SERVICE MANUAL

HY 28000 & HP 28000
MARINE TRANSMISSIONS

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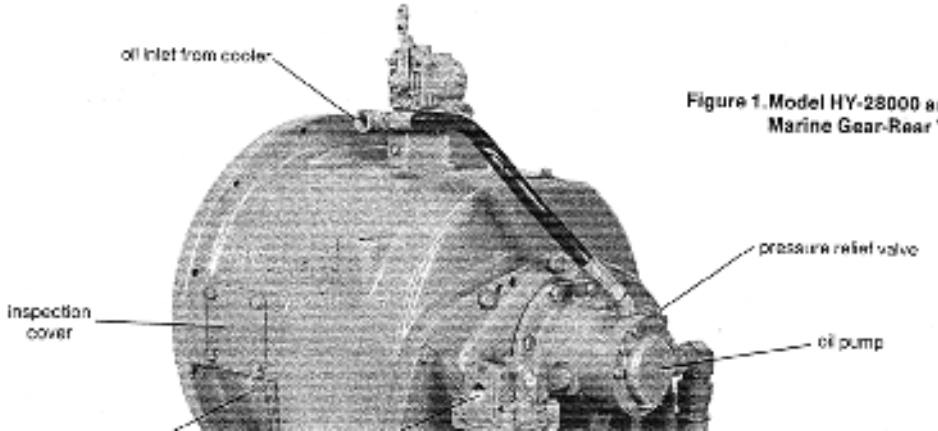


Figure 1. Model HY-28000 and HP-28000 Marine Gear-Rear View

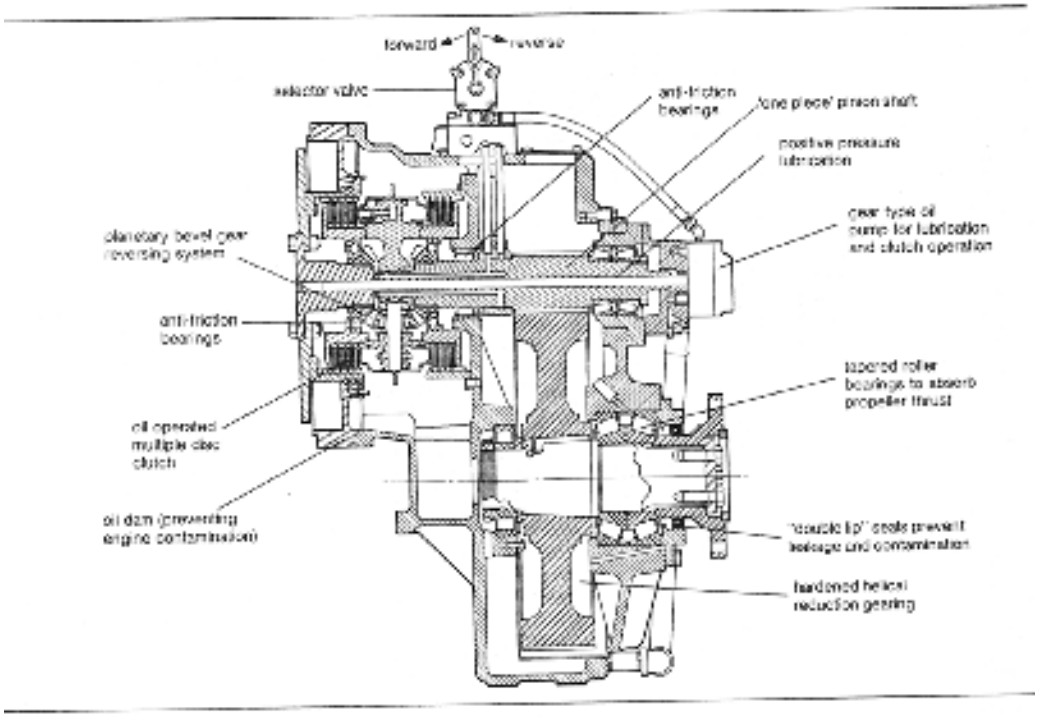


Figure 3. Cross-Section With Special Features

SECTION 1. INTRODUCTION

The function of this manual is to provide information for the installation, operation, maintenance and repair of the “CAPITOL” reverse and reduction marine gear. This manual should be made readily available to all those

cylinders, clutch discs and a planetary bevel gear reversing system. The reduction gear assembly for anti-engine rotation consists of a pinion and driven gear arrangement. The engine rotation unit is created by the addition of an idler gear to the reduction assembly. A selector valve provides shifting to forward, neutral or reverse. An oil

pump supplies oil pressure for clutch engagement, and lubrication for bearings, gears and clutch. The marine gear is direct mounted to the engine flywheel by means of a flywheel adapter and an oil dam keeps the marine gear sump free from engine contamination.

1.2 REDUCTION RATIOS

Various reduction ratios are available depending on the desired difference between engine speed and propeller speed. These ratios are subject to change and are available upon request.

The HP series is of greater capacity than the HY and the clutch pack and pinion shaft diameter vary slightly. However, the two models are similar in design and the function of parts , maintenance procedures, etc. for both units is the same.

1.3 ACCESSORIES

OIL COOLER
Various capacity coolers are available depending on engine horsepower and type of use, and are purchased optionally. However, an oil cooler must be used with a Capitol marine gear unit.

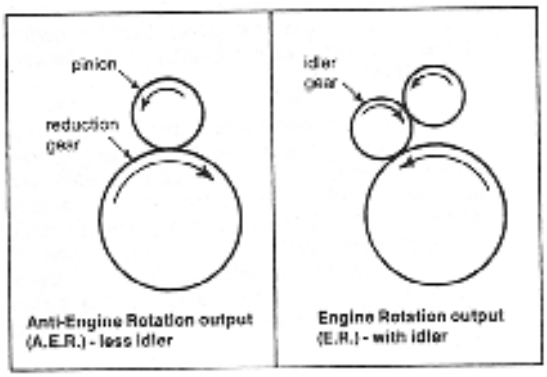
COUPLING KIT

A prop shaft coupling kit, included mounting bolts is available to meet most requirements.

SECTION 2. PRINCIPLES OF OPERATION

2.1 GENERAL

The Capitol reverse and reduction gears are available in several reduction ratios. The marine gear unit is normally supplied for a right hand engine (when viewed from the front) and an anti-engine rotation output. This results in a right-hand rotation of the propshaft in forward. For twin screws installations, where two right hand engines are used, the port unit is furnished with an idler gear. This produces an engine rotation output, thus the propellers can be turning opposite to each other in outboard direction.



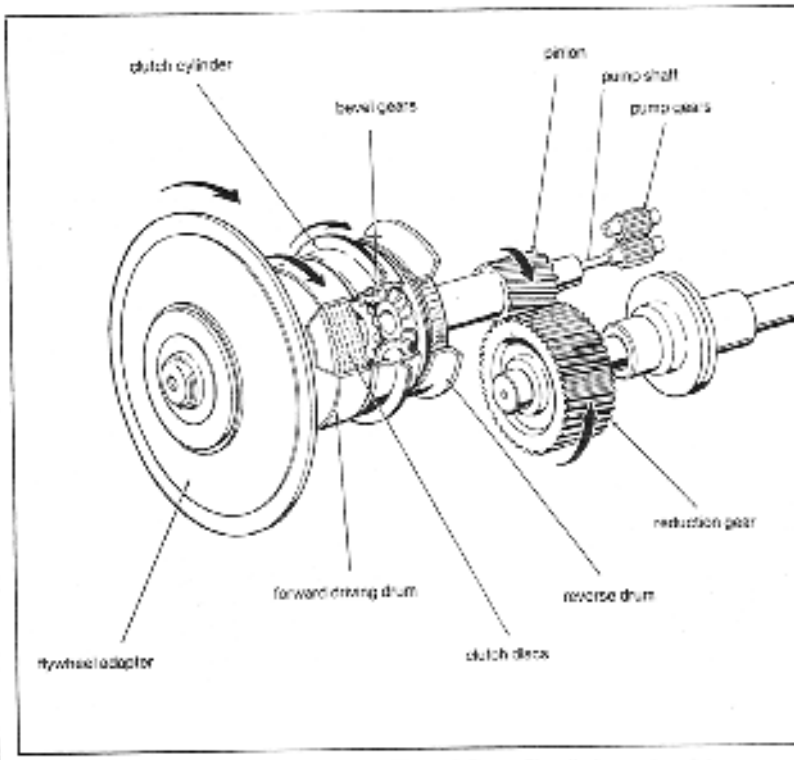


Figure 4. Power Flow (in forward mode)

The stub shaft, clutch driving drum and forward clutch driving discs always rotate at engine speed. When the forward clutch is activated the clutch pack rotates in engine direction. The pinion, rotating at engine speed, drives the reduction gear. The output speed is determined by the reduction ratio (The number of teeth in the reduction gear compared to the number of teeth in the pinion, e.g. 3:1, 4:1, etc.)

When the reverse clutch is activated, the clutch pack is held stationary to the housing. Power is transferred through the bevel gears, reversing the rotation of the pinion gear, thus causing the reduction gear and output coupling to rotate in reverse mode.

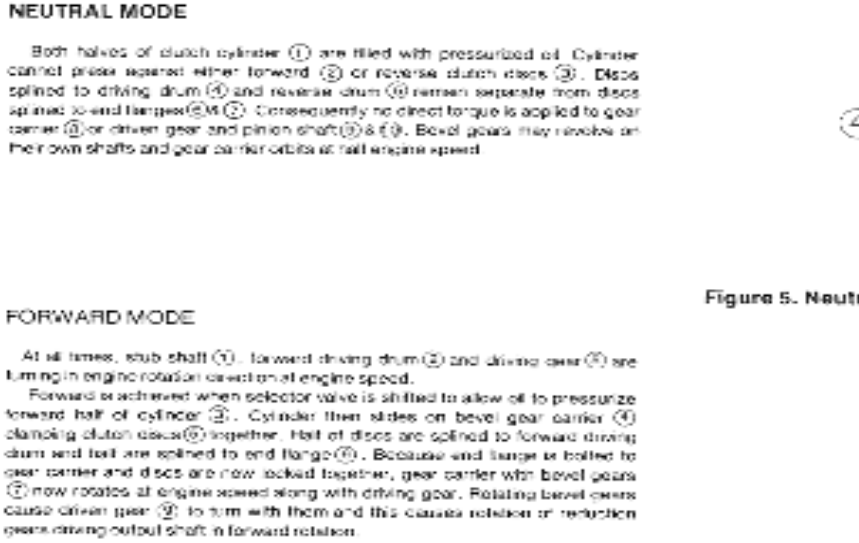
In forward mode the entire clutch pack rotates in fixed conjunction with the engine. In this way there is minimal loss of power from the engine.

2.3 REVERSE GEAR CASE AND CLUTCH ASSEMBLY

The clutch assembly is a multiple disc type clutch activated by a hydraulic mechanism. This mechanism is formed by a carrier for the bevel gears and by two cylinders bolted together which act as the clutch pistons. The movement of the cylinders is regulated by the selector valve, which directs pressurized oil to the proper cylinder depending on the mode selected. The bevel gears inside the carrier transmit power flow to the pinion.

The clutch operates as follows:

A. 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. Springs in the gear case aid in centering the cylinder when returning to neutral from forward or reverse positions.



NEUTRAL MODE

Both halves of clutch cylinder ① are filled with pressurized oil. Cylinder cannot press against either forward ③ or reverse clutch discs ⑤. Discs splined to driving drum ④ and reverse drum ⑥ remain separate from discs splined to end flanges ⑧ & ⑨. Consequently no direct torque is applied to gear carrier ⑩ or driven gear and pinion shaft ⑪ & ⑫. Bevel gears may revolve on their own shafts and gear carrier orbits at half engine speed.

Figure 5. Neut

FORWARD MODE

At all times, stub shaft ①, forward driving drum ② and driven gear ⑦ are turning in engine rotation at full engine speed.

Forward is achieved when selector valve is shifted to allow oil to pressurize forward half of cylinder ③. Cylinder then slides on bevel gear carrier ④ clamping clutch discs ⑤ together. Half of discs are splined to forward driving drum and half are splined to end flange ⑧. Because end flange is bolted to gear carrier and discs are now locked together, gear carrier with bevel gears ⑦ now rotates at engine speed along with driving gear. Rotating bevel gears cause driven gear ⑫ to turn with them and this causes rotation of reduction gears driving output shaft in forward rotation.

Figure 6. Forw

2.3 REVERSE GEAR CASE AND CLUTCH ASSEMBLY

B. 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 bevel gear carrier) are clamped against the clutch driving discs splined to the forward clutch driving drum. This provides a transfer of power from the engine to the reduction gears resulting in the forward motion of the boat.

C. Reverse position: Oil is exhausted from the forward cylinder. The pressure in the rear cylinder clamps 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 causing the engine to transmit power to the pinion shaft via the bevel gears, which reverse the rotation of the pinion shaft. Thus- backward motion of the boat is obtained.

REVERSE MODE

Reverse is achieved when cylinder (1) is pressurized and slides against reverse clutch discs (2) clamping them together. Half of the discs are splined to the stationary reverse drum (3) and half are splined to end flange (4) bolted to gear carrier (5). Rotating gear carrier then drives the bevel gears (6) now rotable on their shafts causing driven gear (7) to turn in anti-engine direction producing reverse output.

pressure oil ■ exhaust oil ■

Figure 8. Clutch Pressure Circuit —Neutral

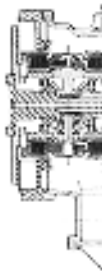


Figure 9. Clutch Pressure and Exhaust Circuit —Forward

Figure 10. Clutch Pressure and Exhaust Circuit —Reverse

2.4 HYDRAULIC SYSTEM

Oil is supplied to the hydraulic and lubrication systems of the marine gear by means of an oil pump provided with a pressure regulating valve to maintain the correct oil pressure. The pump is driven directly from the engine flywheel by means of a splined shaft. Consequently, oil is being circulated throughout the unit when the engine is running. The oil is continually circulated through a filtering screen and an oil cooler. An oil dam completely separates the marine gear lubrication system from the engine lubricating system.

SECTION 3. INSTALLATION AND OPERATION

3.1 UNCRATING AND HANDLING

Tapped holes have been provided for insertion of lifting hooks to aid in handling of unit. Average weight of HY 28000 is 1800 lbs. The HP-28000 is 1900lbs.

Check parts for shortage and any damage that may have occurred (the parts information section may be used as reference). Report immediately any shortage or damage to your local distributor, transfer agent or Capitol Gears.

3.2 PRELIMINARY INSTALLATION

SPECIAL TOOLS REQUIRED

1. Chain hoist or equivalent
2. Straight edge
3. Feeler gauge
4. Thousandths dial indicator

The insure proper alignment of driving members it is recommended that engine flywheel housing, flywheel, oil dam and stub shaft be dial indicated to insure trueness.

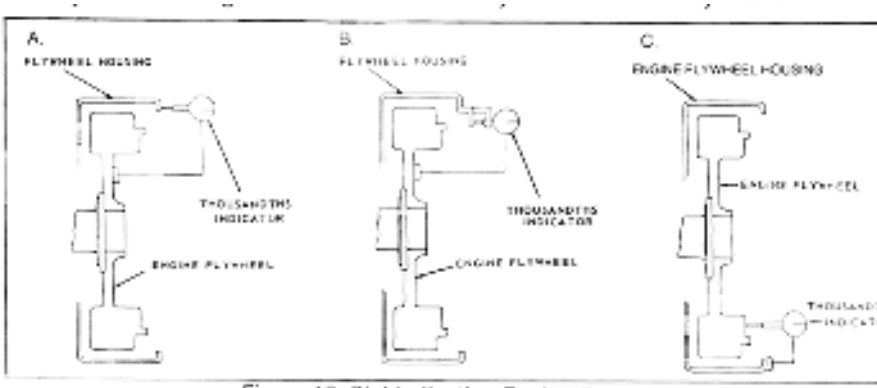


Figure 12. Dial Indicating Engine Flywheel and Flywheel Housin

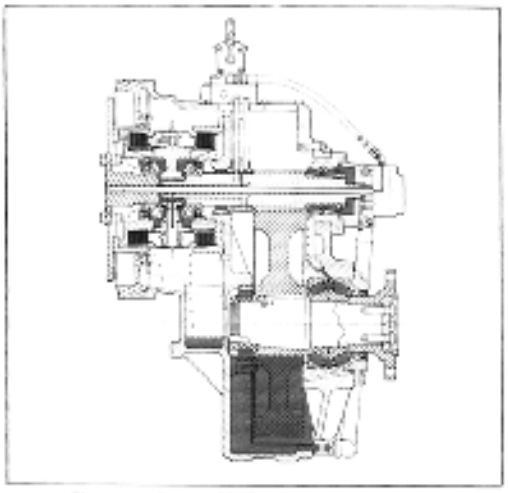


Figure 11. Internal Lubrication Oil Diagram

1. (fig 12A) Dial indicate the bolt face of the engine flywheel housing flange. Rotate engine flywheel. Record reading. Face deviation must not exceed a total indicator reading of .007 inch.

2. (Fig 12A) Mount indicator with stern riding on flywheel housing bore as shown. Rotate flywheel and record reading. The bore eccentricity must not exceed a total indicator reading of .007 inch.

3. (Fig. 12C) Set stern to ride on the pilot bore of the engine flywheel as shown. Record reading. Pilot bore eccentricity must not exceed a total indicator reading of .007 inch.

The sum total of all readings in steps 1 through 4 must not exceed .007".

5. Separate the clutch driving drum and flywheel drive flange assembly from the clutch assembly.

Remove clutch driving drum from the flywheel drive flange, leave stub shaft attached.

6. Thoroughly clean the drive flange to flywheel mating surface and secure drive flange to flywheel.

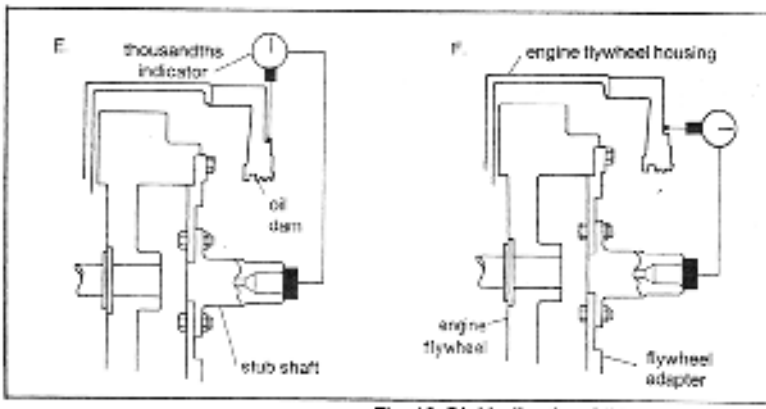


Fig. 13. Dial Indicating Oil Dam and Stub S

7. Bolt on flywheel adapter and stub shaft assembly to engine flywheel.

8. Secure oil dam on engine flywheel housing with 2 cap screws. "Top" mark goes up, or drain slots down.

9. Dial indicate rear oil dam pilot O.D as shown in figure E and dial indicate bolt face as shown in figure F. Record both readings. Total indicator readings must not exceed .007 inch.

10. Dial indicate stub shaft as shown in figure G. Record the reading. Total indicator reading must not exceed .007 inch.

The sum total of all readings in steps 9 and 10 must not exceed .007 inch.

11. Check clearance between drive flange O.D and oil dam ID with feeler gauge. Minimum clearance must not be less than .006". Secure with self locking fasteners.

12. If slinger shield is present on unit, remove slinger shield.

13. Install clutch driving drum on flywheel adapter sealing with #2 Permatex.

14. Reassemble slinger shield, if present, to oil dam, replace and tighten cap screws. Secure cap screws with lockwire.

15. Place subassembly consisting of clutch and gear carrier in position on splines of driving stub shaft. Note: The forward pack contains the greater number of discs and it goes toward the engine. Also the forward end flange is stamped "this side toward engine".

16. Remove the side inspection covers to facilitate installation.

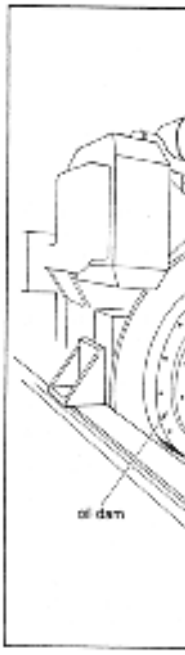


Fig. 14.

3.3 INSTALLATION OF MARINE GEAR

1.Using suitable hoist, lift marine gear assembly into position behind engine. Ease unit forward over clutch assembly, taking care that clutch discs enter reverse clutch drum properly so that teeth are not damaged.

NOTE:
Use screwdriver through side inspection hole and move disc teeth to align with reverse drum

2. Secure main housing to oil dam housing. Tighten cap screws to 42 foot-pounds torque (HY units) and 30 foot-pounds torque (HP units)

Check clutch end float:
a) insert screwdriver through side inspection hole and pry clutch fore and aft.
End float should be 1/6” to 3/32”.
b) Replace gasket and inspection covers.

3. Turn reduction gear over for several revolutions with bar making sure gear is free to turn.

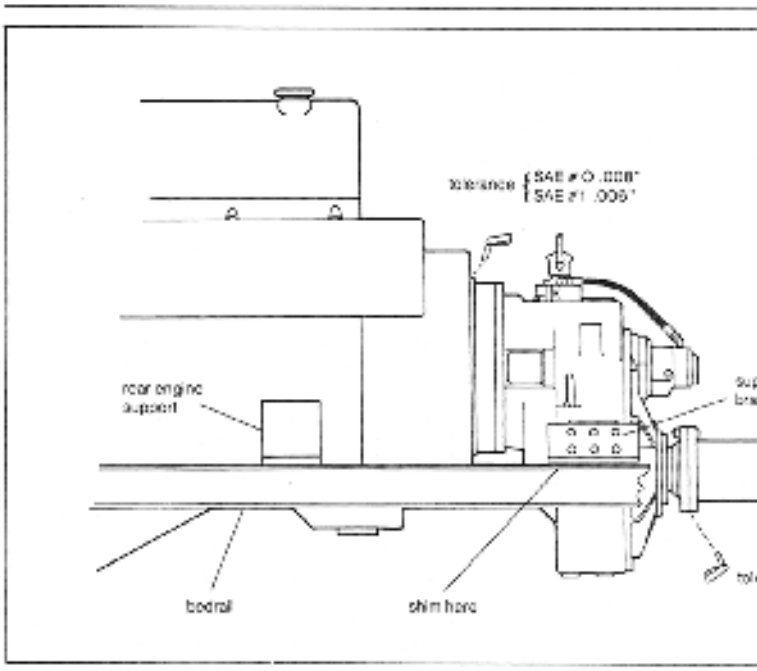


Fig. 15. Alignment of the Engine and the Marine Gear

3.4 ALIGNMENT

Final alignment of output flange and propeller shaft coupling must be accomplished when the vessel is afloat and not in dry dock, because most hulls will flex. This is positively necessary to meet warranty requirements.

Mounting pads on housing permit unit to be bolted to bed rails, power plant frame, keelsons etc.

The distance of the first shaft bearing from the mating surface of the marine gear output coupling is extremely important. To avoid undue force on the marine gear bearings, the propeller shaft bearing should be located at least twelve and preferably twenty shaft diameters from the marine gear output coupling.

NOTE:
The same alignment procedures should be followed even if a flexible coupling is used. The most accurate method is to use a non-flexible spacer of the same size. Flexible couplings are used only to dampen noise and vibration not to correct misalignment.

3.5 WATER PIPING

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

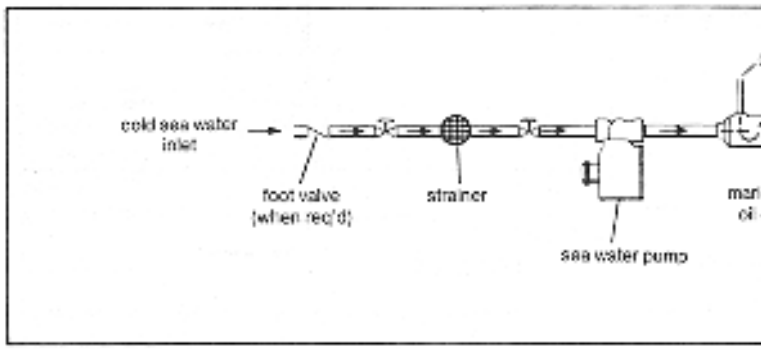


Fig. 16. Separate pump system

Now align propeller shaft coupling to marine gear coupling. Lay a straight edge across the edges at top and sides to line up couplings. Do no burr or mar mating surfaces. Insert feeler gauge between couplings and run it all around the flange. Clearance should not be more than .006" at any point. Shim engine and marine gear as necessary.

Loosen gear housing to engine housing bolts and check with feeler gauge. Maximum variation for SAE #0 housing .008"; for SAE #1 housing .006".

Tighten four gear housing cap screws at 90° intervals. Secure engine and gear mounting feet. Loosen four gear housing bolts. Recheck housing and coupling parallelism. If within tighten housing and coupling bolts.

NOTE:
Under no condition is the engine to be supported by gear housing.

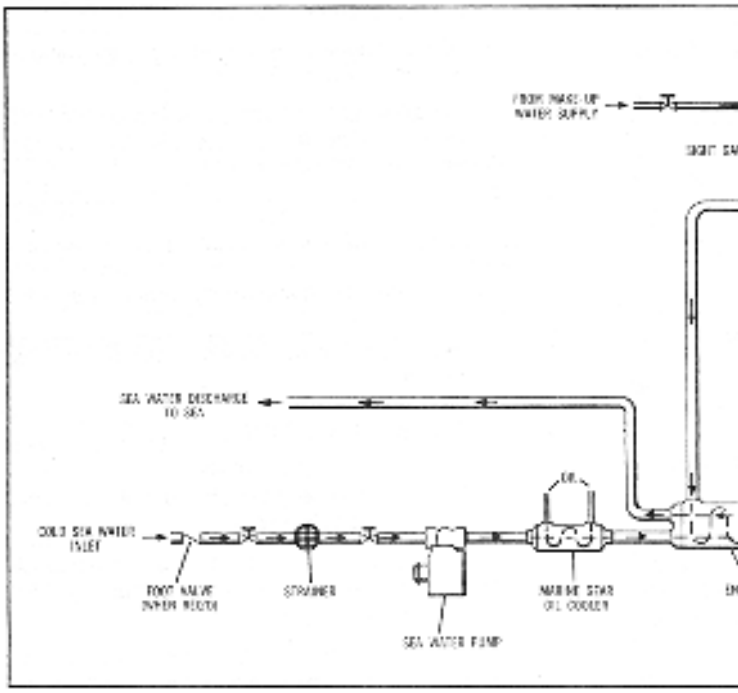


Fig. 17. Heat exchange system

The connections shown on the following diagrams are recommendations for optimum performance.

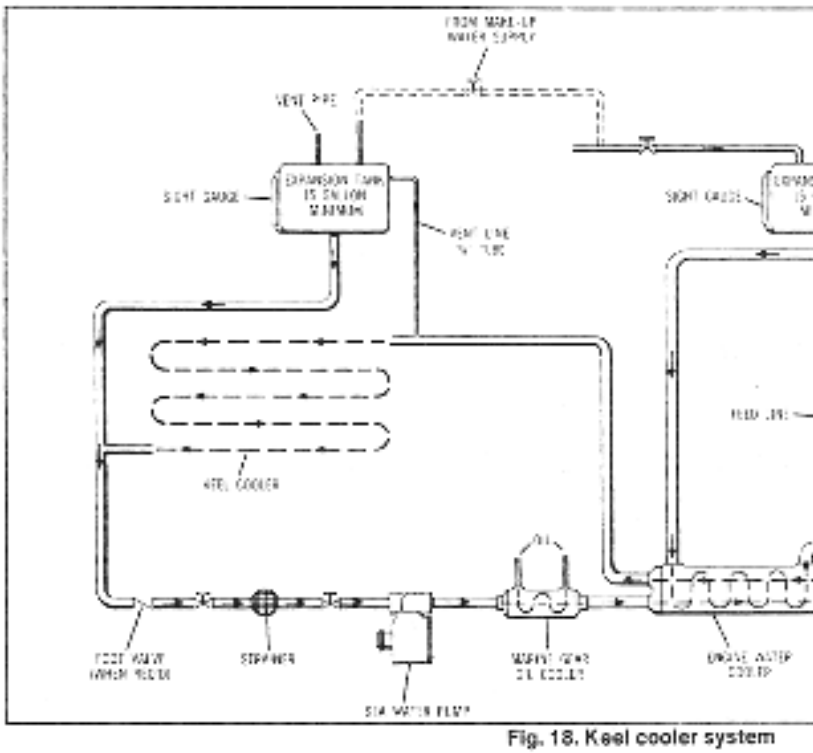


Fig. 18. Keel cooler system

3.6 START UP PROCEDURE

1.Remove reduction gear inspection cover and pour in recommended oil until level is up to full mark on dipstick (see lube chart). Replace inspection hole cover but do not secure.

2. Install pressure gauge of 300 pound capacity directly on top of gear or on bulkhead. Connect gauge to control valve with 1/8” steel tubing or hydraulic hose. (note: Electric type oil pressure gauges are not recommended.)

Marine gear is now ready for start up.

3. Engage starter for approximately 30 seconds. (DO NOT START ENGINE.) This activates pressure pump which pre-lubricates marine gear, preventing premature wear before load is applied.

4. Start engine and check all connections for leaks.

5.Oil pressure is adjusted at factory for testing purposes only and it may be necessary to readjust pressure to the correct level (200-210 PSI). This should be done at normal operating speed only after maximum temperature is achieved.

6. After unit has been operated a few minutes, stop engine, check oil level and add sufficient oil to bring level to full mark on dipstick. (see lube chart for capacities, opposite.)

7. Shift several times to insure that all cylinders, hoses and cooler are full of oil.

8. Install selector valve cables and shift to insure valve lever goes into full detent in all 3 positions: forward, neutral and reverse.

9. Marine gear is now ready for sea trials and final adjustments

3.7 OPERATING PRACTICES

CAUTIONS
1. A capitol marine gear should not be shifted unless engine is at idle speed.

2. Marine gear cannot be operated continuously in reverse mode for more than 30 mins at 75% of available horsepower.

3. 'Windmilling' (freewheeling) is strictly prohibited as extensive internal damage may result. In the case of a twin screw application where only one engine may be used a great deal, shaft breaks should be installed (as an alternative an auxiliary lube system may be installed).

SECTION 4. PREVENTATIVE MAINTENANCE

To insure a long service life of the Capitol Marine gear and to prevent costly and unexpected failures it is very important that a regular maintenance schedule be established and followed.

4.1 LUBRICANTS

For all normal ambient operating conditions, 30°F (-1°C) to 85°F (29°C), we recommend a good grade, anti-foaming, heavy duty, SAE 30 motor oil.

Where high ambient temperatures are encountered, over 85°F (29°C), it may be necessary to use SAE 40 motor oil.

Where extremely cold ambient temperatures are encountered, under 30°F (-1°C), it may be necessary to use SAE 20 motor oil.

Oil capacity
HY and HP 28000:
Approximately 30 to 32 quarts.

Bring oil up to full mark on dipstick. Operate unit in forward and reverse for several minutes. This will fill: cooler, clutch cylinders, pump hoses etc. Stop engine and all required oil to return level to 'full' mark on dipstick.

Oil pressure
Operating oil pressure must be at least 200-210 PSI at normal operating speed and maximum operating temperature.

Pressure adjustment
See fig. 20 p.17

Oil temperature

Operating oil temperature range is 160°F (71°C) at control valve, 160° to 180° (82°C).

4.2 ROUTINE MAINTENANCE

Oil Cooler Assembly

Check zinc pencils in oil cooler and change if badly eroded. Check zinc pencils at approximately every 400 hours of operation.

Check water tubes for obstructions at approximately every 2000 hours of operation and flush if necessary.

Oil filter
The oil filter element should be replaced every 400 hours of operation or at the same time oil is changed.

Oil Breather
Remove oil breather every 400 hours of operation or at the same time oil is changed. Clean diesel fuel can be used for flushing.

Pressure gauge
Periodically check pressure gauge by substituting a calibrated pressure gauge of known accuracy.

Visual inspection
At frequent intervals check all oil lines, water hoses, and connections for leaks. Tighten all external bolts and connections and visually inspect external components for wear or damage.

Wear analysis
At periodic intervals record pressure readings at idle speed. A gradual decline is normal. Readjust pressure relief valve to maintain proper operating pressures. See fig.20. p.17.

Inspection/Overhaul Interval
A complete inspection of the Capitol marine gear should be made at least as often as the engine is overhauled. Parts such as commutator bushings, oil seals, quad rings, clutch discs, bearings etc. Showing any fatigue or wear should be replaced. It may be desirable to completely rebuild the marine gear at this time (see sect. 7).

4.3 MAINTENANCE SCHEDULE AND CHECK SHEET

Ship's No._____
Engineer_____
Marine gear serial no._____
Date service began_____

INTERVAL Normal operation	MAINTENANCE DESCRIPTION	RECORD
DAILY	-Check oil level -Check oil pressure	
After first 100 hours	-Change oil and flush sump	☐
Every 400 hours	-Check zinc pencils -Change oil -Replace filter element -Remove and clean oil breather	

Every 2000 hours	-Check gear backlash -Check water tubes in cooler	
At engine overhaul	-Inspect clutch and all gearing and replace as necessary	
Frequently	-Check all oil lines and connections -Check all external components -Check all mounting bolts -Check alignment	

SECTION 5. TROUBLE SHOOTING

5.1 TROUBLE SHOOTING

SYMPTOM	PROBABLE CAUSE	REMEDY
A. Low oil pressure (at full operating speed And temperature).	1. Low oil level	Inspect gaskets, seals, hoses & fittings for leakage.
	2. Clogged suction screen	Remove suction screen and clean with a good grade solvent or diesel fuel.
	3. Clogged filter element	Replace element
	4. Dirt or sludge in marine gear	Remove drain plugs, flush gear with commercial solvent or diesel fuel. Start engine; at idle shift gear several times, full forward to full reverse for approx. 5-7 min. Shut down engine and drain gearbox thoroughly. Refill gear with proper oil and run for approx. 25 to 50 hours. Drain gearbox and refill with new oil. This will remove any residual solvent.

	5. Worn or incorrectly adjusted pump assembly	Refer to oil pump section (page 16) or fig. 20 p.17
	6. Oil too hot	Check heat exchanger system for clogged oil cooler or hoses.
	7. Worn commutator bushings	See wear limits chart (p.21)
	8. Incorrect lubricant	See lube chart
	9. Scratched clutch cylinders or hard 'O' rings in clutch cylinders	replace as necessary
B. High oil pressure (at full operating speed and temperature).	1. Incorrectly adjusted pump assembly	Refer to figure 20.
	2. Inoperable relief plunger	Refer to p.16
	3. Incorrect oil	See lube chart
	4. Oil too cold	Check heat exchanger system
C. Overheating	1. Insufficient oil cooler Capacity	Install adequate oil cooler
	2. Insufficient flow of cooling water	Increase water line size
	3. Clutch slipping	Refer to symptom A
	4. Water temperature too high at cooler	Decrease water temperature to cooler or relocate heat exchanger in cooling system
D. Excessive noise in Marine gear	1. Bearings worn or broken	Inspect bearings for scored races, broken roller, flat spots…
	2. Gears worn or broken	Inspect gears and measure backlash (refer to replacement wear limits chart).
	3. Noise in forward only	Reverse position may be mistakenly used for forward. Selector valve lever must point forward when boat is in forward motion.
	4.Noise in reverse only	This is normal because more gears are in operation in reverse mode

E. Noisy Pump	1. Dirt or sludge in oil	Remove oil pump and hoses. Clean thoroughly and reinstall
	2. Clogged hoses	Clean and replace as required
	3. Pump cavitation	Inspect suction hoses for leaks. Oil level may be too low.
	4. Defective oil pump assembly	Refer to repair and overhaul selection
F. Clutch does not release	1. Improper oil in sump	Refer to lube chart
	2. Clutch disc warped	Replace as necessary
	3. Forward and reverse clutch cylinders dirty or distorted	clean or replace as necessary
	4. Rear commutator bushing is worn	Replace as necessary see wear limits
	5. Clutch discs fused due to slippage and overheating	replace as necessary
G. Clutch slippage	1. Low oil pressure	see symptom A
	2. Oil temperature too high	Temperature should be 160F (71C), selector valve, 160-180 at sump. Check heat exchanger system.
	3. Worn clutch discs	Replace as necessary
	4. Improper oil	See lube chart
H. Clutch burned out	1. Low oil pressure	1. See symptom A
	2. Clutch is shifted at other than engine speed	install interlock shift control
	3. Marine gear misaligned	Check alignment as described in installation section pg.7.
	4. Excessive heat	Check cooling system
I. No neutral	1. Warped clutch discs	replace as necessary
	2. Scored clutch cylinders	replace as necessary
	3. Damaged seal rings	Replace all seal rings
	4. Worn or damaged	refer to repair and overhaul

	commutator bushing	section. See wear limits
	5. Worn control valve	Replace if necessary. Note: Control valve is the least likely source of trouble.
J. Delay in clutch engagement	1. Cylinder timing screw out Of adjustment	remove dome nut and adjust screw (counter-clockwise) to speed up reaction
K. Clutch engages too fast	1. Cylinder timing screw out Of adjustment	Remove dome nut and adjust screw in (clockwise) to delay reaction