TWIN DISC
INCORPORATED

Service Manual

Marine Transmission

Model:
MG-509

Document Number: 1015793

NOTICE

Twin Disc, Incorporated makes no warranty or guaranty of any kind, expressed, implied or otherwise, with regard to the information contained within this manual. Twin Disc, Incorporated has developed this manual through research and testing of the information contained therein. Twin Disc, Incorporated assumes no responsibility for any errors that may appear in this manual and shall not be liable under any circumstances for incidental, consequential or punitive damages in connection with, or arising out of, the use of this manual. The information contained within this manual is subject to change without notice.

SERVICE MANUAL SM-149

MODEL MG-509
MARINE TRANSMISSION

ORIGINAL ISSUE
November 1965
Revision D — July 1982

Twin Disc, Incorporated

1328 Racine Street

Racine, Wisconsin, U.S.A.

53403

Printed in U.S.A.

REVISION AND REISSUE DATA

Revision A—July 1977
Pages changed: Service Information, 28, 30, 38, 39, 84

Revision B—November 1978
Pages changed: 28, 84
Pages added: 89, 90, 91, 92, 93, 94, 95

Revision C—August 1981
Pages changed: 32, 84, 85

Revision D—June 1982
Pages changed: Section 1, 38, 47. All torque values given in text, 60, 88.
Pages removed: Service Information, Warranty

A NOTE: "Flagging" indicates areas revised."

TABLE OF CONTENTS

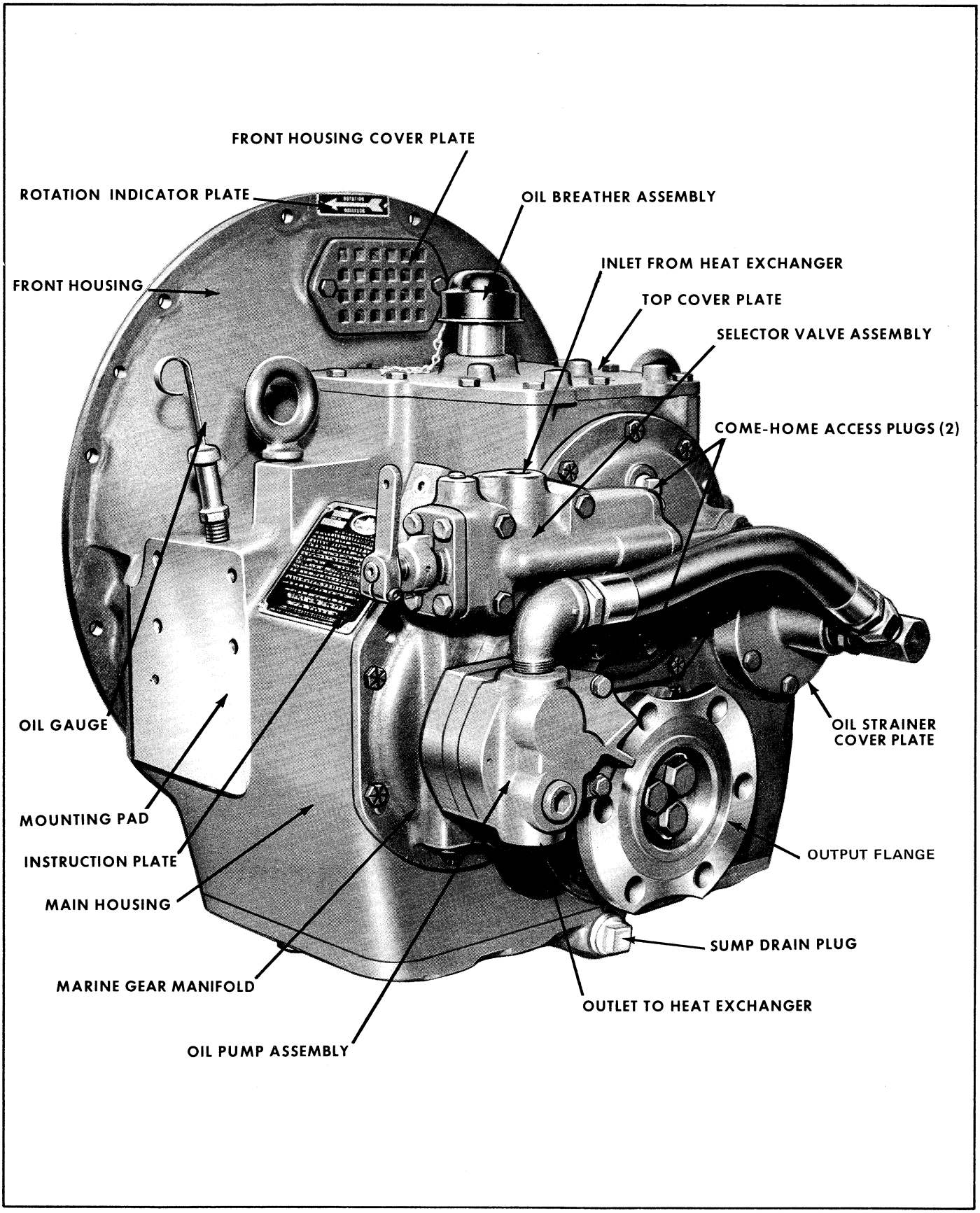


Figure 1. Model MG-509 Marine Gear – Rear View.

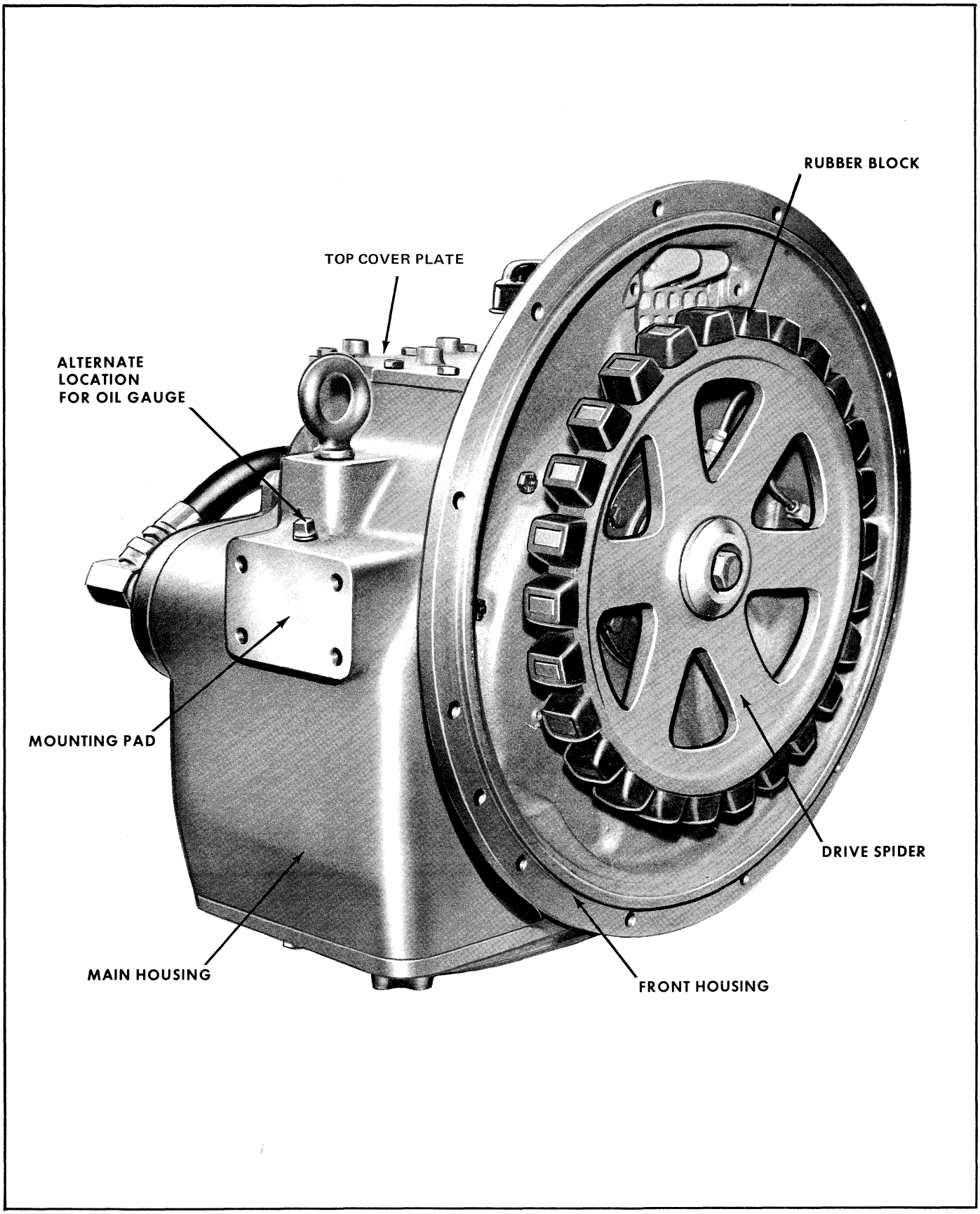


Figure 2. Model MG-509 Marine Gear — Front View.

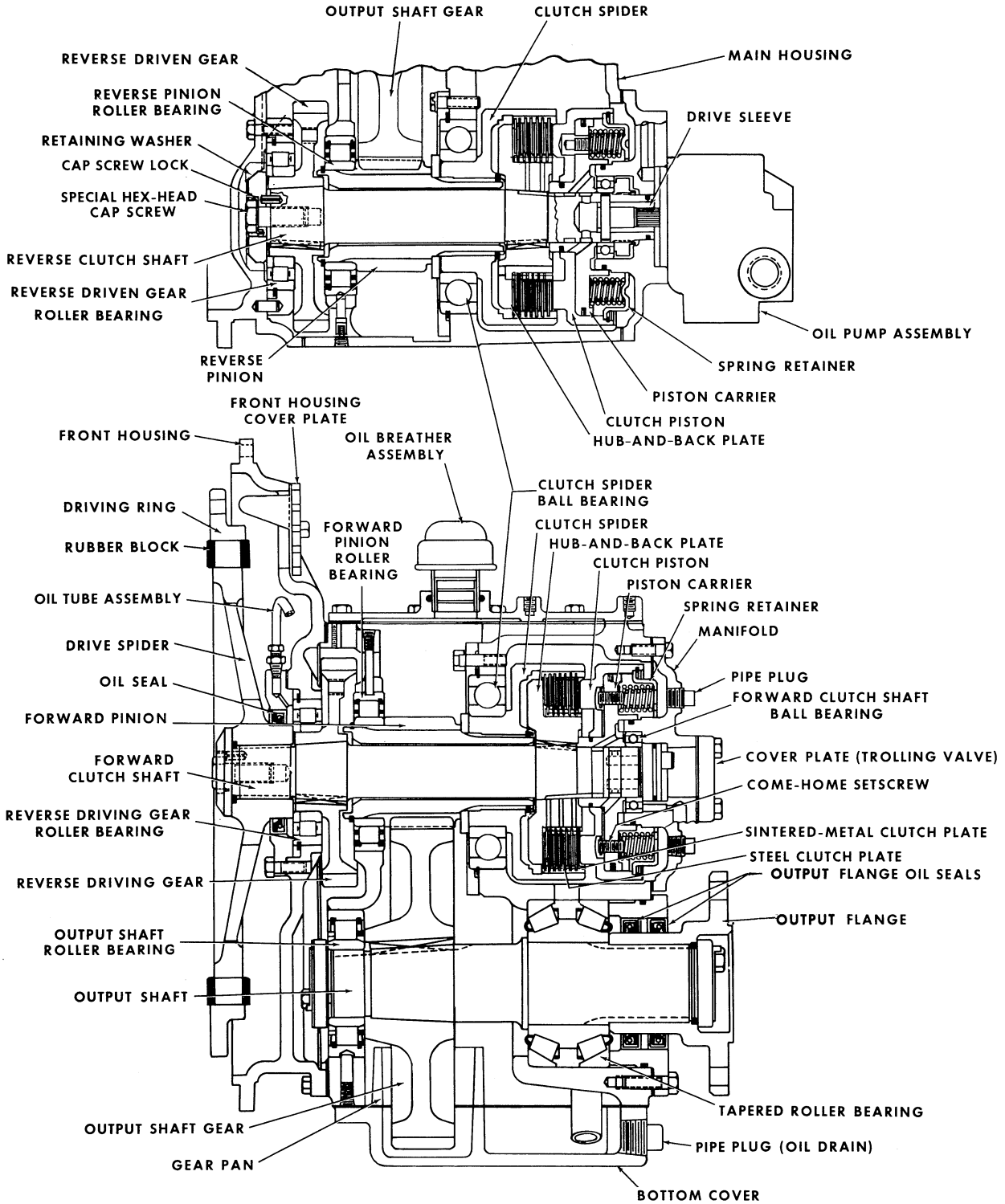


Figure 3. Model MG-509 Marine Gear – Cross-section View. (Shallow case unit shown)

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

PREVENTIVE MAINTENANCE-TROUBLE SHOOTING.

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

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

LIFTING BOLT HOLES.

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

CAUTION

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

CAUTION

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

SAFETY.

General.

Safe operating practices should be employed by all personnel servicing this unit. Twin Disc, Incorporated will not be responsible for personal injury resulting from careless use of hand tools, lifting equipment, power tools, or unaccepted maintenance/working practices.

Important Safety Notice.

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

SOURCE OF SERVICE INFORMATION.

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

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

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

WARRANTY

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

Section II DESCRIPTION

NOTE

Refer to Figures 3, 4 or 5 for location of parts described in this Section.

6. MARINE GEAR.

A. General. The MG-509 marine gear is manufactured in two basic configurations; a "shallow case" and a "deep case". The "shallow case" version is made in the following ratios; 1.45:1, 2.00:1, 2.48:1 and 2.95:1. The "deep case" model is made for the 3.8:1 and 4.5:1 ratios which, because of the larger diameter gears and pinions, requires a larger area of enclosure. The bottom cover of the "deep case" model is approximately two and one half times deeper than the "shallow case" bottom cover. See planographs at the rear of the book. The basic construction of the two models is the same. Therefore, the repair procedures are the same on both configurations. Throughout the book, the "shallow case" version is illustrated in preference to the "deep case". The Model MG-509 series marine gear is a right-hand rotation marine gear for use with a right-hand rotation engine (directions from front of engine).

Due to heavier construction of components, housing, output group, etc., used in the "deep case" version, the parts are not interchangeable between "shallow case" and "deep case" versions. The marine gear can be converted easily and quickly for left-hand rotation applications by changing the hose connections to the oil pump.

The marine gear consists of three major sub-assemblies: 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 spur-tooth gears and pinions that are in constant mesh. Three ratios of reduction gears are available in the "shallow case" configuration, 1.45:1, 2.00:1, and 2.95:1. The "deep case" design has two ratios available, 3.8:1 and 4.5:1.

A 10 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 strained before entering the marine gear hydraulic system.

The MG-509 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 insure that proper alignment between the marine gear and the engine is attained.

B. Accessories. Accessories described below are available for the MG-509 Marine Gear. A heat exchanger *must be used* with the marine gear; however, a heat exchanger other than those available from Twin Disc may be selected. Consult Twin Disc when a heat exchanger is furnished from a source other than Twin Disc.

(1) Pressure Gauge Assembly. A pressure gauge assembly is supplied with each marine gear as standard equipment. Normally, the gauge is mounted in the pilot house of the vessel with a pressure line connection between heat exchanger and selector valve. In this manner, a constant visual check of oil pressure in the marine gear may be conveniently observed.

(2) Trolling Valve Assembly. A trolling valve assembly is available as optional equipment. It is mounted easily and quickly on the manifold. The function of the trolling valve is to reduce the propeller rpm while permitting the high engine rpm required for the operation of engine accessories. This feature is particularly important for some fishing operations.

(3) Hose-and-Heat-Exchanger Kits. Hose-and-heat-exchanger kits are available as optional equipment. Each kit consists of a heat exchanger with mounting feet, flexible hose, and attaching parts. The heat exchanger is mounted in a location convenient to both engine water and marine gear oil. 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 ninety days. If over fifty percent 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. Listed below is the zinc rod data for the MG-509.

Marine Gear	MG-509
Exchanger	M1961-D
Quantity of Zinc Electrode	2
Part Number of Zinc Electrode	M1988

(4) Companion Flange Assembly. A companion flange assembly is available as optional equipment. The companion flange is bolted directly to the propeller flange. A hole in the propeller shaft and in one side of the companion flange must be drilled and reamed by the purchaser. The flange must be clamped in place when drilling and reaming for the thrust pin. The bolt header will hold this thrust pin in position in the companion flange.

(5) Top Power Take-off. A top power take-off is available as optional equipment. The power take-off is a manual clutch controlled drive for a generator, winch, pump, or any other application. The power take-off is independently controlled and not connected in any manner to the selector valve located on the marine gear. The power take-off is mounted directly to the top of the marine gear housing. Consult the Marine Gear Application Department of Twin Disc, Incorporated for any further information.

7. DRIVE SPIDER GROUP OF PARTS.

A. Driving Ring. The driving ring is a high quality 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 single 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. Extreme caution must be observed during marine gear installation to achieve the dial indicator tolerances specified in the section 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 installed in a seal carrier.

8. FRONT HOUSING GROUP OF PARTS.

A. Front Housing. The front housing, which contains the reverse driving gear roller 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, that is covered by the front housing cover plate, permits inspection of the driving ring, drive spider, and rubber blocks. The bearing retainer for the reverse driven gear roller bearing is bolted to the front housing.

B. 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 to inspect the input drive components; spider, driving ring, and rubber blocks. The air deflecting lugs on the cover (ventilator) assure a continual movement of warm air from the front housing area, cooling the drive components.

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 bedrails. A cored pocket in the main housing is for the installation of the oil strainer.

B. Oil Strainer. The oil strainer is installed in a cored pocket of the main housing. This type oil strainer must be removed and cleaned periodically to insure a constant flow of pressurized and strained oil through the marine gear. The oil strainer must be kept clean or serious marine gear damage may result. The oil strainer contains a by-pass valve that will operate at two-and-one-half psi pressure differential in the event the strainer should become clogged. This will permit the oil to continue circulating, although the oil will not be strained by the strainer.

C. Oil Breather Assembly. The oil breather assembly is an integral breather cap and baffled

nipple. The breather is installed in the top cover plate of the main housing. The breather hole in the top cover plate is used for filling the main housing sump with the proper amount of oil when required.

D. Oil Gauge. The oil level gauge is mounted in the oil gauge tube which is installed in either side of 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. Bottom Cover. The bottom cover is bolted directly to the bottom of the main housing. The bottom cover encloses the sump area of the marine gear. The "deep case" version of this marine gear series has a bottom cover approximately two and one-half times deeper than the bottom cover of the "shallow case" version.

F. Gear Pan. The gear pan is an aluminum casting. The gear pan is internally secured to the bottom cover and functions as a splash pan for the output shaft gear to control foaming and prevent oil turbulence around the pump intake which could cause the cavitation of the oil pump with resulting poor clutch operation.

G. 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 GROUP OF PARTS.

A. Manifold. The manifold is a multi-purpose component of the marine gear that provides a mounting surface for the selector valve, oil pump, and trolling valve 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 marine gear from the engine or the propeller flange. Drilled passages in the manifold are used to convey the pressurized oil from the selector valve to the piston carriers for engagement of the clutches, and to the center of the clutch plate stack for cooling purposes.

B. Come-Home Access Pipe Plugs. Two access holes for the forward clutch are tapped in the manifold for come-home lock-up of the clutch. During normal hydraulic operation, pipe plugs are installed in these two holes.

C. 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. 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 regulates 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 counterbored hole on the interior side of the front housing. The oil return pipe aligns with the oil tube assembly connected to the front housing and bearing retainer. The oil return pipe supplies low pressure through the oil tube assembly to the bearing retainer to lubricate the reverse driving gear roller bearing. Cross-drilled holes in the return pipe spray low pressure oil on the gears and pinions.

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 tapered roller bearing are mounted on the shaft. The output shaft supports the keyed and taper fitted output gear and the spline-connected propeller flange.

B. Output Shaft Gear. The output shaft gear is a spur-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 is the connecting output member of the marine gear. The flange has a sufficient number of adequate diameter holes for connection to the output shaft flange. The output flange has two cut-out sections one hundred eighty degrees apart to facilitate the removal of the reverse clutch. The mating propeller flange must be the same diameter and have matching cut-outs to accomplish this service feature of in-the-boat removal of the reverse clutch. The output flange is internally-splined for installation on the output shaft.

D. Output Flange Oil Seals. Two output flange oil seals are installed in the bearing retainer and seal around the flange hub. The lip of the inner seal points toward the gear, and prevents the leakage of oil from the marine gear into the bilge. The lip of the outer

seal points toward the output flange, and prevents the leakage of bilge into the marine gear. The space between the seals is filled with a water pump type grease through the grease fitting in the bearing retainer.

E. Output Shaft Roller Bearings. 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 secured on the shaft by the retainer washer and capscrew. The outer race of the roller bearing is secured in position by a retaining pin, spring, and pipe plug installed in the main housing.

F. Tapered Roller Bearing. The tapered roller bearing is the largest bearing in the marine gear. The bearing free play is shim adjusted with shims located between the bearing retainer and marine gear main housing. Dial indicating the output shaft end play provides a means of checking the bearing free play. 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 hole in the pocket.

12. FORWARD CLUTCH GROUP OF PARTS.

The forward pinion is a gear and 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 spur teeth that mesh with the output shaft gear. The pinion is spray lubricated by the oil return pipe assembly.

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 retainer pin, spring, and pipe plug installed in the main housing. The roller bearing is lubricated by the oil return pipe assembly.

C. Clutch Spider. The clutch spider has internal gear teeth which mesh with the sintered-metal clutch plates. The clutch spider is spline 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. A snap ring in the outer race of the ball bearing retains the bearing in position between the main housing and the bearing retainer. The bearing is lubricated by the oil return pipe assembly.

E. Forward Clutch Shaft. The input end of the forward clutch shaft is spline-connected to the drive spider; also, the reverse driving gear is keyed to a tapered area of the shaft at this end. Low pressure oil from the manifold passes through the forward clutch shaft ball bearing and through a drilled hole in the piston carrier to an undercut area in the forward clutch shaft. The oil then lubricates and cools the clutch plate stack by passing through a series of drilled holes in the clutch hub-and-back plate. High pressure oil from the manifold passes through two drilled holes in the lock plate, which are aligned with two horizontally drilled holes in the clutch shaft. Two cross-drilled holes in the clutch shaft connect the horizontally drilled holes with another undercut area in the clutch shaft. The undercut diameter of the shaft connects with a drilled hole in the piston carrier. This admits the high pressure oil behind the clutch piston for clutch engagement. A piston ring installed on the lock plate prevents the high pressure oil in the manifold from entering the low pressure oil area.

F. Forward Clutch Shaft Ball Bearing. The forward clutch shaft ball bearing is mounted on the manifold end of the forward clutch shaft, and is retained in position by the lock plate. The ball bearing is the pilot bearing from 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. Seven sintered-metal clutch plates, with external gear teeth are the driven plates. The driven plates are designed with a grid pattern in the plate face to permit the flow of cooling and lubricating oil to pass through with equal distribution.

H. Clutch Piston. The clutch piston is mounted on the piston carrier and installed so that the piston is in direct contact with the clutch plates. The spring retainer which holds the release springs against the piston carrier is secured to the clutch piston by a snap ring. High pressure oil is admitted between the clutch piston and the piston carrier to engage the clutch. During engagement, the release springs are compressed; the clutch piston moves back quickly and positively during disengagement due to the force exerted by the release springs.

I. Piston Carrier. The piston carrier is the stationary member of the clutch, and is installed on

the forward clutch shaft. The piston carrier rotates with the shaft and is horizontally stationary. Two piston rings installed on the piston carrier prevent the leakage of high pressure oil from the area between the clutch piston and the piston carrier during clutch engagement. Two setscrews installed in the piston carrier permit the positive lock-up of the forward clutch should hydraulic failure occur. (Come home feature).

J. Hub and Back Plate. The hub and back plate is keyed in position on a tapered area of the forward clutch shaft. External gear teeth of the hub and back plate mesh with the internal gear teeth of the steel clutch plates. The clutch plate stack is engaged against the hub and back plate by the clutch piston.

K. Reverse Driving Gear Roller Bearings. The reverse driving gear roller bearing is installed on the reverse driving gear. The outer race of the roller bearing contains a snap ring which retains the bearing in position between the front housing and the bearing retainer. The inner race of the bearing is secured in position by the hub of the reverse driving gear. The bearing is lubricated by oil from the oil tube assembly through a drilled hole in the bearing retainer.

L. Reverse Driving Gear. The reverse driving gear is keyed to a taper on the forward clutch shaft. The spur-tooth driving gear meshes with the reverse driven gear. Two tapped puller screw holes are machined in the gear to facilitate its removal from the shaft. The gear is lubricated by oil from the oil return pipe assembly.

13. REVERSE CLUTCH GROUP OF PARTS.

A. Reverse Pinion. The reverse pinion is a gear and 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 spur teeth that mesh with the output shaft gear. The pinion is lubricated by the oil return pipe assembly.

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 retainer pin, spring, and pipe plug installed in the main housing. The roller bearing is lubricated by the oil return pipe assembly.

C. Clutch Spider. The clutch spider has internal gear teeth which mesh with the sintered metal clutch plates. 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. A snap ring in the outer race of the ball bearing retains the bearing in position between the main housing and the bearing retainer. The bearing is lubricated by oil from the return pipe assembly.

E. Reverse Clutch Shaft. The input end of the reverse clutch shaft is tapered and keyed to the reverse driven gear. Low pressure oil from the manifold passes through the reverse clutch shaft ball bearing and through a hole drilled in the piston carrier to an under cut area in the reverse clutch shaft. The oil then lubricates and cools the clutch plate stack by passing through a series of drilled holes in the hub and back plate. High pressure oil from the manifold passes by two flat areas of the drive sleeve into a horizontally-drilled hole through the reverse clutch shaft. Two cross-drilled holes in the clutch shaft connect the horizontally drilled hole with another undercut area in the clutch shaft. The undercut diameter of the shaft connects with a drilled hole in the piston carrier. This admits the high pressure oil behind the clutch piston for clutch engagement.

F. Reverse Clutch Shaft Ball Bearing. The reverse clutch shaft ball bearing is mounted on the manifold end of the reverse clutch shaft, and is retained in position by a shroud nut. 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. Seven sintered metal clutch plates with external gear teeth, are the driven plates. The driven plates are designed with a grid pattern in the plate face to permit the flow of cooling and lubricating oil to pass through with equal distribution.

H. Clutch Piston. The clutch piston is mounted on the piston carrier and installed so that the piston is in direct contact with the clutch plates. The spring retainer which holds the release springs against the piston carrier is secured to the clutch piston by a snap ring. High pressure oil is admitted between the clutch piston and the piston carrier to engage the clutch. During engagement the release springs are compressed; the clutch piston moves back quickly

and positively during disengagement, due to the force exerted by the release springs.

I. Piston Carrier. The piston carrier is the stationary member of the clutch, and is installed on the reverse clutch shaft. The piston carrier rotates with the shaft and is horizontally stationary. Two piston rings installed on the piston carrier prevent the leakage of high pressure oil from the area between the clutch piston and the piston carrier during clutch engagement.

J. Hub and Back Plate. The hub and back plate is keyed in position on a tapered area of the reverse clutch shaft. External gear teeth of the hub and back plate mesh with the internal gear teeth of the steel clutch plates. The clutch plate stack is engaged against the hub and back plate by the clutch piston.

K. Reverse Driven Gear Roller Bearing. The reverse driven gear roller bearing is installed on the reverse driven gear. The outer race of the bearing contains a snap ring which retains the bearing in position between the bearing carrier and the front housing. The inner race of the bearing is secured in position by the retainer washer. The bearing is lubricated by oil from the oil return pipe through a cast slot in the front housing.

L. Reverse Driven Gear. The reverse driven gear is keyed to a taper on the reverse clutch shaft. The spur-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 from the shaft. The gear is lubricated by oil from the oil return pipe assembly.

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 ones 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.

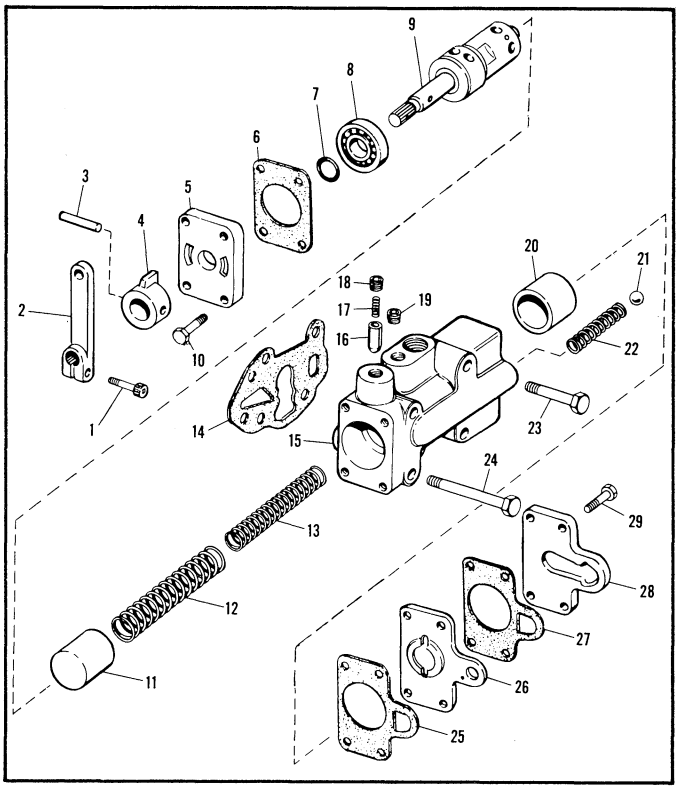


Figure 4. Selector Valve Assembly – Exploded View.

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 the 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 clamp screw. A drilled hole is provided in the lever for the connection of remote control linkage. Therefore, the selector valve assembly may be operated manually at the marine gear location, or from a remote location by the installation of linkage.

F. Pressure Regulation Piston. The pressure regulation piston is a cylindrically-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. Two springs (one inside of

the other) are 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 two springs which are installed in the open end of the pressure regulation piston also are 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. Piston 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, and pressure increasing on the rate control piston, 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 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 the 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.

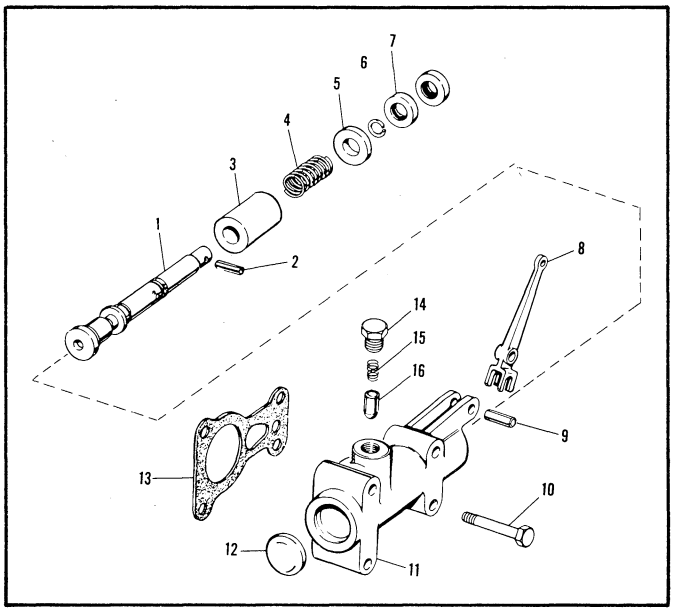


Figure 5. Trolling Valve Assembly – Exploded View.

15. TROLLING VALVE ASSEMBLY.

A. Trolling Valve Body Assembly. The trolling valve body assembly consists of the valve body and an expansion plug. The body is a high-quality casting that contains four drilled holes for installation on the manifold. The body contains a main cavity that is enclosed at one end by the expansion plug. A drilled and tapped hole for installation of the detent parts is machined perpendicular to the main cavity. Two arm-like extensions of the body contain drilled holes for the installation of the trolling valve lever.

B. Trolling Valve Stem. The trolling valve stem is a ground steel shaft that is externally shouldered and internally drilled. The lever end of the stem extends beyond the body and contains a drilled hole for the installation of a roll pin which the lever engages.

C. Trolling Valve Piston and Spring. The trolling valve piston is a cylindrically-shaped steel piece that has been drilled out from one end. Also, the piston contains a smaller hole through the closed end for the passage of the valve stem. The trolling valve piston spring is installed within the piston, and retained on the valve stem by a centering washer and a snap ring. The washer also restricts the movement of the piston.

D. Trolling Valve Lever. The trolling valve lever is a bronze casting that contains a slotted end and two drilled holes. The slotted end engages the roll pin on the valve stem. The drilled hole nearest the slotted end is the fulcrum point of the lever and is installed

within the two arm-like extensions on the body by a roll pin. The drilled hole at the end of the lever is for the connection of remote control linkage.

E. Oil Seals. Two oil seals are installed in the main cavity of the trolling valve body at the lever end. The seals prevent the leakage of oil from the valve and the entry of foreign matter into the valve.

F. Detent. The detent, spring and capscrew are installed in a drilled and tapped hole in the top of the trolling valve body. The primary function of the detent is to provide a positive locking device in the no-troll position. Another function is to provide a friction positioning device for the stem in the selected trolling position.

16. OIL PUMP ASSEMBLY.

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

B. Flexible Hose. The oil-strainer-to-pump flexible hose is connected to the pump by an elbow fitting and to the oil strainer cover by an adapter union.

17. 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, or other cooling systems, passes through the heat exchanger to accomplish this cooling. The heat exchanger is provided with mounting feet for installation at a convenient location. This maintenance manual contains instructions for heat exchangers used with right-hand engines, left-hand engines, and marine gears with the top power take-off.

B. Flexible Hose and Fittings. Sufficient flexible hose is provided with each hose-and-heat-exchanger kit for a normal installation. Bushings also are provided for adapting the flexible hose.

CAUTION

The cooling oil is circulated by a positive displacement pump. Therefore, no obstructions or reduced diameter fittings should be introduced into the hydraulic system.

18. GENERAL INFORMATION CHART.

Table I lists all the general information about the marine gear relative to its operation. Complete knowledge of the items contained therein is essential to the proper operation of the marine gear.

Table I.

OIL PRESSURE

Cooling and Lube – 20-24 psi at 1800 rpm and 180 degrees F. using plugged hole below pump on pump vertical center line on manifold.
Neutral – 50-85 psi at 1800 rpm and 180 degrees F.
Engaged – 175-200 psi at 1800 rpm and 180 degrees F.

OIL TEMPERATURE

Sump or heat exchanger inlet:

See page 28.

OIL CAPACITY

2.2 gal. "shallow case"–less heat exchanger.
3.5 gal. "deep case"–less heat exchanger.
Fill to full mark on gauge while engine is at low idle.

OIL VISCOSITY

See page 28.

OIL CHANGE INTERVAL

Replace oil after every 1000 hours of operation.

OIL STRAINER

Remove and clean after every 1000 hours of operation or sooner if required.

OIL PUMP CAPACITY

8 gpm at 1800 rpm
10.6 gpm at 2400 rpm

DRY WEIGHT

560 lbs. Shallow Case Model
720 lbs. Deep Case Model

MAXIMUM TROLLING SPEED

Engine Governed Speed (Continuous Rating)	Maximum Engine Speed When trolling
1800 rpm	850 rpm
2400 rpm	

MAXIMUM SPEED LIMITS

Shallow Case Model–3000 rpm; except with drive ring A6911 then 2350 rpm.
Deep Case Model–3000 rpm with drive rings B5005, 215041, or A6441-A. 2300 rpm with ring A6911.

Section III PRINCIPLES OF OPERATION

19 GENERAL.

A Description. The Model MG-509 Marine Gear "shallow case" is a marine reverse and reduction gear available in four ratios 1.45:1, 2.00:1, 2.48:1 and 2.95:1. "Deep case" ratios are 3.8:1 and 4.5:1. 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. 6). 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.

20. POWER FLOW.

A. Neutral (Fig. 7). 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 internal gear teeth of the steel clutch plates mesh with the external gear teeth of the hub and back plate which is directly connected to 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 to a taper on the forward clutch shaft. The reverse driving gear meshes with the reverse driven gear which is keyed to a taper on 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 mesh with the external gear teeth of the hub-and-back plate which is directly connected to the reverse clutch shaft. Therefore, the steel clutch plates of the reverse clutch rotate in anti-engine (or reverse) direction and at engine speed. Since both forward and reverse clutches are disengaged, there is no further power flow within the gear.

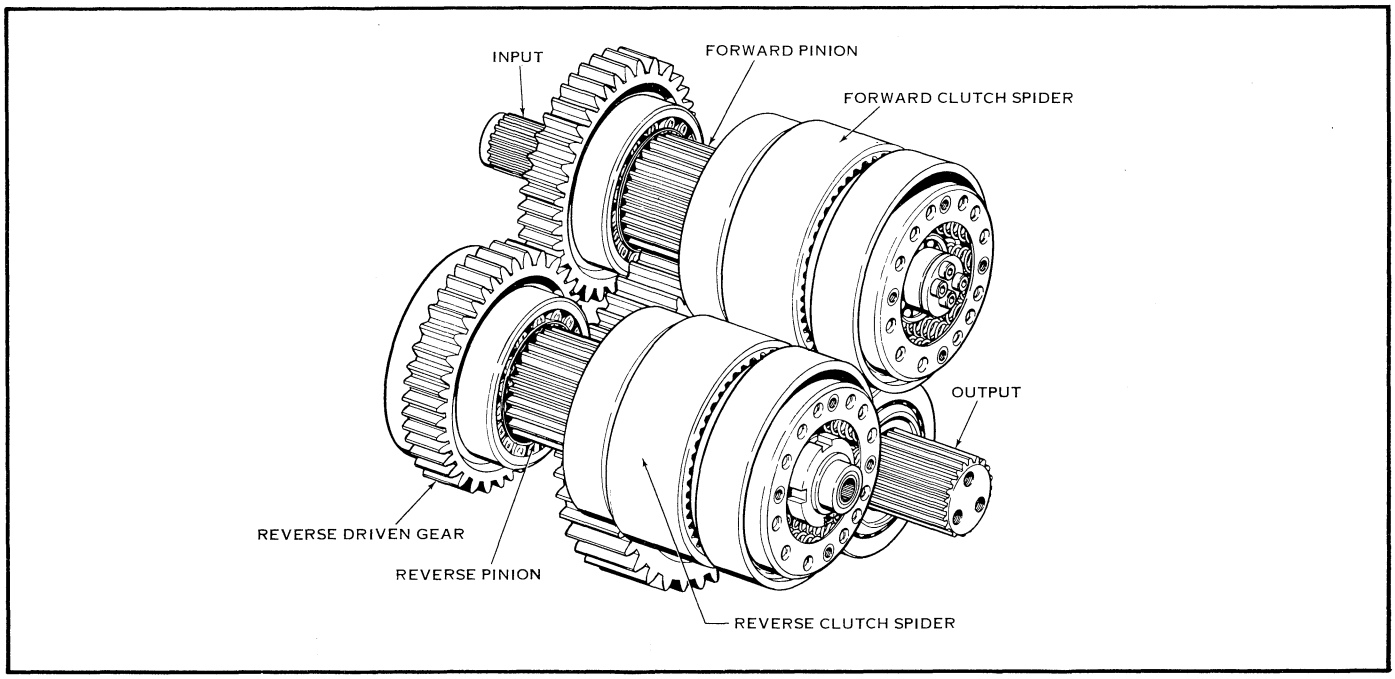


Figure 6. MG-509 Marine Gear Power Flow – Schematic View.

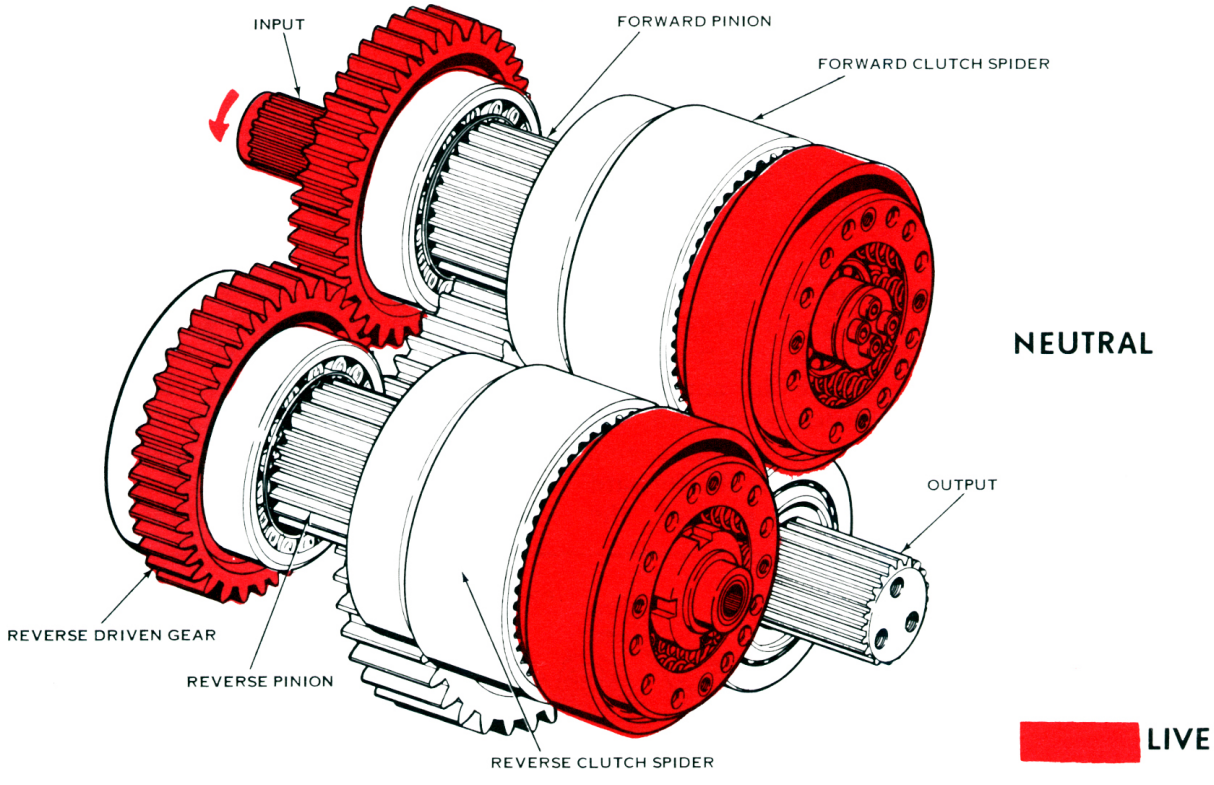


Figure 7. MG-509 Marine Gear Power Flow – Neutral.

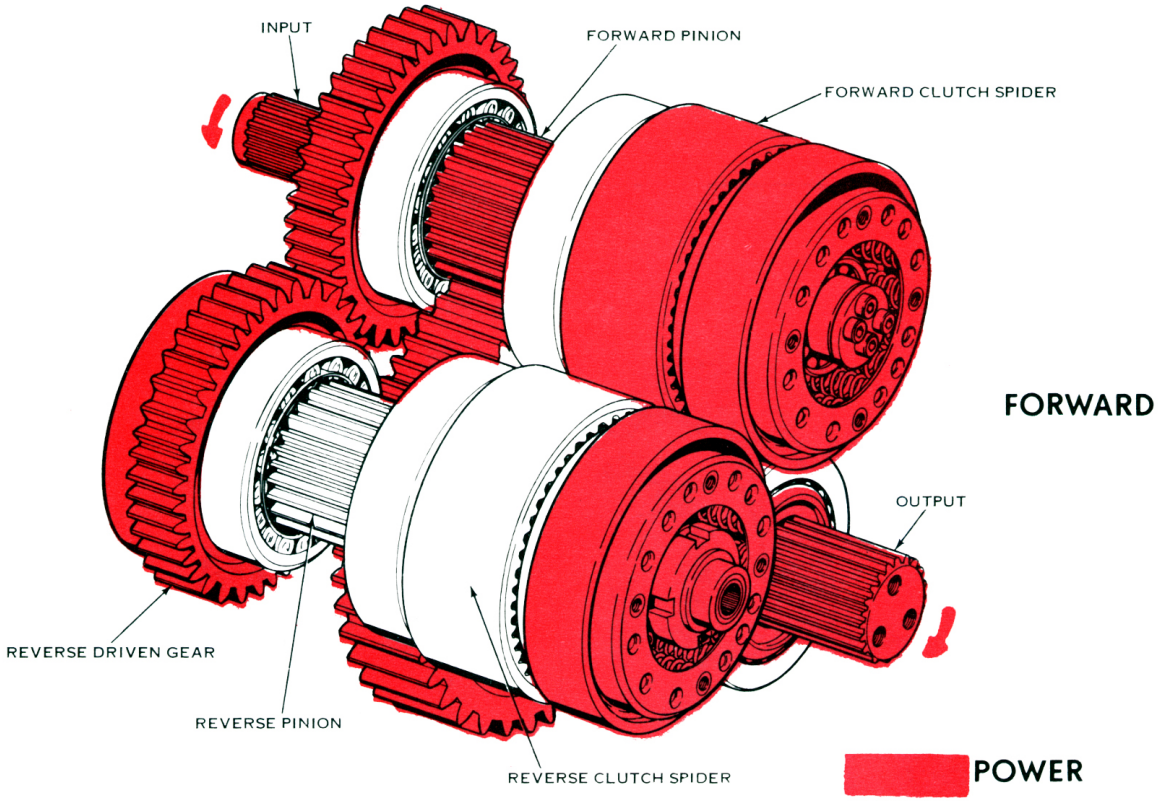


Figure 8. MG-509 Marine Gear Power Flow — Forward

B. Forward (Fig. 8). 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 gear teeth 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 flange rotate at a reduced speed due to the ratio between the output shaft gear and the forward pinion.

C. Reverse (Fig. 9). 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-metal clutch plates. The external gear teeth 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 flange rotate at a reduced speed due to the ratio between the output shaft gear and the reverse pinion.

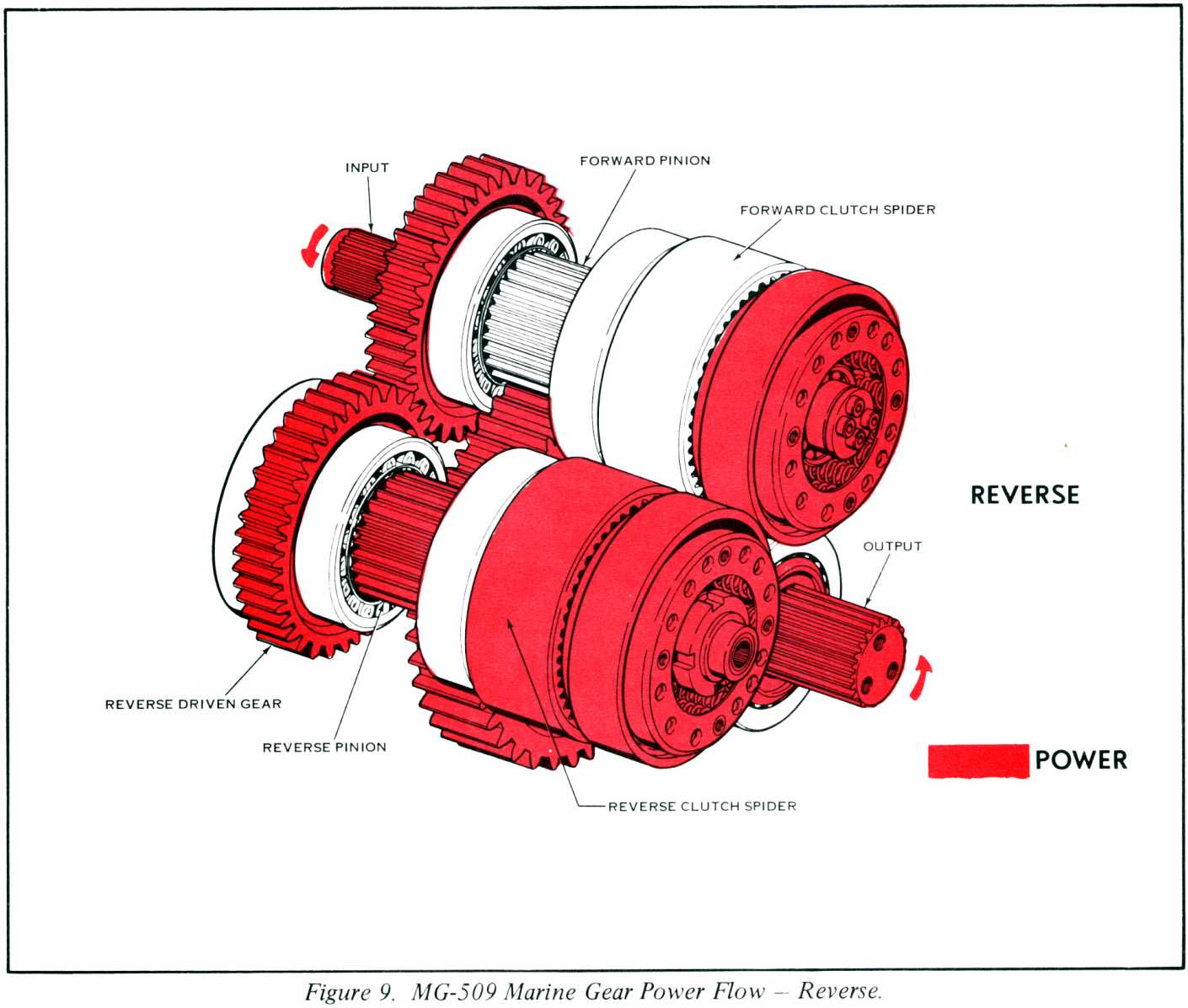


Figure 9. MG-509 Marine Gear Power Flow – Reverse.

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 on a gear under other conditions will vary accordingly.

21. GENERAL.

A. Description. The hydraulic system in the Model MG-509 Marine Gear serves to distribute 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 pressures the oil for both high and low pressure requirements. The selector valve assembly is both a pressure regulator and distributor for the hydraulic system; therefore, the valve is regarded as the "heart" of the 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 a full-flow type oil strainer. The oil return pipe assembly that is installed in the gear serves to regulate the low pressure oil supply and also to distribute this oil for lubrication purposes. A heat exchanger must be installed in the hydraulic system to maintain the oil within the gear at the proper temperature.

B. External Oil Circuit (Fig. 10). Oil is drawn from the sump through the oil strainer to the oil pump assembly. From the oil pump assembly the oil is conveyed to a heat exchanger where the oil is cooled. The cooled oil returns from the heat exchanger to the selector valve assembly through a flexible hose and tee fitting. The tee fitting is installed in the top of the selector valve body. The pressure gauge or connecting line to the gauge is connected to the tee fitting. This pressure reading will be of high pressure oil.

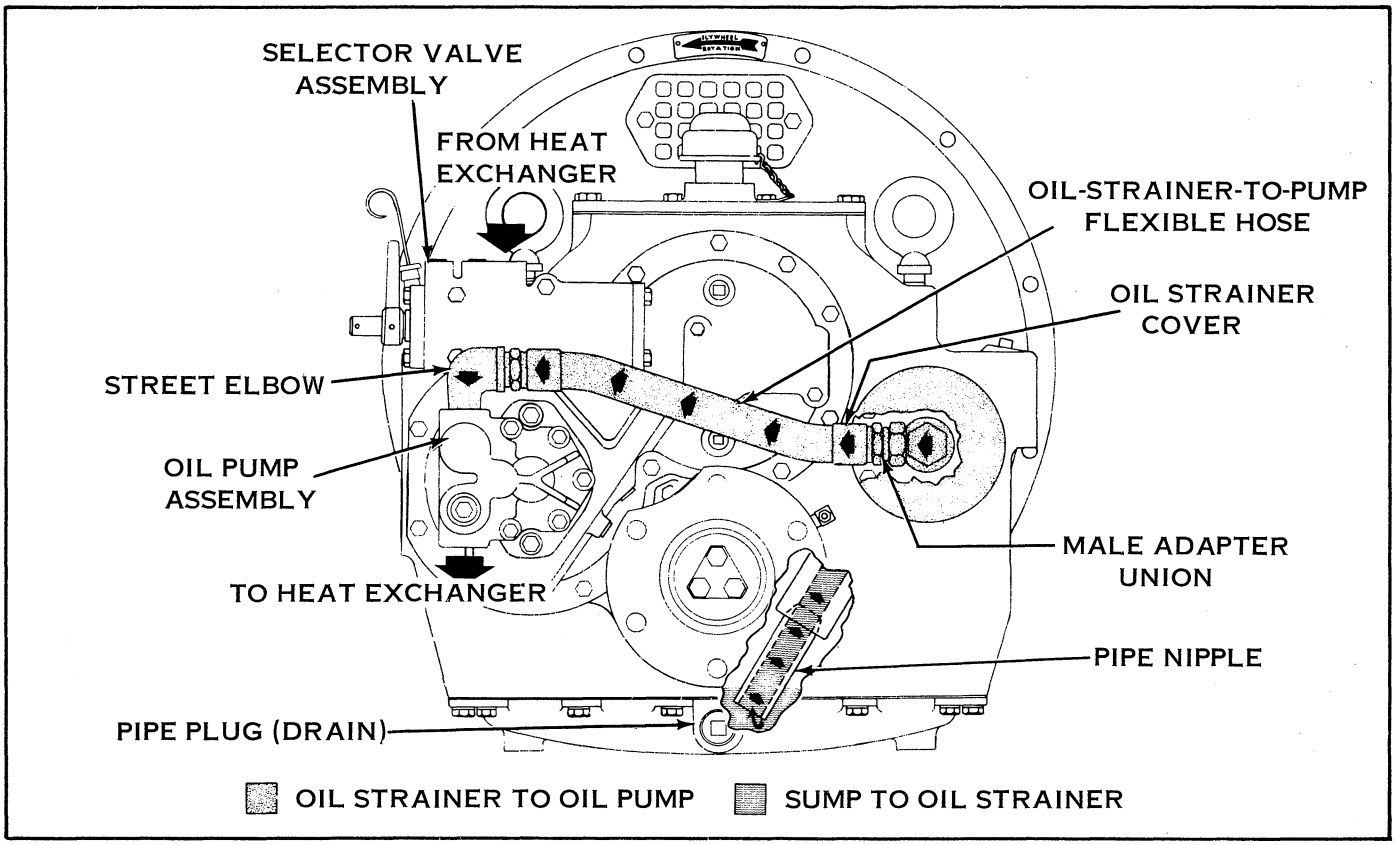


Figure 10. External Oil Circuit in Hydraulic System.

22. 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 (Fig. 11 & 12). 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 55-85 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 20-34 psi. Passage D (which is the engaging outlet to the reverse clutch) is 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.

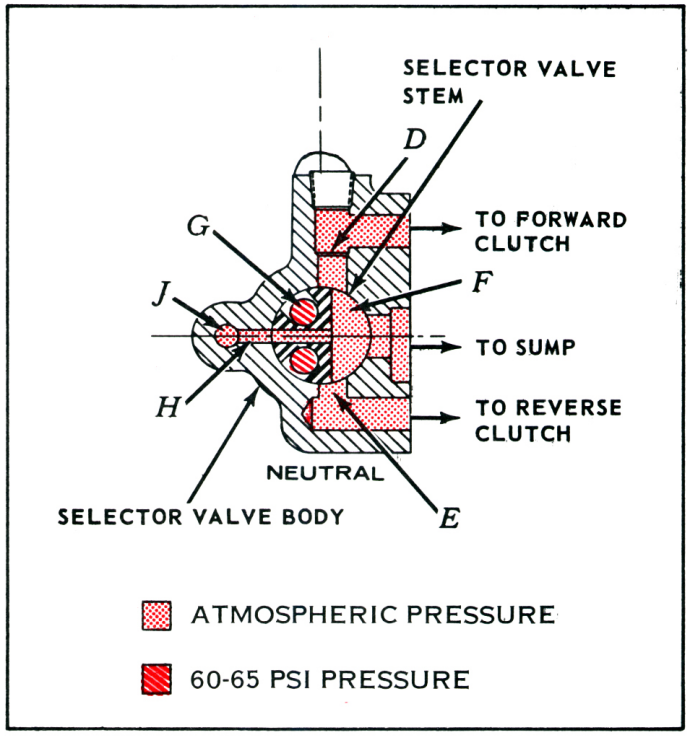


Figure 11. Selector Valve – Neutral – Sectional View.

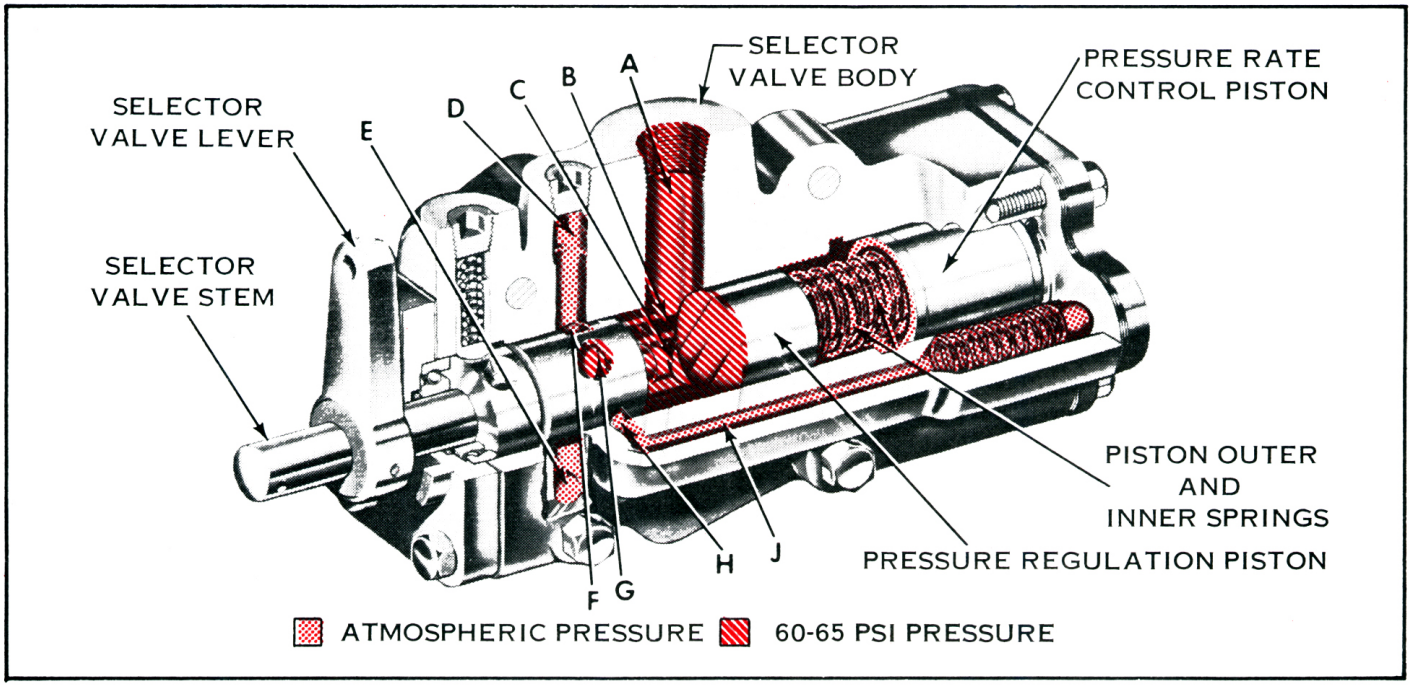


Figure 12. Selector Valve – Neutral – Cut-a-way View.

C. Selector Valve – Forward (Figs. 13 & 14). 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 13 and 14. The 55-85 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. 19) 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 55-85 psi to an engaging pressure of 170-200 psi. The time required to accomplish all the above action is approximately 1-1/2 seconds. When in forward, Passage E (fig. 13) (and Channel W, fig. 19) remains at atmospheric pressure since Slot F (fig. 13) remains open to sump. When a shift is made from forward to neutral, the valve stem is rotated to the position illustrated by Figures 11 and 12. 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 netural position is attained again.

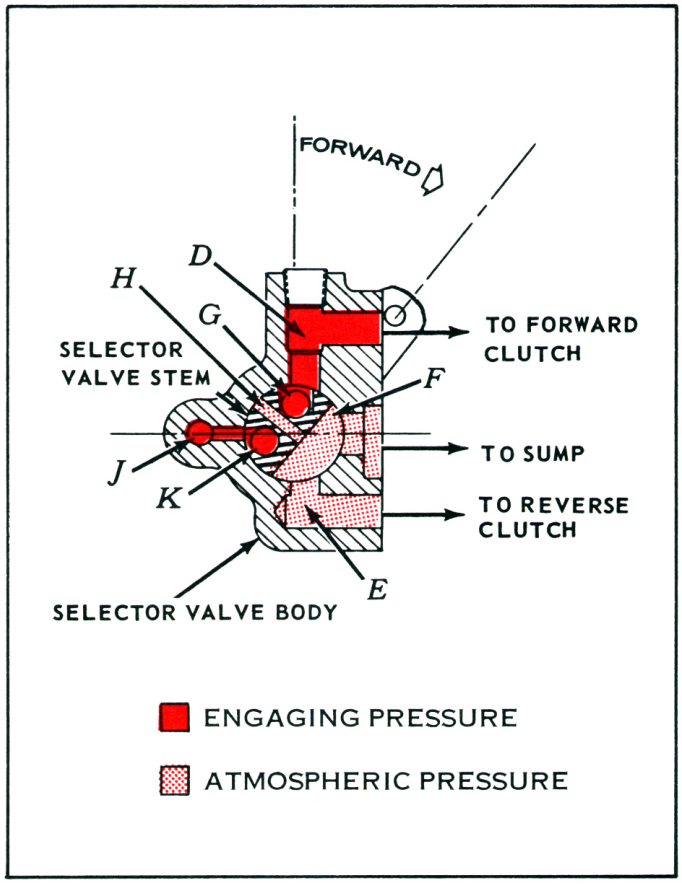


Figure 13. Selector Valve – Forward – Sectional View.

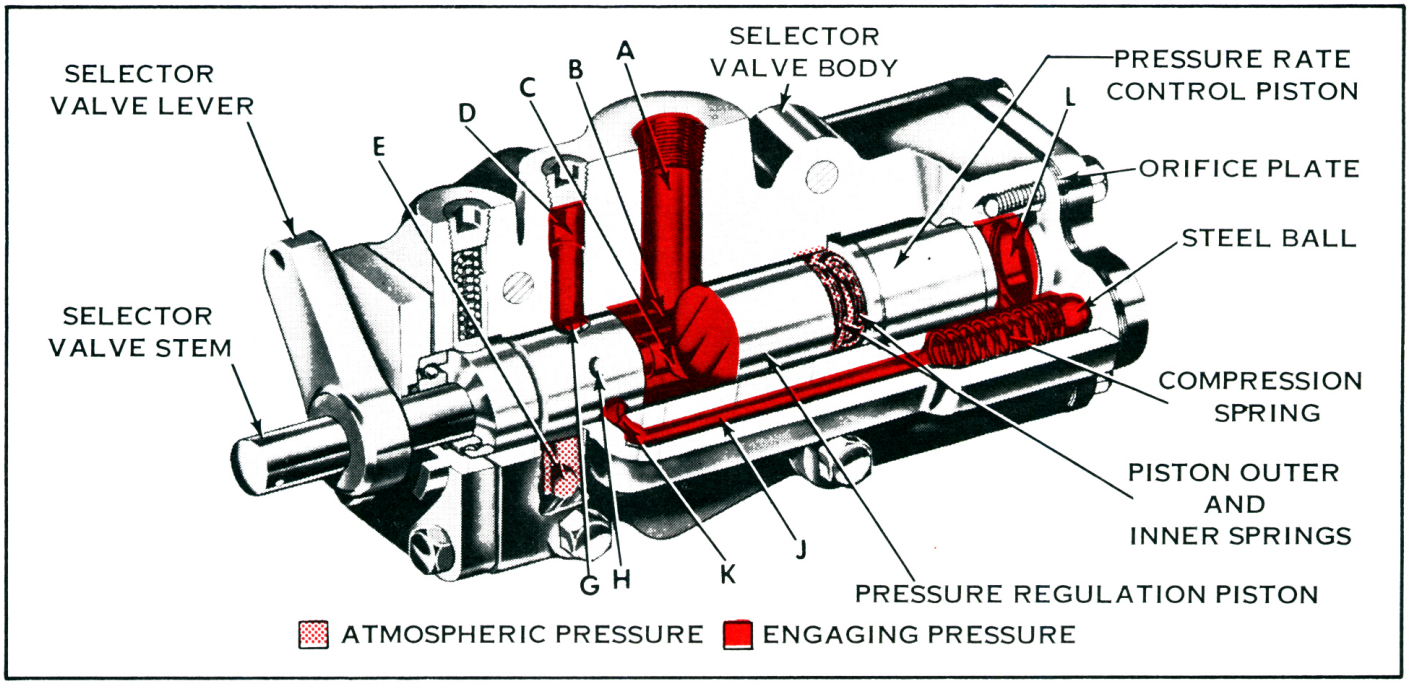


Figure 14. Selector Valve – Forward – Cut-a-way View.

D. Selector Valve – Reverse (Figs. 15 & 16). 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 15 and 16. The 55-85 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. 21) 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 55-85 psi to an engaging pressure of 170-200 psi. The time required to accomplish all the above action is approximately 1-1/2 seconds. When in reverse, Passage D (fig. 15)(and Channel X, fig. 21) remains at atmospheric pressure since Slot F (fig. 15) remains open to sump. When a shift is made from reverse to netural, the valve stem is rotated to the position illustrated by Figures 11 and 12. 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.

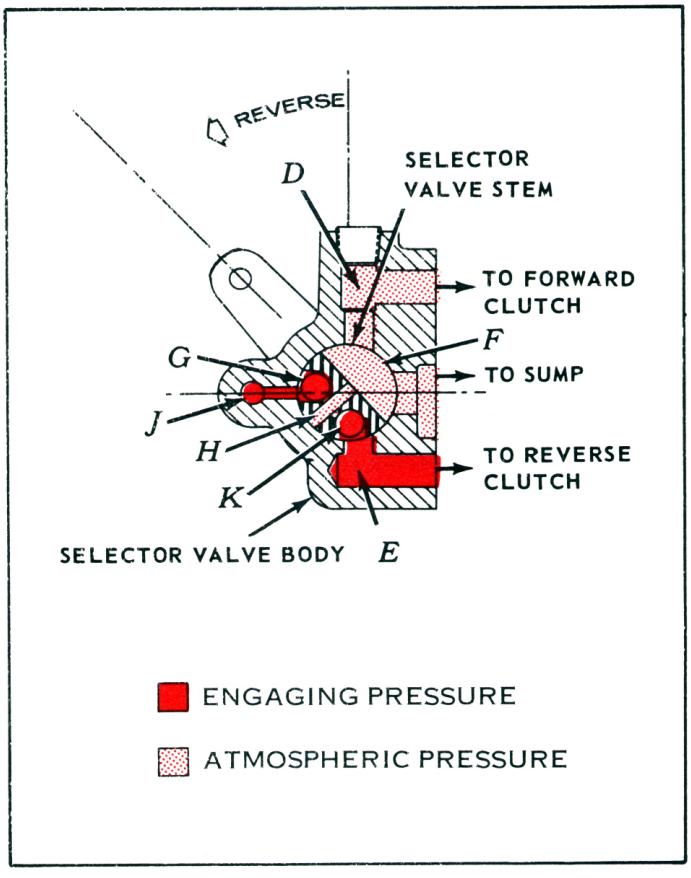


Figure 15. Selector Valve – Reverse – Sectional View.

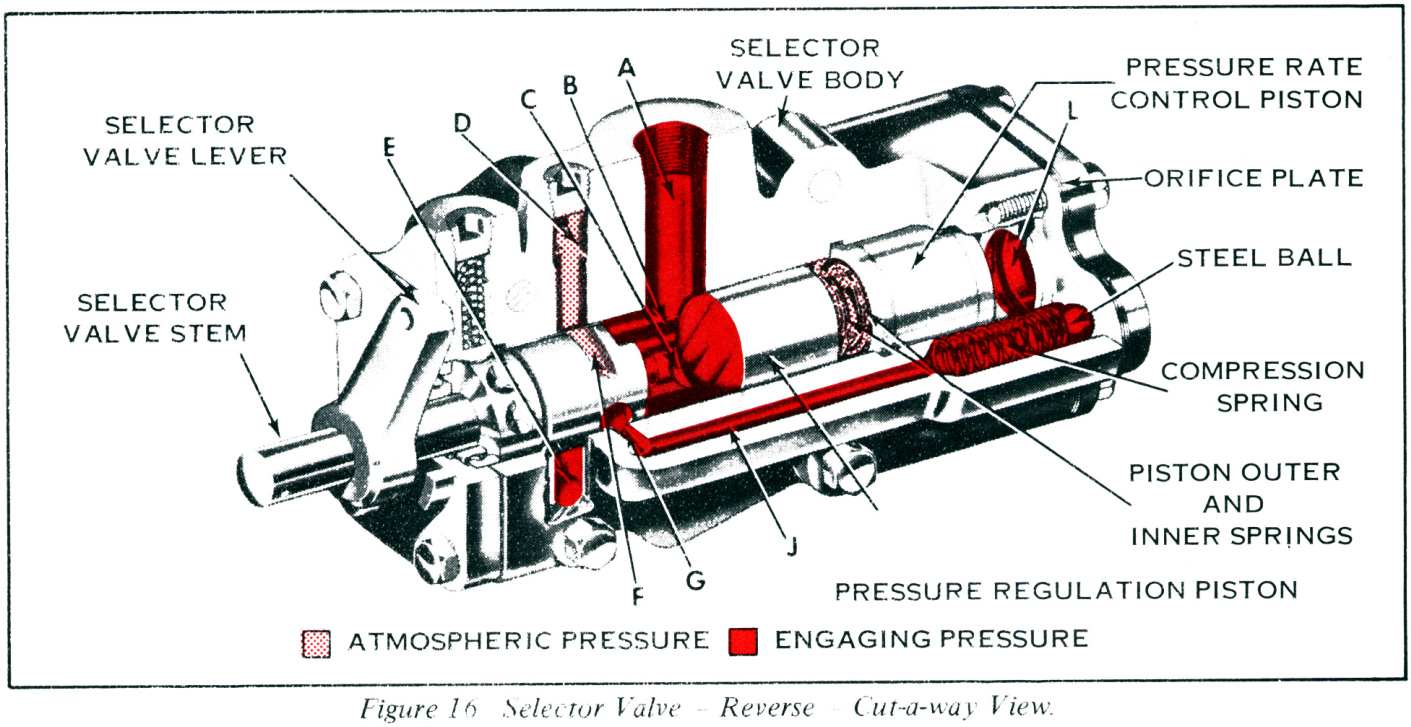


Figure 16. Selector Valve – Reverse – Cut-a-way View.

23. OIL FLOW.

A. Oil Flow – Neutral (Figs. 17 & 18). Some of the 20-34 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, the reverse driving and driven gear roller bearings, and the reverse driving and driven gears in all positions of the selector valve. The remainder of the 20-34 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 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 located in the manifold. The pressurized oil is metered through the manifold to the ball bearings on the clutch shafts. From the ball bearings the oil passes through angular-drilled holes in the piston carrier to an undercut diameter on the clutch shafts. From the undercut diameter the oil passes through drilled holes in the hub and back plate to 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. 12) and a drilled port in Passage E (fig. 12) 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. Center-drilled and cross-drilled holes in each clutch shaft connect each chamber to an area between each clutch piston and piston carrier through an angular-drilled hole in the carrier. Since Passage D and Passage E are at atmospheric pressure when in the neutral position (paragraph 22B), then the area between each clutch piston and piston carrier also is at atmospheric pressure.

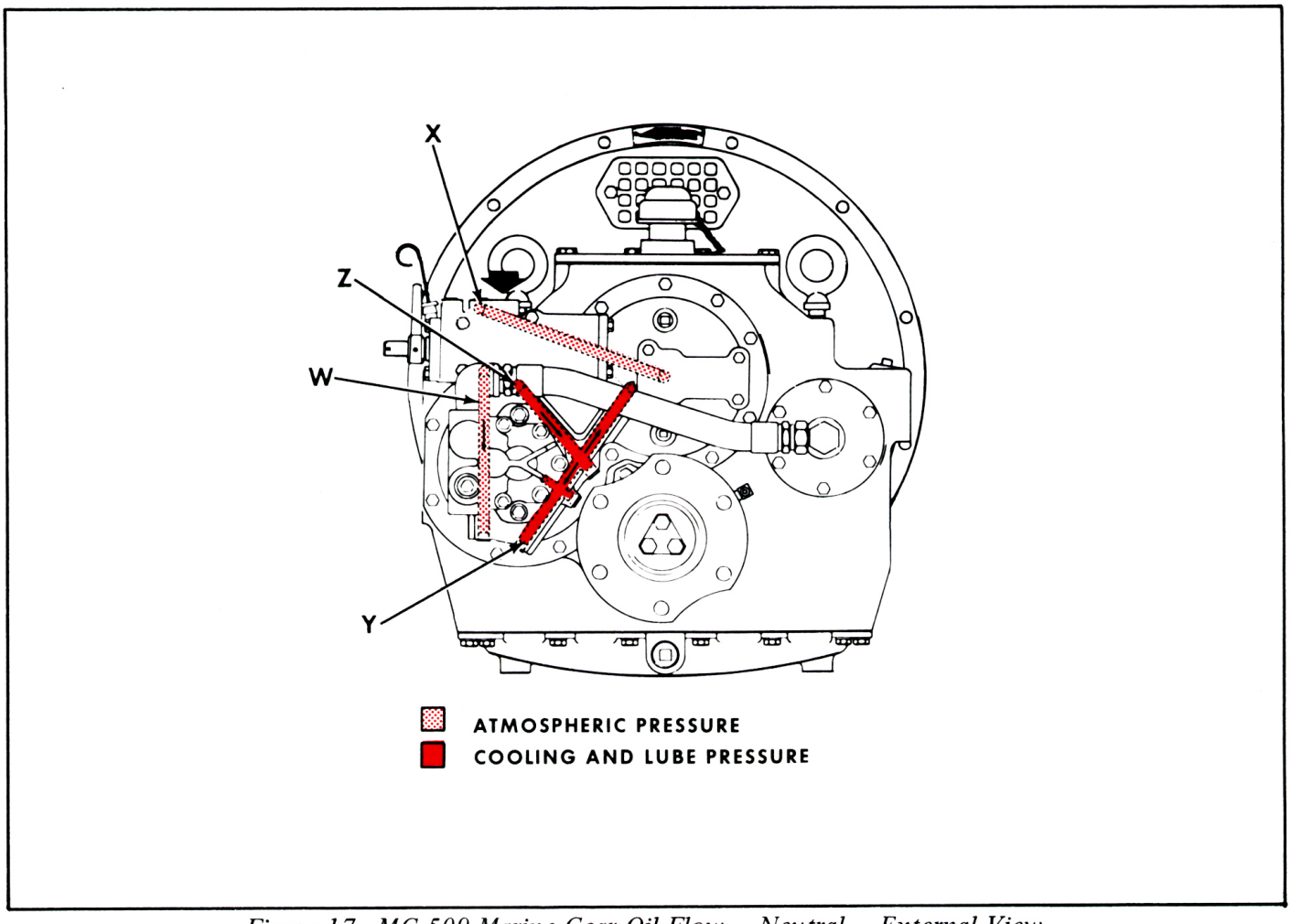
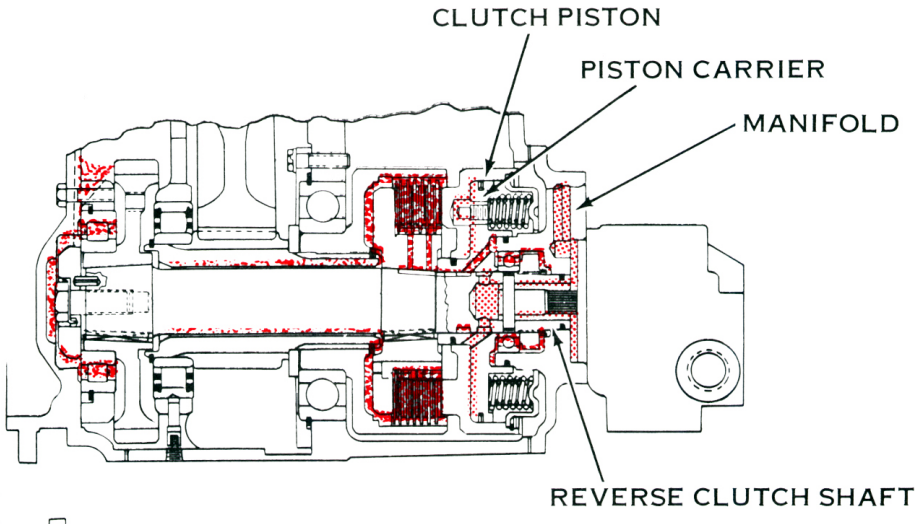


Figure 17. MG-509 Marine Gear Oil Flow – Neutral – External View.



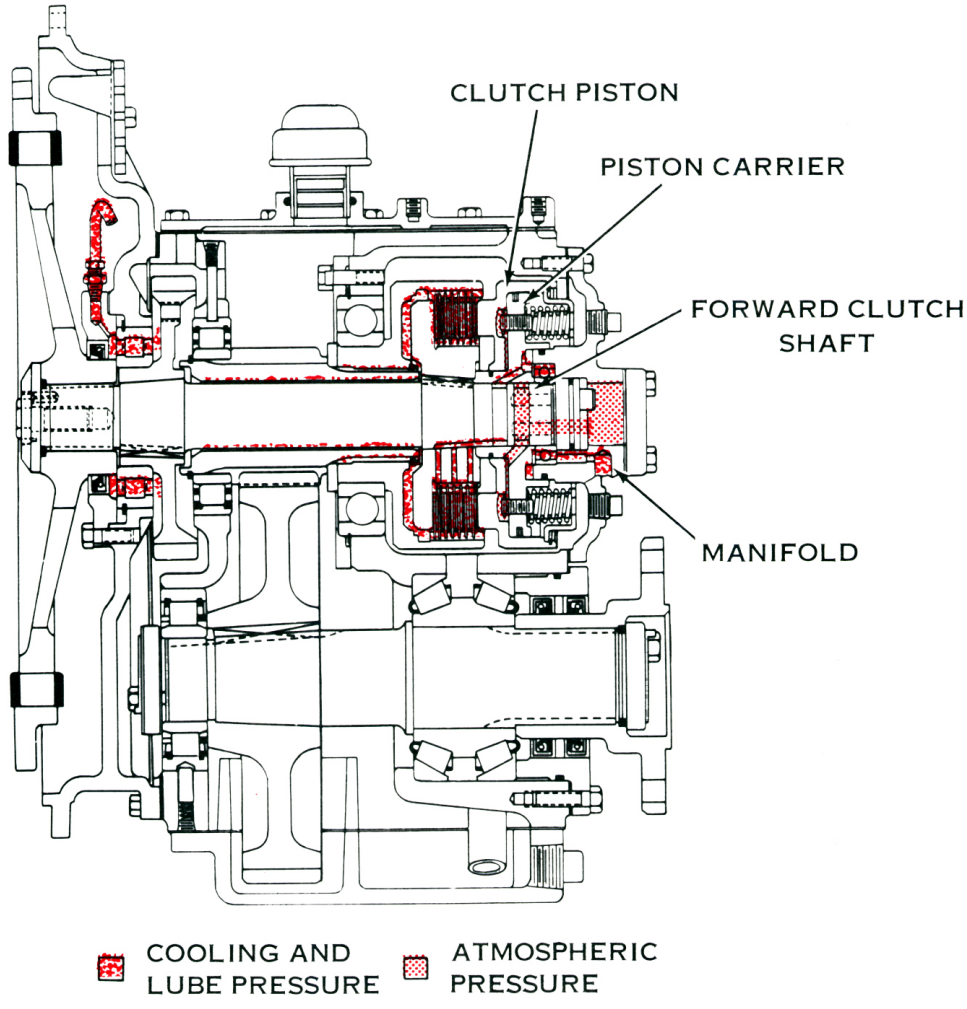


Figure 18. MG-509 Marine Gear Oil Flow – Neutral – Cross-sectional View.

B. Oil Flow – Forward (Figs. 19 & 20). The port in Passage D (Figs. 13 & 14) 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 175-200 psi oil then passes through the center-drilled and cross-drilled holes in the clutch shaft to the area between the clutch piston and the piston carrier, through an angular hole in the piston carrier. This moves the piston forward to compress and engage the clutch plate stack. The area between the reverse clutch piston and reverse piston carrier remains at atmospheric pressure as described in Paragraph 23A.

C. Oil Flow – Reverse (Figs. 21 & 22). The port in Passage E (figs. 15 & 16) 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 175-200 psi oil then passes through the center-drilled and cross-drilled holes in the clutch shaft to the area between the clutch piston and piston carrier through an angular hole in the piston carrier. This moves the piston forward to compress and engage the clutch plate stack. The area between the forward clutch piston and forward piston carrier remains at atmospheric pressure as described in Paragraph 23A.

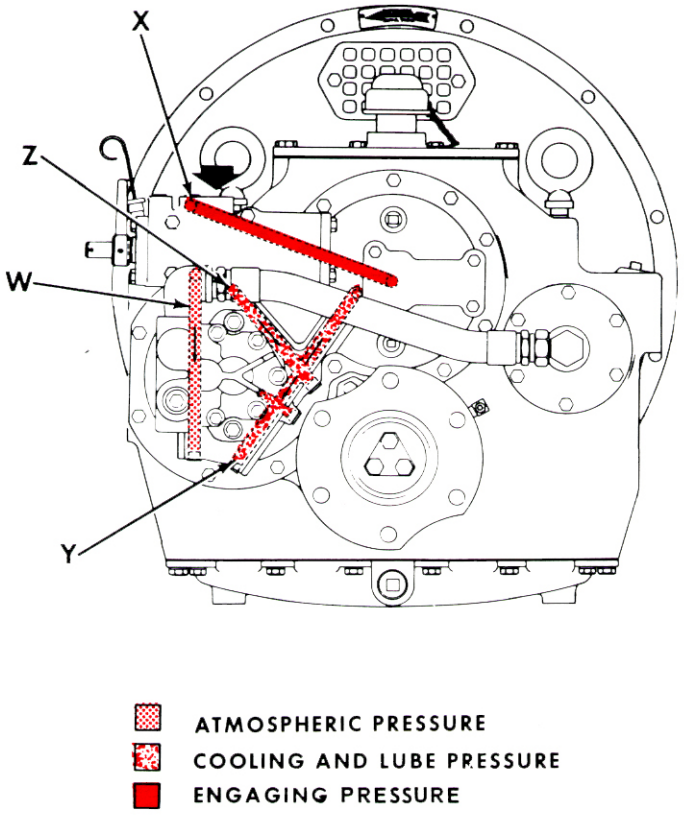


Figure 19. MG-509 Marine Gear Oil Flow – Forward – External View.

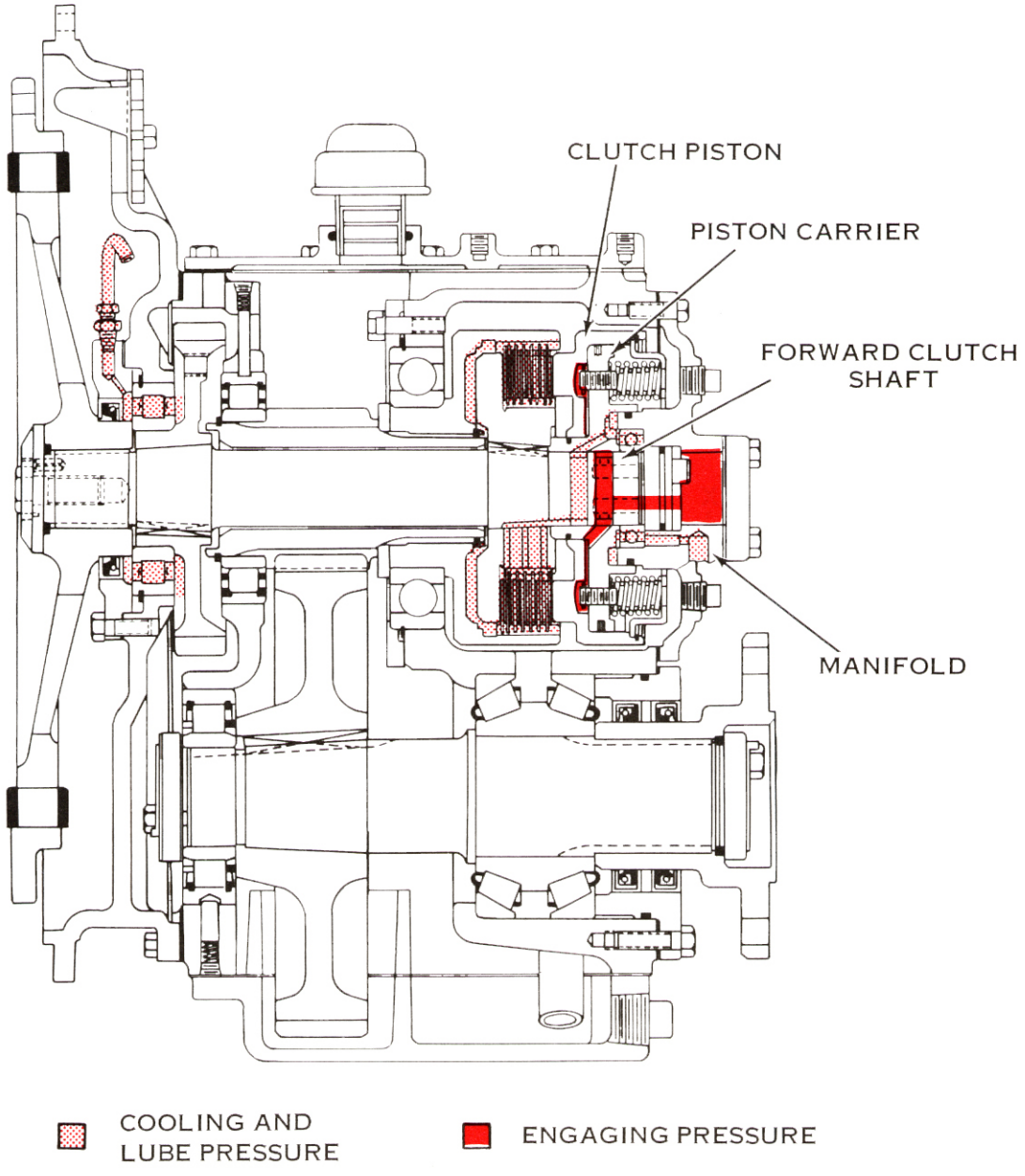


Figure 20. MG-509 Marine Gear Oil Flow – Forward – Cross-sectional View.

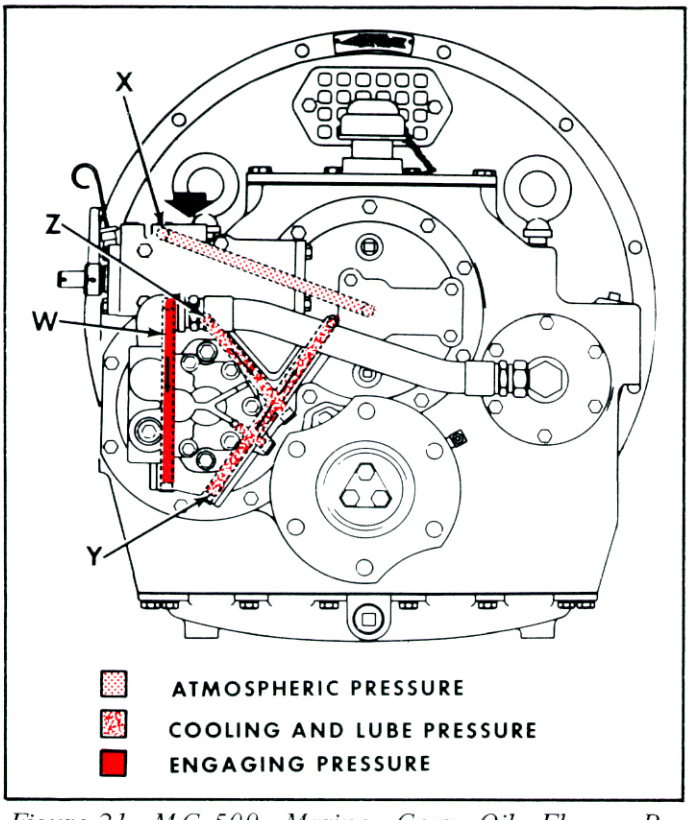


Figure 21. MG-509 Marine Gear Oil Flow – Reverse – External View.

24. TROLLING VALVE ASSEMBLY.

A. General. The trolling valve assembly is mounted on the manifold at the forward clutch shaft location. The function of the trolling valve is to reduce the engaging pressure to the forward clutch to permit the clutch to operate in the partially disengaged position. This enables the engine to operate at a relatively high speed while the propeller shaft turns at a reduced speed. This feature is particularly important in some types of fishing operations.

B. Operation. The trolling valve functions in the hydraulic system between the selector valve assembly and the forward clutch. The oil pressure is not affected by the trolling valve when the trolling valve lever is in the no-troll position. However, when the forward clutch is engaged and the lever is placed in a trolling position, the oil pressure to the forward clutch is reduced resulting in a partially disengaged clutch. Excess oil that is present because of this condition flows through the clutch for additional cooling.

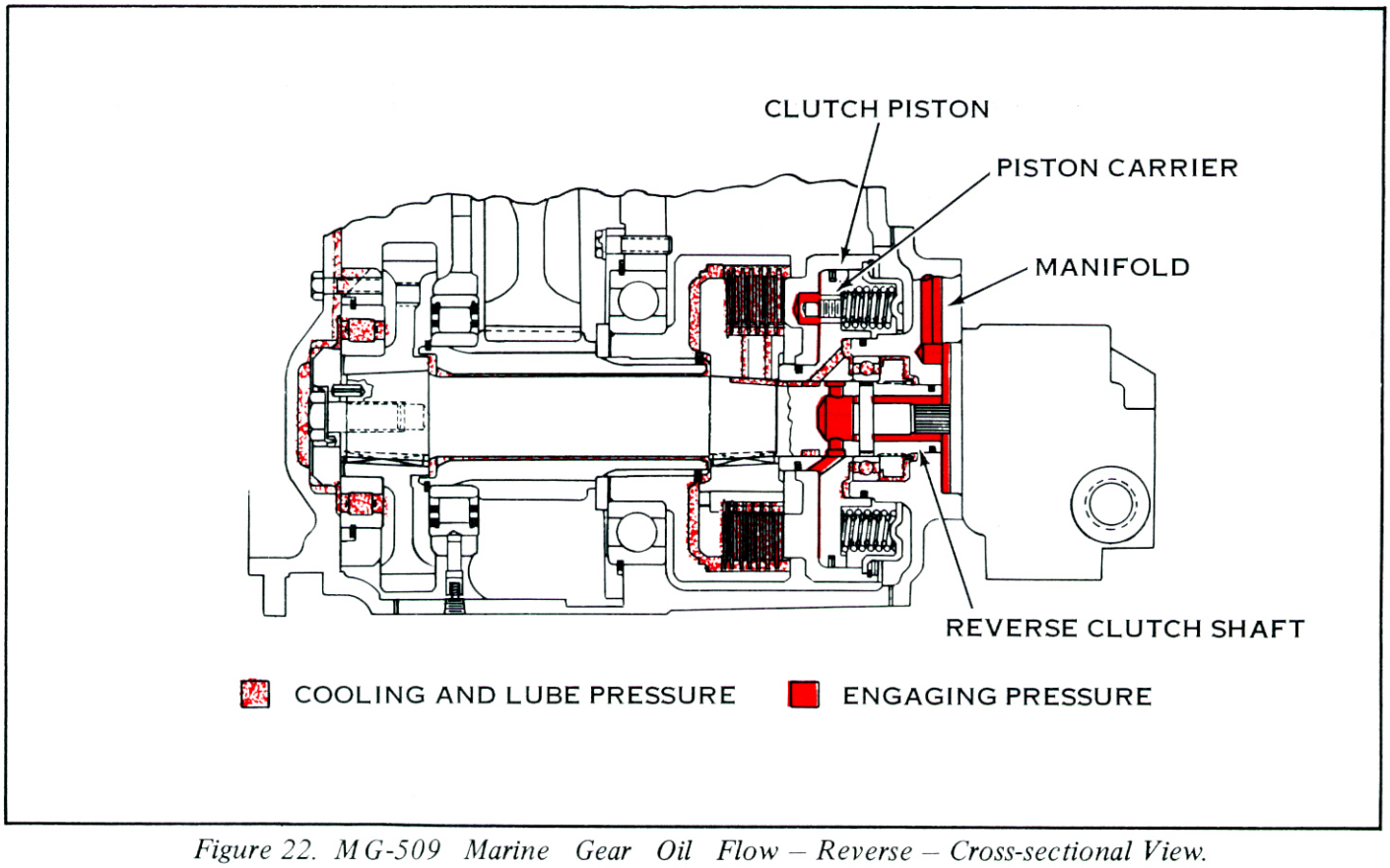


Figure 22. MG-509 Marine Gear Oil Flow – Reverse – Cross-sectional View.

MARINE TRANSMISSION LUBRICATING OIL RECOMMENDATIONS

1. OIL SERVICE CLASS

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

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

2. OIL VISCOSITY

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

Sump Temperature, also Oil Temperature into Heat Exchanger		Recommended Oil Viscosity
During Start-up	Steady Operating Conditions	
A. Models MG502, MG506, MG509, MG510A, MG512, MG514 and MG514M		
	Below 150° F.	This operating condition is **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.
B. Models MG521, MG527, MG530, MG530M and MG540		
	Below 150° F.	This operating condition is **not** approved.
35° F. Minimum	150° – 185° F.	SAE viscosity number 40 engine oil
50° F. Minimum	175° – 200° F.	SAE viscosity number 50 engine oil
	Over 200° F.	This operating condition is **not** approved.

Section V. PREVENTIVE MAINTENANCE

25. GENERAL.

A. Lubrication. All moving parts of the MG-509 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 minimal however, it is very important that the following directions be complied with.

B. Overhaul Interval. A complete overhaul of the MG-509 Marine Gear should be made at the same time that the engine is overhauled. All parts showing signs of wear, fatigue, etc., should be replaced at this time.

26. HYDRAULIC SYSTEM.

A. Oil Capacity and Weight. The oil capacity of the MG-509 Marine Gear "shallow case" is 2.2 gallons, 2.75 gallons with the heat exchanger, or to the "Full" mark on the oil gauge. Oil capacity "deep case" is 3.5 gallons less heat exchanger.

(See page 28).

B. Oil Level. The oil level should be checked daily using the oil gauge in the marine gear. The oil level must be checked with the engine running at low idle. 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.

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 bottom cover. 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 gauge tube is serrated to accomodate a suction hose. Remove the oil level gauge. Operate suction pump until the marine gear oil has been removed. After suction draining, remove the hose and install the oil gauge in the tube.

E. Filling. Make certain the drain pipe plug is tight. Remove the oil breather assembly from the opening in the top cover plate. Use the recommended quality, type and weight oil, and fill through the opening in the cover plate from which the breather had been removed. The oil level must be checked after filling with the engine running at low idle. Install the oil breather assembly in the top cover plate.

27. COMPONENT PARTS.

A. Oil Strainer. The oil strainer is installed in the main housing, and secured in position by the oil strainer cover.

(1) Change Interval. The oil strainer should be removed and cleaned every 1000 hours of operation or at the same time the oil is changed. The oil strainer cover gasket should be replaced at this time.

(2) Removal. Disconnect the oil-strainer-to-pump flexible hose from the male adapter union installed in the oil strainer cover reducer bushing. Remove the six hex-head capscrews that secure the oil strainer cover to the main housing. Pull the oil strainer cover, the oil strainer cover gasket, and the oil strainer from the main housing. Unscrew the oil strainer from the oil strainer cover. Discard the oil strainer cover gasket.

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

(4) Installation. Install the oil strainer in the oil strainer cover. Use a new oil strainer cover gasket, and place the oil strainer cover and gasket in position against the main housing. Secure the oil strainer cover to the main housing with the six hex-head capscrews previously removed. Connect the flexible hose to the union.

B. 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.

C. Oil Breather Assembly. Remove the oil breather assembly every 500 hours of operation at

the same time the oil is changed. Flush the oil breather assembly in clean diesel fuel.

28. PERIODIC VISUAL INSPECTION.

A. General. Inspect the mounting parts of the marine gear frequently. 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 malfunction.

Ⓐ **F. Zinc Electrodes.** Inspect the zinc electrodes used to protect the system from the effect of galvanic action. Replace zinc electrode showing extensive disintegration.

Section VI. TROUBLE SHOOTING.

29. GENERAL.

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.

30. TROUBLE-SHOOTING CHART.

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.

31. COME-HOME FEATURE.

A. General. A come-home feature has been designed into the forward clutch in the event of hydraulic system failure. Simply, the come-home feature is a mechanical lock-up of the forward 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 two come-home access plugs (fig. 1) from the manifold over the forward clutch location. Use a screwdriver, and alternately tighten the come-home setscrews (fig. 3) in a clockwise direction until mechanical lock-up of the clutch is attained.

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. 27A).
	1–2. Stuck pressure regulation piston in selector valve assembly.	1–2. Remove selector valve assembly (par. 33A). Disassemble the valve (par. 39), and clean the piston.
	1–3. Broken piston rings in clutches.	1–3. Remove the manifold (par. 33A), 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 a loose come-home setscrew by turning counterclockwise, or replace a missing setscrew.

Table II. Trouble Shooting.

Symptom	*Cause*	*Remedy*
	1–5. Damaged or worn oil pump assembly.	1–5. Remove oil pump assembly (par. 33A). 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.
	1–7. Clogged or plugged orifice in orifice plate of selector valve assembly.	1–7. Remove orifice plate cover (par. 39A (5)). Clean parts.
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. 26E).
	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. 26B).
	4–5. Improper oil in sump.	4–5. Drain marine gear, and fill with proper oil (par. 26).
	4–6. Trolling at too high an engine speed.	4–6. Refer to Table I.
	4–7. Clutch plates warped.	4–7. Replace clutch plates (par. 33A).

Table II. Trouble Shooting.

Symptom	*Cause*	*Remedy*
5. Excessive Noise.	5–1. Worn splines between reverse driving and driven gears and clutch shafts.	5–1. Remove marine gear (pars. 35 & 36). Disassemble marine gear (pars. 38-48), and replace worn splined parts.
	5–2. Bearing failure.	5–2. Remove marine gear (pars. 35 & 36). Disassemble marine gear (pars. 38-48), and replace damaged or worn parts.
	5–3. Worn or damaged rubber blocks.	5–3. Remove marine gear (pars. 35 & 36). Replace worn or damaged rubber blocks.
6. No Neutral.	6–1. Clutch plates warped.	6–1. Replace clutch plates (par 33A).
7. Harsh Engagement.	7–1. Steel ball in selector valve not seating properly.	7–1. Remove orifice plate cover (par. 39A (5)). Clean parts. Replace parts if necessary.

Table III. Trouble Shooting – Top Power Take-Off.

Symptom	*Cause*	*Remedy*
1. Clutch Slips.	1–1. Improper adjustment.	1–1. Adjust clutch (par. 65).
2. Clutch will not remain engaged.	2–1. Clutch adjustment too tight.	2–1. Adjust clutch (par. 65).
	2–2. Improper remote engaging linkage.	2–2. Adjust linkage as required to assure proper travel of operating lever. Engaging force must be removed after complete engagement of the clutch.
3. Power Take-off continues to drive when clutch is disengaged.	3–1. Warped or welded clutch plates.	3–1. Remove power take-off and replace clutch plates.
	3–2. Bearing failure.	3–2. Remove power take-off, and replace bearings.

Section VII. HYDRAULIC CLUTCH OVERHAUL

32. GENERAL.

Due to the unique design of the MG-509 Marine Gear, it is possible to service the forward and reverse clutches without disconnecting the gear from the engine or output shaft companion flange. With this feature, it is unnecessary to disturb the alignment of the gear, or to accomplish the time-consuming operating of removing the gear from the installation. Other serviceable parts, while the gear is installed, are the selector valve assembly, the trolling valve assembly, the oil pump assembly, the oil strainer, and if present, the top power take-off. Also, it is possible to service the output flange oil seals by disconnecting the propeller shaft companion flange and then moving the shaft rearward approximately 3 inches.

33. HYDRAULIC 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, the pressure gauge assembly, and the trolling valve assembly (if used). Disconnect the heat exchanger lines from the pressure side of the oil pump assembly and the selector valve assembly. Disconnect the male adapter union from the oil-strainer-to-pump flexible hose. Disconnect the top power take-off flexible hose (if used) from the manifold.

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

(3) Remove the four hex-head capscrews that secure the trolling valve assembly (if used) to the manifold. Remove the trolling valve assembly and the trolling-valve-to-manifold gasket from the manifold. Discard the gasket. If a cover plate is used in place of the trolling valve assembly, it is unnecessary to remove the plate.

(4) Remove the two hex-head capscrews that secure the oil pump assembly 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 hex-head capscrews that secure the top cover plate, or top power take-off (if used), to the main housing. Remove the top cover plate, with attached parts, and the top cover plate gasket from the main housing. Discard the gasket.

(6) Reach down through the top cover plate opening in the main housing, and firmly grasp the oil return pipe assembly. Carefully, push the oil return pipe assembly rearward through the manifold, and remove the oil return pipe and the corprene ring gasket from the manifold. Discard the gasket.

(7) Remove the 11 hex-head capscrews that secure the manifold (fig. 23) to the main housing. Install two pusher screws in the 3/8-16 UNC tapped holes in the manifold. Remove the manifold, with attached parts, and the main housing-to-manifold gasket from the main housing. Discard the gasket. Remove the two piston rings from the manifold. Discard the piston rings.

(8) Remove the piston ring from the reverse clutch shaft. Discard the piston ring. Straighten the lip of the shroud nut on the reverse clutch shaft, (fig. 24). Use special tool T-9069, and remove the shroud nut from the reverse clutch shaft. Use a standard bar puller with a stud installed in each 3/8-16 UNC tapped hole in each locating pin positioned in the piston carrier, and remove the reverse clutch shaft ball bearing and piston carrier (fig. 25), with attached parts, from the reverse clutch shaft. Remove the parts through a cut-out in the output flange (fig. 26).

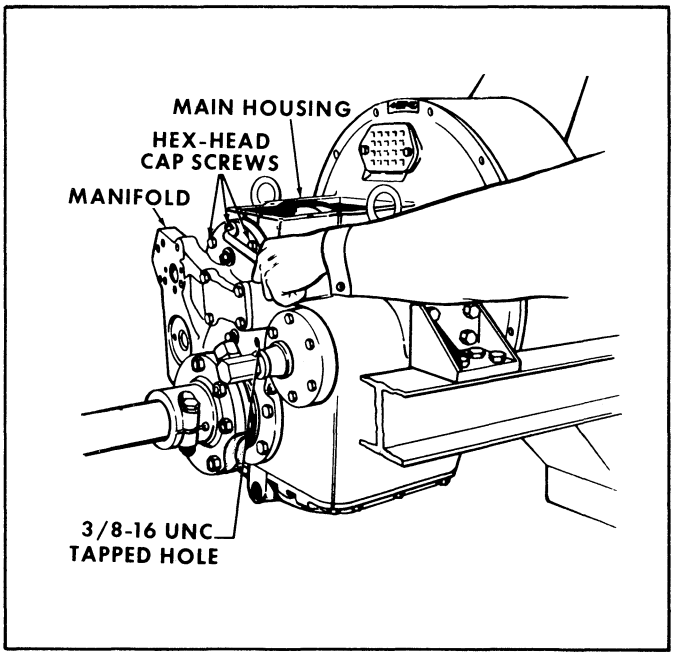


Figure 23. Removing the Manifold.

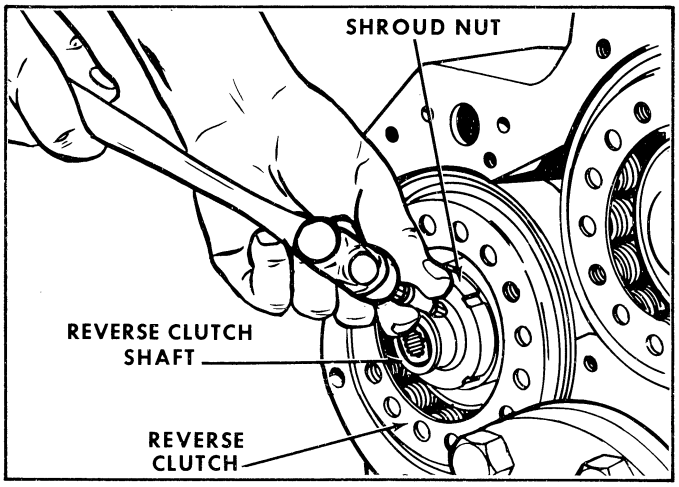


Figure 24. Straightening the Lip of the Shroud Nut.

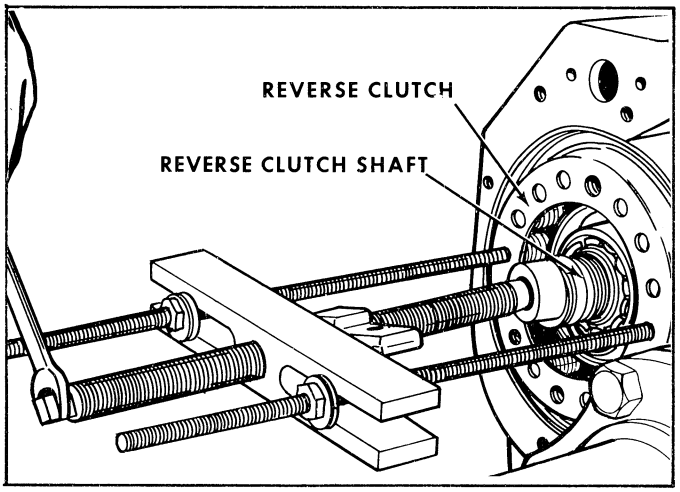


Figure 25. Removing the Reverse Clutch with a Standard Bar Puller.

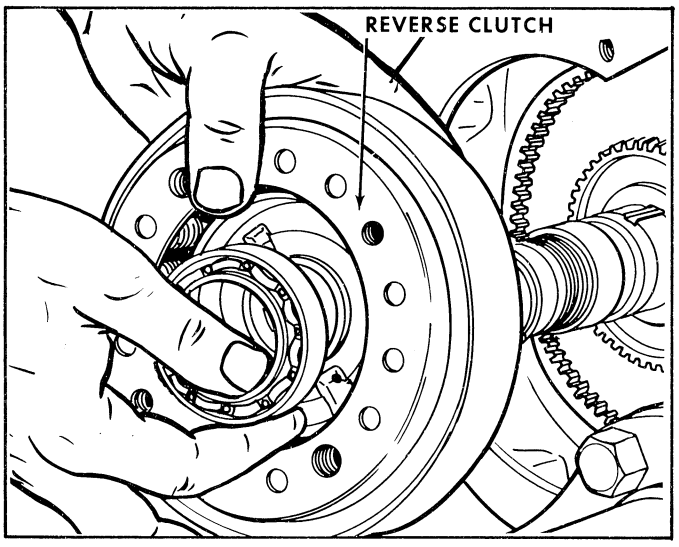


Figure 26. Removing the Reverse Clutch from the Main Housing.

CAUTION

Be sure that the drive sleeve pin is centered in the reverse clutch shaft while the piston carrier is being removed.

NOTE

The following disassembly is required to change clutch release springs. If only the clutch plates are to be changed, the piston carrier with attached parts can remain assembled.

(9) Remove the drive sleeve pin and drive sleeve from the reverse clutch shaft. Use special tool T-8884, and compress the spring retainer that positions the sixteen outer and inner release springs against the piston carrier. Remove the internal snap ring that secures the spring retainer in the clutch piston.

CAUTION

Do not attempt to remove the internal snap ring unless the spring retainer and release springs are compressed, securely.

(10) Remove the spring retainer and release springs from the clutch piston and the piston carrier. Gently tap the piston from the carrier. Remove the two rollpins and the two headless flat point setscrews from the carrier only if replacement of parts is necessary. Remove the piston ring and the lathe cut ring from the carrier. Discard the rings.

(11) Fabricate a pair of stiff wire hooks with hooks approximately 1/16 inch long. The hooks should be basically "L" shaped. Remove the seven sintered metal clutch plates and the seven steel clutch plates from the hub and back plate. Discard the clutch plates. Use a standard bar puller with 3/8-16 UNC studs (fig. 28), and remove the hub and back plate from the reverse clutch shaft only if removal is necessary.

(12) Remove and disassemble the forward clutch by the following described procedure. In place of the shroud nut, the drive sleeve, and the drive sleeve pin, the following parts are removed during forward clutch procedure. Remove the piston ring from the lock plate. Discard the piston ring. Cut and remove the lock wire from the two socket-head capscrews that secure the lock plate to the forward clutch shaft. Remove the two socket-head capscrews and the lock plate.

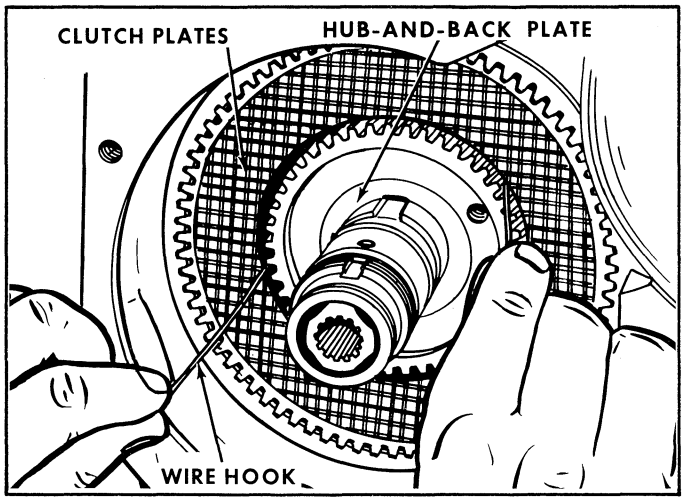


Figure 27. Removing the Clutch Plates from the Hub-and-Back Plate.

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

(1) (Lightly coat the tapers on shaft and hub and wipe.) Install the 3/8 x 1/4 x 1-3/8 key in the forward clutch shaft. Carefully align the keyway of the hub and back plate with the installed key in the forward clutch shaft. Firmly seat the hub and back plate on the taper of the forward clutch shaft. Use 200-300 lbs. force to seat the taper and then dial indicate an advance of hub on shaft of 0.022-0.038 inches by using the following procedure: make a sleeve from steel tubing 1/4 inch wall stock 2-1/4 inches long, slightly larger in I.D. than the O.D. of the clutch shaft (1-13/16 inches). Substitute capscrews three inches long with two inches threaded the same thread size as the lock plate retainer screws, (fig. 59, 31). Place the sleeve over the clutch shaft against the hub and back plate. Place the lock plate against the sleeve and install the two long capscrews through the lock plate into the clutch shaft. Attach a dial indicator so its stem reads the advance of the clutch hub and back plate onto the clutch shaft. Using the long lock plate screws, pull the lock plate and sleeve against the hub advancing it on the shaft a minimum of 0.022 and maximum of 0.038 inches. Remove dial indicator, fabricated sleeve, long capscrews, and the lock plate from the clutch shaft.

(2) Press the locating pins into the piston carrier. Install a roll pin into each 3/8 x 1 headless flat-point setscrew. Install both setscrews, with roll pins, into the flat face of the piston carrier. Use a screwdriver, and firmly lock the roll pins in position against the piston carrier. Install the new piston ring and the new lathe cut rubber ring in the piston carrier. Lightly oil the new rings.

(3) Scribe a mark on the clutch piston and the piston carrier from the center line of the locating pin hole so that both marks will be visible during assembly. Gently tap the piston carrier into the clutch piston. During assembly, carefully align the above scribed marks so that the locating pins in the carrier will enter the holes in the piston. *Be careful not to damage the piston rings!*

(4) Carefully position the sixteen inner and outer release springs on the piston carrier. Place the spring retainer in position, and make certain to align the two holes in the retainer with the two installed setscrews in the carrier. Use two "C" clamps, and compress the spring retainer and springs into the clutch piston until the snap ring groove in the piston is fully exposed. Install the internal snap ring in the clutch piston. Remove the "C" clamps.

(5) Start with a sintered metal clutch plate and alternately install the seven new sintered-metal clutch plates and the seven new steel clutch plates onto the hub and back plate.

NOTE

Grease the last three sintered-metal clutch plates. This will hold the clutch plates in position for the installation of the piston carrier, with attached parts, onto the forward clutch shaft.

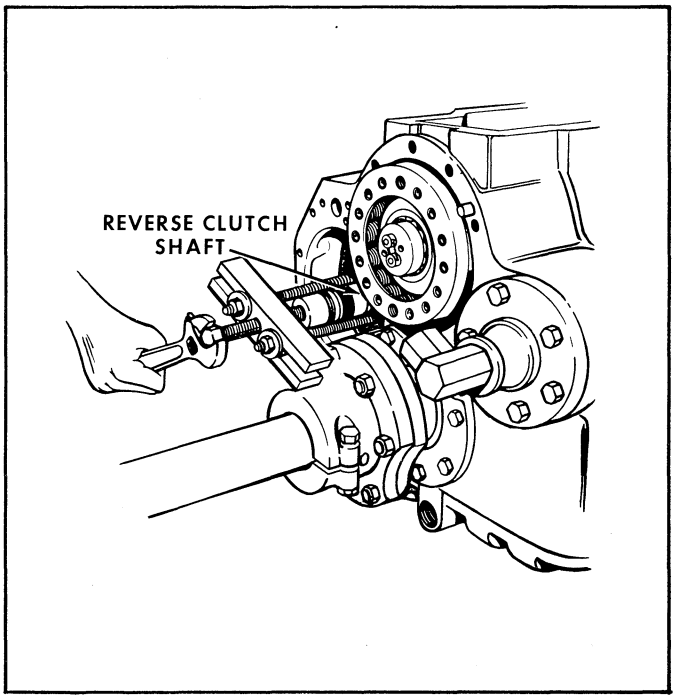


Figure 28. Removing the Hub-and-Back Plate with Standard Bar Puller.

(6) Use special tool T-12513 (fig. 29), and install the piston carrier, with attached parts, on the forward clutch shaft.

CAUTION

When installing the piston carrier, with attached parts, do not use a hammer or other object to drive the parts into position. As the clutch piston is brought into place, check to make certain that the clutch plates are in the correct position.

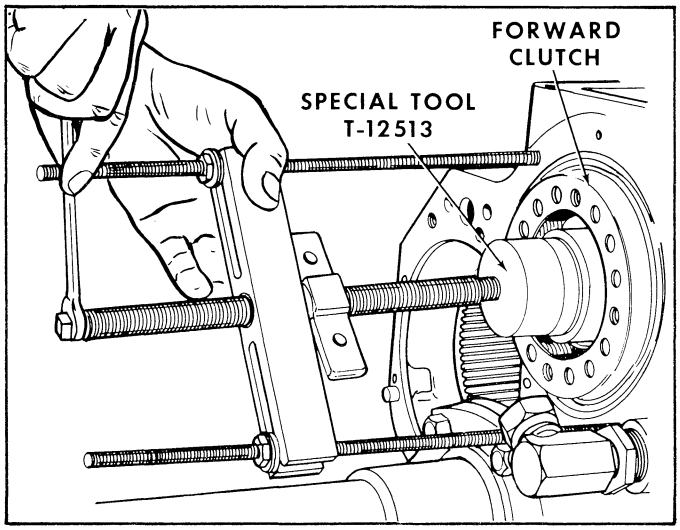


Figure 29. Installing the Forward Clutch with Special Tool T-12513.

(7) Use special tool T-12513, and press the forward clutch shaft ball bearing onto the forward clutch shaft and against the piston carrier. Install a new piston ring in the lock plate. Place the lock plate in position against the forward clutch shaft, and secure the lock plate to the shaft, with two 3/8-24 x 1-1/4 socket-head capscrews. Tighten the capscrews to 27 ± 2 lbs.-ft. torque. Lock wire the capscrews together.

(8) Assemble and install the reverse clutch by following the above described procedure. In place of the lock plate and screws, the following parts are installed during reverse clutch procedure. Use a fabricated sleeve (1/4-inch wall) made from steel tubing two and one half inches long and slightly larger in I.D. than the O.D. of the clutch shaft (one and thirteen sixteenths). Use a washer one sixteenth thick slightly larger in I.D. (one and thirteen sixteenths) than the O.D. of the clutch shaft. With these parts and the shroud nut, the hub and back plate can be advanced on the clutch shaft taper as covered above. Prior to the installation of the piston carrier, with attached parts, install the drive sleeve in the reverse clutch shaft. Align the hole in the drive sleeve with the hole in the reverse clutch shaft. Grease the drive sleeve pin, and insert the pin through the reverse clutch shaft and the drive sleeve. The grease must hold the drive sleeve pin in position when the piston carrier, with attached parts, is installed. After the reverse clutch shaft ball bearing is installed, secure the ball bearing on the shaft with the shroud nut. Use special tool T-9069, and tighten the shroud nut to 270-300 lbs. ft. torque. Lock the shroud nut to the shaft by bending the lip of the nut into the groove in the shaft. Install a new piston ring on the shaft.

(9) Install two new piston rings in the manifold. Place the manifold and a new main-housing-to-manifold gasket in position on the two dowel pins in the main housing. Secure the manifold to the main housing with eleven 3/8-16 x 1 hex-head capscrews. Tighten the capscrews to 27 ± 2 lbs. ft. torque.

CAUTION

Do not use excessive or abusive force when installing the manifold as damage to the piston rings in the manifold or on the shafts will result.

(10) Install a new corprene ring gasket (fig. 58, 40b) 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.

(11) Place the top cover plate, or top power take-off (if used), and a new top cover plate gasket in position on the main housing, and secure the cover plate to the housing with the capscrews previously removed. Place the 3/8 inch plain washer and breather chain clip in position beneath one of the capscrews. Tighten the 3/8-16 capscrews to 27 ± 2 lbs. ft. torque. Tighten the 1/4-20 capscrews to 7 ± 1 lbs. ft. torque.

(12) 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 two 3/8-16 x 1 hex-head capscrews. Tighten the capscrews to 27 ± 2 lbs. ft. torque.

(13) If a trolling valve assembly had been removed, place the trolling valve assembly and a new trolling-valve-to-manifold gasket in position against the manifold, and secure the trolling valve to the manifold with four 3/8-16 x 1 hex-head capscrews. Tighten the capscrews to 34-38 lbs. ft. torque.

(14) 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 assembly to the manifold with two 3/8-16 x 2-3/4 hex-head capscrews and two 3/8-16 x 4-1/4 hex-head capscrews. Tighten the capscrews to 27 ± 2 lbs. ft. torque.

(15) Connect the oil strainer-to-pump flexible hose to the male adapter union in the oil strainer cover. Connect the heat exchanger lines to the pressure side of the oil pump assembly and to the selector valve assembly. Connect the linkage to the selector valve assembly, the pressure gauge, and the trolling valve assembly (if used). Connect the top power take-off flexible oil hose assembly (if used) to the manifold.

34. OIL SEAL REPLACEMENT.

A. Removal. The following procedure describes the removal of the output flange oil seals while the marine gear is installed in the boat.

(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 26D.

(2) Scribe an alignment mark across the outside diameter of the output flange and the propeller shaft companion flange for installation purposes. Remove the attaching parts that secure the output flange and companion flange together. Slide the propeller shaft and companion flange rearward approximately 3 inches.

(3) Bend back the locking edges of the lock plate located at the output flange end of the output shaft. Remove the three hex-head capscrews, the lock plate, and the retainer washer that secure the output flange on the output shaft. Discard the lock plate. Remove the lathe cut ring from the end of the output shaft. Discard the ring. Remove the output flange from the output shaft.

(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 from the bearing retainer. Discard the "O" ring. Remove the two output flange oil seals from the bearing retainer. Discard the oil seals.

B. Installation. The following procedure describes the installation of the output flange oil seals while the marine gear is installed in the boat.

(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. The outer face of the rear seal must be flush with the rear face of the retainer. A gap of approximately 1/4 inch will exist between the seals if installed properly. Install a new bearing retainer "O" ring on the bearing retainer. Place the bearing retainer and the bearing retainer shims that were removed during disassembly in position against the main housing. Secure the retainer to the housing with seven 7/16-14 x 1-1/4 hex-head capscrews. Tighten the capscrews to 40 ± 3 lbs. ft. torque.

(2) Carefully, install the output flange on the output shaft. DO NOT DAMAGE THE OIL SEALS! Install a new lathe cut ring around the end of the output shaft. Bend the three locking edges of a new lock plate slightly prior to installation to facilitate locking after installation. Secure the output flange to the output shaft with the retainer washer, the lock plate, and three 5/8-18 x 1-1/2 hex-head capscrews. Tighten the capscrews to 130 ± 10 lbs. ft. torque. Bend the lock plate against the flat of the capscrews.

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

(4) After the installation has been completed, fill the marine gear sump with oil as described in Paragraph 26E. Lubricate the output flange oil seals as described in Paragraph 27B.

Section VIII. REMOVAL

35. PRIOR TO REMOVAL.

A. Hydraulic System. Drain the hydraulic system of oil (paragraph 26D).

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. See page 38. Ⓐ

36. REMOVAL.

A. Output Flange Connection. Scribe an alignment mark across the outside diameter of the output flange and the propeller shaft companion flange for installation purposes. Remove the attaching parts that secure the output flange and companion flange together. Slide the propeller shaft and companion flange rearward approximately 4 inches 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 attaching parts 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

37. OPTIONAL TOP POWER TAKE-OFF.

A. Disconnect the auxiliary drive and all other connections on the output end of the clutch shaft (fig. 64, 50). Remove key (51) and disconnect the linkage on the operating lever assembly (17). Disconnect and remove the flexible oil hose assembly (57) from the male pipe adapter union (56) and the street pipe elbow (58). Remove the male pipe elbow and the special pipe plug (55) from the bearing carrier (54). Remove the street pipe elbow from the manifold (fig. 58, 39a) (fig. 64, 58). Remove the twelve hex-head capscrews (2 & 21) that secure the power take-off housing (20) to the main housing (fig. 61, 21). Remove the power take-off housing and power take-off housing gasket (fig. 64, 22) from the main housing. Discard the gasket. Remove the two dowel pins (31) from the main housing only if replacement of parts is necessary.

B. Disassemble the power take-off assembly by the following procedure:

(1) Remove the six hex-head capscrews (fig. 64, 8) and the plain washer (9) that secure the top cover plate (12) to the power take-off housing (20). Remove the top cover plate and the top cover plate gasket (13), from the main housing. Discard the gasket. Remove the oil breather assembly (6) and the breather "O" ring (5) from the top cover plate. Discard the "O" ring. Remove the breather chain "S" link (7), the breather chain (10) and the breather chain clip (11) from the breather only if replacement of parts is necessary.

(2) Remove the hex-head capscrew (fig. 64, 18) and the hex nut (19) that secure the operating lever (17) to the operating shaft (15). Remove the operating lever from the operating shaft. Remove the two hex-head capscrews (28) and the two lock washers (29) that secure the operating yoke (30) to the operating shaft. Remove the two Woodruff keys (16) from the operating shaft. Remove the operating shaft and the two oil seals (14 & 32) from the power take-off housing. Discard the oil seals.

(3) Remove the three hex-head capscrews (fig. 64, 63) that secure the bearing retainer (62) and the bearing carrier (54) to the power take-off housing. Remove the bearing retainer and the bearing retainer gasket (61) from the bearing carrier. Discard the gasket. Remove the oil seal (64) from the bearing retainer. Discard the oil seal. Remove the external snap ring (60) that retains the clutch shaft ball bearing (59) on the clutch shaft. Install three hex-head capscrews in the three 1/2-13 UNC tapped holes in the bearing carrier. Use a standard foot-puller, and remove the bearing carrier, clutch shaft ball bearing, and bearing carrier gasket (53) from the clutch shaft. Discard the gasket. Remove the ball bearing from the bearing carrier.

(4) Remove the clutch shaft (fig. 64, 50) with attached parts, from the outer race of the clutch shaft roller bearing (23). Remove the assembled parts through the bottom of the power take-off housing. Remove the outer race of the clutch shaft roller bearing from the power take-off housing only if replacement of parts is necessary. Use a standard bearing puller, and remove the inner race of the clutch shaft roller bearing from the clutch shaft. Remove the external snap ring (24) from the clutch shaft. Press the clutch spider (33), clutch spider gear (27), clutch shaft ball bearings (25 & 35), and bearing spacer (26) from the clutch shaft. Remove the three hex-head capscrews (34) that secure the clutch spider gear to the clutch spider. Remove the clutch shaft ball bearings and bearing spacer from the clutch spider only if replacement of parts is necessary.

(5) Remove the lock screw (fig. 64, 36e) and setscrew (36d) from the hub and back plate (36c). Press the clutch assembly from the clutch shaft. The key (49) will fall free. Remove the three cotter pins (46d) and three lever link pins (46e) that secure the six lever links (46b) to the sliding sleeve (46a). Remove the two hex-head capscrews (47b) and two hex nuts (47e) that secure the split collar (47c) to the sliding sleeve. Remove the split collar. Retain the two collar shims (47d). Remove the hex-socket-head pipe plug (47a) from the split collar only if replacement of parts is necessary.

(6) Compress the adjusting lock pin (fig. 64, 44) and remove the adjusting ring (45) that is secured to the hub and back plate. Remove the adjusting lock pin and the adjusting lock pin spring (43) from the floating plate (42). Remove the floating plate, five sintered-metal driving plates (37), and four steel driven plates (38) from the hub and back plate. Remove the three flat-head machine screws (36a) that secure the three plate keys (36b) to the hub and back plate. Remove the plate keys from the hub and back plate. Remove the three cotter pins (46d) and three lever link pins (46c) that secure the six lever links (46b) to the three levers (39). Remove the three cotter pins (40) and three lever pins (41) that secure the three levers (39) to the floating plate. Remove the levers.

(7) Remove the hex-socket-head pipe plug (fig. 64, 1) from the power take-off housing, and the special pipe plug (48) from the clutch shaft only if replacement of parts is necessary. Remove the piston ring (52) from the clutch shaft. Discard the piston ring.

38. MISCELLANEOUS EXTERNAL PARTS.

A. Remove the thirteen hex-head capscrews (fig. 61, 11 & 16) and one plain washer (17) that secure the top cover plate (10) to the main housing (21). Remove the top cover plate and the top cover plate gasket (9) from the main housing. Discard the gasket. Remove the oil breather assembly (13) and the breather "O" ring (12) from the top cover plate. Discard the "O" ring. Remove the breather chain "S" link (14), the breather chain (15), and the breather chain clip (18) from the breather only if replacement of parts is necessary.

B. Remove the two hex-head capscrews (fig. 58, 17) that secure the front housing ventilating cover plate (16) to the front housing (13). Remove the cover plate from the front housing. Remove the two drive screws (15) that secure the rotation indicator plate (14) to the front housing. Remove the rotation indicator plate from the front housing only if replacement of parts is necessary. Remove the two eyebolts (fig. 61, 19) from the main housing only if replacement of parts is necessary.

C. Remove the oil gauge (fig. 61, 5) from the oil gauge tube (6). Remove the oil gauge tube from the main housing. Remove the square-head pipe plug (fig. 58, 21) from the main housing.

D. Disconnect the oil-strainer-to-pump flexible hose (fig. 61, 28) from the adapter union (29). Remove the flexible hose from the street elbow (27). Remove the street elbow from the oil pump assembly (fig. 58, 37). Remove the adapter union from the reducer bushing (fig. 61, 25). Remove the reducer bushing from the oil strainer cover (24). Remove the six hex-head capscrews (26) that secure the oil strainer cover to the main housing. Remove the oil strainer cover, with attached oil strainer (22) and the oil strainer cover gasket (23) from the main housing. Discard the gasket. Remove the oil strainer from the oil strainer cover. DO NOT discard the oil strainer after cleaning as the oil strainer can be used again.

E. If replacement of the instruction plate (fig. 61, 8) is necessary, remove the four drive screws (7) 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.

NOTE

If a gear ratio change is being accomplished, the new specification data must be placed on the new plate.

39. MANIFOLD GROUP OF PARTS .

A. Remove the two hex-head capscrews (fig. 58, 36) that secure the oil pump assembly (37) to the marine gear manifold (39a). Remove the oil pump assembly and the pump-to-manifold gasket (38) from the manifold. Discard the gasket. Remove the four hex-head capscrews (44 & 45) that secure the selector valve assembly (43) to the manifold. Remove the selector valve assembly and the selector-valve-to-manifold gasket (41) from the manifold. Discard the gasket. Disassemble the selector valve assembly by the following procedure:

(1) Remove the clamp screw (fig. 62, 1) that secures the selector valve lever (2) to the selector valve stem (9). Remove the selector valve lever from the selector valve stem. Remove the rollpin (3) from the stop collar and valve stem. Remove the selector valve stop collar (4) from the selector valve stem.

(2) Remove the two hex-socket-head pipe plugs (fig. 62, 18 & 19), the indexing detent spring (17) and the indexing detent (16) from the selector valve body (15).

(3) Remove the four hex-head capscrews (fig. 62, 10) that secure the selector valve stem cover (5) to the selector valve body. Remove the selector valve stem cover and the selector valve stem cover gasket (6) from the selector valve body. Discard the gasket.

(4) Remove the selector valve stem (fig. 62, 9) from the selector valve body. Remove the "O" ring (7) and the selector valve stem ball bearing (8) from the selector valve stem. Discard the "O" ring.

(5) Remove the four hex-head capscrews (fig. 62, 29) that secure the orifice plate cover (28), the orifice plate cover gasket (27), the orifice plate (26) and the orifice plate gasket (25) 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 (21) will pop out.

(6) Remove the compression spring (fig. 62, 22), the pressure rate control piston (20), the piston outer spring (12), the piston inner spring (13) and the pressure regulation piston (11) from the selector valve body.

CAUTION

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

B. Remove the oil return pipe assembly (fig. 58, 40) and the corprene ring gasket (40b) from the manifold. Discard the gasket. Remove the roll pin (40a) that indexes the oil return pipe assembly in the manifold only if replacement of parts is necessary. Disassemble the oil return pipe assembly by the following procedure only if replacement of parts is necessary:

(1) Remove the roll pin (fig. 58, 40f) nearest the straight end of the oil return pipe (40e). Remove the oil return pipe spring (40c) and the oil return pipe piston (40d) from the oil return pipe.

(2) Remove the outer roll pin (fig. 58, 40h), and the inner roll pin (40g) from the flanged end of the oil return pipe.

C. Remove the four hex-head capscrews (fig. 58, 33) that secure the trolling valve cover (32) to the manifold. Remove the cover and the cover-to-manifold gasket (31) from the manifold. Discard the gasket.

D. If the marine gear is equipped with a trolling valve assembly rather than a trolling valve cover, remove the four hex-head capscrews (fig. 58, 35) that secure the trolling valve assembly (34) to the manifold. Remove the trolling valve assembly and the trolling-valve-to-manifold gasket (31) from the manifold. Discard the gasket. Disassemble the trolling valve assembly by the following procedure:

(1) Place the trolling valve assembly in a soft-jawed vise. Remove the roll pin (fig. 63, 9) that secures the trolling valve lever (8) to the trolling valve body (11). Remove the trolling valve lever from the trolling valve body. Remove the trolling valve pin (2) from the protruding end of the trolling valve stem (1).

(2) Remove the indexing detent screw (fig. 63, 14), the indexing detent spring (15), and the indexing detent (16) from the trolling valve body.

(3) Remove the expansion plug (fig. 63, 12) from the trolling valve body by carefully tapping the protruding end of the trolling valve stem. Discard the expansion plug.

(4) Place a brass rod of approximately 3/4 inch diameter through the expansion plug opening of the trolling valve body and against the trolling valve stem. Carefully tap the brass rod, and remove the trolling valve stem, with attached parts, from the valve body. Remove the two oil seals (fig. 63, 7) from the valve stem. Discard the oil seals. Remove the round-wire snap ring (6), the centering washer (5), the trolling valve piston spring (4) and the trolling valve piston (3) from the valve stem.

E. Remove the eleven hex-head capscrews (fig. 58, 29 & 30) that secure the marine gear manifold assembly (39) to the main housing. Install two pusher screws in the 3/8-16 UNC tapped holes in the manifold. Remove the manifold assembly and the main-housing-to-manifold gasket (28) from the main housing. Discard the gasket. Remove the two dowel pins (27) from the manifold or main housing only if replacement of parts is necessary. Remove the hex-socket-head pipe plug (39c), the five hex-socket head pipe plugs (39b), and the two square-head pipe plugs (39d) from the manifold only if replacement of parts is necessary. Remove the two piston rings (fig. 59, 32 & Fig. 60, 38) from the shafts. Discard the piston rings.

40. FORWARD CLUTCH GROUP OF PARTS.

A. Remove the piston ring (fig. 59, 32) from the lock plate (30). Discard the piston ring. Remove the two socket-head capscrews (31) that secure the lock plate to the forward clutch shaft. Remove the two socket-head capscrews and the lock plate.

B. Use a standard bar puller with a stud installed in each 3/8-16 UNC tapped hole in each locating pin (fig. 59, 20) positioned in the piston carrier (22), and remove the forward clutch shaft ball bearing (29) and piston carrier, with attached parts, from the forward clutch shaft (see figure 25). Remove the parts through a cutout in the output flange (fig. 61, 39). (See figure 25).

C. Use special tool T-8884, and compress the spring retainer (fig. 59, 26) that positions the sixteen inner and outer release springs (24 & 25) against the piston carrier. Remove the internal snap ring (27) that secures the spring retainer in the clutch piston (19).

CAUTION

Do not attempt to remove the internal snap ring unless the spring retainer and release springs are compressed.

D. Remove the spring retainer and the release springs from the clutch piston and the piston carrier. Gently tap the piston from the carrier. Remove the two locating pins from the carrier. Remove the two roll pins (fig. 59, 34) and the two headless-flat-point setscrews (33) from the carrier only if replacement of parts is necessary. Remove the piston ring (21) and the seal ring (23) from the piston carrier. Discard the rings. (See figure 27).

E. Use special tool T-8872 and remove the seven sintered-metal clutch plates (18) and seven steel plates from the hub and back plate (16). Use a standard bar puller with 3/8-16 UNC studs, and remove the hub and back plate from the forward clutch shaft. Remove the key (7) from the forward clutch shaft. (See figure 28).

41. REVERSE CLUTCH GROUP OF PARTS.

A. Remove the piston ring (fig. 60, 38) from the reverse clutch shaft (11). Discard the piston ring. Straighten the lip of the shroud nut (37) on the reverse clutch shaft. Use special tool T-9069, and remove the shroud nut from the reverse clutch shaft.

B. Use a standard bar puller with a stud installed in each 3/8-16 UNC tapped hole in each locating pin (fig. 60, 26) positioned in the piston carrier (27), and remove the reverse clutch shaft ball bearing (36) and piston carrier, with attached parts, from the reverse clutch shaft. Remove these parts through a cutout in the output flange (fig. 61, 39).

CAUTION

Be sure the drive sleeve pin (fig. 60, 34) is centered in the reverse clutch shaft while the piston carrier is being removed.

C. Remove the drive sleeve pin (fig. 60, 34) and the drive sleeve (35) from the reverse clutch shaft. Use special tool T-8884, and compress the spring retainer (31) that positions the sixteen outer and inner release springs (29 & 30) against the piston carrier. Remove the internal snap ring (32) that secures the spring retainer in the clutch piston (24).

CAUTION

Do not attempt to remove the internal snap ring unless the spring retainer and release springs are compressed.

D. Remove the spring retainer and the release springs from the clutch piston and the piston carrier.

Gently tap the piston from the carrier. Remove the two locating pins from the carrier. Remove the two roll pins (fig. 60, 40) and the two headless-flat-point setscrews (39) from the carrier only if replacement of parts is necessary. Remove the piston ring (25) and the seal ring (28) from the piston carrier. Discard the rings.

E. Remove the seven sintered-metal clutch plates (fig. 60, 23) and the seven steel clutch plates (22) from the hub and back plate (21). Use a standard bar puller with 3/8-16 UNC studs, and remove the hub and back plate from the reverse clutch shaft. Remove the key (12) from the reverse clutch shaft. (See figure 28).

42. DRIVE SPIDER GROUP OF PARTS.

A. Remove the hex-head capscrew (fig. 58, 3) that secures the retainer washer (6) to the forward clutch shaft (fig. 59, 6). Remove the capscrew (fig. 58, 41), retainer washer from the forward clutch shaft. Remove the roll pin (fig. 59, 4) from the forward clutch shaft only if replacement of parts is necessary. Remove the lathe-cut ring (fig. 58, 5) from the end of the forward clutch shaft. Discard the ring. Remove the 26 rubber blocks (2) from the drive spider (6) only if replacement of parts is necessary. Use a standard puller, and remove the drive spider from the forward clutch shaft. (See figure 30).

B. Disconnect the oil tube assembly (fig. 58, 8) from the 90 degree male tube fitting (7) installed in the front housing (13) and the male tube fitting (9) installed in the bearing retainer (10). Remove the tube fittings from the front housing and bearing retainer.

C. Remove the six hex-head capscrews (fig. 58, 19) that secure the bearing retainer to the front housing. Remove the bearing retainer (10) with the oil seal, and the bearing retainer gasket (11) from the front housing. Discard the gasket. Remove the oil seal (20) from the bearing retainer. Discard the oil seal.

43. FORWARD CLUTCH SHAFT GROUP OF PARTS.

A. Remove the snap ring from the outer race of the reverse driving gear roller bearing (fig. 58, 12). Remove the 14 hex-head capscrews (18) that secure the front housing to the main housing. Remove the four hex-head capscrews (fig. 60, 3) that secure the front housing to the bearing carrier (4). Install two pusher screws in the 7/16-14 UNC tapped holes in the front housing. Remove the front housing and the front-to-main-housing gasket (fig. 58, 24) from the main housing. Discard the gasket. Remove the two dowel pins (25) from the front or main housing only if replacement of parts is necessary. (See figure 32).

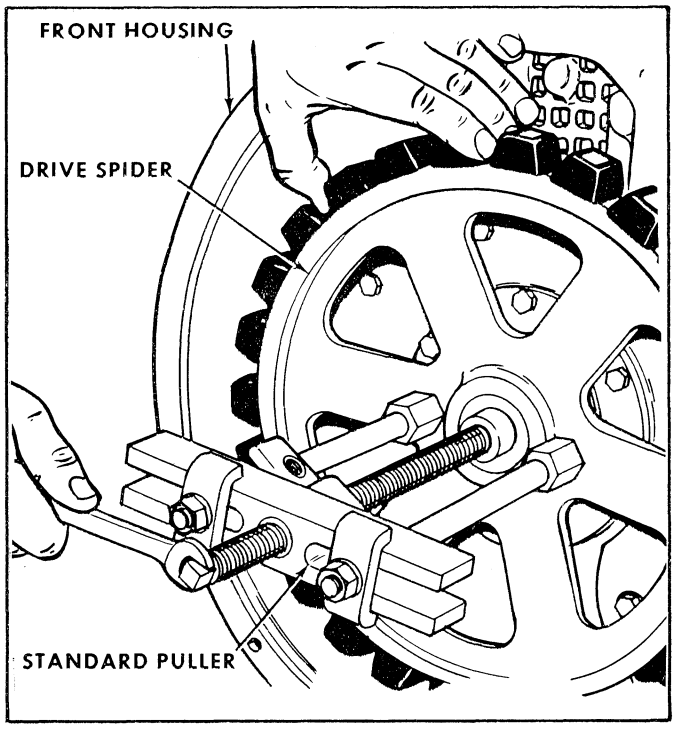


Figure 30. Removing the Drive Spider from the Forward Clutch Shaft.

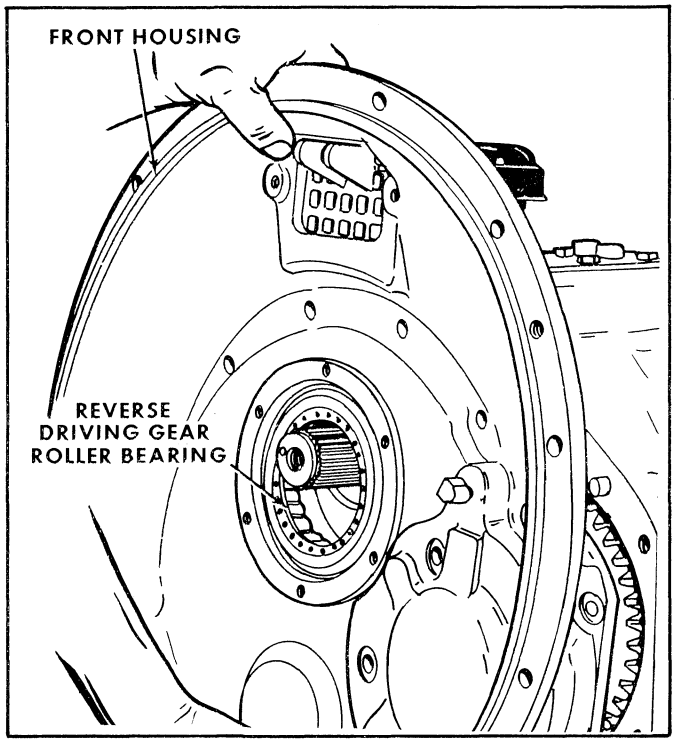


Figure 31. Removing the Front Housing from the Main Housing.

B. Use a standard puller, and remove the reverse driving gear roller bearing (fig. 58, 12) from the reverse driving gear (fig. 59, 1). Use a standard puller, with 1/2-13 UNC or 5/8-11 UNC threaded studs, and remove the reverse driving gear from the forward clutch shaft. Remove the forward clutch shaft from the main housing. Remove the key (fig. 59, 5) from the forward clutch shaft.

NOTE

An alternate method of disassembly may be used. Remove the forward clutch shaft, with attached parts, from the main housing. Press the forward clutch shaft from the reverse driving gear. Remove the key from the forward clutch shaft. Use the drilled holes in the reverse driving gear, and remove the reverse driving gear roller bearing from the reverse driving gear.

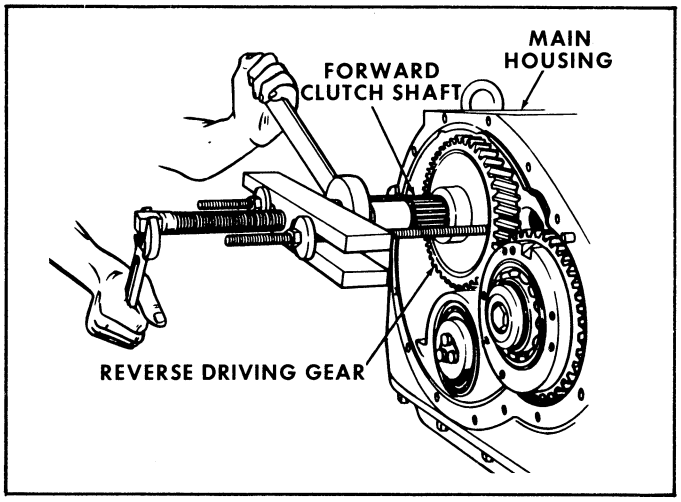


Figure 32. Removing the Reverse Driving Gear from the Forward Clutch Shaft.

44. REVERSE CLUTCH SHAFT GROUP OF PARTS.

A. Remove the special hex-head capscrew (fig. 60, 1) that secures the retaining washer (2) to the reverse clutch shaft (11). Remove the capscrew retaining washer (2) from the reverse clutch shaft. Remove the roll pin (9) from the reverse clutch shaft only if the replacement of parts is necessary. Remove the thrust washer (5), bearing carrier (4) and bearing (5).

B. Remove the reverse clutch shaft and the reverse driven gear from the main housing. Press the reverse clutch shaft from the reverse driven gear. Remove the key (fig. 60, 10) from the reverse clutch shaft.

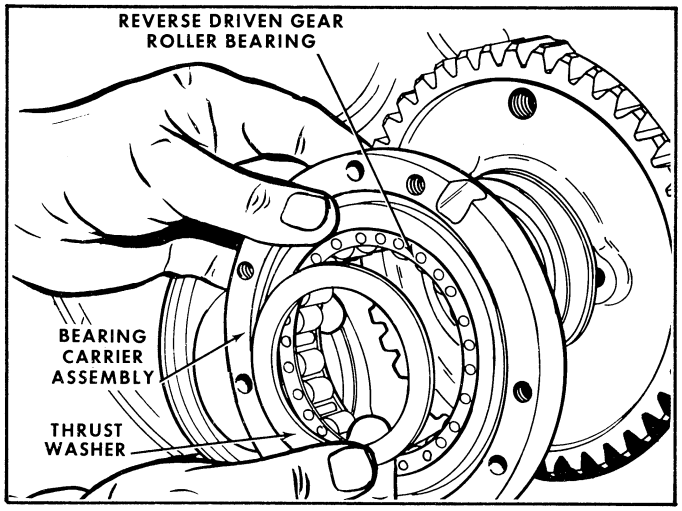


Figure 33. Removing the Bearing Carrier Assembly.

45. BOTTOM COVER GROUP OF PARTS.

A. Remove the 18 hex-head capscrews (fig. 61, 54) that secure the bottom cover (52) to the main housing. Remove the bottom cover and the bottom cover gasket (51) from the main housing. Discard the gasket. Remove the square-head pipe plug (53) from the bottom cover.

B. Bend back the locking edges of the two capscrew locks (fig. 61, 49). Remove the two hex-head capscrews (48) that secure the gear pan (50) to the bottom cover. Remove the capscrew locks and gear pan from the bottom cover. Discard the capscrew locks. Remove the pipe nipple (fig. 58, 26) from the main housing.

46. OUTPUT SHAFT GROUP OF PARTS.

A. Bend back the locking edges of the lock plate (fig. 61, 42). Remove the three hex-head capscrews (43) that secure the retainer washer (41) and the lock plate to the output shaft (31). Remove the lock plate and the retainer washer from the output shaft. Discard the lock plate. Remove the lathe-cut ring (40) from the end of the output shaft. Discard the ring. Use a standard puller, and remove the output flange (39) from the output shaft.

B. Remove the seven hex-head capscrews (fig. 61, 38) that secure the bearing retainer (35) to the main housing. Remove the bearing retainer and the bearing retainer shims (34) from the main housing. Retain the shims. Remove the bearing retainer "O" ring (33) from the bearing retainer. Discard the "O" ring. Remove the two oil seals (37) from the bearing retainer. Discard the oil seals. Remove the hydraulic fitting (36) from the bearing retainer only if replacement of parts is necessary (see figure 34).

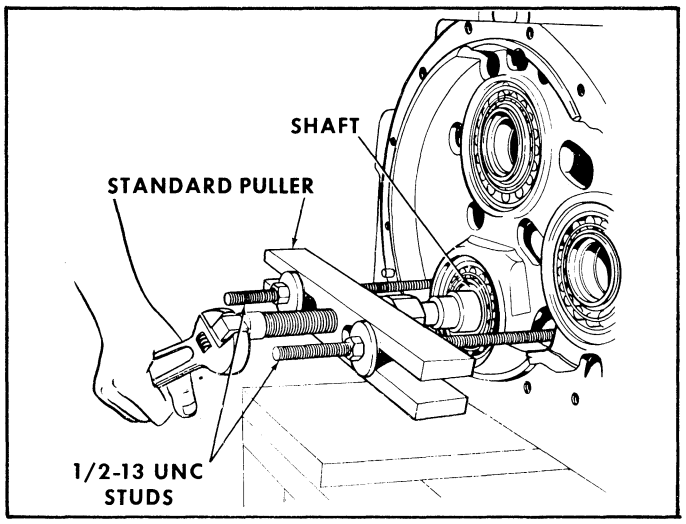


Figure 34. Removing the Output Shaft Gear from the Output Shaft.

D. Rotate the output shaft gear (fig. 61, 47) until the puller holes in the gear are aligned with the holes in the web of the main housing. Use a standard bar puller with two 1/2-13 UNC studs, and remove the output shaft, with attached parts, from the gear and main housing. Remove the plug (46), spring (45), and pin (44) from the main housing. Remove the gear and the inner race of the output shaft roller bearing (4) from the main housing. Use special tool T-9060 and remove the outer race of the output shaft roller bearing from the main housing. Remove the key (30) from the output shaft. Remove the cup of the tapered roller bearing (32) from the output shaft. Press the output shaft from the double cone of the tapered roller bearing. Press the cup of the tapered roller bearing from the main housing.

47. REVERSE PINION GROUP OF PARTS.

A. Remove the hex-socket-head pipe plug (fig. 61, 56), the retainer pin spring (57) and the retainer pin (58) from the side of the main housing.

B. Bend back the locking edges of the six capscrew locks (fig. 60, 16). Remove the six hex-head capscrews (15) that secure the bearing retainer (17) to the main housing. Discard the capscrew locks. Slip the bearing retainer back on the reverse pinion (13). Remove the snap ring from the clutch spider ball bearing (18). Gently tap the reverse pinion, and remove the pinion, with attached parts, from the main housing. The bearing retainer and the snap ring will fall free when the pinion is removed. Remove the external snap ring (20) that secures the clutch spider (19) on the reverse pinion. Press the reverse pinion from the clutch spider. Remove the clutch spider ball bearing from the clutch spider. Remove the reverse pinion spacer (14) from the reverse pinion. Remove the external snap ring (7) that secures the inner race of the reverse pinion roller bearing (8) on the reverse pinion. Remove the inner race of the reverse pinion roller bearing from the reverse pinion only if replacement of parts is necessary. Use special tool T-9061, and remove the output race of the reverse pinion roller bearing from the main housing.

48. FORWARD PINION GROUP OF PARTS.

A. Remove the hex-socket-head pipe plug (fig. 58, 21), the retainer pin spring (22) and the retainer pin (23) from the top of the main housing.

B. Bend back the locking edges of the six capscrew locks (fig. 59, 11). Remove the six hex-head capscrews (10) that secure the bearing retainer (12) to the main housing. Slip the bearing retainer back on the forward pinion (8). Remove the snap ring from the clutch spider ball bearing (13). Gently tap the forward pinion, and remove the pinion, with attached parts, from the main housing. The bearing retainer and snap ring will fall free when the pinion is removed. Remove the external snap ring (15) that secures the clutch spider (14) on the forward pinion. Press the forward pinion from the clutch spider. Remove the clutch spider ball bearing from the clutch spider. Remove forward pinion spacer (9) from the forward pinion. Remove the external snap ring (2) that secures the inner race of the forward pinion roller bearing (3) on the forward pinion. Remove the inner race of the forward pinion roller bearing only if replacement of parts is necessary. Use special tool T-9061, and remove the outer race of the forward pinion roller bearing from the main housing.

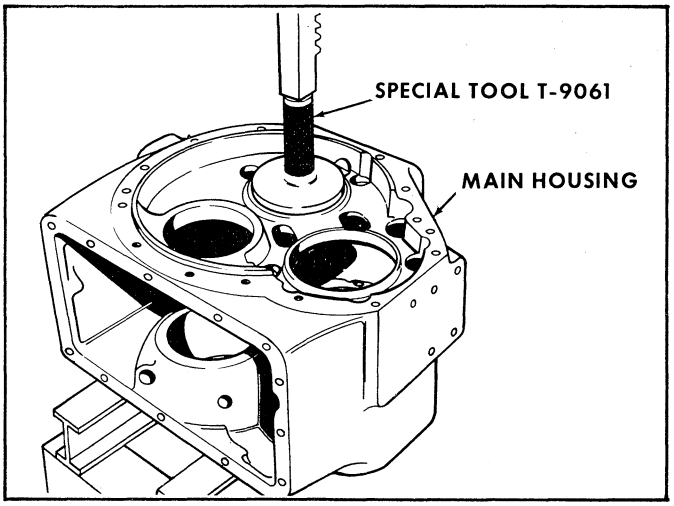


Figure 35. Pushing the Outer Race of the Forward Pinion Roller Bearing into the Main Housing for Removal with Special Tool T-9061.

Section X. CLEANING AND INSPECTION

49. GENERAL.

A. **Oil Seals.** Replace all oil seals.

B. **Gaskets.** Replace all gaskets.

C. **Lock Plates.** Replace all flexible lock plates.

D. **Piston Rings.** Replace all piston rings.

E. **Capscrew Locks.** Replace all capscrew locks.

F. **"O" Rings.** Replace all "O" rings.

50. 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.

51. 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. Replace a damaged driving ring.

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 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 manifold. Inspect the orifice in the special pipe plug (fig. 64, 48). Use a small wire to make certain the orifices are clean and clear.

K. Power Take-off Clutch Plates. Inspect the plates for broken, cracked, or otherwise damaged teeth. Check for worn or warped plates. Replace plates, if necessary.

Section XI. ASSEMBLY

D

NOTE

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

NOTE

Assemble taper bores and their mating shaft seats with surfaces cleaned with a petroleum-based solvent. Wipe off excess solvent.

52. ROLLER BEARINGS.

NOTE

When installing the outer race of the following roller bearings, make certain to align the hole in the bearing outer race with the hole in the main housing prior to installation.

A. Use special tool T-9061, and press the outer race of the forward pinion roller bearing (fig. 59, 3) into the main housing (fig. 61, 21). Secure the outer race in the main housing with the retainer pin (fig. 58, 23), the retainer pin spring (22) and the 1/8 inch hex-socket-head pipe plug (21).

B. Use special tool T-9061, and press the outer race of the new reverse pinion roller bearing (fig. 60, 8) into the main housing. Secure the outer race in the main housing with the retainer pin (fig. 61, 58), the retainer pin spring (57), and the 1/8 inch hex-socket-head pipe plug (56).

C. Use special tool T-9060, and press the outer race of the new output shaft roller bearing (fig. 61,4) into the main housing. Secure the outer race in the main housing with the retainer pin (44), the retainer pin spring (45), and the 1/8 inch hex-socket-head pipe plug (46).

53. FORWARD PINION GROUP OF PARTS.

A. Use special tool T-9062, and install the inner race of the new forward pinion roller bearing (fig. 59, 3) on the forward pinion (8). Secure the inner race of the forward pinion roller bearing on the forward pinion with the external snap ring (2). Place the forward pinion spacer (9) in position on the forward pinion. Press the clutch spider (14) into the clutch spider ball bearing (13) with the ball bearing snap ring groove away from the spider. Press the forward pinion into the clutch spider. Make sure the spider is squarely seated. Secure the clutch spider to the forward pinion with the external snap ring (15).

B. Partially install the forward pinion, with attached parts, into the main housing. Slip the bearing retainer (fig. 59, 12) and snap ring (13) over the forward pinion. Gently tap the forward pinion into position in the main housing. Install the snap ring on the clutch spider ball bearing. Position the bearing retainer against the main housing with the flat side of the retainer facing the reverse clutch location. Secure the bearing retainer to the main housing with six new capscrew locks (11) and six 3/8-16 x 1-1/8 hex-head capscrews (10). Tighten the capscrews to 27 ± 2 lbs. ft. torque. Bend the capscrew locks against the flats of the capscrews.

54. REVERSE PINION GROUP OF PARTS.

A. Use special tool T-9062 and install the inner race of the new reverse pinion roller bearing (fig. 60, 8) on the reverse pinion (13). Secure the inner race of the reverse pinion roller bearing on the reverse pinion with the external snap ring (7). Place the reverse pinion spacer (14) in position on the reverse pinion. Press the clutch spider (19) into the clutch spider ball bearing (18) with the ball bearing groove away from the spider. Secure the clutch spider to the reverse pinion with the external snap ring (20).

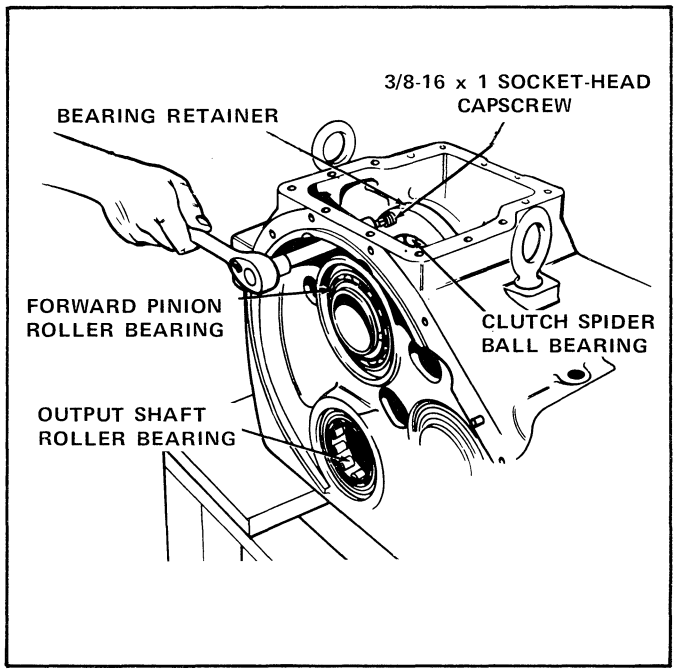


Figure 36. Securing the Bearing Retainer to the Main Housing.

B. Partially install the reverse pinion, with attached parts, into the main housing. Slip the bearing retainer (fig. 60, 17) and snap ring (18) over the reverse pinion. Gently tap the reverse pinion into position in the main housing. Install the snap ring on the clutch spider ball bearing. Position the bearing retainer against the main housing with the flat side of the retainer facing the forward clutch location. Secure the bearing retainer to the main housing with six new capscrew locks (16), and six 3/8-16 x 1-1/8 hex-head capscrews (15). Tighten the capscrews to 27 ± 2 lbs. ft. torque. Bend the capscrew locks against the flats of the capscrews.

55. OUTPUT SHAFT GROUP OF PARTS.

A. Press the output shaft (fig. 61, 31) into the double cone of the tapered roller bearing (32).

B. Install the proper cup of the tapered roller bearing into the main housing. Install the 1/2 x 3/8 x 2-3/4 key (fig. 61, 30) in the output shaft. Partially install the output shaft, with attached parts, into the main housing. Place the output shaft gear (47) into position through the bottom of the main housing; carefully align the key in the output shaft with the keyway in the output shaft gear. Install the output shaft into the output shaft gear until the gear is fully on the taper of the output shaft. The torque tightening of the retainer washer capscrews (1) later, will properly locate the gear on the shaft. Install the remaining cup of the tapered roller bearing into the main housing.

C. Install two new oil seals (fig. 61, 37) in the bearing retainer (35). The lip of the outer seal must point rearward, and the lip of the inner seal must point forward. The outer face of the rear seal must be flush with the rear face of the retainer. A gap of approximately 1/4 inch will exist between the seals if installed properly. Install a new bearing retainer "O" ring (33) on the bearing retainer. Place the bearing retainer in position against the main housing, and secure the retainer to the housing with two 7/16-14 x 1-1/4 hex-head capscrews (38). The screws should be turned only finger tight.

D. Use special tool T-9061, and install the inner race of the new output shaft roller bearing (fig. 61, 4) on the output shaft. Bend the three locking edges of the new lock plate (2) slightly prior to installation to facilitate locking after installation. Place the retainer washer (3) and the lock plate in position against the output shaft and inner race. Secure the inner race to the output shaft with the retainer washer, the lock plate, and three 3/8-24 x 1-1/4 hex-head capscrews (1). Tighten the capscrews to 27 ± 2 lbs. ft. torque. Bend the lock plate against the flats of the capscrews.

56. REVERSE CLUTCH SHAFT GROUP OF PARTS.

A. Install the reverse driven gear roller bearing (fig. 60, 5) with snap ring, in the bearing carrier. Place the reverse driven gear (6) on an arbor press, hub end up. Press the reverse driven gear roller bearing inner race (5) onto the reverse driven gear.

B. Place the reverse driven gear, with attached parts, on an arbor press, bearing side down. Install the 3/8 x 1/4 x 1-5/8 key (fig. 60, 10) in the reverse clutch shaft (11). Wash taper as per note on use of solvents, Section XI. Set the shaft vertically and place the gear (6) over the shaft and key. Apply a force of approximately 250 lbs. to seat the taper of gear to that of the shaft. Set up a dial indicator to read gear movement down the taper and advance the gear down the taper 0.014 minimum-0.030 inches maximum. Install the roll pin (9) into the reverse clutch shaft. Lightly oil the screw head seat of the special hex-head capscrew (1). Install the reverse clutch shaft, with attached parts, into the reverse pinion through the front of the main housing. Place the bearing carrier (4) and bearing (5) onto the bearing inner race on the input end of the reverse clutch shaft. Place the thrust washer section of the roller bearing against the bearing inner race (5). Install the retainer washer (2), and special capscrew (1). Tighten the capscrew (1) to between 125 and 140 lbs. ft. torque.

57. FORWARD CLUTCH SHAFT GROUP OF PARTS.

A. Place the reverse driving gear (fig. 59, 1) on an arbor press, hub end up. Press the reverse driving gear roller bearing (fig. 58, 12), without snap ring onto the reverse driving gear. The snap ring groove in the ball bearing must be at the top side of the bearing. Place the reverse driving gear, with attached part, on an arbor press, roller bearing down. Install the 3/8 x 1/4 x 1-5/8 key (fig. 59, 5) in the forward clutch shaft (6). Wash and prepare the tapers with a petroleum based solvent, and wipe off excess solvent. Set the clutch shaft in a press vertically with taper end up. Carefully, align the hub of the gear with the key and shaft taper. Place the gear down on the taper with approximately a 250 lb. force. Attach a dial indicator to read gear downward movement and press with a force to advance the gear on the taper 0.014 inches minimum to 0.030 inches maximum. Install the forward clutch shaft, with attached parts, into the forward pinion through the front of the main housing.

B. Install two 3/8 x 1 dowel pins (fig. 58, 25) in the main housing. Grease one side of a new front-to-main-housing gasket (24) and carefully align the gasket against the main housing. Place the front housing (13) in position against the gasket. Make certain the dowel pins are in proper alignment with the dowel pin holes in the front housing. Install two 3/8-16 x 3 studs through the front housing and into the bearing carrier assembly (fig. 60, 4). Gently, tap the front housing into position against the main housing. Install two 3/8-16 x 1-1/4 hex-head capscrews (3) partially into the bearing carrier (4). Remove the two studs, and install two additional 3/8-16 x 1-1/4 hex-head capscrews. Secure the four capscrews evenly to 27 ± 2 lbs. ft. torque. Secure the front housing to the main housing with fourteen 3/8-16 x 1 hex-head capscrews (fig. 58, 18). Tighten the capscrews to 27 ± 2 lbs. ft. torque. Install the snap ring in the groove of the reverse driving gear roller bearing (12).

58. DRIVE SPIDER GROUP OF PARTS.

A. Press a new oil seal (fig. 58, 20) into the bearing retainer (10). Place the bearing retainer, with oil seal, and a new bearing retainer gasket (11) in position against the front housing. Secure the bearing retainer to the front housing with six 3/8-16 x 1 hex-head capscrews (19). Tighten the capscrews to 27 ± 2 lbs. ft. torque. Install the 90 degree 1/8 inch male tube fitting (7) into the front housing. Install the 1/8 inch male tube fitting (9) into the bearing retainer. Connect the oil tube assembly (8) to the male tube fittings. Use special tool T-8873, and press the drive spider (6) onto the forward clutch shaft. Install twenty-six new rubber blocks (2) on the drive spider.

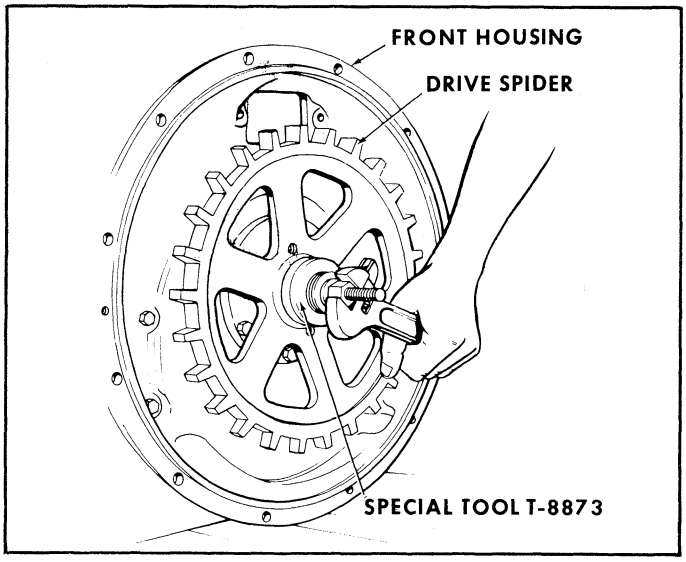


Figure 37. Install the Drive Spider on the Forward Clutch Shaft with Special Tool T-8873.

B. Install the roll pin (fig. 59, 4) in the forward clutch shaft. Install a new lathe-cut ring (fig. 58, 5) on the end of the forward clutch shaft. Lightly, oil the screw head seat of the 5/8-18 x 1-1/2 hex-head capscrew (3). Place the retainer washer (4) in position against the drive spider and secure the washer to the shaft with one 5/8-18 x 1-1/2 hex-head capscrew (3). Tighten the capscrew between 125 and 140 lbs. ft. torque. Bend the capscrew lock against the capscrew in three places.

59. REVERSE CLUTCH GROUP OF PARTS.

A. Place marine gear, with input end down on a bench. Install the 3/8 x 1/4 x 1-3/8 key (fig. 60, 12) in the reverse clutch shaft. Wash and prepare the tapers of shaft and hub-and-back plate with a petroleum-based solvent and wipe off the excess solvent. Use 200-300 lbs. force to seat the tapers on the shaft and hub. Make a sleeve from steel tubing (1/4-inch wall) slightly larger in I.D. 1-13/16 inches than the O.D. of the clutch shaft and 2-1/2 inches long. Place the sleeve against the hub over the shaft. Place a spacer washer with an I.D. slightly larger than the O.D. (1-13/16 inches) of the clutch shaft and about a sixteenth of an inch thick against the sleeve. Start the shroud nut (37) on its thread and screw it up to the spacer washer and sleeve. Attach a dial indicator so the stem of the indicator will read the advance movement of the clutch hub on the shaft taper. Tighten the shroud nut to obtain a hub advance of 0.022 to 0.038 inches on the clutch shaft. Remove the shroud nut, spacer washer, and sleeve from the shaft.

NOTE: A current change has been made in the MG-509 clutch. The change involves the addition of a pin between the hub and back plate and the piston carrier. This change will eliminate relative movement between the hub and back plate and the piston carrier that has occurred in severe applications. In these severe applications, the piston carrier has become loose on the clutch shaft causing spinning of the carrier and loss of clamp. This has sometimes resulted in loosening of the clamp nut, (M2037F), which retains the piston carrier. This change should reduce the possibility of this happening.

Replaced and new parts required are listed below:

Replaced Part Number	New Part Number	Description
A4636C	A4636D	Piston Carrier
A4968	A4968A	Hub & Back Plate
— — —	A2711BL	Pin

Two of each part number is required for each marine gear, (one set for forward clutch and one set for reverse clutch).

When assembling the new parts, the following procedure should be used:

1. Drive pin A2711BL into the reamed hole in the face of A4968A hub and back plate.

2. When assembling the piston carrier group, the slot in the face of A4636D piston carrier must be indexed so that it engages the A2711BL pin. The slot in the piston carrier is oversize to permit easier assembly.

It is possible to rework A4636C and A4968 into A4636D and A4968A. Sketch B & C show how to rework these parts. Sketch A shows pin A2711BL. (See page 86 & 87).

There were fifty-nine (59) units built which used a square headed pin part number B-2378. The serial numbers of these units are:

3C8978	thru	3C8993	inclusive
3C9109	thru	3C9126	inclusive
3C9246	thru	3C9270	inclusive

These units with the B-2378 square headed pin sketch D, had a clutch hub number A4968-A with a 5/32 inch diameter pin hole. When servicing these fifty-nine (59) units the hub pin hole should be enlarged to .1880-.1865 (see sketch C). Use pin A-2711-BL and discard pin B2378. A4968A furnished for service will have a .1880-.1865 size pin hole.

B. Press the two locating pin (fig. 60, 26) into the piston carrier (27). Install a roll pin (40) into each 3/8 x 1 headless flat-point setscrew (39).Install both setscrews, with roll pins, into the flat face of the piston carrier. Use a screwdriver, and firmly lock the roll pins in position against the piston carrier. Install a new piston ring (25) and a new seal ring (28) in the piston carrier. Lightly, oil the new rings.

C. Scribe a mark on the clutch piston (fig. 60, 24) and the piston carrier from the center line of a locating pin hole so that both marks will be visible during assembly. Gently tap the piston carrier into the clutch piston. During assembly, carefully align the above scribed marks so that the locating pins in the carrier will enter the proper holes in the piston. *Do not damage the rings!*

D. Carefully position the sixteen inner release springs (fig. 60, 29) and the sixteen outer release springs (30) on the piston carrier. Place the spring retainer (31) in position, and make certain to align the two larger holes in the retainer with the two installed locating pins in the carrier. Use two "C" clamps, and compress the spring retainer and springs into the clutch piston until the snap ring groove in the piston is fully exposed. Install the internal snap ring (32) in the clutch piston. Remove the "C" clamps.

CAUTION

SINTERED-METAL CLUTCH PLATES

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

All sintered-metal clutch plates must be submerged in oil (use same oil as will be used in 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!

E. Start with a sintered-metal clutch plate and alternately install the seven sintered-metal clutch plates (fig. 60, 23) and the seven steel clutch plates (22) onto the hub and back plate.

NOTE

Grease the last three sintered-metal clutch plates. This will hold the clutch plates in position for the installation of the piston carrier, with attached parts, onto the reverse clutch shaft.

F. Install the drive sleeve (fig. 60, 35) in the reverse clutch shaft. Align the hole in the drive sleeve with the hole in the reverse clutch shaft. Grease the drive sleeve pin (34), and insert the pin through the reverse clutch shaft and the drive sleeve. The grease must hold the drive sleeve pin in position when the piston carrier, with attached parts, is installed. Use special tool T-12513, and install the piston carrier, with attached parts, onto the reverse clutch shaft.

CAUTION

When installing the piston carrier, with attached parts, do not use a hammer or other object to drive the parts into

position. As the clutch piston is brought into place, check to make certain that the clutch plates are in the correct position.

G. Press the reverse clutch shaft ball bearing (fig. 60, 36) onto the reverse clutch shaft and against the piston carrier. Secure the ball bearing on the reverse clutch shaft with the shroud nut (37). Use special tool T-9069, and tighten the shroud nut to 270-300 lbs. ft. torque. Lock the shroud nut to the shaft by bending the lip of the nut into the groove in the shaft. Install a new piston ring (38) on the shaft.

60. FORWARD CLUTCH GROUP OF PARTS.

A. Install the 1/8 x 1/4 x 1-3/8 key (fig. 59, 7) in the forward clutch shaft. Wash and prepare the tapers of the clutch shaft and hub-and-back plate with a petroleum-based solvent. Wipe off excess solvent. Seat the tapers with a 200-300 pound force on the clutch hub and back plate (fig. 59, 16). Make a steel tubing sleeve (1/4-inch wall) slightly larger in I.D. than the O.D. (1-13/16 inches) of the clutch shaft (6) and 2-1/4 inches long. Substitute capscrews four inches long with two inches threaded the same size threads as the lock plate screws (31). Place the sleeve over the clutch shaft (6) against the hub and back plate. Place the lock plate against the sleeve and install the two long capscrews through the lock plate and into the clutch shaft. Attach a dial indicator so its stem reads the advance of the clutch hub and back plate onto the clutch shaft taper. Using the long lock plate screws, pull the lock plate and sleeve against the hub, advancing it on the shaft a minimum of 0.022 and a maximum of 0.038 inches. Remove the dial indicator, fabricated sleeve, long screws, and the lock plate from the clutch shaft.

B. (See paragraph 59A page 49 for information involving added pins to clutch assemblies.) Press the two locating pins (fig. 59, 20) into the piston carrier (22). Install a roll pin (34) into each 3/8 x 1 headless-flat-point setscrew (33). Install both setscrews, with roll pins, into the flat face of the piston carrier. Use a screwdriver, and firmly lock the roll pins in position against the piston carrier. Install a new piston ring (21) and a new seal ring (23) in the piston carrier. Lightly oil the new rings.

C. Scribe a mark on the clutch piston (fig. 59, 19) and the piston carrier from the center line of a locating pin hole so that both marks will be visible during assembly. Gently, tap the piston carrier into the clutch piston. During assembly, carefully, align the above scribed marks so that the locating pins in the carrier will enter the proper holes in the piston. Do not damage the rings!

D. Carefully position the sixteen inner release springs (fig. 59, 24) and the sixteen outer release springs (25) on the piston carrier. Place the spring retainer (26) in position, and make certain to align the two larger holes in the retainer with the two installed locating pins in the carrier. Use two "C" clamps, and compress the spring retainer and springs into the clutch piston until the snap ring groove in the piston is fully exposed. Install the internal snap ring (27) in the clutch piston. Remove the "C" clamps.

CAUTION

SINTERED-METAL CLUTCH PLATES

The possibility of clutch pack failure exists on initial start-up after rebuild, due to a 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.

E. Start with a sintered-metal clutch plate and alternately install the seven sintered-metal clutch plates (fig. 59, 18) and the seven steel clutch plates (17) onto the hub and back plate.

NOTE

Grease the last three sintered-metal clutch plates. This will hold the clutch plates in position for the installation of the piston carrier, with attached parts, onto the forward clutch shaft.

F. Use special tool T-12513, and install the piston carrier, with attached parts, onto the forward clutch shaft.

CAUTION

When installing the piston carrier, with attached parts, do not use a hammer or other object to drive the parts into position. As the clutch piston is brought into place, check to make certain that the clutch plates are in the correct position.

G. Press the forward clutch shaft ball bearing (fig. 59, 29) onto the forward clutch shaft and against the piston carrier. Install a new piston ring (32) in the lock plate (30). Place the lock plate in position against the forward clutch shaft, and secure the lock plate to the shaft with two 3/8-24 x 1-1/4 socket-head capscrews (31). Tighten the capscrews to 27 ± 2 lbs. ft. torque. Lock wire the capscrews together.

61. OUTPUT FLANGE GROUP OF PARTS.

A. Use a feeler gauge, and measure the distance between the bearing retainer (fig. 61, 35) and the main housing. The shims available for bearing adjustment are in two sizes; 0.0045-0.0055 inches thick, or 0.0063-0.0077 inches thick. Select the proper amount of bearing retainer shims (34). Remove the two hex-head capscrews (38) that secure the bearing retainer to the main housing. Install the selected amount of shims between the bearing retainer and the main housing, and secure the retainer and shims to the housing with seven (7/16-14 x 1-1/4) hex-head capscrews (38). Tighten the capscrews to 40 ± 3 lbs. ft. torque. Install the hydraulic fitting (36) in the bearing retainer.

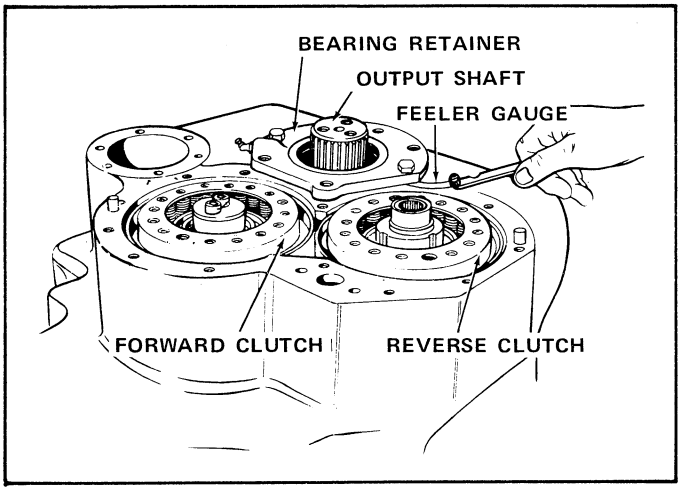


Figure 38. Measuring for the Trial Shim Pack to Adjust the Tapered Roller Bearing Set.

B. Use special tool T-8872, and carefully install the output flange (fig. 61, 39) on the output shaft (31). Install a new lathe-cut ring (40) around the end of the output shaft. Bend the three locking edges of a new lock plate (42) slightly, prior to installation to facilitate locking after installation. Secure the output flange to the output shaft with the retainer washer (41), the lock plate (42), and three 5/8-18 x 1-1/2 hex-head capscrews (43). Tighten the capscrews to 130 ± 10 lbs. ft. torque. Bend the lock plate against the flats of the capscrews.

C. Attach a dial indicator so the stem or plunger rests on a smooth area of the output flange. Mark a spot adjacent to the plunger. Apply a force of approximately one-hundred fifty to two hundred pounds downward, or toward the main housing, on the output flange. Turn the shaft through two complete revolutions or oscillate the shaft ninety degrees six times. This is done to seat and align the tapered roller bearings. While still applying the force, stop the shaft rotation with the stem of the plunger adjacent to the mark made previously. Zero the dial indicator. Apply a pulling force of one-hundred fifty to two hundred pounds on the flange in an upward, or away from the main housing, direction. Rotate the shaft two complete revolutions or six ninety degree oscillations, while applying the force. Stop the shaft rotation with the mark adjacent to the indicator stem and force still applied. Read the true shaft end play (bearing free play) on the indicator. The end play should be 0.002 to 0.007 inches. Add or subtract shims (fig. 61, 34) until this end play is obtained. Recheck with indicator and above procedure after each shim replacement.

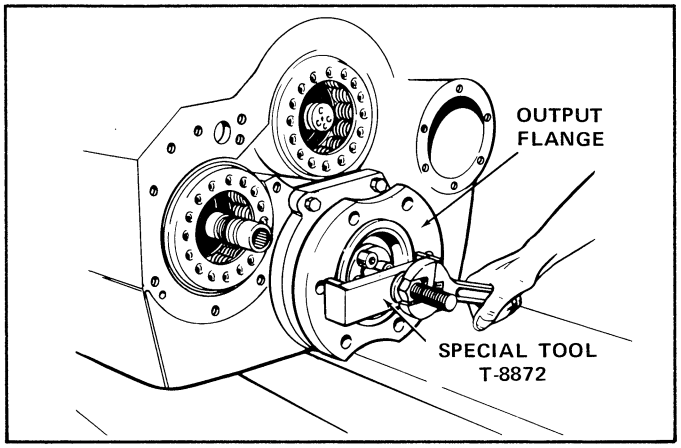


Figure 39. Installing the Output Flange on the Output Shaft with Special Tool T-8872.

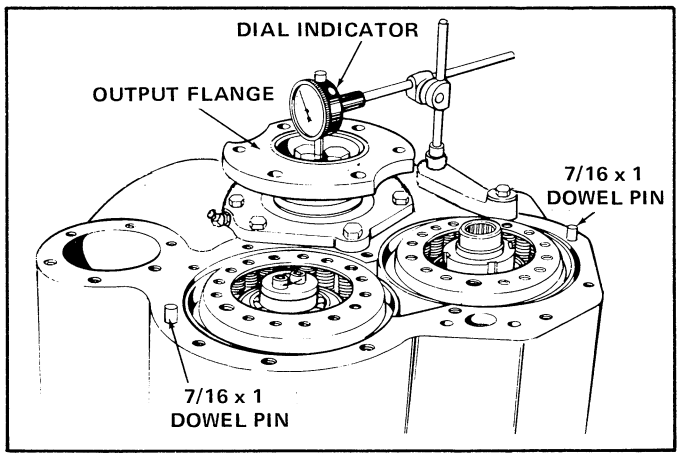


Figure 40. Checking for End Play with a Dial Indicator.

62. MANIFOLD GROUP OF PARTS.

A. Install a new piston ring (reverse clutch shaft) (fig. 60, 33) and a new piston ring (forward clutch shaft) (fig. 59, 28) in the piston ring grooves of the marine gear manifold (fig. 58, 39a). Install two 7/16 x 1 dowel pins (27) in the main housing. Grease the housing side of a new main-housing-to-manifold gasket (28), and position the gasket against the main housing. Place the manifold in position against the gasket making certain to align the dowel pin holes with the installed dowel pins. Secure the manifold to the main housing with eleven 3/8-16 x 1 hex-head capscrews (29). Tighten the capscrews to 27 ± 2 lbs. ft. torque.

NOTE

Do not use excessive or abusive force to install the manifold as damage to the piston rings in the manifold or the piston rings on the shaft and lock plate will occur.

B. Install the 1/8 inch hex-socket-head pipe plug (fig. 58, 39c) the five 1/4 inch hex-socket-head pipe plugs (39b) and the two 3/8 inch square-head pipe plugs (39d) in the manifold.

C. Install the outer roll pin (fig. 58, 40h) in the hole of the oil return pipe (40e) nearest the flanged end of the pipe. Install the inner roll pin (40g) inside of the installed roll pin. Install the oil return pipe piston (40d) and the oil return pipe spring (40c) in the return pipe 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 outer roll pin (40f) in the remaining hole in the return pipe. Install the roll pin (40a) and a new corprene ring gasket (40b) in the manifold. Reach down through the opening in the top of the main housing and install the front end of the return pipe in the counterbored hole in the front housing.

NOTE

Be sure to align the hole in the oil return pipe flange with the roll pin in the manifold. After installation, the flange must be flush with the manifold.

D. Assemble and install the selector valve assembly (fig. 58, 43) by the following procedure:

(1) Use an arbor press, and press the selector valve stem (fig. 62, 9) into the selector valve stem ball bearing (8). Install the selector valve stem, with ball bearing, into the selector valve body (15). Install a new "O" ring (7) in the selector valve stem cover (5). Place the selector valve stem cover and a new selector valve stem cover gasket (6) in position against the selector valve body, and secure the cover to the body with four 5/16-18 x 1 hex-head capscrews (10). Tighten the capscrews to 15 ± 2 lbs. ft. torque.

(2) Install the pressure regulation piston (fig. 62, 11) (smaller of the two pistons), the piston outer spring (12), the piston inner spring (13), the pressure rate control piston (20) and the compression spring (22) in the selector valve body. Place the steel ball (21) in position against the compression spring, and secure a new orifice plate gasket (25), the orifice plate (26), a new orifice plate cover gasket (27) and the orifice plate cover (28) to the selector valve body with four 5/16-18 x 1 hex-head capscrews (29). Tighten the capscrews to 15 ± 2 lbs. ft. torque.

(3) Install the indexing detent (fig. 62, 16) and the indexing detent spring (17) 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 (18). Install the 1/4 inch hex-socket-head pipe plug (19) in the adjacent hole in the body.

(4) Install the selector valve stem stop collar (fig. 62, 4) on the selector valve stem (9). Secure the collar to the stem with roll pin (3). Place the lever (2) in position on the selector valve stem, and secure the lever to the stem with the clamp screw (1).

(5) Place the selector valve assembly and a new selector-valve-to-manifold gasket (fig. 62, 14) in position against the manifold. Secure the selector valve to manifold with two 3/8-16 x 2-3/4 hex-head capscrews (23) and two 3/8-16 x 5-3/4 hex-head capscrews (24). Tighten the capscrews between 17 and 25 lbs. ft. torque.

CAUTION

Overtightening of the four capscrews may bind the selector valve stem.

E. If a trolling valve assembly (fig. 63) is used, assemble and install the trolling valve assembly by the following procedure:

(1) Install the trolling valve piston (fig. 63, 3) and the trolling valve piston spring (4) on the

trolling valve stem (1). Secure the piston and spring on the stem with the centering washer (5) and the round-wire snap ring (6).

(2) Install a new expansion plug (fig. 63, 12) in the trolling valve body. Install the trolling valve stem, with attached parts, into the trolling valve body. Position special tool T-6989 in place on the protruding end of the trolling valve stem. Slide a new oil seal (7) over the tapered tool with the lip of the seal pointing towards the valve body. Use special tool T-6988, and drive the oil seal into the body far enough to permit the second oil seal to be started in the body. Slide the second new oil seal over the tapered tool with the lip of the seal pointing away from the valve body. Use the driving tool, and drive both seals into place so that the second seal is flush with the end of the valve body.

(3) Install the trolling valve pin (fig. 63, 2) in the trolling valve stem. Place the trolling valve lever (8) in position around the trolling valve stem and between the extending arms of the trolling valve body. Secure the lever to the body with roll pin (9).

(4) Place the indexing detent (fig. 63, 16) and the indexing detent spring (15) in position in the trolling valve body, and secure the detent and spring in the body with the indexing detent screw (14).

(5) Place the trolling valve assembly and a new trolling-valve-to-manifold gasket (13) in position against the manifold. Secure the valve to the manifold with four 3/8-16 x 2-1/2 hex-head capscrews (10). Tighten the capscrews to 27 ± 2 lbs. ft. torque.

F. If the marine gear is not equipped with a trolling valve assembly, place the trolling valve cover (fig. 58, 32) and a new cover-to-manifold gasket (31) in position against the manifold. Secure the cover to the manifold with four 3/8-16 x 1 hex-head capscrews (33). Tighten the capscrews to 27 ± 2 lbs. ft. torque.

63. BOTTOM COVER GROUP OF PARTS.

A. Install the 3/4 x 2-1/2 pipe nipple (fig. 58, 26) in the main housing. Install the 1 inch square-head pipe plug (fig. 61, 53) in the bottom cover (52). Place the gear pan (50) in position against the bottom cover, and secure the gear pan to the bottom cover with two new capscrew locks (49) and two 3/8-16 x 5/8 hex-head capscrews (48). Tighten the capscrews to 27 ± 2 lbs. ft. torque. Bend the locking edges of the capscrew locks against the flats of the capscrews and ears of the gear pan.

B. Grease the cover side of the new bottom cover gasket (fig. 61, 51), and position the gasket against the cover. Place the cover and gasket in position against the main housing, and secure the cover to the housing with eighteen 3/8-16 x 1-1/4 hex-head capscrews (54). Tighten the capscrews to 27 ± 2 lbs. ft. torque.

64. MISCELLANEOUS EXTERNAL PARTS.

A. Install the oil strainer (fig. 61, 22) in the oil strainer cover (24). Place the oil strainer cover and a new oil strainer cover gasket (23) in position against the main housing. Secure the cover to the housing with six 3/8-16 x 1-3/4 hex-head capscrews (26). Tighten the capscrews to 27 ± 2 lbs. ft. torque.

B. Place the oil pump assembly (fig. 58, 37) and a new pump-to-manifold gasket (38) in position against the manifold. Secure the pump to the manifold with two 3/8-16 x 1 hex-head capscrews (36). Tighten the capscrews to 27 ± 2 lbs. ft. torque.

C. Install the 3/4 inch street elbow (fig. 61, 27) in the oil pump assembly. Install the 1 inch to 3/4 inch reducer bushing (25) in the oil strainer cover. Install the 90 degree, 3/4 inch male adapter union (29) in the reducer bushing. Connect the oil-strainer-to-pump flexible hose (28) to the street elbow and the adapter union.

D. Install the oil gauge tube (fig. 61, 6) in the main housing. Install the oil gauge (5) in the oil gauge tube. Install the 3/8 inch square-head pipe plug (20) in the main housing.

E. Place a new instruction plate (fig. 61, 8) in position against the main housing, and secure the plate to the housing with four drive pins (7). Make certain the correct data appears on the new plate.

F. Install the two eyebolts (fig. 61, 19) in the main housing, if removal had been necessary.

G. Place the front housing ventilating cover plate (fig. 58, 16) in position against the front housing. Secure the cover plate to the front housing with two 3/8-16 x 1 hex-head capscrews (17). Tighten the capscrews to 27 ± 2 lbs. ft. torque. Place the rotation indicator plate (14) in position against the front housing. Secure the indicator plate to the front housing with two drive pins (15).

H. Assemble the breather chain "S" link (fig. 61, 14), the breather chain (15) and the breather chain clip (18) to the oil breather assembly (13).

Install a new breather "O" ring (12) in the top cover plate (10). Install the oil breather assembly in the top cover plate. Place the top cover plate, with attached parts, and a new top cover plate gasket (9) in position against the main housing, and secure the top cover plate to the main housing with eleven 3/8-16 x 7/8 hex-head capscrews (11) and two 1/4-20 x 1 hex-head capscrews (16). Make certain one of the 3/8-16 capscrews and one 3/8 inch plain washer (17) secures the breather chain clip (18) to the top cover plate. Tighten the 3/8-16 capscrews to 27 ± 2 lbs. ft. torque and the 1/4-20 capscrews to 7 ± 1 lbs. ft. torque.

65. OPTIONAL TOP POWER TAKE-OFF.

A. Assemble and install the optional top power take-off by the following procedure:

(1) Install a new piston ring (fig. 64, 52) on the clutch shaft (50). Install the special pipe plug (48) in the input end of the clutch shaft. Install the 1/8 inch hex-socket-head pipe plug (1) in the power take-off housing (20).

(2) Secure the three levers (fig. 64, 39) to the floating plate (42) with three lever pins (41) and three cotter pins (40). Secure the six lever links (46b) to the levers with three lever link pins (46c) and three cotter pins (46d). Bend the fingers of the cotter pins. Place the three plate keys (36b) in position in the hub-and-back plate (36c). Secure each plate key to the hub-and-back plate with a 10-24 x 3/4 flat-head machine screw (36a). Stake the flat-head machine screws in the slots of the plate keys. Start with a sintered-metal cltuch plate and alternately install five sintered-metal driving plates (37) and four steel driven plates (38) onto the hub-and-back plate. Install the floating plate, with attached parts, on the hub-and-back plate. Install the adjusting ring (45) finger tight onto the hub-and-back plate. Install the adjusting lock pin spring (43) and adjusting lock pin (44) into the floating plate.

(3) Position the split collar (fig. 64, 47c) with two collar shims (47d) on the sliding sleeve (46a). Secure the split collar to the sliding sleeve with two 3/8-24 x 2-1/4 hex-head capscrews (47b) and two 3/8-24 hex nuts (47e). Tighten the capscrews and hex nuts to 27 ± 2 lbs. ft. torque. Install the 1/8 inch hex-socket-head pipe plug (47a) into the split collar.

(4) Install the sliding sleeve (fig. 64, 46a) on the clutch shaft (50). Install the 3/8 x 3/8 x 2 key (49) in the clutch shaft. Press the hub-and-back plate, with attached parts, on the clutch shaft. Carefully, align the keyway in the hub-and-back plate with the key in the clutch shaft. Secure the six lever links (46b) to the sliding sleeve with three lever link pins (46e) and three cotter pins (46d). Bend the fingers of the cotter pins. Install the 3/8 x 3/16 hex-socket-head lock screw (36e) into the hub and back plate.

(5) Press the new clutch shaft ball bearings (fig. 64, 25 & 35) and the bearing spacer (26) into the clutch spider (33). Secure the clutch spider gear (27) to the clutch spider with three 3/8-24 x 1-1/2 hex-head capscrews (34). Tighten the capscrews to 27 ± 2 lbs. ft. torque. Press the clutch spider on the clutch shaft. Carefully, align the clutch spider lug teeth with the external lug teeth of the sintered-metal driving plates (37). Install the external snap ring (24) on the clutch shaft. Press the inner race of a new clutch shaft roller bearing (23) on the clutch shaft. Press the outer race of the new clutch shaft roller bearing into the power take-off housing (20).

(6) Install the clutch shaft, with attached parts, through the bottom of the power take-off housing (fig. 64, 20), carefully aligning the inner and outer races of the clutch shaft roller bearing (23). Press the clutch shaft ball bearing (59) into the bearing carrier (54) in position against the power take-off housing (20). Use suitable blocking between the clutch spider gear and the power take-off housing, and press the clutch shaft ball bearing, with bearing carrier, on the clutch shaft. Secure the ball bearing on the clutch shaft with the external snap ring (60). Remove the blocking. Press a new oil seal (64) in the bearing retainer (62). Position a new bearing retainer gasket (61), against the bearing carrier. Install the bearing retainer, with oil seal, against the bearing carrier. When positioning the bearing retainer against the bearing carrier, exercise caution to prevent cutting the lip of the oil seal on the keyway of the clutch shaft. Secure the bearing retainer and the bearing carrier to the power take-off housing with three 3/8-16 x 2-1/4 hex-head capscrews (63). Tighten the capscrews to 27 ± 2 lbs. ft. torque.

(7) Press two new oil seals (fig. 64, 14 & 32) into the power take-off housing. Install the operating shaft (15) and the operating yoke (30) in the power take-off housing. Align the operating yoke with the trunnions of the split collar. Install the two Woodruff keys(16) between the operating shaft and the operating yoke, and secure the yoke to the shaft with two 3/8 inch lock washers (29) and two 3/8-16 x 1-1/2 hex-head capscrews (28). Tighten the capscrews to 27 ± 2 lbs. ft. torque. Place the operating lever (17) in position on the operating shaft, and secure the lever to the shaft with the 3/8-16 x 2 hex-head capscrew (18) and the 3/8-16 hex nut (19).

Tighten the capscrew and hex nut to 34-38 lbs. ft. torque.

B. Install the two 3/8 x 1 dowel pins (fig. 64, 31) in the main housing. Place the power take-off housing, with attached parts, and a new power take-off housing gasket (22) in position against the main housing. Secure the power take-off housing to the main housing with two 1/4-20 x 7 hex-head capscrews (2) and ten 3/8-16 x 1 hex-head capscrews (21). Tighten the 1/4-20 capscrews to 7 ± 1 lbs. ft. torque and the 3/8-16 capscrews to 27 ± 2 lbs. ft. torque.

C. Install the special pipe plug (fig. 64, 55) and the 45 degree, 1/4 inch male pipe adapter union (56) in the bearing carrier. Install the 90 degree, 1/4 inch street pipe elbow (58) in the manifold. Install the flexible oil hose assembly (57) in the street pipe elbow and the adapter union.

D. Place the clutch in a neutral position. Compress the adjusting lock pin (fig. 64, 44) and turn the adjusting ring (45) in a clockwise direction. The clutch will be in proper adjustment when the clutch will be engaged with a 855 lbs. in. torque maximum on the operating shaft (15). Whenever the reading is less than 500 lbs. in. torque required to engage the clutch, further adjustment of the clutch is necessary. The procedure must be done throughout the first day of operation until the clutch plates wear in.

E. Clutch adjustment may also be accomplished by using the standard operating lever assembly (fig. 64, 17) furnished with the unit. The drilled hole at the end of the operating lever is used to determine the pounds pull required to engage the clutch. The distance from the center of this hole to the center of the operating shaft is ten inches. Using an accurate standard fish scale, the clutch will be in proper adjustment when the operating lever requires between 50 and 85 pounds pull. Any other pull required to engage the clutch indicates that further adjustment is necessary.

F. Assemble the breather chain "S" link (fig. 64, 7), the breather chain (10) and the breather chain clip (11) to the oil breather assembly (6). Install a new breather "O" ring (5) in the top cover plate (12). Install the oil breather assembly in the top cover plate. Place the top cover plate, with attached parts, and a new top cover plate gasket (22) in position against the power take-off housing, and secure the top cover plate to the power take-off housing with six 3/8-16 x 1 hex-head capscrews (8). Make certain one of the capscrews and the one 3/8 inch plain washer (9) secures the breather chain clip to the top cover plate. Tighten the capscrews to 27 ± 2 lbs. ft. torque. Install the 3/8 x 3/8 x 2-1/2 key (51) in the clutch shaft.

Section XII. INSTALLATION

66. PRIOR TO INSTALLATION

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

CRANKSHAFT END PLAY CAUTION

Most Twin Disc products are made to be mounted directly on the flywheel of the engine. It is possible, due to mis-match 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. This 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 the interference. This engine crankshaft end play check is considered mandatory.

Compensate for crankshaft end play when making the following runout checks.

B. Checking Face of Engine Flywheel Housing. Bolt a thousandths indicator or gauge to the engine flywheel so that the indicator is perpendicular to the face of the engine flywheel housing, and the indicator stem is riding on the face of the flange (fig. 41). Rotate the engine flywheel and note the face deviation of the engine flywheel housing flange. The face deviation must not exceed .008 inch.

C. Checking Bore of Engine Flywheel Housing. With indicator bolted as in Paragraph 66B above, adjust the indicator stem so that it will ride on the bore of the engine flywheel housing (fig. 42). Rotate the engine flywheel and note the bore eccentricity of the engine flywheel housing bore. The bore eccentricity must not exceed .008 inch.

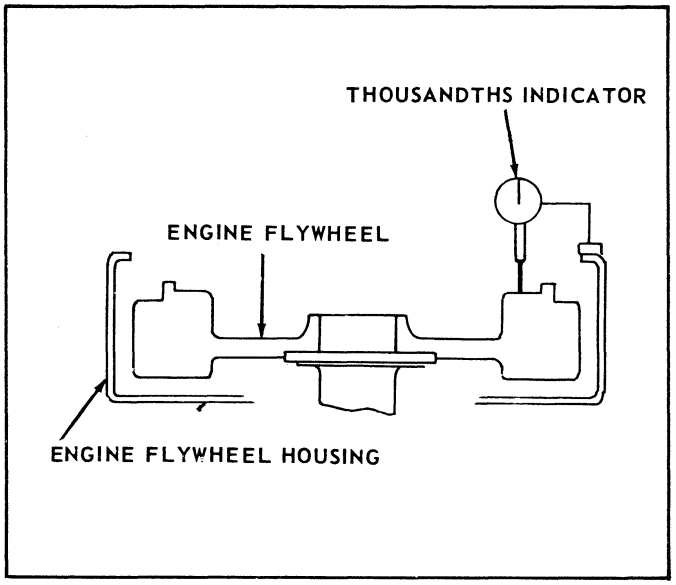


Figure 41. Checking the Face of the Engine Flywheel Housing.

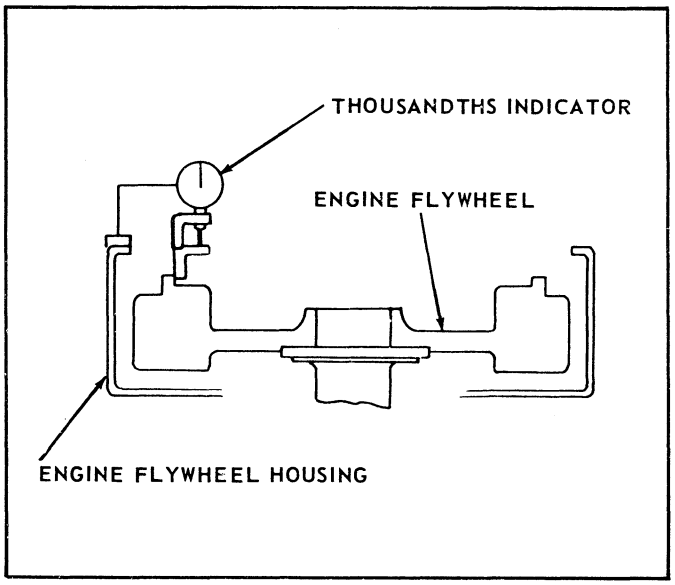


Figure 42. Checking the Bore of the Engine Flywheel Housing.

D. 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. 43). 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.

E. **Checking Driving Ring Pilot Bore of Engine Flywheel.** With the indicator bolted as in Paragraph 66D above, adjust the indicator stem so that it will ride on the driving ring pilot bore of the engine flywheel (fig. 44). The driving ring pilot bore eccentricity of the engine flywheel should not exceed .005 inch maximum total indicator reading.

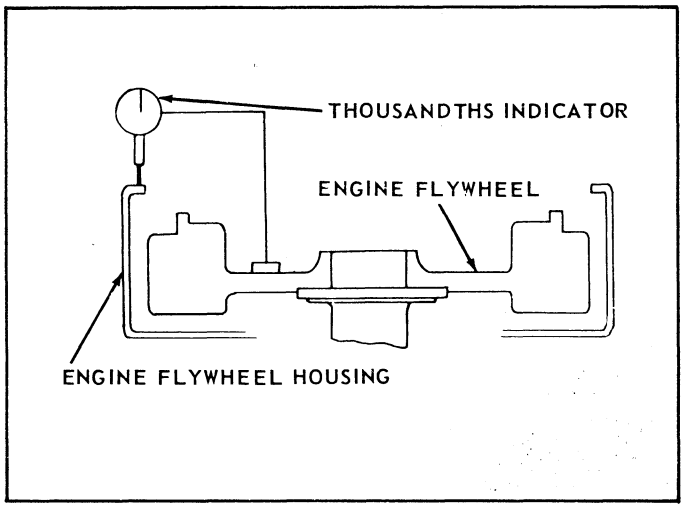


Figure 43. Checking the Driving Ring Surface of the Engine Flywheel.

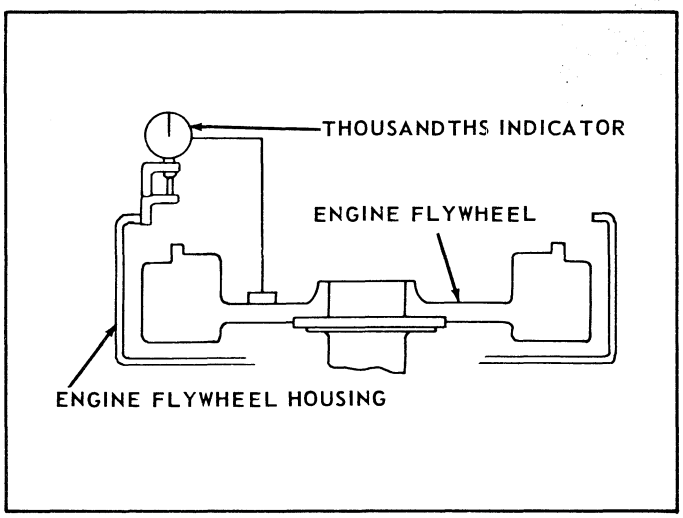


Figure 44. Checking the Driving Ring Pilot Bore of the Engine Flywheel.

67. INSTALLATION.

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

B. Alignment (Fig. 45). Install the support brackets on the side mounting pads of the marine gear. Install the driving ring on the engine flywheel. Bolt an indicator to the engine block and set the indicator stem on the engine flywheel housing. Set the indicator gauge at zero. Lift the marine gear with a hoist, or other suitable means, and place the unit in position against the engine flywheel housing. Guide the rubber blocks on the drive spider into the driving ring. Secure the front housing of the marine gear to the engine flywheel housing with suitable fasteners. Use a feeler gauge between each support bracket and engine bedrail. Add shims between the brackets and bedrails to equal the feeler gauge readings. Carefully release the lifting force on the marine gear. The indicator gauge must remain steady at the zero mark. If the reading moves from zero, lift the marine gear and insert additional shims. Continue this procedure until the marine gear is completely at rest on the bedrails and the gauge maintains a steady zero reading. After obtaining the correct zero reading, secure the support brackets to the engine bedrails. If the indicator changes after bolts are torqued, re-shim until indicator remains at zero.

C. Hydraulic System. Fill the hydraulic system with the proper type, weight and amount of oil as specified in Paragraph 26.

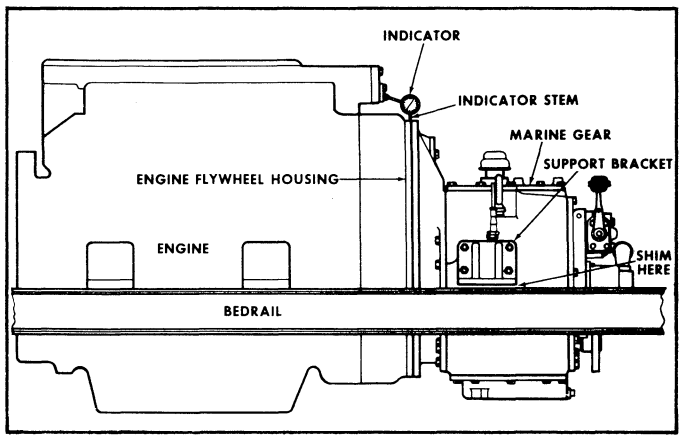


Figure 45. Alignment of Engine and Marine Gear.

68. ALIGNMENT.

NOTE

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

A. Propeller Shaft Installation.

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

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

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

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

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

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

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

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 coupling, and prepare for bolting together. Care should be taken not to burr or mar this connection because the fit is very critical. A 0.002 inch feeler gauge is inserted between the flanges of the coupling. The feeler gauge is run completely around the coupling.

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

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

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

During the process of securing final alignment, it may be necessary to shift the engine many times. When it becomes apparent that the alignment is reasonably close, the holes for the lag studs are marked and drilled. Then with final alignment secured, the necessary steel or hardwood shims are made up and the engine and gear is fastened in place. The alignment is then rechecked, and if satisfactory, the coupling is bolted together.

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

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

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.

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

69. SPECIAL TOOLS.

Figures 46 through 56 in this section identify the special tools by tool number. All pertinent information necessary for tool fabrication is shown on each tool drawing. These tools are intended primarily to make overhaul procedures easier. Twin Disc, Incorporated will not manufacture these tools for general use.

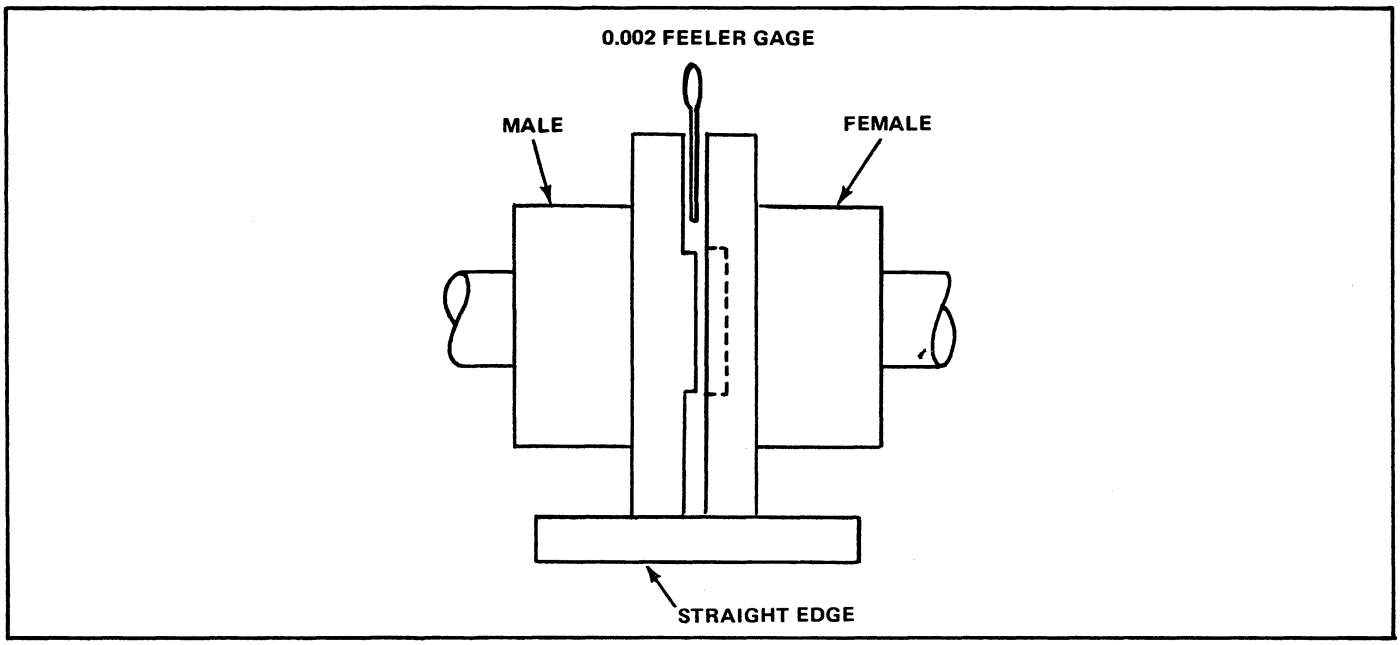


Figure 46. Checking the Squareness of the Coupling.

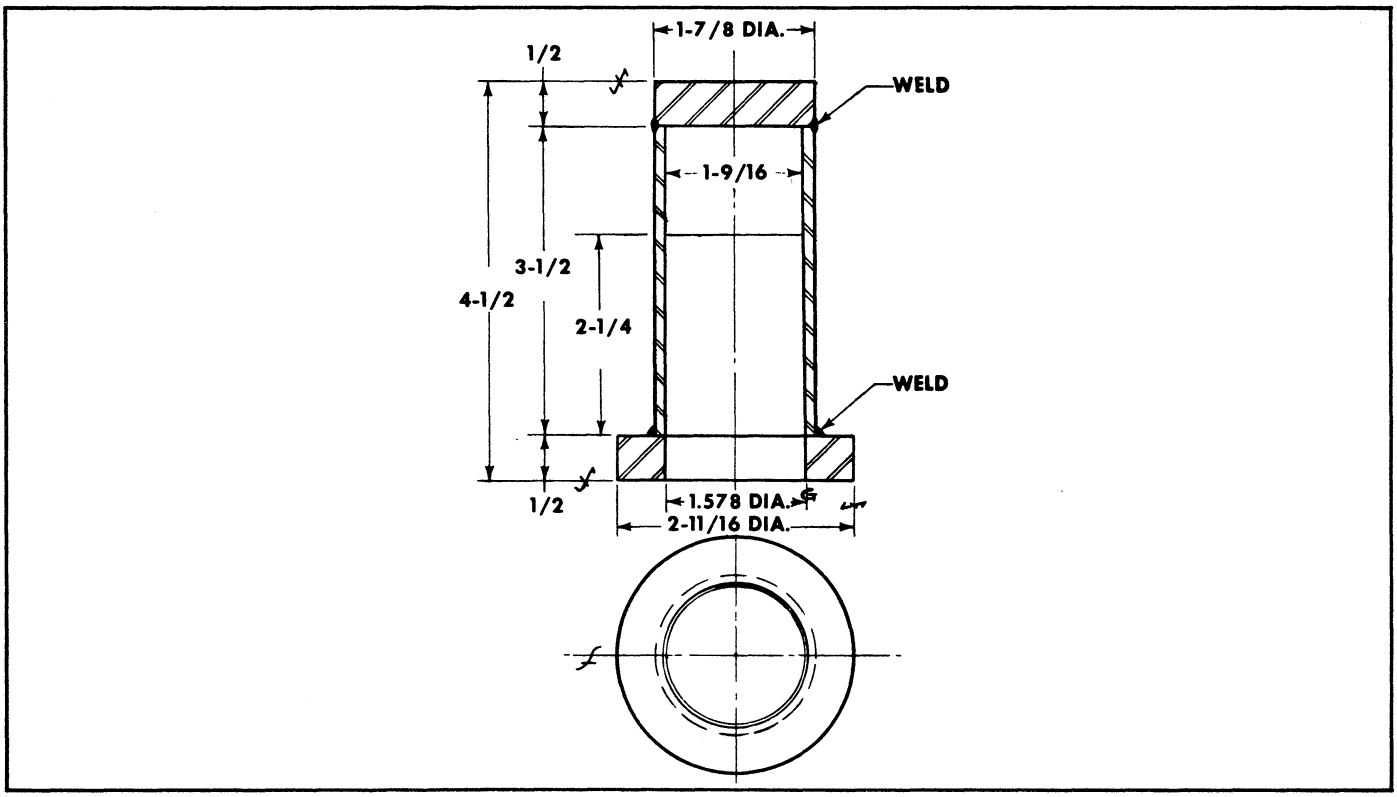


Figure 47. Special Tool T-12513.

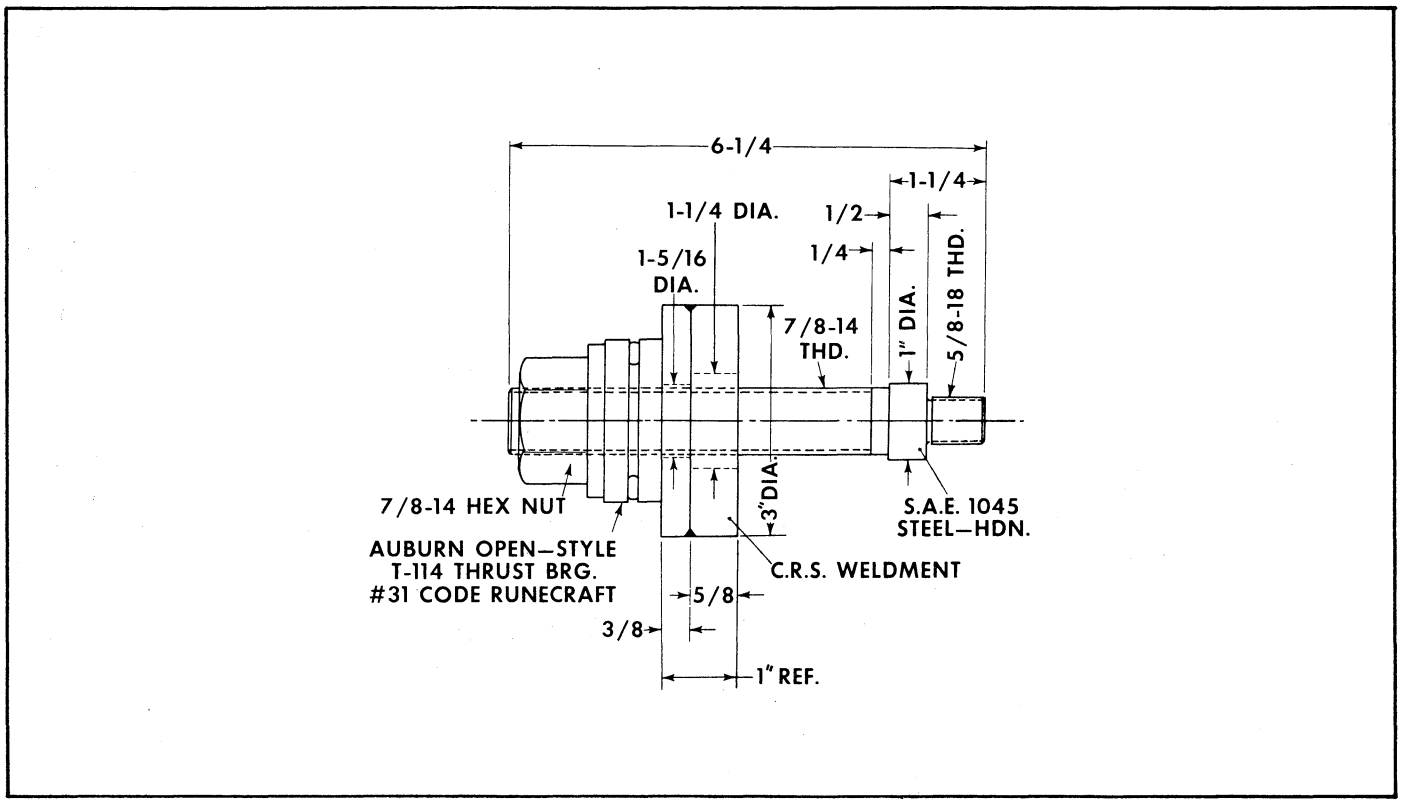


Figure 48. Special Tool T-8873.

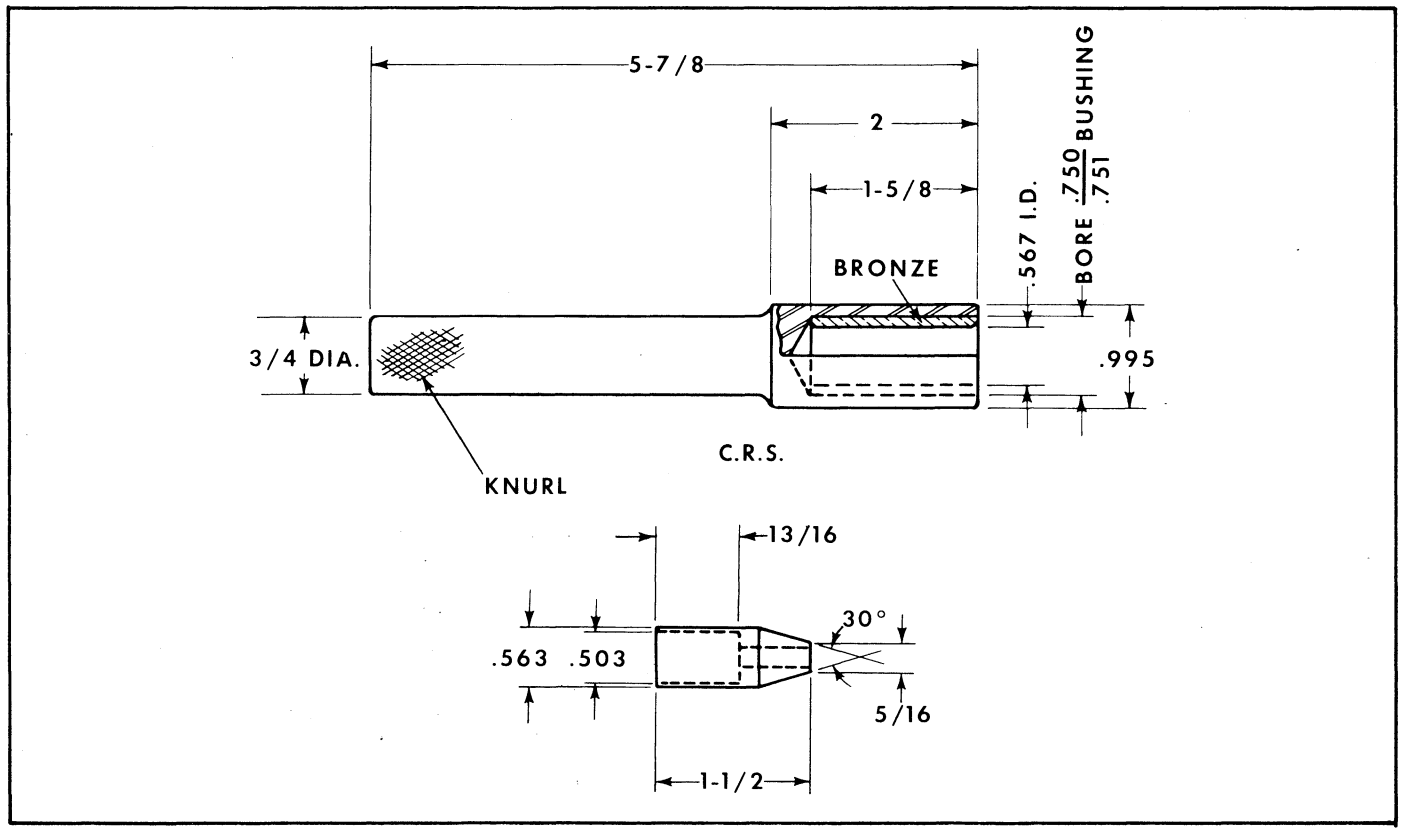


Figure 49. Special Tools T-6988 and T-6989 (Trolling Valve).

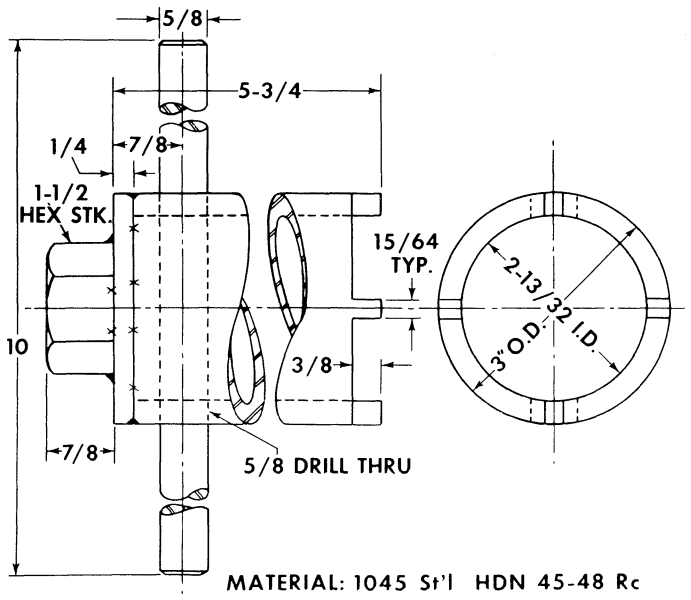


Figure 50. Special Tool T-9069.

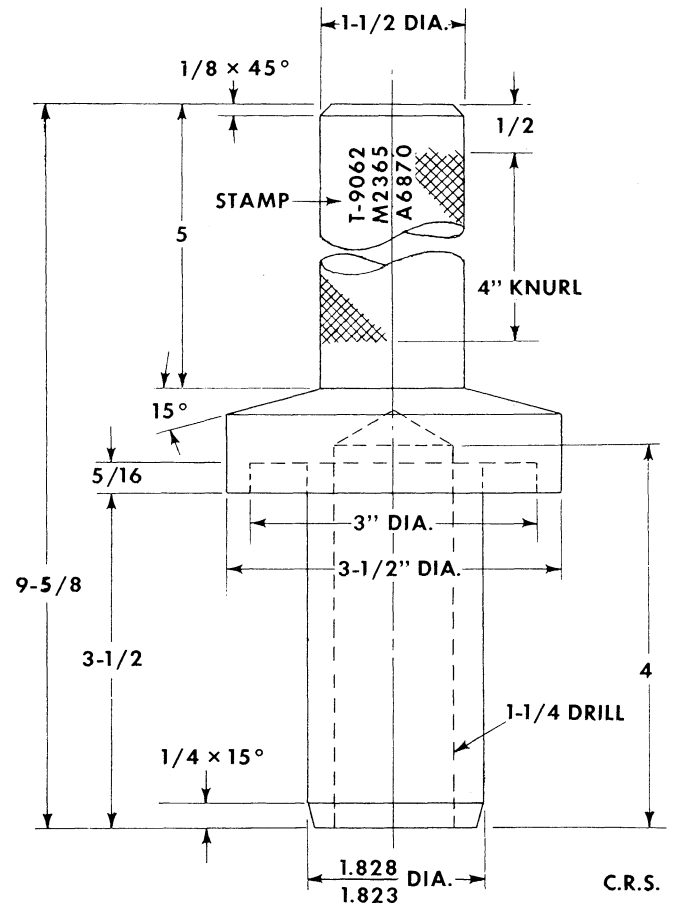


Figure 51. Special Tool T-9062.

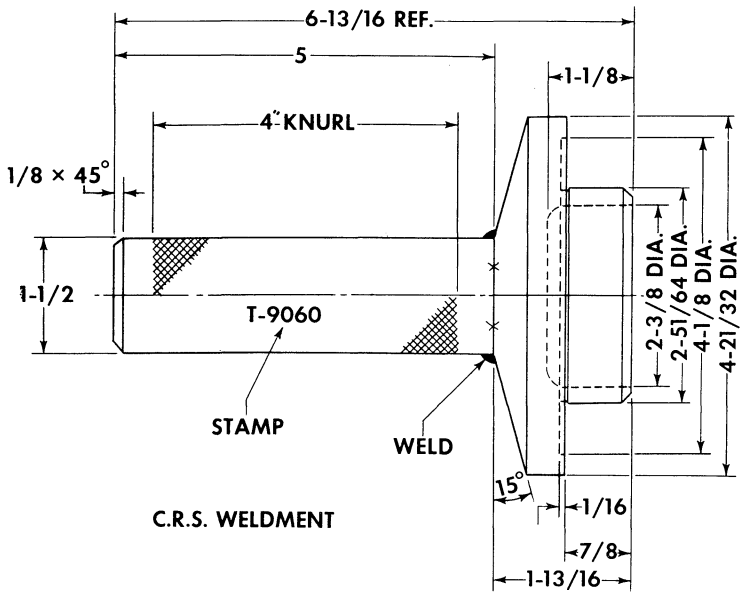


Figure 52. Special Tool T-9060.

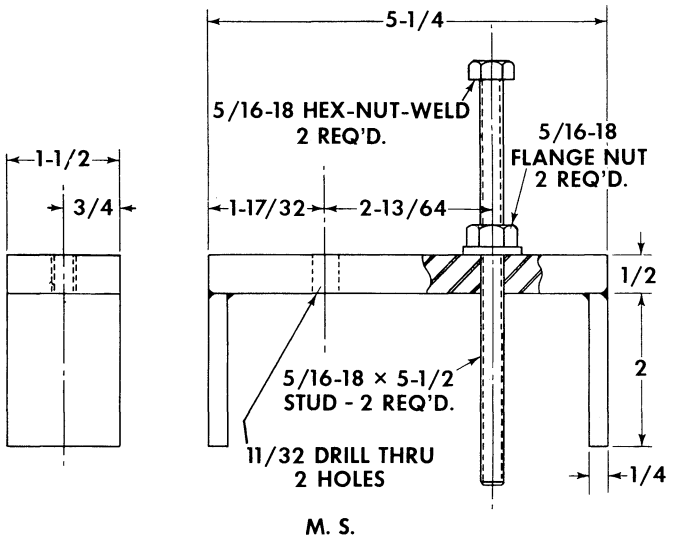


Figure 53. Special Tool T-8884.

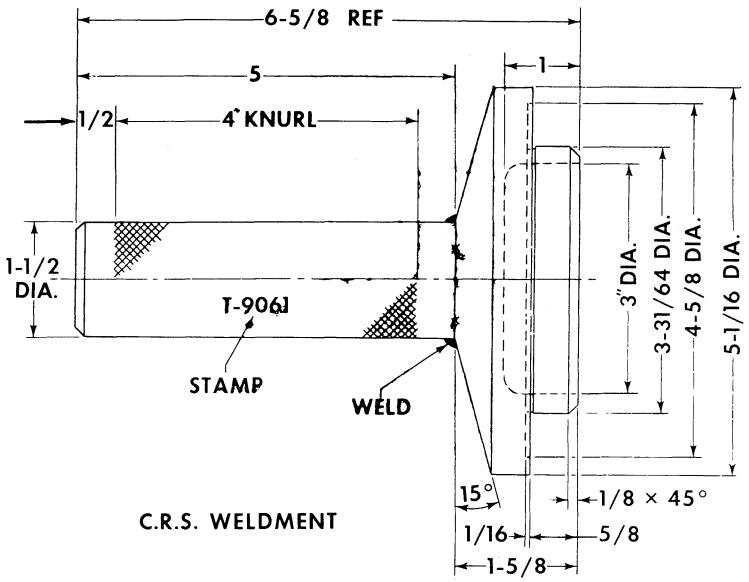


Figure 54. Special Tool T-9061.

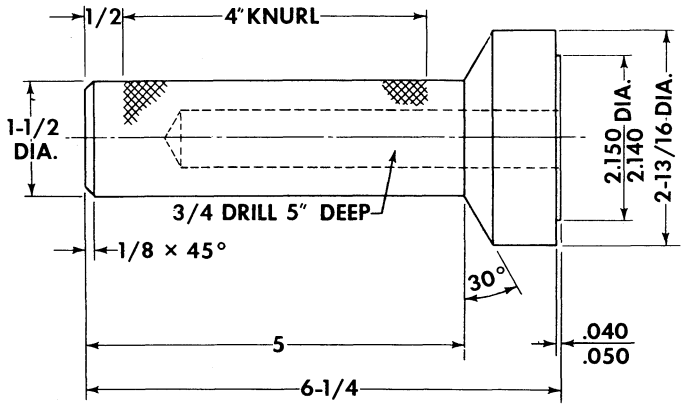
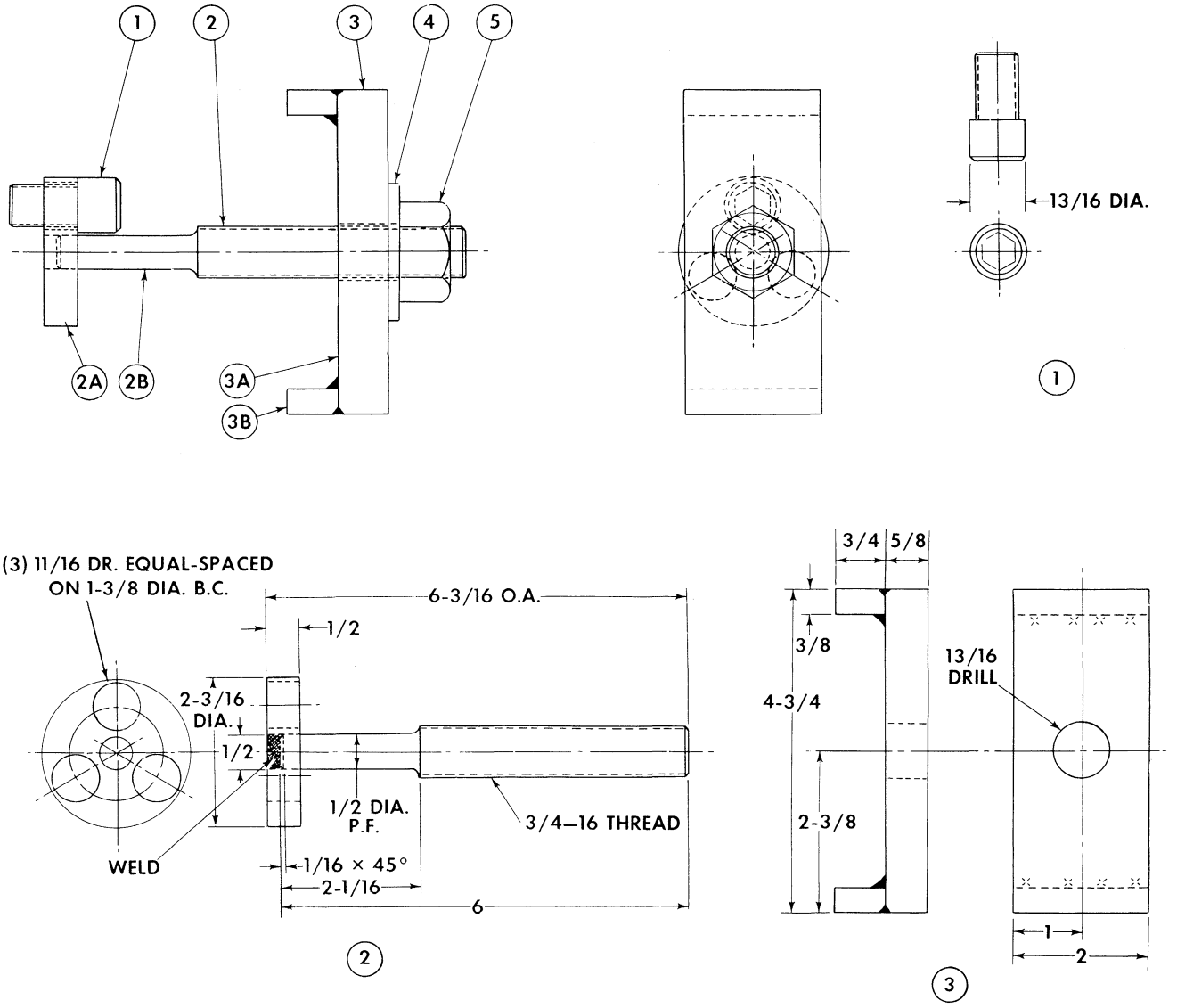


Figure 55. Special Tool T-8869.



DET.	REQ.	MAT.	DESCRIPTION
1	3	STK.	5/8-18 × 1 SOC. HD. CAP SCREW
2	1		SCR. WELDMENT
2A	1	M.S.	PLATE (2-1/4 DIA. × 5/8)
2B	1	1045	SCREW (HDN.) 7/8 DIA. × 6-1/4
3	1		PUSHER WELDMENT
3A	1	M.S.	PLATE (3/4 × 2 × 5)
3B	2	M.S.	LEG (3/8 × 2 × 7/8)
4	1	STK.	PLAIN HEAVY WASHER(13/16 I.D. - 2 O.D.)
5	1	STK.	3/4-16 HEX NUT

Figure 56. Special Tool T-8872.

Section XIV. PARTS LIST

70. PARTS LIST.

Use figures 58 through 64 and the adjacent parts list for ordering spare or replacement parts in accordance with the instructions contained in Paragraphs 3 and 4. Following the parts list are planographs of the MG-509 Marine Gear.

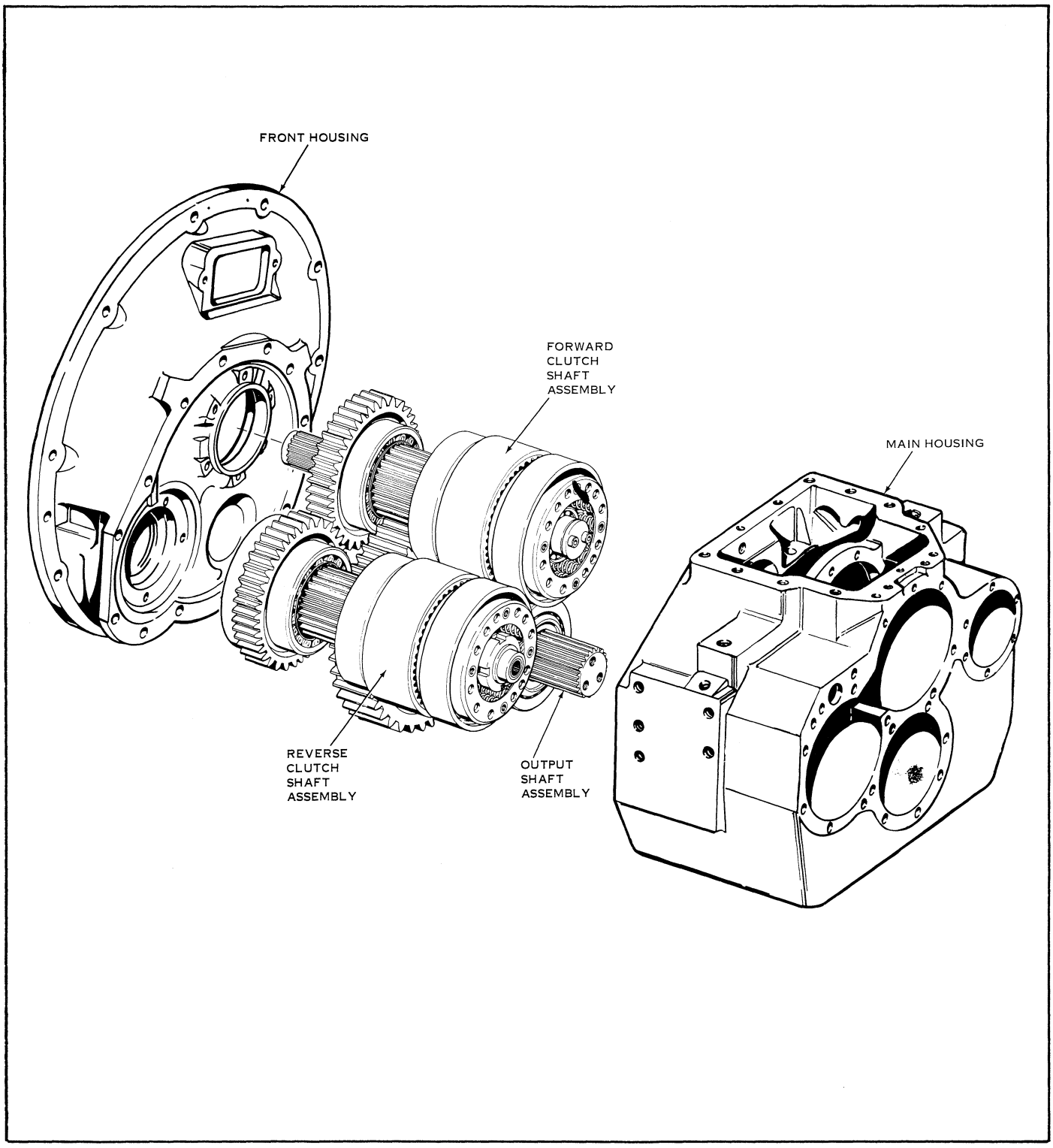


Figure 57. Orientation of Marine Gear Major Assemblies.

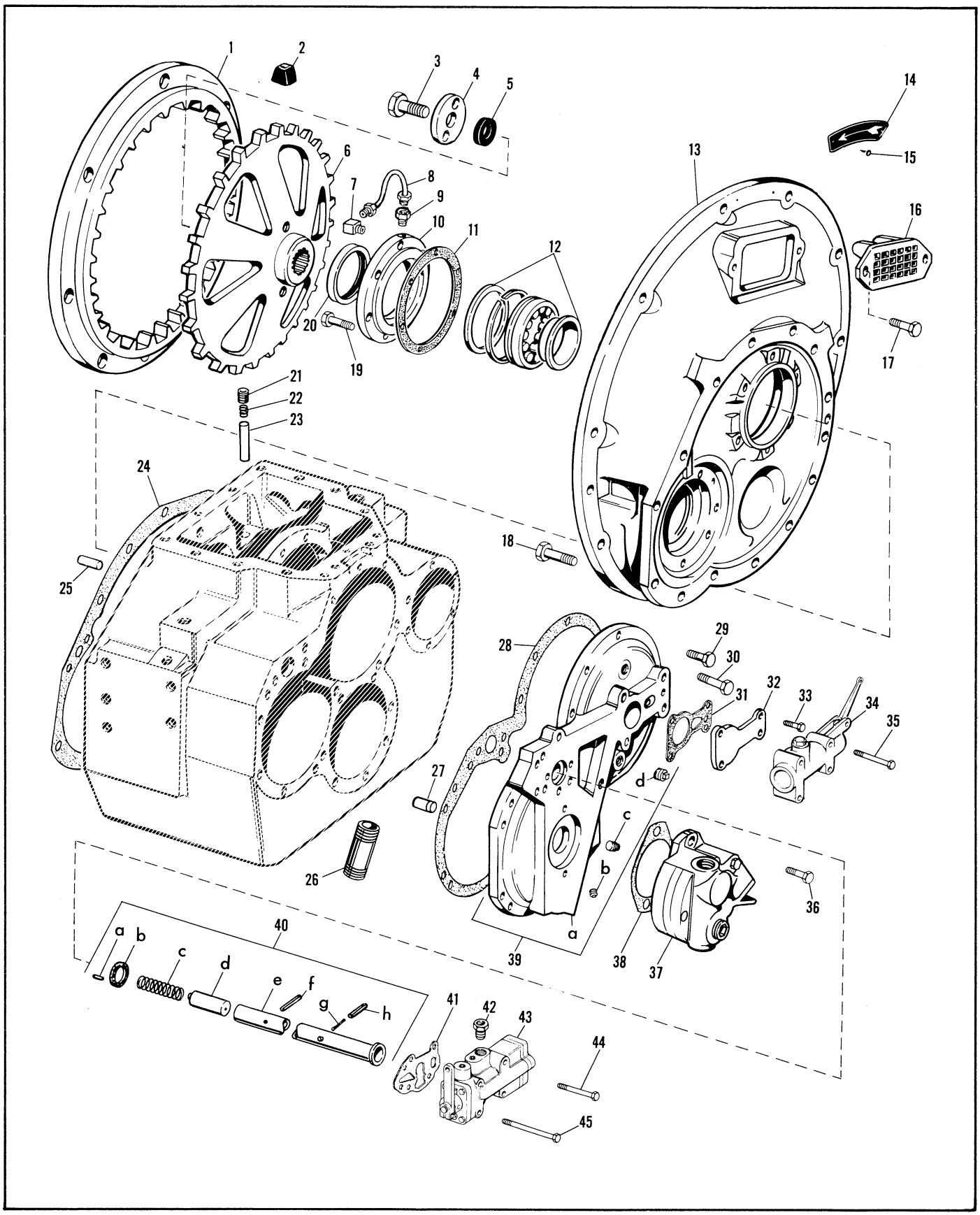


Figure 58. Input and Housing Groups of Parts. – (Shallow case model shown).

INPUT AND HOUSING GROUP OF PARTS

Item	*Description*	*Quantity*
1	RING, Driving	1
2	BLOCK, Rubber	26
3	CAPSCREW, Hex-head (5/8-18 x 1-1/2)	1
4	WASHER, Retainer	1
5	SEAL, Rubber	1
6	SPIDER, Drive	1
7	FITTING, Tube, male (1/8 inch)(90 degrees)	1
8	TUBE, Lube (1/4 inch with nuts)	1
9	FITTING, Male, connector, oil lube tube	1
10	RETAINER, Bearing (front housing)	1
11	GASKET, Bearing retainer	1
12	ROLLER BEARING	1
13	HOUSING, Front (SAE No. 1)	1
14	PLATE, Rotation indicator	1
15	SCREW, Drive, rotation indicator	2
16	COVER, Ventilating, housing, front	1
17	CAPSCREW, Hex-head (3/8-16 x 1)	2
18	CAPSCREW, Hex-head (3/8-16 x 1)	14
19	CAPSCREW, Hex-head (3/8-16 x 1)	6
20	SEAL, Oil	1
21	PLUG, Pipe (1/8 inch)	1
22	SPRING, Bearing locating pin	1
23	PIN, Input shaft bearing	1
24	GASKET, Flat, front to main housing	1
25	PIN, Dowel, front housing	2
26	NIPPLE, Pipe	1
27	PIN, Dowel, Manifold to main housing	2
28	GASKET, Flat, Manifold to housing	1
29	CAPSCREW, Hex-head (3/8-16 x 1)	9
30	CAPSCREW, Hex-head (3/8-16 x 1-1/2)	2
31	GASKET, Flat, trolling valve or cover	1
32	COVER, Trolling valve mounting hole	1
33	CAPSCREW, Hex-head, trolling valve cover (3/8-16 x 1)	4
34	TROLLING VALVE ASSEMBLY	1
35	CAPSCREW, Hex-head (3/8-16 x 2-1/2)	4
36	CAPSCREW, Hex-head, (3/8-16 x 1)	2
37	OIL PUMP ASSEMBLY	1
38	GASKET, Flat, oil pump to manifold	1
39	MANIFOLD ASSEMBLY	1
A	MANIFOLD	1
B	PLUG, Pipe (1/4 inch)	5
C	PLUG, Pipe (1/8 inch)	1
40	PIPE, Return oil assembly	1
A	ROLL PIN	1
B	GASKET, Ring Corprene	1
C	SPRING, Oil lube pipe	1
D	PISTON, Tube, return oil	1
E	TUBE, Return oil	1
F	ROLL PIN, Outer	1
G	ROLL PIN, Inner	1
H	ROLL PIN, Outer	1
41	GASKET, Flat, selector valve to manifold	1
42	BUSHING, Reducer	1
43	SELECTOR VALVE ASSEMBLY	1
44	CAPSCREW, Hex-head (3/8-16 x 2-3/4)	2
45	CAPSCREW, Hex-head (3/8-16 x 4-1/4)	2

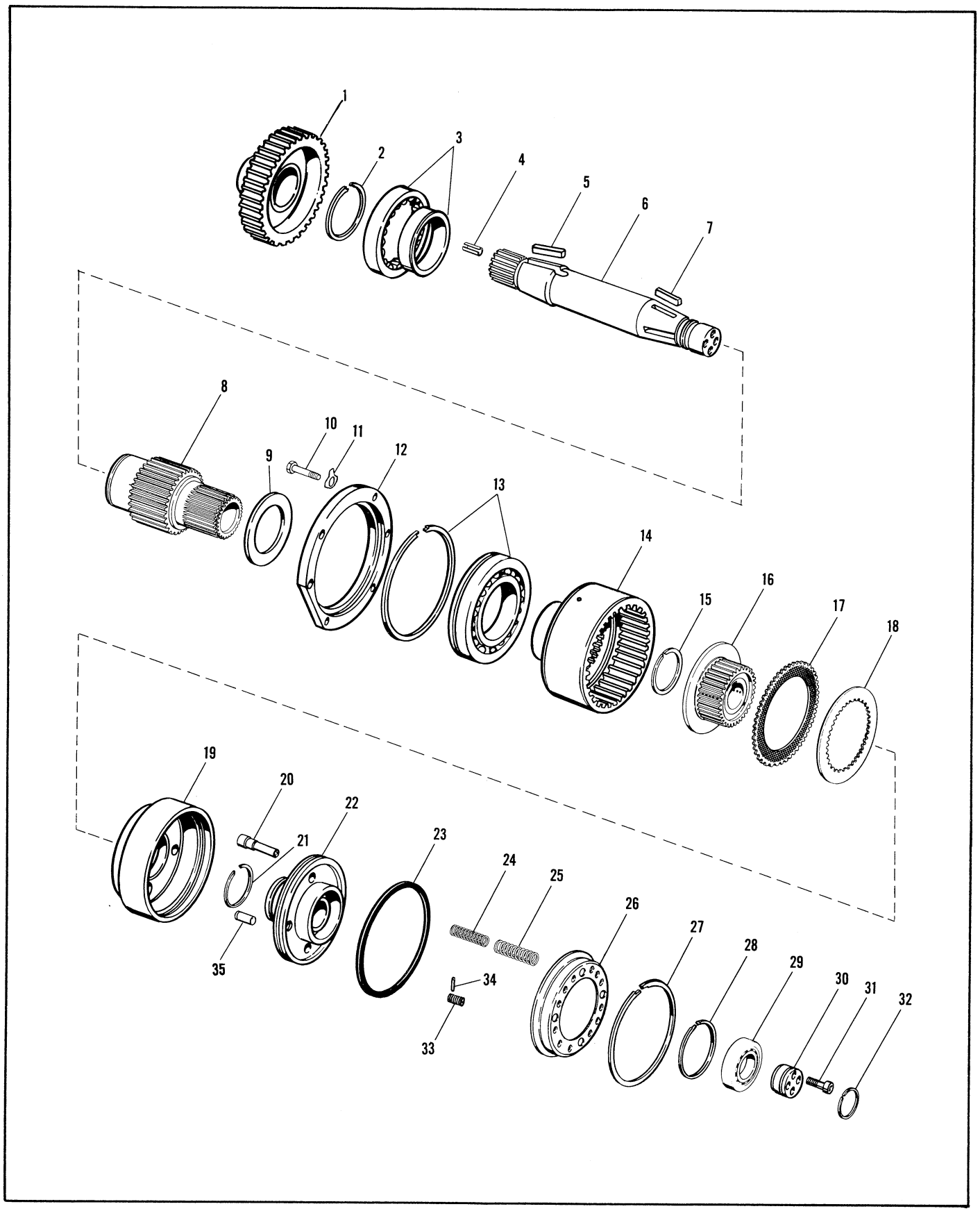


Figure 59. Forward Clutch Shaft Group of Parts. (Shallow case model shown).

FORWARD CLUTCH SHAFT GROUP OF PARTS

Item	*Description*	*Quantity*
1	GEAR, Reverse driving	1
2	RING, Snap, external	2
3	ROLLER BEARING	1
4	ROLL PIN	1
5	KEY, Reverse gear	1
6	SHAFT, Input	1
7	KEY, Input shaft	1
8	GEAR, Pinion, forward	1
9	SPACER, Forward pinion	1
10	CAPSCREW, Hex-head (3/8-16 x 1-1/8)	6
11	LOCK, Screw	6
12	RETAINER, Bearing	1
13	BALL BEARING	1
14	SPIDER, Clutch	1
15	RING, Snap, external	1
16	PLATE, Hub-and-back	1
17	PLATE, Clutch faced driving	7
18	PLATE, Clutch, steel driven	7
19	PISTON, Clutch	1
20	PIN, Dowel	2
21	RING, Seal, piston type	1
22	CARRIER, Piston	1
23	RING, Seal, lathe cut	1
24	SPRING, Inner release	16
25	SPRING, Outer, release	16
26	RETAINER, Spring	1
27	RING, Snap internal	1
28	RING, Seal, piston type	1
29	BALL BEARING	1
30	PLATE, Lock, input shaft	1
31	CAPSCREW, Hex-head (3/8-24 x 1-1/4)	2
32	RING, Piston type, seal	1
33	SCREW, Come home, headless set	2
34	ROLL PIN	2
35	PIN, dowel	1

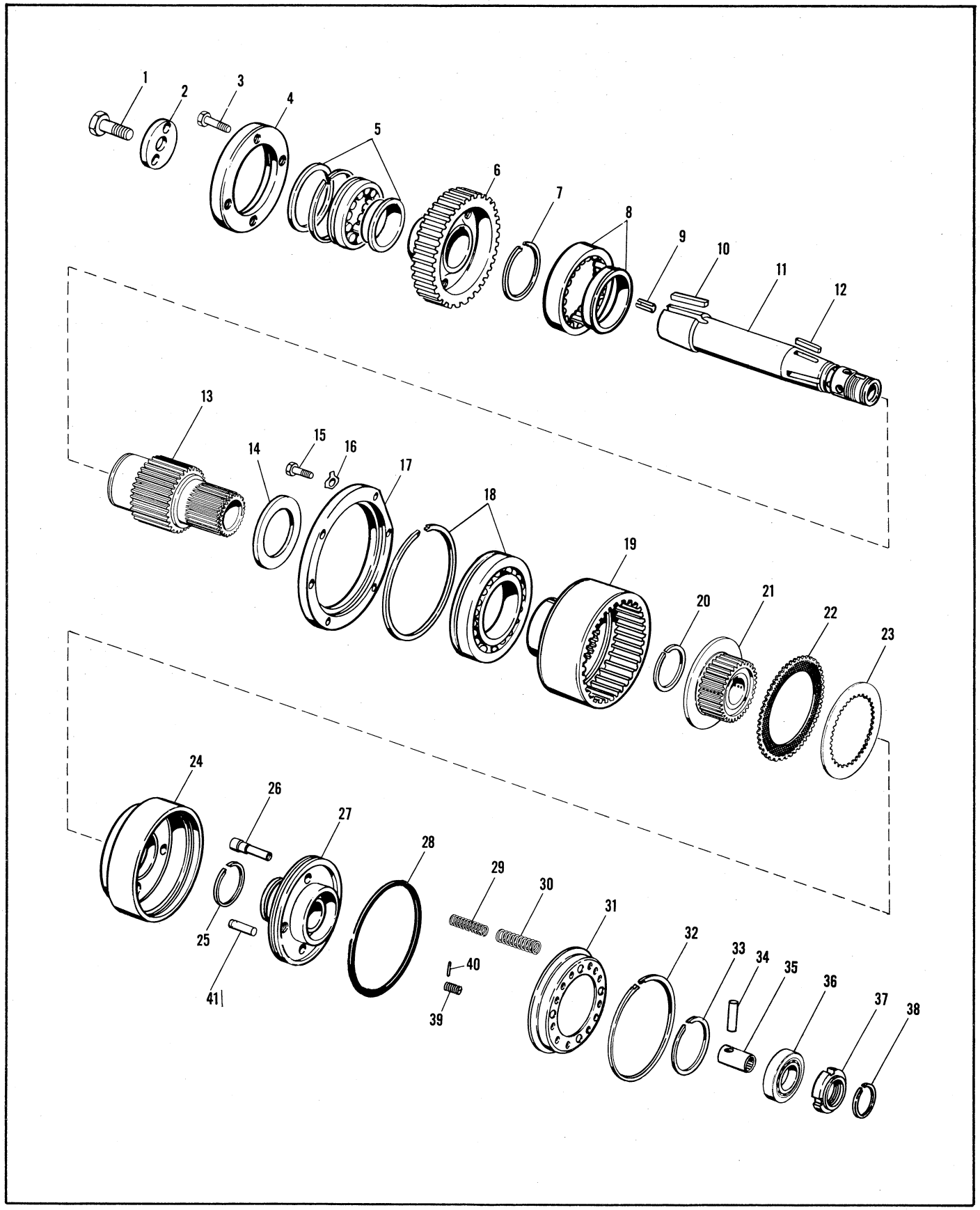


Figure 60. Reverse Clutch Shaft Group of Parts. – (Shallow case model shown).

REVERSE CLUTCH SHAFT GROUP OF PARTS

Item	*Description*	*Quantity*
1	CAPSCREW, Hex-head (5/8-18 x 1-1/2)	1
2	WASHER, Retainer	1
3	CAPSCREW, Hex-head (3/8-16 x 1-1/4)	4
4	RETAINER, Bearing	1
5	ROLLER BEARING	1
6	GEAR, Reverse, driven	1
7	RING, Snap, internal	1
8	ROLLER BEARING	1
9	ROLLPIN	2
10	KEY, Gear (3/8 x 1/4 x 1-5/8)	1
11	SHAFT, Reverse clutch	1
12	KEY, Input and reverse shaft (3/8 x 1/4 x 1-3/8)	1
13	GEAR, Pinion	1
14	SPACER, Forward and reverse pinion	1
15	CAPSCREW, Hex-head (3/8-16 x 1-1/8)	6
16	LOCK, Screw	6
17	RETAINER, Bearing	1
18	BALL BEARING	1
19	SPIDER, Clutch	1
20	RING, Snap, external	1
21	PLATE, Hub-and-Back	1
22	PLATE, Clutch, faced, driving	7
23	PLATE, Clutch, steel, driven	7
24	PISTON, Clutch	1
25	RING, Seal, piston type	1
26	PIN, Dowel	2
27	CARRIER, Piston	1
28	RING, Lathe cut	1
29	SPRING, Inner, release	16
30	SPRING, Outer, release	16
31	RETAINER, Spring	1
32	RING, Snap, internal	1
33	RING, Seal, piston type	1
34	PIN, Oil pump sleeve drive	1
35	SLEEVE, Drive, oil pump	1
36	BALL BEARING	1
37	NUT, Shroud	1
38	RING, Seal, piston type	1
39	SCREW, Come home, headless set	2
40	ROLLPIN	2
41	PIN, dowel	1

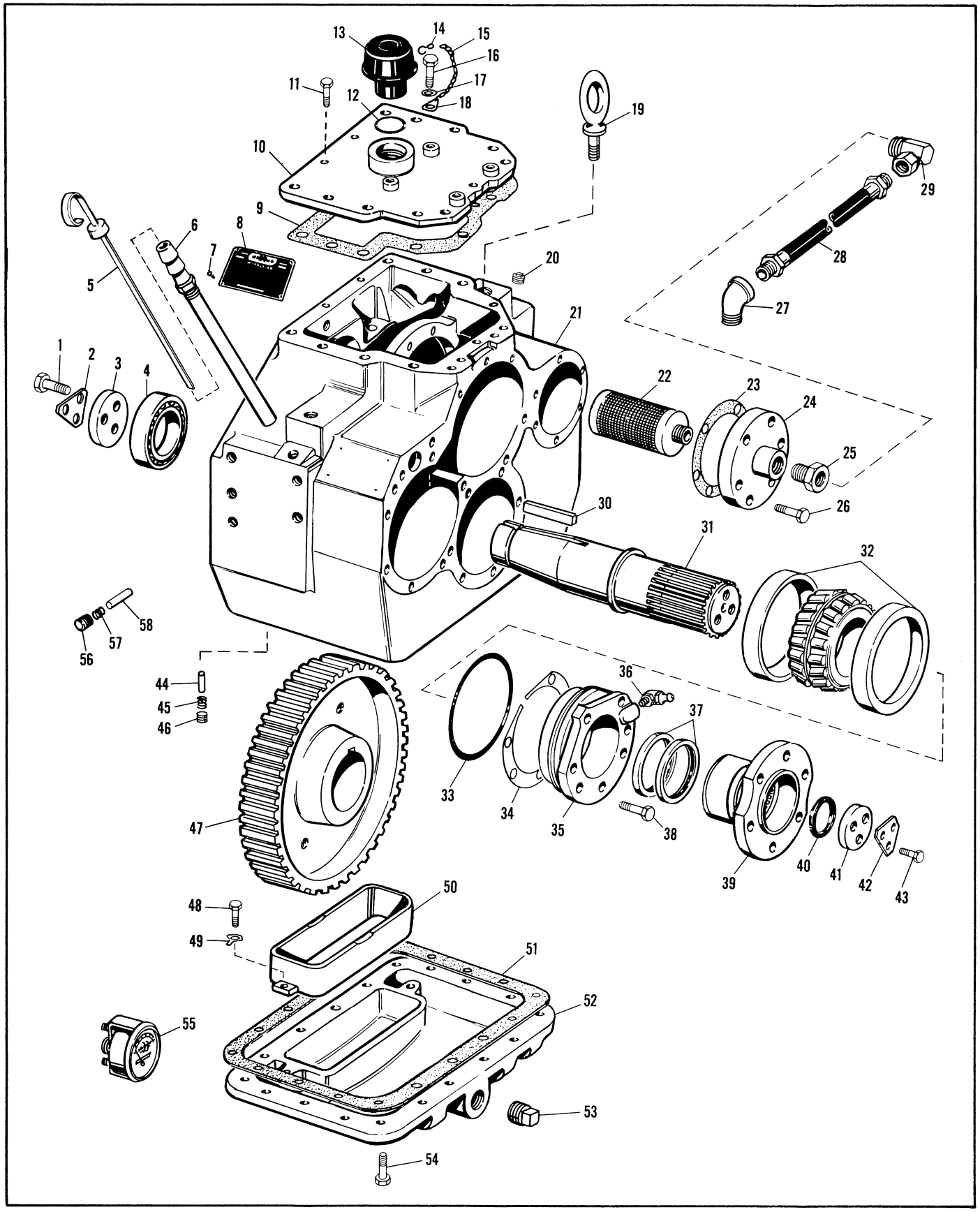


Figure 61. Main Housing and Output Groups of Parts. – (Shallow case model shown).

MAIN HOUSING AND OUTPUT GROUP OF PARTS

Item	*Description*	*Quantity*
1	CAPSCREW, Hex-head (3/8-24 x 1-1/4)	3
2	LOCK, Screw	1
3	WASHER, Retainer	1
4	ROLLER BEARING	1
5	GAUGE, Oil level	1
6	TUBE, Oil gauge	1
7	SCREW, Drive	4
8	PLATE, Instruction	1
9	GASKET, Flat, top cover	1
10	COVER, Top	1
11	CAPSCREW, Hex-head (3/8-16 x 7/8)	11
12	"O" RING, Breather assembly	1
13	BREATHER ASSEMBLY	1
14	LINK, "S" Chain	1
15	CHAIN, Breather	1
16	CAPSCREW, Hex-head (1/4-20 x 1)	2
17	WASHER, Flat, plain (3/8 inch)	1
18	CLIP, Chain, breather	1
19	EYEBOLT	2
20	PLUG, Pipe, hole, level gauge option	1
21	HOUSING, Main	1
22	ELEMENT, Filter	1
23	GASKET, Cover, filter	1
24	COVER, Filter	1
25	BUSHING, Reducer (1 to 3/8) filter cover	1
26	CAPSCREW, Hex-head (3/8-16 x 1-3/4)	6
27	ELBOW, Street (3/4 x 90 degrees) oil pump	1
28	HOSE, Flexible (14 inches long)	1
29	UNION ADAPTER (3/4 x 90 degrees)	1

Item	*Description*	*Quantity*
30	KEY, Output shaft gear	1
31	SHAFT, Output	1
32	TAPERED ROLLER BEARING	1
33	"O" RING	1
34	SHIM, Retainer, bearing (average 3 per unit)	3
	SHIM, Retainer, bearing	1
35	RETAINER, Bearing	1
36	FITTING, Hydraulic	1
37	SEAL, Oil	2
38	CAPSCREW, Hex-head (7/16-14 x 1-1/4)	7
39	FLANGE, Output	1
40	SEAL, Rubber	1
41	WASHER, Retainer	1
42	LOCK, Screw	1
43	CAPSCREW, Hex-head (5/8-18 x 1-1/2)	3
44	PIN, Bearing	1
45	SPRING, Bearing pin	1
46	PLUG, Bearing pin	1
47	GEAR, output	1
48	CAPSCREW, Hex-head (3/8-16 x 1)	2
49	LOCK, Screw	2
50	PAN, Gear	1
51	GASKET, Bottom cover	1
52	COVER, Bottom	1
53	PLUG, Drain, Bottom cover	1
54	CAPSCREW, Hex-head (3/8-16 x 1-1/8)	18
55	GAUGE, Pressure, oil	1
56	PLUG, Pipe, bearing pin	1
57	SPRING, Bearing pin	1
58	PIN, Bearing, locating	1

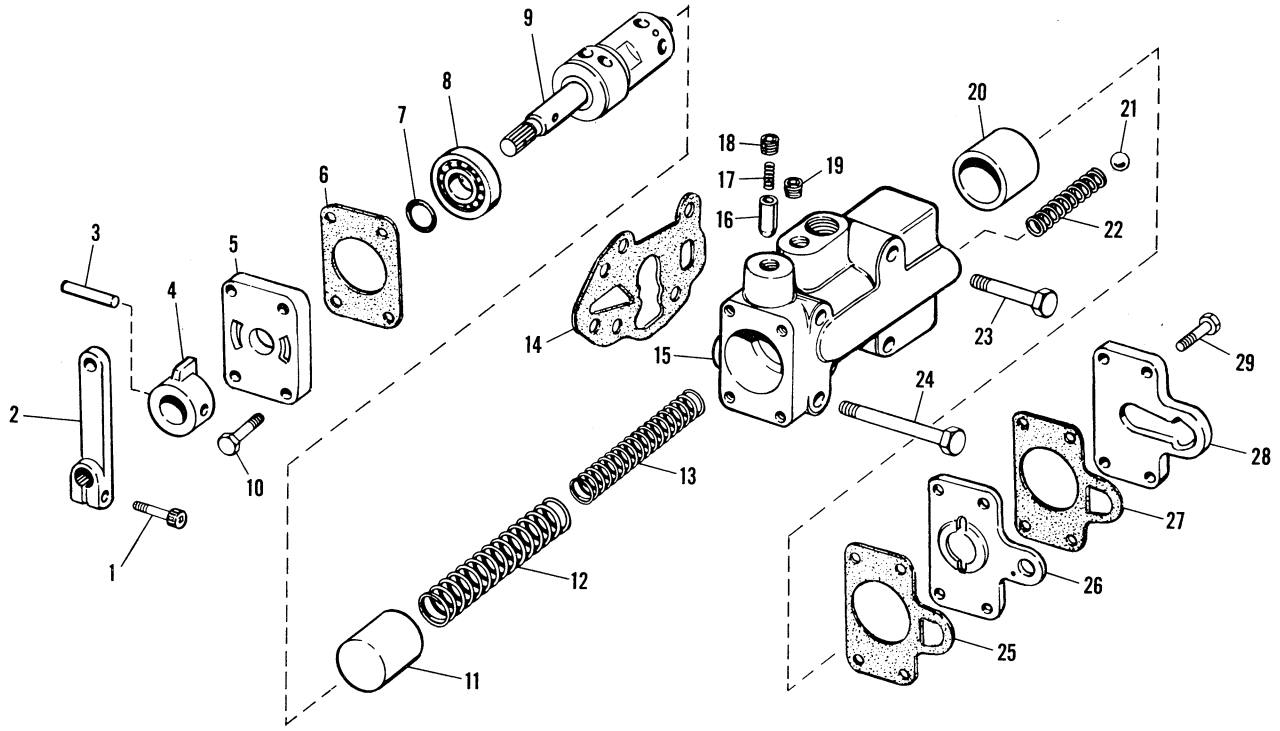
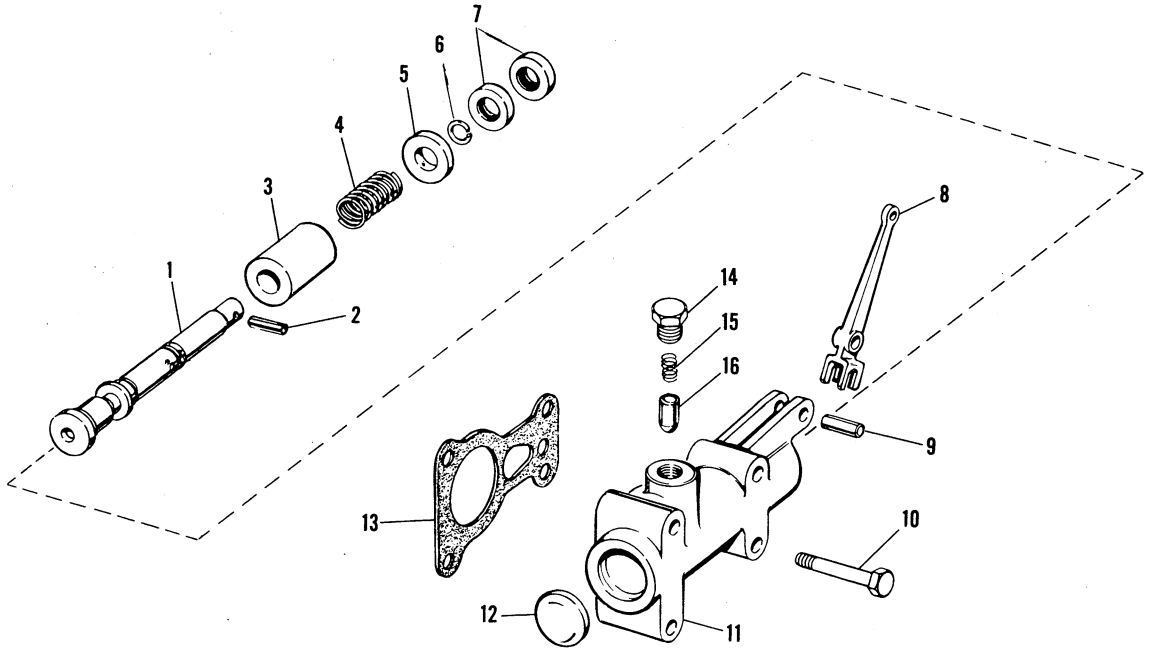


Figure 62. Selector Valve Assembly Group of Parts.

SELECTOR VALVE ASSEMBLY GROUP OF PARTS

Item	*Description*	*Quantity*
1	CAPSCREW, Socket-head (3/8-20 x 7/8)	1
2	LEVER, Shift	1
3	ROLLPIN	1
4	COLLAR, Stop	1
5	COVER, Valve	1
6	GASKET, Flat, cover valve	1
7	"O" RING	1
8	BALL BEARING	1
9	STEM, Valve, selector	1
10	CAPSCREW, Hex-head (5/16-18 x 1)	4
11	PISTON, Regulator, pressure, high	1
12	SPRING, Outer, piston *	1
13	SPRING, Inner, Piston *	1
14	GASKET, Flat, valve to manifold	1
15	BODY, Valve, selector	1
16	DETENT, Indexing	1
17	SPRING, Detent, indexing	1
18	PLUG, Pipe, hex-socket-head (1/4 inch)	1
19	PLUG, Pipe, hex-socket-head (1/4 inch)	1
20	PISTON, Control, rate, pressure	1
21	BALL, Steel	1
22	SPRING, Compression, plate, orifice	1
23	CAPSCREW, Hex-head (3/8-16 x 2-3/4)	2
24	CAPSCREW, Hex-head (3/8-16 x 4-1/4)	2
25	GASKET, Flat, plate, orifice	1
26	PLATE, Orifice	1
27	GASKET, Flat, Plate orifice	1
28	COVER, Plate, orifice	1
29	CAPSCREW, Hex-head (5/16-18 x 1)	4

* *Not serviced separately. Replace as pair. Assembly number XA2707-AD*



XA6514B

Figure 63. Trolling Valve Assembly Group of Parts.

TROLLING VALVE ASSEMBLY GROUP OF PARTS

Item	*Description*	*Quantity*
1	STEM, Valve trolling	1
2	PIN, Valve, trolling	1
3	PISTON, Valve, trolling	1
4	SPRING, Piston, Valve trolling	1
5	WASHER, Centering	1
6	RING, Snap, round wire	1
7	SEAL, Oil	2
8	LEVER, Valve, trolling	1
9	ROLL PIN	1
10	CAPSCREW, Hex-head (3/8-16 x 2-1/2)	4
11	BODY, Valve, trolling	1
12	PLUG, Expansion	1
13	GASKET, Flat	1
14	SCREW, Detent, indexing	1
15	SPRING, Detent	1
16	DETENT, Indexing	1

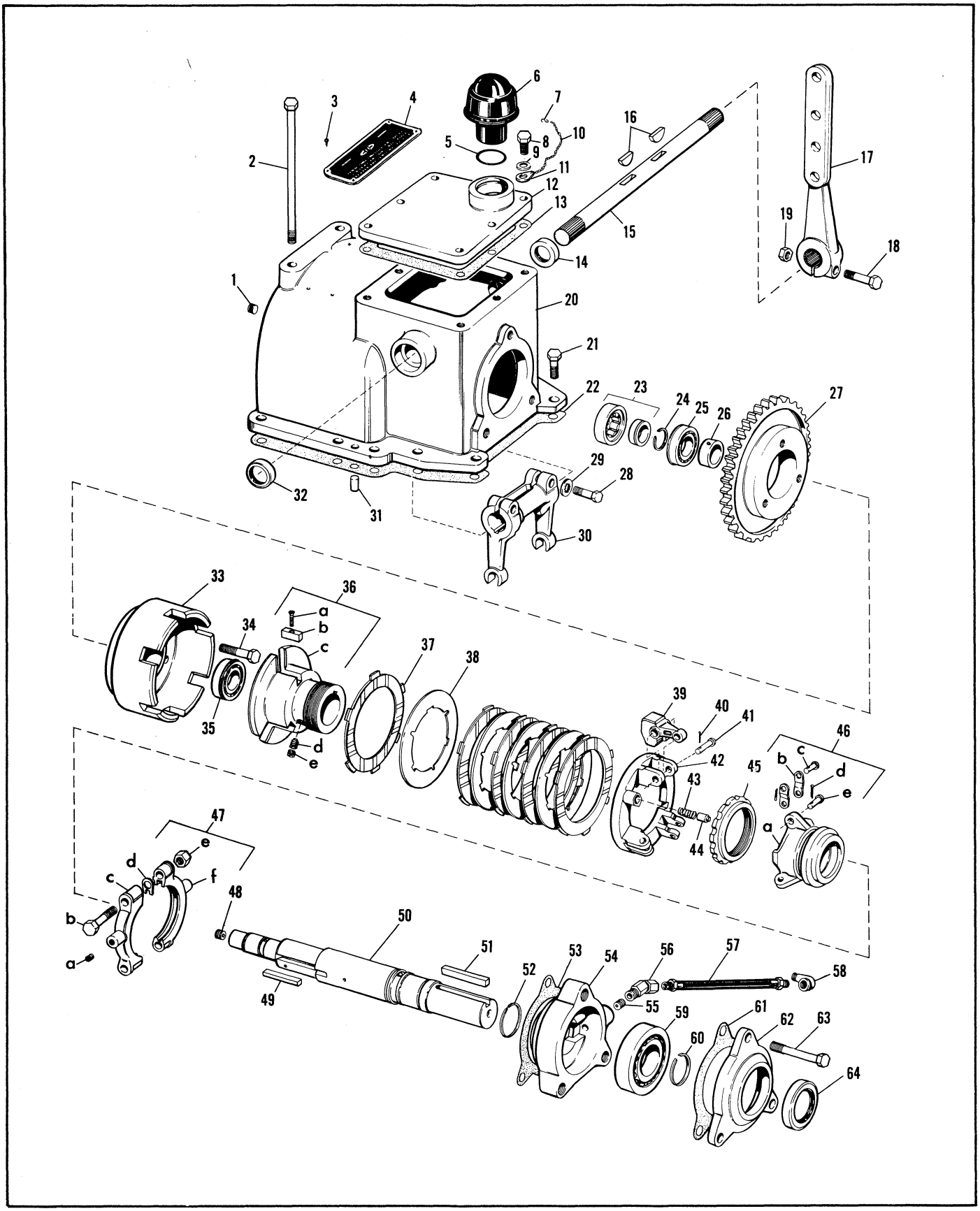


Figure 64. Optional Top-mounted Power Take-off for Marine Gear MG-509.

TOP MOUNTED P.T.O. GROUP OF PARTS

Item	*Description*	*Quantity*
1	PLUG, Pipe, Hex-socket-head 1/8 inch	2
2	CAPSCREW, Hex-head (1/4-20 x 7)	2
3	SCREW, Drive	4
4	PLATE, Name and Instruction	1
5	"O" RING, Breather *	1
6	BREATHER, Oil assembly *	1
7	LINK, "S" chain, breather *	1
8	CAPSCREW, Hex-head * (3/8-16 x 1)	6
9	WASHER, Flat *	1
10	CHAIN, Breather *	1
11	CLIP, Chain, breather *	1
12	PLATE, Cover top	1
13	GASKET, Flat	1
14	SEAL, Oil	1
15	SHAFT, Operating	1
16	KEY, Woodruff	2
17	LEVER, Operating	1
18	CAPSCREW, Hex-head (3/8-16 x 2)	1
19	NUT, hex (3/8-16)	1
20	HOUSING, Take-off, power	1
21	CAPSCREW, Hex-head (3/8-16 x 1) *	10
22	GASKET, Flat *	1
23	ROLLER BEARING, Clutch shaft	1
24	RING, Snap, internal	1
25	BALL BEARING, Clutch shaft	1
26	SPACER, Bearing	1
27	GEAR, Spider clutch	1
28	CAPSCREW, Hex-head (3/8-16 x 1-1/2)	2
29	WASHER, Lock 3/8 inch	2
30	YOKE, Operating	1
31	PIN, Dowel	2
32	SEAL, Oil	1
33	SPIDER, Clutch	1
34	CAPSCREW, Hex-head (3/8-24 x 1-1/2)	3
35	BALL BEARING	1
36	PLATE, Hub-and-Back assembly	1
	(a) Screw, Machine, flat-head (10-24 x 3/4)	3
	(b) Key, Plate	3
	(c) Plate, Hub-and-back	1

Item	*Description*	*Quantity*
37	PLATE, Clutch, faced (driving)	5
38	PLATE, Clutch, steel (driven)	4
39	LEVER, Clutch	3
40	PIN, Cotter	3
41	PIN, Lever	3
42	PLATE, Floating	1
43	SPRING, Pin, lock, adjusting	1
44	PIN, Lock, adjusting	1
45	RING, Adjusting	1
46	SLEEVE, Sliding assembly	1
	(a) SLEEVE, Sliding	1
	(b) LINK, Lever	6
	(c) PIN, Link, lever	3
	(d) PIN, Cotter	3
	(e) PIN, Link, lever	3
47	COLLAR ASSEMBLY	1
	(a) PLUG	1
	(b) CAPSCREW, Hex-head (3/8-24 x 2-1/4)	2
	(c) COLLAR, Split	2
	(d) SHIM, Collar	2
	(e) NUT	2
48	PLUG, Orifice, pipe	1
49	KEY, Square (3/8 x 3/8 x 2)	1
50	SHAFT, PTO, output	1
51	KEY, Square (3/8 x 3/8 x 2-1/2)	1
52	RING, Seal, piston type	1
53	GASKET, Flat	1
54	CARRIER, Bearing	1
55	PLUG, Pipe, special	1
56	UNION, Adapter, pipe, male 1/4 inch 45 degrees	1
57	HOSE, Oil, flexible assembly	1
58	ELBOW, Pipe, street 1/4 inch 90 degrees	1
59	BALL BEARING	1
60	RING, Snap, external	1
61	GASKET, Flat, carrier	1
62	RETAINER, Bearing	1
63	CAPSCREW, Hex-head (3/8-16 x 2-1/4)	3
64	SEAL, Oil	1

** Parts supplied with main Marine Gear*

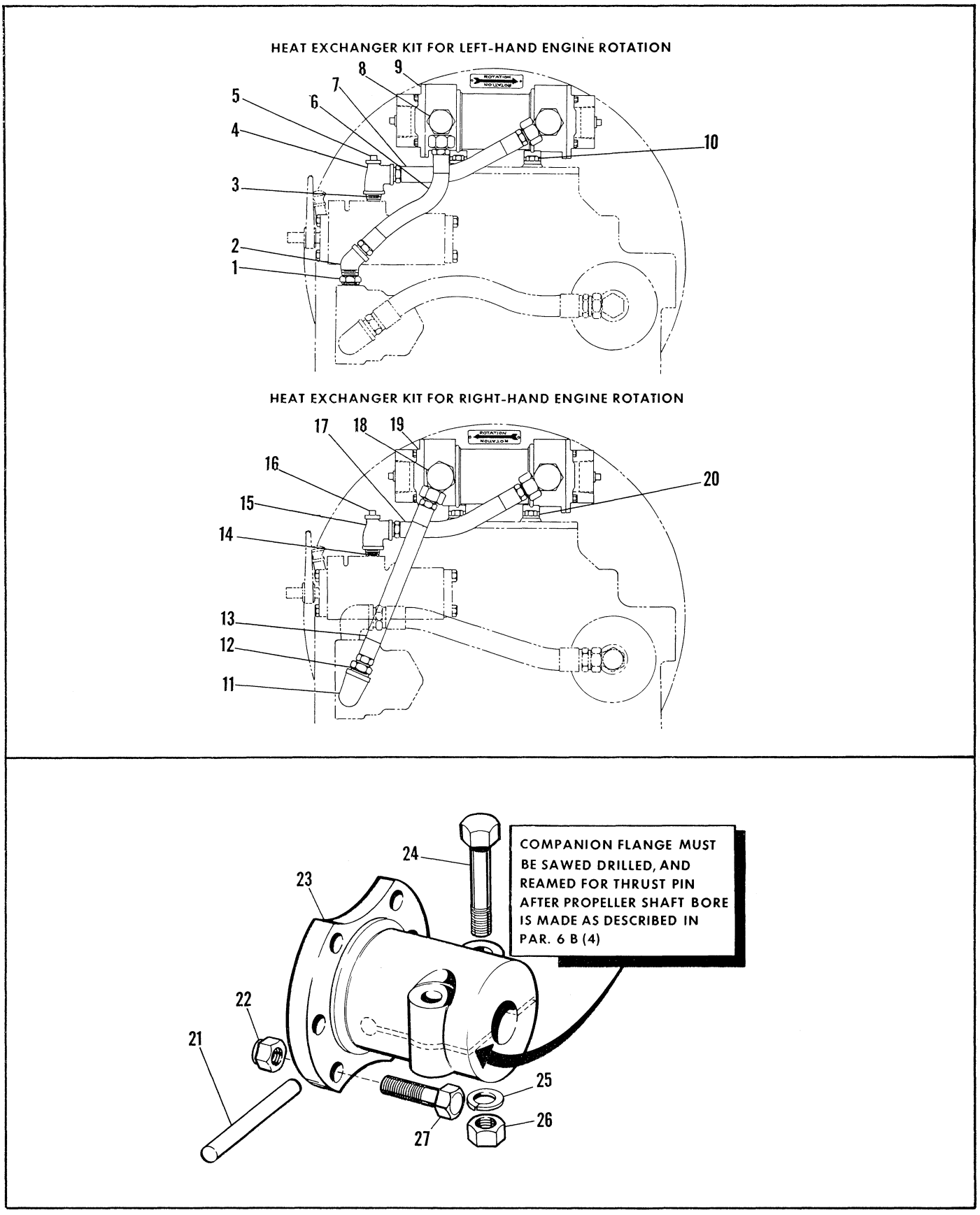


Figure 65. Heat Exchanger and Companion Flange — Optional Equipment.

OPTIONAL EQUIPMENT

Item	*Description*	*Quantity*
1	BUSHING, Reducer 3/4 inch to 1/2 inch	1
2	ELBOW, Street, 1/2 inch, 45 degree	1
3	NIPPLE, Pipe (1/2 x 1-1/8)	1
4	TEE, Pipe (1/2 x 1/4 x 1/2)	1
5	PLUG, Pipe, Square-head (1/4 inch)	1
6	HOSE, Flexible (I.D. 1/2 inch)	1
7	HOSE, Flexible (I.D. 1/2 inch)	1
8	UNION, Adapter, Male, 1/2 inch, 90 degree	2
9	EXCHANGER, Heat	1
10	CAPSCREW, Hex-head (3/8-16 x 1/2)	4
11	ELBOW, Street, 1/2 inch, 90 degree	1
12	BUSHING, Reducer, 3/4 to 1/2 inch	1
13	HOSE, Flexible, I.D. 1/2 inch	1
14	NIPPLE, Pipe, 1/2 x 1-1/8	1
15	TEE, Pipe (1/2 x 1/4 x 1/2)	1
16	PLUG, Pipe, Square-head, 1/4 inch	1
17	HOSE, Flexible, I.D. 1/2 inch	1
18	UNION, Adapter, Male 1/2 inch, 90 degree	2
19	EXCHANGER, Heat	1
20	CAPSCREW, Hex-head (3/8-16 x 1/2)	1
	Heat Exchanger Kit for MG-509 Marine Gear with Top Power Take-Off.	
	(NOT SHOWN)	
	Exchanger, Heat	1
	Hose, Flexible (1/2 x 36)	2
	CLIP, Pipe	1
	CAPSCREW, Hex-head (3/8-16 x 1-3/4)	1
	TEE, Pipe (1/2 x 1/4 x 1/2)	1
	PLUG, Pipe, Square-head (1/4 inch)	1
	NIPPLE, Pipe (1/2 x 1/2)	1
	BUSHING, Reducer (1 inch to 1/2 inch)	2
21	PIN, Thrust	1
22	NUT, Stop, Hex (5/8-18)	6
23	FLANGE, Companion	1
24	CAPSCREW, Hex-head (3/4-16 x 4)	2
25	WASHER, Lock (3/4 inch)	2
26	NUT, Hex (3/4-16)	2
27	CAPSCREW, Hex-head (5/8-18 x 2-1/4)	6

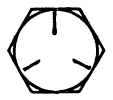
TORQUE VALUES

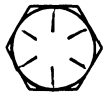
FOR TIGHTENING CAPSCREWS, BOLTS, NUTS, TUBE FITTINGS AND PLUGS.

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.

C

(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.

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

C

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

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

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

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

FOR 37°, 45° AND INVERTED FLARED FITTINGS PER SAE STANDARDS J512, J514, and J516 WITH LATEST SUFFIX. (1)

FOR TAPER PIPE THREADED FITTINGS USE THE PIPE PLUG TORQUE VALUES SHOWN ON PAGE 1.

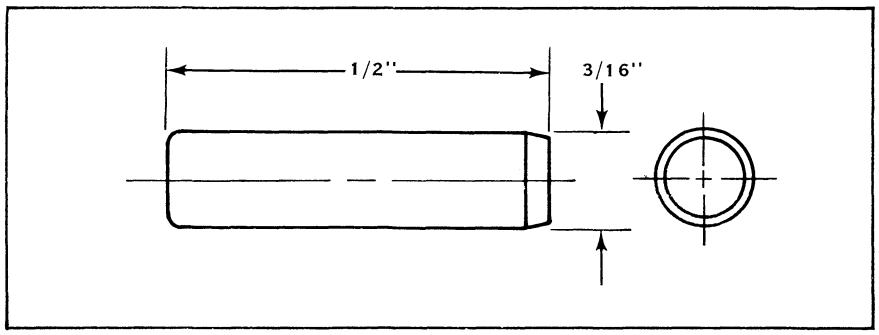
NOMINAL THREAD O.D.	NOMINAL TUBE SIZE	PLUG PART NUMBER (2)	TIGHTENING TORQUE, LB. FT. NUTS & PLUGS	TORQUE LB. IN. EQUIV.
5/16	1/8	– – –	3.6 ± 0.5	43 ± 6
3/8	3/16	M2080G	8.6 ± 1.0	103 ± 12
7/16	1/4	M2080E	12 ± 1.5	144 ± 18
1/2	5/16	M2080C	15 ± 2	180 ± 24
9/16 & 5/8	3/8	M2080A	18 ± 2	216 ± 24
11/16	7/16	– – –	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.

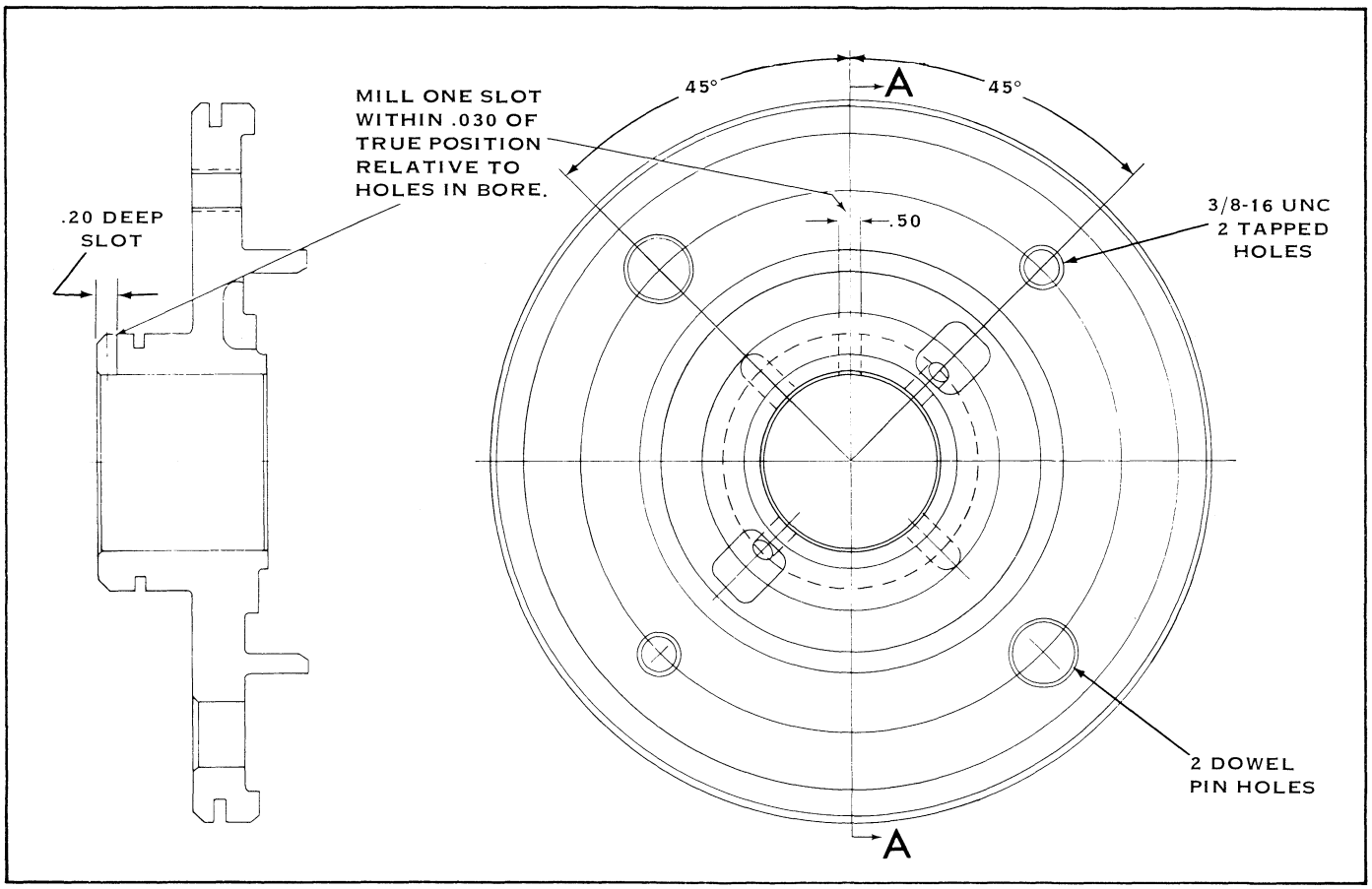
(2) THIS IS A PARTIAL LIST. USE THREAD O.D. TO DETERMINE THE RECOMMENDED ASSEMBLY TORQUE OF THE UNLISTED STRAIGHT THREAD "O" RING PLUGS.

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.

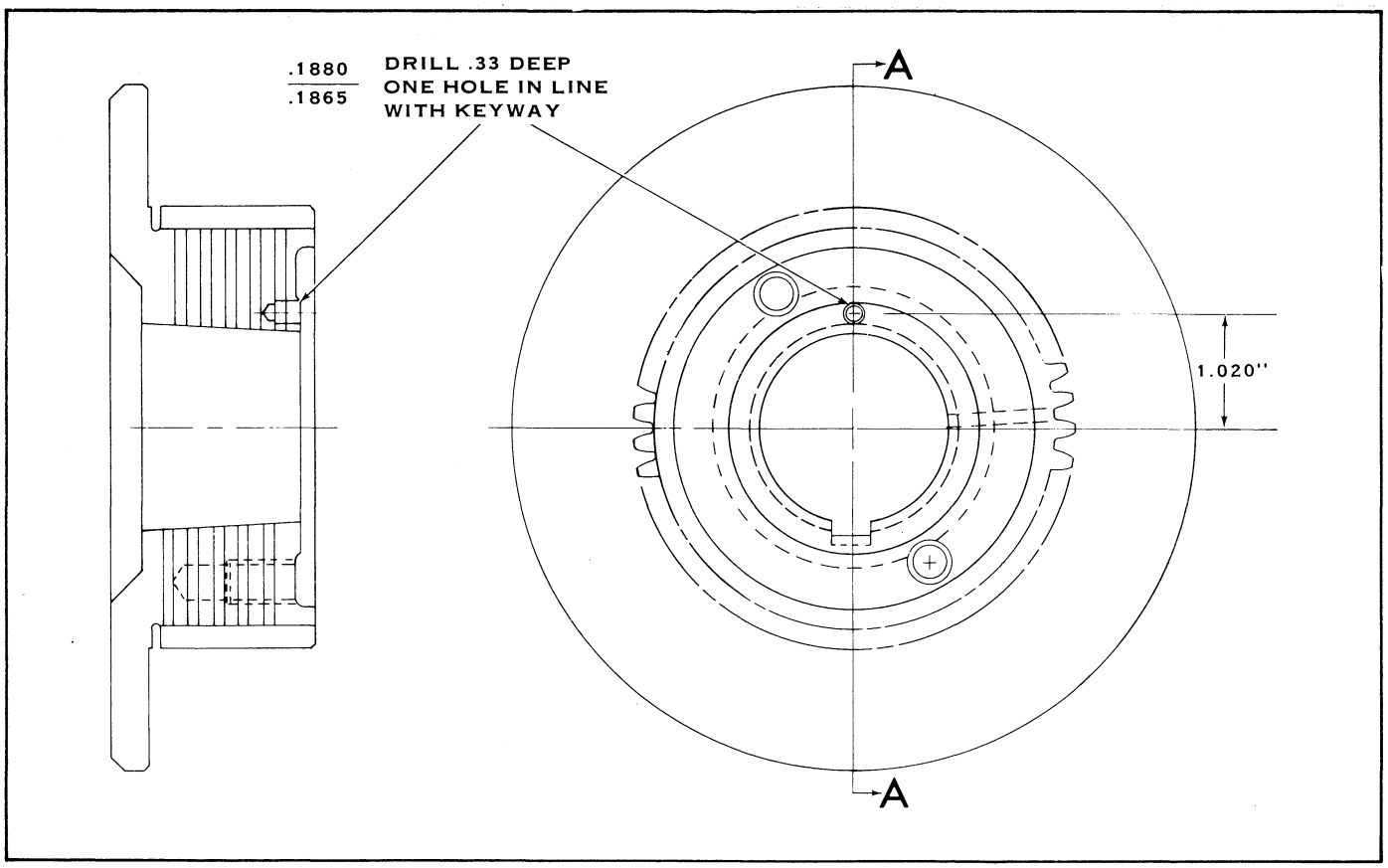
Revision D—July 1982



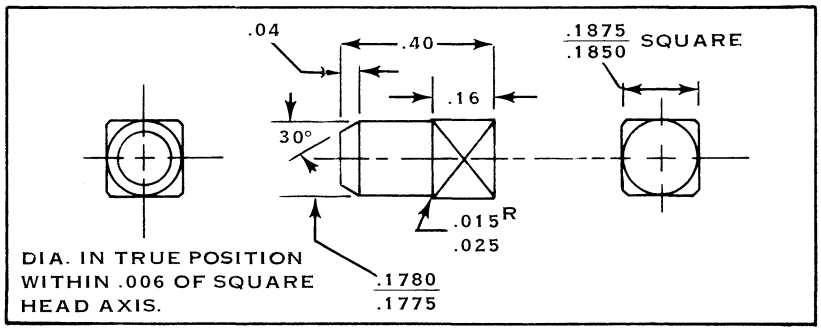
Sketch A. Dowel Pin



Sketch B. Piston Carrier A-4636-D



Sketch C Hub & Back Plate A-4968-A



Sketch D. Pin-Square Head

now available . . .

2451 HYDRAULIC PRESSURE & FLOW TEST KIT

Service Tested,

Approved and Recommended

for

Twin Disc, Incorporated *Hydraulic Systems*

KIT INCLUDES:

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

CONTENTS OF KIT 2451

Part No.	Qty.	Description
6652	1	Gauge Bar
6653	7	Gauge 400 psi
6234	2	Gauge 100 psi
6258	1	Gauge 60 psi
6654	1	Gauge 30 psi
6094	11	Hose 10 ft. Long
0799	2	"D" Clip
0800	2	Strap
0801	2	Coated Clips
0802	1	Stretch Cord
0803	2	Suction Cup
6311	5	Nipples NPT-2
0076	5	Coupler NPT-2

Part No.	Qty.	Description
0804	2	Screw 1/4-20 x 2-3/4 lg.
0831	7	90° Elbow 4 SAE x 4 JIC M
0039	10	Adapter 4 SAE x 4 JIC M
0721	1	Adapter 3 SAE x 4 JIC M
0013	3	Adapter 6 SAE x 4 JIC M
0752	1	Adapter 5 SAE x 4 JIC M
6655	1	Flow Meter 30 GPM
6656	1	Flow Meter 10 GPM
6657	1	Hose 10 – 100R1 18 inches Long
6658	1	Hose 12 – 100R1 18 inches Long
6660	2	Adapter 10 SAE MX 10 JIC M
6659	2	Adapter 12 SAE MX 12 JIC M
6641	4	Adapter 45° 4 SAE x 4 JIC M
6299	1	Box Storage with fills

anufactured for Twin Disc, Incorporated by Owatonna Tool Co., 2013 4th St. N.W., Owatonna, Minnesota 55060, 1-800-553-5338

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: Owatonna Tool Co., 2013 4th St. N.W., Owatonna, Minnesota 55060. Part Number for the Kit is No. 2451.

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

RUNOUT TOLERANCE FOR MARINE GEAR OUTPUT FLANGES

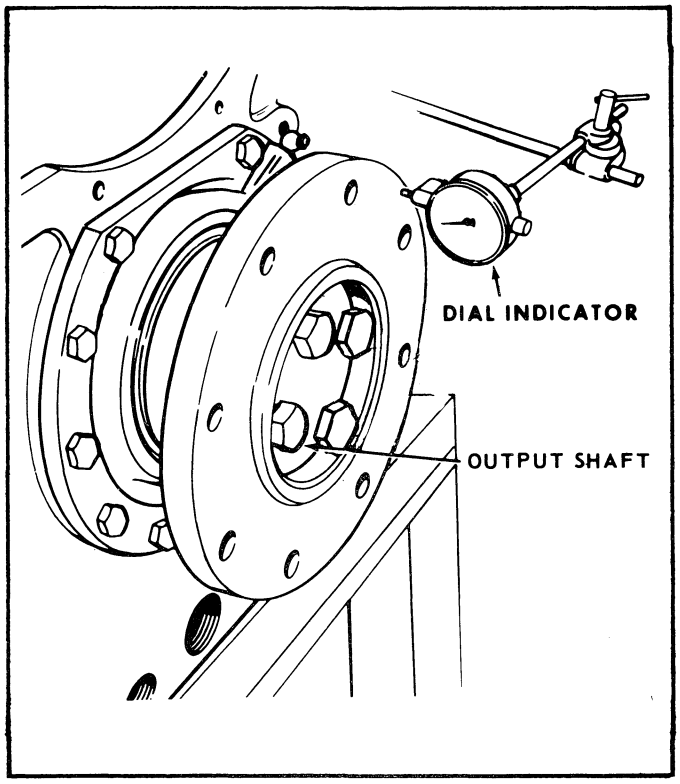
All Twin Disc 500 series marine transmissions are checked for output flange pilot and face runout after assembly. The chart below indicates the maximum allowable runout at these points for the various models. It is suggested that after rebuilding in the field these runouts be checked. If runouts in excess of those shown in the chart are found, in some cases, removing the output flange and rotating it on the output shaft 180 degrees will correct the excessive runout condition.

MODEL	FACE RUNOUT "A"	PILOT RUNOUT "B"
MG502	.004	.004
MG506	.004	.004
MG507	.004	.004
MG508	.004	.004
MG509	.004	.004
MG510A	.004	.004
MG512	.005	.004
MG513	.005	.004
MG514	.005	.004
MG518	.005	.004
MG520	.005	.004
MG521	.005	.004
MG527	.006	.004
MG-530	.0065	.0045
MG540	.0065	.0045

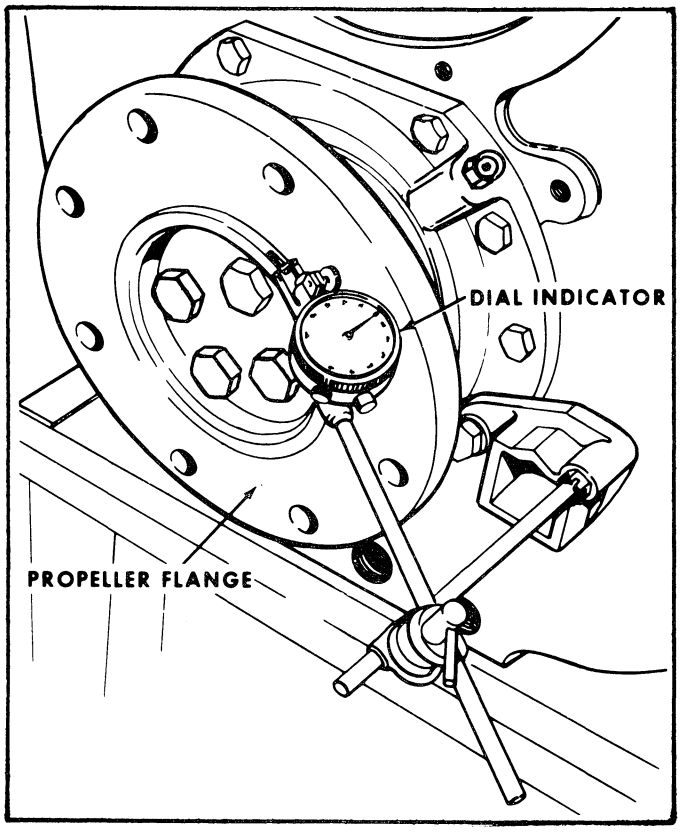
Runouts shown are total indicator readings.

NOTE

Any new transmission which is modified after shipment from Twin Disc (i.e. ratio change) should have face and pilots checked after modification.



FACE RUNOUT "A"



PILOT RUNOUT "B"

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

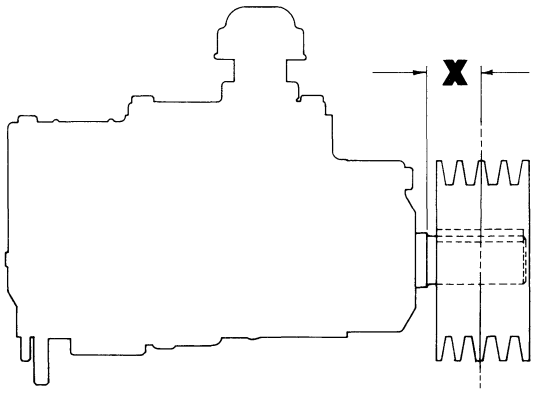
Each of the top PTOs listed has the same capacity rating.

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.

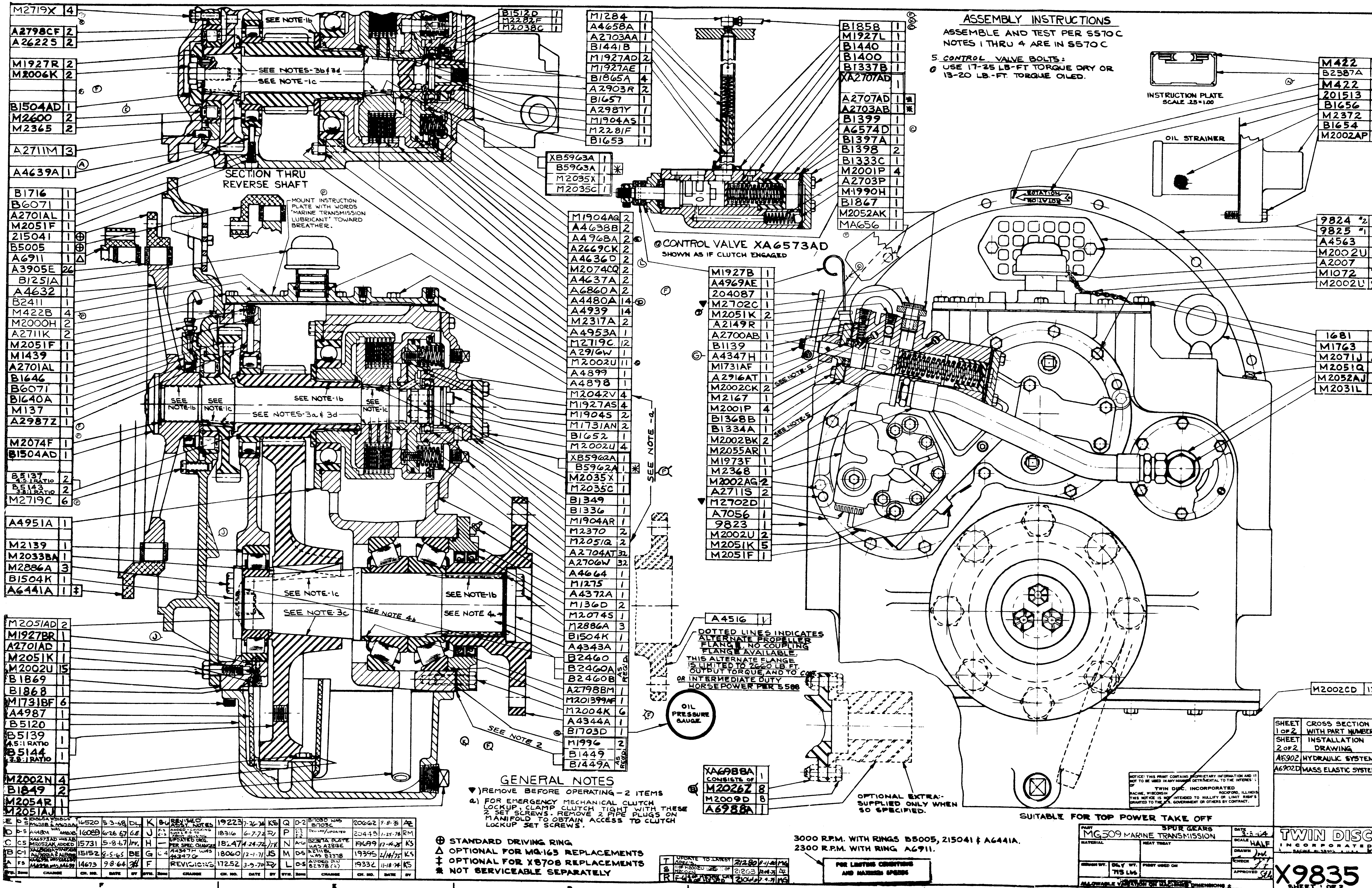
IMPROVED FACED CLUTCH PLATE FOR TOP PTO'S

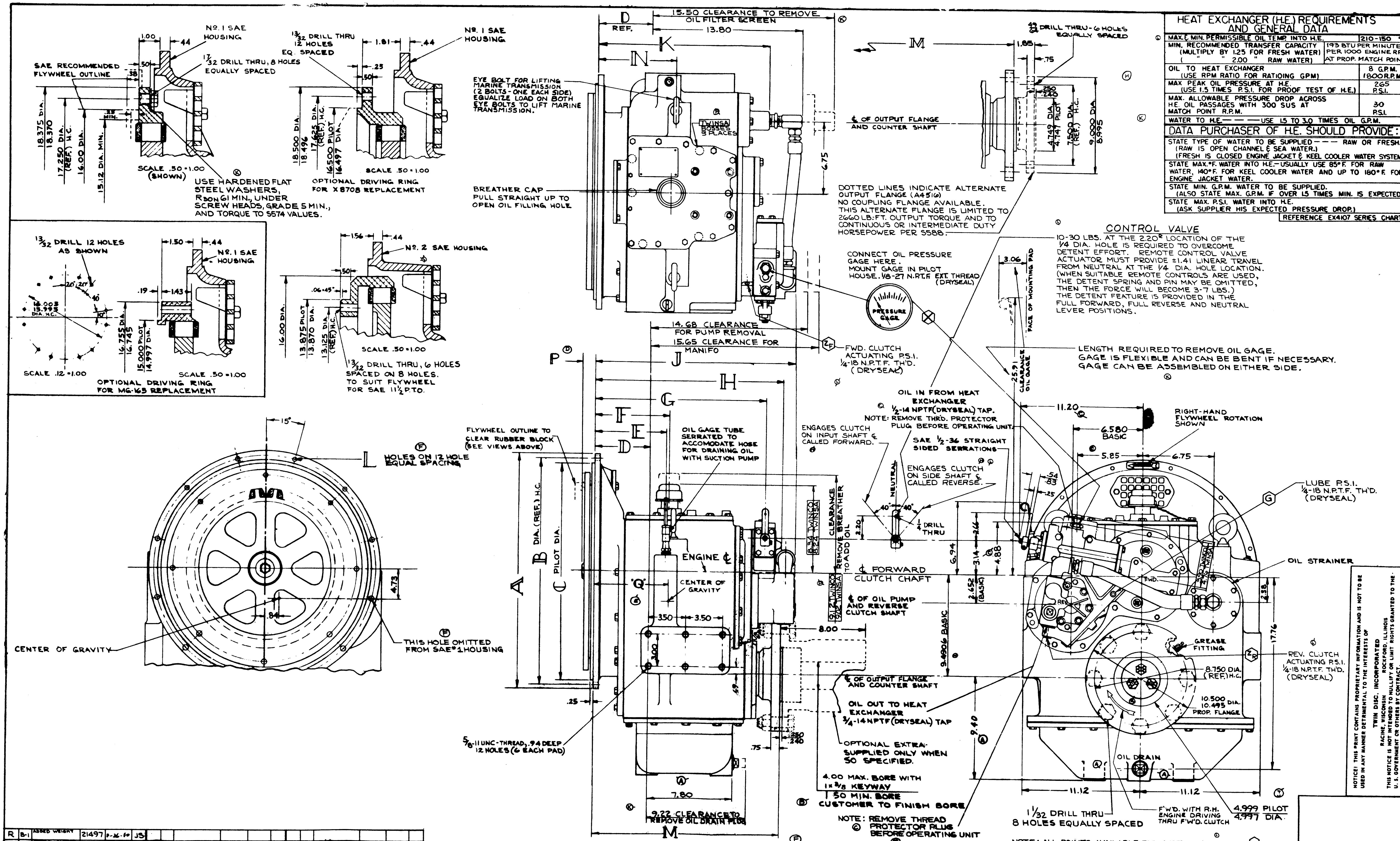
An improved clutch plate is available for the following mechanical top PTO's: X-9807, X-9807-A, X-9804, X-9804-A and X-9804-B.

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.


ASSEMBLY INSTRUCTIONS
ASSEMBLE AND TEST PER S570C
NOTES 1 THRU 4 ARE IN S570C
5. CONTROL VALVE BOLTS:
USE 17-25 LB-FT TORQUE DRY OR 13-20 LB.-FT. TORQUE OILED.
INSTRUCTION PLATE SCALE .25=1.00
OIL STRAINER
ROTATION
SECTION THRU REVERSE SHAFT
MOUNT INSTRUCTION PLATE WITH WORDS "MARINE TRANSMISSION LUBRICANT" TOWARD BREATHER.
CONTROL VALVE XA6573AD
SHOWN AS IF CLUTCH ENGAGED
SEE NOTES-3b & 3d
SEE NOTE-1c
SEE NOTE-1b
SEE NOTES-3a & 3d
SEE NOTE-3c
SEE NOTE 4b
SEE NOTE 2
SEE NOTE-5
DOTTED LINES INDICATES ALTERNATE PROPELLER FLANGE. NO COUPLING FLANGE AVAILABLE.
THIS ALTERNATE FLANGE IS LIMITED TO 2660 LB.FT. OUTPUT TORQUE, AND TO CONT. OR INTERMEDIATE DUTY HORSEPOWER PER S588
OIL PRESSURE GAUGE
OPTIONAL EXTRA: SUPPLIED ONLY WHEN SO SPECIFIED.
SUITABLE FOR TOP POWER TAKE OFF
GENERAL NOTES
▼) REMOVE BEFORE OPERATING – 2 ITEMS
a) FOR EMERGENCY MECHANICAL CLUTCH LOCKUP, CLAMP CLUTCH TIGHT WITH THESE 2 SET SCREWS. REMOVE 2 PIPE PLUGS ON MANIFOLD TO OBTAIN ACCESS TO CLUTCH LOCKUP SET SCREWS.
⊕ STANDARD DRIVING RING
△ OPTIONAL FOR MG-163 REPLACEMENTS
‡ OPTIONAL FOR X8708 REPLACEMENTS
✱ NOT SERVICEABLE SEPARATELY
3000 R.P.M. WITH RINGS B5005, 215041 & A6441A.
2300 R.P.M. WITH RING A6911.
FOR LIMITING CONDITIONS AND MAXIMUM SPEEDS
SHEET 1 OF 2 CROSS SECTION WITH PART NUMBERS
SHEET 2 OF 2 INSTALLATION DRAWING
A6902 HYDRAULIC SYSTEM
A6902D MASS ELASTIC SYSTEM
TWIN DISC, INCORPORATED RACINE, WISCONSIN ROCKFORD, ILLINOIS
SPUR GEARS
MG509 MARINE TRANSMISSION
SCALE HALF
715 Lbs
TWIN DISC INCORPORATED RACINE, WIS. U.S.A.
X9835
SHEET 1 OF 2



No. 1 SAE HOUSING
SAE RECOMMENDED FLYWHEEL OUTLINE
17/32 DRILL THRU, 8 HOLES EQUALLY SPACED
SCALE .50 = 1.00 (SHOWN)
USE HARDENED FLAT STEEL WASHERS, R30N 61 MIN., UNDER SCREW HEADS, GRADE 5 MIN., AND TORQUE TO S574 VALUES.
13/32 DRILL THRU 12 HOLES EQ. SPACED
OPTIONAL DRIVING RING FOR X8708 REPLACEMENT
SCALE .50 = 1.00
13/32 DRILL 12 HOLES AS SHOWN
SCALE .12 = 1.00
OPTIONAL DRIVING RING FOR MG-165 REPLACEMENT
No. 2 SAE HOUSING
13/32 DRILL THRU, 6 HOLES SPACED ON 8 HOLES. TO SUIT FLYWHEEL FOR SAE 11 1/2 P.T.O.
15.50 CLEARANCE TO REMOVE OIL FILTER SCREEN
EYE BOLT FOR LIFTING MARINE TRANSMISSION (2 BOLTS - ONE EACH SIDE) EQUALIZE LOAD ON BOTH EYE BOLTS TO LIFT MARINE TRANSMISSION.
TWINSA BOSSES 3 PLACES
BREATHER CAP PULL STRAIGHT UP TO OPEN OIL FILLING HOLE
℄ OF OUTPUT FLANGE AND COUNTER SHAFT
13/64 DRILL THRU - 6 HOLES EQUALLY SPACED
DOTTED LINES INDICATE ALTERNATE OUTPUT FLANGE (A4516) NO COUPLING FLANGE AVAILABLE. THIS ALTERNATE FLANGE IS LIMITED TO 2660 LB.FT. OUTPUT TORQUE AND TO CONTINUOUS OR INTERMEDIATE DUTY HORSEPOWER PER S588.
CONNECT OIL PRESSURE GAGE HERE. MOUNT GAGE IN PILOT HOUSE. 1/8-27 N.P.T.F. EXT. THREAD (DRYSEAL)
PRESSURE GAGE
14.68 CLEARANCE FOR PUMP REMOVAL
15.65 CLEARANCE FOR MANIFO
FWD. CLUTCH ACTUATING P.S.I. 1/4-18 N.P.T.F. TH'D. (DRYSEAL)
CONTROL VALVE
10-30 LBS. AT THE 2.20R LOCATION OF THE 1/4 DIA. HOLE IS REQUIRED TO OVERCOME DETENT EFFORT. REMOTE CONTROL VALVE ACTUATOR MUST PROVIDE ±1.41 LINEAR TRAVEL FROM NEUTRAL AT THE 1/4 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.
FACE OF MOUNTING PAD
LENGTH REQUIRED TO REMOVE OIL GAGE. GAGE IS FLEXIBLE AND CAN BE BENT IF NECESSARY. GAGE CAN BE ASSEMBLED ON EITHER SIDE.
OIL IN FROM HEAT EXCHANGER 1/2-14 NPTF (DRYSEAL) TAP.
NOTE: REMOVE THRD. PROTECTOR PLUG BEFORE OPERATING UNIT.
ENGAGES CLUTCH ON INPUT SHAFT ℄ CALLED FORWARD.
SAE 1/2-36 STRAIGHT SIDED SERRATIONS
ENGAGES CLUTCH ON SIDE SHAFT ℄ CALLED REVERSE.
NEUTRAL
1/4 DRILL THRU
RIGHT-HAND FLYWHEEL ROTATION SHOWN
6.580 BASIC
LUBE P.S.I. 1/4-18 N.P.T.F. TH'D. (DRYSEAL)
OIL STRAINER
FLYWHEEL OUTLINE TO CLEAR RUBBER BLOCK (SEE VIEWS ABOVE)
OIL GAGE TUBE SERRATED TO ACCOMODATE HOSE FOR DRAINING OIL WITH SUCTION PUMP
HOLES ON 12 HOLE EQUAL SPACING
ENGINE ℄
CENTER OF GRAVITY
℄ FORWARD CLUTCH SHAFT
℄ OF OIL PUMP AND REVERSE CLUTCH SHAFT
CLEARANCE REMOVE BREATHER TO ADD OIL
THIS HOLE OMITTED FROM SAE #1 HOUSING
GREASE FITTING
REV. CLUTCH ACTUATING P.S.I. 1/4-18 N.P.T.F. TH'D. (DRYSEAL)
8.750 DIA. (REF.) H.C.
10.500 10.495 DIA. PROP. FLANGE
℄ OF OUTPUT FLANGE AND COUNTER SHAFT
OIL OUT TO HEAT EXCHANGER 3/4-14 NPTF (DRYSEAL) TAP
OPTIONAL EXTRA-SUPPLIED ONLY WHEN SO SPECIFIED.
4.00 MAX. BORE WITH 1 x 3/8 KEYWAY
1.50 MIN. BORE
CUSTOMER TO FINISH BORE
5/8-11 UNC-THREAD, .94 DEEP 12 HOLES (6 EACH PAD)
9.22 CLEARANCE TO REMOVE OIL DRAIN PLUG
OIL DRAIN
1 1/32 DRILL THRU - 8 HOLES EQUALLY SPACED
F'WD. WITH R.H. ENGINE DRIVING THRU F'WD. CLUTCH
4.999 4.997 PILOT DIA.
NOTE: REMOVE THREAD PROTECTOR PLUG BEFORE OPERATING UNIT
NOTE: ALL POINTS AVAILABLE FOR TESTING ARE CODED

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)	193 BTU PER MINUTE PER 1000 ENGINE RPM AT PROP. MATCH POINT
OIL TO HEAT EXCHANGER (USE RPM RATIO FOR RATIOING GPM)	8 G.P.M. AT 1800 R.P.M.
MAX PEAK OIL PRESSURE AT H.E. (USE 1.5 TIMES P.S.I. FOR PROOF TEST OF H.E.)	265 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.

SAE HOUSING	A	B	C	D	E	F	G	H	J	K	L	M	N	P	Q
No. 1	21.75	20.87	20.125 20.120	5.00	6.60	6.88	15.77	17.39	18.62	16.10	11-15/32 DRILL THRU	17.38	7.25	1.06	8.22
No. 2	19.25	18.38	17.625 17.620	5.90	7.50	7.78	16.67	18.29	19.52	17.00	12-13/32 DRILL THRU	18.28	8.15	.16	9.12

SUITABLE FOR TOP POWER TAKE OFF

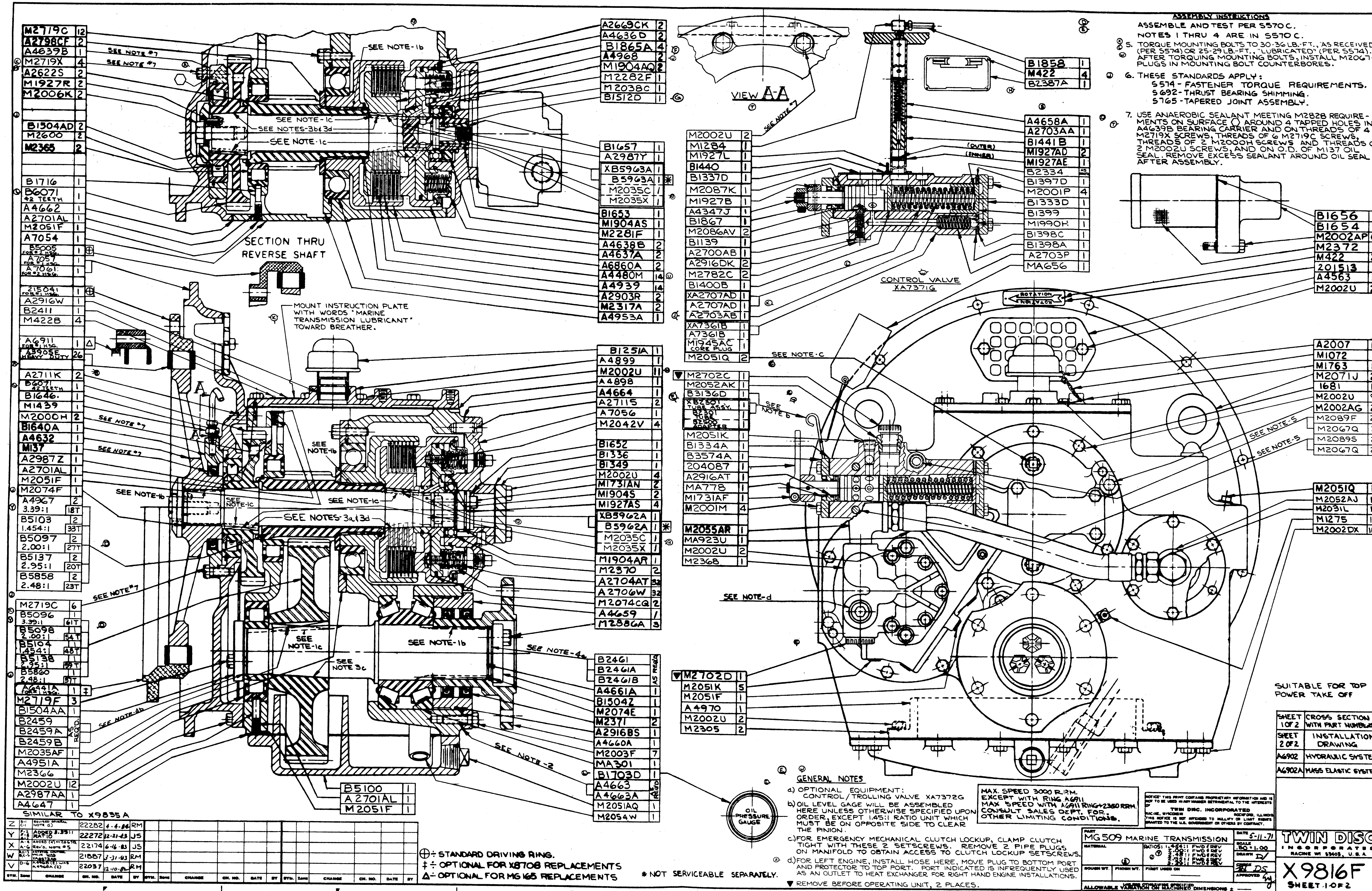
SYM.	ZONE	CHANGE	CH. NO.	DATE	BY	SYM.	ZONE	CHANGE	CH. NO.	DATE	BY	SYM.	ZONE	CHANGE	CH. NO.	DATE	BY
R	B-1	ADDED WEIGHT	21497	8-26-80	JS												
E	C1 B3	[illegible] SHEET.	16600	7-16-68	GE	K	—	REVISED H.E. DATA NOTES & DIM'S	19573	8-5-75	R.K.	Q	B-2	[illegible]	21280	8-11-80	MG
D	B-4	COLUMN "P" ADDED [illegible]	16404	2-12-68	RK	J	A-5	ADDED NOTE TO H.E. BLOCK	19298	4-26-7?	KS	P	C-3 C-5	ADDED TWINSA BOSSES & DIM'S.	21357	3-28-80	KS
C	B3	[illegible]	15731	5-8-67	JMK	H	A-6	REVISED H.E. REQUIREMENTS	19223	2-26-7?	KS	N	C-4	ENGAGES CLUTCH NOTES, REVISED	21205	10-16-79	MG
B	C1	1.50 MIN. BORE WAS 2.50	15152	8-5-65	BE	G	B-1	REVISED OIL CAPACITY NOTE	19171	6-5-74	JN	M	[illegible]	DIM'S, AND NOTES REVISED	20912	8-22-79	MG
A	AB1 CD1	ADDED 2" SQ. [illegible] 9.40 WAS 9.27	14750	11-11-64	GE	F	D-2	REVISED HOLE SPACING	18514	11-21-72	R.K.	L	[illegible]	[illegible] UPDATED	20448	1-25-78	RM

MG 509 MARINE TRANSMISSION

TWIN DISC INCORPORATED RACINE, WIS.

X9835

SHEET 2 OF 2



ASSEMBLY INSTRUCTIONS

ASSEMBLE AND TEST PER S570C.

NOTES 1 THRU 4 ARE IN S570C.

5. TORQUE MOUNTING BOLTS TO 30-36 LB.-FT., "AS RECEIVED" (PER S574) OR 25-29 LB.-FT., "LUBRICATED" (PER S574). AFTER TORQUING MOUNTING BOLTS, INSTALL M2067Q PLUGS IN MOUNTING BOLT COUNTERBORES.

6. THESE STANDARDS APPLY:
S514 - FASTENER TORQUE REQUIREMENTS.
S692 - THRUST BEARING SHIMMING.
S765 - TAPERED JOINT ASSEMBLY.

7. USE ANAEROBIC SEALANT MEETING M2828 REQUIREMENTS ON SURFACE AROUND 4 TAPPED HOLES IN A4639B BEARING CARRIER AND ON THREADS OF 4 M2719X SCREWS, THREADS OF 6 M2719C SCREWS, THREADS OF 2 M2000H SCREWS AND THREADS OF 2 M2002U SCREWS, AND ON O.D. OF M137 OIL SEAL. REMOVE EXCESS SEALANT AROUND OIL SEAL AFTER ASSEMBLY.

GENERAL NOTES

a) OPTIONAL EQUIPMENT: CONTROL/TROLLING VALVE XA7372G

b) OIL LEVEL GAGE WILL BE ASSEMBLED HERE UNLESS OTHERWISE SPECIFIED UPON ORDER, EXCEPT 1.45:1 RATIO UNIT WHICH MUST BE ON OPPOSITE SIDE TO CLEAR THE PINION.

c) FOR EMERGENCY MECHANICAL CLUTCH LOCKUP, CLAMP CLUTCH TIGHT WITH THESE 2 SETSCREWS. REMOVE 2 PIPE PLUGS ON MANIFOLD TO OBTAIN ACCESS TO CLUTCH LOCKUP SETSCREWS.

d) FOR LEFT ENGINE, INSTALL HOSE HERE, MOVE PLUG TO BOTTOM PORT AND PROTECTOR TO TOP PORT. PORT INDICATED IS INFREQUENTLY USED AS AN OUTLET TO HEAT EXCHANGER FOR RIGHT HAND ENGINE INSTALLATIONS.

▼ REMOVE BEFORE OPERATING UNIT, 2 PLACES.

MAX. SPEED 3000 R.P.M. EXCEPT WITH RING A6911. MAX SPEED WITH A6911 RING = 2350 R.P.M. CONSULT SALES DEPT. FOR OTHER LIMITING CONDITIONS.

⊕ ÷ STANDARD DRIVING RING.
‡ ÷ OPTIONAL FOR X8708 REPLACEMENTS
Δ ÷ OPTIONAL FOR MG165 REPLACEMENTS

* NOT SERVICEABLE SEPARATELY.

SHEET 1 OF 2	CROSS SECTION WITH PART NUMBERS
SHEET 2 OF 2	INSTALLATION DRAWING
A6902	HYDRAULIC SYSTEM
A6902A	MASS ELASTIC SYSTEM

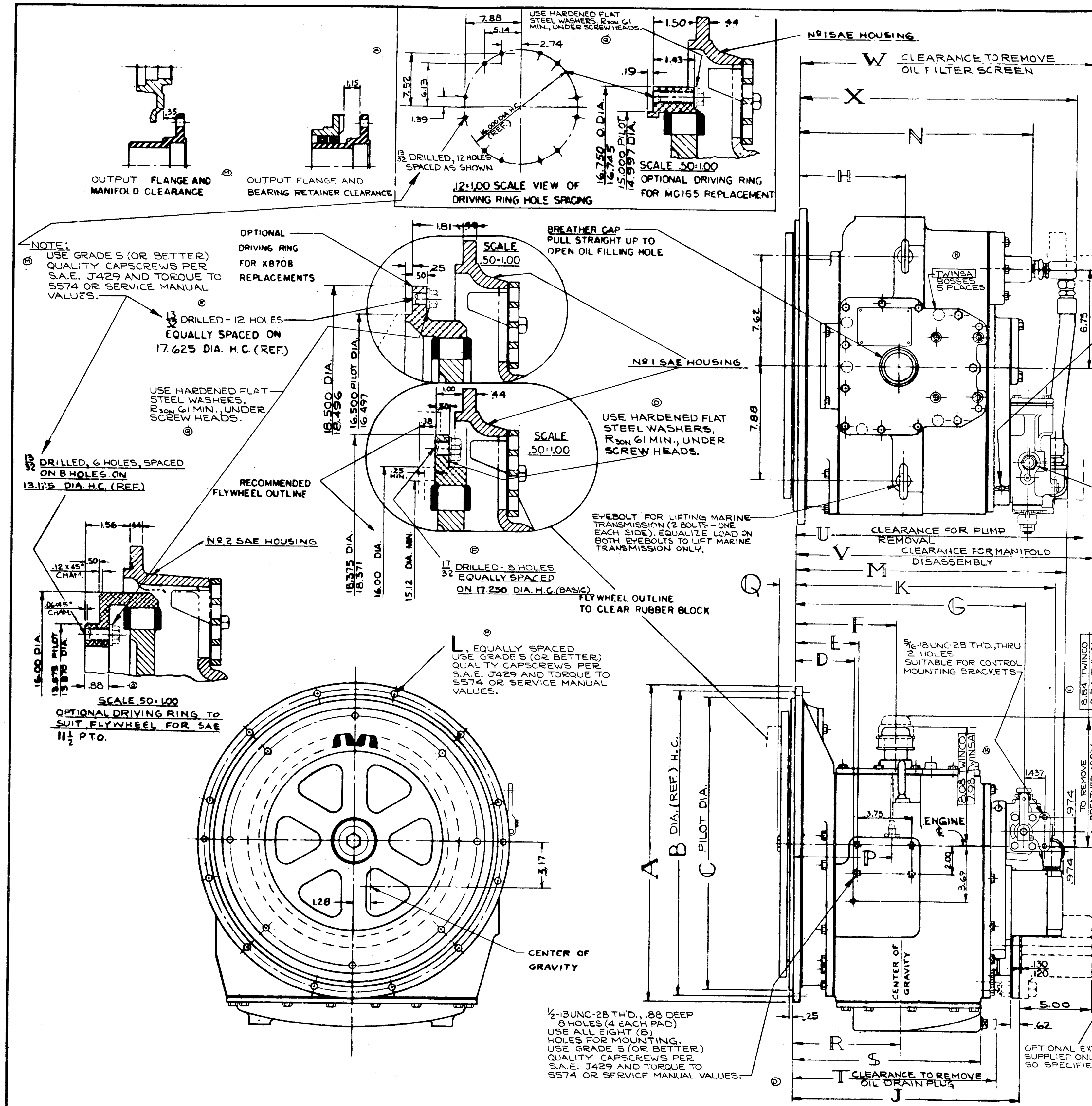
SYM.	ZONE	CHANGE	CH. NO.	DATE	BY
Z		REVISED GENERAL NOTE d)	22282	4-4-86	RM
Y		ADDED 2.35:1 RATIO	22272	12-21-83	JS
X		ADDED ... REV'D. NOTE #5	22174	6-16-83	JS
W			21887	3-31-83	RM
V			22037	12-10-82	RM

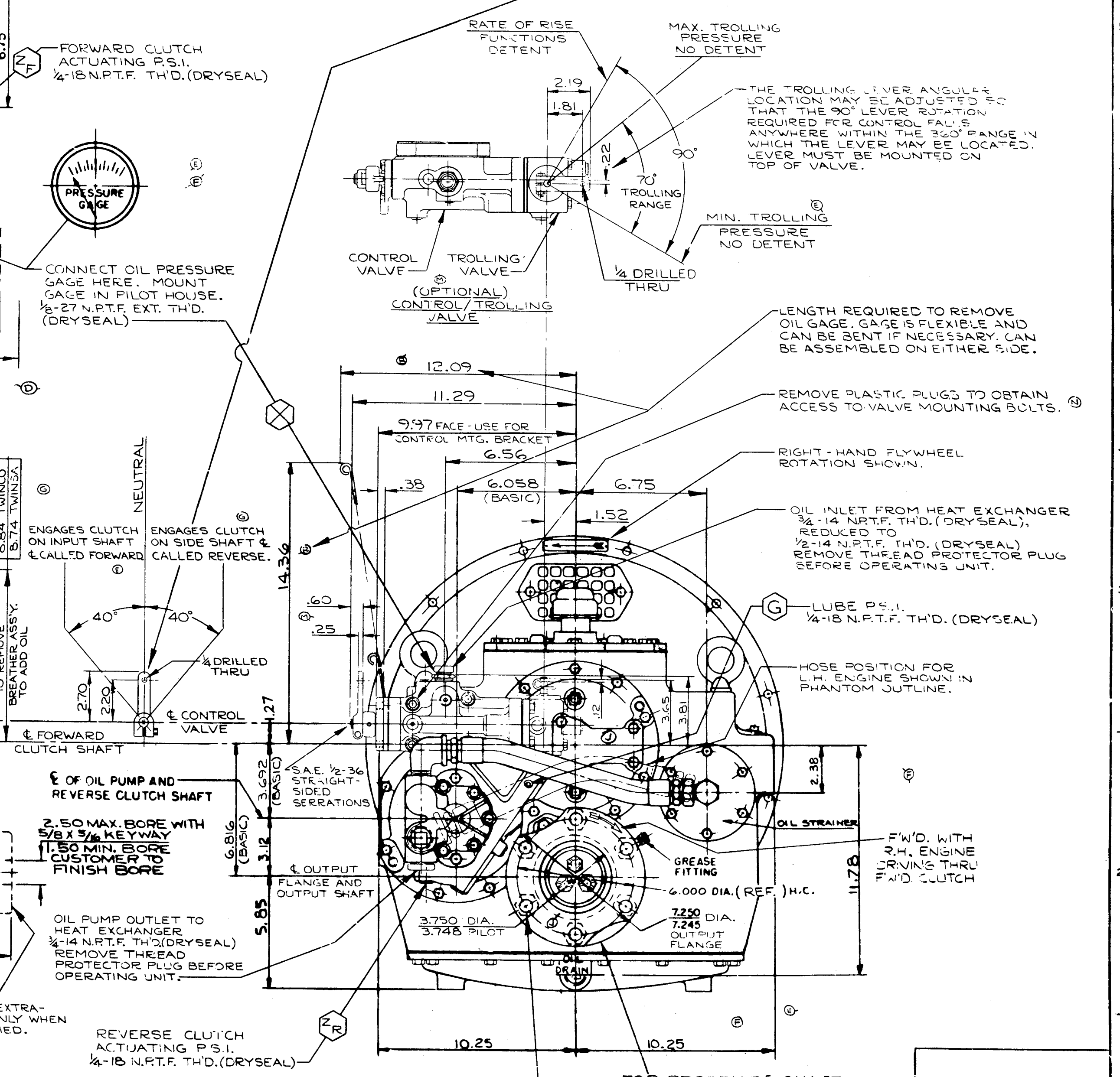
PART: MG 509 MARINE TRANSMISSION — DATE 5-11-71

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

X9816F

SHEET 1 OF 2





(OPTIONAL) TROLLING VALVE INSTALLATION AND OPERATING NOTES:

1.) REFER TO VALVE ASSEMBLY DRAWING FOR ADDITIONAL INSTALLATION NOTES. CONTROL HEAD FOR TROLLING VALVE MUST INCLUDE A DEVICE TO LOCK TROLLING VALVE CONTROL LEVER IN THE DETENTED NO-TROLL POSITION DURING MANEUVERING, DOCKING AND OTHER OPERATING CONDITIONS THAT REQUIRE FULL POWER TO THE PROPELLER.

2.) MAXIMUM ENGINE SPEED WHILE TROLLING, 1100 R.P.M. OR 60% OF FULL-LOAD ENGINE SPEED, WHICHEVER IS SMALLER.

3.) WITH CONTROL VALVE LEVER IN NEUTRAL, SELECT TROLLING FUNCTION BY MOVING TROLLING CONTROL LEVER OUT OF LOCKED DETENTED POSITION TO MAXIMUM TROLLING POSITION. SELECT TROLLING DIRECTION OF TRAVEL BY MOVING CONTROL VALVE LEVER TO FORWARD OR REVERSE. MOVE TROLLING CONTROL LEVER FROM MINIMUM TROLLING POSITION TO SELECT DESIRED TROLLING SPEED. WHEN TROLLING LEVER IS ADVANCED CLOSE TO DETENTED NO-TROLL POSITION, THE TROLLING CLUTCH MAY ENGAGE FULLY.

CONTROL VALVE

10-30 LBS. AT THE 2.20R LOCATION OF THE ¼ DIA. HOLE IS REQUIRED TO OVERCOME DETENT EFFORT. THE DETENT FEATURE IS PROVIDED IN THE FULL FORWARD, FULL REVERSE AND NEUTRAL LEVER POSITIONS (THE DETENT SPRING AND PIN MAY BE OMITTED WHEN REMOTE CONTROL SYSTEMS PROVIDE FORWARD, NEUTRAL AND REVERSE DETENTS THAT CORRESPOND EXACTLY WITH VALVE DETENT POSITIONS. FORCE AT THE LEVER HOLE TO OPERATE THE VALVE THEN REDUCES TO 3-7 LBS.). THE REMOTE CONTROL VALVE ACTUATOR MUST PROVIDE ±1.41 LINEAR TRAVEL FROM NEUTRAL AT THE ¼ DIA. HOLE LOCATION. ROTATIONAL STOPS AT THE STATED VALUE TRAVEL LIMITS HAVE A MAXIMUM CAPACITY OF 100 LBS. AT THE ¼ DIA. HOLE LOCATION. VALVE ACTUATORS WITH FORCE CAPABILITY EXCEEDING THIS LIMIT MUST HAVE SEPARATE STOPPING DEVICES SO CAPACITY OF THE VALVE ROTATIONAL STOPS IS NOT EXCEEDED. EXCEEDING THE CAPACITY OF THE VALVE ROTATIONAL STOPS CAN CAUSE LOSS OF CONTROL.

HEAT EXCHANGER (H.E.) REQUIREMENTS		
PERMISSIBLE OIL TEMPERATURE INTO H.E.	210°F. MAX.	150°F. MIN.
MIN. HEAT TRANSFER CAPACITY (MULTIPLY BY 1.25 FOR FRESH AND 2.0 FOR RAW WATER H.E.)	BTU PER MIN. PER ENGINE RTD. H.P. CONTINUOUS DUTY 1.484	P.C. & INT. DUTY 1.272
APPROX. OIL FLOW TO H.E.	.444 G.P.M. PER 100 ENGINE R.P.M.	
PEAK OIL PRESSURE AT H.E. (PROOF TEST H.E. AT 1.5 x P.S.I.)	265 P.S.I.	
MAX. ALLOWABLE OIL PRESSURE DROP ACROSS H.E. WITH 300 SUS OIL AT RATED ENGINE RPM	30 P.S.I.	
WATER FLOW TO H.E. - USE 1.5 TO 3.0 TIMES OIL G.P.M.		
H.E. WATER PRESSURE RATING, MIN., = 1.5 x H.E. INLET WATER P.S.I.		
DATA H.E. PURCHASER MUST ALSO TELL VENDOR		
STATE IF RAW (OPEN CHANNEL & SEA) OR FRESH (CLOSED ENGINE JACKET & KEEL COOLER) WATER WILL COOL H.E.		
STATE MAX. WATER TEMP. INTO H.E. -- TYPICAL -- RAW WATER - 85°F, KEEL COOLER WATER - 140°F, ENGINE JACKET WATER - 180°F.		
STATE MIN., ALSO MAX. G.P.M. OF WATER FLOW TO H.E.		
H.E. INSTALLATION & SERVICE REQUIREMENTS		
OIL LINES, TRANSMISSION TO H.E. AND RETURN ---- (1) MAX. VELOCITY IN FITTINGS, PIPE, HOSE AND TUBES - 25 FT./SEC. (2) BURST PRESSURE, MIN., = 10 x PEAK OIL PRESSURE AT H.E. (3) HOSE - SAE J517 100R1 MEETING USCG 46CFR 56.60-25(C), 275°F. TEMP. RATING. (4) PROTECT LINES FROM MECHANICAL DAMAGE.		
ZINC ANODES PROTECT H.E. RAW WATER PASSAGES FROM CORROSION. CHECK & REPLACE THEM FREQUENTLY.	REF. EX4107 SERIES CHARTS	

S.A.E. HOUSING	A	B	C	D	E	F	G CONTROL VALVE	G CONTROL/TROLLING VALVE	H	J	K CONTROL VALVE	K CONTROL/TROLLING VALVE	L	M	N	P	Q	R
Nº 1	21.75	20.875	20.125 20.120	3.980	4.25	6.88	15.78	16.41	7.25	15.62	17.85	18.48	12 $\frac{15}{32}$	18.62	16.10	6.600	1.03	7.60
Nº 2	19.25	18.375	17.625 17.620	4.880	5.15	7.78	16.68	17.31	8.15	16.52	18.75	19.38	12 $\frac{13}{32}$	19.52	17.00	7.500	.13	8.50

S.A.E. HOUSING	S	T	U	V	W	X
Nº 1	12.83	14.10	19.66	20.65	20.50	18.80
Nº 2	13.73	15.00	20.56	21.55	21.40	19.70

$\frac{49}{64}$ DRILLED THRU 6 HOLES EQUALLY SPACED USE GRADE 5 (OR BETTER) QUALITY CAPSCREWS PER S.A.E. J429 AND TORQUE TO S574 OR SERVICE MANUAL VALUES.

FOR PROPELLER SHAFT COUPLING CLEARANCE DATA, SEE B3513.

NOTE:
ALL POINTS AVAILABLE FOR TESTING ARE CODED ⬡.

SUITABLE FOR TOP POWER TAKE OFF.

SIMILAR TO X9835A

SYM.	ZONE	CHANGE	CH. NO.	DATE	BY	SYM.	ZONE	CHANGE	CH. NO.	DATE	BY	SYM.	ZONE	CHANGE	CH. NO.	DATE	BY
E	A-1 A-3 E-3	REVISED/UPDATED	20448	1-25-78	RM	K	A-1	ADDED GEAR RATIOS TO TITLE BLOCK	21497	8-26-80	JS	Q	E-6 F-3,4	ADDED .88 DIM., HARDENED WASHER NOTES	22316	3-27-84	JS
D	—	REVISED H.E. DATA NOTES & DIM'S.	19573	8-5-75	R.K	J	B-1	PICTORIALLY REVISED TO SHOW PLACE HD. SCREWS	21280	8-11-80	MG	P	A-1	ADDED 3.39:1 RATIO	22272	12-21-82	JS
C	A-5	ADDED NOTE TO H.E. BLOCK	19298	9-20-74	KS	H	C-3 C-4	ADDED TWINSA BOSSES & DIM'S.	21357	3-28-80	KS	N	A-4 A-6	ADDED NOTE REV'D. H.E. DATA	22174	6-16-83	JS
B	B-3	12.09 WAS 14.09 14.36 WAS 19.72	19223	7-26-74	KS	G	C-3	ENGAGES CLUTCH NOTES REVISED	21205	10-16-79	MG	M	B-2,3, -4 C8-6	XA7175G VALVE WAS XA6573O - ADDED NOTES	21887	3-31-83	RM
A	B-1	REVISED OIL CAPACITY NOTE	19171	6-5-74	JN	F	C-6 B-4,5 C-6	REVISED NOTES AND DIM'S.	20662	9-8-78	AZ	L	B-5	REVISED CONTROL VALVE NOTE	21941	4-28-82	KS

FORM 1900 126M3

PART: MG 509 MARINE TRANSMISSION	DATE: 5-11-71
MATERIAL:	SCALE: .25=1.00
GEAR RATIOS: 1.454:1, 2.00:1, 2.95:1, 3.39:1 FORWARD & REVERSE	DRAWN:
ROUGH WT.: — FINISH WT.: 538 APPROX. FIRST USED ON:	CHECK: DS
UNLESS OTHERWISE SPECIFIED ALLOWABLE VARIATION ON MACHINED DIMENSIONS ± —	APPROVED:

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

X9816F
SHEET 2 OF 2

1015793

TWIN DISC, INCORPORATED RACINE, WISCONSIN 53403, U.S.A. 262-638-4000/262-638-4482 (FAX) WWW.TWINDISC.COM