

TECHNICAL MANUAL

WESTERBEKE L25

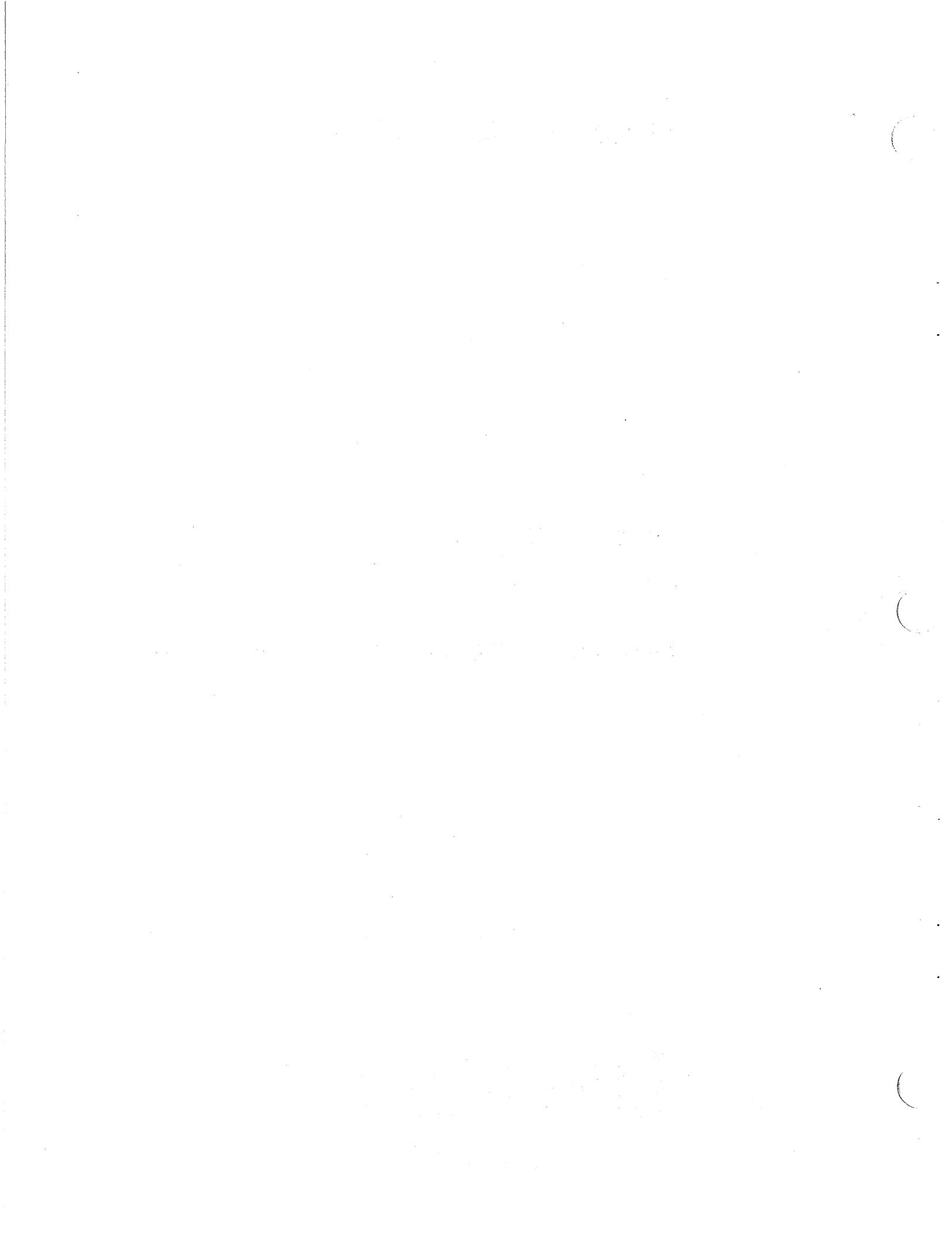
Marine Diesel Engine

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SECTION INDEX

GENERAL

Introduction

Installation

Operation

Maintenance

ENGINE OVERHAUL

OTHER OVERHAUL

Marine Engine Electrical System

Cooling System (External)

Transmissions

GENERATOR SETS

HYDRAULIC CRANKING SYSTEM

SERVICE BULLETINS

YOUR NOTES

INTRODUCTION

5

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 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 sheer 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

try 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

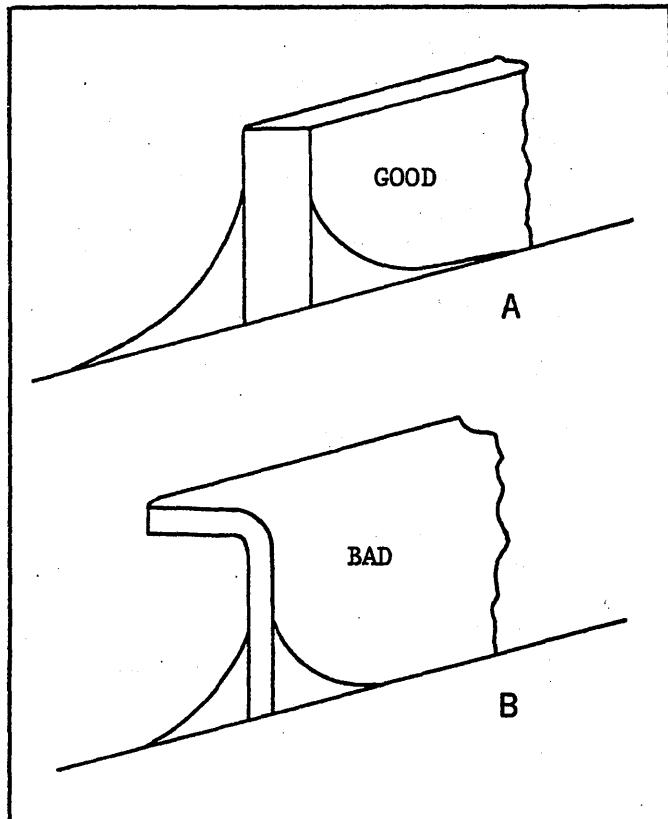
It is recommended that bronze hanger bolts of appropriate size be used through the engine flexible mounts. Lag screws are less preferred because their hold on the wood is weakened every time they are moved, whereas the lag bolt stays in position and the nut on top is used to tighten the engine down or 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.

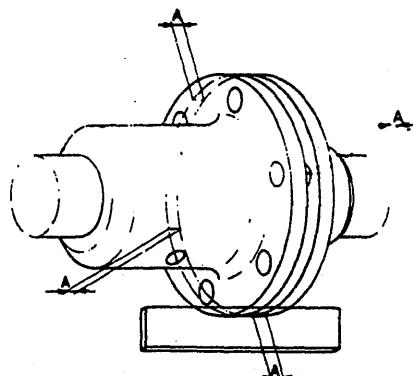
One particularly annoying result of misalignment may be leakage of transmission oil through the rear oil seal. Check to make sure that alignment is within the limits prescribed.

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 realign at a further period.

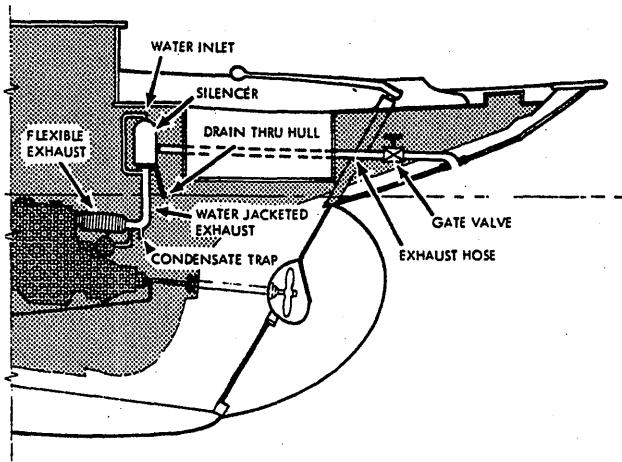
The coupling should always be opened up and the bolts removed whenever the boat is hauled out or moved from the land to the water, and during storage in a cradle. The flexibility of the boat often puts a very severe strain on the shaft or the coupling or both when it is being moved. In some cases the 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.

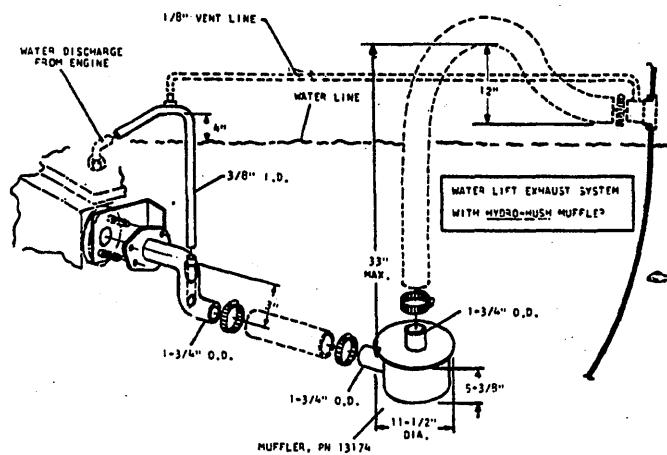
Brass or copper is not acceptable for wet exhaust systems, as the combination of salt water and diesel exhaust gas will

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

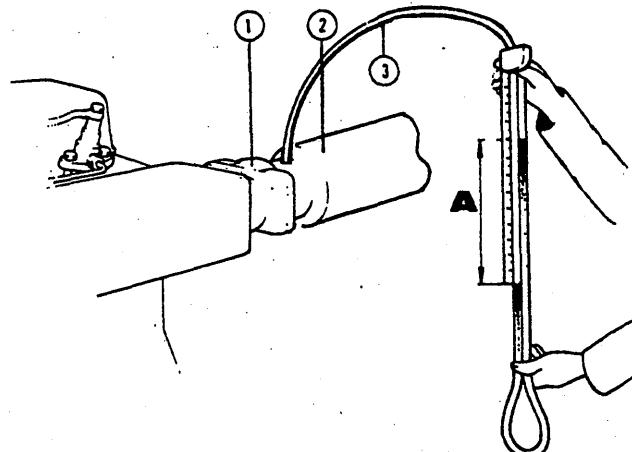
Back pressure must be measured on a straight section of the exhaust line and as near as possible to the engine exhaust manifold. The engine should be run at maximum load during the measurement period. Set-up should be as shown below.

1. For normally aspirated engines:

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

2. For turbo-charged engines:

<u>Pressure Test</u>	<u>Mercury Test</u>	<u>Water Column</u>
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 aspirated 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 realigned. 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 air-locks 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.

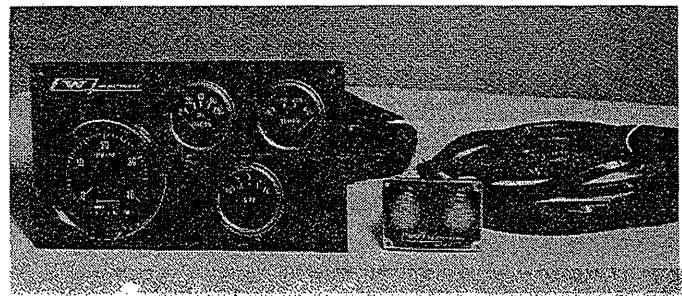
Keep fuel lines as far as possible from exhaust pipe for minimum temperature, to eliminate "vapor locks".

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.

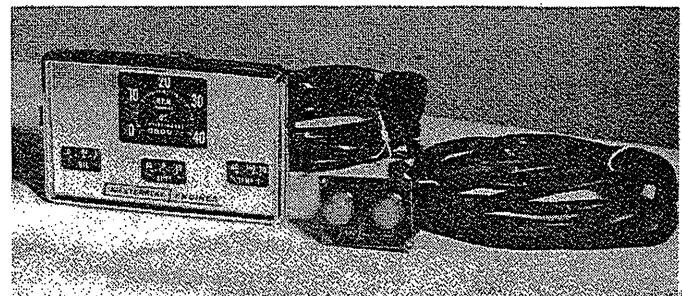
The final connection to the engine should be through flexible rubber hoses.

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,

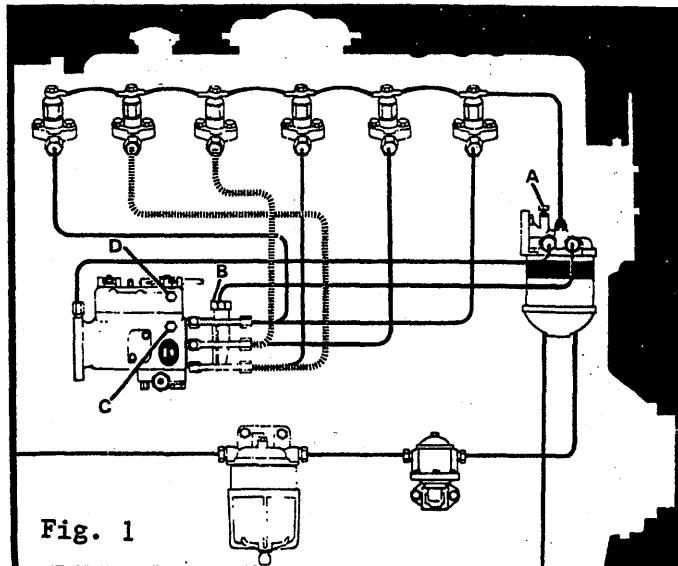


Fig. 1

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

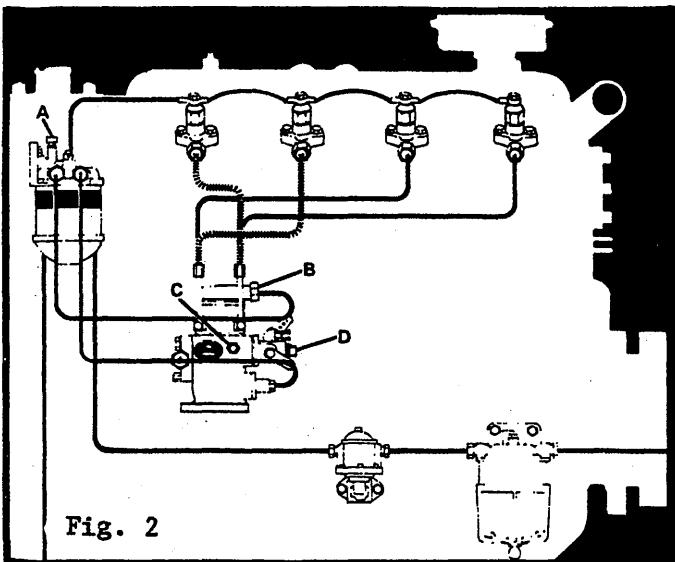


Fig. 2

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 retighten 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 overfill. See Note next page.

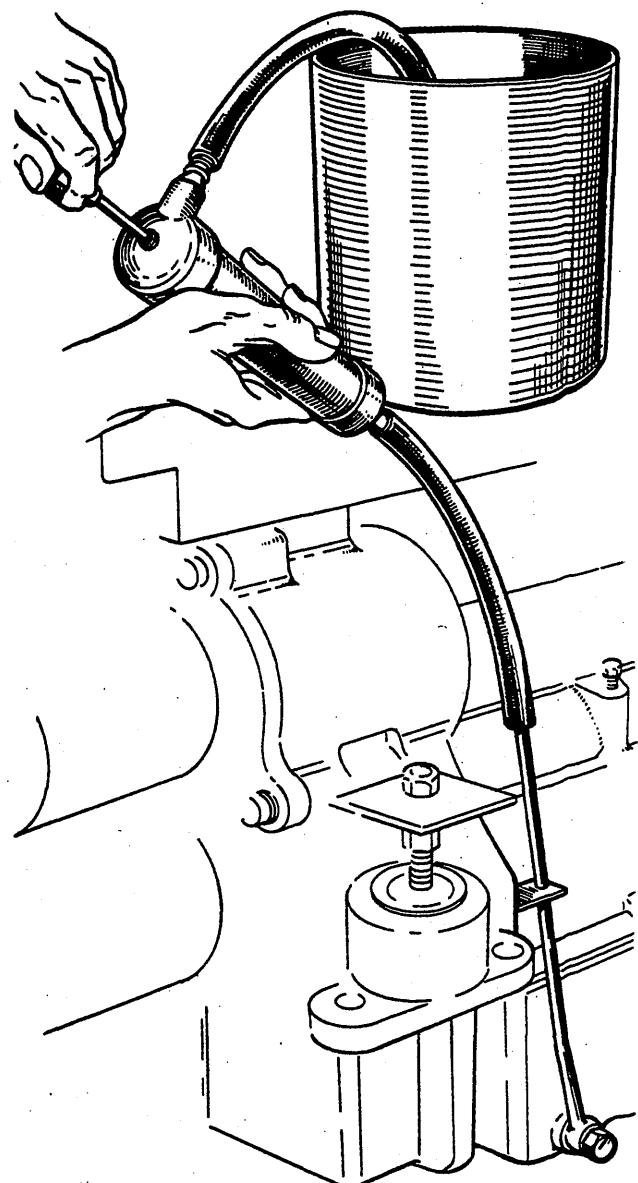


FIGURE 1

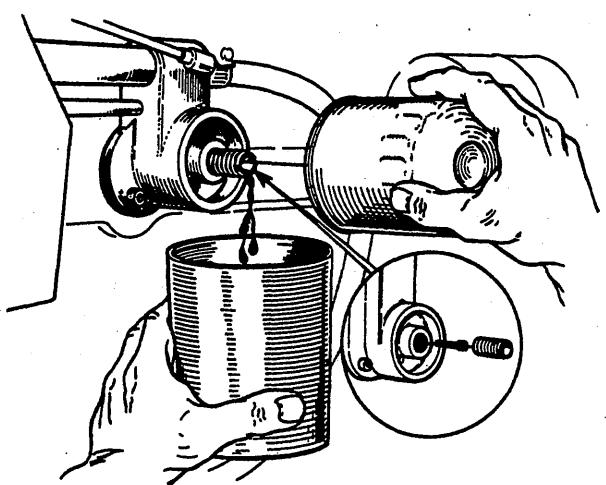


FIGURE 2

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		
		00/45°F	45°/80°F	OVER 80°F
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	Gulf lube 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

Two series of engines have been used referred to in the text as MK 3 and MK 4. They can be identified by the 2 letter prefix in the serial number. The MK 3 prefix is SP and the MK 4 is FK.

TECHNICAL DATA

Firing order	1, 2, 4, 3
Camshaft end-float	0.0025 to 0.0075 in. (0.064 to 0.191 mm.)
Connecting rod end-float on crankpin	0.004 to 0.010 in. (0.10 to 0.25 mm.)
Crankshaft end-float	0.003 to 0.011 in. (0.08 to 0.28 mm.)
Valve seat angle	44° 30' to 45° inlet and exhaust
Valve seat width - inlet and exhaust	1/8 in. (1.59 mm.)
Flywheel run out	0.005 in. (0.13 mm.) maximum
Oil pressure	35 to 40 lb./sq. in.
Projection above block face by piston crown at TDC	Mk 4: 0.010 to 0.026 in. (0.25 to 0.67 mm.)
Clearance between block and piston	Mk 1-Mk 3: 0.025 to 0.043 in. (0.64 to 1.09 mm.)
Compression ring to groove clearance	0.0016 to 0.0036 in. (0.041 to 0.091 mm.)
Oil control ring to groove clearance	0.0018 to 0.0038 in. (0.046 to 0.097 mm.)
Ring gap	0.009 to 0.014 in. (0.23 to 0.36 mm.)
Valve face angle	45° to 45° 15'
Valve clearance - inlet and exhaust (cold)	0.015 in. (0.38 mm.)
Inlet valve face (fitted) below cylinder head face	Mk 1-Mk 3: 0.050 in. Mk 4: 0.050 in.
Exhaust valve face (fitted) below cylinder head face	Mk 1-Mk 3: 0.025 in above Mk 4: 0.050 in.

Tightening Torques

Cylinder head: 7/8 in. (14 UNC)	65 to 70 lb./ft. (8.98 to 9.67 kg./m.)
Main bearing cap: 7/8 in. (14 UNC)	65 to 70 lb./ft. (8.98 to 9.67 kg./m.)
Connecting road big end: 5/8 in. (24 UNC)	30 to 35 lb./ft. (4.15 to 4.84 kg./m.)
Flywheel: 5/8 in. (24 UNF)	50 to 55 lb./ft. (6.92 to 7.61 kg./m.)
Rocker shaft: 5/8 in. (16 UNC)	17 to 22 lb./ft. (2.35 to 3.04 kg./m.)
Manifolds	
Bolts: 5/8 in. (18 UNC)	15 to 18 lb./ft. (2.07 to 2.49 kg./m.)
Nuts: 5/8 in. (24 UNC)	15 to 18 lb./ft. (2.07 to 2.49 kg./m.)
Front cover: 5/8 in. (20 UNC)	5 to 7 lb./ft. (0.69 to 0.97 kg./m.)
Sump: 5/8 in. (20 UNC)	6 to 8 lb./ft. (0.83 to 1.11 kg./m.)
Rear oil seal retainer: 5/8 in. (18 UNC)	12 to 15 lb./ft. (1.66 to 2.07 kg./m.)
Crankshaft pulley: 7/8 in. (20 UNF)	24 to 28 lb./ft. (3.32 to 3.87 kg./m.)
Oil pump: 5/8 in. (18 UNC)	12 to 15 lb./ft. (1.66 to 2.07 kg./m.)
Camshaft thrust plate: 5/8 in. (20 UNC)	2.5 to 3.5 lb./ft. (0.35 to 0.48 kg./m.)
Camshaft sprocket: 5/8 in. (18 UNC)	12 to 15 lb./ft. (1.66 to 2.07 kg./m.)
Rocker cover: 5/8 in. (20 UNC)	2.5 to 3.5 lb./ft. (0.35 to 0.48 kg./m.)
Chain tensioner to cylinder block: 5/8 in. (20 UNF)	5 to 7 lb./ft. (0.69 to 0.97 kg./m.)
Injectors to cylinder head	10 to 14 lb./ft. (1.38 to 1.93 kg./m.)

Camshaft

Valve timing	17° – 51° – 51° – 17°
Bearings	Steel backed white metal bush
Oversize bearings available	0·020 in. (0·513 mm.) o/s on OD std. ID
Journal diameter	1·5597 to 1·5605 in. (39·617 to 39·637 mm.)
End-float	0·0025 to 0·0075 in. (0·064 to 0·191 mm.)

Connecting Rods and Big End Bearings

Length between centres	4·927 to 4·929 in.
Big end bore	2·0825 to 2·0830 in.
Small end bore	0·8121 to 0·8125 in.
Bearing liner wall thickness	0·0719 to 0·07225 in.
Undersize bearings available	0·002, 0·010, 0·020 in.
End-float on crankpin	0·004 to 0·010 in.

Crankshaft and Main Bearings**Main bearing journal diameter:**

Blue	2·1253 to 2·1257 in.
Red	2·1257 to 2·1261 in.
Green	2·1153 to 2·1157 in.
Yellow	2·1157 to 2·1161 in.

Regrind diameters:

0·010 undersize	2·1152 to 2·1157 in.
0·020 undersize	2·1055 to 2·1060 in.

Main journal fillet radius:

Front intermediate and rear	0·080 to 0·094 in.
Centre Double radius of	0·07 to 0·08 in.
Crankpin journal diameter	1·9368 to 1·9376 in.
Crankpin fillet radius	0·070 to 0·084 in.
Crankshaft end-float	0·003 to 0·011 in.
Thrust washer thickness	0·091 to 0·093 in.

Cylinder block

Standard cylinder bore diameter	3·1881 to 3·1884 in.
Cylinder liners available	Std. and 0·020 o/s on outside diameter
Bore for cylinder liners	3·3115 to 3·3125 std.

Flywheel and Ring Gear

No of teeth on gear	110
Ring gear fitting temperature	600 degrees F
Maximum run out	0·003 in.

Pistons

Protrusion above block face	Mk 3: 0·010–0·022 in. Mk 4: 0·010–0·026 in.
Piston pin diameter	0·8119–0·8123 in.
Clearance in small end bush	0·0001–0·0003 in.
Piston ring gap	Measured in 3·188 in diameter ring top ring gap 0·013–0·018 in. 2nd ring gap 0·009–0·014 in. 3rd ring gap 0·009–0·014 in. Gap increases by approximately 0·003 in. for every 0·001 in. increase in bore above 3·188 in. 0·0015–0·0035 in.
Ring to groove clearance	

Cylinder Head

Valve guide protrusion above spring seats	0.260 (inlet and exhaust)
Inlet valve depth below head face	Mk 3: 0.050 in.
	Mk 4: 0.050 in.
Exhaust valve depth below head face	Mk 3: 0.025 in. above
	Mk 4: 0.050 in.
Valve spring free length	1.48 in.

Fuel Injection Equipment

Please see separate information booklets on overhaul of CAV fuel injection pump and injectors.

Maximum gross BHP = 34 at 2,800 r.p.m. (BS649)

Rated BHP at 1,200 r.p.m.	10.6
1,400 r.p.m.	13.8
1,600 r.p.m.	16.8
1,800 r.p.m.	19.4
2,000 r.p.m.	21.8
2,200 r.p.m.	23.5
2,400 r.p.m.	25.6
2,600 r.p.m.	26.7

Cylinder bore X stroke 81×77.6 mm.

Fuel consumption on full load lb./b.h.p./hour 0.45

Lubricating oil pressure lb./sq. in. 35-40

Lubricating oil capacity pints 6

Fresh water capacity pints 10

Exhaust connection 1½ in. BSP or 1½ in. ID hose

Nett weight of bare engine 372 lb.

Maximum torque 68 lb./ft. at 2,000 r.p.m.
Standard rotation anti-clockwise looking at flywheel

Minimum battery capacity in ampere hours 100 at 12 volt

Battery polarity Negative earth

Water circulation thermostat 82 degrees centigrade

Fuel injection timing (static) 14° BTDC No. 1 cyl. Mk.4; 12° BTDC No. 1 cyl. Mk.3

Fuel injection timing (dynamic) 30° BTDC No. 1 cyl.

Fuel injector pressure setting 165 ats

Fuel injector type CAV

Fuel injector pump type CAV 3247F161

Maximum idling speed 3,000 r.p.m. (normally set by works at 2,500 r.p.m.)

Minimum idling speed 750 r.p.m.

Firing order 1-2-4-3

Alternator type Lucas 17ACR with machine sensed regulator

Compression ratio Mk 1-3: 18:1, Mk 4 19:1

Swept volume 1,599 c.c.

GENERAL DESCRIPTION

The engine is a four cylinder, 'in line', overhead valve unit operating on the four stroke cycle with direct flow cylinder head and bowl-in-piston combustion chambers. The cylinder bores are machined directly in the cast iron cylinder block which is cast integral with the upper half of the crankcase and are provided with full length water jacketing.

The cast iron crankshaft runs in five large diameter main bearings fitted with aluminium/tin, steel-backed bearing shells. End-float and thrust are controlled by half-thrust washers located in the cylinder block on either side of the centre main bearing.

Seals pressed in the front cover and the rear oil seal carrier prevent oil leaks from the front and rear of the crankshaft. The front seal runs on the pulley hub whilst the rear seal runs on the crankshaft flange itself.

The connecting rods are 'H' section forgings having separate big end caps retained by two bolts and located by hollow dowel pins. Big end bearing shells are, again, steel-backed aluminium/tin. The small ends have steel-backed bronze bushes.

Solid skirt aluminium alloy pistons with two compression and one oil control ring situated above the piston pin bore are used. The combustion chamber is machined in the piston crown. The piston pins are fully floating and are retained in position by circlips installed in grooves at each end of the piston bore.

The camshaft is driven at half engine speed by a single row chain and sprockets from the crankshaft. This timing chain is automatically tensioned by a snail cam bearing against a pivoted tensioner arm. A skew gear and an eccentric, machined integral with the camshaft, drive the oil pump and the fuel lift pump. A thrust plate bolted to the cylinder block front face and located between the front bearing journal and the sprocket flange retains the cam-shaft.

A duplex chain and sprockets driven at half engine speed drives the distributor type fuel injection pump and sea water circulating pump.

Overhead valves are mounted 'normal' to the cast iron cylinder head in valve guides and are operated by rockers, push rods and tappets from the camshaft. The rockers are mounted on a shaft supported by four mounting posts bolted to the cylinder head. Valve clearances are adjusted by screws in the rocker arms.

A cast iron flywheel is mounted on the crankshaft flange and ensures a smooth running engine. A drive plate is fitted to the crankshaft flange or flywheel to couple the engine to the gearbox. The drive for the starter motor is provided by a steel ring gear shrunk onto the fly-wheel periphery.

The sump is a steel pressing and has a well for the lubricating oil. The engine lubrication system is the force feed type incorporating a full flow oil filter. The oil pump, which is mounted externally on the engine, may be of the eccentric bi-rotor type or the sliding vane type. Both types of pump incorporate a non-adjustable plunger type relief valve.

An oil filler cap is located in the rocker cover and also incorporates a filter gauze for crank-case ventilation. Crankcase ventilation is by semi-closed positive systems.

Four-point mounting for the engine and gearbox assembly is provided. Sandwich type rubber flexible mountings are available.

CYLINDER BLOCK

The cylinder block is cast iron and is cast integral with the upper half of the crankcase.

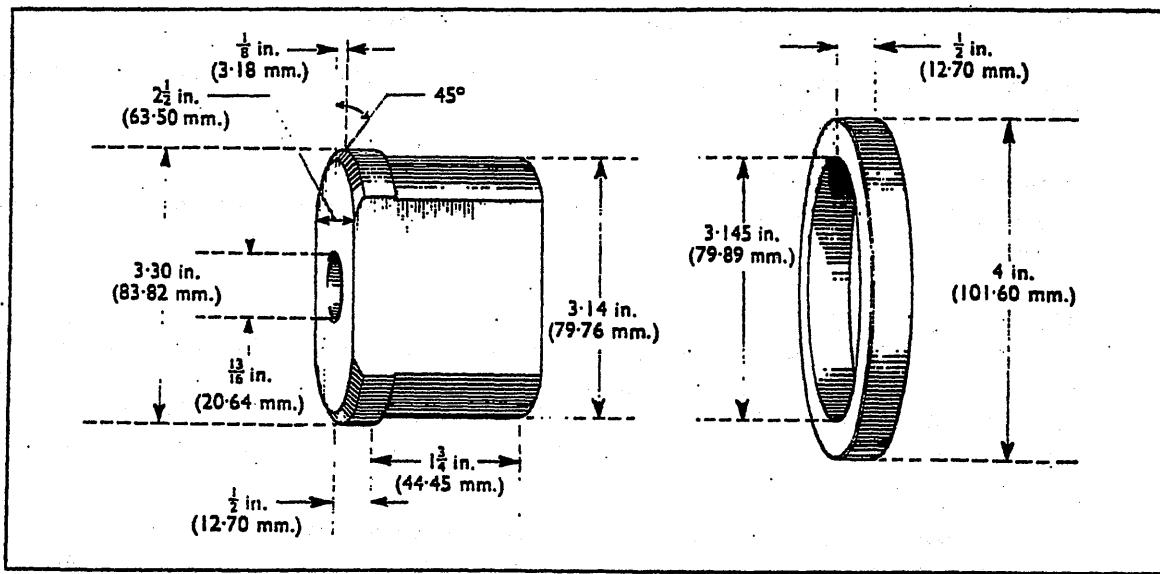
Internally the crankcase incorporates five main bearings with removable caps retained by bolts fitted without lockwashers. The intermediate and rear caps are identical, but their positions must not be interchanged. When dismantling these caps ensure that their positions

are marked, this is normally done, in production, by a number 2 stamped on the front intermediate cap and 4 on the rear intermediate cap. The rear cap is not marked. All caps must be fitted with the cast arrows pointing forwards.

The crankshaft bearing liner parent bore in the cylinder block may be either standard or 0.015 in. (0.38 mm.) oversize. Where the bore is oversize the bearing caps and inside the crankcase are marked with WHITE paint spots. The camshaft bearing parent bore may be 0.020 in. (0.51 mm.) oversize but in this case the block is unmarked. Tappet bores may also be 0.004 in. (0.10 mm.) oversize and the cylinder block in this case is marked with WHITE paint adjacent to the tappet bores.

The cylinder bores are machined directly into the cylinder block. Cast iron dry type cylinder liners, however, may be fitted and two sizes of liner are available, a standard size and one 0.020 in. (0.508 mm.) oversize on the outside diameter.

To remove and replace the cylinder liners, a cylinder liner remover and replacer ring should be made to the dimensions shown. Locate the remover in the bottom of the cylinder liner, with the cylinder block inverted, and press the liner out on a suitable press. When replacing or fitting a liner, ensure that the cylinder bore is machined to the correct size (see Service Data section). Place the remover adaptor in the replacer ring and locate in the cylinder liner, which should be lubricated on the outside with tallow (no other lubricant should be used). Press the liner into the bore from the top on a suitable press. Cut the connecting rod clearance slots in the base of the liner and machine the bore to give the correct clearance for the piston being fitted.



Cylinder Liner Remover

Replacer Ring

CYLINDER HEAD

The cylinder head is made of cast iron. Ten bolts are used to retain the cylinder head, 3.79 in. (96.3 mm.) long. The cylinder head gasket is steel faced.

The valves operate in guides fitted directly in the cylinder head. When fitting valve guides, press each new guide into the cylinder head until the upper end protrudes above the spring seat face the correct distance (see Service Data section).

After fitting new valve guides or reaming the valve stem bore the valve seats must be recut to ensure that the seat is concentric with the valve stem bore.

The valve seats may be re-faced with a cutter tool with an included angle of 90° and the pilot diameter of the cutter should be 0·310 in. (7·87 mm.).

INLET MANIFOLD

The inlet manifold is of cast aluminium and has separate ports for each cylinder. A tapped hole is incorporated in the air cleaner mounting flange for the engine ventilation system vacuum connection. The manifold gasket is of a composition type material. A cold starting aid is fitted below the air filter.

EXHAUST MANIFOLD/HEAT EXCHANGER

A cast aluminium exhaust manifold combined with heat exchanger and header tank is fitted. The heat exchanger tube stack is retained by two neoprene end covers and worm drive clips. Raw water is fed into the forward end cover and discharged from the rear cover normally direct to the engine exhaust system. A 4 lb. pressure cap is fitted to the header tank. A drain plug is located at the lowest point. An air bleed valve is fitted at the forward end to assist filling with fresh water.

The manifold gaskets are of compressed fibre. Ensure that the centre gasket is fitted the correct way up as the centre flange is not symmetrical.

FRONT COVER

The front cover is an aluminium gravity die casting bolted to the front face of the cylinder block. A composition gasket ensures an oil tight joint. To prevent oil leaks around the crank-shaft pulley boss, an oil seal is pressed in the front cover.

A timing mark is incorporated on a pad on the front cover to facilitate injection timing at 12° BTDC No. 1 cylinder.

FUEL INJECTION SYSTEM

Injectors. Fuel injectors have long stem four hole nozzles set to 170 ats. A copper washer between injector face and cylinder head ensures a gas tight joint.

FUEL INJECTION PUMP

The rotary distributor type fuel injection pump is retained to the rear face of the timing cover by 3 studs and nuts and a paper joint ensures an oil tight seal. Injection timing is adjustable by rotating the pump bodily within the limits of the slots in the mounting flange. Timing marks are provided on a machined pad on the rear face of the front cover and on the adjacent injection pump flange.

Injector pipes should always be fitted carefully, ensuring that there is no undue strain on any connection. Pipe nuts should not be over-tightened in an attempt to cure a leak. Always fit a new pipe if a sound joint cannot be obtained.

FUEL FEED SYSTEM

Fuel oil is fed to the engine by a diaphragm type mechanical lift pump operated by an eccentric on the camshaft. A non-return valve on the inlet connection to the pump prevents the possibility of fuel syphoning back to the tank. The lift pump feeds fuel to the injection pump via a disposable cartridge type filter. The filter is constantly vented of air by a bleed valve located on the filter head. This vent, combined with injector leak off, is connected to a high point on the main fuel tank.

The fuel injection pump is lubricated entirely by fuel oil and the excess is fed back to the filter via a non-return valve. A final filter is fitted beneath the inlet connection of the fuel injection pump.

REAR OIL SEAL CARRIER

The crankshaft rear oil seal is pressed into an aluminium carrier which is bolted to the cylinder block rear face, and fitted with a composition type gasket. The oil seal runs on the periphery of the flywheel mounting figure. After removing the carrier, the oil seal can be easily replaced. When fitting the carrier the seal must be aligned concentrically with the crankshaft if oil leaks are to be avoided.

SUMP

The pressed steel sump has a well and is bolted to the base of the cylinder block. A drain dip stick tube is located on the starboard side. The gaskets are made of cork and aluminium.

When fitting the sump ensure that the front face is flush with the block face before tightening up.
Hylomar non setting jointing compound should be used.

ROCKER COVER

The rocker cover is a steel pressing retained by screws and plain washers around the flanged edges. A cork and rubber gasket is set into the rocker cover flange to prevent oil leaks.

This gasket should give satisfactory service for up to ten removals of the rocker cover. Replace the gasket when it no longer provides an effective seal.

VALVES AND SPRINGS

The valves, which have 45° seats, are mounted vertically in the cylinder head. The valve positions are: inlets 2, 3, 6 and 7 and exhausts 1, 4, 5 and 8. The valves all have the same head diameter but are not interchangeable. The inlet valves are 0·125 in. (3·17 mm.) longer than the exhausts. Valve stems are phosphate coated to improve durability and prevent scuffing during 'running in'. A neoprene oil seal is fitted to each valve stem immediately below the valve spring retainer. The valve springs are of a symmetrical design and can be fitted either way round. Valve spring retention is by a steel retainer and tapered collets, which have three ribs locating in corresponding grooves in the valve stem. The collets do not grip the valve stem, but allow the valve to rotate during engine operation, thus reducing wear and promoting longer life.

ROCKER SHAFT AND TAPPETS

The rocker shaft assembly is retained by four bolts fitted with plain washers.

The rocker arms which are banded are arranged in pairs with rockers on either side of a rocker shaft support. A compression spring between each pair holds them against the supports, the end rockers being retained by the washers and split pins at the ends.

The chilled cast iron tappets can only be removed from the crankcase after removing the camshaft. Rockers are fitted at No. 2 and No. 7 with a radius ground to clear the rocker cover.

CAMSHAFT AND TIMING CHAIN

The camshaft used can be identified by the number 109E cast on the shaft at the rear end and by a band of paint (BLUE).

The camshaft runs in three steel-backed white metal bushes, which may have a standard size or a 0·020 in. (0·51 mm.) oversize outside diameter. The bushes available in service are pre-sized and require no machining after fitting. When one bush requires replacement it is advisable to replace all three bushes as camshaft alignment may be affected if only one bush is changed.

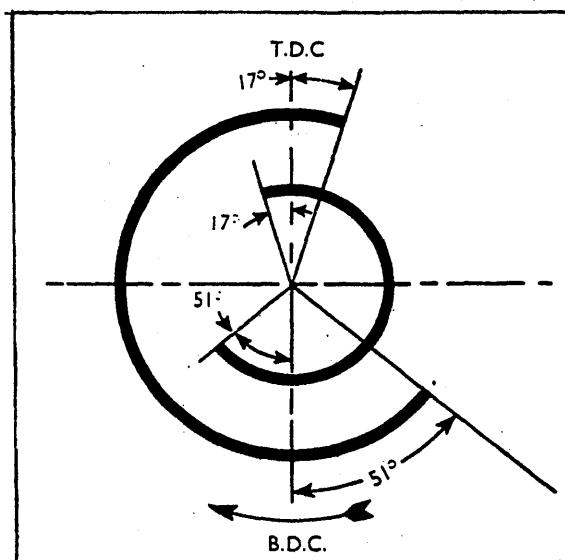
Remove the bushes using camshaft bearing remover Tool No. P.6031 with adaptor set P.6031-3. Locate the remover and guide detail '-3a' adjacent to the collar and with the spigot in the bearing. If the centre liner is being removed also use the centraliser detail '-3d'. Remove the bush by screwing down the wing nut.

The camshaft front and rear bushes are both approximately $\frac{1}{2}$ in. (19.1 mm.) wide, the front one having an additional oil hole for the rocker shaft oil feed, and the centre bush approximately $\frac{1}{3}$ in. (15.9 mm.) wide. Fit the bushes using a replacer detail '-3b' in addition to the adaptors previously used.

Ensure that the oil holes in the bushes and cylinder block are correctly aligned before fitting and that the splits in the bushes are upwards and outwards at 45° to the vertical. A line scribed on the remover and guide detail '-3a' can be used as a guide to facilitate oil hole alignment.

The camshaft is retained by a sintered iron thrust plate bolted to the cylinder block front face and located in a groove behind the camshaft flange.

A single row timing chain, with an automatic mechanical tensioner, is used. This tensioner consists of spring-loaded snail cam bearing against a pivoted tensioner arm. The timing chain runs across a synthetic rubber pad on the tensioner arm and in use the links wear two grooves in the pad so that the chain runs directly on the rollers. DO NOT dress the surface of the pad to remove the grooves.



Nominal Valve Timing Diagram

The sprockets incorporate timing marks to facilitate correct valve timing. Note the identification pin on the crankshaft sprocket. The crankshaft sprocket can be removed with remover Tool No. P.6116 and replaced with replacer Tool No. P.6032A or B.

CRANKSHAFT AND BEARINGS

The cast iron dynamically balanced crankshaft runs in five aluminium/tin main bearings. The shaft is heat treated to improve fatigue strength.

In new engines the crankshaft may be either standard or 0.010 in. (0.25 mm.) undersize on the main bearing journals and crankpins. The crankshaft main bearing journals are graded, the standard crankshaft webs being marked, adjacent to the journal, with a paint spot, BLUE for the smallest grade and RED for the largest. Where the crankshaft is 0.010 in. (0.25 mm.) undersize the grades are GREEN and YELLOW respectively.

The crankshaft main bearing journals may be ground 0.010 in. (0.25 mm.), 0.020 in. (0.51 mm.), undersize and the crankpins to 0.030 in. (0.76 mm.) undersize. When grinding crankshafts undersize it is important to maintain the correct fillet radii at all times. Re grinding will remove the benefits of heat treatment and thus reduce the life of the crankshaft.

The centre main bearing journal has a double radius of 0·070 in. (1·78 mm.) and 0·080 in. (2·03 mm.) and the rear main bearing has a double fillet radius, the inner radius of which must be maintained at 0·100 to 0·110 in. (2·54 to 2·79 mm.) when regrinding. The remaining main journal fillet radii are 0·080 to 0·094 in. (2·03 to 2·39 mm.). The crankpin journal fillet radii are 0·080 to 0·094 in. (2·03 to 2·39 mm.). The crankpin journal fillet radii are 0·080 to 0·094 in. (2·03 to 2·39 mm.). Grind the crankshaft revolving anti-clockwise when viewed from the front. Ensure that the fillet radii are smooth and free from visual chatter marks. The main bearing journal length between the thrust faces can be increased by up to 0·020 in. (0·51 mm.) providing an equal amount is machined from each face and the corresponding oversize thrust washers fitted. The crankpin length must not exceed 0·010 in. (0·25 mm.) oversize.

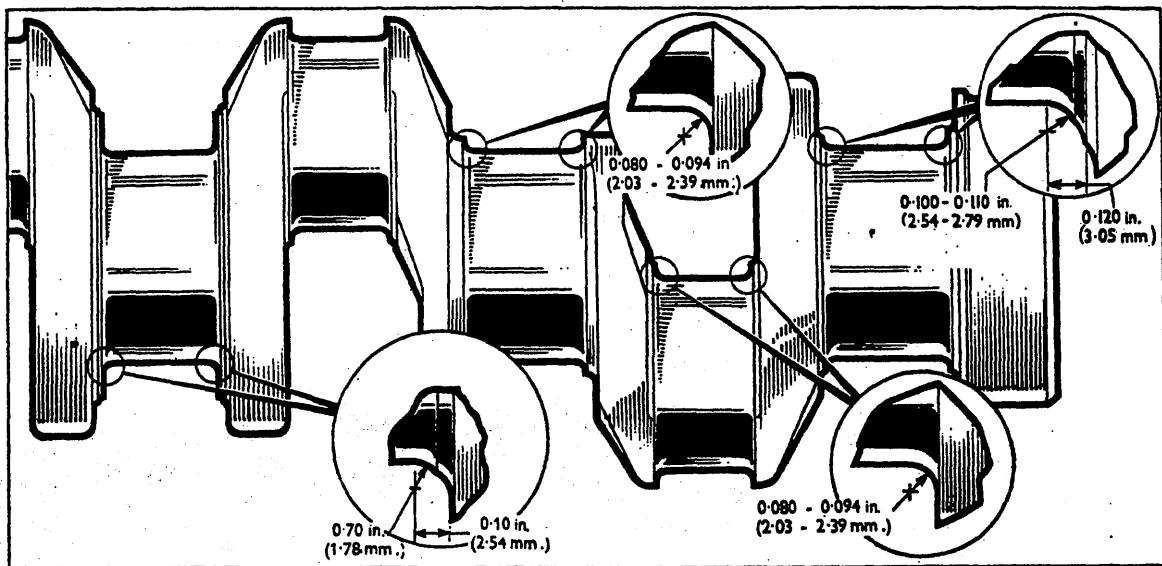
Main bearing journal and crankpin ovality should not exceed 0·0004 in. (0·010 mm.) TIR and taper 0·0005 in. (0·013 mm.). The centre main bearing run-out relative to the front and rear journals should not exceed 0·002 in. (0·05 mm.) TIR. The crankpins should be parallel to the main journals within 0·001 in. (0·02 mm.) and be within 0·005 in. (0·13 mm.) on either side of the centre line through No. 1 crankpin and main journal. The thrust faces should be smooth and square to the bearing journal within 0·0005 in. (0·013 mm.) TIR. After grinding, crankpins and journals should be polished, with a fine lapping paper and the crankshaft revolving clockwise to produce a good surface finish. Grinding will remove the surface heat treatment and reduce the overall life of the crankshaft.

Crankshaft thrust is taken by steel-backed white metal half thrust washers located in the cylinder block at the centre main bearing. Standard size washers and 0·0025 in. (0·064 mm.), 0·005 in. (0·127 mm.), 0·0075 in. (0·191 mm.) and 0·010 in. (0·254 mm.) oversize washers are available.

CONNECTING RODS

Connecting rods are H section steel forgings with detachable big end caps. The caps are located by two hollow dowel pins pressed into the connecting rod and retained by two bolts fitted without lockwashers. The connecting rod can be identified by the number forged on the web. An oil squirt hole machined in the connecting rod feeds oil from the crankpin to the non-thrust side of the cylinder bore.

The steel-backed big end bearing liners have aluminium/tin bearing surfaces. The upper liner which locates in the connecting rod incorporates an oil hole, the lower liner being plain. Undersize liners are available in 0·002 in. (0·05 mm.), 0·010 in. (0·25 mm.), 0·020 in. (0·51 mm.), 0·030 in. (0·76 mm.) and 0·040 in. (1·02 mm.) sizes.



Crankshaft Fillet Radii

The connecting rod small end bearing is a steel-backed bronze bush, which is not available in service, the connecting rod being serviced with the bush already fitted.

When dismantling an engine examine the piston markings to check the connecting rods for straightness. A heavy marking on the piston skirt above the pin on one side together with a correspondingly heavy marking below the pin on the other side indicates a bent connecting rod which should either be straightened or a replacement fitted. The connecting rod small and big ends should be parallel and square to the longitudinal centre line within 0·005 in. per inch (cm.) length.

When assembling a connecting rod to the piston ensure that it is fitted the correct way round. The marking 'FRONT' is embossed on the web to facilitate this.

CONNECTING ROD NUMBERING

Connecting rods are numbered when installed in the engine during manufacture, to facilitate correct reassembly should they be dismantled.

The number is stamped on the camshaft side of the big end so that a cap replaced with the numbers together must be in its original position. Never reassemble a bearing cap to another connecting rod.

It is advisable when removing connecting rods from an engine to check that the connecting rods have been colour coded correctly. The connecting rods are colour coded as follows
1 Red, 2 Yellow, 3 Blue, 4 None.

PISTONS, PISTON PINS AND RINGS

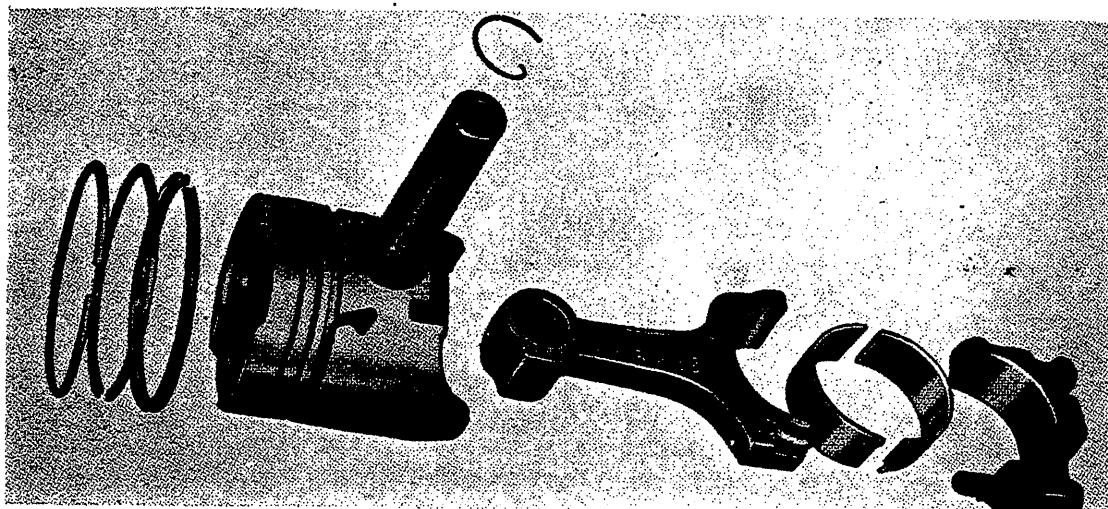
The pistons are made of an aluminium alloy and are of the solid skirt type with thermal slots in the oil control ring groove and the upper part of the piston skirt. The combustion chamber bowl is machined in the piston crown.

The piston should be fitted with the combustion chamber bowl offset to the left side of the engine, when facing the flywheel.

The piston pin is offset in the piston 0·04 in. (1·0 mm.) towards the thrust side of the engine.

The tubular steel piston pins are fully floating and are retained in position by circlips installed in grooves at each end of the piston pin bore. The piston pins are selected to give the correct fit in the piston pin bore and small end bush in the connecting rod. Pistons are only supplied in service complete with the piston pin, to ensure the correct fit. The piston pins should not be interchanged.

Three piston rings are fitted, two compression and one oil control ring. The lower compression ring is stepped externally on the bottom face and the upper ring is chrome plated and tapered on the periphery. Both rings are marked 'TOP' and must be fitted this way round. The oil control rings have narrow ring lands and may be fitted either way round.



Oversize pistons and rings are not available and replacement cylinder liners should be fitted. Pistons graded to cylinder bore size are fitted to new engines. One grade only is supplied for spares.

FLYWHEEL AND RING GEAR

The cast iron flywheel is located concentrically on the crankshaft flange and retained by six bolts fitted with washers and Loctite. A drive for the engine starter motor is provided by a ring gear shrunk onto the flywheel. An additional steel or cast iron weight is dowelled and bolted to the flywheel to increase inertia and provides a smooth running engine at low speeds.

The flywheel ring gear locates in a retention groove and can be removed by cutting between two adjacent teeth with a hack saw and splitting the gear with a chisel. In no circumstances should pressure be applied in an attempt to dismantle the ring gear for repositioning on the flywheel.

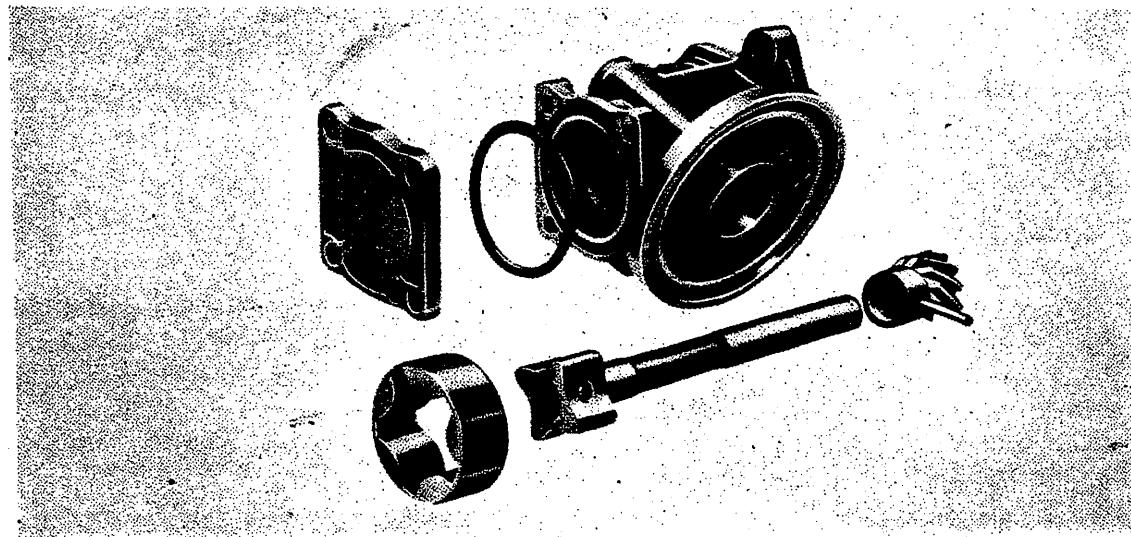
When replacing the ring gear it must be heated evenly to a temperature not exceeding 600°F (316°C) or the ring gear wear resistant properties will be destroyed. If the ring gear is heated by a naked flame place the ring gear on a bed of fire bricks and then play the flame in a circular motion onto the bricks about 1½ in. (38·1 mm.) from the inside of the gear until it reaches the required temperature. The correct temperature can be detected by using a special type of temperature sensitive crayon, or alternatively by polishing a section of the ring gear and heating until it turns dark blue. Fit the ring gear with the chamfers on the leading faces of the gear teeth relative to the direction of rotation. Allow the ring gear to cool naturally in air, DO NOT QUENCH.

The flywheel and ring gear assembly are dynamically balanced to close limits. The weight is located on the flywheel by three dowels and is retained by six bolts with spring washers.

THE OIL PUMP

The oil pump and filter assembly is bolted to the right-hand side of the cylinder block and can be removed with the engine in place. The oil pump, which is driven by a skew gear on the engine camshaft, has the full flow element type filter bolted to a mounting flange integral with the oil pump body.

Oil is sucked from the sump through a tube pressed into the cylinder block sump face. A spring-loaded filter gauze located on the end of this tube provides primary filtration. The gauze can be removed by bending back the retaining lug and sliding the gauze out sideways. A pressure relief valve oil return pipe is also pressed into the cylinder block sump face parallel to the inlet tube.



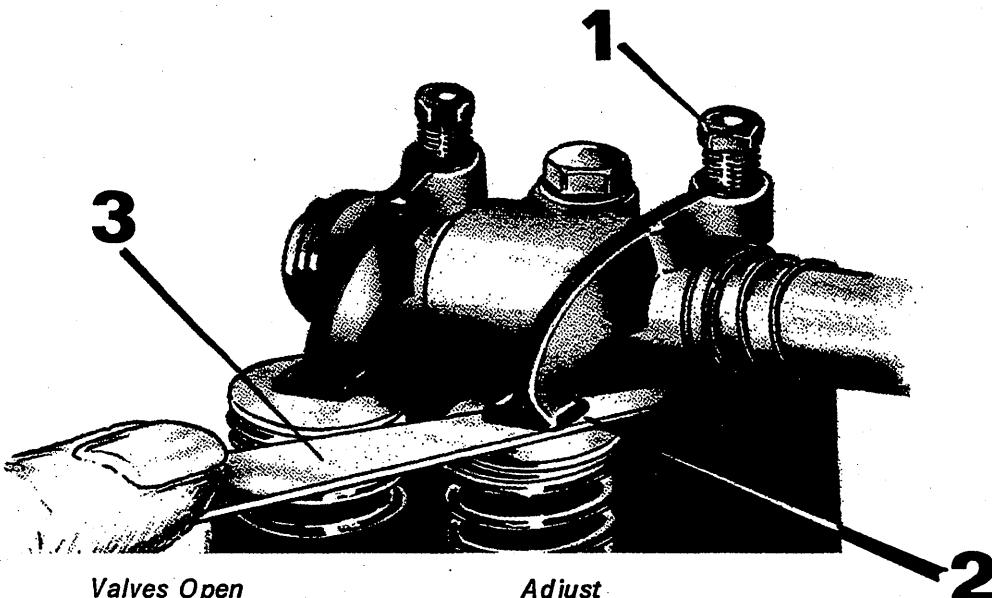
Eccentric Bi-rotor Type Oil Pump

THE OIL FILTER

The full flow type oil filter is screwed to a mounting flange integral with the oil pump body and is of the disposable cartridge type.

VENTILATION SYSTEM

A semi-closed positive ventilation system is fitted as standard and consists of a breather and oil separator and a connecting tube to the inlet manifold.

ADJUSTING VALVE CLEARANCE*Valves Open**Adjust*

1 Exhaust and 6 Inlet	3 Inlet and 8 Exhaust
3 Inlet and 8 Exhaust	1 Exhaust and 6 Inlet
2 Inlet and 4 Exhaust	5 Exhaust and 7 Inlet
5 Exhaust and 7 Inlet	2 Inlet and 4 Exhaust

**1 - ADJUSTING SCREW
2 - VALVE ROCKER ARM
3 - FEELER BLADE**

Venting the Fuel System

1. Open the throttle to maximum, ensure the stop control is in the run position.
2. Operate hand primer with filter vent open.
3. Slacken high pressure pipe unions on injectors.
4. Unscrew the vent screw one turn located on the side of the fuel injection pump and operate hand primer for a few seconds. When fuel issues free of air bubbles when the fuel lift pump hand primer is operated tighten the vent screw. Refer to illustration Fuel Injection Pump No. 2.
5. Operate the starter and observe the high pressure connections on the injectors when fuel issues from all four, tighten connections on injectors.
6. Start engine in normal way, using cold start device if fitted.

MAINTENANCE AND REPAIR

Section A

TOP ENGINE OVERHAUL – DECARBONISE CYLINDER HEAD AND REGRIND VALVES

Op. No.

- A1** Disconnect battery.
- A2** Shut off fuel supply.
- A3** Turn off seacock. Drain cooling system. Drain taps are located on port side of cylinder block and underside of heat exchanger.
- A4** Disconnect sea water outlet hose on top of sea water pump.
- A5** Disconnect exhaust pipe from exhaust manifold, also throttle cable.
- A6** Remove all four injector high pressure supply pipes ($\frac{1}{8}$ in. AF unions) and protect exposed unions on injectors and pump with plastic caps.
- A7** Loosen hose clips on two hoses connecting exhaust manifold to engine.
- A8** Remove two $\frac{1}{2}$ in. AF bolts from thermostat housing and detach complete with thermostat.
- A9** Remove six $\frac{1}{2}$ in. AF bolts securing manifold to cylinder head and remove manifold.
- A10** Remove all injector leak off pipes ($\frac{7}{16}$ in. AF) and fuel filter vent to No. 4 injector.
- A11** Disconnect alternator tensioner bracket $\frac{1}{2}$ in. AF and slacken alternator mounting bracket and remove drive belt.
- A12** Remove five $\frac{1}{2}$ in. AF bolts securing inlet manifold to cylinder head and leave manifold in position.
- A13** Remove four $\frac{1}{4}$ in. UNC posidrive screws and detach cylinder head cover. Remove four $\frac{9}{16}$ in. AF bolts evenly and remove rocker assembly.
- A14** Remove eight pushrods and retain in assembly order.
- A15** Slacken ten $\frac{11}{16}$ in. AF cylinder head bolts evenly until loose, remove bolts and cylinder head. Place head on a suitable working surface taking care not to damage the protruding injector nozzles.
- A16** Remove eight $\frac{1}{2}$ in. AF nuts and washers and withdraw injectors and copper seating washers from cylinder head.
- A17** Using a valve spring compressor withdraw all valves and retain in assembly order. Thoroughly clean cylinder head of all dirt and carbon, paying particular attention to inlet and exhaust ports and injector holes. If possible clean the inlet ports with a rotary wire brush to give a polished finish particularly in the area around the valve throat where the airflow fin is at its widest point. A smooth unobstructed surface in the inlet ports will ensure highest engine performance. Clean all valves of carbon deposits and re-cut seats if necessary to limits outlined in reference data. Lightly regrind all valves before assembly.
- A18** Re-assemble valves in cylinder head, if new valve guides have been fitted the valves should be reseated with lapping compound then smear an anti-scuffing compound such as colloidal graphite on valve stems, fit new stem oil seals and assemble springs, retainers and split cones.

- A19** Check valve rocker oil feed hole is clear of obstruction, hole is located at No. 1 rocker pillar base.
- A20** Clean tops of pistons of carbon and remove all traces of old cylinder head gasket from top of cylinder block. Thoroughly clean out exhaust manifold. Check injector sprays and pressure setting. Take care no gasket material enters push rod holes.
- A21** Fit new gasket and carefully position head on engine, replace the ten bolts and tighten evenly in the order below to 65–70 lb./ft.
- A22** Reassemble engine in reverse order A1–A16 using new joints and copper seating washers where applicable.

TO SERVICE FUEL INJECTION PUMP

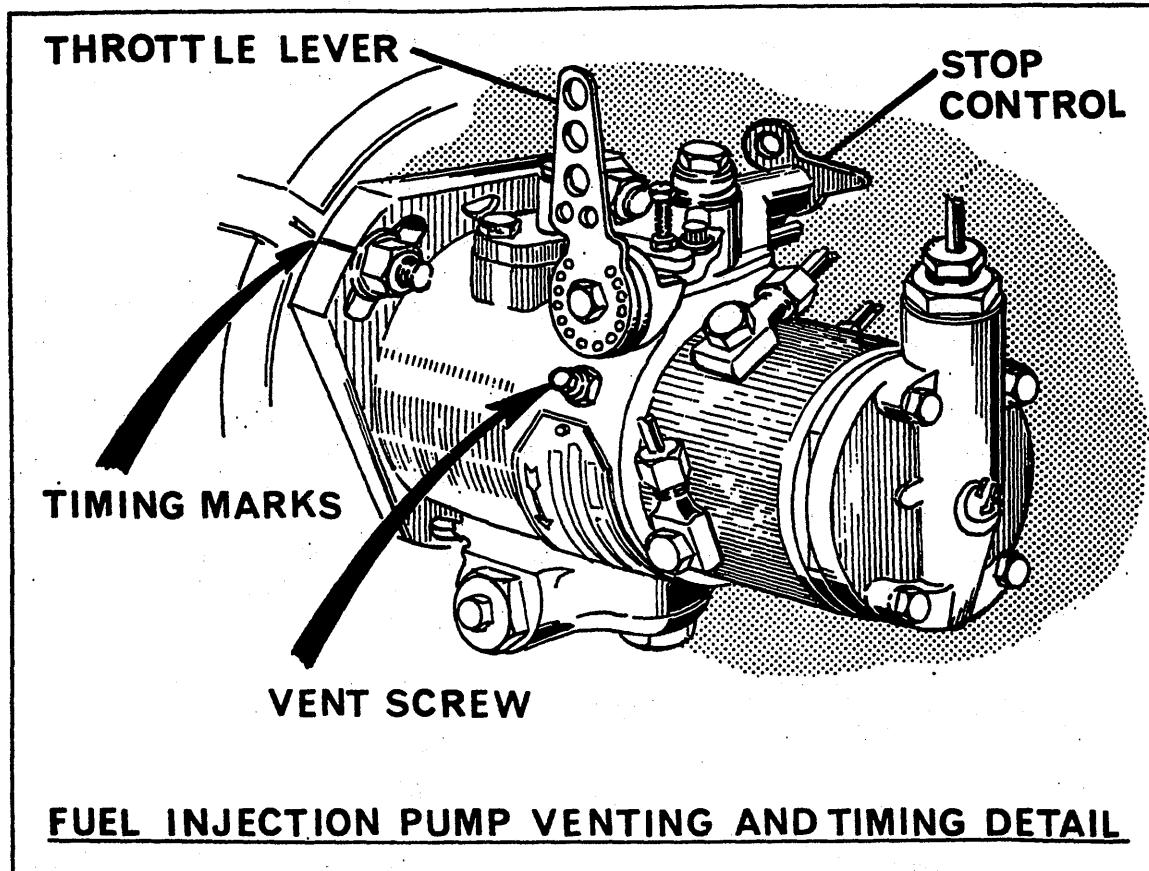
Op. No.

- B1** Disconnect battery.
- B2** Shut off fuel supply.
- B3** Remove fuel injector high pressure pipes.
- B4** Disconnect fuel feed and return pipes from top of injection pump.
- B5** Disconnect stop cable and return spring, also throttle cable from pump.
- B6** Remove three $\frac{1}{2}$ in. AF nuts securing pump to chaincase and withdraw pump to the rear, note position of master tooth on drive shaft for ease of re-assembly.
Note: It is necessary to remove the port bearer before removing the fuel injection pump.
- B7** Service pump in accordance with Lucas-CAV schedule. (Lucas-CAV agent).
- B8** Reassemble pump in reverse order and vent system before attempting to start engine. Ensure timing marks on pump flange and chaincase are aligned as in illustration No. 2.

TO SERVICE FUEL INJECTION PUMP DRIVE CHAIN AND SPROCKETS

Op. No.

- C1** Carry out operations B1–B6.
- C2** Drain fresh water from cylinder block.
- C3** Remove alternator drive belt, fresh water pump pulley ($4 \times \frac{1}{2}$ in. AF bolts) and crank-shaft pulley $\frac{5}{8}$ in. AF bolts).
- C4** Remove sea water pump ($\frac{1}{2}$ in. AF bolts) and drive coupling to pump and swing pump out of the way still attached to hoses.
- C5** Remove twelve $\frac{7}{16}$ in. AF bolts and one $\frac{1}{2}$ in. AF bolt from chaincase cover and carefully lever off cover from either side taking care to leave the two locating dowels in position.
- C6** Fit the crankshaft pulley bolt and a suitable spacer to prevent damaging the thread in the crankshaft and turn the crankshaft until the removable link in the duplex chain is in the position shown in illustration No. 3 below. Withdraw the link and remove the chain.
- C7** Remove the $\frac{7}{16}$ in. AF bolt and ball race retainer.
- C8** Apply heat to the chaincase in the area around the driven sprocket. When approximately 100°C carefully lever out sprocket and ball race assembly.
- C9** Using crankshaft sprocket remover tool No. S2340 locate on sprocket and draw off sprocket.
- C10** Locate new sprocket on crankshaft, align keyway with crankshaft key and drive sprocket on with a suitable brass or aluminium drift. Fit sprocket dowel.



Tighten the bolts as shown in Fig. 1. This should preferably be done with the engine hot, using a Torque wrench and repeating the sequence in stages until the correct torque figure of 65/70 lb./ft. (8.9-9.7 kg./m.) is achieved. After this operation it will be necessary to reset the valve clearances.

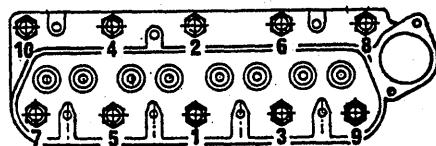
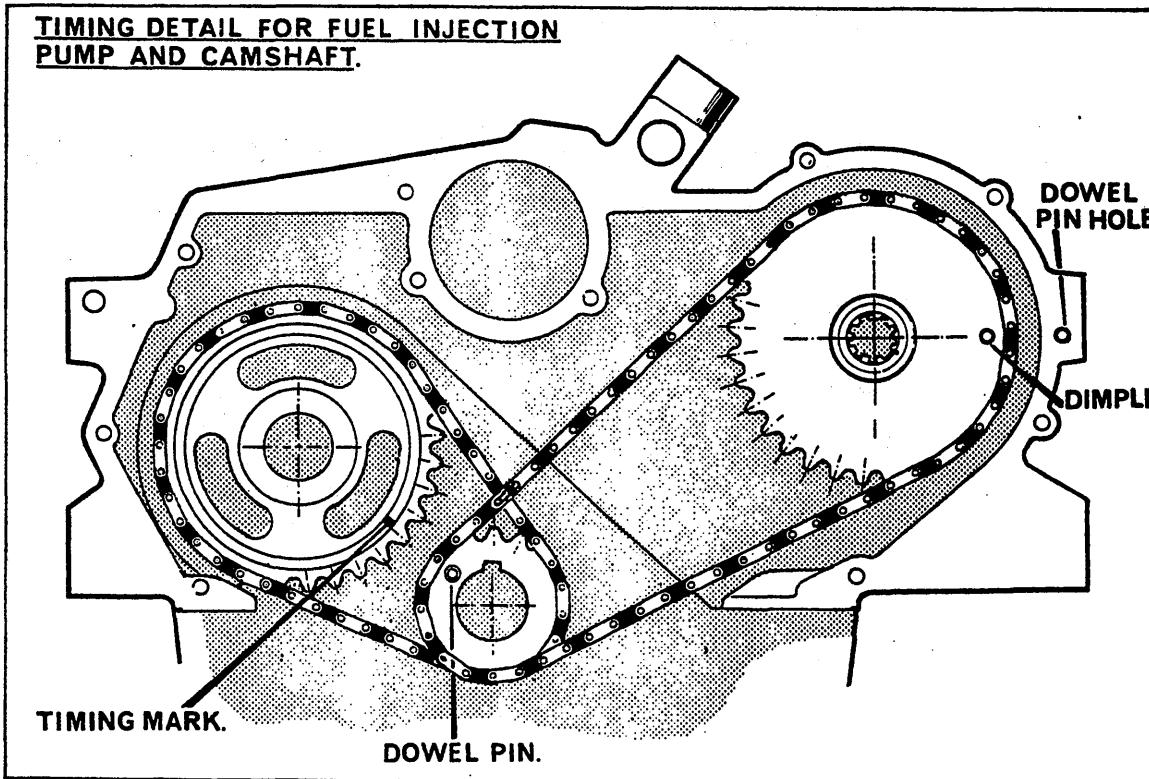
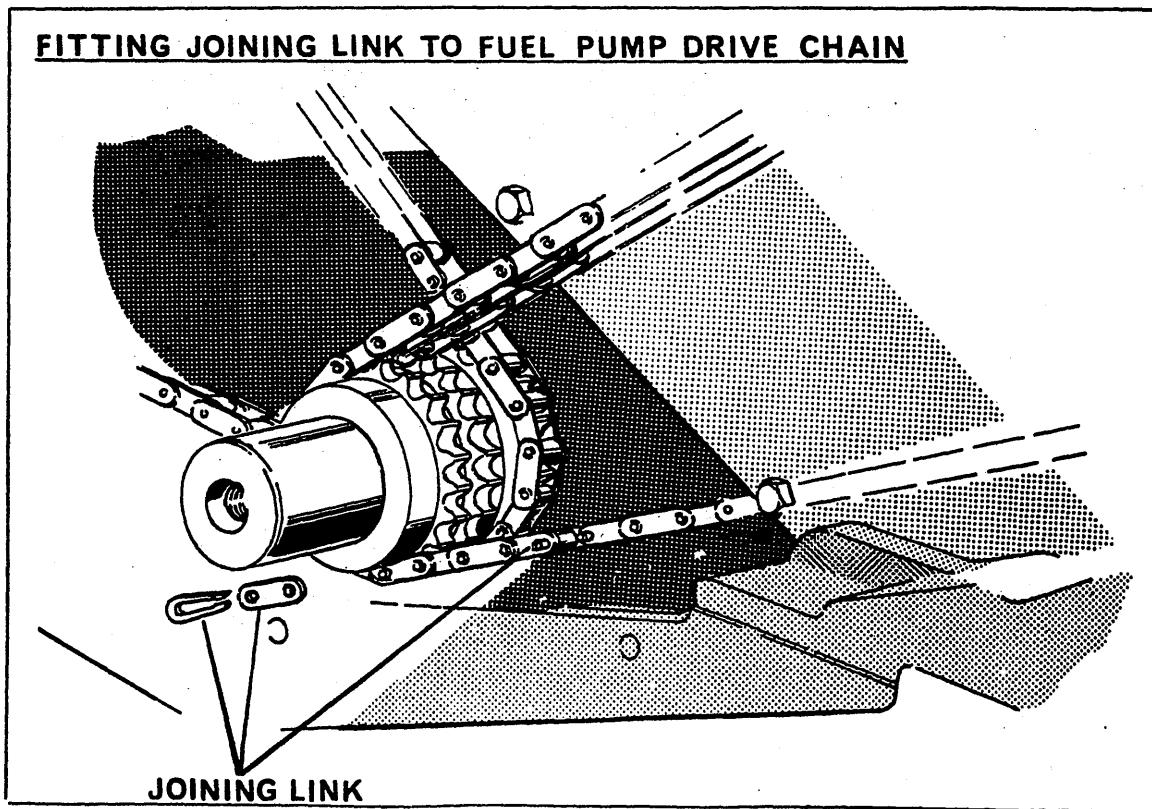
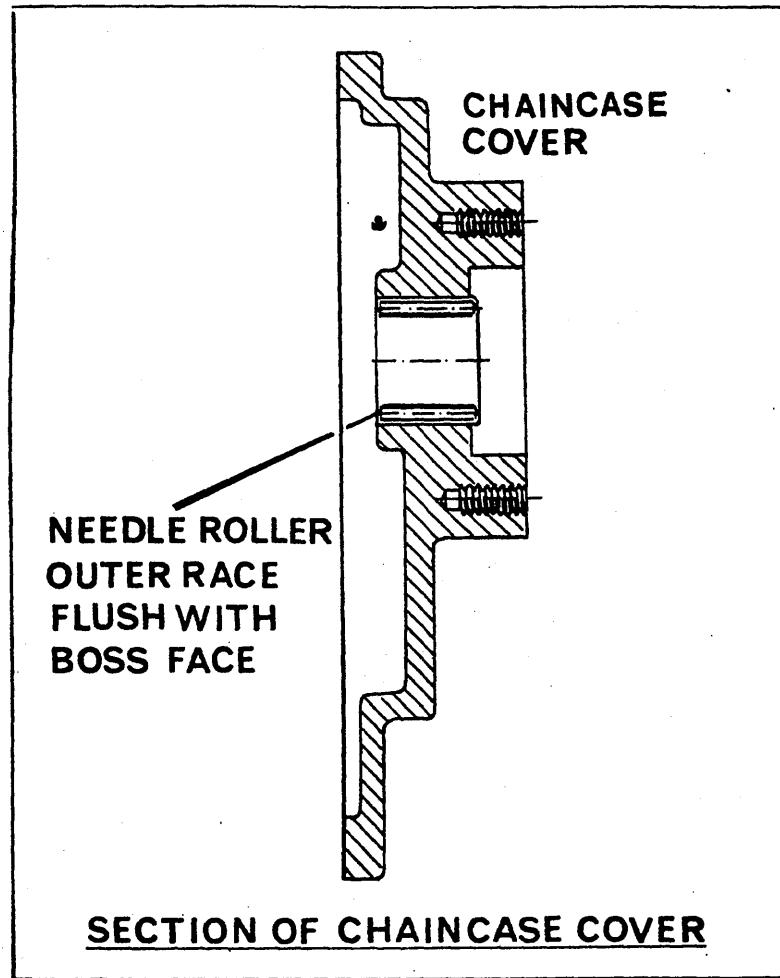


Fig 1 CYLINDER HEAD BOLTS

- C11 To replace ball race on driven sprocket, drive off old race with a drift and press on replacement ensuring that ball race is properly seated against shoulder.
- C12 To replace needle roller inner race use tool No. S2350 and draw off race and press on replacement flush with end of sprocket hub.
- C13 To replace needle bearing outer race in chaincase cover press out race with tool No. S2360 and with the tool fit replacement as shown in illustration No. 4 below.
- C14 If necessary overhaul fresh water pump as outlined in Section D below.
- C15 Heat chaincase again and press in sprocket assembly ensuring that it is fully seated against shoulder. Check this by placing a straight edge on sprocket face and measuring gap between straight edge and chaincase joint face at three different points. Assemble ball race retainer and bolt.
- C16 Turn crankshaft until timing mark on camshaft sprocket is opposite dowel on crankshaft sprocket, fit duplex chain and position pump sprocket so that its timing mark is opposite right hand dowel on chaincase and chain ends are in position to accept joining link. See illustration No. 3 below.
- C17 Fit joining link and retaining clip with open end facing opposite direction of rotation. Remove bolt from crankshaft and reassemble in reverse order C1-C5 and B1-B6. See illustration No. 5, illustration No. 3 and No. 4 and No. 5.



The #1 cylinder is at the flywheel end.

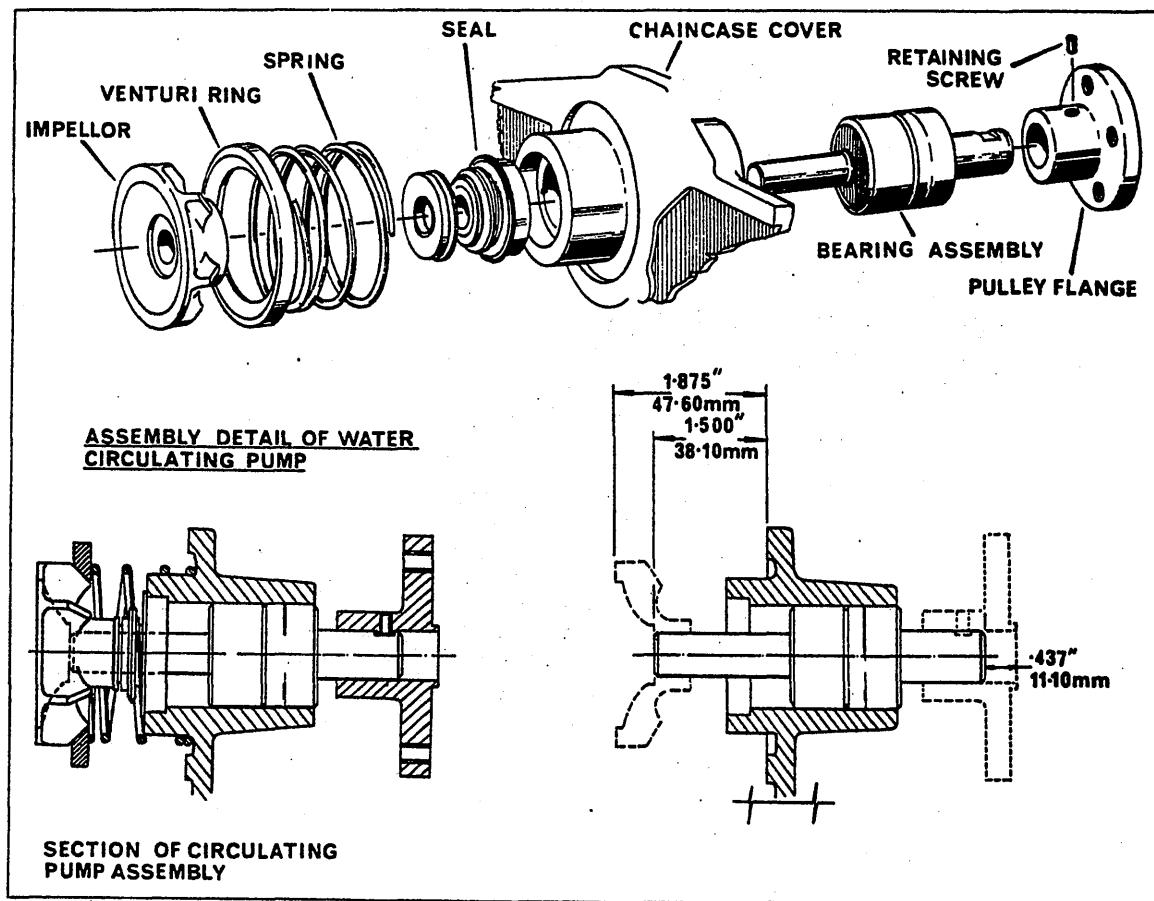


TO SERVICE FUEL INJECTOR PUMP DRIVE CHAIN ONLY

Op. Nos C1-C6 and C16-C17. Replace chain if wear greater than .002 in. per link.

TO SERVICE FRESH WATER PUMP***Op. No.***

- D1 Carry out operations C2-C5.
- D2 Withdraw fresh water pump pulley flange from pump shaft, after removing drive pin when fitted.
- D3 Remove bearing retaining clip if fitted and press out pump and bearing assembly from front to rear.
- D4 Draw off impellor and remove venturi ring and thrust spring.
- D5 Heat the chaincase cover and press in replacement bearing and shaft assembly using Loctite or equivalent compound. Fit the pump seal over the shaft and locate in the chaincase then fit seal thrust washer.
- D6 Press on pump impellor with spring and venturi ring in position shown. Press on pulley flange to correct dimension and replace drive pin when fitted. Check dimensions again before reassembling cover to engine. Ensure correct alignment of locking screw to flat on shaft. See illustration No. 6.
- D7 Reassemble in reverse order C1-C5. When tightening 3 bolts around the pump ensure the impellor turns freely in the timing case.



- G8** Carefully align the pivot pin hole of yoke with pivot pin hole in end bracket by moving solenoid assembly and fit pin (with head uppermost when installed on engine).
Note: A new pin MUST be used after dismantling a starter.
- G9** Fit the two bolts retaining the solenoid ensuring that the rubber sealing diaphragm is properly seated in the recess and fully tighten bolts.

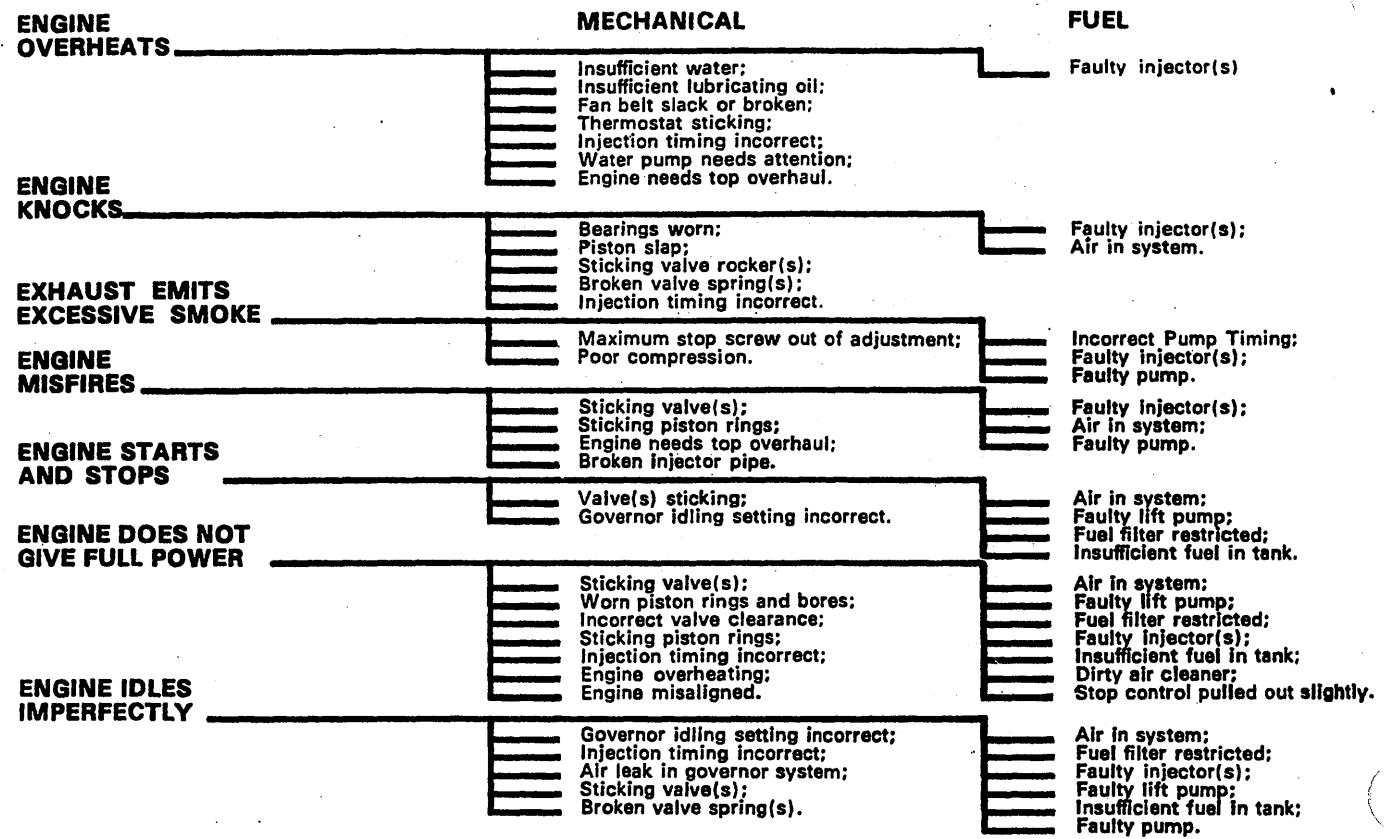
TO SERVICE INJECTORS

- H1** Carry out operations A6, A10, A16.
- H2** Insert plugs in cylinder head injector holes to avoid ingress of dirt.
- H3** Service injectors in accordance with Lucas - C.A.V. schedule (Lucas-C.A.V. agent).
- H4** Replace copper seating washers and reassemble in reverse order.

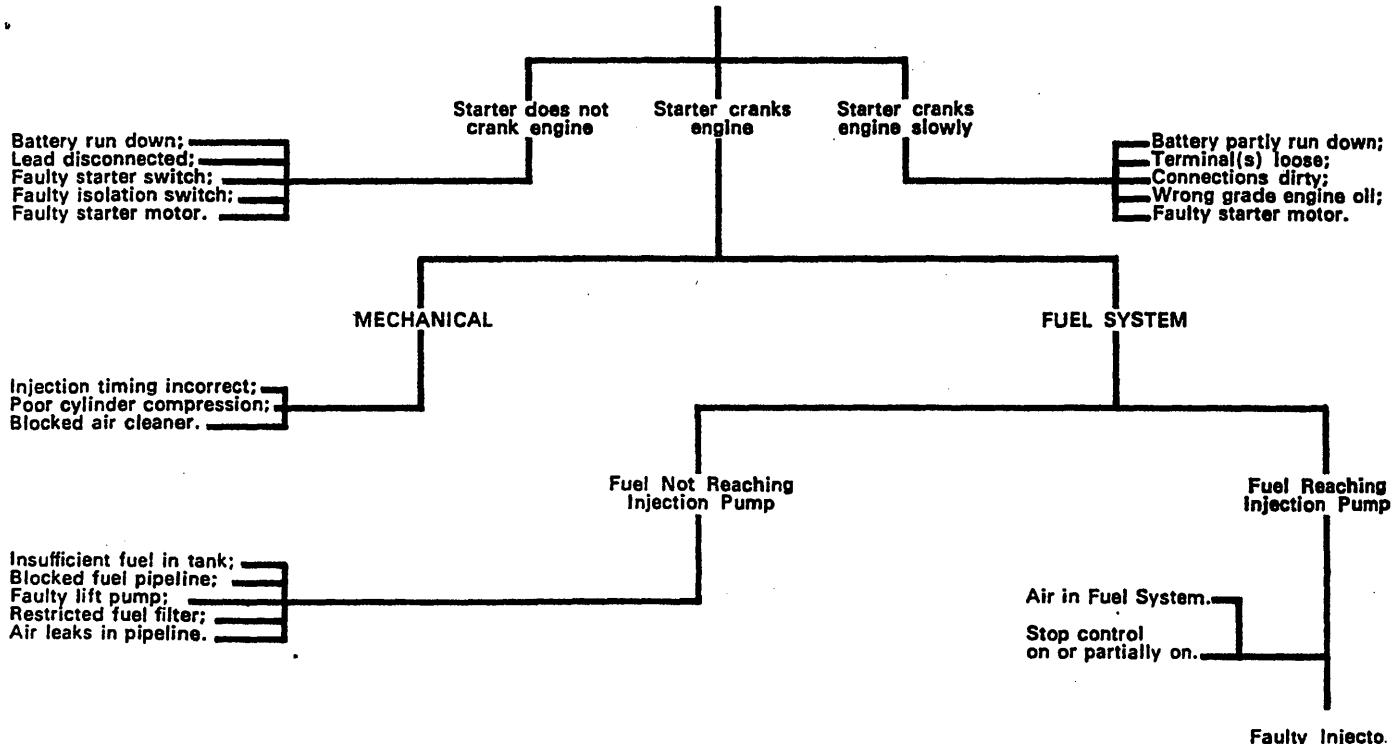
TO CHANGE FUEL FILTER

- J1** Turn off fuel supply.
- J2** Unscrew the securing bolt and remove the filter bowl and element.
- J3** Discard the elements and upper and lower sealing rings.
- J4** Wash out bowl with clean fuel oil. Do not use a cloth.
- J5** Unpack the new element and rings and fit new sealing rings to filter head and filter bowl.
- J6** Reassemble bowl.
- J7** Bleed system.
- J8** Run and check for leaks.

DIESEL ENGINE FAULT FINDING CHART

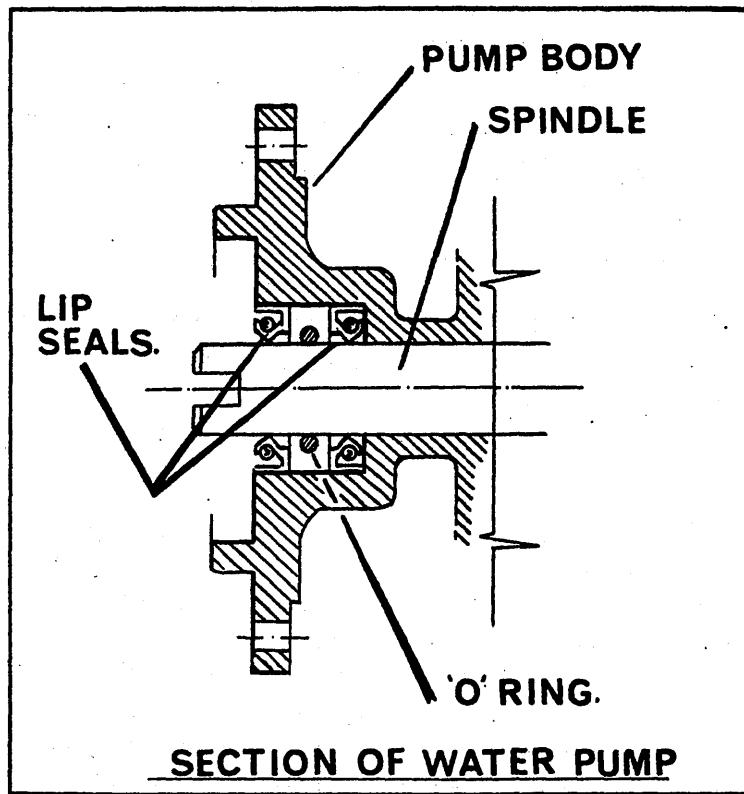


ENGINE WILL NOT START



TO SERVICE SEA WATER PUMP**Op. No.**

- E1** Shut off seacock. Remove hoses from pump.
- E2** Remove two $\frac{1}{2}$ in. AF bolts and withdraw pump and drive coupling.
- E3** Remove pump cover plate.
- E4** Pull out shaft with impellor and remove cam if worn. Replace seals and refit shaft and replacement impellor and cam. See section through sea water pump to ensure seals and 'O' ring are fitted in correct relationship to each other.
- E5** Check cover for wear marks, either replace cover or machine flat and square with bush. Check gasket and refit cover.
- E6** Replace pump and drive coupling.

**TO SERVICE CRANKSHAFT, BEARINGS, PISTONS AND CAMSHAFT****Op. No.**

- F1** Carry out operation A1–A15 inclusive.
- F2** Carry out operation B1–B6 inclusive and C2–C5 inclusive.
- F3** Drain lubricating oil and remove dipstick and extension tube.
- F4** Disconnect fuel feed from lift pump to filter and crankcase breather to inlet manifold. Remove inlet manifold complete with fuel filter.
- F5** Remove wiring harness and alternator.
- F6** Disconnect fuel supply from lift pump and remove pump (two $\frac{1}{2}$ in. AF bolts).
- F7** Remove three $\frac{1}{2}$ in. AF bolts and withdraw oil pump and filter.
- F8** Remove starter motor ($2 \times \frac{3}{16}$ in. AF bolts). Remove two $\frac{7}{16}$ in. AF bolts from forward face of flywheel housing and remove cover plate.

- F9** Remove gearbox if fitted and flywheel housing ($6 \times \frac{9}{16}$ in. AF bolts).
- F10** Remove flywheel and stubshaft ($\frac{9}{16}$ in. AF nuts) or flywheel inertia weight ($6 \times \frac{1}{2}$ in. AF bolts) and drive plate if hydraulic gearbox is fitted.
- F11** Invert engine and remove sixteen $\frac{7}{16}$ in. AF bolts securing sump.
- F12** Remove two remaining $\frac{7}{16}$ in. AF bolts from chaincase and remove chaincase complete with duplex sprocket and chain.
- F13** Bend over lock tabs and remove two $\frac{1}{2}$ in. AF bolts and camshaft sprocket and chain also chain tensioner pad.
- F14** Remove four $\frac{1}{2}$ in. AF bolts and crankshaft rear oil seal housing.
- F15** Remove eight $\frac{9}{16}$ in. AF connecting rod bolts and remove the bearing caps and retain in assembly order.
- F16** Remove ten $\frac{11}{16}$ in. AF bolts and remove main bearing caps and place in assembly order. Withdraw crankshaft and thrust bearings.
- F17** Push out piston/connecting rod assemblies through top of cylinder block.
- F18** Remove circlips from pistons and push out gudgeon pins, retain pins with pistons.
- F19** Remove two bolts securing camshaft thrust retainer and camshaft thrust bearing.
- F20** Withdraw camshaft.
- F21** Remove tappets (Cam followers).

Refer to dimensional data in this manual and check all wearing surfaces for deviation.

Refer to earlier pages for information on the replacement of cylinder liners, connecting rod small end bushes and camshaft bushes.

Re-assemble engine in reverse order F1–F21 with the following addition:

1. Ensure that the connecting rods are placed the correct way on the piston – one side of the con. rod is marked 'front'. Space the piston ring gaps at 120 degrees between each, liberally oil the assemblies and fit to the cylinder bores using a piston ring clamp.
2. When replacing chaincase ensure that the sump face is flush with the cylinder block sump face and position fuel pump drive sprocket centres using tool No. S2370. This will ensure correct chain tension and centering of the crankshaft pulley oil seal.
3. When fitting gearbox stub shaft to flywheel check runout on ground diameter. This must not exceed 0.003 in. Lightly tighten nuts and tap with hammer and drift until within above limit. Tighten nuts to 50 lb./ft. A special spanner is available for the purpose Part No. S2380.

TO SERVICE STARTER MOTOR

Service as for Lucas 25689F starter with the exception of pinion drive assembly as follows:

- G1** Remove starter from engine and clamp in a vice.
- G2** Unscrew and withdraw long clamping bolts. Remove yoke pivot pin.
- G3** Remove two bolts and remove solenoid assembly.
- G4** Withdraw end bracket.
- G5** Drive the circlip locking ring off the circlip towards the pinion and lever the circlip off the shaft. Remove the locking ring and then the pinion assembly.
- G6** Fit a replacement pinion assembly on shaft and ensure that the yoke is facing the correct way – the radiused portion of the arm must face towards the solenoid.
- G7** Fit the solenoid assembly over the yoke arm and then fit the circlip and ring and end bracket to the starter body and tighten the two clamp bolts.

OTHER OVERHAUL

CONTENTS	SECTION	PAGE
MARINE ENGINE ELECTRICAL SYSTEM.....	Q	
Activation by Fuel Pressure.....	Q.2	
Activation by Lube Oil Pressure.....	Q.4	
COOLING SYSTEM (EXTERNAL).....	R	
TRANSMISSIONS.....	S	
Type SA1 Manual.....	S.2	
Type SA0 Manual.....	S.9	
SA1 and SA0 Clutch Adjustments.....	S.21	
SA1 and SA0 Reduction Units.....	S.23	
Type RB - Freewheeling.....	S.25	
Paragon P-21 Series, Hydraulic.....	S.29	
Warner Hydraulic.....	S.35	

SECTION Q

Q.2

MARINE ENGINE ELECTRICAL SYSTEM

ACTIVATION BY FUEL PRESSURE (Push Button Start)

This system is supplied on all four and six cylinder Westerbeke engines beginning January 1975. Basically, the system is very simple and eliminates the need for a separate switch position to activate the engine alarm system, when supplied.

Starting is accomplished by operation of the start push button which causes the starting motor to crank.

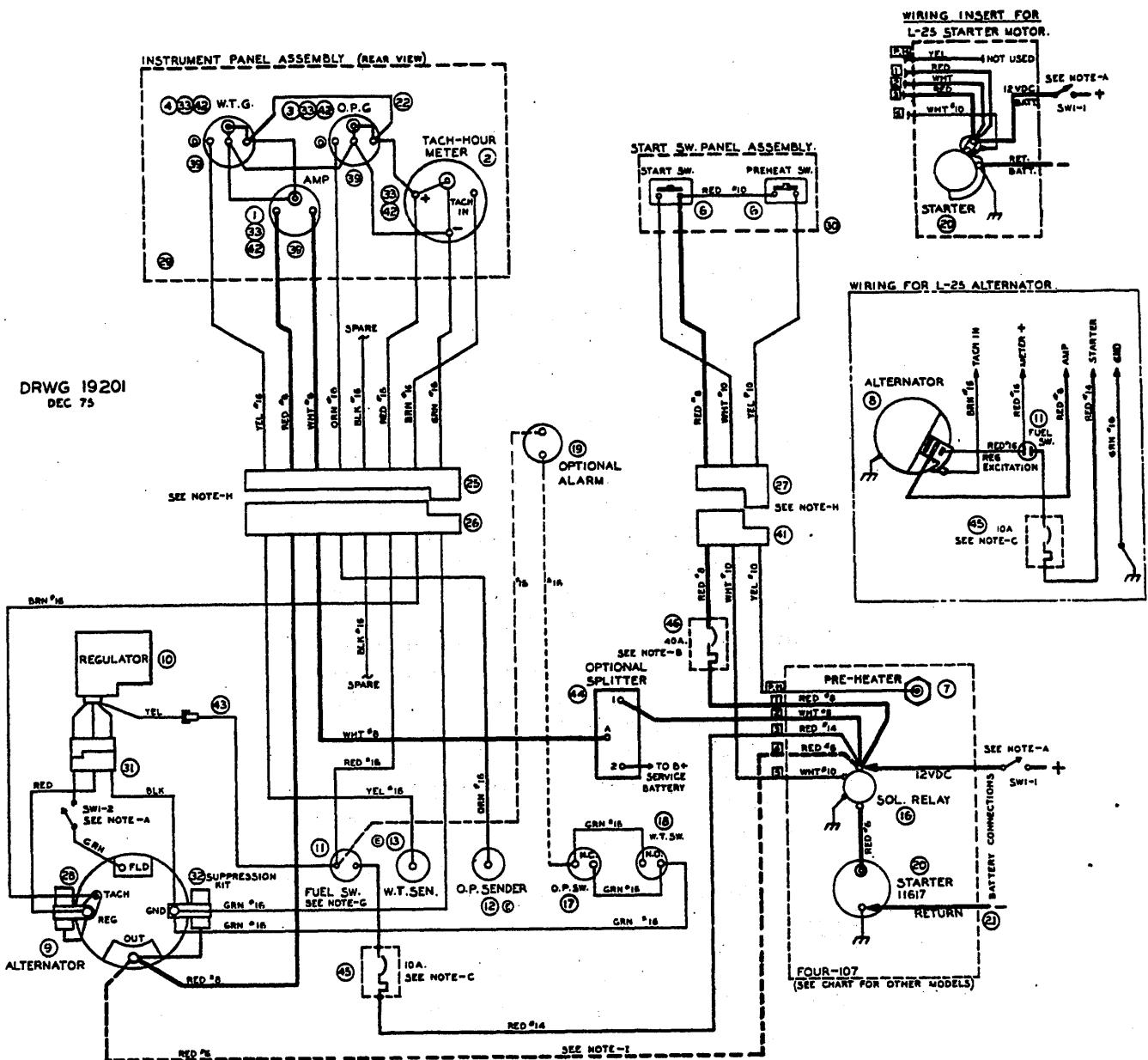
Once the engine is running, fuel pressure developed in the low pressure side of the fuel injection pump operates a fuel pressure switch. Voltage is then applied to the alarm system (if supplied) and to the alternator for excitation and for all instruments.

When the engine is stopped, fuel pressure drops and the fuel pressure switch removes voltage from these devices.

When an engine is supplied with a pre-heating device, the device is energized by a separate push button.

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

**ACTIVATION BY FUEL PRESSURE
(PUSH BUTTON START)**



NOTES ON OWNERS RESPONSIBILITY:

② AN ON-OFF SWITCH MUST BE INSTALLED IN THIS LINE TO DISCONNECT THE STARTER CIRCUIT FROM THE BATTERY IN AN EMERGENCY & WHEN LEAVING THE BOAT. ISOLATE DIESEL ENGINE STARTERS TYPICALLY DRAW 800 TO 800 AMPS WHEN CRANKING. THE DURATION OF INDIVIDUAL CRANKING CYCLES SHOULD NOT EXCEED 30 SECONDS. A SWITCH WITH CONTINUOUS RATING OF 175 AMPS AT 12 VDC WILL NORMALLY SERVE THESE FUNCTIONS, BUT SUCH A SWITCH MUST NEVER BE USED TO "MAKE" THE STARTER CIRCUIT. ADDITIONALLY, THE SWITCH MUST HAVE A SECOND POLE WITH A 5 AMP CONTINUOUS RATING TO SWITCH THE ALTERNATOR FIELD. WITHOUT THIS SECOND POLE DAMAGE WILL OCCUR TO THE ALTERNATOR IF THE SWITCH IS OPENED WHILE THE ENGINE IS RUNNING.

- ③ A 50 AMP FUSE OR BREAKER (SLO-BLOW PREFERRED) MUST BE INSTALLED IN THIS LINE.
- ④ A 10 AMP FUSE OR BREAKER (SLO-BLOW PREFERRED) MUST BE INSTALLED IN THIS LINE.

OTHER NOTES

⑤ WARNING: SENDER CONNECTION: CONTACT WITH B+ MAY DAMAGE SENDER.

⑥ SENDER & HEATER RETURNS ARE THROUGH ENGINE BLOCK.

- ⑦ IF ADDITIONAL PRESSURE SWITCHES ARE REQ'D TO START BOAT ACCESSORIES, A FLEXIBLE HOSE MUST BE RUN FROM THE FUEL PRESSURE MANIFOLD TO A NEARBY BULKHEAD AND ALL PRESSURE SWITCHES MOUNTED AT THE BULKHEAD, INCLUDING THE FUEL SWITCH PRESSURE SWITCH SUPPLIED.
- ⑧ APPLY SILASTIC OR TIGHT WOUND PLASTIC ELECTRICAL TAPE AROUND CONNECTORS CONNECTED.

ADDITIONAL NOTES:

- ⑨ THIS CONDUCTOR INSTALLED WHEN PANEL IS NOT ORDERED.

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 pre-heating 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.

COOLING SYSTEM (EXTERNAL)

1. DESCRIPTION

The Four Marine Diesel Engines 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.

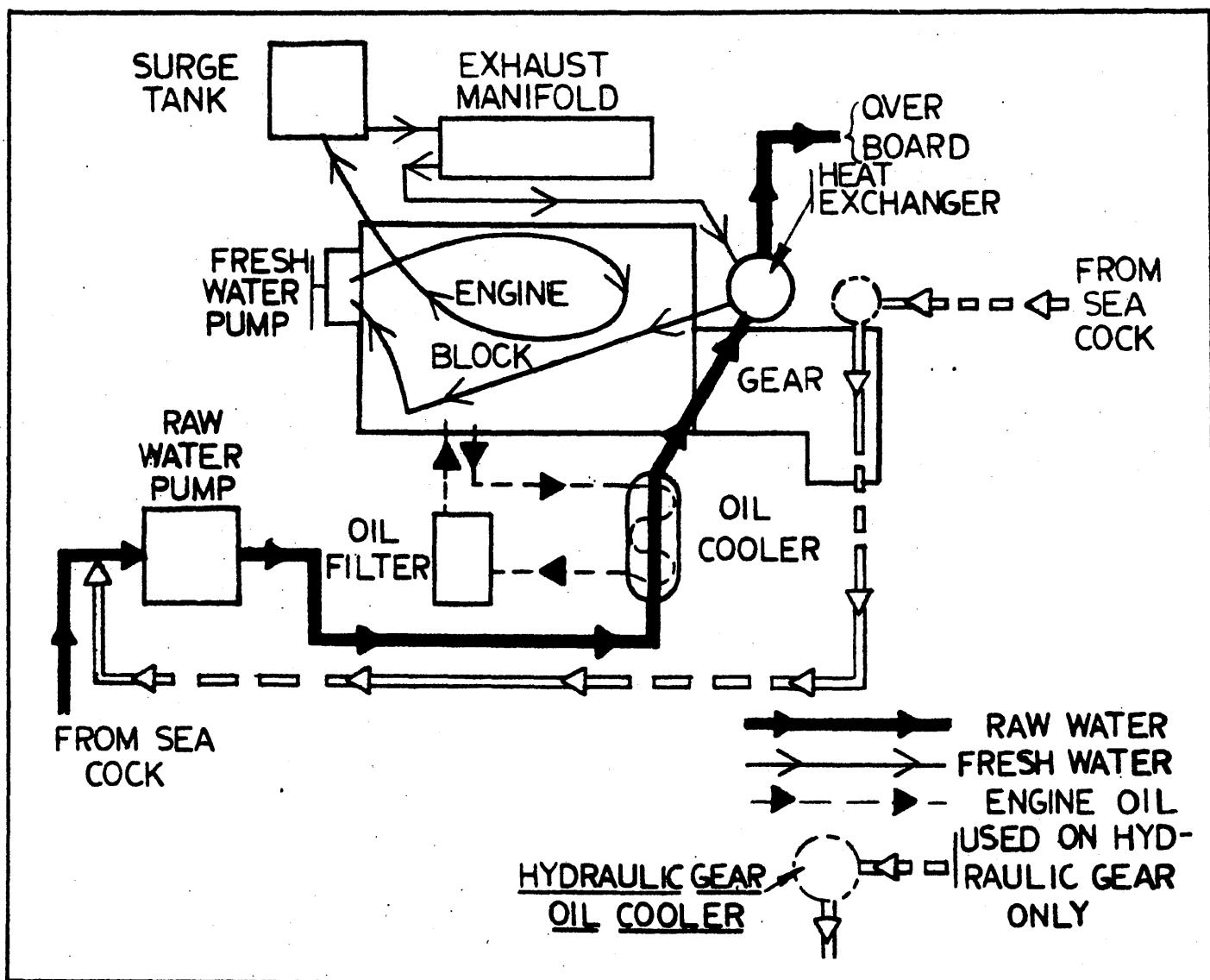
2. FRESH WATER SYSTEM

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 discharged into the lower part of the cylinder block, where it is circulated through the block and cylinder head by means of a centrifugal fresh water pump. 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 indirectly cooled by the unrestricted fast-flowing stream of sea water which absorbs the heat from the fresh



R.2

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 oil cooler to the heat exchanger. After passing through the heat exchanger (and transmission oil cooler if installed), the raw water is then piped overboard.

The oil cooler conducts heat away from the bearings and other friction surfaces by the lubricating oil, which is circulated by the oil pressure pump and cooled by the flow of sea water through the tubes of the oil cooler. When the engine is equipped with a water cooled transmission for a hydraulic or RB sailing gear the sea water is also circulated through the tubes of a transmission oil cooler, and then piped overboard. In this sense both the engine oil cooler and transmission oil cooler are heat exchangers.

4. SEA WATER PUMP

The water pump is mounted on the front of the timing cover and is driven from the fuel pump gear. 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.

5. DRAIN COOLING SYSTEM

Remove the pressure cap from expansion tank and open petcock on left hand side of cylinder block below the air filter, and the fresh water drain petcock on bottom left side of heat exchanger. (Turn petcocks counter-clockwise to open.)

6. FILLING COOLING SYSTEM

Ensure the petcock on left hand side of cylinder block and petcock on bottom of heat exchanger is closed. (Turn clockwise to close.)

Open air vent petcock on top of heat exchanger. Remove fill cap on top of expansion tank and pour coolant into system until coolant free of air bubbles issues from vent petcock. Close air vent petcock on top of heat exchanger and completely fill system to within one inch from top of tank.

7. IMPELLER REPLACEMENT

- a. Remove front end cover and gasket.
- b. Remove impeller.
- c. To replace the neoprene impeller coat the impeller and impeller chamber with TEXACO Regal Starfak No. 2 grease only.
- d. Align impeller key way 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 four screws and lockwashers.
- f. In the event of wear being present on end cover, the cover may be reversed.

8. THERMOSTAT

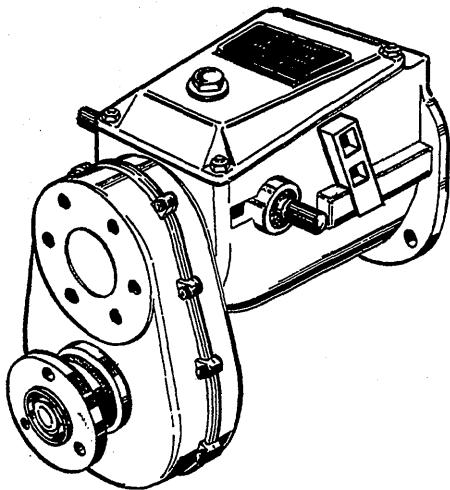
- a. Drain cooling system (approximately two quarts).
- b. Remove the nuts retaining the thermostat housing to the cylinder head and lift-up housing.
- c. Lift out thermostat.
- d. Test the opening temperature by placing the thermostat in water. Raise to the temperature stamped on bottom of thermostat.
- e. If thermostat fails to open, fit new thermostat. Allow the temperature to cool. If it sticks open, renew new thermostat.
- f. Install thermostat with new gasket and secure thermostat housing to cylinder head.
- g. Replace coolant, remove, or if system was drained, fill expansion tank to within one inch from top of tank with clean fresh water and a suitable corrosion inhibitor or antifreeze solution.
- h. Start engine and run until normal operating temperature is reached. Stop engine, carefully remove expansion tank filler cap and add coolant as required.

9. REMOVE SEA WATER PUMP

- a. Remove hoses from pump.
- b. Remove the four bolts securing pump to adapter plate, and pull pump away from plate.
- c. Remove drive tang between water pump coupling and fuel pump drive gear.
- d. To replace the pump, reverse the procedure above, using sealing compound. (Rector seal or its equivalent on inlet and discharge hose connections to prevent air leaks. Secure with hose clamps.)

L25 TRANSMISSION

MANUAL MARINE REVERSE GEAR



SPECIFICATIONS

O/A Length (Direct Drive)	. . .	10 in.
O/A Length (Reduction 2:1)	. . .	12 $\frac{1}{4}$ in.
Maximum Width	. . .	9 $\frac{1}{4}$ in.
Weight (Direct Drive)	. . .	28 $\frac{1}{2}$ lb.
Weight (Reduction 2:1)	. . .	41 $\frac{1}{2}$ lb.
H.P. Rating	. . .	1.5 h.p. per 100 r.p.m.
Torque Capacity	. . .	50 lb./ft.
Maximum R.P.M.	. . .	4,000 r.p.m.
Astern Revolutions	. . .	79% of Ahead
Lubrication – Splash	. . .	S.A.E. 30 Oil
Oil Capacity:		
Direct Drive	. . .	1 pint
2:1 Reduction	. . .	1 $\frac{1}{2}$ pint

DESCRIPTION

The Forward Drive is engaged by moving the gear lever forward which engages the double friction clutch. The operation takes place through a ball-bearing control operating a system of toggles which force home a set of plungers, thus clamping together a series of hardened steel friction discs which are interleaved, alternative plates being attached to the engine shaft and propeller shaft. Additionally, at the engine end a split cone clamps the engine shaft and frictionally locks the epicyclic gearing to it. The double clutch arrangement eliminates entirely the slight rattle at low speeds noticeable in the normal type of epicyclic gear.

The Neutral Position is obtained with the lever midway between forward and reverse, the forward and reverse drives are then released and permit the gearing to run idle.

The Reverse Drive is obtained by drawing the lever right back. This releases the forward drive and contracts a lined brake band by means of a cam, thus clamping the outer portion of the gear and causing a reverse motion of the propeller shaft through epicyclic gearing. The reverse drive is approximately 79% of the engine speed.

IMPORTANT: See that oil level is maintained in the reverse gear and reduction drive, if fitted.

ADJUSTMENT OF GEAR

First remove Inspection Cover of Gear Box.

AHEAD CLUTCH (Ref: Plate "M")

Rotate the drum M4 until the locking tab M20 is observed. This tab locks the aft part of drum to the forward part and engages in castellations cut in the forward portion. Lock the drum by pulling the Gear Control Lever into reverse and slack off the set screw M22 securing locking tab. Take care not to slacken too far and drop the screw into the gearbox. Lift tab out of the slot. Tighten the Ahead Clutch by turning the aft portion clockwise one or two divisions. Do NOT overdo this, otherwise you may burst the drum since tremendous pressure can be exerted by the leverage obtained through the toggles. These toggles M23 must throw over dead centre and are thus self-locking in Ahead. There must be NO continual strain on the Operating Collar such as would be caused by constant pressure on the gear lever. The lever is held lightly in position in neutral by means of a roller which engages the indent in the cam plate. See illustration on page:S2

REVERSE BAND

If the gear slips in reverse, remove Inspection Cover. Tighten the hexagon lock nut M43 slightly so that drum is locked when lever is pulled right back. Do NOT overtighten or the reverse band will drag in Neutral and Ahead. This will cause overheating and loss of power. When the correct adjustment is found, replace top cover. If the lock nut is slack remove and give a sharp blow to the top locking portion and re-assemble.

REDUCTION GEAR

The drive is by triple roller chain and all bearings are Ball Bearings. THERE ARE NO ADJUSTMENTS. Careful alignment with the Propellor Shaft is VERY IMPORTANT. The Gear Box and reduction gear have a common lubricating system.

CHANGE the oil once per season or every 500 hours, whichever is the more frequent. To DRAIN OIL, attach sump pump to tube on side of gearbox having first removed the hexagon plug M49.

SERVICE INSTRUCTIONS

Normal adjustments for the reverse gear are given on page S2 and particular attention is directed to notes on remote gear controls given below. 90% of all gear troubles can be traced to distant controls which are either badly designed, are too flimsy, or cause the cam roller to ride out of the indent in the camplate in Neutral. Do NOT use long or heavy levers and try to arrange that the remote lever is upright in the Neutral position, otherwise it may drag on the gear shift and cause the reverse band to bind in Neutral. It will also impose a constant load on the operating collar which will heat and then wear from undue friction when running in Ahead.

IF GEAR TROUBLES SHOULD DEVELOP, first make an examination and find if:

- (a) The controls have bends which will flex and weaken,
- (b) Have elbows or joints which strike against the floor or bulkheads or adjacent parts, thus preventing full pressure and throw at the gear.
- (c) See that joints are not stiff or rusty and keep them lubricated.
- (d) See that control handle does not strike the dash or pull loose from the bracket so that full travel and pressure fail to reach the gear.
- (e) See that the controls do not cramp, rub or stick so as to maintain a constant pressure against the trunnions of the operating collar and so cause heat and wear from undue friction when running in Ahead.

(f) Check the adjustments of both AHEAD and REVERSE to see that these are correct.

(g) Check for worn or unevenly adjusted Toggles and Toggle Links. These may have been replaced at some time and were not correctly adjusted to produce even pressure on the clutch plates through the plungers. Examine the links; they should all come into correct closed position at 'A' as shown in Sketch Fig. 1. Should one of the links close up and two remain open as in Fig. 2, then the link that shows correct should be filed slightly at 'A' until all bear equally at this point when closed. If two links show correct and the third open, then both closed ones must be filed slightly until this space is closed by all three toggles. As this is most important when fitting new toggles it is best to order three complete sets of toggle assemblies comprising Parts Numbers M24, M25, M28, M23, M26 and 27. When adjustment is fairly tight, the lever should throw in with a snap and require a sharp pull to disengage the toggles.

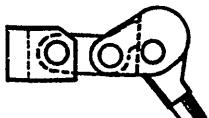


FIG 1

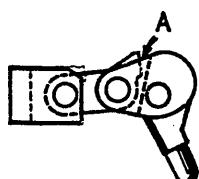


FIG 2

IMPORTANT

Ahead clutch must not be adjusted so tight that toggles will not close up with links at 'A' Fig. 2. Fig. 1 shows correct position with central pin just past dead center and therefore locked in ahead without constant pressure on the control lever and operating collar.

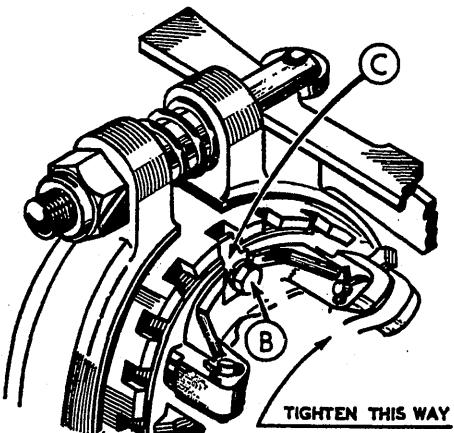


FIG 3

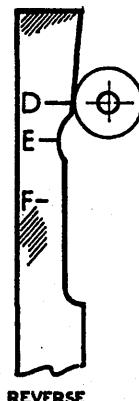


FIG 4

ADJUSTMENT OF REVERSE BAND

Pull control lever aft until rollers rests on cam at 'D', see Fig. 4. Now tighten nut sufficiently to lock drum. Do not overtighten the nut so as to cause the band to pinch the drum as the roller rides out of neutral notch between 'E' and 'F'. Figures 4, 5, and 6 show relative positions of the cam roller and cam plate in reverse, ahead and neutral.

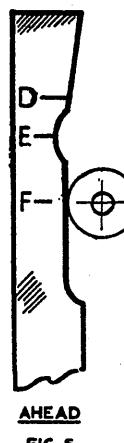


FIG 5

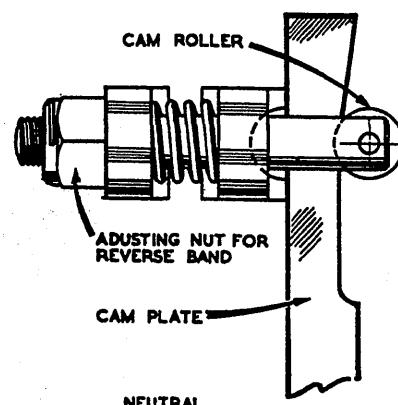


FIG 6

ADJUSTMENT OF AHEAD DRIVE

Turn drum so that tab 'C' is at top position. See Fig. 3. Pull control lever aft so as to lock drum. Slack off screw 'B', lift tab 'C' out of slot. Tighten ahead clutch by turning clockwise aft portion that carries toggles. Correct adjustment is important. If too tight gear will not remain in ahead. See Fig. 2. If too slack the clutch will slip under load. A notch or two either way will make all the difference. Note the tab is offset and can be reversed for closer adjustment.

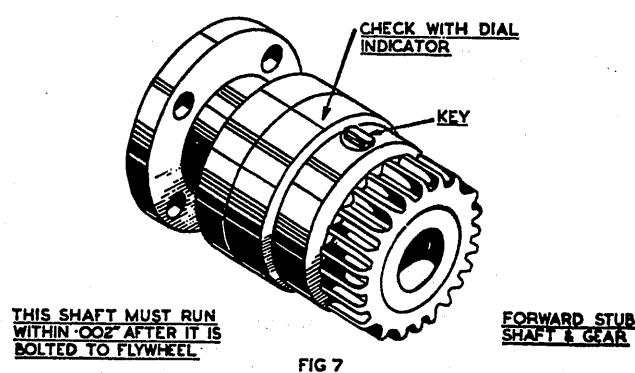


FIG 7

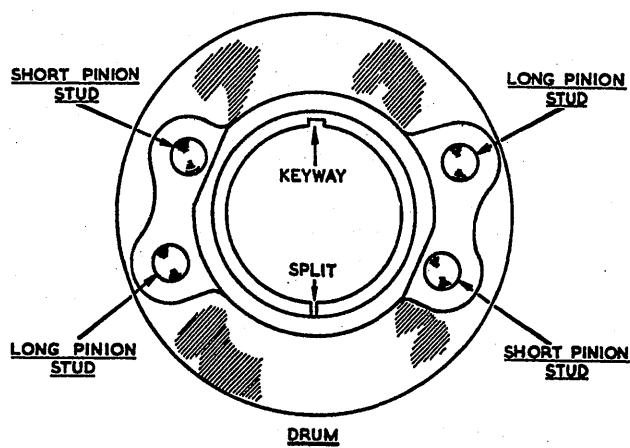
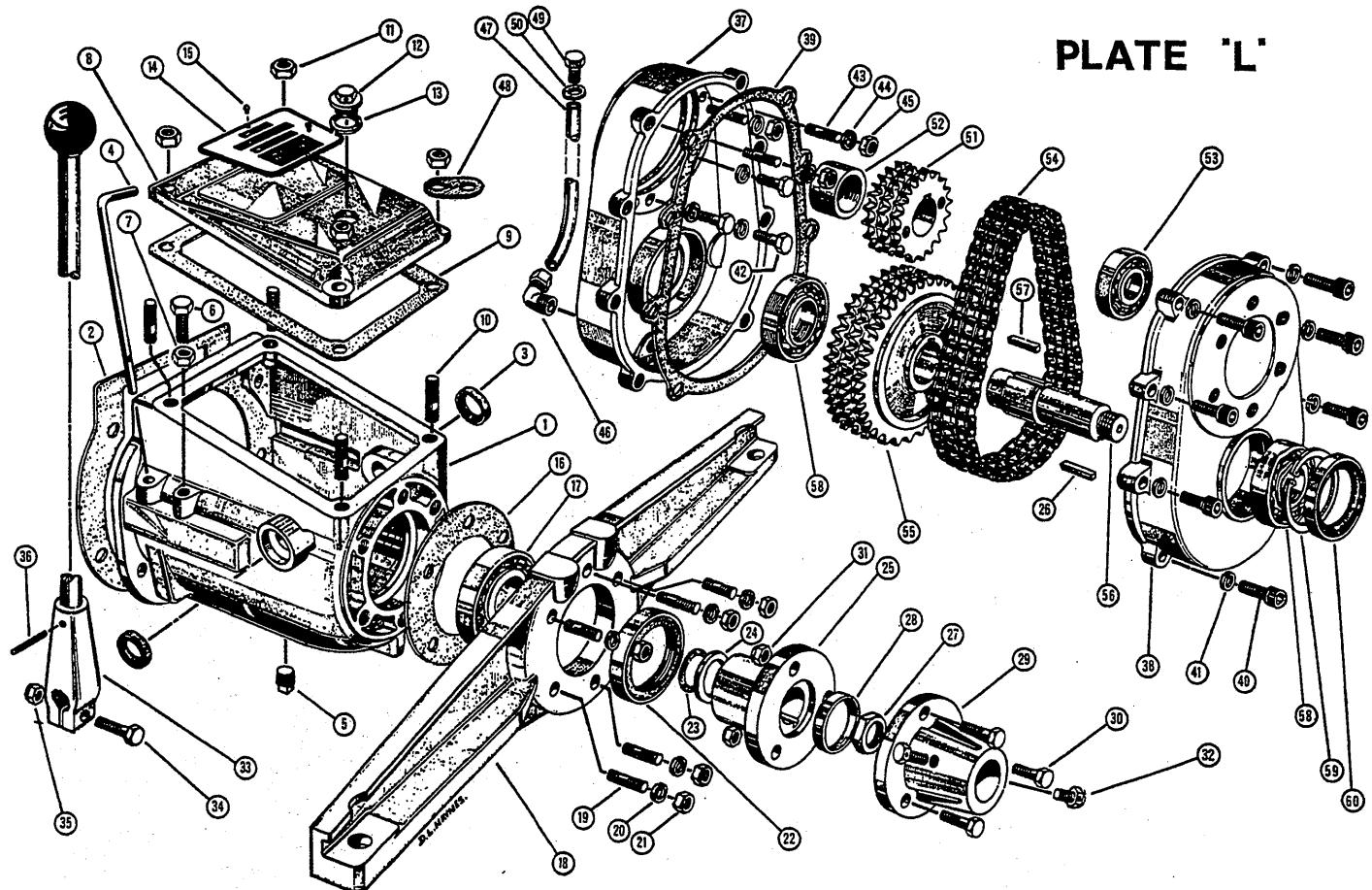


FIG 8

VIEWED FROM FORWARD END

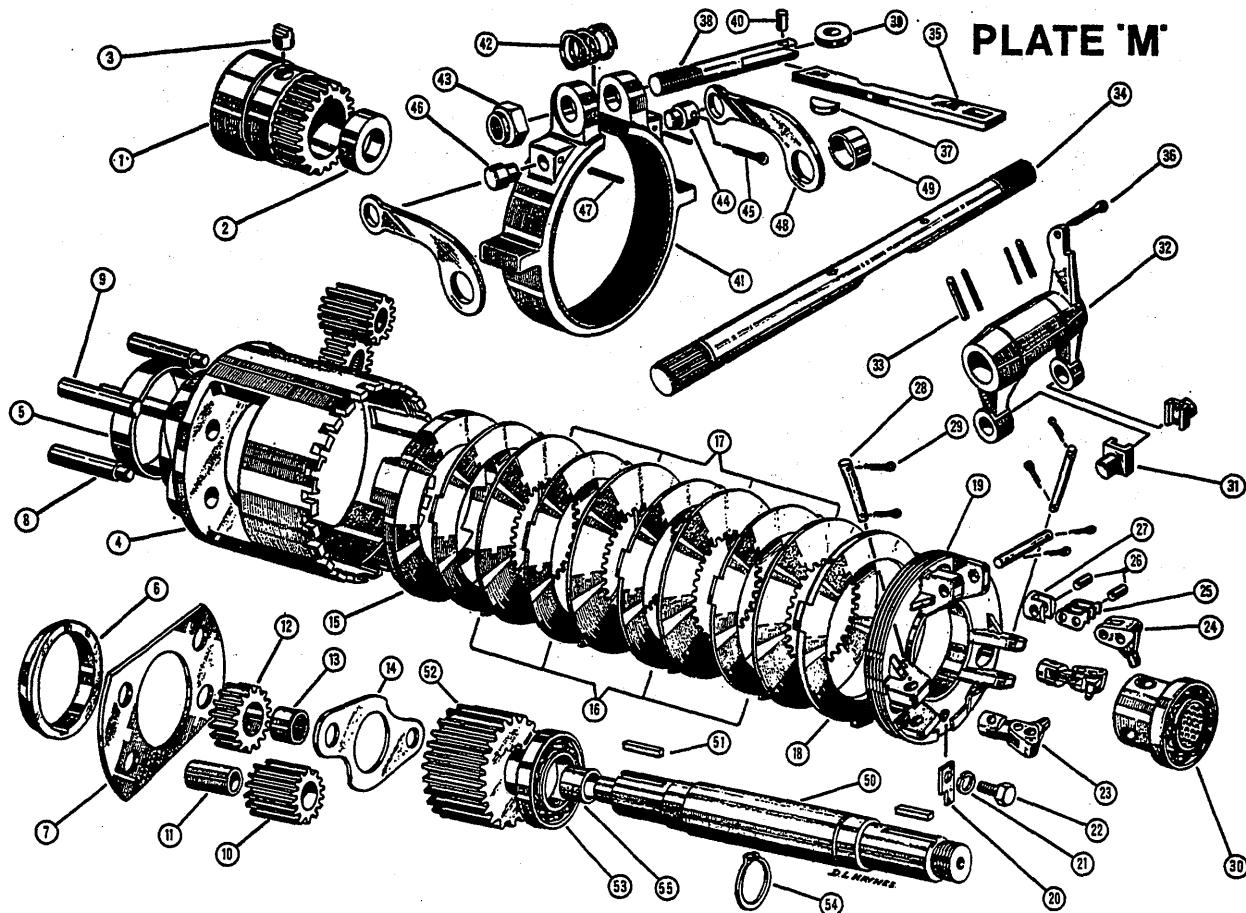
PLATE 'L'



GEARBOX AND REDUCTION GEAR

Plate	Description	Qty.	Plate	Description	Qty.
L1	Gearbox	1	L35	S.L. nut for clamp bolt	1
L2	Joint, support flange to gearbox	1	L36	Transax pin securing lever	1
L3	Cross shaft seal	2	L37	Reduction gear housing	1
L4	Dip-stick, gearbox oil level	1	L38	Cover, reduction gear housing	1
L5	Drainplug, gearbox	1	L39	Joint, reduction gear cover to housing as required	8
L6	Set screw, band anti-rattle	1	L40	Socket screw	3
L7	Lock nut	1	L41	Spring washer for socket screw	3
L8	Inspection cover	1	L42	Bolt securing reduction case to GB	3
L9	Joint, inspection cover to gearbox	1	L43	Stud securing reduction case to GB	3
L10	Stud	4	L44	Spring washer	6
L11	Nut	4	L45	Nut	3
L12	Oil filler plug, inspection cover	1	L46	Elbow	1
L13	Fibre washer, oil filler plug	1	L47	Pipe (drain)	1
L14	Engine identification label	1	L48	Clip	1
L15	Brass pin, securing label	2	L49	Set screw	1
L16	Joint gearbox/reduction also used on DD	1	L50	Washer	1
L17	Ball bearing, main shaft	1	L51	Drive sprocket	1
L18	Support bracket rear engine, vertical (Wolf)	1	L52	Spacer for drive sprocket	1
L19	Stud securing aft bearer	6	L53	Ball bearing, aft top	1
L20	Spring washer for stud	6	L54	Triple chain, 50 links/or	1
L21	Nut for stud	6	L55	Triple chain, 46 links	1
L22	Oil seal, aft end cover or bearer DD	1	L56	Driven sprocket 38T/or	1
L23	O ring coupling	1	L57	Driven sprocket 31T	1
L24	Washer coupling	1	L58	Lower shaft, reduction gear	1
L25	Half coupling, gearbox	1	L59	Key for driven sprocket	1
L26	Half coupling, gearbox for flex coupling	1	L60	Ball bearing, lower shaft	1
L27	Key, shaft to coupling	1		Circclip	1
L28	Nut, securing coupling to main shaft	1		Oil seal	1
L29	Register, coupling	1		Aft end cover, reverse gearbox	1
L30	Shaft half coupling (state bore)	1		Support bracket rear engine, vertical (Tiger)	1
L31	Bolt, coupling	3		Support bracket, rear engine, starboard	1
L32	Nut, self locking for bolt	3		Elbow	1
L33	Shaft lock screw	2		Straight connector	1
L34	Gear lever socket	1		Drain plug aft bearer	1
	Gear Lever assembly	1		Fibre washer for drain plug	1
	Clamp bolt gear lever	1		for water cooled GB	1

* Not Illustrated



CLUTCH

Plate	Description	Qty.
M1	Gear, forward stub shaft	1
M2	Pilot bush for gear	1
M3	Cone key for gear	1
M4	Drum	1
M5	Drum bush	1
M6	Split cone	1
M7	Forward push plate	1
M8	Stud, long pinion	2
M9	Stud, short pinion	2
M10	Long pinion with bush	2
M11	Bush only, long pinion	2
M12	Short pinion with needle roller	2
M13	Needle roller	2
M14	Thrust disc	1
M15	Head	1
M16	Clutch disc with lugs	4
M17	Clutch disc with teeth	4
M18	Clutch disc with lugs, thick	1
M19	Drum arm plate	1
M20	Adjusting clip	1
M21	Spring washer	1
M22	Set screw for clip }	1
M23	Toggle assembly with plunger	3
M24	Toggle only	3
M25	Toggle links only (set of 3)	3
M26	Pin only toggle and plunger	6
M27	Plunger only	3
M28	Pin	3
M29	Split pin	6
M30	Operating collar assembly	1
M31	Control shoe	2
M32	Fork lever	1
M33	Transax pin, pair	2
M34	Cross shaft	1
M35	Camplate	1
M36	Split pin	1
M37	Cam shoe	1
M38	Camshaft with roller and pin	1
M39	Cam roller only	1
M40	Pin only for cam roller	1
M41	Brake bands with link pins	1
M42	Spring for brake band	1
M43	Adjusting nut, brake band S/L	1
M44	Link pin, starboard	1
M45	Split pin for link pins	1
M46	Link pin only, port (short)	1
M47	Transax pin for link pins, pair	2
M48	Link plate	2
M49	Cross shaft/Link spacer	1
M50	D.D. Main shaft/or Reduction main shaft }	1
M51	Key, main shaft to gear and coupling	1
M52	Gear, main shaft	1
M53	Ball bearing, drum arm plate	1
M54	Circlip	1
M55	Bush for main shaft	1

- (h) Check for badly worn Split Cone M6. The gear may have been allowed to slip continuously in Ahead, due to neglect to adjust the clutch when it became necessary. This would cause wear on the split cone which later adjustment might fail to correct until a new split cone had been fitted. It is possible that the corresponding recess in the drum may also have become badly worn so that the drum requires replacing or re-bushing. Clutch plates may also become worn or the surface torn, which would necessitate renewal. In order to test for a split cone which might require replacement: Adjust the Ahead Clutch so that the toggles snap over dead center by moderate pressure of the gear lever and without undue force, then the split cone should grip the sleeve of Gear M1 so that there is no end play of the Drum. Such end play can be observed when the Inspection Cover is removed and indicates that the cone is worn too much to still grip the sleeve. It must be replaced. When reassembling the gear it is important to see that the Key M2 engages the keyway in the cone and NOT the split in the cone. See Figs. 7 and 8.

TO REMOVE THE REVERSE GEAR FROM ENGINE

(Reference: Plate "M")

Disconnect tail shaft coupling and slide well aft.

The gearbox is secured by two nuts outside and two similar nuts inside. Remove gearbox lid, undo nuts and slide gearbox off.

CAUTION: Observe the condition of the gear on the forward stub shaft and also the bronze pilot bush inside the gear. If either is worn the stub shaft must be removed. When replacing, it is very important that the shaft must run true within .002 in. after it is bolted to the flywheel. This should be checked by means of a dial indicator before finally fitting the reverse gear assembly.

REMEMBER ALSO WHEN PUSHING THE ASSEMBLED DRUM OVER THE GEAR M1, TO ENTER THE CONE KEY IN THE KEYWAY AND NOT THE SPLIT IN THE BRONZE SPLIT CONE M6. See Figure 8. Another point: if it is intended to completely dismantle the reverse gear, it is better to slack off the nut L27 which secures the coupling BEFORE commencing to remove the gearbox as it is then so much easier to lock the shaft M50 to prevent it from turning.

TO DISMANTLE THE REVERSE GEAR

(Reference: Plates "L" and "M")

Clamp the gearbox firmly in a bench vice, gripping that portion at the bottom behind the drain plug; proceed as follows:

1. The Drum Assembly may be removed, after the adjusting clip M20 has been lifted clear of the notch, by unscrewing anti-clockwise away from the Drum Arm Plate M19. The clutch plates can then be removed and examined. See Item 5 for removal of gears, thrust plates, etc.
2. The Brake Band Assembly can now be removed after slackening the Nut M43 sufficiently to slide out the Cam Plate M35. It is not necessary to withdraw the cam plate from the assembly, but if this is done be careful not to lose the Cam Shoe M37.
3. To remove Operating Collar Assembly. This necessitates removal of Main Shaft M50. Undo Nut L27, draw off Coupling L25 with a coupling drawer and remove Key L26. Move the Fork Lever so as to free the shoes off the Operating Collar M30. The shaft may now be driven out by means of a rubber hammer. Press off gear M52 and release M30. Take care not to lose the shoes M31.
4. The Ball Bearing should be driven out with a suitable brass punch from inside the box but the Aft End Cover must first be removed; six set screws secure this. If it is only required to replace the Oil Seal L23, this cover can be removed after pulling the coupling. It is only necessary to disturb the keys if the shaft is to be driven out.

CAUTION: If Either the Coupling L25 or the Reduction Drive Sprocket L51 has been removed from the Shaft M50, great care must be taken in replacing; first that the Key M51 does not trip or fall into the reduction drive housing, and second, that something heavy like a block of lead or brass is held against the forward end of Shaft M50 to take the thrust when the coupling or sprocket is driven back into place. This operation must not be attempted when the gear is fully assembled or when the reverse gear is fitted to engine. After replacing the coupling or sprocket, check to see that the ball bearing is tight against the circlip on the shaft. If there is a gap here it means that Thrust Disc M14 will be pinched because the Gear M52 is too far forward. There should be $\frac{1}{32}$ in. to $\frac{1}{16}$ in. of end float on the Thrust Disc M14 between the two Gears M52 and M1 when correctly assembled.

5. To remove Cone M6 or Planet Gears M10 and M12 proceed as Item 1, then, after lifting out the Clutch Plates M17, M16, M18 and Head M15 the pinion studs should be pressed inwards when the gears will come free and the Cone also. If the Cone is worn or scored it must be replaced and the corresponding surface in the Drum should also be examined for similar wear. When the Cone and Forward Push Plate M7 are in position there should be $\frac{1}{16}$ in. to $\frac{1}{8}$ in. clearance between the Plate and the Drum to permit the Cone to be forced forward and close tightly on the Gear M1. When reassembling, the pinion studs are entered from the forward end of the Drum. Begin with the two short studs. These should enter the holes adjacent to the two flats on the forward boss. Turn the Drum over and place the Cone in position, followed by the Forward Push Plate M7, then drop the two short pinions over the studs. Next press these short pinion studs home flush. Now enter the long pinion studs, small end first, hold the pinions in place and press these studs home. Assemble the Thrust Disc M14 and drop the Head in position over the ends of the pinion studs.

When reassembling Clutch Plates in the Drum the sequence is: Head M15, Plate with Lugs M16, Plate with Teeth M17 and alternately thereafter, finishing with Pressure Plate, i.e. Thick Plate with Lugs M18. It will be found easier to assemble the drum into gearbox by tilting the box and entering the gear M52 into the splined plates, finally screwing home the Drum Arm Plate M19. When replacing the coupling L25 before fitting the key to the shaft slide the 'O' ring up to the bearing, having first checked there are no cuts in the ring. Next slide on the washer then fit the key. Slide the coupling on past the key then move the washer into the recess in the face of the coupling. A little grease placed in the recess helps to ensure that the washer will not be displaced when pushing the coupling home.

TO DISMANTLE REDUCTION DRIVE WHEN FITTED TO REVERSE GEAR

1. Drain the oil by removing the bottom bolt holding the cover to the housing, or the drain plug, then remove the remaining cover bolts or drain with a sump pump.
2. Remove the nut securing the coupling to the lower shaft. Draw off the coupling with coupling drawer.
3. Warm the cover around the ball-race housings which should allow them to be drawn away from the housing. It may be necessary to tap the bolt bosses lightly with a rubber hammer by making a glancing blow in the direction the cover is required to go.
4. After removal of the cover, in order to remove the triple chain which is endless, it is necessary to remove both sprockets evenly and at the same time. The top sprocket is withdrawn by means of two bolts $\frac{1}{2}$ diam and length 2 in. to 3 in. The sprocket is already threaded for these bolts and will be forced off the shaft as both these bolts are screwed evenly home.
5. To remove the lower sprocket complete with shaft, warm forward ball-race, then ease the shaft from the case at the same time as the top sprocket is being withdrawn.

6. If it is desired to remove the housing from the gearbox, undo the six bolts or nuts which will allow it to come clear from the ball bearing which forms a spigot between the two castings.

TO FIT REDUCTION DRIVE CASE TO REVERSE GEAR

1. Offer the top sprocket to the gearbox shaft and see that the key is fitting the keyway. Do NOT fit the sprocket just yet.
2. Bolt the reduction housing to the gearbox.
3. See that both the sprockets are perfectly clean and free from any burrs. Fit the ball-races to the lower shaft.
4. Fit the chain over both the sprockets and tap the top sprocket on to the gearbox shaft approximately two-thirds of the way when the ball-race on the lower sprocket will enter its housing, then tap both the sprockets home evenly. When home, sprockets should be $\frac{1}{2}$ in. outside the face of the housing. See 'Caution', page 12. Fit the bearing L53 to the end of the M50 shaft.
5. Fit the oil seal to the cover and fit the cover to the housing.
NOTE: Immersing the cover in hot water will cause the casting to expand and allow the cover to be tapped easily over the ball-races.
6. Screw up cover evenly and test to see that reduction drive turns freely. It is sometimes necessary to fit an extra joint between the faces of the housing and the cover to give perfect freeness. When replacing the coupling L25 before fitting the key to the shaft slide 'O' up to the bearing having first checked there are no cuts in the ring. Next slide on the washer then fit the key. Slide the coupling on past the keyway then move the washer into the recess in the face of the coupling. A little grease placed in the recess helps to ensure that the washer will not be displaced when pushing the coupling home.

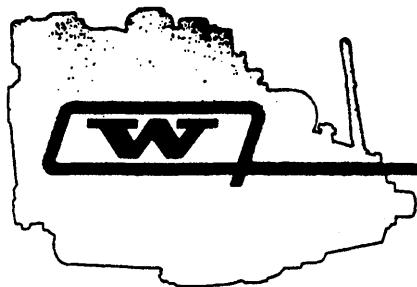
NOTE: These Fitting Instructions are for Gearboxes which already have had a Reduction Drive fitted. If a Reduction Drive is to be fitted to a direct drive gearbox, the gearbox shaft must be changed for a M50 shaft before commencing the operation described above, and oil transfer holes must be drilled in the aft end of the gearbox case to correspond with those in the front face of the reduction case.

SECTION V

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 #69

Subject: Exhaust system failures

Models: All marine generators and marine engines

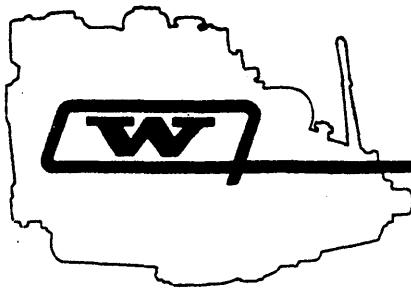
When engine sea water is fed into an exhaust system so that the full stream strikes a surface, erosion may cause premature failures.

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.

PN 19149

May 6, 1974



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.

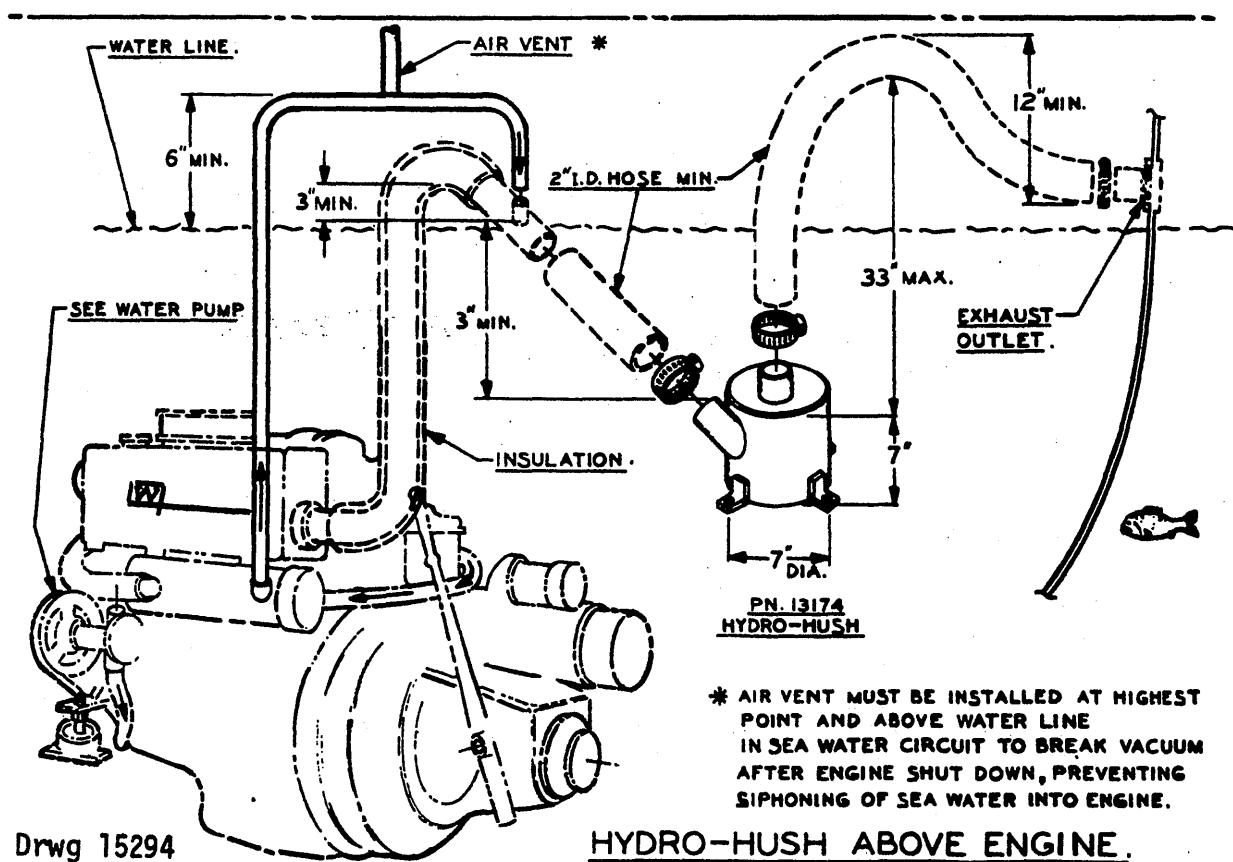
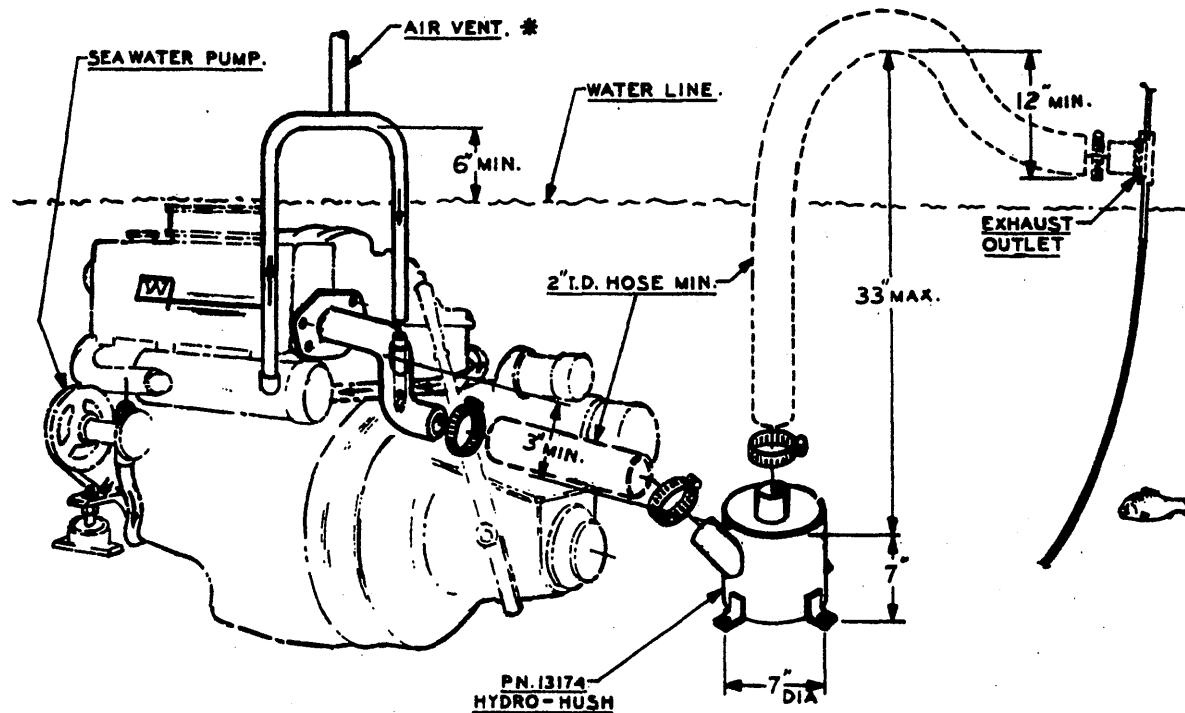
There must be an unblocked vent to atmosphere at the high point of the sea water circuit (where it passes above the waterline) to break the vacuum which would encourage siphoning through the sea water circuit upon engine shutdown. Such siphoning would fill the engine with sea water through its exhaust. 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.

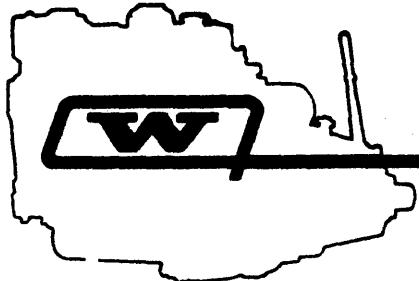
HYDRO-HUSH BELOW ENGINE.



* AIR VENT MUST BE INSTALLED AT HIGHEST POINT AND ABOVE WATER LINE
IN SEA WATER CIRCUIT TO BREAK VACUUM
AFTER ENGINE SHUT DOWN, PREVENTING
SIPHONING OF SEA WATER INTO ENGINE.

Drwg 15294

HYDRO-HUSH ABOVE ENGINE.



WESTERBEKE

MARINE ENGINE PRODUCTS

SERVICE BULLETIN #82

ISSUED: May 7, 1975

SUBJECT: Battery Recommendations

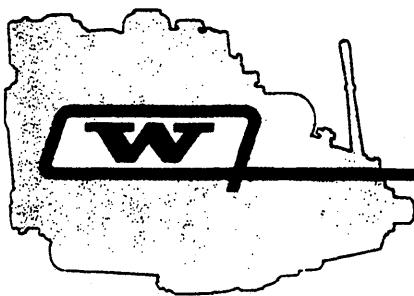
MODEL: All

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.



WESTERBEKE

MARINE ENGINE PRODUCTS

SERVICE BULLETIN #83

SUBJECT: Short Profile Sailing Gear

MODEL: WESTERBEKE L25, 30, 40, 50

DISTR: All transmission Shipments, Distributors

DESCRIPTION

The short profile sailing gear is a helical gear transmission shifted via a mechanical friction clutch. The housing is made of high strength aluminum resistant to sea water. Helical gears are shaved and case hardened and their shafts run on heavy duty roller bearings. Mechanical gear shifting requires little movement and minimum effort, a truly finger tip control.

LUBRICATING OIL TYPE

Type A transmission fluid is strongly preferred but HD engine oil, SAE 20 or 30, may be used if engine speed never exceeds 2800 RPM. Multi-grade engine oil is NOT acceptable.

LUBRICATING OIL LEVEL

The circular marking ring on the dipstick indicates the HIGHEST allowable oil level. The bottom of the dipstick indicates the LOWEST allowable oil level. The level is measured on a dry dipstick by resting the threaded plug on top of the housing - it must not be threaded into the housing at all.

MAINTENANCE

Check the gearbox oil level at monthly intervals. Always use the same type oil when adding oil. The gearbox oil should be changed after the first hundred hours of operation. Then it should be changed every season. Air Vent Hole in dipstick cover must be kept clean and open at all times for proper operation of the transmission, to prevent blowing the rear seal.

LONG TERM STORAGE

If the gearbox is put out of operation for a prolonged period of time, the best procedure to protect it from corrosion is to fill it completely with oil of the same type normally used. Don't forget to drain to normal level before next start.

SERVICE BULLETIN #83 con't

INSTALLATION ANGLE

The installation angle must not exceed 18° to the horizontal.

ROTATION

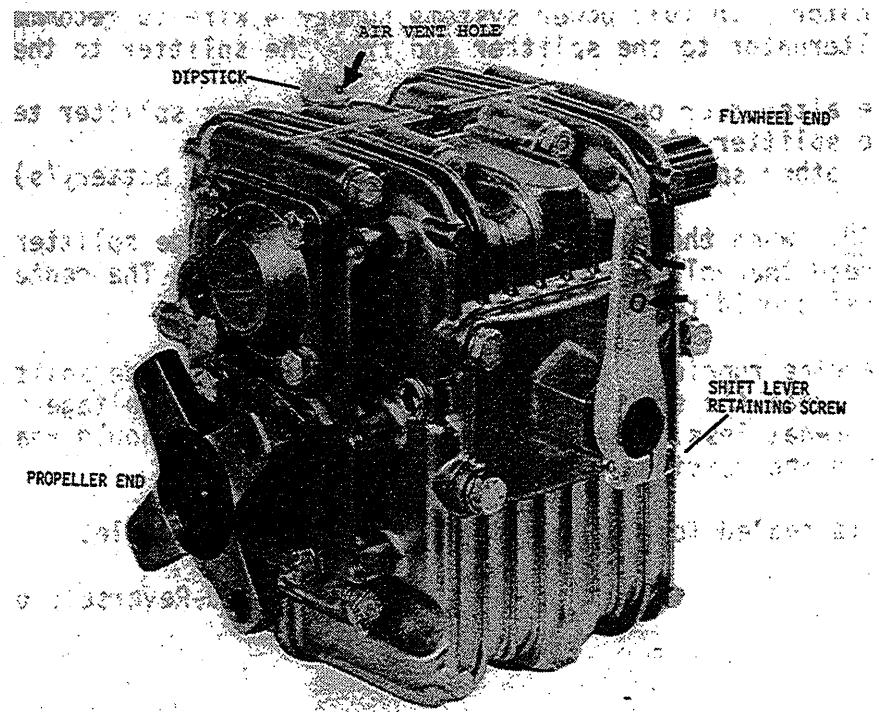
This transmission turns a RIGHT HAND propeller on the above engine models.

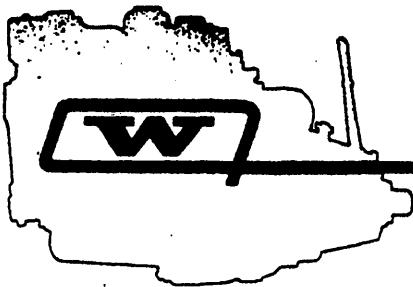
OPERATING TEMPERATURE

This transmission is air cooled and proper ventilation of the engine compartment is required. The operating temperature of the transmission oil should not exceed 230 degrees F. This figure will generally not be exceeded if the engine compartment is vented for escape of heated air. Higher Temperatures risk oil seal damage.

SHIFT CONTROLS

By loosening its retaining screw, the shifting lever can be rotated into any position required for the control cable. The control cable must be at right angles to the shift lever when the shift lever is in neutral position. The control must allow 1 3/8" MINIMUM travel either side of neutral position, measured at the shift lever hole furthest from the shaft. When the shift lever is vertical as in the photograph below, shifting the lever toward the flywheel end produces REVERSE, while shifting towards the propeller end produces FORWARD. If the shifting lever is in the down position the opposite effect occurs. Shifting the lever toward the flywheel end produces FORWARD while shifting aft produces REVERSE.





WESTERBEKE

MARINE ENGINE PRODUCTS

SERVICE BULLETIN #87

ISSUED: September 18, 1975

SUBJECT: Alternator Output Splitter

MODEL: All Marine Engines

DISTR: Distributors, Shipments

GENERAL DESCRIPTION: The splitter is a solid state device which allows two batteries to be recharged and brought to the same ultimate voltage from a single alternator as large as 120 amp and, at the same time, isolates each battery so that discharging one will have no effect on the other. Charging rates are in proportion to the batteries' voltage (state of discharge). This method precludes the necessity, and even the desirability, of a rotary switch for selecting which battery is to be charged. It also assures that ships' services cannot drain the engine starting battery.

INSTALLATION:

1. Mount splitter on a metal surface other than the engine, preferably in an air stream if available. Do not install near engine exhaust system. Install with cooling fins aligned vertically.
2. Be sure to use a wire size appropriate to the output of the associated alternator. In full power systems number 4 wire is recommended from the alternator to the splitter and from the splitter to the batteries.
3. Connect the alternator output terminal to the center splitter terminal.
4. Connect one splitter side terminal to one battery(s).
5. Connect the other splitter side terminal to the other battery(s).

TEST INFORMATION: When the engine is not running, the side splitter terminals should read the voltage of the respective battery. The center splitter terminal should read zero voltage.

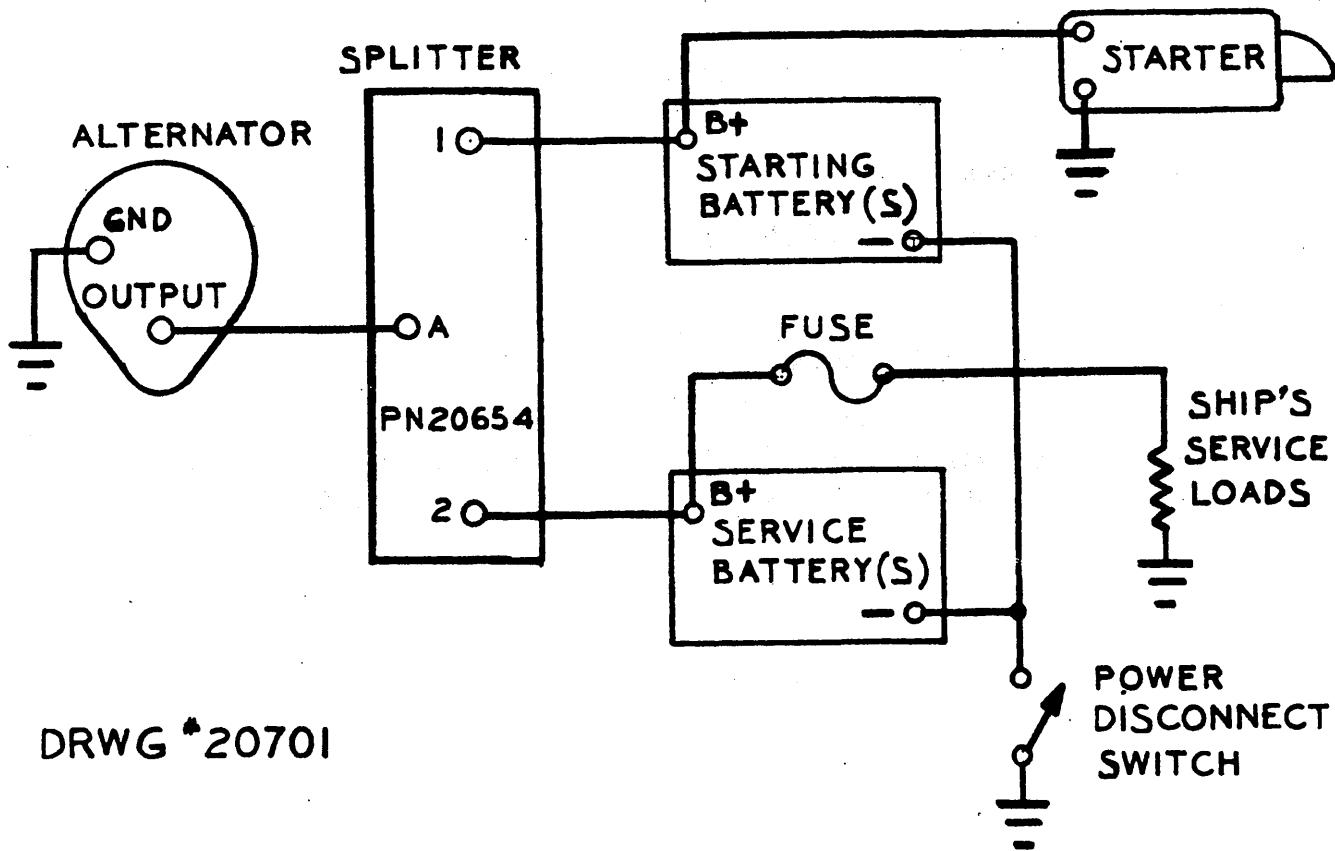
With the engine running and alternator charging, the side splitter terminals should read the same voltage which should be the voltage of the regulator or somewhat less. The center splitter terminal should read .82 volts higher than the readings of the side terminals.

This unit is sealed for maximum life and is not repairable.

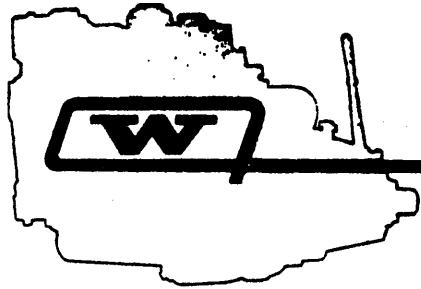
Continued-Reverse Side

SERVICE BULLETIN #87 (Continued)
(Alternator Output Splitter)

BY-PASSING SPLITTER: In the event of failure, batteries may be charged directly from alternator by connecting either splitter terminal #1 or #2 to terminal A, bypassing the splitter itself. This should not be done simultaneously for both batteries unless they are, and will remain at, the same voltage (state of charge).



DRWG *20701



WESTERBEKE

MARINE ENGINE PRODUCTS

SERVICE BULLETIN 94

ISSUED: September 9, 1976

SUBJECT: Fuel Pressure Switch Installation

MODEL: A11

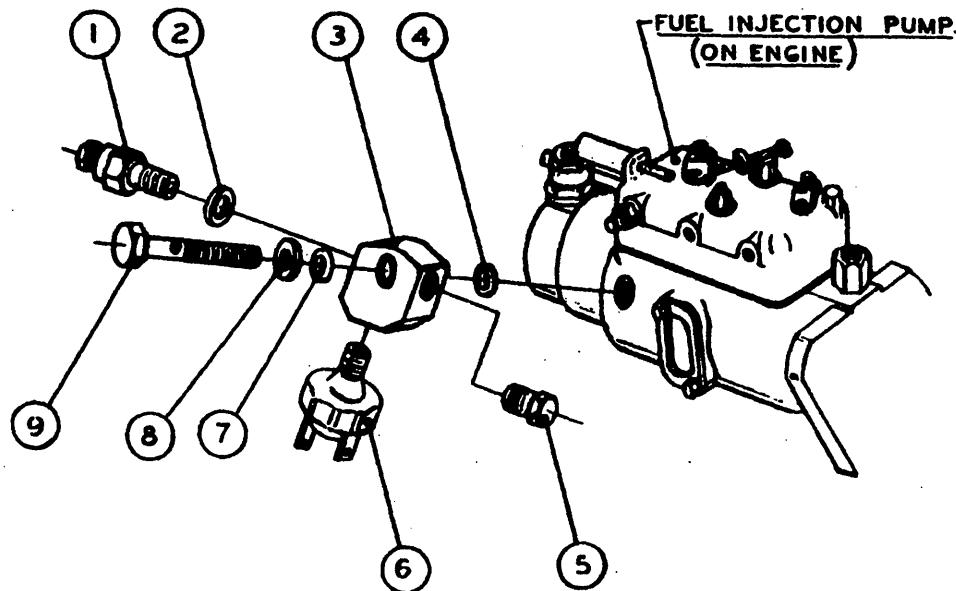
DISTR: Distributors, Shipments

Overleaf is a parts list and an illustration showing the proper installation of the fuel pressure switch used on most of our engine products.

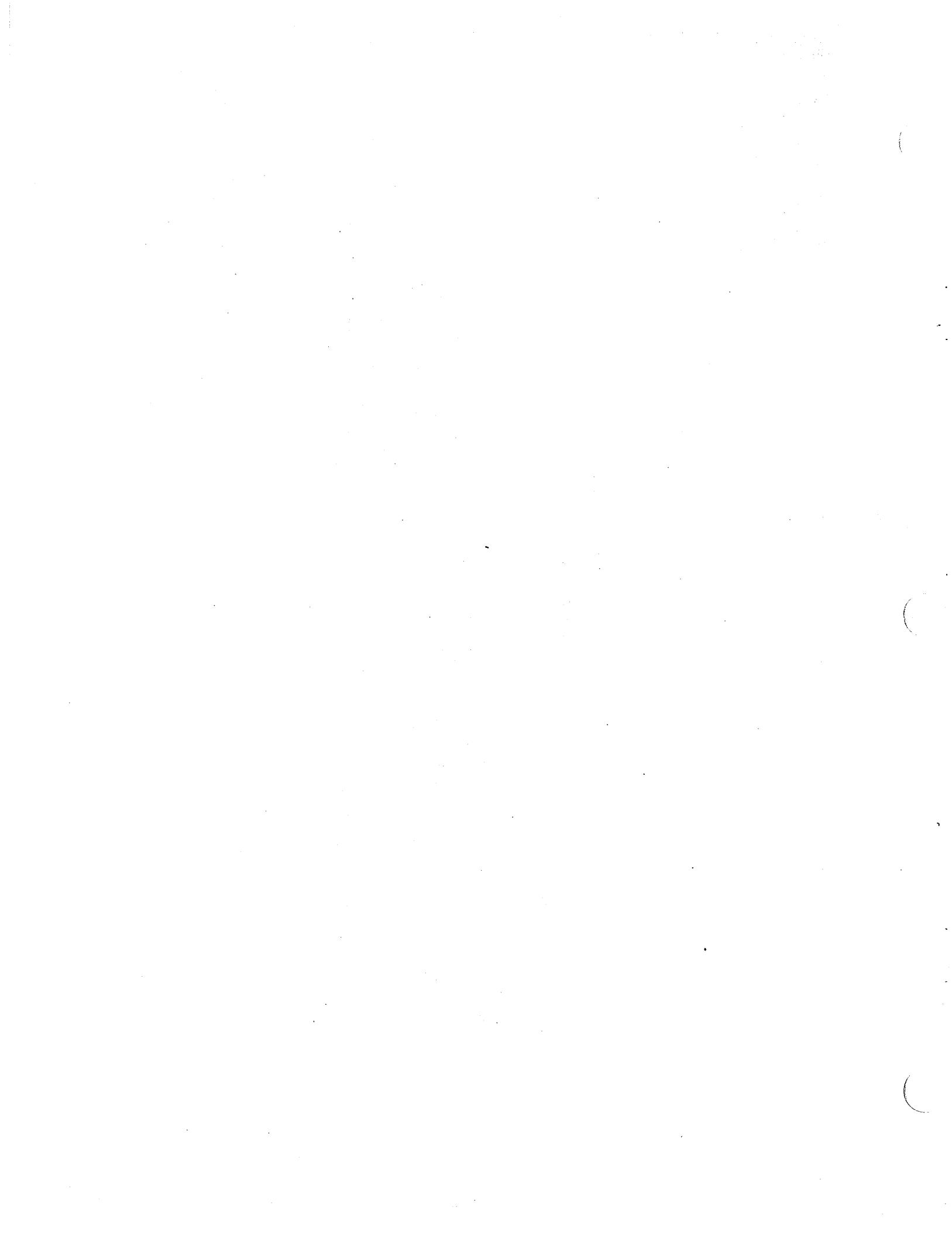
P/N 21564

9/9/76

DATE	REV	REVISION RECORD	AUTH	SR	CH.



ITEM	PART NO.	DESCRIPTION	QTY
TOLERANCES (EXCEPT AS NOTED)			
		J. H. WESTERBEKE CORP.	
		AVON, MA. 02322	
DECIMAL	ALL ENGINES	SCALE	DRAWN BY B.J.S.
± ~		NONE	APPROVED BY
FRACTIONAL	TITLE	INSTALLATION DWG, FUEL PRESS.	
± ~		SWITCH TO A FUEL INJECTION PUMP	
ANGULAR	DATE	DRAWING NUMBER	
± ~	9-9-76		21743

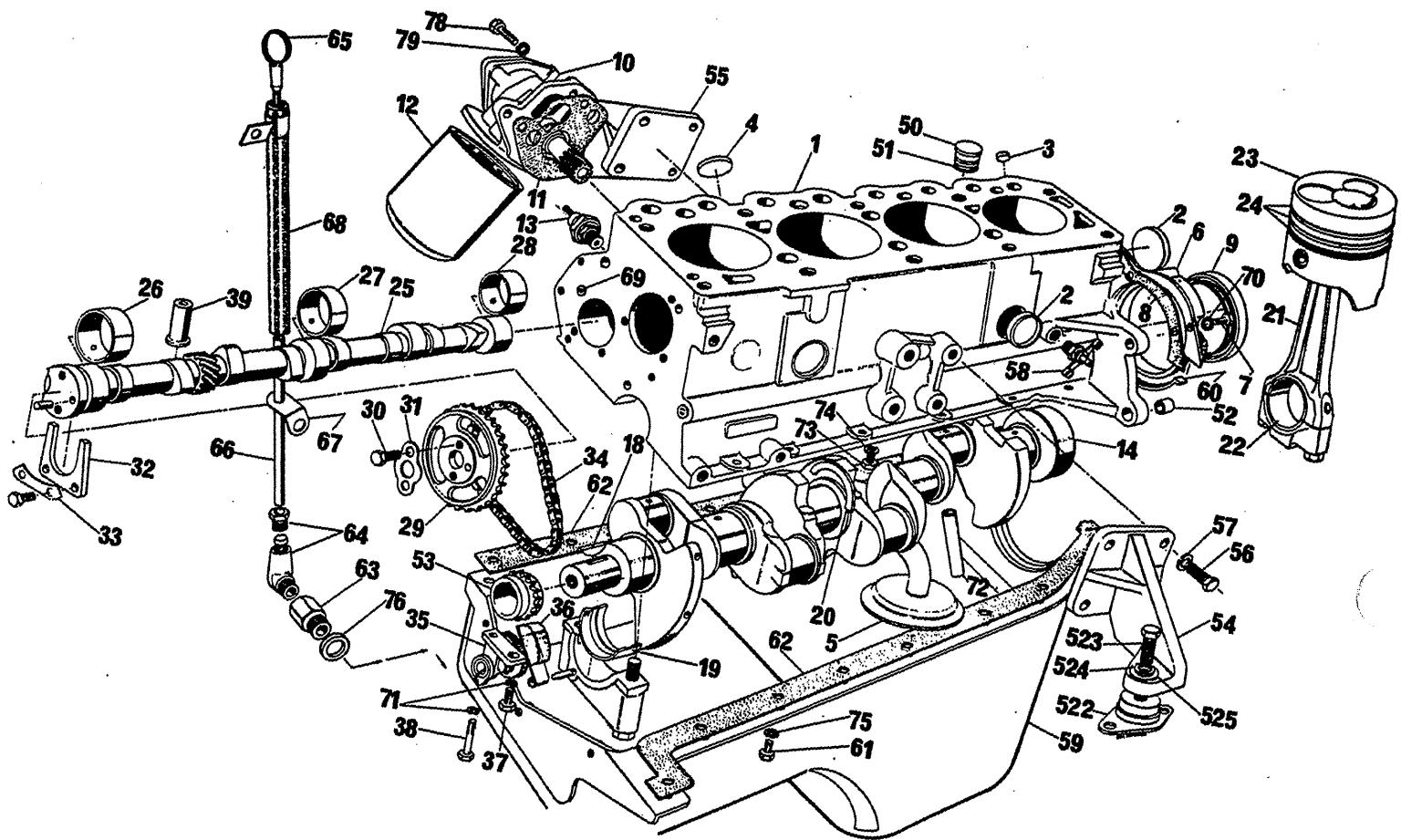


PARTSLIST

CONTENTS

WESTERBEKE L25: BLOCK	101
WESTERBEKE L25: HEAD - MANIFOLDS	105
WESTERBEKE L25: PUMPS - COVERS - ALTERNATOR	109
WESTERBEKE L25: FUEL SYSTEM	113
WESTERBEKE L25: BACK END - STARTER	117
WESTERBEKE L25: ELECTRICAL SYSTEM	119
J TYPE MANUAL TRANSMISSION: EXTERNAL - REDUCTION	121
J TYPE MANUAL TRANSMISSION: INTERNAL - CLUTCH	125
SUPERCEDED PARTS USED PRIOR TO SN 5375	128

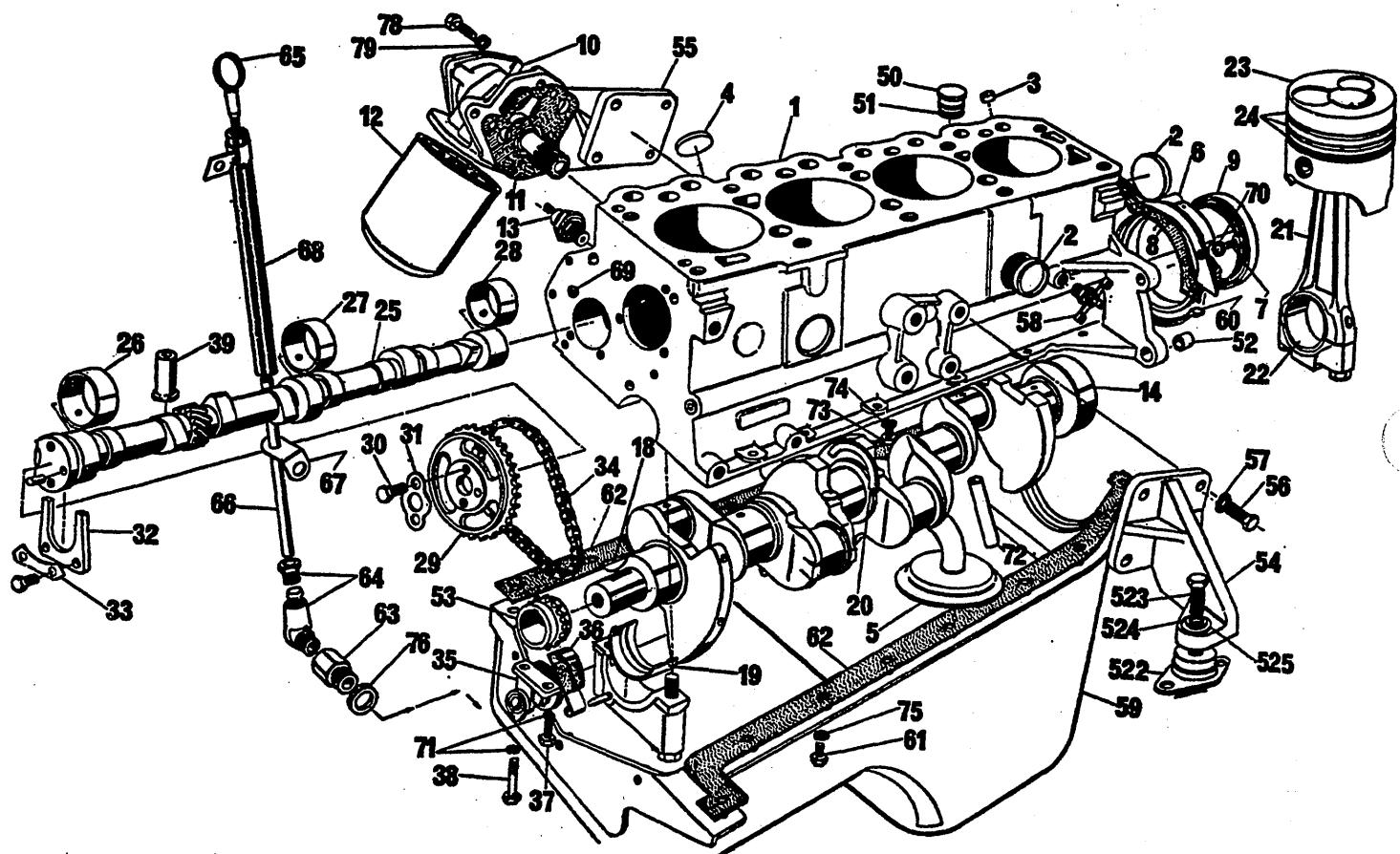
WESTERBEKE L25: BLOCK



WESTERBEKE L251 BLOCK

REF	PN	NAME	REMARKS	QUAN
1	21224	BLOCK	CYLINDER-BARE	1
2	21225	PLUG	CORE	3
3	21226	PLUG	DIPSTICK BORE	1
4	21227	PLUG	CORE	1
5	21228	PIPE	OIL PICK-UP	1
6	21229	SUPPORT	OIL SEAL	1
7	21230	BOLT	OIL SEAL SUPPORT	4
8	21231	GASKET	OIL SEAL SUPPORT	1
9	21232	SEAL	OIL	1
10	21233	PUMP	OIL	1
11	21234	GASKET	OIL PUMP	1
12	21235	FILTER	OIL	1
13	21236	SWITCH	OIL PRESSURE	1
14	21237	CRANKSHAFT		1
15	21238	STUD	STUB SHAFT	6
16	21239	NUT	STUB SHAFT	6
17	21240	SHAFT	STUB	1
18	21241	KEY	CRANKSHAFT	1
19	21242	BEARING	CRANKSHAFT-HALF ONLY	10
20	21243	BEARING	THRUST-CRANKSHAFT	2
21	21244	ROD	CONNECTING	4
22-1	21245	BEARING	CONNECTING ROD-HALF ONLY	8
22-2	21391	ISOLATOR		4
23-1	21246	PISTON	ASSEMBLY	4
23-2	21392	BOLT	ISOLATOR	4
24-1	21247	RING	PISTON-COMPLETE SET FOR ONE PISTON	1
24-2	21393	LOCKWASHER	ISOLATOR BOLT	4
25-1	21248	CAMSHAFT		1
25-2	21394	WASHER	FLAT-ISOLATOR-BOLT	4
26	21249	BEARING	CAMSHAFT FRONT	1
27	21250	BEARING	CAMSHAFT CENTER	1
28	21251	BEARING	CAMSHAFT REAR	1
29	21252	SPROCKET	CAMSHAFT	1
32	21255	BEARING	THRUST-CAMSHAFT	1
33	21256	RETAINER	CAMSHAFT THRUST BEARING	1
34	21257	CHAIN	CAMSHAFT	1
35	21258	TENSIONER	CAMSHAFT CHAIN	1
36	21259	PAD	CAMSHAFT CHAIN TENSIONER	1
37	21260	BOLT		1
38	21261	BOLT		1
39	21262	FOLLOWER	CAM	8
50	21275	PLUG		1
51	21276	O-RING		1
52	21277	DOWEL	BLOCK REAR FACE	2
53	21278	SPROCKET	CRANKSHAFT	1
54	21279	MOUNT	FRONT LEFT	1
55	21280	MOUNT	FRONT RIGHT	1
56	21281	BOLT	MOUNT	8
57	21282	WASHER		8
58	21283	PETCOCK	CYLINDER BLOCK DRAIN	1
59-1	21284	SUMP		1
59-2	21285	SUMP		1
59-3	21286	PLATE	FRONT	1

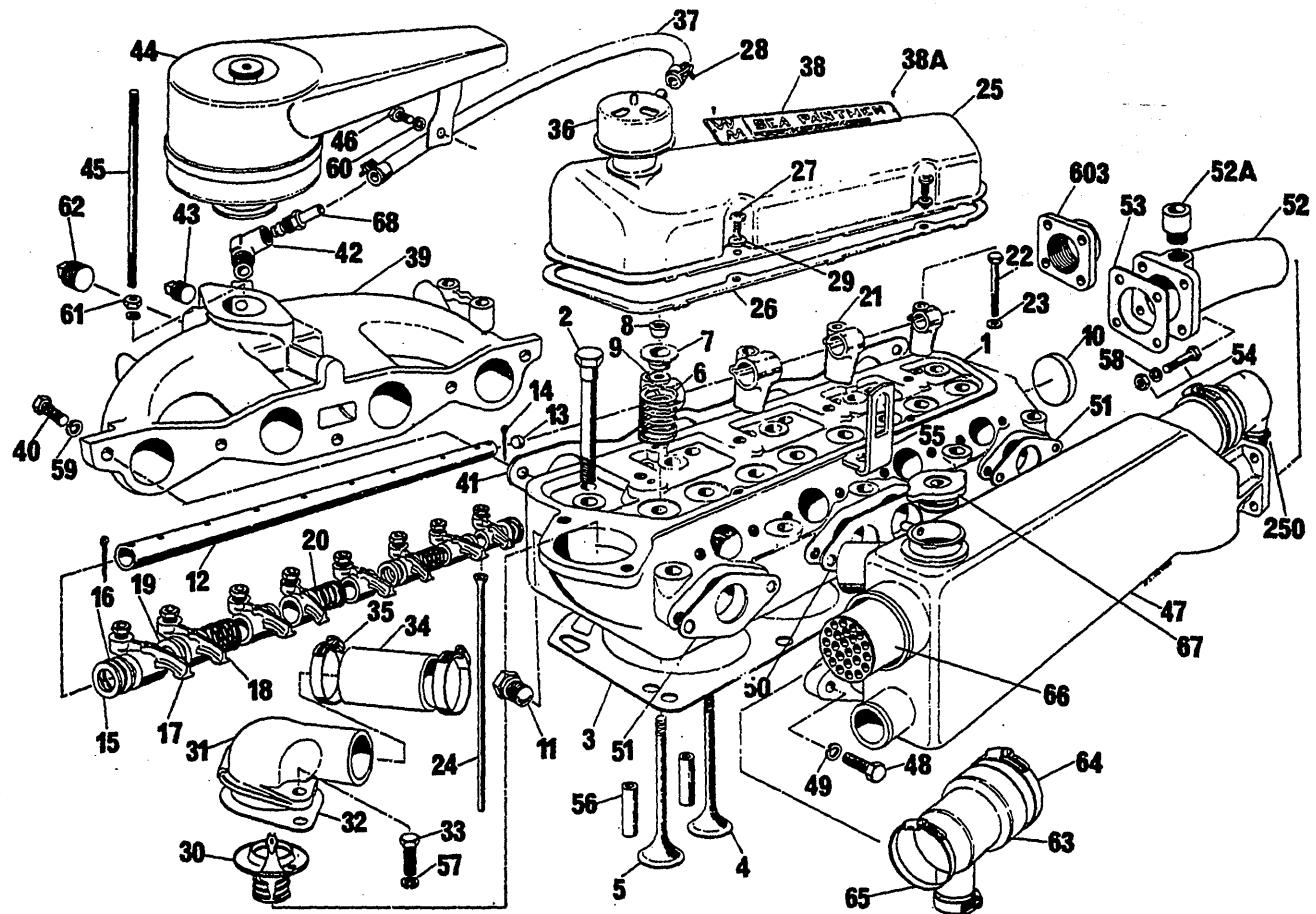
WESTERBEKE L258 BLOCK



WESTERBEKE L25: BLOCK

RFF	PN	NAME	REMARKS	QUAN
59-4	21287	NUT		1
60	21288	SEAL	SUMP REAR	1
51	21289	SCREW	SUMP	18
52	21290	GASKET	SUMP-ONE PAIR	1
53	21291	ADAPTER	SUMP PLUG	1
54	21292	ELBOW	SUMP PLUG	1
55	21293	DIPSTICK		1
56	21294	TUBE	DIPSTICK	1
57	21295	BRACKET	DIPSTICK TUBE	1
58	21296	TUBE	DIPSTICK EXTENSION	1
59	21297	PLUG	OIL GALLERY	1
70	21298	WASHER		4
71	21299	WASHER		2
72	21300	TURE	ASSY-OIL PUMP RETURN	1
73	21301	BOLT	PICK-UP TO BLOCK	1
74	21302	LOCKWASHER		1
75	21303	WASHER	SUMP	16
76	21304	WASHER	SUMP PLUG	1
77	21305	WASHER		1
78	21306	BOLT		3
79	21307	WASHER		3
80	21308	WASHER	BLOCK	3

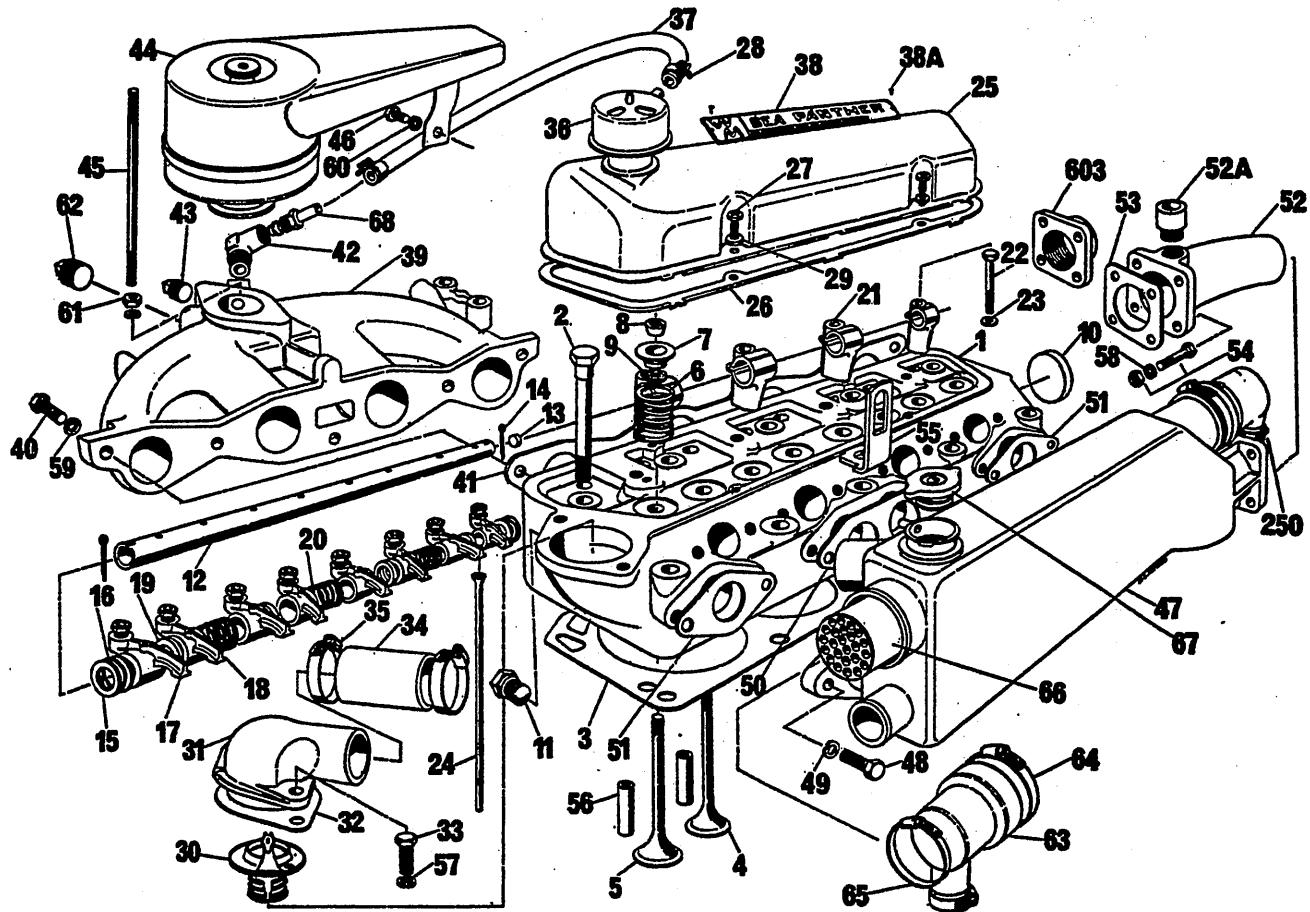
WESTERBEKE L25: HEAD - MANIFOLDS



WESTERBEKE L25: HEAD - MANIFOLDS

RFF	PN	NAME	REMARKS	QUAN
1	21088	HEAD	CYLINDER	1
2	21089	ROLT	CYLINDER HEAD	10
3-1	21090	GASKET	CYLINDER HEAD	1
3-2	21396	FLANGE	EXHAUST	1
4	21091	VALVE	INLET	4
5	21092	VALVE	EXHAUST	4
6	21093	SPRING	VALVE	8
7	21094	RETAINER	VALVE SPRING	8
8	21095	SPLITCONE	VALVE SPRING	16
9	21096	SEAL	OIL-VALVE STEM	8
10	21097	COREPLUG	CYLINDER HEAD AFT	1
11	21098	PLUG	TEMPERATURE SENDING TAPPING	1
12	21099	SHAFT	ROCKER	1
13	21100	PLUG	ROCKER SHAFT END	2
14	21101	PIN	COTTER-ROCKER SHAFT	2
15	21102	WASHER	ROCKER SHAFT END	4
16	21103	WASHER	ROCKER SHAFT END	2
17	21104	ROCKER	ARM-RIGHT HAND	4
18	21105	ROCKER	ARM-LEFT HAND	4
19	21106	SPACER	ROCKER	4
20	21107	SPRING	ROCKER	3
21	21108	SUPPORT	ROCKER SHAFT	4
22	21109	BOLT	ROCKER SHAFT SUPPORT	4
23	21110	LOCKWASHER	ROCKER SHAFT SUPPORT BOLT	4
24	21111	PUSHROD		8
25	21112	COVER	VALVE	1
26	21113	GASKET	VALVE COVER	1
27	21114	SCREW	VALVE COVER	4
28	21115	CLAMP	HOSE-BREATHER HOSE AT VALVE COVER	1
29	21116	WASHER	VALVE COVER SCREW	4
30	21117	THERMOSTAT		1
31	21118	HOUSING	THERMOSTAT	1
32	21119	GASKET	THERMOSTAT HOUSING	1
33	21120	BOLT	THERMOSTAT HOUSING	2
34	21121	HOSE	THERMOSTAT HOUSING	1
35	21122	CLAMP	HOSE,THERMOSTAT HOUSING	2
36	21123	CAP	BREATHER	1
37	21124	HOSE	BREATHER	1
38-1	21125	NAMEPLATE	"WATERMOTA"-VALVE COVER	1
38-2	21126	RIVET	VALVE COVER NAMEPLATE	4
39	21127	MANIFOLD	INTAKE	1
40	21128	SCREW	INTAKE MANIFOLD	5
41	21129	GASKET	INTAKE MANIFOLD	1
42	21130	ELBOW	BREATHER HOSE TO FILTER	1
43	21131	PLUG		1
44	21132	FILTER	AIR	1
45	21133	STUD	INTAKE AIR FILTER	1
46	21134	SCREW	AIR FILTER BRACKET	1
47	21135	MANIFOLD	EXHAUST	1
48	21136	SCREW	EXHAUST MANIFOLD MOUNTING	6
49	21137	LOCKWASHER	EXHAUST MANIFOLD MOUNTING	6
50-1	21138	GASKET	EXHAUST MANIFOLD-CENTER PORT	1
50-2	21207	CLAMP	HOSE-MANIFOLD OUTLET	1

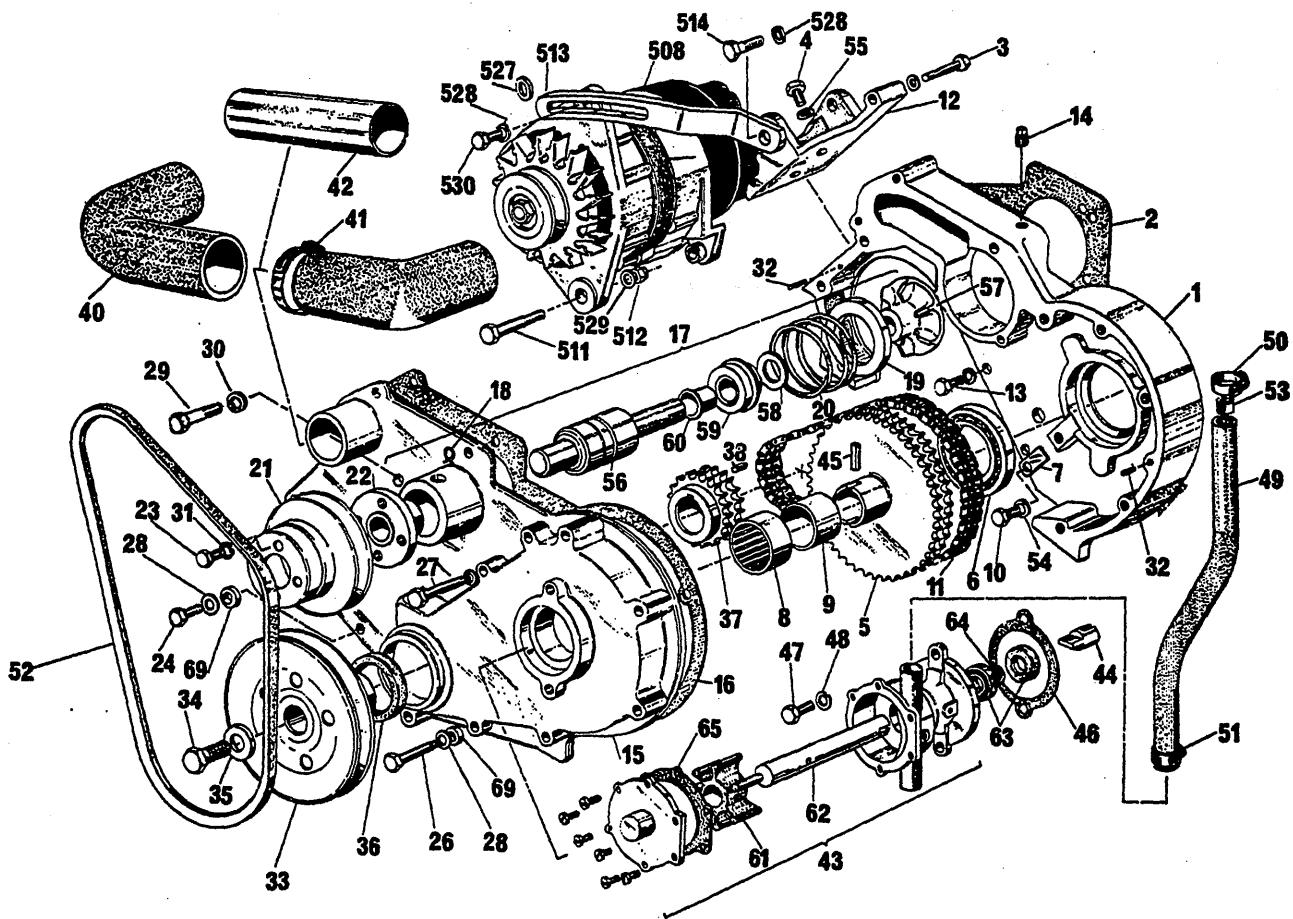
WESTERBEKE L25: HEAD - MANIFOLDS



WESTERBEKE L251 HEAD - MANIFOLDS

RFF	PN	NAME	REMARKS	QUAN
51	21139	GASKET	EXHAUST MANIFOLD-FRONT AND REAR PORTS	2
52-1	19438	ELBOW	EXHAUST-WATER INJECTED	1
52-2	21141	INLET	EXHAUST ELBOW	1
53	21142	GASKET	EXHAUST FLANGE	1
54	21143	SCREW	EXHAUST FLANGE	4
55	21144	EYE	LIFTING	1
56	21145	GUIDE	VALVE	1
57	21146	LOCKWASHER	THERMOSTAT HOUSING BOLT	2
58	21147	LOCKWASHER	EXHAUST FLANGE CAPSCREW	4
59	21148	LOCKWASHER	INTAKE MANIFOLD SCREW	5
60	21149	LOCKWASHER	AIR FILTER BRACKET SCREW	1
61	21150	NUT	AIR CLEANER STUD	1
62	21151	PLUG	THERMOSTAT TAPPING	1
63	21152	ELBOW	MANIFOLD INLET-MOLDED	1
64	21153	CLAMP	MANIFOLD ELBOW	1
65	21154	CLAMP	HOSE-MANIFOLD INLET	1
66	21155	EXCHANGER	BUNDLE ONLY	1
67	21156	CAP	FILLER	1
68	21157	ADAPTER	BREATHER HOSE TO FILTER ELBOW	1

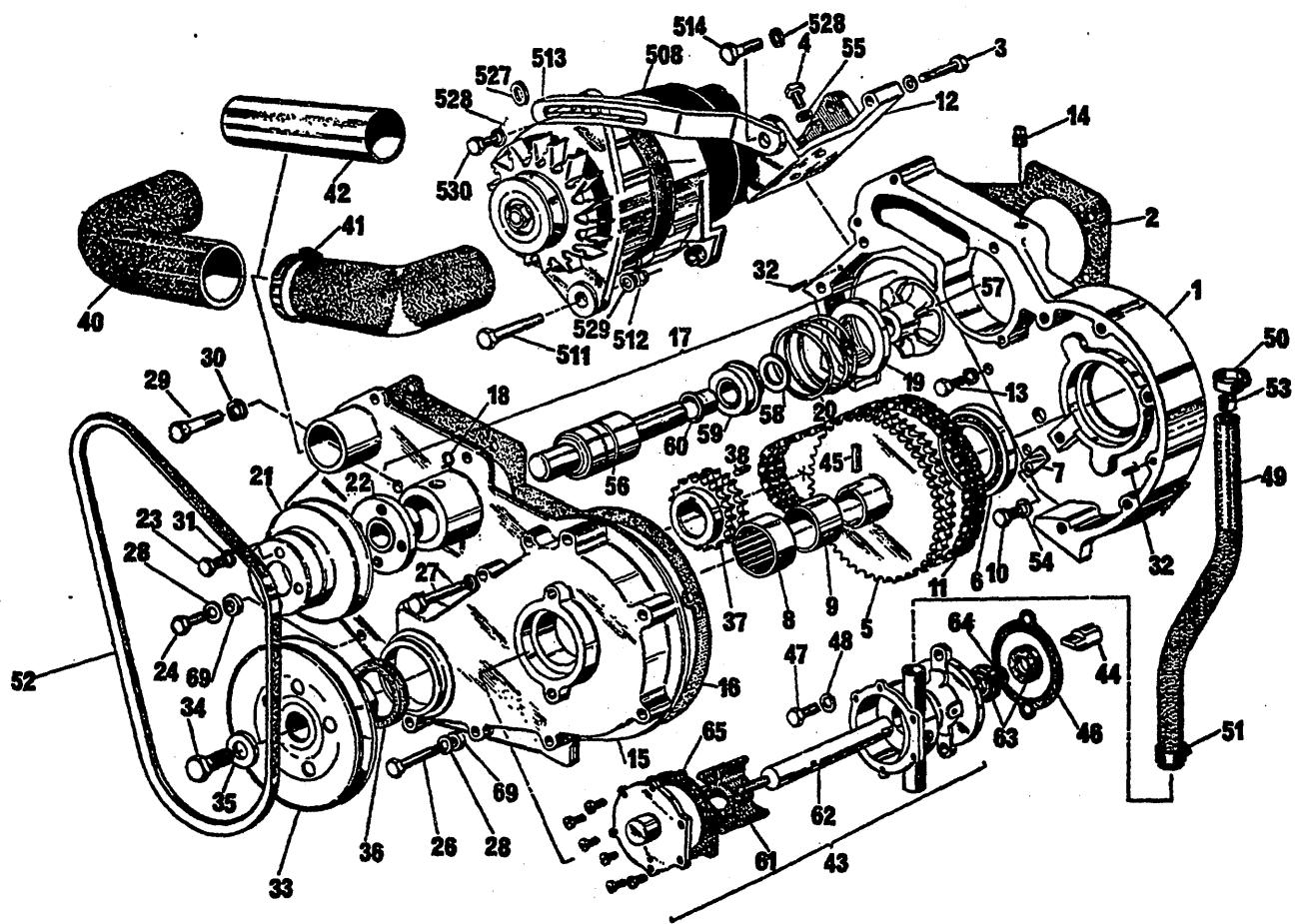
WESTERBEKE L251 PUMPS - COVERS - ALTERNATOR



WESTERBEKE L25: PUMPS - COVERS + ALTERNATOR

RFF	PN	NAME	REMARKS	QUAN
1	21158	CASE	CHAIN	1
3	21160	BOLT	BRACKET TO CHAIN CASE	1
4	21161	SCREW		2
5	21162	SPROCKET	PUMP DRIVE	1
6	21163	RACE	BALL	1
7	21164	RETAINER	BALL RACE	1
8-1	21165	BEARING	NEEDLE ROLLER	1
8-2	21386	ALTERNATOR		1
9	21166	RACE	INNER	1
10	21167	BOLT	BALL RACE RETAINER	1
11-1	21168	CHAIN	DUPLEX	1
11-2	21387	BOLT	ALTERNATOR	1
12-1	21169	BRACKET	ALTERNATOR	1
12-2	21388	NUT	ALTERNATOR BOLT	2
13-1	21170	BOLT		2
13-2	21389	STRAP	ADJUSTING	1
14-1	21171	PLUG	CHAIN COVER	1
14-2	21390	BOLT	ADJUSTING STRAP	1
15	21172	COVER	CHAIN CASE	1
16	21173	GASKET	CHAIN CASE COVER	1
17	21174	PUMP	ASSEMBLY-WATER-CENTRIFUGAL	1
18	21175	CLIP	LOCATING	1
19	21176	RING	VENTURI	1
20	21177	SPRING		1
21	21178	PULLEY	WATER PUMP	1
22	21179	FLANGE	WATER PUMP PULLEY	1
23	21180	BOLT	WATER PUMP PULLEY FLANGE	4
24	21181	BOLT	CHAIN CASE COVER	5
25	21182	LOCKWASHER		3
26	21183	BOLT	CHAIN CASE COVER	7
27	21184	BOLT	CHAIN CASE COVER	1
28	21185	WASHER	CHAIN CASE	12
29	21186	BOLT	CHAIN CASE COVER	1
30-1	21187	WASHER	CHAIN CASE	1
30-2	21253	BOLT	CAMSHAFT GEAR	2
31-1	21189	WASHER	WATER PUMP PULLEY	4
31-2	21254	RETAINER	CAMSHAFT GEAR BOLT	1
32	21190	DOWEL	CHAIN CASE COVER	2
33	21191	PULLEY	CRANKSHAFT	1
34	21192	BOLT	CRANKSHAFT PULLEY	1
35	21193	WASHER	CRANKSHAFT PULLEY BOLT	1
36	21194	SEAL	OIL-FRONT	1
37	21195	SPROCKET	CRANKSHAFT	1
38	21196	PIN	DRIVE	1
40	21197	HOSE	MOLDED	2
41	21198	CLAMP	HOSE	4
42	21199	TUBE	HOSE CONNECTING	1
43	21200	PUMP	SEA WATER	1
44	21201	DRIVE	SEA WATER PUMP	1
45	21202	KEY	DRIVE	1
46	21203	GASKET	SEA WATER PUMP TO COVER	1
47	21204	BOLT	SEA WATER PUMP	2
48	21205	WASHER	SEA WATER PUMP	2

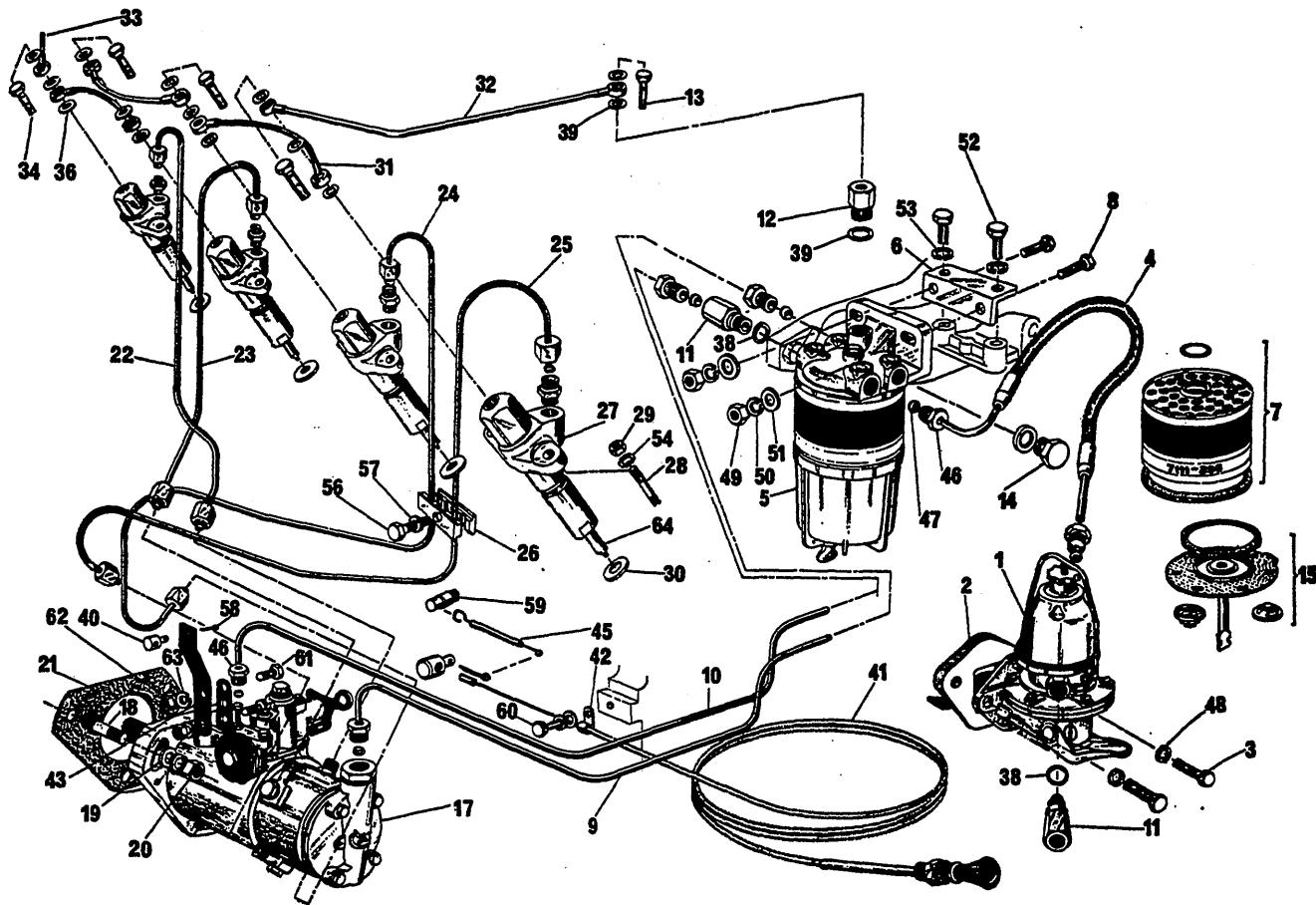
WESTERBEKE L25; PUMPS - COVERS - ALTERNATOR



WESTERBEKE L25: PUMPS - COVERS - ALTERNATOR

REF	PN	NAME	REMARKS	QUAN
49	21206	HOSE	SEA WATER PUMP OUTLET	1
50	21207	CLAMP	HOSE-SEA WATER LINE	1
51	21208	CLAMP	HOSE-SEA WATER FROM PUMP	1
52	21209	BELT		1
53	21210	BUSHING	HOSE REINFORCING	1
54	21211	LOCKWASHER		1
55	21212	LOCKWASHER		3
56	21213	BEARING	ASSEMBLY-FRESH WATER PUMP	1
57	21214	IMPELLER	FRESH WATER PUMP	1
58	21215	SEAT	FRESH WATER PUMP	1
59	21216	SEAL	FRESH WATER PUMP	1
60	21217	SLINGER	FRESH WATER PUMP	1
61	21218	IMPELLER	SEA WATER PUMP	1
62	21219	SHAFT	SEA WATER PUMP	1
63	21220	SEAL	ASSEMBLY-SEA WATER PUMP	2
64	21221	O-RING	SEA WATER PUMP	1
65	21222	GASKET	SEA WATER PUMP FRONT COVER	1
69	21223	WASHER	CHAIN CASE COVER BOLT	7

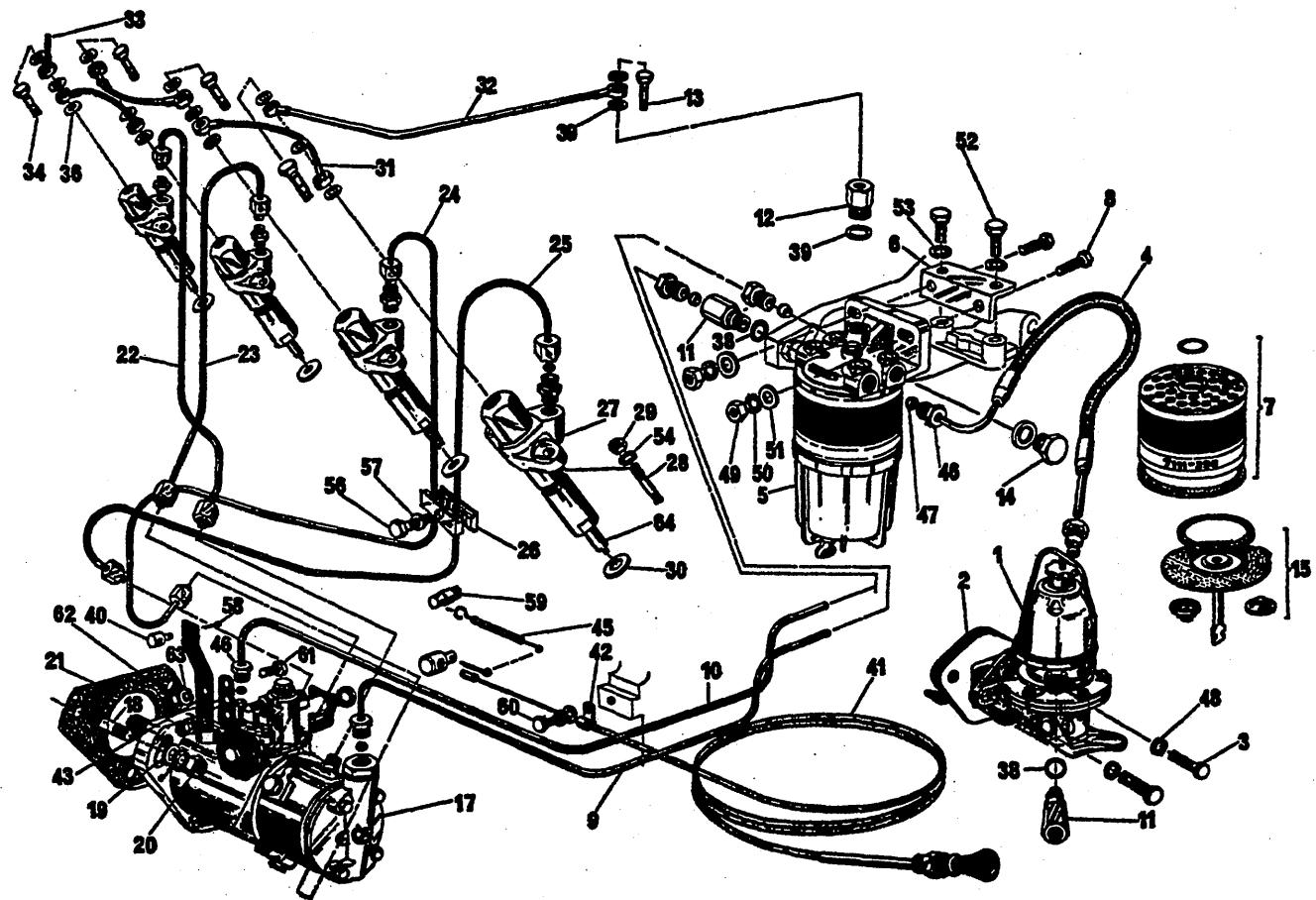
WESTERBEKE L25: FUEL SYSTEM



WESTERBEKE L251 FUEL SYSTEM

RFF	PN	NAME	REMARKS	QUAN
1-1	21313	PUMP	FUEL LIFT	1
1-2	21314	PRIMER	FUEL LIFT PUMP	1
2	21315	GASKET	FUEL LIFT PUMP	1
3	21316	SCREW	FUEL LIFT PUMP MOUNTING	2
4	21317	LINE	LIFT PUMP TO FILTER	1
5	21318	FILTER	FUEL	1
6	21319	BRACKET	LIFT PUMP	1
7	21320	ELEMENT	FUEL FILTER	1
8	21321	SCREW	FUEL FILTER MOUNTING	2
9	21322	LINE	FILTER TO INJECTION PUMP	1
10	21323	LINE	INJECTION PUMP DRAIN TO FILTER	1
11	21324	VALVE	NON-RETURN	1
12	21325	VALVE	CONSTANT BLEED	1
13	21326	BOLT	BANJO-FILTER VENT	1
14	21327	PLUG	FILTER	1
15	21328	KIT	DIAPHRAGM-LIFT PUMP	1
17	21329	PUMP	INJECTION	1
18	21330	STUD	INJECTION PUMP MOUNTING	3
19	21331	WASHER	INJECTION PUMP MOUNTING	3
20	21332	NUT	INJECTION PUMP MOUNTING	3
21	21333	GASKET	INJECTION PUMP	1
22	21334	LINE	#1	1
23	21335	LINE	#2	1
24	21336	LINE	#3	1
25	21337	LINE	#4	1
26	21338	CLAMP	FUEL LINE (PAIR)	2
27	21339	INJECTOR		4
28	21340	STUD	INJECTOR	8
29	21341	NUT		8
30	21342	WASHER		4
31-1	21343	LINE	INJECTOR SEAT	3
31-2	21344	LINE	ASSEMBLY-INJECTOR RETURN	3
31-3	21345	BANJO	RETURN-INDIVIDUAL EXCL BANJO'S	7
32-1	21346	LINE	ASSEMBLY-RETURN FROM INJECTOR TO FILTER	1
32-2	21347	LINE	RETURN-EXCL BANJO'S	1
32-3	21348	BANJO	RETURN LINE-INJECTOR TO FILTER	1
33-1	21349	LINE	ASSEMBLY-CONSTANT BLEED	1
33-2	21350	LINE	CONSTANT BLEED-EXCL BANJO'S	1
34	21351	BOLT	BANJO	4
36	21352	WASHER	BANJO-INJECTOR	12
38	21353	WASHER	BANJO-FILTER	1
39	21354	WASHER	BANJO-FILTER HEAD	3
40	21355	TERMINAL	ATTACHMENT TO FUEL PUMP	2
41	21356	CABLE	FUEL PUMP STOP	1
42	21357	CLAMP	CABLE	1
43	21358	ARM	THROTTLE	1
44	21359	BRACKET	THROTTLE	1
45	21360	SPRING	STOP CABLE RETURN	1
46	21361	NUT.	FUEL LINE	6
47	21362	FERRULE	FUEL LINE	6
48	21363	WASHER		2
49	21364	NUT		2
50	21365	LOCKWASHER		2

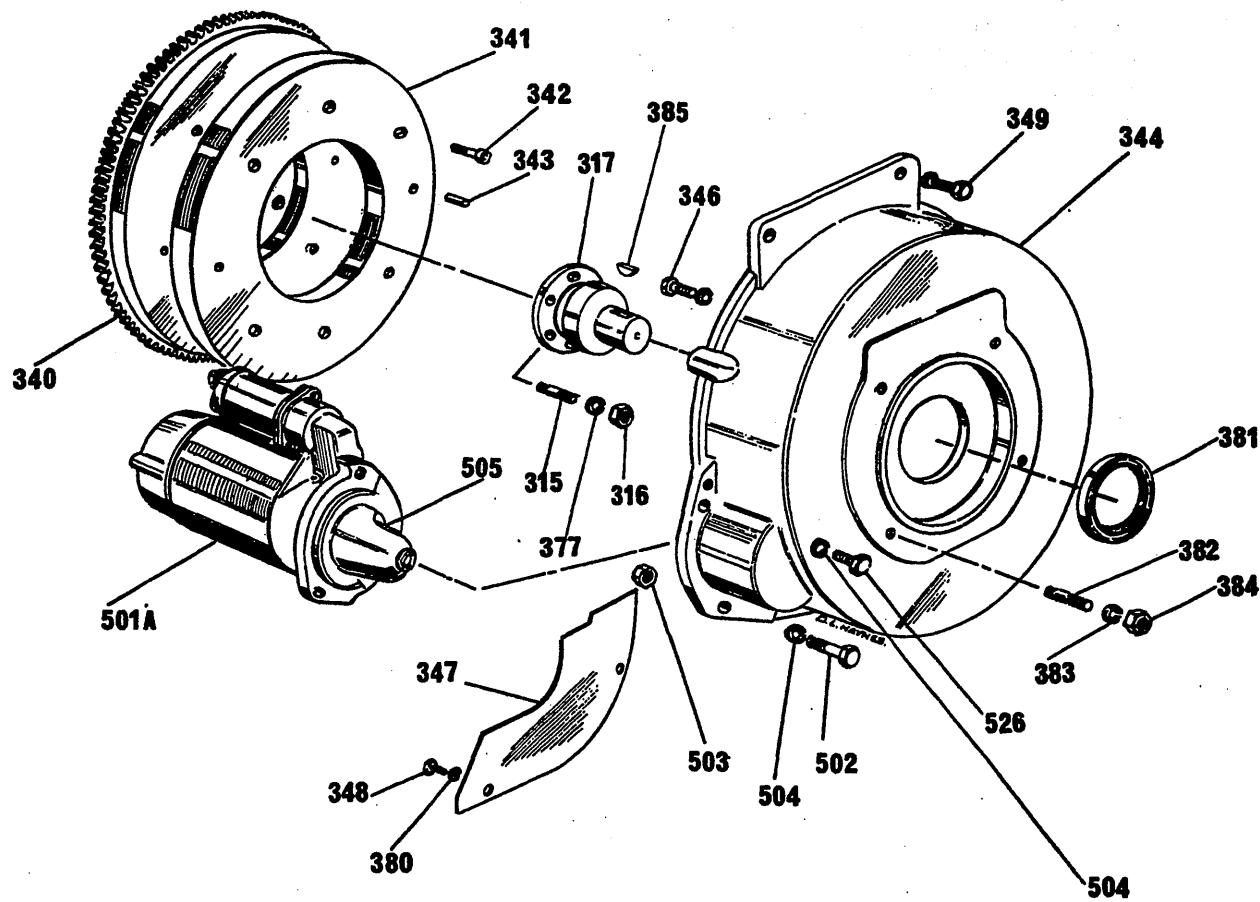
WESTERBEKE L25: FUEL SYSTEM



WESTERBEKE L251 FUEL SYSTEM

REF	PN	NAME	REMARKS	QUAN
51	21366	WASHER		2
52	21367	BOLT		2
53	21368	LOCKWASHER		2
54	21369	WASHER	SHAKEPROOF	8
56	21370	SCREW		2
57	21371	LOCKWASHER		2
58	21372	PIN	SPLIT	2
59	21373	PIN	ANCHOR	1
60	21374	SCREW	CLIP	1
61	21375	BOLT	EXTENSION	2
62	21376	NUT	EXTENSION BOLT	2
63	21377	LOCKWASHER		2
64	21378	NOZZLE	INJECTOR	1
65	21379	COVER	INJECTION PUMP	1

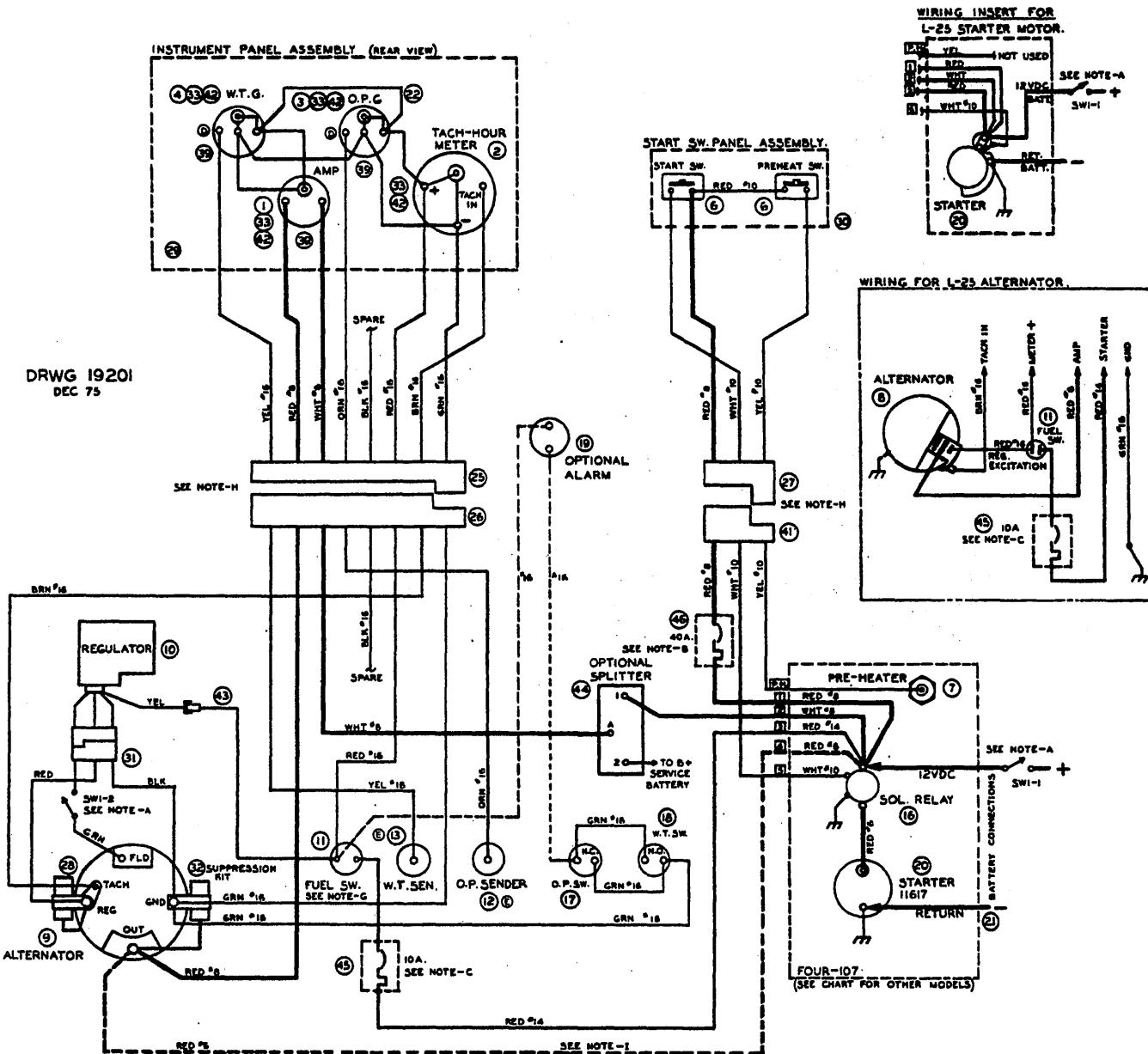
WESTERBEKE L25: BACK END - STARTER



WESTERBEKE L251 BACK END - STARTER

RFF	PN	NAME	REMARKS	QUAN
1	21380	MOTOR	STARTER	1
2	21382	BOLT	STARTER MOUNTING	1
3	21383	NUT	STARTER MOUNTING BOLT	1
4	21384	LOCKWASHER		2
5	21385	PINION	ASSEMBLY	1
15	21238	STUD	STUB SHAFT	6
16	21239	NUT	STUB SHAFT STUD	6
17	21240	SHAFT	STUB	1
26	21395	BOLT	STARTER MOUNTING	1
40	21263	FLYWHEEL	FLYWHEEL	1
41	21264	WEIGHT		1
42	21265	BOLT		6
43	21266	DOWEL		3
44-1	21267	HOUSING	FLYWHEEL-J TYPE	1
44-2	21268	HOUSING	FLYWHEEL-BW TYPE	1
44-3	21269	HOUSING	FLYWHEEL-TMP TYPE	1
44-4	21270	HOUSING	FLYWHEEL-Z TYPE	1
46	21271	BOLT	HOUSING	4
47	21272	PLATE	HOUSING COVER	1
48	21273	SCREW	HOUSING COVER PLATE	2
49	21274	SCREW	HOUSING	2
77	21305	LOCKWASHER		6
80	21308	LOCKWASHER		2
81	21309	SEAL	FLYWHEEL HOUSING	1
82	21310	STUD	FLYWHEEL HOUSING	4
83	21311	LOCKWASHER	FLYWHEEL HOUSING STUD	4
84	21312	NUT	FLYWHEEL HOUSING STUD	4

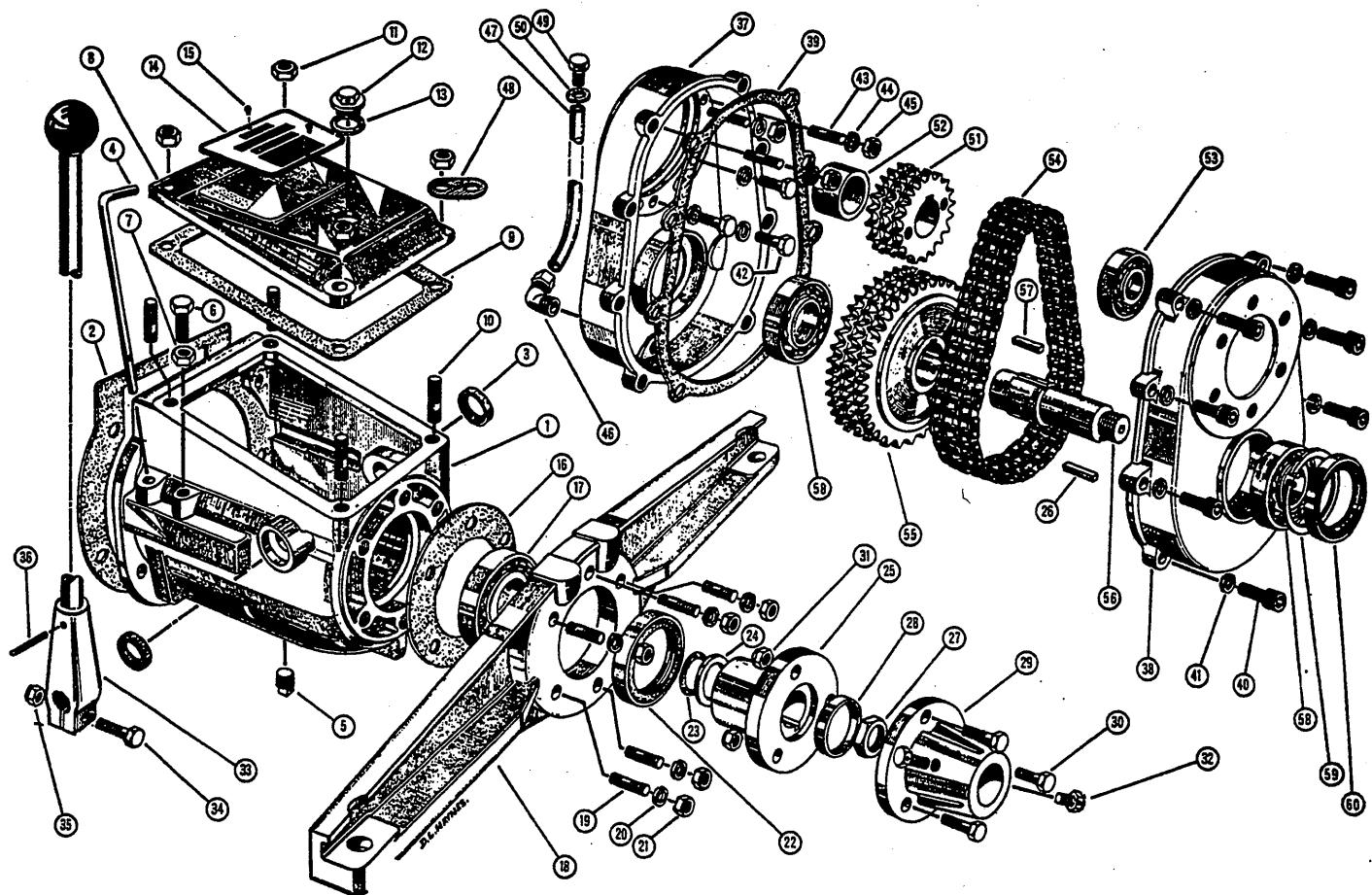
WESTERBEKE L25: ELECTRICAL SYSTEM



WESTERBEKE L25: ELECTRICAL SYSTEM

RFF	PN	NAME	REMARKS	QUAN
1	19165	AMMETER		1
2	11917	TACHOMETER	HOUR METER	1
3	19166	GAUGE	OIL PRESSURE	1
4	19168	GAUGE	WATER TEMPERATURE	1
6	11957	SWITCH	PUSHBUTTON	2
8	21386	ALTERNATOR		1
11	11383	SWITCH	FUEL N.O.	1
12	19167	SENDER	OIL PRESSURE	1
13	19169	SENDER	WATER TEMPERATURE	1
20	21380	MOTOR	STARTER	1
25	19209	CABLE	INSTRUMENT PANEL	1
26	19208	HARNESS	ENGINE-INSTRUMENT	1
27	19206	CABLE	STARTING PANEL	1
29	12885	PANEL	LESS INSTRUCTIONS	1
30	19203	PANEL	START-PREHEAT	1
31	11675	CABLE	ALTERNATOR TO REGULATOR	1
32	11532	KIT	SUPPRESSION-ALTERNATOR	1
33	11432	LAMP		4
39	16023	RING	ADAPTER	3
41	19205	HARNESS	ENGINE-STARTING	1
42	19216	HOLDER	LAMP	4
44	20654	SPLITTER	OPTIONAL	1
45	20946	BREAKER	CIRCUIT-10 AMP	1
46	20947	BREAKER	CIRCUIT-40 AMP	1

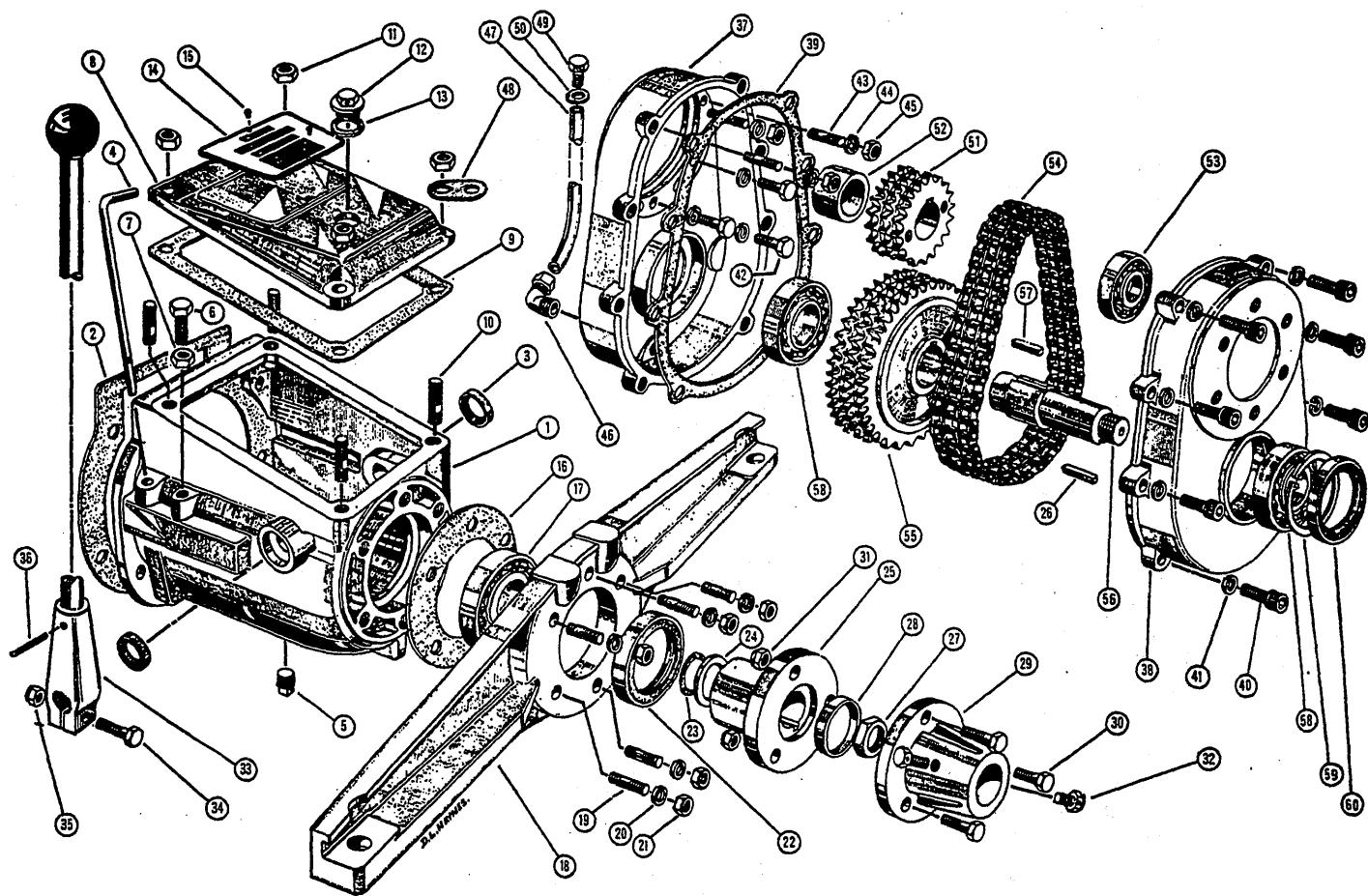
J TYPE MANUAL TRANSMISSION: EXTERNAL + REDUCTION



J TYPE MANUAL TRANSMISSION: EXTERNAL - REDUCTION

RFF	PN	NAME	REMARKS	QUAN
1	21020	HOUSING	FOR TRANSMISSION	1
2	21019	GASKET	SUPPORT FLANGE TO TRANSM HSING	1
3	21421	SEAL	CROSS SHAFT	2
4	21018	DIPSTICK	TRANSM HSING OIL LEVEL	1
5	20991	PLUG	DRAIN-TRANSM HSING	1
6	21007	SCREW	SET-BAND ANTI-RATTLE	1
7	20985	NUT	LOCK	1
8	21011	COVER	INSPECTION	1
9	21012	GASKET	INSPECTION COVER TO TRANSM HSING	1
10	21401	STUD		4
11	20987	NUT		4
12	21002	PLUG	OIL FILLER-INSPECTION COVER	1
13	21003	WASHER	FIBER-OIL FILLER PLUG	1
14	21013	NAMEPLATE	ENGINE IDENTIFICATION	1
15	21010	PIN	BRASS, SECURING NAMEPLATE	2
16	21009	GASKET	TRANSM HSING/REDUCT ALSO USED ON DD	1
17	20994	BEARING	PALL-MAIN SHAFT	1
18-1	21441	MOUNT	REAR - LOW	1
18-2	21439	MOUNT	REAR - HIGH	1
18-3	21438	ADAPTER	USED WITH 21439 MOUNT	1
19	21401	STUD	SECURES AFT BEARER	6
20	20989	LOCKWASHER	FOR STUD	6
21	20987	NUT	FOR STUD	6
22	20996	SEAL	OIL-AFT END COVER OR BEARER DD	1
23	21000	COUPLING	O-RING	1
24	21001	COUPLING	WASHER	1
25	20999	COUPLING	HALF-TRANSM HSING	1
26	21060	KEY	SHAFT TO COUPLING	1
27	20998	NUT	SECURES COUPLING TO MAIN SHAFT	1
28	20997	RING	COUPLING-PILOTING	1
29	20990	COUPLING	SHAFT HALF	1
30	20992	BOLT	COUPLING	3
31	20986	NUT	SELF-LOCKING-FOR BOLT	3
32	21416	SCREW	SHAFT LOCK	2
33	21404	BUSHING	SHIFT LEVER	1
34	20992	BOLT	CLAMP-SHIFT LEVER	1
35	20986	NUT	SELF-LOCKING-FOR CLAMP BOLT	1
36	21443	PIN	TRANSAX-SECURES LEVER	1
37	21022	HOUSING	REDUCT TRANSMISSION	1
38	21023	COVER	REDUCTION TRANSM HSING	1
39	21024	GASKET	REDUCT TRANSM COVER TO HSING	1
40	21025	SCREW	BUSHING	8
41	20989	LOCKWASHER	FOR BUSHING SCREW	8
42	20993	BOLT	SECURES REDUCT CASE TO GB	3
43	21401	STUD	SECURES REDUCTION CASE TO GB	3
44	20989	LOCKWASHER		6
45	20987	NUT		3
46	21402	ELBOW	DRAIN	1
47	21418	PIPE		1
48	21419	CLIP		1
49	21408	SCREW	SET	1
50	21420	WASHER		1
51	21026	SPROCKET	DRIVE	1

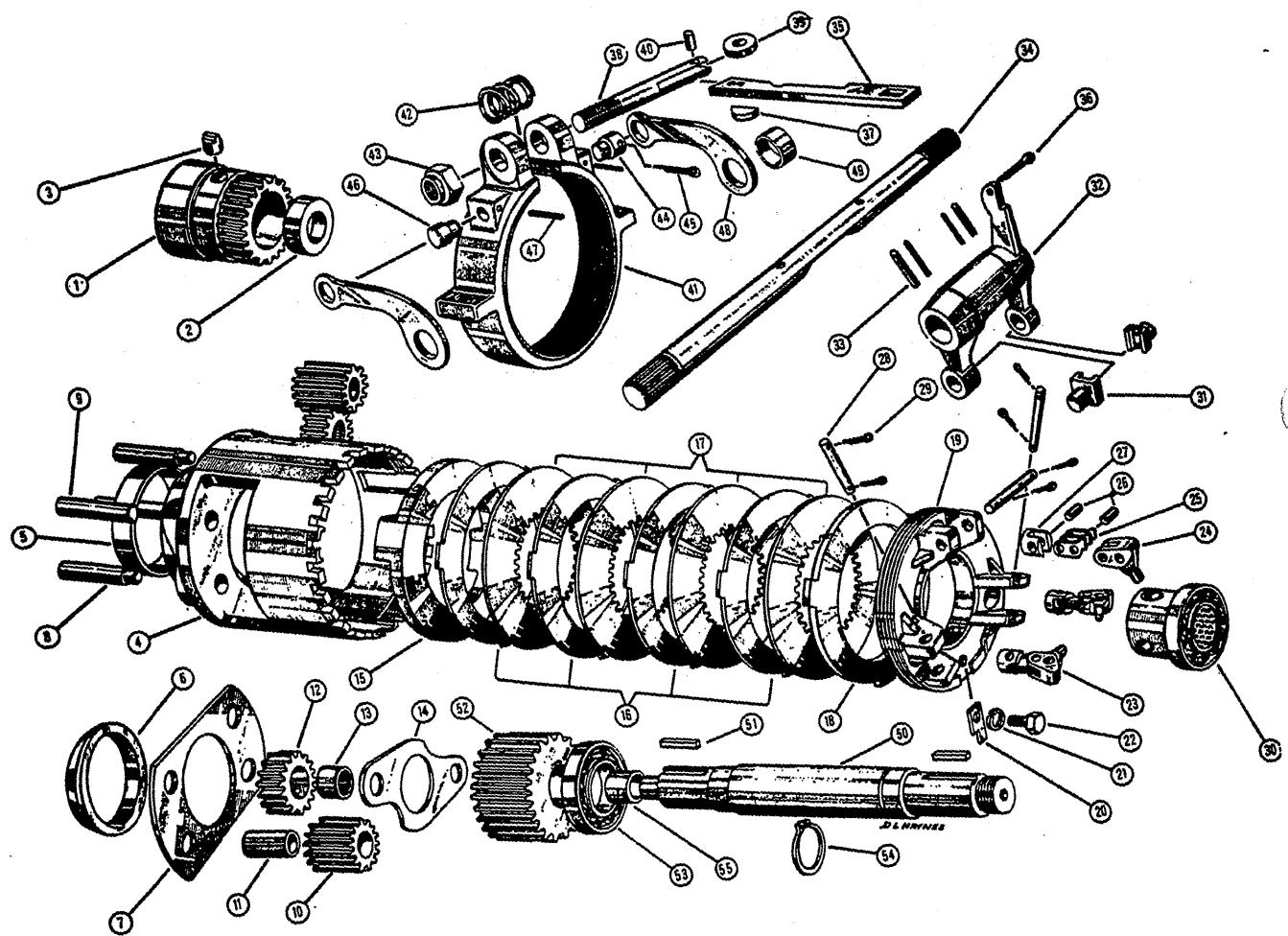
J TYPE MANUAL TRANSMISSION: EXTERNAL - REDUCTION



J TYPE MANUAL TRANSMISSION: EXTERNAL - REDUCTION

RFF	PN	NAME	REMARKS	QUAN
52	21028	SPACER	FOR DRIVE SPROCKET	1
53	21027	BEARING	BALL-AFT TOP	1
54-1	21005	CHAIN	TRIPLE-50 LINKS	1
54-2	21006	CHAIN	TRIPLE-46 LINKS	1
55-1	21030	SPROCKET	DRIVEN-38T	1
55-2	21031	SPROCKET	DRIVEN-31T	1
56	21029	SHAFT	LOWER-REDUCT GEAR	1
57	21060	KEY	FOR DRIVEN SPROCKET	1
58	21004	BEARING	BALL-LOWER SHAFT	2
59	21033	CIRCLIP		1
60	21034	SEAL	OIL	1
61	21398	COUPLING	HALF-TRANSM HSING FOR FLEX COUPLING	1
62	21417	LEVER	SHIFT ASSEMBLY	1
63	21008	COVER	AFT END-REVERSE TRANSM HSING	1
64	21412	BRACKET	SUPPORT-REAR ENGINE-VERTICAL	1
65	21397	BRACKET	SUPPORT-REAR ENGINE-STARBOARD	1
66	21415	ELBOW	FOR WATER COOLED TRANSM	1
67	21413	CONNECTOR	STRAIGHT-FOR WATER COOLED TRANSM	1
68	21399	PLUG	DRAIN-AFT BEARER-FOR WATER COOLED TRANSM	1
69	21400	WASHER	FIBER-FOR DRAIN PLUG-FOR WATER COOLED TRANS	1

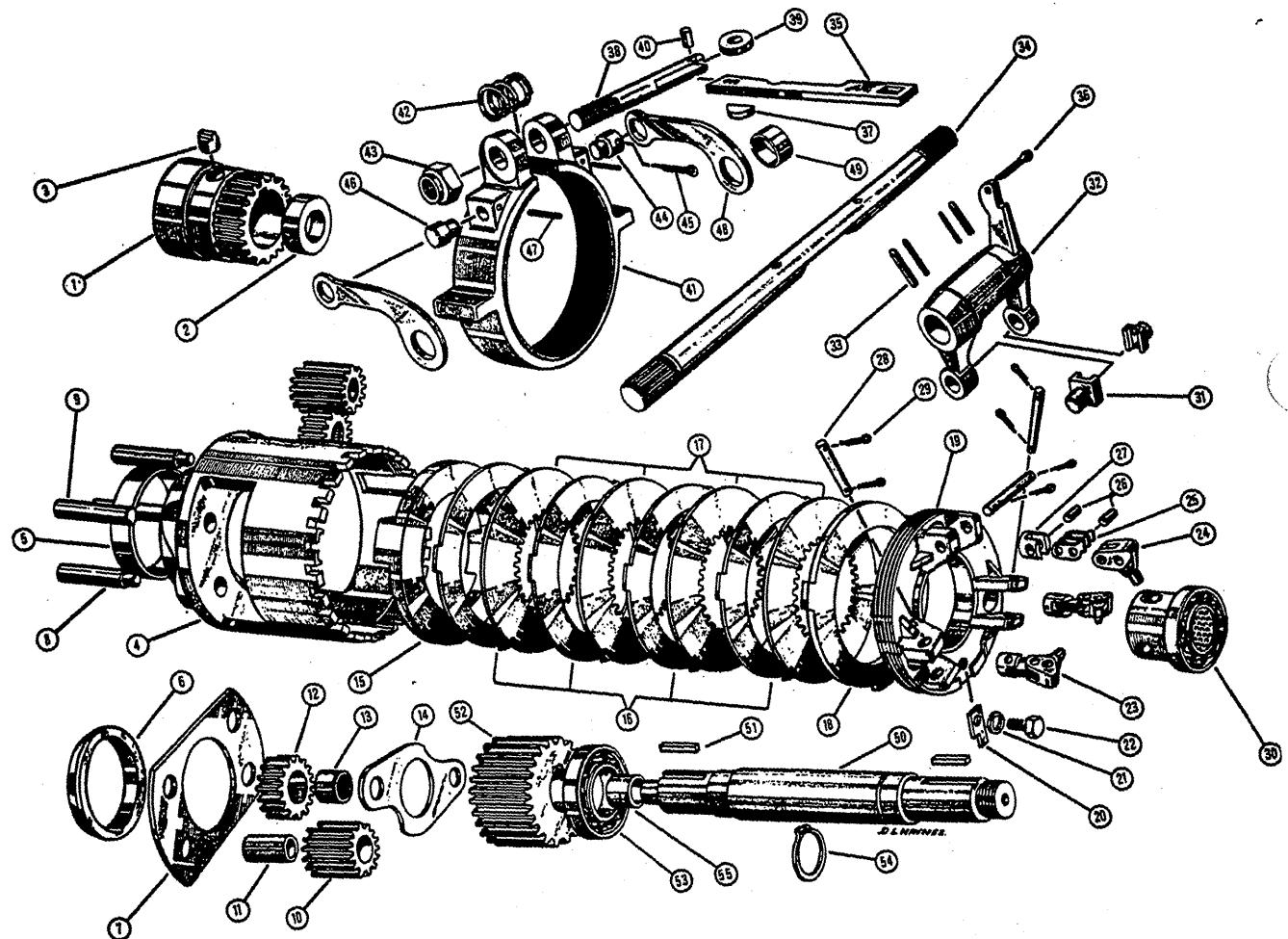
J TYPE MANUAL TRANSMISSION: INTERNAL - CLUTCH



J TYPE MANUAL TRANSMISSION: INTERNAL - CLUTCH

RFF	PN	NAME	REMARKS	QUAN
1	21061	GEAR	FORWARD STUB SHAFT	1
2	21062	BUSHING	PILOTING-FOR GEAR	1
3	21063	KEY	CONE-FOR TRANSMISSION	3
4	21043	DRUM		1
5	21044	BUSHING	DRUM	1
6	21054	CONE	SPLIT	1
7	21049	PLATE	FORWARD PUSH	1
8	21048	STUD	LONG PINION	2
9	21047	STUD	SHORT PINION	2
10	21067	PINION	LONG-WITH BUSHING	2
11	21064	BUSHING	LONG PINION	2
12	21065	PINION	SHORT-WITH NEEDLE ROLLER	2
13	21066	ROLLER	NEEDLE	2
14	21079	DISC	THRUST	1
15	21050	HEAD		1
16	21052	DISC	CLUTCH-WITH LUGS	4
17	21051	DISC	CLUTCH-WITH TEETH	4
18	21053	DISC	CLUTCH-WITH THICK LUGS	1
19	21045	PLATE	DRUM ARM	1
20	21086	CLIP	ADJUSTING	1
21	20988	LOCKWASHER		1
22	21087	SCREW	SET-FOR CLIP	1
23	21074	TOGGLE	ASSEMBLY-WITH PLUNGER	3
24	21069	TOGGLE		3
25	21070	TOGGLE	LINKS ONLY (SET 3)	3
26	21072	PIN	FOR TOGGLE AND PLUNGER	6
27	21080	PLUNGER		3
28	21071	PIN		3
29	21073	PIN	SPLIT	6
30 *	21078	COLLAR	ASSEMBLY-OPERATING	1
32	21405	LEVER	FORK	1
33	21442	PIN	TRANSAX-PAIR	2
34	21414	SHAFT	CROSS	1
35	21068	CAMPLATE		1
36	21057	PIN	SPLIT	1
37	21084	SHOE	CAM	1
38	21077	CAMSHAFT	WITH ROLLER AND PIN	1
39	21083	ROLLER	CAM	1
40	21085	PIN	FOR CAM ROLLER	1
41	21058	BANDS	BRAKE-WITH LINK PINS	1
42	21076	LOCK	FOR BRAKE BAND	1
43	21075	NUT	ADJUSTING-BRAKE BAND S/L	1
44	21055	PIN	LINK-STARBOARD	1
45	21057	PIN	SPLIT-FOR LINK PINS	1
46	21056	PIN	LINK-PORT (SHORT)	1
*31	21406	SHOE		1

J TYPE MANUAL TRANSMISSION: INTERNAL - CLUTCH



J TYPE MANUAL TRANSMISSION: INTERNAL - CLUTCH

RFF	PN	NAME	REMARKS	QUAN
47	21444	PIN	TRANSAX-FOR LINK PINS (PAIR)	2
48	21081	PLATE	LINK	2
49	21082	SHAFT	CROSS/LINK SPACER	1
50-1	21016	SHAFT	MAIN-DD	1
50-2	21017	SHAFT	MAIN-REDUCTION	1
51	21060	KEY	MAIN SHAFT TO TRANSM & COUPLING	1
52	21059	GEAR	MAIN SHAFT	1
53	21046	BEARING	BALL-DRUM ARM PLATE	1
54	21015	CIRCLIP		1
55	21014	BUSHING	MAIN SHAFT	1

SUPERCEDED PARTS USED PRIOR TO SN 5375

REF	PN	NAME	REMARKS	QUAN
1	21441	EXCHANGER	FORWARD (SN 172-3372)	1
2	21432	BRACKET	FORWARD HEAT EXCHANGER (SN 172-3372)	1
3	21427	OUTLET	FORWARD HEAT EXCHANGER (SN 172-3372)	1
4	21409	MANIFOLD	EXHAUST (SN 172-3372)	1
5	21040	ELBOW	EXHAUST MANIFOLD (SN 172-3372)	1
6	21403	BEND	EXHAUST MANIFOLD-45 DEGREE (SN 172-3372)	1
7	21410	ALTERNATOR	12/24 VOLT SYSTEM (SN 172-6073)	1
8	21429	BRACKET	ALTERNATOR (SN 172-6073)	1
9	21423	RELAY	STARTER-12/24 VOLT SYSTEM (SN 172-6073)	1
10	20984	STARTER	12/24 VOLT SYSTEM (SN 172-6073)	1
11	21038	SOLENOID	STARTER-12/24 VOLT SYSTEM (SN 172-6073)	1
12	21038	SWITCH	SERIES-12/24 VOLT SYSTEM (SN 172-6073)	1
13	21428	DRIVE	ASSEMBLY-TACHOMETER (SN 172-6073)	1
14	21422	ALTERNATOR	24 VOLT SYSTEM (SN 6173-16974)	1
15	21435	BRACKET	ALTERNATOR-24 VOLT SYSTEM (SN 6173-16974)	1
16	20995	REGULATOR	24 VOLT SYSTEM (SN 6173-16974)	1
17	21039	SOLENOID	STARTER-24 VOLT SYSTEM (SN 6173-16974)	1
18	21041	PULLEY	ALTERNATOR-24 VOLT SYSTEM (SN 6173-16974)	1
19	21433	BOLT	CHAINCASE DOWEL (SN 172-17374)	1
20	21188	BOLT	CHAINCASE (SN 172-17374)	1
21	21035	STRAP	ALTERNATOR ADJUSTING (SN 6073-16974)	1
22	21425	HOUSING	TACHOMETER DRIVE (SN 6073-16974)	1
23	21407	FLANGE	TACHOMETER DRIVE (SN 6073-16974)	1
24	21436	COUPLING	TACHOMETER DRIVE (SN 6073-16974)	1
25	21431	HOUSING	FLYWHEEL (SN 172-16974)	1
26	21042	ALTERNATOR	12 VOLT SYSTEM (SN 17074-4175)	1
27	21037	STARTER	12 VOLT SYS-BTM MTD SOL (SN 17074-21475)	1
28	21437	HOUSING	FLYWHEEL (SN 17074-21475)	1
29	21426	COVER	ROCKER (SN 172-23074)	1
30	21036	GASKET	ROCKER COVER (SN 172-23074)	1
31	21434	STUC	ROCKER COVER (SN 172-23074)	1
32	21430	NUT	ROCKER COVER (SN 172-23074)	1
33	21021	SEPARATOR	OIL (SN 172-4075)	1
34	21032	HOSE	BREATHER (SN 172-4075)	1
35	21424	CAP	OIL FILTER (SN 172-4075)	1
36	21445	SLEEVE	OIL FILTER CAP (SN 172-4075)	1
37	21446	PUMP	FUEL INJECTION (SN 172-4075)	1