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Service Manual

Marine Transmissions

Model:
MG-506-1

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SERVICE MANUAL

SM-241

**MODEL MG-506-1
MARINE TRANSMISSION**

**ORIGINAL ISSUE — APRIL 1984
Revision A, August 1985
Revision B, November 1995**

**Twin Disc, Incorporated
1328 Racine Street
Racine, Wisconsin 53403
U.S.A.**

Printed in U.S.A.

REVISION AND REISSUE DATA

Revision A, August 1985. Page changed: 2-1
Revision B, November 1995. Pages changed: 12-7, 12-9

|
A NOTE: "Flagging" indicates area revised.
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TWIN DISC, INCORPORATED EXCLUSIVE LIMITED WARRANTY MARINE TRANSMISSION

- A. Twin Disc, Incorporated warrants all assembled products and parts, (except component products or parts on which written warranties issued by the respective manufacturers thereof are furnished to the original customer, as to which Twin Disc, Incorporated makes no warranty and assumes no liability) against defective materials or workmanship *for a period of twenty-four (24) months from the date of original shipment by Twin Disc, Incorporated to the original customer, but not to exceed twelve (12) months of service, whichever occurs first.* **This is the only warranty made by Twin Disc, Incorporated and is in lieu of any and all other warranties, express or implied, including the warranties of merchantability or fitness for a particular purpose and no other warranties are implied or intended to be given by Twin Disc, Incorporated.**

The original customer does not rely upon any tests or inspections by Twin Disc, Incorporated or on Twin Disc, Incorporated's application engineering.

- B. **The exclusive remedy provided by Twin Disc, Incorporated whether arising out of warranty within the applicable warranty period as specified, or otherwise (including tort liability), shall at the sole option of Twin Disc, Incorporated be either the repair or replacement of any Twin Disc, Incorporated part or product found by Twin Disc, Incorporated to be defective and the labor to perform that work and to remove and reinstall (or equivalent credit). In this context, labor is defined as the flat rate labor hours established by Twin Disc, Incorporated in the published Twin Disc Flat Rate Schedule, required to remove, disassemble, inspect, repair, reassemble, reinstall and test the Twin Disc, Incorporated product only. Authorized reasonable travel and living expenses will be considered for payment. Under no circumstances, including a failure of the exclusive remedy, shall Twin Disc, Incorporated be liable for economic loss, consequential, incidental or punitive damages.**

The above warranty and remedy are subject to the following terms and conditions:

1. Complete parts or products upon request must be returned transportation prepaid and also the claims submitted to Twin Disc, Incorporated within sixty (60) days after completion of the in warranty repair.
 2. The warranty is void if, in the opinion of Twin Disc, Incorporated, the failure of the part or product resulted from abuse, neglect, improper maintenance or accident.
 3. The warranty is void if any modifications are made to any product or part without the prior written consent of Twin Disc, Incorporated.
 4. The warranty is void unless the product or part is properly transported, stored and cared for from the date of shipment to the date placed in service.
 5. The warranty is void unless the product or part is properly installed and maintained within the rated capacity of the product or part with installations properly engineered and in accordance with the practices, methods and instructions approved or provided by Twin Disc, Incorporated.
 6. The warranty is void unless all required replacement parts or products are of Twin Disc origin or equal, and otherwise identical with components of the original equipment. Replacement parts or products not of Twin Disc origin are not warranted by Twin Disc, Incorporated.
- C. As consideration for this warranty, the original customer and subsequent purchaser agree to indemnify and hold Twin Disc, Incorporated harmless from and against all and any loss, liability, damages or expenses for injury to persons or property, including without limitation, the original customer's and subsequent purchaser's employees and property, due to their acts or omissions or the acts or omissions of their agents, and employees in the installation, transportation, maintenance, use and operation of said equipment.
- D. Only a Twin Disc, Incorporated authorized factory representative shall have authority to assume any cost or expense in the service, repair or replacement of any part or product within the warranty period, except when such cost or expense is authorized in advance in writing by Twin Disc, Incorporated.
- E. Twin Disc, Incorporated reserves the right to improve the product through changes in design or materials without being obligated to incorporate such changes in products of prior manufacture. The original customer and subsequent purchasers will not use any such changes as evidence of insufficiency or inadequacy of prior designs or materials.
- F. If failure occurs within the warranty period, and constitutes a breach of warranty, repair or replacement parts will be furnished on a no-charge basis and these parts will be covered by the remainder of the unexpired warranty which remains in effect on the complete unit.

Section 1.

INTRODUCTION

GENERAL INFORMATION.

Scope.

This publication provides the information necessary for the operation and maintenance of the Twin Disc, Incorporated equipment specified on the cover of this manual. Specific engineering details and performance characteristics can be obtained from the Service Engineering Department of Twin Disc, Incorporated, Racine, Wisconsin, U.S.A.

Operation and maintenance personnel responsible for this equipment should have this manual at their disposal and be familiar with its contents. Applying the information in the manual will result in consistent performance from the unit and help reduce down-time.

Special Tools.

Engineering drawings are included for the fabrication of special tools that should be used during disassembly and assembly of a unit. Repair of this equipment should not be attempted without special tools. Twin Disc does not manufacture these tools for general use.

REPLACEMENT PARTS.

Parts Lists.

Illustrations with complete parts listings are provided in appropriate sections of the manual to facilitate ordering spare or replacement parts.

WARNING

All replacement parts or products (including hoses and fittings) must be of Twin Disc origin or equal, and otherwise identical with components of the original equipment. Use of any other parts or products will void the warranty and may result in malfunction or accident, causing injury to personnel and/or serious damage to the equipment.

Ordering Parts.

Renewal Parts and Service Parts Kits, may be obtained from any authorized Twin Disc distributor or

service dealer. They are listed under POWER TRANSMISSION EQUIPMENT in the Yellow Pages of most metropolitan telephone directories.

NOTE

Do NOT use planographs included in this manual for ordering parts. Parts must be ordered from the bill of material. Bill of material numbers are stamped on the unit's nameplate.

If the bill of material sheet from which part numbers are obtained is unavailable, proceed as follows:

1. Provide the figure number of the illustration containing the part, the item number of the part, the description of the part, and the quantity required.
2. Do not use the word "complete", but state exactly each item wanted.
3. Do not designate the quantity by "sets", but specify the part required.
4. Specify the model, bill of material, and serial number of the unit involved. These numbers are stamped on the unit's nameplate.

Parts Shipment.

Furnish the complete shipping destination and postal address. All parts shipments made from the factory will be F.O.B. factory location, U.S.A. State specifically whether the parts are to be shipped by freight, express, etc. If shipping instructions are not specified on the order, the equipment will be shipped the best way, considering time and expense. Twin Disc, Incorporated will not be responsible for any charges incurred by this procedure.

Twin Disc, Incorporated, having stipulated the bill of material number of the unit's nameplate, absolves itself of any responsibility resulting from any external, internal, or installation changes made in the field without the express written approval of Twin Disc. All returned parts, new or old, emanating from any of the above stated changes will not be accepted for credit. Furthermore, any equipment which has been subjected to such changes will not be covered by a Twin Disc Warranty.

PREVENTIVE MAINTENANCE — TROUBLE SHOOTING.

Frequent reference to the information provided in this manual regarding daily operation and limitations of this equipment will assist in obtaining trouble free operation. Schedules are provided for the recommended maintenance of the equipment, and if observed, minimum repairs, aside from normal wear, will result.

In the event a malfunction does occur, a trouble shooting table is provided to help identify the problem area, and list information that will help determine the extent of the repairs necessary to get a unit back into operation.

LIFTING BOLT HOLES.

Most Twin Disc products have provisions for attaching lifting bolts. The holes provided are always of adequate size and number to safely lift the Twin Disc product.

CAUTION

These lifting points must not be used to lift the complete power unit. Lifting excessive loads at these points could cause failure at the lift point (or points) and result in damage or personal injury.

CAUTION

Select lifting eyebolts to obtain maximum thread engagement with bolt shoulder tight against housing. Bolts should be near but should not contact bottom of bolt hole.

SAFETY.

General.

Safe operating practices should be employed by all personnel servicing this unit. Twin Disc, Incorporated will not be responsible for personal injury

resulting from careless use of hand tools, lifting equipment, power tools, or unaccepted maintenance /working practices.

Important Safety Notice.

Because of the possible danger to person(s) or property from accidents which may result from the use of manufactured products, it is important that correct procedures be followed. Products must be used in accordance with the engineering information specified. Proper installation, maintenance, and operation procedures must be observed. Inspection should be made as necessary to assure safe operations under prevailing conditions. Proper guards and other suitable safety devices or procedures that may be desirable or specified in safety codes should be provided. These devices are neither provided by Twin Disc, Incorporated nor are they the responsibility of Twin Disc, Incorporated.

SOURCE OF SERVICE INFORMATION.

Each series of maintenance manuals issued by Twin Disc, Incorporated is current at the time of printing. When required, changes are made to reflect advancing technology and improvements in state of the art.

Individual product service bulletins are issued to provide the field with immediate notice of new service information. These service bulletins are distributed to all the Twin Disc distributorships throughout the United States and in many foreign countries.

For the latest service information on Twin Disc products, contact any Twin Disc Distributor, or write to the Service Engineering Department, Twin Disc, Incorporated, Racine, Wisconsin, U.S.A.

WARRANTY.

Equipment for which this manual was written has a limited warranty. For details of the warranty, contact any Twin Disc Distributor, service dealer, or the Warranty Administration Department, Twin Disc, Incorporated, Racine, Wisconsin, U.S.A.

Section 2.

DESCRIPTION AND SPECIFICATIONS

General. (See Figures 2-1 and 2-2).

1. The Twin Disc MG506-1 Marine Transmission described is right-hand rotation, (when viewed from the front of the engine) for installation on a right-hand engine. Never use these marine transmissions with a left-hand engine.

2. The marine transmission consists of four major subassemblies: the forward clutch group of parts, the reverse clutch group of parts, the input group of parts, and the output group of parts. The selector valve assembly is externally-mounted on the rear of the unit over the forward clutch location. The selector valve assembly is the control device that hydraulically engages the desired clutch. A 2.65 gpm @ 2000 rpm oil pump assembly is externally-mounted at the rear of the unit over the reverse clutch location. The oil pump assembly supplies oil under pressure to the selector valve assembly through the pump mount for clutch engagement, clutch cooling, and bearing and gear lubrication. The oil is strained and filtered (when filter used) before entering the marine transmission hydraulic system. The MG506-1 Marine Transmission is a flange-type unit that is bolted directly to the engine flywheel housing. The driving ring furnished with the transmission is installed on the engine flywheel. The standard driving ring is designed to mesh with the rubber blocks installed on the drive spider which is installed on the input shaft. This method of drive is used because of the comparative ease of removal and installation; however, care must be exercised during installation to ensure that proper alignment between the marine transmission and the engine is attained. An optional driving ring and drive spider is also available.

3. The designation "Forward and Reverse" clutch assembly does not necessarily mean that the boat propulsion direction agrees. In marine transmission engineering terms, the "Forward" clutch assembly, when engaged, means the drive from input to output is through the least number of gears. The "Reverse" clutch, when engaged, directs the drive through the greatest number of gears from input to output. In the Model MG506-1, the forward clutch drive train includes four gears; the reverse clutch drive train includes five gears.

Reduction Ratios.

The following reduction ratios are available with the Model MG506-1 Marine Transmission described in this maintenance manual: 1.50:1, 1.97:1, 2.50:1 and 2.96:1.

Optional Equipment.

The accessories described below are available with the Model MG506-1 Marine Transmission:

1. *Companion Flange.*

2. *Hose-and-Heat-Exchanger Kit.* A hose-and-heat-exchanger kit, when included as part of the marine transmission will consist of the heat exchanger, flexible hose, and attaching parts. The heat exchanger should be mounted in a location convenient to both engine water and marine transmission oil. A heat exchanger must be used with the marine transmission; however, a heat exchanger other than those available from Twin Disc may be selected, provided it meets the requirements of Table 2-3. It is also advisable to install an oil pressure gauge with a range of 0 to 500 psi between the heat exchanger and the oil inlet entry port of the selector valve assembly.

3. *Mounting Brackets.* Mounting brackets with the necessary capscrews and washers facilitate installation of the marine transmission, and are available as optional equipment.

4. *Oil Filter Assembly.* If a trolling valve is being used, Twin Disc recommends that an oil filter assembly be installed in the hydraulic system between the heat exchanger and the selector valve assembly. The oil filter assembly should have sufficient capacity for oil pressures to 400 psi with a flow rate of 4 gpm. A replaceable 25 Micron (minimum) element should be contained in the oil filter assembly. If a trolling valve is not being used, the filter is not recommended. Contact Twin Disc, Incorporated, Marine Application Engineering Department, Racine, Wisconsin, U.S.A. for further information.

INPUT GROUP OF PARTS. (See Figure 2-3).

1. *Driving Ring.* The driving ring is a high-quality aluminum casting that is bolted to the engine

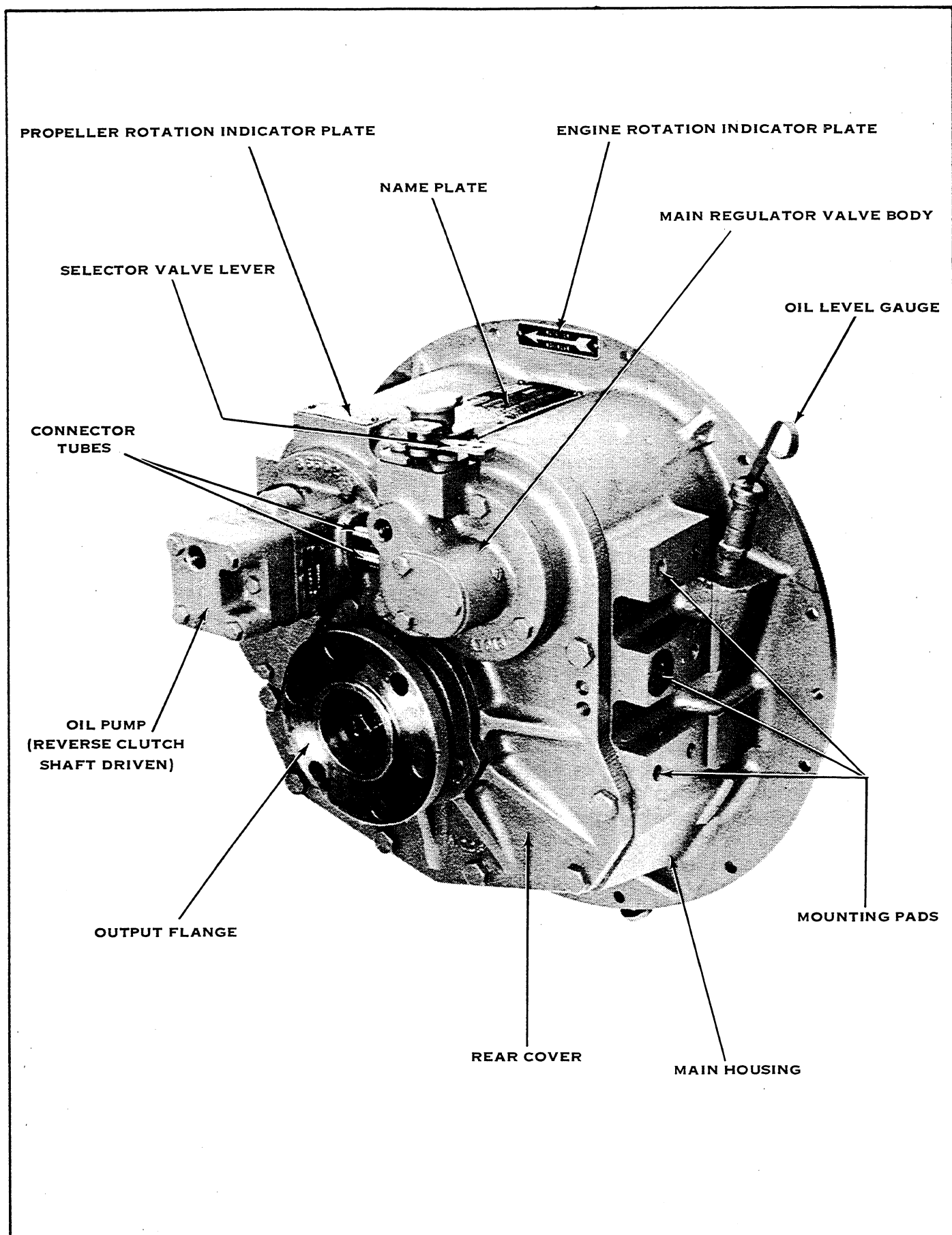


Figure 2-1. MG-506-1 Marine Transmission — Rear View.

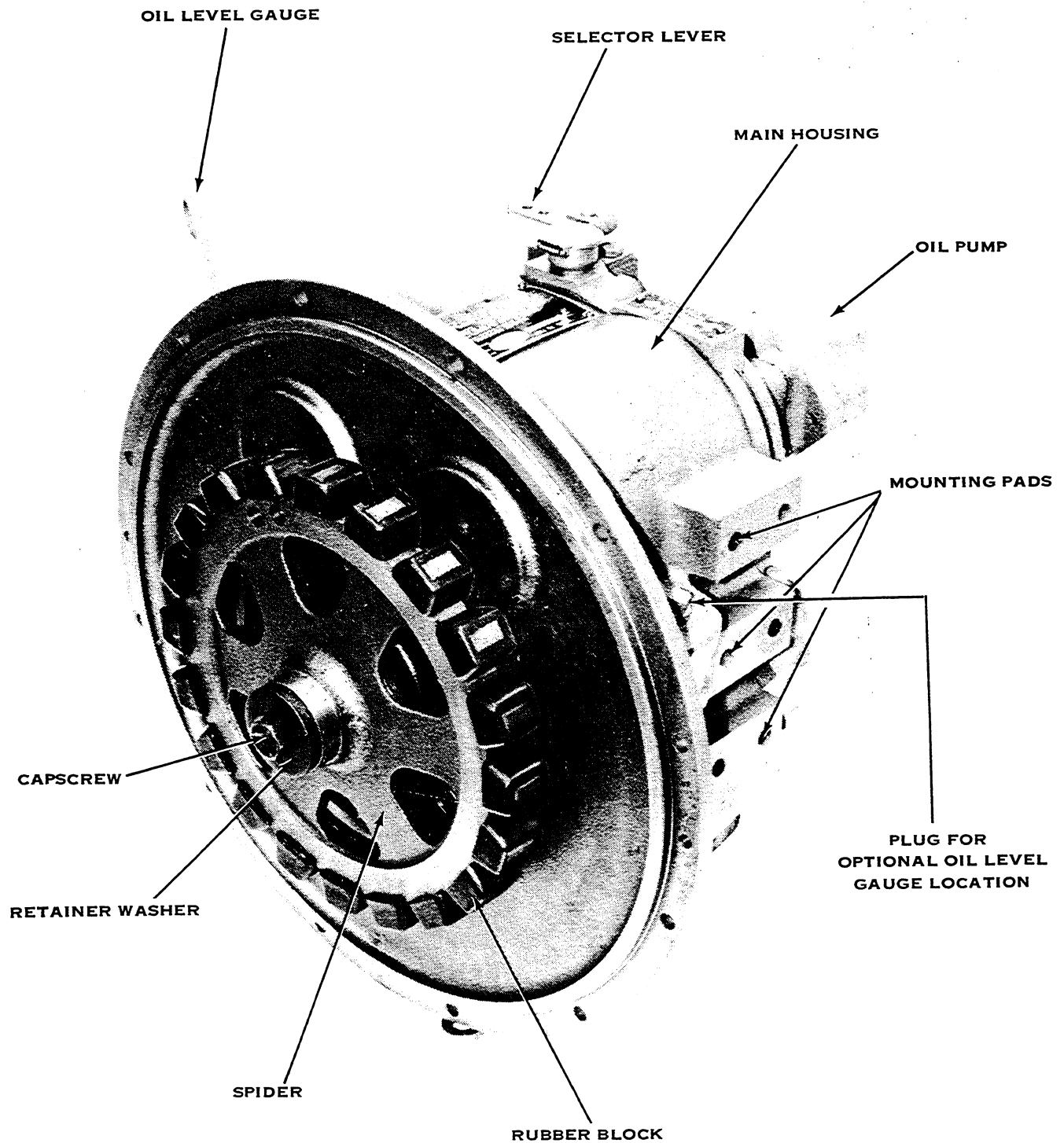


Figure 2-2. MG-506-1 Marine Transmission — Front View.

flywheel. The ring has machined internal gear teeth that mesh with the rubber blocks installed on the drive spider.

2. **Drive Spider.** The drive spider, with rubber blocks installed, is the connecting member between the driving ring on the engine flywheel and the marine transmission. (External lugs are machined on the drive spider for rubber block installation). The drive spider is keyed on the tapered input shaft, and secured on the shaft with a retainer washer, and a capscrew. Two threaded puller screw holes are machined in the drive spider for use during disassembly procedures.

3. **Rubber Blocks.** The rubber blocks, molded in an involute tooth shape, are installed on the external lugs of the drive spider. Misalignment caused by hull distortion is absorbed by the cushioning effect of the rubber blocks; however, extreme care must be observed during the marine transmission installation to achieve the dial indicator tolerances specified in the section on installation. The rubber blocks also tend to absorb torsional vibrations which may be present.

4. **Input Shaft.** The protruding end of the input shaft contains a keyway and is tapered for the installation of the drive spider. The internal end of the input shaft contains a keyway for the installation of the input gear. Tapered roller bearings are mounted on the shaft on both sides of the input gear. One bearing cup is installed in the bearing support, and the other bearing cup is installed in a web of the main housing.

5. **Input Gear.** The input gear is keyed on the input shaft between the tapered roller bearings. The word "FRONT" in cast letters appears on one side of the gear to aid in proper installation. The input gear turns in engine direction, and is in constant mesh with the forward clutch housing gear.

FORWARD AND REVERSE CLUTCH GROUP OF PARTS.

1. **General.** The forward clutch group of parts and the reverse clutch group of parts are identical in construction and parts, except for the width of the clutch housing gears. Therefore, the following description will apply to both the forward and reverse clutch groups of parts.

2. **Clutch Shaft.** The clutch shaft is made of steel, and contains two horizontally-drilled passages that

are intersected by cross-drilled holes. One passage supplies oil pressure for clutch engagement, and the other passage supplies oil pressure for clutch cooling and lubrication of moving parts. A solid ball plug is installed at the rear end of the clutch engagement passage in the clutch shaft to contain the oil. An orifice is drilled at the front end of the cooling and lubrication passage in the clutch shaft to permit a metered flow of oil to return to lubricate the front tapered bearings. A slot milled in the rear end of the clutch shaft is used to drive the oil pump assembly. A tapered roller bearing installed on each end of the clutch shaft (and in the main housing) supports the clutch shaft, and therefore, the clutch pack in the marine transmission. Ring shaped grooves are machined in the clutch shaft for a snap ring and three piston rings. Two piston rings are installed in the grooves at the rear end of the clutch shaft to direct oil to the proper passage. Another piston ring is installed in the groove of the clutch shaft at the clutch piston location. An external snap ring used to retain the return spring, is installed in the groove of the clutch shaft at approximately the mid-point of the shaft.

3. **Clutch Housing Gear.** The clutch housing gear is installed on the clutch shaft adjacent to the front tapered roller bearing, and contains the clutch pack. The forward clutch housing gear is in constant mesh with the input gear and the reverse clutch housing gear. The external teeth of the back plate and the nine sintered-metal clutch plates are aligned with the internal teeth of the clutch housing gear. Three cross-drilled holes in the clutch housing gear permit the cooling and lubricating oil to return to sump.

4. **Clutch Pack.** The clutch pack is contained within the clutch housing gear, and consists of the clutch piston, the clutch piston spring, nine sintered-metal clutch plates, eight steel clutch plates, and back plate, the clutch hub pinion assembly and two needle bearings. The clutch housing gear is bored internally to contain the clutch piston. The piston ring installed on the clutch shaft seals the inside diameter of the clutch piston, and the piston ring installed on the outer periphery of the clutch piston seals the outside diameter of the clutch piston. The clutch piston spring is positioned around the clutch shaft, between the clutch piston and the external snap ring installed in the clutch shaft. The clutch hub pinion assembly is installed on the clutch shaft between the thrust bearings and the cone of the rear tapered roller bearing. Two thrust needle bearings and four thrust races separate the clutch hub pinion assembly from the

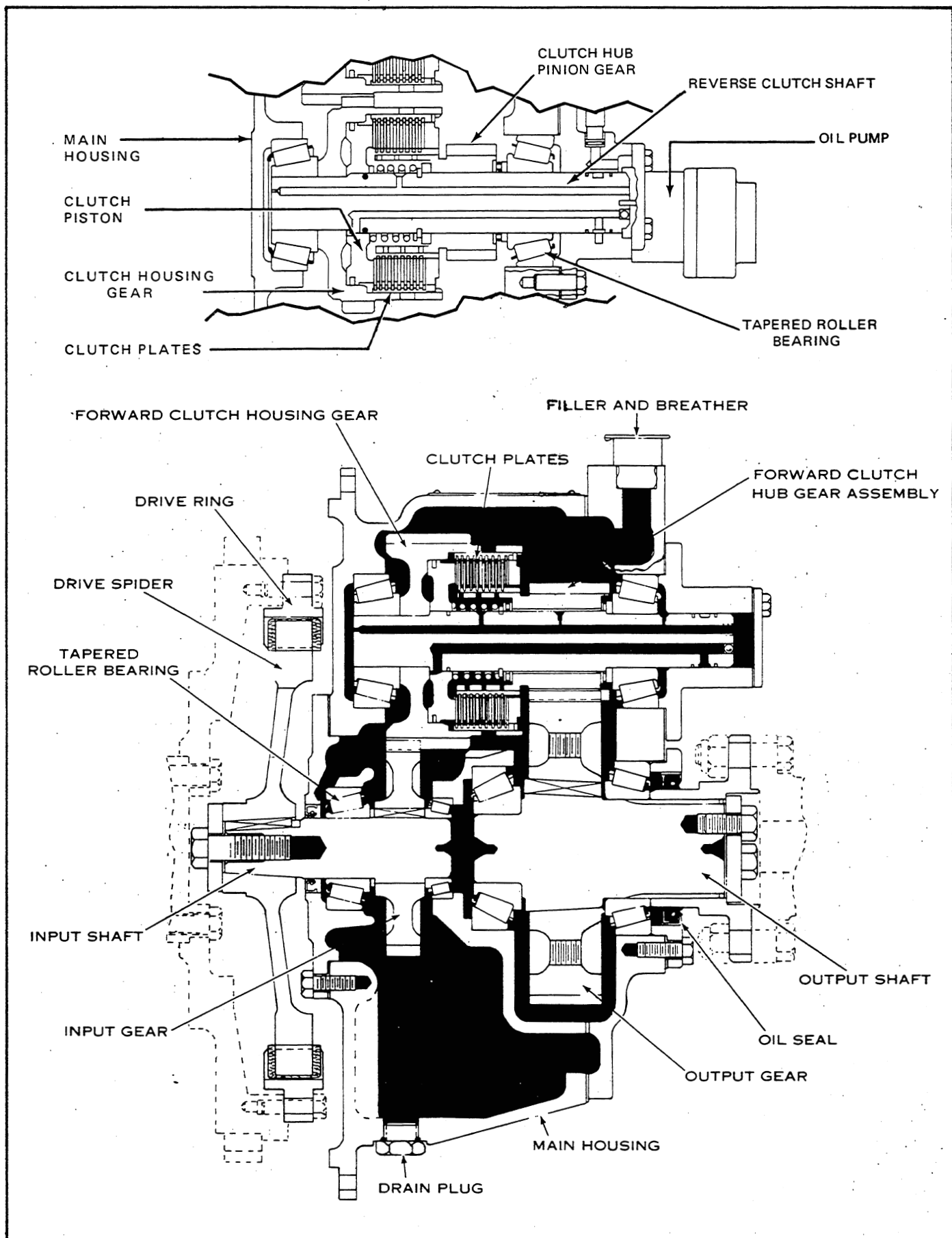


Figure 2-3. MG-506-1 Marine Transmission — Cross Section Drawing.

snap ring and the bearing cone. The external teeth of the sintered-metal clutch plates and the back plate are aligned with the internal teeth of the clutch housing gear. The back plate is retained in the clutch housing gear by an internal snap ring. The internal teeth of the steel clutch plates are aligned with the smaller diameter external teeth of the clutch hub pinion assembly. The larger diameter external gear teeth of each clutch hub pinion assembly is in constant mesh with the output gear.

MAIN HOUSING GROUP OF PARTS.

1. **Main Housing Assembly.** The main housing, two dowel pins, the rear cover, and nine capscrews form the main housing assembly. The main housing and the rear cover are dowel pin located prior to machining of the shaft bores. Therefore, these parts are a matched assembly and not serviced separately.

2. **Main Housing.** The main housing is a high-quality casting that has integral mounting pads for the support of the marine transmission on the engine bed rails. The oil level gauge tube is installed in the main housing and contains the oil level gauge.

A hex-head pipe plug installed in the bottom of the main housing functions as a drain plug for the marine transmission.

3. **Rear Cover.** The rear cover is indexed to the main housing with two dowel pins, and secured to the housing with a gasket and nine hex-head capscrews. Tapped pusher screw holes are machined in the rear cover adjacent to the dowel pin holes to facilitate removal. A machined bore in the rear cover provides for the installation of the filter screen. Bearing bores for installation of the clutch shaft bearings and the output shaft bearing also are provided in the rear cover. In addition, external mounting pads on the rear cover permit the installation of the selector valve assembly, the pump mount, and the bearing retainer. The breather-filler cap is also installed in the rear cover.

4. **Bearing Retainer.** The bearing retainer is secured to the rear cover with six hex-head capscrews. The bearing retainer is installed around the output shaft, and bearing retainer shims are used to adjust the end play of the output shaft tapered roller bearings. LOCTITE plastic gasket material is used to prevent oil leakage around the bearing retainer. The bearing retainer oil seal is installed in the

bearing retainer to prevent oil leakage past the output flange.

5. **Bearing Support.** The bearing support is secured to the front of the main housing with six hex-head capscrews. The bearing support is installed around the input shaft, and bearing support shims are used to adjust the end play of the input shaft tapered roller bearings. LOCTITE plastic gasket material is used to prevent leakage around the bearing support. The bearing support oil seal is installed in the bearing support to prevent oil leakage past the input shaft.

OUTPUT GROUP OF PARTS.

1. **Output Shaft.** The larger diameter central area of the output shaft is tapered and contains a keyway for the installation of the output gear. The output shaft tapered roller bearings are installed on the shaft on both sides of the output gear. One bearing cup is installed in the bearing bore of an integral web of the main housing, and the other bearing cup is installed in a bearing bore in the rear cover of the main housing assembly. The output end of the output shaft is splined for installation of the output flange.

2. **Output Gear.** The output gear is installed on the keyed tapered area of the output shaft between the output shaft tapered roller bearings. The output gear is in constant mesh with the forward clutch hub pinion assembly and the reverse clutch hub pinion assembly.

3. **Output Flange.** The output flange is spline-connected on the output shaft, and secured to the shaft by the lathe-cut rubber seal ring, the retainer washer, the roll pin, and either one or three hex-head capscrews, depending on ratio. The seal ring prevents oil leakage past the splined areas of the output shaft and the output flange. The output flange also provides for the installation of a six-bolt companion flange.

PUMP MOUNT GROUP OF PARTS.

The pump mount is installed on the rear cover with three hex-head capscrews at the reverse clutch group of parts location. The pump mount shims between the pump mount and the rear cover permit the proper end play adjustment to be made for the reverse clutch shaft tapered roller bearings. The pump mount also provides a mounting pad for the oil pump assembly. Two holes in the pump mount per-

mit the connection of the lube oil connector tube and the main oil connector tube to be made to the main regulator valve body.

OIL PUMP ASSEMBLY.

1. **Oil Pump Assembly.** The oil pump assembly is a positive-displacement, gear-type pump that is tang driven by the reverse clutch shaft. The oil pump assembly is secured to the pump mount by a gasket and four hex-head capscrews. The oil pump assembly is secured to the pump mount by a gasket and four hex-head capscrews. The oil pump assembly is driven at engine speed and has a rated capacity of 2.65 gpm @ 2000 rpm.

2. **Suction Tube.** The suction tube connects the filter screen and the inlet port of the oil pump assembly.

SELECTOR VALVE ASSEMBLY.

1. **General.** The selector valve assembly is installed on the rear cover of the marine transmission with three hex-head capscrews at the forward clutch group of parts location. The regulator valve body shims, between the selector valve assembly and the rear cover, permit the proper end play adjustment to be made for the forward clutch shaft tapered roller bearings. The selector valve assembly consists of the selector valve group of parts and the main regulator valve group of parts assembled in a common valve bore in the main regulator valve body. The selector valve hydraulically functions by the mechanical movement of the shaft lever, and the main regulator valve controls main and lube oil pressure in the hydraulic system.

2. **Selector Valve Group of Parts.** The selector valve group of parts basically consists of the valve body, valve body center bore cover, cover gasket, shift lever, regulator piston, detent assembly plate, thrust race, valve spool and spring set (inner and outer). The rotary-type selector valve contains milled slots that direct oil flow to the forward clutch, neutral, or reverse clutch selections through integral passages in the valve body bore. Rotary mechanical movement of the selector valve is accomplished by movement of the shift lever. From the detented neutral position the lever is moved 51 degrees to either forward or reverse clutch positions. The detent ball in the detent plate retains each selected position (neutral, forward, reverse) of the valve spool in the valve body. An O-ring seals the valve spool in the valve body from external leakage along the spool.

3. **Main Regulator Valve Group of Parts.** The main regulator valve group of parts consists of the piston, and a pair of springs. Shims, one or two usually, are placed behind the springs to increase the oil pressure rating to desired range. The piston fits in the drilled end of the selector valve spool. A large flange on the bottom of the piston operates against the springs when oil pressure is exerted on the top of the piston. As the piston moves downward toward its regulating point, it uncovers a port to the lubrication circuit. This overage oil from the regulating piston supplies the needed lube pressure for the unit.

HOSE-AND-HEAT EXCHANGER KIT. (See Table 2-1.)

1. **Heat Exchanger.** The heat exchanger is designed to maintain the oil in the hydraulic system of the marine transmission at the proper temperature by passing coolant from the engine through the heat exchanger. Consequently, the heat exchanger should be installed in a location convenient to both engine coolant and marine transmission oil.

2. Heat exchangers furnished by Twin Disc, to be used for salt water applications, have zinc rods installed at the inlet and outlet heads. See Figure 2-4. These rods must be checked every 90 days. If over 50% of the rod is disintegrated, it should be replaced to provide effective protection.

3. Excessive corrosion of the zinc rod indicates electrolytic action. A careful inspection should be made to determine if this action is caused by a short circuit or external grounded electric current. These conditions must be eliminated to avoid the necessity of frequent replacement of the zinc rods. If these conditions do not exist, it is evident that the corrosion is due to local electrolysis. If rods are corroded with foreign material, they should be cleaned with a wire brush.

Table 2-1.

Marine Transmission	Heat Exchanger	Quantity	Part Number of Zinc Electrode
MG506-1	M1959-F	1	M1988

4. **Flexible Hose and Fittings.** Sufficient flexible hose and fittings are provided with the kit to accommodate a normal installation.

GENERAL INFORMATION CHART.

The following table provides general information

relative to marine transmission operation. These specifications must be observed to obtain proper operation of the marine transmission.

Table 2-2. General Information

OIL PRESSURE * Normal: 300-320 psi @ 1800 rpm and 180° F. (Minimum 270 psi at cruising speed). Cooling and Lube: 4.5 psi @ 1800 rpm and 180° F.	OIL PUMP CAPACITY 2.65 gpm @ 2000 rpm. 2.5 gpm @ 2000 rpm.
OIL CAPACITY 1.2 U.S. gallons, or fill to "Full" mark on gauge.	MAXIMUM SPEED 3000 rpm.
OIL CHANGE INTERVAL Replace every 1000 hours of operation, or 6 months, whichever occurs first.	SHIFTING LIMITS "Neutral" to "Forward" or "Reverse" — under 80% governed engine rpm. Shifting across "Neutral" — under 50% governed engine rpm.
FILTER SCREEN Remove and clean every 1000 hours of operation, or 6 months, whichever occurs first.	DRY WEIGHT Approximately 220 lbs.

* Some applications require boost pressure to 350-370 psi. Check nameplate on unit for correct operating pressures.

MARINE TRANSMISSION LUBRICATING OIL RECOMMENDATIONS.

Also approved are SAE-API service class CC engine oil and MIL-L-2104B.

1. Oil Service Class:

Use SAE-API service class CD engine oil which is certified by the oil company to pass TO-2 or C-3 Test Specification.

2. Oil Viscosity:

Note, Multi Viscosity Oils (i.e. 10W-40 etc.) are not recommended and should not be used in Twin Disc Marine Transmissions.

SUMP TEMPERATURE, ALSO OIL TEMPERATURE INTO HEAT EXCHANGER		Recommended Oil Viscosity
During Start-up	Steady Operating Conditions	
	Below 150° F.	This operating condition is <u>not</u> approved.
32° F. Minimum	150° — 185° F.	SAE viscosity number 30 engine oil
32° F. Minimum	175° — 210° F.	SAE viscosity number 40 engine oil
	Above 210° F.	This operating condition is <u>not</u> approved.

Table 2-3. Heat Exchanger Requirements and General Data.

HEAT EXCHANGER (H.E.) REQUIREMENTS	
PERMISSIBLE OIL TEMPERATURE INTO H.E.	210° F. MAX. — 150° F. MIN.
MIN. HEAT TRANSFER CAPACITY (MULTIPLY BY 1.25 FOR FRESH WATER) (MULTIPLY BY 2.00 FOR RAW WATER)	BTU PER MIN. PER ENGINE RTD. HP.: CONTINUOUS DUTY: 1.484 P.C. & INT. DUTY: 1.272
APPROXIMATE OIL FLOW TO H.E.	.132 G.P.M. PER 100 ENGINE R.P.M.
PEAK OIL PRESSURE AT H.E. (PROOF TEST H.E. AT 1.5 × P.S.I.)	445 P.S.I.
MAX. ALLOWABLE OIL PRESSURE DROP ACROSS H.E. WITH 300 SUS OIL AT RATED ENGINE RPM	30 P.S.I.
WATER FLOW TO H.E.	USE 1.5 TO 3.0 TIMES OIL G.P.M.
H.E. WATER PRESSURE RATING, MIN.	= 1.5 × H.E. INLET WATER P.S.I.
DATA H.E. PURCHASER MUST ALSO TELL VENDOR	
STATE IF RAW (OPEN CHANNEL & SEA) OR FRESH (CLOSED ENGINE JACKET & KEEL COOLER) WATER WILL COOL HEAT EXCHANGER	
STATE MAX. WATER TEMPERATURE INTO HEAT EXCHANGER TYPICAL: RAW WATER - 85° F. KEEL COOLER WATER - 140° F. ENGINE JACKET WATER - 180° F.	
STATE MIN., ALSO MAX. G.P.M. OF WATER FLOW TO HEAT EXCHANGER	
H.E. INSTALLATION & SERVICE REQUIREMENTS	
OIL LINES, TRANSMISSION TO HEAT EXCHANGER AND RETURN —	
(1) MAX. VELOCITY IN FITTINGS, PIPE, HOSE AND TUBES — 25 FT./SEC.	
(2) BURST PRESSURE MIN. = 10 × PEAK OIL PRESSURE AT H.E.	
(3) HOSE — SAE J517 100R1 MEETING USCG 46CFR 56.60-25(C), 275° F. TEMP. RATING	
(4) PROTECT LINES FROM MECHANICAL DAMAGE. ZINC ANODES PROTECT H.E. RAW WATER PASSAGES FROM CORROSION. CHECK AND REPLACE THEM FREQUENTLY.	

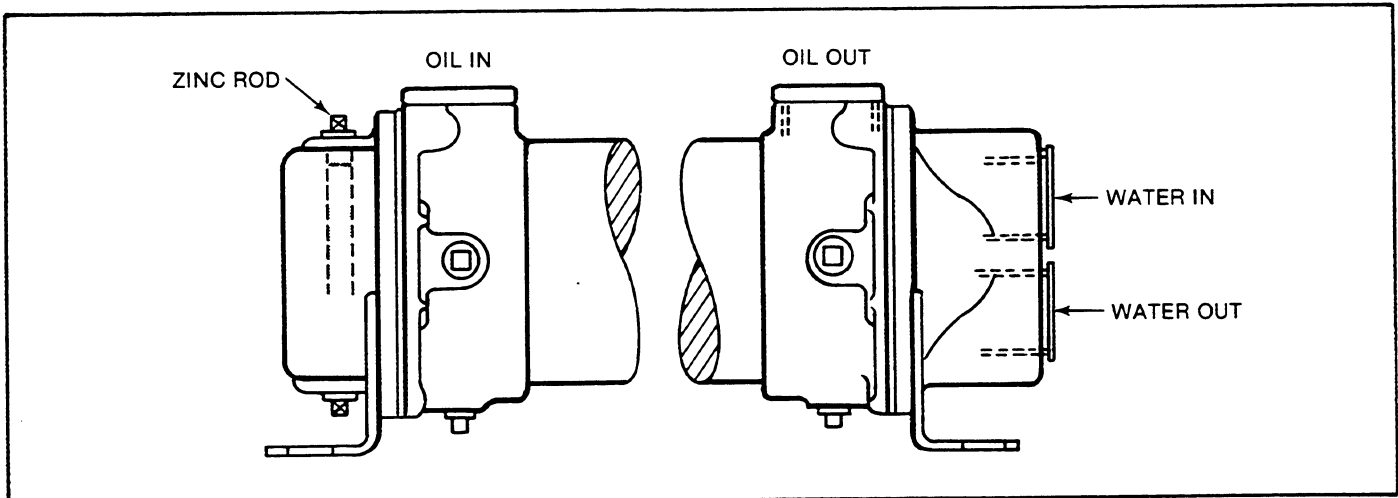


Figure 2-4. Typical Heat Exchanger Plumbing.

Section 3. OPERATION

GENERAL.

1. **Description.** The Model MG506-1 Marine Transmissions are reverse and reduction transmissions available in four ratios: 1.50:1, 1.97:1, 2.50:1 and 2.96:1. Within their rated capacities, all ratios may be operated continuously in the forward propulsion direction. However, as stated previously, the Marine Transmission can only be installed on right-hand rotation engines. The marine transmission is completely hydraulic in all phases — all bearings are oil lubricated, both clutches are engaged by high pressure oil, and both clutches are oil lubricated.

2. **Direction of Drive.** The input shaft always turns in engine direction, and the forward clutch shaft always turns in anti-engine direction. Therefore, when the marine transmission is engaged in the forward position, the output shaft will turn in engine direction as the clutch hub pinion assembly installed on the forward clutch shaft is meshed with the output gear. When the marine transmission is engaged in the reverse position, the output shaft will turn in anti-engine direction.

POWER FLOW.

1. **Neutral.** See Figure 3-1. When in neutral, all parts that rotate in the marine transmission while in this position, turn at engine speed. The connecting member between the engine and the marine transmission is the driving ring that is bolted to the engine flywheel. The rubber blocks that are installed on the drive spider are meshed in the driving ring. The drive spider is keyed to the input shaft. The input gear is keyed to the input shaft. Therefore, the input gear turns at engine speed and in engine direction. The input gear is in constant mesh with the forward clutch housing gear, and turns the gear, the clutch shaft, and the sintered metal clutch plates at engine speed and in anti-engine direction. The forward clutch housing gear is in constant mesh with the reverse clutch housing gear, and the gear, the clutch shaft, and the sintered metal clutch plates rotate at engine speed and in engine direction. The oil pump assembly which is connected to the end of the reverse clutch shaft, also rotates at engine speed and in engine direction. Since neither forward nor reverse clutch is engaged, there is no further power flow within the gear.

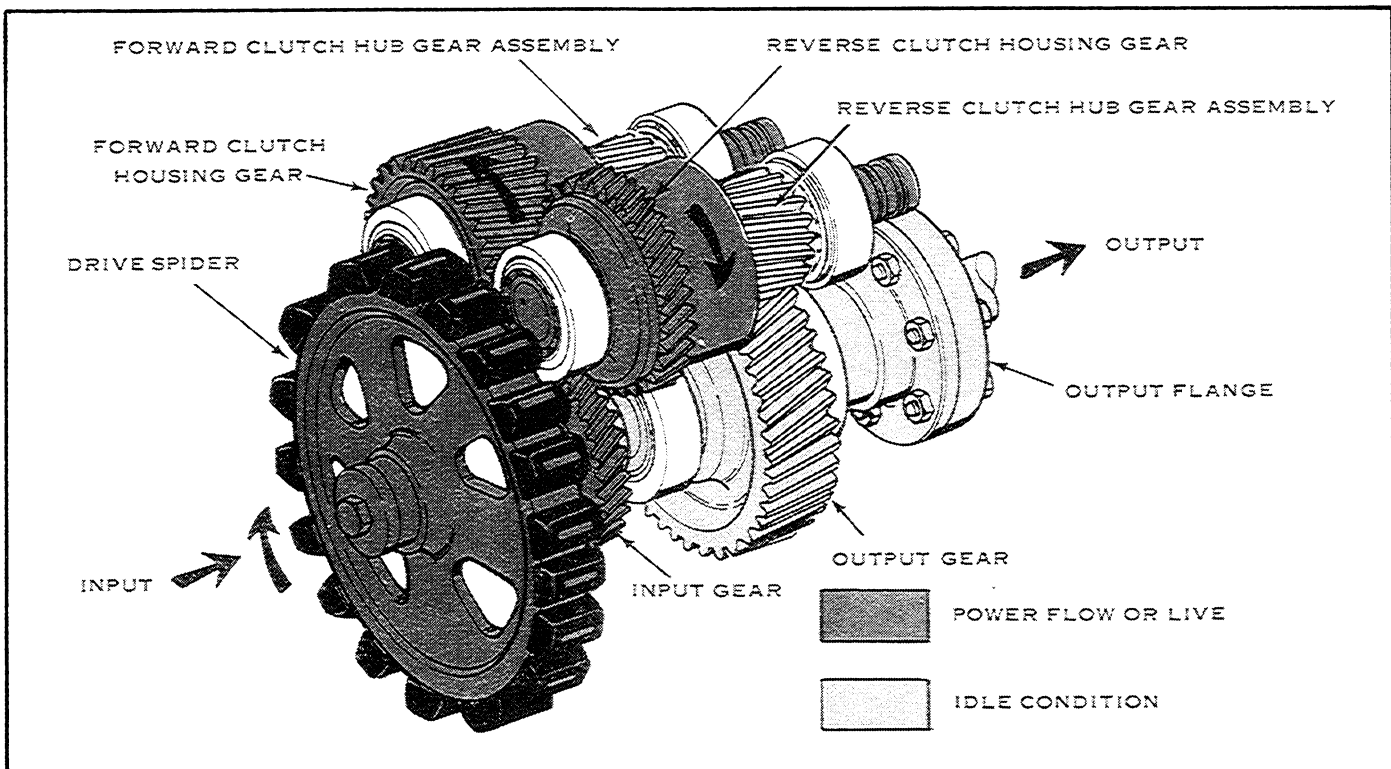


Figure 3-1. MG-506-1 Marine Transmission Power Flow — Neutral — Schematic View.

2. **Forward.** See Figure 3-2. When forward clutch is selected, all the marine transmission parts which were turning during neutral selection are still turning. However, when forward is selected, the forward clutch faced and metal plates are clamped together by the clutch piston and back plate. The internal teeth of the steel clutch plates are meshed with the smaller diameter external teeth of the clutch hub pinion assembly and turn the pinion gear at engine speed and in anti-engine direction. The larger external gear teeth of the pinion gear are in constant mesh with the output gear which is keyed to the output shaft. The output flange is spline-connected to the output shaft and, therefore, the flange rotates in engine direction when in forward. The output shaft and flange rotate at a speed that is reduced from the engine speed due to the ratio between the pinion gear and the output gear.

3. **Reverse.** See Figure 3-3. When in reverse, all the marine transmission parts that rotated in neutral are still turning. However, when reverse clutch is selected, the reverse clutch steel and faced plates are clamped together by the clutch piston and back plate. The internal teeth of the steel clutch plates are meshed with the smaller diameter external teeth of the clutch hub pinion assembly, and turn the pinion gear at engine speed and in engine direction. The

larger diameter external gear teeth of the pinion gear are in constant mesh with the output gear which is keyed to the output shaft. The output flange is spline-connected to the output shaft and, therefore, the flange rotates in anti-engine direction when in the reverse clutch position. The output shaft and the output flange rotate at a speed that is reduced from the engine speed due to the ratio between the pinion gear and the output gear.

HYDRAULIC SYSTEM.

General.

1. **Description.** The hydraulic system delivers oil pressure for clutch engagement, clutch cooling, and lubrication functions. The sump, which is located in the bottom of the main housing, contains an adequate amount of oil for all functions of the system. The oil pump assembly pressurizes the oil for pressure requirements. The selector valve assembly functions as both a regulator and distributor for the hydraulic system. The selector valve assembly directs the oil to engage either the forward or reverse clutch depending on the position of the selector valve. The selector valve assembly also directs oil to the lube system. Piston rings on the ends of the clutch shafts separate the lube and clutch pressure oil.

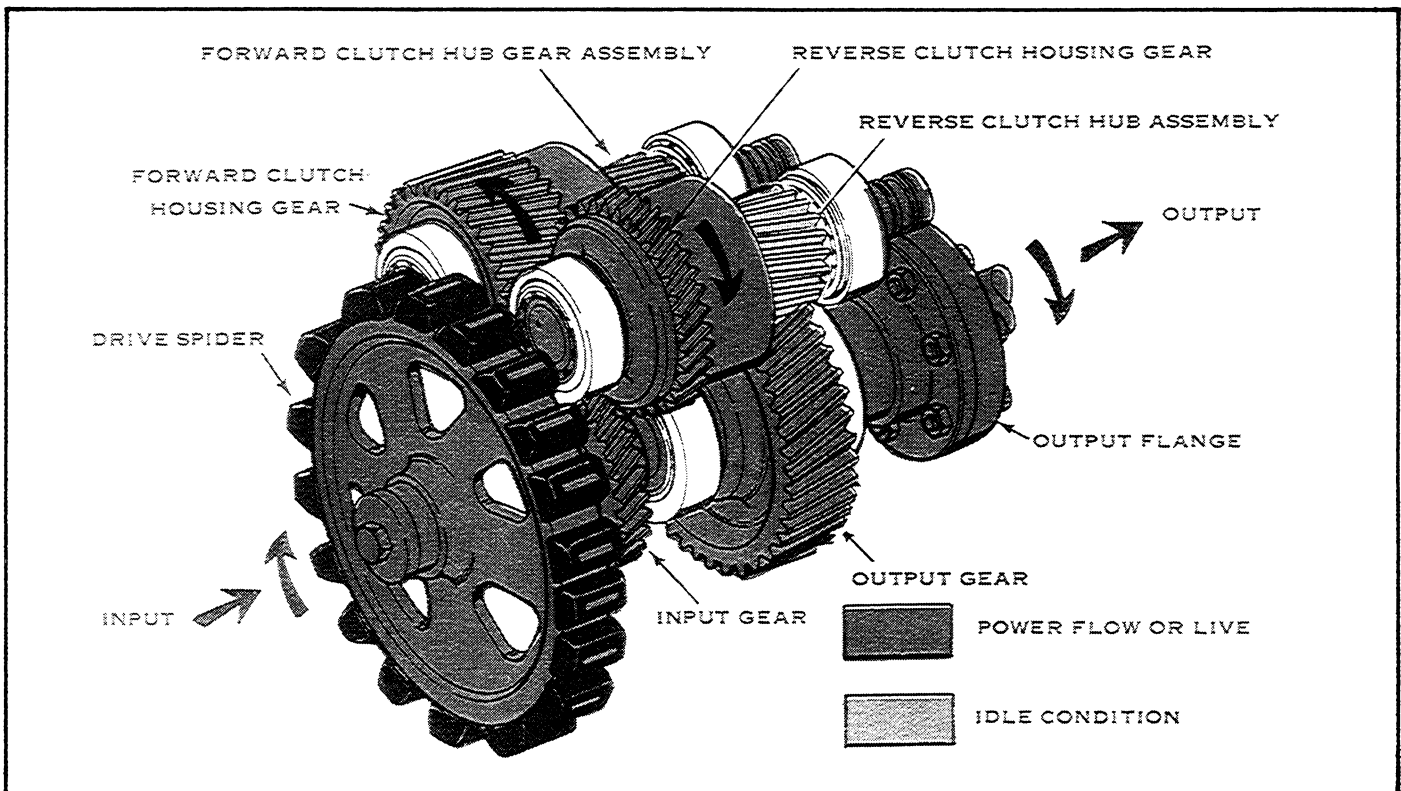


Figure 3-2. Model MG-506-1 Marine Transmission Power Flow — Forward — Schematic View.

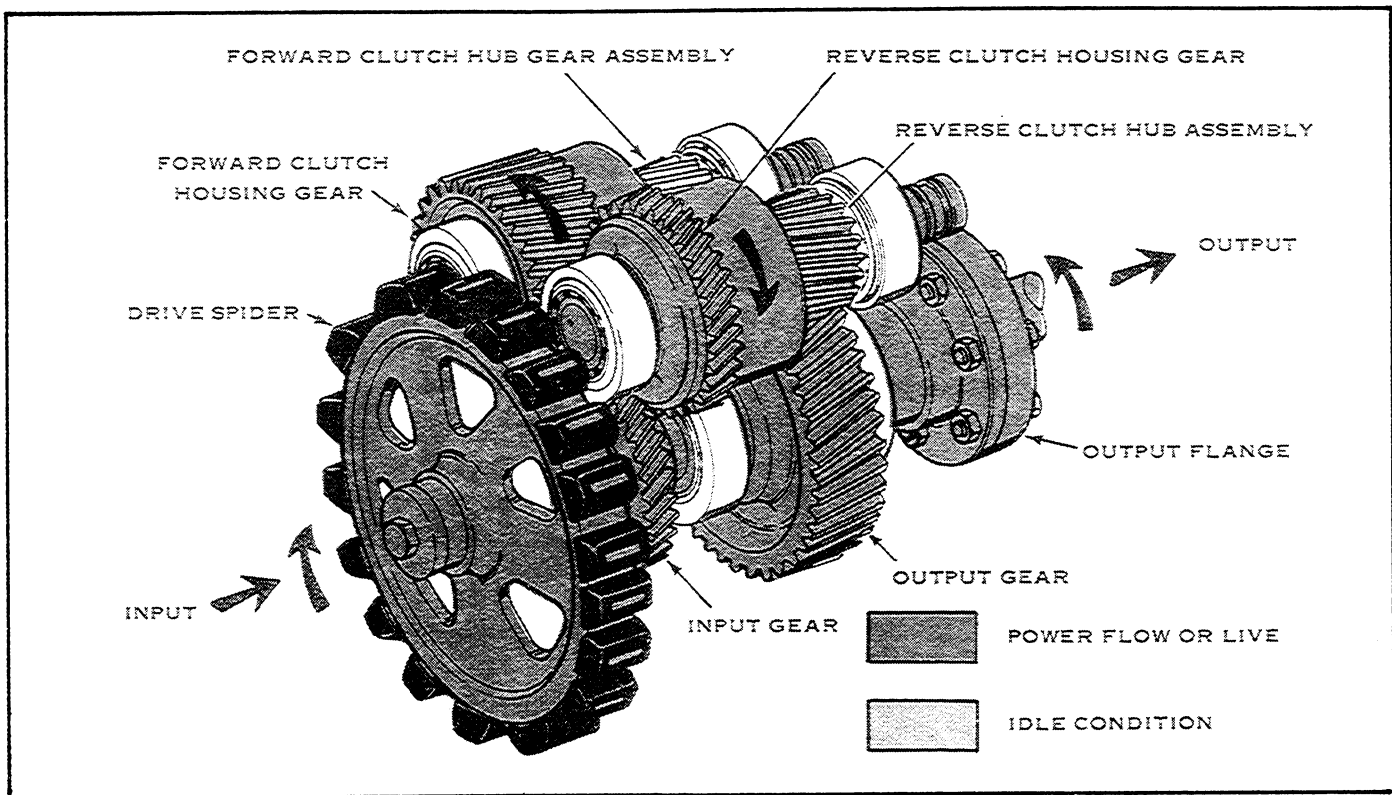


Figure 3-3. Model MG-506-1 Marine Transmission Power Flow — Reverse — Schematic View.

2. Oil Circuit. Oil is drawn from the sump through the filter screen and suction tube to the oil pump assembly. From the oil pump assembly the oil is conveyed by a flexible hose to the remotely-located heat exchanger where the oil is cooled. The cooled oil returns from the heat exchanger through a flexible hose (and the oil filter assembly if installed) to the oil inlet port of the selector valve assembly. Oil is conveyed from the selector valve assembly to the pump mount by the oil connecting tubes. The oil tubes connecting the selector valve assembly to the pump mount convey oil to the reverse clutch shaft for clutch engagement and lubrication.

OIL FLOW.

1. Neutral (Figure 3-4). Oil is drawn from the sump through the filter screen and suction tube to the oil pump assembly. From the oil pump assembly the oil is conveyed by a flexible hose to the remotely-located heat exchanger where the oil is cooled. The cooled oil returns from the heat exchanger through a flexible hose (and the oil filter assembly if installed) to the oil inlet port of the selector valve assembly. Oil is pressurized by the main regulator valve in the regulator body to approximately 300 psi. Overage oil from the valve chamber of the regulator valve enters the lube oil passages and a connecting tube conveys lube oil to the pump mount. The lubricating oil is sup-

plied to both clutch shafts for cooling and lubricating functions in the marine transmission. Since neither clutch is engaged, the remainder of the oil in the chamber not required for cooling and lubrication is returned to sump.

2. Forward Clutch Applied (Figure 3-5). Oil is drawn from the sump through the filter screen and suction tube to the oil pump assembly. From the oil pump assembly the oil is conveyed by the flexible hose to the remotely-located heat exchanger where the oil is cooled. The cooled oil returns from the heat exchanger through a flexible hose (and the oil filter assembly, if installed) to the oil inlet port of the selector valve assembly. Oil is pressurized by the main regulator valve in the regulator valve body to approximately 300 psi. Oil is routed by the selector valve spool in the valve body to an annular groove and cross-drilled hole in the forward clutch shaft. An annular chamber formed in the rear of the clutch shaft is sealed on both sides by piston rings. The cross-drilled hole in the clutch shaft intersects a horizontally-drilled hole in the shaft that is terminated by a ball plug installed in the end of the shaft. A second cross-drilled hole, that also intersects the horizontally-drilled hole, permits the oil to enter the chamber between the forward clutch housing gear and the clutch piston. The oil pressure moves the clutch piston against the clutch plates, and the for-

ward clutch is engaged. Any oil that exists in the reverse clutch is returned to sump by the position of the selector valve and the force exerted by the clutch piston spring. Overage oil in the regulator valve body chamber passes by the regulator valve and enters the lube oil tube for cooling and lubricating functions as described in Neutral.

3. Reverse Clutch Applied (Figure 3-6). Oil is drawn from the sump through the filter screen and suction tube to the oil pump assembly. From the oil pump assembly the oil is conveyed by a flexible hose to the remotely-located heat exchanger where the oil is cooled. The cooled oil returns from the heat exchanger through a flexible hose (and the oil filter assembly if installed) to the oil inlet port of the selector valve assembly. Oil is pressurized by the main regulator valve in the regulator valve body to approximately 300 psi. Oil is routed by the selector valve in the valve body to the annular groove and cross-drilled hole in the reverse clutch shaft. An annular chamber formed in the rear of the clutch shaft is sealed on both sides by piston rings. The cross-drilled hole in the clutch shaft intersects a horizontally-drilled hole in the shaft that is terminated by a ball plug installed in the end of the shaft. A second cross-drilled hole that also intersects the horizontally-drilled hole permits the oil pressure to enter the chamber between the reverse clutch housing gear and the clutch piston. The oil pressure moves the clutch piston against the clutch plates, and the reverse clutch is engaged. Any oil that exists in the forward clutch is returned to sump by the position of the selector valve and the force exerted by the clutch piston spring. Overage oil in the regulator valve body chamber passes by the regulator valve and enters the lube oil connecting tube for cooling and lubricating functions as described in Neutral.

BACK DRIVING.

All current Twin Disc production marine transmissions can be back driven (propeller windmilling with dead engine) for the following conditions provided that the vessel speed when back driving the marine

transmission, does not exceed the normal maximum speed of the vessel.

Intermittent Back Driving.

Examples:

Sail boat auxiliary - short trips, less than one day.

Towing purse boats in seining operations.

Twin Screw vessel with operation of only one engine for part of the day.

Towing home a boat with engine trouble, short trip, less than one day.

1. Start the engine and operate the marine transmission in neutral at normal fluid pressures for a minimum of four minutes, doing this once every 12 hours for Model MG506-1.

2. Maintain the back driven marine transmission's oil level as for normal propulsion, or use above full oil level.

Continuous Back Driving.

Examples:

Towing to deliver a boat.

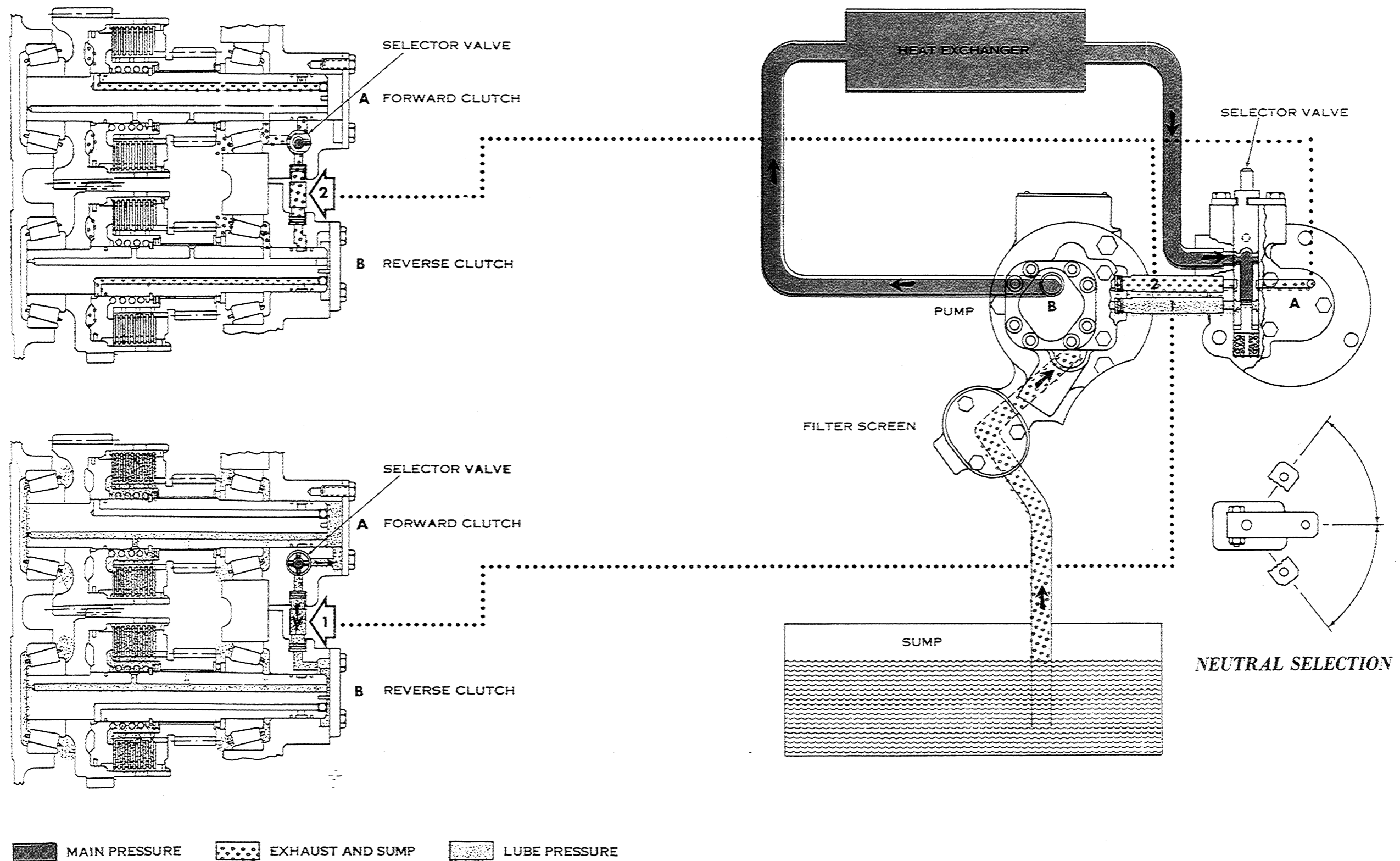
Towing home a boat with engine trouble, long trip.

Sail boat auxiliary - long trips.

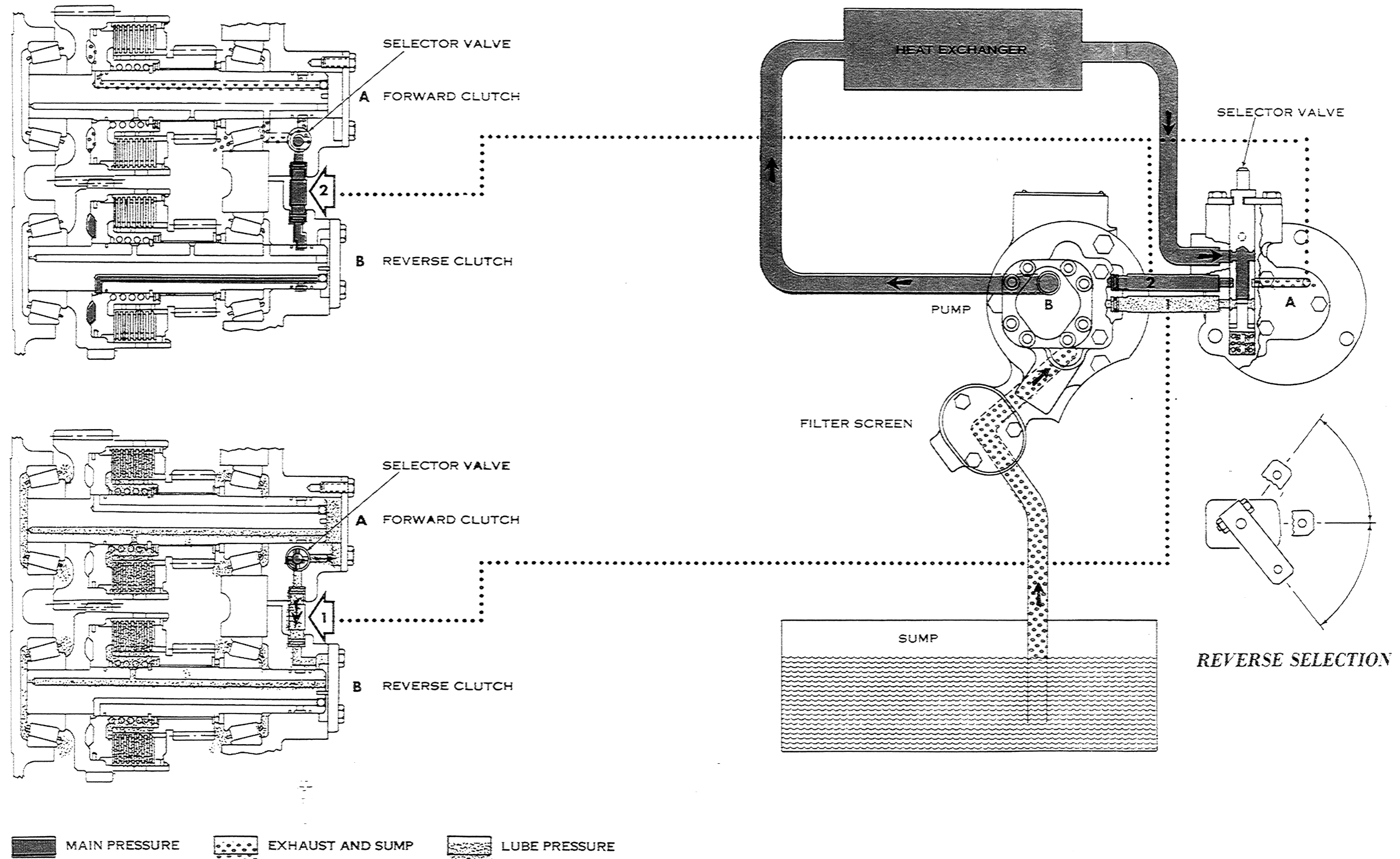
1. Start the engine and operate the marine transmission in neutral at normal fluid pressures for a minimum of four minutes every 8 hours for Model MG506-1. Maintain oil level as above.

2. An alternate would be to lock the propeller shaft to prevent rotation.

3. Prior to backdriving, plug dipstick tube, fill unit with oil, then pump oil out of unit down to recommended level. Repeat this as described above.



Model MG-506-1 Marine Transmission Oil Flow — Neutral — Schematic View. Figure 3-4.



Model MG-506-1 Marine Transmission Oil Flow — Reverse Figure 3-6.

Section 4.

PREVENTIVE MAINTENANCE

GENERAL.

1. **Lubrication.** All moving parts of the MG506-1 Marine Transmission are lubricated by the oil within the sump as it travels throughout the hydraulic system. The preventive maintenance required to keep the transmission functioning properly is slight; however, it is very important that the following directions be complied with.

2. **Overhaul Interval.** A complete overhaul of the Model MG506-1 Marine Transmission should be made at the same time the engine is overhauled. All parts showing signs of wear, fatigue, etc. should be replaced at that time.

HYDRAULIC SYSTEM.

1. **Oil Capacity.** The oil capacity of the Model MG506-1 Marine Transmission is 1.2 gallons, or to the "full" mark on the oil level gauge. The oil used in the marine transmission should be of the same quality and type recommended by the engine manufacturer for use in the engine. Use SAE 30 HD when the inlet water temperature to the heat exchanger is above 85° F., and SAE 20 HD when the inlet water temperature to the heat exchanger is below 85° F.

2. **Oil Level.** The oil level should be checked daily using the oil level gauge in the marine transmission. Check the oil level with the engine at idle speed and the marine transmission in "Neutral". The oil level must be maintained at the "full" mark on the oil level gauge.

3. **Oil Change Interval.** The oil must be changed every 1000 hours of operation, or 6 months, whichever occurs first. Boats that are placed in dry dock or storage for periods of three months or more, should have the oil changed in the marine transmission prior to return to active use.

4. **Draining.** When a complete oil change of the hydraulic system is required, it is necessary to drain the oil from the heat exchanger and connecting hoses as well as the marine transmission sump. In addition, if an oil filter assembly is installed, the filter and connecting hoses must be drained and the filter element replaced. Alternate methods of draining the

marine transmission sump of oil are possible as described below:

a. **Gravity Drain.** Remove the hex-head plug from the bottom of the main housing. Allow sufficient time for the marine transmission oil to drain from the sump, and then install the plug securely in place.

b. **Suction Drain.** A suction pump can be used to drain the marine transmission sump. The oil level gauge tube is serrated to accommodate a suction hose. Remove the oil level gauge, and install a suction hose on the oil level gauge tube. Operate the suction pump until the marine transmission oil has been removed from the sump. After suction draining, remove the pump and hose, and install the oil level gauge in the tube.

5. **Filling.** Make certain the drain plug is tight. Remove the breather cap from the breather cap nipple assembly. Use the recommended quality, type and weight oil and fill the marine transmission sump with 1.2 U.S. gallons of oil. Pour the oil into the breather cap nipple. After filling, start the engine and shift the unit from "Forward" to "Reverse" several times permitting the oil lube lines and heat exchanger to fill with oil. Check the oil level. With the engine at idle speed and the marine transmission in "Neutral", the oil level must be to the "full" mark on the oil level gauge. Install the breather cap after proper oil fill has been attained. Operate the marine transmission to raise the oil temperature to operating range and recheck the oil level, filling to the "full" mark as required.

COMPONENT PARTS.

1. **Filter Screen.** The filter screen is installed in the bottom of the rear cover, and extends into the sump of the marine transmission.

a. **Cleaning Interval.** The filter screen should be removed and cleaned every 1000 hours of operation, or 6 months, whichever occurs first, at the same time the oil is changed.

b. **Removal.** Remove the filter screen from the rear cover.

c. **Installation.** Use pipe thread compound on the threads of the filter screen, and install the filter screen in the rear cover.

2. **Breather Cap.** Remove the breather cap from the breather cap nipple assembly every 1000 hours of operation at the same time that the oil is changed. Flush the breather cap in clean diesel fuel. Install the cap on the nipple after cleaning.

3. **Heat Exchanger and Hoses.** Disconnect the hoses from the heat exchanger every 1000 hours of operation at the same time that the oil is changed. Drain the hoses and the heat exchanger of all oil. After draining, connect the hoses to the heat exchanger.

4. **Oil Filter Assembly.** If an oil filter assembly is used in the hydraulic system, the filter and connecting hoses must be drained every 1000 hours of operation and the filter element must be replaced. Accomplish these procedures at the same time that the oil is changed.

PERIODIC VISUAL INSPECTION.

1. **General.** Frequently inspect the mounting parts of the marine transmission. Replace any damaged parts.

2. **Heat Exchanger and Oil Filter Connection Lines.** Inspect the heat exchanger and oil filter connecting lines for leaks, sponginess, or other damage. Replace a damaged line.

3. **Pressure and Temperature Gauge Assemblies.** Periodically inspect the pressure and temperature gauge assemblies for damage. Replace a damaged gauge. If a gauge is suspected of being inaccurate, replace the gauge with one of proven accuracy to determine the extent of malfunction.

NOTE

Zinc anodes are installed in the heat exchanger to help protect it from corrosion. Remove and inspect the anodes frequently because they are consumed as they provide protection. Replace the anodes as necessary. See Figure 4-1.

OIL SEAL REPLACEMENT.

Prior to Replacement.

1. **General.** If it becomes necessary to replace the bearing retainer oil seal (Figure 12-2, 25) because of

leakage, this procedure can be accomplished without removing the marine transmission from the engine. Follow the description below to accomplish this replacement.

2. **Draining.** In most installations, it will be necessary to drain the marine transmission sump of oil in order to accomplish the oil seal replacement.

Drain the marine transmission sump of oil.

3. **Output Flange Clearance.** Scribe an aligning mark across the outside diameter of the output flange (26) and the companion flange for installation purposes. Remove the bolts, and nuts that secure the companion flange to the output flange. Slide the propeller shaft rearward until sufficient clearance is apparent for the removal of the output flange.

Oil Seal Replacement.

1. **Removal.** Remove the capscrew (Figure 12-2, 29), retainer washer (28), and the seal ring (27) from the output flange and the output shaft (19). Discard the seal ring. Remove the spline-connected output flange from the output shaft. It may be necessary to use a gear puller to accomplish this removal. Remove the bearing retainer oil seal (25) from the bearing retainer (23). Discard the oil seal.

2. **Installation.** Install a new bearing retainer oil seal (25) in the bearing retainer (23). The oil seal must be installed flush with the rear face of the bearing retainer, and the lip of the seal must point towards the output gear (20). Carefully install the output flange (26) on the splines of the output shaft (19). Do not damage the lip of the oil seal during this procedure. Secure the output flange on the output shaft with a new lathe-cut rubber seal ring (27), retainer washer (28), and the 1/2-20 × 1 hex-head capscrews (29). Tighten the capscrews to 65 ± 5 lbs. ft. torque. Bend the capscrew lock against a flat of the capscrew. Check the output shaft end play; end play must be between 0.001 and 0.004.

AFTER REPLACEMENT.

1. **General.** After replacement of the bearing retainer oil seal (Figure 12-2, 25) has been accomplished, and the output shaft end play has been verified as being correct, the following procedures of driveline connection and oil filling of the marine transmission sump can be completed.

2. **Drive Line Connection.** Slide the propeller shaft and the companion flange forward against the output flange (26). Align the scribed marks on the companion flange and the output flange. Secure the

flanges together with the bolts and nuts previously removed.

3. **Filling.** Fill the marine transmission sump with oil.

Section 5.

TROUBLE SHOOTING

GENERAL.

This section of the maintenance manual has been prepared to assist maintenance personnel in trouble shooting equipment discussed in the manual. When trouble shooting the equipment, always remember to consider the entire power package.

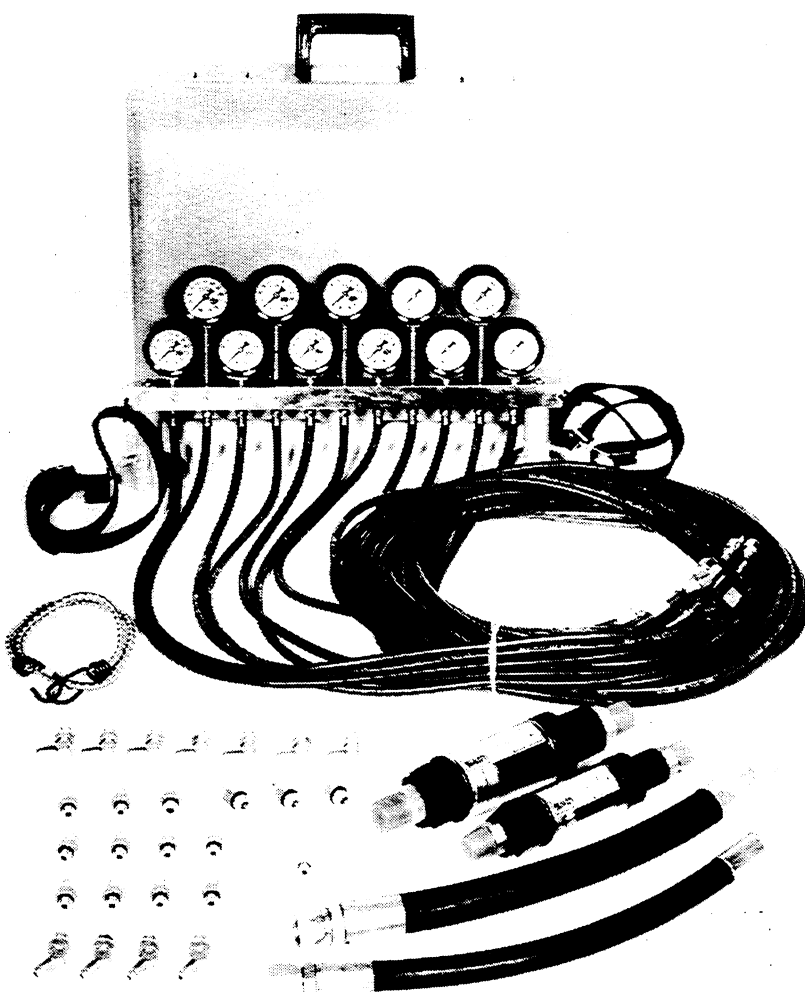
PRESSURE AND FLOW TEST KIT.

A portable pressure and flow test kit NU2451 is available and contains the necessary equipment to accurately test and trouble shoot the hydraulic system of this

Twin Disc unit. The kit is ruggedly constructed for field use and contains pressure gauges, hoses, adapters, flow meters, straps, clips, etc. Contact the Twin Disc Service Engineering Department, Racine, Wisconsin, for specific information concerning this test kit. See Figure 5-1.

TROUBLE SHOOTING CHART.

The trouble shooting chart (Table 5-1) is organized in three columns. Proper use of the chart will aid in the rapid determination and repair of functional difficulties that may occur.



CONTENTS OF OTC #NU 2451

Part No.	Qty.	Description
NU 6652	01	Gauge Bar
303402	07	Gauge, 400 psi
15343	02	Gauge, 100 psi
46938	01	Gauge, 60 psi
303434	01	Gauge, 30 psi
303238	11	Hose, 10 ft. Long
207606	02	"D" Clip
10473	01	Sash Chain, 2 ft.
208054	02	Bushing
NU 0802	01	Stretch Cord
19754	02	Suction Cup
207895	05	Nipples NPT-2
210458	05	Coupler NPT-2
15665	02	S-Hook
11017	02	Screw, 1/4-20 x 2 3/4" Long
202868	07	90° Elbow, 4 SAE x 4 JIC M
202867	10	Adapter, 4 SAE x 4 JIC M
202854	01	Adapter, 3 SAE x 4 JIC M
205977	03	Adapter, 6 SAE x 4 JIC M
202853	01	Adapter, 5 SAE x 4 JIC M
NU 6655	01	Flow Meter, 30 GPM
HED-600010	01	Flow Meter, 10 GPM
NU 6657	01	#10 Hose - 100R1 18" Long
NU 6658	01	#12 Hose - 100R1 18" Long
203220	02	Adapter 10 SAE M x 10 JIC M
205951	02	Adapter 12 SAE M x 12 JIC M
206938	04	Adapter 45° 4 SAE x 4 JIC M
213137	01	Storage Box With Fills

NOTE: Twin Disc will not stock or sell this kit.

Manufactured for Twin Disc, Incorporated by Owatonna Tool Co., 2013 4th Street N.W., Owatonna, MN 55060, 1-800-533-5338

Figure 5-1. Pressure and Flow Test Kit NU2451

Table 5-1. Trouble Shooting Chart

Symptom	Cause	Remedy
1. Low Oil Pressure.	1-1. Partially clogged filter screen.	1-1. Remove and clean filter screen.
	1-2. Stuck main regulator piston.	1-2. Remove main regulator valve parts from valve body, and clean parts.
	1-3. Broken or worn piston rings on clutch shafts.	1-3. Remove pump mount and selector valve assembly from rear cover. Remove piston rings from clutch shafts. Install new piston rings on clutch shafts.
	1-4. Damaged or worn oil pump assembly.	1-4. Remove and replace the oil pump assembly.
	1-5. Damaged or worn clutch piston rings.	1-5. Remove marine transmission. Disassemble clutches, and replace damaged or worn parts.
	1-6. Scored valve bore in selector valve assembly.	1-6. Remove selector valve assembly. Disassemble selector valve assembly and inspect valve bore.
	1-7. Reverse clutch housing gear turning on shaft.	1-7. Remove and replace reverse clutch shaft and gear assembly.
2. No Oil Pressure.	2-1. Low oil level or empty sump.	2-1. Check gaskets, hoses, and seals for oil leakage. Replace parts causing leakage and fill marine transmission sump.
	2-2. Fully clogged filter screen.	2-2. Remove and clean filter screen.
	2-3. Damaged suction tube.	2-3. Disassemble and inspect suction tube. Replace parts as required.
	2-4. Damaged or worn oil pump assembly.	2-4. Remove and replace oil pump assembly.
	2-5. Broken clutch shaft.	2-5. Refer to Remedy 1-5.
3. High Oil Pressure.	3-1. Stuck main regulator piston.	3-1. Refer to Remedy 1-2.
4. Overheating.	4-1. Insufficient heat exchanger capacity.	4-1. Replace present heat exchanger with heat exchanger of sufficient capacity.
	4-2. Insufficient cooling water flow.	4-2. Replace lines and/or hoses with larger inside diameter lines and/or hoses.
	4-3. Slipping clutch.	4-3. Low oil pressure (Symptom 1). Remove marine transmission, disassemble, and inspect for worn clutch plates.

Table 5-1. Trouble Shooting Chart

Symptom	Cause	Remedy
5. Excessive Noise. * Special rolling tools are required.	4-4. Oil level too high.	4-4. Correct oil level.
	4-5. Improper oil in sump.	4-5. Drain marine transmission, and fill with proper oil.
	4-6. Clutch piston spring broken.	4-6. Refer to Remedy 1-5.
	4-7. Clutch plates warped.	4-7. Refer to Remedy 1-5.
	4-8. Improper bearing adjustment with shims (especially after overhaul).	4-8. Check end play of shafts, and make proper shim adjustments.
	5-1. Air leak in suction side of system.	5-1. Tighten all fittings and/or replace a damaged tube. *
	5-2. Worn gear teeth or splines on marine transmission parts.	5-2. Overhaul marine transmission. Replace worn parts.
	5-3. Bearing failure.	5-3. Overhaul marine transmission. Replace damaged parts.
6. No Neutral.	5-4. Worn or damaged rubber blocks.	5-4. Remove marine transmission. Replace worn or damaged rubber blocks.
	5-5. Excessive bearing end play.	5-5. Check and reset end play.
	6-1. Clutch plates warped.	6-1. Refer to Remedy 1-5.
	6-2. Clutch piston spring broken and jammed.	6-2. Refer to Remedy 1-5.
	6-3. Selector valve linkage incorrect.	6-3. Check linkage and adjust.
7. Harsh Engagement.	6-4. Scored bore in valve body of selector valve assembly.	6-4. Refer to Remedy 1-6.
	7-1. Air in oil.	7-1. Correct air leaks in suction side of system. Change oil to proper type.
	7-2. Binding clutch piston.	7-2. Refer to Remedy 1-5.
8. Leakage Between Main Housing and Rear Cover.	8-1. Main housing gasket failure.	8-1. Remove marine transmission. Disassemble, and replace main housing gasket.
9. No Pressure and No Output Power.	9-1. Input shaft broken.	9-1. Overhaul marine transmission. Replace broken or damaged parts.
	9-2. Drive spider broken.	9-2. Refer to Remedy 9-1.
	9-3. Drive spider or input gear keys sheared.	9-3. Refer to Remedy 9-1.

Section 6.

REMOVAL AND UNIT DISASSEMBLY

PRIOR TO REMOVAL.

1. **Hydraulic System.** Drain the hydraulic system of oil.
2. **Connecting Linkage.** Disconnect all connecting linkage and lines to the marine transmission.
3. **Support.** Support the marine transmission with a hoist, or other suitable equipment, prior to the removal of any mounting parts.

REMOVAL.

1. **Output Flange Connection.** Scribe an alignment mark across the outside diameter of the output flange and the companion flange for installation purposes. Remove the bolts and nuts that secure the output flange and companion flange together. After the removal of attaching parts, move the propeller shaft rearward until sufficient clearance is apparent for marine transmission removal.

2. **Engine Bedrail Connections.** Disconnect the mounting brackets installed on the engine bedrails from the mounting pads of the marine transmission or from the engine bedrails.

3. **Engine Connection.** Remove the 12 hex-head capscrews that secure the main housing of the marine transmission to the engine flywheel housing. Slide the marine transmission rearward until the rubber blocks on the drive spider are clear of the driving ring installed on the engine flywheel. Remove the marine transmission. Remove the driving ring from the engine flywheel only if replacement of parts is necessary.

DISASSEMBLY.

Miscellaneous External Parts.

1. Remove the oil level gauge (Figure 12-1, 5) from the oil level gauge tube (6). Remove the tube (6) from the main housing (2).
2. Remove the drain plug (50) and O-ring (51).
3. Remove breather cap (12) only if parts are being replaced.

4. If replacement of the name plate (3) is necessary, remove the four drive screws (4) that secure the name plate to the main housing. Remove the name plate from the main housing, and transfer the data stamped on the old plate to the new plate.

5. If replacement of the rotation indicator plates (7 and 10) is necessary, remove the four drive screws (8 and 11) that secure the rotation indicator plate to the main housing. Remove the rotation indicator plate from the main housing.

6. Remove the pipe plug (1) from the main housing.

7. Remove capscrew (Figure 12-2, 1) and retainer washer (2).

8. Use a puller to remove drive spider (5). See Figure 6-1.

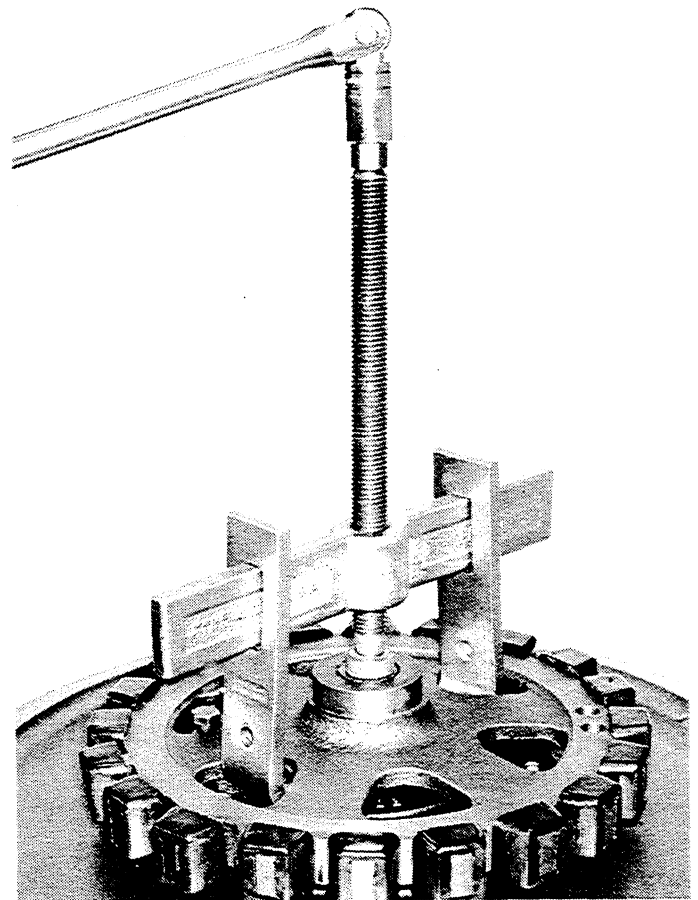


Figure 6-1. Removing Input Drive Spider.

9. Remove capscrews (Figure 12-2, 13) and use two of the capscrews as pushers in the threaded holes in bearing support (7) to remove the bearing support. See Figure 6-2.

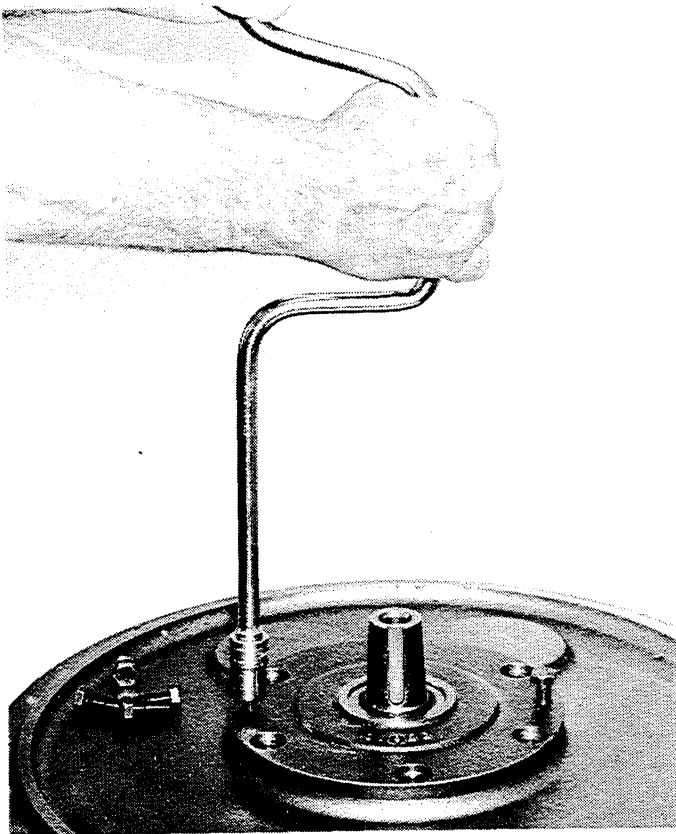


Figure 6-2. Using Pusher Screws to Remove Input Bearing Support.

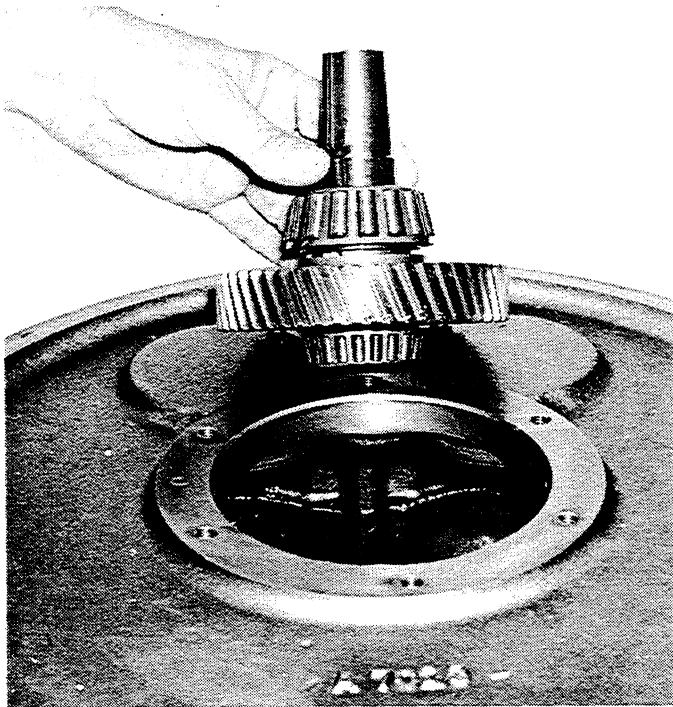


Figure 6-3. Removing the Input Shaft and Gear Assembly from Main Housing.

10. Remove the input shaft and gear assembly. See Figure 6-3.

11. Turn the transmission over so that the output shaft is up.

12. Remove the three capscrews (figure 12-1, 4), filter screen cover (45), gasket (46) and screen (47) from the rear cover (14). See Figure 6-4.

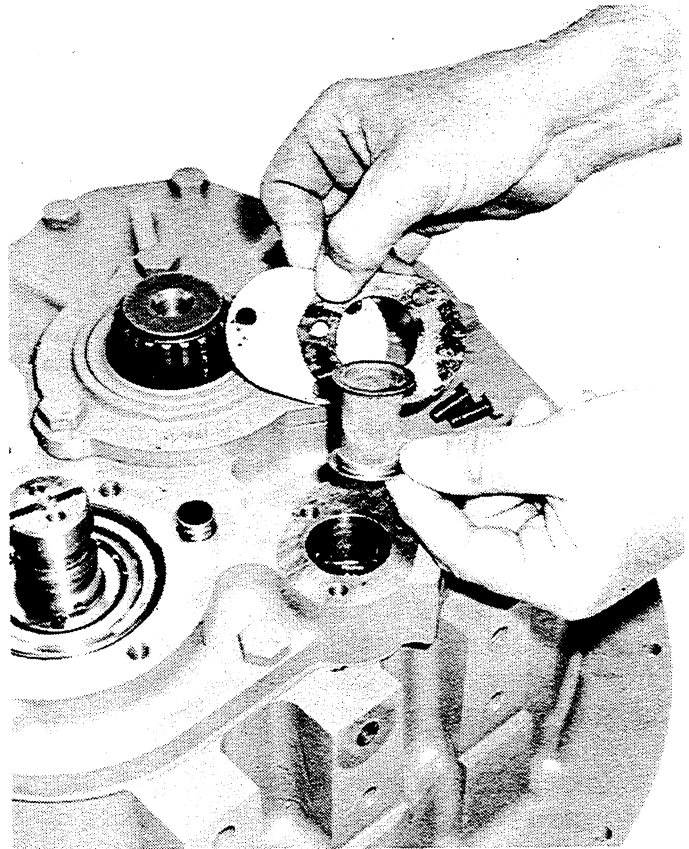


Figure 6-4. Pump Suction Filter Screen and Cover Plate Removal.

13. Remove the four hex-head capscrews (Figure 12-1, 42) that secure the oil pump assembly (43) to the pump mount. Remove the oil pump assembly and the oil pump gasket (41) from the pump mount. Discard the gasket. Disassemble the parts only if replacement of parts is necessary.

14. Remove the hex-head capscrew (Figure 12-2, 29) and the retainer washer (28) that secure the output flange (26) on the output shaft (19). See Figure 6-5. Some ratios have three capscrews on the output flange. Use a standard gear puller and remove the output flange (Figure 12-2, 26) from the output shaft (19). Remove the lathe cut ring (27) from the output flange (26). Discard the seal ring.

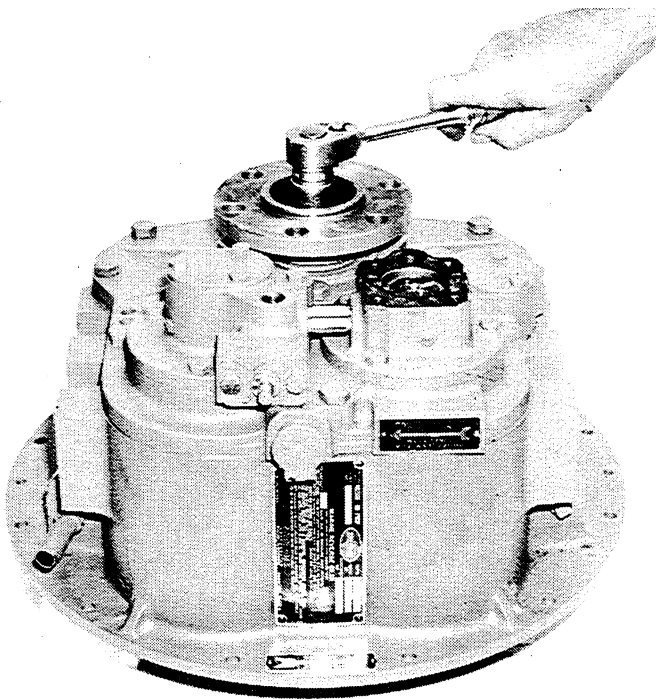


Figure 6-5. Removing Output Flange.

15. Loosen the hex-head cap screw (Figure 12-1, 17), and nut (20), and remove selector lever (19). Remove the three hex-head cap screws (34) and (30) that secure the selector valve assembly (29) to the rear cover (14). Simultaneously, remove the pump mount and selector valve assembly from the rear cover. See Figure 6-6. Remove the two jumper tubes (Figure 12-1, 36), and four O-ring seals (35 and 37) from between the pump mount and selector valve assembly. Remove the pump mount shims (38) and O-ring (48), and valve body shims (16) from the rear cover.

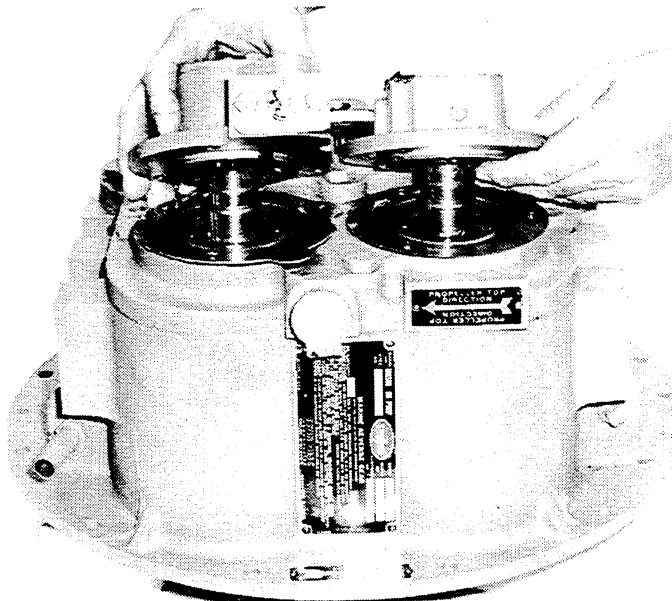


Figure 6-6. Removing or Installing Pump Mount and Valve Body Together.

16. Remove the three hex-head cap screws (Figure 12-2, 24) that secure the bearing retainer (23) to the rear cover. Remove the bearing retainer and the bearing retainer shims (22) from the rear cover. See Figure 6-7. Remove the bearing retainer oil seal (Figure 12-2, 25) from the bearing retainer. Discard the oil seal.

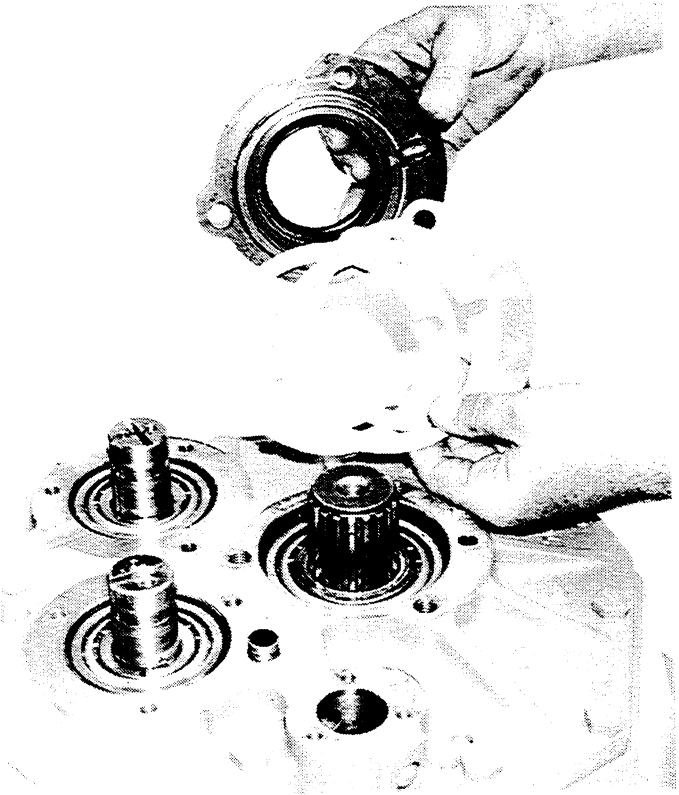


Figure 6-7. Output Shaft Bearing and Shims Removed.

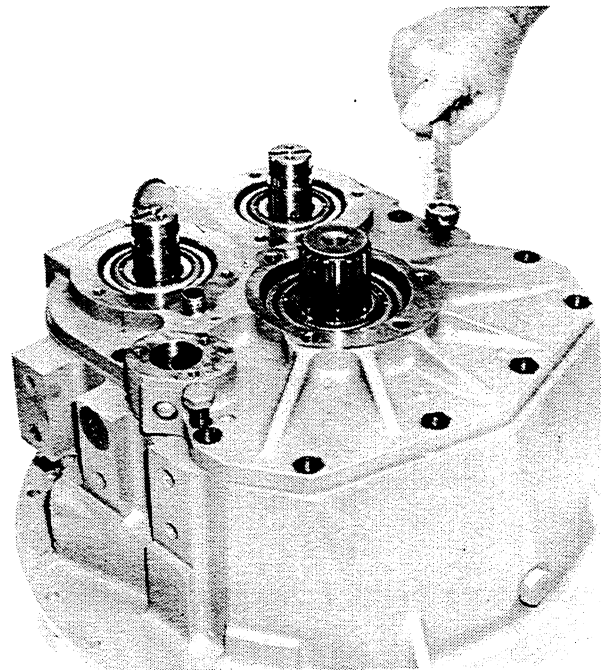


Figure 6-8. Using Pusher Screws to Remove Rear Cover.

17. Remove the nine hex-head capscrews (Figure 12-1, 15 and 49) that secure the rear cover (14) to the main housing (2). See Figure 6-8. Use two 1/2-13 pusher screws and remove the rear cover and the main housing gasket (Figure 12-1, 13) from the main housing. Do not remove the two dowel pins (9) from the rear cover or main housing. Remove the bearing cups of the output shaft tapered roller bearing (Figure 12-2, 21), the forward clutch shaft tapered roller bearings (Figure 12-3, 21), and the reverse clutch shaft tapered roller bearing (Figure 12-4, 21) from the rear cover only if replacement of parts is necessary.

18. Remove the output shaft and gear assembly. See Figure 6-9.

19. Remove the reverse clutch assembly. See Figure 6-10.

20. Remove the forward clutch assembly. See Figure 6-11.

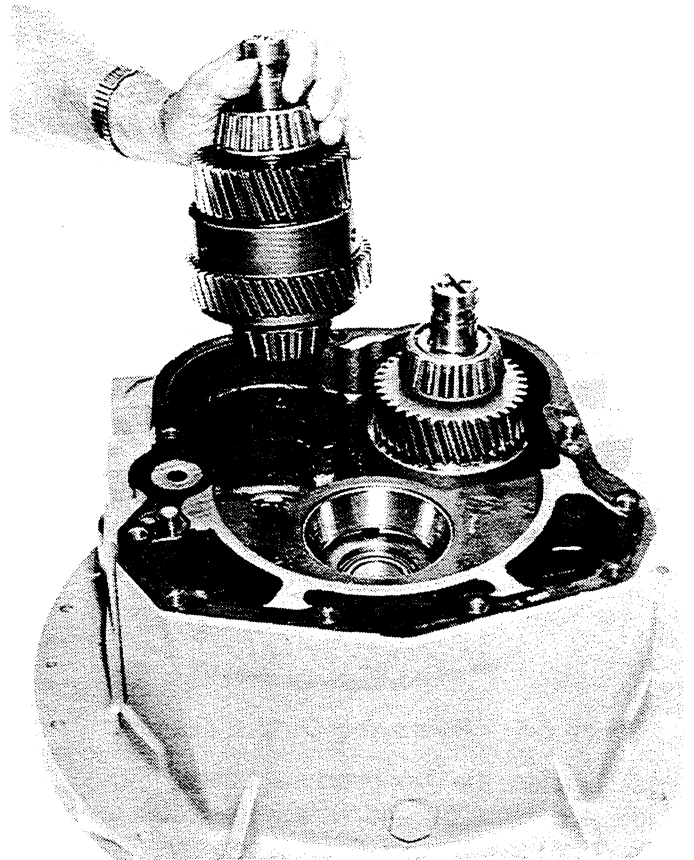


Figure 6-10. Removing or Installing the Reverse Clutch Assembly.

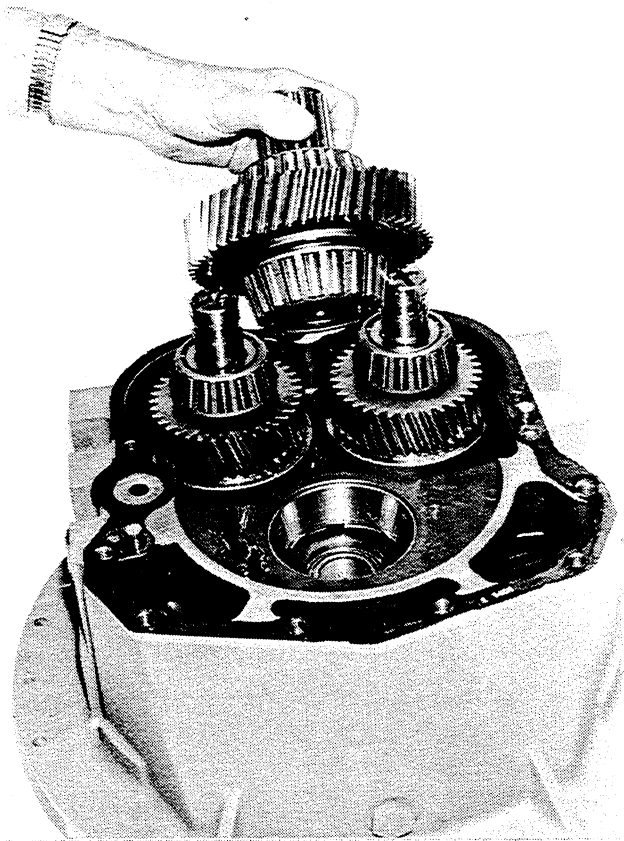


Figure 6-9. Removing or Installing Output Shaft and Gear Assembly.

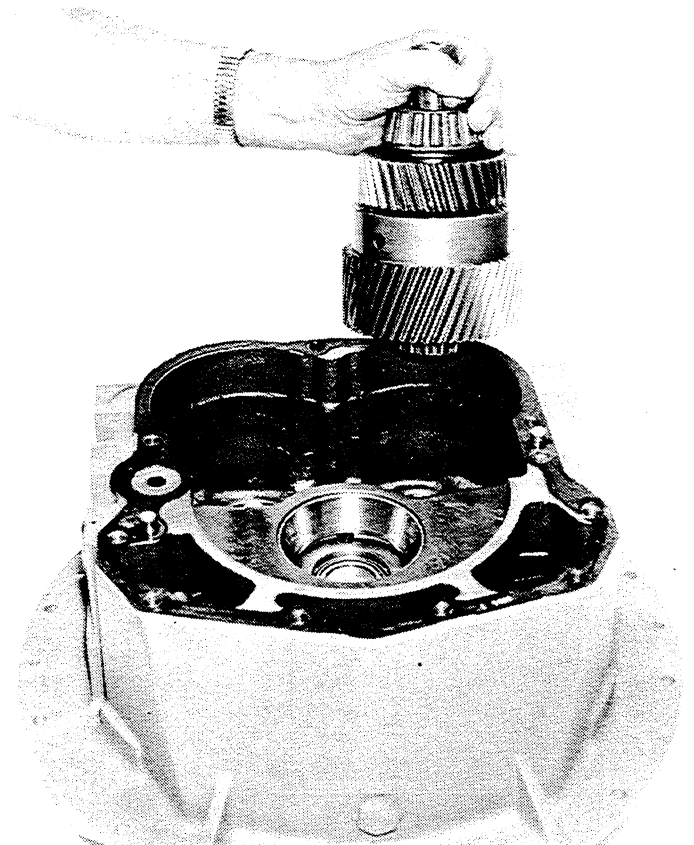


Figure 6-11. Removing or Installing the Forward Clutch Assembly.

Section 7.

CLEANING AND INSPECTION

CLEANING

General.

NOTE

Replace all oil seals, gaskets, O-rings, lock plates, piston rings, seal rings, snap rings, etc., as a part of any maintenance or overhaul procedure. Shims which could be damaged or destroyed in disassembly should also be replaced.

1. Using Stoddard® solvent, or equivalent or steam cleaning, clean all parts. Parts cleaned with solvent or steam cleaned must be dried and oiled immediately.
2. Examine all parts carefully for grit, dirt and abrasives and reclean them if necessary.
3. Clean all oil passages by working a piece of wire back and forth through the passages and then flushing them with cleaning solvent.
4. Use clean solvent to flush oil pumps, valves, etc.
5. Flush all hoses, tubing, coolers, etc., particularly if the unit is being disassembled due to an internal failure.

Cleaning Bearings.

Do not remove grease in which new bearings are packed. Thoroughly wash bearings that have been in service, in clean solvent. Soak bearing in solvent if they are particularly dirty or filled with hardened grease.

CAUTION

Never dry bearing with compressed air. Do not spin bearings while they are not lubricated. Oil bearings with SAE 10 engine oil immediately after cleaning. Be sure bearings are oiled before inspection.

Preventing Entrance of Dirt into Bearings.

Dirt and grit in bearings are often responsible for bearing failure; consequently, it is important to keep bear-

ings clean. Do not remove grease from new bearings. Keep the wrapper on new bearings until they are to be installed. Do not expose clean bearings if they are not to be assembled at once. Wrap them with a clean lint-free cloth or paper to keep out dust.

Previously Sealed Joints.

1. For previously sealed joints, scrape surfaces to remove old gasket material. Gel-type paint removers containing methylene chloride can be used to wipe off cured sealant.
2. Clean surfaces with 1, 1, 1-trichloroethane to remove oil and grease residue.
3. Test for clean surfaces by applying a few drops of cool water to the surfaces. Parts are sufficiently clean if water covers the surface of the part in a film. If the water puddles or forms beads, use fresh solvent and reclean.

INSPECTION.

Housings, Cast Parts, and Machined Surfaces.

NOTE

Units with matched housings require replacement of both halves. These must be kept in matched halves.

1. Replace cast parts or housings that are cracked.
2. Inspect bores for wear, grooves, scratches and dirt. Remove burrs and scratches with crocus cloth or soft stone. Replace parts that are deeply grooved or scratched.
3. Inspect oil passages for obstructions. If an obstruction is found, remove it with compressed air or by working a wire back and forth through the passage and flushing it with solvent.
4. Inspect machined surfaces for burrs, scratches, nicks and foreign matter. If such defects cannot be removed with crocus cloth or a soft stone, replace the part.

5. Inspect threaded openings for damaged threads. Chase damaged threads with a tap of the correct size.

6. Inspect studs for damaged threads and looseness. Replace defective studs.

7. Inspect dowel pins for wear or damage. Replace defective dowels. This applies where matched set of parts is not involved.

8. Inspect dowel pin holes for wear due to movement between mating parts. If a dowel pin hole is worn, rebores and sleeve the hole when possible. Otherwise, replace the parts. This applies where matched set of parts is not involved.

Valve Seats.

Inspect valve seats for burrs, nicks and scratches. If these defects cannot be removed with a crocus cloth, replace the part. Check to see that the valve is seating properly after reworking the valve seat.

Bearings.

1. Inspect bearings for roughness of rotation. Replace the bearing if the rotation is rough.

2. Inspect bearings for corrosion, scored, scratched, cracked, pitted or chipped races, and for indication of excessive wear of balls or rollers. If one of these defects is found, replace the bearing.

3. Inspect bearing bores and shafts for grooved, burred, or galled conditions that would indicate that the bearing has been turning in its housing or on its shaft. If the damage cannot be repaired with a crocus cloth, replace the part.

Bushings and Sleeves.

Inspect bushings for size and out-of-roundness, scores, burrs, sharp edges, and evidence of overheating. Remove scores with a crocus cloth. If

the bushing is out-of-round, deeply scored, or excessively worn, replace it.

Thrust Washers and Spacers.

Inspect thrust washers for distortion, scores, burrs and wear. Rework or replace any defective thrust washers or spacers.

Gears.

1. Inspect gears for scuffed, nicked, burred or broken teeth. If the defect cannot be removed with a soft stone, replace the gear.

2. Inspect gear teeth for wear that may have destroyed the original tooth shape. If this condition is found, replace the gear.

3. Inspect thrust faces of gears for scores, scratches and burrs. If these defects cannot be removed with a soft stone, replace the gear.

Splined Parts.

Inspect splined parts for stripped, twisted, chipped or burred splines. Remove burrs with a soft stone. Replace the part if other defects are found.

Snap Ring.

Replace damaged or distorted snap rings.

Springs.

Inspect springs for broken or distorted coils. Replace the spring if either of these defects are found.

Flexible Hoses.

Inspect all flexible hoses for cracks and sponginess. Replace damaged hoses.

Section 8.

SUBASSEMBLIES

ASSEMBLY NOTE

Place the inner race of all roller bearings in a 275° F. oven for 30 minutes maximum.

CAUTION

Submerge all sintered clutch plates in transmission oil for one hour.

ASSEMBLY NOTE

Oil torque values are given for all screws; therefore, screws should be oiled before installing.

NOTE

In the discussion that follows, the input side of the transmission is the front and the output side is the rear.

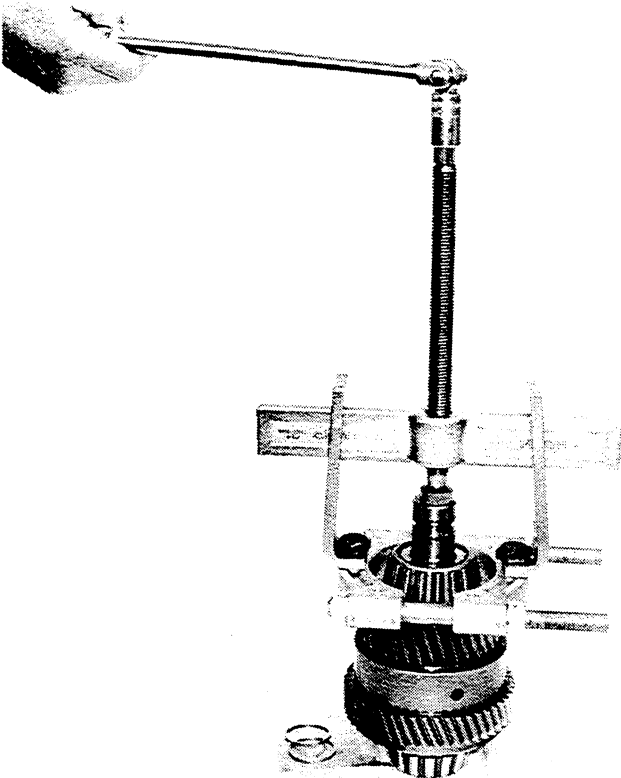


Figure 8-1. *Pulling the Rear Bearing Cone from the Reverse Clutch Shaft.*

FORWARD CLUTCH.

Disassembly.

1. Support the forward clutch assembly on a work surface with the output end up.
2. Remove two piston rings (Figure 12-3, 22) from the rear end of the clutch shaft.
3. Remove roller bearing (21) inner race using guillotine-type puller. See Figure 8-1.

CAUTION

Be sure the puller is under the inner cone of the race.

4. Lift clutch hub and pinion assembly (Figure 12-3, 15) and remove steel thrust washers (18 and 20) and needle thrust bearing (19). See Figure 8-2.

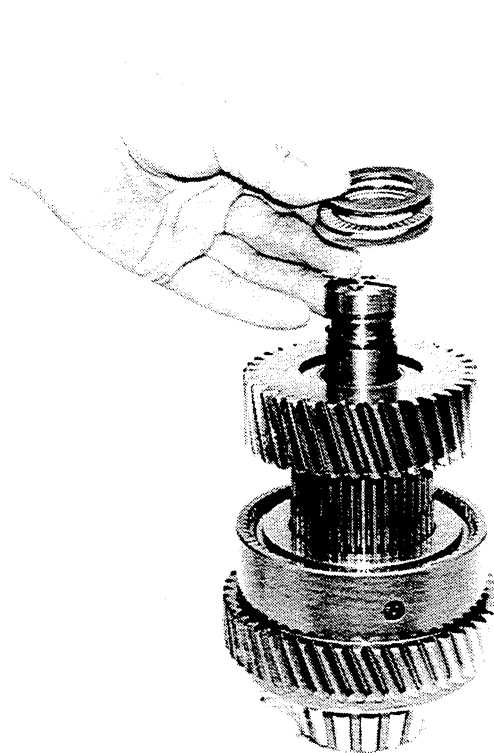


Figure 8-2. *Removing or Installing the Rear Thrust Bearing, Spacer and Washer from the Reverse Clutch Shaft.*

5. Remove the clutch hub and pinion assembly. See Figure 8-3.

6. Remove steel thrust washers (Figure 12-3, 12 and 14) and needle thrust bearing (13). See Figure 8-4.

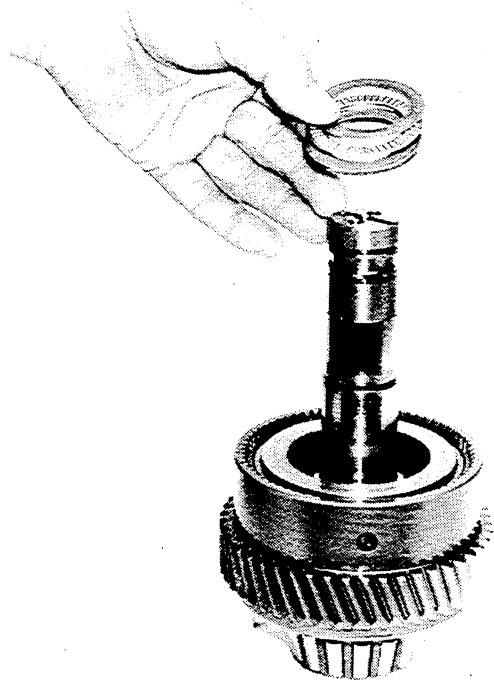


Figure 8-3. *Removing or Installing the Clutch Hub and Pinion Assembly.*

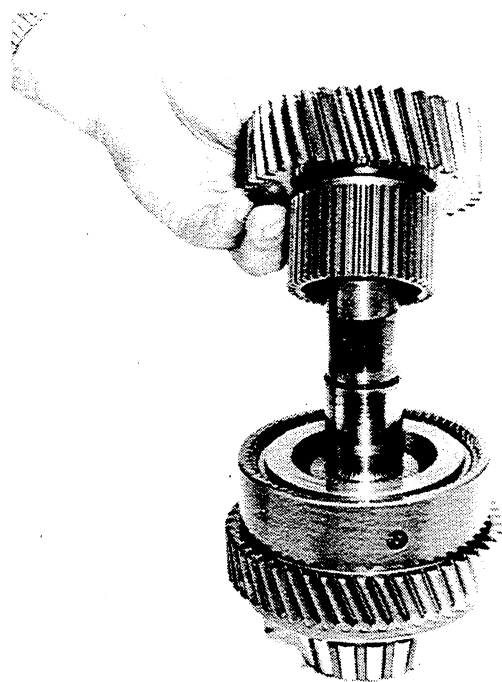


Figure 8-4. *Removing or Installing the Front Thrust Bearing, Spacer and Washer from the Reverse Clutch Shaft.*

7. Remove internal snap ring (Figure 12-3, 9). See Figure 8-5.

8. Remove back plate (Figure 12-3, 8), faced clutch plates (7), and steel clutch plates (6). See Figure 8-6.

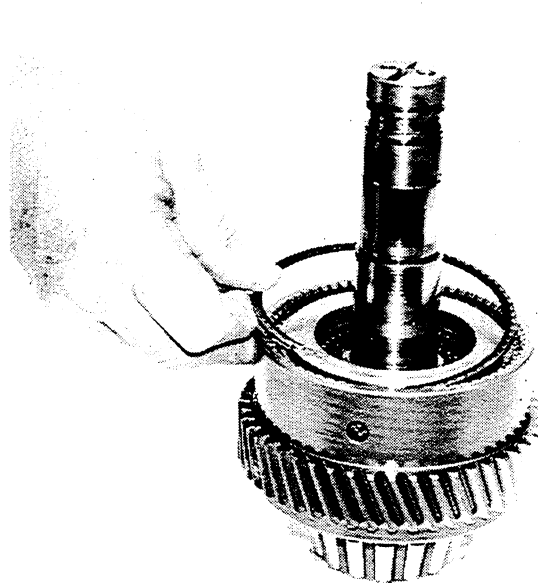


Figure 8-5. *Removing or Installing the Internal Retaining Snap Ring on the Housing Gear.*

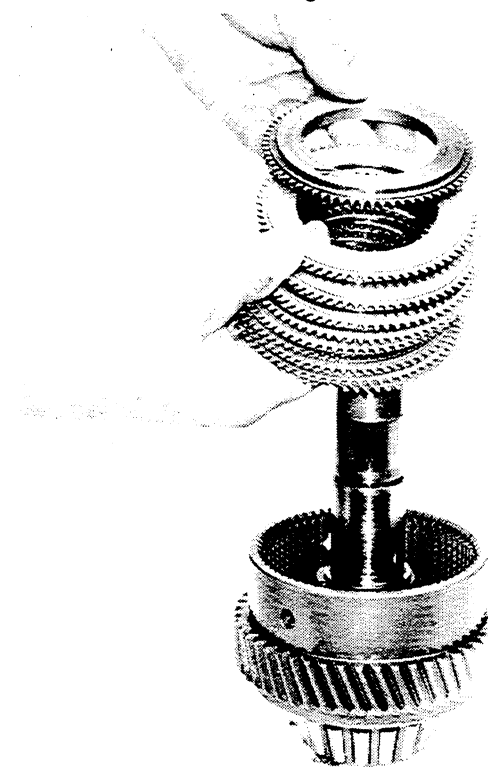


Figure 8-6. *Removing or Installing Clutch Plates and Back Plate on Reverse Housing Gear.*

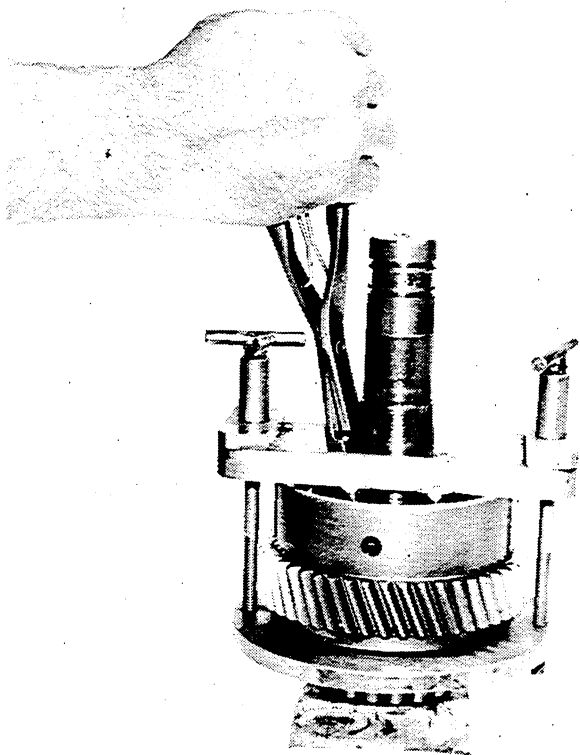


Figure 8-7. *Compressing Clutch Piston Return Spring and Removing External Retaining Snap Ring.*

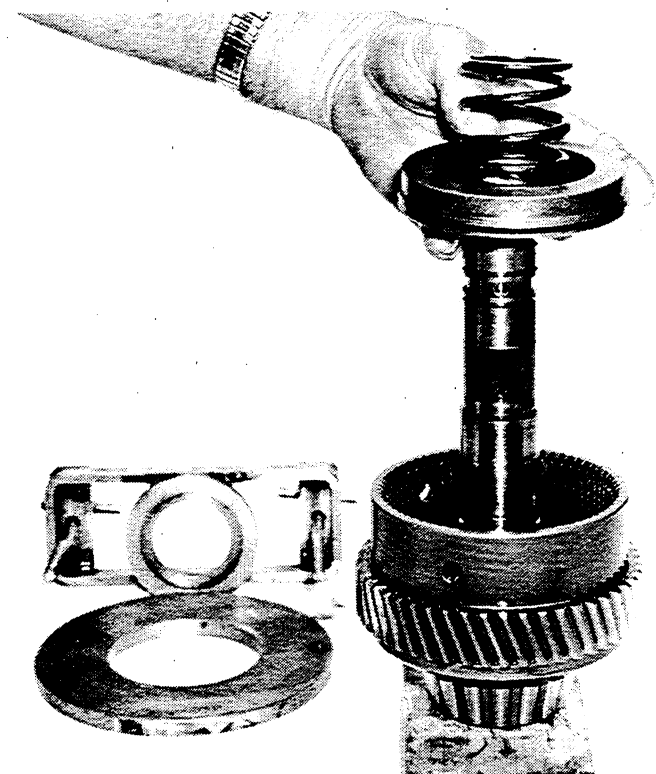


Figure 8-8. *Removing or Installing Clutch Piston and Return Spring.*

9. Compress the clutch return spring (Figure 12-3, 10) with special tool T-16752 and remove external snap ring (11). See Figure 8-7.

10. Remove the clutch piston (Figure 12-3, 3) and piston return spring (10). See Figure 8-8.

CAUTION

Do not remove front roller bearing (Figure 12-3, 1) inner race unless it is damaged or worn. The bearing is destroyed during removal.

11. If necessary, cut the bearing (1) cage and remove the cage and rollers.

12. Grip onto the lip on the inner race with a puller and remove the inner race.

CAUTION

Do not attempt to remove the clutch housing gear (2) from clutch shaft assembly (17). These items are not serviced separately.

Cleaning and Inspection.

See Section 7.

Assembly.

1. Install a new piston ring (Figure 12-3, 5) on clutch shaft (17).

2. Install a new piston ring (4) onto the clutch piston (3) and install the clutch piston.

3. Install piston return spring (10). See Figure 8-8.

4. Use special tool T-16752 to compress the spring and install external snap ring (Figure 12-3, 11). See Figure 8-7.

5. Install clutch plates (Figure 12-3, 6 and 7). Begin with a driving (sintered) plate and alternate with a driven (steel) plate.

6. Install the back plate (8). See Figure 8-6.

7. Install internal snap ring (Figure 12-3, 9). See Figure 8-5.

8. Install thrust washer (Figure 12-3, 12), needle thrust bearing (13), and thrust washer (14) in that order. See Figure 8-4.

9. Install clutch hub and pinion assembly (Figure 12-3, 15). See Figure 8-3.

10. Install steel thrust washer (Figure 12-3, 18), needle thrust bearing (19), and steel thrust washer (20), in that order. See Figure 8-2.

11. Install heated inner races of tapered roller bearings (Figure 12-3, 1 and 21).

12. Install two piston rings (22) into the grooves provided on the rear of the clutch shaft (17).

REVERSE CLUTCH.

Repeat the above procedure to disassemble and assemble the reverse clutch.

OUTPUT GROUP OF PARTS.

Disassembly.

1. Support the output group on the output gear (Figure 12-2, 20) in a press with the rear end of the output shaft up. Press the output shaft out of the output gear (2) and roller bearing (21) inner race.

NOTE

Do not remove front roller bearing (17) inner race on units with 2.96:1 and 2.50:1 ratios unless the bearing is worn or damaged. The bearing is destroyed in removal.

2. To remove roller bearing (17) inner race, cut the cage and remove the rollers.

3. Grip onto the lip on the inner race with a puller and remove the inner race.

4. For units with ratios of 1.20:1, 1.50:1 and 1.97:1, use special tool T-12127 and an arbor press to press the shaft out of the bearing (17) inner race.

Cleaning and Inspection.

See Section 7.

Assembly.

1. Install heated roller bearing (Figure 12-2, 17) inner race onto the front of output shaft (19) and seat it against the shoulder on the shaft.

2. Install output shaft key (18).

3. Install output gear (20) and hand press it onto the output shaft.

4. Install heated bearing (21) inner race onto the rear of the output shaft.

NOTE

Assembly of the rest of the output group is given in Section 9.

INPUT SHAFT GROUP.

Disassembly.

1. Place the input group in a press with the front end down and the weight resting on the input gear. (Figure 12-2, 15).

2. Press the input shaft (11) out of the input gear (15) and roller bearing (16) inner race.

3. Turn the shaft over and support it on roller bearing (9) inner race and press out the shaft.

4. Remove keys (10 and 12).

Cleaning and Inspection.

See Section 7.

Assembly.

1. Install key (Figure 12-2, 12).

2. Heat input gear (15) for no more than thirty minutes in a 275° F. oven and install the gear onto the input shaft.

3. Install the heated inner races of roller bearings (9 and 17) and seat the front race against the shoulder and the rear race against the input gear.

SELECTOR VALVE.

Disassembly.

1. Remove capscrews (Figure 12-1, 33), cover (32), and gasket (31).

2. Loosen hex-nut (20) and remove shift lever (19).

3. Remove capscrews (18) and detent plate (21).

4. Remove valve spool (23), regulator piston (24) outer spring (25), inner spring (26), and shim (27).

5. Remove O-ring (22) from valve spool (23).

6. Remove pipe plug (28).

Cleaning and Inspection.

See Section 7.

Assembly.

1. Install pipe plug (Figure 12-1, 28).

2. Install O-ring (22) onto valve spool (23).

3. Install valve spool (23), regulator piston (24), outer spring (25), inner spring (26), and shim (27) into the valve body (29).

4. Install detent plate (21) and secure it with capscrews (18). Torque the capscrews 15 ± 2 lbs. ft.

5. Install shift lever (19) and tighten hex nut (20) to 7 ± 1 lbs. ft.

Section 9.

UNIT ASSEMBLY AND INSTALLATION

NOTE

In the discussion that follows, the input side of the transmission is the front, and the output side is the rear. Right and left sides are determined by facing the output end.

NOTE

Oiled torque values are used throughout; therefore, oil all capscrews before installing.

ASSEMBLY OF SUBASSEMBLIES.

Installing Forward and Reverse Clutches and Output Group.

1. Install the outer races of roller bearings (Figure 12-2, 17; 12-3, 1; and 12-4, 1) into main housing (Figure 12-1, 2).
2. Install the forward and reverse clutch groups and output group. See Figures 6-9, 6-10, and 6-11.
3. Install outer races of roller bearings (Figure 12-2, 21; 12-3, 21; and 12-4, 21) into the rear cover (Figure 12-1, 14).
4. Install gasket (13) and rear cover (14) onto main housing (2).

NOTE

The main housing and rear cover are matched when machining and, therefore, not serviced separately.

5. Secure the rear cover with capscrews (15 and 49). Figure 6-8 shows the cover being removed. Torque the capscrews 65 ± 5 lbs. ft.

Output Shaft Endplay Adjustment.

1. Install bearing retainer (Figure 12-2, 23) and secure it with capscrews (24) tightened finger tight.
2. Apply forward pressure on the output shaft (19) and rotate the shaft several revolutions in each direction.

3. Tighten capscrews (24) finger tight again and then measure with a taper gauge the space between bearing retainer (23) and rear cover (Figure 12-1, 14). See Figure 9-1. Make up a shim pack (Figure 12-2, 22) equal to the measured space plus 0.005 inch.

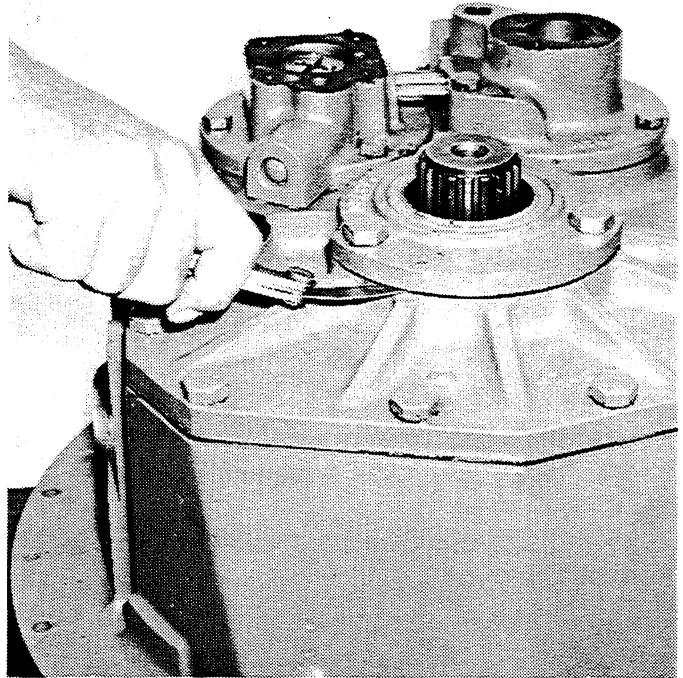


Figure 9-1. Measuring Shim Space Between Output Bearing Retainer and Rear Cover.

4. Install the shim pack (22) and bearing retainer (23) (see Figure 6-7) and secure them with capscrews (Figure 12-2, 24). Torque the capscrews 65 ± 5 lbs. ft.
5. Install an eyebolt into the rear end of the output shaft.
6. Apply 60 to 100 lbs. downward pressure on the output shaft while rotating it several revolutions in each direction.
7. Install a dial indicator with the tip resting on the end of the output shaft. Mark with a felt marker the spot where the tip is resting. Zero the indicator.
8. Use a fish scale and hoist to apply 60 to 100 lbs. upward pressure on the output shaft and rotate it

several revolutions in each direction. Stop with the indicator tip resting on the marked spot. The indicator reading is the end play.

9. Add or remove shims as necessary to adjust the endplay to 0.001 to 0.004 inch.

10. Use special tool T-11684 to install oil seal (Figure 12-2, 25) into the rear of bearing retainer (23) with the lip on the oil seal toward the oil being retained.

11. Apply anaerobic plastic sealant as follows:

a. For previously sealed joints, scrape surfaces to remove old plastic sealant. Gel-type paint remover containing methylene chloride may be used to wipe off cured sealant.

b. Clean surfaces of rear cover (Figure 12-1, 14), shims (Figure 12-2, 22) and bearing retainer (23) with 1,1,1-trichloroethane to remove all oil and grease residue.

c. Use Twin Disc primer MA579 (LOCQUIC T) or equivalent on both mating surfaces. Allow the primer to dry. This usually takes three to four minutes.

d. Keep surfaces clean and free of oil and grease from this point on.

e. Apply a thin layer of LOCTITE NO. 49[®] on both sides of each shim (22).

12. Install shim pack (22) and bearing retainer (23) and secure with capscrews (24). Torque the capscrews 65 ± 5 lbs. ft.

Reverse Clutch Shaft End Play Adjustment.

1. Apply 60 to 100 lbs. downward (forward) pressure onto the reverse clutch shaft while rotating the shaft several revolutions in each direction.

2. Install pump mount (Figure 12-1, 39) without shims (38) and secure the mount with capscrews (40) tightened finger tight.

3. Use a taper gauge to measure the space between the pump mount (39) and the front cover (14). See Figure 9-2.

4. Make up a shim pack (Figure 12-1, 38) equal to the measurement and add .005.

5. Install the shim pack (See Figure 9-3) under the pump mount (Figure 12-1, 39) and secure with capscrews (40). Torque the capscrews 27 ± 2 lbs. ft.

6. Install an eyebolt into the threaded hole in the rear end of the reverse clutch shaft. See Figure 9-4.

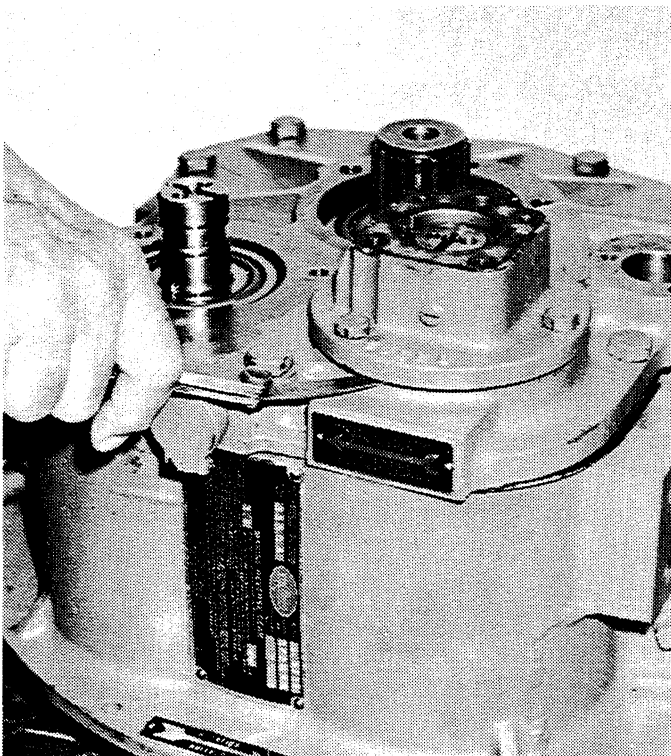


Figure 9-2. Measuring Shim Space Between Pump Mount and the Rear Cover.

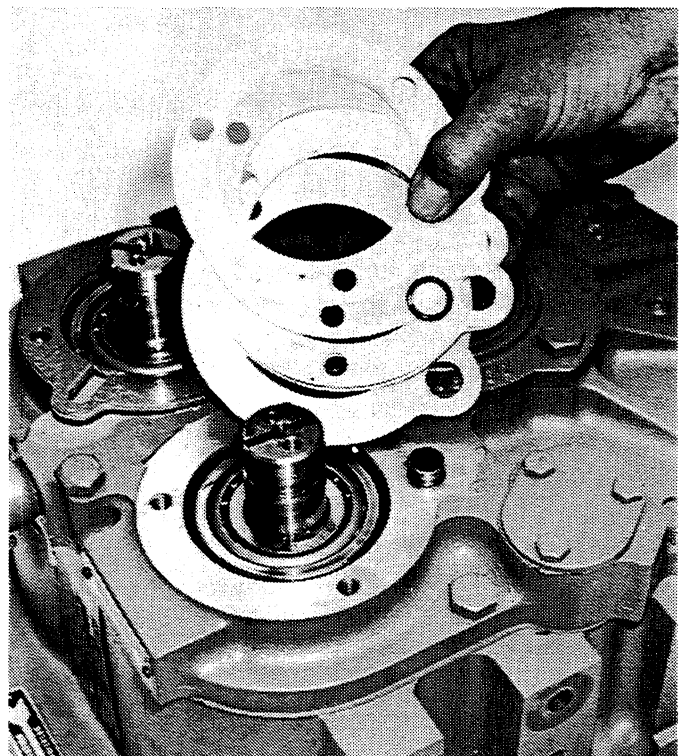


Figure 9-3. Pump Mount Shims and O-Ring Seal.

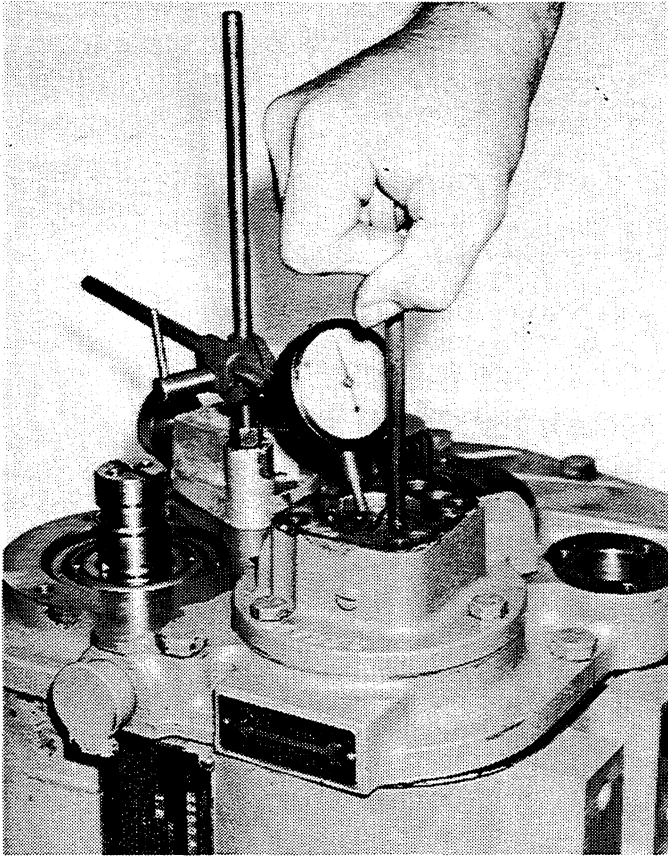


Figure 9-4. Applying Pushing Force While Checking Reverse Clutch Shaft End Play.

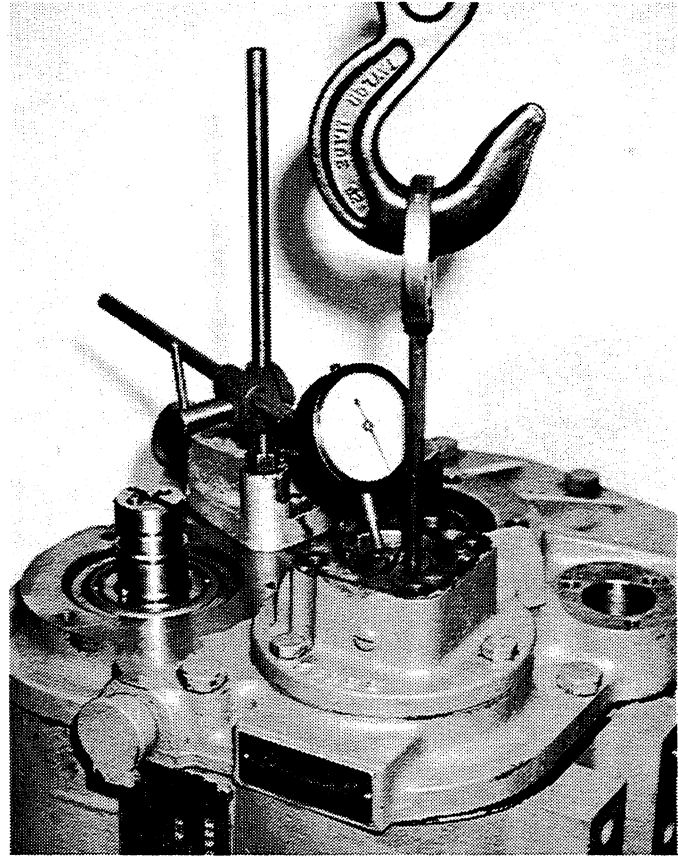


Figure 9-5. Applying Pulling Force While Checking Reverse Clutch Shaft End Play.

7. Install an indicator with the tip resting on the clutch shaft. Mark with a felt marker the spot where the indicator tip is resting and zero the indicator.

8. Use a hoist and fish scale to apply 60 to 100 lbs. upward (rearward) pressure and rotate the reverse clutch shaft (by turning the output shaft) several revolutions in each direction. See Figure 9-5. Stop with the tip resting on the marked spot. The indicator reading is the end play.

9. Add or remove shims (Figure 12-1, 38) to adjust the endplay to 0.003 to 0.006 inch.

NOTE

Due to connector tubes (36) the pump mount and the main regulator valve body (29) must be installed at the same time. Therefore, the endplay of the forward clutch must be checked before the pump mount is installed.

Forward Clutch Shaft End Play Adjustment.

1. Follow the procedure given above for the reverse clutch with the following exceptions:

2. Shim under the main regulator valve body (Figure 12-1, 29) on the forward clutch shaft (Figure 12-3, 17).

3. Cover (32) must be removed to get access to the forward clutch shaft to install the eyebolt.

4. After the shim pack size has been determined for the forward clutch shaft, clean all mating surfaces and apply anaerobic plastic sealant as described for the output shaft above.

5. With anaerobic plastic sealant applied to shims for both the forward and reverse clutch shafts, install the shim packs for both shafts.

6. Install O-rings (Figure 12-1, 35 and 37) onto connector tubes (36).

7. Install connector tubes (36) into their bores in pump mount (39) and main regulator valve body (29).

8. Install O-ring (48) over the protruding connector tube on the rear of the rear cover (14).

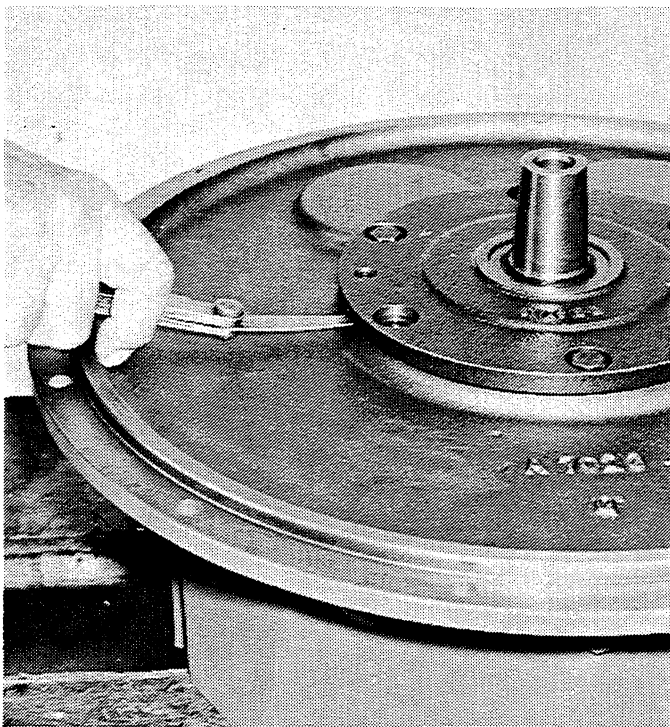


Figure 9-6. Measuring Shim Space Between Support and Housing.

9. Install pump mount (39) and main regulator valve body (29) at the same time. See Figure 6-6.

10. Secure the pump mount (39) with capscrews (40) and the main regulator valve body with capscrews (30 and 34). Torque the capscrews 27 ± 2 lbs. ft.

11. Install filter screen (47), gasket (46), and cover (45). See Figure 6-4. Secure with capscrews (Figure 12-1, 44). Torque the capscrews 15 ± 2 lbs. ft.

Installing Input Shaft.

1. Turn the unit on the working surface so that the front (input) side is up.

2. Install the outer race of rear roller bearings (Figure 12-2, 16) into its bore in the housing.

3. Install the input shaft group. See Figure 6-3.

4. Install outer race of front roller bearing (Figure 12-2, 9) into its bore in the bearing support (7).

5. Install bearing support (7) without shims (8) or oil seal (6).

6. Secure bearing support (7) with capscrews (13) tightened finger tight.

Adjusting End Play of Input Shaft.

1. Measure with a taper gauge the space between the bearing support (7) and main housing (Figure 12-1, 2). See Figure 9-6.

2. Make up a shim pack (Figure 12-2, 8) (see Figure 9-7) equal to the space measured plus 0.005 inch.

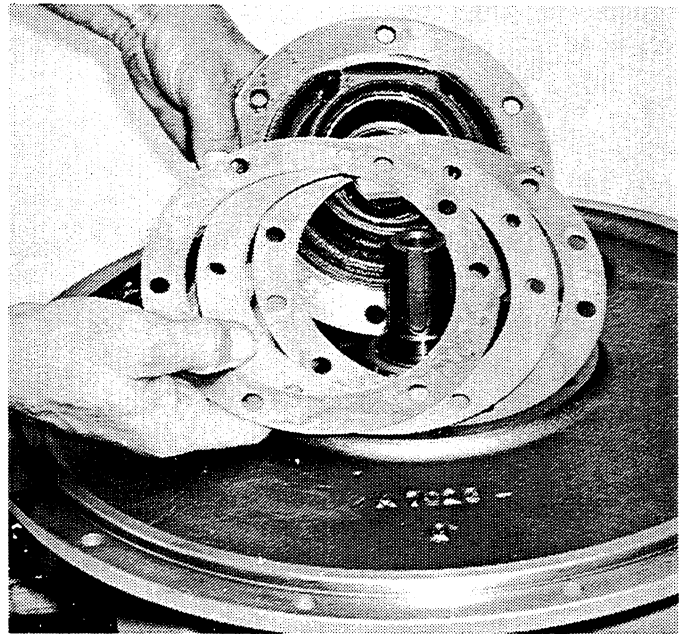


Figure 9-7. Installing Shims and Input Bearing Support.

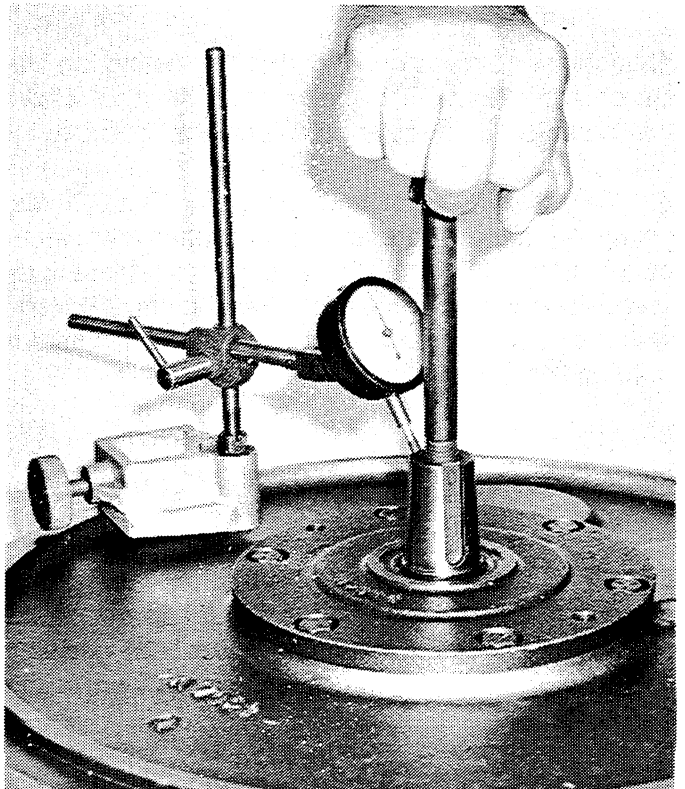


Figure 9-8. Applying Pushing Force While Dial Indicating End Play of Input Shaft.

3. Install the shim pack under the bearing support (Figure 12-2, 7) and secure with capscrews (13). Torque the capscrews 27 ± 2 lbs. ft.

4. Install an eyebolt into the front of the input shaft and apply 60-100 lbs. downward pressure while rotating the input shaft several revolutions in each direction. See Figure 9-8.

5. Install a dial indicator with the tip resting on the front end of the input shaft.

6. Use a fish scale and hoist to apply 60-100 lbs. forward (upward) pressure on the input shaft. See Figure 9-9.



Figure 9-9. *Applying Pulling Force While Dial Indicating End Play of Input Shaft.*

7. Zero the indicator and place a felt pen mark on the input shaft where the indicator is resting.

8. Rotate the input shaft several revolutions in each direction and stop with the indicator tip resting on the marked spot.

9. The indicator reading is the input shaft endplay.

10. Add or remove shims to adjust the end play to 0.001 to 0.004 inch.

11. Remove the bearing support (7) and shims (8).

12. Clean all shims and mating surfaces and apply anaerobic plastic sealant to shims and mating surfaces following the procedure given above for the output shaft shims.

13. Use special tool T-12126 to install oil seal (6) into bearing support (7) with the lip on the seal toward the oil being retained.

14. Install the shim pack and bearing support. Secure with capscrews (13). Torque the capscrews 27 ± 2 lbs. ft.

Miscellaneous External Parts.

1. Install drain plug (Figure 12-1, 50) and O-ring (51). Tighten snugly.

2. Install oil level gauge tube (6) if removed, and oil level gauge (5).

3. Install oil fillter and breather (12).

4. Install gasket (41) and oil pump assembly (43) aligning the tang on the pump shaft with the slot in the reverse clutch shaft. See Figure 9-10. Secure with capscrews (Figure 12-1, 42). Torque the capscrews 15 ± 2 lbs. ft.

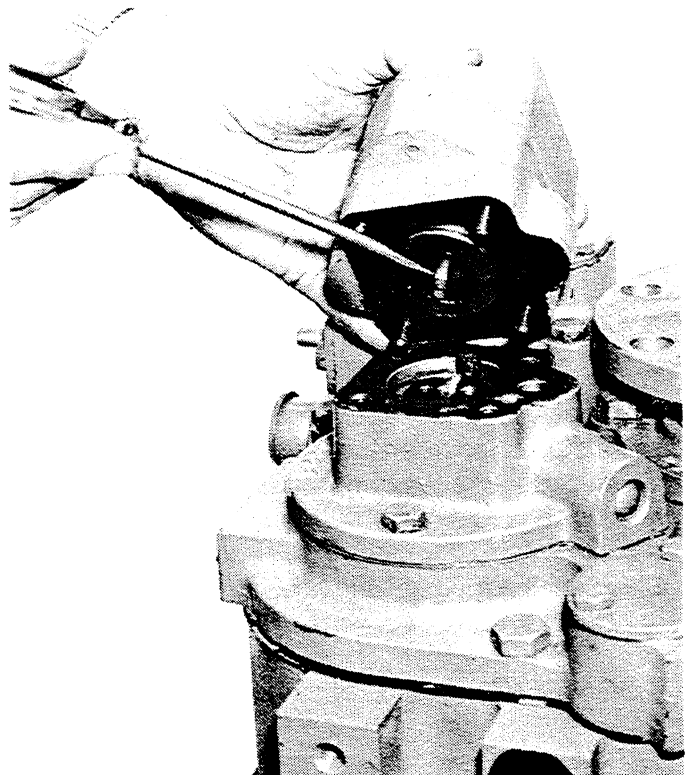


Figure 9-10. *Installing Oil Pump with Care to Align Drive Tang.*

5. Install the output flange (Figure 12-2, 26), lathe-cut seal ring (27), and retainer washer (28). Secure with capscrew (29). Torque the capscrew 130 ± 10 lbs. ft.

6. Install rubber blocks (4) onto drive spider (5).

7. Install input shaft key (10) and drive spider (5). Secure with retainer washer (2) and capscrew (1). Torque the capscrew 130 ± 10 lbs. ft.

PRIOR TO INSTALLATION.

CAUTION

Most Twin Disc products mount directly onto the flywheel of the engine. Flywheel-to-driven component interference is possible due to mismatch of components or other reasons. Therefore, engine crankshaft endplay as well as flywheel alignment checks must be made before the driven component is installed.

After installation of the driven component, crankshaft endplay should be measured again. Endplay at the second measurement should be the same as the first. A difference in these two endplay measurements could be an indication of interference. Consequently, the driven component should be removed and the source of interference found and corrected.

Twin Disc will not be responsible for system damage caused by engine to Twin Disc component interference regardless of the cause of interference. This engine crankshaft endplay check is considered mandatory.

General.

The transmission front housing flange and pilot, and the engine flywheel and the flywheel housing must be checked for trueness. Make certain the engine flywheel and the flywheel housing are clean prior to making the tests.

Clean engine flywheel and housing thoroughly before check.

ALIGNMENT.—(Also reference SAE J-1033)

1. Bolt a thousandths increment dial indicator or gauge to the engine flywheel so that the indicator is perpendicular to the face of the engine flywheel

housing, and the indicator stem is riding on the face of the flange. See Figure 9-11.

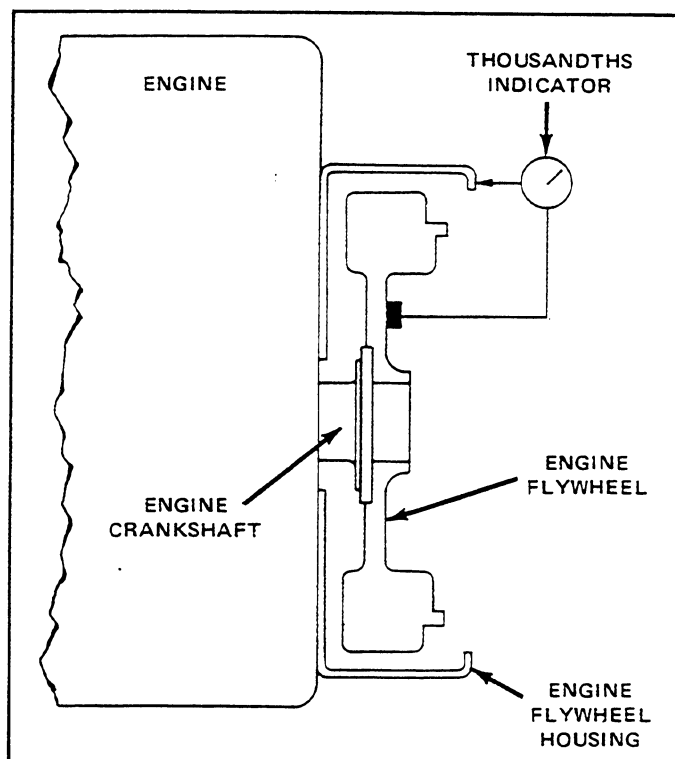


Figure 9-11. Checking the Race of Engine Flywheel Housing.

All figures are total indicator readings.

TABLE No. 1 - FLYWHEEL HOUSING TOLERANCES		
SAE Housing No.	Face Deviations	Bore Eccentricity
00	.012	.012
0	.010	.010
½	.010	.010
1	.008	.008
2	.008	.008
3	.008	.008
4	.006	.006
5	.006	.006
6	.006	.006

Table 9-1. Flywheel Housing Tolerances.

2. Rotate the engine flywheel, always keeping a thrust in the same direction, and note the face deviation of the engine flywheel housing flange. The face deviation must not exceed the figures given in Table 9-1.

3. With the indicator mounted as in the above paragraph, adjust the indicator stem so that it will ride on the bore of the engine flywheel housing. See Figure 9-12.

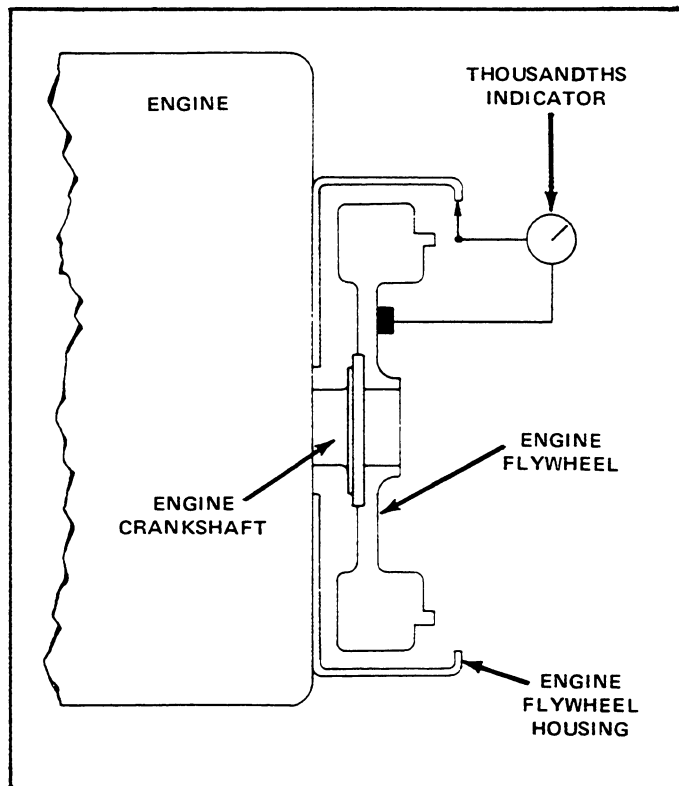


Figure 9-12. Checking the Bore of Engine Flywheel Housing.

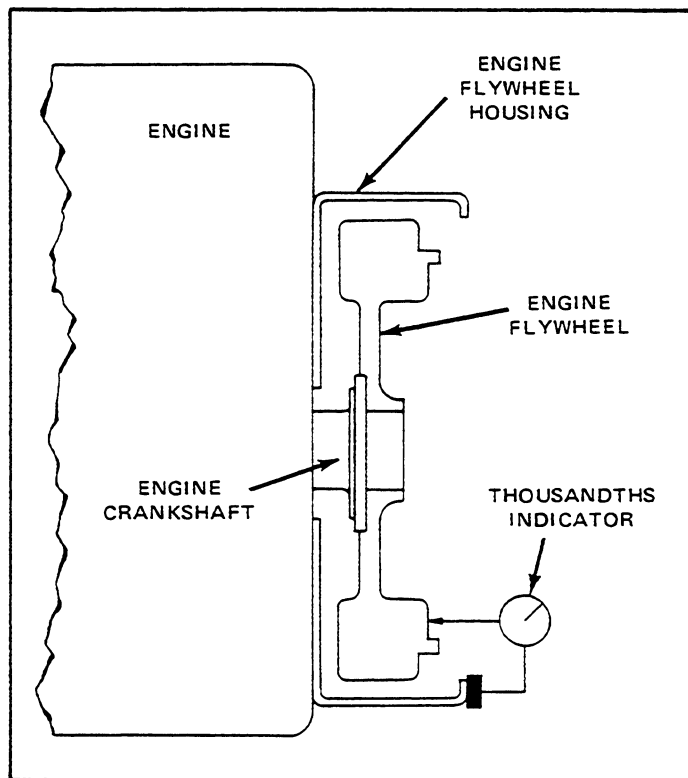


Figure 9-13. Checking the Driving Ring Surface of Engine Flywheel.

4. Rotate the engine flywheel and note the bore eccentricity of the engine flywheel housing bore. See Table 9-1 for allowable tolerances.

5. Bolt a thousandths dial indicator or gauge to the engine flywheel housing so that the indicator is perpendicular to the engine flywheel, and the indicator stem is riding on the inner face of the flywheel. See Figure 9-13. Rotate the flywheel. The variation of the face runout of the surface to which the driving ring is bolted should not exceed 0.0005 per inch of diameter.

6. With the indicator mounted as in the paragraph above, adjust the indicator stem so that it will ride on the driving ring pilot bore of the engine flywheel. See Figure 9-14. Rotate the flywheel. The driving ring pilot bore eccentricity of the engine flywheel should not exceed 0.005 inch maximum total indicator reading. Thrust on the flywheel should be in one direction at all times to obtain a correct reading.

7. Readjust the indicator so that the stem will ride on the pilot bearing bore of the flywheel. See Figure 9-15. Rotate the flywheel. The eccentricity of the pilot bearing bore should not exceed 0.005 maximum total indicator reading. Eccentricity between the driv-

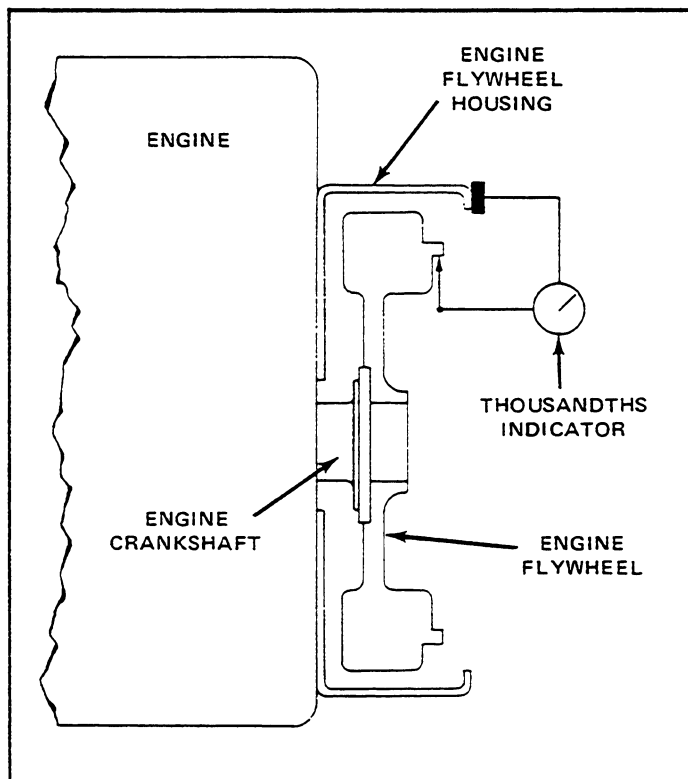


Figure 9-14. Checking the Driving Ring Pilot Bore of Engine Flywheel.

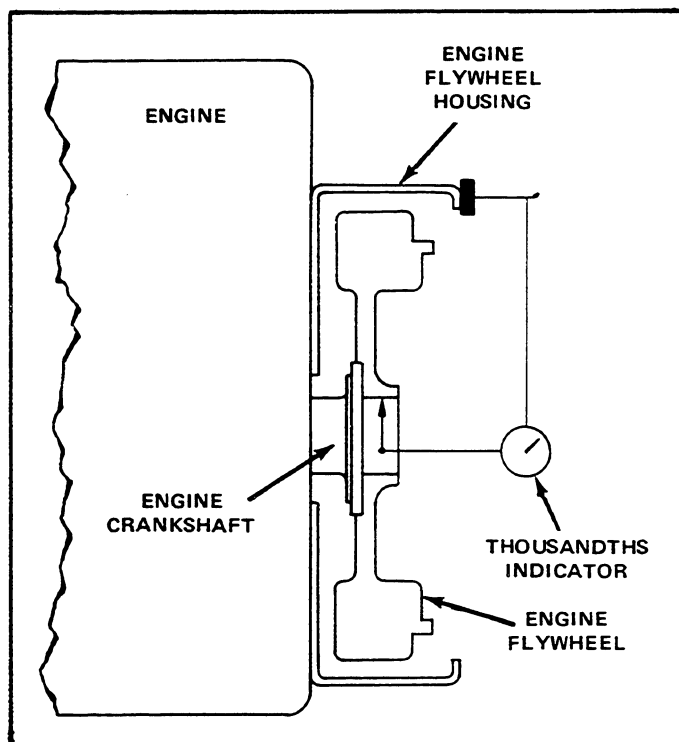


Figure 9-15. Checking Pilot Bearing Bore of Engine Flywheel.

ing ring pilot bore (Figure 9-14) and pilot bearing bore (Figure 9-15) should not exceed 0.008 inch total indicator reading.

INSTALLATION.

Alignment.

Proper alignment of an engine and marine unit is critical...both during the initial installation and at frequent intervals during the life of the boat. It is rather common for a boat to change its form with various loads and with age. A bend is actually formed in the keel which changes the original engine and shaft alignment. The following steps may be taken to secure proper marine transmission alignment.

NOTE

The transmission output flange and companion flange are match reamed. Therefore, the index mark that was made on these flanges during disassembly must be aligned.

Propeller Shaft Installation.

1. A wire is run through the shaft log and secured to a brace near the engine bed, giving the wire a position equivalent to the shaft centerline.

2. The stern bearing and stuffing box are installed and bolted into position with the wire passing through each in the exact center of the bore. With the bearing and stuffing box in place, the wire is then removed.

3. The propeller shaft is then installed in its proper position.

4. If an intermediate shaft is used, it is blocked into position and its coupling is aligned with the propeller shaft coupling (see the following section — "Engine and Marine Transmission Alignment"). If there is an intermediate bearing in the line, this is installed and positioned with shims during the alignment process.

5. If a light shaft is used without an intermediate bearing, the shaft must be centered and supported to take out the droop while alignment of the flange couplings is being made.

Engine and Marine Transmission Alignment to Propeller Shaft. see Figure 9-16.

1. It is important to align the engine and transmission, only when the boat is afloat, and NOT in dry-dock. During this alignment period, it is also advisable to fill the fuel tanks and add any other ballast that will be used when the boat is in service. With the engine and transmission in position on the engine bed, arrangements must be made to have a controlled lifting or lowering of each of the four corners of the engine. If threaded holes are provided in each of the engine mounts, jacking screws can be used in them. The engine can be raised by screwing down, or lowered by backing off the desired amount. Steel plates must be inserted under the jacking screws so that the bolts will not damage the engine bed. Lifting can also be accomplished by the use of chain hoists or properly placed jacks. Adjustable shims also are available and can simplify the whole problem, particularly for future realignment.

2. It will also be necessary to move the engine and transmission from one side or the other on the bed to obtain horizontal alignment. This can be done with a jack placed horizontally between the engine and the foundation. At the same time, a straight edge is laid across the edges of the flanges at the top and side to check the parallel alignment of the coupling edges. See Figure 9-17.

3. As the engine and marine transmission come into their aligned position, it will be possible to match the output flange and propeller coupling, and prepare for

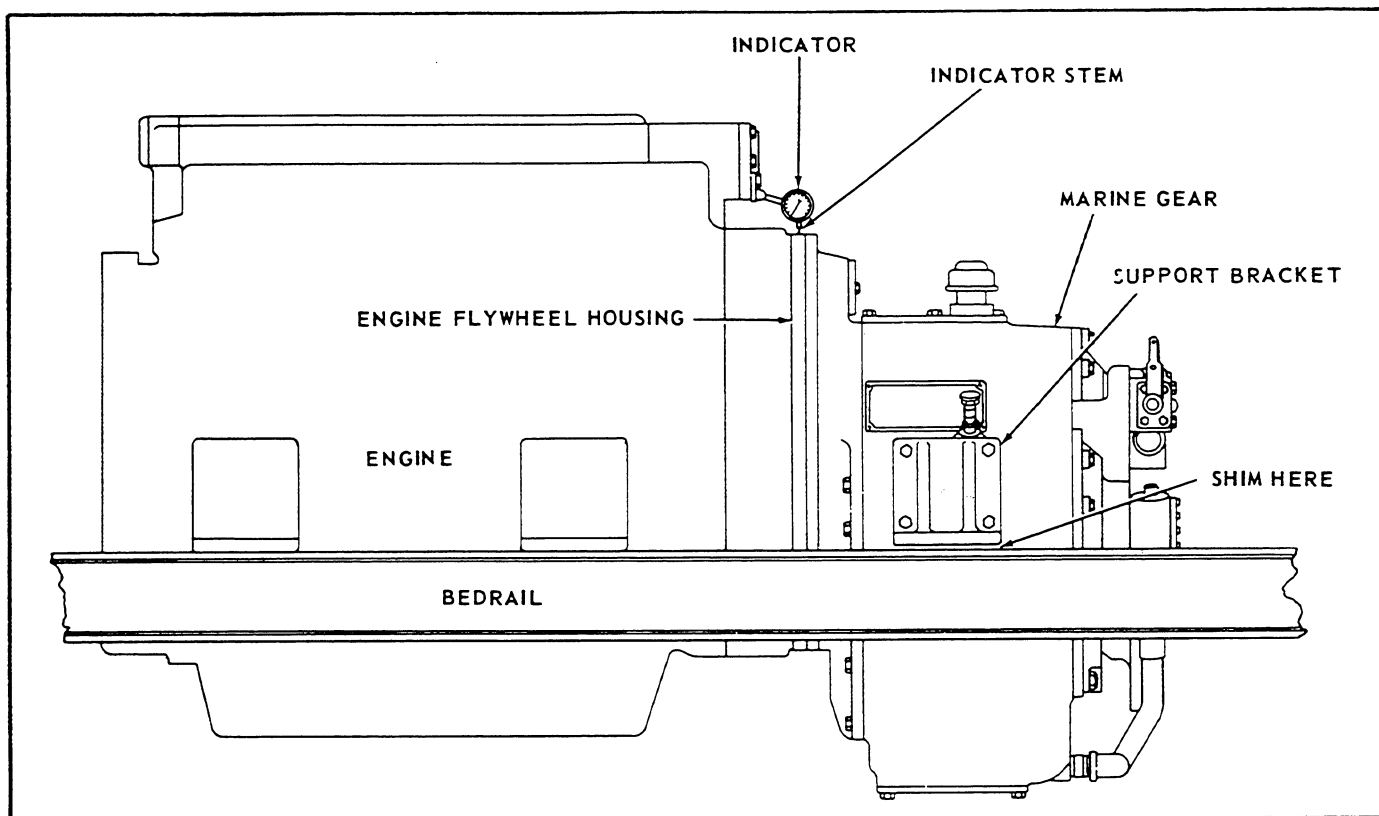


Figure 9-16. *Alignment of Engine and Marine Transmission — Schematic View.*

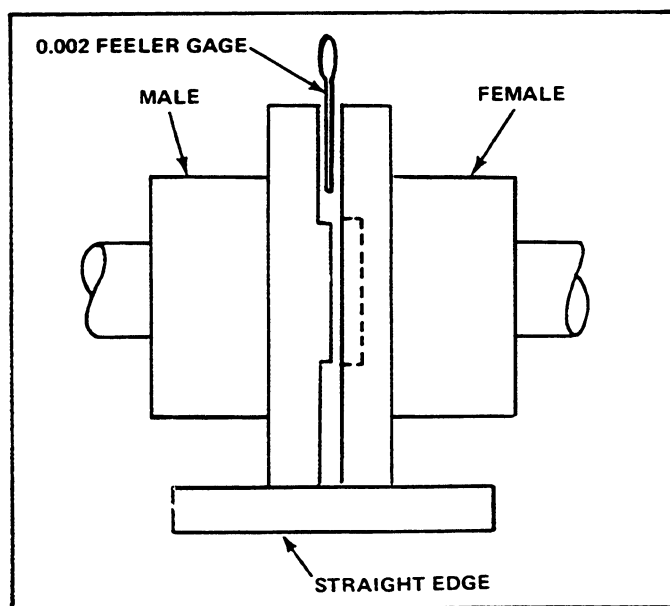


Figure 9-17. *Checking Alignment (Parallelism) of Coupling and Propeller Flanges.*

bolting together. Care should be taken not to burr or mar this connection because the fit is very critical. Place a 0.002-inch feeler gauge between the flanges of the coupling. The feeler gauge is moved (slid) completely around the coupling.

4. Then the marine transmission flange coupling is rotated 90, 180 and 270 degrees with the feeler blade being moved around the flange again in each successive position. If the alignment is correct, the feeler gauge will fit snugly, with the same tension, all around the flange coupling.

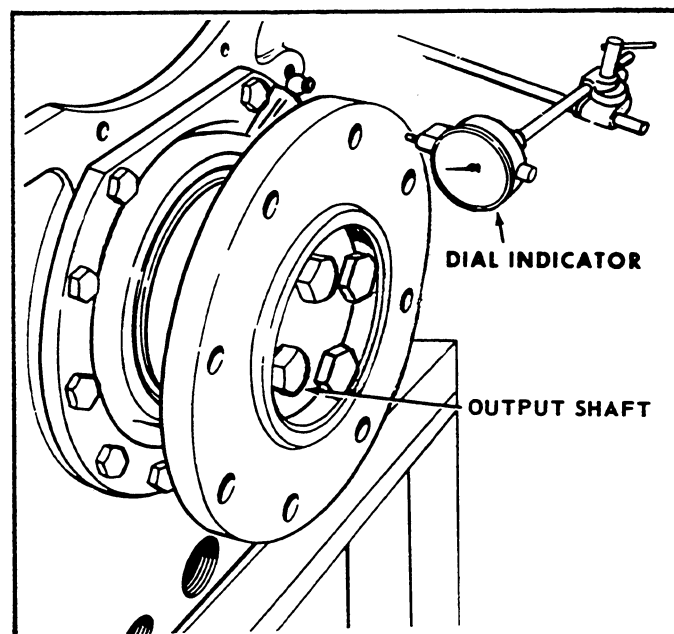


Figure 9-18. *Checking Race Runout of Output Flange.*

5. If the alignment varies during rotation, then further alignment is necessary, or the marine transmission and shaft couplings should be checked for improper face runout. See Figure 9-18 and 9-19. Runout must not exceed 0.004-inch. Face runout on the marine transmission output flange can usually be corrected by repositioning the coupling on its spline.

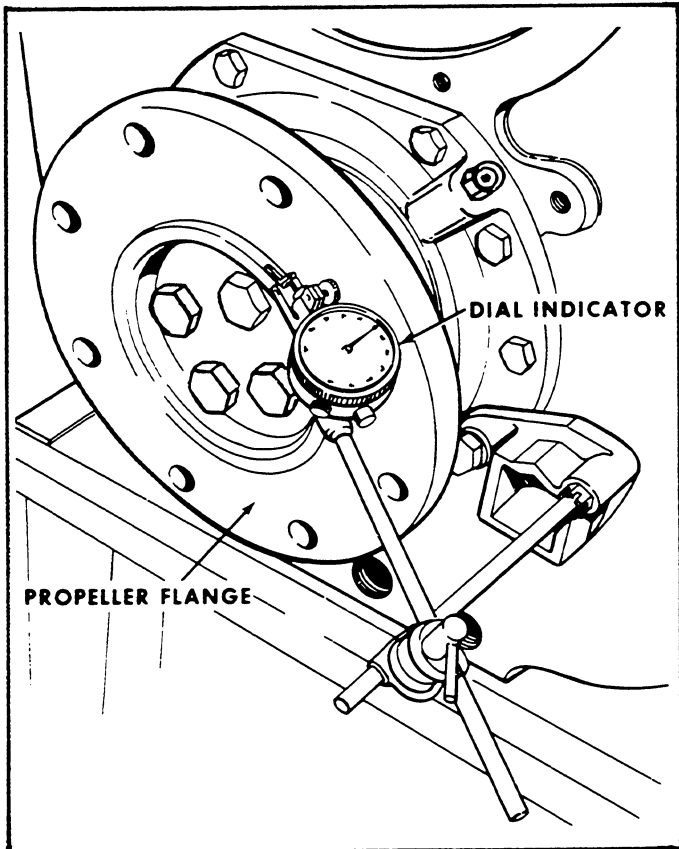


Figure 9-19. Checking Pilot Runout of Output Flange.

Shaft coupling runout is usually due to inaccuracy of taper fit or key interference.

6. Some boats are not structurally rigid and some carry their load in such a way that they will “hog” or go out of normal shape with every loading and unloading. Where this condition exists, it may be necessary to make a compromise between the top and bottom coupling clearance by leaving a greater clearance at the bottom of the marine transmission output flange and propeller coupling. This clearance might be 0.005 to 0.007-inch while the top would maintain the standard 0.002-inch.

7. During the process of securing final alignment, it may be necessary to shift the engine many times. When it becomes apparent that the alignment is reasonably close, the holes for the lag studs are marked and drilled. Then with final alignment

secured, the necessary steel or hardwood shims are made up and the engine and transmission is fastened in place. The alignment is then rechecked, and if satisfactory, the coupling is bolted together.

8. Although it is not necessary to align a flexible coupling as accurately as a solid coupling, the closer it is in the initial alignment, the more vibration-free it will be. The most accurate method of alignment is to align the shaft on to the marine transmission with flexible coupling out of the system. This can be done with a spacer the same size as the coupling but not flexible in nature. Flexible couplings are used only for noise and vibration dampening...and not to correct inadequate alignment.

9. When a heavy boat is dry-docked, it naturally undergoes some bending. Therefore, it is always good practice to unbolt the marine transmission coupling and prevent bending of the shaft.

CAUTION

Be sure the transmission is filled with oil before starting. See Section 4 for proper oil and filling procedure.

WARNING

Transmission controls must be checked for proper function and alignment after any transmission installation or maintenance procedure to assure that the transmission selector valve is properly indexed in relation to the operator's control lever. Failure to do so could cause control system malfunction, resulting in personal injury and/or damage to equipment and property.

For mechanical controls: Movement of the Operator's selector lever to forward, neutral or reverse must position the transmission selector valve in the forward, neutral or reverse detents.

Power operated controls: Selector valve positioning devices must be installed so that full travel of the actuating cylinder places the transmission selector valve in the detent position for forward or reverse, as selected, without exerting pressure on the rotational stop collar on the selector valve stem. Selection of neutral must place the selector valve in the neutral detent position. Improper installation of power engaging devices could cause failure of the selector valve rotational stop collar permitting improper positioning of the selector valve with resultant control malfunction.

WARNING

See specific marine transmission installation drawings for detail and dimensional information needed for proper installation of power engaging devices.

Section 10.

ACCESSORIES AND OPTIONAL EQUIPMENT

TROLLING VALVE.

GENERAL.

A trolling valve is offered as optional equipment. Also, an after sale and installation, trolling valve kit is available for field installation. An oil filter (less hoses) is supplied with the trolling valve for field installation. The trolling valve groups are available for units with 300-320 psi or 350-370 psi applications. See Planograph.

INSTALLATION. (Field)

SELECTOR VALVE.

1. Remove the selector valve (refer to figure 48) assembly and pump mount. Remove the pump outlet to heat exchanger inlet oil line at the pump outlet only. Then remove heat exchanger outlet to valve inlet oil line from selector valve assembly, high pressure inlet only.
2. Remove hydraulic pump by removing the four screws which fasten it to the pump mount. These screws **will be** reused.
3. Remove three 3/8 hex-head capscrews from pump mount which **will be** reused.
4. Remove three 3/8 hex-head capscrews from main regulator valve body, which **will not** be reused.
5. Remove selector valve assembly, pump mount, and connector tubes by sliding them to the rear until they come off the forward and reverse clutch shafts simultaneously. It may be necessary to uncouple the marine transmission flange from the companion flange and move both flanges to the rear to permit this assembly to be removed.

TROLLING VALVE. (See Twin Disc manual TM-4).

1. Install the trolling valve assembly. Assemble four new O-rings removed from 8-1/2 x 11 plastic bag, to the two connector tubes.
2. With the old shim pack installed over the pilot diameter of the old selector valve assembly, measure the pilot face to top of shim distance, using a depth micrometer.
3. Remove three 3/8 hex nuts holding nine shims to the trolling valve assembly pilot face.

4. Select a combination of new shims to get the same pilot face to top of shim distance for the trolling valve assembly as for the old selector valve assembly. Recheck this distance with depth micrometer with the selected shim pack placed over the pilot diameter on the trolling valve. The pilot face to top of shim distance must be the same for the new trolling valve assembly as it was for the old selector valve assembly to assure the same forward clutch shaft bearing endplay.

5. Clean mating surfaces of the new trolling valve assembly, pump mount, shims, and rear cover and apply anaerobic sealant to the shims, the face of the pump mount and the trolling valve face.

6. Assemble pump mount with its shim pack, connector tubes, and new trolling valve assembly with its shim pack. Then slide this assembly onto the forward and reverse clutch shafts, simultaneously.

7. Install three **new** 3/8 hex-head capscrews into the new trolling valve assembly and the rear cover, and install three **used** 3/8 hex-head screws into the pump mount and rear cover. Tighten these capscrews to 27-30 lbs. ft. torque.

8. Reinstall the hydraulic pump making certain that the pump drive tang engages the shaft drive slot. Torque the screws to 15-17 lbs. ft.

9. Reinstall the oil line from the pump outlet to the heat exchanger inlet.

10. Mount the filter assembly supplied with the trolling valve parts. Two thinwall pipe plugs from filter inlet and outlet and one thinwall pipe plug from new trolling valve assembly high pressure oil inlet, 90 degree elbow must be removed and discarded.

11. Connect oil line from the heat exchanger outlet to the filter assembly inlet, located on the side of the filter. The oil line that was used to connect the heat exchanger discharge to the old selector valve inlet may be suitable.

12. Connect the filter assembly outlet to new trolling valve assembly high pressure inlet with hydraulic flexible hose or tubing. Hydraulic hoses, tubing, and fittings needed to connect the filter to the heat

exchanger and to the trolling valve assembly are not supplied by Twin Disc. Hydraulic lines must withstand 450 psi continuously.

TROLLING VALVE OPERATION

Control and linkage to the trolling valve operating lever are to be furnished by the customer. See planograph of trolling valve, to determine distance travel of linkage. The trolling valve lever must be

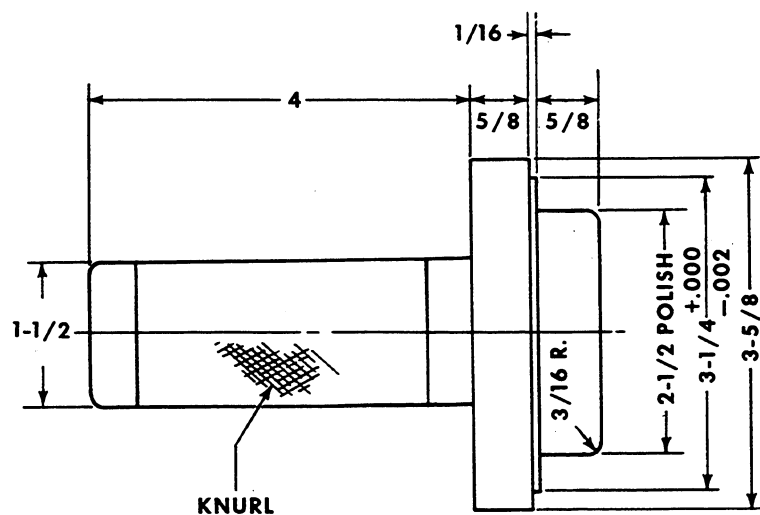
moved through a 79 degree arc from detent to plate stop to control trolling operation.

The trolling valve provides trolling speeds by varying the propeller speed with fixed engine speed. The valve accomplishes this by mechanically changing the clutch apply pressure valve spring tension through a cam movement. This will cause the applied clutch to slip a percentage selected to hold desired trolling speed.

Section 11. SPECIAL TOOLS

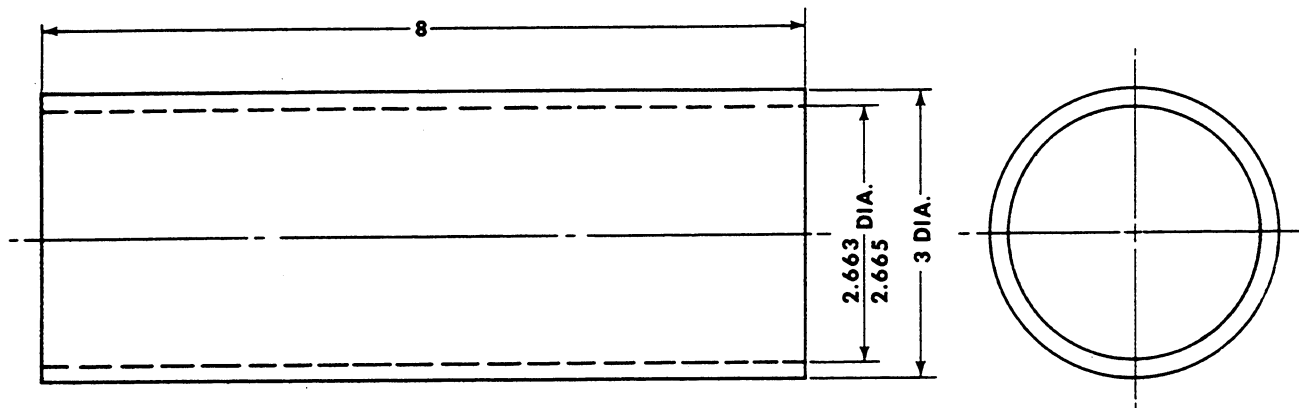
GENERAL.

Figures or illustrations used in this section identify the special tools by tool number. All pertinent information necessary for tool fabrication is shown on each drawing. These tools are intended primarily to make overhaul procedures easier. Twin Disc will not manufacture these tools for general use.



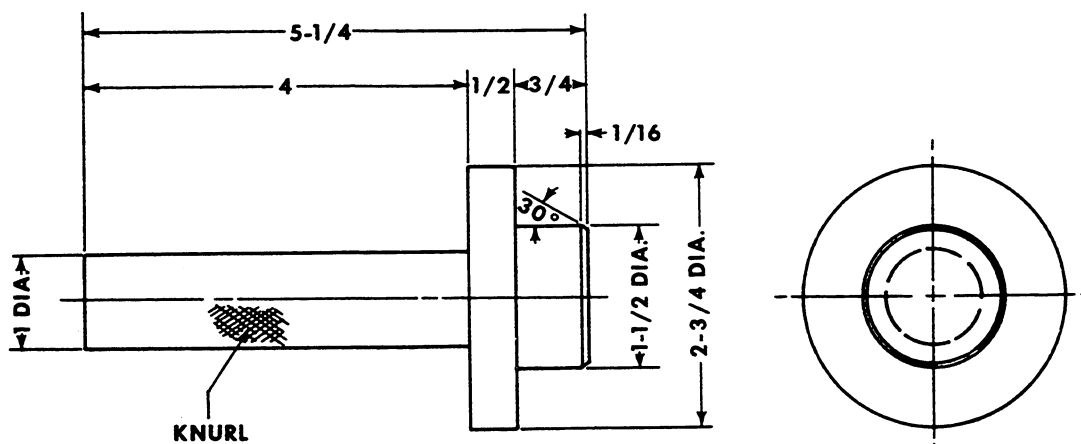
MATERIAL: STEEL-CARB. & HARDEN

Special Tool T-11684



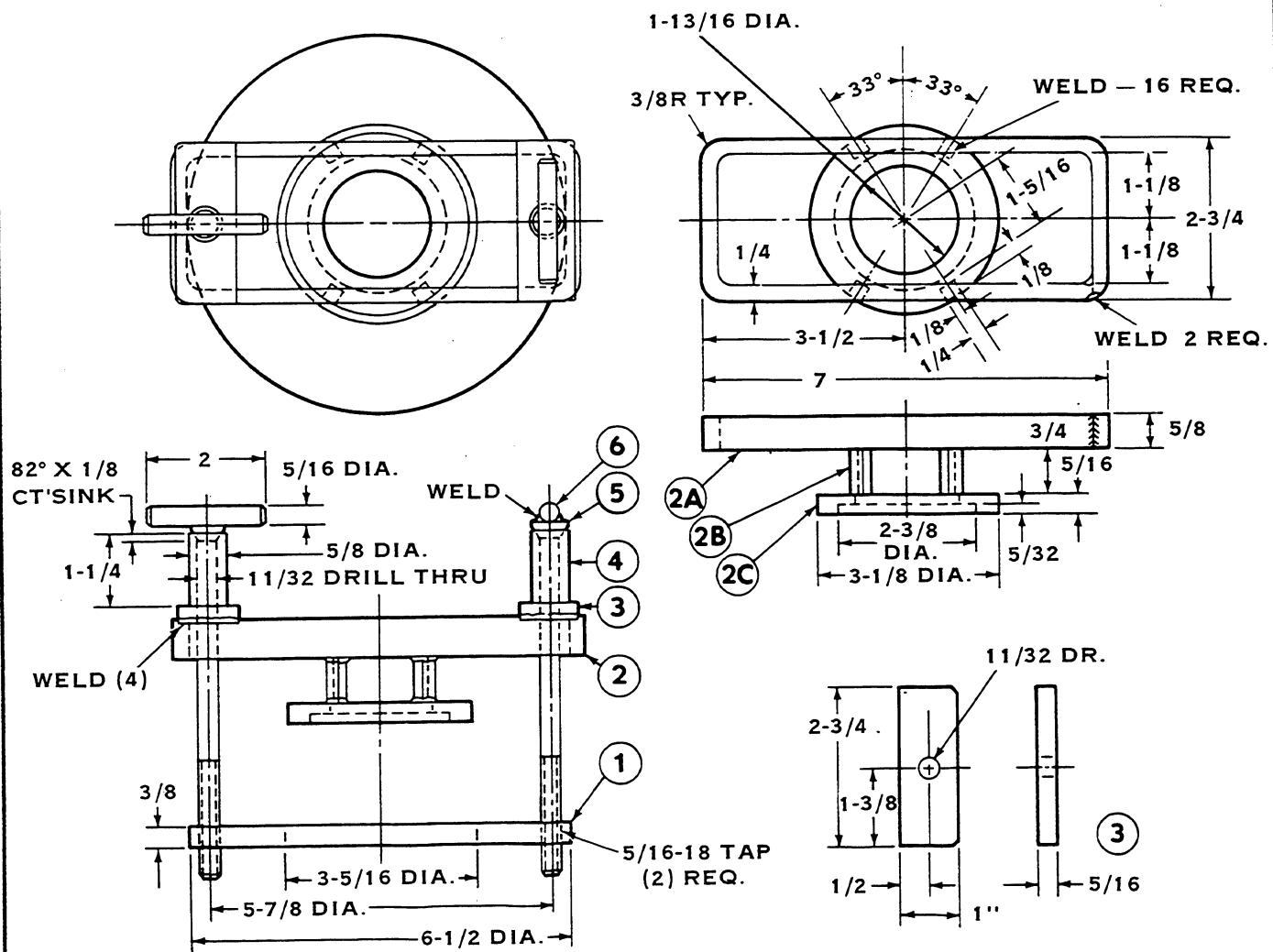
MATERIAL: 3" O.D. \times 2-5/8 I.D. \times 8-1/4 LG. SEAMLESS MECHANICAL TUBING

Figure 11-1. Special Tool T-12127.



MATERIAL: HEAT TREATED #4150—3 DIA. \times 5-3/8

Figure 11-2. Special Tool T-12126.



DET	REQ	MAT	DESCRIPTION	STOCK SIZE		
6	2	CRS	BAR	5/16	DIA.	2-1/8
5	2	PUR	FLAT HD. SCR.	5/16-18 X 6		
4	2	CRS	SPACER	5/8	DIA.	1-3/8
3	2	CRS	CLAMP	1/2	1"	3-1/4
2C	1	MS	PLATE	3-1/4	DIA.	1/2
2B	4	CRS	SPACER	1/4	1/4	7/8
2A	1	CRS	SUPPORT	1/4	5/8	20
2	1		WELDMENT			
1	1	CRS	PLATE	6-1/2	DIA.	5/8

Special Tool T-16752

Section 12.

DRAWINGS AND DATA

The following drawings and data of the product for which this manual was written are included for your convenience.

Item	Description	Qty
1	PLUG, oil tube and dip stick hole (alternate)(3/8)	1
2	HOUSING, main*	1
3	PLATE, name	1
4	SCREW, drive	4
5	GAUGE, oil level	1
6	TUBE, oil level gauge	1
7	PLATE, flywheel direction of rotation	1
8	SCREW, drive	2
9	PIN, dowel*	2
10	PLATE, propeller rotation direction indicator	1
11	SCREW, drive	2
12	FILLER & BREATHER, oil	1
13	GASKET, flat	1
14	COVER, rear*	1
15	CAPSCREW, hex-head (1/2-13 × 2-1/4)	1
16	SHIM (0.005, 0.007, 0.020 in.)	A/R
17	CAPSCREW, hex-head (1/4-20 × 1)	1
18	CAPSCREW, hex-head (5/16-18 × 3/4)	2
19	LEVER, shift	1
20	NUT, hex (1/4-20)	1
21	PLATE, detent	1
22	O-RING	1
23	SPOOL, valve	1
24	PISTON, regulator	1
25	SPRING, outer	1
26	SPRING, inner	1
27	WASHER, pressure adjusting shim	A/R
28	PLUG, pipe (1/8-27)	1
29	BODY, main regulator valve	1
30	CAPSCREW, hex-head (3/8-16 × 1)	2
31	GASKET, flat cover	1
32	COVER	1
33	CAPSCREW, hex-head (5/16-18 × 3/4)	3
34	CAPSCREW, hex-head (3/8-16 × 2)	1
35	O-RING	2
36	TUBE, connector	2
37	O-RING	2
38	SHIM (0.005, 0.007, 0.020 in.)	A/R
39	MOUNT, pump	1
40	CAPSCREW, hex-head (3/8-16 × 1)	3
41	GASKET, flat	1
42	CAPSCREW, hex-head (5/16-18 × 3/4)	4
43	PUMP ASSEMBLY, oil	1
44	CAPSCREW, hex-head (5/16-18 × 3/4)	3
45	COVER, filter screen	1
46	GASKET, flat cover	1
47	SCREEN, filter	1
48	O-RING	1
49	CAPSCREW, hex-head (1/2-13 × 1-1/4)	8
50	PLUG, drain	1
51	O-RING	1

* Parts are not serviceable separately.
Serviced under assembly number XA7024-A.

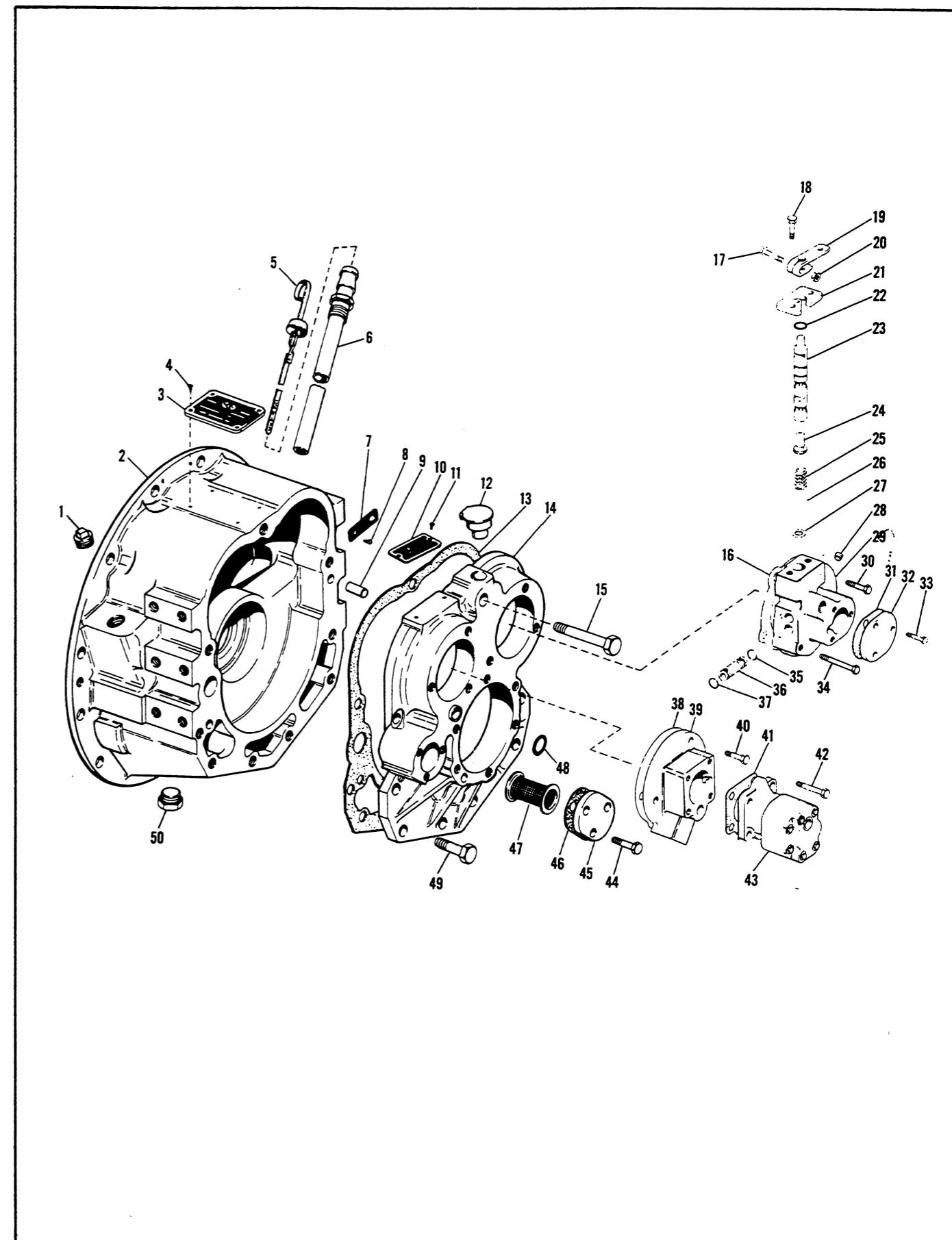


Figure 12-1. External Parts Group.

Item	Description	Qty
1	CAPSCREW, hex-head (5/8-11 × 2).....	1
2	WASHER, retainer.....	1
3	RING, drive.....	1
4	BLOCK, rubber.....	20
5	SPIDER, drive.....	1
6	SEAL, oil (input shaft).....	1
7	SUPPORT, bearing.....	1
8	SHIM (0.005, 0.007, 0.020 in.).....	A/R
9	TAPERED ROLLER BEARING.....	1
10	KEY, input shaft (3/8 × 1/4 × 1-5/8).....	1
11	SHAFT, input.....	1
12	KEY, input shaft (3/8 × 1/4 × 1-1/8).....	1
13	CAPSCREW, hex-head (3/8-16 × 1).....	6
14	CAPSCREW, hex-head.....	8
15	GEAR, input.....	1
16	TAPERED ROLLER BEARING.....	1
17	TAPERED ROLLER BEARING.....	1
18	KEY, output shaft (1/2 × 3/8 × 1-1/4).....	1
19	SHAFT, output.....	1
20	GEAR, output.....	1
21	TAPERED ROLLER BEARING.....	1
22	SHIM (0.005, 0.007, 0.020 in.).....	A/R
23	RETAINER, bearing (output shaft).....	1
24	CAPSCREW, hex-head (1/2-13 × 1-1/4).....	3
25	SEAL, oil.....	1
26	FLANGE, output.....	1
27	RING, lathe cut seal.....	1
28	WASHER, retainer, (output shaft).....	1
29	CAPSCREW, hex-head (5/8-18 × 1-1/2).....	1

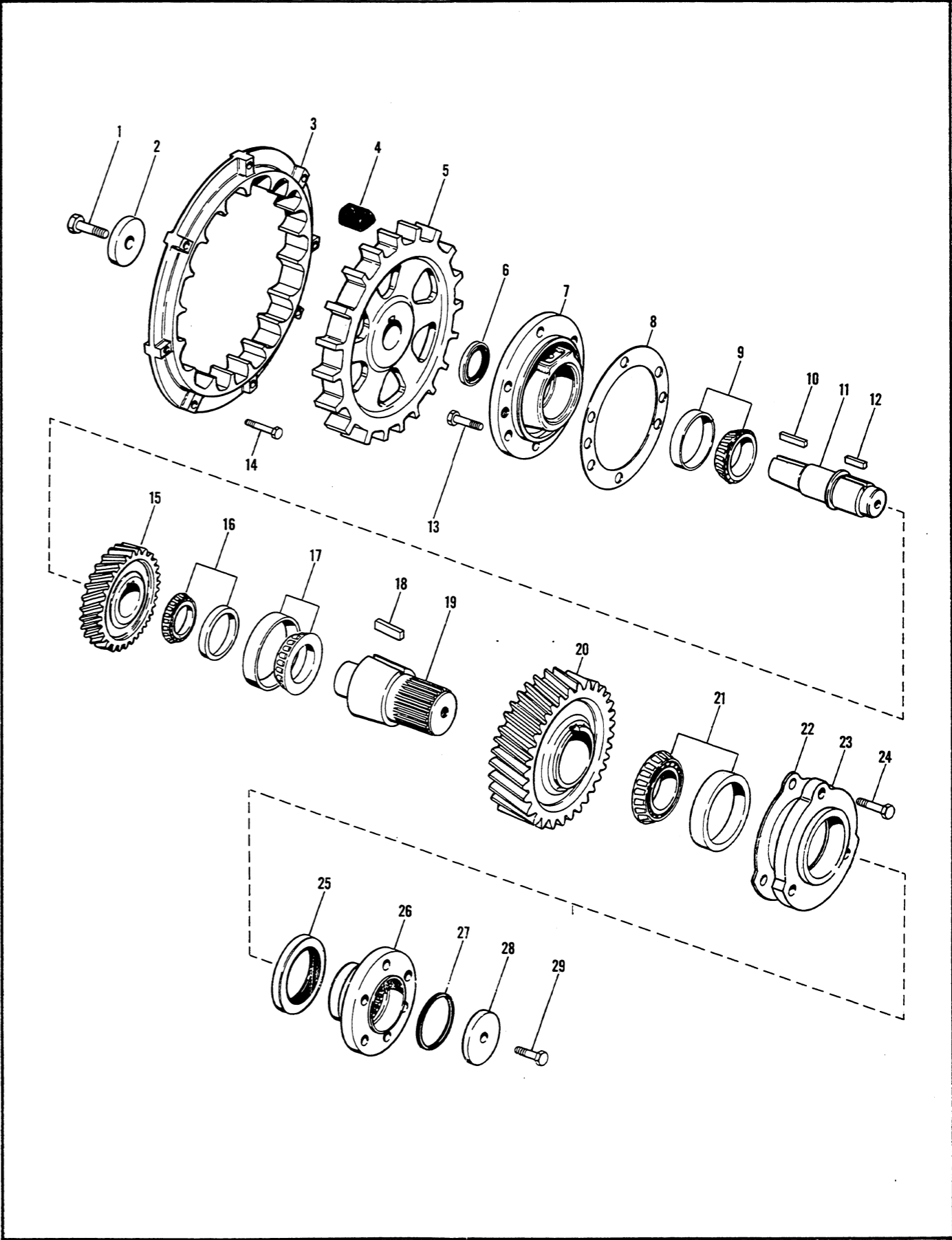


Figure 12-2. Input and Output Group of Parts.

Item	Description	Qty
1	TAPERED ROLLER BEARING.....	1
2	GEAR, clutch housing, forward*	1
3	PISTON, clutch.....	1
4	RING, seal, piston.....	1
5	RING, seal, piston.....	1
6	PLATE, clutch, steel.....	8
7	PLATE, clutch, faced.....	9
8	PLATE, back.....	1
9	RING, snap, internal.....	1
10	SPRING, return, piston.....	1
11	RING, snap external.....	1
12	WASHER, race, thrust, steel.....	1
13	NEEDLE THRUST BEARING.....	1
14	WASHER, race, thrust, steel.....	1
15	HUB, clutch pinion, assembly*	1
16	BUSHING, pinion*	1
17	SHAFT, clutch, assembly*	1
18	WASHER, race, thrust, steel.....	1
19	NEEDLE THRUST BEARING.....	1
20	WASHER, race, thrust, steel.....	1
21	TAPERED ROLLER BEARING.....	1
22	RING, seal, piston type.....	2

* Not serviceable separately.

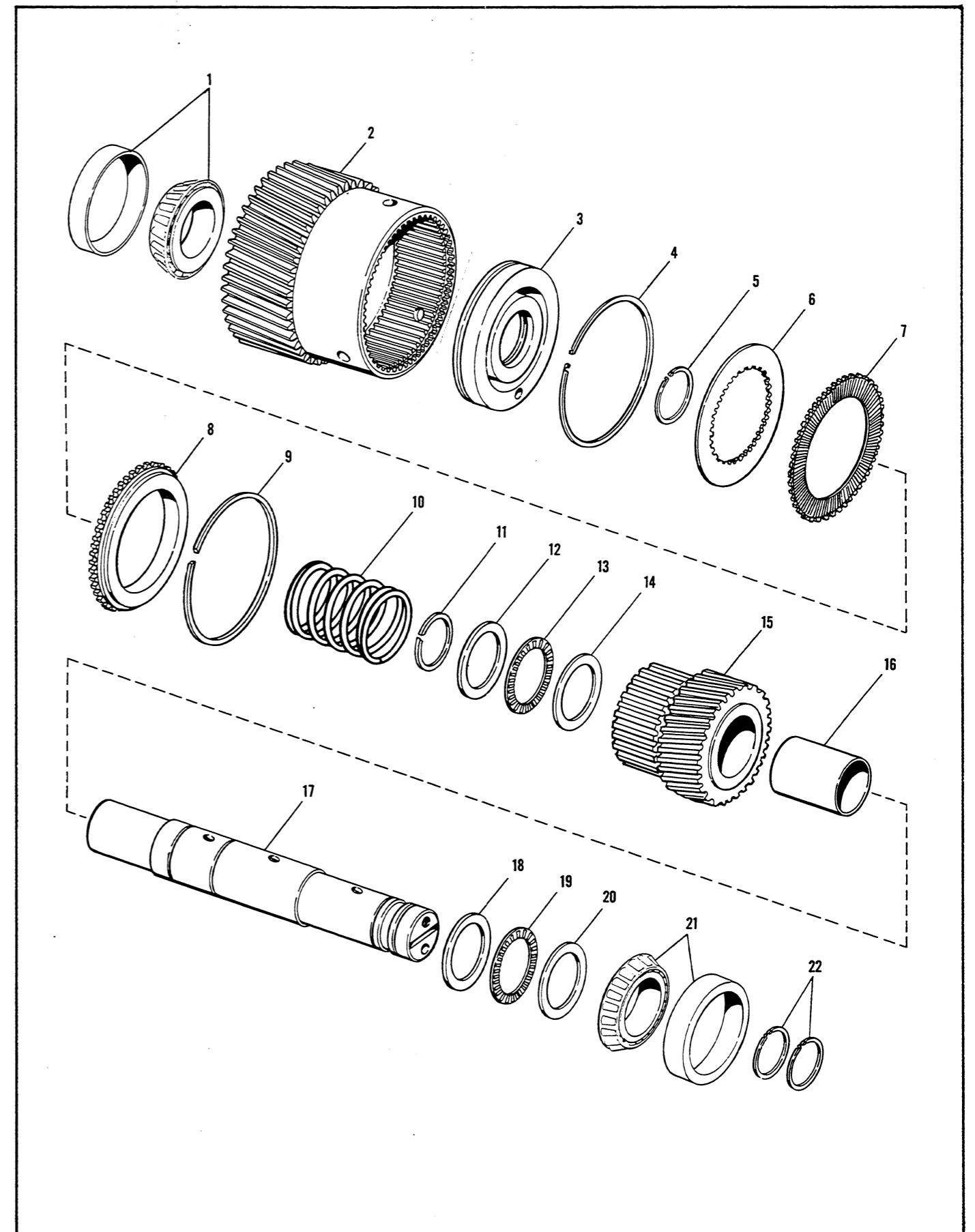


Figure 12-3. Forward Clutch Group of Parts.

Item	Description	Qty
1	TAPERED ROLLER BEARING.....	1
2	GEAR, clutch housing, reverse*	1
3	PISTON, clutch.....	1
4	RING, seal, piston.....	1
5	RING, seal, piston.....	1
6	PLATE, clutch, steel.....	8
7	PLATE, clutch, faced.....	9
8	PLATE, back.....	1
9	RING, snap, internal.....	1
10	SPRING, return, piston.....	1
11	RING, snap, external.....	1
12	WASHER, race, thrust, steel.....	1
13	NEEDLE THRUST BEARING.....	1
14	WASHER, race, thrust, steel.....	1
15	HUB, clutch pinion, assembly.....	1
16	BUSHING, pinion *.....	1
17	SHAFT, clutch assembly*.....	1
18	WASHER, race, thrust, steel.....	1
19	NEEDLE THRUST BEARING.....	1
20	WASHER, race, thrust, steel.....	1
21	TAPERED ROLLER BEARING.....	1
22	RING, seal, piston type.....	2
* Not serviceable separately.		

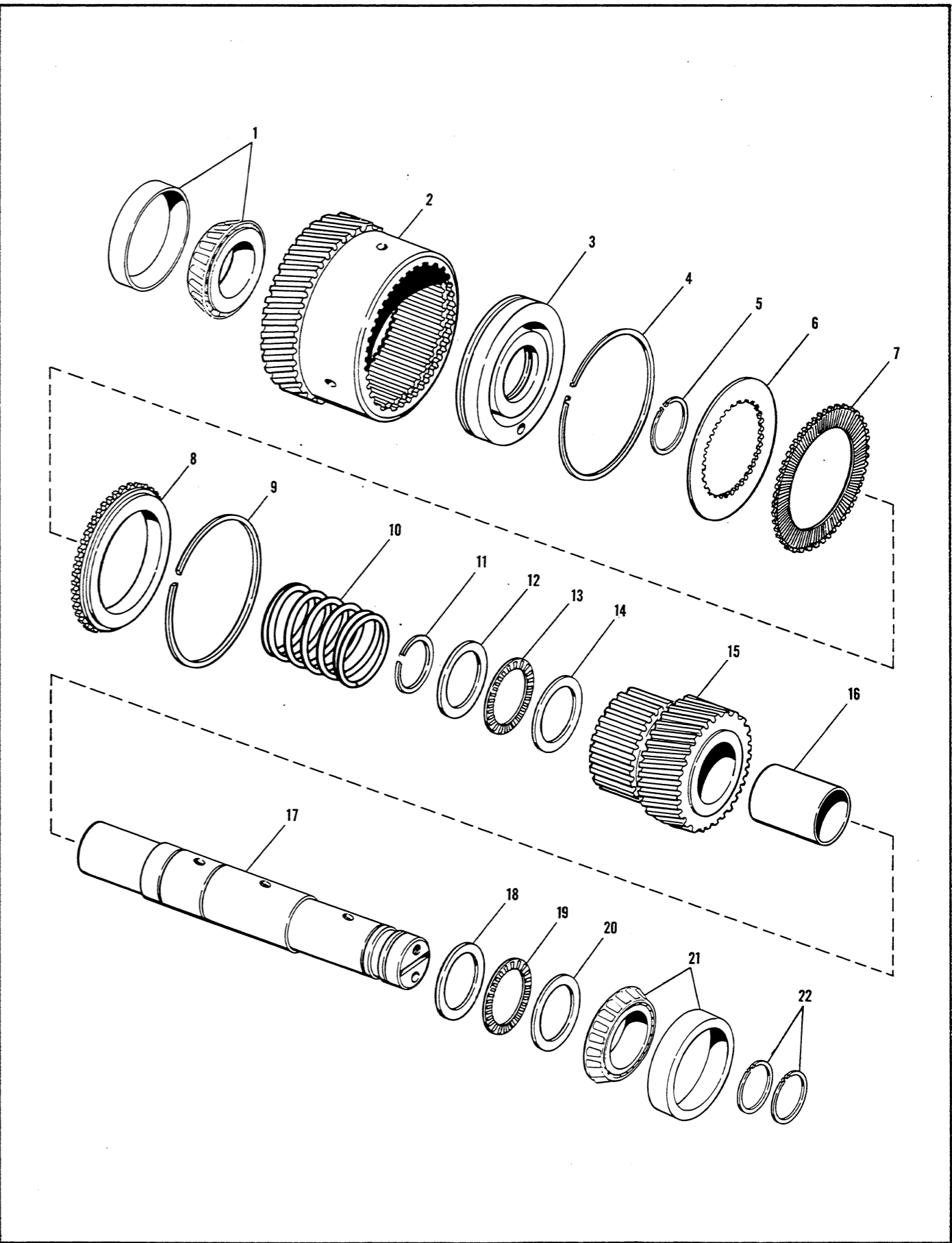
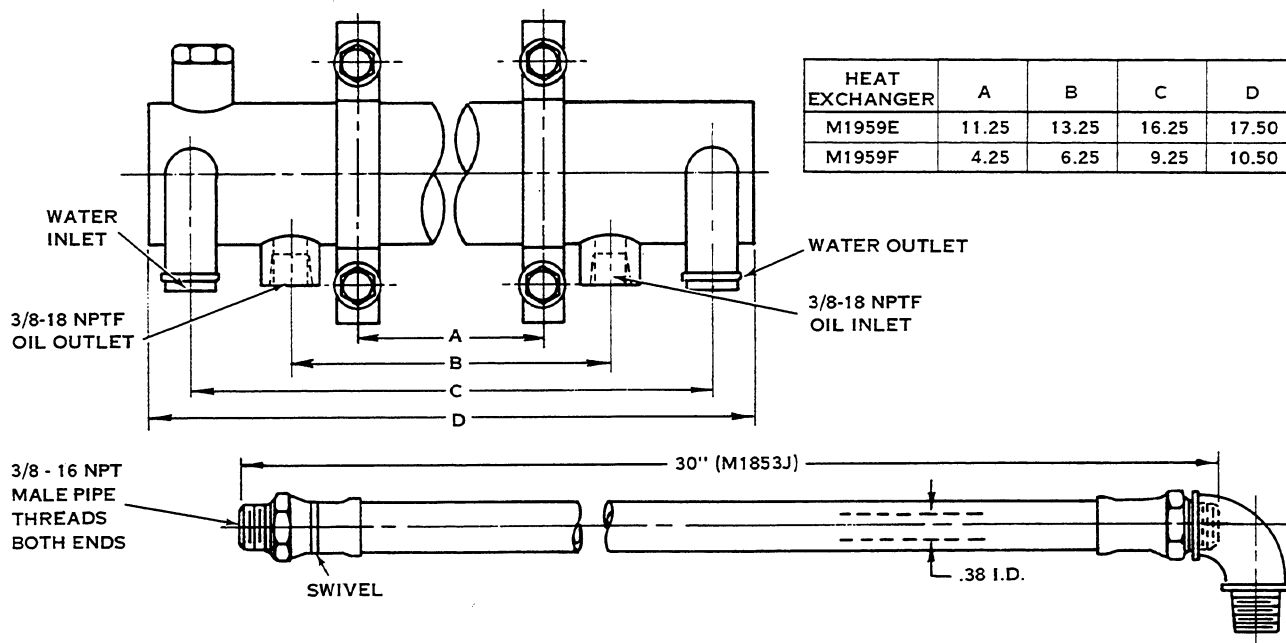


Figure 12-4. Reverse Clutch Group of Parts.



HEAT EXCHANGER	A	B	C	D
M1959E	11.25	13.25	16.25	17.50
M1959F	4.25	6.25	9.25	10.50

XB 1936 CONSISTS OF (SPEC. K-85)			XB1936A CONSISTS OF (SPEC. K-86)		
M1959E	1	HEAT EXCHANGER	M1959F	1	HEAT EXCHANGER
M1853J	2	FLEXIBLE HOSE (3/8 I.D.)	M1853J	2	FLEXIBLE HOSE (3/8 I.D.)
M2053BA	2	PIPE NIPPLE (3/8)	M2053BA	2	PIPE NIPPLE (3/8)
M2055AD	2	90° ELBOW (3/8)	M2055AD	2	90° ELBOW (3/8)
M2001F	4	HEX. HEAD CAPSCREW (5/16 x 5/8)	M2001F	4	HEX. HEAD CAPSCREW (5/16 x 5/8)
M2048F	4	PLAIN WASHER	M2048F	4	PLAIN WASHER

FOR RIGHT HAND ENGINE (FRESH WATER COOLING)

FOR RIGHT HAND ENGINE (SALT WATER COOLING).

Figure 12-5. Heat Exchanger Kits — MG-506-1

TORSIONAL COUPLING CONSIDERATIONS FOR MARINE TRANSMISSIONS

Some marine transmissions may incorporate the use of a torsional coupling in place of a rubber block drive between the engine and transmission. The different styles are shown on the last two sheets of the applicable marine transmission assembly drawings.

Flywheel housing vents should have no restrictions which would prevent the free flow of air for cooling the coupling. The ambient temperature of the air around the coupling has an operating range between -22° F (-6° C) and 176° F (80° C). Care should be taken to have the baffles installed properly so that hot air is ported out of the housing.

The element should be visually inspected following the first 100 hours of operation and every 2000 hours or every six months, whichever comes first thereafter. Torsional vibration, misalignment, degradation by contaminants (oil), heat, ultraviolet radiation, and excessive system torque can cause cracks or other signs of distress to appear on the surface of the rubber. The above described items affect the life of the coupling element.

BEARING LOCKNUT TORQUE

Size	M-2012	M-2281	(1) Torque Lb. Ft.	M2012	(1) Torque Lb. Ft.	M-2037	(1) Torque Lb. Ft.
01 03	BC A		15 ± 2 34 ± 5				
04 05 06	B C D	C	46 ± 6 75 ± 10 92 ± 12				
07 08	E F	F	125 ± 16 160 ± 20	AF	230 ± 30	E (3) F	150 ± 20 190 ± 25
09 10 11	G H J	G H J	200 ± 25 240 ± 30 290 ± 40	(2) AG AH AJ	300 ± 40 370 ± 50 440 ± 55	G H J	240 ± 30 290 ± 40 350 ± 45
12 13 14	K L M	K M	350 ± 45 400 ± 50 460 ± 60	AK AL AM	530 ± 70 600 ± 75 710 ± 90	K L M	430 ± 55 490 ± 65 580 ± 75
15 16 17	N P Q	AJ P	550 ± 70 660 ± 85 770 ± 100	AN AP AQ	830 ± 110 1000 ± 130 1200 ± 150	N & AN P Q	680 ± 85 800 ± 100 950 ± 120
18 19 20	R S T	S & AH	900 ± 120 1000 ± 130 1150 ± 150	AR AS AT	1350 ± 170 1500 ± 190 1700 ± 225	R S T	1100 ± 140 1300 ± 170 1400 ± 180
21 22 24	U V W	V	1300 ± 170 1400 ± 180 1800 ± 225	AU AV AW	2000 ± 250 2200 ± 275 2700 ± 350	U V W	1600 ± 200 1800 ± 225 2200 ± 275
26 28 30	X Y Z	X	2200 ± 275 2600 ± 325 3100 ± 400	AX AY AZ	3300 ± 425 4000 ± 500 4800 ± 600	X Y Z	2700 ± 350 3300 ± 425 4000 ± 500

(1) TORQUE VALUES APPLY TO SOLID SHAFTS.
TORQUE VALUES MAY OR MAY NOT BE SATISFACTORY ON THIN-WALLED SHAFTS.
TORQUE VALUES APPLY TO THREADS LUBRICATED WITH SAE 20 OR 30 OIL.

(2) M-2281-AG IS TO HAVE SAME ASSEMBLY TORQUE AS M-2012-AG.

(3) M-2037-AA IS TO HAVE 120 ± 15 LB. FT. ASSEMBLY TORQUE.

**STRAIGHT THREADED TUBE FITTINGS, HOSE FITTINGS
AND PLUGS WITH "O" RINGS.**

**FOR 37°, 45° AND INVERTED FLARED FITTINGS PER SAE STANDARDS
J512, J514, and J516 WITH LATEST SUFFIX.**

(1)

**FOR TAPER PIPE THREADED FITTINGS USE THE PIPE PLUG TORQUE
VALUES.**

NOMINAL THREAD O.D.	NOMINAL TUBE SIZE	PLUG PART NUMBER (2)	TIGHTENING TORQUE, LB. FT. NUTS & PLUGS	TORQUE LB. IN. EQUIV.
5/16	1/8	---	3.6 ± 0.5	43 ± 6
3/8	3/16	M2080G	8.6 ± 1.0	103 ± 12
7/16	1/4	M2080E	12 ± 1.5	144 ± 18
1/2	5/16	M2080C	15 ± 2	180 ± 24
9/16 & 5/8	3/8	M2080A	18 ± 2	216 ± 24
11/16	7/16	---	25 ± 3	
3/4	1/2	M2080K	30 ± 4	
7/8	5/8	M2080M	40 ± 5	
1-1/16	3/4	M2080F	55 ± 7	
1-3/16 & 1-1/4	7/8	M2080N	65 ± 8	
1-5/16 & 1-3/8	1	M2080B	80 ± 10	
1-5/8	1-1/4	M2080J	100 ± 12	
1-7/8	1-1/2	M2080D	120 ± 15	
2-1/2	2	M2080X	230 ± 30	

(1) THIS CHART DOES NOT APPLY TO OTHER THAN THE 3 FLARED DESIGNS QUOTED.
THUS DO NOT USE THIS DATA FOR SLEEVED COMPRESSION TYPE FITTINGS,
REFRIGERATION TUBE FITTINGS, AIR LINE TUBE FITTINGS NOR THE MANY
FLARELESS FITTINGS.

(2) THIS IS A PARTIAL LIST. USE THREAD O.D. TO DETERMINE THE RECOMMENDED
ASSEMBLY TORQUE OF THE UNLISTED STRAIGHT THREAD "O" RING PLUGS.

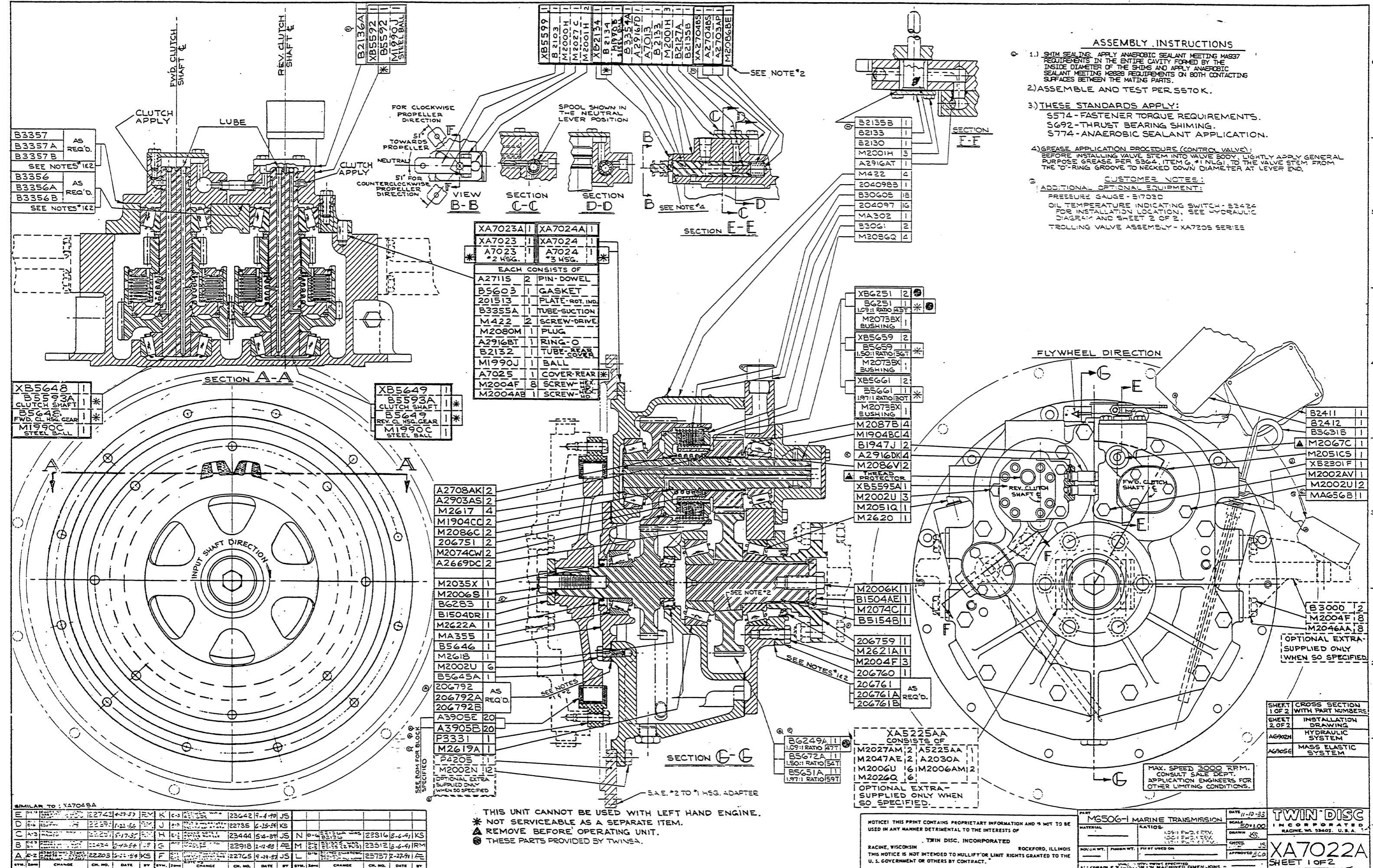
THE FLARELESS FITTINGS ARE BEST ASSEMBLED WITH NUMBER OF TURNS AFTER SOME
INITIAL TIGHTENING OR RUNNING TO THE STOP PROVIDED AND THEN TIGHTENING
WITH AN ADDITIONAL 5 TO 50 POUNDS FEET OF TORQUE. NO STANDARD DATA HAS
BEEN PREPARED FOR THE FLARELESS FITTINGS.

TORSIONAL COUPLING CONSIDERATIONS FOR MARINE TRANSMISSIONS

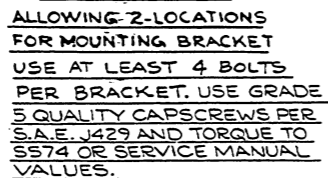
Some marine transmissions may incorporate the use of a torsional coupling in place of a rubber block drive between the engine and transmission. The different styles are shown on the last two sheets of the applicable marine transmission assembly drawings.

Flywheel housing vents should have no restrictions which would prevent the free flow of air for cooling the coupling. The ambient temperature of the air around the coupling has an operating range between -22° F (-6° C) and 176° F (80° C). Care should be taken to have the baffles installed properly so that hot air is ported out of the housing.

The element should be visually inspected following the first 100 hours of operation and every 2000 hours or every six months, whichever comes first thereafter. Torsional vibration, misalignment, degradation by contaminants (oil), heat, ultraviolet radiation, and excessive system torque can cause cracks or other signs of distress to appear on the surface of the rubber. The above described items affect the life of the coupling element.



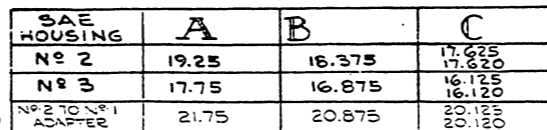
NOTE:
FLYWHEEL OUTLINE MUST
CONFORM TO S.A.E. J620d
NO. 11 1/2.



SIMILAR TO:XA7048A

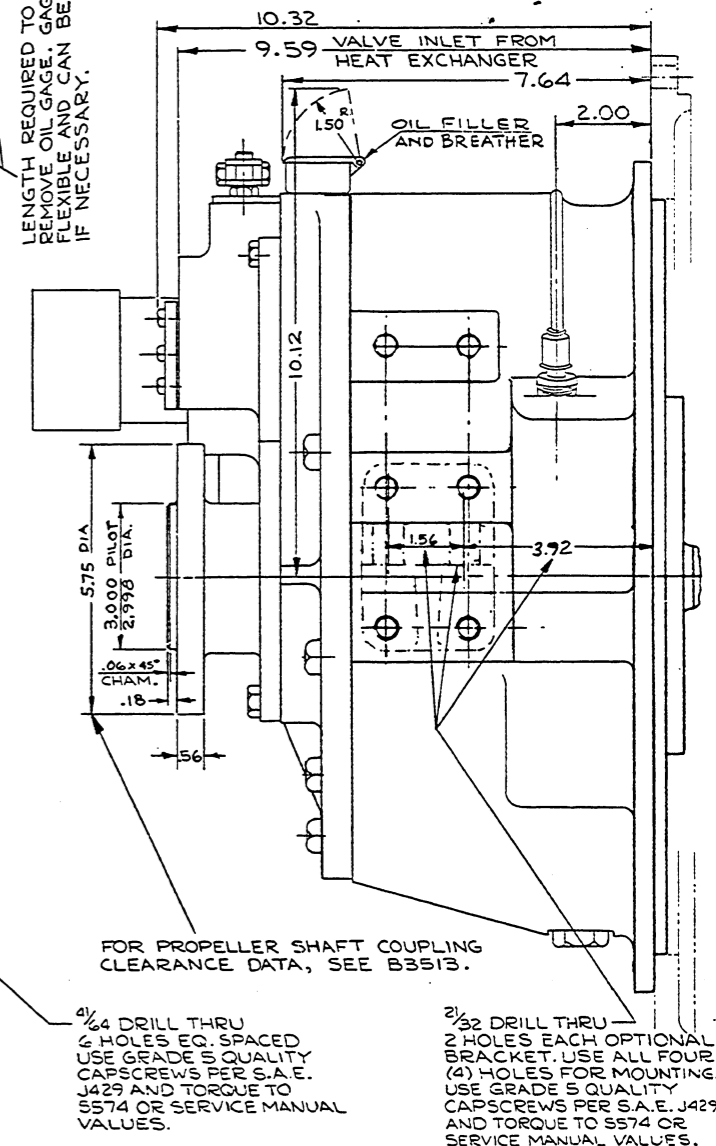
[illegible]

NOTE:
ALL POINTS AVAILABLE FOR TESTING ARE CODED



CENTER OF GRAVITY						
	S.A.E. HSG. #2			S.A.E. HSG. #3		
RATIO:	D	E	F	D	E	F
1.09:1						
1.50:1						
1.97:1				4.04	1.15	.72

LENGTH REQUIRED TO
REMOVE OIL GAGE. GAGE IS
FLEXIBLE AND CAN BE BENT
IF NECESSARY.



FOR PROPELLER SHAFT COUPLING
CLEARANCE DATA, SEE B3513.

OPTIONAL TEMPERATURE INDICATING SWITCH:
CUSTOMER TO INSTALL IN A $\frac{3}{4} \times \frac{1}{2} \times \frac{3}{4}$ PIPE TEE WITH 2 OF $\frac{3}{4} \times \frac{3}{8}$ REDUCER BUSHINGS IN THE HYDRAULIC LINE LEADING FROM THE MARINE TRANSMISSION PUMP TO THE HEAT EXCHANGER INLET. REFER TO THE HYDRAULIC DIAGRAM.

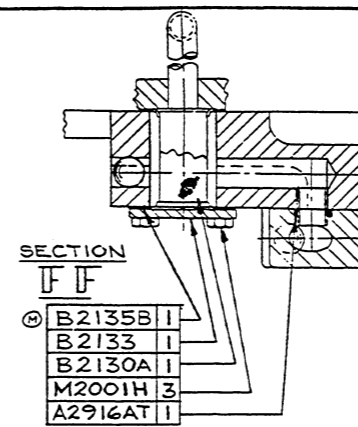
PART MG506-1 MARINE TRANSMISSION			DATE 11-10-83
MATERIAL			SCALE 50=100
			DRAWN KS
ROUGH WT	FINISH WT 220*	FIRST USED ON	CHECK LFA JS
UNLESS OTHERWISE SPECIFIED			APPROVED ECO
ALLOWABLE VARIATIONS IN DIMENSIONS =			

TWIN DISC
INCORPORATED
MACHINE, MN 55403 • U.S.A.

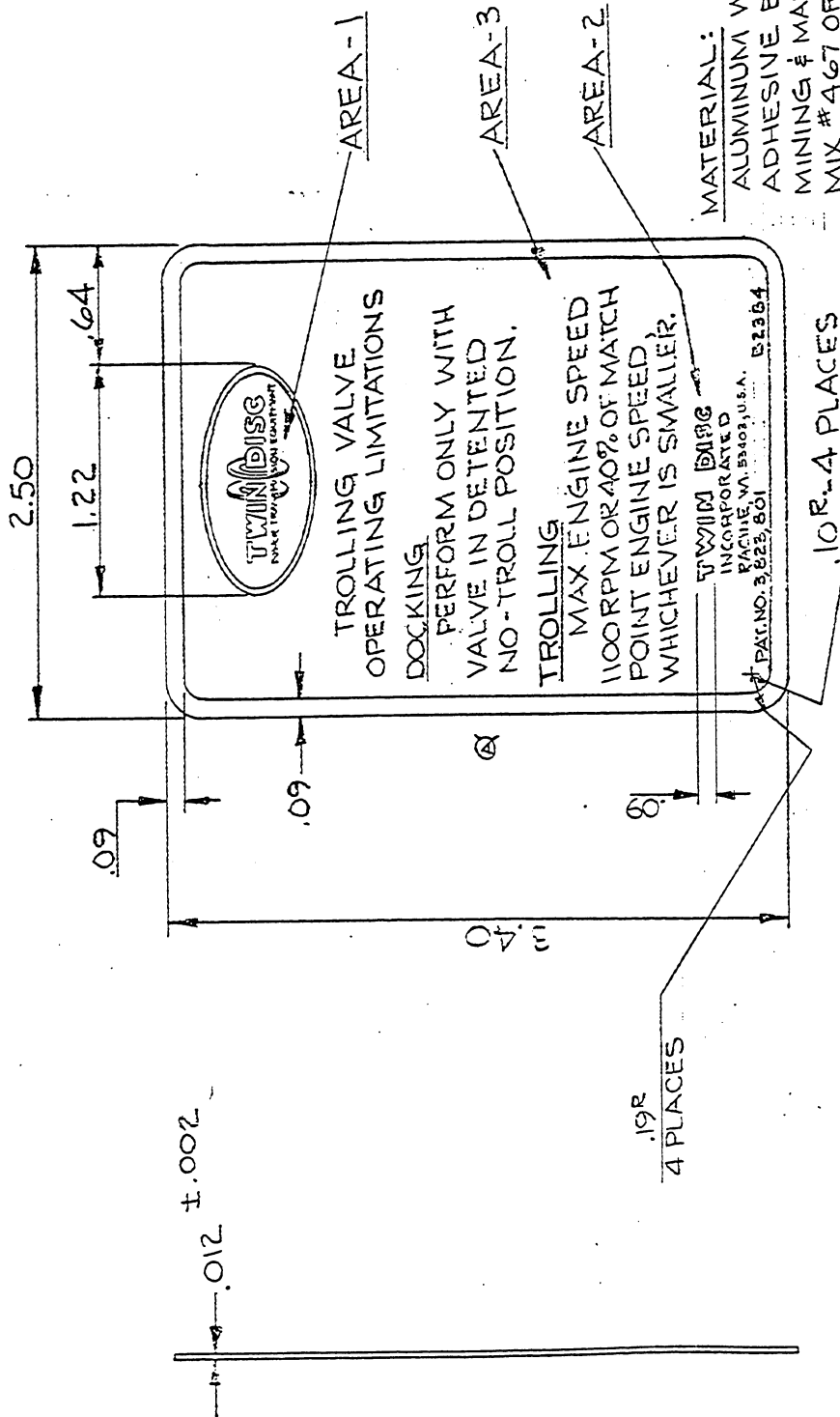
XA7022A

SHEET 2 OF 2

HEAT EXCHANGER (H.E.) REQUIREMENTS			
PERMISSIBLE OIL TEMPERATURE INTO H.E.		120°F. MAX. 150°F. MIN.	
MIN. HEAT TRANSFER CAPACITY	BTU PER MIN. PER ENGINE	R.T.D. H.P.	
(MULTIPLY BY 1.25 FOR FRESH) (AND 2.0 FOR RAW WATER H.E.)	CONTINUOUS DUTY	P.C. & INT. DUTY	
APPROX. OIL FLOW TO H.E.	1.484	1.272	
	132 G.P.M. PER 100 ENGINE R.P.M.		
PEAK OIL PRESSURE AT H.E. (PROOF TEST) H.E. AT 1.5 X P.S.I.	445 P.S.I.		
WATER FLOW/OIL PRESSURE DROP ACROSS H.E. WITH 30 G.S.U. OIL AT 150°F. IN	30 P.S.I.		
MAX. ALLOWABLE OIL - USE 1.5 TO 3.0 TIMES OIL G.P.M.			
H.E. WATER PRESSURE RATING, MIN. = 1.5 X H.E. INLET WATER P.S.I.			
DATA H.E. PURCHASER MUST ALSO TELL VENDOR			
STATE IF RAW (OPEN CHANNEL & SEA) OR FRESH (CLOSED ENGINE JACKET & KEEL COOLER; WATER WILL COOL H.E.)			
STATE MAX. WATER TEMP. INTO H.E. - TYPICAL - RAW WATER - 85°F. KEEL COOLER WATER - 140°F. ENGINE JACKET WATER - 180°F.			
STATE MIN. ALSO MAX. G.P.M. OF WATER FLOW TO H.E.			
H.E. INSTALLATION & SERVICE REQUIREMENTS			
OIL LINES, TRANSMISSION TO H.E. AND RETURN ----			
(1) MAX. VELOCITY IN FITTINGS, PIPE, HOSE AND TUBES - 25 FT./SEC.			
(2) BURST PRESSURE, MIN. = 10 X PEAK OIL PRESSURE AT H.E.			
(3) HOSE - SAE J517 100R1 MEETING USCG 46CFR 56.60-25(C), 275°F. TEMP. RATING. (4) PROTECT LINES FROM MECHANICAL DAMAGE.			
ZINC ANODES PROTECT H.E. RAW WATER PASSAGES FROM CORROSION.			
CHECK & REPLACE THEM FREQUENTLY. REF. EX4107 SERIES CHARTS			



PART MG506-1 MARINE TRANSMISSION		DATE 1-13-83	TWIN DISC INCORPORATED RACINE, WI. 53405, U.S.A.
MATERIAL	RATIO: 2.56:1 FWD. & REV. 2.50:1 FWD. & REV.	DRAWN KS	
ROUGH WT.	FINISH WT.	FIRST USED ON	HECK. JS
UNLESS OTHERWISE SPECIFIED ALLOWABLE VARIATION ON MACHINE DIMENSIONS ±			APPROVED J.S.
			XAT048A SHEET 1 OF 2



MATERIAL:
ALUMINUM WITH PRESSURE SENSITIVE
ADHESIVE BACKING OF MINNESOTA
MINING & MANUFACTURING CO.
MIX #467 OR EQUIVALENT
QUALITY, PROTECTED BY
PAPER COVERING.

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RACINE, WISCONSIN
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DATE 4-29-75
SCALE FULL
DRAWN KOS
CHECK REB JS
APPROVED KOS

PART
PLATE - INSTRUCTION
MATERIAL
SEE NOTE
ROUGH WT. FINISH WT.
NOISE

FIRST USED ON XA7205
M506 MARINE TRANSMISSION

UNLESS OTHERWISE SPECIFIED
ALLOWABLE VARIATION ON MACHINED DIMENSIONS ± .010 ©

④ COLOR SCHEME:
AREA-1: TRADEMARK RELIEF, DISC FACES AND CENTERS
TO BE SUNKEN BLUE ENAMEL. LETTERS, OVAL OUTLINE
AND DISC OUTLINES TO BE RAISED BRIGHT ALUMINUM. TO
BE DIRECTLY PROPORTIONAL IN SIZE TO TRADEMARKS SHOWN
ON SHEET OF AUTHORIZED TRADEMARKS 6/80.
AREA-2: SHADED LETTERS ARE TO HAVE SUNKEN BLACK
ENAMEL RELIEFS AND BRIGHT RAISED ALUMINUM OUTLINE.
AREA-3: PLATE BACKGROUNDS TO BE SUNKEN BLACK ENAMEL.
BORDER, AND LETTERS TO BE RAISED BRIGHT ALUMINUM.

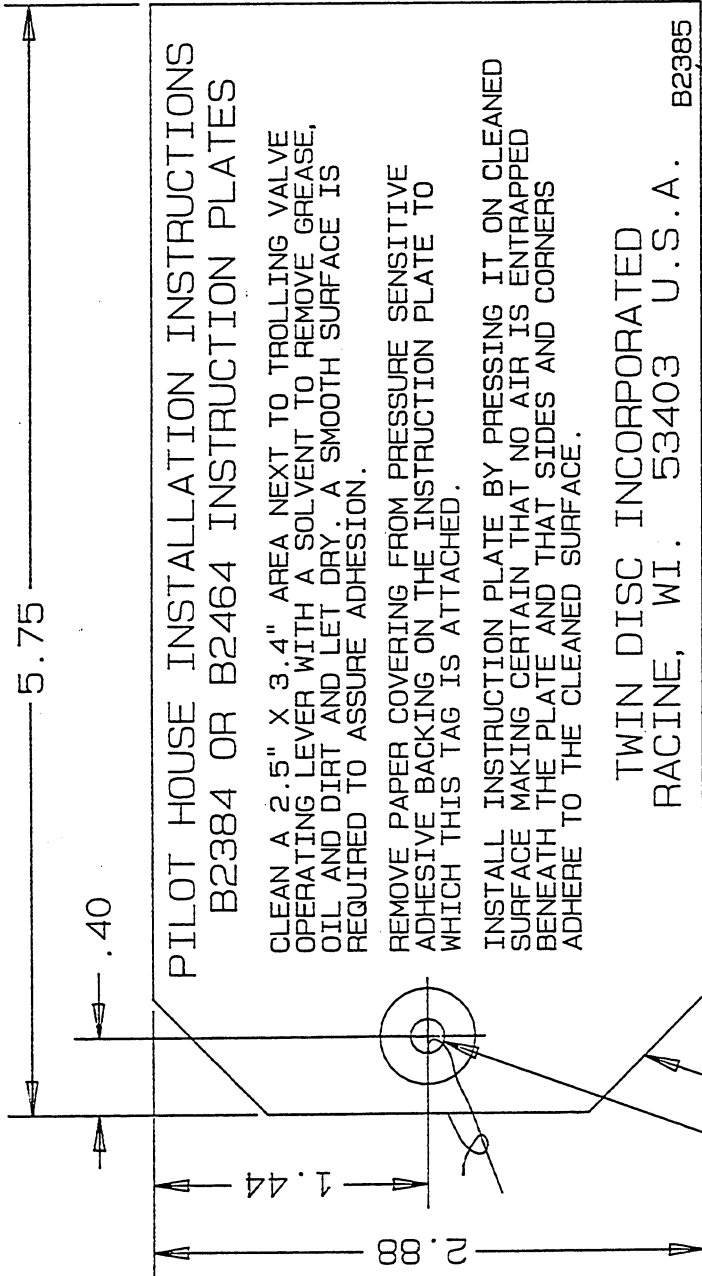
SIMILAR TO:

SYM.	CHANGE	CH. NO.	DATE	BY
C	ADDED SHEET 1 OF 2, AS MANUFACTURED BY TWINCO	21958	5-21-82	RM
B	REVIS-13 AREA-1 NOTE	21787	10-15-81	JS
A	DOCKING WAS DOCKING AND MANEUVERING	19685	11-19-75	KS

TWIN DISC
INCORPORATED
RACINE, WI. 53403, U.S.A.

B2384 SHEET 1 OF 2
AS MANUFACTURED BY TWINCO

12.00 LONG WIRE.
METAL REINFORCED. TWO STRANDS.



USE .12 TO .14
HIGH LETTERS

USE .08 TO .10
HIGH LETTERS

TWIN DISC INCORPORATED
RACINE, WI. 53403 U.S.A. B2385

PRINT PART
NO. HERE

APPROX. .60 X 45°
2 PLACES

NOTE:

TAG TO HAVE BLACK LETTERING
ON NATURAL TAG CARDBOARD
BACKGROUND.

UNLESS OTHERWISE SPECIFIED MACHINED DIMENSIONS ± .010 ALL ANGULAR TOLERANCES ± 1°		DATE 1-9-81
FIRST USE XAT205 SERIES ASSY MG506 & MG507 MODEL		SCALE 1.00 = 1"
SIMILAR TO MA656 B2386		DRN. AZ
NAME TAG-INSTRUCTION PLATE INSTALLATION INSTRUCTION		CHK REB JS
		APP'D BCA

TWIN DISC
INCORPORATED
ROCKFORD, IL 61101 U.S.A.
RACINE, WI 53403 U.S.A.

B2385

8.50

XAT205 SERIES, HG506 AND HG507 TROLLING VALVE GROUP
FIELD INSTALLATION INSTRUCTIONS

- A. REMOVE SELECTOR VALVE ASSEMBLY AND PUMP MOUNT FOLLOWING THE STEPS OUTLINED BELOW:
1. REMOVE THE PUMP OUTLET TO HEAT EXCHANGER INLET OIL LINE AT THE PUMP MOUNT ONLY. THEN REMOVE HEAT EXCHANGER OUTLET TO VALVE INLET OIL LINE FROM SELECTOR VALVE ASSEMBLY HIGH PRESSURE INLET ONLY. THESE SCREWS REMOVE HYDRAULIC PUMP BY REMOVING THE FOUR (4) SCREWS WHICH FASTEN IT TO THE PUMP MOUNT. THESE SCREWS WILL BE REUSED.
 2. REMOVE THREE (3) HEX. HEAD SCREWS FROM PUMP MOUNT, WHICH WILL BE REUSED.
 3. REMOVE THREE (3) HEX. HEAD SCREWS FROM MAIN REGULATOR VALVE BODY, WHICH WILL NOT BE REUSED.
 4. REMOVE SELECTOR VALVE ASSEMBLY, PUMP MOUNT, AND CONNECTOR TUBES BY SLIDING THEM TO THE REAR UNTIL THEY COME OFF THE FWD. AND REV. CLUTCH SHAFTS SIMULTANEOUSLY. IT MAY BE NECESSARY TO UNCOUPLE THE MAIN REGULATOR FLANGE FROM THE COMPARTMENT FLANGE AND MOVE BOTH FLANGES TO THE REAR TO PERMIT THIS ASSEMBLY TO BE REMOVED.
- B. INSTALL THE XA7227 SERIES:
1. ASSEMBLY FOUR (4) NEW A29160E "O" RINGS, FROM (8-1/2 x 11) PLASTIC BAG, TO THE TWO (2) CONNECTOR TUBES.
 2. WITH THE OLD SHIM PACK INSTALLED OVER THE PILOT DIAMETER OF THE OLD SELECTOR VALVE ASSEMBLY, MEASURE THE PILOT FACE TO TOP OF SHIM DISTANCE USING A DEPTH MICROMETER.
 3. REMOVE THREE (3) HEX. NUTS HOLDING NINE (9) SHIMS TO THE XA7227 SERIES TROLLING VALVE ASSEMBLY PILOT FACE.
 4. SELECT A COMBINATION OF NEW SHIMS TO GET THE SAME PILOT FACE TO TOP OF SHIM DISTANCE FOR THE TROLLING VALVE ASSEMBLY AS FOR THE OLD SELECTOR VALVE ASSEMBLY. RECHECK THIS DISTANCE WITH DEPTH MICROMETER WITH THE SELECTED SHIM PACK PLACED OVER THE PILOT DIAMETER ON THE TROLLING VALVE. THE PILOT FACE TO TOP OF SHIM DISTANCE MUST BE THE SAME FOR THE NEW TROLLING VALVE ASSEMBLY AS IT WAS FOR THE OLD SELECTOR VALVE ASSEMBLY TO ASSURE THE SAME FWD. SHIM BEARING END PLAY.

THIN DISC, INCORPORATED
CONTINUED ON OPPOSITE SIDE
RACINE, WI 53403

FRONT FACE

USE .12 TO .14
HIGH LETTERS

USE .08 TO .10
HIGH LETTERS

USE .12 TO .14
HIGH LETTERS

PRINT PART NO.
HERE

CONTINUED FROM OPPOSITE SIDE

5. CLEAN MATING SURFACES OF NEW TROLLING VALVE ASSEMBLY, PUMP MOUNT, SHIMS, AND REAR COVER. APPLY A 1/16 DIAMETER BEAD OF ANAEROBIC SEALANT TO THE I.D. OF THE SHIM PACK. THE FACE OF THE PUMP MOUNT AND THE TROLLING VALVE FACE - 5774 GIVES MORE DETAILED ANAEROBIC SEALANT APPLICATION INSTRUCTIONS.
6. ASSEMBLY PUMP MOUNT WITH ITS SHIM PACK, CONNECTOR TUBES, AND NEW TROLLING VALVE ASSEMBLY WITH ITS SHIM PACK. THEN SLIDE THIS ASSEMBLY INTO THE FWD. AND REV. CLUTCH SHAFTS SIMULTANEOUSLY.
7. INSTALL THREE (3) NEW HEX. HEAD SCREWS INTO THE NEW TROLLING VALVE ASSEMBLY AND THE REAR COVER AND INSTALL THREE (3) USED HEX. HEAD SCREWS INTO THE PUMP MOUNT AND THE REAR COVER.
8. TIGHTEN THE SIX (6) HEX. HEAD SCREWS TO 34-38 LB.-FT. OF TORQUE. TANG ENGAGES THE SHIM DRIVE SLOT.
9. REINSTALL THE HYDRAULIC PUMP MAKING CERTAIN THAT THE PUMP DRIVE TANG ENGAGES THE SHIM DRIVE SLOT.
10. TORQUE THE SCREWS TO 19-21 LB.-FT.
11. REINSTALL THE OIL LINE FROM THE PUMP OUTLET TO THE HEAT EXCHANGER INLET.
12. REINSTALL THE FILTER ASSEMBLY, SUPPLIED WITH THE (XAT205 SERIES) HG506 OR HG507 TROLLING VALVE GROUP. TWO (2) THERMAL PIPE PLUGS FROM FILTER INLET AND OUTLET AND ONE (1) THERMAL PIPE PLUG FROM HEAT EXCHANGER INLET 90° ELBOW MUST BE REMOVED AND DISCARDED.
13. CONNECT OIL LINE FROM THE HEAT EXCHANGER OUTLET TO THE FILTER ASSEMBLY INLET, LOCATED ON THE SIDE OF THE FILTER. THE OIL LINE THAT WAS USED TO CONNECT THE HEAT EXCHANGER DISCHARGE TO THE OLD SELECTOR VALVE INLET MAY BE SUITABLE.
14. CONNECT THE FILTER ASSEMBLY OUTLET TO NEW TROLLING VALVE ASSEMBLY HIGH PRESSURE INLET WITH HYDRAULIC FLEXIBLE HOSE OR TUBING. HYDRAULIC HOSES, TUBING, AND FITTINGS NEEDED TO CONNECT THE FILTER TO THE HEAT EXCHANGER AND TO THE TROLLING VALVE ASSEMBLY ARE NOT SUPPLIED BY THIN DISC. HYDRAULIC LINES MUST WITHSTAND 450 PSI CONTINUOUSLY.

REAR FACE

NOTE:

TAG TO HAVE BLACK LETTERING
ON AG MANILLA BACKGROUND.

SIMILAR TO:

SYM.	CHANGE	CH. NO.	DATE	BY
C	REVISED TITLE, NOTES B, E-B, B-II	22656	9-5-85	KS
B	ADDED "SHEET 1 OF 2, AS MFD BY TWINCO"	22605	5-14-85	RM
A	REVISED REDRAWN	21444	1-9-81	AZ

NAME	HEAT TREAT
TAG - FIELD INSTRUCTION	NONE
MATERIAL	FINISH WT.
AG MANILLA CARDBOARD	
ROUGH WT.	FIRST USED ON
	ASSEMBLY NO. XAT205 SERIES MG506/MG507

UNLESS OTHERWISE SPECIFIED
ALLOWABLE VARIATION ON MACHINED DIMENSIONS ±

DATE	SCALE	DRAWN	CHECKED	APPROVED
7-9-81	NONE	AZ	J6	Bca

TWIN DISC
INCORPORATED
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B2386
SHEET 1 OF 2
AS MANUFACTURED BY TWINCO

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