WAR DEPARTMENT TECHNICAL MANUAL

TM 55 1149

ENGINE, MARINE, GASOLINE, KERMATH MODEL SEA RAIDER SPECIAL, 550 H.P. FRESH WATER COOLED



WAR DEPARTMENT · 22 NOVEMBER 1944

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TM 55-1149, Engine, Marine, Gasoline, Kermath Model Sea-Raider Special, 550-HP, is published for the information and guidance of all concerned.

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BY ORDER OF THE SECRETARY OF WAR:

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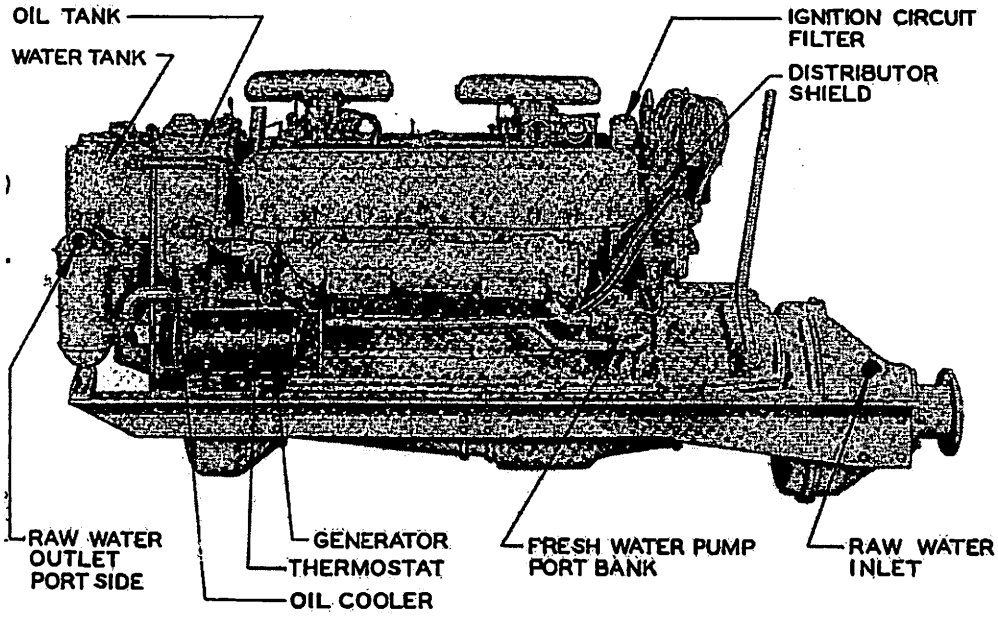
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For explanation of symbols, see FM 21-6.

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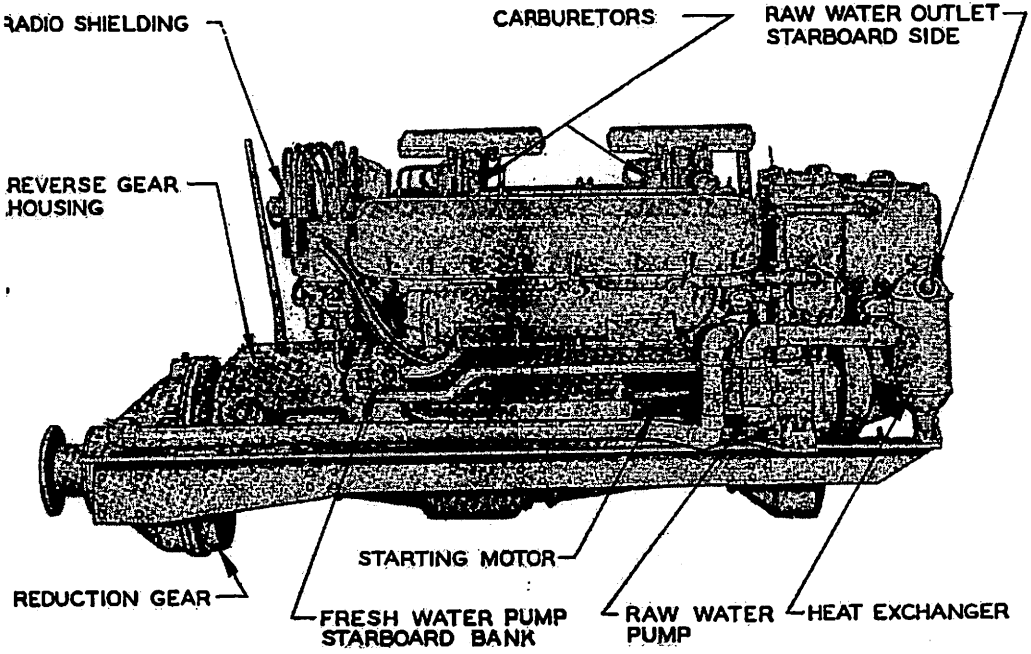
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1949 MODEL KERMATH SEA RAIDER SPECIAL

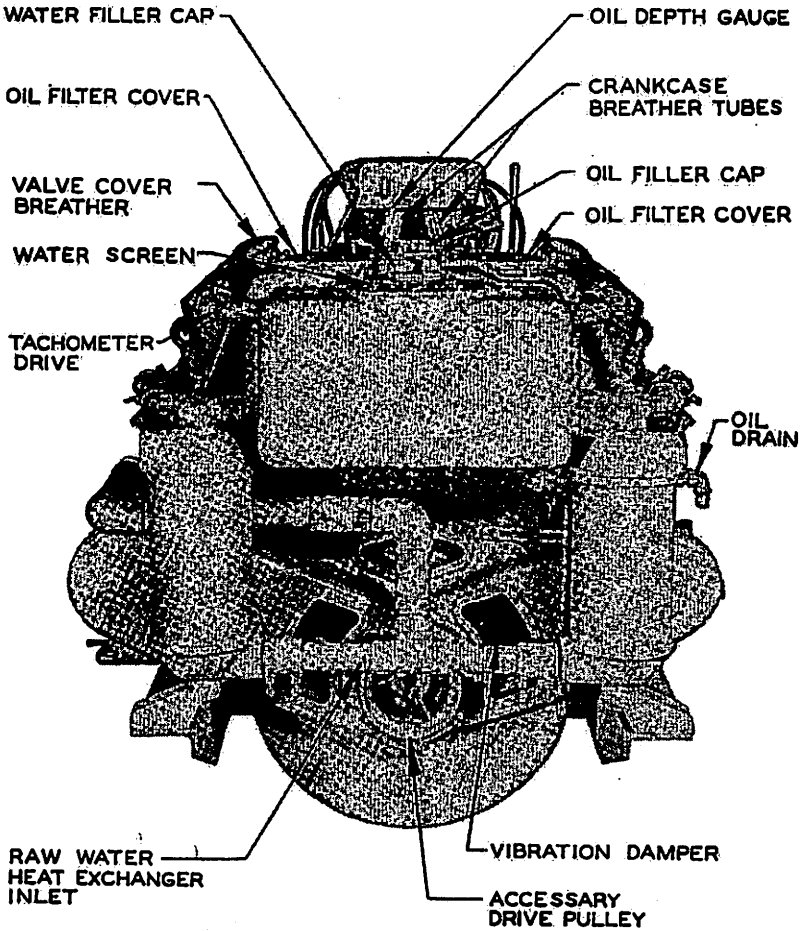
PORT SIDE - SEA RAIDER SPECIAL
FRESH WATER COOLED, WITH 2.44:1 REDUCTION GEAR

PLATE I

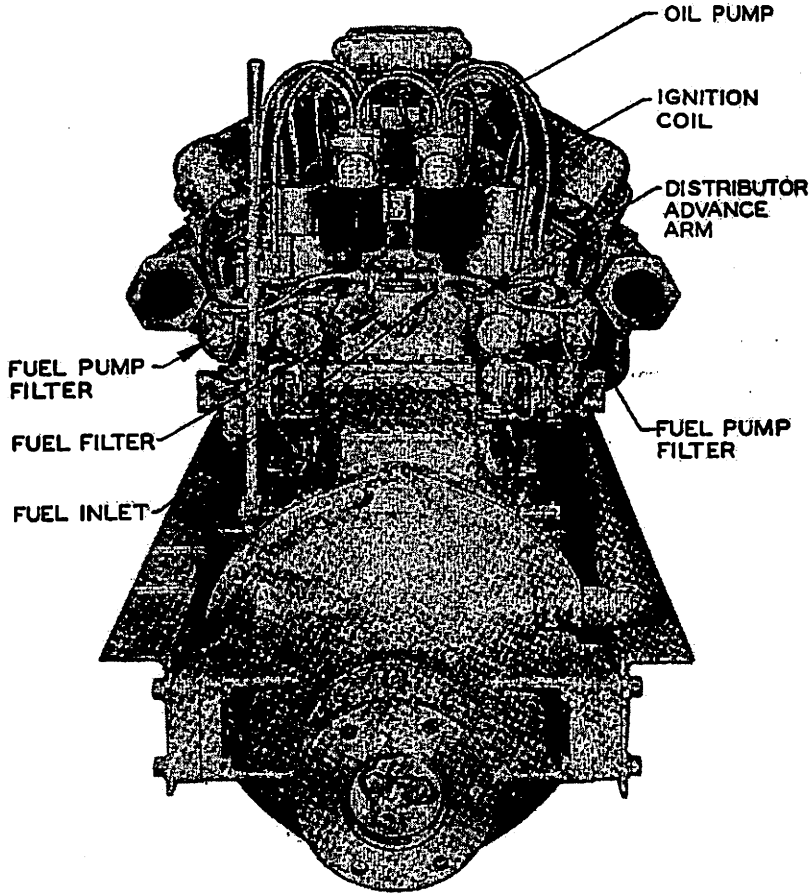


STARBOARD SIDE - SEA RAIDER SPECIAL
FRESH WATER COOLED, WITH 2.44:1 REDUCTION GEAR

PLATE II



FLYWHEEL END - SEA RAIDER SPECIAL PLATE III



REVERSE AND REDUCTION GEAR END - SEA RAIDER SPECIAL WITH RADIO SHIELDING

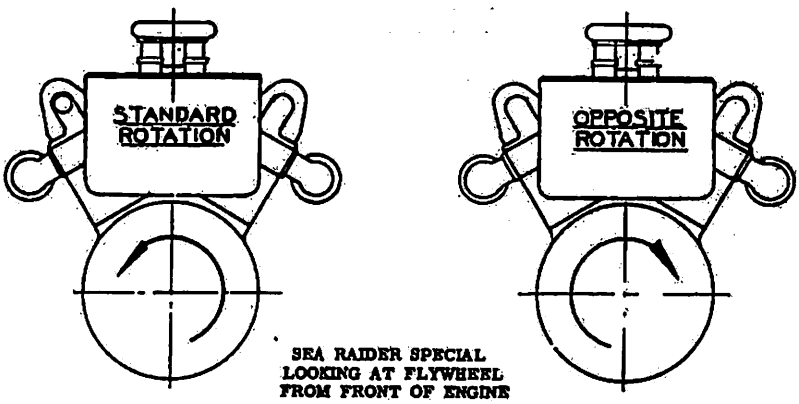
PLATE IV

INSTRUCTIONS
OPERATION AND MAINTENANCE
OF
KERMATH SEA RAIDER SPECIAL ENGINE

This booklet is prepared for the purpose of providing the boat builder and the operator with the data essential to proper installation and operation of the Kermath Sea Raider Special Engine. To insure dependable service from this engine a reasonable amount of maintenance attention is required. Certain simple cautions must be observed. Read this booklet carefully. In the event there should arise a special problem not specifically covered in this booklet communicate with the Service Department of the Kermath Manufacturing Company. This department will cooperate in every possible manner and endeavor to offer a practical solution based on experience with this engine over a long period.

Each Kermath Sea Raider Special Engine is carefully tested through its operating range before the engine leaves the factory. The operating range is from 400 to 2400 rpm. The idling speed is set at 400 rpm without load. This speed should not be reduced. Every effort should be made to avoid changing any engine adjustments during the process of installation. Both water and oil are drained from the engine prior to shipment.

HIGH QUALITY MOTOR FUEL OF NOT LESS THAN 87 OCTANE RATING IS REQUIRED; DO NOT USE A FUEL OF LOWER OCTANE RATING; MAXIMUM OUTPUT AND DEPENDABLE SERVICE MUST NOT BE EXPECTED IF THIS CAUTION IS IGNORED.



SEA RAIDER SPECIAL
LOOKING AT FLYWHEEL
FROM FRONT OF ENGINE

INSTALLATION

The construction of the engine timbers should be carefully considered by the boat builder. It must be remembered that all of the thrust forces used in propelling the boat are transmitted from the engine to the hull through the engine timbers. It is important therefore that the members used in supporting the engine be not only of ample proportion but so laid out as to distribute the thrust forces to the hull without undue concentration of stress at a limited number of localized points. The engine stringers should be made as long as possible. Cross-bracing should be well fitted and adequately fastened. Use bolts wherever possible. The cross-bracing should be fastened to the frames and not to the planking of the hull.

The arrangement of the engine compartment must provide ample room around the engine to permit proper servicing. In the case of twin screw installations provide sufficient room to permit an operator to work between the engines. The engine compartment should be floored tightly to prevent small parts from being dropped into inaccessible parts of the bilge. The flooring should be kept as low as possible. Provide ample room at the forward end of the engine so that the hand turning crank may be engaged without any interference. The hand turning lever is used for checking engine settings.

Group the fuel line valves in an accessible location. Group the electrical connections in an accessible location.

PROPELLER SHAFT ALIGNMENT

Top performance cannot be expected if the engine and the coupling on the propeller shaft are not in correct alignment. The engine may be placed in alignment with the propeller shaft coupling before the boat is launched but good practice requires that the propeller shaft alignment be checked after the boat is in its natural element. Most boats will change their shape slightly after they are launched. This alignment should be checked before the engine is started for the first time and any misalignment corrected. Neglect of this caution may cause serious trouble. Recheck the alignment after the first 25 hours of operation on a new boat and periodically thereafter depending upon the type of service in which the boat is engaged. If the boat is operated in rough water where a certain amount of "working" may be expected, the periods between inspection of alignment should be shorter than on boats used in comparatively calm water.

The face of the engine coupling and the face of the propeller shaft coupling must be parallel or as near thereto as it is possible to align them. Keep the coupling connecting bolts tight.

EXHAUST LINES

The installation of the exhaust lines is a matter which must be given careful consideration by the naval architect and the boat builder. Since the details of such an installation will differ on various types of boats, the following remarks are in the form of cautions and suggestions for consideration.

The exhaust lines must provide a venting of the exhaust gasses in a free manner. Avoid all possible restrictions. If pipe is used for the exhaust lines the size used must not be smaller than 3 1/2". If tubing is to be used to make up the exhaust lines, the use of 4" tubing is suggested. Make every effort to avoid sharp bends in the exhaust lines. All turns should be made using the largest radius possible within the limitation of the installation. In the event that it is necessary to install sound controling devices make certain that such devices are of ample capacity. Do not knowingly incorporate anything in the exhaust line of a restrictive nature.

The cooling of the exhaust line is a problem which must be worked out in accordance with the requirements of a particular installation. There are certain precautions which must be observed. Any water piped to the exhaust line, either for disposal of engine cooling water or for the purpose of cooling the exhaust line, must be entered at a point which will positively prevent water working back through the engine. The ideal exhaust line will drain itself overboard but this arrangement is not always possible. If the construction of the boat requires the elevation of the exhaust line any cooling water entered into the exhaust line must be admitted beyond the high point of the exhaust line so that the water cannot work back to the engine. Water or vapor working back to the engine is one of the common causes of valve sticking complaints. Every effort should be made to reduce the possibility of encountering trouble in this connection. If water jackets are used to cool the exhaust line make certain that the water passages therein are of sufficient area to prevent the possibility of creating a back pressure on the engine water pumps. Such a water jacket, of course, should be provided with a means to permit draining in freezing temperatures. Under some conditions it may be advisable to use only a proportion of the cooling water discharged by the engine for the purpose of cooling the exhaust line disposing of the balance of discharge water overboard in a separate line.

Where the engines are mounted low in the hull and the exhaust manifold exhaust outlet is near or below the water line, a water-jacketed exhaust line should be installed. This jacketed exhaust line should be carried up into a "U" bend to a height which is well above the water line. The pipe joining the after side of the "U" bend can then be given a gradual fall to the point where it passes through the hull above the water line. When the specified fall is provided, the water used to cool the water-jacketed portion of the pipe may be mixed with the dry exhaust gasses which have passed through the inner tube of the "U" bend. This arrangement not only avoids necessity for further water-jacketing of remainder of the exhaust line but provides an economical means of disposing of water which has passed thru the exhaust pipe water-jacket.

CAUTION: Since the inner water-jacket of the "U" bend presents a cold surface to the hot exhaust gases, condensation will result if the engine is operated at or near idling speeds for any length of time, an appreciable quantity of water will accumulate on the engine side of the "U" bend and this fluid will run back into the exhaust manifold and from there into the combustion chamber of the engine. This may cause sticky valves, shorted out spark plugs and if water is present in the cylinders in any appreciable quantity, it may bend connecting rod or break the piston, when the starting motor is engaged. A condensation drain should be provided at the lowest point between the end of the exhaust manifold and the water-jacketed part of the pipe. This drain should be opened when the engines make a cold start. The drain should remain open while the power plant is idling or cruising at such a low speed that exhaust pressure is not sufficient to drive the condensation over the top of the "U" bend. If installation will permit, a short section of 3 or 4" pipe should be formed into a trap to catch the condensation at low speeds. Such an arrangement will retain the condensation for a short period of time and act as a safe guard in event the drain is not opened when the engine is started or operated at low speed.

The drain previously referred to is for the inside of the exhaust passage, and additional drain must be provided for the water in the jacket of the "U" bend. Water repeatedly freezing in this part of the pipe during cold weather has been known to almost completely close the exhaust passage where two concentric copper tubes were used to provide the jacket of the "U" bend. This restriction caused a mysterious loss of power as damage due to freezing was not visible on the outside pipe.

FUEL SYSTEM

The fuel line between the tank and the engine should be of ample capacity. This line should not be smaller than 1/2" copper tubing. The line should be securely fastened to prevent vibration along the run from the fuel tank to the engine bed. A horizontal loop or approved gasoline proof hose should be installed on the fuel line in the run between engine bed and the fuel line engine connections. This portion of the fuel line should never be rigidly mounted. A shut-off valve should be provided in the fuel line in an accessible position. The shut-off valve should be located on the tank side of any filter incorporated in the fuel line so that the line may be closed off to permit cleaning of the filter unit. Filter units should be mounted in a position which will allow placing a container under the filter units to receive the liquid drained off.

The shape and dimensions of the tank or tanks will be dictated by the requirements of the installation. The tank or tanks may be located above or below the level of the carburetors on the engine.

The preferred location of the tanks is below the carburetors as this arrangement avoids subjecting the float valves to constant fuel pressure when the engine is stopped. If dirt is present in the fuel, a carburetor float valve may be held off its seat causing fuel to overflow into the intake manifold and cylinders. Fuel accumulating in a combustion chamber not only creates a fire hazard but may damage the engine on the next start, should fuel be trapped in one of the cylinders on the compression stroke.

When the top of the tank is above the carburetors, a valve should be provided in the fuel line and operating personnel instructed to close this valve as soon as the engine is stopped. Whenever possible, the fuel tanks should be so located so that there will be less than four feet gravity head on the fuel pump inlet. The pressure of the fuel which is above the pump inlet adds to the discharge pressure of the pump and this may result in fuel pressure so high that the float valves of the carburetors will be forced from their seats causing irregular operation at idle or at slow cruising speeds due to an over-rich mixture.

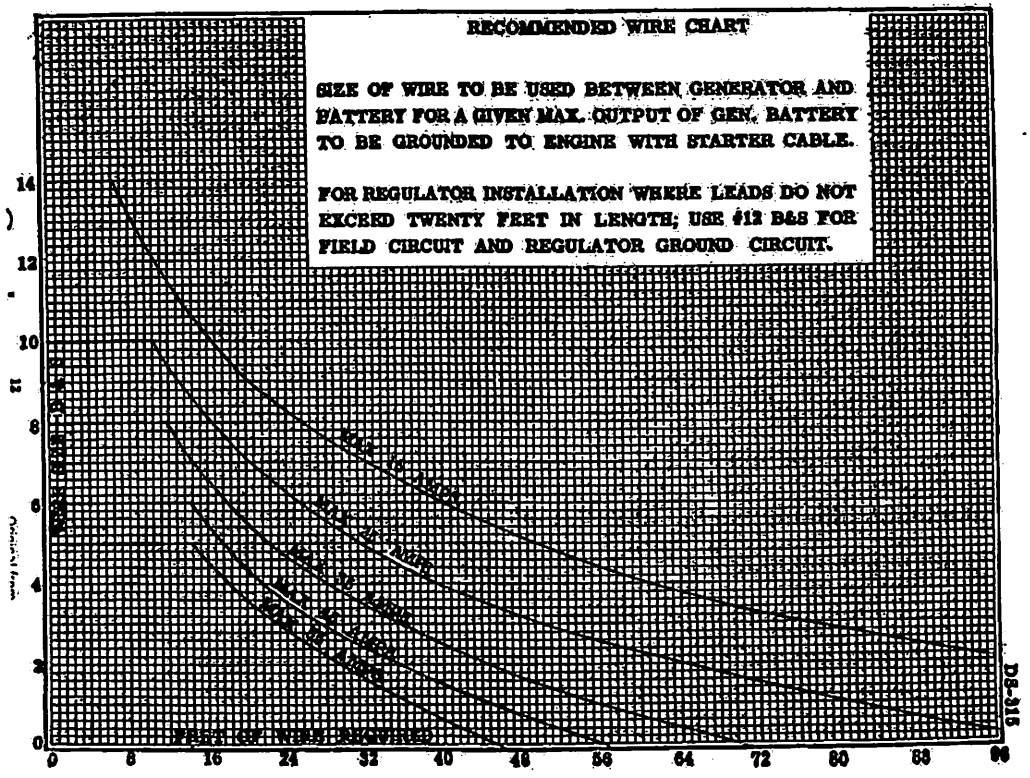
The tanks must be so mounted that they are secure against shifting if the boat is operating in rough water. Each tank must be provided with a generously proportioned vent. The vent must be extended through piping or tubing to a point outside of the hull. This vent line must be tightly connected. When the tank is being filled, the gasoline fumes within the tank are displaced by liquid gasoline. The gasoline fumes are heavy and if they are admitted to the boat will find their way into the bilge and possibly into the engine compartment. These fumes are explosive and a spark or an open flame may result in a disastrous explosion. The vent should conduct the fumes to the outside of the hull at a point where they cannot find their way back into the boat.

The aperture in the tank provided for filling should be of a generous proportion. This aperture must be connected tightly to an extension leading the filler cap to a point above the deck line.

In the event the fuel line is entered into the tank at the top and conducted down inside of the tank some provision should be made to permit draining the tank should such a necessity be encountered. Clean-out plates should be provided on the tank in a location where they will be accessible. If the tanks are mounted in a separate compartment provide generous ventilation to minimize condensation of water vapor inside the fuel tank.

ENGINE ROOM VENTILATION

Large engines operating at wide open throttle use an enormous quantity of air. This item is frequently underestimated. To secure top performance it is essential that an ample supply of fresh air be provided within the engine compartment. It is advisable to keep the velocity of the air through the ventilating apertures at a reasonable figure. It is therefore suggested that apertures be provided having a free area of not less than 16 square inches per 100 H.P. of the engine rating. This rule of thumb data has worked out well in practice in all cases except those in which the air is conveyed through long ducts involving sharp turns. Whenever it is necessary to use long ducts involving several sharp turns, the area must be substantially increased.


RECOMMENDED WIRE CHART
SIZE OF WIRE TO BE USED BETWEEN GENERATOR AND BATTERY FOR A GIVEN MAX. OUTPUT OF GEN. BATTERY TO BE GROUNDED TO ENGINE WITH STARTER CABLE.
FOR REGULATOR INSTALLATION WHERE LEADS DO NOT EXCEED TWENTY FEET IN LENGTH; USE #12 B&S FOR FIELD CIRCUIT AND REGULATOR GROUND CIRCUIT.
#14
#12
#10
#8
#6
#4
#2
#0
0
8
16
24
32
40
48
56
64
72
80
88
96
FEET OF WIRE REQUIRED
DS-315

WIRING

Use properly insulated new stranded wire in sizes of adequate capacity. Wire sizes should not be less than those indicated on the wiring diagram and if the circuit lengths are long step up the wire sizes to wires of greater capacity. The capacity of wire diminishes as the length increases. Use marked wires to indicate various circuits as this simplifies checking the circuit. All wires should be fitted with terminals. In soldering terminals to the end of wires never use acid core solder. Rosin core solder should be used. All wiring connections should be cleaned so that a good contact is afforded. Keep all connections tight. Do not run wires beneath the floor boards of the boat if there is danger of the wires coming in contact with bilge water which will rapidly deteriorate the insulating material.

Storage batteries used in connection with the engine electrical system should be located as close to the engine as possible. Storage battery or batteries should be well fastened to prevent same from coming adrift in a seaway. The use of a lead lined covered box to contain the batteries is recommended. This box, of course, must be ventilated. If it is not possible to so mount the storage battery, a wooden cover for the battery should be provided to prevent the possibility of a battery being short-circuited if a wrench is accidently dropped across the terminals. The batteries should be periodically inspected to ascertain the fluid level. Accessibility is of prime importance. Use a heavy duty type storage battery of not less than 140 ampere hour capacity.

CONTROL RODS

Control rods are required for the throttle, choke and reverse gear. The spark setting is automatically controlled by the speed of the engine and needs no manually operated control. The details of the control rods will be dictated by the requirements of an individual installation so we suggest the following be observed. For the throttle and choke control use 3/8" diameter rod and provide ample supporting brackets to prevent vibration and rattle. It is important to make certain that a complete opening and closing of the carburetor throttle valve is effected. The same caution should be observed with regard to the choke valves. The four carburetors on this engine are synchronized when the engine leaves the factory and the control rod installed by the boat builder should be connected to the throttle lever provided on the engine control without changing the carburetor butterfly synchronization. A lever is also provided for connecting the choke controls.

The reverse gear lever control arrangement should be sufficiently substantial to withstand bending or flexing when forcing the reverse gear into forward or reverse motion. It is essential that a full throw in both directions be obtained. The reverse gear must lock into AHEAD motion and also into REVERSE motion. A slight back lash in the controls should be in evidence when they are locked in AHEAD or REVERSE motion. With the reverse gear control lever extending upward from the cross shaft the lever moves forward for AHEAD motion and aft for REVERSE motion. The total arc of travel of the reverse gear control lever is approximately 43°.

THINGS TO DO

Each Day Engine Is Operated:

Check lubricating oil level. See lubrication Instructions Page 38.
Check water or anti-freeze level in fresh water tank.
Lubricate water pumps - use waterproof grease. Do not apply pressure to grease cup cap, turn down only until cap contacts grease in cup.
Check raw water strainer.

Each 50 Hours of Operation:

Lubricate distributor - sparingly.
Lubricate generator - sparingly. (Take up slack in grease cup cap.)
Check electrical circuit for loose connections.
Tighten external nuts and capscrews.
Clean fuel filters including fuel pump screens.

Each 100 Hours of Operation:

Change oil.
Inspect oil tank screen.
Change oil filter cartridge if oil is dirty.
Check tappet clearance.
Check spark plug gap.
Check generator belt tension.
Saturate felt under distributor rotor - light oil.
Check distributor breaker point gap.
Inspect distributor cap and rotor.
Check and clean screen in fresh water tank.

Each 200 Hours of Operation:

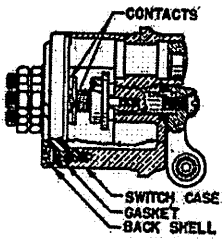
Check generator brushes.
Check starter brushes.
Check alignment between engine and shaft coupling.
Lubricate starting motor.
Inspect water pump gears.
Clean oil cooler.
Inspect heat exchanger.

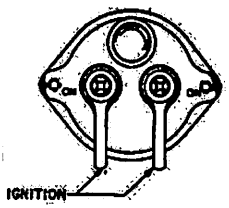
FOR CONTINUOUS SERVICE OF LONG PERIODS IT IS RECOMMENDED THAT THIS ENGINE BE OPERATED AT A SPEED NOT EXCEEDING 75% OF THE MAXIMUM R.P.M. ATTAINED AT WIDE OPEN THROTTLE.

TO START ENGINE

Before starting the engine for the first time read carefully the instructions regarding lubrication. Make certain that there is oil in the engine. Go over the water lines to see that all connections have been made and be sure that any valves incorporated in the water lines are open. Check the engine electrical system to see that all connections are properly located and tight. Inspect the fuel line and correct any leaks found therein. Open the proper valves in the fuel line.

Place the reverse gear control lever in "NEUTRAL" position. Set the throttle about one-quarter open and adjust the choke control so that the choke valves are completely closed. Turn the ignition switches to "ON" position. (Note: In some installations a master switch may control all electrical circuits. In such installations make certain that the master switch is closed.) Press the starter button.





IGNITION SWITCH

Start and run with both levers at "ON" position.

As soon as the engine begins to fire release the starter button and open the choke valves so they are only partly effective. As soon as the engine begins to warm up the choke valves should be fully opened. Note the oil pressure gauge and the ammeter to check the indication thereon. Observe all water discharge lines to make certain that the cooling water is circulating properly. Recheck fuel and water lines and correct any leaks found in same. When all corrections have been made cast off and operate the engine at a moderate speed until it is thoroughly warmed up.

Do not operate the engine at more than 75% of the maximum rpm for the first 10 hours. In order to ascertain the maximum rpm in a particular installation it is permissible to operate the engine at wide open throttle for periods not to exceed 5 minutes duration after the engine has been thoroughly warmed up. During this 10 hour interim do not operate the engine at minimum idling speed for extended periods. Do not "run in" the engine with the reverse gear disengaged. Most of the running in this initial interim should be between 1000 rpm and 1500 rpm under load.

Before returning to the mooring from a trial run try the clutch controls in reverse position while the boat is out in open water to make certain that any remote controls installed are operating properly.

When the engine is stopped after being warmed up, it will not be necessary to choke the engine to restart. Never choke an engine that is warm. This may result in flooding. If the engine is flooded close the throttle to idling position and open the choke valves fully. Engage the starter and turn the engine for about a minute with the electric starter to blow out the excess fuel.

TO STOP ENGINE

After making a run it is suggested that the engine be operated at reduced speed for a period of four or five minutes to cool off and then turn the switch to "OFF" position. Do not turn the ignition switch to "OFF" position with the engine operating above idling speed except in the case of extreme emergency. If the engine continues to fire with the switch in the "OFF" position turn the switch back to "ON" position and let the engine idle until it is cooled off so that it will stop when the switch is again turned to "OFF" position. The reverse gear control should always be set at "NEUTRAL" position when the engine is stopped.

ACCESSORY DRIVE

The accessory drive assembly provides a means for driving the ignition distributors. The fuel pumps are also driven from the same shaft. A cam on the drive shaft is used to operate the fuel pumps. The principal caution to be observed in the assembly of this unit is to provide a slight back lash barely discernible in the gears.

CAMSHAFT

Each cylinder head on the Sea Raider Special Engine employs a single camshaft. The camshaft operates the intake and the exhaust valves. The camshaft used on the starboard bank is the same as used on the port bank. A different camshaft, however, is used on engines of opposite rotation. To insure long life of the cam surfaces it is essential that the proper tappet clearance be observed. The tappet clearances should be checked each 100 hours of operation and adjustments made if required. Insufficient tappet clearance will cause a scoring of the cam surfaces. The proper clearance between the valve tappet and the valve stem is .015" for intake valves and .025" for exhaust valves with engine warm. Two feeler gauges should be used, simultaneously, one under each valve tappet screw.

The camshaft is hollow and is supported in seven bearings. Oil is conducted under pressure through an oil manifold to the center camshaft bearing at which point it is admitted into the camshaft through a metering dowel. The oil within the camshaft is thus forced to the other camshaft bearings. Replacement of camshaft bearings is seldom required except after a very long period of operation. In replacing the camshaft bearings the proper practice is to replace the entire set as it is of the utmost importance that the camshaft be kept in plane. The camshaft bearings are of the bronze-backed babbitt lined shell type and are fitted without shims.

The end play of the camshaft is controlled by flanges on the rear camshaft bearing. The standard total end play is .005-.006". This clearance must be carefully observed since it is a factor in the back lash between the camshaft gear and camshaft drive pinion. When the end play exceeds .010" the condition should be corrected by the installation of new bearings.

The standard camshaft setting provides a closing of the exhaust valve at 5° after top center. The intake valve begins to open at dead top center. In checking the camshaft setting it is important to first provide proper tappet clearance between the valve tappet and the end of the valve stem.

A means of effecting a variation in the camshaft setting is provided through an adjustable coupling arrangement incorporated in the vee drive shaft. To expose this arrangement it is necessary to unship the large packing nut mounted on the housing enclosing the vee drive shaft. When this packing nut has been released four capscrews must be removed from the sleeve surrounding the adjustable coupling. After these screws are removed the sleeve can be pressed down into the housing exposing the coupling. Four capscrews maintain the coupling setting. After these capscrews are loosened the camshaft may be turned slightly without moving the crankshaft thereby affording the correction of any slight difference in the camshaft timing which might result by the installation of a new camshaft, a new camshaft gear or a new camshaft drive pinion. This adjustment can be made without difficulty. The principal caution to be observed is to make certain the coupling positioning capscrews are made tight before the housing sleeve is assembled. The housing sleeve must be reassembled before attempting to start the engine.

The camshaft drive pinion and shaft are mounted in a sleeve bearing which in turn is assembled in the housing attached to the after end of the cylinder head. The end play of the camshaft drive shaft is .004". This end play is controlled by the thickness of the thrust washers used under the camshaft drive pinion. The drive pinion and the camshaft gear are lubricated by a directed stream of oil coming from a metered fitting. The drive shaft runs in bushings that are lubricated under pressure from the engine oiling system. The back lash between the drive pinion and the camshaft gear should be .004-.006".

CARBURETORS

There are four Zenith downdraft carburetors model 23M4AV-16 equipped with flame arresters.

CARBURETOR SPECIFICATIONS

Part No.	Name of Part
C38-33	Venturi 44M/M
C51-10	Main Jet #39 = 1.95 M/M flow 694 to 703 cubic centimeters (See Note)
C52-3	Compensating Jet #34 = 1.7 M/M flow 549 to 558 cubic centimeters (See Note)
C56-1	Idling Jet #16 = .8 M/M. This jet is not flowed.
C58-1	Cap Jet #1. This jet is not flowed.
C50-4A	Cap Jet Base 4W. This jet is not flowed.
C55-1	Accelerating Jet #20 = 1.0 M/M. Not flowed.
C35-35x1	Accelerating Pump full stroke.
C111-67	Accelerating Pump check valve spring.
C81-15	Fuel valve seat #60 = 4 M/M. Not flowed.

Note. Jets are flowed with filtered fresh water at temperature 72° F. and 1 meter gravity head.

The Zenith 23 Series Carburetor is of the double venturi, downdraft type with the regular Zenith system of fuel metering. (See Fig. 1.)

Carburetor Air Capacity

The Large Venturi (1) controls the air capacity of the carburetor. Its size depends upon the piston displacement and the maximum operating speed of the engine.

The discharge end of the Small Venturi (12) is located near the throat of the large venturi, at the point of greatest suction. This arrangement produces a very high suction in the small venturi and helps to atomize the fuel.

The Fuel Metering System

The Main Jet (2), often referred to as the "high-speed jet," controls the mixture at intermediate and high speed. The fuel from this jet passes through the Cap Jet Base Retainer (25) and is discharged into the air stream through the slot in the Small Venturi (12).

The Compensator Jet (3) controls the mixture at low speed and idling. The fuel is metered by Compensator Jet (3) and passes through channel A and B into Well (13) and through

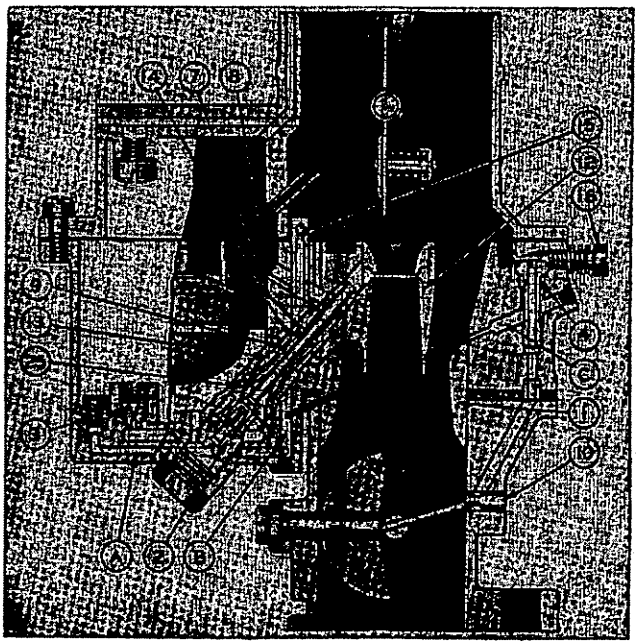


FIGURE 1

the holes in the Cap Jet Base (9), into the Annulus (14) between the Cap Jet Base and the Cap Jet Base Retainer. At low and intermediate speed the fuel passes through the Cap Jet Calibration (7) and Cap Jet Tip (8) and is discharged into the air stream through the slot in the small venturi. The Cap Jet Calibration, by means of the size and shape of its opening, controls the mixture at low and intermediate speed. Air is admitted into the Well (13) through the Ventilating Hole (15). Introducing air into the discharge jet below the fuel level reduces the surface tension of the fuel; in other words, helps fuel flow at low suction and restricts the fuel flow at high suction.

The Idling System which controls the mixture at closed throttle is in itself a small carburetor with a discharge jet, fuel metering jet and mixture control. The Idling Jet (4) meters the fuel and the Idling Adjusting Needle (16) controls the air for the mixture. The fuel enters the idling system through the Compensator Jet (3) and passes through Channels (A, B and C) to the Idling Jet (4) where it is mixed with the air.

The idling mixture is discharged through a specially shaped discharge jet, or a so-called Priming Plug (10), located at the throttle. When the engine is idling the air velocity at the

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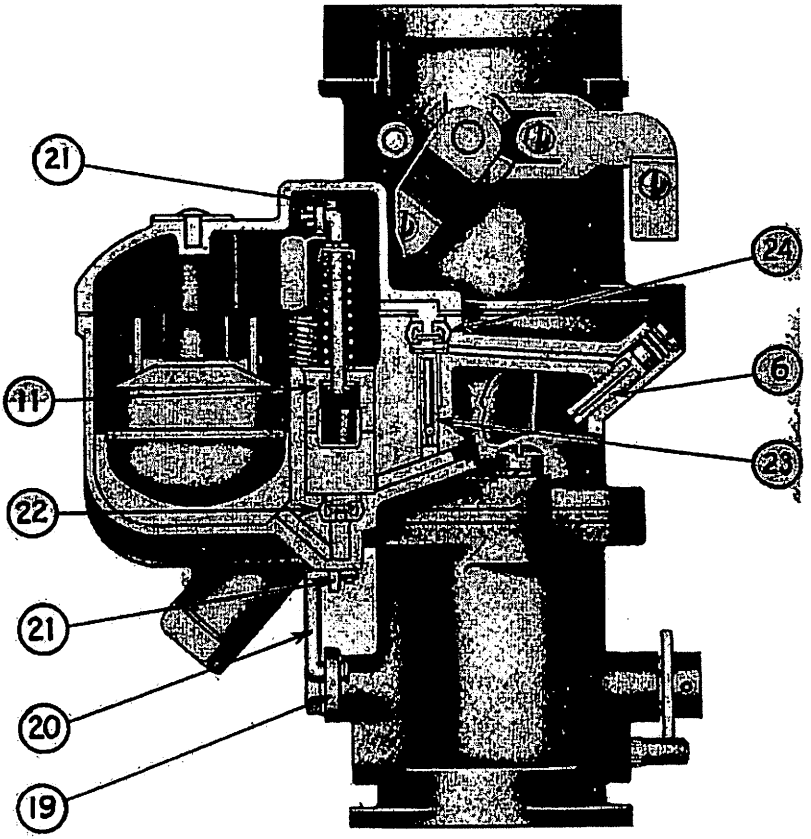


FIGURE 2

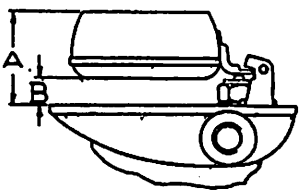
throttle is very high. By locating the Printing Plug (10) at the throttle complete atomization and distribution of the fuel is obtained.

The Accelerating Pump

(See Fig. 2.) When the throttle is opened, the Accelerating Pump Lever (19) and linkage (20 and 21) moves the accelerating pump piston down in the pump cylinder. Check valve (22) is closed by the pump pressure and the fuel contained in the pump cylinder (accelerating charge) is forced through Check Valve (23) and Accelerating Jet (6) into the air stream. Check Valve (24) is also closed by the accelerating pump pressure during the downward stroke of the piston and prevents the fuel charge from passing back into the float bowl.

Check Valve (23) is spring loaded (accelerating pump check valve spring C111-67) to prevent fuel from being sucked over at high-speed, wide-open throttle.

FLOAT SETTING



Tolerance of ±3/64" on the Following Dimensions:

Dimension "A" ---------- 2-3/32"
Dimension "B" ---------- 11/16"

Remove carburetor cover and invert same to check float setting.

CONNECTING RODS

An articulated type of connecting rod is used in this engine consisting of a master rod and a link rod. When installing connecting rods the rotation of the engine must be taken into consideration. The link rod must always lead the master rod in relation to the engine rotation. On the standard rotation engine the link rod is used on the starboard cylinder bank. On opposite rotation engine the link rod is used on the port cylinder bank.

Lubrication of all bearing surfaces is provided by the engine oiling system. Oil is forced to the connecting rod bearings through passages drilled in the crankshaft from both adjacent main bearings. In the master rod the oil is conducted through a rifle drilled passage to the piston pin bushing. Drilled passages conduct the oil to the bushings of the link rod and also to the piston pin bushing in the link rod.

The connecting rod bearings in the master rod are of the shell type. No shims are used. These bearing shells are not adjustable. Filing the connecting rod cap in an attempt

to provide an adjustment must be prohibited. If the bearings are badly worn, they should be replaced by new bearing shells. The lower shell is maintained in position by a dowel in the connecting rod cap. When installing the upper shell check the oil hole in it to see that there is no restriction of the oil passage for the lubricant to supply the link yoke and piston pin bushing.

The cap for the master rod is matched to the rod and piloted by dowel studs. Both the master rod and the cap are stamped with numbers indicating the pin of the crankshaft on which they should be replaced. When reassembling the connecting rod cap to the rod it is important that the numbers of the cap and rod be matched. When the connecting rods are installed on the crankshaft all numbers must be on the same side.

The link rod is attached to the master rod by a pin at the yoke end. The pin is maintained in position by a bolt which not only clamps the yoke pin but also dowels same through the medium of a groove provided. The positioning of the yoke pin is essential to maintain the alignment of oil holes. Oil is forced into the yoke pin which is plugged at each end. Holes in the pin are provided to lubricate the bushings in the yoke end of the link rod. Holes are also provided to permit forcing oil into passages drilled in the link rod to conduct the lubricant to the piston pin bushing.

The installation and removal of the link rod yoke pin can be made at only one point without interference either from the cheeks of the crankshaft or the web of the crankcase. This position is reached when the top of the piston on the master rod is approximately 1 1/2 inches below the top surface of the cylinder block casting on the upward stroke turning in the direction of the engine rotation. The link pin clamping bolt should be removed before the crankshaft is rotated to the aforementioned position.

To remove a connecting rod requires a rather extensive disassembly operation. Both the cylinder heads must be removed from the engine. See instructions under heading "Valve-Grinding." The oil pan on the engine must be removed. Unship the yoke pin clamping bolt and rotate the crankshaft to the point which will permit removing the yoke rod pin. When the yoke pin has been removed, the link rod with the piston may be worked up out of the cylinder block. If a complete disassembly of the engine is to be made, it is best to unship all six link rods and remove the cylinder block, pistons and link rods at one time.

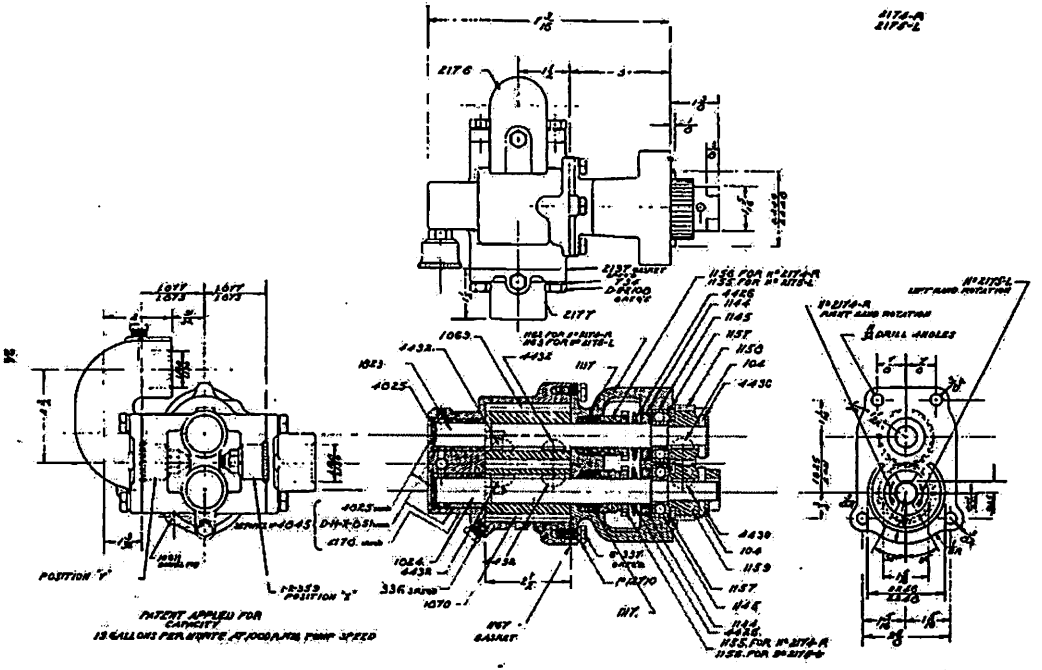
The master rod will not pass through the cylinder bore. It is therefore necessary to remove the cylinder block on the master rod side. If a complete disassembly of the engine is in process, it is best to unship all six master rods and lift the cylinder block together with the pistons and rods at the same time.

For instructions regarding the removal of the piston from the connecting rod see that portion of this booklet covering instructions on pistons.

A reversal of the above procedure is necessary to make an installation of connecting rods. Bear in mind that the rotation of the engine determines the location of the master rod as compared to the link rod. Make certain that the identification numbers on the master rod and cap are matched. The link rods are numbered and should match the master rods. The

master rods must be properly fastened before attempting to install the link rods. After the master rods are installed the link rods should receive the next consideration. When installing the link rod yoke pin make certain that the groove for the lock bolt is in its proper position. After the pin has been pushed into place, the crankshaft should be rotated so that access is to be had to allow the clamping bolt to be installed. Make certain that all connections are made tight and properly locked with cotter pins.

ALL BEARING SURFACES MUST BE COATED WITH A FILM OF OIL BEFORE THEY ARE ASSEMBLED. THIS WILL PROVIDE LUBRICATION UNTIL THE ENGINE SYSTEM TAKES UP THAT TASK.



FRESH WATER PUMP

FRESH WATER OR INDIRECT COOLING SYSTEM

. This system is sometimes referred to as a closed cooling system and in some instances, it is called a fresh water cooling system. The purpose of the system is to provide a means of using fresh water in the water jackets of the engine and, in turn, cooling this fresh water with raw or sea water in which the boat is operating. Two separate water systems are thus employed. These are called the raw water and the fresh water system.

Raw Water System: The raw water system uses the water in which the boat is operating and its function is to cool the fresh water used in the engine cooling system through the medium of a heat exchanger. Raw water must be piped from the inlet connection in the hull to the water-jacket of the reduction gear housing. From there it is conducted through tubing to the raw water pump from which it is then forced through the heat exchanger units and discharged. The raw water pump suction line must be fitted with a strainer so located that access may be had for cleaning purposes. Periodic inspection of this strainer should be made. If the unit is operating in dirty water this inspection should be made daily.

To insure long life of the raw water pump all foreign matter must be prevented from passing through the pump. If foreign matter passes through the pump it becomes lodged in the heat exchanger restricting that unit so that excessive back pressure is built up against the raw water pump. The raw water passages of the heat exchanger should be inspected and cleaned each 200 hours of operation unless operating conditions show that an inspection is required more frequently.

Due to the large volume of water used in the raw water system, it is recommended that only a portion of this water be used for exhaust line cooling purposes and a separate discharge line be arranged for disposal of the larger portion. Any disposal line installed should be kept free of restrictions and the combined area of the exhaust pipe cooling water pipe plus the area of the disposal line should, in no case, be smaller than the area of raw water pump discharge. DO NOT ROTATE THE HEAT EXCHANGER COVER. THE DISCHARGE CONNECTION MUST BE MAINTAINED IN POSITION SHOWN ON PHOTOGRAPHS OF ENGINE TO SECURE PROPER BAFFLING EFFECT. OVERHEATING WILL RESULT IF THIS CAUTION IS IGNORED.

In the raw water system the direction of flow is as follows: Raw water is first drawn from the hull fitting through the raw water strainer then through the water-jacket on the reduction gear housing from which it passes through a long tube along the side of the engine and into the inlet of the raw water pump. The raw water pump is mounted on a bracket attached to the engine rail on the starboard side of the engine near the starting motor. After passing through the raw water pump the water is carried forward and across the engine through a line which goes to a threaded hose nipple in the base of each one of the heat exchangers. After passing through the inside of the tubes in the heat exchanger, the water is collected and discharged through a threaded opening in the top cover of the heat exchanger. As previously advised, the top or bottom cover of the heat exchanger must not be rotated because the raw water circulation through the heat exchanger is of the three-pass type. The raw water enters the base of the heat exchanger, goes to the top where it is baffled so that

it is forced down through the center section of the cooling element where a baffle in the lower cover again directs the water upward through the tubes where it is collected by the top cover for discharge overboard.

The raw water pump is of the belt driven double gear type. In addition to the usual bronze pumping gears in the after body of the pump, this pump is equipped with steel driving gears which drive both the upper and lower pumping gears. The extra steel gears are intended to prevent sand cutting of the pump gears by holding the pumping gear teeth from metal to metal contact. These auxiliary gears are located in a splash lubricated gear box at the forward end of the pump. Leakage from the gear housing along the rotating shaft is prevented by means of a self-adjusting oil seal. The pump gear housing should be lubricated with SAE 40 engine oil and the level should be maintained up to the oil level plug on the outside of the gear housing at all times. The gear housing is equipped with a breather plug which may be removed for replenishing the lubricant. Leakage of water from the pumping chamber along the drive shafts is prevented by rotating seals which are spring loaded and therefore self-adjusting. Further information concerning the construction of this pump may be obtained by referring to the sectional assembly drawing appearing on Page 29.

Fresh Water System: The engine is cooled by a closed system. Use fresh water only in the closed system. A supply of fresh water sufficient to replenish the closed system should always be carried aboard.

Filling the Fresh Water System: Remove the cover of the WATER supply tank which is located over the flywheel housing of the engine. The filling should be accomplished slowly to permit the water to circulate throughout the passages in the engine. The engine should be started and operated for two or three minutes adding water, if necessary, to maintain the level. After the closed system has been filled, the level of the water in the supply tank should be checked daily, prior to starting the engine. Approximately 18 gallons of fresh water or antifreeze solution are required to fill the fresh water system.

The fresh water which is passed through the water jackets of the cylinder block, cylinder head and exhaust manifold is drawn from the bottom of the fresh water tank through the heat exchanger. After the water is picked up by the fresh water pump, it is forced into a line running along the outside of the cylinder block to the oil cooler. After passing over the oil cooler elements, the water is discharged into a line which is connected to a flange on the top of the water jacket of the exhaust manifold. From the jacket of the exhaust manifold the water is then distributed into the lower part of the cylinder block through three short connections, and into the upper part of the cylinder block through a hole in each of the exhaust manifold flanges. After passing through the cylinder block and cylinder head the water is discharged into the thermostat housing from which it flows through a line connected to the top of the fresh water tank. The water circuit described above is the normal one followed after the engine has reached a temperature of 160° and the main valve of the thermostat is opened. Prior to the time the engine reaches a temperature of 160° the main valve of the thermostat is closed and water passes through the by-pass valve of the thermostat and returns to the suction side of the water pump without being cooled by the heat exchanger. Each bank of cylinders is equipped with its own water pump, oil cooler, thermostat and heat ex-

changer so that the equipment described above will be found duplicated on the opposite bank of the engine. The fresh water tank, however, is common to both systems and forms a main reservoir for cooling water. The fresh water tank is equipped with a large screen to prevent scale, water pump grease and other foreign matter from obstructing the fresh water passages in the heat exchangers. The fresh water tank screen should be inspected periodically by looking through the filler cap opening and in event that the screen requires cleaning, it may be reached by removing a large circular cover on top of the fresh water tank.

The fresh or jacket water pumps are of the two-gear type and are driven by bevel gears on the vertical drive shaft. The steel spur gears of which are automatically lubricated from the main oil supply of the engine. The drive shafts of these pumps are equipped with packing glands which must be kept tight in order to prevent loss of fresh water or anti-freeze solution. Internal construction of the fresh water pumps is shown in the cross-sectional assembly on Page 24. The packing glands on the fresh water pump are threaded to correspond to the rotation of the drive shaft so that the rotation of the shaft tends to keep the glands tight. Two pumps #2175-L of identical construction are used on the standard rotation engines. Opposite rotation engines are equipped with two #2174-R pumps.

Inspect the bronze gears of the pumps after each 200 hours of operation. This may be accomplished by unshipping the water line connections. When these flanges are free remove the capscrews which fasten the water pump gear cover and slip the cover endwise off the gears. Gears which are badly pitted or scored should be replaced. Inspect the cover and replace if it shows worn faces. Operation in water having sand in suspension causes rapid wear of water pump gears. Boats in such service should carry spare pumps in reserve.

Plates are mounted on the side of the cylinder block. The removal of these plates will permit access to the water jackets for the purpose of removing sediment and scale. Clean-out plates are provided on the exhaust manifold also. The water jacket passages should be inspected and cleaned each 1000 hours of operation.

Operating Temperature: Normal temperature of the fresh water system with the engine in operation long enough to warm up is approximately 165° F. A sudden change from wide open throttle to idle position will cause a slight rise in indicated temperatures. This is not an indication of trouble and the temperature will quickly revert to normal. A slight rise in temperature may be expected when the engine is stopped. This is normal.

Any sudden increase of temperature other than those mentioned indicates the need of examining the fresh water system. Excessive temperature indications may be caused by:

(1) Lack of water in the supply tank.
Remedy: Add sufficient fresh water to bring level to the proper height in the tank. A reserve supply of fresh water should be carried aboard the boat to be used for making any required replacement.

(2) Clogged screen in fresh water tank.
Remedy: Clean the screen. If water pump grease in excessive amount is used in the fresh water pump, the excess grease will be forced into the fresh water

system. Grease will pass through the engine and may lodge in the screen in the fresh water tank. The screen is installed to prevent the grease and scale from getting through to the heat exchanged unit as it is easier to clean the screen than it is to clean the heat exchanger unit. If the screen is restricted with grease it should be soaked in a solvent. Use kerosene or fuel oil. If gasoline is used as a solvent, be certain that the work is performed out-of-doors and not in any confined space.

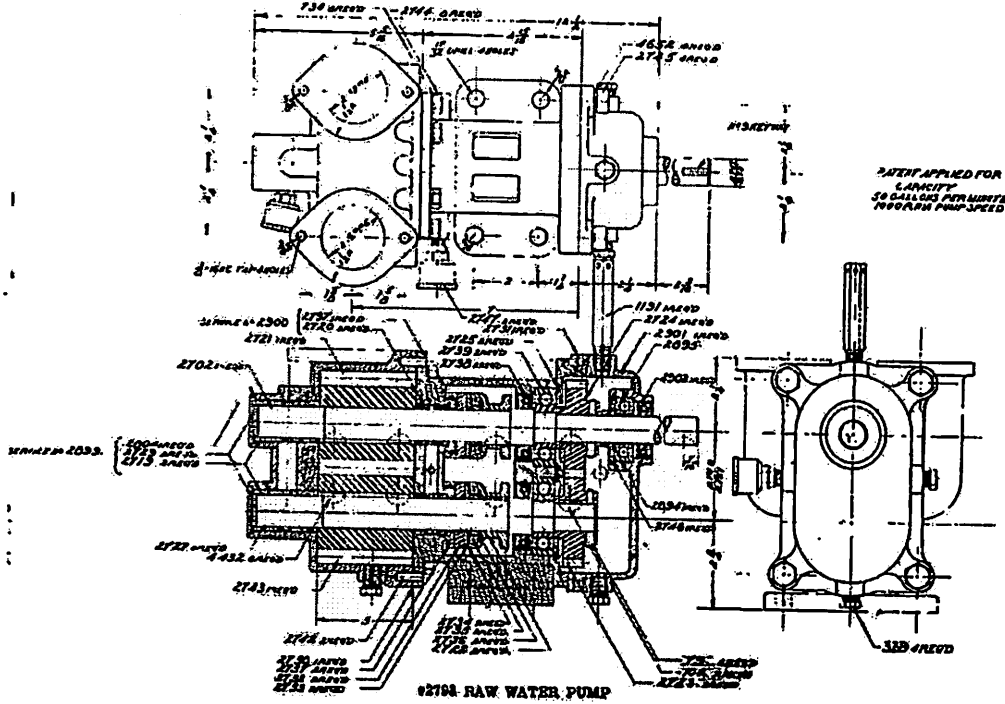
(3) Lack of water in the engine system caused by leak in water connections.
Remedy: Repair the leak and refill the system to proper level. Caution: If a large proportion of the fresh water has been lost through a leak always allow the engine to cool off before refilling the system to prevent any possible damage to parts caused by cold water coming into contact with overheated castings.

(4) Insufficient circulation of raw water.
Remedy: Investigate the condition of raw water inlet strainer. If dual raw water strainers are installed, turn the valve so that the water goes through the clean side of the strainer. If no obstructions are found in the strainer, check all connections for leaks in the raw water line. If the raw water pump leaks at the packing glands, the seal disc should be replaced. If the trouble cannot be located in the suction line, the water pump or the line to the heat exchanger, disassemble and inspect the heat exchanger to see if these water passages are obstructed by foreign matter.

Thermostat: To check the thermostat unit, the unit may be removed from the engine and placed in a container with sufficient fresh water to completely cover the unit. Place a thermometer in the container and heat the water slowly. The thermostat valve will begin to open at approximately 160° F. if the unit is in good order. The opening of the valve will increase as the temperature rises. The valve will close quickly if the unit is removed from the water due to the drop in temperature.

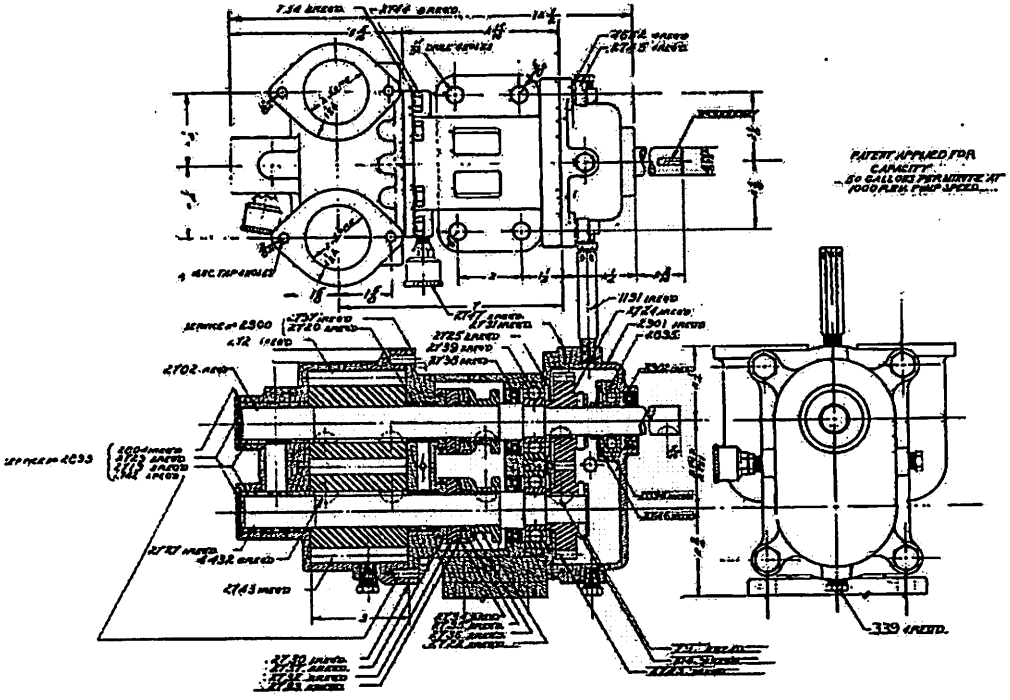
Cold Weather Operation: The capacity of the closed cooling system on the engine is eighteen gallons. Note: If a boat heating system is incorporated in the fresh water hook-up this capacity will change. IF ANTI-FREEZE SOLUTIONS ARE USED THE CORRECT CAPACITY SHOULD BE TAKEN INTO CONSIDERATION IN CALCULATING ANTI-FREEZE PROPORTIONS. If an anti-freeze solution is used in the closed system, remember that the raw water system must be drained after each period of operation to prevent ice forming in the raw water line. There are five raw water drains provided on the engine. The raw water drains are located as follows:

(1) Under the pumping body of the raw water pump.
(2) At the lowest point in the raw water line near the reduction gear.
(3) The lower drain on the side of each heat exchanger base.
(4) The water jacket of the Reduction Gear.



#2798 RAW WATER PUMP

Supplied on Contracts: W1311QM-310
and First 37 Engines in Contract W2759 TC-58



#2199 RAW WATER PUMP Supplied on Contract W1746-TC-38
after first 37 Engines.

RAW WATER STRAINERS SHOULD BE DRAINED

If anti-freeze is not used in the CLOSED SYSTEM, this system must be drained during freezing temperatures. Ten drains are provided for the closed system and are located as follows:

(1) At the underside of each fresh water pump.
(2) On the underside of each elbow attached to each fresh water pump.
(3) The drain plug on the side of each heat exchanger body.
(4) At the after end of the cylinder block on the outside of each bank.

It is suggested that the fresh water in the closed system be drained out and replaced with fresh water at least twice a year if the boat is operating at a station where drainings are not required by climatic conditions.

CRANKSHAFT

A counterweighted seven bearing crankshaft is used in the Sea Raider Special engine. The crankshaft is flanged at the forward end to receive the flywheel. The driving end of the crankshaft is tapered. The crankshaft is drilled to conduct the lubricating oil from the main bearings to the connecting rod pins. The after end of the crankshaft is drilled to conduct lubricating oil to the reverse gear.

Steel back alloy faced bearings are used for both main and connecting rod bearings.

The end play of the crankshaft is controlled at the rear main bearing. The bearing shells used at this point are provided with flanges. The clearance between these flanges and the crankshaft check on the forward side or the crankshaft gear on the after side must be .006-.007" total. When installing new main bearings this end play clearance must be provided.

To install new main bearing shells it is best to invert the crankcase so that the crankshaft may be lowered into place. The crankshaft gear must be in position on the crankshaft. If the vertical shaft gear (part #V-357-1) has been disturbed, it should be remounted before the crankshaft is lowered into the crankcase.

Insert the upper bearing shells in the crankcase centering all of the shells carefully so that the overlap is equal on each side. The shells for #7 bearing are provided with flanges. Note that there is a slight difference in the thickness of the flanges. Place the lower shell for #7 bearing in position and for the purpose of checking the end play clearance install only the cap for #7 bearing. Install the cap so that the number stamped thereon is on the same side of the engine as the number stamped on the crankcase. After setting up tightly on the nuts holding the bearing cap in place take a small pinch bar and move the crankshaft as far forward as it will go. Using a feeler gauge ascertain the clearance between the crankshaft check and the front flange of the rear bearing. Next check the back lash between the crankshaft gear and the vertical shaft gear. With the crankshaft moved as far as possible forward there should be .004" back lash between these two gears.

If there is ample back lash between the two gears but insufficient end play between the crankshaft and the bearing flange reverse the bearing shell so that the thicker flange is on the other side of the web and check again for crankshaft end play.

When the crankshaft is moved as far aft as possible there should be no back lash between the two gears. If a back lash results in this position after the proper crankshaft end play has been provided it is necessary to reduce the thickness of the upper thrust washer on the vertical drive gear. This will result in a closer meshing of the two gears which should be tight when the crankshaft is in the after position. Any adjustment to the vertical drive gear should not be made until after proper end play clearance is obtained between the crankshaft and #7 main bearing.

If it is found necessary to increase the clearance as provided by the new bearing shells on #7 bearing file the thick flange of the bearing to secure the proper end play. Remember that the thick flange of the bearing in #7 cap must be on the same side as the thick flange of the upper shell in the crankcase.

After #7 bearing is properly fitted and the cap installed, fit the lower bearing shells to the remaining bearing caps. The shells should be carefully centered so that the overlap extending beyond the edge of the bearing cap is equal on both sides. A careful inspection should be made of the alignment of the oil hole in the bearing cap and the oil hole in the bearing shell. Open up the hole in the bearing shell if it is necessary to produce a proper alignment with the oil hole as it is important that there be no restriction in the oil line.

Main bearing stud nuts should be pulled up with even tension. The correct tension is 150 ft. lbs. Use a torque indicator wrench for this if it is possible to do so. Cotter pins should be carefully installed and locked. Check each nut individually to see that the cotter pin has been properly installed and locked.

Whenever the crankshaft is removed from an engine the oil holes drilled in the shaft to conduct the oil to the connecting rod bearings should receive a thorough and careful cleaning. Oil holes are drilled from the main journal to the adjacent connecting rod pins. The after end of the crankshaft is drilled to provide lubrication for the reverse gear unit. This passage also should receive attention and be carefully cleaned.

Bolts used for mounting the flywheel to the crankshaft should be inserted in the crankshaft before the crankshaft is lowered into the crankcase.

Caution: No shims are used in the shell type bearings in this engine. If the diametrical clearance is excessive replace both halves of the bearing shell. Never file bearing caps in an attempt to make an adjustment. This destroys the concentricity of the bearing.

VIBRATION DAMPER

All crankshafts have a natural period of torsional vibration i.e., the crankshaft normally rotates in the main bearings at a relatively uniform r.p.m. At certain speeds it may, however, also vibrate about its center of rotation with an oscillating motion. The connecting rods of the engine on the power strokes apply impulses to the crankshaft and should the frequency of these forces coincide with the natural period of vibration of the crankshaft, the amplitude of the torsional movement may become great enough, at certain speeds, to cause an appreciable stress in the material of the crankshaft. To prevent the shaft from being subjected to the vibratory torsional stress, the Sea Raider Special is equipped with a vibration damper.

The damper consists of the following principal parts: a center hub which is bolted rigidly to the crankshaft, a steel disc which is in turn bolted to the center hub, a flywheel or inertia members supported on a bronze bushing and flexibly driven by a layer of vulcanized rubber which is bonded to both the flywheel and the steel disc of the damper. The flywheel can, therefore, oscillate on the bronze bushing within the restraining limits imposed by the rubber. It can be seen that the flywheel, within certain narrow limits, can either proceed or lag slightly behind the normal rotational movement of the crankshaft. Conversely, if the crankshaft tends to vibrate in a rotary manner in its main bearings, this movement is suppressed due to the damping action of the rubber between the crankshaft and the flywheel.

To obtain maximum efficiency and not have an actual detrimental effect, each type of damper must be specifically designed and tested for use with a particular model engine with the rubber composition and hardness held to within very narrow limits.

Six steel safety studs have been provided so that the flywheel will be retained in place in event the rubber bond should fail for any reason.

The steel gear for the starting motor is mounted on the flywheel in the conventional manner and when the starter pinion engages this ring gear, the cranking effort is carried through the rubber between the plate and the flywheel to the crankshaft. The rubber of the damper has been given a protective coating prior to shipment. It should not, however, be unnecessarily exposed to lubricating oil for a long period of time. The bushing in the flywheel is of a special design, in that the inner surface is recessed to retain a heavy grade of lubricant. The design of the bushing is such that same need be inspected, cleaned and re-greased only at the time the engine is overhauled.

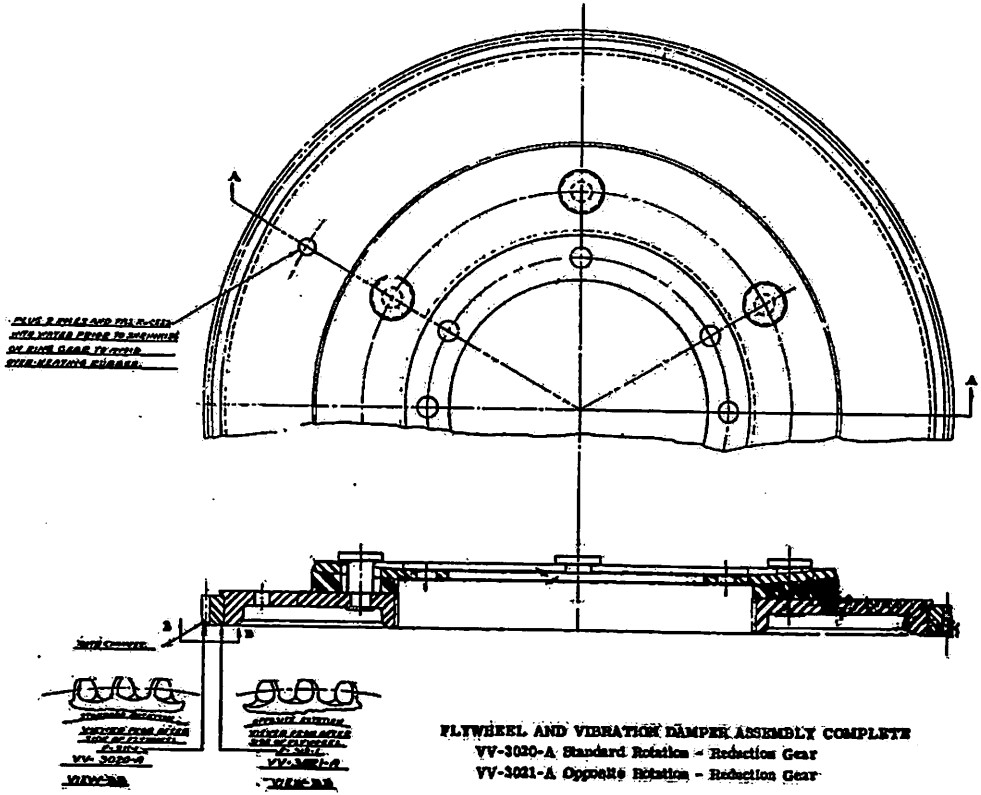
After an overhaul the vibration damper bushing should be repacked with Texaco Marfax #3 or equivalent. Do not overlubricate. Use only sufficient grease to fill the depressions in the inside of the damper bushing. Prior to final assembly, the rubber behind the bushing and on the outside may be protected by U.S.R. Cote #5060 manufactured by the U. S. Rubber Company, Detroit, Michigan.

Nominal clearance between the inside diameter flywheel and the outside diameter bushing is .001 tight to .001 loose. (A light Tap Fit.) A clearance of .002 to .004 is allowed between the outside diameter of the hub and the inside of the bushing.

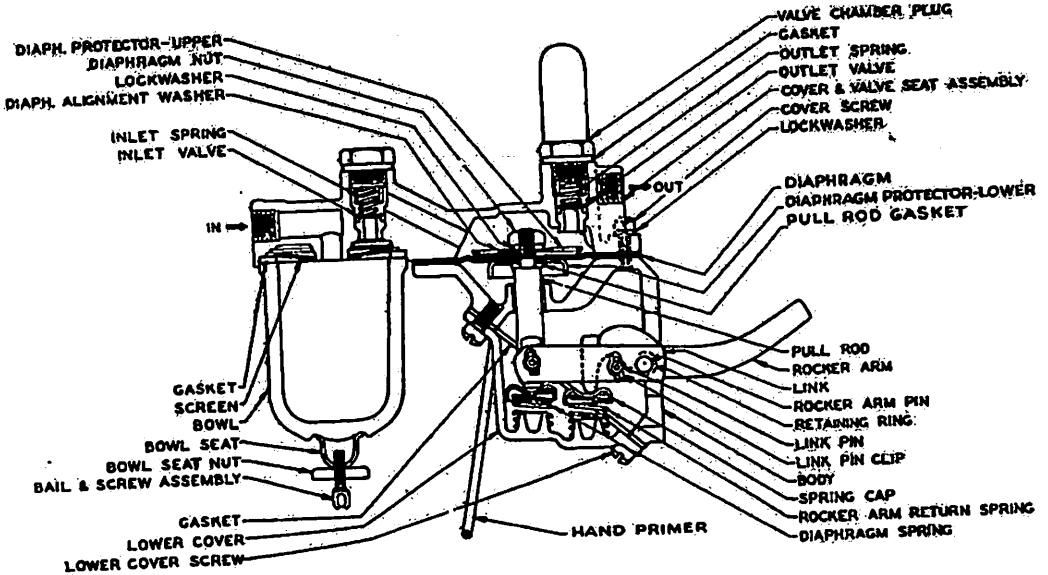
When installing a new bushing the fit of the hub in the bushing should be checked prior to installing the dowels in the hub and the front plate. The hub should turn freely but without appreciable side motion if the clearances are correct.

The cross-sectional assembly shows the correct arrangement of the parts of the damper assembly. Two kinds of dampers are supplied on the Sea Raider Special. The reduction gear type may be identified by a 13-5/16" diameter front plate.

Dampers having a front plate diameter of 15-1/4" or a symbol VV-3063-A stenciled in the front plate having a smaller diameter of 13-5/16" have been especially designed and tuned for direct drive installations and they must not be used on engines equipped with reduction gears.



FLYWHEEL AND VIBRATION DAMPER ASSEMBLY COMPLETE
VV-3020-A Standard Rotation - Reduction Gear
VV-3021-A Opposite Rotation - Reduction Gear


DIAPH. PROTECTOR-UPPER
DIAPHRAGM NUT
LOCKWASHER
DIAPH. ALIGNMENT WASHER
INLET SPRING
INLET VALVE
IN
GASKET
SCREEN
BOWL
BOWL SEAT
BOWL SEAT NUT
BAIL & SCREW ASSEMBLY
GASKET
LOWER COVER
LOWER COVER SCREW
VALVE CHAMBER PLUG
GASKET
OUTLET SPRING
OUTLET VALVE
COVER & VALVE SEAT ASSEMBLY
COVER SCREW
LOCKWASHER
OUT
DIAPHRAGM
DIAPHRAGM PROTECTOR-LOWER
PULL ROD GASKET
PULL ROD
ROCKER ARM
LINK
ROCKER ARM PIN
RETAINING RING
LINK PIN
LINK PIN CLIP
BODY
SPRING CAP
ROCKER ARM RETURN SPRING
DIAPHRAGM SPRING
HAND PRIMER

FUEL PUMP

FUEL PUMP

The fuel pump supplied on the engine is of a conventional mechanically operated diaphragm type. The fuel pump is fitted with a bowl in which will be found a screen that should receive periodic inspection. Dirt and water will accumulate in the strainer bowl. Make certain that the shut-off valve in the fuel line is closed before attempting to remove the bowl from the fuel pump. The fuel pump is fitted with a hand priming device which may be used to fill the carburetor bowl. This device should be used when the engine is started for the first time or after any occasion requiring the draining of the carburetor bowl. It will reduce the amount of cranking by the starting motor that otherwise would be required. Make use of this feature and save the storage battery.

A study of the accompanying sectional illustration of the fuel pump will provide an understanding of its construction. If a bit of dirt under the check valve in the pump renders it inoperative, make certain that the valves lie perfectly flat on the valve seat when reinstalled after cleaning. Do not distort or stretch the valve springs as this affects the pressure setting.

To install a new diaphragm in the fuel pump requires careful attention to the following details. Place the diaphragm over the threaded end of the pull rod. Line up the holes in the diaphragm with the screw holes in the body diaphragm flange. Place the upper diaphragm protector washer over the threaded end of the pull rod cup-side up. Place the hexagon shaped diaphragm alignment washer over the end of the pull rod. Assemble the lock washer and the pull rod nut, maintaining the position of the diaphragm alignment washer and keeping the diaphragm from twisting and turning.

THE POSITION OF THE DIAPHRAGM WHEN THE FUEL PUMP COVER IS ASSEMBLED IS THE MOST IMPORTANT SINGLE ITEM TO BE OBSERVED IN REPAIRING OR ASSEMBLING THIS TYPE OF FUEL PUMP. IF THE DIAPHRAGM IS NOT IN THE PROPER POSITION WHEN THE TOP COVER SCREWS ARE TIGHTENED, THE PUMP WILL NOT FUNCTION CORRECTLY WHEN REPLACED ON THE ENGINE. Lay the cover on the pump in the proper position determined by marks made on the cover and body before the pump was disassembled. Insert screws from the top through the lock washers, the upper cover and diaphragm. Tighten the screws until they barely engage the lock washers. Now use a small screwdriver and exert a pressure upward on the linkage so that the diaphragm is forced to its extreme high position. While it is held in this position the cover screws should be tightened alternately and securely.

LUBRICATION

A full pressure dry sump system is employed for the lubrication of the Kermath Sea Raider Special engine. The system consists of a dual oil pump, a reservoir, related oil lines and drilled passages. The oil pump is provided with two separate sections, one section being termed the scavenger pump and the other section is used as a pressure pump. The pump is located at the after end of the crankcase between the vee of the cylinder blocks. The oil reservoir is located at the forward end of the engine directly over the flywheel housing.

The system is simple in operation. The oil which is spilled off the bearings within the engine accumulates in a small sump in the oil pan. This oil is picked up by the scavenger pump and returned to the oil reservoir. The pressure pump takes the oil from the reservoir and forces it through the lubrication system of the engine.

The sole function of the scavenger pump is to take the oil from the oil pan and return it to the reservoir. In the event the scavenger pump fails to fulfill this duty, first examine all scavenger pump suction line connections to make certain that there are no leaks. Do this before taking the pump apart. The end of the oil pump suction line in the oil pan is protected by a screen. This screen is of large area and will seldom require cleaning except at such times as the engine may be disassembled for a general overhauling.

The function of the pressure pump is to force the oil to all of the bearings in the engine. When the oil leaves the pressure pump it is carried through an oil manifold which is connected to each of the seven main bearing caps. From each main bearing the oil is forced through holes drilled in the crankshaft to the connecting rod pins. From the connecting rod bearings oil is forced through drilled holes to the wrist pin bushings.

The reverse gear is lubricated by the engine oiling system. Oil is forced to the reverse gear unit through a passage drilled in the after end of the crankshaft.

The camshaft bearings are lubricated by a line which is tapped off from the main pressure pump discharge line. This line connects with a drilled passage at the under side of the after end of the cylinder head. On the upper side of the cylinder head this passage is again connected with an oil manifold which conducts the oil to the center camshaft bearing. At this point the oil is admitted to the interior of the hollow camshaft and conducted from the center main bearing to the remaining camshaft bearings. Sufficient oil is spilled off the camshaft bearings to adequately lubricate the valve tappets, valve tappet bushings and valve stems. The camshaft drive pinion and the camshaft driven gear are lubricated by a spray directed on the teeth coming from a metered fitting. The surplus oil accumulating on top of the cylinder head is conducted back to the oil pan by way of the vertical shaft housing and en route floods all of the gearing in this drive. All bushings in the camshaft driving mechanism are lubricated under pressure through drilled holes. All oil coming down the vertical shaft housing drops into the oil pan and returns to the small sump from which it is removed by the scavenger pump and placed in the reservoir over the flywheel for recirculation.

Two lubricating oil coolers are used on each engine. An oil cooler is mounted on each side of the oil tank. The oil coolers are of the plate type. Oil coming from the scavenger pump passes through this cooler and is then admitted to the reservoir. A relief valve is used to prevent building up an excessive pressure within the cooler unit and is incorporated in the scavenger return line just back of the oil tank.

The plate type cooler will lose its effectiveness if formation of gum or foreign matter restricts the flow of the oil through the plate assembly. For this reason a periodic cleaning of the unit is recommended. The setting of cleaning periods will be determined by the characteristics of the service in which the engine is engaged and also by the quality of the oil being used. The operator should determine the time between cleaning periods by studying the oil temperatures. If the oil temperatures gradually increase and the increase cannot be attributed to climatic conditions the cooler unit should be cleaned.

To clean the cooler unit it must be removed from the engine. Submerge the cooler unit in a solvent such as carbontetrachloride, gasoline or kerosene. Place the cooler unit in the solvent so that the openings of the unit are on top so that no air can be trapped in the cooler unit. If a hand operated oil pump is available force the circulation of the solvent through the unit. If there is a source of compressed air available use air at low pressure to assist in forcing the solvent through the oil passage spaces. All cleansing operations should be carried out in the open air. Do not attempt to clean the unit using the solvents mentioned in a confined enclosure. Carbontetrachloride acts more rapidly than gasoline or kerosene. Gasoline or kerosene are effective if sufficient time is allowed for soaking. Beware of fire if either of these latter two liquids are used. Make certain that all of the solvent is drained out of the unit before making a reassembly of the oil cooler.

Unless experience indicates the need of a more frequent cleaning it is suggested that the unit be cleaned each 200 hours of operation.

Grease cups are provided for the lubrication of the water pump shaft. Use waterproof grease for this purpose. The water pump shaft should be lubricated before each days operation but the lubricant should be used sparingly.

The generator is also provided with grease cups which should be filled with a light grade of regular cup grease. Avoid over lubrication, as it is only necessary to turn the cap of the cup down until a very light pressure is exerted on the grease.

The distributor should receive a drop of oil at the same time. The starting motor requires no outside lubrication as it is provided with oilless type bushings.

Be careful to avoid over lubrication of the engine. The quantity of oil required to fill the lubricating system will vary slightly with different angles of installation in the boat. Engines fitted with reduction gears supplied under contract W 1311 tc-310 and W 2789 tc-58 are pressure lubricated from the engine oiling system. Oil is conducted through a hole drilled in the after end of the crankshaft to the reverse gear. The tailshaft of the reverse gear is drilled to carry the oil back in to the reduction gear. Oil return holes are drilled through the reduction gear adapter plate and the oil pan flange. Due to the large diameter of the reduction gear housing some oil will be trapped in the reduction gear, particularly at low speeds but it will be returned to the system when the engine reaches approximately 1500 R.P.M. It is advisable, therefore, to check the lubricating oil in the tank while the engine is operating at cruising speed just prior to the completion of the run. By proceeding in this manner the correct amount of lubricating oil will be in the engine for the next run.

To Fill the Oiling System

All oil is drained from the engine before it is shipped from the factory. When starting a new engine, for the first time, pour eight gallons of oil in to the oil reservoir (tank nearest the cylinder block). Remove the cover of the reverse gear housing and pour about one gallon of oil over the reverse gear and operating mechanism, making certain that some oil reaches the ball bearing throw-out collar and the exterior surface of the reverse gear drum. Replace the cover plate and tighten holding screws. When the engine is started and is idled at the dock, a quantity of lubricating oil will disappear from the tank, as it is pumped back in to and retained in the reduction gear housing.

After the engine is warmed up and the boat is under way at a cruising speed of approximately 1500 R.P.M., the oil which has previously been retained in the reduction gear housing will be returned to the oil pan, where it will be picked up by the scavenger pump and returned to the oil tank and this will result in a gradual increase in the quantity of oil in the main tank. While the engines are operating at 1500 R.P.M. or above, additional oil should be added if necessary to bring the oil level up to within approximately three inches from the top of the filler opening in the oil tank.

Do not try to fill the oil reservoir to the brim. The reservoir is provided with an overflow which will conduct excess oil back into the oil pan. When the engine is in operation a comparatively small quantity of oil is in the oil pan. If an excessive quantity of oil is admitted to the system the after connecting rods may splash in the oil and cause a fouling of those cylinders.

USE SAE #40 OIL WHEN THE WATER TEMPERATURE IS 45° F. OR HIGHER. USE SAE #20 OIL IF THE WATER TEMPERATURE IS BELOW 20° F. USE THE BEST GRADE OIL AVAILABLE IN YOUR VICINITY THAT IS FREE OF AGENTS WHICH MIGHT PROVE DETRIMENTAL TO ALLOY TYPE BEARINGS.

To Change Engine Oil

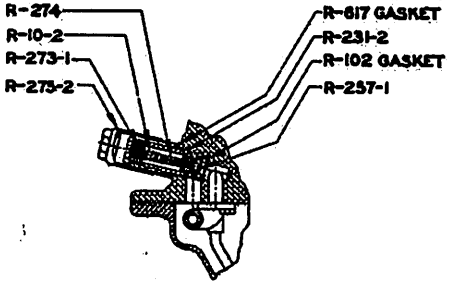
The engine lubricating oil should be changed each 100 hours of operation. The best time to change the engine oil is after the engine has had a run of sufficient duration to thoroughly warm up the oil. Place a suitable container of adequate capacity beneath the drain cock provided at the oil reservoir and drain off the oil in the tank. To get out the small amount remaining in the oil pan start the engine and operate at the lowest possible speed. As soon as the oil ceases to flow from the tank stop the engine and refill the system with new oil. If the oil is dirty when withdrawn from the engine change the filter cartridges on engines

Engines fitted with the plate type oil coolers have incorporated in the lubricating system two cartridge type filter units. The filter units are mounted inside of the reservoir. Access to the filter cartridges may be had by removing the circular covers attached to the upper surface of the oil reservoir. The filter cartridges are provided with handles to make easy their withdrawal. New filter replacement cartridges should always be carried as spares.

Oil Pressure Adjustment

To prevent building up excessive pressures in the oil lines a spring loaded relief valve is incorporated in the lubricating system. The relief valve will be found on the side of the crankcase just aft of the flywheel housing on the generator side of the engine. The relief valve is adjustable. When the protecting cover is removed a slotted screw will be exposed. To increase the pressure turn the screw to the right. To decrease the pressure turn the screw to the left. Any adjustment of the oil pressure relief valve must be made when the oil is hot.

The standard setting of this relief valve will register a minimum of 60 pounds pressure on the oil pressure gauge when the engine is operating at wide open throttle and the oil is hot. The indicated pressure can be expected to drop off as the engine speed is reduced.



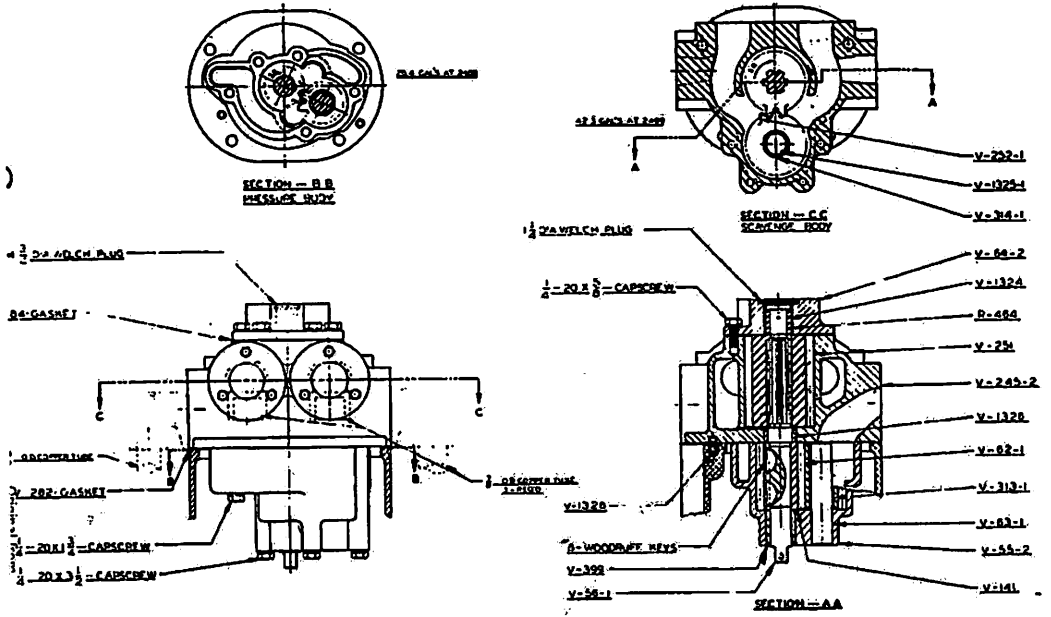
OIL PRESSURE REGULATOR ASSEMBLY

Oil Pump

The oil pump is located between the cylinder banks at the after end of the vee of the engine. A dual oil pump is used consisting of a scavenger and pressure section. The pump operates at crankshaft speed.

The scavenger pump removes the oil as it accumulates in the oil pan and returns this oil to the tank located over the flywheel housing. The scavenger pump comprises the upper portion of the assembly. To disassemble this portion of the pump it is not necessary to remove the entire pump from the engine. The oil pump cover may be removed exposing the scavenger pump gears. The scavenger pump drive gear is splined on the driving shaft. The idler gear is provided with bushings. Both gears may be slipped off the shaft after the pump cover is removed. Clearances to enable one to check for wear in this portion of the pump is to be found listed in the Table of Clearances. In reassembling the scavenger pump it is essential that the gasket between the cover and the pump body be in good condition. The use of a new gasket is recommended if it is possible to do so. The gasket thickness is .0025".

The lower portion of the oil pump assembly houses the pressure pump. The pressure pump takes the oil from the tank over the flywheel and forces the oil through the lubricating system. To disassemble the pressure pump it is necessary to remove the entire pump



OIL PUMP V 1327-2A

assembly from the engine. This may be accomplished by disconnecting all oil lines attached to the pump and removing the pump mounting capscrews. The removal of the pressure pump body exposes the pressure pump gears. The drive gear of the pressure pump is keyed to the drive shaft. It is not necessary to disturb the position of the drive gear on the shaft except in the event of making a replacement of the gear. The pressure pump idler gear may be readily slipped off the idler gear shaft.

To check the wear in the oil pump ascertain the clearance between the housing and the end of the gear teeth, also between the end of the gear and the housing. The bushings in the idler gear should be checked for wear on the idler shaft. The back lash between the drive gear and idler gear should be checked. The Table of Clearances should be consulted in making these checks. The remarks in this paragraph are applicable to both the pressure pump and the scavenger pump.

PISTONS

The pistons used in the Sea Raider Special Engine are of the aluminum alloy type. Four piston rings are employed. All of the piston rings are above the piston pins. For standard clearances, see the "Table of Clearances."

The piston pin is of the full floating type. It is retained in the piston by a snap ring located in the outer ends of each of the piston pin bosses. At room temperature a properly fitted piston pin will have a light push fit in the piston pin bosses. If the piston pin is disassembled, make sure that both snap rings in each piston are properly installed and seated in the bottom of the snap ring groove. Failure to properly lock the pin in place will result in the pin working endways and scoring the cylinder wall.

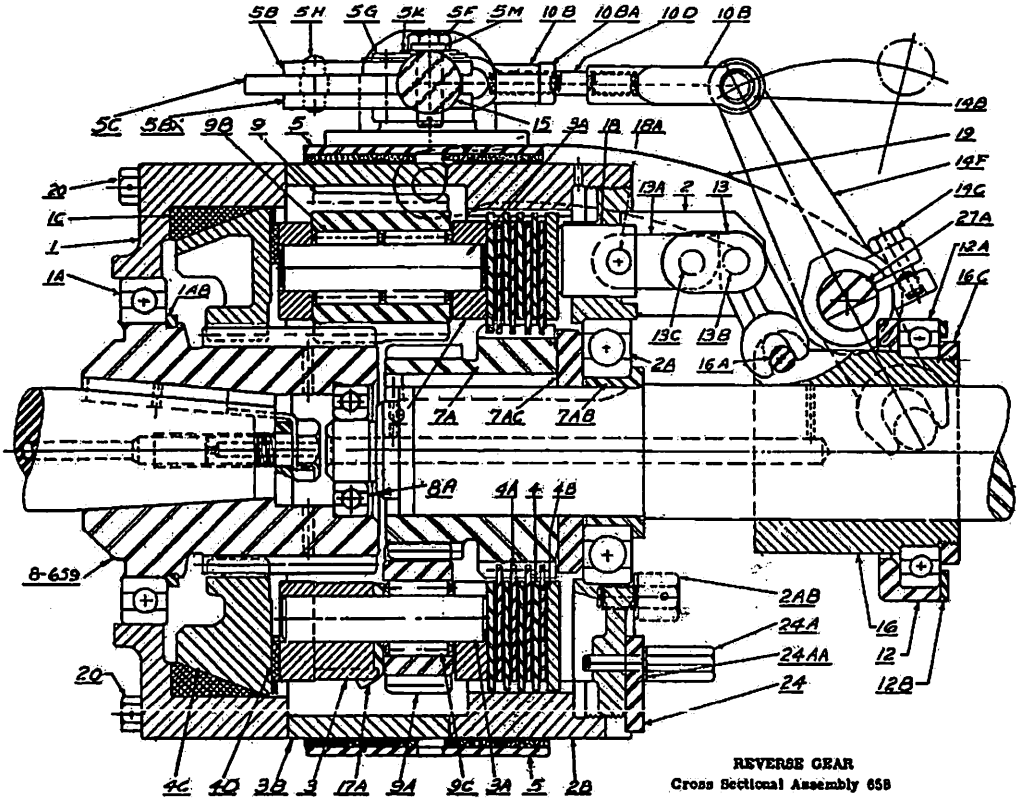
Four piston rings are used on each piston; counting from the top of the piston, the rings are installed in the following order:

Groove #1: 3/32" x 5-1/4" Compression

Groove #2 & 3: 1/8" x 5-1/4" Combination Compression and Oil Scraper Ring, installed with outer groove down.

Groove #4: 1/4" x 5-1/4" Oil Control Ring.

When installing new piston rings, the rings should be checked before they are placed on the pistons. Place the piston ring in the lower portion of the cylinder bore in which it will be used. The lower portion of the cylinder bore is suggested since it is less subject to wear. Square up the piston ring by using a piston as a guide. With feeler gauge ascertain the clearance between the ends of the piston ring. The gap clearance should not be less than .020". File the ends of the piston ring if necessary to provide this minimum clearance. The maximum gap clearance is of minor importance. After the piston rings have been tested in the cylinder bore for gap clearance check the rings in the proper grooves of the piston to make certain that they are not tight in the piston groove. After these checks, the piston rings may be installed on the piston which will be used in the cylinder bore in which the rings



REVERSE GEAR
Cross Sectional Assembly 65B

were checked. Lubricate the piston rings with light oil after they have been installed on the pistons.

Whenever a piston is removed from the engine it should be carefully cleaned before it is replaced. When cleaning the piston do not use sharp implements. The material of which the piston is made is soft and easily mutilated. Avoid scratching the finished surfaces. Pistons stamped with the letter "M" are used on the master rods. Pistons without a letter designation are used on the link rods. Pistons stamped #1 are used in the cylinders directly behind the flywheel.

Pistons and piston rings should be well coated with lubricating oil when they are installed in the cylinder block to provide lubrication until the engine system can take up this work.

REVERSE GEAR

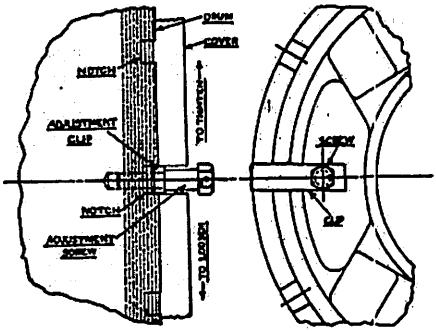
The assembly through which power is transmitted from the crankshaft to the propeller shaft is called a reverse gear. This however is somewhat of a misnomer since this unit provides not only the reversing mechanism but also a clutch mechanism for forward drive and the means of effecting a neutral.

With the control lever extended upward a shifting of the lever forward provides the forward drive. The movement of the operating lever to an after position provides a reversing drive. The neutral position is about midway between the two extremes. The unit will lock in AHEAD or ASTERN position and any remote controls installed to operate the gear unit must be so arranged as to effect a proper locking in both directions. No lock is in evidence in the neutral position. When the unit is locked in either AHEAD or REVERSE position a slight back lash should be noticeable in the control arrangement. This is required to prevent undue thrust on the clutch operating collar. Ball and roller bearings are employed throughout the gear unit. The entire unit is lubricated by the engine oiling system and therefore requires no separate lubrication attention other than that which it should receive when a new engine is started for the first time or when an engine is started for the first time after a complete rebuilding. In such instances, it is recommended that a gallon of oil be poured over and into as many parts as can be reached to provide a temporary lubrication until the engine oiling system begins to work. This oil should be the same as is used in the engine. Do not use grease in the gear unit.

A planetary type reverse gear is employed. The forward drive is through the medium of two clutches. At the forward end of the drum a cone clutch is incorporated which transmits the power from the engine to the drum of the gear unit. At the after end of the drum a multiple disc clutch transfers the power from the drum to the engine tailshaft. The tailshaft is coupled to the propeller shaft. When both clutches are engaged the gear unit is considered to be in AHEAD position. Both clutches operate at the same time from a single control. In neutral position both clutches are disengaged.

In ASTERN position both clutches are disengaged but the brake band is clamped to the drum preventing the drum from rotating. This braking action causes the power to be transmitted from the gear on the crankshaft to the star gears within the drum. The star gears by mating with the gear on the tailshaft cause the tailshaft to turn in reverse rotation. The gear unit used provides a reverse ratio of 100%.

If there is evidence that the clutch is not holding properly in forward motion first check the controls to see that a proper engagement is being accomplished. If these are in order it will be necessary to adjust the clutch. To do this first stop the engine. Remove the cover plate from the reverse gear housing. Place the control lever in AHEAD position and rotate engine by hand until the adjustment lock clip is accessible. Move the reverse gear control lever into ASTERN position so that the brake band will clamp the drum. Loosen the lock clip screw only sufficient to lift the clip out of the notch. When the clip is out of the notch tighten the clutch by turning the cover clockwise one or more notches and replace the clip and tighten the screw. Replace the cover plate and set the control lever at neutral position. Start the engine and take a trial run where the throttle may be fully opened to check whether or not the clutch will hold a maximum power output. If the clutch continues to slip repeat the operation until it holds. One or two notches adjustment is usually sufficient to take care of the normal wear of the clutch plates. If a seemingly abnormal adjustment is required to make the clutch hold, it is recommended that the clutch discs be inspected. If they are badly scored they should be replaced.



ADJUSTMENT FOR FORWARD DRIVE

Fig. 1

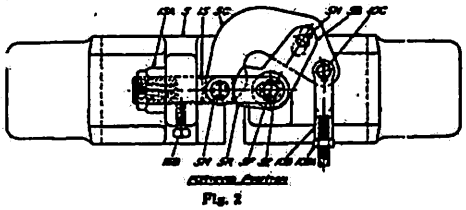
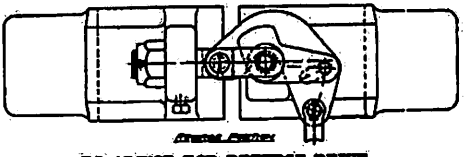


Fig. 2

Under normal circumstances the reverse adjustment requires little attention. If however the brake band fails to keep the drum from slipping an adjustment is required and should be made at the first opportunity,

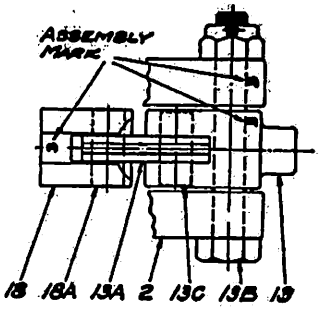


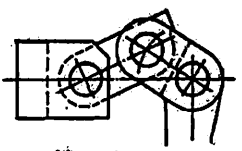
TO ADJUST FOR REVERSE DRIVE

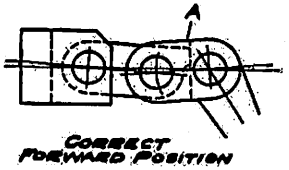
as the drum must be maintained in a stationary position in order to effect a reversing of the propeller shaft rotation. This adjustment may be made by removing the cover plate of the reverse gear housing. Withdraw the cotter pin which locks the adjustment nut on the cam-

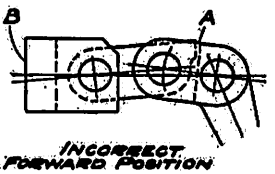
shaft. Slack off the set screw in the side of the reverse band lug. Pull the operating lever into reverse position and tighten the adjusting nut (15A) with a wrench to a position which will keep the drum from revolving when the engine is at full power. Be sure to replace the cotter pin to maintain the position of the adjusting nut. Set up and re-wire the set screw in the brake band lug.

Caution: Do not adjust the band so tight that the cam (5C) cannot be pulled into a locked position. The cam centers must be snapped past as shown when locked for reversed motion.









When these gears leave our factory they are adjusted so that each of the 3 plungers No. 18 (see cut) exert uniform pressure against the clutch discs when the lever is thrown into go ahead. Each plunger is numbered for the place where it goes and if the plungers are removed for any purpose they must be put back into their same places. See cut for assembly marks. When the gear is correctly installed and adjusted the three toggles pass center when in go ahead and abut tightly at "A" (see cut). This prevents them from jumping out and causing the clutch to slip.

In the event it should be necessary to remove the reverse gear for either examination or repair, the operator must remove the reverse gear housing. First set the control lever in reverse position. Remove the cover plate and unship the clevis pin at the after end of the rod operating the brake band locking mechanism. Unship the two brake band anchor

arms by withdrawing the cotter pins and slipping the anchor arms sidewise off the pivot on the brake band. Remove all of the capscrews in the reverse gear cover including all of the capscrews around the reduction gear housing. When the reduction gear adapter is removed the reverse gear housing can be lifted free.

When the reverse gear is exposed remove the three bolts maintaining the toggle plungers. These three bolts are located in the extension of the rear cover of the reverse gear unit. After the bolts are removed each toggle assembly should be withdrawn. With the toggle assembly out of the way it will be easy to locate a screw having a large hex head which is used to retain the ball bearing in the after cover of the reverse gear. Remove this screw. After this screw is removed it will be possible to withdraw the tailshaft as an assembly with the reduction gear adapter, the pinion and bearing assembly. SEE REDUCTION GEAR. When the tailshaft is out of the way the reverse gear drum assembly can be worked aft off the gear on the crankshaft. The drum assembly is heavy and must be handled carefully. The installation of the reverse gear is a reversal of the operation outlined.

REDUCTION GEAR

The reduction gear is of the internal type with helical teeth. The drive pinion has external teeth and is keyed to the main shaft of the reverse gear. The driven gear is of the internal type and is supported on anti-friction bearings. See Reverse & Reduction Gear Sectional Assembly.

The forward end of the slow speed shaft which carries the internal gear is supported on the front end by a roller bearing. The rear end of this shaft is positioned and supported by a double row ball bearing. This latter bearing also takes the propeller thrust, in both forward and reverse directions. The inner race of the double row bearing is clamped between a sleeve on the slow speed shaft and the forward end of the propeller coupling flange. The outer race is clamped between a shoulder on the reduction gear housing and the oil seal retainer.

An oil seal of the automatic type is used to prevent oil from leaking out along the propeller shaft flange. As previously stated, the reduction gear is pressure lubricated from the main oil supply of the engine. It is cooled by the circulation of raw water through the water jacket of the reduction gear housing.

To disassemble the reduction gear, remove the capscrews in the outer and largest flange of the reduction gear housing and disconnect the water lines and the propeller coupling flange. The propeller shaft should be moved aft approximately four inches after which the reduction gear driven gear, supporting bearings and housing may be removed as a unit. After the main housing is out of the way, the capscrews which hold the reduction gear adapter plate to the oil pan may be removed. Next remove the three bolts holding the toggle levers in position. Remove the toggle levers after which the reverse gear main shaft, together with the propeller gear on the front end may be pulled back out of position and the adapter plate and shaft assemblies may be removed to the bench for further disassembly. (See Reverse Gear for additional information.)

In reassembling the gear it is important that the precautions given under "Reverse Gear" be observed. After the capscrews which hold the adapter onto the oil pan are thoroughly tightened, they should be secured with lockwire to prevent their backing out and damaging the gear.

The reduction gear pinion ball bearing may be disassembled by removing the lockwire and taking out the three drilled head capscrews which hold the pinion washer in place, after which the drive pinion may be pressed off of the reverse gear main shaft. The pinion must be tightly fitted to the reverse gear main shaft and parts should be covered with a light coating of white lead and oil to prevent scuffing of shaft on re-assembly. Lockwire must be replaced to prevent pinion washer and capscrews from working loose and damaging the gear train. The cross-sectional assembly of the Reverse and Reduction Gear gives further information regarding the relation of the above parts.

VALVE AND VALVE SPRINGS

Four valves are used in each cylinder two for intake and two for exhaust. All valves are interchangeable for use either in intake or exhaust ports. A single valve spring is used with each valve. Within the valve spring a smaller spring is used only for the purpose of maintaining the position of an oil seal.

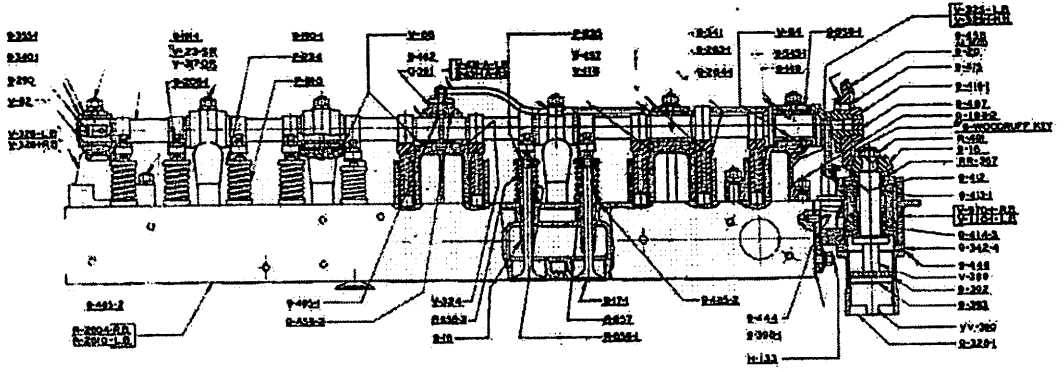
The lower row of valve guides on each head is provided with an oil seal at the upper end of the valve guide in the form of a felt washer located in a retainer cup. New felt washers should be installed after each valve grinding job if it is possible to do so. Valve locks are in the form of a split tapered washer. Two pieces are required for each valve. The valve spring retainer washer is tapered to conform with the valve lock. At the upper side of the cylinder head casting the retainer is used to position the valve spring.

The valve springs are cadmium plated to resist corrosion. Do not use valve springs that show signs of rusting. The valve spring is loaded to 44 pounds when compressed to a length of 2 1/4". The load is 70 pounds when the spring is compressed to a length of 1 7/8". A variation of plus or minus 4 pounds is allowed.

VALVE GRINDING

Drain the engine so that water will not run into the cylinder when the cylinder head is lifted. Disconnect the water line from the cylinder head and remove the tachometer drive shaft and body from the forward end of the valve tappet cover. Remove the valve tappet cover. Remove the carburetors and control rods. Disconnect exhaust line at the flange on the exhaust manifold. If sufficient assistance is available to lift the cylinder head with the manifolds attached this may be done, otherwise it will be necessary to remove intake and exhaust manifolds. Remove the cylinder head stud nuts. Do not release the nuts holding the camshaft bearing caps. These nuts are located on studs which hold the camshaft bearing brackets in position.

Unscrew the large packing nut on the vertical drive shaft housing. Back this off until it is free. Remove the four capscrews immediately above the packing nut so that the vertical shaft sleeve may be dropped. Remove the oil line providing lubrication to the valve



CYLINDER HEAD ASSEMBLY
Part Number Subject to Change.
Always Mention Engine Serial Number

operating mechanism. Lift the cylinder head straight upward and remove to a suitable working space.

Remove the camshaft by unshipping the nuts holding the camshaft bearing caps. Replace the bearing caps (match numbers) setting the nuts down tight to maintain the camshaft bearing brackets in proper location. Remove the valve tappets and place them in the order in which they were removed from the engine so that they can be returned into the same bushings with the same faces toward the camshaft brackets. Depress the valve spring and the valve spring retainer washer so that the locks can be removed. Valve retainer locks are in the form of a split tapered washer. Remove the inner spring and felt oil seal. Remove the valves and note the number stamped thereon. This number should mate with the number stamped on the ports in the cylinder head when valves are reassembled.

Clean the valves carefully making certain that all gum accumulations on the valve stem are removed. If a valve refacing machine is available make use of it. The seat angle is 45°. Select valve number one and place it in the port in the cylinder head correspoodingly marked. Place grinding compound on the valve seat sparingly and put the valve into place. A large screwdriver may be used to rotate the valve by placing the end of the screwdriver in the slot provided in the valve. Press the valve against the cylinder head and revolve it part way around forward and backward until the compound is worked out. Remove the valve and clean it and the seat in the cylinder head. Repeat the operation until the valve and the seat in the cylinder head are both polished and clear of pits. A seat of 1/32" wide is ample to hold compression.

When number one valve is properly fitted start on number two valve and continue through the entire set. When all of the valves have been ground carefully wash the valves, the seats in the cylinder head and also wash out the valve guides. Oil the stem of the valves and place them in position so that they may be reassembled with the valve springs and retainers. If available use new felt oil seals when reassembling after the valve grinding job.

The next operation is to reinstall the camshaft and careful attention to this detail is essential. Turn the engine until the number one cylinder is at exactly dead top center commencing the suction stroke. Number one cylinder is directly behind the flywheel. Note the plane of the tang on the vee drive shaft. Set the camshaft drive shaft so that the slot at the lower end is in alignment with the tang on the vertical drive shaft. Remove the camshaft bracket bearing caps. Place the camshaft in the bearings so that the number one intake valve cam is just making contact with the intake valve tappet. The cam will be on the starboard side for a standard rotation engine and on the port side for an opposite rotation engine. Place the camshaft in position and reinstall the camshaft bearing cap. The cylinder head is now ready to install on the engine.

The use of a new cylinder head gasket is recommended. If this is not available smooth out any rough spots in the used cylinder head gasket. Replace the nuts on the cylinder head studs and turn them down as tight as one can with the fingers. Beginning at the center stud work to the ends of the cylinder head by turning each nut slightly. Repeat same sequence until all of the nuts have been drawn down securely. If a torque wrench or tension indicator

wrench is available tighten each nut to 95 foot pounds. After the engine has been operated a few hours and is still warm tighten the cylinder head nuts again in the same order. Before starting the engine it will be necessary to check the valve tappet adjustment. Reset the valve tappets after the engine has warmed up.

THE VEE SHAFT

Two vee shafts are employed one for each bank of cylinders. The vee shaft drives the camshaft and the accessory units (fuel pump and distributor). These shafts are driven from the upper end of the vertical shaft and they operate at crankshaft speed. The shafts are supported in bushings lubricated under the engine oiling system. Thrust washers are provided and used to control the end play of the vee shafts. See Table of Clearances. A loose coupling is provided at the upper end of each vee shaft to facilitate the removal of the cylinder heads without requiring a disassembly of the entire camshaft driving mechanism.

To remove the vee shafts from the engine requires a removal of the cylinder heads. The vee shaft housing and oil pump are next dismounted. The assembly immediately below the oil pump must then be removed after which the vee shafts can be removed in the direction of the gear end. A careful study of the sectional view of this part of the engine is recommended in the event it is necessary to disassemble any of these parts.

VERTICAL SHAFT

The vertical shaft is just what the name implies. It constitutes the driving medium for the water pump, oil pump, camshaft and accessory units including fuel pump and distributor. The shaft is driven by a spiral bevel gear mounted on the crankshaft. It operates at crankshaft speed. This shaft is supported in a bushing at the lower end which is lubricated under pressure from the engine oiling system. The bushing is pressed into the crankcase. Thrust washers are used on both the upper and lower ends of this bushing.

The upper end of the vertical shaft is piloted in a gear used to mate with the two vee shafts which operate the camshaft. This gear is splined to receive the vertical shaft. The nut retaining the vertical shaft in position is locked by a ring surrounding the nut. This lock ring must be removed before the nut can be unshipped. Due care must be exercised to see that the lock ring is replaced upon reassembly.

WATER PUMP DRIVE SHAFT ASSEMBLY

The exterior portion of this assembly is exposed when the water pump is removed from the engine. The balance of the assembly is within the crankcase. This assembly may be withdrawn from the crankcase after removing the mounting capscrews.

In this assembly it is important that the end play be maintained within the limit specified in the Table of Clearances. The end play is governed by the thickness of the thrust washer in back of the bevel driving gear. The drive shaft bushings should be checked for wear. These bushings are lubricated by the engine oiling system. If the unit is dismassembled

do not forget to coat the bearing surfaces with a film of oil when the reassembly is made to provide lubrication untill the engine system takes up this task. The back lash in the gears must be checked when the unit is reinstalled. The gears must not be tight. A slight variation in the back lash may be effected by the use of one or more additional gaskets when the unit is reassembled in the crankcase.

COLD WEATHER OPERATION

The first consideration in cold weather operation is the possibility of ice formation within the engine cooling system. This must be avoided. If freezing temperatures prevail or are to be expected all water must be drained from the system. SEE FRESH WATER SYSTEM COLD WEATHER OPERATION. If there is any question regarding the temperature drain the engine. Do not take chances.

The second item for consideration in cold weather is the lubricating oil. Winter type oil should be used. If the temperature is 20° F. or lower the oil should be drained from the reservoir over the flywheel at the end of a run. This oil should be heated and put back into the engine the next time the engine is to be started.

Before attempting to start an engine in real cold weather rotate the engine two full revolutions by hand before engaging the electric starter. This will break the drag of the oil made heavy by the low temperature. Make every effort to conserve the storage battery energy which unit has a reduced output as the temperature drops. Do not add distilled water to the storage battery at any time except immediately after the engine has been started for a run of sufficient duration to bring up the charge in the battery. The addition of distilled water temporarily reduces the charge and the battery is liable to freeze at low temperatures if this caution is ignored.

Keep the fuel line filters clean. Any water accumulated in same may freeze and cause trouble.

Do not use an open flame heating device in the engine compartment. If hard starting is encountered fill the water jacket spaces with warm water and heat the lubricating oil.

STORAGE SUGGESTIONS

If the engine is to be idle for a long period, the following suggestions may be helpful:

Drain both the fresh and raw water systems as outlined in the instructions under the heading of "Cold Weather Operation." Run the engine for a few minutes without cooling water to warm up and dry out. Replace all drains, close all drain cocks and valves. Remove the spark plugs and through the holes provided admit to each cylinder about one half cup of heavy engine oil. Rotate the engine slowly by hand at least two full revolutions to distribute the heavy oil on the cylinder walls. Replace the spark plugs so that foreign matter cannot enter the cylinders during lay-up period.

Remove the carburetors and the electrical equipment which should be stored in a warm dry place. Cover the ends of all electrical connections with a coat of vaseline to prevent

oxidation. Tag the wires so that they can be replaced in the proper order without difficulty.

Disconnect the exhaust line from the exhaust manifold and install a blank gasket. This will reduce the accumulation of condensation in the exhaust ports and help to keep the exhaust valve from sticking. Reconnect the exhaust line so that the blank gasket is tight. THIS GASKET MUST BE REMOVED BEFORE THE ENGINE IS STARTED.

A light coating of oil or grease should be applied to the external surfaces of the engine to prevent corrosion.

Do not remove the oil in the engine when it is laid up. The best time to make this change is just before the engine is put back into service. This will permit not only the removal of the old oil but also of any condensation that may accumulate in the crankcase during the storage period. This oil may be withdrawn by an oil gun or pump after removing one of the after crankcase side plates.

Provide as much ventilation as possible to the motor compartment during the storage period. This will assist in reducing the accumulation of condensation.

The storage battery must be removed and kept in a place where the condition may be checked at frequent intervals and recharged when required. A storage battery will freeze at low temperature if it is not kept well charged.

DATA SHEET

KERMATH SEA RAIDER SPECIAL

CYLINDERS	12
BORE	5-1/4
STROKE	6
DISPLACEMENT (cu. in.)	1558
FIRING ORDER-STANDARD ROTATION	1-4-9-8-5-2-11-10-3-6-7-12
FIRING ORDER-OPPOSITE ROTATION	1-6-7-10-3-2-11-8-5-4-9-12
TAPPET CLEARANCE-EXHAUST (HOT MOTOR)	.025
TAPPET CLEARANCE-INLET (HOT MOTOR)	.015
OIL PRESSURE (WHEN OIL IS HOT) AT W.O.T.	40#
OIL FOR WATER TEMPERATURE ABOVE 45° F	SAE 40
OIL FOR WATER TEMPERATURE BELOW 45° F	SAE 30
SPARK PLUG-RADIO SHIELDED TYPE	Champion 62S
SPARK PLUG GAP-RADIO SHIELDED PLUG	.030-.035"
DISTRIBUTOR POINT GAP	.018-.020"
INLET VALVE OPENS	T.D.C.
EXHAUST VALVE CLOSES	8°A.T.C.
CARBURETOR-ZENITH (4 UNITS)	23M4A-16(S-770)
REVERSE GEAR DIRECT DRIVE ENGINES	Joes 658
ELECTRICAL EQUIPMENT	12 Volt Standard

KERMATH SEA RAIDER SPECIAL

CLEARANCE

	Minimum	Maximum	Repair
Accessory Drive			
Drive Shaft End Play	.004	.006	.010
Drive Shaft Diametrical	.001	.0015	.004
Drive Gear Back Lash	.004	.006	.010
Camshaft			
Camshaft Gear-Back Lash	.004	.006	.010
Camshaft End Play	.005	.006	.010
Camshaft Rear Bearing-Diametrical	.001	.003	.006
Inter. Bearing	.001	.003	.006
Center Bearing	.001	.003	.006
Front Bearing	.001	.003	.006
Camshaft Pinion Back Lash	.004	.006	.010
Camshaft Drive Shaft End Play	.004	.004	.010
Camshaft Drive Shaft Diametrical	.0015	.002	.004
Connecting Rod			
Crank Pin Bearing-End Play	.006	.008	.012
Crank Pin Bearing-Diametrical	.002	.004	.008
Link Rod-End Play	.004	.004	.008
Link Rod-Diametrical	.001	.0015	.004
Piston Pin Bushing-Diametrical	.001	.0015	.004
Crankshaft			
Main Bearing Front #1-End Play	*	*	*
Main Bearing Inter. #2-End Play	*	*	*
Main Bearing Inter. #3-End Play	*	*	*
Main Bearing Center#4-End Play	*	*	*
Main Bearing Inter. #5-End Play	*	*	*
Main Bearing Inter. #6-End Play	*	*	*
Main Bearing Rear #7-End Play	.006	.007	.011
Main Bearing Front #1-Diametrical	.0025	.005	.009
Main Bearing Inter. #2-Diametrical	.0025	.005	.009
Main Bearing Inter. #3-Diametrical	.0025	.005	.009
Main Bearing Center#4-Diametrical	.0025	.005	.009
Main Bearing Inter. #5-Diametrical	.0025	.005	.009
Main Bearing Inter. #6-Diametrical	.0025	.005	.009
Main Bearing Rear #7-Diametrical	.0025	.005	.009
Crankshaft Gear Back Lash	.004	.006	.010
Distributor			
Driven Gear-Back Lash	.006	.008	.012
Breaker Point Gap	.018	.020	Adjus.

* Standard Bearing Shells will provide ample end clearance if they are centered and correct end play is maintained at rear bearing.

KERMATH SEA RAIDER SPECIAL

CLEARANCE

	Minimum	Maximum	Repair
Oil Pump			
Drive Shaft-End Play	.002	.0025	.005
Drive Shaft-Diametrical	.001	.0015	.003
Pressure Pump Gear-Back Lash	.006	.007	.010
Pressure Pump Gear-End Play	.002	.0025	.005
Pressure Pump Gear-Diametrical	.001	.0015	.004
Pressure Pump Idler Bushing-Diametrical	.001	.0015	.004
Scavenger Pump Gear-Back Lash	.006	.007	.011
Scavenger Pump Gear-End Play	.002	.0025	.005
Scavenger Pump Gear-Diametrical	.001	.0015	.004
Scavenger Pump Idler Bushing-Diametrical	.001	.0015	.004
Piston			
Piston Skirt-Room Temperature	.008	.009	.012
Piston Pin in Bosses	.0001L*	.0005T*	.004
Piston Ring-Side in Groove #1 (top)	.0045	.006	.009
Piston Ring-Side in Groove #2	.0035	.004	.007
Piston Ring-Side in Groove #3	.0035	.004	.007
Piston Ring-Side in Groove #4	.0015	.003	.007
Piston Ring Gap	.020	.030	.040
Piston Pin Bushing-Diametrical	.0015	.002	.004
*Clearance .0001 Loose to .0005 tight. Light hand push fit desired.			
Valve			
Valve Tappet-Intake-Between Tappet & Valve Stem	.015	.015	Adjust
Valve Tappet-Exh.-Between Tappet & Valve Stem	.025	.025	Adjust
Valve Stem in Guide-Intake	.003	.004	.008
Valve Stem in Guide-Exhaust	.003	.004	.008
Tappet in Bushing	.001	.0015	.003
Vee Shaft			
Vee Shaft-Back Lash	.004	.006	.010
Vee Shaft-End Play	.006	.008	.012
Vee Shaft-Bushing-Diametrical	.0015	.0025	.004
Vertical Shaft			
Vertical Shaft-Back Lash	.004	.006	.010
Vertical Shaft-End Play	.004	.006	.010
Vertical Shaft Bushing-Diametrical	.0015	.0025	.004
Vertical Shaft Gear-Upper			
Vertical Shaft Gear-Upper-Back Lash	.004	.006	.010
Vertical Shaft Gear-Upper-End Play	.004	.006	.010
Vertical Shaft Gear-Upper Bushing-Diametrical	.0015	.0025	.004
Water Pump Drive Shaft - (Fresh Water Pump)			
Water Pump Drive Shaft-Back Lash	.004	.006	.010
Water Pump Drive Shaft-End Play	.004	.006	.010
Water Pump Drive Shaft Bushings-Diametrical	.001	.0015	.004

ELECTRICAL EQUIPMENT DATA

Delco-Remy Starter Motor - 12 Volt

Brush Tension 38-40 oz.					
No Load Test	-	Amps 75	Volts 8.0	R.P.M. (Bendix)	2000
Lock Torque Test	-	Amps 500	Volts 3.5	Torque Ft. lbs.	45

Delco-Remy Distributor - 12 Volt

Cam Angle 37°			
Start Advance	430 rpm engine	Maximum advance	1400 rpm engine
Degree	2.0 engine	Degree	27.0 engine

Delco-Remy Coil - 12 Volt

12 volt coil requires no external resister.

Delco-Remy Generator - 12 Volt - 55 Amperes

Cold Output 55 Amperes Field Current 1.54-1.71 Amperes at 12 volts
Volts 13 at 950 Generator rpm (approx.)

Maximum output when hot controlled by current regulator.

Delco-Remy Voltage Control Box - 12 Volt - 55 Amperes (Neg. Ground)

Cut-out Relay

Relay Air Gap	.057"
Relay Point Gap	.020"
Points close (Hot)	13.5 Volts

Current Regulator Unit

Point Gap	.015"
Current Setting	55 Amperes

Voltage Regulator Unit

(Open Circut	135° -145° F.)
Point Gap	.015"
Voltage Setting	15.5 Volts

NOTE: Generators and regulators may be changed at any time. Always make settings to conform with data stamped on unit name plate.

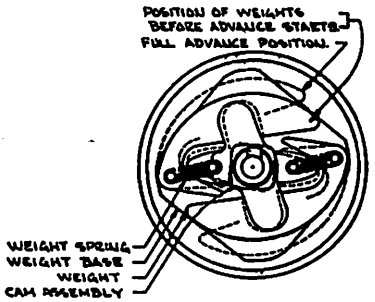
IGNITION SYSTEM

The ignition system consists of the ignition coil, condenser, distributor circuit breaker unit, low and high tension wiring, spark plugs and a source of electrical energy (battery).

There are two distinct circuits in the ignition system. The primary low-tension circuit includes the source of electrical energy, the distributor contact points and circuit breaker mechanism, the primary of the coil, and the condenser. The secondary high-tension circuit includes the secondary of the ignition coil, the rotor and distributor cap, the high tension wiring and spark plugs.

The primary circuit is completed and broken by the circuit breaker mechanism of the distributor, causing a buildup and collapse of a magnetic field in the ignition coil. The condenser is connected across the distributor contact points. When the points open, the current has a tendency to continue to flow and form an arc across the points. The condenser reduces this arc because it has the ability or capacity to store up electrical energy. The current flows into and charges the condenser. The condenser action causes a quick reduction of the current flow in the primary circuit. This results in a rapid collapse of the coil magnetic field which induces the high voltage in the secondary. This high voltage is distributed to the correct cylinder spark plug wire by means of the rotor and distributor cap.

Centrifugal Spark Advance: Where speed variations are encountered, a spark advance based on engine speed is necessary to develop maximum power. Illustration shows the centrifugal spark control mechanism which operates to secure this advance. As engine speed increases, the weights gradually throw out and rotate the cam to give the desired spark advance for the speed at which the engine is running.



CENTRIFUGAL SPARK ADVANCE MECHANISM

Distributor Cap

Distributor caps are made of a phenol resin compound. Repeated surface moisture from condensation may cause leakage across the cap surface, which if continued will cause permanent failure due to formation of a carbonized path on the surface of the material. Where excessive condensation is encountered in service it is important that a periodic inspection be made of the distributor cap. The cap should be wiped dry. If the carbonized path is in evidence the cap should be replaced. Contact rings on the inner side of the distributor cap should also be inspected and if it is dirty, the rings should be carefully wiped clean. A mild metal polish may be found useful for cleaning this contact ring. The carbon brush on the underside of the center terminal of the distributor cap should be inspected to make certain that same is free and the spring lively.

Distributor Rotor

The rotor is that part of the distributor which selects the circuit of the spark plugs to be fired. The rotor is indexed by a narrow and a wide flat spot on the cam to which it is mounted. The rotor should be removed after 50 hours of operation so that a few drops of light engine oil may be applied to the felt wick found beneath it. The felt wick provides lubrication for the automatic cam advance. The brush located on one arm of the rotor should be inspected to make sure that the spring is lively and the brush is clean. The metal tongues of the rotor should be inspected to see if they are badly pitted by arcing between the tongue of the rotor and the segment of the distributor cap. Rotors with tongues badly burned should be replaced.

Distributor Breaker Points

The circuit breaker mechanism consists of a stationary point mounted on the contact support and a movable lever arm which is actuated by the cam of the distributor. To adjust the breaker point gap the clamp screw of the contact support is released. The adjusting screw is then turned to a position that will create the correct breaker point gap. The clamp screw should then be tightened.

The correct breaker point gap is .018-.020. This setting should be checked each 50 hours of operation. Breaker points must be synchronized so that both sets of spark plugs fire at the same time.

Ignition Coils

Coils do not require special service other than to keep all terminals and connections clean and tight. The Delco Remy coils used on the Sea Raider Special are of 12 volt heavy duty type and require no external resistors when used on a 12 volt electrical system. In case of failure in the winding coil it is necessary to replace the coil unit.

If the coil does not fire at the engine satisfactorily, the unit should be checked. A lamp and test points may be used to check open and grounded circuits. The test for an open primary circuit is to hold the test point on each of the low tension terminals of the coil. If the lamp fails to light the primary circuit is open. To check the secondary circuit, hold one test point at the high tension terminal and the other at one of the low tension terminals. The lamp will not light, but tiny sparks will be noticed at the point of contact if the winding is not open. If the winding is open no spark will occur.

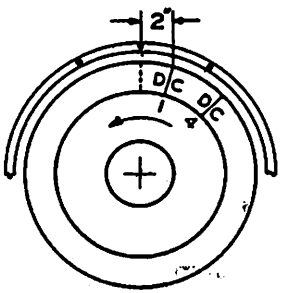
To check for grounded wiring hold one test point on the metal container and touch the other points to the high and low tension terminals. If the lamp lights or tiny sparks appear at the point of contact, the internal wires are grounded.

IGNITION TIMING

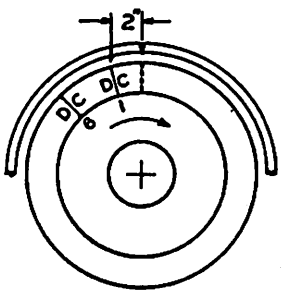
The Delco-Remy distributor is set to fire at a point 2° before top center as measured across the face of the flywheel. To check this setting or to locate for timing a distributor first remove one set of spark plugs from each cylinder bank to facilitate turning. Turn the engine in the rotation of operation until #1 cylinder is coming up on the compression stroke and the top dead center mark is 2° from alignment with the center marking running across the upper capscrew hole in the flywheel housing. Note illustration.

The distributor breaker points should open as the flywheel comes up to this setting.

A very slight variation of this setting may be helpful but any further adjustment should be made only at wide open throttle when the distributor head may be rotated slightly after relieving the clamp maintaining the distributor in position. A variation in fuels may require a slight change in the distributor setting. If pinging is encountered back off the distributor just far enough to eliminate the pinging.

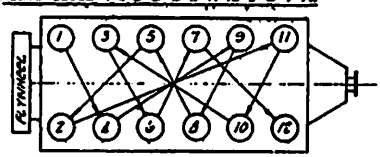


STANDARD ROTATION

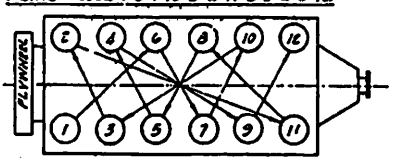


OPPOSITE ROTATION

FIRING ORDER 1-4-3-6-5-2-11-10-3-8-7-12



FIRING ORDER 1-6-7-10-3-2-11-8-5-4-9-12



FLYWHEEL SETTING
IGNITION TIMING

Conditions Affecting Ignition Performance

If the ignition performance is unsatisfactory the following conditions should be kept in mind as possible causes of poor ignition performance.

1. Resistance in Ignition Circuit - Energy is lost whenever resistance is present in a circuit. Oxidized, burned or pitted distributor contacts offer resistance to the flow of primary current. A loose connection or poor ground at the condenser will cause faulty ignition. Connections at the battery, ammeter, coil, and ignition switch should be clean and tight.

2. Poor Insulation in Ignition Circuit - Insulation in the ignition circuit is very important. The high tension cables should not be oil soaked, cracked, or punctured, as this will result in a loss of electrical energy. Examine the distributor cap for burned paths. If any of these conditions are present, the cables or distributor cap should be replaced.

3. Incorrect Spark Plug Gap Setting - Spark plugs should be cleaned when dirty, oil, and carbon are present. Replace the plugs if the points are badly burned or the porcelain cracked. The size of the gap largely determines the voltage required to fire the plug. Set the plug gaps carefully.

Champion #62-S Radio Shielded Gap .030"-.035"

4. Battery - The battery is an important factor since it must furnish current to the coil to create the magnetic field. Be sure it is charged and in good condition. The battery terminals should not be dirty, loose, or corroded, because these conditions cause resistance in the circuit.

5. Arcing Across Coil Terminals - When excessive moisture collects on the coil top, the high tension spark will sometimes arc across to the low tension terminals causing the engine to miss. Continued arcing will eventually burn a path across the surface of the coil top.

6. Centrifugal Advance - Improper operation of the centrifugal advance of the distributor will result in sluggishness of the engine or excessive pinging. The distributor should be checked if no other cause is located.

7. Defective Condenser - Usually indicated by reduction in breaker point life.

Distributor Maintenance

Lubrication: Distributors with grease cups should have the grease cups kept filled with medium cap grease and turned down one turn every 50 hours. Apply a small amount of petrolatum to the breaker cam when lubricating the distributor. Avoid excessive lubrication.

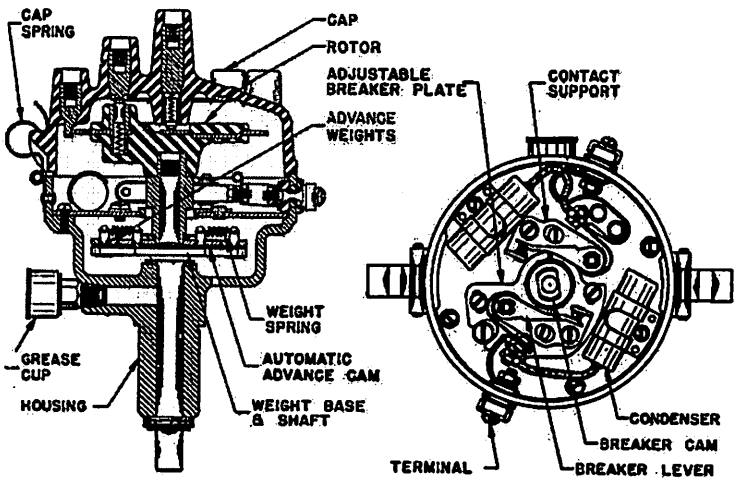
Inspection: The cap should be removed at regular intervals (each 100 hours) and the contact points, rotor, and cap examined. Check the high tension wiring for frayed or damaged insulation and poor connections at the cap or plugs. Replace if necessary. Replace the cap or

rotor if they are cracked or show carbonized paths indicating the secondary current is leaking to ground over the surface of the material.

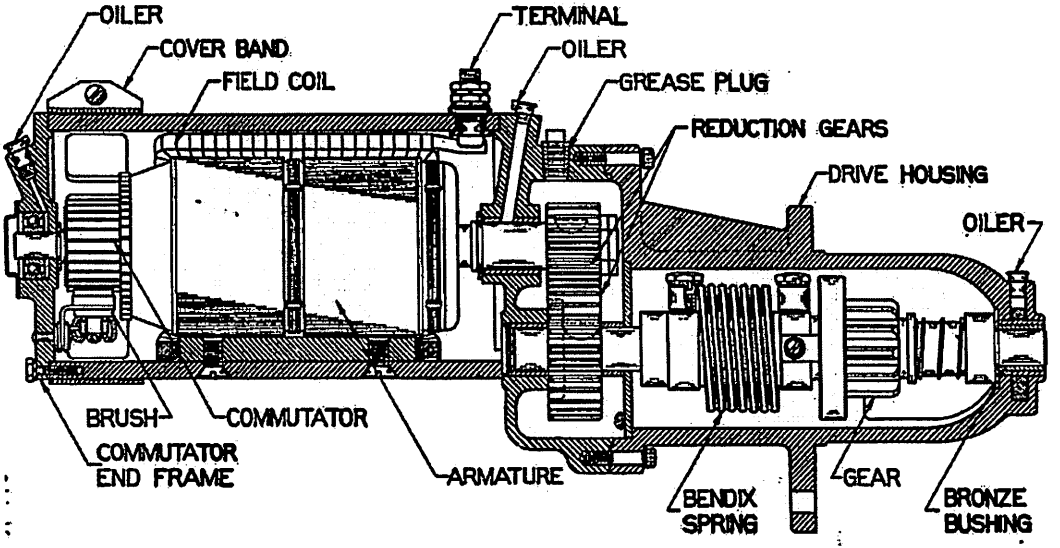
Contact Points: That are burned or pitted should be replaced or dressed with a clean, fine-cut contact file. The file should not be used on other metals and should not be allowed to become greasy or dirty. NEVER USE EMERY CLOTH TO CLEAN CONTACT POINTS. Contact surfaces, after considerable use, may not appear bright and smooth, but this is not necessarily an indication that they are not functioning satisfactorily.

Oxidized Contact Points: May be caused by high resistance or loose connections in the condenser circuit, oil or foreign materials on the contact surfaces, or most commonly, high voltages. Check for these conditions where burned contacts are experienced.

The Contact Point Opening: Must be set to the proper limits (.018-.020"). Points set too closely may tend to burn and pit rapidly. Points with excessive separation tend to cause a weak spark at high speed. The point opening of new points may be checked with a feeler gauge. Exercise caution in checking used contact points with feeler gauge unless dressed to parallel surfaces. Dial indicator affords better checking on used points.



DELCO-REMY TYPE DISTRIBUTOR



STARTING MOTOR - 12 VOLT
DELCO MODELS 543 & 572

STARTING MOTOR

The starting motor rotates the engine when the circuit between the starting motor and the storage battery is completed at the magnetic starting switch. The starting and continued running of the engine after the cranking is dependent upon the proper functioning of other engine parts. The starting motor supplied on the Sea Raider Special engine is of a reduction gear type and engagement with the ring gear on the flywheel is through the medium of a Bendix drive.

The Bendix drive is a device which connects the starting motor to the ring gear on the flywheel so that the motor may turn the engine. The pinion of the Bendix drive is mounted on a threaded sleeve in such a manner that when the armature revolves the threaded sleeve turns the pinion moving it endwise and causing it to mesh with the teeth on the flywheel ring gear and thereby cranking the engine. As soon as the engine runs under its own power, the flywheel ring gear drives the Bendix pinion at a higher rate of speed than the threaded sleeve is revolving. This causes the gear to be turned in the opposite direction on the threaded or spiral shaft so the pinion automatically demeshes.

Delco-Remy Model 542 Standard Rotation Engine (12 Volt)
Delco-Remy Model 572 Opposite Rotation Engine (12 Volt)

The above Delco-Remy Starting Motors are 12 volt, six pole, gear reduction units with the armature supported on a ball bearing in the commutator end and a bushing in the gear housing, and bushings in both the gear housing and drive housing supports the drive shaft. The motors use a Bendix type drive. Specifications are as follows:

Model 542 clockwise rotation viewing drive end.
Model 572 counter clockwise rotation viewing drive end.
Brush spring tension 36-40 ounces
No load - 2000 r.p.m. at 75 amperes at 9.0 volts
Lock torque test - 45 ft. lbs. at 500 amperes at 3.5 volts.

STARTING MOTOR MAINTENANCE

Starting motor maintenance may be divided into two sections, normal maintenance required to assure continued normal operation of the starting motor, and the checks and repairs of an inoperative starting motor.

Normal Maintenanc

Lubrication: Every 500 hours of operation add 8-10 drops light engine oil to the visible hinge cap oilers, remove grease plug in gear housing and add graphite grease if needed. During the disassembly-assembly procedure, add a few drops of light engine oil on the bushings, clean and repack the ball bearing, clean and repack the gear housing with graphite grease.

Inspection: The cover band should be removed and the commutator and brushes inspected at regular intervals. If the commutator is dirty, it may be cleaned with #00 sandpaper. Blow out dust. Never use emery cloth to clean commutator. If the commutator is rough, out of round, or has high mica, it should be turned down on a lathe. Worn brushes should be replaced. If brushes wear rapidly, check for excessive brush spring tension and roughness or high mica on the commutator.

Starting Motor Disassembly

At regular intervals, the actual time depending on the type of operation, the starting motor should be disassembled for a thorough cleaning and inspection of all parts. The Bendix drive should be cleaned and oiled with a penetrating oil, as any accumulation of dirt on the drive might restrict the free movement of the pinion. Put a few drops of light engine oil in each bearing. Never clean the armature or fields in any degreasing tank, or with grease dissolving materials, since these may damage the insulation. The commutator should be trued in a lathe, if necessary, and the mica undercut. Replace all parts showing excessive wear. All wiring and connections should be checked. Rosin flux should be used in making soldered connections. Acid flux must never be used on electrical connections. Submit reassembled unit to NO-LOAD and LOCK tests.

Checking of Improperly Operating Starting Motor

If the starting motor does not develop rated torque and cranks the engine slowly or not at all, check the battery, battery terminals and connections, and battery cables. Corroded, frayed, or broken cables should be replaced and loose or dirty connections corrected. The startingt motor switch should be checked for burned contacts and the switch contacts cleaned or replaced, if necessary. If all these are in order, remove the cover band of the starting motor and inspect the brushes and commutator. The brushes should form good contact with the correct brush spring tension. A dirty commutator can be cleaned with a strip of No. 00 sandpaper held against the commutator with a piece of wood while the starting motor operates. NEVER USE EMERY CLOTH TO CLEAN COMMUTATOR. If the commutator is very dirty, or burned, or has high mica, remove the armature from the starting motor and take a cut off the commutator in a lathe. Undercut the mica. If there are burned bars on the commuta-

tor, it may indicate open circuited armature coils which will prevent proper cranking. Inspect the soldered connections at the commutator riser bars. An open armature will show excessive arcing at the commutator bar which is open, on the no-load test. Repair may sometimes be made if the commutator is not too badly burned by resoldering leads in riser bars (with flux), turning down commutator and undercutting mica. Tight or dirty bearings will reduce armature speed or prevent the armature from turning. A worn bearing, bent shaft, or loose field pole screws will allow the armature to drag on the pole shoes, causing slow speed or failure of the armature to revolve. Check for these conditions. If the brushes, brush spring tension, and commutator appear in good condition, the battery and external circuit found satisfactory, and the starting motor still does not operate correctly, it will be necessary to remove the starting motor for no-load and torque checks.

No Load Test

Connect the starting motor in series with a battery of the specified voltage and an ammeter capable of reading several hundred amperes. If an r.p.m. indicator is available, read the armature r.p.m. in addition to the current draw.

Torque Test

It is advisable to use in the circuit a high current carrying variable resistance, so that the specified voltage at the motor can be obtained. A small variation of the voltage will produce a marked difference in the torque developed.

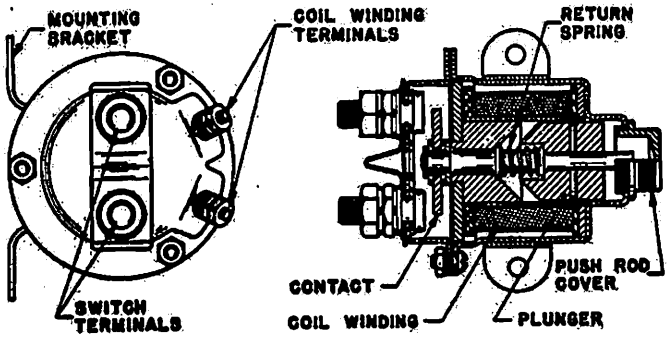
Interpreting the Results of No Load and Torque Tests

1. Rated torque, current draw, and no load speed indicates normal condition of starting motor.
2. Low free speed and high current draw with low developed torque may result from:
   a. Tight, dirty, or worn bearings, bent armature shaft or loose field pole screws which would allow the armature to drag.
   b. Shorted armature. Check armature further on growler.
   c. A grounded armature or field. Check by raising the grounded brushes and insulating them from the commutator with cardboard and then checking with a test lamp between the insulated terminal and the frame. If test lamp lights, raise other brushes from commutator separately to determine whether it is the fields or armature that is grounded.
3. Failure to operate with high current draw:
   a. A direct ground in the switch, terminal, or fields.
   b. Frozen shaft bearings which prevent the armature from turning.
4. Failure to operate with no current draw:
   a. Open field circuit. Inspect internal connections and trace circuit with a test lamp.
   b. Open armature coils. Inspect the commutator for badly burned bars. Running free speed, an open armature will show excessive arcing at the commutator bar which is open.

c. Broken or weakened brush springs, worn brushes, high mica on the commutator, or other causes which would prevent good contact between the brushes and commutator. Any of these conditions will cause burned commutator bars.

5. Low no-load speed, with low torque and low current draw indicates:
   a. An open field winding. Raise and insulate ungrounded brushes from commutator and check fields with test lamp.
   b. High internal resistance due to poor connections, defective leads, dirty commutator, and causes listed under 4 c above.

6. High free speed with low developed torque and high current draw indicates shorted fields. There is no easy way to detect shorted fields, since the field resistance is already low. If shorted fields are suspected, replace the fields and check for improvement in performance.



SECTIONAL VIEW OF MAGNETIC SWITCH
(12 VOLT TYPE)
MODEL 1422

STARTING SWITCH - MAGNETIC

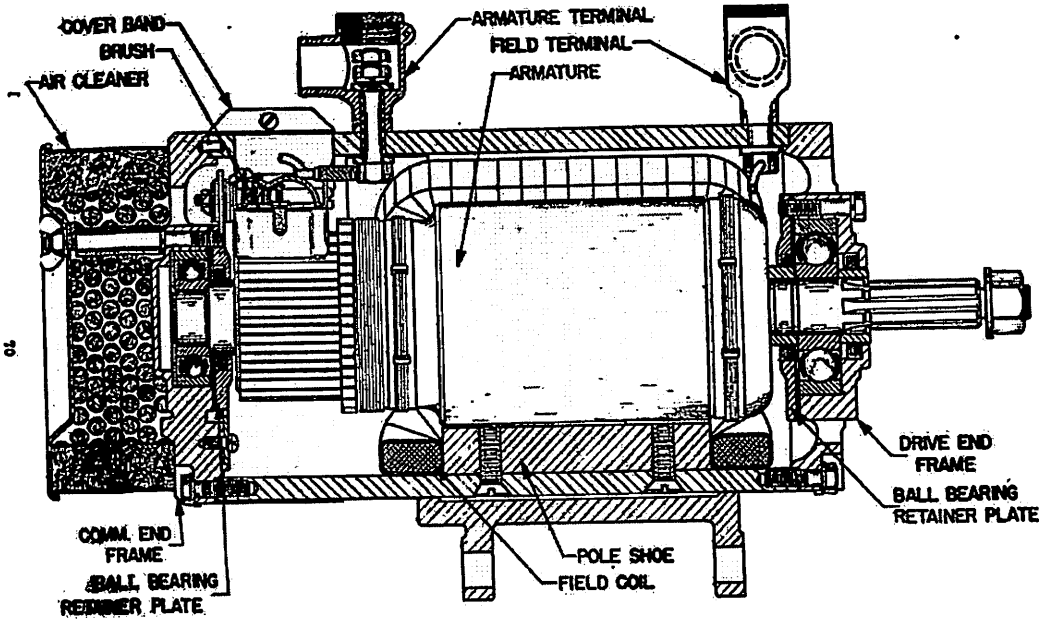
Since it is of prime importance to keep the starting motor circuit as short as possible a magnetic type starting switch is furnished with each engine to be incorporated in the starting motor circuit. The magnetic starter switch can be operated from a remote station through a medium of a primary circuit of low amperage. In this type of hook-up the push button primary control switch, when closed, causes the current to flow through the coil winding of the magnetic switch. The magnetic attraction of the winding on the switch plunger closes the contacts across the main battery terminals, thus completing the battery to starting motor circuit. This arrangement permits the use of short heavy cables of low resistance between the battery and the starting motor, assuring that maximum battery voltage is available for starting purposes.

The Model 1422 Magnetic Switch is a 12 volt, electrically operated, starting motor switch. The specifications are as follows:

Maximum voltage to close switch . . . 7.0 volts
Current draw . . . 12.0-13.0 Amperes at 12 volts.

This unit requires very little attention other than to periodically inspect all terminal connections to make sure that they are clean and tight.

As indicated on the sectional drawing, the push rod cover can be removed and the main controls can be closed by pressing the plunger down by hand. This feature can be used for checking the main battery circuits or an emergency start may be made from the engine room in event of failure of the push button control switch or associated wiring.


COVER BAND
BRUSH
AIR CLEANER
ARMATURE TERMINAL
FIELD TERMINAL
ARMATURE
DRIVE END FRAME
BALL BEARING RETAINER PLATE
COMM. END FRAME
BALL BEARING RETAINER PLATE
POLE SHOE
FIELD COIL

GENERATOR

THE GENERATOR

The generator is a device which transforms mechanical energy into electrical energy. It consists of field coils which create a magnetic field as current flows through them, an armature which as it revolves carries conductors through the magnetic field and the commutator and brushes to carry off the current induced in the conductors. It is the function of the generator to supply current for electrical needs of the engine and to keep the storage battery in a charged condition.

A shunt type generator is used on the Sea Raider Special engine. This type generator reaches maximum output at a relatively low rpm and the output does not taper off at high speed. The output of the generator is controlled entirely by external regulation through the medium of a control box supplied as part of the engine equipment.

The operator should ascertain the voltage of the electrical equipment on any particular engine. This information will be found stamped on the name plate of the generator.

The generator is driven by two vee belts. The vee belts should be kept in proper adjustment. Do not maintain the belt or belts rigidly tight. The belt or belts should have a movement of approximately 3/4" across the belt travel at a point which is about half way between the drive and driven pulley. In those installations where two belts are used to drive the generator it should be remembered that in the event it is necessary to renew a generator drive belt, both belts should be renewed at the same time. Belts are available in matched pairs and if possible should be so ordered and installed.

Delco-Remy Model 1117304 Standard Rotation Engine
Delco-Remy Model 1117305 Opposite Rotation Engine

The above Delco-Remy Generators are of the 6-9/16 inch diameter frame size, insulated, ventilated, four brush, shunt unit, with an automotive carburetor type air cleaner mounted on the commutator end frame, with ball bearings in both the drive end and commutator end. Specifications are as follows:

Model 1117304 Counterclockwise rotation viewing drive end for standard rotation engine.
Model 1117305 Clockwise rotation viewing drive end for opposite rotation engine.
55 amperes at 13 volts at 950 r.p.m. - cold output (output controlled by current regulator setting).
Brush spring tension 24-28 ounces.
Field current at 12 volts - 1.54-1.71 amperes.

Generator Maintenance

Most generator difficulties can be traced to causes in the external circuit. The external circuit must be kept in good condition. Defective wiring, loose or corroded connections in the circuit will cause high voltage which will result in injury to the generator and regulator and will as well shorten the life of the storage battery and the distributor points.

General maintenance may be divided into two sections, normal maintenance required to assure continued operation of the generator and the checking and repair of inoperative generator.

Normal Generator Maintenance

Lubrication: The two grease cups should be turned down one turn every 100 hours of operation. Never oil commutator.

Inspection: The cover band should be removed and the commutator and brushes inspected at regular intervals. If the commutator is dirty, it may be cleaned with No. 00 sandpaper. Blow out dust. NEVER USE EMERY CLOTH TO CLEAN COMMUTATOR. If the commutator is rough, out of round, or has high mica, it should be turned down in a lathe and the mica undercut.

Worn brushes should be replaced. They can be seated with a brush seating stone.

The brush seating stone is an abrasive material which, held against the revolving commutator, carries under and seats the brushes in a few seconds. Blow out the dust. NEVER USE EMERY CLOTH. Check brush spring tension which should be approximately 25 ounces.

Generator Disassembly

At regular intervals, depending on the type of operation, the generator should be disassembled for a thorough cleaning and inspection of all parts. Never clean the armature or field in any degreasing tank, or grease dissolving materials, since these may damage insulation. The ball bearings should be cleaned and repacked with a good grade of ball bearing grease. The commutator should be trued in a lathe and the mica undercut if necessary. All wiring and connections should be checked. Rosin flux should be used in making all soldered connections. Acid flux solder must never be used on electrical connections.

Checking Inoperative Generator

Several conditions may require removal of the generator from the engine and further checking of the generator as follows:

1. No output
2. Unsteady or low output
3. Excessive output
4. Noisy generator

1. No output.
   a. Check with test points from one of the main terminals to frame. Light should not light. If it does, the generator is grounded. Raise brushes from commutator and check field, commutator and the terminals separately to locate ground.
   b. If generator is not grounded, check field for open circuit.
   c. If the field is not open, check for shorted field. Field draw at 12 volts should be 1.54-1.71 amperes. Excessive current draw indicates shorted field.
   d. If trouble has not yet been located, remove armature and check on growler for short circuit.
2. Unsteady or Low Output.
   Check as follows:
   a. Check drive belt tension.
   b. Check brush spring tension and brushes for sticking.
   c. Inspect commutator for roughness, grease and dirt, dirt in slots, high mica, out of round, burned bars. With any of these conditions, the commutator must be turned down in a lathe and mica undercut. In addition, with burned bars which indicate open circuit, the open circuit condition must be eliminated or the armature replaced.
3. Excessive Output.
   Excessive output usually results from a high regulator setting, however, it may also be caused by a short between the charging and field circuits. The location of the defect can be determined by removing the "FIELD" terminal of the regulator. If the output drops off, the short is in the regulator and it should be inspected for burned leads, windings or charred insulation. If the output continues high with the "FIELD" terminal wire removed, the short is in the writing or the generator. Remove the wire from the "F" terminal of the generator. If the output now drops off, the short is in the wiring; if it continues high, the generator is at fault.
4. Noisy Generator.
   Noisy generator may be caused by loose mounting or drive pulley, or worn, dry, or dirty bearings, or improperly seated brushes. Brushes may be seated by using brush seating stone, referred to above.

Installation Caution

After the generator is reinstalled on the engine, or at any time after leads have been disconnected and then reconnected to the generator, the generator must be correctly polarized, before starting the engine. To polarize the generator, disconnect the lead at the "F" terminal of the regulator and momentarily connect this lead to the "BAT" terminal of the regulator. This allows a momentary surge of current from the battery to the generator which correctly polarizes the generator with respect to the battery it is to charge.

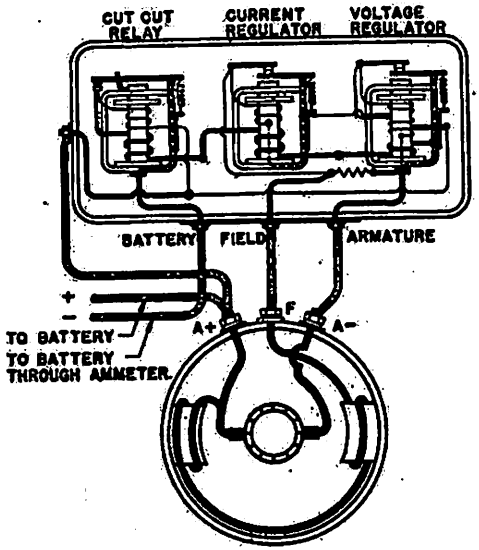
Current and Voltage Regulator.

The current and voltage regulator box is sometimes referred to as the voltage regulator or as an apparatus box. Enclosed in the housing a cut-out relay, a vibrating voltage regulator unit and a vibrating current regulator unit are mounted on the same base for convenience.

This control box exercises its influence on the output of the generator. It is always used with a shunt type generator. The shunt generator may have either two or four brushes depending on its rated output and the number of poles but it does not have a "third brush." The control box governs the generator output and upon its proper functioning depends the source of electrical energy required for the engine ignition and starting system. The operator should acquire a thorough understanding of the functions of the regulator unit as an aid in tracing possible trouble. Without trying to establish an alibi of any sort, it may be stated that most regulator unit trouble can be traced to outside sources. As a first offender the blame can be placed on loose or dirty connections. As a second offender wire of inadequate capacity in the circuit from the generator to the regulator then to the ammeter and back to the storage battery. Wire of inadequate capacity in this circuit sets up a resistance simulating the effect of a fully charged battery and thereby causes a reduction in the generator output. The battery may be starved but the regulator unit does not have a chance to learn of this condition because of the resistance setup by wire of inadequate capacity. Improper connections can cause trouble so it is well to consult a wiring diagram if there is any question as to where a particular lead should be connected. Care should be exercised in making connections to avoid changing the polarity. The breaker points are arranged to provide a long life when connections are made to agree with the polarity stamped on the name plate attached to the cover of the regulator box. If this polarity is reversed, the life of the points is rapidly reduced.

The control box should be mounted in vertical plane with the terminals at the lower edge. Mounting of the control box on the engine is not recommended. It is better practice to mount the control box on a bulk head as near to the engine as is convenient so that the circuit wires may be kept as short as possible. The unit should be kept free of vibration insofar as it is possible to do so. A rubber gasket is provided between the housing and the base of the control box. If the cover is removed for the purpose of adjusting or renewing parts be sure that the gasket is in place when the cover is reinstalled.

WHEN MAKING CHECKS ON THE SETTING OF THE UNITS WITHIN THE CONTROL BOX, THE CONTROL BOX MUST BE SET UP IN THE SAME POSITION AS IT IS MOUNTED DURING OPERATION.



SCHEMATIC WIRING DIAGRAM SHOWING 3 WIRE CIRCUIT.

Voltage Control Box Hints.

1. Do not tamper with control box adjustments unless you know what you are doing and have proper instruments with an understanding of their usage.
2. The cut-out relay makes and breaks the circuit between the generator and the battery.
3. The voltage regulator unit limits the voltage of the circuit thus protecting the electrical accessories and the storage battery against damage from high voltage.
4. The current regulator unit is a protection to the generator preventing it from exceeding its maximum rated output.
5. A regulator cannot increase the generator output beyond the generator's designed maximum.
6. Never set the current regulator above the specified output of the generator.
7. Never adjust the voltage regulator setting below the cut-out relay setting.

8. Voltage regulator and cut-out relay settings must be made at operating temperatures (135-145° F.).

9. Never close the cut-out relay contacts by hand while the unit is hooked up in circuit.

10. Never file contact points while the unit is hooked up in circuit.

11. All checks and settings of the unit must be made with the regulator box in the same plane as it is mounted in operation.

12. The control box should be mounted in vertical plane with the terminals at the bottom, adjacent to but not attached to the engine.

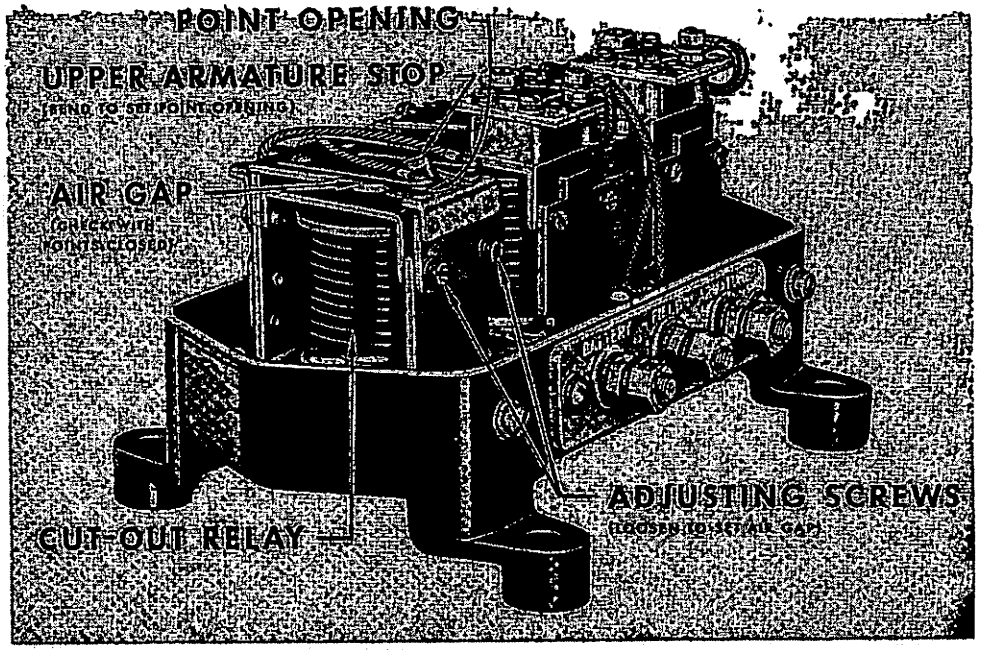
13. Be sure the rubber gasket is in place whenever the cover is reassembled.

14. Make certain that all connections are clean and tight and made with regard to the polarity indicated on the name plate of the control box.

15. Make certain that trouble does not exist in the exterior circuit before going to work on the control box.

Caution

A burned resistance unit, regulator winding or fused contacts will usually result only from open circuit operation or extreme resistance in the charging circuit. If such units are found in the control box check the circuit for loose or dirty connections and analyze the wiring from the standpoint of capacity.



CONTROL BOX - TERMINAL SIDE

Cut-out Relay

A cut-out relay is used to close the circuit between the generator and the battery when the generator voltage reaches the value at which the relay is set to operate. The relay also opens the circuit to prevent the battery from discharging through the generator when the battery voltage exceeds the generator voltage.

To check the closing voltage of the contact points in the cut-out relay first consult the data on the name plate of the control box and also the data on electrical equipment. The relay must be checked at operating temperature. The best time to make such a check is at the end of a run before the relay has cooled off. Reduce the engine speed to idle range and remove the cover from the apparatus box. Connect an accurate reading volt meter running one lead to the armature circuit connection of the regulator box and the other lead to the terminal of the storage battery which is grounded to the engine. Gradually increase the engine speed and note the voltage at which the relay points close.

CAUTION: Never close the contact points manually while the battery is connected. Never attempt to file the contact points while the battery is connected. The resistance through the generator and relay is very low and to complete the circuit to the battery when the generator is not operating would allow enough current to flow to damage the relay winding and possibly the generator armature.

ADJUSTMENT: Disconnect battery lead and make certain that the relay is set to the correct air gap between the armature and the core. Check for correct point opening gap. The closing voltage of the cut-out relay contact points can be adjusted by loosening the lock screw and turning the eccentric screw to increase or decrease the tension of the armature spring. Note the illustration of the cut-out relay unit. Increasing the tension will increase the closing voltage. Tighten the lock screw securely after the adjustment.

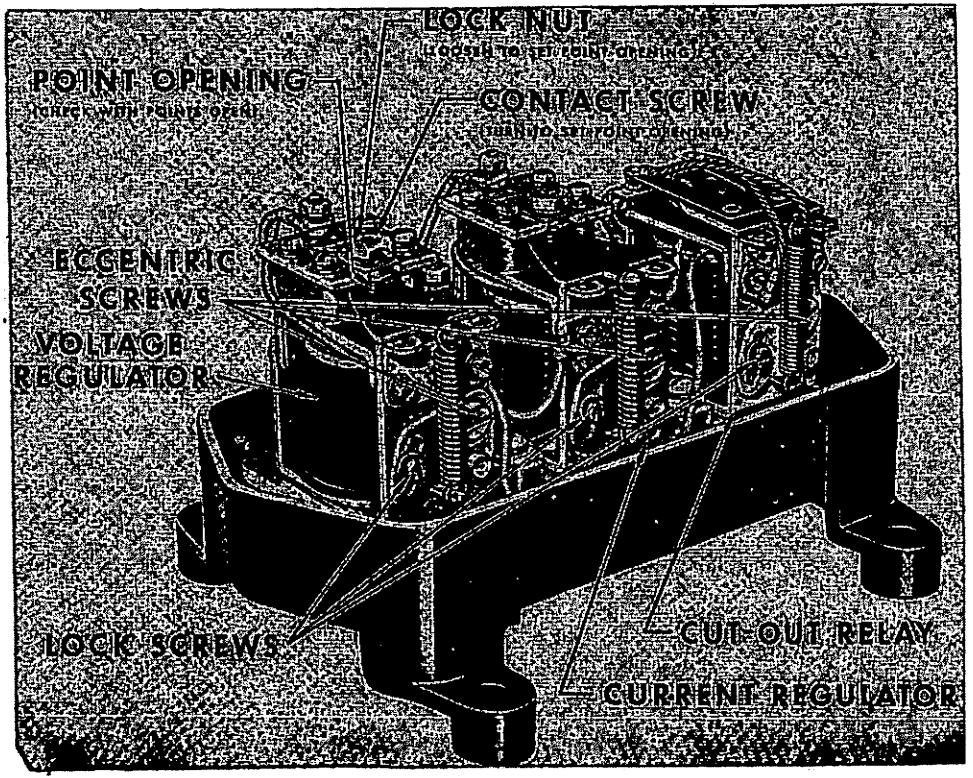
NOTE: The cut-out relay closing voltage must never be above the voltage required to open the contact points of the voltage regulator unit. If the cut-out unit does not seem to respond to adjustment bridge the voltage regulator contact point with a jumper and recheck the cut-out relay. Necessity for the above procedure indicates an improper setting of the voltage regulator.

To avoid the possibility of shorting the circuit disconnect the battery lead while making adjustments, reconnecting same to check the settings.

Voltage Regulator

It is the function of the voltage regulator unit to govern the voltage of the generator output.

Regulators are magnetic switches which operate on a principle similar to that of the cut-out relay but their function is different. A regulator's function is to prevent the generator output from exceeding a safe maximum and to reduce the output in accordance with the requirements of the connected electrical load and the condition of the charge of the battery. As a battery approaches a charged condition its voltage increases. The higher the current input



CONTROL BOX - BACK

into the battery the higher this voltage will go. With the small capacity generators used up until recent years this condition was not serious. However, the present day type generator is capable of outputs that would produce serious consequences as the battery approaches full charge. The battery would gas and overheat and its voltage would be forced up above the normal rating. This high voltage would greatly shorten the life of the electrical units. It is for this reason that a form of regulation is required to reduce the generator output when less current is required. To control the voltage, a voltage regulator is employed. To control the output in amperes a current regulator is employed. Regulators cannot increase the generator output beyond the maximum for which the generator is designed.

The voltage regulator unit consists primary of a wound core, a set of points and an armature positioned by a spiral spring or springs so that the contact points are normally held closed (one contact point is attached to the armature). When the points are closed the full generator output is available. As the battery approaches a charged condition and the line voltage increases, the magnetic field of the voltage winding in the core increases its strength. When the voltage for which the unit is set is reached the magnetic field is strong enough to overcome the spring tension and pull the armature toward the coil separating the contact points. When the contact points open, the field circuit is forced to go through a resistance which reduces the field current and so reduces the generator output.

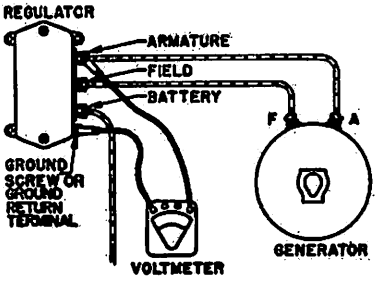
As soon as the generator output is reduced the armature is released from the core and the points are closed again thus completing the cycle. This complete cycle takes place very rapidly and under certain conditions it may be completed at a speed of several hundred times a second thus regulating the voltage to a constant value. The opening and closing of the contact points however causes wear on the contact surfaces for which compensation must at times be made.

Adjustment: The voltage regulator unit must be checked for operating temperature. First ascertain the correct setting as noted on the name plate of the control box. Due to the possibility of change in the equipment, this information may not be included on the electrical equipment data. Stop the engine and disconnect the lead on the battery terminal of the regulator and leave it disconnected while making this check since this unit must be set on open circuit. Connect one of the volt meter leads to the armature terminal on the regulator. The other volt meter lead must be connected to the "A plus" terminal of the control box on a two wire circuit or to the ground connection terminal of the control box on a single wire circuit. The illustration showing the connections for the voltage regulator check indicates a two wire circuit which is used on some engines in service. On single wire circuits, the terminal at the end of the control box must be connected to ground.

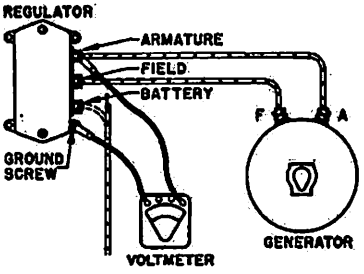
Start the engine and operate same to give a generator speed as listed on the name plate of the generator. Note the voltage at which the regulator operates. If incorrect, stop engine and first adjust the point opening to obtain .015" gap.

To adjust the point opening hold the armature down against the core and adjust the contact point opening by adjusting the upper contact screw. Tighten the lock nut securely

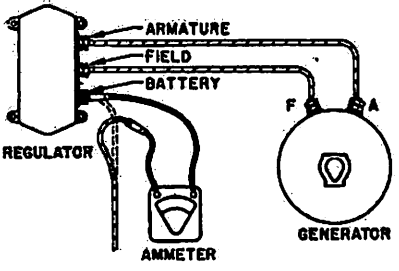
RELAY CLOSING VOLTAGE CHECK



VOLTAGE REGULATOR CHECK



CURRENT. REGULATOR CHECK



after adjusting the point. Notes: When checking the points for the correct point opening do not remove the upper contact from its natural position. The spring holding the upper contact should rise slightly above the fiber insulator when the points are together and at rest to insure a wiping action on the points when they are in operation. If the contact points are pitted or burned clean with a thin contact file just before adjusting the point opening.

When the point opening is correct the voltage setting can be adjusted by loosening the lockscrew and turning the eccentric screw to increase or decrease the tension of the armature spring. Increasing the tension increases the voltage regulator setting and decreasing the tension decreases the setting. Spring tension should always be reduced to lower the voltage below the specified value and then increased to bring the voltage setting up to the proper value. Tighten the lockscrew securely after completing the adjustment.

The Current Regulator

The current regulator is a means used to provide a limiting effect on the generator output in amperes. If the generator ampere output exceeds the setting of the current regulator, this unit comes into action.

The current regulator windings are composed of a few turns of heavy wire and carry the entire output of the generator. The contact points are normally held closed by spring tension which retains the armature in the up position so that the generator field circuit is conducted directly through the points. When the current flowing through the current regulator windings which is total generator output reaches the value for which the regulator has been set, sufficient magnetic force is created in the regulator core to overcome the armature spring tension. The armature is attracted downward toward the regulator core and the contact points are separated. With the points separated the generator field circuit is forced through a resistance reducing same and the generator output is accordingly lowered.

The instant the current flowing through the regulator windings begins to drop off, the magnetic field created by this current begins to weaken. It is quickly reduced to a value which can no longer retain the armature in a down or open point position. The armature spring moves the armature upward closing the points. This shorts the resistance out of the generator field circuit and the generator output increases. When it reaches the value for which the regulator is set the armature is once more pulled down and resistance again inserted into the generator field circuit. This is a vibrating action which takes place so rapidly the armature cannot be observed to move regulating for a constant current output.

In operation either the current regulator or the voltage regulator functions at any one time, both never operate at the same time. When the requirements of the connected electrical load are large and the battery is low, the current regulator unit operates to prevent the output from exceeding the rated output of the generator and the voltage regulator unit is inoperative. If the requirements of the connected electrical load are reduced and the battery comes up to charge, the voltage regulator unit operates to prevent high voltage at the battery and in the circuit and the increasing resistance of the battery as it becomes charged tapers down the generator output.

The output is thus reduced by the action of the vibrating voltage regulator unit to what is required by the connected electrical load plus a small sustaining charge of a few amperes to the battery.

From the foregoing it should be understood that the charging rate as indicated on the ammeter may be expected to vary in accordance with the condition of the storage battery as to per cent of charge and the connected electrical load.

To Check Current Regulator: The current regulator setting must be made at operating temperature. It is necessary to maintain the contact points closed in the voltage regulator unit to prevent that unit from operating while attempting to check the setting of the current regulator. This may be conveniently done by bridging the voltage regulator contact points with a jumper lead. The lead is illustrated in the diagram showing the connections for the current regulator check. Connect an accurate reading ammeter in the circuit between the storage battery and the battery terminal of the control box.

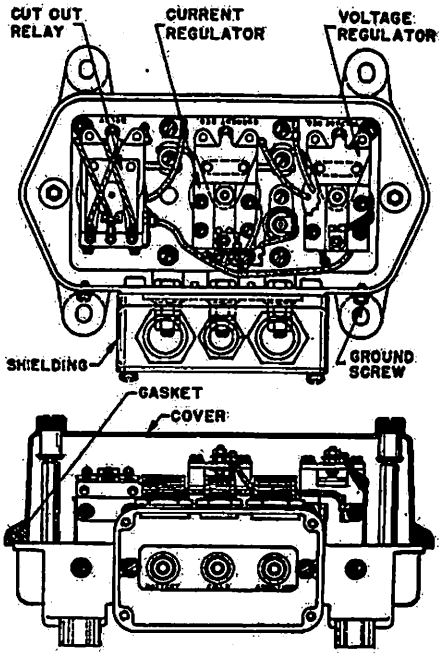
Note the setting information as listed on the name plate of control box. Start the engine and increase the engine speed gradually until the generator is running at the speed specified in the test data. Note the current regulator setting as indicated on the test ammeter.

If an adjustment is required stop the engine and disconnect the battery terminal lead from the control box. First check the point opening gap.

When checking points for correct opening do not move the upper contact from its natural position. The spring holding the upper contact should rise slightly above the fiber insulator when the points are together and at rest to insure a wiping action on the points when they are in operation. If the contact points are pitted or burned clean with a thin, fine cut contact file before adjusting the point openings.

To make the point opening adjustment hold the armature down against the core and adjust the contact point opening by resetting the upper contact screw. Be sure to tighten the lock nuts securely after making the adjustment.

The setting of the current regulator is varied by adjusting the tension of the armature springs. This tension may be changed by loosening the lockscrew and turning the eccentric screw to increase or decrease as desired. Increasing the tension will increase the current setting and decreasing the tension will decrease the current setting. Do not at any time set the current regulator above the rated ampere capacity as shown on the name plate of the control box.



The Delco-Remy Model 5638 Current and Voltage Regulator is a heavy-duty 55 ampere, 12-volt unit, fitted for shielding to reduce radio interference. It is designed for operation with a negative grounded system and has the following specifications:

Cut-Out Relay - AIR GAP - .057 inch
Cut-Out Relay - POINT OPENING - .020 inch
Cut-Out Relay - CLOSING VOLTAGE - 13.5 volts

Current Regulator - POINT OPENING - .015 inch
Current Regulator - CURRENT SETTING - 55 amperes

Voltage Regulator - POINT OPENING - .015 inch
Voltage Regulator - VOLTAGE SETTING - 15.5 volts

NOTE: All electrical checks must be made with the regulator AT OPERATING TEMPERATURE (146° F.) The regulator may be checked at the end of a run, or after the unit has been operated for 45 minutes or until operating temperature has been reached. The unit must be in the actual operating position (vertical) when the checks are made.

Cut-out Relay Adjustments

Air Gap: With regulator disconnected, measure AIR GAP (.057 inch) between armature and core (not between brass pin in armature and core) with points held closed. To adjust, loosen the two ADJUSTING SCREWS, and raise or lower the lower contact bracket as required. Tighten screws after adjustment.

Point Opening: Bend the UPPER ARMATURE STOP to adjust POINT OPENING (.020 inch). If both sets of points do not close at the same instant, bend the spring fingers slightly until they do.

Closing Voltage: Connect a test voltmeter between the ARMATURE TERMINAL and the GROUND SCREW. Gradually increase generator speed and note the voltage at which the cut-out relay points close. To adjust, loosen the LOCK SCREW and turn the ECCENTRIC SCREW to change the spiral spring tension. Increasing the tension increases the closing voltage and decreasing the spring tension lowers the closing voltage. Check setting by bringing generator to a stop, then slowly increasing speed until points close. Relay closing voltage must be below the voltage regulator setting, otherwise the voltage regulator will operate and hold the voltage below the value required to close the cut-out relay.

Voltage Regulator Adjustments

Point Opening: The regulator POINT OPENING (.015 inch) is checked with the armature held down against the core. To adjust, loosen the LOCK NUT and turn the CONTACT SCREW. The spring holding the upper contact screw should rise slightly above the fiber insulator when the points come together. This provides a wiping action which improves their operation.

Voltage Setting: (15.5 volts) Connect a test voltmeter between the ARMATURE terminal and ground screw and disconnect the lead from the BATTERY terminal. With the unit hot - at operating temperature - run the generator at a medium speed and note voltage setting. To adjust, loosen the LOCK SCREW and turn the ECCENTRIC SCREW to change the spiral spring tension. Increasing the tension increases the voltage setting, decreasing the spring tension lowers the voltage setting. After tightening the lock screw, check the setting by slowing the generator until the cut-out relay points open, then bringing the generator back to speed. The voltage regulator setting must always be above the cut-out relay setting, otherwise the voltage regulator would operate and prevent the voltage from reaching a value sufficient to cause the cut-out relay to operate.

Current Regulator Adjustments

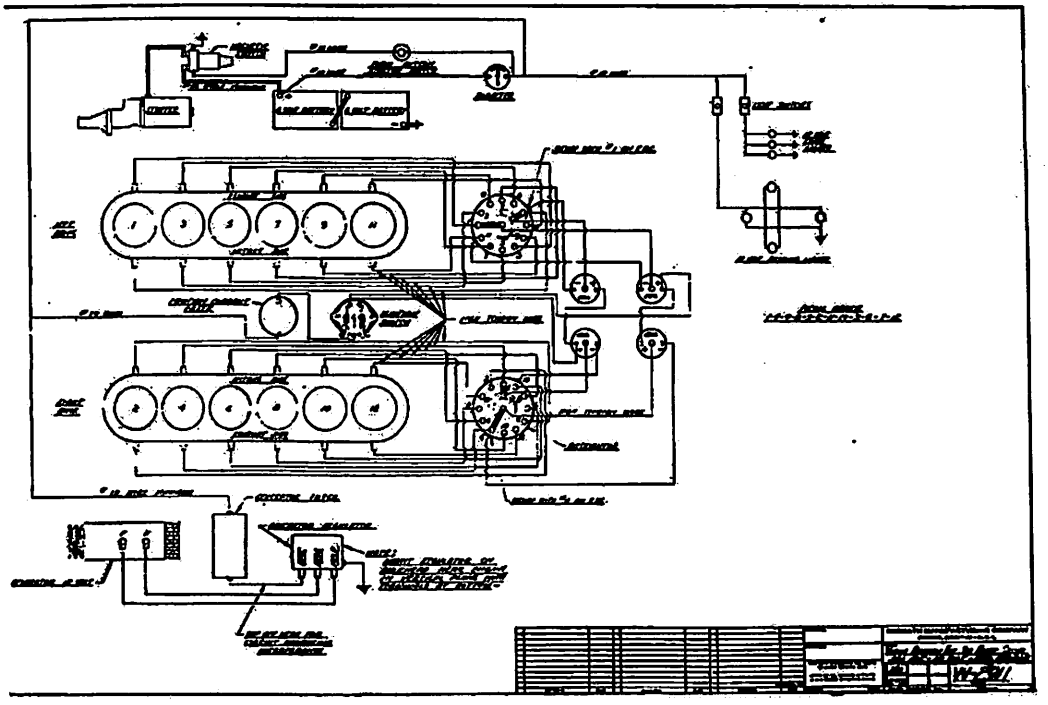
Point Opening: The regulator POINT OPENING (.015 inch) on the current regulator is checked and adjusted in exactly the same manner as the Voltage Regulator POINT OPENING, discussed on the previous page.

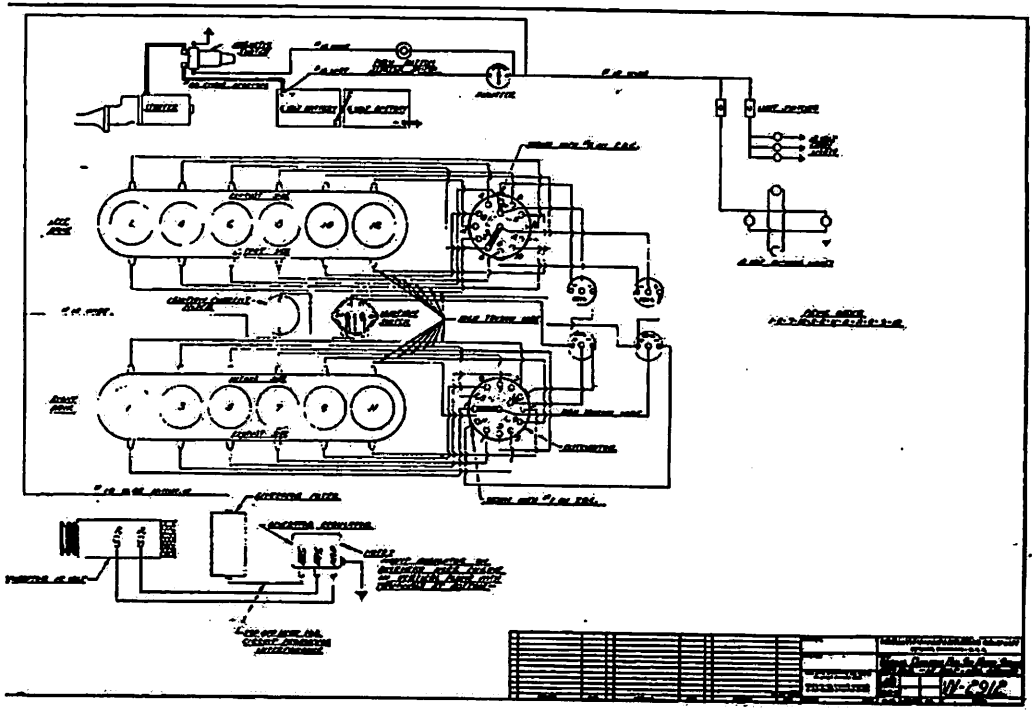
Current Setting: (55 amperes) Connect a test ammeter into the circuit at the BATTERY terminal and bridge the voltage regulator contact points with a jumper lead to prevent it from

operating. Turn on lights or other electrical accessories to prevent high voltage, operate the generator at a medium speed (regulator at operating temperature) and note the CURRENT SETTING. To adjust, loosen the LOCK SCREW and turn the ECCENTRIC SCREW to change the spiral spring tension. Increasing the tension increases the current setting, decreasing the spring tension lowers the current setting.

Cleaning Contact Points

If the voltage or the current regulator contact points appear to arc excessively, it is possible they have become oxidized and the points should be cleaned. Emery cloth or sandpaper must never be used to clean the contacts, since particles of emery or sand might embed in the point surface and prevent normal operation.




W-C912