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Service Manual

Marine Transmission

Model:
MG-502

Document Number: 1015924

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SERVICE MANUAL

MODEL MG-502
MARINE TRANSMISSION
CONVENTIONAL

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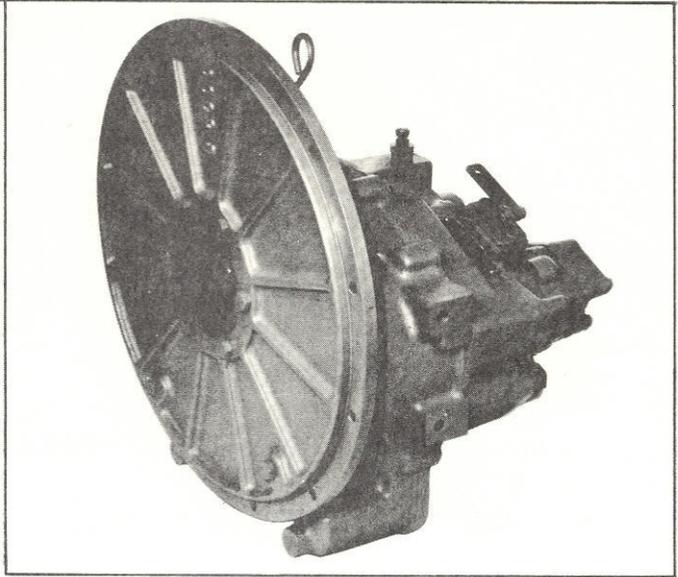
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WITH OPTIONAL HOUSING PILOT FLANGE

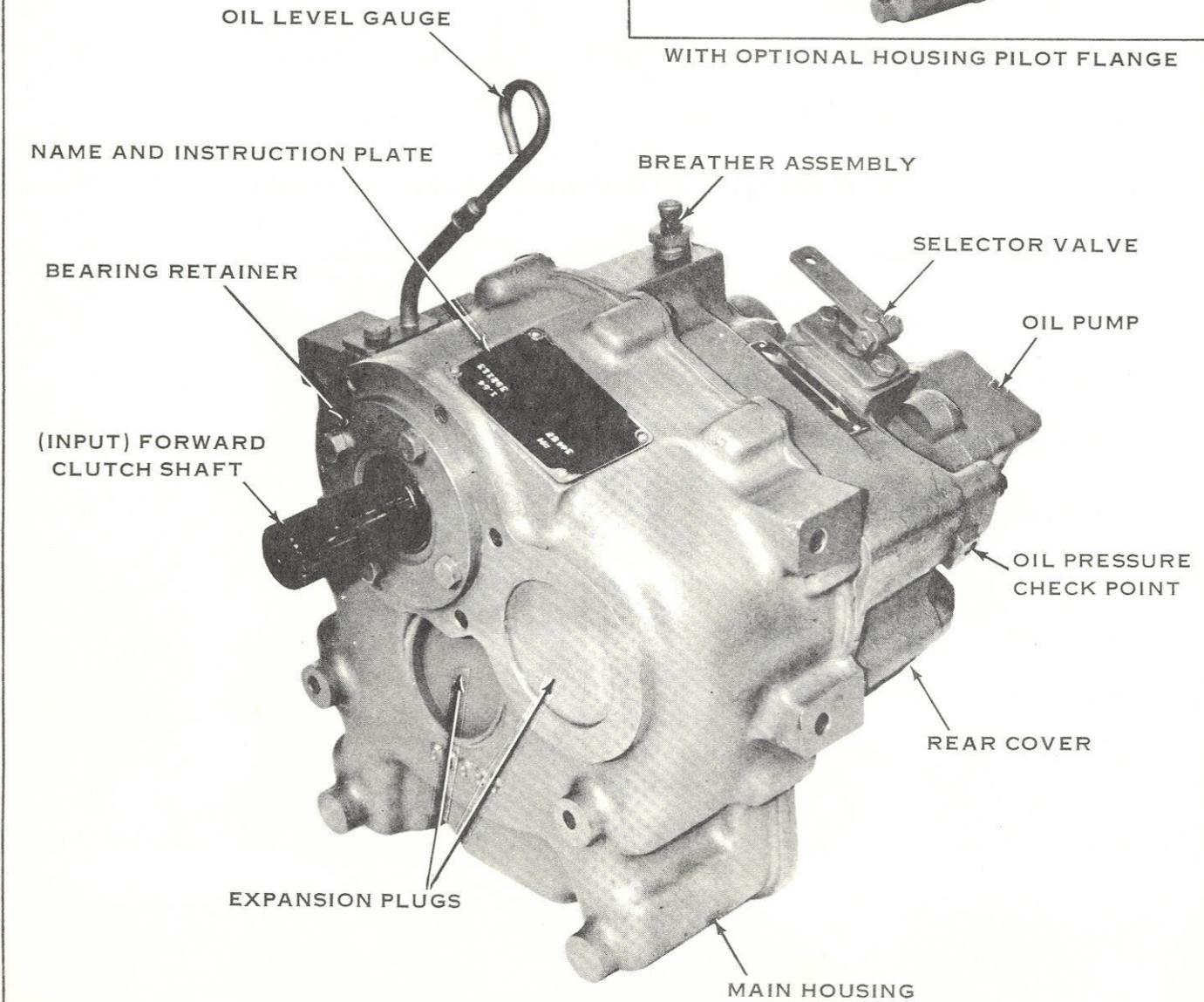


Figure 1. Marine Gear Model MG-502 — Visual Index.

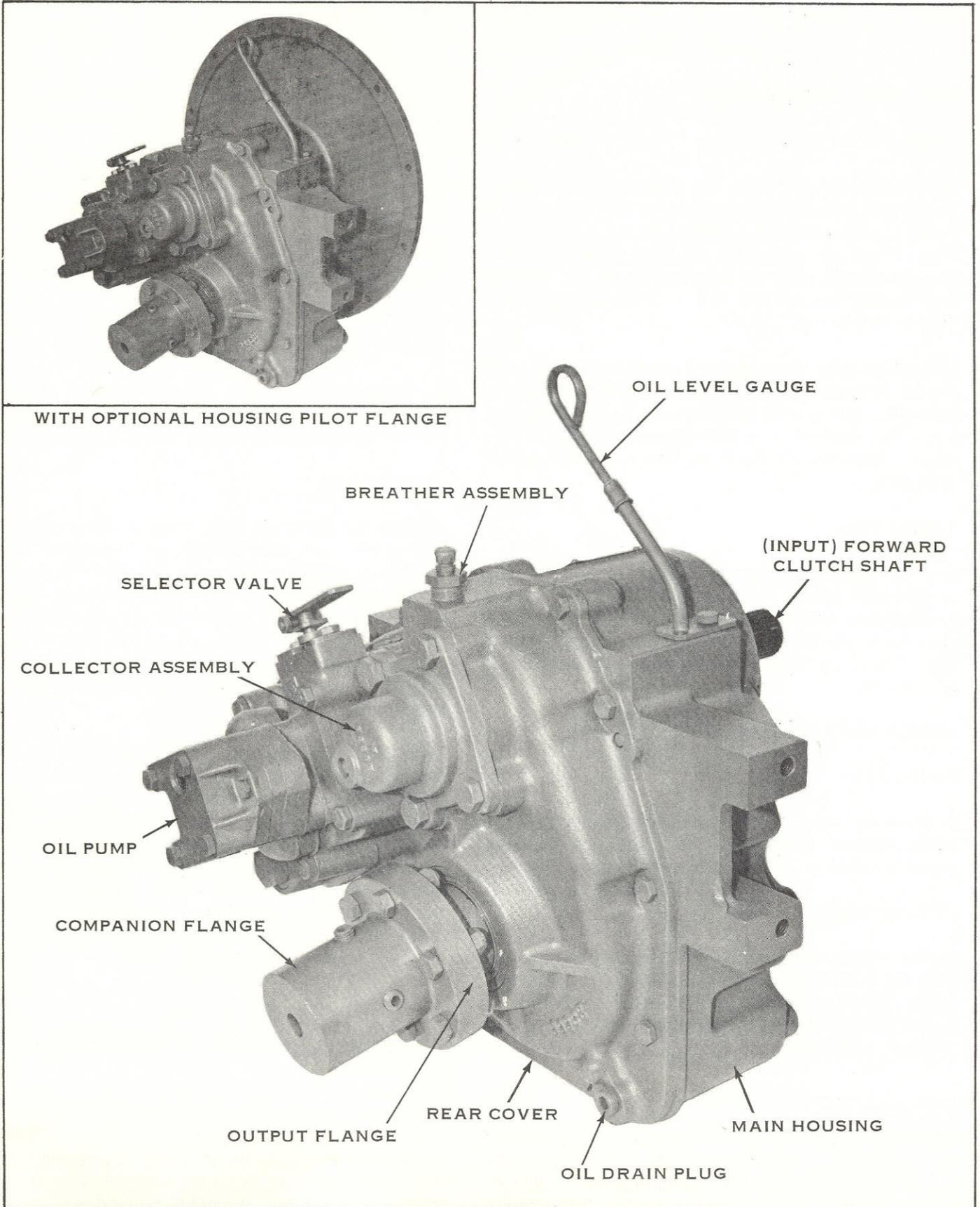


Figure 2. Marine Gear Model MG-502 – Visual Index.

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 downtime.

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.

RENEWAL PARTS AND KITS.

Parts Lists.

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

Ordering Parts.

Renewal Parts and Service Parts Kits, may be obtained from an 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 (formally specifications). 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 (formally specifications), 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 materials (formally specifications) number on 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 a 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.

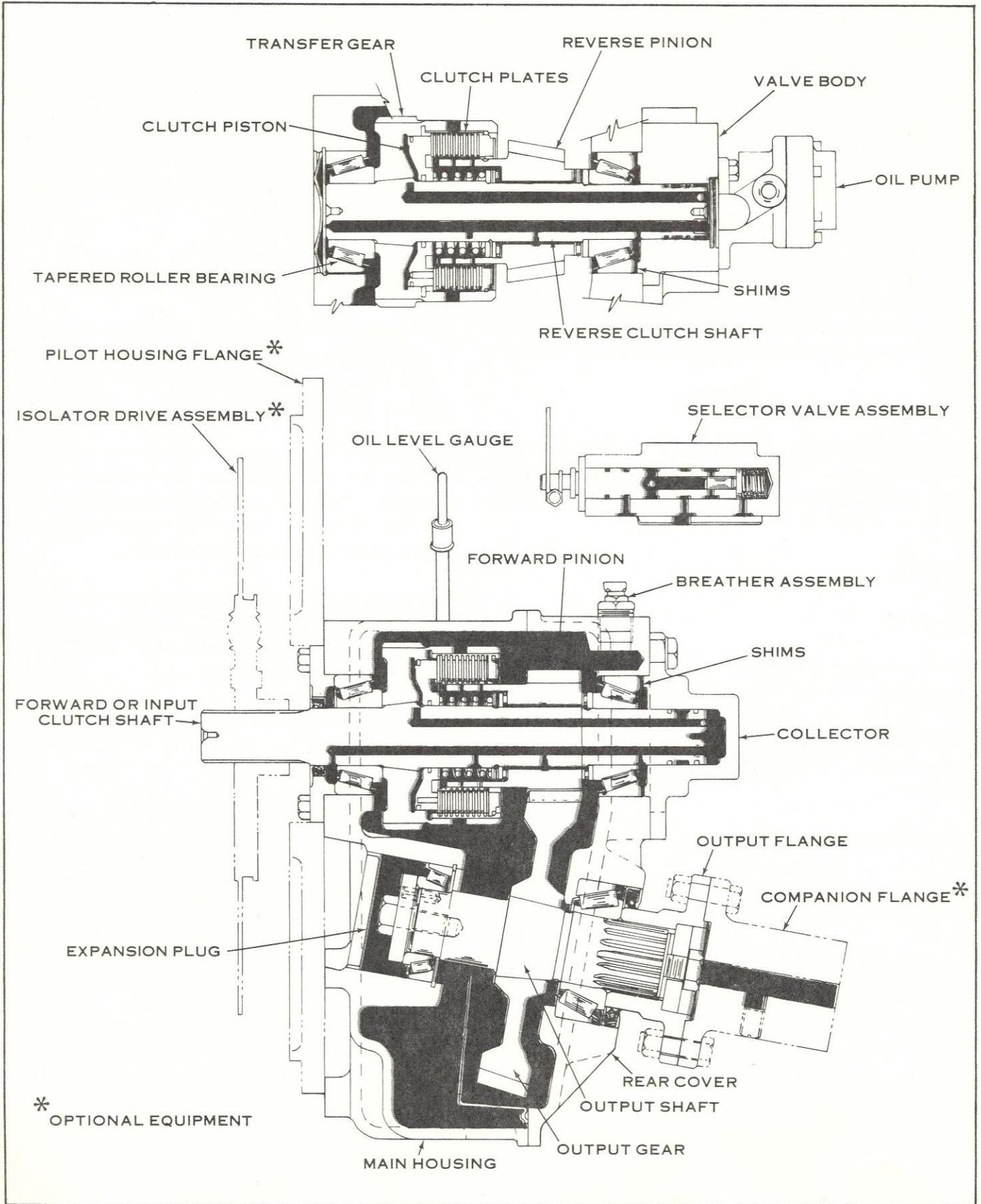


Figure 3. Marine Gear Model MG-502 – Cross-section.

Section II. DESCRIPTION

6. MODEL MG-502 CONVENTIONAL MARINE FORWARD AND REVERSE GEAR

A. General. The Model MG-502 Marine Gear is a lightweight, high capacity gear designed for pleasure craft use. The output shaft exits from the gear at an angle of 10 degrees downward from the input clutch shaft. This provides engine level mounting capability. Full Power operation capability of the gear in either forward or reverse direction eliminates the need for opposite rotation engines. A similar marine gear, MG-502 "V" drive configuration will be treated in a separate manual. This manual is devoted to the conventional MG-502 Marine Gear. Conical, helical gears are used for quiet smooth operation.

NOTE

Throughout the text, there will be references to locations of parts, etc. These references are based on the following:

Front = Input or end of unit attached to prime mover.

Left = Viewed from front of engine (prime mover) position.

Right = Viewed from front of engine (prime mover) position.

Rear = Viewed from engine (prime mover) position, to be section farthest from prime mover.

B. Reduction Ratios. The following ratios are available in the conventional MG-502 Marine Gear: 1.54:1, 2.00:1, 2.47:1. Ratios are varied by changes in clutch pinion and output driven gears.

C. Accessories or Optional Equipment. The following compatible equipment is available and recommended through Twin Disc, Incorporated for use with the MG-502:

(1) **Oil Pressure Gauge.** This is a quality gauge available in a range of 0-400 psi. The scale on the gauge also has the equivalent values in the metric system, kilograms/cm², shown below the english.

(2) **Heat Exchanger.** Heat exchanger kits are available through Twin Disc for the MG-502. The purpose of the heat exchanger is to maintain the marine gear oil at a proper temperature. Kits are designed for either salt or fresh water operation. Specify type of water used when ordering. The hose sizes included in the kits are to be considered minimum in diameters. Do not add smaller hoses or fittings, introducing restriction to oil flows.

7. INPUT GROUP OF PARTS.

A. Torsional Isolator Drive. A torsional isolator drive couples the engine flywheel to the input clutch shaft. The unit consists of a flex drive plate and a torsional absorbing hub assembly. The flex drive plate is bolted to the flywheel while the input clutch shaft connects through a splined hub to the torsional damper hub. This drive tends to dampen engine torsional vibrations, protecting the marine gear from stress and noise. The customer (purchaser) supplies this drive, normally. Twin Disc will supply the drive when so ordered. The drive meets SAE No. J-620C-11.5-inch requirements.

B. Input Clutch Shaft. The input clutch shaft (forward) is the means by which the engine power is directed into the marine gear for reduction and direction of drive. The input clutch shaft (forward) is an extreme press taper fit to a transfer gear, meshed to a driven reverse clutch transfer gear on the reverse clutch shaft. A clutch pack and hub pinion couple the forward shaft to the output gear and shaft.

8. MAIN HOUSING GROUP OF PARTS.

A. Rear Cover – Collector Assembly.

(1) **Rear Cover.** The rear cover attaches to the main housing with two dowel pins and nine hex-head cap screws.

CAUTION

Do not alter dowels or attempt their removal and replacement. Machining alignment of bores could be adversely affected.



The cover and main housing are a sub-assembly, supplied for service replacement as a matched machined set, *only*. The rear cover nor main housing is replaceable separately. The rear cover provides bearing bores to support the two clutch shaft assemblies and the output shaft assembly rear bearings. The rear cover completes the enclosure for the main marine gear components and provides, with the main housing, an oil sump area for the lubricating and hydraulic system oil.

(2) **Collector Assembly.** The collector assembly fits over the rear end of the forward clutch shaft and attaches to the rear cover with four hex head cap screws. The collector serves the purpose of a manifold to direct lubricating and clutch apply oil through the clutch shaft to the forward clutch assembly and bearings. A pair of connecting (jumper) tubes are used to join oil passages from the valve body to the collector. The pilot on the collector provides a means to shim-adjust and retain the forward clutch rear tapered roller bearing. A gear pan encloses the lower section of the output gear. The gear pan attaches to the inside forward face of the rear cover with two hex-head cap screws. The purpose of the gear pan is to prevent turbulence near the end of the pump suction tube which may cause cavitation of the pump with resultant pressure loss. Also, some oil retained in the pan will provide initial gear lubrication when unit is started after standing several hours. A plastic gasket compound is used between the collector and rear cover to seal the parting surfaces.

B. Main Housing – Suction Tube.

(1) **Main Housing.** The main housing is a not-serviced-separately item. It is only supplied with the rear cover as a sub-assembly for service replacement. The main housing provides bearing bores for supporting the clutch and output shaft's front tapered roller bearings. The main housing with the rear cover contains all main components and provides a sump area for storage of lubricating clutch apply oil. Plastic gasket compound is used between the parting surfaces of main housing and rear cover to seal this joining point.

(2) **Suction Tube.** The pump suction tube is considered as an integral part of the housing sub-assembly. The tube is not serviced separately. The pump end of the tube is rolled in the rear cover 0.59-0.65 inch below the rear cover rear face and must be a pressure tight fit.

(3) **Breather.** The breather is assembled with a reducer into a tapped hole at the top of the

rear cover. The breather vents any internal pressure to the atmosphere.

9. OIL PUMP.

A positive displacement, gear type, oil pump is used. The pump is mounted, with four hex-head cap screws and a gasket, on the valve body and is slot driven from the rear end of the reverse clutch shaft. The oil pump turns at all times that the engine is turning, being driven through the clutch shaft transfer gearing and slot at the end of the reverse clutch shaft and tang on the pump drive shaft.

NEW PUMP REQUIREMENTS

Pump to deliver 2.5 GPM @ 3000 pump RPM @ 300 PSI .

NORMAL OPERATING CONDITIONS

Pressure range 300 – 350 PSI

Speed range 600 – 4400 pump RPM.

A filter screen, No. 50 square mesh brass or monel metal wire cloth, is installed in a cavity at the oil pump end of the pump suction tube. The screen is retained by an "O" ring and plug in the selector valve body. The plug also serves as access to remove and clean the filter screen. Oil pump and system protection is provided by this screen.

To adapt an oil pump to either left or right hand engines, a left or right hand rotation oil pump is available. Each direction of rotation requires its separate pump. Field rebuilding repair of oil pump is not recommended. An exchange can be arranged with pump manufacturer.

10. CONTROL AND REGULATOR VALVE ASSEMBLY.

The control and regulator valve assembly (selector valve assembly) consists of a cast body in which the selector valve and a regulator valve are assembled. The regulator valve consists of a valve piston and a spring set; one inner and one outer spring, with a washer installed in a bore of the valve body integrally with the selector valve stem. The selector valve consists of a valve stem, detent plate, "O" ring, and lever. The entire valve assembly attaches to the rear cover, behind the reverse clutch assembly. Two connecting tubes connect from the valve body to the collector to convey lubrication and clutch apply oil to the forward clutch shaft. The oil pump is attached with four cap screws and a gasket to the rear surface of the valve body. Plastic gasket compound is used for a seal between the valve body

assembly and the rear cover. Five hex-head cap screws retain the valve body to the rear cover.

11. REVERSE CLUTCH SHAFT AND GEAR ASSEMBLY.

A. Bearings. A tapered roller bearing is used on each end of the clutch shaft. The end play for the bearing set is adjusted with shims between the valve body assembly pilot and the rear bearing cup (outer race). End play range is 0.003-0.005 inches.

CAUTION

The front bearing cup is machined square on the back face to seat on the snap ring. Do not change this cup with the other three or bearing failure will result.

B. Clutch Shaft. The clutch shaft is an integral part of the sub-assembly consisting of the clutch shaft and transfer gear. The gear is an extreme taper press fit on the shaft. These two pieces are serviced as an assembly, only. Not serviced, separately. Passages for clutch application and lubrication are drilled longitudinally and cross-drilled in the clutch shaft.

C. Clutch Pack Assembly. The clutch pack assembly consists of a pinion gear and bushing assembly, a piston, piston return spring, and a nineteen plate clutch pack. The pack has two sintered, faced-on-one-side only plates, eight sintered, faced (both sides), and nine steel plates. A backing plate and internal snap ring retain the plate stack in the hub. The sintered (faced) plates are meshed with external teeth to the internal spline of the transfer gear. The steel plates are meshed with internal teeth to the external teeth of the clutch hub. External teeth on the clutch back plate mesh with the internal teeth of the transfer gear. In assembly, the one-side-sintered plates are used on the ends of the pack. The plate against the piston, contacts the piston surface with its steel side (unsintered). The plate on the back plate end of the pack, contacts the back plate with its steel side (unsintered). The plates between the two special end plates are alternately nine steel and eight sintered to make up the pack.

D. Thrust Bearings and Washers. The pinion hub assembly has thrust washers, and needle thrust roller bearings at each end to reduce the friction and load from these forces.

E. Oil Seal Rings. Two oil seal, hooked end, piston type, seal rings are used in the grooves near the rear end of the clutch shaft to port the oil passages through which oil is directed down the clutch shaft drillings.

12. FORWARD (INPUT) CLUTCH SHAFT AND GEAR ASSEMBLY.

A. General. This clutch shaft and gear assembly is very much like the reverse clutch shaft assembly described above in paragraph (11).

B. Bearings. A tapered roller bearing is used on each end of the forward clutch shaft. The end play for the bearing set is adjusted with shims between the collector at the rear of the rear cover and the rear outer bearing race (cup) of the tapered roller bearing assembly. The forward bearing cup or outer race is retained in position by a bearing retainer on the front of the main housing. The bearing end play range is 0.003 to 0.005 inches.

C. Clutch Pack Assembly. The forward (input) clutch pack assembly is the same as the reverse clutch pack assembly described above in paragraph (11C).

D. Thrust Bearings and Washers. The reverse clutch and forward clutch are constructed the same in respect to the thrust washers and bearings.

E. Oil Seal Rings. As in the reverse clutch shaft assembly, the forward (input) clutch has two oil seal rings of the hooked end, piston type design to port the clutch apply and lubrication oil through the shaft drillings.

13. OUTPUT SHAFT GROUP OF PARTS.

The output shaft assembly consists of; the output shaft, output gear (pressed on shaft taper), two tapered roller bearings, a spacer, a lathe cut seal ring, a rear retainer washer, cap screw, output flange, a front retainer washer, cap screw, shims, a snap ring, and an expansion plug. A gear pan attached to the rear cover shrouds the lower section of the output gear.

A. Output Shaft. The output shaft is designed with a downward ten degree angle toward the rear. The shaft is supported in a large tapered roller bearing at the rear and a smaller tapered roller bearing at the front. The front bearing outer bearing race (cup) is retained with an internal snap ring in its bore in the main housing. The larger tapered roller bearing cup at the rear is pressed into its bore to bottom in the rear cover. The output shaft bearings are adjusted for end play with shims located between the front end of the shaft and the front retainer washer. The end play range is 0.003 to 0.005 inches.

B. Output Gear. The output gear is a press fit onto a taper on the shaft. The gear is a helical, conical, machined gear to compensate for the ten degrees of output shaft downward angle mounting.



C. Output Shaft Seals. Counting the expansion plug at the front of the output shaft in the main housing, three seals are used on the output group of parts. A double-lip type seal, spring loaded on the oil control side is pressed into the rear cover. The seal lips ride on a seal machined surface on the output flange. To seal possible leakage down the spline between the output flange and shaft, a lathe cut seal ring is installed and retained with the flange retaining washer.

OIL PRESSURES

*Minimum oil pressure when cruising – 275 PSI. Oil pressure gauge attached to oil pump at port to heat exchanger (3/8-18 NPTF. Dry Seal). Use a “tee” connection fitting when heat exchanger is used.

OIL TEST PRESSURES

Input RPM	Shift	Min. PSI*	Max. PSI*
1800	Forward	310	340
	Neutral	310	340
	Reverse	310	340
600	Forward	275	335
	Neutral	290	335
	Reverse	275	335

**Oil temperature for test 85-95° F. viscosity 200-260 SUS.

D. Output Flange. The output flange with a companion flange afford the means of shaft connection to the propeller. The output flange is constructed with a hub and flange section. The hub is internally splined to connect to the marine gear’s output shaft. The external area of the hub is machined for a seal surface for the oil seal. The flange section is flat machined and drilled with six equally spaced holes for attaching the companion flange. The flange face surface must not exceed .004 inch total indicator reading when installed in marine gear. The pilot of the flange, must not have more than 0.004 inch total indicated runout. A companion flange will be supplied by Twin Disc on order only. The companion flange will have six bolts with self-locking nuts select ream-fitted to the holes. Also two setscrews will be installed in the hub of the companion flange ninety degrees apart. The hub will be shaft bored to accommodate customers propeller shaft size (customer must specify). If the customer requires a key seat (keyway), he must machine this himself on a center line through the flange which bisects the setscrew centerlines, placing these forty-five degrees to each side. The keyway must be milled opposite the bore side from the setscrew holes. A lathe cut seal ring, retainer washer, and cap screw secure the output flange to the marine gear output shaft.

TYPE OIL FOR TEMPERATURE

(See page 16.)

OIL CHANGE INTERVAL

Check oil weekly or every 20 hours of operation. Clean suction screen and refill unit with clean oil yearly. To drain oil, remove drain plug, or use suction drain hose attached to oil level gauge tube. Fill oil to “full” mark on gauge with engine at idle speed and marine gear in neutral.

OIL PUMP CAPACITY NEW PUMP REQUIREMENTS

Pump to deliver 2.5 GPM @ 3000 pump RPM @ 330 PSI.

NORMAL OPERATING CONDITIONS

Pressure range 300-350 PSI
Speed range , 600-4400 pump RPM

14. PERTINENT INFORMATION AND DATA.

The following table of information provides important service information in one location.

TABLE I

GENERAL INFORMATION

OIL CAPACITY

3.5 pints U.S. measure (does not include heat exchanger and connections used externally). Fill to “full” mark on oil level gauge with engine at low idle speed and marine gear in neutral.

MAXIMUM PERMISSIBLE MARINE GEAR SPEED

4000 RPM

DRY WEIGHT

132 lbs.

Section III. PRINCIPLES OF OPERATION

15. GENERAL.

A. Description. The Model MG-502 Marine Gear is a marine reverse and reduction gear available in three ratios at this time; 1.54:1, 2.00:1, and 2.47:1. Within their rated capacities, all ratios may be operated continuously in either the forward or reverse position. Identical ratios in forward and reverse permit the type of installation known as "Twinning"; that is, mounting two gears on two right-hand (or left-hand) rotation engines and running one gear in forward and the other gear in reverse to obtain opposite rotation of the propellers (for counter-acting torque). This marine gear is completely hydraulic in all phases – all bearings are oil lubricated, both clutches are engaged by high pressure oil, and both clutches are oil pressure lubricated and cooled.

B. Direction of Drive. The forward (input) clutch shaft and transfer gear always rotate in engine direction. The reverse clutch shaft and transfer gear always rotate in anti-engine direction. When the forward clutch is engaged, the output shaft driven gear will rotate in anti-engine direction, because it is meshed with the forward clutch shaft pinion. When the reverse clutch is engaged the output driven gear will rotate in engine direction due to the output gear mesh with the reverse clutch shaft pinion.

16. POWER FLOW.

A. Neutral. When in neutral, all parts that rotate in the marine gear turn at engine speed. The torsional isolator bolted to the engine flywheel is the connecting member between the engine and the marine gear. The splined hub of the torsional isolator meshes with the splines on the forward (input) clutch shaft. The internal spline of the steel clutch plates mesh with the external splines of the pinion hub which is connected through the pinion to the output driven gear. The sintered faced plates of the forward clutch connect directly to the internal splines of the forward clutch transfer gear with their external splines. The transfer gear connects through its taper press fit directly to the clutch shaft. Therefore, the

clutch shaft, transfer gear, and faced clutch plates are turning in engine direction. The steel plates, hub and pinion, and output gear are not turning with the forward clutch disengaged. The reverse clutch transfer gear is constantly meshed with the forward clutch transfer gear. The transfer gears have the same number of teeth, so the drive-driven ratio is 1:1. The reverse transfer gear and clutch shaft are rotating in anti-engine direction at engine speed. The sintered faced reverse clutch plates are constantly meshed to the internal spline of the reverse transfer gear with their external spline. The reverse clutch steel plates are constantly meshed to the external hub spline of the reverse pinion with their internal spline. In neutral, the reverse transfer gear, clutch shaft, and sintered faced clutch plates are turning in anti-engine direction. The oil pump driven from the reverse clutch shaft also is turning in anti-engine direction at engine speed. Both clutches, being disengaged, prevents further power flow in the marine gear.

B. Forward. When forward speed is selected, all the marine gear parts which were turning during neutral selection are still turning. However, when forward is selected, the forward clutch steel and faced plates are clamped together by the clutch piston and back plate. This connects the forward clutch shaft and transfer gear to the clutch pinion, meshed to the output gear. The output gear, taper press fitted to the output shaft then turns the output shaft, flange, and propeller at a reduced speed in anti-engine direction. The reduced speed results from ratio of pinion to output gear.

C. Reverse. When in reverse, all the marine gear parts that were rotating in neutral are still turning. However, when reverse is selected, the reverse clutch steel and faced plates are clamped together by the clutch piston and back plate. This connects the reverse clutch shaft and transfer gear to the clutch pinion which is meshed to the output gear. The output gear, taper press fitted to the output shaft, then turns the output shaft, flange, and propeller at a reduced speed in engine direction of rotation. The reduced speed results from ratio of reverse pinion to output gear.

POWER FLOW 10° ANGLE DRIVE

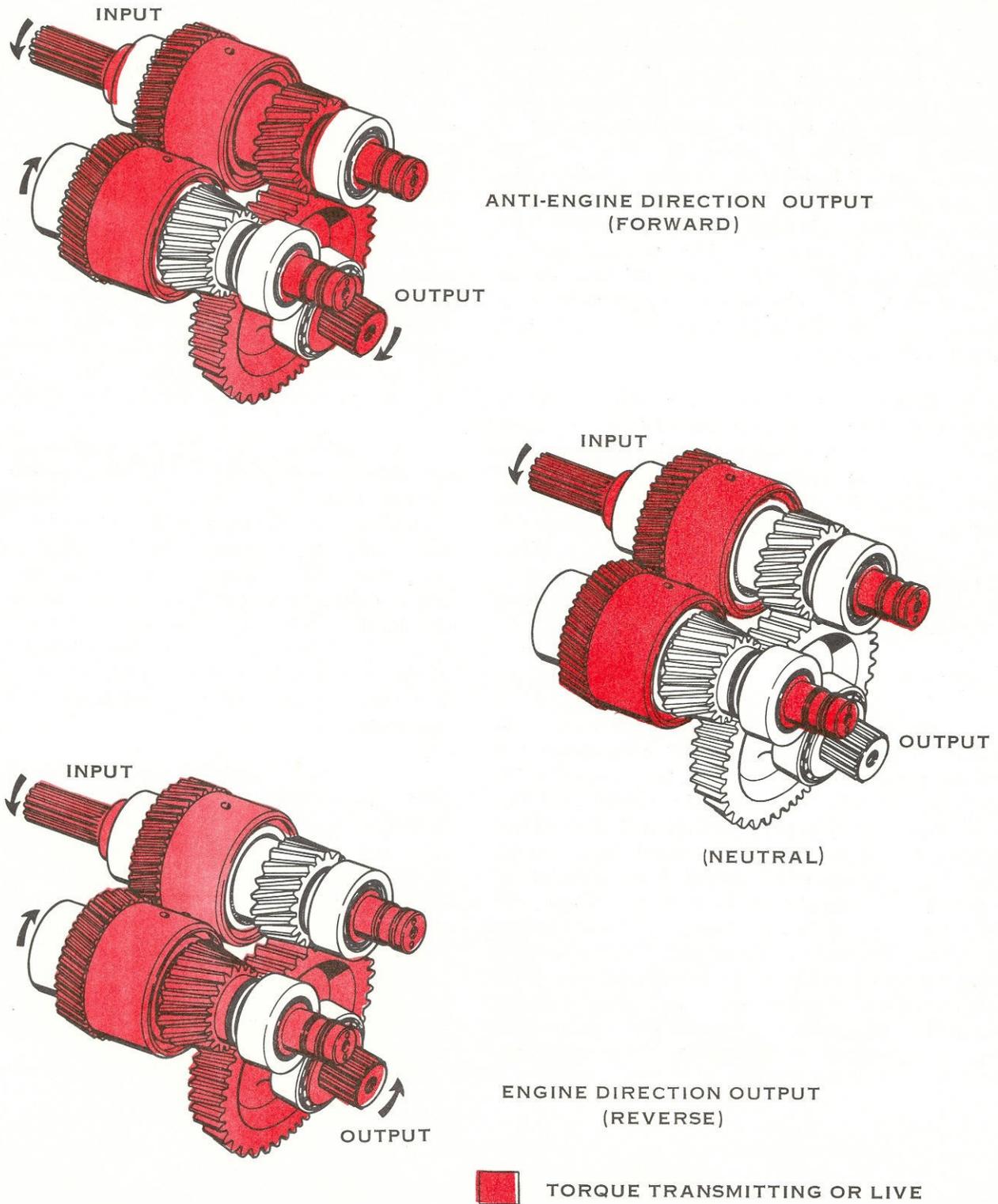


Figure 4. Power Flow Diagrams.

Section IV. HYDRAULIC SYSTEM

17. GENERAL.

A. Description. The hydraulic system in the Model MG-502 Marine Gear serves to deliver oil pressure for clutch engagements, lubrication, and cooling. The sump, which is located in the bottom section of the main housing, contains an adequate amount of oil for all hydraulic system requirements. The oil pump provides the source of oil pressure and volume for the system. The selector valve, integral with the pressure regulating valve, controls the oil routing and pressure regulation of the system. The valve body, connecting tubes and collector are further means for direction of the clutch apply and lubricating oil flows. The valve body and collector have drilled passages for this purpose. An oil suction strainer filters the oil before entering the oil pump to be pumped throughout the system. The clutch shafts have oil passages drilled longitudinally and crosswise to distribute the oil for clutch application, lubrication, and cooling. The only external plumbing involved, is that used for installing the heat exchanger. Connections for the heat exchanger are provided on the selector valve body (3/8-18 NPTF dry seal) for inlet from heat exchanger, and on the oil pump (3/8-18 NPTF dryseal) for outlet to the heat exchanger. The heat exchanger will keep the hydraulic system oil at the proper temperature. A

1/4-18 NPTF is tapped at the control valve and plugged to attach an oil pressure gauge connection.

B. Oil Circuit. The oil pump draws the oil from the sump through a strainer on the suction side of the pump. The pressure side of the oil pump displaces oil under pressure through the heat exchanger and into the selector valve where it is regulated for pressure. The overage oil from the pressure regulator valve is routed to the clutches through their shafts for lubrication and cooling. Regulated pressure oil from the regulator valve is directed to the selector valve. In the neutral position of the selector valve, the pressure oil is dead-headed, or blocked, and both clutch apply passages are open to exhaust (sump) through the valve. When the selector valve is rotated to the forward position (output shaft anti-engine direction), the clutch apply passages to the forward clutch are charged with pressurized oil to apply the clutch. The reverse clutch passages are connected through the selector valve at this time to exhaust to sump. When the selector valve is rotated to the reverse position (output shaft engine direction) the clutch apply passages to the reverse clutch are charged with pressurized oil to apply the clutch. The forward clutch passages are connected through the selector valve at this time to exhaust to sump. (See schematic circuit drawing).

ZINC ELECTRODE RODS USED IN HEAT EXCHANGERS FOR SALT WATER OPERATION

Heat exchangers furnished by Twin Disc, to be used for salt water applications, have zinc rods installed at the inlet and outlet heads.

These rods must be checked every 90 days. If over 50% of the rod is disintergrated, it should be replaced to provide effective protection.

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.

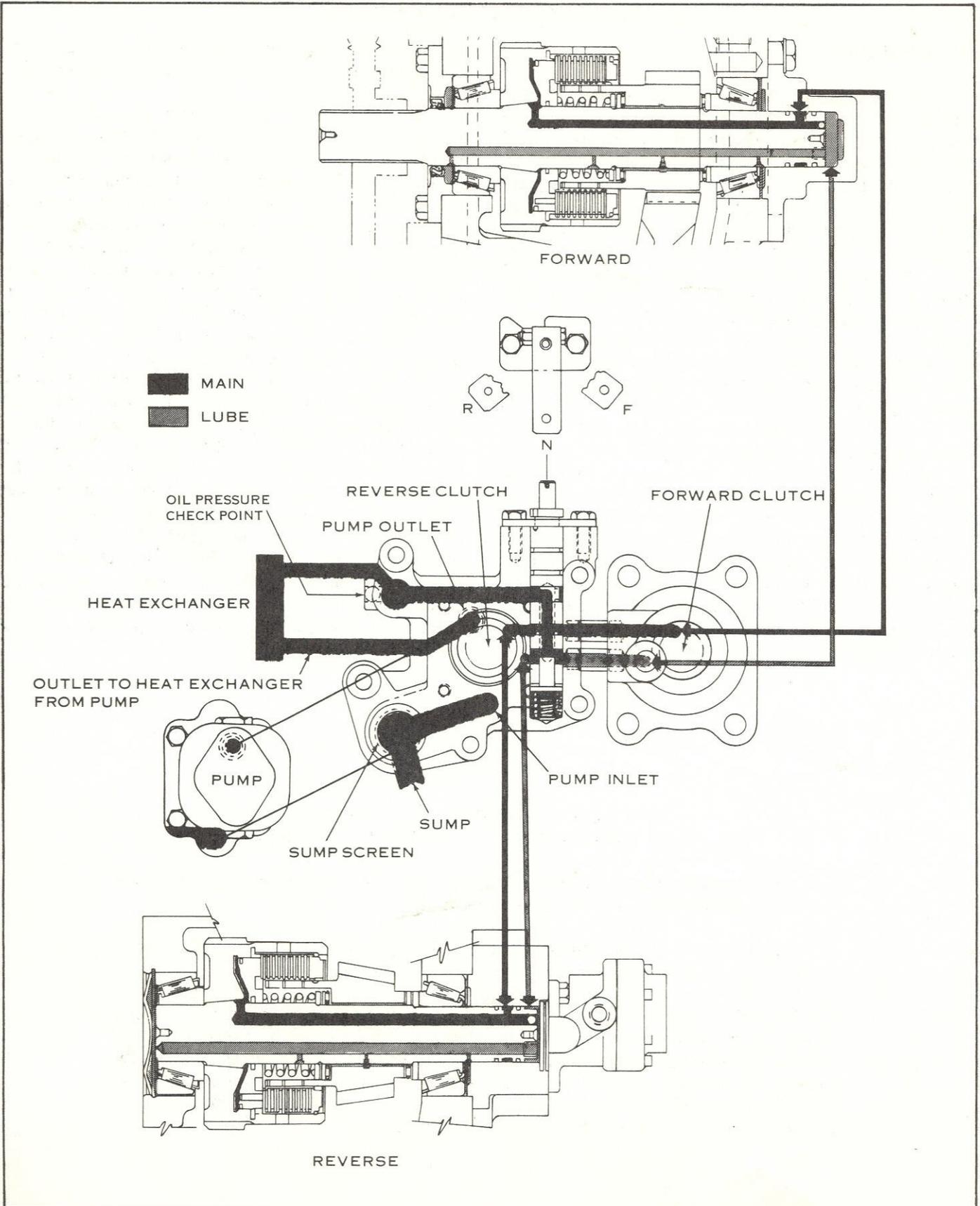


Figure 5. Oil Circuit Schematic Drawing.

Section V. PREVENTIVE MAINTENANCE

18. GENERAL.

A. Lubrication. All moving parts of the Marine Gear are lubricated by the oil within the sump as it travels throughout the hydraulic system. The preventive maintenance to keep the gear functioning properly consists of checking the oil level at given intervals and changing oil as recommended. Cleaning the oil strainer is also a part of preventive maintenance.

B. Overhaul Interval. A complete overhaul of the MG-502 Marine Gear should be made at the same time that the engine is overhauled. All parts showing signs of wear, fatigue, etc., should be replaced at that time.

19. HYDRAULIC SYSTEM.

A. Oil Capacity and Weight. The oil capacity of the MG-502 Marine Gear is 3.5 pints U.S. measure. This is less heat exchanger and connections. Fill to the "Full" mark on the oil level gauge with engine running at idle speed in "neutral." (See page 16).

B. Oil Level. The oil level should be checked after each twenty hours of service or weekly. The oil level must be checked with the engine running in "neutral", at idle speed and operating temperature. Maintain level at the "Full" mark on oil level gauge.

C. Oil Change Interval. The oil must be changed, system flushed, and suction screen cleaned once yearly.

D. Draining. The oil sump is drained through the removal of the socket head drain plug located in the lower left corner of the rear cover. Allow sufficient time for draining and install the drain plug. Tighten the plug securely in place.

E. Filling. Make certain the drain plug is tight, and fill the sump with three and one-half pints of proper oil (paragraph 19A). Remove the breather and bushing (reducer) from the top of the rear cover. Pour the oil (with a small funnel) through the breather opening into the unit. Start the engine and run in "neutral" until oil is circulated throughout the hydraulic system. Check the oil level on the oil level gauge. With oil at operating temperature and engine

running at low idle speed, fill the oil sump to read "Full" on the oil level gauge. Install and secure the breather and bushing.

20. HYDRAULIC SYSTEM COMPONENT PARTS.

A. Suction Strainer. The suction strainer access plug should be removed and the strainer removed and cleaned once yearly, at the same time the oil is drained and changed. Use a suitable solvent to clean the strainer, inspecting the strainer for any damage to wire gauze. Replace a strainer that is in any way damaged. Check the "O" ring on the strainer access plug and install the plug and serviceable "O" ring. Tighten the plug securely.

B. Breather Cap. Remove and clean the breather cap at the yearly oil change interval.

C. Heat Exchanger and Hoses. During the annual oil change and flush period, disconnect hoses from heat exchanger and thoroughly flush exchanger with a suitable solvent. Inspect the zinc electrode used to protect the system from the effect of galvanic action. Replace zinc electrode showing extensive disintegration.

D. Oil Filter. Follow oil filter manufacturer's recommendations. Twin Disc type are changed every year or 1000 hours of operation, whichever occurs first.

21. PERIODIC VISUAL INSPECTION.

A. General. Inspect engine bay and marine gear daily, either at the time before morning start up, or at the end of the day's use, whichever is most convenient. Check the following points.

B. Oil Leakage. Check for oil leakage at the parting surfaces between the main housing and rear cover, rear output shaft flange seal, valve body and rear cover, oil pump and valve body, collector and rear cover, connecting tubes between valve body and collector, oil strainer access plug, and drain plug. Correct any leakage which is excessive. An excessive leak would be a leak resulting in oil puddles and oil consumption. An acceptable leak after 700 hours of operation, would be one which could be hand rag wiped clean daily. Repair as required in the event of excessive oil leakage.

C. Heat Exchanger Connecting Lines. Inspect



these lines daily. Check for leakage, tight connections, physical damage, and routing or hanging. Replace damaged or defective lines.

D. Pressure and Temperature Gauges. Inspect the gauges for physical damage, or leaks at connections or lines. If a gauge is suspected of being inaccurate, replace the gauge with one of proven

accuracy to determine the condition of removed gauge. Replace defective gauges.

E. Marine Gear Mounting and Drive Fittings. Inspect the marine gear mounting for loose bolts or cracked brackets. Repair or replace. Inspect the output flange and companion flange for security of attachment. Repair as required.

MARINE TRANSMISSION LUBRICATING OIL RECOMMENDATIONS

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.

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

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	
A. Models MG502, MG506, MG509, MG510A, MG512, MG514 and MG514M		
	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.
B. Models MG521, MG527, MG530, MG530M and MG540		
	Below 150° F.	This operating condition is <u>not</u> approved.
35° F. Minimum	150° – 185° F.	SAE viscosity number 40 engine oil
50° F. Minimum	175° – 200° F.	SAE viscosity number 50 engine oil
	Over 200° F.	This operating condition is <u>not</u> approved.

A

Section VI. TROUBLE SHOOTING

22. GENERAL.

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

23. PRESSURE AND TEMPERATURE CHECKS.

A. Main Pressure. Attach an 0-500 psi range pressure gauge to the (3/8-18 NPTF dryseal) selector valve inlet from the heat exchanger with a tee and read the following pressure for conditions given.

Input RPM	Selector Position	Min. PSI	Max. PSI
1800	Forward	310	340
	Neutral	310	340
	Reverse	310	340

600	Forward	290	335
	Neutral	290	335
	Reverse	290	335

B. Temperature. Attach a temperature gauge in the same line which the oil pressure gauge was used and check the operating temperature range. It should be 140 degrees F. minimum to 180 degrees F. normal. The maximum temperature at the heat exchanger inlet is 225 degrees F. maximum. Measure this from a tee connected at the pump outlet to heat exchanger. Same thread size tapped hole as the heat exchanger outlet to the selector valve used for oil pressure check.

C. Trouble Shooting Chart. The trouble shooting chart is prepared in three columns. Proper use of the chart will aid in the rapid determination and repair of any functional difficulties that may occur.

Table II. Trouble Shooting.

<i>Symptom</i>	<i>Cause</i>	<i>Remedy</i>
<i>1. Low oil pressure.</i>	1-1. Partially clogged oil strainer.	1-1. Remove and clean oil strainer.
	1-2. Stuck regulator valve piston in selector valve assembly.	1-2. Remove the selector valve and clean and inspect the regulator valve.
	1-3. Broken seal rings on clutch shaft.	1-3. Remove the collector and valve body and replace oil seal rings on shafts.
	1-4. Damaged or worn oil pump assembly.	1-4. Remove and replace oil pump assembly.
	1-5. Improper selector valve linkage adjustment.	1-5. Adjust control linkage to selector valve properly.
<i>2. No oil pressure.</i>	2-1. Low oil level or empty sump.	2-1. Check unit for oil leakage. Repair and refill properly.
	2-2. Fully clogged oil strainer.	2-2. Refer to Remedy 1-1.
	2-3. Damaged or worn oil pump assembly.	2-3. Refer to Remedy 1-4.

Table II. Trouble Shooting.

<i>Symptom</i>	<i>Cause</i>	<i>Remedy</i>
<i>3. High oil pressure.</i>	3-1. Stuck regulator valve piston in selector valve body.	3-1. Refer to Remedy 1-2.
<i>4. Overheating.</i>	4-1. Insufficient heat exchanger capacity.	4-1. Install proper heat exchanger.
	4-2. Insufficient cooling water flow.	4-2. Inside diameter of water lines too small. Replace lines with ones of proper size.
	4-3. Clutch slipping.	4-3. Low oil pressure at clutch will cause slippage. Refer to Symptom 1.
	4-4. Oil level too high.	4-4. Correct oil level.
	4-5. Improper oil in sump.	4-5. Drain and fill marine gear with proper oil.
<i>5. Excessive noise.</i>	5-1. Excessive backlash in gears.	5-1. Backlash expected to be 0.005-0.016 inch.
	5-2. Bearing failure.	5-2. Remove and overhaul marine gear, replacing the defective parts.
	5-3. Torsional isolator worn excessively.	5-3. Replace torsional isolator after marine gear removal.
<i>6. No neutral.</i>	6-1. Clutch plates warped.	6-1. Replace clutch plates. Overhaul unit.
	6-2. Selector valve incorrectly positioned.	6-2. Check and adjust control linkage.

**Section VII. MINOR REPAIRS –
UNIT MOUNTED TO ENGINE IN THE BOAT.**

24. GENERAL.

There are a few components which can be service replaced while the marine gear is mounted in the boat on the engine. Because of its light weight and size, removing the unit from a boat should pose no great problems.

A. Oil Pump. The oil pump can be removed and replaced as follows: Disconnect the heat exchanger line from the pump outlet port and remove the four hex-head cap screws which retain the pump to the selector valve body. Remove the oil pump and gasket from the valve body. Remove the access plug and remove the pump suction strainer from the valve body. Clean and replace the oil strainer. Install the oil pump reversing the removal procedures. Tighten the pump retaining screws to 15-17 lbs.-ft. torque.

B. Selector Valve. The selector valve and/or the collector should be removed as a pair because of the jumper connecting tubes between them. They can be removed with the marine gear mounted in the boat. Remove the oil pump first as in paragraph 24A above. Then, remove the linkage from the selector valve and remove the five hex-head cap screws, three short and two longer ones from the selector valve body, which retain the body to the rear cover. Remove the four hex-head cap screws which secure the collector to the rear cover. Remove the valve body and collector from the rear cover as an assembly. Separate the valve body from the collector and connecting tubes. Pull the tubes from whichever part they remain in. Before installation of these parts, inspect the connecting tube "O" rings to see if they are still serviceable and clean the mounting area on the rear cover of all old plastic gasket compound. Apply new plastic gasket compound to the valve body and collector mounting

areas on the rear cover. Install the valve body and collector, using the reverse of the removal procedures. Tighten the cap screws on the valve body to 27-30 lbs.-ft. torque and the cap screws on the collector to 61-68 lbs.-ft. torque.

C. Output and Coupling Flanges. The output and coupling (companion) flanges can be removed with the marine gear mounted to the engine. However, a realignment check, as covered in the section at the rear of this manual, pertaining to marine gear installation, must be executed upon reinstallation. Remove the six mounting bolts and nuts which retain the companion flange to the output flange. Be sure to match mark each flange as the holes are line reamed to each other. Remove the retaining cap screw, retainer washer (with lathe cut seal ring), and the output flange from the output shaft. Use a puller to remove from the splined area of the shaft. The flange double-lipped oil seal can be removed and replaced at this time. The seal is destroyed in removal. Install the new seal squarely in the bore of the rear cover and tap the seal inward until the seal casement is flush with the exterior of the seal bore. Install these parts in the reverse order of removal procedures. Tighten the retaining screw into the output shaft to 125-140 lbs.-ft. torque. Tighten the flange bolts to 40-44 lbs.-ft. torque.

D. Clutch Shaft Oil Seal Rings. The two hook type piston seal rings used on the rear of each of the clutch shafts can be replaced after removal of the valve body and collector. See paragraphs 24A and 24B above.

E. Heat Exchanger. The heat exchanger should be accessible enough to remove with the marine gear installed in the boat and lines disconnected from the oil pump and selector valve.



Section VIII. REMOVAL

25. PRIOR TO REMOVAL.

A. **Hydraulic System.** Drain the hydraulic system of oil Paragraph 19D.)

B. **Connecting Linkage and Lines.** Remove the control linkage from the marine gear selector valve. Disconnect the heat exchanger oil and water lines from the marine gear and engine. Remove heat exchanger for a thorough cleaning.

C. **Output and Companion Flanges.** Mark and remove the six bolts, securing the output and companion flanges together.

D. **Support.** Support the marine gear and engine with a hoist or suitable equipment prior to the removal of any mounting parts.

26. REMOVAL.

A. **Output Flange Connection.** Scribe an alignment mark across the outside diameter of the output and companion flanges for ease of installation. Slide the propeller shaft and companion flange rearward approximately four inches for marine gear removal clearance.

B. **Mounting to Bed Rails.** Disconnect the brackets mounted on the engine bed rails from the mounting pads of the marine gear, or from the engine bed rails.

C. **Engine Attachment.** Remove the attaching parts that secure the front main housing flange of the marine gear to the engine flywheel housing. Slide the marine gear rearward until the forward (input) clutch shaft slides free of the splined hub of the torsional isolator. Remove the marine gear. Remove the torsional isolator drive from the engine flywheel only if replacement of the parts is necessary.

LIFTING BOLTS OR EYEBOLTS

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

These lifting points should **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.

Twin Disc can supply lifting eyebolts for most of its products. They range in size from (3/8) thread to (1-1/4) inch thread and ultimate load capacity of 3 ton to 33 ton. Consult the Service Engineering Department, 1328 Racine Street, Racine, Wisconsin 53403, U.S.A.

PROCEDURE TO USE WHEN PREPARING TO ASSEMBLE COMPONENTS WHICH USE "LOCTITE" PLASTIC SEALANT ON PARTING OR JOINT MATING SURFACES.

1. Scrape surfaces to remove old plastic gasket material.
2. Clean surfaces with trichlorethylene or equivalent type solvent.
3. Test for a clean surface by applying a few drops of water (cool) to surface. Parts are sufficiently clean if water covers the part surface in a film. If water puddles or forms beads, use fresh solvent and reclean.
4. Use Twin Disc primer MA579 ("Locquic T") or equivalent primer on both mating surfaces. Allow primer to dry. This usually takes three to four minutes. Keep surfaces clean from this point on. Oil, grease, etc., must be prevented from contaminating these surfaces.
5. Apply a thin continuous bead of (M2828 (2cc)) or (M2828A (50cc)) anaerobic plastic sealant to one surface. Complete the assembly of components and final torque tighten all attaching capscrews to Twin Disc torque specifications.
6. Allow two hours curing time at room temperature before filling unit with oil. This time is applicable, only if the priming step (4) is accomplished. Otherwise, curing time will be twenty-four hours without the use of primer.

Section IX. DISASSEMBLY

27. MISCELLANEOUS EXTERNAL PARTS.

A. General. Make a jig or stand from strap or bar steel stock to hold the marine gear main housing. The weldment you make should be similar to that shown in the following disassembly illustrations. Place the marine gear in the stand in its normal upright position.

B. Oil Pump. Remove the four hex-head cap screws (fig. 48, 25) and remove the oil pump (24) and gasket (23) from the valve body (22).

C. Strainer. Remove the "O" ring and plug (fig. 48, 28, 27) and remove the wire gauze strainer (29) from the valve body and cover.

D. Selector Valve and Collector. Remove the three hex-head cap screws (fig. 48, 26), one hex-head cap screw (30), and one hex-head cap screw (31) which secure the valve body (22) to the rear cover. Remove the four hex-head cap screws (18) which secure the collector (17) to the rear cover (5). Remove the valve body and collector from the rear cover as an assembly. Remove the shims (fig. 49, 22) and (fig. 50, 22) from behind bearing cups of clutch shafts. Pull the collector from the connecting tubes (fig. 48, 20) and valve body (22). The collector connecting tubes may remain in either the valve body or the collector. Remove the connecting tubes (20), and remove the "O" rings (19) and (21) from the tubes. Remove the nut (6), cap screw (8), and remove the lever (7) from the valve stem (12). Remove the two cap screws (9), and remove the detent plate (10) and "O" ring (11) from the valve body and valve stem. Remove the valve stem (12), pressure regulator valve (13), and pressure regulator inner and outer springs (14) & (15) from the valve body. Remove the thrust race (16) from the valve body (22).

E. Breather. Remove the breather and reducer (fig. 48, 3, 4) from the rear cover only if cleaning and/or replacement of the parts is necessary.

F. Oil Level Gauge. Remove the oil level gauge (fig. 47, 1) and screw (2) from the oil level tube (3). Remove the tube (3) from the main housing (4).

G. Expansion Plug. Use a punch and remove the output shaft, front bearing bore, expansion plug (fig. 47, 12). Remove the reverse clutch shaft, front bearing bore, expansion plug (10) only if replacement of the parts is necessary. Remove the reverse clutch shaft front bearing internal snap ring (11) only if replacement of the part is necessary.

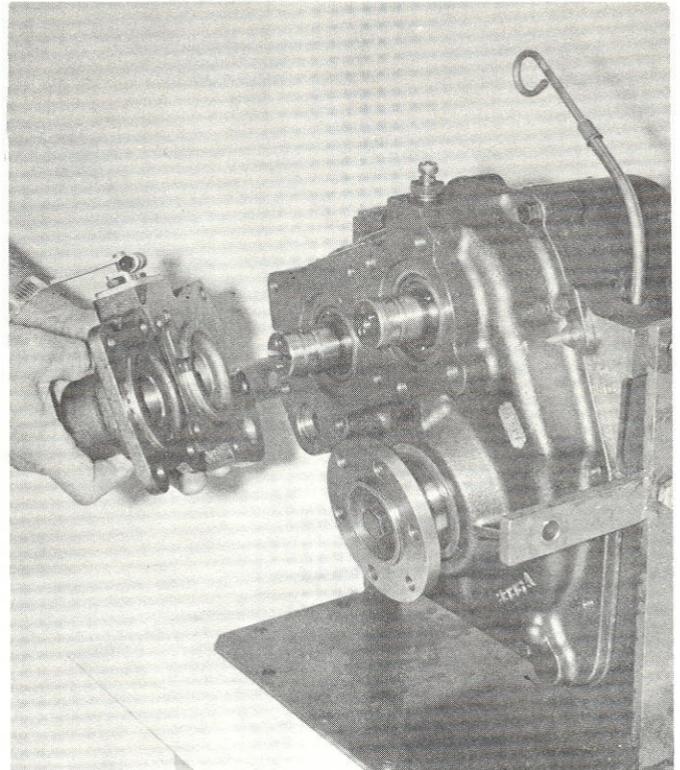


Figure 6. Removing Valve Body and Collector from the Rear Cover.

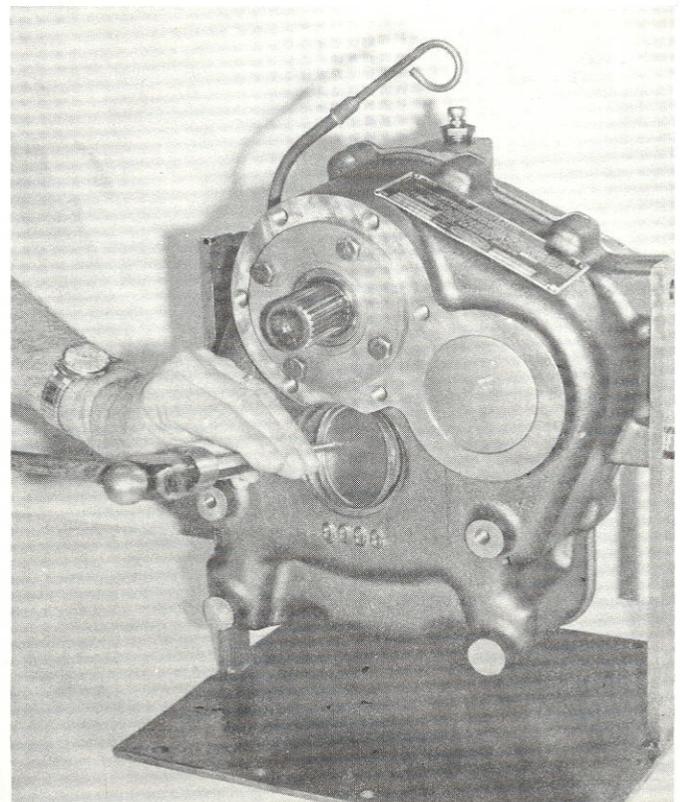


Figure 7. Removing Expansion Plug.

28. OUTPUT SHAFT AND FRONT BEARING.

A. Remove the bearing retainer washer screw (fig. 51, 1) washer (2), and shims (3) from the bearing bore.

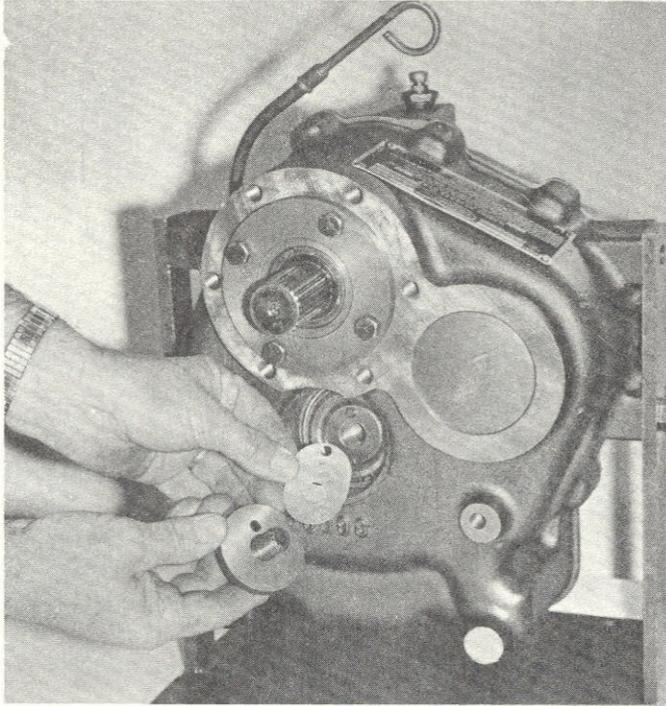


Figure 8. Retainer, Screw, and Shims Removed.

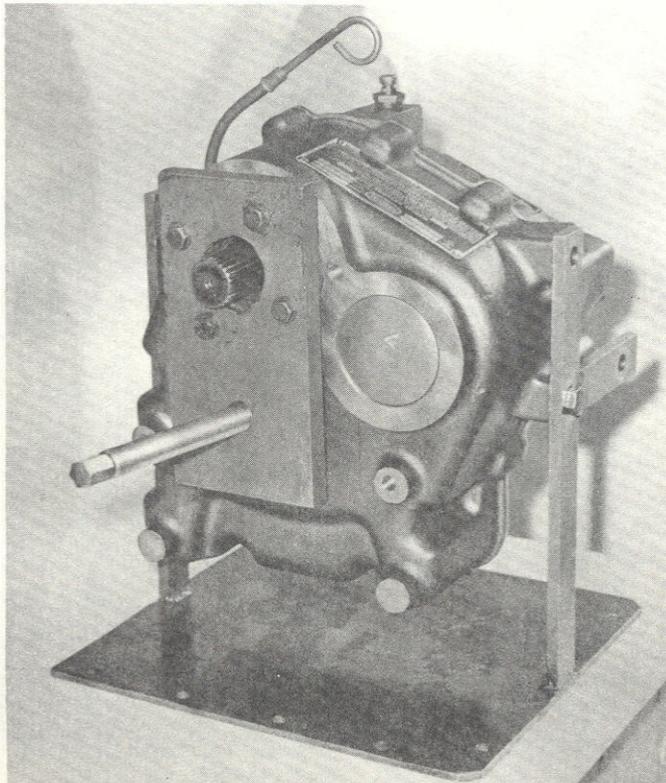


Figure 9. Special Tool T-16751 in Place.

B. Output Shaft. Remove the four hex-head cap screws (fig. 47, 8) which secure the bearing retainer (9) onto the main housing over the input (forward) clutch shaft. Use longer screws (3/8-16 x 1-7/8) and attach special tool T-16751 output shaft remover onto the main housing on top of the bearing retainer (9).

29. REAR COVER ASSEMBLY.

Remove the nine hex-head cap screws (fig. 48, 32) and remove the rear cover, pushing the output shaft from its front tapered roller bearing with the jack screw of special tool T-16751. The output shaft removes with the rear cover.

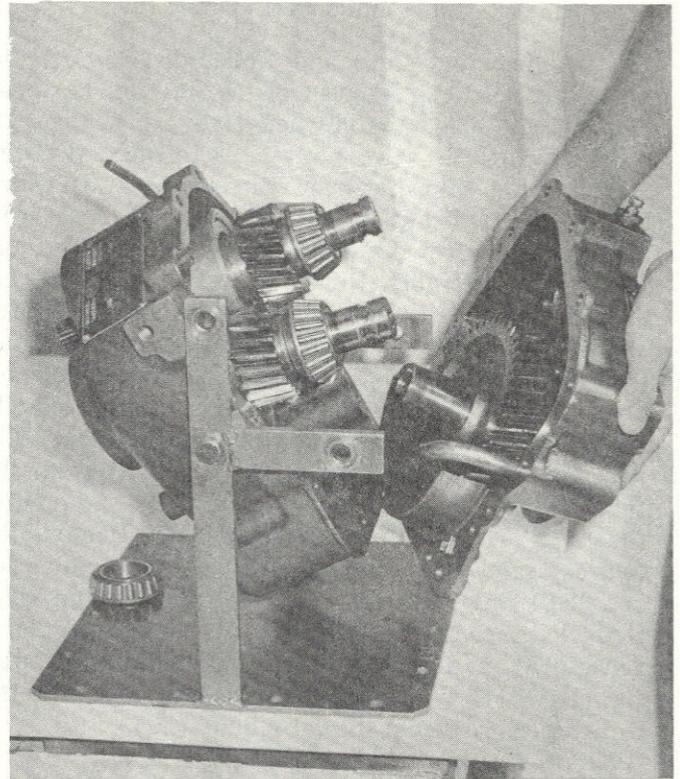


Figure 10. Removing Rear Cover Assembly.

30. CLUTCH SHAFT ASSEMBLIES.

Remove the reverse and forward clutch shaft assemblies from the main housing.

31. OUTPUT SHAFT FLANGE.

Set the rear cover with attached parts on the bench so the output flange faces up. Remove the output flange retainer screw (fig. 51, 15), washer (14), and lathe cut seal ring (13).

Use a puller, and remove the output flange (12) from the output shaft (7).

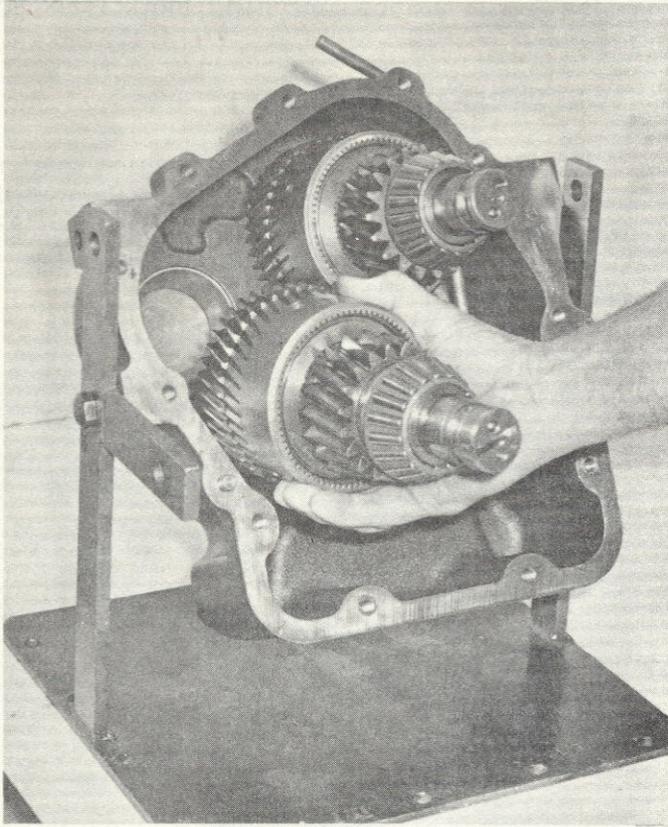


Figure 11. Removing Reverse Clutch Assembly.

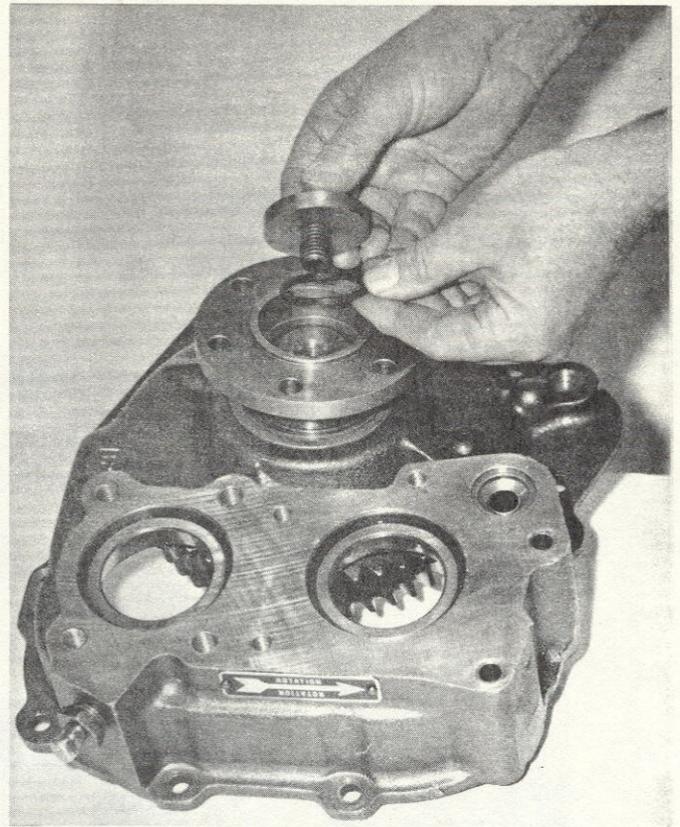


Figure 13. Screw, Washer, and Seal Removed.

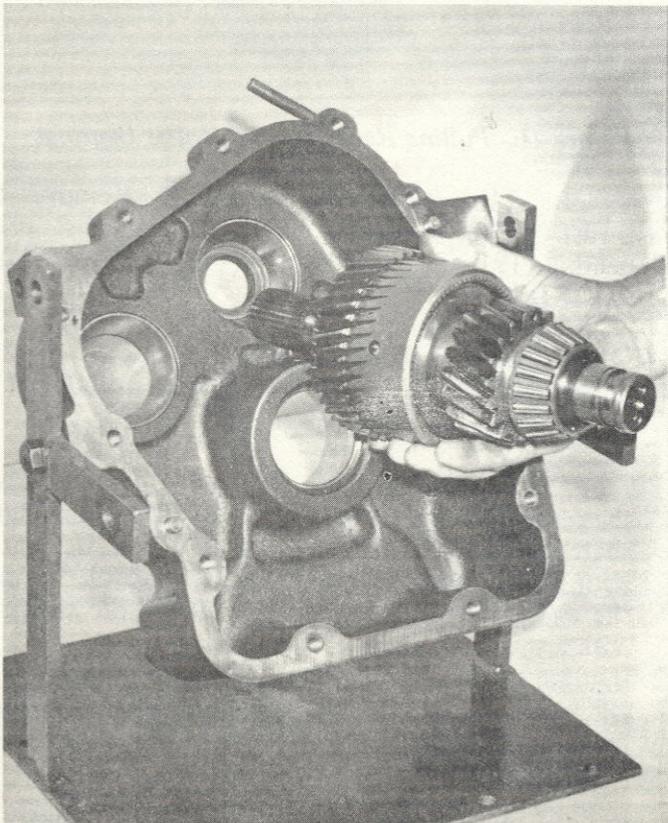


Figure 12. Removing Forward Clutch Assembly.

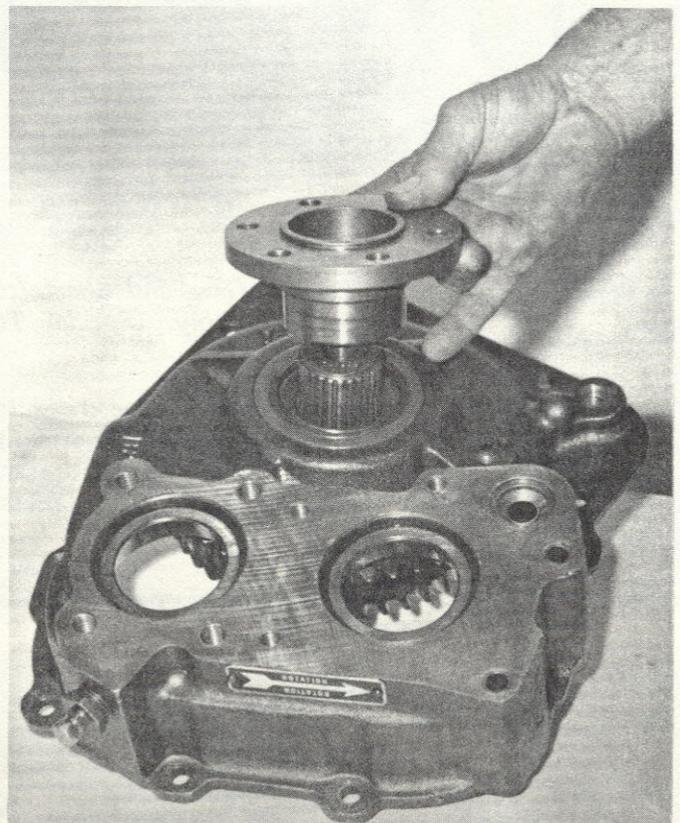


Figure 14. Output Flange Removed.

32. OUTPUT GEAR PAN AND SHAFT.

A. Gear Pan. Remove the two hex-head cap screws (fig. 47, 13) and remove the gear pan (14) from the rear cover.

B. Output Shaft. Install special tool T-16753 onto the rear cover. With this tool, pull the shaft and gear from the rear tapered roller bearing cone assembly.

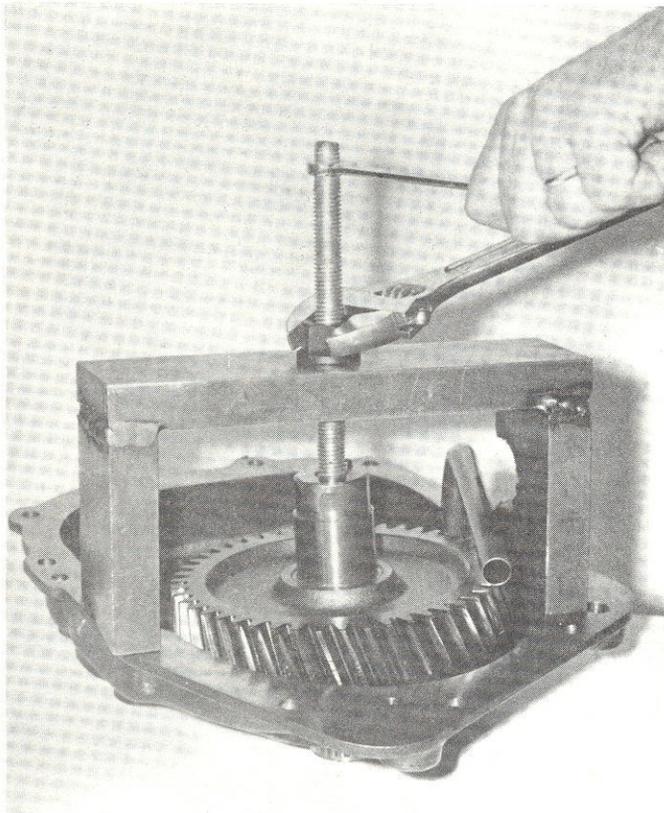


Figure 15. Removing Output Gear and Shaft from Rear Bearing Assembly. (Special Tool T-16753).

There is, normally, no reason to remove the output gear from the output shaft. If gear replacement is necessary, the gear can be pressed from the shaft using approximately 32 tons static force, pressing through gear hub.

33. REAR OUTPUT SHAFT FLANGE OIL SEAL – BEARING CUP.

A. Oil Seal. Pull the oil seal (fig. 51, 11) rearward from the rear cover.

B. Bearing Cup. Tap or press the bearing cup (fig. 51, 10) rearward from the rear cover. The bearing spacer (9) should have removed from the

shaft (7) with bearing cone (10) removal (paragraph 32B).

34. REVERSE CLUTCH SHAFT.

A. General. Place the reverse/clutch shaft on the bench so the rear section faces up. Remove the two piston type hook end oil seal rings (fig. 49, 23). Attach a bearing puller and remove the rear tapered roller bearing cone (21).

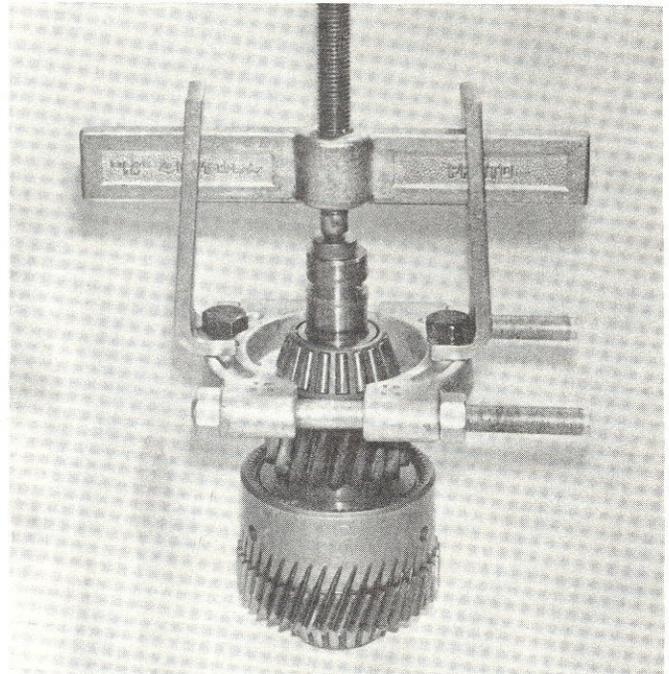


Figure 16. Pulling Rear Tapered Roller Bearing.

B. Thrust Bearing Assembly. Remove the thrust washer, (fig. 49, 20) needle thrust roller bearing (19), and thrust washer (18) from the clutch shaft (3).

C. Reverse Pinion Gear. Remove the reverse pinion (fig. 49, 17) and thrust bearing assembly (16, 15, 14) from the clutch shaft (3).

D. Clutch Piston Return Spring. Attach the spring compressor tool T-16752 to the clutch shaft and attached parts, and compress the spring with pressure on the spring retainer (fig. 49, 12) until the snap ring (13) is exposed. Remove the snap ring with a snap ring plier.

Remove the back plate retaining snap ring (10), and remove the back plate (9), the faced and steel clutch plates (7 & 8) from the transfer gear (2) and clutch shaft (3).

Remove the clutch spring retainer (12) and clutch piston return spring (11) from the clutch shaft.

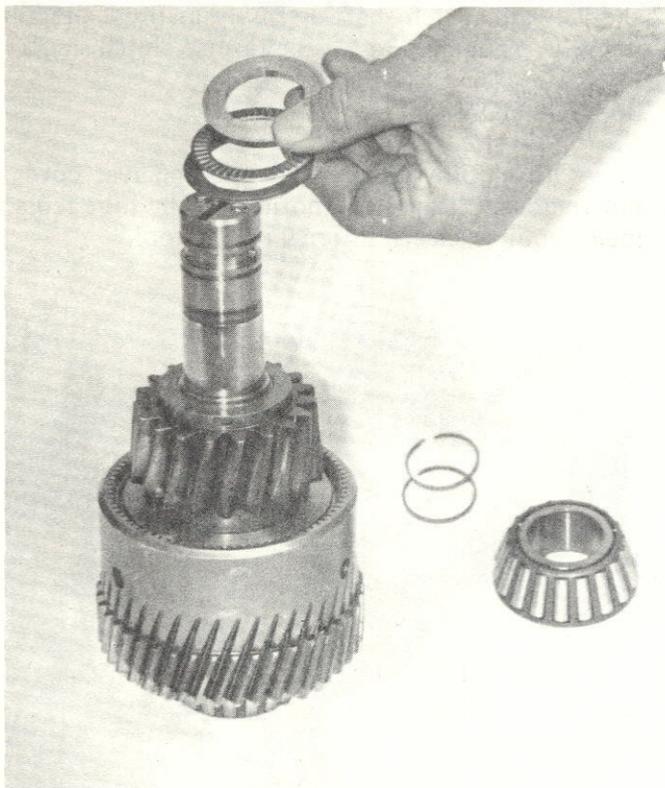


Figure 17. Removing Thrust Bearing Assembly.

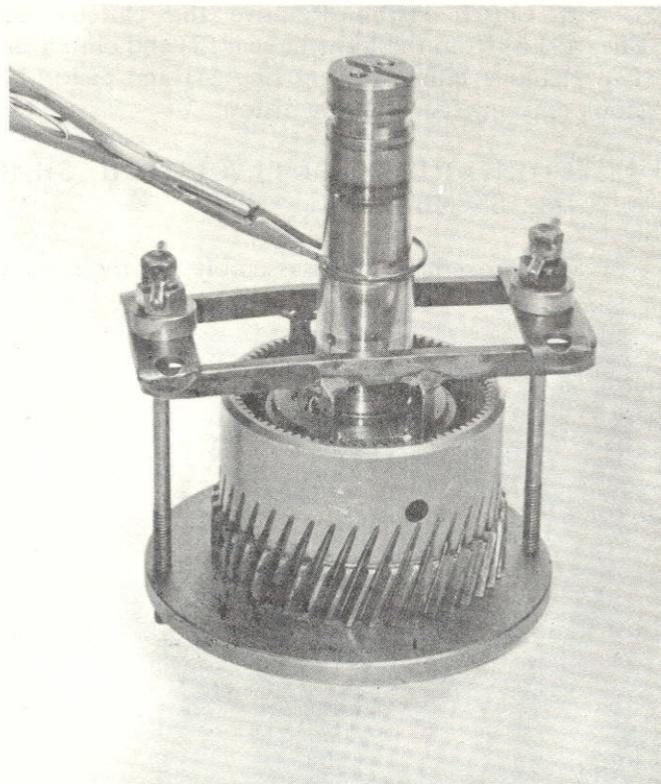


Figure 19. Removing Snap Ring. (Special Tool T-16752).

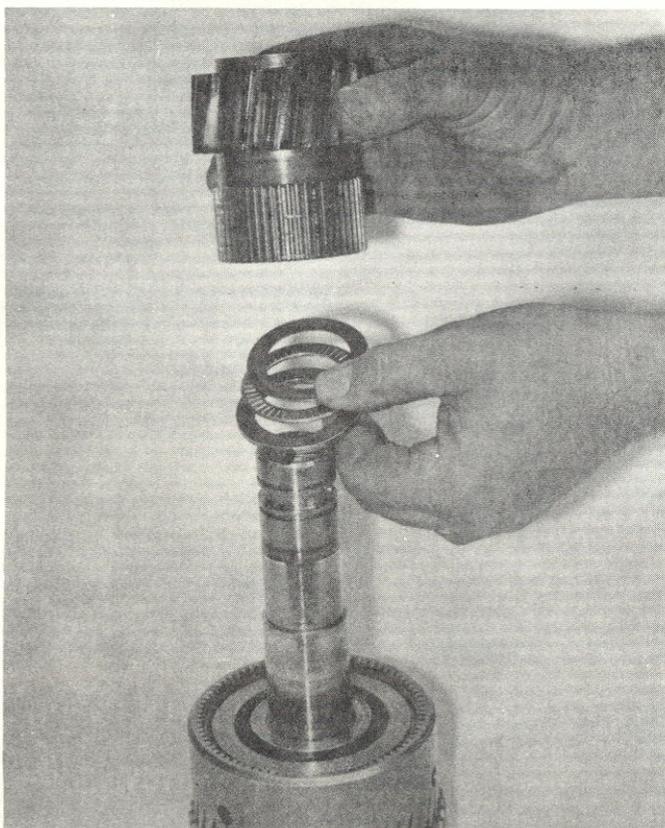


Figure 18. Removing Pinion and Thrust Bearing Assembly.

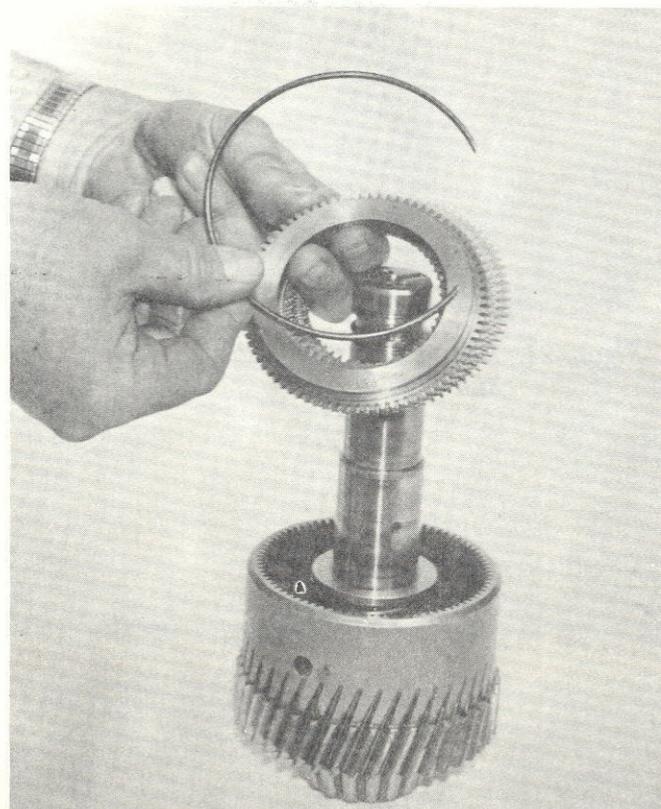


Figure 20. Snap Ring, Back Plate, and Clutch Plates Removed.

E. Clutch Piston. Remove the clutch piston (fig. 49, 6) from the transfer gear (2) and clutch shaft (3). Remove lathe cut seal ring (4) and piston type hook end ring (5) from the piston.

35. FORWARD (INPUT) CLUTCH SHAFT DISASSEMBLY.

The procedures of disassembly are the same for

the forward clutch shaft assembly as those described above in paragraph 34 for the reverse clutch shaft.

36. SUCTION TUBE.

The suction tube, rolled into the rear cover is not removed in the field, normally. The tube replacement requires special internal rolling tool.

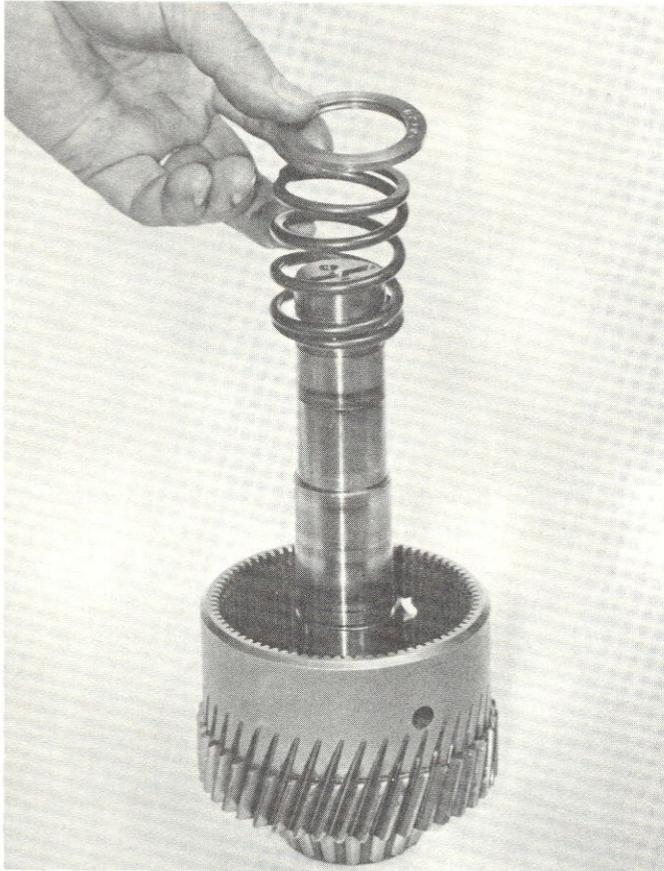


Figure 21. Removing Clutch Piston Return Spring and Retainer.



Figure 22. Clutch Piston Removed.

Section X. CLEANING AND INSPECTION

37. GENERAL.

- A. **Oil Seals.** Replace all oil seals.
- B. **Gaskets.** Replace all gaskets.
- C. **Piston or Lathe Cut Oil Seal Rings.** Replace all piston or lathe cut oil seal rings.
- D. **"O" rings.** Replace all "O" rings.
- E. **Expansion Plugs.** Replace all expansion plugs removed or leaking.
- F. **Snap Rings.** Replace distorted or damaged snap rings.
- G. **Shims.** Replace damaged shims.

38. CLEANING.

- A. **Roller Bearings.** Use standard maintenance procedures to clean all roller bearings.
- B. **Oil Pump Assembly.** Use fresh cleaning agent to flush the oil pump assembly.
- C. **All Other Parts.** Thoroughly clean all other parts with a suitable cleaning agent. After cleaning, dry with compressed air. Lubricate all machined surfaces with clean oil. Examine each part after cleaning to make certain all foreign matter has been removed.

NOTE

Do not use any abrasive material on selector valve parts as damage will result.

39. INSPECTION.

- A. **Roller Bearings.** Use standard maintenance procedures to inspect all roller bearings.
- B. **Castings.** Inspect all castings for cracks. Replace a cracked casting.

NOTE

The main housing and rear cover are not serviced separately.

Inspect all bearing bores and mounting faces for wear, grooves, scratches, etc. Remove burrs and scratches

with a crocus cloth. Inspect tapped holes for damaged threads. Chase damaged threads with a used tap of the correct size. Replace castings which cannot be repaired.

C. Splined Parts. Inspect all splined parts for worn, twisted, chipped, or burred splines. If possible, remove these defects with a soft stone. Replace a splined part that cannot be repaired.

D. Threaded Parts. Inspect all threaded parts for damaged threads. Repair damaged threads with a thread die, or file, or a three-cornered fine file. Replace a threaded part that cannot be repaired.

E. Pressure or Temperature Gauge. Inspect the gauges and connecting lines for damage. Replace damaged parts.

F. Torsional Isolator Drive. Inspect the drive plate and hub of the torsional isolator for cracks, rivet looseness, etc. Replace a damaged or defective torsional isolator assembly.

G. Heat Exchanger – Flexible Hose Lines. Inspect the heat exchanger for leaks, damaged mounting brackets, and connections. Check the zinc electrode on salt water installations. Inspect the hoses for cracks, sponginess, or other damage. Repair or replace parts as required.

H. Gear Teeth. Inspect all gear teeth for cleanliness and damage. Foreign particles tend to collect in the root of the gear teeth. Clean thoroughly and repair minor damage with a fine file or crocus cloth. Replace a gear that cannot be repaired.

I. Orifices and Small Oil Passages. It is very important that all orifices and small oil passages be clean and clear. Inspect these in the selector valve body and collector. Also, the clutch shafts. Use a pipe stem cleaner or small wire to probe and clear the small oil passages.

J. Clutch Plates. Inspect the clutch plates for damaged spline teeth and excessive wear. The grooves in the faced plates control the flow of cooling and lubricating oil. When the grooves are very shallow, due to material wear, the plate is no longer serviceable and must be replaced. The exact serviceable depth of plate grooves is subject to so many variables that the best policy is to replace doubtful appearing plates. Replace plates with damaged or worn spline teeth.



ANAEROBIC SEALANT APPLICATION

This procedure is to be used for assembly of joints where anaerobic sealant is used to provide a seal between mating surfaces. It applies to joints where a seal against leakage of oil, grease, gasoline, diesel fuel, hydraulic fluid, water, and air is to be achieved.

A. Surface Condition. Machining accuracy of flange faces must provide .003 in. max. gap between assembled mating surfaces.

Surfaces of cup plugs, expansion plugs, and shims to be in "as received" condition but must also provide .003 in. max. gap.

B. Approved Sealant. The recommended sealant is "Loctite plastic gasket", Twin Disc part numbers M2828 and M2828A.

C. Application Procedure.

(1) For previously sealed joints, scrape surfaces to remove old plastic gasket material. Gel type paint removers containing methylene chloride can be used to wipe off cured sealant. **Caution** – This material may chemically burn skin so follow vendor's directions carefully.

(2) Clean surface with 1, 1, 1-trichloroethane (also known as methyl chloroform) which meets OSHA requirements. This is available as Dow Chemical CHLOROTHENE NU or CHLOROTHENE VG and as PPP INDUSTRIES INC. TRI-ETHANE and as equivalent material from other sources. Other chlorinated hydrocarbons probably will work satisfactorily but with the above available, we approve only the above. Oil content is to be limited to 10% maximum, by volume.

We approve these for their cleaning characteristics but do not recommend these unless you have OSHA approval to use them. Stoddard Solvent. Hydrocarbon cleaning solvents meeting all but Kauri-butanol value and Bromine no. of Type I of ASTM D484 latest year (ANSI Z11.42 latest year). These have a low flash point. Mobil Corp.

SOVASOL No. 5, Standard Oleum and American Oil Company STANISOL plus many other mineral spirits meet this specification.

(3) Test for a clean surface by applying a few drops of cool water to surface. Parts are sufficiently clean if water covers the part surface in a film. If water puddles or forms beads, use fresh solvent and reclean.

(4) Use Twin Disc primer MA579 (Locquic T) or equivalent primer on both mating surfaces. Allow primer to dry. This usually takes three to four minutes. Keep surfaces clean from this point on. Oil, grease, etc. must not contaminate primed surfaces.

(5) Apply a thin continuous bead of M2828 (2 cc) or M2828A (50 cc) anaerobic plastic sealant to one surface.

a. Flanges and Shims. Use a 1/16 diameter bead following a continuous path all around the seal surface on side of bolt holes towards fluid being retained. Be certain that narrow overlap areas are covered. It is optional to spread material into thin film just before mating surfaces are assembled.

b. Expansion Plugs. Use a 1/16 diameter bead in corner formed by bore and shoulder that positions plug. Install plug against the shoulder and deform center of plug to expand the outside diameter to provide seal.

c. Cup Plugs. Use a 1/16 diameter bead on outside diameter of cup plug and drive plug into the bore. (Excess to wipe to outside rather than off into unit.)

Complete the assembly of components and torque all attaching screws to Twin Disc torque specifications.

(6) Allow two hours curing time at room temperature before filling unit with oil. This time is applicable, only if the priming step (4) is accomplished. Otherwise, allow 24 hours curing time when primer is not used.

Section XI. ASSEMBLY

40. TORQUE TIGHTENING.

A torque chart is included at the rear of this manual. Assembly torque is given for fasteners assumed to be oiled.

CAUTION

Before assembly, all bearings which require press fits are to be slowly heated to 300 degrees F. before installation. The bearings are to be pressed in place by an arbor press having a capacity between 30 and 50 tons pressure. Properly heated bearings can be installed in many cases without a press.

CAUTION**Sintered Metal Clutch Plates**

The possibility of clutch pack failure exists on initial start-up after rebuild, due to lack of lubrication until lube pressure builds up.

All sintered-metal clutch plates must be submerged in oil (use same oil as will be used in the unit) for a minimum of one (1) hour prior to assembly. A longer soaking period would be even more beneficial. Covering the plates with oil from an oil can, during assembly, is not sufficient.

NOTE

Use "Loctite" plastic sealant on all core plug installations.

41. ASSEMBLY OF REVERSE CLUTCH SHAFT ASSEMBLY.

A. Clutch Apply Piston. Install a lathe cut oil seal ring (fig. 49, 4) into the I.D. groove of the piston hub. Install a piston type hook end oil seal ring (5) in the groove of the piston periphery. Prelubricate the ring seals. Use a piece of shim stock to protect the lathe cut ring during its start on the clutch shaft when installing. Set the clutch shaft (3) with attached parts (2) (transfer gear) on the bench so the rear end of the shaft faces up. Carefully install the clutch piston (6) onto the shaft and into the transfer gear.

B. Clutch Plates. There are eight faced, nine steel, and two faced-on-one-side-only clutch plates used in the clutch pack. Install one of the faced-on-one-side-only plates with its steel surface against the clutch apply piston. Then alternately

install a steel (fig. 49, 8) then a faced plate (7) until all eight faced plates and nine steel plates are installed. The last plate will be steel. Install the remaining faced-on-one-side-only plate with its faced surface against the steel plate and its steel side toward the back plate. Install the back plate (9) into the transfer gear against the steel side of the faced-on-one-side-only plate. Secure the back plate in the transfer gear with internal snap ring (10).

C. Clutch Piston Return Spring. Install the piston return spring (fig. 49, 11) over the clutch shaft and against the clutch piston. Install the spring retainer (12) against the spring. Use special tool T-16752 and compress the spring to expose the snap ring groove in the clutch shaft (3). Install the external snap ring (13) in its groove.

D. Thrust Bearing Assembly. Install the thrust race (fig. 49, 14) against the spring retainer (12) over the clutch shaft. Install the needle thrust roller bearing (15) over the clutch shaft against the thrust race. Install the thrust race (16) over the clutch shaft, against the needle thrust roller bearing.

E. Clutch Hub and Pinion. Install the clutch hub and pinion (fig. 49, 17) onto the clutch shaft and against the thrust bearing race (16). You will have to twist and shake the hub to mesh the splines of the hub with the internal spline teeth on the steel clutch plates (8).

F. Thrust Bearing Assembly. Install the thrust race (fig. 49, 18) against the hub and pinion, over the clutch shaft. Install the needle thrust roller bearing (19) against the thrust race (18). Install the thrust race (20) against the needle thrust bearing (19).

G. Tapered Roller Bearings. Maintain shaft in an upright position. Heat and install the rear cone assembly (fig. 49, 21). Install front bearing cone assembly (1) onto shaft (3). Don't hammer bearing cones into place as plates will jump out of their splines and cause a failure. Pressing bearing cone assembly into place is acceptable. Press the front bearing cup (1) into its bearing bore in the main housing (fig. 47, 4) to bottom against the snap ring (11). The back face of the cup is squarely machined to seat against the snap ring. Press the rear bearing cup (fig. 49, 21) into its bore of the rear housing. Press the cup from the rear toward the front with the cup back face to the rear. Press the cup slightly below, or almost flush with the rear of rear cover.

42. FORWARD (INPUT) CLUTCH ASSEMBLY.

The assembly of the forward or input clutch assembly is the same as the reverse clutch covered in paragraph 41 above. The only area of difference is front tapered roller bearing cup installation.

43. OUTPUT SHAFT ASSEMBLY.

A. Output Gear. The taper fitting of the output gear (fig. 51, 8) to the output shaft (7) is done according to the procedures outlined on pages (42 and 43). Assemble gear over shaft taper and seat with 500 lb. force. Press gear in place to achieve .050-.080 advance. 32 tons force requirement is expected. Maximum runout from shaft centers to gear face opposite cone face .005 TIR. Install the output shaft bearing spacer (9) over the shaft and against the rear of the gear hub.

B. Output Shaft Rear Bearing Cup. Press the output shaft rear bearing cup (fig. 51, 10) into its bore in the rear cover assembly. The cup back face should bottom against the shoulder in the bore. The narrow front face of the cup faces rearward.

44. REAR COVER ASSEMBLY.

A. Output Shaft. Install the output shaft with attached parts into its bore of the rear housing. Check to see that bearing spacer (fig. 51, 9) remained in position on the output shaft. Heat and install the tapered bearing cone (10) to butt tightly against spacer (9).

B. Gear Pan. Place the gear pan (fig. 47, 14) over the bottom section of the output gear against the rear cover. Secure the gear pan to the cover with two hex-head cap screws (13) (5/16-18 x 1/2). Tighten the screws to 15-17 lbs.-ft. torque.

C. Forward Clutch Shaft Rear Bearing. Install the rear bearing cup (fig. 50, 21) in its bore of the rear cover. Press the cup into the bore from the rear until the back face of the cup is flush or slightly forward of the rear surface of the rear cover.

45. MAIN HOUSING ASSEMBLY.

A. Output Shaft Front Bearing Cup. See page 30 for procedures involved in use of Anaerobic Sealant application. Install the cup retaining and locating internal snap ring (fig. 51, 5) in the groove provided in the bearing bore. Press the bearing cup (4) from front to rear, back face first, to bottom against the snap ring.

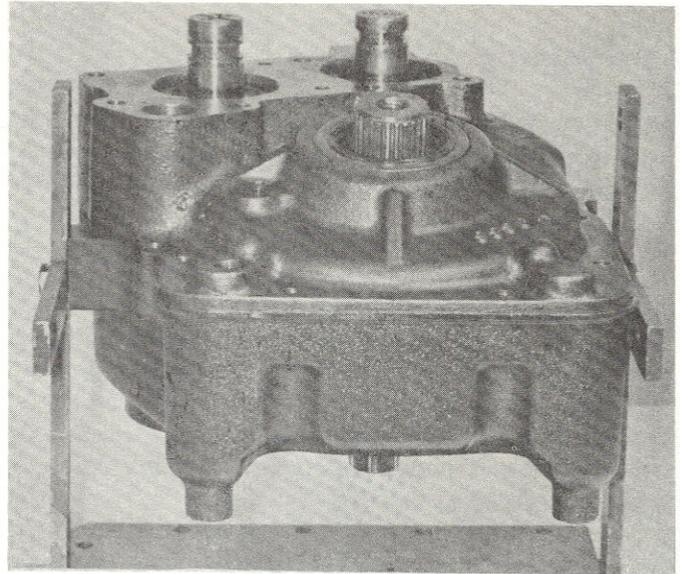


Figure 23. Rear Cover in Position.

B. Assembly of Components into Main Housing. Mount the main housing in the stand or fixture in a position with the rear or open end up. Place the reverse clutch shaft assembly into its bore of the housing. Place the forward (input) clutch shaft into its bore of the main housing. Apply a thin line of anaerobic plastic gasket compound having a viscosity of 20,000 centipoises to the mating (parting) surface of the main housing and rear cover. (See page 30). The Twin Disc Part Numbers M2828 and M2828-A meets these requirements. The plastic gasket must be capable of sealing at operating temperatures of 0 degrees F. to 210 degrees F. Carefully set the rear cover with attached parts onto the main housing, locating the clutch shafts in their bores and the output shaft in its bore of the main housing. Index the rear cover onto the dowel pins of the main housing and tap the cover in place over the dowels. Secure the rear cover to the main housing with nine hex-head cap screws (fig. 48, 32) (3/8-16 x 7/8). Tighten the cap screws to 27-30 lbs.-ft. torque.

46. ADJUSTMENT OF BEARING END PLAY.

A. General. There is only one acceptable method to measure the bearing end play for the tapered roller bearings used in the marine gear. This method is to dial indicate the shaft end play. Trial shim packs can be selected by use of depth micrometer measurements, but actual end play of the shafts must be taken as final check.

B. Select Trial Shim Pack. Use a depth micrometer and measure the distance from the collector pilot to the machined surface.

Also measure the distance from the pilot of the valve body to the machined mounting surface of the body. Press the clutch shaft rear bearing cups down to contact the rollers of their bearing cones. Measure the distance from the machined surface of the rear cover to the back face of the bearing cups. Subtract 0.003 inches from each of the measurements taken. The result is the thickness of the trial shim pack for each location.

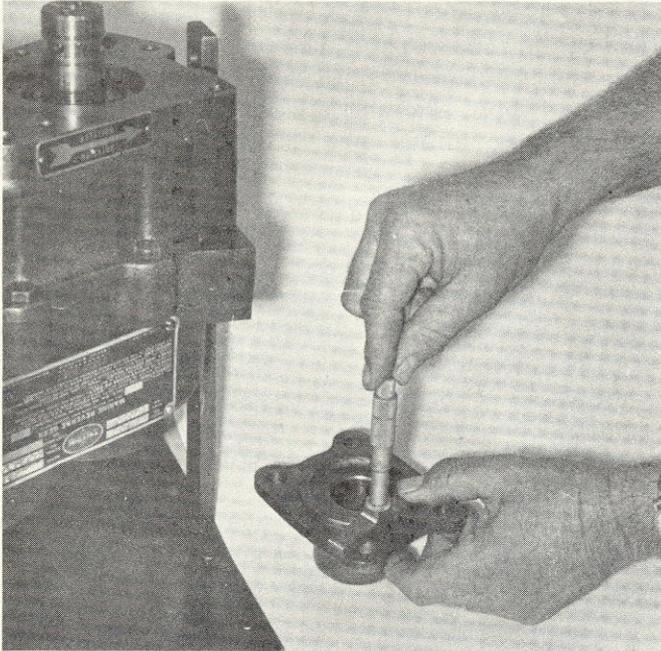


Figure 24. *Measuring Collector Pilot to Machined Surface.*

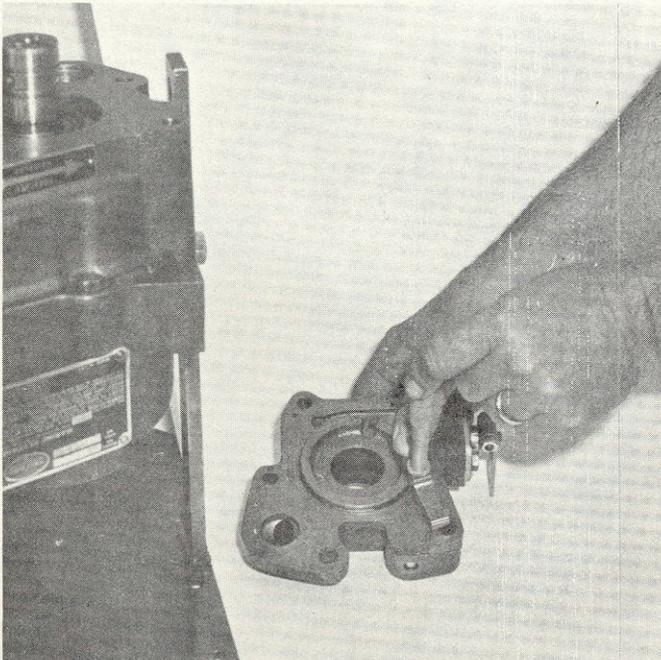


Figure 25. *Measuring Valve Body Pilot to Machined Surface.*

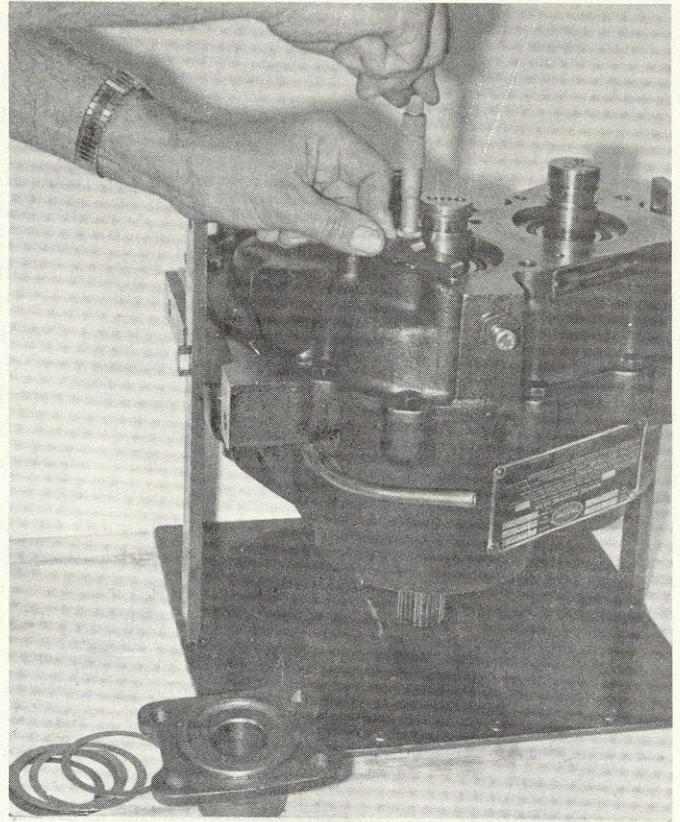


Figure 26. *Measuring Rear Cover to Forward Clutch Rear Bearing Cup.*

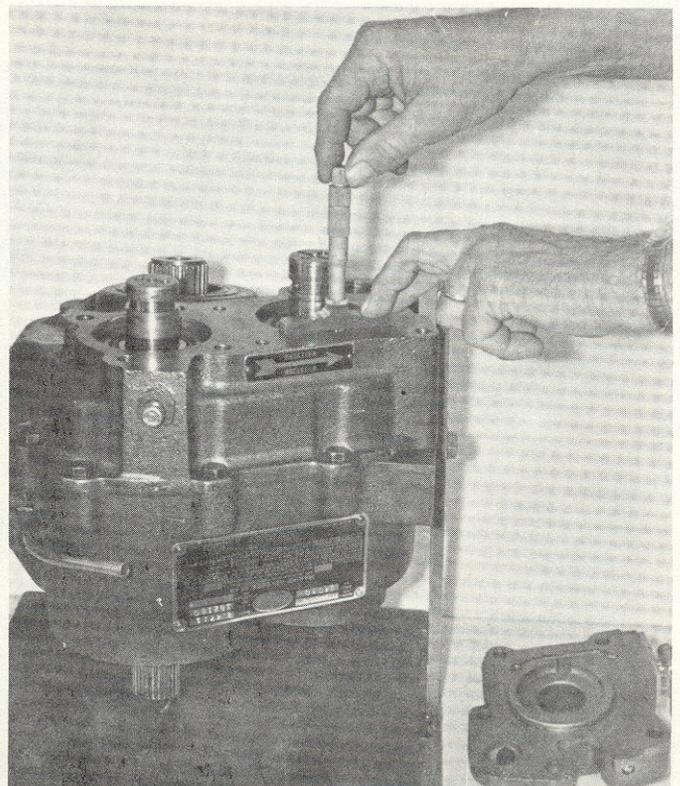


Figure 27. *Measuring Rear Cover to Reverse Clutch Rear Bearing Cup.*

C. Reverse Clutch Shaft End Play. Install the trial shim pack (fig. 49, 22) behind the rear bearing cup of the reverse clutch shaft. Install the valve body (fig. 48, 22) over the reverse clutch shaft and onto the rear cover. Secure the valve body with three hex-head cap screws (26) (3/8-16 x 2-1/2), one hex-head cap screw (30) (3/8-16 x 5), and one hex-head cap screw (31) (3/8-16 x 4-1/4). Tighten the cap screws to 27-30 lbs.-ft. torque. Attach a lifting eye with a ten inch stem into the threaded hole of the clutch shaft. The hole is a (5/16-18 x 5/16) thread. Mount a dial indicator so the stem or finger of the indicator contacts the end of the clutch shaft outside the eye bolt hole. This is necessary to permit the shaft to rotate with the dial indicator in position. Mark a spot next to the indicator stem. Apply a 100-300 lbs. force, approximately, downward on the clutch shaft, and while maintaining this force turn the shaft two full turns. Continue the pushing force and zero the dial indicator. Pull steadily with a 100-200 lbs. force (hoist) while turning the shaft through two complete turns. Continue the force, and read the indicator stopped on the selected spot. The indicator now shows the actual bearing end play. Select shims to obtain the end play of 0.003-0.005 inches, preferably near the low end of this range. Mark and set the final selected shim pack aside for final assembly later.

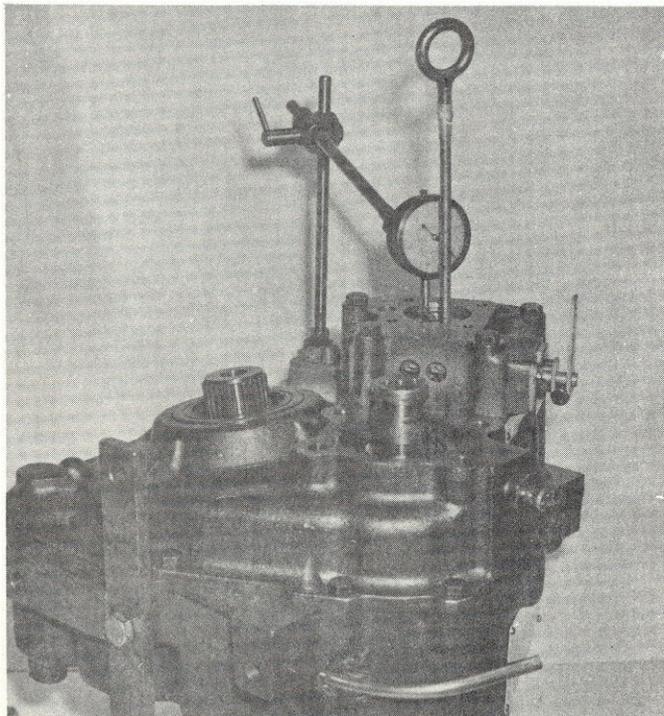


Figure 28. Dial Indicator Mounted for End Play Check-Reverse Clutch Shaft.

D. Forward (Input) Clutch Shaft End Play Check. The same procedures covered above in paragraph 46C are used for the forward clutch shaft and collector, exception being in checking end play from opposite end.

The method of pushing and pulling the clutch shaft varies because of the inaccessibility of the rear of the shaft with collector mounted. Install an oil seal double lip type (fig. 47, 7) into the bore of the bearing retainer (9). Press the seal, dust lip outboard and oil lip inboard, into the bore from the front until the seal casement is flush with the outer surface of front of bore. Prelubricate the seal. Apply plastic gasket to mounting area of retainer (9) and main housing. (See page 30.) Install the bearing retainer (9) over the input end (splined) of the forward clutch shaft and against the main housing. Secure the retainer with four hex-head capscrews (8) (3/8-16 x 7/8). Tighten the capscrews to 27-30 lbs.-ft. Follow the same procedure for checking the end play as given for the reverse clutch shaft in paragraph 46C. Use cardboard or reasonable facsimile to protect the splines, and with a vise grip plier apply force downward and upward as described. See figures 30 and 31.

The collector mounting cap screws – four hex-head (fig. 48, 18) (1/2-13 x 1-1/4) are tightened to 61-68 lbs.-ft. torque for the end play check.

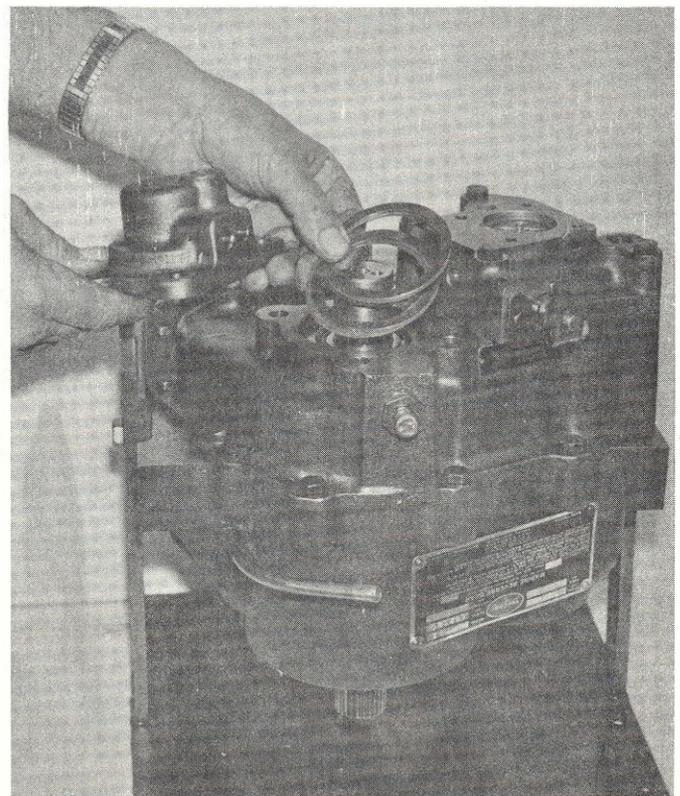


Figure 29. Installing Trial Shim Pack and Collector.

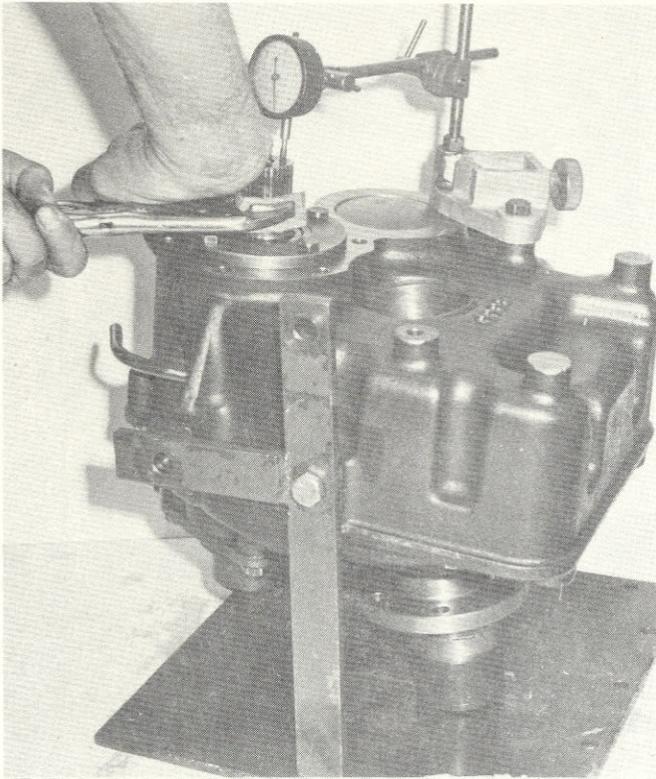


Figure 30. Checking End Play of Forward Clutch Shaft-Downward Pressure Applied.

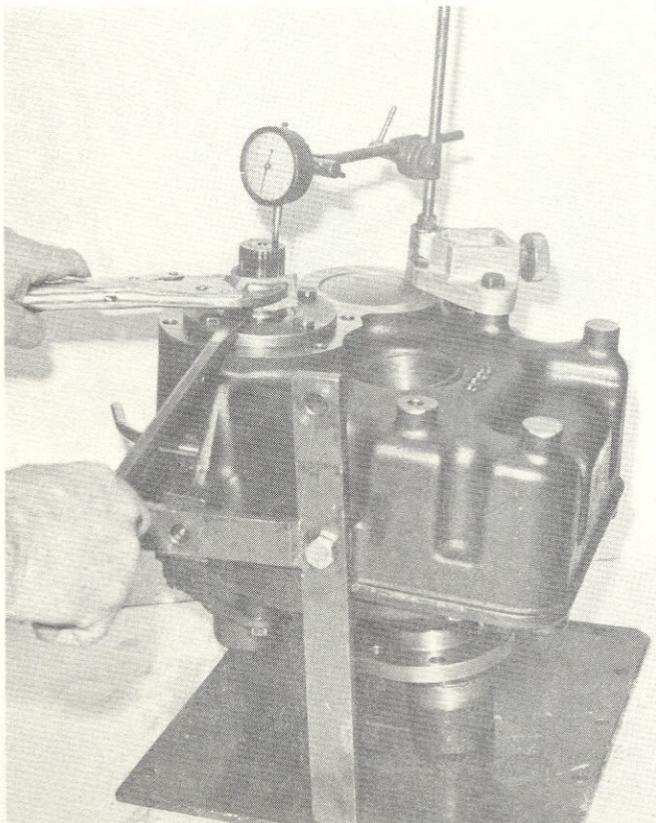


Figure 31. Checking End Play of Forward Clutch Shaft-Upward Pressure Applied.

E. Final Assembly of Valve Body and Collector. Install the thrust race (fig. 48, 16), spring (15), spring (14), and regulator piston (13) into their bore of the valve body. Install the "O" ring (11) into its groove on the valve stem (12). Prelubricate the "O" ring and the valve stem and install the stem into the valve bore against the regulator piston and springs. Be sure the piston enters its hole in the valve stem. Secure the valve stem (12) in the valve body (22) with the detent plate (10) and two hex-head capscrews (9) (5/16-18 x 3/4). Tighten the capscrews to 15-17 lbs.-ft. torque. Attach the lever (7) to the valve stem (12) and retain the lever to the stem with hex-head capscrew (8) (1/4-20 x 1) and nut (6). Do not torque tighten at this time. Tighten the nut enough that it will not be lost in shipping. Torque tighten this capscrew after the transmission is installed and the controls are rigged. Install "O" rings (19) and (21) in their grooves of the connecting tubes (20). Prelubricate the "O" rings and connecting tube bores of the collector and valve body. Install the connecting tubes into the collector bores, and install the valve body over the connecting tubes.

Apply a strip of plastic gasket to the valve body, collector, and rear cover mounting areas (See page 30). Install two piston type oil seal hook end rings (fig. 49, 23) in the end grooves on the reverse shaft (3) and two similar oil control rings (fig. 50, 23) in the end grooves of the forward (input) clutch shaft. Prelubricate the rings. Install the valve body and collector over their clutch shafts and onto the rear cover. Secure the collector and valve bodies to the rear cover. Use four hex-head capscrews (fig. 48, 18) (1/2-13 x 1-1/4) to secure collector. Tighten screws to 61-68 lbs.-ft. torque. Use three hex-head capscrews (26) (3/8-16 x 2-1/2), one hex-head capscrew (30) (3/8-16 x 5), and one hex-head capscrew (31) (3/8-16 x 4-1/4). Tighten these capscrews to 27 lbs.-ft. torque.

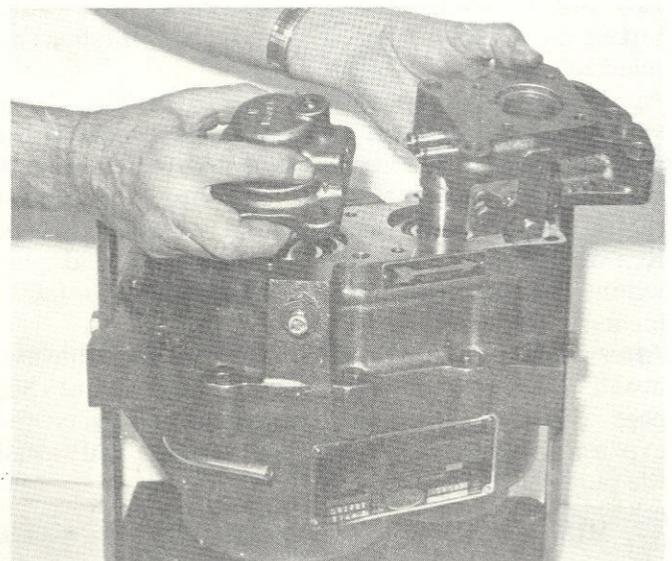


Figure 32. Joining Valve Body and Collector.

F. Output Shaft. Install the double lip type oil seal (fig. 51, 11) into the bore of the rear cover with the oil lip inboard and the dust lip outboard. Press the seal into the bore until the seal casement is flush with the outer surface of the bore. Pre-lubricate the seal. Heat the output flange to 150 degrees F. Use a portable hydraulic press set and install the output flange (12). Install the lathe cut seal ring (13), retainer washer (14), and hex-head capscrew (15) (5/8-11 x 1-1/4). Tighten the capscrews to 125-140 lbs.-ft. torque. Place a support (steel or wood block) under the flange with the marine gear input end up. Install the roll pin (6) into its hole in the front end of the output shaft if it was removed during disassembly. Install the tapered bearing cone (4) squarely on the end of the output shaft (7). Use the retainer washer (2) and cap screw (1) to advance the bearing cone approximately 3/4 up on the shaft. Do not seat bearing cone all the way. Once seated, you lose all end play and have to disassemble and start procedure over again.

Remove screw (1) and washer (2) and install a trial shim pack. Measure the thickness of shim pack removed on disassembly and add approximately 0.005 inches more shim. Shims are available in 0.005, 0.007, and 0.020 inch sizes. Trial shim pack must be larger than desired shim pack. Install the retainer washer (2), cap screw (1) with trial shim pack, and using the cap screw advance the bearing cone onto the end of the shaft as far as shim pack will permit. Tighten the screw (1) to 125-140 lbs.-ft. torque. Turn the unit over in the stand and mount a dial indicator on the rear cover so the stem or finger rides on the output flange. Mark a spot on the flange next to the indicator stem. Apply 100-300 lbs. force downward on the flange while rotating the output shaft through two full turns. Continue the pushing force while setting dial indicator to zero with the finger (stem) on selected spot.

Apply a 100-300 lbs. force upward on the flange while rotating the shaft two full turns. Continue the upward force, while reading the dial indicator with the stem stopped on the selected spot. The indicator should now show the actual end play of the bearings. Remove shims as required to bring the end play within the specified tolerance of 0.003 to 0.005 inches.

After the output shaft end play has been adjusted, install the expansion plug. Apply plastic gasket (See page 30) to the bore area which contacts the expansion plug (cupshaped) (fig. 47, 12) and install the plug.

47. MISCELLANEOUS AND EXTERNAL PARTS.

A. Drain Plug. Install the drain plug (fig. 48, 33) and tighten securely.

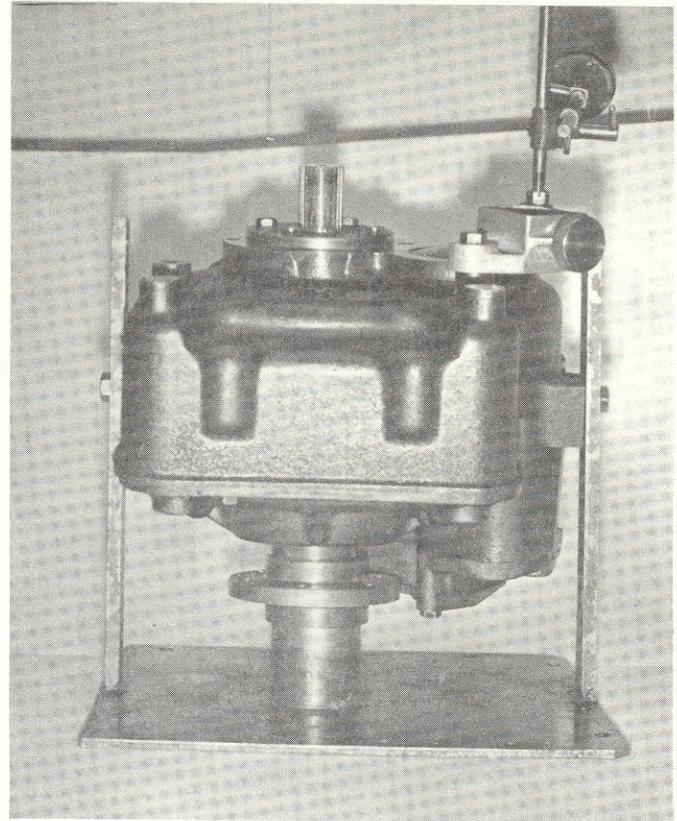


Figure 33. Support Below Output Flange.

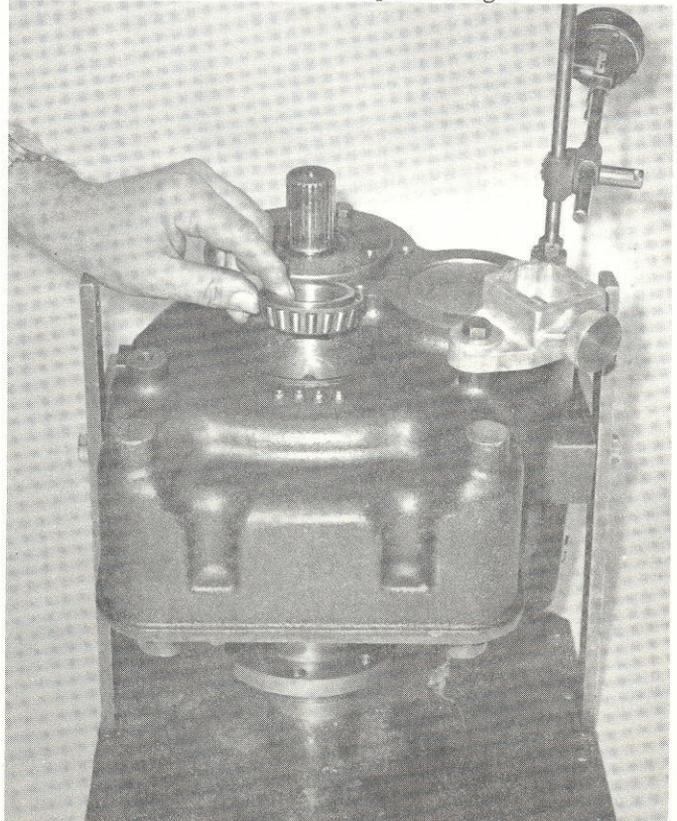


Figure 34. Install Bearing Cone.

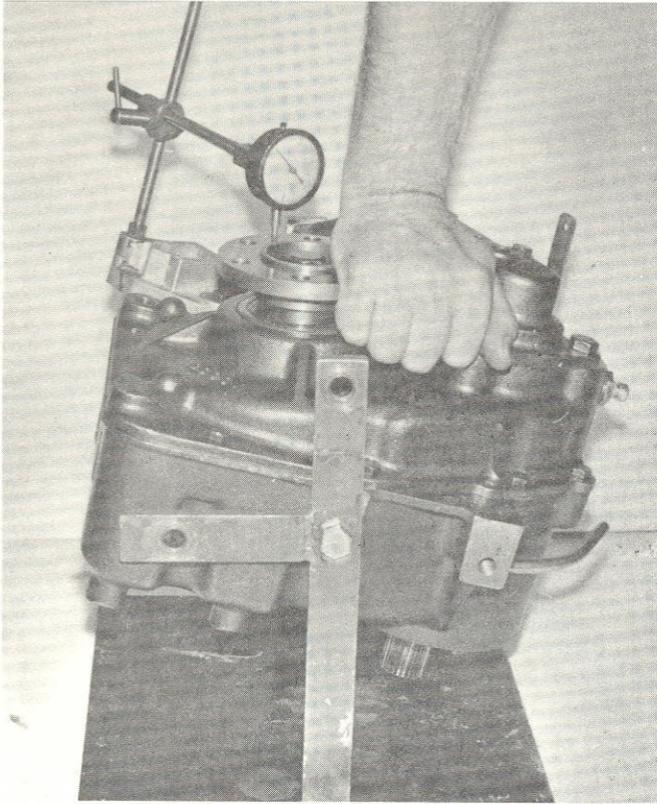


Figure 35. Checking End Play-Downward Force Used.

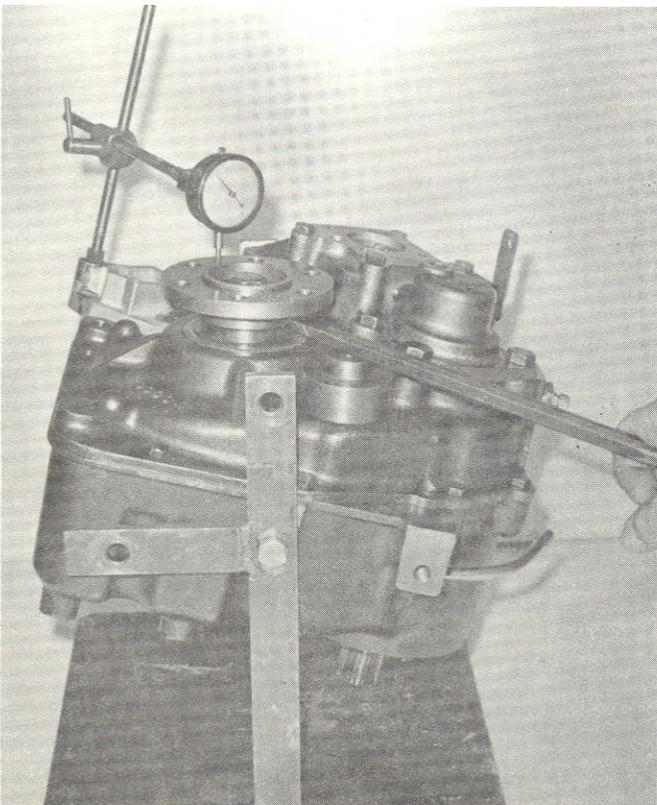


Figure 36. Checking End Play-Output Shaft.

B. Oil Level Gauge Tube. Install the oil level gauge tube (fig. 47, 3) into the main housing (4). Secure the tube in the housing with the hex-head cap screw (2) (5/16-18 x 5/8). Tighten the tube screw (2) to 15-17 lbs.-ft. torque. Install the oil level gauge (1) into its tube (3).

C. Oil Strainer. Install the oil strainer (fig. 48, 29) into its bore in the selector valve and rear cover. Install the "O" ring (28) and plug (27) to cover the strainer opening in the valve body.

D. Rotation Indicator. Install the engine rotation indicator plate (fig. 48, 2) and secure it to the rear cover with two drive screws (1), if it was removed during disassembly.

E. Name and Instruction Plate. Install and secure the name and instruction plate (fig. 47, 5) to the top of the main housing with four drive screws (6). (normally not removed).

F. Oil Pump. Place an oil pump mounting gasket (fig. 48; 23) onto the valve body (22) and secure the oil pump to the valve body with four hex-head cap screws (25) (5/16-18 x 3-1/2). Tighten the cap screws to 15-17 lbs.-ft. torque.

G. Breather and Reducer Bushing. Install the reducer bushing (fig. 48, 4) and breather assembly (3) into the provided threaded hole at the top of the rear cover (5). Later production units replace breather and bushing and incorporate breather function in new designed oil level gauge. A plug is used when breather and bushing are eliminated.

48. RUNOUT CHECKS.

A. Input Shaft. Check the runout between the input shaft and the O.D. surface or pilot of the front bearing retainer (fig. 47, 9). Maximum of 0.003 inch total indicator reading.

B. Flywheel Adapter (Optional from Twin Disc). Check the runout between the input shaft and flywheel adapter mounting surface on main housing, just beyond the bearing retainer. Approximately 2-1/4 inches from centerline of input shaft. Maximum allowable runout is 0.003 inch total indicator reading.

C. Output Flange. Check the runout between the output flange pilot (fig. 51, 12) and the rear cover. The maximum total indicator reading allowed is 0.004 inches. Check the runout between the flange face and rear cover. The maximum total indicator reading allowed is 0.004 inch.

CAUTION

Most Twin Disc products are made to be mounted directly on the flywheel of the engine. It is possible, due to mismatch of components or many other reasons, to have flywheel to driven component interference. As a result, it is necessary that engine crankshaft end play be measured before the driven component is installed.

After installation of the driven component, crankshaft end play should again be measured. The second measurement should be the same as the first end play measurement. If it is not the same, it could be an indication of interference. Consequently, the driven component should be removed, 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 end play check is considered mandatory.

Section XII. INSTALLATION

49. PRIOR TO INSTALLATION.

A. General. The engine must be checked for trueness of the flywheel and the flywheel housing. Thoroughly clean the engine flywheel and the engine flywheel housing prior to making the test.

B. Checking Face of Engine Flywheel Housing. Bolt a thousandths 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 (fig. 37). Rotate the engine flywheel and note the face deviation of the engine flywheel housing flange. The face deviation must not exceed .008 inch.

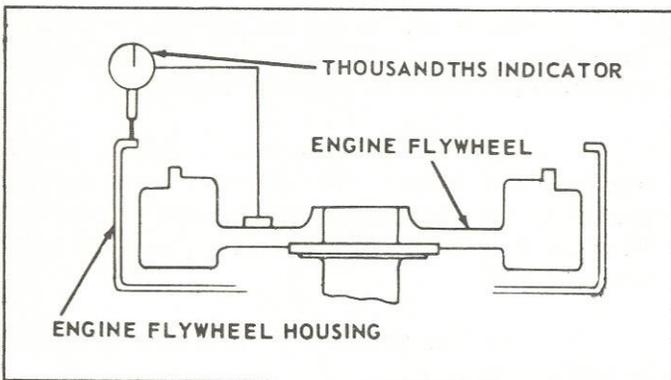


Figure 37. Checking the Face of the Engine Flywheel Housing.

C. Checking Bore of Engine Flywheel Housing. With indicator bolted as in Paragraph 50B above, adjust the indicator stem so that it will ride on the bore of the engine flywheel housing (fig. 38). Rotate the engine flywheel and note the bore eccentricity of the engine flywheel housing bore. The bore eccentricity must not exceed .008 inch.

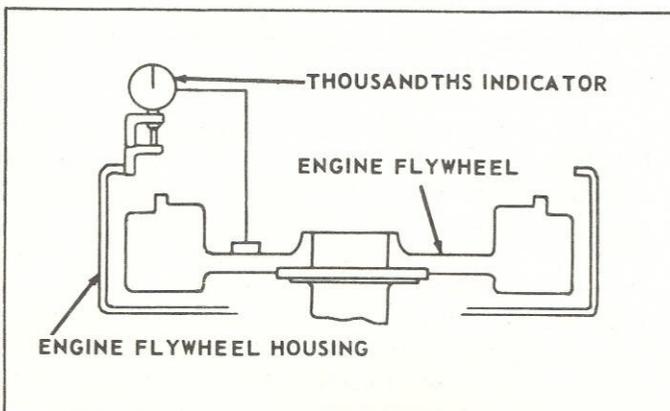


Figure 38. Checking the Bore of the Engine Flywheel Housing.

D. Checking the Torsional Isolator Mounting Surface on the Flywheel. Bolt a dial indicator to the engine flywheel housing so the stem of the indicator contacts the mounting surface for the isolator, perpendicularly. The variation of face runout of isolator mounting surface should not exceed 0.0005 inch per inch of diameter of isolator (fig. 39).

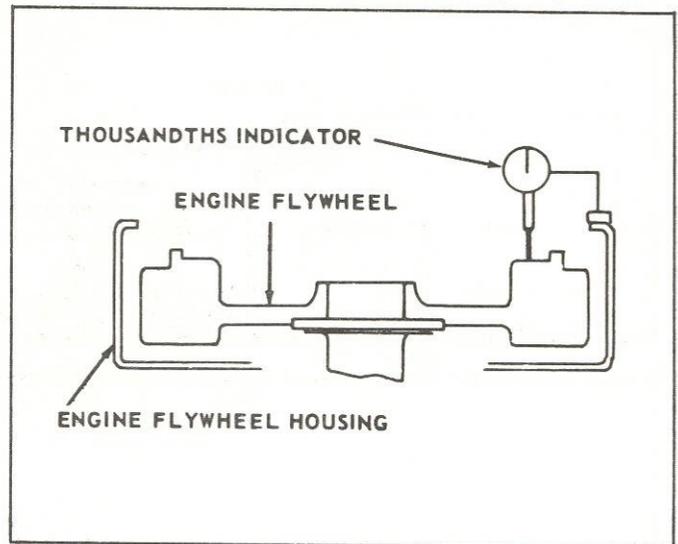


Figure 39. Checking the Isolator Surface of the Engine Flywheel.

E. Checking Isolator Pilot Bore of Engine Flywheel. With the indicator bolted as in Paragraph 50D above, adjust the indicator stem so that it will ride on the isolator pilot bore (fig. 40). The pilot bore eccentricity of the engine flywheel should not exceed .005 inch maximum total indicator reading.

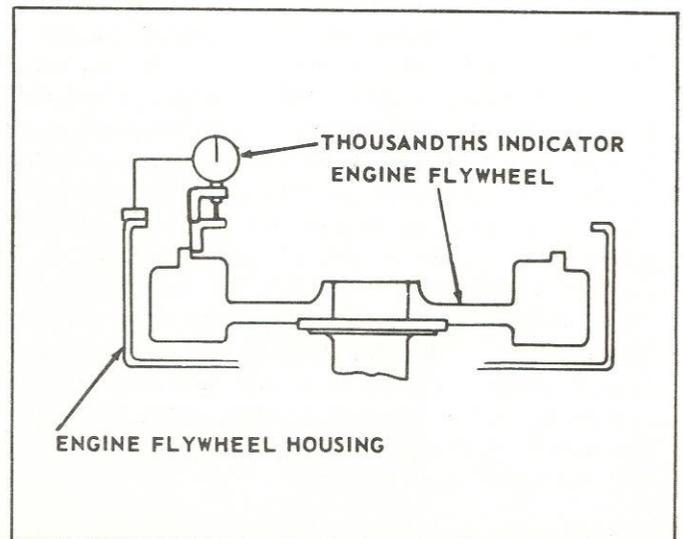


Figure 40. Checking the Isolator Pilot Bore of the Engine Flywheel.

B 50. INSTALLATION.

A. General. The alignment of the marine gear with the engine is an extremely important factor in obtaining lengthy, trouble-free performance from the marine gear. An extra few minutes of time for an accurate and proper installation will be returned many times in avoiding unnecessary future downtime.

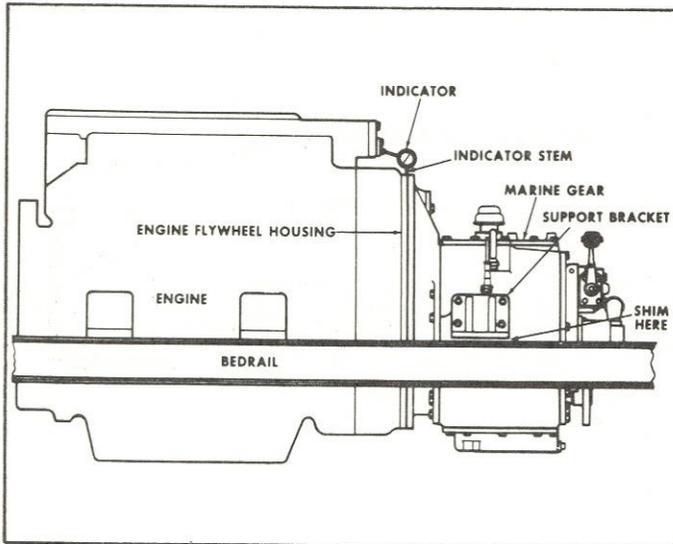


Figure 41. Alignment of Engine and Marine Gear.

B. Alignment (fig. 41). Install the support brackets on the side mounting pads of the marine gear. Install the isolator on the engine flywheel. Bolt an indicator to the engine block and set the indicator stem on the engine flywheel housing. Set the indicator gauge at zero. Lift the marine gear with a hoist, or other suitable means, and place the unit in position against the engine flywheel housing. Guide the input shaft spline into the isolator. Secure the housing adapter of the marine gear to the engine flywheel housing with suitable fasteners. Use a feeler gauge between each support bracket and engine bedrail. Add shims between the brackets and bedrails to equal the feeler gauge readings. Carefully release the lifting force on the marine gear. The indicator gauge must remain steady at the zero mark. If the reading moves from zero, lift the marine gear and insert additional shims. Continue this procedure until the marine gear is completely at rest on the bedrails and the gauge maintains a steady zero reading. After obtaining the correct zero reading, secure the support brackets to the engine bedrails. Gauge must remain at zero after bolting to bedrails.

C. Hydraulic System. Fill the hydraulic system with the proper type, weight, and amount of oil as specified in Paragraph 19E.

B 51. ALIGNMENT.

NOTE

Proper alignment of an engine and marine units 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 under 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 gear alignment.

A. 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 Gear Alignment”). If there is an intermediate bearing in the line, this is installed and positioned with shims during the alignment process.

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 are being made.

B. Engine and Marine Gear Alignment to Propeller Shafts. It is important to align the engine and gear 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 gear 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 the threaded holes are provided in each of the engine mounts, jacking screws can be used in each of the engine mounts. 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.

It will also be necessary to move the engine and gear from one side or the other on the bed to secure 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 sides to check the parallel alignment of the coupling edges (See Figure 42).

As the engine and marine gear then comes into its aligned position, it will be possible to match the male and female halves of the propeller coupling, and prepare for bolting together. Care should be taken not to burr or mar this connection because the fit is very critical. A 0.002 inch feeler gauge is inserted between the flanges of the coupling. The feeler gauge is run completely around the coupling.

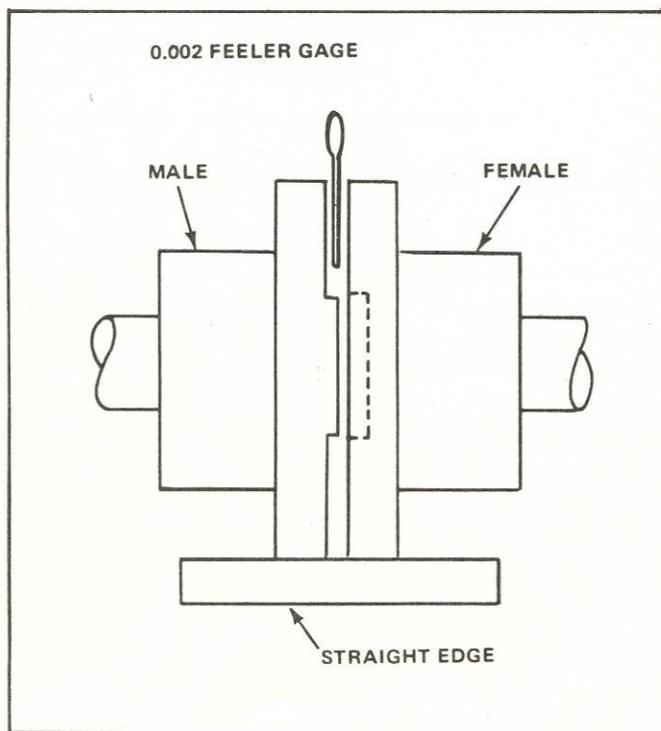


Figure 42. Measuring Alignment.

Then the marine gear flange coupling is rotated 90 degrees, 180 degrees and 270 degrees with the feeler being run around the flange again in each successive position. If the alignment is correct, the feeler gauge fits snugly with the same tension all around the flange coupling.

If the alignment varies during rotation, then further alignment is necessary or the marine gear and shaft couplings should be checked for improper face runout. Face runout on the marine gear coupling can usually be corrected by repositioning the coupling on its spline. Shaft coupling run-out is usually due to inaccuracy of taper fit or key interference.

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 gear and propeller coupling. This clearance might be 0.005 to 0.007 inches while the top would maintain the standard 0.002 inch.

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 gear is fastened in place. The alignment is then rechecked, and if satisfactory, the coupling is bolted together.

Although it is not as 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 gear 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 . . . not to correct inadequate alignment.

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

TAPER FITTING ASSEMBLY INSTRUCTIONS FOR OUTPUT GEAR.

52. A. Surface Preparation.

(1) Check Conditions of Tapered Surfaces.

The assembler at time of rebuilding should be sure that the parts fit well as determined by brightness of fit for full length of taper, due to previous assembly and disassembly, or by use of a very thin red lead compound, powder or equivalent to assure full length of taper contact. He should also remove any rust scales, badly worn spots, nicks, ridges or projections by suitable means. Re grinding may be required and building up of the surface may be required. If building up of the surface is required, build up using only the same material as the receiving part. Spraying on or other permanently adhering methods are acceptable. DO NOT use chrome, copper, zinc, cadmium, lead, tin, solder, silver, nickel or other dissimilar to receiving part material unless approved in writing by a qualified Twin Disc person, in a letter, assembly print, service literature, etc.

(2) Clean the surfaces properly. Good washing practices prior to unit assembly comes first followed by clean assembly habits and the last operation before assembling the joint is to remove all remaining traces of grease and oil from the tapered surfaces, using approved solvents, then air drying or drying with paper towels. Advance the hub along the shaft the required amount before permitting any oil, dust or other contaminant to fall upon these tapered surfaces.

B. Approved Solvents.

(1) We recommend only 1, 1, 1-trichloroethane (also known as methyl chloroform) which meets OSHA requirements. This is available as Dow Chemical CHLOROTHENE NU or CHLOROTHENE VG and as PPG INDUSTRIES, INC. TRI-ETHANE and as equivalent material from

other sources. Other chlorinated hydrocarbons probably will work satisfactorily but with the above available, we approve only the above. Oil content is to be limited to 10% maximum, by volume.

(2) We approve these for their friction control characteristics but do not recommend these unless you have OSHA approval to use them.

Stoddard Solvent. Hydrocarbon cleaning solvents meeting all but Kauri-butanol value and Bromine no. of Type I of ASTM D484 latest year (ANSI Z11.42 latest year). These have a low flash point. Mobil Corp. SOVASOL No. 5, Standard Oleum and American Oil Company STANISOL plus many other mineral spirits meet this specification.

C. Advance.

(1) Advance the gear the specified amount. This may require special fixtures, an external forcing means or only the bolts in the unit. The amount of advance is the distance from the ready position to the final position.

(2) The ready position is when the parts are assembled tightly enough to simulate "hand-press" assembly. Use the given preload force.

(3) The final position is the operating position. Measurements of advance: The desired method is miking from a constant spot on the shaft to a constant spot on the hub. For example, two ready distances are 1.280 and 1.282 and the two final distances using the same spots are 1.291 and 1.290, which give an advance of .0095 inches. A dial indicator could be used if "stick" and "slip" movement is negligible, or compensated for.

Section XIII. SPECIAL TOOLS

53. SPECIAL TOOLS.

Figures 43 through 45 in this section identify the special tools by tool number. All pertinent information necessary for tool fabrication is shown on each tool drawing. These tools are intended primarily to make overhaul procedures easier. Twin Disc Incorporated will not manufacture these tools for general use.

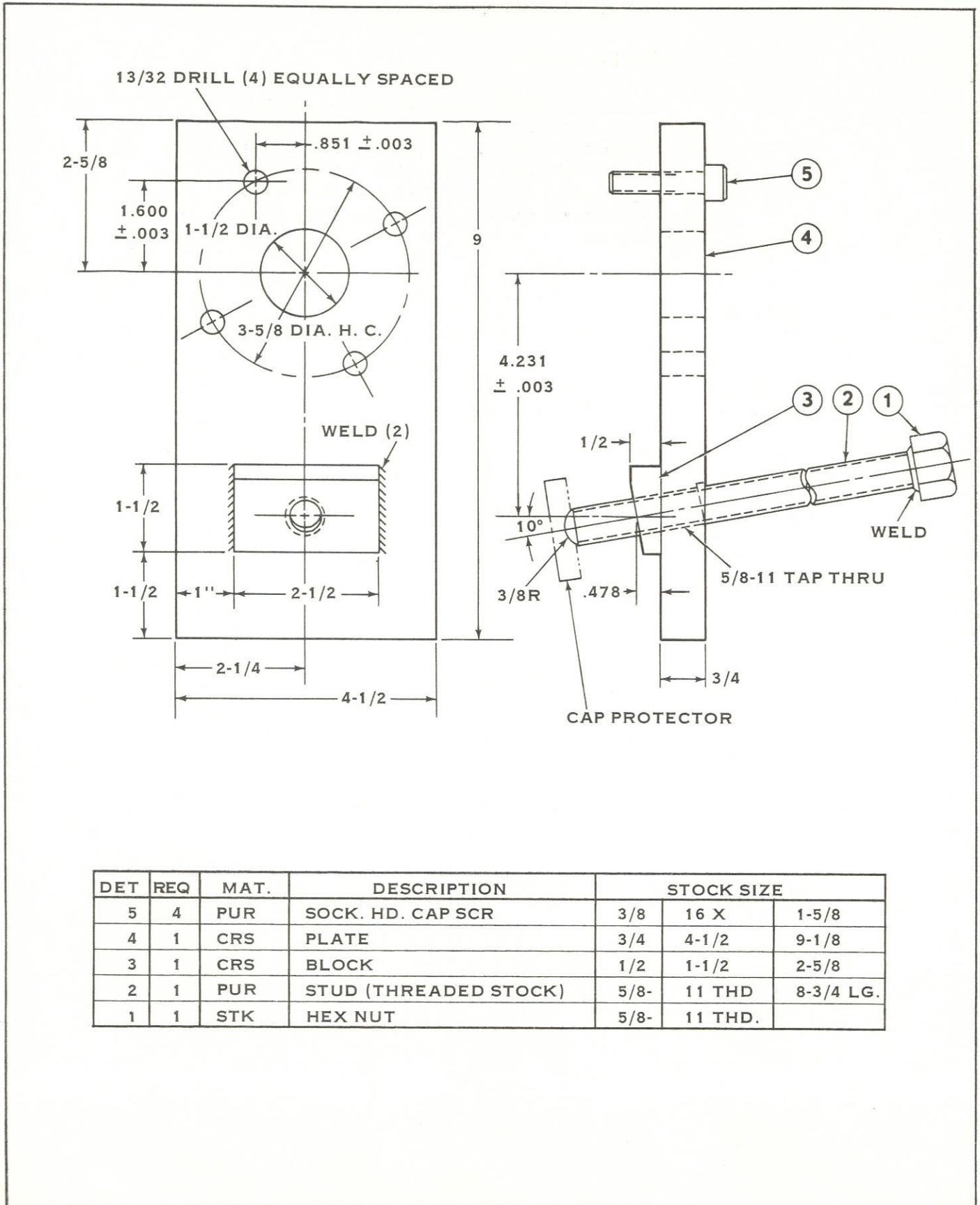


Figure 43. Special Tool T-16751.

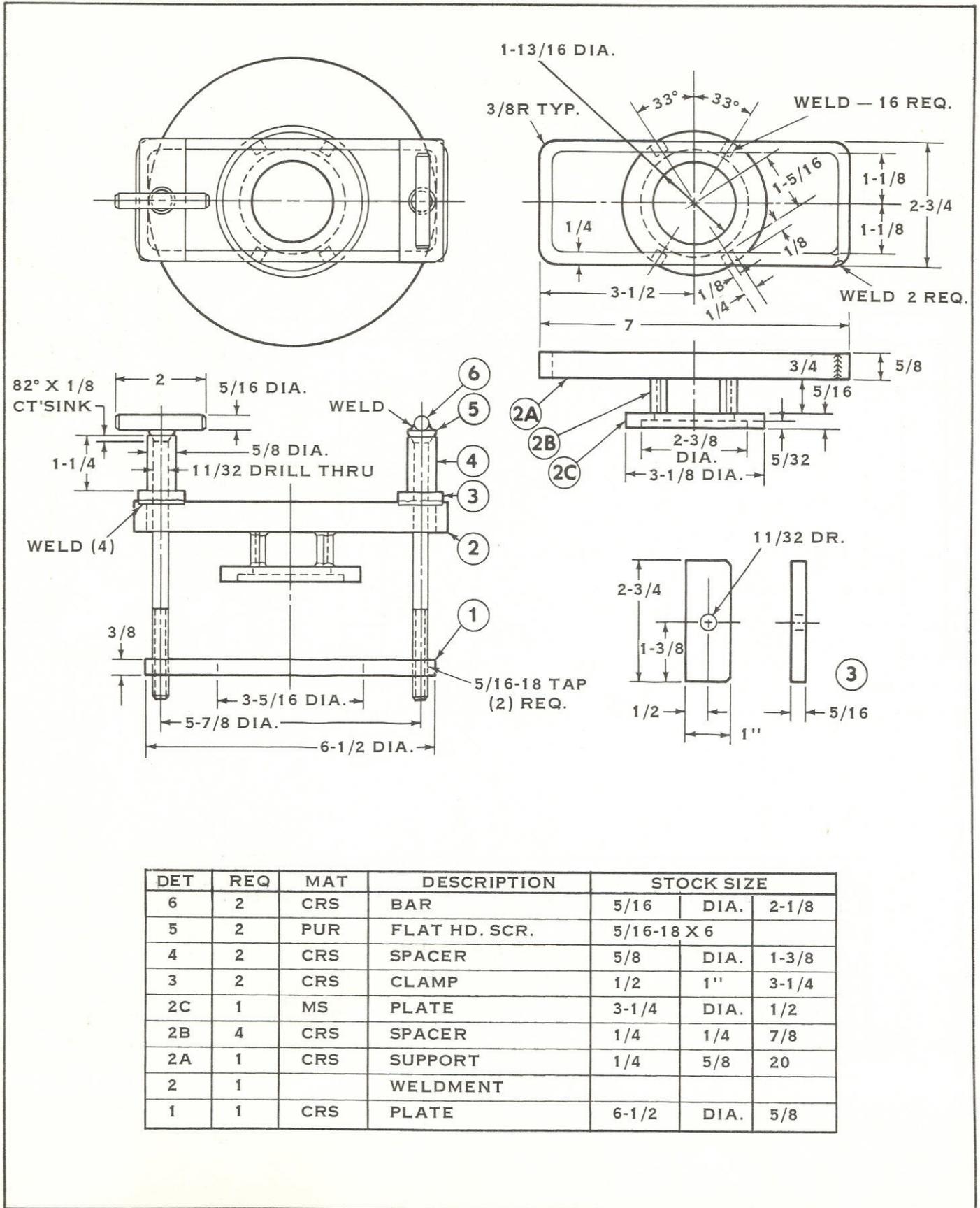


Figure 44. Special Tool T-16752.

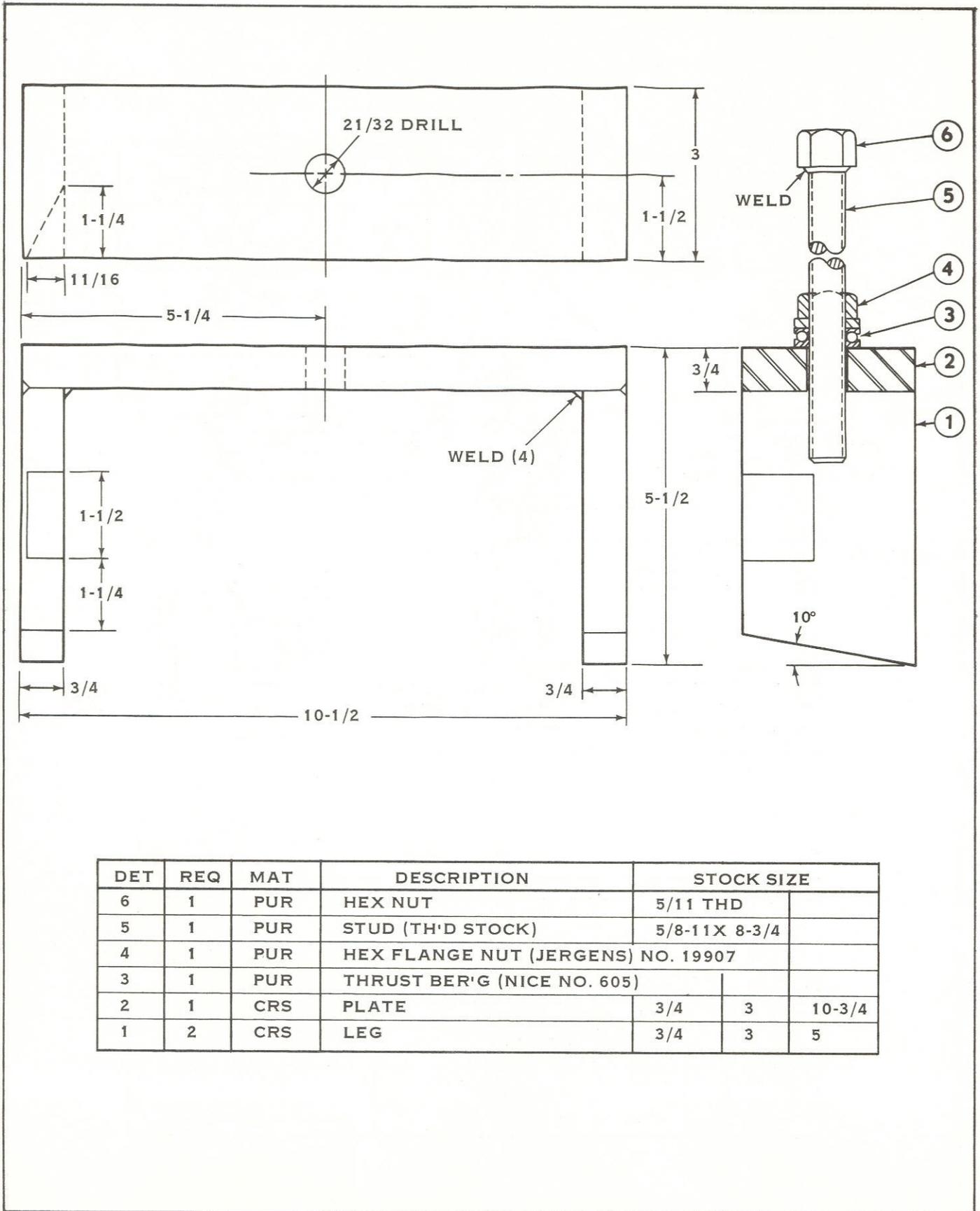
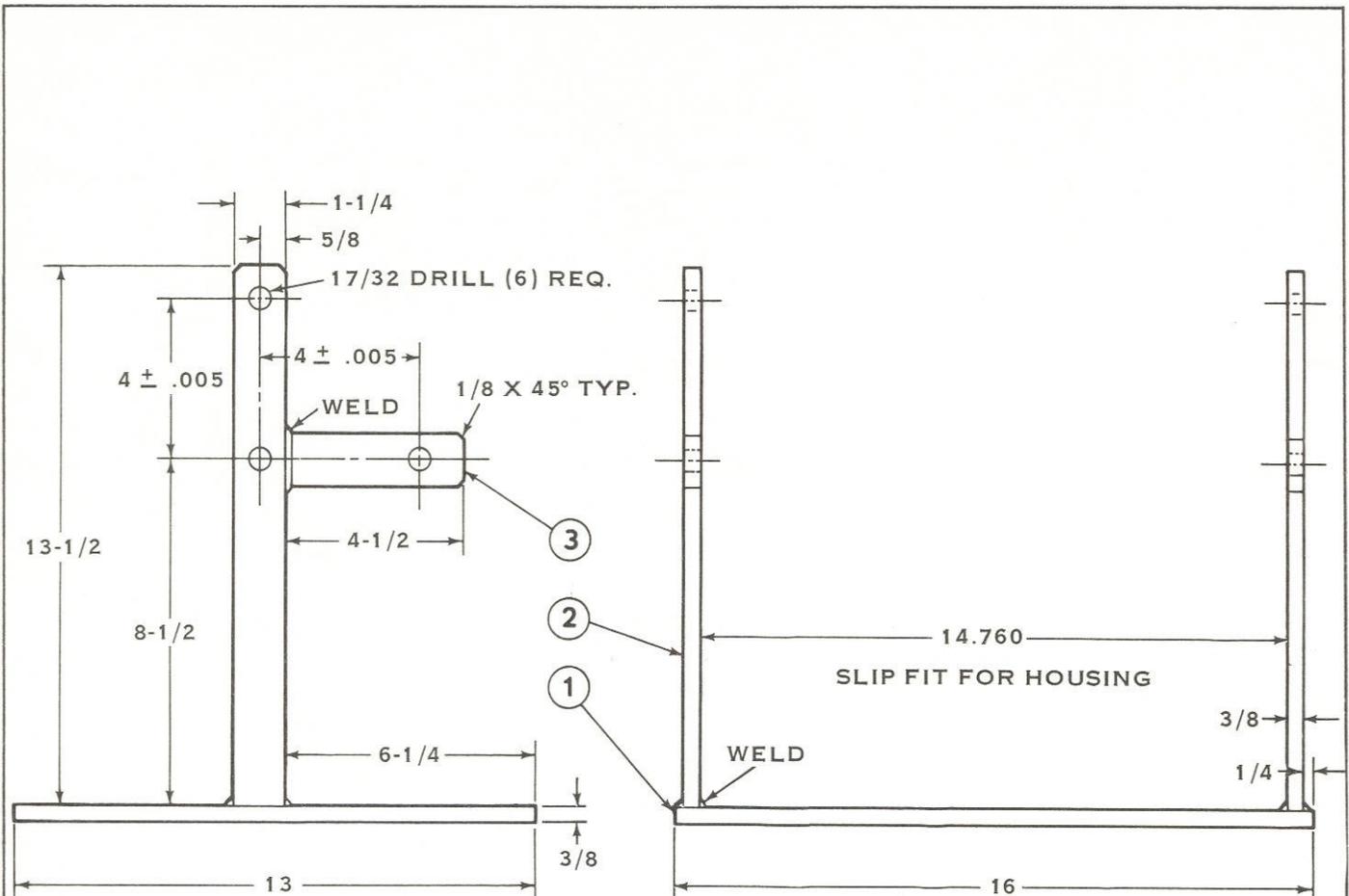


Figure 45-1. Special Tool T-16753.



DET	REQ	MAT.	DESCRIPTION	STOCK SIZE		
3	2	CRS	BAR	3/8	1-1/4	4-5/8
2	2	CRS	SUPPORT	3/8	1-1/4	13-5/8
1	1	CRS	BASE	3/8	13	16

Figure 45-2. Special Tool T-16754.



Section XIV. PARTS LIST.

54. PARTS LIST.

Use Figures 46 through 52 and the adjacent parts list for ordering spare or replacement parts in accordance with the instructions contained in Paragraphs 3 and 4. Following the parts list are planographs of the MG-502 Marine Gear.

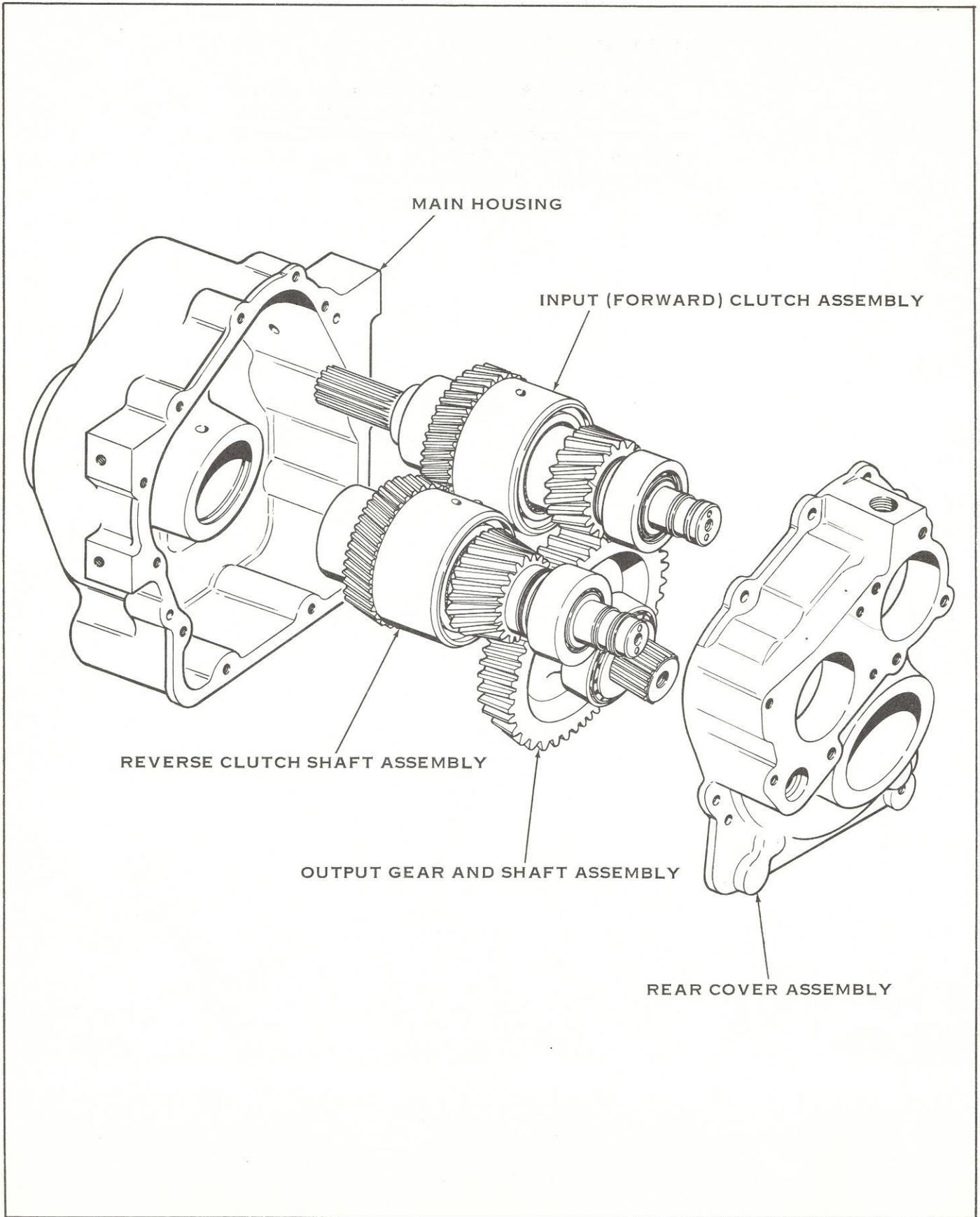


Figure 46. Relationship of Main Marine Gear Components.

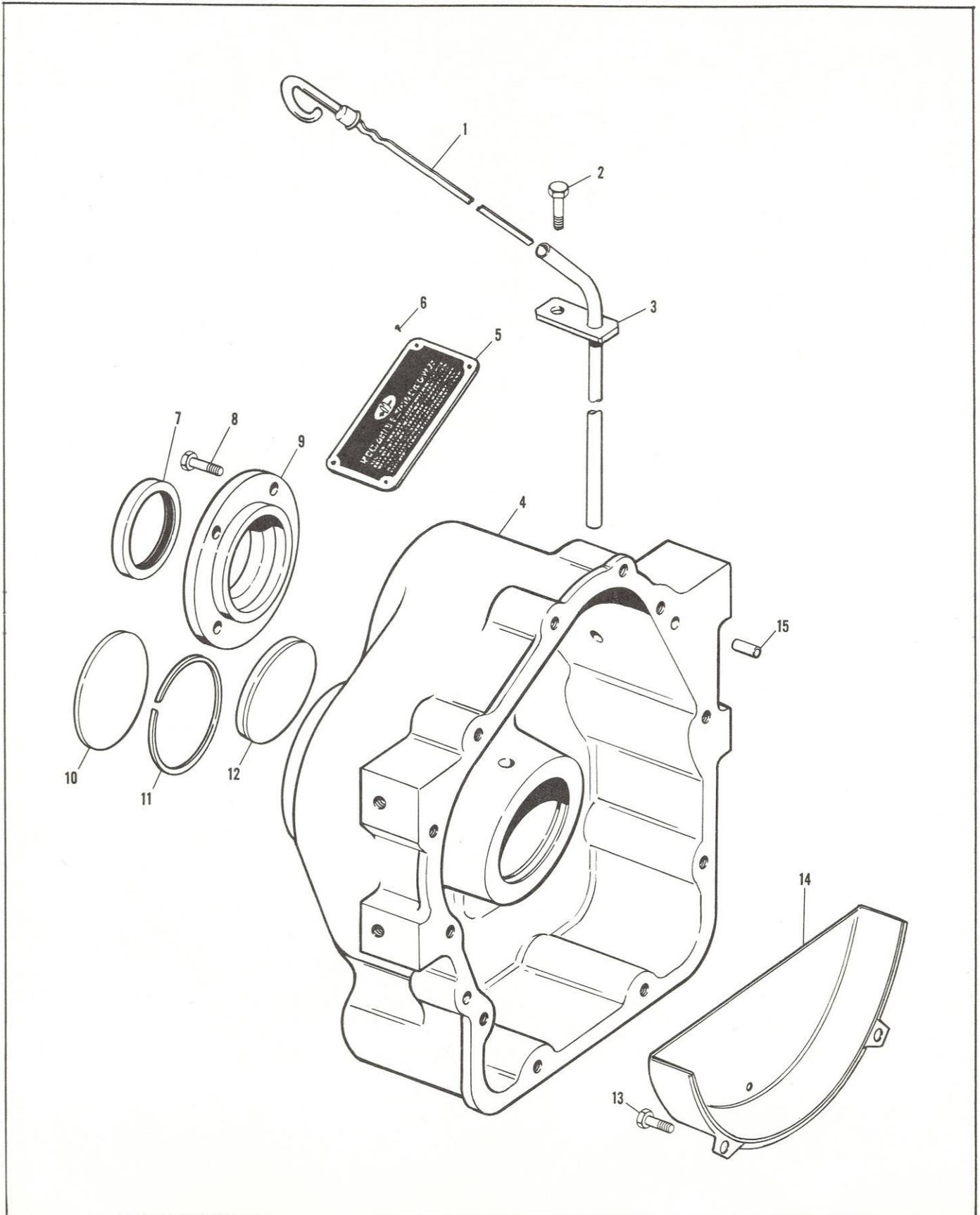


Figure 47. Main (Front) Housing and Related Parts.

MAIN HOUSING AND RELATED PARTS

<i>Item</i>	<i>Description</i>	<i>Quantity</i>
1	GAUGE, oil level	1
2	SCREW, cap, hex-head (5/16-18 x 5/8)	1
3	TUBE, oil level gauge	1
4	HOUSING, main	1
5	PLATE, name and instruction	1
6	SCREW, drive	4
7	SEAL, oil	1
8	SCREW, cap, hex-head (3/8-16 x 7/8)	4
9	RETAINER, input shaft bearing	1
10	PLUG, expansion (reverse shaft)	1
11	RING, snap, internal	1
12	PLUG, expansion (output shaft)	1
13	SCREW, cap, hex-head (5/16-18 x 1/2)	2
14	PAN, gear	1
15	PIN, dowel	2

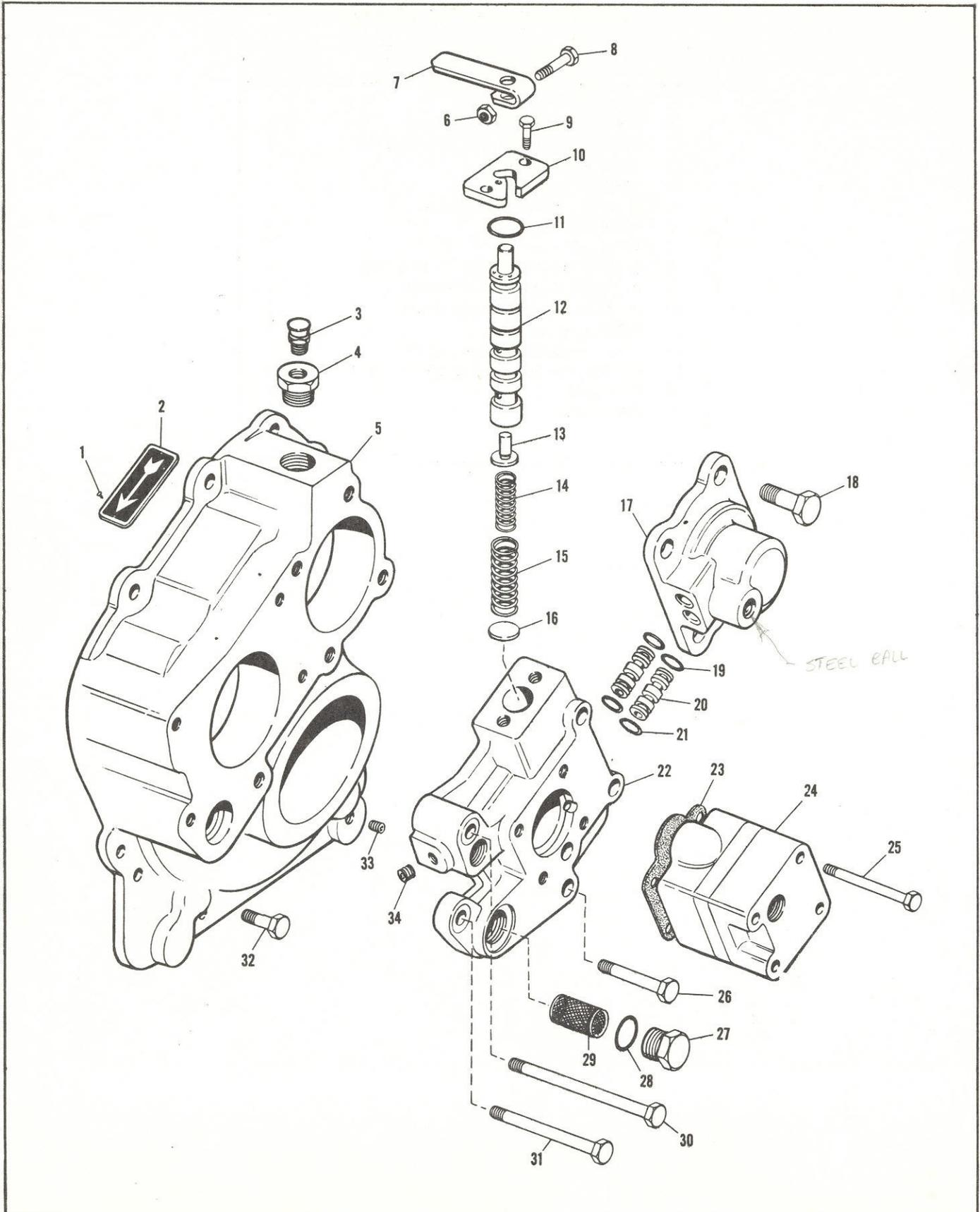


Figure 48. Rear Cover with External Related Parts.

REAR COVER WITH EXTERNAL RELATED PARTS

<i>Item</i>	<i>Description</i>	<i>Quantity</i>
1	SCREW, drive	2
2	PLATE, rotation indicator	1
3	BREATHER **	1
4	BUSHING, reducer **	1
5	COVER, rear*	1
6	NUT, hex (1/4-20 lever)	1
7	LEVER, shift	1
8	SCREW, cap, hex-head (1/4-20 x 1)	1
9	SCREW, cap, hex-head (5/16-18 x 3/4)	2
10	DETENT PLATE ASSEMBLY	1
11	"O" RING	1
12	STEM, valve	1
13	PISTON, regulator	1
14	SPRING, inner	1
15	SPRING, outer	1
16	RACE, thrust	1
17	COLLECTOR ASSEMBLY	1
18	SCREW, cap, hex-head (1/2-13 x 1-1/4)	4
19	"O" RING	2
20	TUBE, connector	2
21	"O" RING	2
22	VALVE BODY ASSEMBLY	1
23	GASKET	1
24	OIL PUMP ASSEMBLY	1
25	SCREW, cap, hex-head (pump) (5/16-18 x 3-1/2)	4
26	SCREW, cap, hex-head (3/8-16 x 2-1/2)	3
27	PLUG	1
28	"O" RING	1
29	SCREEN, filter	1
30	SCREW, cap, hex-head (3/8-16 x 5)	1
31	SCREW, cap, hex-head (3/8-16 x 4-1/4)	1
32	SCREW, cap, hex-head (3/8-16 x 7/8)	9
33	PLUG	1
34	PLUG	1

* – *Not Serviced as Separate Items.*

** – *Later units incorporate breather in oil level gauge and eliminate these parts, replacing them with a plug.*

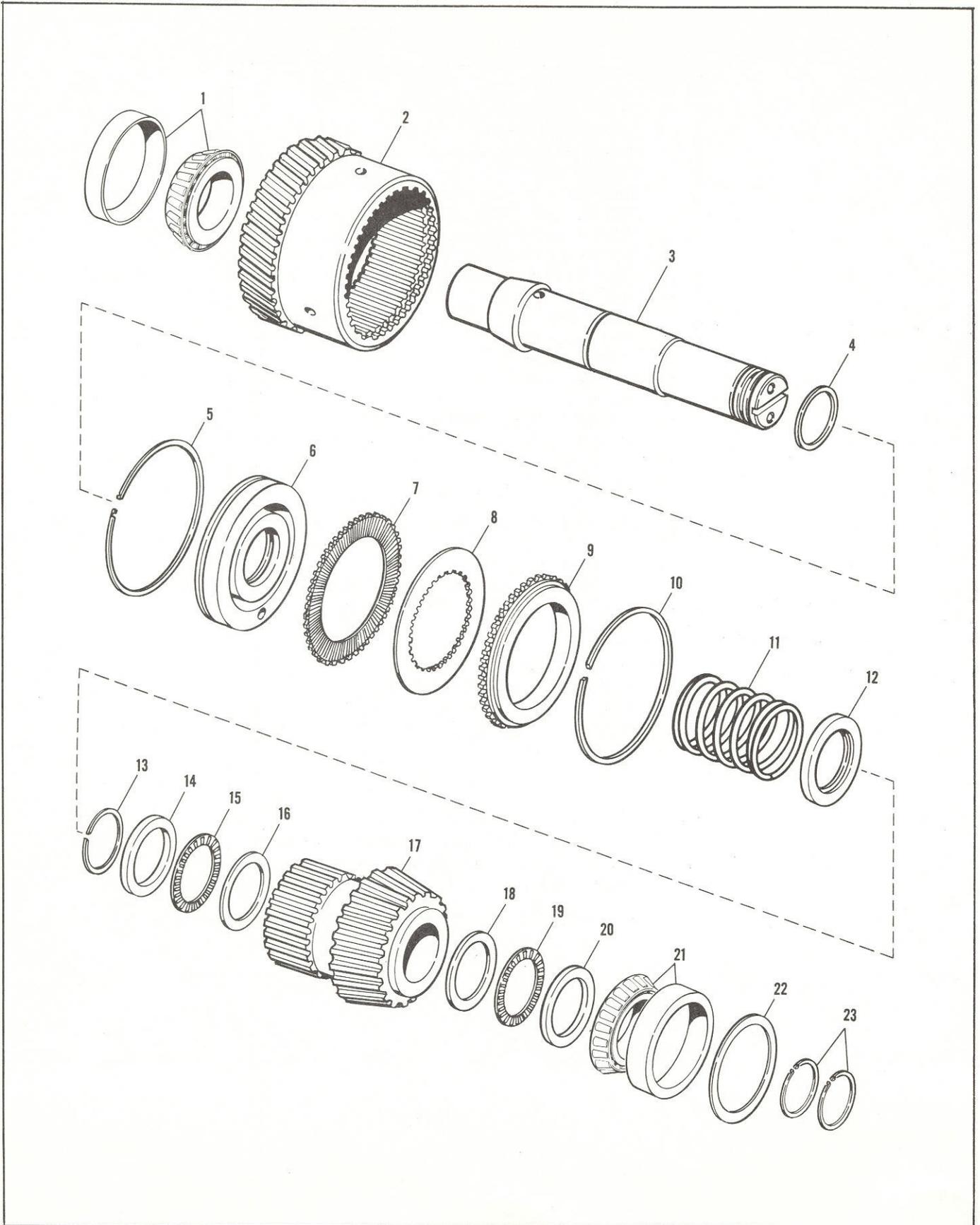


Figure 49. Reverse Clutch Assembly.

REVERSE CLUTCH ASSEMBLY

<i>Item</i>	<i>Description</i>	<i>Quantity</i>
1	TAPERED ROLLER BEARING	1
2	GEAR, forward clutch transfer*	1
3	SHAFT, reverse*	1
4	RING, lathe cut	1
5	RING, piston	1
6	PISTON, clutch	1
7	PLATE, (sintered)	8
	PLATE (sintered one side only)	2
8	PLATE, clutch (steel)	9
9	PLATE, clutch back	1
10	RING, snap (internal)	1
11	SPRING, clutch piston	1
12	RETAINER, spring	1
13	RING, snap (external)	1
14	RACE, thrust	1
15	TAPERED ROLLER THRUST BEARING	1
16	RACE, thrust	1
17	REVERSE PINION ASSEMBLY	1
18	RACE, thrust	1
19	TAPERED ROLLER THRUST BEARING	1
20	RACE, thrust	1
21	TAPERED ROLLER BEARING	1
22	SHIM	
	.005	A/R
	.007	A/R
	.020	A/R
23	RING, piston	2

* - *Not serviced Separately.*

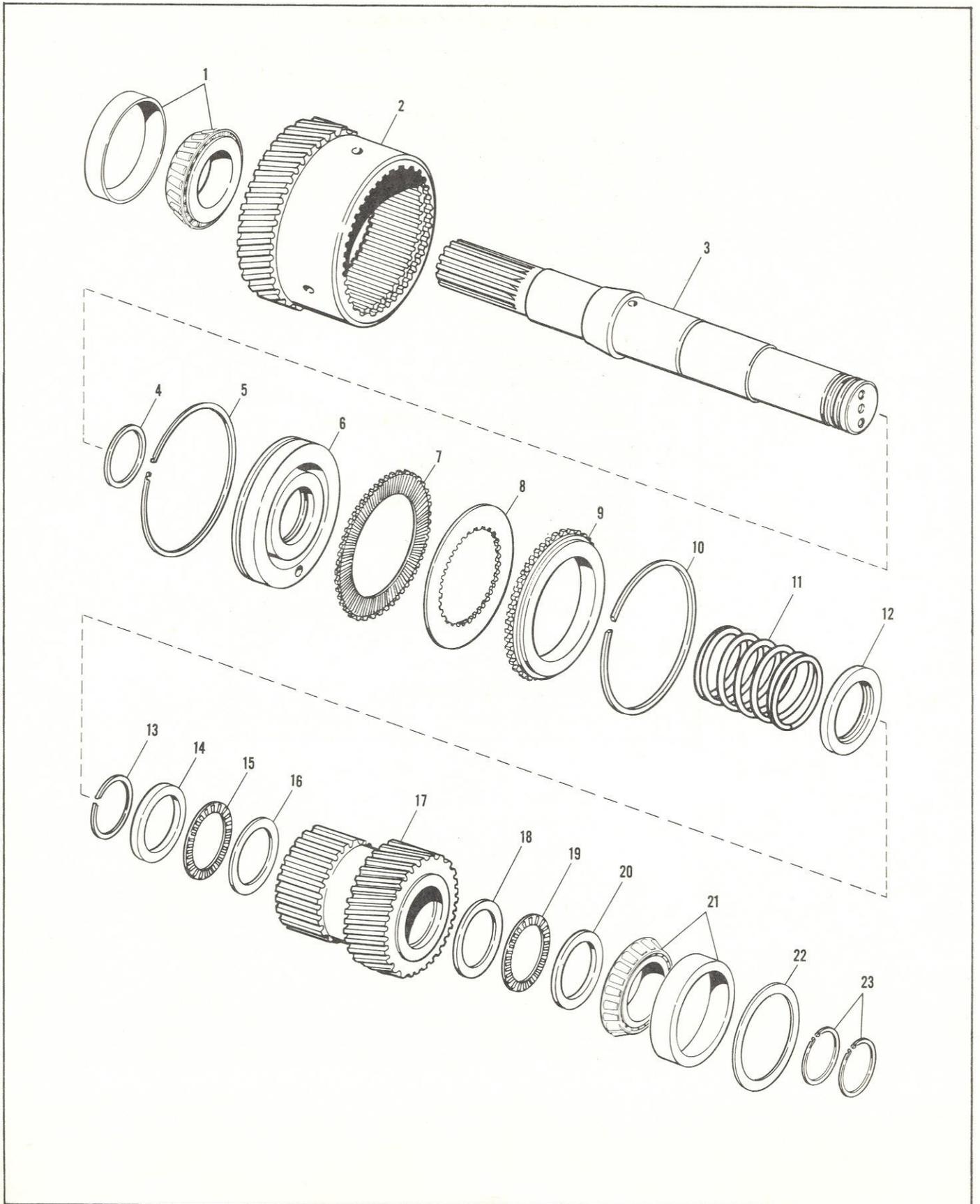


Figure 50. Input (Forward) Clutch Assembly.

INPUT (FORWARD) CLUTCH ASSEMBLY

<i>Item</i>	<i>Description</i>	<i>Quantity</i>
1	TAPERED ROLLER BEARING	1
2	GEAR, forward clutch transfer*	1
3	SHAFT, input clutch*	1
4	RING, lathe cut	1
5	RING, piston	1
6	PISTON, clutch	1
7	PLATE, (sintered)	8
	PLATE (sintered one side only)	2
8	PLATE, clutch (steel)	9
9	PLATE, clutch back	1
10	RING, snap (internal)	1
11	SPRING, clutch piston	1
12	RETAINER, spring	1
13	RING, snap (external)	1
14	RACE, thrust	1
15	THRUST NEEDLE ROLLER BEARING	1
16	RACE, thrust	1
17	FORWARD PINION ASSEMBLY	1
18	RACE, thrust	1
19	THRUST NEEDLE ROLLER BEARING	1
20	RACE, thrust	1
21	tapered roller bearing	1
22	SHIM	
	.005	A/R
	.007	A/R
	.020	A/R
23	RING, piston	2

* - *Not Serviced Separately.*

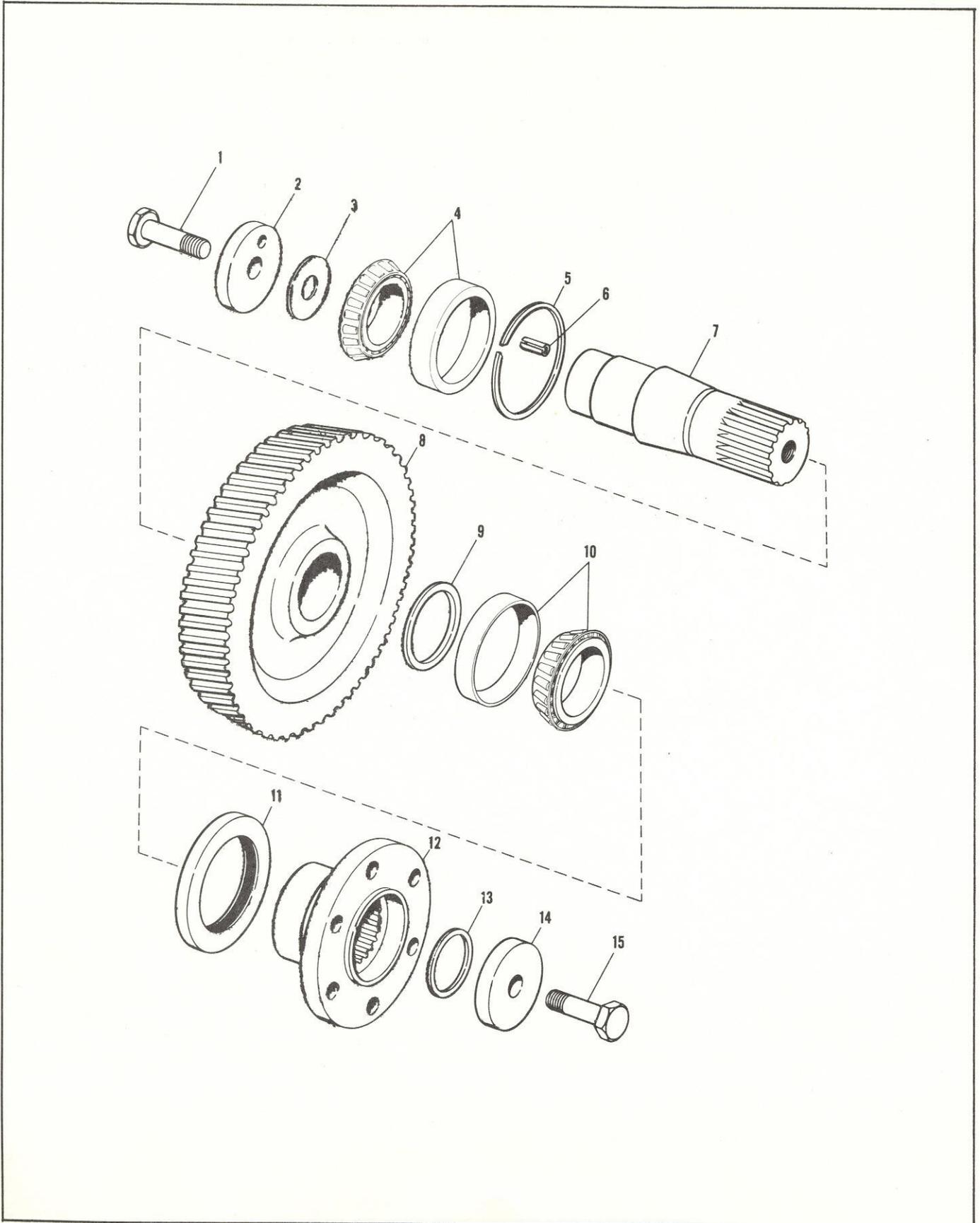


Figure 51. Output Shaft Group of Parts.

OUTPUT SHAFT GROUP OF PARTS

<i>Item</i>	<i>Description</i>	<i>Quantity</i>
1	SCREW, cap, hex-head (5/8-11 x 1-1/4)	1
2	WASHER, retainer	
3	SHIM	
	.005	A/R
	.007	A/R
	.020	A/R
4	TAPERED ROLLER BEARING	1
5	RING, snap	1
6	ROLL PIN	1
7	SHAFT, output	1
8	GEAR, conical involute helical output	1
9	SPACER, output shaft	1
10	TAPERED ROLLER BEARING	1
11	SEAL, oil	1
12	FLANGE, output	1
13	RING, lathe cut	1
14	WASHER, retainer	1
15	SCREW, cap, hex-head (5/8-11 x 1-1/4)	1

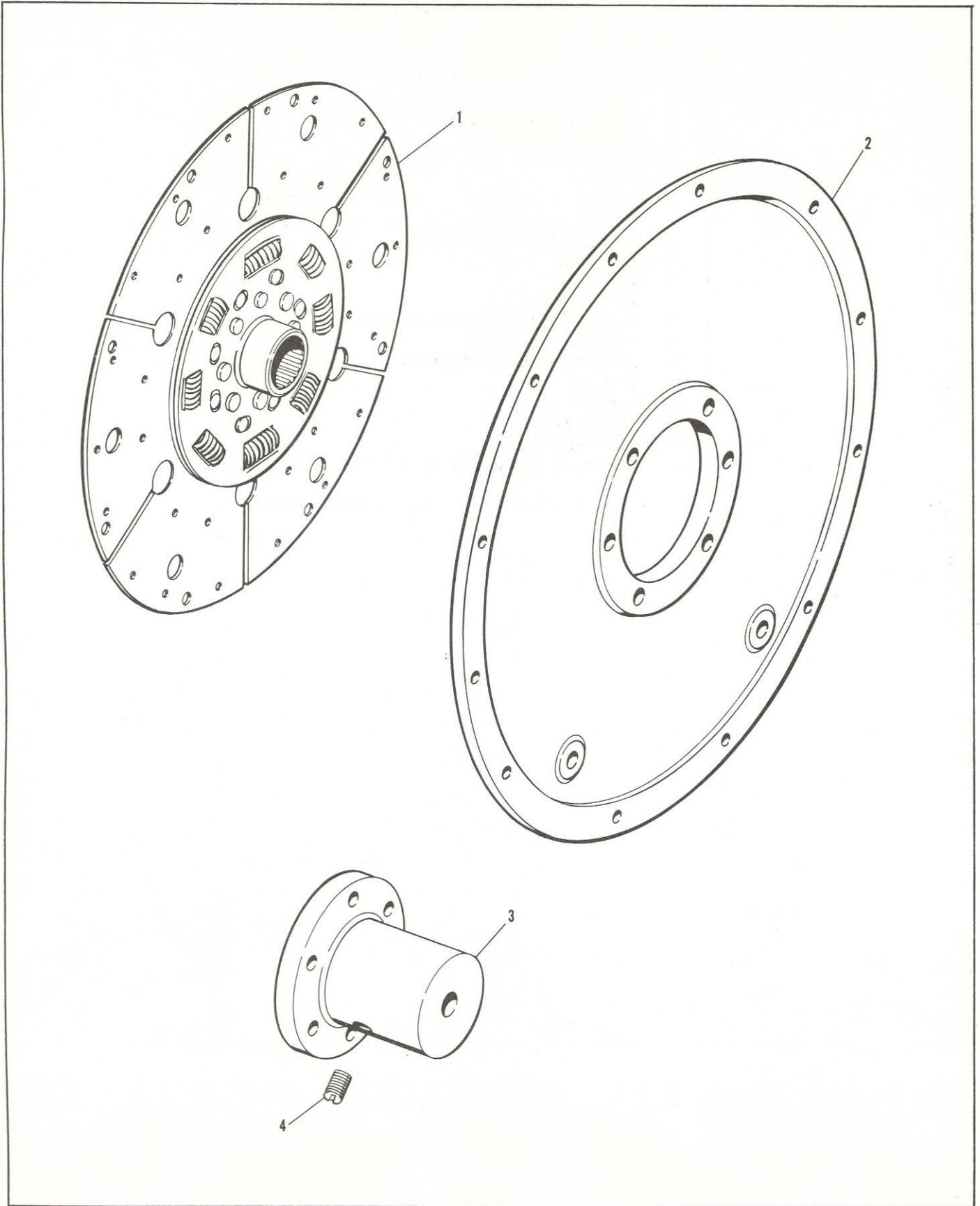


Figure 52. Optional Parts — Twin Disc will Supply on Order.

OPTIONAL PARTS – TWIN DISC WILL SUPPLY ON ORDER.

<i>Item</i>	<i>Description</i>	<i>Quantity</i>
1	TORSIONAL ISOLATOR*	1
2	FLANGE, housing*	1
3	FLANGE, companion*	1
4	SETSCREW, (1/2-13 x 25/32)*	2
	* –	
	* – <i>Parts supplied on special order only.</i> <i>Considered optional equipment.</i>	

TORQUE VALUES FOR TIGHTENING CAPSCREWS, BOLTS, NUTS, TUBE FITTINGS AND PLUGS.

CAP SCREWS, BOLTS & NUTS					
TORQUE (LB. FT.) FOR COURSE AND FINE THREADS (1)					
NOMINAL THREAD DIAMETER	SAE GRADE 5		SAE GRADE 8		Screws for Universal Joint Bearing Caps
	AS (2) RECEIVED	LUBRI- (3) CATED	AS (2) RECEIVED	LUBRI- (3) CATED	LUBRI- (3) CATED
1/4	9 ± 1	7 ± 1	14 ± 1	11 ± 1	----
5/16	19 ± 2	15 ± 2	27 ± 2	22 ± 2	----
3/8	33 ± 3	27 ± 2	46 ± 4	38 ± 3	----
7/16	52 ± 4	40 ± 3	73 ± 6	60 ± 5	64 ± 4
1/2	80 ± 6	65 ± 5	112 ± 8	90 ± 7	100 ± 7
9/16	112 ± 8	90 ± 8	158 ± 12	130 ± 10	----
5/8	158 ± 12	130 ± 10	224 ± 16	180 ± 15	190 ± 10
3/4	280 ± 20	225 ± 20	390 ± 30	320 ± 25	330 ± 17
7/8	448 ± 32	360 ± 30	630 ± 50	510 ± 40	510 ± 25
1	680 ± 50	540 ± 45	960 ± 70	775 ± 60	----
1 1/8	850 ± 60	675 ± 60	1360 ± 100	1100 ± 85	----
1 1/4	1175 ± 85	925 ± 75	1850 ± 150	1500 ± 125	----
3 DASHES 120° APART		6 DASHES 60° APART		 (4) 12 Pt. Head and Undercut Body	
SAE STANDARD HEX BOLT HEAD MARKINGS					

TAPERED PIPE PLUGS		
RECOMMENDED TORQUE (LB. FT.)		
NPTF SIZE	LUBRICATED (a)	
	In Cast Iron or Steel	In Aluminum
1/16-27	8.5 ± 1.0	5.5 ± 0.7
1/8-27	10.5 ± 1.3	6.5 ± 0.8
1/4-18	25 ± 3	16 ± 2
3/8-18	27 ± 3	17 ± 2
1/2-14	50 ± 6	30 ± 4
3/4-14	54 ± 7	34 ± 4
1 -11 1/2	80 ± 10	50 ± 6
1 1/4-11 1/2	85 ± 10	55 ± 7
1 1/2-11 1/2	85 ± 10	55 ± 7

(a) THE LUBRICANT IS TO BE JOHN CRANE INSOLUBLE PLASTIC LEAD SEAL NO. 2 OR EQUIVALENT OR LOCTITE NO. 92 OR EQUIVALENT AND PLUGS ARE TO BE CAPABLE OF REMOVAL WITHOUT DAMAGE. OVERTIGHTENING MAY CAUSE INITIAL LEAKAGE PLUS POTENTIAL REMOVAL DAMAGE. AN OPTION OF A MAX. OF TWO FULL TURNS AFTER FINGER TIGHTENING THE PLUG MAY BE USED IF REQUIRED AND IF REMOVAL CONDITIONS ARE MET.

(1) THESE TORQUE VALUES APPLY TO USE OF IRONS, STEELS AND ALUMINUM TAPPED HOLES.

THE THREAD ENGAGEMENT LENGTH IN ALUMINUM IS TO BE TWICE THE NOMINAL THREAD DIAMETER AND ENGAGEMENT LENGTH RATIO IS TO BE 1.5 FOR IRONS AND SOFT STEEL. WHEN ZINC PLATING IS USED, LUBRICATE THE ZINC PLATED SURFACES OF THE SCREWS AND/ OR NUTS AND USE SPECIAL TORQUE VALUES.

(2) USE FOR ALL CAPSCREWS, BOLTS AND NUTS COATED ONLY WITH THE FASTENER MANUFACTURER'S RUST PREVENTATIVE OIL AND USE FOR PARTS WIPED OR WASHED NEARLY FREE OF OIL. DO NOT USE FOR PLATED PARTS.

(3) USE FOR ALL CAPSCREWS AND NUTS WHOSE THREADS AND WASHER FACE ARE LUBRICATED, ALSO FOR SCREWS OR NUTS WHOSE WASHER FACE IS ASSEMBLED AGAINST A HARDENED WASHER OR SMOOTH FINISHED HARD PART. (R_c 40 OR ABOVE AND 40AA MAX.). ALSO USE FOR PLATED SCREWS (EXCEPT ZINC PLATED). LUBRICATING THE THREADS AND SCREW OR NUT FACE WITH SAE 20 OR 30 OIL IS RECOMMENDED FOR BEST RESULTS FOR ALL THE GRADE 8 SCREWS AND IS REQUIRED FOR ALL THE UNIVERSAL JOINT BEARING CAPSCREWS.

DO NOT USE MOLY-DISULFIDE, WHITE LEAD, COPPER FILLED OR OTHER SUCH FILLED LUBRICANTS WITH THESE TORQUE VALUES. SUCH LUBRICANTS REQUIRE SPECIAL TORQUE VALUES.

(4) SOCKET HEAD SCREWS AND 12 POINT HEAD SCREWS WITH FULL BODY ARE GRADE 8 OR BETTER QUALITY AND ARE TO BE ASSEMBLED WITH THE ABOVE TORQUE VALUES.

**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 SHOWN ON PAGE 1.**

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.



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.

PRESSURE & FLOW TEST KIT FOR USE ON TWIN DISC PRODUCTS

A portable pressure and flow test kit has been developed to accurately test the operation of hydraulic systems used on Twin Disc products.

This kit contains a sufficient number of components to trouble shoot the most complicated power-shift transmission hydraulic system. It can, of course, also be used on the simpler systems such as single stage converters and marine gears.

Please note that in addition to the pressure test equipment, the kit also contains two *flow meters*. These flow meters will eliminate guessing about pump performance, as pump performance can now be measured.

A complete description of the kit is provided on the reverse side of this sheet. Those interested in the kit should contact the kit manufacturer directly.

The Manufacturer is: The Nuday Company, 14615 Wyoming, Detroit, MI 48238. Nuday Part Number for the Kit is No. 2451.

NOTE: TWIN DISC WILL NOT STOCK OR SELL THIS KIT.

now available . . .



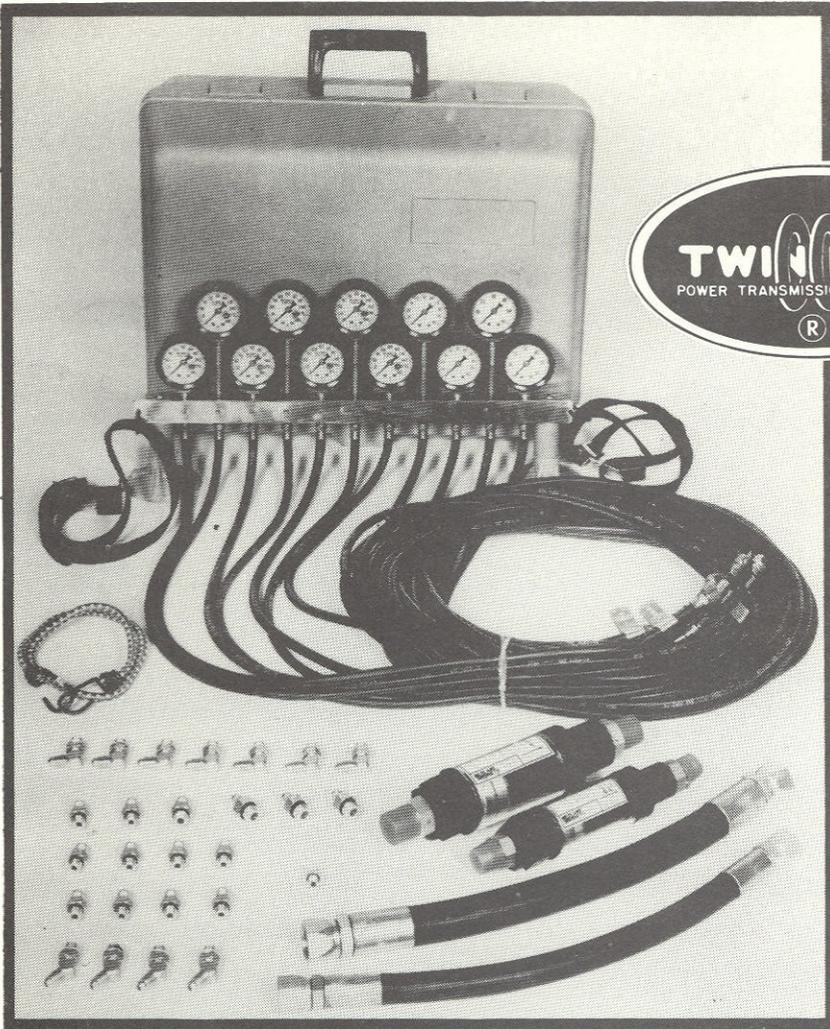
2451 HYDRAULIC PRESSURE & FLOW TEST KIT

Service Tested,

Approved and Recommended

for

Twin Disc, Incorporated Hydraulic Systems

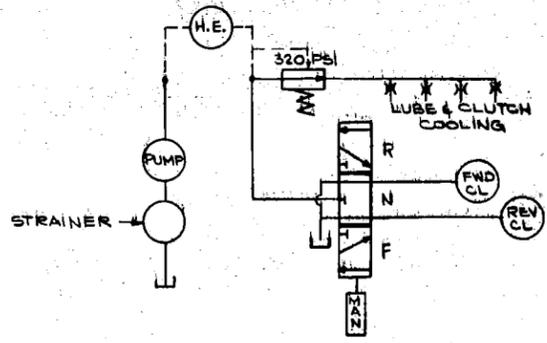


KIT INCLUDES:

- 10 & 30 GPM flow meters.
- Large rubber suction cups to grip and absorb vibration and road shock.
- Hoses clearly identified with a tag for easy identification and installation.
- Hose adapters to fit most hydraulic systems.
- Rubber stretch cable with spring hook ends to hold the unit vertically against a line pressure surge, and to hook around the gauges to hold the hoses when they're not in use.
- Two heavy duty 32-inch long adjustable straps with rubber covered clips.

CONTENTS OF KIT 2451

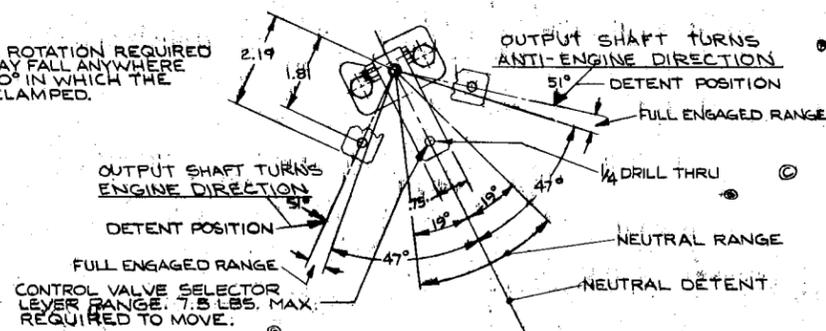
Part No.	Qty.	Description	Part No.	Qty.	Description
6652	1	Gauge Bar	0804	2	Screw 1/4-20 x 2-3/4 lg.
6653	7	Gauge 400 psi	0831	7	90° Elbow 4 SAE x 4 JIC M
6234	2	Gauge 100 psi	0039	10	Adapter 4 SAE x 4 JIC M
6258	1	Gauge 60 psi	0721	1	Adapter 3 SAE x 4 JIC M
6654	1	Gauge 30 psi	0013	3	Adapter 6 SAE x 4 JIC M
6094	11	Hose 10 ft. Long	0752	1	Adapter 5 SAE x 4 JIC M
0799	2	"D" Clip	6655	1	Flow Meter 30 GPM
0800	2	Strap	6656	1	Flow Meter 10 GPM
0801	2	Coated Clips	6657	1	Hose 10 - 100R1 18 inches Long
0802	1	Stretch Cord	6658	1	Hose 12 - 100R1 18 inches Long
0803	2	Suction Cup	6660	2	Adapter 10 SAE MX 10 JIC M
6311	5	Nipples NPT-2	6659	2	Adapter 12 SAE MX 12 JIC M
0076	5	Coupler NPT-2	6641	4	Adapter 45° 4 SAE x 4 JIC M
			6299	1	Box Storage with fills



HYDRAULIC CIRCUIT DIAGRAM

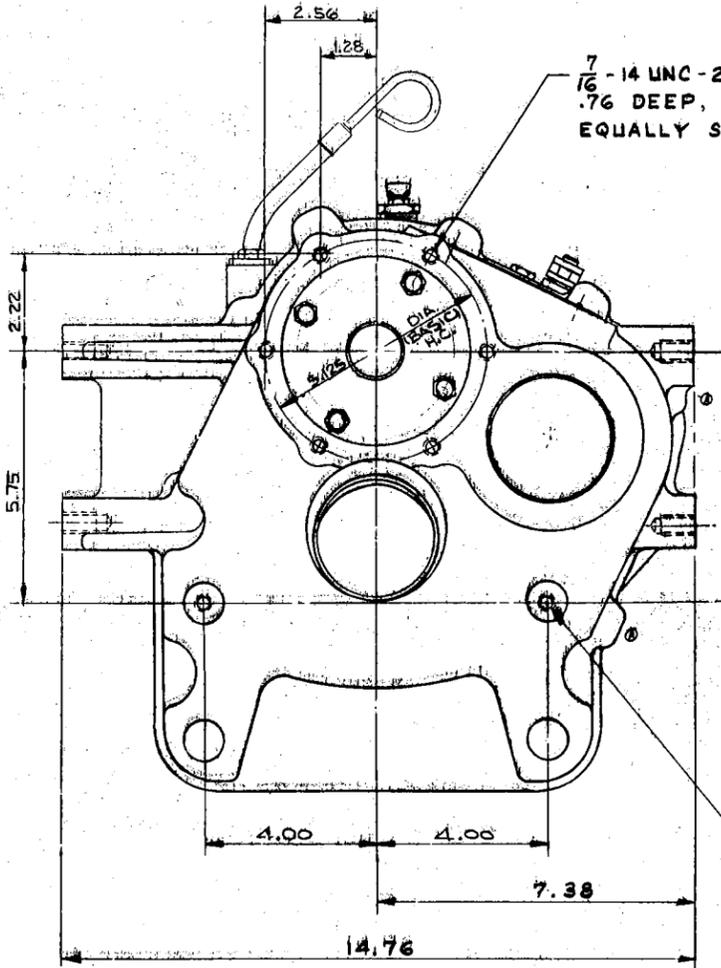
EXTERNAL SPLINE DATA	
FLAT ROOT SIDE	ANGLE 30°
NUMBER OF TEETH 26	PITCH DIA. 1.300
PITCH DIA. (REF) 1.300	FORM DIA. MAX. 1.248
CHAMFER APPROX. NONE	ENGINE
MINOR DIAMETER MIN.	1.2220
CIRCULAR TOOTH THICKNESS	MAX. ACT. .0760
	MIN. ACT. .0730
MEASUREMENT OVER .002 DIA. PINS WITH NONE TO FLAT	MAX. ACT. 1.4450
	MIN. ACT. 1.4403

THE 102° LEVER ROTATION REQUIRED FOR CONTROL MAY FALL ANYWHERE WITHIN THE 360° IN WHICH THE LEVER MAY BE CLAMPED.

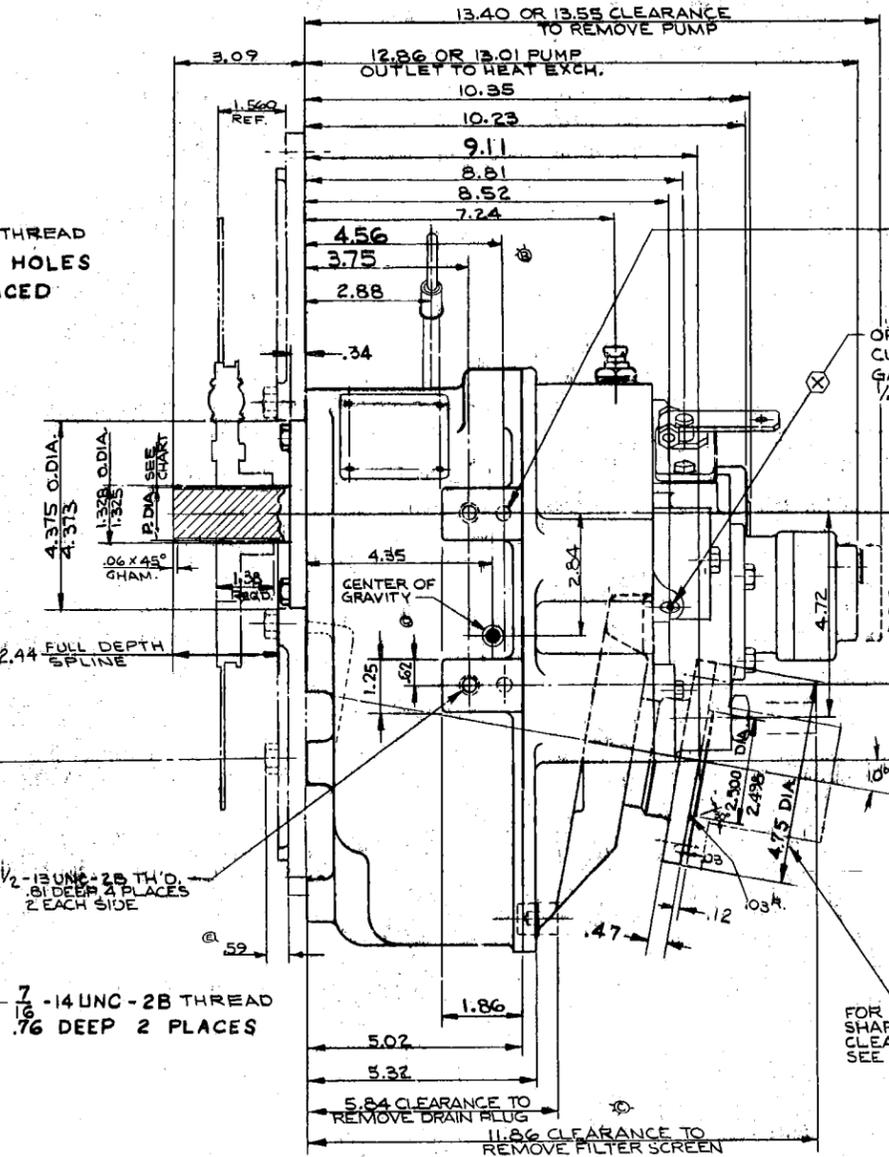


CONTROL VALVE SELECTOR LEVER RANGE, 7.3 LBS. MAX. REQUIRED TO MOVE.

HEAT EXCHANGER (H.E.) REQUIREMENTS AND GENERAL DATA	
MAX. MIN. PERMISSIBLE OIL TEMP INTO H.E.	210-180 °F.
MIN. RECOMMENDED TRANSFER CAPACITY (MULTIPLY BY 1.25 FOR FRESH WATER) PER 1000 ENGINE R.P.M. (RAW WATER) AT PROP. MATCH POINT	10.5 BTU PER MINUTE
OIL TO HEAT EXCHANGER (USE RPM RATIO FOR RATIOING GPM)	2.5 G.P.M. AT 3000 R.P.M.
MAX. PEAK OIL PRESSURE AT H.E. (USE 1.5 TIMES P.S.I. FOR PROOF TEST OF H.E.)	410 P.S.I.
MAX. ALLOWABLE PRESSURE DROP ACROSS H.E. OIL PASSAGES WITH 300 SUS AT MATCH POINT, R.P.M.	30 P.S.I.
WATER TO H.E. — USE 15 TO 30 TIMES OIL G.P.M.	
DATA PURCHASER OF H.E. SHOULD PROVIDE:	
STATE TYPE OF WATER TO BE SUPPLIED — RAW OR FRESH. (RAW IS OPEN CHANNEL & SEA WATER.) (FRESH IS CLOSED ENGINE JACKET & KEEL COOLER WATER SYSTEMS.)	
STATE MAX. °F. WATER INTO H.E. — USUALLY USE 85° F. FOR RAW WATER, 140° F. FOR KEEL COOLER WATER AND UP TO 180° F. FOR ENGINE JACKET WATER.	
STATE MIN. G.P.M. WATER TO BE SUPPLIED. (ALSO STATE MAX. G.P.M. IF OVER 15 TIMES MIN. IS EXPECTED.)	
STATE MAX. P.S.I. WATER INTO H.E. (ASK SUPPLIER HIS EXPECTED PRESSURE DROP.)	
REFERENCE EX4107 SERIES CHARTS.	



7/16 - 14 UNC - 2B THREAD .76 DEEP, 6 HOLES EQUALLY SPACED



1/2 - 13 UNC - 2B THD .81 DEEP 2 PLACES 2 EACH SIDE

7/16 - 14 UNC - 2B THREAD .76 DEEP 2 PLACES

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

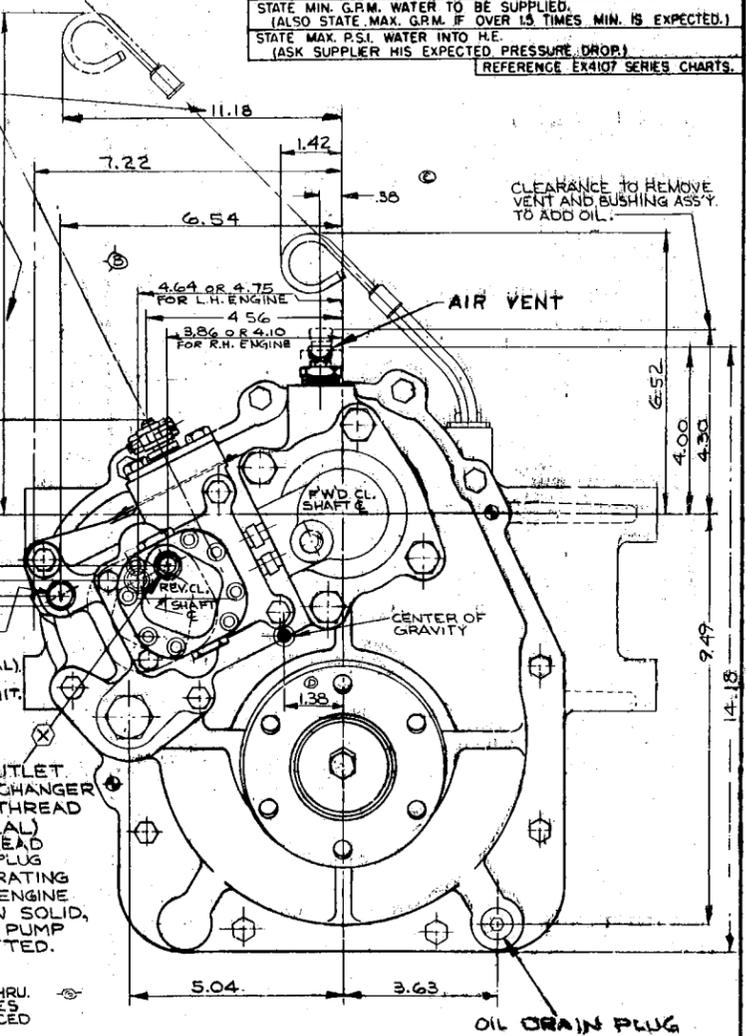
LOCATION FOR OPTIONAL BOATYARD INSTALLED DOWELS, .50 MAX. DIA., 4 HOLES, .88 MAX. DEPTH PERMISSIBLE, 2 EACH SIDE.

OPTIONAL TO INSTALL LINE TO CUSTOMER SUPPLIED OIL PRESSURE GAUGE (400 P.S.I. MIN.) 1/4-18 N.P.T.F. THREAD (DRYSEAL).

CONTROL VALVE INLET FROM HEAT EXCHANGER 1/8-18 N.P.T.F. THREAD (DRYSEAL). REMOVE THD PROTECTOR PLUG BEFORE OPERATING UNIT.

OIL PUMP OUTLET TO HEAT EXCHANGER 1/8-18 N.P.T.F. THREAD (DRYSEAL). REMOVE THREAD PROTECTOR PLUG BEFORE OPERATING UNIT. R.H. ENGINE PUMP SHOWN SOLID, L.H. ENGINE PUMP SHOWN DOTTED.

FOR PROPELLER SHAFT COUPLING CLEARANCE DATA, SEE B3313.



CLEARANCE TO REMOVE VENT AND BUSHING ASSY. TO ADD OIL.

NOTICE: THIS PRINT CONTAINS PROPRIETARY INFORMATION AND IS NOT TO BE USED IN ANY MANNER DETRIMENTAL TO THE INTERESTS OF TWIN DISC, INCORPORATED. RACINE, WISCONSIN. ROCKFORD, ILLINOIS. THIS NOTICE IS NOT INTENDED TO NULLIFY OR LIMIT RIGHTS GRANTED TO THE U. S. GOVERNMENT OR OTHERS BY CONTRACT.

MATERIAL		FINISH TREAT	
MATERIAL		FINISH TREAT	
NO. IN WT.	FINISH WT.	FINISH USED ON	APPROVED
	149*		
ALLOWABLE VARIATION ON MACHINED DIMENSIONS ±			

TWIN DISC, INCORPORATED
RACINE, WISCONSIN
X9994A
SHEET 2 OF 2

REV.	BY	DATE	DESCRIPTION
E	KS	1-18-77	ADDED BOLT
D	KS	10-9-76	ADDED CENTER OF GRAVITY
C	KS	8-2-76	UPDATED I.E. CLEARANCE DIM.
B	RG	8-2-76	ADDED FINISH
A	JS	4-14-74	REVISED DRAWING

NOTE: THE FLYWHEEL HOUSING ADAPTER (S.A.E. J617 B #3) TORSIONAL ISOLATOR (S.A.E. J620 C 1 1/2) AND PROPELLER-SHAFT COUPLING (S.A.E. J756 ZS) SHOWN IN PHANTOM ARE NORMALLY CUSTOMER SUPPLIED, BUT ARE AVAILABLE FROM TWIN DISC INC. WHEN ORDERED SEPARATELY.

NOTE: ALL POINTS AVAILABLE FOR TESTING ARE CODED ○.

