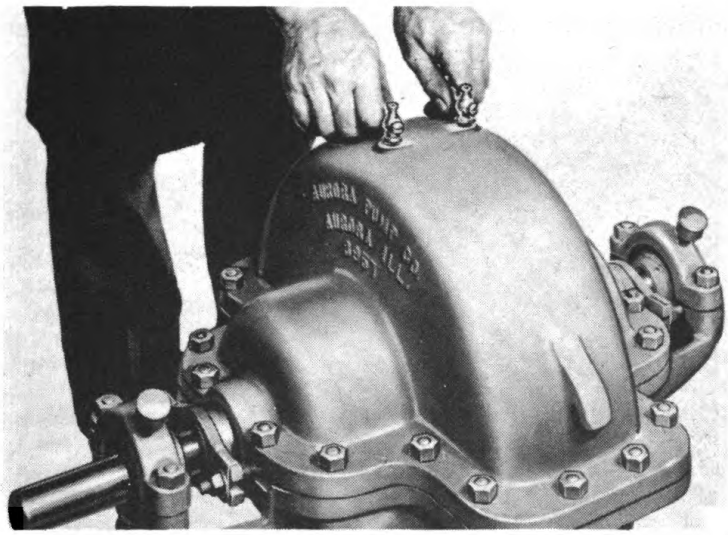


Figure 17—Open Petcocks to Release Air When Priming

b. **Bearing Lubrication.**—It would be impossible to over-emphasize the importance of proper lubrication of the ball bearings in the pump. The grease cup located at top center of the bearing cap, found on both ends of the pump. **Do not use hard, waterproof grease.** To fill grease cup, remove top and fill with grease. Screw top onto bowl securely and turn down as required, thus forcing grease to bearings. See Lubrication Section XVI.

SECTION VIII
PREPARING THE ENGINE FOR SERVICE

12. CARE OF BATTERY.

a. Chrysler engines are properly adjusted and thoroughly tested at the factory and shipped with lubricant in all parts requiring lubrication, except the engine crankcase and the carburetor air cleaner. The battery installed with this unit is shipped dry and it will be necessary to fill the three plate sections with the supply of electrolyte fluid found packed with each unit. This fluid should be brought to above the top of the plates to maintain the correct level. This level should be maintained through periodic checks by adding distilled water. When electrolyte fluid has been added the battery becomes activated and fully charged.

b. Fill the crankcase with engine oil to the level of the oil gage. (Figure 18.) Next fill the fuel tank with gasoline, free from dirt and

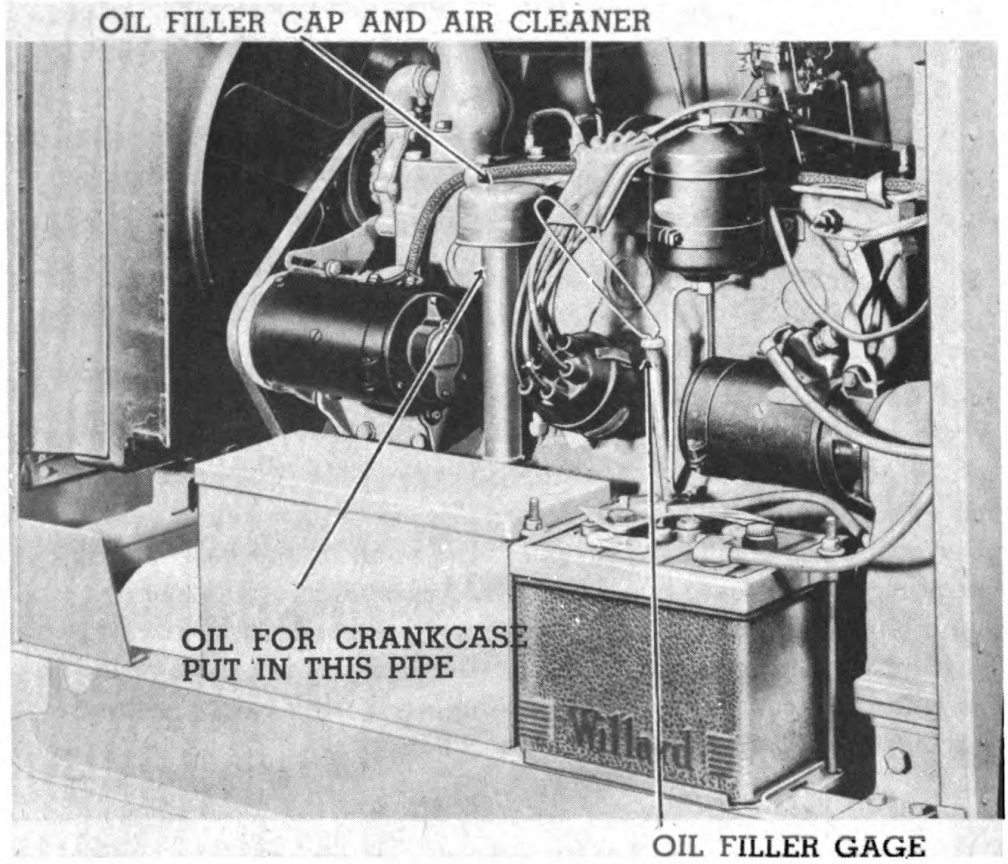


Figure 18—Close Up View Showing Oil Filler Pipe and Gage.

water. Then fill radiator with water until it comes to the top of radiator overflow pipe found immediately under radiator vent cover.

c. Before placing a new engine in service or one that has been in storage, careful attention should be given to the following points:

(1) See that the engine shows no signs of damage resulting from transit or storage.

(2) That all mechanism, control rods, and so forth, are free and operate properly.

(3) That the engine oil pan contains a sufficient amount of engine oil of the recommended viscosity. Check oil level with indicator located on distributor side of engine.

(4) Be sure the oil pump is functioning. This can be checked after the engine is started by noting the oil pressure gage.

(5) That all other points requiring lubrication are supplied with the proper lubricant.

(6) That the cooling system is filled with clean water and, in cold temperatures, with sufficient anti-freeze solution.

(7) That the air cleaner is filled with oil. Refer to Lubrication Section XVI for recommendations.

(8) That all electrical connections are properly and securely made.

SECTION IX
HOW TO START THE ENGINE

13. STARTING ENGINE.

a. The necessary starting mechanism will be found on the pump end of the unit immediately above the flexible coupling. (Figure 13.) To start the engine turn ignition switch to the left and push in starter push rod button. This operation turns the starting motor, engaging starting mechanism. Use the same principle in starting the engine on this unit as you would employ in starting your own automobile. Do not hold starter push rod button down and grind the starting motor for a long period of time. This not only runs the battery down but if the engine fails to start it would indicate that something is wrong.

b. If starting is not accomplished in the first few revolutions, release handle and repeat operation. This engine is equipped with an automatic choke in the same manner as modern automobiles and if starting in cold temperatures seems sluggish, by working the throttle three or four times the action serves as a booster pump to increase the flow of gasoline. Care should be exercised in this operation lest you unintentionally flood the carburetor and impede starting. **This applies to cold temperature starting only.** Throttle priming should not be used in warm or normal temperature conditions.

c. This unit is equipped with a crank handle which will permit turning the motor over by hand should starting apparatus fail to function.

SECTION X
HOW TO STOP THE ENGINE

14. STOPPING ENGINE.

To stop the engine the ignition switch should be moved to the right, to a neutral position, and the engine will come to a complete stop. Normally, it is advisable before stopping to allow engine to run at idle for two or three minutes to avoid boiling over of radiator.

SECTION XI
COOLING SYSTEM

15. GENERAL.

a. The engine cooling system consists of radiator, cylinder water jacket, engine water pump, fan and thermostat. The engine water jacket extends the full length of the cylinder block. Water is forced by the pump through a distributing tube directly around the exhaust valve seats. The engine water pump is of the centrifugal type, mounted on the front on the cylinder block and carrying the fan on the outer end of the shaft. It is driven by the same V-belt that drives the fan and generator.

b. Engines operating where there is a danger of the cooling solution freezing should be protected by the addition of a suitable anti-freeze preparation to the cooling system. Generally, the recommendations of the manufacturer of the anti-freeze preparation selected, as they apply to the ratio of water and anti-freeze for the prevailing temperature, may be followed with assurance of adequate protection. It is advisable, however, to insure against damage from freezing through a sudden or unexpected drop in temperature by making the anti-freeze solution strong enough to withstand such an emergency.

CAUTION

Anti-freeze preparations containing salt, calcium chloride, soda, sugar or mineral oils should never be used.

c. To drain the cooling system, open drain cock at base of radiator and open the drain cock at base of cylinder water jacket, cock located on the distributor side of engine forward of distributor.

SECTION XII
COLD WEATHER OPERATION

16. OPERATING IN COLD WEATHER.

When operating at temperatures below freezing (32°F.), special precautions should be taken. The cooling system should be filled with a suitable anti-freeze solution. For special lubricants suitable for low temperature operation, refer to Lubrication Section XVI of this manual. Water in the fuel will cause trouble by freezing in the fuel lines of carburetor. Water can be removed from the fuel by straining through chamois. Keep the fuel lines and fuel pump sediment cup clean.

SECTION XIII
HOT WEATHER OPERATION

17. OPERATING IN HOT WEATHER.

When operating in abnormally high atmospheric temperatures, special precautions should be taken. Insure maximum circulation of air around engine by removing hood side panels. Operate at as low engine speed as possible. When finished operating, run the engine at idle speed for at least two or three minutes in order that head dissipation will be even and to avoid boiling after the engine is stopped. For special lubricants suitable for high temperature operation, refer to Lubrication Section XVI.

SECTION XIV
DEMOLITION

18. GENERAL.

Destruction must be as complete as the available time, equipment and personnel will permit. Destroy the same parts on all identical units of equipment, to prevent salvaging from one unit to be used on another unit. If thorough destruction of all parts cannot be completed, the most important features of the equipment should be destroyed, and parts essential to the operation or use of the equipment and which cannot be easily replaced, should be ruined or removed.

19. WHY.

To prevent the enemy from using or salvaging this equipment for his benefit.

20. WHEN.

Upon orders of the Commanding Officer.

21. WHERE.

If possible, upon a highway or air field runway, to obstruct enemy advance.

22. HOW AND WHAT TO DESTROY.

a. The method of demolishing must be determined by material and time available.

b. Method No. 1. By explosives.

(1) Remove and empty fire extinguishers.

(2) Puncture fuel and oil tank.

(3) Place a 2-pound charge of TNT on cylinder head.

(4) Place a 2-pound charge of TNT on pump casing next to shaft.

(5) Cut all hose and douse with gasoline, ignite.

(6) Ignite a M14 incendiary grenade under each tire or douse with gasoline and ignite.

(7) Insert tetyrl nonelectric caps with at least five feet of safety fuse in each charge placed.

(8) Ignite the fuses and take cover.

(9) Elapsed time of two to three minutes if charges are prepared before hand and carried with the equipment.

b. Method No. 2. By gun fire or grenades.

(1) Remove and empty fire extinguishers.

(2) Puncture fuel and oil tank.

(3) Fire upon the equipment with artillery, 50-calibre machine gun, rifle, rockets or grenades, first at the engine main cylinders, carburetor magneto, pump casing gear case, eccentric, tires, and at the diaphragm on a diaphragm pump.

(4) Cut all hose and douse with gasoline, ignite.

(5) Douse tires with gasoline, ignite or use M14 incendiary grenade.

(6) About three to five minutes of concentrated fire on this equipment should destroy it beyond use.

c. Method No. 3. By sledge hammer, axes, pick axes, crowbars or other heavy tools available.

(1) Remove and empty fire extinguishers.

(2) Puncture fuel and oil tank.

(3) Cut all hose and douse with gasoline; then ignite.

(4) Smash engine cylinder head, cylinders, crankcase, pump casings, gear cases, eccentric, carburetor, magneto and pump casing.

(5) Cut through fabric on all tires, douse each tire with gasoline, and ignite.

(6) If time permits, bury or scatter all pieces.

(7) The time required will depend upon tools available.

PART THREE
MAINTENANCE INSTRUCTIONS

SECTION XV
GENERAL DESCRIPTION

23. SCOPE.

Part three contains information for the guidance of personnel of the using organizations responsible for the maintenance (1st and 3d Echelon) of this equipment. It contains information needed for the performance of the scheduled lubrication and Preventive Maintenance Services as well as description of the major components and the functions.

SECTION XVI
LUBRICATION

24. GENERAL.

a. **Recommended Lubrication.**—Proper lubrication is of vital importance to obtain the maximum standard of performance and to prevent premature wear of moving parts. Careful attention to the lubrication recommendations contained in the Lubrication Order will reduce operating maintenance to a minimum. All lubrication recommendations are based on War Department standards as recommended by the Corps of Engineers.

b. **Pump Bearings.**—It would be impossible to over-emphasize the importance of proper lubrication of ball bearings in the pump. If too much grease is forced to the bearings they will run hot. Ordinarily an inexperienced operator would add more grease at this point with the result that the bearings can get extremely hot and become damaged. The natural condition of these bearings are to run only slightly warm to the touch of the hand. To add grease, the bearing caps on both ends of the rotating element should be given a slight pressure turn. To fill the greasecup use a knife or spatula. Never use a grease, or pressure gun for this operation.

WAR DEPARTMENT LUBRIC
WAR DEPARTMENT WASHINGTO

PUMP, CENTRIFUGAL, GASOLINE ENGINE-DRIVEN, BASE-MC
(LEFF, MODEL AURORA AD2,) CHRY

MFR'S SERIAL NO. LOCATED ON DISTRIBUTOR SIDE OF ENGINE, UNDER BEARING BRACKET AN

Clean fittings before applying the lubricant gun. Clean parts with SOLVENT, dry-cleaning or OIL, fuel, diesel. Dry before lubricating. Use of gasoline is prohibited.

Requisition Replacement Orders from A
War Plans Division, War Planning, OCE, F

ILLUSTRATIONS NO. 1 - 2

ILLUSTRATION NO. 3

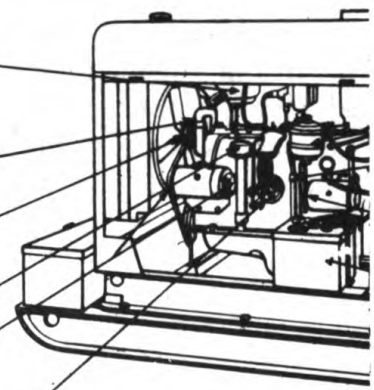
ILLUSTRATION NO. 4

ILLUSTRATIONS NO. 5 - 6

ILLUSTRATION NO. 7

ILLUSTRATION NO. 8

	OPERATING LUBRICANT	HOURS
Air Cleaner (*Check oil level and refill to level mark. Every 64 hours disassemble and clean entire cleaner*)	OE	8
Engine Water Pump Seal (*Front Fitting*)	CG	64
Engine Water Pump Bearing (*Rear Fitting*)	WP	64
Crankcase Breather Cap (*Clean and Oil*)	OE	64
Generator (*2 Oil Cups*)	OE	64
Crankcase Fill (See Key) At very high atmospheric temperature change engine oil after every 32 hours of operation.	OE	
Distributor (*Grease Cup*) (Turn cup down 1 full turn, refill as necessary) Every 256 hours put 2 or 3 drops on the wick under the rotor. Do not over-lubricate. Keep oil or grease away from breaker points.	CG	8



KEY

LUBRICANT	CAPACITY	LOWE
OE—OIL, Engine		Above
Crankcase	5 qts.	SA
Air Cleaner	½ qt.	OE S
Other points		OE S
CG—Grease, General Purpose		CG
OH—OIL, hydraulic		
SA—FLUID, Shock Absorber (Light)		
WP—GREASE, Water Pump (All Temp		
WB—GREASE, General Purpose No.		

* Below 0° F — CRANKCASE. Every with 4 quarts OE-10 and mark new le 1 quart gasoline; run engine 5 minute with OE-10 and to *normal level* with

No. 1113

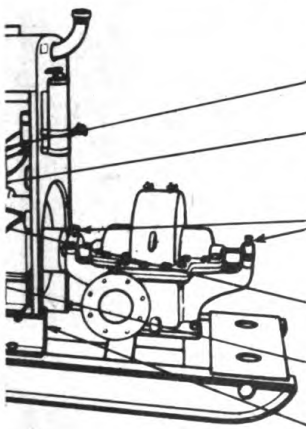
ATION ORDER NO. 1113
N 25, D. C., 20 OCT 1944

)UNTED, 4-IN. DISCHARGE, 480-GPM AT 300-FT HEAD, SLER MODEL T108-503 ENGINE

D ON UPPER PORTION OF INSTRUMENT PANEL. REFERENCE TM 5-2316

Maintenance Publications Office,
P. O. Box 1679, Columbus, Ohio

Hours indicated are actual operating hours for normal service conditions. For extreme conditions of heat, water, and dust change crankcase oil and lubricate more frequently.



OPERATING HOURS	LUBRICANT		
128		Oil filter (*Replace filtering element*)	ILLUSTRATION NO. 9
8		Crankcase Level Gage — Located back of the battery between starting motor and Distributor	ILLUSTRATION NO. 10
8	WB	Pump (*Two grease cups*) — (Turn cup down 1 full turn, refill as necessary)	ILLUSTRATION NO. 11
64	OE	Starter Motor (*1 oil cup*)	ILLUSTRATION NO. 12
64		Battery — Test battery. Fill to proper level with distilled water.	
64		Crankcase Drain (*Drain immediately after operation*). — Drain plug can be reached from manifold side of the engine directly in front of the flywheel housing.	

ST EXPECTED AIR TEMPERATURE		
+32° F	+32° to 0° F	Below 0° F
)E E 30	OE SAE 10	*
AE 30	OE SAE 10	OH or SA
AE 30	OE SAE 10	OESAE10
lo. 1	CG No. 0	CG No.0

eratures)
(All Temperatures)

32 hours drain crankcase, refill vel, then fill to normal level with s to mix. Maintain to *new level* gasoline.

Copy of this Lubrication Order will remain with the equipment at all times; instructions contained therein are mandatory and supersede all conflicting lubrication instructions dated prior to 20 OCT 1944.

By order of the Secretary of War:
G. C. MARSHALL,
Chief of Staff

OFFICIAL:
J. A. ULIO,
Major General,
The Adjutant General

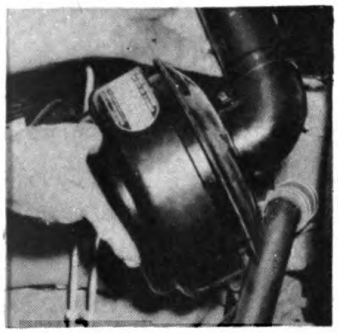
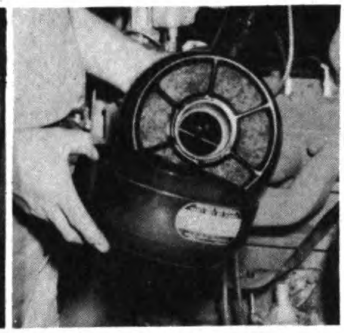


ILLUSTRATION NO. 1



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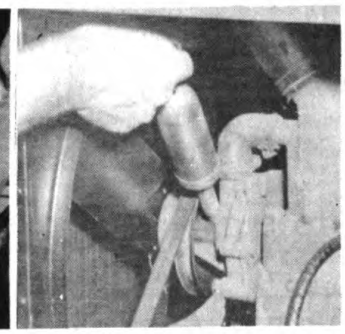

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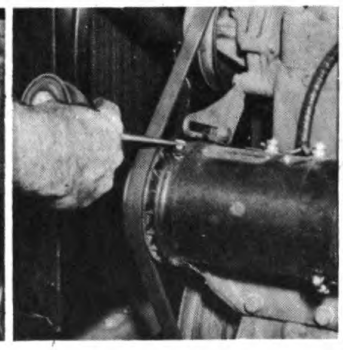

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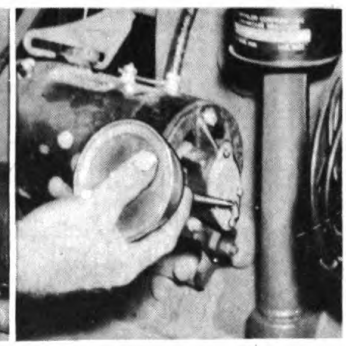

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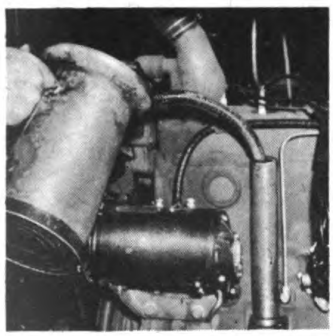

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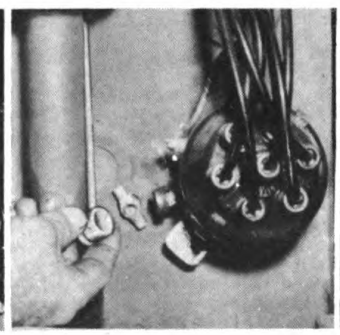

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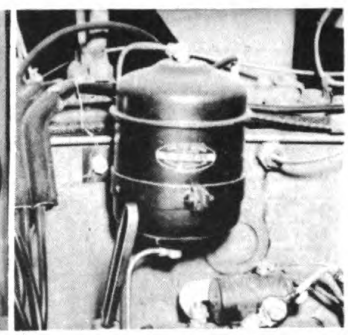

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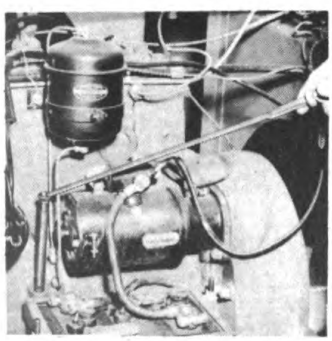

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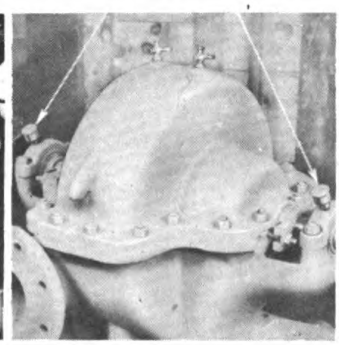

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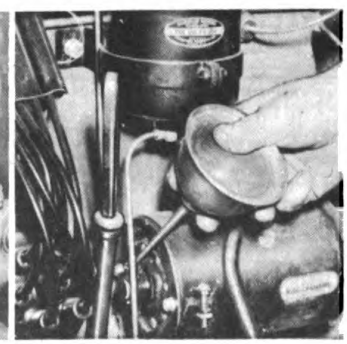


ILLUSTRATION NO. 12

c. **How to Check Oil Level.**—The oil level indicator (Illustration No. 9) located on the left side of the engine, should be withdrawn, wiped clean, inserted into the crankcase and again withdrawn for a reading. The indicator is marked at "FULL" and "HALF FULL". A third marking between "FULL" and "HALF FULL" indicates the "RUNNING LEVEL". The "FULL" mark shows the proper level of oil after the engine has remained idle for a few hours. As soon as the engine is started, the level will drop somewhat due to the filling of oil passages and the filter. Oil should not be added until the level is below "running level". The level should never be allowed to drop below the "half full" mark.

d. **Carburetor Air Cleaner.**—To service the carburetor air cleaner remove wing nut holding air cleaner support bracket to cylinder head. Loosen clamp on air cleaner tube to carburetor. Remove air cleaner; remove wing nut attaching bracket and base to head assembly and remove base. Wash filter in SOLVENT, dry cleaning or OIL, fuel, diesel, and drain, dry with compressed air. Empty old oil from base or reservoir and refill as outlined in the Lubrication Order No. 1113.

e. **Fuel Pump**—To service the fuel pump remove glass bowl sediment trap from fuel pump and remove foreign matter. This is accomplished by loosening the bail nut at the base of the bowl removing the glass bowl, gasket and screen. Clean strainer screen and reassemble.

SECTION XVII
PREVENTIVE MAINTENANCE SERVICES

25. GENERAL.

Preventive Maintenance Services as prescribed by army regulations are a function of using organization echelons of maintenance. Its services consist generally of: before, during and after-operation services and weekly services performed by the operator or crew; the scheduled services (256 hours and 64 hours) performed by organization maintenance personnel.

26. OPERATOR OR CREW MAINTENANCE.

The operator or crew is the most important single factor in preventive maintenance. Only through him can the mechanic know what difficulties a piece of equipment is giving. Each operator is required to perform a certain daily maintenance service on his equipment as a matter of routine service. The faithful performances of these services will do much to prolong the life of the equipment, avoiding major repairs and overhauling by higher echelons. Reference is made to "Preventive Maintenance Services" Engineers Equipment, Technical Manual TM9-2810 and Lubrication Order No. 1113. Numbers 1 to 86 used below refer to WD, AGO Form No. 48.

27. BEFORE-OPERATION SERVICES.

The purpose of these operations is to determine if conditions of equipment has changed since last operated.

a. Item 1, TAMPERING AND DAMAGE.—Check for damage from falling debris, shell fire, sabotage, or collision.

b. Item 2, FIRE EXTINGUISHER.—See that it is full, in proper working order, and securely mounted.

c. Item 3, FUEL, OIL, AND WATER.—Check fuel tanks, see that they are full. Check oil in engines and coolant in radiator. Do not fill radiator (when cold) to overflow; allow room for expansion.

d. Item 4, ACCESSORIES.—See that they are properly mounted, all connections tight, and in good operating condition.

e. Item 6, LEAKS, GENERAL.—Check for fuel, oil, and water leaks and that piping connections are tight.

f. Item 7, ENGINE WARM UP.—Before applying load, allow

engine to warm up at a fast idling speed. **DO NOT RACE A COLD ENGINE.**

g. Item 8, CHOKE.—Use choke to start cold engine. When engine starts, adjust choke until engine runs without missing. Gradually push control button in as engine warms up. Never operate with partly closed choke.

h. Item 9, INSTRUMENTS.—**Oil gage:** After engine warms up oil pressure gage should read 25 to 35 pounds. If pressure drops below 10, stop engine. Locate and correct trouble. **Ammeter:** When engine is running at normal speed, needle should be in "charge range". If needle shows discharge continuously, locate trouble and correct.

i. Item 21, TOOLS AND EQUIPMENT.—Inspect reserve supplies of oil and lubricants, see that they are complete, and emergency equipment, tools, and spare parts are in good condition and in place.

j. Item 22, ENGINE OPERATION.—Check engine for normal operation and note any unusual sounds or unsatisfactory characteristics that would indicate trouble. Check oil pressure again and frequently during operation.

28. DURING-OPERATION SERVICES.

Operator's responsibility is to detect deficiencies in operation, unusual sounds, odors, or other signs of abnormal operation that indicate trouble ahead if not corrected promptly. Report deficiencies that develop during operation on Form No. 48.

a. Item 31, ENGINE AND CONTROLS.—Check engine for power, unusual noise, and response to controls.

b. Item 32, INSTRUMENTS.—Check all gage readings frequently. If oil gage indicator shows an unusual drop or no pressure, stop engine immediately. Engine must not be operated until failure is corrected. Report all irregular gage readings immediately to proper authority.

c. Item 38, FUEL, OIL, AND WATER.—Check for adequate supply of fuel. Check crankcase oil level, add oil if necessary. Check coolant in radiator.

d. Item 48, AIR CLEANER.—If operating under extremely dusty conditions, remove oil bowl, clean, and refill as required.

29. AFTER-OPERATION SERVICES.

The following daily after-operation services are performed by

the operator or crew immediately after the operation period and during continuous operations at 8-hour intervals.

a. Item 54, FUEL, OIL, AND WATER.—(1) Fill the fuel tank. Use only clean fuel. (2) Check crankcase oil level. Fill to full mark.

(3) Check coolant in radiator. Level should be at or near overflow when hot. If contaminated with oil, rust, or dirt, it should be changed. Check anti-freeze value when using. Run engine to thoroughly mix solution if anti-freeze is added.

b. Item 60, FIRE EXTINGUISHER.—Check to see that the fire extinguisher is in good condition and securely mounted. Be sure that the nozzle is clean of any obstruction such as dirt or corrosion.

c. Item 63*, ACCESSORIES AND BELTS.—Check all accessories for proper operation, loose connections, and mountings. Check fan belt for tension (¾ inch slack).

d. Item 64*, ELECTRIC WIRING.—Examine all wiring, see that connections are tight, wires clean, and undamaged.

e. Item 65*, AIR CLEANER.—Remove oil bowl, clean and refill.

f. 66*, FUEL FILTERS.—Check sediment bowl for accumulated dirt. Remove bowl, clean and reassemble.

g. Item 73, LEAKS, GENERAL.—Examine fuel and oil system piping for leaks and loose connections. Check water pump and radiator for leaks.

h. Item 83, LUBRICATE AS NEEDED.—The operator should inspect lubricating points and lubricate if inspection indicates it necessary, Lubricate in accordance with Lubricating Order.

i. Item 85, TOOLS AND EQUIPMENT.—Check all tools and equipment assigned to this unit to see that they are present and properly stowed.

30. DON'TS.

a. Don't attempt to run unit if excessive pounding can be heard. Look for mechanical defects.

b. Don't operate equipment without checking to see that proper lubrication has been maintained.

c. Don't try to make pump adjustments without first shutting off power.

---

*Those items marked by an asterisk (*) require additional weekly services.

d. Don't run unit if excessive vibration is present. Check over installation for possible cause of trouble.

e. Don't operate the pump with a closed discharge without a relief valve.

NOTE

Complete Form 48, Driver's Trip Ticket, and record any worn or damaged parts requiring replacement or repair.

SECTION XVIII
ORGANIZATIONAL MAINTENANCE SERVICES

31. GENERAL.

a. Weekly and monthly "Preventive Maintenance Services" operations below are outlined for use with WD AGO Form 464 Work Sheet for Engineer Equipment.

MAIN ENGINE

Monthly or 256 hrs.	Weekly or 64 hrs.	Operation
16	16	**RADIATOR.** Clean core air passages. Check for leaks. If contaminated with rust, oil, or other foreign matter, flush and refill. Protect coolant from freezing in cold weather. Record value of antifreeze on Form 464.
17	17	**WATER PUMP, FAN, AND SHROUD.** Check pump for leaks. See that fan blades are in good condition and properly aligned. See that shroud is securely mounted.
18	18	**BELTS.** Check fan belt for tension (approximately $^{3}/_{4}$-inch slack). See that it is in good condition. Replace if badly worn.
11	11	**CYLINDER HEAD, MANIFOLD, AND GASKETS.** Check for cracks and leaks. On new or reconditioned motors tighten bolts on cylinder head at first 64-hour check. Preferably by Third Echelon.

Monthly or 256 hrs.	Weekly or 64 hrs.	Operation
12	12	**VALVES.** While engine is hot, check and adjust valves to .008-inch clearance for intake, .012 inch for exhaust. If engine is cold, check and adjust valves to .014-inch clearance for intake, .014-inch clearance for exhaust.
13		**COMPRESSION TEST.** Test all cylinders and record on Form 464.
14	14	**CRANKCASE, BREATHER.** Drain crankcase and refill at intervals specified on Lubrication Order No. 1113 while engine is still warm. Wash filler cap breather before replacing.
15	15	**OIL FILTER.** Drain filter housing, remove element, flush housing with fuel oil or solvent, renew element, reassemble filter, check for leaks.
43	43	**FUEL TANK, CAP AND GASKET.** See that tank is in good condition and securely mounted. Clean filter neck and cap. See that vent hole is open, all fuel lines are in good condition, and connections tight.
41	41	**AIR CLEANERS.** Remove and wash element. Clean oil bowl and refill. See that unit is securely mounted and all connections tight.
38	38	**FUEL PUMP.** See that it is securely mounted and all connections tight. Remove and clean sediment bowl.
39	39	**CARBURETOR AND LINKAGE.** See that unit is securely mounted. Check all connections with a few drops of oil.
47	47	**BATTERY.** Clean battery and cable terminals with brush and dampened cloth, apply thin film of general purpose grease over terminals, check solution with hydrometer and record on Form 464 add distilled water if required, keep caps tight and vent holes open.

Monthly or 256 hrs.	Weekly or 64 hrs.	Operation
48	48	**GENERATOR AND STARTER.** Examine all wiring, see that connections are tight, wires clean, and undamaged. Check mounting bolts on starter.
48		Check starter and generator commutator and brushes for wear or surplus oil deposit. Clean commutator. Use No. 00 sandpaper if necessary. Replace brushes if badly worn or broken.
49		**DISTRIBUTOR OR MAGNETO.** Check distributor breaker points. Adjust to .020-inch clearance.
46	46	**SPARK PLUG.** Remove and clean plugs and adjust points to .025 inch. Replace if broken or damaged.
50		**COIL, WIRING, SWITCHES.** See that all mounting and connections are tight, wires clean, and switches in good condition.
29	29	**CRANKCASE.** See that crankcase oil is level with filler plug opening. (Drain and change oil at intervals specified on Lubrication Order No. 1113.)
32	32	**FUEL PUMP.** Clean sediment bowl, check fuel lines and connections for leaks.
26	26	**AIR CLEANER.** Clean and refill cup.
		MAIN ASSEMBLIES
80	80	**FRAME.** Check for cracks or breaks. TIGHTEN BED BOLTS.
84	84	**PUMP.** (a) Check for leakage at gasket points between shell halves. Tighten nuts holding two halves in place. (b) Check for excessive leakage at packing gland and repack if necessary.
		GENERAL
2	2	**LUBRICATION.** Perform all lubrication services as required by the Lubrication Order at

Monthly or 256 hrs.	Weekly or 64 hrs.	Operation
		the time of inspection. Make certain all fittings are clean and bearings are taking grease.
4	4	**FIRE EXTINGUISHER.** See that it is full, in proper working order, and securely mounted.
3	3	**TOOLS AND EQUIPMENT.** Check and clean all tools. See that they are properly stored. Clean reserve supplies of all fuel and lubricants. See that cans are in good condition and that caps fit tightly.
5	5	**PUBLICATIONS.** See that Technical Manual, Lubrication Order and Form 26 are on the machine.

SECTION XIX
SERVICE ADJUSTMENTS

32. PACKING SHAFT.

Pumps are packed and lubricated ready for use. Should excessive water seepage show a leak around the shaft, this can be taken up by the addition of additional packing without disassembling the pump. The packing used is for gasoline or clear cold water, long fibre asbestos, square braided, and well impregnated with oils and graphite. These are held in position by means of a

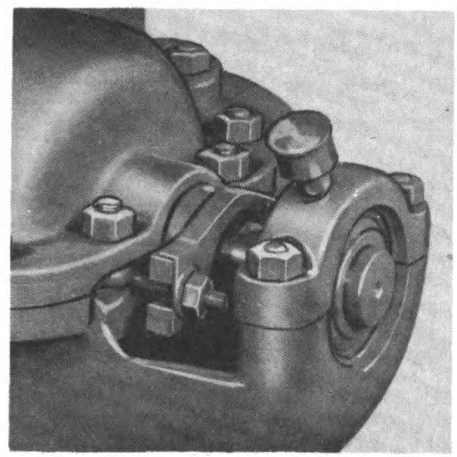


Figure 19—Packing Gland held in Position by Means of a Nut and Washer

divided packing gland clamped in position and drawn tightly by means of a nut and washer. (Figure 19.) To repack the packing in the coupling side the following procedure is outlined: Release the nuts holding the packing gland in position and remove the packing. This can be done by means of a hook wire or screwdriver. The lantern ring may be caught with the wire hook in two small grooves on the outer diamater. After the packing has been removed, cut the new packing to proper length so that it will lap around the shaft leaving about one-eighth inch of opening between ends. Insert two rings of packing in front of lantern ring, slide lantern ring and packing in place and proceed to pack the box, taking care to overlap the ends so that packing will bind on each other. Pressure with the hand and fingers should be sufficient to push the rows of packing in place. If it is not, either the packing is too large or some obstruction exists. If the packing is uneven, an extra ring is placed on outside of water-seal. After all rings are placed, glands are returned into position and inserted into stuffing box tight enough to permit just a few drops of water to drip out per minute. This slight amount of water lubricates the packing and shaft. The opposite packing box has no lantern ring so it can be packed to full depth.

33. MINOR TUNE-UP PROCEDURE.

a. This tune-up procedure should be performed frequently in order to maintain the standard of performance originally built into the engine. If the engine performance indicates the need for further inspection or adjustment after doing the following work, the "Performance Inspections" should be made.

b. Clean the spark plugs by sand-blasting and wiping off porcelain. Adjust the points to .025-inch gap, using a round feeler gage. Too wide a gap reduces power; too narrow a gap causes uneven engine idling.

c. Adjust distributor breaker points to open .020 inch. (Figure 20.) Check distributor cap and rotor for cracks and corrosion. Inspect the small lead wires for breakage or damaged insulation. Check for excessive play in distributor vacuum advance plate bearing.

d. Using the timing marks on the crankshaft pulley or a timing indicator over number six cylinder, set the timing so that the breaker points open at top dead center.

NOTE

This timing has been established for regular grade gasoline of approximately 70 octane rating.

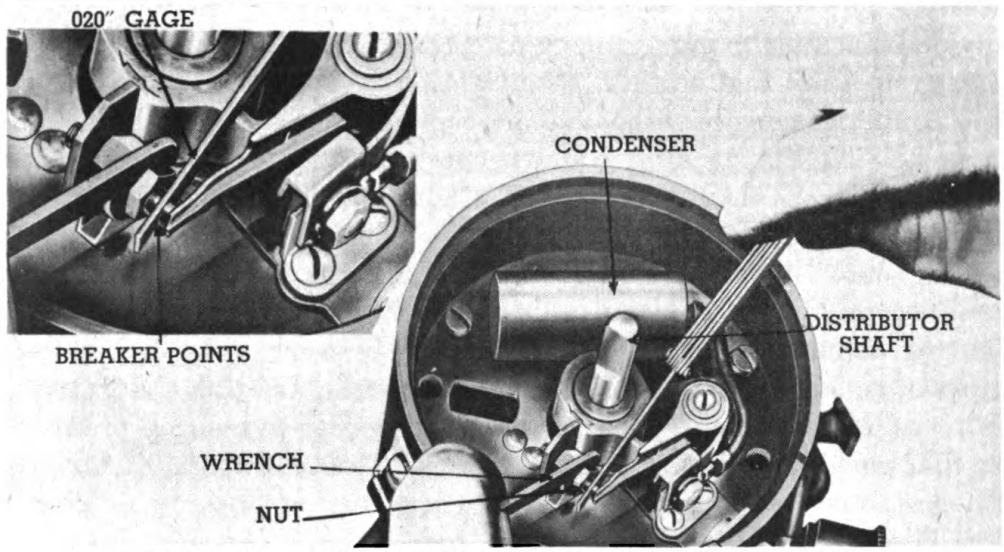


Figure 20—Adjusting Distributor Points .020 Inch Gap

e. Clean and oil the carburetor air cleaner. Clean the fuel filter bowl and screen. Replace the bowl gasket. Then set the carburetor idle mixture adjustment to a point where engine runs smoothly at idle speed.

f. Inspect primary and high tension wires for poor insulation or connections and tighten as required.

34. PERFORMANCE INSPECTIONS.

a. **General.**—When making a complete engine analysis in order to determine the cause of improper engine performance, or when performing a major tune-up, the following inspections should be made, using suitable testing equipment:

b. **Check Battery and Line Voltage**—(Figure 21.) The battery is the source of electrical energy for starting the engine. The amount of charge to the battery is governed by the regulator unit which, in turn, functions according to the state of charge of the battery. Excessive voltage will cause distributor points to burn and cause hard starting. The voltage should be checked at the battery terminal of the voltage regulator with an accurate voltmeter.

c. **Vacuum Test**—The vacuum test will reveal many causes of unsatisfactory engine performances. The following conditions affect vacuum readings: Improper carburetor adjustments; improper valve timing; burned, riding or sticky valves; loose valve guide and weak springs; leaky intake manifold and carburetor gaskets; improper piston ring seal. A steady reading of eighteen to twenty inches of

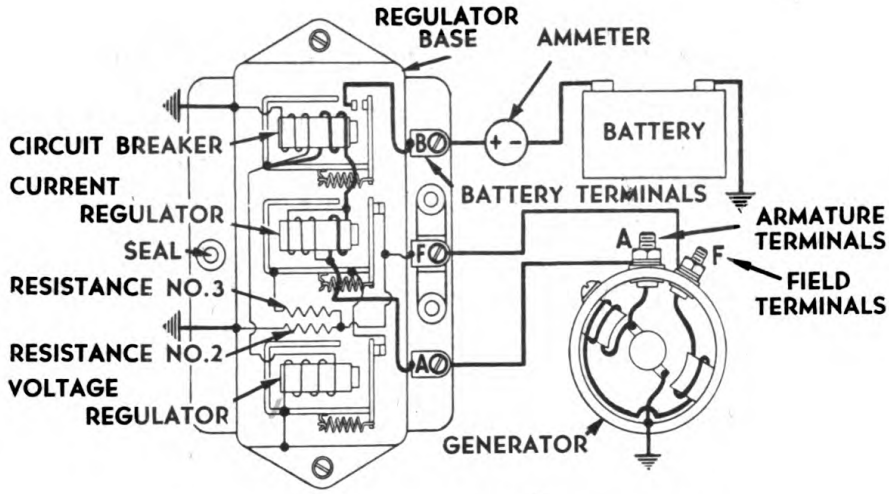


Figure 21—Diagram of Voltage Regulator

vacuum up to 1000-foot altitude indicates normal performance at idling speed. Most manufacturers of vacuum gages publish complete instructions for interpreting vacuum gage readings.

d. **Compression Test**—Compression should be tested while cranking the engine with the starter, all spark plugs out and the throttle wide open. Compression pressure depends upon cranking speeds, engine temperature and compression ratio. If the reading is reasonably high and uniform, not varying more than ten pounds between cylinders, the compression pressure may be considered normal. If the compression test shows an abnormal condition, it may be advisable to make an internal inspection of the valves, pistons, rings, and so forth. An extremely low reading in two adjacent cylinders might indicate a blown out cylinder head gasket.

e. **Condenser Test**—The condenser may be tested without removing it from the distributor by using an accurate condenser tester. A defective condenser may cause burning of the breaker points which, in turn, will affect the performance of the engine.

f. **Coil Test**—The ignition coil transforms battery voltage into high voltage for the spark plugs. In order to test the coil, an accurate coil tester is required. Most up-to-date equipments permit testing the coil without removing it.

35. MAJOR TUNE-UP PROCEDURE.

a. A major tune-up, consisting of the "Performance Inspections"

and the "Minor Tune-up" plus the following operations may be required to bring about standard engine performance.

b. Clean and test battery. Clean the top of battery and battery connections with water and brush if necessary, and wipe with a dry cloth.

c. Tighten terminal bolt and ground wire connections to engine.

d. Tighten battery hold down clamps bolts.

e. Check the condition of the battery with the battery hydrometer.

f. If the battery is run down or dead replace it with a battery that is fully charged.

g. Tighten all primary and high tension wire connections.

h. Service carburetor air cleaner. Clean the element of the carburetor air cleaner with a SOLVENT, dry cleaning, and compressed air and refill. (Figure 22.) See Lubrication Section XVI.

i. Tighten cylinder head and manifold nuts and oil pan capscrews.

j. Tighten the cylinder head stud nuts with a torque wrench to 52½- to 57½-foot pounds and the capscrews to 65- to 75-foot pounds.

k. Tighten manifold to block stud nuts, carburetor to manifold stud nuts, and oil pan cap screws.

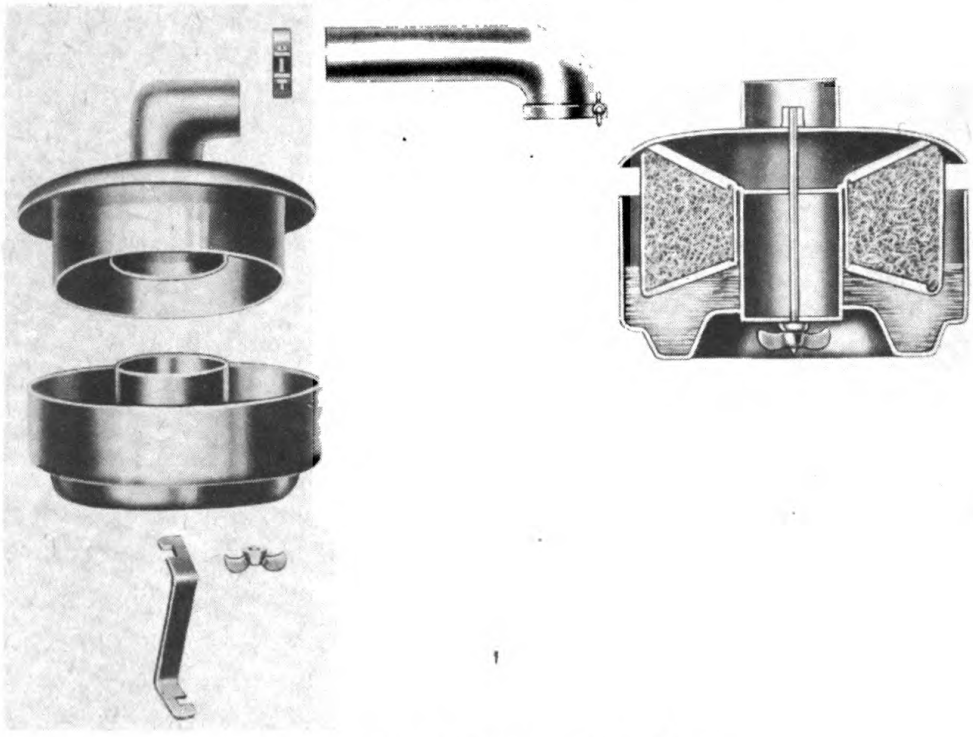


Figure 22—Carburetor Air Cleaner

36. TO ADJUST VALVE TAPPETS.

Run the engine until normal operating temperature is reached, then with the engine running at idling speed, hold tappet from turning and adjust the seal lock adjusting screw until a .008-inch feeler gage will go between the adjusting screw and the end of the inlet valve stem, and on the exhaust valve tappets. (Figure 23.)

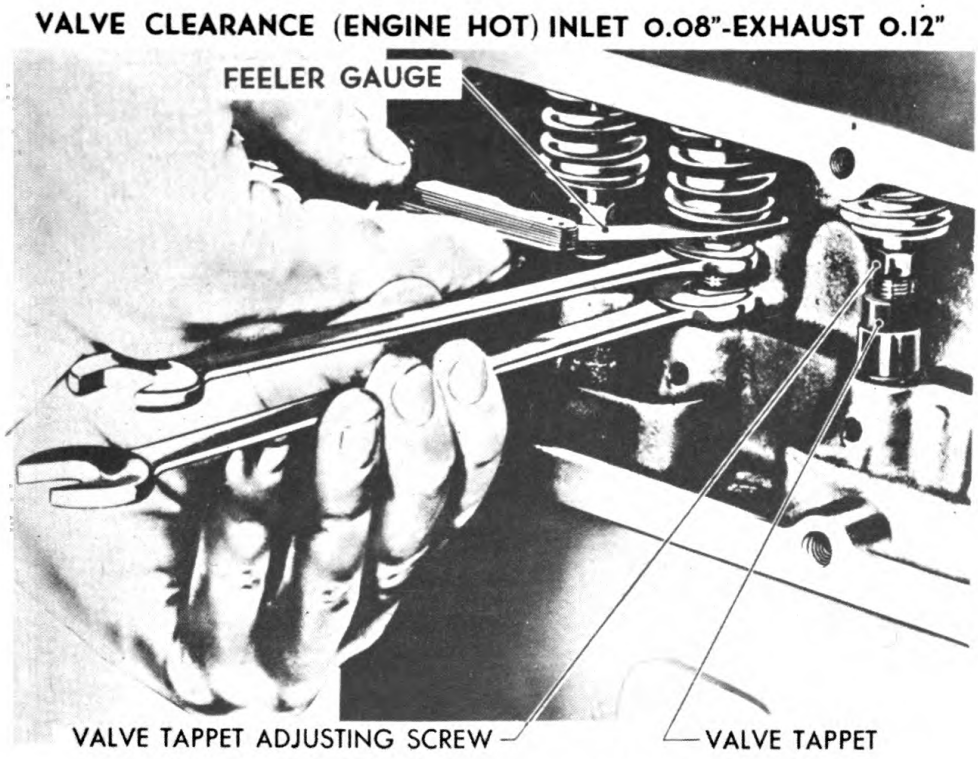


Figure 23—Valve Tappet Adjustments

37. TO TEST COMPRESSION.

Run the engine long enough to establish normal operating temperature. Remove all spark plugs and install compression gage in the spark plug hole of one cylinder. (Figure 24.) With the throttle wide open, crank the engine with the starter until maximum compression is registered on the gage. Record the reading for that cylinder and repeat the test on the other five cylinders. Compression pressure depends upon cranking speeds, engine temperature and compression ratio. If the reading indicated by the compression gage is reasonably high (90 to 110 pounds) not varying more than ten pounds between cylinders, the compression pressure can be considered normal. If the pressure in any cylinder is weak, inject oil in

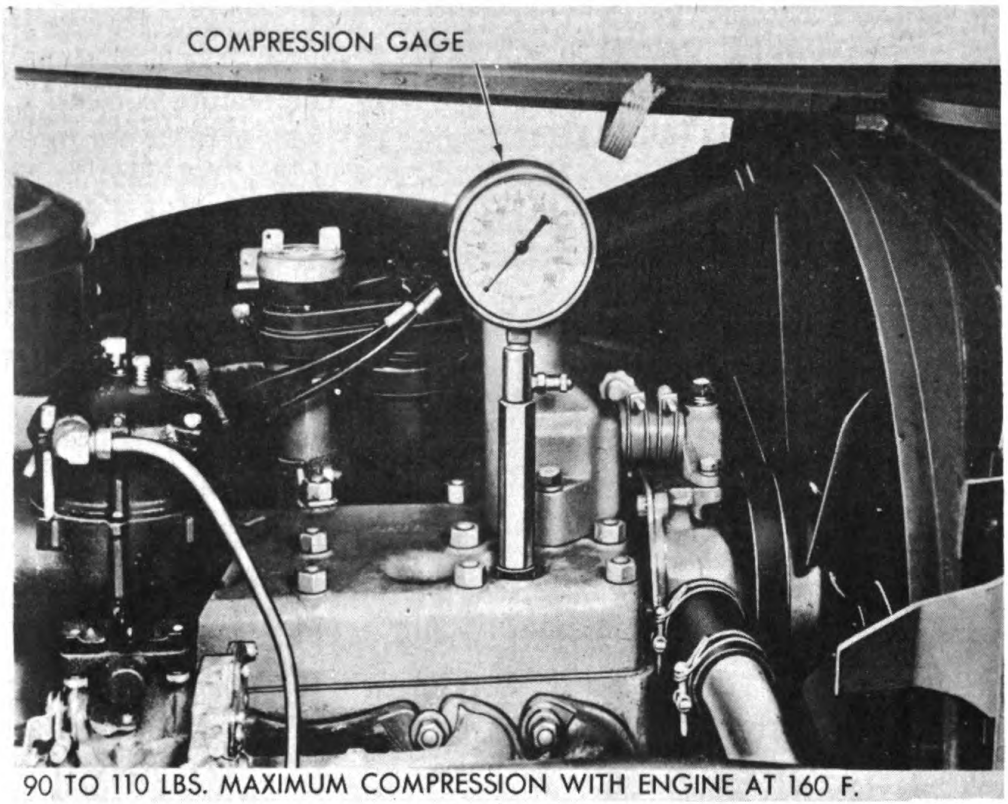


Figure 24—Compression Test

spark plug hole on top of the piston with piston down. Wait a few minutes for oil to run down over rings, to prevent oil getting on valves and repeat compression test. The oil seals the rings so that a low reading on the first test, which remain low on the second test, indicates leaky valves. A low reading on the first test, which becomes a high reading on the second test, indicates leaky rings. If either condition exists, grind the valves or replace the piston rings. An extremely low compression reading on two adjacent indicates a leaking cylinder head gasket. A gasket which has blown out between cylinders will cause erratic explosions between the two cylinders. Replace gasket.

38. SERVICE IGNITION SYSTEM.

Make ignition circuit tests. Wipe all dirt or oil off distributor cap and rotor and inspect the cap and rotor for cracks or damage.

39. TIMING SPECIFICATIONS.

In low altitudes, gasoline of 70 octane rating will give best engine performance with timing set at top dead center. When using lower grade fuels, or after carbon has accumulated, spark ping may

be excessive with the engine timed at top dead center. In such cases, retard the timing not to exceed four degrees after top dead center. In high altitudes there is less tendency for spark ping, and the same thing is true in low altitudes when using fuel with a higher octane rating than 70. In such cases, improved performance may be obtained by advancing the spark not to exceed two degrees before top dead center. Within the fore-going limits (two degrees before top dead center to four degrees after top dead center), a good rule to follow is to set the ignition timing at a point where a slight ping is audible when accelerating from low speed with wide open throttle.

40. HOW TO ADJUST IGNITION TIMING.

Connect one head from the timing light to number one spark plug and the other lead to a convenient ground. Place a chalk mark (figure 25) on crankshaft pulley and timing gear cover at desired setting and run engine at idling speed. Loosen the major adjustment lock screw and rotate distributor body clockwise to retard and counterclockwise to advance ignition timing. Point the neon light at the chalk mark on pulley. The neon light should flash when the chalk mark is opposite the mark on timing gear cover, indicating correct

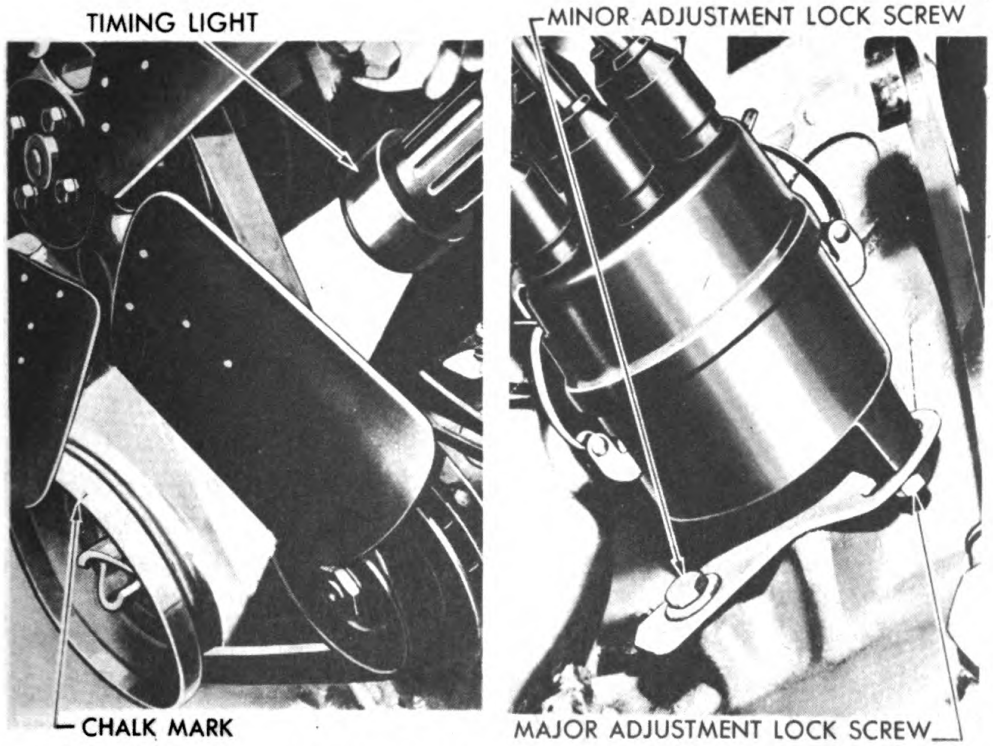


Figure 25—Timing Adjustments

setting of ignition timing (position of piston when firing occurs). To make a minor change in ignition timing, loosen the minor adjustment lock screw and rotate the distributor body slightly in the proper direction.

41. CLEAN, TEST AND ADJUST SPARK PLUGS.

a. Remove spark plugs from engine and wipe exterior of plugs clean and dry. Clean the plugs and inspect for mechanical defects. Reset gap to 0.025 inch and test in tester before installing in engine. Use round feeler gage and make all adjustments on the side wire of the plug. (Figure 26.) If the center electrode is bent, the porcelain

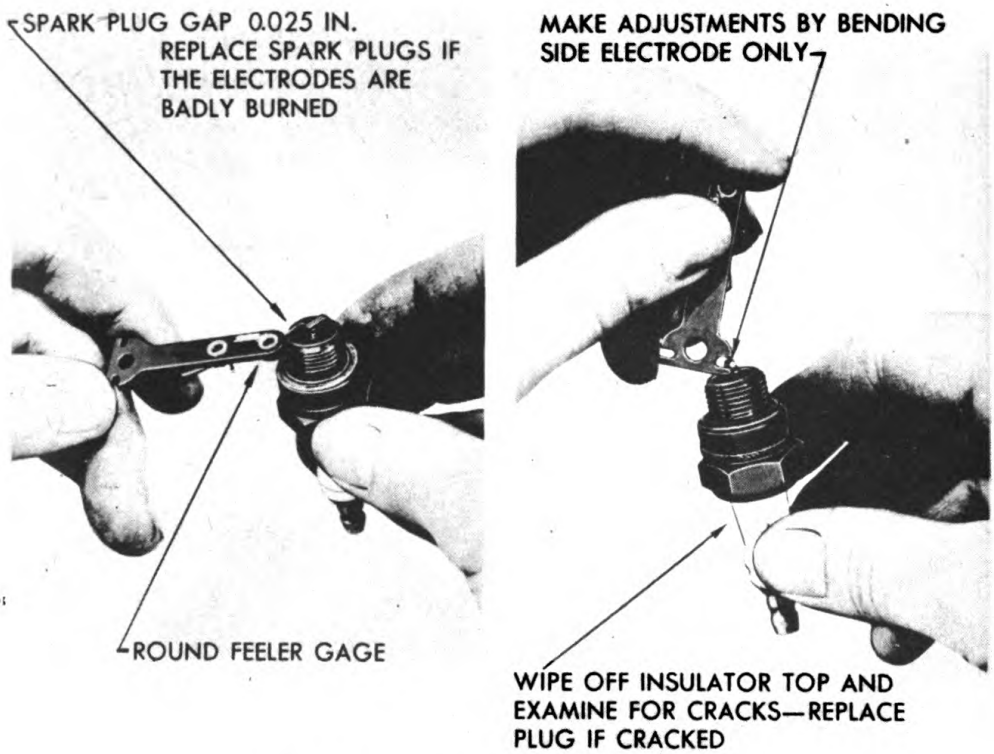


Figure 26—Spark Plug Adjustments

may crack, resulting in plug failure. Install plugs that test satisfactorily and replace those that do not. When installing spark plugs, use a new gasket and tighten them with a tension wrench to 26- to 32-foot pounds.

b. Check the carburetor float level. It should be 5/64 inches from the top of the float chamber (gasket removed) to the top of the float. Bend the float arm to obtain the correct position.

SECTION XX
TROUBLE SHOOTING

PUMP

Possible Causes	Reason
If no Water is Delivered.	1. Speed of engine too low. 2. Discharge head too high. 3. Suction lift too high.
If not Enough Water is Delivered.	1. Air leaks in suction line connection. 2. Speed too low. 3. Suction lift too high. 4. Strainer not immersed deeply enough.
Not Enough Pressure. Pump Works for Awhile and Then Quits.	1. Speed too low. 2. Leaky suction line. 3. Carburetor or distributor trouble. 4. The strainer may be clogged with foreign matter.

ENGINE

If Engine Stops or Fails to Start.	
1. No contact at ignition switch.	1. Turn on ignition switch and check for loose wires.
2. Moisture, dirt or oil in distributor cap.	2. Clean distributor cap and points.
3. Burned points.	3. Replace points and set to proper clearance.
4. Shorted condenser.	4. Check and replace.
5. Broken pig tail wire in condenser.	5. Replace condenser.
6. Broken insulation on large wire running from coil to distributor cap.	6. Replace wire.
7. Cracked distributor cap or rotor.	7. Replace.
8. Ignition coil defective.	8. Check coil. To do this, turn ignition switch on and pull

Possible Causes	Reason
	large wire running from coil to distributor out of the center of distributor cap and hold end of wire about ¼ inch to ½ inch from cylinder block while engine is being cranked. If coil is functioning properly, a spark will jump ¼ inch to ½ inch from wire to block. If coil proves defective, replace.
9. No fuel entering the cylinder.	9. Check to see if fuel is reaching carburetor. To do this, remove air cleaner and work throttle noting if fuel enters throat of carburetor.
If Fuel is not Reaching Carburetor.	
1. Stoppage or kink in fuel line.	1. Check fuel line and replace if found kinked.
2. Air leak in fuel line.	2. Check and eliminate air leaks.
3. Dirt, water or ice in pump sediment bowl or screen.	3. Clean out tank and fuel pump sediment bowl.
4. Carburetor float needle valve sticking.	4. Remove fuel line at carburetor and remove and inspect needle valve and seat. Replace if necessary.
If Engine Misses.	
1. Faulty ignition system and faulty fuel system.	1. A loose or broken ignition connection or a restricted flow of fuel through the carburetor. If miss is at low or idling speeds, check for improper fuel mixture and spark plug gaps improperly adjusted. Make necessary adjustments or replacements.
No Oil Pressure.	
1. Broken oil lines or tubes.	1. Replace line or tubes.

ELECTRICAL SYSTEM

Possible Causes	Reason
Slow Starting Motor Speed.	
1. Low battery voltage or specific gravity. Dirty or burned commutator or brushes.	1. Recharge or replace battery.
2. Engine oil too heavy for cold weather.	2. See Lubrication Section for proper grade of oil and change oil.

GENERATOR

If Charging Rate is Too Low.	
1. High resistance in circuit.	1. Check all connections.
2. Current and voltage regulator out of adjustment.	2. Replace or adjust regulator.
3. Loose or slipping fan belts.	3. Adjust to proper tension.
4. Dirty or burned generator commutator or brushes.	4. Clean commutator or replace brushes.

COOLING SYSTEM

Overheating.	
1. Loose fan belt.	1. Adjust belt.
2. Obstruction in cooling system.	2. Flush cooling system.
3. Collapsed or obstructed hose connections.	3. Replace hose.
4. Insufficient cooling solution.	4. Add solution.
5. Thermostat stuck in closed position.	5. Replace.
Engine runs too Cold.	
1. Thermostat remains open.	1. Replace.
Loss of Cooling Solution.	
1. Leakage at hose connections.	1. Repair or replace parts affected.

This service information applies particularly to the Leff Pumping unit, powered with a Chrysler T-108-503 carburetor type gasoline driven-engine.

PART FOUR
AUXILIARY EQUIPMENT

This Pump does not have any Auxiliary equipment.

PART FIVE
REPAIR INSTRUCTIONS

SECTION XXI
GENERAL

42. SCOPE.

These instructions are published for the information and guidance of the maintenance personnel responsible for the third or higher echelon of maintenance of this equipment which is beyond the scope of tools, equipment or supplies normally available to using organizations.

SECTION XXII
REPAIR INSTRUCTIONS

43. SERVICING THE RAMSEY FLEXIBLE COUPLING.

The Ramsey flexible coupling consists of two pinions encircled by a Ramsey chain and coupled in place by using a cotter pin inserted on the end of the chain connecting pin. Uncoupling and removing the chain disconnects the coupling. Guide links keep the chain in positive engagement with the pinions, with sufficient clearance to allow the shaft bearings relief from thrust strains should the shaft be slightly out of line.

44. TO DISASSEMBLE THE RAMSEY COUPLING.

Remove the cotter pin inserted in the end of pin connecting chain (figure 27) and remove chain connecting pin (figure 28.) This releases the chain (figure 29) exposing the two pinions to view. These pinions are held in position on the pump shaft or engine power take-off shaft by means of a key and locked into position with a hollow head setscrew. To remove the pinion from the shaft, it is necessary to release the hollow head setscrew (figure 30) and remove pinion.

45. REASSEMBLY OF RAMSEY FLEXIBLE COUPLING.

To reassemble the Ramsey flexible coupling, the first step is to place the key in the keyway much in the manner as shown

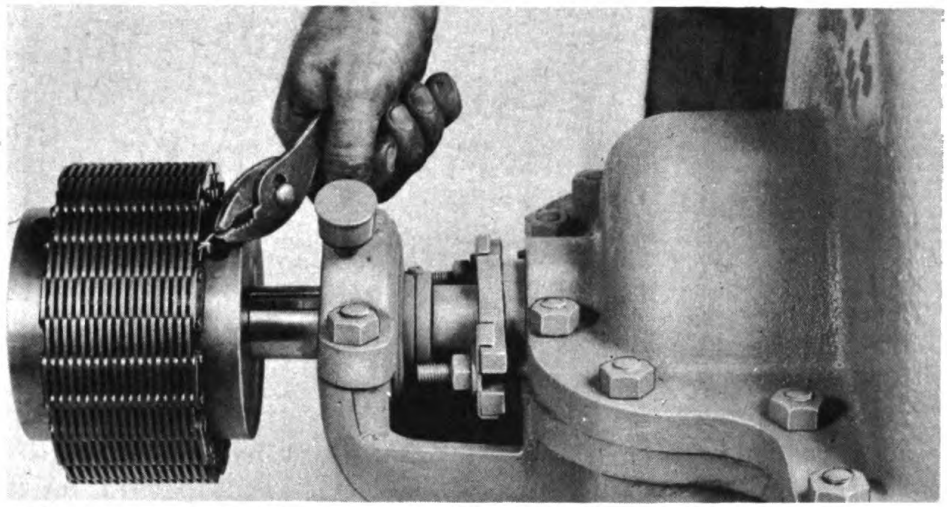


Figure 27—Removing Cotter Pin to Release Coupling Lock Pin

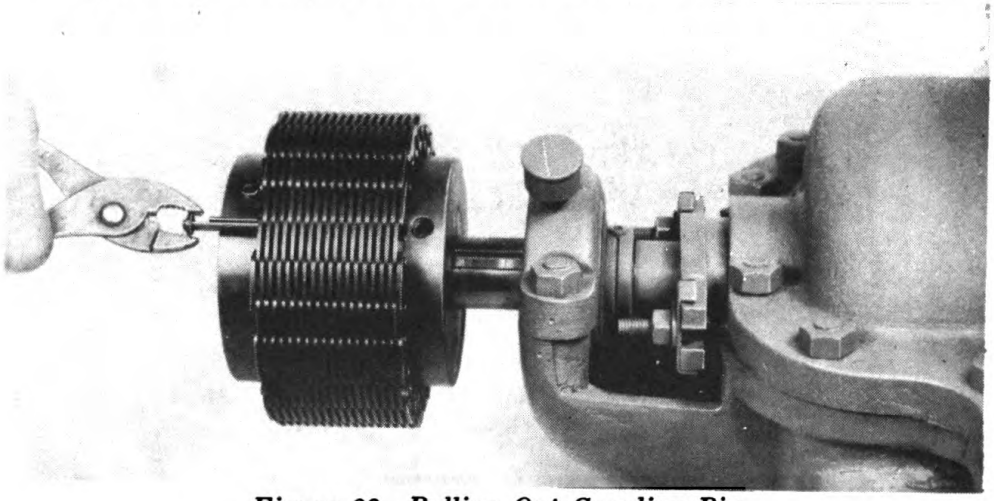


Figure 28—Pulling Out Coupling Pin

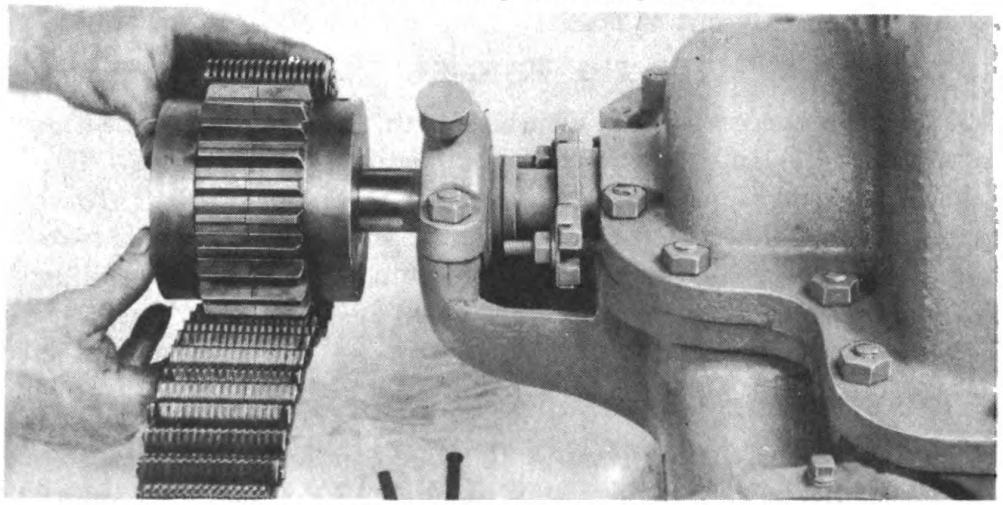
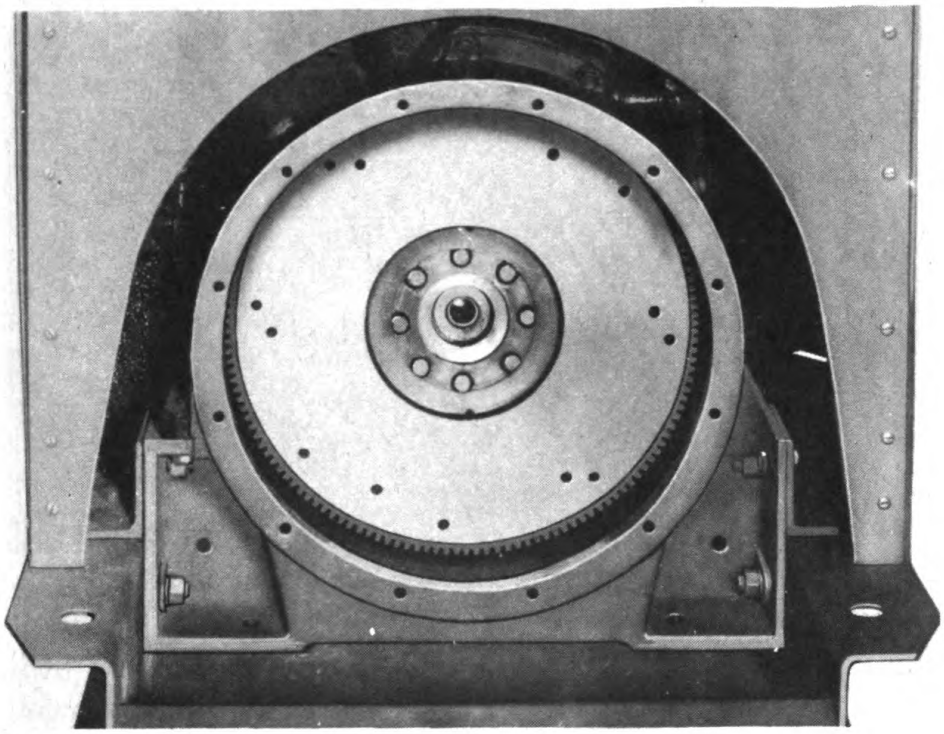
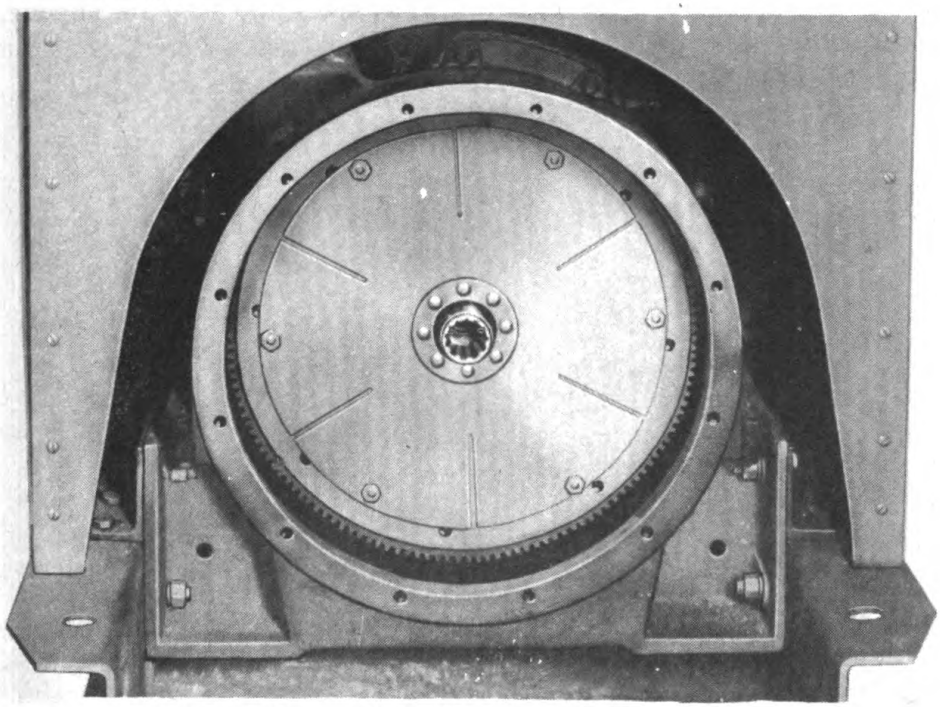


Figure 29—Removing Coupling Chain



A—Bare Housing



B—Housing with Drive Disc Installed

Figure 30—Progressive Steps of Assembling Ramsey Coupler to Engine Flywheel

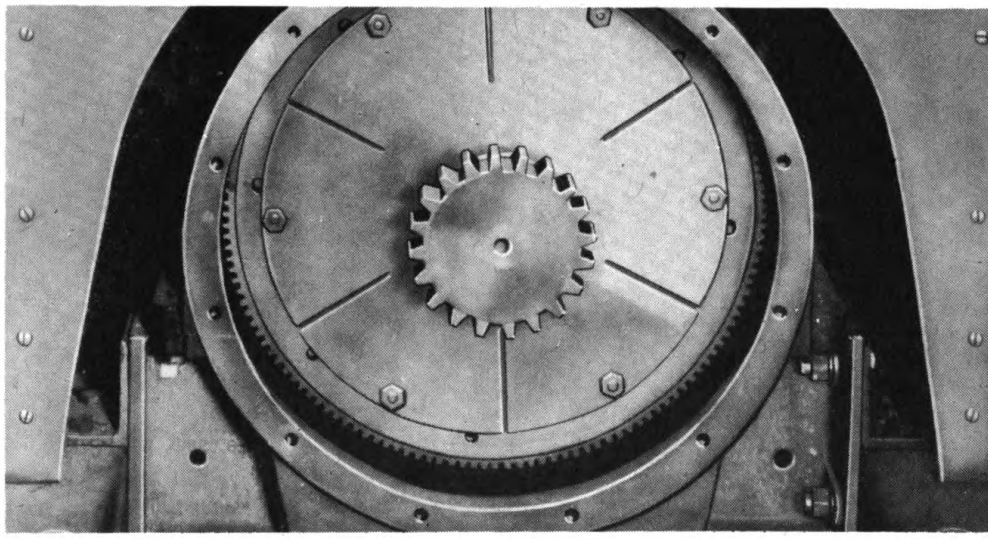


Figure 30C—Engine Pinion Mounted on Shaft of Drive Disc

in figure 31. Insert pinion on shaft, setting pinion by fastening the hollow head setscrew. Then check alignment at the coupling by placing a straight edge across the pinions. This should be at four points on the coupling, the points being ninety degrees apart. The distance between the faces of the coupling halves should also be checked at four points with a thickness gage. If units are aligned, continue to reassemble in the reverse manner outlined for disassembly.

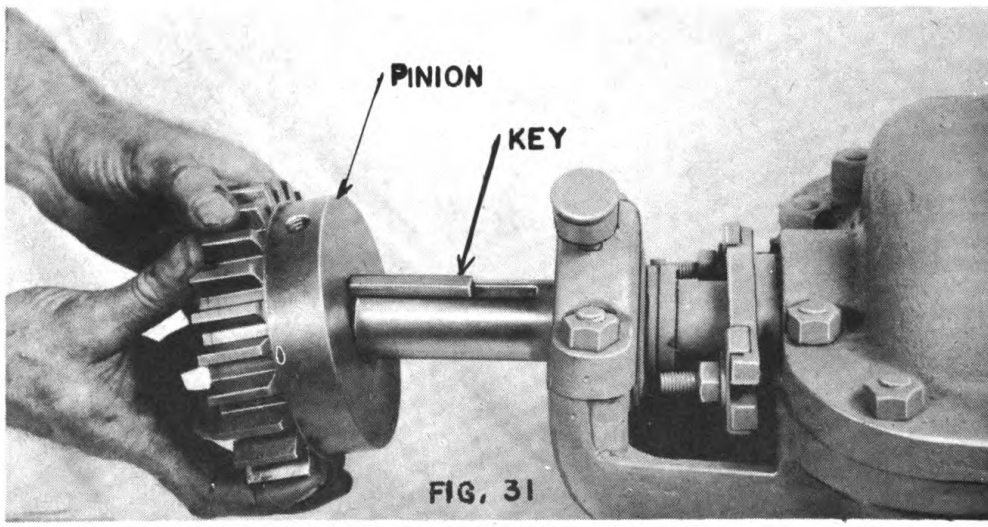


Figure 31—Align Pinion Shaft with Key for Reassembly

46. DISASSEMBLY OF THE PUMP.

a. The pump used in this equipment is a two-stage horizontally split case centrifugal pump. The first steps to disassembling being

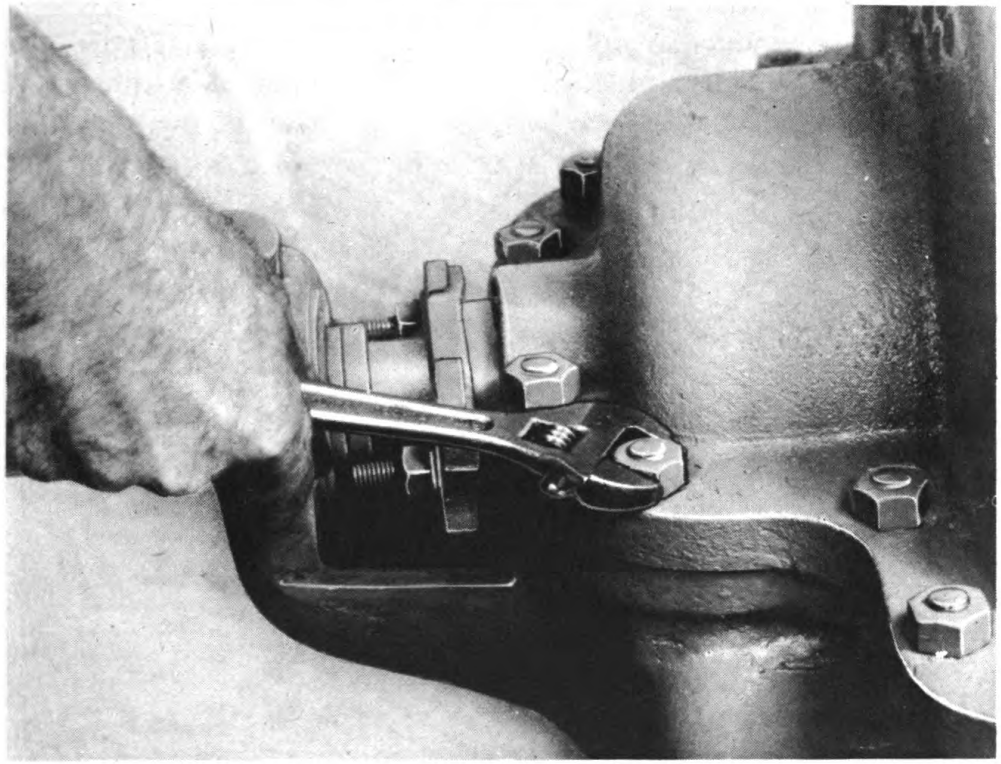


Figure 32—First Step for Pump Disassembly

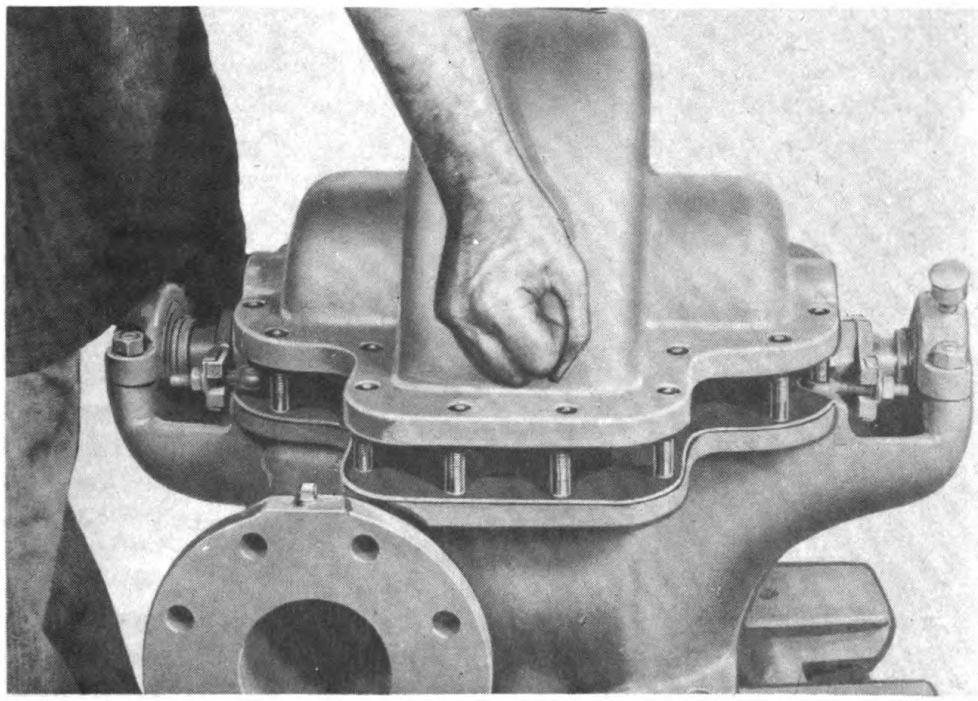


Figure 33—Removing Upper Shell Half of Pump

to remove the nuts joining the top section to the bottom. (Figure 32.) The upper shell half is provided with ears on either side to assist in lifting this element off of the assembly. This may be accomplished

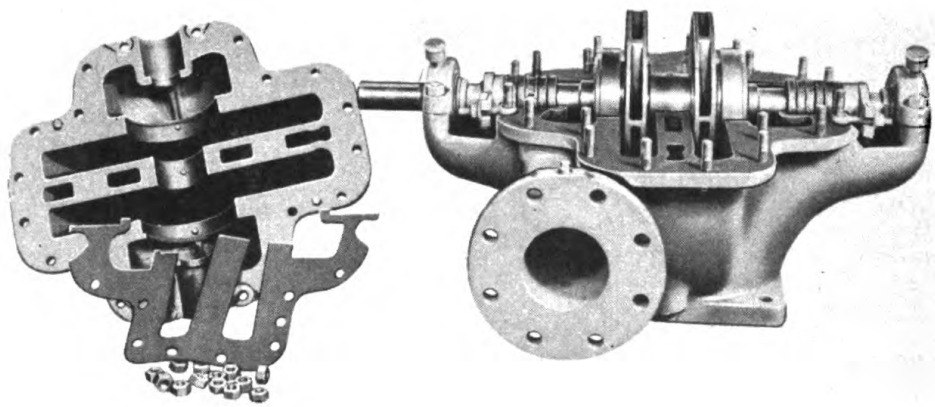


Figure 34—Exposed View of Interior of Pump

by one or two men (figure 33) or can be used to place the wire rope and lifted off by means of a hoist. This exposes the interior of the pump. (Figure 34.) If the upper shell half sticks, the same can be pried loose with a pinch bar. Remove the gaskets between the two shell halves and place in a pail of water so that they will stay wet. If the shell gaskets dry out, they will shrink so that they will not fit and cannot be used over again.

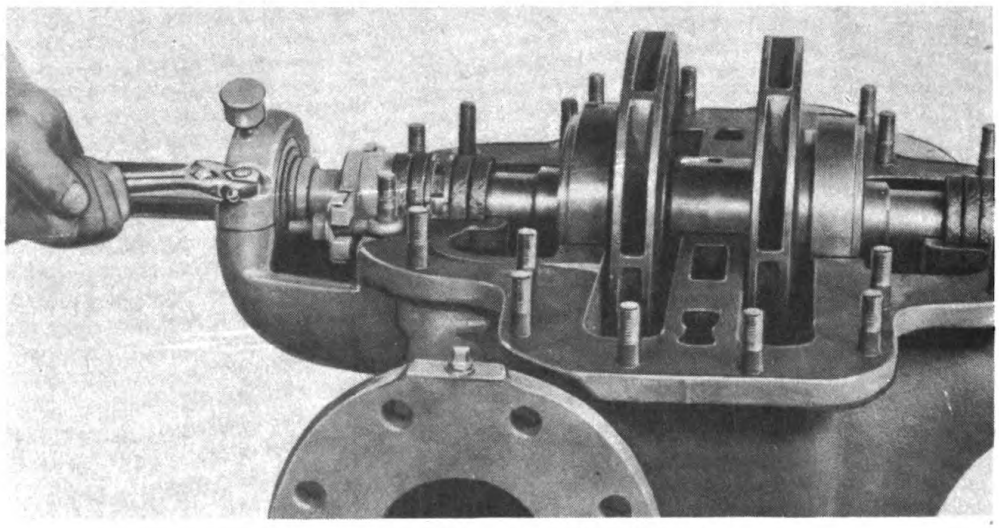


Figure 35—Removing Bearing Caps

b. The next step is to remove the two nuts holding the ball bearing cap on both ends of the assembly. (Figure 35.) Loosen the nuts on the swing bolts holding the pocking glands in position and remove the gland halves. Then lift the rotating element free of the lower shell half.

47. SERVICING THE WEARING RINGS AND IMPELLERS.

To service the wearing rings or impellers, the unit must be disassembled to this point. When the rotating element can be freed from the lower shell half, (figure 35A) clean up hub of impeller and inspect for excessive wear. Replace wearing ring to either side of

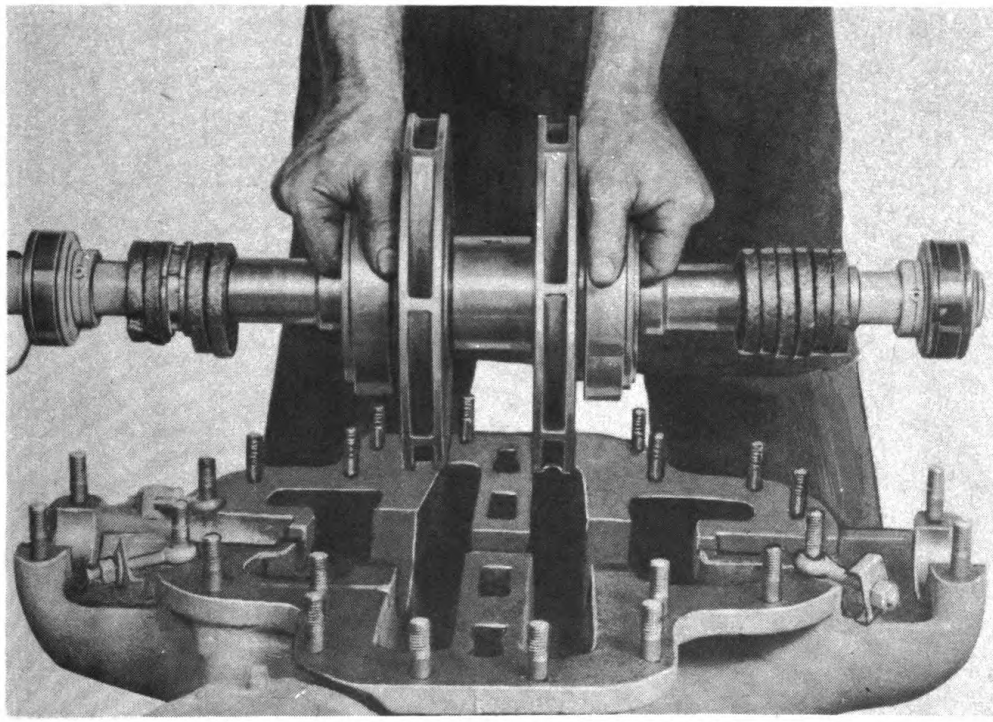


Figure 35A—Removing Rotating Element

rotating element, if excessive wear is noted. To service impellers, it is necessary to complete the disassembly of the rotating element.

48. DISASSEMBLING THE ROTATING ELEMENT.

a. The wearing plates or rings can be slipped off of the impeller hubs after which the ball bearing should be removed. Loosen setscrews (figure 35D) and the ball bearing will slip off the shaft. Slip off lantern ring (figure 35C) after which remove the shaft sleeve on either side of the impeller. These sleeves are threaded with both right

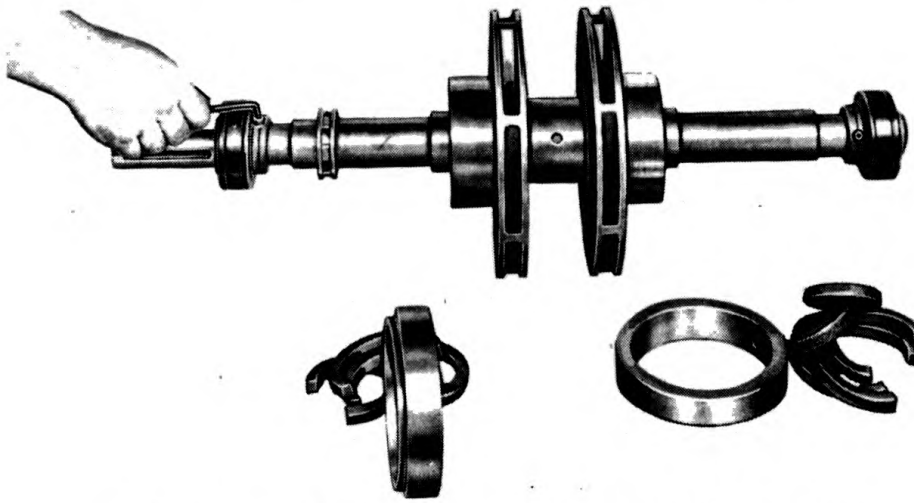


Figure 35B—Loosen Setscrew Holding Bearing in place

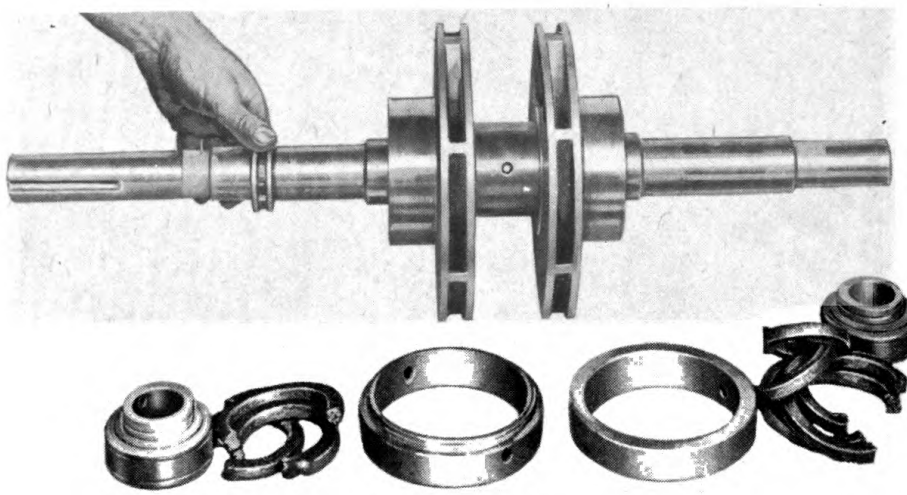


Figure 35C—Removing Lantern Ring

and left hand threads. To loosen shaft sleeve on the coupling side of rotating element, turn clockwise while on the opposite end turn counterclockwise. (Figure 36.) Then remove the impeller from the coupling end of the rotating element.

b. Note in figure 37 that the impeller is held on the shaft by means of two keys which prevents it from rotating when in action. Before removing impellers, it is advisable to match mark impellers in the shaft ends, so that in reassembling, the impellers will go back in the same location they were furnished.

c. The next step is to remove the shell bushing and separator sleeve (figure 38). To remove the right hand shaft sleeve unscrew

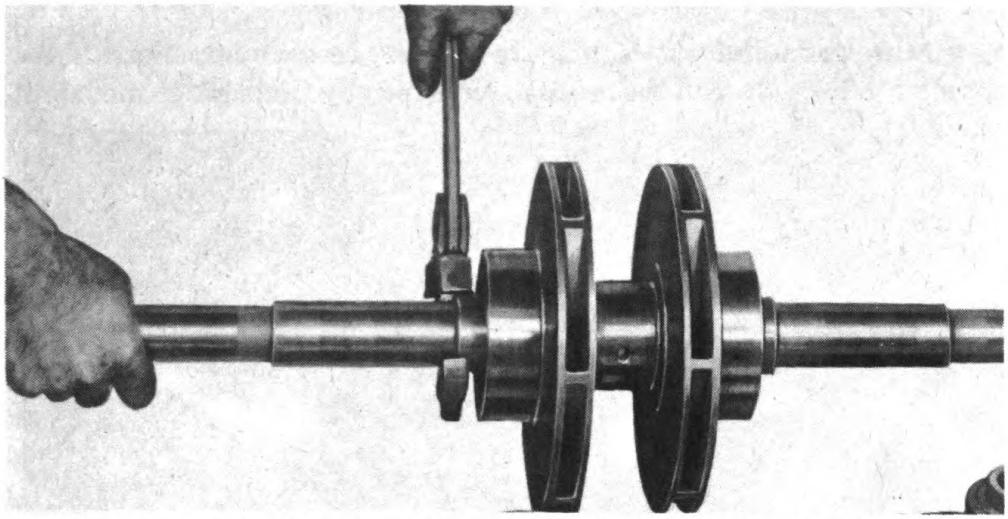


Figure 36—Removing Sleeve from Coupling Side of Shaft

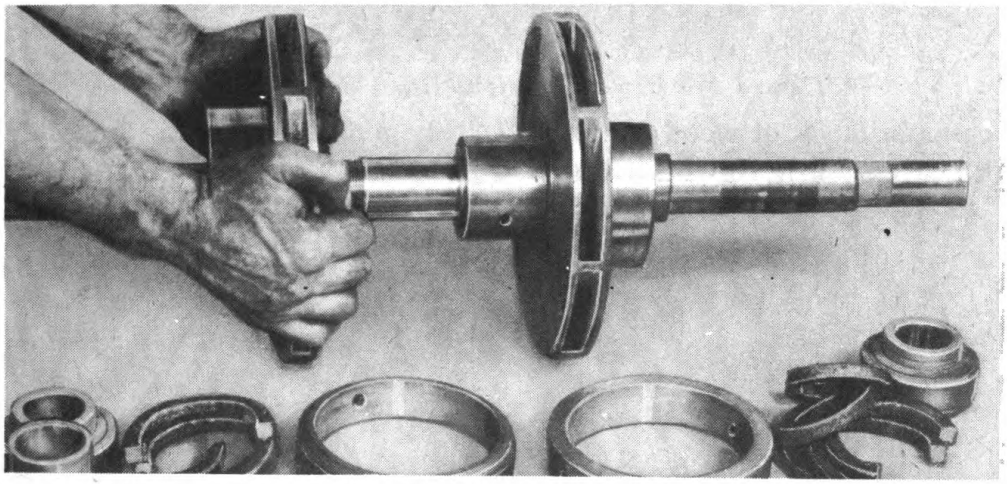


Figure 37—Removing Impeller from Coupling End of Shaft

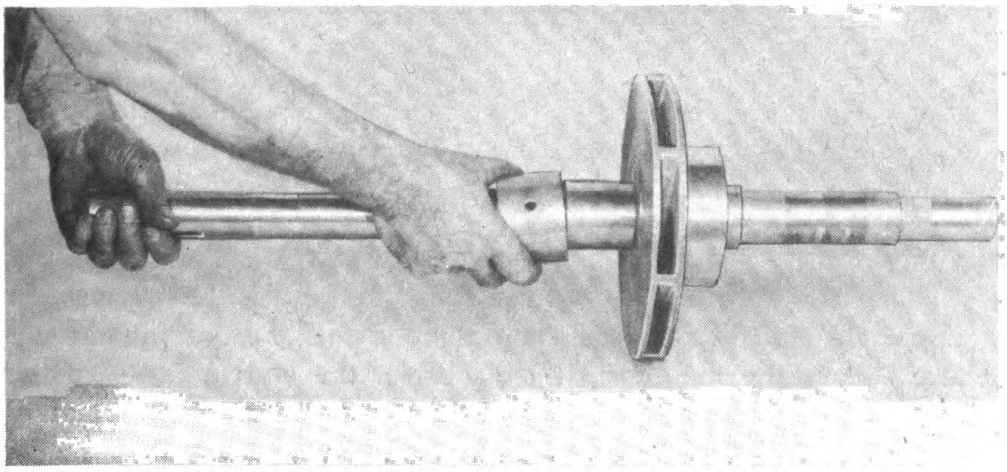


Figure 38—Removing Shell Bushing and Separator Sleeve

by turning counterclockwise (figure 39) and remove impellers. If the impeller sticks, it can be easily removed by knocking the shaft

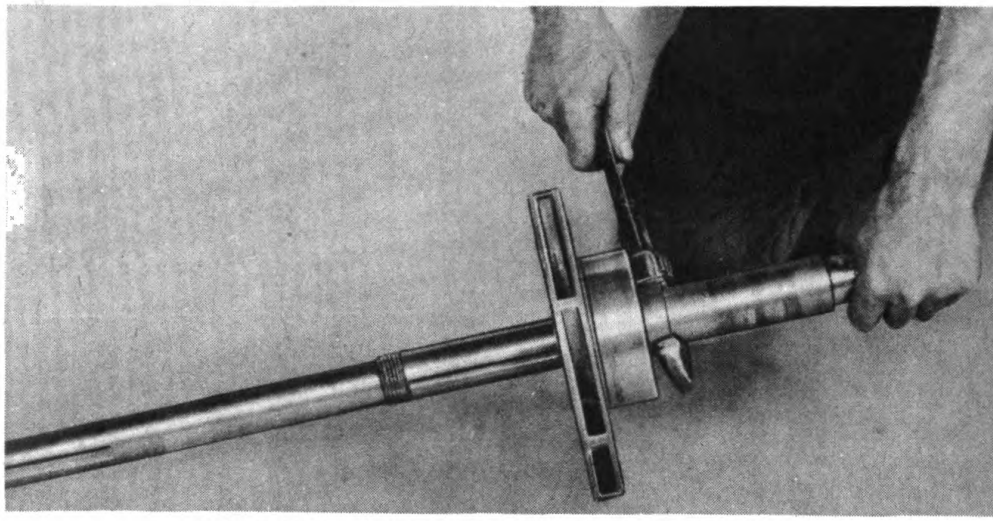


Figure 39—Removing Right Hand Shaft Sleeve

against a block of wood (figure 40). This generally jars the impeller and disassembly has been completed.

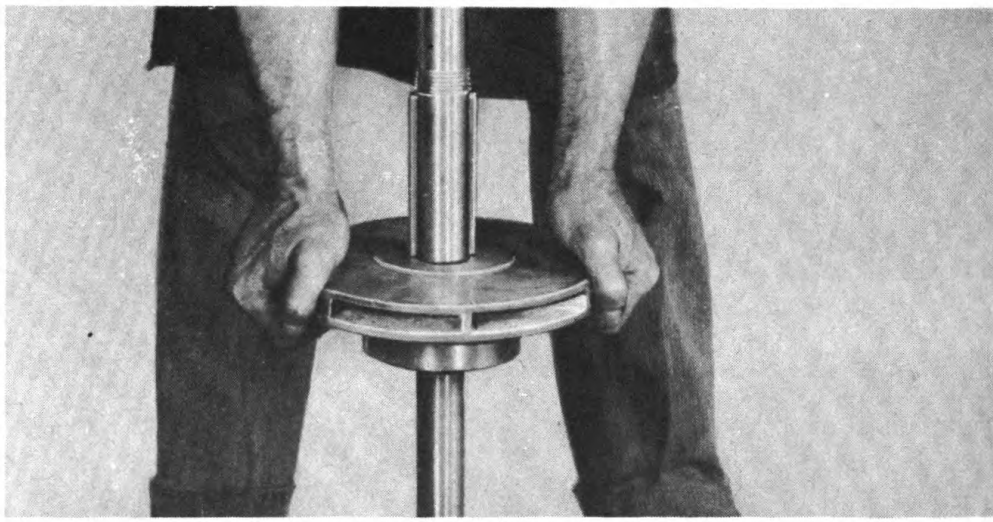


Figure 40—Jarring Impeller Loose

49. REASSEMBLING ROTATING ELEMENT.

The first step is to place the impeller key in the keyway on the opposite side of the shaft and then install the right hand impeller. This is the impeller which goes on the end opposite to the coupling end. After the impeller has been placed approximately in the center on the keyway, install the right hand shaft sleeve screwing clockwise; then add the separator sleeve which fits over

the shaft and held in position by the two keys and goes between the impellers (figure 41). Then add the shell bushing which fits over the separator sleeve. Next, add the left hand impeller. To properly set impeller, jar assembly by knocking shaft against a block of wood

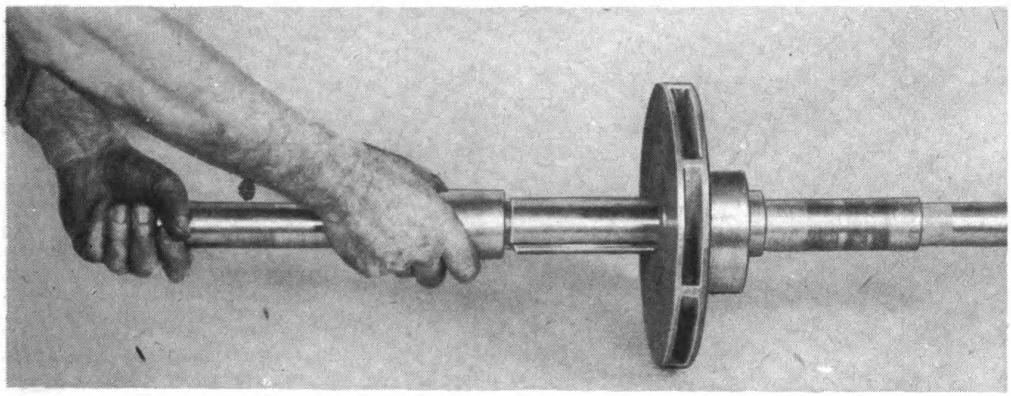


Figure 41—Installing Separator Sleeve

(figure 42). This will permit the impeller to set in position without injury to any of the rotating element. For the next step, add the left hand shaft sleeve (figure 43) screwing it on counterclockwise. After

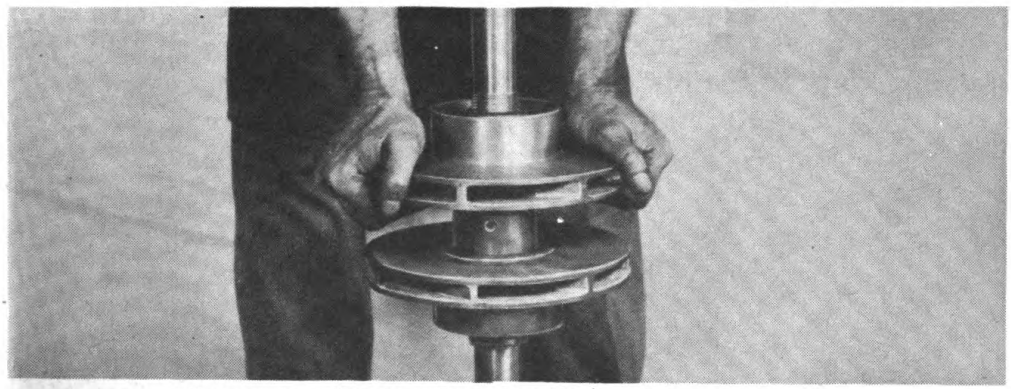


Figure 42—Setting Impeller in Position on Shaft

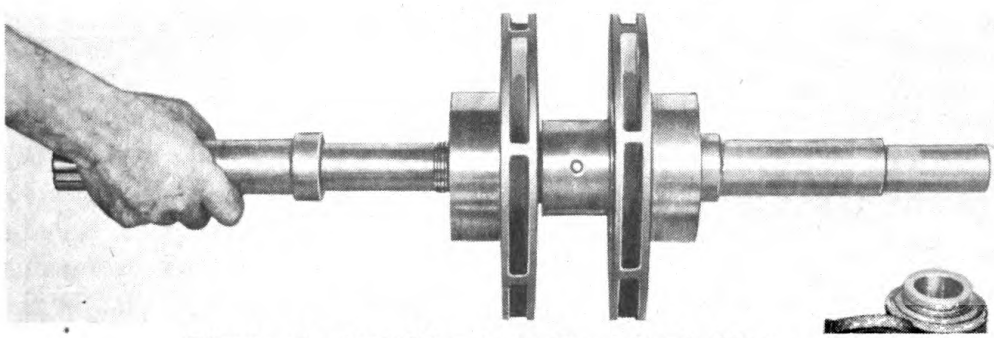


Figure 43—Installing Left Hand Shaft Sleeve

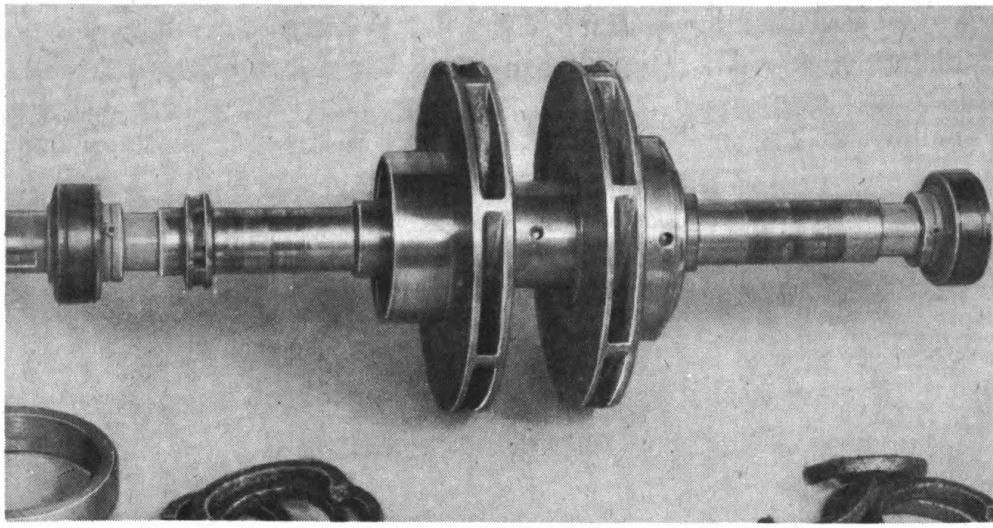


Figure 44—Restoring Bearings to Shaft

which the lantern ring can be added to the rotating shaft, making sure that it is on the coupling side which has the by-pass groove from volute to packing box. Slide ball bearings on each end of the shaft with the collar projection toward the impellers. Do not fasten ball bearings at this time as these must be adjusted when the rotating element is installed in the lower shell (figure 44). Then add the shell wearing rings to the hub as indicated in figure 45.

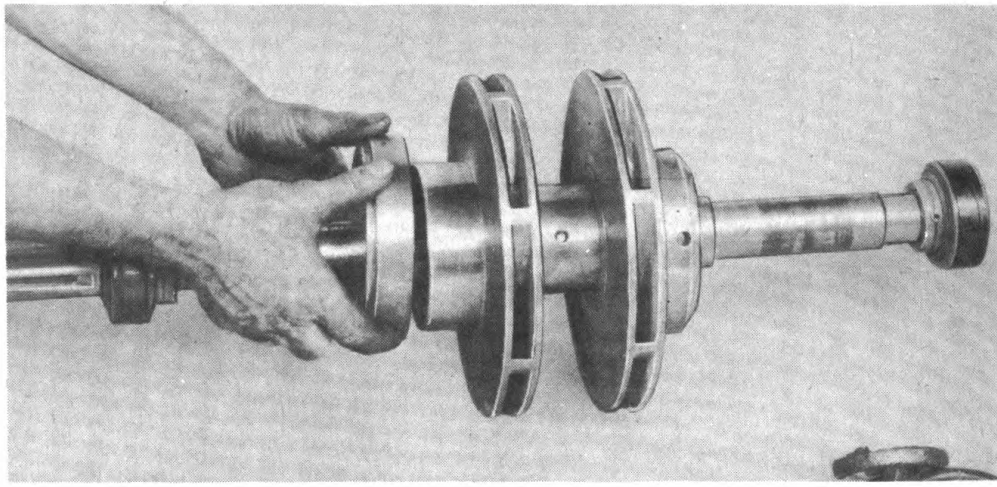


Figure 45—Adding Shell Wearing Rings

50. REASSEMBLY OF PUMP.

In figure 45A the fully assembled rotating element is along side of the lower shell half. Note particularly the three dowel pins in the center of the lower shell half. These dowel pins fit into the holes

indicated in figure 45A when the rotating element is placed in position. The upper shell half is also equipped with three dowel pins for the purpose of locking these parts against rotating during pumping action.

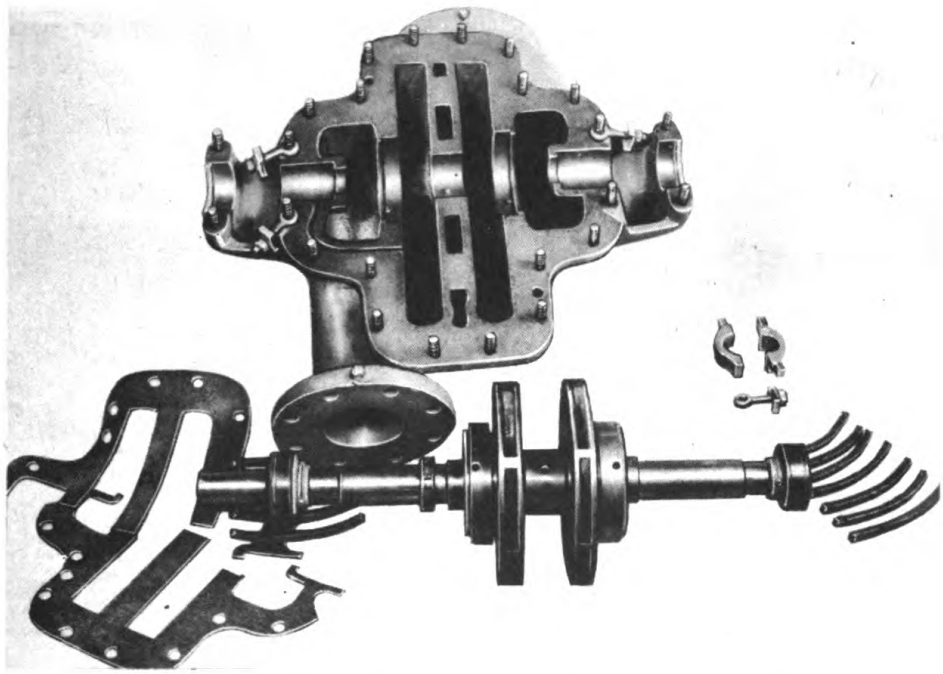


Figure 45A—Assembled Rotating Element Ready for Installation in Lower Shell Half

51. REASSEMBLY OF ROTATING ELEMENT.

The first step in reassembling is to place the rotating element into position on the lower shell half, turning the shell wearing rings and bushing so that they slip over the dowel pins in the lower shell half. (Figure 46.) Then center the impellers in the volute and make sure that the grease groove in the ball bearing outer race is in line with the grease hole of the bearing cap. The grease cup hole in the bearing cap must not extend beyond the flat outer ring of the ball bearing, otherwise grease will not go into the ball bearing but will leak on to the outside of the ball bearing. Then insert the bearing thrust ring in the groove on the bearing arms on both sides of the lower shell half. Push these rings downward into position (figure 47). Next install the bearing caps before tightening, making sure that

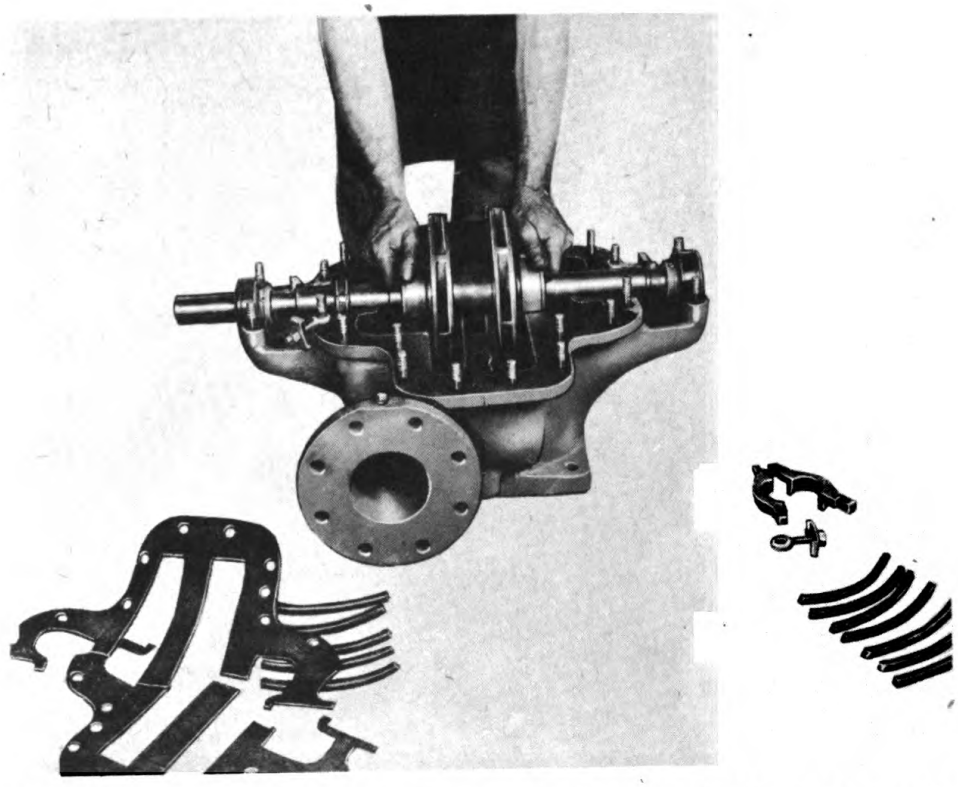


Figure 46—Turning Shell Wearing Rings to Bring in Position of Dowel Pins

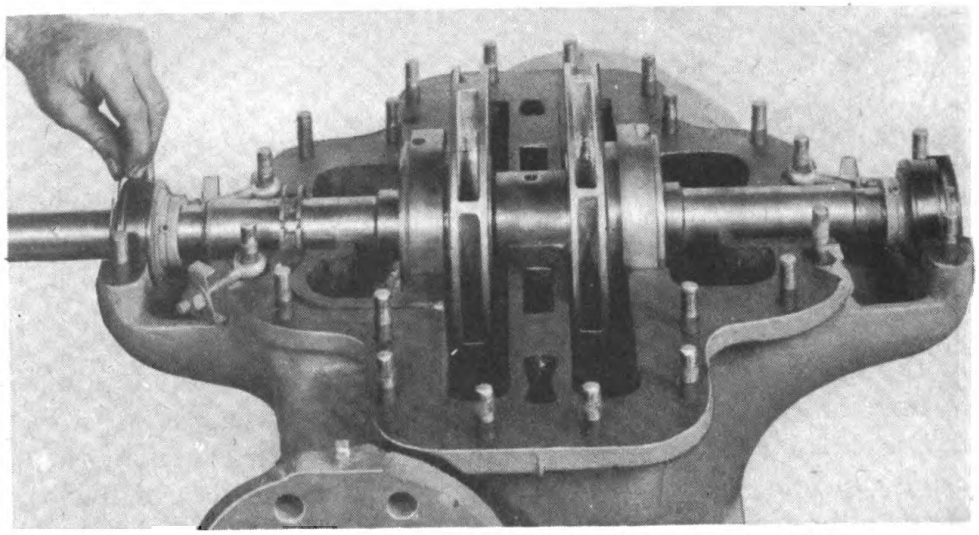


Figure 47—Insert Bearing Thrust Ring into Position

the thrust ring fits into the upper groove of the bearing caps. (Figure 48.) Draw the ball bearing over against the thrust ring on both ends of the shaft. (Figure 49.) At this point, adjust the impellers so

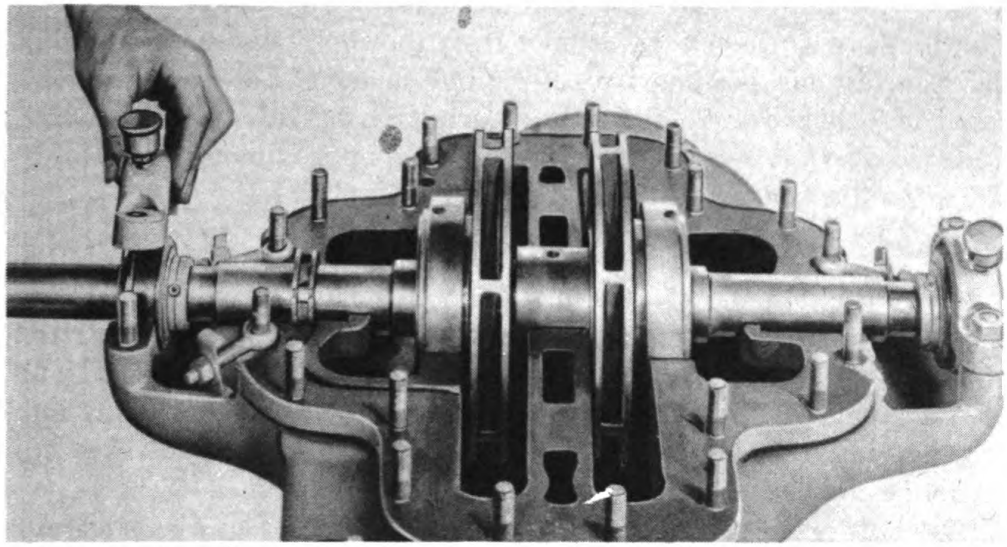


Figure 48—Adding Bearing Caps to Assembly

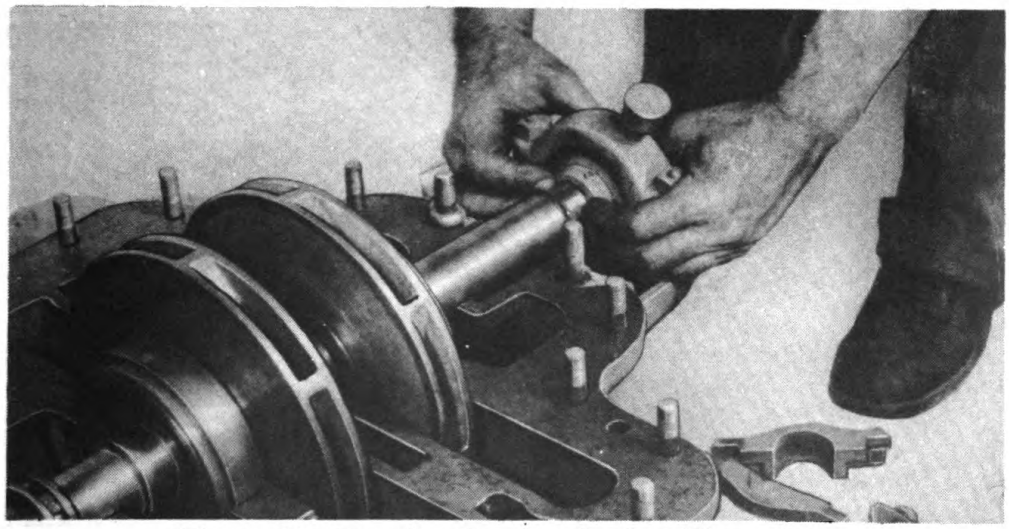


Figure 49—Drawing Bearing Against Thrust Ring

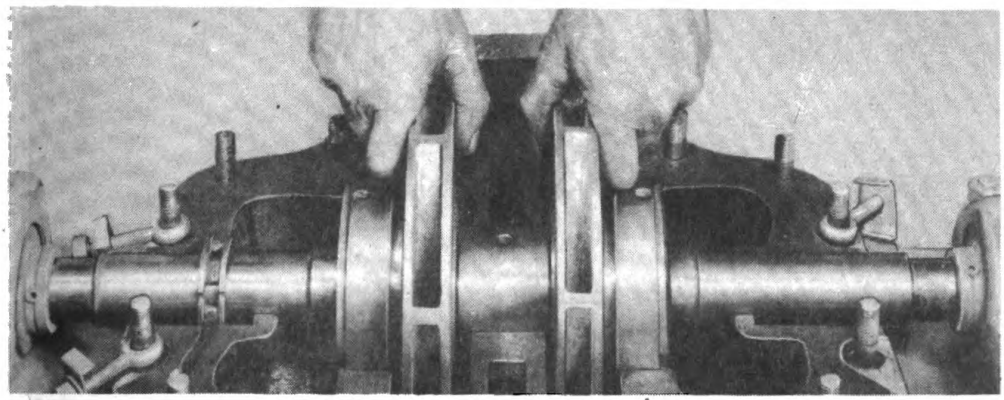


Figure 50—Spacing Impellers

that they are spaced equal distance from the shell bearing (figure 50). Then fasten into position by locking ball bearing. For proper adjustment of ball bearings, bring the bearing flush with the thrust ring and then force it away from the thrust ring approximately 1/64 inch. Then set the bearing with the hollow head setscrew.

52. PACKING SHAFT.

a. In packing the shaft, work from the coupling end and insert the packing rings by forcing down around the shaft staggering rings so that the ends come reverse of each other in order to bind and overlap the ends. After second ring is placed, bring lantern ring into position aligning with the groove in the volute. Then add three additional rings outside on the lantern ring. (Figure 51.)

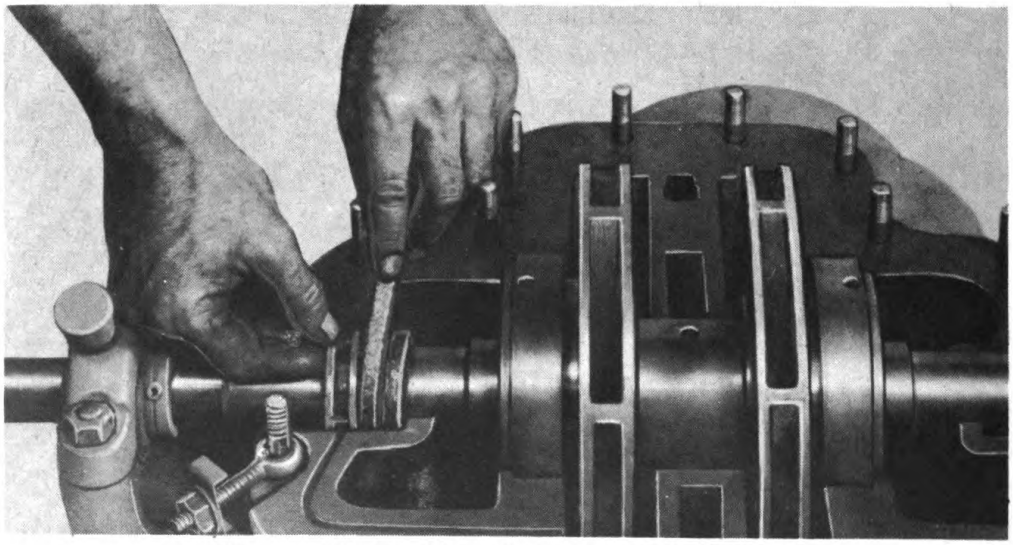


Figure 51—Packing Coupling End of Shaft

b. On the opposite end, proceed to pack the shaft in the same manner as outlined for the coupling end, and as this will have no lan-

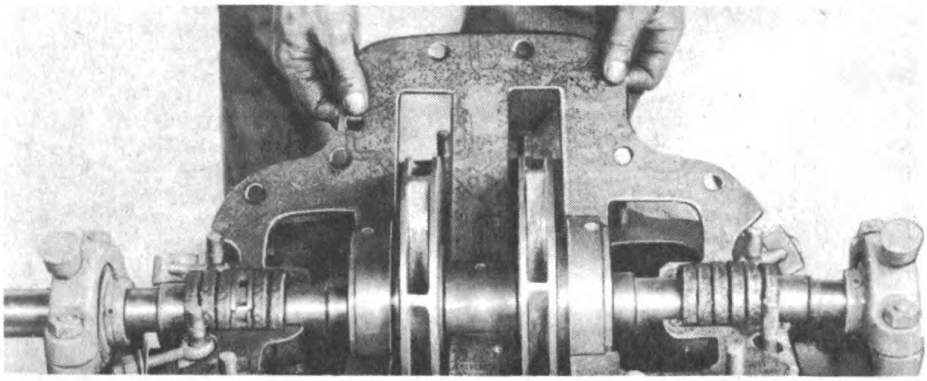


Figure 52—Placing Gasket in Position

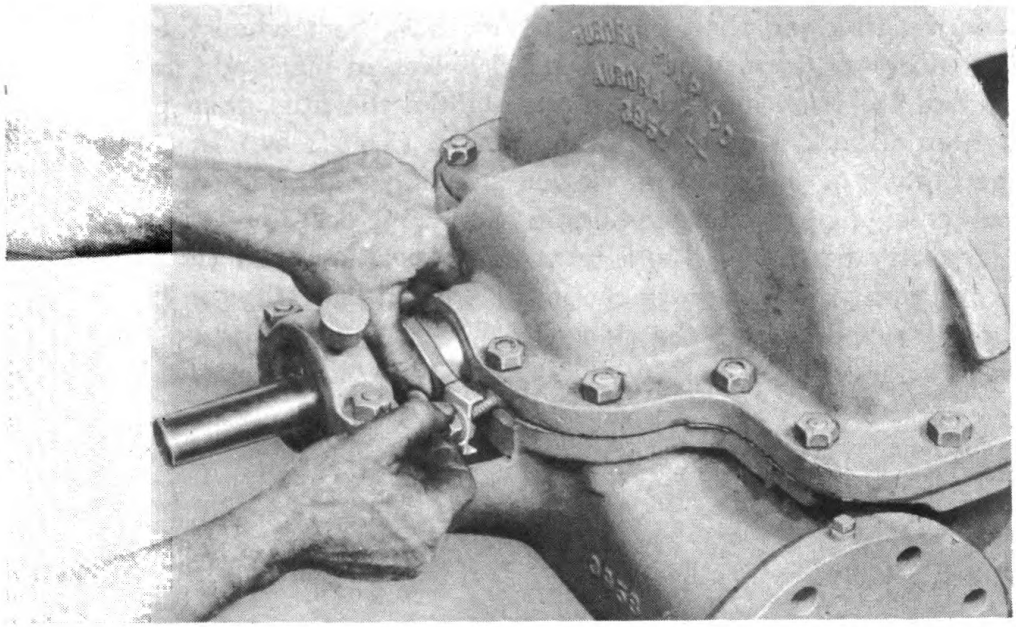


Figure 53—Lock the Packing Gland Halves in Place

tern ring, straight packing can be utilized. Bring the gasket into place as indicated in figure 52 and restore the upper shell half. The pins in the upper shell half must slide into the holes on the shell wearing rings and shell bushing. This can be done by moving the upper shell half back and forth slightly and let it drop into place, making sure that the dowel pins slip into place. In order to prevent the

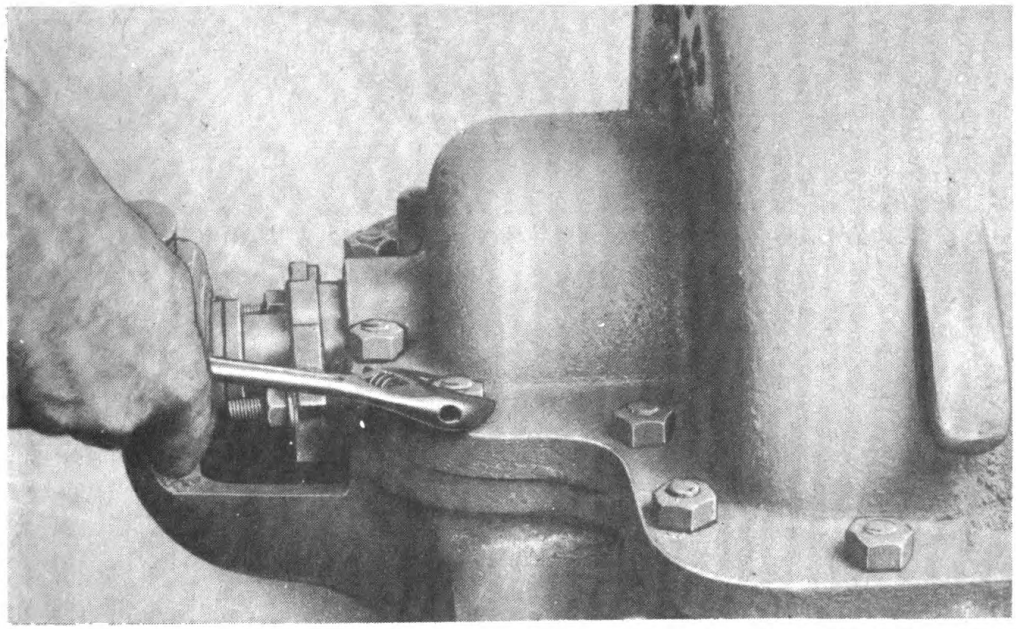


Figure 54—Attaching Upper Shell Half by Tightening Stud Nuts

wearing ring and shell bushing from being bent when the flange is bolted down. Restore packing gland halves in place and swing bolts (figure 53) back into position and tighten the nuts, then proceed to tighten all nuts around the pump flange. (Figure 54.) In (figure 55) the bottom of the pump is viewed showing four drain plugs for the convenience of draining the liquid should the occasion require. These plugs may be removed and returned to position after the pump has been drained. These plugs cannot be viewed from the top but can be readily reached from the side.

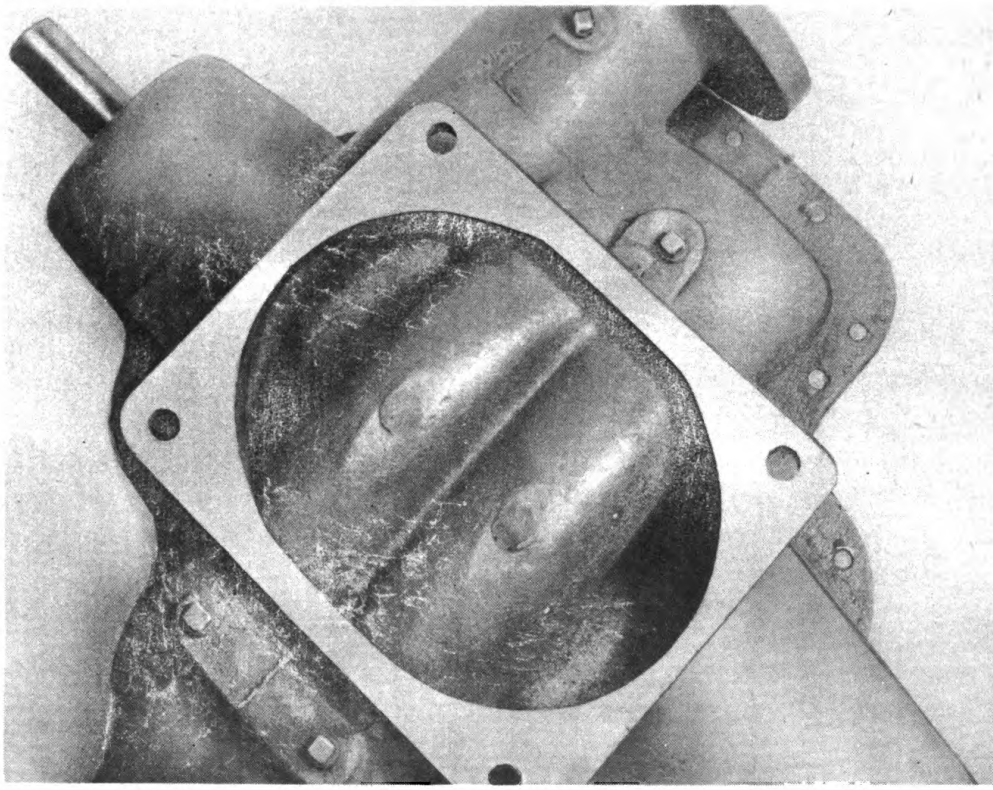


Figure 55—Bottom View of Pump Showing 4 Drain Plugs

SECTION XXIII
ENGINE OVERHAUL INSTRUCTIONS

53. GENERAL.

Service information given in this section of the manual applies particularly to the Chrysler T-108-503 carburetor type engine. Engine performance can be maintained at a high standard of efficiency through careful adjustments. All high compression engines demand accurate settings of the ignition and fuel systems for maximum performance. Frequent tune-up and inspection of this unit will insure more efficient operation. The tune-up and inspection operations immediately following are designed as a guide to first and second echelon operators in maintaining peak engine performance. (Figures 56 and 57.)

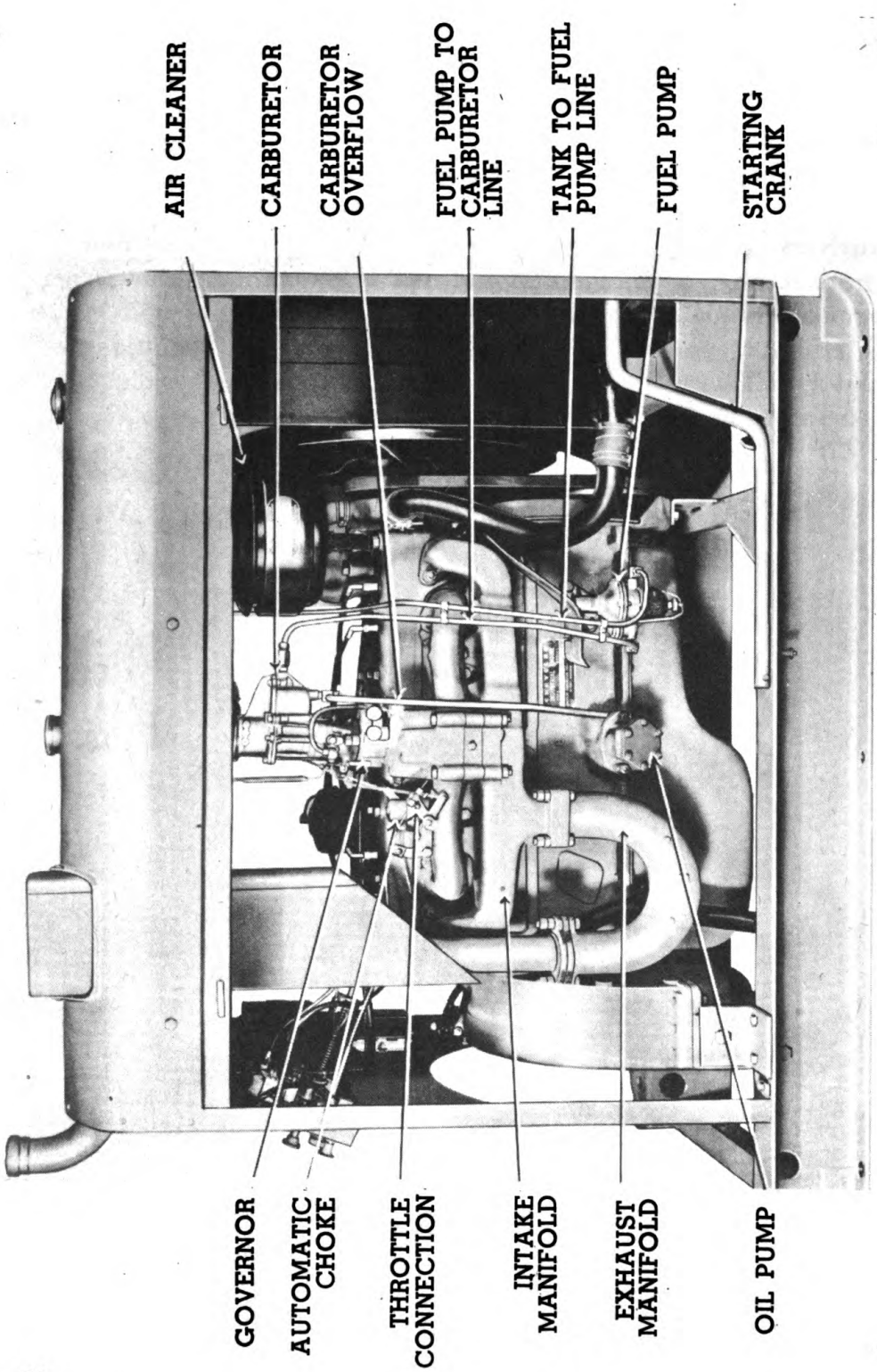


Figure 56—View of Carburetor Side of Chrysler T-108-503 Engine

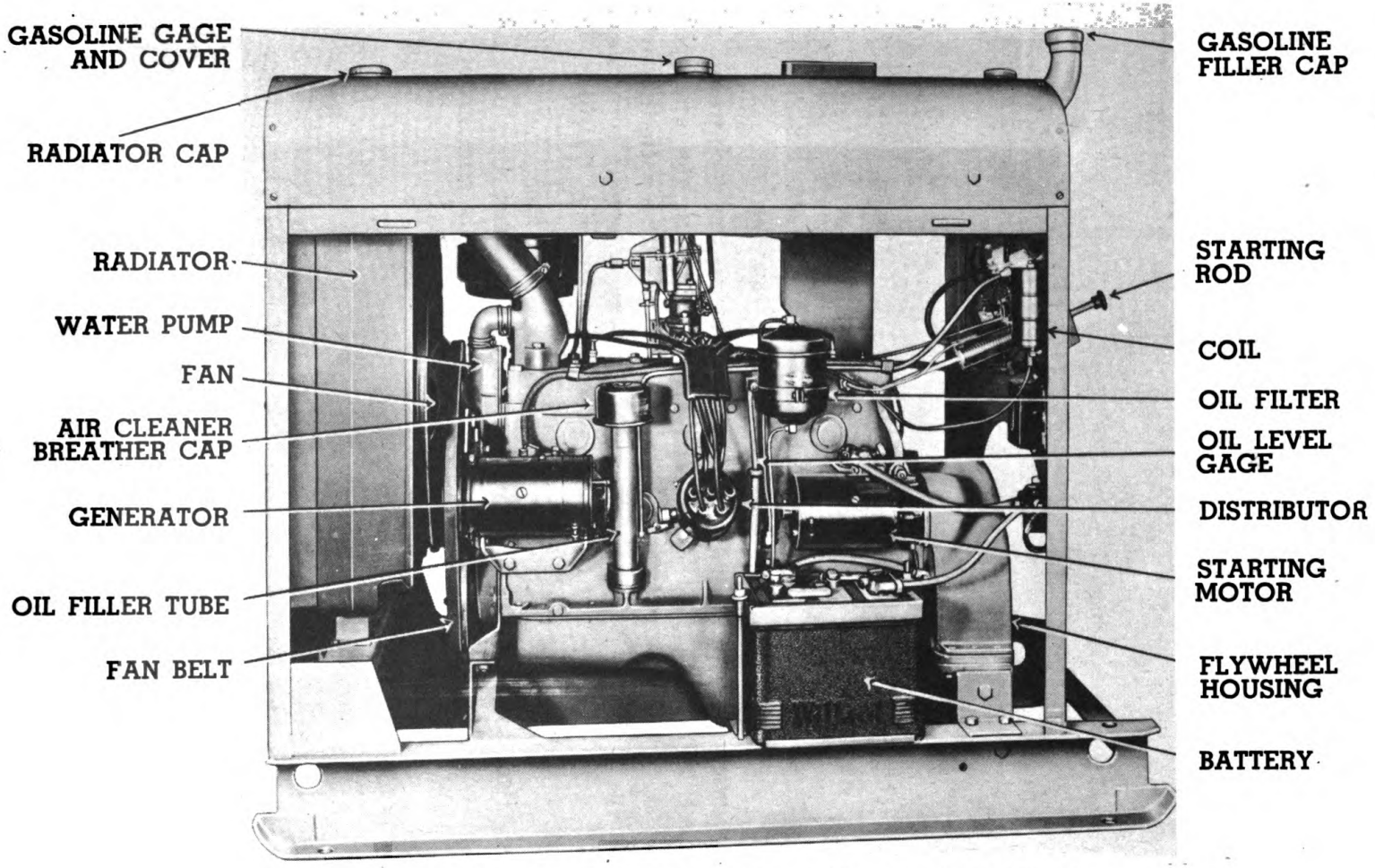


Figure 57—View of Distributor Side of Chrysler T-108-503 Engine

54. DISASSEMBLY OF HOOD AND FRAME.

a. If the occasion requires that you effect a disassembly of the hood and frame of this unit the first step is to remove the exhaust stack. This is accomplished by removing the stack to hood spacer, screws and nuts and lifting the stack upward. (Figure 58.) Then

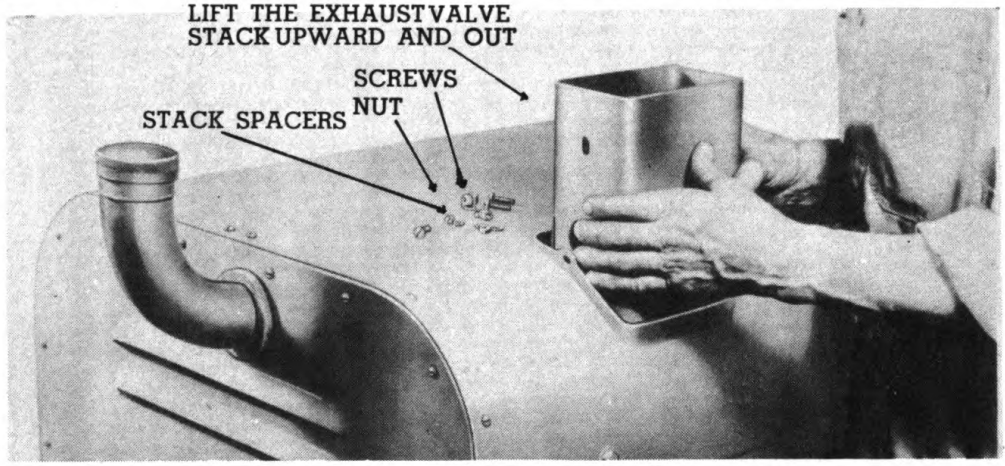


Figure 58—Lifting Exhaust Stack from Position

loosen the thumb nut holding the air cleaner to the carburetor, removing the air cleaner. Disconnect the fuel line at the gas tank opening and remove throttle spring, which is connected onto the hood, forming the top portion of the frame. Then remove twenty screws and washers at both ends of the hood. This will enable you to lift off the hood beneath which the gasoline tank is fastened. (Figure 59.)

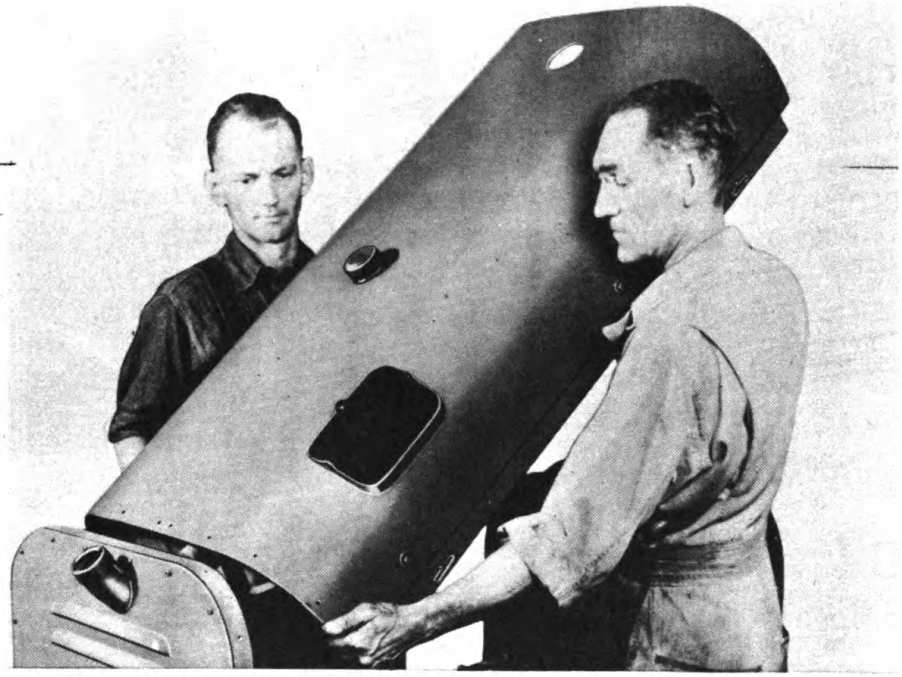
b. The gasoline tank is equipped with a goose neck filler pipe and to remove the hood it will be necessary to lift it up and out at the same time.

55. TO REMOVE THE RADIATOR.

After the solution has been drained and the hood has been removed, in order to remove the radiator it will be necessary that the hose connections be disconnected. This is accomplished by loosening the clamps as indicated in figure 60. Remove three bolts on each side of the skid base which hold the radiator assembly in place, figure 61, after which the radiator assembly can be lifted out of position.

56. TO REMOVE INSTRUMENT PANEL. (Figure 62.)

a. It will be necessary to remove the bolts holding the panel to the skid base and to disconnect all connections installed in the instrument panel or hung on the back thereof. (Figure 63.)



BE CAREFUL TO SLIP THE GOOSE NECK FILLER PIPE, ATTACHED TO GASOLINE TANK, SO AS NOT TO SPRING ASSEMBLY AND CAUSE CONNECTION TO LEAK

Figure 59—Removing Hood and Gasoline Tank

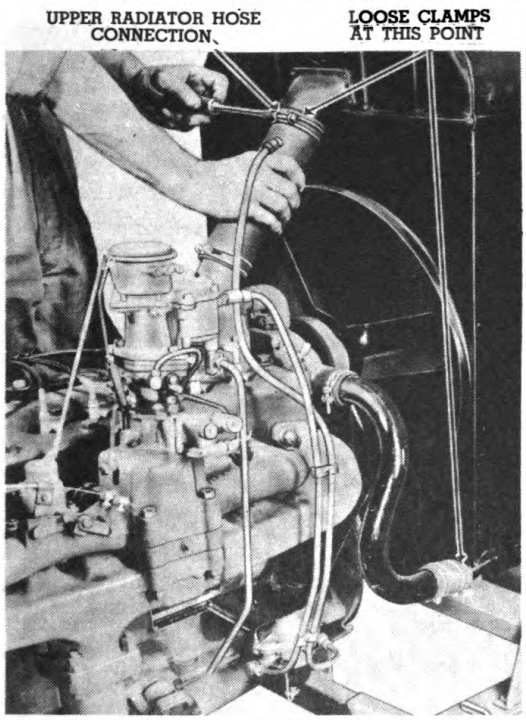


Figure 60—Disconnecting Radiator Hose Connection

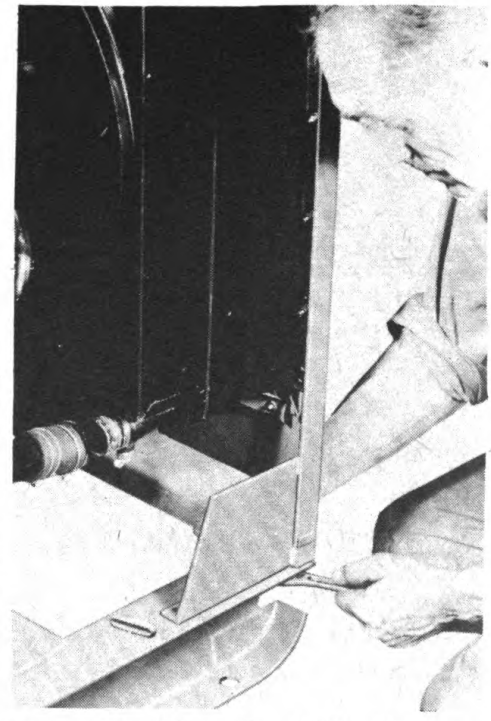


Figure 61—Removing Bolts Anchoring Radiator to Skid Base.

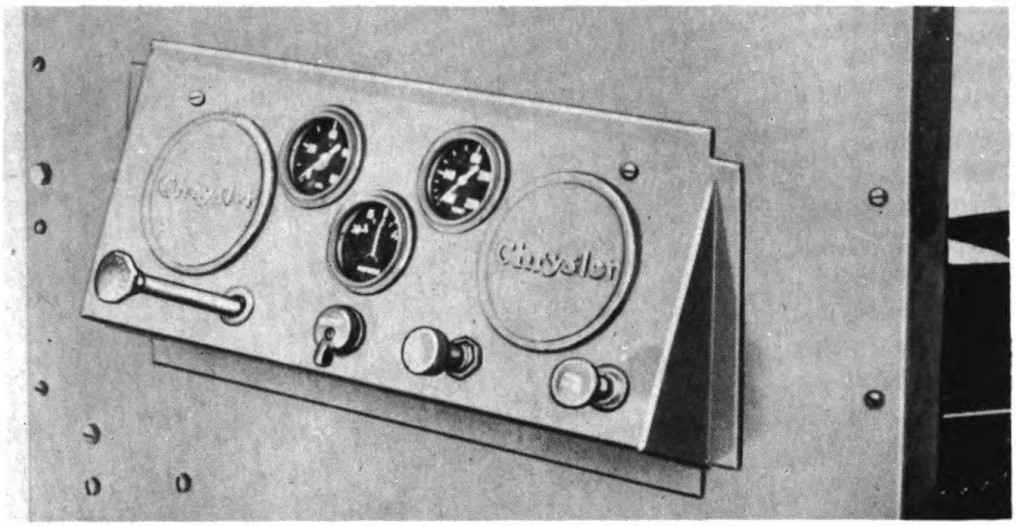


Figure 62—Instrument Panel

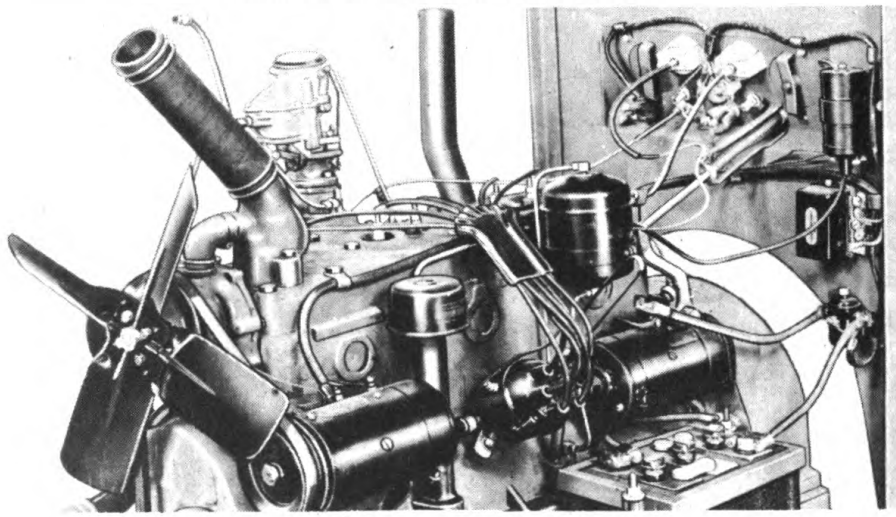


Figure 63—Inside View

b. To reassemble the hood, frame, radiator or instrument panel, it is merely necessary to reverse the procedure for disassembly.

c. The Chrysler T-108-503 engine is of the poppet valve gasoline burning type with liquid cooling and pressure lubrication. (Figure 64.)

57. ENGINE OILING SYSTEM. (Figure 65.)

a. It is lubricated by oil drawn from the oil pan by the oil pump (figure 66), and forced under pressure through drilled passages in the cylinder block to the crankshaft and crankshaft bearings. (Figure 67.)

b. Passages are drilled in the crankshaft to allow oil to be forced through the crankshaft bearings to the connecting rod bearings. (Fig-

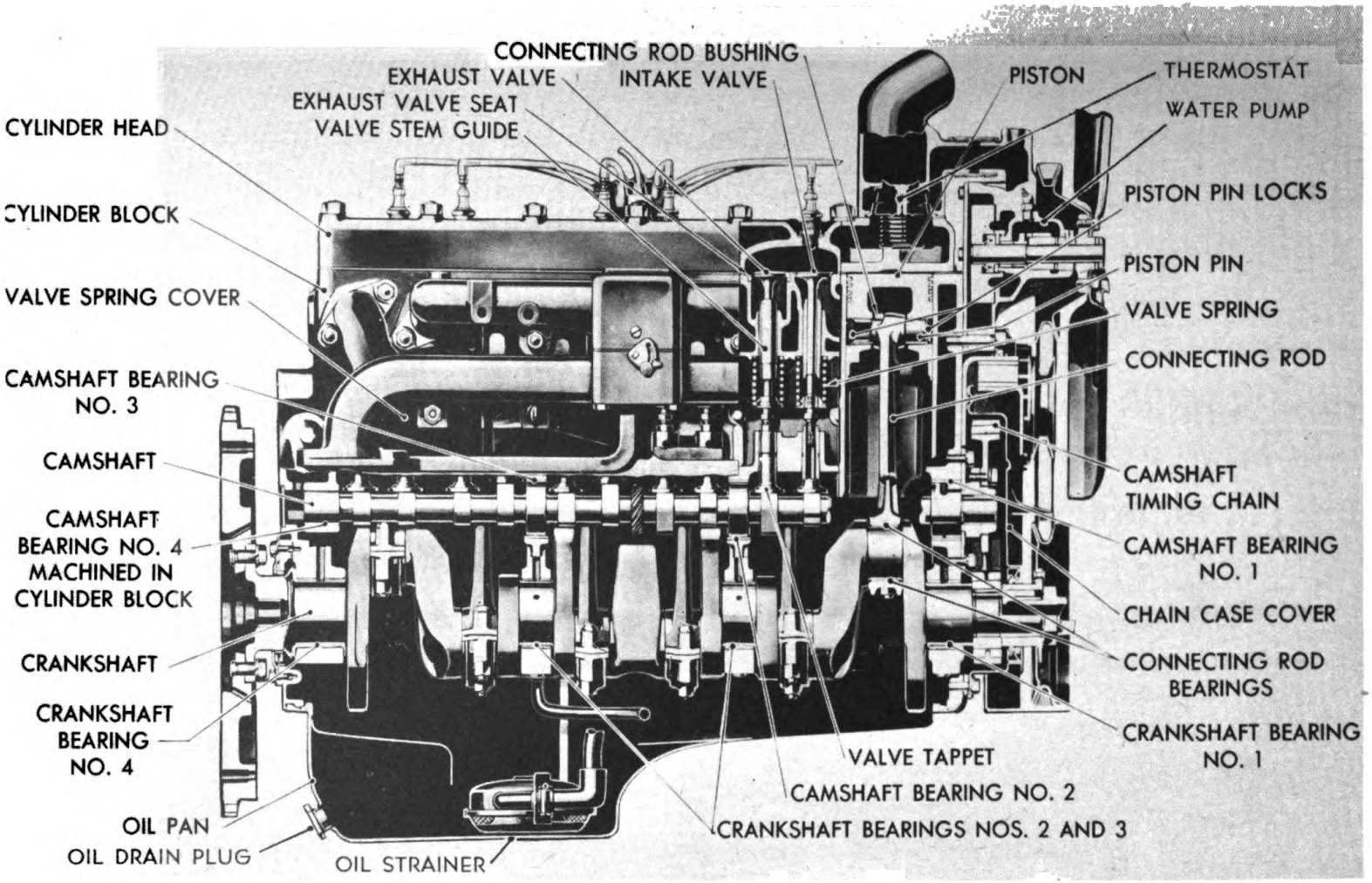


Figure 64—Side Sectional View Showing Functional Elements

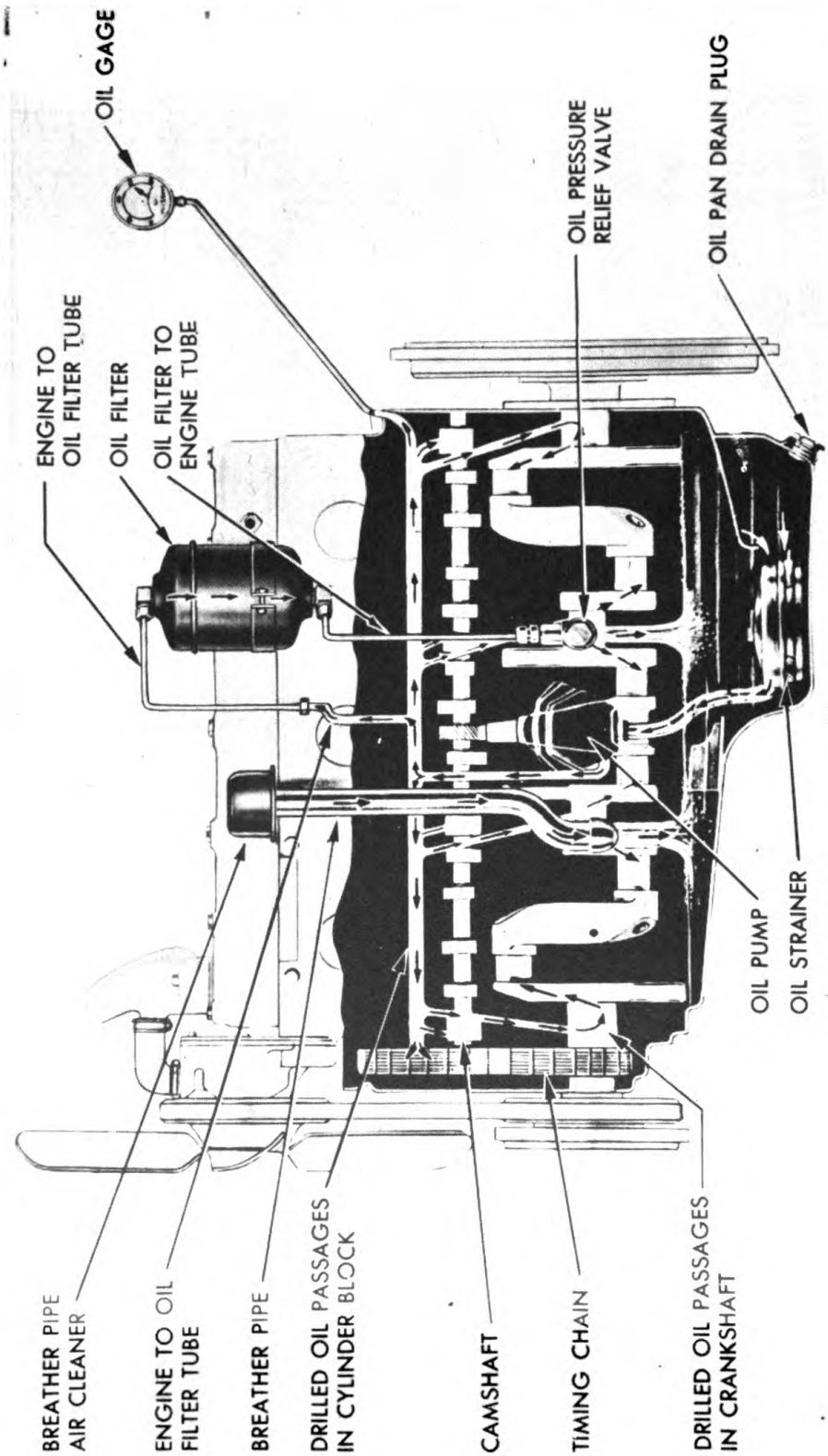
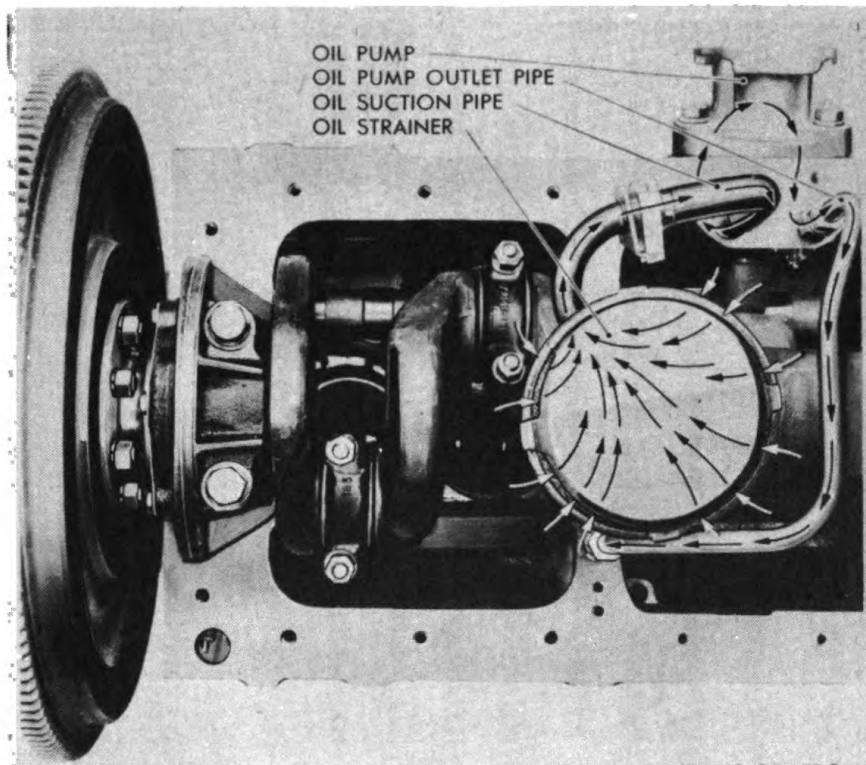


Figure 65—Oiling System



SUCTION CREATED BY REVOLVING GEARS IN THE OIL PUMP DRAWS OIL FROM THE OIL PAN THROUGH A STRAINER SCREEN INTO THE PUMP, THE OIL IS FORCED THROUGH THE PUMP BY THE REVOLVING ACTION OF THE PUMP GEARS INTO THE OIL PUMP OUTLET PIPE. THE OIL PUMP OUTLET PIPE CARRIES THE OIL FROM THE OIL PUMP LOCATED ON THE RIGHT SIDE OF THE ENGINE TO THE DRILLED OIL PASSAGES AT THE LEFT SIDE OF THE ENGINE.

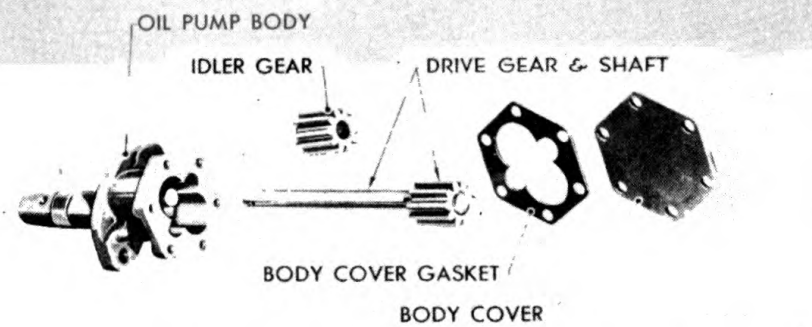
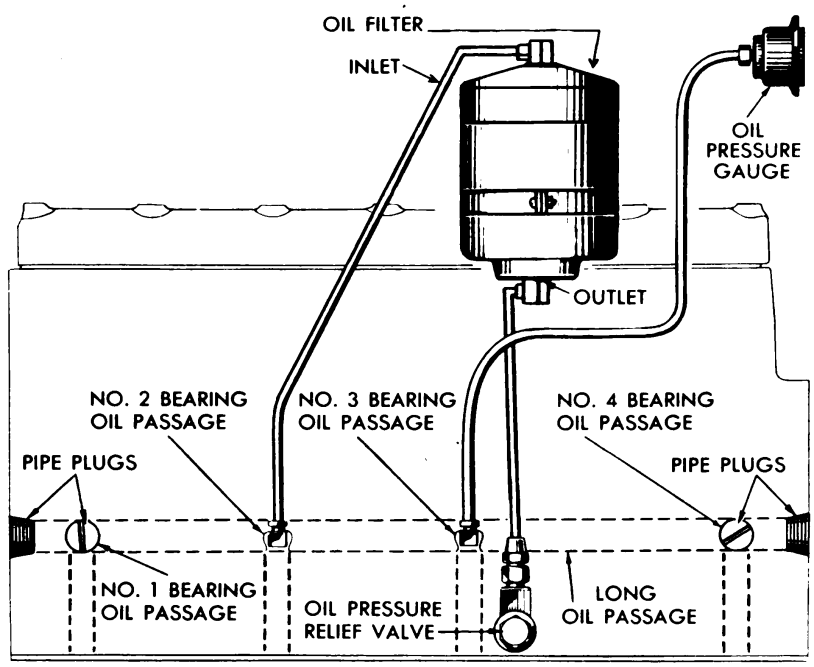


Figure 66—Oil Strainer and Oil Pump

ure 68.) A limited amount of oil is forced from the camshaft front bearing to the chain case to lubricate the timing chain and sprockets (figure 68). The cylinder walls, the pistons, the piston pins and valve tappets are lubricated by an oil spray from the connecting rod bearings. (Figure 69.) The camshaft thrust plate is lubricated through an oil passage in the camshaft. (Figure 69.) Oil pressure is controlled by a relief valve mounted on the left side of the engine. (Figure 70.)



OIL PASSAGES ARE DRILLED IN THE CYLINDER BLOCK AND ARE THE PASSAGES THROUGH WHICH THE OIL TRAVELS TO ALL CAMSHAFT AND CRANKSHAFT BEARINGS. THE OUTER ENDS OF THE No. 1 AND No. 4 BEARING OIL PASSAGES ARE CLOSED WITH PIPE PLUGS ALONG THE LEFT SIDE OF THE ENGINE, THE OIL FILTER INLET TUBE IS ATTACHED AT No. 2 AND THE OIL PRESSURE GAGE TUBE AT No. 3. THE LONG OIL PASSAGE DRILLED THE FULL LENGTH OF THE CYLINDER BLOCK IS CLOSED AT EACH END WITH A COUNTER-SUNK HEAD PIPE PLUG.

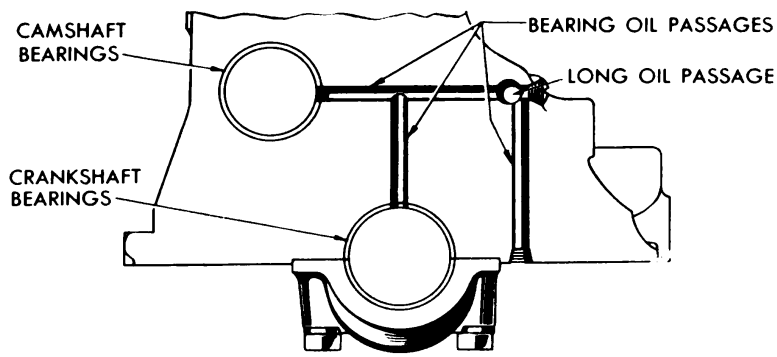


Figure 67—Crankshaft and Camshaft Bearing Oiling

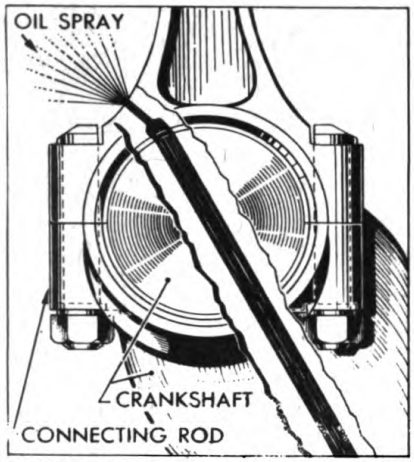
The engine oil passes through the filter when the relief valve plunger is off its seat. (Figure 70.)

58. COOLING SYSTEM.

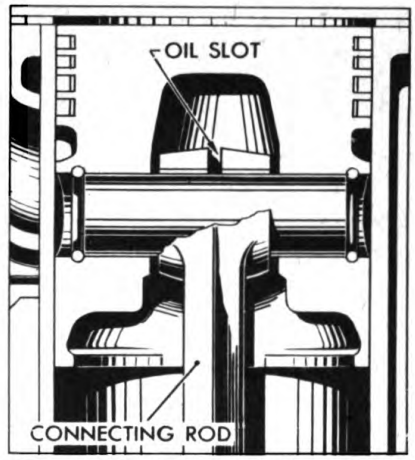
a. **Circulation.** The cooling solution is circulated by a centrifugal pump, through water jackets around the cylinder bores and valve ports where it picks up heat generated by combustion. From the

Figure 68—Connecting Rod Bearings and Timing Chain Oiling

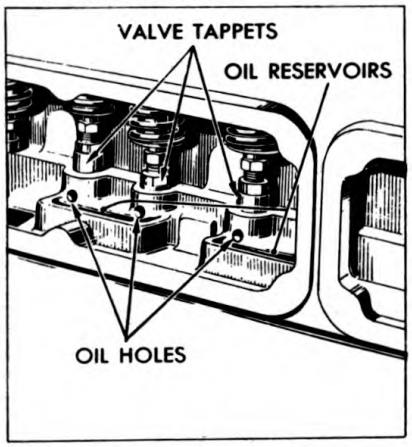
cylinder block, the solution circulates to and through the fin and tube type radiator where heat is dissipated into air drawn through the radiator by a fan. The circulation of the cooling solution and engine temperature are automatically controlled by a thermostat and bypass located in the cylinder head. (Figures 71 and 72.) The water pump and fan are mounted on the front of the engine and are belt driven. (Figure 73.) The water pump consists of a shaft and impeller mount-



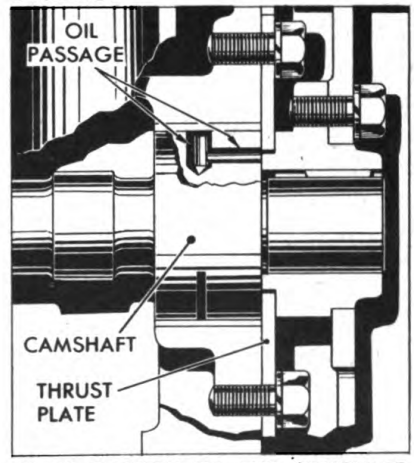
AS THE CRANKSHAFT REVOLVES AND THE OIL HOLE DRILLED IN EACH CONNECTING ROD PASSES THE OIL PASSAGE IN THE CRANKSHAFT, A SPRAY OF OIL IS RELEASED TO THE CYLINDER BORE WALLS, PISTON PINS AND VALVE TAPPETS.



AN OIL SLOT IS MACHINED IN THE TOP OF EACH CONNECTING ROD THROUGH WHICH OIL SPRAYED FROM THE OIL HOLE IN THE CONNECTING ROD LOWER BEARINGS CAN REACH THE CONNECTING ROD PISTON PIN BUSHING.



OIL HOLES ARE DRILLED IN THE CYLINDER BLOCK AT EACH VALVE TAPPET TO ALLOW THE OIL SPRAYED FROM THE OIL HOLE IN THE CONNECTING ROD LOWER BEARINGS AND COLLECTED IN OIL RESERVOIRS TO REACH THE VALVE TAPPETS.

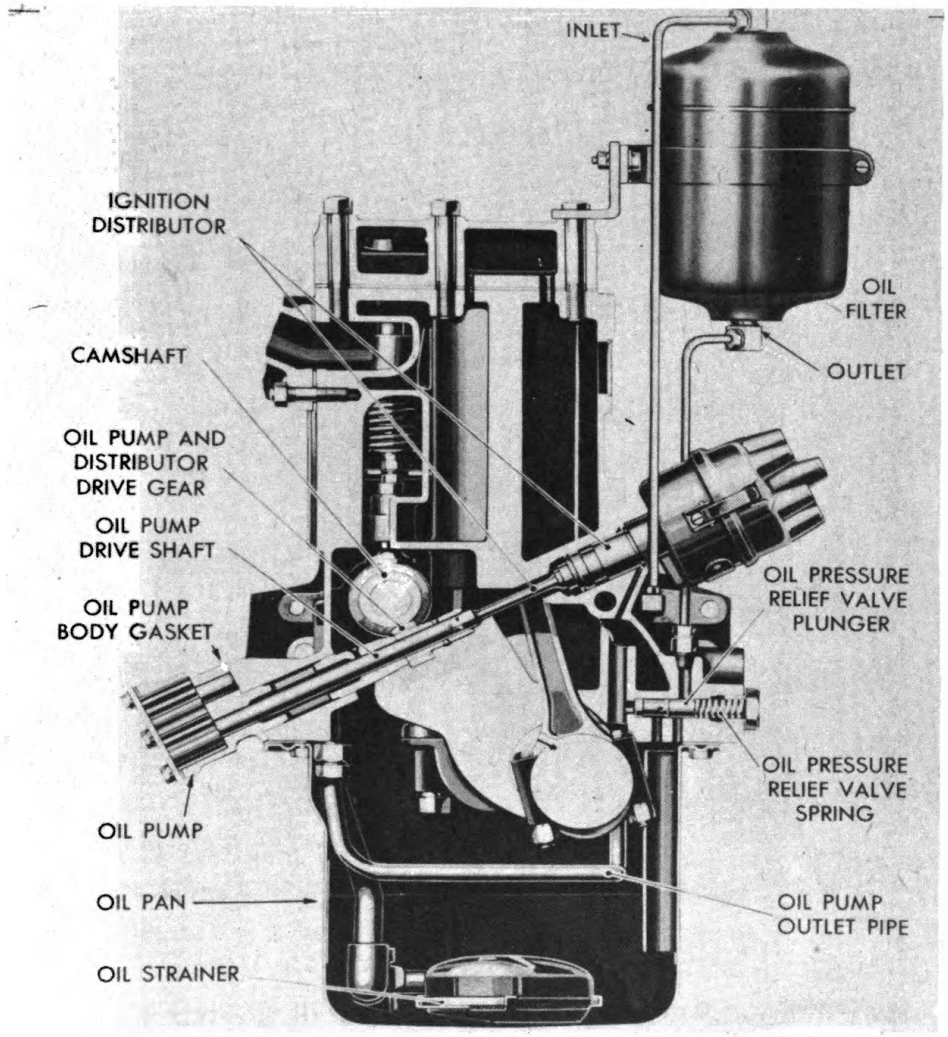


OIL IS SUPPLIED TO THE CAMSHAFT THRUST PLATE THROUGH AN OIL PASSAGE DRILLED IN THE FRONT END OF THE CAMSHAFT THAT OBTAINS ITS SUPPLY OF OIL AS IT REVOLVES PAST THE CYLINDER BLOCK OIL PASSAGE OPENING.

Figure 69—Pistons, Piston Pins, Valve Tappets and Camshaft Oiling

ed in two bearings in the housing. The fan is bolted to a hub mounted on the forward end of the shaft.

b. **Thermostat.** If for any reason the thermostat has been removed or a new thermostat is to be installed, install with "marked front" facing the radiator with gaskets above and below thermostat as shown in figure 71. Place the cylinder head water outlet elbow and by-pass elbow assembly over the head and pump openings. In-



OIL PRESSURE IS CONTROLLED AUTOMATICALLY BY A PLUNGER WHICH OPERATES AGAINST SPRING PRESSURE. WHEN THE OIL PRESSURE IN THE SYSTEM OVERCOMES THE SPRING PRESSURE THE OIL PRESSURE RELIEF VALVE PLUNGER IS UNSEATED AND EXCESS OIL RETURNS TO THE OIL PAN. THE OIL GOES THROUGH THE FILTER AFTER THE BEARINGS HAVE BEEN SUPPLIED AND THE OIL PRESSURE RELIEF VALVE PLUNGER IS UNSEATED. THE OIL FILTER TUBES ARE NOT DIRECT OIL PASSAGES AND IF THE OIL FILTER BECOMES CLOGGED, OIL WILL STILL CIRCULATE TO THE BEARINGS.

Figure 70—Oil Pressure Relief Valve and Oil Filter

stall the capscrews with lockwashers to attach the outlet elbow and tighten clamps to attach the by-pass elbow.

59. CONNECTING ROD BEARING REPLACEMENT.

Removing Oil Pan. Drain the engine oil and remove the capscrews which hold the engine oil pan to the crankcase. Lower the oil pan, remove the old gaskets and clean the pan thoroughly. Install the oil drain plug. Remove the cap bolt nuts and bearing caps from the

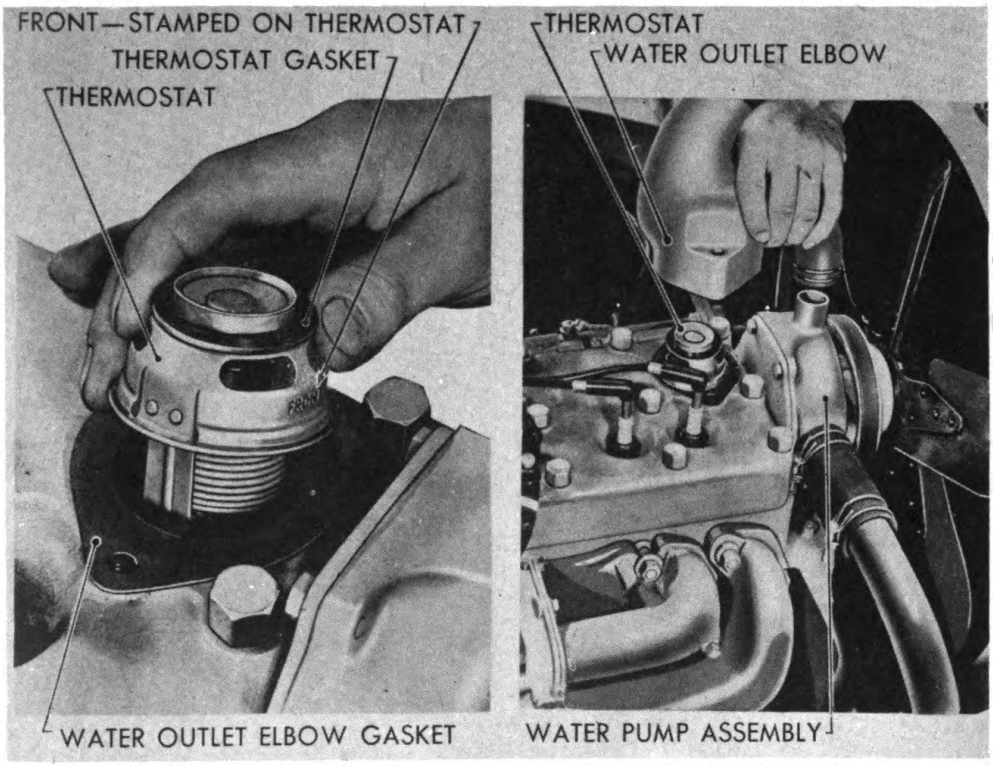


Figure 71—Cooling System—Thermostat Control

connecting rods. Raise the rods off the crankshaft and remove the bearings.

NOTE

A number is stamped on the lower end of the rod and cap, on the camshaft side. These numbers serve two purposes, they correspond to the number of the cylinder and they indicate the position in which the connecting rod must be installed.

60. INSPECT CRANKSHAFT CONNECTING ROD BEARING JOURNALS AND BEARINGS.

If the journals are scored, or rough, or if, when measured with a micrometer, the journal wear exceeds 0.002 inch, taper or out of round exceeds 0.001 inch, regrind the journals or rebuild the engine. If the crankshaft journals are smooth and the wear does not exceed the maximum allowable, inspect the bearings. If the bearing metal is checked or cracked, replace the bearings. To check connecting rod bearing clearance, oil the crankshaft journal and place a piece of 0.003 inch brass shim stock ¼ inch wide and one inch long length-

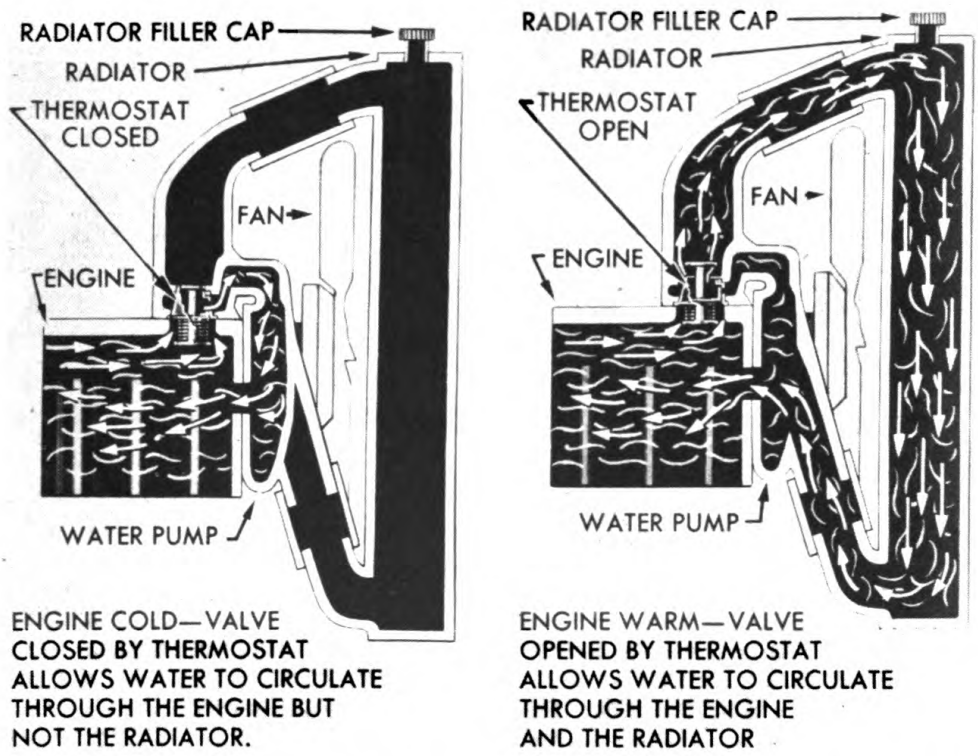


Figure 72—Cooling System—Operation of Cooling System Thermostat

wise between the bearing and journal. (Figure 74.) Install the bearing cap and tighten the cap bolt nuts to 45- to 50-foot pounds. If the shim does not cause a heavy drag when the crankshaft is moved, the bearing clearance exceeds the maximum allowable of 0.0025 inch and new standard or undersize bearings will be required. Connecting rod bearings are available in undersizes of 0.010 inch, 0.012 inch.

61. INSTALL CONNECTING ROD BEARINGS.

Clean the bores of the connecting rods, the bearings and the journals thoroughly. Place the bearings in the rods and caps and attach the rods to the crankshaft. Tighten the cap bolt nuts to 45- to 50-foot pounds with torque wrench.

62. INSTALL OIL PAN.

Install new gaskets on the oil pan. Raise the pan into position and install the attaching cap screws. Fill the engine with engine oil of the proper grade for the temperature. See Lubrication Section XVI.

63. PISTON AND RING REPLACEMENT.

Remove cylinder head. Drain engine oil, remove oil pan and

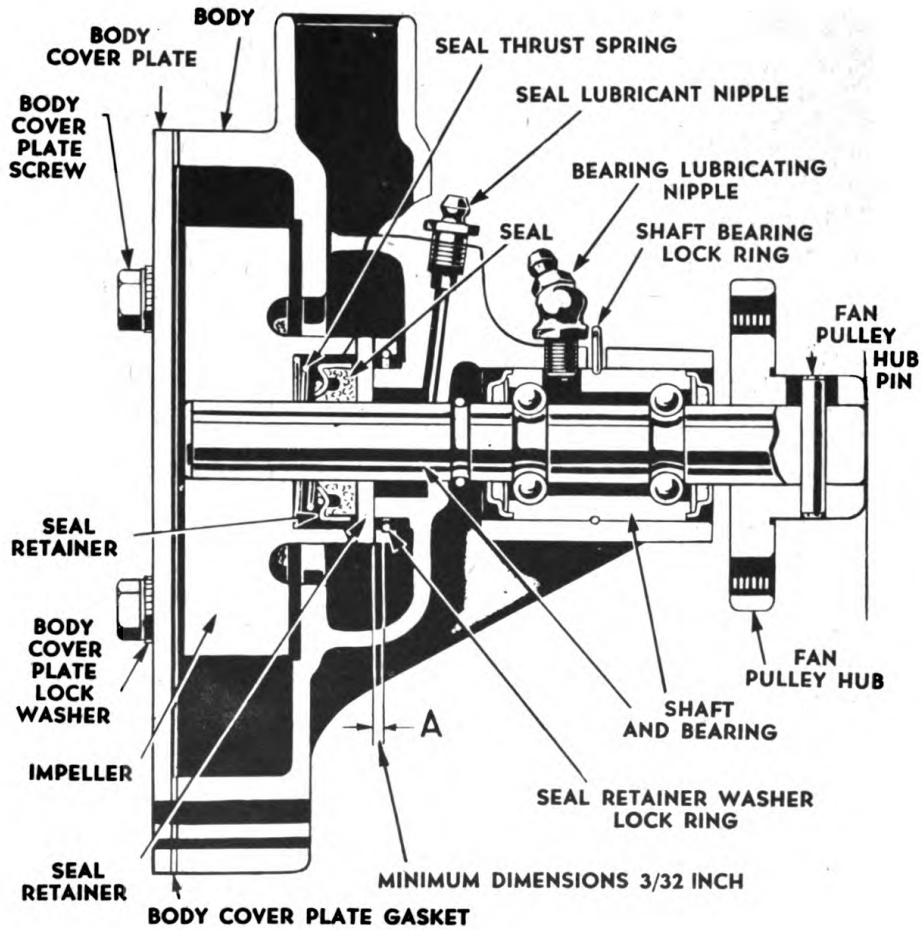


Figure 73—Cutaway View of Engine Water Pump

disconnect connecting rod caps. Push connecting rod and piston out through the top of the cylinder bore. As each connecting rod and piston assembly is removed from the engine, assemble the bearing inserts and cap in the same position in which they were removed. Inspect piston, ring and connecting rod assemblies. Remove any ridge that may have formed in the cylinder bores at the top of the ring travel with cylinder ridge reamer. Do not cut more than 1/64 of an

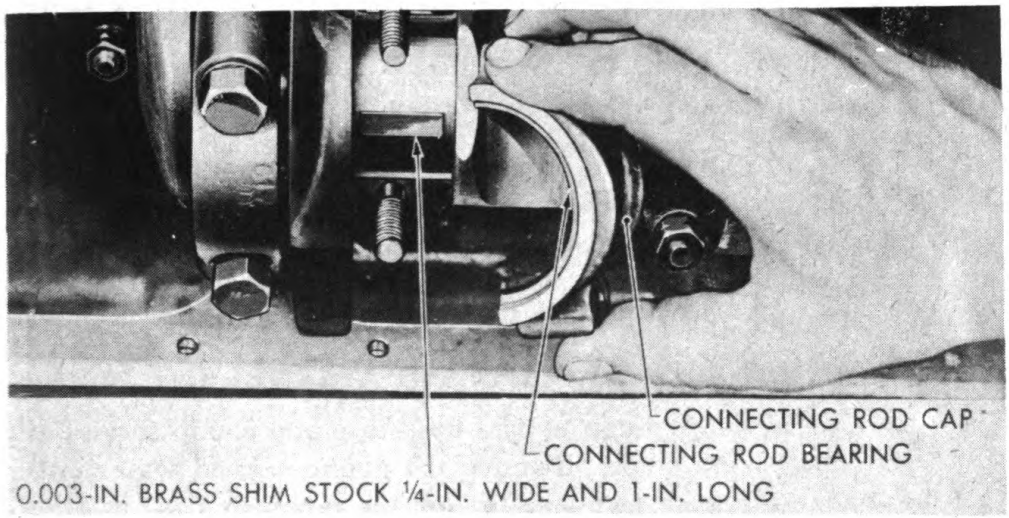


Figure 74—Checking Connecting Rod Bearing Clearance

inch below bottom edge of ridge. Assemble and install piston, ring and connecting rod assemblies. Install connecting rod bearings. Install oil pan. Install cylinder head.

64. CHAIN CASE COVER OIL SEAL, TIMING CHAIN AND SPROCKET REPLACEMENT.

a. Drain the radiator and remove hood. Loosen hose clamp at lower radiator hose and at the water pump housing connection and pull hose away from pump. Loosen both hose clamps of the upper radiator inlet hose and pull hose away from radiator core.

b. Remove three foot bolts on each side of the skid which hold the radiator assembly in place, after which the radiator can be lifted off. Remove lower pulley and then remove the nuts and cap bolts that attach the timing chain cover. This will expose the timing chain

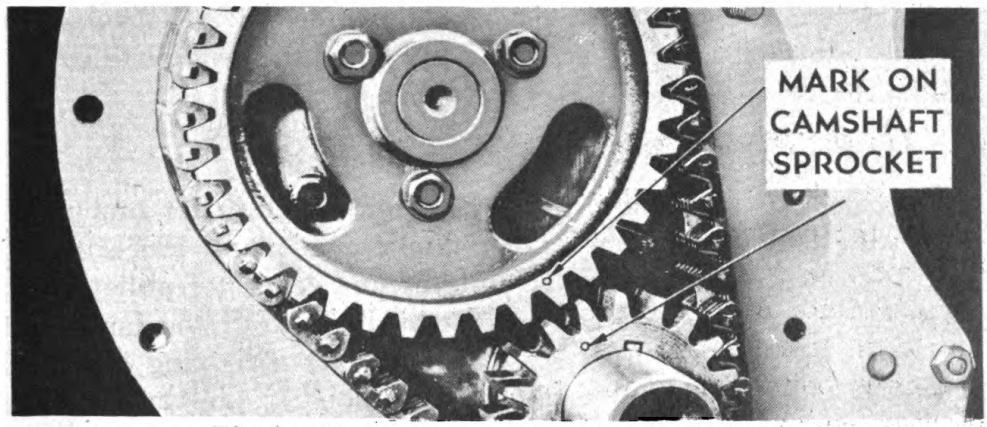


Figure 75—Timing Sprockets and Chain

and sprockets. (Figure 75.) Inspect and remove timing chain and sprockets.

65. REMOVE FAN BELT.

Loosen the generator mounting bolt nuts and the adjusting strap capscrew. Remove the nut from water pump stud that holds the adjusting strap and move the strap off the stud. Then move the generator toward the engine and remove the fan belt from the generator drive pulley.

66. REMOVE ELBOW AND BYPASS ASSEMBLY.

Loose the water pump bypass hose to pump clamp screws and pull hose away from elbow. Remove the cylinder head water outlet elbow attaching cap screws and lift off the elbow bypass assembly carefully to prevent damaging the thermostat.

67. REMOVE WATER PUMP.

Remove the four capscrews that attach the fan blades to the water pump and remove the fan blades and fan hub. Remove the water pump stud nuts, move the pump forward off the studs and lift it out.

68. INSTALL CRANKSHAFT SPROCKET.

Install the crankshaft sprocket drive key in the crankshaft and press the crankshaft sprocket on the shaft with the mark 0 facing out. (See figure 75.) Then reassemble in the reverse manner of disassembly. In reassembling the unit at this point, inspect all gaskets, hose connections and bolts carefully. If damaged in any degree, replace. Install oil seal in chain case cover. When reassembling the water pump and fan be sure to use a new gasket on the attaching studs. Install the stud nuts and cap bolts with lockwashers; securely attach fan pulley and fan with reinforcement plate toward pulley.

69. TO CONNECT AND ADJUST FAN BELT.

Attach the generator adjusting strap to the water pump stud and to the generator, but do not tighten connections. Place the fan belt over the crankshaft fan drive pulley and generator pulley. Pivot the generator away from the engine by hand until the fan belt is taut with less than ½-inch slack. Tighten the adjusting strap and mounting bolts. Reassemble radiator and hood in the reverse order of disassembly.

70. CRANKSHAFT BEARING REPLACEMENT.

Remove Crankshaft Bearings—(Figures 76 and 77.) Remove engine oil pan. Remove oil pump outlet pipe and screw the oil strainer and suction pipe out of the block. Remove the two lower chain case cover capscrews which enter the oil pan front and oil seal plate and three screws which hold the plate to the block. Mark the bearing caps and the cylinder block (figure 85) so that the caps can be installed in their original position. The center bearing caps are machined with a slight offset and damage will result if they are installed in the wrong position. Remove the front bearing cap and turn the crankshaft in the direction it runs to remove the upper half of the bearing. If the upper half of the bearing does not rotate freely with the crankshaft, use removing tool or an old bearing shell. After the front bearing and crankshaft journal have been inspected, install the bearing and cap to hold the crankshaft in line and remove the other bearings for inspection.

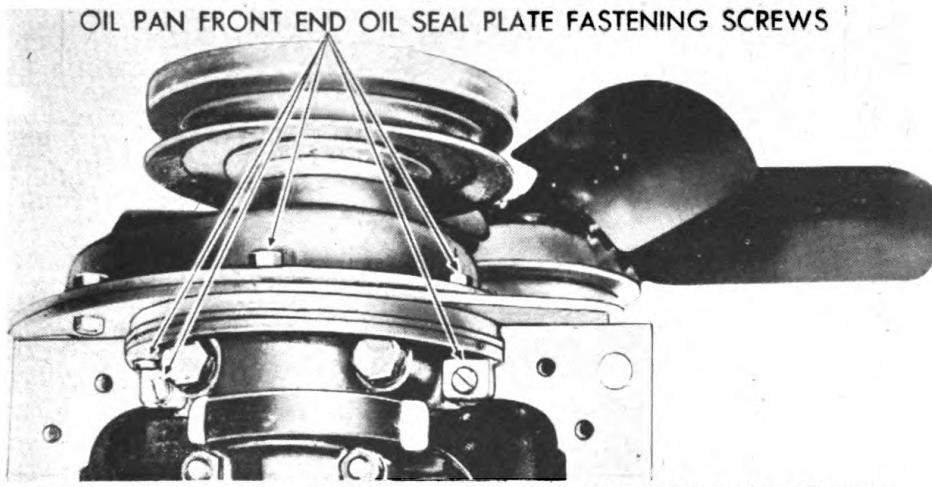


Figure 76—Oil Pan Front End Oil Seal Plate Fastening Screws

Figure 77—Upper Crankshaft Bearing Removal

71. INSPECT BEARINGS AND CRANKSHAFT MAIN BEARING JOURNALS—Figure 78.)

Examine the bearing for scores or cracks in the bearing metal and inspect the crankshaft journals for scores or roughness. If the bearings and journals are smooth and in no way damaged, oil a journal and place a piece of 0.003 inch brass shim stock ½ inch wide and one inch long lengthwise between the bearing and the journal. Install the bearing cap and tighten the cap bolt nuts to 75- to 80-foot pounds with torque wrench. If the shim does not cause a perceptible drag when the crankshaft is moved, the bearing clearance is in excess of the maximum allowable clearance of 0.0035 inch. If the bearings are scored or damaged or if the bearing clearance exceeds 0.0035 inch replace the bearings. If the crankshaft journals are scored or damaged, rebuild the engine assembly.

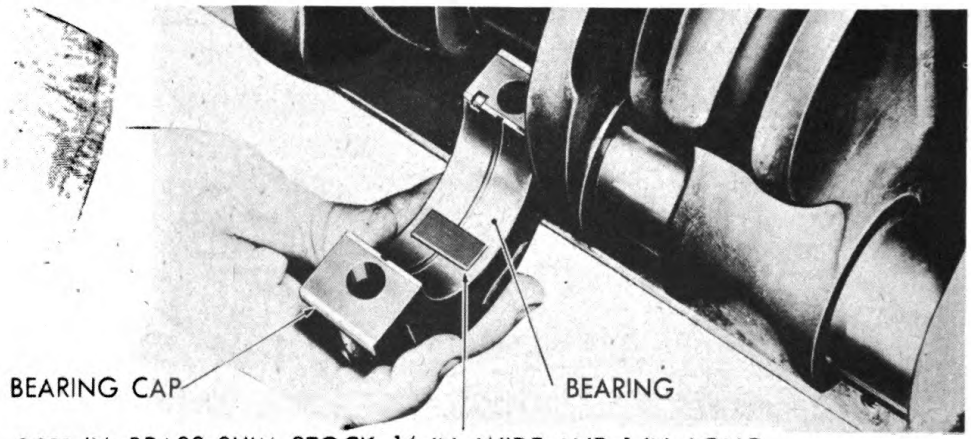


Figure 78—Checking Crankshaft Bearing Clearance

72. INSTALL CRANKSHAFT BEARINGS.

a. The upper half of the front and rear bearings have oil holes while the lower halves do not. (Figure 79.) Both halves of the intermediate bearings are the same. Install the upper halves of the new bearings with special replacer. (Figure 77.) Install the lower halves of the bearings and bearing caps. Use new cap gaskets and oil seal at rear bearing. Tighten the bearing cap screws to 75- to 80-pounds with torque wrench. Screw oil suction pipe and strainer into the block and connect the oil pump outlet pipe.

b. Place oil pan front end oil seal plate in position and install three screws which hold it to the crankcase. Install the two lower chain case cover cap screws which enter the oil pan front end oil

seal plate. Install engine oil pan and fill engine with proper grade of engine oil depending on the temperature (See Lubrication Section XVI).

SECTON XXIV

DISASSEMBLY OF ENGINE (ENGINE REMOVED FROM MOUNTING)

73. REMOVE CARBURETOR AND GOVERNOR ASSEMBLY.

Disconnect the fuel tube at the carburetor connection. Disconnect the carburetor control rod from the carburetor throttle lever and the rod from automatic choke. Remove the carburetor attaching stud nuts and remove the carburetor. (Figure 80.)

74. REMOVE STARTER.

Remove wires and the attaching cap screws and pull starter out of flywheel housing. (Figure 81.)

75. REMOVE GENERATOR.

Remove cap bolt from adjusting strap and the two nuts and

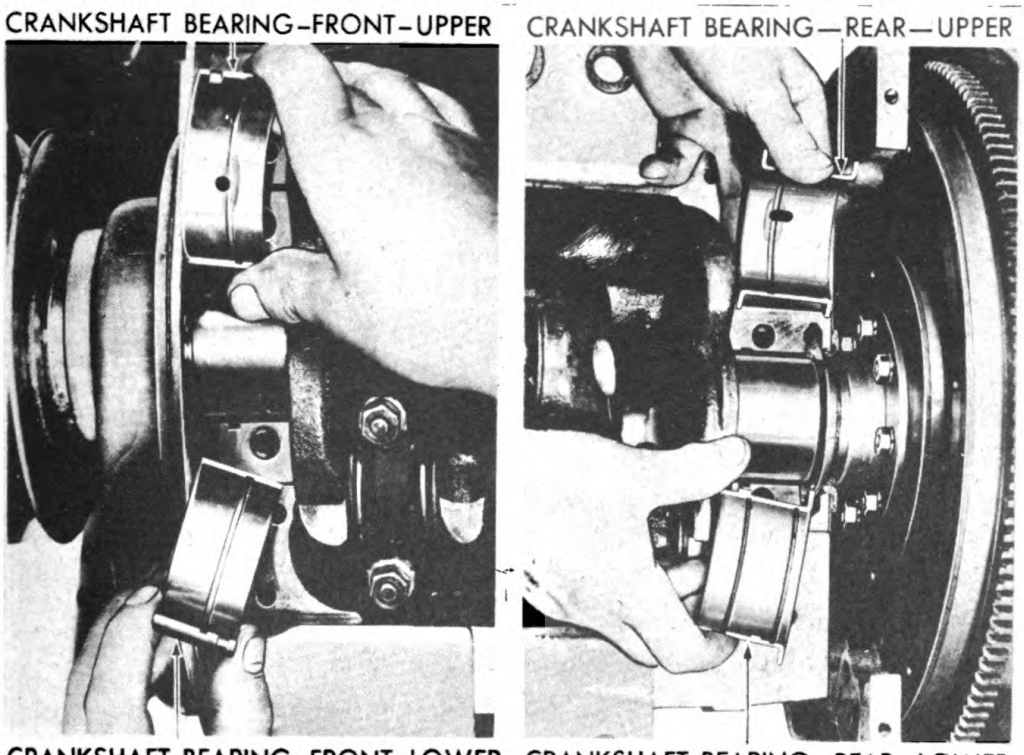


Figure 79—Crankshaft Front and Rear Bearings

bolts that attach the generator to the generator mounting bracket. (Figure 81.)

76. CLEAN ENGINE ASSEMBLY.

Thoroughly wash the engine exterior with SOLVENT, dry cleaning, and dry with compressed air.

77. REMOVE IGNITION UNITS.

Remove the spark plug cables from the spark plugs. Remove the spark plugs. Remove the nut from the cylinder head stud that attaches the cable tube and mounting bracket and remove the bracket from the stud. (Figure 81.) Release the distributor cap clamp springs and remove the distributor cap and spark plug cables. Disconnect the primary wire and remove the cap screw that holds the distributor lock plate to the cylinder block and pull the distributor assembly out of the block.

78. REMOVE FUEL PUMP.

Remove the wing nut which holds the heat shield to the fuel pump. Loosen the exhaust manifold stud nut that attaches the end of the shield and slide the shield from the stud. Remove the shield from the pump. Disconnect the fuel pump to carburetor tube at the pump. Remove the two attaching capscrews and remove the pump.

79. REMOVE OIL PUMP—(Figure 80.)

Remove the two oil pump attaching cap screws and pull the pump out of the cylinder block.

80. REMOVE WATER PUMP (Figure 81) AND WATER DISTRIBUTING TUBE.

Remove the two case clamp screws and disconnect the bypass elbow. Loosen the generator adjusting strap at the generator adjusting screw. Remove the nuts from the three pump attaching studs and remove the pump. Pull the water distributing tube out of the block. If the tube is corroded or damaged by removal, install a new tube when the engine is reassembled. Remove the cylinder head elbow and thermostat. Then temporarily install the elbow and pump and reverse flush the cylinder block.

81. REMOVE OIL PAN—(Figure 80.)

Lift engine and drain oil from crankcase and remove oil pan. Remove oil pan gaskets and thoroughly clean the oil pan. Mount

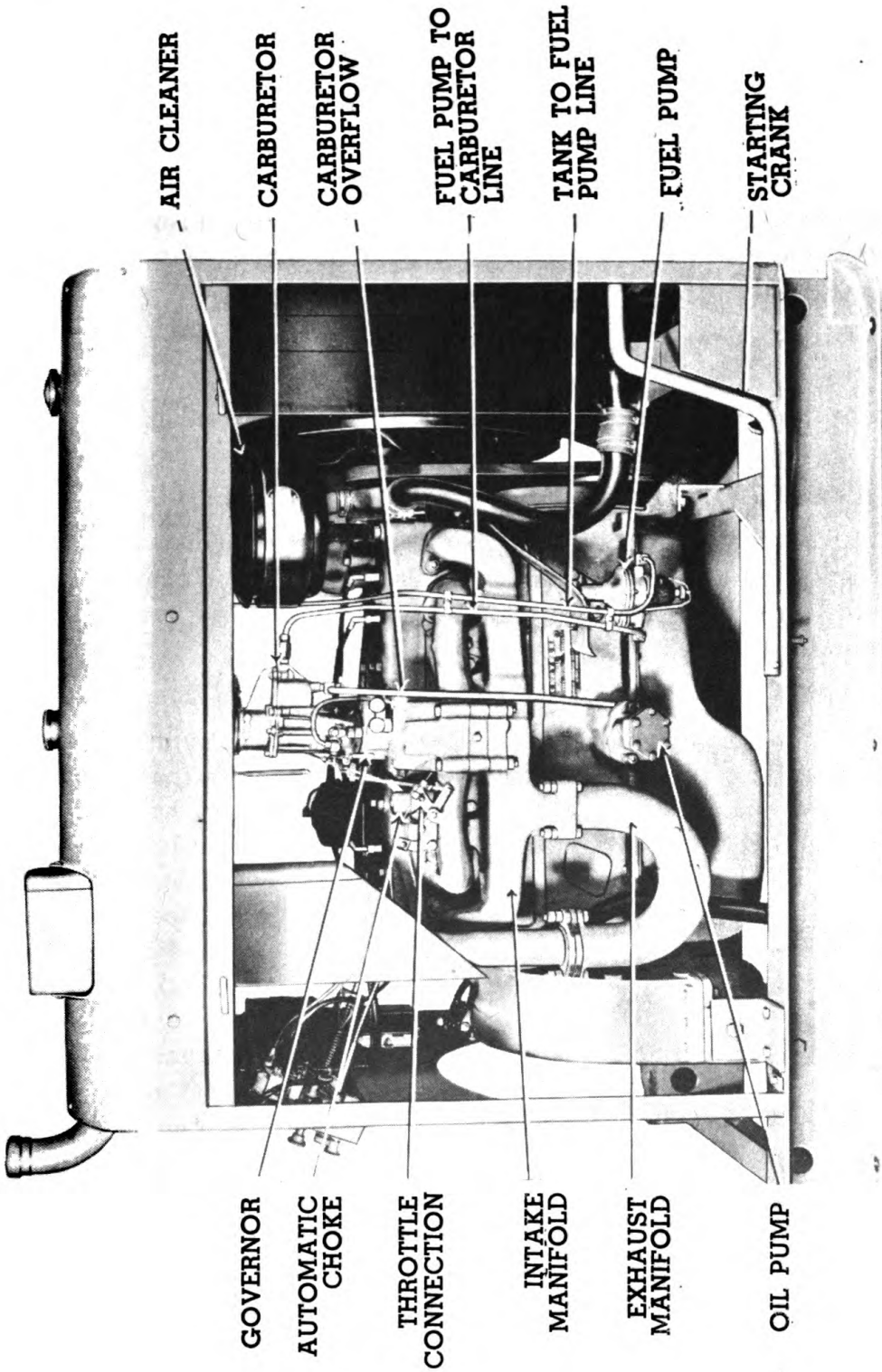


Figure 80—Manifold Side View of Engine

the engine in an engine stand so that the oil pan flange of the crankcase can be securely clamped to the engine stand.

82. REMOVE MANIFOLD ASSEMBLY AND CRANKCASE VENTILATOR

Remove the stud nuts which attach the manifold assembly to the block and remove the manifold. Remove cap screws in top of crankcase ventilator pipe and remove from engine.

83. REMOVE THERMOSTAT AND OIL PRESSURE RELIEF VALVE—(Figure 80.)

Remove the water outlet elbow and lift out the thermostat. Remove the oil pressure relief valve cap, spring and valve.

84. REMOVE OIL FILTER, BREATHER PIPE AND AIR CLEANER—(Figure 81.)

Remove two cylinder head stud nuts which hold the oil filter bracket to the cylinder head. Disconnect tubes from engine. Lift off air cleaner cap. Remove breather pipe by shaking and lifting the pipe from the engine.

85. REMOVE CYLINDER HEAD AND VALVES—(Figure 82.)

Remove the cylinder head cap screw and lift the cylinder head and gasket from the cylinder block. Clean carbon from the cylinder head, block and piston heads. Remove the valve spring covers and cover studs from the cylinder block. Turn engine until the front valve is all the way down on its seat and insert jaws of valve lifter, figure 83, between the lower end of the valve spring and the cylinder block, with the cupped jaw up. Hold the valve down and screw up the valve lifter until the valve spring is fully compressed. Remove the valve spring retainer locks from the lower end of the valve stem. Remove the valve lifter and lift the valve out of the valve guide. Raise the lower end of the valve spring above the tappet screw and pull the spring retainer and spring out between the tappet screw and the valve stem guide. Remove all valves and springs in this manner and place the valves in board with twelve holes or other device so that they can be identified with the port from which they were removed, and be reinstalled in their original position.

86. REMOVE TIMING CHAIN AND SPROCKETS—(Figure 84.)

Remove the starting crank jaw with socket wrench and pull the fan pulley from the crankshaft, and screws from chain case cover and remove cover using universal gear puller and two 3/8 inch

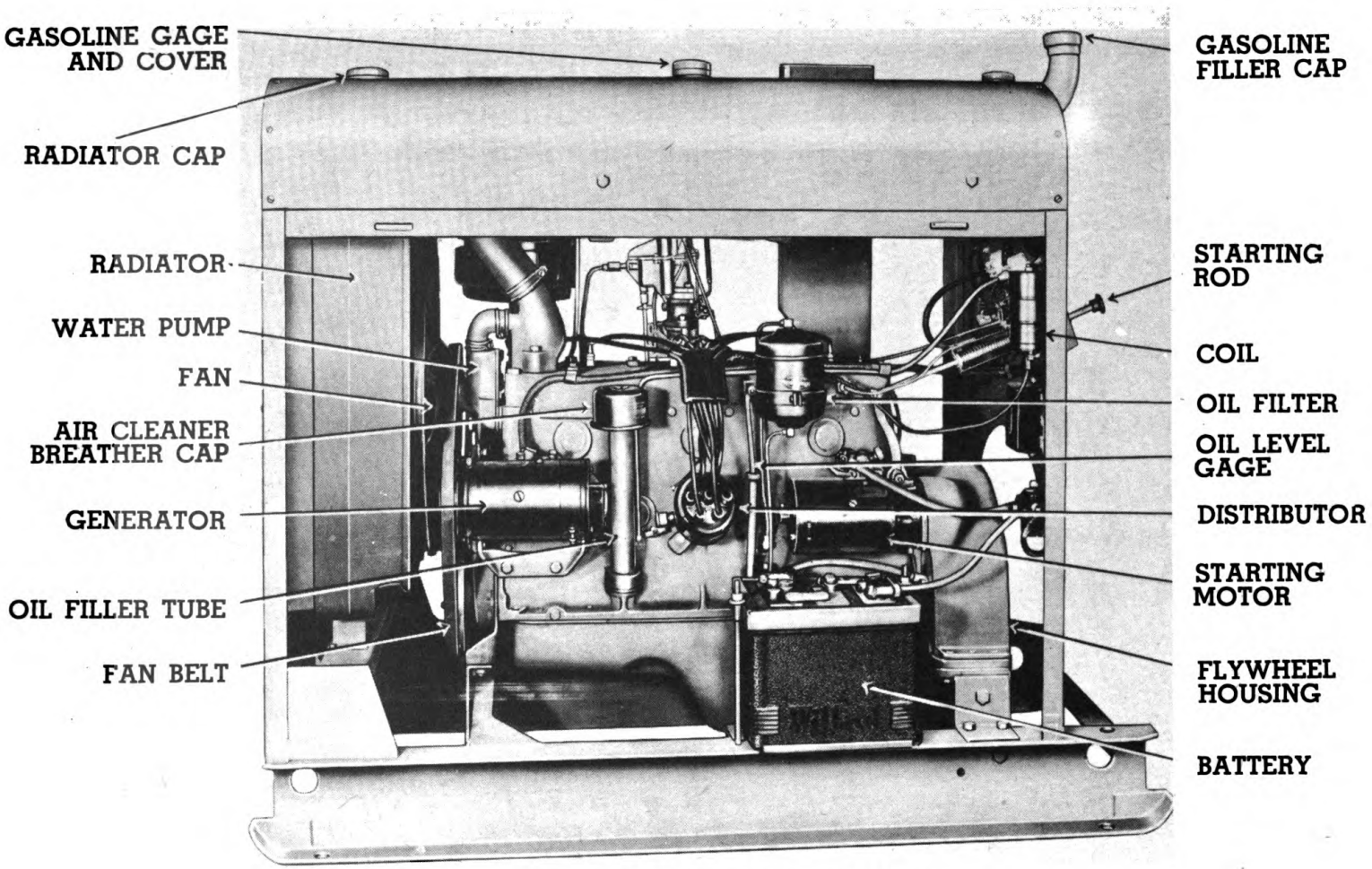


Figure 81—Distributor Side View of Engine

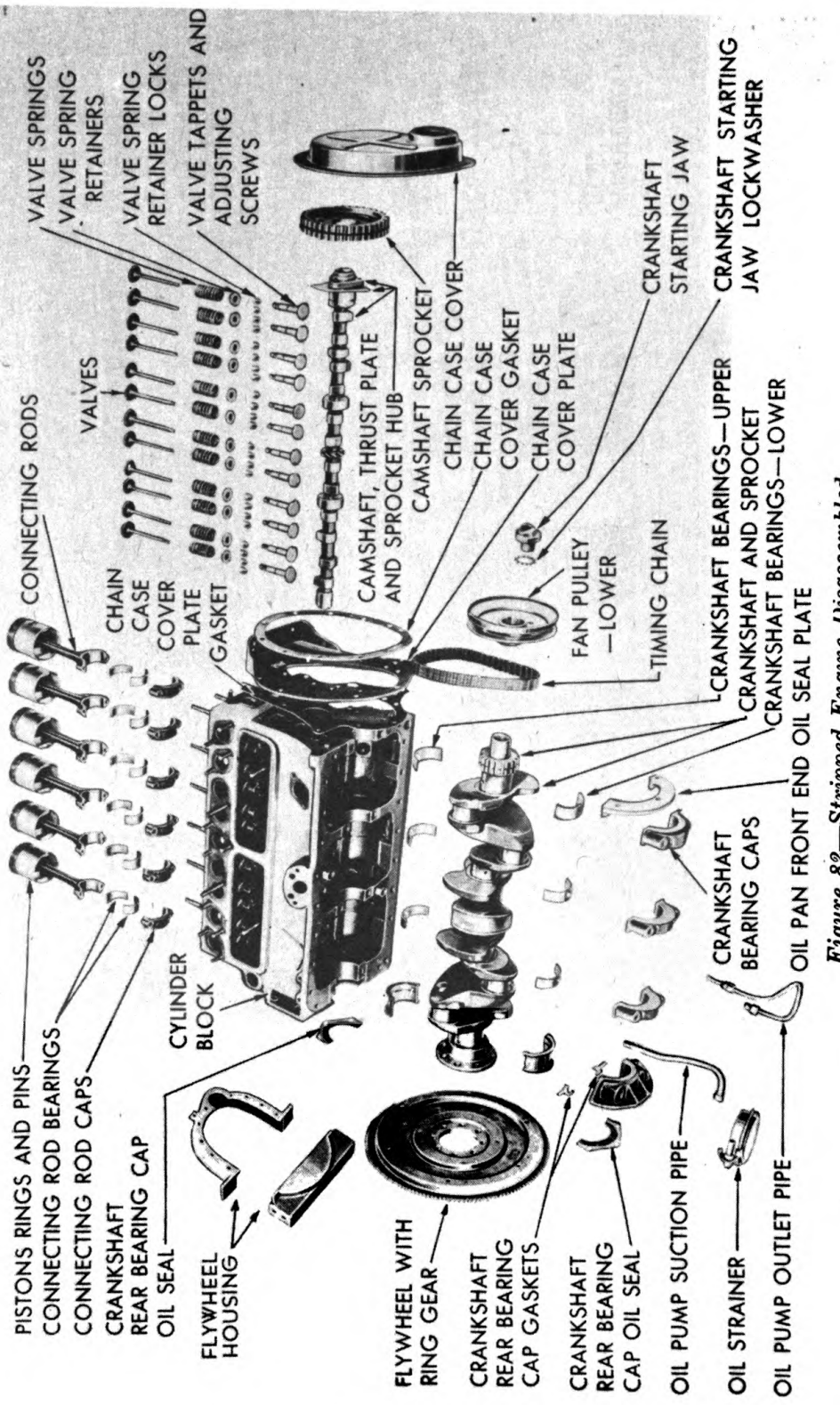


Figure 82—Stripped Engine Disassembled

capscrews. Turn the crankshaft clockwise so that the top span of the chain is tight. If the amount of slack in the lower span is greater than ¾ inch, replace the chain. If sprockets are noticeably worn, replace the sprockets. Remove the camshaft sprocket and chain. Remove the chain case cover plate and gasket.

87. REMOVE PISTON AND CONNECTING ROD ASSEMBLIES. —(Figure 82.)

Remove the oil strainer assembly from oil pump inlet pipe and unscrew the pipe from the cylinder block. Remove the connecting rod bolt nuts, the bearing caps and bearings. Push the piston and connecting rod assemblies out through the top of the cylinder bores.

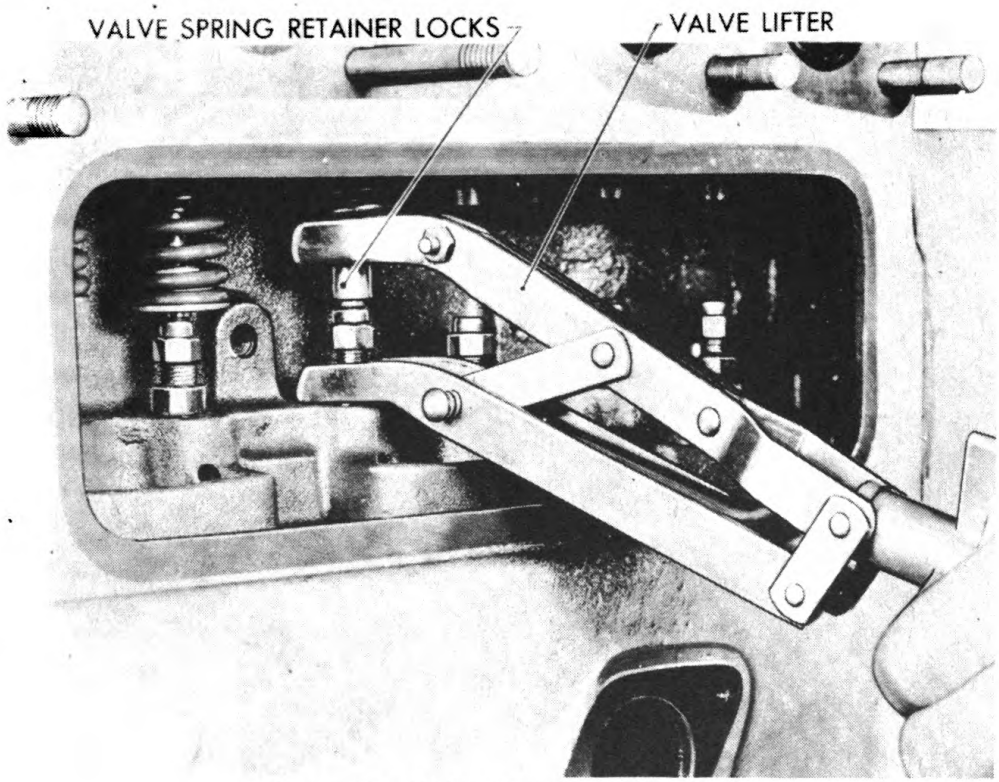


Figure 83—Valve Spring Removal

88. REMOVE CRANKSHAFT, FLYWHEEL AND BEARINGS.

Remove three screws which hold the oil pan front seal plate in place and remove the plate. Prick punch the front and intermediate crankshaft bearing caps and the block so that the caps can be installed in their original position. (Figure 85.) The intermediate caps are machined off center and damage will result if they are in-

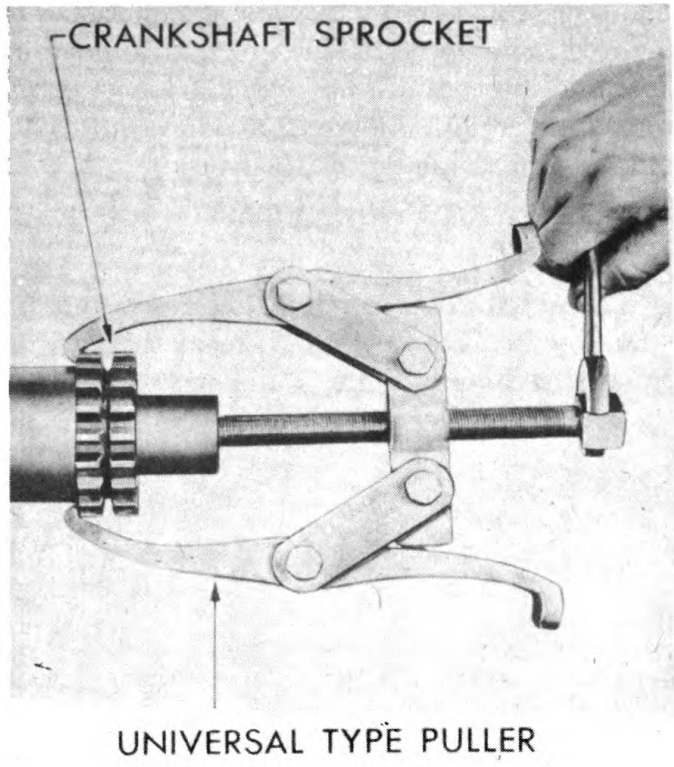


Figure 84—Crankshaft Sprocket Removal

stalled wrong. Remove the cap screws and bearing caps and lift the crankshaft out of the block. Remove the bearings from the caps and block. Remove capscrews which hold rear bearing oil seal upper half to end of crankcase. Remove the bolts which attach the flywheel to

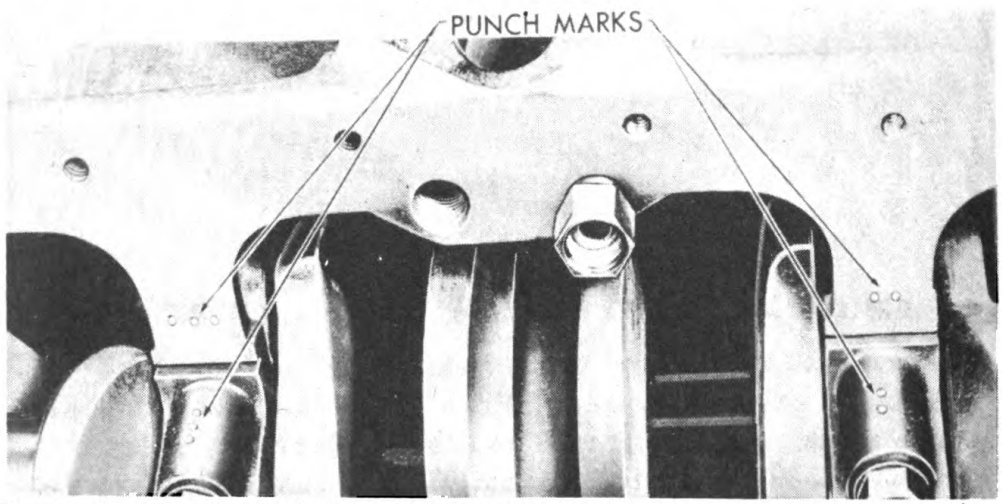


Figure 85—Punch Marks on Cylinder Block and Crankshaft Bearing Caps

the crankshaft and remove the flywheel. Remove the crankshaft sprocket.

89. MEASURE CAMSHAFT BEARING CLEARANCE— (Figure 86.)

Attach a dial indicator to the cylinder block with the plunger of the indicator resting against the back of the cam adjacent to the bearing. Pry the camshaft to and from the indicator so that the clearance in the bearing will be shown on the indicator. Check all bearings in the same manner.

90. REMOVE CAMSHAFT AND TAPPETS.

a. Remove two cap screws which hold the camshaft thrust plate to the cylinder block. Turn the camshaft one revolution to move the tappets away from the cams and pull the camshaft out slowly, being careful not to damage the camshaft or bearings. Lift the tappets from their guides and keep them in order so that they can be installed in their original position.

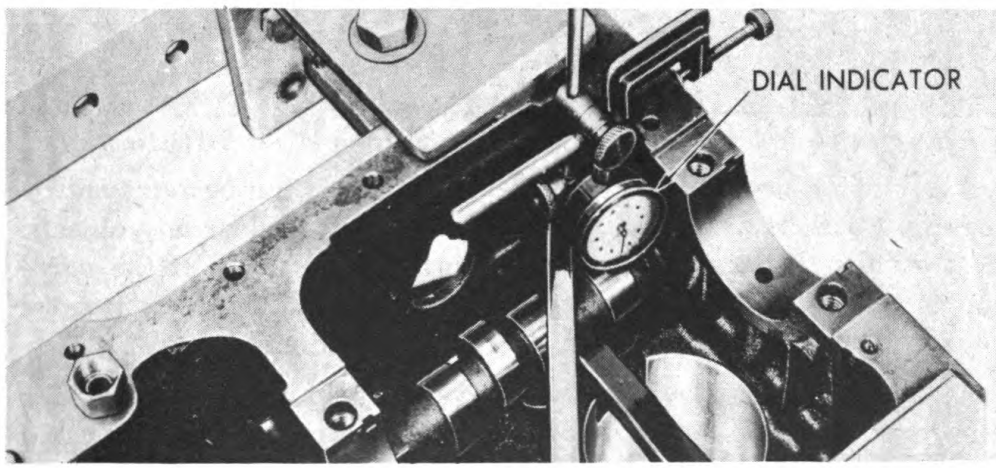


Figure 86—Measuring Camshaft Bearing Clearance

b. To remove the camshaft or thrust plate without removing the engine assembly, proceed to remove the radiator, then the water pump, cylinder head, fuel pump, oil pump, valve tappet cover plates and crankshaft pulley. Remove timing chain case cover, camshaft sprocket and timing chain. Raise the valves and hold them in position by inserting two wooden wedges under each valve head at opposite points to prevent cocking or warping of the valve head. (Figure 86A.) This operation is not necessary if the valves are being ground as the valves and springs will be removed.

c. Lift the valve tappets and hold them in place with spring type

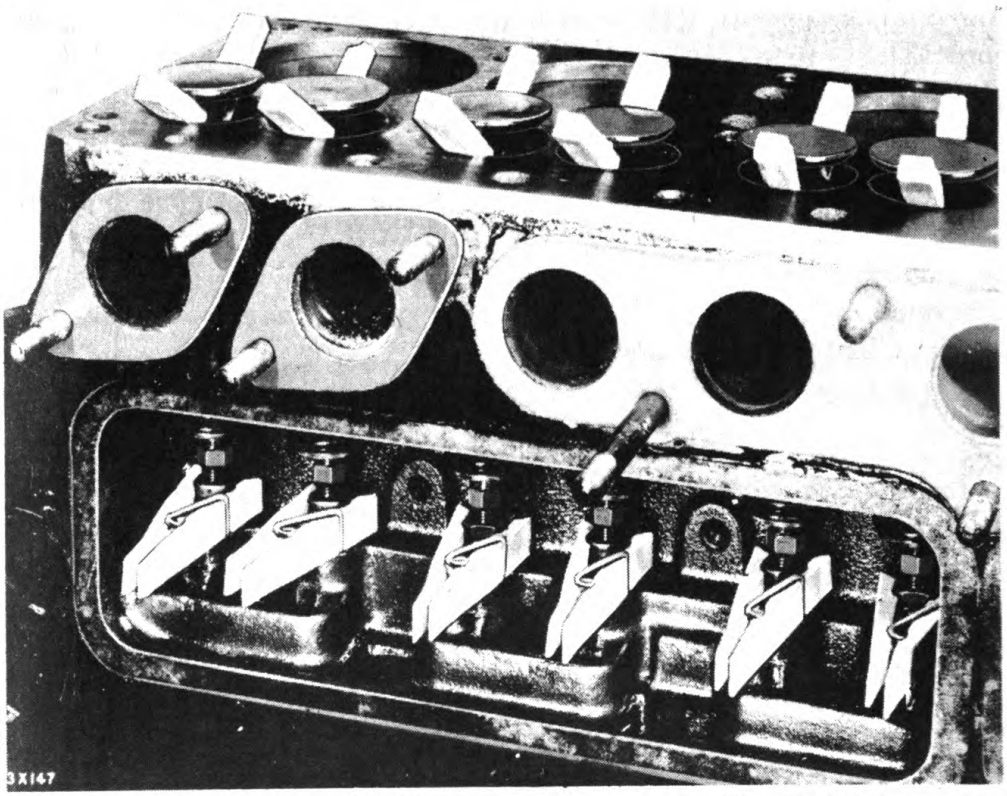


Figure 86A—Holding Up Valves and Tappets for Camshaft Removal

clothes pins or similar tools. The Camshaft may then be removed by rotating it as it is drawn out so that the cams will clear any objects. Press off the thrust plate and collar in an arbor press. If the valve tappets are to be replaced, remove the oil pan and then remove the clothes pins and the tappets will drop down and out.

d. To reassemble the camshaft, reverse the foregoing operations using new gaskets, reset the ignition timing and check the valve tappet clearance with the engine hot.

91. MEASURE CAMSHAFT JOURNALS AND DETERMINE BEARING WEAR.

a. If the camshaft bearing clearance, as determined, exceeds 0.002 inch measure each camshaft bearing journal with micrometer and replace the camshaft if the journals are worn 0.002 inch or more below the standard journal sizes which are as follows:

No. 1 (front bearing journal)	1.9980 inch
No. 2 (intermediate)	1.9665 inch
No. 3 (intermediate)	1.9350 inch
No. 4 (rear bearing journal)	1.2475 inch

b. The camshaft bearing wear will be the amount of the measured clearance, minus the standard clearance of 0.002 inch and the camshaft journal wear. If the bearing wear exceeds 0.002 inch, replace the bearings.

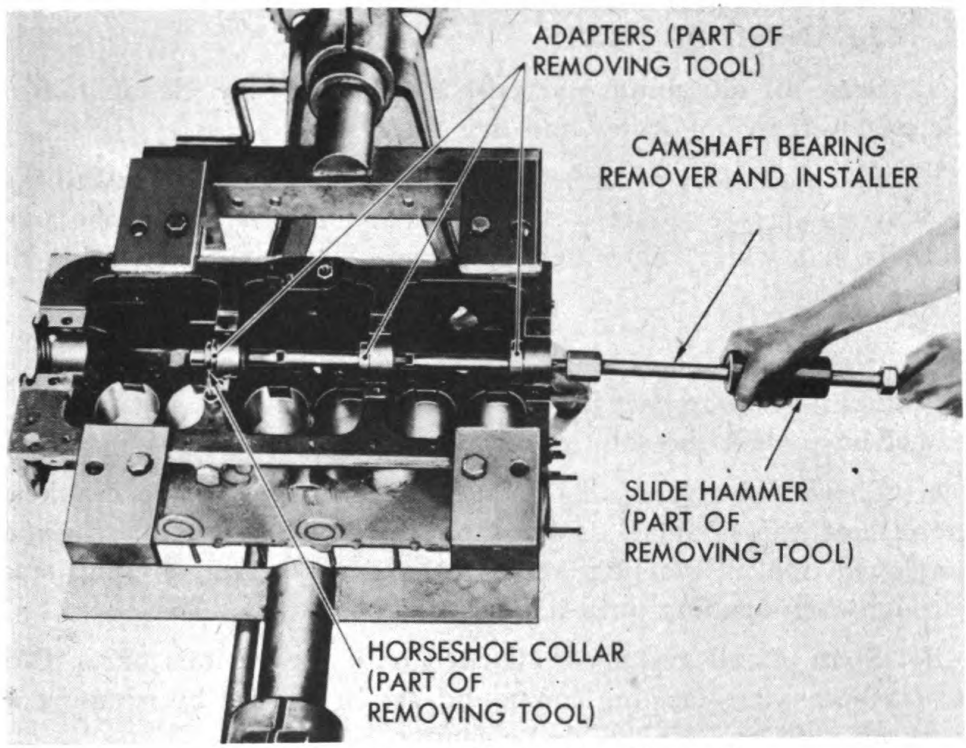


Figure 87—Camshaft Bearing Removal

92. REMOVE CAMSHAFT BEARINGS—(Figure 81.)

Select the proper size tool adapter for each of the three removable bearings. Insert the adapters into the bearings from the rear. Insert the puller shaft through the adapters and install one of the horse shoe collars behind one adapter. Slide the hammer of the tool against the outside nut on the driving rod with sufficient force to start the bearing and repeat the operation until bearing is out of the bore. Leave the adapter in the block to guide the puller shaft and pull the other bearings in the same manner. When all three replaceable bearings have been pulled from the block, remove the puller and bearings.

93. REMOVAL OF BELLHOUSING.

Remove the cap screws which attach the bellhousing to cylinder block and the bolts holding it to the skid base releasing it from starting motor and pull housing off the dowel pins.

94. CLEANING AND INSPECTION.

After the engine has been completely torn down and sub-assemblies have been disassembled, clean all component parts of the engine thoroughly to remove oil, grease and carbon.

95. CLEANING OF PARTS.

a. Soak all aluminum parts in SOLVENT, dry cleaning. Rinse the parts off in hot water and dry them.

b. Place all steel parts in suitable cleaning solution. Leave them in long enough to dissolve all grease and dirt. Remove the parts, rinse in hot water, blow out with compressed air, and wipe dry.

CAUTION

Never, under any circumstances, immerse an aluminum or aluminum alloy part in a steel stripping solution, regardless of how weak the solution may be.

c. Thoroughly clean all oil lines and passages in the crankcase, crankshaft, connecting rods and other parts where such passages are employed for lubricating reciprocating parts, by forcing steam through each opening until it flows without restriction.

d. Strip off all gaskets shellacked onto the various parts. Clean all surfaces where sealing compound has been used by scraping and washing with SOLVENT, dry cleaning.

96. INSPECTION OF PARTS.

a. As soon as each part has been cleaned as explained, inspect it and keep it properly covered to protect it from dust and dirt if it is to be used for reassembly. If available, apply magnaflux inspection process to all steel parts except ball and roller bearings, studs, standard nuts and washers.

b. Install new piston rings at every overhaul.

c. Install new crankcase (main) bearings and connecting rod bearings at every overhaul.

d. Replace loose, damaged or worn bushings with new bushings. Replace all loose, broken or damaged studs with new studs.

97. CYLINDER BLOCK AND HEAD.

Inspect and Repair Cylinder Block Casting—(Figure 88.) Inspect the casting thoroughly including the bearing supports for cracks. If

crack is found other than in cylinder bore or valve seat and the crack is accessible, repair by welding. If crack is found in cylinder bore or valve seat or in such a location that a satisfactory welding job cannot be done, replace the cylinder block. Remove camshaft sprocket oil tube, blow out with compressed air and reinstall.

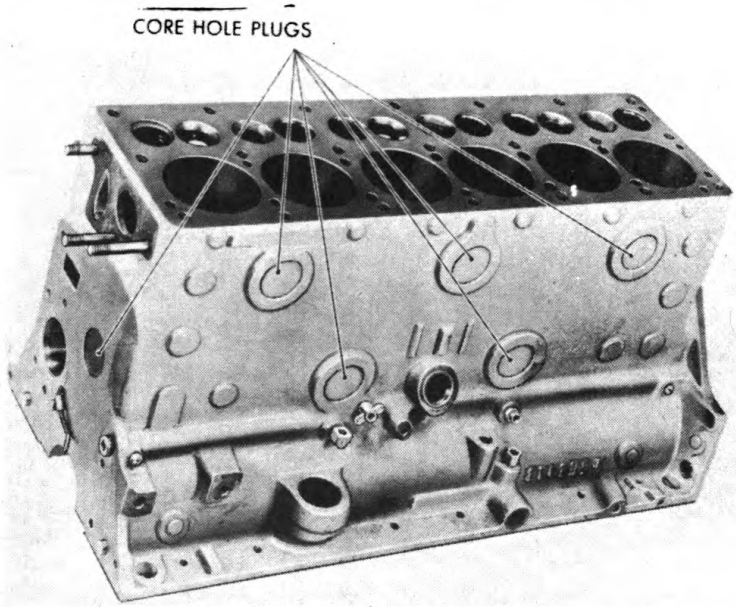


Figure 88—Cylinder Block

98. INSPECT GASKET SURFACES OF CYLINDER BLOCK AND HEAD—(Figures 88 and 89.)

Lay a straightedge across the gasket surfaces of the block and head. With a 0.006 inch feeler gage, check for low spots in the surface around the combustion chambers. If the feeler gage can be passed between the straightedge and the surface of the block or head, resurface the part until it is just flat. Do not remove more metal than necessary, as metal removed from either gasket surface alters the compression ratio of the engine.

99. INSPECT AND REPLACE CORE HOLE PLUGS—(Figure 88.)

If leakage at a core hole plug is apparent, drive a center punch or similar tool through the center of the plug and remove the plug. Clean the plug seat thoroughly and remove any sharp edges or irregularities from the new plug. Coat the edge of the plug with white lead and insert the plug in the core hole with the concaved surface facing inward. Expand the plug tight in the hole by striking it in the center with blunt drift and hammer.

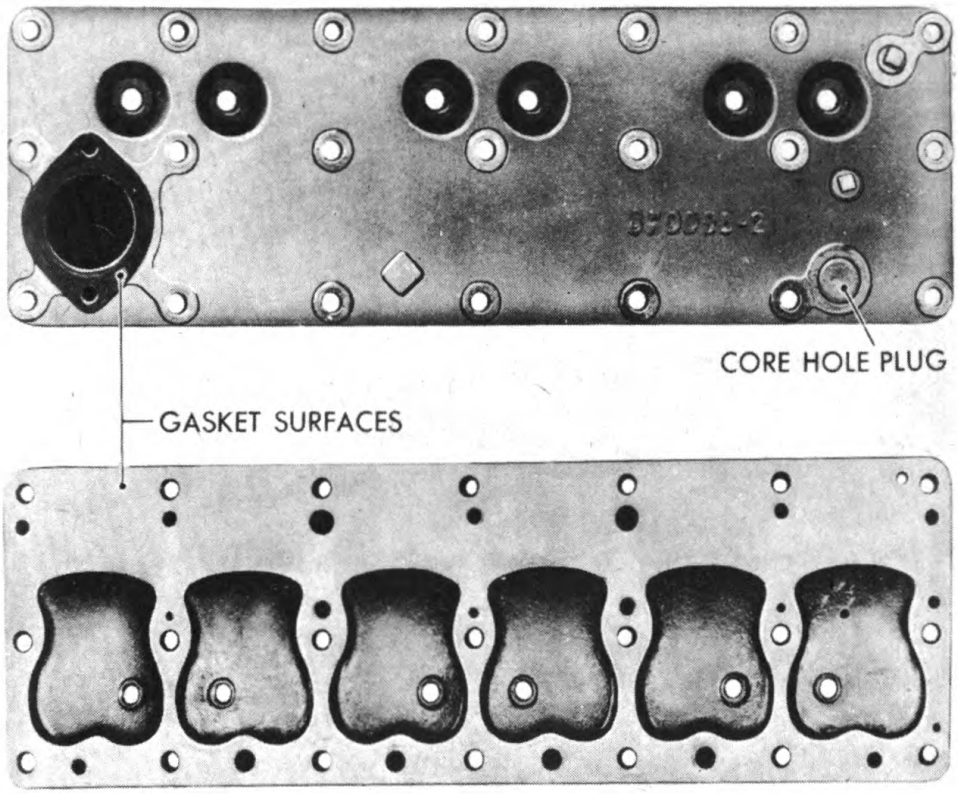


Figure 89—Cylinder Head

100. INSPECT AND REPAIR CYLINDER BORES—(Figure 90.)

Remove any ridge that may have formed at the top of the piston ring travel with the ridge reamer. Do not cut more than 1/64 inch below bottom edge of ridge. Measure out of round and taper of cylinder bores with cylinder gage. If cylinder bore is out of round more than .002 inch, tapered more than .0015 inch or scored, recondition the bore for oversize piston. Bore to within 0.001 inch of the finished size, then hone to a smooth, bright finish to assure satisfactory ring life. If the cylinder walls are smooth, not tapered more than .0015 inch or out of round more than 0.002 inch, reboring is not necessary.

101. INSPECT AND REPAIR CRANKSHAFT.

Examine the crankshaft bearing and connecting rod bearing journals for score or damage and measure the journals for wear with micrometer. If one or more journals are tapered or out of round more than 0.001 inch, or wear on the diameter of the journal is greater than 0.002 inch regrind the journals with crankshaft grinder for undersize bearings selected. When regrinding the journals, main-

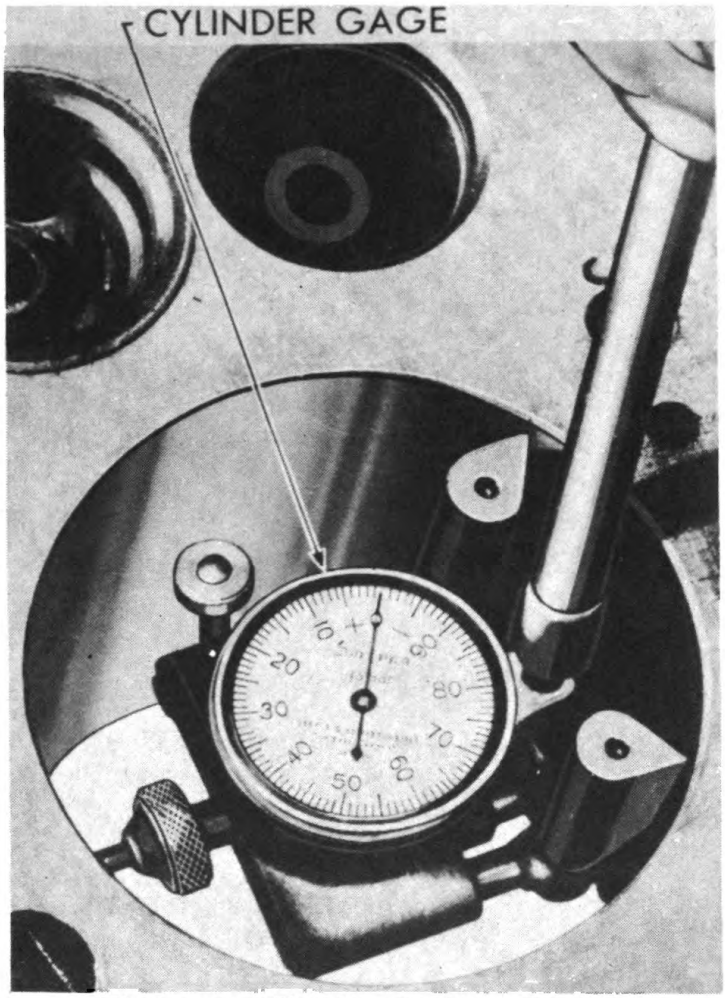


Figure 90—Checking Cylinder Bore Wear

tain bearing fillets with a true radius of 3/32 inch to 5/32 inch for the connecting rod bearings and 1/16 inch to 1/8 inch for the crankshaft (main) bearings. (Figure 91.) Run out should not exceed 0.002 inch.

102. INSPECT BEARINGS—(Figure 92.)

If the crankshaft (main) bearings and connecting rod bearings are damaged or the surface metal is cracked or checked, replace the bearings. Crankshaft (main) bearings and connecting rod bearings are available in standard size and undersizes of 0.010 inch and 0.012 inch.

103. CAMSHAFT, BEARINGS AND TAPPETS.

Inspect Camshaft—(Figure 93.) Measure camshaft bearing journals with micrometer. Examine oil pump and distributor driving

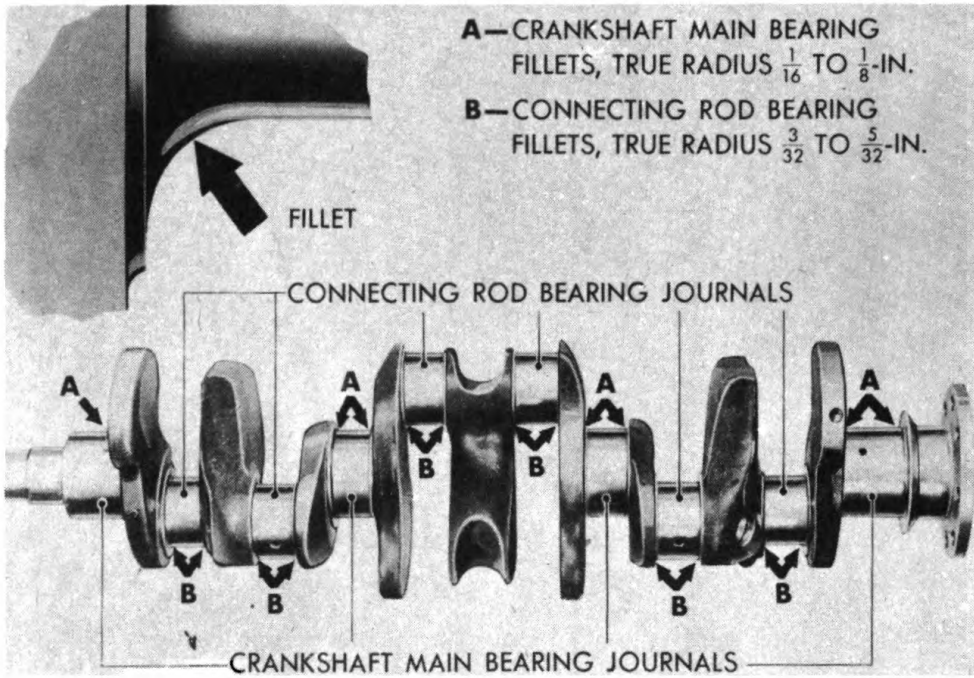


Figure 91—Crankshaft Bearing Fillets

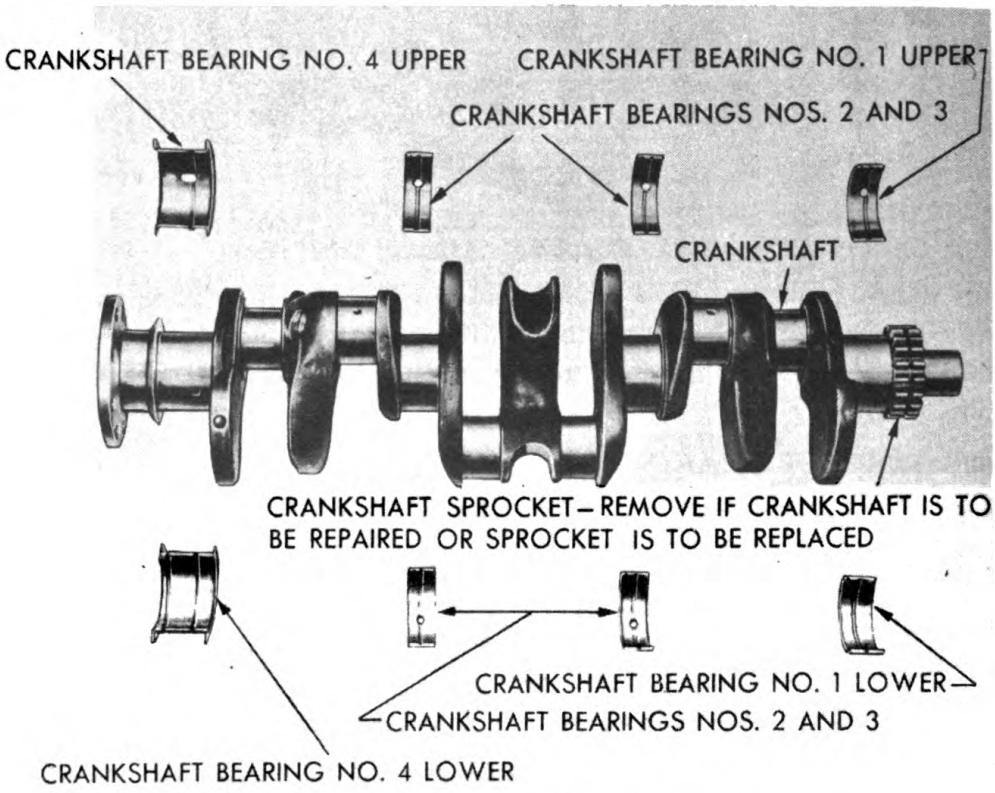


Figure 92—Crankshaft and Bearings

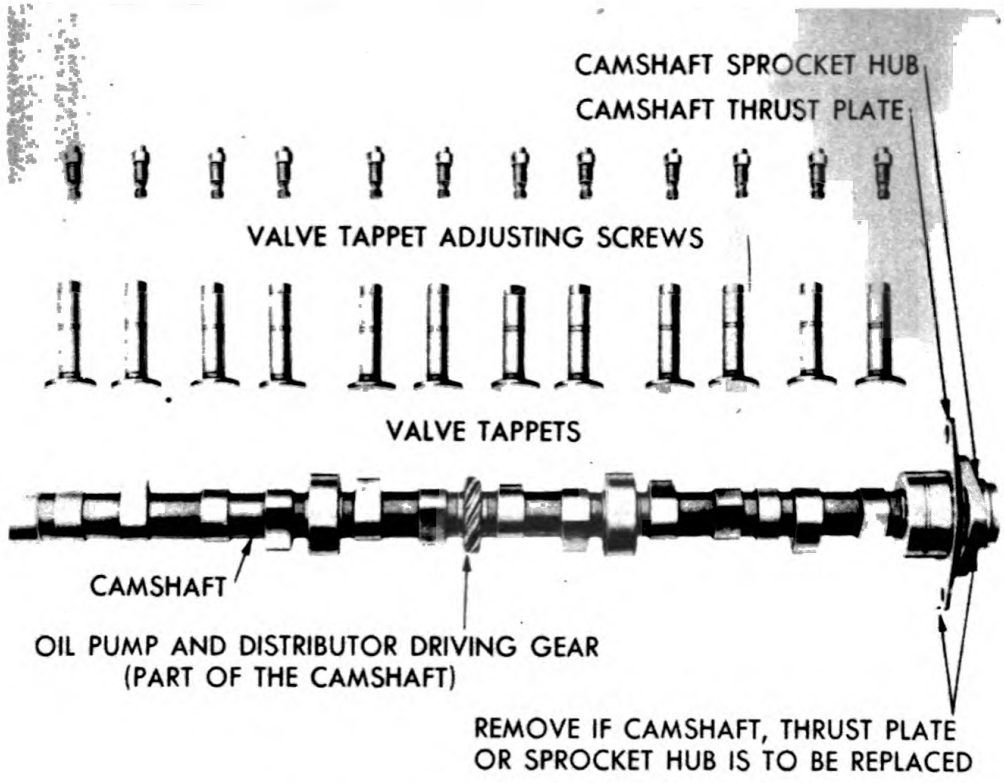


Figure 93—Camshaft and Tappets

gear and if damaged or worn to any noticeable extent, replace the camshaft. Measure camshaft end play by inserting feeler gage between the sprocket thrust plate and the front end of the front bearing journal. (Figure 94.) If the clearance at that point is greater than 0.006 inch replace the thrust plate, sprocket hub or both.

104 INSPECT TAPPETS.

Insert tappet in its guide and attach a dial indicator to exhaust manifold stud. (Figure 95.) Raise the tappet just above the lower end of its normal travel. Adjust the plunger of the indicator against the upper end of the tappet and move the top of the tappet in and out (crosswise of the engine). The tappet guide clearance will be shown by the indicator. If the clearance is greater than 0.0025 inch, ream cylinder block opening and install 0.008 inch oversize tappet. If the top of the tappet screws are worn unevenly, grind the surface of the screws flat and smooth.

105. TIMING CHAIN AND SPROCKETS.

Replace chain or sprockets if worn or damaged.

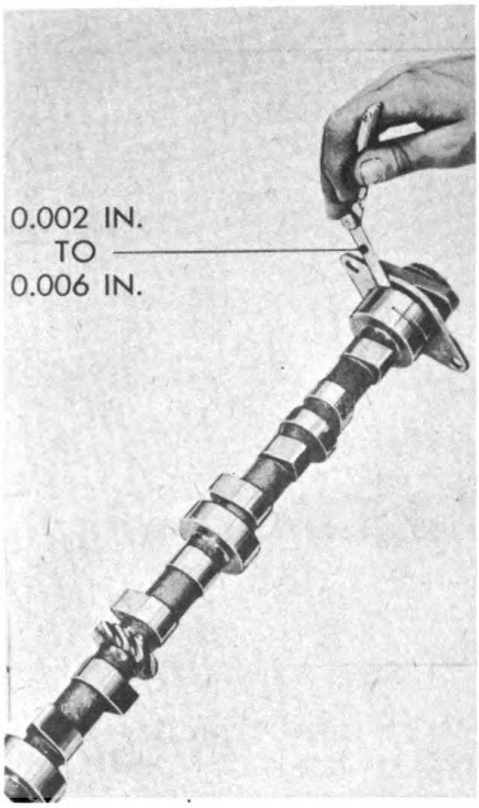


Figure 94—Checking Camshaft End Play

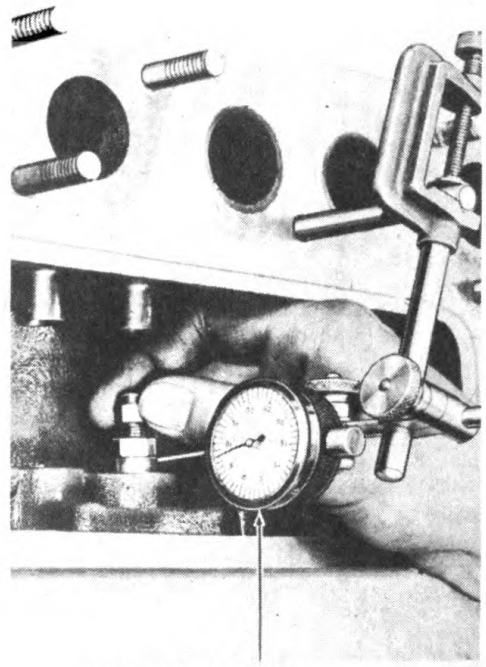


Figure 95—Checking Valve Tappet Clearance

106. PISTONS, PISTON PINS AND CONNECTING RODS.

Inspect Pistons and Rings.—(Figure 96.) Install piston in piston vise and remove piston pin. Remove piston rings and thoroughly clean carbon from piston ring grooves with groove cleaner and oil return holes. Examine piston carefully and if cracked or damaged, replace the piston. Check ring side clearance in grooves with new piston rings. If the side clearance exceeds the maximum allowable clearance of 0.008 inch for compression rings or 0.004 inch for oil rings, replace the piston. If the cylinders are not rebored, it is not necessary to replace a piston unless the piston is damaged or the ring grooves are worn in excess of the maximum allowable specifications.

107. FITTING PISTONS TO CYLINDER BORES.

If the cylinders are not rebored, select or machine pistons that will just slide down through the bottom of the cylinder bores under their own weight. (Figure 97.) If the cylinders have been rebored, select or machine pistons that will require three to five pounds pull to remove a 0.002 inch feeler, ½ inch wide, when installed be-

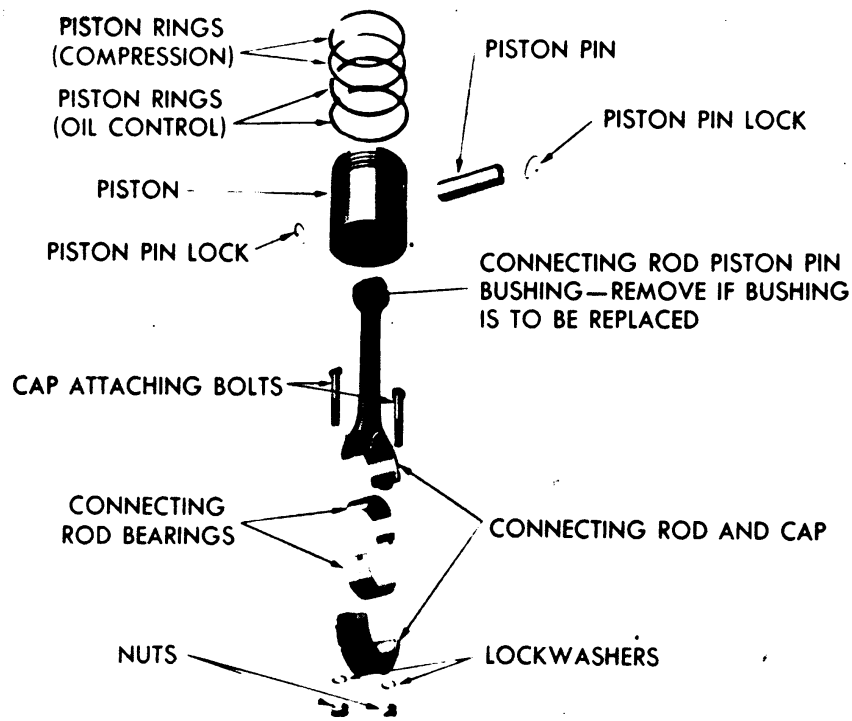


Figure 96—Pistons and Connecting Rod Disassembled

tween the thrust side of the piston skirt and the cylinder wall. (Figure 98.) Fit the piston at normal room temperature (70°F). Finished pistons are available in standard size and oversizes of 0.020 inch and 0.040 inch.

108. SELECT PROPER PISTON RING SET—(Figure 100.)

a. Install standard piston rings if cylinder bore wear does not exceed 0.002 inch out of round or 0.0015 inch taper; or if the cylinders are rebored.

b. Standard ring sets are available in sizes of standard to 0.004 inch oversize and 0.003 inch to 0.060 inch oversize.

109. FIT PISTON RINGS.

Measure cylinder bore diameter with inside micrometer near the bottom of the bore and use piston rings selected for that size bore. Place the rings squarely in the bottom of the cylinder bore and measure the end gap. (Figure 100B.) If necessary, file the ends of the rings with a mill file to create a gap of 0.007 inch to 0.015 inch.

110. INSPECT AND FIT PISTON PINS—(Figure 101.)

Measure diameter of piston pin with micrometer and if the diameter is less than 0.8591 inch, replace the pin. Fit piston pin in the

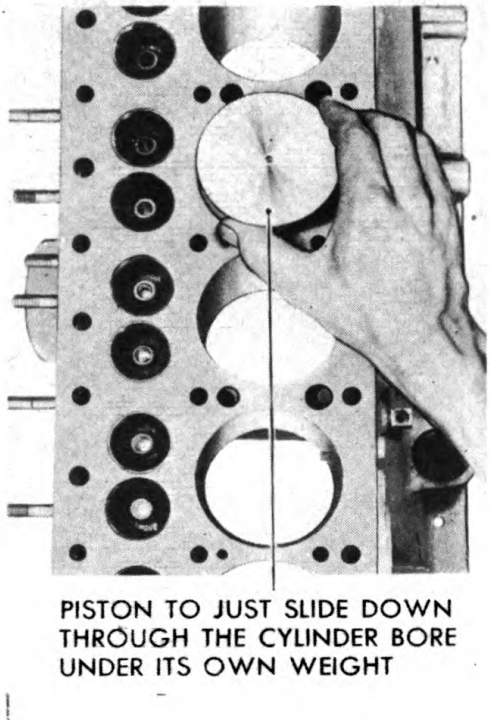


Figure 97—Fitting Piston to Cylinder Not Rebored

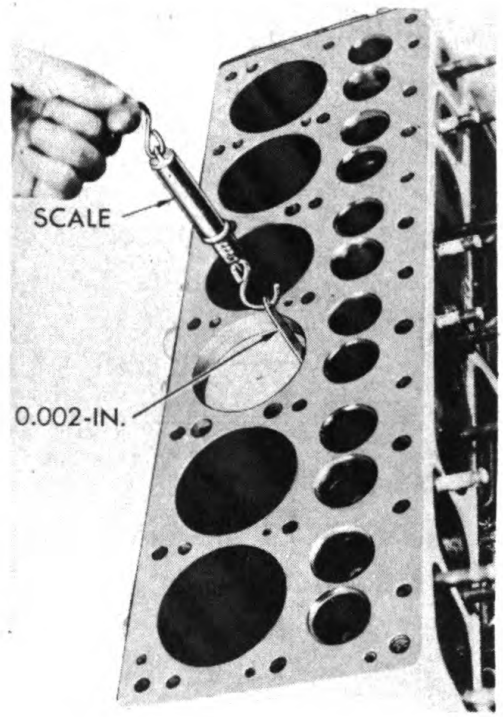


Figure 98—Fitting Piston to Rebored Cylinder

bushing at upper end of connecting rod with a tight thumb push fit at room temperature of 70°F. Fit piston pin in the piston bosses with a tight thumb press fit with the piston heated to 1000°F. and pin at 70°F. When fitting a pin to a new piston and the clearance at the connecting rod bushing is excessive, replace the bushing and ream with adjustable or grind for proper fit. When fitting an oversize piston pin to old piston, ream or grind pin holes in piston and connecting rod bushing for the correct fit.

111. INSPECT CONNECTING RODS.

Check connecting rods with a liner. If rod is bent or twisted more than 0.0025 inch, use connecting rod press to straighten the rod.

112. VALVES AND SPRINGS Clean and Inspect Valves.

If the valve seat is badly burned, the head cracked or warped, replace the valve. Measure the valve stem in several places with micrometer. The standard measurement for the stem is 0.3405 inch. If the stem is worn more than 0.002 inch, replace the valve. If the valve stem is worn excessively uneven, replace the valve spring as the spring is not seating squarely.

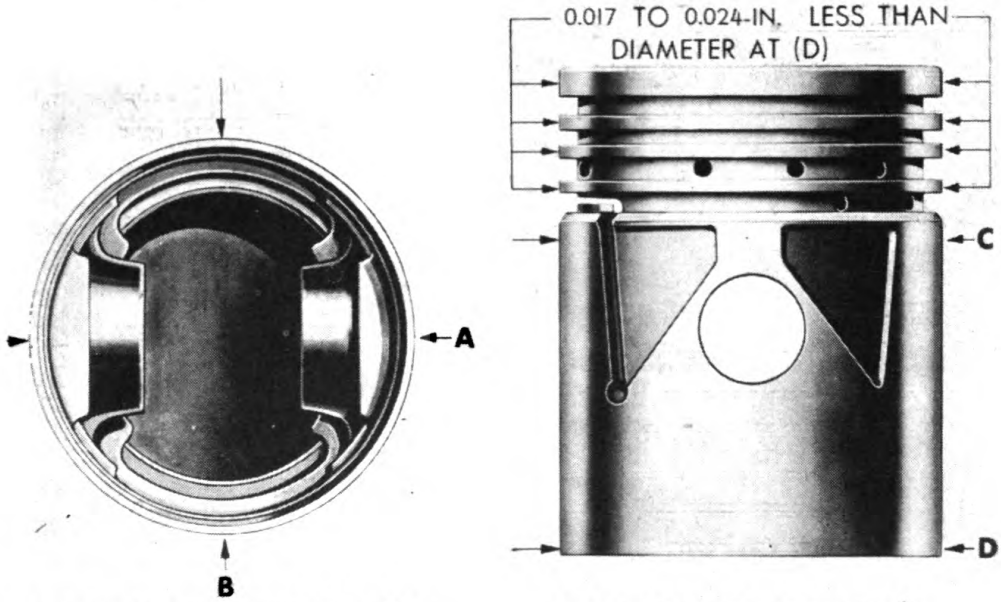


Figure 99—Cam Ground Piston

113. CLEAN AND INSPECT VALVE STEM GUIDES.

Thoroughly clean the interior of the valve stem guide with a wire valve guide brush and SOLVENT, dry cleaning. Place the valve in the guide with the head 5/16 inch above the top of the cyl-

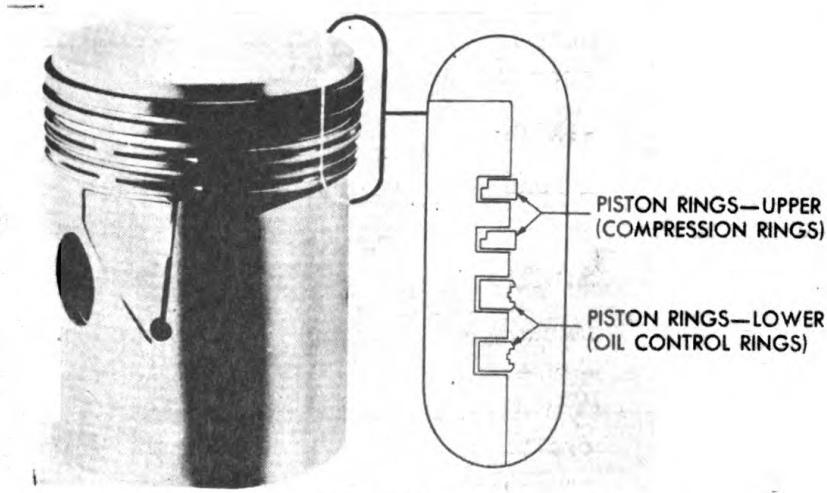


Figure 100—Standard Piston Rings

Figure 100A—Checking Side Clearance in Piston Groove

inder block. Attach a dial indicator to one of the cylinder block studs and adjust the plunger of the indicator against the edge of the valve head. Hold the valve so that it will not turn and move the valve toward and away from the indicator and note amount of play shown by the indicator. The clearance between the valve stem and guide will

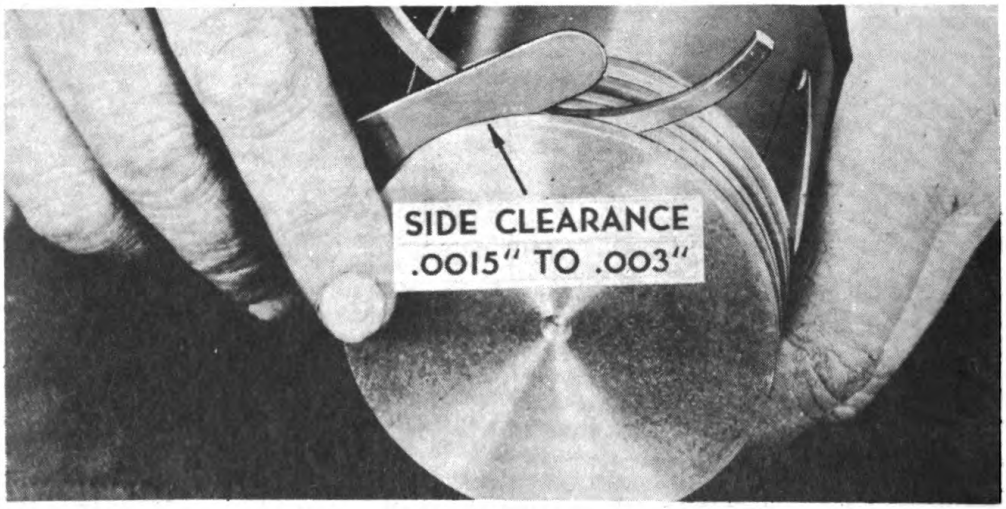


Figure 100B—Fitting Piston Rings

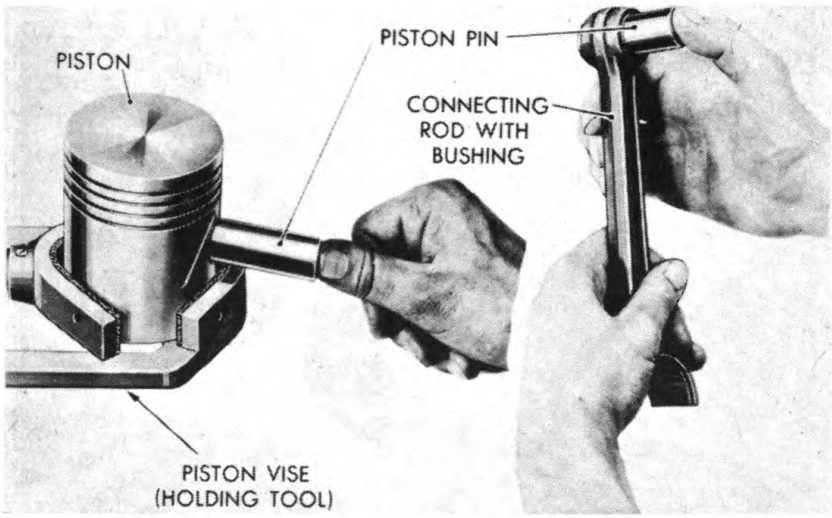


Figure 101—Fitting Piston Pin

be one-half the dial indicator reading. The amount of wear in the guide would be the clearance less wear on the valve stem. If an intake valve stem guide is worn more than 0.003 inch or exhaust valve stem guide is worn more than 0.005 inch, replace the guide.

114. INSPECT VALVE SEATS.

Inspect intake valve seat for cracks or damage. Examine exhaust valve steel inserts and if cracked or loose in the cylinder block, replace with oversize insert.

115. INSPECT AND TEST VALVE SPRINGS.

Wash the springs in SOLVENT, dry cleaning, and examine the spring carefully. If the metal is rusted or etched, replace the spring. Test the springs for proper tension by using a valve spring tester. The tension of a standard spring is 40 to 45 pounds when the spring is compressed to a length of 1¾ inch, or 107 to 115 pounds when the spring is compressed to a length of 1⅜ inch. Replace any spring which compresses to either length with less than the minimum specified pressure as such a spring is weak and will cause inefficient engine performance.

116. REMOVE VALVE STEM GUIDES.

Drive the valve stem guide down and out of the block with special drift. (Figure 102.)

117. INSTALL VALVE STEM GUIDES—(Figure 102.)

Wipe the exterior of valve stem guide clean and blow out the hole in the block with compressed air. Start the guide in the

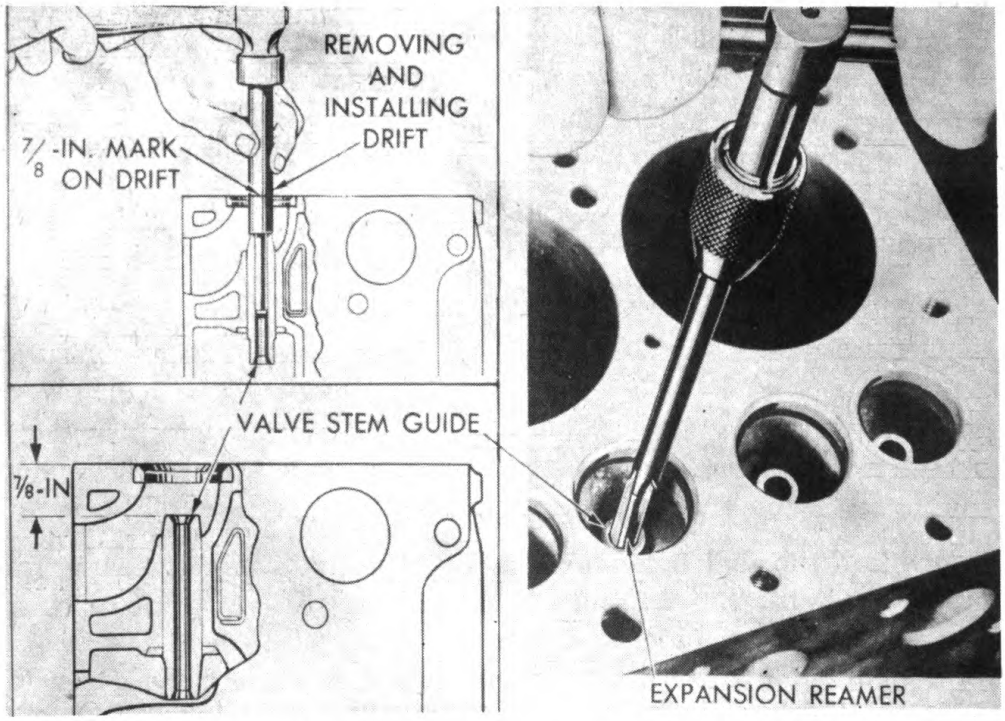


Figure 102—Installing and Removing Valve Stem Guide

hole with the tapered end up. Use the valve stem guide installing drift and drive the guide down until the top of the guide is located 7/8 inch below the top surface of the cylinder block. (Figure 102.) Ream new intake valve guides with an expansion type reamer to 0.342 inch to 0.343 inch and new exhaust valve guides to 0.344 to 0.345 inch. (Figure 102.) If a valve with a slightly worn stem is to be installed, reduce these dimensions the amount of the wear on the valve stem. Use micrometer and adjust the reamer so that the maximum diameter of the reamer at any point corresponds to the desired inside diameter of the valve stem guide.

118. REPLACE VALVE SEAT (EXHAUST).

Remove valve seat insert. Cut the counterbore 0.0035 inch smaller in diameter than the insert to be installed. Run the cutter down until it bottoms in the original counterbore. Clean cuttings from counterbore and valve port. Chill the insert with dry ice and use drift to install the insert in the block and peen over with peening tool.

119. REFACE VALVES.

Set the valve refacer to reface the valves at an angle of 45 de-

grees and dress the abrasive wheel so that it is true. Install the valve in the chuck and reface it smooth and true. Do not remove more metal than is necessary, to get a smooth, even surface. If the head is warped or burned enough to require excessive grinding, replace the valve. If the end of the valve stem is worn uneven from tappet contact, square it up on valve refacer.

120. GRIND VALVE SEATS.

Install the 11/32 inch pilot in the valve stem guide. Install the correct size stone with an angle of forty-five degrees on the valve reseating outfit and dress the stone on the dresser which is a part of the valve seat grinder kit. Place the grinder and stone assembly over the pilot in the valve stem guide and grind just enough to make a smooth seat 1/16 inch to 3/32 inch wire with less than 0.0005 inch run out. Check the concentricity of the seat with a dial indicator. If the seats are too wide, use a twenty degree angle stone to reduce the width. When the grinding operation has been completed, remove all abrasive and cuttings from the valve seats and ports.

121. MANIFOLD ASSEMBLIES.

Inspect and Disassemble Intake and Exhaust Manifold Assembly. Inspect the manifold flanges for cracks and true flat surfaces. Remove the four capscrews which hold the intake and exhaust manifolds together and inspect the heat control valve. If the valve is burned or damaged or the valve shaft is excessively loose in the manifold, chisel away the welds where the valve is welded to the shaft, raise the tabs of the valve and remove the shaft and valve. Install new shaft bushings and valve. Lay the valve against the flat side of the shaft, bend the tabs around the shaft and weld the tabs to the shaft.

122. ASSEMBLE INTAKE MANIFOLD TO EXHAUST MANIFOLD.

Lay straightedge lengthwise over the gasket surfaces of port flanges of the manifold assembly to check for uniform height of the flanges. If a 0.010 inch feeler gage will pass between the straightedge and any of the manifold flanges, loosen the capscrews which hold the manifolds together and shift the manifolds, if possible, to overcome the uneven condition of the flanges. If necessary, resurface the flanges just enough to make them even with each other within 0.010 inch.

123 FLYWHEEL AND BELLHOUSING.

Inspect Flywheel. Inspect the teeth of the flywheel ring gear and if damaged replace the ring gear.

124. TO REPLACE RING GEAR.

a. To replace the ring gear cut off the old ring gear with a chisel. Spread it apart and remove it from flywheel. Clean ring gear recess in flywheel thoroughly. Heat the new ring gear to 600°F.

b. Place the ring gear over the flywheel and allow it to shrink into the recess in the flywheel.

125. FLYWHEEL BELLHOUSING.

Inspect the bellhousing casting thoroughly. If any cracks are found that cannot be welded satisfactorily, replace the bellhousing. (Figure 103.)

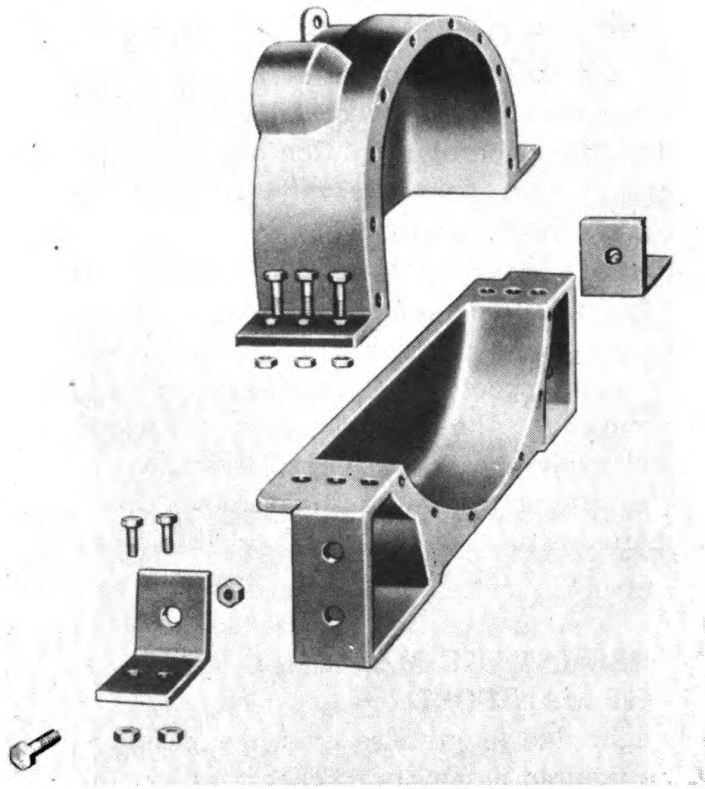


Figure 103—Close Up of Bellhousing

126. OIL PAN AND STRAINER.

Inspect the oil pan for dents. If the gasket surfaces are damaged or not level, repair or replace the oil pan.

127. OIL STRAINER—(Figure 104.)

Open one of the lips on the strainer plate and remove the plate. Remove strainer screen and wash it in SOLVENT, dry cleaning. Shape the screen so that the edges of the relief hole in the center

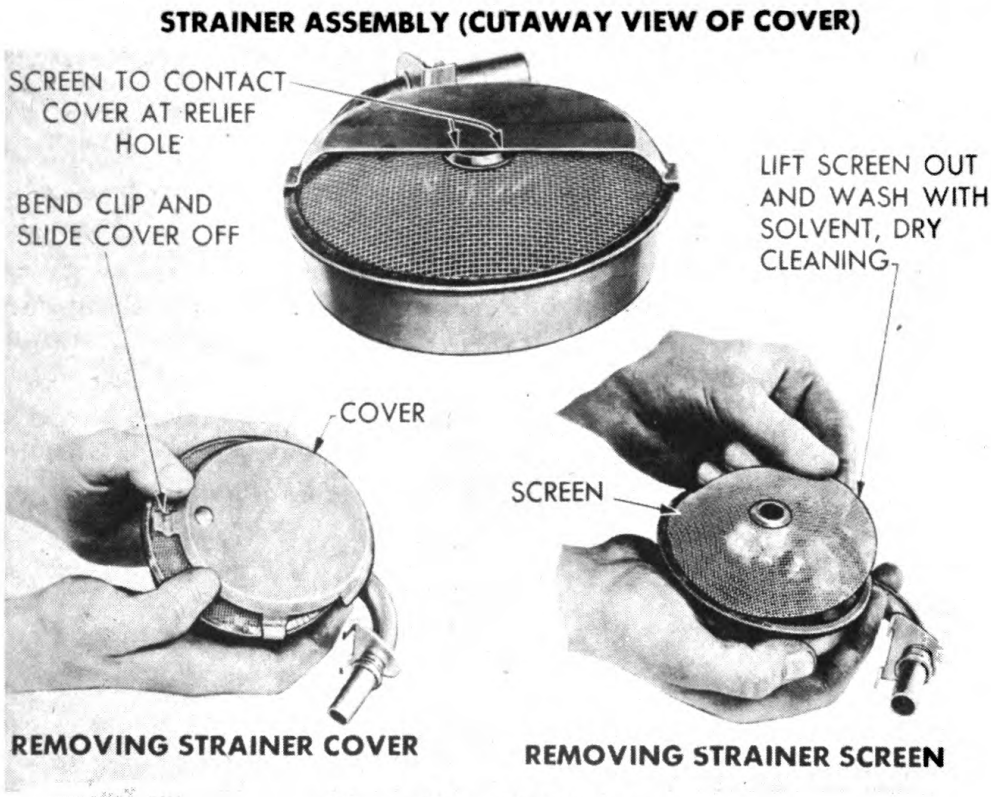


Figure 104—Oil Strainer

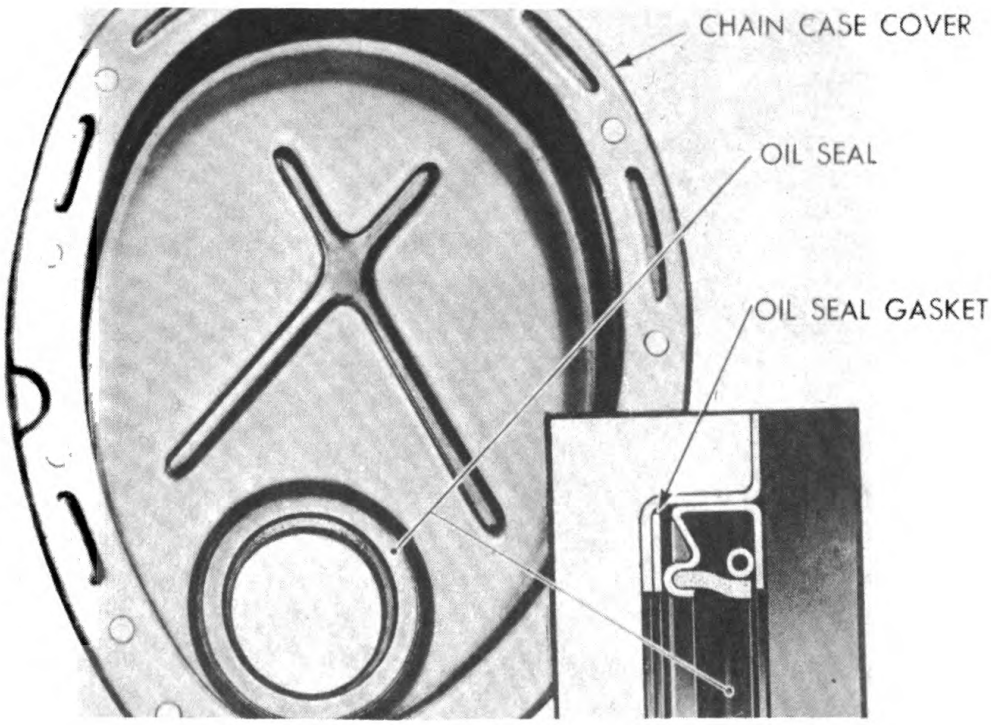


Figure 105—Chain Case Cover Oil Seal

of screen fully contacts the plate. Install strainer plate and bend over lip.

128. CHAIN CASE COVER AND FAN PULLEY.

Chain Case Cover—(Figure 105.) Inspect the chain case cover gasket surface for being true and smooth. Remove the chain-case cover oil seal and gasket from the inside of the cover. Install a new gasket in the cover and drive a new seal into place, making sure the seal seats against the gasket.

129. FAN DRIVE PULLEY.

Inspect the surface of the fan pulley. If it is worn or scored where the oil seal contacts, replace the pulley.

SECTION XXV
REASSEMBLY OF ENGINE

130. GASKETS AND OIL SEALS.

When assembling the engine, use new gaskets and oil seals.

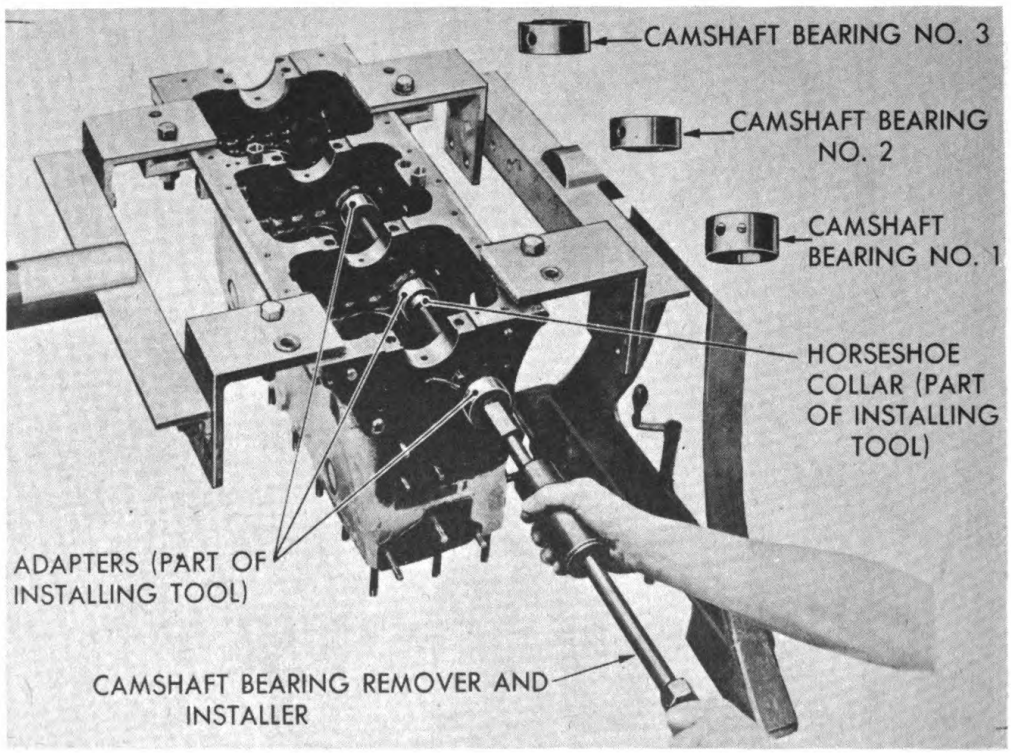


Figure 106—Camshaft Bearing Installation

131. PRESERVATIVE COATING ON NEW PARTS.

Remove all traces of grease-type or wax-like preservative coating on new metal parts to be installed in the engine by scrubbing thoroughly with a stiff brush and SOLVENT, dry cleaning.

132 REASSEMBLY OF STRIPPED ENGINE.

a. If available, mount cylinder block in engine stand.

b. **Install Camshaft Bearings**—(Figure 106.) The rear ends of the camshaft bearings are chamfered to facilitate installation. An oil hole is machined in each bearing which must line up with an oil hole in the block. The front bearing has a second oil hole which must line up with the hole which supplies oil to the timing chain. Install the correct size adapter of camshaft bearing tool (figure 106), in each of the two intermediate bores. Install the correct adapter in the front bearing and start the front bearing in its bore. Insert the installer shaft through all three adapters and install a horseshoe collar forward of the front adapter. With the sliding hammer of the tool, drive the front bearing into place (figure 106), being sure the oil holes are in alignment. Remove the installer shaft but leave the front and rear adapters in the bores to guide the shaft when installing number two bearing. Place the adapter in number two bearing and start the bearing in its bore. Install the horseshoe collar forward of that bearing and drive the bearing into place. Remove the installer shaft and number three adapter. Place number three bearing in the adapter and drive it into place with the procedure used on the other bearings. The bearings are manufactured to such close limits that no fitting or burnishing is required.

133. INSTALL TAPPETS AND CAMSHAFT.

Place the tappets in the guides out of which they originally came or to which they have been fitted. Coat the camshaft journals with oil, insert the shaft through the front bearing and move it back into position, being careful not to burr or scratch the bearings with the edge of a cam or bearing journal. Install the capscrews which hold the sprocket thrust plate in place.

134. INSTALL VALVES AND SPRINGS.

Place the valve springs in position with the close coiled end of the springs up and the valve spring retainers in the lower end of the springs. (Figure 107.) Coat the valve stems with oil and install each valve in its proper guide from which they were removed. Insert the jaws of the valve lifter between the spring retainer and the cyl-

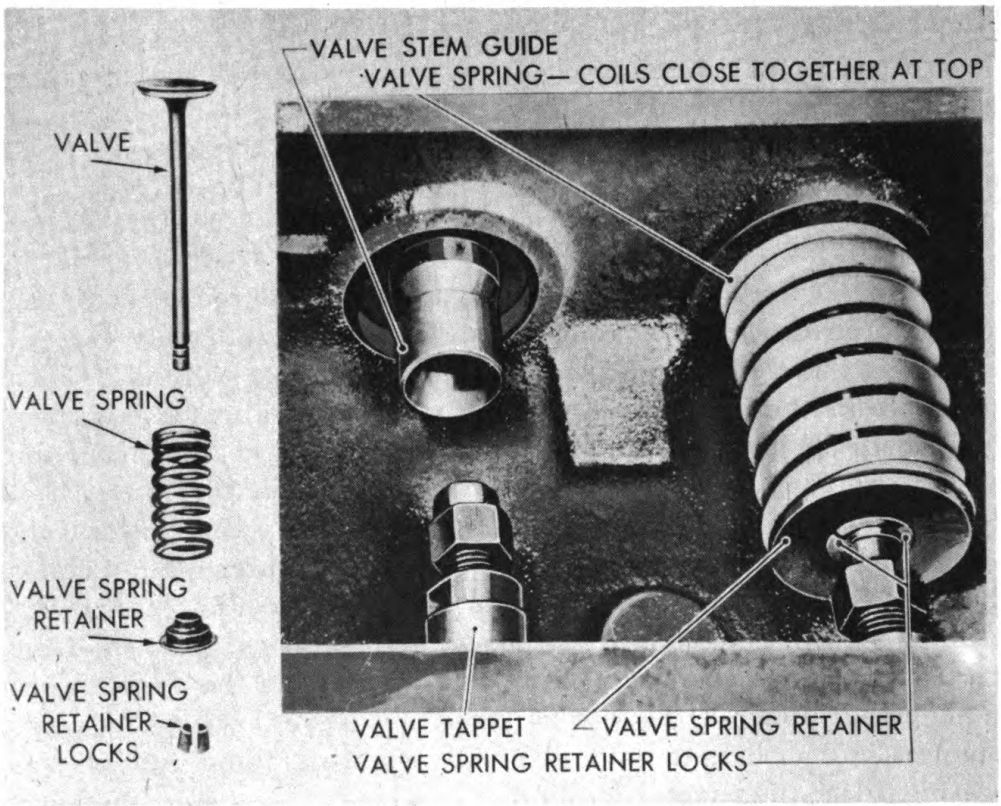
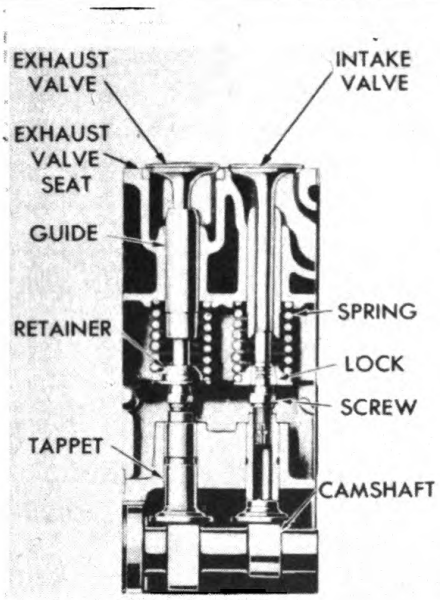


Figure 107—Valves and Springs

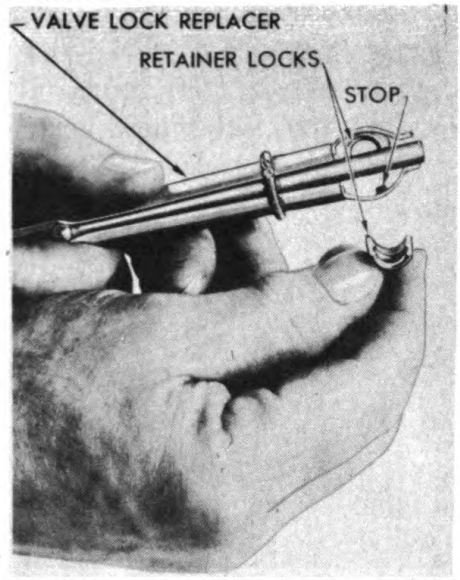
inder block with the cupped jaw up. Hold the valve on its seat and raise the valve lifter until the spring is full compressed. Assemble the valve locks in the lock replacer (figure 108), with the plunger of the tool pushed out. Place the end of the plunger against the valve stem in line with the grooves in the stem and push the tool toward the stem to place the locks in position. Lower the lifter and remove the lock replacer. Set valve tappets with a thickness gage and special tappet wrenches so that they have to 0.012 inch clearance, and install valve tappet covers with new gaskets on covers, screws and studs. After the engine has been assembled and run-in, readjust the tappets to the proper clearance.

135. ASSEMBLY OF FLYWHEEL AND SPROCKET TO CRANKSHAFT.

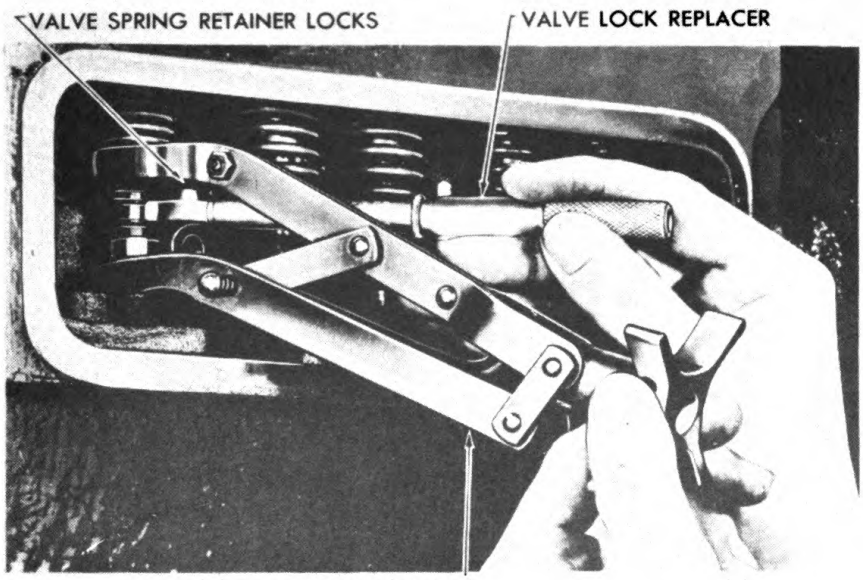
Place the flywheel over the flange of the crankshaft and install the bolts. The bolt holes are unevenly spaced and will line up in one position only. Install key in crankshaft and press the timing chain sprocket on the small end of the crankshaft with the mark 0 facing out.



VALVES



LOADING VALVE LOCK REPLACER



VALVE LIFTER

Figure 108—Valve Spring Installations

136. INSTALL CRANKSHAFT AND BEARINGS.

Wipe the bearing bores in the block thoroughly clean and install the upper halves of the crankshaft bearings in the bores. The upper halves of the front and rear bearings have oil holes while the lower halves do not. Both halves of the intermediate bearings are the same. Lay the crankshaft assembly in the bearings. Install the rear cap and bearing with gaskets and tighten the cap screws. Check the end play of the crankshaft by prying the shaft toward and meas-

uring the clearance between the front end of the bearing and the side of the adjacent crankthrow. (Figure 109.) If the end play exceeds 0.008 inch with new bearing, replace the crankshaft. Install other bearings and caps and tighten the capscrews to 75- to 80-foot pounds.

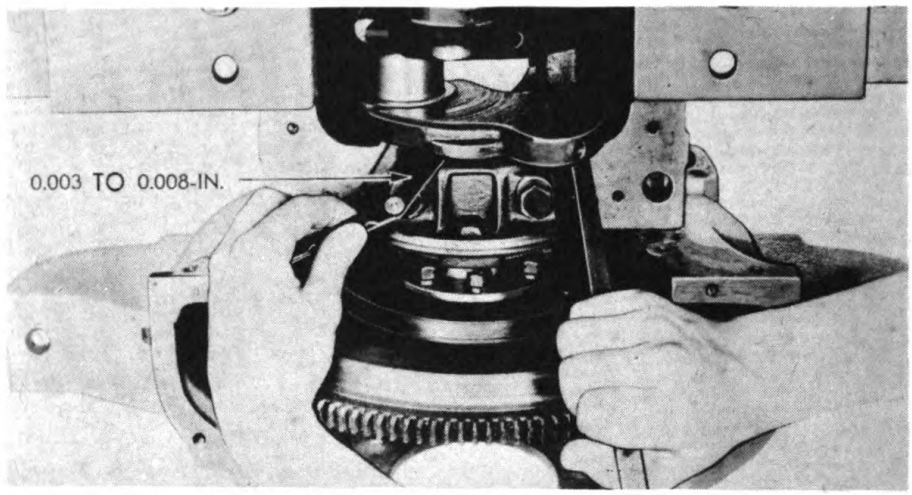


Figure 109—Checking Crankshaft End Play

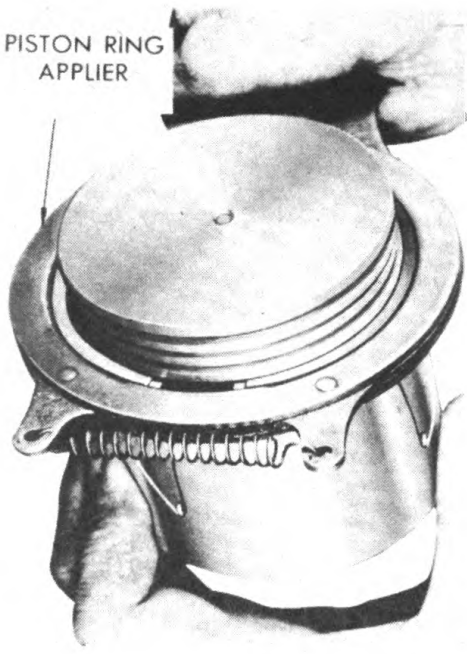


Figure 110—Piston Ring Installation

Figure 111—Piston and Connecting Rod Assembly

137. ASSEMBLE PISTONS AND CONNECTING RODS.

Heat the piston to 100°F. and place the upper end of the connecting rod in the piston with the small oil hole in the lower end of the rod opposite the slotted side of the piston. Insert the piston pin through the piston and connecting rod bushing. Install a **new** retaining ring in the piston at each end of the pin. Install the piston rings of the type selected with piston ring applier. (Figure 110.)

138. INSTALL PISTON AND CONNECTING ROD ASSEMBLIES.

Coat the piston and rings with engine oil, and space the ring gaps evenly around the circumference of the piston. Install the piston ring compressor over the rings and install the piston in the cylinder (figure 111), with the oil hole in large end of the connecting rod toward the valve side of the engine. Wipe the bores of the connecting rods and the bearing caps thoroughly clean, install the bearings and attach the connecting rods to the crankshaft using new lockwashers. Tighten the cap bolt nuts to 45- to 50-foot pounds with torque wrench.

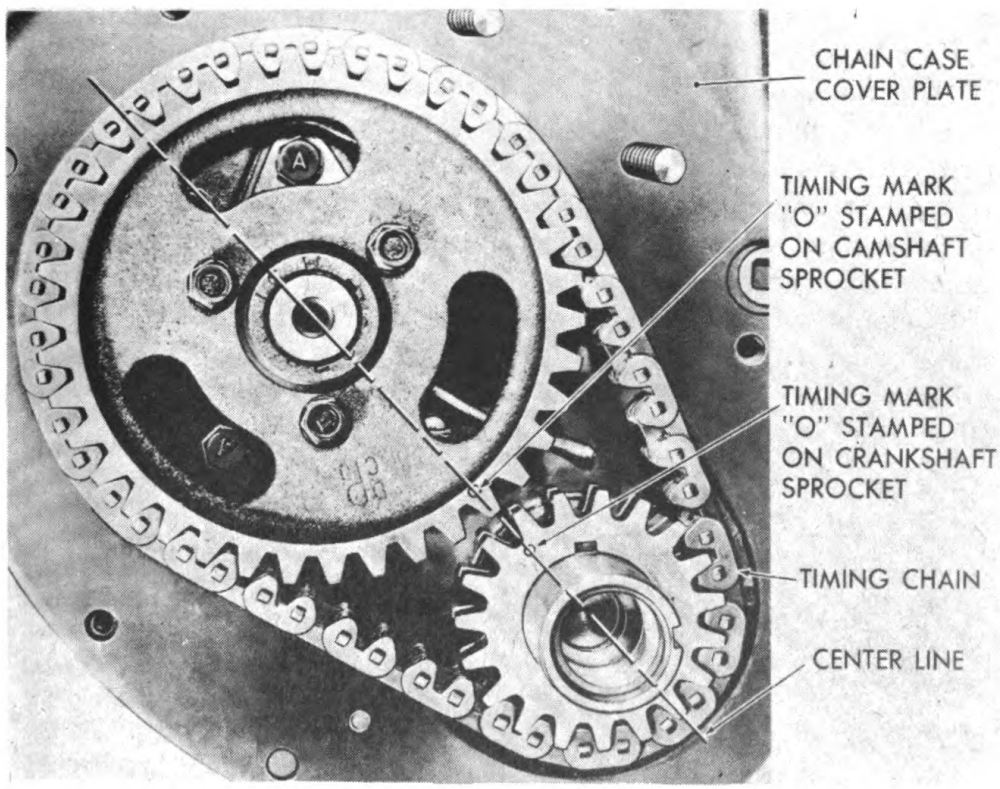


Figure 112—Timing Chain and Sprocket Installation

139. INSTALL CAMSHAFT SPROCKET AND TIMING CHAIN.

Install the chain case cover plate with a new gasket. Turn the crankshaft so that the mark 0 on the face of the crankshaft sprocket is directly in line with the crankshaft and camshaft centers. Place the camshaft sprocket on its hub and install two cap screws temporarily. Turn the camshaft until the mark 0 on the camshaft sprocket is also directly in line with the crankshaft and camshaft centers, (figure 112), then remove the camshaft sprocket. Place the chain around both sprockets and reinstall the camshaft sprocket. When the installation is completed, the 0 marks on both sprockets must be directly between the crankshaft and camshaft centers.

140. INSTALL CHAIN CASE COVER, ENGINE SUPPORT AND FAN PULLEY.

Place a new gasket on the cover and install the cover with the cover reinforcement over the five lower screw holes. Start the attaching capscrews but do not tighten. Drive or push the fan pulley into place and install shakeproof lockwasher and starting crank jaw. Then tighten the cover attaching screws and nuts.

141. INSTALL CYLINDER HEAD.

With a clean cloth, wipe the surfaces of the cylinder head and block thoroughly clean. Wipe the tops of the cylinder bores and pistons clean and blow off with compressed air. Apply a thin coating of engine oil, or SEAL, gasket, to both sides of a new cylinder head gasket and place the gasket over the cylinder head studs. Place the oil filter bracket under cap screw 9 and 15. (Figure 113.) Connect the oil filter pipes to the filter and crankcase. Place a shake-proof lockwasher then radimeter tube clip under capscrew 19 and a shakeproof lockwasher over cap screw 6. Install the breather pipe in the crankcase with the pipe bracket over stud 6. Install the

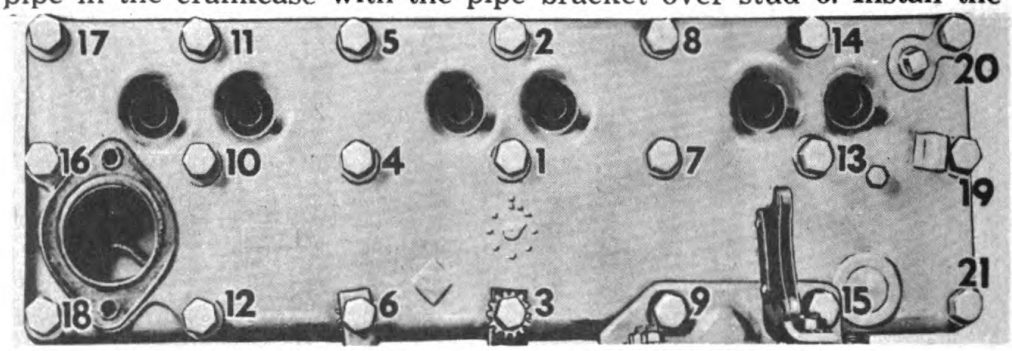


Figure 113—Cylinder Head Capscrew Tightening Sequence

cylinder head stud nuts and capscrews in the order shown in figure 113. Tighten the stud nut 52½- to 57½-foot pounds and the cap screw to 64- to 70-foot pounds with torque wrench. (Figure 113A.) If a torque wrench is not available when installing the cylinder head, make sure that the cylinder head and cylinder block are free from carbon and dirt. Tighten the cylinder head capscrews in sequence as shown in figure 113 drawing all capscrews down evenly. Repeat the operation until they are tight. The final tightening and check of the tension should be made after the engine has been running and is still warm.

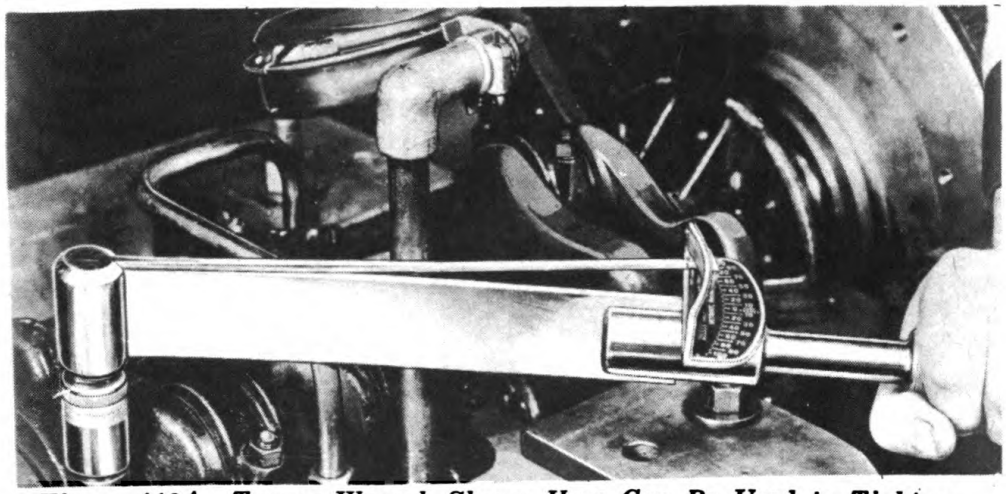


Figure 113A—Torque Wrench Shown Here Can Be Used to Tighten Cylinder Head

142. INSTALL MANIFOLD ASSEMBLY.

Place new gaskets over studs and install the manifold assembly

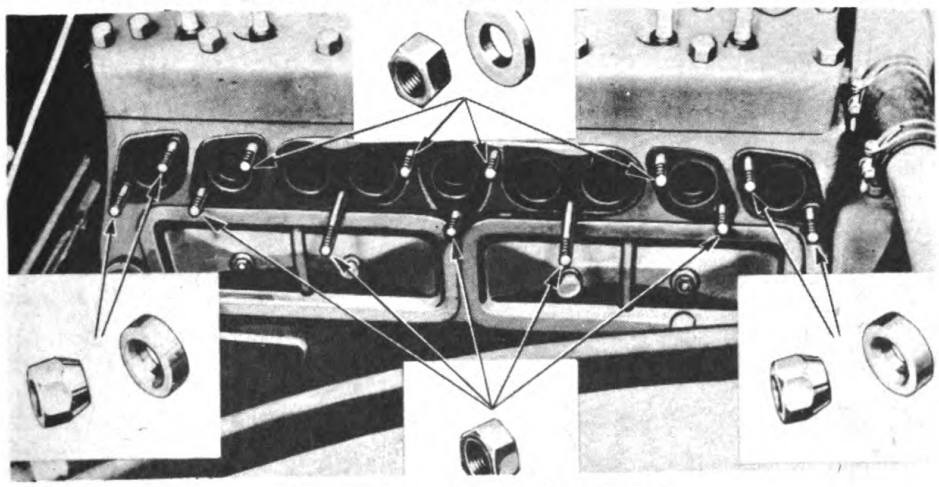


Figure 114—Manifold Stud Nuts

over the flange studs and install washer and nuts in the order shown in figure 114. Put the ventilator in place and install the attaching cap screws.

143. INSTALL OIL RELIEF VALVE AND THERMOSTAT.

Apply compressed air to the oil relief valve opening to remove any dirt or foreign matter. Wash the plunger, spring and cap in engine oil, and install in that order with a good gasket under the cap. (Figure 115.) Install the thermostat with mark "FRONT" toward radiator with gaskets above and below thermostat. (Figure 116.) Install the elbow and tighten the capscrews.

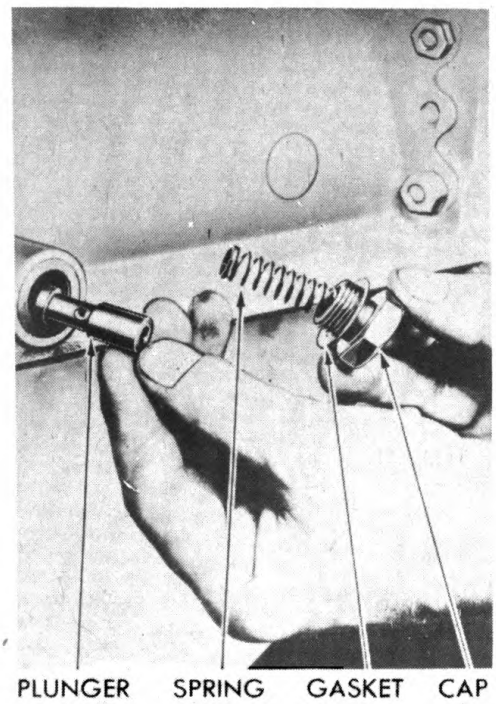


Figure 115—Oil Pressure Relief Valve Installation

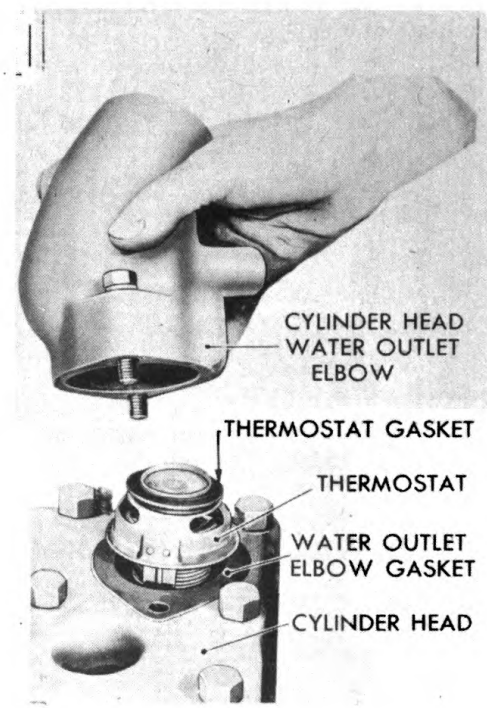


Figure 116—Thermostat Installation

144. INSTALL OIL STRAINER.

Install the oil pump inlet pipe. Then connect the strainer to the pipe and insert a new cotter pin. **Position the strainer and elbow as shown in figure 117, so that movement of the strainer is not restricted by the oil pan baffles.**

145. INSTALL OIL PAN—(Figure 118.)

Place new end gaskets in position and let the ends of the gaskets protrude as they will be compressed into place when the

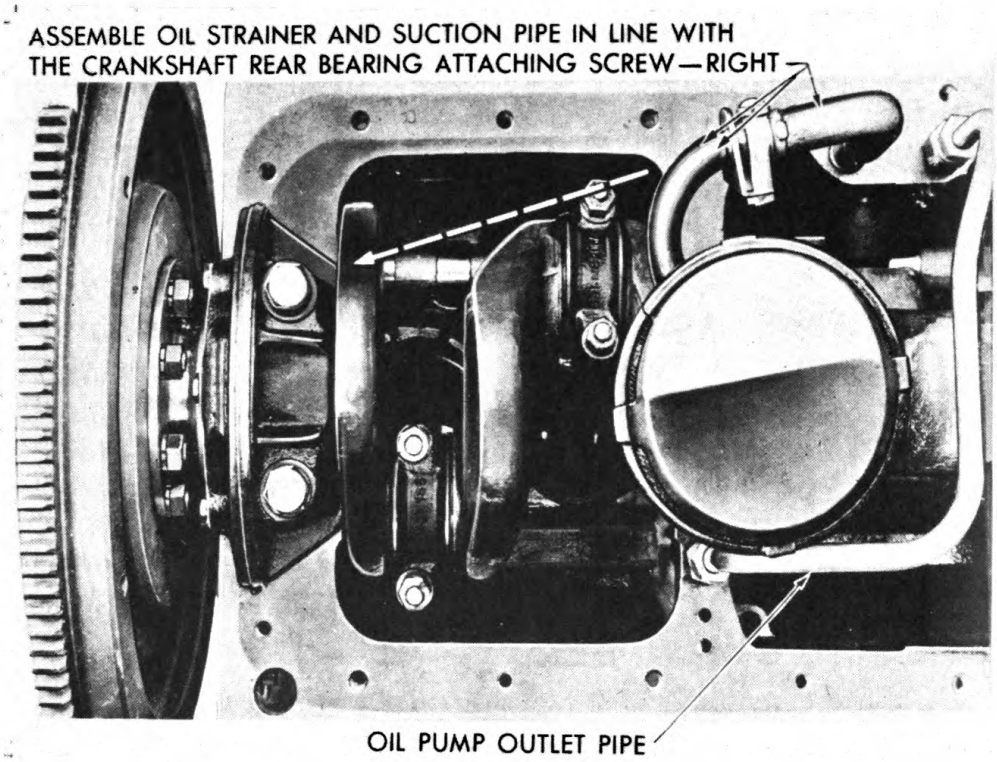


Figure 117—Floating Oil Strainer Installation

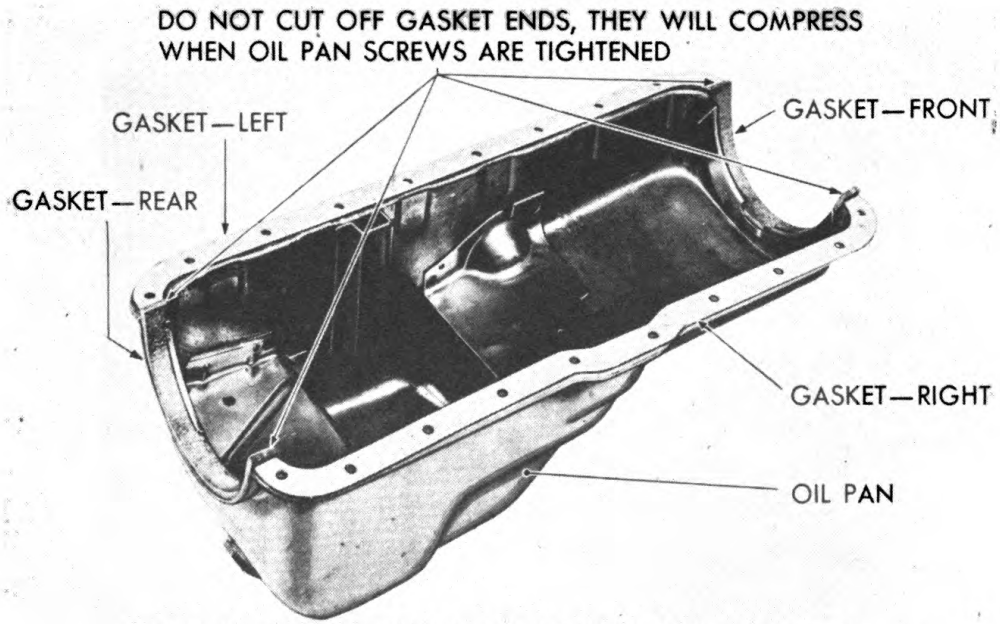


Figure 118—Oil Pan Gaskets

pan is installed. Place new side gaskets over the ends of the end gaskets. Remove the engine from the stand and install the pan and attaching capscrews.

SECTION XXVI
INSTALLATION OF ENGINE ACCESSORIES

146. INSTALL CARBURETOR AND GOVERNOR ASSEMBLY.

Examine carburetor manifold studs and replace or tighten, as required. Place a new gasket over the manifold studs and install the carburetor with the gasoline line connection toward radiator. Attach the carburetor to the manifold with lockwashers and nuts. Attach the carburetor control rod ball joint to the carburetor throttle lever. Connect the fuel tube to the carburetor. Connect automatic choke lever. For service information on carburetor see paragraph 168.

147. INSTALL FUEL PUMP.

Place a new cylinder block to fuel pump gasket on the fuel pump and insert the fastening capscrews with lockwashers into the fuel pump body. Attach the fuel pump to the block. Connect the carburetor fuel tube to the pump. Place the heat shield over the stud on the pump and insert the end of the shield under the exhaust manifold end stud nut. Tighten the exhaust stud nut and install and tighten the wing nut on the pump.

148. INSTALL WATER DISTRIBUTING TUBE AND WATER PUMP.

Insert the water distributing tube in the block. Place a new water pump gasket on the three water pump attaching studs and install the water pump on the studs. Install the generator adjusting strap on the left hand stud and install the stud nut with a shakeproof lockwasher. Do not tighten the nut securely until the fan belt is adjusted. Install the other two lockwashers and nuts on the water pump attaching studs and tighten securely. Install the bypass elbow and hose assembly on the pump and tighten clamps.

149. INSTALL OIL PUMP.

Crank engine by hand and hold thumb tightly over number one cylinder spark plug hole or install a compression gage in the number one spark plug hole to determine when the piston is rising on the compression stroke. When compression is felt by thumb or

shows on gage, turn crank until piston is on top dead center. Turn pump drive shaft until the slot in the end of the drive shaft lines up with the holes in the mounting shaft. Then turn the shaft gear one tooth counterclockwise. (Figure 119.) Place new gasket on the pump and carefully install the pump while holding it in this position. Do not turn the drive gear while installing the pump.

150. INSTALL IGNITION UNITS.

When installing the distributor, see that number one piston is at top dead center on compression stroke and the distributor rotor is in number one firing position. Then insert distributor into the cylinder block opening and move the rotor back and forth slightly to allow tongue of distributor shaft to engage slot of oil pump drive shaft. Install lock plate hold-down capscrew with a shakeproof lockwasher but do not tighten. Rotate distributor body until the points are just about to open. Tighten hold down capscrew. Install the distributor cap with the distributor to spark plug cables attached (figure 120), registering the projection in the cap opening with the notch in the distributor body. Lock the distributor cap in place with the

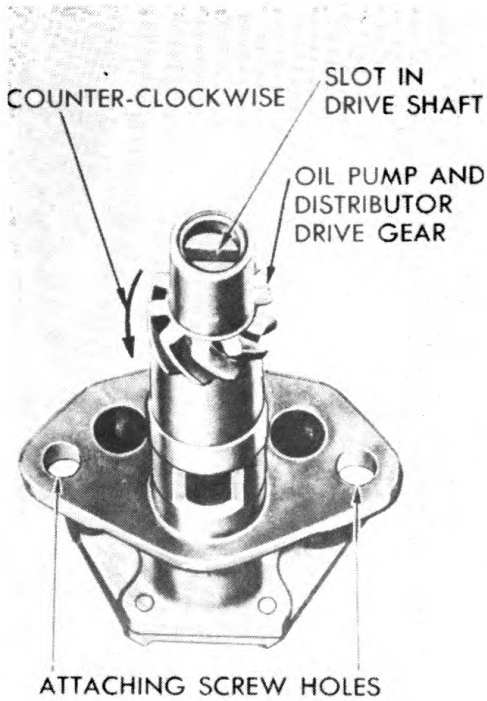


Figure 119—Lining Up Slot in Oil Pump Shaft

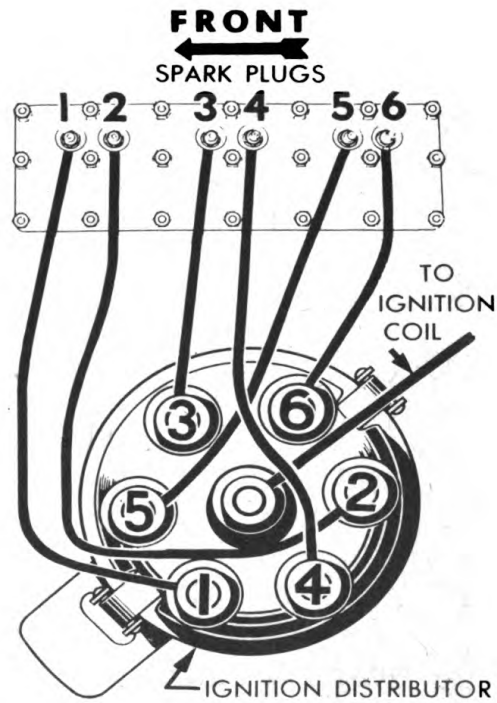


Figure 120—Spark Plug Cable Connections

two cap hold-down springs. Attach the cable bracket to the left hand center cylinder stud. Install the spark plugs with new gaskets and attach the spark plug cables to the plug terminals.

SECTION XXVII
ELECTRICAL SYSTEM

151. GENERAL.

The electrical system consists of the starting and ignition systems, the current being supplied by a battery which is kept charged by the engine generator. Proper maintenance of the electrical system is essential to insure positive and quick starting of the engine, and maximum engine performance. The wiring and electrical connections are shown on the wiring diagram. (Figure 121.)

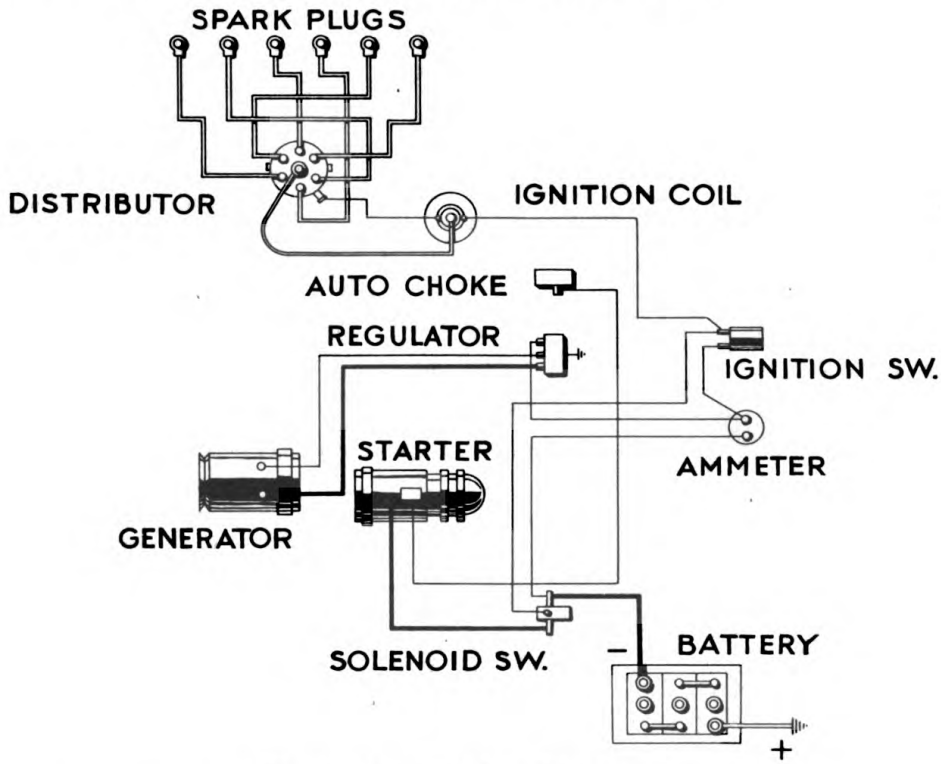


Figure 121—Wiring Diagram

152. STARTING MOTOR.

The starting motor is the positive shift type with sliding gear and over-running clutch and a solenoid switch which cuts off the

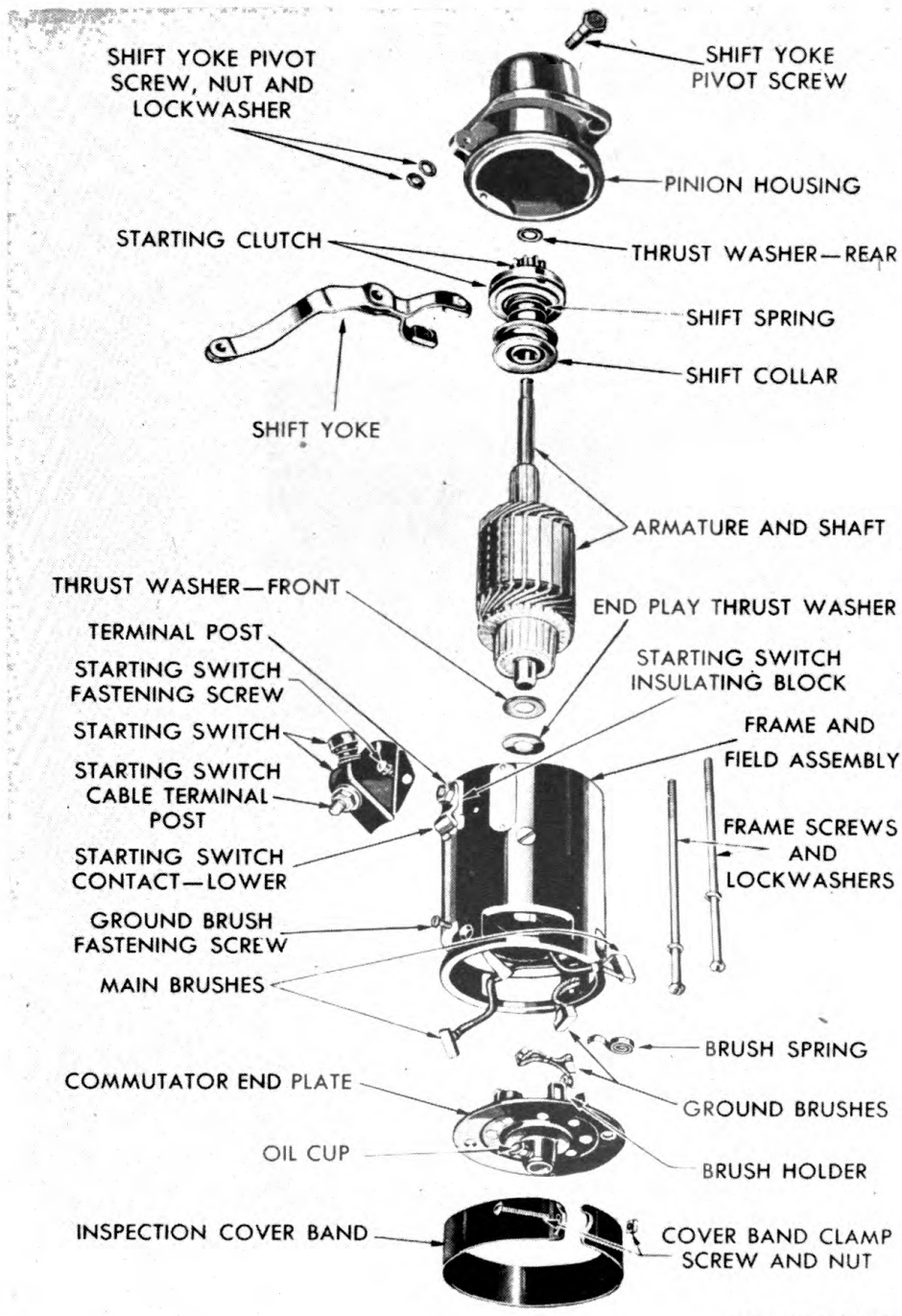


Figure 122—Exploded View of Starting Motor

current to the starter when the ignition switch is in the off position. Under normal conditions, no maintenance attention is needed other than periodical lubrication. See Lubrication Section XVI. Repairs to the starting motor require electrical experience and testing equipment. Unless operator is equipped to do this type of repair a new starting motor should be requisitioned and the old motor returned for repair.

153. TO REMOVE THE STARTING MOTOR.

Disconnect the wires from the terminal post. Disconnect wire from battery, tape end to avoid short circuit; remove the bolts attaching starter to flywheel housing; draw out the starting motor assembly.

154. FAILURE OF OPERATION.

a. In case the starter fails to operate, the following procedure may be used to locate the cause of the trouble: First, a visual inspection should be made of all wires to be sure that none are broken and that all connections are clean and tight, particularly at the battery terminal. To test the starting motor circuit on the engine, the following equipment is required:

(1) An accurate indicating ammeter with 0- to 50-ampere scale.

(2) An accurately calibrated voltmeter with a 15-volt scale graduated in 0.1-volt divisions.

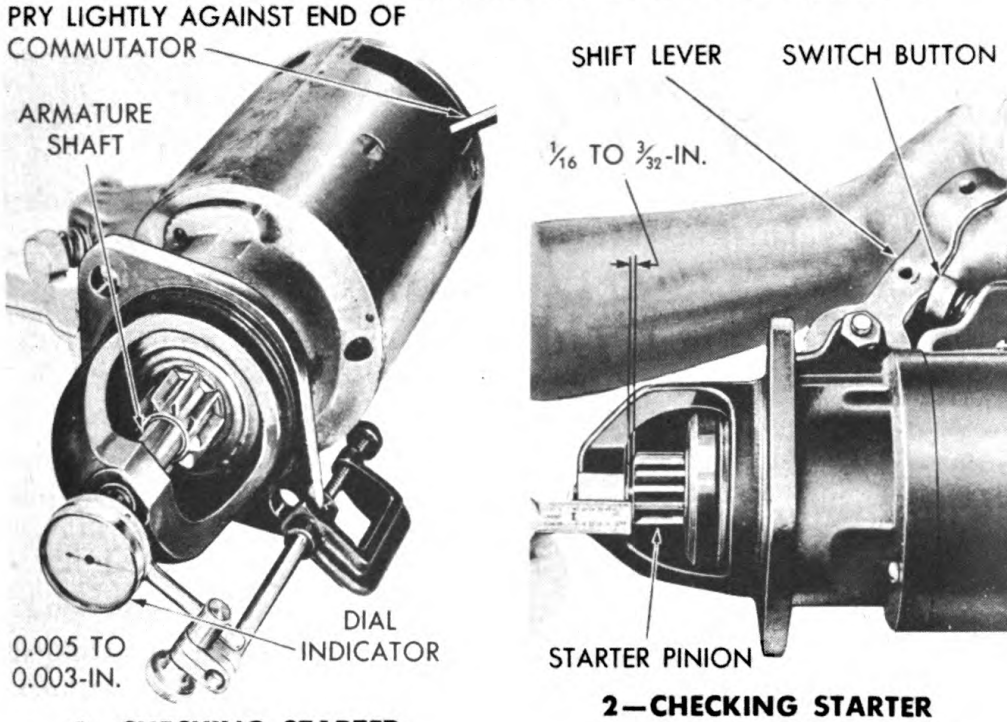
(3) A 500-ampere shunt.

(4) A 1000-watt carbon pile.

b. If the commutator is dirty or discolored, it can be cleaned with 00 sandpaper. Blow the sand out of the motor after cleaning. Should the commutator be rough or worn, the motor should be removed from the engine for cleaning and reconditioning. Next, check the brushes and be sure they slide or swing freely in their holders and make full contact on the commutator. Worn brushes should be replaced. Inspect starting motor switch by making a visual inspection of the switch contacts. If the contact blade is only slightly burned, it can be reconditioned by filing. If the burning is excessive, the switch should be replaced with a new part. The starting circuit should be given a voltage loss test to make sure there is no loss of starting motor efficiency due to high resistance connections. In making this check, the voltage loss from the battery terminal to the starting motor terminal should not exceed .12 volt maximum for each 100 amperes. The loss in voltage between the battery ground post and the starting motor frame should not exceed .12 volt maximum for

each 100 amperes. If the voltage loss is greater than the above limits the voltage should be measured over each part of the circuit to locate the resistance causing voltage loss.

c. If the starting motor pinion disengages from the flywheel after a start is made, but the starter switch fails to break contact and the armature continues to revolve, the starter switch push rod may be stuck. This same condition will occur if the solenoid winding is short circuited. Under this condition, the unbalanced relation of the windings causes a feed back through the coil sufficient to keep the starter switch contact and push rod in the closed position.



1—CHECKING STARTER ARMATURE END PLAY

2—CHECKING STARTER PINION CLEARANCE

Figure 123—Checking for Starting Motor End Play and Pinion Clearance

155. GENERATOR.

a. A large capacity, air-cooled, shunt type generator with automatic cut-out, current and voltage regulator is used. The output of the generator is controlled in relation to the voltage requirements, keeping the battery fully charged and maintaining proper voltage under normal running conditions. This means that the ammeter hand may gradually approach zero, indicating that the battery requires less current at that time. The voltage control feature of the generator prevents over-charging of the battery and because there

is no excessive voltage, long life is assured for the electrical system.

b. The generator becomes warm by the nature of its work. The harder the work, the warmer it will become. To reduce this natural heat, an inbuilt fan draws fresh, cool air into the rear end of the generator and forces the hot air out the front end. The fresh air passes over the brushes and commutator. The faster the generator runs, the faster the air moves through it, forcing out the natural heat developed in the generator.

c. The generator requires no maintenance attention, other than periodic lubrication. See Lubrication Section XVI. Repair to the generator requires experience and testing equipment. Unless operator is equipped to do this type of repair a new generator should be requisitioned and the old generator returned for repair.

156. TO REMOVE THE GENERATOR.

Disconnect the lead wires; remove the adjusting strap bolt; remove the support bracket bolts.

157. CURRENT AND VOLTAGE REGULATOR.

a. The regulator assembly contains three units, each with its own function to perform. These consist of the circuit breaker, the current regulator and the voltage regulator.

b. The circuit breaker is an automatic switch between the generator and the battery which closes the charging circuit when the generator is charging and opens the circuit when it is not charging, thus preventing the battery discharging back through the generator.

c. The current regulator unit limits the maximum current output in amperes. When the generator output reaches a predetermined maximum, the regulator points are opened, cutting in a resistance in the generator field circuit and reducing the output. Immediately upon the dropping of the output, the points close, cutting out the resistance and the output rises. These cycles occur so rapidly that the points vibrate at a high frequency, thus holding the output constant at a predetermined maximum.

d. The voltage regulator unit is used for holding the voltage of the electrical system constant within close limits. When the voltage rises to a predetermined point the regulator contact points vibrate thus cutting in and out a resistance in the generator field circuit.

e. The regulator units are sealed to indicate they have the original factory setting. Regulators which require adjustments should be taken to an experienced electrical mechanic.

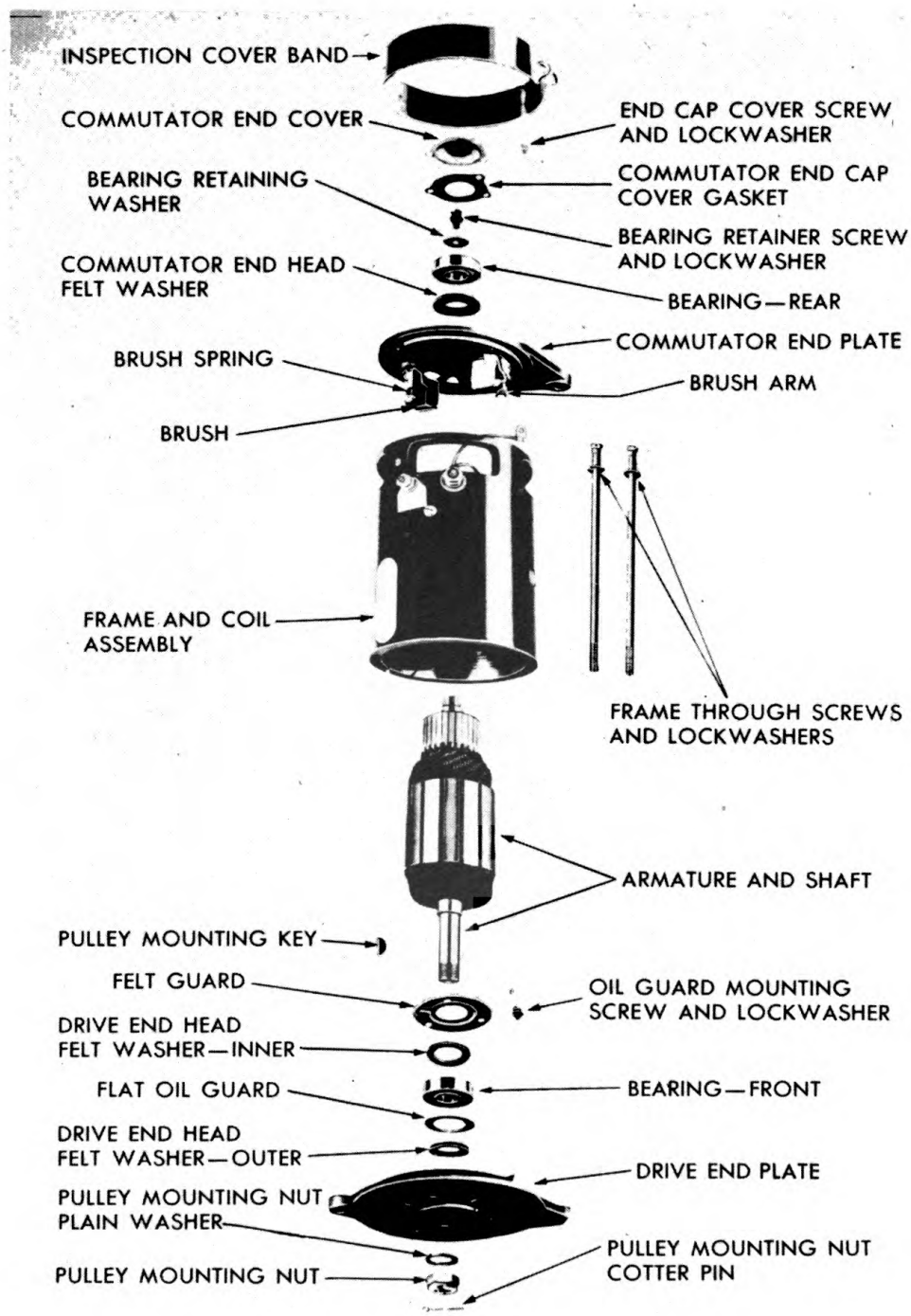


Figure 124—Exploded View of Generator

158. DISTRIBUTOR.

The distributor is of the dust-proof type and contains a set of breaker points which are timed to open and close the circuits to the spark plugs, depending on engine speed. This is taken care of by a governor operated by centrifugal weights in the base of the distributor which regulates the spark timing according to speed.

159. REMOVAL OF DISTRIBUTOR.

To remove the distributor, remove the cap, disconnect the small primary lead wire at the distributor, remove the hold-down screw and withdraw the unit.

160. ADJUSTMENT.

a. Since the breaker points are timed to open and close at the exact instant necessary for efficient engine operation, the adjustment of the points is an important factor in correct distributor operation.

b. The breaker points can be adjusted with a feeler gage, but the points must be dressed so that they are clean and make flat contact with each other. Rotate the distributor shaft so that the breaker point rubbing block is on the high point of the cam; loosen lock nut (figure 126); turn ignition point screw with wrench clockwise to open gap, and counterclockwise to close gap. Adjust point gap with feeler gage to .020 inch. Tighten lock nut.

c. After the breaker point gap has been properly adjusted, the ignition timing should always be checked and set to the correct specification. (Top dead center).

d. To remove the breaker points (with distributor removed) lift off the rotor, remove the dust cover plate, and remove the screw and clip which holds the primary lead wire, condenser lead wire and the breaker point spring. Lift the breaker arm off its pivotal point. Remove the retaining lock screw and lift up the stationary point plate.

e. If the breaker points and the spark plugs are properly adjusted, and the engine misses at high speed, the breaker arm spring tension should be checked. The tension at the breaker points should be eighteen to twenty ounces. Correct tension may be obtained by shifting the breaker arm spring in its slot until the tension is correct. Make certain that the copper conductor strap, parallel to the spring, is not tight against the spring. If the conductor strap is drawn too tightly, it is likely to fracture.

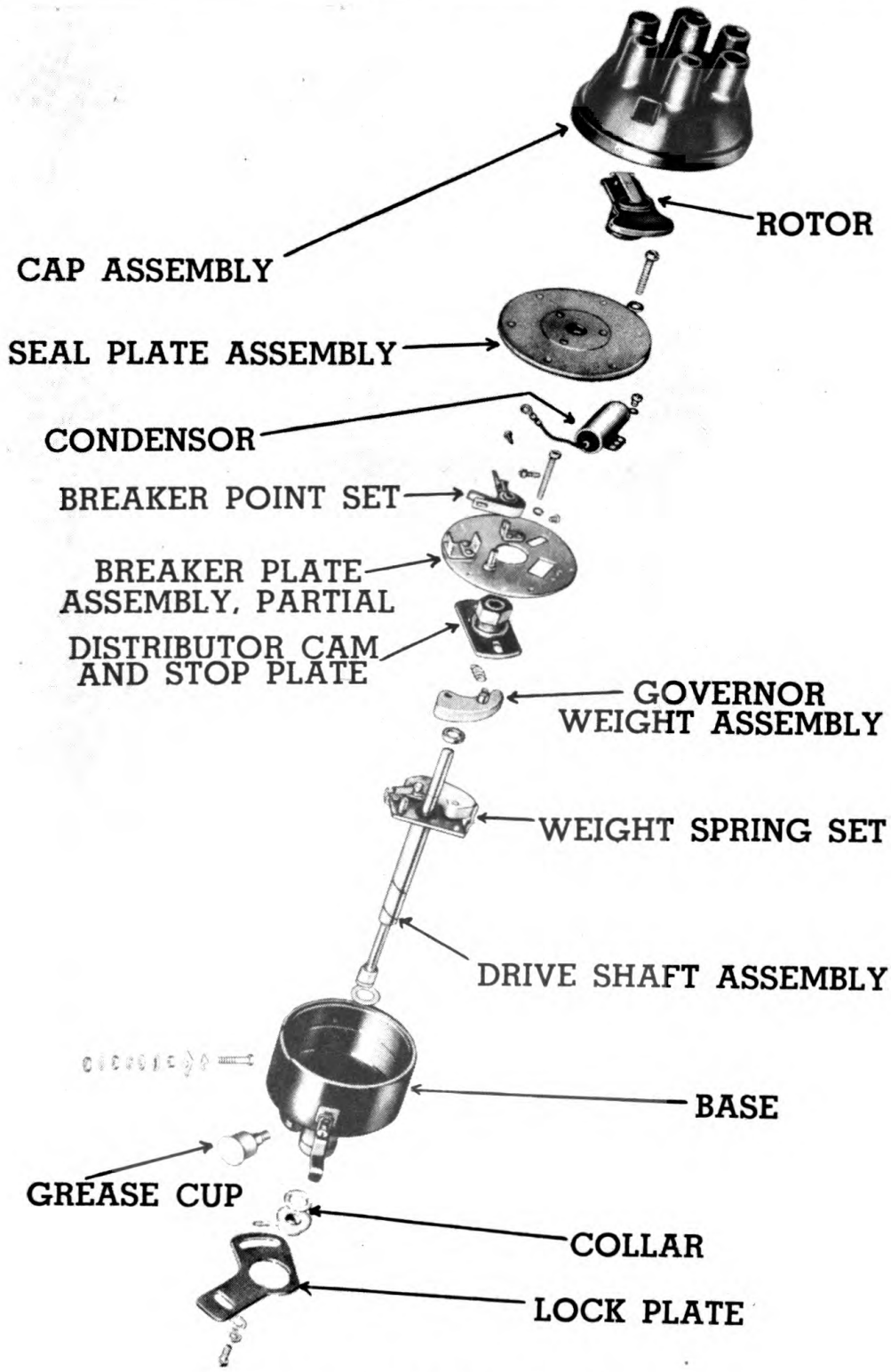


Figure 125—Exploded View of Distributor

CAUTION

The slightest trace of oil, grease or dirt on the contact surface of the breaker points will aggravate pitting and burning, necessitating frequent replacement of breaker points.

f. When installing the distributor assembly on the engine, see that number one piston is at top dead center on compression stroke and the distributor rotor is in number one firing position.

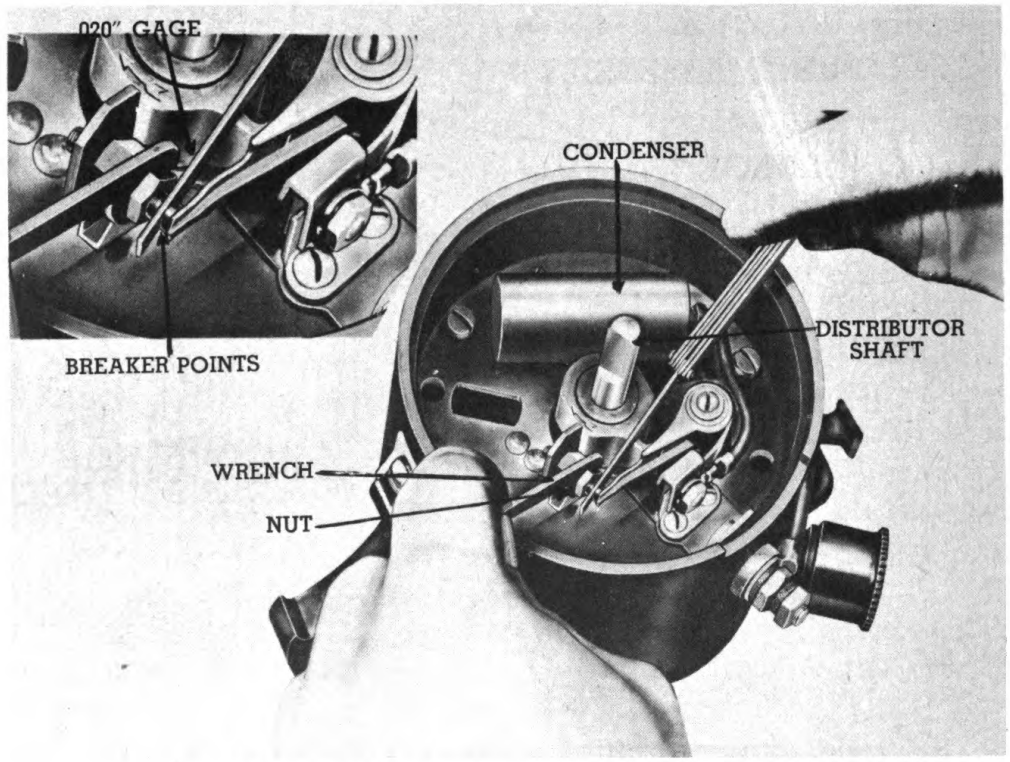


Figure 126—Breaker Point Adjustment

161. IGNITION COIL.

a. The ignition coil transforms battery voltage into high voltage for the spark plugs. If there are indications that the coil is not delivering a satisfactory spark, first check all connections to see that they are clean and tight.

b. A quick coil check may be made by removing the coil high tension wire at the distributor cap and holding it near the cylinder head. With the ignition switch turned on and the starting motor cranking the engine, a spark should jump from the end of the high tension wire to the cylinder head.

c. If the spark is less than ¼-inch long, the electrical system

should be tested with accurate electrical testing equipment, to determine the cause of the difficulty.

162. SPARK PLUGS.

a. For the best engine performance and economical operation, the spark plugs should be kept clean. They should be cleaned frequently in a sandblast type cleaner which will remove the deposit formed by the use of chemically treated fuels for high compression engines. If this deposit is not removed, the engine may miss under heavy load. In addition to cleaning the electrodes, the porcelains should also be cleaned frequently to remove dirt and oil.

b. After cleaning the spark plugs, adjust the gap to .025 inch, using a feeler gage. Make all adjustments on the side wire of the plug. If the center electrode is bent, the porcelain may crack, resulting in plug failure.

c. The spark plugs should be tested occasionally with a reliable tester and replaced if faulty.

SECTION XXVIII
FUEL SYSTEM

163. GENERAL.

The engine fuel system consists of the fuel pump (with sediment bowl) and the carburetor. Nothing has a more direct connection with the performance of the engine than the fuel system, and the proper functioning of its component units. Dependent upon the fuel system are vitally important factors such as performance, power, economy and quick starting in cold weather.

164. THE FUEL PUMP—(Figure 127.)

The fuel pump forces the fuel from the source of supply to the carburetor, insuring constant pressure under all operating conditions. It is of the diaphragm type, mounted on the manifold side of the engine, driven by an eccentric on the camshaft.

165. TO REMOVE AND CLEAN FILTER BOWL.

It is not necessary to remove the pump from the engine. Loosen the nut which holds the filter bowl to the body; remove filter bowl, gasket and filter screen; clean bowl and wipe it dry; clean filter screen in kerosene and dry it with compressed air. Do not wipe the

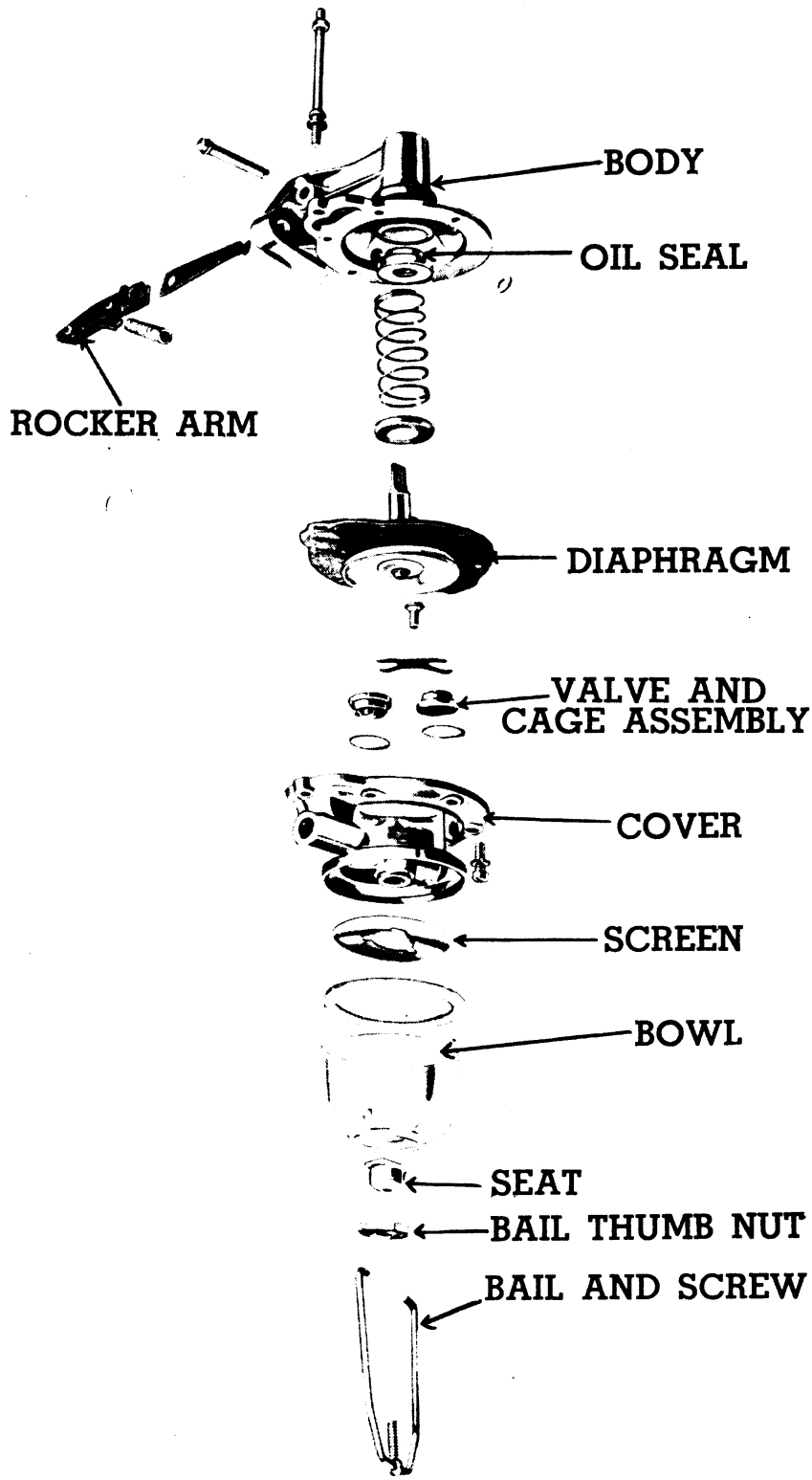


Figure 127—Exploded View of Fuel Pump

screen with a cloth. Lint might cling to the screen and later lodge in the orifices of the carburetor. To assemble, reverse above operations using a new gasket.

166. TO REMOVE FUEL PUMP FROM ENGINE.

Remove pump heat shield; disconnect fuel lines from pump; remove mounting screws. To install fuel pump to engine, reverse above operations.

167. TO DISASSEMBLE THE FUEL PUMP—(Figure 128.)

a. Remove filter bowl, remove the screws which hold the two halves of the pump body together and separate the halves. Use care not to tear the diaphragm if it happens to stick to each half of the body. Remove the inlet and outlet retainer screw and lift out the retainer and valves. Use care not to lose the paper gaskets. Remove the diaphragm by compressing it and unhooking it from the rocker arm; compress and remove the rocker arm return spring. To remove the rocker arm, drive out the pivot pin. The pivot pin is staked in place and the staking should be filed or chipped off before driving out the pin. To remove the oil seal, chip off pieces of the pump body which clinch the oil seal. It is only necessary to

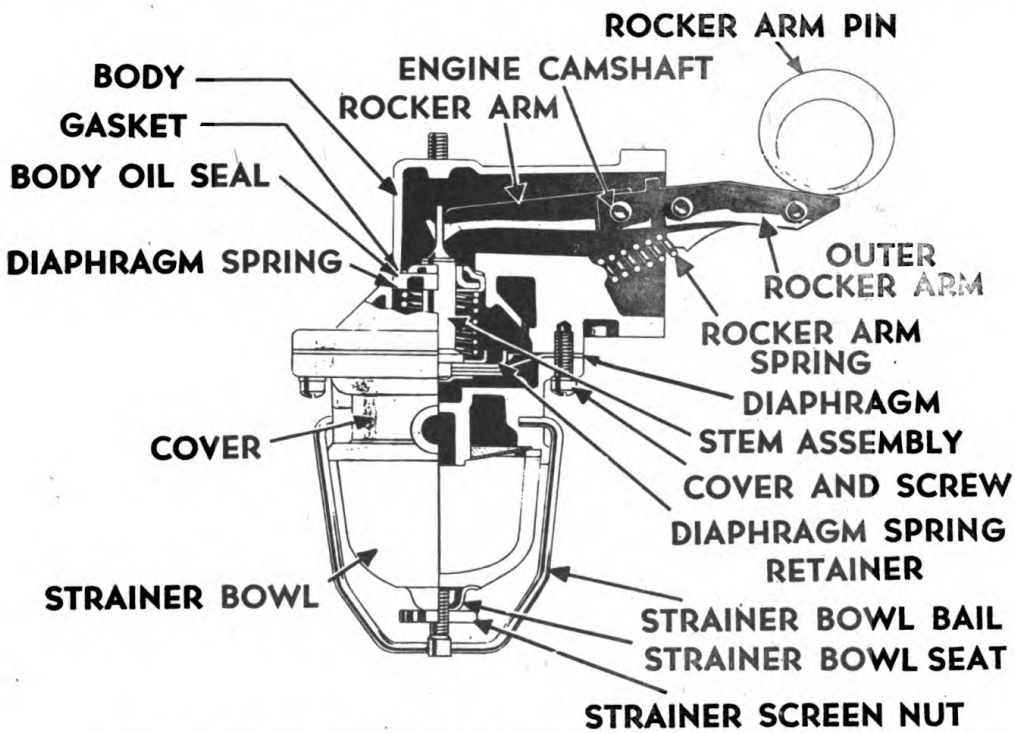


Figure 128—Sectional View Showing Fuel Pump Assembly

replace the oil seal when an excessive amount of oil leaks out of the vent hole in the body above the diaphragm.

b. To assemble the fuel pump, reverse the above operations using care to hold the rocker arm to the end of its stroke tight against the spring pressure when tightening the screws which hold the two halves of the pump together. When assembling the inlet and outlet valves in the pump cover, make certain that they are assembled properly. These valves are identical, but one should be assembled with the spring side up and the other with the spring side down so that the retainer plate lies flat when holding the valves in place.

c. It frequently occurs that fuel supply difficulties are not caused by the fuel pump and its operation; therefore, it is recommended that the following items be checked before disassembling the fuel pump:

(1.) Check carburetor float and needle for proper functioning.

(2.) Check fuel line for leaks, kinks or other obstructions.

(3.) Dirty filter screen.

(4.) Leaks at diaphragm flange.

(5.) Loose valve plugs.

(6.) Leaks at pipe connections.

d. Do not use shellac or any other adhesive on diaphragm. Gum deposits in fuel pump or carburetor should be removed with SOLVENT, dry cleaning, and compressed air.

168. THE CARBURETOR.

The carburetor is of the plain tube, down-draft type with fixed calibrated jets, covering all speed ranges except the idle, and suitable for all atmospheric temperatures. Therefore, no adjustments of the fuel mixture is required, except for the idle. The small screw on the outside of the carburetor is for idle adjustment only.

169. TO ADJUST THE IDLE MIXTURE.

To decrease the mixture (less fuel to air) turn the adjusting screw clockwise. To increase the mixture (more fuel to air) turn the adjusting screw counterclockwise. The usual adjustment is from ¾ to 1¼ turn off the seat.

170. TO CHECK LEVEL OF CARBURETOR FLOAT.

Remove carburetor air horn and gasket; use a float gage or lay a steel straightedge across float chamber; measure from lower edge of straightedge to top of float in "UP" position. This measure-

ment should be 5/64 inch. If a change in float level is necesasry bend the lip of the float away from the needle to raise, or toward the needle to lower the level. **Bend the vertical lip of the float only.** (Figure 129.)

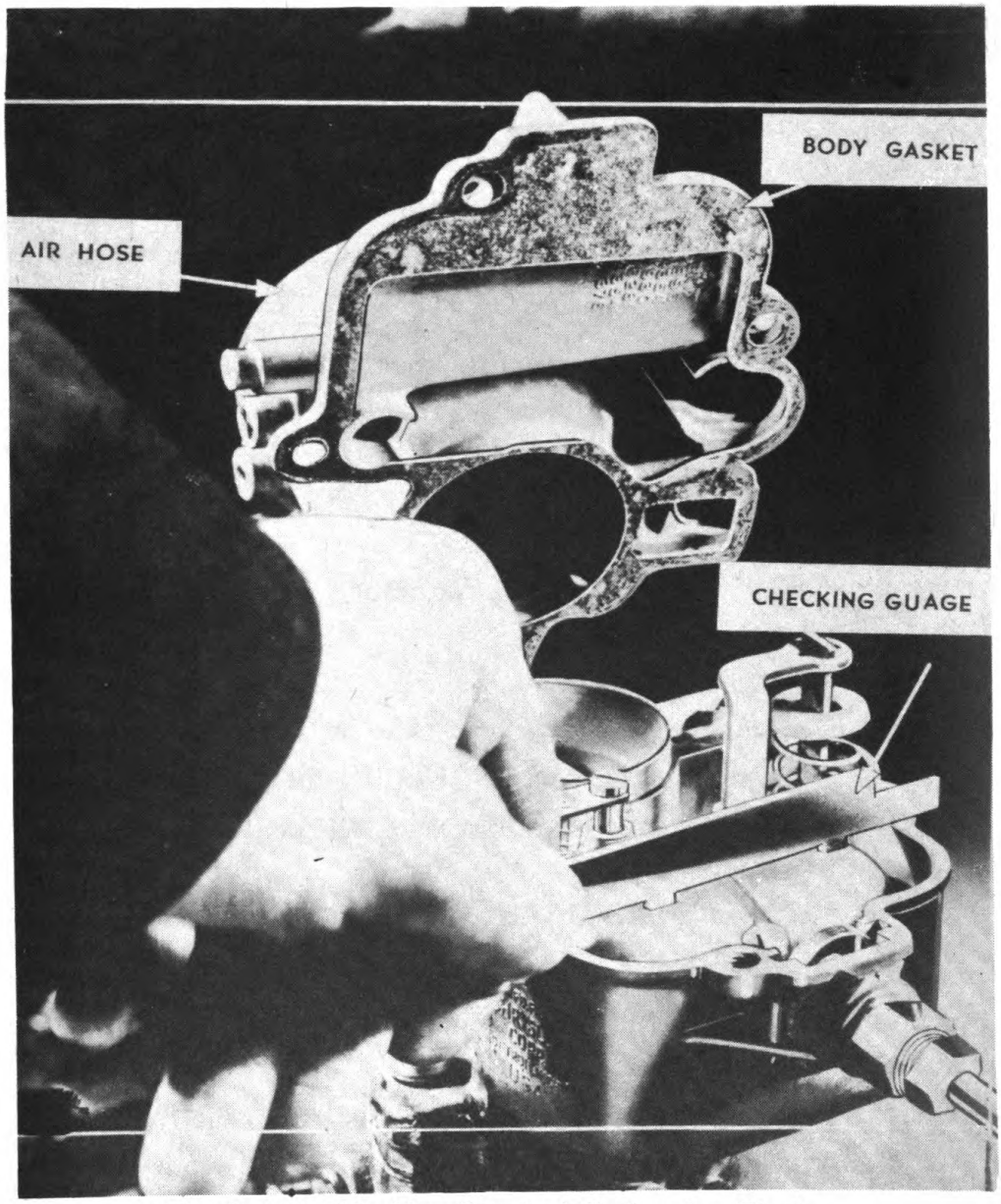


Figure 129—Checking Level of Carburetor Float

171. TO CLEAN CARBURETOR.

a. If gum residues from fuel form in the carburetor or in the orifices, it will seriously impair the performance of the engine. Dis-

assemble the carburetor and soak the parts in SOLVENT, dry cleaning, until the gum is dissolved and then clean with stiff bristly brush, dry with compressed air. Thoroughly clean and dry before reassembling.

CAUTION

Never clean jets with a drill, as the jets will be enlarged, making the mixture too rich for proper performance.

b. The addition of one pint of light engine oil to each five gallons of fuel in the fuel system will retard the formation of gum. This is recommended in cases where the engine remains out of operation for several weeks or longer. This is not necessary when benzol fuel is used. Any accumulation of dirt or water in fuel system will cause trouble. See that only clean fuel reaches the engine.

c. Every month the fuel pump sediment bowl should be removed and cleaned. Dirt or water in the fuel pipes may be removed by blowing them out with compressed air or a tire pump. Keep all connections in the fuel line tight.

172. TO REMOVE CARBURETOR.—

a. Remove air cleaner and throttle control rod.

b. Disconnect fuel line.

c. Disconnect choke control.

d. Remove carburetor flange bolts and carburetor from engine.

173. TO DISASSEMBLE CARBURETOR AFTER REMOVAL.

Each design carburetor requires a different method of disassembly (see figure 130).

174. TO DISASSEMBLE CARBURETOR.—

a. Remove float cover screws and raise the cover.

b. Remove float pin retainer spring, float and float needle.

c. Remove accelerator pump link.

d. Push out accelerator pump plunger assembly.

e. Remove the idle orifice plug and tube and blow out with air.

f. Remove economizer assembly.

g. Remove main metering jet and blow out with air.

h. Use compressed air to clean carburetor jets. Never use drills or wire. To assemble and install, reverse the foregoing operations.

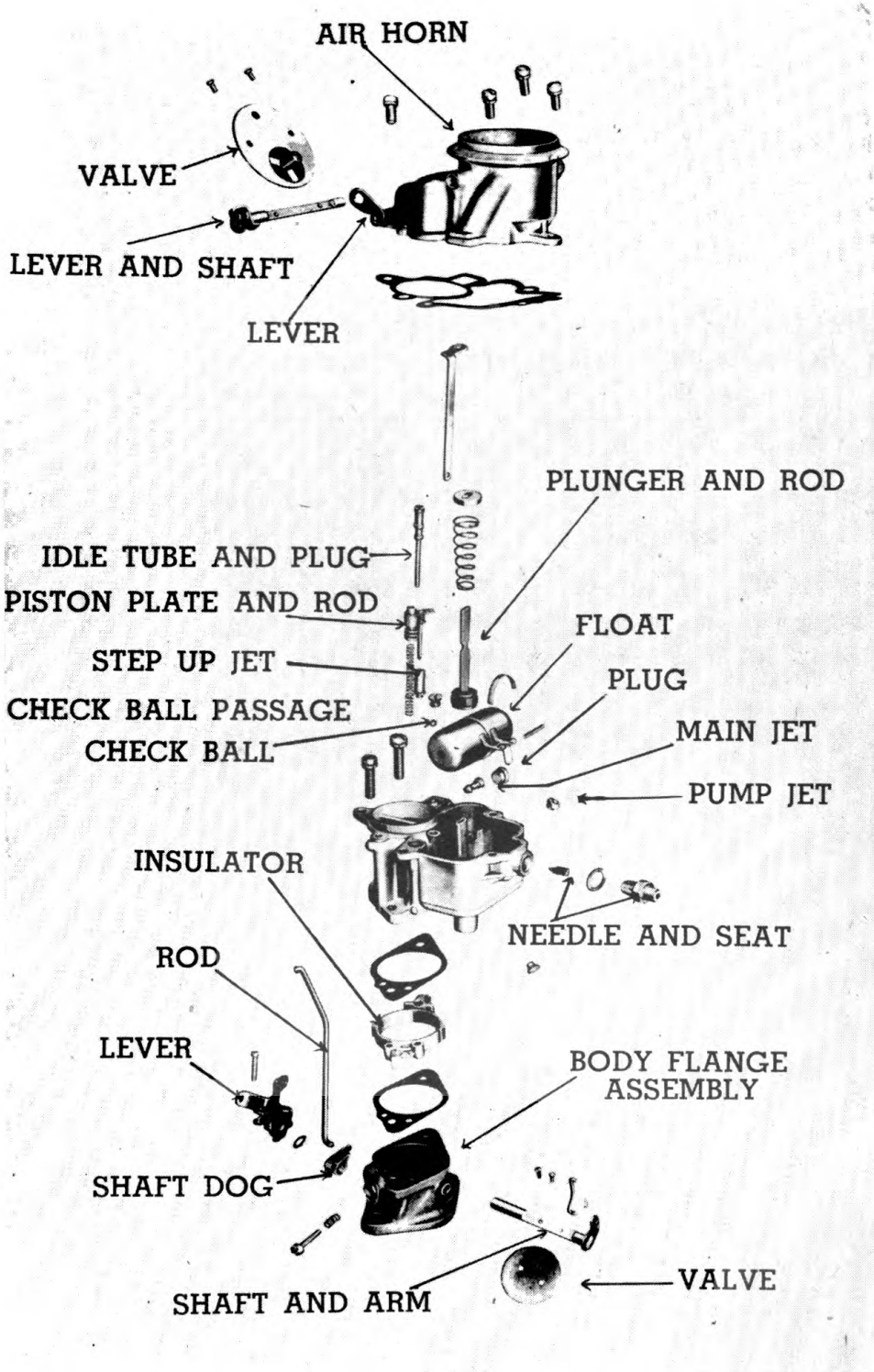


Figure 130—Exploded View of Carburetor Showing Order of Assembly

175. AUTOMATIC CHOKE.

a. An automatic choking device is provided which operates the carburetor choke when starting and during the warm-up period of a cold engine. After the engine reaches normal operating temperatures, the choke valve opens and remains open until the exhaust manifold starts to cool.

b. The automatic choke should not be lubricated. Lubrication will cause sticking and unsatisfactory operation. Use SOLVENT, dry cleaning, for removing gum from the choke mechanism. This is particularly important at the beginning of cold weather.

176. AUTOMATIC CHOKE ADJUSTMENT—(Figure 131.)

a. Open hand throttle one-fourth way; remove cover from automatic choke and air cleaner from carburetor so that position of carburetor choke valve can be observed. Move automatic choke lever until hole in brass shaft lines up with slot in bearing. Insert special tool through shaft, pushing tool all the way down so that it engages notch in base of automatic choke. Loosen automatic choke lever clamp screw and hold the butterfly closed in carburetor and while in this position tighten choke lever lock screw as shown in figure

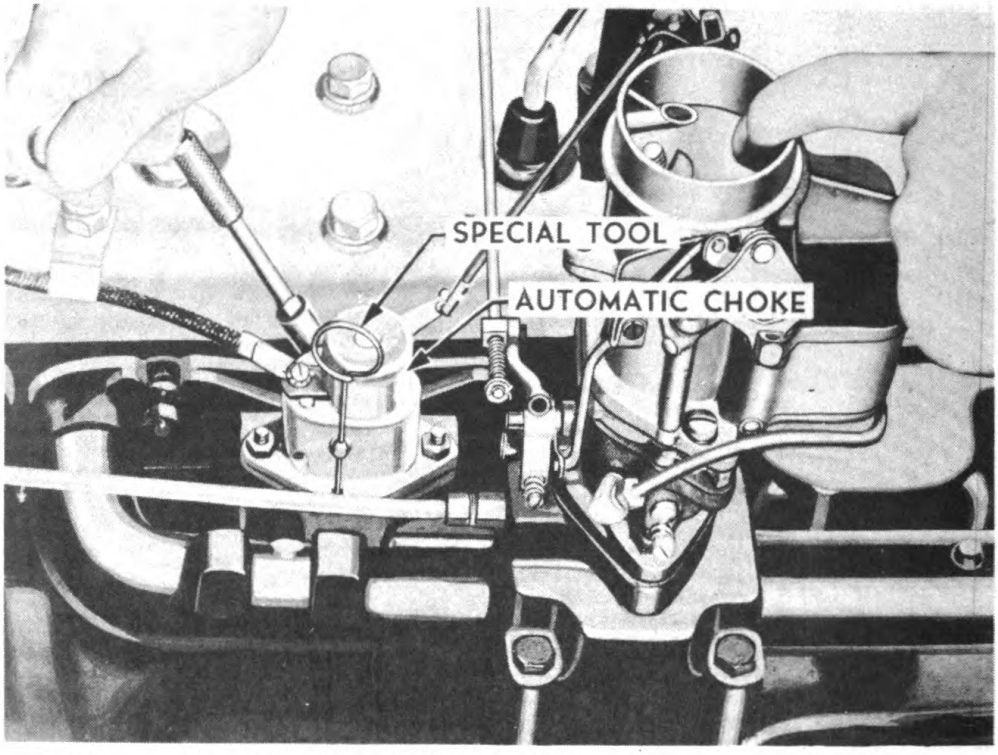


Figure 131—Adjusting Automatic Choke Requires Special Tool

131. Replace air cleaner, checking to **be sure that tightening of air cleaner clamp does not bind choke valve or shaft.** See that fast idle or choke mechanism does not bind or interfere with operation of carburetor choke valve.

CAUTION

Do not handle or bend the hairpin shaped thermostat in the base of the automatic choke, as this thermostat is set and heat tested at the factory.

b. Always make this check with carburetor throttle partly open. Never use a terminal screw on the automatic choke that is longer than the original factory installed screw.

SECTION XXIX
OIL PUMP REBUILDING

177. REMOVE COVER AND CHECK DRIVE SHAFT END PLAY —(Figure 132.)

Remove the cover and gasket. Attach a dial indicator to the pump body so that the indicator button contacts the oil pump drive gear. Move the drive shaft up and down to indicate the amount of end play on the dial. If the end play exceeds 0.010 inch, determine whether the end play is the result of wear on the distributor drive gear end of the shaft or at the oil pump drive gear end of shaft.

178. MEASURE CLEARANCE BETWEEN PUMP DRIVE GEAR AND BODY—(Figure 132.)

Push the pump drive gear into the housing as far as it will go and lay a small steel scale across the outer end of the gear. Measure the space between the steel scale and the cover flange surface of the oil pump body with a thickness gage. The oil pump drive gear should extend 0.003 inch above the body cover flange and if the measurement is less than this amount, the difference indicates the amount of wear between the inner end of the oil pump drive gear and the body.

179. MEASURE CLEARANCE BETWEEN DISTRIBUTOR DRIVE GEAR AND BODY—(Figure 132.)

Push on the distributor drive gear end of the pump drive shaft so the pump drive gear will be forced out of the pump body as far as it will go and measure the distance with a thickness gage between a small steel scale, placed across the end of the pump drive

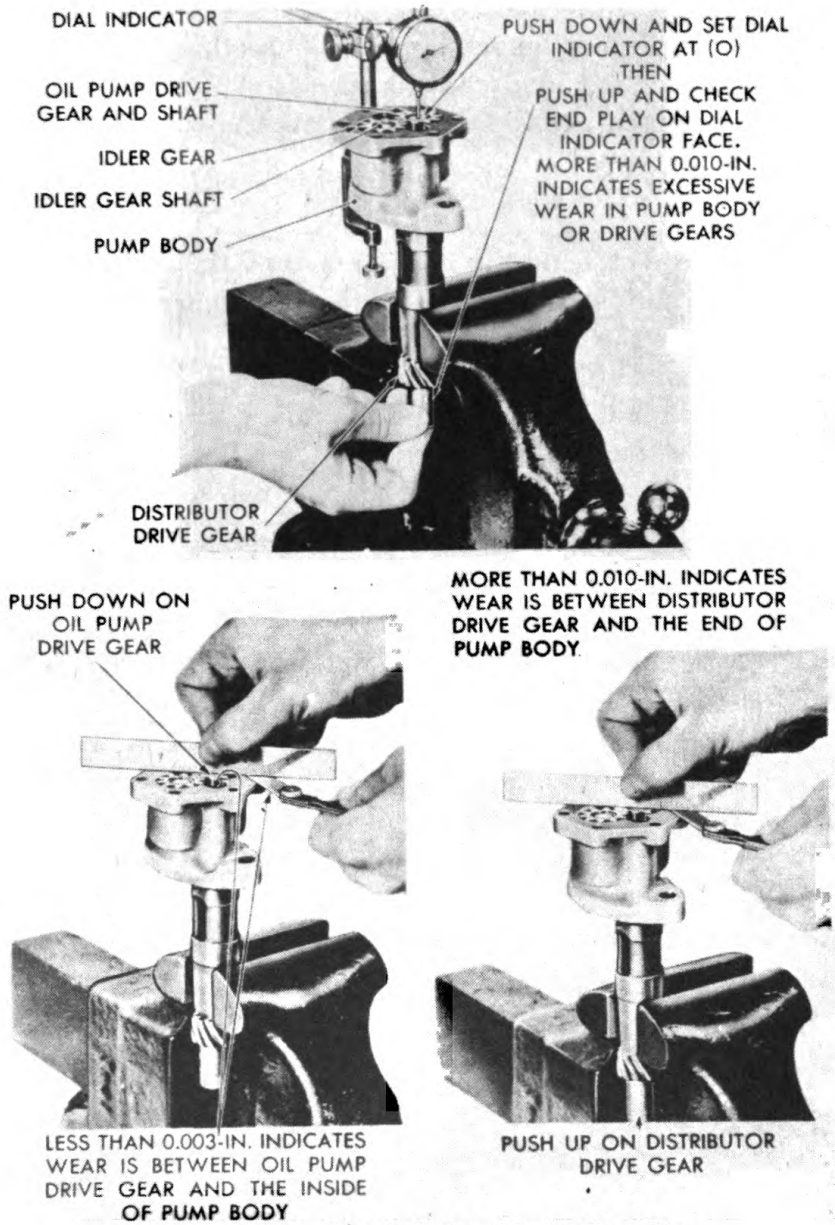


Figure 132—Check Drive Shaft End Play

gear and the pump body cover flange surface. This measurement will indicate the amount of wear between the distributor drive gear and the end surface of the pump body drive shaft housing. The clearance at the distributor drive gear end is excessive if this measurement is more than 0.010 inch.

180. MEASURE IDLER GEAR CLEARANCE IN BODY AND IDLER GEAR SHAFT WEAR—(Figure 133.)

Insert a thickness gage between the idler gear and pump body

and measure the clearance between the shaft and the gear. If the clearance is more than 0.0065 inch, remove the idler gear and drive the idler gear shaft out of the body. Then measure the idler gear shaft diameter with a micrometer. If it is worn more than 0.001 inch below 0.4885 inch, which is standard, replace the shaft. If the clearance exceeds the shaft wear by 0.015 inch, replace the idler gear. Replace the idler gear shaft or pump body if the idler gear shaft is not a tight press fit in the body.

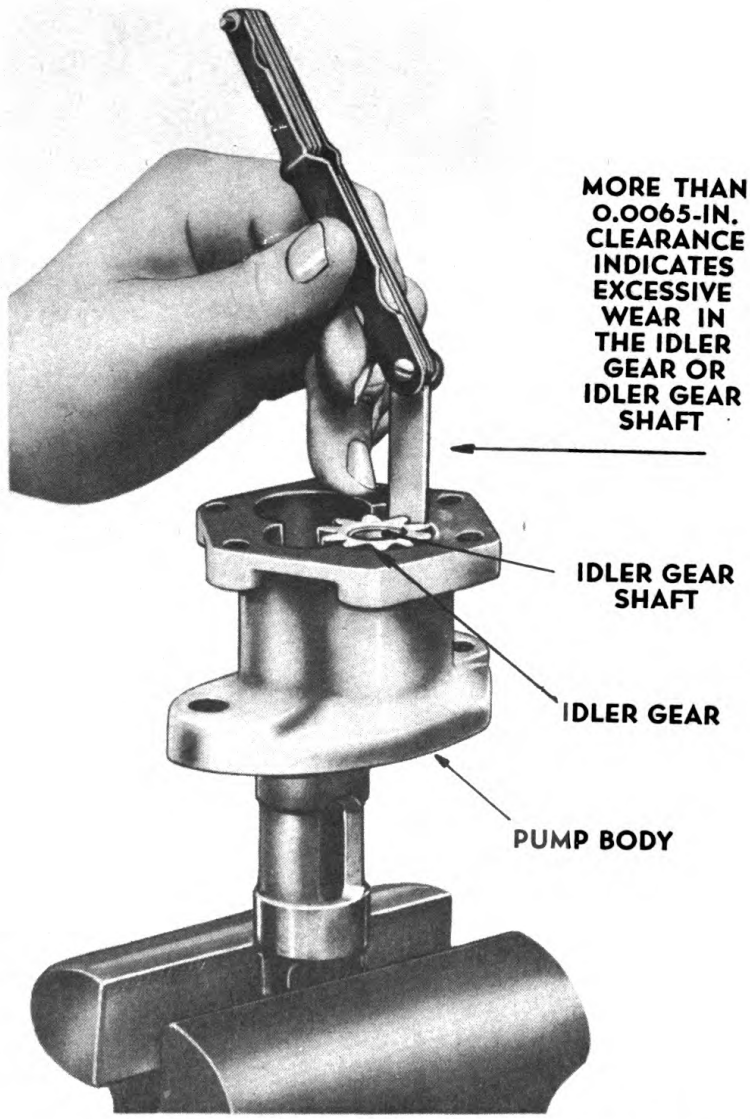


Figure 133—Checking Idler Gear and Shaft Clearance

181. REMOVE PUMP DRIVE SHAFT AND GEAR ASSEMBLY AND CHECK PUMP GEAR AND BODY WEAR— (Figure 134.)

Drive out the distributor drive gear pin and press the shaft out of the gear. Pull the pump drive shaft and gear assembly out of the pump body. If there is excessive wear between the pump drive gear and the body, measure the parts to determine where the wear exists. Measure the width of the oil pump drive gear across

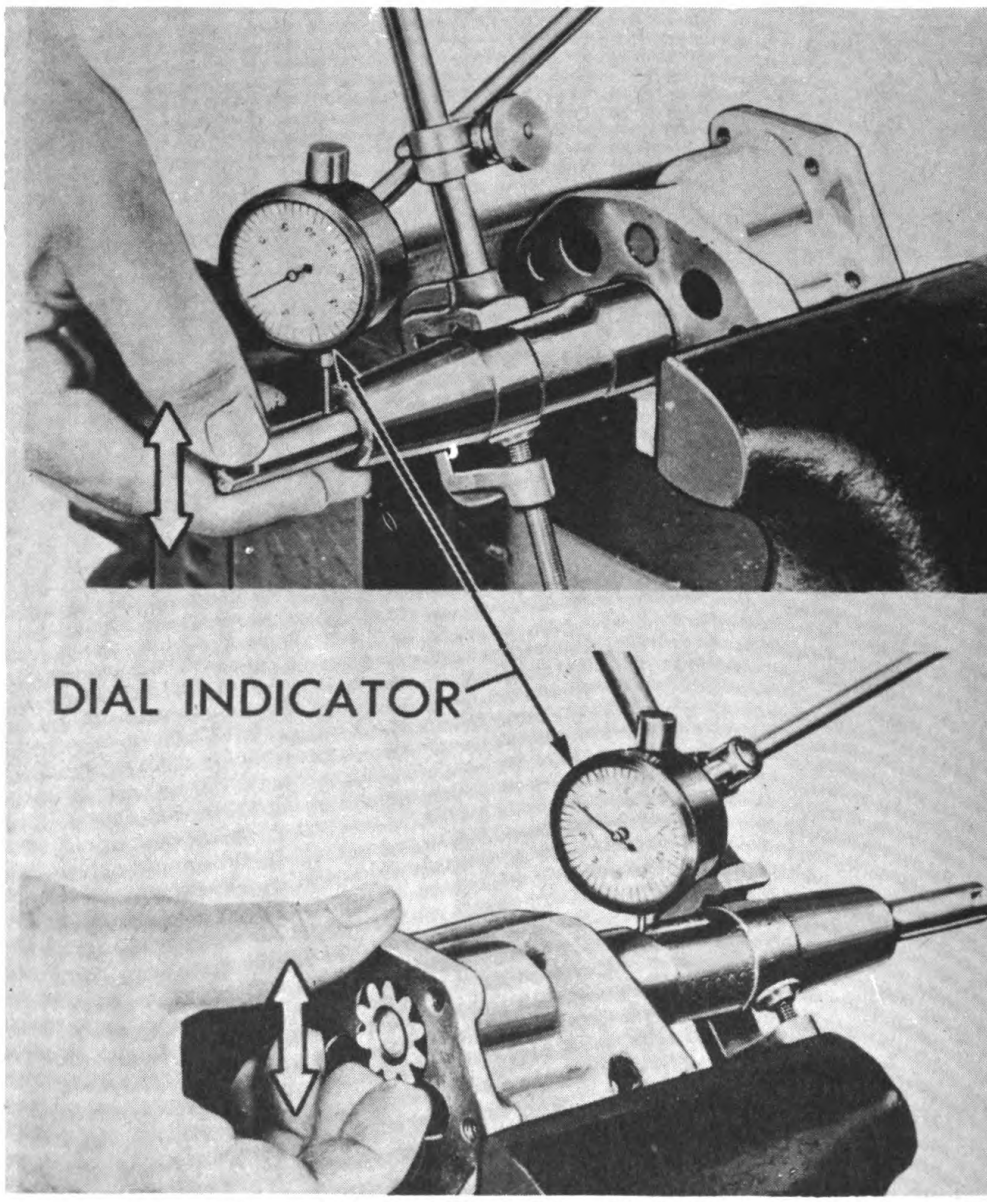


Figure 134—Checking Drive Shaft Clearance

the face with outside micrometer. The gear is worn if it measures less than 1.3105 inch. Then install the gear and shaft in the pump body and lay a small steel scale across the drive gear and body cover flange. Measure the space between the steel scale and the body cover flange of the gear with a thickness gage. The length of the gear plus or minus the feeler gage measurement will indicate the depth of the body gear compartment, which is originally 1.3075 inch. If the depth of the gear compartment is greater than that amount, the pump body is worn. Replace the gear or body if they are excessively worn.

182. INSPECTION OF OIL PUMP PARTS.

Inspect Cover and Gasket—(Figure 135.) Inspect the cover for damage or cracks and for wear caused by the gears rubbing on the cover. If the cover is merely scored or worn by the gears, reverse the cover when the pump is reassembled. Cover wear indicates excessive drive shaft end play. Replace the cover gasket when making oil pump repairs to maintain the correct clearance between the cover and the gears.

183. INSPECT PUMP GEARS—(Figure 135.)

Inspect the pump drive gear and idler gear teeth and if excessive wear is evident, replace the gears. If wear is not visible, measure the diameter of the gears with a micrometer. Replace the drive gear if the diameter is less than 1.161 inch and replace the idler gear if the diameter is less than 1.163 inch.

184. CHECK GEAR AND BODY CLEARANCE.

If the idler gear and shaft and the pump drive gear and shaft assembly are satisfactory, reinstall them in the pump body. Then measure the clearance between the gears and the body with a thickness gage. If the clearance between the body and gears exceeds 0.004 inch, replace the pump body.

185. INSPECT BODY—(Figure 135.)

Inspect the pump body for sand holes, cracks or irregular machined surfaces that might cause leaks. Replace the body if it is unsatisfactory.

186. MEASURE DRIVE SHAFT CLEARANCE IN PUMP BODY—(Figure 134.)

Insert the pump drive shaft and gear assembly in the pump body and attach a dial indicator to the pump body with the indicator button against the drive shaft at the distributor drive gear

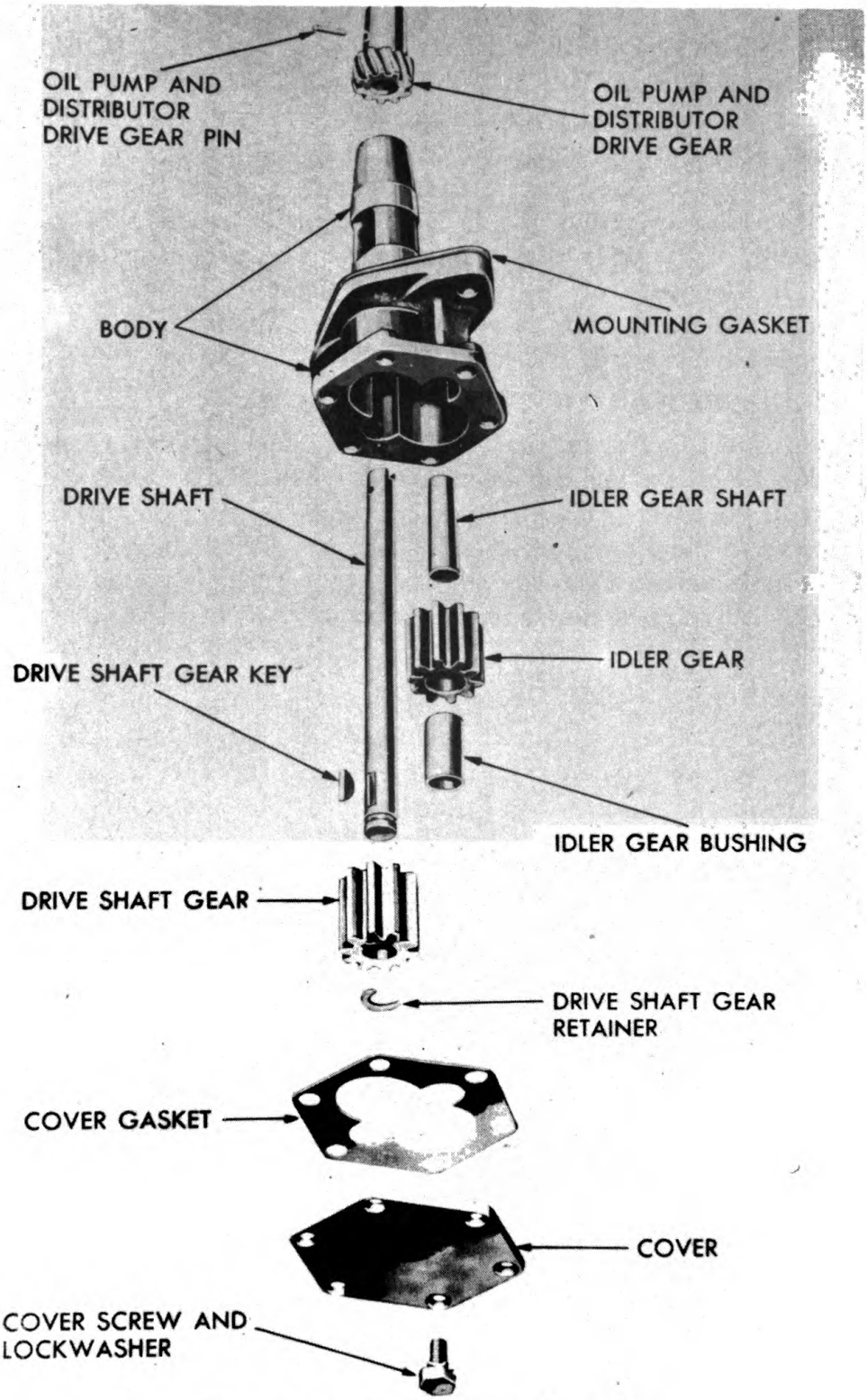


Figure 135—Oil Pump Disassembled

end. (Figure 134.) Move the shaft away and then towards the indicator button and note the indicator reading. Then move the dial indicator on the pump body so the indicator button contacts the drive shaft through the opening in the body shaft housing, and determine the clearance at this point. If the clearance at either end of the shaft exceeds 0.002 inch, remove the shaft and measure the diameter with a micrometer. Replace the shaft if it measures less than 0.484 inch. Replace the pump body if the clearance exceeds 0.001 inch more than the shaft is worn.

187. CHECK FIT OF PUMP DRIVE GEAR ON SHAFT.

Check the fit of the pump drive shaft gear on the pump drive shaft and if it is loose, replace the gear and shaft assembly. To remove the pump drive gear from the shaft, press the gear on the shaft until the horseshoe shaped retainer is exposed and remove the retainer. Then press the gear off the shaft and remove the key.

188. ASSEMBLY OF OIL PUMP.

Install Idler Gear Shaft and Gear—(Figure 136.) If the original drive shaft and gear and the distributor gear are to be installed, it is important to hold the end play to 0.005 inch to 0.010 inch to prevent wear of the pump cover. Install the drive shaft and gear assembly in the pump housing. Line up the pin hole of the distributor drive gear with the hole in the drive shaft and start the gear on the shaft with the gear tooth end of the gear towards the housing. Press the gear on the shaft until the pin hole of the gear is accurately aligned with the hole in the shaft. The location of the distributor gear on the shaft affects the pump drive gear end play and it is therefore important to use a straight punch to align the pin holes properly before installing the pin. When the gear is properly positioned on the shaft, there should be 0.005-inch to 0.010-inch clearance between the gear and the housing when measured with a feeler gage. Drive a new pin through the gear and shaft and rivet each end of the pin slightly. Turn the shaft by hand to make sure that it turns freely.

189. INSTALLATION OF NEW DRIVE SHAFT AND DISTRIBUTOR DRIVE GEAR—(Figure 136.)

If the pump drive gear and shaft assembly or the distributor drive gear requires replacement, replace both parts. The new parts must be assembled and properly drilled to maintain the correct end play. Install the drive shaft and gear assembly in the oil pump body. Then start the distributor drive gear on the shaft with the gear tooth end of the gear towards the housing and with the pin hole,

which is drilled through one side of the gear hub, at right angle to the drive shaft slot. Press the gear on the shaft until a 0.005-inch thickness gage will just pass between the end of the housing and end of the gear. Then drill through the shaft and other side of gear and countersink the drill hole on each side of the gear. Drive a new pin through the gear and shaft and peen over each end of the pin to retain it in place.

190. INSTALL COVER.

a. If the cover is visibly worn, caused by the gears contacting the cover, clean all paint off the cover, turn it over and assemble the unworn surface toward the gears with a new gasket.

b. Gasket as furnished is of a given thickness. If gasket material is used there should be no variation as to thickness.

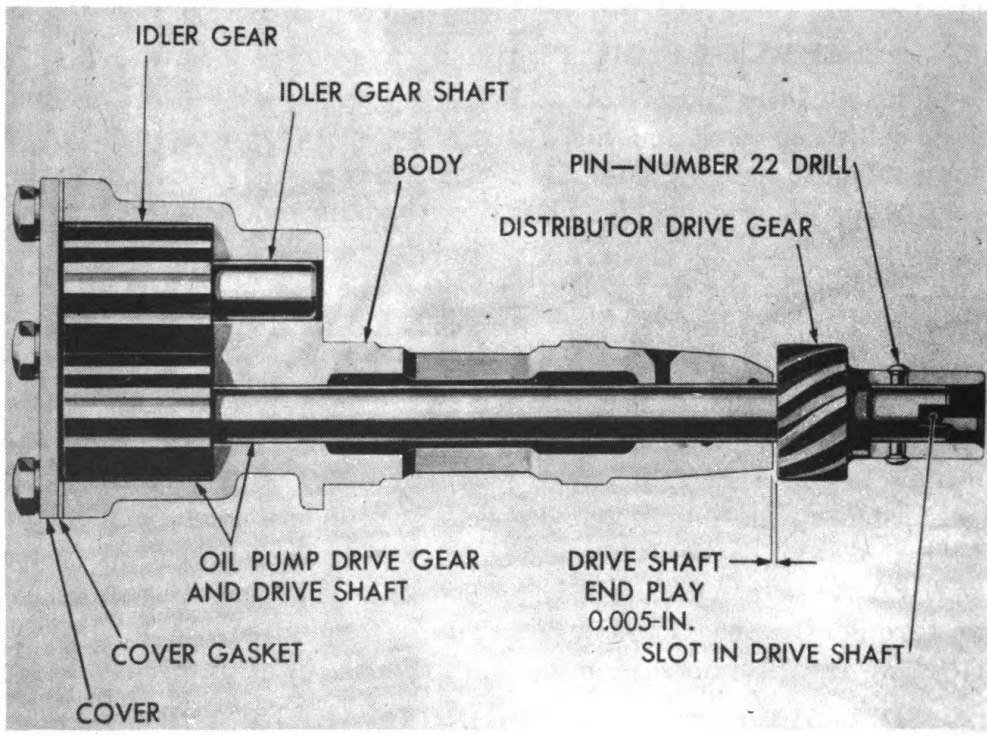


Figure 136—Oil Pump Assembled

SECTION XXX
TROUBLE SHOOTING

PUMP

Possible Causes	Reason
If No Water is Delivered.	1. Impeller completely plugged with foreign matter.
If Not Enough Water is Delivered.	1. Impeller partially plugged.
	2. Mechanical defects; shell wearing ring worn -- impeller damaged.
Not Enough Pressure.	1. Mechanical defects; shell wearing ring worn or damaged impeller.

ENGINE

If Engine Stops or Fails to Start.	1. Remove and rebuild distributor assembly.
If Fuel is Not Reaching Carburetor.	1. Repair or replace.
If Engine Knocks under Load.	1. Adjust ignition timing. 2. Remove carbon. 3. Replace bearings. 4. Check cooling system for circulation.
No Oil Pressure.	
1. Defective oil gage.	1. Replace oil gage.
2. Loose connecting rod or main bearing.	2. Recondition engine and replace bearings.
3. Broken or weak oil relief valve plunger spring.	3. Install new spring of the proper tension.
4. Worn pump gears and housing.	4. Replace.

GENERATOR

Possible Causes	Reason
If Charging Rate is Too Low.	
1. Current and voltage regulator out of adjustment.	1. Replace or adjust regulator.
If Charging Rate is Too High.	
1. Current and voltage regulator out of adjustment.	1. Replace or adjust regulator.
2. Poor ground at regulator.	2. Ground regulator.

COOLING SYSTEM

Overheating.	
1. Inoperative water pump due to sheared impeller pin.	1. Remove pump and replace broken pin.
Loss of Cooling Solution.	
1. Cylinder head gasket blown.	1. Replace.

This service information applies particularly to the Leff Pumping unit. Chrysler T-108-503 carburetor type gasoline driven engine.

SECTION XXXI

TOLERANCES AND CLEARANCES

ENGINE

	Inside Diameter
Cylinder bore	3 - 7/16 inches
Stroke	4¼ inches

CAMSHAFT

Bearing clearance	.002 inch to .004 inch	
End-play	.002 inch to .006 inch	
Bearing sizes	Diameter	Length
No. 1 - front	2 inches	1-3/32 inch
No. 2	1-31/32 inch	1-1/16 inch
No. 3	1-15/16 inch	1-1/16 inch
No. 4	1-1/4 inch	1-1/4 inch

CONNECTING ROD

	Inside Diameter
Bearing clearance	.001 to .003 inch

End play at bearings	.005 inch to .011 inch
Bearing size	2-1/8 inch to 1-7/32 inch

CRANKSHAFT

Bearing clearance	.0015 inch to .003 inch	
End play	.003 inch to .008 inch	
Bearing sizes	Diameter	Length
No. 1	2½ inches	1.155 inch
Nos. 2 and 3	2½ inches	1.155 inch
No. 4	2½ inches	1.589 inch
Thrust taken by	Rear bearing	

CYLINDERS

Maximum allowable taper	.0015 inch
Maximum allowable out-of-round	.002 inch
Recondition working limits	.0005 inch

PISTON PINS

Bearing length	1⅛ inch
Ream after installing	.8592 to 8596 inch
Clearance in piston	Thumb push fit at 100°F.
In connecting rod bushing	Thumb push fit at normal room temperature.

PISTON RINGS

Gap clearance	.007 inch to .015 inch
Side clearance	.0015 inch to .003 inch
Compression rings (top)	
Number per piston	2
Width	3/32 inch
Oil control rings (lower)	
Number per piston	2
Width	5/32 inch

VALVES

	Outside Diameter
Stem diameter	.340 inch to .341 inch
Guide diameter to ream after installing:	Inside Diameter
Inlet	.342 inch to .343 inch
Exhaust	.344 inch to .345 inch
Stem clearance in guide:	
Inlet	.001 inch to .003 inch
Exhaust	.003 inch to .005 inch

Distance from top of valve guide to top face of cylinder block	7/8 inch

VALVE SEATS

Angle	45°
Width	.090 inch

VALVE SPRINGS

Valve spring pressure in pounds:	
Compressed to 1 3/8 inch	107 to 115 pounds
Compressed to 1 3/4 inch	40 to 45 pounds

VALVE TAPPETS

Valve tappet clearance to check timing	(engine cold)
Inlet	.014 inch
Exhaust	.014 inch
Valve clearance (engine hot)	
Inlet	.008 inch
Exhaust	.012 inch

VALVE TIMING

Inlet opens	12° B. T. D. C.
Exhaust closes	6° A. T. D. C.

FUEL SYSTEM

Carburetor—Distance from top edge of float chamber to top of float	5/64 inch
Fuel Pump—Pounds pressure	3½ to 4½ pounds

COOLING SYSTEM

Hose sizes	Inside Diameter
Inlet	2⅛ inch
Outlet - upper	1½ inch
Outlet - lower	1½ inch
By-pass	1 inch
Location of drain cock	Lower edge of water jacket left side of engine and bottom of radiator.
Temperature for thermostat to start opening	157° to 162° F.
Temperature when thermostat is fully open	183° to 187° F.
Water pump shaft end play	.003 inch

Water pump shaft bushing	
Inside diameter - front bushing	.595 inch
rear bushing	.6709 inch

ELECTRICAL SYSTEM

DISTRIBUTOR

Breaker point opening	.020 inch
Breaker point spring tension	18 to 20 ounces
Number of cylinder for checking timing	1 or 6
Piston position when points open	Top dead center

SPARK PLUGS

Type	Auto-Lite - A-5
Thread	Metric 14 millimeter
Spark plug gap	.025 inch

APPENDIX

191. SCOPE.

This section is devoted to the preparation of the equipment for shipment and to the scope of the using arms.

192. LIMITED STORAGE.

a. If the equipment is to be stored for thirty days or less, thoroughly clean each piece of equipment with SOLVENT, dry cleaning, being careful to remove dirt, excess oil and grease. If paint has deteriorated, or is damaged in cleaning, remove loose paint and rust and repaint the area.

b. Lubricate thoroughly as specified in the Lubrication Section XVI.

193. DEAD STORAGE.

If the equipment is to be placed in storage for a long period of time, the disassembled unit should be processed in accordance with TM5-9715 (gasoline engine and pump), "Preparation of Corps of Engineers Equipment for Storage".

194. SHIPMENT.

If the equipment is to be shipped or transported by truck or rail, care must be taken to prevent damage to the component parts of the pump assembly. As this equipment is mounted on a skid base, crating, or anchoring, to prevent shifting while enroute, whereby damage to the units could be caused, is recommended.

195. EXPORT SHIPMENT.

If the equipment is to be processed for export shipment, inspection as to its mechanical condition should be made by competent personnel. Make certain that all required tools, spare parts, catalogs, accessories and attachments available to the equipment are placed in the tool box and then process as outlined in TB5-9711-1, "Preparation Corps of Engineers Equipment for Overseas Shipment".

196. REFERENCES.

The following technical manuals, bulletins, or pamphlets referred to in this manual, or bearing on the care of Corps of Engineers Equipment, are available and may be requisitioned from AG Depot in accordance with paragraph 6, AR 310-200, and War Department Circular No. 264, 28 June 1944:

Basic Maintenance Manual	TM38-250
Engineers Supply Catalog—List of all Service Parts	ENG 9-2316

Preparation of Corps of
Engineers Equipment for Overseas Shipment TB5-9711-1
Motor Vehicle Inspections and Preventive
Maintenance Services TM9-2810
Preparation of Corps of Engineers Equipment for Storage.....TM5-9715
Preparation of Spare Parts for Corps of
Engineers Equipment for Export TM5-9713

197. FORMS.

The following forms for the Maintenance Corps of Engineers Equipment were referred to in this manual:

Corps of Engineers Preventive Maintenance
and Lubrication Record Card ..... WD AGO Form No. 478E
Duty Roster .....WD AGO Form No. 6
Lubrication Order ..... No. 1113
MWO and Major Unit Assembly Replacement Record, WD AGO Form No. 478
Preventive Maintenance Services and Technical Inspection
Work Sheet for Engineers Equipment ..... WD AGO Form No. 464
Property Issue Slip ..... WD AGO Form No. 446
Requisition ..... WD AGO Form No. 445
Spot Check and Inspection Report for
all Motor Vehicles ..... WD AGO Form No. 9-70

198. ABBREVIATIONS.

The following symbols and abbreviations, together with their meaning, apply to this manual:

ABDC	After Bottom Dead Center
AG	Adjutant General
AGO	Adjutant General's Office
ASME	American Society of Mechanical Engineers
ATDC	After Top Dead Center
BBDC	Before Bottom Dead Center
BTDC	Before Top Dead Center
ENG	Pertaining to Engineer Supply Catalog
Fig.	Figure
Ft ft	Foot or feet
GPM	Gallons per minute
In., in.	Inch or inches
MD	Mounting Distance
mm	Millimeter
MWO	Modification Work Order
NC	National Coarse Thread -- same as USS - United States Standard Thread
No.	Number
°C	Degrees Centigrade
°F	Degrees Fahrenheit
RHP	Rated Horsepower
RPM	Revolutions per minute
SAE	Society Automotive Engineers
TB	Technical Bulletin
TM	Technical Manual
WD	War Department

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