SERVICE MANUAL
HY-24000 & HY- 25000
Marine Transmission

NOTE

THIS SERVICE MANUAL IS
GUARANTEED EFFECTIVE
FOR SERIAL NO.
ONLY

CAUTION

DO NOT OPERATE IN REVERSE MODE TO MOVE VESSEL FORWARD

DO NOT OPERATE CONTINUOUSLY IN REVERSE MODE FOR MORE THAN 30 MINUTES AT 75% OF AVAILABLE HORSEPOWER.

DO NOT OPERATE UNTIL OVER 150° F (65°C)

DO NOT OPERATE UNIT WITH HIGH OR LOW OIL PRESSURE

DO NOT 'WINDMILL' UNIT IN EVEN OF ENGINE FAILURE (PROP SHAFT SHOULD BE LOCKED TO PREVENT 'WINDMILLING').

DO NOT ATTEMPT FINAL ALIGNMENT OF OUTPUT FLANGE AND PROP SHAFT COUPLING WHEN VESSEL IS IN DRY-DOCK.

DO NOT SHIFT TRANSMISSION UNLESS ENGINE IS AT IDLE SPEED.

DO NOT USE TRANSMISSION TO SUPPORT REAR OF ENGINE.

MODEL HY-25000 MARINE GEAR CAPITOL GEARS INC.

The purpose of this supplement is to provide information pertinent to the installation and servicing of the HY-25000 marine gear.

I. How to use the service manual

The following service manual sections apply fully to both HY-24000 and HY-25000 marine gears:

Section 1. Introduction
Section 2. Principles of Operation
Section 3. Installation
Section 4. Preventative Maintenance
Section 5. Trouble shooting
Section 6. Repair of external subassemblies

Section 7. "Repair of Internal Subassemblies" applies to HY-24000 models. When repairing or overhauling HY-25000 marine gears, consult the appropriate sections of this supplement first, and then go to the service manual.

Section 8. "Repair Parts" applies to HY-24000 models only. When ordering parts for HY-25000 marine gears, refer to the appropriate cross section drawing.

II. Installation

For marine gears furnished with #5 adapter kit (with labyrinth groove type oil seal), follow the procedure given in paragraphs 1 through 11 of section 3.2, "Installation Preparation." Use gasket # 1-01102-3600 between the engine Flywheel housing and oil dam adapter.

Paragraphs 12 through 15 do not apply. Instead, substitute the following procedure:

" At this point, flywheel adapter, drive flange, and oil dam are in place. Clutch driving drum is to be installed directly onto the flywheel adapter. Coat the mating surfaces with sealant, then install drum using the 12 self locking hex head cap screws provided."

Follow the remainder of the installation procedure as given in the manual.

For units with other adapter kits, use the complete installation procedure given in section 3.

III. Remote oil pump

HY-25000 marine gears adapted to Detroit Diesel engines are sometimes furnished with remote oil pumps that are mounted on the engine and driven by one camshaft. Installation of these pumps requires the use of parts not furnished by Capitol Gears. Also, pumps are available for both clockwise rotation (part #1 14279-0000) and counterclockwise rotation (part # 1-14279-0200). See the pump drawing, and plumbing diagram SK880223 furnished with this manual.

IV. Internal Subassemblies- Clutch

HY-2500 marine gears are furnished with clutch parts number 1-00100-5400 (standard clutch). The assembly and disassembly procedure given in the manual may be used, and is correct for either clutch. When ordering repair parts, consult the appropriate subassemblies drawing.

V. Internal subassemblies- Pinion Shaft

On some units, the roller bearing cones are secure at the rear of the pinion shaft by a retainer plate and five socket head, self-locking screws. The method of disassembly and assembly are self-evident. We recommend heating the bearing cones in hot oil to ease installation. Torque the screws evenly to 25 LB. FT torque; Re-torque after parts have cooled.

NOTE: For 2.04 ratio models only, pinion with its bearings and bearing retainer may be removed or installed while the rear cover remains in place on the housing.

VI. Internal subassemblies- Output gear rear bearing

The bearing cup is pressed into an iron cap that also carries the rear oil seal, bearing endplay is adjusted by adding or removing shims as necessary. Correct endplay is between zero and .002 inches.

VII. Oil Filters

HY-2500 marine gears in current production (serial numbers 10200-0186 and higher) are supplied with a 25-micron, paper element type oil filter to be pumped into the high-pressure oil circuit (part # 1-13811-1000). The filter element should be replaced after the first 100 hours of operation and every 400 hours thereafter. This element cannot be cleaned, see the drawing on page 58 a.

Earlier HY-25000 marine gears as well as all HY-24000 and HY-22000 were furnished with a metal screen type oil filter mounted in the suction line between sump and oil pump. The elements in these filters may be cleaned and re-used. See the drawing on page 58. NEVER USE PAPER FILTER ELEMENTS IN A SUCTION SIDE FILTER!

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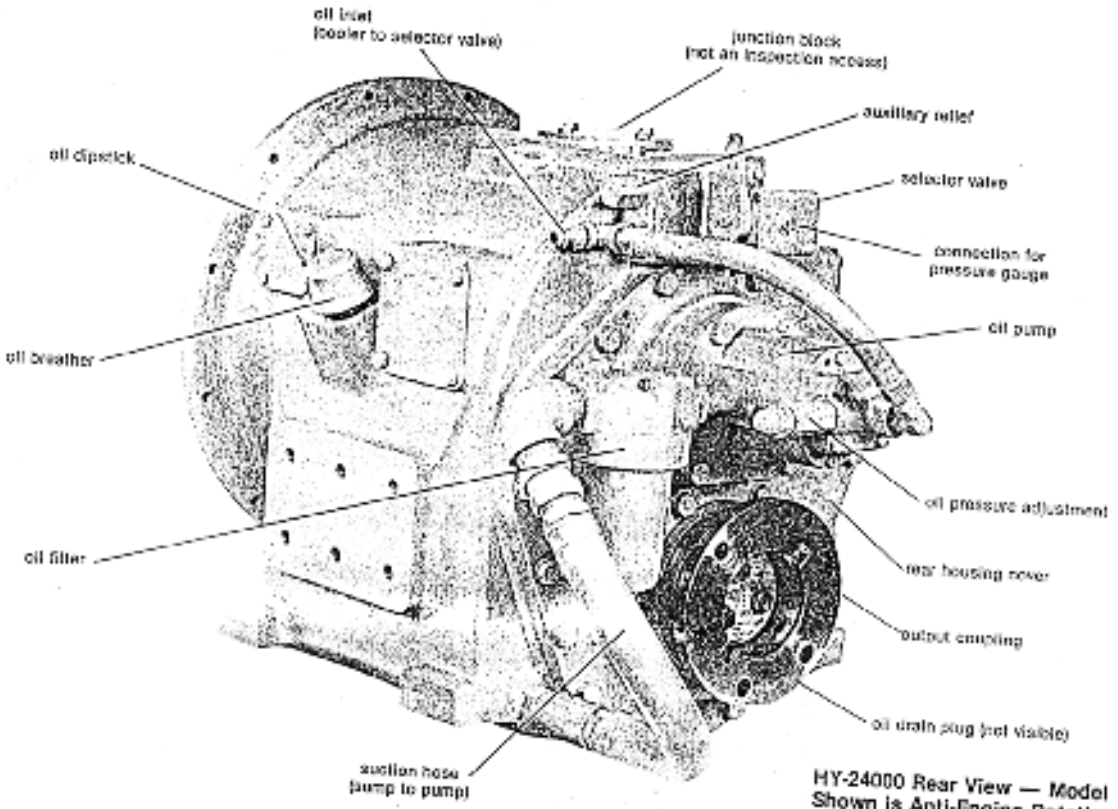
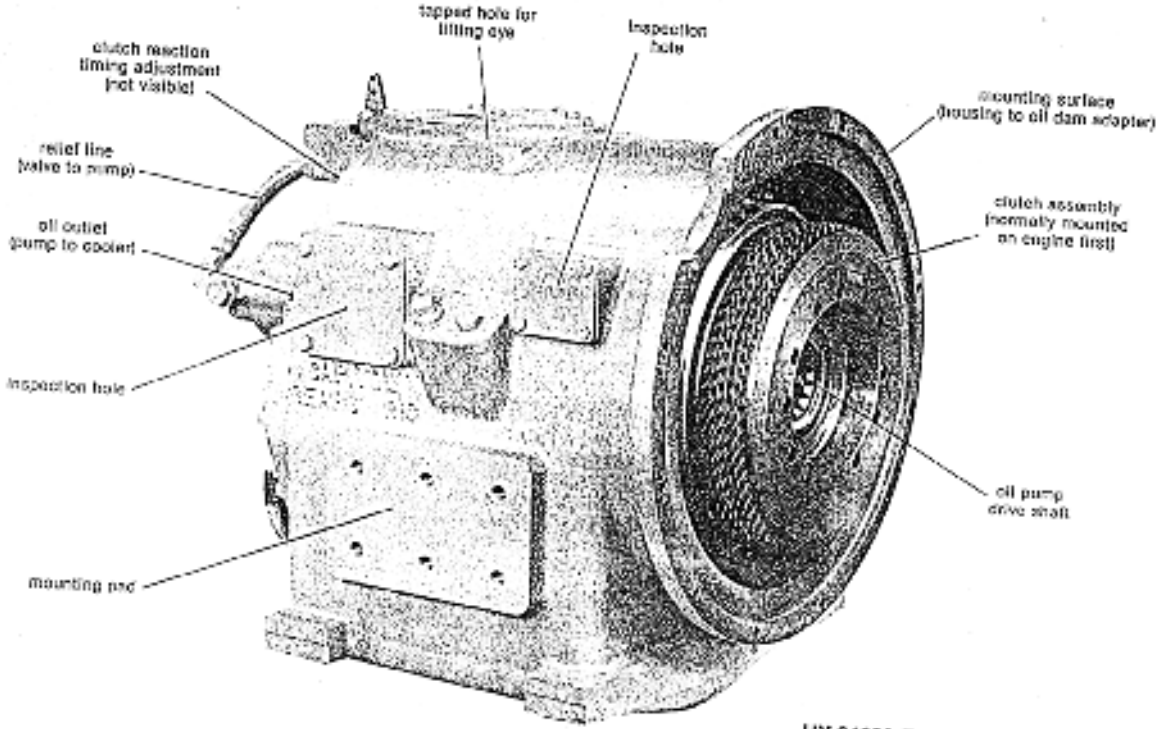


HY-24000 Rear View — Model Shown is Anti-Engine Rotation (A.E.R.) for Right Hand Engine.



HY-24000 Front View — Adapter Parts are Not Shown.

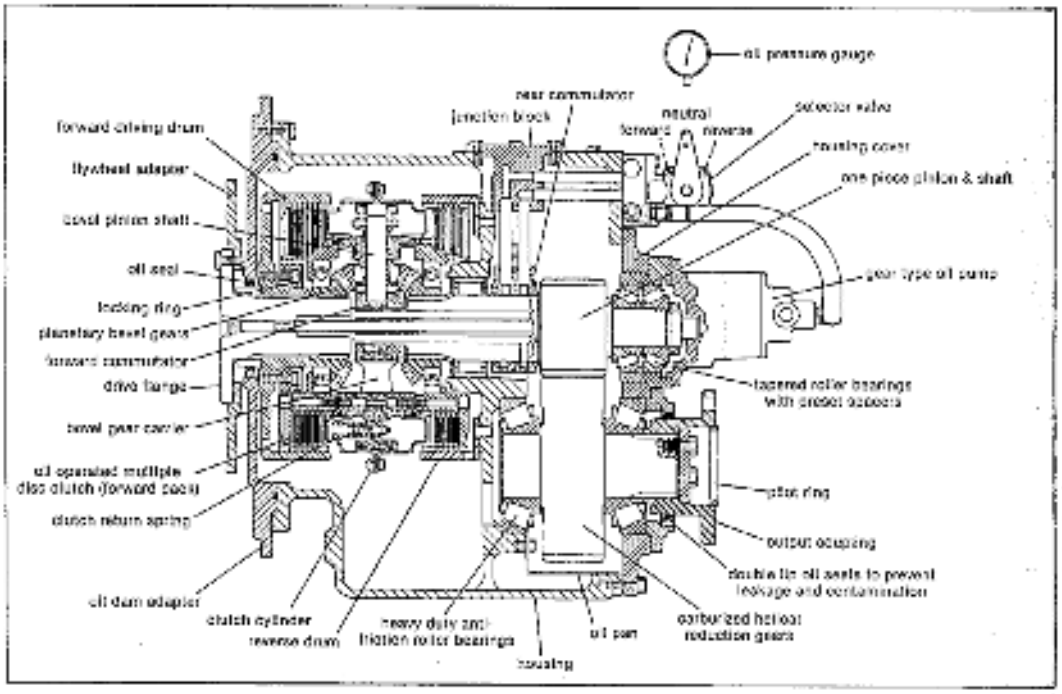


Figure 1. Cross Section Showing Components and Design Features.

SECTION 1. INTRODUCTION

The purpose of this manual is to provide assistance to operation and maintenance personnel to reduce downtime and obtain consistent performance from the Capitol HY-24000 Marine Transmission.

This service manual contains thorough installation and operation procedures, steps for proper maintenance and repair, a trouble-shooting guide for assessing difficulties promptly, and illustrated parts information section, and engineering drawings for fabricating special tools. It should be made readily available to all those responsible for the operation or servicing of the transmission.

Performance characteristics and other details may be obtained from the engineering department of capital gears inc. St. Paul, Minnesota, U.S.A.

1.1 DESCRIPTION

The Capitol marine transmission is operated hydraulically, the clutch is activated by high-pressure oil and the gears, bearings and clutch discs are lubricated and cooled by low-pressure oil.

The marine gear consists of six major groups of parts; adapter group, clutch pack, oil pump, selector valve, pinion, shaft and reduction gear. The adapter parts vary according to engine application and include a flywheel adapter, drive flange, an oil dam/housing adapter that prevents engine oil contamination and a clutch driving drum. The clutch pack consists of reciprocating cylinders, clutch discs and a planetary bevel gear reverse system. The oil pump supplies oil pressure for clutch engagement and lubrication of bearings, gears and clutch. The selector valve is used to obtain forward neutral or reverse. The one-piece pinion and shaft drives the output gear directly or through an intermediary gear called an idler.

1.2 OPTIONAL EQUIPMENT

OIL COOLER
Various capacities oil coolers for salt or fresh water are available depending on engine size and are purchased optionally. However, an oil cooler must be used with a Capitol marine transmission.

HOSE AND FITTING KIT
Kits that include the necessary hose and fittings are available for use with Capitol oil coolers.

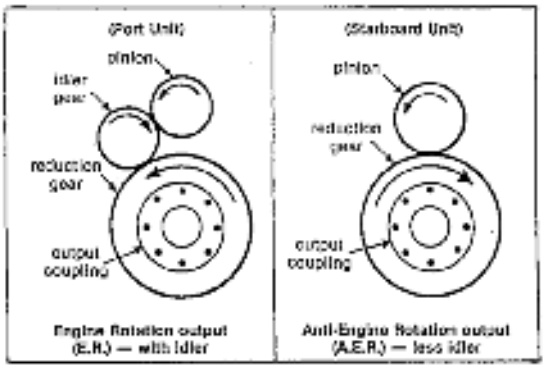
CLUTCHES
A forward-neutral clutch and a forward-neutral brake clutch are available in addition to the standard forward-neutral-reverse model.

KEYED OUTPUT SHAFT & COUPLING KIT
A keyed output shaft and a pilot bored prop shaft coupling kit are also available.

SECTION 2. PRINCIPLES OF OPERATION

2.1 OUTPUT ROTATION

The Capitol marine gear in forward mode provides output rotation in the opposite direction as engine rotation. The marine gear unit is normally supplied for a right hand engine (when viewed from the front). This produces a right hand rotation output of the prop shaft in forward (When viewed from the rear of the transmission). For twin-screw installations, where two right hand engines are used, the port unit is furnished with an idler gear. The idler gear produces, in forward, and output rotation the same as engine rotation.* Thus the two propellers can be turning opposite each other in outboard direction (see diagram below.) *Note: Engine rotation transmissions are installed on right hand engines only.



2.2 REDUCTION RATIO

The reduction ratio is the number of teeth in the reduction gear compared to the number of teeth in the pinion, for example, 144 teeth compared to 36, or 4 to 1. Output speed is then a product of engine r.p.m and the reduction ratio; for example 2000 r.p.m x 1/4 = 500 r.p.m output speed. The HY-24000 features three reduction ratios available in anti-engine or engine rotation output. They are 1.00 (to 1) 1.53 and 2.04.

2.3 POWER FLOW

The flywheel adapter, being directly fastened to the engine flywheel continually rotates the drive flange assembly, clutch-driving drum and forward clutch discs at engine speed.

NEUTRAL
In neutral no direct torque is applied to clutch and pinion. Consequently reduction gear and output flange do not rotate.

FORWARD (see fig.2)
When forward is selected the entire clutch becomes locked with the driving drum and rotates at engine speed. The clutch drives the pinion in engine direction and the pinion drives the reduction gear and output flange in anti-engine direction at a speed determined by the reduction ratio.

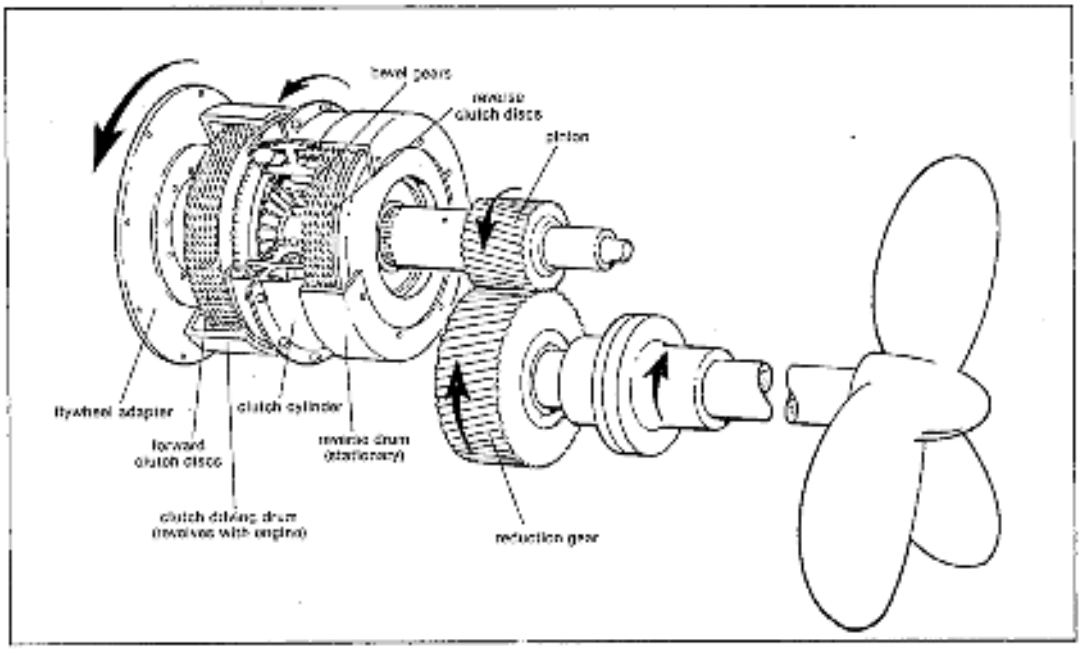
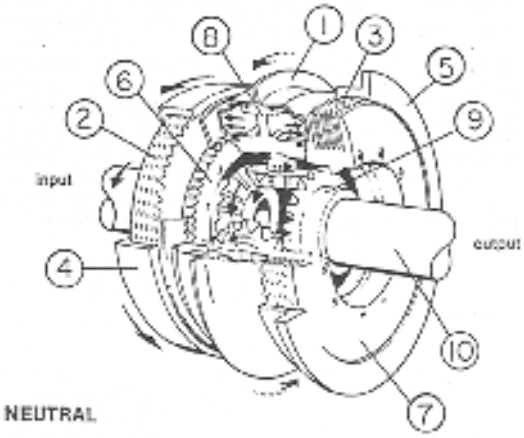


Figure 2. Power Flow (in forward mode).

When reverse is chosen the clutch is held stationary to the housing. Engine power is transferred through the clutch bevel gears and the pinion is driven in anti-engine rotation at engine speed. This causes reduction gear and output flange to rotate in engine direction (reverse).

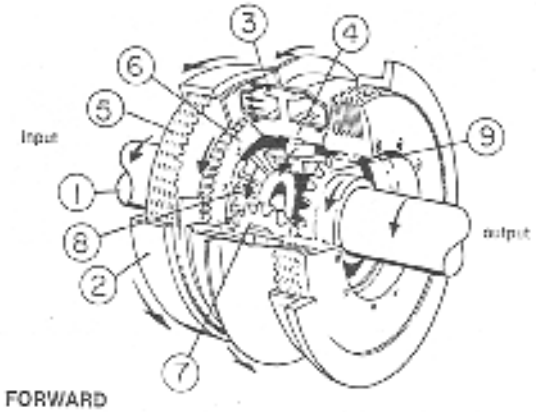
2.4 CLUTCH

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 acts 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.



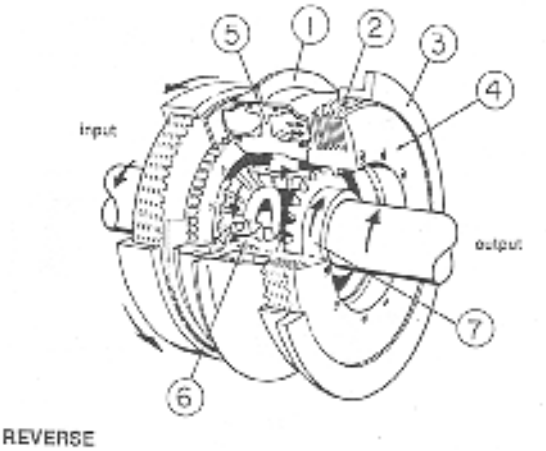
NEUTRAL

NEUTRAL MODE
Both halves of clutch cylinder (1) are filled with pressurized oil. Cylinder cannot press against either forward (2) or reverse clutch discs (3). Discs splined to driving drum (4) and reverse drum (5) remain separate from discs splined to end flanges (6) & (7). Consequently no direct torque is applied to gear carrier (8) or driven gear and output shaft (9) & (10). Bevel gears may revolve on their own shafts and gear carrier orbits at half engine speed.



FORWARD

FORWARD MODE
At all times, stub shaft (1), clutch driving drum (2) and driving gear (8) are turning in engine rotation direction at 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) claming clutch discs (5) together. Half of discs are splined to forward driving drum and half are splined to forward driving drum and half are splined to the 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 (9) to turn with them and this causes rotation of output shaft in forward rotation.



REVERSE

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 the end flange (4) bolted gear carrier (5). Rotating gear carrier then stops. The bevel gears (6) now rotate on their shafts causing driven gear (7) to turn in anti-engine direction producing reverse output.

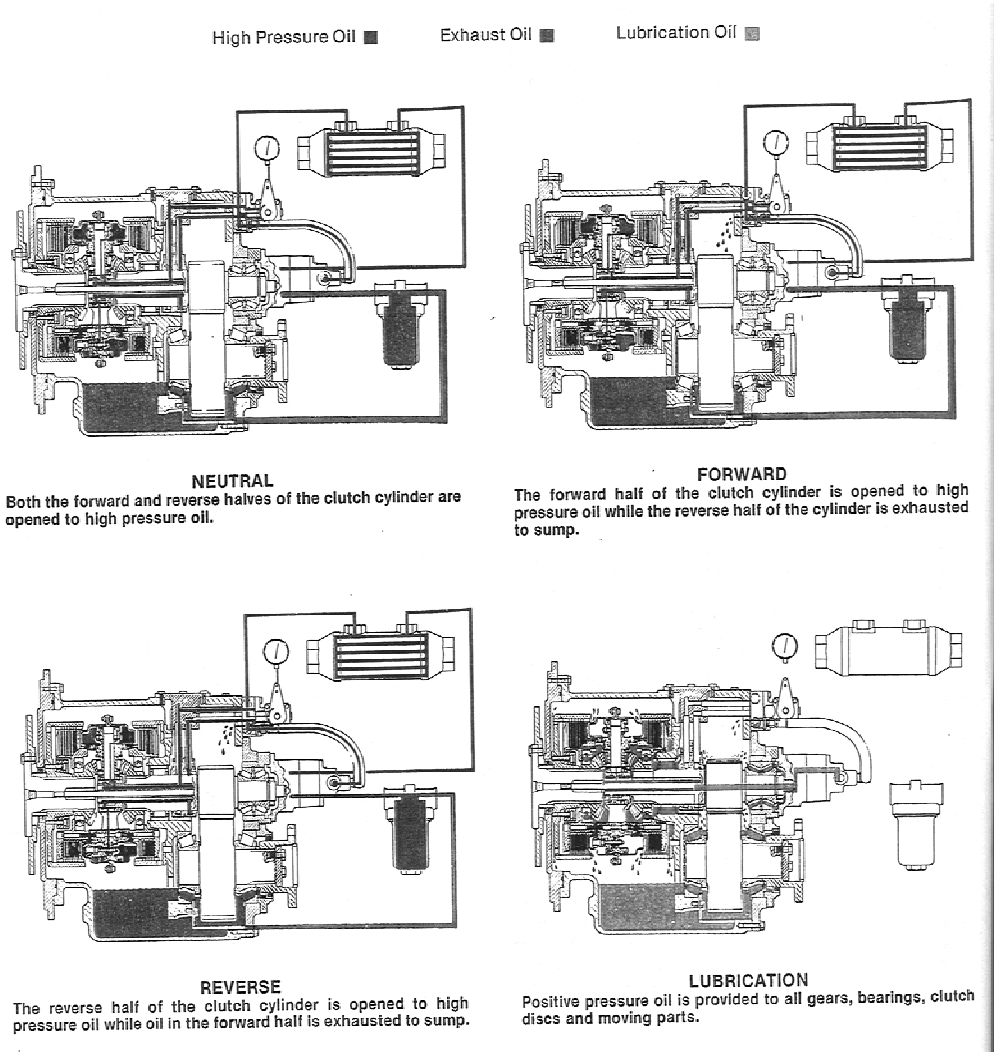
2.5 HYDRAULIC SYSTEM

Pressurized oil is provided by a gear type oil pump, which is externally mounted, and engine driven by means of a splined shaft. The pump includes a pressure relief valve to maintain the correct operating pressure.

Oil is drawn from the sump through a suction hose and oil filter, and then sent under pressure through the oil cooler and to the selector valve and pressure relief valve. The selector valve is used to obtain forward, neutral or reverse by routing the high-pressure oil through internal passages to the clutch. Low-pressure oil is channeled to cool bearings, gears and clutch discs. An oil dam keeps the transmission oil within the transmission housing.

In neutral the ports to both the forward and reverse sides of the clutch cylinder are opened and the balanced pressure that results keeps the clutch cylinder centered between the forward and reverse clutch discs. Oil is distributed through the lubrication system.

When the selector valve is shifted to either forward or reverse mode, high-pressure oil is allowed to flow only to one half of the clutch cylinder to engage the selected pack. Oil in the other half of the cylinder is exhausted to sump. In forward or reverse, oil is also distributed through the lubrication system.



NEUTRAL
Both the forward and reverse halves of the clutch cylinder are opened to high pressure oil.

FORWARD
The forward half of the clutch cylinder is opened to high pressure oil while the reverse half of the cylinder is exhausted to sump.

REVERSE
The reverse half of the clutch cylinder is opened to high pressure oil while oil in the forward half is exhausted to sump.

LUBRICATION
Positive pressure oil is provided to all gears, bearings, clutch discs and moving parts.

SECTION 3. INSTALLATION AND OPERATION

NOTE: IMPROPER INSTALLATION AND ALIGNMENT IS THE GREATEST CAUSE OF TRANSMISSION FAILURE. PLEASE FOLLOW INSTRUCTIONS CAREFULLY.

3.1 UNCRATING AND HANDLING

Tapped holes have been provided for insertion of eyebolts to aid in handling the unit. Average weight of HY-24000 housing is 465lbs; clutch is 115 lbs; adapter parts weigh approximately 100 lbs.

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

3.2 INSTALLATION PREPARATION

SPECIAL TOOLS REQUIRED

1. Chain hoist or equivalent
2. Straight Edge
3. Feeler Gauge
4. Thousandths Dial indicator

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

1.Mount thousandths dial indicator as shown (Fig, 3A). Dial indicates 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. 3B) 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, 3C). Mount indicator to flywheel housing so that stern is on inner face of flywheel. Record deviation of face run out. It must not exceed a total indicator reading of .007 inch.

4. (Fig 3D). 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".

NOTE:
Keep all mating surfaces clean. Use cleaning solvent or diesel fuel.

5.Separate the clutch assembly and clutch-driving drum (if necessary).

6. Remove oil dam adapter from transmission housing (if necessary).

7. Thoroughly clean flywheel adapter to engine mating surfaces and secure flywheel adapter (and drive flange) to engine flywheel with cap screws and lock washers (not furnished). Refer to figure 10.

8. Locate oil dam housing adapter (with new oil seal) on engine flywheel housing (be careful not to damage oil seal on splines of drive flange shaft). Secure adapter tentatively with cap screws and lock washers (not furnished).

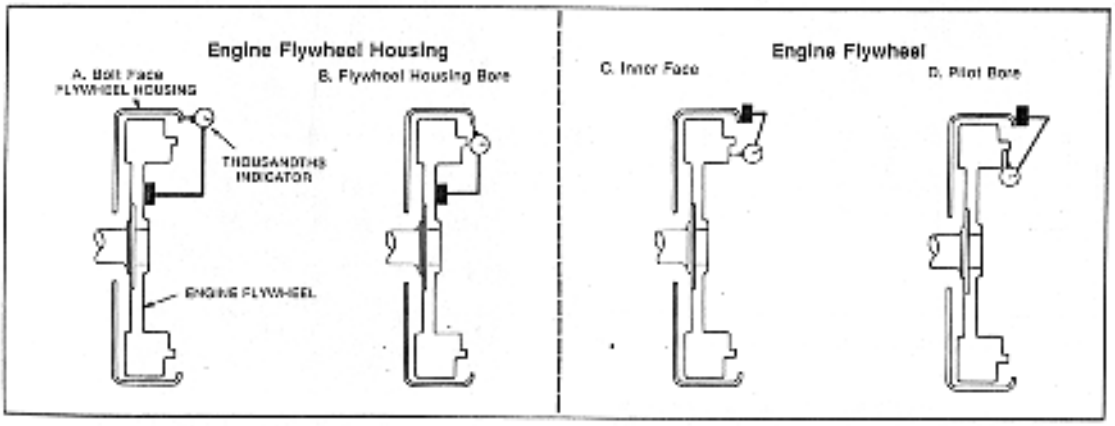


Figure 3. Dial Indicating Flywheel Housing and Engine Flywheel.

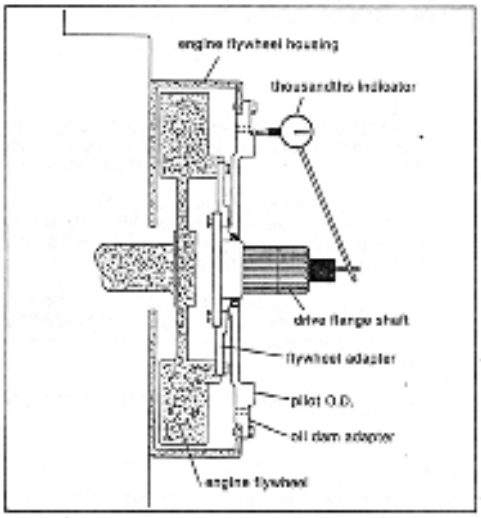


Figure 4. Dial Indicating Oil Dam Adapter Pilot O.D.

9. Dial indicate oil dam pilot O.D. as shown in figure 4. Record reading. Total indicator reading must not exceed .007 in.

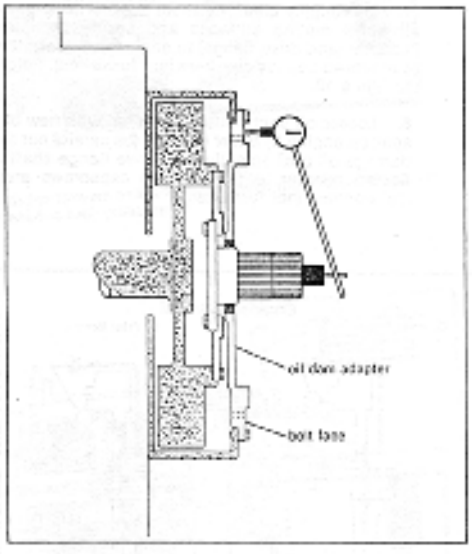


Figure 5. Dial Indicating Oil Dam Adapter Bolt Face.

10. Dial indicate oil dam bolt face as shown in figure 5. Record reading. Total indicator reading must not exceed .007 in.

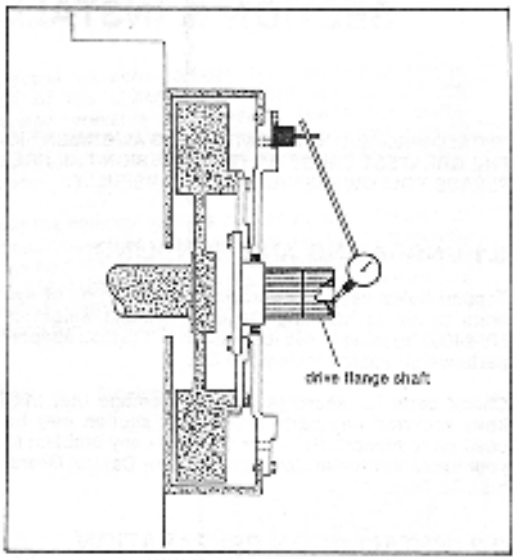


Figure 6. Dial Indicating Drive Flange Shaft.

11. Dial indicate drive flange on chamfer as shown in fig. 6. Record reading. Total indicator reading must not exceed .007 in.

The sum total of plus and minus readings in steps 9,10, and 11 must not exceed .007 in.

12. Apply anti-seize compound to splines of clutch driving drum and to tapered surface of drum where locking ring is applied.

13. Locate clutch driving drum on drive flange shaft and install snap ring in groove on drive flange shaft to secure drum see fig. 7.

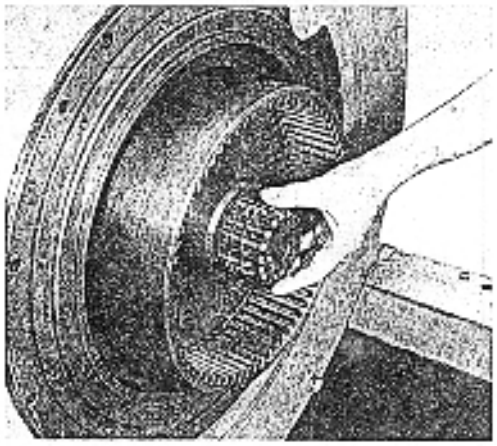


Figure 7. Installing Snap Ring in Groove on Drive Flange Shaft.

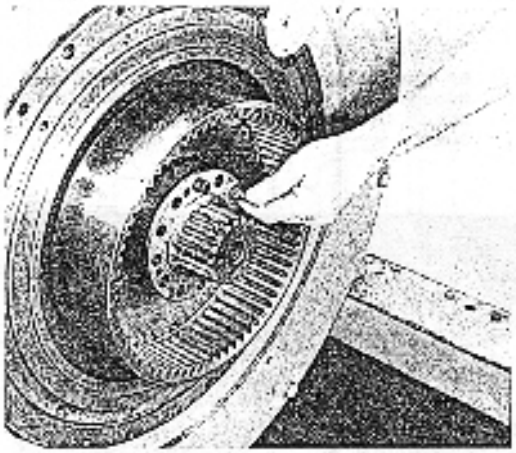


Figure 8. Installing Locking Ring on clutch Driving Drum.

15. Apply locking ring (see fig. 8) on clutch driving drum. Secure by torquing socket head cap screws* alternately as follows: 8 lb-ft the first time, 15 lb-ft the second time and 21 lb-ft the third time around. Torque all cap screws again at 21 lb-ft. for evenness. DON'T NOT OVER TORQUE!

*Note: Special self-locking cap screws are used. Do not substitute.

16. Using adequate hoist, install clutch on drive flange shaft (see fig.9) being careful that disc teeth enter driving drum properly. Forward end flange marked "toward engine" must be placed toward the engine flywheel. The forward pack contains more discs and must go toward the engine or severe damage may result.

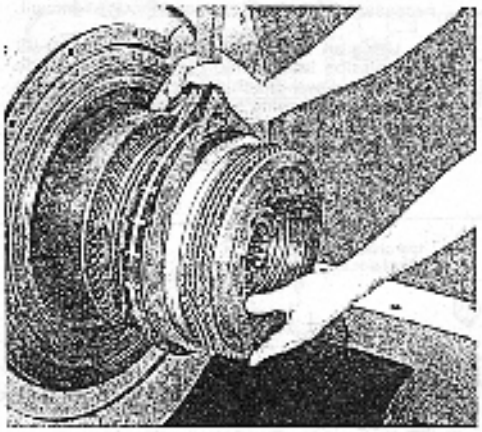


Figure 9. Installing Clutch on Drive Flange Shaft.

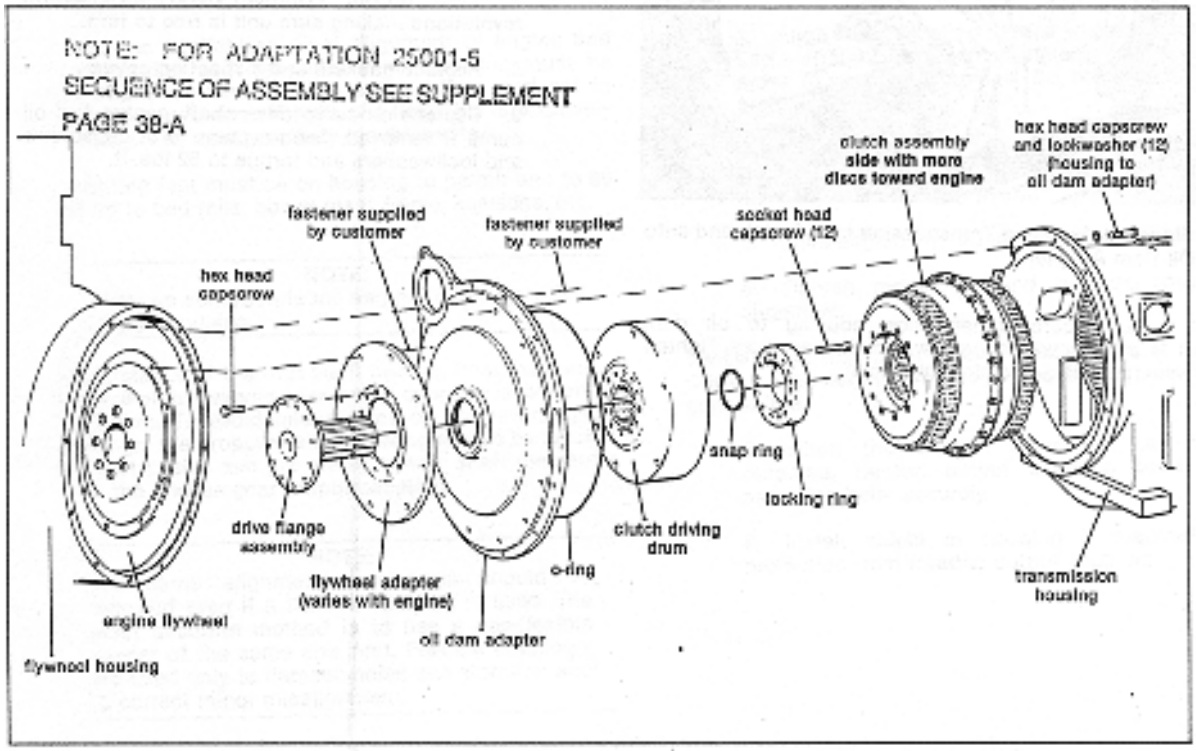


Figure 10. Sequence of Assembly: Adapter Parts, Clutch and Housing.

3.3 INSTALLATION OF TRANSMISSION

1.Apply a small amount of grease to oil dam adapter and locate large o-ring.

2. Remove side inspection covers to facilitate installation.

3. Remove oil pump and oil pump drive shaft if necessary, for limited space or difficult alignment.

4.Using an adequate hoist (see fig 11) lift transmission into position behind engine. Ease unit forward over clutch assembly gently twisting transmission housing so that discs enter reverse drum properly without damaging teeth. A screwdriver may be used through the side inspection hole to align disc teeth with the reverse drum.

5.Secure transmission housing to oil dam adapter with cap screws and lock washers. Tighten to 28 pounds-foot torque.

6. Check clutch end float: insert screwdriver through side inspection hole and pry clutch fore and aft. See fig.12. End float should be 1/16” to 3/32”.

7. Turn output coupling over for several revolutions making sure unit is free to turn.

8. Replace gaskets and inspection covers

9. Replace oil pump drive shaft, gasket and oil pump if removed. Secure pump with cap screws and lock washers and torque to 62lbs-ft.

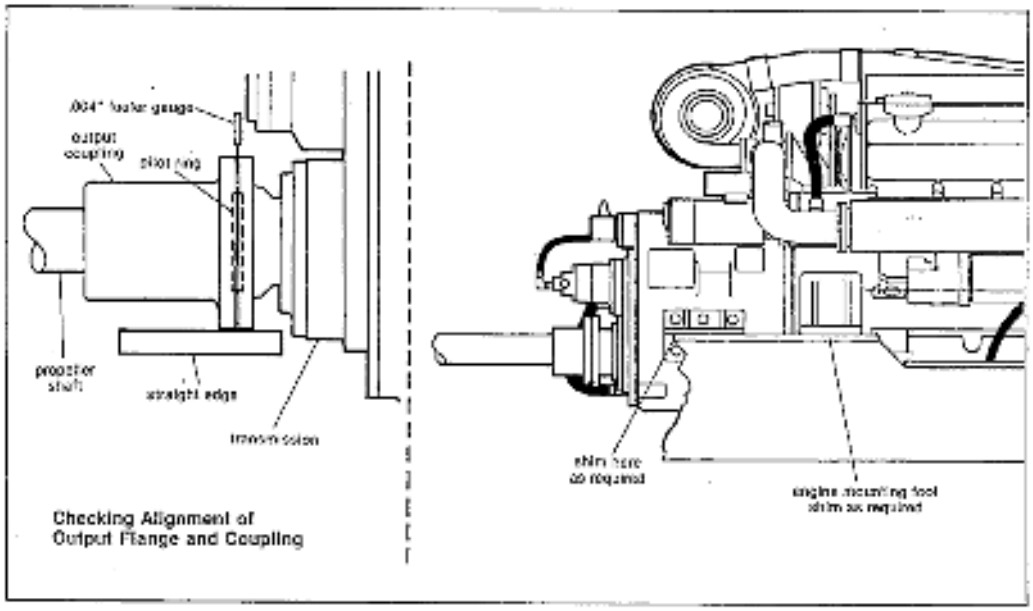


Figure 13. Alignment of Transmission and Engine to Prop Shaft Coupling.

3.4 ALIGNMENT

In marine application, final alignment of engine and transmission with 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 feet must be on housing to permit unit to be bolted to bed rails, power plant frame, keelsons, etc.

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

The distance of the first shaft bearing from the mating surface of the reverse gear output coupling is extremely important. To avoid undue force on the reverse gear bearings, the propeller shaft bearing should be located at least twelve and preferably twenty shaft diameters from the reverse 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 first. Flexible couplings are used only to dampen-noise and vibration and to correct minor misalignment.

1. Align shaft coupling to reverse gear coupling. Lay a straight edge across the edges at top and sides to line up couplings. Do not burr or mar mating surfaces.

2. Insert feeler gauge between couplings and run it all around the flange. Clearance should not be more than .004” at any point.

3. Shim engine and transmission as necessary

4. Tighten mountings and recheck coupling alignment.

These steps may have to be repeated several times. Correct alignment is extremely important in preventing gear failure.

5. When the correct clearance has been obtained tighten output coupling bolts and mounting bolts securely.

6. Install shield or housing if required for protection from rotating output coupling.

3.5 WATER PIPING

To assure proper cooling of a capitol marine transmission, 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. Transmission oil temperature should not exceed 150°F (65°C).

See installation drawing or page 57 for oil cooler plumbing instructions.

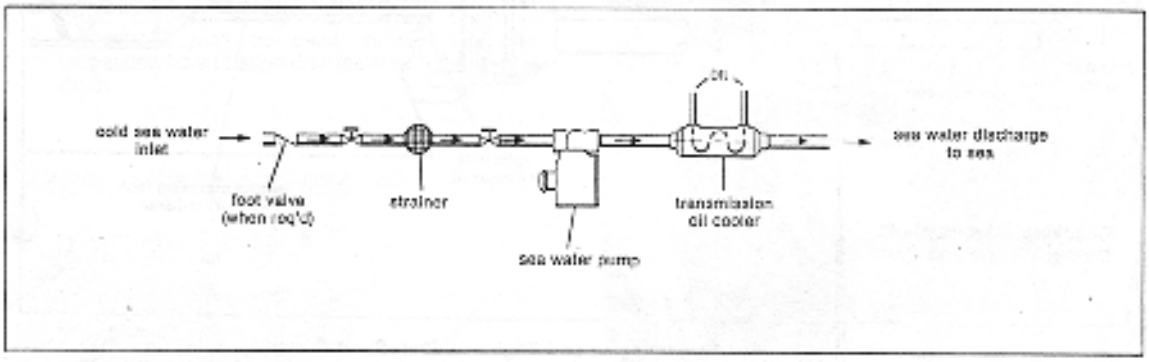


Figure 14. Separate Pump System.

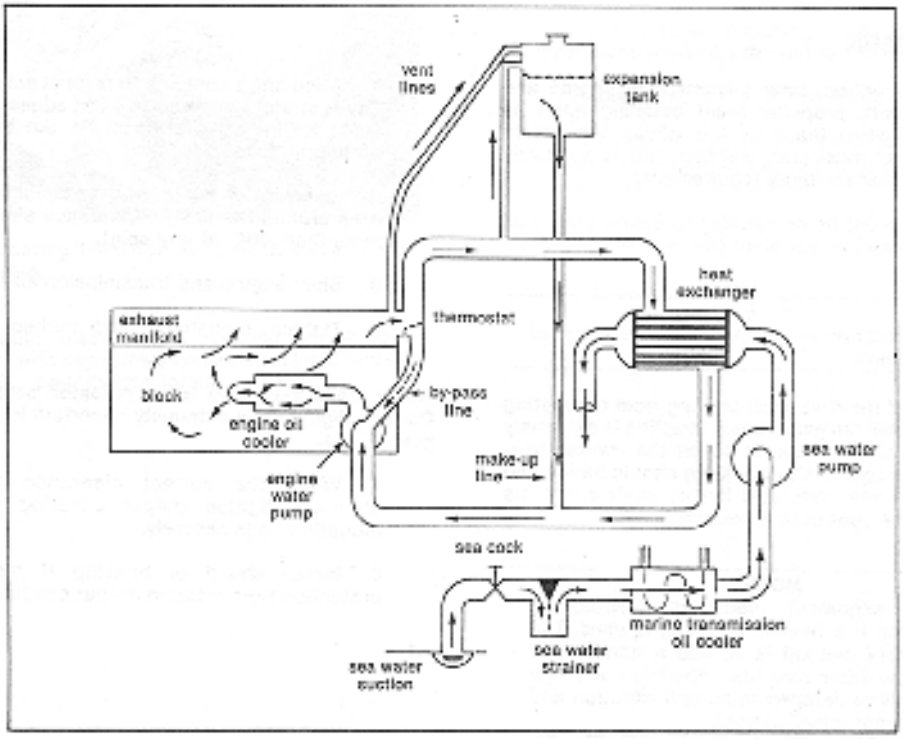


Figure 15. Heat Exchanger System.

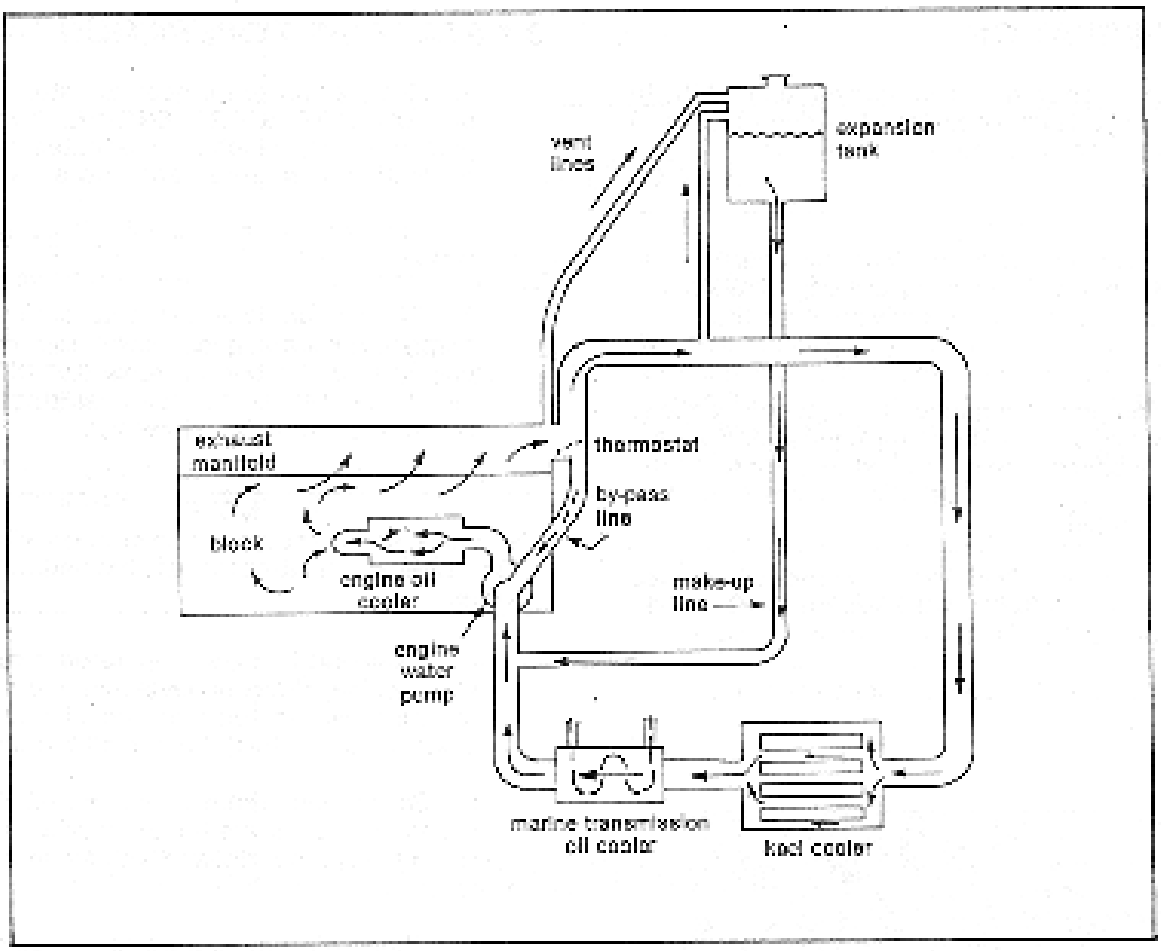
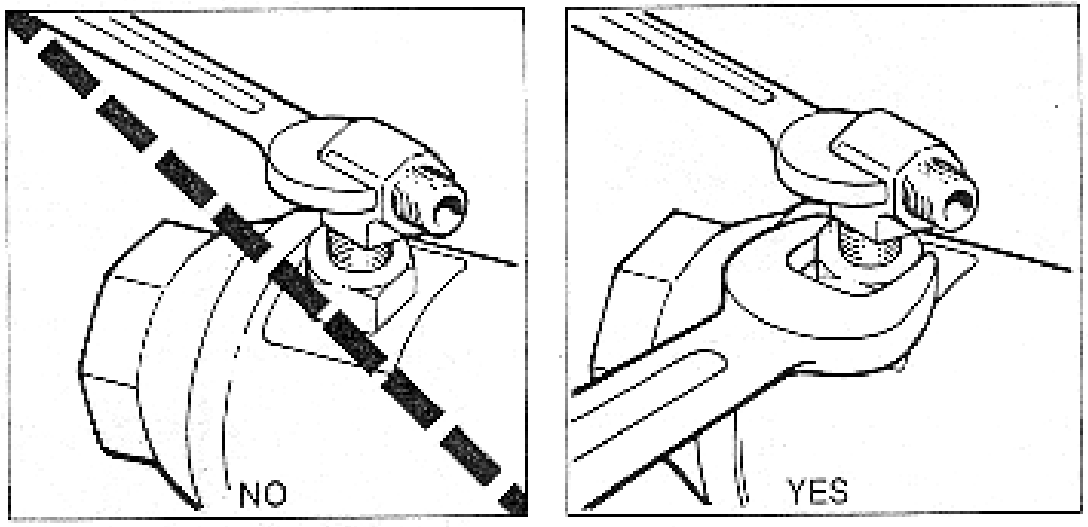


Figure 16. Keel Cooler System.



CAUTION: ALWAYS USE BACKUP WRENCH ON COOLER FITTINGS

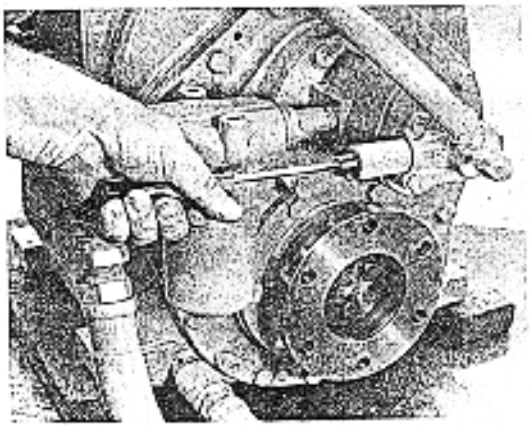
3.6 PRE-OPERATION

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

2. Install pressure gauge of 300-pound capacity directly on top of gear or on bulkhead. Connect gauge to control valve with hydraulic hose. (Note: Electric type oil pressure gauges are not recommended.)

3. Remove oil breather and add recommended oil until level is up to full mark on dipstick (see lube chart p.13) replace but do not secure.

4. Make sure all mounting bolts are tight.



CORRECT OIL PRESSURE: 200-210 PSI
AT NORMAL OPERATING SPEED AND TEMPERATURE

Figure 17. To adjust oil pressure, remove dome nut and turn relief screw to the right (clockwise) for greater pressure, and to the left (counter-clockwise) for reduced pressure. CAUTION: Screw is under tension.

3.7 START-UP & OPERATION

1. Engage starter for approximately 30 seconds, but DO NOT START ENGINE. This activates pressure pump which pre-lubricates transmission, preventing premature wear before load is applied.

2. Start engine and check all connections for leaks.

3. 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 set at normal operating speed and temperature (see fig.17 below).

NOTE:
Normally, unit pressure at idle start up will be 180 PSI, but final adjustment must be made as noted above

4. 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). Secure oil breather.

5. Shift several times to insure that all cylinders, hoses and cooler are full of oil (level should point toward engine in forward, away from engine in reverse).

6. Check oil temperature at the selector valve. Temperature should be 120 to 150F. If overheating occurs it may be an indication of misalignment, inadequate cooling system, incorrect endplay etc. Engine should be shut down immediately and the problem located. See sec. 5.

Figure 18. Clutch Cylinder Timing Adjustment; used to regulate shifting time. Turn screw clockwise for slower response and counter-clockwise for faster response.

3.8 OPERATING PRACTICES

CAUTION

1. Transmission should not be in reverse mode (Lever away from engine) to move vessel

2. Transmission should not be operated in reverse for more than 30 minutes at 75° of Available horsepower.

3. Transmission should not be operated with Temperature over 150°F (65°C)

4. Shifting should only occur with engine at idle speed.

5. Never support rear of engine with forward transmission housing.

6. 'Wind milling' or freewheeling will almost certainly cause extensive internal damage to the Transmission. In the case of a twin screw application where only one engine is used primarily, shaft brakes must be installed. Another alternative is an auxiliary lubrication system.

7. Final alignment of engine and transmission With proper shaft coupling must be accomplished when vessel is afloat and not in dry-dock.

SECTION 4. PREVENTATIVE MAINTENANCE

To insure a long service life of the Capitol Marine Transmission and to prevent costly and unexpected Failures, it is very important that a regular maintenance Schedule is established.

4.1 LUBRICANTS

Use oil-meeting requirements of MIL-L-2104B or API SERVICE CLASS. CC. Series 3 oils are not recommended because they may shorten clutch life.

Oil Capacity (approximate, depending on cooler, hoses, etc.)
14.5 quart (13.7 liters)
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 add required oil to return level to "full" mark on dipstick.

Oil pressure
Operating oil pressure must be at least 200-1210 PSI at normal operating speed and maximum operating temperature.

Pressure adjustment
See fig. 17, p.12.

Oil temperature
Ideal operating oil temperature range is 130-150F (55-65C) at selector valve. Unit will tolerate higher temperatures but clutch life may be shortened considerably.

4.2 ROUTINE MAINTENANCE

Oil Cooler Assembly

If seawater is used for coolant, 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 cleaned 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. 17 p.12.

Inspection/Overhaul Interval

A complete inspection of the Capitol marine transmission should be made at least as often as the engine is overhauled. Parts such as commutator bushings, oil seals, o-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 sec.7)

See schedule sheet, next page.

4.3 MAINTENANCE SCHEDULE AND CHECK SHEET

Engineer_____
Transmission serial No_____
Date Service Began_____

INTERVAL **MAINTENANCE DESCRIPTION** **RECORD**
Normal operation

DAILY	-Check Oil level -Check oil pressure	
After first 100 hours	-Change oil and flush sump	☐
Every 400 hours	-Check zinc pencils -Change oil if contaminated -Remove and clean oil breathers -Wash filter element	
Every 2000 hours	-Check gear backlash (see p.37) -Check water tubes in cooler	
At engine overhaul	-Inspect clutch and all gearing and replace as necessary -Inspect and or overhaul entire transmission	
Frequently	-Check all oil lines and connections -Check all external components -Check all mounting bolts -Check alignment	

SECTION 5. TROUBLE SHOOTING

5.1 TROUBLE/REMEDY CHART

SYMPTOM	PROBABLE CAUSE	REMEDY
A. Low oil pressure (At full operation speed and temperature).	1. Faulty pressure gauge	1. Check gauge against one of known accuracy
	2. Low oil level	2. Inspect gaskets, seals, hoses, and fittings for leakage. Pressure test oil cooler-tubes may leak.
	3. Clogged filter element	3. Clean filter element. Replace if damaged
	4. Clogged parts in selector valve, base plate or housing	4. Flush clean with solvent and blow dry.
	5. Clogged suction hose	5. Remove hose and clean with solvent. Blow dry.
	6. Dirt or sludge in transmission	6. 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 3-5 minutes maximum. Shut down engine and drain gearbox thoroughly. Refill gear with proper oil and run for 25-50 hours. Drain sump and refill with new oil. This will remove any residual solvent.
	7. Worn pump assembly	7. Refer to oil pump section or fig. 17.
	8. Incorrectly adjusted pressure relief valve	8. See fig. 17
	9. Oil too hot	9. Check heat exchanger system for clogged oil cooler or hoses.
	10. Worn commutator bushing	10. See wear limits chart
	11. Incorrect lubricant	11. See lube chart
	12. Scratched clutch cylinders or hard quad rings in clutch cylinders	12. Replace as necessary
B. High oil pressure (at full operating speed and temperature)	1. Incorrectly adjusted pressure relief valve.	1. Refer to fig. 17
	2. Inoperable relief plunger in base plate	2. Refer to p. 21

	3. Incorrect oil	3. See lube chart
	4. Cold oil	4. Check heat exchanger system
	5. Cold oil at start-up	5. Transmission should be preheated see p.12
C. No oil pressure	1. Faulty pressure gauge	1. Check pressure with gauge of Known accuracy
	2. Broken hose	2. Replace hose, Inspect all hoses.
	3. No oil in transmission	3. Fill with proper oil see pg. 12
D. Overheating	1. Insufficient oil cooler capacity	1. Install adequate oil cooler
	2. Insufficient flow of cooling water	2. Increase water line sizes.
	3. Clutch slipping	3. Refer to symptom A.
	4. Water temperature too high at cooler	4. Decrease water temperature to cooler or relocate heat exchanger in cooling system.
E. Excessive noise in Transmission	1. Bearings worn or broken	1. Inspect bearings for scored, races, broken roller, flat spots etc.
	2. Gears worn or broken	2. Inspect gears and replace if necessary
	3. Noise in forward only	3. 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	4. This is normal because more gears are in operation in reverse mode.
	5. Improper alignment	5. Refer to section 3. p. 9
F. Noisy Pump	1. Dirt or sludge in oil	1. Remove oil pump and hoses. Clean thoroughly and reinstall
	2. Clogged hoses	2. Clean and replace and required
	3. Pump Cavitations	3. Oil level may be too low
	4. Defective oil pump assembly	4. Refer to oil pump section
G. Clutch does not release	1. Transmission is misaligned	1. Refer to installation section
	2. Improper oil in sump	2. Refer to lube chart
	3. Clutch discs warped	3. Replace as necessary
	4. Forward and reverse clutch	4. Clean or replace as necessary

	cylinders dirty or distorted 5. Rear commutator bushing is worn	5. Replace as necessary. See replacement wear limits chart
	6. Incorrect linkage adjustment to selector valve assembly	6. Adjust linkage
	7. Clutch discs fused due to slippage and overheating	7. Replace as necessary
G. Clutch slippage	1. Low oil pressure	1. See symptom A.
	2. Improper oil in sump	2. Refer to lube chart
	3. Clutch discs warped	3. Replace as necessary
	4. Forward and reverse clutch cylinders dirty or distorted	4. Clean or replace as necessary
	5. Rear commutator bushing is worn	5. Replace as necessary. See replacement wear limits chart
	6. Incorrect linkage adjustment to selector valve assembly	6. Adjust linkage
	7. Clutch discs fused due to slippage and overheating	7. Replace as necessary
H. Clutch slippage	1. Low oil pressure	1. See symptom A.
	2. Transmission is misaligned	2. Refer to installation section
	3. Oil temperature too high	3. Temperature should be 130 to 150F (55 to 65 C) at selector valve. Check heat exchanger system.
	4. Worn clutch discs	4. Replace as necessary, see replacement wear limits chart
	5. Incorrect linkage adjustment to selector valve assembly	5. Adjust linkage
	6. Improper oil	6. See lube chart
I. Clutch burned out	1. Low oil pressure	1. See symptom A.
	2. Clutch is shifted at other than engine speed	2. Install interlock shift controls
	3. Transmission misalignment	3. Check installation and alignment as described in installation section.
	4. Excessive heat	4. Check cooling system see p.10.
J. No neutral	1. Transmission is misaligned	1. Refer to installation Section
	2. Warped clutch discs	2. Replace as necessary

	3. Scored clutch cylinders 4. Worn or damaged commutator bushings (forward or rear)	3. Replace as necessary 4. Replace all 4 quad rings
	5. Worn selector Valve	5. Replace as necessary. See replacement wear limits
K. Clutch engages too slow	1. Cylinder timing screw Out of adjustment	1. Remove dome nut and adjust screw (counter-clockwise) to speed up reaction. See fig, 18.
L. Clutch engages too fast	1. Cylinder timing screw Out of adjustment	1. Remove dome nut and adjust screw (counter-clockwise) to delay Reaction. See fig, 18.

SECTION 6. REPAIR OF EXTERNAL SUBASSEMBLIES

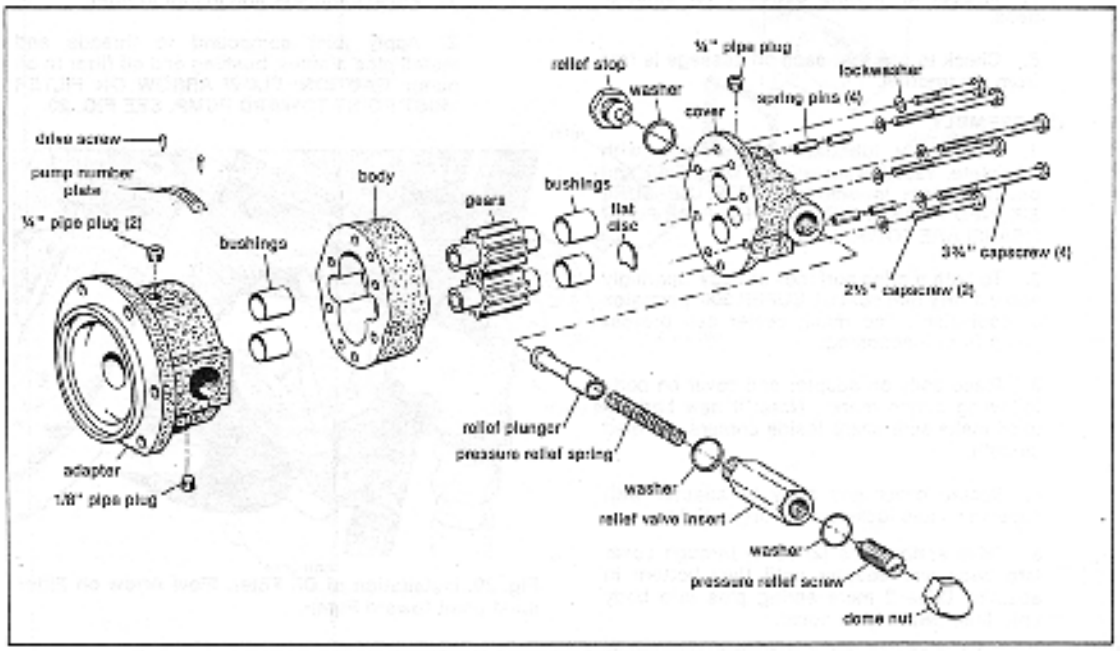


Figure 19. Exploded View of Oil Pump Assembly.

CAUTION:
Avoid contact with rotating output coupling and always shut down engine when doing even minor inspection or repair. Avoid contact with metal surfaces as operating temperature may exceed 200°

6.1 OIL PUMP

A. OIL PUMP DISASSEMBLY

1. Remove oil pump assembly and filter from main housing cover by removing cap screws and hoses.

2. Remove cap screws and lock washers securing pump cover, pump body and pump adapter.

3. Using a soft hammer, separate cover, body and adapter from spring pins. NOTE: FOR REASSEMBLY, PUNCH MARK ALONG SIDE OF COVER, BODY AND ADAPTER.

4. Remove pump gears resting in adapter

5. Remove dome nut and relief valve insert. NOTE: PRESSURE RELIEF SPRING IS UNDER TENSION

6. Unscrew and separate pressure relief screw from relief valve insert. Remove pressure relief spring and plunger.

B. CLEANING AND INSPECTION

1. Remove all permatex and clean all parts with good grade cleaning solvent or diesel fuel. Blow dry with compressed air.

2. Inspect gears and oil pump for damage or excess wear. See replacement wear limits chart.

3. Inspect cover and adapter for wear caused by gears. Note: If grooving does not exceed .030", both surfaces can be repaired by grinding smooth (.030" max cut).

4. Inspect bushings in cover for wear, out of round condition or burrs. If they are worn, damaged or loose, replace and ream to size: .749"/. 750".
NOTE: Cover may be ordered with bushings installed and reamed to size.

5. Inspect bushings (2) in adapter for wear out of round condition or burrs. If bushings are damaged, replace as necessary, and ream to size .749”/. 750”.
NOTE: Adapter may be ordered with bushings installed and reamed to size.

6. Check relief plunger for free movement in adapter bore. Replace if necessary.

7. Inspect all mating surfaces for smoothness

8. Check to see that each oil passage is free from obstruction.

C. ASSEMBLY

1. Generously lubricate pump gears with lubriplate, Vaseline, or engine weight oil and position them in adapter. NOTE: BE SURE SPLINED ENDS (INSIDE DIAMETER OF PUMP GEARS) ARE TOWARD COVER.

2. To both mating surfaces of body, sparingly apply a very thin coat of “SUPER 300” permatex or equivalent. Too much sealer can prevent pump from functioning.

3. Place body on adapter and cover on body following punch marks. NOTE: if new body is used make sure sharp inside corners are filed smooth.

4. Secure cover and body to adapter with cap screws and lock washers finger tight.

5. Drive spring pins 92) down through cover into body and adapter until they bottom in adapter. Drive 2 or more spring pins into body until flush with top of cover.

6. Insert pump shaft through adapter into pump gear and revolve shaft to check ease of operation.

7. Tighten all six cap screws to 8 pounds-foot torque.

8. Remove any excess permatex from seams with solvent

9. Recheck for ease of operation, or severe damage to shaft may result.

10. Generously lubricate relief plunger with Vaseline or lubriplate and position cup end last in bore of adapter. Check to make sure plunger slides freely.

11. Insert pressure relief spring into cup of plunger.

12. Screw pressure relief screw into relief valve insert just enough to start threads.

13. Install washer and relief valve insert with pressure screw in place.

14. Tighten relief valve insert. Do not tighten relief screw.

15. Cap and lock pressure relief screw with dome nut and washer.

D. RE-INSTALLATION

NOTE: DO NOT use Teflon Tape. It may clog the pump

1. Flush canister and install in filter.

2. Apply joint compound to threads and install pipe nipples, bushing and oil filter to oil pump. **CAUTION: FLOW ARROW ON FILTER MUST POINT TOWARD PUMP. SEE FIG. 20.**

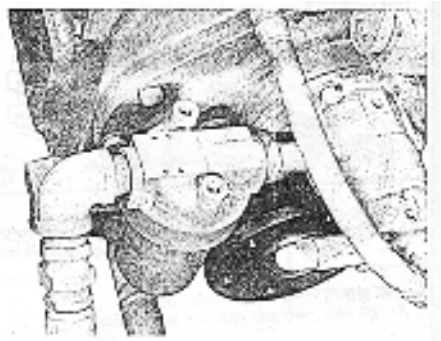


Fig. 20. Installation of Oil Filter. Flow Arrow on Filter must point toward Pump.

3. Apply grease to bearing container and locate new oil pump gasket on container.

4. Install oil pump and filter on bearing container. Secure pump with cap screws and lock washers and torque to 62 lb-ft.

5. Install suction hose to tee and oil pump

6. On units with idler gear, connect hose from oil pump to idler shaft.

E. PUMP ROTATION

The direction of pump rotation is the same as engine rotation. If engine rotation is changed the plumbing to the pump must be changed. See cross section assembly drawing for details.

6.2 SELECTOR VALVE AND RELATED PARTS

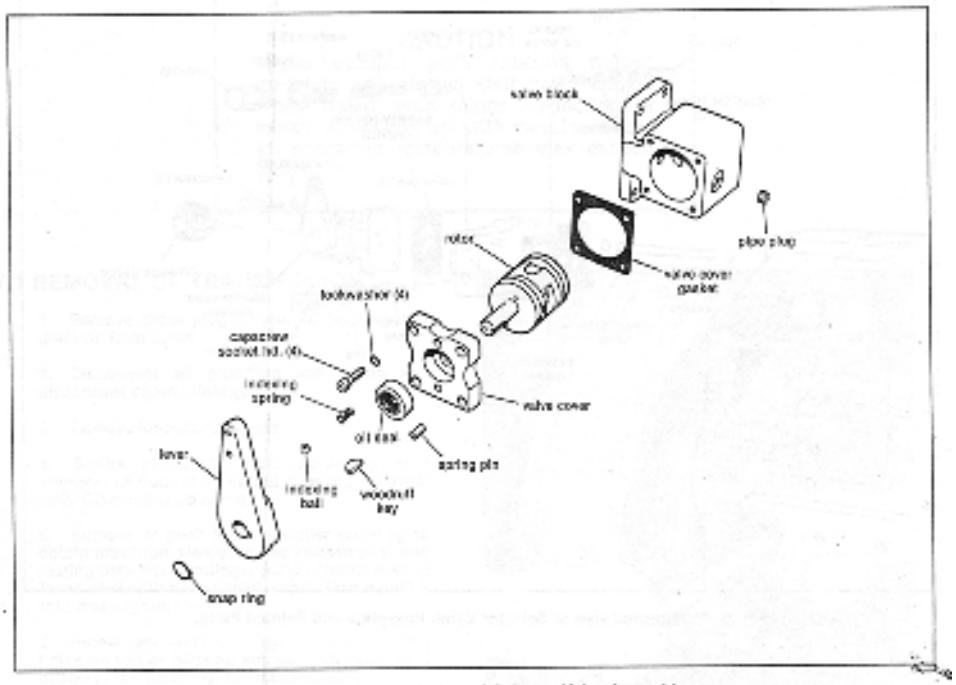


Figure 21. Exploded View of Selector Valve Assembly.

A. REMOVAL

1.Disconnect hoses and control linkage from lever on selector valve.

2. Remove cap screws and lock washers. Lift off selector valve and base plate being very careful to keep gaskets in proper configuration for replacement (they may be fixed in position with wire. Etc.)

B. DISASSEMBLY

1. Remove snap ring from rotor shaft and note position of keyways on level to rotor (match mark if desired). Remove lever from rotor being careful not to lose indexing ball and spring.

2. Remove key from rotor shaft.

3. (Note position of cover). Remove cover, cover gasket, and rotor from block.

4. Remove safety relief adjustment end cap from base plate. Remove washers, spring and plunger. NOTE: SPRING IS UNDER TENSION.

5. Remove clutch timing parts (dome nut, jam nut, washers and set screw).

6. Remove commutator tubes from housing and discard o-rings.

C. CLEANING AND INSPECTION

1. Clean all parts thoroughly with oil and clean all oil ports. Blow dry with compressed air.

2. Inspect rotor and valve block for scoring. Excessive scoring indicates replacement. Valves are not repairable.

3. Inspect oil seal in cover. If it is worn or shows evidence of leaking, replace it.

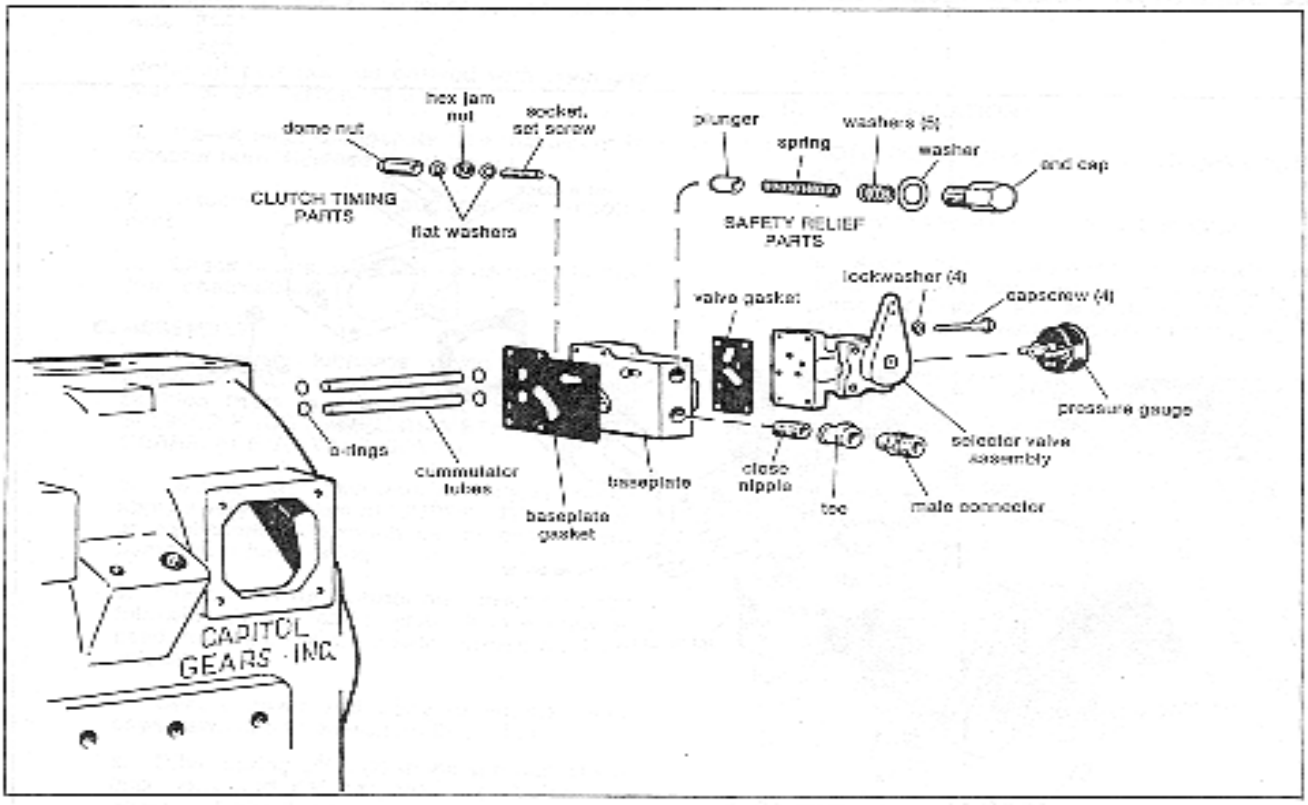


Figure 22. Exploded view of Selector Valve, Baseplate and Related Parts.

D, ASSEMBLY

NOTE:
On all fittings use Permatex super 300 sealant, graphite paste, or equivalent. Caution: Do no use no.1 permatex or Teflon tape.

1.If necessary install new oil seal in cover. Press seal in until it bottoms in bore (rubber race out). Apply lubricant to seal.

2. Insert rotor shaft through oil seal in cover.

3. Set key in rotor shaft and install lever with indexing ball and spring. Make sure that keyway in rotor shaft remains toward the side of cover as shown in figure 21.

4. Tap control lever into position with a soft hammer and secure with snap ring.

5. Position new cover gasket on pilot face of cover.

6. Install rotor with cover into selector valve body. Secure cover with four cap screws. Tighten to 4 pounds foot torque. Check for correct assembly by moving lever back and forth.

7. Install safety relief adjustment parts in base plate.

8. Install clutch-timing parts in base plate

9. Install new o-rings in commutator and base plate. Install tubes in commutator.

10. Mount base plate gasket to correct position. Locate base plate and valve gasket properly (see fig. 22).

11. Install selector valve assembly with hex head cap screws and lock washers.

12. Connect pressure gauge, hose and control linkage.

SECTION 7. REPAIR OF INTERNAL SUBASSEMBLIES

CAUTION:
Avoid contact with rotating output coupling and always shut down engine when doing even minor inspection or repair. Avoid contact with metal surfaces as operating temperatures may exceed 200°F.

7.1 REMOVAL OF TRANSMISSION

1. Remove drain plug at rear of housing and drain oil from sump.

2. Disconnect all plumbing and wiring and disconnect control linkage.

3. Remove inspection covers.

4. Scribe alignment mark across outside diameter of flanges on output coupling for exact refit. Disconnect coupling.

5. Remove or push back propeller coupling to obtain maximum clearance and remove pilot ring resting between couplings. NOTE: Protect mating faces of couplings and pilot ring to insure proper refit and alignment.

6. Screw two 1/2 –13 UNC eye bolts into lifting holes on top of housing and connect hoist so it supports the weight of the transmission.

7. Remove cap screws and lock washers holding housing to oil dam.

8. Insert screwdriver or similar object through side inspection hole to hold clutch assembly inside housing. Slowly move housing aft and away from oil dam. See fig. 23.

CAUTION
Clutch is loose! It must be secured in transmission housing to prevent failing

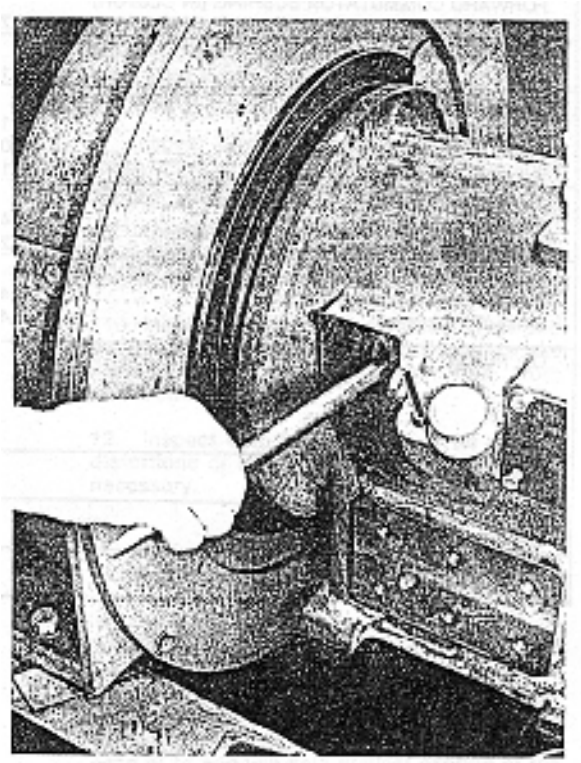


Figure 23. Maintaining Clutch in Housing during Removal of Transmission.

Capitol Gasket and Seal kit no. 1-10193-000 includes all of the gaskets, seals and o-rings needed for repairs.

The quad rings required for the bevel gear carrier must be purchased separately.

7.2 TABLE: REPLACEMENT WEAR LIMITS

ITEM	NEW DIMENSIONS MINIMUM	NEW DIMENSIONS MAXIMUM	REPLACEMENT WEAR LIMIT
BACKLASH — Reduction Gears	.004	.008	.020
PINION SHAFT			
O.D. At Forward Commutator	1.7450	1.7455	1.7440
O.D. At Rear Commutator	3.1661	3.1668	3.1651
O.D. At Rear Bearing	1.7721	1.7726	1.7711
FORWARD COMMUTATOR BUSHING (IN CLUTCH)			
I.D.	1.7495	1.7505	1.752
REAR COMMUTATOR BUSHING			
I.D.	3.169	3.170	3.174
CLUTCH DISC THICKNESS			
Driving (External Teeth)	.150	.160	.140
Driven (Internal Teeth) Thin	.085	.095	.075
Driven (Internal Teeth) Thick	.160	.175	.150
CLUTCH PACK THICKNESS — Clutch No. 1-00100-5004			
Forward Pack (Compressed)	1.485	1.540	1.365
Reverse Pack (Compressed)	1.240	1.340	1.160
CLUTCH PACK THICKNESS — Clutch No. 1-00100-3900			
Forward Pack (Compressed)	1.485	1.540	1.365
Brake (Compressed)	.470	.510	.440
OIL PUMP			IF DEEP GROOVES ARE PRESENT, OR MORE THAN .006" CLEARANCE EXISTS BETWEEN PUMP GEARS AND BODY
SELECTOR VALVE			IF DEEP GROOVES ARE PRESENT (.025" DEEP)
DRIVING DRUM SPLINES CLUTCH END FLANGE SPLINES			IF GROOVES ARE PRESENT VERTICAL TO THE SPLINE
ALL SPLINED PARTS			REPLACE IF FIT IS NOT SNUG.

7.3 CLUTCH AND REVERSE GEARS

A) DISASSEMBLY (SEE FIG.25)

1. Remove socket head cap screws, lock washers (and Allen nuts) securing both clutch flanges to bevel gear carrier.

2. Lift off clutch flanges and clutch discs.

3. Press and remove bearings, driving gear and driven gear from forward and reverse clutch flanges,

4. Remove locknuts, clutch identification tag and cap screws from outer perimeter of cylinders.

5. Separate and remove cylinders.

6. Remove and discard quad rings from bevel gear carrier (always replace with new quad rings to avoid internal leaks).

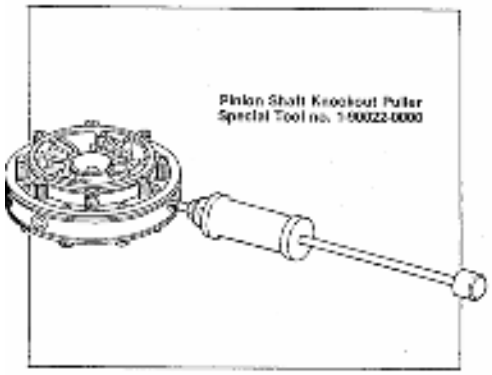


Figure 24. Removing Bevel Pinion Shaft with Puller.

7. Remove cap screws and locknuts securing pinion shafts in bevel gear carrier and remove bevel pinion shaft with puller. See fig. 24.

B) CLEANING AND INSPECTION

1.Inspect bevel pinions for wear, chips, and breaks or out of round condition. If there is any damage, we recommend replacing all of them as a set.

2. Check all bevel pinion bearings and thrust washers for distortion or rough operation.

3. Clean all parts with a good grade cleaning solvent or diesel fuel. Blow dry with compressed air. Coat bearings with light oil.

4. Inspect all oil passages in bevel gear carrier to see that they are free from obstruction.

5. Inspect bevel gear carrier for cracks chips or worn mounting surfaces. Pay special attention to quad rings grooves. Discard carrier if damaged.

6. Inspect forward commutator bushing for chips, heat scores, scratches, distortion or wear (see wear limits p.24). Repair or replace as necessary (see part c).

7. Inspect all hardware and springs for wear or distortion. Inspect return spring ring. Repair or replace as necessary.

8. Remove clutch discs from flanges or inspect discs for broken teeth, heat scores or wear (see wear limits pg.24). Replace as necessary.

9. Inspect driving gear and driven gear for wear, chips or cracks. If either one is damaged we recommend replacing both as a set.

10. Check both clutch flange ball bearings for wear, distortion or rough operation. Replace if necessary.

11. Inspect forward and reverse clutch end flanges for wear, cracks or distortion and make certain all oil passages are free from obstructions.

12. Inspect both clutch cylinders for cracks, distortions or scratches. Repair or replace as necessary.

C. ASSEMBLY

1. In order to install a new commutator bushing, either the bushing should be frozen or the bevel gear carrier heated. This will allow ease of fit and will help prevent scoring of the gear carrier bore. An anti-seize compound should be used on the bushing also.

NOTE:
Bushing may be frozen with a solution of alcohol and water or dry ice. Gear carrier may be heated in hot oil or water (200°F, 93°C maximum)

2. Line up holes in flanged end of bushing with roll pins in bevel gear carrier. Press in new bushing on side of carrier stamped “REV’. Until it seats in bore. The roll pins will lock the bushing in place and insure line up of oil holes in the bushing and bevel gear carrier.

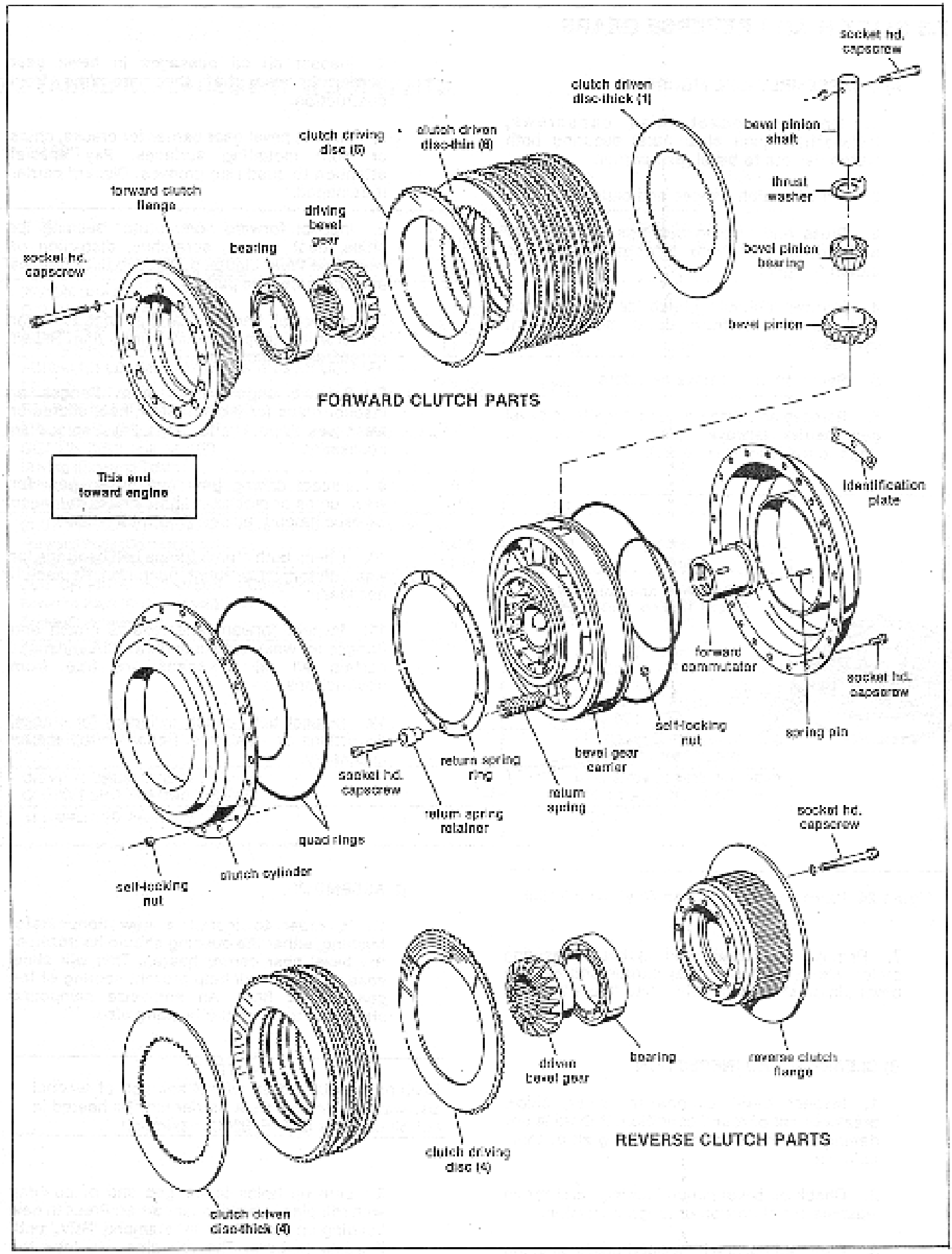


Figure 25. Exploded View of Standard Clutch no. 1-00100-5004.

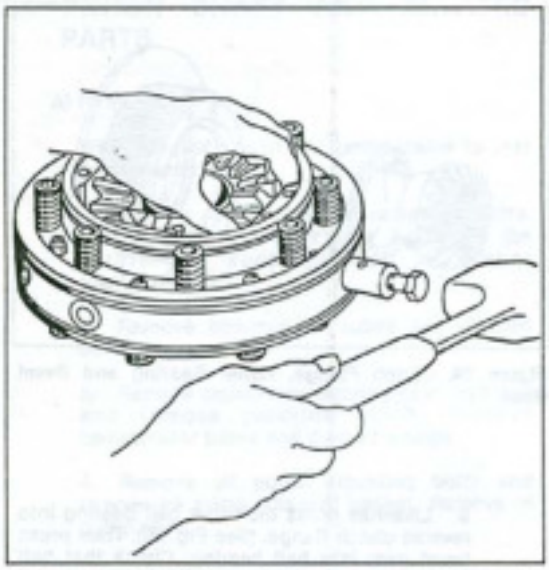


Figure 26. Installation of Bevel Pinion Shaft using Protective Capscrew (½-20 NF).

3. Installation of bevel pinion shafts: (see fig.26)

A. Lay gear carrier flat on table.

B. Apply lubricant on shafts and bores to ease fit and prevent damage.

C. Insert protective cap screws on top of pinion shaft and tap shaft into carrier bore just enough to protrude slightly in to inner recess. Make sure holes will match.

D. Place bevel pinion with bearing on shaft. Tap shaft into bearing until holes in shaft and carrier match.

E. Insert socket head cap screw and nut. Torque to 8 lbs-ft.

4. Replacement of return springs, return spring ring and retainers (if necessary): insert return spring retainers through ring and into return springs and secure in gear carrier using cap screws. Tighten cap screws tentatively until top of spring retainer protrudes the specified distance from the face of the bevel gear carrier hub as shown in figure 27.

5. Without installing quad rings, place cylinders on bevel gear carrier by hand. There must be a uniform gap between cylinders of .015 to .025". See fig.27. Check with a feeler gauge. If necessary re-adjust return spring height and install locknuts.

6. Apply lube in quad ring grooves in bevel gear carrier and slip on four new quad rings avoiding twists in the rings.

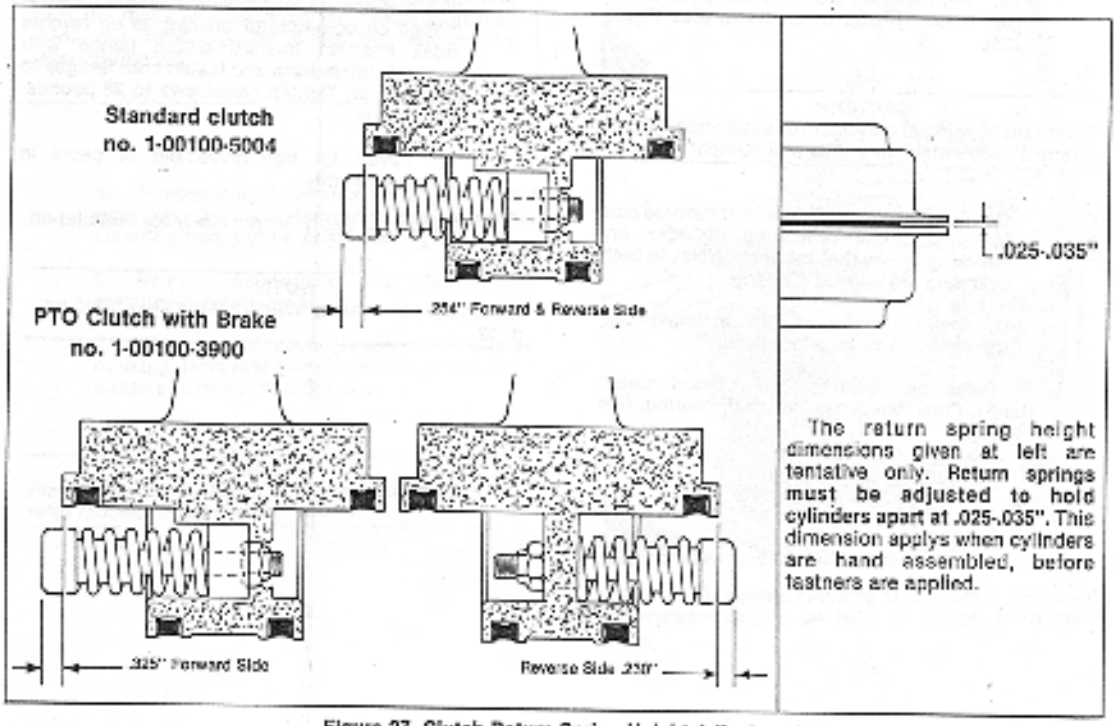


Figure 27. Clutch Return Spring Height Adjustment.

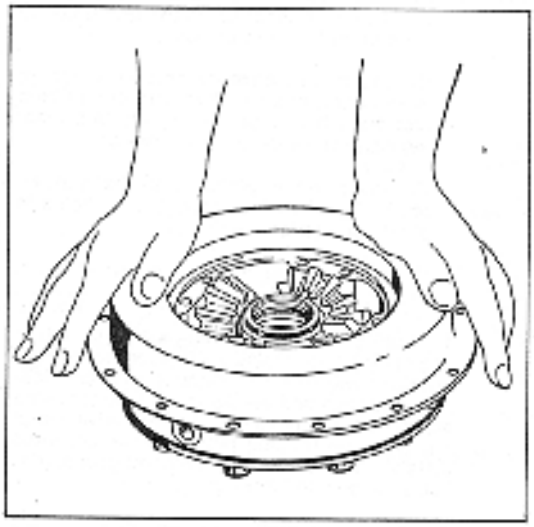


Figure 28. Installing Clutch Cylinders on Bevel Gear Carrier.

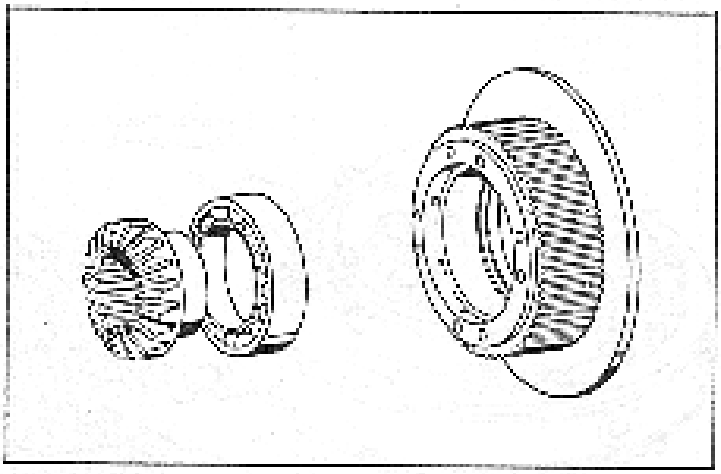


Figure 29. Clutch Flange, Roller Bearing and Bevel Gear.

7. To install cylinders:

A) Apply a light coat of lubricant on inner walls of each clutch cylinder as well as on quad rings.

B) With forward size of bevel gear carrier up, press cylinder on by hand (see figure 28).

CAUTION:
To prevent twisting or damaging of quad rings, take care to slip cylinders on evenly and straight down.

C). Turn bevel gear carrier over (reverse side up) and press remaining cylinder on, checking to see that cap screw holes in both cylinders are aligned properly.

D) Insert cap screws and locknuts and tighten to 15 pounds foot torque.

8. Press ball bearing into forward clutch flange. Press bevel gear into ball bearing. See fig. 29

9. Likewise press the other ball bearing into reverse clutch flange (see fig.29). Then press bevel gear into ball bearing. Check that ball bearings on both clutch flanges are well seated.

10. Arrange the driving friction discs (external tooth) with the steel driven discs (internal tooth) against the forward and reverse clutch flanges. Refer to the appropriate illustration in the parts information section.

11. Position reverse clutch flange and reverse clutch discs on reverse side of gear carrier (flange on commutator bushing is on reverse side). Position forward clutch flange with forward clutch discs and fasten both flanges to gear carrier. Tighten cap screws to 28 pounds foot torque.

12. Check for free movement of gears in clutch assembly.

NOTE:
Clutch cylinder timing adjustment is illustrated on p.12

7.4 PINION SHAFT AND RELATED PARTS

A) REMOVAL

With adequate hoist tip transmission to rest engine end down.

1. Remove selector valve mounting bolts. Remove selector valve and base plate (be careful to keep gaskets in proper configuration).

2. Remove commutator tubes and discard o-rings

3. Remove cap screws securing junction block and remove junction block. Remove commutator tubes and discard o-rings.

4. Remove oil pump mounting bolts and remove oil pump. Discard gasket. Remove oil pump shaft.

MODELS WITH 2.04 A.E.R OR E.R RATIOS

The pinion shaft may be extracted from the housing without removing the output coupling and housing cover.

Attach a suitable hoist to the bearing retainer and hold the rear commutator so the pinion shaft may slide out freely (pinion shaft will accompany bearing retainer).

5. Remove output retainer plate from output coupling. With suitable puller remove output coupling from output shaft. See fig. 30.

6. Remove Cap screws and lock washers securing housing cover.

7. With hoist, lift cover (pinion included) from housing. Hold rear commutator so pinion shaft slides out freely. See fig 31.

NOTE:
Pinion and shaft repair kits are available for all ratio models. See page 51.

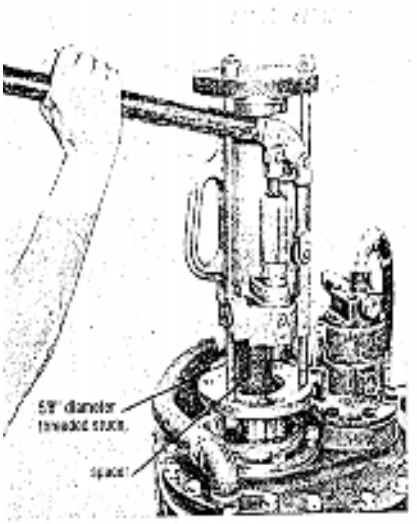


Figure 30. Pulling Output Coupling from Shaft Using Jack and Special Tool no. 1-90325-0000.

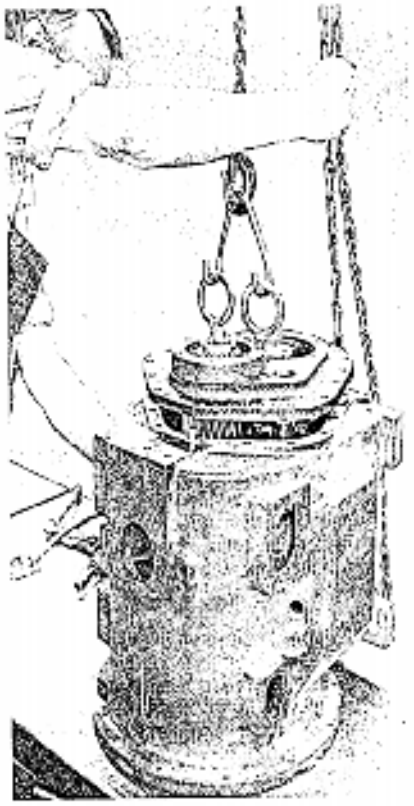


Figure 31. Removing Housing Cover and Pinion Shaft. Commutator should be held so pinion shaft slides freely.

B. DISASSEMBLY

1.Remove bearing locknut from the end of pinion shaft and remove keyed washer.

2. With suitable press extract pinion shaft out of bearing retainer. See fig.32.

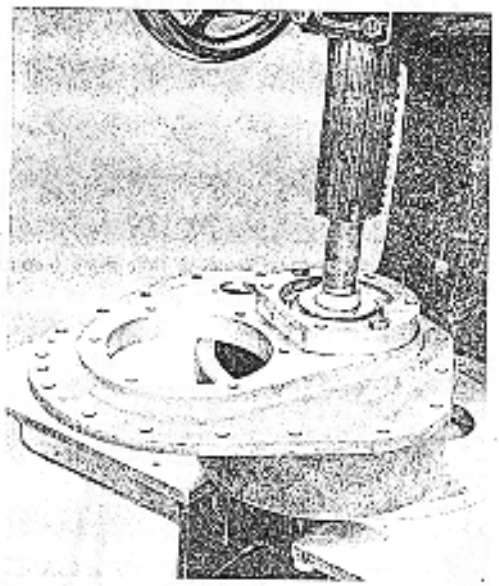


Figure 32. Extracting Pinion Shaft from Bearing Retainer using Press.

C. CLEANING, INSPECTION AND REPAIR

1. Inspect pinion bearings for roughness of rotation, corrosion, scoring, scratches, burrs, cracks, pitted or chipped races and wear of rollers. If ONE of these conditions is found, replace the entire bearing set (5 pieces). Otherwise clean bearings thoroughly with solvent.

2. Inspect pinion teeth, threads and spline for damage. Inspect both commutator-mating surfaces and inspect bearing mating surfaces for grooved, burred or galled conditions. If damage cannot be repaired with crocus cloth, pinion shaft must be replaced.

3. Clean pinion thoroughly. Flush all parts with solvent.

4. Inspect roller bearing mounted in housing bore for conditions mentioned in step 1. Clean bearing with solvent or replace as necessary.

5. Inspect rear commutator for damage or wear (see wear limits p.24) Discard if necessary. Other wise clean thoroughly.

6. Remove oil filter canister and clean element. Flush canister clean.

7. Flush clean all ports in selector valve base plate and junction block. Flush all commutator tubes.

D. REASSEMBLY

1. If necessary install new roller bearing in housing and secure with snap ring. See fig 33.

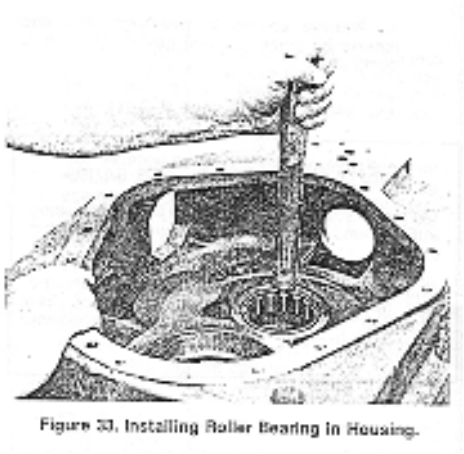


Figure 33. Installing Roller Bearing in Housing.

2. Apply lubricant to bearing surface on threaded end of pinion shaft.

NEW BEARING CUPS AND CONES COME IN MATCHED PAIRS. BE SURE NOT TO MIX PARTS.

3. Heat pinion bearing cones in hot oil (212°F, 100°C maximum)

4. (Refer to fig. 34) Press both bearing cups (A) into bearing retainer (B) snug against bearing spacer.

5. Apply Lubriplate grease or equivalent to outside diameter of bearing retainer and install bearing retainer in housing cover (C).

2.04 RATIO MODELS ONLY:
Since pinion diameter clears cover bore, the pinion bearing retainer assembly may be installed in the cover after the cover is on the housing.

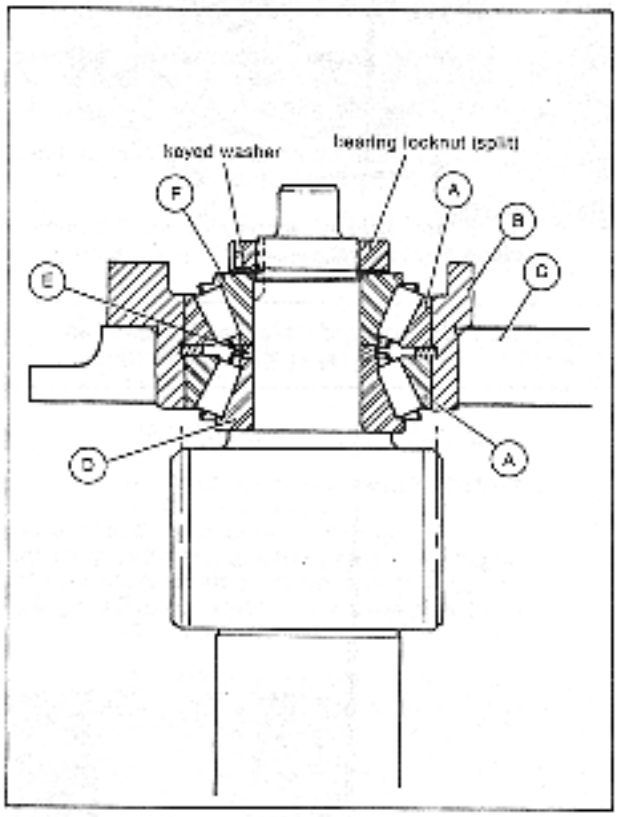


Figure 34. Installing Pinion in Housing Cover.

6. Press heated bearing cone (D) on to pinion shaft and apply spacer (E).

7. Install housing cover (C) onto pinion shaft

8. Press* heated bearing cone (F) onto pinion shaft snug against bearing spacer (E). *NOTE: A protective spacer is recommended to prevent damage to bearing.

9. Locate keyed washer behind bearing cone (F).

10. Apply Loctite 242 or equivalent on threads of pinion shaft (Threads must be clean first). Locate bearing locknut on threads and tighten with spanner wrench to 220 lbs-ft. (Wrench should be resting on side of locknut opposite the split).

Tighten locking cap screw.

11. Apply lubriplate or equivalent to o-ring grooves in rear commutator, junction block and selector valve base plate. Install new o-rings.

12. If new commutator or new pinion are being used check to see that fit between them is not too tight. Clearance must be .002" min. Otherwise assembly will be very difficult and commutator may freeze on shaft.

IF PINION PARTS SHOW WEAR OR DAMAGE THE TRANSMISSION HOUSING SHOULD BE FLUSHED CLEAN WITH SOLVENT.
WEAR TO PINION PARTS INDICATES WEAR TO OUTPUT PARTS, IDLER (IF PRESENT) AND CLUTCH. WE RECOMMEND A COMPLETE INSPECTION AT THIS TIME.

7.5 OUTPUT GEAR, IDLER, HOUSING AND RELATED PARTS

A. <u>REMOVAL AND DISASSEMBLY</u>

NOTE: PINION SHAFT PARTS SHOULD BE REMOVED PRIOR TO REMOVAL OF OUTPUT PARTS

1. Remove cap screws securing output retainer plate and remove plate from output shaft.

2. With engine end of transmission flat on table, pull output coupling from output shaft using suitable puller see fig.30.

3. Remove cap screws securing output shaft bearing retainer and remove bearing retainer. Discard oil seal. Take care not to damage shims and remove them.

4. Remove housing cover cap screws and remove housing cover. Use suitable hoist. See fig.31.

5. Remove idler gear assembly from housing (or cover) if present. If idler bearings are suspected of wear, remove snap rings and bearings.

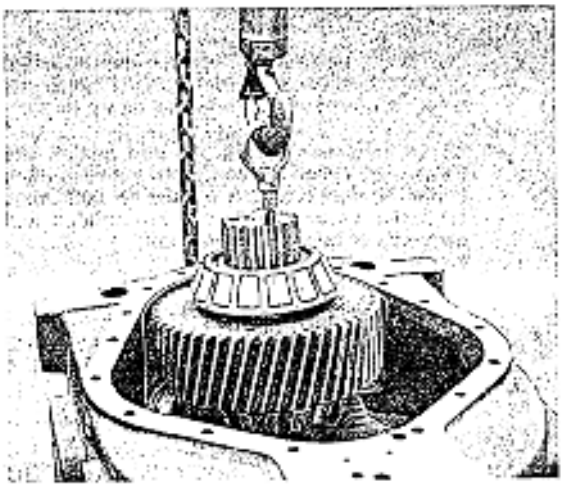


Figure 35. Removing (or installing) Output Gear.

B.CLEANING INSPECTION AND REPAIR

1.Inspect tapered roller bearings on both ends of output shaft for; rough rotation, corrosion, scoring, scratches, burrs, cracks, pitted or chipped races and wear. If one of these conditions is found, discard bearing(s).

2. Inspect bearing cups in housing bore and cover for any sign of damage or wear. Discard if necessary.

NOTE: If bearing cup warrants replacement, the bearing cone should be replaced also- and vice versa.

3. Inspect output gear for nicks, burrs, scratches, damage or wear of any kind. Teeth may be repaired with a flat file or grinding wheel, otherwise gear must be replaced, clean gear with solvent.

4.Inspect idler gear if present for nicks, burrs, damage or wear. Check bearings for smooth rotation. If wear is suspected, remove snap rings and replace as necessary. Clean all parts including idler hose with solvent. Make sure internal oil passage in shaft is clear.

5. Inspect output coupling at bearing mating surface for nicks or burrs. File smooth or discard output coupling. Inspect oil seal surface for grooves. Discard coupling if it is grooved.

6. Inspect mating surfaces of output flange and propeller coupling and file smooth as necessary. Otherwise replace couplings.

7. Inspect housing cover bored and inspect all mating surfaces on both sides of cover. Repair nicks or burrs with file or crocus cloth; clean cover with solvent.

C. HOUSING AND RELATED PARTS

Housing should now be tipped upright:

1. Flush clean and inspect main housing. Inspect front and rear mating surfaces and repair with file or crocus cloth.

2. Inspect reverse clutch drum for deep scratches or wear. Repair or replace as necessary; clean with solvent.

3. Flush clean oil breather and suction hose (sump to filter). Flush all hoses.

4. If not already accomplished, thoroughly clean selector valve.

CAUTION: Housing and cover are line-bored as a set and should be replaced as a set only

D. RE-ASSEMBLY

1. To install new tapered roller bearings on output gear shaft, roller assemblies must be heated. Each assembly is then pressed on to shaft snug against shoulder of gear. See fig 36.

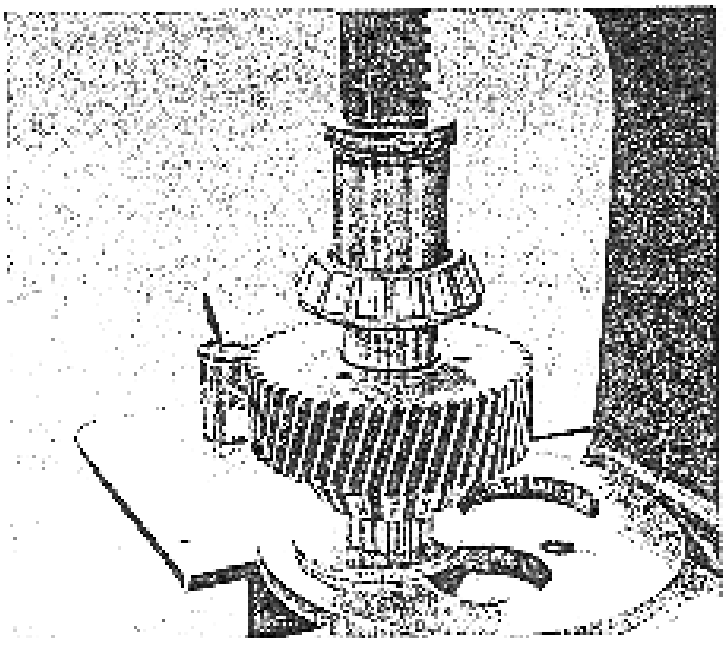


Figure 36. Pressing Roller Bearing onto Shaft.

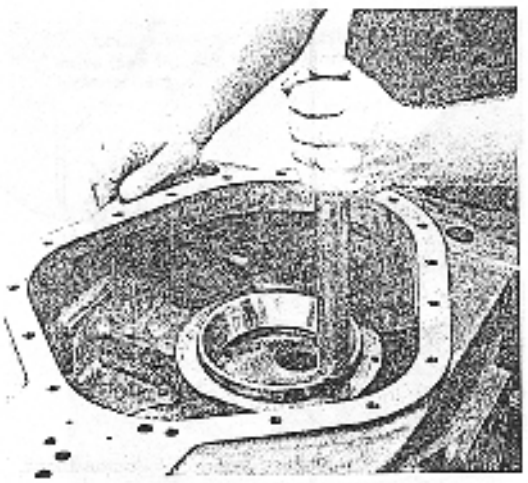


Figure 37. Installing New Bearing Cup in Housing.

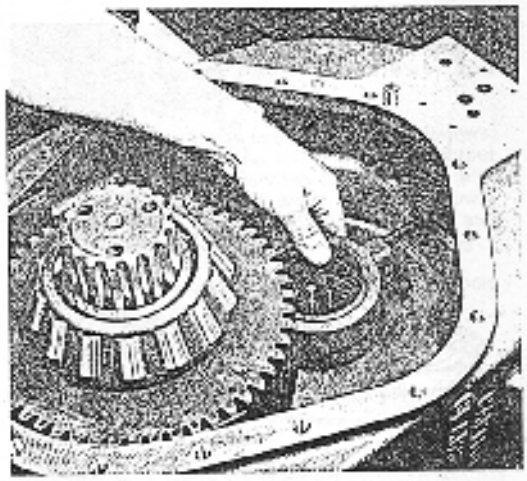


Figure 38. Locating Rear Commutator in Housing.

3. Using adequate hoist lower output gear with roller bearings on the shaft onto housing. See fig. 35.

4. MODELS WITH IDLER GEAR ONLY:

A. Press roller bearings in idler shaft snug against snap rings.

B. Install shaft and bearings into idler gear and secure with snap rings.

C. Install new o-ring on idler shaft.

D. Install idler assembly into housing bore. Tap lightly if necessary so that shaft bottoms in bore.

7.6 INSTALLATION OF PINION, COVER AND RELATED PARTS

1. If a new commutator and/or pinion shaft are being used the clearance between them must be checked. It has to be at least .002" or assembly will be very difficult and commutator may freeze on shaft.

2. With anti-rotation stud and new O-rings installed, rest rear commutator in place in housing. See fig. 38.

3. Apply new cover gasket to housing (a small amount of grease may be used to keep gasket in place).

4. If new pinion, idler gear or output gear are being installed apply marking compound to gear teeth. Apply compound to pinion only on non-idler

5. Using adequate hoist, install the assembly consisting of housing cover, bearing retainer with bearings and pinion shaft (see fig. 31) onto dowels in the housing cover mounting surface. Note: Rear commutator should be held by hand and may need to be jiggled while pinion shaft is tapped into it.

2.04 RATIO MODELS ONLY: Since the pinion is able to clear the housing cover bore; the cover alone may be installed first. The pinion bearing retainer assembly can then be lowered into the housing through cover.

6. Tap the cover evenly with a soft hammer until cover is 1/8" from housing. Locate cap screws and lock washers. Tap cover down firm and torque cap screws to 62 lb-ft. see fig.39

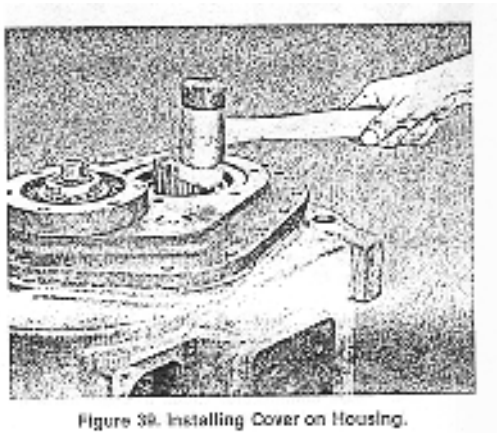


Figure 39. Installing Cover on Housing.

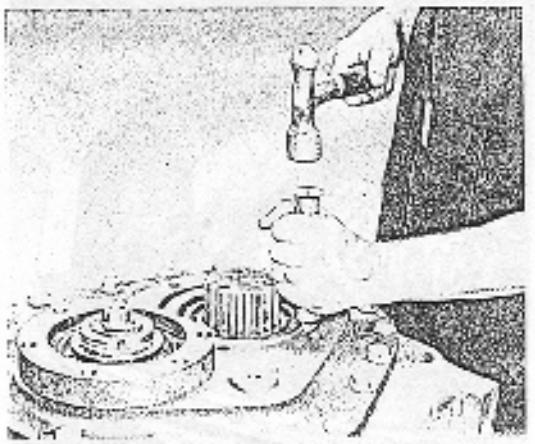


Figure 40. Installing Bearing Cup in Cover.

Figure 42. Applying Pliable Sealant to Junction Block.

7. Install oiled bearing cup in output bore in cover and tap it snug against roller assembly. See fig.40.

7.7 INSTALLATION OF COMMUTATOR, JUNCTION BLOCK, SELECTOR VALVE AND RELATED PARTS

1. Install commutator tubes in commutator see fig.41.

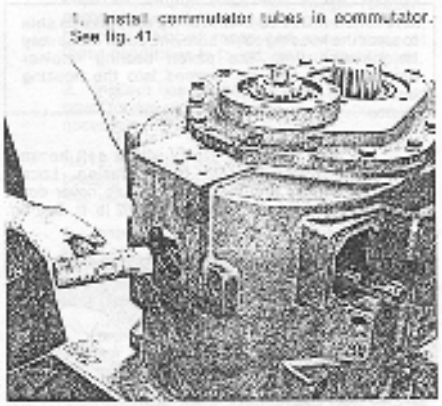


Figure 41. Installing Commutator Tubes in Commutator

2. With new O-rings installed in junction block apply a pliable sealant to mounting surface. See fig.42.

3. Install junction block making sure commutator tubes, enter holes in block. Secure junction block with cap screws. See figure 43.

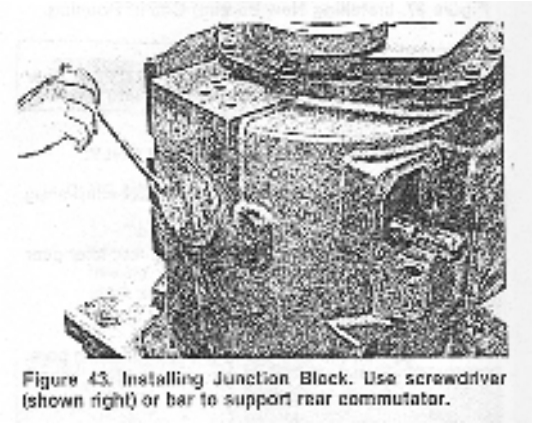


Figure 43. Installing Junction Block. Use screwdriver (shown right) or bar to support rear commutator.

4. Slide commutator tubes through ports in housing and into commutator.

5. Apply base plate gasket in proper configuration (see fig. 22) to housing.

6. Install new O-rings with grease in base plate. Mount base plate see fig 44.

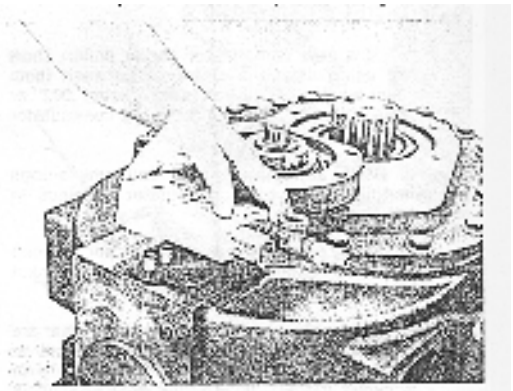


Figure 44. Locating Baseplate Gasket and Baseplate.

7. Locate selector valve gasket and selector valve (see fig 45) secure with cap screws and lock washers.

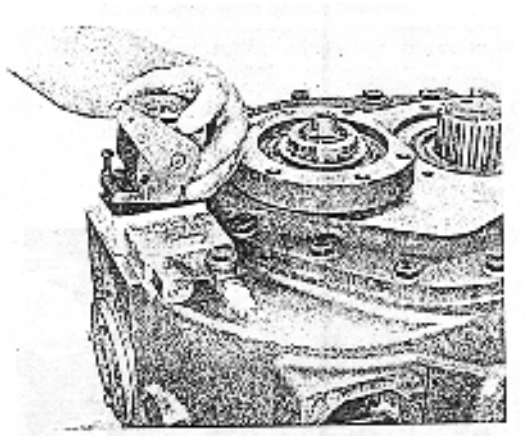


Figure 45. Locating Selector Valve Gasket and Selector Valve.

7.8 INSTALLATION OF OIL PUMP, OUTPUT COUPLING AND RELATED PARTS

1.Locate shims (old shims may be re-used if they are not damaged) on cover.

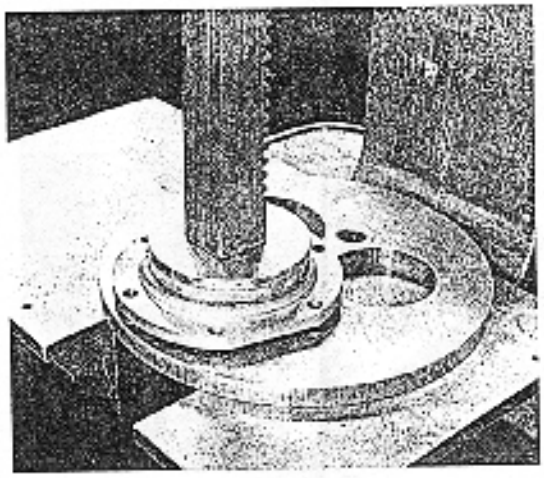


Figure 46. Pressing New Oil Seal in Bearing Cap Retainer.

2. Press in new oil seal in bearing cap retainer (see fig.46) and install bearing cap retainer in cover. Secure with cap screws and lock washers. Torque to 62 lbs-ft.

3. Check endplay in output shaft as follows: Connect eyebolt and hoist to end of output shaft. Mounting thousandths dial indicator with tip resting on end of shaft. Raise and lower output shaft with hoist. Twist shaft back and forth several times to seat rollers in bearing.

Figure 47 demonstrates the use of special tools to achieve the same result.

Endplay should be between .000” and .003”. Otherwise remove bearing retainer and add or subtract shims as necessary. Check endplay again.

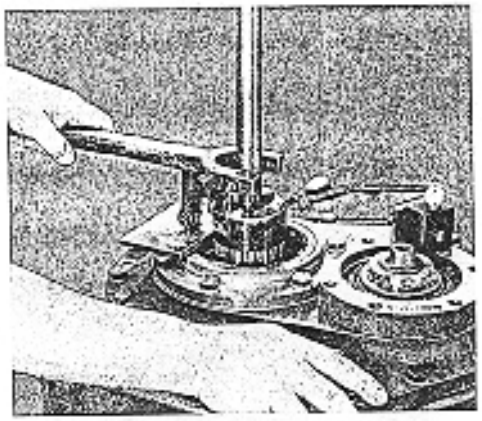


Figure 47. Checking End Play with Special Tool no. 1-90017 and 1-90020. Note: A small steel plate should be located over oil seal to protect it from damage by tool.

4. Heat output coupling in hot oil at 200F for at least ½ hour before installation on output shaft.

5. Locate new oil pump gasket with a small amount of grease.

6. Install oil pump onto bearing retainer and secure with cap screws and lock washers. Tighten to 62 lbs-ft.

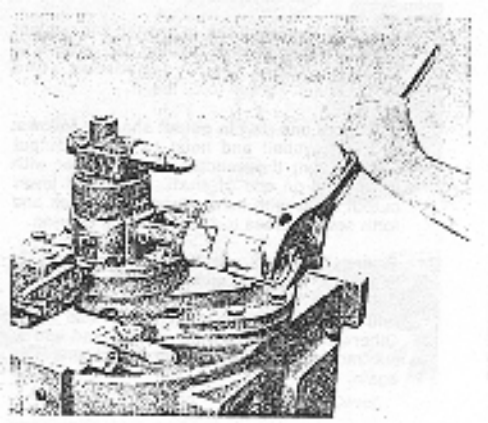


Figure 48. Installing Oil Filter Head.

7. Install pipe nipple and oil filter. See fig 48. Use pipe joint compound on all threaded fittings. BE SURE FLOW ARROW ON FILTER POINTS TOWARD OIL PUMP OTHERWISE SEVERE DAMAGE MAY RESULT.

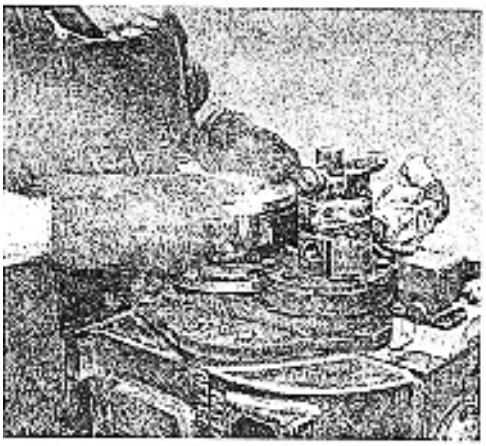


Figure 49. Installing Hot Output Coupling on Shaft.

8. Install heated output coupling on output shaft. Make sure coupling seats firmly against bearing. If it does not a soft hammer should be used while coupling is hot. See fig. 49.

Another means of securing the coupling on the shaft involves a jack and a special tool no 1-90026-0000 shown in figure 47. The stud is threaded so that a large nut may be placed on the end of it.

9. Install output retainer plate with hex head cap screws. Torque to 62 lbs-ft. see figure 50.

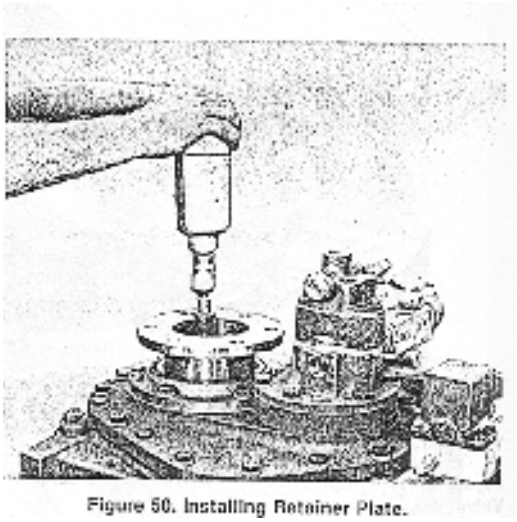


Figure 50. Installing Retainer Plate.

10. Install suction hose from housing to filter. Use joint compound fittings.

7.9 POST ASSEMBLY INSPECTION

Return housing to upright position

1. Check output flange for trueness of rotation as follows:

A. Pilot ring groove (see fig. 51) using a thousandths dial indicator as shown, rotate the output flange. Variation must not exceed .003” maximum.

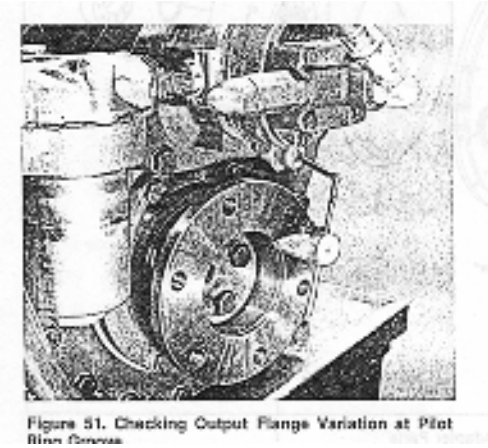


Figure 51. Checking Output Flange Variation at Pilot Ring Groove

B. Mounting face (see fig.52) mount indicator as shown and rotate coupling. Variation must not exceed .003” maximum.

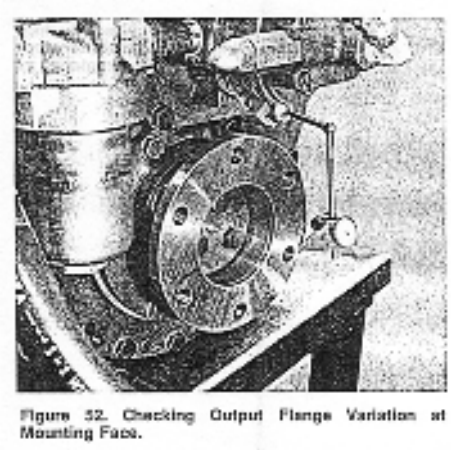


Figure 52. Checking Output Flange Variation at Mounting Face.

2. CHECKING BACKLASH
A.E.R MODELS (WITHOUT IDLER GEAR)
Place hand on pinion shaft through engine end of housing and twist pinion back and forth (output gear should be stationary). There must be a slight amount of play between the teeth of the pinion and output gear.

E.R MODELS (WITH IDLER GEAR)
Hold output gear stationary and reach through side inspection hole toward idler gear. Move idler gear gently back and forth. There must be a slight amount of play between the teeth of idler gear and other gears.

3. CHECKING TOOTH CONTACT (ALL MODELS)
If a new pinion and/or idler are installed, check for tooth contact with marking compound. Units without idler gear-apply compound to pinion. Units with idler gear – apply compound to idler gear.

7.10 ADDITIONAL ASSEMBLY

1.Install oil breather cap and oil dipstick

2. Install inspection covers and gasket

3. Connect hose from selector valve tee to oil pump.

4. Install oil drain plug.

5. On idler models, make sure hose is installed between idler shaft and oil pump

6. Make sure reverse clutch drum has been installed.

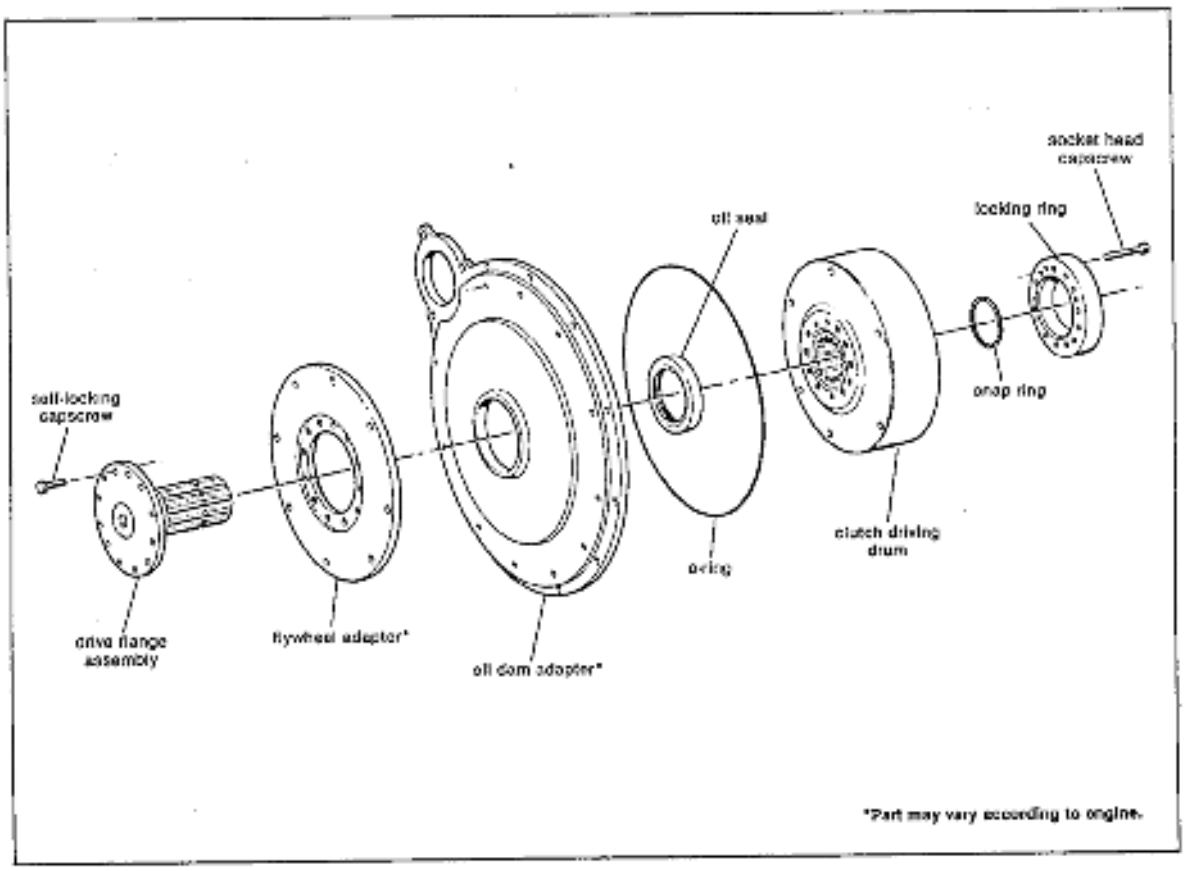


Figure 53. Adapter Parts

7.11 ADAPTER PARTS

1.Clean and inspect drive flange shaft, clutch and driving drum. Check splines for chips, deep grooves or wear. Replace parts as necessary.

2. Remove oil dam adapter. Remove and discard oil seal. Install new seal in oil dam adapter.

3. While oil dam is removed, inspect flywheel adapter and drive flange for distortion or rough mounting surfaces. Repair or replace as necessary.

SECTION 8 PARTS INFORMATION

8.1 PARTS ORDERING PROCEDURE

A. Contact your local dealer, distributor or authorized service center.

B. Contact Capitol Gears Inc. If the above cannot supply the part(s) you need. Write:

Customer Service
Capitol Gears Inc.
349 North Hamline ave.
St. Paul MN 55104
USA

Cable address:
"Cap marine"
tel: (612) 645-9491
Telex: 29-7081

C. Always give complete part description as shown in the sample column below:

Necessary Information	Sample
1. Model	HY-24000
2. Option Code	2-24000-02011-3011
3. Serial #	11300-1081
4. Ratio	1.53 A.E.R
5. Eng.mfg.No (if any)	
6. Part number	1-00230-4400
7. Description	clutch disc driving
8. Fig. # and item #	Fig. 57 item 6
9. Quantity being ordered	10

NOTE:
Please do not use the terms set or complete when ordering parts but specify exactly each part required

A list of distributors for capitol gear equipment may be obtained by writing to the Customer Service Department at the address mentioned above.

Do not send any equipment to the factory without authorization from the Customer Service department.

Capitol Gears will route parts with customers' best interest in mind if routing is not specified when ordering.

Capitol Gears inc. Will provide its distributors, dealers and service centers with current changes and additions to service literature. Contact your local capitol representative for up to date service material.

CAPITOL GASKET AND SEAL KIT NO. 1-10193-0000 includes the necessary gaskets, seals and o-rings commonly used for repair.

Clutch quad-rings must be purchased separately.

8.2 UNIT RECORD

"CAPITOL" Marine Gear
Model_____
Serial no._____
Installed in (name of vessel)_____
Installed by_____date_____
Address_____
For use with (engine and model type)_____
Type of Service_____
Purchased from (Dealer's name and address)_____
_____
Date Purchased_____

8.3 OIL PUMP

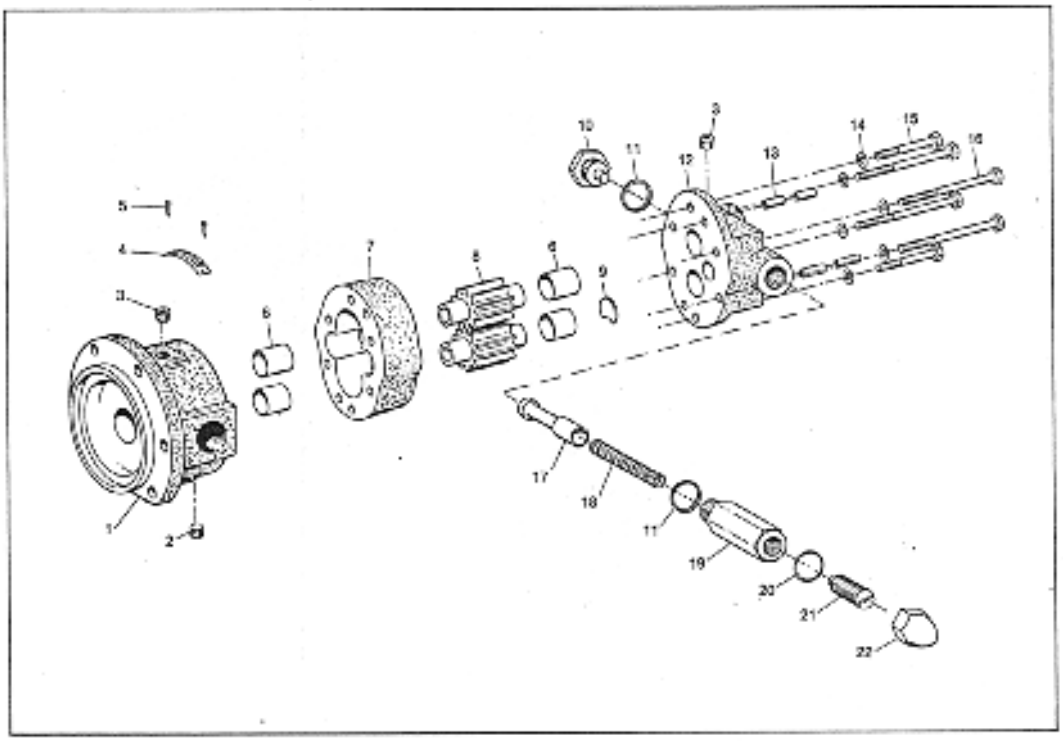


Figure 54. Oil Pump Assembly no. 1-13730-0000 (Right or Left Hand)

ITEM	DESCRIPTION	PART NO	QTY
REF	ASSEMBLY, OIL PUMP (RIGHT OR LEFT)	1-13730-0000	1
1	ASSEMBLY, PUMP ADAPTER (INCLUDES ITEMS 2,3,4,5,6)	1-13525-1000	1
2	PIPE PLUG, HEX SOCKET; 1/8 N.P.T	1-11279-0200	1
3	PIPE PLUG, HEX SOCKET; ¼-18	1-11279-0300	2
4	PLATE PUMP NUMBER	1-11209-0000	1
5	DRIVE SCREW, ROUND HEAD	1-13275-0000	2
6	BUSHING	1-11125-0000	4
7	BODY, PUMP	1-13531-0000	2
8	GEAR, PUMP	1-13530-0000	2
9	DISC, FLAT	1-13731-0000	1
10	STOP, RELIEF	1-10285-0100	1
11	WASHER	1-10288-0700	2
12	ASSEMBLY, PUMP COVER (INCLUDES ITEMS 6,9,3)*	1-13721-1000	1
13	SPRING PIN	1-12097-2000	4
14	LOCKWASHER	1-05309-0800	6
15	CAPSCREW, HEX HD; ¼-20 X 21/2	1-13543-0000	2
16	CAPSCREW HEX HD; ¼-20 X 33/4	1-13544-0000	4
17	PLUNGER RELIEF	1-10258-1000	1
18	SPRING, PRESSURE RELIEF	1-13413-0000	1
19	INSERT, RELIEF VALVE	1-13412-0000	1
20	WASHER	1-12902-0000	1
21	SCREW, PRESSURE RELIEF	1-06660-0800	1
22	NUT, DOME	1-06667-0800	1

*Bushings are installed and reamed to size

8.4 SELECTOR VALVE

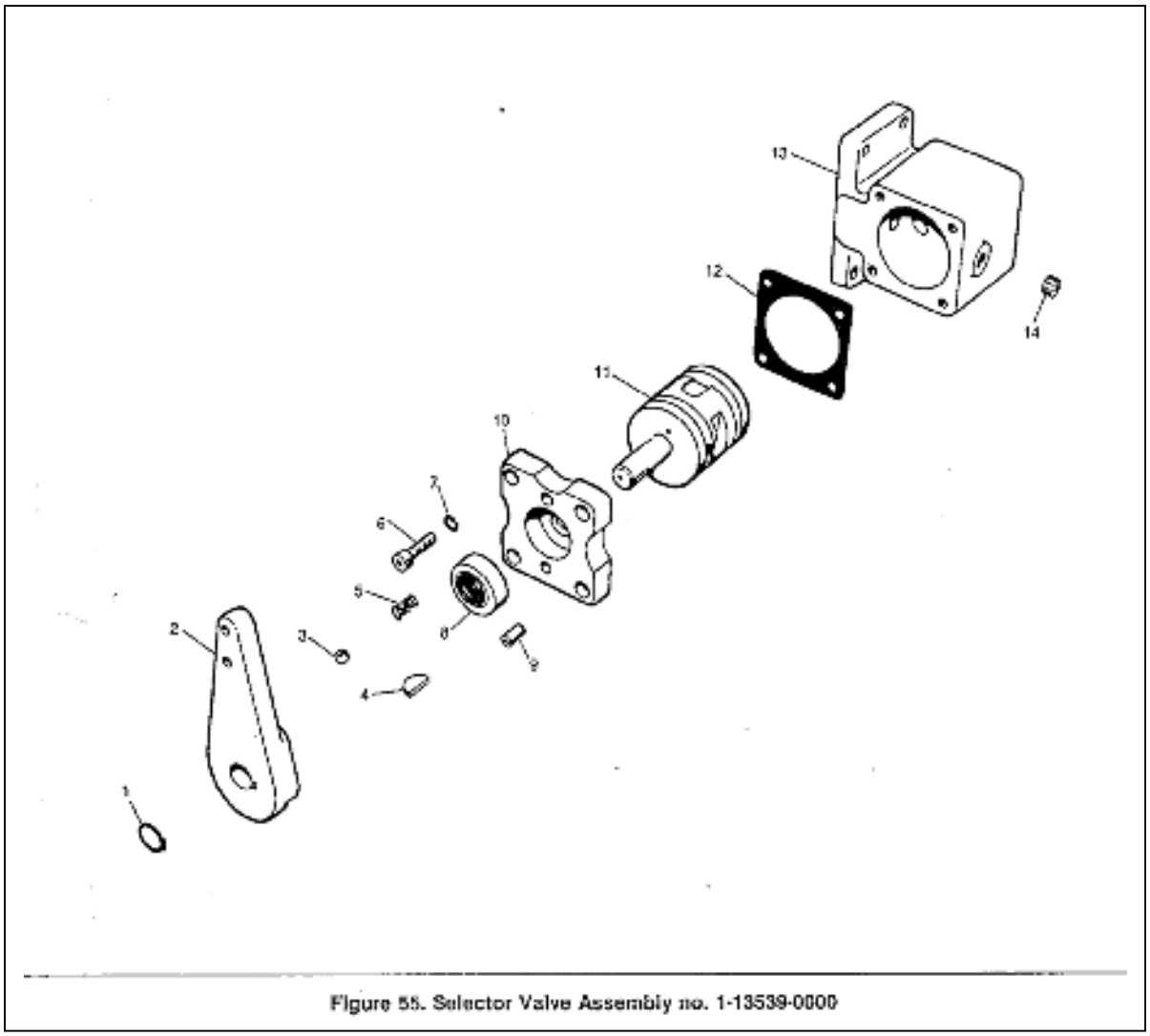


Figure 55. Selector Valve Assembly no. 1-13539-0000

ITEM	DESCRIPTION	PART NO.	QTY
REF	ASSEMBLY, SELECTOR VALVE	1-13539-0000	1
1	SNAP RING	1-01180-1500	1
2	LEVER, SELECTOR VALVE	1-12419-0000	1
3	BALL, INDEXING	1-11200-0000	1
4	KEY, WOODRUFF	1-01164-3200	1
5	SPRING, INDEXING	1-01132-1500	1
6	CAPSCREW, SOCKET HD; 10-24 X ½	1-12844-0000	4
7	LOCKWASHER, LIGHT	1-01160-1500	4
8	OIL SEAL	1-01155-1500	1
9	SPRING PIN	1-12097-0800	1
10	COVER, VALVE	1-12417-1000	1
11	VALVE, ROTARY CONTROL (ROTOR)	1-01144-1500	1
12	GASKET, VALVE COVER	1-01156-1500	1
13	BLOCK VALVE	1-13532-0000	1
14	PIPE PLUG, HEX SOCKET	1-11279-0200	1

8.5 ADAPTER
PARTS

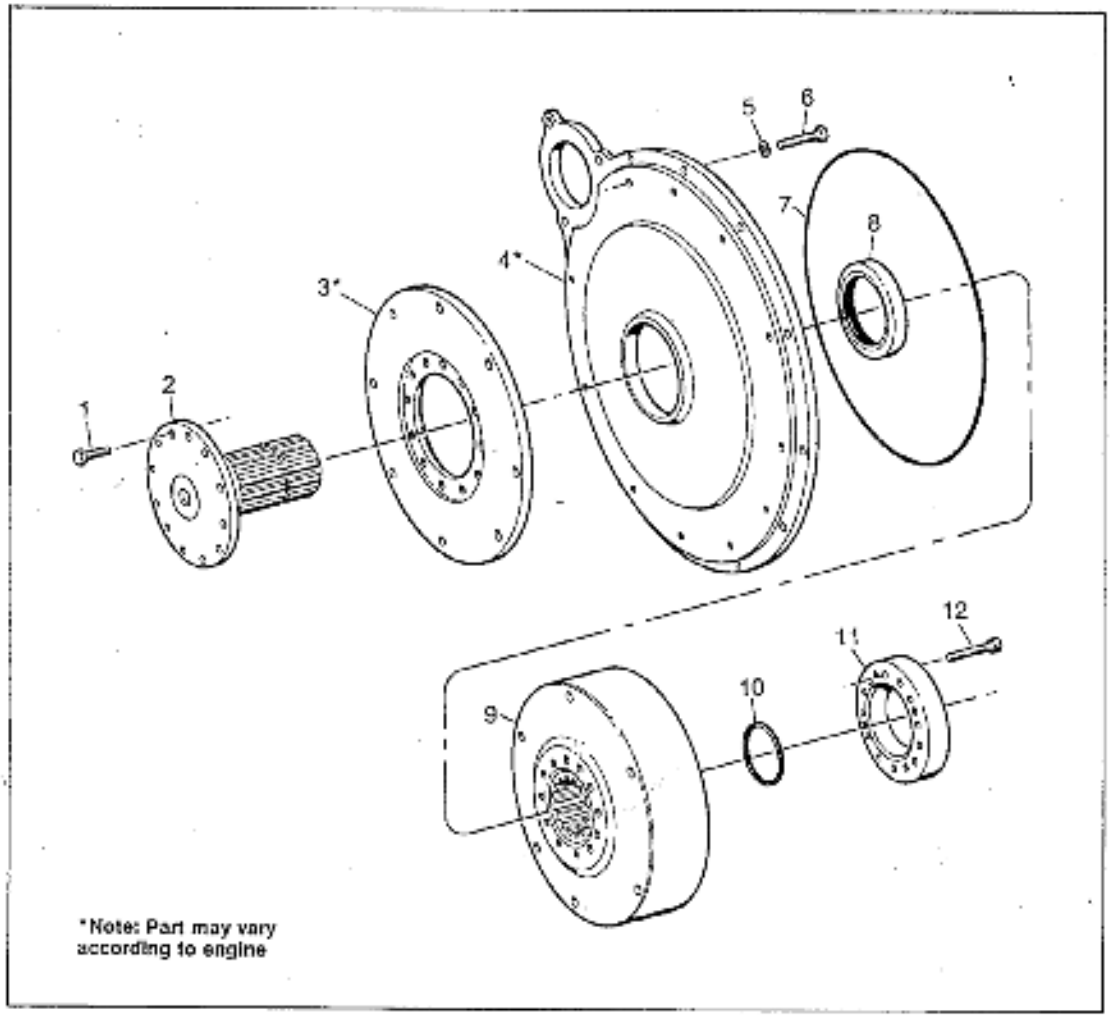


Figure 56. Adapter Parts

ITEM	DESCRIPTIOIN	PART NO.	QTY
1	CAPSCREW, SELF-LOCKING ½-13 N,C 1”	1-13805-0000	12
2	ASSEMBLY, DRIVE FLANGE (INCLUDES PIPE PLUG AND SPACER)	1-13710-0000	1
3	ADAPTER FLYWHEEL; SEE DRAWING		
4	ADAPTER, OIL DAM; SEE DRAWING		
5	LOCKWASHER, LIGH 3/8	1-09460-0800	12
6	CAPSCREW, HEX. HD; 3/8-16 N.C 11/2	1-07926-0800	12
7	O-RING	1-13499-0000	1
8	OIL SEAL	1-12970-0000	1
9	DRUM, CLUTCH DRIVING	1-13501-2000	1
10	SNAP RING	1-1151-3700	1
11	LOCKING RING, DRUM	1-13849-0000	1
12	CAPSCREW, SELF LOCKING SOCKET HD 3/8-16 X 1 ¾”	1-11405-0000	12

8.6 CLUTCH

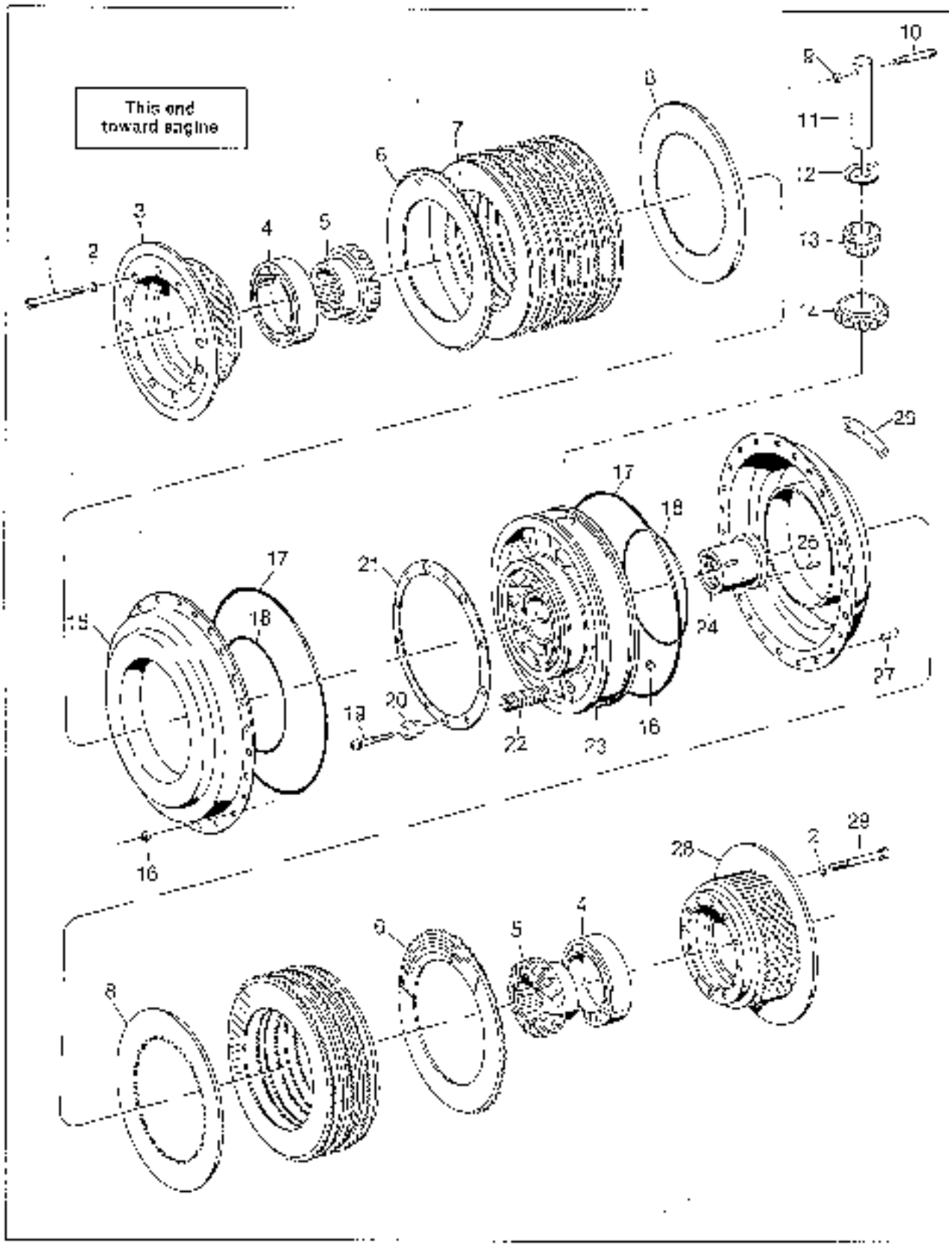


Figure 57. Clutch Assembly no. 1-30100-5004

8.6 CLTUCH

ITEM	DESCRIPTION	PART NO.	QTY
REF	ASSEMBLY CLUTCH	1-00100-5004	1
1	CAPSCREW, SOCKET HD 3/8-16 X 31/4”	1-12247-0000	12
2	LOCKWASHER; 3/8”	1-08755-0800	24
3	END FLANGE, FORWARD CLUTCH	1-00212-5000	1
4	BALL BEARING	1-00211-2500	2
5	GEAR BEVEL (DRIVING AND DRIVEN)	1-00215-2600	2
6	CLUTCH DISC, DRIVING	1-00230-4400	10
7	CLUTCH DISC, DRIVEN	1-00233-1200	5
8	CLUTCH DISC, DRIVEN (THICK)	1-00233-2900	5
9	NUT, SELF LOCKING	1-00226-3600	3
10	CAPSCREW, SOCKET HD; ¼-28 X 2”	1-09433-0800	3
11	SHAFT, BEVEL PINION	1-00220-3600	3
12	WASHER, THRUST	1-00221-3600	3
13	BEARING, BEVEL PINION	1-00218-2500	3
14	PINION, BEVEL	1-00217-3100	3
15	CYLINDER, CLUTCH (FORWARD AND REVERSE)	1-00234-5500	2
16	NUT, SELF LOCKING	1-11399-0000	36
17	QUAD RING	1-00237-3600	2
18	QUAD RING	1-00238-5800	2
19	CAPSCREW, SOCKET HD; 5/16-18 X 2”	1-05386-0800	12
20	RETAINER, RETURN SPRING	1-00243-3600	12
21	RING, RETURN SPRING	1-13917-0000	1
22	SPRING, RETURN	1-00239-3700	12
23	CARRIER, BEVEL GEAR (DOES NOT INCLUDE BEVEL PINION OR RETURN SPRING ASSEMBLY)	1-00219-3700	1
24	BUSHING, FORWARD COMMUTATOR	1-00247-3600	1
25	SPRIN GPIN; 3/16 DIA. X 5/8”	1-12096-1000	3
26	NAME PLATE	1-12398-0000	1
27	CAPSCREW, SOCKET HD; 5/16-18 X 5/8”	1-09468-0800	24
28	END FLANGE	1-00210-5000	1
29	CAPSCREW, SOCKET HD; 3/8-16X 3”	1-08746-0800	12

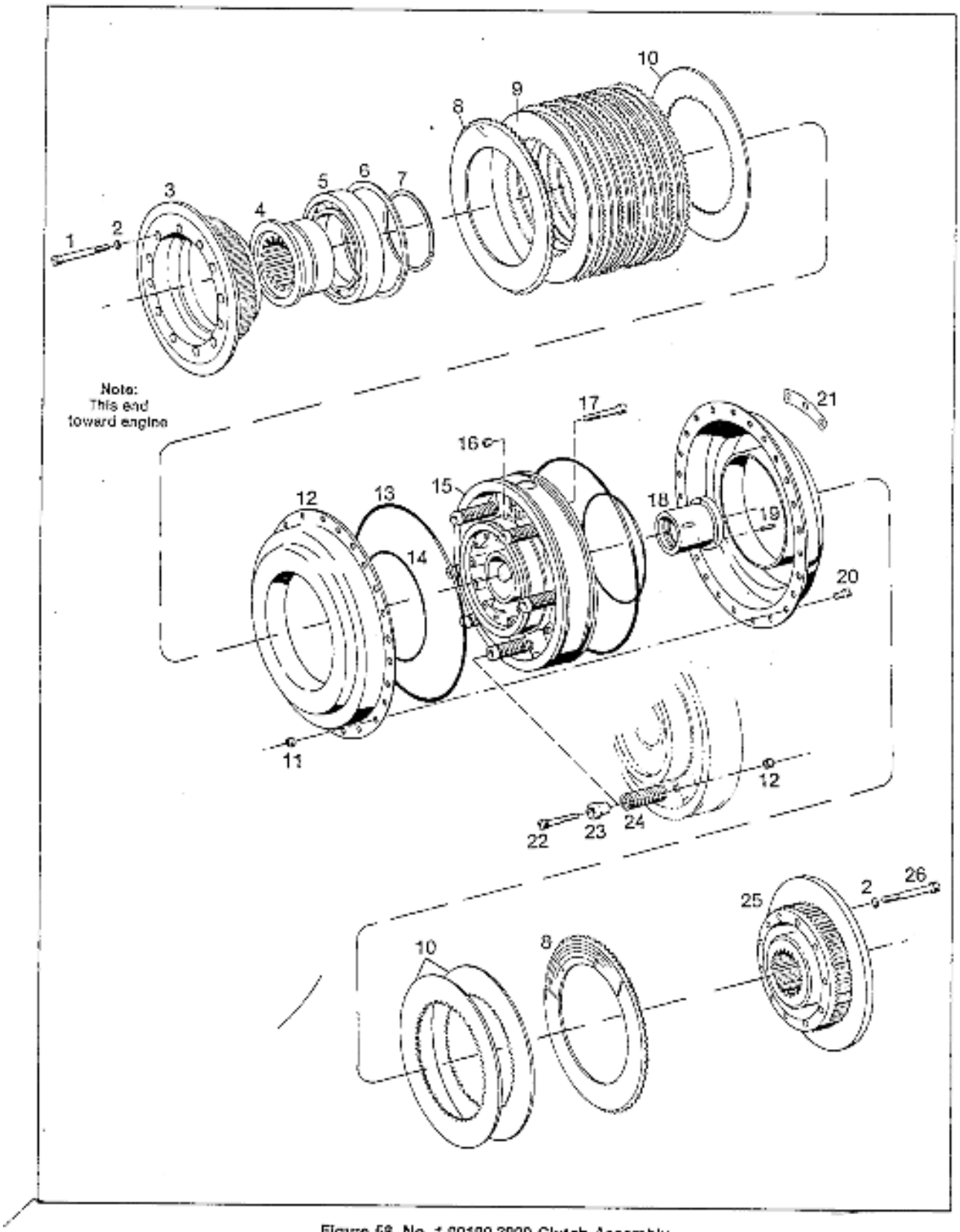


Figure 58. No. 1-00100-3900 Clutch Assembly

8.6 CLUTCH
Cont'd

ITEM	DESCRIPTION	PART NO.	QTY
REF	CLUTCH, ASSEMBLY HY-PTO WITH BRAKE	1-00100-3900	1
1	CAPSCREW, SOCKET HD, 3/8-16 X 3/1/4"	1-12247-0000	12
2	LOCKWASHER	1-08755-0800	24
3	FLANGE, FORWARD CLUTCH	1-00212-3300	1
4	SUPPORT CLUTCH	1-13264-0000	1
5	BEARING BALL	1-00211-2500	1
6	SNAP RING, SPIROLOX	1-13266-0000	1
7	SNAP RING, TRU-ARC	1-11834-0000	1
8	CLUTCH DISC, DRIVING	1-00230-4400	7
9	CLUTCH DISC, DRIVEN	1-00233-1200	5
10	CLUTCH DISC, DRIVEN (THICK)	1-00233-2900	3
11	NUT, SELF LOCKING, 5/16-18 N.C	1-11399-0000	36
12	CYLINDER CLUTCH	1-00234-5500	2
13	QUAD RING	1-00237-3600	2
14	QUAD RING	1-00238-5800	2
15	CARRIER, BEVEL GEAR	1-00219-3700	1
16	NUT SELF LOCKING ¼-28 N.F	1-00226-3600	3
17	CAPSCREW, SOCKET HD. ¼-28 X 2"	1-09433-0800	3
18	BUSHING FORWARD COMMUTATOR	1-00247-3600	1
19	SPRING PIN, 3/16 DIA. 5/8"	1-12096-1000	3
20	CAPSCREW, SOCKET HD, 5/16-18 X 5/8"	1-09468-0800	24
21	NAME PLATE	1-12398-0000	1
22	CAPSCREW, SOCKET HD 5/16-18 X 2"	1-0836-0800	12
23	RETAINER, RETURN SPRING	1-00243-3600	12
24	SPRING RETURN	1-00239-3700	12
25	FLANGE, REVERSE CLUTCH	1-13092-2000	1
26	CAPSCREW, SOCKET HD 3/8-16 X 3"	1-08746-0800	12

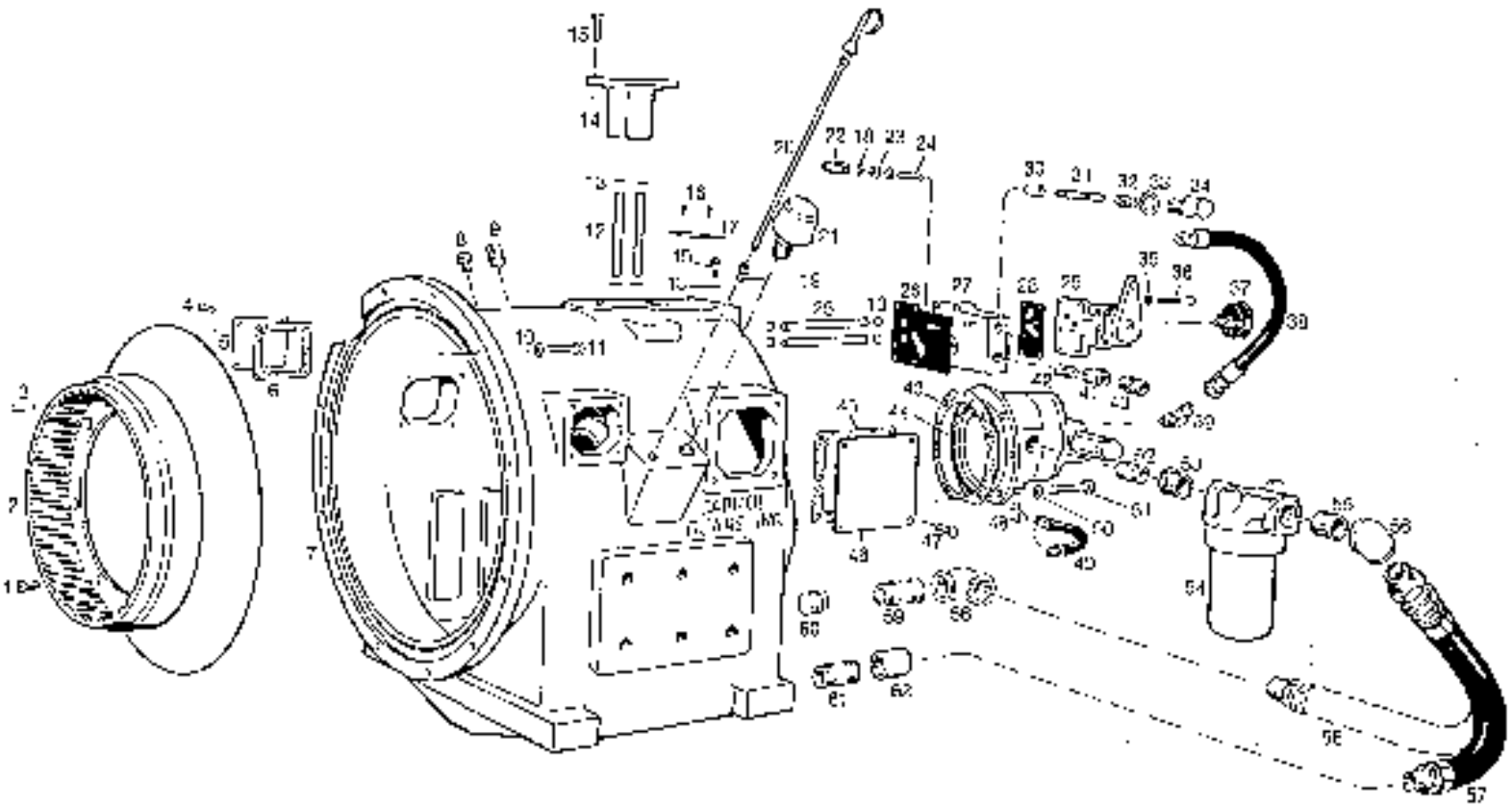


Figure 59. HY-24000 Transmission Pumping and Related Parts.

8.7 TRANSMISSON HOUSING AND RELATED PARTS

ITEM	DESCRIPTION	PART NO.	QTY
1	CAPSCREW , FLAT SOCKET HD ½-13 N.C 1”	1-09741-0800	8
2	DRUM, REVERSE CLUTCH	1-13500-0000	1
3	DOWEL PIN ½ DIA. X ¾ LG	1-13077-0000	2
4	CAPSCREW, HEX HD. ¼-20 N.C ½	1-08087-0800	8
5	COVER	1-01103-1500	2
6	GASKET	1-01131-1500	2
7	HOUSING & COVER ASS’Y		
	(HOUSING NOT SOLD SEPERATELY)		
	FOR MODELS WITHOUT IDLER GEAR AER	1-13490-0000	1
	FOR 1.00 RATIO MODELS WITH IDLER E.R	1-13490-1000	1
	FOR 1.53 RATIO MODELS WITH IDLER E.R	1-13490-2000	1
	FOR 2.04 RATIO MODELS WITH IDLER E.R	1-13490-3000	1
8	CAPSCREW HEX HD; ¼-20 N.F X ¾”	1-11649-0000	1
9	PIPE PLUG, SQUARE HD.	1-11251-0500	1
10	LOCKWASHER, 3/8” LIGHT	1-09460-0800	12
11	CAPSCREW, HEX HD. 3/8-16 N.C X 11/2	1-07926-0800	12
12	TUBE, COMMUTATOR	1-13535-0000	2
13	O-RING	1-13076-0000	8
14	JUNCTION BLOCK	1-13513-0000	1
15	CAPSCREW, HEX HD. 5/16 N.C X 7/8”	1-12151-0000	5
16	DRIVE SCREW	1-13275-0000	2
17	NAME PLATE	1-11210-0000	1
18	WASHER, FLAT	1-09471-0800	3
19	STANDARD NUT, INVERTED FLARE	1-11227-0400	1
20	DIPSTICK	1-13495-0000	1
21	BREATHER	1-13511-0000	1
22	DOME NUT	1-09461-0800	1
23	JAM NUT, HEX; 5/16-18 N.C	1-09464-0800	1
24	SCREW, SOCKET SET; 5/16-18 X 11/2”	1-09466-0800	1
25	TUBE, SELECTOR VALVE	1-13534-0000	2
26	GASKET, BASE PLATE	1-13619-0000	1
27	BASE PLATE	1-13618-1000	1
28	GASKET, SELECTOR VALVE	1-13627-0000	1
29	SELECTOR VALVE (SEE P.42)	1-13539-0000	1
30	PLUNGER	1-12616-0000	1
31	SPRING	1-12618-0000	1
32	WASHER	1-12619-0000	5
33	WASHER	1-10288-0700	1
34	END CAP	1-12617-0000	1
35	LOCKWASHER ¼” LIGHT	1-05309-0800	1
36	CAPSCREW, HEX HD.; ¼-20 N.C X 21/4”	1-12377-0000	1
37	PRESSURE GAUGE	1-09669-09 00	1
38	HOSE	1-07830-1500	1
39	PIPE ELBOW, 90°; 3/8 N.P ¾-16	1-11221-1100	1
40	MALE CONNECTOR; 3/8 N.P X ¾-16	1-11241-1200	1
41	TEE; ½ X 3/8 X 3/8”	1-11260-0200	1
42	CLOSE NIPPLE; 3/8” N.P.T X 1” L.G	1-11233-0300	1
43	GASKET, BEARING RETAINER	1-13541-0000	1
44	OIL PUMP (SEE P.41)	1-13730-0000	1
45	GASKET	1-12438-0000	1

Cont’d

46	COVER	1-12405-0000	1
47	CAPSCREW, HEX HD; 3/8-16 N.C X 5/8”	1-10836-0000	8
48	90 ELBOW- E.R MODELS ONLY (WITH IDLER)	1-11221-0300	1
49	HOSE, IDLER- E.R MODELS ONLY (WITH IDLER)	1-13389-0000	1
50	LOCKWASHER; ½” LIGHT	1-11083-0000	6
51	CAPSCREW, HEX HD. ½-13 N.C X 2 ¼”	1-03734-0800	6
52	PIPE NIPPLE; ¾ N.P.T X 2 ½”	1-11259-0600	1
53	BUSHING; 1 X ¾” N.P.T	1-11253-1200	1
54	OIL FILTER (SEE PG. 58)	1-13286-0000	1
55	CLOSE NIPPLE; 1” N.P.T X 1 ½”	1-11233-0600	1
56	90 ELBOW; 1 X 1” N.P.T	1-11246-0600	1
57	HOSE SUCTION- A.E.R MODELS (NON-IDLER)	1-13475-0000	1
58	HOSE SUCTION – E.R MODELS (WITH IDLER)	1-13493-0000	1
59	PIPE NIPPLE; 1” N.P.T X 2 ½”	1-11259-2700	1
60	PIPE PLUG, S.Q. H.D; 1” N.P.T	1-11251-0600	1
61	PIPE NIPPLE; 1” N.P.T X 2”	1-11259-0900	1
62	COUPLING; 1” N.P.T X 2”	1-11262-0600	1

8.8 PINION SHAFT AND RELATED PARTS

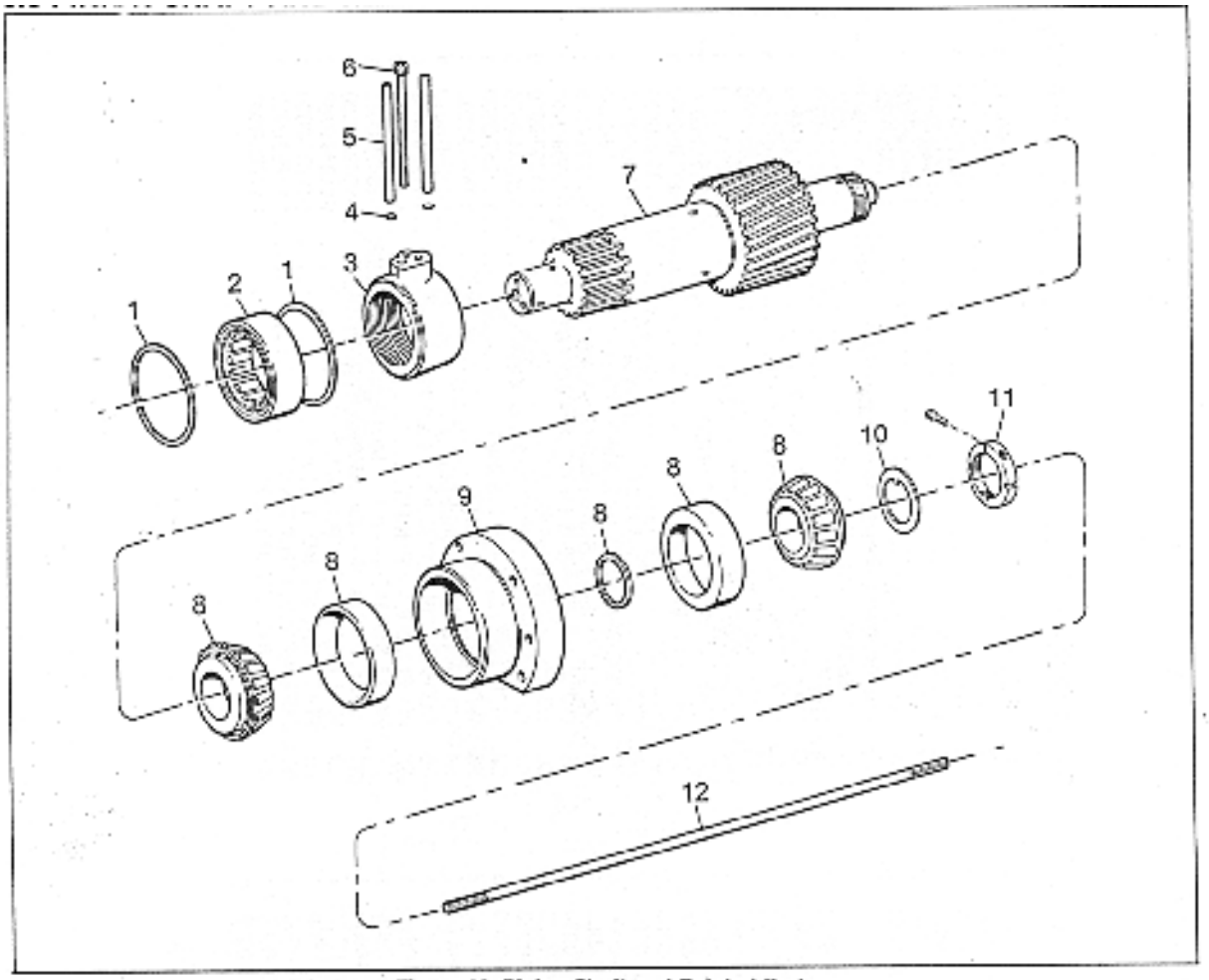


Figure 60. Pinion Shaft and Related Parts.

8.9 IDLER GEAR AND RELATED PARTS

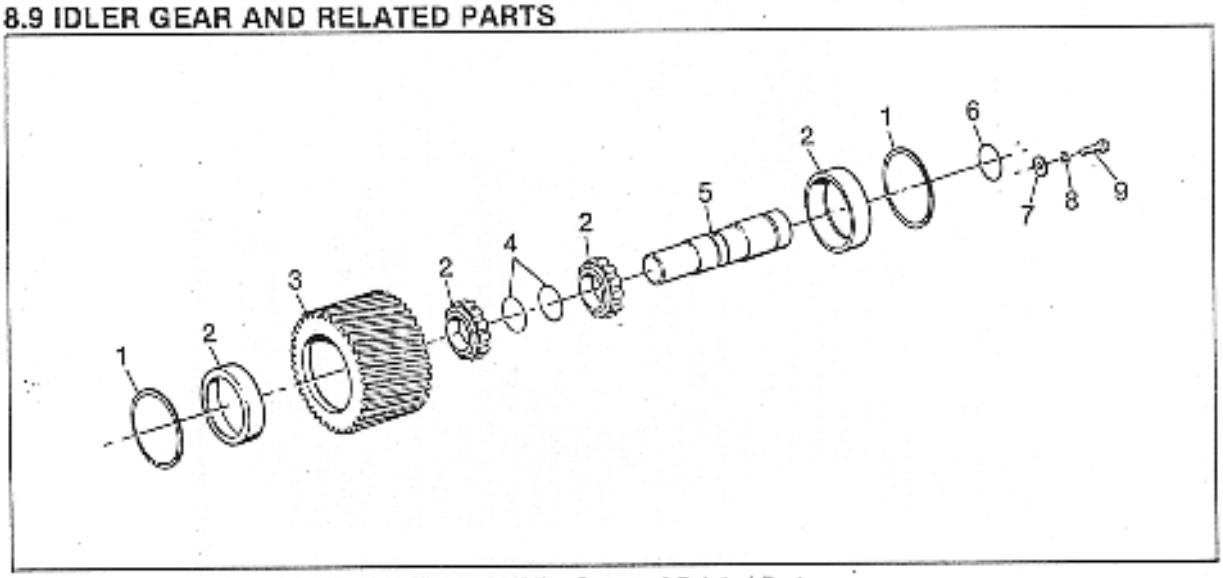


Figure 61. Idler Gear and Related Parts.

8.8 PINION SHAFT AND RELATED PARTS

ITEM	DESCRIPTION	PART NO	QTY
1	SNAP RING	1-13479-0000	2
2	BEARING	1-13507-0000	1
3	COMMUTATOR, REAR	1-13471-0000	1
4	O-RINGS	1-13076-0000	8
5	TUBES, COMMUTATOR	1-13535-0000	2
6	CAPSCREW, SOC. HD; 3/8-24 N.F. X 3" (SELF LOCKING)	1-13486-0000	1
7	ASSEMBLY, PINION SHAFT	SEE SELECTION CHART	1
8	ASSEMBLY, BEARING (5 PIECES)	1-12958-0000	1
9	ASSEMBLY, BEARING RETAINER	1-13504-1000	1
10	WASHER, KEYED	1-13987-0000	1
11	LOCKNUT, BEARING	1-13988-0000	1
12	SHAFT, OIL PUMP	1-13496-0000	1

PINION AND SHAFT REPAIR KITS

The following kits are available that include the pinion and shaft assembly, keyed washer, bearing locknut and a small tube of Loctite locking compound.

RATIO	KIT NUMBER
1.000 A.E.R	1-13518-2000
1.533 A.E.R.	1-13520-2000
2.040 A.E.R	1-13517-2000
1.000 E.R	1-13519-2000
1.535 E.R	1-13548-2000
2.043 E.R	1-13516-2000

8.9 IDLER GEAR AND RELATED PARTS

ITEM	DESCRIPTION	PART NO.	QTY
1	SNAP RING	1-10112-0000	2
2	BEARING	1-10117-0000	2
3	GEAR, IDLER	1-13522-0000	1
4	SNAP RING	1-12763-0000	2
5	SHAFT, IDLER	1-13528-0000	1
6	O-RING	1-10336-0000	1
7	WASHER, SPECIAL	1-10338-0000	1
8	LOCKWASHER, LIGHT 5/16"	1-09458-0800	1
9	CAPSCREW, HEX HD; 5/16-18 X ½"	1-12145-0000	1

PLUG KIT FOR CONVERTING IDLER MODEL (E.R) TO A NON-ILDER MODEL (A.E.R)

DESCRIPTION	PART NO.	QTY
PLUG, NON-IDLER	1-13836-0000	1
O-RING	1-10336-0000	1
CAPSCREW, HEX HD 5/16-18 X ½"	1-12145-0000	1
LOCKWASHER, LIGHT; 5/16"	1-09458-0800	1
WASHER, SPECIAL	1-10338-0000	1

8.10 OUTPUT GEAR AND RELATED PARTS

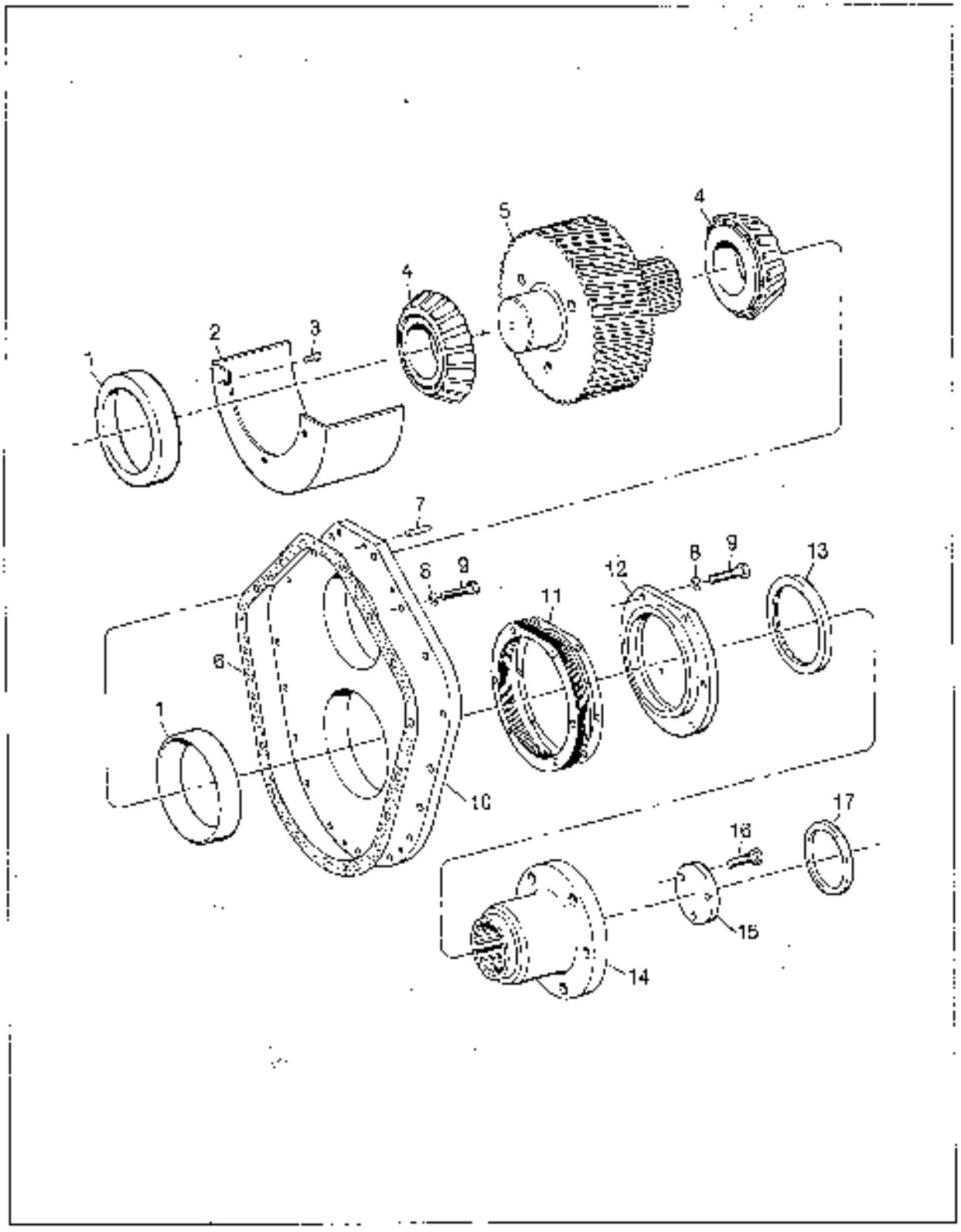


Figure 62. Output Gear and Related Parts.

8.10 OUTPUT GEAR AND RELATED PARTS

ITEM	DESCRIPTION	PART NO.	QTY
1	CUP BEARING	1-11627-0200	2
2	OIL PAN	1-13527-0000	1
3	CAPSCREW, HEX HD; 3/8-16 N.C X ¾" (SELF LOCKING)	1-13768-0000	3
4	CONE, BEARING	1-11627-0100	2
*5	GEAR OUTPUT	SEE SELECTION CHART	
6	GASKET, COVER TO HOUSING	1-13542-0000	1
7	DOWEL PIN; ½ DIA. 1 ¼ L.G	1-12311-0000	2
8	LOCKWASHER, LIGHT; ½	1-11083-0000	23
9	CAPSCREW, HEX HD; 1/2 –13 N.C X 11/2	1-09141-0800	23
10	COVER & HOUSING ** ASS'Y (COVER NOT SOLD SEPERATELY)		
	FOR MODELS WITHOUT IDLER GEAR (AER)	1-13490-0000	1
	FOR MODELS WITH IDLER (ER) 1.00 RATIO	1-13490-1000	1
	FOR MODELS WITH IDLER (ER) 1.53 RATIO	1-13490-2000	1
	FOR MODELS WITH IDLER (E,R) 2.04 RATIO	1-13490-3000	1
11	SHIM PACK (7 PIECES)	1-13540-0000	1
12	OIL SEAL REATINER AND BEARING CUP	1-13503-0000	1
13	OIL SEAL	1-13538-0000	1
14	COUPLING, OUTPUT	1-13512-1000	1
*15	PLATE, RETAINER	1-13862-0000	1
*16	CAPSCREW, HEX HD.; ½-13 N.C X 1 ¼" (SELF LOCKING)	1-13134-0000	3
17	PILOT RING	1-01175-0400	1

* Starred items are available as a kit. They may be ordered by the output gear number plus the suffix –5000 (e.g. Kit number for output gear 1-13354-2000 would be 1-13354-5000).

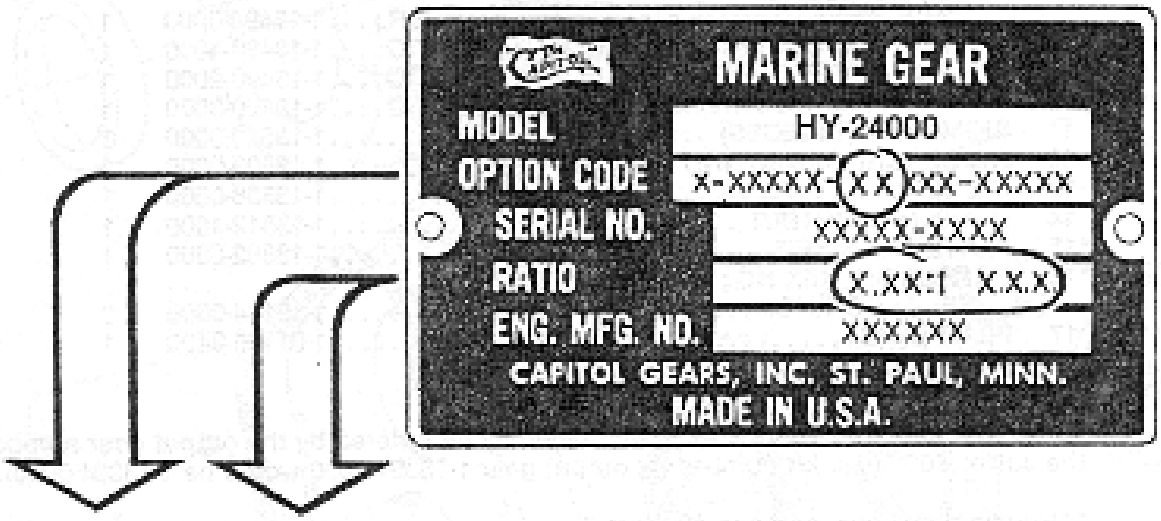
** Housing is shown in item 7

8.11 REDUCTION GAER SELECTION CHART

HOW TO SELECT THE CORRECT PINION AND OUTPUT GEAR FOR YOUR TRANSMISSION:

A. LOCATE THE NAMEPLATE (ON TOP OF HOUSING) AND DETERMINE THE OPTION CODE NUMBERS (CIRCLED IN SAMPLE BELOW) AND THE RATIO. The NUMBER OF TEETH MAY BE CHECKED ALSO.

B. MATCH THIS INFORMATION WITH THE CAHRT BELOW TO DETERMINE THE CORRECT PART NUMBER (S).



OPTION CODE	RATIO	PART NAME	NO. OF TEETH	PART NUMBER
01	1.000 A.E.R.	PINION GEAR	38 38	1-13518-0000 1-13354-2000
02	1.533 A.E.R.	PINION GEAR	30 46	1-13520-0000 1-13356-2000
03	2.040 A.E.R.	PINION GEAR	25 51	1-13517-0000 1-13506-2000
04	1.000 E.R.	PINION GEAR	34 34	1-13519-0000 1-13355-2000
05	1.535 E.R.	PINION GEAR	28 43	1-13548-0000 1-13357-2000
06	2.043 E.R.	PINION GEAR	23 47	1-13516-0000 1-13505-2000

8.12 PROP COUPLING AND KEYED SHAFT KITS

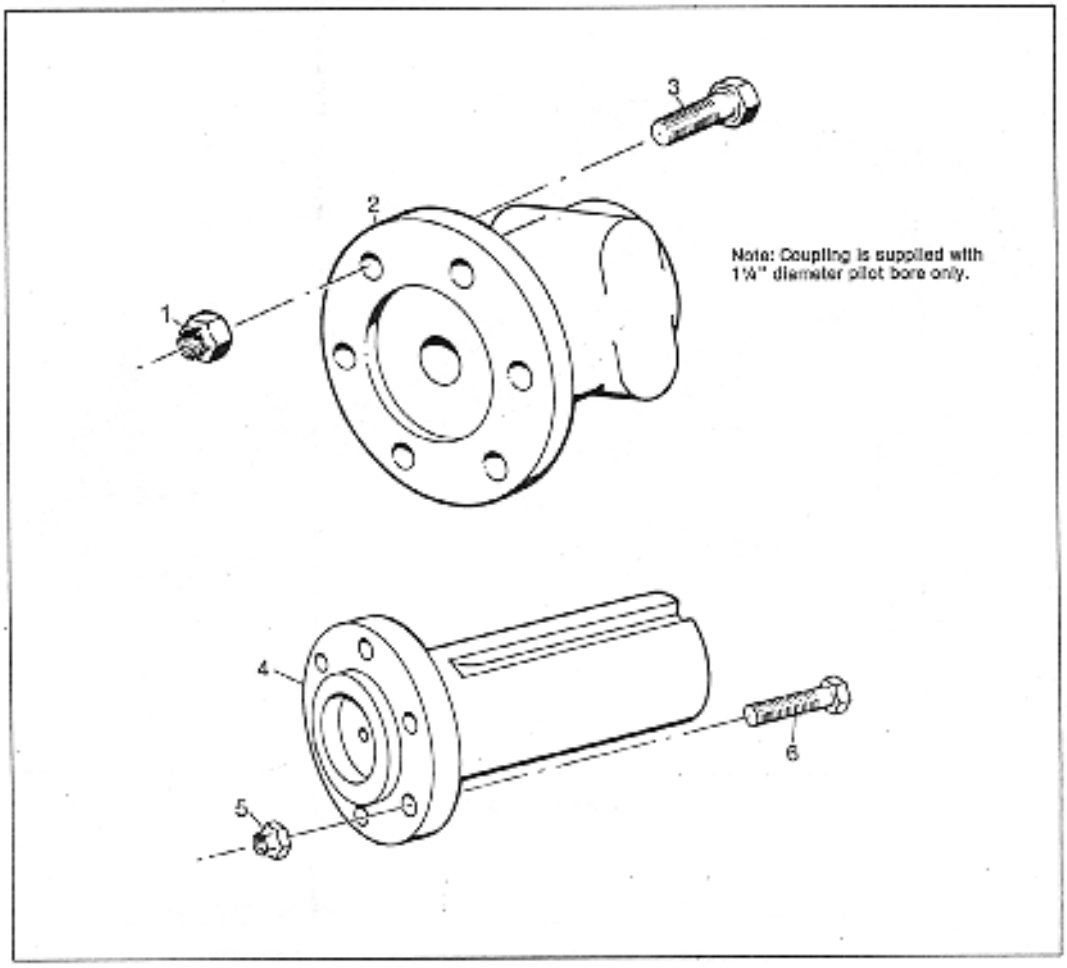


Figure 63. Propeller Flange Coupling and Keyed Shaft Kits.

ITEM	DESCRIPTION	PART NO.	QTY
REF	PROP COUPLING KIT	1-13578-0000	11
1	NUT, SELF LOCKING 5/8-11	1-13304-0000	6
2	COUPLING, SHA	1-13494-0000	1
3	CAPSCREW, HEX HEAD; 5/8 X 2”	1-07554-0800	6
REF	KEYED SHAFT KIT (13 PCS.)	1-13846-0000	1
4	COUPLING, KEYED SHAFT	1-13238-0000	1
5	CAPSCREW, HEX HEAD; 5/8-11 X 2”	1-07554-0800	6
6	NUT, SELF-LOCKING; 5/8-11	1-13304-0000	6

8.13 OIL COOLERS

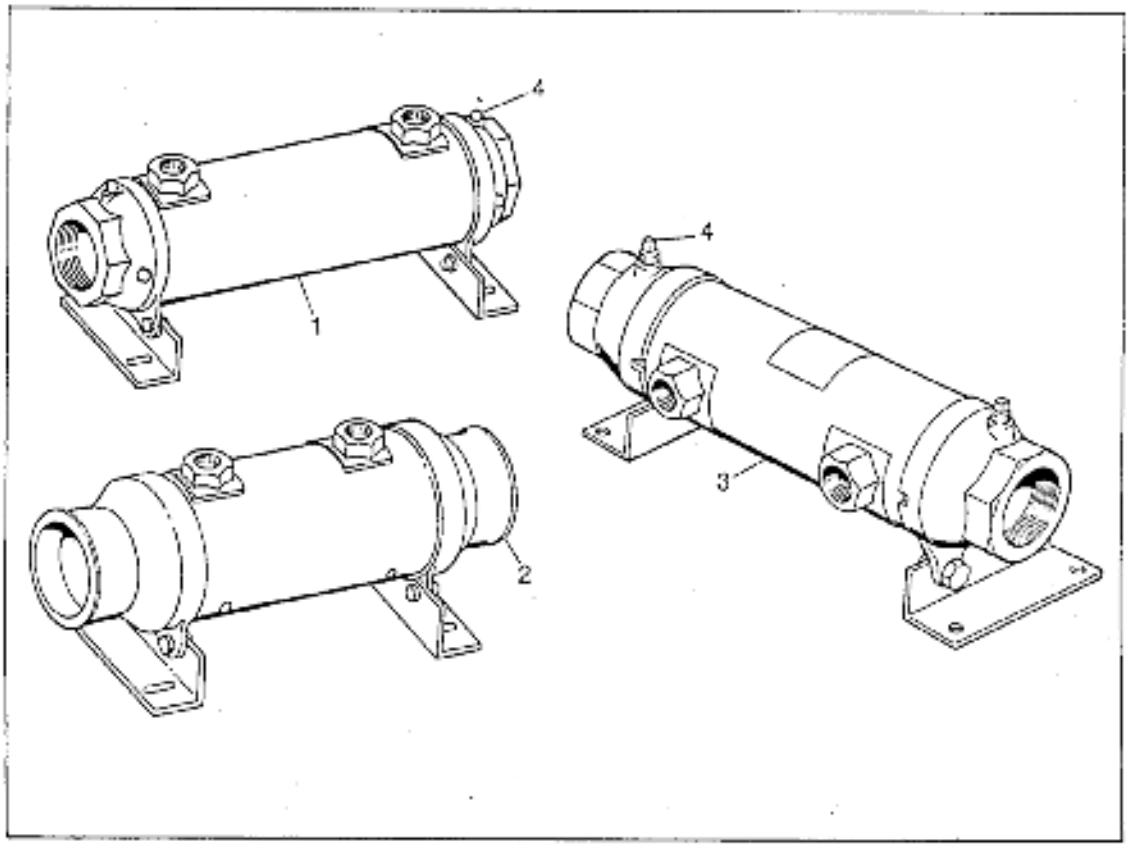


Figure 64. Oil Coolers

ITEM	DESCRIPTION	PART NO.	QTY
1	SEA WATER COOLER (17” X 5-1/8” DIA)	1-13769-0000	1
2	FRESH WATER COOLER (191/2” X 6 1/8” DIA.)	1-13795-0000	1
3	SEA WATER COOLER (123/4” X 4 3/8” DIA)	1-07808-5000	1
4	ZINC PENCILS	1-12445-0400	2

8.14 HOSE AND FITTING KIT

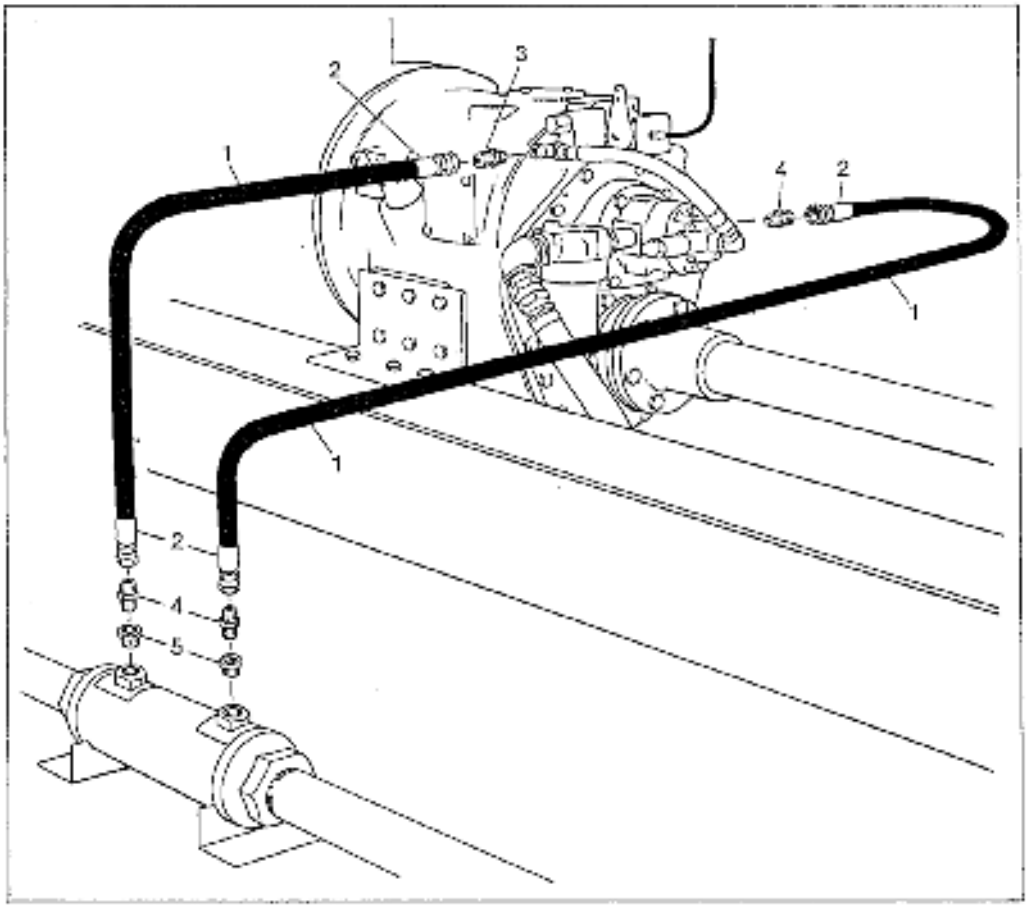


Figure 85. Hose and Fitting Kit no. 1-13949-0000.

ITEM	DESCRIPTION	PART NO.	QTY
REF	HOSE AND FITTING KIT *	1-13949-0000	1
1	HOSE; ½" I.D X 6 FT.	1-11505-0000	1
2	FEMALE FITTING; 7/8-14 JIC	1-11282-0500	4
3	MALE CONNECTOR; ½ N.P.T X 7/8-14 J.I.C	1-11214-1800	1
4	MALE CONNECTOR; ¾ N.P.T X 7/8-14 J.I.C	1-11214-2000	3
5	BUSHING; 1" X ¾	1-11253-1200	2

*NOTE: oil cooler is not included in hose and fitting kit

8.15 OIL FILTER

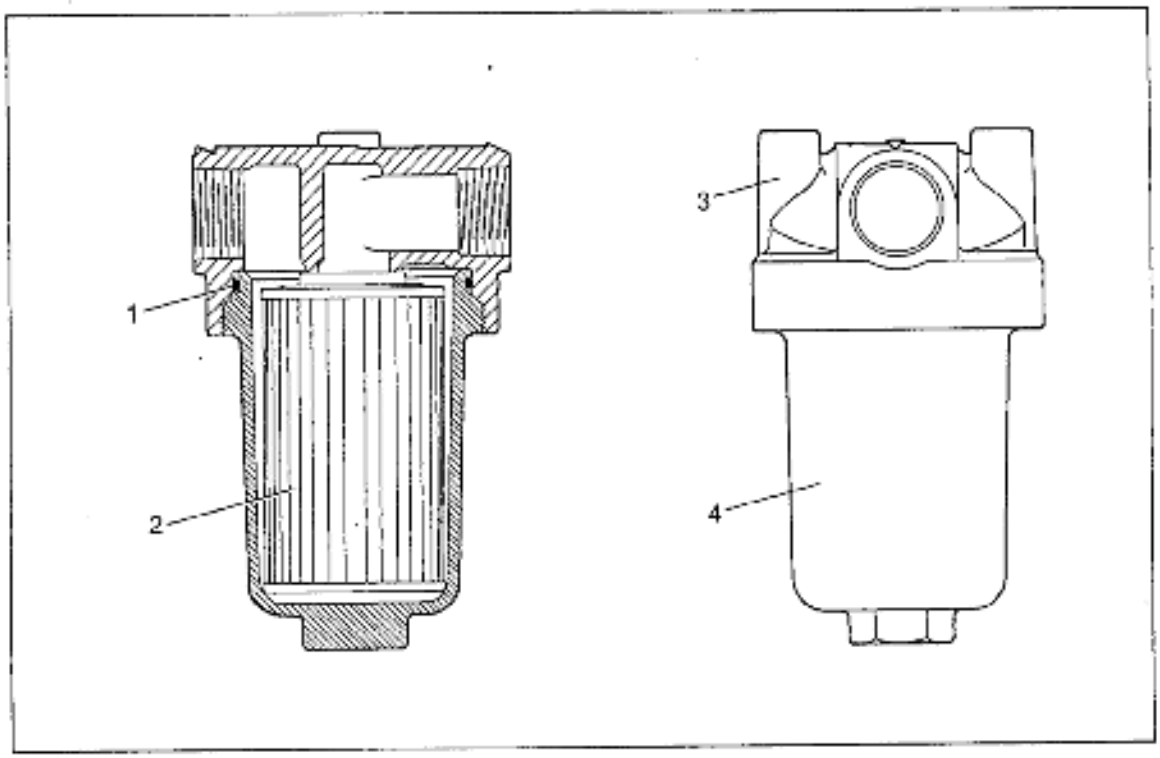
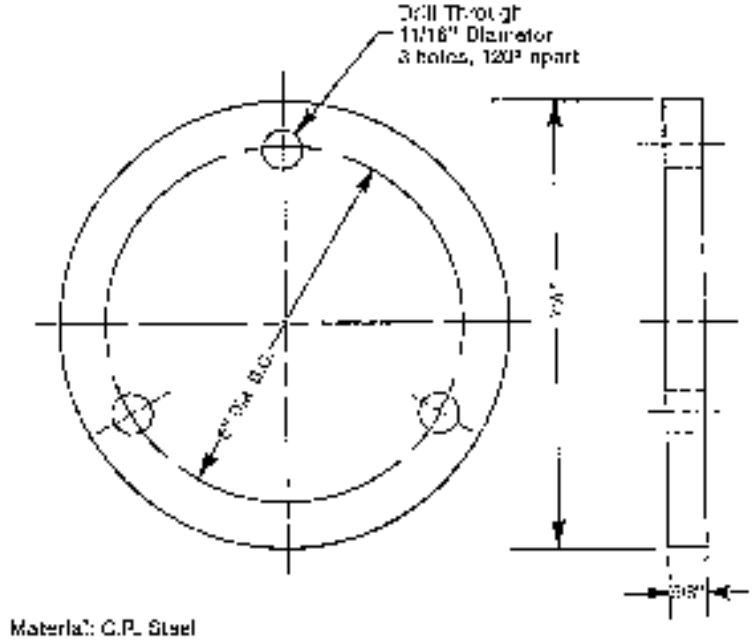


Figure 66. Cross-Section and External View: Oil Filter no. 1-13286-0000.

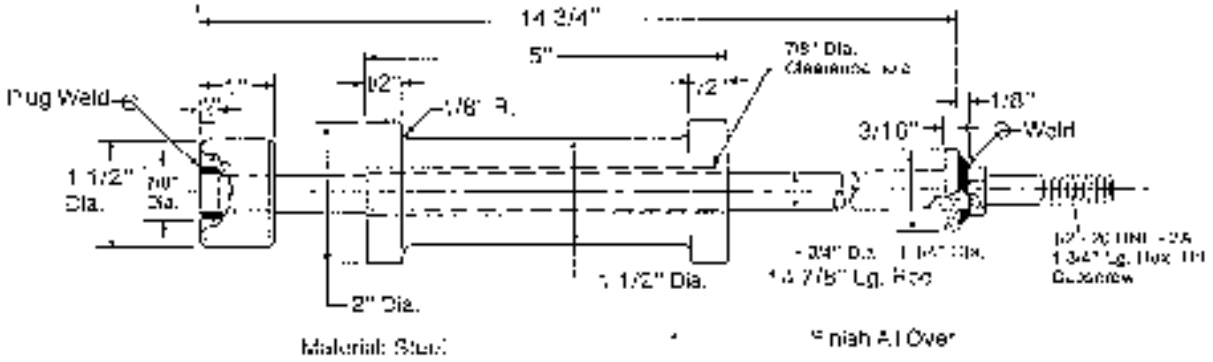
ITEM	DESCRIPTION	PART NO.	QTY
REF	OIL FILTER ASSEMBLY	1-13286-0000	1
1	HOUSING SEAL	1-15110-0000	1
2	ELEMENT ASSEMBLY	1-03151-1500	1
3	HEAD	1-13286-0100	1
4	HOUSING	1-03151-1200	1

SECTION 9. SPECIAL TOOLS

Special tools, which may be used in repair work, are shown on the following pages. All pertinent information for fabrication is included. These tools are not normally available from Capitol Gears, Inc.



HY-24000 Pulling Attachment for Output Coupling
Special Tool No. 1-90025-0000



Pinion Shaft Knockout Puller
for HY and HP Clutches
Special Tool no. 1-90022-0000