OPERATOR'S MANUAL

WESTERBEKE 12B TWO

MARINE DIESEL ENGINE

Publication # 37185

Edition One

January 1988

WESTERBEKE

WESTERBEKE CORPORATION
AVON INDUSTRIAL PARK, AVON, MA 02322 • TEL: (617) 588-7700

Engine parts from Torrsen Marine - www.torresen.com - 231-759-8596

SAFETY PRECAUTIONS

The following symbols appear in this manual to call attention to and emphasize conditions potentially dangerous to the operator.

WARNING

The above symbol is used in the manual to warn of possible serious personal injury or loss of life.

CAUTION

The above symbol is used in the manual to caution personnel of possible damage to equipment.

Read the manual carefully and thoroughly before attempting to operate the equipment. Know when dangerous conditions can exist and take necessary precautions to protect personnel and equipment.

Fuels, exhaust gases, batteries, electrical equipment, and moving and hot parts are potential hazards that could result in serious personal injury or death. Follow recommended procedures carefully.

Always operate bilge blowers for at least five minutes before starting a gasoline-fueled engine; ensure no gasoline fumes are present before starting.

- Prevent Electric Shock

  Shut off electric power before accessing electrical equipment.

  Use insulated mats whenever working on electrical equipment.

  Make sure your clothing is dry, not damp (particularly shoes), and keep your skin surfaces dry when handling electrical equipment.

  Remove wristwatch and jewelry when working on electrical equipment.

  Do not connect utility shore power to vessel's AC circuits, except through a ship-to-shore double-throw transfer switch. Damage to vessel's AC generator may result if this is not done.

  Be extremely careful when working on electrical components. High voltage can cause injury or death.

- Exhaust Gases Are Toxic

  Ensure that the exhaust system is adequate to expel gases discharged from the engine. Check exhaust system regularly for leaks and make sure the exhaust manifolds are securely attached and no warping exists.

  Be sure the unit and its surroundings are well-ventilated.

- Use Extreme Care When Handling Engine Fuel (A constant danger of explosion or fire exists)

  Do not fill fuel tank(s) while the engine is running.

  Do not smoke or use an open flame near the engine or the fuel tank.

- Do Not Alter or Modify the Fuel System

  Be sure all fuel supplies have a positive shut-off valve.

  Be certain fuel line fittings are adequately tightened and free of leaks.

  Make sure a fire extinguisher is installed nearby and is properly maintained. Be familiar with its proper use. Extinguishers rated ABC by the NFPA are appropriate for all applications encountered in this environment.

- Use Extreme Care When Servicing Batteries

  Wear rubber gloves, a rubber apron, and eye protection when servicing batteries.

  Lead acid batteries emit hydrogen, a highly-explosive gas, which can be ignited by electrical arcing or by a lighted cigarette, cigar, or pipe. Do not smoke or allow an open flame near the battery being serviced. Shut off all electrical equipment in the vicinity to prevent electrical arcing during servicing.

- Avoid Moving Parts

  Do not service the unit while the unit is running; if a situation arises in which it is absolutely necessary to make operating adjustments, use extreme care to avoid moving parts and hot exhaust system components.

  Do not wear loose clothing or jewelry when servicing equipment; avoid wearing loose jackets, shirts or sleeves, rings, necklaces, or bracelets that might be caught in moving parts.

  Make sure all attaching hardware is properly tightened. Keep protective shields and guards in their respective place at all times.

  Do not check fluid levels or the drive-belt's tension while the unit is operating.

  Do not work on the equipment when mentally or physically incapacitated by fatigue.

IMPORTANT

PRODUCT SOFTWARE DISCLAIMER

Product software of all kinds, such as brochures, drawings, technical data, operator's and workshop manuals, parts lists and parts price lists (and other related information), instructions and specifications provided from sources other than Westerbeke, is not within Westerbeke's control and, accordingly, is provided to Westerbeke customers only as a courtesy and service. WESTERBEKE CANNOT BE RESPONSIBLE FOR THE CONTENT OF SUCH SOFTWARE, MAKES NO WARRANTIES OR REPRESENTATIONS WITH RESPECT THERETO, INCLUDING THE ACCURACY, TIMELINESS OR COMPLETENESS THEREOF, AND WILL IN NO EVENT BE LIABLE FOR ANY TYPE OF DAMAGES OR INJURY INCURRED IN CONNECTION WITH, OR ARISING OUT OF, THE FURNISHING OR USE OF SUCH SOFTWARE.

For example, components and subassemblies incorporated into Westerbeke's products and supplied by others (such as engine blocks, fuel systems and components, transmissions, electrical components, pumps and other products) are generally supported by their manufacturers with their own software, and Westerbeke must depend on such software for the design of Westerbeke's own product software. Such software, however, may be outdated and no longer accurate. Routine changes made by Westerbeke's suppliers, of which Westerbeke rarely has notice in advance, are frequently not reflected in the supplier's software until after such changes take place.

Westerbeke customers should also keep in mind the time span between printings of Westerbeke product software, and the unavoidable existence of earlier, non-current Westerbeke software editions in the field. Additionally, most Westerbeke products include customer-requested special features that frequently do not include complete documentation.

In summation, product software provided with Westerbeke products, whether from Westerbeke or other suppliers, must not and cannot be relied upon exclusively as the definitive authority on the respective product. It not only makes good sense, but is imperative that appropriate representatives of Westerbeke or the supplier in question be consulted to determine the accuracy and currency of the product software being consulted by the customer.

FOREWORD

Thank you for selecting a Westerbeke marine product for your use. We at Westerbeke are pleased to have you as a customer.

Read this manual carefully and observe all safety precautions included throughout. Operating procedures, periodic preventive maintenance procedures, installation checks, system descriptions and minor adjustment procedures are included herein so you can operate your equipment safely and properly, maintain the equipment at a high level of efficiency, and expect dependable performance and long service life in return.

Should your unit require special attention, contact your Westerbeke dealer for assistance. The Westerbeke Service Organization is trained to provide the support necessary to ensure long-term dependable performance.

If, within 60 days of submitting the Warranty Registration Form for your unit, you have not received a Customer Identification Card (see below) registering your warranty, please contact the factory in writing with Model information, including the engine's serial number and commission date.

from: WESTERBEKE CORPORATION
AVON INDUSTRIAL PARK
AVON, MA 02322

Mail To:

WESTERBEKE

CUSTOMER IDENTIFICATION

Adam Smith
85 Maple Street
Alden, IN 12234

Model W 12 TWD Ser. # 1234C706

Expires 7/7/88

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 within the engine's crate.

Before accepting shipment of the engine from the transportation company, the crate should be opened and the contents inspected for concealed damage. If either visible or concealed damage is noted, you should require that the delivery agent sign "Received in damaged condition" on the proper delivery receipt. Also check the contents of the shipment against the packing list and make sure that the proper notation is made if any discrepancies exist. These noted discrepancies are your protection against loss or damage. Claims concerning loss or damage *must* be made to the *carrier*, not to the Westerbeke Corporation.

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GENERAL

Introduction

This manual contains the equipment operating procedures as well as additional information needed to help the operator keep the equipment in proper working order. Study and follow the instructions carefully. A planned maintenance program is included in this manual; adhering to the program will result in better equipment performance and longer equipment life. Proper diagnosis of a problem is the most important step to satisfactory repair; therefore, a troubleshooting table is included.

Understanding the Diesel Engine

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

Therefore, to a great extent, a diesel engine requires the same preventive maintenance as a gasoline engine. The most important factors are proper ventilation and 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 (that is, water, sediment, or allege) 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. Be careful not to put gasoline in the diesel fuel tank(s). Gasoline does not have the same lubricating qualities as diesel fuel; consequently, gasoline in the fuel lines will damage components in the fuel lift pump assembly, fuel injection pump and injectors.

The diesel engine does differ from the gasoline engine, however, in its handling and firing of fuel. The carburetor and ignition systems are done away with and in their place are two components - the fuel injection pump and the fuel injectors.

Ordering Parts

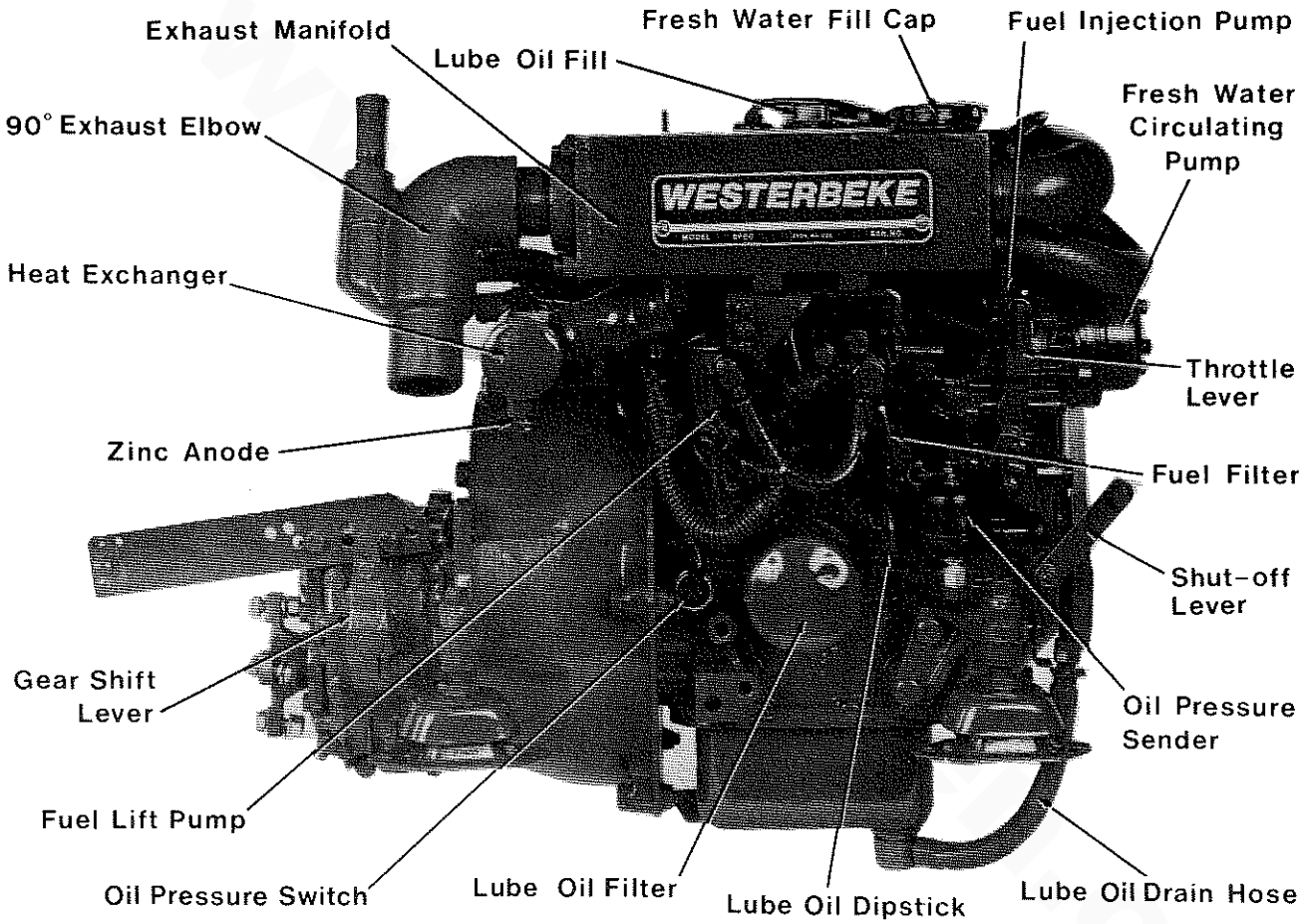
When contacting your Westerbeke dealer, parts distributor, or the factory concerning your Westerbeke unit, always provide the engine's model and serial number, and transmission number as they appear on the black and silver "Westerbeke" plate which is mounted on the engine's exhaust manifold. When ordering parts for your Westerbeke engine, be sure to insist upon Westerbeke factory packaged parts, because "will fit" or generic parts are frequently not made to the same specifications as original equipment.

Note that component locations in the manual are referenced from the front of the engine which is the pulley/drive belt end. (The flywheel/transmission end is the rear end.) Left and right sides are determined by the engine; imagine straddling the engine and facing in the same direction as the front of the engine: the left side is at your left, the right side is your right.

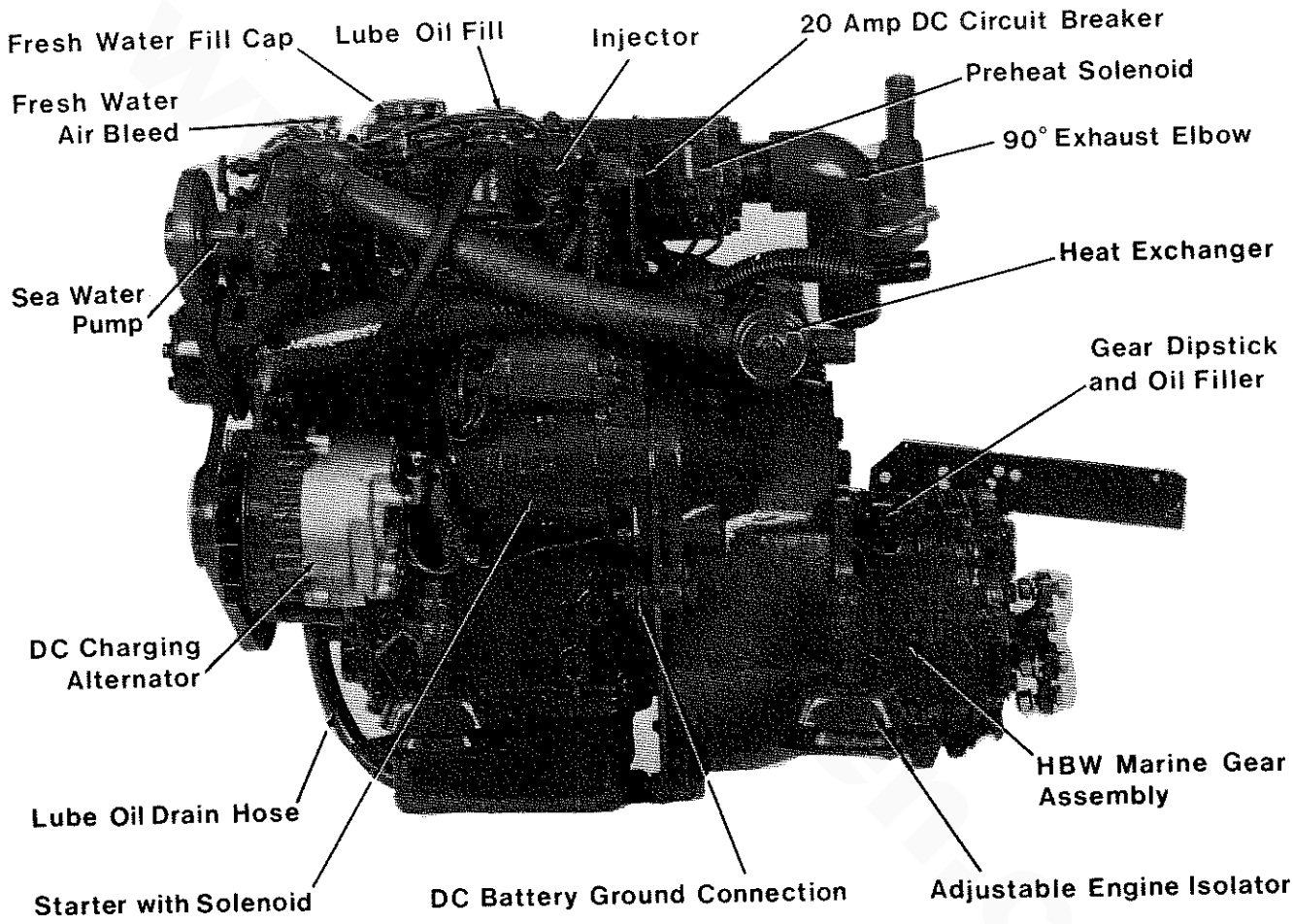
Westerbeke engines and generator sets are thoroughly checked and given a final run under various load conditions before leaving the factory. Test running the engine ensure dependable operation, long service, and a satisfied owner.

Care at the factory during assembly, and thorough testing, have resulted in a Westerbeke diesel engine capable of many thousands of hours of dependable service. However, the manufacturer cannot control the treatment the unit receives in the field. That part is up to the owner/operator.

W 12B TWO Marine Diesel Engine



W 12B TWO Marine Diesel Engine



W 12B TWO MARINE DIESEL ENGINE

GENERAL SPECIFICATIONS

Engine Type	Diesel, four-cycle, two-cylinder, fresh water cooled, vertical, in-line (12 hp at 3600 rpm maximum)
Governor	Mechanical, centrifugal weight type
Valve Mechanism	Overhead
Combustion Chamber	Swirl chamber type
Bore & Stroke	2.56 x 2.68 inches (65 x 68 mm)
Piston Displacement	27.52 cubic inches (0.45 liters)
Firing Order	1-2
Direction of Rotation	Clockwise, when viewed from the front
Maximum Torque (at 2700 rpm)	19 lb-ft (2.83 kg-m)
Compression Ratio	25:1
Compression Pressure	455 psi (32 kg/cm^2) at 320 rpm
Valve Seat Angle	Intake 45° Exhaust 45°
Valve Clearance (engine cold)	Intake 0.0098 inches (0.25 mm) Exhaust 0.0098 inches (0.25 mm)
Dimensions	Height: 19.57 inches (497.07 mm) Width: 17.75 inches (450.85 mm) Length: 24.90 inches (632.46 mm)
Inclination	Continuous 14° Temporary 25° (not to exceed 30 min.)
Dry Weight	205 lbs (92.9 kgs)
Fuel Consumption	0.3 U.S. gph (1.14 lph) running at 2500 rpm (approximate)

W 12B TWO SYSTEM SPECIFICATIONS

FUEL SYSTEM	Open flow, totally self-bleeding
Fuel	No. 2 diesel oil (cetane rating of 45 or higher)
Injection Pump	Nippondenso (Bosch M type)
Injection Timing	25° ± 0.5° BTDC (Static)
Nozzle	Throttle type
Injection Starting Pressure	2275.2 psi (160 kg/cm^2)
Lift Pump	12-Volt DC; lift capacity 6 ft (1.8 m)
Fuel Filter (on engine)	Canister type, with replaceable element
Air Cleaner	Metal screen type - cleanable
Air Flow (engine combustion)	27.0cfm (0.77cmm)
COOLING SYSTEM	
General	Fresh water cooled block, thermostatically-controlled with sea water exchanger system
Operating Temperature	170 - 190° F (77 - 88° C)
Fresh Water Pump	Centrifugal type, metal impeller, belt-driven
Sea Water Pump	Positive displacement, rubber impeller, belt-driven
Sea Water Flow, at 3600 rpm (measured before discharging into exhaust elbow)	gpm (lpm) approximate
System Capacity (fresh water)	4.0 qts (3.78 liters)
LUBRICATION SYSTEM	
General	Forced lubrication by gear pump
Oil Filter	Paper element, spin-on type
Sump Capacity (includes filter)	3.27 U.S. qts (3.1 liters)

W 12B TWO SYSTEM SPECIFICATIONS

Operating Oil Pressure	35 - 55 psi (2.46 - 3.86 kg/cm^2)
Oil Grade	API specification CC or CD

ELECTRICAL SYSTEM

Starting Battery	12-Volt, 35 A-H, (-) negative ground (recommended) (45 A-H cold areas)
Battery Capacity	90 - 125 (Ampere-Hours)
Starting Aid	12-Volt sheathed type glow plug
Starter Motor	12-Volt, 1.2KW, solenoid, actuated shift
DC No-Load Current	60 Amps at 11.5 Volts (6500 rpm, min.)
Cold Cranking Current	209 Amps at 12 Volts
Alternator	12-Volt DC, 35 Amps
Regulator	Internal regulator, built into alternator 14.4 Volts DC ± 3 Volts

TRANSMISSION

HBW 50

Standard Gear Ratio	2:1
Optional Gear Ratio	2.5:1
Direction of Rotation	Right handed - standard transmission
Lubrication Fluid	Automatic Transmission Fluid (ATF) Type A or Dexron II
Sump Capacity	0.32 U.S. qts (0.3 liters) approximate

BW 3

Standard Gear Ratio	2.47:1
Direction of Rotation	Right handed - standard transmission
Lubricating Oil Grade	API specification of CC or CD
SAE Grade	SAE 20 or SAE 30 exclusively
Sump Capacity	0.37 U.S. qts (0.35 liters) approximate

INSTALLATION CHECKS

General

Because the crafts in which Westerbeke engines are installed vary in design, installation procedures will vary according to your craft's specific design. It is not the intent of this section to advise boatyards or installers on procedures already well-developed and well-understood. However, it is important that the owner/operator realize there are details of the installation which require periodic checks to ensure the best operating conditions for the equipment and safe operating conditions for the personnel on board. Proper location and installation of the diesel engine in the vessel are of prime importance.

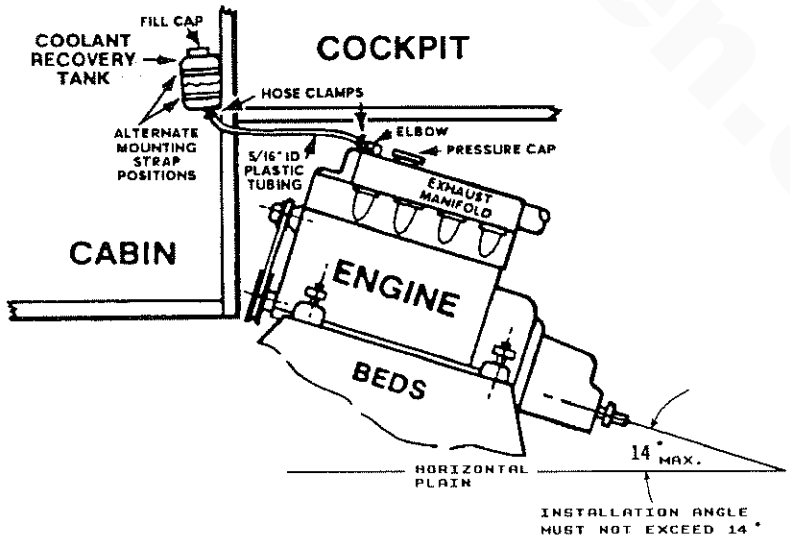
Factors in the installation that must be considered are ventilation, to aid in cooling and to provide air for engine combustion; exhaust system, to properly discharge raw cooling water, quiet the exhaust and expel exhaust gas; cooling water supply; fuel supply; and electrical connections.

CAUTION

For safety reasons, the engine and transmission are **NOT** filled with lubricating oil for shipment. Before leaving the factory, however, each engine with transmission is thoroughly tested with oil in it. This testing, among other things, provides all internal parts with a coating of oil. This oil acts as a preservative, providing reliable protection against corrosion for at least one year if the engine and transmission are properly stored.

Location

The location should be such that it is *dry*, and away from being splashed by bilge water or water from above. The engine should be properly ventilated and accessible for minor servicing and repairs (access for major repairs should be given consideration as well). The location must be properly ventilated to provide fresh air for engine combustion. The engine's lubrication oil sump dipstick, the fresh water and oil fills, and the transmission's dipstick and transmission or oil fill port must be accessible.



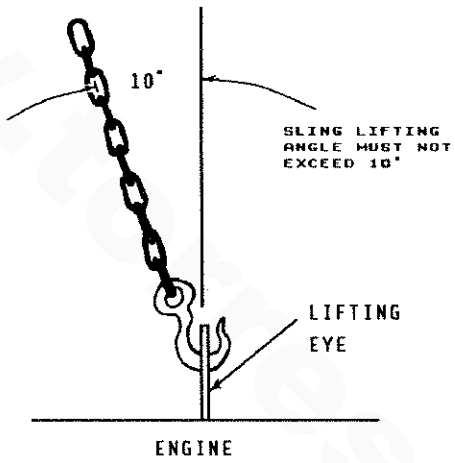
Please note that the engine's installation angle cannot exceed 14° from the horizontal plain.

Rigging and Lifting

The engine is fitted with lifting eyes. Rope or chain slings capable of supporting the engine's weight should be attached to the eyes and the engine lifted by means of tackle attached to these slings. The lifting eyes 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 significant sheer stress on the engine's lifting eyes. Strain placed on the engine's lifting eyes by the lifting sling must not be in excess of 10° from the vertical plain.



The general rule in moving engines is to see that all of the 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 the possibility of accidents by avoiding haste. Do not lift the engine by its propeller coupling, or pry against this coupling with a crowbar, because excessive pressure of this type may distort the coupling.

In certain situations it may be necessary to lift the engine in positions other than the horizontal position. Certain situations exist by which the engine must be lowered endwise through a small hatchway which cannot be made larger. Under these conditions, if the opening of the hatchway is extremely narrow, it is possible to reduce, to some extent, the outside dimensions of the engine by removing external components such as the alternator, the cooling system's piping, the heat exchanger, certain filters, the mounting lugs and other obstructive equipment. This accessory equipment should be removed by a competent mechanic and special care should be taken to avoid damaging any exposed parts. In addition, be careful not to allow dirt from entering any opening created by the removal of equipment. Parts removed should be returned to their respective position as soon as the engine has cleared the hatchway.

In case it becomes necessary to hoist the engine either front-end upwards or transmission-end upwards, the attachment of slings must be done carefully to avoid the possibility of damaging the parts on which the weight may bear. Special rigging work is best done by someone experienced and competent in handling heavy machinery.

Engine Bolts

Bronze or stainless steel hanger bolts of appropriate size are recommended for use through the engine's flexible mounts. Less preferred are lag screws because their hold on the wood is weakened every time they are moved, whereas the hanger bolts stay in position. If the nut on top of the hanger bolt is removed to allow the engine to be lifted from its resting place, the hanger bolt itself remains in place as a stud. Consequently, the bond between the hanger bolt and the wood is not weakened by the removal of the nut or the engine.

Foundation for the Engine

A good engine bed contributes much toward the satisfactory operation of the engine. The engine's bed must be rigidly constructed and neither deflect nor twist when it is subjected to the engine's weight or to the pressures that the boat may experience while operating in rough seas. The bed must keep the engine's alignment within one or two thousandths of an inch of this position at all times. The bed has to withstand the forward push of the propeller shaft which pushes against the thrust washer bearing which finally pushes against the engine's bolts and bed.

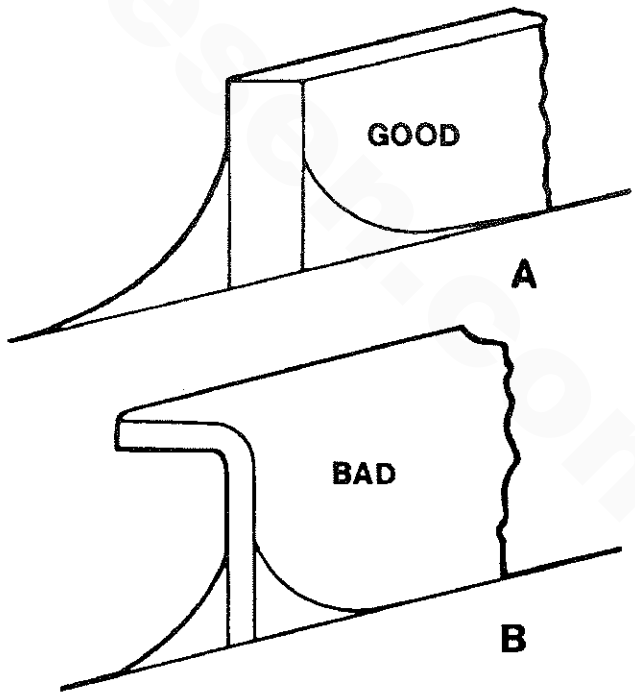
In fiberglass hulls, we recommend that similar wooden stringers as in wooden hulls be formed, fitted, and then glassed securely to the hull. This allows the hanger bolts to be installed firmly in the wood, thereby reducing noise and transmitted vibration.

The engine support stringers must be as wide or wider than the engine mounting isolator. Isolator overhang and/or rounded stringer surfaces are detrimental to the isolators' ability to retain vibration.

Preformed fiberglass engine beds, when used, should be of sufficient thickness to properly support the engine and should be well-glassed to the hull when installed.

The temptation to install the engine on a pair of fiberglass angle irons must be resisted. Such construction will allow engine vibration to pass through to the hull. Flexible mounts require a firm foundation against which they must act if they are to perform their function. When possible, follow bed design **A** and avoid bed design **B** (refer to the illustration).

Supports between the bed stringers, and extending from the stringers to the hull, may be required for proper support and to aid in the absorption of vibrations.



Note: Avoid excessive height, use solid stringer construction (A).

Propeller Coupling

The propeller shaft coupling fitted to the transmission's output flange must transmit not only the power of the engine to turn the propeller shaft and propeller, but must also transmit the thrust of the engine/transmission either ahead or astern.

The coupling bore should be carefully machined for a slight forced fit onto the shaft and an accurate mating surface for the coupling to the output flange of the transmission.

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's 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 to the coupling. The key should fit the side of the keyway closely, but should not touch the top of the keyway in the hub of the coupling.

If driving the coupling over the shaft is difficult, the coupling can be expanded by heating it 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, use a propeller which will permit the engine to reach its full rated RPM at full throttle while under a normal load and while it is moving the boat forward through the water. (See pages 53 and 56.)

Alignment of the Engine

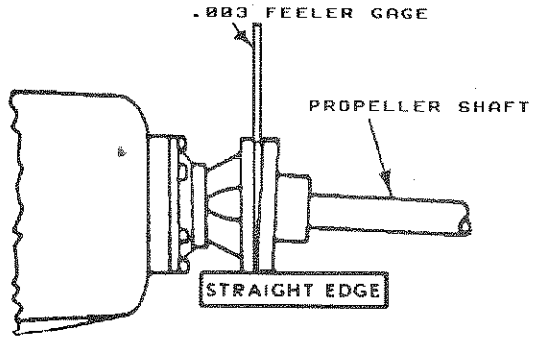
The engine must be exactly aligned with the propeller shaft in the proper fashion. No matter what material is used to build a boat the material will be found to be flexible to some extent; hence, the boat's hull will change its shape to a greater extent than is usually realized when the boat is launched and operated in the water. Therefore, it becomes extremely important to check the engine's alignment at frequent intervals and to correct any errors when they appear.

Misalignment between the engine and the propeller shaft often creates serious problems which are often blamed on other areas suspected of causing the trouble. Misalignment will cause excessive bearing wear, rapid shaft wear and will, in many cases, reduce the life of the boat's hull by loosening the hull's fastenings. A bent propeller shaft will have the exact effect as those just stated; therefore, a perfectly straight propeller shaft is absolutely necessary. One particularly annoying result of misalignment may be leakage of transmission oil through the transmission's rear oil seal. If oil is leaking from this seal, check and make sure that the coupling's alignment is within the limits prescribed on page 14.

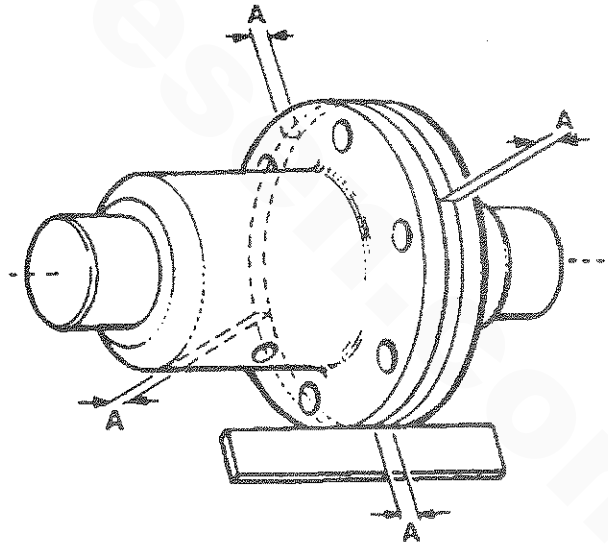
Never attempt a final alignment with the boat on land. The boat should be in the water and have had an opportunity to assume its final water form. The best time to perform the propeller shaft/transmission coupling alignment is with the fuel and water tanks about half full and all the usual equipment on board, and after the main mast has been stepped and the 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 easily slipped backward and forward into the counterbore, and when a feeler gauge indicates that the flanges come together at all points. The alignment between the propeller shaft coupling and the engine's coupling can contain an error no greater than one thousandth of an inch per inch of the coupling diameter. For example, if your propeller shaft coupling is three inches in diameter, the maximum error that can be allowed in the alignment is three thousandths of an inch (.003).



In making the final check for alignment, the engine's 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 (A), while rotated 90° between each position. This test will also check whether the propeller's half-coupling is in exact alignment on its shaft. Then, keeping the propeller coupling in one position, the alignment should be checked by rotating the engine's half-coupling in 90° increments, checking dimension A while in each 90° position until the half-coupling has been rotated full circle.

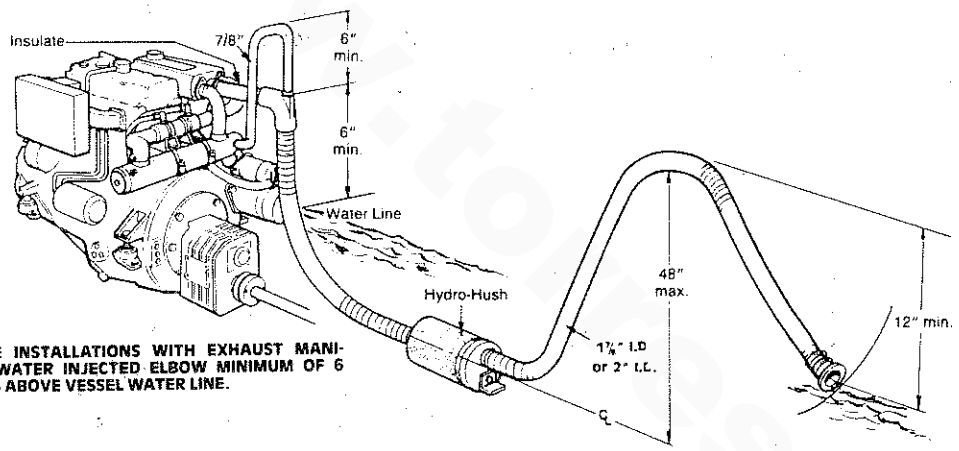


The engine's alignment should be rechecked after the boat has been in service for one to three weeks and, if necessary, perform the alignment again. Usually it will be found that the engine is no longer in alignment. This does not mean that the work has been done improperly at first; rather, it means that the boat has taken some time to take its final shape and that the engine's bed and stringers have probably absorbed some moisture. It may even be necessary to realign the coupling halves again at a later time.

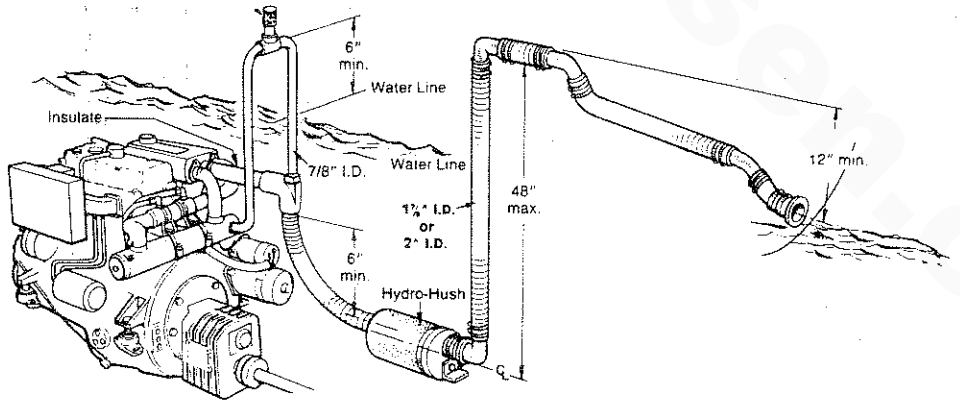
Exhaust System

The exhaust system provides an outlet line to vent engine exhaust gases out of and away from the vessel. The system also discharges sea water which has passed through the engine's sea water circuit by mixing it with hot exhaust gases. This mixing helps cool the exhaust gases and exhaust elbow and plumbing. The exhaust system and the sea water supply to the exhaust *must* be configured to prevent the siphoning of sea water into the exhaust through the sea water cooling circuit and to prevent the entry of sea water into the exhaust through the circuit's thru-hull discharge port. If not prevented, sea water entering through the discharge port can fill the exhaust system muffler and enter the engine's cylinders. This will prevent proper starting and possibly cause damage to internal engine components.

The sea water supply hose to the exhaust system water injection elbow should be routed (looped) at least 12 inches above the vessel water line. An anti-siphon break should be installed, when needed, at the top of this loop. The top of the loop should be placed high enough above the vessel's water line so as to remain above the water line when the vessel is underway, no matter what the angle of heel or roll may be.



ENGINE INSTALLATIONS WITH EXHAUST MANIFOLD/WATER INJECTED ELBOW MINIMUM OF 6 INCHES ABOVE VESSEL WATER LINE.



ENGINE INSTALLATIONS WITH EXHAUST MANIFOLD/WATER INJECTED ELBOW AT OR BELOW VESSEL WATER LINE

The sea water supply thru-hull sea cock fittings *must* be of the flush-hull type. High-speed scoop type of fittings should not be used as they tend to encourage siphoning.

The exhaust discharge from the water lift muffler should be routed well above the water line then downward to the thru-hull discharge. This routing will prevent sea water entry if the thru-hull discharge fitting becomes submerged when the vessel heels or rolls while under way, or is subjected to following sea conditions. Refer to the figures shown above for recommended exhaust system installations.

Exhaust Back-Pressure

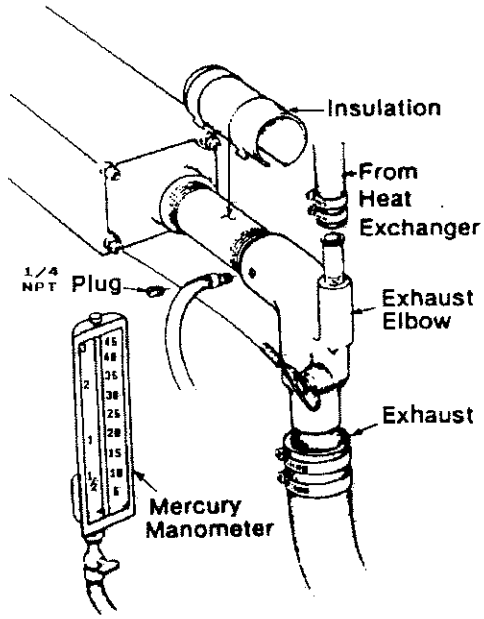
The exhaust discharge hose must be of adequate size and minimal run to prevent excessive exhaust back-pressure. Exhaust back-pressure should be checked before a generator is put into service. (Refer to the illustration.) Excessive back-pressure will affect the engine's performance.

To measure for back-pressure, use a mercury manometer, a pressure gauge, or a water column. A boatyard or marine mechanic should have a manometer or a pressure gauge.

Measure back-pressure at the exhaust elbow when the engine is running at 3600 rpm. Back-pressure, as measured by a manometer, a pressure gauge, or water column, should not be over the following specifications:

NOTE: Other pressure gauges may be available to test for exhaust back-pressure. Check with a competent mechanic.

Refer to the pressure specifications below.

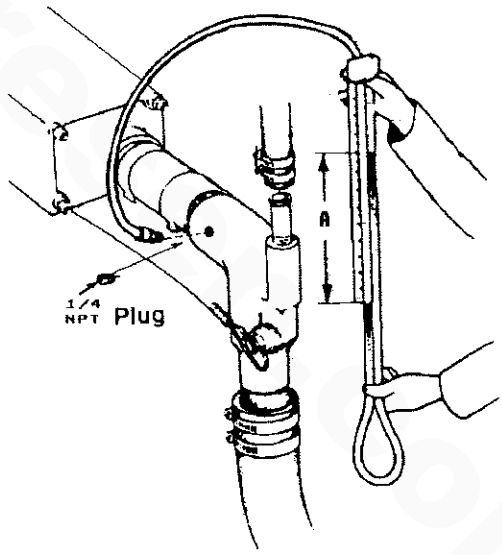


A water column can be made by taking a clear plastic tube and taping one end of the tube along a yardstick and fitting the other end of the tube with a 1/4 inch NPT (National Pipe Tap) pipe fitting.

Measure back-pressure at the exhaust elbow when the engine is running at 3600 rpm.

Dimension **A** cannot exceed 39 inches of water.

Back pressure, as measured by a gauge instrument, should not exceed the following specifications:



3 inches of mercury (0.104 kg/cm^2)
39 inches of water in a water column
(.099 kg/cm^2 at 4° C)
22 ounces psi
1 1/2 psi

Excessive back-pressure can be caused by a small diameter exhaust hose, a small muffler, sharp bends in the exhaust hose, improper fittings, water pockets, and a high volume of water in the exhaust system due to the length of the exhaust discharge hose. The use of elbows and fittings in the exhaust discharge hose's routing should be limited since these will create flow restrictions and contribute to exhaust back-pressure. The generator's exhaust system must be separate from any other engine's exhaust system. Dry portions of the exhaust system between the engine's exhaust manifold and the water injected exhaust elbow must be insulated to hold in the heat.

Exhaust System Failures

When the engine's sea water is fed into an exhaust system so that the full stream of this water strikes a surface, erosion takes place. This erosion may cause premature failures. The proper design of either a water jacketed or 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 directly strike a surface. In addition, the velocity of the entering sea water stream should be as low as possible, which can be achieved by having inlet fittings as big in diameter as possible.

The best protection against exhaust system leaks is to routinely inspect the complete exhaust system. Check for leaks around manifolds, gaskets, and welds. Make sure exhaust lines are not heating surrounding areas excessively. If excessive heat is present, correct the situation immediately. If you notice a change in the sound or appearance of the exhaust system, inspect the exhaust system and correct the cause.

Exhaust risers installed off the exhaust manifold should not exceed **8 lbs** in total weight when rigidly connected. Excessive weight and vibration can result in a manifold failure and/or the fracturing of the riser from the manifold at its attachment. Dry portions of the exhaust connected to the manifold, which lay before the water injected exhaust system, *MUST* be properly insulated to retain the exhaust heat within the exhaust pipe

WARNING

Although diesel engine exhaust gases are not as toxic as exhaust fumes from gasoline engines, carbon monoxide is present in diesel exhaust fumes in less concentration. Carbon monoxide is a dangerous gas that can cause unconsciousness and is potentially lethal. Some of the symptoms or signs of carbon monoxide inhalation or poisoning are as follows:

- o Dizziness
- o Intense Headache
- o Weakness and Sleepiness
- o Vomiting
- o Muscular Twitching
- o Throbbing in Temples

If you experience any of the above symptoms, get out into fresh air immediately.

Make sure there are no unnecessary objects suspended from any portion of the exhaust lines. Excessive weight could cause deflection or distortion of the lines, resulting in damage or leaks. Inspect insulated portions of the exhaust system to ensure there is no deterioration of the insulation.

Oil Drain

An oil sump drain hose is installed on the engine with the discharge end secured by a bracket at the front of the engine. Oil may be drained from this hose by removing the cap and the discharge end of the hose from the support bracket and lowering the hose into a container. The hose cap fitting is 1/4 inch NPT (National Pipe Tap) and can be extended, or have a pump added, for easier removal of the old oil, if desired.

Connecting Pressure Sensing Devices to Oil Galleries

Oil pressure sensing devices, such as senders and switches, must not be connected to an engine's oil gallery with the use of extended nipples or tees. The reason is simply that continued engine vibration causes fatigue of the fittings used to make such a connection. If these fittings fail, the engine loses its oil pressure and quickly seizes.

When additional sensing devices such as switches or sensors need to be installed that function on engine pressure, these devices must be bulkhead-mounted and connected to the oil gallery using an appropriate grade of lubricating oil hose. Any fittings used to connect the hose to the gallery must be of steel or malleable iron composition. Brass must not be used for this application.

Cooling System

The engine is fresh water cooled by an engine-mounted heat exchanger. Sea water is used as the heat exchanger's cooling medium. Sea water is pumped into the exchanger by a sea water pump, where it cools the fresh water that circulates through the engine block, and is then injected into the exhaust discharge, carrying with it the heat removed from the engine's fresh water cooling system.

Sea water should be supplied to the sea water pump through a flush-type hull fitting using a wire-reinforced hose between the thru-hull fitting and the sea water pump. The sea water should be directed through a visual-type sea water strainer, which will trap debris before it reaches the sea water pump and the heat exchanger, and then be delivered to the pump. Hoses routed from the thru-hull fitting to the strainer and to the sea water pump should be wire-reinforced to prevent the hose from collapsing while the engine is running (suction from the pump may collapse a non-reinforced hose). The sea water strainer should be mounted at or below the water line to make sure the sea water line remains primed.

CAUTION

DO NOT use a scoop-type thru-hull fitting as a means of supplying sea water to the engine. Water pressure against this type of fitting , while the vessel is under sail, can push sea water past the sea water pump's impeller into the engine's exhaust system, filling it and the engine as well. Flush-type, clear, thru-hull fittings are recommended and should be located on the hull so as to be below the waterline during all angles of boat operation.

The use of common-type street elbows is not recommended for plumbing the sea water circuit. These generally have very restrictive inside diameters. Machine fittings are preferred.

Automatic Alarm System

High Water Temperature Alarm

A high water temperature alarm has been supplied with the instrument panel. If the engine's fresh water coolant reaches 205° F (96° C), a switch located at the engine's thermostat housing area will close sounding this alarm which will emit a *continuous* signal. Refer to the "DESCRIPTION OF INSTRUMENT PANELS" section of this manual for the location of the alarm in your engine panel, page 23.

Low Oil Pressure Alarm

A low oil pressure alarm switch is located off the engine's oil gallery. This switch monitors the engine's oil pressure. Should the engine's oil pressure fall to 10 - 15 psi, the switch will close sounding this same alarm. In this event, the alarm will emit a *pulsating* signal. Refer to the "DESCRIPTION OF INSTRUMENT PANELS" section of this manual for the location of the alarm in your engine panel, page 23.

Sea Water Intake System

Make sure the intake system (sea water cooling system) is in proper order. Check that the hull inlet, sea cock and strainer are unobstructed. Sea cocks and strainers should be at least one size greater than the inlet thread of the sea water pump. The strainer should be of the type that may be withdrawn for cleaning while the vessel is at sea and should be mounted below the water line to ensure self-priming. Inspect the sea water lines to ensure there are no collapsed sections, which would restrict water flow. Make sure there are no air leaks at any of the connections.

Fuel System

The fuel system should be installed in such a manner as to allow the engine-mounted fuel lift pump to maintain a positive inlet pressure to the injection pump under all operating conditions. The minimum size of the fuel supply line and fuel return line is 1/4 inch, inside diameter, and there should be a primary fuel filter installed between the fuel tank and the fuel lift pump. Only one fuel filter is installed on the engine, between the mechanical fuel lift pump and the injection pump; this filter has a replaceable filter element.

The fuel tank's fuel pickup tube should be clear and unobstructed. No screens or gauze strainers should be incorporated in the fuel pickup tube.

Make sure that the fuel supply and return lines are securely anchored to prevent chafing and that all fittings are sufficiently tightened to prevent leaking. Also make sure your fuel system has a positive shut-off valve; know its location and how it operates.

> NOTE: DO NOT use spring-loaded check valves in the fuel supply line in lieu of mechanical shut-off valves.

The fuel return at the tank should extend down into the tank in the same manner as a pickup tube. This practice is particularly important in installations where fuel tanks are below the engine's fuel system.

Ensure that the fuel tank filler is properly sealed to prevent water entry should it become awash. The fuel tank's vent should be routed so as to prevent water entry as well.

Be sure there is a fire extinguisher installed near the unit and that it is properly maintained. Be familiar with its use. An extinguisher with the NFPA rating of ABC is appropriate for all applications in this environment.

Electrical System

The electrical system should be checked to ensure that all wiring harnesses are tied down properly with clamps or plastic ties, spaced at intervals close enough to prevent chafing from vibration. Check to ensure that all the engine's harness connections are tight and that they are made to the appropriate terminals.

WARNING

Do not smoke or allow an open flame near batteries. Lead acid batteries emit hydrogen, a highly-explosive gas. Turn off the emergency switch in the positive line of battery.

Make sure the positive (+) battery connection is connected to the battery connection of the starting solenoid. The negative (-) battery connection should be connected to the system ground (the engine block).

WARNING

When servicing the battery or checking the electrolyte level, wear rubber gloves, a rubber apron, and eye protection. Battery acid may splash on the skin or into the eyes inadvertently when removing electrolyte caps.

Check level and specific gravity of battery electrolyte to ensure maximum engine starting efficiency. Make sure terminals are clean and tight.

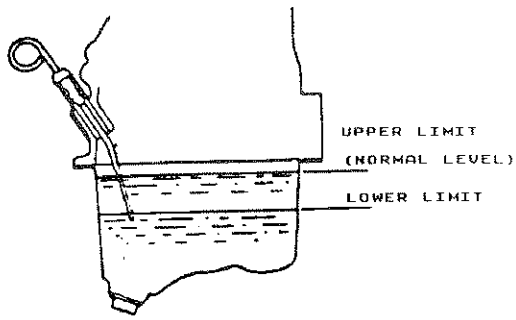
Ventilation

The ventilation requirements of the engine include the following: combustion air is required for the engine's cylinders and ventilating air is required to clear the bilges below the engine, as well as the compartment in which the engine is located, of potentially toxic and flammable diesel fumes. Refer to the "SPECIFICATIONS" section of this manual for the W 12B engine's airflow requirements, page 8.

PREPARATION FOR STARTING

This section of the manual provides the operator with preparation, initial starting, break-in, starting (cold or warm), and stopping procedures. Follow the procedures as presented, for the conditions indicated, and your Westerbeke engine set will give you reliable performance and long service life.

Fill your engine with oil up to or near the upper limit on the dipstick (the installation angle may have an effect on the dipstick reading). Select readily available lubricating oil with an API specification of CC or CD and an SAE number suitable for the temperature in your operating area (see page 47). For the quantity of oil needed in this engine, refer to the "SYSTEM SPECIFICATION" section of this manual, page 8.



Fill the transmission to the **FULL** mark on the dipstick with the correct lubricant. (Refer to the "SYSTEM SPECIFICATIONS" section of this manual, page 9.)

Each unit is supplied with a coolant recovery kit (#24977) as standard equipment, to which the following applies:

A. Remove the pressure cap from the engine's exhaust manifold and slowly fill the engine's cooling system with a mixture of water and antifreeze suitable for your temperature zone. (See the "COOLING SYSTEM" section of this manual, page 39.) Operate the engine and observe the coolant level in the manifold. Maintain this level to the base of the filler neck. Once the engine reaches its operating temperature (170 - 190° F), ensure that there is coolant flow to the domestic water heaters when installed. Top off the cooling system and install the pressure cap.

B. Make sure the plastic recovery tank is properly mounted near the unit (with the bracket provided), in a location where it can be monitored and filled easily. The recovery tank should be mounted at manifold level or above. In these installations that require it, the plastic recovery tank can be mounted below the exhaust manifold's level.

C. Add coolant to the plastic tank after the engine has been started and operating temperature has been reached, to ensure that all air is expelled from the manifold and the engine's cooling system. With the manifold filled and the pressure cap installed, fill the plastic recovery tank half full. Monitor daily and add coolant as needed.

Fill the fuel tank with a good grade of No. 2 diesel fuel and prime the fuel system up to the engine (see page 31). When returning fuel is free of air, the engine's fuel system is bled and the engine is ready to start.

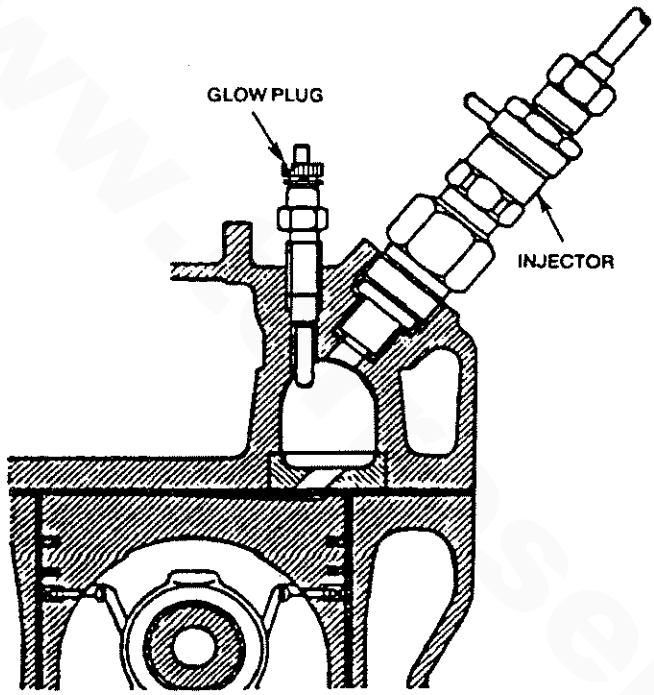
NOTE: When the PREHEAT switch is depressed, the glow plugs in the cylinder head are energized; use the PREHEAT switch intermittently to prevent overheating the glow plugs.

Ensure that the Installation Checks have been made in accordance with those specified in the "INSTALLATION CHECKS" section of this manual (refer to page 10).

Description of Starting System

Westerbeke diesel engines use electric starters assisted by glow plugs for both normal and cold weather starting. The figure below shows a cross-sectional view of one cylinder. The glow plug is located in the combustion chamber so that its tip is in the injector nozzle's spray path. When the glow plug is energized by the PREHEAT button, the plug glows red at the tip and assists in igniting the fuel. The result is a rapid start with less wear on the starter.

This system is common to Westerbeke Diesels. The start circuitry is designed so that the PREHEAT button must be depressed for the time specified in the "Preheat" chart shown on page 26 . Then, while keeping the PREHEAT button engaged, the START button is depressed to crank the engine.



Combustion Chamber

NOTE: The START button will not energize unless the PREHEAT button is depressed. When depressing the preheat switch, we are activating the glow plugs in the cylinder head, so use the preheat intermittently so as not to overheat the glow plugs.

DESCRIPTION OF INSTRUMENT PANELS

Westerbeke offers two types of control panels as optional equipment for the W 12B engine. Read the following instructions that apply to the panel you purchased with your engine.

Captains Panel

General

This manually-operated control panel is equipped with a key switch, an RPM gauge, a PREHEAT and START button, and an instrument test button along with a low oil pressure/high water temperature alarm. The RPM gauge is illuminated when the key switch is turned ON and remains illuminated while the engine is in operation. The key switch and the three buttons serve the following functions:

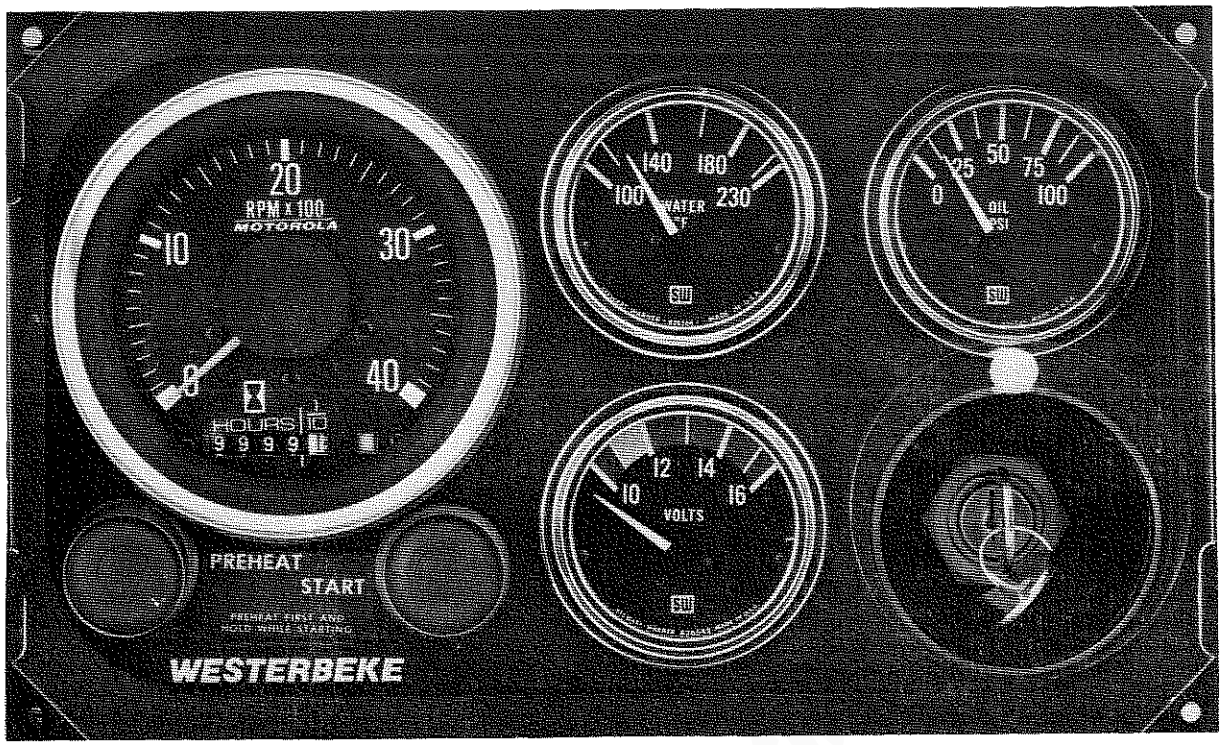
1. Key Switch: The Key Switch provides power only to the instrument panel cluster. Refer to the "STOPPING PROCEDURE" section of this manual, page 28.

2. PREHEAT: The PREHEAT button activates the alternator's regulator, the engine's glow plugs, and bypasses the engine's oil pressure alarm switch. In addition, this button energizes the START button.

3. START: The START button, when pressed, energizes the starter's solenoid which cranks the engine. This button will not operate electrically unless the PREHEAT button is pressed and held at the same time.

4. Test Button: The Test Button, located above the key switch, tests the alternator, the oil pressure, and the water temperature control circuits. When this button is pressed, the alternator, the oil pressure, and the water temperature indicator lights illuminate in addition to sounding the alarm.

5. Alarm: The alarm is located above the test button and will sound if the engine's oil pressure falls below 15 psi. In this event, the alarm will emit a *pulsating* signal. The alarm will also sound if the water temperature in the fresh water cooling circuit rises to 210° F. In this event, the alarm will emit *continuous* signal.



Admirals Panel

General

This manually-controlled control panel is equipped with a key switch and an RPM gauge with an ELAPSED TIME meter which measures the engine's running time in HOURS and in 1/10 hours. The panel also includes a water temperature gauge which indicates water temperature in degrees Fahrenheit (WATER ° F), an oil pressure gauge which measures the engine's oil pressure in pounds per square inch (OIL PSI), and a DC control circuit voltage gauge which measures the system's voltage (VOLTS). All gauges are illuminated when the key switch is turned ON and remain illuminated while the engine is in operation. The panel also contains two rubber-booted push buttons, one for PREHEAT and one for START.

1. Key Switch: The Key Switch provides power only to the instrument cluster. Refer to the "STOPPING PROCEDURE" section of this manual, page 28.

2. PREHEAT: The PREHEAT button activates the alternator's exciter, the engine's glow plugs, and bypasses the engine's protective oil pressure switch. In addition, this button is energizes the START button.

3. START: The START button, when pressed, energizes the starter's solenoid which cranks the engine. This button will not operate electrically unless the PREHEAT button is pressed and held at the same time.

NOTE: An alarm buzzer is supplied with every Admiral Panel. The installer is responsible for electrically connecting the buzzer to the four-pin connection on the engine's electrical harness. The installer is also responsible for installing the buzzer in a dry location so that it will be audible to the operator should it sound while the engine is running. The buzzer will sound when the ignition key is turned ON and should silence when the engine has started and when the engine's oil pressure rises above 15 psi.

STARTING PROCEDURE

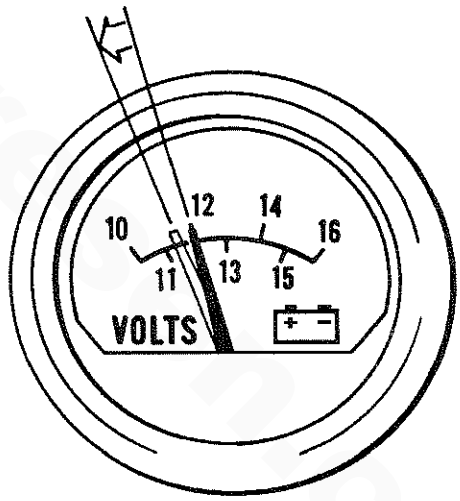
1. Place the transmission in the NEUTRAL position and advance the throttle to its full open position for a cold engine, and partially open for a warm engine.

2. Turn the key switch to the ON position (2 o'clock).

3. Depress and hold the PREHEAT switch. Preheat according to the following chart:

Atmospheric Temperature	Preheating Time
+41° F (+5° C) or higher	Approx. 10 sec.
+41° F (+5° C) to +23° F (-5° C)	Approx. 20 sec.
+23° F (- 5° C) or lower	Approx. 30 sec.
Limit of continuous use	1 minute

Proper glow plug function is indicated by a voltmeter drop when the PREHEAT switch is depressed. This drop will be slight but discernible. If no voltage drop is noted, it may indicate defective glow plugs or a faulty preheat circuit (check for loose connections).



While holding the PREHEAT button depressed, depress the START button. The starter motor will run, thereby cranking the engine. As soon as the engine runs, release the START button and PREHEAT button. Check your instrumentation for proper engine operation. Ensure sea water discharge with exhaust discharge.

Should the engine not start when the START button is depressed for 10 to 12 seconds, release both buttons and wait 30 seconds; repeat the previous procedure. Never run the starter motor for more than 30 seconds at a time.

CAUTION

Prolonged cranking intervals without the engine starting can result in filling the engine-mounted exhaust system with sea water coolant. This may happen because the sea water pump is pumping sea water through the sea water cooling system during cranking. This sea water can enter the engine's cylinder's by way of the exhaust manifold once the exhaust system fills. Prevent this from happening by closing the sea water supply thru-hull shut-off, drain the exhaust muffler, and correct the cause for the excessive engine cranking needed to obtain a start. Engine damage resulting from this type of sea water entry is not a warrantable issue; the owner/operator should keep this in mind.

Once the engine starts, run it at idle for a few minutes to warm up the engine and check instruments for proper oil pressure and battery charging voltage. Never attempt to engage the starter while the engine is running.

NOTE: Some unstable running may occur in a cold engine, but this condition should smooth out as the operating temperature of 170 - 190° F (77 - 88° C) is reached.

Engine parts from Torrsen Marine - www.torresen.com - 231-759-8596

STOPPING PROCEDURES

A manual pull type stop control (tee handle or knob) is provided by the installer in a location close to the engine's controls. Know the location of this control before attempting to start the engine. To stop the engine, pull out on this tee handle or knob fully and hold it out until the engine comes to a complete stop. Push back on this control to return it to the engine run position otherwise the engine will not restart.

With the engine stopped, turn the key switch to the OFF position (12 o'clock). If the key switch is left ON, the battery will discharge. The alarm buzzer will sound in the Admirals Panel but not in the Captains Panel should the key switch be left ON. The best method of preventing the battery from discharge is to remove the key from the key switch after stopping the engine.

CAUTION

DO NOT attempt to shutdown the engine by turning the key switch OFF. The key switch only provides power to the instrument panel: the engine will continue running even if the key switch is turned OFF.

(An optional key shut-off package is available, however. This option allows the operator to shut-off the engine by turning the key switch OFF which turns OFF an electrically run Fuel Run Solenoid. This electrical shut-off option is installed at the factory upon the specific request/order of the purchaser.)

Engine Break-In Procedures

Although your engine has experienced a minimum of one hour of test operations to ensure accurate assembly and proper operation of all systems, break-in time is required. The service life of your engine is dependent upon how the engine is operated and serviced during its initial hours of use.

Your new engine requires approximately 50 hours of initial conditioning operation to break in each moving part in order to maximize the performance and service life of the engine. Perform this conditioning carefully, keeping in mind the following:

1. Start the engine according to the "STARTING PROCEDURE" section found on page 26; run the engine at fast idle while checking that all systems (sea water pump, oil pressure, battery charging) are functioning.

2. Allow the engine to warm up (preferably by running at fast idle) until the water temperature gauge moves into the 130-140° F range.

3. While using the vessel, run the engine at varying engine speeds for the first 25 hours.

4. Avoid rapid acceleration, especially with a cold engine.

5. Use caution not to overload the engine. The presence of a gray or black exhaust, and the inability of the engine to reach its full rated speed, are signs of an overload.

6. During the next 25 hours, the engine may be operated at varying engine speeds, with short runs at full rated speed. Avoid idling the engine for prolonged periods of time.

Breaking-in a new engine basically involves seating the piston rings to the cylinder walls. This cannot be accomplished by long periods of running at Idle, nor by early running at full speed.

Idle running may glaze the cylinder walls, resulting in excessive oil consumption and smoky operation. Excessive speed or heavy overloading, especially with a cold engine, may cause scoring of the cylinder walls, producing similar results.

As indicated above, operate the engine in moderation during the 50-hour break-in period. (On one hand don't baby the engine, but on the other hand, however, don't abuse it.)

Starting Under Normal Conditions

Follow the procedure below for normal starting of the engine:

1. Check the engine and transmission lubricant levels and fill, if necessary.

2. Make sure there is sufficient fuel on board. Keep fuel tank(s) as full as possible. Check the fuel filters and water separators for the presence of contaminants and/or water. Drain and clean them as needed.

3. Check the coolant level in the plastic recovery tank. Add coolant solution as needed.

   NOTE: Excessive loss of coolant from the plastic recovery tank indicates a cooling system leak. Check the entire cooling system and pressurize the system to locate the leak. In cases of excessive coolant loss, the system must be refilled as outlined under the "PREPARATION FOR STARTING" section of this manual, page 21.

4. Check for oil and fuel leaks, particularly if signs of such leaks are found on the bottom of the engine or below the engine.

Start the engine in accordance with the "STARTING PROCEDURE" instructions found on page 26, and allow the engine's operating temperature to reach 140 - 150° F before operating the engine underway.

Starting Under Cold Conditions

Under extremely cold temperatures, the following conditions can occur. Follow the instructions listed below when operating your engine in cold weather.

LUBRICATING OIL TURNS VISCOUS - Make certain that the lubricating oil used conforms with the ratings for the prevailing atmospheric temperature. Refer to the "LUBRICATION SYSTEM" section of this manual, page 47 for an atmospheric/oil viscosity specification table.

VOLTAGE ACROSS THE BATTERY TERMINALS DROPS - Make certain that the battery is fully charged to minimize voltage drop across the battery terminals.

THE TEMPERATURE OF THE INTAKE AIR IS LOW AND THE COMPRESSION TEMPERATURE DOES NOT RISE ENOUGH - Allow the glow plugs to operate sufficiently to aid in starting during the preheat period whenever the temperature of the intake air is low and when the compression temperature does not rise enough. Refer to the preheat chart found in the "STARTING PROCEDURE" section, page 26.

FUEL SYSTEM

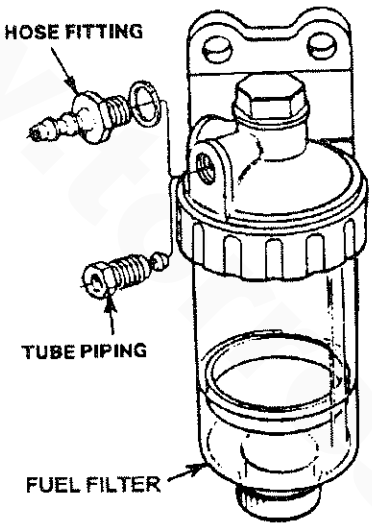
Diesel Fuel

Use No. 2 diesel fuel with a cetane rating of 45. Never use kerosene or home heating oil.

In cold weather particularly, water vapor is produced by condensation when air is present in the fuel tank. Keep fuel tank(s) full and completely free of dirt and water.

Fuel Filters

A primary fuel filter of the water entrapment type must be installed between the fuel tank and the engine. Such a filter, shown here, is available from your local Westerbeke representative or your boatbuilder. This filter, adapted for boatbuilder use, comes complete with fittings for either hose or metal tubing. Mount it in an accessible place, inspect it often and drain off water accumulation frequently.



INSTALLATION INSTRUCTIONS

1. BOLT SEDIMENT/WATER TRAP SECURELY TO AN ACCESSIBLE STRUCTURE SO POSITIONED THAT A RECEPTICLE TO CATCH DRAINAGE CAN BE PLACED UNDER IT.
2. IF FUEL IS TO BE PIPED WITH COPPER, OR BUNDY TUBING, USE NUTS AND FERRULES PROVIDED. BE SURE THE TUBING PROJECTS 1/4 INCH THROUGH THE FERRULE BEFORE TIGHTENING THE NUT.
3. IF FUEL IS TO BE PIPED WITH HOSE, USE THE TWO BRASS BARBED FITTINGS AND WASHERS SUPPLIED. BE CERTAIN THAT THE HOSE SELECTED HAS DIAGONAL BRAID INSERTED (TO CLING ON THE BARB), THAT IT IS NEOPRENE LINED, AND THAT IT IS USCG APPROVED.
4. IF WATER IS PRESENT IN THE FUEL, IT WILL COLLECT SLOWLY IN THE BOTTOM OF THE SEDIMENTER. WHEN THE RED FLOAT RING REACHES THE DRAIN LINE ON THE PLASTIC BOWL, LOOSEN THE BOTTOM DRAIN PLUG UNTIL ALL WATER RUNS OUT.
5. TIGHTEN DRAIN PLUG SECURELY SO NO AIR CAN ENTER THE SYSTEM.
6. ENERGIZE THE FUEL PUMP TO REFILL THE BOWL.

If a water trap type filter is not installed between the fuel tank and the engine-mounted fuel system, any water in the fuel system will tend to lay in the bottom of the electric lift pump. Internal metal parts of the lift pump will rust. Particles will pass on to filters and eventually to the injection pump and injectors with damaging results and the possibility of expensive repairs. Remember, water damage to the fuel system is not covered under the Westerbeke warranty.

In addition, any gasoline in the fuel system will damage the engine's fuel lift pump assembly, as gasoline does not have the same lubricating qualities as diesel fuel, as well as have a damaging effect on the injection pump and the injectors.

Although most boatbuilders supply a water trap/filter, some do not. Westerbeke offers a sedimentary/water trap/filter as an optional extra at moderate cost. The filter is supplied with fittings for either hose or metal tubing fuel lines.

Priming the Fuel System

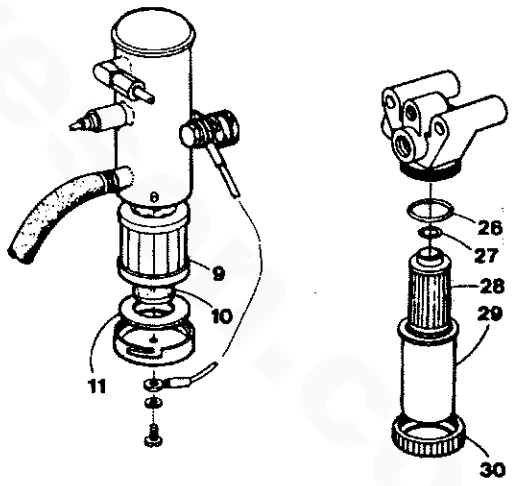
The Westerbeke self-bleeding fuel system is semiautomatic in operation. The self-bleeding feature of the fuel system allows for easy servicing of the fuel filters. Simply remove the and replace the filter elements (take care in catching any fuel that may drain out of the fuel filtering assemblies) as described in the "Replacing the Fuel Filter Elements" section below. Energize the PREHEAT switch and allow the electric fuel pump to operate for 20 to 30 seconds to prime and bleed air from the system. (No fittings should be opened.) Then proceed to start the engine as you normally would. If the engine does not start, stop and wait a few moments, and then repeat the bleed procedure as indicated above. When the PREHEAT switch is depressed, the preheat elements (the glow plugs) are energized, so take care not to over heat them.

CAUTION

Prolonged cranking intervals without the engine starting can result in filling the engine-mounted exhaust system with sea water coolant. This may happen because the sea water pump is pumping sea water through the sea water cooling system during cranking. This sea water can enter the engine's cylinders by way of the exhaust manifold once the exhaust system fills. Prevent this from happening by closing the sea water supply thru-hull shut-off, drain the exhaust muffler, and correct the cause for the excessive engine cranking needed to obtain a start. Engine damage resulting from this type of sea water entry is not a warrantable issue; the owner/operator should keep this in mind.

Replacing the Fuel Filter Elements

While it is unlikely that the operator will be forced to service the system at sea, the possibility does exist. Therefore, it is recommended that banjo washers, injector seat washers, electric lift pump filter and gasket, fuel filter and gasket be carried on board at all times. Select the parts for your engine from the Parts List and purchase spares from your local Westerbeke Dealer or Distributor. For example, hardware kit #33093 includes replacement elements with gaskets (items #9, 11, 26, 27, 28). If a leak should develop at a fuel banjo or sealing washer location that cannot be remedied by a slight tightening of the filter cup retainer, replace the filter along with the O-rings supplied with the new filter.



After the first 50 hours of operation, loosen ring # 30 and discard filter element # 28. Clean bowl # 29 and install a new filter using new # 27 and 28 gaskets. *Be careful in catching any fuel that may spill from within these fuel filter assemblies*. This same service is required of the # 9 filter element in the electric fuel lift pump. Similarly, install a new # 9 filter element along with a new # 11 gasket. The base of the electric fuel pump is removed with the aid of an open end wrench. Twist the base off the pump's locking tabs and reinstall the base by twisting it back on the locking tabs. Place the wrench on the hex nut cast into the base.

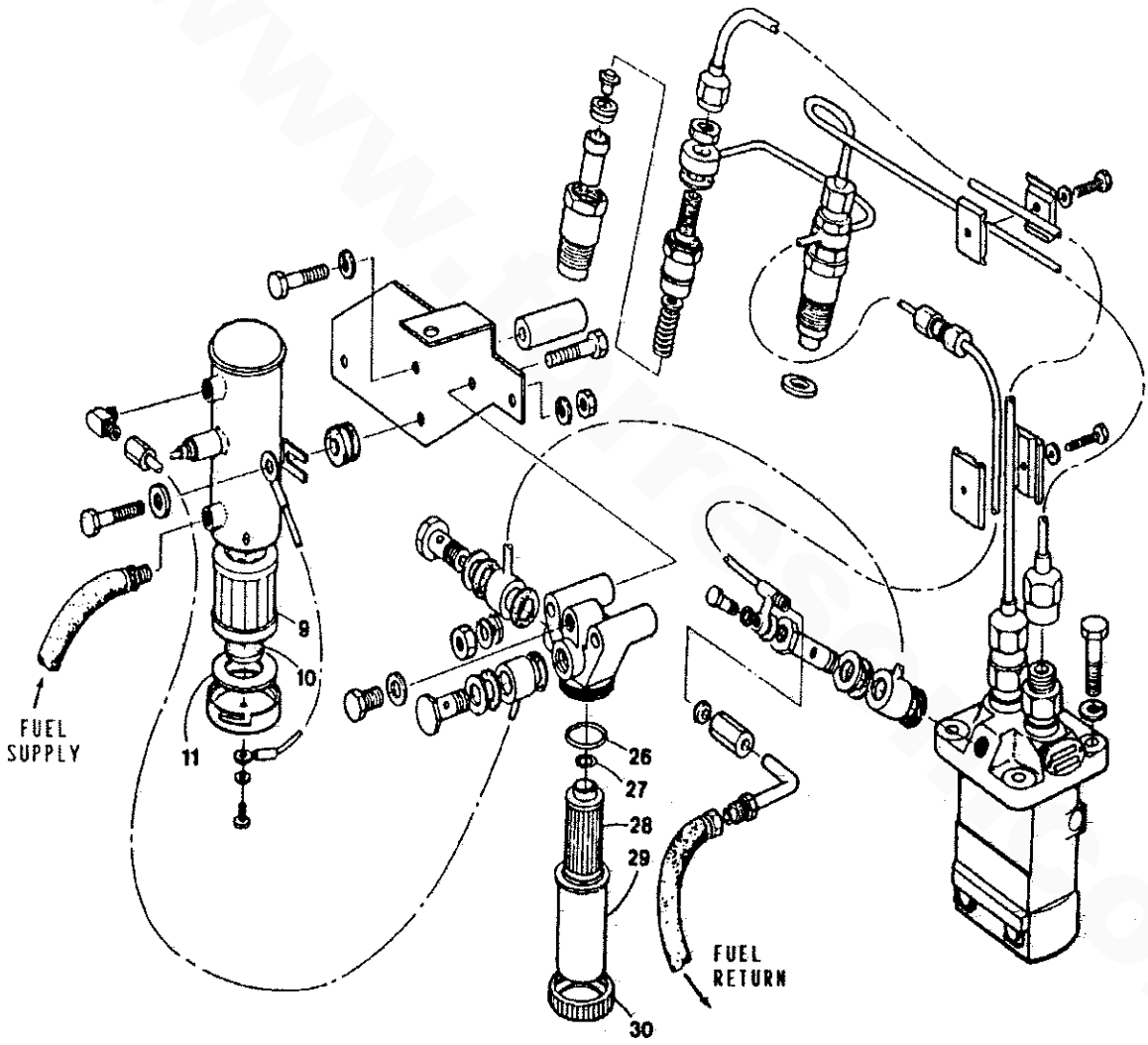
NOTE: **DO NOT** over-tighten the filter cup retainer; excessive tightening can strip the soft aluminum threads on the fuel filter assembly.

After the first 50-hour change, the change period may be increased to 200 hours or once per season.

Fuel Injection Pump

The illustration shown below is an exploded view of the W 12B TWO's fuel system. The fuel injection pump, located at the lower right-hand corner, is one of the most important components of the diesel engine and, therefore, calls for the utmost caution in handling. Furthermore, the fuel injection pump has been thoroughly bench-tested and should not be tampered with.

Idle speed and timing adjustment are the only adjustments the servicing dealer can perform on the injection pump. Other types of adjustments or repairs must be performed by a qualified injection service shop.



W 12B TWO's Fuel System

To obtain long and satisfactory service from the injection pump, always use fuel which is free from impurities and maintain a good filtration and water separation system between the fuel tank and generator engine. Service this system regularly: the injection pump it saves may be your own.

ELECTRICAL SYSTEM

Engine 12-Volt DC Control Circuit

The Westerbeke W 12B TWO propulsion engine has a 12-Volt DC electrical control circuit, as shown on the wiring diagrams which follow on pages 34 to 37. Refer to these diagrams when troubleshooting or servicing electrical components on the engine.

CAUTION

To avoid damage to the battery charging circuit, never shut off the engine battery switch while the engine is running.

Shut off the engine battery switch, however, to avoid electrical shorts when working on the engine electrical circuit.

Battery Specification

The minimum recommended capacity of the battery used in the engine's 12-Volt DC control circuit is 90 - 125 Ampere-hours (minimum).

CAUTION

When quick-charging the battery with an external charger, be sure to disconnect the battery cables from the battery. Leaving the charging circuit connected while quick-charging will damage the alternator's diodes.

Alternator

CAUTION

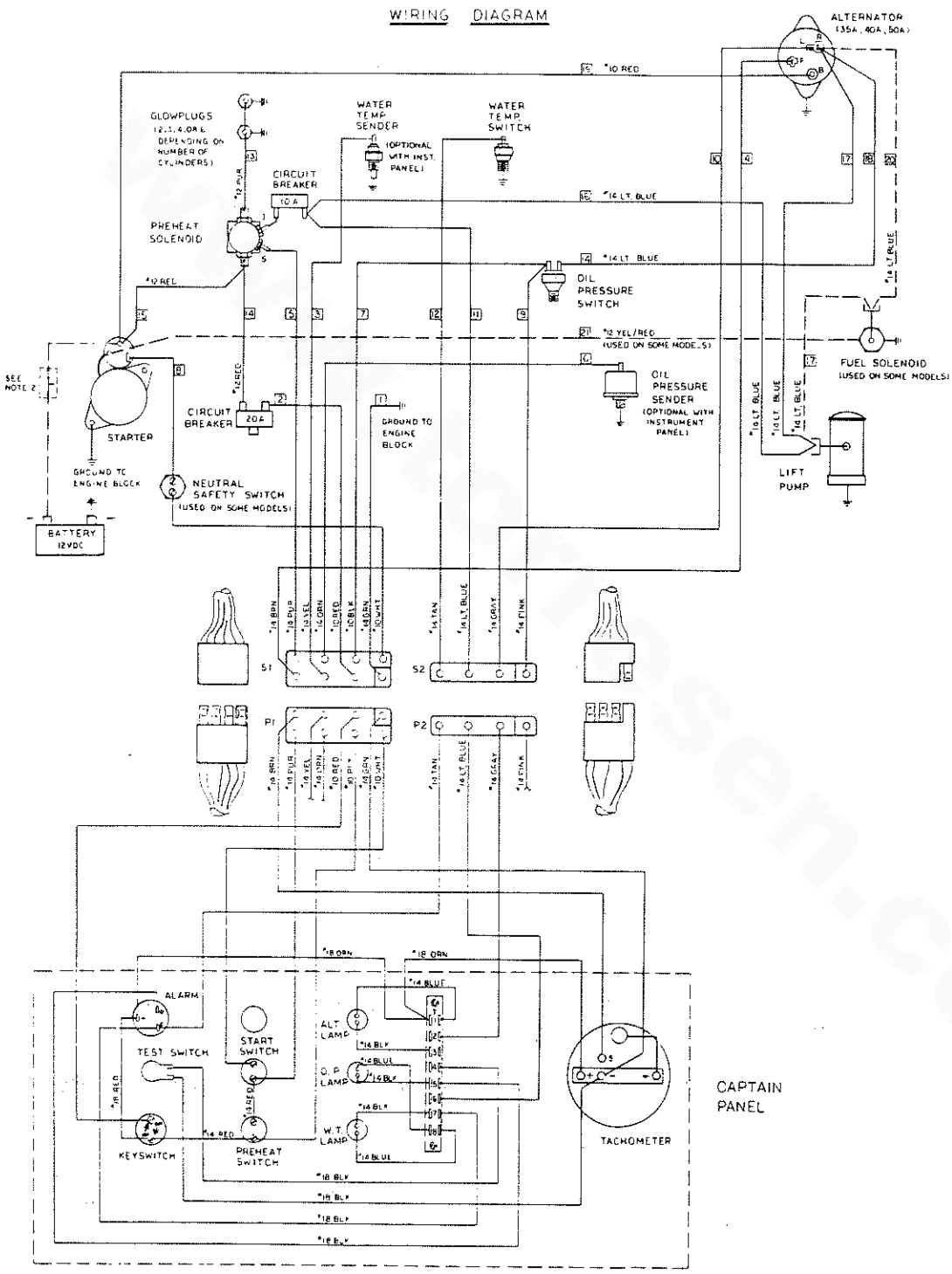
When testing the alternator circuit (charging circuit), do not use a high-voltage tester such as a megger; damaged diodes could result.

During high-speed operation of the engine, do not disconnect the positive terminal of the battery from the **B** terminal of the alternator, nor disconnect the negative terminal of the battery from the ground.

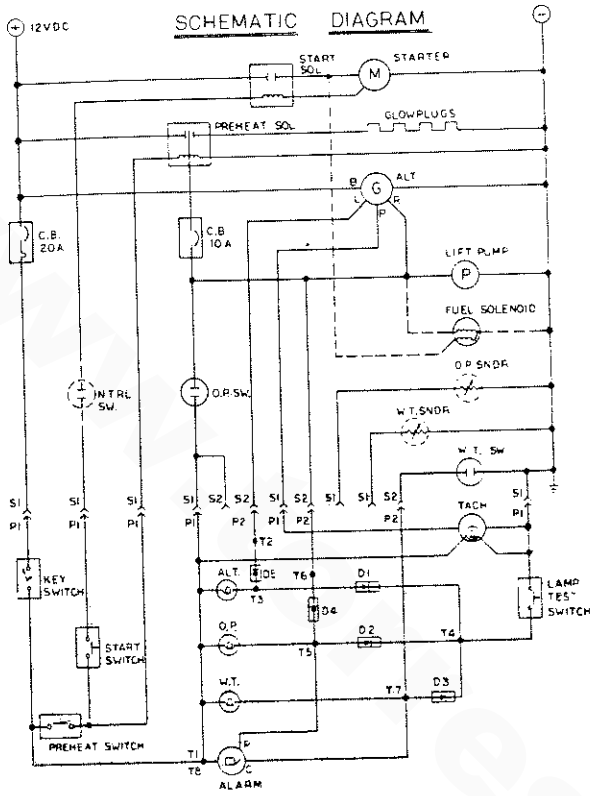
When cleaning the engine with a steam cleaner, be careful to keep steam away from the alternator.

Refer to pages 34 to 37 for the two electrical system wiring schematics (one is used for the Captains panel and the other for the Admirals Panel).

DC Wiring Diagram #36467 Showing the Captains Panel Wiring
page 1 of 2



DC Wiring Diagram #36467 Showing the Captains Panel Wiring



START: 1. TURN KEY TO ON POSITION. THE ALARM WILL SOUND, OIL PRESSURE AND BATTERY CHARGE INDICATORS WILL LIGHT.

2. PUSH PREHEAT SWITCH FOR 15 TO 60 SECONDS AS REQUIRED. ALARM WILL STOP.

3. WHILE CONTINUING TO PUSH PREHEAT SWITCH, PUSH THE START SWITCH ALSO. WHEN THE ENGINE STARTS RELEASE THE START SWITCH ONLY.

4. WHEN THE OIL PRESSURE INDICATOR LAMP GOES OUT RELEASE THE PREHEAT SWITCH.

STOP: TURN THE KEY TO THE OFF POSITION.

NOTES:

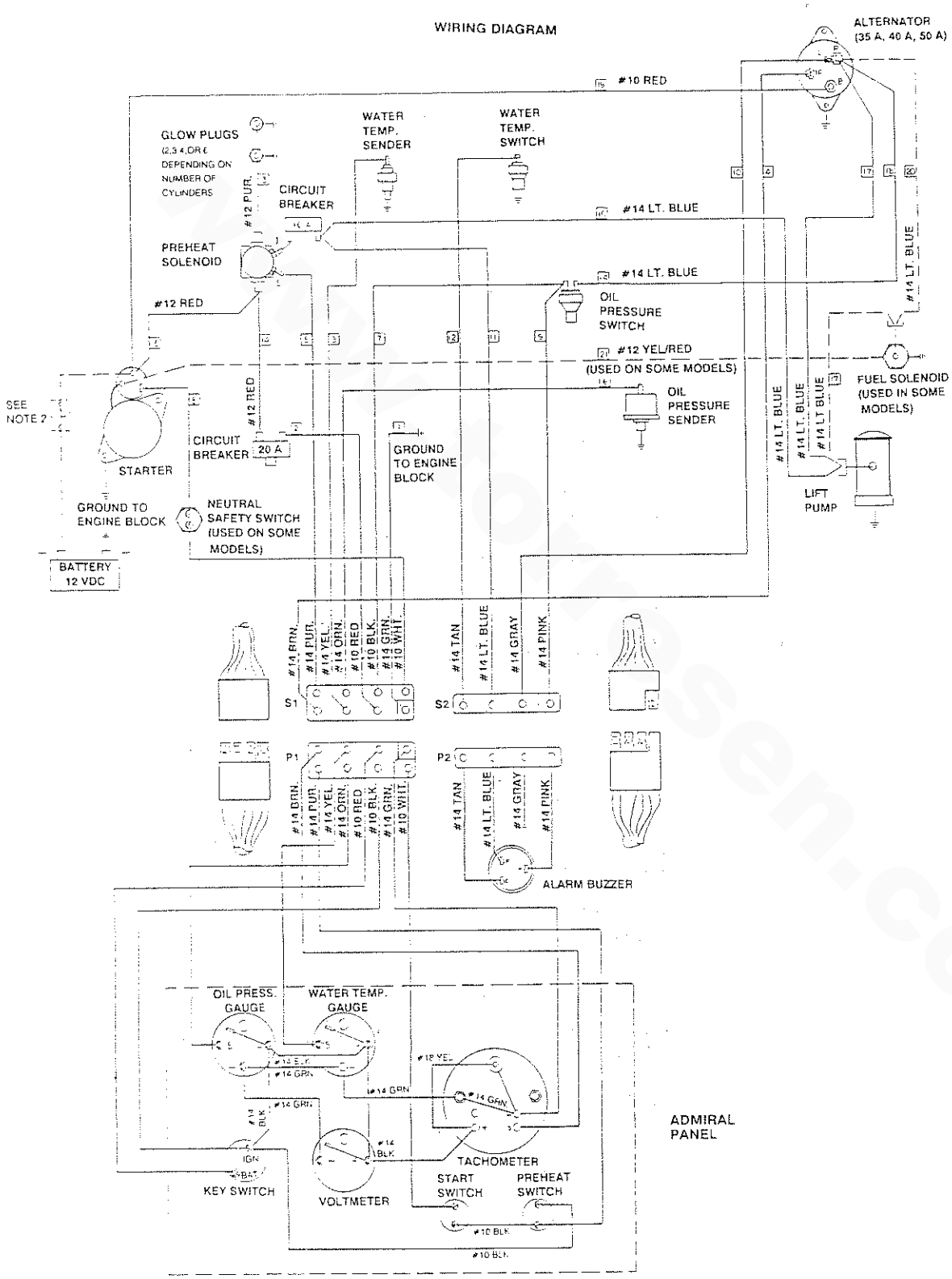
1. THIS PRODUCT IS PROTECTED BY A MANUAL RESET CIRCUIT BREAKER LOCATED NEAR THE STARTER. EXCESSIVE CURRENT DRAIN WILL CAUSE THE BREAKER TO TRIP AND THE ENGINE WILL SHUT DOWN. THE BUILDER/OWNER MUST BE SURE THAT THE INSTRUMENT PANEL WIRING AND ENGINE ARE INSTALLED TO PREVENT CONTACT BETWEEN ELECTRICAL DEVICES AND SALTWATER.

2. AN ON-OFF SWITCH SHOULD BE INSTALLED BETWEEN THE BATTERY AND STARTER TO DISCONNECT THE BATTERY IN AN EMERGENCY AND WHEN LEAVING THE BOAT. A SWITCH WITH A CONTINUOUS RATING OF 175 AMPS AT 12VDC WILL SERVE THIS FUNCTION. THIS SWITCH SHOULD NOT BE USED TO MAKE OR BREAK THE CIRCUIT.

3. PINK WIRE AT PLUG 2 IS UNUSED AND SHOULD BE INSULATED.

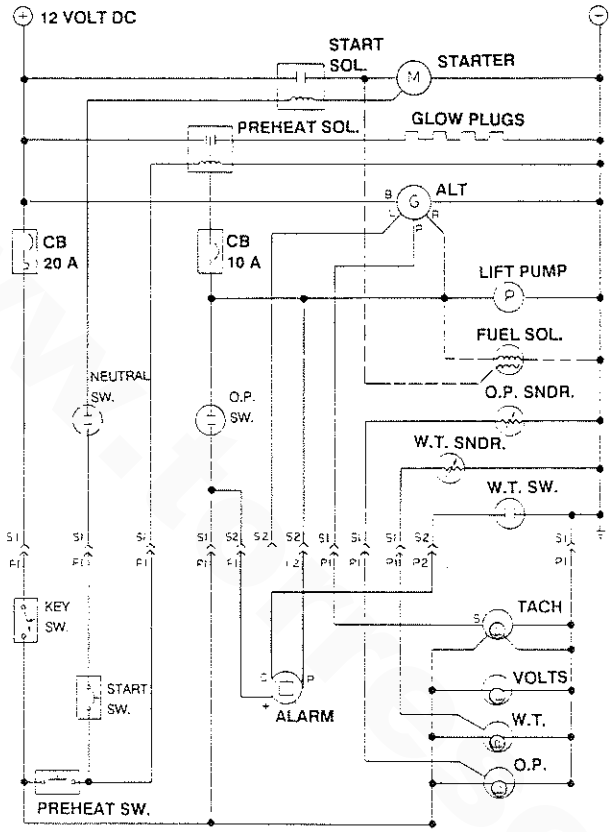
DC Wiring Diagram #36844 Showing the Admirals Panel Wiring

page 1 of 2



DC Wiring Diagram #36844 Showing the Admirals Panel Wiring

SCHEMATIC DIAGRAM



NOTE:

1. THIS PRODUCT IS PROTECTED BY A MANUAL RESET CIRCUIT BREAKER LOCATED NEAR THE STARTER. EXCESSIVE CURRENT DRAIN WILL CAUSE THE BREAKER TO TRIP AND THE ENGINE WILL SHUT DOWN. THE BUILDER/OWNER MUST BE SURE THAT THE INSTRUMENT PANEL, WIRING, AND ENGINE ARE INSTALLED TO PREVENT CONTACT BETWEEN ELECTRICAL DEVICES AND SALT WATER.

2. AN ON-OFF SWITCH SHOULD BE INSTALLED BETWEEN THE BATTERY AND STARTER TO DISCONNECT THE BATTERY IN AN EMERGENCY AND WHEN LEAVING THE BOAT. A SWITCH WITH A CONTINUOUS RATING OF 175 AMPS AT 12 VOLTS DC WILL SERVE THIS FUNCTION. THIS SWITCH SHOULD NOT BE USED TO MAKE OR BREAK THE CIRCUIT.

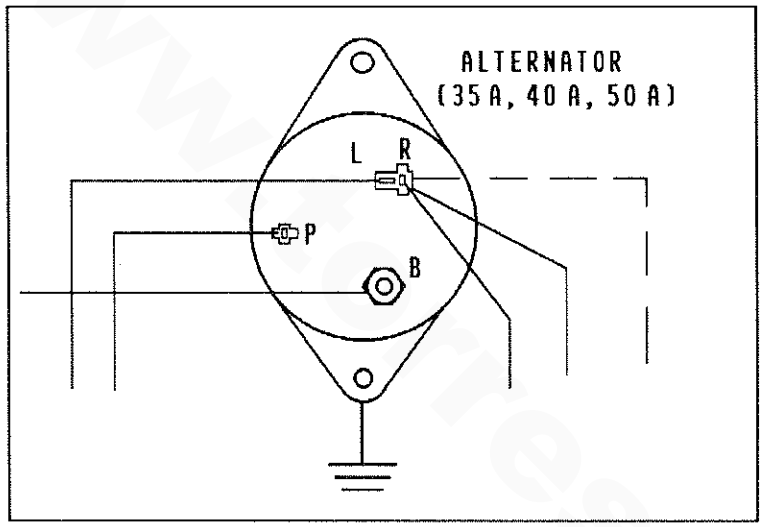
3. THE GRAY WIRE AT PLUG #2 IS UNUSED AND SHOULD BE INSULATED.

The charging system consists of an alternator with an internal voltage regulator, an engine-mounted circuit breaker, a battery and connecting wires.

Because of the use of IC's (integrated circuits), the electronic voltage regulator is very compact and is built into the rear bracket of the alternator.

Charging Voltage Test

If you suspect that the alternator is not producing enough voltage to charge the engine's battery, perform the following voltage test.



Interconnections for Charging Voltage Test

1. Using a voltmeter, connect the voltmeter's red wire clip to the **B** output terminal on the alternator. Refer to the schematic shown above.

2. Connect the other wire clip to a ground on the engine.

3. Start the engine and increase the engine's speed to 2000 rpm. Now record the reading given by the voltmeter.

The voltage reading for a properly operating alternator should be between 13.5 to 14.5 volts. If your alternator is over or under charging, have it replaced or rebuilt by a reliable service shop.

> Note: Before removing the alternator for repair, ensure that 12-Volts excitation is present at the **R** terminal should the above test show only battery voltage at the **B** output terminal.

COOLING SYSTEM

Description

Westerbeke marine diesel engines are designed and equipped for fresh water cooling. Heat produced in the engine by combustion and friction is transferred to fresh water which circulates throughout the engine. This circulating fresh water cools the engine block and its internal moving parts. The heat is transferred externally from the fresh water to sea water by means of a heat exchanger, similar in function to an automotive radiator. Sea water flows through the tubes of the heat exchanger while fresh water flows around the tubes; engine heat transferred to the fresh water is conducted through the tube walls to the sea water which is then pumped into the exhaust system where finally it is discharged overboard. In other words, the engine is cooled by fresh water, the fresh water is cooled by sea water, and the sea water carries the transferred heat over the side through the exhaust system. The fresh water and sea water circuits are independent of each other. Using only fresh water within the engine allows the cooling water passages to stay clean and free from harmful deposits. The two independent circuits and their components are discussed in the following paragraphs.

Fresh Water Circuit

> NOTE: Refer to paragraphs **A** and **B** in this section for the recommended antifreeze and water mixture to be used as the fresh water coolant, and for information on filling the fresh water system.

Fresh water is pumped through the engine by a belt-driven circulating pump, absorbing heat from the engine. The fresh water coolant circulates through the engine's block absorbing heat, then passes through the thermostat into the exhaust manifold, to the heat exchanger where it is cooled, and then is returned to the engine block through the suction side of the fresh water circulating pump. When the engine is started cold, external fresh water flow is prevented by the closed thermostat (although some fresh water flow is bypassed around the thermostat to prevent exhaust manifold from overheating). As the engine warms up, the thermostat gradually opens, allowing full flow of the engine's fresh water coolant to flow unrestricted to the external portion of the cooling system.

A. Fresh Water Coolant (Antifreeze) Mixture.

It is recommended that a freshwater and antifreeze mixture be used year-round. Water, when it freezes, expands sufficiently to split the heat exchanger and crack the engine block. A water/antifreeze mixture of proper concentration will prevent freezing (see page 40 for an antifreeze/water mixture chart).

Use soft water with few impurities, such as tap water (potable water) or rainwater. Never use hard or foul water. Use of hard water or water containing impurities will lead to the collection of scale in the engine and heat exchanger which will reduce the cooling system's efficiency.

Antifreeze of poor quality or without rust inhibitors will cause corrosion within the cooling system. Always use antifreeze which is compatible with aluminum cooling system components and is made by a reliable manufacturer. Never mix different brands of antifreeze.

Make sure that the cooling system of the engine is well cleaned before adding antifreeze. Recommended antifreeze for year round use is ZEREX or PRESTONE with rust inhibitors.

In order to control the concentration of the mixture, mix the antifreeze and freshwater thoroughly before adding it to the cooling system.

ANTIFREEZE CONCENTRATION DATA

Antifreeze Concentration	%	13	23	30	35	45	50	60
Freezing Temperature	° F	23	14	5	- 4	- 22	- 40	- 58
	(° C)	(- 5)	(-10)	(-15)	(- 20)	(- 30)	(- 40)	(- 50)

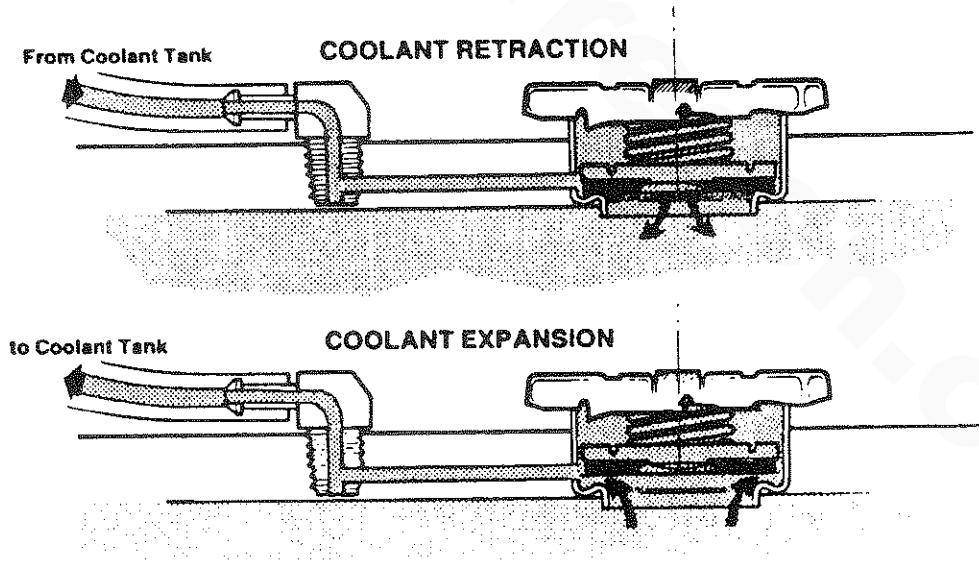
NOTE: It is advisable that an antifreeze concentration be selected on the basis of a temperature which is about 10° F (5° C) lower than the actual atmospheric temperature expected.

B. Filling the Fresh Water System

A coolant recovery tank kit is supplied with each Westerbeke diesel engine. The purpose of this recovery tank is to allow for engine coolant expansion and contraction, during engine operation, without the loss of coolant and without introducing air into the cooling system.

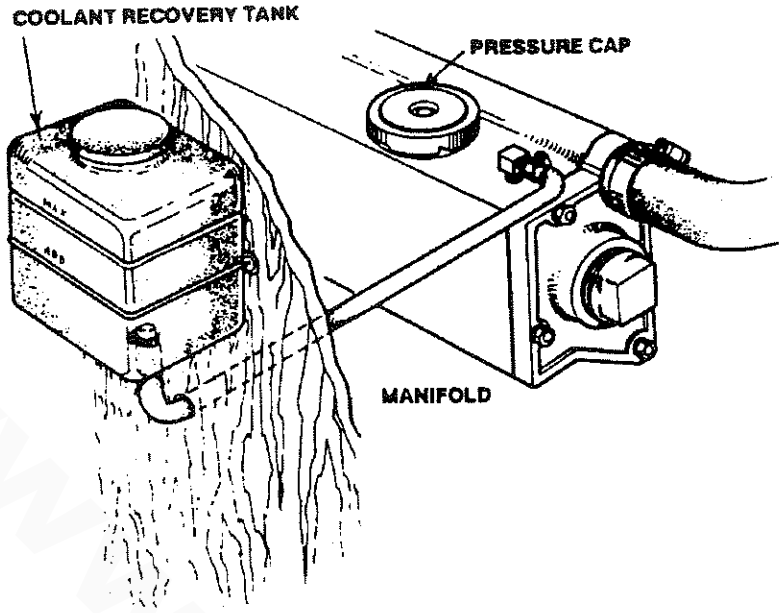
This coolant recovery tank should be installed at, or above, engine manifold level, in a location where it can be easily monitored and where coolant can be easily added if needed (see the figure below). A stainless steel mounting bracket is supplied with each kit along with a 30-inch length of clear plastic hose and clamps to connect the hose between the engine's manifold fitting to the hose spud on the base of the recovery tank.

FUNCTION OF MANIFOLD PRESSURE CAP



Coolant from the engine, when heated during engine operation, will expand, lifting the spring-loaded manifold pressure cap, and enter the recovery tank by way of the hose connecting the recovery tank to the manifold.

When the engine is shut down and cools, a small check valve in the pressure cap is opened by the contraction of the engine coolant, allowing some of the coolant in the recovery tank to be drawn back into the engine's cooling system, free of air and without loss.



Coolant Recovery Tank, Recommended Installation

Fill the fresh water system as follows:

1. Remove the pressure cap from the manifold.

2. Pour a clean, antifreeze mixture into the manifold and allow enough time for the coolant to fill the fresh water cooling system.

3. Start the engine and allow it to come up to its operating temperature. Monitor the coolant in the manifold and add antifreeze coolant as air is expelled. Once all air is expelled from the system, fill the manifold to the filler neck and install the pressure cap.

4. Remove the plastic cap from the plastic coolant recovery tank and fill the tank with coolant halfway between the **ADD** mark and the **MAX** mark. Replace the plastic cap.

5. Run the engine and observe the coolant's expansion flow into the plastic recovery tank.

6. Check for leaks between the pressure cap/filler neck and then plastic recovery tank. Stop the engine and allow it to cool. Coolant should be drawn back into the cooling system as the engine's temperature comes down.

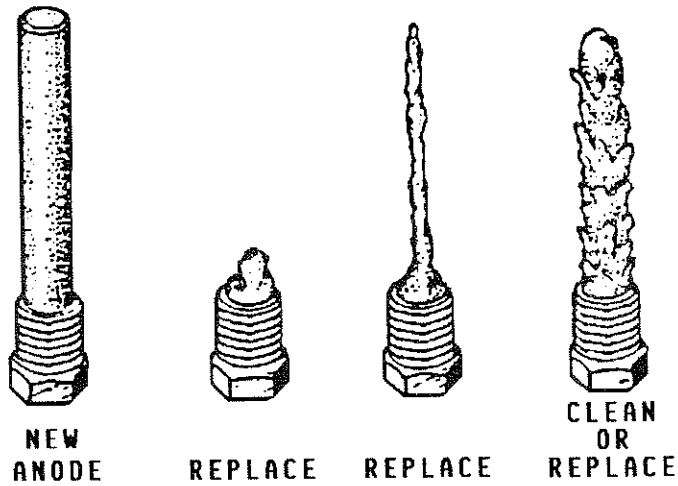
7. Add coolant to the recovery tank, as required, to top off the fresh water coolant system.

Thermostat

Generally, thermostats are of two types. One is simply a choking device which opens and closes as the engine's temperature rises and falls. The second type has a bypass mechanism. Usually this is a disc on the bottom of the thermostat which moves downward to close off an internal bypass passage within the head. Since 1980, each type of thermostat has a hole punched through it. The hole is a bypass to prevent the exhaust manifold from overheating during the engine's warm-up. Replacement thermostats must have this design characteristic.

Sea Water Circuit

The sea water flow is created by a belt-driven, positive displacement, neoprene impeller pump. The pump draws sea water directly from the ocean through the sea cock and sea water strainer and passes the water to the heat exchanger's sea water inlet. The sea water passes through the heat exchanger's tubes, from which heat from the fresh water system is absorbed, and then the sea water is discharged from the cooling system overboard through the water-injected wet exhaust system.



Zinc Anode Conditions

A zinc anode, or pencil, is located in the sea water cooling circuit within the heat exchanger. The purpose of the zinc anode is to sacrifice itself to electrolysis action taking place in the sea water cooling circuit, thereby reducing the effects of electrolysis on other components of the system. The condition of the zinc anode should be checked monthly and the anode cleaned or replaced as required. Spare anodes should be carried on board.

Sea Water Pump

The sea water pump is a self-priming, belt-driven rotary pump with a non-ferrous housing and a neoprene impeller. The impeller has flexible vanes which wipe against a curved cam plate within the impeller housing, producing the pumping action. On no account should this pump be run dry. There should always be a spare impeller and impeller cover gasket aboard (an impeller kit). Sea water failures occur when lubricant (sea water) is not present. Such failures are not warrantable and the operator's are cautioned to ensure that sea water flow is present at start-up.

Alternator and Water Pump Drive Belt Tension

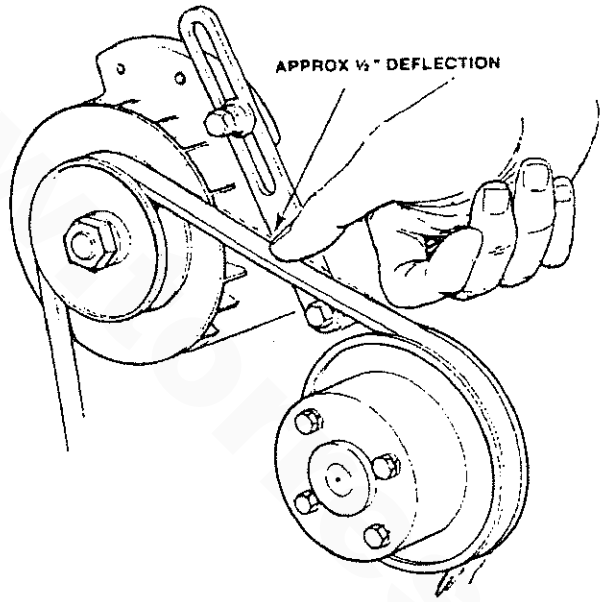
WARNING

Never attempt to adjust the drive belt's tension while the engine is in operation.

CAUTION

Excessive alternator and water pump drive belt tension can cause rapid wear of the belt and reduce the service life of the fresh water pump and alternator shaft bearings. Excessive slack or the presence of oil on the belt can cause belt slipping, resulting in high operating temperature, as well as insufficient alternator output.

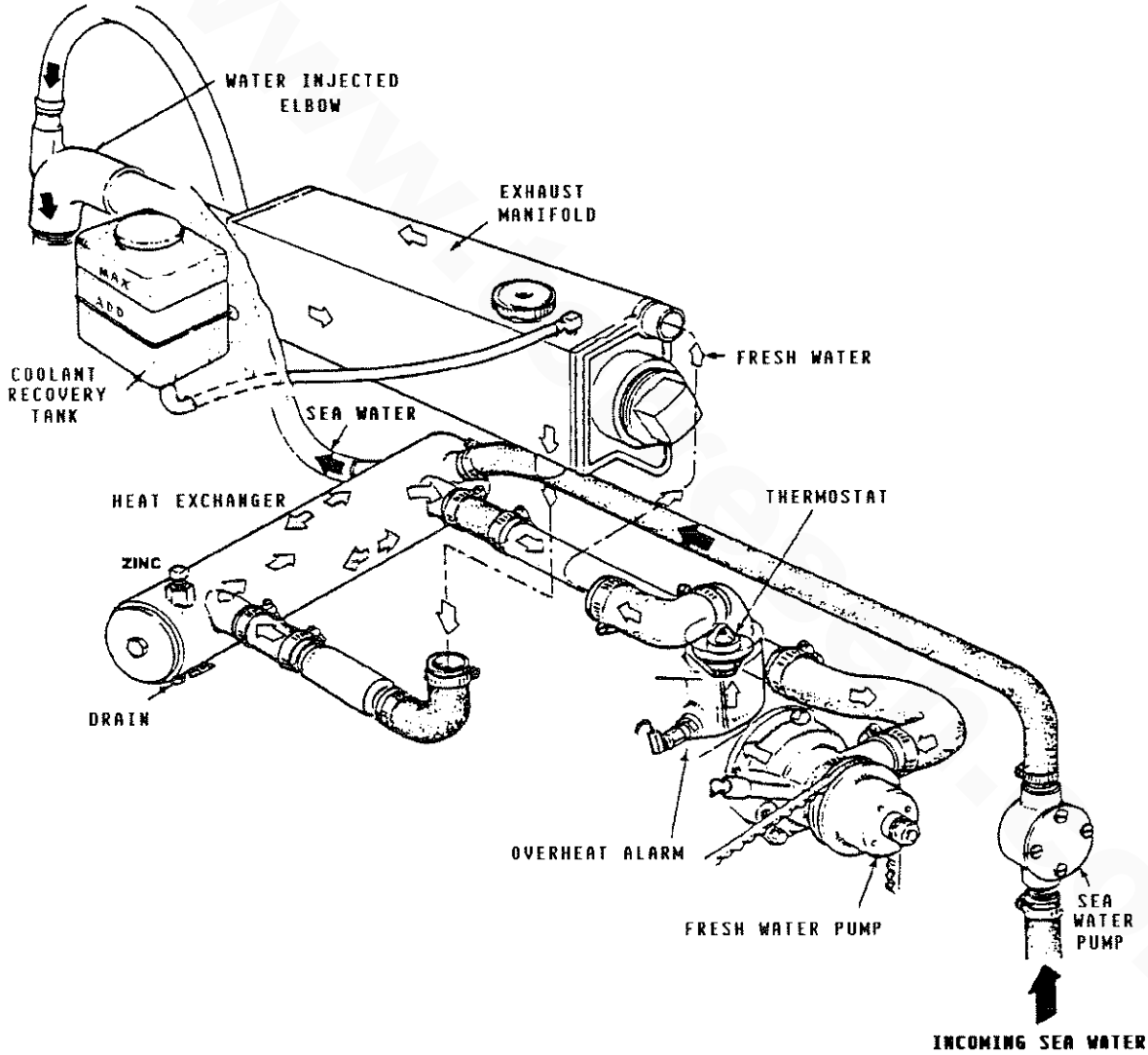
The alternator and water pump drive belt(s) is/are properly adjusted if the belt can be deflected no less than 3/8 inch and no more than 1/2 inch (10 mm, 12 mm) as the belt is depressed with the thumb at the midpoint between the two pulleys on the longest span of the belt. (See the figure below.) A spare drive belt should be carried on board.



Alternator and Water Pump Belt Tension

Illustrated below is a typical Westerbeke engine's cooling system. Both fresh water and sea water flow through their independent cooling circuits. Refer to your engine's Parts List for part numbers and part descriptions if you need to order cooling system parts for your engine.

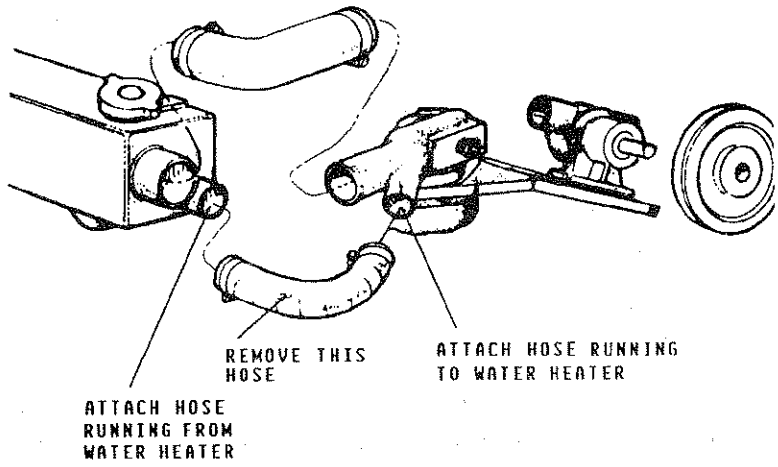
NOTE: When the remote expansion tank #24177 is used, the plastic coolant recovery tank should be removed and discarded and its connection point on the exhaust manifold plugged with a 1/8 NPT fitting.



Typical Cooling System

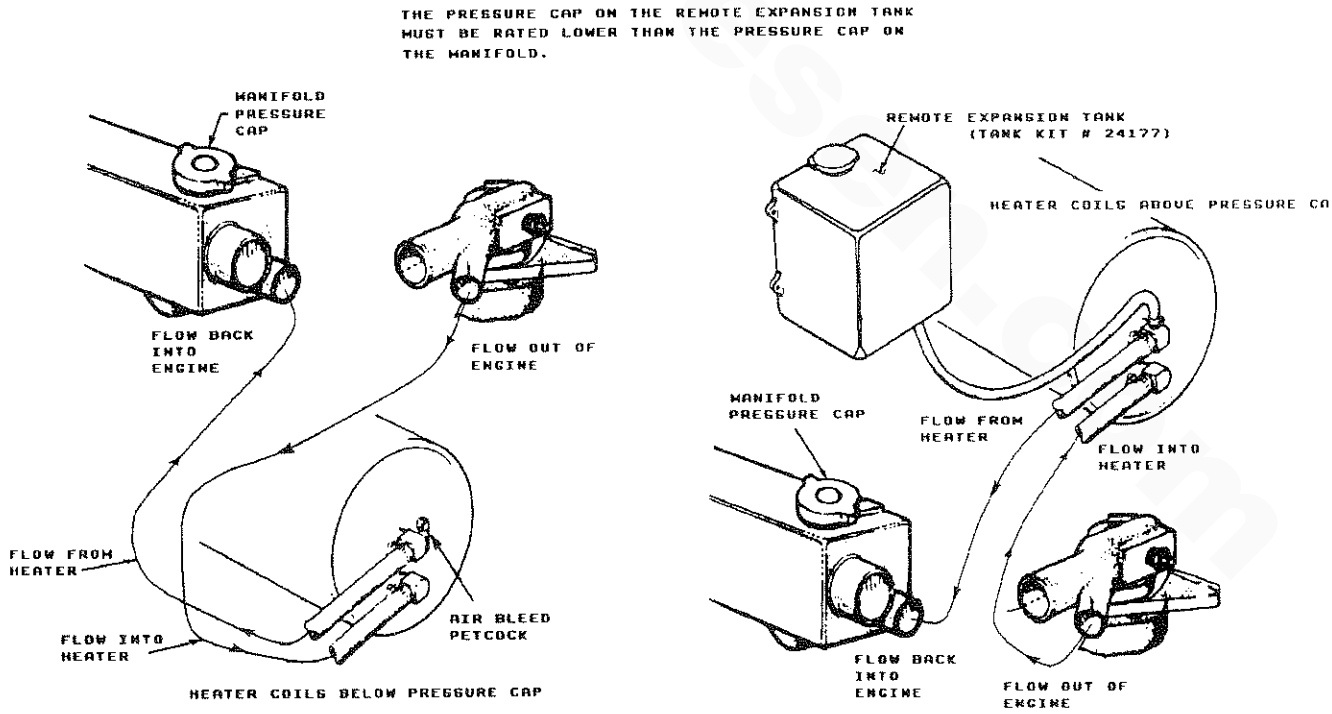
Domestic Hot Water

The 12B TWO engine is equipped with domestic hot water heater connections. If the owner/operator wishes to connect a hot water heater, remove only the small hose that connects with the thermostat housing and the exhaust manifold and connect to these hose connections the hoses that run to the heater.



General: With the small hose removed, there remain two connecting points for hoses to run to and from the water heater. These connections, when plumbed correctly, should allow for a flow of heated engine cooling system water to and from the domestic water heater without effecting the operation of the engine's cooling system.

Installation: The heater should be mounted conveniently either in a high or low position in relation to the engine so that the connecting hoses from the heater to the engine can run in a reasonably direct line without any loops which might trap air. The connection made to the thermostat housing should connect to the lower of the two connections on the water heater while the upper connection on the heater returns to the connection on the exhaust manifold. (Note: Use a good grade of wire reinforced 1 inch I.D. hose to plumb from the engine's connections to the hot water heater.)



The illustrations shown above are Flow Control designs which have been adapted to operate with the single pass manifolds installed on the 12B TWO diesel engine.

Hoses should rise continuously from their low point at the heater to the engine so that trapped air will rise naturally from the heater to the engine. If trapped air is able rise to the heater, then an air bleed petcock must be installed at the higher fitting on the heater for bleeding air while filling the system. Avoid loops in hose runs which will trap air.

> Note: If any portion of the heating circuit rises above the engine's own pressure cap, then a pressurized (aluminum) remote expansion tank *must* be installed in the circuit to become the highest point. The remote expansion tank's part number is 24177. Install the remote expansion tank in a convenient location such as in a sail locker so the fresh water coolant level can easily be checked.

The cap on the engine mounted expansion tank should not be opened once the remote system is installed and filled.

The hose connection from the heater to the remote expansion tank should be routed and supported so as to rise continuously from the heater to the tank, enabling any air in the system to rise.

Refer to the illustrations on the previous page.

Engine parts from Torrsen Marine - www.torresen.com - 231-759-8596

LUBRICATION SYSTEM

Engine Oil

For engine lubrication, use lubricating oil designated for diesel service. These oils are classified according to the API specifications into service grades CA, CB, CC and CD. The use of CC or higher (CD) grades, made by well-known manufacturers is recommended. The oil selected should be used thereafter.

Engine Oil Viscosity (SAE Number)

Use an oil having a viscosity best suited to the atmospheric temperature. Use of an all-season oil SAE 10W-30 with minimum viscosity change under different temperatures is suggested.

Atmospheric Temperature	Viscosity
68° F (20° C) or higher	SAE 30 or 10W-30
41° F (5° C) - 68° F (20° C)	SAE 20 or 10W-30
41° F(5° C) - or lower	SAE 10W-30

NOTE: Do not use an engine lubricating oil with an SAE number greater than 30 in the engine.

Oil Pressure

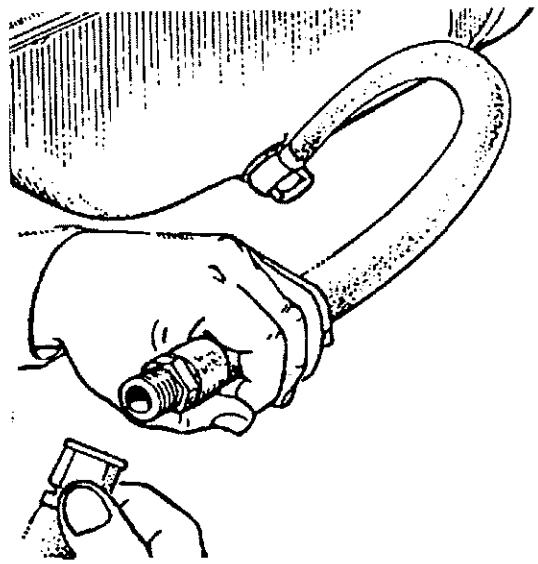
The engine's oil pressure, during operation, is indicated by the oil pressure gauge on the Admiral Panel (see page 24).

During normal operation, the oil pressure will range between 35 and 55 psi. At idle speed, the oil pressure will range between 20 and 35 psi. At the time of cranking, the oil pressure will rise proportionately with speed.

NOTE: A newly started, cold engine can have an oil pressure reading upwards of 60 psi. A warmed engine can have an oil pressure reading as low as 35 psi. These readings will vary depending upon the speed at which the engine is running.

Engine Oil Change (to include filter)

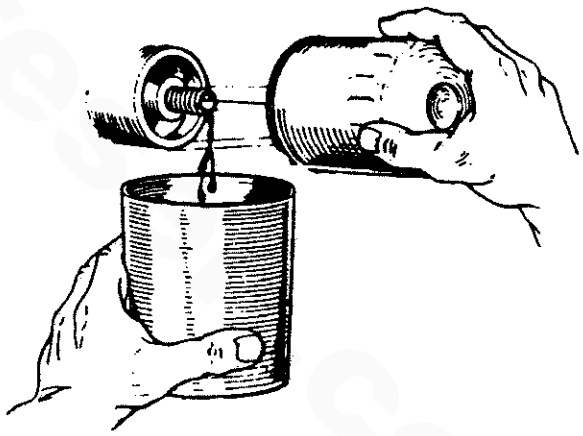
1. Draining the Oil Sump



Discharge the old oil through the sump drain hose (attached at the front of the engine) while engine is still warm. Drain the old oil completely, replace the hose in its bracket, and replace the end cap securely.

Always observe the old oil as it is removed. A yellow/gray emulsion indicates the presence of water in the oil. Although this condition is rare, it does require prompt attention to prevent serious damage. Call a competent mechanic should water be present in the oil. Sea water present in the oil can be the result of a fault in the exhaust system attached to the engine and/or a siphoning through the sea water cooling circuit into the exhaust, filling it up into the engine (refer to the installation illustrations on page 15).

2. Replacement of the Oil Filter



When removing the used oil filter, you may find it helpful and cleaner to punch a hole in the upper and lower portion of the old filter to drain the oil from it into a container before removing it. This helps to lessen spillage. A small style automotive filter wrench should be helpful in removing the old oil filter. Place some paper towels and a plastic bag around the filter when unscrewing it to catch any oil left in the filter. (Oil or any other fluid on the engine reduces the engine's cooling ability. Please keep your generator's engine clean.) Inspect the old oil filter as it is removed to make sure that the rubber sealing gasket came off with the old oil filter. If this rubber sealing gasket remains sealed against the engine block, gently remove it. The replaceable cartridge-type oil filter requires no cleaning inside, so it may be properly disposed of.

When installing the new oil filter element, wipe the filter gasket's sealing surface on the engine block free of oil and apply a thin coat of clean engine oil to the rubber gasket on the oil filter. Screw the filter onto the threaded oil filter stub, and then tighten the filter firmly by hand

NOTE: Generic filters are not recommended, as the material standards or diameters of important items on generic parts might be entirely different from genuine parts. Immediately after an oil filter change and oil fill, run the engine to ensure that the oil pressure is normal and that there are no oil leaks around the new oil filter.

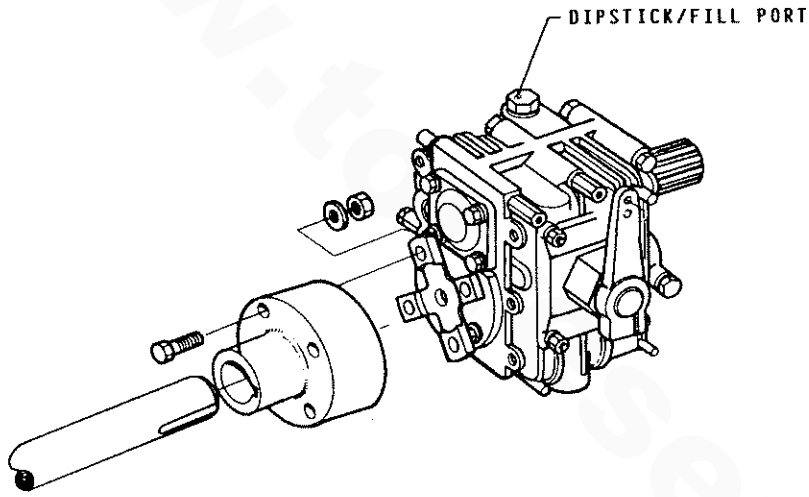
3. Filling the Oil Sump

Add fresh oil through the oil filler cap on the valve cover (refer to the photographs on pages 5 and 6 for the location of the oil filler cap and lube oil dipstick). After refilling the oil, run the engine for a few moments while checking the engine's oil pressure. Ensure there is no leakage around the new oil filter or from the oil drain system, and then stop the engine. Then check the quantity of oil with the lube oil dipstick. Fill to, but not over, the high mark on the dipstick, should the engine require additional oil.

THE HBW 50 TRANSMISSION

General

The HBW 50 transmission is equipped with a positively-driven, mechanically-operated helical gearing system. The servo-operated multiple-disc clutch requires only a minimum effort to change drives. This feature makes the transmission suitable for a single-lever remote control with a rod linkage, such as a Morse or Bowden cable. For safety reasons, the transmission is **NOT** filled with transmission fluid for shipment. Before leaving the factory, however, each transmission is thoroughly tested with fluid in the transmission. This testing, among other things, provides all internal parts with a coating of transmission fluid. This fluid acts as a preservative, providing reliable protection against corrosion for at least one year if the transmission is properly stored.



Lubrication

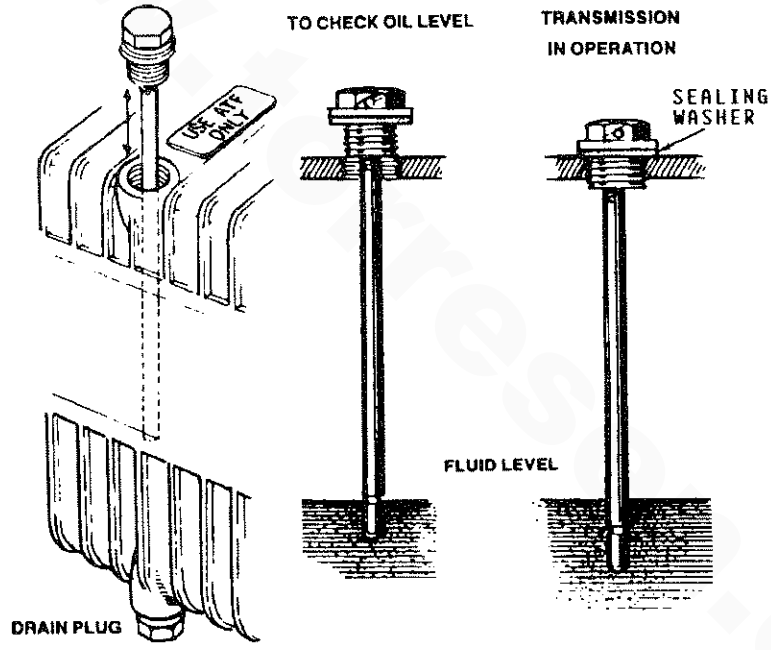
The HBW 50 transmission is an immersion-lubricated type. Fill the transmission up to or near the top of the machined notch cut on the dipstick with approximately 0.32 U.S. quarts (0.3 liters) of automatic transmission fluid (ATF).

Change the transmission fluid after the first 30 hours of engine operation and thereafter every 250 hours (or once per year, minimum). The HBW 50 transmission has a drain plug for draining the old transmission fluid. To ensure that most of the old fluid is drained from the transmission, run the engine in NEUTRAL for approximately 10 to 15 minutes so the transmission fluid may warm and flow better from the transmission. This transmission fluid may also be removed by inserting a small tube through the dipstick opening (where the transmission fluid is added) and attaching a pump onto the tube so the old fluid may be sucked out.

The operating oil temperature must not exceed 266° F (130° C). If this temperature is to be exceeded during normal operation, an optional transmission oil cooler should be installed. Consult you local Westerbeke Dealer for details on this cooler.

NOTE: To check the transmission fluid level, remove the dipstick and wipe off all transmission fluid on the dipstick, and place the dipstick back in the hole where it was removed, making sure that the base of the dipstick's threaded portion rests on the transmission housing. Now remove the dipstick and see where the fluid measures on the dipstick. If the transmission's fluid level lies below the notch, add enough transmission fluid to raise the level back up to the notch. Do not overfill the transmission.

DO NOT screw the dipstick into this hole to check the transmission fluid level. Screw the dipstick into this hole only after an accurate reading of the fluid's level has been taken. Make sure that the dipstick is screwed in before and while the engine is operating. Ensure that the sealing washer is present.



The Transmission drain plug is located directly below the dipstick and is the same size hex head as the dipstick. This drain plug also has a sealing washer.

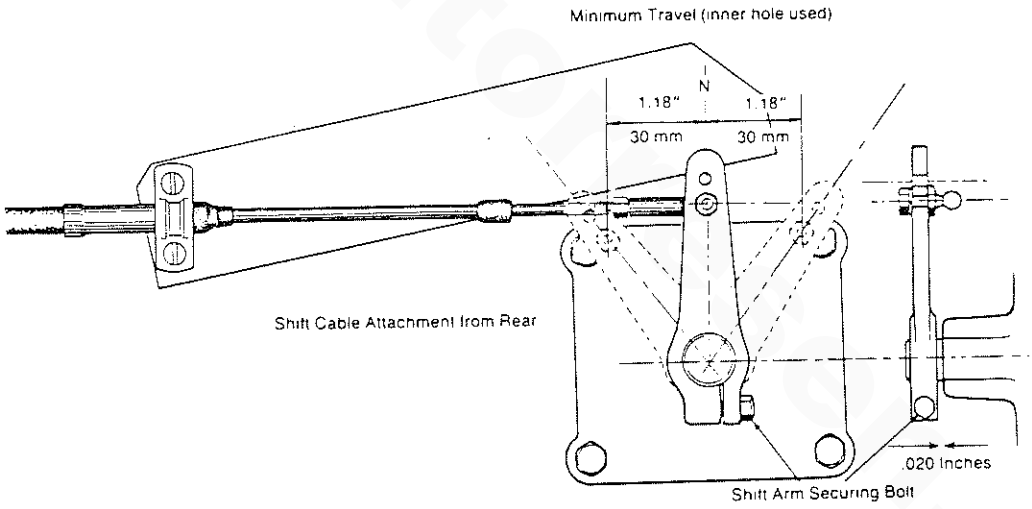
Alignment

Misalignment between the transmission's coupling and the propeller shaft's coupling can create serious problems. Ensure that the alignment procedures outlined in the "Propeller Coupling," the " Propeller, " and the " Alignment of the Engine" sections of this manual are followed, pages 13 and 14.

Controls

The only controls required to operate the transmission is a single lever remote control cable. The cable should be attached to the gear box lever using the cable bracket supplied with the unit. Both the gear box lever and the remote control lever must be in the NEUTRAL position when the cable is attached to the gear box lever. This allows the remote cable an equal throw distance to shift the gear box into FORWARD or into REVERSE from the NEUTRAL position without running out of cable. Allow approximately 1.18 inches (1 3/16) of cable throw from the NEUTRAL position on the transmission's gear box lever to the each of the two drive positions.

NOTE: If the throw distance (or travel) of the remote cable is too short, the gear box lever cannot fully engage the transmission into FORWARD or REVERSE. In this situation, the transmission's clutch plates will wear prematurely and the transmission will eventually fail.



NOTE: Excessive throw distance in the remote control lever is not detrimental to the transmission. Note that the position of the remote control lever should align with the NEUTRAL marking on its bracket when the transmission is really in NEUTRAL.

Shifting

To shift the transmission from NEUTRAL into FORWARD, exert a *heavy push* to the remote control lever. A gentle throw may not carry enough force to actually shift the transmission's internal gears. A gentle throw is signalled by the transmission not engaging into the desired drive. Make sure the remote control lever is lubricated at lease once each operating season. Shift the transmission while the engine is running at 1200 rpm or below. The clutch pack within the transmission makes an audiable "clunk" when engaging into gear.

CAUTION

NEVER remove or loosen the four-bolt gear box lever cover from transmission. The position of this plate and the actuating lever inside of the transmission has been finely adjusted at the factory to ensure equal throw distance of internal mechanisms. Loosening of this cover's capscrews voids the transmission's warranty.

Sailing Operation

The HBW 50 transmission can be left in its NEUTRAL position while sailing. Leaving the transmission in NEUTRAL while sailing alleviates unnecessary drag on the vessel because the propeller is able to freewheel (spin). However, should the operator wish to stop the rotation of the propeller shaft while under sail, this can be done by placing the transmission into REVERSE to lock the propeller shaft.

Service

If any seal on the transmission shows signs of leaking, have the transmission looked at by a qualified Westerbeke Dealer. This problem, especially concerning the rear seal, is often contributed to an improper alignment of the transmission's coupling and the propeller shaft's coupling. Refer to the "Alignment of the Engine" section of this manual, page 13.

Recommended Propeller Size

Propeller Recommendations (using HBW 50 transmission 2:1 reduction)	12 D x 6 P - 2 blade or 11 D x 6 P - 3 blade Propeller should allow the engine to reach its full rated RPM (3600 + 000 - 100) at full open throttle while underway.
Propeller Recommendations (using optional HBW 50 transmission with 2.5:1 reduction)	12 D x 8 P - 2 blade or 12 D x 6 P - 3 blade Propeller should allow the engine to reach its full rated RPM (3600 + 000 - 100) at full open throttle while underway.

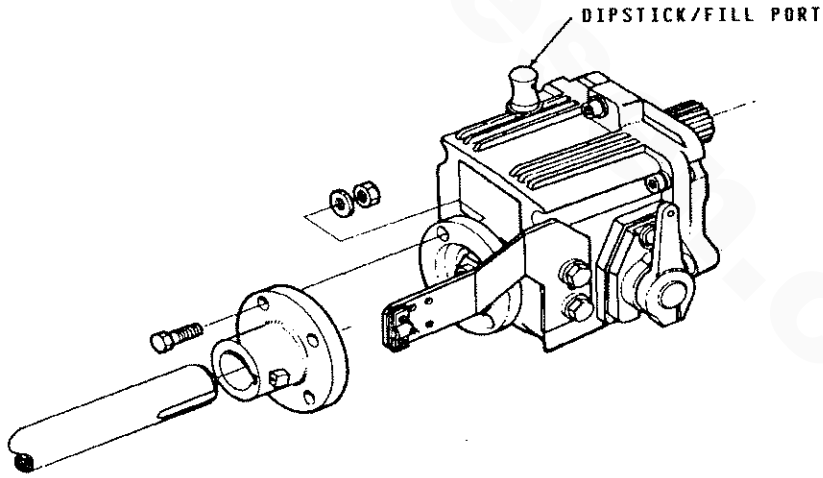
THE BW 3 TRANSMISSION

General

The BW 3 transmission rotates opposite to the engine when the transmission is in FORWARD gear. When the transmission is engaged in FORWARD, the input power is transmitted to the output shaft by helical spur gears. When the transmission is engaged in REVERSE, the input power is transmitted to the output shaft by a high-performance roller chain. This feature makes the transmission suitable for a single-lever remote control with a rod linkage, such as a Morse or Bowden cable. For safety reasons, the transmission is **NOT** filled with lubricating oil for shipment. Before leaving the factory, however, each transmission is thoroughly tested with lubricating oil in the transmission. This testing, among other things, provides all internal parts with a coating of lubricating oil. This fluid acts as a preservative, providing reliable protection against corrosion for at least one year if the transmission is properly stored.

Lubrication

The BW 3 transmission is an immersion-lubricated type. Fill the transmission up to or near the top of the machined notch cut on the dipstick with approximately 0.37 U.S. quarts (0.32 liters) of either SAE 20W/20 or W30 engine oil. Do not mix SAE grades. Do not use multi-grade oils. Use an oil having an API specification of CC, CD, SC, or SE.



Change the transmission oil after the first 30 hours of engine operation and thereafter every 250 hours (or once per year, minimum). The BW 3 transmission has a drain plug for draining the old transmission fluid. To ensure that most of the old oil is drained from the transmission, run the engine in NEUTRAL for approximately 10 to 15 minutes so the transmission oil may warm and flow better from the transmission. This

transmission oil may also be removed by inserting a small tube through the dipstick opening (where the transmission oil is added) and attaching a pump onto the tube so the old oil may be sucked out.

The operating oil temperature must not exceed 266° F (130° C). If this temperature is to be exceeded during normal operation, an optional transmission fluid cooler should be installed. Consult you local Westerbeke Dealer for details on this cooler.

NOTE: To check the transmission fluid level, remove the dipstick and wipe off all transmission oil on the dipstick, and place the dipstick back in the hole where it was removed, making sure that the dipstick's rubber head is properly inserted into the oil port. Now remove the dipstick and see where the oil measures on the dipstick. If the transmission's oil level lies below the notch, add enough transmission oil to raise the level back up to the notch. Do not overfill the transmission.

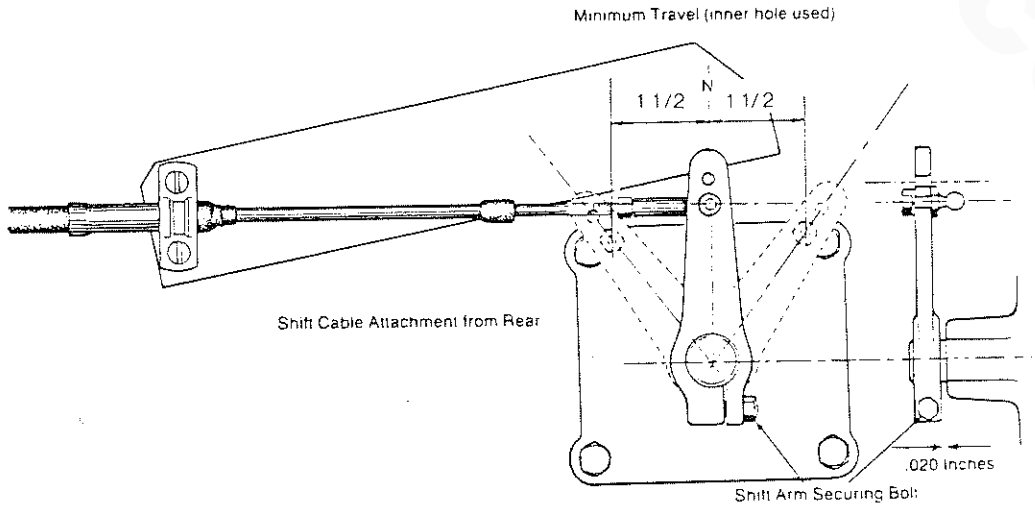
DO NOT force the dipstick into the oil port to check the transmission oil level. Excessive pressure can ruin the dipstick. Make sure that the dipstick is properly inserted into the oil port before and while the engine is operating.

Alignment

Misalignment between the transmission's coupling and the propeller shaft's coupling can create serious problems. Ensure that the alignment procedures outlined in the "Propeller Coupling," the " Propeller, " and the " Alignment of the Engine" sections of this manual are followed, pages 13 and 14.

Controls

The only controls required to operate the transmission is a single lever remote control cable. The cable should be attached to the gear box lever using the cable bracket supplied with the unit. Both the gear box lever and the remote control lever must be in the NEUTRAL position when the cable is attached to the gear box lever. The shift cable when properly adjusted should allow for an equal throw of the transmission shift lever into FORWARD or REVERSE from the NEUTRAL position without running out of cable. Allow approximately 1 1/2 inches of cable throw from the NEUTRAL position on the transmission's gear box lever to the each of the two drive positions.



NOTE: If the throw distance (or travel) of the remote cable is too short, the gear box lever cannot fully engage the transmission into FORWARD or REVERSE. In this situation, the transmission's internal gears will wear prematurely and the transmission may over heat.

NOTE: Excessive throw distance in the remote control lever is not detrimental to the transmission. Note that the position of the remote control lever should align with the NEUTRAL marking on its bracket when the transmission is really in NEUTRAL.

Shifting

To shift the transmission from NEUTRAL into FORWARD, exert a *heavy push* to the remote control lever. A gentle throw may not carry enough force to actually shift the transmission's internal gears. A gentle throw is signalled by the transmission not engaging into the desired drive. Make sure the remote control lever is lubricated at lease once each operating season. Shift the transmission while the engine is running at 1200 rpm or below.

CAUTION

NEVER remove or loosen the two-bolt gear box shift lever cover from transmission. The position of this plate and the actuating lever inside of the transmission has been finely adjusted at the factory to ensure equal throw distance of internal mechanisms. Loosening of this cover's capscrews voids the transmission's warranty.

Sailing Operation

The BW 3 transmission should be left in its NEUTRAL position while sailing. Leaving the transmission in NEUTRAL while sailing alleviates unnecessary drag on the vessel because the propeller is able to freewheel (spin). However, if the transmission is left in its FORWARD gear while sailing, the transmission will not be damaged. (Leaving the transmission in NEUTRAL is just good sailing practice.)

Service

If any seal on the transmission shows signs of leaking, have the transmission looked at by a qualified Westerbeke Dealer. This problem, especially concerning the rear seal, is often contributed to an improper alignment of the transmission's coupling and the propeller shaft's coupling. Refer to the "Alignment of the Engine" section of this manual, page 13.

NOTE: Never loosen the four gear box lever cover screws, except in the course of qualified servicing; this upsets critical adjustments. Disassembly of the transmission in the field is not recommended. If an overhaul or repair is needed, the work should be done by Westerbeke or an authorized Westerbeke service center.

Recommended Propeller Size

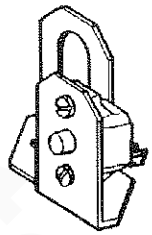
Propeller Recommendations (using BW 3 transmission 2:1 reduction)	12 D x 6 P - 2 blade or 11 D x 6 P - 3 blade Propeller should allow the engine to reach its full rated RPM (3600 + 000 - 100) at full open throttle while underway.

ENGINE TROUBLESHOOTING

Introduction

The tables which follow indicate troubleshooting procedures based upon certain problem indicators, the probable causes of the problems, and the recommendations to overcome these problems.

Note that the engine's control system (electrical system) is protected by a 20-Ampere manual reset circuit breaker located on the rear lifting bracket.



Problem	Probable Cause	Verification/Remedy
Key switch ON but no panel or test function.	1. Battery OFF.	1. Turn Battery ON.
	2. 20 Amp circuit breaker is tripped.	2. Reset the breaker by pushing in the button.
	3. Loose battery cable connection	3. Check the + connection to the starter and the - connection to the ground stud on the bell housing.
PREHEAT switch is de-pressed: no preheat solenoid activation: no electric fuel pump or alternator excitation.	1. Faulty solenoid, connections or switch.	1. Connection for 12 volts at S terminal of the solenoid is faulty.
		1. Check the preheat switch.
	2. Faulty connection or tripped 10 Amp breaker on the I terminal on the preheat solenoid.	2. Check for 12 volts at the 10 Amp breaker. Check for 12 volts at fuel lift pump and at the R terminal on the alternator when the preheat button is pushed.

ENGINE TROUBLESHOOTING

Problem	Probable Cause	Verification/Remedy
START switch is depressed: no starter engagement.	1. Connection to solenoid faulty.	1. Check connection S at the starter solenoid for 12 volts with the switch depressed.
	2. Faulty START switch.	2. Check switch with an ohmmeter.
	3. Faulty solenoid.	3. Twelve volts is present at the S terminal of the starter solenoid.
	4. Loose battery connection.	4. Check battery connections at both the + and - ground.
	5. Low batteries.	5. Check battery charge state. Low voltrage at the solenoid's S terminal with no activation.
Engine cranks, but does not start.	1. Shut-off valve at fuel tank.	1. Return shut-off valve to its ON position. Now bleed the fuel system.
	2. Faulty fueling system. to engine.	2. Check for fuel
	3. Air is in the fuel system.	3. Bleed the fuel system. Locate the leak and correct it.
	4. Fuel pump is not operating.	4. Check pump operation.
	5. Fuel filters are clogged.	5. Clean/replace filters.
Failure to stop.	1. Mechanical Run linkage disconnected.	1. Stop engine by manually moving the RUN linkage to STOP. That failing, shut off fuel and air.

Problem	Probable Cause	Verification/Remedy
Engine Stops.	1. Fuel starvation. Fuel shut-off is turned OFF.	1. Check to see that the shut-off valve at the fuel tank is ON.
	2. Fuel pump is inoperative	2. Inspect the fuel pump for 12 volt and to see if it is pumping.
	3. Water is in the fuel.	3. Pump water out of the bottom of the fuel tank(s) and change the fuel filters and bleed the fuel system.
	4. Exhaust system is restricted.	4. Check exhaust system for some type of blockage such as carbon buildup at the exhaust elbow. Check for a fault in the muffler. Check for a collapsed exhaust hose.
Battery runs down.	1. Alternator output. is low.	1. Check drive belt tension. Make an output check with a voltmeter at the B + terminal on the alternator.
	2. Faulty alternator.	2. Voltage leak through the alternator when not operating.
	3. Bad battery connections.	3. Connections are corroded or loose at the battery or/and at the engine.

MAINTENANCE AND ADJUSTMENTS

Introduction

This section contains a scheduled preventive maintenance program and several adjustment procedures the owner/operator can perform without the benefit of sophisticated and expensive tools and instruments.

Preventive Maintenance

Perform the preventive maintenance in accordance with the schedules listed in the following paragraphs. Adherence to these schedules will ensure the equipment is maintained in the best possible condition and that it will perform to expectations. Those items marked by an asterisk (*) are recommended to be performed by an authorized dealer or distributor.

Daily (before each use)

1. Check the oil sump level. Maintain the oil level at or near upper level mark on dipstick.
2. Check the coolant level in the plastic recovery tank. Maintain this level at or above the level marked **ADD**.
3. Check the transmission's lubricant level, and add additional lubricant as needed.
4. Visually inspect the unit; check for loose belts, chafed or broken wires, loose brackets and fittings, damaged hoses, loose clamps, and other equipment not properly secured. This check should include the propeller shaft coupling to the transmission's output flange.
5. Check the fuel supply. Fill tank(s) with a good grade of No. 2 diesel fuel, if required.
6. Check the primary filter/water separator. Drain and service as required. (A primary filter/water separator is optional, but strongly recommended.)
7. Check the engine's gauges or lights for proper oil pressure, operating temperature, and starting battery charging voltage once the engine is operating.
8. Check the alternator's output gauge (if installed) for proper DC voltage.

Monthly

Check the condition of the zinc anode in the heat exchanger's sea water circuit. Clean or replace the anode, as required. Keep the area inside the heat exchanger clean of zinc anode debris.

Servicing After Initial 50 Hours of Operation

1. Change the engine's lubrication oil and oil filter.
2. Replace the fuel filter element in the electric fuel lift pump and in the optional water/sediment separator, if a separator has been installed.

*3. Torque the cylinder head bolts.

*4. Adjust valve clearances.

5. Adjust the alternator and water pump drive belt tension, if required.

6. Lubricate the throttle, the RUN linkage cable, and the transmission's remote control cable.

7. Change the transmission's transmission fluid if your engine is equipped with a HBW 50 transmission, or change the transmission oil if your engine is equipped with a BW 3 transmission.

Servicing After Every 100 Hours of Operation

1. Change the engine's lubrication oil and oil filter.

2. Adjust the alternator and water pump drive belt tension, if required.

3. Check the transmission fluid or oil level.

Servicing After Every 250 Hours of Operation

1. Replace the fuel filter elements in the electric fuel lift pump and in the optional water/sediment separator.

2. Change the transmission's transmission fluid if your engine is equipped with a HBW 50 transmission, or change the transmission oil if your engine is equipped with a BW 3 transmission.

Servicing After Every 500 Hours of Operation

*1. Torque the cylinder head bolts.

*2. Adjust the valve clearances.

3. Drain, flush, and refill the fresh water cooling system. The illustration on page 5 shows the heat exchanger and the zinc anode location. The drain plug for the fresh water system is next to the zinc anode.

*4. Check the condition of the starter motor drive pinion; lubricate the pinion.

5. Check the resistance of the glow plugs. (.4 to .6 ohms)

NOTE: Items highlighted by an asterisk (*) should be performed by a competent mechanic.

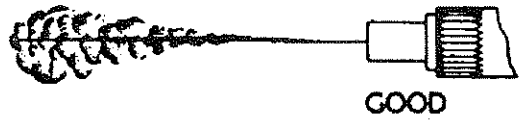
Servicing After Every 800 Hours of Operation

*1. Remove and check fuel injectors.

Injector spray pressure:

1991 psi + 140 psi
(140 kg/cm^2 + 10 kg/cm^2)

Eliminate undesirable injection conditions including after dripping.



*2. Check the engine's compression pressure. Remove each glow plug and check each cylinder's compression pressure. The engine's cranking speed is at 280 rpm.

Standard	Minimum	
455 psi (32 kg/cm^2)	369.7 psi (26 kg/cm^2)	(Maximum difference between cylinders: 35.5 psi (2.5 kg/cm^2)

*3. Check the battery-charging alternator for proper operation.

*4. Check the tightness of bolts, nuts, and clamps.

Servicing After Every 1000 Hours of Operation

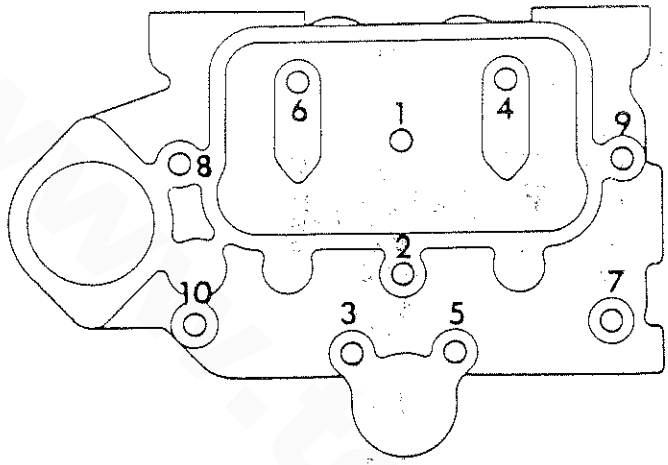
1. Remove, clean, and pressure test the primary heat exchanger. (A local automotive radiator shop should be able to clean and test the heat exchanger.)

   NOTE: Operating in silty and/or tropical waters may require that a heat exchanger cleaning be performed more often than every 1000 hours.

*2. Check the injection pump's timing.

Torquing Cylinder Head Bolts

Tighten the cylinder head bolts according to the sequence shown in the illustration shown to the right. Make sure the engine is cold when this is done. Loosen one head bold one-half turn and then tighten it between 56 to 59 lb-ft (7.8 to 8.2 kg-m). Then proceed to the next head bolt in the sequence numbering shown.

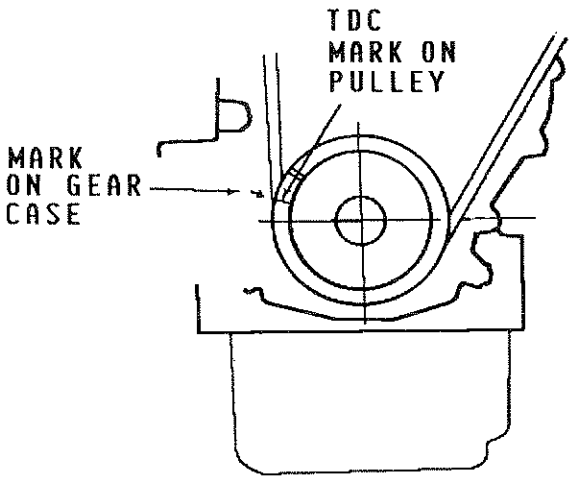


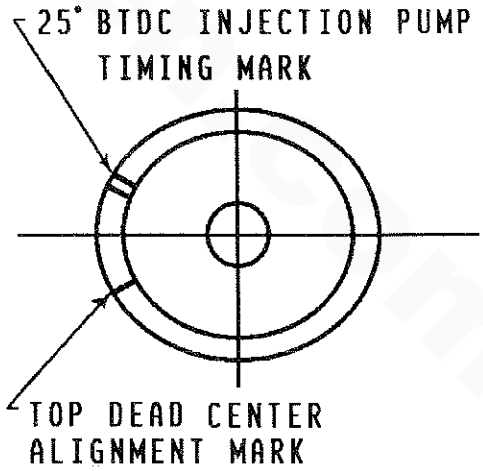
Valve Clearance Adjustment

NOTE: Retorque the cylinder head bolts before adjusting the engine's valves.

1. Remove the rocker arm cover.

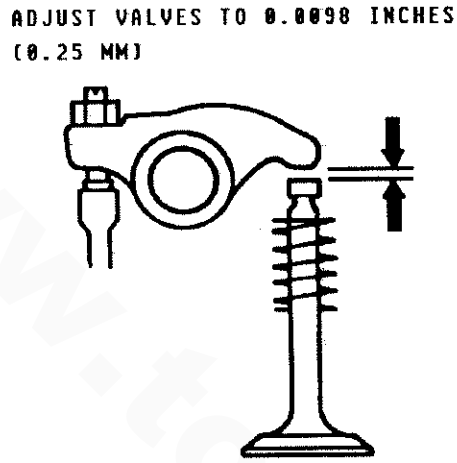
2. Position the No. 1 piston at Top Dead Center (TDC) of its compression stroke. To do this, align the timing mark on the gear case with that on the crankshaft pulley (refer to the photograph shown below). Now adjust the No. 1 piston's intake and exhaust valves.





3. Facing the front of the engine, rotate the crankshaft 170° clockwise to position the No. 2 piston at TDC of its compression stroke. Now adjust the No. 2 piston's intake and exhaust valves.

NOTE: Adjust all valves to 0.0098 inches (0.25 mm) with the engine cold.



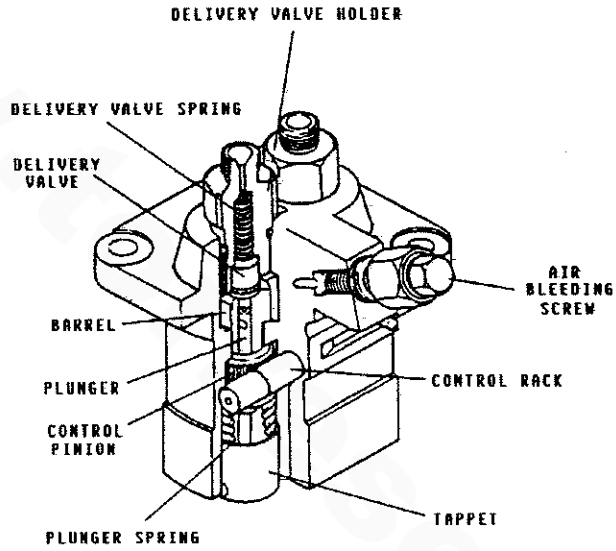
Adjusting a valve's clearance with a feeler gauge.

Injection Pump Timing Adjustment (Spill Timing)

If your engine's fuel injection timing is not properly adjusted, the engine will not operate properly and will be difficult to start. Have the injection pump delivery rate checked by a well established fuel injection shop. Adjust the injection timing as follows:

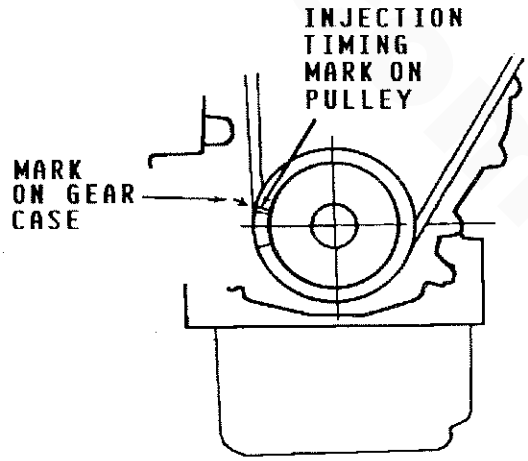
> NOTE: The fuel lever (throttle) must be in the **RUN** position while making the adjustment or no fuel will flow to the fuel injection pump.

Refer to the illustration below when servicing the fuel injection pump. First remove the high-pressure fuel line from between the No. 1 injector and the No. 1 fuel delivery valve holder. Remove the No. 1 fuel delivery valve holder and remove the delivery valve spring beneath the holder. Reinstall only the delivery valve holder and reattach the hight pressure fuel line to the delivery holder. Attach it so that the end that would connect to the fuel injector is pointing away from the engine. Fuel will flow from this line during the timing check.

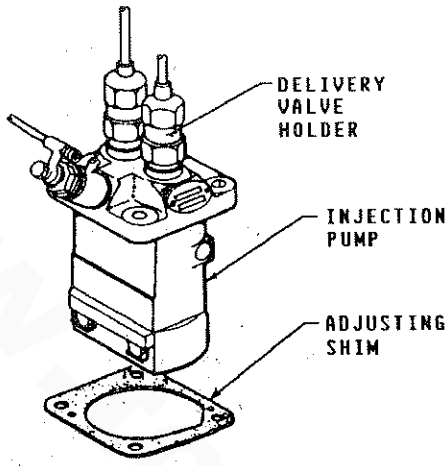


Cutaway View of the W 12B TWO's Fuel Injection Pump

Move the throttle lever to mits full open position and operate the electric lift pump. Rotate the crankshaft clockwise (as viewed from the front), catching the fuel from the No. 1 fuel line, until the instant the fuel completely stops flowing (no drips). At this instant, the 25° BTDC timing mark on the crankshaft pulley should be directly aligned with the timing indicator on the front of the gear case (see the illustration to the right).



If the specified injection timing (25° BTDC) cannot be attained, adjust the timing by increasing or decreasing the thickness of the injection pump mounting shim. Changing the shim thickness by 0.004 inch (0.01mm) changes the injection timing by approximately one degree. To advance the timing, decrease the shim thickness, as required. To retard the timing, increase the shim thickness, as required. Refer to your engine's parts List for shim part numbers.



Fuel Injection Pump with an Adjusting Shim

LAY-UP AND RECOMMISSIONING

General

Many owners rely on their boatyards to prepare their craft, including engines and generators, for lay-up during the off-season or for long periods of inactivity. Others prefer to accomplish lay-up preparation themselves.

The procedures which follow will allow you to perform your own lay-up and recommissioning, or to use as a check list if others do the procedures.

These procedures should afford your engine protection during a lay-up and also help familiarize you with the maintenance needs of your engine.

If you have any questions regarding lay-up procedures, call your local servicing dealer; he will be more than willing to provide assistance.

Propeller Coupling

The transmission and propeller half couplings should always be opened up and the bolts removed whenever the boat is hauled out of the water or moved from land to water, and during storage in a cradle. The flexibility of the boat often puts a severe strain on the propeller shaft or coupling, or both, while the boat is taken out or put in the water. 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 have been dry for a considerable period of time.

Fresh Water Cooling System

A 50-50 solution of antifreeze and fresh water is recommended for use in the fresh water cooling system at all times. This solution may require a higher concentration of antifreeze, depending on the area's winter climate. Check the solution to ensure that the antifreeze protection is adequate.

Should more antifreeze be needed, drain an appropriate amount from the engine block and add a more concentrated mixture. Operate the engine to ensure a complete circulation and mixture of the antifreeze concentration throughout the cooling system. Now recheck the antifreeze solution's strength.

Lubrication System

With the engine warm, drain all the lubricating oil from the oil sump. Remove and replace the oil filter. (Place some paper towels and a plastic bag around the filter to catch the oil during its removal.)

When installing the new oil filter, be sure to apply a small amount of oil on the rubber sealing gasket at the base of the filter. Fill the sump with the correct amount of oil for your engine. (Refer to the"SYSTEM SPECIFICATIONS" section of this manual, page 8.) Use an oil with an API specification of CC or CD. Run the engine and check for proper oil pressure and ensure that there are no leaks.

CAUTION

Do not leave the engine's old lubricating oil in the sump over the lay-up period. Lubricating oil and combustion deposits combine to produce harmful chemicals which can reduce the life of your engine's internal parts.

Fuel System

Top off your fuel tanks with No. 2 diesel fuel. Fuel additives should be added at this time to control algae and condition the fuel. Care should be taken that the additives used are compatible with the primary filter/water separator used in the system. Change the element in your primary fuel filter/water separator, if the fuel system contains one, and clean the separator sediment bowl.

Change the fuel filter elements on the engine and bleed the fuel system, as needed. Start the engine and allow it to run for 5 - 10 minutes to ensure that no air is left in the fuel system. Check for any leaks that may have been created in the fuel system during this servicing, correcting them as needed.

Sea Water Circuit

Close the thru-hull sea cock. Remove the sea water intake hose from the sea cock. Place the end of this hose into a 5-gallon bucket of clean fresh water. Before starting the engine, check the zinc anode found in the primary heat exchanger on the engine and clean or replace it as required. Clean the sea strainer, if one is installed in the inside of the hull.

Start the engine and allow the sea water pump to draw fresh water through the system. When the bucket is empty, stop the engine and refill the bucket with an antifreeze solution slightly stronger than needed for winter freeze protection in your area.

Start the engine and allow all of this mixture to be drawn through the sea water system. Once the bucket is empty, stop the engine. This antifreeze mixture should protect the sea water circuit from freezing during the winter lay-up, as well as providing corrosion protection.

Remove the impeller from your sea water pump (some antifreeze mixture will accompany it, so catch it in a bucket). Examine the impeller. Acquire a replacement, if needed, and a cover gasket. Do not replace the impeller (into the pump) until recommissioning, but replace the cover and gasket.

Intake Manifold and Through-Hull Exhaust

Place a clean cloth, lightly soaked in lubricating oil, in the opening of the intake manifold to block the opening. Do not shove the cloth out of sight. (If it is not visible at recommissioning, and an attempt is made to start the engine, you may need the assistance of a servicing dealer.) Make a note to remove the cloth prior to start-up. The through-hull exhaust part can be blocked in the same manner.

Starter Motor

Lubrication and cleaning of the starter drive pinion is advisable, if access to the starter permits its easy removal. Ensure that the battery connections are shut off before attempting to remove the starter. Take care in properly replacing any electrical connections removed from the starter.

Cylinder Lubrication

It is not necessary to remove the fuel injectors from the cylinder head to squirt light lubricating oil into the cylinders for the few months of normal lay-up. However, if you anticipate a longer lay-up period (12 months or more), we recommended that this procedure be performed. The light oil in the cylinders will prevent the pistons rings from sticking to the cylinder walls. Ensure that you have replacements for the injector and return line sealing washers.

Spares

Lay-up time provides a good opportunity to inspect your Westerbeke engine to see if external items such as drive belts or coolant hoses need replacement. Check your basic spares kit and order items not on hand, or replace those items used during the lay-up, such as filters and zinc anodes.

Batteries

If batteries are to be left on board during the lay-up period, ensure that they are fully charged, and will remain that way, to prevent them from freezing. If there exists any doubt that the batteries will not remain fully charged, or that they will be subjected to severe environmental conditions, remove the batteries and store them in a warmer, more compatible environment.

Recommissioning

The recommissioning of your Westerbeke engine after a seasonal lay-up generally follows the same procedures as those presented in the "PREPARATIONS FOR STARTING" section, page 21, regarding preparation for starting and normal starts. However, some of the lay-up procedures will need to be counteracted before starting the engine.

1. Remove the oil-soaked cloths from the intake manifold and from the through-hull exhaust port.

2. Remove the sea water pump cover and gasket and discard the old gasket. Install the sea water pump impeller removed during lay-up (or a replacement, if required). Install the sea water pump cover with a new cover gasket.

WARNING

Wear rubber gloves, a rubber apron, and eye protection when servicing batteries.

Lead acid batteries emit hydrogen, a highly-explosive gas, which can be ignited by electrical arcing or a lighted cigarette, cigar, or pipe. Do not smoke or allow an open flame near the battery being serviced. Shut off all electrical equipment in the vicinity to prevent electrical arcing during servicing.

3. Reinstall the batteries that were removed during the lay-up, and reconnect the battery cables, making sure the terminals are clean and that the connections are tight. Check to ensure that the batteries are fully-charged.

4. Check the condition of the zinc anode in the sea water circuit and clean or replace the anode as needed. Note that it is not necessary to flush the antifreeze/fresh water solution from the sea water coolant system. When the engine is put into operation, the system will self-flush in a short period of time with no adverse affects.

5. Start the engine in accordance with procedures in the "PREPARATIONS FOR STARTING" section of this manual, page 21.

Engine parts from Torrsen Marine - www.torresen.com - 231-759-8596

TABLE OF STANDARD HARDWARE TIGHTENING TORQUES

Unless stated otherwise for a specific assembly, use the following torque values when tightening standard hardware.

	Pitch	lb-ft	kg-m
Grade 4T			
6mm bolt head/nut	1	2.9 - 5.1	0.4 - 0.7
8mm bolt head/nut	1.25	7.2 - 11.6	1.0 - 1.6
10mm bolt head/nut	1.25	13.7 - 22.4	1.9 - 3.1
10mm bolt head/nut	1.5	13.0 - 21.7	1.8 - 3.0
12mm bolt head/nut	1.25 (ISO)	25.3 - 39.8	3.5 - 5.5
12mm bolt head/nut	1.5	25.3 - 39.8	3.5 - 5.5
12mm bolt head/nut	1.75	21.7 - 36.2	3.0 - 5.0
13mm bolt head/nut	1.5	32.5 - 50.6	4.5 - 7.0
14mm bolt head/nut	1.5	36.2 - 57.9	5.0 - 8.0
14mm bolt head/nut	2	34.0 - 55.7	4.7 - 7.7
16mm bolt head/nut	1.5	54.2 - 79.6	7.5 -11.0
16mm bolt head/nut	2	51.4 - 76.7	7.1 -10.6
Grade 6T			
6mm bolt head/nut	1	4.3 - 6.5	0.6 - 0.9
8mm bolt head/nut	1.25	10.8 - 15.9	1.5 - 2.2
l0mm bolt head/nut	1.25	21.7 - 32.5	3.0 - 4.5
10mm bolt head/nut	1.5	19.5 - 30.4	2.7 - 4.2
12mm bolt head/nut	1.25 (ISO)	36.2 - 57.9	5.0 - 8.0
12mm bolt head/nut	1.5	36.2 - 50.6	5.0 - 7.0
12mm bolt head/nut	1.75	34.7 - 49.2	4.8 - 6.8
Grade 7T, 8T and 8.8			
6mm bolt head/nut	1	5.8 - 8.7	0.8 - 1.2
8mm bolt head/nut	1.25	14.5 - 21.7	2.0 - 3.0
10mm bolt head/nut	1.25	28.9 - 39.8	4.0 - 5.5
10mm bolt head/nut	1.5	26.8 - 37.6	3.7 - 5.2
12mm bolt head/nut	1.25 (ISO)	54.2 - 75.9	7.5 -10.5
12mm bolt head/nut	1.5	50.6 - 65.1	7.0 - 9.0
12mm bolt head/nut	1.75	43.4 - 61.5	6.0 - 8.5
13mm bolt head/nut	1.5	57.9 - 86.8	8.0 -12.0
14mm bolt head/nut	1.5	72.3 -108.5	10.0 -15.0
14mm bolt head/nut	2	68.7 -101.3	9.5 - 14.0
16mm bolt head/nut	1.5	108.5 - 166.4	15.0 - 23.0
16mm bolt head/nut	2	101.3 - 159.1	14.0 - 22.0
Grade 5 capscrew			
1/4 UNC		9 - 11	1.2 - 1.5
1/4 UNF		11 - 13	1.5 - 1.8
5/16 UNC		18 - 20	2.5 - 2.8
5/16 UNF		21 - 23	2.9 - 3.2
3/8 UNC		28 - 33	3.7 - 4.6
3/8 UNF		30 - 35	4.1 - 4.8
7/16 UNC		44 - 49	6.1 - 6.8
7/16 UNF		50 - 55	6.9 - 7.6
1/2 UNC		68 - 73	9.4 -10.1
1/2 UNF		73 - 80	10.1 -11.1

TORQUE SPECIFICATIONS

	Lb-ft	Kg-m
Cylinder head bolt (M8) *	25.3 - 28.9	3.5 - 4.0

(See the " **Tightening Cylinder Head Bolts**" section of this manual on page 63.)

Rocker cover nut (M8)	3.6 - 5.1	0.5 - 0.7
Connecting rod cap nut	23.1 - 25.3	3.2 - 3.5
Flywheel bolt	47.0 - 50.6	6.5 - 7.0
Crankshaft pulley nut (M24)	108.5 - 144.7	15 - 20
Oil drain plug	36.2 - 43.4	5.0 - 6.0
Oil filter	7.9 - 9.4 (or tighten firmly by hand)	1.1 - 1.3
Nozzle holder	36.2 - 43.4	5.0 - 6.0
Nozzle holder and retaining nut	43.4 - 57.9	6.0 - 8.0
Glow plug	10.8 - 14.5	1.5 - 2.0
Starter **B** terminal nut (on copper stud)	7.2 - 8.7	1.0 - 1.2

* NOTE: M8 indicates Metric, 8 mm thread diameter

SPARE PARTS

Since a possibility exists in which the engine may need to be serviced at sea or while in a port other than your home port, certain spare parts should be kept on board to help minimize delays in your voyage. Please refer to your engine's Parts List for part numbers when ordering spare parts.

Listed below are those spare parts that should be carried on board at all times.

1. An Impeller Kit
2. A Fuel System hardware Kit
3. An Electric Fuel Lift Pump Filter and a Secondary Fuel Filter.
4. An Alternator/Sea Water Pump Belt
5. Hose Clamps
6. A Spare Oil Filter with a Spare Quart of Diesel Service Engine Oil along with a Quart of Transmission Lubricant and a Gallon of Premixed Antifreeze.

Other parts, whose life expectancy cannot be accurately predetermined, should be carried on board (in addition to those listed above) especially if the vessel is to be taken on long ocean voyages. These parts are listed below.

1. Fuel Injectors
2. Glow Plugs
3. Cooling System Hoses
4. An Alternator
5. A Starter
6. A 20 Amp DC Circuit Breaker
7. An Electric Fuel Lift Pump
8. A Sea Water Pump
9. Battery Terminal Connectors

The spare parts listed directly above are those we *recommend* be carried on board during long ocean voyages. You may wish to ask other boat owners who have similar crafts and who have completed long ocean voyages as to what spare parts they carried on board and what parts were needed at specific times of the voyage. From the list provided directly above and from these inquiries, you can determine what spare parts may be needed. In addition, if you are planning a long ocean voyage, consult your local Westerbeke dealer for a listing of the Westerbeke dealers located on your route.

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