

OPERATOR'S MANUAL

WESTERBEKE

13A • 18 • 21A • 27A • 33A

Marine Diesel Engines

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

Thank you for having selected a Westerbeke Diesel Engine for your use.

This manual describes the procedures for proper handling and routine maintenance of:

W13A, W18, W21A, W27A and W33A

Marine Diesel Propulsion Engines

To obtain best operating condition and longest life, it is important to use it sensibly and carry out operation and maintenance according to this manual.

If you have questions about your equipment or in the event of a failure, please contact your nearest Westerbeke distributor or dealer.

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

We look forward to your continued patronage.

from: J.H. Westerbeke Corp.
Avon Industrial Park
Avon, MA 02322

Mail To:



J. H. WESTERBEKE CORP.

AVON INDUSTRIAL PARK, AVON, MASS. 02322

CUSTOMER IDENTIFICATION

W-21A 1234C508 Pleasure Craft
expires 7/7/87

Adam Smith
85 Maple Street
Alden, IN 12234

PN

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GENERAL SPECIFICATIONS

ITEM	CHARACTERISTIC	W13A	W18	W21A	W27A	W33A
Type	Vert., 4 cycle, water cooled diesel engine					
Compustion chamber	Swirl chamber type					
No. of cylinders	2	3	3	4	4	
Bore & stroke (inches)	2.76x3.07	2.56x3.07	2.87x3.07	2.87x3.07	3.07x3.07	
Cu. In. displacement	37	47	60	80	91	
Compression ratio	23	23	23	23	23	
Firing order	1-2	1-3-2	1-3-2	1-3-4-2	1-3-4-2	
Dry weight, std. (lbs)	289	345	345	424	480	
Fuel	#2 diesel fuel only					
Injection pump	Bosch type					
Nozzle	Throttling type					
Injection pressure	All models: 1707 lbs.					
Governor	Contrifugal weight type					
Lubrication system	Pressure lubrication					
Oil filter	Filter paper type					
Engine Oil Capacity qt.	2.5	4.0	4.0	4.0	4.2	
Engine Oil Capacity lt.	2.36	3.78	3.78	3.78	3.93	
Fresh water Cooling system	Forced circulation, water cooling by heat exchanger					
Coolant capacity (Engine Proper)	6qts	5qts	5qts	8qts	8qts	
	Always fill to top of filler neck					
Starter KW	1.2	1.2	1.2	1.6	1.6	
Alternator V-A	12-50	12-50	12-50	12-50	12-50	
Glow plug	Sheathed type - all models					
Battery capacity	60 AH	75 AH	75 AH	90 AH	90 AH	

INSTALLATION, PREPARATION AND SUPPLY CAUTIONS

* Check important aspects of installation before operating engine.

- (1) Alignment (Error to be no more than one thousandth of an inch per inch of coupling diameter) (See Figure 1)
- (2) Provide sufficient ventilation
- (3) Provide adequate service room around engine (See warranty clauses)

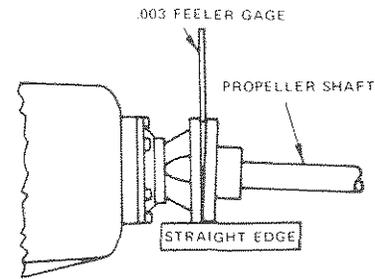


Figure 1.
Checking Coupling Alignment

- * Fill fuel tank with CLEAN #2 diesel from a reputable manufacturer.
- * Fill lubricating oil to full mark on dipstick (Select readily available lubricating oil with A.P.I. spec. CC or CD and S.A.E.# suitable for your operating area.)
- * Fill cooling system with suitable mixture of water and antifreeze to suit your temperature zone. (See page 19).
- * Propulsion units - fill transmission/V-drive to correct level on dipstick with correct lubricant.
- * Plug-in Panel Harness Connection. After assembly, joint should be taped to prevent corrosion or, preferably, assembled using a silicon grease which can be obtained at an electronic store such as Radio Shack, etc.

SAFETY PRECAUTIONS

- * Never operate engine with inadequate ventilation. Confirm that there are no exhaust leaks inside engine compartment.
- * Do not touch moving parts during operation.
- * Do not touch hot parts such as exhaust pipe, and do not place combustible materials near the unit.
- * Inspect and adjust parts of the engine only after it is stopped.
- * Check and refill engine oil, cooling water, transmission and fuel after the engine is brought to a stop.
- * A coolant recovery bottle was supplied with the engine together with instructions for installation. Be sure that it is in place. Attempting to operate with only the manifold as an expansion tank exposes the operator to a severe steam burn if the manifold pressure cap is removed while the engine is hot. (Follow instructions on Page 6.)

- * Always use tools that fit correctly and use caution during servicing. Both S.A.E. and metric sizes are found on the units, use care in selecting the replacing hardware.
- * Be sure that current carrying wires are protected from abrasion and that all connections are tight.

PREPARATIONS

Take steps as shown below in starting your engine for the first time or after a prolonged shut-down.

1. Fill your engine with oil up to or near the upper limit on the dipstick. Use a good grade of oil with API specification of CC or better. For quantity of oil, you may refer to the General Specifications page 3 (see Figure 2).
2. Fill the transmission/V-drive to full mark on their dipstick with the correct lubricant.
3. Your engine is supplied with a coolant recovery system (See figure 3) to which the following instructions apply:

a) Fill engine completely to the neck of the manifold pressure cap with an antifreeze mixture.

b) Open airbleed petcock on manifold or thermostat housing to allow air in system to escape while filling. Close tight after filling.

c) Then fill the recovery tank to the bottom level line. Need for adding coolant is indicated when a cold engine has coolant level below the bottom level line.

4. Fill the fuel tank with #2 Diesel fuel with 45 Cetane rating. The interior of the fuel tank must be maintained clean. Be careful not to allow introduction of dirt when filling fuel.
5. NOTE: Engine oil, coolant and transmission levels should be checked at least once a day prior to engine use. Visually look over unit for any abnormalities and correct as needed.

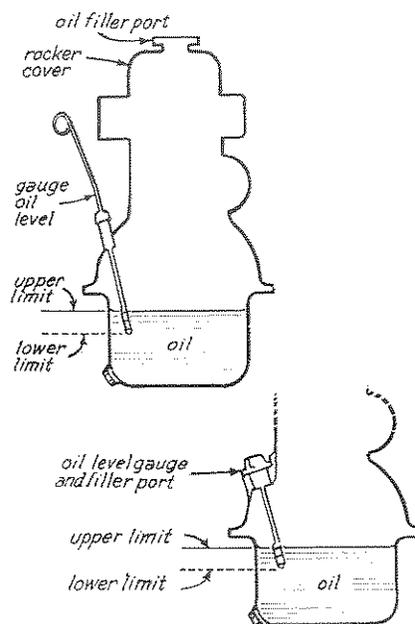


Figure 2. Oil Capacity

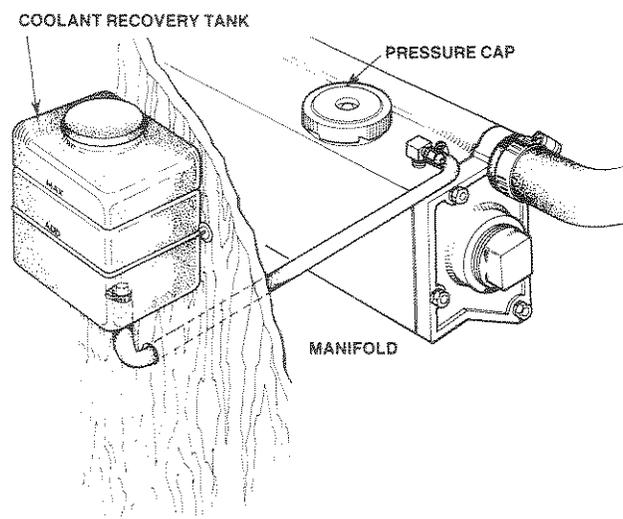


Figure 3. Coolant Recovery System

BREAKING IN YOUR NEW ENGINE

While your engine has had a minimum of one hour of test operations to demonstrate accurate assembly and correct operation of all systems, it still requires break in time.

Service life of your engine is dependent on how your engine is operated and serviced during initial hours of operation.

Your new engine needs approximately fifty hours of initial conditioning operation for breaking in each moving part, thus helping to maximize performance and service life of engine. Perform this conditioning carefully, keeping the following points in mind.

1. Start engine, run at a fast idle while checking that all systems are functioning - sea water pump, oil pressure, battery charge.
2. Warm engine, preferably by running propeller at fast idle while tied down, until water temperature gauge moves into the 130 - 140 degree range.
3. Then use engine at varying RPM's for first twenty five hours (transmission lubricant should be changed on models having HBW transmissions).
4. Avoid rapid acceleration especially with a cold engine.
5. Use caution not to overload engine. Grey or black smoke and inability of engine to reach rated RPM is a sign of overload.
6. Next twentyfive hours may be run at varying RPM's with short runs at top RPM. Avoid prolonged idling.

Explanation:

"Breaking in" a new engine is basically a seating of the piston rings to the cylinder walls. This is not accomplished by long periods of running idle, nor by early running under full load.

Idle running may glaze the cylinder walls causing oil consumption and smoky operation. Excessive speeds and loads may score cylinder walls with similar results, especially with the engine cold.

As indicated above, operate the engine in moderation during the initial 50 hours of break in. Don't baby it, yet do not abuse it.

DESCRIPTION OF STARTING SYSTEM

All Models use an electric starter assisted by glow plugs for both normal and cold weather starting. Figure 4 is a cross section through one cylinder. The glow plug enters the combustion chamber so that the end is in the spray path of the injector nozzle. When the glow plugs are energized by the preheat button, they glow red at the tips and assist rapid ignition of the fuel. The result is rapid starts with less wear on the starter.

This system is common to Westerbeke Diesels. The start circuitry is designed so that, first, the preheat button must be depressed for the time specified in the glow plug use chart shown below.

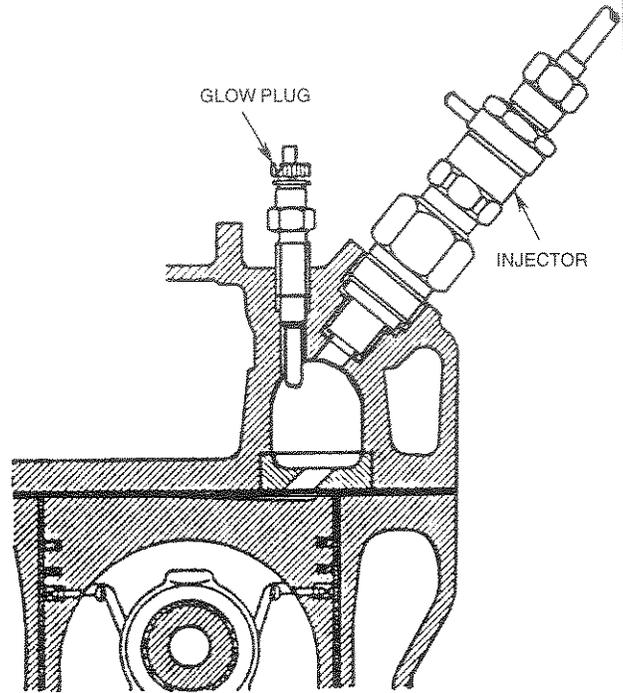


Figure 4. Combustion Chamber

After which, and while keeping the preheat button engaged, the start button is depressed to crank the engine.

NOTE: Starter button will not energize unless preheat is depressed.

Glow Plug Use Data

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

For complete starting and stopping procedures, see pages 10 and 11.

INSTRUMENT PANEL Description and use of:

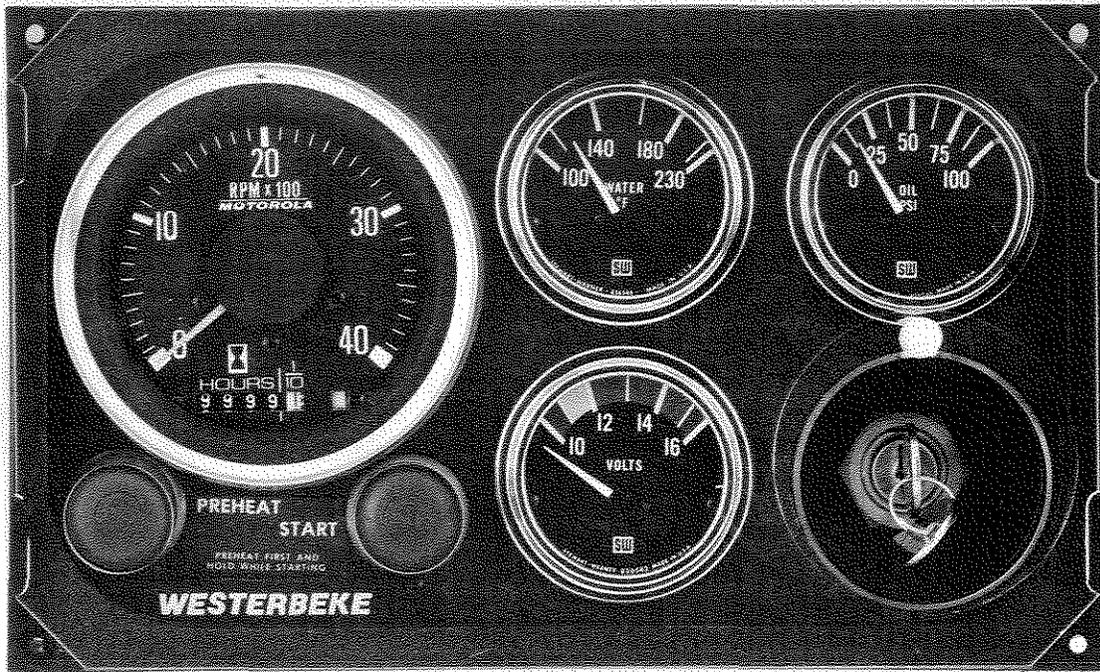


Figure 5. Instrument Panel

Note 1: When engine is stopped after use, the water temperature and oil pressure gauges may stay at their running readings.

Note 2: When engine is next to be used, turn keyswitch ON. The temperature and pressure gauges will "ZERO" and the voltmeter will register battery voltage. The electric fuel pump, mounted on the engine, will also begin to operate, purging any air accumulated in the system and the engine hour meter will begin to function.

Note 3: The engine is now prepared for starting.

Note 4: FOR INITIAL STARTS:

The self-bleeding feature of these models make it such that no fittings or such in the fuel system need be opened to remove air from the engine fuel system. The operator need only to fill the vessel's fuel tanks and manually prime any primary filter/water separator between the fuel tank and engine. Then turn On the engine key switch activating the electric fuel pump on the engine and allow it to operate for 30 - 60 seconds to prime the engine fuel system and bleed any air in it out through the return.

STARTING PROCEDURES

1. Place transmission in neutral, advance throttle full open, (warm engine partially). Press Preheat button and hold for the number of seconds indicated on Page 8 in "Glow Plug Use Data".
2. While still engaging Preheat button, press Start button.
3. The starter will crank the engine which should start in 10 seconds or less.
4. As soon as the engine starts, release buttons and throttle back to a moderate warm up speed.
5. Should the engine NOT start even though cranking for 10 seconds, release the buttons for 30 seconds and repeat the sequence by preheating the glow plugs sufficiently. The starter motor should never be run more than 30 seconds at a time.

NOTE: Excessive cranking without a start may place excess cooling water into the exhaust that cannot be expelled, filling the exhaust and entering the engine cylinders producing a hydraulic lock. Avoid this by shutting off the raw water thru hull and open immediately once engine starts.

6. Proper glow plug function is indicated by voltmeter drop when Preheat button is depressed. (See Figure 6). 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 connection).

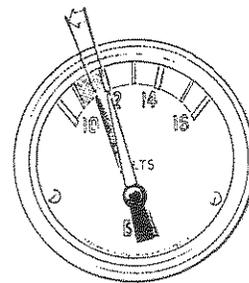


Figure 6. Voltmeter Gauge

7. As soon as the engine has started, release both Start and Preheat buttons. Check that, with engine running, oil pressure and battery charge voltage are registering and that raw water is discharging with the exhaust.

Note: An alarm buzzer is supplied with every unit and is the responsibility of the installer to electrically connect the alarm buzzer to the two tagged terminal connection on the engine electrical harness and install the buzzer in a dry location so that it will be audible to the operator should it sound during engine operation. This buzzer will sound when the ignition key is turned on and should silence when the engine is started and oil pressure rises above 15 lbs.

8. To warm up engine, run a few minutes at idle to make checks in '7' above. Then operate under reduced load (50 to 60 percent) until operating temperature rises into the 140° - 150° range.

STOPPING PROCEDURES

1. Model W13A Only (See Figure 7)

a) To stop the engine move the throttle control through the idle position to stop. As the throttle is moved past idle there will be increased resistance to movement because a spring loading must be overcome. Hold the throttle firmly against the pressure until the engine comes to a complete stop.

b) With the engine stopped, turn the key back to "OFF" position. The battery will be discharged if the key is left at "ON" position. An engine alarm buzzer is provided to warn the operator of this possibility. Best precaution is always to remove the key.

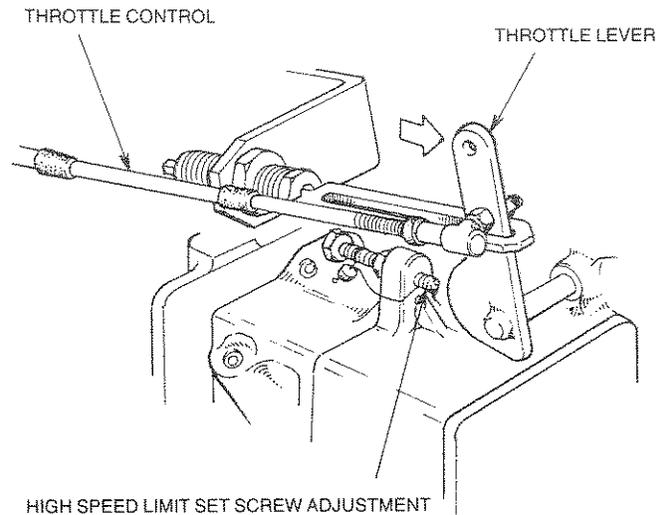


Figure 7. Model W13A Idle Position

2. Models W18, W21A, W27A and W33A (See Figure 8)

a) Each model has a manual shut-off. A 'T' handle or knob is pulled to shut off fuel. Simply pull the shut-off and hold out until the engine stops completely. Then, PUSH THE STOP CONTROL BACK TO THE RUN POSITION.

b) With the engine stopped, it is necessary to turn off the keyswitch. If you fail to do this, the panel remains energized and the electric fuel pump continues to run. This oversight results in a dead battery.

c) While an engine alarm buzzer is provided to warn the operator if this happens, the best precaution is always to remove the key.

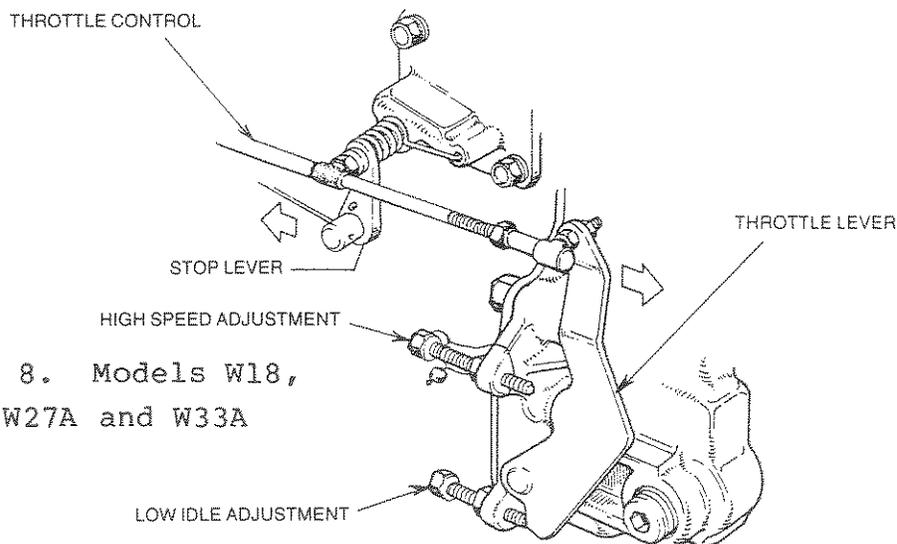


Figure 8. Models W18,
W21A, W27A and W33A

CAUTIONS ON STARTING AND OPERATION

1. Normal Starting

Follow the procedures below for routine starting of your engine.

- a) Check the engine and transmission lubricant levels and fill if necessary.
- b) Insure that you have sufficient fuel. Keep tank as full as possible.
- c) Check cooling water level, and fill if necessary.
NOTE: Check for leaks of water or oil, particularly when signs of such leaks are found on the bottom of the engine or in the drip tray.
- d) Start the engine in accordance with the procedures given on the preceding pages.
- e) Allow the engine to warm up to 140° - 150° F before placing the engine under heavy load.

2. Starting Under Cold Conditions

The following three adverse conditions occur as the atmospheric temperature drops dramatically, and the engine must, under such conditions, be started by taking steps described below:

- a) LUBRICATING OIL TURNS VISCOUS - Make certain that viscosity -(SAE#)-is proper for the prevailing atmospheric temperature. (Study page 13).
- b) VOLTAGE ACROSS BATTERY TERMINALS DROPS - Check that the battery is fully charged.
- c) THE TEMPERATURE OF INTAKE AIR IS LOW AND COMPRESSION TEMPERATURE DOES NOT RISE ENOUGH - Allow the glow plug to operate sufficiently to aid starting. (See table on page 8.)

3. Cautions During Operation

- a) Confirm that the oil pressure is normal during normal operation.
- b) Confirm that exhaust gas is as follows:
 - * While engine is cold.....White smoke
 - * When the engine grows warm.....Almost smokeless
 - * When the engine is overloaded.....Some black smoke
- c) Check for abnormal noise such as knocking, friction or leaking sounds, vibration and blow-back sounds. Investigate and correct.
- d) Check for leaks of fuel, lubricant and coolant.
- e) A knocking sound is normal while the engine is cold, during quick acceleration and at idle. This is produced by the combustion of diesel fuel in the cylinders under compression as the cylinder temperature rises to normal operating range. This combustion is better regulated and more efficient, producing less noise.

REQUIREMENTS FOR PROPER OPERATION

LUBRICATION SYSTEM

1. 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 prepared by well-known makers is recommended. The oil selected should be used thereafter.

2. Engine Oil Viscosity (S.A.E.#)

Use oil having viscosity best suited to the atmospheric temperature. Use of an all-season oil SAE10W-30 with minimum viscosity change under different temperatures is suggested.

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

NOTE: Do not use engine lube oil with an SAE# greater than #30 in generator engines.

3. Oil Pressure

The oil pressure during operation of the engine is indicated by the oil pressure gauge.

During normal operation.....Oil pressure will range between 40 and 70 PSI.

At idle speed.....20 - 35 P.S.I.

At the time of cranking.....Pressure will rise proportionately with speed.

4. Engine Oil Change (to include filter)

To renew engine oil, discharge old oil through the sump drain hose attached at front of engine while engine is still warm.

Drain old oil completely, replace the hose, plug the end securely. Proceed to Step #5 (oil filter change) before completing step #4. Add fresh oil through the oil filler cap on the valve cover or side oil filler on some models. After refilling oil, idle the engine for several minutes and stop. Then check the quantity of oil by the oil dip stick. Fill to, but not over, the high mark on the dipstick. Always observe old oil as it is removed. A yellow/grey emulsion indicates presence of water in the oil. While this condition is rare, it does require prompt attention to prevent serious damage. Call a competent mechanic.

5. Replacement of Oil Filter
(See Figure 9)

When removing the used filter, cover over with a plastic bag. This will allow both filter element and spilled oil to be collected cleanly without spilling oil in the bilge.

Being a replaceable cartridge type, the oil filter requires no cleaning inside. In installing the oil filter element, apply engine oil thinly onto the O-ring, and then tighten it by hand firmly.

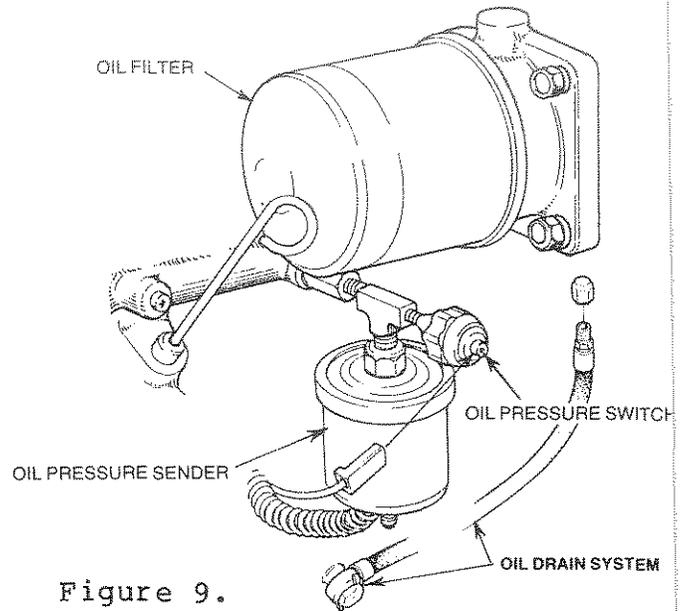


Figure 9.
Oil Filter and Oil Drain System

Note A: Generic filters are not recommended since the material standard or diameters of important items might be entirely different from genuine parts.

Note B: Immediately after filter change and oil fill, run engine to ensure that oil pressure is normal and that there are no oil leaks.

FUEL SYSTEM

1. Diesel Fuel

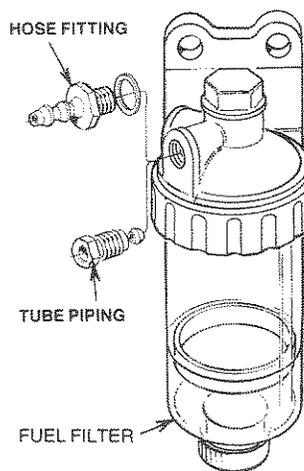
USE #2 DIESEL FUEL. NEVER USE KEROSENE OR HOME HEATING OIL.

In cold weather particularly, water vapor is produced by condensation when air is present in the fuel tank. The tank, therefore, should be kept full as much as possible.

The fuel tank, furthermore, needs to be kept completely free of dirt and water.

2. Fuel Filter

It is required that a primary fuel filter (See Figure 10) of the water entrapment type be installed between the fuel tank and the engine. Such a filter is available under Part #32974 from your local Westerbeke representative or your boat builder. This filter, adapted for boat builder use, comes complete with fittings for either hose or metal tubing. Mount in an accessible place, inspect often and drain off any accumulated water and debris.



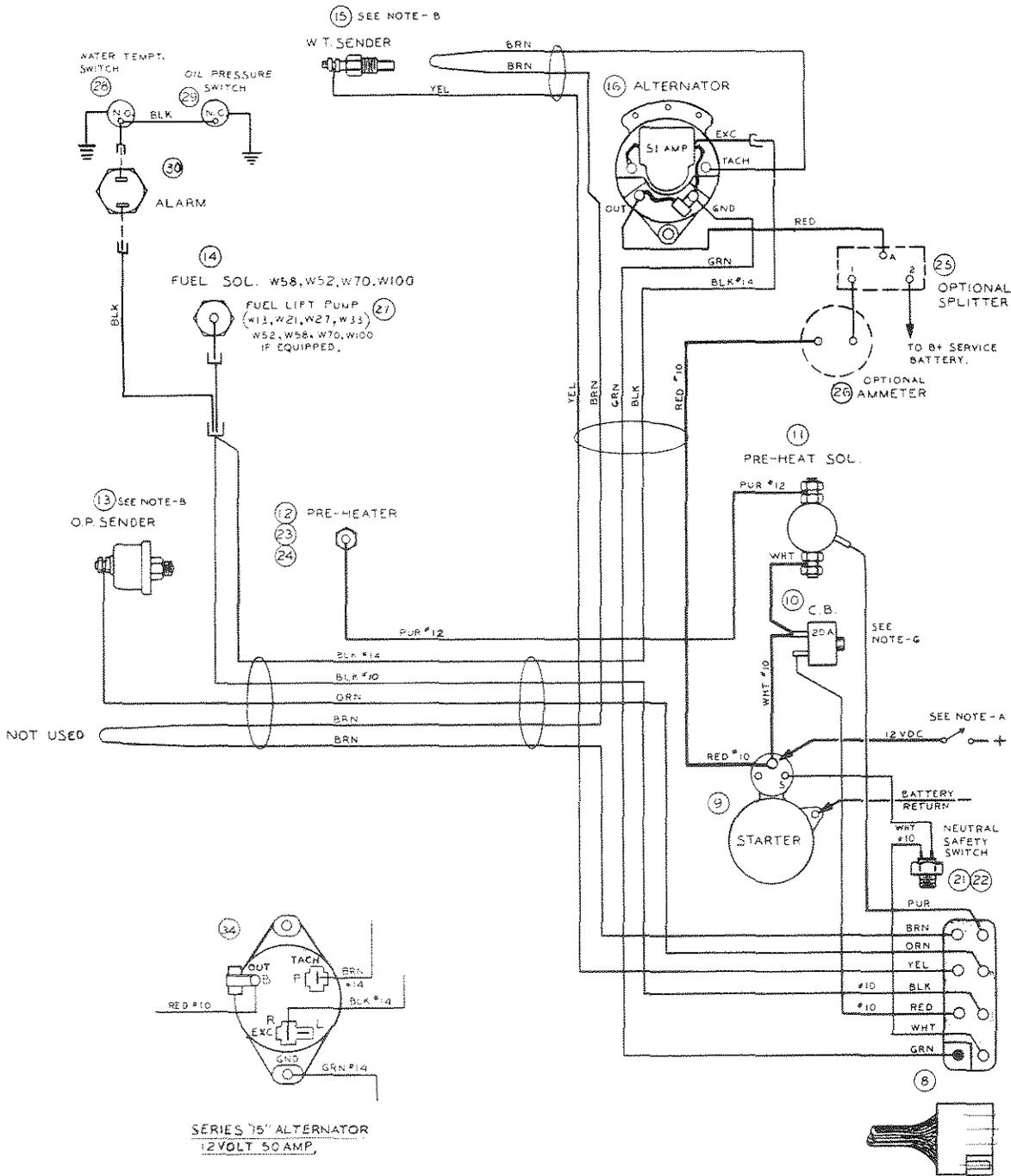
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Installation Instructions

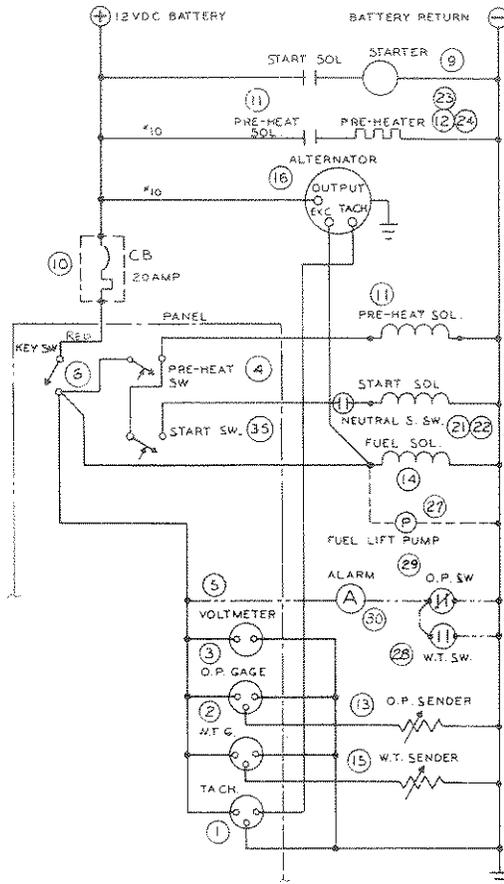
1. Bolt Sedimentator/Water Trap securely to an accessible structure so positioned that a receptacle to catch drainage can be placed under.
2. If fuel is to be piped with copper or Bundy tubing, use nuts and ferrules provided. Be sure the tubing projects 1/4 inch through the ferrule before tightening 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 Sedimentator. 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 system.
6. Energize fuel pump to refill bowl.

Figure 10.
Sedimentator/Water Trap (#32974)

Figure II.
Marine Engine Wiring Diagram



Schematic Diagram



NOTES:

NOTES ON BUILDER/OWNER'S RESPONSIBILITY.

- (A) AN ON-OFF SWITCH MUST BE INSTALLED IN THIS LINE TO DISCONNECT THE STARTER CIRCUIT FROM THE BATTERY IN AN EMERGENCY & WHEN LEAVING THE BOAT. 12VOLT DIESEL ENGINE STARTERS TYPICALLY DRAW 200 TO 300 AMPS WHEN CRANKING. THE DURATION OF INDIVIDUAL CRANKING CYCLES SHOULD NOT EXCEED 30 SECONDS. A SWITCH WITH CONTINUOUS RATING OF 175 AMPS AT 12 VDC WILL NORMALLY SERVE THESE FUNCTIONS, BUT SUCH A SWITCH MUST NEVER BE USED TO MAKE THE STARTER CIRCUIT.

OTHER NOTES:

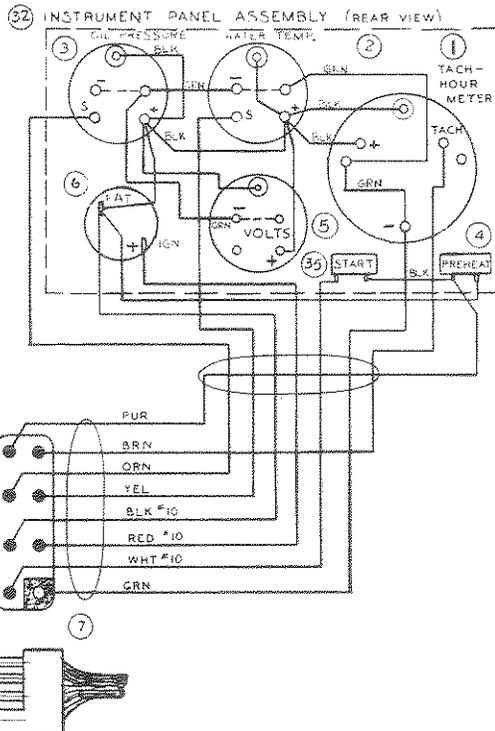
- (B) WARNING ; SENDER CONNECTION ; CONTACT WITH B+ MAY DAMAGE SENDER.
 (C) ALL RETURNS ARE THROUGH ENGINE BLOCK.
 (D) FOR WIRING OF AUXILIARY ALTERNATORS SEE THE FOLLOWING DIAGRAMS
 MOTOROLA 85 AMP, 11232
 MOTOROLA 120 AMP, 11231
 LEECE-NEVILLE 53 AMP, 16385
 LEECE-NEVILLE 105 AMP, 16614

- (E) IF ADDITIONAL PRESSURE SWITCHES ARE REQ'D TO START BOAT ACCESSORIES, A FLEXIBLE HOSE MUST BE RUN FROM THE OIL PRESSURE MANIFOLD TO A NEARBY BULKHEAD AND ALL PRESSURE SWITCHES MOUNTED AT THE BULKHEAD.

- (F) APPLY SILASTIC OR TIGHT WOUND PLASTIC/SPICE ELECTRICAL TAPE AROUND CONNECTORS CONNECTED.

- (G) CAUTION:

THIS PRODUCT IS PROTECTED BY A MANUAL RESET CIRCUIT BREAKER LOCATED NEAR THE STARTER AND AS CLOSE TO THE SOURCE OF CURRENT AS POSSIBLE. EXCESSIVE CURRENT DRAIN ANYWHERE IN THE INSTRUMENT PANEL, WIRING, OR ENGINE WILL CAUSE THE BREAKER TO TRIP. IN THIS EVENT, MOST ENGINE MODELS WILL SHUT DOWN BECAUSE THE OPENED BREAKER DISCONNECTS THEIR FUEL SUPPLY. THEREFORE THE BUILDER/OWNER MUST BE SURE THAT THE INSTRUMENT PANEL, WIRING AND ENGINE ARE INSTALLED TO PREVENT CONTACT BETWEEN ELECTRICAL DEVICES AND SALT WATER.



ITEM	DESCRIPTION	QTY	ASSY	OPTION																									
35	SWITCH, START	1																											
34	ALTERNATOR, 12V. 50A.	1																											
33	PANEL, LESS INSTRUMENTS	1																											
32	PANEL, COMPLETE	1	1																										
31		1																											
30	ALARM	1																											
29	OIL PRESS. SW. N.C.	1																											
28	WATER TEMP. SW. N.O.	1																											
27	FUEL LIFT PUMP	1																											
26	AMMETER (OPTIONAL)	1																											
25	SPLITTER (OPTIONAL)	1																											
24	GLOW PLUGS W30EVED AERCH	1																											
23	GLOW PLUGS WAO	1																											
22	NEUTRAL SAFETY SW. PARAGON	1																											
21	NEUTRAL SAFETY SW. WARNER	1																											
20	PANEL, LESS INSTRUMENTS	1																											
19	PANEL, COMPLETE	1	1																										
18	SUPPRESSION KIT ALT.	1																											
17	TACH. KIT ALTERNATOR	1																											
16	ALTERNATOR, 51 A.	1																											
15	SENDER, WATER TEMP.	1																											
14	SOLENOID, FUEL	1																											
13	SENDER, OIL PRESSURE	1																											
12	PRE-HEATER (W38)	4																											
11	SOLENOID, PRE-HEAT	1																											
10	CIRCUIT BREAKER 20AMP	1																											
9	STARTER, MARINE ENGINE	1																											
8	HARNES, ENGINE	1	1																										
7	HARNES, PANEL	1	1																										
6	KEY SWITCH, IGNITION	1																											
5	VOLTMETER	1																											
4	SWITCH, PRE-HEAT	1																											
3	OIL PRESSURE GAUGE	1																											
2	WATER TEMP. GAUGE	1																											
1	TACHOMETER	1																											
<table border="1"> <thead> <tr> <th>ITEM</th> <th>DESCRIPTION</th> <th>QTY</th> <th>ASSY</th> <th>OPTION</th> </tr> </thead> <tbody> <tr> <td></td> <td>J.H. WESTERBEKE CORP. AYON, MA 02322</td> <td></td> <td></td> <td></td> </tr> <tr> <td>~</td> <td>NONE</td> <td></td> <td></td> <td></td> </tr> <tr> <td>~</td> <td>WIRE WARRIOR DIESEL ENG. WIRING DIA. FOR VOLTMETER, KEY SW. & TWO PUSHBUTTONS.</td> <td></td> <td></td> <td></td> </tr> <tr> <td>~</td> <td>2-22-84</td> <td></td> <td>33685</td> <td></td> </tr> </tbody> </table>					ITEM	DESCRIPTION	QTY	ASSY	OPTION		J.H. WESTERBEKE CORP. AYON, MA 02322				~	NONE				~	WIRE WARRIOR DIESEL ENG. WIRING DIA. FOR VOLTMETER, KEY SW. & TWO PUSHBUTTONS.				~	2-22-84		33685	
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If a water trap type fuel filter (see page 14) is not interposed between the fuel tank and engine lift pump, any entrained water 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 injection pump and injectors with damaging and expensive results. IT IS WELL TO REMEMBER THAT WATER DAMAGE TO THE FUEL SYSTEM IS NOT COVERED UNDER THE WESTERBEKE WARRANTY.

While many boat builders do supply a water trap/filter, there are some who do not. It is to prevent such omission that Westerbeke offers a sedimenter/water trap/filter as a desirable optional extra at moderate cost. It is supplied with fittings for either hose piping or metal tube piping.

All of the engine/generator models covered by this manual have two replaceable fuel filters in the engine mounted fuel system. One is in the base of the electric fuel pump and the other in the filter assembly located just after the discharge side of the electric fuel pump. These are shown on Figure 12 showing a typical "A" Series fuel system.

The self-bleeding feature of these models fuel systems allows for easy servicing of these filters. Simply remove and replace the filter elements. (Take care to catch any fuel when removing filter elements.) Turn your keyswitch ON and allow the electric fuel pump to operate for 20 - 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 fails to start, stop and wait a few moments, then repeat the bleed procedure as above.

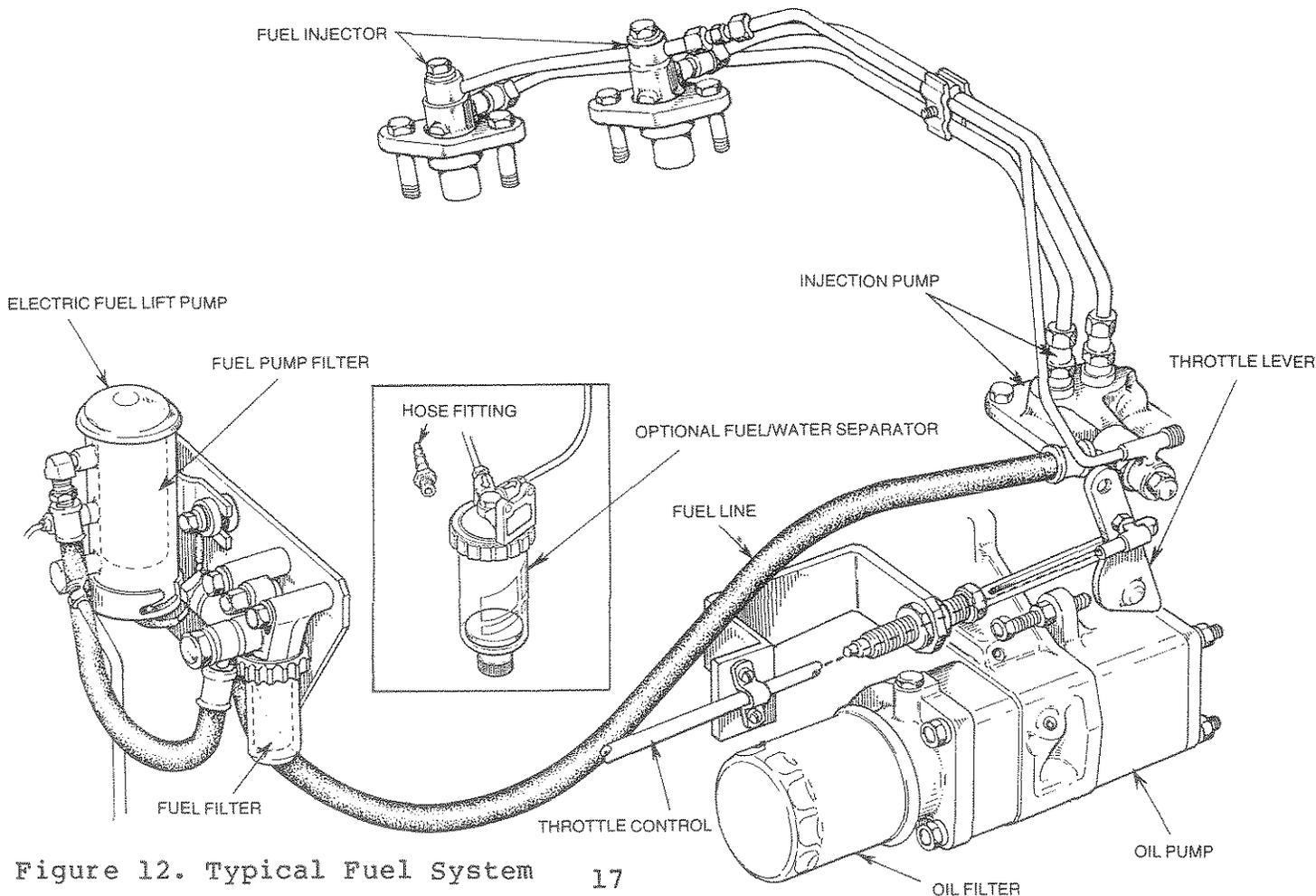


Figure 12. Typical Fuel System 17

3. Notes on Fuel System

See Figure 12 for a typical illustration of a fuel system for these engines. It is also illustrative of the self-bleeding and priming system used by Westerbeke.

The Westerbeke self-bleeding fuel system is semi-automatic in operation. 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 will supply fuel system washers for All "A" series models.

If a leak should develop at a fuel banjo or sealing washer location and cannot be remedied by a simple tightening of the fitting, replace the washers.

4. Replacing Filter Elements

After the first 50 hours of operation, remove, discard and replace the fuel filter elements in the electric fuel pump and engine mounted filter assembly.

Install new sealing gasket or "O" rings supplied with the replacement filter elements.

After the first 50 hour change, the change period should be every 200 hours or once per season.

5. Fuel Injection Pump

The fuel injection pump 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.

To obtain long and satisfactory service life from of your injection pump:

1. Always use the correct grade of fuel - #2 Diesel.
2. Filter the fuel to remove any water or impurities.
3. Clean and renew the fuel filters regularly.

COOLING SYSTEM

1. Cooling Water

As cooling water, use soft water with few impurities such as tap water (potable water) or rainwater. Never use hard water or foul water. Use of hard water or water containing much impurity will lead to collection of scale in the engine and heat exchanger with resultant decline in cooling efficiency.

2. Antifreeze

It is recommended that a freshwater and antifreeze mixture be used year round. Use an antifreeze that is compatible with aluminum cooling system components. Keep in mind that water when it freezes expands to break the engine heat exchanger and the engine block. So maintain an antifreeze mixture in the cooling system year round. Do not be caught short.

*Antifreeze of poor quality or without rust inhibitor will cause corrosion of the cooling system. Always use antifreeze prepared by a reliable maker. Never use it mixed with antifreeze of a different brand.

*Make sure that the cooling system of the engine is cleaned well before adding antifreeze.

*Recommended antifreeze for year round use is ZEREX or PRESTONE with rust inhibitor.

*Mix the antifreeze and fresh water thoroughly before adding it to the cooling system.

ANTIFREEZE ADDITION DATA

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

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

3. Fresh Water Cooling System

The system consists of a belt driven circulating pump and a heat exchanger. The freshwater/antifreeze mixture is circulated through the engine block where it picks up heat it and passes through a thermostat which maintains engine operating temperature. It then flows through the exhaust manifold picking up more heat and passes through the heat exchanger where it is cooled and then returned to the block to repeat its path.

Raw water is pumped through the heat exchanger by a belt or engine driven pump. It picks up heat from the fresh water and then is discharged into the exhaust muffler with exhaust gases where it is discharged overboard through exhaust gas pressure.

The total system is very reliable and requires only a daily check of the water level in the system plus routine checks of hose clamps, fittings, drive belts, and raw water pump.

A zinc anode is located in the raw water side of the engine heat exchanger. This anode will deteriorate from electrolysis action taking place in the raw water circuit. This anode should be checked monthly. Cleaned and replaced as needed. An important component of the raw water circuit is the raw water pump. Inspect this pump seasonally for wear and impeller deterioration. Repair or replace components as needed.

It is recommended, therefore, that zinc anodes, water pump belt(s), raw water pump repair kit and raw water pump impeller kit be maintained on board for unexpected field repairs. These items can be purchased/ordered through local dealers. Refer to your models parts list for correct item part numbers.

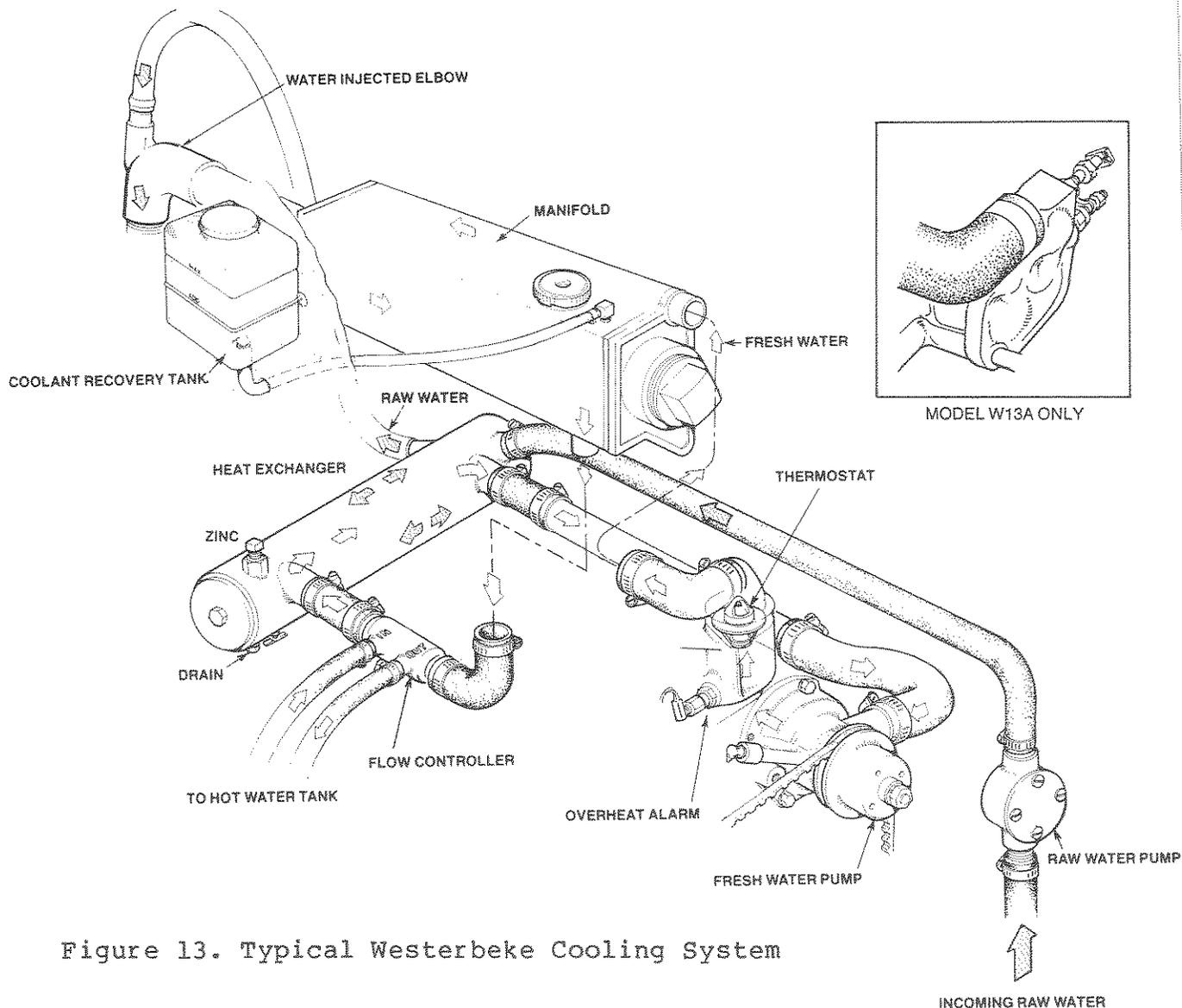


Figure 13. Typical Westerbeke Cooling System

4. Alternator Belt and Water Pump Tension (See Figure 14)

The belts are properly tensioned when they deflect 10 to 12 mm (0.39 to 0.47 in.) as they are de-pressed with a finger between the pulley and pulley of the long distance side. Excessive tension can cause quick wear of the belt and bearings of the water pump and the alternator. Excessive slackness or presence of oil on the belt, on the other hand, can lead to engine overheating, insufficient charging due to a slipping alternator belt and rapid wear of the belt.

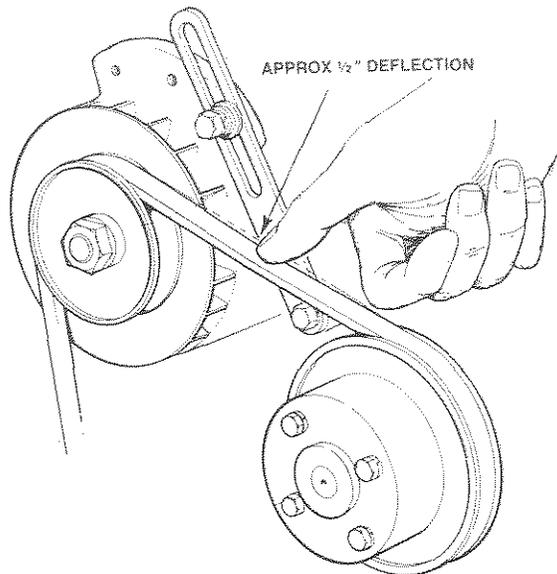


Figure 14.
Alternator Belt and Water Pump Tension

CAUTION:

Never attempt to adjust tension of any drive belt while the engine is in operation.

WIRING DIAGRAM

Your engine has a 12 volt DC start/run circuit. A pictorial schematic of this is illustrated in Figure 11. Study it and learn to understand how the system functions.

For installing electrical parts, connect them correctly by referring to the electrical diagram and at the same time check for damaged wire sheathing and confirm that grounding is provided properly. Care must always be taken while working on the electrical system.

NEVER SHUT THE ENGINE BATTERY SWITCH OFF WHILE THE ENGINE IS RUNNING. DAMAGE TO THE BATTERY CHARGING ALTERNATOR WILL RESULT SHOULD THIS BE DONE.

Figure 15 at right shows a typical engine Flow Control mechanism and its bypass connection for normal use. If it is desired to connect a hot water heater, remove the bypass hose altogether as instructed on the following page. Study these instructions carefully.

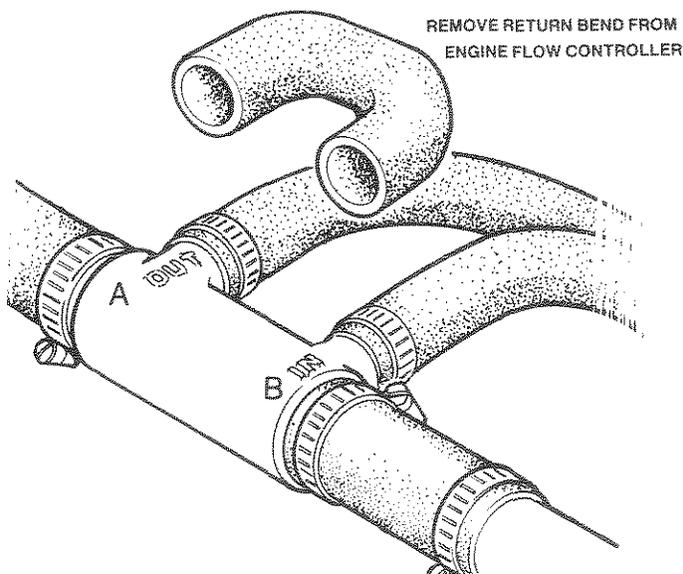


Figure 15. Flow Control Mechanism

All engines come complete a with Flow Control which, when properly connected to a heater tank, produces domestic hot water from waste engine heat.

Principle: With the bypass hose removed, there remains 2 connecting points A and B for 7/8 I.D. hose to and from the water heater. These connections assure a flow of hot water through the heater at all times and yet preclude excessive restriction of engine cooling water flow caused by the heater - all simply and automatically.

Installation: The heater should be mounted conveniently close to the engine, either in high or low position, so that connecting hoses from heater to engine can run in a reasonably direct line without loops which might entrap air. Connection Point A on the Flow Control housing should connect to the lower of the two connections on the water heater while the upper connection on the heater returns to B, nearest to the heat exchanger.

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 should 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 and avoid this problem. Trapped air will stop water circulation from the engine flow control to or from the heater. If any portion of the engine cooling water circuit to or from the heater rises above the engine's own pressure cap, then the pressurized remote expansion tank must be installed in the circuit to become the highest point. The tank kit Part Number is 24177. Install the remote expansion tank in a convenient location such as a sail locker for ease of checking fresh water coolant level. Connect the remote tank with a single hose 5/8 I.D. - 7/8 I.D. to a tee fitting directly at the connection on the hot water heater that is the return to the flow-control. The cap on the engine mounted expansion tank/manifold 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 up and out. Figure 16 below illustrates domestic water heater connections when installed below or above the engine manifold pressure cap.

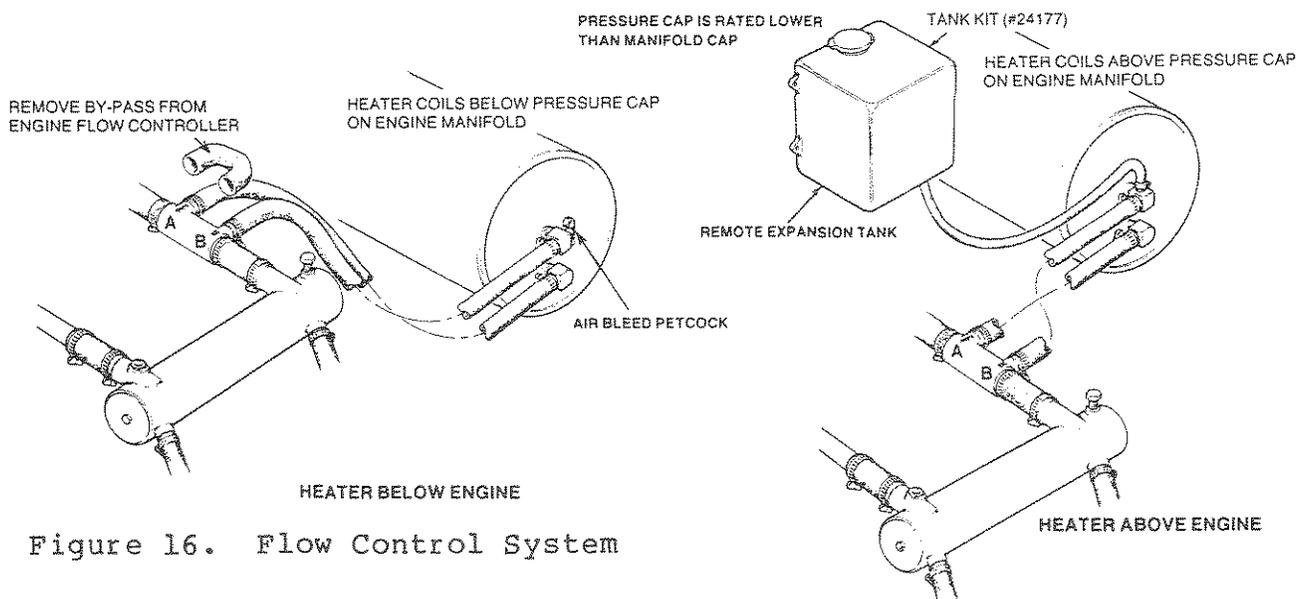


Figure 16. Flow Control System

RECOMMENDED MAINTENANCE SERVICE

Check and service your engine at specified intervals to maintain it in its best conditions and permit it to perform as it should. As for those asterisked items, it is suggested that you have them performed by an authorized distributor or dealer.

1. Daily Inspection Before Use

- A. Check engine oil level and add as needed.

No refill is required if the level is near the upper limit line of the gauge.

- B. Check fresh water coolant levels.

Refill up to the ADD line on coolant recovery tank.

- C. Check transmission lubricant level and refill as needed. Check your fuel supply. Check filter/water separators.

- D. Visually check engine for loose parts (alternator belt and bolts etc.), damage and leaks. Correct as required.

- E. Check operation of gauges and meters.

After starting your engine, check oil pressure, water temperature and voltage reading.

- F. Check for abnormality with exhaust gas, noise and vibration.

2. Servicing Following Initial 50 Hours Of Operation

- A. Renewal of engine oil.

- B. Replacement of lube and fuel filters (two fuel filters).

- *C. Tightening of bolts and nuts (torque cylinder head hold-down bolts).

- D. Change transmission lubricant (HBW models initially change at 25 hours).

- E. Adjust engine idle speed if needed.

- *F. Adjustment of valve clearance.

3. Servicing At Every 100 Hours Of Operation

- A. Renewal of engine oil.

- B. Replacement of oil filter.

4. Servicing At Every 200 Hours Of Operation

TRANSMISSIONS

All HBW models turn right hand propellers.
 All HBW models have their own oil sumps and dipsticks.
 All HBW models use ATF lubricant.
 All HBW models should be shifted into gear in one swift motion - not allowed to slip in slowly.

Control Of Gearbox (See Figure 18)

1. The gearbox is suitable for single lever remote control using 33C cable.
2. The cable should attach at right angles to the actuating lever using the cable bracket supplied.
3. Both gear box lever and remote lever must be in neutral position when cable is attached so that travel of gearbox lever will be equal forward or reverse.
4. Check that actuating lever hub does not touch cover plate hub. Maintain at least 0.5 mm (0.002") clearance.
5. Over travel of the actuating lever does no harm. However, if the travel is too short to give full engagement, premature wear, excessive heat generation and gear failure may result.

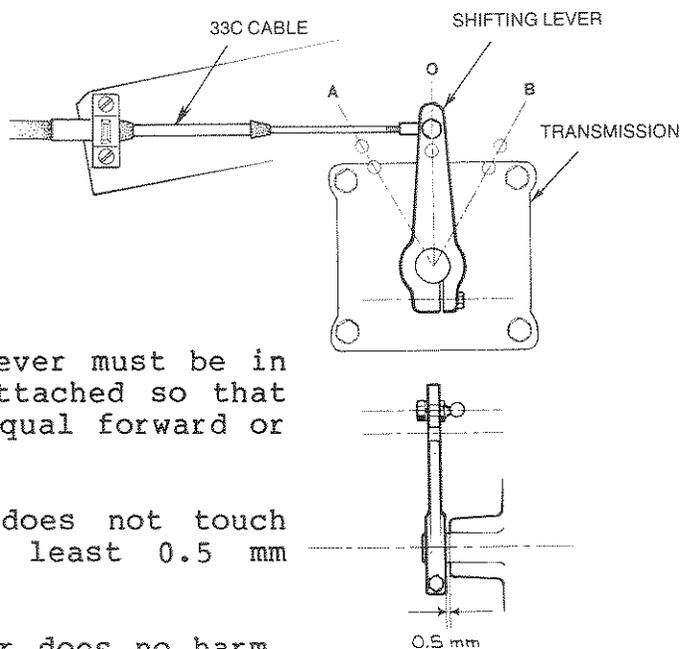


Figure 18.
Control of
Gear box

6. The position of the cover plate underneath the actuating lever is factory adjusted to ensure equal lever travel from neutral to A and B. **DO NOT LOOSEN THE CAPSCREWS HOLDING THIS ASSEMBLY.** Doing this voids transmission warranty.
7. Fill gearbox with automatic transmission fluid to the level indicated by the dipstick mark (See Figure 19).
8. Note that to check oil level, the dipstick drops on the housing. It does not screw in.
9. The HBW gear box can be free-wheeled in Neutral. To stop propeller shaft rotation while under sail, place the gear into Reverse.

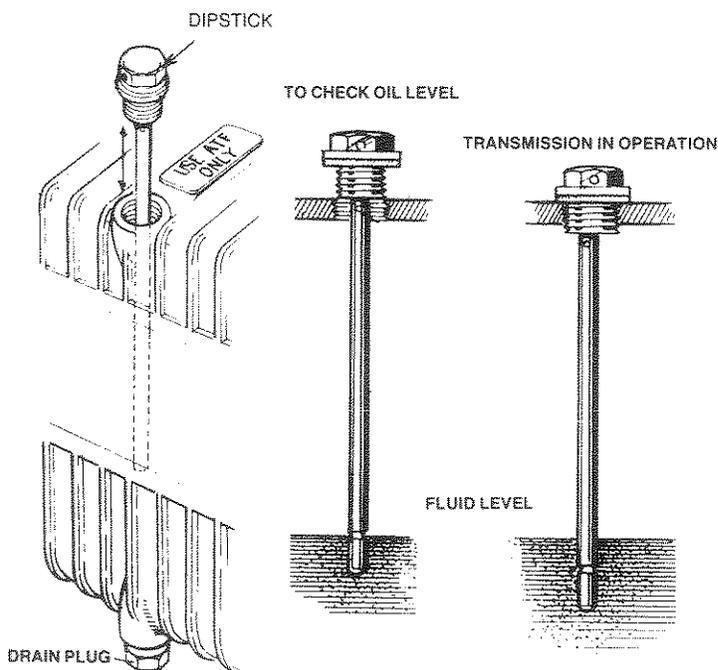


Figure 19. Dipstick Oil Levels

Each engine model may be fitted with a variety of transmission options. For ratio and/or type, see table below.

Model	1.5:1	2:1	2.5:1	2:1 V-Drive
W13A	HBW-100	BW-3 HBW-50	HBW-50	
W18	HBW-100	BW-7 HBW-50	HBW-100	HBW-150V
W21A	HBW-100	BW-7 HBW-50	HBW-100	HBW-150V
W27A	HBW-100	BW-7 HBW-100	HBW-150	HBW-150V
W33A	HBW-100	BW-7 HBW-100	HBW-150	HBW-150V
Rotation-----Right Hand-----				

These transmissions have their own oil sumps and dipsticks. "S" and "HBW" units use ATF lubricant, while "BW" units may use either #20 or #30 S.A.E. engine oil.

The transmissions, their dipsticks and markings are illustrated in Figure 20 below. For dipsticks that are threaded in the case, measure oil by dropping dipstick on the case. Do not screw in.

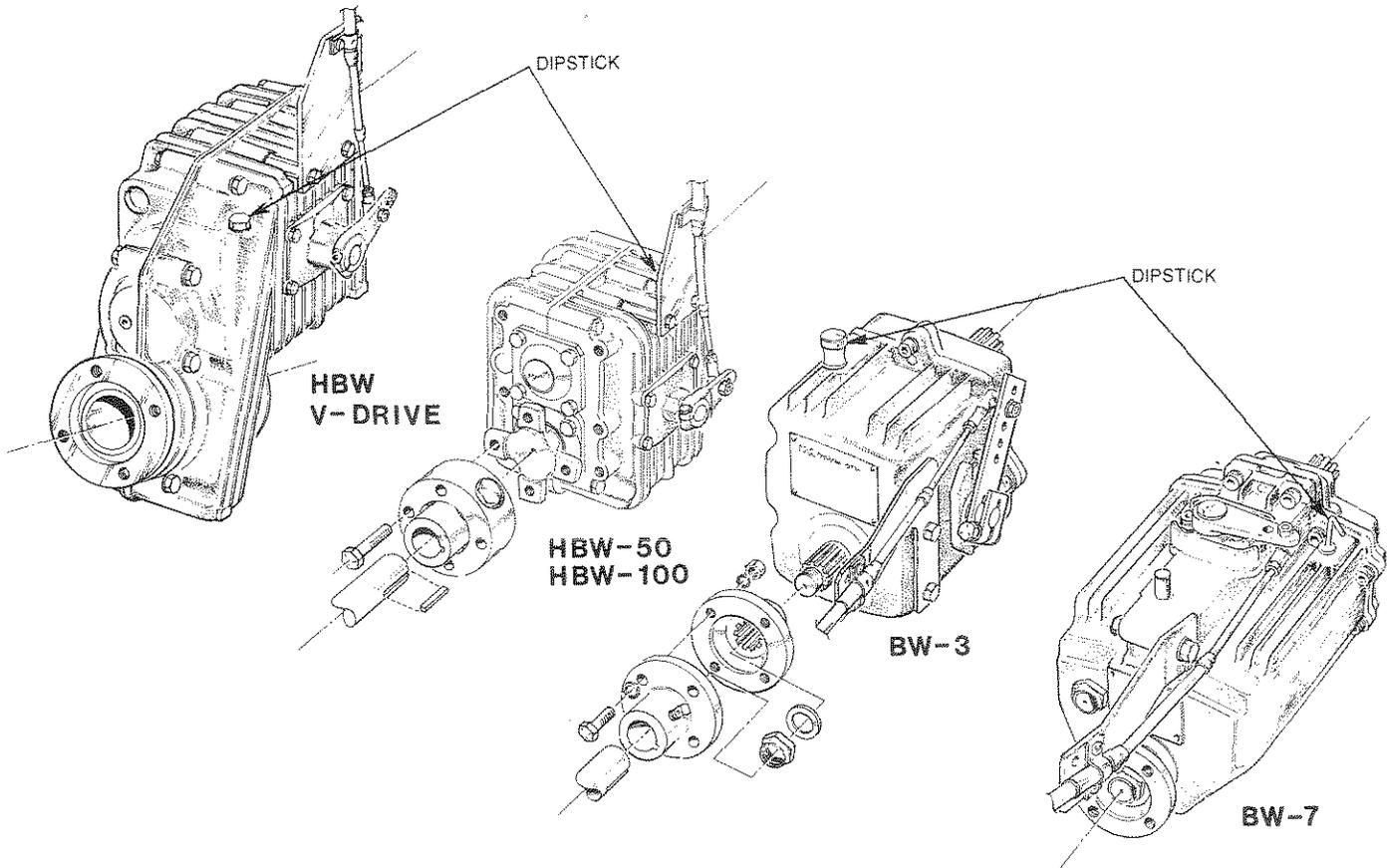
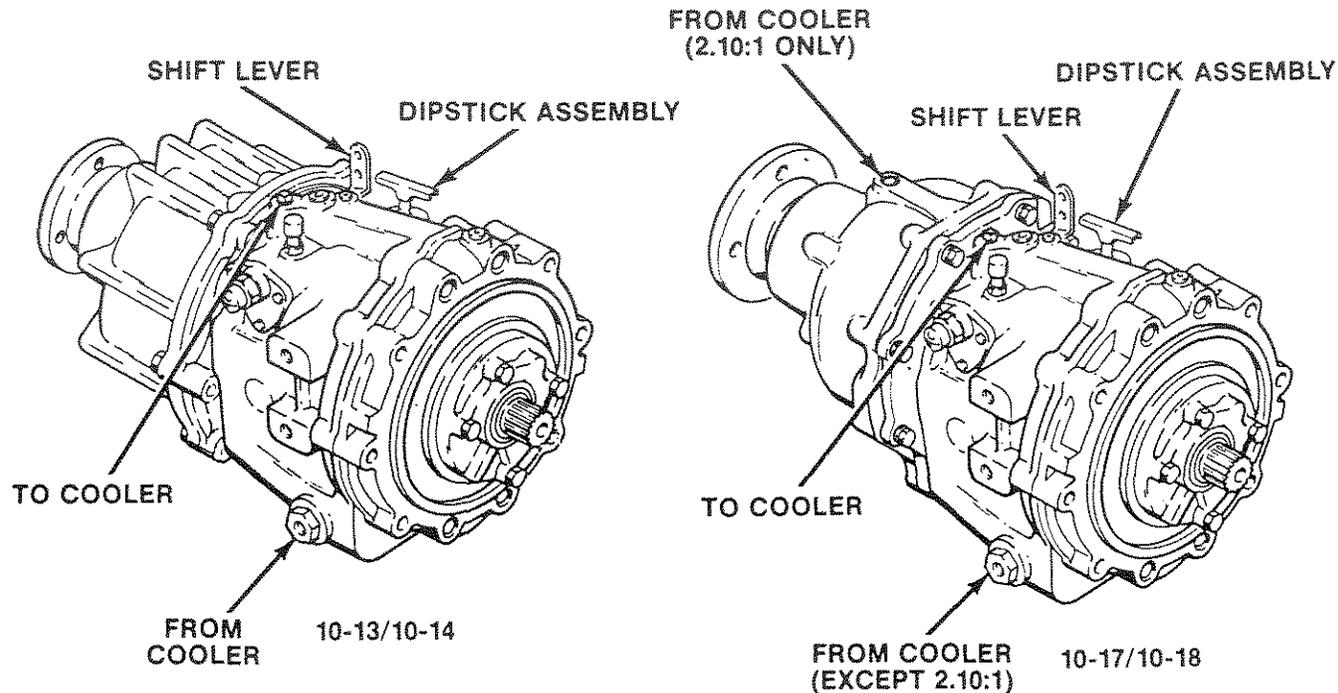


Figure 20. Transmission

WARNER HYDRAULIC TRANSMISSIONS



1. CONTROL LEVER POSITION

The position of the control lever on transmission when in forward should be shifted to the point where it covers the letter "F" on the case casting, and is located in its proper position by the poppet ball. The Warranty is cancelled if the shift lever poppet spring and/or ball is permanently removed, or if the the control lever is changed in any manner, or repositioned, or if linkage between remote control and transmission shift lever does not have sufficient travel in both directions. This does not apply to transmissions equipped with Warner Gear electrical shift control.

2. LUBRICATION

The properties of the oil used in the transmission are extremely important to the proper function of the hydraulic system. Therefore, it is extremely important that the recommended oil, automatic transmission fluid (ATF), Type A or Dexron II be used.

NOTE: Be sure the cooler is properly installed when required and the transmission contains oil before cranking or starting the engine.

3. FILLING AND CHECKING THE HYDRAULIC SYSTEM

The oil level should be maintained at the full mark on the dipstick. Check oil level prior to starting engine. Check daily before starting engine. The hydraulic circuit includes the transmission, oil cooler, cooler lines and any gauge lines connected to the circuit. The complete hydraulic circuit must be filled when filling the transmission and this requires purging the system of air before the oil level check can be made. The air will be purged from the system if the oil level is maintained above the pump suction opening while the engine is running at approximately 1500 RPM. The presence of air bubbles on the dipstick indicates that the system has not been purged of air.

New applications or a problem installation should be checked to insure that the oil does not drain back into the transmission from the cooler and cooler lines. Check the oil level for this drain back check only, immediately after the engine has been shut off and again after the engine has been stopped for more than one hour (overnight is excellent). A noticeable increase in the oil level after this waiting period indicates that the oil is draining from the cooler and cooler lines. The external plumbing should be changed to prevent any drain back.

4. STARTING ENGINE

Move the shift lever to the center position where the spring-loaded ball enters the chamfered hole in the side of the shift lever and properly locates lever in neutral position before starting engine.

5. SHIFTING

Shifts from any selector position to any other selector position may be made at any time and in any order if the engine speed is below 1000 RPM; however, it is recommended that all shifts be made at the lowest feasible engine speed. Move the shift lever to the extreme forward position where the spring loaded ball enters the chamfered hole in the side of the shift lever and properly locates lever in forward position.

Move transmission shift lever to the extreme rearward position where the spring-loaded ball enters the chamfered hole in the side of the shift lever and properly locates it in the reverse position.

6. FREEWHEELING

Under sail with the propeller turning, or at trolling speeds with one of two engines shut down, the design of the gear maintains adequate cooling and lubrication. Attempting to place the gear into forward or reverse while under sail to stop propeller shaft rotation will have no effect. To stop propeller shaft rotation while under sail, a mechanical shaft brake would be needed.

7. COOLING PROBLEMS

Water passages inside of the cooler will sometimes become clogged, and this will reduce cooling capacity and cause overpressuring. Back flushing of the cooler will sometimes help to flush the foreign material from the cooler passages. The cooler and hose should be thoroughly flushed or replaced in the event a failure has occurred. Metallic particles from the failure tend to collect in the case of the cooler and gradually flow back into the lube system. Replace oil cooler to prevent contamination of the new transmission.

Water hoses may collapse and reduce or completely shut off all flow to the cooler. Collapsed hoses are usually caused by aging of the hoses or improper hose installation. Hose installation should be made with no sharp bends. Hoses should be routed so there is no possibility for engine shifting to cause hoses to pull loose or become pinched. A visual inspection of hoses while under way will sometimes allow detection of faulty hoses.

Reduction or complete loss of water flow can be caused by a faulty water pump. A rubber water pump impeller will sometimes fail and after such a failure the cooler passages may be restricted by the particles of rubber from the failed impeller. Water pump cavitation may be caused by improper or faulty plumbing or an air leak on the inlet side of the pump. The water pump may not prime itself or may lose its prime when inlet plumbing is not properly installed.

It is possible for cross leaks to occur inside the cooler, permitting oil to flow into the water or water flow into the oil. Checking transmission fluid levels at each days use will help spot such a happening, undetectable loss of fluid and/or emulsified fluid.

ROUTINE CHECKS AND MAINTENANCE

ANNUAL CHECKS

1. PROPELLER AND OUTPUT SHAFT ALIGNMENT: This check should also be made any time the propeller strikes a heavy object and after any accident where the boat is stopped suddenly. Shaft alignment should also be checked after the boat has been lifted by a hoist or moved on a trailer.
2. SHIFT LEVER POSITIONING: The selector controls must position the shift lever exactly in F, N and R selection positions with the ball poppet centered in the shift lever hole for each position.
3. BOLT TORQUE: Check all bolts for tightness.
4. COOLER CONNECTIONS: Check water lines, oil lines and connections for leakage. Make sure lines are securely fastened to prevent shifting.
5. CHANGING OIL: A seasonal oil change is recommended in pleasure boats. Work boats require more frequent changes. Change oil any time the oil becomes contaminated, changes color or becomes rancid smelling. Automatic transmission fluids (ATF), Type A is recommended for use.

DAILY CHECKS

1. Check transmission oil level.
2. Check for any signs of oil leakage in the bellhousing, at gasket sealing surfaces or at the output shaft oil seal.
3. A quick visual check of the general condition of the equipment may cause faulty equipment to be detected.
4. Listen for any unusual noises and investigate to determine the cause of any such noises.

Note: Low engine idle speed can produce drive damper chatter.

WINTER STORAGE

1. Drain water from transmission oil cooler. This will prevent freezing in cooler climates, and prevent harmful deposits from collecting.

GENERAL CHECKS

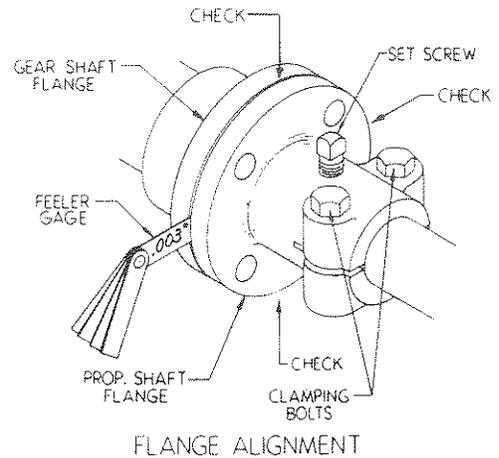
1. Check coupling alignment each time a transmission is replaced in the boat.

2. Check shift linkage adjustment to insure that the transmission shift lever is positioned so that the spring loaded ball enters the chamfered hole in the side of the shift lever.
3. Connect an oil cooler into the cooler circuit before cranking or starting the engine. Various cooler circuits have been used and the correct cooler connections should be found from service literature prior to making the cooler installation.
4. Use a cooler of sufficient size to insure proper cooling.
5. Check engine rotation and transmission pump setting and the propeller rotation prior to assembling the transmission to engine.
6. Check oil pressure and temperature when transmission function indicates that a problem exist.
7. Use the recommended fluid for filling the transmission.
8. Fill the transmission prior to starting the engine.
9. Check oil level immediately after the engine has been shut off.
10. Use a clean container for handling transmission fluid.
11. Replace cooler and lines after a transmission failure, prior to installing a new or rebuilt transmission.
12. Check fluid level at operating temperature.

WALTER V-DRIVES

FLANGE ALIGNMENT - DIRECT COUPLED MODELS

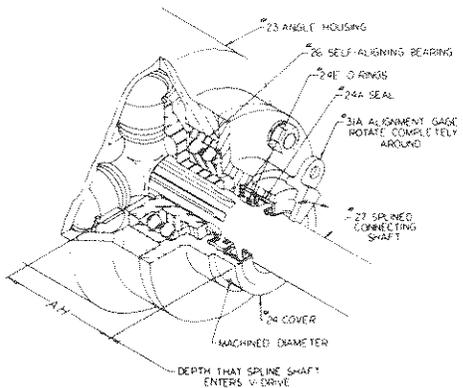
Install the propeller shaft flange on to the propeller shaft and tighten the two clamping bolts on the split hub (none on RV-10D). A self-locking set screw is provided for the propeller shaft flange. Spot drill the propeller shaft and then securely tighten the set screw. Many good installations are ruined by improper shaft flange alignment. Accurate alignment will ensure a smooth operating drive train and eliminate many problems that arise due to misalignment. Final alignment should not be attempted until the boat has been allowed to "settle" in the water. After the engine has been installed, adjust the mounts per manufacturer's instructions until the pilot diameters of the gear shaft flange and the propeller shaft flange engage freely. Butt the flange



faces together. Without rotating either flange, check with a feeler gauge in at least four places as shown in the illustration. If the maximum feeler gauge that can slip between the flange faces at any point is .003", the unit is properly aligned. If a thicker gauge can be inserted at any point, the engine must be readjusted until proper alignment is obtained. Turn the propeller shaft flange 1/4 of a turn without moving the gear shaft change. Try inserting the .003" feeler gauge as described above. The gap will not change if the propeller shaft is straight. If it increases, the shaft or flange is bent and must be removed and straightened. Rotate the propeller shaft flange in two more 1/4 turn increments and repeat the procedure. The pilot diameters must be rechecked to ensure that they still engage freely. Secure the two flanges together with the heat treated bolts and special high collared lockwashers supplied.

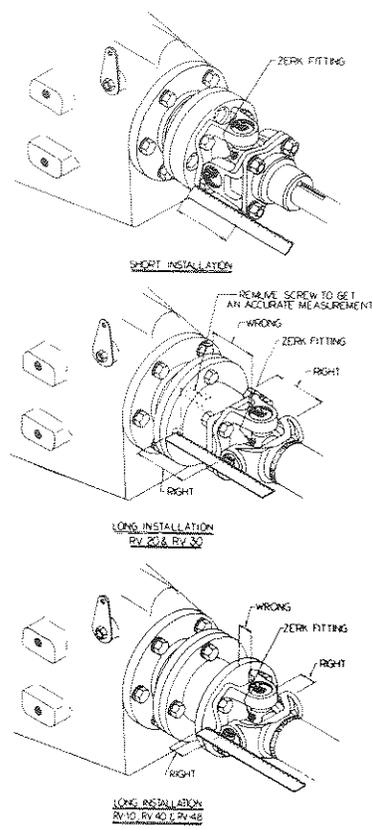
ENGINE ALIGNMENT - INDEPENDENT MODELS

The engine must be adjusted so that the alignment of the flexible joint is within 3°. An accurate steel rule should be used for this purpose as shown in the illustration. On short installations using a flexible joint assembly, the faces of the flexible joint must be parallel within 1/8". Measure this in at least four places around the diameter without rotating the assembly. With long installations using the #36 tubular drive shaft (also on all RV-10D's) the distance from the #33A spool adapter to the bores in the universal joint which is welded to the tubular shaft must be measured on both sides of the joint. Rotate the shaft exactly 1/4 of a turn and measure to the same joint. The four distances must be equal within 1/8". (Do not measure



to the joint end that is on the spool adapter. This distance will not vary with misalignment since the joint is bolted and cannot move.) Put the #31A alignment gauge on the machined diameter of the #24 cover and slide it completely around. It will indicate how the engine must be moved to center the spline shaft in the oil seal. Re-measure the joints to see if

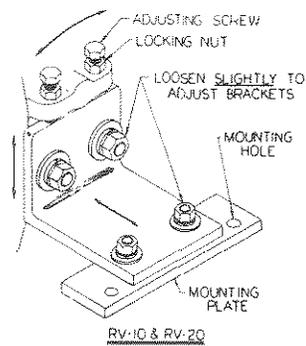
they are still parallel within 1/8". It is important that both alignments be checked thoroughly. It is possible for the spline shaft to be perfectly centered and the flexible joint to be out more than 3°. Premature failure of the #26 self-aligning bearing and seals may occur due to misalignment. The zerk fitting (located on the cross of the universal joint) should be greased with a light alemite lubricant. The above procedure should be repeated after the boat has been placed in operation. It is possible for the engine to slightly shift and settle, especially if it has rubber mounts.



FLANGE ALIGNMENT - INDEPENDENT MODELS

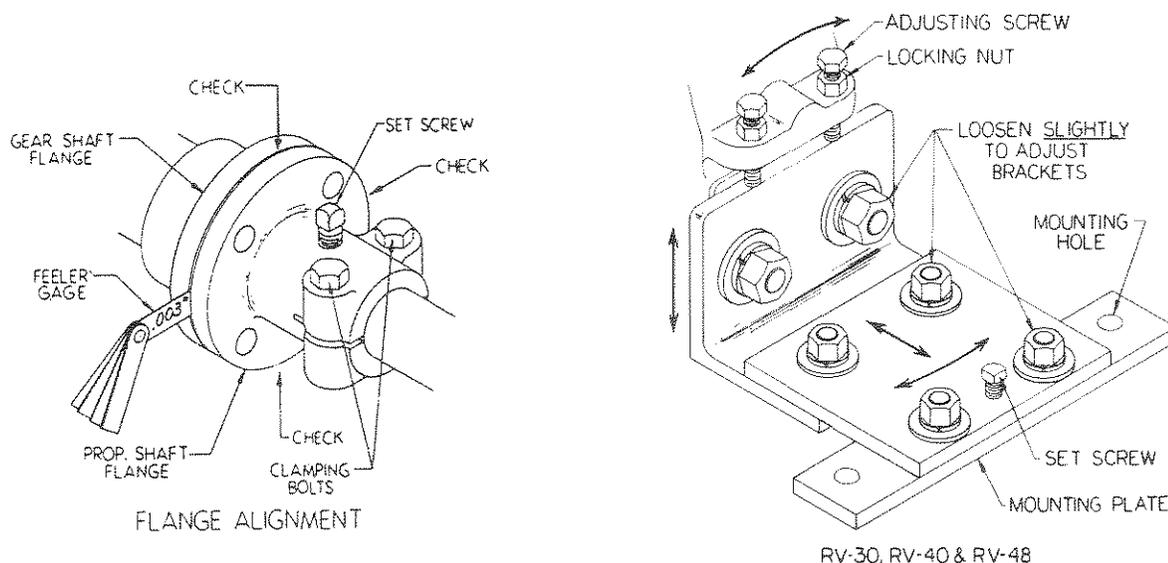
Install the propeller shaft flange on to the propeller shaft and tighten the two clamping bolts on the split hub (none on RV-10). A self-locking set screw is provided for the propeller shaft flange. Spot drill the propeller shaft and securely tighten the set screws.

All V-drives are supplied with 3-way adjustable mounting brackets (2-way on the RV-10 and RV-20) as standard equipment. The brackets must face downward as shown in the illustration to properly absorb propeller thrust. The mounting plates can be removed and reversed to fit wider engine bed centers. Before installing the V-drive, loosen all the nuts on the mounting brackets and check to see that the studs are in the center of the slots. Retighten the nuts. Place the V-drive on the engine bed, lining it up "by eye" to the propeller shaft flange as closely as possible. Firmly bolt it down through the holes provided in the mounting plates. Loosen the locking nuts on the adjusting screws. Slightly loosen the nuts on the mounting brackets just enough to be able to move the V-drive.



Many good installations are ruined by improper propeller shaft flange alignment. Accurate alignment will ensure a smooth operating drive train and eliminate many problems that arise due to misalign-

ment. Final alignment should not be attempted until the boat has been allowed to "settle" in the water. Adjust the V-drive until the pilot diameters of the gear shaft flange and the propeller shaft flange engage freely. Butt the flange faces together. Without rotating either flange, check with a feeler gauge in at least four places as shown in the illustration. If the maximum feeler gauge that can slip between the flange faces at any point is .003", the unit is properly aligned. If a thicker gauge can be inserted at any point, the V-drive must be readjusted until proper alignment is obtained. Turn the propeller shaft flange 1/4 of a turn without moving the gear shaft flange. Try inserting the .003" feeler gauge as described above. The gap will not change if the propeller shaft is straight. If it increases, the shaft or flange is bent and must be removed and straightened. Rotate the propeller shaft flange in two more 1/4 turn increments and repeat the procedure. The pilot diameters must be rechecked to ensure that they still engage freely. Tighten the nuts on the mounting brackets and the locking nuts on the adjusting screws. Remove the set screws from the brackets (none on RV-10 or RV-20), spot drill and securely tighten. Recheck the flange alignment to make sure the V-drive did not move out of alignment. Secure the two flanges together with the heat treated bolts and special high collared lock-washers supplied.



WATER AND SWITCH CONNECTIONS

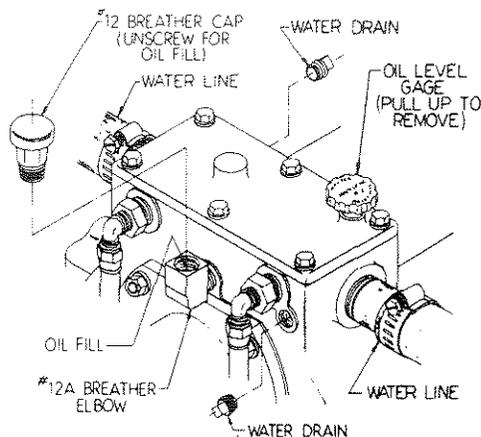
Hook up the water lines to the two pipe connections on the V-drive (intake and exhaust lines are interchangeable). Generally, one line from the seacock to the V-drive and another from the V-drive to the intake of the engine water circulating pump are utilized. In some cases, scuppers through the hull are connected to and from the V-drive to provide independent water-cooling and are actuated by the movement of the water. With closed cooling systems, the V-drive should be incorporated into the system between the cooler and the suction side of the water pump. Proper operating temperatures are from 140° to 180°F, although safe operating temperatures may be as high as 210°F. On the models equipped with an oil circulating pump, the #49 oil

pressure drop switch and the 12 volt #49A warning light should be hooked up per the wiring diagram. The switch may be grounded to any part of the V-drive or engine (either terminal may be used for the ground).

OIL FILL

Pull out the #21 oil level gauge. Unscrew the #12 breather cap and fill the V-drive with SAE #30 motor oil through the #12A breather elbow. On the RV-10 only, the oil may be added by removing the plug in the #6D top cover. See table below for approximate oil capacities. The amount varies with the angle of installation. The oil level should be checked with the oil level gauge fully inserted in the unit. The proper level is between the "H" and "L" marks on the gauge. Add a 2 ounce tube of Molykote (molybdenum disulfide), which is supplied with each V-drive for extra lubrication and break-in. It provides protection against scoring or galling of gears, bearings and other moving parts.

Additional Molykote after break-in is not required. Reinstall the breather cap. The oil level should be rechecked after the unit has been run and allowed to sit for about a minute. Add oil if necessary.



	RV-10	RV-20	RV-30	RV-40	RV-48
Oil capacity (Approx.)	1 pint	2 pints	3 pints	4 pints	4 pints

DEALER PREPARATION

The propeller shaft and engine alignment must be checked and corrected, if necessary, before the boat is delivered. Final alignment should not be attempted until the boat is allowed to "settle" in the water. The oil level must be checked and oil added if required. While the boat is being run, the water connections should be checked for leaks. The oil pressure drop switch and warning light (if the V drive is equipped with an oil circulating pump) should be checked for proper operation. Do not transport the boat with the propeller shaft coupling connected. Damage to the shaft, shaft log and V-drive can result.

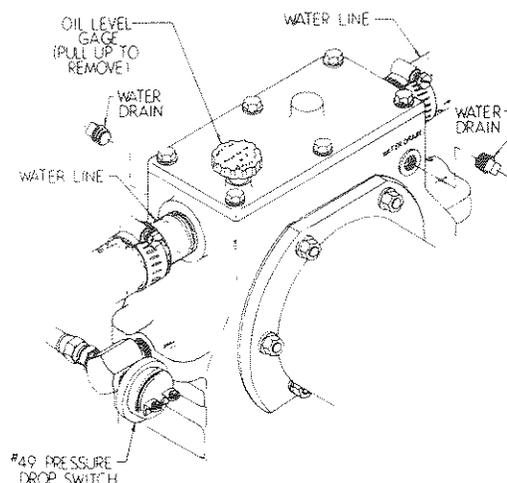
OPERATION

A pressure drop warning light is mounted on the instrument panel on V-drives equipped with an oil circulating pump. The warning light will stay on until the boat gets under way and the engine speed increases to sufficient RPM for the pump to maintain pressure. This normally occurs at approximately 1200 RPM, but the actual speed may vary by as much as 400 RPM. Extended cruising at low RPM, such as when trolling, is not harmful to the V-drive, even though the warning light may stay lit. Normal operation is between 6 to 12 PSI. The light will go on when the oil pressure drops below 2 PSI. Loss of oil and/or insufficient oil level are the major causes of pressure drop. The oil level should immediately be restored,

and while running the boat, the unit should be checked for leaks. If the oil level is normal and the light stays lit when the boat reaches normal cruising speed, the wiring should be checked for loose and/or corroded connections. If the wiring is correct and the light remains lit, the #49 pressure drop switch, which is mounted on the side of the V-drive (see illustration), should be checked for proper operation. The switch can easily be removed and an accurate oil pressure gauge installed in its place. If the pressure is normal, the switch should be replaced. If the pressure is below normal, the oil lines should be checked for blockage. The pump should be inspected and replaced if necessary. The pump is standard on the RV-48 and an optional feature on other models (not available on the RV-10).

The oil level should be checked several times during the season, especially on V-drives without pumps (see OIL FILL).

A clatter or rattle in the V-drive at low RPM is due to the over-riding of the propeller during the compression stroke of the engine. Although annoying, it is not harmful. It may be reduced by adjusting the idle speed and/or tuning up the engine for smoother operation.

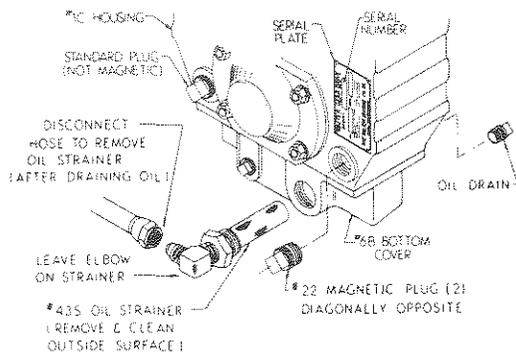


MAINTENANCE

1. OIL CHANGE AND JOINT LUBE

After the first 100 hours of operation and every season and/or 500 hours thereafter, the oil should be changed. Run the boat to warm up the V-drive to operating temperature. Turn off the engine. Remove the plug in the #6B bottom cover that is opposite the #43S oil strainer. Reinstall after draining. Disconnect the oil hose leading from the #43S strainer (leave the elbow on the strainer). Unscrew the strainer and clean the outside surface. Reinstall the strainer and reconnect the oil hose. Unscrew the two #22 magnetic plugs that are located on diagonally opposite corners of the #1C main housing.

The plugs can be checked to see if they are magnetic only after removal. Touch the inside face with a metallic object, such as a screwdriver. Clean them and reinstall. Usually, there are four plugs in the bottom part of the main housing. Only two of these are magnetic. The other two need not be removed (see illustration). Refill with SAE 30 motor oil to the proper level (see INSTALLATION - OIL FILL). The Zerk fitting on the external universal joint should be greased with a light alemite lubricant (see ENGINE ALIGNMENT).



2. WATER DRAIN

For protection from freezing during winter lay-up, remove the small pipe plugs (located diagonally opposite) on the front and back of the housing marked "Water Drain" (see illustration). On the RV-10 only, one of the water lines going into the #6 water-cooled bottom cover must be disconnected to drain the water.

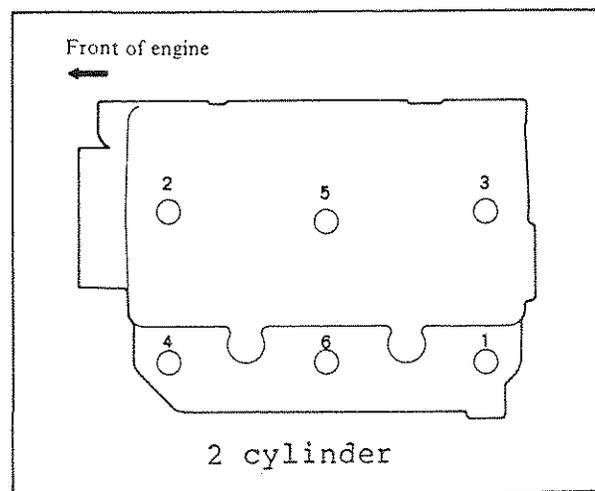
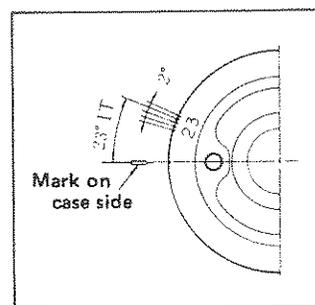
3. FLANGE AND ENGINE REALIGNMENT

When the boat is launched after being in drydock, the line-up of the V-drive to the propeller shaft flange and the engine to the V-drive should be rechecked and corrected if necessary. Some engines with rubber mounts may sag and must be raised with adjustments or shims for proper alignment (see "Flange Alignment" and "Engine Alignment").

MODEL W13A:
ADJUSTMENT OF VALVE CLEARANCE

1. Remove the rocker cover and loosen the rocker arm nut. Check the valve clearance with a feeler gauge and, if necessary, adjust it with the adjusting screw.
2. Adjust the intake and exhaust valves on No.1 cylinder side first at TDC on compression stroke of No. 1 cylinder. Then, adjust on No. 2 cylinder side at TDC on compression stroke of No. 2 cylinder.
3. Each cylinder piston is at TDC on compression stroke when the timing mark on the gear case is in alignment with that on the crankshaft pulley.
4. After adjustment, keep the adjusting screw from turning and tighten the rocker arm nut securely.

NOTE: Retighten the cylinder head bolts before valve clearance is adjusted.



W13A
Bolts #1,2,3,4,5, & 6
(17mm 7 - 8 Kg-m)

Rocker Shaft Holddown Bolts
(14mm 3.5 Kg-m)

Note: mm sizes shown are
socket size for head bolt.

MODELS W18 and W21A:
ADJUSTMENT OF VALVE CLEARANCE

CAUTION:

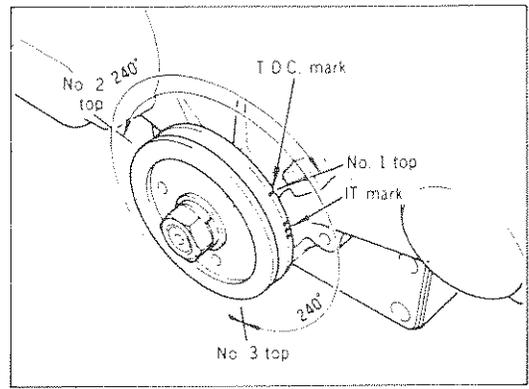
- * Adjust the valve clearance when the engine is cold.
- * Tighten the cylinder head bolts to the specified torque.

1. Pull off the air breather pipe from the rocker cover, and then loosen off rocker cover bolts. Adjust the valve clearance at top dead center of compression stroke of each cylinder as described below.

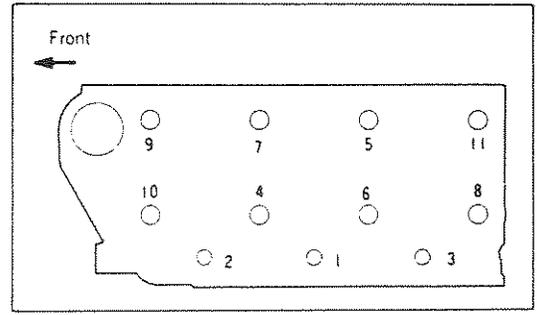
2. Align the timing marks on the gear case and the crankshaft pulley shown. In this position, No. 1 cylinder is in top dead center of its compression stroke. Check both intake and exhaust valve clearances of the cylinder. If the valves have no specified clearance, adjust by means of the adjusting screws. Remember to align the timing marks properly; if not, the valve will interfere with the piston because of wrong cam position.

3. Next, the piston of No. 3 cylinder comes to top dead center. Turn the crankshaft 240° clockwise from the above position, aligning the timing mark of the crankshaft with that of the gear case. Then check and adjust the valve clearance.

4. To check No. 2 cylinder valve clearance, turn the crankshaft another 240° clockwise, then align the timing marks and check and adjust the valve clearance in a similar manner.



Timing Mark



Cylinder Head Bolt Tightening Sequence

Description		Standard value
Cylinder head bolt tightening torque	10 mmφ	7 to 8 kg·m (50.6 to 57.8 ft·lbs.)
	12 mmφ	11 to 12 kg·m (79.5 to 86.8 ft·lbs.)

3 Cylinder Head Bolt Tightening Sequence

W-18 & W-21A
Bolts #4,5,6,7,8,9,10 & 11
(17mm 11-12 Kg-m)

Bolts #1,2, & 3
(14 mm 7 - 8 Kg-m)

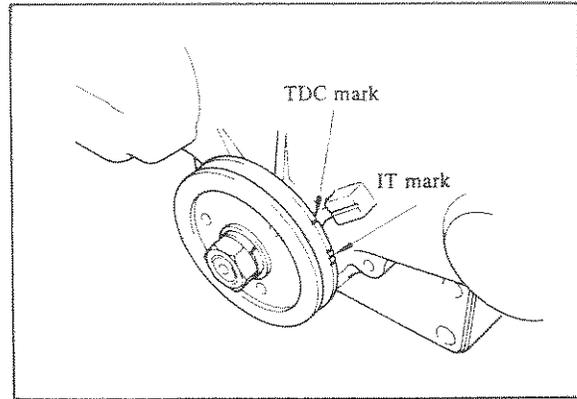
Note: mm size shown are socket size for head bolt.

Rocker Shaft Holddown Bolts

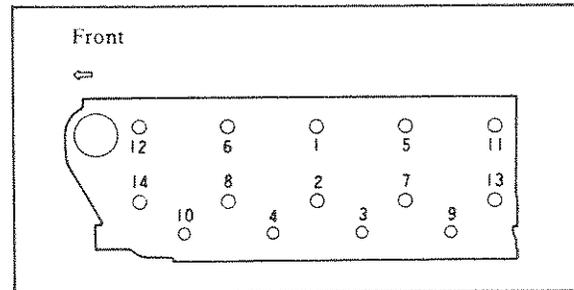
Bolts (14 mm 3.5 Kg-m)

MODELS W27A and W33A:
 ADJUSTMENT OF VALVE CLEARANCE

1. Pull off the air breather pipe from the rocker cover, and then loosen off rocker cover bolts.
2. Adjust the valve clearance at top dead center of compression stroke (cold) of each cylinder. Prior to the measurement of the valve clearance, retighten cylinder head bolts to specified torque. Give care to exact alignment of the timing mark of the gear case with that on the crankshaft pulley; if not, the valve may be pushed up by the piston, depending on the position of cam lobe.



Timing Mark



4 Cylinder Head Bolt Tightening Sequence

W-27A

Bolts 1, 2, 5, 6, 7, 8, 11, 12, 13, & 14
 (17mm 15-16 Kg-m)

Bolts 3, 4, 9 & 10
 (14mm 12-13 Kg-m)

Rocker Shaft Holddown Bolts
 14mm (12-13 Kg-m)
 10mm (3.5 Kg-m)

Note: mm sizes shown are socket size for head bolt.

W-33A

Bolts 1, 2, 5, 6, 7, 8, 11, 12, 13, & 14
 (22mm 15-16 Kg-m)

Bolts 3, 4, 9, & 10
 (22mm 11-12 Kg-m)

Rocker Shaft Holddown Bolts
 14mm 3.5 Kg-m
 10mm 0.7 Kg-m

TABLE OF TIGHTENING TORQUE	kg-m	lb-ft.
Cylinder head bolt (M10) W18, W21, W27, W33	7 - 8	50.7 - 57.9
(M12) W18, W21	11 - 12	79.6 - 86.8
W13, W27	12 - 13	86.8 - 94.0
(M14) W33*	15 - 16	108.5 - 115.7
(M14) W33 (#3,4,9,10)*	11 - 12	79.6 - 86.8
*(See drawing on Page "Cylinder Head" Section.)		
Crank pulley nut W13	15 - 20	108.5 - 144.6
W18, W21, W27, W33	20 - 25	108.5 - 180.8
Main bearing cap bolt W18, W21, W27, W33	5.0 - 5.5	36.2 - 43.4
Connecting rod cap nut W13, W18, W21, W27	3.2 - 3.5	23.1 - 25.3
Connecting rod cap bolt W33	5.5 - 6.0	37.9 - 43.0
Flywheel bolt - with separate washers	11.5 - 12.5	83.2 - 90.4
Flywheel bolt - washer attached	13 - 14	95.0 - 100.0
Oil pan drain plug	5 - 6	36.2 - 43.4
Oil filter	1.1 - 1.3	8.0 - 9.4
Delivery valve holder (injection pump)	4 - 5	28.9 - 36.2
Holder mounting bolt, nozzle	1.5 - 2.0	10.8 - 14.5
Holder body and retaining nut, nozzle	6 - 8	43.4 - 57.9
Glow plug	1.5 - 2.0	10.8 - 14.5

UNLESS OTHERWISE INDICATED

Grade 6T

6mm bolt/nut	0.7 - 1.0	5 - 7
8mm bolt/nut	1.6 - 2.3	12 - 17
10mm bolt/nut	3.2 - 4.7	23 - 24
12mm bolt/nut	5.6 - 8.2	41 - 59
14mm bolt/nut	7.7 - 10.5	56 - 76

Grade 8T and 8.8

6mm bolt/nut	.8 - 1.2	6 - 9
8mm bolt/nut	1.8 - 2.7	13 - 20
10mm bolt/nut	3.7 - 5.5	27 - 40
12mm bolt/nut	6.4 - 9.5	46 - 69
14mm bolt/nut	10.4 - 14.0	75 - 101

Grade 5 capscrew

1/4 UNC	1.2 - 1.5	9 - 11
1/4 UNF	1.5 - 1.8	11 - 13
5/16 UNC	2.5 - 2.8	18 - 20
5/16 UNF	2.9 - 3.2	21 - 23
3/8 UNC	3.7 - 4.6	28 - 33
3/8 UNF	4.1 - 4.8	30 - 35
7/16 UNC	6.1 - 6.8	44 - 49
7/16 UNF	6.9 - 7.6	50 - 55
1/2 UNC	9.4 - 10.1	68 - 73
1/2 UNF	10.1 - 11.1	73 - 80

ENGINE TROUBLESHOOTING

PROBLEM	REMEDY
1. ENGINE DOES NOT START	
a. Starting switch is defective	Correct connections and contacts
b. Deficient drive torque of the starter motor	The battery is exhausted, trouble with the starter motor, or dirty or loose wiring
c. Improper viscosity of engine oil	Check the viscosity and renew oil if necessary
d. Engine too cold	Use glowplug starting aid
e. Seizure of moving parts	Rectify
f. Air present in fuel system	Purge thoroughly with electric fuel pump
g. No fuel in fuel tank	Refill
h. Fuel filter clogged	Clean or renew
i. 20 Amp circuit breaker tripped	Manually reset
2. ENGINE STALLS WHILE IN OPERATION	
a. Fuel tank is empty	Refill
b. Fuel filter clogged	Clean or renew
c. Air present in fuel system	Retighten fuel line connections and allow electric fuel pump to run long enough to purge air thoroughly
3. IMPROPER OIL PRESSURE	
a. Oil shortage	Refill
b. Oil leak through connections	Repair
c. Oil pressure sender defective	Replace
d. Oil filter clogged	Replace
4. ENGINE OVERHEATING	
a. Cooling water shortage	Refill
b. Water leaks	Repair
c. Belt loose or smeared with oil	Clean or renew
d. Raw water pump defective	Repair or renew
e. Thermostat defective	Replace
5. BATTERY IS UNDERCHARGED	
a. Belt tension improper	Rectify
b. Faulty wiring circuit	Rectify
c. Alternator not functioning (observe voltmeter)	Replace
d. Battery faulty	Replace
e. Faulty voltage regulator	Repair or renew

WESTERBEKE LIMITED WARRANTY

1. Warranty Obligation and Duration

Westerbeke warrants to the original consumer purchaser that all standard Westerbeke marine engines and generator sets manufactured or supplied by us will be free from defects in material and workmanship for a period of one year: from date of commission, or date of purchase on repower, OR fifteen hundred (1500) hours on Commercial Generators, only (whichever occurs first).

2. Remedy

Westerbeke will elect to repair or replace free of charge to you any product or part returned to our factory transportation costs prepaid which we adjudge defective in materials or workmanship. Alternatively, we may reimburse at our discretion a portion of labor costs incurred to repair defective parts or products on site. If you request shipment of replacement parts to you prior to our determination of cause of failure, such shipment will be sent C.O.D.

3. Notification

If you encounter a problem with your Westerbeke engine or generator set within the warranty period as stated above, contact your nearest authorized Westerbeke Master Distributor directly, by telephone or letter.

Be prepared to furnish the following information:

- a. number of hours on unit
- b. date of commission, date of purchase
- c. owner's office and home telephone
- d. model number, serial number
- e. name of vessel
- f. present location of vessel or product
- g. name and address of builder
- h. boat model name
- i. who performed prior servicing, installation
- j. description of current problem
- k. any service outlet consulted and their diagnosis

4. Exclusions

This warranty shall not apply to:

- a) failures due to wear and tear, misuse, accident or negligence, including but not limited to improper storage or installation, inadequate maintenance, overloading and insufficient lubrication;
- b) consequential harm caused by overheating of engine cooling water or loss of engine lubricating pressure (these conditions should be constantly monitored by engine instruments and/or alarms);
- c) consequential harm caused by improper installation or failure of accessories attached to our product, such as water heaters and refrigeration compressors;
- d) products altered or modified in a manner not authorized in writing by Westerbeke;
- e) products damaged in transit;
- f) replacement of engine fluids, filter elements or vee belts, engine tune-up, valve adjustment, oil and water leaks, or any other normal service items;
- g) specially manufactured products provided to customer specifications;
- h) fuel systems, cooling systems, exhaust systems, electrical systems and cable control systems beyond the connection points on the product.

5. Application of Warranty

THIS WARRANTY IS IN LIEU OF ALL OTHER EXPRESS WARRANTIES. ANY WARRANTY IMPLIED BY LAW, INCLUDING WARRANTIES OF MERCHANTABILITY OR FITNESS, IS IN EFFECT ONLY FOR THE DURATION OF THE EXPRESS WARRANTY SET FORTH IN THE FIRST PARAGRAPH ABOVE. NO REPRESENTATIVE OR PERSON IS AUTHORIZED TO GIVE ANY OTHER WARRANTY OR TO ASSUME FOR WESTERBEKE ANY OTHER LIABILITY IN CONNECTION WITH THE SALE OF ITS PRODUCTS. WESTERBEKE WILL NOT BE LIABLE FOR ANY CONSEQUENTIAL DAMAGES RESULTING FROM THE USE OR INSTALLATION OF ITS PRODUCTS.

SOME STATES DO NOT ALLOW LIMITATIONS ON HOW LONG AN IMPLIED WARRANTY LASTS OR THE EXCLUSIONS OR LIMITATION OF INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATIONS AND EXCLUSION MAY NOT APPLY TO YOU. THIS WARRANTY GIVES YOU SPECIFIC LEGAL RIGHTS, AND YOU MAY ALSO HAVE OTHER RIGHTS WHICH VARY FROM STATE TO STATE.



