

# **TECHNICAL MANUAL**

## **WESTERBEKE DS5, DS7, W7 Marine Diesel Engines**

## **WESTERBEKE WPD3, WPD4 Marine Diesel Generators**

**Publication #12310**

Edition Three

June 1978



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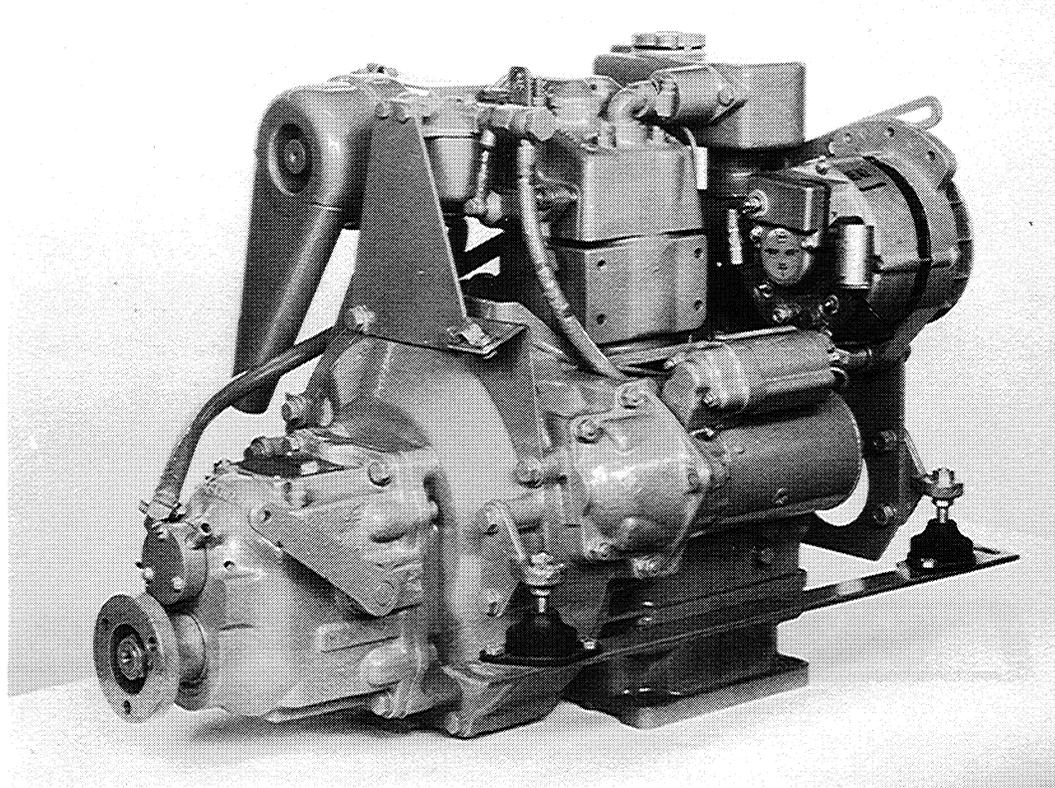
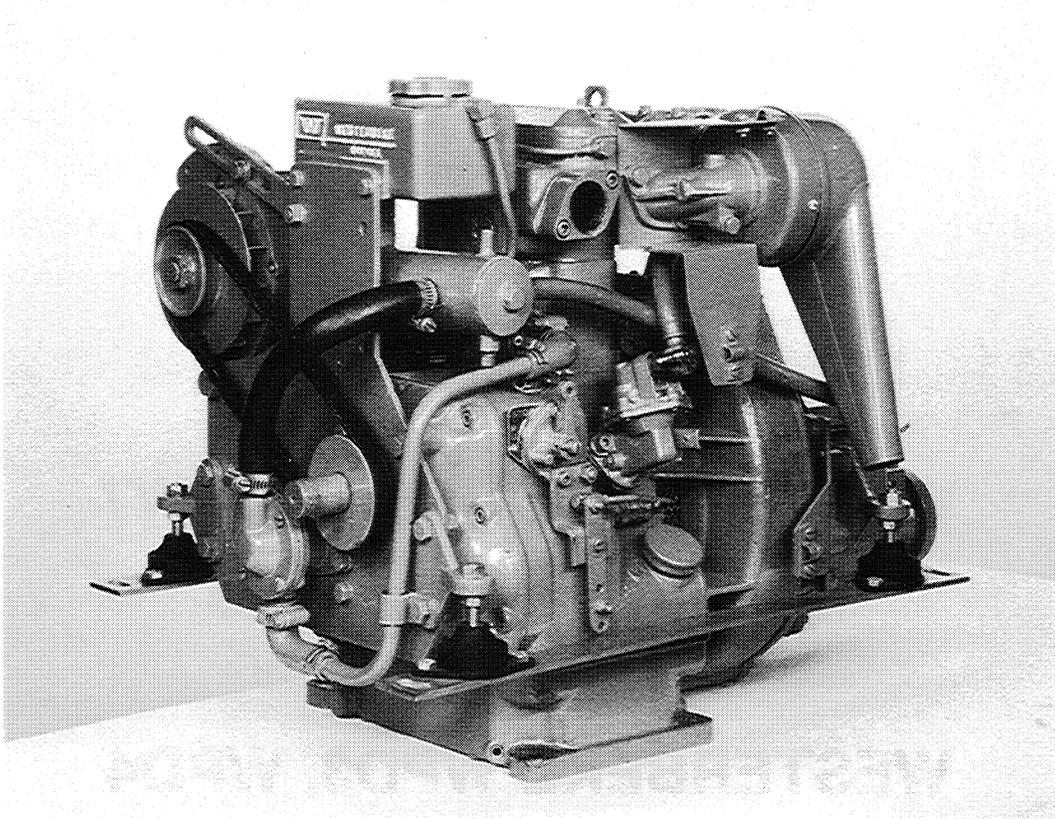
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WESTERBEKE 7 MARINE ENGINE

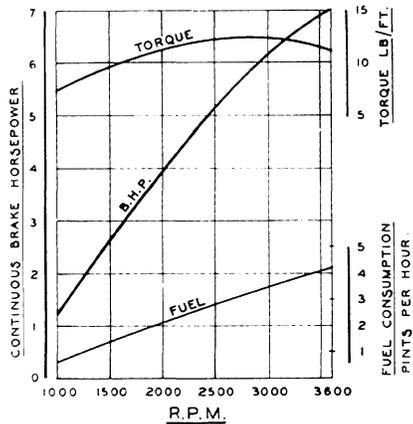
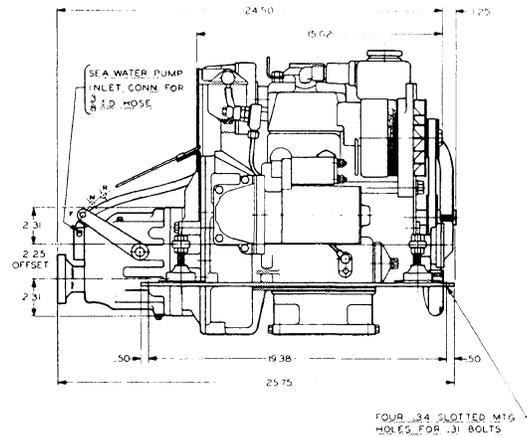
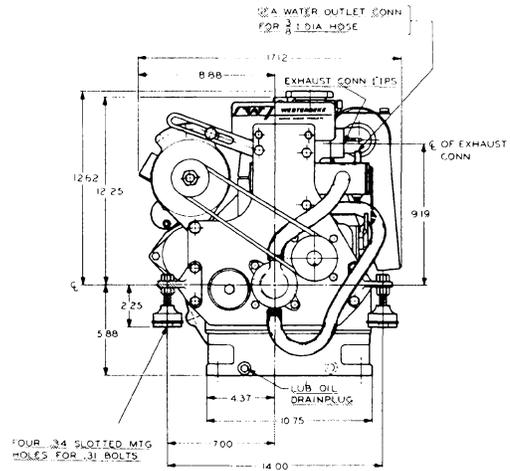


## WESTERBEKE 7 SPECIFICATIONS

- Type:** One cylinder four cycle vertical diesel.
- Displacement:** 18.5 cu. in. (303 cc.); bore 3", stroke 2 $\frac{5}{8}$ ".
- Power:** 7 hp. at 3600 rpm continuous.
- Compression Ratio:** 17:1.
- Weight:** 186 lb. with 2:1 reduction gear.
- Cylinder Block:** Aluminum.
- Cylinder:** Cast Iron.
- Cylinder Head:** Aluminum.
- Crankshaft:** Steel, counterbalanced.
- Connecting Rod:** Forged Steel.
- Piston:** Aluminum.
- Bearings:** Tri metal.
- Lubrication:** Full pressure to main and large end bearings.  
Full flow integral replaceable lube oil filter.
- Cooling System:** Fresh water cooling with heat exchanger.
- Installation Angle:** 15° maximum.
- Fuel System:** Bryce injection pump, variable speed governor with automatic overload control. Camshaft driven fuel lift pump with hand primer.
- Fuel Consumption:** See fuel consumption curve.
- Electrical System:** 12-volt starter, 55-amp alternator.
- Transmission:** Paragon/Westerbeke 2:1 reduction and reverse gear with positive neutral.

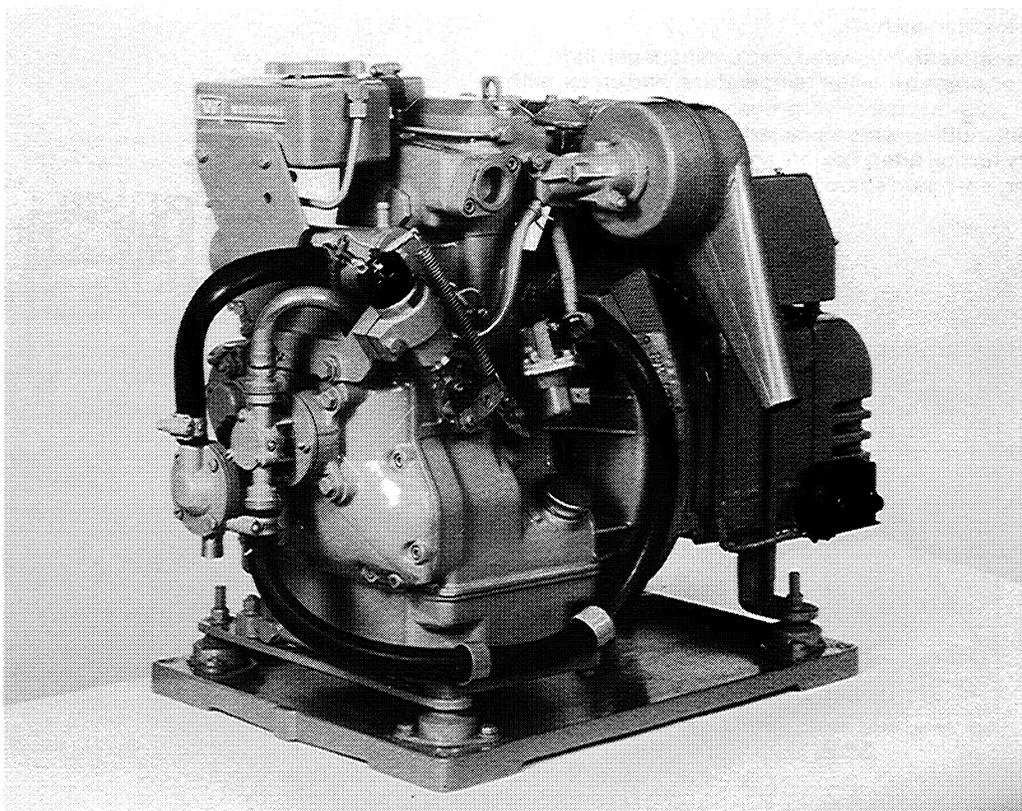
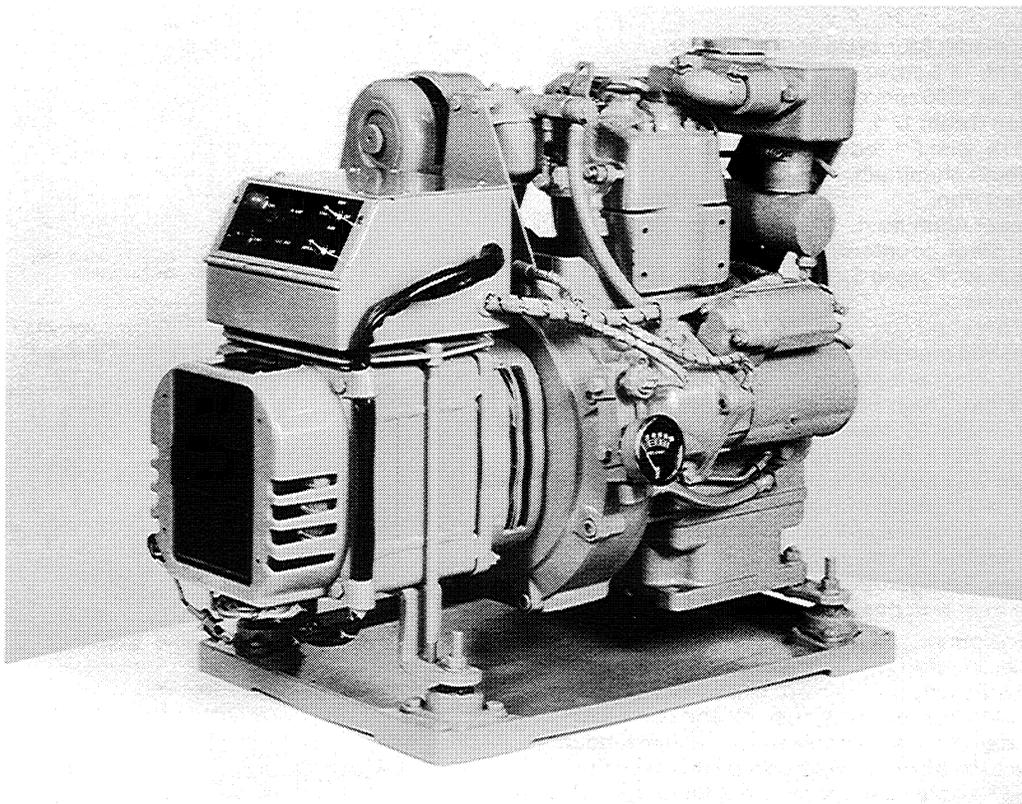
**Standard Equipment:** 2:1 manual reverse and reduction gear; electric starter, 55-amp alternator, factory pre-wiring with push-button start; closed circuit cooling system with heat exchanger, fresh and raw water pumps mounted; adjustable flexible engine mounts; full flow lube oil filter, sump pump and hose; fire-shielded flexible hose connections for fuel supply and return, secondary fuel oil filter, fuel lift pump with hand primer; threaded 1" IPS exhaust flange; mounting brackets for control cables; illustrated parts list and instruction manual.

**Optional Equipment:** Pre-wired instrument panel, indicating oil pressure, water temperature, and amps, with 10-foot plug-in cable; Hydro-hush stainless steel water lift muffler; water-injected exhaust elbow; primary fuel oil filter; flexible shaft coupling; sea water strainer; on-board spare parts kit.



2a

WPD-4 MARINE GENERATOR

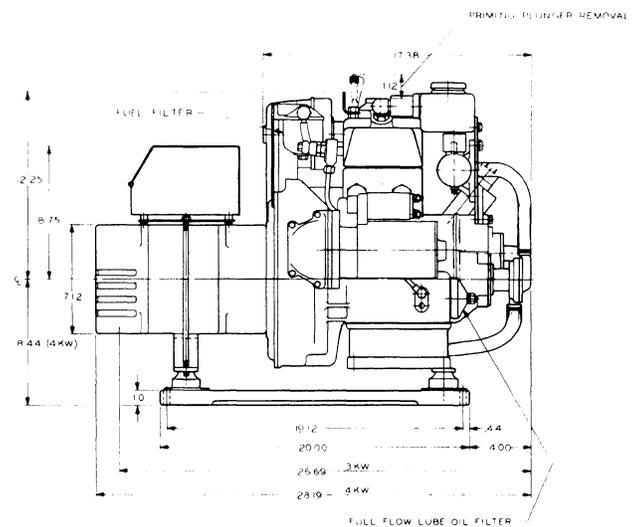
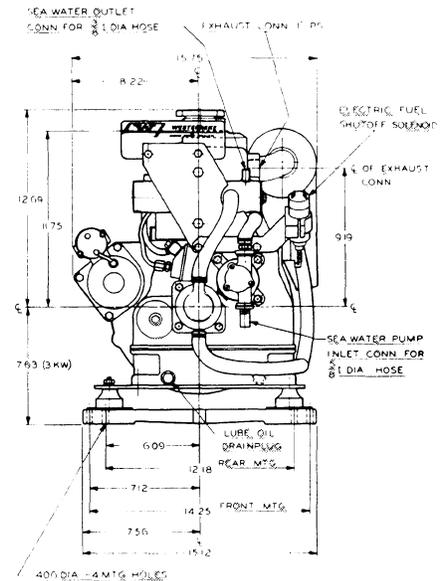


## WESTERBEKE WPD-4 SPECIFICATIONS

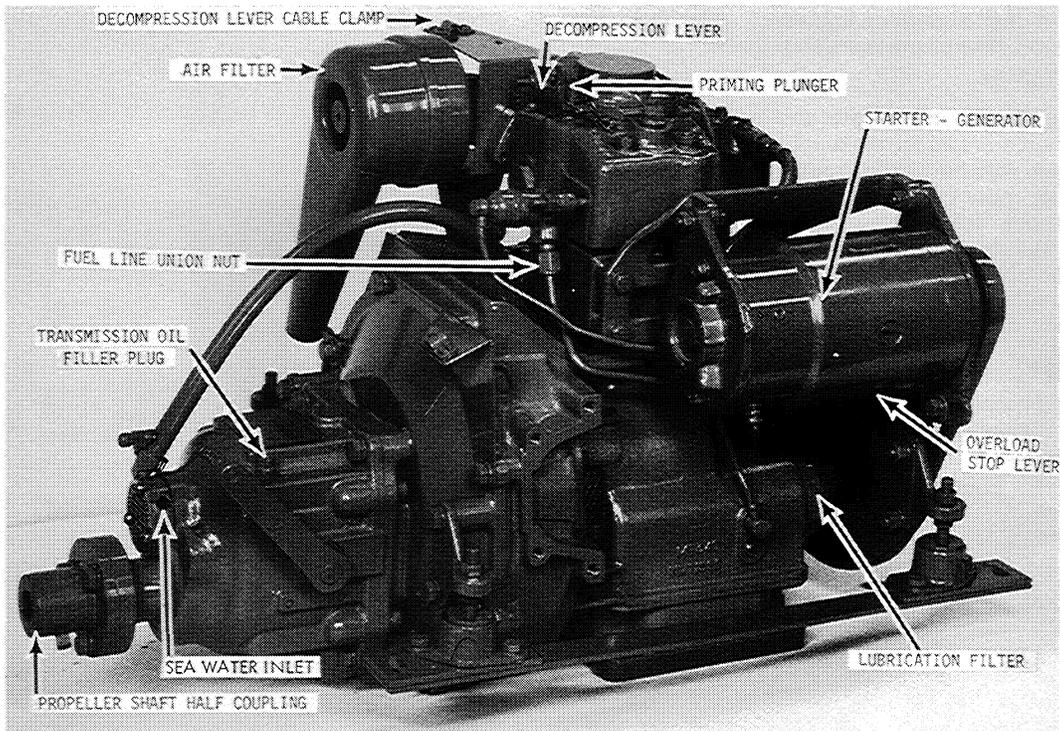
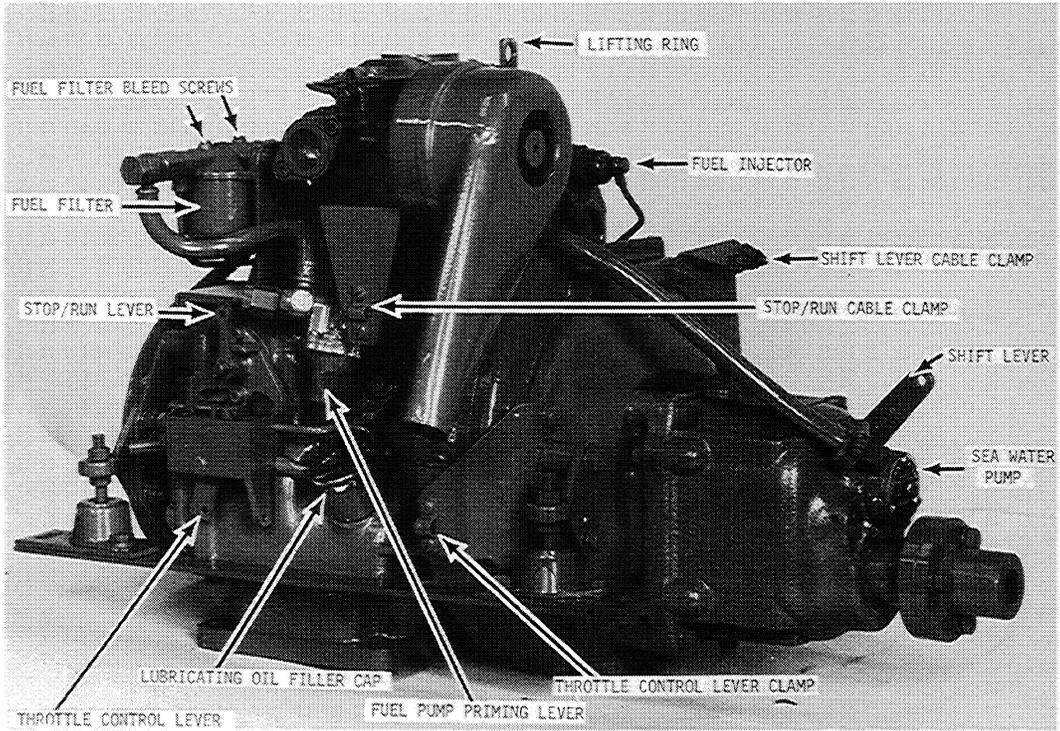
- Engine:** Single cylinder, fresh water cooled four cycle diesel.
- Displacement:** 18.5 cu. in. (303 cc); bore 3", stroke 2 $\frac{5}{8}$ ".
- Power:** 7 hp. at 3600 rpm.
- Cooling:** Fresh water cooling with heat exchanger.
- Starting:** Engine mounted 12-volt starting motor.
- Lubrication:** Full pressure to main and connecting rod bearings. Full flow integral replaceable lube oil filter.
- Mounting:** Engine-generator assembly is mounted on aluminum drip-pan base with heavy duty shielded rubber mounts to minimize vibration.
- Fuel System:** Bryce injection pump, governed to 3600 rpm. Camshaft-drive fuel lift pump with hand primer.
- Fuel Consumption:** Approx. 0.45 gallons per hour at full output.
- Alternator:** Rotating field, single bearing with shaft-mounted fan.
- Output:** 4000 watts for continuous operation; up to 33 amps, 120 volts, AC. 12 volts DC, 0-8 amps for battery charging.
- Frequency:** 60 Hertz.
- Phase:** Single.
- Power Factor:** Unity.
- Controls:** Angle-mounted on top of generator for visibility. Cover swings up for easy servicing. Electric start and stop. Solid state battery charging control circuit reduces heat, increases efficiency and reliability, and is immune to vibration and shock. High water temperature/low oil pressure shut down.
- Weight:** 233 lbs.

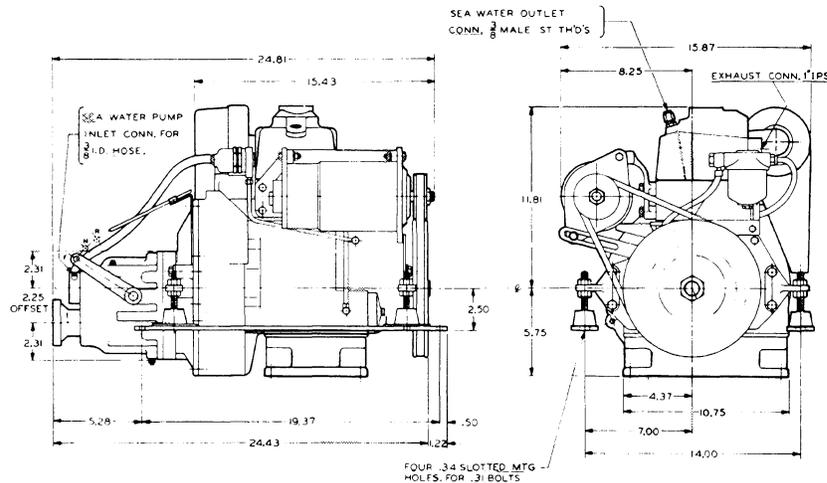
**Standard Equipment:** Integral drip-pan base with vibration isolators and drain plug; closed circuit cooling system with heat exchanger, fresh and raw water pumps mounted; full flow lube oil filter, sump pump and hose; fire shielded flexible hose connections for fuel supply and return, secondary fuel oil filter, fuel lift pump with hand primer; electric start and fuel shut off; high water temperature/low oil pressure shut down; battery charge circuit with charge indicator light; 1" IPS threaded exhaust flange; illustrated parts list and instruction manual.

**Optional Equipment:** Remote start; shore transfer switch; high capacity primary fuel filter; water injected exhaust elbow; Hydro-hush stainless steel water lift muffler; sea water strainer; on-board spare parts kit.



DS MARINE ENGINE





### MODEL D S MARINE ENGINE SPECIFICATIONS

**ENGINE:** Single cylinder, water cooled four cycle diesel.

**DISPLACEMENT:** 15.9 cu. in; bore 3 in. stroke 2-1/4 in.

**POWER:** 5 hp. at 3000 rpm.

**COOLING:** Positive displacement rubber impeller raw water pump.

**STARTING:** Engine-mounted 12 volt starting motor.

**LUBRICATION:** Full pressure to main and connecting rod bearings. Full flow integral replaceable lube oil filter.

**FUEL SYSTEM:** Bryce injection pump, governed to 3000 rpm. Camshaft-drive fuel lift pump with hand primer.

**FUEL CONSUMPTION:** Approx. 0.45 gallons per hour at full output.

**MOUNTING :** Engine-rails on propeller shaft center line with height adjustment nuts locked in place, mounted on flexible engine mounts.

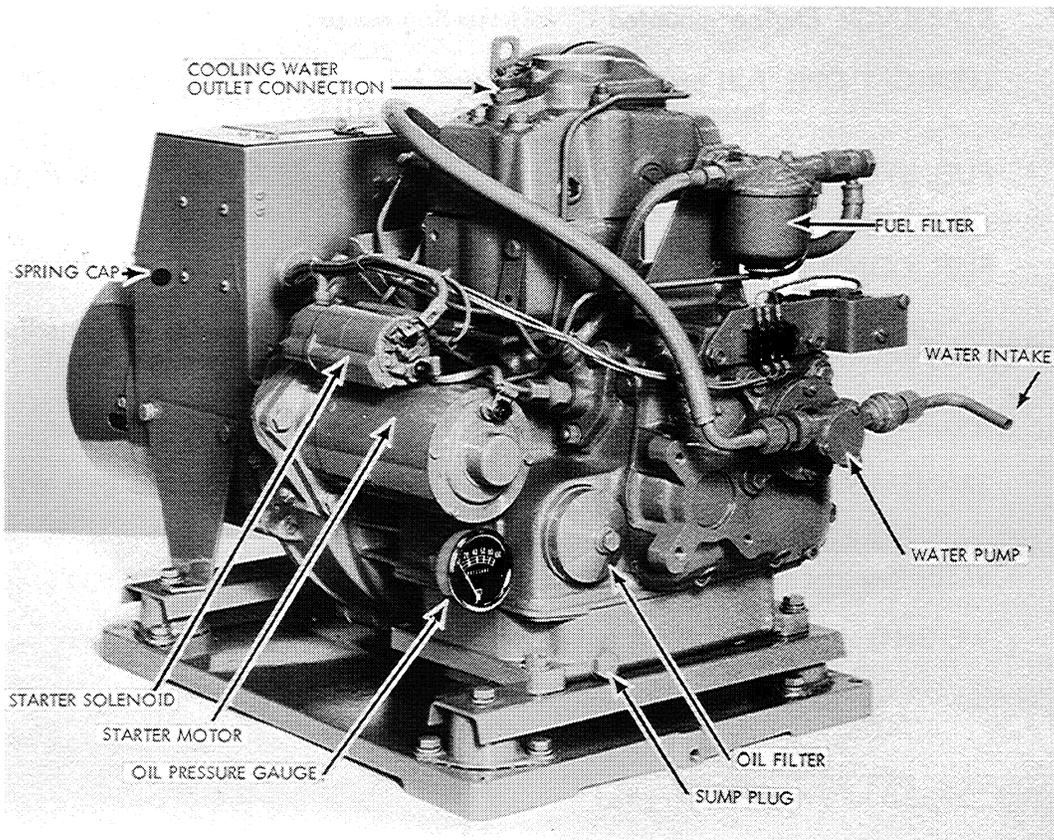
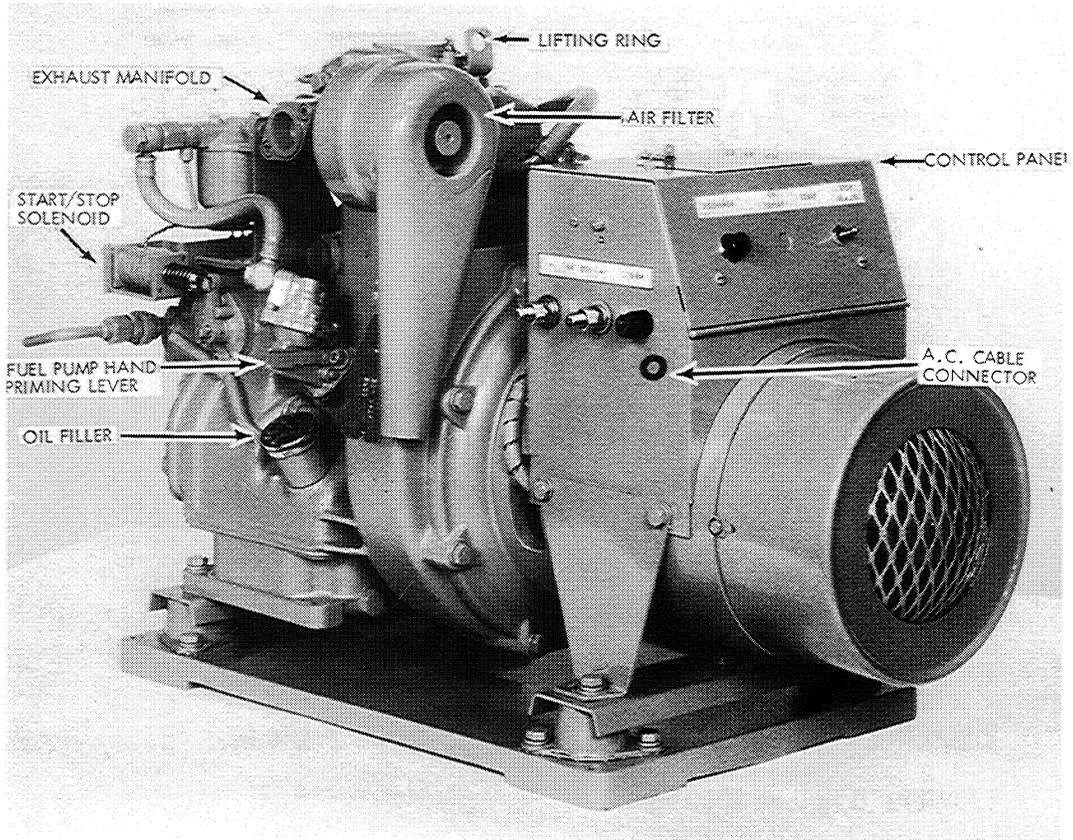
**INSTALLATION ANGLE:** 15° maximum

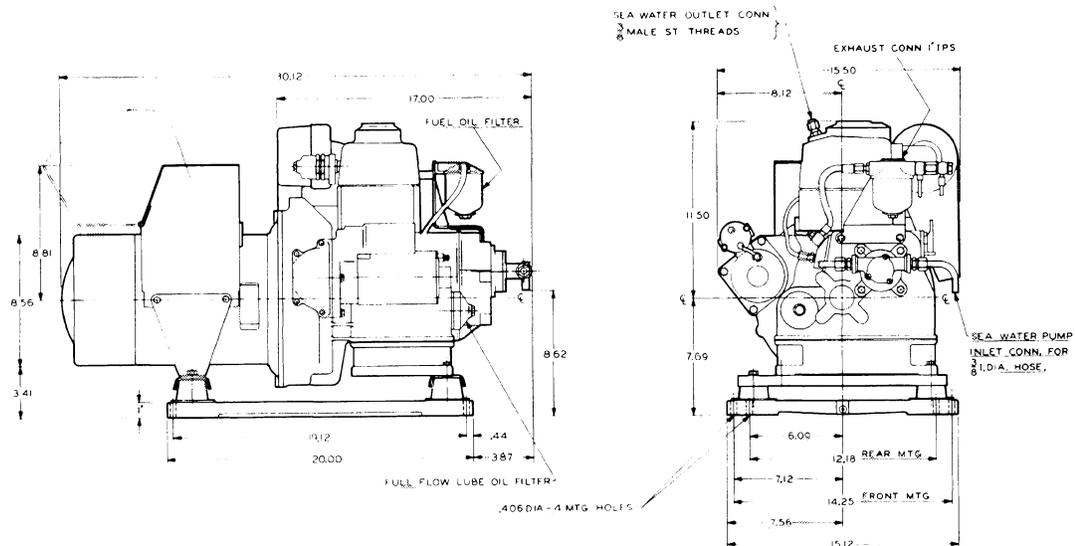
**TRANSMISSION:** Paragon/Westerbeke 2:1 reduction and reverse gear with positive neutral.

**SIZE:** See drawing above.

**WEIGHT:** 187 lbs. with 2:1 reduction gear.

### WPDS-3 MARINE GENERATOR





### MODEL WPD-3 MARINE GENERATOR SPECIFICATIONS

**ENGINE:** Single cylinder, water cooled four cycle diesel.

**DISPLACEMENT:** 15.9 cu. in.; bore 3 in.; stroke 2-1/4 in.

**POWER:** 5.5 hp at 3600 rpm.

**COOLING:** Positive displacement rubber impeller raw water pump.

**STARTING:** Engine-mounted 12 volt starting motor.

**LUBRICATION:** Full pressure to main and connecting rod bearings. Full flow integral replaceable lube oil filter.

**MOUNTING:** Engine-generator assembly is mounted on aluminum drip-pan base with heavy duty shielded rubber mounts to minimize vibration.

**FUEL SYSTEM:** Bryce injection pump, governed to 3600 rpm. Camshaft-drive fuel lift pump with hand primer.

**FUEL CONSUMPTION:** Approx. 0.45 gallons per hour at full output.

**ALTERNATOR:** Rotating field, single bearing with shaft-mounted fan.

**OUTPUT:** 3000 watts for continuous operation; 25 amps, 120 volts AC. 12 volts DC, 0-5 amps for battery charging.

**FREQUENCY:** 60 Hertz.

**PHASE:** Single

**POWER FACTOR:** Unity.

**CONTROLS:** Angle-mounted on top of generator for visibility. Cover swings up for easy servicing. Start-stop toggle switch. Solid state battery charging control circuit reduces heat, increases efficiency and reliability, and is immune to vibration and shock. Charge indicator light.

**SIZE:** See drawing above.

**WEIGHT:** 233 lbs.

**OPTIONAL EQUIPMENT:** Remote start shore power transfer switch-high-capacity primary fuel oil filter-exhaust silencer-automatic shut-down due to low oil pressure or high water temperature - safety control electric fuel shut off.



# SECTION INDEX

## GENERAL

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Installation	Maintenance

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## OTHER OVERHAUL

Marine Engine Electrical System  
Cooling System (External)  
Transmissions

## GENERATOR SETS

## HYDRAULIC CRANKING SYSTEM

## SERVICE BULLETINS

# YOUR NOTES

## IMPORTANT

THIS MANUAL IS A DETAILED GUIDE TO THE INSTALLATION, START-UP, OPERATION AND MAINTENANCE OF YOUR WESTERBEKE MARINE DIESEL ENGINE. THE INFORMATION IT CONTAINS IS VITAL TO THE ENGINE'S DEPENDABLE, LONG TERM OPERATION.

READ IT !

KEEP IT IN A SAFE PLACE

KEEP IT HANDY FOR REFERENCE AT ALL TIMES

FAILURE TO DO SO WILL INVITE SERIOUS RISK, NOT ONLY TO YOUR INVESTMENT, BUT YOUR SAFETY AS WELL.

### UNDERSTANDING THE DIESEL....

The diesel engine closely resembles the gasoline engine inasmuch as the mechanism is essentially the same. Its cylinders are arranged above its closed crankcase; its crankshaft is of the same general type as that of a gasoline engine; it has the same sort of valves, camshaft, pistons, connecting rods, lubricating system and reverse and reduction gear.

Therefore, it follows to a great extent that a diesel engine requires the same preventative maintenance as that which any intelligent operator would give to a gasoline engine. The most important factors are proper maintenance of the fuel, lubricating and cooling systems. Replacement of fuel and lubricating filter elements at the time periods specified is a must, and frequent checking for contamination (i.e. water, sediment etc.) in the fuel system is also essential. Another important factor is the use of the same brand of "high detergent" diesel lubricating oil designed specifically for diesel engines.

The diesel engine does differ from the gasoline engine, however, in the method of handling and firing its fuel. The carburetor and ignition systems are done away with and in their place is a single component - the Fuel Injection Pump - which performs the function of both.

Unremitting care and attention at the factory have resulted in a Westerbeke engine capable of many thousands of hours of dependable service. What the manufacturer cannot control, however, is the treatment it receives in service. This part rests with you!

### ORDERING PARTS

Whenever replacement parts are needed, always include the complete part description and part number (see separate Parts List furnished, if not part of this publication). Be sure to include the engine's model and serial number. Also be sure to insist upon Westerbeke factory packaged parts, because "will fit" parts are frequently not made to the same specifications as original equipment.

### GENERATOR SETS

Westerbeke diesels are used for both the propulsion of boats and for generating electrical power. For generator set applications, all details of this Manual apply, except in regard to certain portions of the Installation, Operation and Maintenance sections. Additional information is provided in the section titled Generator Sets, Section T.



# INSTALLATION

## FOREWORD

Since the boats in which these engines are used are many and varied, details of engine installation are equally so. It is not the purpose of this section to advise boatyards and engine installers on the generally well understood and well developed procedures for installation of engines. However, the following outline of general procedure is included because it is valuable in explaining the functions of each component, the reasons why, the precautions to be watched and the relationship of the installation to the operation of the engine. There are details of the installation which should have a periodic check and of which the operator should have a thorough understanding to insure good operating conditions for the engine and correct procedure for its servicing.

## INSPECTION OF EQUIPMENT

The engine is shipped from the factory mounted securely and properly crated. Accessory equipment is shipped in a separate small box, usually packed with the engine crate.

Before accepting shipment from the transportation company, the crate should be opened and an inspection made for concealed damage. If either visible or concealed damage is noted, you should require the delivering agent to sign "Received in damaged condition". Also check contents of the shipment against the packing list and make sure note is made of any discrepancies. This is your protection against loss or damage. Claims for loss or damage must be made to the carrier, not to J. H. Westerbeke Corporation.

## RIGGING AND LIFTING

The engine is fitted with lifting rings.

Rope or chain slings should be attached to the rings and the engine lifted by means of tackle attached to this sling. The lifting rings have been designed to carry the full weight of the engine, therefore auxiliary slings are not required or desired.

CAUTION: Slings must not be so short as to place the engine lifting eyes in significant shear stress. Strain on the engine lifting eyes must not be in excess of 10° from the vertical. A spacer bar must be placed between the two lifting eyes, if supported by valve cover studs.

The general rule in moving engines is to see that all equipment used is amply strong and firmly fixed in place. Move the engine a little at a time and see that it is firmly supported. Eliminate possibility of accidents by avoiding haste. Do not lift from the propeller coupling, or

pry against this with crowbar, as you may distort the coupling.

In some cases it may be necessary to lift the engine in other than the regular horizontal position. It may be that the engine must be lowered endwise through a small hatchway which cannot be made larger. If the opening is extremely restricted it is possible to reduce, to some extent, the outside clearances such as generator, cooling piping, water tank, filters, mounting lugs, etc. This accessory equipment should be removed by a competent mechanic and special care should be taken to avoid damage to any exposed parts and to avoid dirt entering openings. The parts which have been removed should be returned to position as soon as the restriction has been passed.

In case it is necessary to hoist the engine either front end upwards or reverse gear end upwards, the attachment of slings must be done very carefully to avoid the possibility of damage to the parts on which the weight may bear. It is best if special rigging work be done by someone experienced and competent in the handling of heavy machinery.

## ENGINE BOLTS

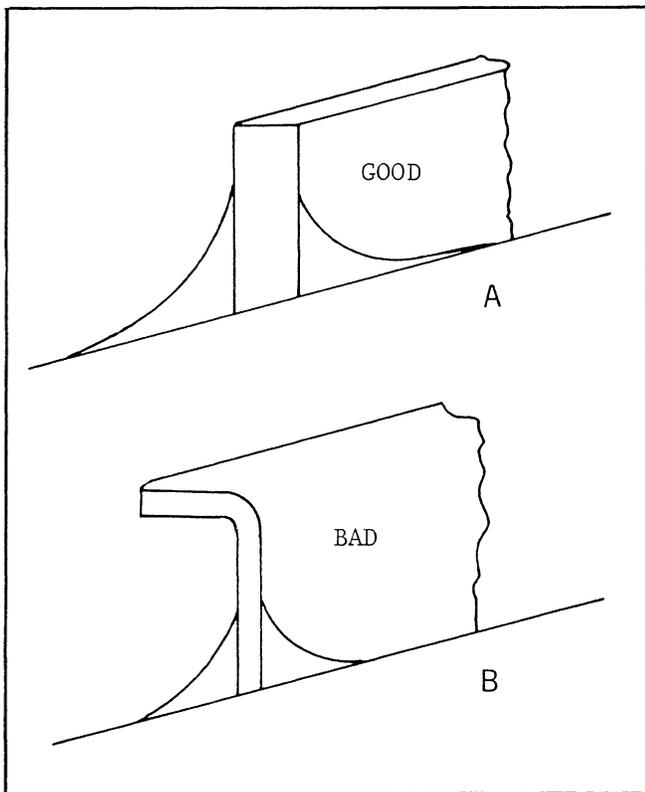
It is recommended that bronze hanger bolts of appropriate size be used through the engine flexible mounts. Lag screws are less preferred because their hold on the wood is weakened every time they are moved, whereas the lag bolt stays in position and the nut on top is used to tighten the engine down or is removed to permit the engine to be lifted. The bolt itself stays in position at all times, as a stud, and the bond between the bolt and the wood is not weakened by its removal.

## FOUNDATION FOR ENGINE

A good engine bed contributes much toward the satisfactory operation of the engine. The engine bed must be of rigid construction and neither deflect nor twist when subjected to the engine weight or the position the boat may have to take under the effects of rough seas. The bed must keep the engine within one or two thousandths of an inch of this position at all times. It has to withstand the forward push of the propeller which is applied to the propeller shaft, to the thrust washer bearing in the engine and finally to the engine bolts and engine bed.

In fiberglass hulls, we recommend that similar wooden stringers as in wooden hulls be formed and fitted, then glassed to the hull securely. This allows hanger bolts to be installed firmly in wood, thus reducing noise and transmitted vibration.

The temptation to install the engine on a pair of fiberglass "angle irons" should be resisted. Such construction will allow engine vibrations to pass through to the hull. Flexible mounts require a firm foundation against which to react if they are to do their job. When possible, follow bed design "A" and avoid bed design "B".



## PROPELLER COUPLING

Each Westerbeke Diesel engine is regularly fitted with a suitable coupling for connecting the propeller shaft to the engine.

The coupling must not only transmit the power of the engine to turn the shaft, but must also transmit the thrust either ahead or astern from the shaft to the thrust bearing which is built into the reduction gear housing of the engine. This coupling is very carefully machined for accurate fit.

For all engine models, a propeller half-coupling, bored to shaft size for the specific order, is supplied. The coupling either has a keyway with set screws or is of the clamping type.

The forward end of the propeller shaft has a long straight keyway. Any burrs should be removed from the shaft end. The coupling should be a light drive fit on the shaft and the shaft should not have to be scraped down or filed in order to get a fit. It is important that the key be properly fitted both to the shaft and the coupling. The key should fit the side of the keyway very closely, but should not touch the top of the keyway in the hub of the coupling.

If it seems difficult to drive the coupling over the shaft, the coupling can be expanded by heating in a pail of boiling water. The face of the propeller coupling must be exactly perpendicular to the centerline or axis of the propeller shaft.

## PROPELLER

The type and size of propeller varies with the gear ratio and must be selected to fit the application based upon boat tests. To utilize the full power of the engine, and to achieve ideal loading conditions, it is desirable to use a propeller which will permit the engine to reach its full rated speed at full throttle under normal load.

## ALIGNMENT OF ENGINE

The engine must be properly and exactly aligned with the propeller shaft. No matter what material is used to build a boat it will be found to be flexible to some extent and the boat hull will change its shape to a greater extent than is usually realized when it is launched and operated in the water. It is therefore very important to check the engine align-

ment at frequent intervals and to correct any errors when they may appear.

Misalignment between the engine and the propeller shaft is the cause of troubles which are blamed often on other causes. It will create excessive bearing wear, rapid shaft wear and will, in many cases, reduce the life of the hull by loosening the hull fastenings. A bent propeller shaft will have exactly the same effect and it is therefore necessary that the propeller shaft itself be perfectly straight.

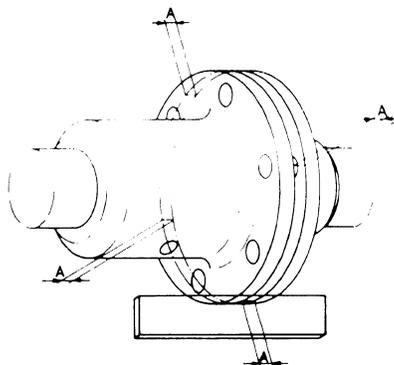
One particularly annoying result of misalignment may be leakage of transmission oil through the rear oil seal. Check to make sure that alignment is within the limits prescribed.

The engine should be moved around on the bed and supported on the screw-jacks or shims until the two halves of the couplings can be brought together without using force and so that the flanges meet evenly all around. It is best not to drill the foundation for the foundation bolts until the approximate alignment has been accurately determined.

Never attempt a final alignment with the boat on land. The boat should be in the water and have had an opportunity to assume its final water form. It is best to do the alignment with the fuel and water tank about half full and all the usual equipment on board and after the main mast has been stepped and final rigging has been accomplished.

Take plenty of time in making this alignment and do not be satisfied with anything less than perfect results.

The alignment is correct when the shaft can be slipped backwards and forward into the counterbore very easily and when a feeler gauge indicates that the flanges come exactly together at all points. The two halves of the propeller coupling should be parallel within 0.002 inches (A).



In making the final check for alignment, the engine half coupling should be held in one position and the alignment with the propeller coupling tested with the propeller coupling in each of four positions, rotated 90° between each position. This test will also check whether the propeller half coupling is in exact alignment on its shaft. Then, keeping the propeller coupling in one position the alignment should be checked rotating the engine half coupling to full position each 90° from the next one.

The engine alignment should be rechecked after the boat has been in service for one to three weeks and, if necessary, the alignment remade. It will usually be found that the engine is no longer in alignment. This is not because the work was improperly done at first, but because the boat has taken some time to take its final shape and the engine bed and engine stringers have probably absorbed some moisture. It may even be necessary to re-align at a further period.

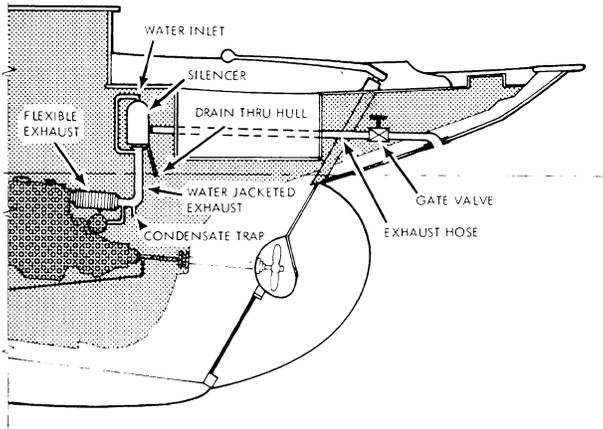
The coupling should always be opened up and the bolts removed whenever the boat is hauled out or moved from the land to the water, and during storage in a cradle. The flexibility of the boat often puts a very severe strain on the shaft or the coupling or both when it is being moved. In some cases the shaft has actually been bent by these strains. This does not apply to small boats that are hauled out of the water when not in use, unless they are dry for a considerable time.

#### EXHAUST SYSTEM

Exhaust line installations vary considerably and each must be designed for the particular job. The general requirements are to provide an outlet line with a minimum of restrictions and arranged so that sea water, rain water, or condensation cannot get back into the engine. There should be a considerable fall in the line between the exhaust manifold flange and the discharge end. This slope in the pipe makes it difficult for water to be driven in very far by a wave; and a steep drop followed by a long slope is better than a straight gradual slope. Avoid any depression or trough to the line which would fill with water and obstruct the flow of exhaust gas. Also avoid any sharp bends.

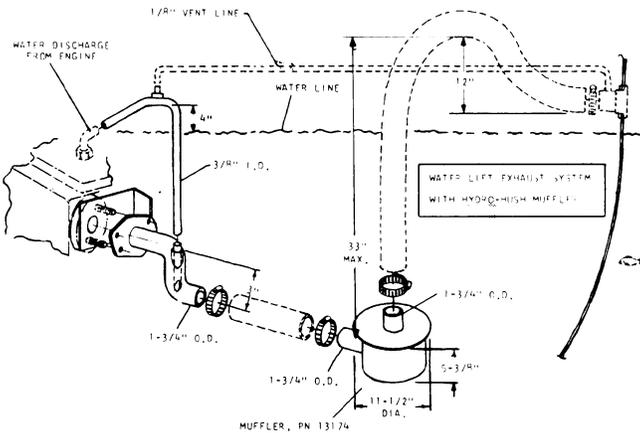
Brass or copper is not acceptable for wet exhaust systems, as the combination of salt water and diesel exhaust gas will

cause rapid deterioration. Galvanized iron fittings and galvanized iron pipe is recommended for the exhaust line. The exhaust line must be at least as large as the engine exhaust manifold flange and be increased in size if there is an especially long run and/or many elbows. It should be increased by 1/2" in I.D. for every 10 feet beyond the first 10 feet.



**EXHAUST SYSTEM WITH WATER JACKETED STANDPIPE**

To insure vibration doesn't transmit to hull, use a flexible section preferably of stainless steel, no less than 12" overall, threaded at each end and installed as close to the engine as possible. This flexible section should be installed with no bends and covered with insulating material. The exhaust pipe should be properly supported by brackets to eliminate any strain on the manifold flange studs. Many installations use flexible rubber exhaust hose for the water cooled section of the exhaust line because of the ease of installation and flexibility. Provide adequate



**WATER LIFT EXHAUST SYSTEM WITH "HYDRO-HUSH" MUFFLER**

support for the rubber hose to prevent sagging, bending, and formation of water pockets.

Always arrange that water discharge into the rubber hose section is behind a riser or sufficiently below the exhaust flange so that water cannot possibly flow back into the engine. Also make sure that entering sea water cannot spray directly against the inside of the exhaust piping. Otherwise excessive erosion will occur.

**MEASURING EXHAUST GAS BACK PRESSURE**

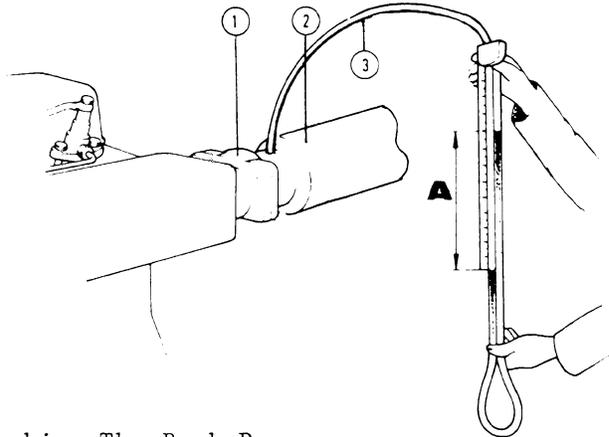
Back pressure must be measured on a straight section of the exhaust line and as near as possible to the engine exhaust manifold. The engine should be run at maximum load during the measurement period. Set-up should be as shown below.

1. For normally asperated engines:

Pressure Test	Mercury Test	Water Column
1-1/2" Max PSI	3" Mercury	= 39"

2. For turbo-charged engines:

Pressure Test	Mercury Test	Water Column
0.75 Max PSI	1-1/2" Mercury	= 19-1/2"



**Checking The Back Pressure**

1. Exhaust pipe flange
2. Exhaust line
3. Transparent plastic hose, partly filled with water. Measurement "A" may not exceed 39" for normally asperated engines and 19.5" for turbo-charged engines.

**WATER CONNECTIONS**

Seacocks and strainers should be of the full flow type at least one size greater than the inlet thread of the sea water pump. The strainer should be of the type which may be withdrawn for cleaning while the vessel is at sea.

Water lines can be copper tubing or wire-wound, reinforced rubber hose. In

any case, use a section of flexible hose that will not collapse under suction, between the hull inlet and engine and between the outlet and the exhaust system. This takes up vibration and permits the engine to be moved slightly when it's being re-aligned. Do not use street elbows in suction piping. All pipe and fittings should be of bronze. Use sealing compound at all connections to prevent air leaks. The neoprene impeller in the sea (raw) water pump should never be run dry.

#### FUEL TANK AND FILTERS

Fuel tanks may be of fiberglass, monel, aluminum, plain steel or terne plate. If made of fiberglass, be certain that the interior is gel coated to prevent fibers from contaminating the fuel system. Copper or galvanized fuel tanks should not be used. It is not necessary to mount the tank above the engine level as the fuel lift pump provided will raise the fuel from the tank. The amount of lift should be kept minimum (6 feet being maximum). If a tank is already installed above engine level it can be utilized in this position. Great care should be taken to ensure that the fuel system is correctly installed so that airlocks are eliminated and precautions taken against dirt and water entering the fuel.

A primary fuel filter of the water collecting type should be installed between the fuel tank and the fuel lift pump. A recommended type is available from the list of accessories. The secondary fuel filter is fitted on the engine between the fuel lift pump and the injection pump and has a replaceable element.

As the fuel lift pump has a capacity in excess of that required by the injection pump, the overflow is piped to the fuel tank and should be connected to the top of the tank or as near the top as possible.

To insure satisfactory operation, a diesel engine must have a dependable supply of clean diesel fuel. For this reason, cleanliness and care are especially important at the time when the fuel tank is installed, because dirt left anywhere in the fuel lines or tank will certainly cause fouling of the injector nozzles when the engine is started for the first time.

#### FUEL PIPING

We recommended copper tubing together with suitable fittings, both for the supply line and the return line. Run the tubing in the longest pieces obtainable to avoid

the use of unnecessary fittings and connectors. The shut off valve in the line between the fuel tank and engine should be of the fuel oil type, and it is important that all joints be free of pressure leaks.

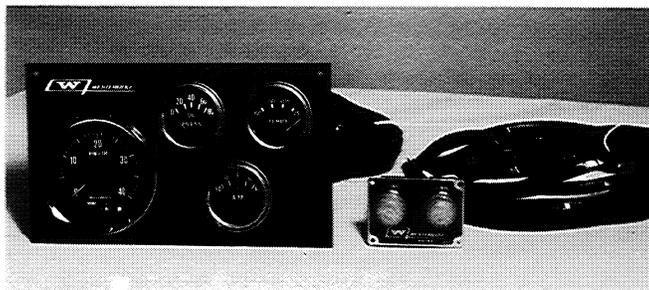
Keep fuel lines as far as possible from exhaust pipe for minimum temperature, to eliminate "vapor locks".

The fuel piping leading from the tank to the engine compartment should always be securely anchored to prevent chafing. Usually the copper tubing is secured by means of copper straps.

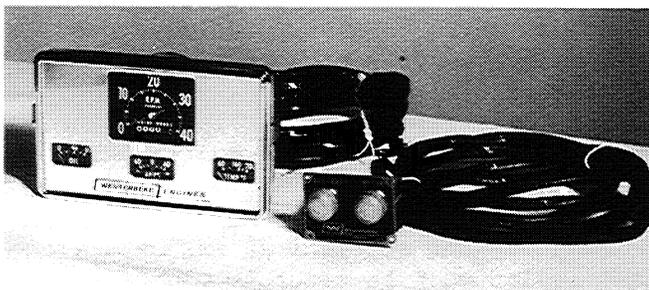
The final connection to the engine should be through flexible rubber hoses.

#### ELECTRIC PANEL

The Westerbeke all-electric panel utilizes an electronic tachometer with a built-in hour meter. Tachometer cables are no longer required, except for the Skipper mechanical panel. Mounted on the panel are an ammeter, water temperature gauge and oil pressure gage. Each instrument is lighted. The all-electric panel is isolated from ground and may be mounted where visible. It is normally pre-wired.



WESTERBEKE ALL-ELECTRIC PANEL



SKIPPER MECHANICAL TACH PANEL

#### ELECTRICAL EQUIPMENT

Most Westerbeke engines are supplied pre-wired and with plug-in connectors. Never make or break connections while the engine is running. Carefully follow all instructions on the wiring diagram sup-

plied, especially those relating to fuse/circuit breaker requirements.

Starter batteries should be located as close to the engine as possible to avoid voltage drop through long leads. It is bad practice to use the starter batteries for other services unless they require low amperage or are intermittent. In cases where there are substantial loads (from lights, refrigerators, radios, depth sounders, etc.) it is essential to have a complete, separate system and to provide charging current for this by means of a second alternator or "alternator output splitter".

Starter batteries must be of a type which permits a high rate of discharge (Diesel starting).

Carefully follow the recommended wire sizes shown in the wiring diagrams. Plan installation so the battery is close to engine and use the following cable sizes:

- #1 - for distances up to 8 feet
- #1/0 - for distances up to 10 feet
- #2/0 - for distances up to 13 feet
- #3/0 - for distances up to 16 feet

#### MECHANICAL CONTROLS

The recommended practice is to have the stop-run lever loaded to the run position and controlled by a sheathed cable to a push-pull knob at the pilot station. The throttle lever should be connected to a Morse type lever at the pilot station by a sheathed cable.

The transmission control lever may be connected to the pilot station by a flexible, sheathed cable and controlled by a Morse type lever. The single-lever type gives clutch and throttle control with full throttle range in neutral position. The two-lever type provides clutch control with one lever and throttle control with the other.

Any bends in the control cables should be gradual. End sections at engine and transmission must be securely mounted. After linkages are completed, check the installation for full travel, making sure that, when the transmission control lever at the pilot station is in forward, neutral and reverse, the control lever on the transmission is on the respective detent. Check the throttle control lever and the stop-run lever on the fuel injection pump for full travel.

# OPERATION

## PREPARATION FOR FIRST START

The engine is shipped "dry"...with lubricating oil drained from the crankcase and transmission. Therefore, be sure to follow these recommended procedures carefully before starting the engine for the first time.

1. Remove oil filler cap and fill oil sump with heavy duty, diesel lubricating oil to the highest mark on the dipstick. See table under Maintenance for an approved lubricating oil. Do not overfill. Select an approved grade from the listing and continue to use it.
2. If the Reverse Gear has a manual clutch, fill to the highest mark on the dipstick with S.A.E. 30 lubricating oil. You may use the same oil as in the engine.  
If Reverse Gear is hydraulic, fill to the highest mark on the dipstick with type A Hydraulic fluid. Do not overfill.
3. Fill fresh water cooling system only after opening all pet-cocks and plugs until all entrapped air is expelled. On fresh water cooled engines, fill the fresh water cooling system with fresh clean water and/or anti-freeze solution (see Cold Weather precautions in Maintenance Section).  
Use a 50-50 anti-freeze solution if cold weather is to be experienced.  
Fill surge tank to within one inch of the top. Check this level after engine has run for a few minutes. If trapped air is released, the water level may have dropped. If so, refill tank to within one inch of top and replace filler cap.
4. Ensure battery water level is at least 3/8" above the battery plates and battery is fully charged so that it is capable of the extra effort that may be required on the first start.
5. Fill fuel tank with clean Diesel fuel oil; No. 2 diesel fuel oil is recommended. The use of No. 1 is permissible but No. 2 is preferred because of its higher lubricant content.

NOTE: If there is no filter in the filler of the fuel tank, the recommended procedure is to pour the fuel through a funnel of 200 mesh wire screen.

6. Fill grease cup on water pump, if present, with a good grade of water pump grease.

## BLEEDING THE SYSTEM

The fuel injection system of a compression ignition engine depends upon very high fuel pressure during the injection stroke to function correctly. Relatively tiny movements of the pumping plungers produce this pressure and if any air is present inside the high pressure line, then this air acts as a cushion and prevents the correct pressure, and therefore fuel injection, from being achieved.

In consequence it is essential that all air is bled from the system whenever any part of the system has been opened for repair or servicing. Running out of fuel is a misfortune that also necessitates complete bleeding of the system before the engine can be restarted.

The following instructions for fuel system bleeding apply to typical systems using in-line DPA pumps (shown in Figs. 1 and 2).

Before priming and bleeding, insure that the outside of the bleed screws and surrounding area is thoroughly clean to prevent dirt and foreign matter entering the system.

DPA DISTRIBUTOR PUMPS The following priming and venting sequence is applicable to both mechanically and hydraulically governed DPA pumps. The only difference is the physical location on the pump of the governor bleed screw "D" and this is indicated in the appropriate illustration,

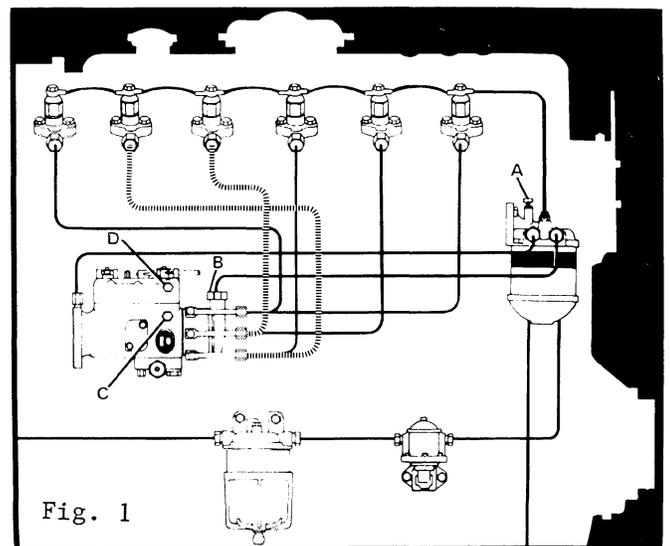
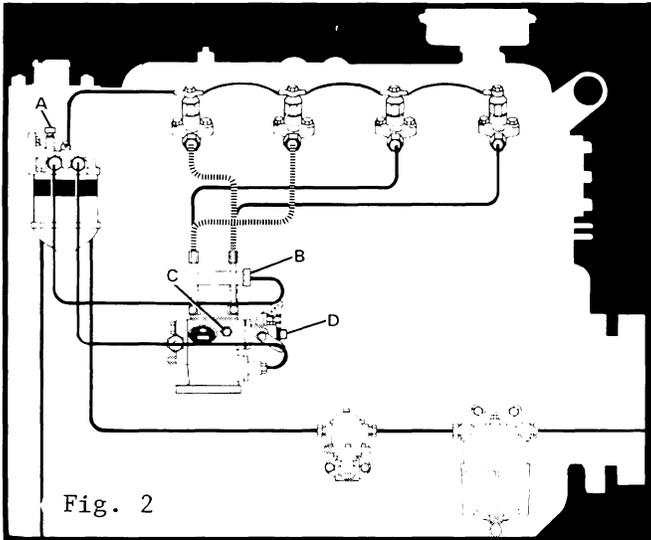


Fig. 1

Fig. 1 for mechanically governed and Fig. 2 for hydraulically governed pumps.



If the fuel system is fitted with a fuel feed pump, slacken both the filter bleed screw "A" and the injection pump fuel inlet union "B", and operate the hand priming lever of the feed pump until fuel free from air issues from both the vents. Tighten both the vent connections. In a gravity fed fuel system turn on the fuel and carry out the same procedure with the bleed screw and fuel inlet.

Slacken the vent valve fitted to one of the two hydraulic head locking screws "C" and the bleed screw "D" on the governor housing. Operate the hand priming lever of the feed pump, until fuel free from air bubbles issues from the vent "C" and then tighten this bleed screw.

NOTE: The space within the governor housing (vented by screw "D") is normally filled, and its contents lubricated, by fuel oil back-leaked from the pump plungers, the pump rotor and the advance device if fitted. This is the normal way in which this space becomes filled with oil and this can naturally take a long time at feed pump pressures.

However, if the reason that the pump is being vented is because a pipe line or injector or filter element has been changed or serviced or the system has run out of fuel, then the governor housing will still be filled with fuel oil and bleeding by means of the hand priming lever of the feed pump will suffice. In this event, close the governor bleed screw "D" as soon as fuel free from air issues from the vent.

If, however, a new pump has been fitted to the system, then its governor housing will most likely be empty of fuel oil and

bleeding proceeds as follows.

Leave the governor bleed screw "D" slackened. Next slacken any two injector pipe line connections at the injector end. Set the throttle to the fully open position and turn the engine until fuel free from air flows from the unions. Then re-tighten the loosened injector pipe unions.

Start the engine and run it at fast idling speed until air-free fuel exudes from the governor bleed screw "D". Tighten this screw and stop the engine.

Governing may be erratic during this procedure, therefore stand by to stop the engine should any excessive engine speed develop.

**RECOMMENDED SPARES** Owners are often in doubt as to the amount of fuel injection equipment spares to carry. A great deal depends upon the use of the craft and its location. General coastal use in well-populated areas is one thing, but voyaging up the Amazon delta, for example, would be quite different and would require a comprehensive spares kit.

Generally speaking, the average boat owner is within relatively easy reach of service centers and requires spares only as insurance against breakdown and for general servicing within the scope of the owner or crew.

A suitable kit for such a purpose would consist of a replacement filter element and a set of sealing and "O" rings for each filter. Spare bleed screws for pumps and filters are also required, for screws are easily lost or damaged in a boat when bleeding the system. A full set of high pressure injection pipes should also be carried, for a fractured or cracked pipe could occur at any time and no patching is possible with these pipes. The correct set of pipes can be obtained from the engine manufacturer's agent or service center and will be supplied already bent to shape and cleaned internally with both ends plugged against the entry of dirt. They will be supplied packed as a set and it is important to keep them this way until required for use. It is vitally important that the internal surface of the pipe is kept scrupulously clean until fitted to the engine.

A spare set of fuel injectors of the right type and correctly set for the particular engine together with a set of the correct seating washers will not only enable defective injectors to be changed when required but will also permit engine use while one set is away being serviced.

Do be careful to check with the engine parts list regarding whether the engine requires injector seating washers or not.

Additionally, spare banjo bolts and washers for back leak pipes and low pressure pipes are handy things to have when a joint starts leaking. Remember no equipment ever breaks down when it is stationary in port. Breakdowns and trouble occur when the equipment is working - and that means at sea!

Do not forget the tools. Always carry the correct spanners for the job - hammers and adjustable wrenches may be all right in some locations, but please, not around your fuel injection equipment on your craft.

**HINTS AND TIPS** It is essential to stress the need for absolute cleanliness of the fuel at all times. This requirement also extends to methods of operating and servicing the equipment and to precautions about refueling.

A useful hint when changing filter elements is to obtain a polythene bag large enough and strong enough to hold the filter element and put this around the element and filter head before unscrewing the center bolt. Undo the center bolt and allow element, oil and base all to go into the bag. Then empty the bag into a bowl or container large enough for the contents to be separated and the base and sealing rings recovered if required.

Granulated pieces of substance familiar to all cat owners who live in apartments and sold for use in cat litter boxes is ideal for soaking up diesel fuel spilled when venting or removing pipe lines. Put the material down before working on the system.

Barrier creams of the oil-defying kind are useful and make life much easier when removing the grime from hands. Put on the cream before the job is tackled and then dirt, grease and cream are removed together when the job is completed.

In the majority of fueling installations fuel will be supplied through a hose - always wipe the pump nozzle with a clean non-fluffy piece of cloth before use. None of those grubby old swabs, please - they will do far more harm than good. If you spill any fuel on tank, deck or fittings, wipe it off right away. Diesel fuel oil does not evaporate as does gasoline, and if left, will gather dirt and grit, will track everywhere and keep on smelling. Be careful where you put down the fuel tank

cap when refueling - see that it doesn't pick up dirt or grit - this is how quite a lot of dirt gets into the tank.

Avoid dubious sources of fuel. Job lots of unknown origin are not always the bargain they appear to be and fuel injection equipment is expensive to renew when damaged.

#### WHEN ENGINE STARTS

1. Check Oil Pressure immediately. Normal oil pressure is approximately 50 psi at operating speeds, 15 psi when idling. (Extremely hot engine.)
  2. Check Sea Water Flow. Look for water at exhaust outlet. Do this without delay.
  3. Recheck Crankcase Oil. After the engine has run for 3 or 4 minutes, subsequent to an oil change or new installation, stop the engine and check the crankcase oil level. This is important as it may be necessary to add oil to compensate for the oil that is required to fill the engine's internal oil passages and oil filter. Add oil as necessary. Check oil level each day of operation.
  4. Recheck Transmission Oil Level. (This applies only subsequent to an oil change or a new installation.) In such a case, stop the engine after running for several minutes at 800 rpm with one shift into forward and one into reverse, then add oil as necessary. Check oil level each day of operation.
  5. Recheck Expansion Tank Water Level, if engine is fresh water cooled. (This applies after cooling system has been drained or filled for the first time.) Stop engine after it has reached operating temperature of 175°F and add water to within one inch of top of tank.
- WARNING:** The system is pressurized when overheated and the pressure must be released gradually if the filler cap is to be removed. It is advisable to protect the hands against escaping steam and turn the cap slowly counter-clockwise until the resistance of the safety stops is felt. Leave the cap in this position until all pressure is released. Press the cap downwards against the spring to clear the safety stops, and continue turning until it can be lifted off.
6. Warm-up Instructions. As soon as possible, get the boat underway but at reduced speed, until water temp. gauge indicates 130-150°F. If necessary, en-

gine can be warmed up with the clutch in neutral at 1000 rpm. Warming up with clutch in neutral takes longer and tends to overheat the transmission, if partial engagement occurs, which can be detected by propeller shaft rotation.

7. Reverse Operation. Always reduce engine to idle speed when shifting gears. However, when the transmission is engaged, it will carry full engine load.

NOTE: The SAO transmission requires that, when backing down, the shift lever must be held in the reverse position, since it has no positive overcenter locking mechanism.

#### STOPPING ENGINE

1. Position shift lever in neutral.
2. Move throttle lever to idle position.
3. Pull fuel push-pull STOP control out.  
(The stop control functions by cutting off the fuel from the fuel injection pump.)

NOTE: Idle engine for a few minutes to dissipate heat gradually before shutdown.

#### OPERATING PRECAUTIONS

1. Never run engine for extended periods when excessive overheating occurs as extensive internal damage can be caused.
2. DO NOT put cold water in an overheated engine. It can crack cylinder head, block, or manifold.
3. Keep intake silencer free from lint, etc.
4. Do not run engine at high RPM without clutch engaged.
5. Never Race a Cold Engine as internal damage can occur due to inadequate oil circulation.
6. Keep the engine and accessories clean.
7. Keep the fuel clean. Handle it with extreme care because water and dirt in fuel cause more trouble and service in-
8. Do not allow fuel to run low, because fuel intake may be uncovered long enough to allow air to enter the system, resulting in lost time required for priming.
9. Do not be alarmed if temperature gauges show a high reading following a sudden stop after engine has been operating at full load. This is caused by the release of residual heat from the heavy metal masses near the combustion chamber. Prevention for this is to run engine at idle for a short period before stopping it. High temperature

reading after a stop does not necessarily signal alarm against restarting. If there is no functional difficulty, temperatures will quickly return to normal when engine is operating.

# TEN MUST RULES

IMPORTANT

IMPORTANT

IMPORTANT

...for your safety and your engine's dependability.

ALWAYS -

1. Keep this Manual handy and read it whenever in doubt.
2. Use only filtered fuel oil and check lube oil level daily.
3. Check cooling water temperature frequently to make sure it is 190° or less.
4. Close all drain cocks and refill with water before starting out.
5. Investigate any oil leaks immediately.

NEVER -

6. Race the engine in neutral.
7. Run the engine unless the gauge shows proper oil pressure.
8. Break the fuel pump seals.
9. Use cotton waste or fluffy cloth for cleaning or store fuel in a galvanized container.
10. Subject the engine to prolonged overloading or continue to run it if black smoke comes from the exhaust.

# YOUR NOTES

# MAINTENANCE

## PERIODIC ATTENTION:

After you have taken delivery of your engine, it is important that you make the following checks right after the first fifty hours of its operation:

### FIFTY HOUR CHECKOUT (INITIAL)

Do the following:

1. Retorque the cylinder head bolts.
2. Retorque the rocker bracket nuts and adjust valve rocker clearance.
3. Check and adjust, if necessary, the forward drum assembly and the reverse band on manual SA0 and SA-1 transmissions.
4. Change engine lubricating oil and oil filter.
5. Check for fuel and lubricating oil leaks. Correct if necessary.
6. Check cooling system for leaks and inspect water level.
7. Check for loose fittings, clamps, connections, nuts, bolts, vee belt tensions etc. Pay particular attention to loose engine mount fittings. These could cause mis-alignment.

### DAILY CHECKOUT

Do the following:

1. Check sea water strainer, if one has been installed.
2. Check water level in cooling system.
3. Check lubricating oil level in sump. Fill to highest mark on dipstick.
4. Turn down grease cup on water pump, if used, one full turn.
5. Check lubricating oil level in transmission. Fill to highest mark on dipstick.

### SEASONAL CHECK-OUT (MORE OFTEN IF POSSIBLE)

Do the following:

1. Check generator or alternator "v" belt for tension.
2. Check water level in battery.
3. Change oil in sump. Oil may be sucked out of sump by attaching a suction hose (3/8" ID) over the outside of the oil sump pipe, located aft of the dipstick. Figure 1. See Note, next page.
4. Replace lubricating oil filter. Fig. 2. See Note, next page.
5. Fill sump with approximately 4.5 US quarts of diesel lubricating oil to high mark on dipstick. Do not over fill. See Note next page.

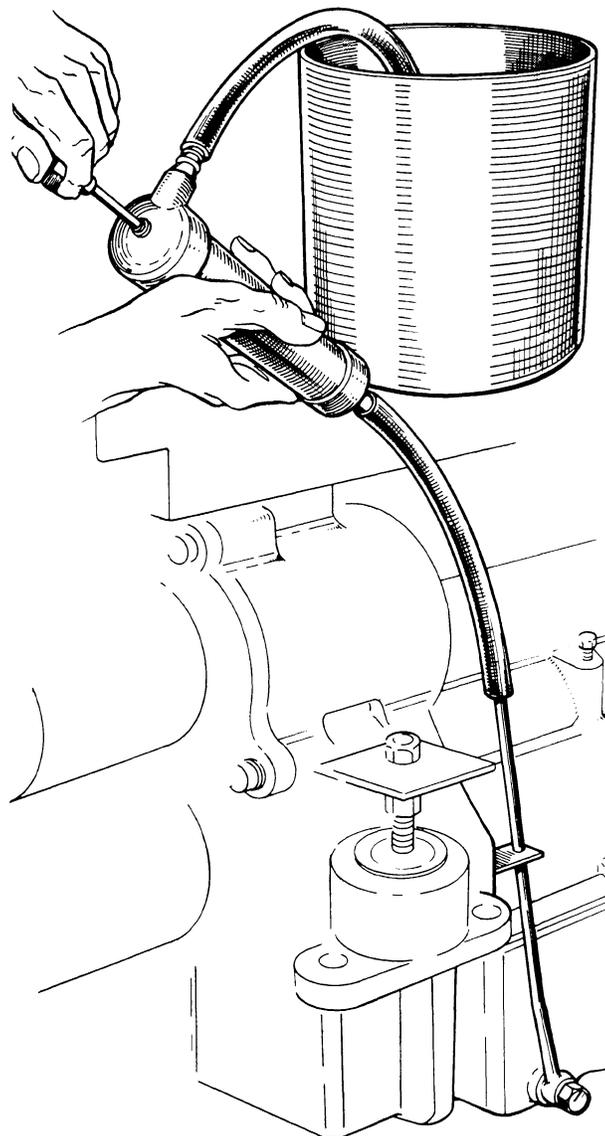


FIGURE 1

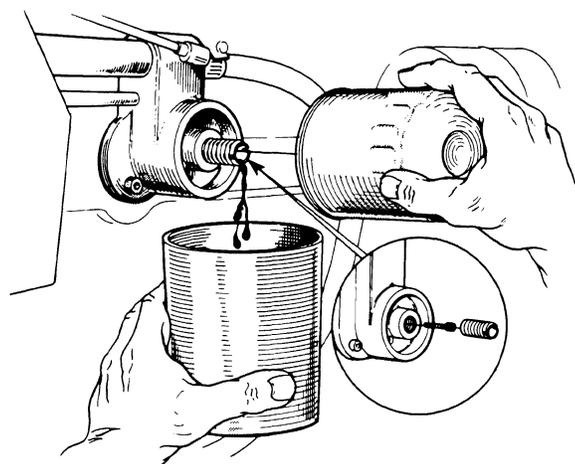


FIGURE 2

CAUTION: The use of different brands of lubricating oils during oil changes has been known to cause extensive oil sludging and may in many instances cause complete oil starvation.

6. Start engine and run for 3 or 4 minutes. Stop engine and check oil filter gasket for leaks. Check oil sump level. This is important as it may be necessary to add oil to compensate for the oil that is required to fill the engine's internal oil passages and oil filter. Add oil as necessary. Change oil in transmission. Use SAE 30, High Detergent Lubricating Oil, Service DG, DM, or DS. Do not overfill. See note below.

IMPORTANT NOTE:

IT IS MANDATORY THAT THE CHECKS 3, 4, 5 AND 6 BE ATTENDED TO WHEN TOTAL OPERATING TIME REACHES 150 HOURS. IN SOME INSTANCES, THIS TOTAL IS REACHED BEFORE END OF SEASON.

7. Clean Air Filter. The time period for replacing the air filter depends on operating conditions, therefore, under extremely dirty conditions, the seasonal frequency should be increased. The correct time periods for replacing the filter will greatly assist in reducing bore wear, thereby extending the life of the engine.
8. Check engine for loose bolts, nuts, etc.
9. Check sea water pump for leaks.
10. Wash primary filter bowl and screen. If filter bowl contains water or sediment, filter bowl and secondary oil fuel filter need to be cleaned more frequently.
11. Replace secondary fuel filter element.
12. Replace air filter.

END OF SEASON SERVICE

1. Drain fresh water cooling system by removing the surge tank pressure cap and opening all water system petcocks.
2. Remove zinc rod (usually located in heat exchanger) and see if it needs replacing. The zinc rod will take care of any electrolysis that may occur between dissimilar metals. Insert new zinc if necessary.

3. Fill fresh water cooling system with antifreeze of a reputable make. (Refer to Cold Weather Precautions.)
4. Start engine. When temperature gauge indicates 175°F, shut engine down and drain lubricating oil. Remove and replace filter. Fill sump with High Detergent Lubricating Oil.
5. Remove air filter. Carefully seal air intake opening with waterproofed adhesive tape or some other suitable medium.
6. Seal the exhaust outlet at the most accessible location as close to the engine as possible.
7. Remove injectors and spray oil into cylinders.
8. Replace injectors with new sealing washer under each injector. Turn engine slowly over compression.
9. Top off fuel tank completely so that no air space remains, thereby preventing water formation by condensation.
10. Leave fuel system full of fuel.
11. Change fuel filters before putting the engine back in service.
12. Wipe engine with a coat of oil or grease.
13. Change oil in transmission.
14. Disconnect battery and store in fully charged condition. Before storing the battery, the battery terminals and cable connectors should be treated to prevent corrosion. Recharge battery every 30 days.
15. Check alignment.

## LUBRICATING OILS

Lubricating oils are available for Westerbeke Diesel engines which offer an improved standard of performance to meet the requirements of modern operating conditions such as sustained high speeds and temperatures.

These oils meet the requirements of the U. S. Ordnance Specification MIL-L-2104B (API Service CC). Any other oils which also conform to these specifications, but are not listed here are, of course, also suitable.

COMPANY	BRAND	S.A.E. DESIGNATION		
		0°/45° <sup>F</sup>	45°/80° <sup>F</sup>	OVER 80° <sup>F</sup>
American Oil Co.	American Supermil Motor Oil	10W	20W/20	30
BP Canada Limited	BP Vanellus	10W	20W/20	30
	BP Vanellus	10W/30	10W/30	10W/30
Chevron Oil Co.	RPM DELO Multi-Service Oil	10W	20W/20	30
Cities Service Oil Co.	CITGO Extra Range	10W	20W/20	30
Continental Oil Co.	CONOCO TRACON OIL	10W	20W/20	30
Gulf Oil Corporation	Gulflube Motor Oil X.H.D.	10W	20W/20	30
Mobile Oil Company	Delvac 1200 Series	1210	1220	1230
Shell Oil Company	Shell Rotella T Oil	10W	20W/20	30
Sun Oil Company	Subfleet MIL-B	10W	20W/20	30
Texaco, Inc.	Ursa Oil Extra Duty	10W	20W/20	30

# YOUR NOTES

# ENGINE OVERHAUL

The following sections contain detailed information relating to the proper operating characteristics of the major components and systems in the engine. Included are disassembly, rework and reassembly instructions for the guidance of suitably equipped and staffed marine engine service and rebuilding facilities. The necessary procedures should be undertaken only by such facilities.

Additional operating characteristics are included in the Operation Section of this manual.

Any replacements should be made only with genuine Westerbeke parts.

**a****technical data**

DS/WPD3

Bore (nominal).....	3in (76.2mm)
Stroke.....	2.25in (57.15mm)
Power and speed (B.S. continuous rating):	
	2.4 bhp at 1500 rev/min
	3.0 bhp at 1800 rev/min
	3.5 bhp at 2100 rev/min
	4.2 bhp at 2500 rev/min
	5.0 bhp at 3000 rev/min
	5.5 bhp at 3600 rev/min
Cubic capacity.....	15.9 in <sup>3</sup> (261 cm <sup>3</sup> )
Compression ratio.....	16.25 to 1
Lubricating oil pressure (min.).....	35 lbf/in <sup>2</sup> (2.46 kgf/cm <sup>2</sup> )
Fuel injection release pressure.....	2350/2650 lbf/in <sup>2</sup> (165.2/186.3 kgf/cm <sup>2</sup> )
Fuel injection timing (by spill):	
Fixed speed	
Up to 2200 rev/min .....	23° before TDC
2201 to 2700 rev/min .....	26° before TDC
2701 to 3300 rev/min .....	29° before TDC
3301 to 3600 rev/min .....	34° before TDC
Variable speed.....	29° before TDC
Inlet valve opens.....	13° before TDC
Inlet valve closes.....	38° after BDC
Exhaust valve opens.....	38° before BDC
Exhaust valve closes.....	13° after TDC
Oil capacity.....	3¼ pints (1.9 litres)

**b****technical data**

W7/WPD4

A2

Bore (nominal).....	3in (76.2mm)
Stroke.....	2.625in (66.68mm)
Power and speed (B.S. continuous rating):	
	2.8 bhp at 1500 rev/min
	3.3 bhp at 1800 rev/min
	4.0 bhp at 2100 rev/min
	5.0 bhp at 2500 rev/min
	6.0 bhp at 3000 rev/min
	6.5 bhp at 3600 rev/min
Cubic capacity.....	18.5 in <sup>3</sup> (304 cm <sup>3</sup> )
Compression ratio.....	17 to 1
Lubricating oil pressure (min.).....	35 lbf/in <sup>2</sup> (2.46 kgf/cm <sup>2</sup> )
Fuel injection release pressure.....	2350/2650 lbf/in <sup>2</sup> (165.2/186.3 kgf/cm <sup>2</sup> )
Fuel injection timing (by spill):	
Fixed speed	
Up to 2200 rev/min .....	26° before TDC
2201 to 2700 rev/min .....	28° before TDC
2701 to 3300 rev/min .....	32° before TDC
3301 to 3600 rev/min .....	33° before TDC
Variable speed.....	28° before TDC
Inlet valve opens.....	13° before TDC
Inlet valve closes.....	38° after BDC
Exhaust valve opens.....	38° before BDC
Exhaust valve closes.....	13° after TDC
Oil capacity.....	4¾ pints (2.7 litres)

Lubricating oil- Disregard weights on page 21 of General Section and use 10W or multiviscosity 10/30w high detergent oil which meets API service CC, CE or SE or meets Mil Spec 2104-B. Use non-detergent oil for the first 50 hours on a generator set then use high detergent.



Camshaft end float.....	0.003/0.010in (0.08/0.25mm)
Crankshaft end float (new).....	0.005/0.017in (0.13/0.43mm)
Crankshaft end float (not to exceed).....	0.020in (0.51mm)
Crankpin ovality (not to exceed).....	0.0025in (0.063mm)
Cylinder bore wear (not to exceed).....	0.010in (0.25mm)
Piston ring gap (new).....	0.012/0.017in (0.30/0.43mm)
Piston ring gap (not to exceed).....	0.045in (1.14mm)
Exhaust valve lift by decompressor (max.)	0.015in (0.38mm)
Bumping clearance.....	0.022/0.026in (0.56/0.66mm)
Valve rocker clearance (cold).....	0.004in (0.10mm)
Valve depth from cylinder head face (new)	0.039/0.057in (0.99/1.45mm)
Main bearing clearance (new).....	0.0008/0.0029in (0.020/0.077mm)
Large end bearing clearance (new).....	0.0010/0.0035in (0.025/0.090mm)
Small end bush diameter (fitted).....	0.8753/0.8757in (22.233/22.243mm)
Reduction gear power take-off shaft end float.....	0.002/0.005in (0.05/0.13mm)
Cylinder reboring diameters:	
Standard.....	3.000/3.001in (76.20/76.23mm)
Oversize:	
0.020in.....	3.020/3.021in (76.71/76.73mm)
0.030in.....	3.030/3.031in (76.96/76.99mm)
0.040in.....	3.040/3.041in (77.22/77.24mm)
Crankshaft regrinding diameters:	
	Main journal and crankpin
Standard.....	1.6250/1.6245in (41.275/41.262mm)
Undersize:	
0.010in.....	1.6150/1.6145in (41.021/41.008mm)
0.020in.....	1.6050/1.6045in (40.767/40.754mm)
Lubricating oil pump:	
Rotor end clearance (new).....	0.001/0.0025in (0.025/0.064mm)
Rotor end clearance (not to exceed).....	0.005in (0.127mm)
Rotor form clearance (new).....	0.002/0.005in (0.051/0.127mm)
Rotor form clearance (not to exceed).....	0.008in (0.203mm)
Shaft/bore clearance (new).....	0.0015/0.003in (0.038/0.076mm)
Shaft/bore clearance (not to exceed).....	0.005in (0.127mm)
Rotor shaft diameter (new).....	0.5918/0.5923in (15.032/15.044mm)

\* \* \* \*

TORQUE SPANNER SETTINGS	lbf ft	kgf m
Large end bolt.....	25	3.46
Cylinder head nut.....	20	2.77
Injector stud nut.....	AB1W 10	1.38
Injector stud nut.....	AC1W 13	1.80
Flywheel nut.....	155	21.43
Flywheel extension or gearwheel bolt.....	27	3.73
Lubricating oil pump screw.....	10	1.38
Lubricating oil filter centre bolt.....	10	1.38
Fuel pump delivery union body.....	15	2.07
Crankshaft and camshaft extension shaft screw.....	14	1.94
Crankshaft gearwheel retaining screw.....	27	3.73
Camshaft gearwheel retaining screw.....	27	3.73
Starting handle shaft retaining screw (Raised Hand Starting).....	27	3.73
Mounting plate screw (4:1 Hand Starting).....	18	2.49
Sliding plate locating screw (4:1 Hand Starting).....	18	2.49
Sliding plate stop screw (4:1 Hand Starting) (Flywheel end).....	8	1.10
Gearwheel retaining clip screw (4:1 Hand Starting) (Flywheel end).....	12	1.66
Gearwheel retaining screw (4:1 Hand Starting) (Gear end).....	18	2.49

## OPERATION

## 10. PREPARATION FOR STARTING

## DS Marine Engine

## A. Preparation After Installation

The engine is shipped "dry," that is, with lubricating oil drained from crankcase and transmission. The following procedures should be checked methodically before starting the engine for the first time.

- (1) Remove the engine lubricating oil filler cap (push down and twist) and fill sump with lubricating oil to high mark on dipstick, approximately 3.25 pints. Do not overfill. Select an approved grade (see Technical Data "Approved Lubricants") and continue to use it.
- (2) Remove square head screw plug in top of transmission housing and fill with lubricating oil to high level mark on dipstick. Use SAE 30 High Detergent Diesel Lubricating Oil. Replace screw plug.
- (3) Fill fuel tank. No. 2 Diesel fuel oil is recommended. No. 1 fuel oil is permissible but No. 2 is preferred because of its higher lubricant quality.
- (4) Lift the decompression lever (A, Fig. B1) vertically and rotate the drive pulley counter-clockwise approximately 12 revolutions to circulate the lubricating oil. Replace decompression lever to its horizontal position. (The decompression lever releases the pressure in the cylinder allowing the engine to crank with no resistance.)

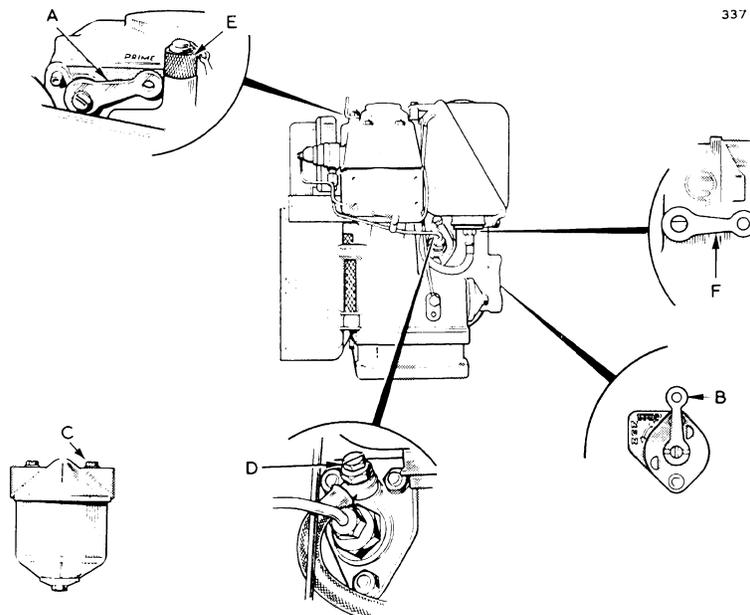


Fig. B1. Bleed and Prime Fuel System

- A – Decompression lever
- B – Stop/Run lever
- C – Inlet Vent Screw
- D – Vent Screw on injection pump
- E – Priming Plunger
- F – Overload stop lever (DS Marine Engine only)
- G – Fuel line union nut

- (5) Check that the starter battery is fully charged and that all electrical connections are properly made and all circuits in order.
- (6) Open cooling system inlet and outlet sea-cocks. There is no need to prime the cooling system as the pump is self-priming.
- (7) Bleed and prime fuel system, refer to Par. B, below.

B. To Bleed and Prime the Fuel System (Fig. B1)

- (1) Position shift lever in neutral.
- (2) Set throttle control lever to full speed position.
- (3) Move STOP/RUN lever (B) to RUN position.
- (4) Loosen inlet vent screw (C) on top of fuel filter, operate the hand priming lever of the fuel lift pump, and when fuel oil free of air bubbles issues from vent screw, tighten screw.

NOTE: If the cam on the camshaft driving the fuel lift pump is on maximum lift, then it will not be possible to operate the priming lever of the fuel lift pump. If such a condition arises proceed as follows:

- (a) Lift decompression lever (A) to vertical position.
- (b) Revolve drive shaft pulley by hand until the fuel lift pump priming lever can be operated.
- (c) Position decompression lever (A) in horizontal position.
- (5) Loosen the outlet vent screw also on top of the fuel filter, operate the priming lever as in step (4) above, and then tighten screw.
- (6) Loosen the vent screw (D) on injection pump, operate priming lever as in step (4) above, and then tighten screw.
- (7) Loosen the fuel line union nut at the fuel injector (fuel line between fuel injection pump and fuel injector). Operate the starter-generator and when fuel oil free of air bubbles issues from union, tighten union nut.

NOTE: Do not crank engine for more than 20 seconds at a time, and leave at rest 2 minutes before attempting to crank engine again.

C. To Start (Fig. B1)

- (1) Position shift lever in neutral position.
- (2) Move throttle control lever to full speed position.
- (3) Position STOP/RUN control lever (B) to RUN position.
- (4) Push down and release the overload lever (F). (The overload lever supplies an excess of fuel oil to the injection pump for instant starting.)
- (5) Lift the decompression lever (A).
- (6) Operate the starter-generator control. As soon as engine starts to crank, replace decompression lever in horizontal position. When engine fires, release starter-generator control.
- (7) Immediately after engine has started, move throttle control lever back so that engine will run at fast idling rpm.
- (8) Refer to paragraph 12 "Procedure After Starting."

D. To Stop

- (1) Move shift lever to neutral position.

NOTE: Let engine run a few minutes at idling speed before shutting off. This permits the water circulation to dissipate excessive heat from the metal masses gradually.

- (2) Move the STOP/RUN lever to the STOP position, and hold in this position until engine shuts off.
- (3) Turn key switch to off position.

## WPD-3 Marine Generator

## E. Preparation After Installation

The Generator set is shipped "dry," that is, with lubricating oil drained from crankcase. The following procedures should be carried out, and checked methodically before starting the generator set for the first time.

- (1) Remove the engine lubricating oil filler cap (push down and twist) and fill sump with lubricating oil to high mark on dipstick approximately 3.25 pints. Do not overfill. Select an approved grade listed and continue to use it. (Refer to Technical Data, "Approved Lubricants.")
- (2) Fill fuel tank. No.2 diesel fuel oil is recommended. No. 1 is permissible but No. 2 is preferred because of its higher lubricant quality.
- (3) Lift the decompression lever (A, Fig. B2), that is, vertically, and rotate the drive pulley counter-clockwise by hand approximately 12 revolutions to circulate the lubricating oil. Replace decompression lever to its horizontal position. (The decompression lever releases the pressure in the cylinder allowing the engine to crank with no resistance.)

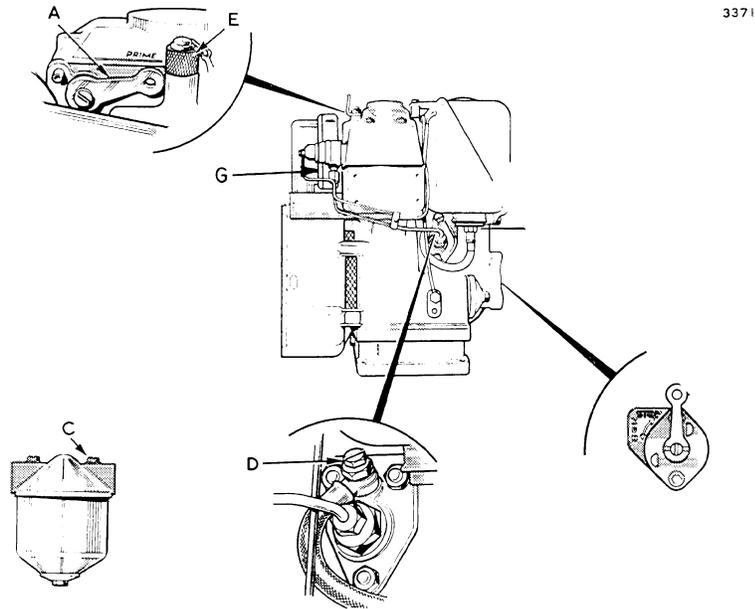


Fig. B2

- (4) Ensure power switch is in OFF/REMOTE position.
- (5) Connect a fully charged 12 volt battery to (+) and (-) battery studs on side of control box. **IMPORTANT:** Ensure correct polarity.
- (6) Ensure that all air inlet and outlet vents are unobstructed.
- (7) Open cooling system, inlet and outlet sea-cocks. (The pump is self-priming.)
- (8) Bleed and prime fuel system (refer to Par. F, below).

## F. Bleed Fuel System (Fig. B2)

- (1) Ensure power switch is in OFF/REMOTE position.
- (2) Move STOP/RUN lever (B) to RUN position.
- (3) Loosen inlet vent screw (C) on top of fuel filter, operate the hand priming lever of the fuel lift pump, and when fuel oil free of air bubbles issues from vent screw, tighten screw.

NOTE: If the cam on the camshaft driving the fuel lift pump is on maximum lift , then it will not be possible to operate the fuel lift pump hand primer. In this case , proceed as follows:

- (a) Lift decompression lever (A) to vertical position.
  - (b) Revolve drive shaft pulley by hand until the fuel lift pump priming lever can be operated.
  - (c) Position decompression lever (A) in horizontal position.
- (4) Loosen the outlet vent screw also on top of the fuel filter, operate the priming lever as in step (3) above, and then tighten screw.
  - (5) Loosen the vent screw (D) on injection pump, operate priming lever as in step (3) above, and then tighten screw.
  - (6) Loosen the fuel line union nut at the fuel injector (fuel line between fuel injector pump and fuel injector). Turn START switch on control panel to START which causes starter motor to start and may cause the engine to fire up. Read Section 10 below regarding time limits on energizing . When fuel oil free of air bubbles issues from the loosened union, tighten union nut.
- G. To Start and Stop

NOTES:

- (1) Do not operate START switch for more than 20 seconds at a time, and leave at least 10 seconds before attempting another start.
- (2) Start the plant and run without electrical load, checking for fuel oil , lubricating oil and coolant leaks. If any leakage, take immediate steps to remedy it. Stop the plant after approximately 5 minutes, allow time for oil to settle, then check lubricating oil level. Add oil as necessary to high mark on dipstick.
- (3) If practical, allow the plant to warm up a short time before connecting a heavy load. Keep the load within the nameplate rating. Continuous generator overloading may cause high operating temperatures that can damage windings.
- (4) To stop generator set it is advisable to run on light load for a few minutes before shutting off. This permits the water to circulate and dissipate excessive heat from the metal masses gradually.
  - (a) To Start Generator Set (with Electric START and Bowdoin STOP/RUN Control Cable).
    - (1) Push STOP/RUN control knob.
    - (2) Switch STARTER switch to ON and hold till engine fires, then release switch.
    - (3) To Stop Generator Set, pull out STOP/RUN control knob. Turn switch to OFF position.
  - (b) To Start Generator Set (with Electric START/STOP – OPTIONAL)
    - (1) Hold control switch on control panel to "START". When engine fires release switch (it will return to center position).
    - (2) To STOP GENERATOR SET – turn switch to OFF/REMOTE .
  - (c) To Start Generator Set (with Automatic Failure shutdown – OPTIONAL).
    - (1) Simultaneously throw control switch to START and OIL DEFEAT (oil override) switch to right. (This can be done by squeezing both switches with thumb and index finger of one hand.)

NOTE: The function of the oil defeat switch is to bypass the flow of current around the Normally Open low oil shutdown switch during starting until sufficient oil pressure is developed during cranking to close the switch. If the switch is released before sufficient pressure is developed the fuel start solenoid will automatically return to the off position.

- (2) Release control switch when engine fires.
- (3) Release OIL DEFEAT switch when oil pressure builds up.
- (4) To Stop Generator Set – Turn switch to OFF/REMOTE position .
- (d) To Start Generator Set (from Remote Control Panel).
  - (1) Place control switch on generator set to OFF/REMOTE.
  - (2) Start generator set from remote control panel as in Par. (b) above.

NOTE: The generator set can be controlled ONLY from the Remote Control Panel from this time on. If it is desired to control generator set from generator panel , the control switch on the Remote Panel must first be placed in the OFF/REMOTE position.

- (3) To Stop Generator Set – Turn switch to OFF/REMOTE position .
- (e) To Start Generator Set (from Remote Control Panel when Automatic Failure Shutdown OPTION included.)
  - (1) Place Control Switch on generator set to OFF/REMOTE.
  - (2) From Remote Control Panel, follow same procedure as in Par . (c) above.

## 11. COLD STARTING

- (a) Below 55<sup>o</sup>F (13<sup>o</sup>C) and if the engine is cold, it is essential to prime the engine for hand starting, and advisable if battery power is low when electric starting. Proceed as follows:
  - (1) Remove the priming plunger (E, Fig. B1).
  - (2) Fill the priming chamber with engine oil – NOT fuel.
  - (3) Replace the priming plunger and press down.
  - (4) It is advisable to keep a quantity of lubricating oil in a suitable container for this purpose.
- (b) Should the engine fire and then stop, prime again and release the overload stop lever (F), if fitted, before attempting to start.
- (c) Below 32<sup>o</sup>F (0<sup>o</sup>C) and if the engine is cold, prime the engine twice.
- (d) If under cold conditions the engine does not run up to its rated speed after starting, operate the priming plunger again while the engine is running .
- (e) To minimize cold starting difficulties, ensure that an SAE 10W viscosity engine oil is used (see "Approved Lubricants," Technical Data). It will also help starting to use No. 1 Diesel fuel.

## 12. PROCEDURE AFTER STARTING

- (a) Check the oil pressure immediately after the engine has started. Under no conditions must the engine be operated with too low oil pressure . Minimum oil pressure approximately 70 psi at 3000 rpm.
- (b) Check sea-water flow at outlet thru-hull fitting. Do this without delay .

NOTE: On new installations or subsequent to an oil change, run engine briefly then stop the engine and check the engine sump and transmission (if fitted) oil levels. It is important that oil required to fill the internal passages and oil filter is compensated for. Add lubricating oil as necessary. Check oil level every day of operation.

- (c) On DS Marine Engine, when operating the engine, make gear shifts ahead and astern quickly and decisively. This is because jaw clutches are used in the SSR transmission and quick engagement prevents the clashing of teeth that will occur if you attempt easy engagement as you would with friction clutches. This is also a reason for using the Morse MI simple lever control, which automatically places throttle in idle position before each gear shift.

NOTE: On DS engines, the transmission is in FORWARD when the shift lever is moved (aft) toward the stern of the boat and in REVERSE when shift lever is moved (forward) toward bow.

### 13. SPECIAL PRECAUTIONS

- (a) DON'T stop the engine by means of the decompressor. This will lead to damaged valve seats and cylinder head joints.
- (b) DON'T stop the engine by allowing the fuel tank to run dry. This will let air into the fuel lines and make it necessary to bleed and prime the system.
- (c) DON'T remove or alter the setting of the overload stop if fitted, or operate the overload stop lever when the engine is running. This will cause overheating, excessive wear and possibly piston seizure.
- (d) DON'T forget to drain the cooling system before leaving the engine to stand idle in cold weather.
- (e) If the engine is used infrequently, extended shutdown periods can result in difficult starting. Run the engine a few minutes frequently to keep it well lubricated.

### 14. POST DELIVERY CHECKOUT

After a customer has taken delivery of his DS engine or WPD-3 Generator, it is advisable, in his own interest, that a general checkover of the engine be carried out after the first 50 hours in service. The checkover should be comprised of the following points:

- (a) Drain engine oil sump, change filter and fill sump with lubricating oil (refer to Par. 18(c)).
- (b) Clean pre-filter (water trap and screen assembly) if installed.
- (c) Replace engine mounted fuel filter (refer to Par. 18(b)).
- (d) Check tightness of cylinder head nuts. The cylinder head must NOT be tightened when the engine is hot. (Refer to Par. 38 (g), and (h), 1 and 2.)
- (e) Check valve rockers clearance (refer to Par. 39).
- (f) DS Marine Engine Only – Check slackness in starter-generator belt. The slackness should not be more than 1/2 in. (13 mm).
- (g) WPD-3 Marine Generator Set – Examine connections in control box.
- (h) Check all engine external bolts and nuts for tightness, especially motor mounting nuts.
- (i) Top up battery with distilled water.
- (j) Bleed fuel system.
- (k) Start engine and run for 5 minutes checking fuel pipes from tank to fuel injector for leaks, especially around the filter gasket(s). Rectify any leaks.
- (l) Check and rectify any oil leak around lubricating oil filter gasket.
- (m) Check and rectify any cooling system leaks.
- (n) Wipe off all lube, fuel, and water drippings. Keep your engine clean so that any leaks which develop are detected at once.

Hereafter the maintenance periods should be in accordance with maintenance schedule.

## 18. FILTER MAINTENANCE

### A. Air Filter

The time period for cleaning the air filter depends on operating conditions, therefore, under dirty conditions, the time period of 250 hours recommended for cleaning should be decreased. The correct maintenance of the air filter will greatly assist in reducing bore wear thereby extending the life of the engine.

To clean the air filter proceed as follows:

- (1) Unscrew the thumb screw securing the air filter to its manifold and remove filter.
- (2) Separate the two halves of the air filter and remove the paper element .
- (3) The element may be cleaned by blowing compressed air from the inside to the outside. Do not attempt to clean the element by any other means .
- (4) A strong light directed into the inside of the element and viewed from the outside will reveal any damage to the paper corrugations. If the element is damaged or shows a large deposit of dirt, replace element.
- (5) Thoroughly wash out the two halves of the air filter in clean diesel fuel oil.
- (6) Dip the thumb screw half of the air filter in a bath of clean engine oil and allow to drain before refitting.
- (7) Position the paper element between the two halves of the air filter.
- (8) Secure air filter to its manifold with sealing ring between air filter and its manifold.

### B. Fuel Oil Filters

It is essential to use clean diesel fuel oil free from water or contamination. Provided clean fuel oil is used, no trouble should be experienced with the fuel system .

- (1) The first filter should be a gauze trap in the filler of the fuel tank; this must not be removed when fuel is being poured into the tank. It should be taken out every 500 hours, cleaned, washed in fuel oil, and immediately replaced. If there is no filter in the filler of the fuel tank the fuel should be poured through a fine gauze strainer.
- (2) The second filter (optional) should be a pre-filter (water trap and screen assembly) installed in the fuel line between the fuel tank and the fuel lift pump. This filter should be cleaned every 250 hours unless the condition of the fuel warrants more regular attention.
- (3) The third final filter (Fig. C1) is mounted to a bracket secured to the engine front cover. It is an element type filter and must be replaced every 250 hours. To replace this filter element proceed as follows:
  - (a) Unscrew the bolt on the bottom of the fuel filter bowl from filter head (3) and withdraw the bowl with its attached bolt. Remove and discard element. Do not remove bolt from bowl.
  - (b) Remove the bowl "O" ring gasket (4) from its groove in the filter head. Replace new "O" ring gasket.

NOTE: When replacing new "O" ring gasket, locate the new gasket in the groove at four diametrically opposite points and seal it all around the groove. Do not fit the gasket at one point and then work it around the groove as the rubber may stretch, thus leaving a surplus which may cause an oil leak.

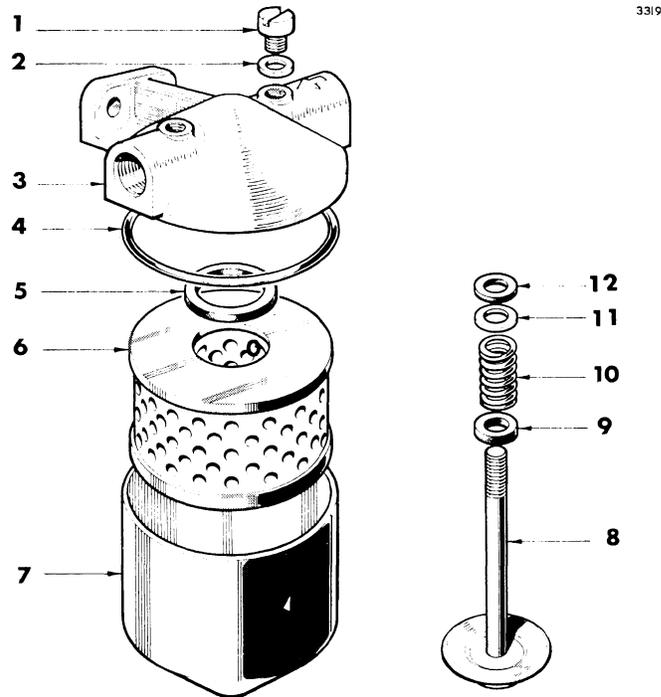


Fig. C1. Fuel Filter Assembly

- |                     |                       |
|---------------------|-----------------------|
| 1. Screw-vent       | 7. Bowl               |
| 2. Washer           | 8. Bolt-center        |
| 3. Head             | 9. Seal bolt (lower)  |
| 4. "O" ring bowl    | 10. Spring            |
| 5. "O" ring element | 11. Washer            |
| 6. Element          | 12. Seal bolt (upper) |

- (c) Remove the element "O" ring gasket (5) from filter head. Replace new "O" ring.
- (d) Thoroughly clean out filter bowl using clean diesel fuel oil.
- (e) Install filter bowl with new element to filter head and tighten bolt .
- (f) Bleed and prime fuel system .
- (g) Start engine and check for leaks in the fuel line and around filter head gasket.

### C. Lubricating Oil Filter

The importance of clean lubricating oil cannot be stressed too highly and all references to engine oil should be taken to mean High Detergent, Diesel Lubricating Oil. Refer to Technical Data for an approved lubricating oil.

If the time period specified (250 hours) for replacement of the filter and the use of the same brand of oil is used during oil changes, a very long life can be obtained from the engine.

To replace the filter element (Fig. C2) proceed as follows:

- (1) Run engine until engine oil is warm.
- (2) Drain sump by removing plug at bottom of sump or the oil may be sucked out of the sump by inserting a suction hose in oil filler opening.
- (3) Unscrew the bolt (4) at the center of the filter bowl (3) and withdraw filter bowl, element and "O" ring. Discard element.
- (4) Thoroughly clean out filter bowl using clean diesel fuel oil.
- (5) Secure bowl with new element and "O" ring to crankcase. Torque bolt to figure shown under Technical Data.

- (6) Fill sump with High Detergent lubrication oil. See "Approved Lubricants" General Data.
- (7) **IMPORTANT.** Start engine and run for 5 minutes and check for leaks .
- (8) Shut down engine. Check oil sump level and add oil as necessary.

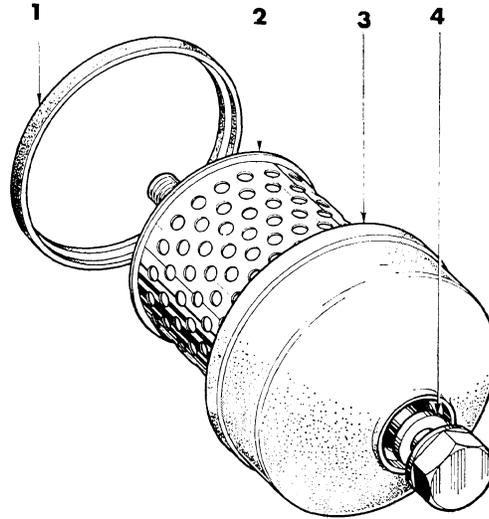


Fig. C2. Lubricating Oil Filter

- |                   |             |
|-------------------|-------------|
| 1. Gasket         | 3. Bowl     |
| 2. Filter element | 4. "O" ring |

### 31. DECARBONISING

A carbon deposit forms on piston and cylinder head and the presence of an excessive carbon deposit is usually indicated by a dirty exhaust and a falling off of power.

Decarbonising necessitates the removal of the cylinder head, followed by the removal of all carbon and the grinding in of the valves. These operations are described in subsequent paragraphs.

### 32. TO REMOVE CYLINDER HEAD

- (a) Drain the cylinder and cylinder head.
- (b) Disconnect the water outlet pipe from the cylinder head, and the water injection elbow.
- (c) If a heat exchange is fitted remove the inlet and outlet pipes.
- (d) Drain and remove fuel tank.
- (e) Remove the air cleaner, air inlet manifold and breather adaptor.
- (f) Disconnect the exhaust pipe at the first joint.
- (g) Disconnect the water inlet pipe from the cylinder head.
- (h) Disconnect the rocker box oil pipe.
- (j) Disconnect the fuel pipes and remove the fuel injector.
- (k) Remove the rocker cover.
- (l) Remove the rocker assembly and withdraw the push rods.
- (m) Remove the cylinder head nuts and lift off the cylinder head.

### 33. TO REMOVE VALVES

- (a) Hold the valve on the seat and depress the valve spring cap and remove the split collets. Valve and spring cap now be removed.

**34. TO REMOVE CARBON**

- (a) Turn the crankshaft until the piston is at the top of its stroke.
- (b) Scrape the carbon from the cylinder head and the top of the piston with a broad blunt tool. Emery cloth must NOT be used. Do not allow carbon dust to fall between the piston and the cylinder bore.
- (c) Thoroughly clean out the exhaust and inlet ports and manifolds.
- (d) DO NOT remove the air cell from the cylinder head. If a carbon deposit has formed in the air cell nozzle, it may be cleaned with a soft piece of wire.
- (e) Make sure that the recesses at the end of the valve guide bores are free from carbon.
- (f) Thoroughly clean the valves and examine the valve seats. If these show signs of pitting, they should be ground in.
- (g) Make sure the valves are seating properly. Leaking valves cause loss of compression and difficult starting.

**35. TO REMOVE VALVE GUIDES**

- (a) EXTREME CARE AND CLEANLINESS is essential at all times when removing or replacing the valve guides.
- (b) Thoroughly wash the cylinder head with petrol or paraffin to ensure that all carbon, oil and dirt has been removed.
- (c) To remove the valve guides, place the cylinder head in boiling water for two minutes. Support the head on blocks at least ½ in. (12 mm) thick, to prevent the valve guides bottoming. Press out the guides from the valve seat side with the aid of a hand press and punch.
- (d) If a press is not available, a drift may be used, but SPECIAL CARE MUST BE TAKEN to avoid the drift slipping, scoring or otherwise damaging the bores.
- (e) DO NOT USE EXCESSIVE FORCE if heavy resistance is encountered, but replace the cylinder head in boiling water for a further two minutes.
- (f) When pressing out the guides ensure that the punch does not score or damage the bores in any way. Failure to observe this precaution may result in the new guides being loose in the cylinder head.

**36. TO REPLACE VALVE GUIDES**

- (a) Before fitting new guides, ensure the bores in the cylinder head and the body of the guides are clean.
- (b) Place the cylinder head in boiling water for two minutes, enter the guides squarely in the bores from the rocker box side, and press home to the shoulder.
- (c) If a press is not available, a drift may be used, but SPECIAL CARE MUST BE TAKEN to avoid the drift slipping, scoring or otherwise damaging the bores.
- (d) The valve guides have a bonded coating and MUST NOT BE REAMED.
- (e) Grind in the valves.

**37. TO GRIND IN VALVES**

- (a) Care must be taken that the valves are returned to their correct seating for this operation.
- (b) Place a very small quantity of grinding paste evenly around the valve seat and insert the valve. Partially rotate the valve backwards and forwards on its seating, exerting a gentle but firm pressure.
- (c) Periodically lift the valve from its seating and give it half a turn, thus ensuring that the grinding paste is evenly spread.
- (d) It is unnecessary to continue grinding once the faces of the valve and its seating have a clean, even, matt-surfaced appearance. A polished surface must not be expected and is unnecessary.
- (e) Wash out the ports thoroughly with petrol or paraffin making sure that all traces of grinding paste are removed from the valves and guides.
- (f) Replace the valves and rotate them backwards and forwards a few times. If the valves have been correctly ground a thin polished line will appear all round the seat.

**38. TO REPLACE CYLINDER HEAD**

- (a) Generally reverse the instructions for removal and dismantling. The rocker bushes and push rod ends should be smeared with molybdenum-disulphide grease before assembly.
- (b) It is **IMPORTANT** that the exhaust and inlet valves be returned to their correct positions.
- (c) If the valves are distorted or very badly pitted, new ones must be fitted and ground in.
- (d) If the valve guides show signs of wear or scoring, they should be replaced.
- (e) Whenever the cylinder head is removed after the engine has been run, a new gasket **MUST** be fitted.
- (f) Before replacing the cylinder head, smear the top of the gasket with 'Golden Hermatite' to prevent sticking. If the gasket sticks to the cylinder head, its removal may cause damage and so accelerate corrosion.
- (g) As the engine is fitted with long through studs from crankcase to cylinder head it is **MOST IMPORTANT** that the cylinder head nuts are correctly tightened and in the right sequence.
- (h) It is advisable to use a torque spanner for tightening the cylinder head nuts. It should be set to the figure shown under Technical Data. Proceed as follows:
  - (i) Screw down each cylinder head nut until finger tight.
  - (ii) Tighten each nut a quarter of a turn at a time, working diagonally across the cylinder head, until all the nuts are tight.
  - (iii) After approximately 20 hours running check again for tightness.
- (j) Do not replace the heat exchanger until after the cylinder head nuts have been tightened.
- (k) When reassembly is complete and before attempting to start the engine, bleed and prime the fuel system.

**39. TO ADJUST VALVE ROCKERS Fig. 9**

- (a) To adjust the clearance, set the engine with valves closed (TDC of firing stroke), loosen the locknut (A) and turn the rocker adjusting screw (B) with a screwdriver. Measure the gap with a feeler gauge, and when the correct setting is obtained (see Technical Data) retighten the locknut. Recheck the gap.
- (b) **IMPORTANT.** The cylinder head must be firmly bolted in position, with all nuts finally tightened, before the rocker clearances are adjusted.

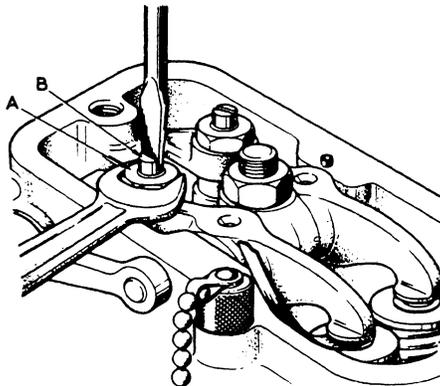


FIG. 9

#### 40. TO REMOVE CYLINDER AND PISTON

- (a) Remove the cylinder head.
- (b) Lift the cylinder off the crankcase and draw it off the piston.
- (c) To remove the piston, take out one gudgeon pin circlip and push out the gudgeon pin. If the gudgeon pin is a tight fit in the piston, wrap the piston in a cloth soaked in hot water. After a few minutes the gudgeon pin will be released and can be pushed out.

#### 41. CYLINDER MAINTENANCE

- (a) When the cylinder bore wear has reached the maximum (see Technical Data) the cylinder should be bored out an oversize piston and rings fitted.
- (b) The cylinder should be rebored and honed to the sizes shown under Technical Data.

#### 42. PISTON MAINTENANCE Fig. 10

Excessive lubricating oil consumption, loss of compression and knocking are signs that a piston may need attention.

- (a) If the ring gaps are excessive (see Technical Data) the rings should be renewed. To measure the gaps remove the rings from the piston noting the order of assembly and which ring face is uppermost.
- (b) Remove all the carbon deposit from the rings and ring grooves. The small holes (A) in the scraper ring grooves should receive attention as their purpose is to return excess oil to the sump.
- (c) Insert the piston into the cylinder bore with the crown towards the bottom end of the bore to about  $\frac{1}{8}$  in. (13 mm) from the bottom edge. Insert the rings one at a time, pushing each ring hard up against the piston crown to ensure that it is level in the cylinder bore. Withdraw the piston sufficiently to allow the gap to be checked with a feeler gauge.
- (d) Assemble the rings on the piston in the correct order with the correct face uppermost. Rings should not be slack or stuck fast in the groove.
- (e) When the engine has been fully run-in, the bore will have a highly polished and very hard surface. If new rings are fitted without the cylinder being rebored or resleeved, the new rings will not bed in satisfactorily. Under these conditions the cylinder should be removed and the hard polished bore lightly roughened using a medium grade emery cloth. The roughening should be carried out radially, by hand, and should be sufficient only to produce a matt surface in the bore. After this treatment the cylinder must be thoroughly washed in petrol or paraffin to remove all traces of carborundum.

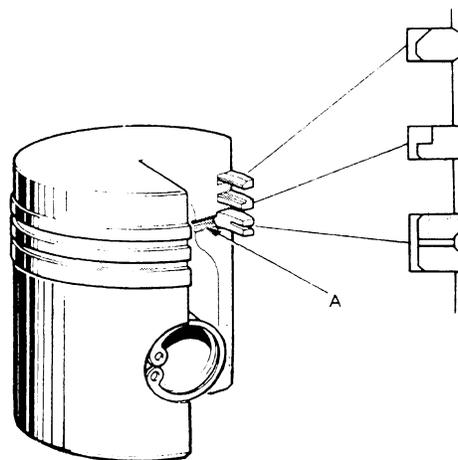


FIG. 10

**43. TO REPLACE CYLINDER AND PISTON**

- (a) Take care that the piston ring gaps are not in line, but well distributed around the piston circumference.
- (b) Replace the shims between the cylinder and crankcase. The thickness of the shims controls the bumping clearance between the piston and cylinder head at TDC.
- (c) Before completing reassembly check the bumping clearance (see Technical Data) as follows:
  - (i) Insert a length of lead wire or soft solder through the injector port in the cylinder head. Pull through sufficient to allow approximately 1 in. (25 mm) to be positioned flat on the cylinder head between the inlet and exhaust valves. Wind any surplus wire around the injector studs.
  - (ii) Replace the cylinder head, fitting a new gasket, and tighten the nuts in the correct sequence with a torque.
  - (iii) Turn the engine over TDC and then carefully remove the wire.
  - (iv) Measure the thickness of the now flattened wire with a micrometer. If the clearance is outside the limit, adjust by changing one or more of the shims at the base of the cylinder, and recheck the bumping clearance.
- (d) After completing reassembly, check the valve rocker clearance.

**44. TO EXAMINE CONNECTING ROD**

- (a) Remove cylinder head and cylinder.
- (b) Check for undue play or shake in the large and small end bearings.

**45. TO REMOVE CONNECTING ROD**

- (a) Remove plant from vessel.
- (b) Remove cylinder head and cylinder.
- (c) Drain oil from engine sump.
- (d) Remove the generator.
- (e) Stand the engine on the bellhousing. To protect the studs support the engine on two pieces of wood of suitable thickness.
- (f) Remove the sump.
- (g) Unscrew the large end bolts and withdraw the connecting rod and piston assembly, being careful to note in which position the bearing halves are fitted.

**46. CONNECTING ROD MAINTENANCE**

- (a) When fitting a small end bush take care that the oil hole coincides with that in the connecting rod and that the bush enters the connecting rod squarely. In the absence of a press, a block of wood and mallet may be used for driving it home.
- (b) New small end bushes are supplied with a reaming allowance, and after fitting must be reamed to the size shown under Technical Data.
- (c) Large end bearings are of the precision thin wall steel back type and consist of two half shells lined with bearing metal. They should be replaced in their original positions.
- (d) New bearings are machined to give the required fit when in position and should not be scraped or bedded in, neither should shims of any description be fitted. If the faces of the connecting rod or its cap are filed the rod becomes useless regarding replacement bearing shells. When fitting, make sure that the connecting rod bore, the outside of the shells and their split faces are clean.
- (e) Connecting rods and caps are stamped with an assembly serial number and care must be taken that numbers are correctly assembled and on the same side.
- (f) Undersize bearings are obtainable from

**47. TO REPLACE CONNECTING ROD**

- (a) Generally reverse the instructions for removal, making sure that the connecting rod cap is away from the depstick side of the engine.
- (b) It is advisable to use a torque spanner for tightening the large end bolts. It should be set to the figure shown under Technical Data.
- (c) Do not over-tighten the large end bolts or the bearing may distort. If a torque spanner is not available, the bolts may be tightened using a moderate force on a spanner gripped approximately 8 in. (200 mm) from the bolt.
- (d) When replacing the cylinder and cylinder head, check the bumping clearance and valve rocker clearance.

**48. TO REMOVE FLYWHEEL**

- (a) Remove the generator and bellhousing adaptor.
- (b) Secure the flywheel by inserting a hexagon wrench key or steel rod through the timing hole in the bellhousing, and locating it in the hole in the flywheel periphery. This rod must not be loose, but a good fit in the flywheel hole.
- (c) Bend back the tabwasher and remove the flywheel retaining nut.
- (d) Remove the securing rod.
- (e) A simple extractor will be required to remove the flywheel, as it is fitted on a tapered shaft and located by a key.
- (f) Remove the flywheel locating key.

**49. TO REPLACE FLYWHEEL**

- (a) Generally reverse the instructions for removal.
- (b) Ensure that the flywheel locating key is replaced in the crankshaft before fitting the flywheel.
- (c) A new tabwasher must be fitted before tightening the flywheel retaining nut. It is advisable to use a torque spanner for tightening the flywheel nut, and should be set to the figure shown under Technical Data.
- (d) When the nut is tight, knock up the tabwasher.

**50. TO REMOVE CRANKSHAFT**

- (a) Remove the cylinder head, cylinder, connecting rod and flywheel.
- (b) Remove the solenoid and starter motor, if fitted.
- (c) Remove the fuel and oil pipes, and place them in a clean container filled with clean fuel. (See Fuel System).
- (d) **(Deleted)**
  
- (e) Remove the gear cover. This is dowelled to the crankcase.
- (f) Remove the crankshaft gearwheel retaining bolt. Withdraw the gear wheel with a simple extractor.
- (g) Remove the nuts retaining the flywheel end main bearing housing. Remove the housing taking care not to damage the oil seat.
- (h) Withdraw the crankshaft by pulling towards the flywheel end.

**51. CRANKSHAFT MAINTENANCE**

- (a) Carefully examine the bearing journals and crankpin. They should be free from score marks and ovality should not exceed the maximum (see Technical Data).
- (b) If these defects are present the crankshaft should be reground to the diameter shown under Technical Data and undersize bearings fitted.
- (c) Carefully clean out the oil holes and make sure they have radiused edges.

**52. MAIN BEARING MAINTENANCE**

- (a) Main bearings are of the precision thin wall steel backed sleeve type lined with bearing metal.
- (b) When removing a gear end bearing from the crankcase or a flywheel end bearing from the bearing housing, heat the crankcase or bearing housing to a temperature of 93/120°C (200/250°F) before pressing out the bearing.
- (c) When fitting a bearing, the crankcase or bearing housing should again be heated as above and the outer surface of the bearing should be smeared with molybdenum-disulphide grease or tallow before pressing in. It is an advantage if the bearing can be placed in a domestic type refrigerator for a time before fitting.
- (d) Do not remove the bearings unnecessarily or their tightness in the crankcase or bearing housing may be affected. It is not advisable to remove the bearings more than five times.
- (e) When fitting a bearing take care that it enters squarely.
- (f) New bearings are machined to give the required fit when in position and should not be scraped or bedded in, neither should shims of any description be fitted.
- (g) Undersize bearings are obtainable.

**53. TO REPLACE CRANKSHAFT AND TIME ENGINE Fig.11**

- (a) Generally reverse the instructions for removal.
- (b) Fit new bearings if the old ones have excessive clearance or show signs of the metal having run.
- (c) If the main bearing housing has been removed make sure it is correctly fitted with the oil drain hole at the bottom.
- (d) When fitting new thrust washers, be sure that the grooved sides are away from the bearing housing and that the tongues (A) are located in their respective recesses. Fit new pins (B).
- (e) Before completing the assembly, check the end float (Y) and if excessive fit new thrust washers (see Technical Data).
- (f) When assembling the gearwheels make sure that the teeth marked with dots are in their relative positions.
- (g) **(Deleted)**
- (h) **(Deleted)**
- (j) Replace the water pump, ensuring that the impeller is correctly fitted to the shaft.
- (k) Check the bumping clearance.
- (l) Bleed and prime the fuel system.

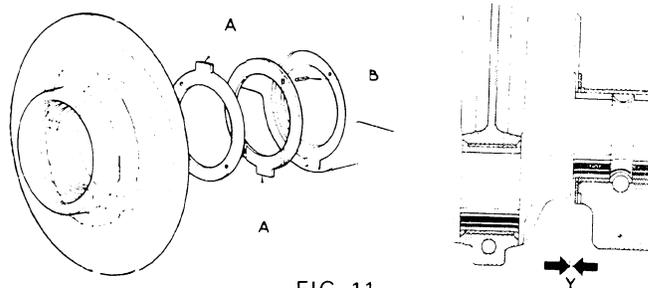


FIG. 11

**54. TO REMOVE CAMSHAFT** Fig. 12

- (a) Drain the engine sump.
- (b) Remove the starter motor, if fitted.
- (c) Drain and remove the fuel tank. Remove the fuel pipes placing them in clean fuel (see Fuel System). Remove fuel injection pump. Cover holes in injector against admission of dirt, etc.
- (d) Remove the water pump, raised hand starting assembly and gear cover.
- (e) Remove the rocker cover, rocker support and rocker assembly and withdraw the push rods.
- (f) Turn the engine onto its side to prevent the tappets from falling into the sump.
- (g) Remove the extension shaft from the camshaft gearwheel.
- (h) Remove the screw (A) retaining the camshaft thrust plate. These are accessible through holes in the gearwheel. Withdraw the camshaft and gearwheel assembly from the gear end of the engine.
- (j) The gearwheel is a tight fit on the camshaft. To fit a new thrust plate, remove the gearwheel retaining bolt and press the shaft from the gearwheel. The gearwheel is keyed to the shaft.

**55. CAMSHAFT MAINTENANCE**

- (a) Carefully examine the faces of the cams. If these are worn or chipped it will be necessary to fit a new camshaft.

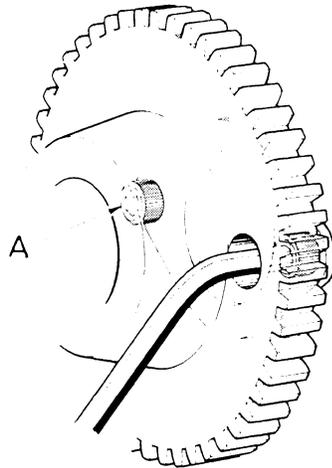


FIG. 12

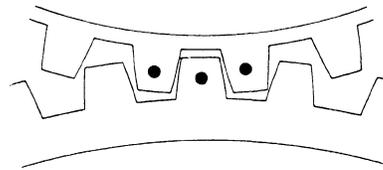


FIG. 13

**56. TO REPLACE CAMSHAFT AND TIME ENGINE** Fig. 13

- (a) Generally reverse instructions for removal.
- (b) When assembling the gearwheels make sure that the teeth marked with dots are in their relative positions.
- (c) Bleed and prime the fuel system, retime the fuel injection pump and adjust the valve clearances.
- (d) Refill the engine sump with lubricating oil.

**57. TO REMOVE GOVERNOR** Fig. 14

- (a) Remove the water pump, raised hand starting assembly and gear cover.
- (b) Remove the screws (A) securing the governor assembly to the crankcase and withdraw it.

**58. TO REMOVE GOVERNOR LINKAGE Fig. 14**

- (a) Remove the governor.
- (b) Remove the gearwheel from the camshaft.
- (c) Move the stop/run lever (B) to the 'RUN' position, i.e. horizontal.
- (d) Remove the screws (C) securing the governor stop cover (D), or speed control bracket if fitted and remove it.
- (e) Loosen the governor bracket screw (E) and remove the bracket (F), speeder spring and speeder spring plunger.
- (f) Remove the operating shaft plug (G) and withdraw the shaft (H) and fuel pump operating lever (J).
- (g) Remove the pin (K) securing the overload stop lever (L) if fitted, and remove the lever. DO NOT loosen the screw (M) clamping the overload stop cam (N) to the spindle. The cam is set and should not be disturbed unless a new fuel pump is fitted (see instructions given under 'To fit new fuel injection pump').
- (h) Remove the overload stop cam and spindle assembly and the return spring (P).

**59. GOVERNOR AND LINKAGE MAINTENANCE Fig. 14**

- (a) Thoroughly clean all parts in paraffin or clean fuel, paying particular attention to all bearings and governor balls.
- (b) Examine the faces of the governor sliding and rotating housings for signs of wear. If worn, the governor assembly must be replaced.
- (c) If oil leaks at the overload stop spindle or the stop/run lever spindle (R), carefully remove the spindle and renew the oil seal. When refitting the spindle ensure that it is free from burrs.

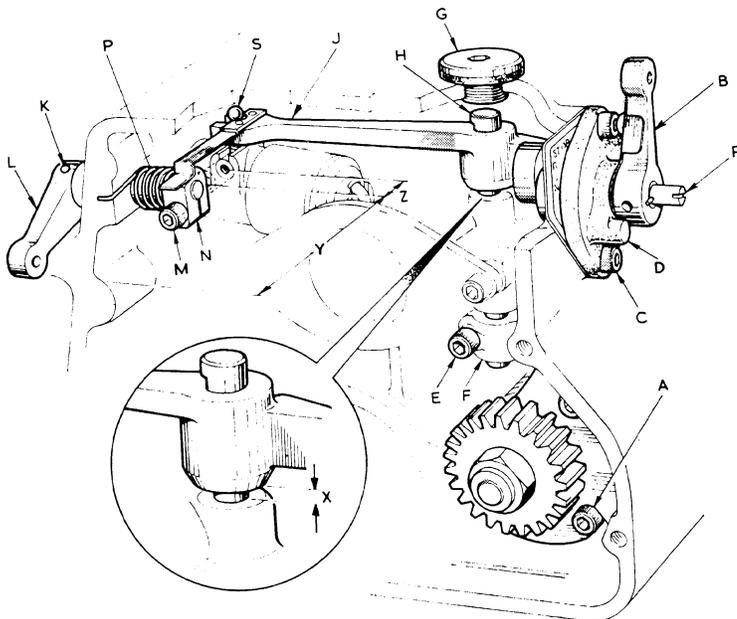


FIG. 14

**60. TO REPLACE GOVERNOR AND LINKAGE Fig. 14**

- (a) Generally reverse the instructions for removal.
- (b) Ensure that the fuel pump lever fork end is correctly located on the fuel pump rack ball (S).
- (c) Before replacing the overload stop assembly, adjust the governor linkage to the correct position as follows:—
  - (i) With the governor bracket screw (E) loose, make sure that the governor bracket fork ends are hard against the governor thrust bearing when the faces of the governor sliding and rotating housings are together.
  - (ii) Push the fuel pump operating lever as far as possible to the fuel pump fully open position.
  - (iii) Tighten the governor bracket locking screw.
  - (iv) Check the setting (X) between the operating shaft bush and the operating lever with a feeler gauge. This should be 0.010in (0.25mm).
  - (v) Replace the overload stop assembly.
- (d) If the overload stop cam has been moved on its spindle, the overload setting will have to be checked. For procedure, see 'To fit new fuel injection pump'.

**61. LUBRICATING OIL SYSTEM Fig. 15**

- (a) The lubricating oil system is as follows:—
  - (i) A rotary oil pump (A) is mounted in the crankcase at the gear end. The pump is driven by a gear from the camshaft.
  - (ii) Oil is drawn through a strainer (B) and fed to the filter (C).
  - (iii) Oil flows from the filter via a hole in the crankcase to the gear end main bearing. It is then transferred via holes in the crankshaft to the large end bearing and the flywheel end main bearing.
  - (iv) The valve rockers are supplied by an external pipe.
  - (v) A pressure relief valve is incorporated to control the oil pressure.
- (b) The cylinder, small end bearing and camshaft are splash lubricated.
- (c) The crankcase can be drained by removing the plug at the bottom of the sump.
- (d) Oil must always be CLEAN and containers, funnels, etc., must be kept in a spotless condition. Use only approved oil. Cheap, unsuitable or dirty oil will cause trouble.

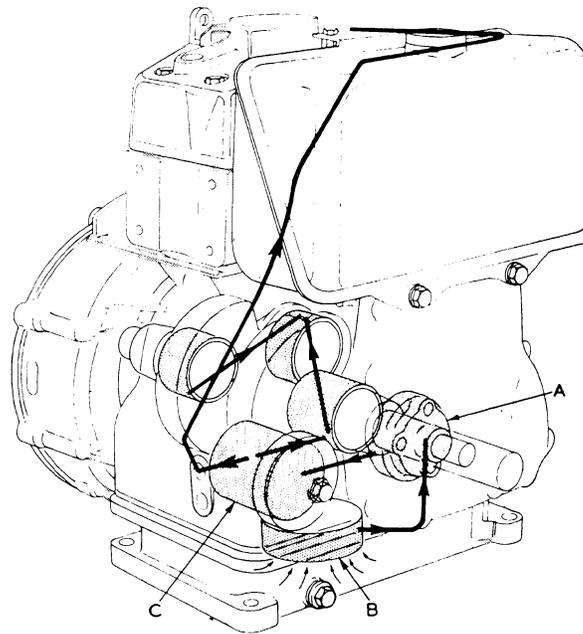


FIG. 15

**62. TO CLEAN OIL FILTER**

- (a) Unscrew the bolt at the centre of the filter cover and withdraw the cover and element.
- (b) Thoroughly clean out the cover and renew the joint ring.
- (c) If the element shows a large deposit of dirt, it should be replaced  
Do not attempt to clean the element.
- (d) When replacing the element, it is advisable to use a torque spanner for tightening the centre bolt.  
It should be set to the figure shown under Technical Data.

**63. OIL PUMP STRAINER**

- (a) To remove
  - (i) Drain oil from the sump.
  - (ii) Remove sump.
  - (iii) Remove the centre bolt and spring plate and remove the strainer.
- (b) To clean, wash the strainer in clean paraffin or fuel.
- (c) To replace, generally reverse the instructions for removal, making sure that the strainer is correctly seated in the sump.

**64. TO REMOVE OIL PUMP**

- (a) Drain the engine sump.
- (b) **(Deleted)**
- (c) Remove the water pump, raised hand starting assembly and gear cover.
- (d) Loosen the oil pump gearwheel retaining nut.
- (e) Remove the camshaft and gearwheel assembly.
- (f) Remove the nut retaining the oil pump gearwheel and remove the gearwheel. The gearwheel is keyed to the shaft.
- (g) Remove the screws securing the pump and withdraw the pump.
- (h) The backplate is dowelled to the body.

**65. OIL PUMP MAINTENANCE**

- (a) Thoroughly clean all parts.
- (b) Carefully examine the rotor and stator. If they are scored or show signs of wear fit new parts.

**66. TO REPLACE OIL PUMP**

- (a) Generally reverse the instructions for removal.
- (b) Pour a small quantity of engine oil into the pump through the port before assembling the pump to the engine.
- (c) It is advisable to use a torque spanner for tightening the oil pump screws. It should be set to the figure shown under Technical Data.

**67. FUEL SYSTEM**

- (a) Fuel from the tank flows through a filter to the injection pump which supplies it under high pressure to the injector.
- (b) A small amount of fuel is always leaking back along the injector nozzle needle and this is returned to the fuel system by a pipe.
- (c) The quantity of fuel injected during each cycle is very small and the fuel injection equipment is manufactured to very fine limits. IT REQUIRES EXTREME CARE AND ABSOLUTE CLEANLINESS IN HANDLING.
- (d) Should any part of the fuel system, including pipes, be removed from the engine, it should be placed in a clean container which is filled with clean fuel. NO FILING, GRINDING, SCRAPING OR SAWING SHOULD BE CARRIED OUT WITHIN A FEW YARDS OF DISMANTLED FUEL INJECTION EQUIPMENT.

- (e) Replace the equipment wet. No rag, cloth or waste should touch it.
- (f) Unless the user has been trained in the care and repair of fuel injection equipment, he should not dismantle it in any way other than as described in subsequent paragraphs.
- (g) Fuel pumps and injectors should be returned to an authorised agent for repair or replacement. Users are advised to keep a nozzle in their spares kit so that a faulty one can be renewed immediately.

#### 68. TO CLEAN FUEL FILTER (Refer to Paragraph 18B)

#### 69 (Deleted).

#### 70 TO REMOVE FUEL INJECTION PUMP

- (a) Drain the fuel tank.
- (b) Remove the solenoid and starter, if fitted.
- (c) Remove the tank-to-pump and pump-to-injector fuel pipes.
- (d) Remove the pump, noting the number and total thickness of shims between the fuel pump and crankcase.

#### 71. TO DISMANTLE FUEL INJECTION PUMP Fig. 16

##### Fixed speed engines

- (a) Thoroughly clean the exterior of the pump.
- (b) Unscrew the union body (A) and lift out the delivery valve spring (B) and the delivery valve (C).
- (c) Withdraw the delivery valve seat (D), the joint (E) and the ring (F).
- (d) Rotate the circlip (G) in its groove until the dowel (H) is between the ends of the circlip.
- (e) Press down the tappet and roller assembly against the spring pressure and shake out the dowel (H).
- (f) Remove the tappet (J) together with the roller and roller pin. Note the number and thickness of the calibrating shims (K) between the tappet and the lower spring plate (L).
- (g) Remove the lower spring plate (L), the plunger (M) and the plunger spring (N). Note the assembly mark on the plunger arm farthest from the rack (P).
- (h) Remove the upper spring plate (R) and the pinion (S). Note the assembly marks on one tooth of the pinion (S) and on the rack (P). Note also the relative position of the 'STOP' mark and arrow on the rack before sliding out the rack from the pump body.
- (j) Remove the element locating screw (T) and push out the element (U) through the top of the pump.

##### Variable Speed Engines

NOTE: Fuel injection pumps fitted to all variable speed engines are subject to special calibration by the manufacturer and only the delivery side may be dismantled. The pump/control side must not be dismantled and should be returned to the manufacturer.

- (a) Thoroughly clean the exterior of the pump.
- (b) Unscrew the delivery union body (A), lift out the delivery spring (B) and the delivery valve (C).
- (c) Withdraw the delivery valve seal (D), the gasket (E) and sealing ring (F).

## 72. FUEL INJECTION PUMP MAINTENANCE

- (a) Each plunger of a pump assembly is mated to one element and must never be used in another.
- (b) Make sure the delivery valve joint and ring are in good condition and that the valve is seating correctly. Leaking valves cause loss of fuel injection pressure and difficult starting.
- (c) Make sure the rack is free throughout its travel.

## 73. TO REPLACE FUEL INJECTION PUMP Fig. 16

- (a) Generally reverse the instructions for removal and dismantling.
- (b) Thoroughly clean all parts in clean fuel and assemble wet.
- (c) The ring (F) should be fitted over the lower shoulder of the union body (A) before the union body is screwed into the pump body. Failure to observe this precaution may result in the ring being crushed between the union body and the joint (E). A torque spanner is advisable for tightening the union body. It should be set to the figure shown under Technical Data.
- (d) When assembling the rack (P) and pinion (S) make sure that the marked tooth of the pinion is opposite the mark on the rack and that the rack is assembled in the pump body so that the 'STOP' mark and arrow will be towards the gear end of the engine when the pump is fitted.
- (e) Make sure that the element (U) can be moved up and down slightly when the locating screw (T) is tightened.
- (f) Replace the plunger (M) with the marked locating arm engaged with the marked slot in the pinion (S), i.e., the marked locating arm is towards the locating screw (T).
- (g) With the element, plunger and pinion correctly assembled, the scroll at the top of the plunger will be adjacent to the fuel port in the side of the element when the rack is in the centre of its travel.
- (h) Replace the tappet (J) making sure that the correct number and thickness of shims is used.
- (i) Press down the tappet and roller assembly and fit the dowel (H) to engage with the slot in the tappet. Rotate the dowel to line up its slot with the ends of the circlip (G) and then turn the circlip in its groove until the ends of the circlip are away from the dowel.

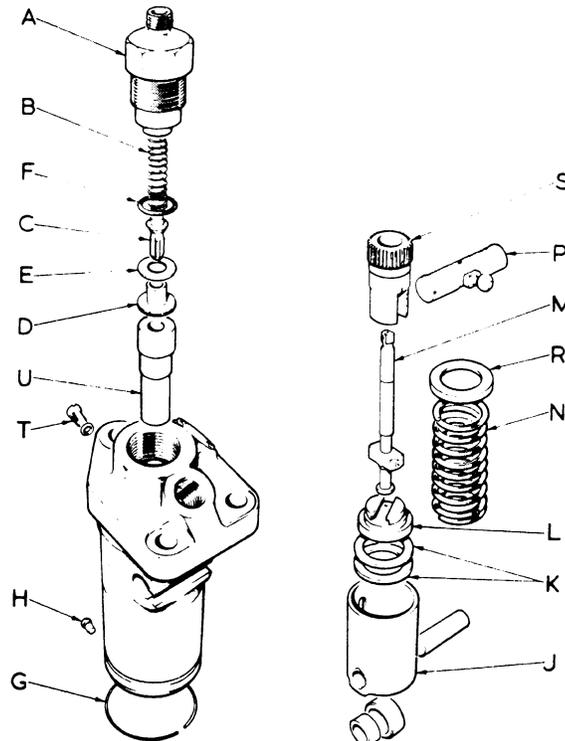


FIG. 16

- (k) Make sure that the fuel pump cam is away from the fuel pump housing – turn the engine until the exhaust or inlet valve is open.
- (l) Make sure that the fuel pump rack ball engages with the governor fork and that the correct number and thickness of shims is fitted between the pump and crankcase.
- (m) IMPORTANT. New fuel injection pumps require special fitting instructions and these are given in the following paragraph.

#### 74. TO FIT NEW FUEL INJECTION PUMP Fig. 14

##### Fixed speed engines

- (a) Make sure that the fuel pump cam is at the bottom of its stroke. Turn the engine until the exhaust or inlet valve is open.
- (b) Turn the STOP/RUN lever (B) until the governor lever fork end is at the centre of the fuel pump housing.
- (c) Fit the fuel pump. Make sure that the fuel pump rack ball (S) has engaged with the governor lever fork.
- (d) Time the fuel injection pump.

##### Variable Speed Engines

- (a) Repeat procedures (a) thru (c) for "Fixed Speed Engines."
- (b) Loosen the overload stop cam screw (M).
- (c) Turn the stop/run lever fully towards the "STOP" position and measure the distance (Y) between the end of the fuel pump rack and the gear cover face using a depth gauge.
- (d) Add 0-500 in. (12-70 mm) (Z) to the depth gauge reading and reset the fuel pump rack in this position by turning the stop/run lever towards the "RUN" position.
- (e) Hold the rack in this position and set the overload stop cam (N) to just touch the overload stop on the fuel pump operating lever. With the overload stop cam in this position, tighten the cam screw (M).
- (f) Check that the total movement from the fully forward (stop) position to the overload stop position is 0-500 in. (12-70 mm).
- (g) Time the fuel injection pump.

NOTE: Variable speed engines are fitted with special fuel injection pumps. Quote the type required when ordering new pumps.

#### 75. TO TIME FUEL INJECTION PUMP Fig. 16 and 17

Before timing the pump be sure the fuel line is bled up to the fuel pump.

- (a) On fixed speed engines running at speeds above 3000 rev/min. and on all variable speed engines, move the stop/run lever towards the 'STOP' position until it is 10° before the vertical position. At this position the pump rack will be held away from the retarded spill point. Fix the stop/run lever in this position and carry out the instructions given in subparagraphs (b) to (k). On all fixed speed engines running at 3000 rev/min. and below, the stop/run lever may be left in the "RUN" position, i. e., horizontal. On variable speed engines, move the speed control to the full speed position. Do not operate the Overload Stop Lever.
- (b) Drain the fuel tank. Remove the pump-to-injector pipe and unscrew the union body from the pump. Make sure that the union body sealing ring is withdrawn with the union body.
- (c) Lift out the delivery valve and spring and place them in clean fuel. Do not disturb the delivery valve seat or the joint washer. Replace the union body and sealing ring leaving out the delivery valve and spring.

- (d) Turn the flywheel until it is a quarter of a turn before TDC on the compression stroke.
- (e) Pour a quantity of fuel into the tank. A small stream of fuel should then flow from the pump.
- (f) Turn the flywheel slowly by hand in the normal running direction until the flow from the pump stops. Find by repeated trial the EXACT flywheel position at which this happens. This position is known as the spill point.
- (g) When the flywheel is in the exact position where the flow stops, the appropriate timing mark preceding the TDC hole in the flywheel should be in line with the hole in the bellhousing.
- (h) If the timing mark indicates a position before the bellhousing hole, add shims between the pump and crankcase until the correct timing is obtained. If the timing mark indicates a position after the bellhousing hole, remove shims to obtain the correct timing.
- (j) Reassemble the fuel injection equipment including the fuel delivery valve and spring. Make sure that the union body sealing ring is fitted and is not damaged.
- (k) Bleed the fuel system.

## 76. TO REMOVE AND TEST FUEL INJECTOR

- (a) Disconnect the fuel feed and leak-off pipes from the injector.
- (b) Remove the injector flange nuts and carefully lever out the injector. Examine the joint washer and renew if necessary.
- (c) Reconnect the injector to the pump-to-injector pipe in such a way that the nozzle points away from the engine.
- (d) Turn the engine over slowly. The fuel should squirt out suddenly in a fine mist spray which should stop as suddenly. If the nozzle fails to spray, or gives a solid squirt of fuel, or dribbles after the spray has stopped, fit a new nozzle.
- (e) When testing, BE CAREFUL to see that the spray is not directed at any exposed part of the body. The force behind the spray will cause it to penetrate the skin.

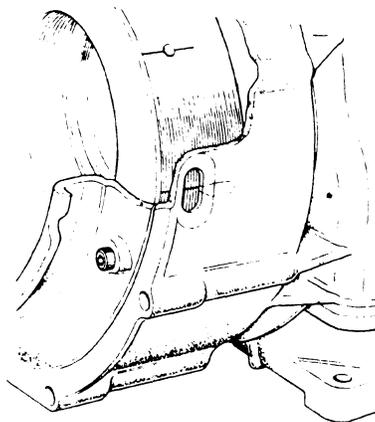


FIG. 17

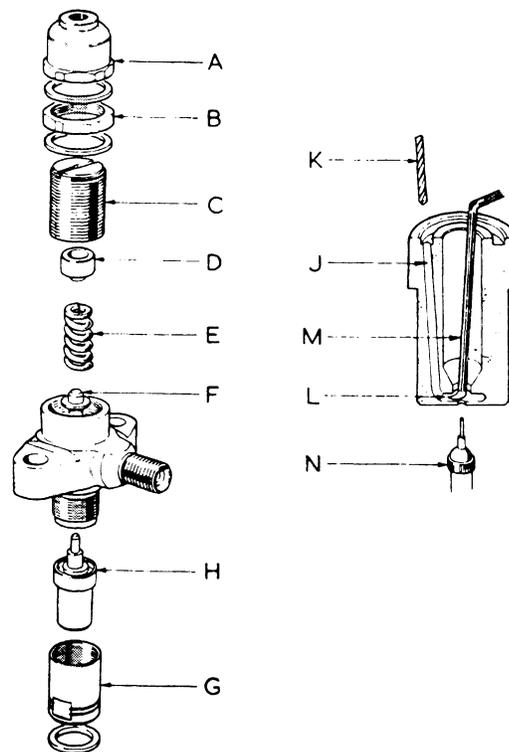


FIG. 18

**77. FUEL INJECTOR MAINTENANCE Fig. 18**

- (a) Thoroughly clean the exterior of the injector.
- (b) Remove the nozzle holder cap nut (A) and the locknut (B).
- (c) Remove the spring adjusting screw (C) and remove the spring pad (D), the spring (E) and the spring pressure rod (F).
- (d) Remove the nozzle nut (G) and the nozzle assembly (H). Each needle of a nozzle assembly is mated to one nozzle body and must never be used in another.
- (e) To ensure a thorough cleaning of all parts they should be left in a bath of clean fuel. After this treatment, any remaining carbon can be scraped off with a soft brass wire brush or a piece of clean wood or brass.
- (f) The nozzle holder and nozzle joint faces must be clean with mirror-like appearance. The nozzle and nozzle nut clamping shoulders must be clean.
- (g) The nozzle body fuel holes (J) should be cleaned by pushing a wire or twist drill (K) down to the fuel chamber (L) being careful not to scratch the joint face.
- (h) Insert a nozzle scraper (M) down into the fuel chamber, press sideways and rotate to remove carbon, etc.
- (j) Soft carbon can be removed from the spray hole with a spray hole cleaner (N).
- (k) Wash the nozzle body and needle in clean fuel and assemble wet.
- (l) To fit a nozzle assembly to the nozzle holder body, hold it hard against the pressure face and tighten the nozzle nut.
- (m) To complete the assembly of the injector, grease the spring assembly and replace it, together with the adjuster, locknut and cap nut.
- (n) Reset the fuel injector release pressure to the figure shown under Technical Data. A test pump for this purpose can be obtained from *Petters Ltd. or their agents*. To adjust the release pressure, loosen the locknut (B) and screw in the adjusting screw (C) to increase the pressure or out to decrease it. Tighten the locknut.
- (p) Injectors not required for immediate use should have pipe connections sealed against the admission of dirt, etc.

**78. TO REPLACE FUEL INJECTOR**

- (a) It is MOST IMPORTANT that the pump-to-injector pipe is correctly fitted or the pipe and injector may be damaged.  
Proceed as follows:
  - (i) Loosely fit the injector flange nuts.
  - (ii) Fit the pipe and tighten the union nuts finger tight, then give them a third of a turn with a spanner.
  - (iii) Tighten the injector flange nuts evenly. It is advisable to use a torque spanner for tightening the nuts. It should be set to the figure shown under Technical Data.
- (b) Reconnect the leak-off pipe.
- (c) Bleed the fuel system.

## 79. TO ADJUST SPEED CONTROL (Figs. 19 and 20)

The centrifugal forces on the governor balls are transmitted to the fuel pump rack. These forces, which vary with the speed of the engine, are balanced by an adjustable speeder spring (A). This adjustment allows a set range of speed. To adjust the speed outside this range a different fuel pump and springs may be required and these are obtainable from the manufacturer.

The speed is set and should not require further adjustment. However, if the setting is disturbed, adjustments are carried out as follows:

### (a) Fixed speed

- (1) Loosen the locknut (C) on the dipstick side of the engine and screw in the adjuster (B) to increase the speed or out to decrease it. Tighten the locknut.

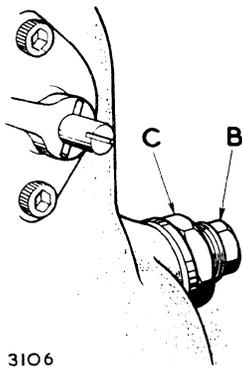


Fig. 19 Fixed

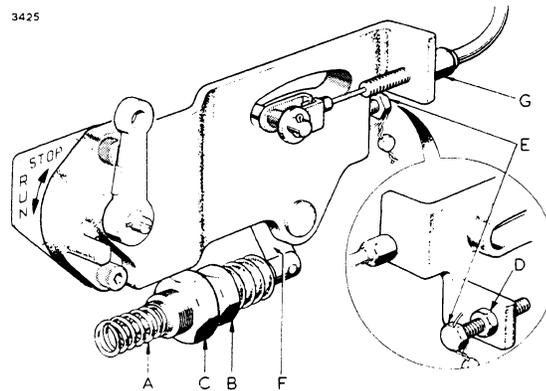


Fig. 20 Variable

### (b) Variable speed

- (1) Set the speed control in the idling position.
- (2) Loosen the locknut (C) and adjust the idling speed to approximately 1000 rev/min by screwing in the adjuster (B) to increase the speed or out to decrease it. Tighten the locknut.
- (3) Set the speed control in the full speed position.

## 80. AIR CLEANER MAINTENANCE (Refer to Par. 18A)

## 81. STARTER MOTOR (WPD-3 GENERATOR)

- (a) Mounting – Make sure the motor is securely mounted on the engine.
- (b) Lubrication – Bearings are lubricated on assembly and require no attention between overhaul periods.
- (c) Terminals – Main terminals and all circuit connections must be clean and tight. Terminal shrouds should be in position.
- (d) Brush gear – Remove the cover and inspect the brushes and commutator. Brushes should be free in their slides. Springs should seat squarely on the brushes. See that the insulation is in good condition. The brushes and commutator should be free from dust and grease and contact surfaces clean, smooth and uniform in colour.
- (e) Solenoid – The solenoid should move freely and contact faces be clean and unburnt. Do not attempt to clean the solenoid without disconnecting the battery.

## 25 ENGINE TROUBLE LOCATING CHART

Trouble	Reason	Causes	Suggested Remedy
Engine will not start	Temperature below 13°C (55°F)	Failure to prime (see Cold Starting)	Prime with lubricating oil
	Fuel supply failure Check by turning engine and listen for the characteristic squeak in the injector	No fuel in tank Air in pipe line Broken fuel pipe or leaking connection Fuel filter choked Faulty injector nozzle Fuel pump plunger sticking Fuel pump tappet sticking	Fill tank and bleed fuel system Bleed the system Repair or renew the pipe or tighten the connection Fit new fuel filter element Fit new nozzle Fit new pump Free and clean tappet
	Poor compression	Valves sticking Cylinder head loose Cylinder head gasket blown Piston rings stuck in groove Worn cylinder and piston  Valves not seating properly	Free the valves Tighten all nuts Fit new gasket Check rings and clean the piston Overhaul the engine Check valve springs Grind in if necessary Check the valve clearance
	Incorrect lubricating oil	Too high a viscosity oil causing excessive engine drag	Drain the sump and fill with correct oil
Engine starts but fires intermittently or soon stops	Faulty fuel supply	Air in fuel lines Water in the fuel Faulty injector nozzle Fuel filter choked	Bleed the system Drain fuel system and fill with clean fuel Fit new nozzle Fit new filter element
	Faulty compression	Broken valve spring Sticking valve Pitted valve	Fit new spring Free the valve Grind or renew
	Dirty engine	Blocked exhaust pipe or similar	Clean out
Engine lacks power and/or shows dirty exhaust	Faulty fuel supply	Faulty fuel pump Faulty injector nozzle Unsuitable fuel	Fit new pump Fit new nozzle Drain the fuel system and fill with correct fuel
	Out of adjustment	Valve clearances incorrect Fuel timing incorrect	Adjust Adjust
	Dirty engine	Blocked exhaust pipe or similar Dirty air cleaner Faulty piston ring Excessive carbon on piston and cylinder head Worn cylinder or piston	Clean out Clean out Fit new ring  Decarbonise Overhaul the engine
Faulty running	Knocking	Carbon on piston crown Injector needle sticking Fuel timing too far advanced Broken piston ring Slack piston Worn large end bearing Loose flywheel Worn main bearing	Decarbonise Fit new nozzle Adjust timing Fit new ring Fit new piston Renew and check lubrication Refit Renew and check lubrication
	Overheating	Cooling system failure: Suction pipe blocked Air leak in suction pipe Broken water pump rotor Faulty water pump seal Overloaded Excessive valve clearance Lubricating oil failure	Check for leaks or blockages Remove and clean Check and tighten fittings Replace rotor and check pump Replace seal and check pump Reduce the load Adjust Check the engine and lubricating oil system for damage. If in order, top up sump and check running
	Speed surges	Overheating Air in fuel pipes Governor sticking	See above Bleed the system Check the governor for correct operation
	Sudden stop	Empty fuel tank Choked injector Fuel pipe broken Seized piston	Fill tank and bleed system Fit new nozzle Repair or renew Fit new cylinder and piston
	Heavy vibration	Faulty installation	Check holding down bolts and flexible mountings and couplings if fitted



# OTHER OVERHAUL

CONTENTS	SECTION
MARINE ENGINE ELECTRICAL SYSTEM.....	Q
COOLING SYSTEM (EXTERNAL).....	R
TRANSMISSIONS.....	S



## SECTION Q

### Marine Engine Electrical System

#### ACTIVATION BY LUBE OIL PRESSURE (Keyswitch Start)

This system is supplied on all 4 and 6 cylinder Westerbeke diesels produced prior to January 1975. Operation is very simple. Putting the start switch in the Run position energizes an alarm system (when supplied). Returning the start switch to Off position de-energizes the alarm.

Turning the start switch to Crank position operates the starting motor and starts the engine. Upon starting, the start switch is released to the Run position.

When the engine develops oil pressure, voltage is supplied to the alternator for excitation and to all instruments. Whenever the engine stops, loss of oil pressure removes voltage from these devices.

When an engine is furnished with a preheating device, it is energized by a separate push button at the key switch panel.

When an engine is furnished with an electric stop solenoid, it is energized by a separate push button at the key switch panel.

NOTE: It is important that your engine installation includes fuses or circuit breakers, as described under "Owner's Responsibility" on the wiring diagram supplied with your engine.



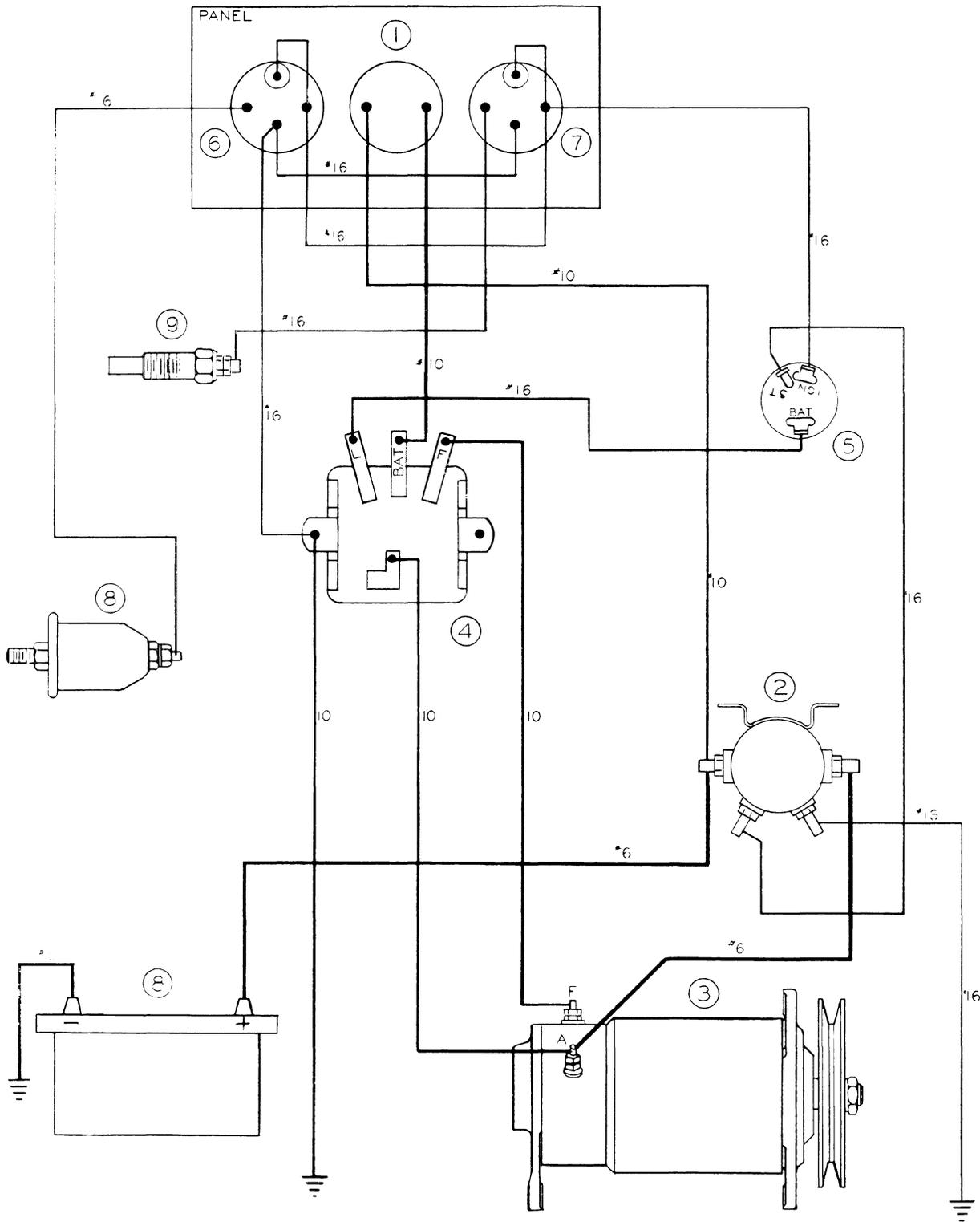


Fig. A2. DS WIRING DIAGRAM FOR ELECTRIC PANEL

- |                    |                             |
|--------------------|-----------------------------|
| 1. Ammeter         | 6. Oil Pressure Gauge       |
| 2. Start Solenoid  | 7. Water Temperature Gauge  |
| 3. Motor/Generator | 8. Oil Pressure Sender      |
| 4. Regulator       | 9. Water Temperature Sender |
| 5. Key Switch      | 10. Battery (Not Supplied)  |

## COOLING SYSTEM (EXTERNAL)

### 1. DESCRIPTION

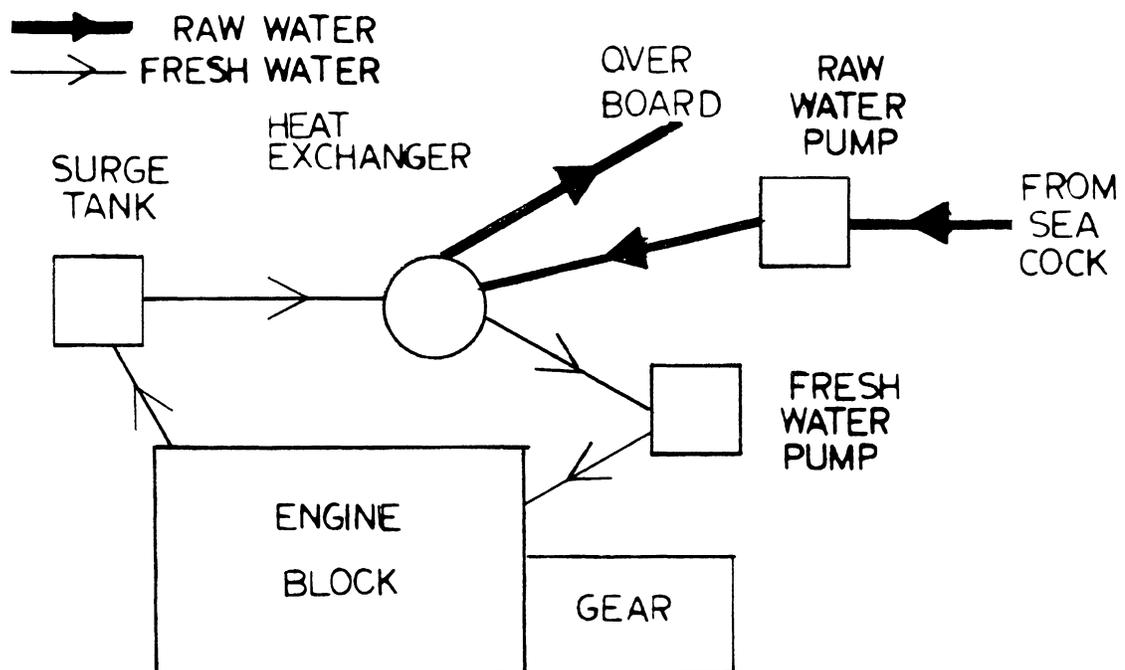
The Westerbeke 7 and WPD-4 units are equipped with a fresh water cooling system. Transfer of heat from the fresh water (closed system) circuit to the sea (raw) water is accomplished by a heat exchanger, similar to an automobile radiator. It differs because raw water, not air, cools the engine's fresh water. An unrestricted fast-flowing stream of sea water flows through the tubes of the heat exchanger while the fresh water flows rapidly under low pressure around the tubes of the heat exchanger. The raw water and fresh water never mix so the water cooling passages in the engine stay clean.

### 2. FRESH WATER SYSTEM

Heat rejected in combustion, as well as heat developed by friction is absorbed by the fresh water. The fresh water flows from the expansion tank to the heat exchanger; here it is cooled and circulated by means of a centrifugal fresh water pump into the engine block and cylinder head. Openings in the water jacket around the cylinder bores connect with corresponding openings in the cylinder head, where the fresh water circulates around the valves and fuel injectors. When the engine reaches its operating temperature, the fresh water then passes out through the thermostat into the expansion tank and the circuit repeats.

### 3. SEA WATER SYSTEM

The engine is directly cooled by the unrestricted fast-flowing stream of sea water which absorbs the heat from the fresh water via the heat exchanger. This raw water is picked up from the sea by a powerful neoprene impeller sea water pump, and passes through the heat exchanger. It then, if the unit is so equipped, flows into the water injected exhaust elbow and overboard thru the exhaust pipe. If no elbow is used it should be piped directly overboard.



#### 4. SEA WATER PUMP

The water pump on the W-7 is located on the rear of the transmission and is aft of the high speed shaft. The water pump is a self-priming, positive displacement rotary pump, with a brass case and a neoprene impeller. The impeller has flexible vanes which wipe against a curved cam plate in the impeller housing, producing the pumping action.

NOTE: As the water pump contains a neoprene impeller, on no account should it be run in a dry condition. Always carry a spare impeller and gasket. The water pump on the WPD-4 is located on the front of the engine and is driven off the half speed shaft (camshaft).

#### 5. DRAIN FRESH WATER SYSTEM

- a. Remove the pressure cap from expansion tank.
- b. Remove the hose from the bottom of the water pump. This hose comes from the block and will drain the block. Water will also drain out of the pump from the heat exchanger and the expansion tank.
- c. The marine engine also has a petcock on the side of the block which may be opened. (Petcocks turn counter-clockwise to open).
- d. There is also a plug in the bottom of the heat exchanger which may be removed in draining system.

#### 6. FILLING FRESHWATER SYSTEM

- a. Replace the plug in the heat exchanger, if removed.
- b. Close the petcock, if opened. (Turn clockwise to close).
- c. Replace the hose on the pump.
- d. Pour coolant (50-50 mix of water and permanent anti-freeze) into the expansion tank and completely fill system to within one inch from top of tank.
- e. Start engine and run until normal operating temperature is reached. Stop engine, carefully remove expansion tank filler cap and add coolant as required.

#### 7. IMPELLER REPLACEMENT

- a. Remove pump cover plate and gasket.
- b. Remove impeller.
- c. Coat the neoprene impeller and impeller chamber with a good grade of water pump grease only.
- d. Align impeller keyway with shaft key. Care should be taken that the impeller blades all lie in the same direction relative to the rotation of the pump, i.e., blades trailing.
- e. Secure end cover and gasket with screws and lockwashers.

#### 8. THERMOSTAT REMOVAL AND REPLACEMENT

- a. Drain cooling system as described in Section 5 above. The complete system need not be drained as long as the level of the coolant is below that of the thermostat housing.
- b. Remove the 2 bolts holding the thermostat housing to the expansion tank.
- c. Loosen the clamp and hose at the elbow entering the cylinder head.
- e. Test the thermostat's opening temperature by placing in water. Raise the temperature of the water to that stamped on the thermostat.
- f. If thermostat fails to open, replace with new thermostat.
- g. Allow the temperature to cool. If the unit sticks open, replace the thermostat.
- h. Install thermostat with a new gasket, and secure the housing to the expansion tank with the bolts and the hose and clamps to the cylinder head.
- i. Replace coolant as described in Section 6 above.

9. REMOVAL OF SEA WATER PUMP
  - a. Shut off sea water thru-hull valve.
  - b. Remove the two hoses from the pump.
  - c. Remove the three mounting screws and the pump cover plate.
  - d. The pump body and impeller can now be taken off together.
  - e. Inspect the impeller and if any vanes are found to be broken, check thru the sea water lines. Broken vanes could block the flow of water thru the lines.
  
10. REMOVAL OF SEA WATER PUMP SHAFT AND SEALS (W-7)
  - a. With a crescent wrench across the flat on the pump shaft unscrew the shaft. LEFT HAND THREAD.
  - b. With a suitable hooked tool, pull out both seals from the transmission.
  - c. When replacing the seals, the first (transmission oil) seal should be placed with the spring side toward the transmission.
  - d. The second (sea water) seal should have the spring side toward the water pump.
  
11. REMOVAL OF FRESH WATER PUMP
  - a. Drain the cooling system and disconnect both hoses from the pump.
  - b. Remove the four screws from the pump cover.
  - c. Lift the De-compression lever and using the nut on the pump shaft, turn the engine over until the  $\frac{1}{4}$  inch hole in the flywheel is visible thru the opening in the flywheel housing just above the starter.
  - d. Drop a suitable pin in the hole to lock the engine and unscrew the pump shaft nut.
  - e. Remove the impeller
  - f. Unscrew the two pump body mounting screws and remove the pump body.
  
12. REPLACING FRESH WATER PUMP SEALS
  - a. After removing the pump body (Section 11), press the seal out from the housing.
  - b. Lightly spread a sealer, such as Permatex #2, on the outside of the new seal and carefully press into the pump housing, taking care not to damage the sealing surface.
  - c. With a small screwdriver, lever the ceramic ring from the pump impeller and remove the neoprene washer.
  - d. Place a new ceramic ring in a new washer and lightly oil outside of the washer
  - e. Press this assembly into the impeller BY HAND, using no tools.
  
13. REMOVING BOTH PUMP SHAFTS (WPD-4) & FRESH WATER PUMP SHAFT (W-7)
  - a. Remove the water pumps.
  - b. Remove the mounting plate with heat exchanger and expansion tank attached.
  - c. Remove the timing case cover.
  - d. Remove the four screws holding the pump shaft and the shafts.
  - e. Timing cover gaskets and seals can be changed at this time.
  - f. Care must be taken when replacing the timing cover that the seals are not damaged going over the shafts.

## 1. TO DRAIN COOLING SYSTEM

- (a) Shut off the sea cock and remove the plugs from the cylinder. This will allow the cooling water to drain out of the cylinder and cylinder head.
- (b) Remove the pump outlet pipe and drain the cooling water from the hose. This will also drain the coolant from the heat exchanger when fitted.
- (c) When replacing the cylinder plugs, it is advisable to wrap 1½ turns of 'P.T.F.E.' tape around the threads. This will prevent the plugs sticking and corroding.
- (d) IMPORTANT. When reassembled and before starting the engine, ensure that the sea cock is opened.
- (e) As the water pump is self-priming, there is no need to prime the cooling system.

## 2. TO FLUSH OUT CYLINDER AND CYLINDER HEAD

This operation is not necessary when a heat exchanger is fitted.

- (a) Drain the cooling water from the cylinder and cylinder head.
- (b) Disconnect the cooling water outlet hose, and remove the plug and pipe fittings from the cylinder head.
- (c) By inserting a piece of wire through the various orifices in the cylinder head, rake out any silt that has collected in the cooling system. This should be carried out while flushing with clean fresh water, preferably under pressure.
- (d) It may be found necessary to flush the cooling system frequently when operating the engine in water with high silt content.
- (e) When replacing the plugs and pipe fittings, it is advisable to wrap 1½ turns of 'P.T.F.E.' tape around the threads. This will prevent the threads sticking and corroding.

## 3. TO REMOVE WATER PUMP Fig. 8 (WPD-3 Generator)

- (a) Close the sea cock and remove the hoses from the pump.
- (b) Remove the pump cover (A) and gasket (B) and remove the impeller (C).
- (c) Inspect the water sealing washer (D), water slinger (E), seal in the pump body (F) and the impeller for damage, and replace if necessary.
- (d) It is not necessary to remove the cam plate from the inside of the pump body.

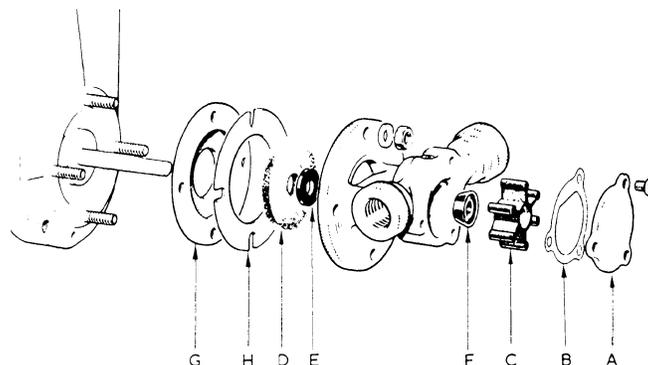


FIG. 8

4. TO REPLACE WATER PUMP Fig 8. WPD-3 Generator
  - a. Replace the water pump adaptor (G) and shim (H), if removed. Replace the water sealing washer and water slinger, leaving a gap between them.
  - b. Carefully slide the water pump body onto the shaft, with the cam plate screw uppermost and tighten up. Ensure that the water slinger is just clear of the pump body.
  - c. Ensure that the pump shaft does not touch the pump cover when the water pump is replaced. If it does, extra shims must be added between the adaptor plate and the pump body.
  - d. Replace the impeller on the shaft and refit gasket and cover plate. The gasket must be positioned so that the cam plate is covered.
  - e. Replace the inlet and outlet hoses.
  
5. TO REMOVE AND REPLACE WATER PUMP (DS MARINE ENGINE)
  - a. Close inlet and outlet cooling system sea-cocks
  - b. Remove hoses from pump.
  - c. Remove cover and gasket from water pump.
  - d. Carefully pull water pump housing with drive pin installed.
  - e. Pull impeller out of housing with drive pin installed.
  - f. Remove drive pin from impeller and insert pin in new impeller. Coat with a thin coat of water pump grease.
  - g. Press impeller in housing, and housing on shaft with pin in slot of shaft and housing hose connections facing upward.
  - h. Align mounting holes and secure gasket and cover.
  - i. Connect hose from inlet petcock to starboard connection on pump and hose from side of cylinder to connection on port side of pump.
  - j. Open inlet and outlet seacocks.
  - k. Start engine and check for leaks.



**TRANSMISSIONS**



## SSR TRANSMISSION

### GENERAL

The SSR Transmission is designed and built for marine use. The three position hand lever operates the gear to give ahead, neutral or astern action. With a shift lever mounted in the normal slant position, the transmission is in FORWARD gear when the shift lever is moved aft or in REVERSE when shift lever is moved forward.

The reduction gear is 2:1 and the propeller rotates counter-clockwise which is the opposite direction to that of the engine. The sea water pump is mounted aft of the high speed shaft of the reverse and reduction gear. No adjustments are required. The only maintenance is to check the lubricating oil level and change the lubricating oil at time periods specified.

### TO REMOVE TRANSMISSION

- (a) The transmission may be removed without removing the transmission oil or the oil may be removed by inserting a 3/8 in. OD suction hose in the dipstick filler opening.
- (b) Remove the bolts securing the drive shaft half coupling to the propeller half coupling. Slide propeller shaft coupling back away from drive shaft coupling approximately 5 in.
- (c) Remove the four bolts securing the transmission housing to flywheel housing adapter. Slide transmission out from engine and remove.

### PREPARATION FOR DISASSEMBLY

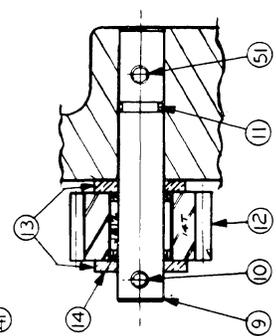
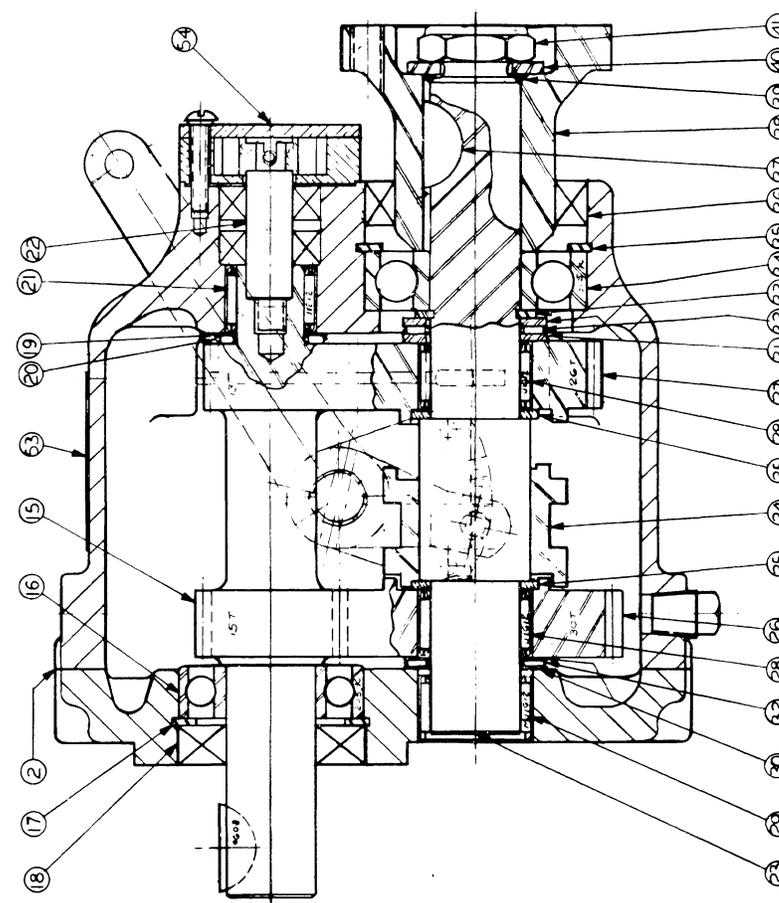
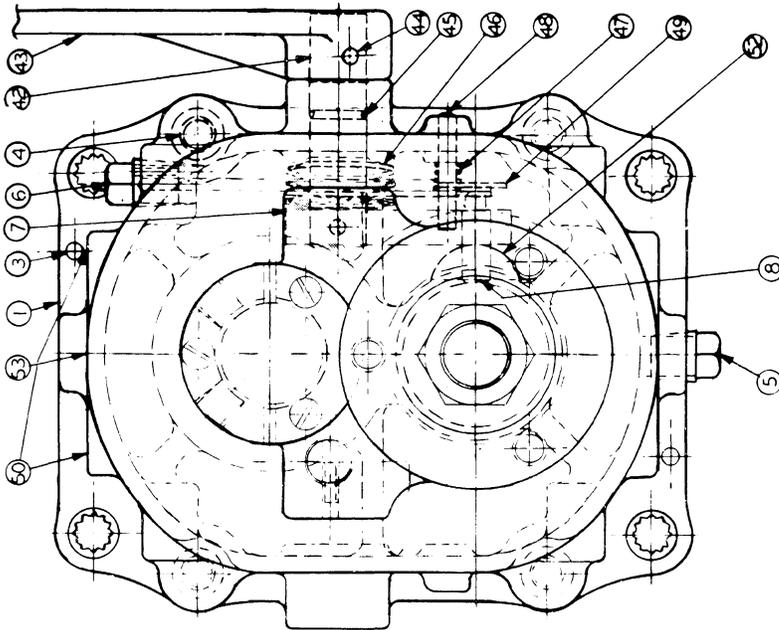
As in any servicing operation, cleanliness is a must and all rules for good workmanship apply. Some of these rules are as follows:

1. Use only clean fluid in any cleaning or washing of parts.
2. Use only clean oil for lubrication when pressing parts together.
3. Never use a hammer to drive ball bearings in place.
4. Never press a ball bearing so that the force is carried through the balls.
5. Use only properly sized wrenches in removing or securing nuts and cap-screws.
6. Replace gaskets and "O" rings with new material.
7. Work on a clean bench and protect gear teeth and oil seal surfaces from nicks and scratches.

### DISASSEMBLY PROCEDURE

1. Remove 3 screws and pump assembly 54.
2. Remove woodruff key from input shaft.
3. Remove 4 screws from front face.
4. Remove front plate 1 containing bearing 16, snap ring 17, seal 18, bearing 23. Protect seal by tape over key slot in shaft.
5. Lift out input shaft 15 which has pump shaft 22 screwed into rear end. Bearing 20 and race 19 are now removable.
6. Remove race 30, bearing 32, gear 26 containing bearing 28, and washer 25.
7. Drive forward pin 48 into box, using flat end punch.
8. Rotate arm 43 to rear, allowing dog 24 to move forward and off shaft. Remove shoe 52.
9. Remove nut 41, washer 40, O-ring 39, coupling 38, and key 37.
10. Support housing on front face. Press shaft 23 forward out of bearing 34.

11. Remove snap ring 33 from shaft. Remove washers 31, bearing 32, gear 27 containing bearing 28, and washer 25.
12. Knock out pin 44. Remove handle 43, slide shaft 42 into housing. Remove detent plate 49, springs 47, and spring washers 46.
13. Drive pin 51 into shaft 9 with flat end punch.
14. Remove shaft 9 with associated gear 12, washers 13, bearing 14, pin 10, and O-ring 11.
15. Remove bearings, seals, snap rings from respective housing and gears as necessary. Press seals and bearings with suitable tools. Do not use hammer.
16. Reassemble in reverse order, replacing seals, gaskets, and O-rings. Be sure to protect input shaft seal by covering input shaft keyway with tape or something similar.



DRAWING 16657

SSR-TRANSMISSION



**GENERATOR SETS**





## WPD-4 DC CONTROL CIRCUIT

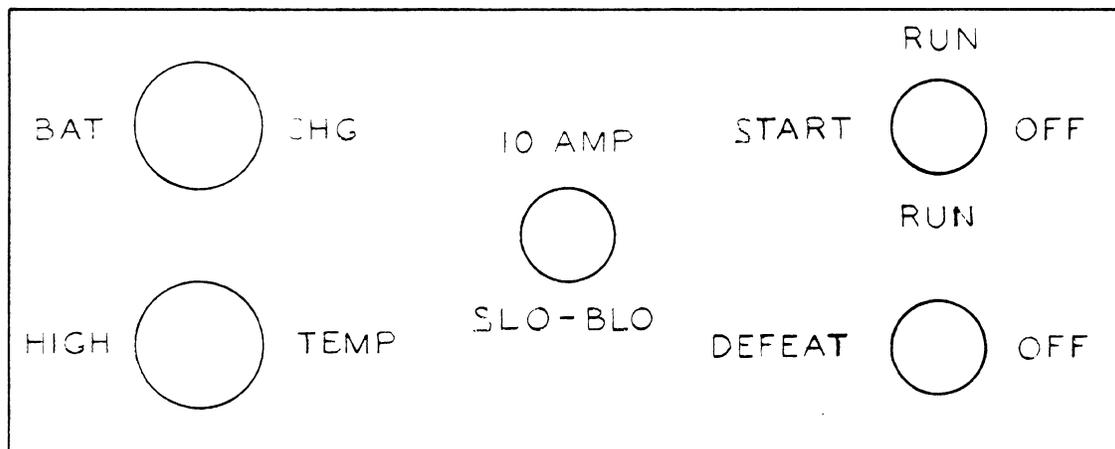
GENERAL: The Genset DC Control Circuit is operated from a 12 VDC battery and manual of nature. The primary control switch selects the start, run and remote modes of operation.

Engine Protection Circuits consist of a hi-water temperature switch (N.C.) and a low oil pressure switch (N.O.) in series. A manual by pass switch for the oil pressure switch is provided for circuit continuity during the start cycle. This is labeled DEFEAT/OFF.

The entire control circuit is protected by a 10 ampere "slo-blo" fuse. Only this type of fuse should be used as when the fuel solenoid is first energized 18 amps will be drawn. Once the fuel solenoid is fully engaged, the current draw is only 1.2 amps.

The hi-water temperature lamp serves as a warning indicator only. This lamp is energized by a N.O. switch which will close at a temperature of 205°F (96°C). It will reset at 160°F.

The automatic safety shutdown water temperature switch is set to open the fuel solenoid circuit at a temperature of 215°F (102°C). The oil pressure switch will open at 12PSI  $\pm$  5PSI. The two safety switches are connected in series with the fuel solenoid.



A regulated 1.5 to 6 amp trickle charge is provided directly to the battery cable connection. The supply for the charger regulator circuit is an AC charge winding in the AC generator. An indicator lamp (green) is connected to this winding at the regulator and indicates that there is AC voltage supplied to the regulator.

An optional remote panel is provided and is connected to a terminal block provided in the panel. This panel operates in parallel with the local panel switch controls.

## TROUBLE SHOOTING

### A. Generator Set Won't Crank

#### 1. Supply Checks

- (a) Check battery terminal voltage. It should be 12.0 to 12.6 volts DC normally, with a minimum of 11.5 volts at open circuit.
- (b) Check for good terminal connections at both the battery and generator set.
- (c) Check for correct battery voltage at the generator set connections. If inadequate wire size is used between the battery and generator set, the resultant voltage drop in the cable will cause below minimum voltage during the crank cycle.

#### 2. Control Checks

- (a) Check to see that throwing the control switch (S-1) into the start position places 12 volts on the start solenoid coil (K-1). If not, check 10 amp fuse (F-1). If fuse is good, replace control switch.
- (b) Check continuity to and through the start solenoid (K-1). If start lead is open or shorted to ground, replace. If solenoid coil is open, replace the solenoid and starter unit.

### B. Generator Set Cranks But Will Not Run

1. Check engine fuel system for fuel. Also check system to determine if air might be leaking into the system.
2. Check the fuel solenoid circuit which consists of the control switch, oil pressure defeat switch, high water temperature safety switch, and fuel solenoid. Set the control switch to run and the oil pressure defeat switch to defeat. The solenoid should engage. If not, check for 12 VDC at the component terminals to determine which is at fault. Replace defective component.
3. If fuel solenoid is receiving voltage and checks good with continuity test, but is still not pulling in, manually move plunger to determine if plunger or linkage is bound in any way. If so, free the binding part.
4. If the start solenoid engages using the procedures in step 2, check for a short in or around the blocking diode (D-1) located on the rear of the control switch. Replace diode if found bad.
5. If the 10 amp fuse blows upon energization of the fuel solenoid, check plunger on solenoid to be sure that it is able to bottom within the solenoid. If not able to bottom, readjust position of solenoid housing until satisfactory.

### C. Engine Cranks, Runs, Then Stops

Check oil pressure switch and water temperature safety switches. The oil pressure and water temperature switches should remain closed with normal engine temperature. If these switches are defective, replace them. A direct reading oil pressure gauge is mounted on the engine and the normal reading should be approximately 60PSI while the engine is running.

### D. Cranking Battery Goes Dead

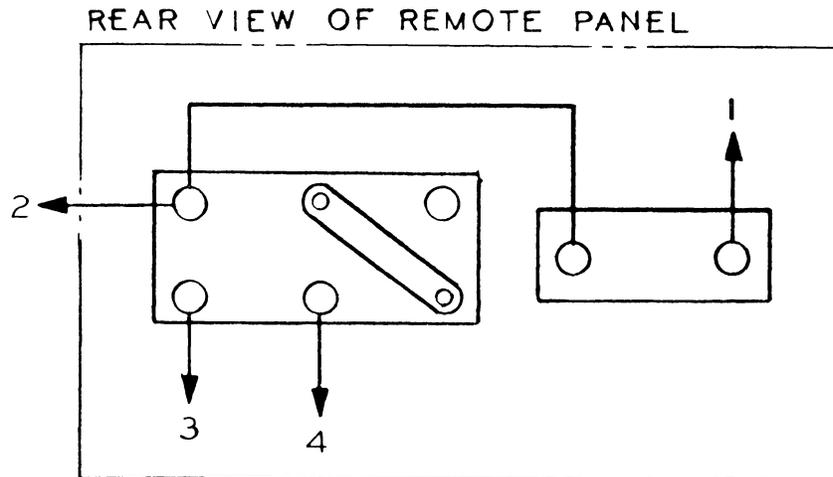
1. Insert an ammeter between the battery and cable and the starter terminal from which the cable was removed. CAUTION-DO NOT PUT CRANKING CURRENT THROUGH AMMETER AS THIS MAY DAMAGE THE METER. The ammeter should give an indication of 1-5 amps. If not, the charging regulator is probably defective and should be replaced.
2. Check the fuse in the charge regulator. If blown, replace.
3. Check charge indicator lamp. If not lighted, check continuity through lamp. Replace if defective. If the lamp is good, check AC voltage at pin 3 of nylon plug under AC generator. A reading of up to 26 VAC is normal. If the AC voltage is not present, the charge winding of the AC generator is open and must be repaired or replaced.



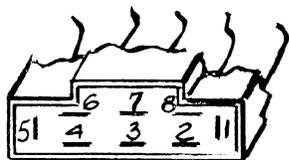
## WPD4 WIRING DIAGRAM

ITEM	SYMBOL	QTY	DESCRIPTION
1	K-1	1	Solenoid, Fuel
2	S-5	1	Switch, High water temperature N.O.
3	S-3	1	Switch, Water temperature N.C.
4	S-4	1	Switch, Oil pressure N.O.
5	SM-1	1	Motor, Starter
6	TB-1	1	Terminal block, 4 term.
12	L-2	1	Lamp, Red, Overtemperature
13	L-1	1	Lamp, Green, Charging
15	S-2	1	Switch, Oil pressure defeat
16	S-1	1	Switch, Control
17	D-1	1	Diode
18		1	Regulator, Battery charging
18A	F-2	1	Fuse, Charger, 10 amp slo-blo
20	F-1	1	Fuse, 10 amp, slo-blo

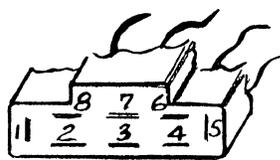
\*NOTE: Recommended wire size for remote panel wiring  
 0-15 ft                    12 AWG stranded wire  
 15-25 ft                 10 AWG stranded wire



WIRES TO GEN.  
WINDINGS.

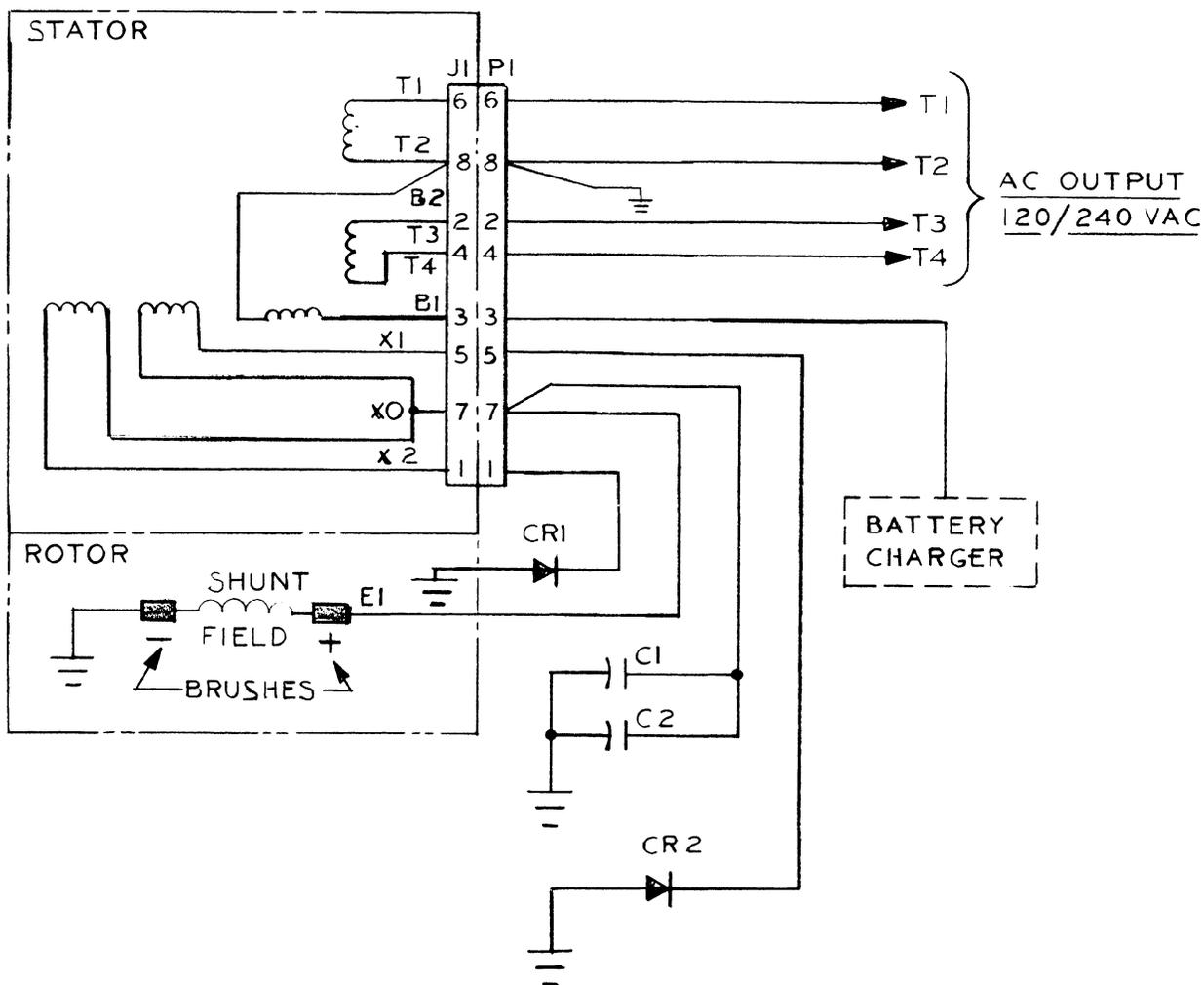


J1



P1

OUTPUT WIRES  
TO TERMINAL BLOCK



TOLERANCES (EXCEPT AS NOTED)	J. H. WESTERBEKE CORP. AVON, MA. 02322		
DECIMAL		SCALE NONE	DRAWN BY <i>Er. Strabulis</i>
FRACTIONAL	TITLE WIRING DIAGRAM, YCB GENERATOR CONTROL.		
ANGULAR	DATE 1-25-78	DRAWING NUMBER 23418	

GENERATOR SETS  
GENERATOR OVERHAUL FOR WPD-4 AND WPD-3 SETS WITH YCB ALTERNATOR

### ALTERNATOR BRUSHES

To inspect the brushes:

1. Remove cover plate on end bell.
2. Unfasten brush mounting screws. Be sure to note which screw matches the brush assembly as the positive and negative use different screw sizes.
3. Slide brushes out of their holders.
4. Replace if worn to 5/16 inch or less.

Use only the replacement brushes specified in the parts catalog as other brushes may have entirely different electrical characteristics. Be sure brushes slide freely in their holders, without any binding. If collector rings are rough, smooth the ring surfaces with #240 sandpaper. Do not use emery cloth.

### LOSS OF RESIDUAL (Flashing the field)

If there is a loss of residual (voltage will not build up) it may be necessary to flash the field.

1. Remove the bell cover plate.
2. Connect a 6 volt lantern battery with two leads.
3. Connect a voltmeter across the output load terminals.
4. Start unit with no load connected to alternator.
5. Momentarily touch positive brush with positive lead of lantern while grounding the negative lead to generator frame. The positive brush is on the left side when facing the end bell. Remove the leads as soon as voltage starts to build up.

If it is necessary to flash the field frequently, the problem is most likely a defective capacitor.

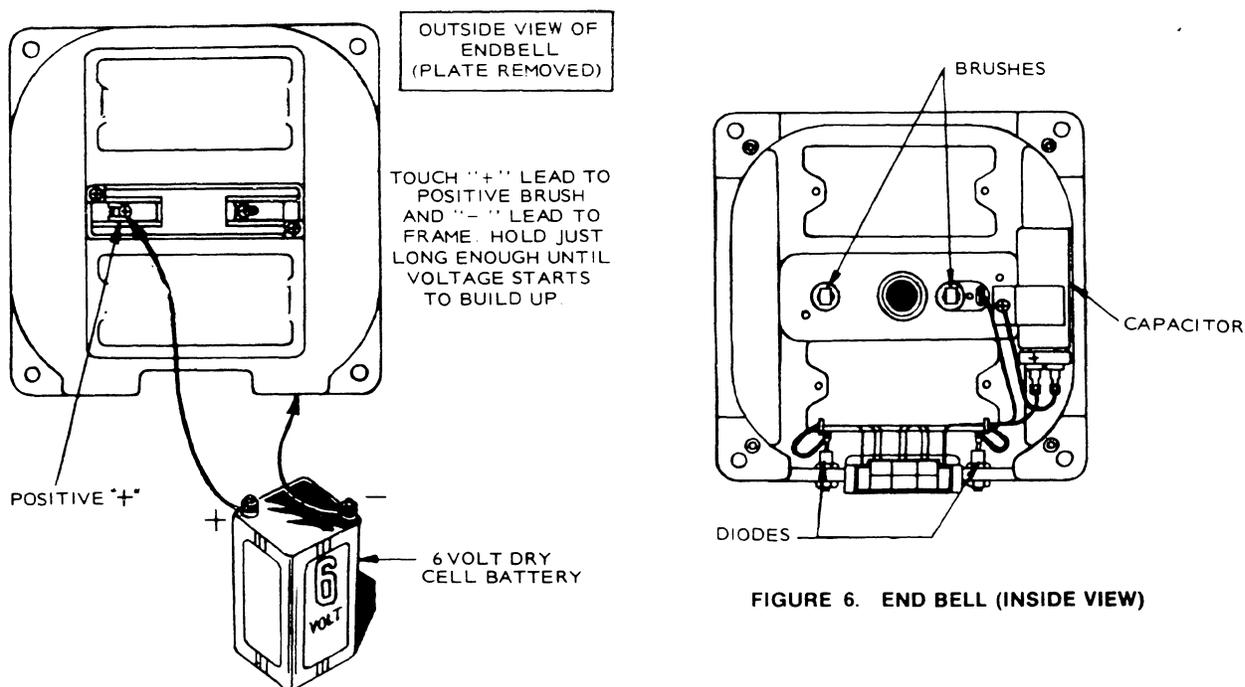
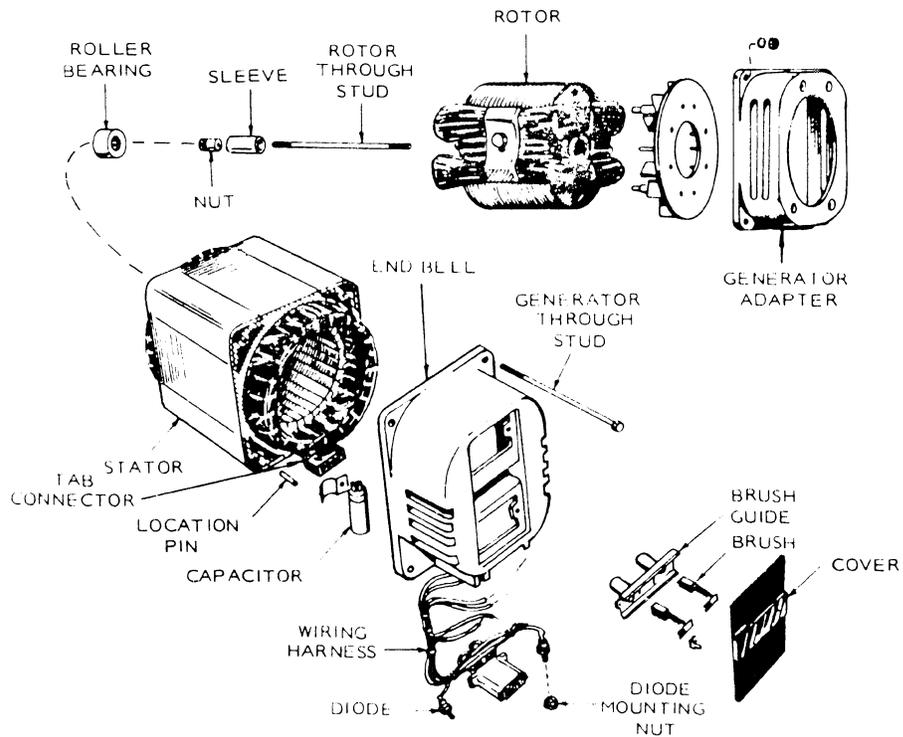


FIGURE 6. END BELL (INSIDE VIEW)

FIGURE 8. FLASHING THE FIELD



### CAPACITOR

Two capacitors are located in the end bell. A defective capacitor will not allow voltage to build up until the field is flashed. If the generator set is running at a constant speed (no fluctuation) but voltage rises and falls, a capacitor may also be defective, and should be replaced.

### TESTING ROTOR WINDINGS

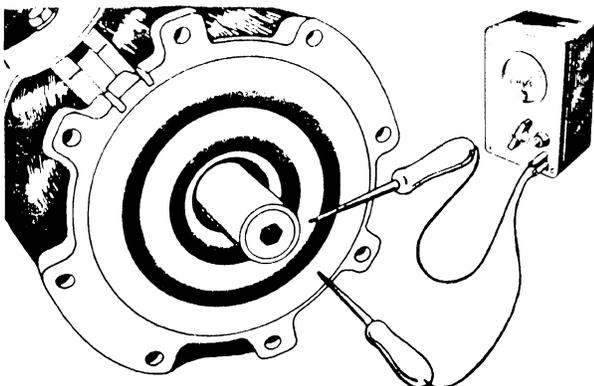
#### A. Winding resistances

Using an accurate ohmmeter touch meter leads to each collector ring. Resistances for a WPD-4 should be between 26.2 and 32.0 ohms. For a WPD-3 they should be between 21.0 and 25.6 ohms. Readings should be taken at 68°F (20°C).

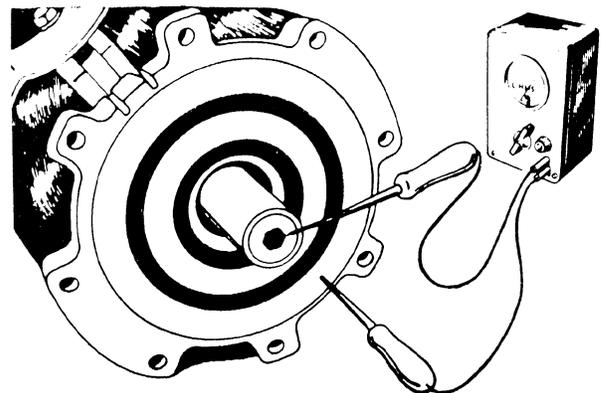
#### B. Testing for grounds

Connect an ohmmeter from each collector ring to rotor shaft (ground). If rotor is servicable, there should be NO reading on the meter.

If either of the above tests do not comply, replace the rotor.



TESTING FOR RESISTANCES



TESTING FOR GROUNDS

## DISMANTLING GENERATOR SET

In the event of a fault necessitating dismantling the generator, it is recommended that it be returned to the manufacturer or to an authorized service agent. If dismantling becomes unavoidable proceed as follows:

1. Disconnect battery cables.
2. Open control box lid, select cables entering control box from generator, and disconnect cables at the box, carefully marking each cable and terminal to ensure correct reconnection.
3. Remove the cover from the end bell.
4. Disconnect the leads between the control box and the battery charging regulator at the regulator terminal.
5. Loosen and remove the 2 nuts from the rods extending from the rear mounts which support the control box. At this point you will be able to set the control box aside without disconnecting any other wiring.
6. Place a block of wood under the flywheel housing to support the engine when generator is removed.
7. Unfasten and remove 4 long capscrews, lockwashers and nuts that fasten end bell, stator and generator adapter together. Pull end bell straight out from stator while unfastening connector plug between stator and end bell.

NOTE: All parts inside of end bell including diodes, capacitors, bearing, wires and connections can be tested at this time. Rotor, stator and collector rings can also be checked or tested at this time without further disassembly.

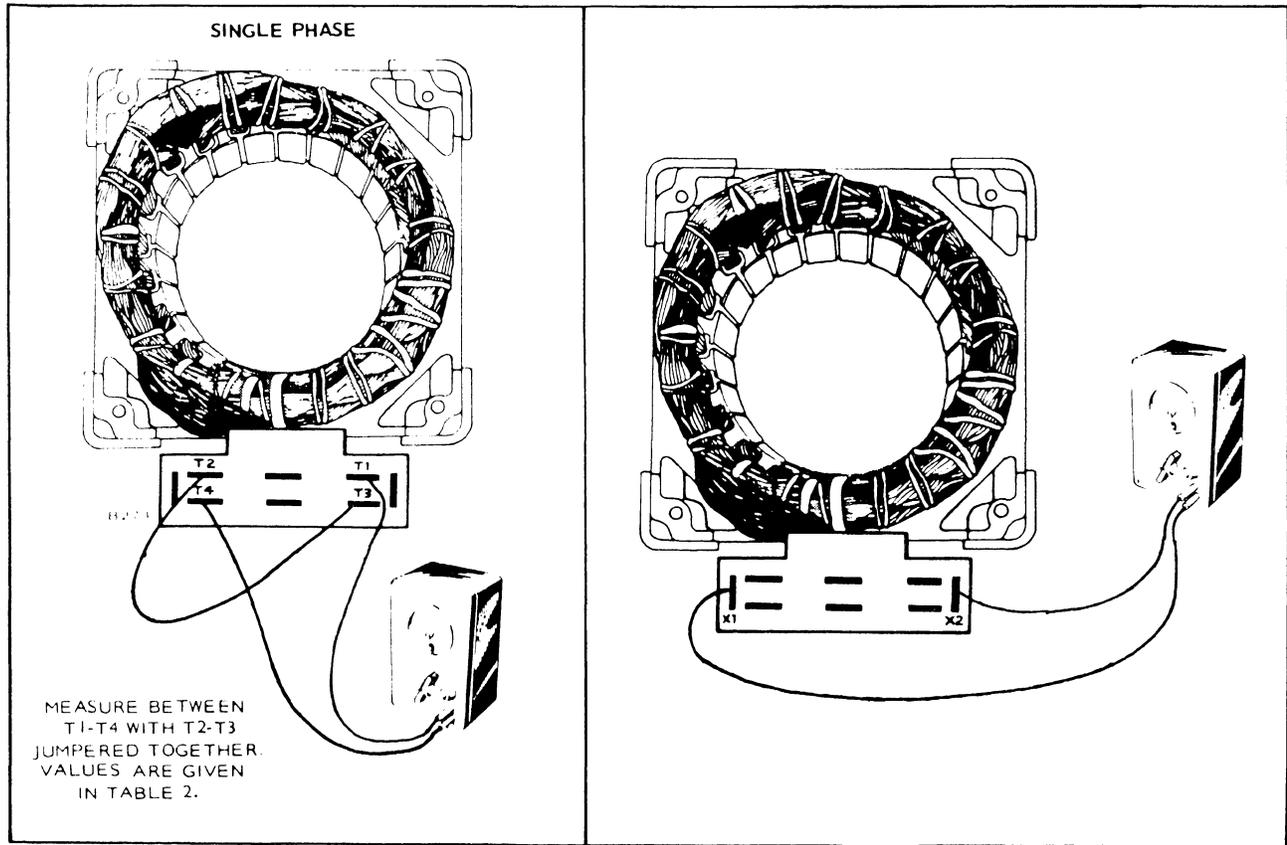
8. Pull stator straight out from alternator, being careful not to lay its weight directly on the rotor.
9. Loosen internal allen screw 3 turns, while supporting the weight of the rotor in the palm of the hand, strike the allen screw squarely and smartly with a hammer. When loose, remove the allen screw and remove the rotor.

NOTE: Do not strike the rotor or stator with hammer as serious damage may occur.

10. Removing and replacing the engine-generator coupling.
  - a. Remove the two screws holding the tapered shaft.
  - b. Pull off the shaft.
  - c. Remove remaining 2 screws to take off the rubber coupling.
  - d. To remove the coupling adapter, insert two 3/8-24 screws in the two threaded holes in the adapter, and screw them in evenly to jack out the adapter.
  - e. Replacement of the coupling is the opposite procedure. Care must be taken not to over torque the mounting screws. Distortion of the coupling could result.
11. Alternator assembly is reverse of disassembly, following the torque settings below.
  - a. Diodes (end bell).....12-15 IN LB
  - b. End Bell to Stator Thru Bolts (4).....5-8 FT LB
  - c. Rotor Thru Stud Nut (Allen Screw).....10-15 FT LB

TESTING STATOR WINDINGS

Check stator windings by connecting an accurate ohmmeter between terminals on stator plug as shown in the illustration. A Wheatstone or Kelvin bridge is required as resistances should be less than 1 ohm. the resistance on WPD-4 should be between 0.37 and 0.47 ohms. The resistance on a WPD-3 should be between 0.75 and 0.96 ohms. These values are for 60 Hertz units only.



TESTING STATOR WINDINGS

TESTING EXCITER WINDINGS

EXCITOR WINDINGS

Check excitor windings by connecting an ohmmeter across X1 and X2 on stator plug. The resistance on WPD-4 should be between 1.29 and 2.20 ohms. On a WPD-3 the reading should be between 1.54 and 2.31 ohms. These values are for 60 Hertz units.

TROUBLESHOOTING

NATURE OF TROUBLE	CAUSE	REMEDY
Low AC output	Brushes not making good contact with slip rings.	Check brush tension and slip rings for out-of-round condition.
	Overloaded.	Remove part of load.

## TROUBLESHOOTING (Continued)

NATURE OF TROUBLE	CAUSE	REMEDY
Alternator Overheats	Windings and parts covered with dirt and oil.	Disassemble alternator and clean.
	Air intake is restricted or incoming air too hot.	Take necessary steps to allow for proper cooling.
	Overloaded.	Check load.
Noisy Alternator	Alternator loose on base.	Tighten mounting bolts.
	Defective bearing.	Replace. Check Alignment.
No Voltage Output	Brushes worn or not seating properly.	Replace brushes when worn to 5/16"
	Alternator leads broken or loose.	Replace broken leads or tighten connection.
	Open circuit, grounded circuit or short circuit.	Test with Series test lamp and repair or replace defective parts.
	Defective diodes(s).	Test and replace.
	Capacitor defective.	Replace.
Incomplete circuit between exciter and slip rings.	Slip ring brush shunt broken.	Check all slip ring brush shunts with an ohmmeter and replace broken brush shunts.
	Slip ring brushes not contacting the slip rings.	Replace slip ring brush spring which may have come off or broken; or replace brushes which may have become worn too much to contact the slip rings.
	Insulating film on slip rings.	Clean slip rings with stone or fine sandpaper and blow out dust. DO NOT USE EMERY CLOTH.
Revolving field windings shorted	Insulation of field coils broken.	Rewind or replace with new rotor.
Revolving field windings open	Original short circuit may have burned a coil or connection.	Test with an ohmmeter and if open replace with a new rotor.
AC stator winding shorted	Insulation or coils broken.	Rewind or replace stator assembly

## 20. WPD-3 GENERATOR

GENERAL: The generator normally requires little maintenance other than the regular Maintenance Schedule operations, which should never be neglected. The only generator tests are simple to perform and do not require major disassembly, only resistance tests. Partial disassembly, and removal of the generator is necessary in order to make certain engine repairs.

The generator is mounted to the engine crankcase through the engine-to-generator adapter plate. The rotor is directly connected by a stub shaft to the engine flywheel. A ball bearing is housed in the generator frame, and supports the out-board (slip ring) end of the rotor. Because of its construction, the generator can't be removed from the engine as a complete unit. It must be disassembled.

The following "Electrical Trouble-Shooting" should be studied and the remedy carried out prior to any disassembly to determine what the trouble may be.

## 21. ELECTRICAL TROUBLE SHOOTING OF THE WPD-3 GENERATOR

## A. Generator Set Won't Crank

1. Check battery terminal voltage. It should be 12.0 to 12.6 volts normally, with a minimum of 11.5 volts at open circuit. If the voltage drops below 9 volts when the start switch is engaged, the battery is probably run down and should be recharged or replaced.
2. Check battery terminal connections both at the battery and generator.
3. Put B+ directly on plus terminal of cranking motor. If engine cranks, trouble is then either in starting solenoid contacts or the starting solenoid coil or the start switch.
  - (a) Check to see that throwing start switch into the start position places 12 volts on the start solenoid coil. If not replace control switch.
  - (b) Check continuity of starting solenoid coil.
  - (c) Listen to hear if starting solenoid contacts close when voltage is applied to coil. If coil checks open or if contacts do not close upon application of voltage replace entire starter or start solenoid.
  - (d) Check fuse, a blown fuse may indicate faulty fuel solenoid adjustment

## B. Generator Set Cranks But Will Not Run

1. Be sure engine is getting fuel and system has been bled of air.
2. Check to see if fuel solenoid is getting voltage. If not, check oil pressure override switch (if provided) and check continuity in control switch S-1.
3. Check to see if fuel solenoid is pulling in when energized. If solenoid pulls in and blows fuse or vibrates. Loosen clamp and adjust position until vibration just stops. If solenoid doesn't pull in check for continuity of coil. If open, replace fuel solenoid.
4. If fuel solenoid is getting voltage and shows continuity, but is not pulling in, move plunger by hand to determine if solenoid is mechanically bound in any way. If so check solenoid mounting bracket. A stroke of more than 3/4 inch will weaken initial pull force of solenoid and it will be slow and blow fuses. Likewise a spring tension greater than required to just close the stop lever may cause solenoid to stall.
5. Check diode D-33, on sets with solenoid, but without auto-shutdown. The diode holds the solenoid on while cranking.

- C. Engine Cranks and Runs, Then Stops
1. Check hold coil of fuel solenoid for continuity. If open, replace.
  2. Check oil pressure cut-out switch and water temperature cut-out switch (if this option is provided). The oil pressure switch should close with high oil pressure and the water temperature switch should be closed at normal engine temperature. If these switches are defective, replace them
  3. Check oil pressure gauge to be certain that oil pressure is normal (approximately 60 psi). If oil pressure is abnormal, determine cause or add oil if necessary.
- D. Cranking Battery Goes Dead
1. After generator is running, insert an ammeter between the B+ binding post on the generator and the wire going to battery +. The + side of the ammeter should be on the positive binding post terminal and the minus side of the ammeter should be on the lead going to the battery +. The ammeter should indicate a charge of approximately 2 amperes up scale on a good battery (open circuit potential voltage of 12.4 to 12.6 volts). CAUTION- Do not put cranking current thru ammeter as this may blow it out.
  2. If there is no battery charge, check the following components in order:
    - (a) Fuse F-1
    - (b) Fuse F-2
    - (c) Relay K-1 Coil and Relay K-1 contacts
    - (d) Diodes D-1, D-2, D-3.
    - (e) Next check to see if there is an AC output of approximately 115 volts AC at terminal L-1 and L-2. If not, then trouble is in main generator.
  3. If there is approximately 115 volts AC present at terminals L-1 and L-2, then check output of transformer of T-1 from terminals 8-11. This should read approximately 20 volts AC.
    - (a) If there is no output voltage at the transformer secondary, check the voltage across the primary. If there is primary voltage, then the transformer is probably burned out and should be replaced.
    - (b) If there is no transformer primary voltage, then put a short circuit across triac Q-1 being careful not to get shocks in the process (it is recommended you use a rubber glove for this operation). If placing a short across Q-1 produces transformer primary voltage and a resultant battery charge, the Q-1 is bad and should be replaced.
    - (c) If step b does not produce transformer voltage and a charging current, then the trouble is either in R-2, C-2 or Diac D-4. The Diac can be checked by placing a short circuit across it. If, resultant charging current then the Diac D-4 is bad and should be replaced.
    - (d) Next Check resistor R-2 and capacitor C-2 and, if defective, replace these units.

- E. Charge Lamp Will Not Go Out When Set Is Running
1. Charging rate may be set too low. Adjust resistor R-2 to produce a two ampere charge on a good battery as in 4.1 above.
  2. Check Capacitor C-4. This can be checked on the 100 or 1000 scale of an ohmmeter. Take the + terminal of the ohmmeter to the + terminal of the capacitor similarly with the negative terminals. The resistance of the capacitor should start at practically a short circuit and build up slowly to a very high value over 100,000 ohms as the capacitor charges up. If the capacitor indicates a short it should be discarded and replaced and if the capacitor indicates an open circuit (no gradual charging effect), then it should be replaced. The capacitor may also be tested on a more complicated capacitance bridge if one is available. Be sure to get the polarity of this capacitor correct as electrolytic capacitors will sometimes explode if the polarity is reversed.
  3. Diode D-1 may be open, which will keep the charging lamp and reduce charge to a mere trickle. Check D-1 and replace if necessary.
  4. Charge lamp 1-1 is a 28 volt lamp (type 1920). Make sure this has not been replaced with a 12 volt lamp as a 12 volt lamp will not go out completely in this circuit.
- F. Charge Lamp Will Not Go On When Generator Set Is Stopped But Control Switch Is In The Run Position
1. Check relay K-1 to make sure that its coil is getting voltage and its normally open contact is closing. Clean contacts if necessary or replace relay if defective.
  2. Check to see if resistor R-1 is open. This should have a value of 50 ohms.
  3. Check to see if the Diode D-1 is shorted.
  4. Make sure charging lamp 1-1 is not burned out.
- G. No 115 Volt AC Generator Output Or Intermittant Output
1. Check field diodes D-5 and D-6 to make sure that they are not open or shorted. Replace if defective.
  2. Check continuity of both field and rotor windings. If these are open, generator will have to be rewound or replaced.
  3. Check to see if there are any shorts from either rotor or field to generator case. If shorted, generator will have to be rewound or replaced.
  4. Check to see if brushes are worn.
  5. Generator may have lost its magnetization from either a bad overload or a bad mechanical shock. If the rotor and field diodes all check O.K., then flashing the field may be necessary to restore magnetization. This can be done while engine is running by applying, from an external source, 115 volts AC, 60 Hz to terminals L-1 and L-2 of the generator for approximately two seconds (no longer). Be careful not to get a shock during this operation as some arcing and sparking will occur when the connection is made and broken. The best procedure is to wire the connections in permanently and then throw a switch on for two seconds and then throw it off and disconnect the wires.
- H. Generator Will Carry A Small Load But Engine Bogs Down At Full Load
1. Be certain that fuel solenoid is fully seated and positioned in mount to give a full 3/4 inch stroke. If fuel solenoid is binding or limited to a short stroke, the fuel shut-off lever may not be opened fully.
  2. Bleed air from fuel system if necessary.
  3. Check fuel pump
  4. Check lift pump
  5. Check for water in fuel.
  6. Check compression.

## 22. DIODE CHECK

- (a) Place (+) probe of meter on (+) of diode and (-) probe of meter on (-) end of diode. A good diode will give a low resistance reading.
- (b) Place (+) probe of meter on (-) end of diode and (-) probe of meter (+) end of diode. A good diode will give a high resistance reading.
- (c) If diode is open you will obtain an infinite resistance reading on meter, by testing diode both ways as in (b) above.
- (d) If diode is shorted, you will obtain a zero reading or meter by testing diode both ways as in (b) above.

## 23. ROTOR AND SHUNT FIELD RESISTANCE TESTS

- (a) Remove the two screws and clips securing generator end cover to generator frame. Remove end cover.
- (b) Remove the four brushes from their brush holders.
- (c) Test the resistance between slip rings. Resistance should read approximately 0.1 ohm.
- (d) Test each lip ring to armature shaft. Test should read open.
- (e) Connect (+) lead of ohmmeter to F+ lead of field and (-) lead of ohmmeter to F- lead of field. (The F- and F+ leads are labeled and connected to terminal studs on brush rig assembly). Field winding should read approximately 4.5 ohms.

## 24. WPD-3 GENERATOR OVERHAUL

## A. Dismantling Generator

In the event of a fault necessitating dismantling the generator, it is recommended that it be returned to the manufacturer or to an authorized service agent. If dismantling becomes unavoidable, proceed as follows:

- (1) Disconnect battery cable. Open control box lid.
- (2) Select cables entering control box from generator and disconnect cables at control box, carefully marking each cable and terminal to ensure correct reconnection.
- (3) Remove the two screws and cover clips securing generator end cover to generator frame.
- (4) Press down spring clip securing brush in its holder. Remove spring clip and lift brush from holder. Repeat for the other 3 brushes.
- (5) Examine brushes for freedom of movement in their holders. Brushes found to be cracked, chipped, or worn below 5/8 inch must be replaced.

NOTE: When removing generator frame, disconnect the spring clips and brush leads from their terminals and remove brushes from their holders.

- (6) Place a block of wood under flywheel housing to support engine when generator frame is removed.
- (7) Remove the bolts securing the control box brackets and control box to the generator fram.
- (8) Remove nut, lockwasher and flatwasher from armature through stud. Remove generator blower. If armature through stud unscrews from armature, taper stub shaft, remove stud.
- (9) Remove the bolts securing the adapter plate to bellhousing and remove generator frame with adapter plate.

## B. Rebuilding Generator

- (1) Secure armature through stud to armature taper stub shaft.
- (2) Slide armature on through stud and stub shaft.
- (3) Position and install generator frame with attached adapter plate over armature, and secure adapter plate to bellhousing.
- (4) Press down spring clip securing brush in its holder. Remove spring clip and lift brush from holder. Repeat for the other three brushes.
- (5) Install brushes in their holders and secure with spring clip. Press spring of clip on top of brush and press down and in.

- NOTE: Insure brush rides in center of its commutator ring.
- (6) Reconnect each brush lead to its terminals and secure with washer and nut.
  - (7) Reconnect cables from generator to control box terminals.
  - (8) Secure control box brackets and control box to generator frame.
  - (9) Lift decompression lever and rotate armature by turning armature blower clockwise, checking that during rotation, there is no fouling between armature and pole shoes.
  - (10) Replace and secure end cover to generator frame with the two screws and cover clips.
  - (11) Reconnect battery cable.

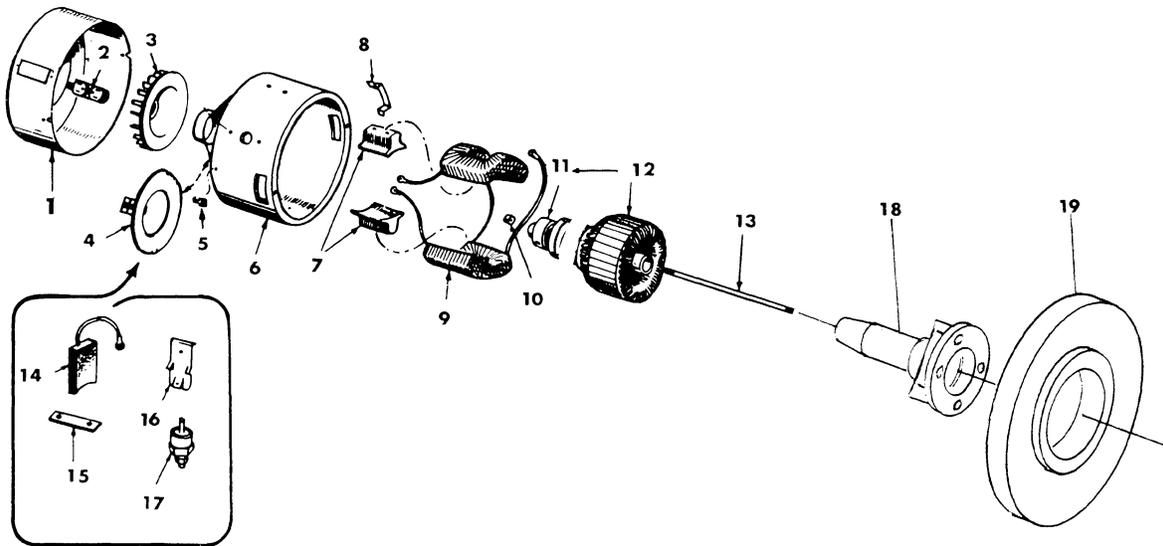
### WPD-3 WIRING DIAGRAM

<u>ITEM</u>	<u>SYMBOL</u>	<u>QUAT.</u>	<u>DESCRIPTION</u>
1	BP-1, 2	2	TERMINAL ASS'Y
3	S	1	STARTER MOTOR
4	S-1	1	SWITCH, CONTROL
5	TB-1	1	TERMINAL BLOCK 7 TERM
6	I-1	1	LAMP, CHARGE, 24 VOLT
7	DI, 2, 3	3	DIODE
8	RI	1	RESISTOR, CHARGE BLEED
9	FI, F2	2	FUSE, 5A
12	TI	1	TRANSFORMER, 120V to 12.6/12.6V
13		1	FUSEHOLDER
14	Q1	1	TRIAC
15	D4	1	DIAC
16	R2	1	REGISTOR, VARIABLE
17	C2	1	CAPACITOR
18	G-1	1	GENERATOR
19	TB-2	1	TERMINAL BLOCK, 3 TERM 30A
20	C3	1	CAPACITOR, ARC .05, 600 WVDC SUPRESSING
21	D5	1	DIODE
22	D6	1	DIODE
31	C4	1	CAPACITOR 250 UF 25WVDC
32	K1	1	RELAY

#### OPTIONS

23		1	PANEL, REMOTE CONTROL
24	S-2	1	SWITCH, REMOTE CONTROL
25	S-3, S-4	2	SWITCH, OP OVERRIDE, NO
26		1	SOLENOID, FUEL
27		1	SWITCH, OIL PRESSURE, NO
28		1	SWITCH, WATER TEMPERATURE, NC





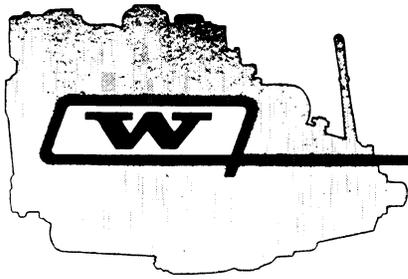
## WPD-3 Generator

- |   |  |
|---|--|
| 1. Generator End Cover                                    | 10. Armature through Stud Nut                |
| 2. Receptacle   | 11. Ball Bearing                             |
| 3. Blower Generator                                       | 12. Armature Assembly<br>(including brushes) |
| 4. Brush Reg. Assembly<br>(including brushes and springs) | 13. Armature thru Stud                       |
| 5. End Bell Cover Clip                                    | 14. Collector Ring Brush                     |
| 6. Generator Frame  | 15. Connector-Rectifiers Strip               |
| 7. Pale Shoe  | 16. Collector Ring Brush Spring              |
| 8. Air Outlet Cover                                       | 17. Rectifier                                |
| 9. Field Coil Set<br>(2 coils wired together)             | 18. Taper Stub Shaft                         |
|   | 19. Engine Flywheel                          |

# SERVICE BULLETINS

The following Bulletins contain supplementary and updated information about various components and service procedures which are important to the proper functioning of your engine and its support systems.

You should familiarize yourself with the subjects and make sure that you consult the appropriate Bulletin(s) whenever your engine requires service or overhaul.

**WESTERBEKE**

MARINE ENGINE PRODUCTS

## SERVICE BULLETIN #20

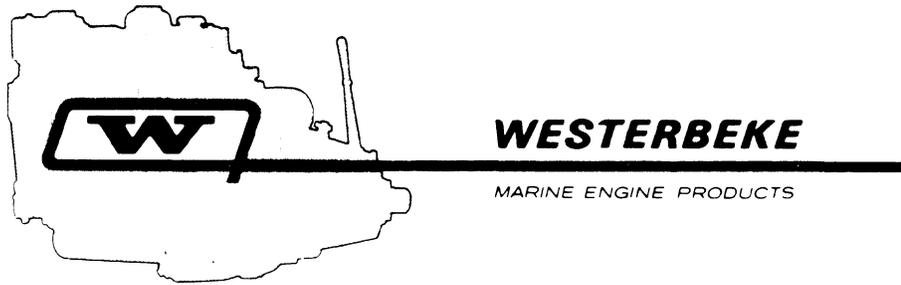
MODEL: ALL ENGINESSUBJECT: CONNECTING PRESSURE SENSING DEVICES TO OIL GALLERIES

Oil pressure sensing devices, such as senders and switches, must never be connected directly to any oil gallery of an engine. The reason is simply that continued engine vibration causes fatigue of the fittings used to make such a connection. If these fittings fail, the engine loses its oil pressure and very quickly siezes.

Such pressure sensing devices must be bulkhead mounted and connected to the oil gallery using an appropriate grade of lubricating oil hose. Any fittings used to connect the hose to the gallery must be of steel or malleable iron. Brass must not be used for this purpose.

6/15/69

#11967



SERVICE BULLETIN NUMBER 43

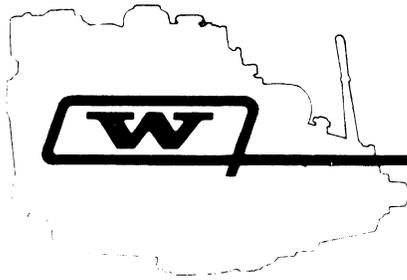
MODEL: DS and WPD 3 Generator Set

SUBJECT: Raw Water Pump Lift Capacity

To protect your engine, it is imperative that the water pump be located no more than 15 inches vertical height from the water line. No more than 24 inches total suction line length.

The thru hull fitting for the water intake must be located well below the water line so pump is not subject to air intake when boat heels. Use 3/8 inch suction line with no bends.

If this type of installation is not practical, then use an auxiliary electric motor driven water pump actuated by an oil pressure switch to automatically provide water to the water pump on the generator set. An AC pump is available which draws 1/2 amp. Remember that the generator trickle charge rate of 2 amps must not be exceeded.

**WESTERBEKE**

MARINE ENGINE PRODUCTS

## SERVICE BULLETIN #60

SUBJECT: Engine R.P.M.

MODEL: DS

The DS engine is very sensitive to correct engine operating R.P.M. It is very important that the engine be wheeled properly to allow it to run up to 3000 R.P.M. while under load. Failure to do this will cause overloading, black smoke, poor performance, early engine failure, and will void the warranty.

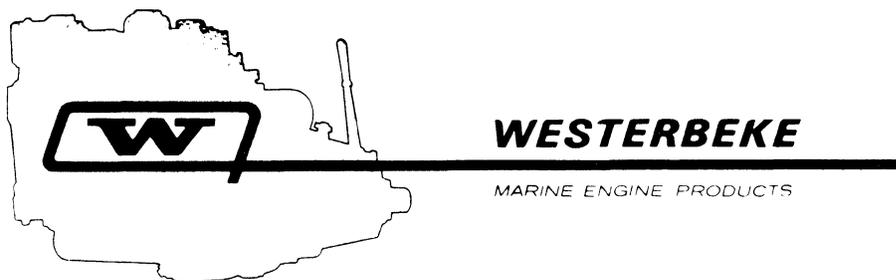
Some typical propellers used on the DS engine are:

11 x 7, two blade, left hand

10 x 8, two blade, left hand

Note the above propeller selection are approximate only and different hulls may require different sizes.

The important issue is to be sure the engine can run at 3000 RPM under load.



SERVICE BULLETIN #61

SUBJECT: Removal of Sacrificial Plug(Westerbeke P/N 17355)

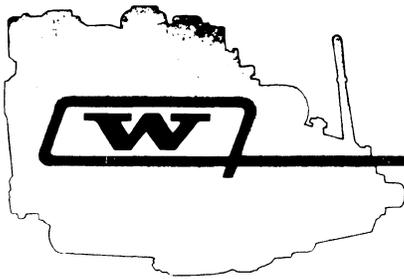
MODEL: WPD-3 and DS

It has been reported that on some occasions the cylinder head zinc plug #17355 has been removed in install an electrical device. This will cause corrosion in the head and shorten the life of the cylinder head and engine. Such action will also void the warranty on those parts affected.

If you wish to install and electrical device in the cylinder head, do so by removing part number 17354 as shown on Page 206 of the WPD-3 and DS Parts List, (P/N 12137 dated July 1, 1973).

8/73

P/N 16030

**WESTERBEKE**

MARINE ENGINE PRODUCTS

SERVICE BULLETIN #69

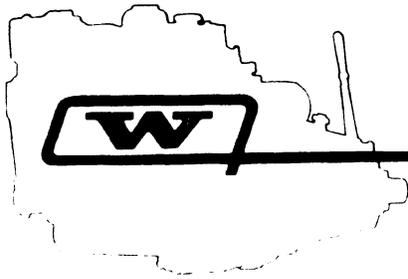
Subject: Exhaust system failures

Models: All marine generators and marine engines

When engine sea water is fed into an exhaust system so that the full stream strikes a surface, erosion may cause premature failures.

Proper design of either a water jacketed or a water injected ("wet") exhaust system to prevent this problem requires that the sea water inlet be positioned so that the entering stream of sea water does not strike a surface directly. Also, the velocity of the entering sea water stream should be as low as possible which is achieved by having inlet fittings as big in diameter as possible.

In addition to the above design considerations, it is usually advantageous to divide the sea water flow at the point of entry to the exhaust system so that only a portion of it enters the exhaust system. The remainder is normally piped directly over the side. The proper proportion of the sea water flow to pass through the exhaust system can only be determined by trial and error. The goal is to prevent excessive exhaust temperatures with the least amount of sea water.



**WESTERBEKE**

MARINE ENGINE PRODUCTS

SERVICE BULLETIN #72

MODELS: ALL

SUBJECT: NON-INTERCHANGEABILITY BETWEEN MANUFACTURERS OF GAUGES AND SENDERS

In recent years we have purchased gauges and senders from four different manufacturers.

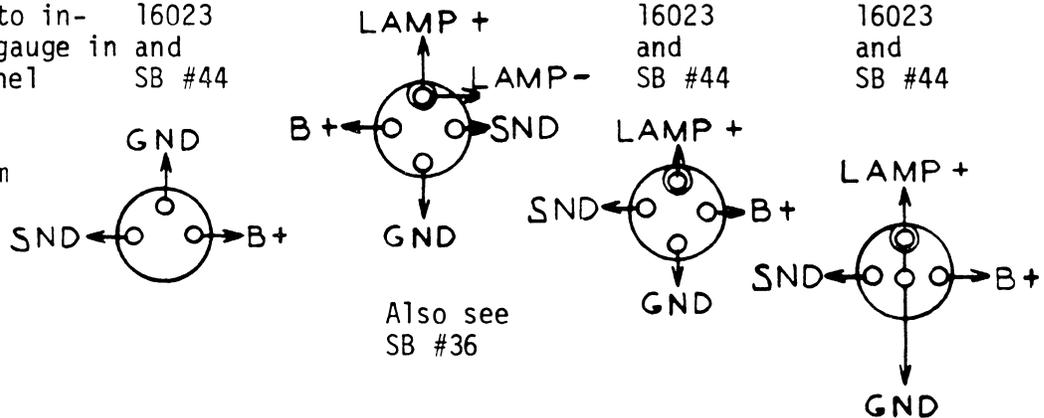
In no case may the gauge of one manufacturer be used with the sender of another manufacturer. In some cases the wiring of either or both the gauge and the sender varies by manufacturer.

Thus it becomes important, when ordering a replacement gauge or ordering a replacement sender, to order a matched set or to know conclusively who the manufacturer is.

Ammeters are electrically interchangeable.

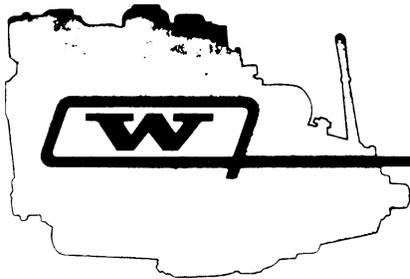
	<u>STEWART-WARNER</u> 2" DIA CASE	<u>VDO</u> 2 3/8" DIA CASE	<u>FARIA</u> 2" DIA CASE	<u>NOVOX</u> 2" DIA CASE
Ammeter	11581	11931	16550	19165
Oil pressure gauge	11544	11914	16548	19166
Oil pressure sender	11542	11916	16551	19167
Water temp. gauge	11545	11913	16549	19168
Water temp. sender	11543	11915	16552	19169
Adapter ring to in- stall 2" dia gauge in and 2 3/8" dia panel cut-out	16023 SB #44		16023 and SB #44	16023 and SB #44

Wiring diagram



5/29/74

PN19190


**WESTERBEKE**

MARINE ENGINE PRODUCTS

SERVICE BULLETIN #81

REISSUED:        October 3, 1975  
 SUBJECT:         Hydro-Hush Muffler Installation  
 MODEL:           A11  
 DISTR:           A11

The diagram on the reverse side shows a proper installation of the Hydro-Hush stainless steel muffler.

Make sure installation is such that water cannot enter engine at any angle of heel or pitch.

Muffler remains approximately twenty-five percent full of water after engine is shut down with maximum thirty-three inch lift used.

Muffler must be installed as close to fore-aft centerline of boat as possible.

There must be an unblocked vent to atmosphere at the high point of the sea water circuit (where it passes above the waterline) to break the vacuum which would encourage siphoning through the sea water circuit upon engine shutdown. Such siphoning would fill the engine with sea water through its exhaust. Pipe the air vent with approximately 3/16 copper tubing to discourage water flow through it when the engine is running. If water flows through the air vent when the engine is running, pipe it over the side or into the transom exhaust outlet. But be sure it will drain upon engine shutdown and function properly as a siphon break by venting the sea water circuit to atmosphere.

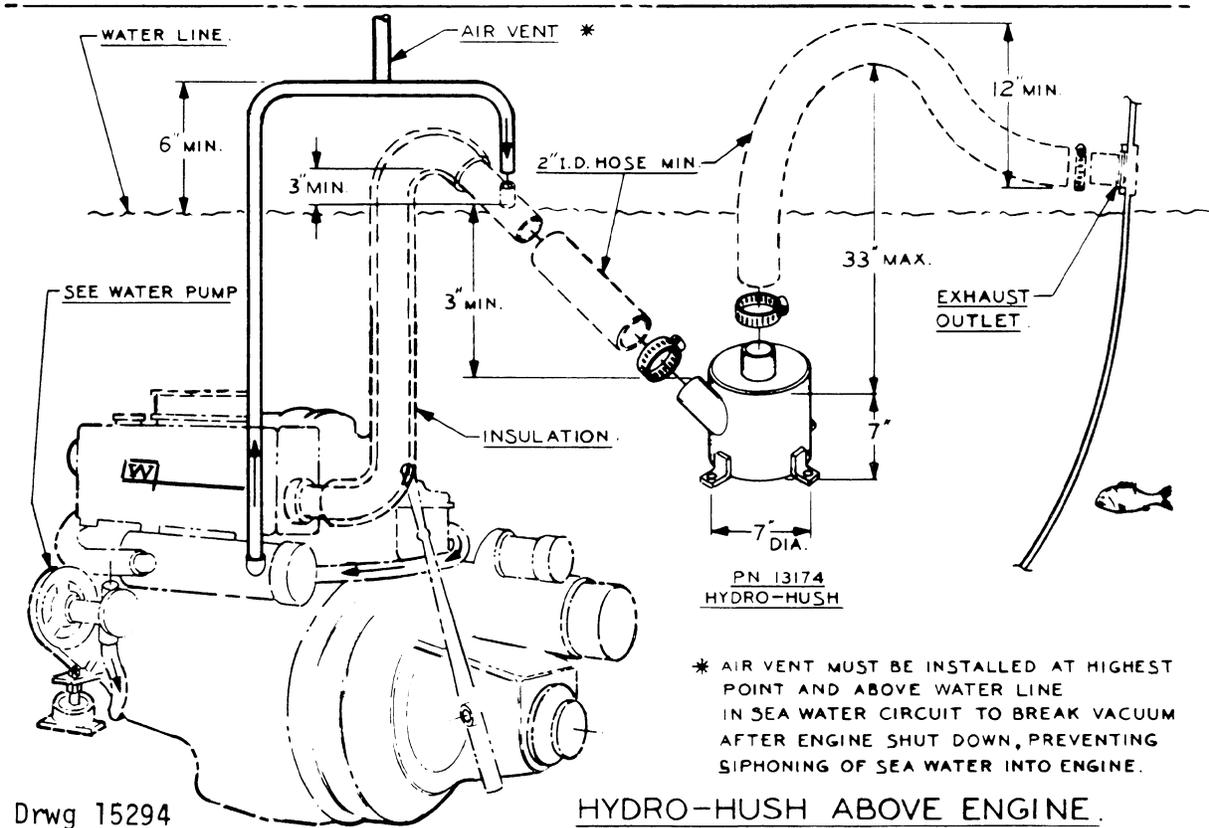
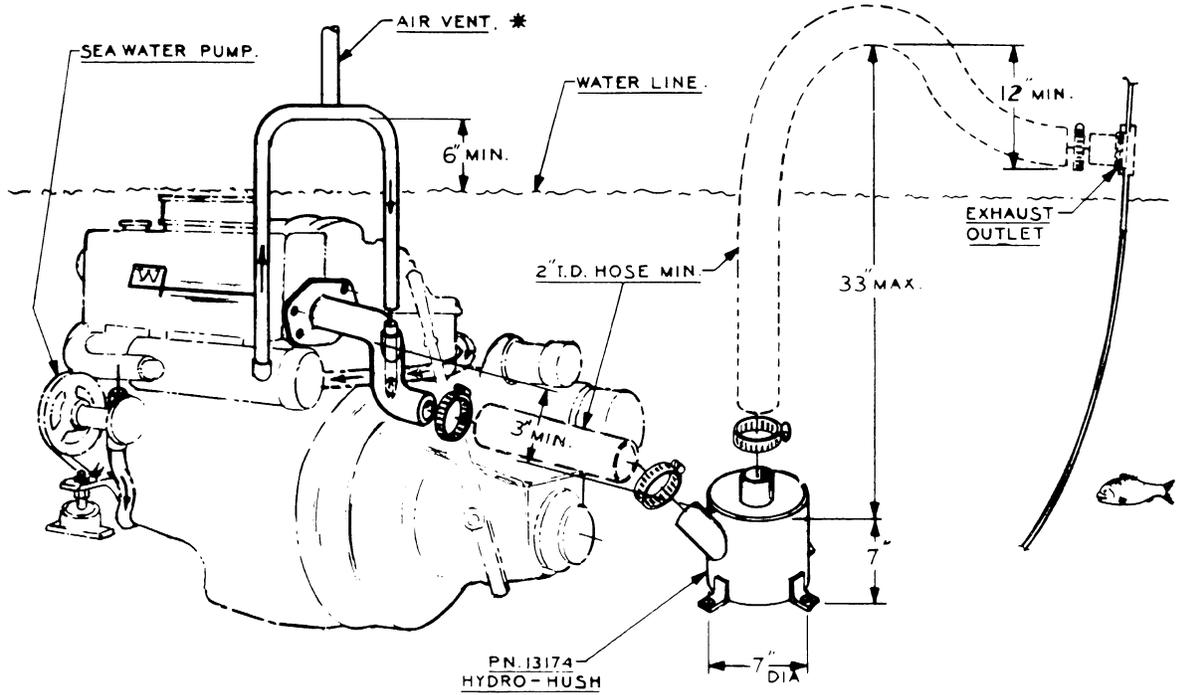
Use as few right angle fittings as possible. If there is any question as to back pressure, check your engine manual.

Exhaust line diameters indicated are minimums. Refer to engine manual for specifics regarding run lengths and sizes greater than indicated.

The installation tips given are to be used as a guide only. We cannot be responsible in any way for muffler installation. We presume basic understanding of good marine practice on the part of the installer.

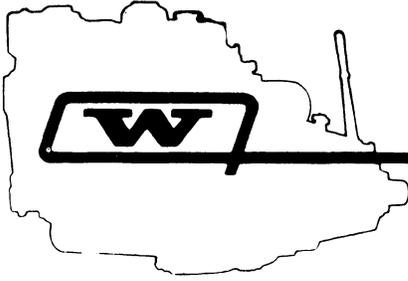
**CAUTION:** As the sea water pump fills the exhaust system with sea water during cranking, be sure to close the intake seacock whenever total cranking between engine starts exceeds approximately 30 seconds. Open seacock immediately after engine starts.

HYDRO-HUSH BELOW ENGINE



Drwg 15294

HYDRO-HUSH ABOVE ENGINE.


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MARINE ENGINE PRODUCTS

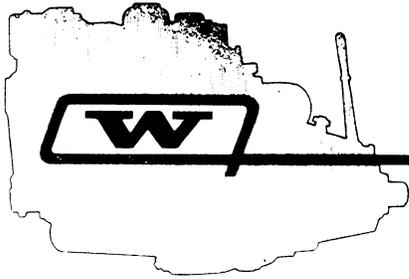
SERVICE BULLETIN #82

ISSUED: May 7, 1975  
 SUBJECT: Battery Recommendations  
 MODEL: All  
 DISTR: Owners, Distributors, Dealers, Manufacturers

BATTERY RECOMMENDATIONS

<u>MODEL</u>	<u>BATTERY AMPERE HOURS</u>	<u>VOLTAGE</u>
Vire, 7 Horsepower, gasoline	40-60	12 V.D.C.
DS, 5 Horsepower, diesel	60-90	12 V.D.C.
Pilot-10, 10 Horsepower, diesel	90-125	12 V.D.C.
Four-60, 15 Horsepower, diesel	90-125	12 V.D.C.
Pilot-20, 20 Horsepower, diesel	90-125	12 V.D.C.
Four-91, 25 Horsepower, diesel	125-150	12 V.D.C.
L25, 25 Horsepower, diesel	125-150	12 V.D.C.
Four-107, 37 Horsepower, diesel	125-150	12 V.D.C.
WPDS-15, 15 Kilowatt, diesel	125-150	12 V.D.C.
Four-154, 53 Horsepower, diesel	150-170	12 V.D.C.
WPDS-20, 20 Kilowatt, diesel	150-170	12 V.D.C.
Four-230, 75 Horsepower, diesel	170-200	12 V.D.C.
Performer-Six, 115 Horsepower, diesel	200 minimum	12 V.D.C.

The ampere hour range shown is minimum. There is no real maximum.



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MARINE ENGINE PRODUCTS

SERVICE BULLETIN 92

ISSUED: April 28, 1976

SUBJECT: Troubleshooting Water Temperature and Oil Pressure Gauges

MODELS: All

DISTR: Distributors, Shipments

Given a presumably faulty gauge indication with the instrument panel energized, the first step is to check for 12 VDC between the ign. (B+) and neg. (B-) terminals of the gauge.

Assuming there is 12 volts as required, leave the instrument panel energized and perform the following steps:

1. Disconnect the sender wire at the gauge and see if the gauge reads zero, the normal reading for this situation.
2. Connect the sender terminal at the gauge to ground and see if the gauge reads full scale, the normal reading for this situation.

If both of the above gauge tests are positive the gauge is undoubtedly OK and the problem lies either with the conductor from the sender to the gauge or with the sender.

If either of the above gauge tests is negative, the gauge is probably defective and should be replaced.

Assuming the gauge is OK, proceed as follows. Check the conductor from the sender to the sender terminal at the gauge for continuity.

Check that the engine block is connected to ground. Some starters have isolated ground terminals and if the battery is connected to the starter (both plus and minus) the ground side will not necessarily be connected to the block.

If the sender to gauge conductor is OK and the engine block is grounded, the sender is probably defective and should be replaced.

P/N 21616

4/28/76

# SERVICE BULLETIN

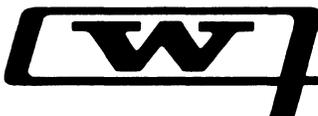
**DATE:** February 8, 1980  
**MODEL:** DS5, DS7, W-7, WPD3, WPD4  
**SUBJECT:** Cylinder Head Nut Torque

**BULLETIN NUMBER:** 105

The torque specification for the cylinder head nuts has been changed as follows:

<u>Old Torque Specification</u>		
Cylinder Head Nut	20 lb ft	2.77 kg m
<u>New Torque Specification</u>		
Cylinder Head Nut	21 lb ft	2.91 kg m
Cylinder Head/Rocker Support Nut	24 lb ft	3.32 kg m

Mark this change in all technical manuals for the above listed engine models. Torque cylinder head nuts cold, check valve rocker clearance after torquing cylinder head nuts and adjust as needed.



**J. H. WESTERBEKE CORP.**

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# SERVICE BULLETIN

V13

*DATE:* February 8, 1980

*BULLETIN NUMBER:* 106

*MODEL:* DS5, DS7, W-7

*SUBJECT:* Sea Water Pump Weep Hole

The transmission on the above model engine has mounted on it, above the output shaft, a sea water pump which supplies sea water to the engine or heat exchanger, for cooling purposes.

When performing daily engine checks, owners should pay particular attention to the weep holes just behind the sea water pump, which are visible on either side of the transmission. If there is any indication of sea water coming out of these weep holes, owners must remove the sea water pump and replace the seal (P.N. 16663) between the pump and the weep holes.

Ensure that these weep holes are not obstructed in any way by rust or scale build-up.

Failure to replace the seal when leakage is found at these weep holes will eventually lead to sea water entering the transmission.

Note: Leakage from these weep holes can also be caused by a blockage in the sea water flow through the engine or heat exchanger cooling circuit.

Please see diagram on overleaf.



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*P/N:* 24607

