NAVSHIPS 341-3124

INSTRUCTION BOOK
MARINE ENGINE

HALL - SCOTT MOTOR CAR CO.
BERKELEY, CALIF.

HALL POWER SCOTT

HANDBOOK SERVICE INSTRUCTIONS

DEFENDER
MARINE ENGINE
MODELS 2268 & 2269

HALL-SCOTT MOTOR DIVISION

PRELIMINARY INSTRUCTION AND PARTS BOOK

CONTRACT NObs-67912

1956

TABLE OF CONTENTS

FOREWORD

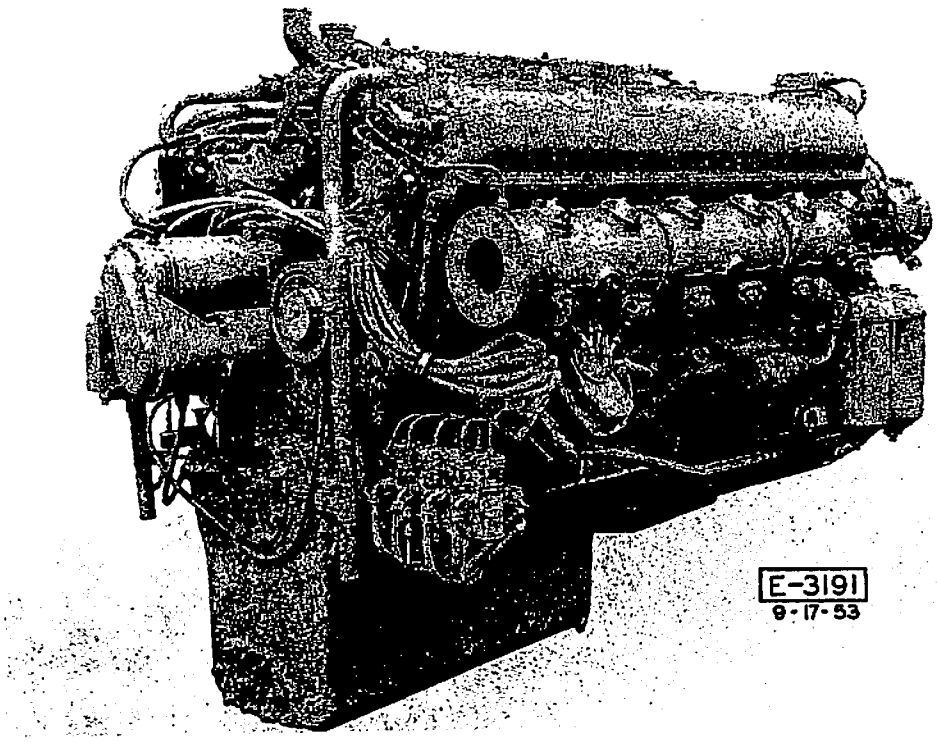
DISTRIBUTOR AND DISTRIBUTOR DRIVE

WIRING DIAGRAM

AN-19-85BHB-2

AN-19-85BHB-3

PARTS LIST



LEFT HAND 3/4 FRONT VIEW OF MODEL 2268-2

FOREWORD

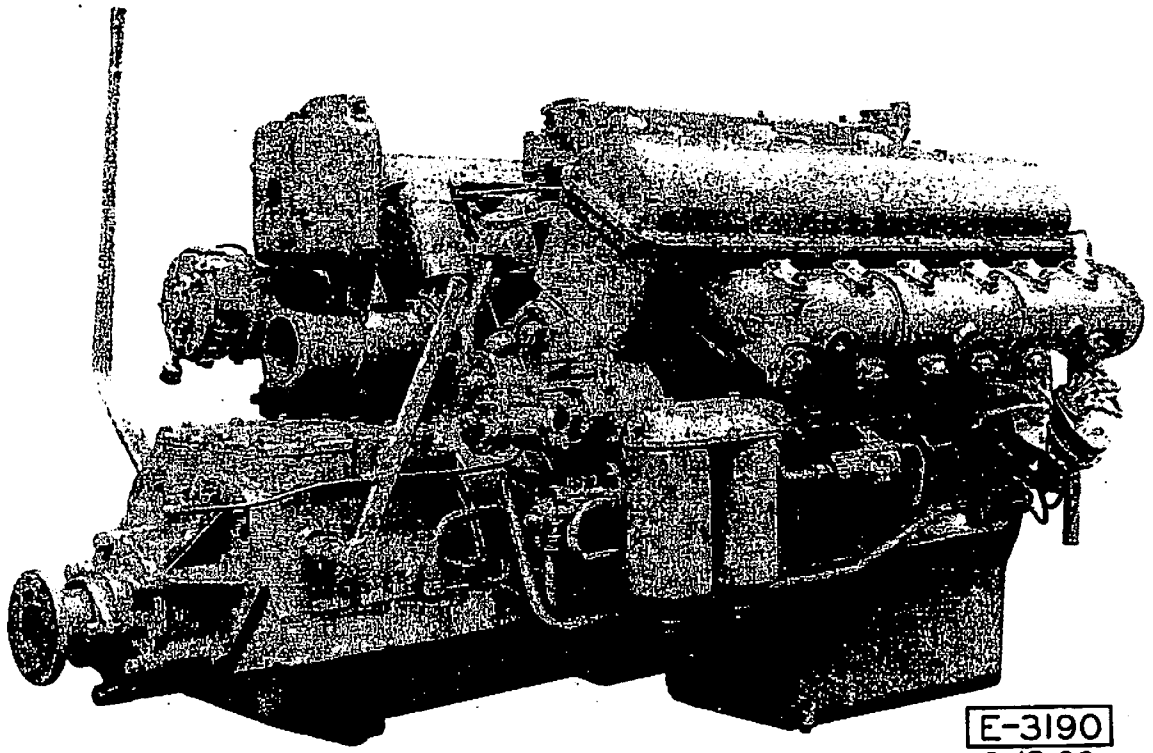
This instruction book is intended to explain and describe, by word and illustration all service, maintenance and parts data required for sea water cooled engines supplied on Contract NObs 62535. A final instruction and parts book will be issued at a later date and will be distinguished from this preliminary book by "Hall-Scott Defender" appearing at the top of each page. In addition the date "10-1-53" and Model 2268-2 and 2269-2" will appear on each page. In the meantime this preliminary issue covers all the major components to be discussed in the final book with these exceptions.

(a) Details of the electric fuel pumps.
(b) Details of the coolant water thermostatic temperature control.
(c) Details of the lubricating oil thermostatic temperature control.
(d) Description of Weston electric tachometer and drive.

It is to be understood that AN 19-85BHB-2, AN 19-85BHB-3 and Hall-Scott production parts list form a part of this publication.

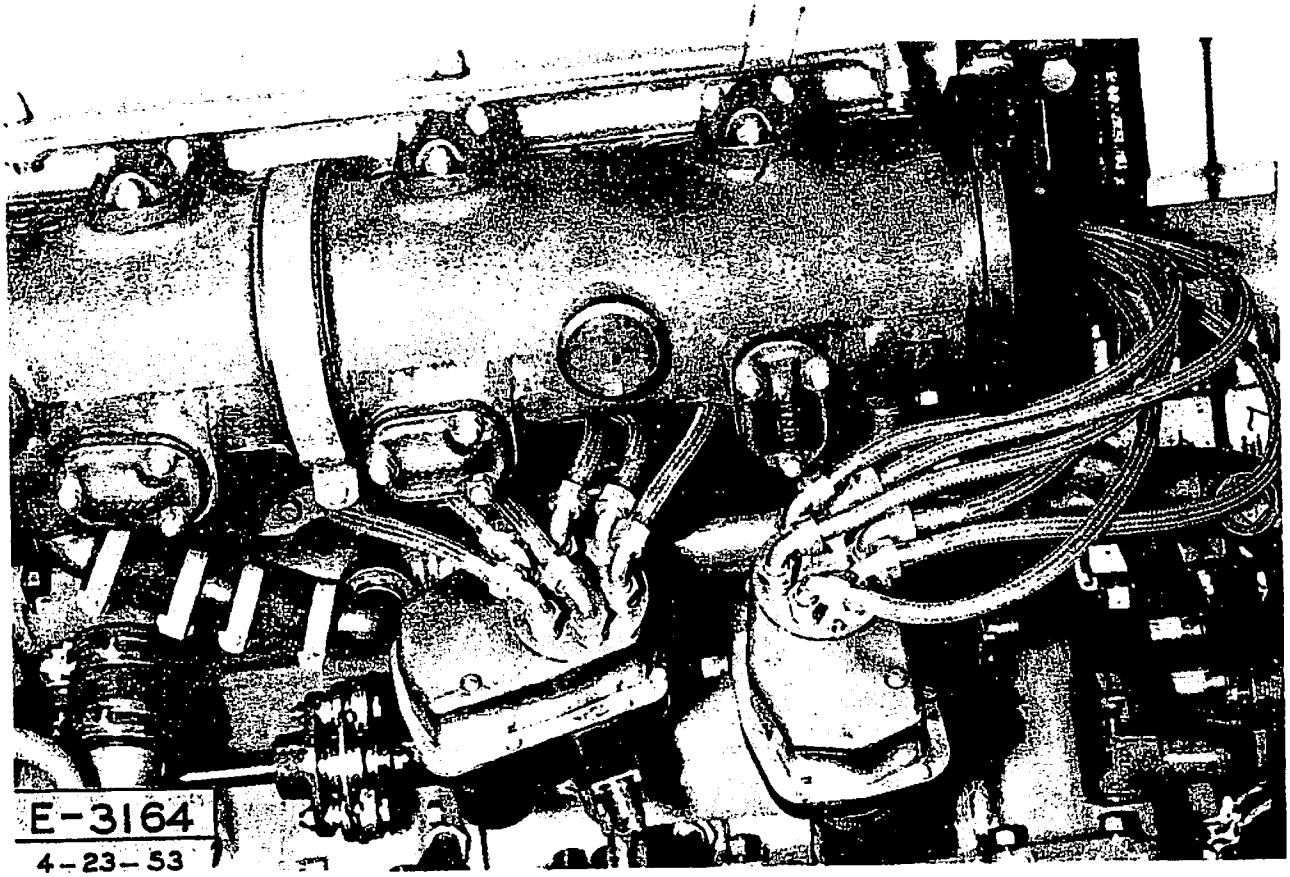
DISTRIBUTOR AND DISTRIBUTOR DRIVE

These engines use the recently developed Ordnance type distributor that is integrally radio shield along with its coil. This unit is suitably modified to meet Navy and Air Corp requirements. As indicated on the wiring diagram, the forward distributor in each case is connected to the spark plugs in the far bank. This is done to avoid any possibility of engine failure should both distributors on one bank cease to operate. This distributor layout must be kept in mind when timing the ignition as outlined on page 6. These distributors are driven by a tongue and groove coupling. This feature permits the distributor to be readily removed from the engine for ease in servicing operations. The drive tongue is offset slightly so it will only reassemble to the drive in one position thus making it practical to replace the distributor in its mounting well without having to retime it. The Delco-Remy 1111597 (Hall-Scott #407976 Distributor and Ignition Coil Assembly is a special water proof and shielded, fungus and corrosion resistant, combination unit. These distributors are mounted on the Drive housing as shown in illustration E-3164. The distributor is a 6 spark, automatic, 24 volt, grounded type with a flange mounting. See illustration #E-3112. A waterproof primary connect-



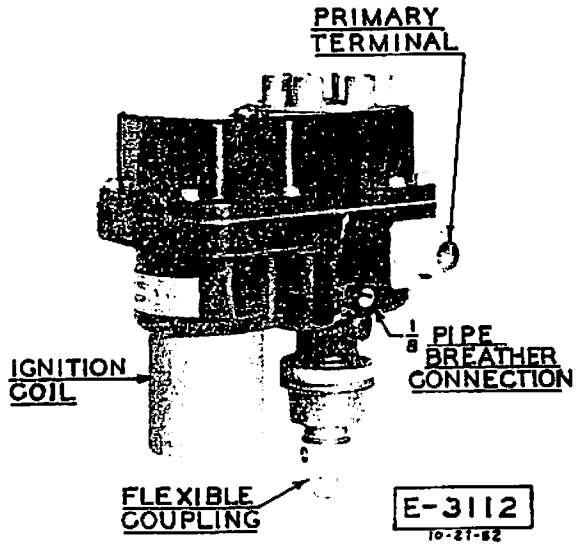
RIGHT HAND 3/4 REAR VIEW OF MODEL 2268-2

ion on the distributor housing encloses a feed-through condenser which is part of the radio suppression built into the distributor. In addition, the distributor has built-in shaft lubrication and a flexible drive coupling. The shaft bushing is composed of a special porous material, and it extends from the upper to the lower part of the housing, spanning an oil reservior. During initial assembly of the distributor, this reservoir is filled with oil, and the oil plug is installed and sealed with sealing compound. During operation of the distributor, the oil seeps through the bushing providing continuous shaft lubrication over relatively long periods of time. The flexible coupling includes a synthetic rubber cushion between the driving member at the extreme lower end of the coupling and the drive member. The flexible cushion absorbs torsional vibration from the engine which might otherwise cause wear of the centrifugal advance mechanism in the distributor. See section drawing E-3113. The distributor is timed to the engine by rotating the distributor in its mounting. The only adjustment provided is the point opening. The ignition coil is an oil-filled, hermetically sealed unit, mounted in the housing assembly. The primary circuit is in series with a separate resistor. A clamp plate holds the ignition coil in the housing assembly, with the flange of the ignition coil case compressing a sealing gasket. A molded one-piece cap covers both the distributor bowl and the ignition coil high tension outlet, making a connection between the coil and the distributor rotor by means of a built-in lead having spring-loaded terminals. A one-piece aluminum cover to which the molded cap is attached by screws, containing six threaded couplings for the high tension leads, fits over the entire assembly and the joint is sealed by a gasket. Accessible by removing a pipe plug in the cover is an opening directly above the ignition coil primary terminal which can accommodate a dwellmeter, tachometer, or a speed indicator. The opening is sealed by applying pipe compound to pipe plug. Radio suppression is employed in the distributor by built-in resistors at each high tension outlet of the molded cap and



DISTRIBUTORS MOUNTED ON RIGHT HAND BANK

also one built into the rotor. Two condensers are used for suppression--one is the above mentioned feed-through condenser at the distributor primary terminal and the other is connected between the ignition coil positive "+" terminal and ground. The third condenser is the standard ignition condenser.



RADIO SHIELD DISTRIBUTOR AND COIL

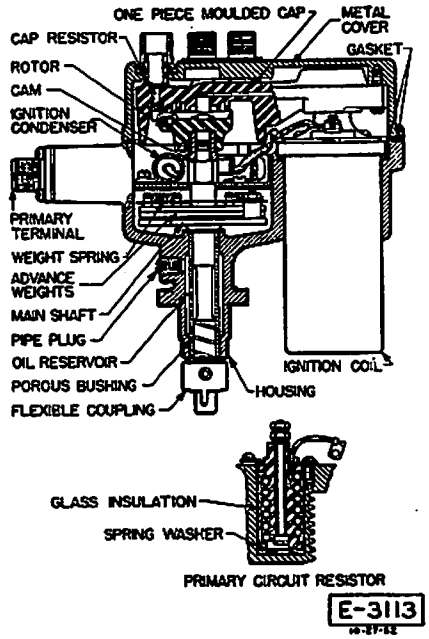
SERVICE INSTRUCTIONS

In most cases it is best to remove the distributors from the engine for servicing them. This is readily done as follows. Unscrew the primary and secondary wires from the distributor. Remove clamps from either side of the distributor face and lift the distributor from its mounting well. All distributors used on these engines are identical with the exception of the firing order dial. The majority of the components are interchangeable with the standard Ordnance unit. The more important exception being the use of the 11/16-24 secondary outlet as compared to 5/8-24 on the Ordnance unit.

DISTRIBUTOR SPECIFICATIONS --

Counterclockwise rotation, viewing drive end
Contact Point Pressure -- 17-21 ounces
Contact Point Opening -- .022"
Cam Angle Range -- 31° - 37°
Centrifugal Advance -- starts 2.0° engine 400 engine r.p.m. Maximum advance 24° engine at 975 engine r.p.m.
Ignition Condenser Capacity -- .18 - .23 mfd.

LUBRICATION -- Every 600 hours of normal operation, remove the pipe plug in the distributor housing, and refill the shaft oil reservoir with Grade 30W engine oil. If unusual heat or other operating conditions are experienced, the reservoir may require more



SECTIONAL VIEW OF DISTRIBUTOR

frequent refilling. When replacing the plug, use a sealing compound that will hold against oil. Every 200 hours of operation, remove the aluminum cover and the molded cap from the Distributor and Coil Assembly and lubricate the following parts. Place a trace of Delco-Remy Cam and Ball Bearing Lubricant (or Ordnance equivalent) on the breaker cam.

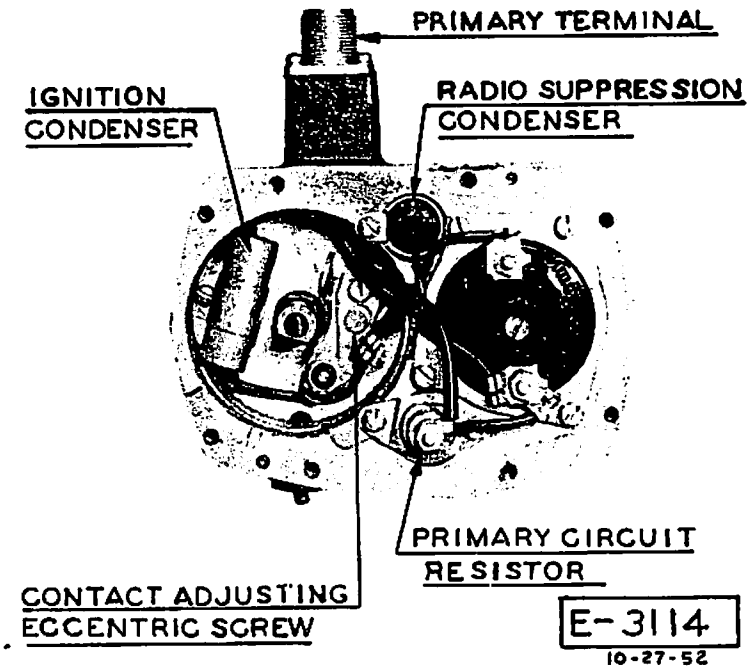
Put 1 to 2 drops of light engine oil (10W) on the breaker lever pivot, and add 3 to 4 drops to the felt wick under the rotor. Avoid excessive lubrication. If too much oil is used, the excess is apt to get on the contact points and cause them to burn.

CAUTION: When reinstalling aluminum cover be sure gasket is properly placed and in good condition. Replace gasket if hard or cracked. Be sure high tension couplings are properly made up.

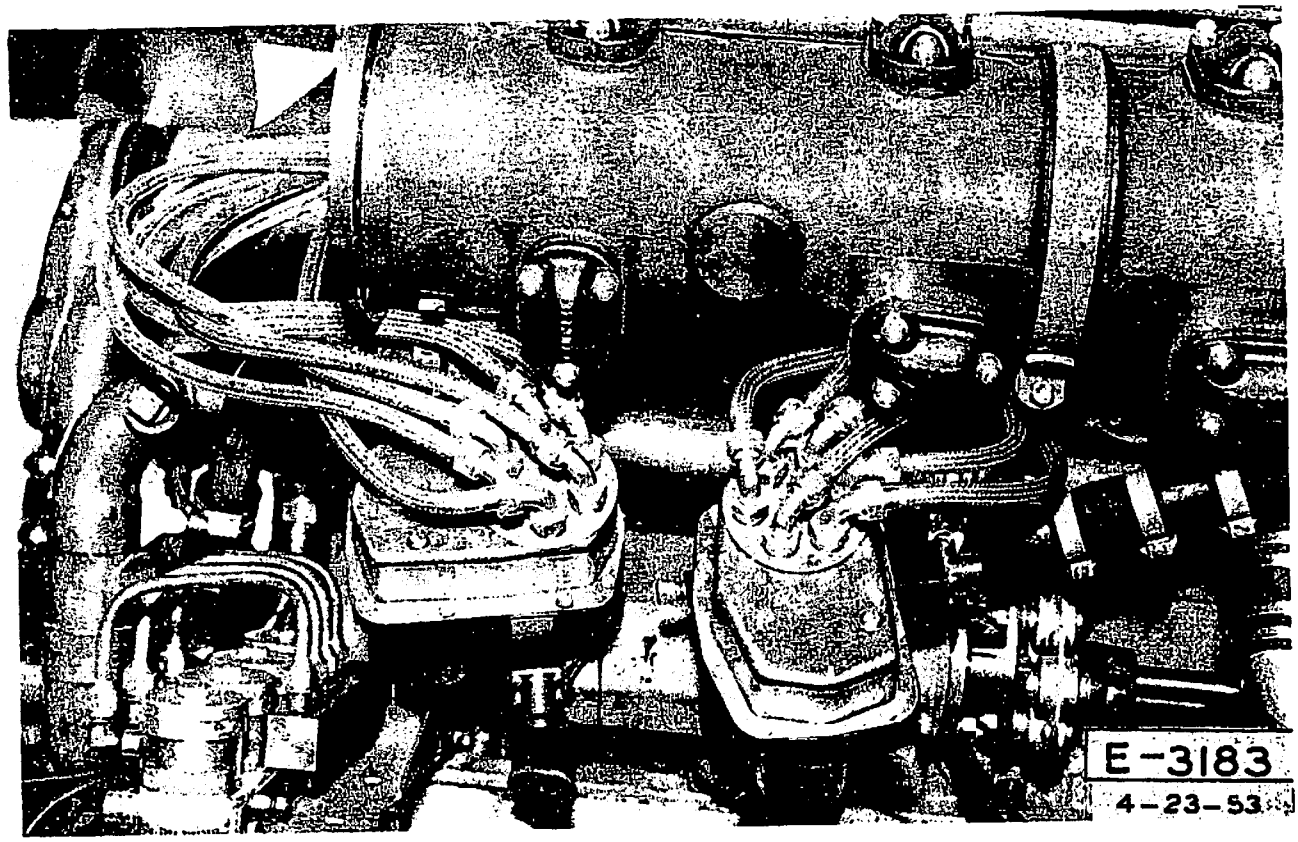
INSPECTION -- Every 200 hours of operation inspect the aluminum cover, molded cap, the contact points, and rotor. Check the high tension wiring for damaged insulation and poor connections at cap or plugs. Replace if necessary. Replace the cap or rotor if they are cracked or show carbonized paths indicating the secondary current is leaking to ground over the surface of the material. If unit has been disassembled check the lubrication and water sealing instructions.

CONTACT POINTS -- Points that are badly burned or pitted should be replaced. In less severe cases they may be dressed with a clean fine-cut contact file. The file should not be used on other metals and should not be allowed to become greasy or dirty. Never use emery cloth to clean contact points. Contact surfaces, after considerable use, may not appear bright and smooth, but this is not necessarily an indication that they are not functioning satisfactorily.

OXIDIZED CONTACT POINTS -- This condition may be caused by high resistance or loose connections in the condenser circuit, oil or foreign materials on the contact surfaces, or most



VIEW OF DISTRIBUTOR WITH CAP AND ROTOR REMOVED



DISTRIBUTORS MOUNTED ON LEFT HAND BANK

commonly high voltage in the primary circuit. Check for these conditions where burned contacts are experienced.

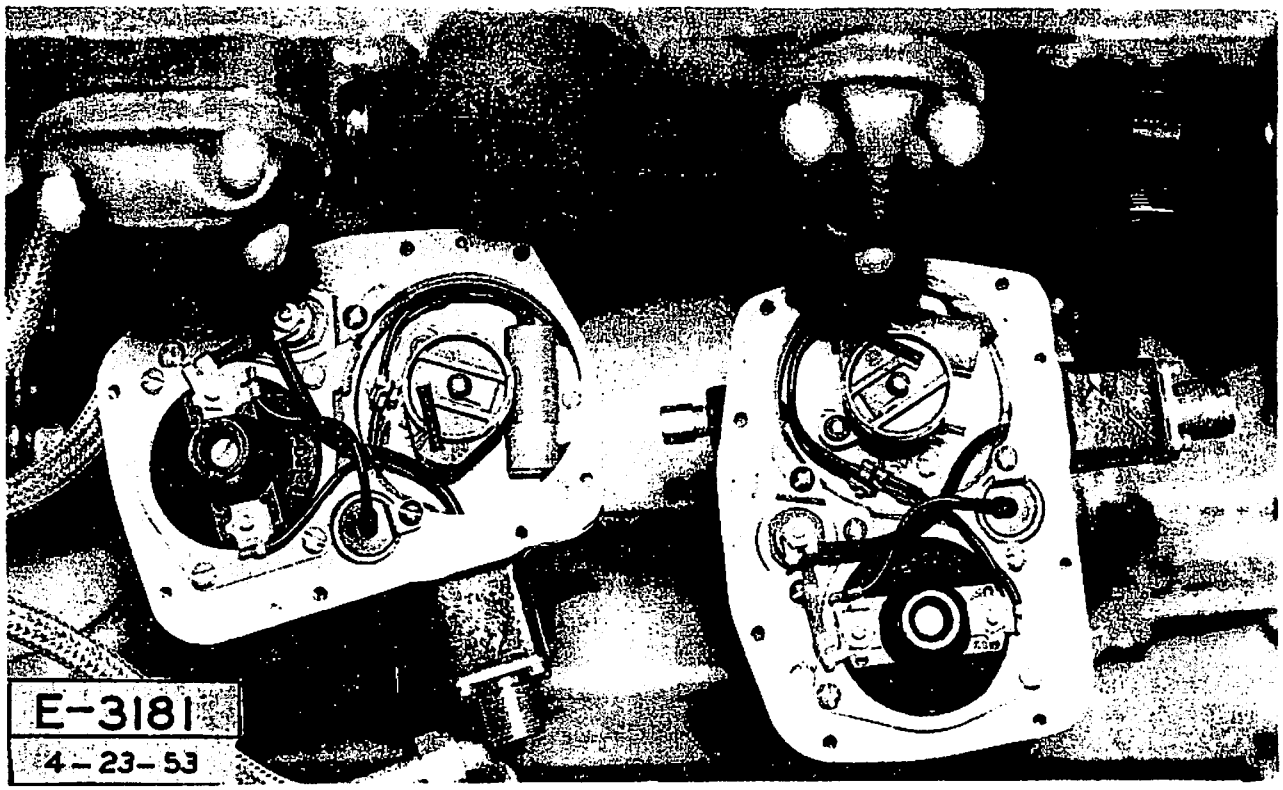
CONTACT POINT OPENING -- Point opening must be set to specification. Points set too closely may tend to burn and pit rapidly. Excessive separation tends to cause a weak spark at high speed. Refer to distributor specifications. Where the specified cam angle setting gives a point opening below the mimumum, then the point gap specification must be given preference. THE CONTACT POINTS SHOULD BE CLEANED BEFORE ADJUSTING IF THEY HAVE BEEN IN SERVICE.

CONTACT POINT PRESSURE -- It is important that contact point pressure fall within the limits. Weak tension will cause point chatter and ignition miss at high speed, while excessive tension will cause undue wear of the contact points, cam and rubbing block. This spring must exert 17 to 21 ounces. The reading is taken just as the points separate. The pressure can be adjusted by bending the spring. If the pressure is too high it can be decreased by pinching the spring in, carefully toward the breaker lever. In order to increase the spring pressure it is necessary to lift the breaker lever from the breaker plate and bend the spring away from the lever. Avoid excessive spring distortion.

USE OF DISTRIBUTOR TEST FIXTURE--
The distributor test fixture accurately checks spark advance and synchronization on distributors removed from the vehicle. It will also show excessive distributor shaft eccentricity as indicated by variation in synchronization. After a distributor has been repaired, the calibration of the centrifugal automatic mechanism should be checked. Proper engine performance cannot be obtained unless the centrifugal curve is within the limits specified for the particular engine.

Engine RPM	Engine Degrees	
	Min	Max.
200	0	0
400	0	5.5
600	6	12
800	14	20
975	22	26
1200	22	26
1400	22	26
1600	22	26

Check the advance both while going up in speed and also while reducing speed. Any difference will indicate a sluggish advance mechanism which must be corrected. The rate of advance may be adjusted by either stretching or installing new weight springs until the specified characteristics are obtained.



ROTOR IN FORWARD DISTRIBUTOR IN POSITION TO FIRE NO. 1 CYLINDER IN FAR BANK. MODEL 2268-1

THE IGNITION CONDENSER -- Unsatisfactory condenser performance may result from any of the following conditions:

(1) Breakdown -- Failure of the insulat- material, a direct short between the metallic elements of the condenser.
(2) Low Insulation Resistance or Leakage-- Condenser will not hold charge.
(3) High Series Resistance -- Excessive resistance in condenser circuit due to broken strands in condenser lead or to defective connections. The condition may cause burned points and ignition failure at initial start and at high speeds.
(4) Improper Capacity

For a complete check of the condenser, it is desirable to use a tester which will check for the above four conditions.

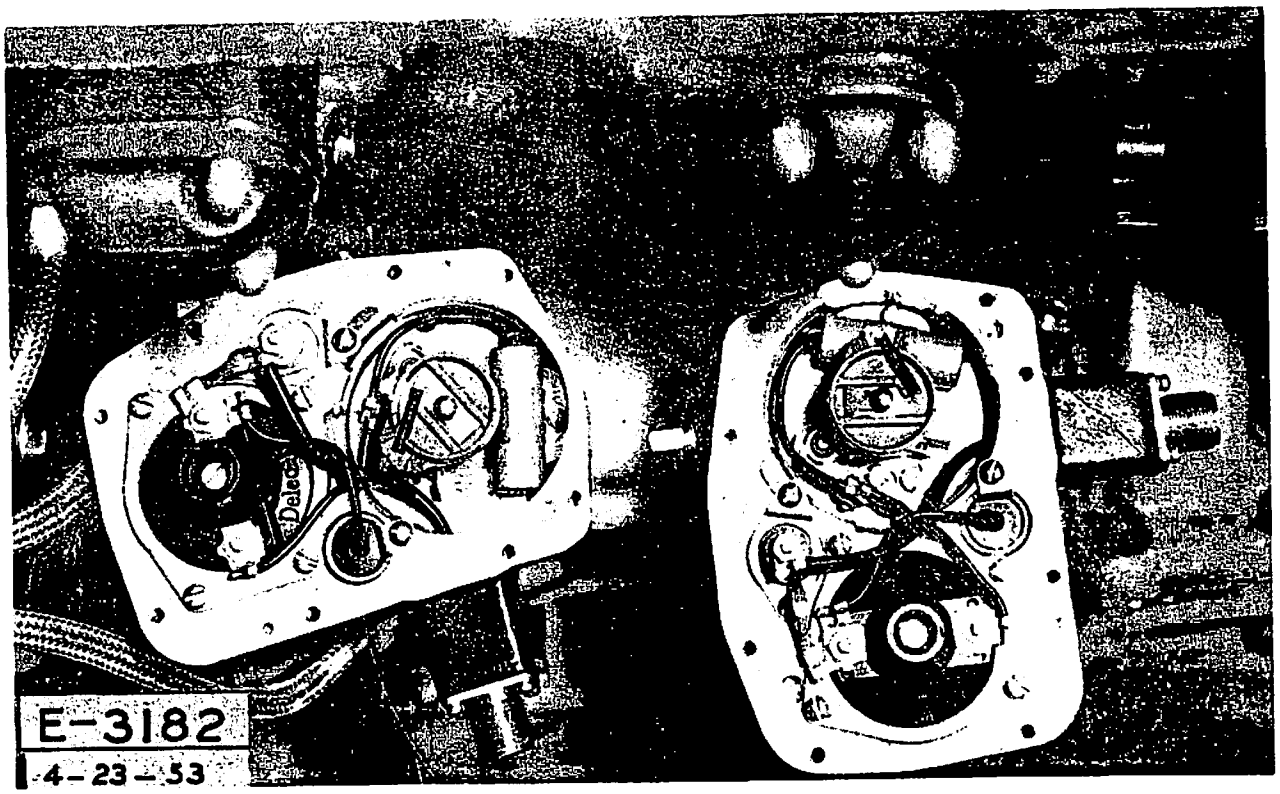
IGNITION TIMING INSTRUCTIONS

IGNITION TIMING DISTRIBUTOR. The ignition distributor is serviced by removing the distributor cap. This is done by unscrewing the eight slotted head machine screws around the flange of the distributor cover. Refer to figure E-3164. The molded cap is attached to the cover. Set the cover and cap assembly aside and proceed to service the distributor points, rotor, cap, ignition coil and other component parts as explained on the preceding pages.

IGNITION TIMING. After the distributor has been serviced as outlined above it is timed to the engine as follows: Ignition timing can only be done after the valve timing has first been set as explained in paragraphs 7-19 through 7-29 in AN-19-85BHB-2.

IGNITION TIMING MODEL 2268-1. To set the timing on a right hand engine (Model 2268-1) the following steps are necessary.

POSITION THE CRANKSHAFT. Remove the timing inspection cover plate from the front of the flywheel housing. Remove the exhaust side spark plug from the number one cylinder in the left hand bank. Do not forget the "hand" of the cylinder banks are determined as one stands at the rear of the engine and faces forward. Turn the engine over by hand in its normal running direction until the number one piston in the left hand bank starts to come up on its compression stroke. This can be determined by blocking the spark plug hole with the thumb and if air is forced out as the piston comes up then it is on its compression stroke. Of course, it is necessary to set the valve timing before the ignition timing is made. Refer to paragraph 7-19 through 7-29 in AN-19-85BHB-2. When number one left hand piston is on its compression stroke continue rotating the engine in its normal running direction until the flywheel mark "T.C. 1 & 6 L.H. BANK" is directly in line with the notch in the flywheel housing inspection hole.



ROTOR IN REAR DISTRIBUTOR IN POSITION TO FIRE NO.6 CYLINDER IN NEAR BANK.MODEL 2268-1

POSITION DISTRIBUTOR. The initial position of the forward distributor of the right hand cylinder bank and the rear distributor of the left hand bank must be such that a plane thru the center line of the distributor and its ignition coil will make an angle of approximately 90 degrees with the center line of the distributor drive shaft. The initial position of the rear distributor of the right hand bank must be such that it will make a similar angle of approximately 30 degrees at the drive end of the distributor drive housing. The initial position of the forward distributor of the left hand bank must be such that it will make a similar angle of approximately 30 degrees at the front end of the distributor drive housing. Refer to figure E-3164 and E-3183.

POSITION ROTORS. Refer to figure E-3181

a. For Firing Left Hand Bank: With the crankshaft in position as described for timing, and the forward distributor of the right hand bank and the rear distributor of the left hand bank in the position shown in figure #-3183, the distributor rotors should be in position to fire #1 cylinder of the left bank or in contact with #1 high tension outlet in distributor cap.

b. For Firing Right Hand Bank: Rotate the crankshaft in its normal running direction 60 degrees until the mark "T.C. 1 & 6 R.H. BANK" is directly in line with the notch in the flywheel housing. Refer to figure 7-8 in AN-19-85BHB-2 this 60 degree location is most important so be careful to see that the flywheel marks come exactly opposite the timing notch in the flywheel housing inspection hole. With the crankshaft in this position and the rear distributor of the right bank and the forward distributor of the left bank in the positions described figures E-3164 and E-3183, the distributor rotors should be in position to fire #6 cylinder of the right bank or in contact with #6 high tension outlet in distributor cap. Refer to figure #E-3182. If the rotor is not in position, to meet the conditions described above under (a) and (b) the distributor must swing slightly in its mounting well. If this does not produce the desired results lift the distributor from its mounting. Reach in thru the mounting hole with long nosed pliers, lift the driven gear out of mesh and rotate it in the desired direction one tooth and set the distributor back in place. Check position of rotor. If the rotor is still not in the correct position the distributor may be rotated a few degrees, clockwise or counterclockwise, by loosening clamps. After adjustment is made be sure clamps are tightened.

REASSEMBLE. Coat the distributor cam with a light coat of petrolatum and one drop of oil on hinge pins as mentioned on page 4 .

TIMING WITH AN INDICATING LIGHT. It is possible to very accurately determine when the breaker points are just opening or just closing by connecting a 24 volt light in series

with the breaker point set under consideration. With the ignition switch "on" the lamp will glow when the points are closed and go out when the points are open. When a slight pressure one way or the other, on the breaker arm, will either light or extinguish the lamp one can be certain that the points are at the correct position for timing as mentioned

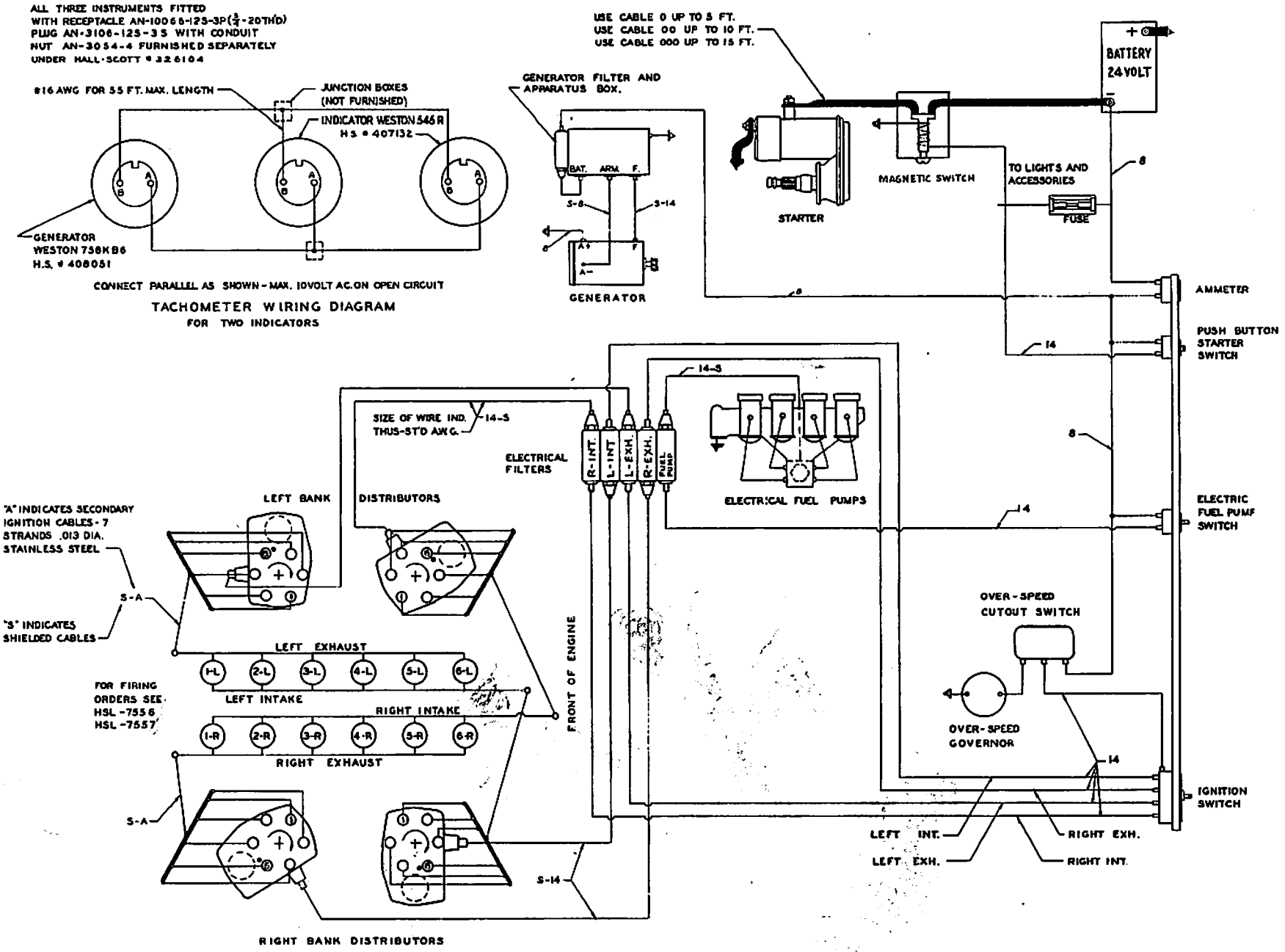
IGNITION TIMING, MODEL 2269-1. To set the ignition timing on a left hand engine (Model 2269-1) the same procedure is followed as outlined in timing Model 2268-1 except:

a. Remove the exhaust side spark plug from number one cylinder in the right hand bank and rotate the crankshaft until this cylinder is on its compression stroke and the flywheel mark "T.C. 1 & 6 R.H. BANK" comes directly opposite the notch in the flywheel housing inspection hole as shown in figure 7-8 in AN-19-85BHB-2.

b. The distributor rotors should be in position to fire #1 cylinder of the right bank or in contact with #1 high tension outlet in distributor cap, with the crankshaft in the position described above under heading "a" and the rear distributor of the right bank and the forward distributor of the left bank in the position described in figure #-3164 and E-3183.

c. On page 7, heading "b", rotate the crankshaft in its normal running direction 60 degrees until the mark "T.C. 1 & 6 L.H. BANK" is directly in line with the notch in the flywheel inspection hole as shown in figure 7-2, in AN-19-85 BHB-2. With the crankshaft in this position and the forward distributor of the right hand bank and the rear distributor of the left bank in the positions described in figure #E-3164 and E-3183, the distributor rotors should be in position to fire #6 cylinder of the left bank or in contact with #6 high tension outlet in distributor cap.

OPERATING CHECK ON IGNITION TIMING. As a final ignition timing check operate the engine as explained in paragraph 6-24 and 6-25 in AN-19-85BHB-2.


ALL THREE INSTRUMENTS FITTED
WITH RECEPTACLE AN-10066-12S-3P(3/4-20TH'D)
PLUG AN-3106-12S-3S WITH CONDUIT
NUT AN-3054-4 FURNISHED SEPARATELY
UNDER HALL-SCOTT # 326104
#16 AWG FOR 55 FT. MAX. LENGTH
JUNCTION BOXES (NOT FURNISHED)
INDICATOR WESTON 546 R H.S. # 407132
GENERATOR WESTON 758KB6 H.S. # 408051
CONNECT PARALLEL AS SHOWN - MAX. 10VOLT AC. ON OPEN CIRCUIT
TACHOMETER WIRING DIAGRAM
FOR TWO INDICATORS
USE CABLE 0 UP TO 5 FT.
USE CABLE 00 UP TO 10 FT.
USE CABLE 000 UP TO 15 FT.
GENERATOR FILTER AND APPARATUS BOX.
BAT. ARM. F.
S-8
S-14
A+
A-
F
GENERATOR
BATTERY 24 VOLT
STARTER
MAGNETIC SWITCH
TO LIGHTS AND ACCESSORIES
FUSE
8
AMMETER
PUSH BUTTON STARTER SWITCH
14
14-S
SIZE OF WIRE IND. THUS-STD AWG.
ELECTRICAL FILTERS
R-INT.
L-INT.
L-EXH.
R-EXH.
FUEL PUMP
ELECTRICAL FUEL PUMPS
ELECTRIC FUEL PUMP SWITCH
"A" INDICATES SECONDARY IGNITION CABLES - 7 STRANDS .013 DIA. STAINLESS STEEL
"S" INDICATES SHIELDED CABLES
S-A
LEFT BANK
DISTRIBUTORS
LEFT EXHAUST
1-L 2-L 3-L 4-L 5-L 6-L
LEFT INTAKE
RIGHT INTAKE
1-R 2-R 3-R 4-R 5-R 6-R
RIGHT EXHAUST
FOR FIRING ORDERS SEE HSL-7556 HSL-7557
FRONT OF ENGINE
OVER-SPEED CUTOUT SWITCH
OVER-SPEED GOVERNOR
IGNITION SWITCH
LEFT INT.
LEFT EXH.
RIGHT EXH.
RIGHT INT.
S-14
RIGHT BANK DISTRIBUTORS

HALL POWER SCOTT

HANDBOOK SERVICE INSTRUCTIONS

DEFENDER
MARINE ENGINE
MODELS 2268 & 2269

HALL-SCOTT MOTOR DIVISION

HALL-SCOTT DEFENDER
MODEL 2268 & 2269

TABLE OF CONTENTS

Section I - INTRODUCTION
1-1 Scope Page 1
1-3 Definitions " 1

Section II - GENERAL DESCRIPTION Page 9

Section III - TABLE OF SPECIFICATIONS
3-1 General Page 19
3-13 Ignition " 19
3-18 Valves and Valve Timing " 20
3-31 Fuel System " 20
3-35 Lubrication System " 23
3-40 Cooling System " 23
3-46 Accessory Drives and Instrument Connections " 23
3-57 Accessory Weights " 23

Section IV - STORAGE INSTRUCTIONS
4-1 Preparation for Storage Treatment Page 25
4-10 Pack in Shipping Container " 26
4-11 Preparation for Service After Storage " 26
4-16 Shipping Case Specification " 27

Section V - ENGINE TROUBLES AND THEIR REMEDIES
5-1 Introduction Page 29
5-3 Hard Starting " 29
5-5 Faulty Running " 29
5-8 Ignition Troubles " 30
5-10 Faulty Fuel System " 30
5-13 Cooling System Troubles " 30
5-15 Oil Circulating Problems " 30
5-18 Engine Noises " 30

Section VI - SERVICE INSPECTION AND ASSOCIATED MAINTENANCE
6-4 Inspection Before Starting Page 33
6-20 Operating Inspection " 34

Section VII - ADJUSTMENT, REPLACEMENT AND MINOR REPAIRS
7-3 Distributor Timing Page 37
7-19 Valve Timing " 40
7-30 Chain Take-Up Adjustment " 42
7-31 Reverse Gear Adjustment " 43
7-35 Accessory Replacement " 43
Wiring Diagram " 49

Section VIII - SERVICE TOOLS Page 55

HALL-SCOTT DEFENDER
MODEL 2268 & 2269
MATERIAL SPECIFICATIONS

Most of the lubricants and gasket cements called for in this handbook are identified by Government Specification numbers. For the benefit of those who do not have ready access to Government publications, the following list has been prepared to aid in the selection of proper materials.

Where a commercial trade name is mentioned it is not intended as a recommendation, but only as a typical example of the material under consideration. For specific recommendations it is suggested that this list along with your request be submitted to your supplier's specification expert.

GOVERNMENT SPECIFICATION NO.	SYMBOL	PRODUCT	USE
Army Specification 62-5		Cement - Gasket liquid for automotive application. Similar to "Permatex" No. 3	Seal for gaskets and threaded fittings
Army Stock 052-C-685-2PX		Cement - Gasket viscous non-hardening. Similar to "Permatex" No. 2	Seal for gaskets and tubing fittings
Army Stock 052-C-675-1PX		Cement - Gasket viscous hardening. Similar to "Permatex" No. 1	Cement for rope type packing between reverse gear upper housing and adapter
JAN-A-669	CAS	Compound - Anti-seize. Contains white lead, graphite, petrolatum, lubricating oil and asphalt	General purpose lubricant for studs and press fit parts. Do not use on spark plugs or oil circulation fittings
Navy Specification 52-C-18		Compound - Rust preventive thin film polar type. To be removable from metal surfaces with a kerosene saturated wiping cloth. Shall be sprayable in a household spray gun at temperatures of 40°F and above. Flash point not less than 100°F. Shall contain no abrasive substances	Grade I - For use on the exterior of the engine Grade II - For use on the interior of the engine
Army Specification 2-104B	OE	Oil - Engine. For general characteristics see paragraph 3-35 in the Service Handbook or paragraph 10-16 in the Overhaul Handbook	Lubrication of the interior of the engine and reverse gear. Viscosity to conform to paragraph 3-36 in the Service Handbook or paragraph 10-17 in the Overhaul Handbook
Navy Specification 14-0-13 Series 9000		Oil - Engine. For general characteristics see paragraph 3-35 in the Service Handbook or paragraph 10-16 in the Overhaul Handbook	Lubrication of the interior of the engine and reverse gear. Viscosity to conform to paragraph 3-36 in the Service Handbook or paragraph 10-17 in the Overhaul Handbook
AN-4062-1		Capsule - Moisture absorbing	Use in spark plug holes of stored engine to control humidity in engine cylinders
JAN-D-169 and AN-D-6		Bag - Moisture absorbing silica gel	Use in exhaust manifolds, intake manifolds and engine shipping case to control humidity around a stored engine
VV-L-761	GO	Lubricant - Gear universal. Viscosity to conform to paragraphs 6-11 and 6-16 in the Service Handbook or paragraphs 11-41 and 11-44 in the Overhaul Handbook	Use on the water pump pilot gears and starter drive gears
AN-O-6	OGP	Oil - General purpose low temperature lubricating. A low viscosity petroleum fraction containing oxidation and rust inhibitors intended for general squirt can use	Use in the bilge pump, starter, throttle controls, generator drive bearings and Bendix drive helix
AN-G-25	CLT	Grease - Low temperature containing a special synthetic oil having extreme low volatility. Generally suited for ball bearings and lightly loaded gear drives	Use for distributor and generator ball bearing lubrication as well as the distributor drive gears
AN-G-14	GRG	Grease - Gasoline and oil resistant	Use as a gasket paste to make a tight joint and facilitate separation of the joint at disassembly

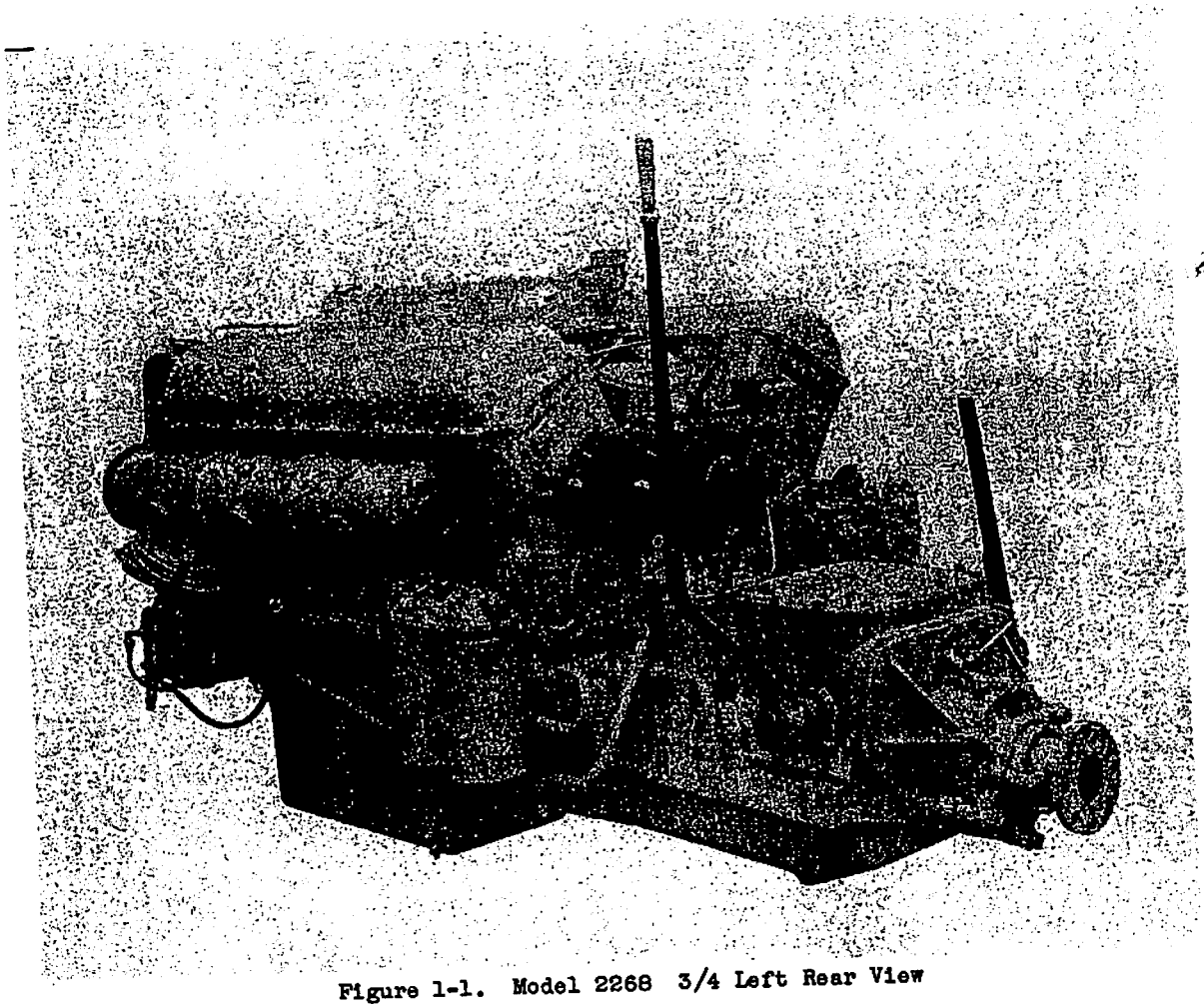


Figure 1-1. Model 2268 3/4 Left Rear View

INTRODUCTION

1-1 SCOPE

1-2 This publication comprises the Service Instructions for RH Engine No. 2268 Stock List No. 1906AAF200 000 (henceforth referred to as Model 2268), for LH Engine No. 2269 Stock List No. 1906AAF200 100 (henceforth referred to as Model 2269) and associated models, if any, manufactured by the HALL-SCOTT MOTOR DIVISION of ACF-BRILL MOTORS CO., 2850 7th Street, Berkeley 10, California, U.S.A.

1-3 DEFINITIONS.

1-4 In this publication the following definitions will be used.

1-5 FRONT END. The front or bow end of the engine is at the flywheel end. That is, the end opposite the propeller drive flange.

1-6 REAR END. The rear end or stern end of the engine is at the propeller drive flange end. That is, the end opposite the flywheel end.

1-7 RIGHT SIDE. The right or starboard side of the engine is on the right hand side as one stands at the propeller drive flange and faces forward.

1-8 LEFT SIDE. The left or port side of the engine is on the left hand side as one stands at the propeller drive flange and faces forward.

1-9 CYLINDER DESIGNATION. The engine cylinders are numbered starting with number one cylinder at the rear of the cylinder block and terminating with number six at the front of the cylinder block. The two cylinder blocks are designated as right hand and left hand. For example, cylinder number "5L" is the fifth cylinder from the rear of the cylinder block in the left hand bank of cylinders.

1-10 SIDES OF THE CYLINDER. The cylinders are designated according to their two sides. The "exhaust side" refers to the side of the cylinder on which the exhaust valve occurs. The "intake side", of course, refers to the side on which the intake valve occurs. For example. "4R EX" is the exhaust side of the fourth cylinder from the rear in the right hand bank of cylinders.

1-11 DIRECTION OF ROTATION. The rotation of the engine is determined by standing at the

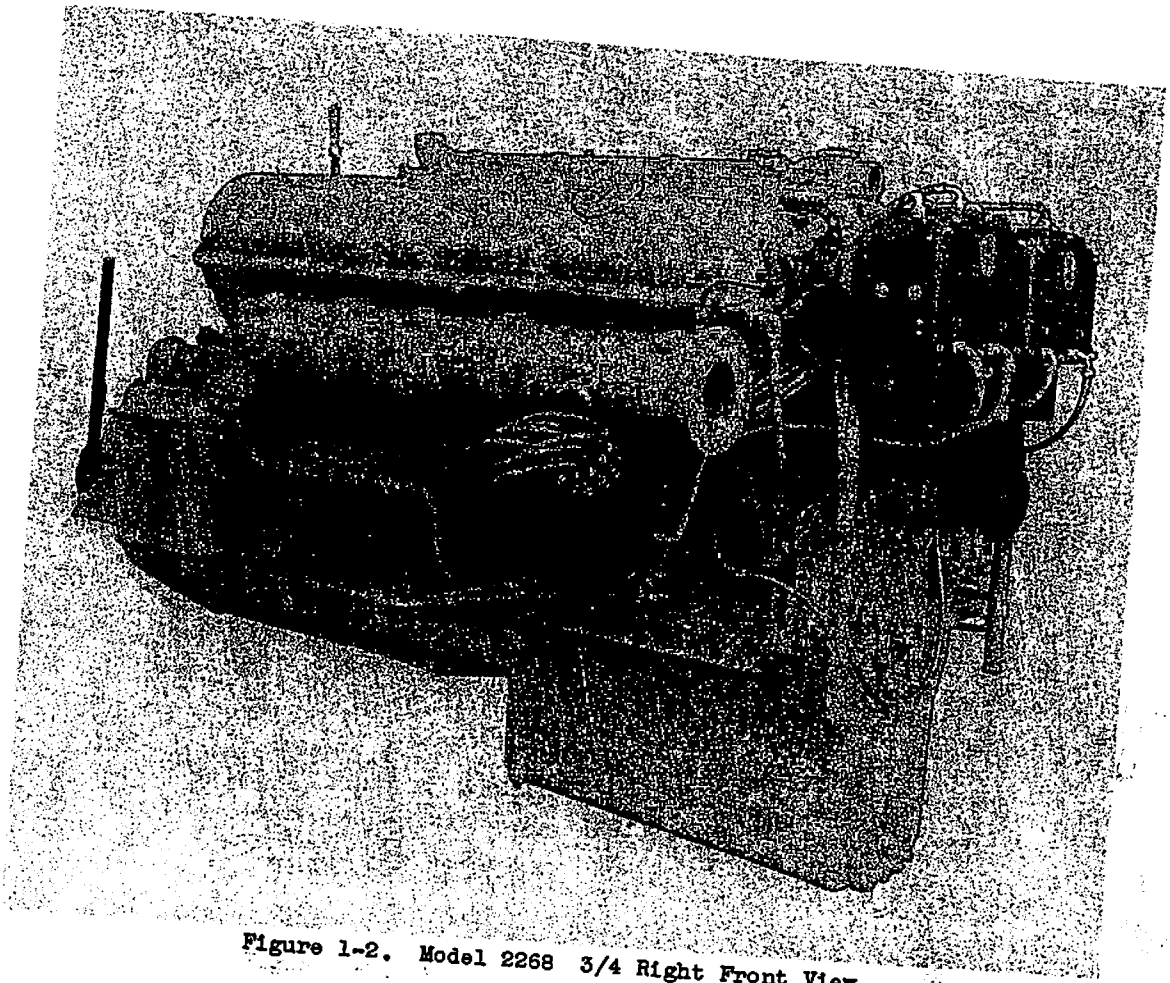


Figure 1-2. Model 2268 3/4 Right Front View

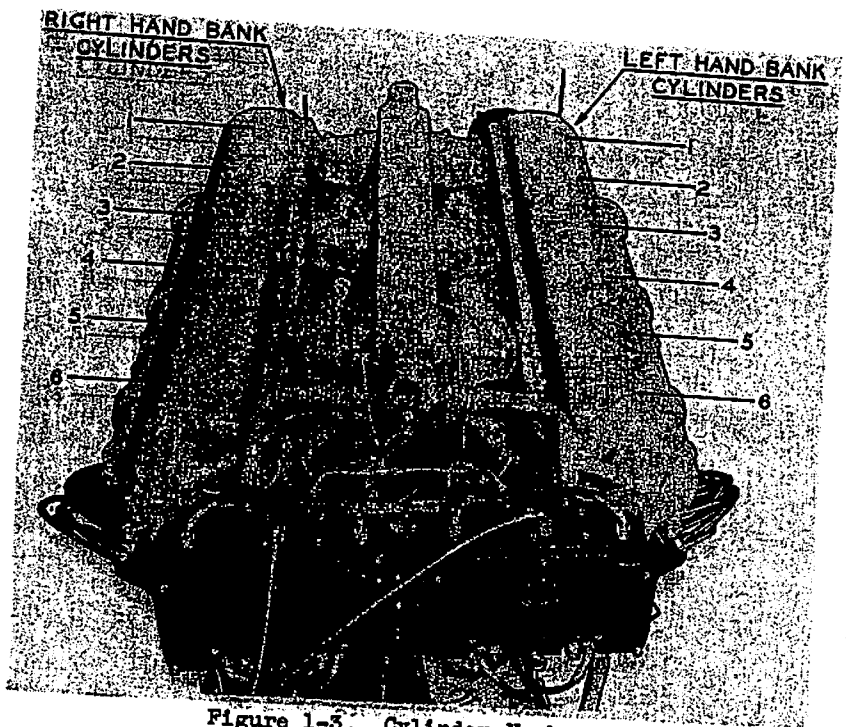


Figure 1-3. Cylinder Numbers

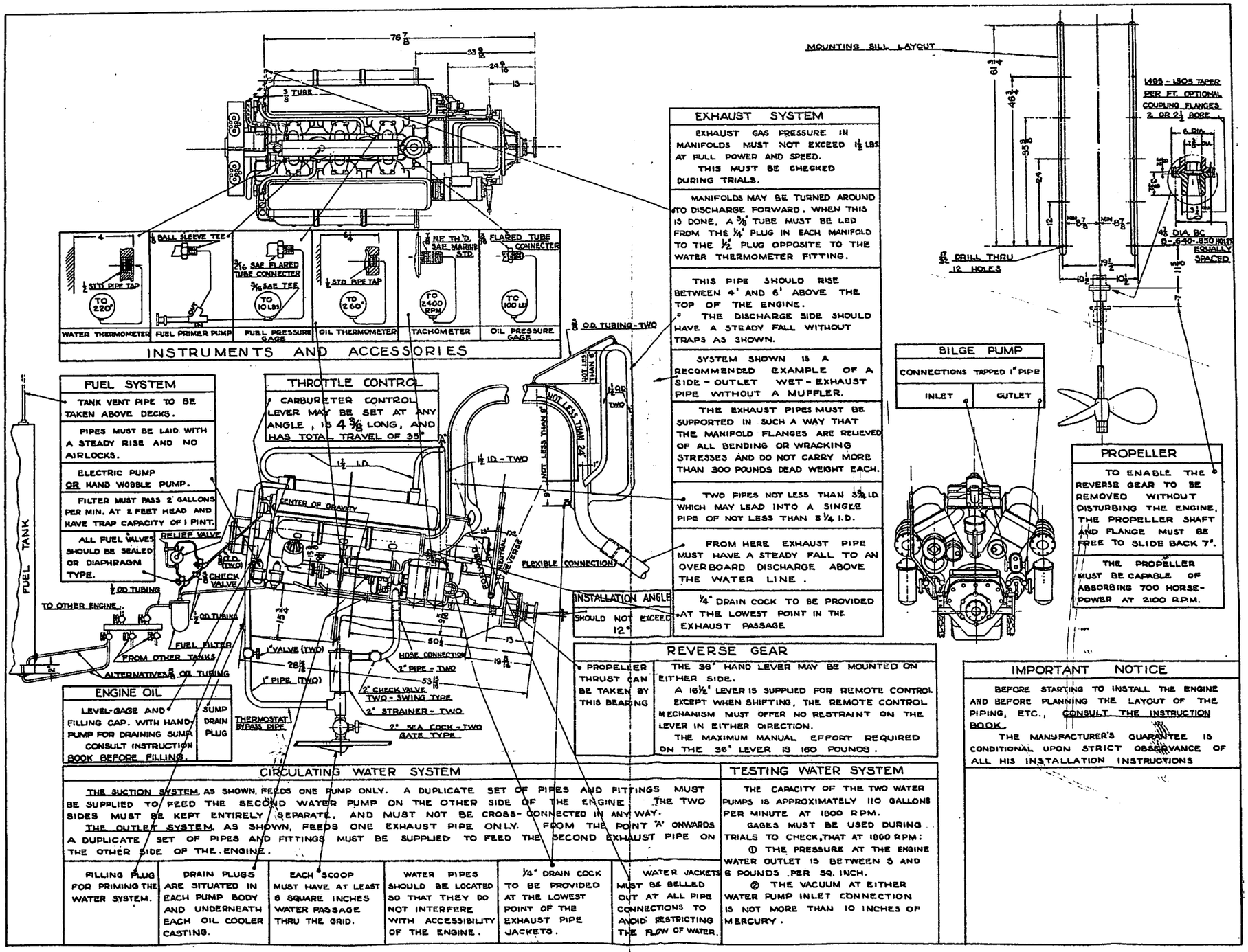


Figure 1-4. Suggested Engine Installation

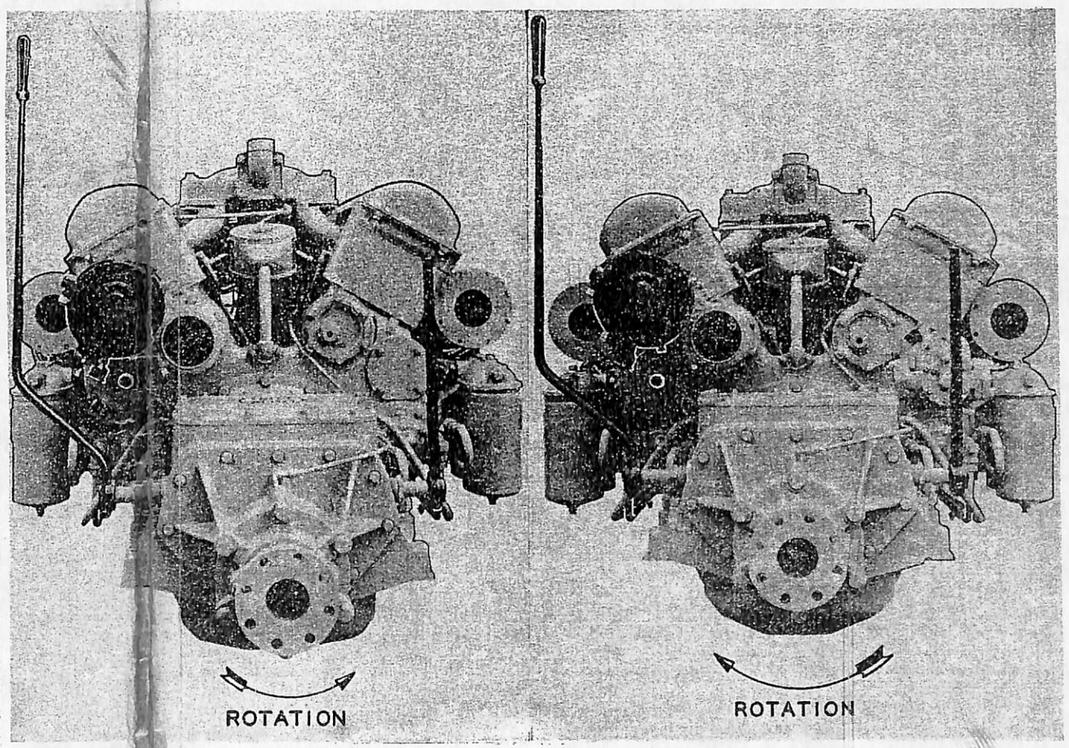


Figure 1-5. Model 2269 Left Hand Rotation (Counterclockwise)

Figure 1-6. Model 2268 Right Hand Rotation (Clockwise)

propeller drive flange and facing forward. When running in a normal manner, the propeller drive flange of a right hand engine rotates clockwise. (Model 2268 is a right hand engine.) When running in a normal manner, the propeller drive flange of a left hand engine rotates counterclockwise. (Model 2269 is a left hand engine.) In a direct drive engine, such as these are, the crankshaft rotation is the same as the propeller drive flange rotation. Refer to figure 1-5 and 1-6.

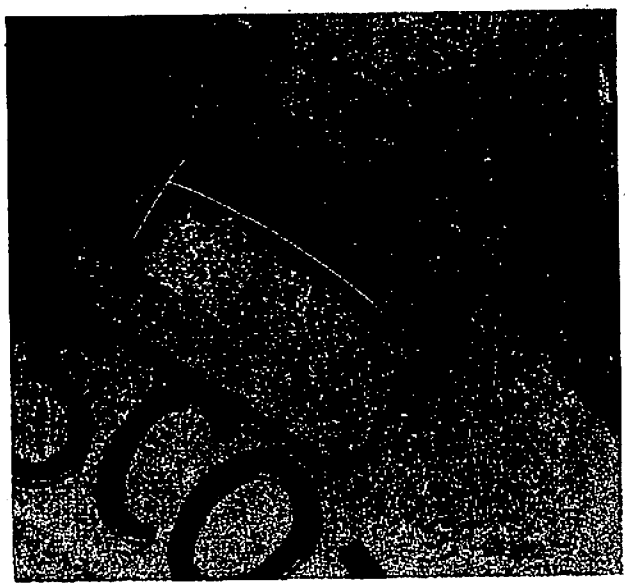


Figure 1-7. Flywheel "Top Center" Mark

1-12 ACCESSORY ROTATION. Direction of rotation of all accessories is understood to mean their rotation as viewed from the rear of the engine facing forward. The ignition distributors, which are mounted in a vertical plane, rotate in a counterclockwise direction when viewed from the drive end of the distributor.

1-13 TOP CENTER. "Top Center" is the angular position of the crankshaft when the piston is at the top of its stroke in the cylinder. For example, "T.C. 1 & 6 R.H. Bank" is the angular position of the crankshaft when number one and number six in the right hand bank are at the top of their stroke. Refer to markings on the flywheel rim. This definition is not to be confused with the piston position when its crank is on the vertical centerline of the engine.

1-14 BOTTOM CENTER. "Bottom Center", (BC) is the angular position of the crankshaft when the piston is at the bottom of its stroke in the cylinder. This is a position 180 degrees from the "top center" position explained in paragraph 1-13.

1-15 INTAKE OPENS. "Intake Opens" is the angular position of the crankshaft at which the intake valve just begins to open. Refer to marks on the rim of the flywheel as seen thru the timing inspection hole in the flywheel housing. These flywheel marks pertain to the number one cylinders, no others. On the right hand engine (Model 2268) the "INT. OPENS" mark for number one cylinder in the left hand bank comes into view first as the engine is rotated. On the left hand engine (Model 2269) the "INT. OPENS" mark for number one cylinder in the right hand bank comes into view first as the engine is rotated.

1-16 EXHAUST CLOSES. "Exhaust Closes" is the angular position of the crankshaft at which the exhaust valve is just closed. Refer to marks on the rim of the flywheel as seen thru the timing inspection hole in the flywheel housing. These

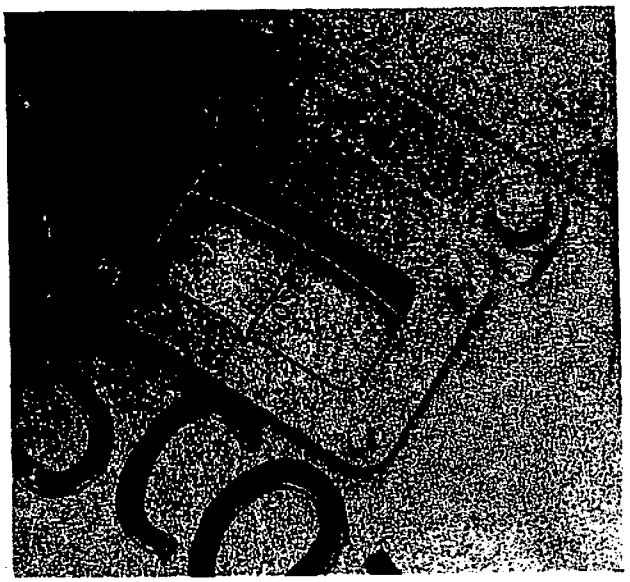


Figure 1-8. Flywheel "Exh Closes" Mark

flywheel marks pertain to the number one cylinders, no others. On the right hand engine (Model 2268) the "EXH. CLOSES" mark for number one cylinder in the left hand bank comes into view first as the engine is rotated. On the left hand engine (Model 2269) the "EXH. CLOSES" mark for number one cylinder in the right bank comes into view first as the engine is rotated.

1-17 ROTATION DEFINITIONS. "C.W." means clockwise rotation. "C.C.W." means counterclockwise rotation. "rpm" means revolutions per minute.

1-18 LEADING AND TRAILING BANKS. The direction of rotation of the crankshaft determines the leading and trailing cyl. banks. The leading cylinder bank is the bank approached first by the engine cranks in the upper half their normal rotation. The trailing cylinder bank is the bank approached last by the engine cranks in the upper half of their normal rotation. For example; on a right hand engine the left hand bank is the leading bank and the right hand bank is the trailing bank. On a left hand engine the opposite is true, that is, the right hand bank is the leading bank and the left hand bank is the trailing bank.

1-19 LIQUID MEASURE DEFINITIONS. "U.S. gal" means United States standard gallon of 231 cubic inches. "Imp. gal" means British Imperial gallon of 277.42 cubic inches.

1-20 STANDARDS DEFINITION. "AN 0000" means Army-Navy standard. "SAE" means Society of

Automotive Engineers. "JAN 00000" means Joint Army-Navy standard. "AGMA" means American Gear Manufacturers Association standard. "AWG" means Standard American Wire Gage.

1-21 THERMAL DEFINITIONS. "F" means Fahrenheit thermometer scale. "C" means Centigrade thermometer scale. "BTU" means British Thermal Units of heat.

1-22 WIRING DIAGRAM DEFINITIONS.
"Arm." means armature.
"Adj." means adjustable.
"Bat." means battery.
"Dist." means distributor.
"Fix." means fixed.
"Grd." means grounded.
"Loc." means locating.
"S." means radio shielded wire.
"Start." means starter.

1-23 MISCELLANEOUS DEFINITIONS.
"in." means United States standard inch.
"ft" means United States standard foot.
"lb" means United States pound, commercial or avoirdupois.
"oz" means United States ounce, commercial or avoirdupois.
"CL" means the centerline of an object.
"cg" means the center of gravity.
"in. of Hg" means inches of mercury as measured in a manometer filled with mercury.
"in. of water" means inches of water as measured in a manometer filled with water.

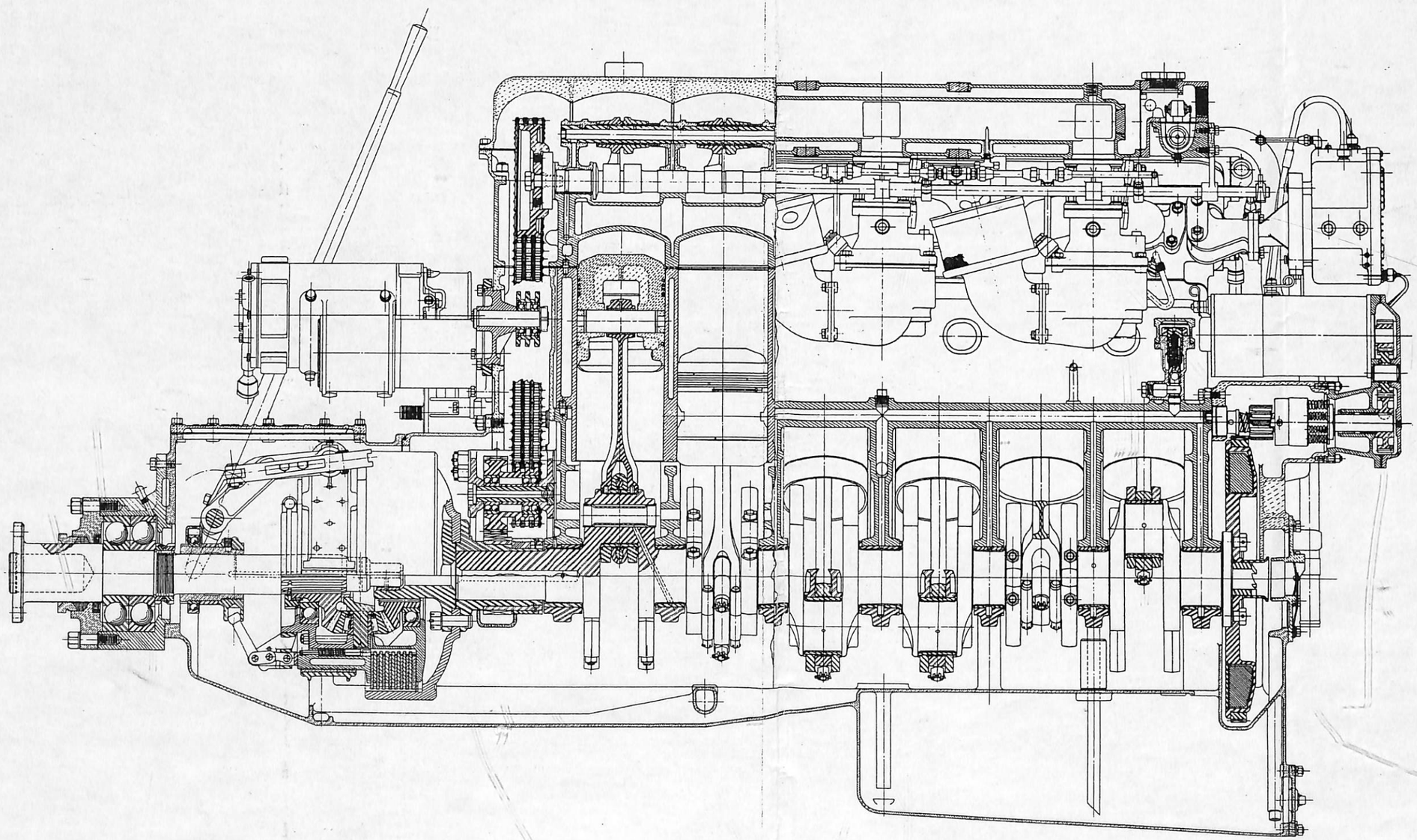


Figure 2-1. Longitudinal Section of Engine

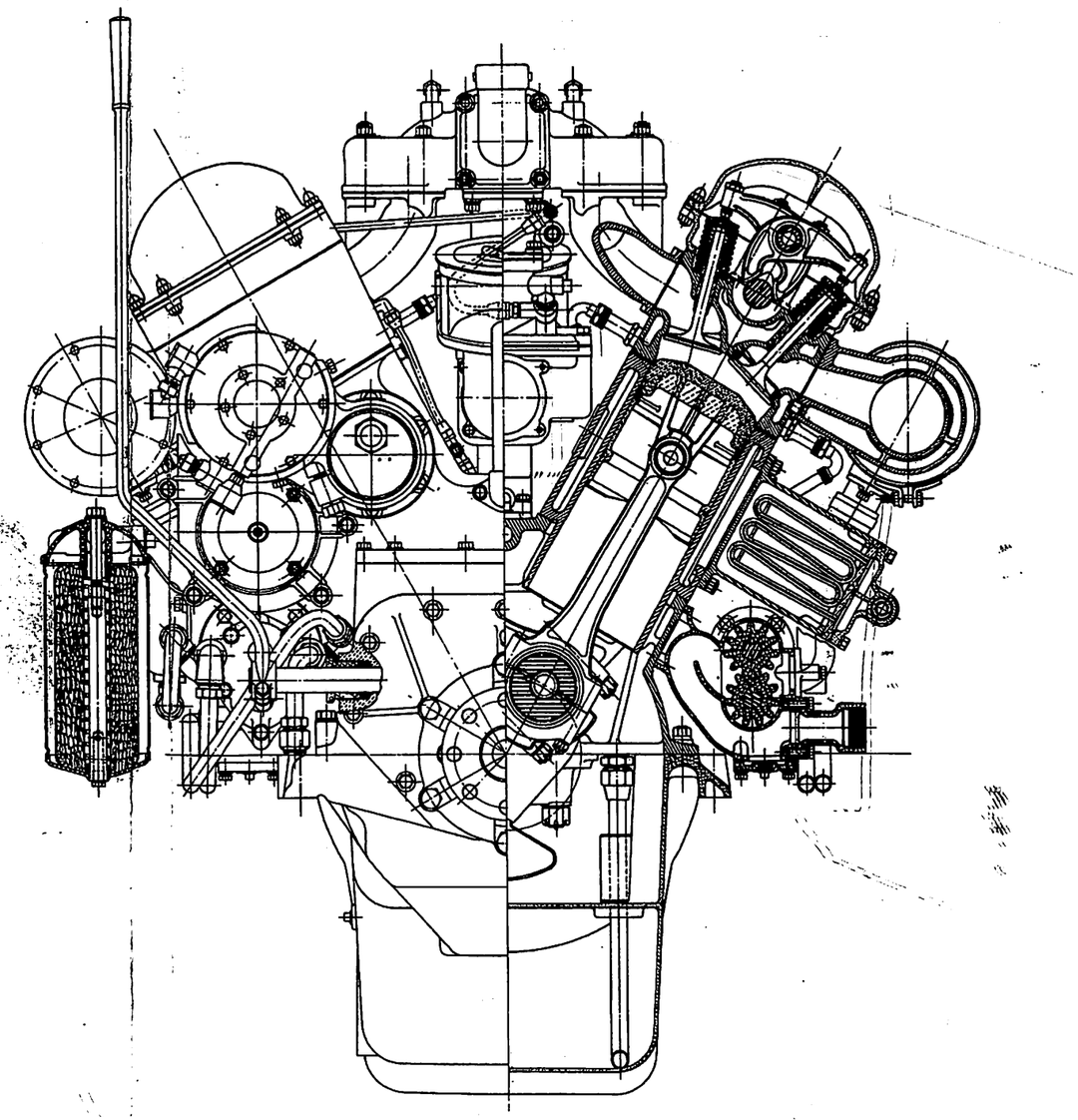


Figure 2-2. Transverse Section of Engine

GENERAL DESCRIPTION

2-1 MODEL 2268 DEFENDER. The Model 2268 Defender is a direct drive gasoline marine engine turning a right hand propeller. The engine propeller shaft flange, on this model, rotates clockwise as one views it from a position at the rear of the engine and faces forward. Refer to name plate on front of cylinder block for model identification. Refer to figure 2-5.

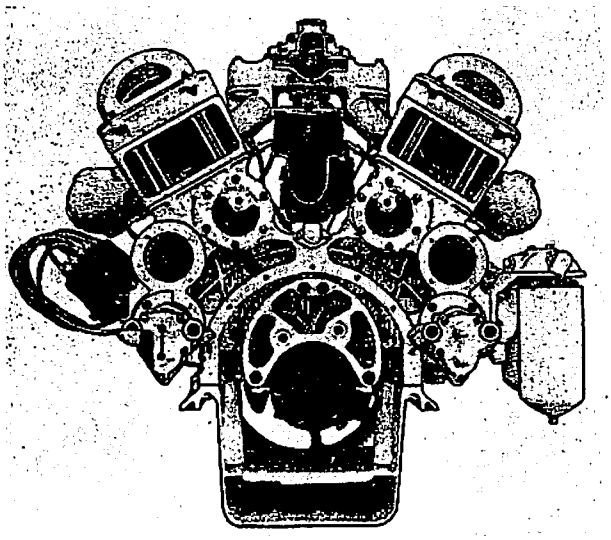


Figure 2-3. Cutaway View, Rear End

2-2 MODEL 2269 DEFENDER. The Model 2269 Defender is a direct drive gasoline marine engine turning a left hand propeller. The engine propeller shaft flange, on this model, rotates counterclockwise as one views it from a position at the rear of the engine and faces forward. Refer to figure 2-5. Refer to name plate on front of cylinder block for model identification.

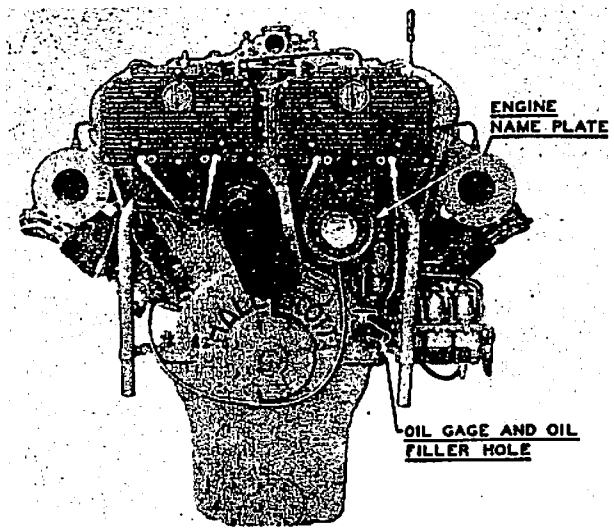


Figure 2-5. Front View of Engine

2-3 CRANKSHAFT. The Crankshafts in these engines are forged molybdemum steel heat treated to desired physical properties. They are counterweighted for good running balance. Crank journals and webs are drilled for full pressure lubrication to connecting rod bearings. Shafts are rigidly supported in seven main bearings. The accessory drive is taken from the reverse

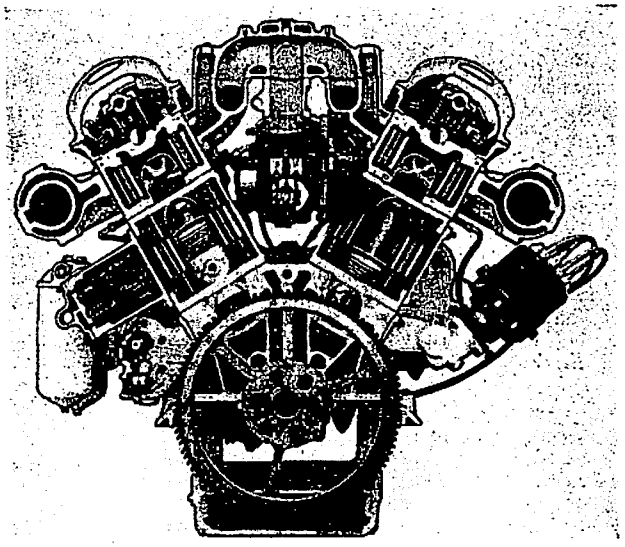


Figure 2-4. Cutaway View, Front End

gear end of the crankshaft where torsional vibration is negligible.

2-4 MAIN BEARINGS. The main journals in this engine are carried in precision type "snap-in" shells. The shells are copper-lead on a steel backing. A surface coating of indium over lead is used to provide a "break-in" surface on the shells. The shells are grooved to distribute the pressure lubrication oil. The center shells are flanged to take the crankshaft end thrust. The replacement main bearing shells, because of the precision finish, may be snapped into the saddle and run without being "line-reamed".

2-5 FLYWHEEL AND VIBRATION DAMPER. The flywheel is mounted on the front end of the crankshaft. The starter ring gear is mounted on the flywheel. The valve timing marks are carried on the front face of the flywheel where they can be viewed through the timing inspection hole in the flywheel housing. A vibration damper is incorporated into the rim of the flywheel. This damper is simply an inertia ring surrounded by a quite viscous fluid. Its purpose is to absorb torsional vibrations.

2-6 GEAR CARRIER. The accessory drive is driven from the crankshaft by gears mounted in a carrier. By selectively positioning the gear carrier on the crankcase, at assembly, a uniform direction of rotation can be obtained for all accessories on both sides of the engine regardless of the direction of crankshaft

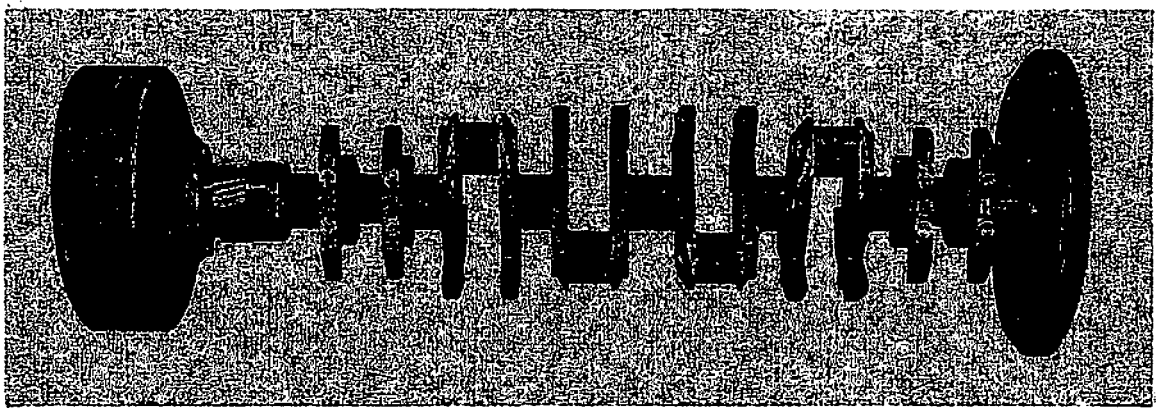


Figure 2-6. Crankshaft, Flywheel and Clutch Drum

rotation thereby simplifying the engine considerably.

2-7 CONNECTING RODS. The connecting rods are "I" section forgings of nickel chromium steel. They are of "yoke" and "blade" design for symmetrical location on the crank journal. Finished weights are held to close tolerance for smoothness of engine operation. A wide bearing shell is used in the "yoke" rod and it rides directly on the crankshaft. The "blade" rod uses a narrow bearing shell and it bears on the outside diameter of the "yoke" rod shell. Shells are precision "snap-in" type copper-lead on the inside diameter and with a steel back on the outside diameter. A surface coating of indium over lead is used to provide a "break-in" surface on the shells. Alloy steel bolts are used to secure the connecting rod caps to the connecting rods.

2-8 PISTON PINS. The piston pins are made of nickel chromium molybdenum steel. The surface is case hardened for maximum wear quality. The piston pin floats in both the piston and the bronze bushing in the connecting rod. It is retained in the piston through the use of soft metal plugs fitted to each side of the piston. Magnetic inspection is employed on the piston pins to assure their being free of cracks.

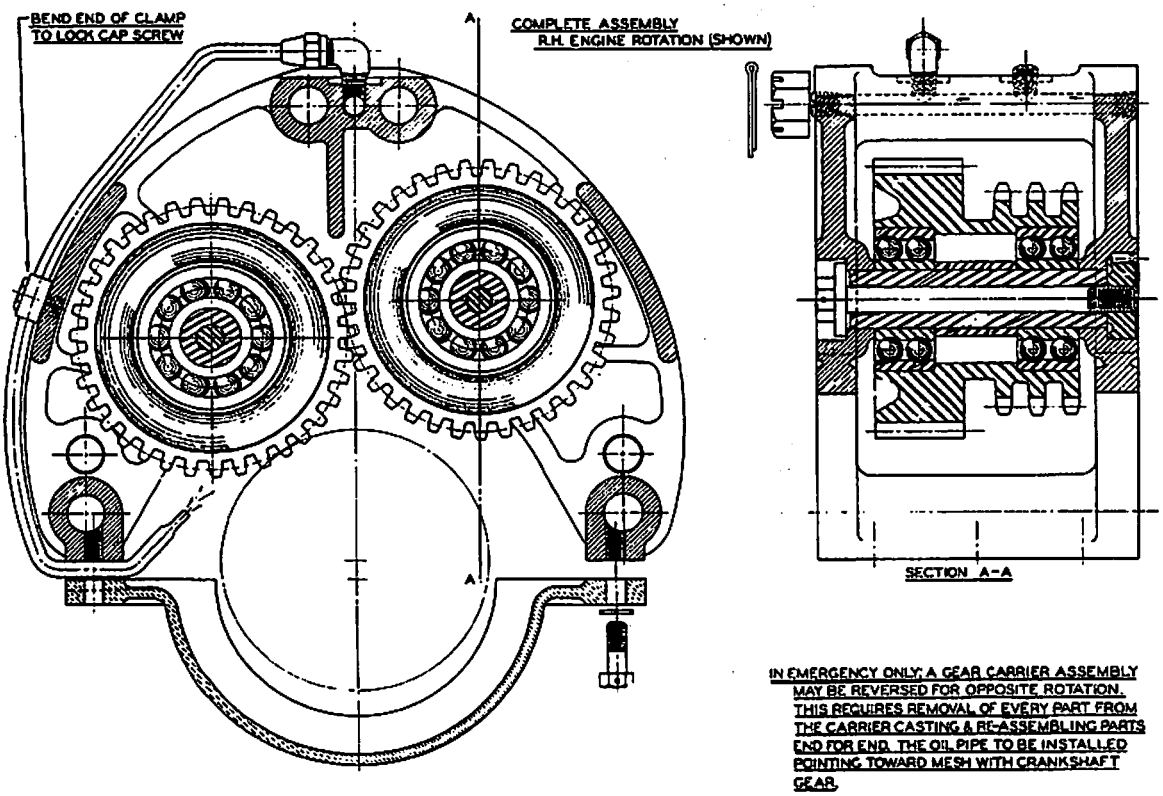


Figure 2-7. Gear Carrier

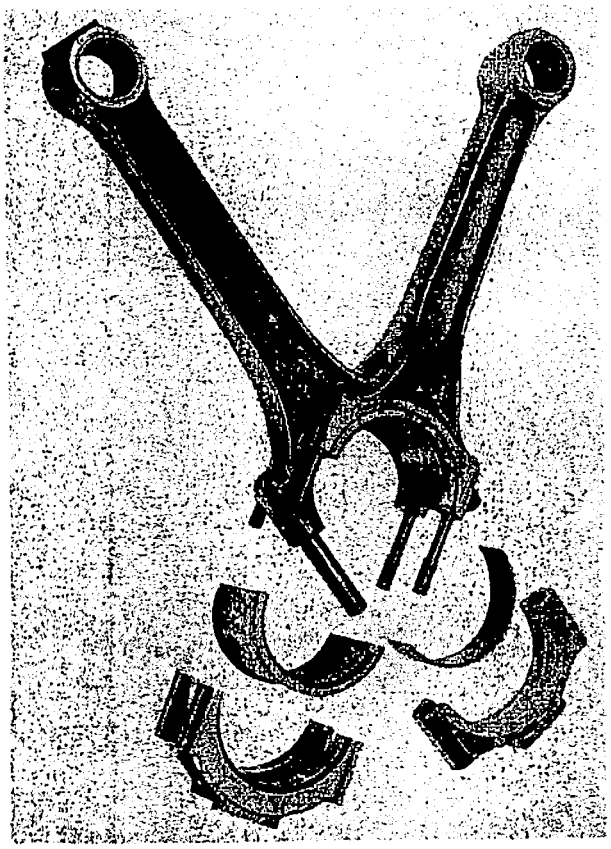


Figure 2-8. Connecting Rods, Exploded

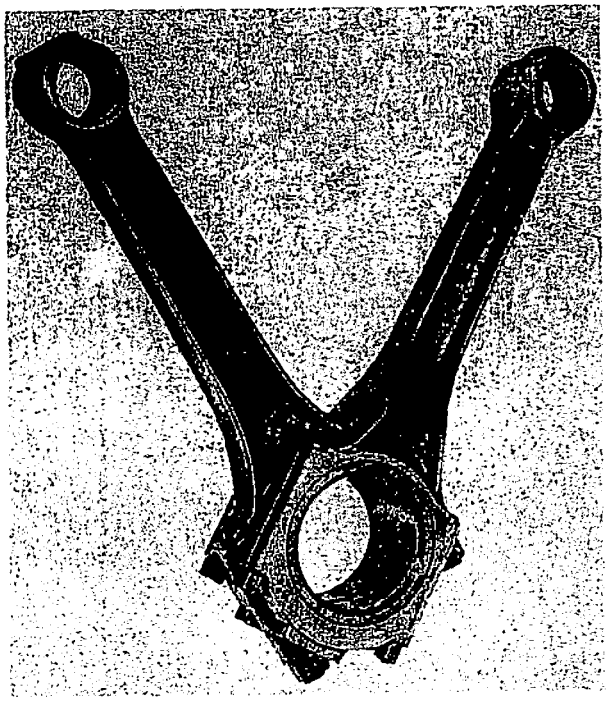


Figure 2-9. Connecting Rods, Assembled

2-9 PISTONS. The pistons used in these engines are of cast aluminum alloy. They are generously ribbed for greater strength and are designed to distribute the mechanical and heat load in the best manner. They are cam ground to permit close fitting to the cylinder bores. Piston ring grooves are located in the piston to provide maximum compression and a minimum of oil consumption. The compression ratio is such that high octane fuel can be used to advantage.

2-10 PISTON RINGS. Piston rings are held to close tolerances on radial tension so that compression pressures can be maintained and oil consumption controlled. The surface finish of the rings is selected to give rapid seating and long wearing properties after seating.

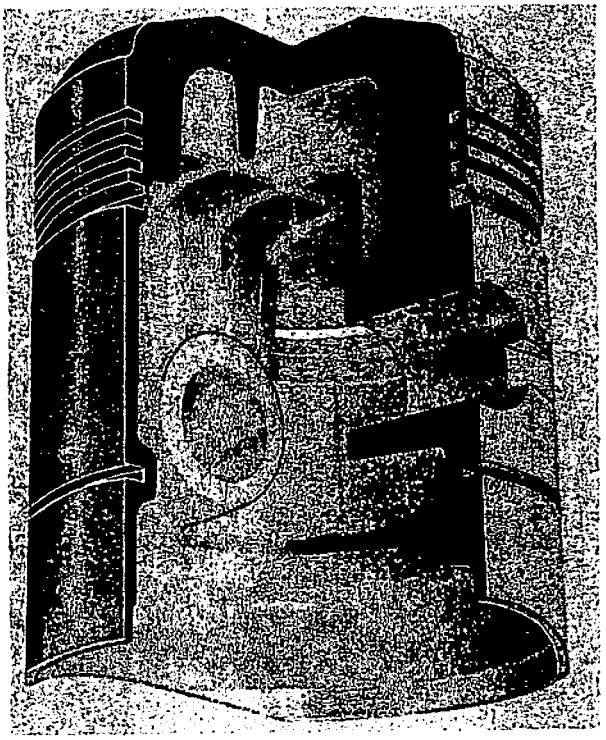


Figure 2-10. Piston - One Half Section

2-11 UPPER CRANKCASE. The upper crankcase is made of alloy cast iron. It is provided with ribbed webs to rigidly support the crankshaft. Internally drilled oil passages supply oil to the main and connecting rod bearings. Accessories are fastened to the upper crankcase so the cylinder blocks may be removed without disturbing the accessories. For maximum rigidity the cylinder head hold down studs pass through the cylinder block and screw directly into the upper crankcase webs over the main journal bearings. In this manner the driving force of the combustion is transmitted directly to the crankshaft.

2-12 CYLINDER BLOCKS. Cylinder blocks are cast of high alloy cast iron, six cylinders en-bloc. The cylinders are completely water jacketed for uniform cooling. Large cover

plates are used to permit cleaning the jacket space. The cylinder wall hardness is such that very good wearing qualities are obtained.

2-13 CYLINDER HEAD. The cylinder heads are cast of alloy iron with six heads in a casting. The entire valve mechanism is self-contained in the head. This includes valves, rockerarms and camshafts. This type construction permits replacement of cylinder heads and valves as a unit. One exhaust valve and one intake valve are used per cylinder. The exhaust valve has a hard metal face and closes against a hard metal replaceable seat. Intake passages are short and direct. Lubricating oil is directed against the camshaft and rockerarm contact. Two spark plugs are used per cylinder. Water jacket space is provided around the entire combustion chamber, valve seats, valve guides and spark plugs. A zinc plug is used in the water jacket space in the head to reduce the electrolytic action of salt water on the structural elements of the engine.

2-14 VALVE MECHANISM. The valves are operated from the cams thru rockerarms. No push rods are used. The cams are proportioned to give maximum engine performance and long valve life. Two springs per valve are used to prevent damage due to spring breakage.

2-15 SPROCKET HOUSING. The sprocket housing is fastened to the rear of the upper crankcase. It is an aluminum casting designed to suppress mechanical noise to a minimum. Its primary

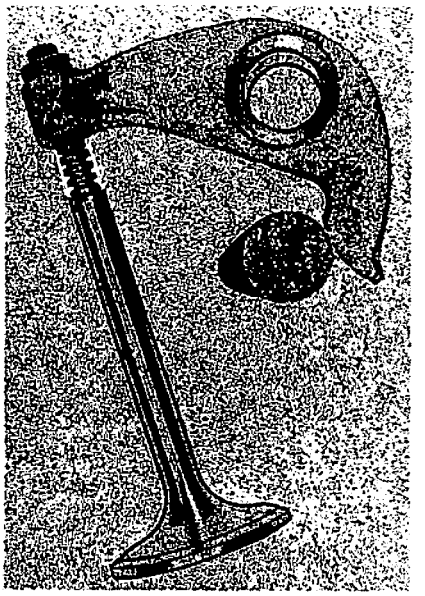


Figure 2-12. Valve Train

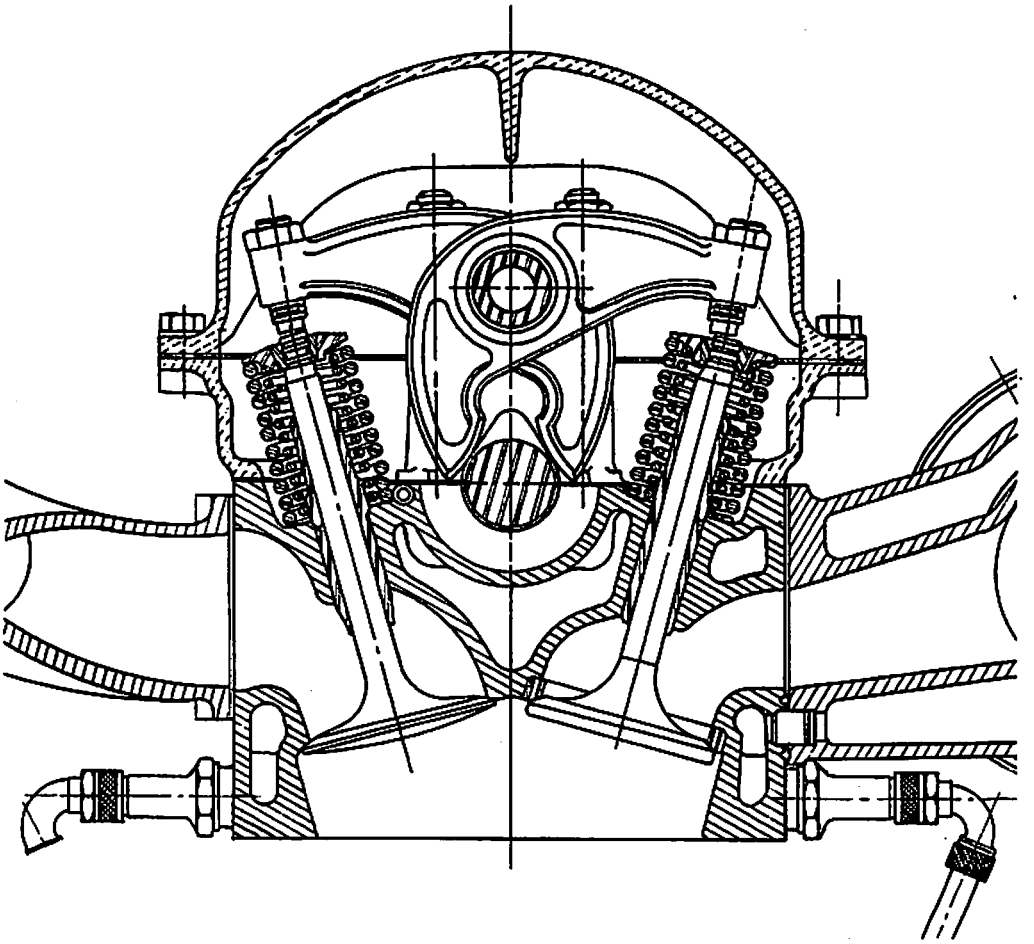


Figure 2-11. Cylinder Head Section

purpose, as its name implies, is to support and protect the accessory drive chain and sprocket. Triple width roller chain running within the housing carry the drive from the gear carrier to the various accessories such as oil pump, water pump, distributor, generator, bilge pump, tachometer drive, and fuel pump. Two manual type chain take-ups are also provided in this housing.

2-18 LOWER CRANKCASE. The lower case is an aluminum casting. It is of a deep section with internal baffles and channels in order to reduce the engine oil consumption. The front section of the case provides an integral oil sump tank as this engine uses a dry sump type of lubrication. A large hand hole is provided to aid in cleaning the sump tank. The lower crankcase is constructed with mounting flanges, each side,

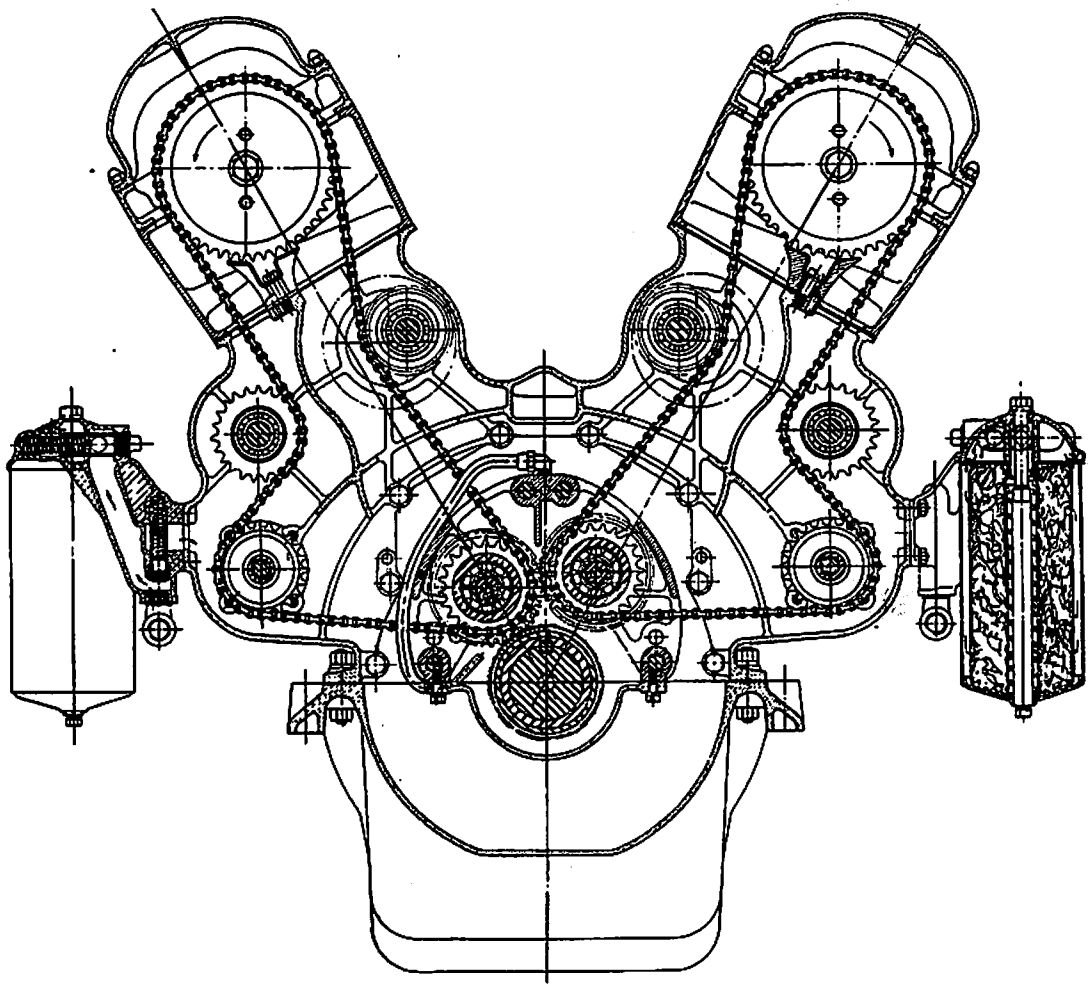


Figure 2-13. Sprocket Housing

2-16 INTAKE MANIFOLD. The intake manifold is a gallery type fed by three carburetors. The mixture, in turn, is distributed to the individual cylinders through six pairs of intake elbows. All of this intake manifold assembly is water jacketed in order to condition the mixture. Priming nozzles are placed in the intake manifold to aid cold starting. A by-pass thermostat is provided to control the water outlet temperature.

2-17 EXHAUST MANIFOLD. Water jacketed exhaust manifolds are used with individual ports to each cylinder. The outlets may be changed from the rear of the engine to the front merely by changing the right exhaust manifold for the left, etc. Two expansion joints are provided in the outer jacket wall.

upon which the engine rests. A hand sump pump and oil gauge are provided at the front end of the lower crankcase.

2-19 OIL PUMPS. Two oil pumps, which are identical in every respect, are used on each engine. The two being used to improve the dependability of the engine. Each oil pump is divided into different sections. The rear section is the scavenging side and it picks up any surplus oil from the rear end of the lower crankcase and delivers it to the oil sump. The front section of the two pumps are the pressure sides.

2-20 OIL PRESSURE REGULATING VALVE. The oil pressure regulating valve is located between the cylinder banks at the front of the engine. The oil pressure supplied to the engine is

controlled by adjusting this valve. When the oil pressure becomes excessive, oil is by-passed back to the oil sump tank thru passages drilled in the upper crankcase.

2-21 OIL COOLERS. Two oil coolers are used on these engines, one is mounted on the outside of each cylinder block. Oil is pumped thru small tubes which are surrounded by cold water. Heat is thereby transferred from the oil to the water. The coolers are identical, each receiving its oil and water from independent oil and water pumps. A by-pass valve is provided in the oil

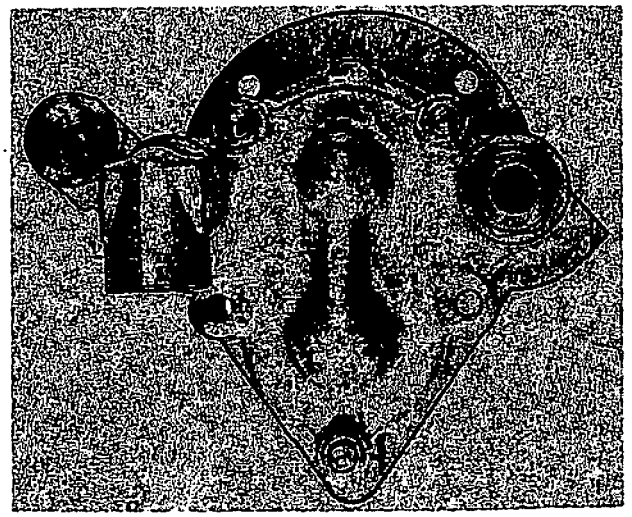


Figure 2-14. Oil Pump



Figure 2-15. Oil Pressure Regulating Valve

cooler cover to insure oil reaching the engine should the cooler become stopped up for any reason. Thermometer bulb adapters are provided in the oil lines suitable for receiving thermometers.

2-22 OIL FILTERS. Two pairs of absorption type replaceable element oil filters are used to condition the lubricating oil. Each pair of filters operates independently from the other pair and is in the oil circuit with the oil pump and oil cooler on its particular side of the engine. The oil filter body is provided with

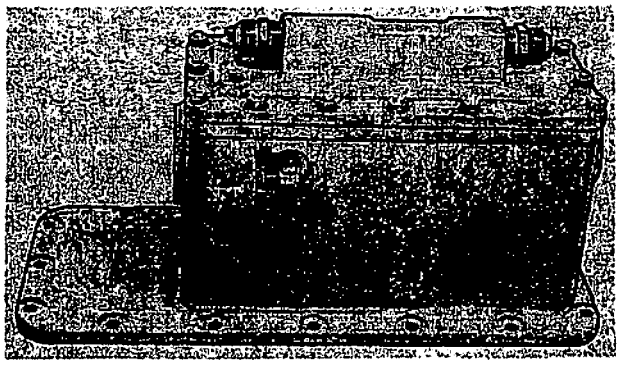


Figure 2-16. Oil Cooler

two by-pass valves. One by-pass valve protects the engine in the event that the filters become stopped up. The other valve is put in to protect the oil system in the event of extreme high pressure as might be encountered when the oil is cold.

2-23 WATER PUMPS. Two gear type water pumps are used, one on either side of the engine. The

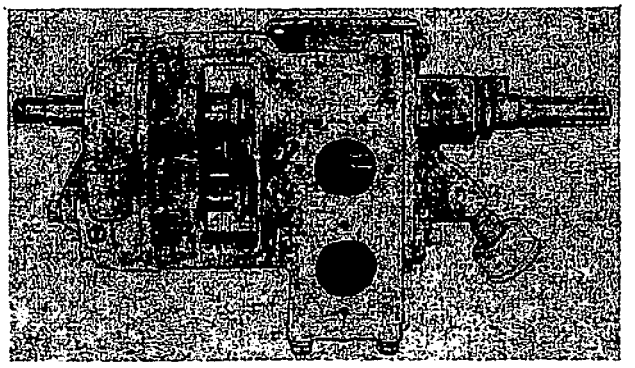


Figure 2-17. Water Pump

pumps operate independently of one another and supply water to the oil cooler, exhaust manifold, cylinder block and cylinder head on its particular side of the engine. The pumps are of the pilot gear type which design permits them to handle considerable sand in the sea water without damage to the pump gears.

2-24 MECHANICAL FUEL PUMPS. Two mechanical vane type fuel pumps are used per engine. The fuel pumps are part of a continuous circuit that assures adequate fuel supply to the carburetors while reducing the chances of vapor lock to a minimum. The circuit is so arranged that a hand or electric fuel pump may be used to fill the system before the engine is cranked. A pressure regulating valve is part of the circuit which make it all quite dependable as well as adaptable to accessory equipment.

2-25 CARBURETORS. Three marine type 2-1/2 in. multiple venturi updraft carburetors are fitted to the intake manifold. The carburetors are located in the "V" between the cylinder blocks. These carburetors are of balanced design so that any exterior restrictions in the air inlet will not alter the mixture ratio. A drain pickup tube is fitted to each carburetor to draw off any gasoline that might run down into the carburetor air intake. These carburetors are

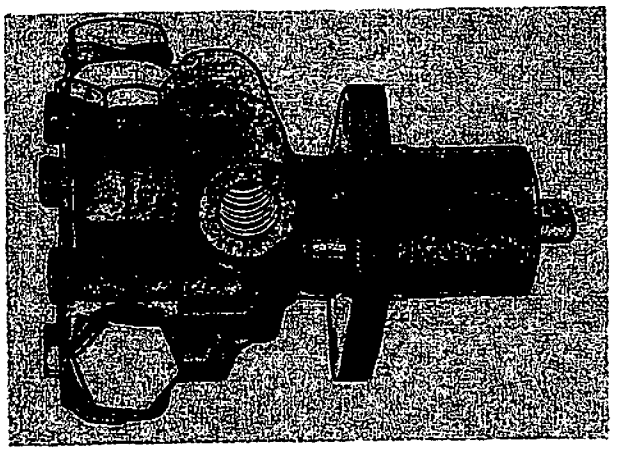


Figure 2-18. Fuel Pump, Mechanical

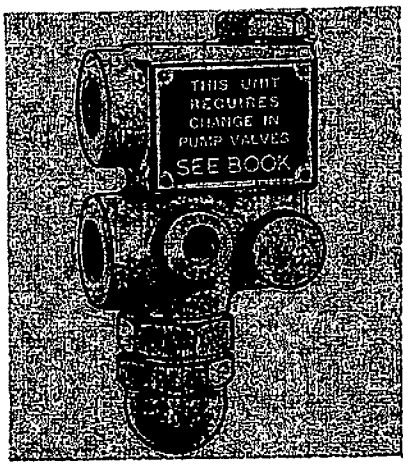


Figure 2-19. Fuel Pressure Regulating Valve

not fitted with a choke valve. Cold starting is made thru the use of a hand priming pump. Wire mesh air filters and back fire traps are fitted to the carburetor air intakes. The three carburetor throttle valves are connected to a common control shaft. Crankcase ventilation is provided thru shrouds fitted to the carburetor air intakes. Distributors and multiple shield boxes are ventilated by pipes to intake manifold.

2-26 REVERSE GEAR. The reverse gear is designed to give direct drive in reverse as well as ahead. The gear is equipped with anti-friction bearings for long trouble free life. Large thrust bearings are provided within the engine assembly to take the full thrust load from the propeller in both forward and reverse. A convenient cover is provided over the reverse gear to permit adjustment when necessary. A 36 in. long hand lever is provided as well as a 16-1/2 in. lever for remote control. Levers may be mounted on either side of the engine. Lubrication is supplied from the engine crankcase.

2-27 IGNITION DISTRIBUTOR. The two ignition distributors are heavy duty units designed especially for this type of service. These distributors are radio shielded and vacuum ventilated. Two sets of breaker points are fitted to each distributor, thus each distributor fires twelve spark plugs. For maximum dependability the distributors are wired so that each distributor fires six spark plugs in each bank of cylinders. In this way, should there be a failure in either distributor, the



Figure 2-20. Carburetors and Manifold

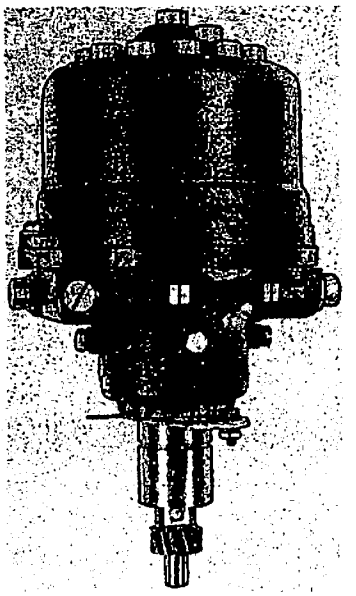


Figure 2-21. Ignition Distributor

engine will continue to develop almost full power as all cylinders will still have one spark plug in operation. The two distributors are identical and thus inter-changeable, one with the other. The only difference in application being the sequence of attaching the secondary wires to the distributor cap. The distributors are provided with numerous adjustable features to make accurate ignition timing a simple operation.

2-28 GENERATOR. A single 24 volt belt driven generator is used on these engines. The same generator is used on both the Model 2268 and 2269 engine. It is a four pole, four brush type generator for a positive ground system.

It is regulated for 25 amperes at 1250 generator rpm at twenty-six volts. It is radio shielded.

2-29 APPARATUS BOX. The generator output is controlled thru the use of an apparatus box which permits the generator output to vary according to the needs of the battery. It is radio shielded to match the rest of the electrical system of the engine.

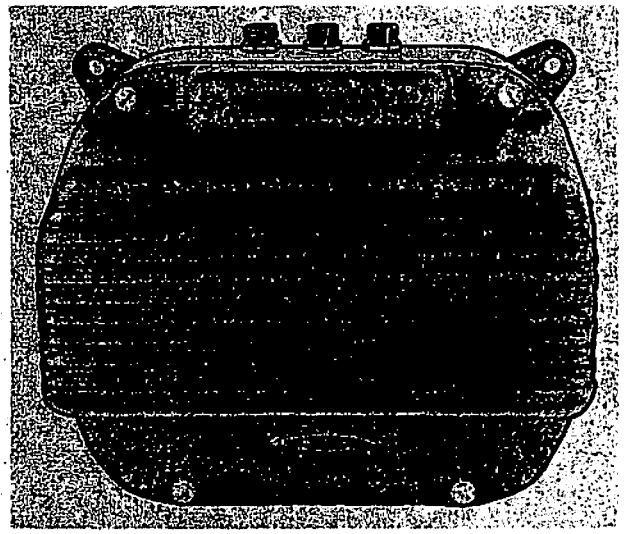


Figure 2-22. Apparatus Box

2-30 STARTER. The electric starting motor is mounted on the flywheel housing and engages the flywheel ring gear thru the use of a inertia shifting pinion. A gear reduction is provided between the starter armature and the cranking pinion. This gives the starter tremendous torque to crank this large engine. The starter is energized thru the use of an instrument panel push button switch. This push button circuit, in turn, closes a magnetic switch which impresses the full battery voltage across the starter motor. The cranking pinion is shifted into engagement with the flywheel ring gear by being mounted on a helical thread. The inertia of the pinion causes it to shift endwise and engage the ring gear. A slipping clutch is provided to absorb the initial shock of engagement. After the engine starts the high velocity of the ring gear kicks the pinion out of engagement.

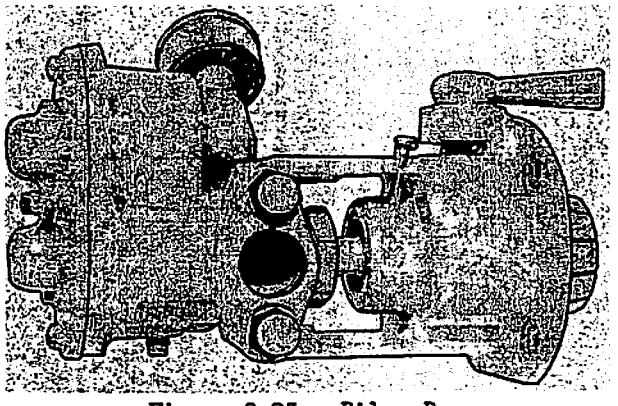


Figure 2-23. Bilge Pump

2-31 SPARK PLUGS. Spark plugs are of the ceramic type with a metal jacket for radio shield system. The single gap type of plug is used. Two spark plugs per cylinder are employed and they are connected in such a way that each spark plug in any particular cylinder draws its energy from separate distributors. This assures maximum freedom from ignition failure.

2-32 BILGE PUMP. Gear type bilge pumps are fitted to Model 2268 engines only. These pumps are mounted on the sprocket housing and are

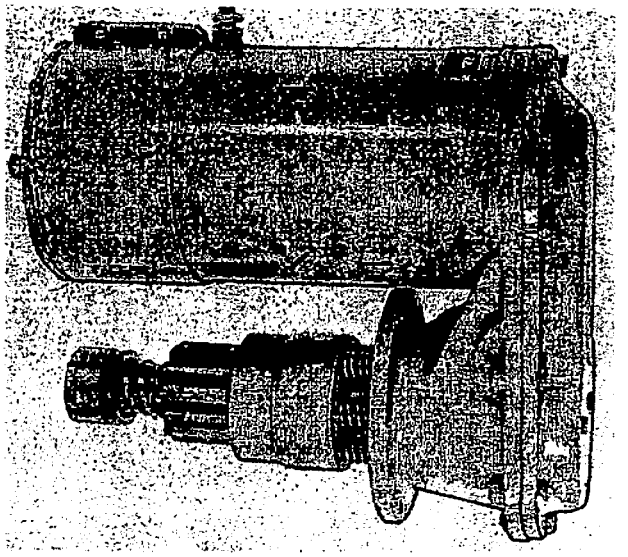


Figure 2-24. Starter

driven through a cone clutch. The pumps are normally stationary and are only engaged when it is necessary to drain the bilge.

2-33 RADIO SHIELDING. The engines are fitted with all necessary equipment to suppress disturbing impulses that interfere with the sending or receiving of radio signals. This is primarily concerned with the electrical equipment, but includes all elements of the engine that might give rise to electrical disturbances. Electrical noise suppression is accomplished by the use of resistor-suppressors, capacitor, filters, metallic shielding, electrical bonding or grounding. The suppression is effective regardless of the amount of engine equipment in use.

2-34 ELECTRIC FUEL PUMP. A six unit electric fuel pump is fitted to the engine to aid in filling the fuel system before starting the engine and to act as an auxiliary pump to the mechanical pumps. The fuel pressure regulating valve is designed so that either the mechanical or electrical pumps can work separately or together. The electrical fuel pump is radio shielded.

2-35 OVERSPEED GOVERNOR. To prevent damage to the engine because of excess speed, a governor is used. This is a mechanical device that controls the ignition circuit. When the engine reaches a predetermined speed the ignition circuit is interrupted. Just as soon as the engine speed drops to a safe rpm then the

ignition circuit is restored and the engine will continue to run, hence there is no danger of the engine stopping. The overspeed governor is mounted on the front of the engine with a tachometer dial included so the attendant in the engine room can tell directly at what speed the engine is running.

2-36 TACHOMETER SENDING UNIT. An electric tachometer sending unit is used on these engines to avoid the use of long tachometer cables to the Bridge. The electric sending unit fastened to the sprocket housing need only be connected by wire to the tachometer receiving unit on the Bridge. This makes a simple installation.

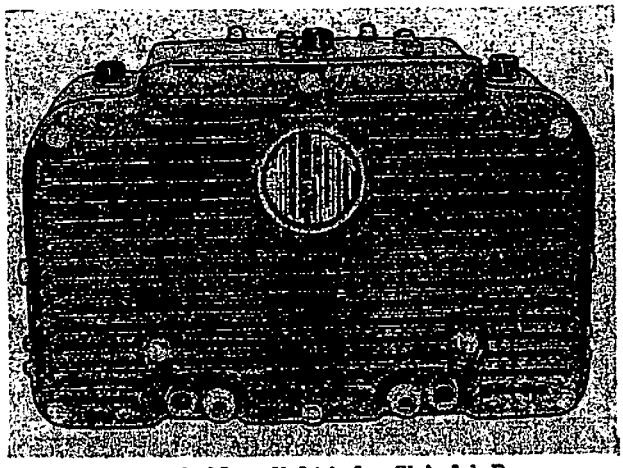


Figure 2-25. Multiple Shield Box

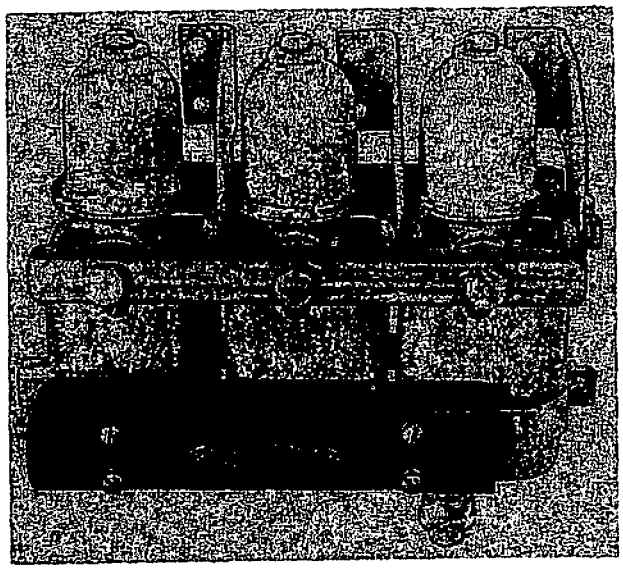


Figure 2-26. Fuel Pump, Electric

TABLE OF SPECIFICATIONS

GENERAL

(Specifications pertain to both models unless otherwise noted).

3-1 MODELS. Hall-Scott Defenders Model 2268 and Model 2269.	
3-2 NUMBER OF CYLINDERS.	12
3-3 BORE.	5-3/4 in.
3-4 STROKE.	7 in.
3-5 DISPLACEMENT. Piston displacement in cubic inches.	2181
3-6 COMPRESSION RATIO.	7.00 to 1
3-7 ROTATION. Propeller drive shafts	
Model 2268	C.W.
Model 2269	C.C.W.
3-8 DRIVE FLANGE. Propeller drive flange	
Outside diameter	6 in.
Pilot diameter (inside)	2.496 - 2.498 in.
Pilot depth	1/4 in.
Bolt circle diameter	4-7/8 in.
Bolt hole diameter	41/64 in.
Bolts required	8
Bolt spacing	equal
3-9 ENGINE MOUNTING.	
Number of bolts required	12
Bolt diameter	1/2 in.
3-10 WEIGHT. Average weight of engines	3975 lb
3-11 DIMENSIONS. Overall	
Width	45-3/8 in.
Height	47-1/4 in.
Length	88 in.
3-12 CENTER OF GRAVITY POSITION.	
Longitudinal distance forward from the rear face of the propeller drive flange.	50-1/2 in.
Vertical distance above the centerline of the propeller drive shaft.	9-3/4 in.
Transverse position of cg falls on the centerline of the engine.	

IGNITION

3-13 IGNITION TIMING DISTRIBUTOR.	
Type.	Dual breaker points, radio shielded and mechanical advance mechanism.
Direction of rotation.	C.C.W. looking at drive end of distributor.
Distributor speed.	1/2 engine crankshaft rpm

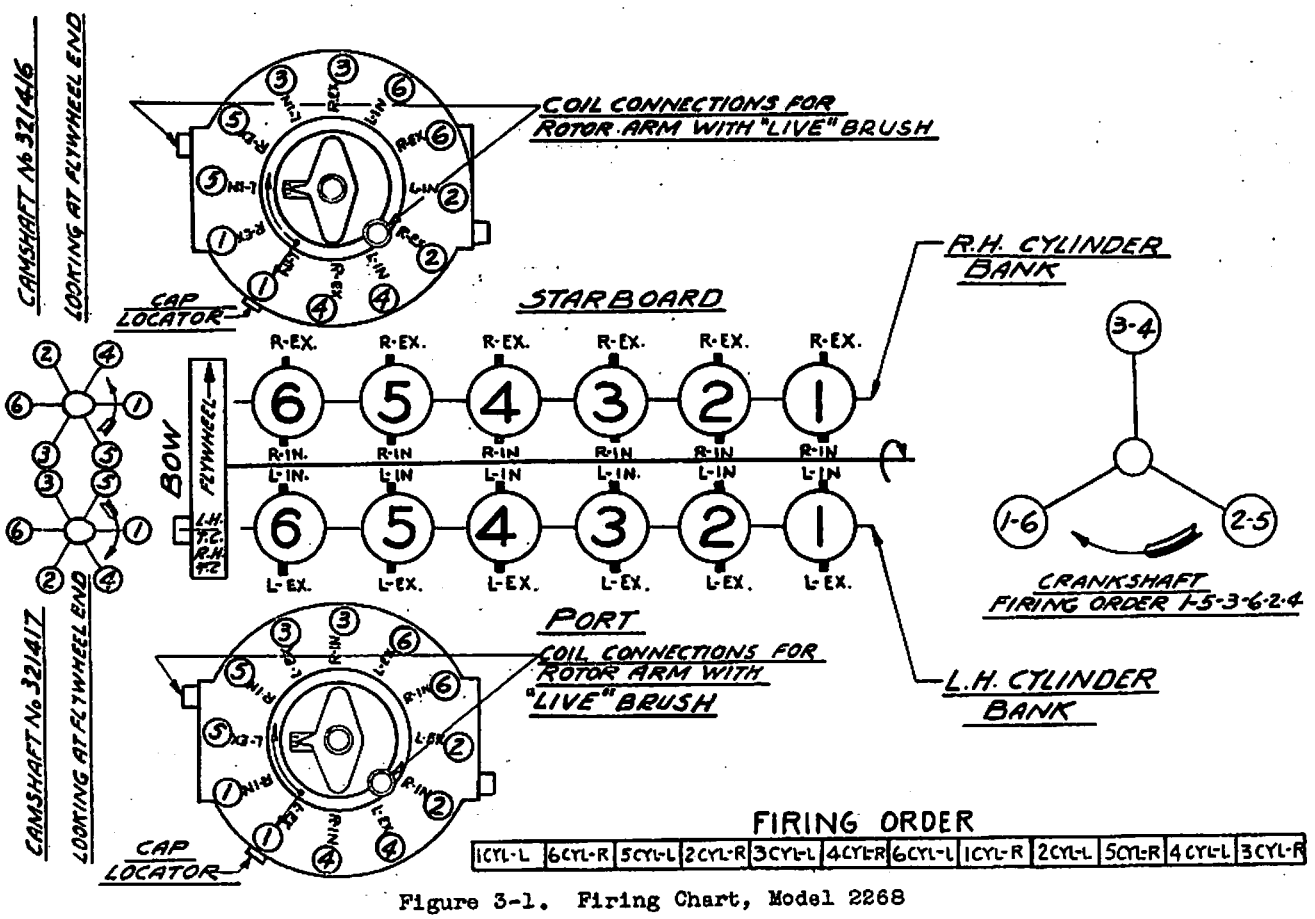


Figure 3-1. Firing Chart, Model 2268

3-14 BREAKER POINT GAP. .018 - .024 in.
Cam Angle. 37°

3-15 SPARK PLUG GAP. .020 in.

3-16 SPARK PLUG TYPE. ceramic - single gap - shielded

3-17 SPARK. Occurs under static conditions at T.C. (When running, the spark timing will vary with the speed under the influence of the automatic advance mechanism). Breaker points are to be synchronized to fire both spark plugs in any one cylinder at the same moment.

VALVES AND VALVE TIMING

3-18 INTAKE OPENS. 17° before T.C.

3-19 INTAKE CLOSES. 70° after B.C.

3-20 EXHAUST OPENS. 67° before B.C.

3-21 EXHAUST CLOSES. 20° after T.C.

3-22 INTAKE. Remains open for 267° of crankshaft rotation.

3-23 EXHAUST. Remains open for 267° of crankshaft rotation.

3-24 VALVE LIFT. .482 in.

3-25 VALVE TAPPET CLEARANCE. Intake Exhaust

3-26 FOR TIMING. Hot .021 .021

3-27 FOR RUNNING. Hot .021 .030

3-28 VALVE SPRING LOADS TOTAL OF INNER AND OUTER SPRING.

3-29 VALVES OPEN. 243 lb 243 lb

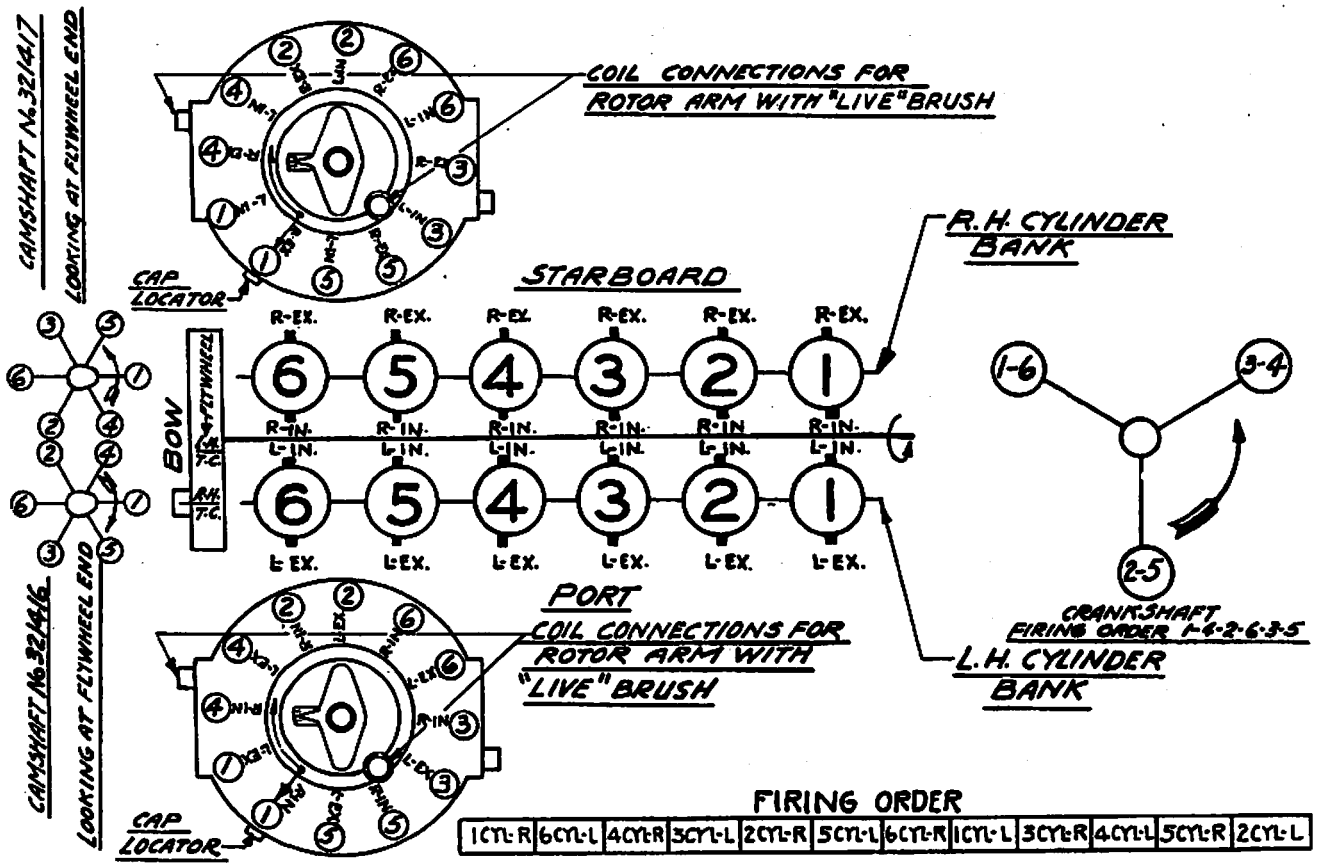


Figure 3-2. Firing Chart, Model 2269

3-30 VALVES CLOSED. 115 lb 115 lb

FUEL SYSTEM

3-31 CARBURETOR TYPE. Multiple venturi updraft. Three carburetors per engine. 2-1/2 in. size.

3-32 FUEL. Aviation quality gasoline of 87 to 91 octane minimum rating.

3-33 FUEL INLET CONNECTION. 3/8 inch American Standard internal pipe thread located in fuel supply cross.

3-34 PRIMING SYSTEM INLET CONNECTION. Primer pump outlet to intake manifold is Standard SAE ball sleeve type connection both ends for 1/8 in. OD tubing. Primer pump inlet to fuel supply is Standard SAE ball sleeve type connection pump end and Standard SAE flared type connection fuel supply end suitable for 3/16 in. OD tubing.

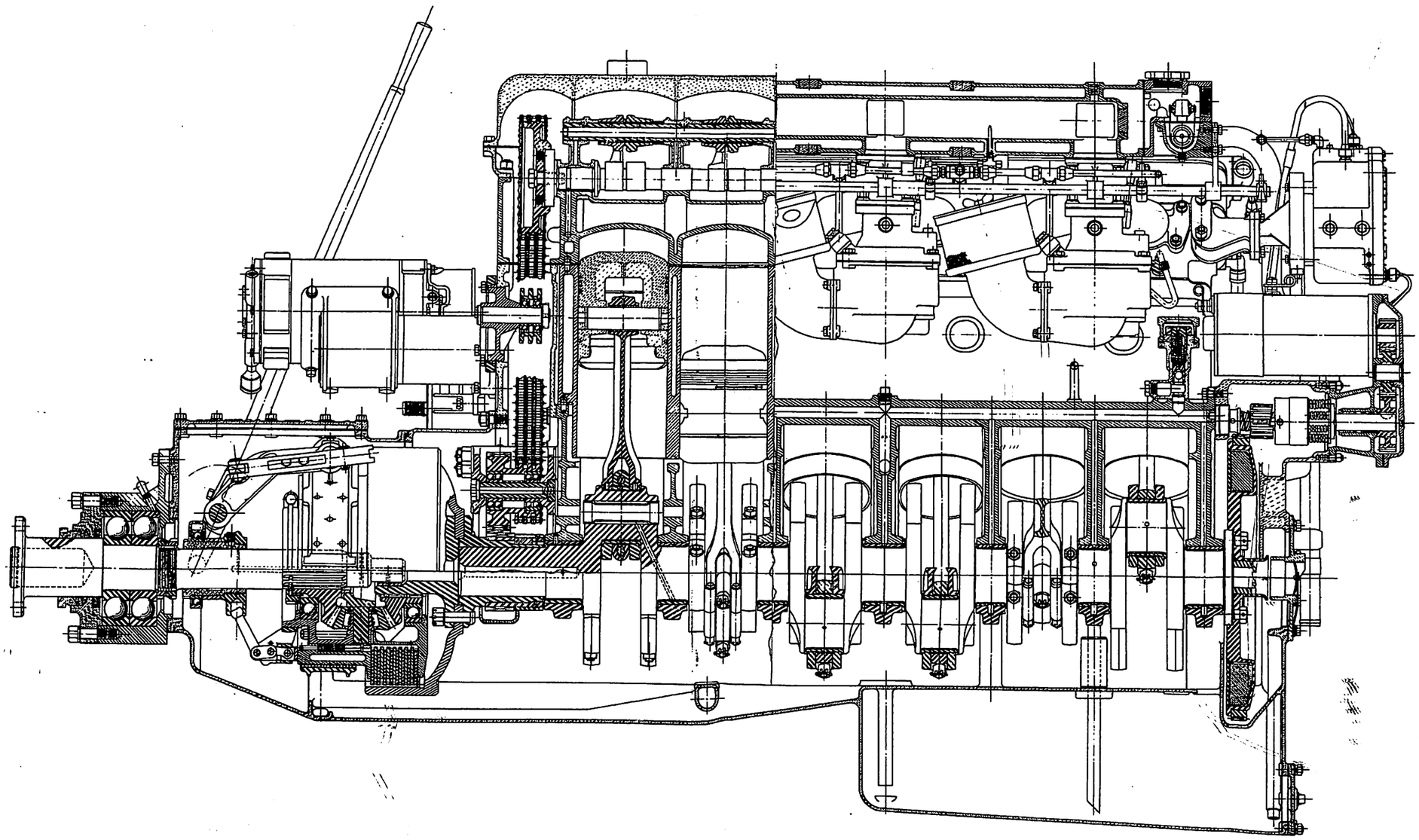


Figure 2-1. Longitudinal Section of Engine

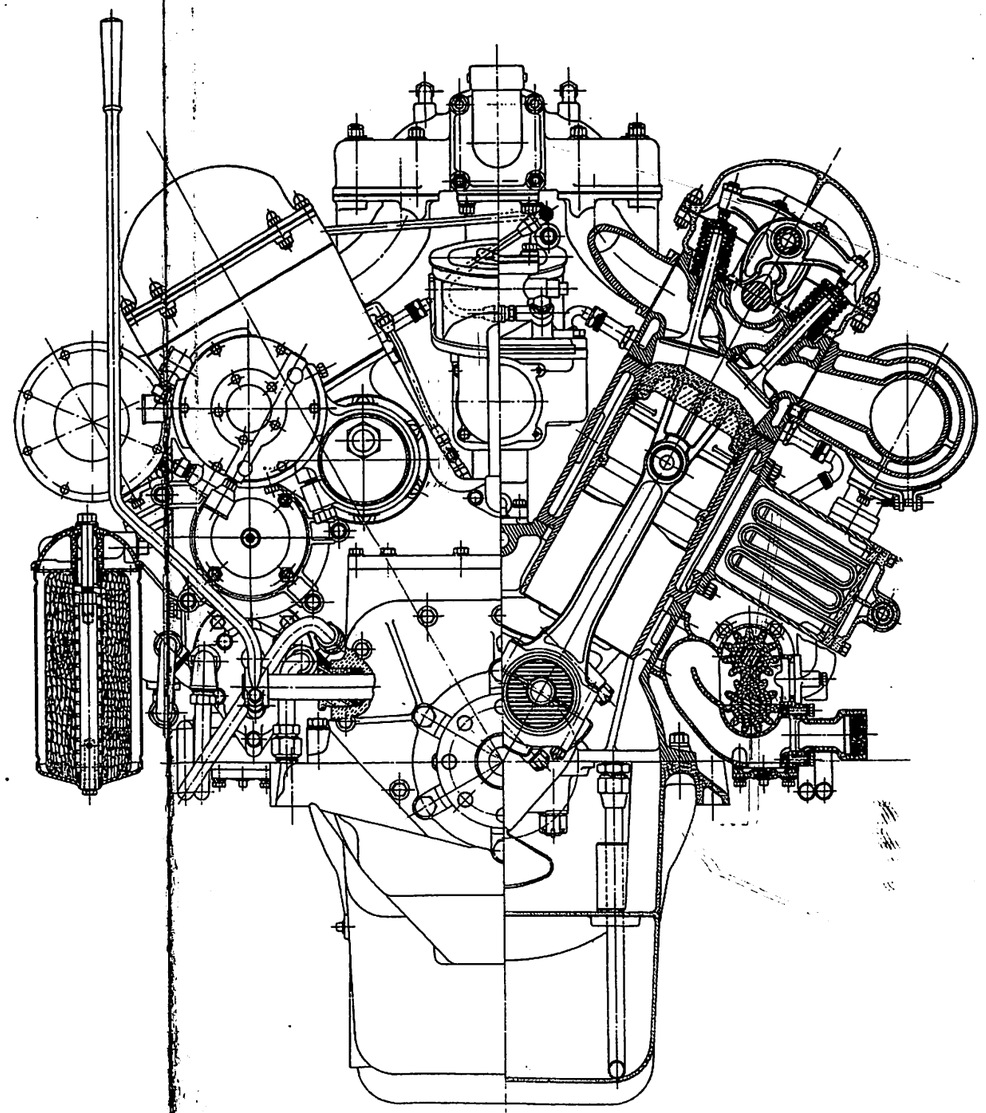


Figure 2-2. Transverse Section of Engine

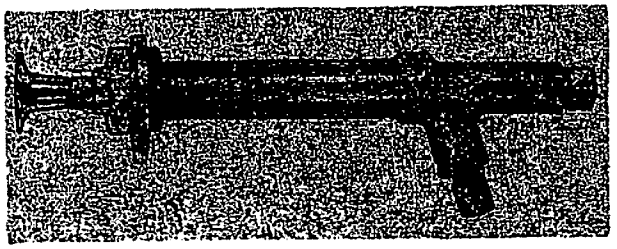


Figure 3-6. Hand Priming Pump

Primer pump is usually mounted on the instrument panel.

LUBRICATION SYSTEM

3-35 TYPE OF OIL REQUIRED. Use a motor oil having the oxidation stability, bearing corrosion preventive properties, and detergent characteristics necessary to make it generally suitable for use in internal combustion engines under heavy service conditions. It must meet U.S. Army specification 2-104B and U.S. Navy specification 14-O-13 series 9000.

3-36 GRADE OF OIL REQUIRED. Use an SAE 20 oil for very light service and cold climates. Use an SAE 30 oil for moderate service and temperate climates. Use an SAE 40 oil for extremely heavy service and hot climates.

3-37 QUANTITY OF LUBRICATING OIL.
7 U.S. (5.83 Imperial) gallons initial fill.
6 U.S. (5.0 Imperial) gallons refill.

3-38 OIL PUMP SPEED. The oil pumps rotate at crankshaft speed.

3-39 OIL PUMP ROTATION. The right hand oil pump drive shaft rotates C.W. while the left hand oil pump drive shaft rotates C.C.W.

COOLING SYSTEM

3-40 TYPE OF COOLING SYSTEM. Two piloted gear type water circulation pumps with thermostatic control on recirculation line to control water temperature.

3-41 COOLING LIQUID. Raw sea water minimum coolant capacity of engine only is 15.5 U.S. (12.9 Imperial) gallons.

3-42 COOLANT OUTLET CONNECTIONS. Two 1-1/2 in. American Standard internal pipe threads.

3-43 COOLANT RECIRCULATION PIPES. Two 1-1/2 in. OD for hose connections.

3-44 COOLANT INLET CONNECTIONS. Two 1-1/2 in. American Standard internal pipe threads.

3-45 SPEED OF COOLANT PUMPS. The coolant pump rotates at crankshaft speed. The right hand pump drive shaft rotates C.W. The left hand pump drive shaft rotates C.C.W.

ACCESSORY DRIVES AND INSTRUMENT CONNECTIONS

3-46 OIL PRESSURE. SAE Standard connection for 5/16 in. OD flared tubing. Located between the cylinder banks near the rear of the engine.

3-47 FUEL PUMP DRIVE. .263 - .265 in. wide slot in end of camshaft. Slot is symetrical about CL of shaft.

3-48 FUEL PUMP SPEED. 1/2 engine crankshaft rpm.

3-49 FUEL PUMP DIRECTION OF ROTATION. The RH fuel pump rotates C.W. and the LH fuel pump rotates C.C.W. as viewed from the rear of the engine.

3-50 STARTER DIRECTION OF ROTATION. The starter armature and drive pinion on the Model 2268 rotate C.C.W. whereas the armature and drive pinion on the Model 2269 rotate C.W. as viewed from the rear of the engine.

3-51 GENERATOR DRIVE SPEED. The generator is driven at 1.7 times engine crankshaft speed.

3-52 GENERATOR DRIVE DIRECTION OF ROTATION. C.W. on all models as viewed from the rear of the engine.

3-53 TACHOMETER DRIVE SPEED. At engine crankshaft speed.

3-54 TACHOMETER DRIVE. Thru flexible cable to electric sending unit.

3-55 TACHOMETER DRIVE DIRECTION OF ROTATION. C.W. on all models as viewed from the rear of the engine.

3-56 MANIFOLD PRESSURE CONNECTIONS. 3/8 in. American Standard internal pipe thread in top of intake manifold.

ACCESSORY WEIGHTS

3-57 CARBURETOR. 23.5 lb each, three used per engine for a total weight of 70.5 lb

3-58 SHIPPING BOX. 2105 lb

3-59 EXHAUST FLANGES WITH GASKETS AND NUTS. total 10.5 lb

3-60 GENERATOR. 63 lb

3-61 GENERATOR DRIVE. 25.5 lb

3-62 APPARATUS BOX (SHIELDED). total 36 lb

3-63 MULTIPLE SHIELD BOX. Two used per engine at 23 lb each. total 46 lb

3-64 STARTER ASSEMBLY. 77 lb

3-65 FUEL PUMPS-MECHANICAL. 3.5 lb each. total 7 lb

3-66 FUEL PUMPS-ELECTRICAL. 11 lb each. total 22 lb

3-67 SPARK PLUGS. Set of 24 5.6 lb

3-68 OIL FILTER. 26.5 lb each total 53 lb

3-69 REVERSE GEAR. Weight of minimum assembly to be lifted as a unit. Does not include cover. 280 lb

Section III
Paragraph 3-70 to 3-78

3-70	FUEL FILTER.	5 lb	3-75	MAGNETIC STARTER SWITCH.	9 lb
3-71	OIL PUMP. 10 lb each	total 20 lb	3-76	OVERSPEED GOVERNOR.	1.5 lb
3-72	WATER PUMP. 32 lb each	total 64 lb	3-77	SENDING UNIT.	2.5 lb
3-73	DISTRIBUTOR. 11.5 lb each	total 23 lb	3-78	TOOL KIT.	12 lb
3-74	BILGE PUMP. RH engine only	28 lb			

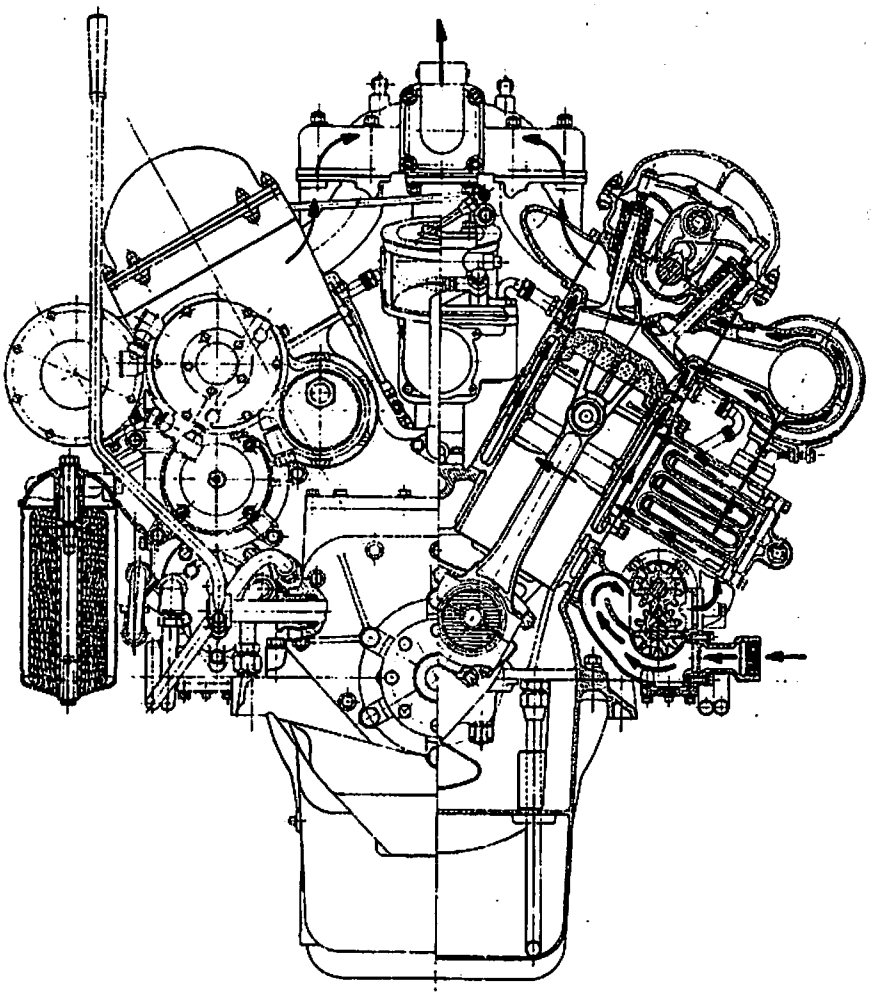


Figure 3-7. Water Circulation Diagram

STORAGE INSTRUCTIONS

4-1 PREPARATION FOR STORAGE TREATMENT. If the engine has been running on leaded fuel prior to its storage it is necessary to run it under its own power for 15 minutes on clean, unleaded fuel to clear all fuel pipes, pumps, pressure regulating valves and carburetors of the leaded fuel. Stroke the priming pump several times to clear it and the priming nozzles of leaded fuel. During this final 15 minute run circulate clear, salt free water through the cooling system. At the completion of this final run before storage and while the engine is still warm, drain all lubricating oil from the engine. Use the hand scavenge pump if the engine is installed in a boat. Also remove all cooling water drain plugs and allow the cooling system to drain completely and refit plugs. Remove drain plugs from carburetor bowls and drain fuel into a closed container.



Figure 4-1. Hand Scavenge Pump

WARNING

Always keep a serviceable fire extinguisher within reach at all times.

Remove plug from fuel pressure regulating valve and drain fuel into a closed container. Replace plugs in carburetor fuel bowl and fuel pressure regulating valve. Remove used oil filter elements and replace them with new elements. Clean the exterior of the engine thoroughly. Remove 12 spark plugs from exhaust sides of cylinder heads. Remove used galvanic plugs in front of cylinder head and replace with new ones.

4-2 PROTECTIVE COMPOUND TO BE USED. The compounds specified by the Navy Department Specifications 52-C-18 dated Jan. 2, 1945, are highly fluid solutions, possessing polar characteristics, and are used for the protection of ferrous and other corrodible metals. They are miscible in lubricating oil without deleterious effect in the mixture percentages involved in the preservation of machinery. These compounds leave soft, non-drying films which are excellent rust inhibitors. The residual films vary in thickness from 0.0003 in. to 0.002 in., depending upon the grade of compound used and the conditions of application. Where these compounds are used on a machine, it is not necessary that the residual films be cleaned or flushed out before the machine is placed in operation. These characteristics make these compounds desirable for use in the preservation of engines for shipment or storage, where service readiness is an important requirement.

There are two grades of these compounds:

Grade I - For use on the exterior of engine; unpainted metal surfaces. Has heavier, tougher film than Grade II, which enables it to withstand weathering better.

Grade II - For use on interior of engine, lubricating and bearing surfaces and other sensitive mechanisms.

4-3 APPLICATION OF PROTECTIVE COMPOUND TO THE INTERIOR OF THE ENGINE CRANKCASE. Fill the engine crankcase to the normal lubricating oil level with Grade II compound as mentioned in paragraph 4-2. Fill thru hole in front of engine where hand scavenge pump and oil level gage fits. Refer to paragraph 3-37 for quantity required. Then either "motor" the engine for three minutes with an auxiliary drive at 600 to 700 rpm or, lacking this, use the engine starting motor to rotate the engine. At the end of three minutes remove the excess protective compound from the engine. Remove four drain plugs from the bottom of the oil filter shells and one plug from the lower crankcase sump tank.

4-4 APPLICATION OF PROTECTIVE COMPOUND TO THE FUEL SYSTEM. Remove the three carburetors from the engine as explained in paragraph 7-43, submerse them in Grade II compound as specified in paragraph 4-2. Drain them thoroughly and replace on the engine. Remove the fuel pumps as explained in paragraph 7-63 and submerse them in Grade II compound and rotate the drive shaft several revolutions to draw the compound into the pump housing. Drain and refit to the engine. Treat the fuel filter to the same submersion routine. Also flush out the fuel pressure regulating valve with Grade II compound.

4-5 APPLICATION OF PROTECTIVE COMPOUND TO THE CYLINDER HEAD. Remove the rockerarm covers and spray all the valve mechanism and drive chain with Grade II compound. Be careful to use a separator in the air line to keep all moisture and dirt out of the air. Rotate the engine while spraying the cylinder heads. Remove all excess compound from both the heads and any

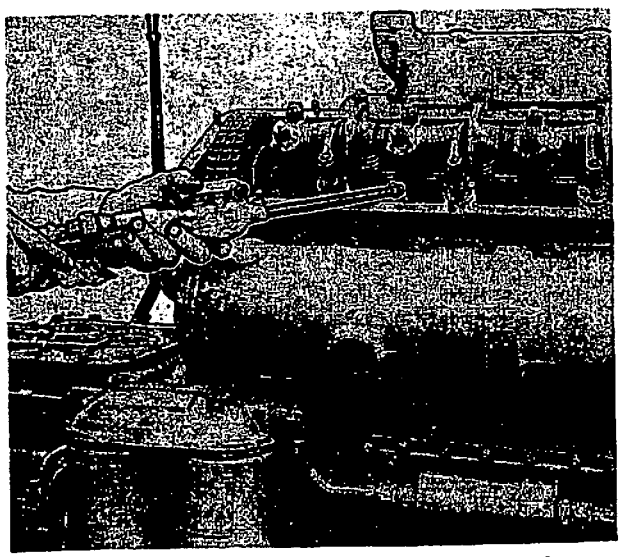


Figure 4-2. Spraying Cylinder Head

that may have drained into the lower crankcase. Replace the rockerarm covers using new gaskets.

4-6 APPLICATION OF PROTECTIVE COMPOUND TO THE COMBUSTION CHAMBER AND CYLINDERS. Spray thru the spark plug holes so as to coat the cylinder walls, combustion chambers, valve heads and valve stems with Grade II compound. Be careful to use a separator in the air line to keep all moisture and dirt out of the air. The piston must be at the bottom of its stroke when the cylinder is being treated. Refer to flywheel markings viewed thru timing inspection hole for piston positions. Then give each cylinder one

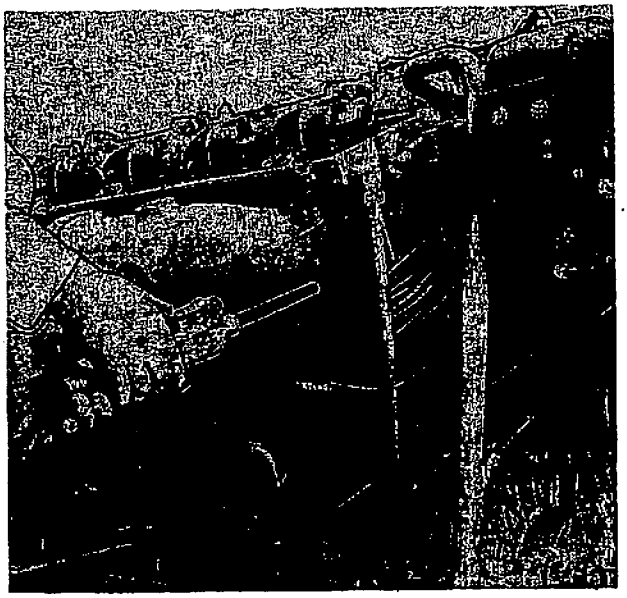


Figure 4-3. Spraying Combustion Chamber and Cylinder

more going over without turning the engine so as to cover any spot that have been scraped clean by prior rotation.

4-7 SPARK PLUG HOLE COVERS. Into each spark plug hole on the exhaust side, screw a moisture absorbing capsule that meets Specification AN-4062-1.

4-8 EXTERIOR PROTECTION. Clean off rust and retouch any spot where paint has been chipped off. Remove air filter from rear carburetor and place two one oz packages of a moisture absorbing agent in the elbow of the air filter base. Silica Gel in a porous bag that meets specification JAN-D-169 or AN-D-6, types III and V must be used. Place a couple of these 1 oz moisture absorber bags in each exhaust manifold. Tie a conspicuous cord on each bag so they will be withdrawn before the engine is put in service. Remove storage battery connection to the engine. Close all engine openings with acid free, oil resistant, waterproof adhesive cloth or paper. Wrap the starter and generator commutator cover bands with acid free, oil resistant, waterproof cloth or paper. Apply Grade I compound, as mentioned in paragraph 4-2, to the unpainted surfaces on the exterior of the engine by brushing or spraying.

4-9 MARK TREATED ENGINES. Place a conspicuous tag on the engine indicating it has been treated for rust prevention and must not be turned over until it is to be put back in service as to do so will damage the protective coating. This tag is to indicate the date the engine was treated and the base at which the treating was done. This tag must refer to this handbook paragraph 4-11 through 4-15 inclusive for instruction on returning the engine to service.

PACK IN SHIPPING CONTAINER

4-10 Install a humidity indicator on the bracket provided in the shipping box. Fit a moisture proof bag over the engine, evacuate the excess air and heat seal the bag air tight. Be careful that the transparent section of the engine bag comes opposite the humidity indicator so the indicator can be seen after the cover is over the engine. Set the engine in the shipping box and then install cover to shipping box. Secure cover. Refer to figure 4-4.

CAUTION

In any case of treating combustion chambers, the fact should not be neglected that the total volume of the combustion space is small, and any excess of compound may result in a hydraulic lock on starting the engine, and serious damage will result. The compounds used have excellent flushing properties. When treating a dirty engine, care should be exercised to see that any foreign matter, which may collect on screens and strainers, is removed before considering the engine properly treated and ready for future service.
While the compounds used may be added to and used for the same purpose repeatedly, extreme care should be exercised toward cleanliness. On the repeated use of any compound, the accumulated dregs should be allowed to settle and then be discarded. New and clean compound only should be used in treating the combustion chambers, and manifold passages.
After recommissioning, the initial fill of lubricating oil should be replaced with new oil after the first hour of operation. This will tend to remove dust, lint, water, dirt and dried compound which may accumulate during long time storage.
Engines which are in storage more than 24 months should, if practicable, be thoroughly flushed out with a suitable solvent, such as kerosene or light hot oil, and then re-coated with the rust preventive compounds.

PREPARATION FOR SERVICE AFTER STORAGE

4-11 REMOVE FROM SHIPPING BOX. Examine the shipping box for any indication of damage to the engine. Inspect the engine through the window provided in the shipping box. If the engine appears to be serviceable, carefully remove the moistureproof cover from engine and again give it a thorough inspection.

4-12 DRAIN ALL EXCESS PROTECTIVE FLUID. Remove drain plugs from oil filter shells, carburetor bowls, fuel pressure regulating valve and from sump of lower crankcase. Replace plugs after fluid has drained. Remove the moisture absorbing capsules from spark plug holes, put in teaspoonful of lubricating oil in each cylinder

and rotate engine through two complete revolutions to make sure it is free.

4-13 REMOVE PROTECTIVE COVERS AND MOISTURE ABSORBERS. Remove auxiliary storage covers from the starter and generator. Remove rear back fire trap and pull two moisture absorbing sacks of chemical from air filter base. Remove two moisture absorbers from each exhaust manifold. Also remove storage covers from all other engine openings.

4-14 REMOVAL OF PROTECTIVE COAT. The nature of the protective coating, as mentioned in paragraph 4-2, is such that the engine can be put back in service with out prior removal of this film from the interior of the engine.

4-15 OIL DRAIN. After putting the engine back in service after storage, it is necessary, after the first three hours of running, to remove all the oil from the crankcase and refill with new oil. Refer to paragraphs 3-35 through 3-37 for type and quantity of oil to use. Replace oil filter elements at this time also.

4-16 SHIPPING CASE SPECIFICATION. The reuseable engine shipping case as shown in figure 4-4 is made of welded steel and is of water tight construction. These cases are 55 inches wide, 60 inches high and 97 inches long. They are of 186 cubic foot external volume and weigh 6240 pounds when completely packed with an engine ready for shipment. Shipping documents are readily available under an auxiliary cover on the end of the case. A glass window is provided to allow inspection of the humidity indicator packed within the air tight engine enclosure. Brass nameplates are attached to both the cover and base of the shipping case. These nameplates show all the essential information pertaining to the identity of the contents. They also show a shipping case serial number which allows the covers and bases to be kept together in matched sets.

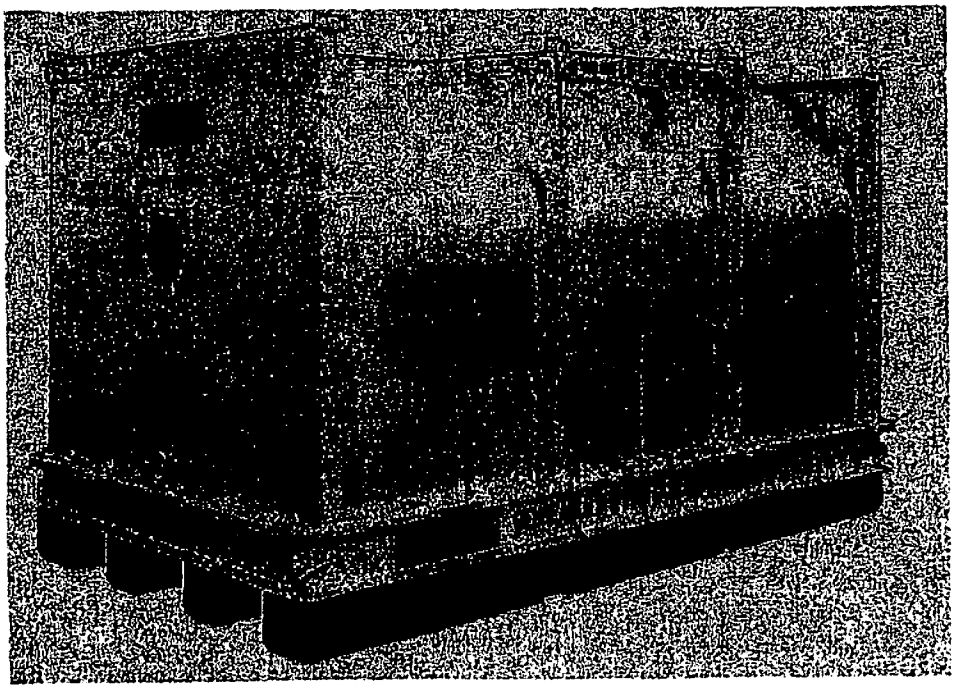


Figure 4-4. Reuseable Shipping Case

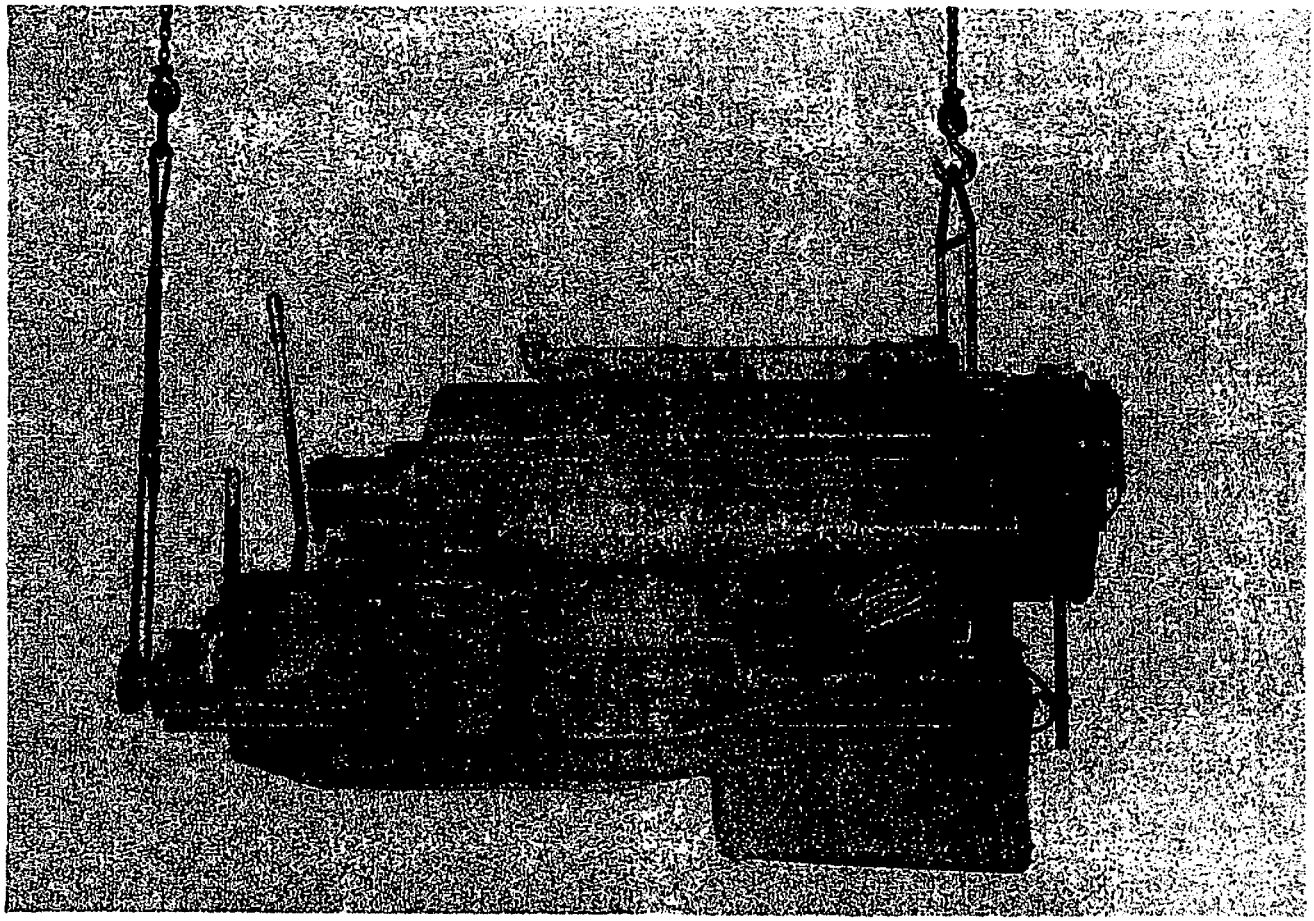


Figure 4-5. Proper Method of Lifting Engine

ENGINE TROUBLES AND THEIR REMEDIES

5-1 INTRODUCTION.

5-2 "Trouble Shooting" comments can only be of a very general nature as there are so many factors that can cause practically the same symptoms. There is no good substitute for experience in locating and correcting troubles and the following list, at best, can only serve as a guide until experience can be gained. In order to make each heading more or less self contained it has been necessary to repeat many items. Most all boats are provided with instruments on the panel so that an alert operator can frequently spot trouble before it becomes serious. This applies especially to the oil pressure gage. Lack of oil pressure or a sudden drop in oil pressure is a sure indication of trouble and the engine should be shut down immediately until the cause is found and corrected. The water temperature gage, ammeter and oil temperature gage should also be watched for possible signs of trouble. The dual ignition switch can be used to spot misfiring and incorrect timing as explained in paragraph 6-24. Unusual noises of any sort coming from the engine should be investigated at once to determine their cause. Many such noises are brought about by the normal wear and tear of service and are nothing to be alarmed about. However, there are other noises that are quite serious as they are a warning of impending breakage. Only by determining the cause of a noise can its seriousness be correctly judged.

HARD STARTING

5-3 STARTER WILL NOT CRANK THE ENGINE.

a. Check to see that the engine is not locked. Turn the engine over by hand to make certain it is free to rotate. If it is locked, find the cause and remove.

b. Check to see that the battery is large enough and has sufficient charge to crank the engine. Either install the correct size battery or charge the battery, whichever is needed.

c. Check for loose or corroded battery terminals.

d. Defective magnetic or push button starter switch.

e. Defective starter motor. Examine the commutator and brushes.

f. Flywheel ring gear teeth broken out.

g. Broken starter drive pinion or starter screw shaft "gummed up" so pinion does not shift.

5-4 ENGINE TURNS OVER, BUT DOES NOT START.

a. See that electricity is getting to the distributor. Make sure that ignition switch is in good order. See that there are no loose or grounded connections between the battery and distributor.

b. Distributor points badly burnt or not opening.

c. Defective distributor condenser.

d. Badly corroded distributor cap terminals.

e. Check spark plug gaps.

f. Air leaks at intake manifold or carburetor gaskets.

g. Make sure fuel is getting to the engine. The hand primer pump may be out of order.

h. Engine is flooded from excessive priming.

j. Check for low compression. If the engine has been out of service for some time a teaspoonful of oil in each cylinder may help to restore compression.

k. Check ignition and valve timing.

l. Spark plug, distributor cap or high tension wires may be shorted by dirt or moisture.

m. Gasoline may be old so that all "light ends" have evaporated.

FAULTY RUNNING

5-5 LACK OF POWER.

a. Low compression may be caused by sticky or leaking valves, stuck or broken piston rings or dry cylinder bores. Add a teaspoonful of cylinder oil to each cylinder through the exhaust side spark plug to determine if this will restore compression. A major overhaul may be required to correct the trouble.

b. Improper timing. Check the valve and ignition timing as outlined in paragraph 7-21 through 7-25 and 7-4 through 7-17.

c. Poor carburetion.

d. Restriction in air intake caused by plugged air cleaner.

e. Throttle control of insufficient travel so throttle cannot open fully.

f. Restriction in fuel supply line.

g. Air leakage in manifold or carburetor gaskets.

h. Excessive engine temperature caused by clogged water jacket or valve closed so as to obstruct water flow through the engine.

j. Air vent to gasoline fuel tank plugged.

k. Pre-ignition caused by excessive carbon deposits, wrong spark plugs, faulty water circulation or warped valve head.

l. Engine and propeller shaft misalignment.

m. Plugged vent in carburetor throat so that power jet valve cannot operate properly.

n. Hot intake air being drawn from engine compartment. Intake air must be cool.

5-6 ROUGH OR UNEVEN IDLING.

a. Improper adjustment of idling screw on the carburetor, gasoline fuel level too high or too low or idle system plugged with dirt. Check adjustment of idle screw as mentioned in paragraph 6-27. Check carburetor fuel level as mentioned in War Dept. Technical Manual Ordnance Maintenance Carburetors (Zenith) chapter 9 paragraph 151h.

b. Air leaks in the intake manifold or carburetor caused by faulty gaskets, warped flanges or loose manifold nuts.

c. Improper ignition caused by a defective coil, faulty condenser, bad spark plug or sluggish distributor breaker arm.

d. Uneven compression.

e. Water leak in cylinder head or block.

5-7 MISSING AT HIGH SPEED.

a. Defective spark plug. Remedy by adjusting gap to clearance shown in paragraph 3-15 or replace the plug.

b. Broken insulation on high-tension wires.

c. Weak distributor breaker point spring.

d. Fuel supply obstruction.

e. Weak valve springs.

f. Improper valve tappet adjustment. Refer to paragraph 3-27 and 7-18.

IGNITION TROUBLES

5-8 PRIMARY CIRCUIT.
a. Corroded, dirty or loose connections.
b. Weak, leaky or grounded condenser.
c. Distributor points pitted or fused.
d. Distributor points set to wrong gap or loose. Refer to paragraph 3-14.
e. Sluggish distributor breaker arm caused by weak spring or hinge bushing too tight on the pin.

5-9 SECONDARY CIRCUIT.
a. Corroded, dirty or loose connection especially in distributor cap.
b. Wet wires.
c. Moisture or carbon on spark plug porcelains.
d. Cracked spark plug insulators.
e. Cracked distributor cap.
f. Carbon brush in distributor rotor is broken or frozen in its holder.
g. Weak ignition coil.
h. Wrong type of spark plug.
j. Improper spark plug gap. Refer to paragraph 3-15.
k. Fouled spark plug.
l. Distributor wires improperly connected so engine is not properly timed.

FAULTY FUEL SYSTEM

5-10 LACK OF FUEL IN THE CARBURETOR.
a. No fuel in the storage tank.
b. Fuel line valve closed.
c. Fuel line obstructed by dirt or kinks.
d. Vane in fuel pumps worn or sticking.
e. Obstructed fuel filter.
f. Loose fuel line connection or broken pipe.
g. Overheated gasoline fuel line so vapor-lock is encountered.

5-11 TOO MUCH FUEL IN THE ENGINE.
a. Excessive use of hand priming pump.
b. Leaky carburetor float.
c. Defective or dirty carburetor fuel valve.
d. Improper carburetor adjustment.

5-12 GASOLINE CARBURETOR TROUBLE.
a. Plugged jets.
b. Leaky float.
c. Broken accelerator spring.
d. Plugged vent in carburetor throat so accelerator pump does not work.
e. Defective or leaky float valve.
f. Improper float setting.
g. Venturis displaced or upside down.
h. Excessive air leakage around throttle valve shaft.
j. Dirty fuel inlet screen.

COOLING SYSTEM TROUBLES

5-13 ENGINE OVERHEATING.
a. Defective thermostat.
b. Under sized water circulation pipes.
c. Stopped up water holes between cylinder block and cylinder head.
d. Excessive salt deposits on the engine jacket surface.
e. Improper spark timing.
f. Excessive detonation.
g. Exhaust manifold plugged with sand and salt.

5-14 ENGINE OVERCOOLING.
a. Faulty thermostat.
b. Operating in cold weather without thermostat or other means of controlling the cooling water temperature.
c. Extended periods of idling or trolling.

OIL CIRCULATING PROBLEMS

5-15 LOW OIL PRESSURE.
a. Incorrect grade of oil. Refer to paragraph 3-35 and 3-36.
b. Badly diluted oil.
c. Excessive engine clearances.
d. Oil pressure regulating valve not properly seating.
e. Air leak in oil pump suction line.
f. Faulty by-pass valve in oil filter base.
g. Worn or damaged oil pump gears.
h. Inaccurate oil pressure gage.

5-16 HIGH OIL PRESSURE.
a. Engine oil too heavy.
b. Oil pressure regulating valve not opening.
c. Obstruction in distributing line.
d. Inaccurate oil pressure gage.

5-17 ELECTRICAL SYSTEM TROUBLES.
a. Ignition troubles are mentioned under paragraph 5-8 through 5-9.
b. Most common difficulty with electrical system is loose or corroded connections.
c. See that all units are securely grounded.
d. See that the voltage and current regulator points are not burnt.

5-18 DESCRIPTION OF ENGINE NOISES.
a. Crankshaft knocks are usually detected as dull, heavy metallic knocks, which either increase in frequency as the speed and load on the engine are increased, or are more noticeable at idling speeds. The most common crankshaft knock is that caused by excessive clearance at one or more main bearings. This is most audible when the engine is cold. Excessive crankshaft end play causes a sharper noise or rap and occurs at irregular intervals whereas a main bearing knock is quite regular.

5-19 CONNECTING ROD NOISES.
a. Connecting rod noises are usually a light pound or knock of much less intensity than main bearing knocks. The noise is usually evident with the engine idling and becomes louder when the engine speed is slightly increased. These noises should not be confused with piston or piston pin noises.

5-20 PISTON NOISES.
a. The most common piston noise is "slap" due to the piston rocking from side to side in the cylinder. Piston slap usually causes a hollow, muffled bell-like sound, or click. Slight piston noises that occur with a cold engine and disappear after the engine is warm, do not ordinarily warrant overhauling. Piston slap is most audible when running the engine at low speed. Piston ring noises generally cause a click, snap or sharp rattle on acceleration.

5-21 PISTON PIN NOISES.
a. The most common piston pin noise is the result of excessive piston pin clearance. This noise is characterized by a sharp, metallic double knock, generally audible with the engine idling.

5-22 VALVE AND TAPPET NOISES.

a. Noisy valve action has a characteristic clicking noise occurring usually at regular intervals. The frequency of valve noise is generally slower than other engine noises as the valve train runs at one half engine speed. If one or two of the valves or tappets are causing the trouble, the clicking will be intermittent. The most common cause of valve noise is excessive tappet clearance.

5-23 SPARK KNOCK AND FUEL KNOCK.

a. Included under this heading are pre-ignition and detonation. Pre-ignition is caused by an incandescent particle of carbon or metal in the combustion chamber, which fires the mixture prematurely while the piston is far from its best ignition position. Detonation on the other hand, is a difficulty that arises after normal ignition has occurred. Instead of the mixture burning in a progressive manner from the point of ignition, it burns part way in a desirable manner until the combustion pressure has reached a certain point and then the remainder of the charge burns with explosive violence causing a metallic ringing noise. Detonation is caused by fuel of insufficient octane rating or the ignition being set too early. Pre-ignition usually occurs along with engine overheating and sometimes causes the engine to run either forward or backwards after the ignition is shut off. Detonation is most noticeable when the engine is laboring or accelerating rapidly.

5-24 UNCOMMON ENGINE NOISES.

a. The following possible causes of engine noise are more rare, but should be considered and checked in locating foreign sounds.

b. Foreign object in the exhaust passages.

c. Loose exhaust pipe at manifold connection.

d. Loose engine accessory such as generator.

e. After extended use, the reverse gear may cause some difficulty from one or more of the following misadjustments. If the lever does not "snap" into the forward position with 160 lb force at the end of the 36 in. lever the reverse gear must be adjusted as mentioned in paragraph 7-32 through 7-34. If the reverse gear will not remain in the reverse position it is probably caused by wear in the brake toggle linkage. This can only be cured by replacing the parts as outlined in applicable Air Force and Navy handbooks. A noise may originate from the reverse gear brake band becoming excessively loose. This can be remedied by adjustment of the brake band locating screw and the brake band balance adjusting stud as mentioned in paragraph 7-32 through 7-34.

SERVICE INSPECTION AND ASSOCIATED MAINTENANCE

6-1 GENERAL. The work outlined in this section is a normal function of the operating organizations. It consists of the periodic inspection, cleaning, servicing, lubricating, adjusting and such maintenance work as is associated with the routine inspection system.

6-2 CLEANLINESS. Cleanliness must be practiced in all work on the engine. This applies to tear-down as well as assembly. A very small quantity of dirt can quickly ruin a fine piece of equipment. Tools, benches, working space and clothing must be kept clean at all times.

6-3 TOOLS. The necessary tools for this work may be found listed in section VIII.

6-4 INSPECTION BEFORE STARTING.

6-5 FUEL LEAKS. See that there is no fuel dripping or collected around the engine or in the bilge. If there is, carefully ventilate the engine compartment and remove all collected vapor and fuel. Locate and correct the source of fuel leakage.

WARNING

Always keep a serviceable fire extinguisher within reach of the engines at all times.

6-6 OIL LEVEL. Check the crankcase oil level and see that it is up to the "FULL" mark on the hand scavenge pump barrel. Oil is added to the crankcase thru the hole at the front of the engine where the oil level gage and scavenge pump fits. Refer to figure 6-5.

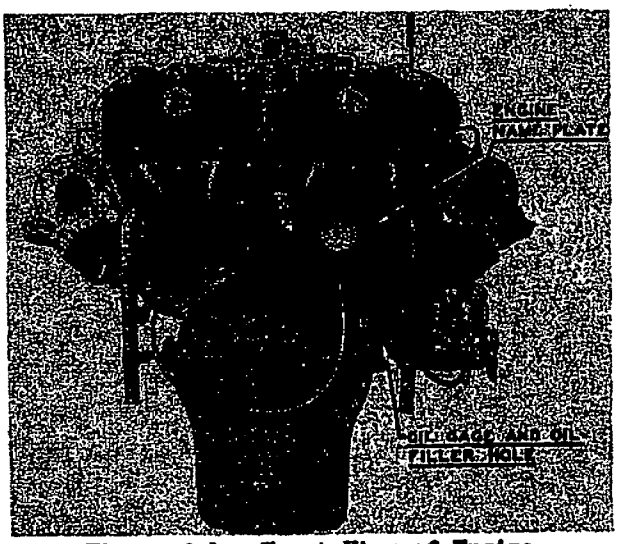


Figure 6-1. Front View of Engine

The oil level must be checked when the boat is on an even keel. If necessary, add oil to bring the level up to the "FULL" mark.

6-7 OIL CHANGE. Change the oil in the engine after every 100 hours of running. In making an oil change, scavenge the crankcase sump thoroughly. Remove the drain plugs from the bottom of the filter shells. Then remove the filter shells and replace the filter elements. Always use new gaskets when replacing the filter shells. Use oil that meets specification mentioned in paragraph 3-35. Use quantity specified in paragraph 3-37. Refer to paragraph 6-23 for adding oil while under way.

6-8 BATTERY. See that all storage battery connections are clean and tight. Add water to the battery as found necessary. Use only clean, salt free water. Inspect the battery for condition of the charge in each cell.

6-9 FUEL FILTER. Drain the fuel filter of any water and sediment that may have collected. During operation turn the fuel filter handle one turn for every two hours of operation. This will clear the filter edges of any accumulated dirt.

6-10 LEAKS. Inspect the engine for any signs of oil or water leaks. Correct any leaks found.

6-11 WATER PUMPS. Examine the water pump packing nuts to see that they are not leaking. If a leak is detected, remove the locking device and tighten the nut just sufficient to stop the leak. Excessive tightness will only result in a scored pump shaft. Replace locks on the packing nuts. Tighten packing nuts only when the engine is not running. Turn down the grease cups on the water pump. One turn of the cup is sufficient for 12 hours of running. Refill grease cups when necessary using grease of soda or soda-alumina base and water repellant. The grease must be of 177°C (350°F) melting point. Refill oil cup with oil that meets specification VV-L-761 (Symbol GO) SAE 90.

6-12 BILGE PUMP. Examine the bilge pump to see that it is fastened securely to the sprocket housing. Any leaks that are detected around the pump packing nuts must be stopped by either tightening the nut or repacking the pump. Tighten just sufficient to stop a leak. Excessive tightness will only result in a scored shaft. See that the grease cup is turned down occasionally depending on how often the pump is used. Use grease of soda or soda-alumina base and water repellant. The grease must be of 177°C (350°F) melting point. Add a drop or two of oil to cup provided. Oil must meet specification AN-O-6 (Symbol OGP).

6-13 SPARK PLUGS. Inspect all spark plug and distributor wire connections. Make sure they are clean and tight. See paragraph 6-24 through 6-25 for operating inspection of spark plugs.

6-14 DISTRIBUTOR. Lubricate the distributor in accordance with the applicable Air Force and Navy handbooks. Turn down the grease cups on the distributor drive. When necessary refill cups with grease per specification AN-G-25 (Symbol CLT).

6-15 GENERATOR. Turn the grease cups down 1/4 turn for every 12 hours of operating time. Refill the grease cups when necessary, using grease according to specification AN-G-25 (Symbol CLT). See that all electrical connections are tight. Remove the generator brush cover band and inspect the commutator and

brushes. The commutator must be kept clean and the brushes must be replaced when they are worn down to 1/2 of their original length. Use a new brush as a comparison to determine their original length. Examine the generator belts for tension and general condition. The belts must be only tight enough to drive the generator. Any excess tension is hard on the drive, generator bearings and the drive belts. Any belts that are frayed or cracked must be replaced. Refer to paragraph 7-52 for replacing generator belts. Refer to the applicable Air Force and Navy handbooks for details on servicing the generator.

6-16 STARTER. Put two drops of oil per specification AN-O-6 (Symbol OGP) in the oil cup at the rear end of the starter. See that the oil level in the starter drive housing is at least up to the lower of the two 1/8 in. pipe plugs in the drive housing cover. If not fill with SAE #90 oil that meets specification VV-L-761 (Symbol GO). Refer to figure 2-24.

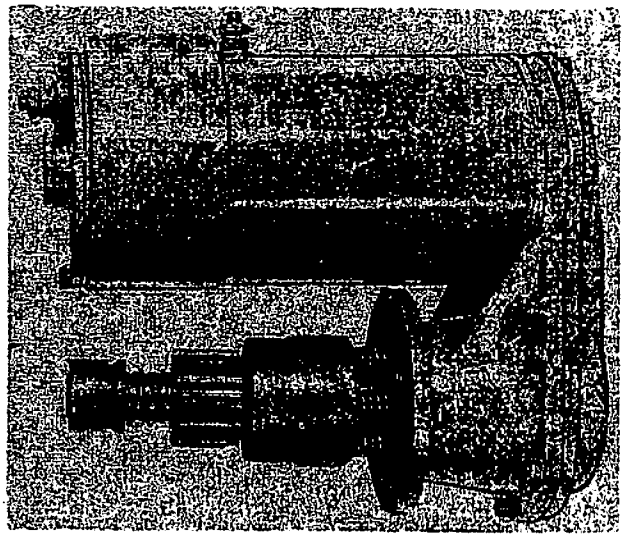


Figure 6-2. Starter

Remove the commutator end cover band and see that the commutator is clean and that the brushes are not worn down to less than 1/2 of their original length. Use a new brush to determine the extent of wear to the old brushes. Refer to applicable Air Force and Navy handbooks for method of replacing starting motor brushes. See that all electrical connections are clean and tight. Refer to applicable Air Force and Navy handbooks for detailed service instructions on the starting motor.

6-17 REVERSE GEAR. Shift the reverse gear lever into the "Ahead" position. It should snap into this position with 160 lb force at the end of the 36 in. lever. If it does not go "in" with a definite snap, adjust the reverse gear according to paragraph 7-32. Then shift the operating lever into the "Reverse" position. It should go into this position with considerably less force than into the "Ahead" position, but it must go "in" with sufficient force to stay "put" while the boat is being reversed. If the reverse needs adjusting refer to paragraph 7-31 through 7-34.

6-18 ENGINE CONTROLS. Inspect all engine controls to see that they move freely and thru a sufficient distance to provide a full range at the engine. Examine for any loose connections. Correct any troubles found. Lubricate the joints and bearings in the controls with oil per specification AN-O-6 (Symbol OGP).

6-19 FUEL SUPPLY. Inspect the fuel supply to make certain it is sufficient for the intended operation. Whenever adding fuel make certain it is of the proper grade as specified in paragraph 3-32.

6-20 OPERATING INSPECTION.

6-21 OIL PRESSURE. Just as soon as an engine is started, watch the oil pressure gage to find out immediately if the oil pressure starts to rise. If not shut the engine off promptly as great damage may be done if the engine is allowed to run without oil pressure. Lack of oil may be caused by any one or more of the following:

a. Oil supply low.
b. Dirt under by-pass valve.
c. Oil is thin and needs changing.
d. There is a leak in one of the oil lines.
e. The oil pump cover gasket is leaking.
f. The oil pump is not functioning properly.

6-22 WATER CIRCULATION. If the oil circulation is functioning as mentioned in paragraph 6-21 next investigate the engine water circulation when the engine is first started up. This is done in two steps. First look at the discharge line overboard to see if water is coming out. If not, shut the engine off until the trouble can be corrected. If the outboard line is discharging water then lay your hand on each exhaust manifold to determine their relative temperature. A hot exhaust manifold is an indication of defective water circulation on that side where the hot manifold occurs. Stop the engine if the cooling water is not circulating correctly. Frequently such circulation troubles arise from valves being closed or the water pump having lost its prime. The pumps may be primed by adding water to the filler hole at the end of the intake manifold.

6-23 ADDING OIL TO CRANKCASE WHILE UNDERWAY. When the oil level has been adjusted as mentioned in paragraph 6-6, and the engine started up, the level registered on the level gage will go down. The faster the engine is run, the lower will be the level until at full speed the level may have fallen two or three inches. This is due to the fact that, the faster the engine is run, the more oil there is in circulation, and therefore the less there is in reserve in the sump. Furthermore, this drop in level varies slightly with individual engines, and also with different installation angles, which explains why it is difficult to place any mark on the level gage indicating the proper "full" level when the engine is running. However, it is an excellent practice for the engineer to familiarize himself with this drop of oil level at various engine speeds, and even to mark them himself on the level gage. The engine should never be run with the oil below the lower mark "lowest safe level (engine running)". Because the oil level goes down as the speed increases, particular care should be taken to check the oil level when running at or near full speed.

An engine showing a level one inch above the lower mark at slow speed might be dangerously short of oil when put on full speed. If the engineer has, as suggested above, familiarized himself with the "full" level at various speeds, he will know approximately to what level he can replenish the engine when under way, without risk of over-filling it, thus saving himself the trouble of having to make more frequent additions of smaller amounts of oil. If he is uncertain on this point, his best plan is to put in two or three gallons whenever the level gets near the lower mark. It is always desirable to run the engine for a few minutes at idling speed before switching off. One reason for this is that it gives time for the excess oil that is in circulation at higher speeds to be returned to the sump by the scavenge pumps, thus enabling the level gage to give a true indication of the amount of oil in the engine.

6-24 IGNITION CHECK. As explained in paragraph 2-27 each distributor is connected so that it fires six spark plugs in each bank of cylinders. By proper manipulation of the ignition switches it is possible to get a quick check on misfiring and also on ignition timing. This is done by shutting off one distributor at a time and allowing the engine to idle on the other distributor. This leaves one spark plug operating in each of the 12 cylinders. With the engine idling in this manner, listen to the engine exhaust to detect any misfiring. If there is an uneven beat to the exhaust indicating misfiring, then on the "live" distributor remove one spark plug wire at a time from the distributor cap. Remove and replace all the distributor wires in turn this way, all the while listening to the engine exhaust until the defective plug or plugs are located. Do not disconnect more than one wire at a time and be careful to disconnect the wire from the distributor and not from the spark plug. Correct the defective spark plugs by cleaning, regapping, or replacing. Refer to paragraph 3-15 for the proper spark plug gap. Then repeat the process for the other distributor going through the same series of operations as explained before. When all spark plugs are firing properly make the following check. With the boat under way at full throttle, switch out one distributor at a time while allowing the engine to operate on the other. If the engine drops off more than 30 rpm under these conditions it is an indication that the ignition timing is too late. If the engine picks up more than 30 rpm it is an indication that the ignition timing is too early. Try this on each distributor and then correct any error in timing discovered. The ignition timing procedure is discussed in paragraph 7-4 through 7-17.

6-25 DETONATION. If the engine detonates at any time during its operating range, corrective measures must be taken as this is hard on the engine. Detonation most commonly comes from two sources. Either the ignition timing is too far advanced or the fuel is of insufficient octane rating. If the proper grade of fuel is unavailable one of two steps must be taken. Either operate the engine at speeds where it does not detonate or retard the ignition timing until detonation stops.

6-26 OIL PRESSURE ADJUSTMENT. When the oil pumps and pressure regulating valve are working correctly the oil pressure will be between 60 and 70 lb per square inch at 66 to 70°C (150 to 160°F) oil temperature and 1600 engine rpm. Carefully adjust the oil pressure regulating valve until the oil pressure is correct. The oil pressure regulating valve is located between the cylinder banks at the front of the engine. To adjust, remove the large hexagon cap and turn the adjusting screw in or out until the correct pressure is obtained. Always replace the cap and screw it down tight after the oil pressure is adjusted. Be sure the cap gasket is in place.

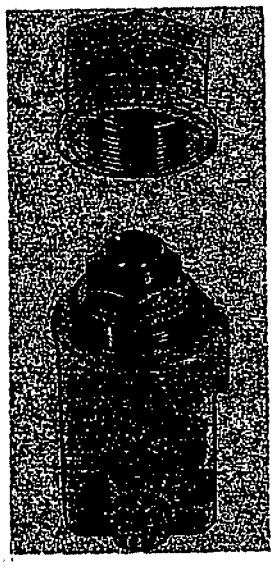


Figure 6-3. Oil Pressure Regulating Valve

6-27 CARBURETOR. The fuel inlet to the carburetor must be taken off occasionally and the screen cleaned. Be careful in replacing this inlet connection so as not to throw a strain on the connection. After this connection has been reassembled, check to see that it is tight and no gasoline escapes either when the engine is running or stopped. The idle adjusting screw is properly adjusted when it is from 1/2 to 3/4 of a turn off its seat. With the engine running, the final idle adjustment can be made on one carburetor, the other two being left alone. Refer to War Department Technical Manual #TM9-1826C Ordnance Maintenance Carburetors (Zenith) Chapter 9 for details on servicing the carburetor.

6-28 MULTIPLE SHIELD. Examine the multiple shield assembly to see that all electrical connections are clean and tight.

6-29 INSTRUMENT CHECK. Each time the engine is started up carefully inspect all the indicating gages to make certain they are all working correctly. Often times impending trouble can first be detected by carefully watching the instruments. A flickering ammeter is an indication of sticking or burnt points in the apparatus box.

6-30 FUEL PRESSURE ADJUSTMENT. The fuel pressure regulating valve is on the front of the engine on the left hand side. This valve is adjusted by removing the acorn type nut from the bottom of the assembly and then turn the exposed

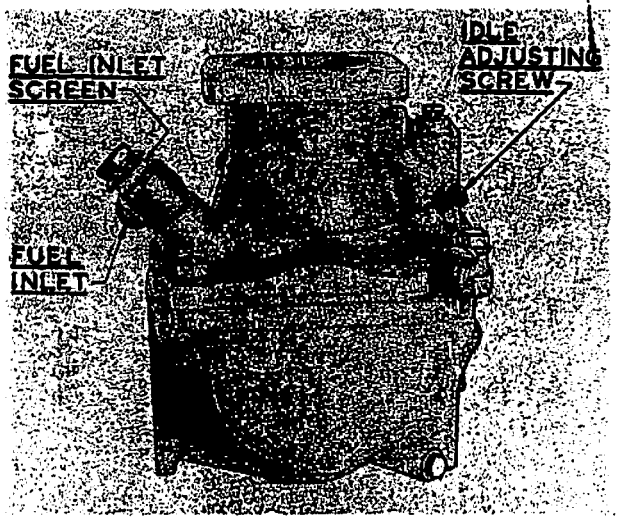


Figure 6-4. Carburetor

adjusting screw until 5 pounds per square inch fuel pressure is maintained at both idle or full throttle. Watch the fuel pressure gage on the instrument panel. Be sure to replace the adjusting screw cap after the adjustment has been completed. See that no fuel leaks occur.

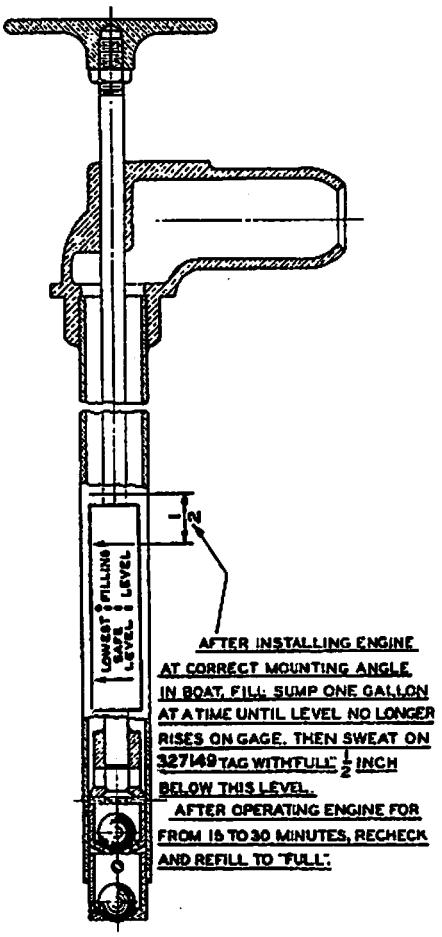


Figure 6-5. Hand Scavenge Pump and Oil Level Gage

7-1 GENERAL. The work outlined in this section can be performed without the facilities usually available at major overhaul activities.

7-2 TOOLS. The necessary tools for this work may be found listed in section VIII.

DISTRIBUTOR

7-3 IGNITION TIMING DISTRIBUTOR. The ignition distributor is serviced by removing the distributor cap. This is done by unscrewing the four high hexagon cap screws that project down from the base of the distributor. Refer to figure 7-1. Do not disturb the two fillister head screws that are conspicuous on the top flange of the cap. Set the cap aside and proceed to service the distributor points, rotor

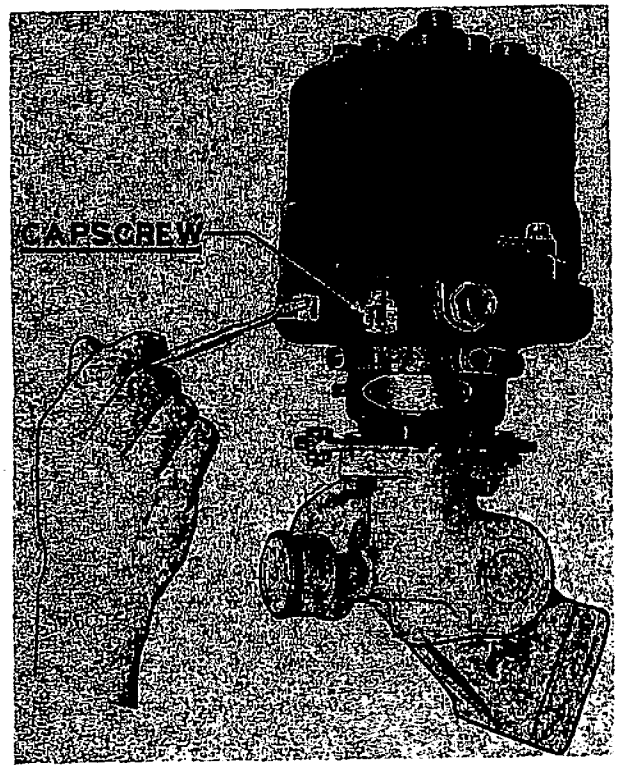


Figure 7-1. Removing Distributor Cap

and cap as explained in applicable Air Force and Navy handbooks.

7-4 IGNITION TIMING. After the distributor has been serviced as outlined in paragraph 7-3 it is timed to the engine as follows: Ignition timing can only be done after the valve timing has first been set as explained in paragraphs 7-20 through 7-29.

7-5 IGNITION TIMING MODEL 2268. To set the timing on a right hand engine (Model 2268) the following steps are necessary.

7-6 POSITION THE CRANKSHAFT. Remove the timing inspection cover plate from the front of the flywheel housing. Remove the exhaust side spark plug from the number one cylinder in the left hand bank. Do not forget the "hand" of the cylinder banks are determined as one stands at the rear of the engine and faces forward. Turn the engine over by hand in its normal running direction until the number one piston in the left hand bank starts to come up on its compression stroke. This can be determined by blocking the spark plug hole with the thumb and if air is forced out as the piston comes up then it is on its compression stroke. Of course, it is necessary to set the valve timing before the ignition timing is made. Refer to paragraph 7-20 through 7-29. When number one

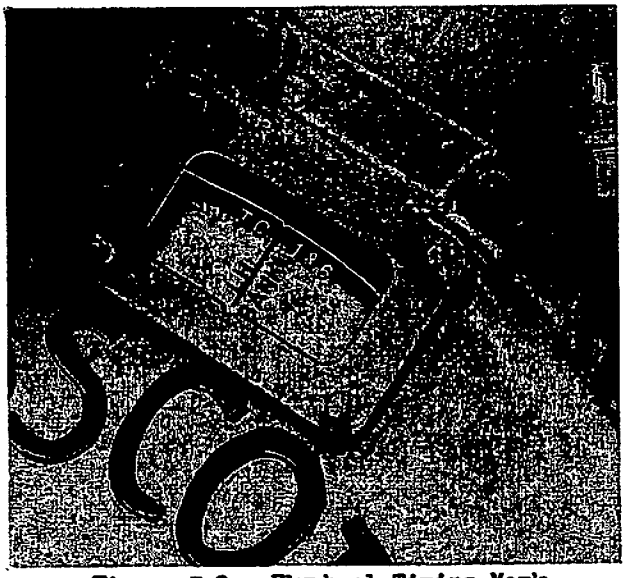


Figure 7-2. Flywheel Timing Mark

left hand piston is on its compression stroke continue rotating the engine in its normal running direction until the flywheel mark "T.C. 1 & 6 L.H. BANK" is directly in line with the notch in the flywheel housing inspection hole.

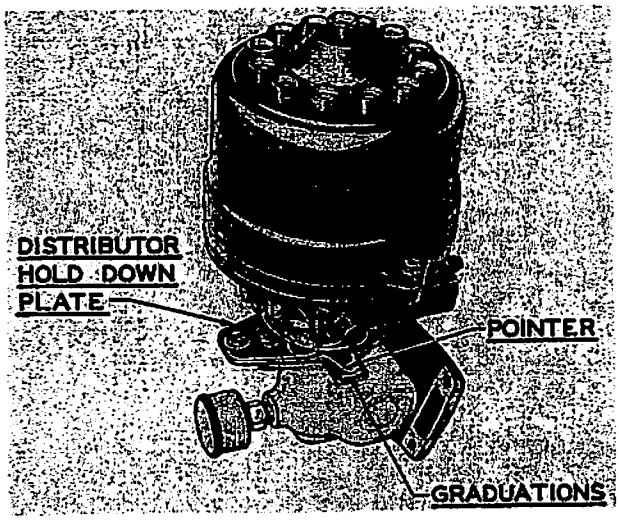


Figure 7-3. Distributor Hold Down Plate and Graduations

7-7 POSITION DISTRIBUTOR. Now loosen the two 1/4 in. cap screws in the distributor hold down plate and rotate both distributors until the pointer is located in the center of the graduation as shown in figure 7-3.

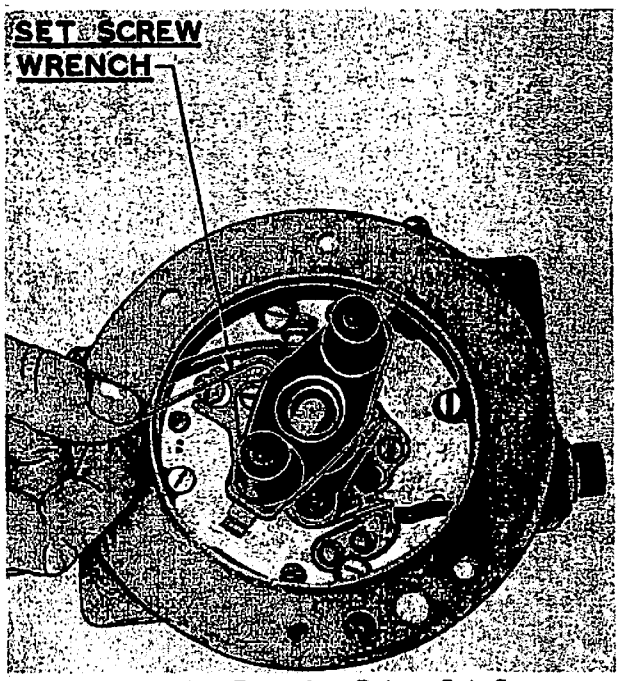


Figure 7-4. Removing Rotor Set Screw

7-8 OPEN DISTRIBUTOR. Remove the caps from both distributors as explained in paragraph 7-3. Lift the lock wire from around the rotor base carefully so as not to bend or break it. Unscrew the hollow head set screw from the base of the rotor by three turns. Do not take this screw completely out as it may be lost. Now carefully lift the rotor from the distributor cam. In some cases it may be necessary to pry the rotor up off the cam, but do so carefully so as not to damage either the rotor or the distributor cam. Loosen the cam by backing out the lock-screw from the center of the cam. This screw is made in such a way that it will pull the cam from the shaft if it is backed out. After the cam is drawn out far enough so it can be freely rotated on its shaft, turn the lock screw down until the cam just starts to drag on the shaft, but still can be turned. This is done to both distributors.

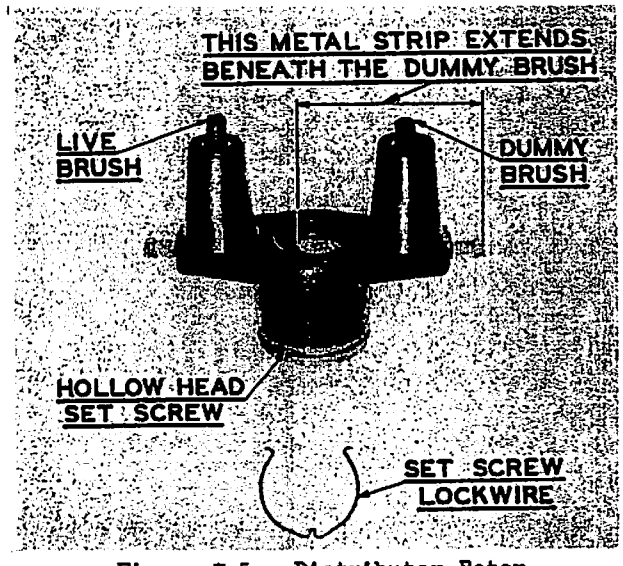


Figure 7-5. Distributor Rotor

7-9 BREAKER POINTS. These distributors are each fitted with two sets of breaker points. One is known as the "fixed" points as they are not adjustable in angular position with respect to the distributor base. The other set is known as the "moveable" points as they are adjustable in angular position with respect to the distributor base.

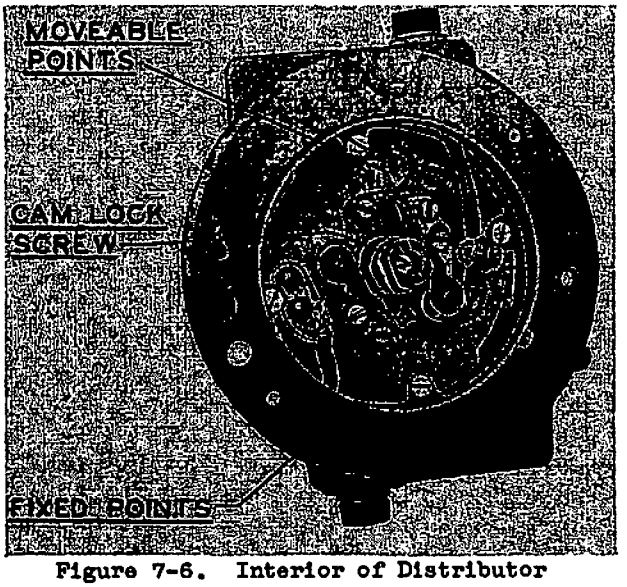


Figure 7-6. Interior of Distributor

7-10 BREAKER POINT GAP. Adjust all the distributor breaker point gaps to the figure shown in paragraph 3-14. (This operation may have been done under instruction in paragraph 7-3). This gap is measured when the breaker arm brush is resting on a high point of the cam. For best results all four distributor point sets (both distributors) must be adjusted to as near the same gap as possible.

7-11 POSITION ROTOR. Place the distributor rotor back on the distributor cam so that it properly engages the flat on the side of the cam. Do not push the rotor clear down as it has to be withdrawn presently. Now turn the rotor opposite to its normal running direction, that is, turn it counterclockwise as you look down on it, until the rotor is positioned with respect to the cap locator dowel as shown in figure 7-7. Note the relative position of the metal strip in the rotor that extends under one of the brush towers and out to the end of the rotor. This is of vital importance as one of the rotor brushes is "alive" and one is a "dummy" for balancing purposes only. The embedded metal strip that extends from the center of the rotor to the tip of the rotor passes beneath the dummy brush tower. With the rotor in the relative position shown in figure

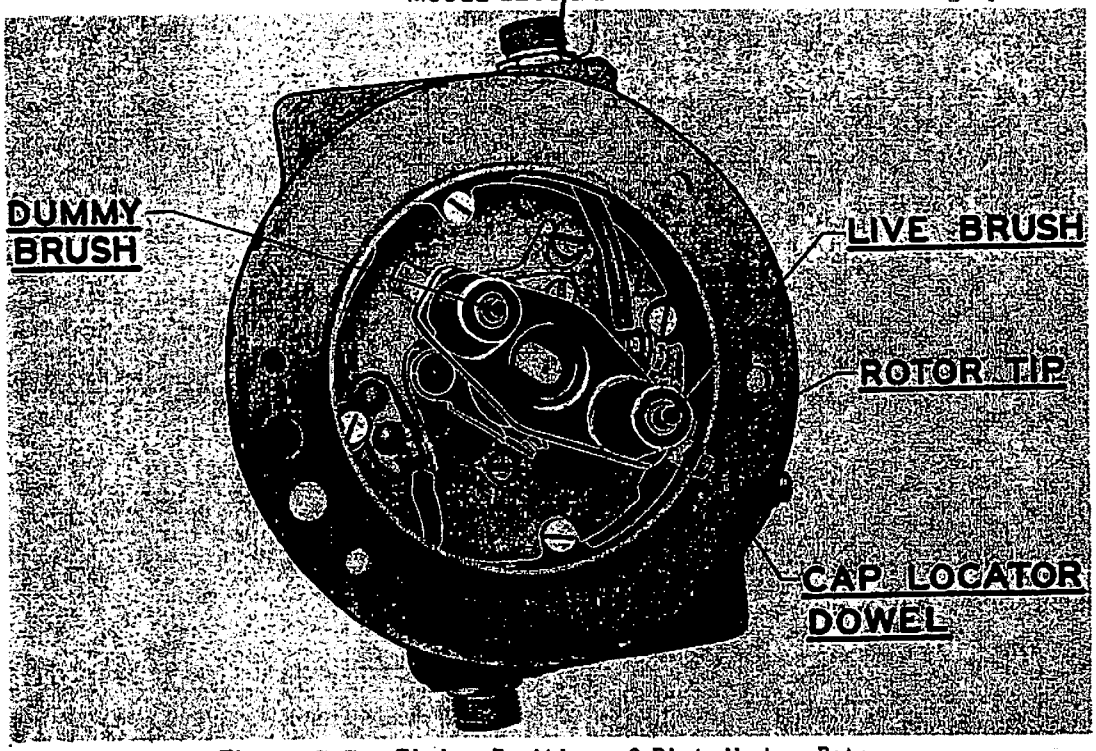


Figure 7-7. Timing Position of Distributor Rotor

7-7 continue to turn the rotor counterclockwise as you look down on it, until the fixed distributor points just close. Make this same adjustment to both distributors. Bear in mind that this is the position where the points would be just opening were the distributor to be turned in its normal running direction. This point of just opening or closing, as the case may be, can be determined thru the use of an electric light as explained in paragraph 7-15. This same treatment applies to both the left hand as well as the right hand distributor. They are both turned counterclockwise for the timing operation. They are turned opposite to their normal running direction so as to take all the backlash out of the drive. This is important. Now carefully pull the rotor from the cam without altering the cam position and tighten down the lock screw in the center of the cam, both distributors.

CAUTION

Be sure the cam is down as far as it will go on the shaft, otherwise the rotor may be raised so high as to damage the distributor cap when the engine is started.

7-12 ADJUSTING MOVEABLE BREAKER POINTS. Rotate the crankshaft in its normal running direction 60 degrees until the mark "T.C. 1 & 6 R.H. BANK" is directly in line with the notch in the flywheel housing. This 60 degree location is most important so be careful to see that the flywheel marks come exactly opposite the timing notch in the flywheel housing inspection hole. The moveable breaker points in the distributors are now swung around by use of the eccentric screw until they are just beginning to open. Securely lock the moveable points in this position, both distributors.

7-13 REASSEMBLE. Coat the distributor cam with a light coat of petrolatum and one drop of oil on hinge pins as mentioned in paragraph 6-14. Set the rotor back in place and see that it is firmly seated. Tighten hollow head set screw and fit spring lock wire.

7-14 COIL CONNECTION. The ignition timing cannot be considered complete until a check is made to see that the distributor points are properly connected to the ignition coils. As mentioned in paragraph 7-11, the fixed distributor points must be connected to the ignition coil so

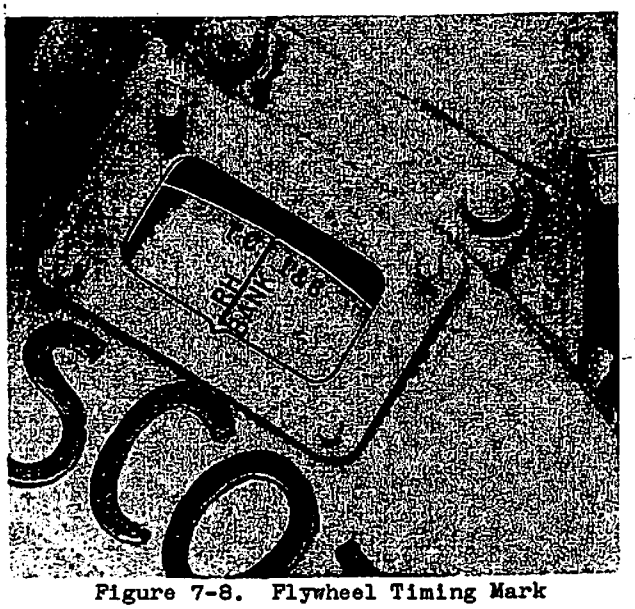


Figure 7-8. Flywheel Timing Mark

that they fire through the "live" brush of the distributor rotor and through the off center connection in the distributor cap. The moveable distributor points must fire through the center contact of the distributor rotor and cap. These connections can be verified by tracing the connecting wires. The ignition coils are located in the multiple shield boxes directly under the secondary connections to the boxes.

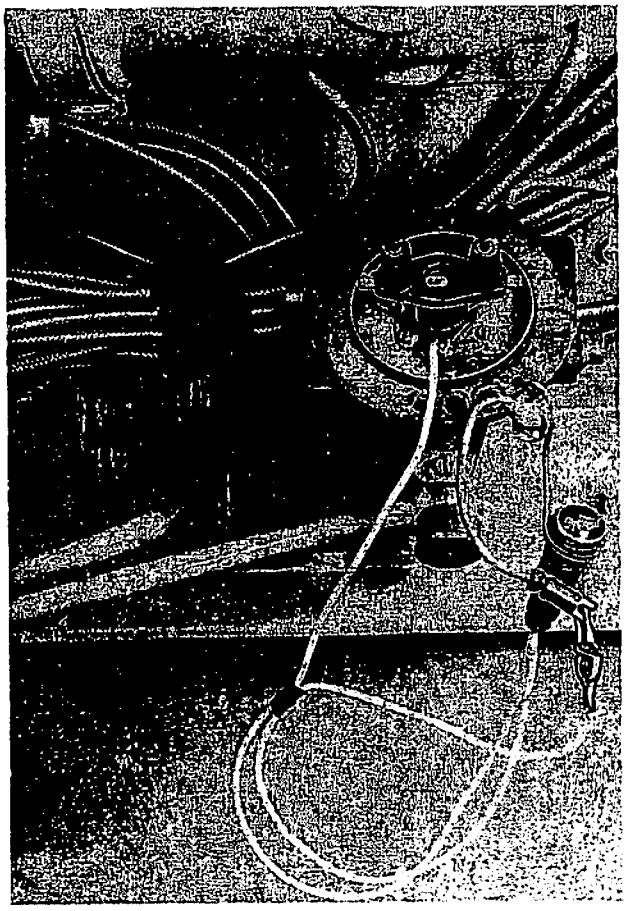


Figure 7-9. Timing Light on Distributor Points

7-15 TIMING WITH AN INDICATING LIGHT. It is possible to very accurately determine when the breaker points are just opening or just closing by connecting a 24 volt light in series with the breaker point set under consideration. With the ignition switch "on" the lamp will glow when the points are closed and go out when the points are open. When a slight pressure one way or the other, on the breaker arm, will either light or extinguish the lamp one can be certain that the points are at the correct position for timing as mentioned in paragraph 7-11.

7-16 IGNITION TIMING, MODEL 2269. To set the ignition timing on a left hand engine (Model 2269) the same procedure is followed as outlined in paragraphs 7-4 through 7-14 with the following exceptions:

a. In paragraph 7-6 remove the exhaust side spark plug from number one cylinder in the right hand bank and rotate the crankshaft until this cylinder is on its compression stroke and the flywheel mark "T.C. 1 & 6 R.H. BANK" comes directly opposite the notch in the flywheel housing inspection hole as shown in figure 7-8.

b. In paragraph 7-12 rotate the flywheel in its normal running direction 60 degrees until the mark "T.C. 1 & 6 L.H. BANK" is directly in line with the notch in the flywheel inspection hole as shown in figure 7-2.

7-17 OPERATING CHECK ON IGNITION TIMING. As a final ignition timing check operate the engine as explained in paragraph 6-24 and 6-25.

7-18 VALVE TAPPET ADJUSTMENT. The valve tappets are adjusted when the engine is at normal operating temperature by removing the rockerarm covers. This will leave the tappet adjusting screws and lock nuts out in the open where they can be easily adjusted. The engine must be rotated until the cams are in a position such that the rockerarm does not rest on the cam "ramp". It is best to rotate the engine until the point of the cams point down away from the rockerarm shaft for the particular cylinder on which the valve tappets are to be adjusted. Loosen the tappet lock nut and with a screw driver turn the tappet screw until the correct clearance is obtained. See paragraph 3-26 and 3-27. Use a feeler gage to set the clearance. Turn the lock nut down tight and again check clearance. It may take several attempts before the clearance comes correct after the locknut is tight. Go over all the valve tappets in this manner making sure the rockerarm shoe is not riding on the cam "ramp" when the adjustment is made.

7-19 VALVE TIMING, MODEL 2268.

7-20 TAPPET ADJUSTMENT FOR TIMING. For valve timing it is necessary to set all the exhaust and intake valve tappet clearances to the figures mentioned in paragraph 3-26. In making this adjustment, be sure the rockerarm shoe is not against the cam "ramp". If the cam point is pointing directly away from the rockerarm shaft one can be certain the rockerarm shoe is not riding on the cam ramp.

7-21 ADJUST TIMING CHAIN. Set the two timing chains to the proper tension as explained in paragraph 7-30.

7-22 POSITION CAMSHAFT. Rotate the engine by hand in its normal direction of rotation while watching the number 6 exhaust valve in the leading bank. Refer to paragraph 1-18 for explanation of leading and trailing banks. When number 6 exhaust valve in the leading bank is just seated, loosen the 3/4 in. cap screw from the back face of the camshaft sprocket in the leading bank and knock or draw the sprocket off its driving taper. The sprocket may be knocked off by using a soft brass drift. It may be drawn off by using two 1/2-20 cap screws in the two tapped holes in the sprocket web. In any event, loosen the sprocket up enough so it will not turn the camshaft as the engine is rotated. The sprocket must, however, be left in a position so it slides on its taper bore and does not catch on the pedestal rest beneath it. It is comparatively simple to determine when the valves are closed as the valve collar may be turned slightly by hand so long as the valve is off its seat, but locks up tight just as soon as the valve comes against its seat. In making the camshaft setting mentioned above, it is con-

venient for one man to oscillate the number 6 exhaust valve collar in the leading bank while another man rotates the engine. As soon as it is impossible to oscillate the valve collar, the valve is seated. After the camshaft sprocket on the leading bank has been loosened up as explained above, continue turning the engine until number 1 exhaust valve in the trailing bank is just closed. Loosen up and drive the trailing bank camshaft sprocket from its driving taper as mentioned above.

7-23 POSITION CRANKSHAFT. Continue to turn the engine in its normal running direction until the flywheel mark "T.C. 1 & 6" leading bank shows in the timing inspection hole and then continue to rotate until the flywheel mark "EXH. CLOSES" comes directly opposite the notch in the timing inspection hole.

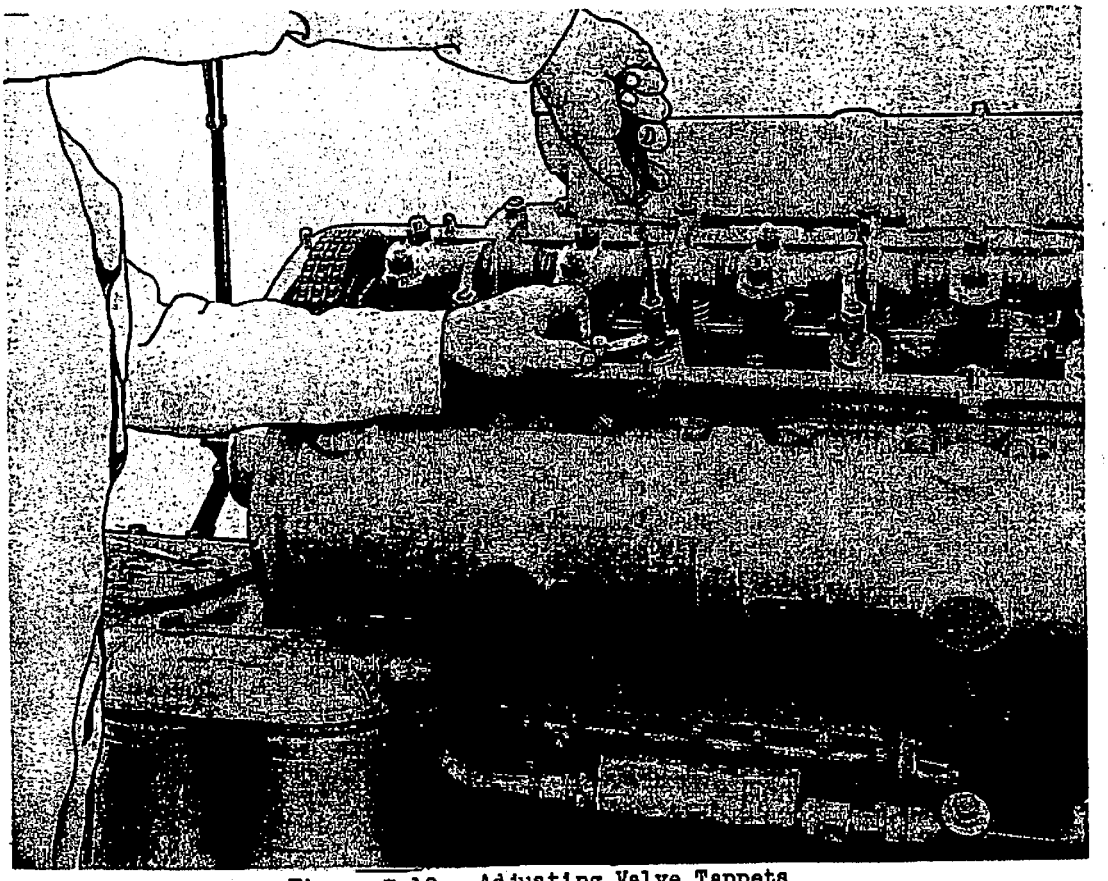


Figure 7-10. Adjusting Valve Tappets



Figure 7-11. Knocking Camshaft Sprocket Off Camshaft Taper

NOTE

There are two "EXH. CLOSES" marks on the flywheel. Only by carefully following the procedure outlined can one be certain of timing to the correct mark.

Now grasp the camshaft sprocket of the leading bank and rotate it in the opposite direction from its normal rotation. This takes all the slack out of the chain on the driving side. Then draw the sprocket on to its driving taper with the 3/4 in. cap screw. Again rotate the engine until the flywheel mark "T.C. 1 & 6" trailing bank comes into view in the timing inspection hole. Continue to rotate until the flywheel mark "EXH. CLOSES" comes directly opposite the notch in the timing inspection hole. Now grasp the camshaft sprocket of the trailing bank and rotate it as far as it will go in a direction opposite to its normal rotation and then draw it on to the camshaft taper with the 3/4 in. cap screw.

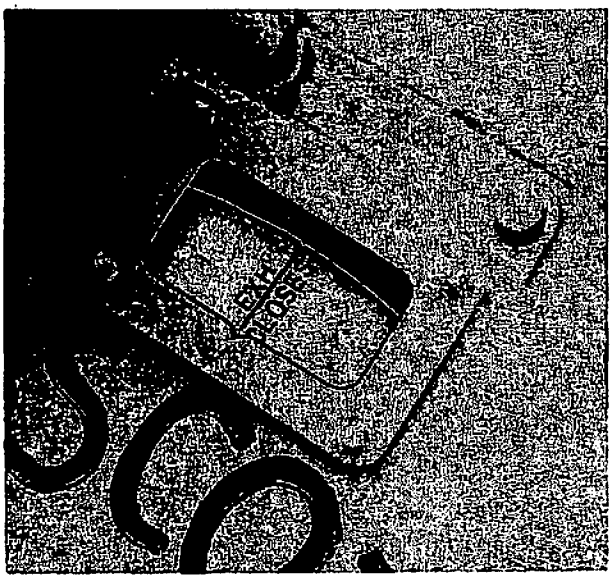


Figure 7-12. Flywheel Timing Mark

7-24 BALANCE VALVE TIMING. After the above routine has been followed, paragraph 7-20 through 7-23, it is necessary to check the exhaust valve timing of number 1 cylinder in the leading bank and number 6 cylinder in the leading bank against the flywheel timing marks. A difference will sometimes appear here because of wear in the camshaft, rockerarm shoe or rockerarm bushing. If a difference in valve timing appears between the two end cylinders of a bank it is necessary to split the difference in timing with relation to the flywheel. For example, if it is found that number 1 cylinder in the right hand bank is timed correctly on the flywheel mark, but number 6 cylinder in the right hand bank falls 1/2 in. late with respect to the flywheel mark, then it is necessary to retime until the number 1 cylinder is 1/4 in. early and number 6 cylinder is 1/4 in. late with respect to the flywheel timing mark. Of course, it is necessary to check both the camshafts in both heads in this respect.

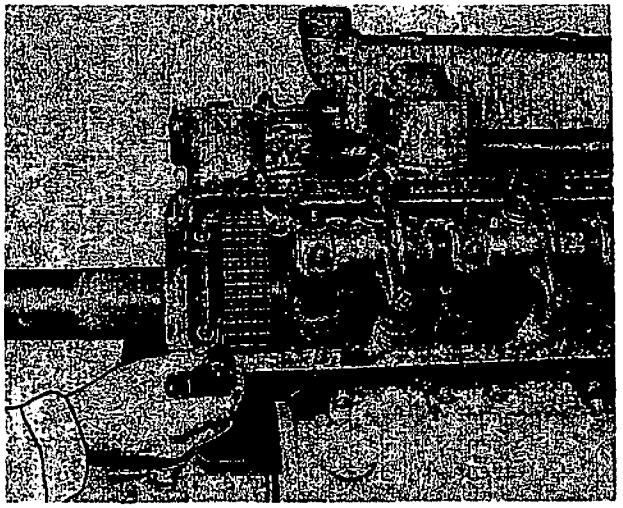


Figure 7-13. Checking Chain Tension

7-25 TRUE UP SPROCKETS. After the proper valve timing has been made it is necessary to see that the camshaft sprockets are running true. If there is found to be a "wobble" in the sprocket it can be corrected by striking the rim of the sprocket with a soft nosed mallet. Do not damage the chain or sprocket teeth. When the sprocket is adjusted on the camshaft so it runs true, tighten up the 3/4 in. cap screw until it is heard to "give" as it grips the camshaft.

7-26 ADJUST VALVE TAPPETS. After the valves are timed it is necessary to open up the exhaust valve tappet clearance to the value shown in paragraph 3-27.

7-27 CHECK IGNITION TIMING. After the valve timing is made it is necessary to check the ignition timing to make sure it is correct with relation to the valve timing. Refer to paragraphs 7-4 through 7-12.

7-28 VALVE TIMING, MODEL 2269.

7-29 The valve timing for Model 2269 is made in exactly the manner outlined in paragraphs 7-20 through 7-27. The reference to leading and trailing cylinder banks takes care of the difference in crankshaft rotation between the right hand and the left hand engine.

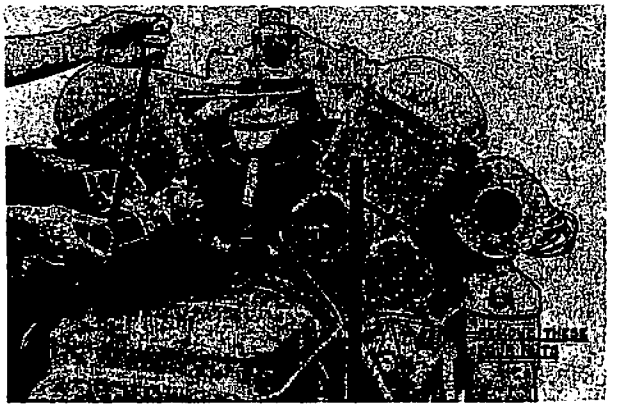


Figure 7-14. Adjusting Chain Take-Up

7-30 CHAIN TAKE-UP ADJUSTMENT. Whenever the accessory drive chains become loose they must be tightened up with the manual chain take-ups located in the rear wall of the sprocket housing. The chain tension is determined by removing both rockerarm covers. Then rotate the engine 1/2 turn in its normal running direction. Then with a 1/4 in. diameter steel rod or other convenient means, move the chain back and forth where it spans the gap between the camshaft sprocket and the chain take-up. If the chain can be moved 3/4 of an inch or more it must be adjusted. This is done by loosening six 3/8 in. nuts in the chain take-up clamp ring. Rotate the chain

take-up in the direction indicated by the arrow cast into the sprocket housing until the chain is taut. Scribe a mark on the clamp ring and support. Now back off the take-up 3/8 in. as measured by the distance between the scribe marks. This gives the chain operating slack. It is necessary to look behind the generator support tube in order to see the arrow cast into the sprocket housing on the left hand side.

7-31 REVERSE GEAR. Shift the reverse gear lever into the neutral position. Remove the flat cover plate from the upper reverse gear housing.

WARNING

Under no circumstances is it safe for anyone to feel around between the clutch engaging parts while the clutch is in the forward position. This unit (the three bell cranks, links, etc.) is easily tripped and might damage a persons hand.
While this cover plate is off be very careful not to drop parts into the opening, leave cloths in the assembly or allow dirt to fall into the opening.

With the cover off, visually examine the clutch engaging and reverse mechanism. Move the hand lever back and forth a few times and note the action of the mechanism. When the hand lever is engaged in the forward position the clutch engaging mechanism compresses the clutch discs and causes the entire unit to rotate solidly as a mass in "forward" and at crankshaft speed. When the hand lever is shifted into neutral (approximately vertical) the forward clutch is disengaged. During this operation the shifter spider "1" recedes unsnapping the toggle links "2" and bell cranks "3" allowing the drum "4" to recede. The engaging drum release is aided by the "quick release" springs "5" which are a part of the engaging drum assembly. The reverse band is free and the reverse gear main shaft "6" is neutral and free. When the hand lever is pulled back into reverse it causes the sliding link "7" to lock the brake toggle "8 and 9" mechanism, causing it to compress the bronze brake band "10" so it firmly grips the drum "4" and holds it from rotation. In fact, the entire bevel gear case and pinion spider are held stationary. This causes the bevel gears to function and drive the reverse gear shaft in the reverse direction at crankshaft speed, hence the one to one reverse ratio.

7-32 CLUTCH ADJUSTMENT. To tighten forward clutch, loosen clamp bolt nut on "11" clutch adjusting ring, then screw this ring (together with its three bellcranks, links and shifter spider) in for tightness or out for looseness. Test lever force and tighten clamp bolt nut and then try lever again. One hundred and sixty pounds at the end of a 36 inch lever is quite sufficient force to hold the clutch, with a considerable safety factor. It is unnecessary to set this clutch up any tighter than mentioned above as it will carry the load without excessive clutch pressure. Once properly adjusted, the clutch will function a long time without further attention.

NOTE

As soon as clutch slippage is noticeable, make above adjustment at once. Do not continue to operate a slipping clutch, as it will cause rapid wear, heating and warping of clutch discs.

7-33 REVERSE BAND. To tighten the reverse band "10", first loosen nut "12" and unscrew the balance adjusting stud "13" three or four turns. With lever in neutral, tighten brake and toggle nut "14", then try lever from neutral to reverse and get the "feel" of this adjustment. Repeat until the band firmly grips the drum "4". Due to the powerful action of this mechanism, ample reversing capacity is possible without excessive hand lever load. In "forward" position a clearance of not less than 1/64 in. should exist completely around the drum and brake band.

7-34 TORQUE REACTION SCREW. Turn the engine 1/4 turn in its running direction to gather all the slack on the trailing side of the reverse band. After the brake band has been properly tightened, and with the hand lever in "reverse" position, very carefully turn the balance adjusting screw "13" so it barely touches the brake band lug at "A". See figure 7-18.

CAUTION

Do not screw this stud down so far that it moves the lug or affects the radial position of the brake band on the drum. If this adjusting stud is down too far, the purpose of the torque-reaction stud will be destroyed, and only the top half of the brake band will bear down on the drum.

After the above adjustment has been effected, tighten locknut "12" without disturbing the position of the stud "13". This adjustment is important in that it causes the reverse reaction load to be assumed by the "13" screw instead of causing the "reaction" to spring the entire unit out of line. Carefully work the hand lever forward, neutral and reverse a few times and the reason for this provision will be readily appreciated. There should be approximately 1/16 in. clearance at "B" between "15" and brake band lug. Install or remove 1/16 thick washers until the adjustment is correct. This 1/16 in. clearance is measured by turning the screw down tight and then backing it off 1/16 in. Measure the clearance under the screw head and fit washers to fill this space.

7-35 DISTRIBUTOR REMOVAL. The distributor is removed from the engine by first removing the distributor cap as explained in paragraph 7-3. Remove the primary wires and shielding from the distributor base. Remove two 1/4 in. cap screws from each end of the distributor hold down plate and pull the distributor from its drive housing. Cover opening to keep out dirt. The distributor cap is removed from the engine by unscrewing all the shielding nuts and pulling the wires out of the cap. If the cap is to be returned to the same side on the same engine, it will save considerable time if the cap is marked with chalk or other suitable means to match the tags on the wires before they are removed.

7-36 INSTALLING THE DISTRIBUTOR. The distributor is fitted to the engine by lowering it into the distributor drive housing so that the

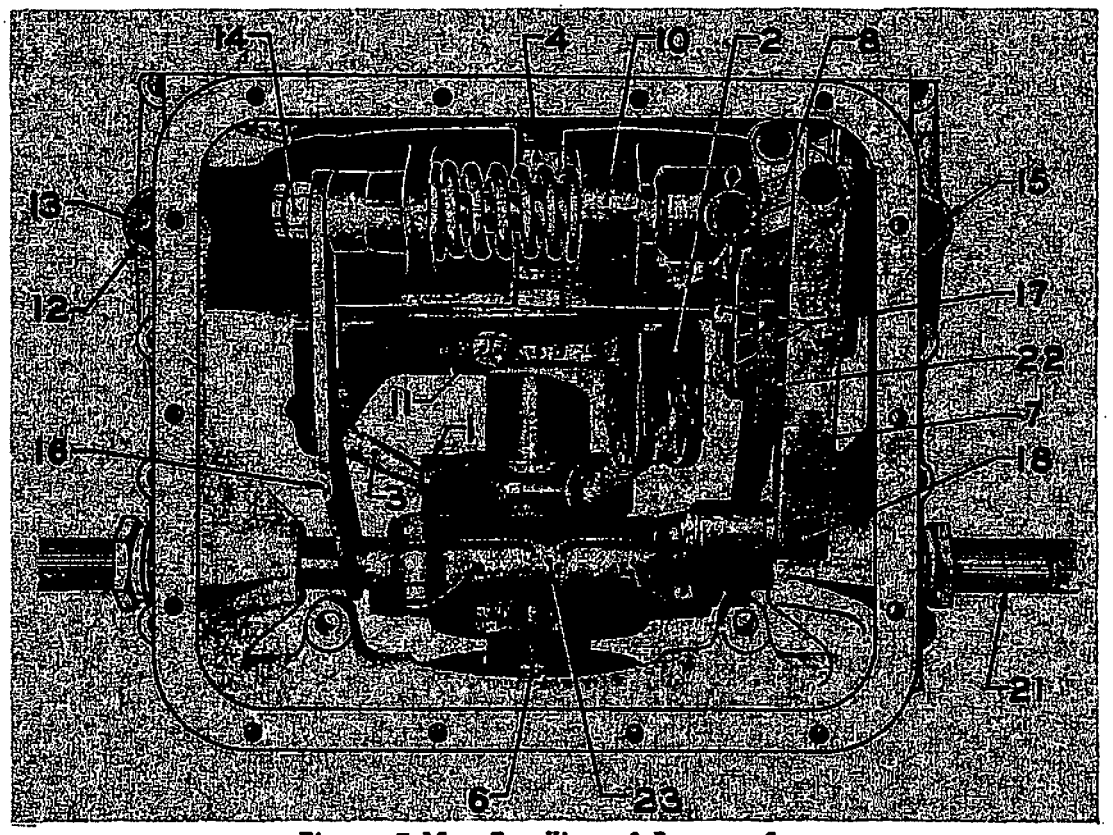


Figure 7-15. Top View of Reverse Gear

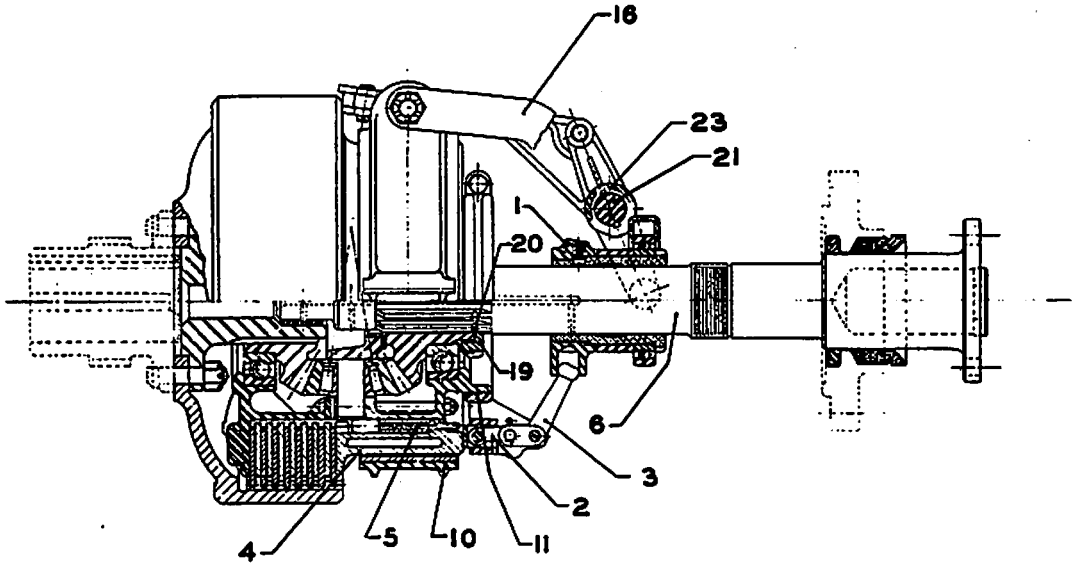


Figure 7-16. Sectional View of Reverse Gear

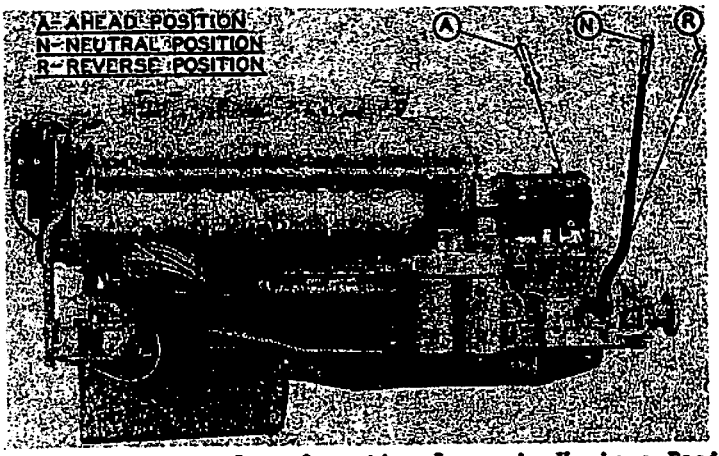


Figure 7-17. Reverse Gear Operating Lever in Various Positions

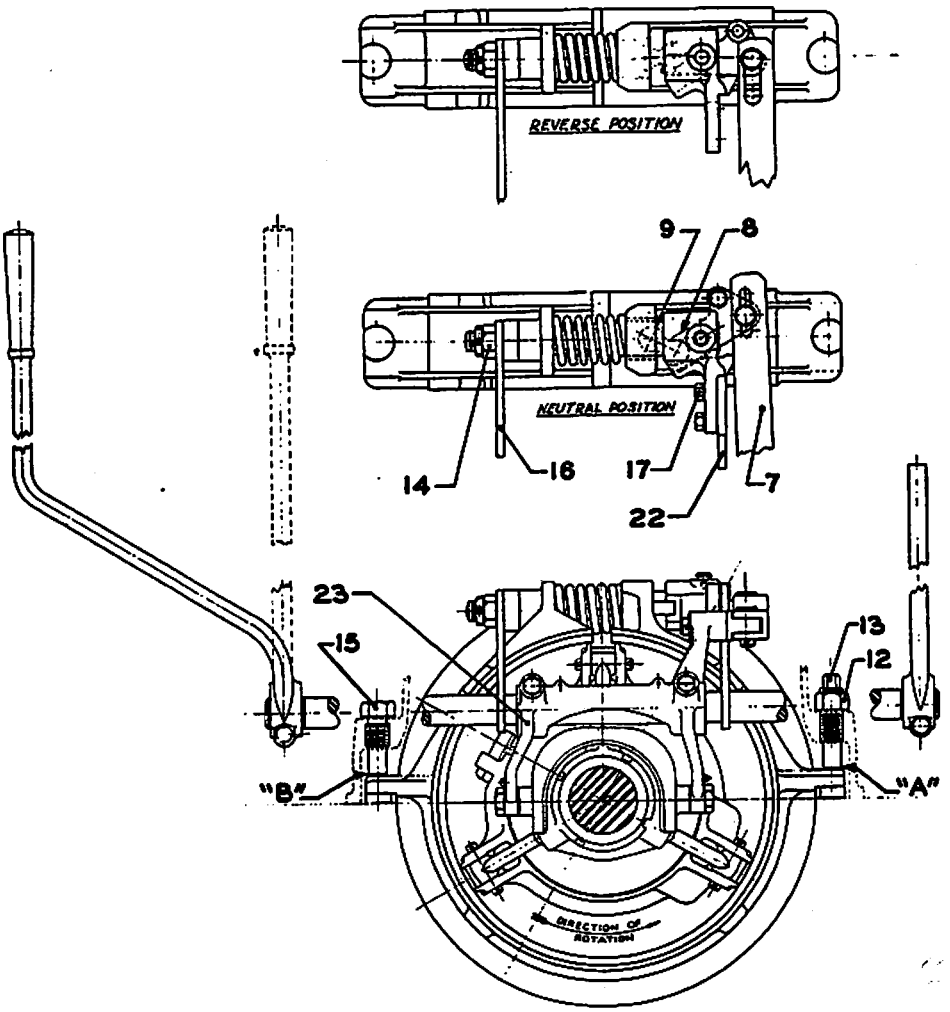


Figure 7-18. End and Top View of Reverse Gear

pointer on the distributor steel mounting plate comes on top of the graduation on the drive housing plate. See figure 7-3. Be sure to see that the drive housing is clean and is packed with grease per specification as mentioned in paragraph 6-14. Locate the pointer in the center of the graduation and secure with 1/4 in. cap screws. Proceed to time the distributor to the engine as outlined in paragraphs 7-4 through 7-16. The wire and shield connections are replaced in the distributor cap as per figure 3-1 and 3-2. The shield conduit is tagged for ease in identification. See that the distributor is lubricated.

7-37 DISTRIBUTOR DRIVE HOUSING REMOVAL. The distributor drive housing removal is made by first removing the distributor per paragraph 7-35. Then loosen and remove two 3/8 in. cap screws that hold the flexible coupling to the drive flange on the distributor drive shaft. Remove the overspeed governor from the right hand distributor drive housing. Now remove the four nuts and washers that fasten the distributor drive housing to the upper crankcase and lift the housing off the studs at the same time flexing the two flexible couplings. With a screw driver carefully pry the flexible coupling spools from the drive dog.

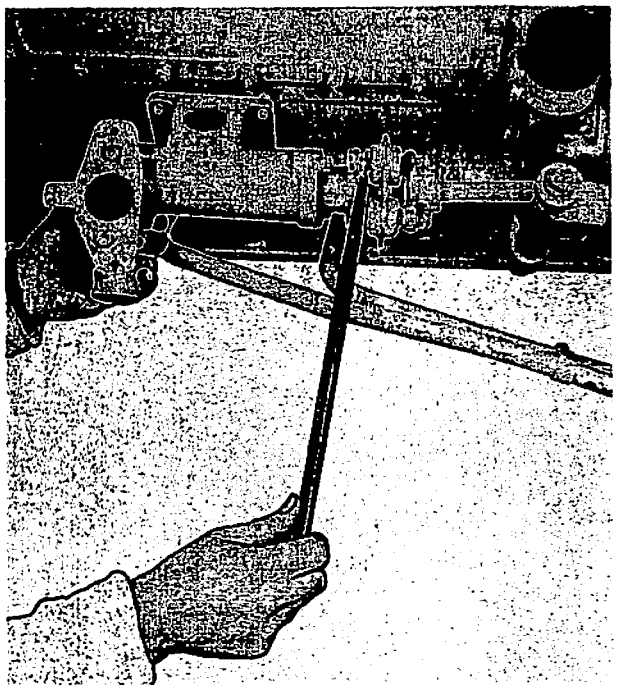


Figure 7-19. Loosening Flexible Coupling

7-38 INSTALLING THE DISTRIBUTOR DRIVE HOUSING. See that the mounting face of the distributor drive housing is smooth and clean. Also the mounting face on the upper crankcase must be smooth and clean. Fit the flexible coupling driving spools into the driving flange on the distributor drive shaft while fitting the housing into place on its mounting studs. Fit the four nuts and washers. Draw the flexible coupling spools into place with the coupling bolts and nuts. Be careful to see that they enter the counterbore squarely. Pull them down until they seat firmly against the shoulder provided. See that the distributor drive is lubricated before it is put in service as mentioned in paragraph 6-14. Fit the overspeed governor drive to the right hand drive housing.

7-39 WATER PUMP REMOVAL. Remove two of the 3/8 in. bolts from the flexible couplings and pry the spools loose from the driving dog on the distributor drive housing shaft. Swing the distributor floating shaft away from the engine and pry it loose at the other end also. Remove the water connections from the bottom of the water pump and allow the water to drain into the bilge. Remove the water connection from the outlet side of the pump. It is best to disconnect and remove the connection between the water pump and oil cooler. Next remove the four 3/8 in. cap screws and move the pump forward, pulling the water pump drive shaft out of the sprocket housing. It is not necessary to remove the bearing retainer plate from the side of the sprocket housing in order to remove the water pump.

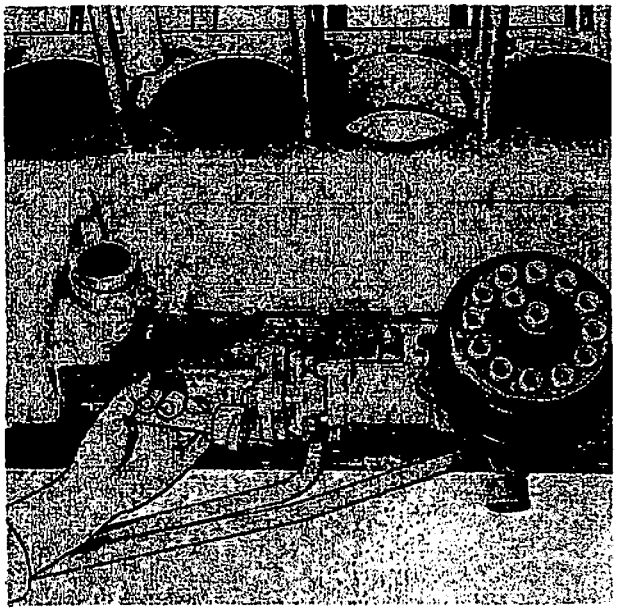


Figure 7-20. Removing Distributor Floating Shaft

7-40 INSTALLING WATER PUMP. See that the mounting face of both the water pump and upper crankcase are clean and smooth. Carefully enter the splined end of the water pump drive shaft into the bearing retainer plate on the sprocket housing so as not to damage the oil retainer. It may be necessary to rotate the shaft slightly to make the mating splines register. Push the water pump into position and secure with four 3/8 in. cap screws and washers. Next fit the distributor floating shaft assembly and the flexible couplings. Carefully enter the flexible coupling driving spools into place in the flexible coupling flanges and draw them into place with their bolts and nuts. Remake the water connections being sure all the gasket faces are clean and smooth. Use new gaskets on all flanges. Coat gaskets, both sides, with cement per Army Spec. 62-5. Lubricate.

7-41 OIL PUMP REMOVAL. The first step in removal of the oil pump is to disconnect all the oil line connections to the pump housing. Then

remove four nuts and washers from the back of the pump as indicated in figure 7-14. The pump may be pulled straight back away from the sprocket housing. It may be necessary to break the body loose from the gasket. This should be done carefully so as not to damage either the pump or its mounting face. Refer to figure 7-14.

7-42 INSTALLING THE OIL PUMP. See that all gasket faces are clean and smooth. See that the anti-friction bearing race is clean. Apply a new gasket coated with cement, Army Spec. 62-5, on the pump side and cup grease per Spec. AN-G-14 (Symbol GRB) on the sprocket housing side. Thread the oil pump housing onto the sprocket housing studs and carefully slide the oil pump into place. The oil pump drive shaft must be rotated until the splines enter the drive sprocket. Secure the oil pump with nuts and washers. Carefully examine the oil circulation pipes to make certain they are free of abrupt bends, dents or other obstructions. The flares must be clean, smooth and free from cracks. Refit the oil circulation pipes to the oil pump if they are found to be in good condition, otherwise replace them.

on the bottom side of the water pump. Do not drain water directly from the manifold as the salt water should not be allowed to run over the engine. Remove all water connections from the intake manifold. Remove all ignition wire connections from the spark plugs and allow them to lay in the bottom of the "V". Remove the fuel line connections from the carburetors and the priming pump connection to the manifold. Remove the distributor and multiple shield ventilating pipes from the intake manifold as well as the vacuum gage connection. Remove the crankcase ventilating pipes from the air filter shrouds. Remove the throttle control linkage from the front end of the throttle control shaft. Now remove 24 - 7/16 in. cap screws from the top of the intake manifold. Slide the intake manifold and carburetor assembly off the engine until it can be lifted straight up. Be careful so as not to damage any spark plugs, wires, pipes or controls. It is best to drain all the gasoline from the carburetor bowls into a closed container. (After this is done the manifold carburetor assembly may be turned upside down and the carburetors removed.)

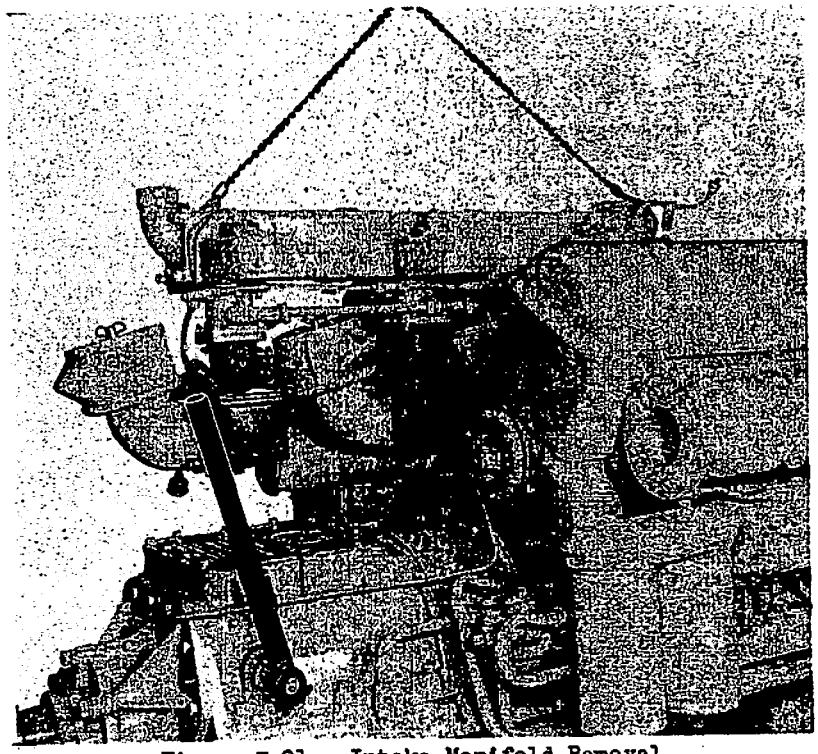


Figure 7-21. Intake Manifold Removal

7-43 CARBURETOR REMOVAL. The carburetors cannot be removed without first taking the intake manifold from the engine. For additional details refer to paragraph 7-45.

7-44 INSTALLING CARBURETOR. The carburetors must be fitted to the intake manifold before the manifold is assembled to the engine. Refer to paragraph 7-46.

7-45 INTAKE MANIFOLD REMOVAL. Drain the water from the intake manifold by opening a connection

7-46 INSTALLING INTAKE MANIFOLD. The carburetors must be fitted to the intake manifold before the manifold is set back on the engine. This is done as follows: Clean off the carburetor mounting flanges, as well as the carburetor extension and manifold flanges. Use new gaskets and assemble the carburetor extension and carburetor to the intake manifold. The extension piece is put on as illustrated in figure 7-22. Install the long carburetor control shaft and connect up the linkage to each carburetor. Lubricate the control linkage with

oil per specification AN-O-6 (Symbol OGP). Slide the carburetor and manifold assembly into place from the rear end of the engine. Be careful not to damage any spark plugs, pipes, wires, or control linkage. Use new gaskets, coat both sides with cement, Army Spec. 62-5. Secure parts with 7/16 in. cap screws and lockwashers. Connect all fuel pipes to the carburetors. Install ventilating pipes to upper crankcase, multiple shield and distributors. Install all spark plug ignition wires being careful to get them on the correct spark plugs per figure 3-1 and 3-2.

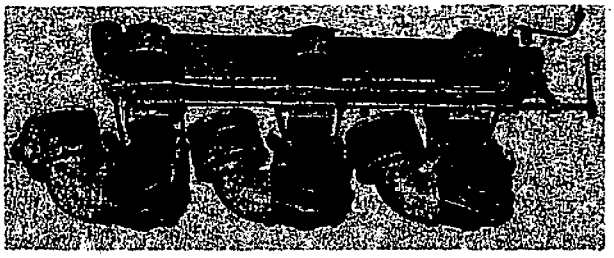


Figure 7-22. Intake Manifold and Carburetor Assembly

7-47 MULTIPLE SHIELD REMOVAL. Open the circuit that leads to the battery. Remove and carefully mark each wire from the multiple shield assembly and starting motor filter to make sure the wire can be returned to its proper place. Remove the ventilating pipes. Remove three 1/4 in. nuts and lockwashers from the back of the multiple shield case and take the assembly from the engine as well as the starting motor filter and the electric fuel pump filter. This operation is repeated for the other assembly. The multiple shield assembly supporting bracket may now be removed. This is done by removing four 3/8 in. cap screws and washers from the multiple shield supports at the front of each cylinder head. Also remove two 5/16 in. nuts and washers from the lower end of the multiple shield supporting leg and then remove the entire bracket from the engine.

7-48 INSTALLING MULTIPLE SHIELD. The multiple shield support is assembled to the engine and secured with cap screws, nuts and washers. The multiple shield assemblies, electric fuel pump filter and starting motor filter are next secured to the support. The exterior wire connections are made to the multiple shield assembly, electric fuel pump filter and starting motor filter, paying careful attention to the wiring diagram figure 7-23. Fit the ventilating pipes to the multiple shield assembly. Secure the wires and pipes with clips and tape so they cannot vibrate excessively.

7-49 STARTER REMOVAL. Disconnect the heavy wire from the storage battery posts or open the knife switch at the battery as the first step so there will be no danger of a short. Then disconnect the wire from the starting motor terminal. Remove eight 5/16 in. nuts and washers from the starter flange that holds the assembly to the flywheel housing. Pull the starter assembly from the engine. In case the multiple shield support is still in place it is necessary to remove the supporting leg from the multiple shield bracket before the starter can be pulled from the engine.

7-50 INSTALLING THE STARTER. The starter flange mounting face and the flywheel housing face must be clean and smooth. Use a new starter flange gasket and coat one side with gasket cement per Army Spec. 62-5. Stick this side against the starter flange. Coat the other side of the gasket with light cup grease per specification AN-G-14 (Symbol GRG). See that the starter drive bushing is clean and smooth. The starter drive sleeve on the end of the starter drive shaft must be clean and free from nicks and burrs so it will freely enter the flywheel housing bushing. Fit the starter to the flywheel housing and secure with nuts and washers. Draw the nuts up evenly so as not to bind or distort the parts. Reconnect the electric wires. Lubricate starter as mentioned in paragraph 6-16.

7-51 GENERATOR REMOVAL. Open the electrical circuit by removing the wire connection from the battery or open the knife switch at the battery if one is provided. Carefully tag and mark all wire connections to the generator so they can be returned to their proper places. Remove the shielding connections and wires. Loosen the two 5/8 in. clamp bolts on the generator mounting bracket and swing the generator around to loosen up the two V-belts. Now remove the four 3/8 in. cap screws from the generator mounting bracket and after removing the V-belts from the generator pulley, lift the generator from the engine.

7-52 INSTALLING GENERATOR. See that the base of the generator is clean, smooth and free from paint or grease. Set the generator in place, fitting the V-belts over the generator drive pulley. Secure the generator with cap screws and lock washers.

CAUTION

Do not use cap screws longer than 3/4 in. and be sure to use lockwashers. If a longer screw is used the field windings of the generator are quite likely to be damaged.

Now rotate the generator bracket on its support so as to bring the V-belts up to operating tension. Make sure the drive and driven pulleys are aligned with one another. Tighten the two 5/8 in. clamp cap screws in the generator bracket. Carefully connect wires to the generator according to the wiring diagram figure 7-23. The generator must be polarized before it is run. This necessitates consulting the applicable Air Force and Navy service or overhaul handbooks for details on polarizing this generator. If this detail is not attended to, the generator and apparatus box may be damaged. Lubricate the generator as mentioned in paragraph 6-15.

7-53 GENERATOR DRIVE REMOVAL. After the generator has been removed as outlined in paragraph 7-51, then the generator drive may be removed as follows: Disconnect the tachometer drive and set it aside. Remove four 3/8 in. cap screws and lockwashers from the generator belt guard and tachometer adapter plate assembly and remove the assembly from the engine. Remove the two V-belts. Now remove eight 1/4 in. cap screws from the tachometer drive flange. Remove the drive flange from the engine, being careful not to bend or otherwise damage the tachometer drive spindle. Remove the cotter pin from the end of the generator drive shaft and then unscrew the 3/4 in. nut. Remove the generator pulley.

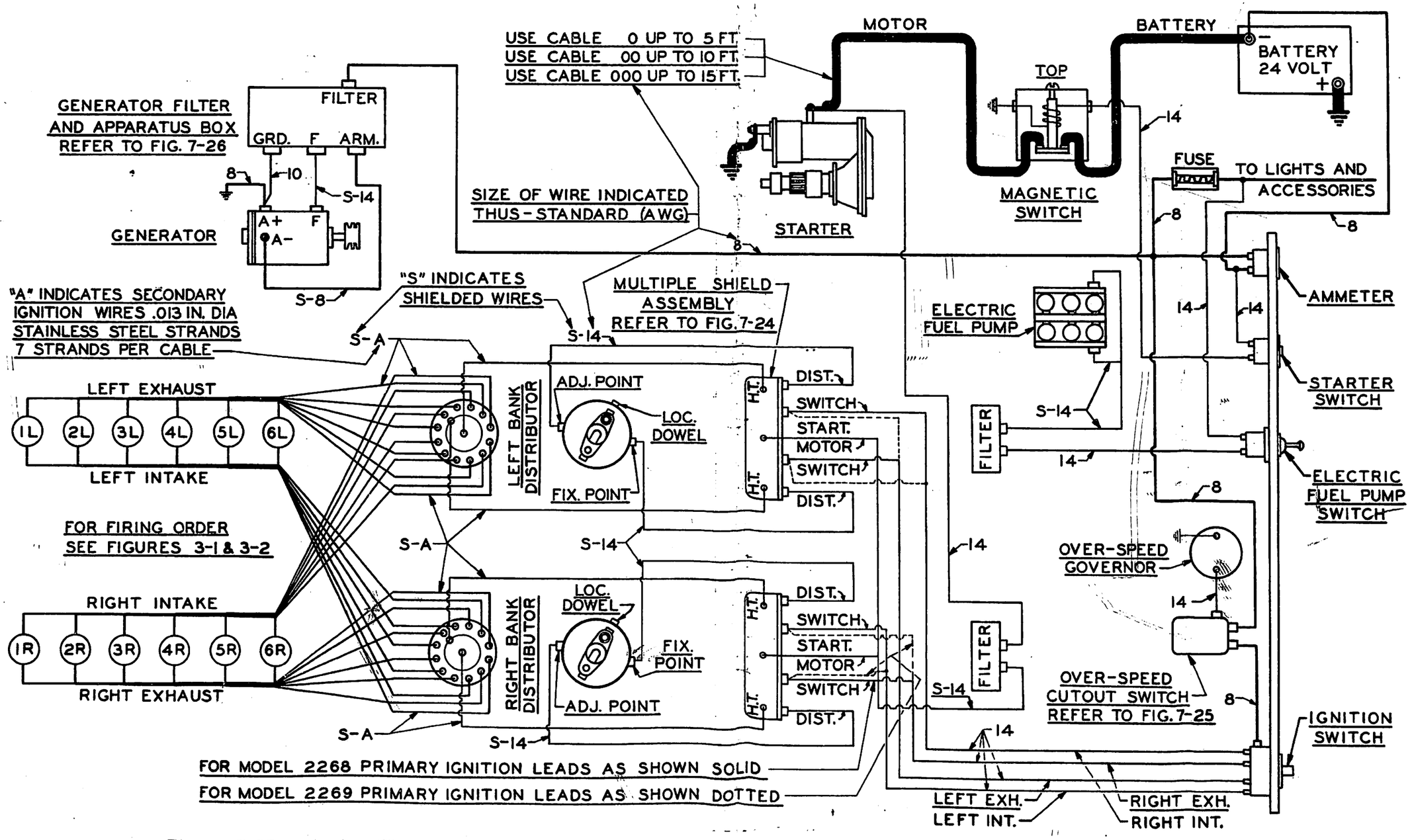


Figure 7-23. Engine Wiring Diagram

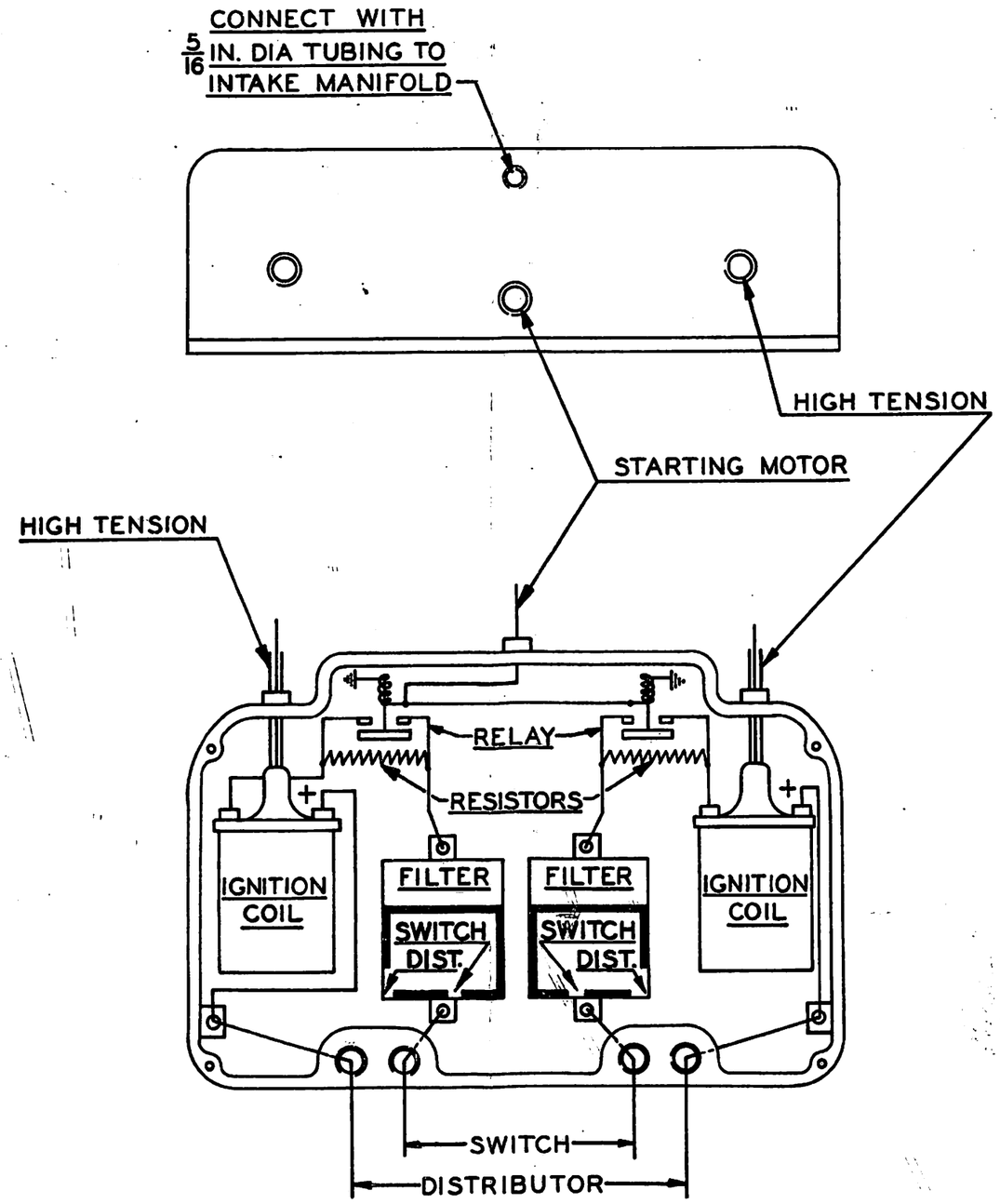


Figure 7-24. Internal Wiring Diagram of Multiple Shield Box

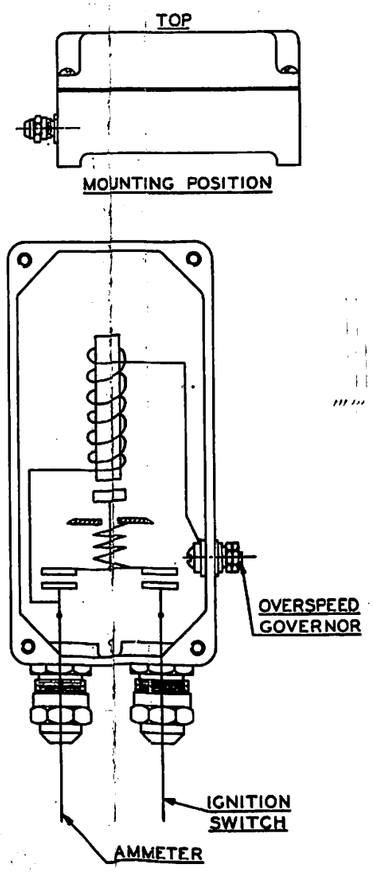


Figure 7-25. Internal Wiring Diagram of Overspeed Governor Cutout Switch

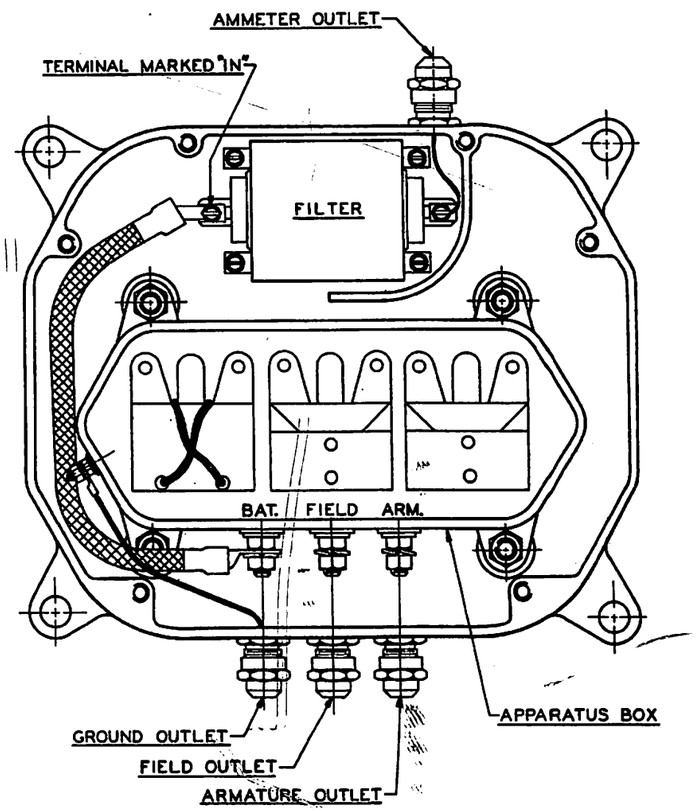


Figure 7-26. Internal Wiring Diagram of Apparatus Box

Now remove four 3/8 in. nuts and lockwashers from the generator drive shaft bearing retainer and pull the retainer from the engine. Cut the lockwire and remove four 3/8 in. cap screws from the generator drive shaft flange and pull the shaft free. Remove generator and idler sprocket support clamp ring assembly nuts and washers and then remove the assembly.

7-54 INSTALLING THE GENERATOR DRIVE. The generator drive is fitted to the engine in the following manner. See that the mounting face and pilot diameter in the sprocket housing is clean, smooth and flat. See that the generator drive sprocket face and pilot diameter is in good condition and clean. After the generator drive shaft flange is smooth and clean fit it to the drive sprocket. Secure with four 3/8 in. cap screws. Pull the shaft into place evenly so it does not bind. Secure the cap screws with a lock wire. Clean the bearing mounting diameter on the generator drive shaft carefully and add a drop or two of oil per specification AN-O-6 (Symbol OGP) to this diameter. Clean the mounting face of the generator drive shaft bearing retainer and see that it is flat and smooth. Coat the mounting face lightly with gasket cement per Army Spec. 62-5. Place a new gasket on this face. Coat the mounting face of the sprocket housing with light cup grease specification AN-G-14 (Symbol GRG). See that the ball bearing and oil seal are placed in the generator drive shaft bearing retainer. Fit the retainer to the engine and secure with nuts and lockwashers. Draw it into place evenly so as not to bind or distort the bearing retainer. Now fit the generator drive pulley to the generator drive shaft. Enter the pulley carefully into the oil seal so as not to damage the lip of the oil seal. Secure the pulley with nut and washer. Lock it in place with a cotter pin. Fit the tachometer drive flange to the generator drive pulley after the mounting faces and pilot diameters have been inspected and found to be in good condition. Draw down the eight 1/4 in. cap screws evenly so as not to bind or distort the tachometer drive flange. Secure with a lock wire. Fit the V-belts to the generator drive pulley. Clean off the mounting faces, dowels and dowel holes and then fit the generator belt guard assembly to the engine. Fasten it with four 3/8 in. cap screws. Clean off the mounting faces and pilot diameter and then fit the tachometer adapter plate to the generator drive assembly. This adapter plate is fitted to the engine with the 17/64 in. diameter hole and the flat edge of the flange on the under side.

7-55 BILGE PUMP REMOVAL. The bilge pump is removed by first removing the inlet and outlet flange connections. Then remove the four 3/8 in. nuts and lockwashers from the pump mounting flange. Pull the pump straight back off its mounting studs. If it becomes necessary to pry on the pump in order to separate it from the sprocket housing be careful not to mar the mounting flange so an oil leak will develop.

7-56 INSTALLING BILGE PUMP. The first step in installing a bilge pump is to see that the pump mounting flange and pilot diameter as well as that of the sprocket housing are clean, smooth and flat. Stick a new gasket to the bilge pump mounting flange with gasket cement per Army Spec. 62-5. Fit the pump to the engine and secure it with four 3/8 in. nuts and lockwashers. Refit the inlet and outlet pipe flanges using new gaskets. See that the pipes are installed so that no strain is thrown on the pump. Lubricate the pump as mentioned in paragraph 6-12.

7-57 OIL PRESSURE REGULATING VALVE REMOVAL. Unscrew four 5/16 in. cap screws and then lift the valve from the engine. Be careful not to damage the mounting faces or the dowels. Refer to figure 2-15.

7-58 INSTALLING AN OIL PRESSURE REGULATING VALVE. Clean off the gasket faces of both the upper crankcase and the regulating valve. Coat the upper crankcase mounting face with gasket cement per Army Spec. 62-5. Coat the regulating valve body with light cup grease per specification AN-G-14 (Symbol GRG). Use a new gasket and set the valve in place and draw down with four 5/16 in. cap screws. Make sure the dowels enter the reamed holes properly. See that the pad on the regulating valve matches that on the upper crankcase. Do not put the valve on backwards.

7-59 EXHAUST MANIFOLD REMOVAL. Drain the cooling water from the engine. Remove the copper tubing connection from the thermostat housing to the exhaust manifold. Remove the exhaust manifold companion flange. Remove the connection that runs to the oil cooler. Remove 24 - 7/16 nuts that attach the manifold to the cylinder head. Frequently the manifold is difficult to remove from the cylinder head and care must be used so the manifold is not damaged. It may be struck with a soft lead hammer or wooden mallet.

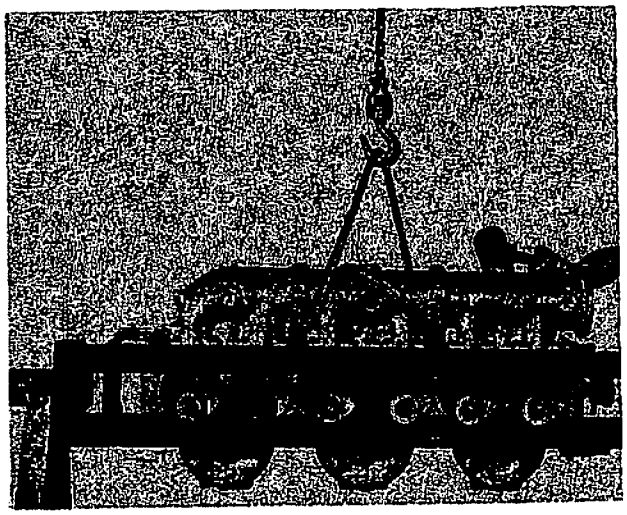


Figure 7-27. Removing Exhaust Manifold

The manifold has unsupported walls in some areas and these points must not be struck as the wall will give way. Strike alternately from end to end and top side then bottom side to carefully work the manifold loose. Some of the brass dowels may be left sticking in the cylinder head. These must be removed by twisting with pliers. This will probably damage them beyond repair.

7-60 INSTALLING EXHAUST MANIFOLD. Carefully clean the mounting faces of the cylinder head and the exhaust manifold. The circular grooves around each dowel hole must be cleaned out so that it can make a leak tight joint against the gasket. See that all the brass hollow dowels are in place in the exhaust manifold. Use new gaskets coated both sides with a viscous non-hardening cement similar to Army Stock No. 052-C-685-2PX. Draw it into place carefully so as not to throw an uneven strain on either the cylinder head or exhaust manifold. Connect water circulation pipes to the oil cooler using new gaskets. Connect up the exhaust manifold companion flange using a new gasket.

7-61 OIL COOLER REMOVAL. Remove the oil pipes that run from the oil cooler to the oil pump and from the upper crankcase. Drain the cooling water from the engine and then remove the water circulation pipes from the oil cooler both ends. Now remove 16 - 3/8 in. nuts and copper washers. Remove the oil cooler assembly as a unit from the engine. Be careful not to damage the studs or mounting flanges.

7-62 OIL COOLER INSTALLATION. See that the mounting face of the oil cooler and cylinder block are clean, smooth and flat. See that all the studs are in good condition. Replace any studs that are defective. Stick a new gasket to the oil cooler face with gasket cement per Army Spec. 62-5. Coat the opposite face of the gasket with light cup grease per specification AN-G-14 (Symbol GRG). Fit the cooler to the engine and secure with nuts and copper washers. Draw it down into place evenly and tight, Replace water and oil circulation pipes.

7-63 FUEL PUMP REMOVAL. Shut off the main fuel valve. Drain the fuel from the fuel pressure regulating valve into a closed container. Refer to figure 2-18 and 2-19. Replace the drain valve. Now remove the fuel line connections from the fuel pump. Remove two 5/16 in. nuts and lockwashers from the fuel pump flange and remove the fuel pump from the engine.

7-64 FUEL PUMP INSTALLATION. Clean off the mounting face of the fuel pump and cylinder head. See that these surfaces are clean, smooth and flat. See that the pilot diameter of the fuel pump is clean as well as the driving tongue. See that the pump by-pass valve is arranged so that it will come on the inside when the pump is installed. Refer to figure 3-3. The valve cap marked with a "V" has the by-pass valve under it. See that the oil passage hole in the cylinder head is clean. Use a new fuel pump flange gasket and stick it to the fuel pump with gasket cement per Army Spec. 62-5, being careful not to plug up the oil hole. Be sure there is an oil hole in the gasket. Coat the cylinder head side of the gasket with light cup grease per specification AN-G-14 (Symbol GRG). Rotate the fuel pump drive tongue so it will line up with the groove in the end of the camshaft. Fit the pump to the engine and secure with 5/16 in. nuts and lockwashers. Make sure the driving tongue is properly entered into the camshaft slot. Connect the fuel pipes if they are in good condition. Open the main fuel valve and fill the system with fuel through the use of an electric fuel pump or other auxiliary means. Make a final check for fuel leaks and correct any found.

7-65 OIL FILTER REMOVAL. Remove the oil circulation pipes from the filter. Remove four 3/8 in. hex nuts and washers from the oil filter base and pull the oil filter assemblies from the engine. See paragraph 7-72 for installation.

7-66 OVERSPEED GOVERNOR REMOVAL. Remove the overspeed governor cable clip from the front of the lower crankcase. Remove the overspeed drive connection from the front of the distributor drive housing. Remove two 3/8 in. cap screws from the overspeed governor bracket and lift the overspeed governor assembly from the engine far enough so the electrical connection can be removed from the back of the overspeed governor assembly.

7-67 OVERSPEED GOVERNOR INSTALLATION. The first step in the installation of the overspeed governor is to fit the drive cable connection to the overspeed governor assembly. Be sure that the driving tongue enters the slot properly so it does not bind. Now connect the electrical lead to the back of the overspeed governor assembly. Set the overspeed governor assembly with its bracket and drive cable on the engine and secure with two 3/8 in. cap screws and lockwashers. Attach the other end of the drive cable to the front end of the distributor drive housing. Make certain that the driving tongue properly enters the driving slot of the distributor drive shaft. Fasten the drive cable supporting clip to the front of the hand starting throw out plate.

7-68 ELECTRIC FUEL PUMP REMOVAL. Remove the electrical connections from the fuel pump. Carefully tag the connections so they can be returned to their proper place on reassembly. Remove the fuel pipe connections to the fuel tank and to the fuel pressure regulating valve. Catch any fuel present in a closed container.

WARNING

Keep a serviceable fire extinguisher within reach at all times.

The fuel pump bracket is fastened to the engine with two 3/8 in. cap screws in the vertical flywheel housing flange and one 1/2 in. cap screw in the horizontal flywheel housing flange. All three of these cap screws must be removed, but first it is necessary to remove a 1/2 in. nut from the stud immediately in back of the vertical flywheel housing flange. This step is necessary so the 3/8 in. cap screw can be removed from the lower hole. After these cap screws have been removed, the entire fuel pump assembly can be lifted from the engine.

7-69 ELECTRIC FUEL PUMP INSTALLATION. Set the electric fuel pump on the engine and fasten with two 3/8 in. cap screws in the vertical flange of the flywheel housing and one 1/2 in. cap screw in the horizontal flange of the flywheel housing. Return the 1/2 in. nut to the vertical flywheel housing flange after the 3/8 in. cap screws are in place. Remake the pipe connections as illustrated in figure 3-3. Fasten the electrical connections as illustrated in figure 7-23.

7-70 TACHOMETER SENDING UNIT REMOVAL. Remove the electrical connections from the sending unit marking each one carefully so it can be returned to its proper place on reassembly. Remove the

driving head from the adapter plate directly beneath the generator. Remove two 3/8 in. hex nuts from the sending unit bracket and lift the sending unit and its drive cable from the engine.

7-71 TACHOMETER SENDING UNIT INSTALLATION. Fit the sending unit drive cable to the sending unit and make sure the driving tongue properly enters the driving slot so that there is no binding. Now set the sending unit and its bracket on the engine and secure with two 3/8 in. hex nuts and lock washers. Fit the driving head of the sending unit to the drive provided directly beneath the generator. Make sure the driven tongue properly enters the driving slot so there is no binding. Remake the electrical connections.

7-72 OIL FILTER INSTALLATION. See that the mounting faces of the oil filter and sprocket housing are clean and smooth. Coat a gasket with cement per Army specification 62-5 one side and stick it to the filter base. Coat the other side of the gasket with soft cup grease AN-G-14 (Symbol GRG). Assemble the oil filter to the engine and secure with nuts and washers. Fit oil pipes.

HALL-SCOTT DEFENDER
MODEL 2268 & 2269

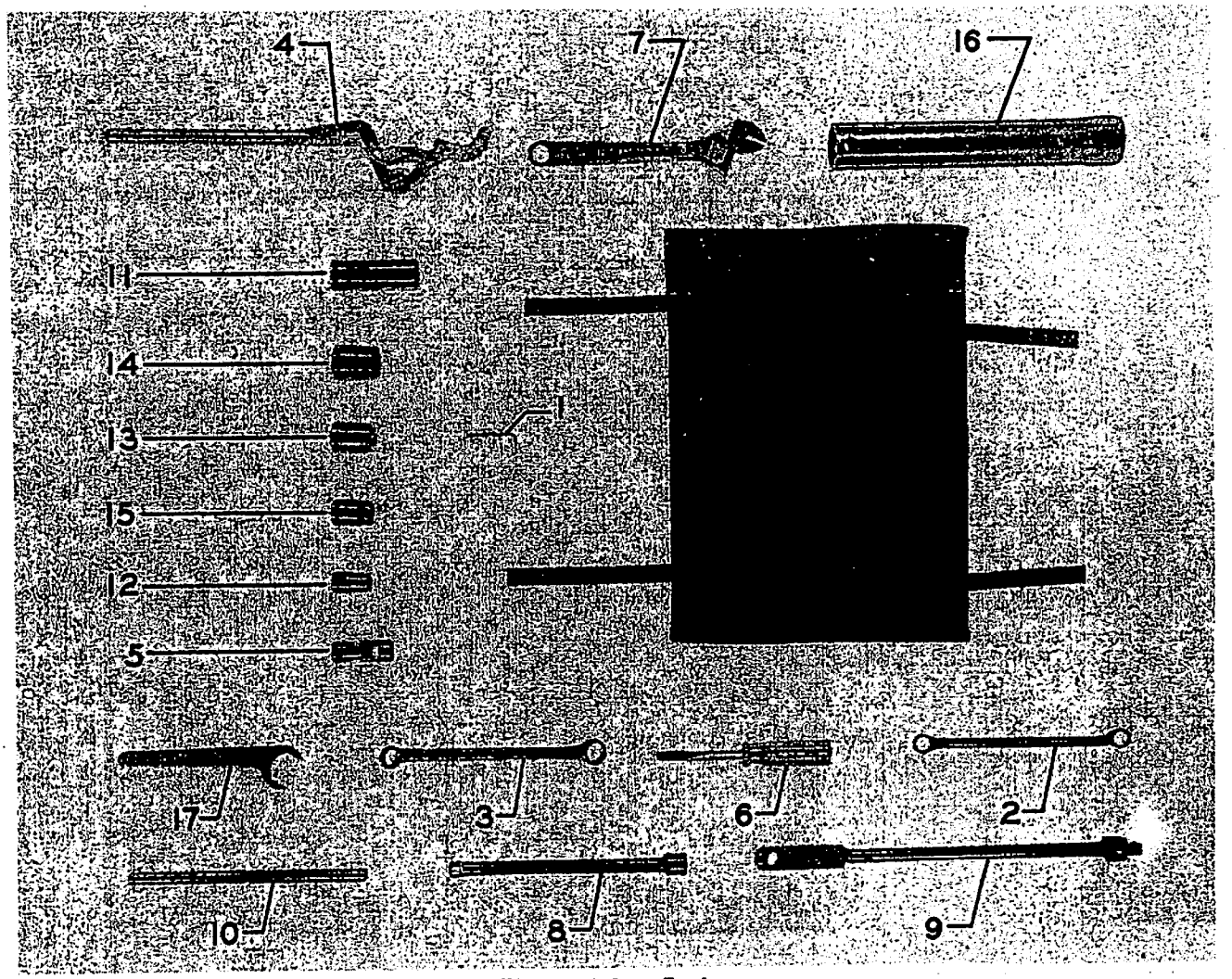


Figure 8-1. Tools

SERVICE TOOLS

8-1 GENERAL. Listed and illustrated in this section will be found all the Government approved service tools. These tools are used for maintenance work as outlined in this handbook. Typical applications are noted below and reference is made to appropriate illustrations of the tools in use.

8-2 TYPICAL TOOLS. Tools that are shown in use, elsewhere in this handbook, but not found listed here are not necessarily Government approved and are thus designated as "typical" to distinguish them from the tools listed in this section.

FIG. AND INDEX NO.	TOOL NO.	NOMENCLATURE	APPLICATION
8-1-1	161002	Wrench - Allen 3/32 in.	Distributor rotor set screw refer to figure 7-4.
-2	306551	Wrench - Cylinder and manifold nut double hexagon	Nuts and cap screws on rockerarm cover, water pump, distributor drive housing and reverse gear cover.
-3	308587	Wrench - Double hex nut 5/8 and 3/4 in. openings	Nuts and cap screws on exhaust manifold; intake manifold and elbows; flywheel housing; upper and lower crankcase flange; valve tappet lock nuts; reverse gear thrust bearing container, packing gland and adapter.
-4	303526	Tool - Valve spring compressor	Used to install and remove valve springs.

FIG. AND INDEX NO.	TOOL NO.	NOMENCLATURE	APPLICATION
-5	317805	Flexocket - 5/8 in. double hexagon	Nuts and cap screws on the exhaust manifold; intake manifold elbows; flywheel housing; upper and lower crankcase flange and reverse gear thrust bearing container.
-6	318282	Screw driver	Distributor cam locking screw.
-7	318283	Wrench - 10 in. single end superadjustable 1-1/8 in. capacity	Adjustable for general purpose application.
-8	318284	Extension - 10 in.	Use with socket to reach cap screws in rear interior wall of reverse gear housing.
-9	318285	Handle - Flexible 17 in.	Use with sockets and extension.
-10	318286	Bar - Cross	Use with flexible handle and with chain take-up socket wrench.
-11	318287	Socket - Double hex 1 hex 1/2 in. square drive	Use on spark plugs.
-12	318288	Socket - Double hex 9/16 hex 1/2 in. square drive	Nuts and cap screws on rockerarm cover, water pump, distributor drive housing and reverse gear cover.
-13	318289	Socket - Double hex 15/16 hex 1/2 in. square drive	Nuts and cap screws on the reverse gear thrust bearing retainer and generator bracket.
-14	318290	Socket - Double hex 1-1/16 hex 1/2 in. square drive	Cap screw on the camshaft drive sprocket.
-15	318442	Socket - Double hex 3/4 hex 1/2 in. square drive	Valve tappet nuts and reverse gear packing nuts.
-16	326894	Wrench - Chain adjustment sprocket	Hex on chain take-up support, Refer to figure 7-14.
-17	326978	Wrench - Water pump packing nut	Water pump packing nuts.