TWIN DISC
INCORPORATED

Service Manual

Marine Transmission

Model:
MG-514

Document Number: 1015886

NOTICE

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SM-133 SERVICE MANUAL

TRANSMISSION

MODEL MG-514 MARINE

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Twin Disc, Incorporated

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A **NOTE:**
"Flagging" indicates areas revised.

TWIN DISC UNIT RECORD

(FOR CUSTOMER'S CONVENIENCE)

Model No. _____

Serial No. _____ *Specification No.* _____

Equipment Manufacturer _____

Equipment Model _____

SERVICE INFORMATION

Each series of Maintenance Manuals issued by Twin Disc, Incorporated is reviewed for accuracy at regular intervals. When required, changes are made in the manual to provide the latest information regarding current design and maintenance practices of the product.

In addition, 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.

To be sure you have the latest Service Information on your Twin Disc product, contact any Twin Disc Distributor for Service Bulletins, or write to the Service Engineering Department, Twin Disc, Incorporated, Racine, Wisconsin, U.S.A.

"**IMPORTANT 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 in the catalog. Proper installation, maintenance, 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 as may be desirable or as may be specified in safety codes should be provided, and are neither provided by Twin Disc, Incorporated nor are the responsibility of Twin Disc, Incorporated."

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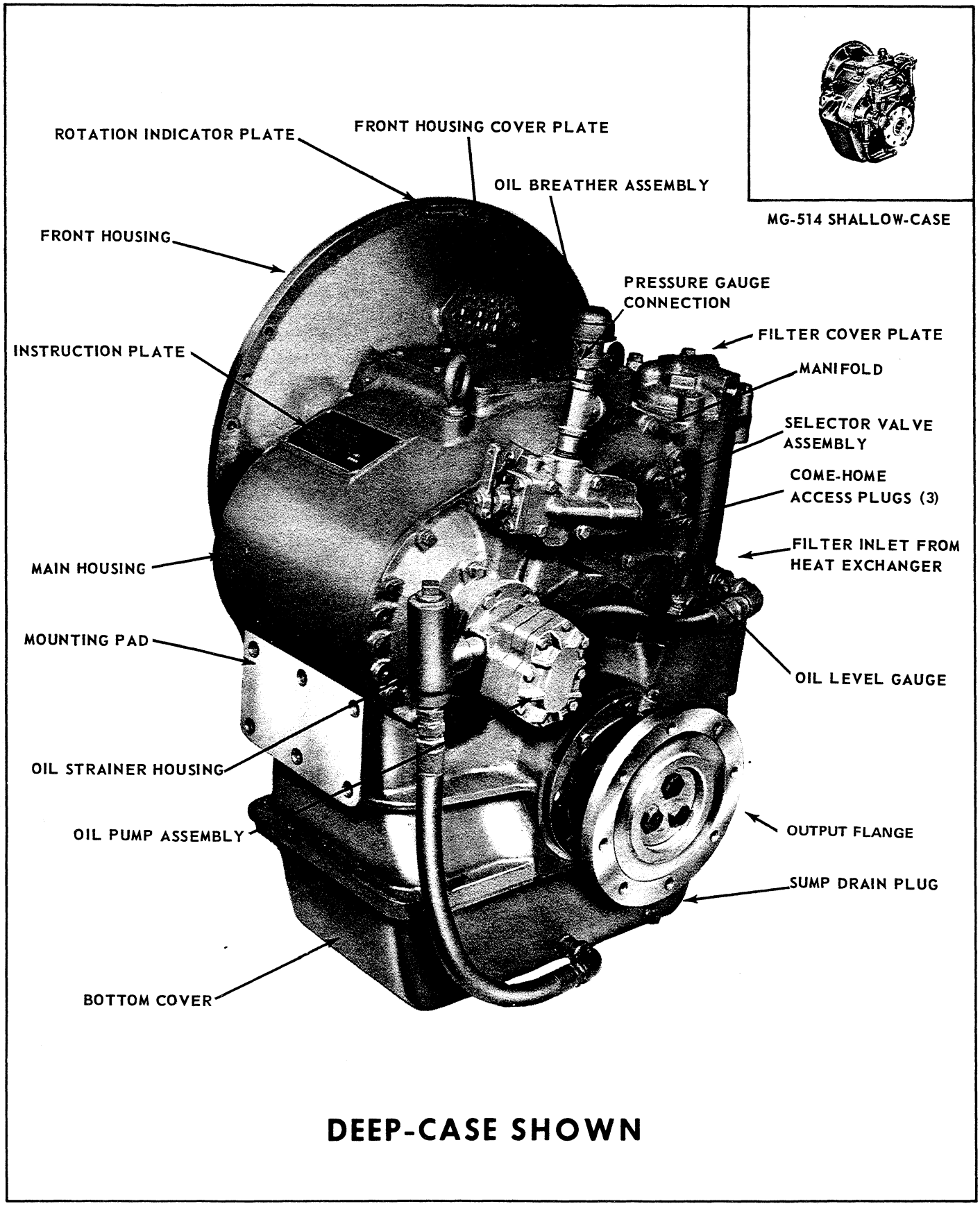

Figure 1. Model MG-514 Marine Gear – Rear View.

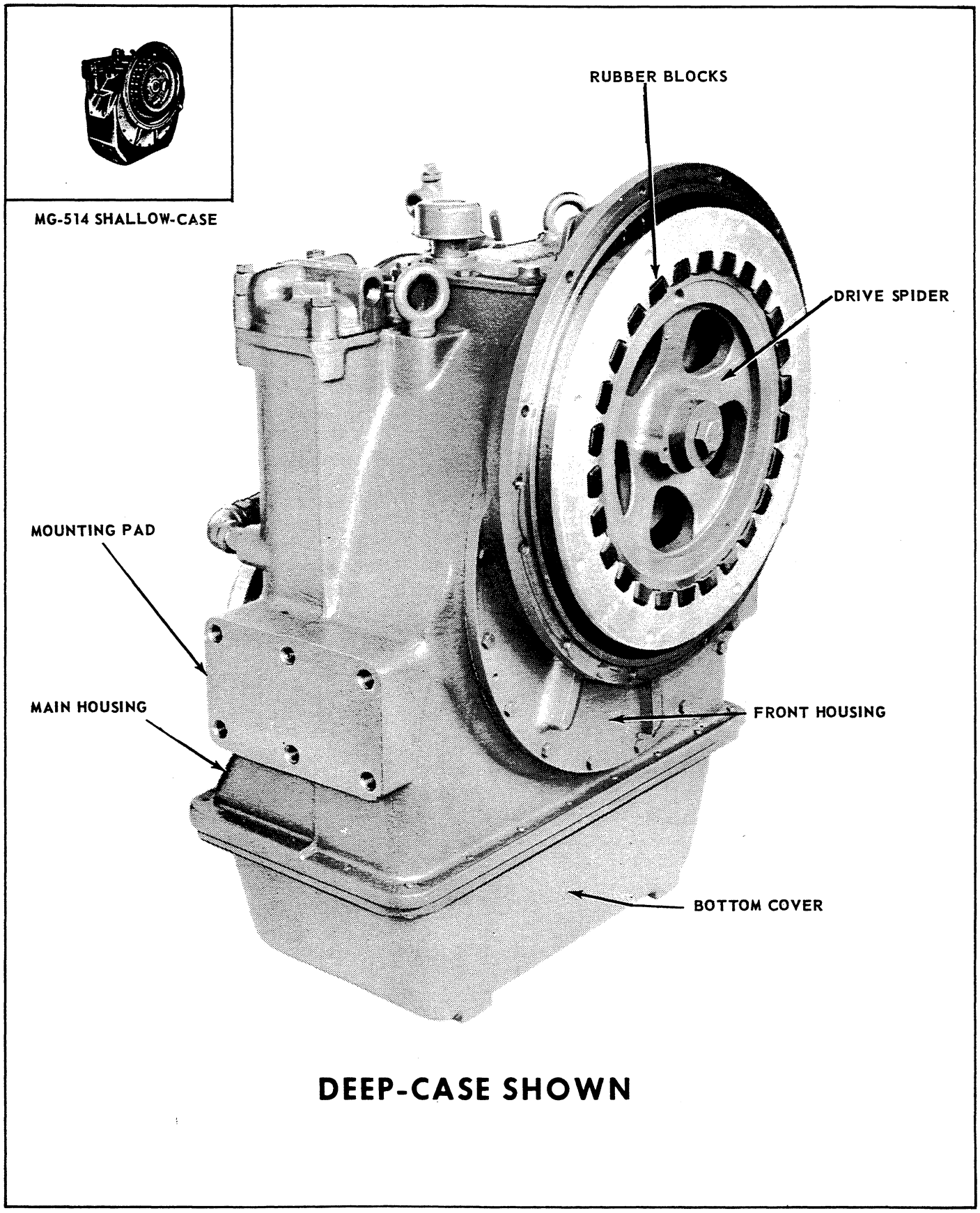

Figure 2. Model MG-514 Marine Gear – Front View.

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.

D

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.

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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.

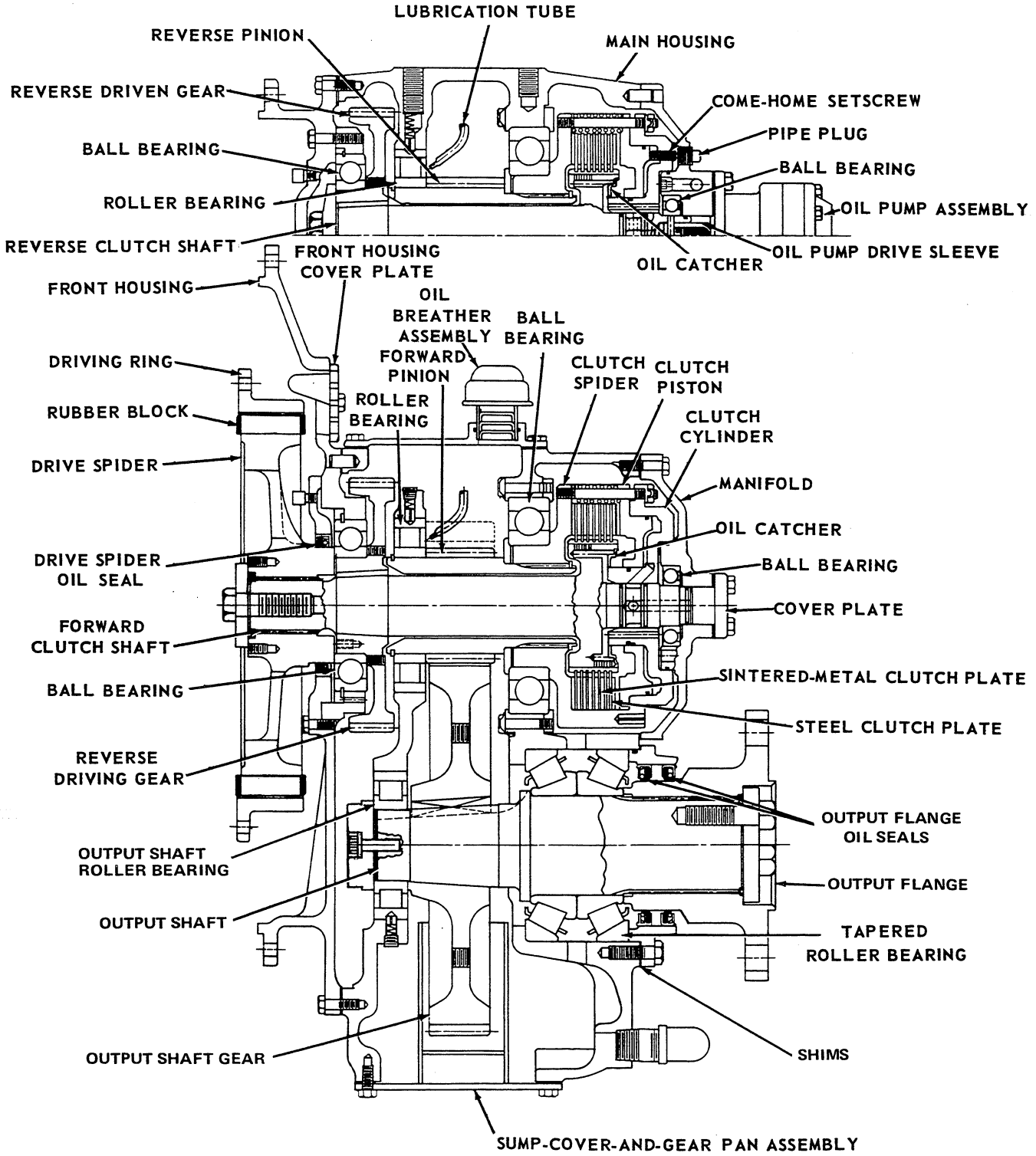

Figure 3. Model MG-514 Cross-Section View (Shallow Case Shown).

Section II. DESCRIPTION

NOTE

Refer to Figures 3 and 4 for location of parts described in this Section.

6. MARINE GEAR.

A. General. The Twin Disc Marine Gear – Model MG-514 described in this manual is a right-hand rotation marine gear (when viewed from the front of the engine) for installation on a right-hand engine. The marine gear can be converted easily and quickly for left-hand rotation applications by changing the oil pump. Refer to Paragraph 16D for information on how to accomplish this modification.

The marine gear consists of three major subassemblies: the forward clutch group of parts, the reverse clutch group of parts, and the output shaft group of parts. The externally-mounted selector valve assembly is the control device that hydraulically engages the desired clutch.

The marine gear contains five hardened and ground helical-tooth gears and pinions that are in constant mesh. A 13.5 gpm oil pump, which is externally-mounted on the manifold, supplies oil pressure to the selector valve assembly of the marine gear for clutch engagement, clutch cooling and bearing and gear lubrication. The oil is filtered twice before entering the marine gear hydraulic system.

The MG-514 Marine Gear is a flange-type unit that is bolted directly to the engine flywheel housing. The driving ring furnished with the gear is installed on the engine flywheel. This ring is designed to mesh with the rubber blocks installed on the drive spider which is spline-connected to the forward clutch shaft. This method of drive is used because of the comparative ease of removal and installation; however, care must be exercised during installation to ensure that proper alignment between the marine gear and the engine is attained.

B. Reduction Ratios. The 2.00:1 and 3.00:1, ratio units are identical in design except for the size of the pinions and output shaft gear. The 4.13:1, 4.50:1, 5.16:1, and 6.00:1 ratio units are also identical in design except for the size of the pinions and output shaft gear, and differ from the 2.00:1 and 3.00:1 ratio units in physical appearance. These units use a deeper case, as the center distance of the gears is greater. The function of parts and maintenance procedures for all MG-514 Marine Gears are the same.

C. Accessories. Accessories that are available for the MG-514 Marine Gear are described below. A heat exchanger *must be used* with the marine gear; however, a heat exchanger other than those available from Twin Disc may be selected.

(1) Pressure Gauge Assembly. The pressure gauge assembly is supplied with each marine gear as standard equipment. Normally, the gauge is mounted in the pilot house with a pressure line connection to the 1/4-inch opening of the reducing tee that is mounted on the selector valve assembly. In this manner, a constant check of oil pressure in the marine gear may be conveniently observed.

(2) Companion Flange. Because of the greater torque through the output shaft of the deeper case units, a larger output flange is used that needs fitted bolts. Therefore, a companion flange with line-reamed holes is furnished as standard equipment. For the 2.00:1 and 3.00:1 ratio units, a companion flange can be furnished as optional equipment to fit the smaller output flange.

(3) Hose-and-Heat-Exchanger Kits. Two hose-and-heat-exchanger kits are available for the MG-514 Marine Gear, and can be purchased as optional equipment. Each kit consists of a heat exchanger with mounting feet, flexible hose, and attaching parts. The heat exchanger must be mounted in a location convenient to both engine water and marine gear oil.

(4) Top Mounted PTO. Contact Twin Disc, Incorporated Service Engineering Department for manual TM-3 which covers Top Mounted PTO. C

7. DRIVE SPIDER GROUP OF PARTS.

A. Driving Ring. The driving ring is a high-qualtiy aluminum casting that is bolted to the engine flywheel. The ring has machined internal gear teeth that mesh with the rubber blocks installed on the drive spider.

B. Drive Spider. The drive spider, with rubber blocks installed, is the connecting member between the driving ring on the engine flywheel and the marine gear. Internally, the drive spider is spline-connected to the forward clutch shaft (which is the marine gear input shaft). The drive spider has a row of external square lugs for rubber block installation.

C. **Rubber Blocks.** The rubber blocks are installed on the external lugs of the drive spider. The rubber blocks are molded in an involute tooth shape. Misalignment caused by hull distortion is absorbed by the cushioning effect of the rubber blocks, however, extreme caution must be observed during marine gear installation to achieve the dial indicator tolerances specified in Section XII of this manual on Installation. The rubber blocks also tend to absorb torsional vibration which may be present.

D. **Drive Spider Oil Seal.** The drive spider oil seal prevents oil leakage at the front end of the marine gear past the hub of the drive spider. The outside diameter of the oil seal is mounted in a seal carrier.

8. FRONT HOUSING GROUP OF PARTS.

A. **Front Housing.** The front housing, which contains the reverse driving gear ball bearing, is bolted to the engine flywheel housing. The rear face of the front housing is bolted and dowelled to the main housing. An opening in the top section of the front housing, covered by the front housing cover plate, permits inspection of the driving ring, drive spider, and portion of rubber blocks. The bearing carrier for the reverse driven gear ball bearing is bolted to the front housing.

B. **Reverse Driving Gear Ball Bearing.** The outer race of the reverse driving gear ball bearing contains a snap ring which retains the bearing in position between the hub of the drive spider and the reverse driving gear. The bearing is lubricated by oil through an elbow fitting in the seal carrier of the drive spider oil seal.

C. **Reverse Driving Gear.** The reverse driving gear is keyed to the forward clutch shaft. The right-hand helical-tooth driving gear meshes with the reverse driven gear. Two tapped puller screw holes are machined in the gear to facilitate the removal of the gear and bearing from the shaft. An additional two tapped pusher screw holes are machined in the gear for the removal of the bearing from the gear. The gear is lubricated by oil from an elbow fitting in the front seal carrier.

D. **Reverse Driven Gear Ball Bearing.** The outer race of the reverse driven gear ball bearing contains a snap ring which retains the bearing in position between the retainer washer and the reverse driven gear. The bearing is lubricated by oil through an elbow fitting in the front housing.

E. **Reverse Driven Gear.** The reverse driven gear is keyed to the reverse clutch shaft. The left-hand helical-tooth driven gear meshes with the reverse driving gear. Two tapped puller screw holes are machined in the gear to facilitate the removal of the gear and bearing from the shaft. An additional two tapped pusher screw holes are machined in the gear for the removal of the bearing from the gear. The gear is lubricated by oil from an elbow fitting in the front housing.

F. **Front Housing Cover Plate.** The front housing cover plate is a grid-pattern casting with air deflection lugs on its interior side. The cover plate is removed from the front housing in order to inspect the rubber block drive. The air deflection lugs of the cover plate assure the continual removal of warm air from the drive through the grid-pattern of the plate.

9. MAIN HOUSING GROUP OF PARTS.

A. **Main Housing.** The main housing is a high-quality casting that has integral mounting pads for the support of the marine gear on the engine bed rails. A cored pocket in the main housing is for the installation of the oil filter element assembly.

B. **Oil Filter.** The oil filter element assembly is installed in a cored pocket of the main housing. The oil filter element is a micronic-type paper element and is a full flow filter. The filter cover plate contains a by-pass valve that will operate at 10 to 14 psi in the event the filter element should become clogged. This will permit the oil to continue circulating, although the oil will be *unfiltered* by the element.

C. **Oil Breather Assembly.** The oil breather assembly is an integral breather cap and nipple. The breather is installed in the top cover plate of the main housing. The breather hole in the top cover plate is used to fill the main housing sump with the proper amount of oil when required.

D. **Oil Level Gauge.** The oil level gauge is mounted in the oil level gauge tube which is installed in the main housing. The gauge is marked for the direct reading of the oil level within the sump at the bottom of the main housing.

E. **Sump-Cover-and-Gear Pan Assembly.** The sump-cover-and-gear pan assembly is constructed of fabricated and welded steel. The pan assembly functions as a cover for the sump area of the main housing, and as a splash pan for the output shaft gear to control foaming and prevent cavitation of the oil

pump. The deeper case units use a casting as a bottom cover and a separate fabricated and welded steel gear pan assembly.

F. Instruction Plate. The instruction plate is mounted on the right side of the main housing. Stamped on the instruction plate are the model, specification, and serial numbers along with the gear ratio of the unit. Other information relative to the operation of the gear also is provided. This information should be read and complied with.

10. MANIFOLD ASSEMBLY.

A. Manifold. The manifold is a multi-purpose component of the marine gear that provides a mounting surface for the selector valve and oil pump assemblies, and also serves as a protective cover for the clutches. The manifold is externally-mounted to the rear surface of the main housing; removal of the manifold will expose both clutches for servicing without disconnecting or removing the gear from the engine or propeller shaft.

Drilled passages in the manifold are used to convey the pressurized oil from the selector valve to the clutch cylinders for engagement of the clutches, and to the center of the clutch plate stack for cooling purposes.

B. Manifold Orifice Pipe Plugs. Two manifold orifice pipe plugs are installed in the interior side of the manifold. These special pipe plugs assure an equal distribution of pressurized oil to reach each clutch plate stack for cooling purposes.

C. Come-Home Access Pipe Plugs. Three access holes for each clutch are tapped in the manifold for come-home lock-up of the gear. During normal hydraulic operation, pipe plugs are installed in these six holes.

D. Oil Return Pipe Assembly. The oil return pipe assembly is not part of the manifold assembly; however, the return pipe is indexed to the manifold by a roll pin which is a part of the manifold assembly. The return pipe is aligned with the selector valve assembly from which it receives a constant flow of pressurized oil for lubrication purposes. The return pipe contains a piston and spring which regulate the low pressure oil supply. A drilled hole through the piston functions as an orifice to meter oil to the front end of the marine gear. The front end of the return pipe is installed in a reamed hole on the interior side of the front housing. The pipe is aligned with a tee fitting which is installed on the exterior side of the front housing. Flexible hoses and fittings from the tee fitting convey lubricating oil to the reverse driving gear ball bearing and the reverse driven gear ball bearing. Cross-drilled holes in the return pipe spray low pressure oil on the gears and pinions. In addition, the 3.00:1, 4.50:1, 5.16:1, and 6.00:1 ratio units have a tube carrier assembly mounted on the oil return pipe to accurately direct lubricating oil to the forward and reverse pinion roller bearings.

11. OUTPUT SHAFT GROUP OF PARTS.

A. Output Shaft. The output shaft is a short, rigid shaft that is straddle-mounted on anti-friction bearings. The inner races of both the output shaft roller bearing and the tapered roller bearing are mounted on the output shaft. The output shaft supports the keyed output shaft gear and the spline-connected output flange.

B. Output Shaft Gear. The output shaft gear is a helical-tooth gear that meshes with both the forward and reverse pinions. Two puller screw tapped holes are machined in the gear to facilitate removal.

C. Output Flange. The output flange (or the companion flange in the deeper case units) is the connecting output member of the marine gear. The 2.00:1 and 3.00:1 ratio units have a 10-1/2-inch outside diameter flange with eight 1-1/32-inch diameter holes on an 8-3/4-inch bolt circle. The deeper case units have an output flange with an 11-inch outside diameter flange and eight 3/4-inch diameter holes on a 9-1/2-inch bolt circle. Both flanges are internally-splined for installation on the output shaft.

D. Output Flange Oil Seals. Two output flange oil seals are installed on the output flange. The lip of the inner seal points towards the gear, and prevents the leakage of oil from the gear into the bilge. The lip of the outer seal points towards the propeller shaft, and prevents the leakage of bilge into the gear. The space between the seals is filled with grease through the grease fitting in the bearing retainer.

E. Output Shaft Roller Bearing. The output shaft roller bearing is the pilot bearing for the output shaft, and is lubricated by the oil within the sump. The inner race of the roller bearing is retained on the shaft by the retainer washer. The outer race of the roller bearing is secured in position by a roll pin installed in the main housing.

F. Tapered Roller Bearing. The tapered roller bearing is the largest bearing in the marine gear.

Cooling and lubricating oil through the forward clutch plate stack collects in a cored pocket above the bearing. This oil lubricates the bearing through the space between the bearing.

12. FORWARD CLUTCH GROUP OF PARTS.

A. Forward Pinion. The forward pinion is a sleeve that fits around the forward clutch shaft, although it does not make contact with the shaft. The pinion is spline-connected to the clutch spider and positioned in the spider by a snap ring and a spacer. A snap ring that is installed on the other end of the pinion retains the forward pinion roller bearing inner race. The center area of the pinion contains helical teeth that mesh with the output shaft gear. The pinion is lubricated by the oil return pipe assembly and the oil brought up by the output shaft gear from the sump.

B. Forward Pinion Roller Bearing. The inner race of the forward pinion roller bearing is retained on the forward pinion by a snap ring. The outer race of the forward pinion roller bearing is secured in position by a roll pin installed in the main housing. The roller bearing is lubricated by the oil return pipe assembly.

C. Clutch Spider Assembly. The clutch spider assembly consists of the clutch spider, twelve staked studs, and six roll pins. The split sleeves and the release springs in the clutch are installed on the studs. The roll pins index in the clutch cylinder. The clutch spider is splined-connected to the forward pinion and positioned on the pinion by a snap ring and a spacer.

D. Clutch Spider Ball Bearing. The clutch spider ball bearing is installed on the hub of the clutch spider. The forward pinion spacer retains the inner race of the ball bearing on the clutch spider, and a bearing retainer secures the outer race of the ball bearing in the main housing. The bearing is lubricated by the oil return pipe assembly.

E. Forward Clutch Shaft Assembly. The forward clutch shaft assembly consists of the forward clutch shaft and a press-fitted oil catcher. The input end of the shaft is spline-connected to the drive spider. The tapered area of the shaft beyond the splines contains a keyway. The keyed reverse driving gear is mounted on this taper. The gear teeth of the shaft mesh with the internal gear teeth of the steel clutch plates. Low pressure oil from the manifold is admitted to the oil catcher area of the shaft through drilled holes in the clutch cylinder. The oil catcher builds up an oil head due to centrifugal force, and forces cooling and lubricating oil to the clutch plate stack through a series of 90-degree spaced holes at the root of the shaft gear teeth. The clutch end of the shaft contains a horizontally-drilled hole in the center of the shaft that connects at a 90-degree angle with a hole drilled from the undercut at the outside diameter of the shaft. High pressure oil from the manifold is admitted through these two holes for the engagement of the clutch. The undercut diameter of the shaft connects with a drilled passageway in the clutch cylinder. This passageway directs high pressure oil behind the clutch piston for clutch engagement. Two high pressure oil piston rings contain the oil within the undercut area of the shaft. Another piston ring at the end of the shaft prevents high pressure oil in the manifold from entering the low pressure oil area behind the clutch cylinder. The forward clutch shaft ball bearing is mounted on the shaft ahead of this single piston ring.

F. Forward Clutch Shaft Ball Bearing. The forward clutch shaft ball bearing is mounted on the manifold end of the clutch shaft. The ball bearing is the pilot bearing for the shaft, and is lubricated by low pressure oil from the manifold.

G. Clutch Plates. Seven steel clutch plates, with internal gear teeth, are the driving plates of the clutch. Eight sintered-metal clutch plates, with external heat-treated lugs, are the driven plates. The driven plates are designed with radial and spiral grooves in the plate face to permit the flow of cooling and lubricating oil to pass through the clutch.

H. Clutch Piston. The clutch piston is designed with twelve lugs. Each lug contains a drilled hole. The lugs are installed over the springs and sleeves which are positioned on the twelve studs in the clutch spider. This method of installation permits the piston to move forward on the studs and compress the release springs during engagement of the clutch, and to move back quickly for disengagement due to the force exerted by the released springs. A high pressure oil piston ring installed in the clutch piston and a similar piston ring installed in the clutch cylinder prevent the escape of high pressure oil past the piston.

I. Clutch Cylinder Assembly. The cylinder assembly consists of the clutch cylinder, three setscrews, and three roll pins. The three come-home setscrews are positioned in the clutch cylinder by the

roll pins. The clutch cylinder is positioned on the clutch spider by the roll pins which are alternately-spaced on the lugs of the spider. The cylinder is secured to the spider by nuts which are installed on the studs that pass through the clutch piston and cylinder.

13. REVERSE CLUTCH GROUP OF PARTS.

A. Reverse Pinion. The reverse pinion is a sleeve that fits around the reverse clutch shaft, although it does not make contact with the shaft. The pinion is spline-connected to the clutch spider and positioned in the spider by a snap ring and a spacer. A snap ring that is installed on the other end of the pinion retains the reverse pinion roller bearing inner race. The center area of the pinion contains helical teeth that mesh with the output shaft gear. The pinion is lubricated by the oil return pipe assembly and the oil brought up by the output shaft gear from the sump.

B. Reverse Pinion Roller Bearing. The inner race of the reverse pinion roller bearing is retained on the reverse pinion by a snap ring. The outer race of the reverse pinion roller bearing is secured in position by a roll pin installed in the main housing. This roll pin is installed from the exterior side of the main housing. The roller bearing is lubricated by the oil return pipe assembly.

C. Clutch Spider Assembly. The clutch spider assembly consists of the clutch spider, twelve staked studs, and six roll pins. The split sleeves and the release springs of the clutch are installed on the studs. The roll pins index in the clutch cylinder. The clutch spider is spline-connected to the reverse pinion and positioned on the pinion by a snap ring and a spacer.

D. Clutch Spider Ball Bearing. The clutch spider ball bearing is installed on the hub of the clutch spider. The reverse pinion spacer retains the inner race of the ball bearing on the clutch spider, and a bearing retainer secures the outer race of the ball bearing in the main housing. The bearing is lubricated by the oil return pipe assembly.

E. Reverse Clutch Shaft Assembly. The reverse clutch shaft assembly consists of the reverse clutch shaft and a press-fitted oil catcher. The input end of the shaft is tapered and contains a keyway. The keyed reverse driven gear is mounted on this taper. The gear teeth of the shaft mesh with the internal gear teeth of the steel clutch plates. Low pressure oil from the manifold is admitted to the oil catcher area of the clutch shaft through drilled holes in the clutch cylinder. The oil catcher builds up an oil head due to centrifugal force, and forces cooling and lubricating oil to the clutch plate stack through a series of 90-degree spaced holes at the root of the shaft gear teeth. The oil pump drive sleeve is installed in the clutch end of the shaft, and is secured in place by a dowel pin. The oil pump shaft is spline-connected to the sleeve. Behind the drilled hole for the sleeve, a smaller horizontally-drilled hole in the center of the shaft connect at a 90-degree angle with a hole drilled from the undercut at the outside diameter of the shaft. High pressure oil from the manifold is admitted through these two holes for the engagement of the clutch. The undercut diameter of the shaft connects with a drilled passageway in the clutch cylinder. This passageway directs high pressure oil behind the clutch piston for clutch engagement. Two high pressure oil piston rings contain the oil within the undercut area of the shaft. Another piston ring at the end of the shaft prevents high pressure oil in the manifold from entering the low pressure oil area behind the clutch cylinder. The reverse clutch shaft ball bearing is mounted on the shaft ahead of this single piston ring.

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I. Clutch Cylinder Assembly. The clutch cylinder assembly consists of the clutch cylinder,

three setscrews, and three roll pins. The three come-home setscrews are positioned in the clutch cylinder by the roll pins. The clutch cylinder is positioned on the clutch spider by the roll pins which are alternately-spaced on the lugs of the spider. The cylinder is secured to the spider by nuts which are installed on the studs that pass through the clutch piston and cylinder.

14. SELECTOR VALVE ASSEMBLY.

A. Selector Valve Body. The selector valve body is a high-quality casting that contains four drilled holes for installation on the manifold. The body contains a main cavity, passageways, and drilled holes for the proper circuitry of the hydraulic system within the valve.

B. Selector Valve Stem. The selector valve stem is designed with channels and ports which align with similar features in the selector valve body. The selection of forward, neutral, or reverse position by the operator results in a rotary and positioning movement of the stem. The stem is indexed in the selected position by the detent, and is aligned with the proper openings in the valve body for the direction of pressurized oil.

C. Selector Valve Stem Ball Bearing. The selector valve stem ball bearing is installed on the selector valve stem. The inner race of the bearing is press-fitted on the stem, and the outer race of the bearing fits in the bearing bore of the valve body and the stem cover. The bearing is lubricated by the pressurized oil seepage past the internal portion of the valve stem.

D. "O" Ring Seal. The "O" ring seal is installed on the selector valve stem between the selector valve stem ball bearing and the selector valve stem cover. The seal prevents the leakage of oil from the selector valve.

E. Selector Valve Lever. The selector valve lever is installed on the selector valve stem, and secured in position by a capscrew. A drilled hole is provided in the lever for the connection of remote control linkage if this should be desired. Also, a drilled hole is provided in the selector valve stem for the connection of another lever. Therefore, the selector valve assembly may be operated manually at the marine gear location, or from a remote area by the installation of linkage.

F. Pressure Regulation Piston. The pressure regulation piston is a cylinderically-shaped steel piece that has been drilled out from one end. The piston moves back and forth in the center area of the main cavity of the valve body. The valve spring assembly is installed in the open end of the piston. The regulation piston is moved in the desired direction either by pressurized oil or spring tension.

G. Pressure Rate Control Piston. The pressure rate control piston is a cylindrically-shaped steel piece that has been drilled out from one end. The piston moves back and forth in the orifice plate end of the main cavity of the valve body. The valve spring assembly which is installed in the open end of the pressure regulation piston also is installed in the open end of the pressure rate control piston. The control piston is moved in the desired direction either by pressurized oil or spring tension.

H. Valve Spring Assembly. The valve spring assembly consists of the piston outer and inner springs. The piston inner spring is installed within the piston outer spring. Both springs are positioned in the main cavity of the valve body between the pressure regulation piston and the pressure rate control piston. The pressurized oil must overcome the tension of both springs in order to move the pistons to the desired positions.

I. Orifice Plate. The orifice plate, with a gasket on each side, is positioned between the selector valve body and the orifice plate cover. The orifice plate contains three holes of various size and function. The largest hole is the entry port for pressurized oil to the pressure rate control piston. The medium size hole is a seat for the steel ball in the valve. The smallest hole is an orifice for metering pressurized oil to the control piston.

J. Steel Ball and Spring. The steel ball and compression spring are located in a passageway of the valve body that is aligned with the ball seat hole in the orifice plate. The compression spring exerts pressure on the steel ball seated in the orifice plate when engaged in forward or reverse position. In neutral position, back-pressure oil overcomes the spring tension, and the ball is unseated which permits an unrestricted flow of oil to return rapidly to the sump.

K. Indexing Detent. The indexing detent is installed in a drilled and tapped hole in the selector valve body. The indexing detent spring keeps the detent under tension at all times, and is retained at the top of the valve body by a pipe plug. The round-bottomed detent fits into mating holes in the valve stem which are related to the forward, reverse,

and neutral positions of the valve. Sufficient force is exerted by a manual or remote shift to unseat the detent from its locating hole in the valve stem; however, when the desired shift has been made the detent secures the valve stem in the required position.

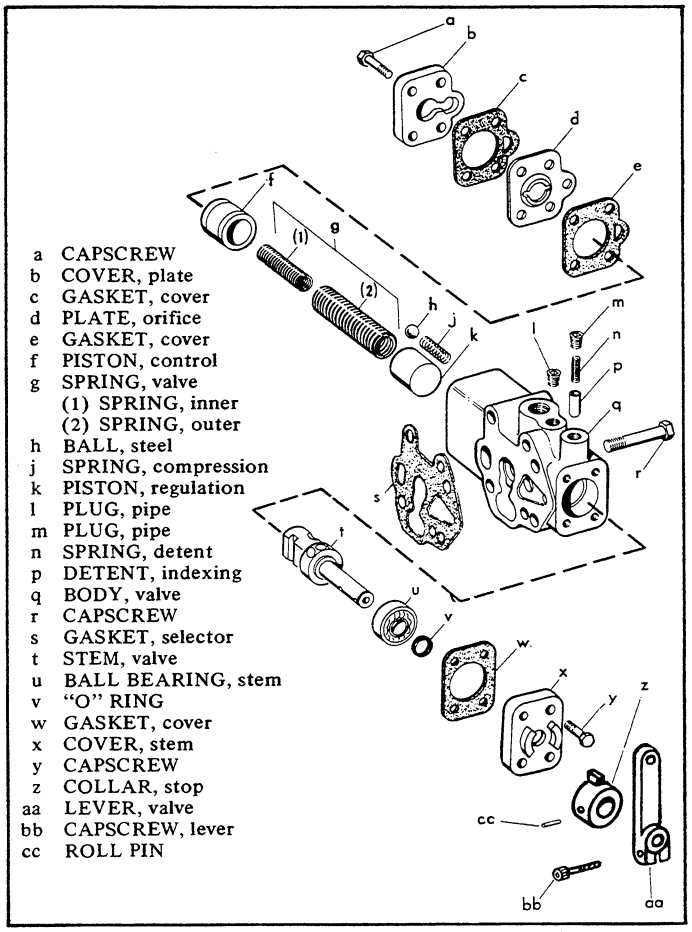


Figure 4. Selector Valve Assembly – Exploded View.

15. HOSE-AND-HEAT-EXCHANGER KITS.

A. Heat Exchanger. The purpose of the heat exchanger is to maintain the oil in the sump of the marine gear at the proper temperature. Coolant from the engine passes through the heat exchanger to accomplish this cooling. The heat exchanger is provided with mounting feet for installation at any convenient location.

B. 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 disintegrated, 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.

The chart indicates the Marine Gear and compatible heat exchanger with zinc rods.

Marine Gear	MG-514
Exchanger	M1959-D
Quantity of Zinc Electrodes	2
Part Number of Zinc Electrode	M1988-A

C. Flexible Hose and Fittings. Sufficient flexible hose is provided with the heat exchanger for a normal installation. Reducer bushings are provided for adapting the flexible hose to the heat exchanger.

16. OIL PUMP ASSEMBLY.

A. Oil Pump Assembly. The oil pump assembly is a rotary-type unit, and is mounted on the manifold. The pump is driven by a splined drive sleeve in the reverse clutch shaft. The shaft rotates at all times at engine speed in anti-engine direction.

B. Flexible Hose. The oil-sump-to-strainer flexible hose is connected to the sump by an elbow fitting, and to the oil strainer housing by an adapter union. The oil strainer housing is connected to the oil pump assembly by a pipe nipple.

C. Oil Strainer. The oil strainer is installed within the oil strainer housing. The housing is plugged at one end to facilitate the removal and cleaning of the oil strainer.

D. Pump Change from Right to Left Hand Rotation. To change from right to left hand engine rotation, the pump must be rotated 180-degrees. The short nipple on the suction side which is also attached to the screen body must be removed and attached to the pump after it has been rotated.

17. GENERAL INFORMATION CHART.

The following table lists all the general information about the marine gear relative to its operation. A complete knowledge of the items contained therein is essential to the proper operation of the marine gear.

TABLE I. GENERAL INFORMATION.

OIL PRESSURE *
Cooling and Lube 18-20 psi at 1800 rpm and 180° F.
Neutral 60-65 psi at 1800 rpm and 180° F.
Engaged 185-215 psi at 1800 rpm and 180° F.

OIL CAPACITY
Shallow Case – Approx. 6 U.S. gallons, or fill to full mark on gauge.
Deep Case – Approx. 9 U.S. gallons, or fill to full mark on gauge.

C

OIL TEMPERATURE AND OIL WEIGHT

* See page 20.

OIL CHANGE INTERVAL
Replace every 1000 hrs. of operation, or 6 months, whichever occurs first.

OIL FILTER CHANGE INTERVAL
Replace every 1000 hrs. of operation, or 6 months, whichever occurs first.

SUCTION OIL STRAINER
Remove and clean every 1000 hrs. of operation.

OIL PUMP CAPACITY
12 gpm at 1600 rpm.
13.5 gpm at 1800 rpm.

DRY WEIGHT
Shallow Case – 1,030 lbs.
Deep Case – 1,358 lbs.

MAXIMUM INPUT SPEED
2500 rpm

* See name and instruction plate.

Section III. PRINCIPLES OF OPERATION

18. GENERAL.

A. Description. The Model MG-514 Marine Gear is a marine reverse and reduction gear available in six ratios: 2.00:1, 3.00:1, 4.13:1, 4.5:1, 5.16:1, and 6.00:1. 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 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.

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 cooled and lubricated by low pressure oil.

A mechanical lock-up, or come-home, feature is provided for clutch engagement in the event emergency operations are necessary.

B. Direction of Drive (Fig. 5). The forward clutch shaft and the reverse driving gear always rotate in engine direction. The reverse clutch shaft and the reverse driven gear always rotate in anti-engine direction. When the forward clutch is engaged, the output shaft gear will rotate in an anti-engine direction due to the gear meshing with the forward pinion. When the reverse clutch is engaged, the output shaft gear will rotate in anti-engine direction due to the gear meshing with the reverse pinion.

19. POWER FLOW.

A. Neutral (Fig. 6). When in neutral, all parts that rotate in the marine gear turn at engine speed. The driving ring that is bolted to the engine flywheel is the connecting member between the engine and the marine gear. The rubber blocks installed on the drive spider are meshed in the driving ring. The drive spider is spline-connected to the forward clutch shaft. The gear teeth of the steel clutch plates are meshed with the external gear teeth of the forward clutch shaft. Therefore, the steel clutch plates of the forward clutch rotate in engine direction at engine speed. The reverse driving gear is keyed on the taper of the forward clutch shaft. The reverse driving gear meshes with the reverse driven gear which is keyed to the taper of the reverse clutch shaft. The ratio between the two gears is 1:1. Anti-engine rotation at engine speed of the reverse clutch shaft is obtained by the meshing of these two gears. The gear teeth of the steel clutch plates are meshed with the external gear teeth of the reverse clutch shaft. Therefore, the steel clutch plates of the reverse clutch rotate in anti-engine (or reverse) direction and at engine speed. The oil pump assembly which is connected to the reverse clutch shaft also rotates in anti-engine direction and at engine speed. Since both forward and reverse clutches are disengaged, there is no further power flow within the gear.

B. Forward (Fig. 7). When in forward, all parts that rotated in neutral at engine speed are still turning. However, when the forward clutch is engaged the steel clutch plates make positive contact with the sintered-metal clutch plates. The external lugs of the sintered-metal clutch plates drive the clutch spider which is spline-connected to the forward pinion. Therefore, the forward pinion rotates in engine direction at engine speed when the forward clutch is engaged. The forward pinion is meshed with the output shaft gear which is keyed to the output shaft. The output flange is spline-connected to the output shaft and, therefore, the flange rotates in anti-engine direction when in the forward position. The output shaft and output flange rotate at a reduced speed due to the ratio between the output shaft gear and the forward pinion.

C. Reverse (Fig. 8). When in reverse, all parts that rotated in neutral at engine speed are still turning. However, when the reverse clutch is engaged the steel clutch plates make positive contact with the sintered-clutch plates. The external lugs of the sintered-metal clutch plates drive the clutch spider which is spline-connected to the reverse pinion. Therefore, the reverse pinion rotates in anti-engine direction at engine speed when the reverse clutch is engaged. The reverse pinion is meshed with the output shaft gear which is keyed to the output shaft. The output flange is spline-connected to the output shaft and, therefore, the flange rotates in engine direction when in the reverse position. The output shaft and output flange rotate at a reduced speed due to the ratio between the output shaft gear and the reverse pinion.

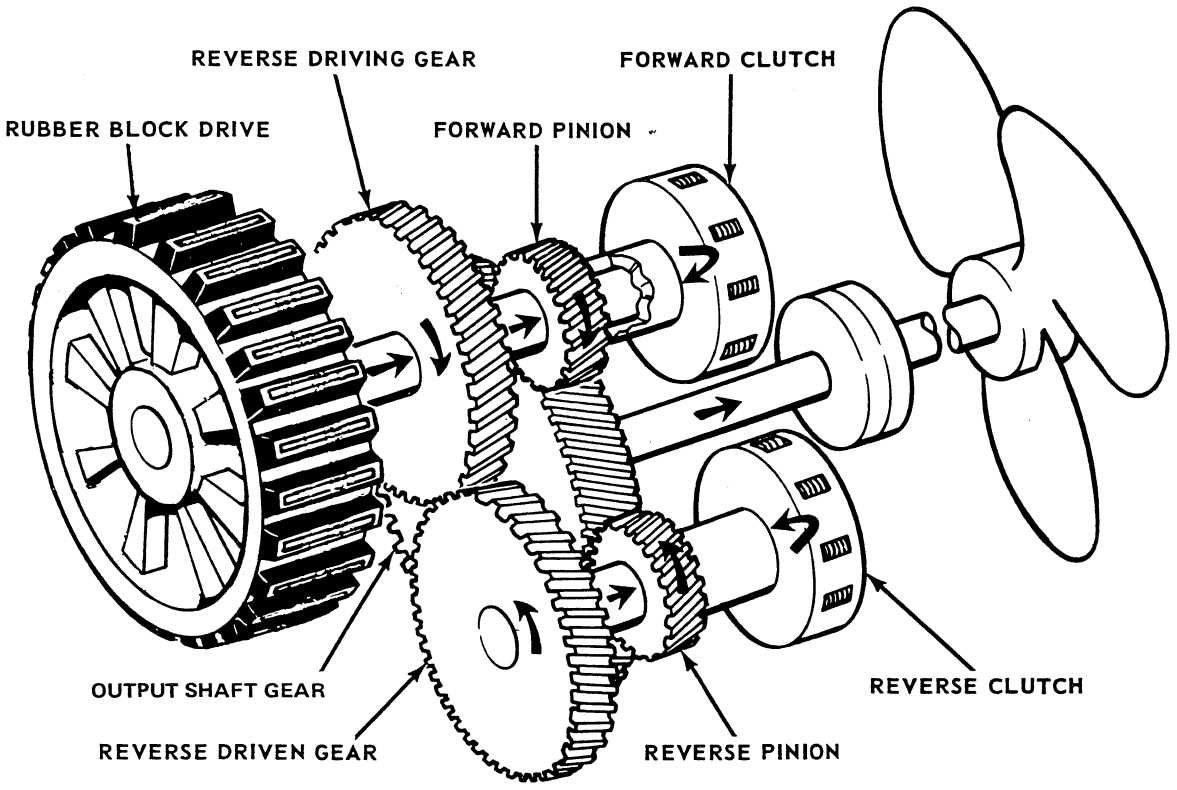


Figure 5. MG-514 Marine Gear Power Flow – Schematic View.

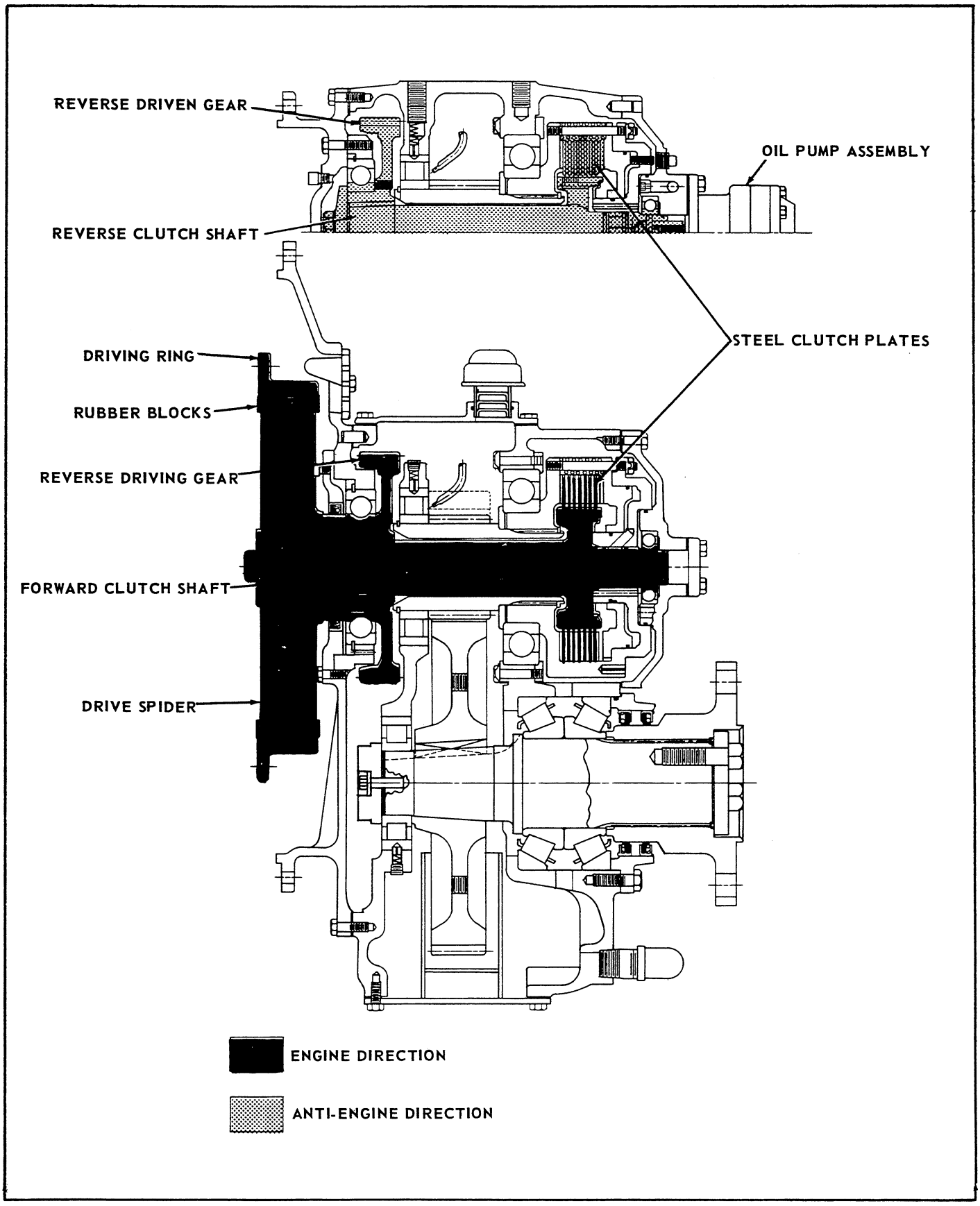


Figure 6. MG-514 Marine Gear Power Flow – Neutral.

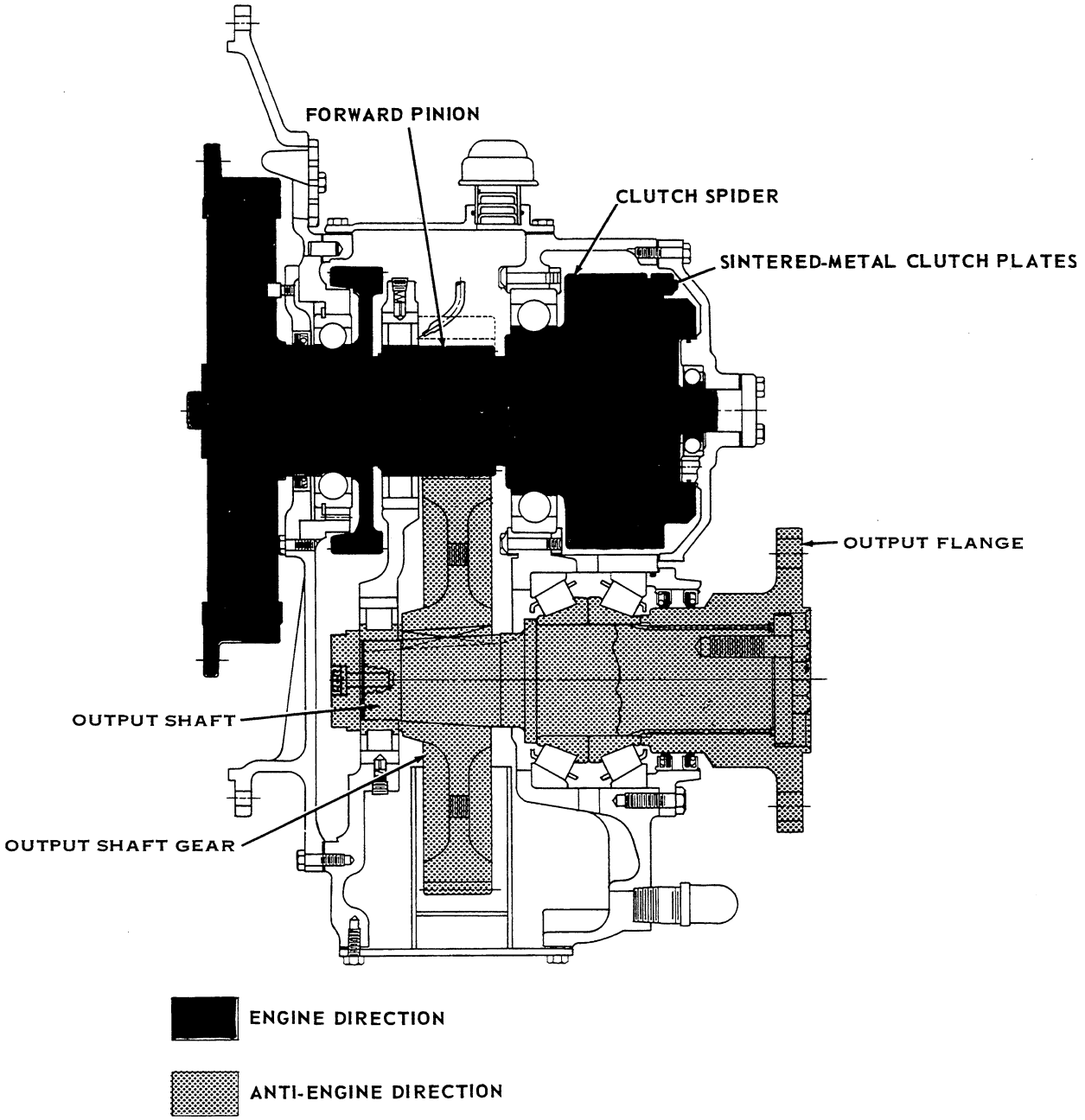


Figure 7. MG-514 Marine Gear Power Flow – Forward

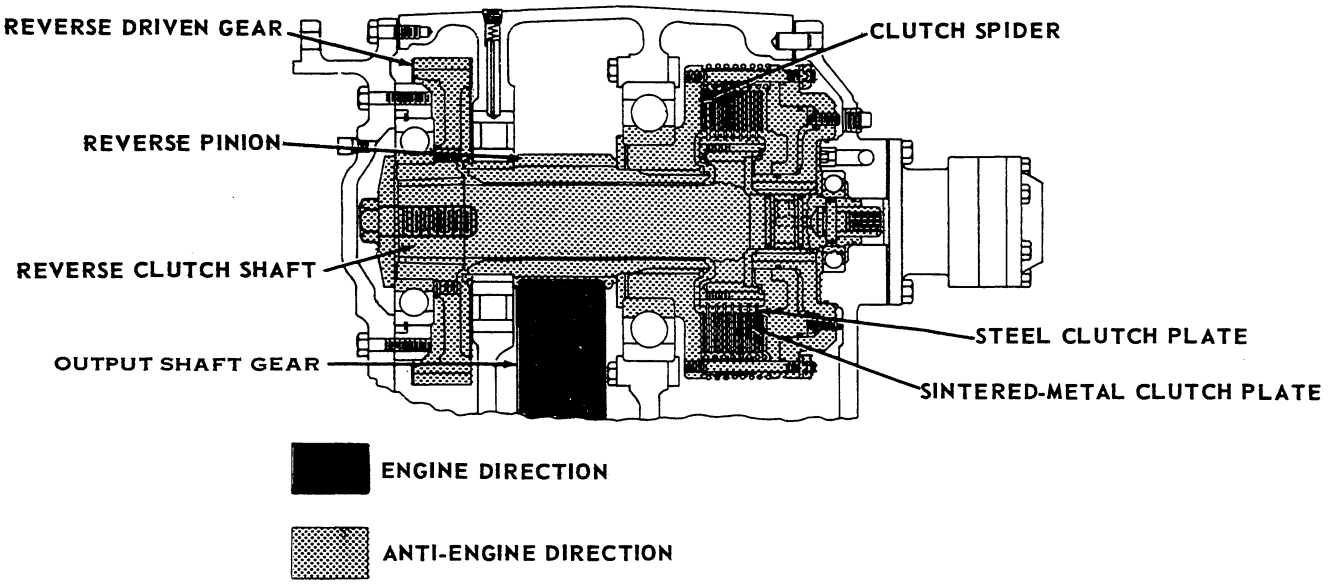


Figure 8. MG-514 Marine Gear Power Flow – Reverse.

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	
	Below 150° F.	This operating condition is **not** 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 **not** approved.

Section IV. HYDRAULIC SYSTEM

NOTE

All pressures given in this section are under the following conditions only: An engine speed of 1800 rpm with a recommended oil in the gear sump and a sump or heat exchanger inlet temperature of 180 degrees F. Pressure readings taken under other conditions will vary.

20. GENERAL.

A. Description. The hydraulic system in the Model MG-514 Marine Gear distributes both high and low pressure oil for clutch engagement, cooling, and lubrication functions. The sump, which is located in the bottom of the main housing, contains an adequate amount of oil for all functions of the system. The oil pump assembly pressurizes the oil for both high and low pressure requirements. The selector valve assembly is both a pressure regulator and distributor for the hydraulic system: The manifold is not only a protective cover for the clutches, but also a distribution component since it contains passageways for high and low pressure oil distribution.

Metal piston rings, which function as oil seals, are used in the clutches. The metal rings prove superior to other types of seals normally used in marine gear clutches. All oil that passes through the hydraulic system is subjected to two full-flow type filters. The oil return pipe assembly regulates the low pressure oil supply and also distributes oil for lubrication purposes. A heat exchanger *must be* installed in the hydraulic system to maintain the oil within the marine gear at the recommended temperature.

B. External Oil Circuit (Fig. 9). Oil is drawn from the sump through the oil strainer to the oil pump assembly. From the oil pump assembly, the oil is conveyed by a flexible hose to the oil filter. The filtered oil is routed from the filter to a remote-mounted heat exchanger. The cooled oil from the heat exchanger is routed to a reduction "tee" fitting on the selector valve assembly. The "tee" fitting on the selector valve has a pipe plug which should be removed and replaced by a pressure gauge or connecting line to a pressure gauge. Pressure reading at this point will be "clutch-apply pressure" oil.

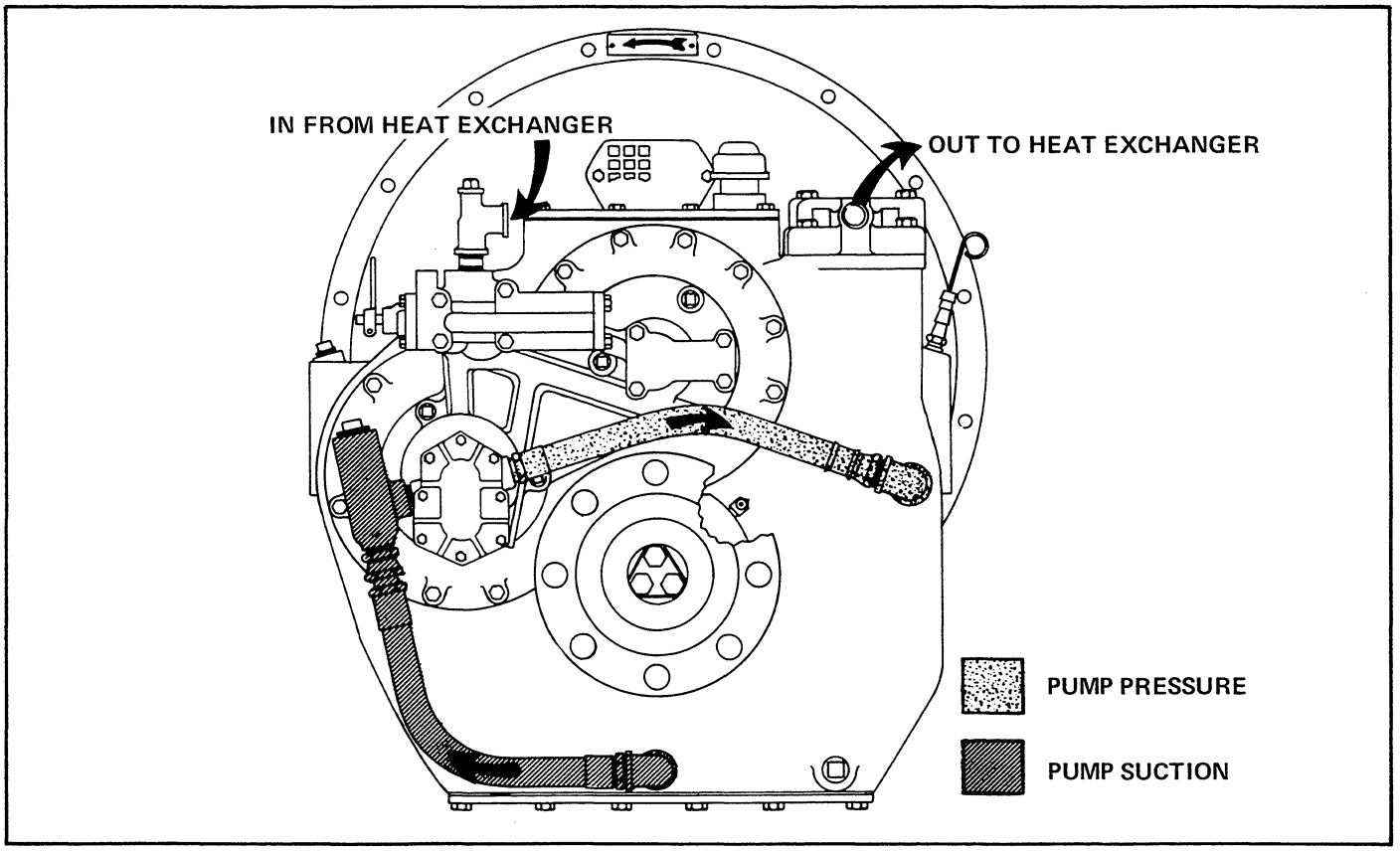


Figure 9. External Oil Flow in Hydraulic System.

21. SELECTOR VALVE ASSEMBLY.

A. General. The selector valve assembly contains passages and ports for the transmission and direction of pressurized oil within the hydraulic system. It is the function of the pressure rate control piston within the selector valve assembly to provide a rapid, yet smooth, pressure rise for the hydraulic system when required.

B Selector Valve-Neutral (Figs. 10 & 11). Oil enters the selector valve body through passage A and fills chamber B. The oil causes the pressure regulation piston to partially compress the piston outer and inner springs against the pressure rate control piston. This results in an oil pressure of 60-65 psi in chamber B. The movement of the pressure regulation piston against the springs exposes port C in the valve body. Port C directs the pressurized oil to the oil return pipe cavity in the front face of the selector valve body. The piston and spring in the oil return pipe regulate the cooling and lubricating oil supply to a pressure of 18-20 psi. Passage D (which is the engaging outlet to the forward clutch) and passage E (which is the engaging outlet to the reverse clutch) are interconnected by slot F in the selector valve stem when in the neutral position. The slot is aligned with a drilled hole and cored cavity in the front face of the valve body. The drilled hole and cored cavity are aligned with drilled holes that pass through the manifold and the main housing to atmosphere. Therefore, passages D and E are at atmospheric pressure at this time. Also, passage J is at atmospheric pressure since port H interconnects with slot F. The area between the pistons and around the springs is vented to the sump through drilled holes in the front face of the valve body, the manifold, and the main housing. This area is at atmospheric pressure at all positions of the valve which permits the return to sump of any leakage oil past the pistons.

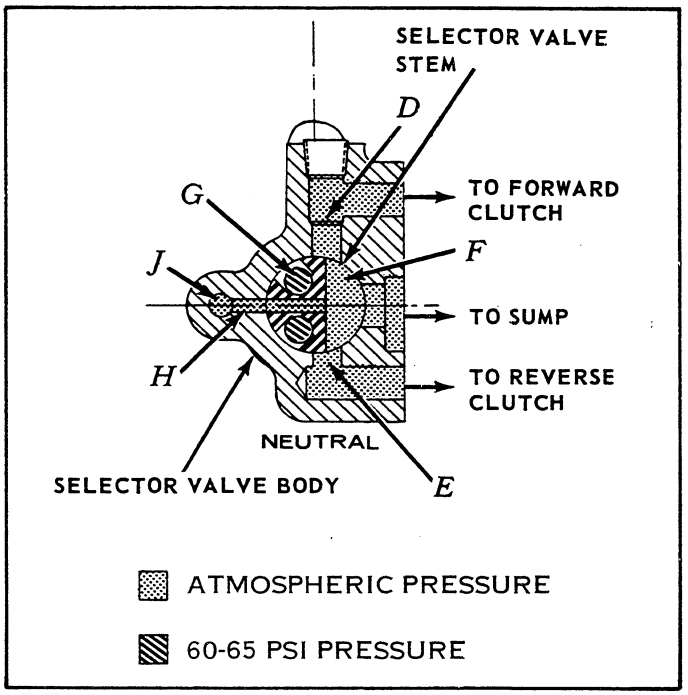


Figure 10. Selector Valve – Neutral – Sectional View.

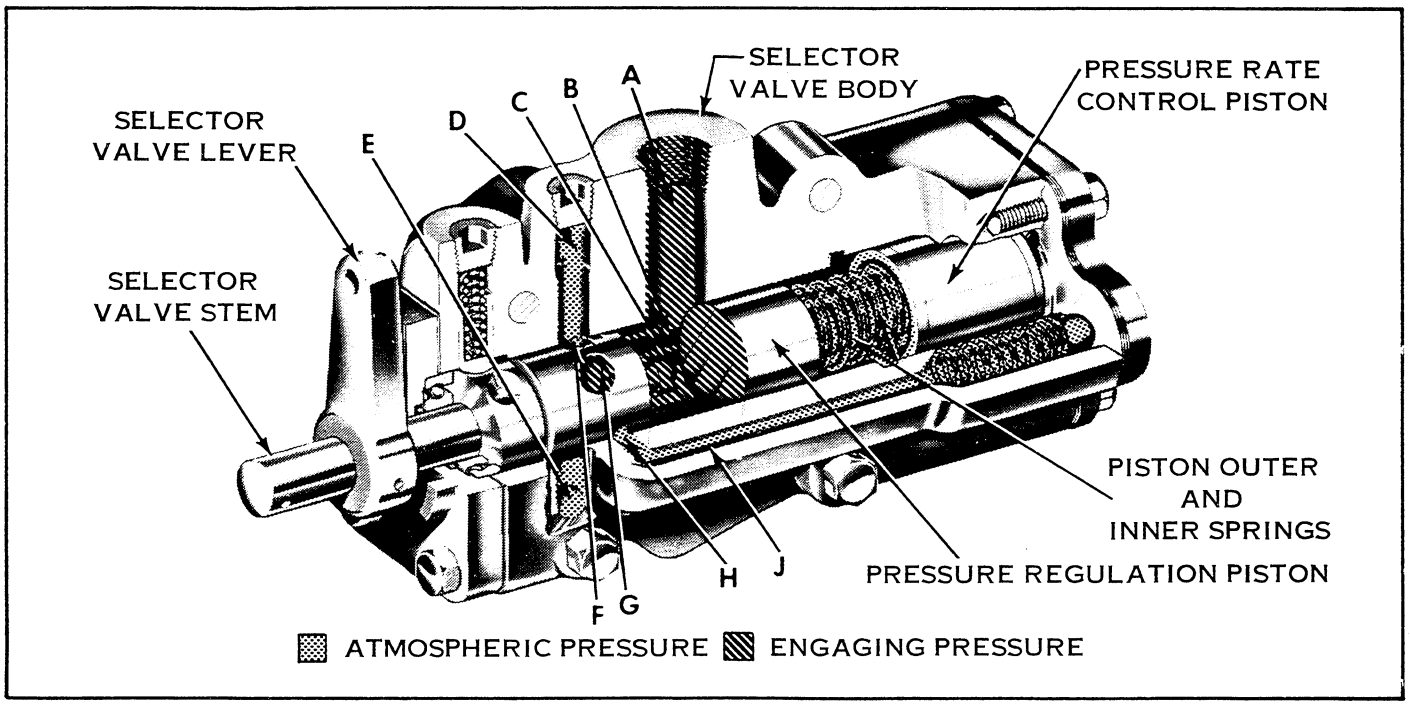


Figure 11. Selector Valve – Neutral – Cutaway View.

C. Selector Valve-Forward (Figs. 12 & 13). When a shift to the forward position is desired, the selector valve lever is moved towards the engine. The shift causes the selector valve stem to rotate and assume the position indicated in Figures 12 and 13. The 60-65 psi oil in chamber B is directed through ports G and K to passages D and J. Passage D is aligned with a drilled hole and channel X (Fig. 18) in the manifold. Pressurized oil from port K travels through passage J and enters chamber L through an orifice in the orifice plate. The orifice in the plate meters the oil for a steady, smooth pressure rise in chamber L. As chamber L fills with oil, the pressure rate control piston moves against the springs until the piston is stopped by a shoulder in the valve body. This causes the pressure in chamber B to rise from 60-65 psi to an engaging pressure of 185-215 psi. The time required to accomplish all the above action is a very short 1-1/2 seconds. When in forward, passage E (and channel W, fig. 18) remain at atmospheric pressure since slot F remains open to sump. When a shift is made from forward to neutral, the valve stem is rotated to the position illustrated by Figures 10 and 11. Under these conditions, passage D is connected to sump by slot F. Passage J also is connected to sump by port H in the valve stem. Since passage D is connected to slot F this permits a rapid drain of oil from the forward clutch to the sump. Since passage J is now at atmospheric pressure, the pressure in chamber L unseats the steel ball against the compression spring permitting a rapid oil drain of chamber L to sump. When the pressure rate control piston is against the orifice plate, the neutral position is attained again.

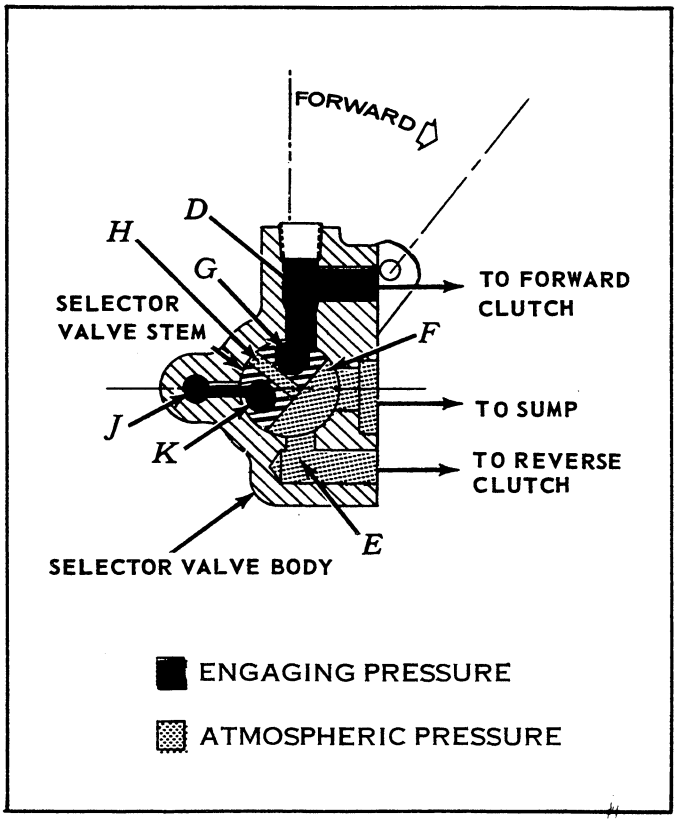


Figure 12. Selector Valve – Forward – Sectional View.

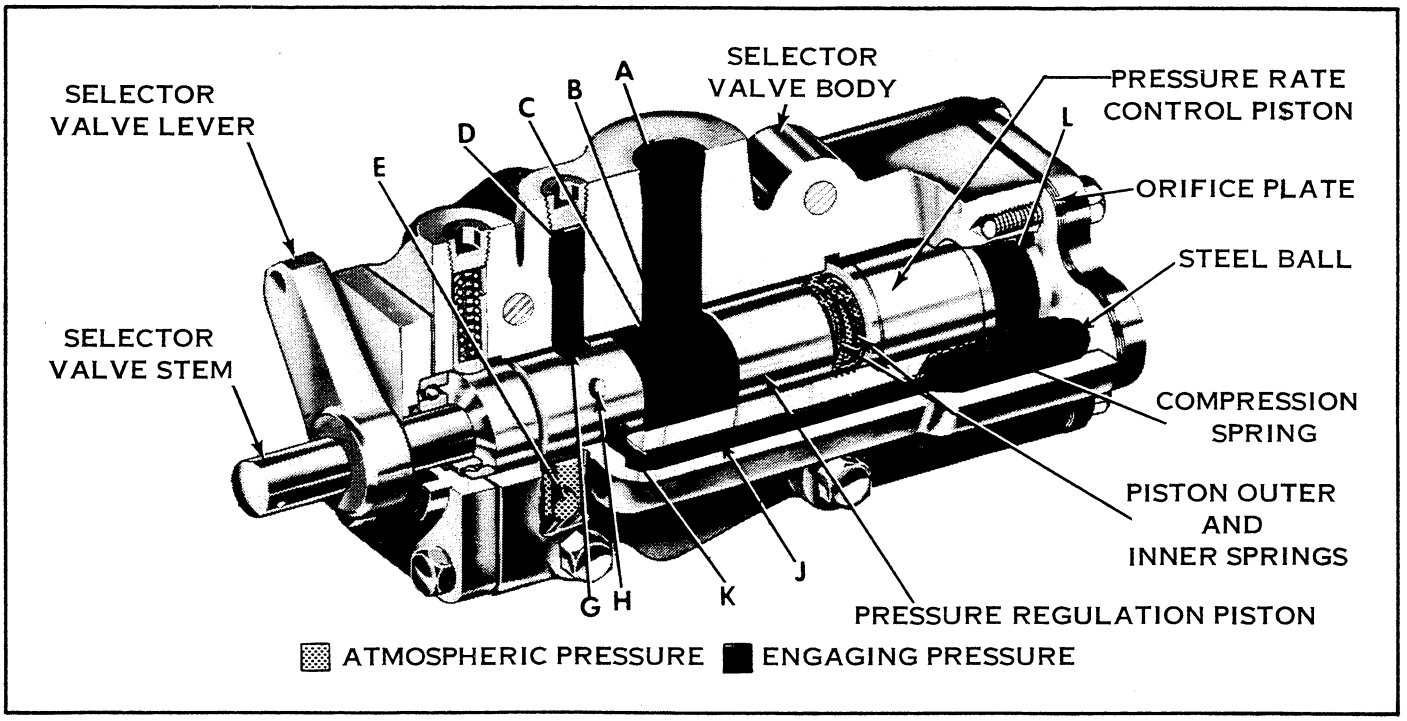


Figure 13. Selector Valve -- Forward -- Cutaway View.

D. Selector Valve-Reverse (Figs. 14 & 15). When a shift to the reverse position is desired, the selector valve lever is moved away from the engine. The shift causes the selector valve stem to rotate and assume the position indicated in Figures 14 & 15. The 60-65 psi oil in chamber B is directed through ports G and K to passages E and J. Passage E is aligned with a drilled hole and channel W (fig. 20) in the manifold. Pressurized oil from port G travels through passage J, and enters chamber L through an orifice in the orifice plate. The orifice in the plate meters the oil for a steady, smooth pressure rise in chamber L. As chamber L fills with oil, the pressure rate control piston moves against the springs until the piston is stopped by a shoulder in the valve body. This causes the pressure in chamber B to rise from 60-65 psi to an engaging pressure of 185-215 psi. The time required to accomplish all the above action is a very short 1-1/2 seconds. When in reverse, passage D (and channel X, Fig. 20) remains at atmospheric pressure since slot F remains open to sump. When a shift is made from reverse to neutral, the valve stem is rotated to the position illustrated by Figures 10 and 11. Under these conditions, passage E is connected to sump by slot F. Passage J also is connected to sump by port H in the valve stem. Since passage E is connected to slot F, this permits a rapid drain of oil from the reverse clutch to the sump. Since passage J is now at atmospheric pressure, the pressure in chamber L unseats the steel ball against the compression spring permitting a rapid oil drain of chamber L to sump. When the pressure rate control piston is against the orifice plate, the neutral position is attained again.

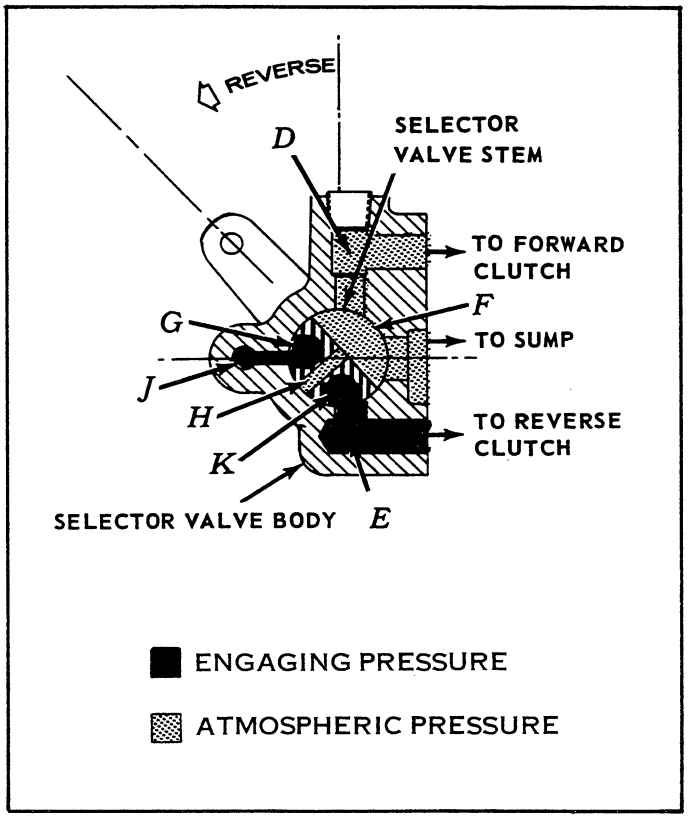


Figure 14. Selector Valve – Reverse – Sectional View.

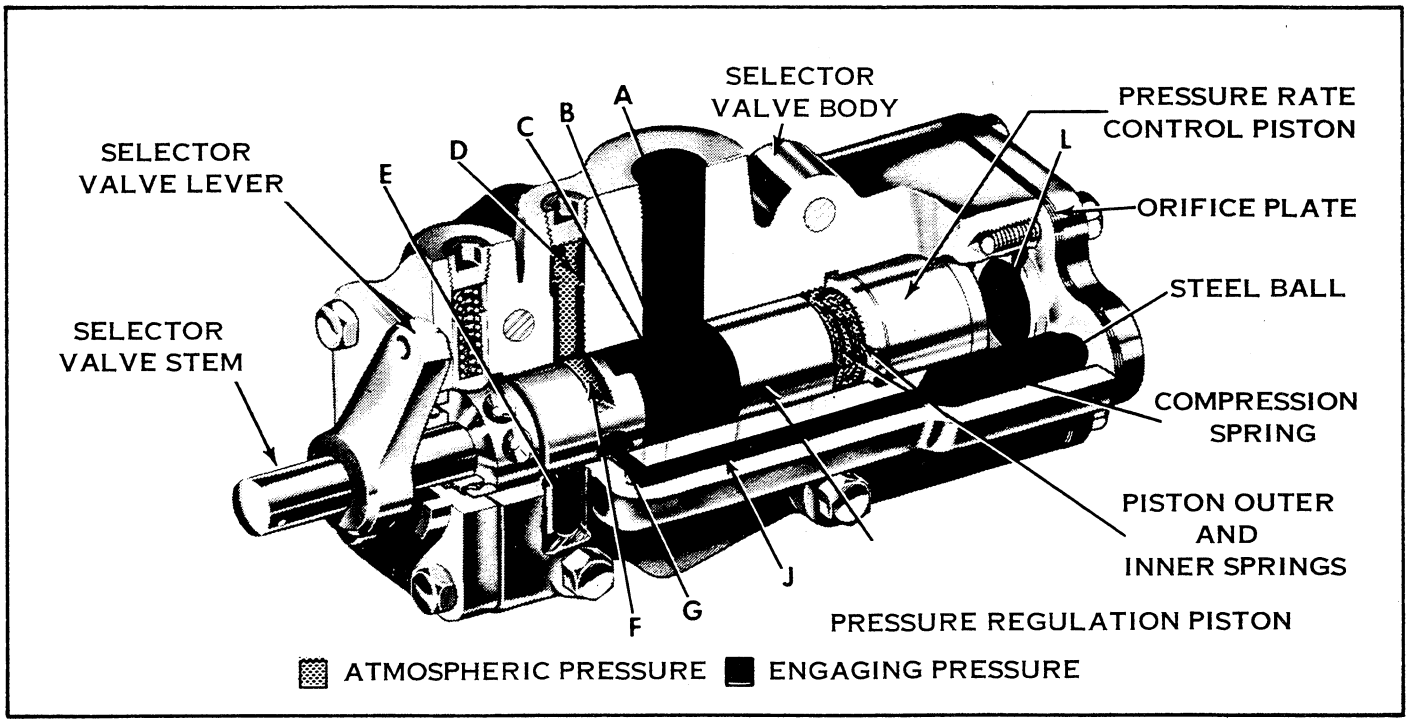


Figure 15. Selector Valve Reverse – Cutaway View.

22. OIL FLOW.

A. Oil Flow–Neutral (figs. 16 & 17). Some of the 18-20 psi oil in the oil return pipe cavity of the selector valve body is metered through the orifice in the return pipe piston. This oil lubricates the forward and reverse pinions, the forward and reverse pinion roller bearings, the clutch spider ball bearings, and the reverse driving and driven gear ball bearings in all positions of the selector valve. The remainder of the 18-20 psi oil in the return pipe cavity is distributed by channel Z in the manifold which directs cooling oil to the forward clutch through an orifice plug installed in the manifold. Branch channel Y in the manifold is interconnected with channel Z and directs cooling oil to the reverse clutch through another orifice plug located in the manifold. The pressurized oil which is metered through the orifice plugs is directed to an area between the front face of the manifold and the rear face of the clutch cylinders. From this area the oil passes through drilled holes in the hub of each cylinder to the oil catcher area of each clutch shaft. Due to centrifugal force in the oil catcher area, the oil passes out through drilled holes in the hub portion of each clutch shaft, through the clutch plates, and returns to the sump. Cooling oil is supplied to the clutch plates in all positions of the selector valve. A drilled port in passage D (Fig. 11)and a drilled port in passage E (Fig. 11) of the selector valve are aligned with similar holes in the manifold. The port in passage D aligns with channel X in the manifold that extends to a chamber at the clutch end of the forward clutch shaft. The port in passage E aligns with channel W in the manifold that extends to a chamber at the clutch end of the reverse clutch shaft. A center-drilled hole and a cross-drilled hole in each clutch shaft connects each chamber to an area between each clutch piston and cylinder through an angular-drilled hole in the cylinder. Since passage D and passage E are at atmospheric pressure when in the neutral position (Par. 21B), then the area between each clutch piston and cylinder also is at atmospheric pressure.

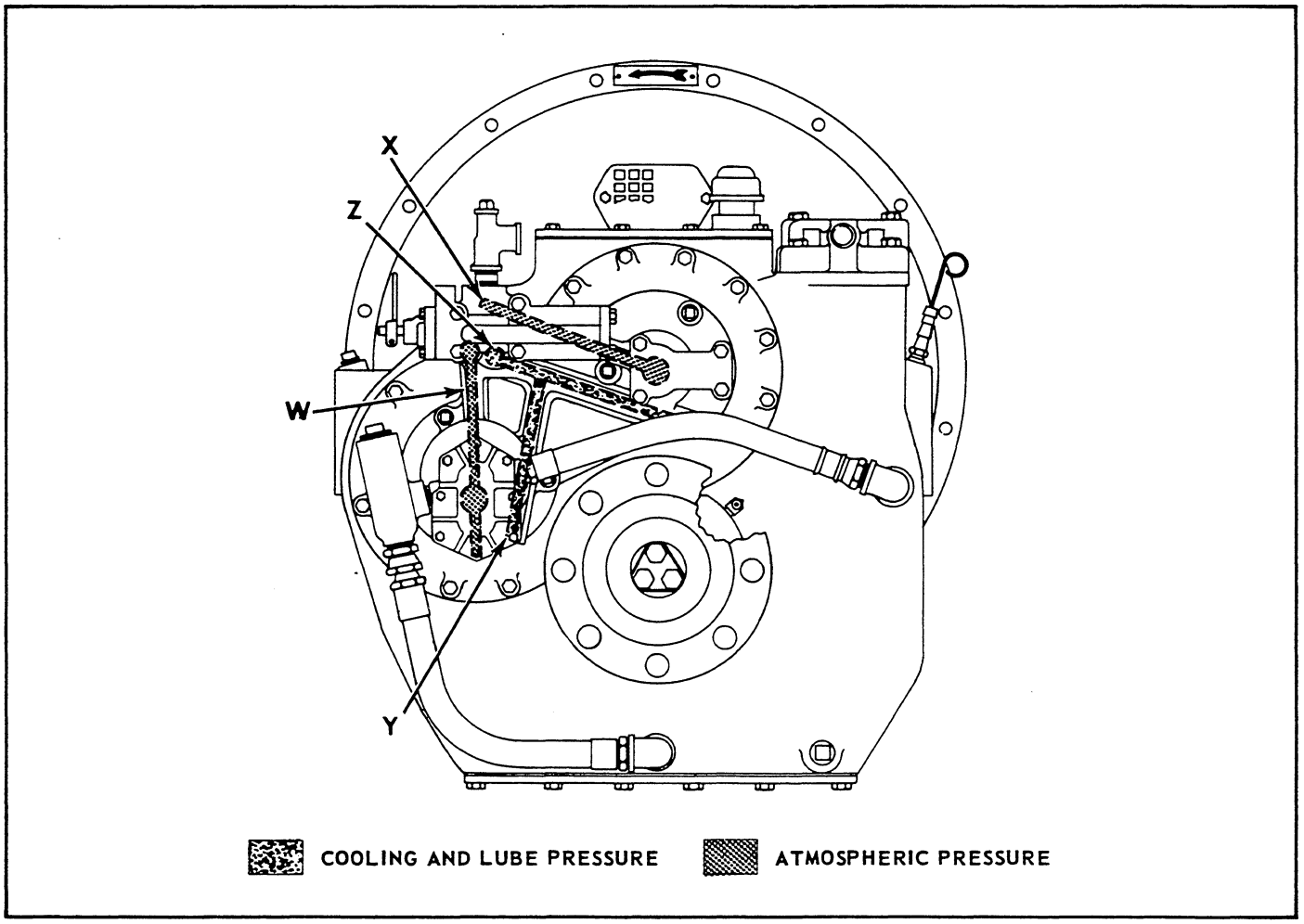


Figure 16. MG-514 Marine Gear Oil Flow – Neutral – External View.

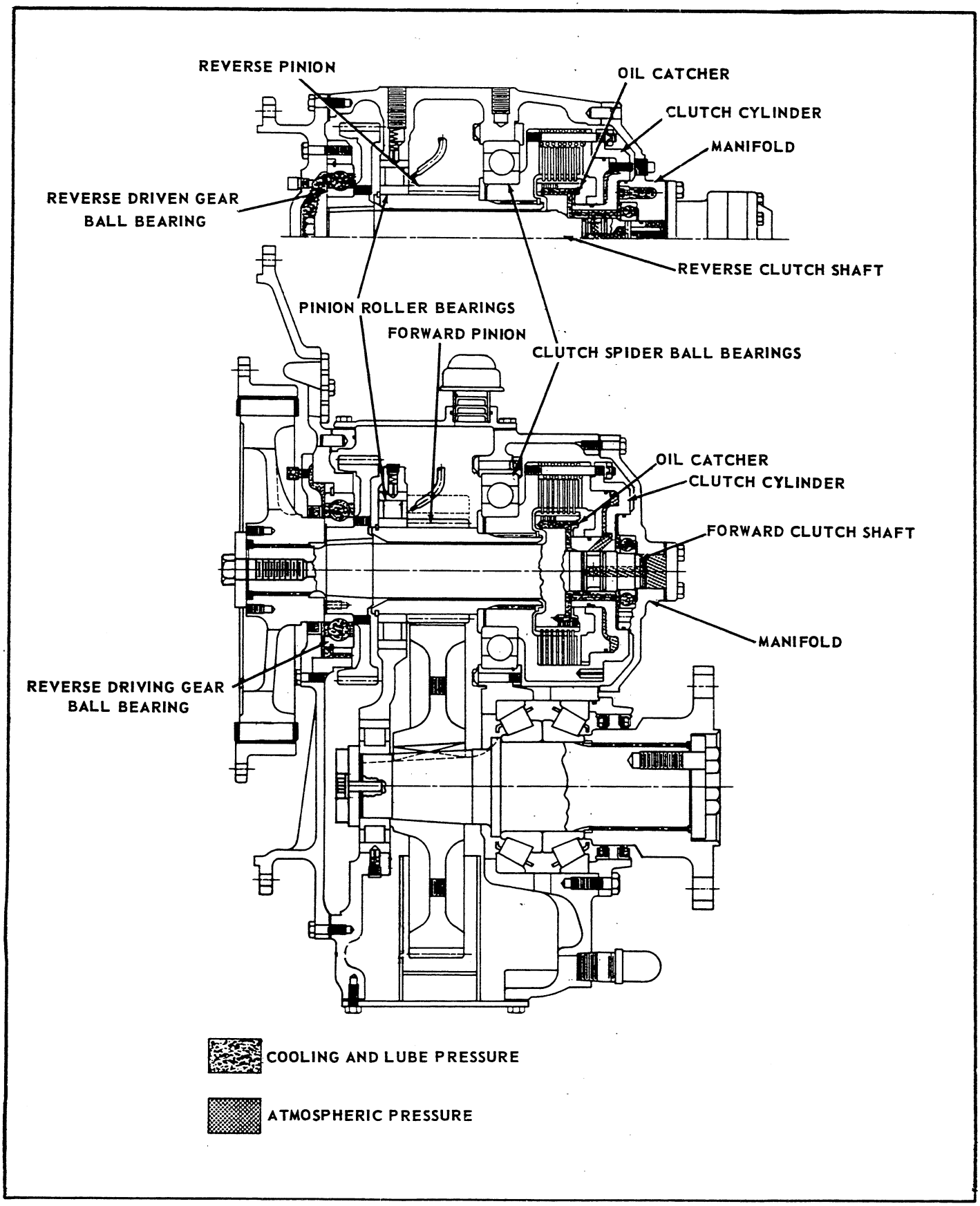


Figure 17. MG-514 Marine Gear Oil Flow – Neutral – Cross-Section View.

B. Oil Flow—Forward (Figs. 18 & 19). The port in passage D (Figs. 12 & 13) is aligned with a drilled hole and channel X in the manifold. Therefore, high pressure oil is supplied to channel X when a shift to forward is made. This oil flows through channel X to the area at the clutch end of the forward clutch shaft. The 185-215 psi oil then passes through the center-drilled and crossed-drilled hole in the clutch shaft to the area between the clutch piston and the clutch cylinder through an angular hole in the cylinder. This moves the piston forward to compress and engage the clutch plate stack. The area between the reverse clutch piston and reverse clutch cylinder remains at atmospheric pressure as described in **Neutral** (Par. 22A).

C. Oil Flow—Reverse (Figs. 20 & 21). The port in passage E (Figs. 14 & 15) is aligned with a drilled hole and channel W in the manifold. Therefore, high pressure oil is supplied to channel W when a shift to reverse is made. This oil flows through channel W to the area at the clutch end of the reverse clutch shaft and around the flats of the oil pump drive sleeve. The 185-215 psi oil then passes through the center-drilled and cross-drilled hole in the clutch shaft to the area between the clutch piston and the clutch cylinder through an angular hole in the cylinder. This moves the piston forward to compress and engage the clutch plate stack. The area between the forward clutch piston and cylinder remains at atmospheric pressure as described in **Neutral** (Par. 22A).

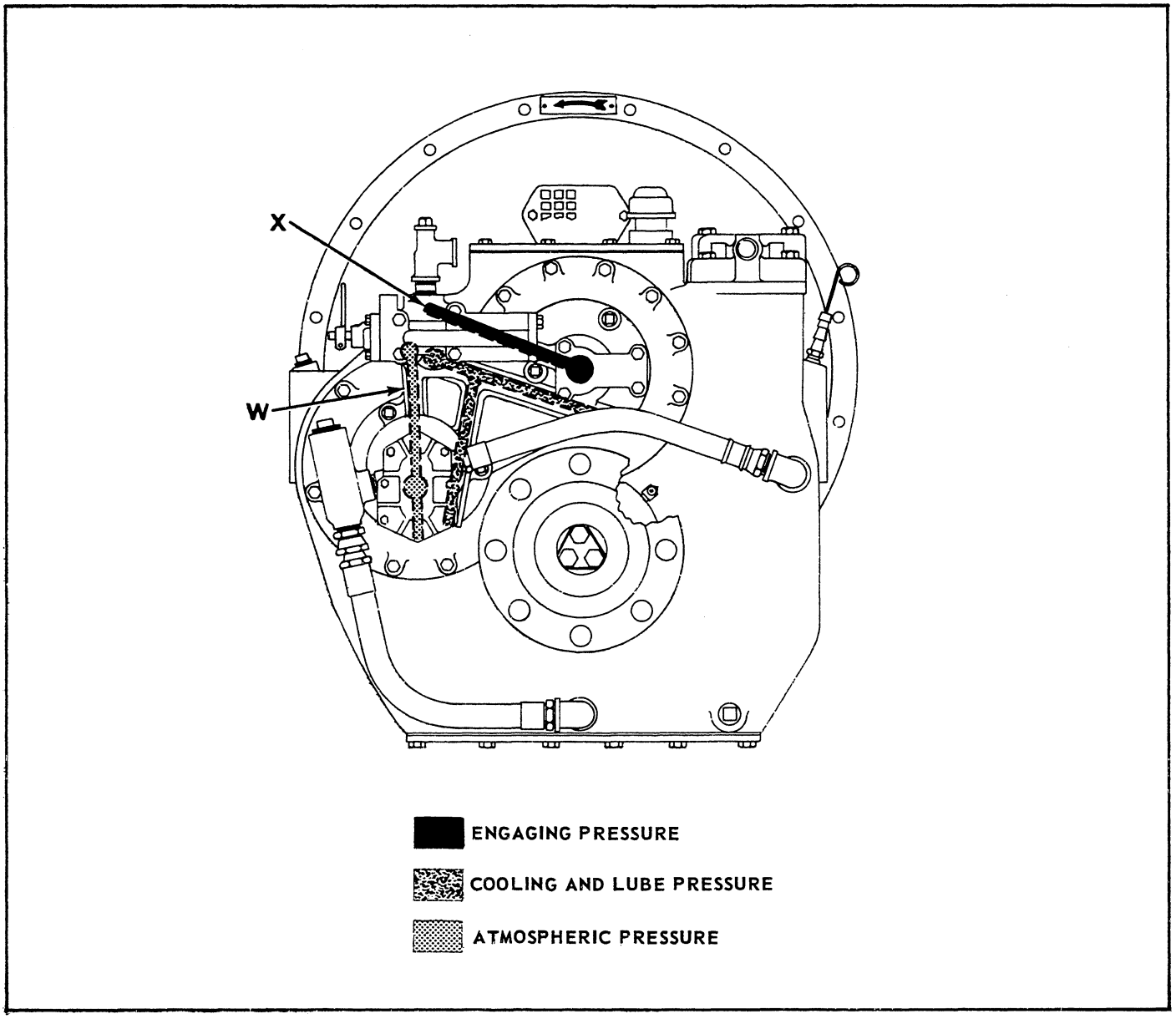


Figure 18. MG-514 Marine Gear Oil Flow – Forward – External View.

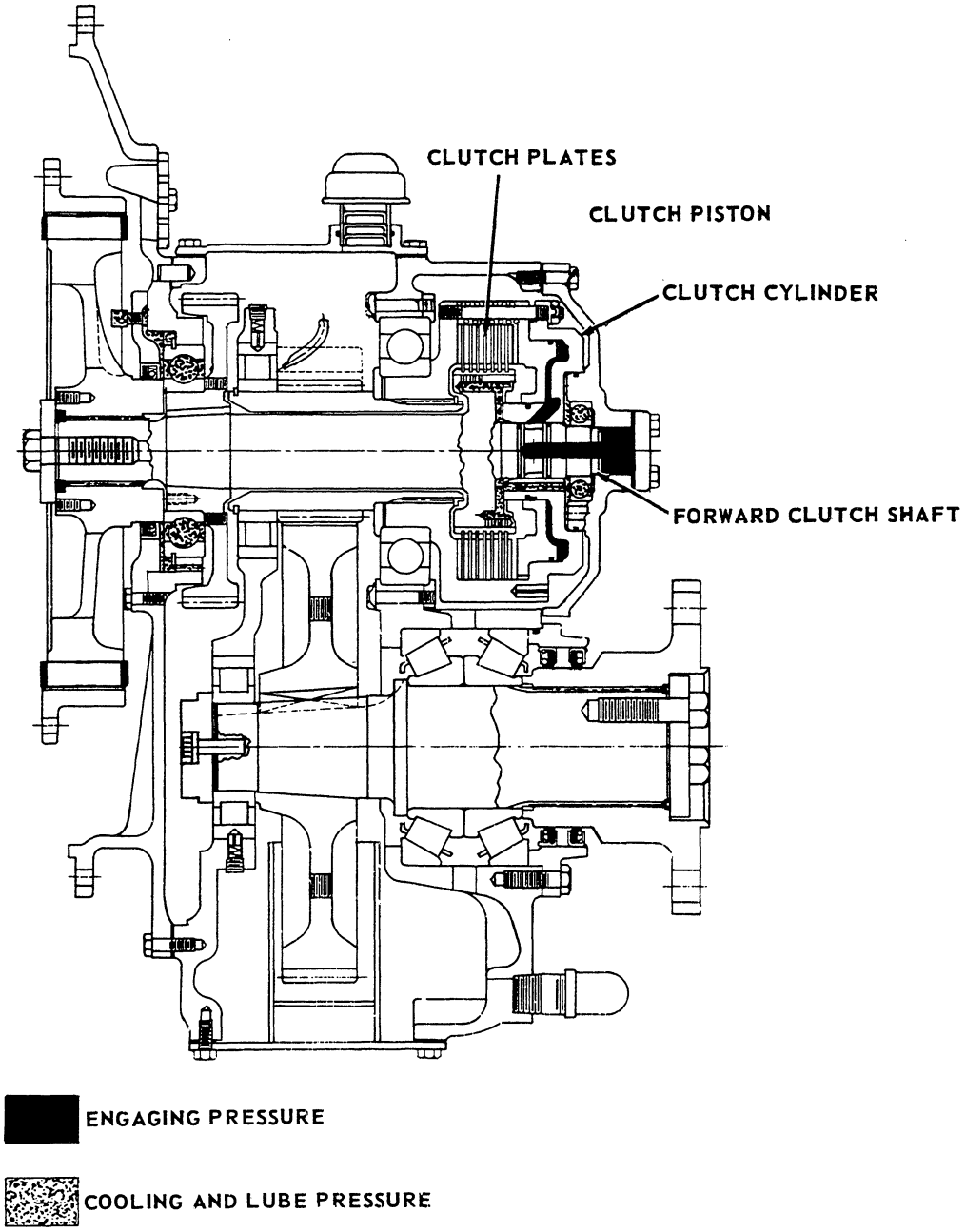


Figure 19. MG-514 Marine Gear Oil Flow – Forward – Cross-Section View

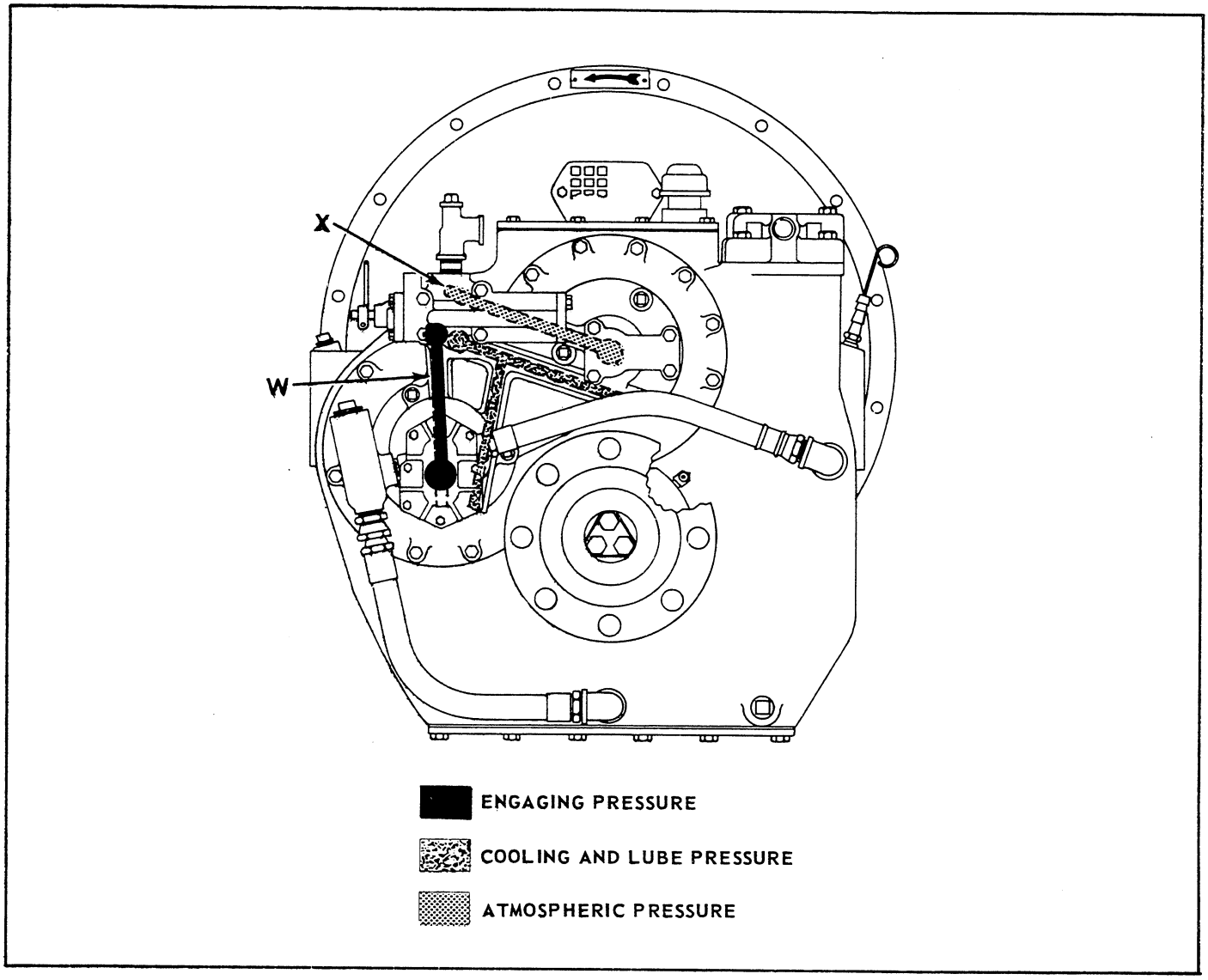


Figure 20. MG-514 Marine Gear Oil Flow – Reverse – External View.

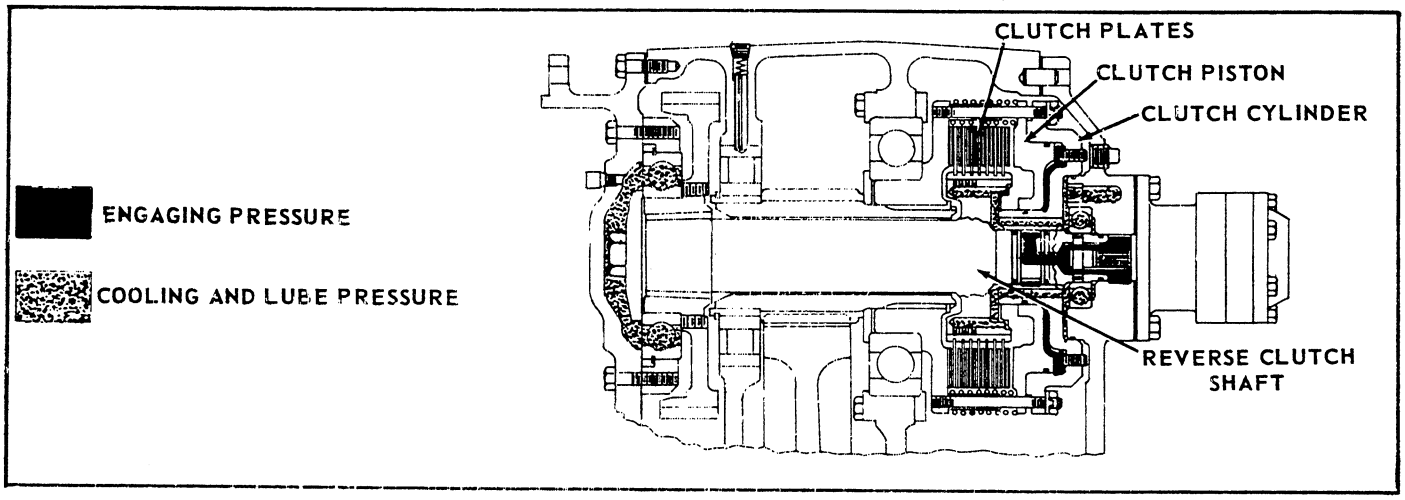


Figure 21 MG-514 Marine Gear Oil Flow – Reverse – Cross-Section View.

Section V. PREVENTIVE MAINTENANCE

23. GENERAL.

A. Lubrication. All moving parts of the MG-514 Marine Gear are lubricated by the oil within the sump as it travels throughout the hydraulic system. The preventive maintenance required to keep the gear functioning properly is slight; however, it is very important that the following directions be complied with.

B. Overhaul Interval. A complete overhaul of the MG-514 Marine Gear should be made at the same time that the engine is overhauled. All parts showing signs of wear, fatique, etc., should be replaced at that time.

24. HYDRAULIC SYSTEM.

A. Oil Capacity and Weight. The oil capacity of the shallow-case MG-514 Marine Gears is 6 U.S. gallons, or to the "Full" mark on the oil level gauge. The oil capacity of the deep-case MG-514 Marine Gears is 9 U.S. gallons, or to the "Full" mark on the oil level gauge. * See page 20.

B. Oil Level. The oil level should be checked daily using the oil level gauge in the marine gear. The oil level should be checked with the unit running at idle speed in neutral. The oil level should be between the "Low" and "Full" marks on the gauge.

C. Oil Change Interval. The oil must be changed every 1000 hours of operation, or 6 months whichever occurs first.

D. Draining. Alternate methods of draining the marine gear are possible as described below:

(1) Gravity Drain. Remove the square-head pipe plug from the main housing at the "Oil Drain" location. Allow sufficient time for the marine gear oil to drain from the unit, and then install the plug securely in place.

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

E. Filling. The Correct filling procedure is as follows:

(1) Remove the breather (see figure 3) from the top of the main housing assembly.

(2) Pour the oil through the breather opening.

(3) Fill the sump with 9 U.S. gallons (34 liters) for deep case or 6.0 U.S. gallons (22.7 liters) for shallow case of the proper weight and type oil. See Page 20 for proper oil.

(4) Start the engine and let it idle with transmission in neutral until oil is circulated throughout the hydraulic system.

(5) With the oil at operating temperature, transmission in neutral and the engine running at low idle, check the oil level with the oil gauge (see figure 3).

(6) Add oil as necessary to bring the oil level up to "FULL" on the oil gauge.

25. COMPONENT PARTS.

A. Oil Filter Element Assembly. The oil filter element assembly is installed in the main housing, and secured in position by the cover plate.

(1) Change Interval. The oil filter element and cover plate gasket should be replaced every 1000 hours of operation at the same time the oil is changed.

(2) Removal. Remove the square-head pipe plug from the main housing at the "Filter Drain" location. Disconnect the selector-valve-to-filter flexible hose from the male adapter union installed in the cover plate. Remove the four hex-head capscrews that secure the cover plate to the main housing. Lift the cover plate and oil filter element assembly from the main housing. Unscrew the filter tube assembly from the cover plate. Discard the oil filter element and the cover plate gasket.

(3) Installation. Install a new oil filter element. Use a new cover plate gasket, and place the cover plate and gasket in position on the main housing. Secure the cover plate to the main housing with the four hex-head capscrews previously removed. Connect the flexible hose to the union. Install the drain pipe plug in the main housing.

B. Oil Strainer. The oil strainer is located within the oil strainer housing that is installed next to the oil pump assembly.

(1) **Cleaning Interval.** The oil strainer should be removed and cleaned every 1000 hours of operation at the same time the oil is changed.

(2) **Removal.** Remove the square-head pipe plug from the top of the oil strainer housing. Lift the oil strainer from the oil strainer housing.

(3) **Cleaning.** Clean the oil strainer in clean diesel fuel. Make certain all foreign matter is removed from the strainer holes.

(4) **Installation.** Place the oil strainer in position in the oil strainer housing and secure with the square-head pipe plug previously removed. Prior to installation, use pipe thread compound on the threads of the pipe plug to ensure a tight, sealed fit in the housing.

C. **Output Flange Oil Seals.** Grease the output flange oil seals every time the boat is docked, or every 100 hours of operation – whichever occurs first. Use a water pump grease or an insoluble-in-water grease.

D. **Oil Breather Assembly.** Remove the oil breather assembly every 1000 hours of operation at the same time the oil is changed. Flush the oil breather assembly in clean diesel fuel.

26. PERIODIC VISUAL INSPECTION.

A. **General.** Frequently inspect the mounting parts of the marine gear. Replace any damaged parts.

B. **Heat Exchanger Connecting Lines.** Inspect the heat exchanger connecting lines for leaks, sponginess, or other damage. Replace a damaged line.

C. **Flexible Hose.** Inspect the flexible hose on the marine gear for leaks, sponginess, or other damage. Replace a damaged hose.

D. **Rubber Blocks.** Remove the front housing cover plate, and inspect the rubber blocks for wear or damage. Replace worn or damaged rubber blocks.

E. **Pressure Gauge Assembly.** Periodically inspect the pressure gauge assembly for damage. Replace a damaged gauge. If the gauge is suspected of being inaccurate, replace the gauge with one of proven accuracy to determine the extent of malfuntion.

Section VI. TROUBLE SHOOTING

27. GENERAL.

This section of the maintenance 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.

28. TROUBLE SHOOTING CHART.

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

29. COME-HOME FEATURE.

A. General. A come-home feature has been designed into each clutch in the event of the failure of the hydraulic system. Simply, the come-home feature is a mechanical lock-up of **EITHER** clutch to enable the boat to return to port.

B. Mechanical Lock-Up. TURN OFF THE ENGINE. Serious injury to personnel may result if the engine is left running. Remove the three come-home access plugs (Fig. 1) from the manifold over the forward clutch location. Use a 3/16 inch hex Allen wrench and alternately tighten the come-home setscrews (Fig. 3) in a clockwise direction until mechanical lock-up of the clutch is attained. NOTE: DO NOT LOCK-UP BOTH CLUTCHES AT THE SAME TIME!

TABLE II. TROUBLE SHOOTING.

Symptom	*Cause*	*Remedy*
1. Low Oil Pressure.	1–1. Partially clogged oil strainer.	1–1. Remove and clean oil strainer (par. 25B).
	1–2. Stuck pressure regulation piston in selector valve assembly.	1–2. Remove selector valve assembly. Disassemble the valve, and clean the piston (par. 38C).
	1–3. Broken piston rings in clutches.	1–3. Remove the manifold (par. 31A), and disassemble the clutches. Replace broken piston rings.
	1–4. Come-home setscrew loose or missing.	1–4. Remove the come-home access pipe plugs. Tighten any loose come-home setscrews by turning counterclockwise, or replace any missing setscrews.
	1–5. Damaged or worn oil pump assembly.	1–5. Remove oil pump assembly (par. 31A). Replace damaged or worn oil pump assembly.
	1–6. Incorrect linkage installed on selector valve assembly.	1–6. Adjust linkage so that selector valve stem is indexed properly by detent pin.
	1–7. Clogged or plugged orifice in the orifice plate or the selector valve assembly.	1–7. Remove orifice plate cover (par. 38C(5)). Clean parts.

TABLE II. TROUBLE SHOOTING.

Symptom	*Cause*	*Remedy*
	1–8. Broken piston rings on clutch shaft.	1–8. Remove marine gear (pars. 33 & 34). Disassemble marine gear (pars. 35-43), and replace broken piston rings.
2. *No Oil Pressure.*	2–1. Low oil level or empty sump.	2–1. Check gaskets and seals for leakage. Replace parts causing leakage. Fill marine gear (par. 24).
	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 1–5.
3. *High Oil Pressure.*	3–1. Stuck pressure regulation piston in selector valve assembly.	3–1. Refer to Remedy 1–2.
4. *Overheating.*	4–1. Insufficient heat exchanger capacity.	4–1. Install heat exchanger of sufficient capacity.
	4–2. Insufficient cooling water flow.	4–2. Inside diameter of water lines too small. Replace lines with larger inside diameter hoses.
	4–3. Clutch slipping.	4–3. Low oil pressure will cause a clutch to slip. Refer to Symptom 1.
	4–4. Oil level too high.	4–4. Correct oil level (par. 24B).
	4–5. Improper oil in sump.	4–5. Drain marine gear, and fill with proper oil (par. 24).
	4–6. Clutch plates warped.	4–6. Replace clutch plates (par. 31).
	4–7. Bearing failure.	4–7. Remove marine gear (pars. 33 & 34). Disassemble marine gear (pars. 35-43), and replace damaged parts.

TABLE II. TROUBLE SHOOTING.

Symptom	*Cause*	*Remedy*
5. *Reduced Oil Pressure.*	5–1. Fully clogged oil filter element will drop oil pressure approximately 10-15 psi from normal reading.	5–1. Replace oil filter element (par 25A).
	5–2. Broken piston rings on clutch shaft.	5–2. Refer to Remedy 1–8.
6. *Excessive Noise.*	6–1. Air leak in oil-sump-to-strainer flexible hose or oil strainer housing.	6–1. Tighten all fittings. Replace a damaged hose.
	6–2. Bearing failure.	6–2. Refer to Remedy 4–7.
	6–3. Worn or damaged rubber blocks.	6–3. Remove marine gear (pars. 33 & 34). Replace worn or damaged rubber blocks.
	6–4. Broken or chipped gear teeth.	6–4. Remove marine gear (pars. 33 & 34). Disassemble marine gear (pars. 35-43), and replace damaged parts.
7. *No Neutral.*	7–1. Clutch plates warped.	7–1. Replace clutch plates (par 31).
8. *Harsh Engagement.*	8–1. Steel ball in selector valve not seating properly.	8–1. Remove orifice plate cover (par. 38C(5)). Clean parts. Replace parts if necessary.

Section VII. CLUTCH OVERHAUL

30. GENERAL.

Due to the unique design of the MG-514 Marine Gear, it is possible to service the forward and reverse clutches without disconnecting the gear from the engine or propeller shaft companion flange. With this feature, it is unnecessary to disturb the alignment of the gear, or to accomplish the time-consuming operation of removing the gear from the installation. Other serviceable parts while the gear is installed are the selector valve assembly, the oil pump assembly, the oil filter, and the oil strainer. Also, it is possible to service the output flange oil seals by disconnecting the propeller shaft companion flange and moving the shaft rearward approximately 3-1/2 inches.

31. CLUTCH OVERHAUL.

A. Removal. The following procedure can be accomplished while the marine gear is installed in the boat.

(1) Disconnect the linkage to the selector valve assembly and the pressure gauge assembly. Disconnect the heat exchanger inlet line.

(2) Remove the four hex-head capscrews that secure the selector valve assembly (Fig. 22) to the manifold. Remove the selector valve assembly, with attached parts, and the selector-valve-to-manifold gasket. Discard the gasket.

(3) Disconnect the swivel male adapter union from the oil-sump-to-strainer flexible hose (Fig. 22). Disconnect the swivel male adapter union from the oil-pump-to-filter flexible hose (Fig. 22). Remove the four hex-head capscrews that secure the oil pump assembly (Fig. 22) to the manifold. Remove the oil pump assembly, with attached parts, and the oil-pump--to-manifold gasket from the manifold. Discard the gasket. Remove the flexible hose from the pressure discharge side of the oil pump.

(4) Disconnect the swivel male adapter union from the oil-sump-to-strainer flexible hose (Fig. 22). Remove the four hex-head capscrews that secure the oil pump assembly (Fig. 22) to the manifold. Remove the oil pump assembly, with attached parts, and the oil-pump-to-manifold gasket from the manifold. Discard the gasket.

(5) Remove the ten hex-head capscrews that secure the top cover plate (Fig. 22) to the main housing. Remove the top cover plate, with attached parts, from the main housing. Discard the gasket.

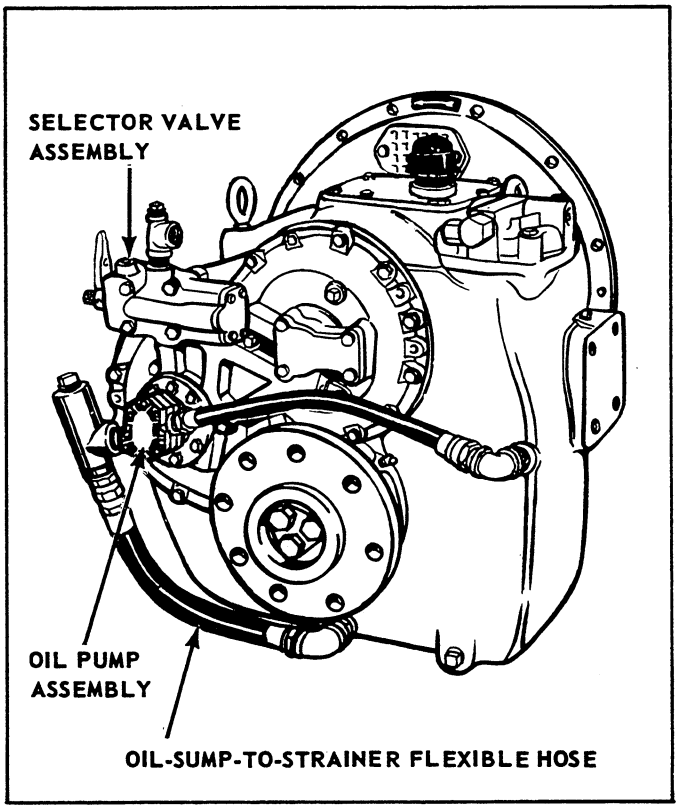


Figure 22. Pump Suction and To-Filter Flexible Hoses.

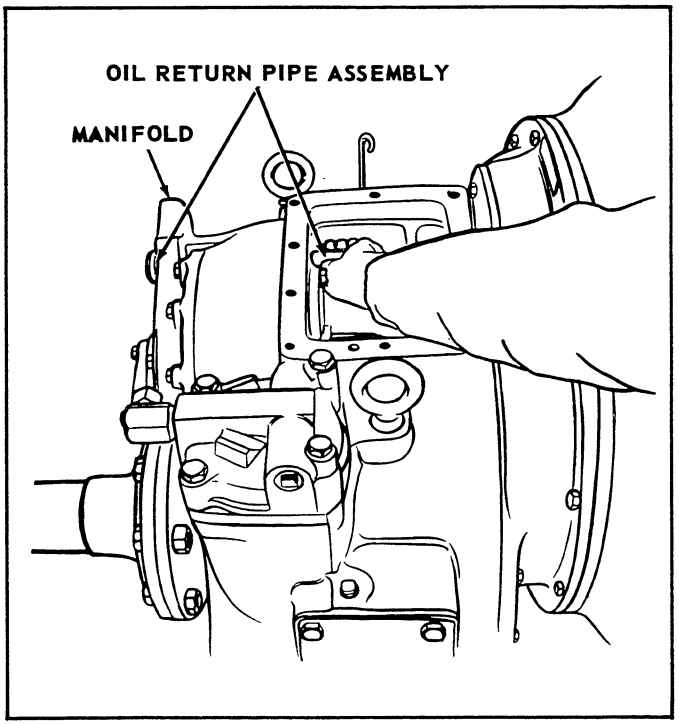


Figure 23. Removing the Oil Return Pipe Assembly.

(6) Reach down through the top cover plate opening in the main housing, and firmly grasp the oil return pipe assembly (Fig. 23). Carefully push the oil return pipe assembly rearward through the manifold, and remove the return pipe and the corprene ring gasket from the manifold. Discard the gasket. On marine gears with a tube carrier assembly installed on the oil return pipe, it is necessary to remove the hex-head capscrew and lock plate that secure the tube carrier assembly to the oil return pipe prior to the removal of the return pipe. As the return pipe is removed from the manifold, it is necessary to hold the tube carrier to prevent the carrier from damage as a result of falling into the gear.

(7) Remove three bolts (Fig. 24) that secure the output flange to the companion flange for manifold removal clearance. Remove the 16 hex-head capscrews that secure the manifold (Fig. 24) to the main housing. Install two pusher screws (Fig. 24) in the 3/8-16 UNC tapped holes in the manifold. Remove the manifold, with attached parts, and the manifold-to-main-housing gasket from the main housing. Discard the gasket. Remove the two piston rings (Fig. 25) and the manifold orifice pipe plugs from the manifold only if replacement of parts is necessary.

(8) Remove the piston ring (Fig. 26) from the forward clutch shaft. Bend back the locking edges of the six lock plates (Fig. 26). Remove the twelve hex nuts and the six lock plates that secure the clutch cylinder (Fig. 26) to the clutch spider.

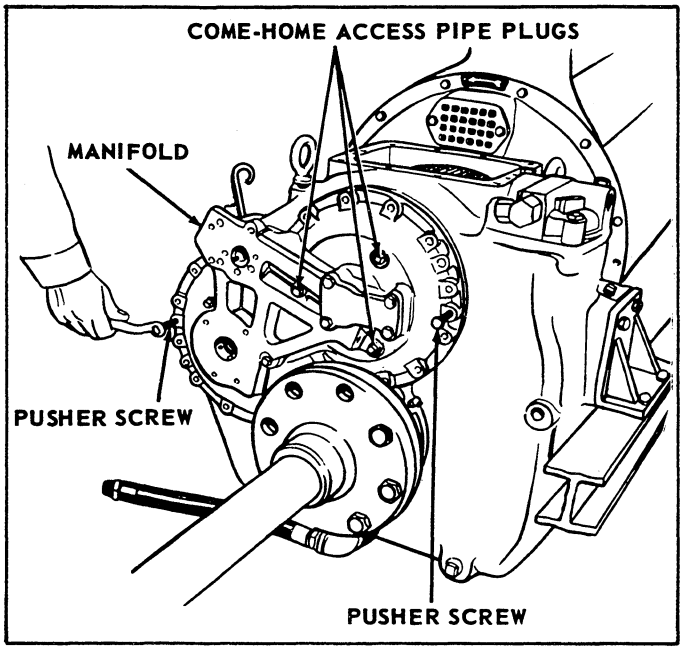


Figure 24. Removing the Manifold with Pusher Screws.

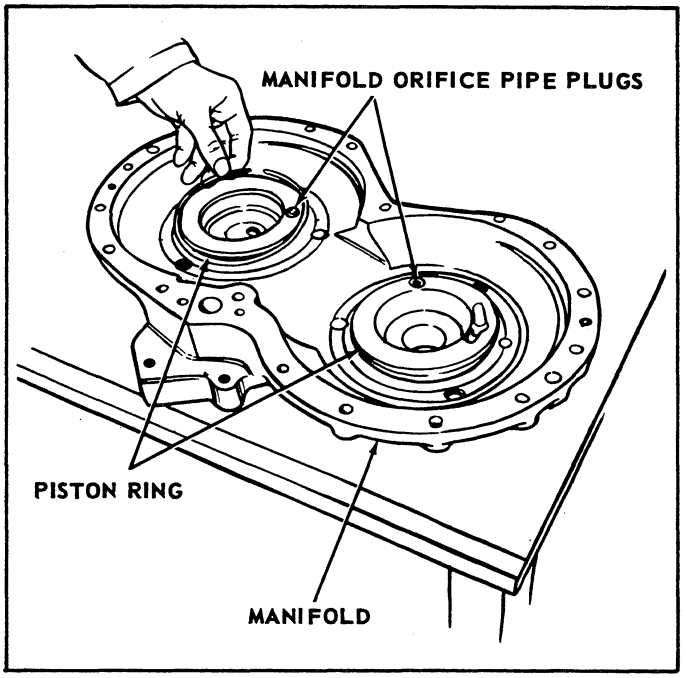


Figure 25. Removing the Piston Ring from the Manifold.

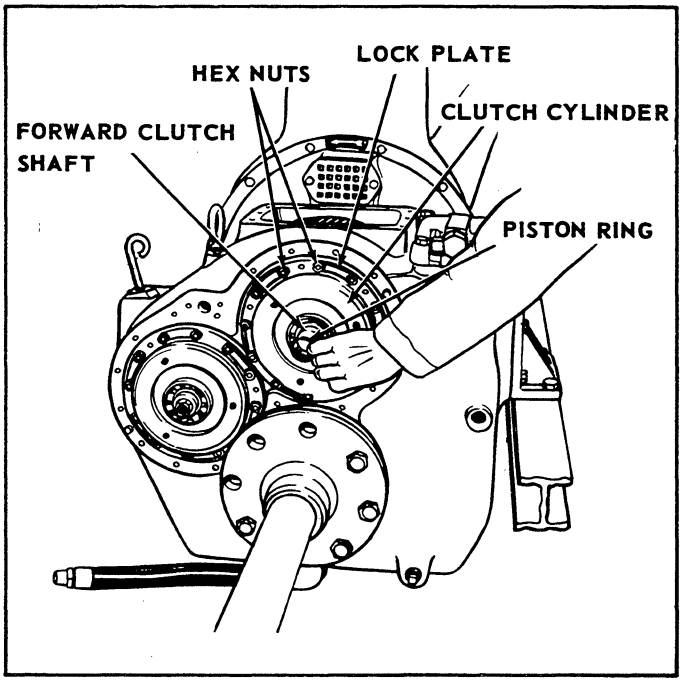


Figure 26. Removing the Piston Ring from the Forward Clutch Shaft.

(9) Install pusher screws (Fig. 27) in the three 3/8-16 UNC tapped holes in the clutch cylinder. Alternately screw the pushers, and remove the clutch cylinder and the clutch piston from the clutch spider, and the ball bearing (Fig. 27) from the forward clutch shaft. Separate the cylinder and piston, and remove a piston ring from each part only if replacement of parts is necessary.

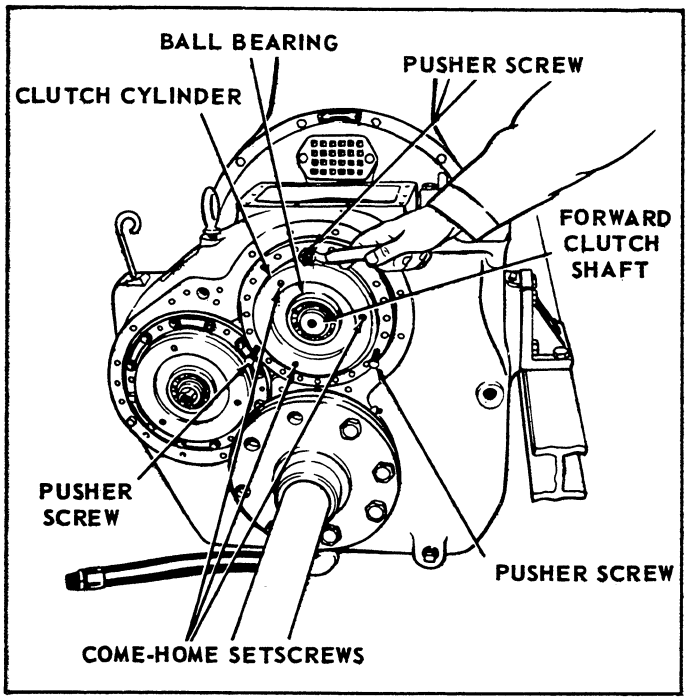


Figure 27. Removing the Clutch Cylinder from the Clutch Spider with Pusher Screws.

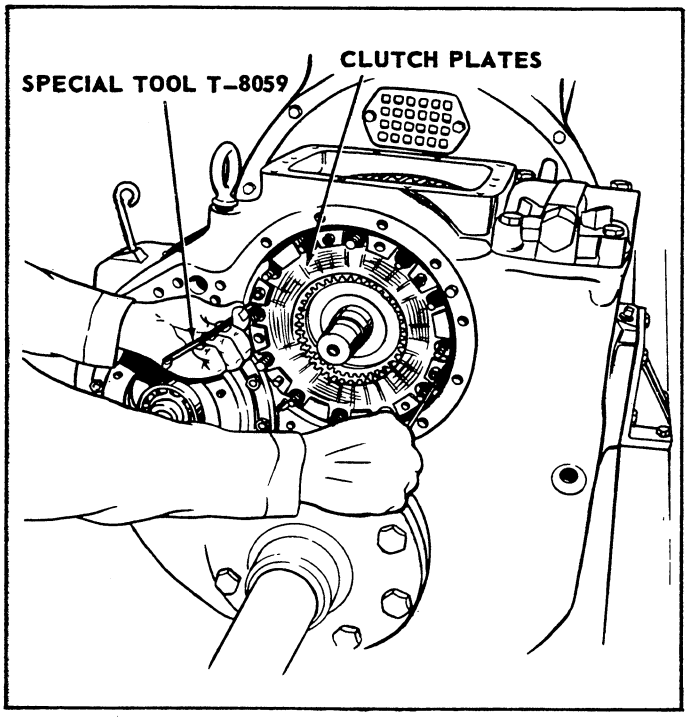


Figure 28. Removing the Clutch Plates from the Clutch Spider with Special Tool T-8059.

(10) Remove the two piston rings from the forward clutch shaft only if replacement of parts is necessary. Remove the twelve release springs from the split sleeves installed on the studs in the clutch spider. Use special tool T-8059 (Fig. 28), and remove the clutch plates from the clutch spider.

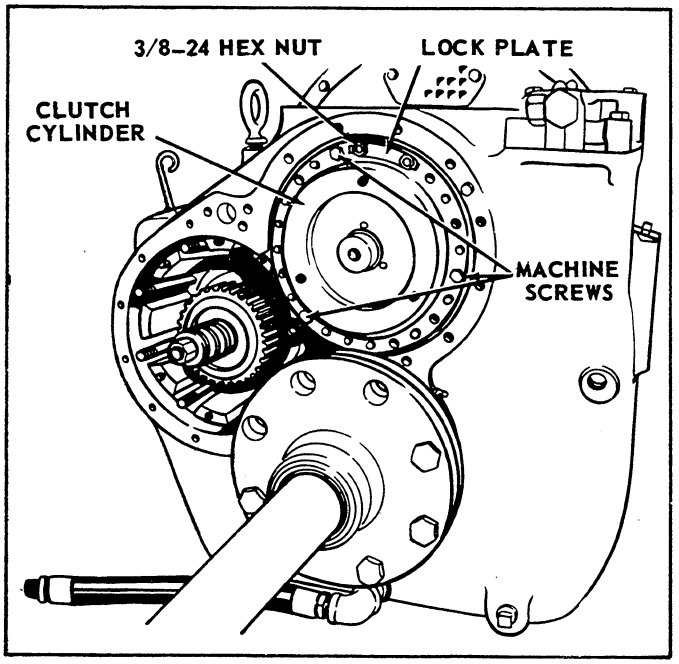


Figure 29. Installing the Clutch Cylinder on the Spider.

(11) Disassemble the reverse clutch by following the procedure described in Paragraphs 31A(7) through 31A(9).

B. Installation. Both clutches may be installed by the following procedure although only the forward clutch procedure will be described.

(1) Place the new clutch plates in position in the clutch spider. Use eight sintered-metal clutch plates and seven steel clutch plates. Alternate the clutch plate stack; begin with a sintered-metal plate and end with a sintered-metal plate. Install the twelve release springs on the split sleeves installed on the studs in the clutch spider. Install new piston rings, if necessary, in the clutch shaft, clutch piston, and clutch cylinder. Place the clutch piston in position in the clutch cylinder.

(2) Place the clutch cylinder (Fig. 29), with piston in position against the clutch spider. Use three 3/8-16 NC x 1 fully-threaded machine screws (Fig. 29) to hold the cylinder to the spider against the tension of the springs. Install six lock plates (Fig. 29) and twelve 3/8-24 hex nuts on the studs on the clutch spider. The center of each lock plate must cover a roll pin. Tighten the hex nuts to 34-38 lbs.-ft. torque, and lock in place by bending the lock plates. Remove the three hold-down machine screws.

(3) Place the ball bearing in position on the forward clutch shaft. Use Special Tool T-6984

(Fig. 30), and drive the bearing on the shaft. Install a new piston ring, if the old one was damaged, on the end of the shaft.

(4) Install the reverse clutch by following the above procedure.

(5) Install the manifold orifice pipe plugs and two new piston rings in the manifold, if removal had been necessary. Place the manifold, and a new manifold-to-main-housing gasket, in position on the two dowel pins in the main housing.**NOTE: DO NOT USE EXCESSIVE FORCE TO INSTALL THE MANIFOLD AS DAMAGE TO THE PISTON RINGS IN THE MANIFOLD OR THE PISTON RINGS ON THE SHAFTS WILL OCCUR.** Secure the manifold to the main housing with sixteen 3/8-16 x 1-1/2 hex-head capscrews. Tighten the capscrews to 34-38 lbs.-ft. torque. Install the three bolts that were removed from the output flange and the companion flange.

(6) Install a new corprene ring gasket in the manifold. Install the oil return pipe assembly in the manifold and against the gasket by indexing the return pipe on the roll pin in the manifold. On marine gears with a tube carrier assembly, hold the tube carrier assembly in position and slide the oil return pipe assembly through the tube carrier during installation of the return pipe. Place the tube carrier assembly in position on the return pipe, and secure the tube carrier to the return pipe with the hex-head capscrew and a new lock plate. The capscrew must index in the return pipe. Bend the lock plate against the capscrew to secure the screw in place.

(7) Place the top cover plate and a new top cover plate gasket in position on the main housing, and secure the cover plate to the housing with ten 3/8-16 x 7/8 hex-head capscrews. Secure the breather chain clip in position beneath one of the capscrews. Tighten the capscrews to 34-38 lbs.-ft. torque.

(8) Place the oil pump assembly, with attached parts, and a new oil-pump-to-manifold gasket in position against the manifold, and secure the oil pump to the manifold with four 3/8-16 x 1 hex-head capscrews. Tighten the capscrews to 34-38 lbs.-ft. torque. Connect the oil-sump-to-strainer flexible hose to the oil strainer housing.

(9) Place the selector valve assembly, with attached parts, and a new selector-valve-to-manifold gasket in position against the manifold, and secure the selector valve to the manifold with two 3/8-16 x 2-3/4 hex-head capscrews and two 3/8-16 x 5-3/4 hex-head capscrews. Tighten the capscrews to 34-38 lbs.-ft. torque.

(10) Connect the heat exchanger outlet line to the selector valve assembly. Connect the flexible hose from the oil pump discharge port to the oil filter inlet port. Connect the linkage to the selector valve assembly and the pressure gauge assembly.

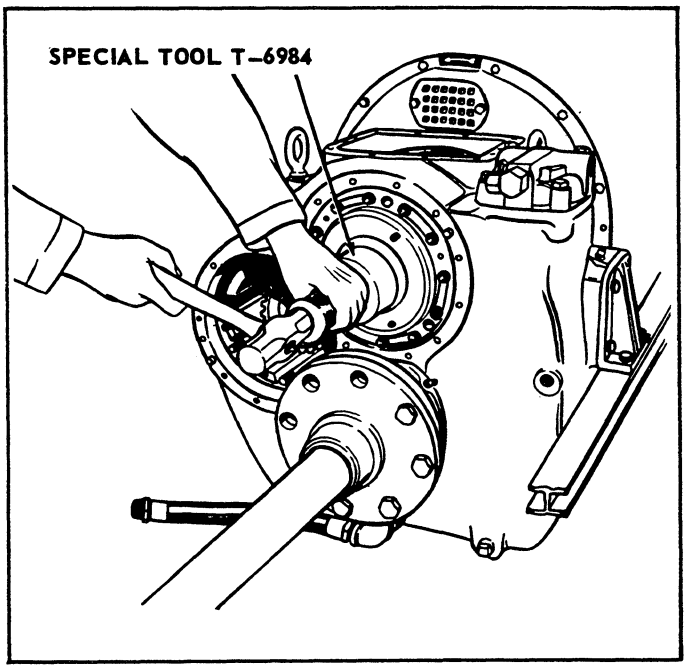


Figure 30. Installing the Ball Bearing on the Forward Clutch Shaft with Special Tool T-6984.

32. OIL SEAL REPLACEMENT.

A. REMOVAL.

(1) Prior to replacing the output flange oil seals, it is necessary in some installations to drain the marine gear sump of oil. Drain the oil from the gear by following the procedure described in Paragraph 24D.

(2) Scribe an aligning mark across the outside diameter of the output flange and the companion flange for installation purposes. Remove the bolts that secure the output flange to the companion flange. Slide the propeller shaft rearward approximately 3-1/2 inches.

(3) Remove the three hex-head capscrews, the retainer washer, and the output flange shim that secure the output flange on the output shaft. Remove the output flange and ring gasket from the output shaft. Discard the gasket. It may be necessary to tap the flange with a babbitt hammer or a brass bar.

(4) Remove the seven hex-head capscrews that secure the bearing retainer to the main housing. Remove the bearing retainer and the bearing retainer shims from the main housing. Remove the bearing retainer "O" ring gasket from the bearing retainer. Discard the gasket. Remove the two output flange oil seals from the bearing retainer. Discard the oil seals.

B. Installation.

(1) Install two new output flange oil seals in the bearing retainer. The lip of the outer seal must point rearward, and the lip of the inner seal must point forward. Install a new bearing retainer "O" ring gasket on the bearing retainer. Place the bearing retainer, and the bearing retainer shims that were removed, against the main housing, and secure the retainer to the housing with seven 1/2-13 x 1-1/2 hex-head capscrews. Tighten the capscrews to 77-85 lbs.-ft. torque.

(2) Carefully tap the output flange on the output shaft. Do not damage the oil seals! Install a new ring gasket in the output flange. Secure the output flange to the output shaft with the output flange shim, the retainer washer, and three 5/8-18 x 1-1/2 hex-head capscrews. Tighten the capscrews to 160-175 lbs.-ft. torque.

(3) Slide the output shaft and companion flange forward against the output flange. Align the scribed marks on the output flange and companion flange. Secure the flanges together with the bolts previously removed.

(4) After the installation has been completed, fill the marine gear sump with oil as described in Paragraph 24E.

Section VIII. REMOVAL

NOTE

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.

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.*

33. PRIOR TO REMOVAL.

A. **Hydraulic System.** Drain the hydraulic system of oil (Par. 24D).

B. **Connecting Linkage.** Disconnect all marine gear connecting linkage and lines.

C. **Support.** Support the marine gear with a hoist, or other suitable equipment, prior to the removal of any mounting parts.

34. REMOVAL.

A. **Output Flange Connection.** Scribe an aligning mark across the outside diameter of the output flange and the companion flange for installation purposes. Remove the bolts and nuts that secure the output flange to the companion flange. After the removal of the attaching parts, move the propeller shaft approximately four inches rearward for marine gear removal clearance.

B. **Engine Bedrail Connection.** Disconnect the brackets mounted on the engine bedrails from the mounting pads of the marine gear or from the engine bedrails.

C. **Engine Connection.** Remove the bolts that secure the front housing of the marine gear to the engine flywheel housing. Slide the marine gear rearward until the rubber blocks on the drive spider are clear of the driving ring installed on the engine flywheel. Remove the marine gear. Remove the driving ring from the engine flywheel only if replacement of parts is necessary.

Section IX. DISASSEMBLY

35. MISCELLANEOUS EXTERNAL PARTS.

A. Remove the reducing "tee" (Fig. 80, 39) from the short pipe nipple (40). Remove the short pipe nipple from the selector valve assembly.

B. Disconnect the male adapter union (Fig. 80, 51) from the oil-sump-to-strainer flexible hose (50). Remove the male adapter union from the oil strainer housing (52). Remove the flexible hose from the 90 degree pipe elbow (49). Remove the elbow and the short pipe nipple (48) from the main housing (Fig. 79, 21). Remove hose assembly (44), elbow (43), and nipple (42) from the oil filter to oil pump connection.

C. Remove the ten hex-head capscrews (Fig. 81, 9) that secure the top cover plate (14) to the main housing. Remove the top cover plate and the top cover plate gasket (15) from the main housing. Discard the gasket. Remove the oil breather assembly (12) and the oil breather "O" ring (13) from the top cover plate. Discard the "O" ring. Remove the breather chain (10), the breather chain "S" link (11), and the breather chain clip (8) from the oil breather only if replacement of parts is necessary.

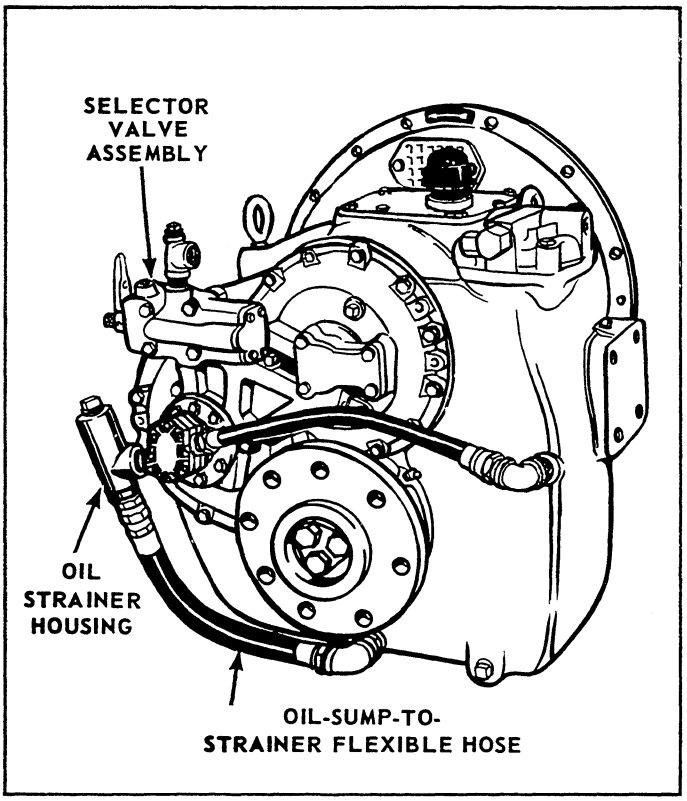


Figure 31. Pump Suction and To-Filter Flexible Hoses.

D. If replacement of the instruction plate (Fig. 81, 5) is necessary, remove the four drive screws (6) that secure the instruction plate to the main housing. Remove the instruction plate from the main housing, and transfer the data stamped on the old plate to the new plate.

E. Remove the oil level gauge (Fig. 81, 16) and the oil level gauge tube (17) from the main housing.

36. DRIVE SPIDER GROUP OF PARTS.

A. Remove the hex-head capscrew (Fig. 79, 2), and the retainer washer (3) that secure the drive spider (6) to the forward clutch shaft (37). Remove and discard the rubber ring gasket (4) from the end of the clutch shaft.

B. Install a puller in the two 3/8-16 UNC tapped holes in the drive spider, and remove the drive spider from the forward clutch shaft. Remove the rubber blocks (Fig. 79, 5) from the drive spider only if replacement of parts is necessary.

37. FRONT HOUSING GROUP OF PARTS.

A. Disconnect the short flexible hose (Fig. 79, 64) and the long flexible hose (62) from the inverted elbow fittings (61 & 65) that are installed in the front housing (12) and the seal carrier (8). Each hose contains a union in order to disconnect it. Unscrew and remove the hoses from the inverted tee fitting (63). Remove the hose clamp (66) and washer (67) from the hose (64) only if replacement of the parts is necessary. Remove the two elbow fittings and the tee fitting only if replacement of parts is necessary.

B. Remove the six hex-head capscrews (Fig. 79, 10) that secure the seal carrier (8) to the front housing (12). Remove the seal carrier and the seal carrier gasket (9) from the front housing. Discard the gasket. Remove the drive spider oil seal (7) from the seal carrier. Discard the oil seal.

C. Remove the snap ring from the outer race of the reverse driving gear ball bearing (Fig. 80, 3).

D. Remove the two hex-head capscrews (Fig. 79, 17) that secure the front housing cover plate (16) to the front housing. Remove the cover plate from the front housing. Remove the two drive screws (15) and the rotation indicator plate (14) from the front housing only if replacement of parts is necessary.

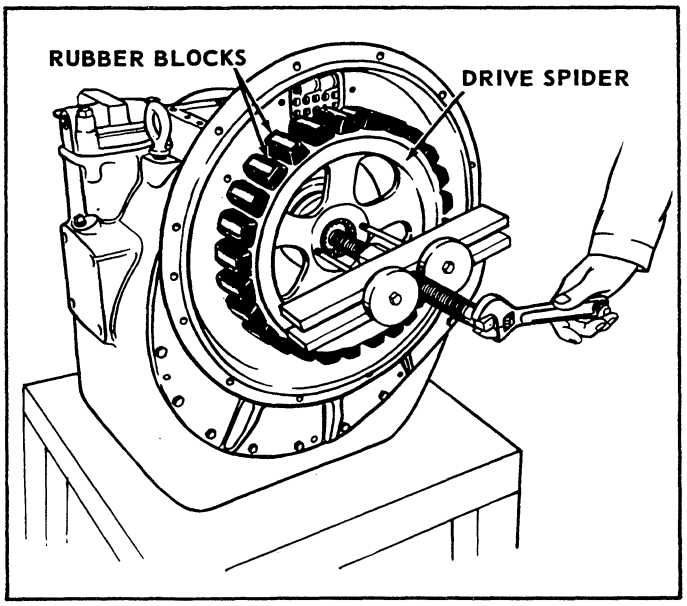


Figure 32. Removing the Drive Spider from the Forward Clutch Shaft.

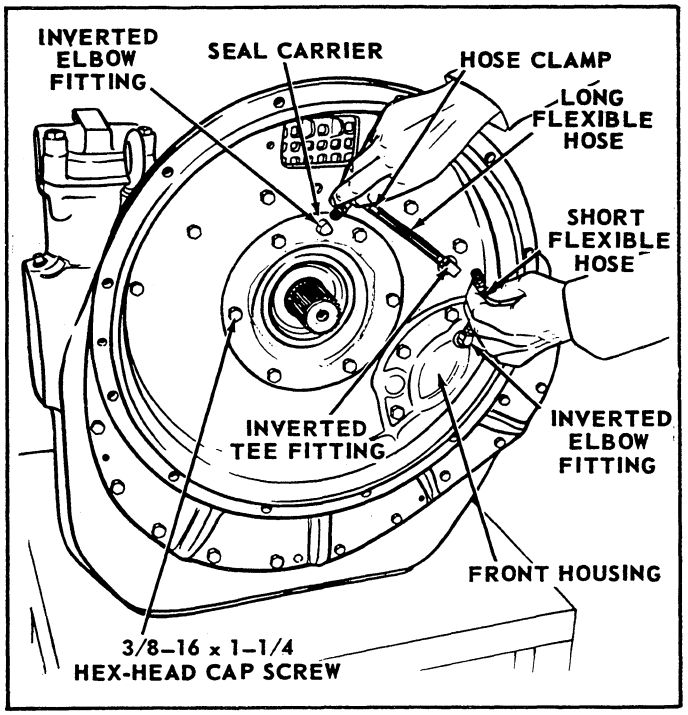


Figure 33. Disconnecting the Lubrication Flexible Hoses.

E. Remove the six hex-head capscrews (Fig. 80, 6) that secure the front housing to the bearing carrier (4). Remove the 19 hex-head capscrews (Fig. 79, 13) that secure the front housing to the main housing (21). Install three pusher screws in the 3/8-16 UNC tapped holes in the front housing. Remove the front housing and the front-housing-to main housing gasket (20) from the main housing. Discard the gasket. Remove the two dowel pins (18) from the front or main housing only if replacement of parts is necessary.

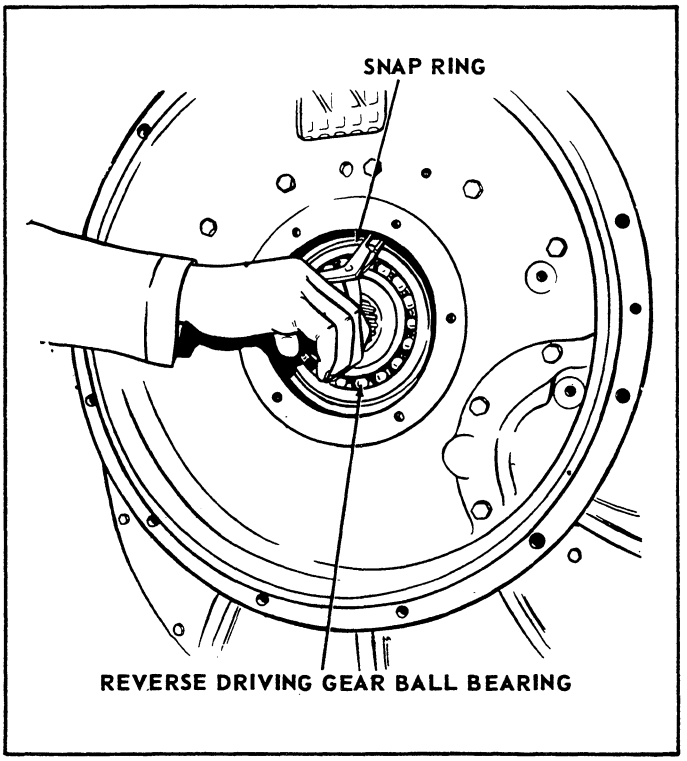


Figure 34. Removing the Snap Ring from the Reverse Driving Gear Ball Bearing.

38. MANIFOLD GROUP OF PARTS.

A. Remove the four hex-head capscrews (Fig. 80, 45) that secure the oil pump assembly (46) to the manifold (Fig. 79, 53). Remove the oil pump assembly, with attached parts, and the oil-pump-to-manifold gasket (Fig. 80, 55) from the manifold. Discard the gasket. Remove the oil strainer housing (52) and the short pipe nipple (47) from the oil pump assembly. Remove the square-head pipe plug (54) and the oil strainer (53) from the oil strainer housing.

B. Remove the four hex-head capscrews (Fig. 79, 57) that secure the cover plate (56) to the manifold. Remove the cover plate and the cover plate gasket (55) from the manifold. Discard the gasket.

C. Remove the four hex-head capscrews (Fig. 80, 41dd & 41ee) that secure the selector valve assembly (41) to the manifold and main housing. Remove the selector valve assembly and the selector-valve-to-manifold gasket (41z) from the manifold. Discard the gasket. Disassemble the selector valve assembly by the following procedure:

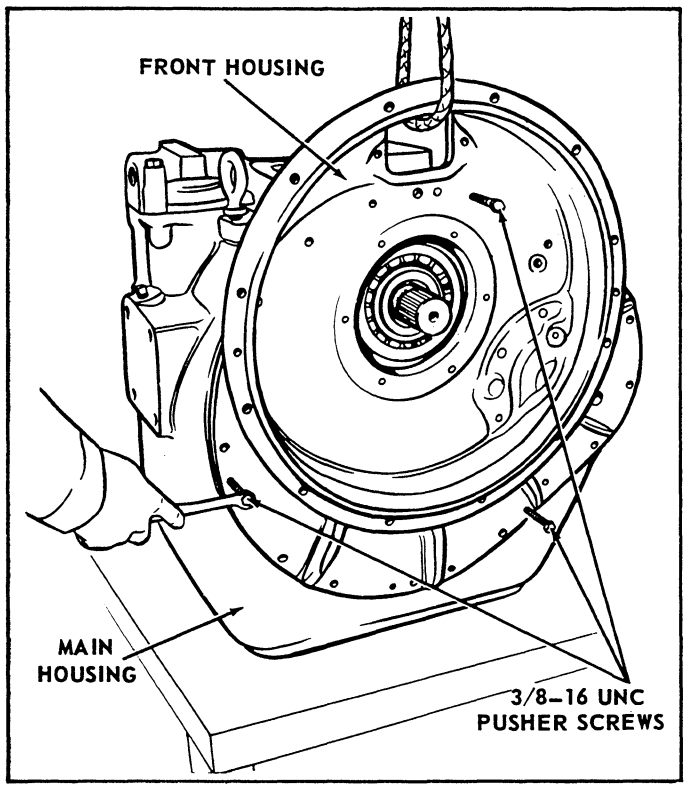


Figure 35. Removing the Front Housing from the Main Housing.

(1) Remove the capscrew (41a) that secures the selector valve lever (41b) to the selector valve stem (41k). Remove the collar pin (41c) and remove the selector valve lever stop collar (41d) from the selector valve stem. Remove the selector valve lever stop collar (41d) from the selector valve stem.

(2) Remove the two hex-socket-head pipe plugs (41v & 41w) the indexing detent spring (41x), and the indexing detent (41y) from the selector valve body (41cc).

(3) Remove the four hex-head capscrews (41g) that secure the selector valve stem cover (41e) to the selector valve body. Remove the selector valve stem cover and the selector valve stem cover gasket (41f) from the selector valve body. Discard the gasket.

(4) Remove the selector valve stem from the selector valve body. Remove the "O" ring seal (41h) and the selector valve stem ball bearing (41j) from the selector valve stem. Discard the "O" ring seal.

(5) Remove the four hex-head capscrews (41q) that secure the orifice plate cover (41r), the orifice plate cover gasket (41s), the orifice plate (41t), and the orifice plate gasket (41u) to the selector valve body. Remove the cover, plate, and gaskets from the selector valve body. Discard the gaskets.

NOTE

When removing the cover and plate, the steel ball (41aa) will pop out.

(6) Remove the compression spring (41bb), the pressure rate control piston (41p), the piston outer spring (41n(1)), the piston inner spring (41n (2)), and the pressure regulation piston (41m) from the selector valve body.

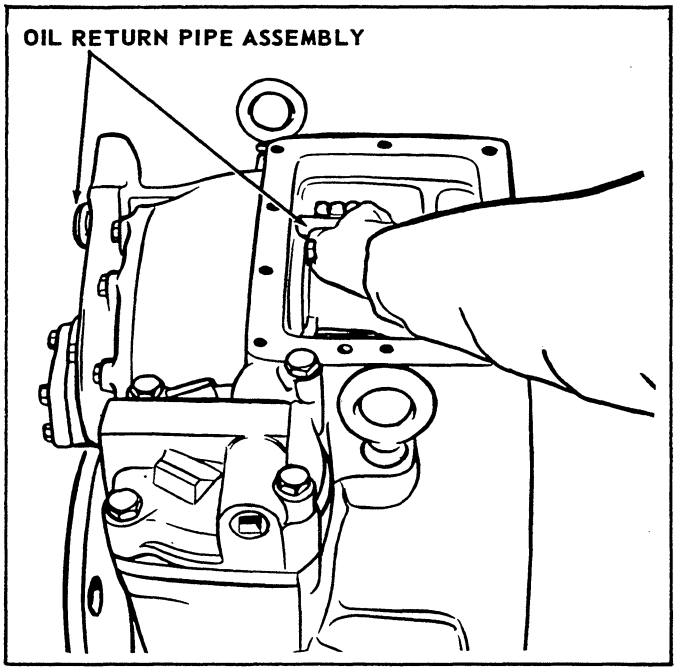


Figure 36. Removing the Oil Return Pipe Assembly.

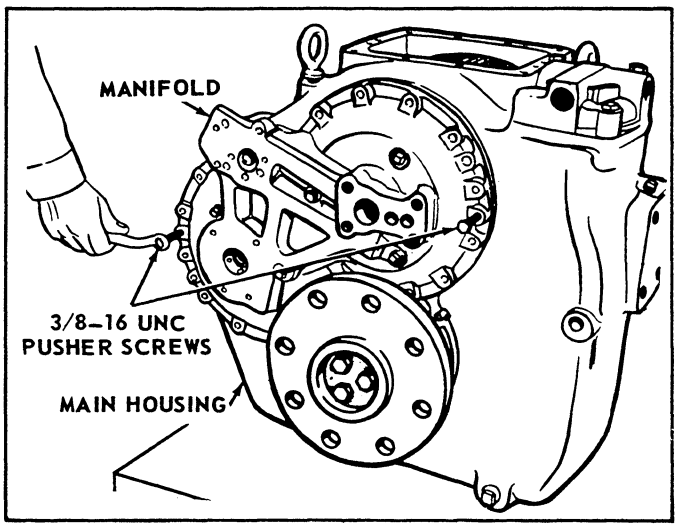


Figure 37. Removing the Manifold from the Main Housing.

CAUTION

Exercise care in the handling of the valve stem and the pistons since these parts are ground accurately to fit in the body.

D. Reach down through the top cover plate opening in the main housing, and firmly grasp the oil return pipe assembly (Fig. 80, 37). Carefully push the oil return pipe assembly rearward through the manifold, and remove the return pipe and the corprene ring gasket (36) from the manifold. Discard the gasket. It may be necessary to gently tap the return pipe at the front end of the gear. Remove the roll pin (35) that indexes the oil return pipe assembly in the manifold only if replacement of parts is necessary. On marine gears with a tube carrier assembly (37e) installed on the oil return pipe, it is necessary to remove the hex-head capscrew (37c) and lock plate (37d) that secure the tube carrier assembly to the oil return pipe prior to the removal of the return pipe. As the return pipe is removed from the manifold, it is necessary to hold the tube carrier assembly to prevent the carrier from damage as a result of falling into the gear. Disassemble the oil return pipe assembly by the following procedure:

(1) Remove the roll pin (37f) nearest the straight end of the oil return pipe (37h). Remove the oil return pipe piston spring (37a) and the oil return pipe piston (37b) from the oil return pipe.

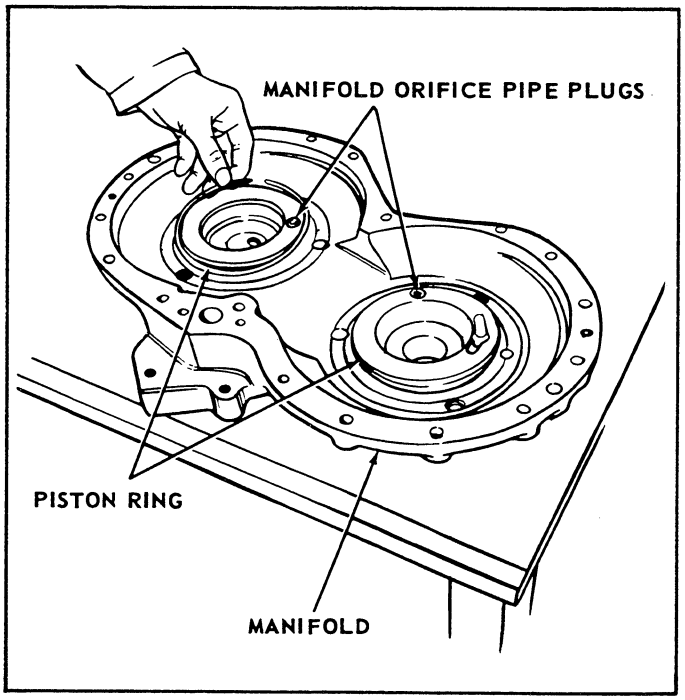


Figure 38. Removing a Piston Ring from the Manifold.

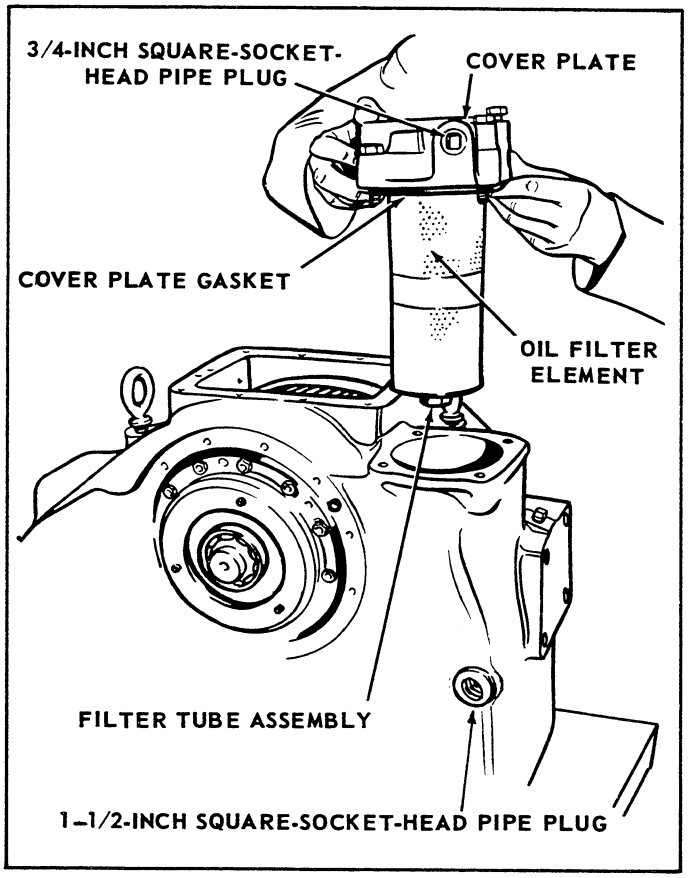


Figure 39. Removing the Oil Filter Element from the Main Housing.

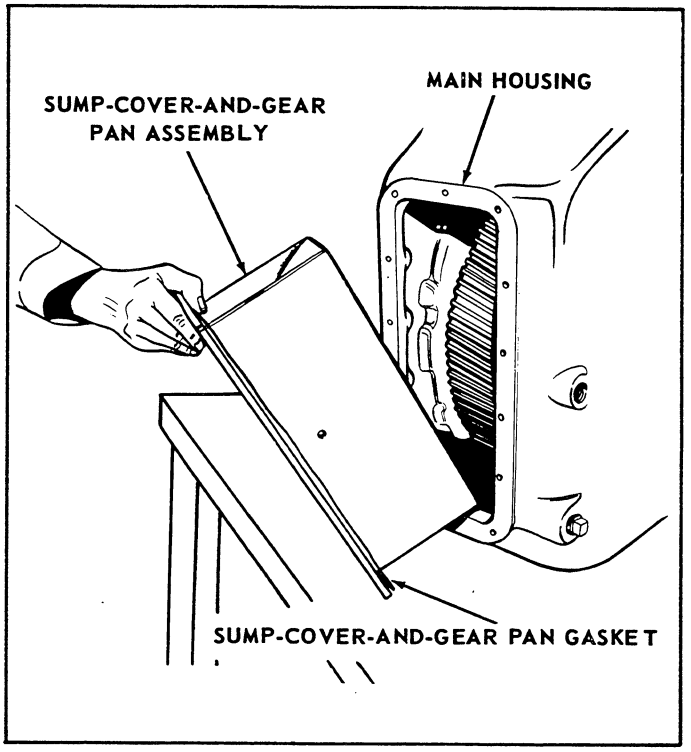


Figure 40. Removing the Sump-Cover-and-Gear Pan Assembly from the Main Housing.

(2) Remove the outer roll pin (37f) and the inner roll pin (37g) from the flanged end of the oil return pipe.

E. Remove the 16 hex-head capscrews (Fig. 79, 60) that secure the manifold to the main housing. Install two pusher screws in the 3/8-16 UNC tapped holes in the manifold. Remove the manifold and the manifold-to-main-housing gasket (51) from the main housing. Discard the gasket. Remove the two dowel pins (54) from the manifold or main housing only if replacement of parts is necessary. Remove the two manifold orifice pipe plugs (52) from the manifold. Remove the two piston rings (Fig. 79, 50 and Fig. 80, 56) from the manifold. Remove the six square-head pipe plugs (Fig. 79, 58) and the four hex-socket-head pipe plugs (59) from the manifold only if replacement of parts is necessary.

39. OIL FILTER GROUP OF PARTS.

A. Remove the four hex-head capscrews (Fig. 81, 21 & 25) that secure the filter cover plate (20) to the main housing. Remove the cover plate, with attached parts, from the main housing. Remove the cover plate gasket (19) from the cover plate. Discard the gasket.

B. Hold the cover plate, and remove the oil filter element assembly (Fig. 81, 18) by unscrewing the filter tube assembly (18d). Separate the filter tube assembly, the filter tube spring (18c), the filter tube spring seat (18b), and the oil filter element (18a) from the cover plate. Discard the oil filter element.

C. Remove the square-socket-head pipe plug (Fig. 81, 22) that secures the oil by-pass piston spring (23) and the oil by-pass piston (24) in the cover plate. Remove the spring and piston from the cover plate.

D. Remove the square head pipe plug (Fig. 81, 26) from the main housing only if replacement of parts is necessary.

40. SUMP-COVER-AND-GEAR PAN GROUP OF PARTS.

A. Remove the 14 special zinc-plated hex-head capscrews (Fig. 81, 48) that secure the sump-cover-and-gear-pan assembly (47) to the main housing.

B. Remove the sump-cover-and-gear-pan assembly and the sump-cover-and-gear-pan gasket (Fig. 81, 46) from the main housing. Discard the gasket.

41. OUTPUT SHAFT GROUP OF PARTS.

A. Prior to removing the output shaft group of parts, the reverse driving and driven gears can be removed by the following procedure:

(1) Install a gear puller in the two 1/2-13 UNC tapped holes in the reverse driving gear (Fig. 79, 19). Remove the gear, with ball bearing from the forward clutch shaft (37). Remove the straight key (36) from the forward clutch shaft. Use pusher screws in the two 3/8-16 UNC tapped holes in the hub of the gear, and remove the reverse driving gear ball bearing (11) from the gear.

(2) Remove the bearing snap ring (fig. 80, 3) from the bearing (3) and remove the carrier (4) from the bearing. Remove the hex-head capscrew (1) and the retainer washer (2) that secure the inner race of the reverse driven gear ball bearing (3) on the reverse driven gear (5). Rig a suitable gear puller, or a portable hydraulic power puller, so that pulling force is applied to the reverse driven gear through the two 1/2-13 UNC tapped holes in the gear, and pushing force is applied to the front end of the clutch shaft (22). Remove the gear (5) and the bearing (3) as an assembly from the clutch shaft (22). Remove the bearing from the gear hub with two 3/8-16 UNC pusher screws. Remove the straight key (21) from the reverse clutch shaft.

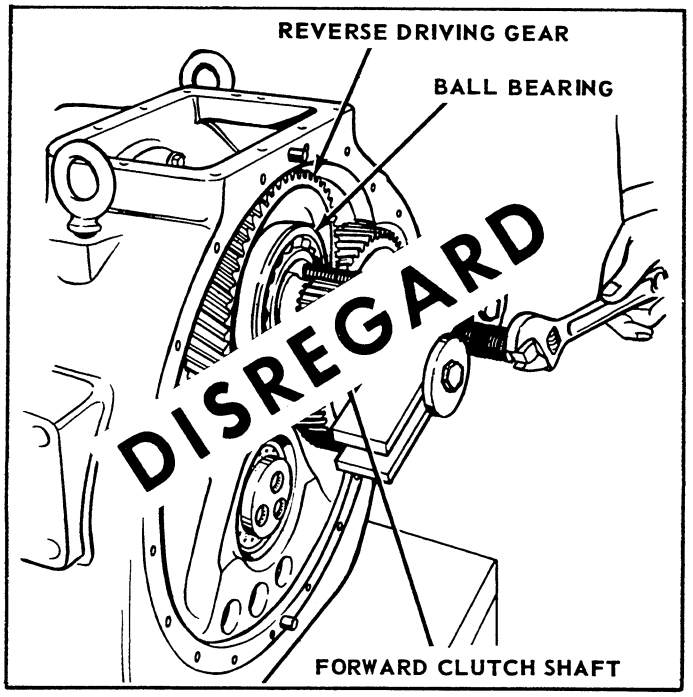


Figure 41. Removing the Reverse Driving Gear and Ball Bearing from the Forward Clutch Shaft.

B. Remove the three 12 point capscrews (Fig. 81, 1), and the retainer washer (2) that secure the inner race of the output shaft roller bearing (3) on the output shaft (28).

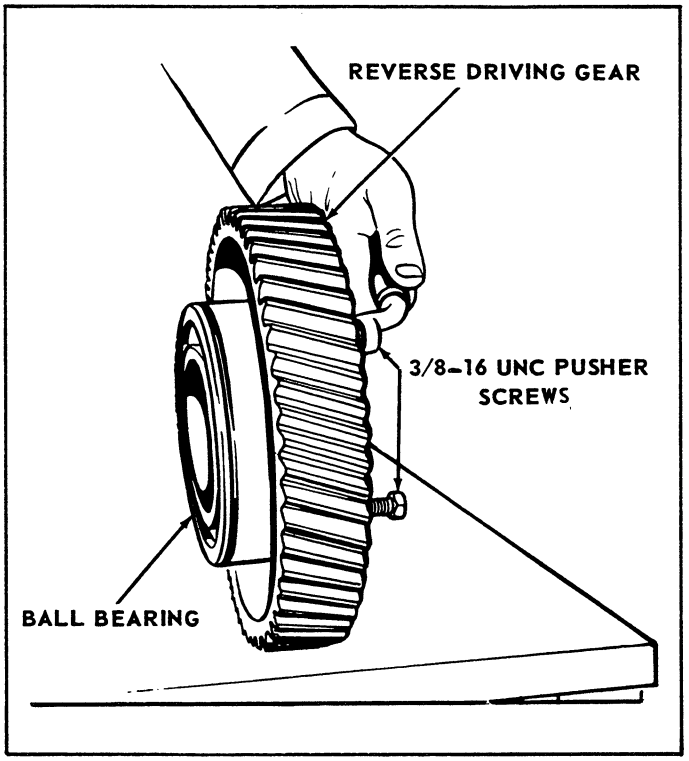


Figure 42. Removing the Ball Bearing from the Reverse Driving Gear.

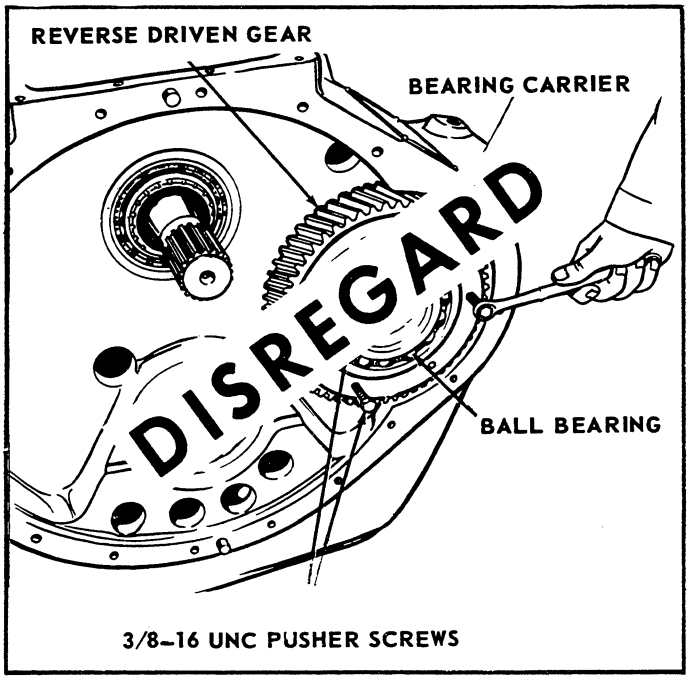


Figure 43. Removing the Bearing Carrier and Ball Bearing from the Reverse Driven Gear.

C. Remove the three hex-head capscrews (Fig. 81, 43), the retainer washer (42), and the output flange shim (41) that secure the output flange (39) on the output shaft. Remove the output flange and the ring gasket (40) from the output shaft. Discard the gasket. Pull the output flange from the shaft with a puller.

D. Remove the seven hex-head capscrews (Fig. 81, 44) that secure the bearing retainer (36) to the main housing. Remove the bearing retainer and the bearing retainer shims (35) from the main housing. Remove the bearing retainer "O" ring gasket (34) from the bearing retainer. Discard the gasket. Remove the two output flange oil seals (38) from the bearing retainer. Discard the oil seals. Remove the 45 degree grease fitting (37) from the bearing retainer, only if replacement of parts is necessary.

E. Place the main housing on its side, filter cavity down. Rotate the output shaft gear (Fig. 81, 45) until the puller holes in the gear are aligned with the holes in the web of the main housing. Place wooden blocks between the gear and the main housing to prevent damage to the gear when the output shaft is removed. Use a puller with 3/4-10 NC threads, and force the output shaft, with attached parts, from the gear and main housing. Remove the straight key (27) from the shaft or gear. Remove bearing cup (29) from bearing cone on the shaft. Remove the gear from the housing. Use a drift pin, and remove the cup from the main housing. Press the cones of the tapered roller bearing (29) from the shaft only if replacement of parts is necessary.

F. Remove the inner race of the output shaft roller bearing (Fig. 81, 3) from the output shaft. Remove the hex-socket-head pipe plug (33), the retainer pin spring (32), and the retainer pin (31) that secure the outer race of the roller bearing in the main housing. Use special tool T-9803, and remove the outer race of the roller bearing from the main housing.

42. FORWARD CLUTCH GROUP OF PARTS.

A. Reach down through the top cover plate opening in the main housing, and bend back the locking edge of the three lock plates (Fig. 79, 30). Remove the six hex-head capscrews (29) and the three lock plates that secure the retainer (32) to the main housing. Place the main housing beneath a hoist, clutch end up. Install male eyebolts in the three 3/8-16 UNC tapped holes in the clutch spider (33). Hold the main housing down, and lift the forward clutch group of parts from the housing using the

hoist. Place the group of parts on a bench and remove the three eyebolts. Remove the hex socket-head pipe plug (23), the retainer pin spring (24), and the retainer pin (25) that secure the outer race of the forward pinion roller bearing (26) in the main housing. Use special tool T-9802, and remove the outer race of the bearing from the housing.

B. Remove the piston ring (Fig. 79, 49) from the end of the forward clutch shaft. Bend back the locking edges of the six lock plates (46). Remove the twelve hex nuts (47) and the six lock plates that secure the clutch cylinder (45) to the clutch spider. Discard the lock plates. Install pusher screws in the three 3/8-16 UNC tapped holes in the clutch cylinder. Alternately turn the pusher screws, and remove the clutch cylinder assembly and clutch piston (42) from the clutch spider, and the forward clutch shaft ball bearing (48) from the forward clutch shaft. Separate the clutch cylinder assembly and the clutch piston, and remove the piston ring (43) from the piston and the piston ring (44) from the cylinder. Remove the three roll pins (45b) and the three special hex-socket-head setscrews (45c) from the cylinder only if replacement of parts is necessary. Remove the six roll pins (33c) from the cylinder or clutch spider only if replacement of parts is necessary.

C. Remove the two piston rings (Fig. 79, 40) from the forward clutch shaft. Remove the twelve release springs (35) and the twelve split sleeves (34) from the clutch spider studs (33b). Remove the forward clutch shaft from the clutch spider. Remove the eight sintered-metal clutch plates (39) and the seven steel clutch plates (38) from the clutch spider.

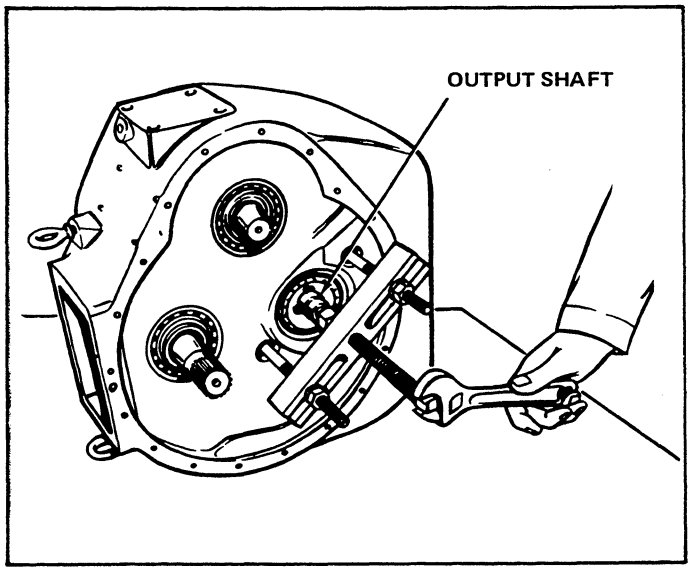


Figure 44. Removing the Output Shaft from the Output Shaft Gear.

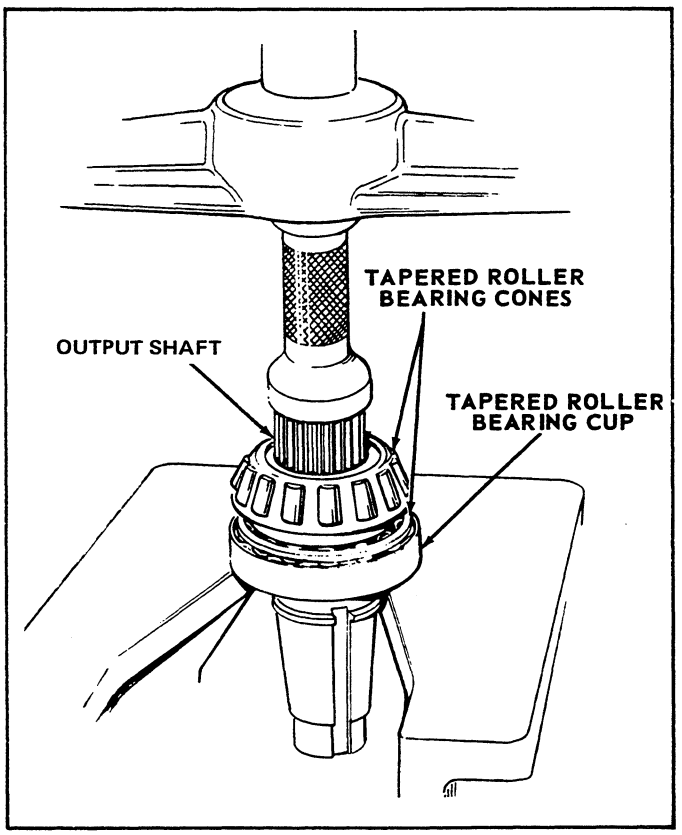


Figure 45. Removing the Tapered Roller Bearing Cones from the Output Shaft.

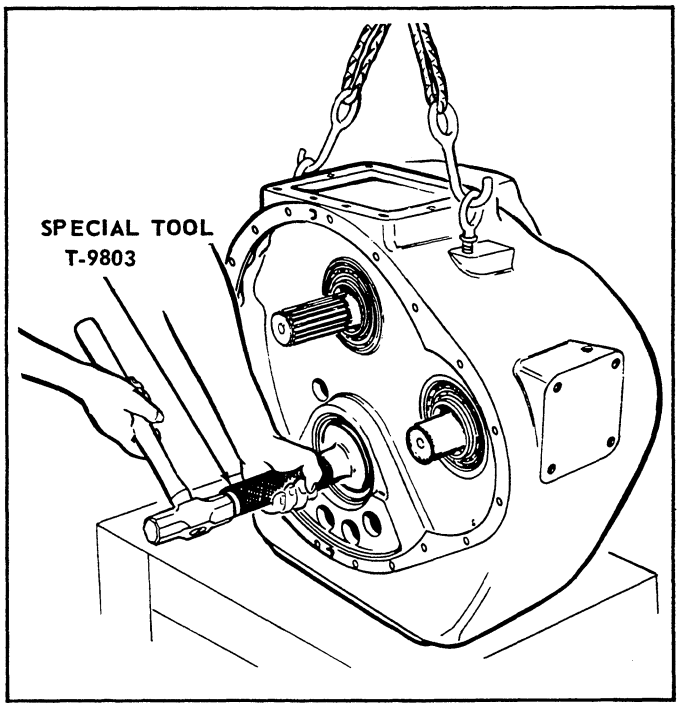


Figure 46. Removing the Outer Race of the Output Shaft Roller Bearing from the Main Housing with Special Tool T-9803.

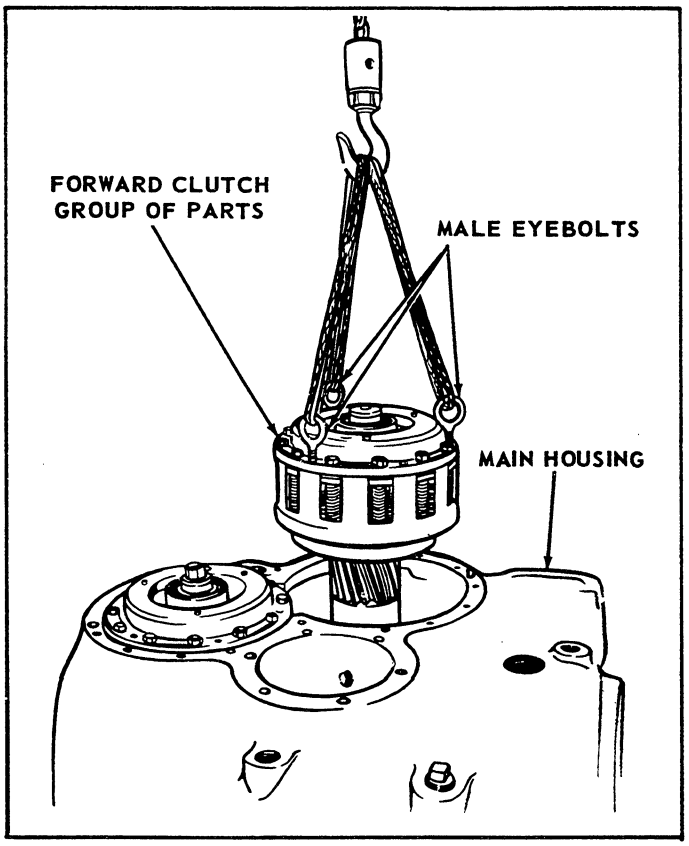


Figure 47. Removing the Forward Clutch Group of Parts from the Main Housing.

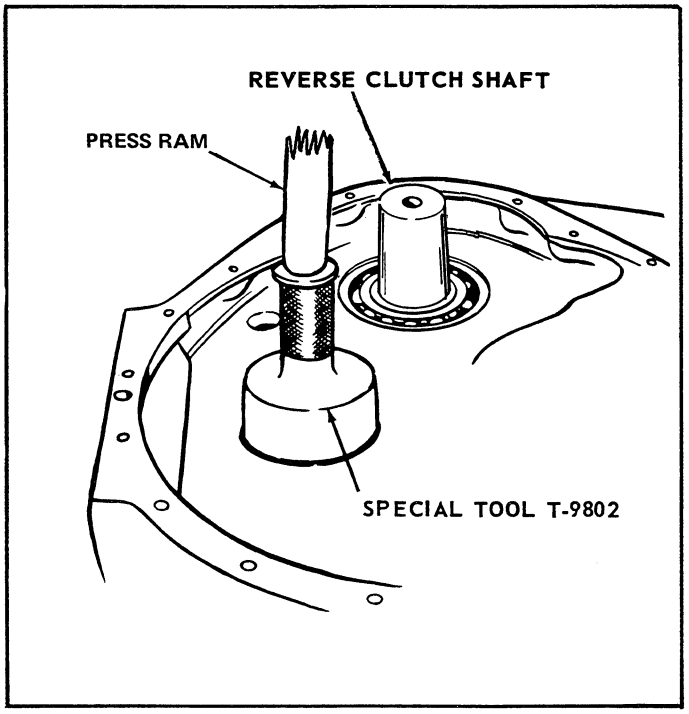


Figure 48. Removing the Outer Race of the Forward Pinion Roller Bearing with Special Tool T-9802.

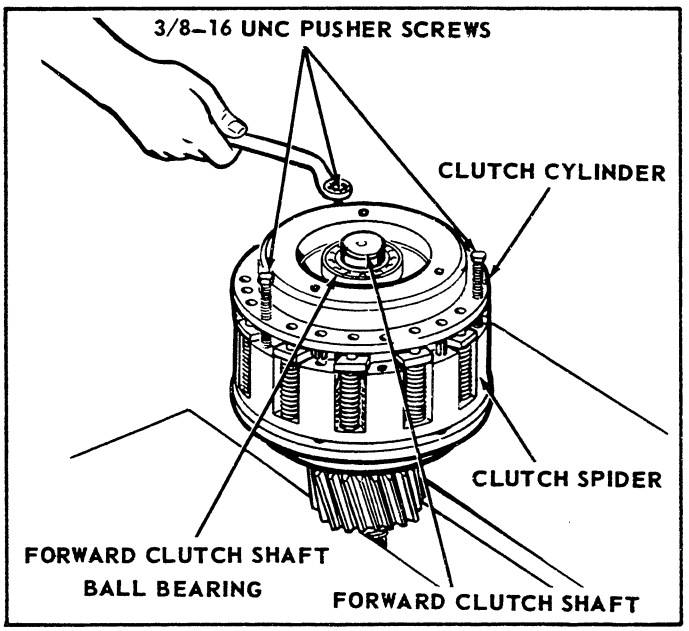


Figure 49. Removing the Clutch Cylinder from the Clutch Spider.

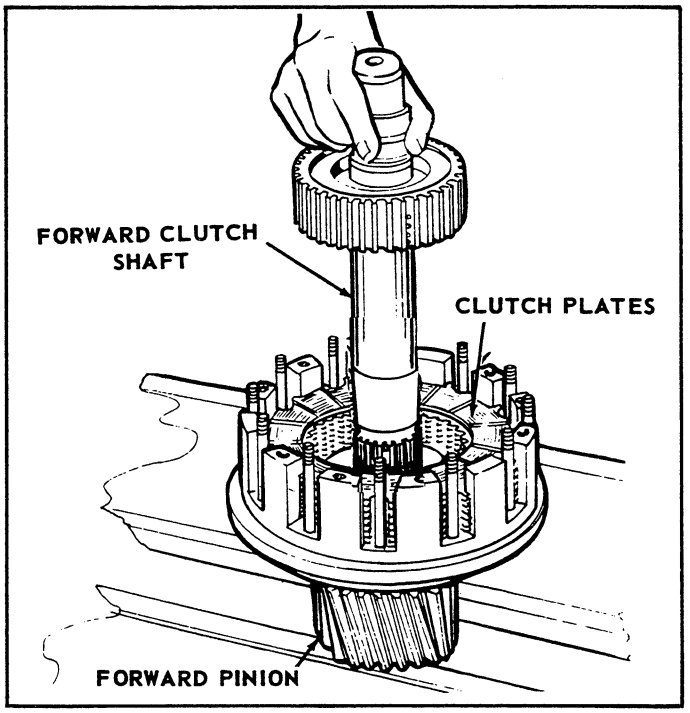


Figure 50. Removing the Forward Clutch Shaft.

D. Remove the external snap ring (Fig. 79, 41) that secures the forward pinion (27) on the clutch spider. Use an arbor press, and press the forward pinion from the clutch spider. Remove the forward pinion spacer (28). Remove the external snap ring (22) from the forward pinion. Remove the inner race of the forward pinion roller bearing (26) from the forward pinion only if replacement of parts is necessary.

E. Remove the clutch spider ball bearing (Fig. 79, 31) from the clutch spider. Place blocks on an arbor press beneath the bearing retainer (32), and press the clutch spider from the ball bearing and bearing retainer. Remove the twelve studs (33b) from the clutch spider only if replacement of parts is necessary.

43. REVERSE CLUTCH GROUP OF PARTS.

A. Reach through the bottom opening in the main housing and bend back the locking edge of the three lock plates (Fig. 80, 15). Remove the six hex-head capscrews (14) and the three lock plates that secure the tapped hole bearing retainer (17) to the main housing. Place the main housing beneath a hoist, clutch end up. Install male eyebolts in the three 3/8-16 UNC tapped holes in the clutch spider (18). Hold the main housing down, and lift the reverse clutch group of parts from the housing using the hoist. Place the group of parts on a bench, and remove the three eyebolts. Remove hex-socket-headless flat-point setscrew (7), the retainer pin spring (8), and the retainer pin (9) that secure the outer race of the reverse pinion roller bearing (11) in the main housing. Use special tool T-9802, and remove the outer race of the bearing from the housing.

B. Disassemble the remaining parts by following the procedure described in Paragraphs 42B through 42E. After removal of the reverse clutch shaft, remove the dowel pin (Fig. 80, 28) that secures the oil pump drive sleeve (23) in the reverse clutch shaft. Remove the drive sleeve from the shaft.

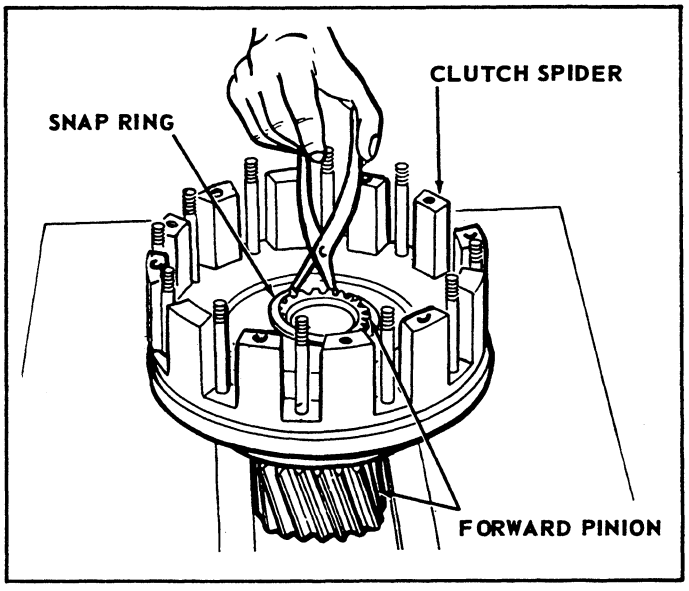


Figure 51. Removing the Snap Ring from the Forward Pinion.

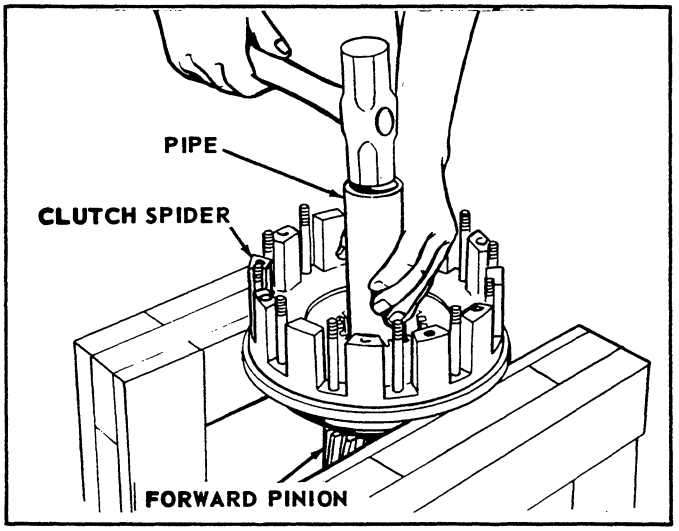


Figure 52. Removing the Forward Pinion from the Clutch Spider.

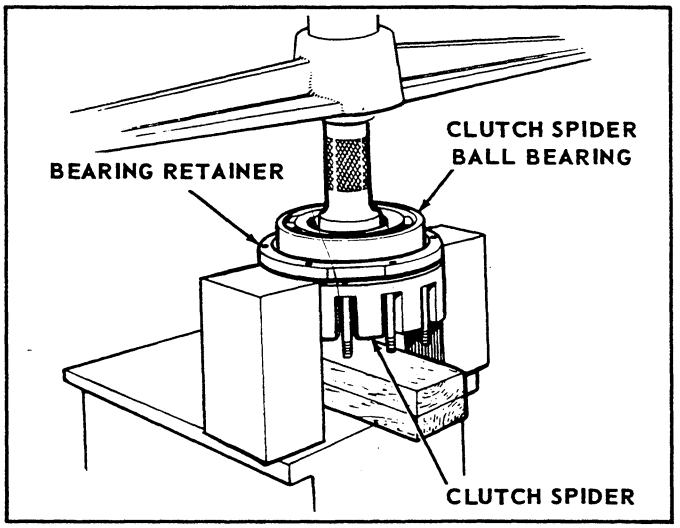
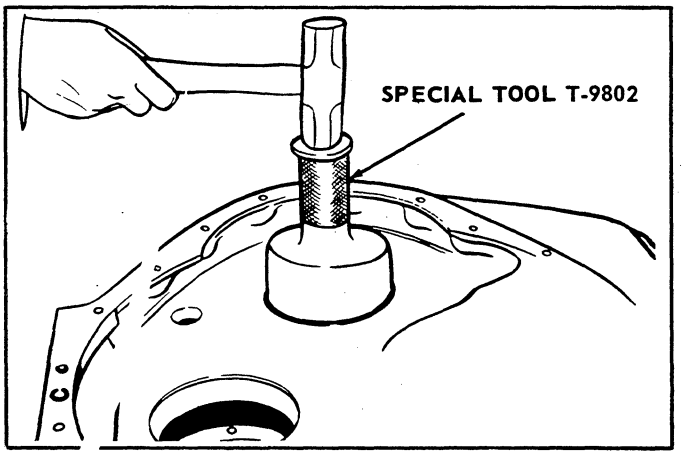


Figure 53. Removing the Clutch Spider Ball Bearing from the Clutch Spider.



Figur 54. Removing the Outer Race of the Reverse Pinion Roller Bearing with Special Tool T-9802.

Section X. CLEANING AND INSPECTION

44. GENERAL.

A. Oil Seals. Replace all oil seals.

B. Gaskets. Replace all gaskets.

C. Lock Plates. Replace all lock plates.

D. Piston Rings. Replace all piston rings.

E. Oil Filter Element. Replace the oil filter element.

F. Snap Rings. Replace all snap rings.

45. CLEANING.

A. Ball and Roller Bearings. Use standard maintenance procedures to clean all ball and 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.

46. INSPECTION.

A. Ball and Roller Bearings. Use standard maintenance procedures to inspect all ball and roller bearings.

B. Castings. Inspect all castings for cracks. Replace a cracked casting. 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 all castings that 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 file or a fine three-cornered file. Replace a threaded part that cannot be repaired.

E. Pressure Gauge Assembly. Inspect the pressure gauge assembly for damage. Replace a damaged pressure gauge assembly.

F. Driving Ring. Inspect the driving ring for damage or wear. Replace the ring if necessary.

G. Drive Spider. Inspect the drive spider for broken, cracked, or otherwise damaged lugs. Inspect the drive spider for a loose fit on the forward clutch shaft. Replace a drive spider that is damaged, or that fits loosely on the forward clutch shaft.

H. Flexible Hose. Inspect all flexible hose for cracks, sponginess, or other damage. Replace a damaged hose.

I. 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.

J. Orifices. It is very important that all orifices be clean and clear. Inspect the orifice in the orifice plate of the selector valve assembly. Inspect the orifice in the oil return pipe piston. Inspect the orifices in the two manifold orifice pipe plugs. Use a small wire to make certain the orifices are clean and clear.

K. Zinc Electrode Rods. Heat exchangers furnished by Twin Disc, to be used for salt water applications, have a zinc rod installed at one end of the heat exchanger. This rod must be checked every 90 days. If over 50% of the rod is disintegrated, 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 rounded 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.

Section XI. ASSEMBLY

47. REVERSE CLUTCH GROUP OF PARTS.

A. Install twelve 3/8 x 3-3/4 clutch spider special studs (Fig. 80, 18b) in the clutch spider (18a).

CAUTION
SINTERED-METAL CLUTCH PLATES

The possibility of clutch pack failure exists on the 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 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.

Apply LOCTITE No. 271 plastic gasket to the threads of the special studs and screw them to bottom in their threaded holes of the clutch spider. After installing studs, check length exposed. Should be 3.310 ± 0.030 inches. Stud thread stand-out from clutch spider should be 0.04 inch. Position the clutch spider ball bearing (16) and the tapped hole bearing retainer (17) on an arbor press, and press the clutch spider into the ball bearing.

B. Press the reverse pinion (Fig. 80, 12) into the inner race of the reverse pinion roller bearing (11). Secure the inner race of the bearing on the pinion with the external snap ring (10). Place the pinion in position on an arbor press, splined end up. Place the reverse pinion spacer (13) in position on the pinion, and press the clutch spider onto the pinion. Oil lubricate the splines of the reverse pinion and clutch spider lightly, and press the spider onto the pinion. This can be done cold. However, sheering of spline material is likely, so it is suggested that the spider be heated in an oven to 250 degrees F. maximum temperature for ease of installation. Secure the pinion to the spider with the external snap ring (27).

C. Install the reverse clutch shaft assembly (Fig. 80, 22) in the clutch spider. Install eight sintered-metal clutch plates (25) and seven steel clutch plates (24) in the clutch spider. Alternate the clutch plate stack; begin and end with a sintered metal clutch plate. Install the twelve split sleeves (19) on the studs in the clutch spider. Install the twelve release springs (20) on the sleeves. Use special tool T-6991, and install six roll pins (18c) in the spider. Install two new 1-3/4 inch piston rings (26) on the reverse clutch shaft.

D. Install three special 3/8 inch hex-socket-head setscrews (fig. 80, 32b) and three roll pins (32c) in the clutch cylinder (32a) and secure the setscrews in place by tension against the roll pins. Install a new 3 inch piston ring (31) in the clutch cylinder, and a new 7 inch piston ring (30) in the clutch piston (29). Carefully, install the clutch piston in the clutch cylinder. Place the cylinder and piston in position against the clutch spider. Use three fully threaded 3/8-16 x 1 machine screws to hold the cylinder to the spider against the tension of the springs. Secure the cylinder to the spider with six new lock plates (33) and twelve 3/8-24 hex nuts (34). Tighten the hex nuts to 38 lbs. ft. torque, and lock in place by bending the ends of each lock plate against the flats of the nuts. The center of each lock plate must cover a roll pin. Remove the three hold-down machine screws.

E. Use special Tool T-9802 and install the outer race of the reverse pinion roller bearing (Fig. 80, 11) in the main housing. When installing the outer race into the housing, carefully align the pin hole in the outer race with the pin hole in the housing. Secure the outer race in position in the housing with the retainer pin (9), the retainer pin spring (8), and the 3/4 inch hex-socket headless flat-point setscrew (7).

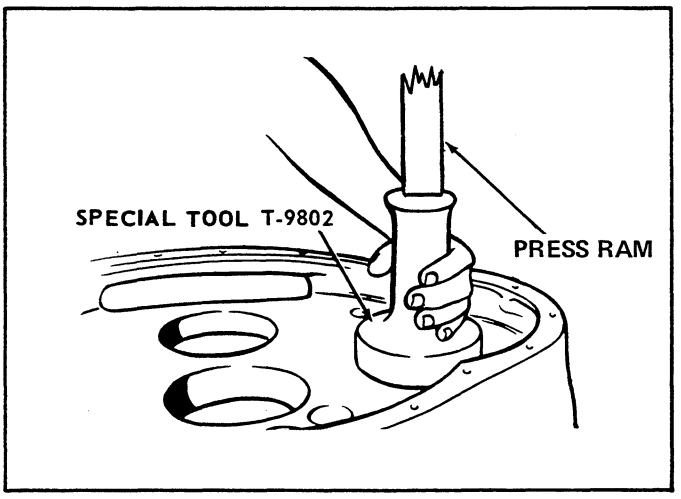


Figure 55. Installing the Outer Race of the Reverse Pinion Roller Bearing in the Main Housing with Special Tool T-9802.

F. Install male eyebolts in the three 3/8-16 UNC tapped holes in the clutch spider. Hold the drilled and tapped hole bearing retainer (Fig. 80, 17) in position in the main housing. Use a hoist, and install the reverse clutch group of parts in the main housing. Seat the clutch group of parts in the main

housing, with an arbor press and a piece of steel tubing the necessary size. Partially bend the locking tab of each new lock plate (15) to facilitate locking after installation. Position the bearing retainer (17) with a flat side facing the forward clutch location. Secure the bearing retainer to the housing with six 3/8-16 x 1-1/2 hex-head capscrews (14) and three new lock plates. Tighten the capscrews to 38 lbs. ft. torque, and lock in place by bending the tabs of the lock plates against the flats of the capscrews.

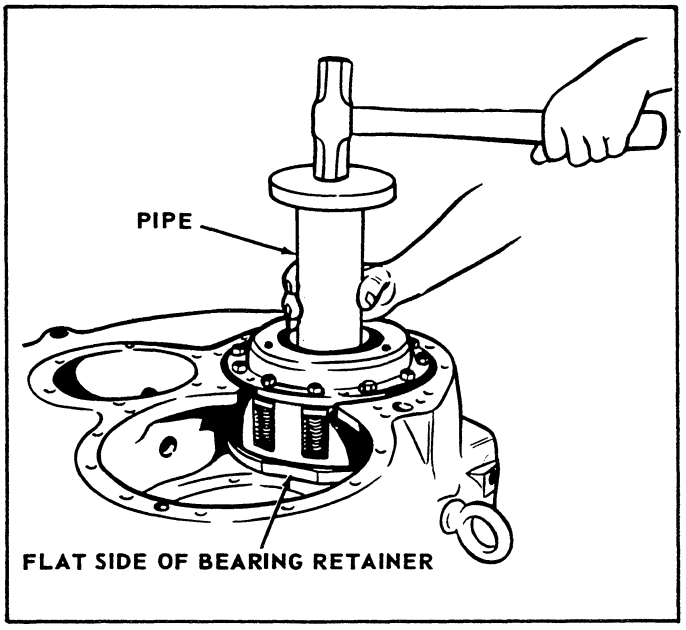


Figure 56. Seating the Reverse Clutch Group of Parts in the Main Housing.

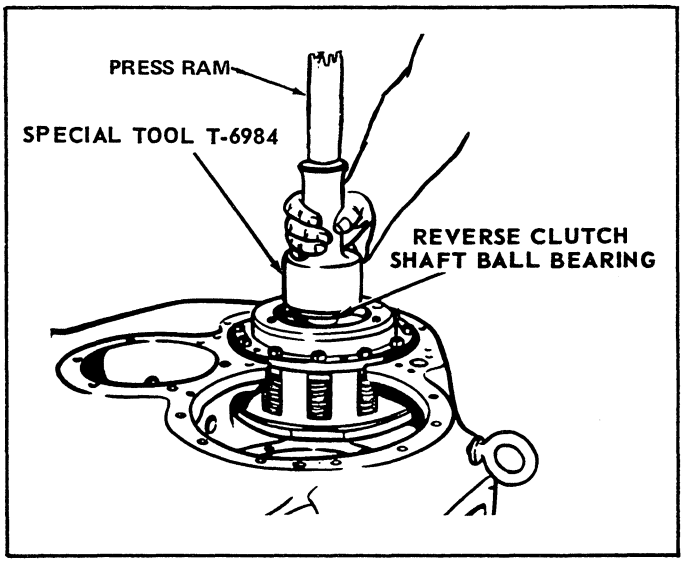


Figure 57. Installing the Reverse Clutch Shaft Ball Bearing on the Reverse Clutch Shaft with Special Tool T-6984.

G. Place the oil pump drive sleeve (Fig. 80, 23) in position in the reverse clutch shaft, and secure the sleeve in the shaft with the 1/4 x 1-1/2 dowel pin (28). Place the reverse clutch shaft ball bearing (58) in position on the reverse clutch shaft. Use special tool T-6984, and install the bearing on the shaft. Install a new 1.57 inch piston ring (57) on the end of the clutch shaft.

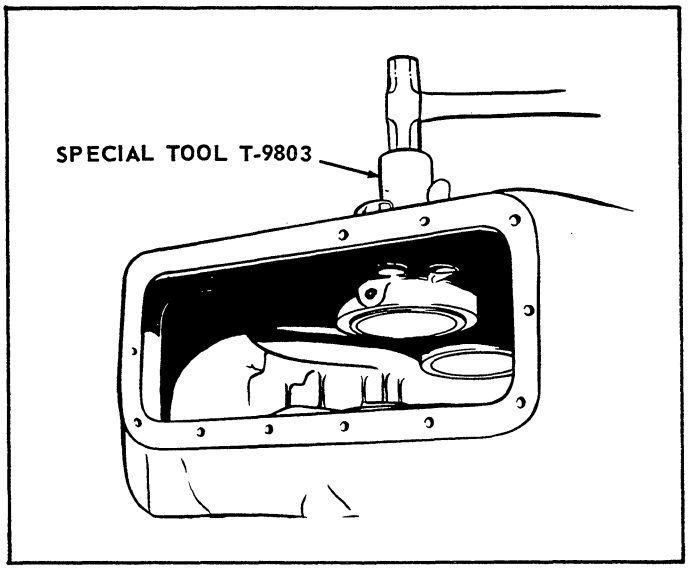


Figure 58. Installing the Outer Race of the Output Shaft Roller Bearing in the Main Housing with Special Tool T-9803.

48. FORWARD CLUTCH GROUP OF PARTS.

A. Assemble the forward clutch group of parts by following the procedure described in Paragraphs 47A through 47D.

B. Use special tool T-9802, and install the outer race of the forward pinion roller bearing (Fig. 79, 26) in the main housing. When installing the outer race into the housing, carefully align the pin hole in the outer race with the pin hole in the housing. Secure the outer race in position in the housing with the retainer pin (25), the retainer pin spring (24), and the 1/4 inch hex-socket head pipe plug (23).

C. Install male eyebolts in the three 3/8-16 UNC tapped holes in the clutch spider. Use a hoist, and install the forward clutch group of parts in the main housing. Seat the clutch group of parts in the main housing with an arbor press and the right size piece of steel tubing. Partially bend the locking tab of each new lock plate (30) to facilitate locking after installation. Place the threaded hole bearing retainer

(32) in the main housing in position with its flat side facing the reverse clutch location. Secure the bearing retainer and bearing to the housing with six 3/8-16 x 1-1/2 UNC hex-head capscrews (29) and three lock plates (30) (new). Tighten the capscrews to 38 lbs. ft. torque and lock in place by bending the tabs of the lock plates against the capscrews.

D. Place the forward clutch shaft ball bearing (Fig. 79, 48) in position on the forward clutch shaft. Use special tool T-6984, and install the bearing on the shaft. Install a new 1.57 inch piston ring (49) on the end of the clutch shaft.

49. OUTPUT SHAFT GROUP OF PARTS.

A. Use special tool T-9803, and install the outer race of the output shaft roller bearing (Fig. 81, 3) in the main housing. When installing the outer race into the housing, carefully align the pin hole in the outer race with the pin hole in the housing. Secure the outer race in position in the housing with the retainer pin (31), the retainer pin spring (32), and the 1/4 inch hex-socket head pipe plug (33).

B. Use special tool T-10468-1, and install the inner cup of the tapered roller bearing (Fig. 81, 29) in the main housing.

C. Wash tapers with a petroleum base solvent, and wipe off excess solvent. Use wooden blocks, and position the output shaft gear (Fig. 81, 45) in the main housing. Place the large end of the tapered hole in the gear to the rear of the main housing.

D. Heat the tapered roller bearing (Fig. 81, 29) in an oven to 275 degrees F. Use an arbor press, and press the output shaft into the cones of the tapered roller bearing. Install the 5/8 x 5/8 x 3-3/8 straight key (27) in the output shaft. Install the output shaft in the output shaft gear making certain to align the key in the shaft with the keyway in the gear. Use special tool T-10468-2, and install the outer cup of the tapered roller bearing in the main housing.

E. Install the 1/8 inch 45 degree grease fitting (Fig. 81, 37) in the bearing retainer (36). Install two new output flange oil seals (38) in the bearing retainer. The seals must be flush with each side of the bearing retainer with a gap between the seals. Also, the lip of the outer seal must point rearward, and the lip of the inner seal must point forward. Install a new bearing retainer "O" ring gasket (34) on the bearing retainer. Place the bearing retainer against the main housing, and secure the retainer to the housing with three 1/2-13 x 1-1/2 hex-head capscrews (44). The screws should be turned only tight enough to take out all end play in the bearings.

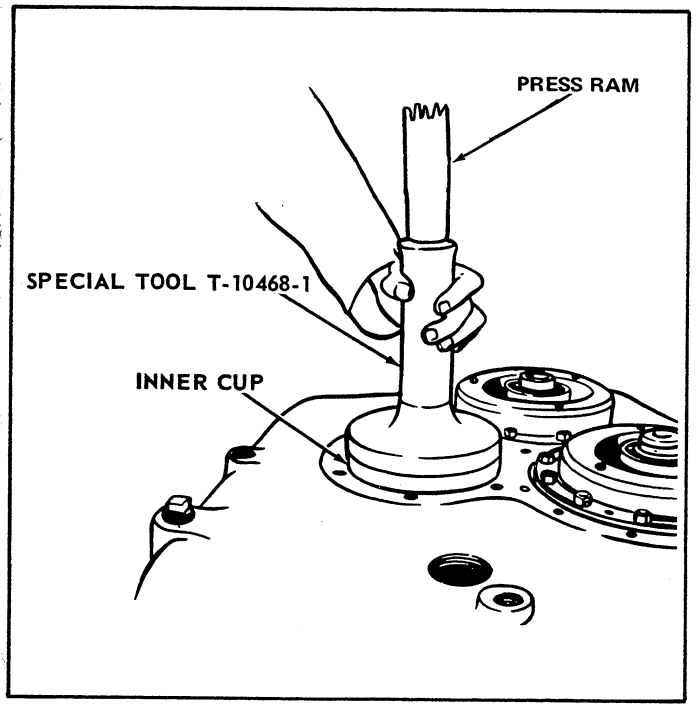


Figure 59. Installing the Inner Cup of the Tapered Roller Bearing in the Main Housing with Special Tool T-10468-1.

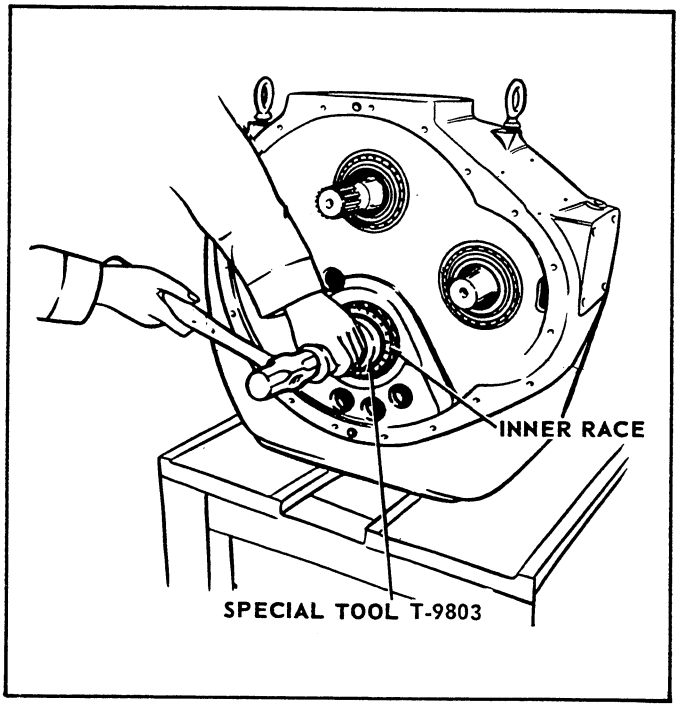


Figure 60. Installing the Inner Race of the Output Shaft Roller Bearing on the output shaft with Special Tool T-9803.

F. Heat the output shaft roller bearing (Fig. 81, 3) in an oven to 200 degrees F. and with special tool T-9803 install the inner race of the output shaft roller bearing (3) on the output shaft. When installing the inner race, lift the output shaft slightly to align the bearing. Secure the inner race of the bearing to the shaft with the retainer washer (2) and three externally wrenched 5/8-18 x 1-1/2 12 point capscrews (1). Tighten the capscrews equally to 175 lbs. ft. torque. Remove the wooden blocks from the output shaft gear and the main housing.

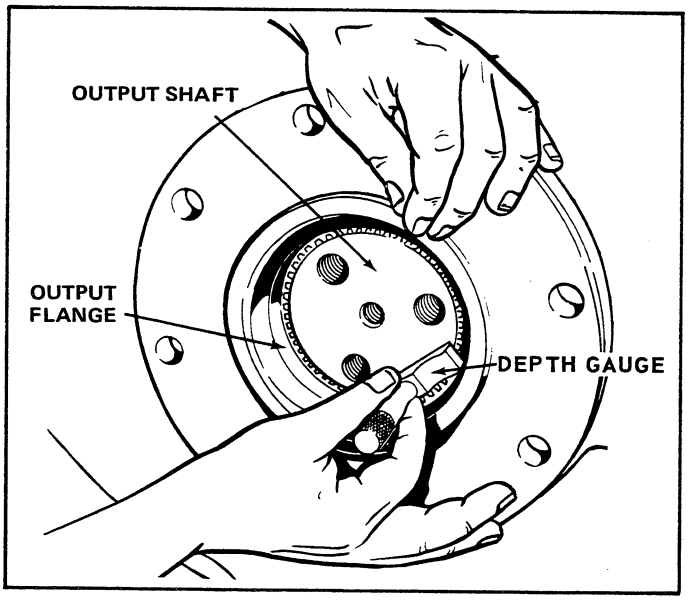


Figure 61. Measuring the Distance between the Output Flange and the Output Shaft.

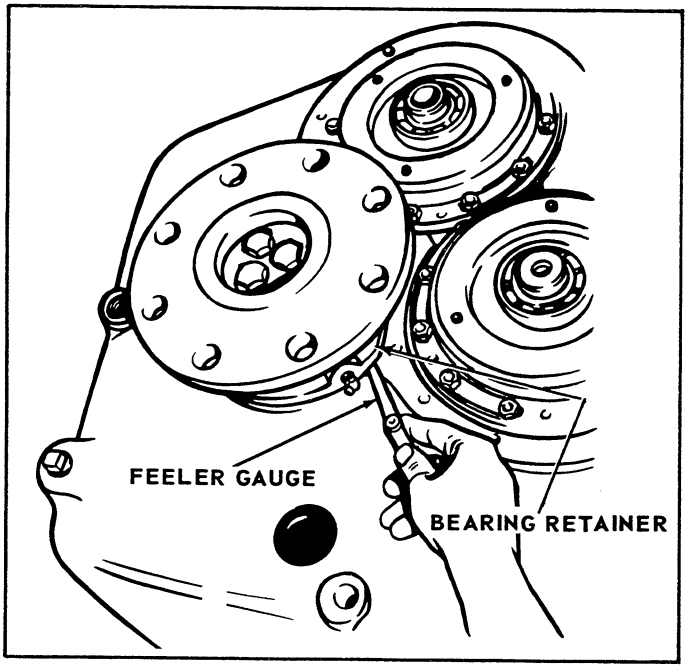


Figure 62. Checking the Tapered Roller Bearing Free Play with a Feeler Gauge.

G. Heat the output flange (Fig. 81, 39) to 150 degrees F. NO HOTTER. Carefully tap the output flange on the output shaft. Do not damage the oil seals in the bearing retainer. Use a block of hard wood, and seat the output flange. Use a depth gauge, and measure the distance from the end of the output shaft to the inner lip or shoulder of the output flange. Select the appropriate number of output flange shims (41) to equal 0.010 to 0.015 inches *less than* the measurement just taken. This adjustment controls the amount of flexing in the retainer washer. Install a new ring gasket seal (40) around the end of the output shaft. Place the above selected amount of shims in position against the output shaft and the retainer washer (42) in position against the output flange. Secure the flange to the shaft with three 5/8-18 x 1-1/2 hex-head capscrews (43). Tighten the capscrews to 175 lbs. ft. torque.

H. Select a trial shim pack by using a feeler gauge to measure the space between the retainer (Fig. 81, 36) and the main housing. Add 0.003-0.008 inches to this measurement to provide the proper bearing end play. Secure the retainer and shims to the housing with eight capscrews (44). Tighten capscrews to 85-95 lbs. ft. torque. Check the bearing free play with a dial indicator as follows: attach the dial indicator to the main housing so the stem or plunger contacts the end of the output shaft. Mark a spot adjacent to the indicator stem and with a hoist and eyebolt screwed in the end of the output shaft, apply a lifting force of approximately two hundred pounds. With this force applied, rotate the output shaft four complete revolutions. With the pulling force still applied, zero the dial indicator. Apply a pushing force of approximately two hundred pounds and rotate the shaft through four complete revolutions. With this pushing force still applied, read the indicator which will now indicate the actual output shaft end play (bearing free play). Add or subtract shims from between the retainer and housing to obtain the desired end play. The purpose of the above procedure is to align and free the bearing rollers so they seat properly and accurate free play can be determined. Tighten the retainer capscrews (44) to 85 lbs. ft. torque.

I. Place the reverse driving gear on the bench with its hub end up. Heat the ball bearing (Fig. 79, 11) in an oven to 275 degrees F. and place it in position on the driving gear without the snap ring (11) in place. The ball bearing must be placed on the gear with the groove for the snap ring installed to the front.

J. Wash the tapered areas of the reverse driving gear (Fig. 79, 19) and the forward clutch shaft (37)

with a petroleum base solvent and wipe off excess solvent. Place the reverse driving gear (19) in position on the forward clutch shaft, aligning key and keyway. Use a force of three hundred pounds maximum to seat the tapers. Then, advance the gear (19) 0.037-0.045 inches on the shaft using a dial indicator to measure advancement and a portable hydraulic press (Porto-Power or the like).

K. Install the reverse driven gear ball bearing (Fig. 80, 3) with snap ring, in the bearing carrier. Place the reverse driven gear (5) on an arbor press, hub end up. Press the reverse driven gear ball bearing, with carrier, onto the gear. Wash the tapered areas of the reverse driven gear and reverse clutch shaft (22) with a petroleum base solvent, and wipe off excess solvent. Install the straight key (21) and place the reverse driven gear on the shaft aligning the key and keyway. Seat the gear onto the shaft with a three hundred pound maximum force. Advance the gear 0.037-0.045 inch on the shaft, using a dial indicator and a portable hydraulic press (Porto-Power or the like). Secure the gear with the attached parts on the shaft with a retainer (2) and capscrew (1). Tighten the capscrew (1) (7/8-9 x 3) to 405-450 lbs. ft. torque dry. Oiled torque value is 325-360 lbs. ft.

50. FRONT HOUSING GROUP OF PARTS.

A. Install two 1/2 x 1 dowel pins (Fig. 79, 18) in the main housing. Use a hoist, and place the front housing (12) and a new front housing to main housing gasket (20) in position against the main housing. Rotate the bearing carrier (Fig. 80, 4) until alignment is attained. Secure the front housing to the main housing with nineteen 3/8-16 x 1-1/4 hex-head capscrews (Fig. 79, 13). Tighten the capscrews to 34-38 lbs. ft. torque. Secure the front housing to the bearing carrier with six 3/8-16 x 1-1/4 hex-head capscrews (Fig. 80, 6). Alternately tighten the capscrews to 34-38 lbs. ft. torque.

B. Install the snap ring in the groove of the reverse driving gear ball bearing (Fig. 80, 3).

C. Install a new drive spider oil seal (Fig. 79, 7) in the seal carrier (8). The lip of the seal must point towards the machined face of the carrier, and the front side of the seal must be flush with the carrier bore. Place the seal carrier, with seal, and a new seal carrier gasket (9) in position against the front housing, and secure the carrier to the housing with six 3/8-16 x 1-1/4 hex-head capscrews (10). The tapped hole in the carrier must be in the top center position. Tighten the capscrews to 34-38 lbs. ft. torque.

D. Install an inverted elbow fitting (Fig. 79, 65) in the seal carrier. Install an inverted elbow fitting (61) and an inverted tee fitting (63) in the front housing. Install the 4-1/4 inch flexible hose (62) in the tee fitting and the elbow fitting in the carrier. Slide the hose clamp (66) over the 9 inch flexible hose (64) and install the hose between the fittings in the front housing. Remove a capscrew from the front housing, and retain the clamp to the housing with the capscrew and washer (67).

E. Place the front housing cover plate (Fig. 79, 16) in position against the front housing, and secure the cover plate to the housing with two 3/8-16 x 7/8 hex-head capscrews (17). Tighten the capscrews to 34-38 lbs. ft. torque.

F. Place the rotation indicator plate (Fig. 79, 14) in position against the front housing, and secure the plate to the housing with two drive screws (15).

51. SUMP-COVER-AND GEAR PAN ASSEMBLY.

A. Place the sump cover and gear pan assembly (fig. 81, 47) and a new sump cover and gear pan gasket (46) in position against the main housing. The small hole in the pan must point towards the output flange.

B. Secure the pan assembly to the main housing with fourteen special zinc-plated 3/8-16 x 7/8 hex-head capscrews (Fig. 81, 48). Tighten the capscrews to 34-38 lbs. ft. torque.

52. OIL FILTER GROUP OF PARTS.

A. Install the 1-1/2 inch square-socket-head pipe plug (Fig. 81,26) in the main housing.

B. Place the oil by-pass piston (Fig. 81, 24) and the oil by-pass piston spring (23) in position in the cover plate (20), and secure the piston and spring in the plate with the 3/4 inch square-socket-head pipe plug (22). The center-drilled hole in the piston must face the pipe plug.

C. Place a new oil filter element (Fig. 81, 18a) in position against the cover plate, and secure the element to the plate with the filter tube spring seat (18b), the filter tube spring (18c), and the filter tube assembly (18d).

D. Place the cover plate (Fig. 81, 20), with attached parts, and a new cover plate gasket (19) in position against the main housing, and secure the plate to the housing with two 1/2-13 x 3 hex-head

capscrews (21) and two 1/2-13 x 2 hex-head capscrews (25). The tapped hole in the cover plate must face rearward. Tighten the capscrews to 77-85 lbs. ft. torque.

53. DRIVE SPIDER GROUP OF PARTS.

A. Install twenty-six rubber blocks (Fig. 79, 5) on the lugs of the drive spider (6). Place the drive spider in position on the forward clutch shaft (37). Install the spider onto the shaft making certain to align the splines of the spider and the shaft. Press the spider (6) onto the forward clutch shaft with a hollow ram Porto-Power or equivalent.

B. Install the lathe cut ring (Fig. 79, 4) in the hub of the spider on the end of the forward clutch shaft. Secure the spider to the shaft with a retainer washer (3) and a capscrew (2) (7/8-9 x 3). Tighten the capscrew to 405-550 lbs. ft. dry.

54. MANIFOLD GROUP OF PARTS.

A. Install the 1/4 inch hex-socket-head pipe plugs (fig. 79, 59) and the six 3/8 inch square-head pipe plugs (58) in the manifold (53). Use special tool T-6987, and install the roll pin (Fig. 80, 35) in the manifold. Install two new 5 inch piston rings (Fig. 79, 50 & Fig. 80, 56) in the manifold. Install the two manifold orifice pipe plugs (Fig. 79, 52) in the manifold. Install the two 1/2 x 1 dowel pins (54) in the main housing. Place the manifold and a new manifold-to-main-housing gasket (20) in position against the main housing. Carefully tap the manifold into position. Do not use excessive force to install the manifold as damage to the piston rings in the manifold or the piston rings on the shafts will occur. Secure the manifold to the main housing with sixteen 3/8-16 x 1-1/2 hex-head capscrews (60). Tighten the capscrews to 34-38 lbs.-ft. torque.

B. Install the outer roll pin (Fig. 80, 37f) in the hole of the oil return pipe (37h) nearest the flanged end of the pipe. Install the inner roll pin (37g) inside of the installed outer roll pin. (The inner roll pin is used on marine gears that do not contain a tube carrier assembly (37e). Install the oil return pipe piston (37b) and the oil return pipe piston spring (37a) in the return pipe and against the installed roll pins. Partially compress the spring by using a small drift through one of the lubrication holes in the pipe, and install the roll pin (37f) in the remaining roll pin hole in the return pipe. Place a new corprene ring gasket (36) in position over the roll pin (35) in the manifold. Install the oil return pipe assembly through the manifold and the main housing and into the counter bore in the front housing. The front housing end of the return pipe is now aligned with the tee fitting installed in the front side of the front housing. On marine gears with a tube carrier assembly, hold the tube carrier assembly in position and slide the oil return pipe assembly through the tube carrier during installation of the return pipe. Place the tube carrier assembly in position on the return pipe, and secure the tube carrier to the return pipe with the special hex-head capscrew (37c) and a new lock (37d). The capscrew must index in the return pipe. Bend the lock plate against the capscrew to secure the screw in place.

C. Assemble and install the selector valve assembly (Fig. 80, 41) by the following procedure:

(1) Use an arbor press, and press the selector valve stem (41k) into the selector valve stem ball bearing (41j). Install the selector valve stem, with ball bearing, into the selector valve body (41cc). Install a new "O" ring (41h) in the selector valve stem cover (41e). Place the selector valve stem cover and a new selector valve stem cover gasket (41f) in position against the selector valve body, and secure the cover to the body with four 5/16-18 x 1 hex-head capscrews (41g). Tighten the capscrews to 19-21 lbs. ft. torque.

(2) Install the pressure regulation piston (41m) (smaller of the two pistons), the piston outer spring (41m(1)), the piston inner spring (41m(2)), the pressure rate control piston (41p), and the compression spring (41bb) in the selector valve body. Place the steel ball (41aa) in position against the compression spring, and install a new orifice plate gasket (41u), the orifice plate (41t) a new orifice plate cover gasket (41s), and the orifice plate cover (41r) to the selector valve body with four 5/16-18 x 1 hex-head capscrews (41q). Tighten the capscrews to 19-21 lbs. ft. torque.

(3) Install the indexing detent (41y) and the indexing detent spring (41x) in the hole of the selector valve body nearest the protruding end of the selector valve stem. Make certain the detent indexes in one of the bores in the stem. Secure the detent and spring in the body with the 1/4 inch hex-socket-head pipe plug (41w). Install the 1/4 inch hex-socket-head pipe plug (41v) in the adjacent hole in the body.

(4) Install the stop collar (Fig. 80, 41d) onto the valve stem (41k) and secure the collar to the stem with roll pin (41c). Place the lever (41b) in position and secure it to the stem with the capscrew

(41a) (5/16-18 x 1). Tighten the capscrew to 19-21 lbs. ft. torque.

(5) Place the selector valve assembly and a new selector-valve-to-manifold gasket (41z) in position against the manifold. Secure the selector valve to the manifold with two 3/8-16 x 2-3/4 hex-head capscrews (41dd) and two 3/8-16 x 5-3/4 hex-head capscrews (41ee). Tighten the capscrews to 17-25 lbs. ft. torque, dry. On units manufactured with one-half inch capscrews used to retain the selector valve to the manifold, tighten the screws uniformly using a criss-cross sequence to 17-25 lbs. ft. torque. Check the freeness of valve stem. If stem binds, loosen the mounting screws and again tighten to 17-25 lbs. ft. torque with the criss-cross sequence. Repeat this until stem moves freely.

D. Place the cover plate (Fig. 79, 56) and a new cover plate gasket (55) in position against the manifold. Secure the cover plate to the manifold with four 3/8-16 x 1 hex-head capscrews (57). Tighten the capscrews to 34-38 lbs. ft. torque.

E. Install the oil strainer (Fig. 80, 53) in the oil strainer housing (52). Use pipe thread compound on the 1 inch square-head pipe plug (54) and install the pipe plug in the housing. Use pipe thread compound on the threads of the 3/4 NPTF x 2 short pipe nipple (47), and install the nipple into the housing. Install the other end of the nipple into the oil pump assembly (46). Place the oil pump assembly, with attached parts and a new oil-pump-to-manifold gasket (55) in position against the manifold. Secure the oil pump assembly to the manifold with four 3/8-16 x 1 hex-head capscrews (45). Tighten the capscrews to 34-38 lbs. ft. torque.

55. MISCELLANEOUS EXTERNAL PARTS.

A. Install the oil level gauge tube (Fig. 81, 17) and the oil level gauge (16) in the main housing. Install the 3/8 inch square-head pipe plug (4) in the main housing.

B. Place a new instruction plate (Fig. 81, 5) in position against the main housing, and secure the plate to the housing with four drive screws (6). Transfer the data from the old instruction plate onto the new instruction plate.

C. Install the breather chain clip (Fig. 81, 8) and the breather chain "S" link (11) on the breather chain (10). Install the "S" link on the oil breather assembly (12). Place the top cover plate (14) and a new top cover plate gasket (15) in position on the main housing, and secure the cover plate to the housing with ten 3/8-16 x 7/8 hex-head capscrews (9). Secure the breather chain clip beneath one of the capscrews. Tighten the capscrews to 34-38 lbs. ft. torque. Install the oil breather assembly and a new oil breather "O" ring (13) in the top cover plate opening.

D. Coat all remaining threaded parts with pipe thread compound.

E. Install the 3/4 inch square-head pipe plug (Fig. 81, 30) in the main housing.

F. Install the 3/4 NPTF x 2 short pipe nipple (Fig. 80, 48) in the main housing. Install the 3/4 inch 90 degree pipe elbow (49) on the nipple Install one end of the oil-sump-to-strainer flexible hose (50) in the elbow. Install the 3/4 inch straight male adapter union (51) in the oil strainer housing, and connect the adapter to the remaining end of the flexible hose.

G. Install the 1/2 NPTF x 1-1/2 short pipe nipple (Fig. 80, 40) in the tapped hole in the selector valve assembly. Install the 1/2 x 1/4 x 1/2 reducing tee (39), on the pipe nipple. Install the 1/4 inch square-head pipe plug (38) in the reducing tee only if a pressure line connection will NOT be made. Connect heat exchanger line to reducing "tee". Connect the filter "in" port to the pump "out" port with elbow (43), nipple (42) and hose (44).

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

56. PRIOR TO INSTALLATION.

A. General. The marine gear flange and pilot, and the engine flywheel and flywheel housing must be checked for trueness. Make certain the engine flywheel and the flywheel housing are clean prior to making the tests.

B. Checking the Marine Gear Flange. Bolt a thousandths indicator or gauge to the drive spider of the marine gear so that the indicator is perpendicular to the face of the marine gear housing, and the indicator stem is riding on the face of the flange (Fig. 63). Rotate the drive spider and note the face runout of the marine gear flange. The face runout must not exceed .017 inch maximum total indicator reading for the SAE No. 0 flange, or a .013 inch maximum total indicator reading for the SAE No. 1 flange.

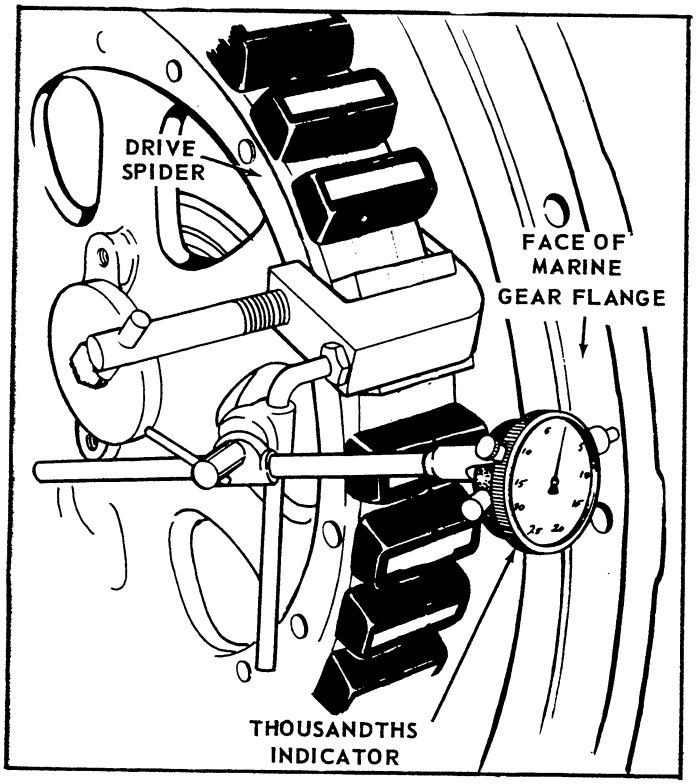


Figure 63. Checking the Face of the Front Housing Flange for Runout.

C. Checking Marine Gear Pilot Ring. With the indicator bolted as in Paragraph 56B above, adjust the indicator stem so that it will ride on the pilot surface of the flange (Fig. 64). Rotate the drive spider and note the pilot surface runout must not exceed .010 inch for the SAE No. 0 flange, or .008 inch for the SAE No. 1 flange. This applies to a continuous 270 degree arc if the balance of the pilot surface is negative in reading; otherwise, it means all 360 degrees.

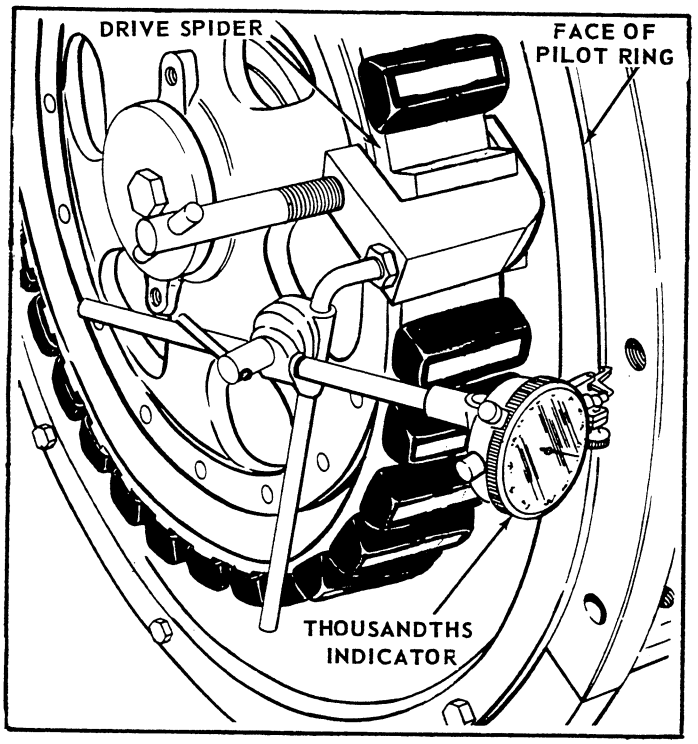


Figure 64. Checking the Pilot Ring for Runout.

D. 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. 65). Rotate the engine flywheel and note the face deviation of the engine flywheel housing flange. The face deviation must not exceed .008 inch maximum total indicator reading.

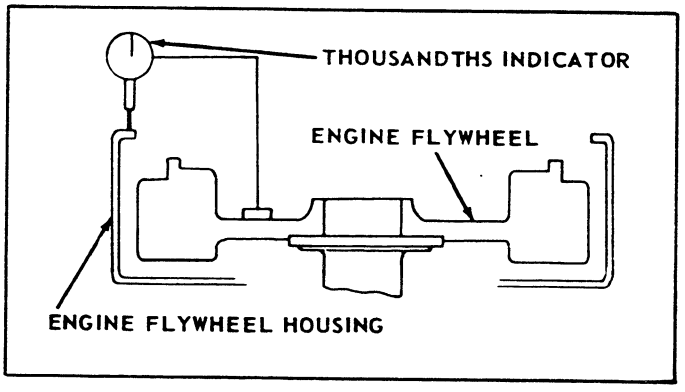


Figure 65. Checking the Face of the Engine Flywheel Housing.

E. Checking Bore of Engine Flywheel Housing. With the indicator bolted as in Paragraph 56D above, adjust the indicator stem so that it will ride on the bore of the engine flywheel housing (Fig. 66). Rotate the engine flywheel and note the bore eccentricity of the engine flywheel housing bore. The bore eccentricity must not exceed .008 inch maximum total indicator reading.

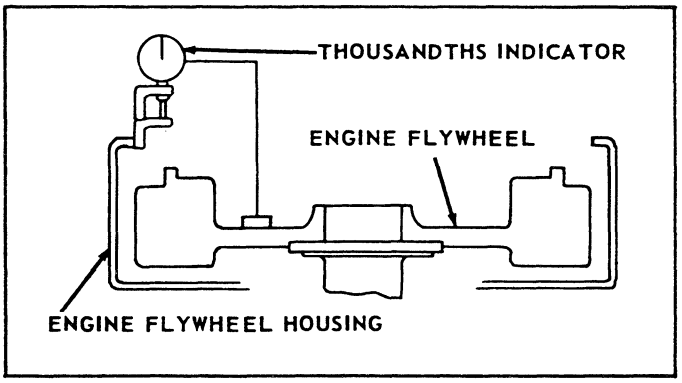


Figure 66. Checking the Bore of the Engine Flywheel Housing.

F. Checking Driving Ring Surface of Engine Flywheel. Bolt a thousandths indicator or gauge to the engine flywheel housing so that the indicator is perpendicular to the engine flywheel, and the indicator stem is riding on the inner face of the flywheel (Fig. 67). The variation of face runout of the surface to which the driving ring is bolted should not exceed .0005 inch maximum total indicator reading per inch of diameter.

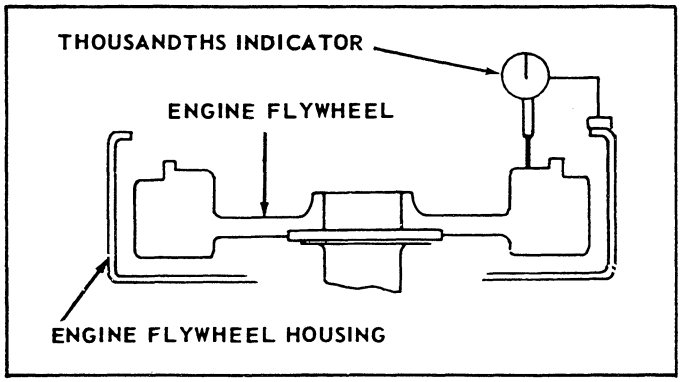


Figure 67. Checking the Driving Ring Surface of the Engine Flywheel.

G. Checking Driving Ring Pilot Bore of Engine Flywheel. With the indicator bolted as in Paragraph 56F above, adjust the indicator stem so that it will ride on the driving ring pilot bore of the engine flywheel (Fig. 68). The driving ring pilot bore eccentircity of the engine flywheel should not exceed .005 inch maximum total indicator reading.

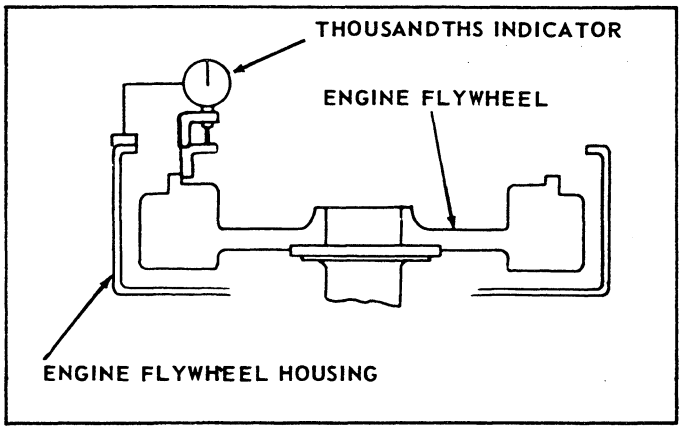


Figure 68. Checking the Driving Ring Pilot Bore of the Engine Flywheel.

57. INSTALLATION.

A. Alignment – General. 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.

B. 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.

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

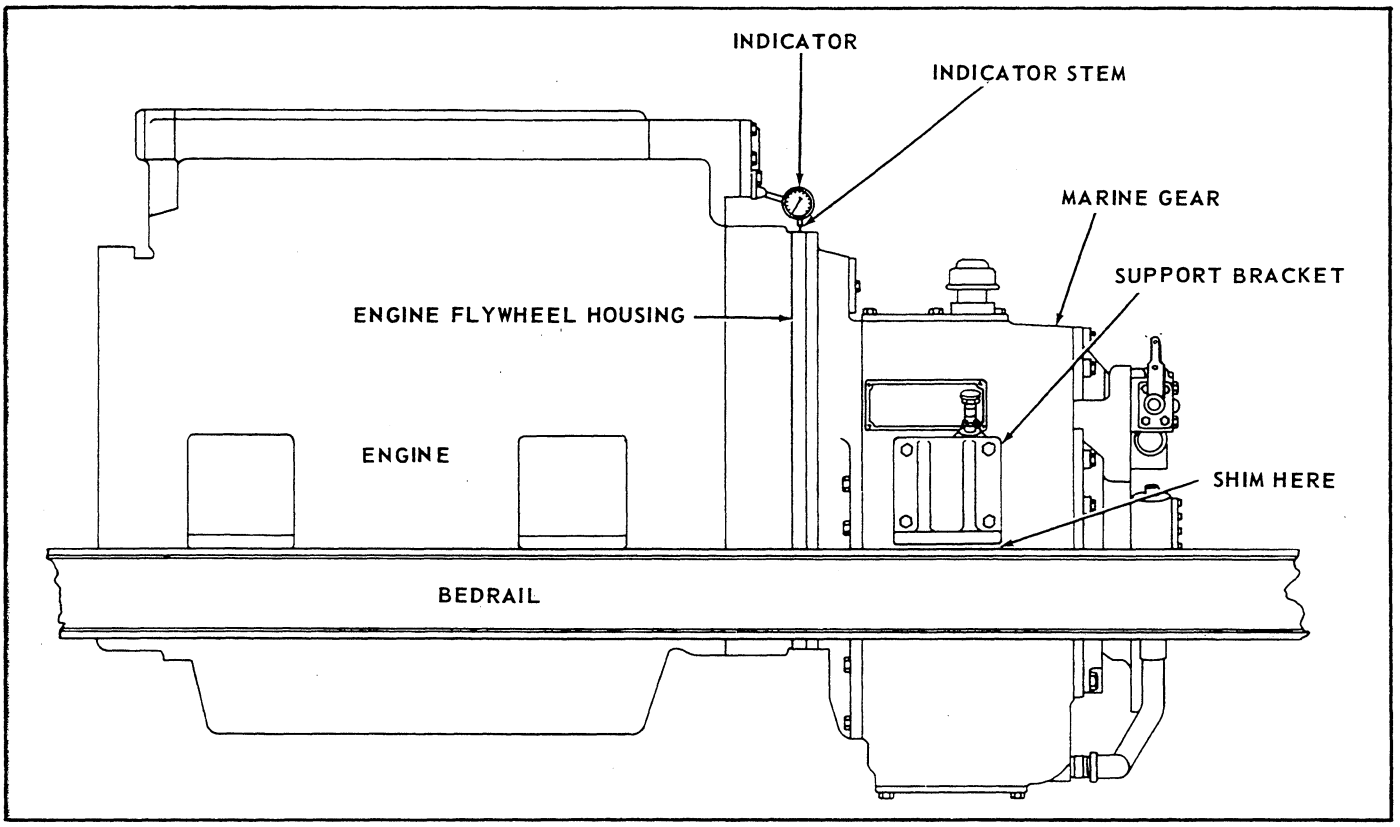


Figure 69. Alignment of the Engine and Marine Gear – Schematic View.

C. Engine and Marine Gear Alignment to Propeller Shaft. 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 threaded holes are provided in each of the engine mounts, jacking screws can be used in them. The engine can be raised by screwing down, or lowered by backing off the desired amount. Steel plates must be inserted under the jacking screws so that the bolts will not damage the engine bed. Lifting can also be accomplished by the use of chain hoists or properly placed jacks. Adjustable shims also are available and can simplify the whole problem, particularly for future realignment.

(1) It will also be necessary to move the engine and gear from one side or the other on the bed to obtain horizontal alignment. This can be done with a jack placed horizontally between the engine and the foundation. At the same time, a straight edge is laid across the edges of the flanges at the top and side to check the parallel alignment of the coupling edges (See Fig. 70).

(2) 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 output flange and propeller coupling, and prepare for bolting together. Care should be taken not to burr or mar this connection because the fit is very critical. Place a

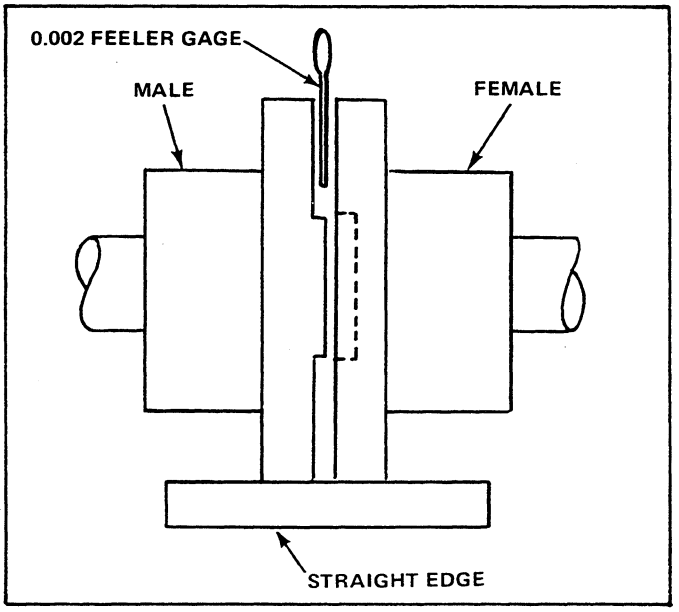


Figure 70. Checking Alignment (Parallelism) of the Coupling and Propeller Flanges.

0.002 inch feeler gauge between the flanges of the coupling. The feeler gauge is moved (slid) completely around the coupling.

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

(4) 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 output flnage can usually be corrected by repositioning the coupling on its spline. Shaft coupling runout is usually due to inaccuracy of taper fit or key interference.

(5) 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 output flange and propeller coupling. This clearance might be 0.005 to 0.007 inch while the top would maintain the standard 0.002 inch.

(6) 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.

(7) 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 . . . and not to correct inadequate alignment.

(8) 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.

D. Hydraulic System. Fill the hydraulic system with the proper type, weight, and amount of oil as specified in Paragraph 24.

WARNING

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

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

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

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

D

Section XIII. SPECIAL TOOLS

58. SPECIAL TOOLS.

Figures 71 through 78 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.

Section XIV. PARTS LIST

59. PARTS LIST.

Use Figure 79 through 82 and the adjacent parts list for ordering spare or replacement parts in accordance with the instructions contained in page 4. Following the parts list are planographs of the MG-514 Marine Gear. D

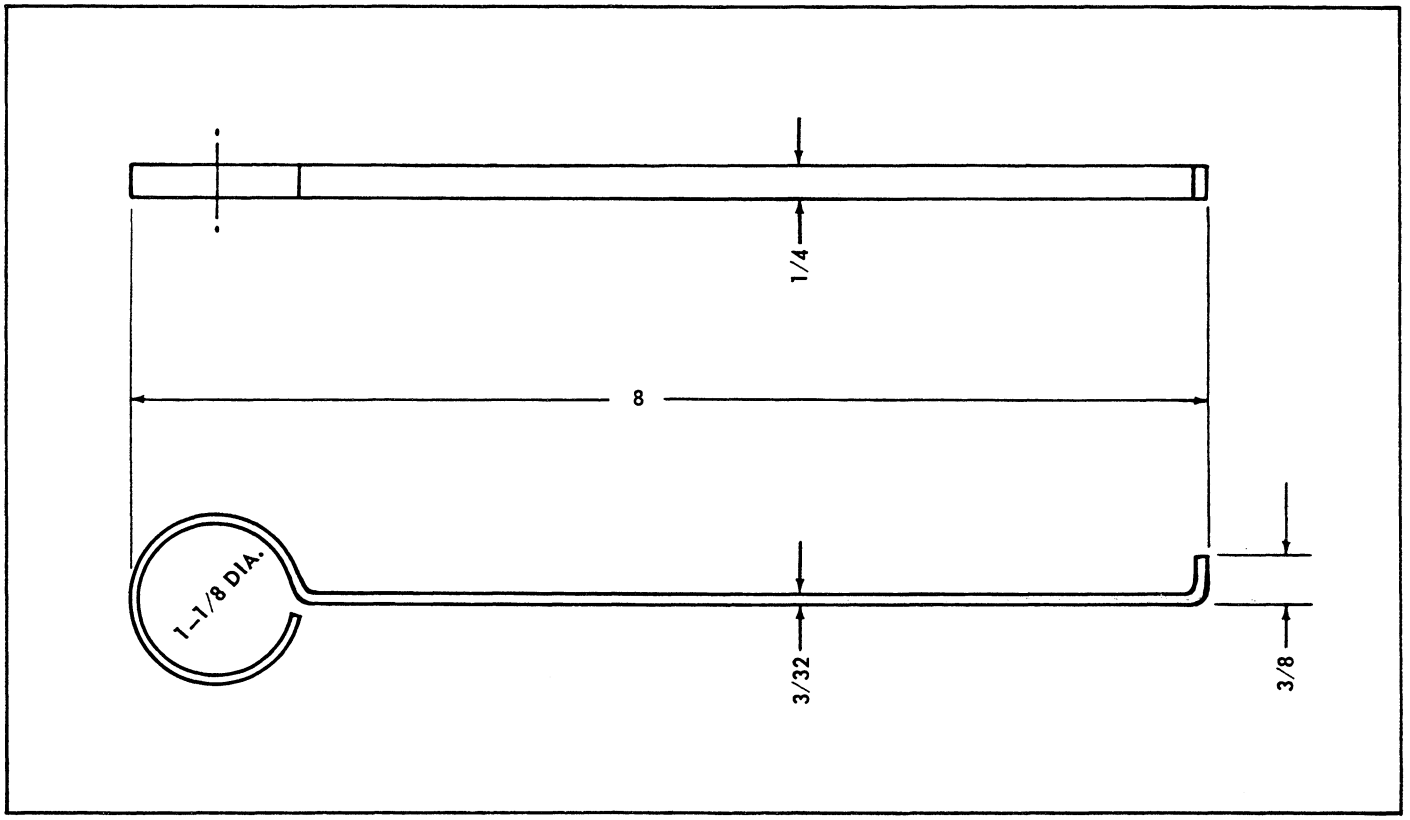


Figure 71. Special Tool T-8059.

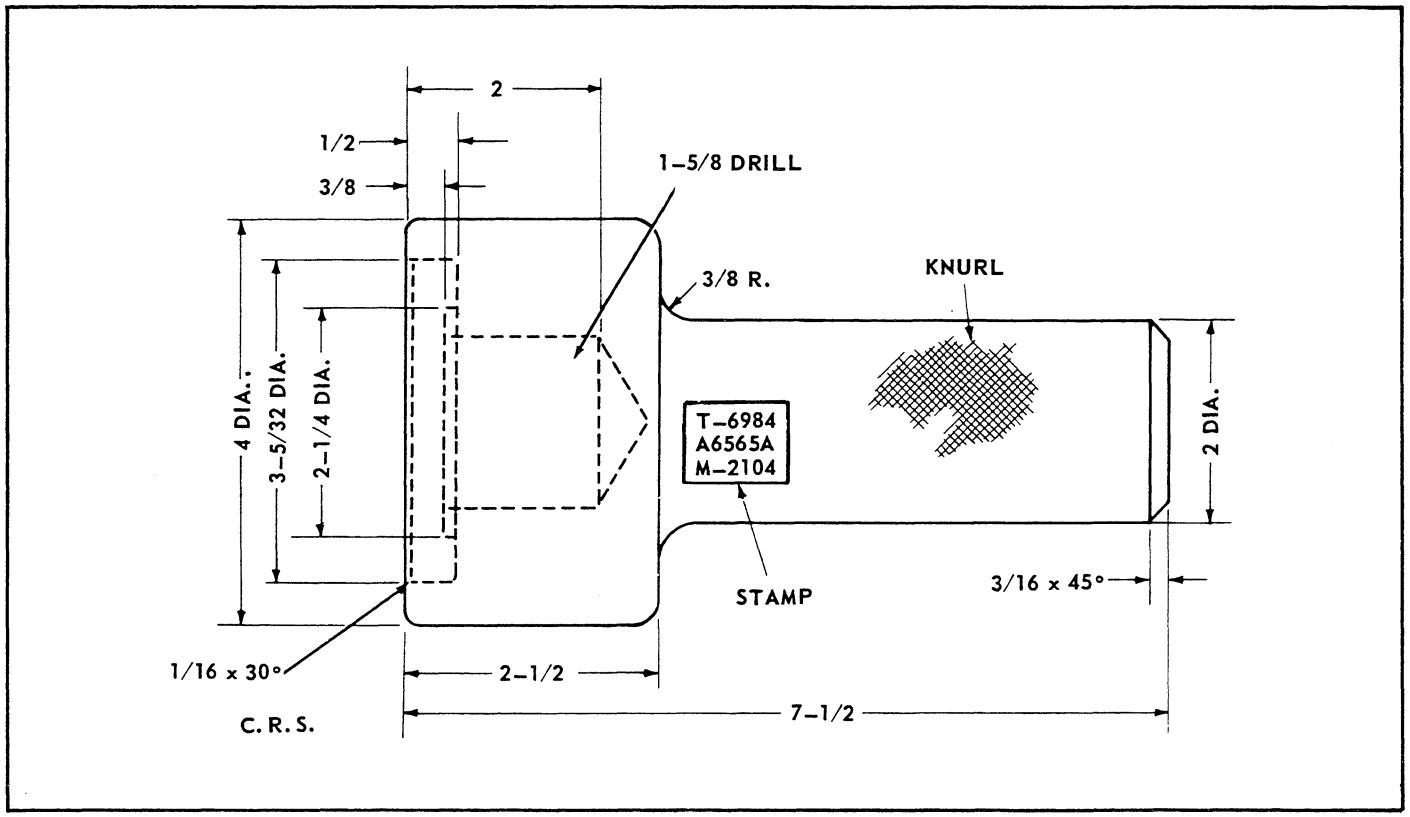


Figure 72. Special Tool T-6984.

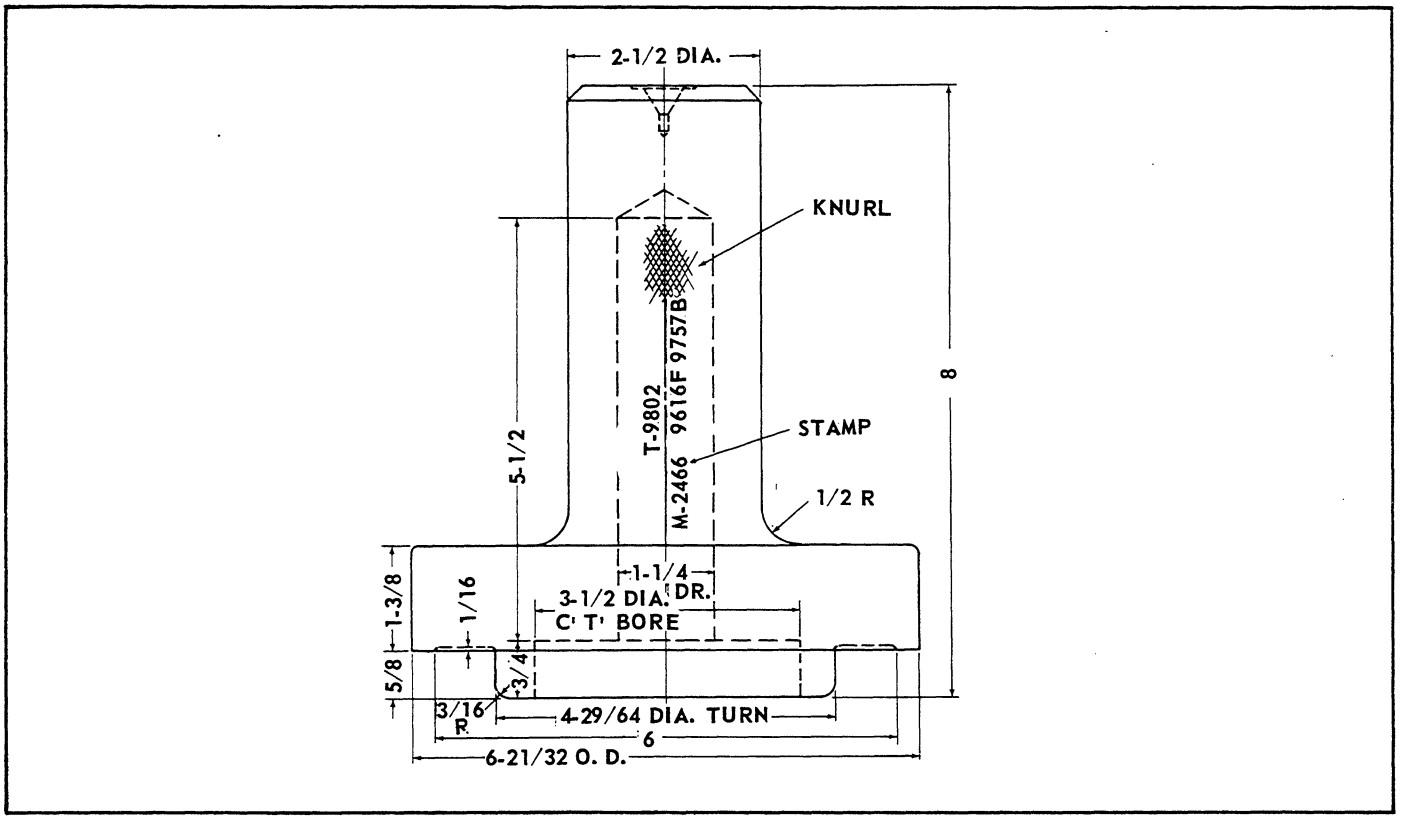


Figure 73. Special Tool T-9802.

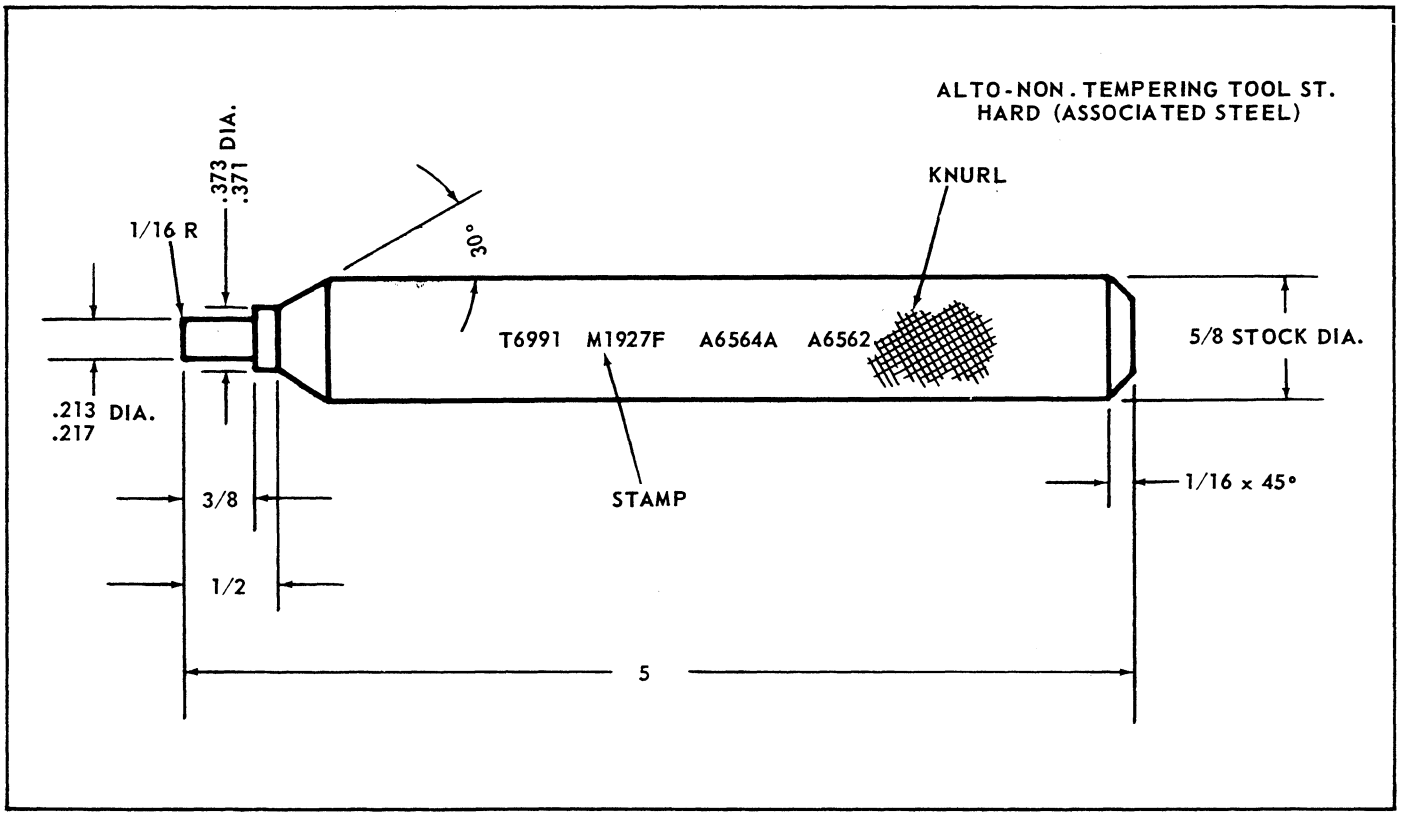


Figure 74. Special Tool T-6991.

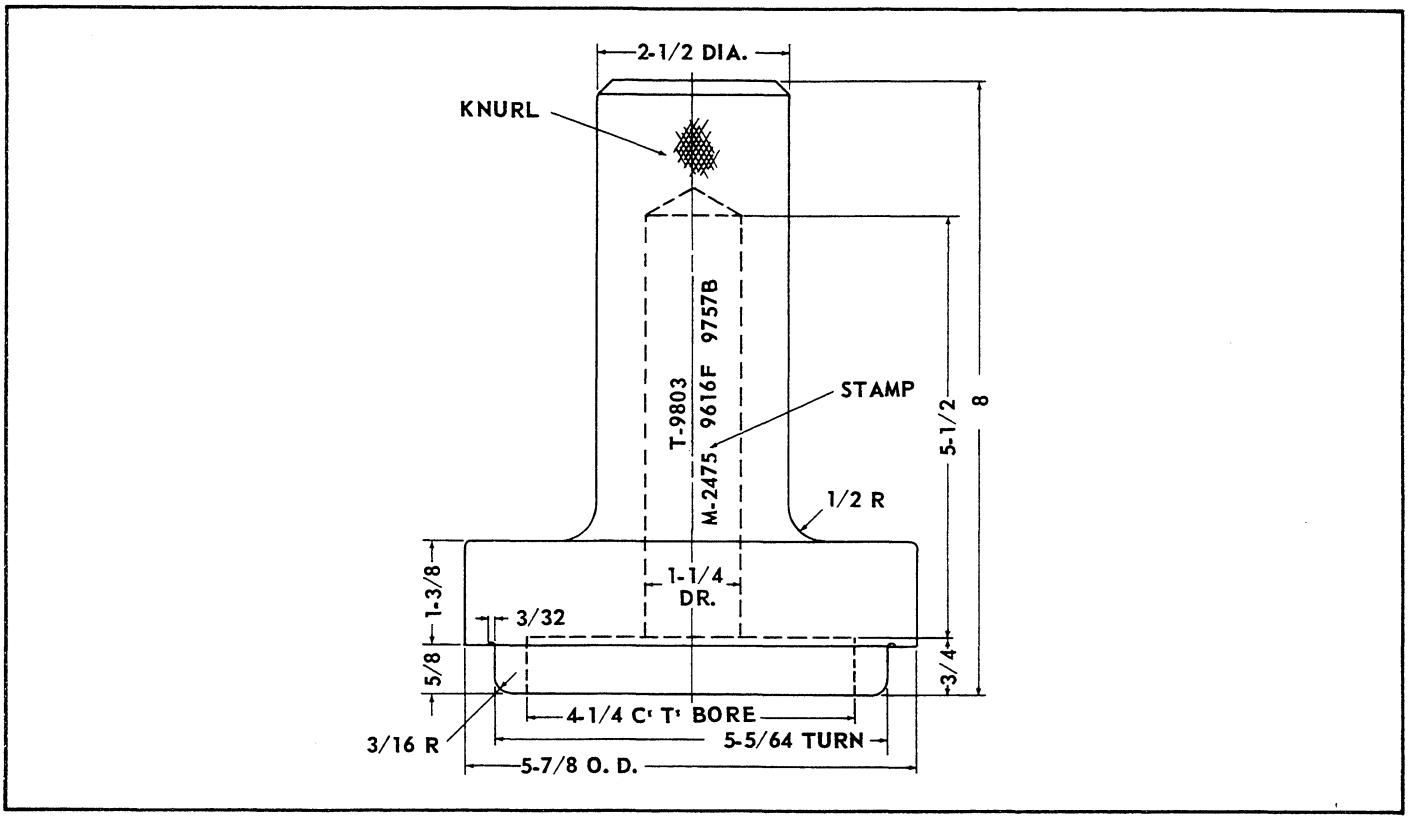


Figure 75. Special Tool T-9803.

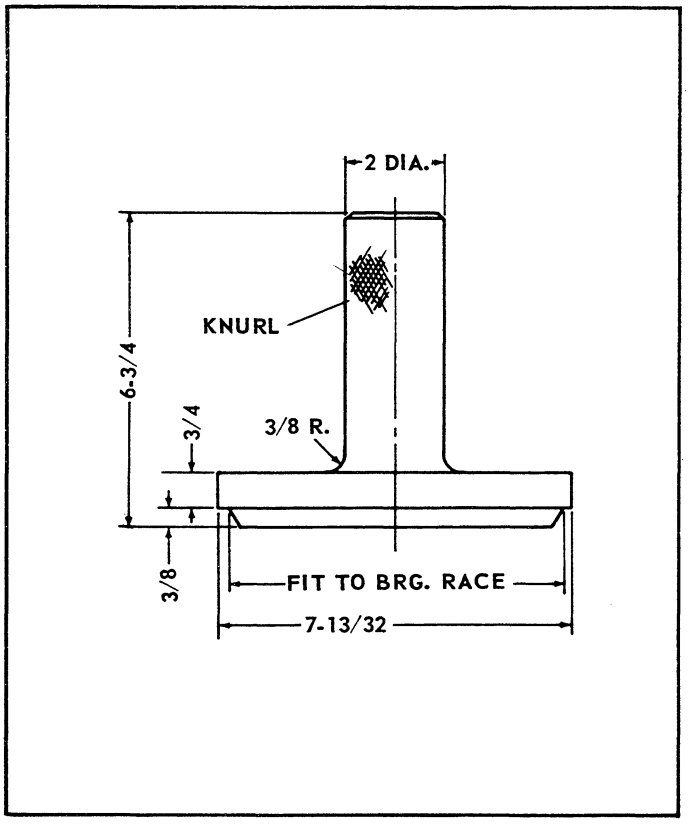


Figure 76. Special Tool T-10468-1.

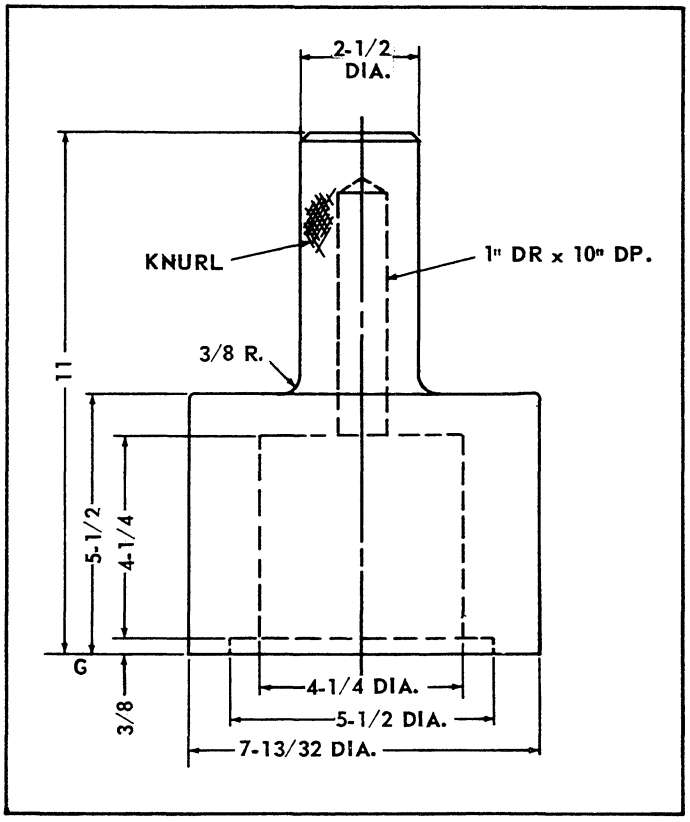


Figure 77. Special Tool T-10468-2.

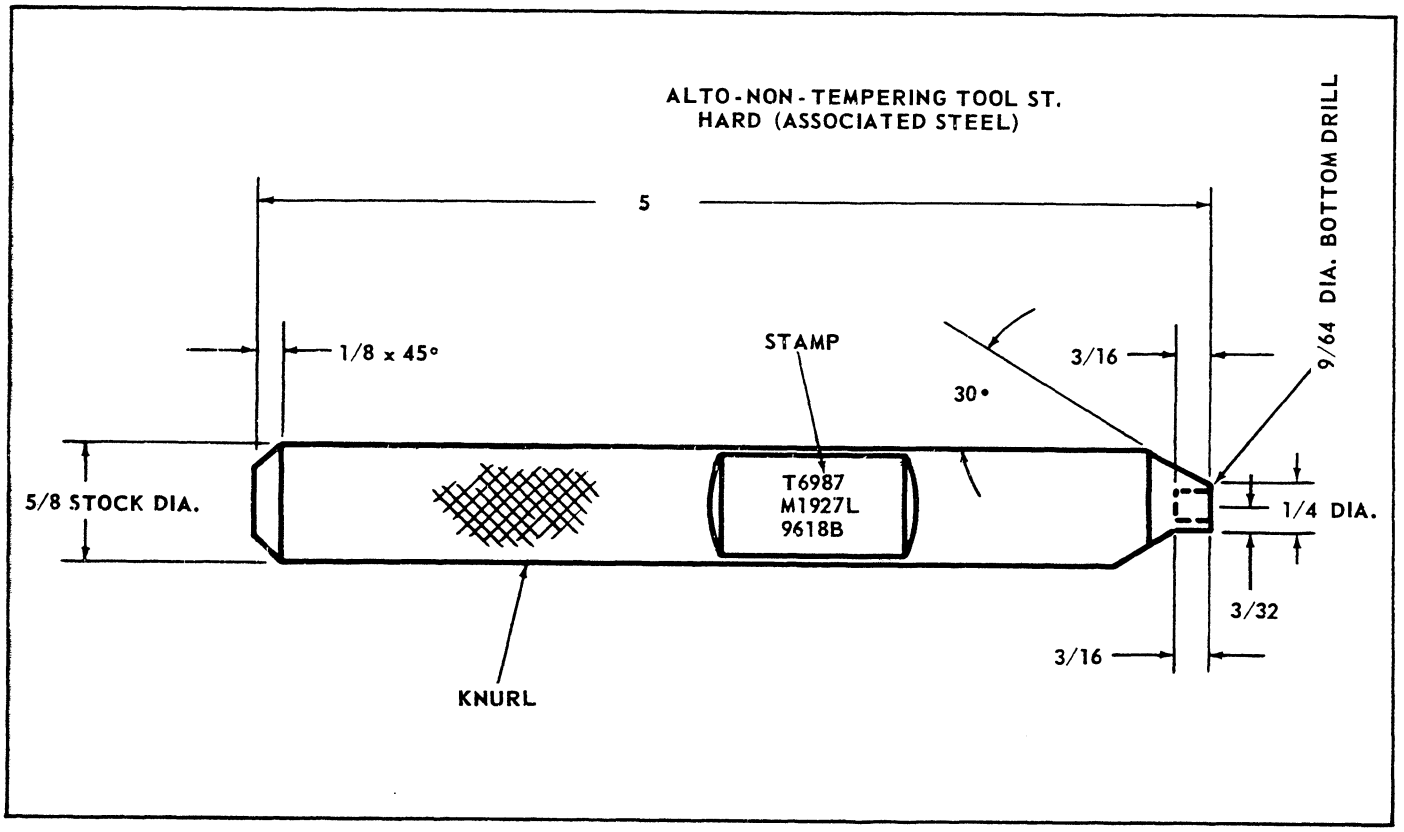


Figure 78. Special Tool T-6987.

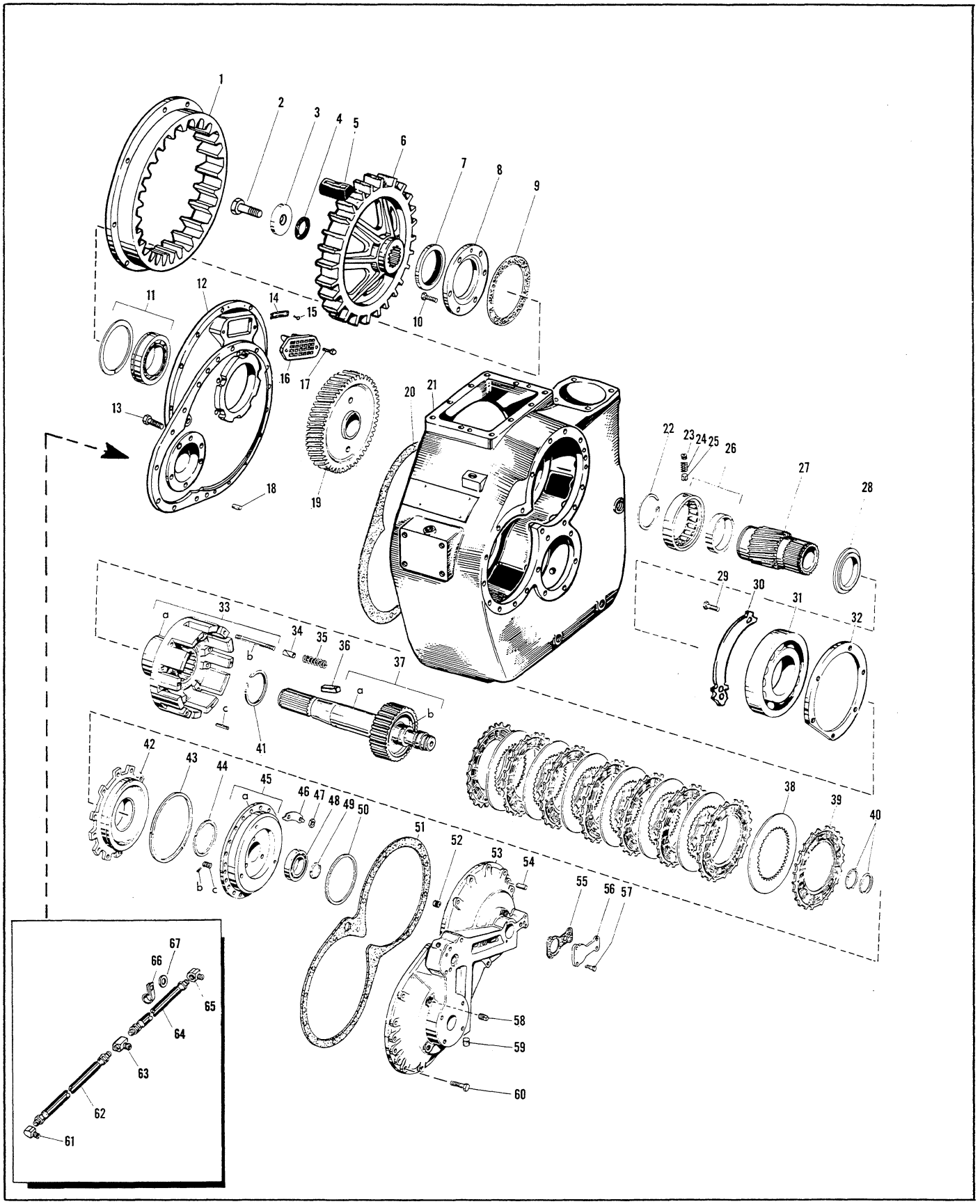


Figure 79. Forward Clutch Group Of Parts – Exploded View. (Shallow case shown).

FORWARD CLUTCH GROUP OF PARTS.

Item	*Description*	*Quantity*
1	RING, Driving	1
2	CAPSCREW, Hex-head (7/8-9 x 3)	1
3	WASHER, Retainer	1
4	GASKET, Ring	1
5	BLOCK, Rubber	26
6	SPIDER, Drive	1
7	SEAL, Oil, Spider, Drive	1
8	CARRIER, Seal	1
9	GASKET, Carrier, Seal	1
10	CAPSCREW, Hex-head (3/8-16 x 1-1/4)	6
11	BEARING, Ball	1
12	HOUSING, Front No. 0 or No. 1 No. 0	1
	No. 1	1
13	CAPSCREW, Hex-head (3/8-16 x 1-1/4)	19
14	PLATE, Indicator, rotation	1
15	SCREW, Drive	2
16	PLATE, Cover, Front Housing	1
17	CAPSCREW, Hex-head (3/8-16 x 7/8)	2
18	PIN, Dowel	2
19	GEAR, Reverse, driving	1
20	GASKET, Flat, Front housing	1
21	HOUSING, Main *	1
22	RING, Snap, external	1
23	PLUG, Pipe (1/4 inch)	1
24	SPRING, Retainer pin	1
25	PIN, Roll	1
26	ROLLER BEARING	1
27	PINION, Forward	1
28	SPACER, Pinion Bearing	1
29	CAPSCREW, Hex-head (3/8-24 x 2)	6
30	PLATE, Lock	3
31	BEARING, Ball	1
32	RETAINER, Plate, Threaded	1
33	SPIDER, Clutch assembly	1
a	SPIDER, Clutch **	1
b	STUD, Spider, Clutch (3/8 x 3-3/4)	12
c	PIN, Roll	6
34	SLEEVE, Split	12
35	SPRING, Release, Clutch	12
36	KEY, Straight	1
37	SHAFT, Clutch, forward, assembly	1
a	SHAFT, Clutch **	1
b	CATCHER, Oil **	1
38	PLATE, Clutch, steel	7
39	PLATE, Clutch, sintered (faced)	8
40	RING, Seal, Piston type (1-3/4 inch)	2
41	RING, Snap, external	1

Item	*Description*	*Quantity*
42	PISTON, Clutch	1
43	RING, Piston seal (7 inch)	1
44	RING, Piston seal (3 inch)	1
45	CYLINDER, Clutch assembly	1
a	CYLINDER, Clutch	1
b	PIN, Roll	3
c	SETSCREW, Socket-head (3/8 inch special)	3
46	LOCK, Screw	6
47	NUT, Hex (3/8-24)	12
48	BEARING, Ball	1
49	RING, Piston type, Oil seal (1.57 inch)	1
50	RING, Piston type, Oil seal (5 inch)	1
51	GASKET, Manifold-to-main-housing	1
52	PLUG, Pipe, orifice, manifold	2
53	MANIFOLD, ***	1
54	PIN, Dowel (1/2 x 1)	2
55	GASKET, Plate Cover	1
56	PLATE, Cover	1
57	CAPSCREW, Hex-head (3/8-16 x 1)	4
58	PLUG, Square-head (3/8 inch)	6
59	PLUG, Socket-head (1/4 inch)	4
60	CAPSCREW, Hex-head (3/8-16 x 1-1/2)	16
61	FITTING, Elbow, inverted	1
62	HOSE ASSEMBLY, Flexible (9 inch)	1
63	FITTING, Tee, inverted	1
64	HOSE ASSEMBLY, Flexible (4-1/2 inch)	1
65	FITTING, Elbow, inverted	1
66	CLAMP, Hose	1
67	WASHER, Plain (3/8 inch)	1

** If desired, a main housing assembly can be purchased consisting of:*

A main housing, dowel pins, instruction plate, & drive screws, pipe plugs, bearing retainer pin springs, bearing retainer pins, filter cavity pipe plug and eyebolts.

*** Cannot be ordered separately.*

**** If desired, a manifold assembly, consisting of the following can be purchased:*

Manifold, six (3/8 inch) pipe plugs, five (1/4 inch) pipe plugs, two orifice (1/4 inch) pipe plugs, and one roll pin (for oil return pipe).

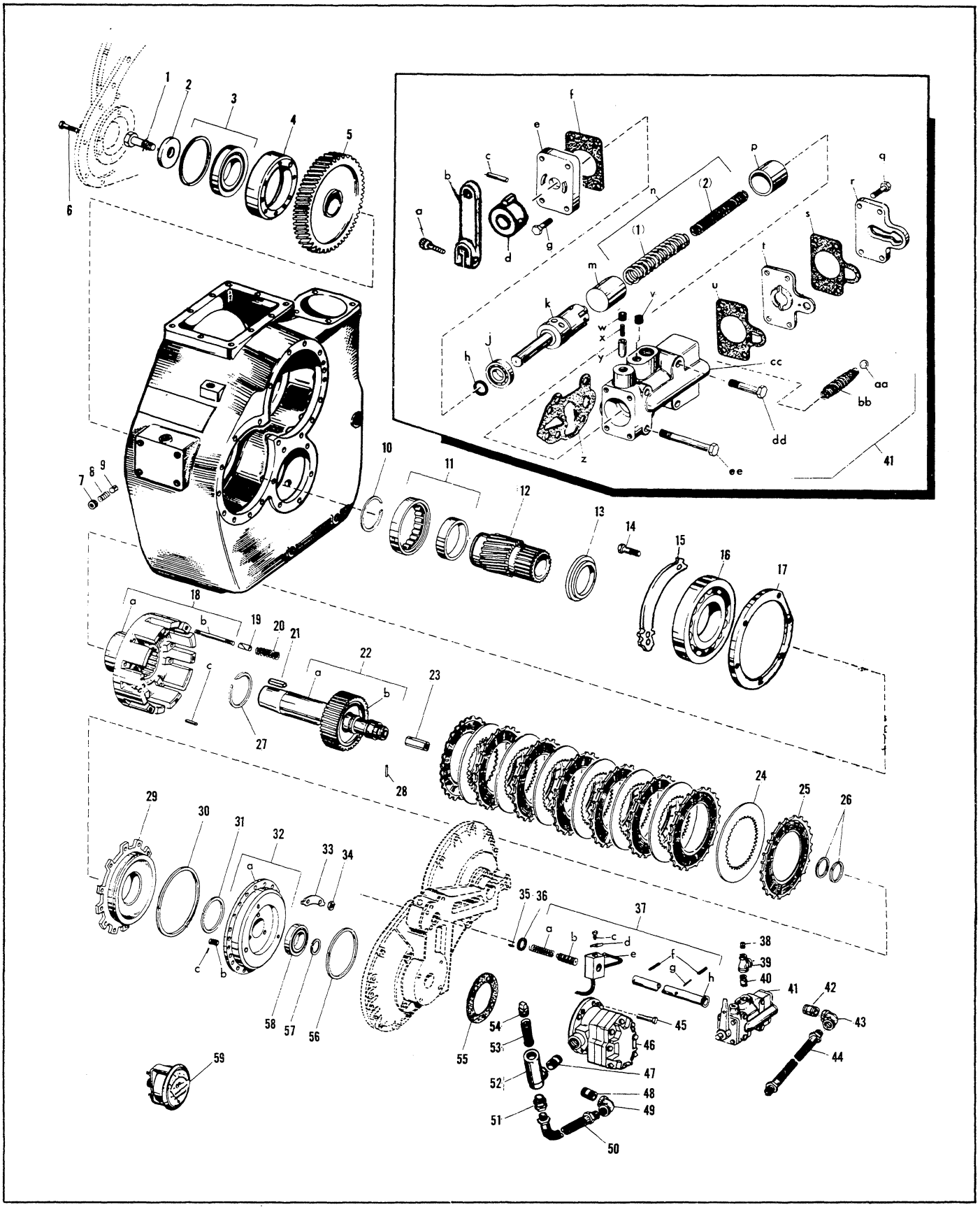


Figure 80. Reverse Clutch Group of Parts – Exploded View. (Shallow case shown).

REVERSE CLUTCH GROUP OF PARTS.

Item	Description	Quantity
1	CAPSCREW, Hex-head (7/8-9 x 3)	1
2	WASHER, Retainer, Reverse shaft	1
3	BALL BEARING	1
4	CARRIER, Bearing	1
5	GEAR, Driven (reverse)	1
6	CAPSCREW, Hex-head (3/8-16 x 1-1/4)	6
7	PLUG, Pipe	1
8	SPRING, Pin, retainer	1
9	PIN, Retainer, bearing	1
10	RING, Snap, external	1
11	ROLLER Bearing, Pinion, reverse	1
12	PINION, Reverse	1
13	SPACER, Pinion, reverse	1
14	CAPSCREW, Hex-head (3/8-24 x 2)	6
15	LOCK, Screw	3
16	BALL BEARING	1
17	RETAINER, Tapped hole, bearing	1
18	SPIDER, Clutch, assembly	1
a	SPIDER, Clutch *	1
b	STUD, Spider, Clutch (3/8 x 3-3/4)	12
c	PIN, roll	6
19	SLEEVE, Split	12
20	SPRING, Release, clutch	12
21	KEY, Straight	1
22	SHAFT, Clutch, reverse assembly	1
a	SHAFT, Clutch, reverse *	1
b	CATCHER, Oil *	1
23	SLEEVE, Drive, Oil pump	1
24	PLATE, Steel, clutch	7
25	PLATE, Sintered metal faced, clutch	8
26	RING, Piston type, oil seal	2
27	RING, Snap external	1
28	PIN, Dowel (1/4 x 1-1/2)	1
29	PISTON, Clutch	1
30	RING, Piston type, oil seal (7 inch)	1
31	RING, Piston type, oil seal (3 inch)	1
32	CLUTCH CYLINDER ASSEMBLY	1
a	CYLINDER, Clutch	1
b	PIN, Roll	3
c	SETSCREW, Socket head (3/8 inch special)	3
33	LOCK, Screw	6
34	NUT, Hex (3/8-24)	12
35	PIN, Roll	1
36	GASKET, Ring, Corprene	1
37	PIPE, Return, Oil assembly	1
a	SPRING, Piston, pipe, return oil	1
b	PISTON, Pipe, return, oil	1
c	CAPSCREW, Hex-head special	1
d	PLATE, Lock	1
e	CARRIER, Tube assembly	1
f	PIN, Roll (outer)	2
g	PIN, Roll (inner)	1
h	PIPE, Return, Oil	1

Item	Description	Quantity
38	PLUG, Pipe, square head (1/4 inch)	1
39	TEE, Reducing (1/2 x 1/4 x 1/2)	1
40	NIPPLE, Pipe, short (1/2 NPTF x 1-1/2)	1
41	SELECTOR VALVE ASSEMBLY	1
a	CAPSCREW, Socket-head (1/4-20 x 7/8)	1
b	LEVER, Valve, selector	1
c	PIN, roll	1
d	COLLAR, Stop	1
e	COVER, Stem, valve selector	1
f	GASKET, Cover valve	1
g	CAPSCREW, Hex-head (5/16-18 x 1)	4
h	"O" RING	1
j	BALL BEARING	1
k	STEM, Valve	1
m	PISTON, High pressure regulation	1
n	SPRING ASSEMBLY	1
	(1) SPRING, Outer	1
	(2) SPRING, Inner	1
p	PISTON	1
q	CAPSCREW, Hex-head (5/16-18 x 1)	4
r	COVER, Orifice plate	1
s	GASKET, Orifice plate	1
t	PLATE, Orifice	1
u	GASKET, Orifice plate	1
v	PLUG, Pipe (1/4 inch)	1
w	PLUG, Pipe (1/4 inch)	1
x	SPRING, Detent	1
y	DETENT	1
z	GASKET, (Valve to manifold)	1
aa	BALL, Orifice plate	1
bb	SPRING, (Orifice plate)	1
cc	BODY, Valve	1
dd	CAPSCREW, Hex-head (3/8-16 x 2-3/4)	2
ee	CAPSCREW, Hex-head (3/8-16 x 5-3/4)	2
42	NIPPLE, Pipe (3/4 inch)	1
43	ELBOW, 90 degree, 3/4 inch	1
44	FLEXIBLE HOSE ASSEMBLY (Pump-to-filter)	1
45	CAPSCREW, Hex-head (3/8-16 x 1)	4
46	PUMP ASSEMBLY	1
47	NIPPLE, Pipe (3/4 inch)	1
48	NIPPLE, Pipe (3/4 inch)	1
49	ELBOW, 90 degree, 3/4 inch	1
50	FLEXIBLE HOSE ASSEMBLY (Suction)	1
51	UNION, Adapter (Suction hose)	1
52	HOUSING, Strainer, oil	1
53	STRAINER, Oil	1
54	PLUG, Pipe, square head, 1 inch (oil strainer)	1
55	GASKET, Oil-pump-to-manifold	1
56	RING, Piston type, seal (5 inch)	1
57	RING, Piston type, seal (1.57 inch)	1
58	BALL BEARING ASSEMBLY	1
59	GAUGE, Oil pressure, assembly	1

** Cannot be ordered separately.*

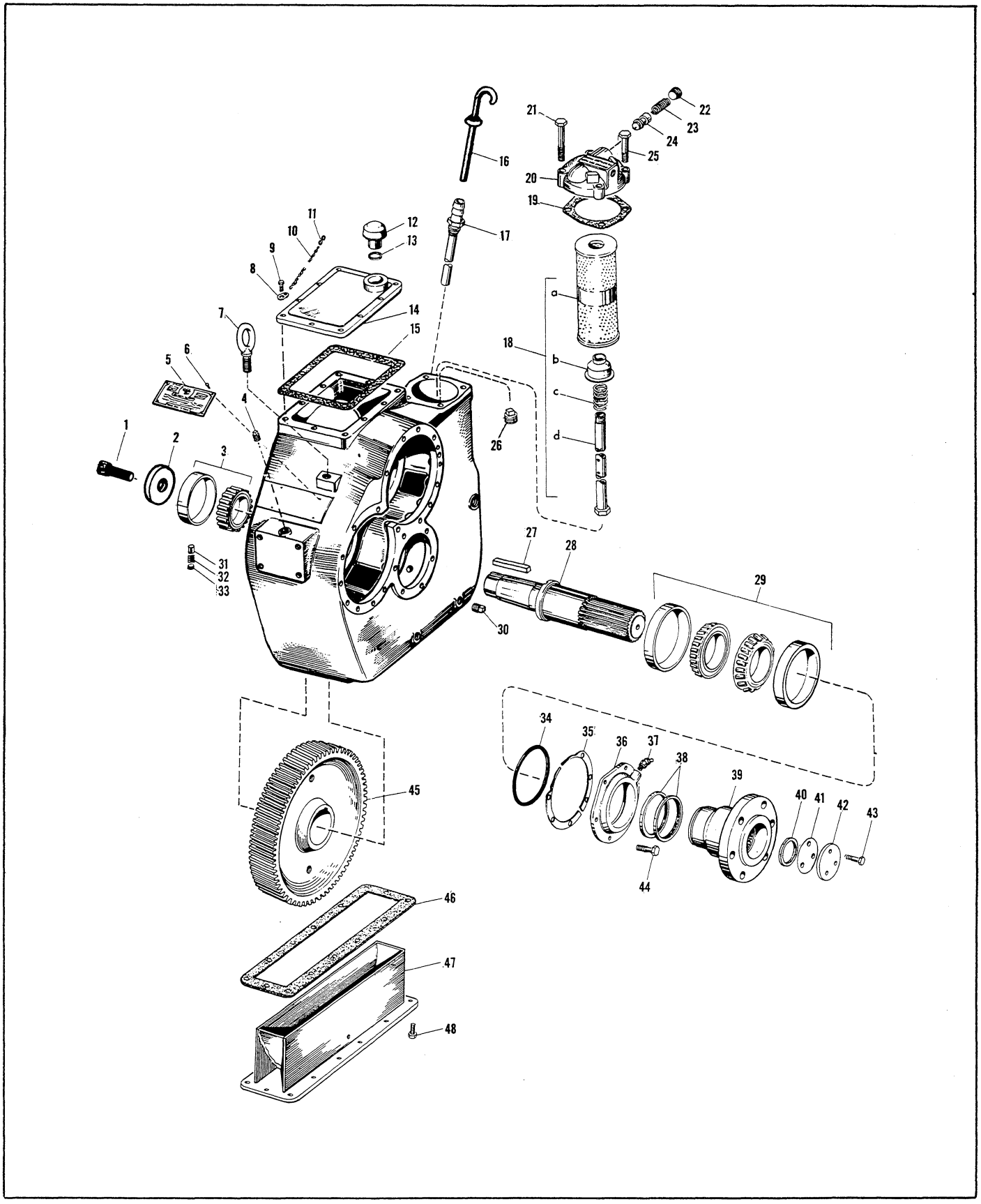


Figure 81. Output Shaft Group of Parts – Exploded View. (Shallow case shown).

OUTPUT SHAFT GROUP OF PARTS.

Item	*Description*	*Quantity*
1	CAPSCREW, 12 Point, externally wrenched (5/8-18 x 1-1/2)	3
2	WASHER, Retainer (output shaft)	1
3	ROLLER BEARING ASSEMBLY	1
4	PLUG, Pipe (3/8 inch)	1
5	PLATE, Instruction	1
6	SCREW, Drive	4
7	EYEBOLT	2
8	CLIP, Chain, breather	1
9	CAPSCREW, Hex-head (3/8-16 x 7/8)	10
10	CHAIN, Breather	1
11	"S" LINK, Chain, breather	1
12	BREATHER, Oil, assembly	1
13	"O" RING, Breather	1
14	PLATE, Cover, top	1
15	GASKET, Flat, plate, cover, top	1
16	GAUGE, Oil, level	1
17	TUBE, Gauge, Oil level	1
18	ELEMENT, Filter, Oil assembly	1
a	ELEMENT	1
b	SEAT, Spring, tube filter	1
c	SPRING, Tube, filter	1
d	TUBE, Filter assembly	1
19	GASKET, Plate, cover (filter)	1
20	COVER, Filter	1
21	CAPSCREW, Hex-head (1/2-13 x 3)	2
22	PLUG, Pipe, square-socket head, 3/4 inch	1
23	SPRING, Piston, by-pass, oil	1
24	PISTON, By-pass, oil	1
25	CAPSCREW, Hex-head (1/2-13 x 2)	2
26	PLUG, Pipe, square socket-head, 1-1/2 inch	1
27	KEY, Straight (5/8 x 5/8 x 3-3/8)	1
28	SHAFT, Output	1
29	TAPERED ROLLER BEARING	2
30	PLUG, Pipe, square socket-head (3/4 inch)	2
31	PIN, Retainer	1
32	SPRING, Pin, retainer	1
33	PLUG, Pipe, hex-socket head (1/4 inch)	1
34	"O" RING	1
35	SHIM, Retainer, bearing	A/R
36	RETAINER, Bearing	1
37	FITTING, Grease (1/8 inch 45 degree)	1
38	SEAL, Oil	2
39	FLANGE, Output	1
40	GASKET, Ring	1
41	SHIM, Flange	A/R
42	WASHER, Retainer	1
43	CAPSCREW, Hex-head (3/4-16 x 2-1/2)	3
44	CAPSCREW, Hex-head (1/2-13 x 1-1/2)	8
45	GEAR, Output shaft	1
46	GASKET, Flat, pan, sump-cover-and-gear	1
47	PAN, Sump, cover-and-gear, assembly	1
48	CAPSCREW, Hex-head (3/8-16 x 7/8) Zinc Plated Special	14

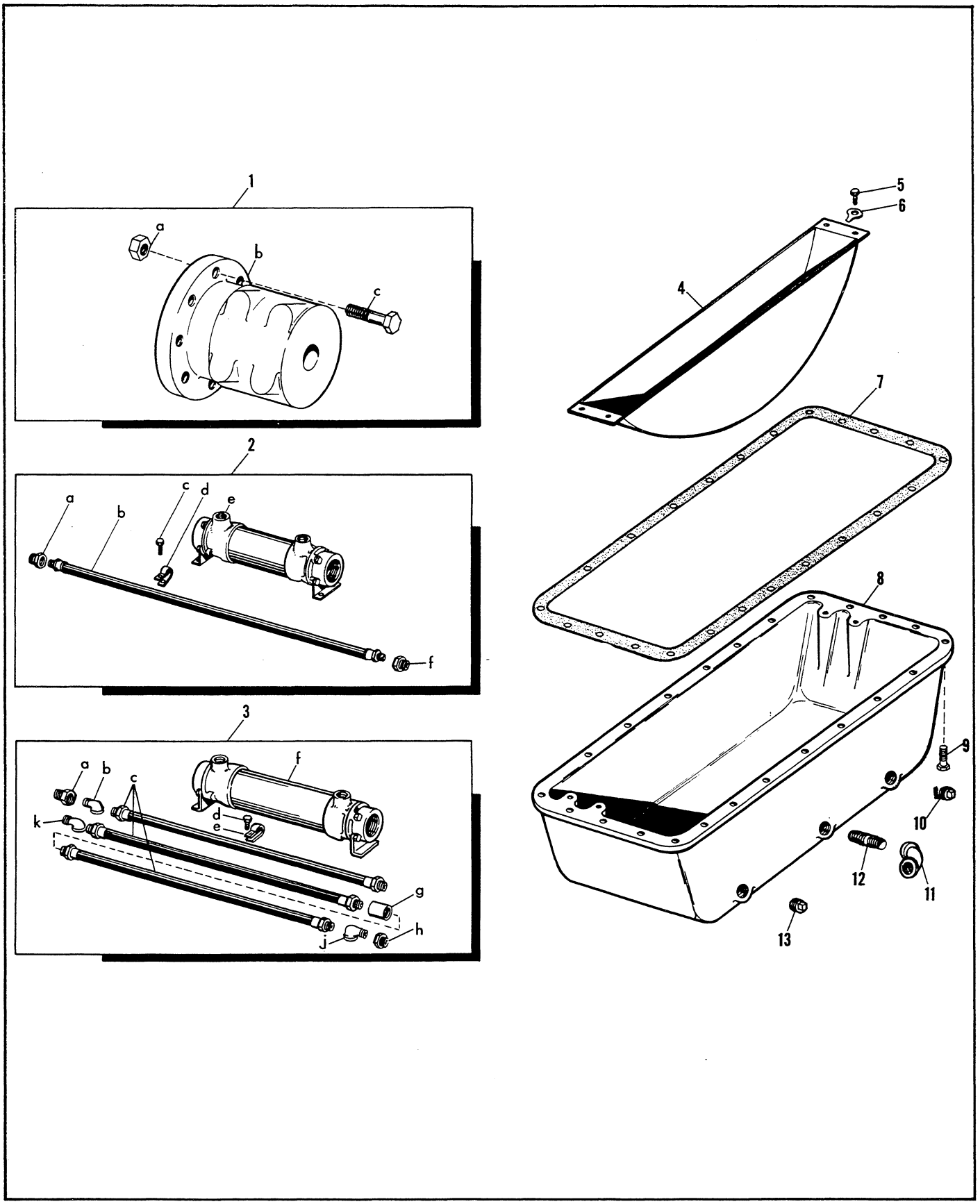


Figure 82. Standard and Optional Equipment for MG-514 Marine Gear – Exploded View.

STANDARD AND OPTIONAL EQUIPMENT – PARTS LIST

Item	*Description*	*Quantity*
	Standard for Deep-Case Units	
1	FLANGE, companion, assembly *	1
a	NUT, stop, light, 3/4-16	8
b	FLANGE, companion	1
c	CAPSCREW, hex-head, 3/4-16 x 3, special	8
	Optional Equipment	
2	KIT, hose-and-heat-exchanger (K-16)	1
a	BUSHING, reducer, 3/4-inch-to-1/2-inch	1
b	HOSE, flexible, 36-inch	2
c	CAPSCREW, hex-head, 3/8-16 x 1-3/4	1
d	CLIP, hose	1
e	EXCHANGER, heat	1
f	BUSHING, reducer, 1-inch-to-1/2-inch	2
3	KIT, hose-and-heat-exchanger (K-35)	1
a	BUSHING, reducer, 3/4-inch-to-1/2-inch	1
b	ELBOW, street, 90-degree, 1/2-inch	1
c	HOSE, flexible, 36-inch	3
d	CAPSCREW, hex-head, 3/8-16 x 1-3/4	3
e	CLIP, hose	3
f	EXCHANGER, heat	1
g	COUPLING, pipe, 1/2-inch	1
h	BUSHING, reducer, 1-inch-to-1/2-inch	2
j	ELBOW, street, 90-degree, 1/2-inch	1
k	ELBOW, street, 90-degree, 1/2-inch	1
	Standard for Deep-Case Units	
4	PAN, gear	1
5	CAPSCREW, hex-head, 3/8-16 x 5/8	4
6	LOCK, screw	4
7	GASKET, flat, cover, bottom	1
8	COVER, bottom	1
9	CAPSCREW, hex-head, 3/8-16 x 1-1/4	22
10	PLUG, pipe, square-head, 3/4-inch	1
11	ELBOW, pipe, 90-degree, 3/4-inch	1
12	NIPPLE, pipe, short, 3/4 NPTF x 2	1
13	PLUG, pipe, square-head, 3/4-inch	1

* – *This assembly also includes Item 39, Figure 81.*

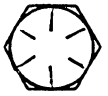
TORQUE VALUES

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 RECEIVED (2)	LUBRICATED (3)	AS RECEIVED (2)	LUBRICATED (3)	LUBRICATED (3)
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	----



(4)

SAE STANDARD HEX BOLT HEAD MARKINGS

12 Pt. Head and Undercut Body

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_c40 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	BC		15 ± 2				
03	A		34 ± 5				
04	B		46 ± 6				
05	C	C	75 ± 10				
06	D		92 ± 12				
07	E		125 ± 16			E	150 ± 20
08	F	F	160 ± 20	AF	230 ± 30	(3) F	190 ± 25
09	G	G	200 ± 25	(2) AG	300 ± 40	G	240 ± 30
10	H	H	240 ± 30	AH	370 ± 50	H	290 ± 40
11	J	J	290 ± 40	AJ	440 ± 55	J	350 ± 45
12	K	K	350 ± 45	AK	530 ± 70	K	430 ± 55
13	L		400 ± 50	AL	600 ± 75	L	490 ± 65
14	M	M	460 ± 60	AM	710 ± 90	M	580 ± 75
15	N	AJ	550 ± 70	AN	830 ±110	N & AN	680 ± 85
16	P	P	660 ± 85	AP	1000 ±130	P	800 ±100
17	Q		770 ± 100	AQ	1200 ±150	Q	950 ±120
18	R		900 ± 120	AR	1350 ±170	R	1100 ±140
19	S	S & AH	1000 ± 130	AS	1500 ±190	S	1300 ±170
20	T		1150 ± 150	AT	1700 ±225	T	1400 ±180
21	U		1300 ± 170	AU	2000 ±250	U	1600 ±200
22	V	V	1400 ± 180	AV	2200 ±275	V	1800 ±225
24	W		1800 ± 225	AW	2700 ±350	W	2200 ±275
26	X	X	2200 ± 275	AX	3300 ±425	X	2700 ±350
28	Y		2600 ± 325	AY	4000 ±500	Y	3300 ±425
30	Z		3100 ± 400	AZ	4800 ±600	Z	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.

TWIN DISC MARINE TRANSMISSION RATINGS

An important consideration when applying a marine transmission is the type of service in which it will be used. The type of service is a form of duty factor which must be applied to the other important application factors which are normally considered (i. e. ratio, engine HP and speed, etc.). The type of service factor when properly used will, in some cases, permit a smaller marine transmission to be used, or on the other hand, will indicate that a more conservative choice is required. In order to remain competitive and to avoid application errors, a clear understanding of types of service and their effect on marine transmission selection is required. Listed on the reverse side are the three types of service normally encountered in marine transmission application.

TYPES OF SERVICE

CONTINUOUS DUTY (C)

Commonly called "Work Boat Service", these marine gear applications are expected to operate continuously at full engine governed speed. The propulsion engine power setting must be known and must be within the marine gears allowable input rating for continuous day long or around the clock service.

Most displacement hull vessels are powered for continuous duty service. However, the actual engine (and marine gear) power loading depends on:

The propeller used.

The vessel's work assignment.

The captain's choice of throttle setting during continuous service.

Twin Disc recommends that all displacement and semi-displacement hull commercial applications be classed as "continuous duty usage" of the marine gear.

Examples:

Fishing trawlers
Purse seiners
Lobster boats and crab boats
Tugs
Tow boats
Buoy tenders
Off-shore supply boats
Ferries
Research vessels
Ocean freighters

INTERMEDIATE SERVICE (I)

Commercial usage of semi-displacement or planing hulls can qualify for intermediate service classification if:

Full throttle usage averages only a few hours per day and

Total annual usage is not over 2,000 hours per year.

Examples:

Crew boats
Party fishing boats
Long range cruisers
Harbor and coastal patrol boats
Search and rescue boats
Fire boats

Compared to continuous commerical service, intermediate service should have a substantial amount of partial throttle operation.

Intermediate ratings are higher than the continuous ratings for each marine gear.

For example, the 3.0:1 ratio MG-514 forward gear train is rated:

420 HP at 2000 rpm for continuous duty and

488 HP at 2000 rpm for intermediate duty and

The additional 68 HP is allowed for intermediate service with the expectation the total yearly hours of usage will be much less than is normal for continuous duty.

PLEASURE CRAFT SERVICE (P)

Marine gear horsepower and rpm ratings are the highest for planing type pleasure boat service.

Normal pleasure boat service presumes there will be only occasional usage at full engine power such as may be necessary to "get up on step" or race a storm to shore. Normal cruising is expected to be at a comfortable part-throttle setting.

NOTE: When a pleasure boat is being planned for commerical party fishing service, the marine gear should be selected according to its intermediate rating.

NOTE: If you are working on an application and are not sure of the type of service rating, please contact:

TWIN DISC, INCORPORATED
Attention: Marine Application Engineering Dept.
1328 Racine Street
Racine, WI 53403

MECHANICAL TOP PTO RATINGS

The chart below shows the various marine transmissions for which mechanical top PTOs are available.

MARINE TRANS. MODEL	TOP PTO ASSY. NO.
MG-508	X-9807
MG-509	X-9807-A
MG-512	X-9804
MG-514	X-9804-A
MG-514M	X-9804-B

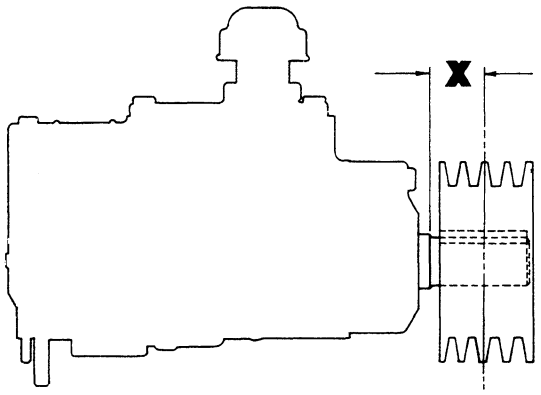
Each of the top PTOs listed has the same capacity rating.

MAXIMUM WORKING TORQUE – 165 lb.-ft.

MAXIMUM SIDE LOAD = SIDE LOAD IN POUNDS *MUST NOT EXCEED* VALUES SHOWN IN SIDE LOAD CHART.

PTO SHOULD NOT BE ENGAGED AT ENGINE SPEEDS ABOVE 1500 RPM.

X in Inches	1/2	1	1-1/2	2	2-1/2
Side Load in Pounds	1108	853	693	584	504



The following formula should be used to determine side load in pounds.

$$L = \frac{126{,}000 \times HP}{N \times D} \times F$$

L = Actual Load in Pounds
N = Shaft Speed in RPM
D = Pitch Diameter of Sprocket, Sheave, etc.
F = 1.0 for Chain or Gear Drive
1.5 for Timing Belts
2.5 for All V Belts
3.5 for Flat Belts

For reciprocating compressors and other severe shock drives, multiply above F factors by 2.1.

These top PTOs all use a mechanical clutch which requires adjustment in order to compensate for normal wear. Since these units are almost always operated from a remote position through linkages, the "feel" at the operating position is not sufficient to judge when clutch adjustment is needed. It is, therefore, suggested that a periodic top PTO operating shaft torque measurement be made.

A properly adjusted top PTO will require an operating shaft torque at the PTO of 50 to 70 lb.-in. As the clutch is used and wear takes place the torque required to engage the clutch will diminish. When this engaging torque is found to be near the low limit, the clutch should be adjusted until a torque near the high limit is required to engage the clutch.

CAUTION

DO NOT ADJUST THE CLUTCH TOO TIGHTLY.

Operating shaft torque in excess of the maximum given can cause breakage of clutch parts.

Clutch operating shaft torque can be measured by using a spring type scale on a lever of a known length which is installed on the PTO operating shaft. The outermost hole on the A-3361 lever furnished by Twin Disc is 10 inches. The product of the scale reading in pounds to engage the clutch times the lever length in inches to the point the scale was attached is equal to the operating shaft torque in pounds-inches.

IMPROVED FACED CLUTCH PLATE FOR TOP PTO'S

An improved clutch plate is available for the following mechanical top PTO's: X-9807, X-9807-A, X-9804, X-9804-A and X-9804-B.

All of these units formerly used 3790-G faced clutch plate. The 3790-G is now replaced by 3790-H for top PTO use.

The 3790-H is heat treated at the lugs and should produce longer life than the former plate.

It will also be noted that the 3790-H does not contain the wide slots through the clutch facing formerly used on the 3790-G.

MG-512 – MG-514 OUTPUT GEAR REMOVAL 1.5:1 Ratio

The standard method for removing the output gear from the output shaft of MG-512 and MG-514 is to use threaded rods in tapped holes in the gear. The threaded rods pass through cored holes in the main housing. This method of removal is shown in the current manuals.

The 1.5:1 ratio output gear is of such small diameter that it is not possible to place the tapped holes in a location which will align them with the cored holes in the main housing. The holes in the gear cannot be moved out because it would place them too close to the gear OD. The holes in the housing cannot be moved in since it would put them too close to the bearing bore. Therefore, an alternate method of gear removal is provided to be used with the MG-512 and MG-514 1.5:1 ratio.

Figure 1 shows this alternate method.

PROCEDURE TO REMOVE OUTPUT GEAR AND SHAFT

1. Remove the drive spider, bearing retainer, drive and driven reverse gears, and front housing from the marine gear.

2. Remove the three externally wrenched twelve point capscrews and retainer washer from the front end of the output shaft.

3. Set the marine gear on the front section of the marine gear main housing. Properly (safely) support with wood blocks.

4. Remove suction and pressure hoses and the oil pump from the rear of the marine gear. Remove the valve assembly from the manifold.

5. Remove the three hex-head capscrews, retainer washer, shims and lathe-cut seal ring which attach and secure the output flange to the output end of the output shaft.

6. Remove the output flange from the output shaft, using a portable hydraulic puller.

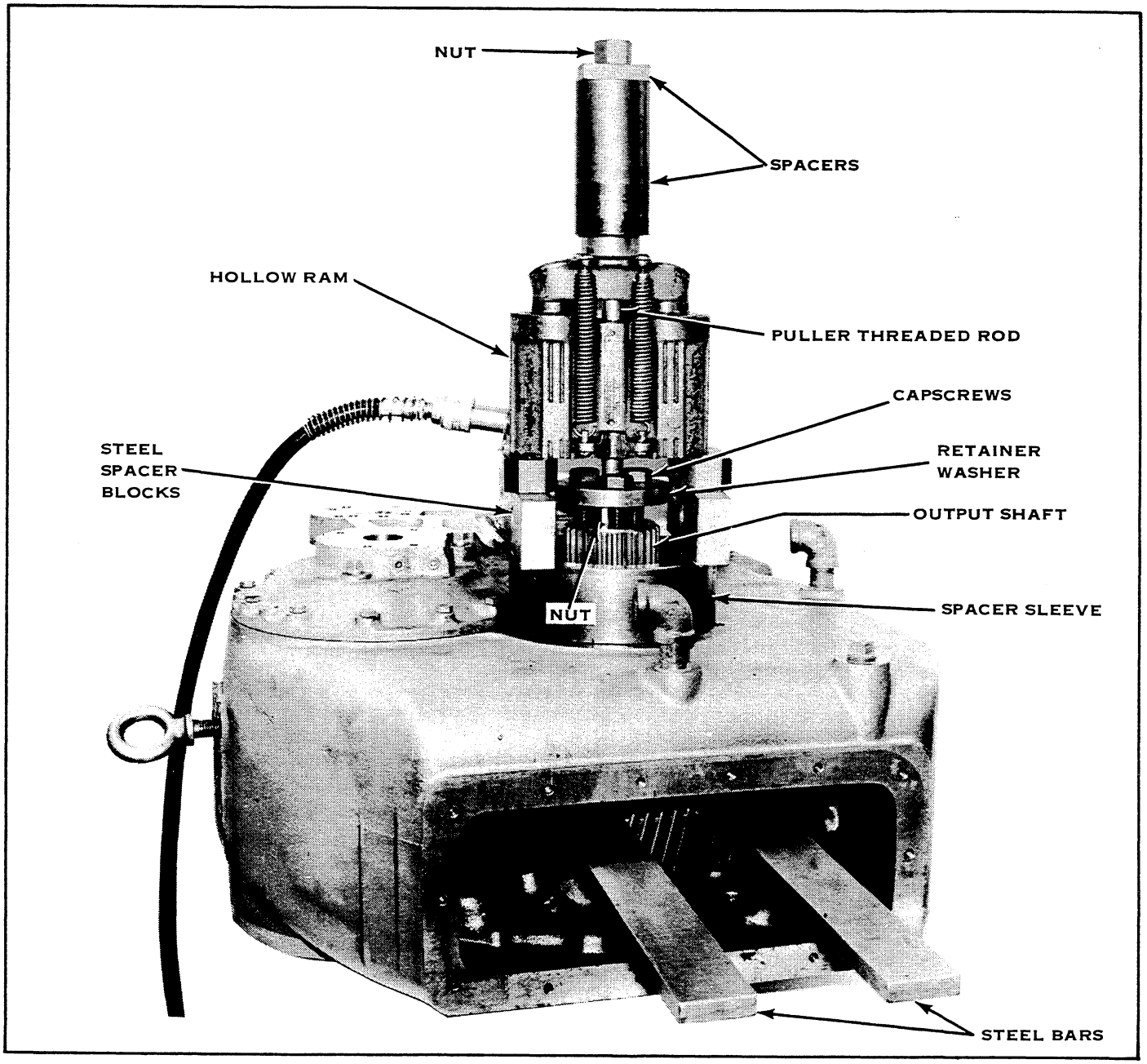
7. Remove the hex-head capscrews which secure the bearing retainer to the main housing around the output shaft. Remove the retainer and shims used to control output shaft bearing end-play.

8. Remove the marine gear bottom cover assembly. Position two 3/4 inch flat steel bars on the hub of the output gear, between the gear and the main housing. This is to restrict the movement of the gear and prevent it from crushing the pinion bearing while pulling. (See Figure 1).

9. Obtain a retainer washer (B-1504-T) from stock and drill a hole approximately 3/4 inches, to fit a heat-treated pulling rod from your portable hydraulic equipment, in the center of the retainer washer.

10. Assemble the modified retainer washer to the pulling threaded rod with a nut flush to the end of the rod. Use the three retainer washer retaining hex-head capscrews and assemble the washer and rod to the end of the output shaft.

11. Using steel bars, sleeves, etc. from press tools or fixtures, rig a hollow-ram type hydraulic puller to attach to the puller rod and marine gear housing. Rig, so the hydraulic-ram pulls on the output shaft while pressing on the marine gear housing. The force created will separate the output gear from the taper fit on the shaft and also push the front roller bearing inner race assembly and the rear bearing cup from the shaft and housing respectively. (See illustration). The output shaft can be removed through its rear bearing bore. The output gear, inner bearing race, key and steel bars can be removed through the bottom cover opening. After the gear separates from the taper of the shaft, the space between the ram and retainer washer must be increased with added spacer material to permit the ram to continue the pulling of the shaft.



INDEXING MG-514 CLUTCHES

The forward and reverse clutches should be indexed to each other so that a release spring in one aligns with the space between springs in the other as the clutches are rotated. Figure 1 shows the clutches properly indexed. Figure 2 shows improper indexing.

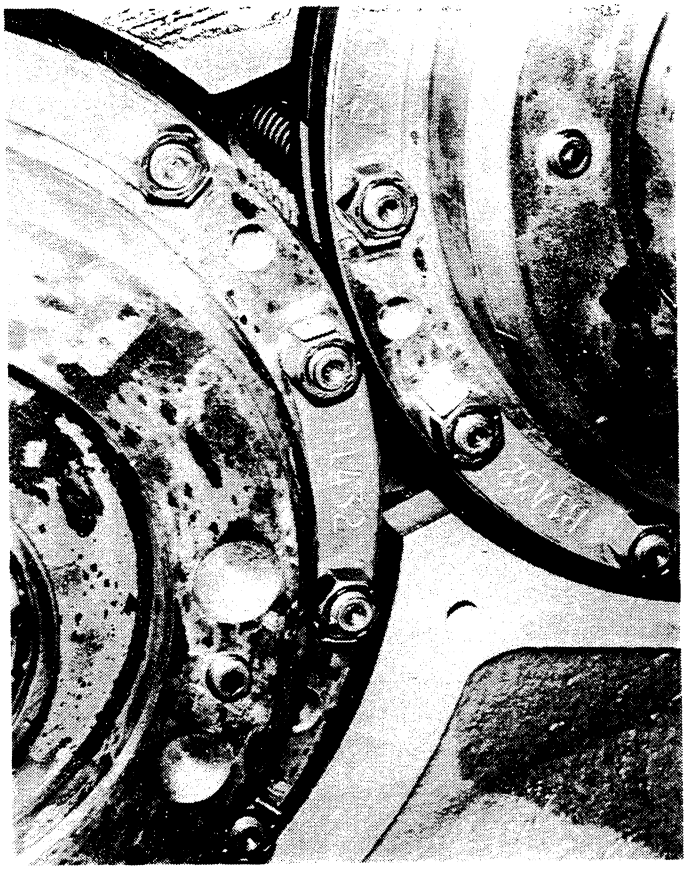


Figure 1. RIGHT.

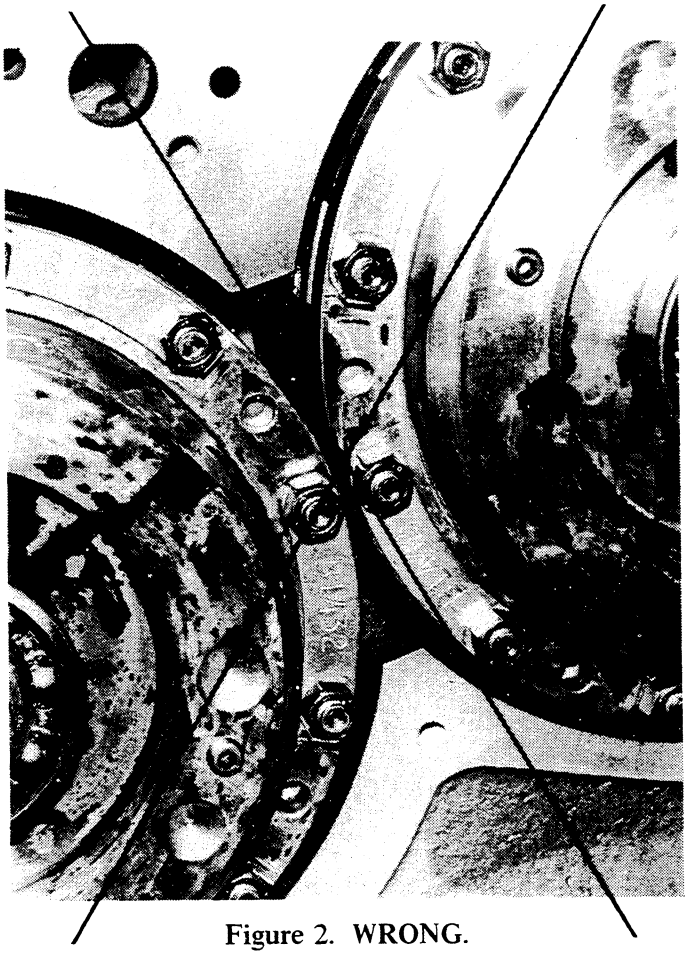


Figure 2. WRONG.

A tool like T-18476 can be used to hold the clutches in proper position before the output gear is meshed with the forward and reverse pinions. Please note that the tool has clearance built in it which allows for spline tooth and gear tooth position variation. A tight fitting tool is not recommended. Figure 3 shows T-18476 in position.

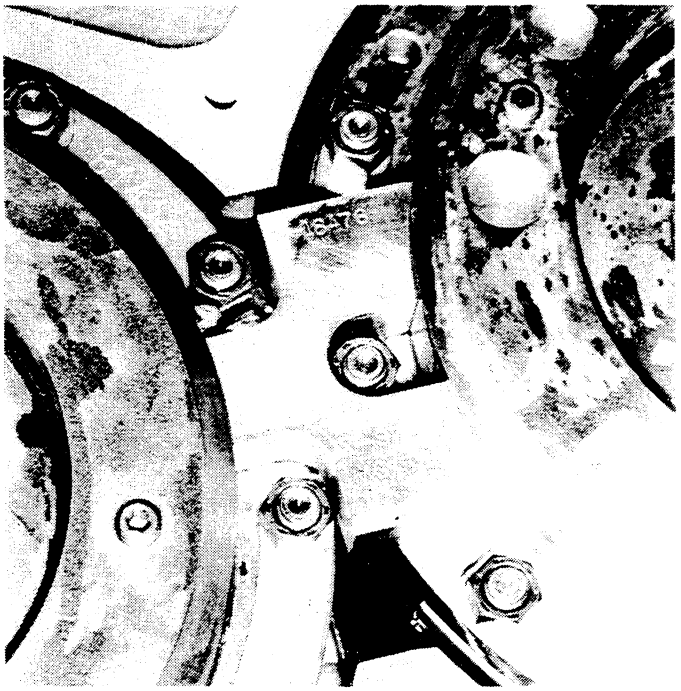
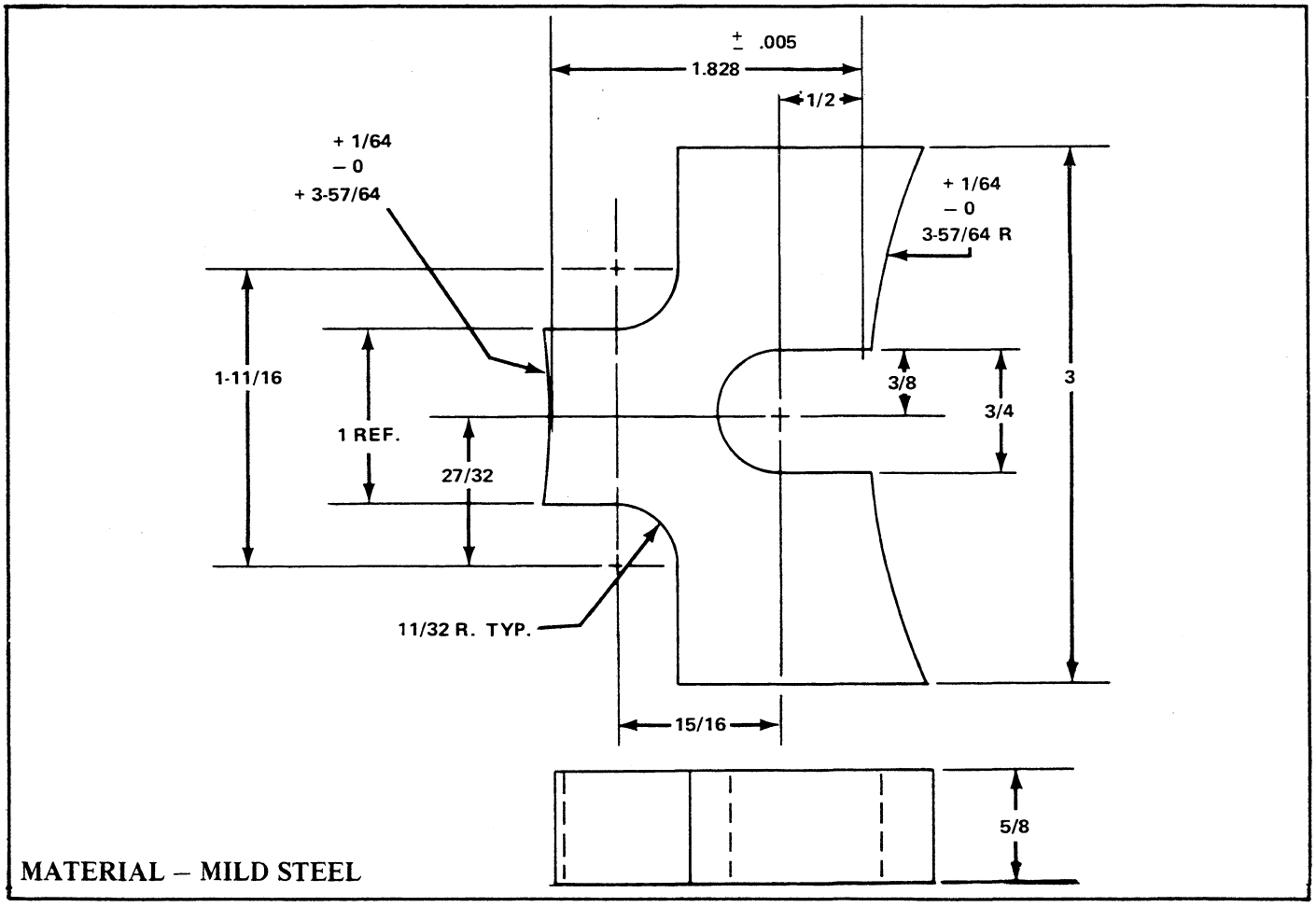


Figure 3. Using T-18476.

Figure 4. T-18476.



MG-514 BEARING AND TRANSFER GEAR CHANGES

M2317A replaced by MA647 for production and service for the MG-514 only.

NOTE

Use the MA647 bearing with the new B5998 transfer gear or the old A6967B transfer gear.

DO NOT use the M2317A bearing with the new B5998 transfer gear.

NOTE

The M2317A bearing is retained for production and service in the MG509. Reason – difference in installed internal running tolerance.

M2465A replaced by MA648 for production and service.

NOTE

Use the MA648 bearing with the new B5997 transfer gear or the old A6966B transfer gear.

DO NOT use the M2465A bearing with the new B5997 transfer gear.

M2466A Replaced by MA649 for production and service.

NOTE

No change on mating housing or pinion gear.

A6966B TRANSFER GEAR – Replaced by XA6966B for service.

XA6966B consists of
- 1 B5997 driving transfer gear
- 1 MA648 ball bearing

NOTE

Use up stock of the old style A6966B gear and mating M2465A bearing only when they will be used together.

DO NOT use old M2465A bearing with new B5997 gear.

A6967B TRANSFER GEAR – Replaced by XA6967B for service.

XA6967B consists of –

1 B5998 driven transfer gear
1 MA647 ball bearing

NOTE

Use up stock of the old style A6967B gear only when it will be used with the M2317A bearing.

DO NOT use the M2317A bearing with the new B5998 gear.

HIGH & LOW SPEED MG-514M MARINE GEARS

Omega MG-514M Marine Gears are built for "high" or "low" speed operation. 1000 – 1750 rpm (FULL LOAD GOVERNED SPEED) is low and 1750 – 2500 rpm is high.

The parts that are different between high and low speed MG-514M are in the Omega dump valve and the pump.

It is possible to change from high to low speed or low to high speed units without extensive marine gear disassembly.

It is suggested that if a change like this is to be made in the field, the specifications of the unit to be changed be compared to the unit desired. This will assure that all parts needed are identified properly.

After the unit has been changed, the name plate should also be changed to include the new specification number.

"L" SHAPED CLUTCH PLATE AVAILABLE FOR MG-514 MARINE TRANSMISSION.

Twin Disc has introduced A6567E steel clutch plate. This plate is wider in the internal tooth area. This will reduce the unit loading on the teeth and will reduce the likelihood of the steel plates notching the hub. A cross-section of the A6567E is shown in Figure 1.

Since the new plates are not symmetrical, they must be assembled in the clutch with the offset facing forward (toward the engine). See Figure 2 for proper assembly.

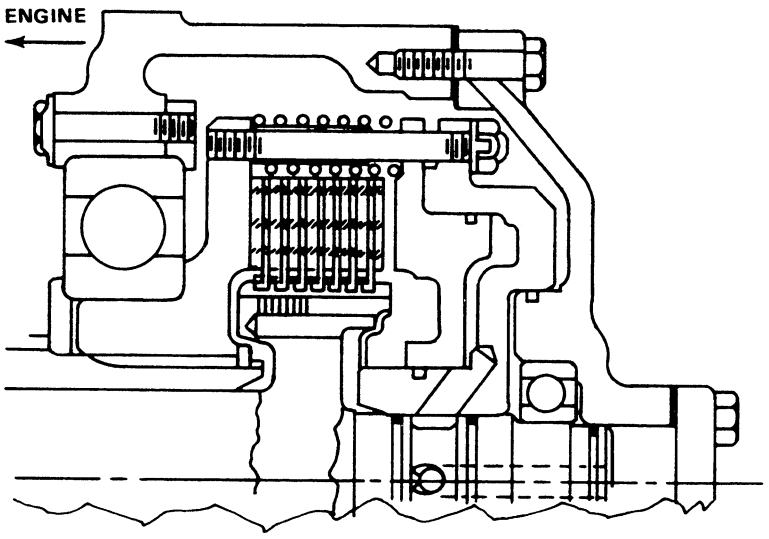


Figure 1.

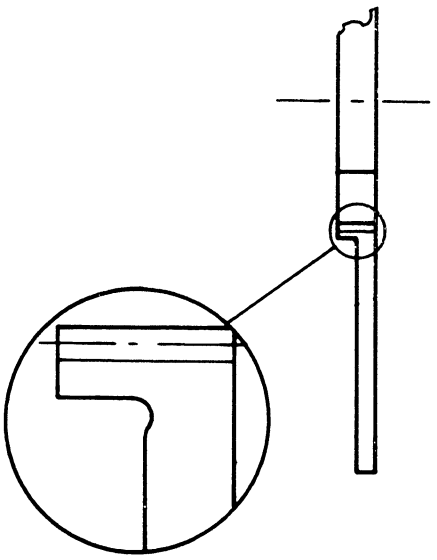


Figure 2.

SPECIAL NOTE: These new clutch plates should not be used on a heavily notched hub. Even though the new plates are wider at the tooth area and would span a notch, the new plate would become notched and could lead to a clutch not releasing.

PREPARATION FOR STORAGE – TWIN DISC MARINE GEARS

It is sometimes necessary to store vessels equipped with Twin Disc Marine Gears or the Marine Gears by themselves. In order to avoid corrosion damage to marine gear components during storage, the following procedure is recommended. In this procedure, any use of special "preservative" oils has been avoided. This has been done for two reasons. They are:

1. "Preservative" oils are not suitable for marine gear normal service operation. If not drained, when placing the vessel back in service, marine gear damage could occur.

2. Recommended transmission oils meeting MIL-L2104C-30 contain a rust inhibitor component which will effectively protect during the usual storage periods (6 months or less).

To prepare Twin Disc Marine Gears for storage up to six months, the following procedure is recommended:

1. Operate the marine gear until temperature is in the normal operating range or 180 degrees F. minimum.
2. Stop engine and completely drain the marine gear.
3. Change marine gear filter elements and clean strainers.
4. Refill marine gear to correct operating oil level with an oil meeting MIL-L2104C-30.

NOTE

Your oil supplier can tell you if the oil you are now using meets the MIL-L2104C-30 specification requirements.

5. After refilling, start engine and shift the marine gear through forward and reverse a couple of times.
6. Shut down engine and place marine gear control valve in neutral position.

7. Seal marine gear breather with water and vapor proof tape, or remove breather, and plug breather hole.

NOTE

It is suggested that a tag be placed at the operator's position, stating that the tape be removed from the breather, or that the breather be re-installed before operating the vessel.

8. To place a vessel back in service, after marine gear preparation for storage as outlined above, it is only necessary to remove the tape from the breather, or remove the plug and re-install the breather.

FOR WORKBOAT MARINE GEARS INSTALLED IN VESSELS, OR MARINE GEARS STORED PRIOR TO INSTALLATION

If the storage period will be longer than six months the following treatment should be given and repeated at six month intervals: Remove the top cover(s) and spray gears and bearings with a coating of MIL-L2104C-30 oil. Rotate input and output shafts manually, as required, to make all surfaces of these components accessible. (Follow procedure step 8 above to place marine gear back in service).

MG-514 TOP POWER TAKE-OFF BOTTOM PLATE

A new bottom plate part number B3543 is available to be used between top PTO's X9804, X9804-A and X9804-B and the marine gears on which they are installed.

This bottom plate should tend to prevent severe marine gear damage in case of top PTO clutch failure.

When plate B3543 is used *do not use gasket B1338-A.* B3543 should be coated at the bolt hole locations on both sides with Plastic Gasket, Twin Disc part number M2828.

It is suggested that the plate be added anytime a top PTO is being overhauled.

IMPORTANT NOTE: The first group of B3543 plates furnished to the field will be made of stainless steel. The stainless steel plates can be easily identified since they will have a protective paper covering on both sides.

NOTE: REMOVE THE PROTECTIVE COVERING FROM BOTH SIDES OF THESE STAINLESS STEEL PLATES.

On the stainless steel plates it will also be necessary to prime the surfaces on which the LOCTITE Plastic Gasket (M2828) is to be used. This is necessary in order to assure curing of the plastic gasket in a reasonable time. Use LOCTITE Locquick T Primer. This primer is available from Twin Disc under part number MA543. Instructions for use of the primer are printed on the container and should be followed.

After the first run of the stainless plates is used up, the plates will be made of shim steel. These will not have the protective covering and will not require the special priming operation.

ENGINE AND PROPELLER ROTATIONS FOR TWIN DISC MARINE GEARS

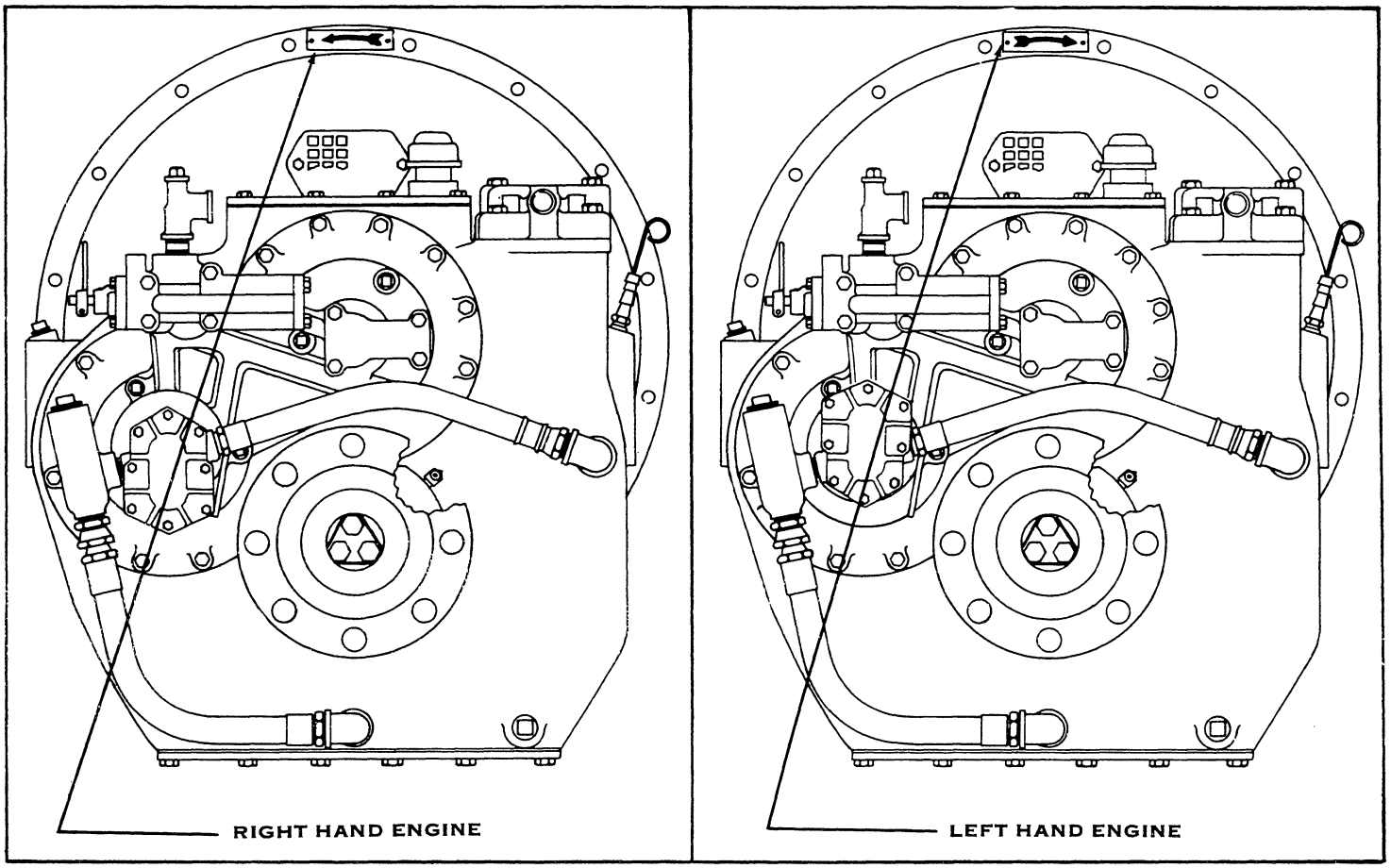
The following marine gear models may be used with either right or left hand rotation engines.

MG508	MG512	MG521
MG509	MG513	MG527
MG511	MG514	MG540

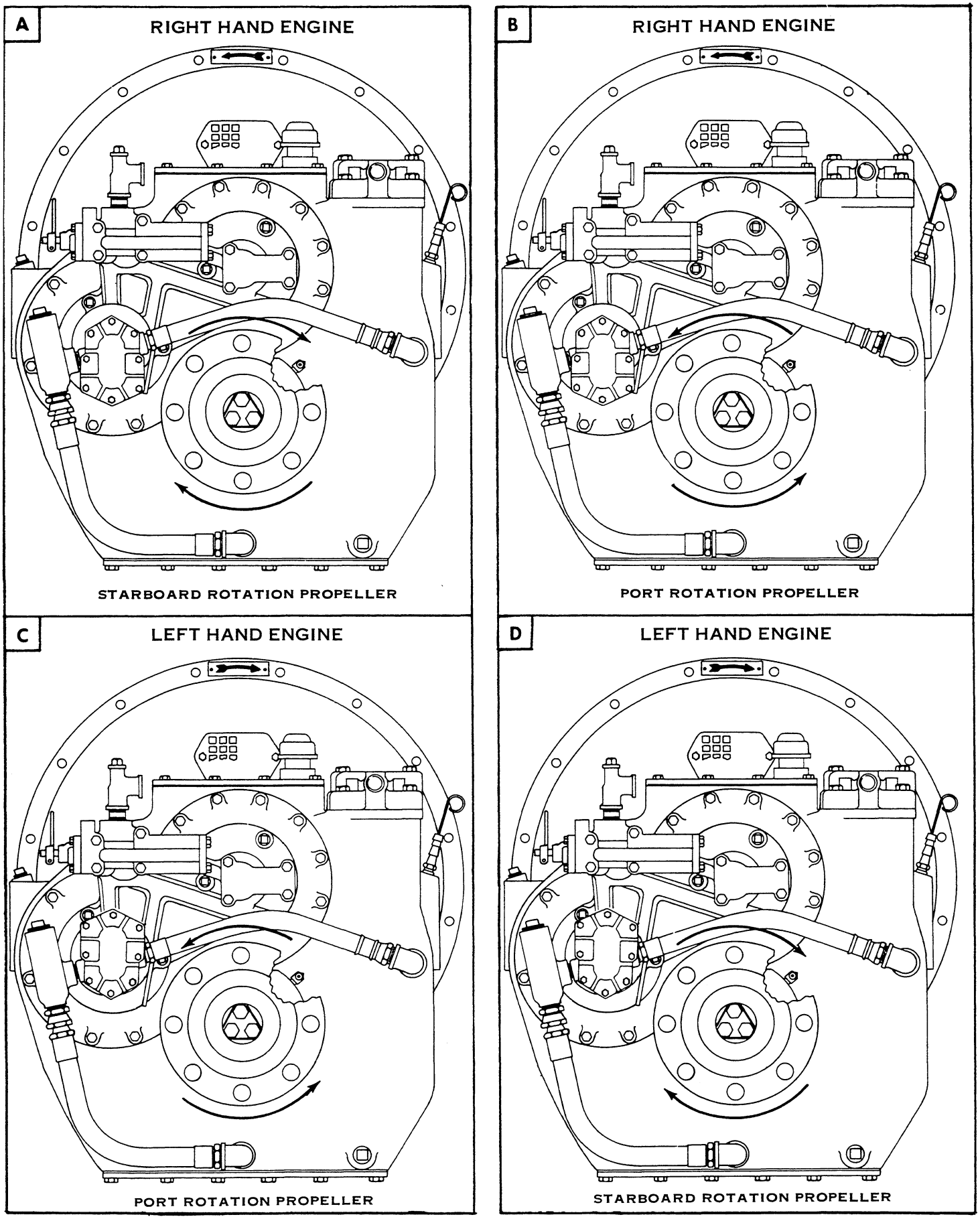
The MG506 is to be used *only* with right hand engines.

The MG506 may *not* be used with left hand engines.

The two views show directions of engine rotation!



The following four views show the possible combinations of engine and propeller rotation, for normal forward propulsion.



The following lists the preferred arrangements:

A. Single engine installations.

1. MG508, MG509, MG511, MG512, MG514, MG521 & MG527, use Condition A.

2. MG506*, MG513 and MG540, use condition B or A.

B. Twin screw installations with engines both of right hand and propellers of opposite rotation use A and B.

C. Twin screw installations using engines of opposite rotation.

1. MG508, MG509, MG511, MG512, MG514, MG521, and MG527, use conditions A and C.

2. MG513 and MG540 conditions A and C are permissible but B and D are preferred.

*As stated above, MG506 units may only be applied to right hand engines. MG506 assemblies with helical gears (production beginning April, 1971, in ratios of 1.5:1, 1.97:1, 2.5:1 and 2.96:1) must be specified according to propeller rotation that will be used, i.e. specify MG506R (right or starboard propeller rotation), if condition A is desired. Specify MG506L (left or port propeller rotation), if condition B is desired.

NOTE: The above information is general. Some applications are not approved for forward propulsion through the marine gear reverse gear train. Consult Twin Disc marine application Engineering Department for specific recommendations.

MG-512 and MG-514 – CHANGING ROTATION

MG-512 and MG-514 marine gears using M2463 pumps can have the hand of rotation changed by rotating the pump 180°. Figure 1 shows the pump mounted for right hand engine rotation. Figure 2 shows the pump mounted for left hand engine rotation.

Figure 1

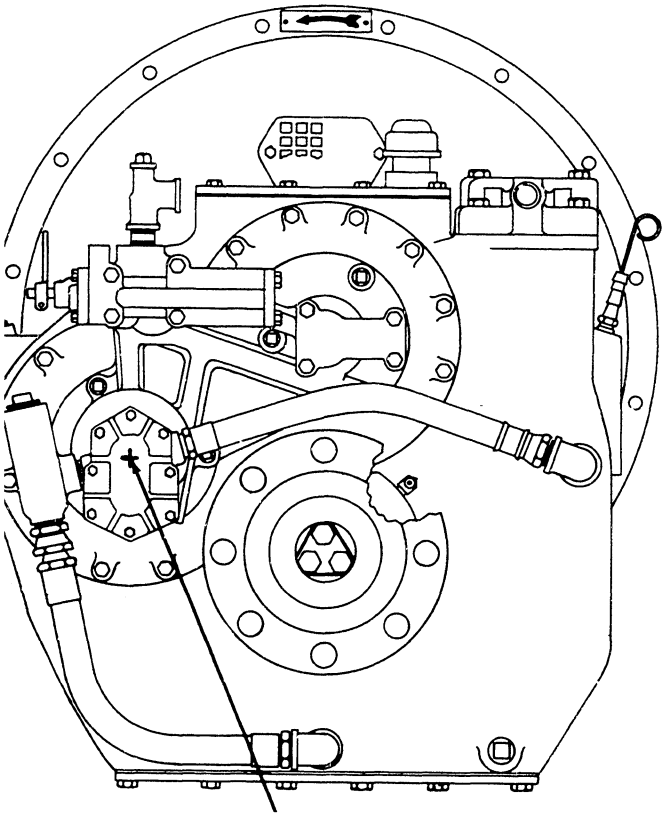
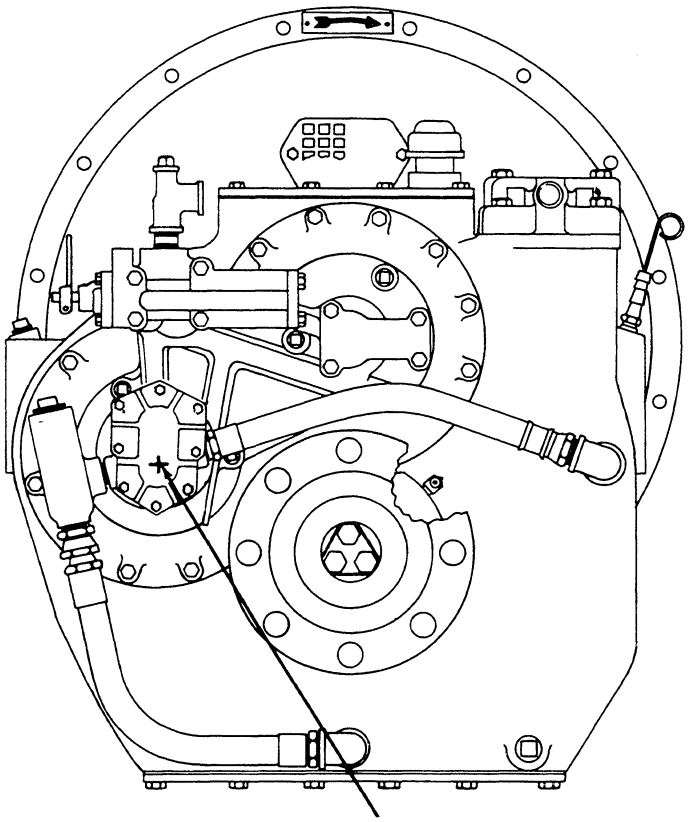


Figure 2



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.

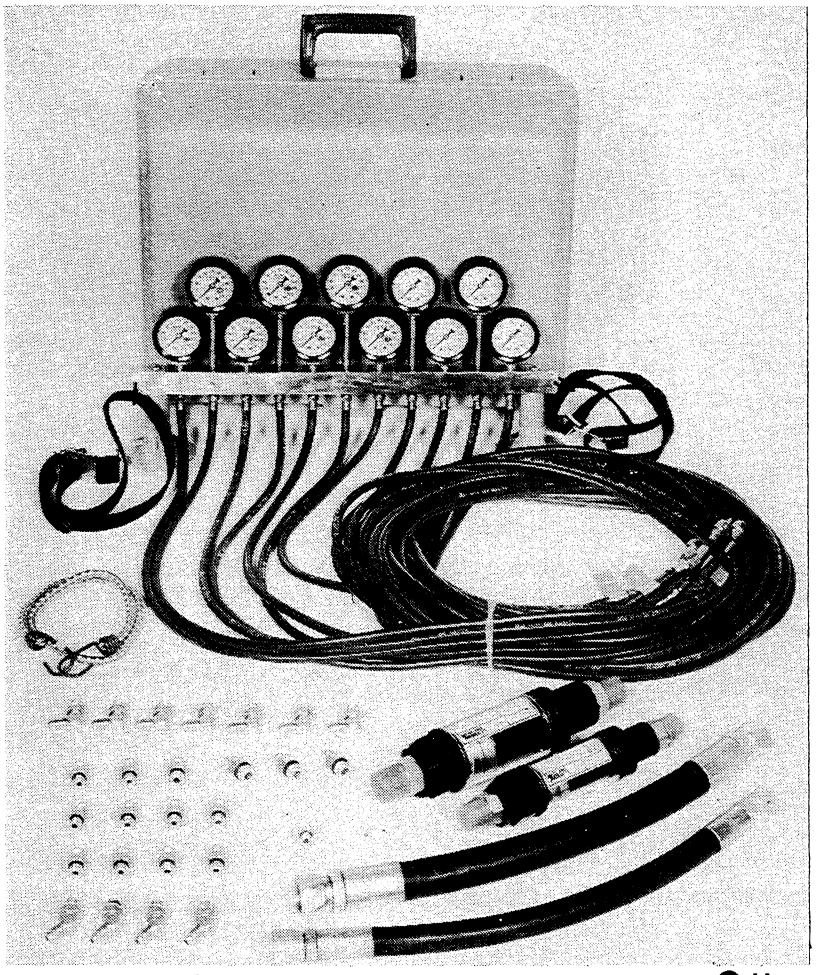
This kit contains a sufficient number of components to trouble shoot the most complicated power-shift transmission hydraulic system. It can, of course, also be used on the simpler systems such as single stage converters and marine gears.

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.



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.**

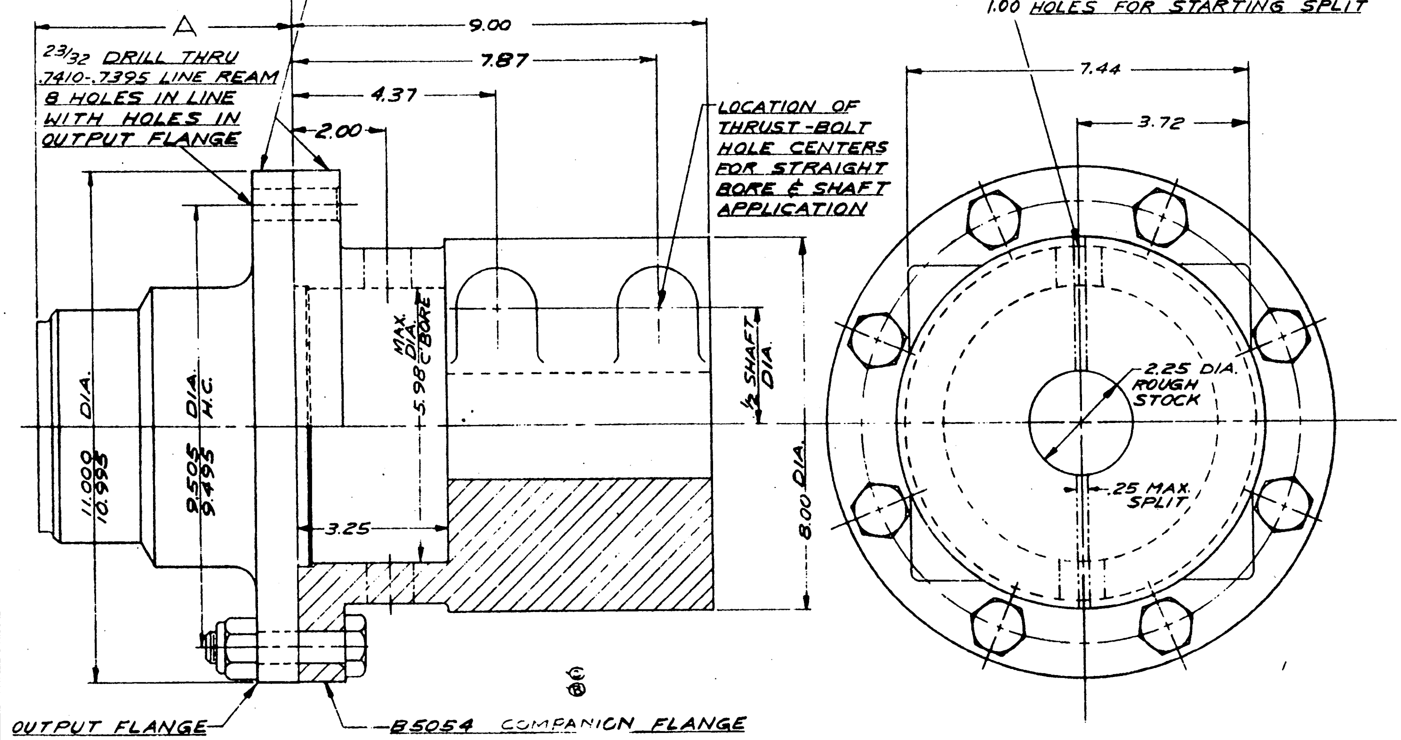
CONTENTS OF KIT 2451

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

Manufactured for Twin Disc, Incorporated by The Nuday Co. 2291 Elliott Ave. Troy, MI 48084

FOR INSTALLATION DIMENSIONS SEE MARINE GEAR INSTALLATION DRAWING

IN EACH LOT RUN, AFTER LINE REAMING HOLES, TO ASSURE PROPER HOLE ALIGNMENT AND ASSEMBLY



ASSY №	8-STOP NUTS-M20241 1-FITTED FLANGE TAG-MA456 WIRE TO COMPANION FLANGE COMPANION FLANGE	OUTPUT FLANGE	DIM. A	USE WITH
XB5054A	B5054	A4411A	5.28	X9664B
XB5054B	B5054	A4806	5.60	X9786
XB5054C	SEE SEPARATE DRAWING ON B5054			
XB5054D	B5054	A4806A	5.60	XA7115
XB5054E				
XB5054F				
XB5054G				
XB5054H				
XB5054J				
XB5054K				
XB5054L				
XB5054M				
XB5054N				
XB5054P				
XB5054Q				
XB5054R				
XB5054S				
XB5054T				
XB5054U				
XB5054V				
XB5054W				
XB5054X				
XB5054Y				
XB5054Z				

RECOMMENDATIONS FOR SPLIT HUB APPLICATIONS:

1. AFTER B5054 IS DRILLED, LINE REAMED, BORED AND KEYWAYED-DRILL 1.00 DIA. HOLES THRU, 180° APART AS SHOWN; SPLIT HUB OF COMPANION FLANGE AND ASSEMBLE TO SHAFT IN AXIAL POSITION REQUIRED

2. WHEN A STRAIGHT BORE IS SELECTED, DRILL 4 HOLES THRU (.75 DIA. TO 1.00 DIA.) FOR THRUST-BOLTS IN LOCATION SHOWN. FIT 4 BOLTS FOR USE AS THRUST DOWELS (.002-.005 LOOSE FIT).

3. KEYWAY TO BE LOCATED ON HORIZONTAL CENTERLINE

4. MAXIMUM BORES - (A) 5.00 DIA. WITH 1.00 SQUARE KEY *
(B) 4.75 DIA. WITH 1.25 SQUARE KEY
(C) 5.25 DIA. WITH 1.00 X .75 RECTANGULAR KEY AND 1½ INCH PER FOOT TAPER

* KEYWAY CORNERS WILL SHOW IN COUNTERBORE

NOTE:
FLANGE O.DIA. AND PILOT DIA. OF B 5054 COMPANION FLANGE) ARE CONCENTRIC WITHIN .002 T.I.R.

Ⓐ

SYM	ZONE	CHANGE	CH NO	DATE	BY
D	A-4	ADDED MA456	19760	5-6-76	JN
C	A-4 C-2	REVISED FITTED FLANGE TAG MA456	18591	2-21-73	KS
B	A-4 C-2	ADDED MA456 TAG	18196	3-30-72	J.S.
A		WAS ...	1834	11-...-	R.K.

PART: FLANGE ASS'Y - COMPANION

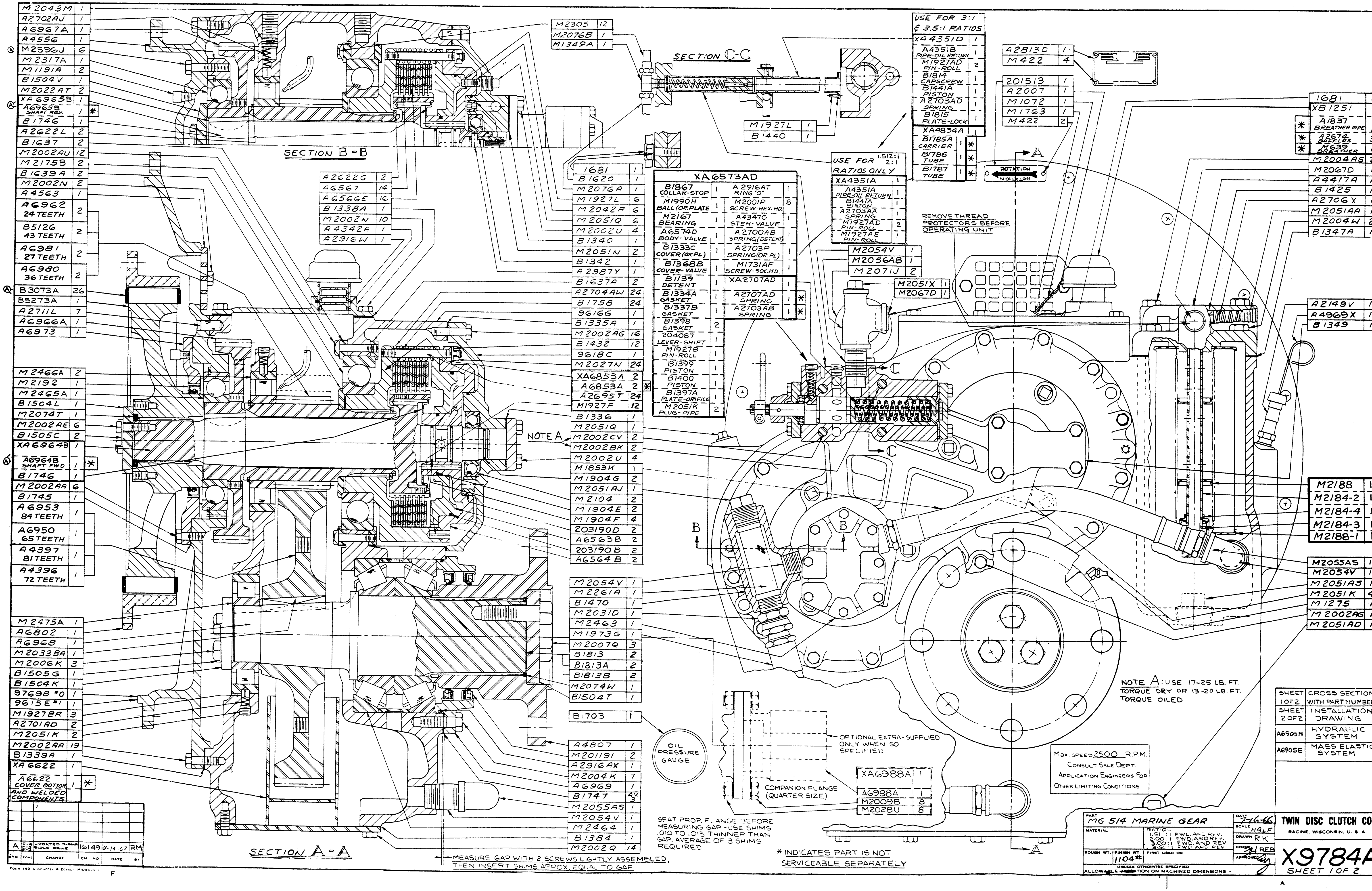
SCALE: HALF

DRAWN: PN

FINISH: AS NOTED

UNLESS OTHERWISE SPECIFIED ALLOWABLE VARIATION ON MACHINED DIMENSIONS ±

XB5054A TO XB5054Z



M2043M 1
A2702AJ 1
A6967A 1
A4556 1
M2596J 6
M2317A 1
M1191A 2
B1504V 1
M2022AT 2
XA6965B 1
A6965B SHAFT REV. 1 *
B1746 1
A2622L 2
B1637 2
M2002AU 12
M2175B 2
B1639A 2
M2002N 2
A4563 1
A6962 24 TEETH 2
B5126 43 TEETH 2
A6981 27 TEETH 2
A6980 36 TEETH 2
B3073A 26
B5273A 1
A2711L 7
A6966A 1
A6973 1
M2466A 2
M2192 1
M2465A 1
B1504L 1
M2074T 1
M2002AE 6
B1505C 2
XA6964B 1
A6964B SHAFT FWD. 1 *
B1746 1
M2002AA 6
B1745 1
A6953 84 TEETH 1
A6950 65 TEETH 1
A4397 81 TEETH 1
A4396 72 TEETH 1
M2475A 1
A6802 1
A6968 1
M2033BA 1
M2006K 3
B1505G 1
B1504K 1
9769B "0 1
9615E "1 1
M1927BR 3
A2701AD 2
M2051K 2
M2002AA 19
B1339A 1
XA6622 1
A6622 COVER BOTTOM AND WELDED COMPONENTS 1 *
SECTION B-B
A2622G 2
A6567 14
A6566E 16
B1338A 1
M2002N 10
A4342A 1
A2916W 1
M2305 12
M2076B 1
M1349A 1
SECTION C-C
M1927L 1
B1440 1
1681 1
B1620 1
M2076A 1
M1927L 6
M2042R 6
M2051Q 6
M2002U 4
B1340 1
M2051N 2
B1342 1
A2987Y 1
B1637A 2
A2704AW 24
B1758 24
9616G 1
B1335A 1
M2002AG 16
B1432 12
9618C 1
M2027N 24
XA6853A 2
A6853A 2 *
A2695T 24
M1927F 12
B1336 1
M2051Q 1
NOTE A
M2002CV 2
M2002BK 2
M2002U 4
M1853K 1
M1904G 2
M2051AJ 1
M2104 2
M1904E 2
M1904F 4
203190D 2
A6563B 2
203190B 2
A6564B 2
M2054V 1
M2261A 1
B1470 1
M2031D 1
M2463 1
M1973G 1
M2007Q 3
B1813 2
B1813A 2
B1813B 2
M2074W 1
B1504T 1
B1703 1
OIL PRESSURE GAUGE
A4807 1
M201191 2
A2916AX 1
M2004K 7
A6969 1
B1747 AV. 3
M2055AS 1
M2054V 1
M2464 1
B1384 1
M2002Q 14
SECTION A-A
MEASURE GAP WITH 2 SCREWS LIGHTLY ASSEMBLED, THEN INSERT SHIMS APPROX. EQUAL TO GAP
XA6573AD
B1867 COLLAR-STOP 1
A2916AT RING "O" 1
M1990H BALL (OR PLATE) 1
M2001P SCREW-HEX.HD. 8
M2167 BEARING 1
A4347G STEM-VALVE 1
A6574D BODY-VALVE 1
A2700AB SPRING (DETENT) 1
B1333C COVER (OK PL) 1
A2703P SPRING (OR PL) 1
B1368B COVER-VALVE 1
M1731AF SCREW-SOC.HD. 1
B1139 DETENT 1
XA2707AD
B1334A GASKET 1
A2707AD SPRING 1 *
B1337B GASKET 1
A2703AB SPRING 1 *
B1398 GASKET 2
204087 LEVER-SHIFT 1
M1927B PIN-ROLL 1
B1399 PISTON 1
B1400 PISTON 1
B1397A PLATE-ORIFICE 1
M2051K PLUG-PIPE 2
USE FOR 3:1 & 3.5:1 RATIOS
XA4351D 1
A4351B PIPE-OIL RETURN 1
M1927AD PIN-ROLL 2
B1814 CAPSCREW 1
B1441A PISTON 1
A2703AD SPRING 1
B1815 PLATE-LOCK 1
XA4834A 1
B1785A CARRIER 1 *
B1786 TUBE 1 *
B1787 TUBE 1 *
USE FOR 1.51:1 2:1 RATIOS ONLY
XA4351A 1
A4351A PIPE-OIL RETURN 1
B1441A PISTON 1
A2703AA SPRING 1
M1927AD PIN-ROLL 2
M1927AE PIN-ROLL 1
M2054V 1
M2056AB 1
M2071J 2
M2051X 1
M2067D 1
A2813D 1
M422 4
201513 1
A2007 1
M1072 1
M1763 1
M422 2
ROTATION
REMOVE THREAD PROTECTORS BEFORE OPERATING UNIT
1681 1
XB1251 1
A1837 BREATHER PIPE 1 *
A2674 BAFFLES 3 *
M635 BREATHER 1 *
M2004AS 2
M2067D 1
A4417A 1
B1425 1
A2706X 1
M2051AA 1
M2004W 2
B1347A 1
A2149V 1
A4969X 1
B1349 1
M2188 1
M2184-2 1
M2184-4 1
M2184-3 1
M2188-1 1
M2055AS 1
M2054V 1
M2051AS 1
M2051K 4
M1275 1
M2002AG 1
M2051AD 1
NOTE A: USE 17-25 LB. FT. TORQUE DRY OR 13-20 LB. FT. TORQUE OILED
OPTIONAL EXTRA - SUPPLIED ONLY WHEN SO SPECIFIED
COMPANION FLANGE (QUARTER SIZE)
XA6988A 1
A6988A 1
M2009B 8
M2028U 8
SEAT PROP. FLANGE BEFORE MEASURING GAP - USE SHIMS .010 TO .015 THINNER THAN GAP. AVERAGE OF 3 SHIMS REQUIRED
* INDICATES PART IS NOT SERVICEABLE SEPARATELY
Max. SPEED 2500 R.P.M. Consult Sale Dept. Application Engineers For Other Limiting Conditions
SHEET 1 OF 2 CROSS SECTION WITH PART NUMBERS
SHEET 2 OF 2 INSTALLATION DRAWING
A6905M HYDRAULIC SYSTEM
A6905E MASS ELASTIC SYSTEM
A F-2 UPDATED RUBBER BLOCK DRIVE 16149 8-14-67 RM
SYM ZONE CHANGE CH NO DATE BY
MG 514 MARINE GEAR
RATIO 1.51:1 FWD. AND REV. 2.00:1 FWD. AND REV. 3.00:1 FWD. AND REV. 3.50:1 FWD. AND REV.
FINISH WT. 1104#
DATE 7-16-66
SCALE HALF
DRAWN RK
TWIN DISC CLUTCH CO. RACINE, WISCONSIN, U.S.A.
X9784A
SHEET 1 OF 2

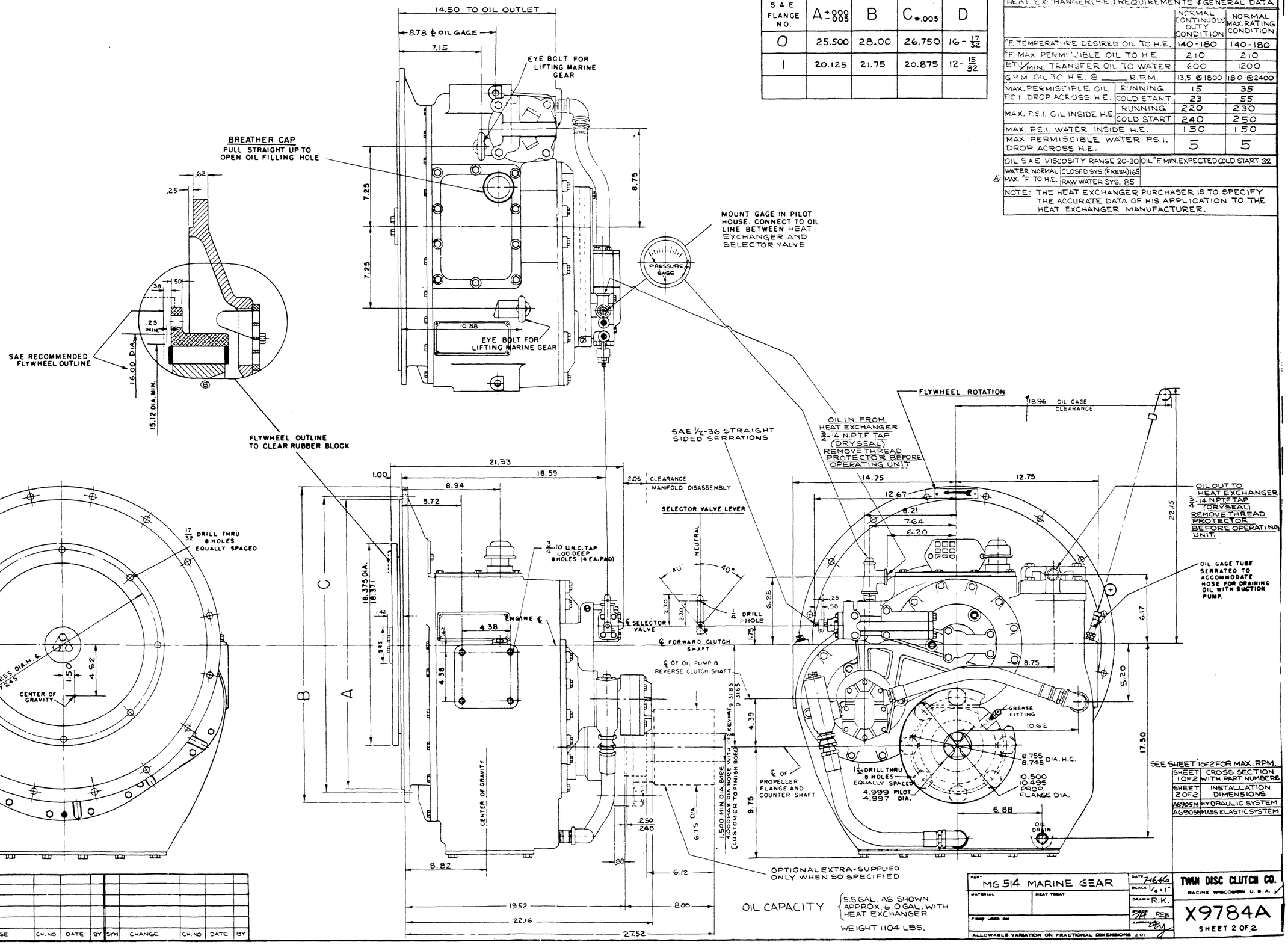
S.A.E. FLANGE NO.	A +.000 −.005	B	C ±.005	D
0	25.500	28.00	26.750	16 - 17/32
1	20.125	21.75	20.875	12 - 15/32

HEAT EXCHANGER (H.E.) REQUIREMENTS & GENERAL DATA		NORMAL CONTINUOUS DUTY CONDITION	NORMAL MAX. RATING CONDITION
°F. TEMPERATURE DESIRED OIL TO H.E.		140-180	140-180
°F. MAX. PERMISSIBLE OIL TO H.E.		210	210
BTU/MIN. TRANSFER OIL TO WATER		600	1200
G.P.M. OIL TO H.E. @ ____ R.P.M.		13.5 @1800	180 @2400
MAX. PERMISSIBLE OIL P.S.I. DROP ACROSS H.E.	RUNNING	15	35
	COLD START	23	55
MAX. P.S.I. OIL INSIDE H.E.	RUNNING	220	230
	COLD START	240	250
MAX. P.S.I. WATER INSIDE H.E.		150	150
MAX. PERMISSIBLE WATER P.S.I. DROP ACROSS H.E.		5	5

OIL S.A.E. VISCOSITY RANGE 20-30 OIL °F. MIN. EXPECTED COLD START 32

WATER NORMAL MAX. °F TO H.E.	
	CLOSED SYS. (FRESH) 165
	RAW WATER SYS. 85

NOTE: THE HEAT EXCHANGER PURCHASER IS TO SPECIFY THE ACCURATE DATA OF HIS APPLICATION TO THE HEAT EXCHANGER MANUFACTURER.



OIL CAPACITY { 5.5 GAL. AS SHOWN. APPROX. 6.0 GAL. WITH HEAT EXCHANGER

WEIGHT 1104 LBS.

SEE SHEET 1 OF 2 FOR MAX. RPM.

SHEET	
SHEET 1 OF 2	CROSS SECTION WITH PART NUMBERS
SHEET 2 OF 2	INSTALLATION DIMENSIONS
A6905N	HYDRAULIC SYSTEM
A6905E	MASS ELASTIC SYSTEM

SYM	CHANGE	CH. NO.	DATE	BY
B	UPDATED RUBBER BLOCK DRIVE	16149	8-14-67	RM
A	NOTE REVISED	16041	5-8-67	JTV

PART MG 514 MARINE GEAR

MATERIAL | HEAT TREAT

FIRST USED ON

ALLOWABLE VARIATION ON FRACTIONAL DIMENSIONS ±.01

DATE 7/6/66

SCALE 1/8 = 1"

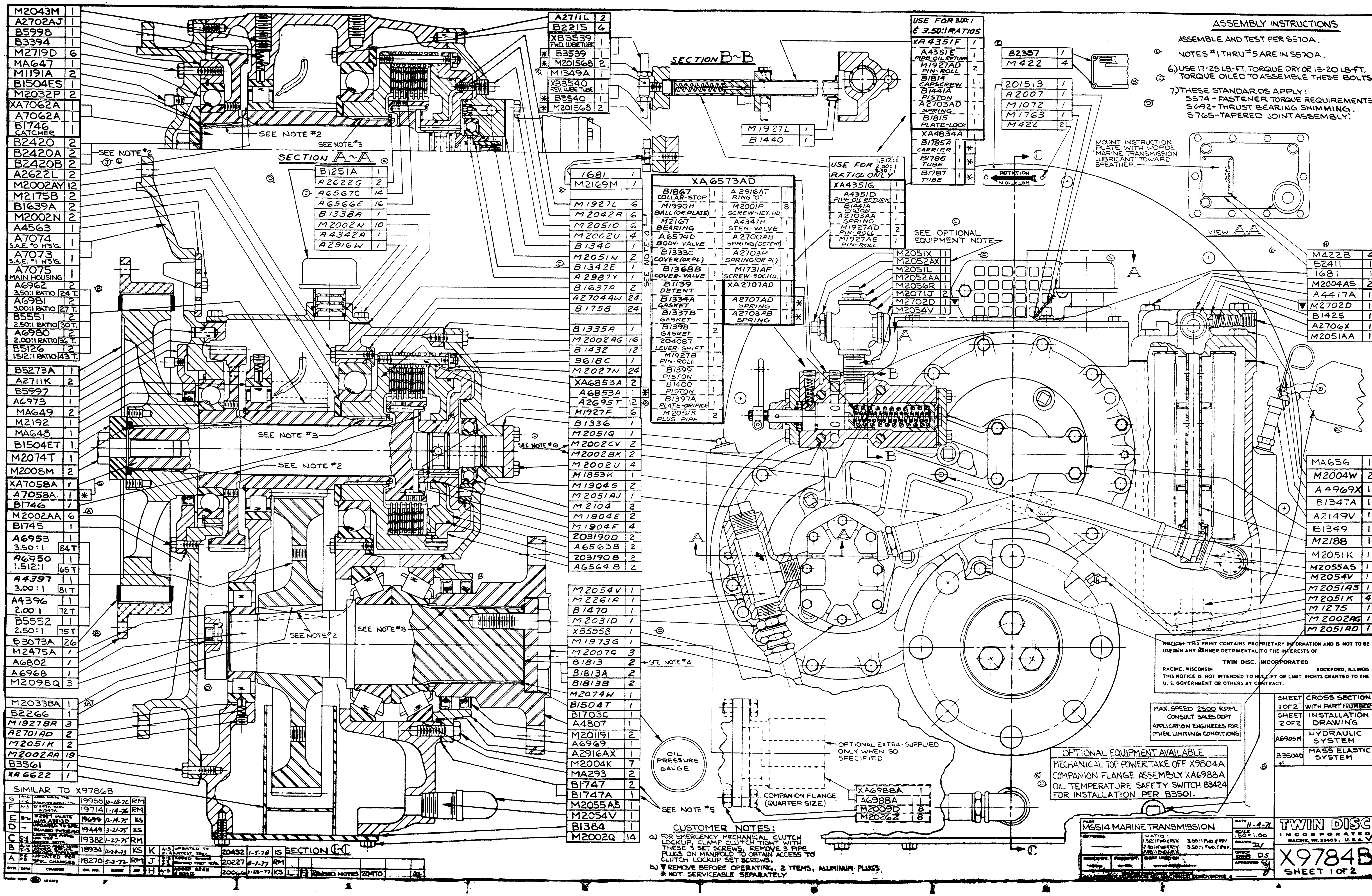
DRAWN R.K.

CHECKED RFB

APPROVED

TWIN DISC CLUTCH CO.
RACINE WISCONSIN U.S.A.

X9784A
SHEET 2 OF 2


M2043M 1
A2702AJ 1
B5998 1
B3394 1
M2719D 6
MA647 1
M1191A 2
B1504ES 1
M2032P 2
XA7062A 1
A7062A 1
B1746 CATCHER 1
B2420 2
B2420A 2
B2420B 2
A2622L 2
M2002AY 12
M2175B 2
B1639A 2
M2002N 2
A4563 1
A7074 S.A.E. "0 H'S'G. 1
A7073 S.A.E. "1 H'S'G. 1
A7075 MAIN HOUSING 1
A6962 3.50:1 RATIO 2 24 T.
A6981 3.00:1 RATIO 2 27 T.
B5551 2.50:1 RATIO 2 30 T.
A6980 2.00:1 RATIO 2 36 T.
B5126 1.512:1 RATIO 2 43 T.
B5273A 1
A2711K 2
B5997 1
A6973 1
MA649 2
M2192 1
MA648 1
B1504ET 1
M2074T 1
M2008M 2
XA7058A 1
A7058A 1 *
B1746 1
M2002AA 6
B1745 1
A6953 3.50:1 1 84 T
A6950 1.512:1 1 65 T
A4397 3.00:1 1 81 T
A4396 2.00:1 1 72 T
B5552 2.50:1 1 75 T
B3073A 26
M2475A 1
A6802 1
A6968 1
M2098Q 3
M2033BA 1
B2266 1
M1927BR 3
A2701AD 2
M2051K 2
M2002AA 19
B3561 1
XA6622 1
SIMILAR TO X9786B
SEE NOTE #2
SEE NOTE #3
SECTION A~A
B1251A 1
A2622G 2
A6567C 14
A6566E 16
B1338A 1
M2002N 10
A4342A 1
A2916W 1
A2711L 2
B2215 6
XB3539 FWD. LUBE TUBE 1
B3539 1 *
M201568 2
M1349A 1
XB3540 REV. LUBE TUBE 1
B3540 1 *
M201568 2
SECTION B~B
M1927L 1
B1440 1
1681 1
M2169M 1
M1927L 6
M2042R 6
M2051Q 6
M2002U 4
B1340 1
M2051N 2
B1342E 1
A2987Y 1
B1637A 2
A2704AW 24
B1758 24
SEE NOTE 4
B1335A 1
M2002AG 16
B1432 12
9618C 1
M2027N 24
XA6853A 2
A6853A 1 *
A2695T 12
M1927F 6
B1336 1
M2051Q 1
M2002CV 2
M2002BK 2
M2002U 4
M1853K 1
M1904G 2
M2051AJ 1
M2104 2
M1904E 2
M1904F 4
2031900 2
A6563B 2
2031908 2
A6564B 2
SEE NOTE #6
M2054V 1
M2261A 1
B1470 1
M2031D 1
XB5958 1
M1973G 1
M2007Q 3
B1813 2
B1813A 2
B1813B 2
M2074W 1
B1504T 1
B1703C 1
A4807 1
M201191 2
A6969 1
A2916AX 1
M2004K 7
MA293 2
B1747 2
B1747A 1
M2055AS 1
M2054V 1
B1384 1
M2002Q 14
SEE NOTE #4
SEE NOTE #5
SECTION C-C
OIL PRESSURE GAUGE
XA6573AD
B1867 COLLAR-STOP 1
A2916AT RING "O" 1
M1990H BALL (OR PLATE) 1
M2001P SCREW-HEX. HD. 8
M2167 BEARING 1
A4347H STEM-VALVE 1
A6574D BODY-VALVE 1
A2700AB SPRING (DETENT) 1
B1333C COVER (OR PL.) 1
A2703P SPRING (OR PL.) 1
B1368B COVER-VALVE 1
M1731AF SCREW-SOC. HD. 1
B1139 DETENT 1
XA2707AD
B1334A GASKET 1
A2707AD SPRING 1 *
B1337B GASKET 1
A2703AB SPRING 1 *
B1398 GASKET 2
204087 LEVER-SHIFT 1
M1927B PIN-ROLL 1
B1399 PISTON 1
B1400 PISTON 1
B1397A PLATE-ORIFICE 1
M2051K PLUG-PIPE 2
USE FOR 3.00:1 & 3.50:1 RATIOS
XA4351F 1
A4351E PIPE-OIL RETURN 1
M1927AD PIN-ROLL 2
B1814 CAPSCREW 1
B1441A PISTON 1
A2703AD SPRING 1
B1815 PLATE-LOCK 1
XA4834A 1
B1785A CARRIER 1 *
B1786 TUBE 1 *
B1787 TUBE 1 *
USE FOR 1.512:1 2.00:1 2.50:1 RATIOS ONLY
XA4351G 1
A4351D PIPE-OIL RETURN 1
B1441A PISTON 1
A2703AA SPRING 1
M1927AD PIN-ROLL 2
M1927AE PIN-ROLL 1
B2387 1
M422 4
201513 1
A2007 1
M1072 1
M1763 1
M422 2
ROTATION
SEE OPTIONAL EQUIPMENT NOTE
M2051X 1
M2052AX 1
M2051L 1
M2052AA 1
M2056R 1
M2071J 2
M2702D 1
M2054V 1
ASSEMBLY INSTRUCTIONS
ASSEMBLE AND TEST PER S570A.
NOTES #1 THRU #5 ARE IN S570A.
6.) USE 17-25 LB-FT TORQUE DRY OR 13-20 LB-FT. TORQUE OILED TO ASSEMBLE THESE BOLTS.
7.) THESE STANDARDS APPLY:
S574 - FASTENER TORQUE REQUIREMENTS.
S692 - THRUST BEARING SHIMMING.
S765 - TAPERED JOINT ASSEMBLY.
MOUNT INSTRUCTION PLATE WITH WORDS "MARINE TRANSMISSION LUBRICANT" TOWARD BREATHER.
VIEW A-A
M422B 4
B2411 1
1681 1
M2004AS 2
A4417A 1
M2702D 1
B1425 1
A2706X 1
M2051AA 1
MA656 1
M2004W 2
A4969X 1
B1347A 1
A2149V 1
B1349 1
M2188 1
M2051K 1
M2055AS 1
M2054V 1
M2051AS 1
M2051K 4
M1275 1
M2002AG 1
M2051AD 1
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.
MAX. SPEED 2500 R.P.M. CONSULT SALES DEPT. APPLICATION ENGINEERS FOR OTHER LIMITING CONDITIONS
SHEET 1 OF 2 CROSS SECTION WITH PART NUMBERS
SHEET 2 OF 2 INSTALLATION DRAWING
A6905N HYDRAULIC SYSTEM
B3504D MASS ELASTIC SYSTEM
OPTIONAL EQUIPMENT AVAILABLE
MECHANICAL TOP POWER TAKE OFF X9804A
COMPANION FLANGE ASSEMBLY XA6988A
OIL TEMPERATURE SAFETY SWITCH B3424
FOR INSTALLATION PER B3501.
OPTIONAL EXTRA - SUPPLIED ONLY WHEN SO SPECIFIED
COMPANION FLANGE (QUARTER SIZE)
XA6988A 1
A6988A 1
M2009D 8
M2026Z 8
CUSTOMER NOTES:
a) FOR EMERGENCY MECHANICAL CLUTCH LOCKUP, CLAMP CLUTCH TIGHT WITH THESE 3 SET SCREWS. REMOVE 3 PIPE PLUGS ON MANIFOLD TO OBTAIN ACCESS TO CLUTCH LOCKUP SET SCREWS.
b) ▼ REMOVE BEFORE OPERATING, 2 ITEMS, ALUMINUM PLUGS
* NOT SERVICEABLE SEPARATELY
MG514 MARINE TRANSMISSION
TWIN DISC INCORPORATED RACINE, WI. 53403, U.S.A.
X9784B
SHEET 1 OF 2
11-4-71
REVISED NOTES 20470

S.A.E. HOUSING NO.	A	B	C	D	E
0	25.500 25.495	28.00	26.750	16-$\frac{17}{32}$ DIA.	.62
1	20.125 20.120	21.75	20.875	12-$\frac{15}{32}$ DIA.	.56

HEAT EXCHANGER (H.E.) REQUIREMENTS AND GENERAL DATA

MAX. & MIN. PERMISSIBLE OIL TEMP. INTO H.E.	210-150 °F.
MIN. RECOMMENDED TRANSFER CAPACITY (MULTIPLY BY 1.25 FOR FRESH WATER) (" " 2.00 " RAW WATER)	315 B.T.U. PER MINUTE PER 1000 ENGINE R.P.M. AT PROP. MATCH POINT.
OIL TO HEAT EXCHANGER (USE RPM RATIO FOR RATIOING GPM)	18 G.P.M. AT 2400 R.P.M.
MAX PEAK OIL PRESSURE AT H.E. (USE 1.5 TIMES P.S.I. FOR PROOF TEST OF H.E.)	285 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 1.5 TO 3.0 TIMES OIL G.P.M.	

DATA PURCHASER OF H.E. SHOULD PROVIDE:

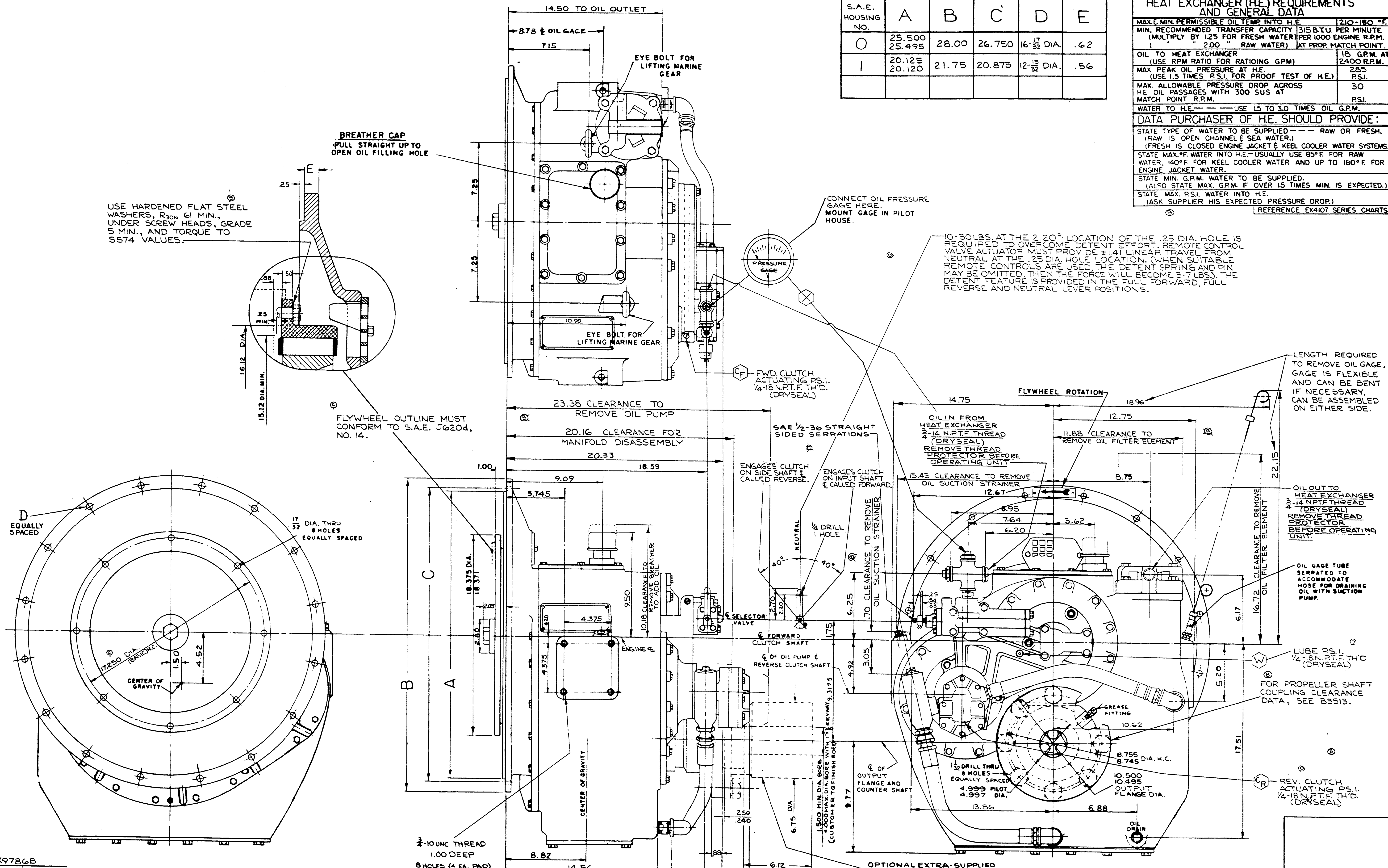
STATE TYPE OF WATER TO BE SUPPLIED — — — RAW OR FRESH.
(RAW IS OPEN CHANNEL & SEA WATER.)
(FRESH IS CLOSED ENGINE JACKET & KEEL COOLER WATER SYSTEMS.)

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 1.5 TIMES MIN. IS EXPECTED.)

STATE MAX. P.S.I. WATER INTO H.E.
(ASK SUPPLIER HIS EXPECTED PRESSURE DROP.)

REFERENCE EX4107 SERIES CHARTS.

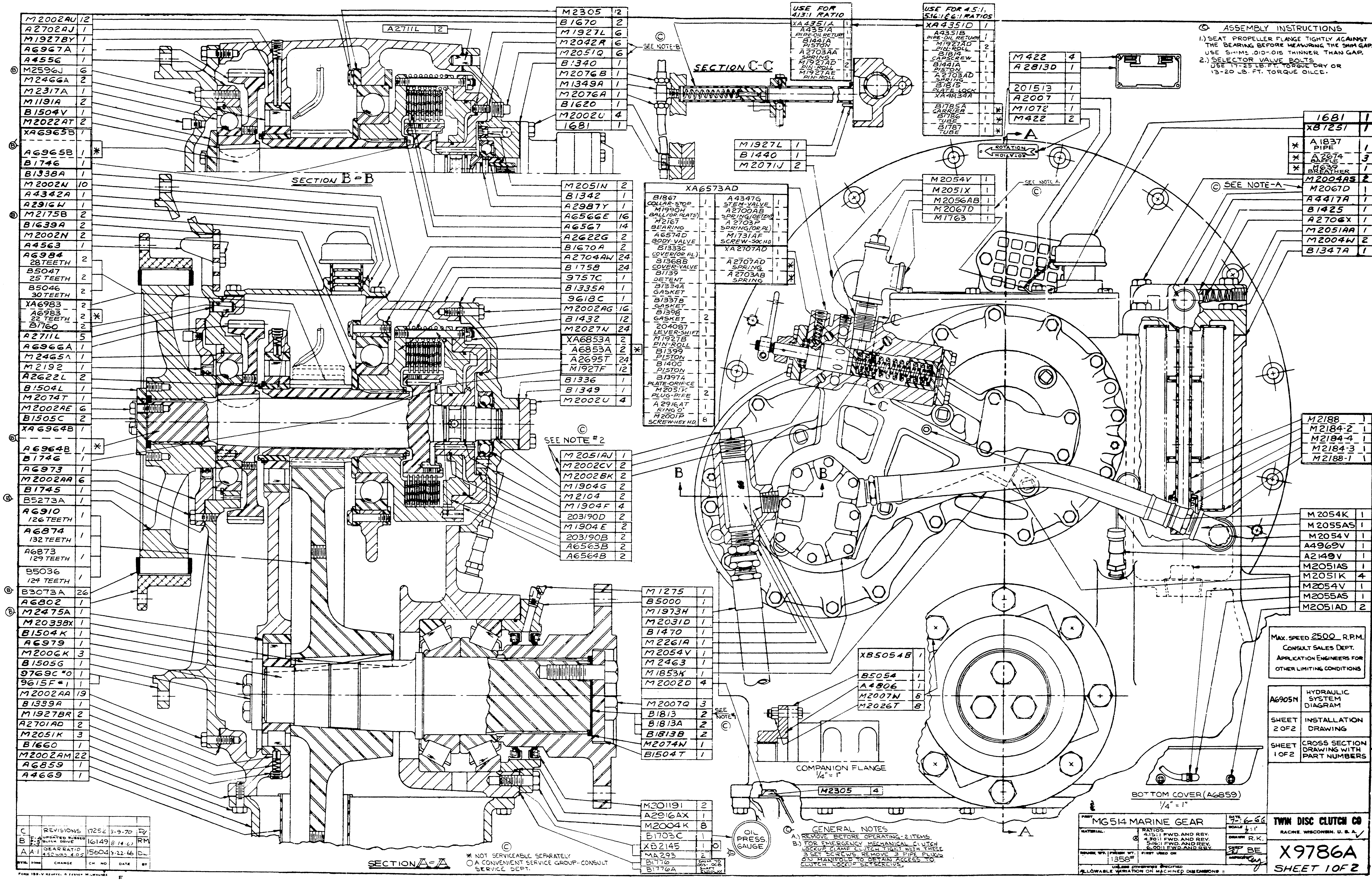


SIMILAR TO X9786B

SYM.	ZONE	CHANGE	CH. NO.	DATE	BY
D	C-3 C-4	ADDED NOTES AND SYMBOLS	20432	1-5-78	KS
C	E-4 F-2	REVISED FLYWHEEL NOTE & BOLT CIRCLE FOR DRIVING RING	20227	8-1-77	RM
B	A-3 C-3 E-3	REVISED H.E. DATA ADDED DIMS.	19540	7-17-75	RM
A	A-2	REMOVED SHEET DESIGNATION BLOCKS	18934	11-19-73	KS

NOTE:
ALL POINTS AVAILABLE FOR TESTING ARE CODED ⬡.

PART: MG514 MARINE TRANSMISSION		DATE 11-4-71	TWIN DISC INCORPORATED RACINE, WI. 53403, U.S.A.
MATERIAL	HEAT TREAT	SCALE .25=1.00	
		DRAWN DV	
ROUGH WT. / FINISH WT.	FIRST USED ON	CHECK REB DS	X9784B
		APPROVED	SHEET 2 OF 2
UNLESS OTHERWISE SPECIFIED ALLOWABLE VARIATION ON MACHINED DIMENSIONS ±.010			



M2002AU	12
A2702AJ	1
M1927BY	1
A6967A	1
A4556	1
M2596J	6
M2466A	2
M2317A	1
M1191A	2
B1504V	1
M2022AT	2
XA6965B	1
A6965B *	1
B1746	1
B1338A	1
M2002N	10
A4342A	1
A2916W	1
M2175B	2
B1639A	2
M2002N	2
A4563	1
A6984 28 TEETH	2
B5047 25 TEETH	2
B5046 30 TEETH	2
XA6983	2
A6983 22 TEETH *	2
B1760	2
A2711L	5
A6966A	1
M2465A	1
M2192	1
A2622L	2
B1504L	1
M2074T	1
M2002AE	6
B1505C	2
XA6964B	1
A6964B *	1
B1746	1
A6973	1
M2002AA	6
B1745	1
B5273A	1
A6910 126 TEETH	1
A6874 132 TEETH	1
A6873 129 TEETH	1
B5036 124 TEETH	1
B3073A	26
A6802	1
M2475A	1
M2039BX	1
B1504K	1
A6979	1
M2006K	3
B1505G	1
9769C *0	1
9615F *1	1
M2002AA	19
B1399A	1
M1927BR	2
A2701AD	2
M2051K	3
B1660	1
M2002AM	22
A6859	1
A4669	1

M2305	12
B1670	2
M1927L	6
M2042R	6
M2051Q	6
B1340	1
M2076B	1
M1349A	1
M2076A	1
B1620	1
M2002U	4
1681	1

M2051N	2
B1342	1
A2987Y	1
A6566E	16
A6567	14
A2622G	2
B1670A	2
A2704AW	24
B1758	24
9757C	1
B1335A	1
9618C	1
M2002AG	16
B1432	12
M2027N	24
XA6853A	2
A6853A *	2
A2695T	24
M1927F	12
B1336	1
B1349	1
M2002U	4

SEE NOTE #2	
M2051AJ	1
M2002CV	2
M2002BK	2
M1904G	2
M2104	2
M1904F	4
203190D	2
M1904E	2
203190B	2
A6563B	2
A6564B	2

M1275	1
B5000	1
M1973H	1
M2031D	1
B1470	1
M2261A	1
M2054V	1
M2463	1
M1853K	1
M2002D	4
M2007Q	3
B1813	2
B1813A	2
B1813B	2
M2074W	1
B1504T	1

M201191	2
A2916AX	1
M2004K	8
B1703C	1
XB2145	1
MA293	2
B1776	
B1776A	

USE FOR 4.13:1 RATIO	
XA4351A	1
A4351A PIPE-OIL RETURN	1
B1441A PISTON	1
A2703AA SPRING	1
M1927AD PIN-ROLL	2
M1927AE PIN-ROLL	1

USE FOR 4.5:1, 5.16:1 & 6:1 RATIOS	
XA4351D	1
A4351B PIPE-OIL RETURN	1
M1927AD PIN-ROLL	2
B1814 CAPSCREW	1
B1441A PISTON	1
A2703AD SPRING	1
B1815 PLATE-LOCK	1
XA4834A	1
B1785A CARRIER *	1
B1786 TUBE *	1
B1787 TUBE *	1

M1927L	1
B1440	1
M2071J	2

M422	4
A28130	1
201513	1
A2007	1
M1072	1
M422	2

M2054V	1
M2051X	1
M2056AB	1
M2067D	1
M1763	1

XA6573AD			
B1867 COLLAR-STOP	1	A4347G STEM-VALVE	1
M1990H BALL (OR PLATE)	1	A2700AB SPRING (DETENT)	1
M2167 BEARING	1	A2703P SPRING (OR PL)	1
A6574D BODY-VALVE	1	M1731AF SCREW-SOC HD	1
B1333C COVER (OR PL)	1	XA2707AD	1
B1368B COVER-VALVE	1	A2707AD SPRING *	1
B1139 DETENT	1	A2703AB SPRING *	1
B1334A GASKET	1		
B1337B GASKET	1		
B1398 GASKET	2		
204087 LEVER-SHIFT	1		
M1927B PIN-ROLL	1		
B1399 PISTON	1		
B1400 PISTON	1		
B1397A PLATE-ORIFICE	1		
M2051H PLUG-PIPE	2		
A2916AT RING "O"	1		
M2001P SCREW-HEX HD.	8		

1681	1
XB1251	1
A1837 PIPE *	1
A2674 BAFFLE *	3
M639 BREATHER *	1
M2004AS	2
M2067D	1
A4417A	1
B1425	1
A2706X	1
M2051AA	1
M2004W	2
B1347A	1

M2188	1
M2184-2	1
M2184-4	1
M2184-3	1
M2188-1	1

M2054K	1
M2055AS	1
M2054V	1
A4969V	1
A2149V	1
M2051AS	1
M2051K	4
M2054V	1
M2055AS	1
M2051AD	2

XB5054B	1
B5054	1
A4806	1
M2007W	6
M2026T	8

M2305	4

ASSEMBLY INSTRUCTIONS

1.) SEAT PROPELLER FLANGE TIGHTLY AGAINST THE BEARING BEFORE MEASURING THE SHIM GAP. USE SHIMS .010-.015 THINNER THAN GAP.
2.) SELECTOR VALVE BOLTS USE 17-25 LB. FT. TORQUE DRY OR 13-20 LB. FT. TORQUE OILED.

Max. SPEED 2500 R.P.M. CONSULT SALES DEPT. APPLICATION ENGINEERS FOR OTHER LIMITING CONDITIONS

A6905N	HYDRAULIC SYSTEM DIAGRAM
SHEET 2 OF 2	INSTALLATION DRAWING
SHEET 1 OF 2	CROSS SECTION DRAWING WITH PART NUMBERS

GENERAL NOTES

A.) REMOVE BEFORE OPERATING - 2 ITEMS.
B.) FOR EMERGENCY MECHANICAL CLUTCH LOCKUP CLAMP CLUTCH TIGHT WITH THESE 3 SET SCREWS. REMOVE 3 PIPE PLUGS ON MANIFOLD TO OBTAIN ACCESS TO CLUTCH LOCKUP SETSCREWS.

* NOT SERVICEABLE SEPARATELY
○ A CONVENIENT SERVICE GROUP - CONSULT SERVICE DEPT.

		REVISIONS			
C			17252	3-9-70	FV
B		UPDATED RUBBER CLUTCH DRIVE	16149	8-14-67	RM
A	A1	GEAR RATIO 4.50 WAS 4.05	15604	9-22-66	D
SYM.	ZONE	CHANGE	CH. NO.	DATE	BY

MG514 MARINE GEAR

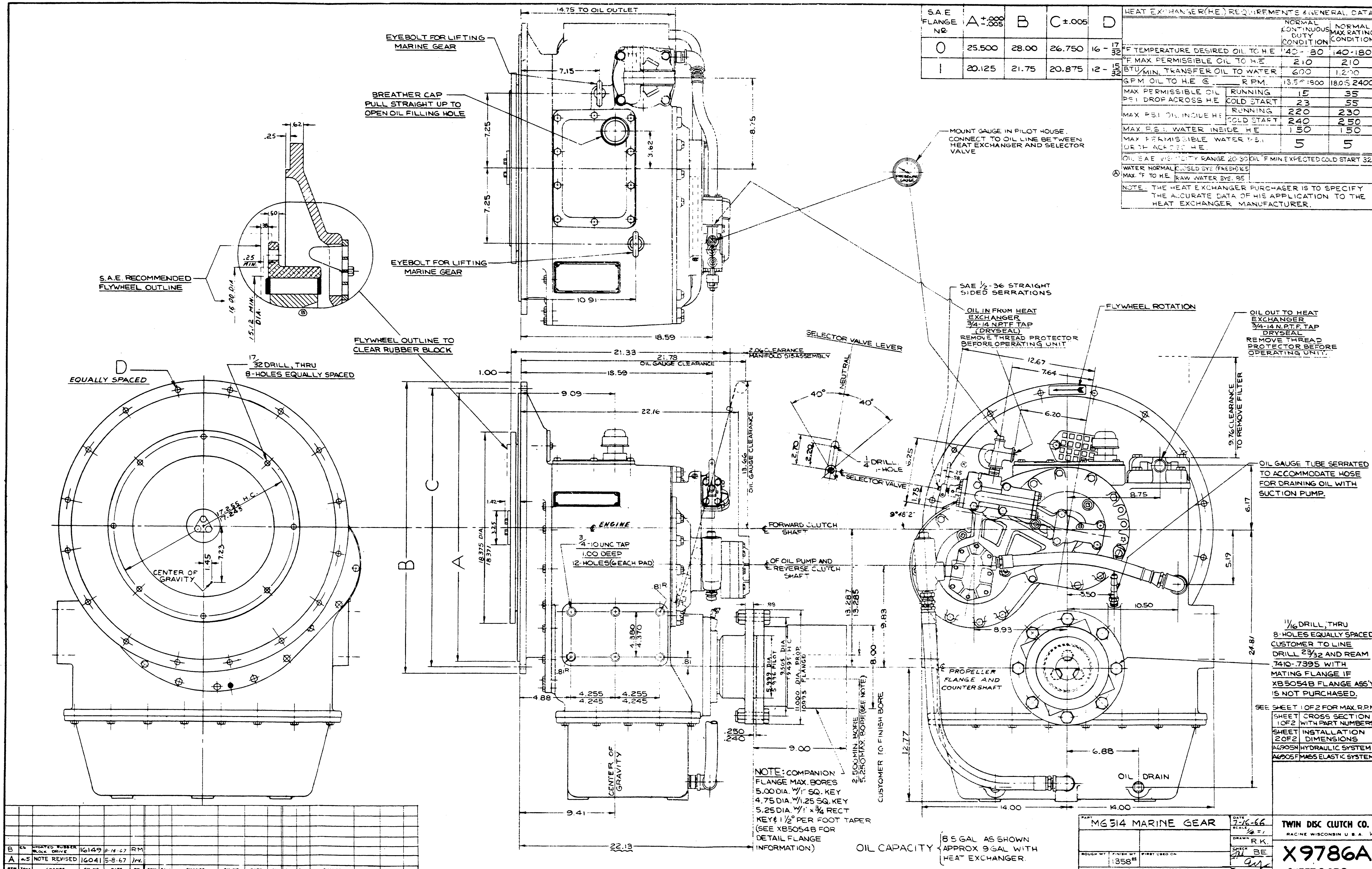
RATIOS: 4.13:1 FWD. AND REV. / 4.50:1 FWD. AND REV. / 5.16:1 FWD. AND REV. / 6.00:1 FWD. AND REV.

DATE 7-6-66 · SCALE 1/2:1 · DRAWN R.K. · FINISH WT. 1358#

UNLESS OTHERWISE SPECIFIED ALLOWABLE VARIATION ON MACHINED DIMENSIONS ±

TWIN DISC CLUTCH CO
RACINE, WISCONSIN, U.S.A.

X9786A
SHEET 1 OF 2


14.75 TO OIL OUTLET
EYEBOLT FOR LIFTING MARINE GEAR
BREATHER CAP PULL STRAIGHT UP TO OPEN OIL FILLING HOLE
EYEBOLT FOR LIFTING MARINE GEAR
S.A.E. RECOMMENDED FLYWHEEL OUTLINE
FLYWHEEL OUTLINE TO CLEAR RUBBER BLOCK
MOUNT GAUGE IN PILOT HOUSE. CONNECT TO OIL LINE BETWEEN HEAT EXCHANGER AND SELECTOR VALVE
PRESSURE GAUGE
SAE 1/2-36 STRAIGHT SIDED SERRATIONS
OIL IN FROM HEAT EXCHANGER 3/4-14 N.P.T.F. TAP (DRYSEAL) REMOVE THREAD PROTECTOR BEFORE OPERATING UNIT
FLYWHEEL ROTATION
OIL OUT TO HEAT EXCHANGER 3/4-14 N.P.T.F. TAP (DRYSEAL) REMOVE THREAD PROTECTOR BEFORE OPERATING UNIT.
D EQUALLY SPACED
17/32 DRILL, THRU 8-HOLES EQUALLY SPACED
2.06 CLEARANCE MANIFOLD DISASSEMBLY
21.78 OIL GAUGE CLEARANCE
SELECTOR VALVE LEVER
NEUTRAL
1/4 DRILL 1-HOLE
SELECTOR VALVE
9.76 CLEARANCE TO REMOVE FILTER
OIL GAUGE TUBE SERRATED TO ACCOMMODATE HOSE FOR DRAINING OIL WITH SUCTION PUMP.
13.66 OIL GAUGE CLEARANCE
ENGINE
3/4-10 UNC TAP 1.00 DEEP 12-HOLES (6 EACH PAD)
CENTER OF GRAVITY
FORWARD CLUTCH SHAFT
OF OIL PUMP AND REVERSE CLUTCH SHAFT
PROPELLER FLANGE AND COUNTERSHAFT
11/16 DRILL, THRU 8-HOLES EQUALLY SPACED CUSTOMER TO LINE DRILL 23/32 AND REAM .7410-.7395 WITH MATING FLANGE IF XB5054B FLANGE ASS'Y. IS NOT PURCHASED.
CUSTOMER TO FINISH BORE
2.500 MIN. BORE 5.250 MAX. BORE (SEE NOTE)
OIL DRAIN
NOTE: COMPANION FLANGE MAX. BORES 5.00 DIA. W/1" SQ. KEY 4.75 DIA. W/1.25 SQ. KEY 5.25 DIA. W/1" x 3/4 RECT KEY & 1 1/2° PER FOOT TAPER (SEE XB5054B FOR DETAIL FLANGE INFORMATION)
OIL CAPACITY {8.5 GAL AS SHOWN APPROX 9 GAL WITH HEAT EXCHANGER.
A
B
C
18.59
21.33
22.16
22.13
9.41
24.81
14.00
12.77
9.83
8.00
6.88
10.50
8.93

S.A.E. FLANGE No.	A +.000 -.005	B	C ±.005	D
0	25.500	28.00	26.750	16 - 17/32
1	20.125	21.75	20.875	12 - 15/32

HEAT EXCHANGER (H.E.) REQUIREMENTS & GENERAL DATA

		NORMAL CONTINUOUS DUTY CONDITION	NORMAL MAX RATING CONDITION
°F TEMPERATURE DESIRED OIL TO H.E.		140-180	140-180
°F MAX. PERMISSIBLE OIL TO H.E.		210	210
BTU/MIN. TRANSFER OIL TO WATER		600	1,200
G.P.M. OIL TO H.E. @ ____ R.P.M.		13.5 @ 1800	18.0 @ 2400
MAX PERMISSIBLE OIL PSI DROP ACROSS H.E.	RUNNING	15	35
	COLD START	23	55
MAX P.S.I. OIL INSIDE H.E.	RUNNING	220	230
	COLD START	240	250
MAX. P.S.I. WATER INSIDE H.E.		150	150
MAX PERMISSIBLE WATER P.S.I. DROP ACROSS H.E.		5	5

OIL S.A.E. VISCOSITY RANGE 20-30 | OIL °F MIN. EXPECTED COLD START 32

Ⓐ WATER NORMAL MAX. °F TO H.E.: CLOSED SYS. (FRESH) 165; RAW WATER SYS. 85

NOTE: THE HEAT EXCHANGER PURCHASER IS TO SPECIFY THE ACCURATE DATA OF HIS APPLICATION TO THE HEAT EXCHANGER MANUFACTURER.

SEE SHEET 1 OF 2 FOR MAX. R.P.M.

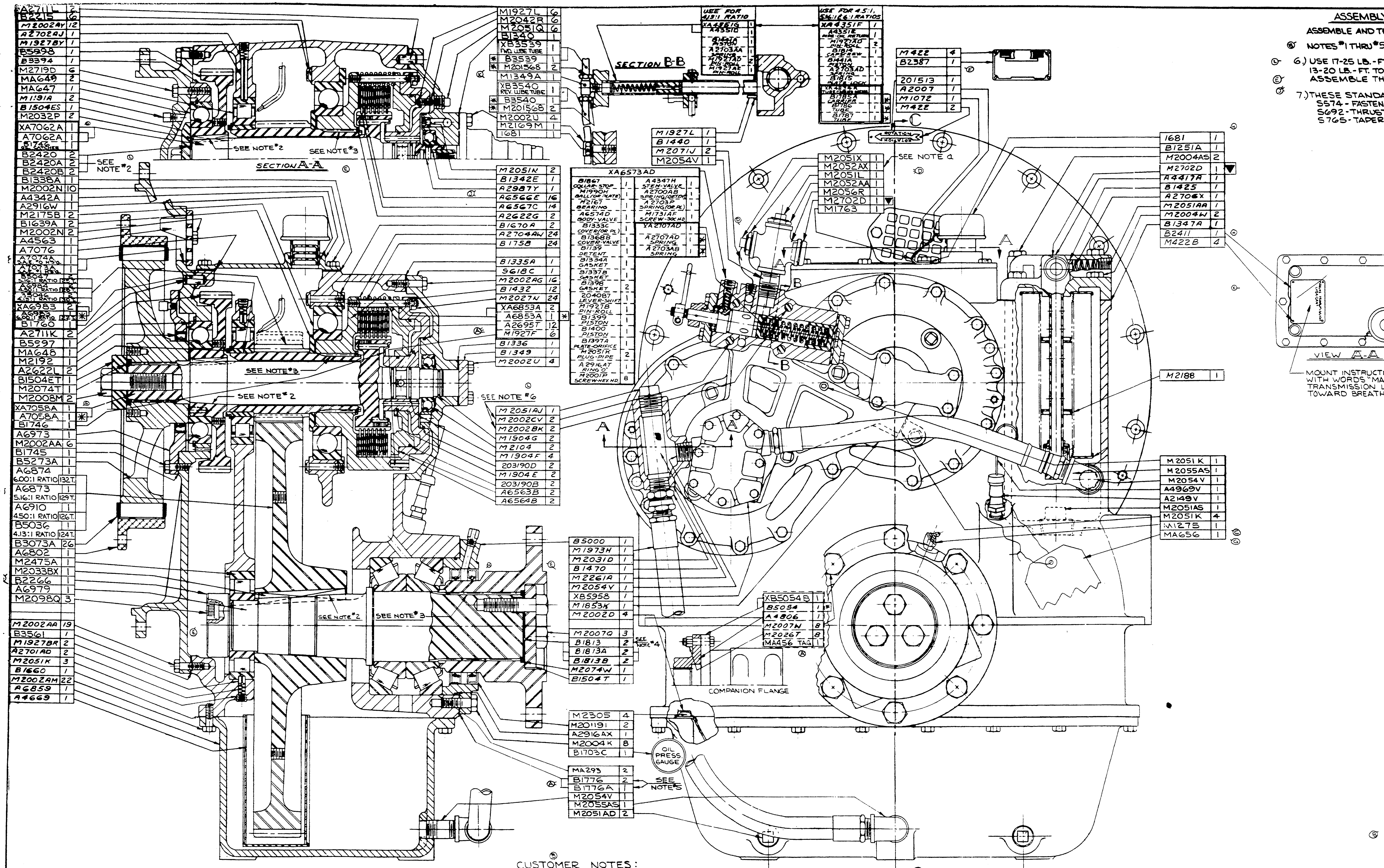
SHEET 1 OF 2	CROSS SECTION WITH PART NUMBERS
SHEET 2 OF 2	INSTALLATION DIMENSIONS
A6905N	HYDRAULIC SYSTEM
A6905F	MASS ELASTIC SYSTEM

SYM	ZONE	CHANGE	CH NO	DATE	BY
B	E5	UPDATED RUBBER BLOCK DRIVE	16149	9-14-67	RM
A	A5	NOTE REVISED	16041	5-8-67	J.F.

PART: MG514 MARINE GEAR
DATE: 7-16-66
SCALE: 1/4 = 1
DRAWN: R.K.
CHECK: BE
FINISH WT: 1358#
UNLESS OTHERWISE SPECIFIED ALLOWABLE VARIATION ON MACHINED DIMENSIONS ±.010

TWIN DISC CLUTCH CO.
RACINE WISCONSIN U.S.A.

X9786A
SHEET 2 OF 2



ASSEMBLY INSTRUCTIONS

ASSEMBLE AND TEST PER S570A.

NOTES *1 THRU *5 ARE IN S570A.

6.) USE 17-25 LB.-FT. TORQUE DRY OR 13-20 LB.-FT. TORQUE OILED TO ASSEMBLE THESE BOLTS.

7.) THESE STANDARDS APPLY:
S574 - FASTENER TORQUE REQUIREMENTS.
S692 - THRUST BEARING SHIMMING.
S765 - TAPERED JOINT ASSEMBLY.

MAX. SPEED 2500 R.P.M. CONSULT SALES DEPT. APPLICATION ENGINEERS FOR OTHER LIMITING CONDITIONS.

SHEET 1 OF 2	CROSS SECTION DRAWING WITH PART NUMBERS
SHEET 2 OF 2	INSTALLATION DRAWING
A6905N	HYDRAULIC SYSTEM DIAGRAM
B3604G	MASS ELASTIC SYSTEM

CUSTOMER NOTES:

a.) OPTIONAL EQUIPMENT AVAILABLE:
MECHANICAL TOP POWER TAKE OFF - X9804A
COMPANION FLANGE ASSEMBLY - XB5054B
OIL TEMPERATURE SAFETY SWITCH - B3424 FOR INSTALLATION PER B3501

b.) FOR EMERGENCY MECHANICAL CLUTCH LOCKUP, CLAMP CLUTCH TIGHT WITH THESE 3 SET SCREWS. REMOVE 3 PIPE PLUGS ON MANIFOLD TO OBTAIN ACCESS TO CLUTCH LOCKUP SET SCREWS.

c.) ▼ REMOVE BEFORE OPERATING, 2 ITEMS, ALUMINUM PLUGS.
✱ NOT SERVICEABLE SEPARATELY

SIMILAR TO X9784B

SCALE IN INCHES 0 1 2 3 TENTHS

PART: MG514 MARINE TRANSMISSION

DATE: 11-4-71 · SCALE: .40 = 1.00 · DRAWN: R.K. · CHECK: DS

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

X9786B
SHEET 1 OF 2

S.A.E HOUSING Nº	A	B	C	D	E
0	25.500 25.495	28.00	26.750	16-17/32 DIA.	.62
1	20.125 20.120	21.75	20.875	11-15/32 DIA.	.56

HEAT EXCHANGER (H.E.) REQUIREMENTS AND GENERAL DATA

MAX. & MIN. PERMISSIBLE OIL TEMP. INTO H.E.	210-150 °F.
MIN. RECOMMENDED TRANSFER CAPACITY (MULTIPLY BY 1.25 FOR FRESH WATER) (" " 2.00 " RAW WATER)	315 B.T.U. PER MINUTE PER 1000 ENGINE R.P.M. AT PROP. MATCH POINT.
OIL TO HEAT EXCHANGER (USE RPM RATIO FOR RATIOING GPM)	18 G.P.M. AT 2400 R.P.M.
MAX PEAK OIL PRESSURE AT H.E. (USE 1.5 TIMES P.S.I. FOR PROOF TEST OF H.E.)	285 P.S.I.
MAX. ALLOWABLE PRESSURE DROP ACROSS HE OIL PASSAGES WITH 300 SUS AT MATCH POINT R.P.M.	30 P.S.I.
WATER TO H.E. — — — USE 1.5 TO 3.0 TIMES OIL G.P.M.	

DATA PURCHASER OF H.E. SHOULD PROVIDE:

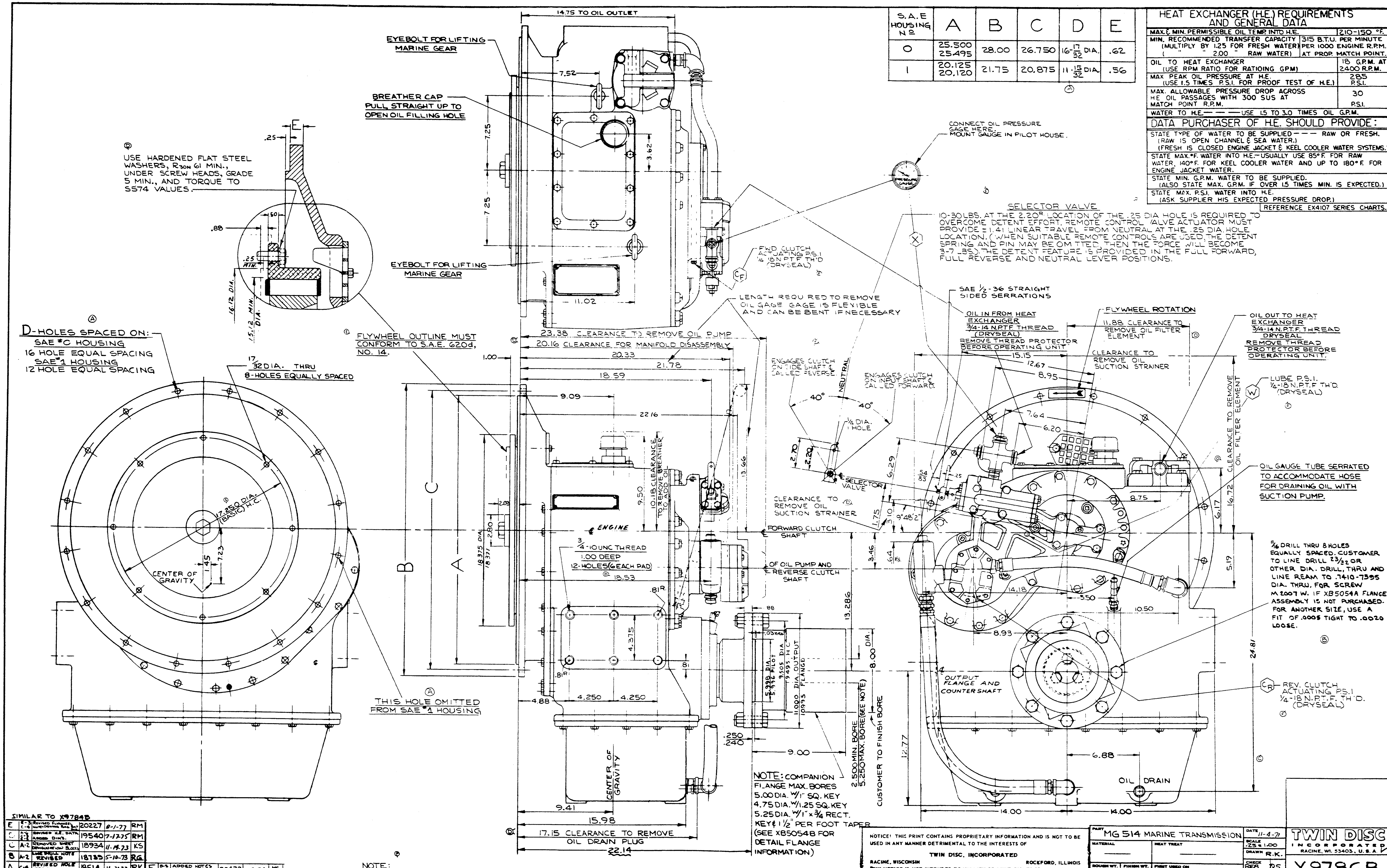
STATE TYPE OF WATER TO BE SUPPLIED — — — RAW OR FRESH. (RAW IS OPEN CHANNEL & SEA WATER.) (FRESH IS CLOSED ENGINE JACKET & KEEL COOLER WATER SYSTEMS.)

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 1.5 TIMES MIN. IS EXPECTED.)

STATE MAX. P.S.I. WATER INTO H.E. (ASK SUPPLIER HIS EXPECTED PRESSURE DROP.)

REFERENCE EX4107 SERIES CHARTS.



14.75 TO OIL OUTLET
EYEBOLT FOR LIFTING MARINE GEAR
BREATHER CAP PULL STRAIGHT UP TO OPEN OIL FILLING HOLE
USE HARDENED FLAT STEEL WASHERS, R30N 61 MIN., UNDER SCREW HEADS, GRADE 5 MIN., AND TORQUE TO S574 VALUES.
CONNECT OIL PRESSURE GAGE HERE. MOUNT GAUGE IN PILOT HOUSE.
SELECTOR VALVE
10-30 LBS. AT THE 2.20R LOCATION OF THE .25 DIA HOLE IS REQUIRED TO OVERCOME DETENT EFFORT. REMOTE CONTROL VALVE ACTUATOR MUST PROVIDE ±1.41 LINEAR TRAVEL FROM NEUTRAL AT THE .25 DIA. HOLE LOCATION. (WHEN SUITABLE REMOTE CONTROLS ARE USED, THE DETENT SPRING AND PIN MAY BE OMITTED, THEN THE FORCE WILL BECOME 3-7 LBS.) THE DETENT FEATURE IS PROVIDED IN THE FULL FORWARD, FULL REVERSE AND NEUTRAL LEVER POSITIONS.
FWD CLUTCH ACTUATING P.S.I. 1/4-18 N.P.T.F. TH'D (DRYSEAL)
EYEBOLT FOR LIFTING MARINE GEAR
LENGTH REQUIRED TO REMOVE OIL GAGE. GAGE IS FLEXIBLE AND CAN BE BENT IF NECESSARY
SAE 1/2-36 STRAIGHT SIDED SERRATIONS
OIL IN FROM HEAT EXCHANGER 3/4-14 N.P.T.F. THREAD (DRYSEAL) REMOVE THREAD PROTECTOR BEFORE OPERATING UNIT
FLYWHEEL ROTATION
11.88 CLEARANCE TO REMOVE OIL FILTER ELEMENT
OIL OUT TO HEAT EXCHANGER 3/4-14 N.P.T.F. THREAD DRYSEAL REMOVE THREAD PROTECTOR BEFORE OPERATING UNIT.
CLEARANCE TO REMOVE OIL SUCTION STRAINER
CLEARANCE TO REMOVE OIL FILTER ELEMENT
LUBE P.S.I. 1/4-18 N.P.T.F. TH'D. (DRYSEAL)
D-HOLES SPACED ON: SAE #0 HOUSING 16 HOLE EQUAL SPACING SAE #1 HOUSING 12 HOLE EQUAL SPACING
17/32 DIA. THRU 8-HOLES EQUALLY SPACED
FLYWHEEL OUTLINE MUST CONFORM TO S.A.E. 620d, NO. 14.
23.38 CLEARANCE TO REMOVE OIL PUMP
20.16 CLEARANCE FOR MANIFOLD DISASSEMBLY
ENGAGES CLUTCH ON IDLE SHAFT & CALLED REVERSE
NEUTRAL
ENGAGES CLUTCH ON INPUT SHAFT & CALLED FORWARD
1/4 DIA. HOLE
SELECTOR VALVE
OIL GAUGE TUBE SERRATED TO ACCOMMODATE HOSE FOR DRAINING OIL WITH SUCTION PUMP.
10.18 CLEARANCE TO REMOVE BREATHER TO ADD OIL
ENGINE
3/4-10 UNC THREAD 1.00 DEEP 12-HOLES (6 EACH PAD)
17.250 DIA. (BASIC) H.C.
CENTER OF GRAVITY
CLEARANCE TO REMOVE OIL SUCTION STRAINER
FORWARD CLUTCH SHAFT
℄ OF OIL PUMP AND ℄ REVERSE CLUTCH SHAFT
11/16 DRILL THRU 8 HOLES EQUALLY SPACED. CUSTOMER TO LINE DRILL 23/32 OR OTHER DIA. DRILL, THRU AND LINE REAM TO .7410-.7395 DIA. THRU. FOR SCREW M2007 W. IF XB5054A FLANGE ASSEMBLY IS NOT PURCHASED. FOR ANOTHER SIZE, USE A FIT OF .0005 TIGHT TO .0020 LOOSE.
OUTPUT FLANGE AND COUNTERSHAFT
REV. CLUTCH ACTUATING P.S.I. 1/4-18 N.P.T.F. TH'D. (DRYSEAL)
THIS HOLE OMITTED FROM SAE #1 HOUSING
2.500 MIN. BORE 5.250 MAX. BORE (SEE NOTE)
CUSTOMER TO FINISH BORE
CENTER OF GRAVITY
OIL DRAIN
17.15 CLEARANCE TO REMOVE OIL DRAIN PLUG

NOTE: COMPANION FLANGE MAX. BORES
5.00 DIA. W/1" SQ. KEY
4.75 DIA. W/1.25 SQ. KEY
5.25 DIA. W/1" x 3/4 RECT. KEY & 1 1/2" PER FOOT TAPER
(SEE XB5054B FOR DETAIL FLANGE INFORMATION)

NOTE: ALL POINTS AVAILABLE FOR TESTING ARE CODED ⬡.

SIMILAR TO X9784B

SYM.	ZONE	CHANGE	CH. NO.	DATE	BY
E	E-3 E-4	REVISED FLYWHEEL NOTE-DRAWING ...	20227	8-1-77	RM
D	A-6 C-3 E-3	REVISED H.E. DATA ADDED DIMS.	19540	7-17-75	RM
C	A-2	REMOVED SHEET DESIGNATION BLOCKS	18934	11-14-73	KS
B	A-2	LINE DRILL NOTE REVISED	18785	5-10-73	RG.
A	C-4	REVISED HOLE SPACING	18514	11-21-72	R.K.
F	B-3 C-4	ADDED NOTES AND SYMBOLS	20432	1-5-78	KS

PART	MG 514 MARINE TRANSMISSION
DATE	11-4-71
SCALE	.25 = 1.00
DRAWN	R.K.
CHECK	REB DS
MATERIAL	—
HEAT TREAT	—
FIRST USED ON	—
UNLESS OTHERWISE SPECIFIED ALLOWABLE VARIATION ON MACHINED DIMENSIONS ±	—

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

X9786B

SHEET 2 OF 2

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