



Service Manual

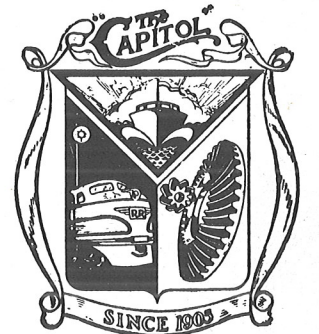
2 HDA AND 2HDC-200
DIRECT DRIVE

2HDA - 8900
REVERSE AND REDUCTION GEARS

CAPITOL GEARS, INC.

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*Service
and
Parts
Manual*

2HD REVERSE AND REDUCTION GEARS

200 DIRECT DRIVE UNIT

EC-8900 REDUCTION UNIT

CAPITOL GEAR, INC.

(Auto Engine Works, Inc.)

349 North Hamline Avenue

St. Paul 4, Minnesota

PRICE \$2.00

INTRODUCTION

This manual provides information and instructions for the operation and maintenance of the 2HD Reverse and Reduction Gear units.

Due to an ever improving product and changes necessitated by special requirements, the contents of this manual are generalized in some instances. However, detailed data are given for all items applicable to the majority of Reverse and Reduction Gear units. Give careful consideration to all information presented herein to assure maximum operating efficiency and to extend the service life of the equipment.

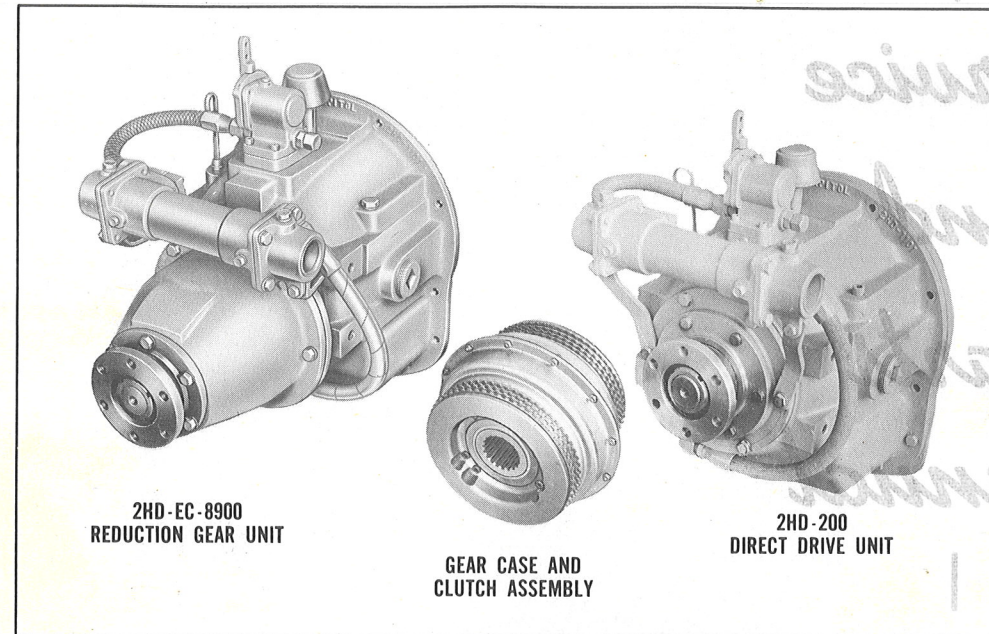


Figure 1. 2HD Reverse and Reduction Gear Units

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DESCRIPTION

GENERAL

The 2HD Reverse and Reduction Gear Unit is available in two distinctly different models: The 2HD-200 is a direct drive unit and the 2HD-EC-8900 is a reduction drive unit (see figure 1).

The basic purpose of both units is to engage and disengage the propeller shaft as desired without stopping or starting the engine, and to allow reversing the propeller shaft rotation as desired. To accomplish this, the units are provided with a hydraulically actuated clutch assembly which is equipped with reverse gears. The only other differences between the two units are defined below.

2HD-200. This model reverse gear provides a direct coupling between the engine and propeller shaft so that the propeller shaft speed is the same as engine speed.

2HD-EC-8900. This model reverse gear includes reduction gears in the aft section of the unit which provide greater propeller efficiency by turning the propeller shaft at a slower speed than that of the engine crankshaft.

REVERSE GEAR CASE AND CLUTCH ASSEMBLY

Both the 2HD-200 and 2HD-EC-8900 Units use the same type reverse gear case and clutch assembly. The assembly is a multiple disc type clutch activated by a hydraulic mechanism. This mechanism consists

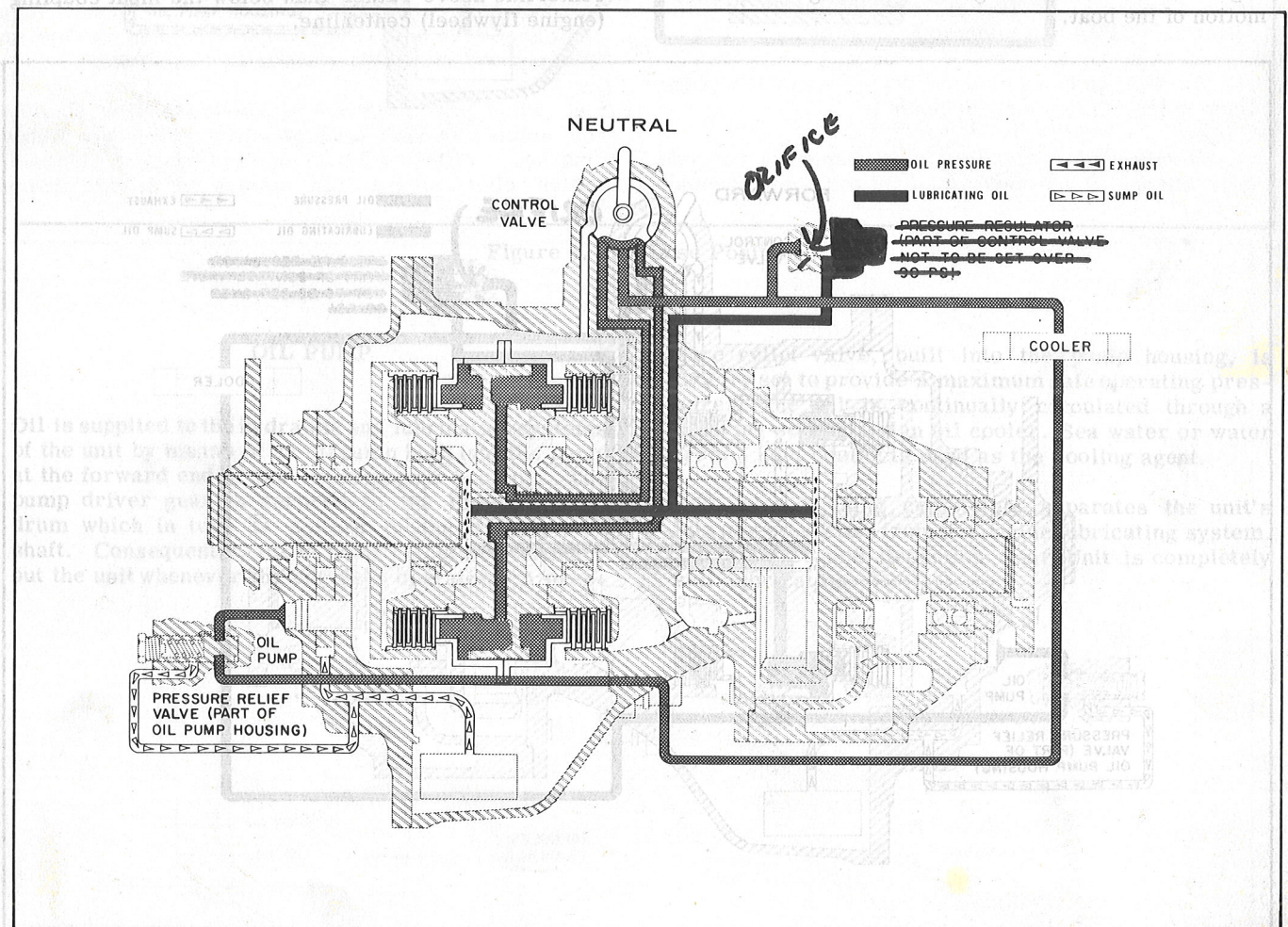


Figure 2. Neutral Position

DESCRIPTION

annular cylinders bolted together to envelop a stationary piston-gear case. This piston-gear case contains the reverse gears. A multiple disc clutch is attached to each end of the case. Oil under pressure enters the cylinders by means of metered passageways in the pinion shaft and reverse gear case. Figures 2, 3, and 4 illustrate the operation of the clutch assembly when the control valve is placed in neutral, forward and reverse positions.

NEUTRAL POSITION: Oil pressure is applied simultaneously to both sides of the piston to keep the cylinder centered and clear of both multiple disc clutches. Twelve springs are installed on the gear case to aid in centering the cylinder and to recenter the cylinder when returning to neutral from forward or reverse positions.

FORWARD POSITION: Oil is exhausted from the rear cylinder while pressure is maintained in the forward cylinder, thus moving the cylinder forward. When the cylinder moves forward, the clutch driven discs (splined to the clutch mechanism) are forced against the clutch driving discs splined to the clutch driving drum. This provides a direct drive coupling from the engine to the reduction gears resulting in forward motion of the boat.

REVERSE POSITION: Oil is exhausted from the forward cylinder. The pressure in the rear cylinder forces the rear clutch driven discs against the stationary clutch discs splined to the reverse clutch drum. This locks the entire clutch assembly in a stationary position forcing the engine to transmit power to the pinion shaft via five bevel gears which reverse the rotation of the pinion shaft. Thus, backward motion of the boat is obtained.

REDUCTION GEAR CASE
The 2HD Reverse and Reduction Gear Unit is available in two distinctly different models: The 2HD-200 and 2HD-EC-8900. The 2HD-200 is available in the following gear ratios:

- 2HD-200 1 to 1
- 2HD-EC-8900 1-1/2 to 1, 2 to 1, 2-1/2 to 1 and 3 to 1

The 2HD-EC-8900 units use a simple two-gear arrangement for speed reduction. An important feature of this unit is the extreme flexibility of installation. As shown in figure 6, the reduction gear case can be rotated 180 degrees to offset the output coupling centerline above rather than below the input coupling (engine flywheel) centerline.

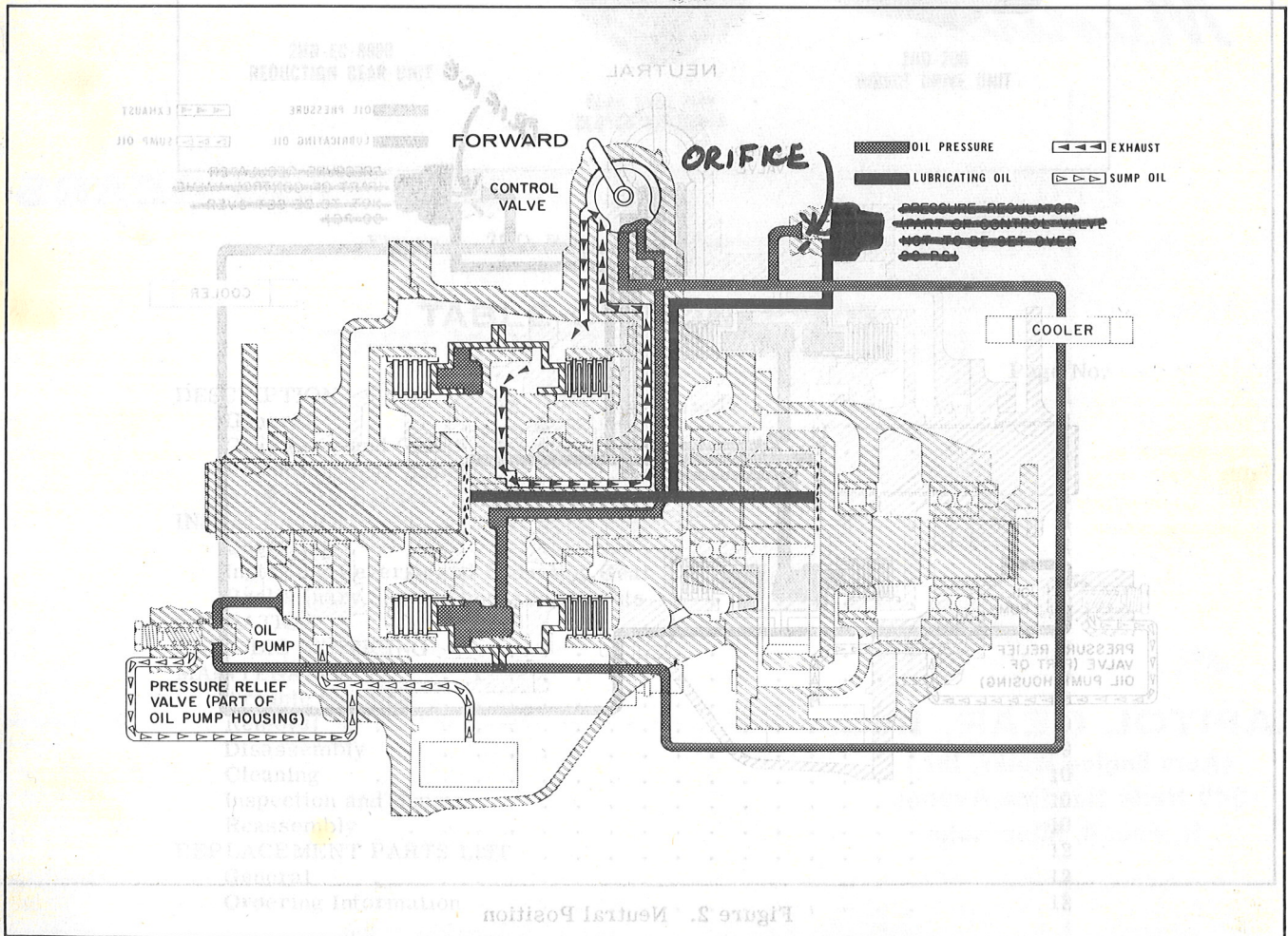


Figure 3. Forward Position

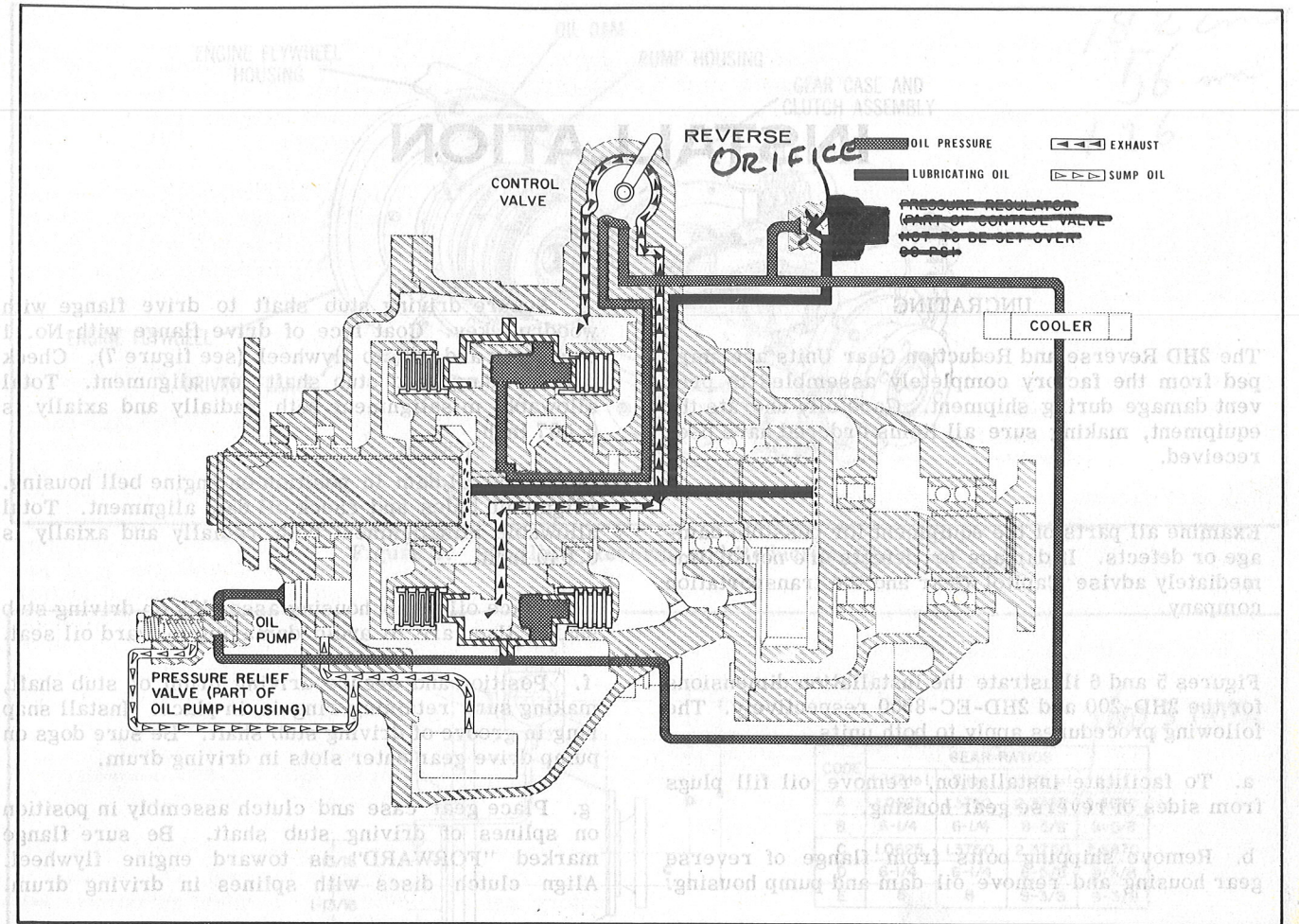
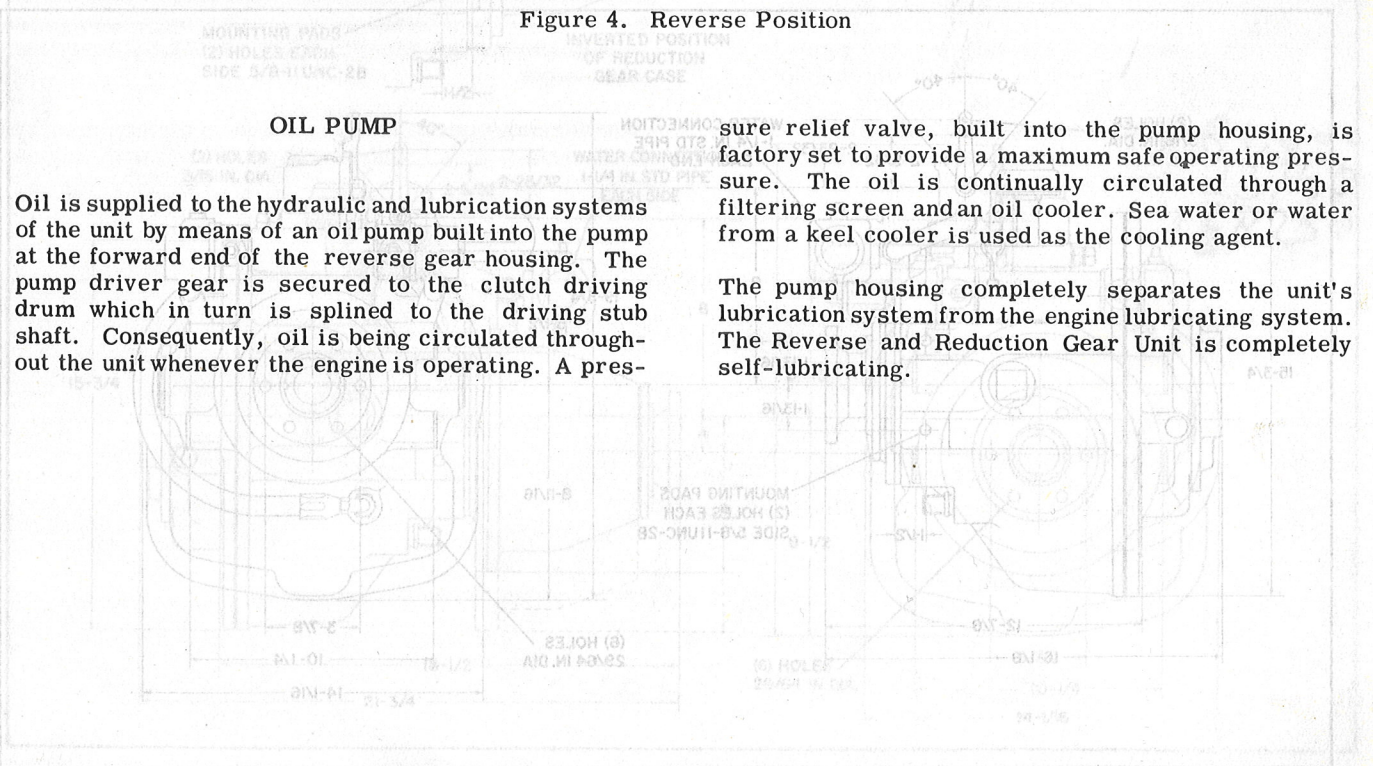


Figure 4. Reverse Position



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Figure 5. 2HD-200 Installation Dimensions

OIL PUMP
Oil is supplied to the hydraulic and lubrication systems of the unit by means of an oil pump built into the pump at the forward end of the reverse gear housing. The pump driver gear is secured to the clutch driving drum which in turn is splined to the driving stub shaft. Consequently, oil is being circulated throughout the unit whenever the engine is operating. A pres-

sure relief valve, built into the pump housing, is factory set to provide a maximum safe operating pressure. The oil is continually circulated through a filtering screen and an oil cooler. Sea water or water from a keel cooler is used as the cooling agent.

The pump housing completely separates the unit's lubrication system from the engine lubricating system. The Reverse and Reduction Gear Unit is completely self-lubricating.

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INSTALLATION

UNCRATING

The 2HD Reverse and Reduction Gear Units are shipped from the factory completely assembled to prevent damage during shipment. Carefully uncrate the equipment, making sure all items ordered have been received.

Examine all parts of the equipment for possible damage or defects. If damage or defects are noted, immediately advise Capitol Gear and the transportation company.

Figures 5 and 6 illustrate the installation dimensions for the 2HD-200 and 2HD-EC-8900 respectively. The following procedures apply to both units.

- a. To facilitate installation, remove oil fill plugs from sides of reverse gear housing.
- b. Remove shipping bolts from flange of reverse gear housing and remove oil dam and pump housing.

c. Secure driving stub shaft to drive flange with woodruff key. Coat face of drive flange with No. 1 Permatex and bolt to flywheel (see figure 7). Check driving flange and stub shaft for alignment. Total allowable misalignment both radially and axially is 0.007 inch.

d. Place oil dam in position on engine bell housing. Align bolt holes and check oil dam alignment. Total allowable misalignment both radially and axially is 0.010 inch.

e. Place oil pump housing assembly on driving stub shaft. Use care to avoid damaging forward oil seal.

f. Position and secure driving drum on stub shaft, making sure retaining ring is in place. Install snap ring in groove of driving stub shaft. Be sure dogs on pump drive gear enter slots in driving drum.

g. Place gear case and clutch assembly in position on splines of driving stub shaft. Be sure flange marked "FORWARD" is toward engine flywheel. Align clutch discs with splines in driving drum.

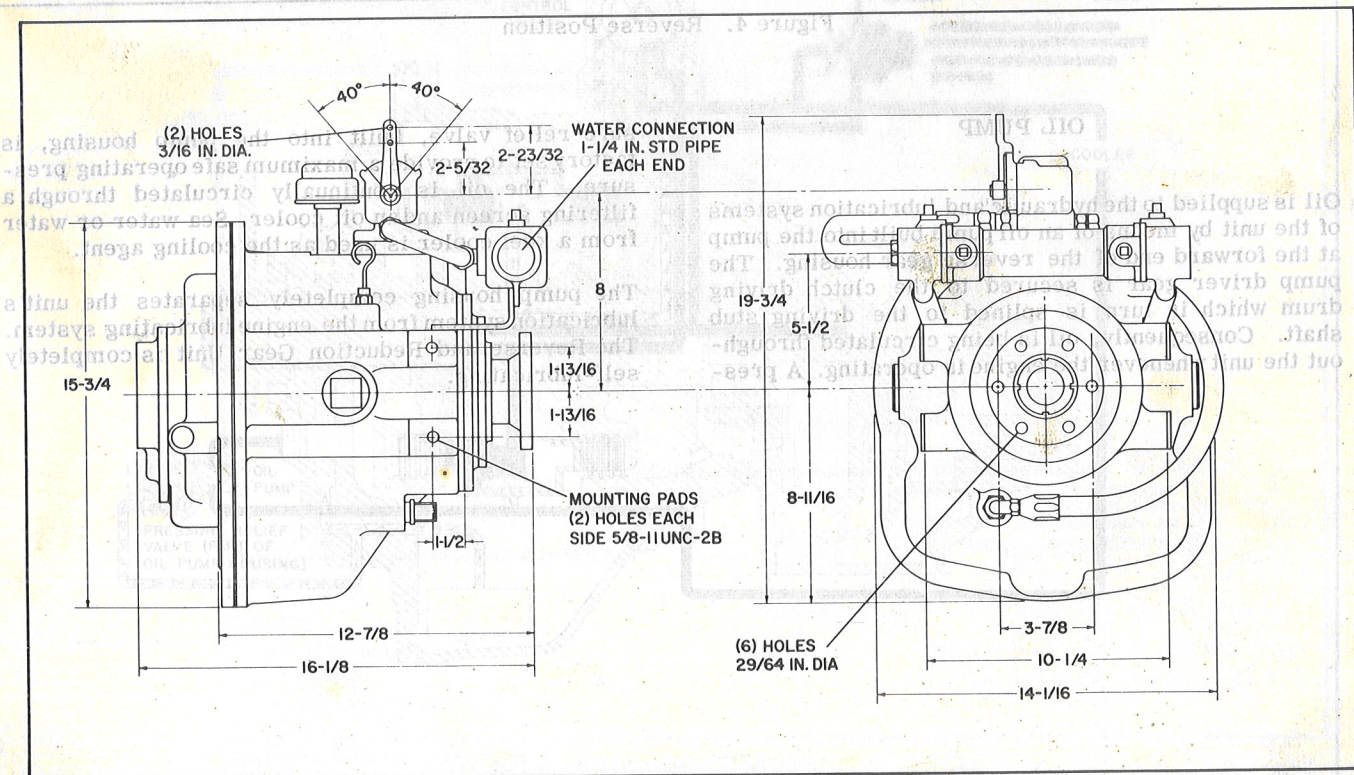


Figure 5. 2HD-200 Installation Dimensions

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INSTALLATION

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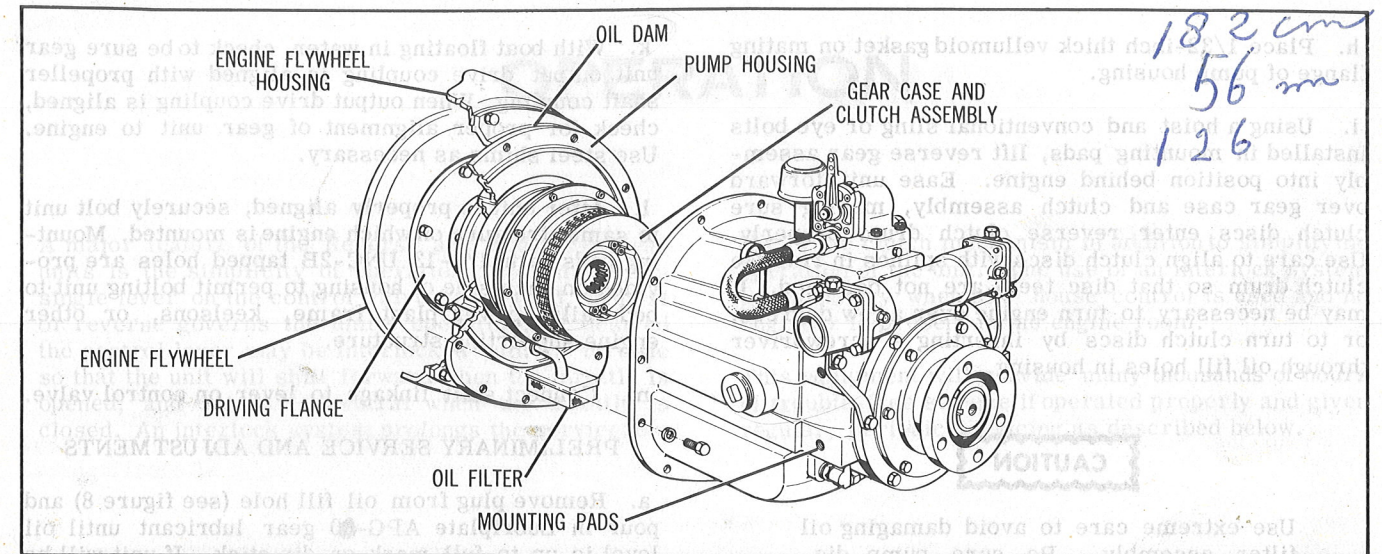


Figure 6. Installing Reverse and Reduction Gear Unit

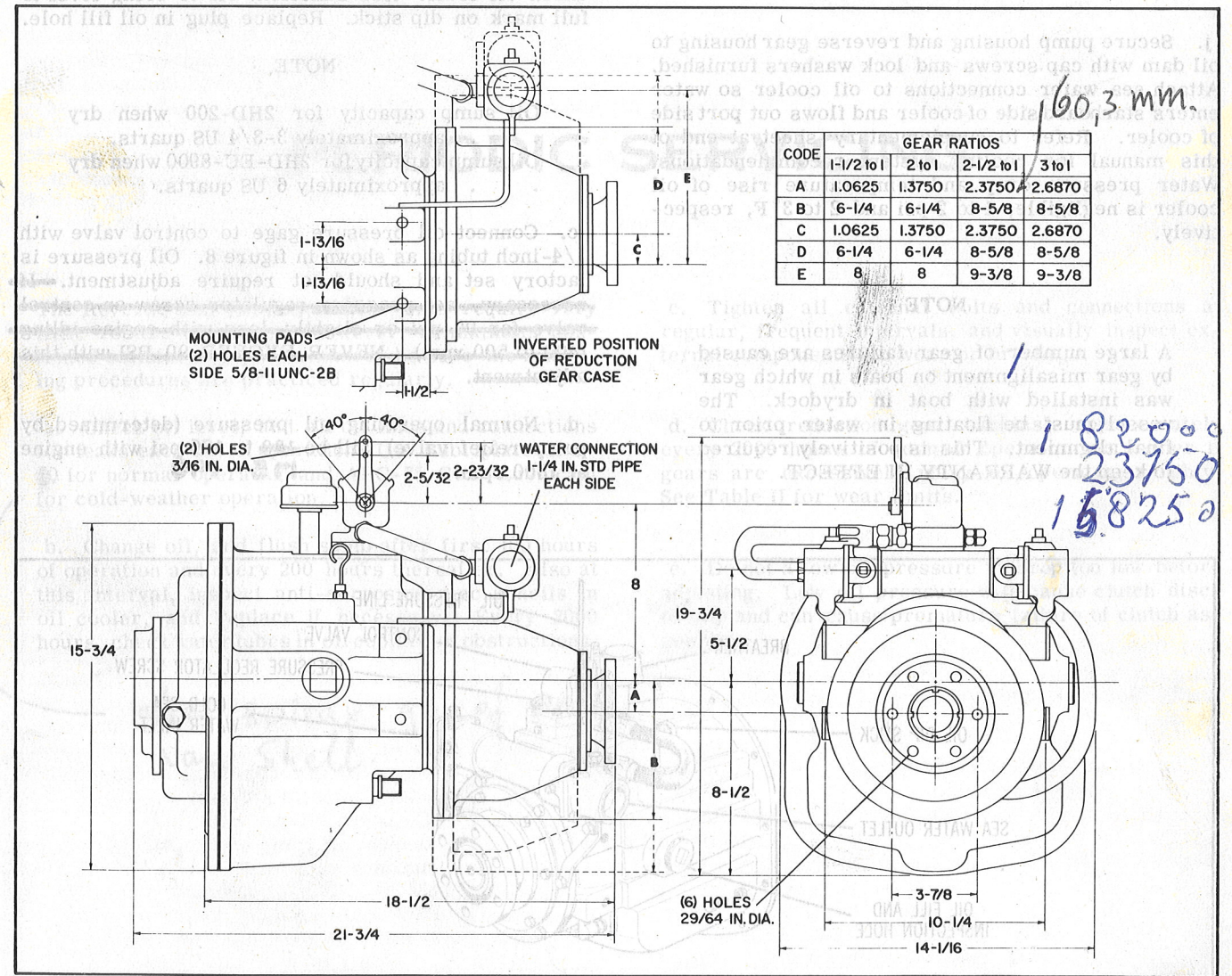


Figure 7. 2HD-EC-8900 Installation Dimensions

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INSTALLATION

- h. Place 1/32-inch thick vellumoid gasket on mating flange of pump housing.
- i. Using a hoist and conventional sling or eye bolts installed in mounting pads, lift reverse gear assembly into position behind engine. Ease unit forward over gear case and clutch assembly, making sure clutch discs enter reverse clutch drum properly. Use care to align clutch discs with splines in reverse clutch drum so that disc teeth are not damaged. It may be necessary to turn engine over a few degrees, or to turn clutch discs by inserting a screwdriver through oil fill holes in housing.

CAUTION

Use extreme care to avoid damaging oil filter assembly. Be sure pump discharge tube enters opening in forward housing; do not bend.

- j. Secure pump housing and reverse gear housing to oil dam with cap screws and lock washers furnished. Attach sea water connections to oil cooler so water enters starboard side of cooler and flows out port side of cooler. Refer to supplementary sheet at end of this manual for cooling system recommendations. Water pressure drop and temperature rise of oil cooler is negligible; 1 to 2 psi and 2 to 3° F, respectively.

- k. With boat floating in water, check to be sure gear unit output drive coupling is aligned with propeller shaft coupling. When output drive coupling is aligned, check for proper alignment of gear unit to engine. Use steel shims as necessary.
- l. After unit is properly aligned, securely bolt unit to same structure on which engine is mounted. Mounting pads with 1/2-13 UNC-2B tapped holes are provided on each side of housing to permit bolting unit to bed rails, power plant frame, keelsons, or other engine supporting structure.
- m. Connect shift linkage to lever on control valve.

PRELIMINARY SERVICE AND ADJUSTMENTS

- a. Remove plug from oil fill hole (see figure 8) and pour in Lubriplate APG-80 gear lubricant until oil level is up to full mark on dip stick. If unit will be operating in temperatures below 32° F, use Lubriplate APG-75 oil. Operate unit a few minutes, then recheck oil level. Add sufficient oil to bring level to full mark on dip stick. Replace plug in oil fill hole.

NOTE

Oil sump capacity for 2HD-200 when dry . . . approximately 3-3/4 US quarts.
 Oil sump capacity for 2HD-EC-8900 when dry . . . approximately 6 US quarts.

- c. Connect oil pressure gage to control valve with 1/4-inch tubing as shown in figure 8. Oil pressure is factory set and should not require adjustment. ~~If necessary, not preadjusted regulator screw on control valve for 90 psi or slightly less with engine idling (400 to 500 rpm). NEVER EXCEED 90 PSI with this adjustment.~~

- d. Normal operating oil pressure (determined by pump relief valve) will be ~~100 to 175~~ **175 190** psi with engine at 1800 rpm.

NOTE

A large number of gear failures are caused by gear misalignment on boats in which gear was installed with boat in drydock. The vessel must be floating in water prior to final alignment. This is positively required to keep the WARRANTY IN EFFECT.

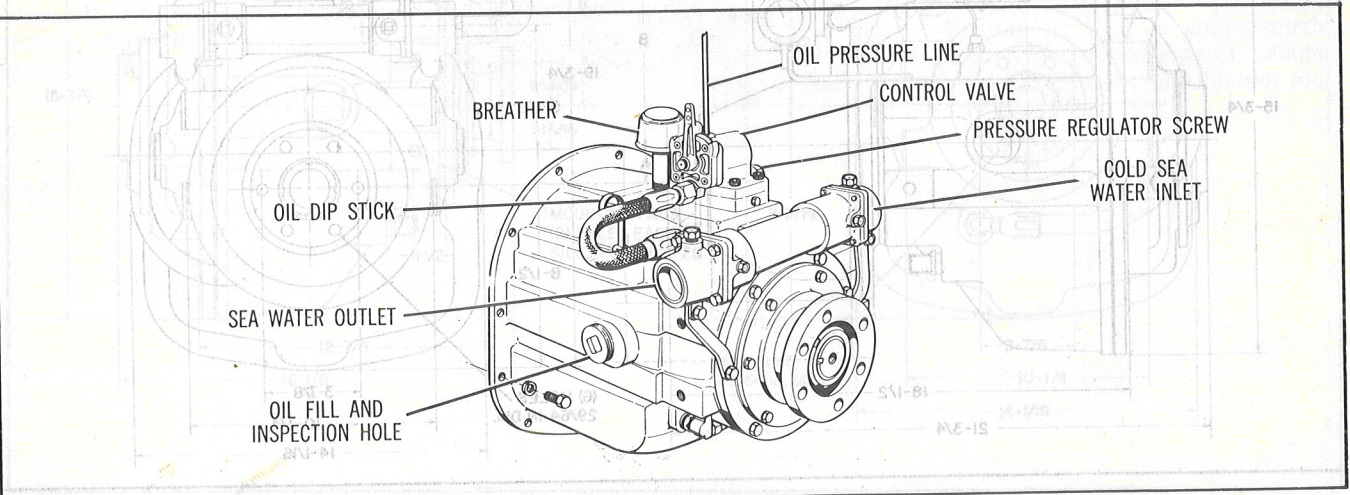


Figure 8. Servicing and Adjustments

OPERATION

A major feature of the Reverse and Reduction Gear units is the simplicity of operation. Movement of a single lever on the control valve to forward, neutral or reverse governs the unit's operation. If desired the control lever may be interlocked with the throttle so that the unit will shift forward when the throttle is opened, and return to neutral when the throttle is closed. An interlock system prolongs the serviceable

life of the clutch mechanism in addition to simplifying operation of the unit. The use of an interlock system is mandatory when pilot house control is used and no engineer is present in the engine room.

This equipment will provide many thousands of hours of trouble-free service if operated properly and given regular, periodic servicing as described below.

PERIODIC SERVICING

The Reverse and Reduction Gear units require very little routine servicing. However, to maintain continued satisfactory performance, be sure the following procedures are practiced regularly.

- c. Tighten all external bolts and connections at regular, frequent intervals, and visually inspect external components for wear or breakage.

- a. Check oil level, and all oil lines and connections for leaks each day of operation. Use Lubriplate APG-80 for normal operation and APG-75 Gear Lubricant for cold-weather operation.

- d. Check reduction gear backlash approximately every 2000 hours of normal operation or sooner if gears are excessively noisy or operating roughly. See Table II for wear limits.

- b. Change oil, and flush sump after first 100 hours of operation and every 200 hours thereafter. Also at this interval, inspect anti-corrosion zinc pencils in oil cooler, and replace if necessary. Every 2000 hours, check water tubes in oil cooler for obstructions.

- e. Do not allow oil pressure to drop too low before adjusting. Low oil pressure will cause clutch discs to slip and can cause premature failure of clutch assembly.

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MAINTENANCE

This equipment does not necessarily require routine overhaul. Overhaul is recommended only to repair or replace specific faulty parts, or when deemed necessary to rebuild the unit due to service in excess of 3000 hours.

To help determine faulty or malfunctioning parts, refer to the Trouble-Shooting information given in Table I.

TROUBLE-SHOOTING

Always determine cause of failures before correcting. Trouble-shooting is a systematic procedure for determining the reason for improperly operating equipment and the corrective measures that must be taken to restore the equipment to peak operating efficiency. Always approach trouble-shooting in a logical manner.

TABLE I. TROUBLE SHOOTING

TROUBLE	PROBABLE CAUSE	REMEDY
1. Low oil pressure (less than 175 lbs) @ 1800 RPM	<p>Low oil level. Dirt or sludge in unit. Defective hose assemblies. Relief valve malfunction. Defective control valve. Worn commutator bushings.</p>	<p>Add Lubriplate APG-80 as needed. Remove drain plugs and flush with a mineral solvent. Check each hose assembly for leaks or plugged condition. Clean relief valve plunger and spring. Install new control valve, or disassemble valve and clean relief valve. Inspect commutator bushings (see Table II for replacement wear limits). Inspect gears and measure backlash (see Table II for replacement wear limits). Check bearings for scored races, flat spots, broken rollers, etc. Replace clutch discs.</p>
2. Unit operates with excessive noise.	<p>Gear worn or broken. Worn bearings.</p>	<p>Remove and clean forward and reverse cylinders. See item 1 above. Oil temperature must not exceed 180° F (normal operating temperature 140 to 160° F). Use Lubriplate APG-80. (If Lubriplate is unavailable, use high quality SAE 30 or SAE 40 non-detergent oil.)</p>
3. Clutch does not release.	<p>Clutch discs worn or warped. Forward and reverse cylinder dirty.</p>	<p>Remove and clean forward and reverse cylinders. See item 1 above.</p>
4. Clutch slips.	<p>Low oil pressure. Oil temperature too high. Oil viscosity too low.</p>	<p>See item 1 above. Oil temperature must not exceed 180° F (normal operating temperature 140 to 160° F). Use Lubriplate APG-80. (If Lubriplate is unavailable, use high quality SAE 30 or SAE 40 non-detergent oil.)</p>
5. Clutch burned out.	<p>Gear unit misaligned.</p>	<p>Check gear unit alignment as described in installation instructions.</p>
6. Oil pump operates with excessive noise.	<p>Dirt or sludge in unit. Oil filter plugged. Defective oil pump.</p>	<p>Remove drain plugs and flush with a mineral solvent. Clean oil filter. Inspect oil pump and replace if necessary.</p>

A few minutes devoted to making operational and visual checks will often isolate the possible source of trouble.

Table I lists various troubles that may occur while using the Reverse and Reduction Gear unit. Each possible source of trouble is followed by a list of probable causes and suggested remedies. While this listing does not cover all possible troubles that may be encountered, it often will be an aid for quickly identifying the adjustments or parts replacement necessary to correct a malfunction.

REMOVAL FROM ENGINE

a. Drain lubricating oil from sump. Disconnect sea water connections from oil cooler. Disconnect shift linkage from lever on control valve. Remove inspection hole covers.

b. Disconnect propeller shaft coupling from output drive coupling. Remove cap screws holding reverse gear housing to engine bell housing.

c. Use an overhead hoist and a suitable sling to lift unit out of boat. Disconnect unit from engine mounting points. Slowly move unit straight aft and away from flywheel. Separate pump housing from reverse gear housing as unit moves aft. Insert a screwdriver or similar tool through oil fill hole, and hold gear case and clutch assembly against flywheel. Gear case and clutch assembly should remain on clutch driving drum and driving stub shaft when unit is removed. When unit clears end of oil filter (see figure 8), lift unit out of boat or place on engine room deck plates.

d. Pull clutch assembly from stub shaft and driving drum. Remove snap ring from groove in driving stub shaft and remove clutch driving drum.

e. Separate pump housing from oil dam, and pull unit from driving stub shaft and driving flange. If necessary, remove oil dam.

DISASSEMBLY

The normal sequence of disassembling the Reverse and Reduction Gear unit is in accordance with the order of index numbering on the exploded view in Replacement Parts List section following. The disassembly instructions given provide a general guide for disassembly and furnish information not readily apparent from the exploded views. Unless the unit is being rebuilt, disassemble only as far as necessary to replace specific faulty parts.

NOTE

Prior to disassembling 2HD-EC-8900, measure reduction gear backlash to determine need for gear replacement. Table II indicates allowable maximum wear limits.

a. Remove dip stick and breather. Detach hose assemblies, and remove control valve assembly and oil cooler.

NOTE

Step b following applies to 2HD-200 units only.

b. Remove rear cover from reverse gear housing complete with bearing, retainer and reverse gear shaft. Disassemble this subassembly in accordance with exploded view in Replacement Parts List section.

NOTE

Steps c and d following apply to the 2HD-EC-8900 units only.

c. Remove reduction gear housing from reverse gear housing complete with output coupling, ring gear, bearings, etc. Disassemble this subassembly in accordance with exploded view in Replacement Parts List section.

d. Remove adapter from reverse gear housing complete with driving pinion, bearing and reverse gear shaft. Disassemble as shown in exploded view.

NOTE

Steps e and f following apply to both 2HD-200 and 2HD-EC-8900 units.

e. Pull oil filter assembly from pump housing. Remove oil pump cover and disassemble oil pump as shown in exploded view.

f. Remove snap rings and remove reverse gear shaft bearing from reverse gear housing. Remove rear commutator bushing. Unscrew pump discharge tube from housing. Remove reverse clutch drum from housing.

CONTROL VALVE

The sequence of disassembly of the control valve assembly is in accordance with the order of index numbering on the exploded view in the Replacement Parts List section.

The control valve and oil cooler probably will require little or no repair except for leaking gaskets or seals. However, clean and inspect these assemblies whenever the Reverse and Reduction Gear unit is overhauled.

REVERSE GEAR CASE AND CLUTCH ASSEMBLY

If gear case and clutch assembly is badly worn, new or rebuilt units are available on an exchange basis from Capitol Gear. However, if repair or overhaul is attempted, the sequence of disassembly is outlined in subsequent instructions and is in accordance

with order of index numbering on the appropriate exploded view in the Replacement Parts List section.

- a. Remove socket head screws securing forward and reverse clutch flanges, and remove flanges.
- b. Slip off forward and reverse clutch disc packs. Remove bevel gears and bevel gear bearings (or bushings) from clutch flanges. Remove forward oil commutator bushing from gear case.
- c. Remove cap screws and nuts from forward and reverse cylinders. Separate cylinders.
- d. Remove 12 return springs from bevel gear case, and remove socket head screws which support pinion shafts. Remove shafts, bevel gears, and bushings.
- e. All other component parts of gear case are now accessible for inspection or replacement.

NOTE

All component assemblies of the Reverse and Reduction Gear unit are available from Capitol Gear on an exchange basis.

CLEANING

After disassembly is completed, thoroughly wash all metal parts in kerosene or a good grade commercial cleaning solvent. Be sure all sediment and accumulations of foreign matter are removed. Clean housings until all traces of hardened grease and dirt are removed. Thoroughly clean all passageways.

TABLE II. REPLACEMENT WEAR LIMITS

Description	Basis of Measurement	New Dimensions		Replacement Wear Limit
		Min. (All dimensions in inches)	Max.	
BUSHING, rear commutator (part no. 2HD-248F)	ID	1.9690	1.9700	1.9720
BUSHING, forward commutator (part no. 2HE-247)	ID	1.1240	1.1260	1.1280
SHAFT, reverse gear, 2HD-200 (part no. 2HD-327)	OD at fwd commutator bushing	1.1215	1.1225	1.1210
SHAFT, and reverse gear, 2HD-EC-8900 (part no. 2HD-327-R)	OD at rear commutator bushing	1.9660	1.9665	1.9655
REDUCTION GEARS, pair, 2HD-EC-8900	OD at fwd bearing	1.9660	1.9665	1.964
	Backlash	0.004	0.010	0.030
BUSHING, oil pump gear (part no. 2HD-1127)	ID new	2.505	2.506	
GEAR, oil pump driver (part no. 2HD-1125)	ID installed	2.502	2.503	2.510
	OD	2.498	2.499	2.496
BUSHING, oil pump pinion (part no. 2HD-1130)	ID	0.877	0.879	0.881
PINION SHAFT, oil pump (part no. 2HD-1303)	OD	0.874	0.875	0.872
DISC, clutch driving (part no. 2HD-230-M)	Thickness	0.130	0.140	0.120
DISC, clutch driven (part no. 2HD-233)	Thickness	0.088	0.100	0.078
CLUTCH PACK	Thickness	0.872	0.960	0.812

INSPECTION AND REPAIR

Visually inspect all parts of the disassembled Reverse and Reduction Gear unit for damage, defects or deterioration. Do not attempt to repair any component part found to be faulty or worn excessively. Unless otherwise specified, repair consists of replacing defective parts. Refer to Table II for replacement wear limits of specific parts. Parts failing to meet the limits indicated must be replaced.

- a. Inspect all castings for breaks or fractures.
- b. Examine all hose assemblies for cracks.
- c. Check gear teeth for chipping or damage. Replace gears if backlash exceeds wear limits listed in Table II. Bevel gears in gear case and clutch assembly should be replaced as a set.
- d. Thoroughly inspect bearings and bushings for damage or excessive wear. If unit is being rebuilt, we recommend replacing forward and reverse oil commutator bushings and all bearings in reduction gear mechanism.
- e. All gaskets, seals, and "O" rings should be replaced.
- f. Inspect splines on clutch driving drum and reverse clutch drum for serrations. Check clutch discs for broken teeth, signs of warping and excessive wear.
- g. Measure bushings and shafts as indicated in Table II, and replace as required.

REASSEMBLY

Reassembly of the Reverse and Reduction Gear unit and its subassemblies is essentially the reverse of disassembly. The following text describes procedures which are not obvious or conflict with the general order of assembly. Refer to the appropriate exploded views in the Replacement Parts List section to determine the physical relationship of the various component parts.

NOTE

Apply a light coating of Lubriplate APG-80 gear lubricant to all metal parts during reassembly to ease installation of parts.

OIL PUMP AND CONTROL VALVE

Reassemble oil pump and control valve in the reverse order of index numbering shown on the appropriate exploded views in the Replacement Parts List section. Use new "O" rings, seals, and gaskets as required. Do not re-use old seals, gaskets, etc. These subassemblies must be assembled and ready for installation before reassembling the Reverse and Reduction Gear unit.

GEAR CASE AND CLUTCH ASSEMBLY

Reassemble the gear case and clutch assembly in the reverse order of disassembly as follows:

- a. Place bushing in each bevel pinion, and align pinions in opening of gear case. Install pinion shafts and attaching parts. Check for free rotation of pinions.
- b. Assemble six return springs, spring retainers and attaching parts on each side of gear case. Tighten attaching screws until top of spring retainers protrude 0.320 - 0.325 inch from face of gear case hub as shown in figure 9.
- c. Install new forward commutator bushing and new inner and outer cylinder "O" rings.
- d. Install forward and reverse cylinders on each side of gear case. Tighten attaching screws securely.
- e. Install bearings (or bushings) and bevel gears in forward and reverse clutch flanges.
- f. Assemble 4 (5 for heavy-duty clutch) externally splined driving discs alternately with 4 (5 for heavy-duty clutch) internally splined driven discs. Align disc pack, and attach entire pack to forward cylinder.
- g. Repeat step "f" above, and install disc pack on reverse clutch flange. Attach unit to reverse clutch cylinder.
- h. After assembly, rotate bevel gears to check for unrestricted rotation and smooth operation of gears.

REVERSE AND REDUCTION GEAR ASSEMBLY

The following procedure applies to complete reassembly of the Reverse and Reduction Gear unit. Observe these instructions to insure a properly operating unit at the completion of reassembly.

- a. Install reverse clutch drum. Install rear oil commutator bushing, and secure with lock pin.
- b. Reassemble oil pump in pump housing as shown on exploded view in Replacement Parts List section. Insert oil filter assembly in hole in housing.

NOTE

Steps c through e following apply to 2HD-EC-8900 units only.

- c. Assemble bearing, driving pinion, snap rings and adapter on reverse gear shaft. Be sure snap ring is installed on forward end of shaft. Insert assembly into reverse gear housing and install attaching screws.
- d. Assemble ring gear, bearings, snap rings, retainer and output coupling into reduction gear housing as shown in exploded view. Tighten lock nut on end of ring gear shaft securely, then back off one-quarter turn. Bend one tab of lock washer into slot on nut.
- e. Place new gasket on adapter flange and place reduction gear assembly in position on adapter. Install attaching screws and tighten securely. Check backlash of reduction gears; correct backlash should be between 0.004 and 0.010 inch.

NOTE

Steps f and g following apply to 2HD-200 units only.

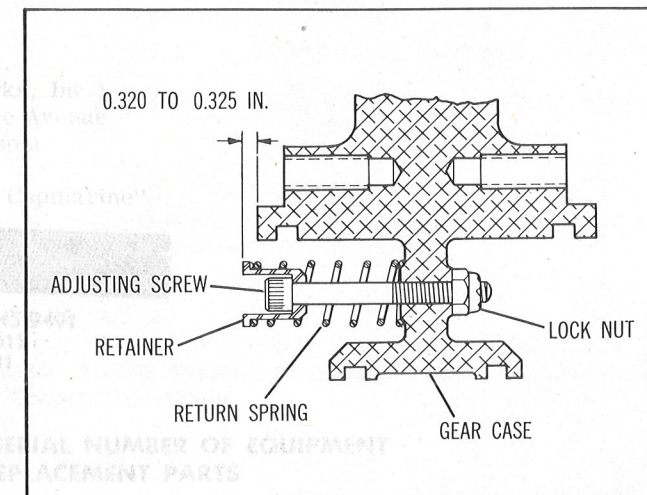


Figure 9. Clutch Spring Adjustment

f. Assemble bearing, retainer, new retainer gasket, rear cover and output coupling on reverse gear shaft. Insert assembly into reverse gear housing and install attaching screws. Coat mating surfaces with No. 1 Permatex before assembly.

g. Securely tighten lock nut on reverse gear shaft, then loosen one-quarter turn. Bend tab of lock washer into slot of lock nut.

NOTE

Steps h and i apply to 2HD-200 and 2HD-EC-8900 units.

h. Reinstall accessories as shown in appropriate exploded views in Replacement Parts List section. Be sure holes in control valve, base and housing are in alignment.

i. Install Reverse and Reduction Gear unit on engine in accordance with preceding installation instructions.

NOTE

Apply a light coating of Lubriplate AP-80 gear lubricant to all metal parts during re-assembly to ease installation of parts.

Reassemble oil pump and control valve in the reverse order of index number.

Reassemble the gear case and clutch assembly in the reverse order of disassembly as follows:

1. Place bushing in each bevel pinion, and align pinions in opening of gear case. Install pinion shafts and attaching parts. Check for free rotation of pinions.

2. Assemble six return springs, spring retainers and attaching parts on each side of gear case. Tighten attaching screws until top of spring retainers protrude 0.820 - 0.325 inch from face of gear case hub as shown in figure 9.

3. Install new forward commutator bushing and new inner and outer cylinder "O" rings.

4. Install forward and reverse cylinders on each side of gear case. Tighten attaching screws securely.

5. Install bearings (or bushings) and bevel gears in forward and reverse clutch langes.

6. Assemble 4 (2 for heavy-duty clutch) externally splined driving discs alternately with 4 (2 for heavy-duty clutch) internally splined driven discs. Align disc packs and attach entire back to forward cylinder.

7. Repeat step 7 above and install disc pack on reverse clutch langes. Attach unit to reverse clutch cylinder.

8. After assembly, rotate bevel gears to check for unrestricted rotation and smooth operation of gears.

9. Reinstall accessories as shown in appropriate exploded views in Replacement Parts List section. Be sure holes in control valve, base and housing are in alignment.

10. Reinstall accessories as shown in appropriate exploded views in Replacement Parts List section. Be sure holes in control valve, base and housing are in alignment.

11. Reinstall accessories as shown in appropriate exploded views in Replacement Parts List section. Be sure holes in control valve, base and housing are in alignment.

12. Reinstall accessories as shown in appropriate exploded views in Replacement Parts List section. Be sure holes in control valve, base and housing are in alignment.

13. Reinstall accessories as shown in appropriate exploded views in Replacement Parts List section. Be sure holes in control valve, base and housing are in alignment.

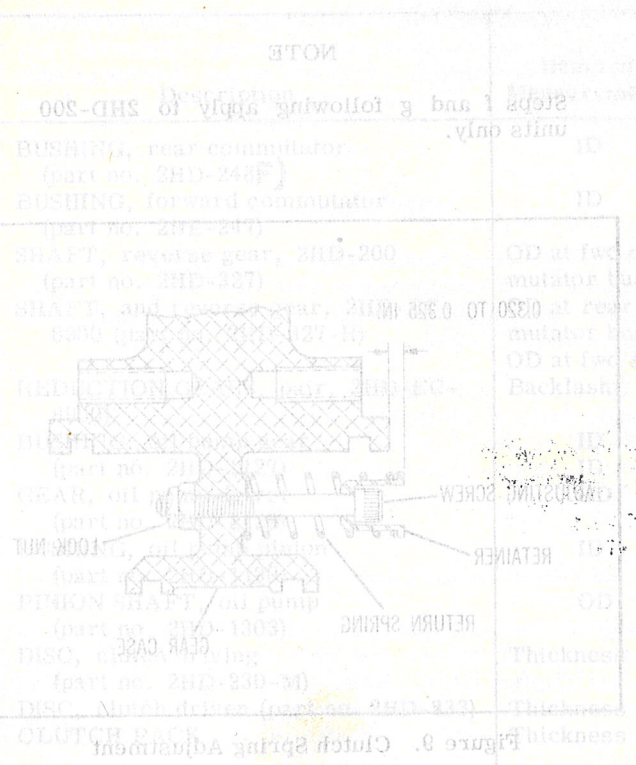


Figure 9. Clutch Spring Adjustment

REPLACEMENT PARTS LIST

GENERAL

The parts list and accompanying illustrations contained herein identify replacement parts for the 2HE Reverse and Reduction Gear units and their component subassemblies. Exploded views which depict the complete unit do not necessarily illustrate all parts, but are intended to establish the physical relationship of various parts that are common to all models. Exploded views depicting component subassemblies are complete, and all listed items are illustrated and indexed accordingly.

In most cases, parts are listed in a logical sequence of disassembly except that attaching parts follow, rather than precede, the items they attach.

ORDERING INFORMATION

To avoid delay in shipment of replacement parts, observe the following instructions:

- a. Specify part number, name and quantity of part(s).
- b. Be sure all orders are complete, correct and clearly written.
- c. Always specify any special shipping instructions.
- d. Always state model and serial number of equipment on which parts will be used.

Order parts from:

Capitol Gear, Inc.
(Auto Engine Works, Inc.)
349 North Hamline Avenue
St Paul 4, Minnesota

Cable Address: "Capmarine"



Telephone: 645-9491
Area Code: 612
Telex: 29-7081

ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF EQUIPMENT WHEN ORDERING REPLACEMENT PARTS

MODEL NO.	ENGINE MAKE
302	BOEING
6-D	BUDA
1948	CADILLAC
1958	CATERPILLAR
1MS-600 SAE #3 Hag	CUMMINS
1T6 SAE #3 Hag	FORD
1-4B1 SAE #3 Hag	GENERAL MOTORS
1H461 SAE #3 Hag	GRAY MARINE
MDM7 and MDM7	HUGHES DIESEL
2-Series SAE #3 Hag	HERCULES
D4-30 SAE #4 Hag	
D6-100 SAE #3 Hag	
D6-140 SAE #3 Hag	
C-6 SAE #1 Hag	
T23MC SAE #1 Hag	
155DKD SAE #3 Hag	
155DPC SAE #3 Hag	

REPLACEMENT PARTS LIST

TABLE OF ADAPTATIONS

The following table lists various engines to which the 2HD Reverse and Reduction Gear units can be adapted. To order replacement parts for the adaptations, consult the engineering assembly drawing accompanying the unit.

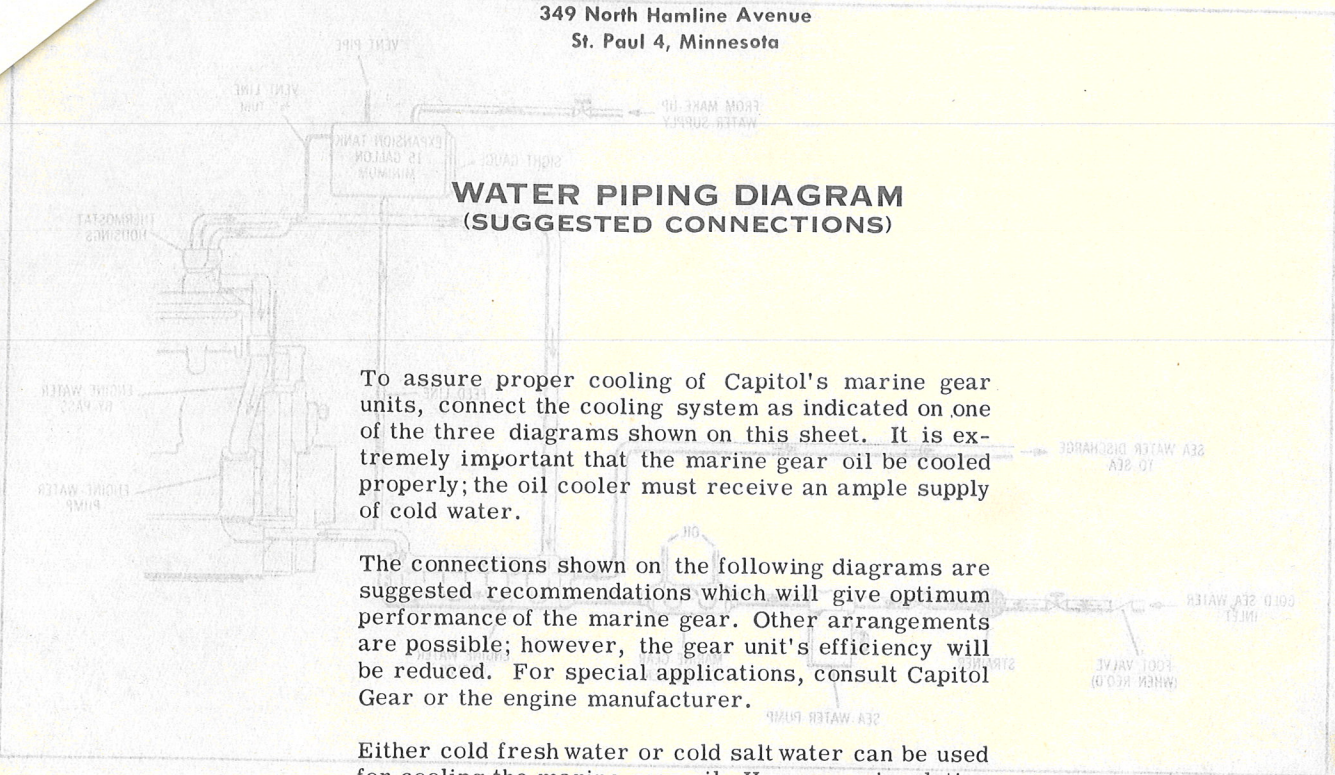
ENGINE MAKE	MODEL NO.	ENGINE MAKE	MODEL NO.
BOEING	502-10C	KERMATH	Sea Mate
BUDA	6-DAMR-273 SAE #3 Hsg	LINCOLN	52-55
CADILLAC	1949-1954 1955	MERCEDES-BENZ	OM-312 and 321 OM-315
CATERPILLAR	D-311 SAE #2 Hsg D-315 SAE #2 Hsg D-318 SAE #1 Hsg 311H SAE #2 Hsg	MINNEAPOLIS-MOLINE	D425-6A SAE #2 Hsg
CUMMINS	JMS-600 SAE #2 Hsg JT6 SAE #2 Hsg J-4B1 SAE #3 Hsg	OLDSMOBILE	49-52 53-55
FORD	Diesel HY Flywheel	OLIVER	Super 188D SAE #3 Hsg
GENERAL MOTORS	2-71 SAE #1 Hsg 3-71 SAE #1 Hsg 4-71 SAE #1 Hsg 2-71 SAE #2 Hsg 3-71 SAE #2 Hsg 4-71 SAE #2 Hsg	P & H	387-C Diesel SAE #1 Hsg
GRAY MARINE	4-D277 SAE #3 Hsg 6-D427 SAE #3 Hsg M6-427 and 363	PALMER	IH461 SAE #2 Hsg
HEDGES DIESEL	V-6 and 4	PENTA	MD47 and MD67
HERCULES	DIX-6ES SAE #4 Hsg DRXC	PERKINS	P-Series SAE #3 Hsg
		RED WING	D4-30 SAE #4 Hsg D6-100 SAE #3 Hsg D6-140 SAE #3 Hsg
		ROLLS-ROYCE	C-6 SAE #1 Hsg
		ROOTS LISTER	TS3MG SAE #1 Hsg
		WAUKESHA	135DKD SAE #3 Hsg 195DLC SAE #3 Hsg

ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF EQUIPMENT WHEN ORDERING REPLACEMENT PARTS

ALWAYS SPECIFY MODEL AND SERIAL NUMBER OF EQUIPMENT WHEN ORDERING REPLACEMENT PARTS

CAPITOL GEAR, INC.
(Auto Engine Works, Inc.)
349 North Hamline Avenue
St. Paul 4, Minnesota

WATER PIPING DIAGRAM (SUGGESTED CONNECTIONS)

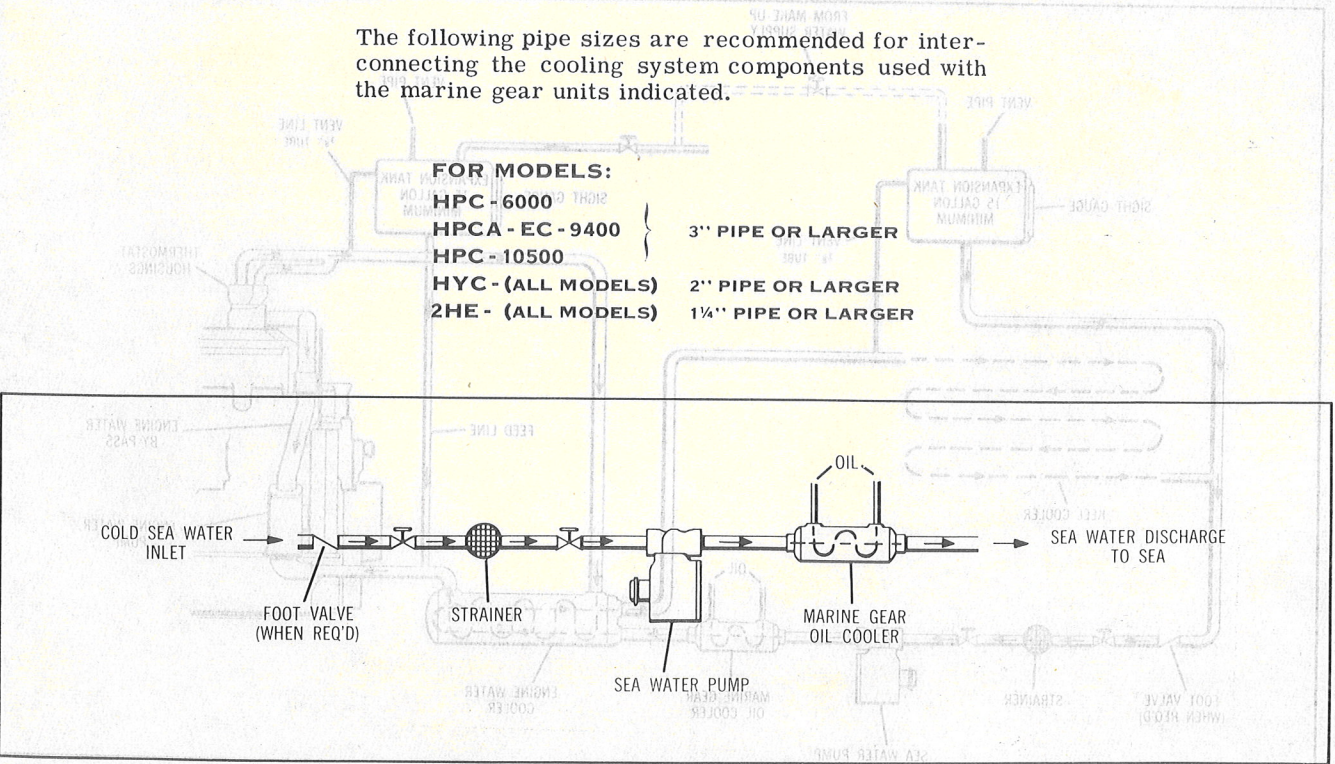


To assure proper cooling of Capitol's marine gear units, connect the cooling system as indicated on one of the three diagrams shown on this sheet. It is extremely important that the marine gear oil be cooled properly; the oil cooler must receive an ample supply of cold water.

The connections shown on the following diagrams are suggested recommendations which will give optimum performance of the marine gear. Other arrangements are possible; however, the gear unit's efficiency will be reduced. For special applications, consult Capitol Gear or the engine manufacturer.

Either cold fresh water or cold salt water can be used for cooling the marine gear oil. However, circulation of salt water through the engine cooling system is not recommended. If salt water must be used for engine cooling, the temperature of the discharge water must not exceed 105° to 110° F.

The following pipe sizes are recommended for inter-connecting the cooling system components used with the marine gear units indicated.



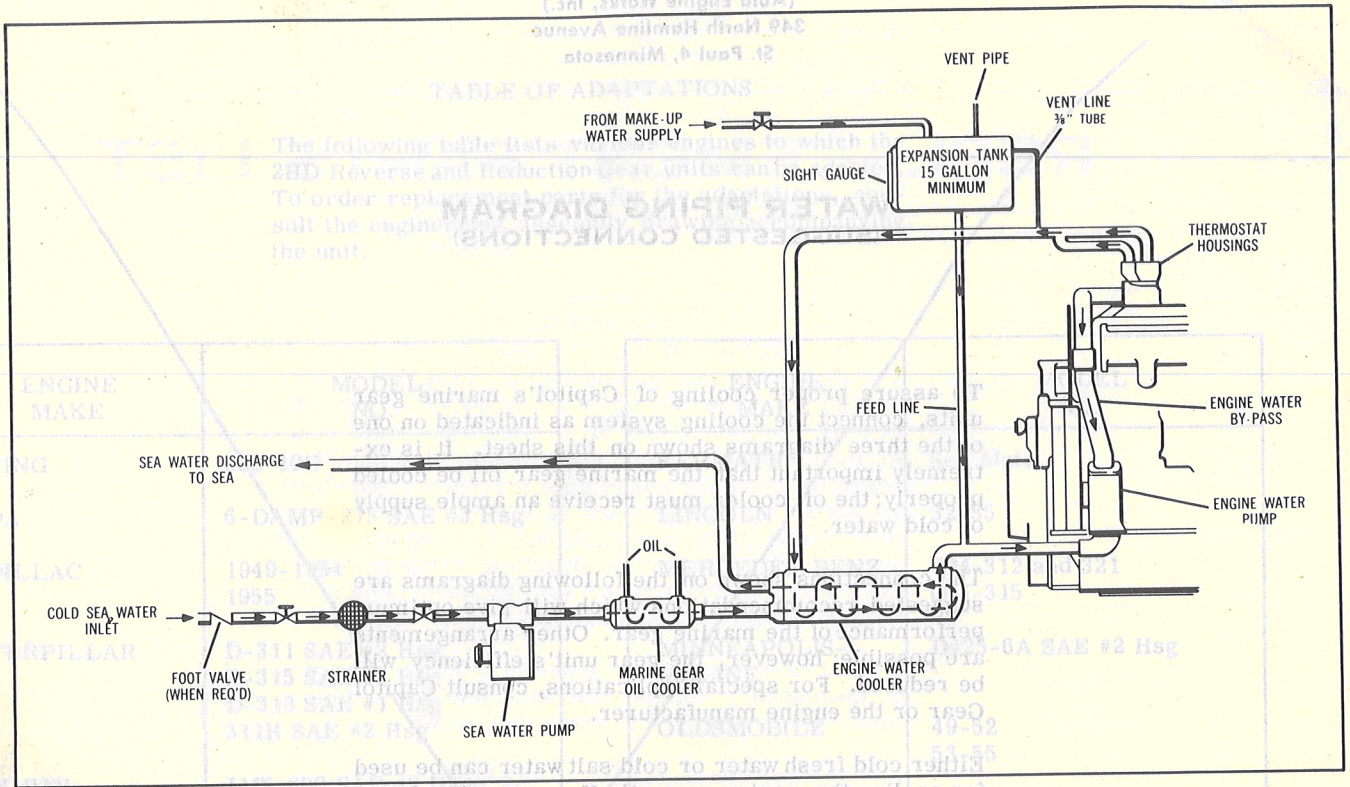
- FOR MODELS:**
- HPC - 6000
 - HPCA - EC - 9400
 - HPC - 10500
 - HYC - (ALL MODELS)
 - ZHE - (ALL MODELS)
- 3" PIPE OR LARGER
2" PIPE OR LARGER
1 1/2" PIPE OR LARGER

SEPARATE PUMP SYSTEM

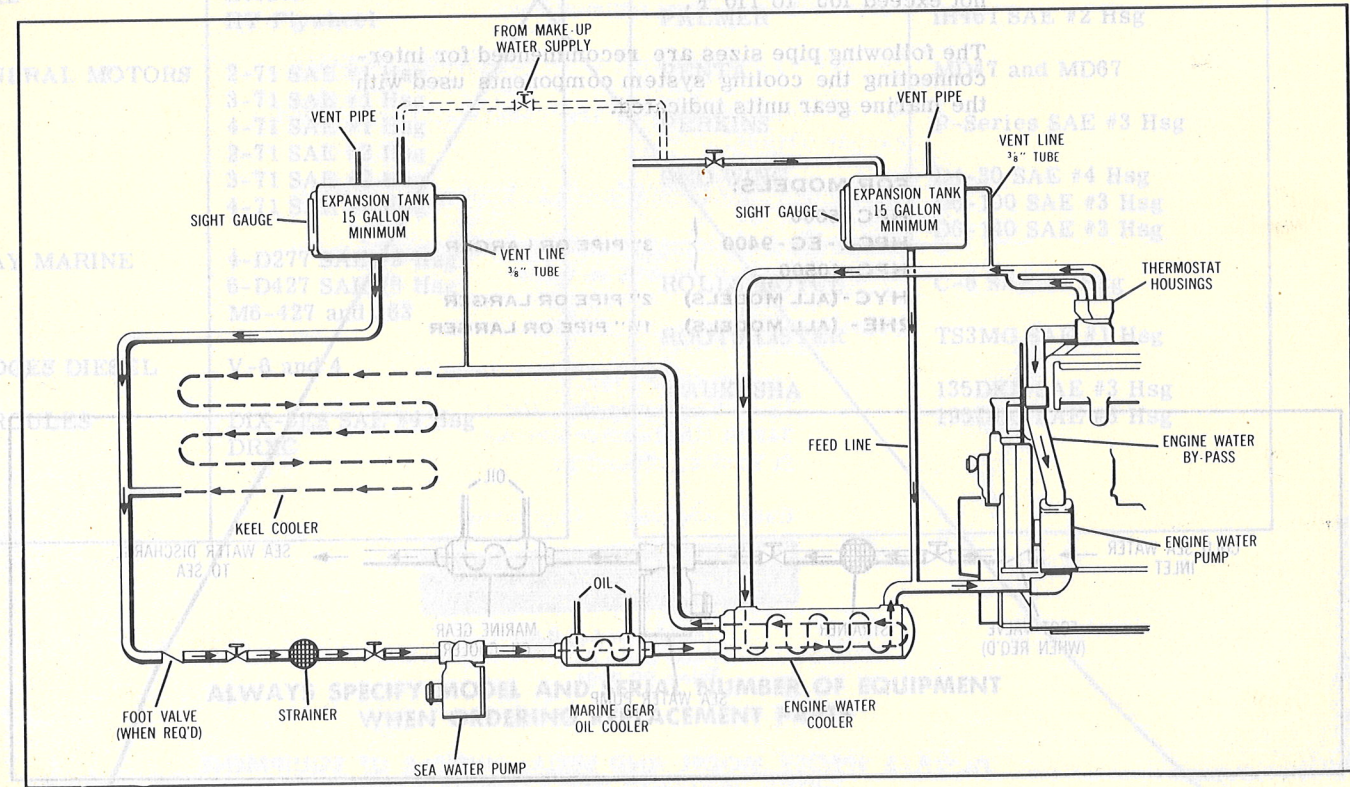
(Auto Engine Works, Inc.)
349 North Mainline Avenue
St. Paul, Minnesota

TABLE OF ADAPTATIONS

The following table lists the adaptations which are made in the construction of the unit to order. To order the unit with the adaptations indicated in this table, check the appropriate boxes in the table.



HEAT EXCHANGER SYSTEM



KEEL COOLER SYSTEM

CAPITOL GEARS, INC.

Service Manual

2 HDA AND 2HDC-200
DIRECT DRIVE

Model 2 HD . EC 8900
Serial 294 - SR
2,5 - 1

Den Oever
0227-511841

MARINE REVERSE
AND
REDUCTION GEARS