

**Series 5000  
Marine Transmission  
Service Manual  
AND  
Series 5000 V-drive  
Marine Transmission  
Service Manual  
Supplement**

***Velvet Drive***<sup>®</sup>  
TRANSMISSIONS

Division of Regal-Beloit Corporation

P.O. Box 238 1208 Old Norris Road Liberty, SC 29657

Phone (864) 843-9234 Fax (864) 843-1276

[www.velvetdrive.com](http://www.velvetdrive.com)



# Section 1

## Introduction and Description

### 1-1. INTRODUCTION

**1-2. PURPOSE.** This manual contains maintenance, service and parts information for the Series 5000 Velvet Drive® Marine Transmission (see figure 1-1).

**1-3. SCOPE.** This manual provides information for maintenance, troubleshooting, removal, disassembly, cleaning, inspection, repair or replacement, assembly and installation of the transmission.

**1-4.** Section P contains an illustrated parts list. The arrangement of the exploded view illustrations is described in the introduction to Section P. Each detailed part shown in the exploded views is assigned

an index number. This same index number is used to identify the part throughout this manual. For example, index number 27 (in parentheses in the text) refers to the output shaft regardless of the manual section or the specific transmission being serviced.

**1-5.** The exploded view illustrations in Section P make it possible to view the complete assembly and major subassemblies, in addition to the illustrations, in the service sections relating to a specific service procedure.

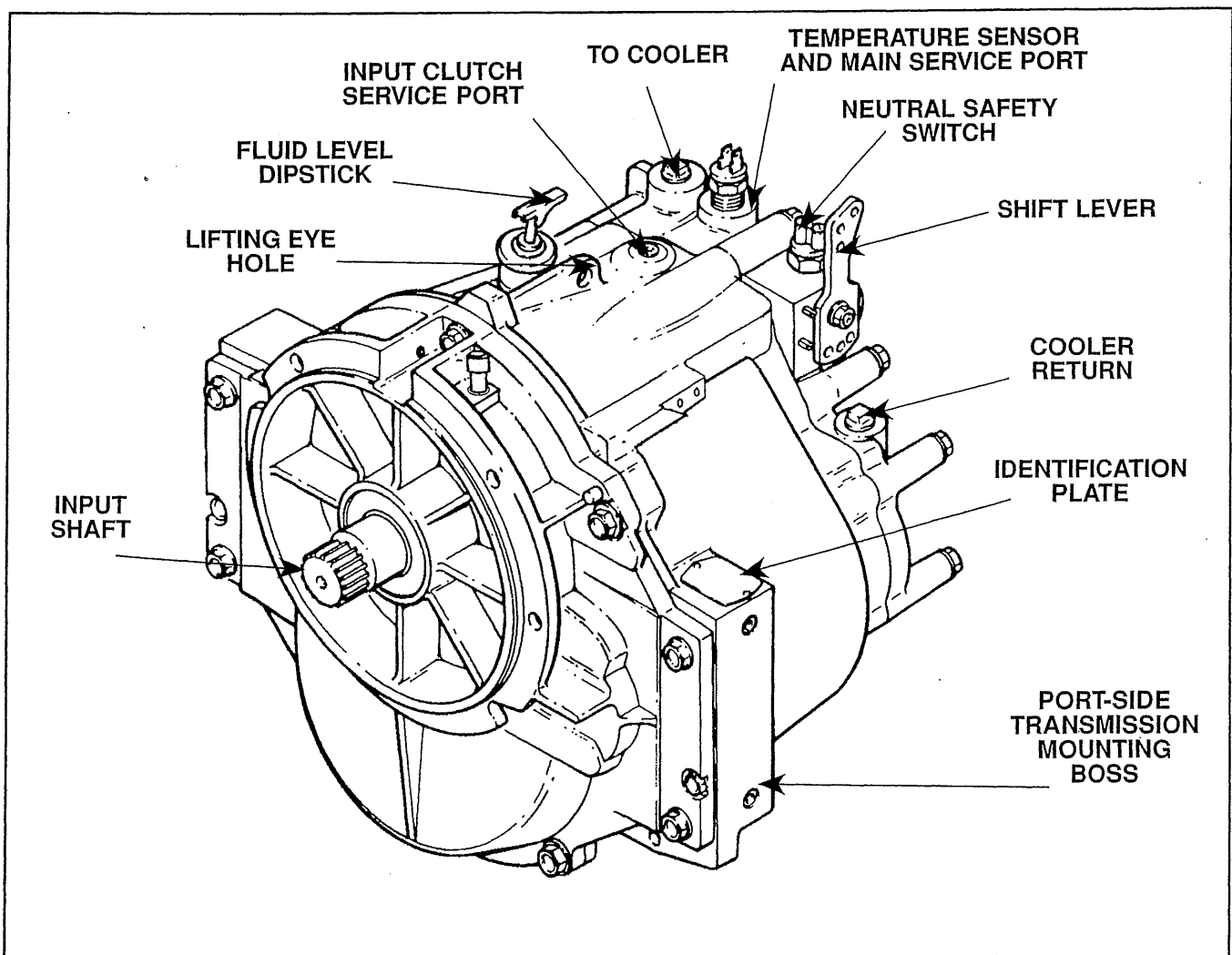


Figure 1-1. 5000 Series Marine Transmission

# TRANSMISSION POWER FLOW

NEUTRAL

INPUT SHAFT CLUTCH

INPUT SHAFT ASSEMBLY

VIEW FROM FRONT

VIEW FROM REAR

LAY SHAFT CLUTCH

VIEW "A"

INPUT CLUTCH ENGAGED  
TURNS R.H. PROPELLER  
FOR FORWARD  
BOAT MOTION

INPUT SHAFT CLUTCH

INPUT SHAFT ASSEMBLY

VIEW FROM FRONT

VIEW FROM REAR

LAY SHAFT CLUTCH

OUTPUT SHAFT ASSEMBLY

LAY SHAFT CLUTCH GEAR

VIEW "B"

LAY SHAFT CLUTCH ENGAGED  
TURNS L.H. PROPELLER  
FOR FORWARD  
BOAT MOTION

INPUT SHAFT CLUTCH GEAR

INPUT SHAFT ASSEMBLY

VIEW FROM FRONT

VIEW FROM REAR

OUTPUT SHAFT ASSEMBLY

VIEW "C"

Figure 1-2. Series 5000 Transmission Operation



1-6. Section T lists special tools. These tools, or their equivalent are required for proper disassembly and assembly of the transmission.

1-7. **ABBREVIATIONS.** Abbreviations, other than those in common use, found in this manual are identified in Table 1-1.

**Table 1-1. Abbreviations**

AR	As Required
ASSY	Assembly
ID	Inside Diameter
NSS	Not Sold Separately
OD	Outside Diameter
PN	Part Number
QTY	Quantity
REF	Reference

**1-8. DESCRIPTION**

1-9. **GENERAL DESCRIPTION.** The Velvet Drive @Series 5000 is a single-speed, forward/reverse, hydraulic-shift transmission. The gear ratio varies from model to model and is listed in Table 1-2.

1-10. The input, lay and output shafts are supported by tapered roller bearings. Needle bearings are used between the shafts and clutch gears on the input and

lay shaft assemblies. Helical gearing is used throughout. The transmission has separate, multi-disc clutches for each direction of output shaft rotation.

1-11. **APPLICATION.** The Series 5000 is a drop center, 8 degree down-angle transmission, specifically designed for twin engine applications requiring nearly horizontal engine installation. It will operate only behind engines with counter clockwise rotation (viewed from flywheel end). This is commonly termed automotive rotation. The Series 5000 transmission's full reversing feature eliminates the need for opposite rotating engines. Thus, a right-hand or left-hand propeller can be used with an automotive rotation engine.

1-12. **DESCRIPTION OF OPERATION.** (See figure 1-2) The transmission input shaft and lay shaft assemblies are geared together and rotate in opposite directions when the engine is running. Each of these shaft assemblies has a hydraulic clutch that engages a clutch gear. Each clutch gear "floats" on needle bearings on its respective shaft and engages the output shaft assembly gear. As shown in view A, with the transmission in neutral and the engine running, the input and lay shaft assemblies rotate in opposite directions with the output shaft stationary. View B shows the power flow when the input shaft hydraulic clutch is engaged (refer to paragraph 1-13, step 2). Output shaft rotation is clockwise or opposite to the engine rotation. View C shows the power flow when the lay shaft hydraulic clutch is engaged (refer to paragraph 1-13, step 3). Output shaft rotation is counterclockwise or the same as engine rotation.

Table 1-2. General Specifications

ASSEMBLY No.	NOMINAL RATIO	ACTUAL RATIO	FLUID CAPACITY* QT/LITER	DRY WEIGHT LB/KG
2001-000-001, R01 & -011	1.00:1	1.054:1	2.01/1.90	100/45
2001-000-002, R02 & -012	1.25:1	1.303:1	2.01/1.90	100/45
2001-000-003, R03 & -013	1.50:1	1.586:1	2.01/1.90	100/45
2001-000-004, R04 & -014	2.00:1	2.040:1	2.01/1.90	100/45
2001-000-005, R05 & -015	2.50:1	2.454:1	2.01/1.90	100/45
2001-000-006, R06 & -016	2.80:1	2.800:1	2.01/1.90	100/45

\* Approximate, depending on angle of transmission installation, for transmission only. Capacity given does not include oil (fluid) cooler and connection lines.

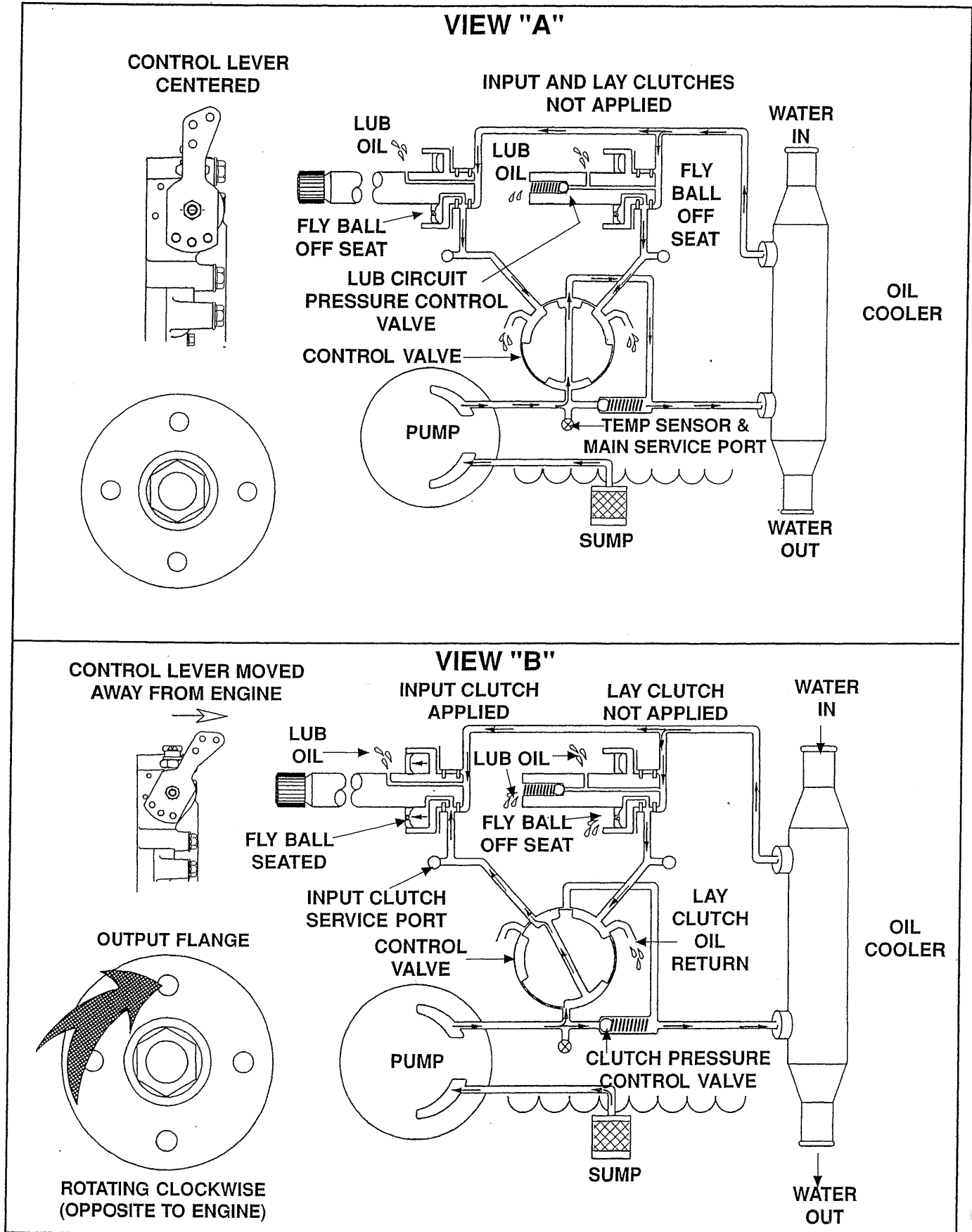
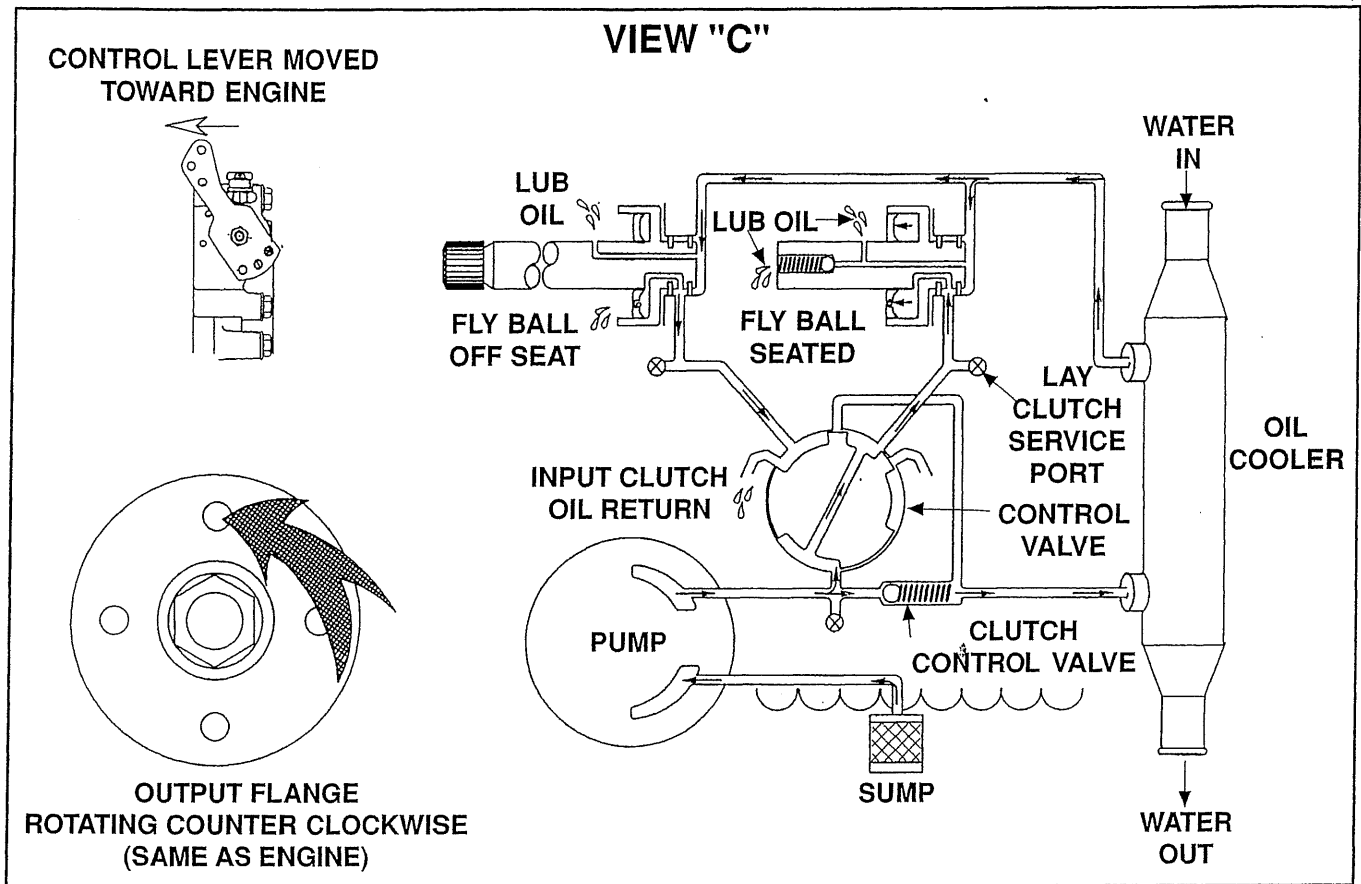


Figure 1-3. Hydraulic Clutch Operation



**1-13. DESCRIPTION OF HYDRAULIC SYSTEM OPERATION.** (See figure 1-3) The transmission hydraulic pump, driven by the input shaft assembly, delivers fluid to the full flow hydraulic system whenever the engine is running. All lubricating fluid must pass through the cooler before returning to the transmission lubrication system.



**CAUTION:** operating the transmission with the oil cooler disconnected, plugged or bypassed will cause immediate damage to the transmission.

1. When the shift lever is in the center position or neutral as shown in view A, fluid is drawn through the filter screen and flows directly to the cooler, bypassing the clutch pressure control valve. From the cooler, fluid returns to both the lay and input shaft assemblies, cooling the clutches and lubricating the bearings. A relief valve in the lay shaft assembly prevents excessive pressure build up in the lubrication circuit.

2. When the transmission shift lever is moved away from the engine as shown in view B, the

pressure control bypass circuit is interrupted, causing fluid to back up against the clutch pressure control valve. The increased fluid pressure is directed to the clutch piston on the input shaft assembly. Fluid pressure closes the fly-ball and moves the piston to engage the clutch plates. With the input shaft assembly clutch engaged, the output shaft turns clockwise, or the opposite direction as the engine.

3. When the transmission shift lever is moved toward the engine as shown in view C, the pressure control bypass circuit is interrupted causing fluid to back up against the clutch pressure control valve. The increased fluid pressure is directed to the clutch piston on the lay shaft assembly. Fluid pressure closes the fly-ball and moves the piston to engage the clutch plates. With the lay shaft assembly clutch engaged, the output shaft turns counterclockwise, or the same direction as the engine.

4. When either clutch is engaged, all fluid must flow past the pressure control valve. When the shift lever is returned to the center position and both clutches are released, fluid is allowed to vent back to the sump. In addition the fly-ball unseats permitting the clutch piston return springs to release the clutch faster.




# Section 2

## Maintenance, Troubleshooting, Removal and Installation

### 2-1. MAINTENANCE

**2-2. GENERAL** The periodic maintenance required for the Velvet Drive ® Series 5000 marine transmission is given in Table 2-1. Follow this schedule to ensure trouble-free operation and long service life.


**2-3. LUBRICATION SCHEDULE.** Refer to Table 2-1.


 **CAUTION: Temperatures in excess of 190°F (88°C) will break down the transmission fluid. If there are signs of burnt fluid or there are other reasons to believe that the transmission has overheated, change the fluid immediately.**


**2-4. APPROVED TRANSMISSION FLUID.** General Motors Dexron IIE or Dexron III fluids are recommended, but any of the following automatic transmission fluids are suitable for use in the 5000 transmission. However, do not mix different brands or types of transmission fluid. Approved specifications are:

1. General Motors Dexron IIE or Dexron III
2. Ford Mercon
3. Detroit Diesel Allison C4
4. Caterpillar TO-4
5. Daimler-Benz 236.6

**2-5. CHECKING TRANSMISSION FLUID LEVEL.** The transmission should be at operating temperature [Do not exceed 190°F (88°C) max] to get an accurate fluid level reading. The fluid will expand when heated and affect the level in the transmission. Any additions to the boat that will change the installed angle of the transmission at rest may require an oil level adjustment.

 **WARNING: Hot transmission fluid can cause burns.**

 **WARNING: Do not enter the engine compartment with the engine running.**

 **CAUTION: Transmission fluid may drain back into the transmission from the cooler and connecting lines after engine shutdown. Fluid level must be checked immediately after engine shutdown. Otherwise, the dipstick reading may not be accurate and transmission could be operated with insufficient fluid.**

**2-6. Warm Fluid Level Check.** With the engine at operating temperature, place the control lever in neutral and shut down the engine. Remove the dipstick (1) by holding the base and turning the T-handle counter clockwise (see figure 2-1) and wipe it clean. Insert the clean dipstick fully into the transmission, withdraw, and read the fluid level. Add or remove fluid as necessary to bring the fluid level to the full mark on the dipstick. Replace dipstick (1) and tighten by holding the base and turning the T-handle securely clockwise.

**2-7. Cold Fluid Level Check.** For ease of checking the fluid level prior to start-up, a cold fluid level mark can be made on the dipstick. First, make the warm fluid level check as described above and adjust the fluid level to the dipstick full mark. Shut down the engine and allow the transmission to cool overnight. With the transmission cold, check the fluid level and put a new cold full mark on the dipstick.

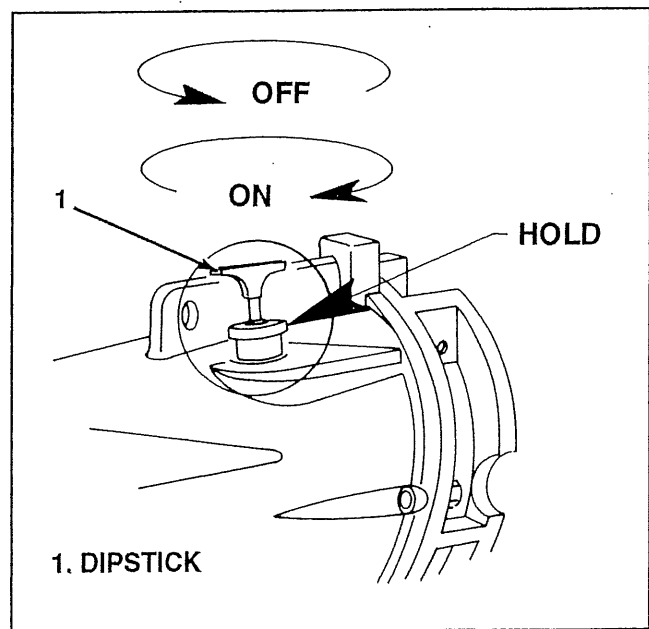





Figure 2-1. Dipstick Removal

 **WARNING: Frequent fluid loss indicates a system leak, even if there is no sign of transmission fluid in the bilge. As example, a defective cooler can allow transmission fluid to enter the engine's cooling system or to be returned overboard with the cooling water.**

**2-8. CHECKING TRANSMISSION FLUID CONDITION.** Whenever the transmission fluid level is checked or any time that there is evidence of transmission overheating, check the condition of the fluid. Remove the dipstick and check for evidence of water or other contaminants. Look for evidence of overheated fluid. The recommended Dexron fluid is normally bright red but will turn dark brown if overheated. Other acceptable fluids (refer to paragraph 2-4) are different in color but all will have a distinctive "burnt" smell if overheated. If there is any evidence of contaminated or overheated fluid, determine and correct the cause and replace the fluid (refer to paragraph 2-9)

**2-9. CHANGING TRANSMISSION FLUID.** A seasonal change of the transmission fluid is required for all pleasure boats. Work boats require transmission fluid change every 1000 hours. In addition, the transmission fluid must be changed any time it becomes overheated, contaminated, changes color, or becomes rancid smelling.

 **WARNING: Do not use gasoline or any other volatile or highly combustible liquid as a cleaning solvent when changing the transmission fluid.**

 **CAUTION: Do not, under any circumstances, start the engine with a cooler line disconnected or plugged.**

1. Place a suitable container near the oil (fluid) cooler return port (103) (see figure 2-2).
2. Remove both cooler lines from the transmission. Be careful to label them for proper return. Drain all fluid from the return line into the container, using moderate air pressure to empty lines. Reconnect the cooler return line and torque fittings to 25-35 lb-ft (34-47 Nm).
3. Remove the dipstick (1) as described in paragraph 2-6.
4. Place a suitable container under the transmission and remove the drain plug (2). Drain all fluid from the transmission and install the drain plug. Torque plug to 20-45 lb-ft (27-34 Nm)
5. Fill the transmission with the proper type (refer to paragraph 2-4) and quantity (determined by dipstick check) of transmission fluid.
6. Replace dipstick and check fluid level (refer to paragraph 2-5).

Table 2-1. Scheduled Maintenance.

MAINTENANCE	INTERVAL		
	WEEKLY	MONTHLY OR 100 HR	ANNUALLY OR 1000 HR
Check transmission fluid level. Add fluid to proper level if required (refer to paragraph 2-5).	X		
Remove dipstick and check transmission fluid for contaminants or overheating (refer to paragraph 2-8).	X		
Change transmission fluid (refer to paragraph 2-9).			X
Check control linkage and control lever for proper operation and adjustment (refer to paragraph 2-14). No sticking, binding or looseness is permitted.		X	
Check oil (fluid) cooler lines and connections for leakage or damage. Connections must be tight.	X	X	X
Check transmission for signs of fluid leakage (refer to paragraph 2-10).		X	X
Check that transmission cover and bell housing mounting bolts are tight. Torque to specifications (refer to table 5-1).			X

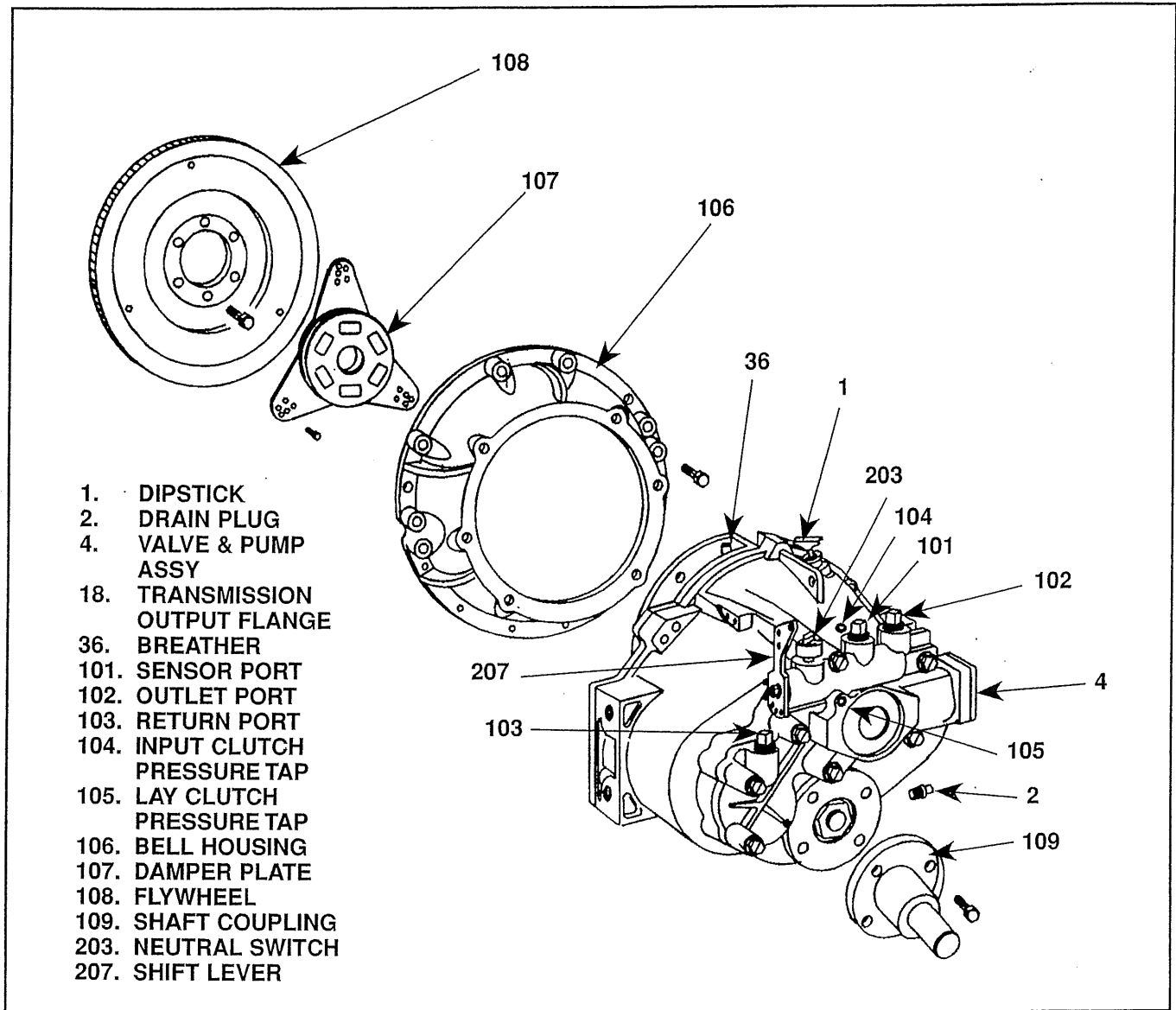


Figure 2-2. Transmission Installation

**2-10. LEAKAGE CHECK.** Since it is important to determine the source of a leak, a leakage check should be made before the transmission is removed from the boat. Dexron fluid leakage will show a red path leading back to the source. Fluid leaking from the valve and pump assembly (4) may be remedied without removing the transmission from the boat (refer to paragraph 2-19). Fluid leaking from the bottom of the bell housing (106) usually indicates a worn or damaged front transmission seal or engine rear seal. Sometimes leakage can be stopped by retorquing transmission bolts to specifications (except those secured with Loctite, refer to Table 5-1). If removal of the transmission is anticipated make note of tell-tale leakage path for future remedy.

## 2-11. TROUBLESHOOTING

**2-12. GENERAL.** In the event of operating difficulty, immediately note and record the symptoms and then shut down the transmission (engine) to prevent possible damage. Proper trouble diagnosis is the most essential part of repair. Without it, unnecessary repairs may be made without correcting the real problem. In some cases, as noted in the preceding paragraphs, useful diagnostic information can be obtained with the transmission installed in the boat. Other times it may be necessary to remove and disassemble, or partially disassemble, the transmission to accurately pinpoint the source of trouble. Specific inspection procedures for individual parts of the transmission are provided in Section 4.

Table 2-2. Troubleshooting Chart

PROBLEM	PROBABLE CAUSE	CORRECTION
No forward or reverse	<p>Low fluid level</p> <p>Low fluid pressure</p> <p>Broken input or output shaft</p> <p>Transmission shift lever incorrectly positioned</p> <p>Damaged shift linkage</p> <p>Cavitation of propeller</p> <p>Broken propeller</p>	<p>Fill to proper level</p> <p>Check pressure per paragraph 2-18. If necessary remove and repair transmission</p> <p>Remove and repair transmission</p> <p>Check for blocked cooler line</p> <p>Adjust shift linkage</p> <p>Repair shift linkage</p> <p>Use lower engine speed or change propeller</p> <p>Repair or replace propeller</p>
No neutral (engine may stall at idle)	<p>Forward or reverse clutch failure</p> <p>Shift linkage out of adjustment</p> <p>Clutch plates not releasing</p> <p>Slipping clutches</p>	<p>Remove and repair transmission</p> <p>Adjust shift linkage</p> <p>Remove and repair transmission</p> <p>Check and adjust control cable adjustment (refer to paragraph 2-14)</p> <p>Check and repair internal damage to clutch assemblies</p>
Transmission overheats	<p>Cooler oil or water flow restricted</p> <p>Cooler size too small for application</p> <p>Cooler hose size too restrictive</p> <p>Low fluid level</p>	<p>Reverse flush cooler and connecting lines. Replace components that cannot be cleaned out.</p> <p>Install larger cooler</p> <p>Install larger ID cooler hoses and fittings</p> <p>Fill to proper level</p>



Table 2-2. Troubleshooting Chart (Cont)

PROBLEM	PROBABLE CAUSE	CORRECTION
Overheated ("burned") fluid	Refer to "Transmission Overheats" above  Repeated overheating	Take corrective action as specified for "Transmission Overheats" plus replace transmission fluid.  Remove, disassemble and inspect transmission
Knocking noise that diminishes when RPM increases	Torsional vibration from improper or damaged damper plate (refer to paragraph 2-17)	Replace damper plate with one of correct design for the application
Other noise that can be isolated to transmission	Internal damage to transmission	Identify noise by type (squeal, grind, frequency, etc.) to aid in finding cause, remove, disassemble and inspect transmission

**2-13. TROUBLESHOOTING CHART.** Table 2-2 lists troubles which may be encountered along with possible causes and corrections.

**2-14. CONTROL CABLE CHECK AND ADJUSTMENT.** Check control cables for sticking or binding and for lost motion. Each cable must be free to move in its housing for its full length without binding. Any cable that sticks must be replaced. It may be possible to compensate for some lost motion by adjusting the bridge control head.

In the following instructions note that:

1. When a right-hand propeller is used, moving the transmission shift lever away from the engine will result in forward boat movement.
2. When a left-hand propeller is used, moving the transmission shift lever toward the engine will result in forward boat movement.

2-15. With the engine shut down, make cable adjustment as follows (see figure 2-3):

**NOTE:** Before the following steps, determine which hole the control cable is connected to, A, B, or C. The center hole is the one most commonly used. Stop to stop travel of the center hole (A, figure 2-3) is approximately 2-3/4 in. (70MM). Stop to stop travel for the outer hole (B) is 3 in. (76MM). Stop to stop travel for the inner hole (C:) is approximately 2-3/32in.(53MM).

1. Disconnect control cable from transmission shift lever (207).
2. Place bridge control lever (111) in central, neutral position.
3. Move transmission shift lever (207) to its central neutral position. Make sure lever detent ball is engaged.
4. Adjust cable ball socket (112) to align with proper hole in transmission shift lever (207). Once established, this setting should not need to be altered.

**NOTE:** In the following step, it may be necessary to back off the stops in the bridge control head. Refer to the bridge control head manual for instructions.

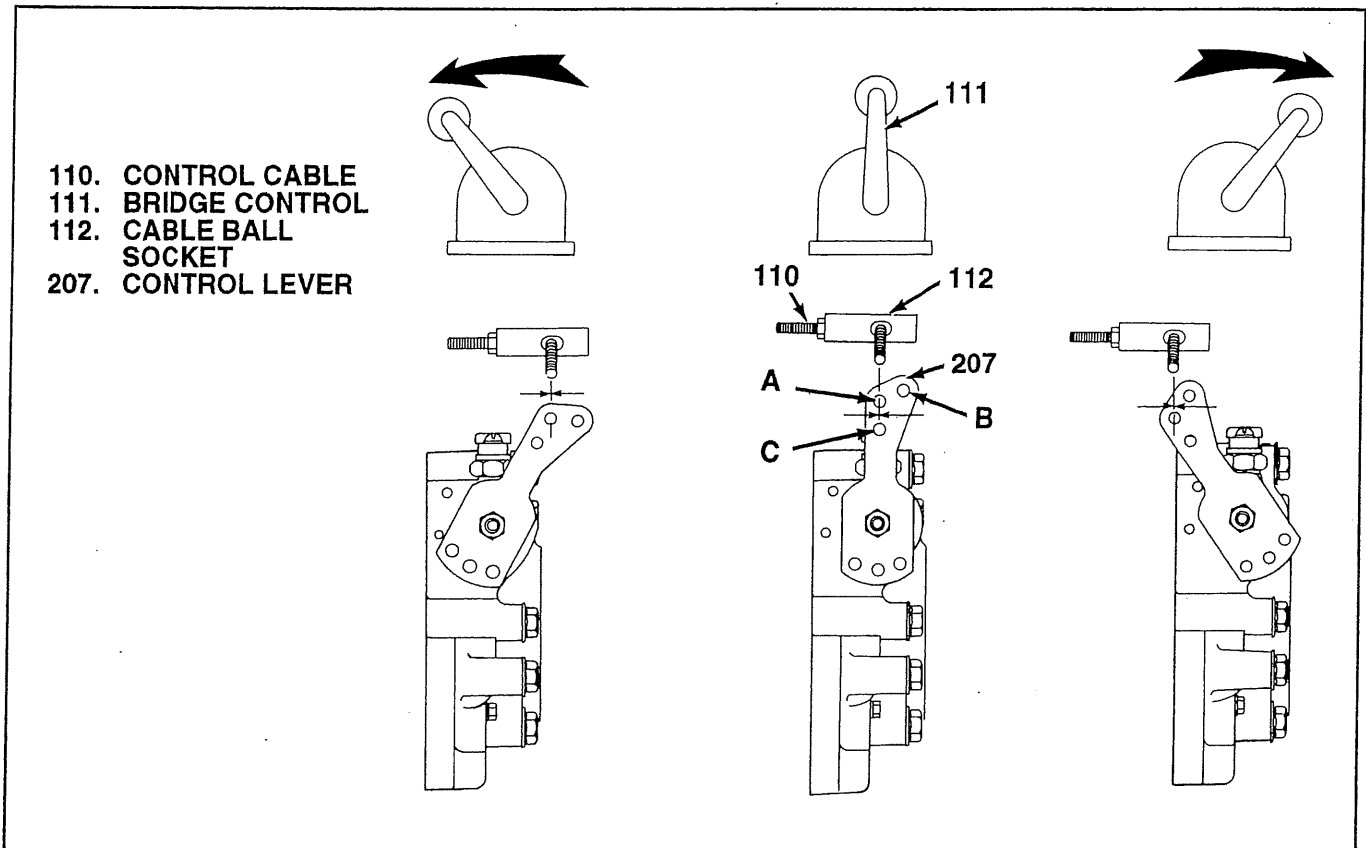


Figure 2-3. Control Cable Adjustment

5. Move bridge control lever (111) to its full forward stop position.

6. Position transmission shift lever (207) in its corresponding forward position, making sure detent ball is engaged.

7. Check that cable ball socket (112) aligns with same hole in transmission shift lever as used in step 4. If not, adjust bridge control.

8. Move bridge control lever (111) to its full reverse stop position and repeat steps 6 and 7.

9. Connect control cable to transmission shift lever (207). Move the bridge control lever (111) into each position and check that transmission shift lever moves into its proper detent, for each position.

**NOTE:** It may be necessary to readjust bridge control head slightly to get proper transmission shift lever positioning. If adjustment is not possible, replacement of worn cable may be required. Readjust control head stops as specified by control head manufacturer.

**NOTE:** For parallel connected stations, steps 1 through 9 above must first be performed independently. Then, both stations shall be connected together to ensure that each will function properly with the added resistance of the other. If reduced cable movement results, one or both cables may require replacement.

**NOTE:** If the two stations are connected in series (two stations connected together with one cable attached to the transmission) refer to the control head manufacturer's instructions.

**2-16. PROPELLER SHAFT ALIGNMENT CHECK** (see figure 2-4) The propeller shaft alignment must be checked whenever any of the following has taken place:

- the boat has been removed and replaced in the water.
- the engine and/or transmission is removed, replaced or repositioned on its bed.
- the propeller has hit a foreign object while under way.
- the output shaft seal and/or bearing has a history of failure.



**CAUTION:** It is possible for the side loading described in following step 1 to exist and still have the flange and coupling faces aligned as described in step 2. Flange and coupling must meet requirements of both steps. Otherwise seal leakage, bearing failure or other misalignment failures may result.

1. With boat in water, remove coupling nuts and bolts and slowly separate shaft coupling (109) from transmission output flange (18). As coupling leaves flange locating boss, check that there is no sudden radial (side to side or up or down) movement. Check that no side loading is required to remate the coupling with the flange boss.

2. With coupling (109) in flange (18) locating boss, draw flanges together using hand pressure only. Using suitable feeler gauge (114), check the clearances between the flanges at four locations, 90 degrees apart. (see figure 2-4) Clearance measurements must not vary from each other by more than 0.003 in. (.076 MM).

3. If alignment conditions of both preceding steps 1 and 2 are not met, adjustment is required. This adjustment shall be done only at the engine and transmission mounts and then only by a qualified marine mechanic. Do not pry against the

transmission output flange or propeller shaft flange to attempt alignment.

4. When alignment is satisfactory, install coupling bolts and nuts and torque to OEM specifications.

**2-17. TORSIONAL VIBRATION.** The delivery of power from a piston engine is not smooth but rather comes in pulses. The engine flywheel uses inertia to smooth out some but not all pulsation. That remaining pulsation is called torsional vibration. In marine applications a damper plate (107, figure 2-2) is used to absorb the torsional vibration by compressing and relaxing a system of springs. The damper must be selected carefully. If its springs are inadequate for the application, damage to the transmission and damper plate itself will result. Proper damper selection is the responsibility of the boat manufacturer, or whoever matches the engine and transmission to the application—not Borg Warner. Borg Warner is not responsible for torsional vibration or any resulting damage to the transmission or other power train components.

**2-18. CONTROL VALVE AND PUMP ASSEMBLY PRESSURE TEST.** Perform the following test to determine if the control valve and pump assembly is functioning properly (see figure 2-5):

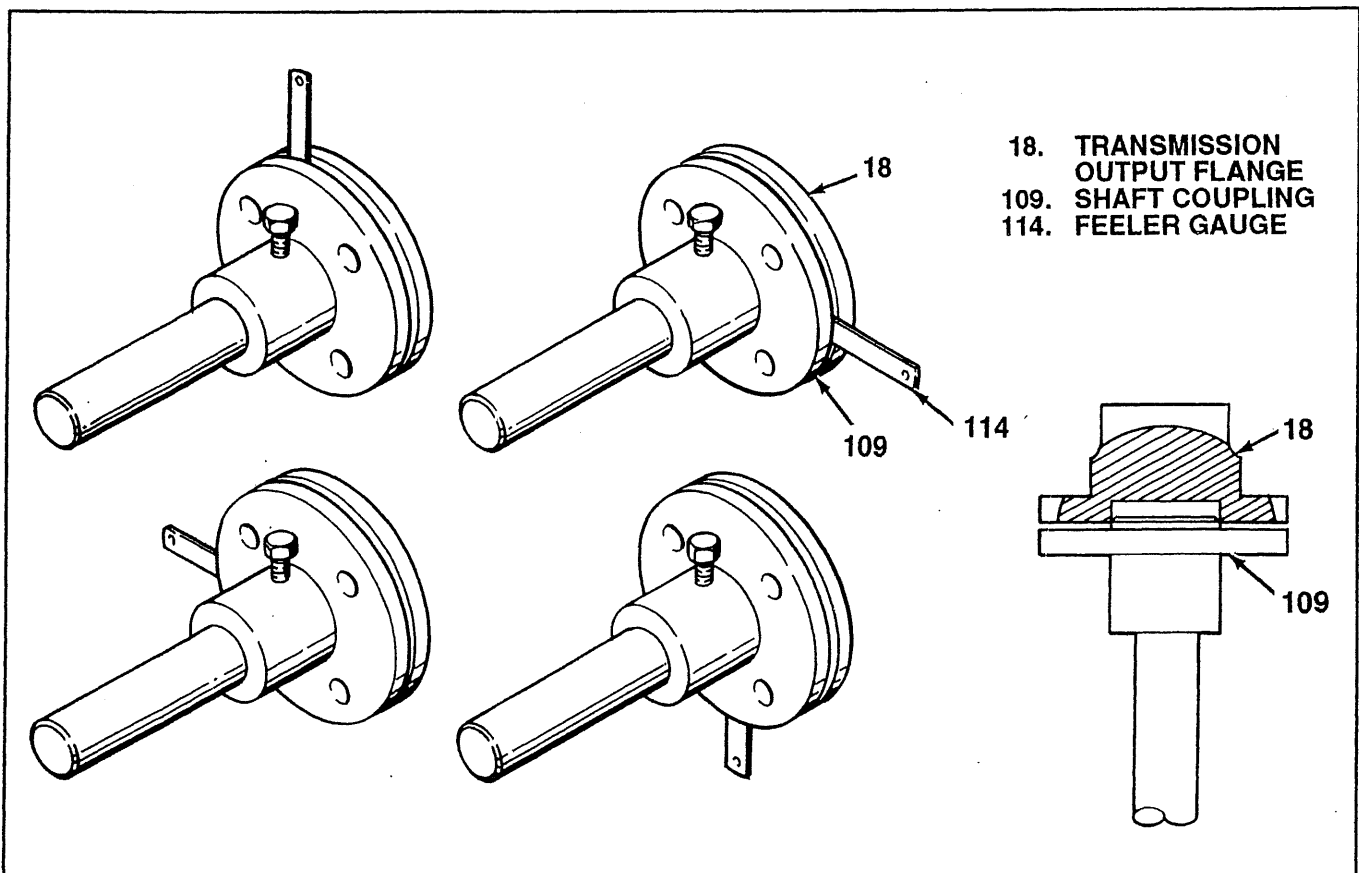


Figure 2-4. Propeller Shaft Alignment

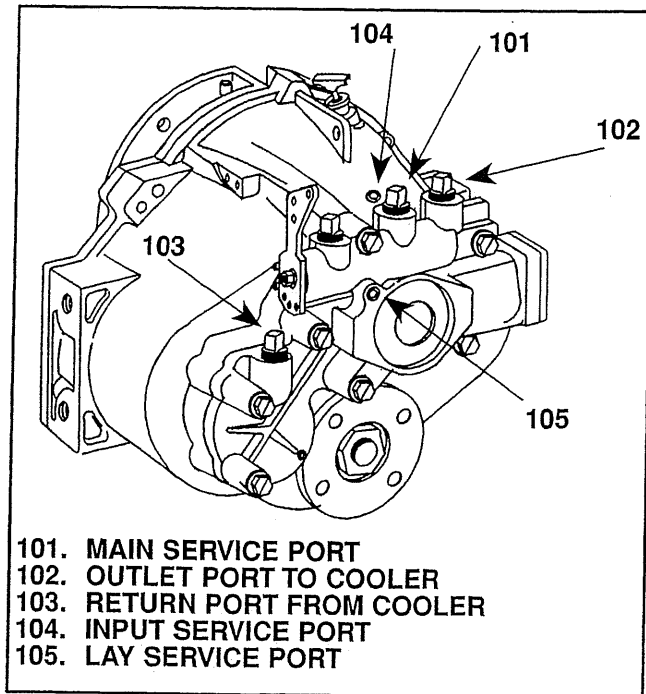


Figure 2-5. Service Port Locations

1. Check fluid level as described in paragraph 2-5 and adjust level as required. Disconnect the propeller shaft (109) from the transmission output flange (18) and separate the flanges completely.

**⚠ WARNING: Propeller shaft must not turn during steps 1 through 15. This could result in personal injury or damage to boat.**

2. Remove the sensor or plug installed in the sensor port (101) and install 0-100 psi (690 kPa) gauge in 3/8-18 NPSF thread port. Remove to-cooler hose from outlet port (102) and install a minimum 10 gal/min (38 lt/min) flow meter. Be careful to follow the flow meter manufacturer's instruction. (see figure 2-5)

3. Start engine and set throttle and 900 rpm (idle speed) with transmission shift lever in neutral (center position). Check to insure there are no leaks at the newly installed flow meter.

4. Pressure in sensor port (101) should read 10-50 psig (68-345 kPa). Flow meter should indicate 0.45 gpm to 3.96 gpm (117 lt/min to 15 lt/min).

5. Increase engine speed to 2400 rpm, pressure in port (101) should read 15-70 psig (103-483 kPa). Flow

meter should indicate 2.11 gpm to 7.40 gpm (8 lt/min to 28 lt/min).

6. Shut down engine and remove 0-100 psi (690 kPa) gauge and install sensor or plug removed in step 2. Remove plugs from input clutch pressure tap (104) and lay clutch pressure tap (105) and install 0-500 psi (3500 kPa) pressure gauges in the 1/8 in. NPT ports.

7. Start engine and set at 900 rpm (idle speed).

8. Move the bridge control to its full forward position. If the shift lever on the transmission has moved away from the engine, port (104) should have 250-400 psig (1724-2758 kPa). If the transmission shift lever has moved toward the engine, port (105) should have 250-400 psig (1724-2758 kPa). The flow meter should indicate 0.45 gpm to 3.96 gpm (1.7-15 lt/min) in both steps 7 and 8.

**NOTE: In step 8 if the transmission shift lever moved away from the engine, the propeller is right handed. If the shift lever moved toward the engine, the propeller is left handed.**

9. Increase engine speed to 2400 rpm and check that gauge readings are within limits specified in step 8. The flow meter should indicate 2.11 gpm to 7.40 gpm (8-28 lt/min).

10. Increase engine speed to 4500 rpm and check that gauge readings are within limits specified in step 8. The flow meter should indicate 3.43 gpm to 9.25 gpm (13-35 lt/min).

11. Reduce engine speed to 900 rpm (idle) and use bridge control to move transmission shift lever to the reverse position. The gauge readings should be opposite of step 8.

12. Increase engine speed to 2400 rpm and check that gauge readings are within limits specified in step 9.

13. Increase engine speed to 4500 rpm and check that gauge readings are within limits specified in step 10.

14. Reduce engine speed to 900 rpm (idle) and shut down engine. Remove pressure gauges and flow meter from ports (101, 102, 104 & 105) and install plugs or sensor removed at step 2.

15. Failure to test within limits indicates leakage or damage to pressure control, manual control valve, pump assembly or one or both clutches.

Table 2-3. Operating Pressures and Flow Rates

INPUT RPM	NEUTRAL PSIG/KPA		ENGAGED CLUTCH, PSIG/KPA		COOLER FLOW, GPM/LT-MIN	
	MIN	MAX	MIN	MAX	MIN	MAX
900	10/68	50/345	250/1724	400/2758	0.45/1.7	3.96/15
2400	15/103	70/483	250/1724	400/2758	2.11/8	7.40/28
4500	--	--	250/1724	400/2758	3.43/13	9.25/35

**2-19. VALVE AND PUMP ASSEMBLY REPLACEMENT WITH TRANSMISSION MOUNTED ON ENGINE.** If trouble is isolated to the control valve and pump assembly and there is no other reason to remove the transmission from the boat, it is possible to replace the valve and pump assembly with the transmission installed in the boat. However, when removing the valve and pump assembly (see figure 3-1), extreme care must be taken to capture and tag the exact number of shims (6) used at each location. If shims drop out or become lost or intermixed for any other reason, abandon this replacement procedure, remove the transmission from the boat and proceed as specified in Sections 3 through 5 in this manual.

**CAUTION:** Improper shimming of input or lay shaft bearings will result in transmission damage. If there is any doubt as to shim thickness at either location, remove transmission from boat so that it can be shimmed properly.

**2-20. VALVE AND PUMP ASSEMBLY REMOVAL** (see figure 3-1) Remove valve and pump assembly as follows:

1. Withdraw valve and pump assembly (4) with extreme care so as not to dislodge any shims (6). If any shims stick to valve and pump assembly rather than being retained in case (46), remove, identify and save these just as soon as clearance permits.
2. Save and record for possible future identification all shims (6) and tag as "INPUT" or "LAY" coming from input shaft assembly (28) or lay shaft assembly (29).

**2-21. VALVE AND PUMP ASSEMBLY INSTALLATION.** Install valve and pump assembly as follows:

1. If the original valve and pump assembly (4) are to be reinstalled, return all shims to their original positions.
2. If pump assembly (202) is replaced, determine shim thickness for input shaft (28) bearing as follows:
  - a. Measure and record dimension E, figure 2-6 on both the new and old pumps.
  - b. If dimension E is greater on the new pump, subtract the difference from the shims removed from the input shaft.
  - c. If dimension E is less than the new pump, add the difference to the shims removed from the input shaft.

**NOTE:** The shims returned to the lay shaft must be the same as those removed.

3. Install valve and pump assembly (4) with extreme care so as not to dislodge any shims (6). If

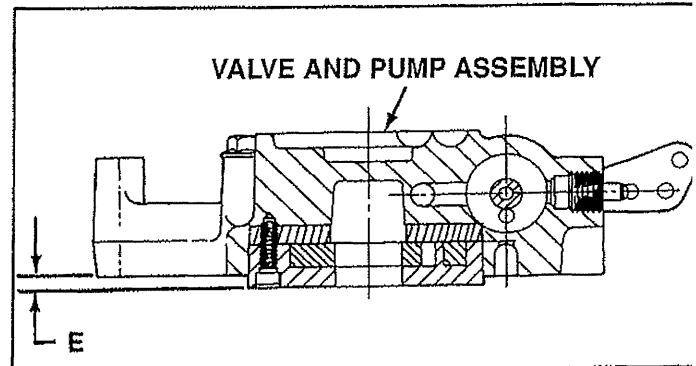


Figure 2-6. Determine Input Shaft Bearing Thickness

any shims become dislodged and its location cannot be identified positively, remove all shims and assemble shim stacks for each location according to recorded data. Use petroleum jelly or cup grease to hold shims in place until assembled.

## 2-22. TRANSMISSION REMOVAL AND INSTALLATION

**2-23. REMOVAL OF TRANSMISSION.** Refer to the OEM manual for specific instructions regarding enclosures, mounts, supports, shift linkage and other components related to the transmission. A suitable hoist or other means for completely supporting the transmission will be required. Proceed as follows (see figures 2-2 and 2-7):

1. Disconnect negative battery terminal.
2. Disconnect electrical connectors from neutral switch assembly (203) and sensor in port (101) (if used) on transmission.
3. Remove the cooler outlet and return lines from the transmission ports (102 and 103) tag each hose for proper identification. Drain all fluid from the lines into a suitable container.
4. Disconnect shift linkage from transmission shift lever (207).
5. Remove coupling nuts and bolts and separate propeller shaft coupling (109) from the transmission output flange (18).
6. Remove rear mounts, raise and support engine.
7. Support transmission with hoist or by other suitable means through the lifting eye on the transmission case.

**CAUTION:** Make sure transmission is completely supported before removing hardware attaching transmission to flywheel housing. Do not allow transmission to "hang" on input shaft.

8. Remove all hardware attaching transmission to bell housing (106).
9. Move transmission straight back away from engine to completely disengage spline on input shaft.
10. Carefully lift out transmission.

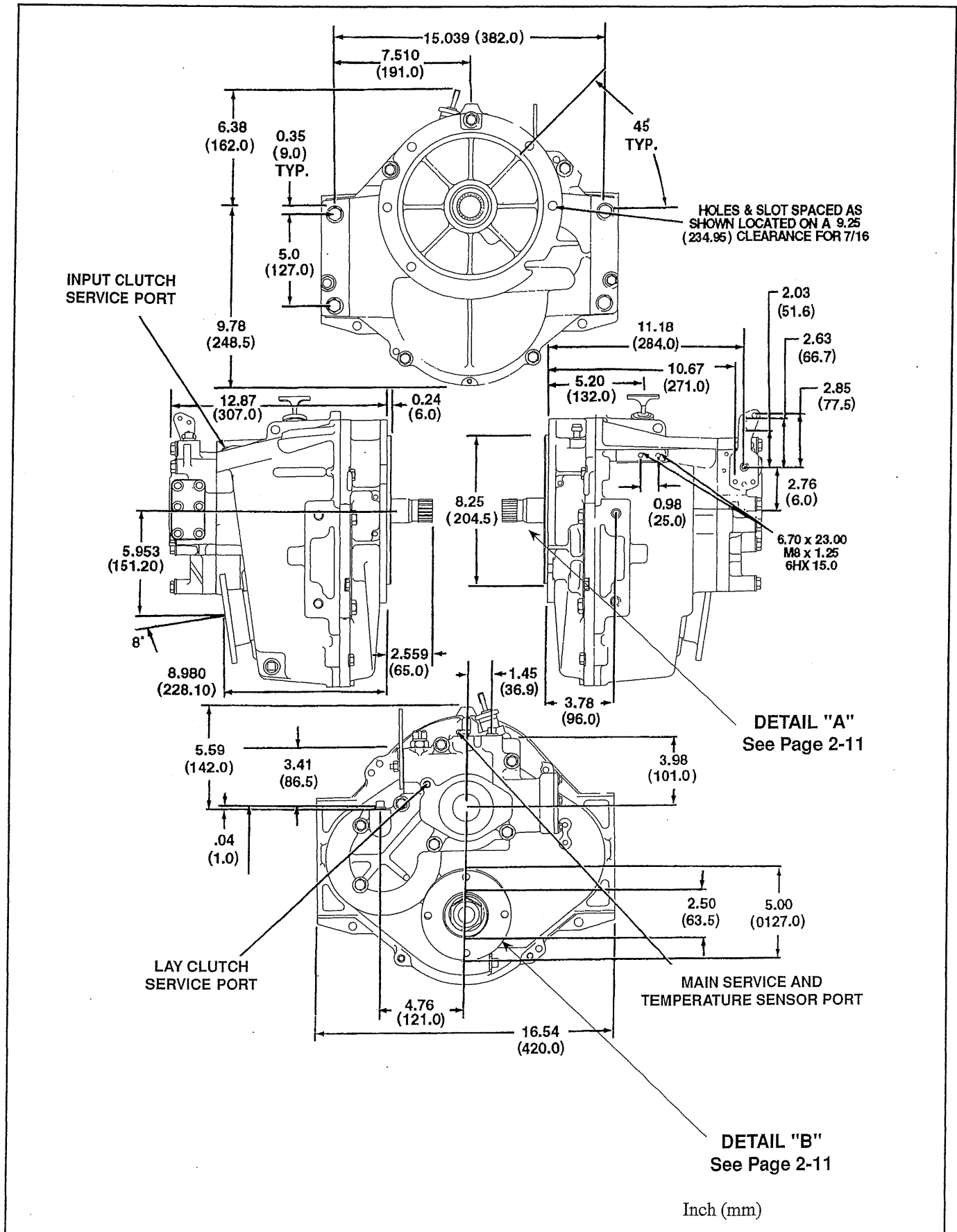
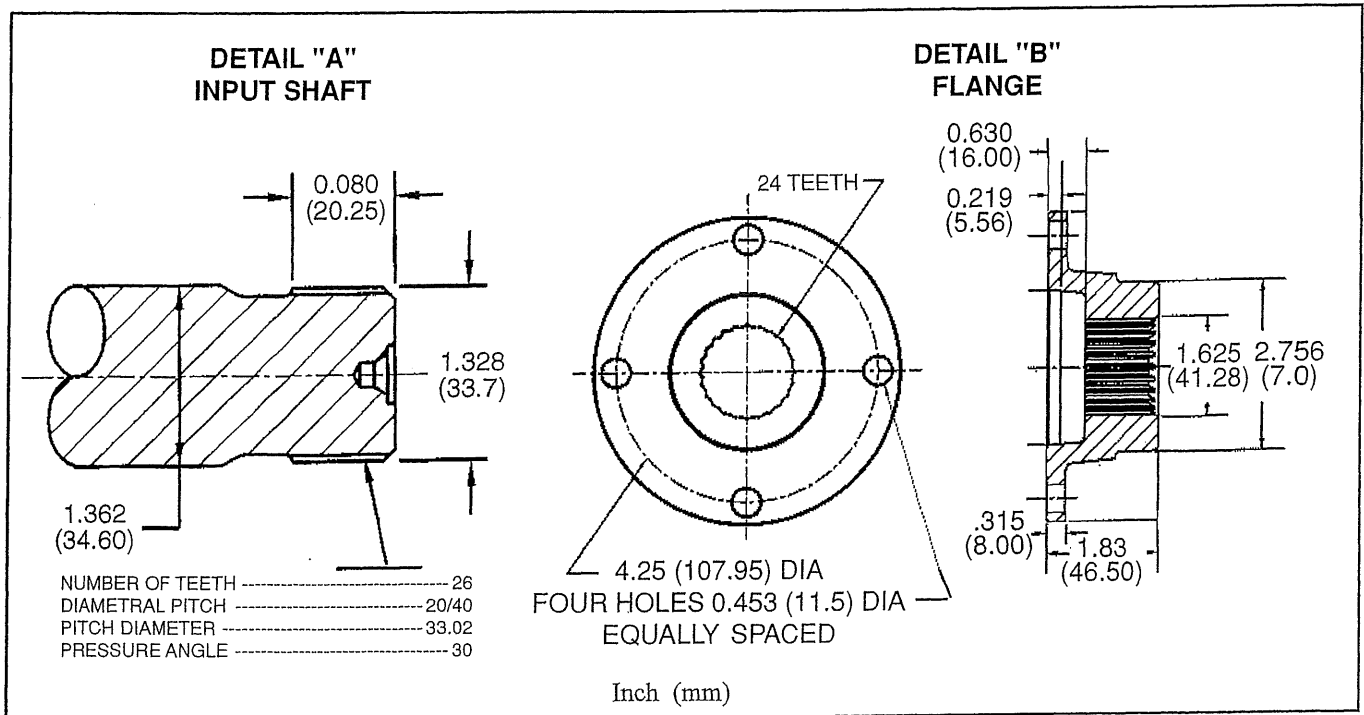


Figure 2-7. Transmission Installation Dimensions



Input Shaft Spline / Flange Dimensions

**2-24. REPAIR/OVERHAUL OF TRANSMISSION.** Refer to Sections 3 through 5 for disassembly, inspection, repair, parts replacement and assembly of the transmission.

**2-25. INSTALLATION OF TRANSMISSION.** Refer to the OEM manual for specific instructions regarding enclosures, mounts, supports, shift linkage and other components related to the transmission. Transmission installation dimensions are shown on figure 2-7. With transmission supported in a suitable manner, proceed as follows (see figure 2-2):

1. Apply a thin film of high temperature grease to spline on transmission input shaft.
2. Position transmission and align with engine. Use guide pins to align transmission during installation.
3. Carefully move transmission forward, engaging spline on input shaft. Install and torque hardware per OEM specifications. Remove hoist.

4. With the boat in the water, connect and align propeller shaft coupling (109) as specified in paragraph 2-16.



**CAUTION: Improper shift linkage adjustment can cause premature clutch failure.**

5. Connect shift linkage to transmission shift lever (207). The control lever at the bridge must agree with the shift lever on the transmission. Adjust the shift linkage if required (paragraph 2-14).
6. Connect the cooler outlet and return lines to the transmission ports (102 and 103). Torque fittings to OEM specifications.
7. Fill transmission with fluid as specified in paragraphs 2-4 and 2-9.
8. Connect electrical connectors to neutral safety switch (203) and sensor in port (101) (if used).
9. Connect negative battery terminal.





# Section 3 Disassembly

## 3-1. GENERAL INFORMATION

3-2. During disassembly, refer to the illustrations provided with the text. In addition, an exploded view of the complete assembly and major subassemblies can be seen on the illustration in Section P, Parts. These exploded view illustrations are listed at the beginning of Section P.

3-3. This section provides instructions for complete disassembly of the transmission. If the transmission is not due for overhaul, and repair affecting specific parts is required, disassemble only to the extent necessary to gain access to these parts. Parts removed from the transmission as subassemblies or groups need not be disassembled for repair unless they contain the affected parts.

## 3-4. REMOVAL AND INSTALLATION OF TRANSMISSION

3-5. Refer to paragraph 2-23 and 2-25.

## 3-6. TRANSMISSION DISASSEMBLY

### 3-7. REMOVAL OF VALVE AND PUMP HOUSING ASSEMBLY.

With the transmission held in a suitable fixture and in its approximate installed position, begin disassembly as follows (see figure 3-1):

1. Remove dipstick (1 or 1A). Position transmission over suitable container, remove drain plug (2) and drain all fluid from transmission.

2. Remove seven bolts (3), one bolt (3A) and washer (3B). Pull valve and pump housing assembly (4) from case (46), keeping mounting faces parallel until pump clears end of input shaft assembly (28).

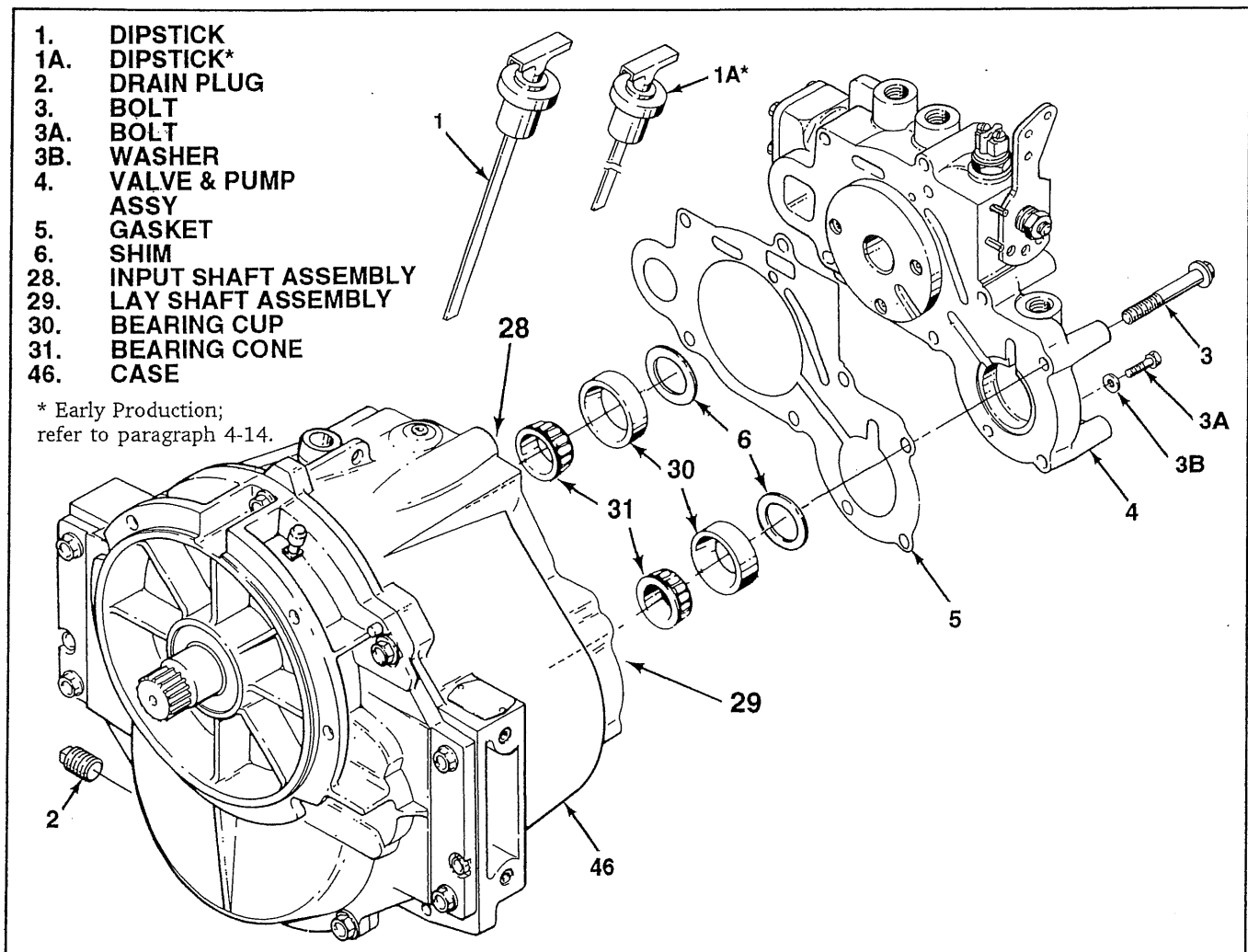


Figure 3-1. Valve and Pump Housing Assembly

3. Remove shim(s) (6), outer bearing cup(s) (30) and bearing cone(s) (31) from input shaft assembly (28) and lay shaft assembly (29).

4. Refer to paragraph 3-13 for disassembly of valve and pump assembly (4).

5. Remove gasket (5). If necessary to scrape, defer this until after transmission is completely disassembled.

**NOTE: If output shaft or clutch assemblies are to be removed, nut (17) may be loosened at this time.**

**3-8. REMOVAL OF CASE COVER AND BEARING CUP ASSEMBLY.** Position the transmission with the pump (just removed) end down. Support the transmission with fixture T-5007 (see Section T) or in another suitable manner to provide clearance for exposed end of input shaft and balance transmission. Proceed as follows (see figure 3-2):

1. Carefully tap small OD end of tapered pins (43) to remove from case cover and magnet assembly (14). (Note direction of taper)

2. Remove two bolts (7), five bolts (8), four bolts (9), four washers (10), and bolt (47).

3. Pull case cover and magnet assembly (14) straight up off of case (46) until cover and bearing cup assembly clears end of input shaft assembly (28).

4. Do not remove bearing cups (12 and/or 13) unless replacement is required.

5. Remove gasket (15). If necessary to scrape, defer this until after transmission is completely disassembled.

6. Remove two oil seals (16) (Note some may only have one.) from case cover and magnet assembly (14).

7. Do not remove breather (36) unless replacement is required.

8. Case cover and magnet assembly (14) and case (46) are a matched set. See listing in Section P.

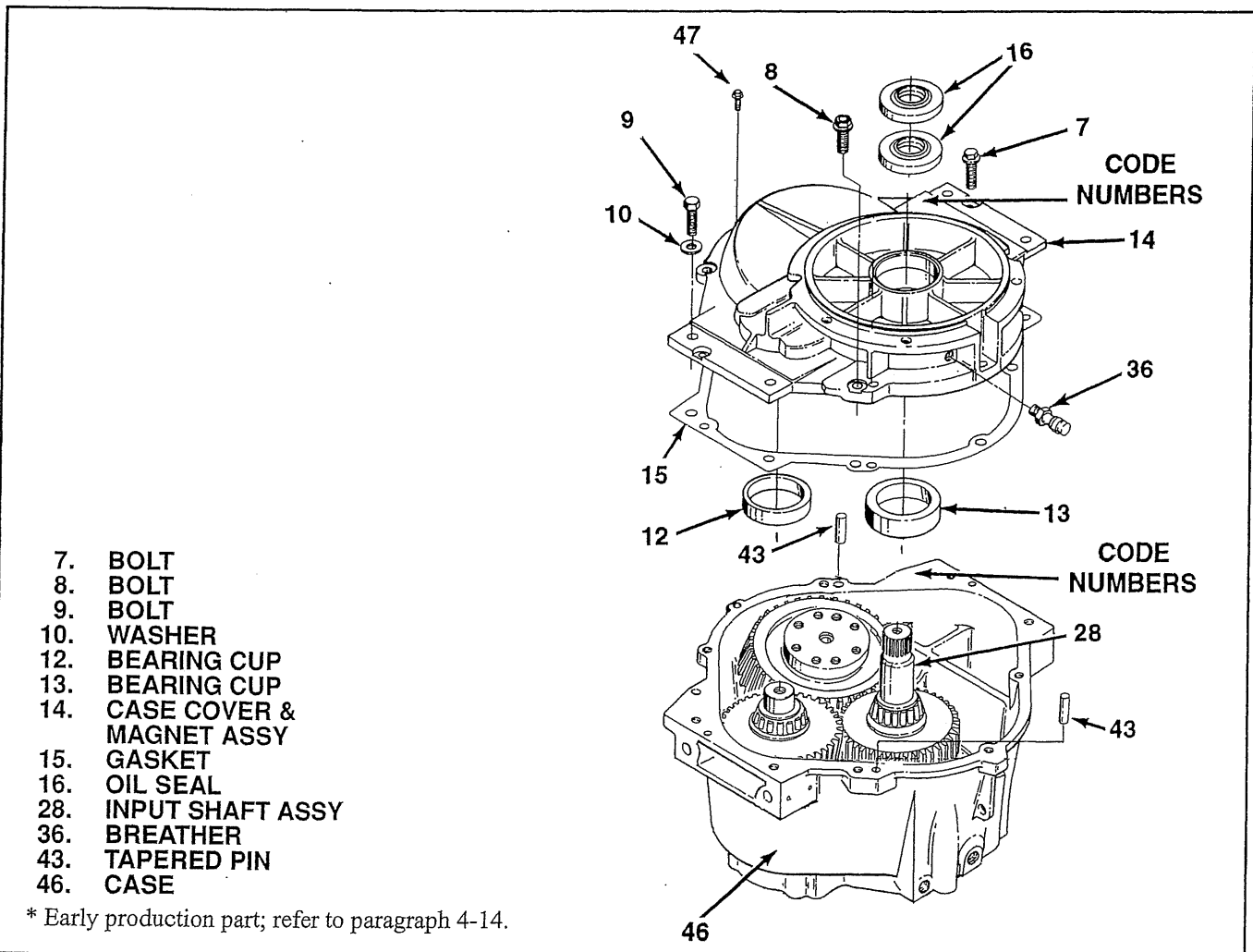
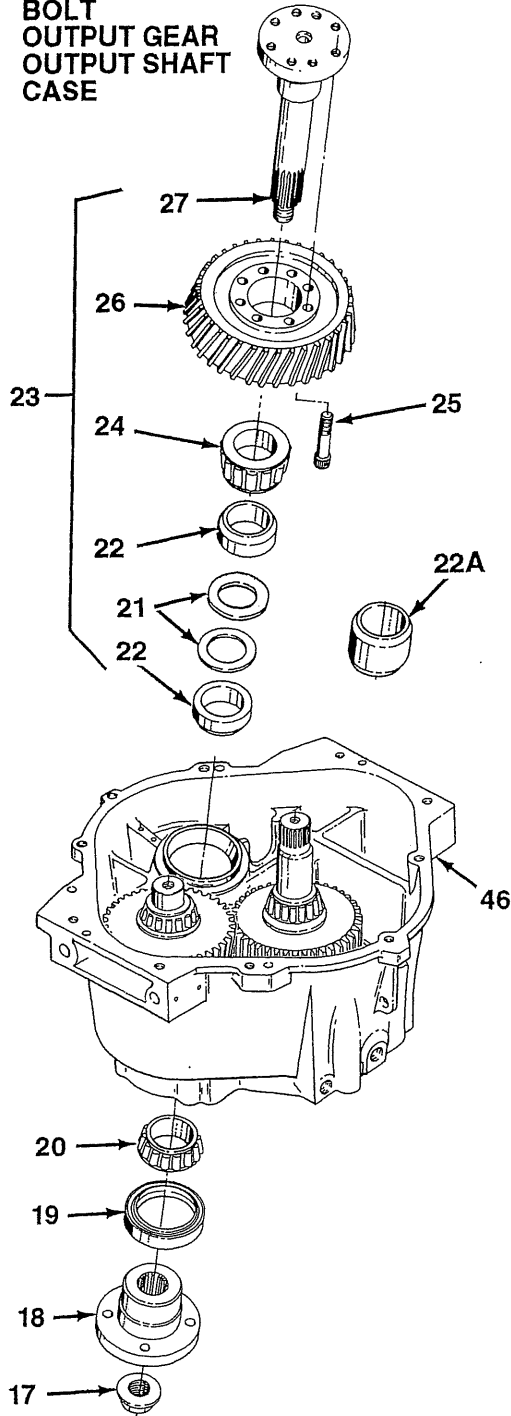


Figure 3-2. Case Cover and Bearing Cup Assembly

- 17. FLANGE NUT
- 18. OUTPUT FLANGE
- 19. OIL SEAL
- 20. BEARING CONE
- 21. SHIM
- 22. SLEEVE
- 22A. SLEEVE\*
- 23. OUTPUT SHAFT ASSY
- 24. BEARING CONE
- 25. BOLT
- 26. OUTPUT GEAR
- 27. OUTPUT SHAFT
- 46. CASE



\* Superseded part; refer to paragraph 4-14.

**WARNING:** Case cover and magnet assembly (14) and case (46) are a matched set. Check the code numbers as shown in figure 5-18 to make sure a matched set is being disassembled. A mismatched case (46) and cover and magnet assembly (14) can result in severe transmission damage.

**3-9. REMOVAL OF OUTPUT SHAFT ASSEMBLY.** With the transmission resting so the exposed gears are resting in the case, proceed as follows see figure 3-3):

1. Holding output flange (18) with coupling wrench T-5005, remove flange nut (17). Remove output flange (18). Remove sealant from output flange, nut and end of output shaft (27) as required.
2. Grasp output gear (26) and remove output shaft assembly (23).
3. Remove shim(s) (21) and two sleeves (22) or one sleeve (22A).

**NOTE:** If one sleeve is removed, two sleeves must be installed when reassembled. Discard the single sleeve and shims removed. Do not use any of the original shims when assembling. Do not attempt to cut single sleeve (22A) in half for reuse.

**NOTE:** In normal field repair it will not be necessary to remove the output gear from the output shaft. If separation is necessary a suitable press will be required.

4. When it is necessary to remove the output gear (26) from the output shaft (27), bearing cone (24) must be removed first. Bearing cone (24) will be destroyed in the process of removal.
5. Remove eight bolts (25) and output gear (26) from output shaft (27) with suitable press.

Figure 3-3. Output Shaft Assembly

**3-10. REMOVAL OF INPUT AND LAY SHAFT ASSEMBLIES.** With open end of transmission up, proceed as follows (see figure 3-4):

1. Remove two bolts (32), oil baffle (33) and the oil suction tube assembly with dipstick guide (34A), if used. Remove oil filler tube with dipstick tube assembly (39). If the oil dipstick tube (39A) is used, it need not be removed.

2. Pull input shaft assembly (28) and lay shaft assembly (29) straight up out of case (46).

3. Refer to paragraph 3-16 for disassembly of input shaft assembly. Refer to paragraph 3-20 for disassembly of lay shaft assembly.

**3-11. REMOVAL OF CASE COMPONENTS.** After removing shaft assemblies, remove remaining case components as follows (see figure 3-5):

1. Remove suction tube assembly (34) if not already removed in paragraph 3-10. Remove o-ring (35) from groove on suction tube assembly.

2. If the dipstick requires a dipstick tube (39A) it need not be removed.

3. Remove pipe plug (40) to ensure proper galley cleaning.

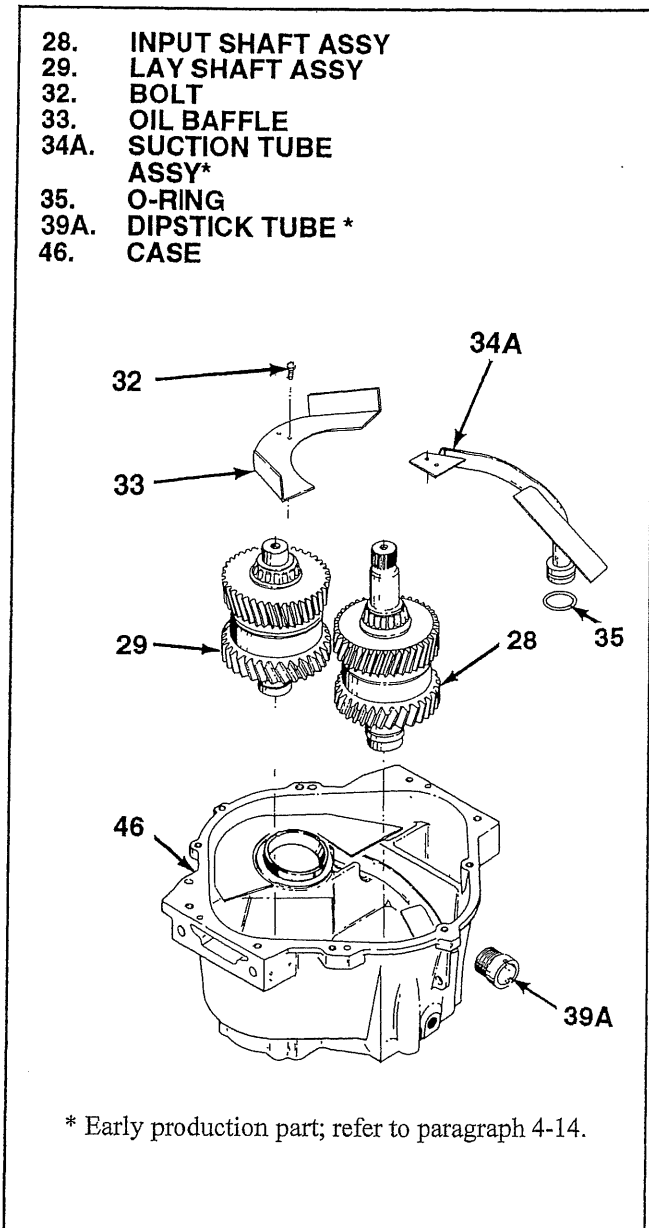


Figure 3-4. Input and Lay Shaft Assemblies

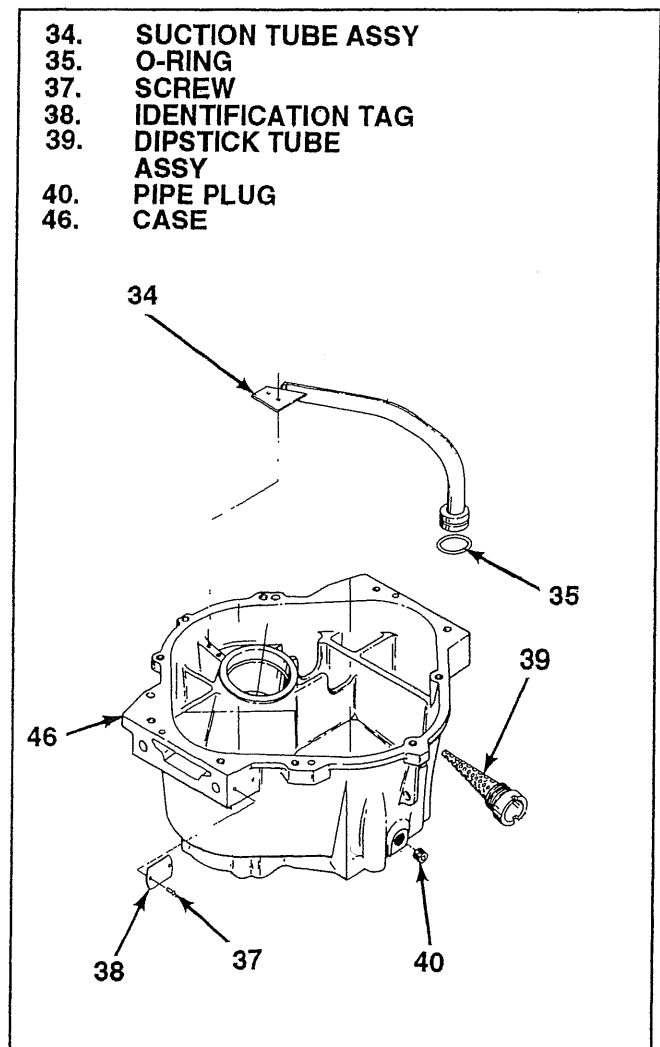


Figure 3-5. Case Components

**3-12. DISASSEMBLY OF CASE ASSEMBLY.** Remove parts from case assembly only if replacement is required. Then, as required, proceed as follows (see figure 3-6):

1. Remove thread inserts (42) using standard Heli-Coil (R) removal tools only if damaged.
2. Press or drive bearing cups (44 and 45) from transmission case (46) using care not to damage case.
3. Case cover and magnet assembly (14) and case (46) are a matched set. See listing in Section P.

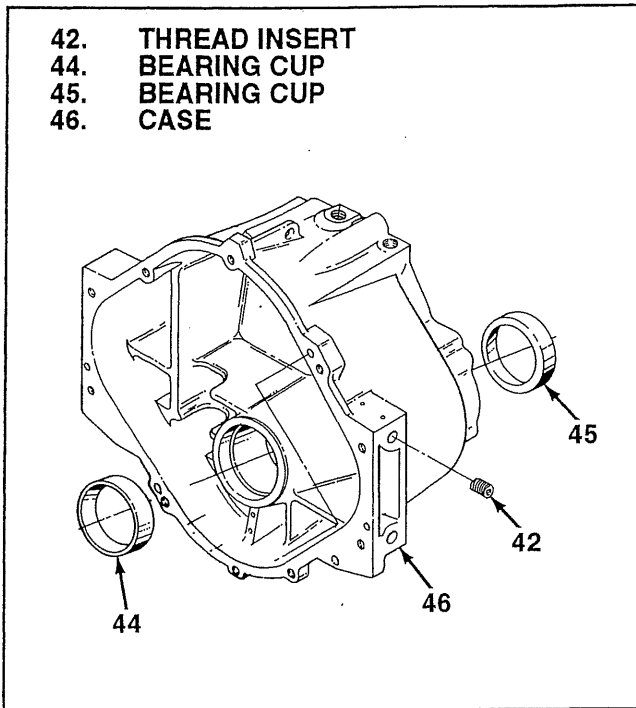


Figure 3-6. Case Assembly

**3-13. DISASSEMBLY OF VALVE AND PUMP HOUSING ASSEMBLY**

**3-14. REMOVAL OF PUMP, SWITCH AND TRANSMISSION SHIFT LEVER.** Proceed as follows (see figure 3-7):

1. Remove three bolts (201) and pump assembly (202). The pump contains matched parts and must be replaced as an assembly if necessary.
2. Remove switch assembly (203) and temperature sensor (101) if used.
3. Holding transmission shift lever (207) to prevent control valve (211) from turning and ball (208) and spring (209) from flying out, remove nut (204). Remove lock washer (205), flat washer (206), shift lever (207), ball (208) and spring (209).

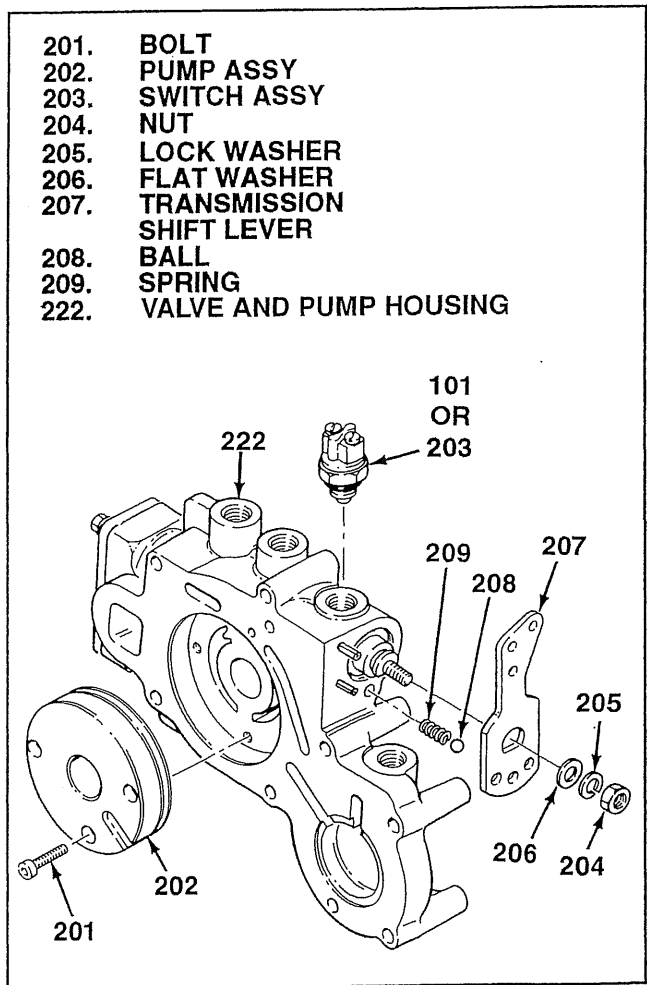


Figure 3-7. Pump, Switch and Transmission Shift Lever

**3-15. REMOVAL OF CONTROL VALVE, PISTON AND SCREEN.** After removing switch as described in paragraph 3-13, remove control valve, piston and screen as follows (see figure 3-8):

**CAUTION:** Control valve (211), valve piston (218 or 218A) and mating bores in valve and pump housing (222) are highly finished. Use care not to scratch or otherwise damage these surfaces. Damaged surfaces may result in, fluid leakage and shifting malfunctions.

1. Remove snap ring (210) and pull control valve (211). Temporarily thread nut (204) back onto control valve to aid in valve removal if necessary.
2. Remove o-ring (212) from groove in control valve (211).

3. Remove six bolts (214), cover plate (215) and gasket (216).

**WARNING:** Cover plate is preloaded with spring pressure from springs (217 and (217A). Care must be taken when removing springs.

If necessary to scrape gasket, defer this until after valve and pump assembly are completely disassembled.

4. Remove springs (217, and 217A if used), valve piston (218 or 218A), washer (219) and screen assembly (220) from valve and pump housing (222).
5. Remove pins (221) only if replacement is required.

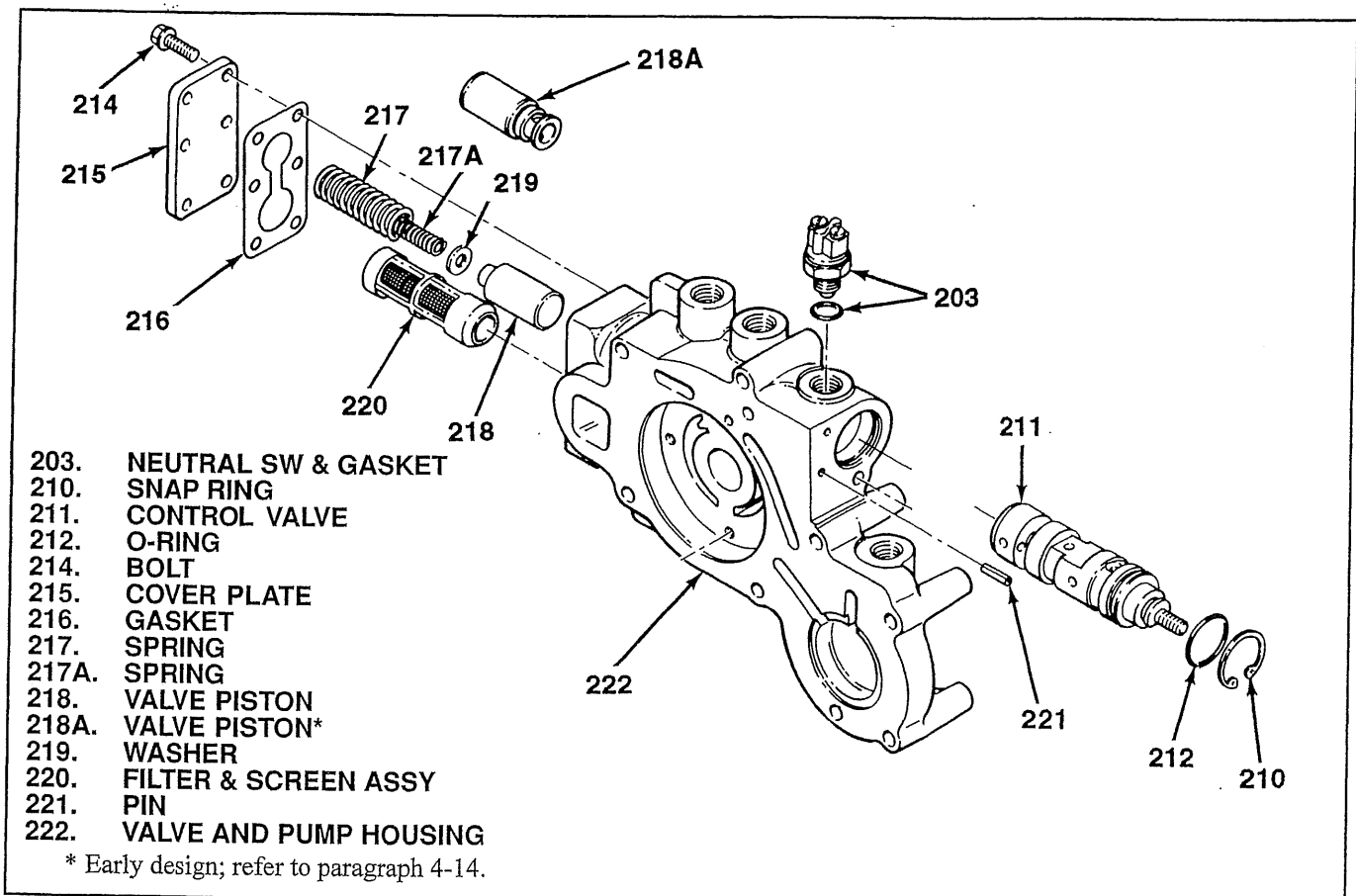


Figure 3-8. Control Valve, Piston and Filter

### 3-16. DISASSEMBLY OF INPUT SHAFT ASSEMBLY

#### 3-17. REMOVAL OF CLUTCH GEAR AND BEARINGS. Proceed as follows (see figure 3-9):

1. Use a suitable collar behind clutch gear (304) to press bearing cone (301) from input shaft (329). Use care not to damage gear teeth.
2. Thrust washer (302), spacer (303) will be removed with clutch gear (304).
3. Remove snap ring (305), three needle bearings (306) and snap ring (307) from input shaft (329). Snap ring (307) may be removed after clutches are removed for convenience.

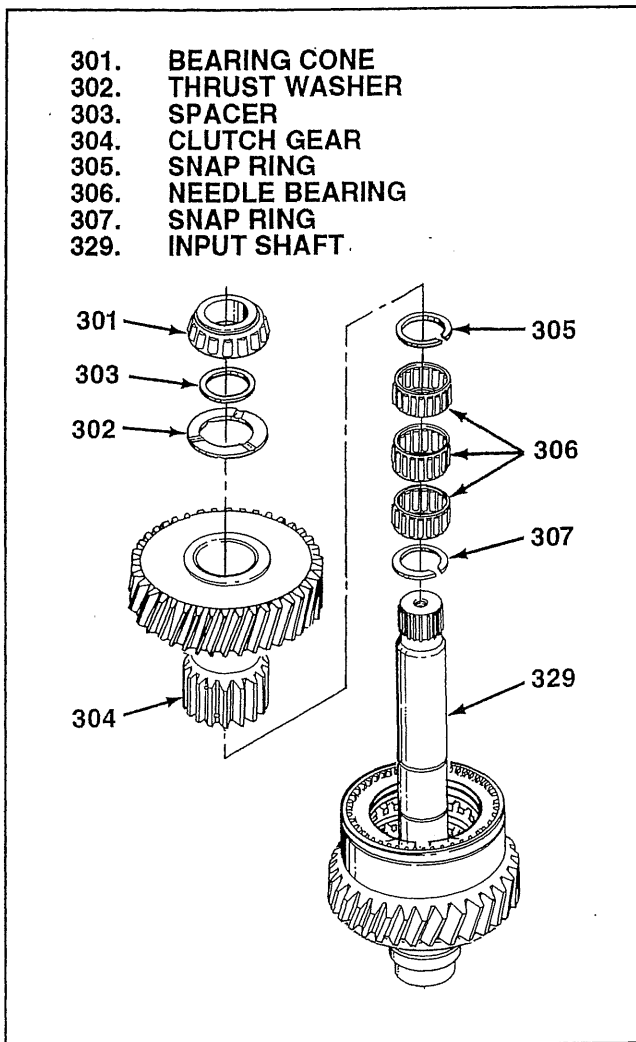


Figure 3-9. Input Clutch Gear and Bearings

#### 3-18 REMOVAL OF CLUTCH GROUP. Support input shaft assembly with splined end up and proceed as follows (see figure 3-10):

1. Remove snap ring (308) and backing plate (309), or backing plate (309A) and one clutch plate (310A).
2. Alternately remove eight clutch disc assemblies (311) and seven clutch discs (312).
3. Remove remaining clutch plate (310).

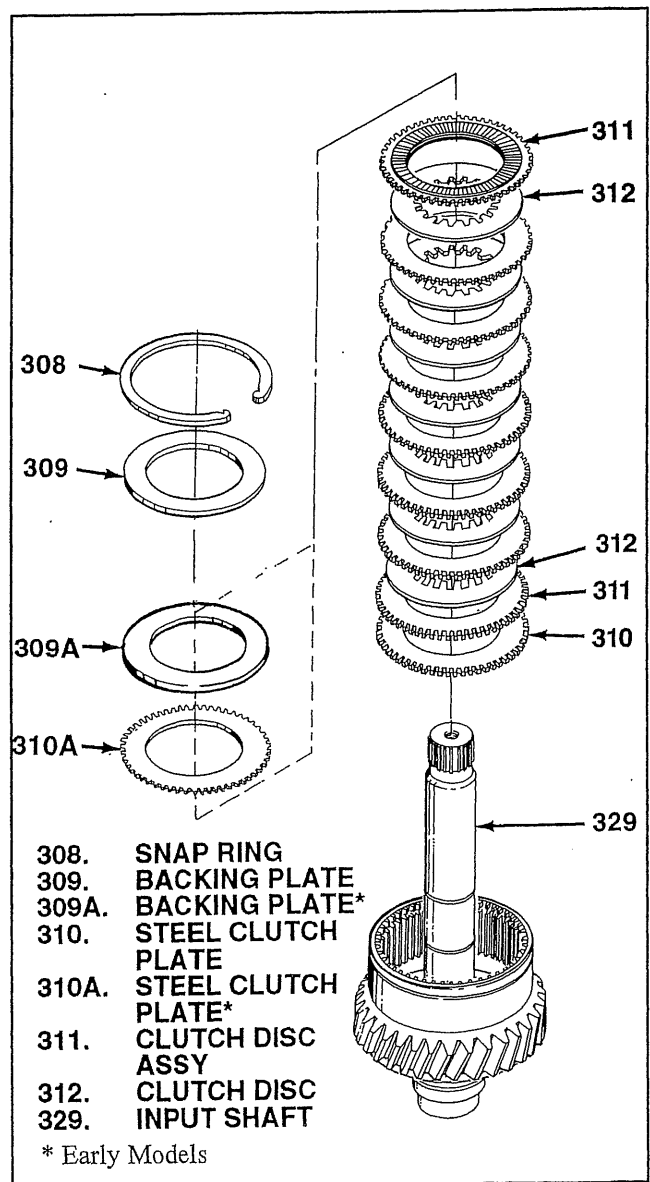



Figure 3-10. Input Clutch Group

**3-19. REMOVAL OF CLUTCH CYLINDER AND PISTON.** Proceed as follows (see figure 3-11):

 **CAUTION:** OD and ID of clutch piston assembly (319) and mating bore in clutch gear cylinder (315) and OD on input shaft (329) are highly finished. Use care not to scratch or otherwise damage these surfaces. Damaged surfaces may result in fluid leakage and shift malfunctions.

1. Remove snap ring (307) if not already removed.
2. Remove twelve bolts (313) and lock plates if used.
3. Remove clutch gear cylinder (315) from input shaft (329).

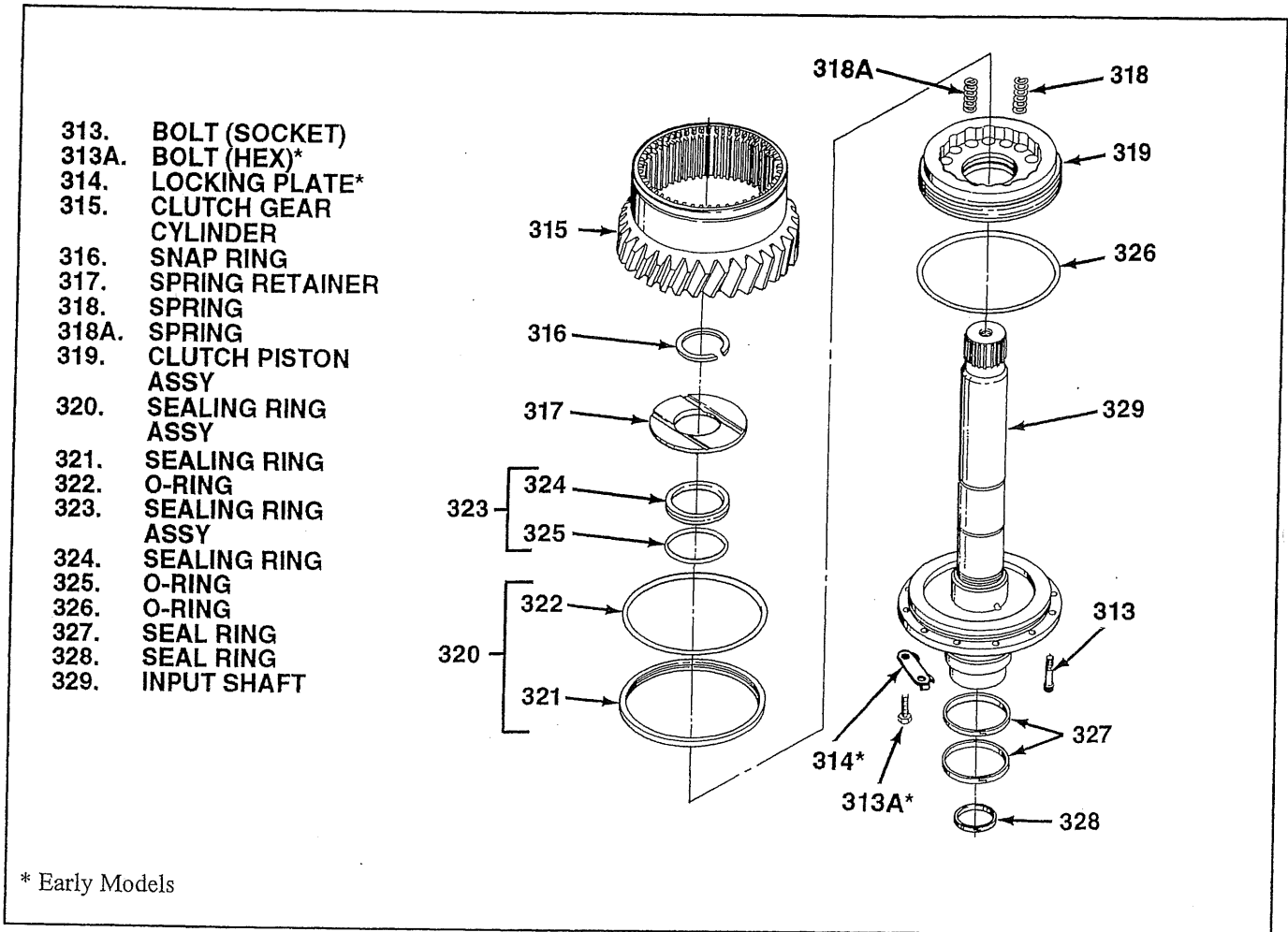


Figure 3-11. Input Clutch Cylinder and Piston



4. Support input shaft (329) in suitable holding fixture (see figure 3-12) in arbor press. Using assembly tool T-5001, press down on spring retainer (317) to compress springs (318, and 318A if used) slightly. Remove snap ring (316).

5. Slowly release arbor press, allowing springs (318, and 318A if used) to expand. Remove assembly tool and spring retainer (317). Remove sixteen springs (318) (transmissions 2001-000-011 thru -016) or four springs (318) and twelve springs (318A)

(transmissions 2001-000-001 thru -006). Remove shaft assembly from arbor press and holding fixture.

6. Remove clutch piston assembly (319) from input shaft (329). Remove sealing ring assembly (320), consisting of sealing ring (321) and o-ring (322), from groove in piston OD. Remove sealing ring assembly (323), consisting of sealing ring (324) and o-ring (325), from groove in piston ID.

7. Remove o-ring (326), two seal rings (327) and seal ring (328) from input shaft (329).

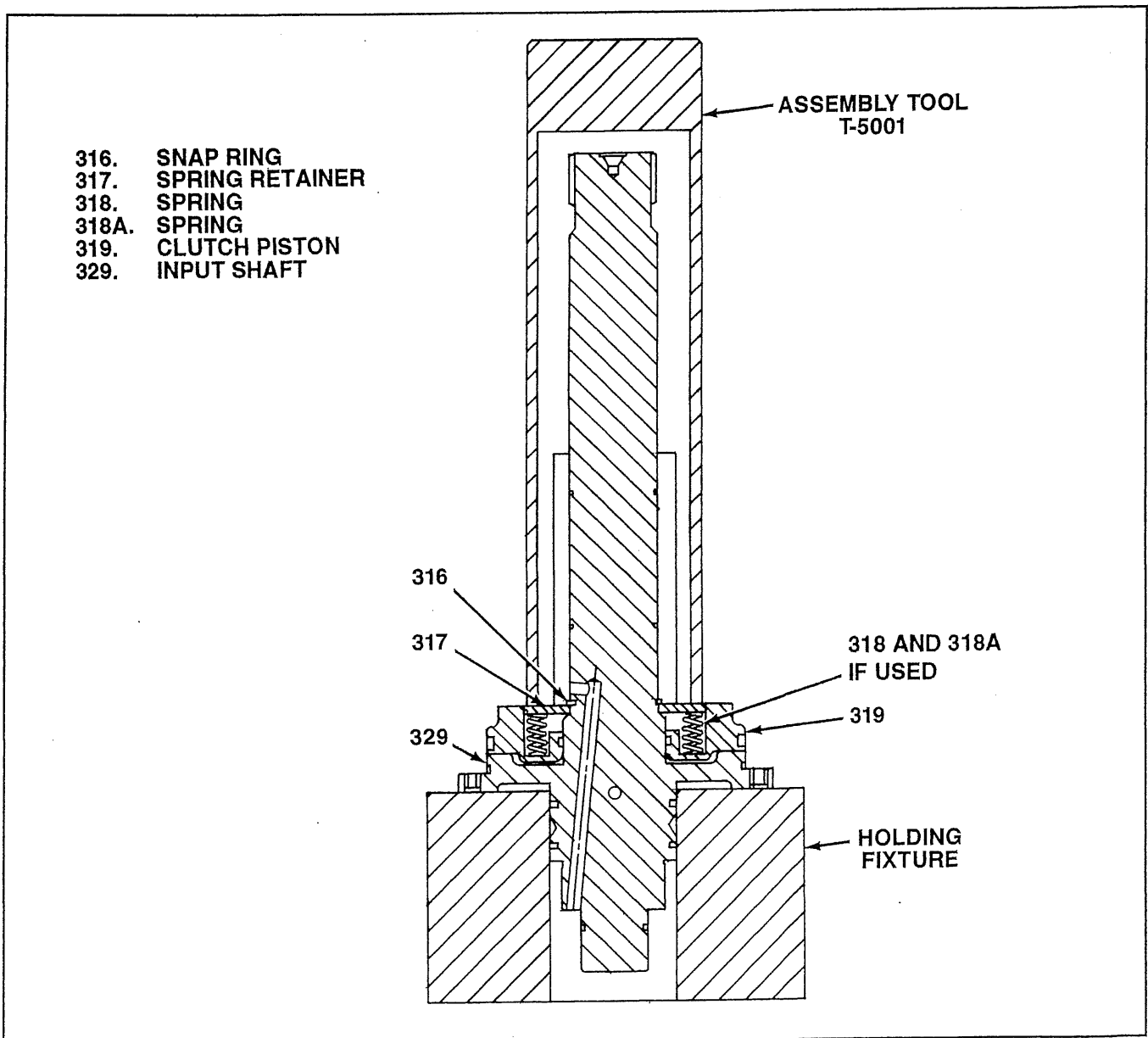


Figure 3-12. Removing Snap Ring

### 3-20. DISASSEMBLY OF LAY SHAFT ASSEMBLY

#### 3-21. REMOVAL OF CLUTCH GEAR AND BEARINGS. Proceed as follows (see figure 3-13):

1. Use a suitable collar behind clutch gear (403) to press bearing cone (402) from lay shaft (427). Use care not to damage gear teeth. Remove clutch gear.
2. Remove three needle bearings (404) and snap ring (405) from lay shaft (427). Snap ring (405) may be removed after clutches are removed if convenient.

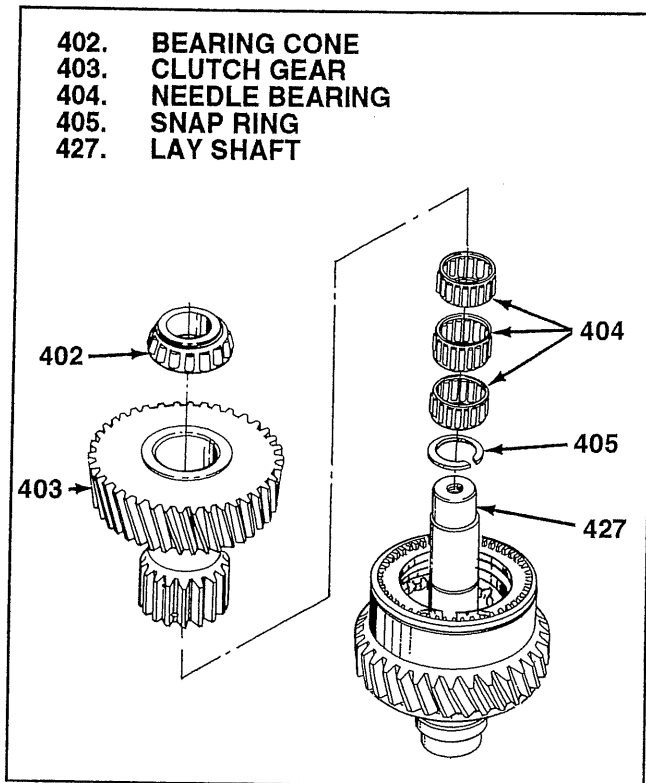


Figure 3-13. Lay Clutch Gear and Bearings

#### 3-22. REMOVAL OF CLUTCH GROUP. Support lay shaft assembly with splined end up and proceed as follows (see figure 3-14):

1. Remove snap ring (406) and backing plate (407), or backing plate (407A) and one clutch plate (408A).
2. Alternately remove eight clutch disc assemblies (409) and seven clutch discs (410).
3. Remove remaining clutch plate (408) and snap ring (405) if not removed earlier.

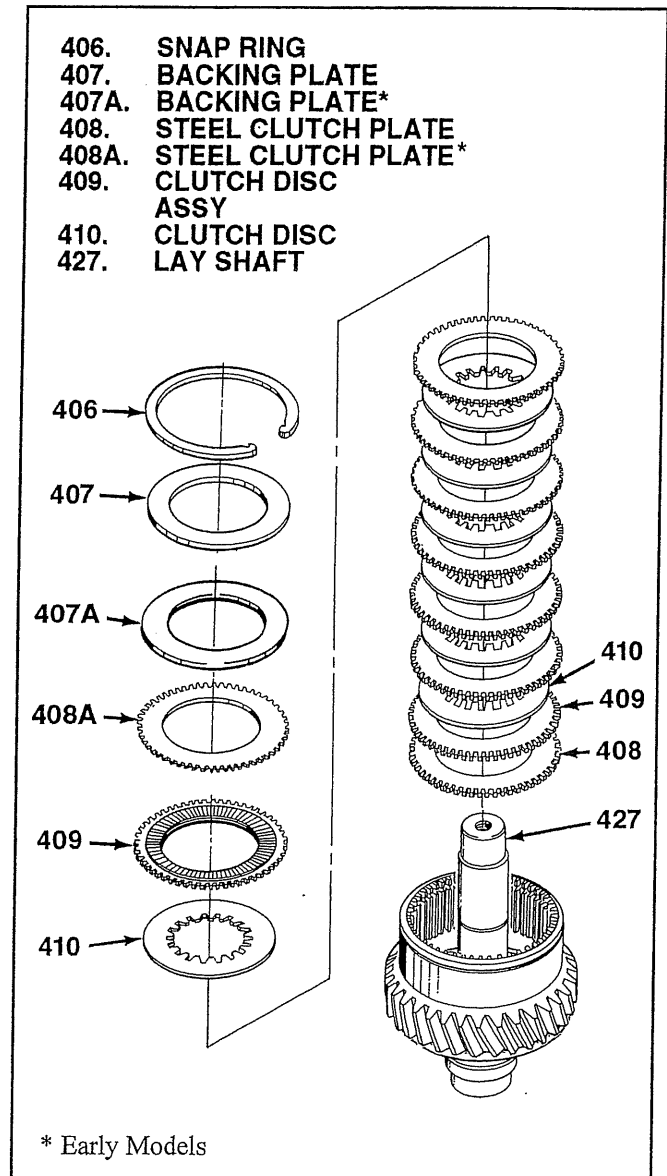


Figure 3-14. Lay Clutch Group

**3-23. REMOVAL OF CLUTCH CYLINDER AND PISTON.** Proceed as follows (see figure 3-15):

**CAUTION:** OD and ID of clutch piston assembly (418) and mating bore in clutch gear cylinder (413) and OD on lay shaft (427) are highly finished. Use care not to scratch or otherwise damage these surfaces. Damaged surfaces may result in fluid leakage and shift malfunctions.

1. Remove twelve bolts (411) and lock plates if used.
2. Remove clutch gear cylinder (413) from lay shaft (427).
3. Support lay shaft (427) in suitable holding fixture (see figure 3-16) in arbor press. Using assembly tool T-5001, press down on spring retainer (416) to compress springs (417, and 417A if used) slightly. Remove snap ring (414).

4. Slowly release arbor press, allowing springs (417, and 417A if used) to expand. Remove assembly tool, thrust washer (415), and spring retainer (416). Remove sixteen springs (417) (transmissions 2001-000-011 thru -016) or four springs (417) and twelve springs (417A) (transmissions 2001-000-001 thru -006 and 2001-000-R01 thru 2001-000-R06). Remove shaft assembly from arbor press and holding fixture.

5. Remove clutch piston assembly (418) from lay shaft (427). Remove sealing ring assembly (419), consisting of sealing ring (420) and o-ring (421), from groove in piston OD. Remove sealing ring assembly (422), consisting of sealing ring (423) and o-ring (424), from groove in piston ID.

6. Remove o-ring (425) and seal rings (426) from lay shaft (427).

7. Remove snap ring (428), spacer (429), spring (430) and ball (431) from lay shaft (427).

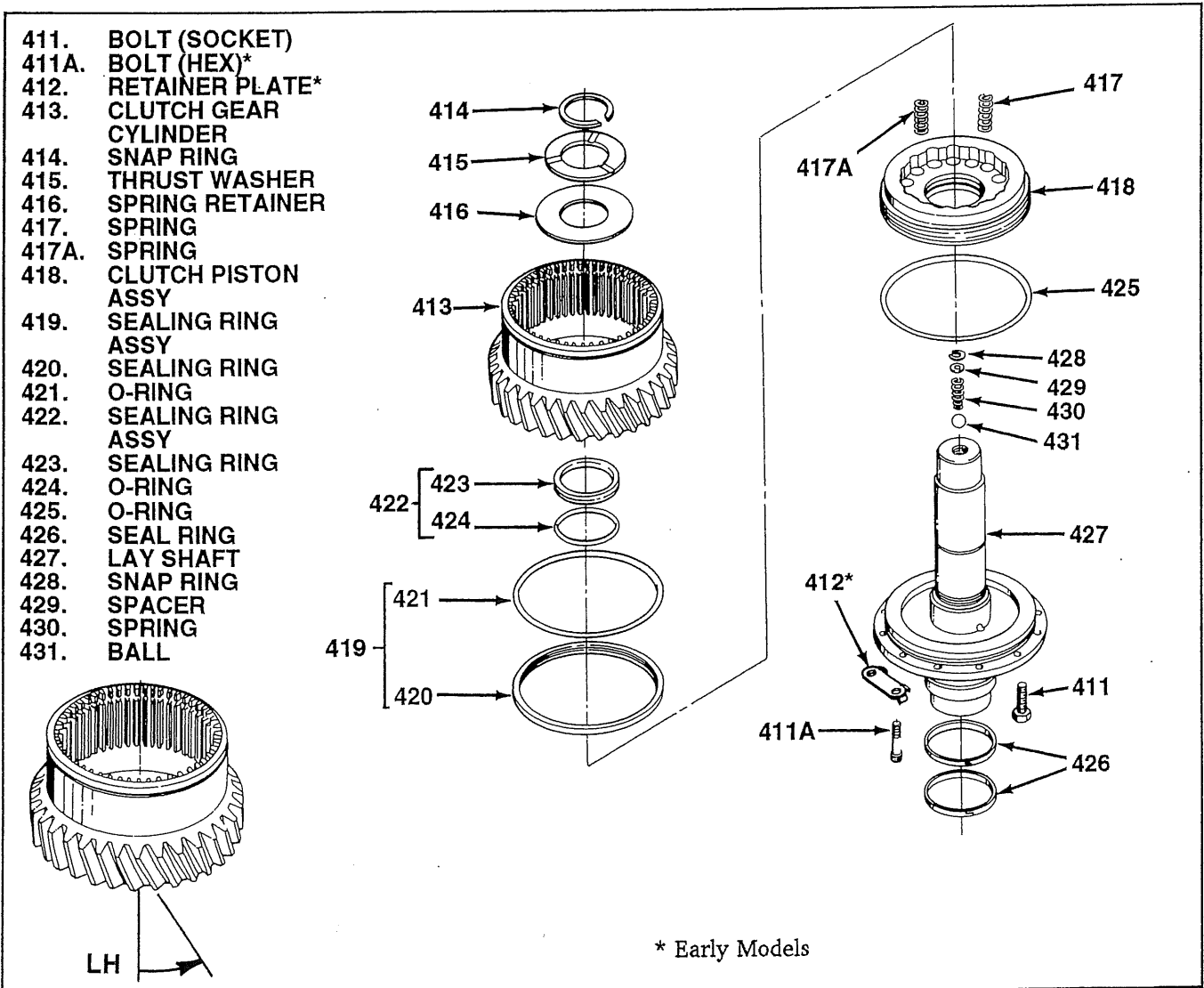


Figure 3-15. Lay Clutch Cylinder and Piston

- 414. SNAP RING
- 415. THRUST WASHER
- 416. SPRING RETAINER
- 417. SPRING
- 417A. SPRING
- 418. CLUTCH PISTON
- 427. LAY SHAFT
- 428. SNAP RING
- 429. SPACER
- 430. SPRING
- 431. BALL

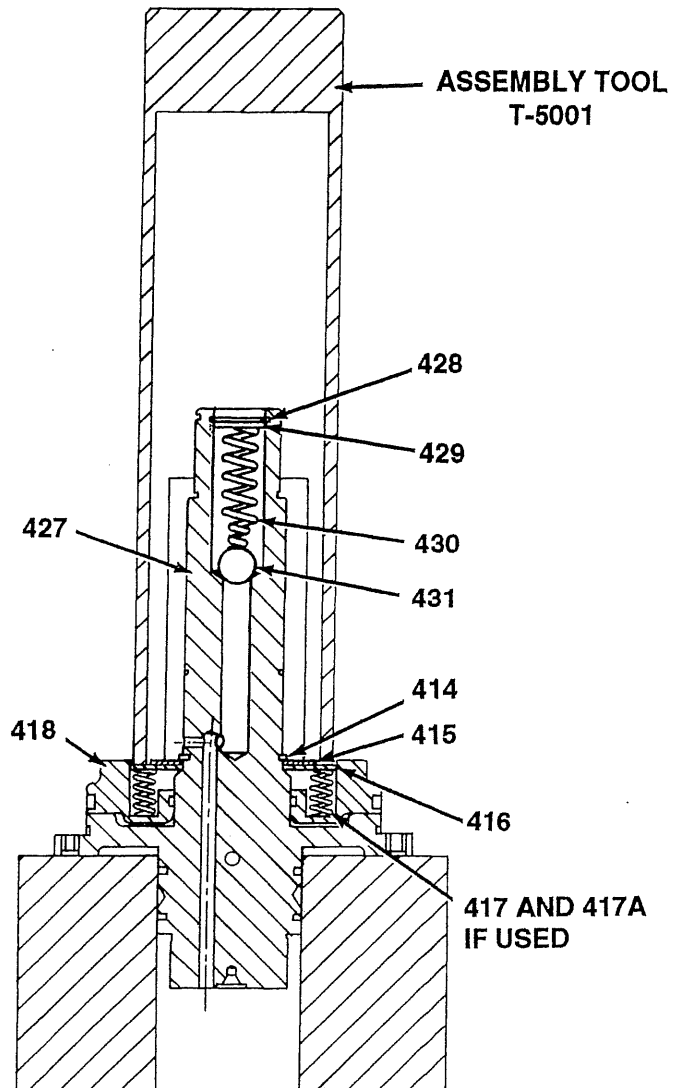


Figure 3-16. Removing Snap Ring

# Section 4

## Cleaning, Inspection, Repair or Replacement

### 4-1. CLEANING

**NOTE:** Prior to cleaning case cover and magnet assembly, check magnet cemented in case bottom for presence of metal particles. Larger, granular or irregular shaped particles indicate chipping or similar damage. Smaller, powderlike particles indicate uneven or excessive wear. If metal particles are detected, be on the lookout for damage or wear when inspecting rotating parts and those with which they mate.

**4-2. GENERAL CLEANING PROCEDURE.** Wash parts in mineral spirits or similar cleaning solvent to remove old lubricant and dirt deposits. Use a bristle brush to remove caked-on deposits. Parts that cannot be cleaned by brushing may be scraped but use care not to damage metal surfaces.

**4-3. DRYING CLEANED PARTS.** Dry parts with low pressure (20 psi 140 kPa max) compressed air. Wiping parts dry could leave lint deposits.

**4-4. LUBRICATING BEARINGS.** Immediately after cleaning, lubricate bearing cones (20, 24 and 31, figure P-1; 301, figure P-3; and 402, figure P-4) and needle bearings (306, figure P-3; and 404, figure P-4) with transmission lubricant (refer to paragraph 2-4). Spin drying bearings will result in damage. Cover lubricated bearings to protect from dust.

### 4-5. INSPECTION

**4-6. GENERAL INSPECTION PROCEDURES.** Visually inspect all parts except o-rings, sealing rings, oil seals and gaskets, which should be replaced with new parts. Inspect for damage or excessive or uneven wear. Reject parts with damage or wear that would affect serviceability of the part. Inspection terms used in this section are as follows:

**Burr:** Local rise of material forming protruding sharp edge.

**Chip:** An area from which a small fragment has been broken off or cut.

**Crack:** Surface break of line nature indicating partial or complete separation of material.

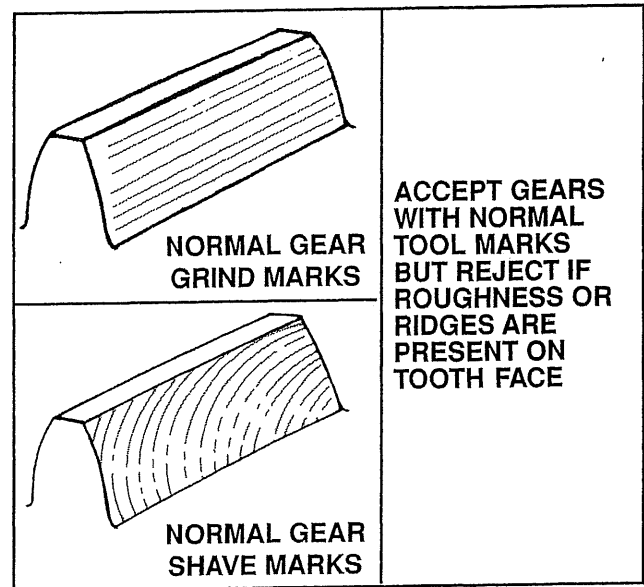


Figure 4-1. Normal Gear Tooth Tool Marks

**Excessive wear:** Heavy or obvious wear beyond expectations considering conditions of operation.

**Indentation:** Displacement of material caused by localized heavy contact.

**Galling:** Breakdown (or build-up) of metal surface due to excessive friction between parts because of lack of lubrication. Particles of the softer material are torn loose and welded to the harder material.

**Nick:** Local break or notch. Usually displacement of material rather than loss.

**Scoring:** Tear or break in metal surface from contact under pressure. May show discoloration from heat produced by friction caused by lack of lubrication.

**Step wear:** Heavy wear that produces a step that can be seen or felt between adjacent contact and non-contact surfaces.

**Uneven wear:** Condition of localized, unevenly distributed wear. Includes hollows, shiny spots, uneven polish and other visual indications.

**4-7. SPECIFIC INSPECTION PROCEDURES.** Inspect parts in accordance with Table 4-1 and as specified in the following paragraphs. Index numbers used in Table 4-1 are those assigned to the exploded views in Section P, Parts.

**4-8 GEAR TEETH INSPECTION.** When specified in Table 4-1, inspect gear teeth as follows:

**NOTE: Do not confuse contact patterns with normal tool marks that are a result of manufacture. Typical tool marks are shown in figure 4-1.**

a. Check gear tooth contact wear patterns. Gears showing evidence of excessive or irregular wear must be replaced.

b. Check gear teeth for chips, galling, nicks or scoring. Gears with chipped, broken teeth, galled or scored must be replaced.

**4-9. SPLINE TEETH INSPECTION.** Check for broken or chipped spline teeth. If any spline tooth is chipped or broken, the part must be replaced. Spline teeth will not show contact patterns as gear teeth do. However, they may show evidence of step wear which is cause for replacement.

#### **4-10. PARTS REPLACEMENT**

4-11. Parts which fail to pass inspection shall be replaced unless repair procedures specified in the following paragraph, or other obvious minor repair, will restore the part to complete serviceability. If there is any doubt about the serviceability of a part, replace it.

**4-12. REMOVING SMALL BURRS.** Use a suitable abrasive stone to remove burrs. Be careful to remove only raised material, not base metal.

**4-13. ROLLER BEARING REPLACEMENT.** If roller bearing cups and cones are replaced, bearings must be reshimmed at assembly.

**4-14. SUPERSEDED PARTS.** As noted in the parts lists in Section P, some parts in early production transmissions have been superseded. Superseded parts may be reused provided they pass all inspection requirements. Superseded parts are not available for replacement nor are they included in repair kits. If the transmission is being overhauled, replacement of all superseded parts and use of all repair kits is recommended for optimum service.

**4-15. EARLY PRODUCTION PARTS.** Early production parts may be used only in their original configuration. Early and current production parts can not be intermingled.

**4-16. MATCHED SETS.** Case cover and magnet assembly (14) and transmission case (46) are a matched set. If either part requires replacement, the complete set as described in Section P must be replaced.

4-17. Three repair kits are available, containing parts which are commonly replaced during repair or overhaul. The kits and their contents are listed in Tables P-1 through P-3. When using kits, replace all applicable parts contained in the kit.

Table 4-1. Inspection

PART (INDEX NO.)	INSPECTION	COMMENTS
All parts (including all springs)	Check for cracks  Check for distortion	Replace parts with cracks  Replace parts that are bent, distorted out of round or discolored due to heat
All threaded parts [except thread inserts (42)]	Check for stripped, crossed or otherwise damaged threads	Replace parts with threads that cannot be cleaned up using a suitable tap or die
Case cover & magnet assy (14), case (46) and valve & pump housing (222)	Check mating faces for burrs or other damage that would prevent proper seating of mating faces	Remove small burrs per paragraph 4-13. otherwise, replace damaged parts or assemblies *
Case cover & magnet assembly (14) & bearing cups (12 & 13)	Check bearing cups (12 and 13) for chipping, galling, scoring or other damage	Replace damaged bearing cups. If bores in cover for cups are scored or damaged, replace assembly.
Output flange (18)	Check spline per paragraph 4-9	Paragraph 4-9
Bearing cones (20, 24, 31, 301 and 402)	Check rollers and races for chipping, galling, scoring or other damage  Make sure bearing cone is lubricated, Slowly rotate rollers, feeling for binding, roughness or flat spots.	Replace damaged bearing cones  Replace bearing cones that have damaged or loose rollers
Output gear (26)	Check gear teeth per paragraph 4-8	Paragraph 4-8
Output shaft (27)	Check bearing journals for scoring  Check for distortion  Check spline per paragraph 4-9	Replace if scored or damaged  Replace if bent or out of round  Paragraph 4-9
Bearing cups (30)	Check cups for chipping, galling, scoring or other damage	Replace damaged bearing cups
Oil baffle (33)	Check for distortion or damage	Replace if bent or cracked
Suction tube assy (34 or 34A)	Check for distortion or damage  Check O-ring gland end for nicks or burrs that would cause leakage	Replace if bent, cracked or if broken welds found  Replace if damaged
Breather (36)	Check that breather is open and that cap moves freely	Replace breather if clogged

\* Case cover and magnet assembly (14) and case (46) are a matched set. See listing in Section P.

Table 4-1. Inspection (Cont)

PART (INDEX NO.)	INSPECTION	COMMENTS
Case (46) and bearing cups (44 & 45)	Check bearing cups (44 and 45) for chipping, galling, scoring or other damage  Check for loose or damaged thread inserts (42)	Replace damaged bearing cups. If bores in case for cups are scored or damaged, replace case *  Replace thread inserts. If not repairable, replace assembly
Pump assy (202)	Visually check for damage or excessive wear	Replace damaged pump
Switch assembly (203)	Test switch to be open when plunger depressed; closed when plunger released	Replace damaged switch
Transmission shift lever (207) & ball (208)	Check for distortion, damage or excessive wear	Replace if lever bent or if ball and detent holes are excessively worn
Control valve (211), valve piston (218 or 218A) or washer (219) & mating bores in valve and pump housing (222)	Check for scratches, nicks, burring, scoring or other damage that would cause leakage or binding	Replace damaged parts
Filter and screen assy (220)	Check for damaged or clogged screen	Replace if necessary
Thrust washers (302 and 415)	Check for distortion, scoring or wear	Replace if bent, scored or if step wear is noted
Clutch gear (304 and 403)	Check gear teeth per paragraph 4-8  Check splines per paragraph 4-9  Check ID for needle bearings	Paragraph 4-8  Paragraph 4-9  Replace if scored or damaged
Needle bearings (306 and 404)	Check rollers for chipping, galling scoring or other damage	Replace damaged bearings
Clutch disc assys (311 & 409) & discs (312 & 410), backing plates (309 or 309A & 407 or 407A) and clutch plates (310 or 310A & 408 or 408A)	Check mating faces for scoring wear or warping	Replace if scored worn or damaged. Mating faces must be smooth. Clutch discs and plates must be flat

\* Case cover and magnet assembly (14) and case (46) are a matched set. See listing in Section P.



Table 4-1. Inspection (Cont)

PART (INDEX NO.)	INSPECTION	COMMENTS
Clutch disc assys (311 & 409) and discs (312 & 410), backing plates (309 or 309A & 407 or 407A) and clutch plates (310 or 310A & 408 or 408A)	Check splines per paragraph 4-9	Paragraph 4-9
Clutch piston assys (319 and 418) and mating sealing surfaces in clutch gear cylinders (315 & 413) and on input and lay shafts (329 & 427)	Check for scratches, nicks, burrs, porosity, scoring or other damage that would cause leakage or binding	Replace damaged parts
Clutch gear cylinders (315 and 413)	Check gears per paragraph 4-8  Check splines per paragraph 4-9	Paragraph 4-8  Paragraph 4-9
Input and lay shafts (329 and 427)	Check splines per paragraph 4-9  Check bearing journals  Check for distortion	Paragraph 4-9  Replace if scored or damaged  Replace if bent or out of round

\* Case cover and magnet assembly (14) and case (46) are a matched set. See listing in Section P.



# Section 5 Assembly

## 5-1. GENERAL INFORMATION

5-2. During assembly, refer to the illustrations specified in the text. In addition, an exploded view of the complete assembly and major subassemblies can be viewed in Section P, Parts. These exploded view illustrations are listed at the beginning of Section P. Note the following during assembly:

1. When a torque value is specified, use a torque wrench to tighten the threaded part. Torque values are specified in the text and also in Table 5-1 at the end of this section.

2. Coat small parts with petroleum jelly to help hold them in place during assembly.

**5-3. LUBRICATION DURING ASSEMBLY.** Lubricate all internal parts, not coated with petroleum jelly or with approved transmission lubricant (refer to paragraph 2-4) just prior to assembly. This will ease assembly and provide initial lubrication.

1. O-rings, sealing rings and shaft seal lips may be damaged during assembly if not lubricated.

2. Make sure bearing cones (20, 24 and 31, figure P-1; 301, figure P-3; and 402, figure P-4) and needle bearings (306, figure P-3; and 404, figure P-4) are thoroughly lubricated before assembly. Running bearings dry, even for a brief period, will cause damage.

## 5-4. LAY SHAFT ASSEMBLY

**5-5. ASSEMBLY OF CLUTCH PISTON AND CYLINDER** Assemble lay clutch piston and cylinder as follows (see figure 5-1):

1. Install ball (431), spring (430) and spacer (429) into end of lay shaft (427). Use a suitable drift to press on spacer and compress spring while installing snap ring (428).

2. Install seal rings (426) and o-ring (425) in grooves in lay shaft (427).

3. Install sealing ring assembly (422), consisting of o-ring (424) and sealing ring (423), in groove in ID of clutch piston assembly (418). Install sealing ring assembly (419), consisting of o-ring (421) and sealing ring (420) in groove in OD of clutch piston.

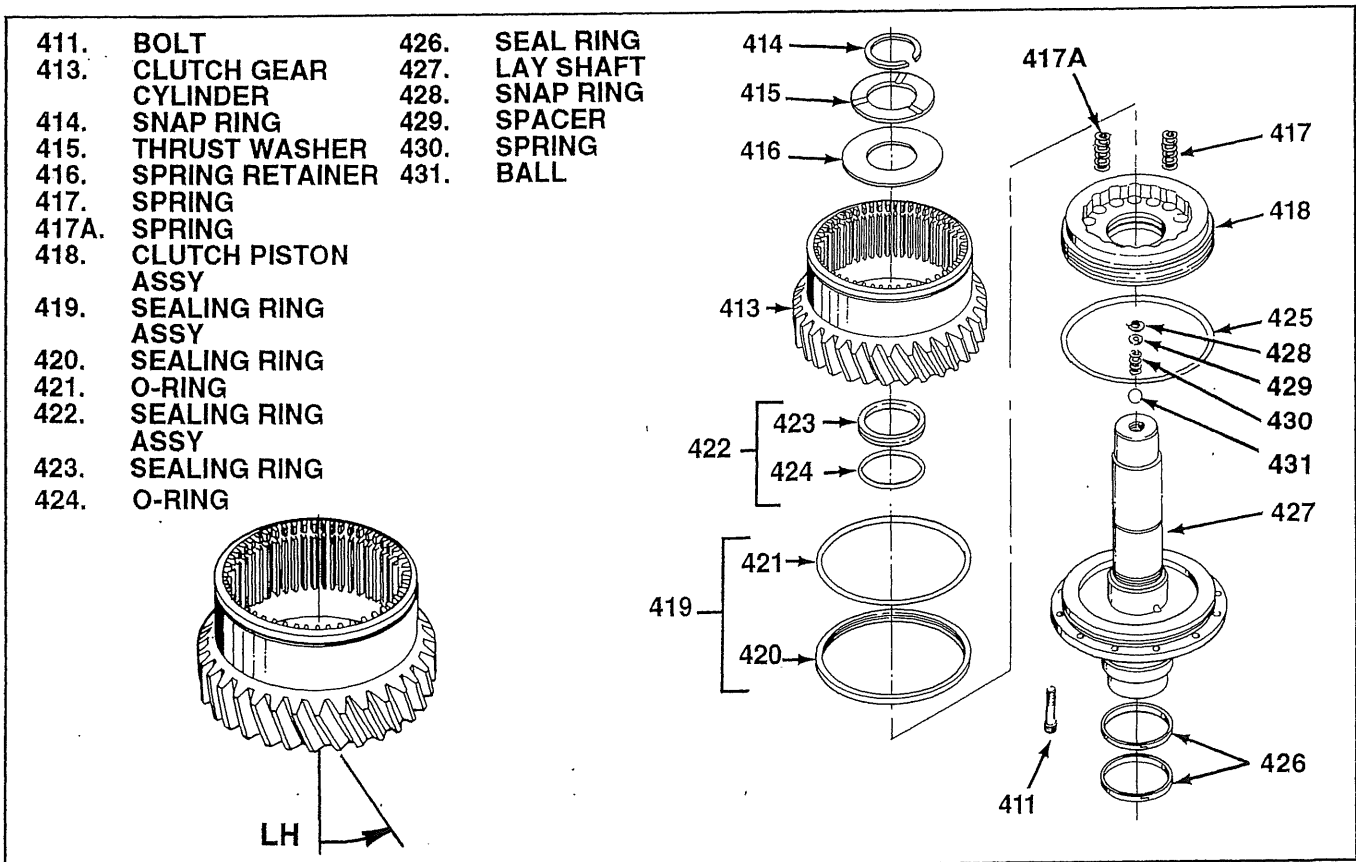


Figure 5-1. Lay Clutch Cylinder and Piston

4. Install clutch piston assembly (418) on lay shaft (427) with sixteen spring holes facing away from shaft flange. Seat piston against shaft flange.

5. Support lay shaft with parts previously installed in suitable holding fixture (see figure 5-2) in arbor press.

6. Install springs (417, and if used 417A) in holes in clutch piston assembly (418) as follows:

a. For transmissions 2001-000-011 thru -016, and 2001-000-R01 thru 2001-000-R06 install sixteen springs (417).

b. For transmissions 2001-000-001 thru -006, first install four springs (417) equally spaced. Then install three springs (417A) between each of the springs (417)—twelve springs (417A) total.

7. Install spring retainer (416) and thrust washer (415). Expand snap ring (414) and slide onto shaft

up against thrust washer.

8. Using assembly tool T-5001, press down on spring retainer (416) to compress springs (417, and 417A if used) and provide access to shaft groove for snap ring (414) (see figure 5-2). Install snap ring in shaft groove. Remove shaft assembly, holding fixture and assembly tool from arbor press. Remove assembly tool from shaft assembly.

9. The helical on the lay clutch gear must be left handed. That means the teeth must be inclined to the left when viewed from the face of the gear (see figure 5-1). If the incorrect helical (input clutch) gear is installed there may be resulting damage to the lay shaft pump side bearing.

10. Using Guide pins, install clutch gear cylinder (413) over clutch piston assembly (418) and onto lay shaft (427). Install twelve bolts (411). Torque bolts to 16-18 lb-ft (22-25 Nm).

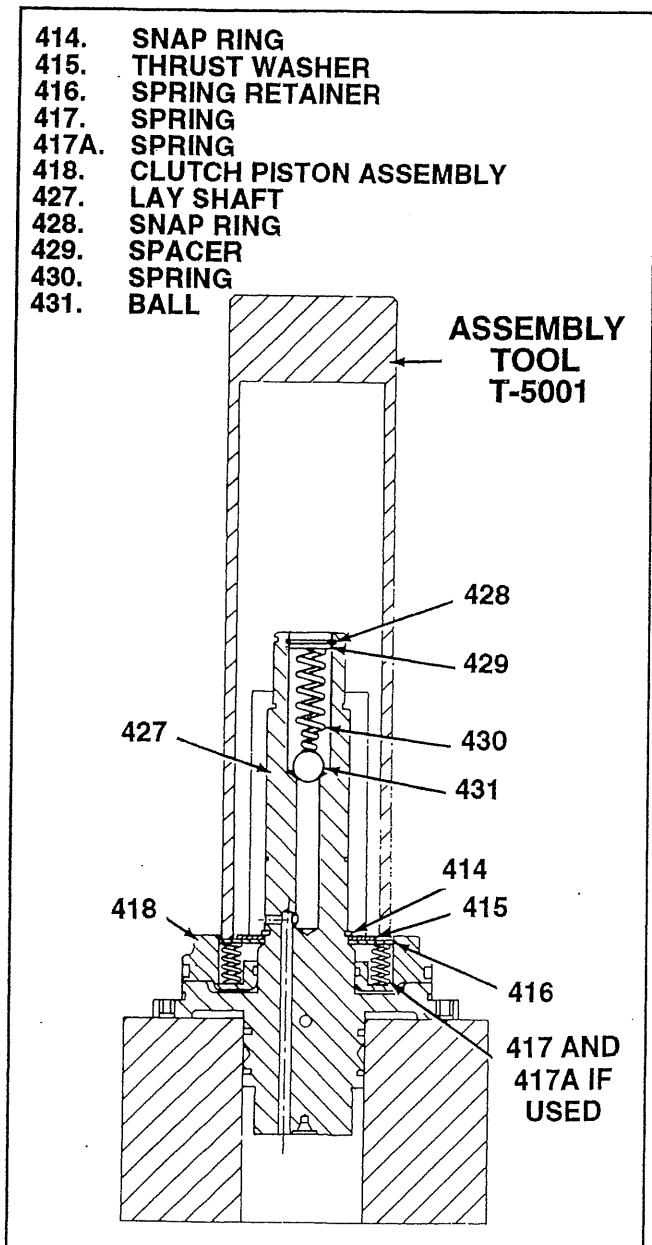


Figure 5-2. Installing Snap Ring

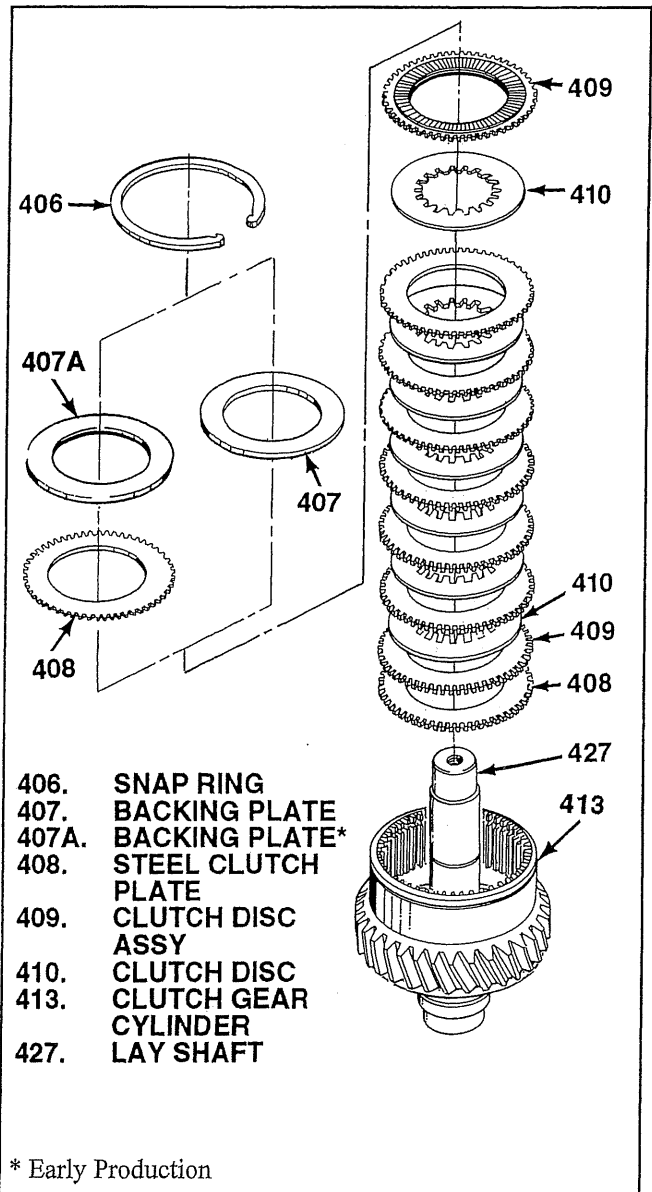


Figure 5-3. Lay Clutch Group

**5-6. ASSEMBLY OF CLUTCH GROUP.** With shaft assembly in holding fixture as described in paragraph 5-5, proceed as follows (see figure 5-3):

1. Align splines and install one steel clutch plate (408) over lay shaft (427), into clutch gear cylinder (413).

2. Starting with one clutch disc assembly (409), alternately install eight clutch disc assemblies and seven clutch discs (410).

3. Install 5.0 mm (0.200 in) thick backing plate (407). If 3.0 mm (0.112 in.) thick backing plate (407A) is used, it must be installed over an additional steel clutch plate (408).

4. Secure clutch group in clutch gear cylinder (413) with snap ring (406).

**5-7. ASSEMBLY OF CLUTCH GEAR AND BEARINGS.** With shaft assembly in holding fixture as described in paragraph 5-5, proceed as follows (see figure 5-4):

1. Install snap ring (405) on lay shaft (427).

2. Select lay clutch gear (403)—not input clutch gear (304) (see figure 5-4). Align splines on clutch discs previously installed and install lay clutch gear (403). This is best done by using a twisting, orbiting motion. Make sure clutch gear is fully installed, engaging all clutch discs. Outside end of gear should be flush to below shoulder on lay shaft (427).

3. Install three needle bearings (404) on lay shaft (427).

4. Position shaft assembly on holding fixture in arbor press. Using drift T-5002, press bearing cone (402) on shaft to seat on shaft shoulder.

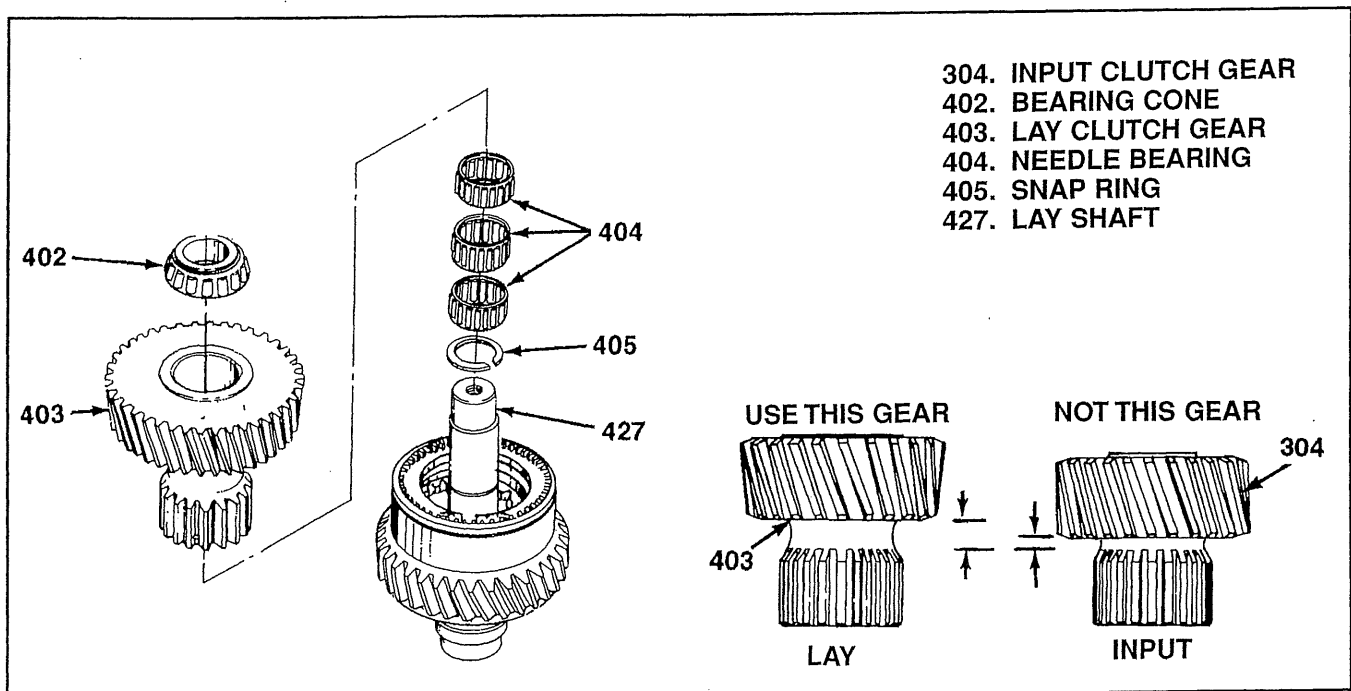


Figure 5-4. Lay Clutch Gear and Bearings

## 5-8. INPUT SHAFT ASSEMBLY

### 5-9. ASSEMBLY OF CLUTCH PISTON AND CYLINDER

Assemble input clutch piston and cylinder as follows (see figure 5-5):

1. Install seal rings (328 and 327) and o-ring (326) in grooves on input shaft (329).

2. Install sealing ring assembly (323), consisting of o-ring (325) and sealing ring (324), in groove in ID of clutch piston assembly (319). Install sealing ring assembly (320), consisting of o-ring (322) and sealing ring (321) in groove on OD of clutch piston.

3. Install clutch piston assembly (319) on input shaft (329) with sixteen spring holes facing away from shaft flange. Seat piston against shaft flange.

4. Support input shaft with piston, o-rings and seal rings (319 through 329) in suitable holding fixture (see figure 5-6) in arbor press.

5. Install springs (318, and if used 318A) in holes in clutch piston assembly (319) as follows:

a. For transmissions 2001-000-011 thru -016, and 2001-000-R01 thru 2001-000-R06 install sixteen springs (318).

b. For transmissions 2001-000-001 thru -006, first install four springs (318) equally spaced. Then

install three springs (318A) between each of the springs (318)—twelve springs (318A) total.

6. Install spring retainer (317). Expand snap ring (316) and slide onto shaft up against spring retainer (317).

7. Using assembly tool T-5001, press down on spring retainer (317) to compress springs (318, and if used 318A) and provide access to shaft groove for snap ring (316). Install snap ring in shaft groove. Remove shaft assembly, holding fixture and assembly tool from arbor press. Remove assembly tool from shaft assembly.

8. The helical on the input clutch gear must be right handed. That means the teeth must be inclined to the right when viewed from the face of the gear (see figure 5-5). If the incorrect helical (lay clutch) gear is installed there may be resulting damage to the rear lay shaft bearing.

9. Using guide pins install clutch gear cylinder (315) over clutch piston assembly (319) and onto input shaft (329). Install twelve bolts (313). Torque bolts to 16-18 lb-ft (22-25 Nm).

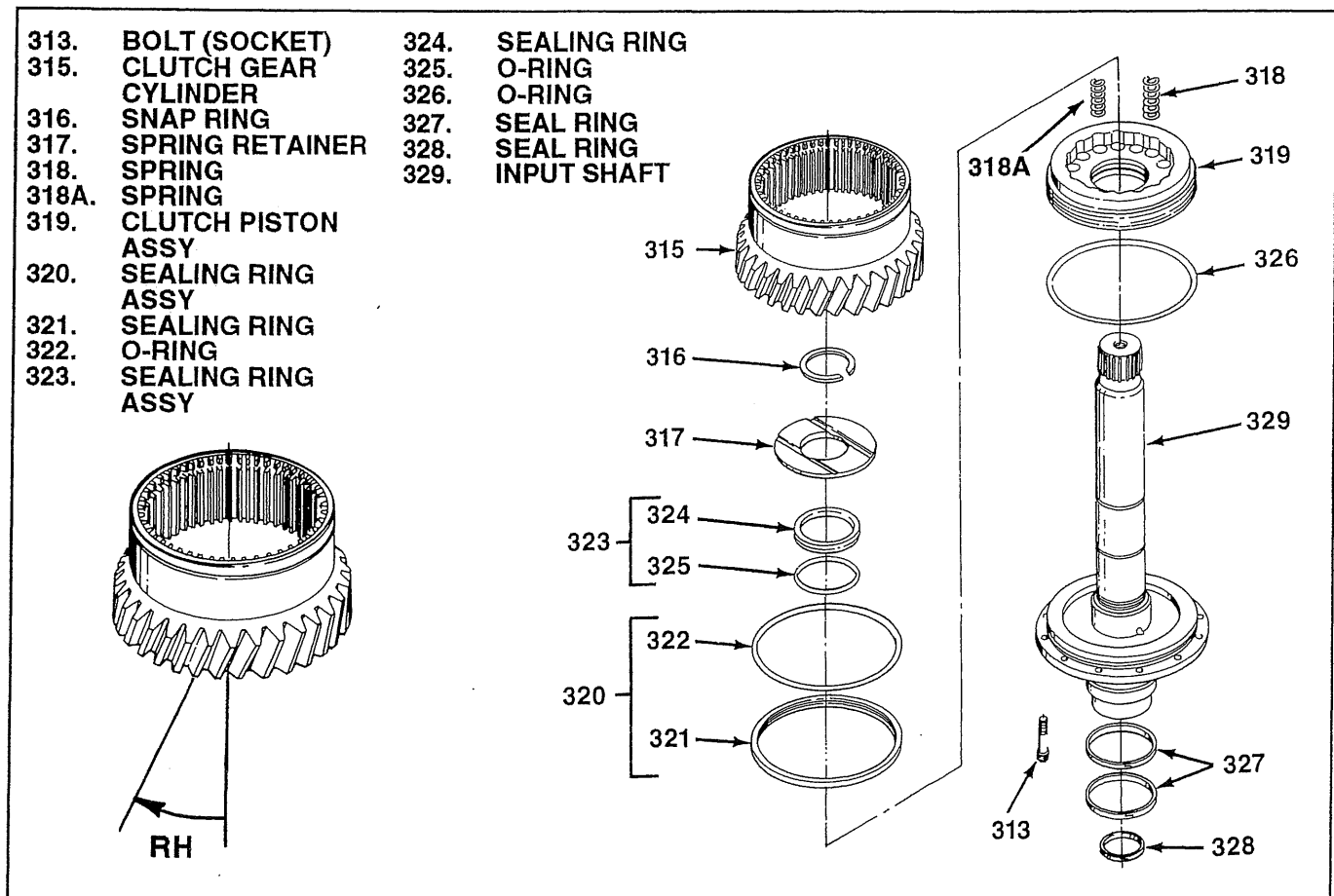


Figure 5-5. Input Clutch Cylinder and Piston

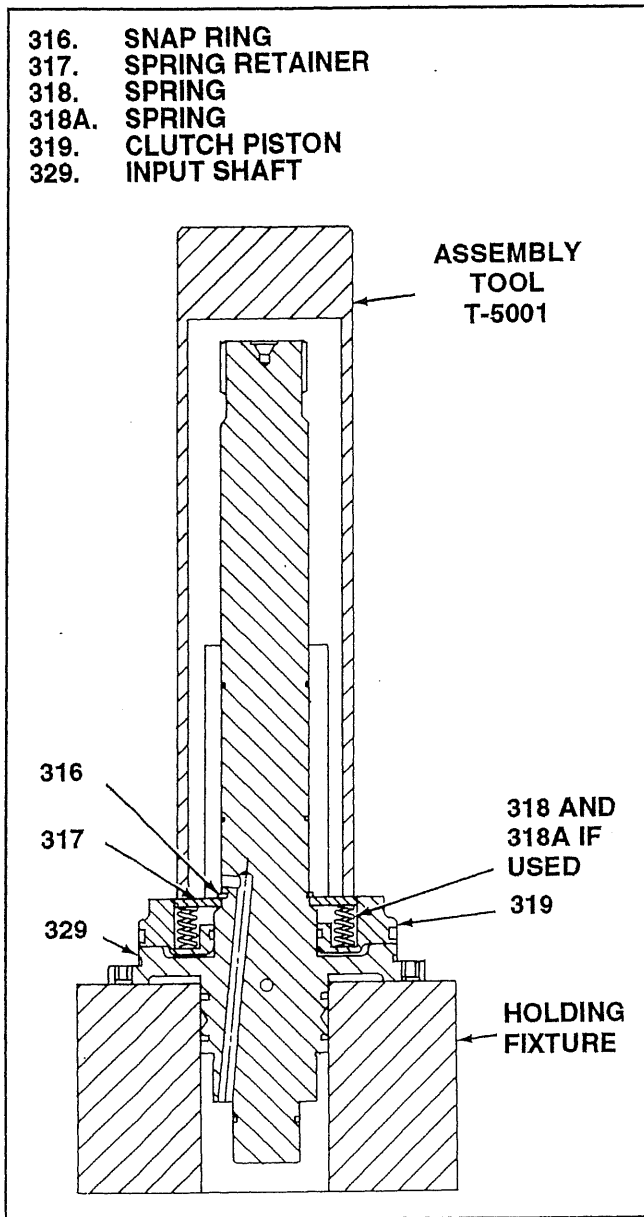


Figure 5-6. Installing Snap Ring

**5-10. ASSEMBLY OF CLUTCH GROUP.** With shaft assembly in holding fixture as described in paragraph 5-9, proceed as follows (see figure 5-7):

1. Align splines and install one steel clutch plate (310) over input shaft (329), into clutch gear cylinder (315).

2. Starting with one clutch disc assembly (311), alternately install eight clutch disc assemblies and seven clutch discs (312).

3. Install 5.0 mm (0.200 in) thick backing plate (309). If 3.0 mm (0.112 in.) thick backing plate (309A) is used, it must be installed over an additional steel clutch plate (310).

4. Secure clutch group in clutch gear cylinder (315) with snap ring (308).

**5-11. ASSEMBLY OF CLUTCH GEAR AND BEARINGS.** With shaft assembly in holding fixture as described in paragraph 5-9, proceed as follows (see figure 5-8):

1. Install snap ring (307) on input shaft (329).  
2. Select input clutch gear (304)—not lay clutch gear (403) (see figure 5-8). Align splines on clutch discs previously installed and install input clutch gear (304). This is best done by using a twisting, orbiting motion. Make sure clutch gear is fully installed, engaging all clutch discs. Outside end of gear should be flush to below shoulder on input shaft (329).

3. Install three needle bearings (306) on input shaft (329).

4. Install snap ring (305). If there are two (2) available groves about 5/16 in (8mm) apart use the groove closest to the bearing. The second groove is not used in the models described in this manual and must remain empty.

5. Install **thrust washer** (302) and **spacer** (303). The spacer (303) fits inside the thrust washer (302).

6. Position shaft assembly on holding fixture in arbor press. Using drift T-5003, press bearing cone (301) on shaft to seat on spacer (303) against snap ring (305).

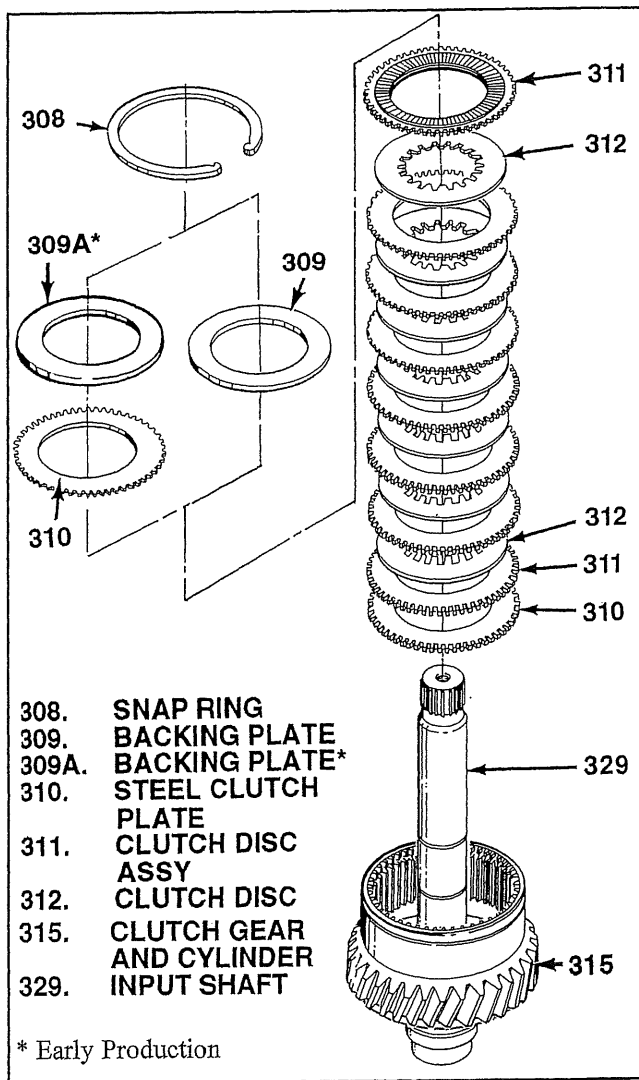


Figure 5-7. Input Clutch Group

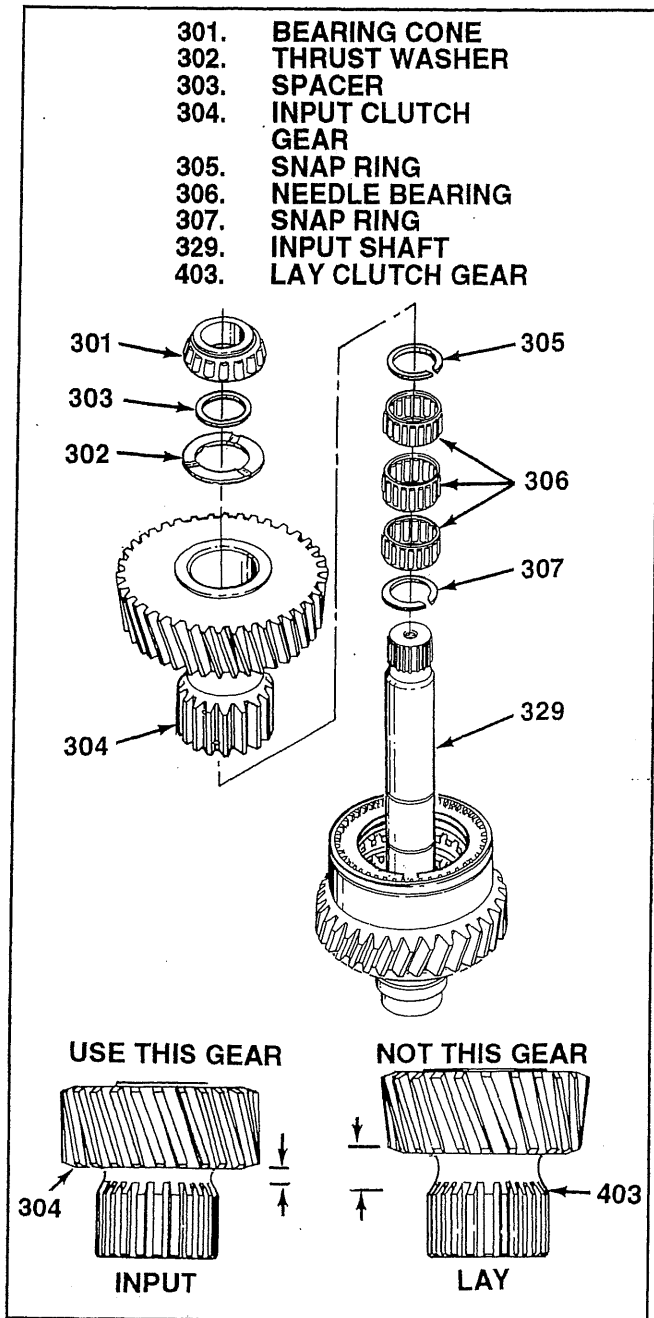


Figure 5-8. Input Clutch Gear and Bearings

## 5-12. VALVE AND PUMP ASSEMBLY

**5-13. SCREEN, PISTON AND CONTROL VALVE AND PUMP ASSEMBLY.** Assemble as follows (see figure 5-9):

1. If removed, press in new pins (221).
2. Install screen assembly (220), chamfered end first, into valve and pump housing (222).
3. Install valve piston parts as follows:
  - a. If valve piston (218) is used, install piston (218)—large end first—washer (219) and springs (217 and 217A) in valve and pump housing (222).

- b. If valve piston 218A is used, install small end first. Install spring (217). It is necessary to hold spring(s) (217A and/or 217) compressed to start screws.

4. Install gasket (216) and cover plate (215) and attach with six bolts (214). Torque bolts to 4-5 lb-ft (5-7 Nm).

5. Install o-ring (212) in groove on control valve (211) using petroleum jelly and install control valve in valve housing (222) with detent socket toward top. Install snap ring (210).

**5-14. CONTROL LEVER, SWITCH AND PUMP ASSEMBLY.** With control valve installed in valve and pump housing, proceed as follows (see figure 5-10):

1. Temporarily install transmission shift lever (207) on control valve previously installed, aligning flats. Turn lever and valve up to installed position as shown in figure 5-10. Remove control lever.
2. Install spring (209), ball (208) and shift lever (207). Holding control lever in place, as shown in illustration 5-10, install flat washer (206), lock washer (205) and nut (204). Holding lever, torque nut to 14-16 lb-ft (19-22 Nm).
3. Install switch assembly (203) Torque switch assembly to 20-25 lb-ft (27-34 Nm).
4. Position pump assembly (202) in valve and pump housing assembly (222) with counterbored holes for bolt head out. Align all three bolt holes and install bolts (201). Torque bolts to 6-8 lb-ft (8-11 Nm).

## 5-15. TRANSMISSION ASSEMBLY

**5-16.** After assembling major subassemblies as described in the preceding paragraphs of this section, assemble transmission as follows:

**5-17. CASE ASSEMBLY.** If replaced, assemble case assembly parts as follows (see figure 5-11):

1. If removed, press new bearing cups (44 and 45) in to bottom in case (46) bores. If bearing cones are replaced, the cups (44 and 45) must be replaced also. Care must be taken to support case so that centerline through cup bores is vertical.
2. If removed, install new thread inserts (42) using standard Heli-Coil® installation tools. Install inserts flush to one turn below mounting face of case (46). Follow Heli-Coil® instructions carefully.



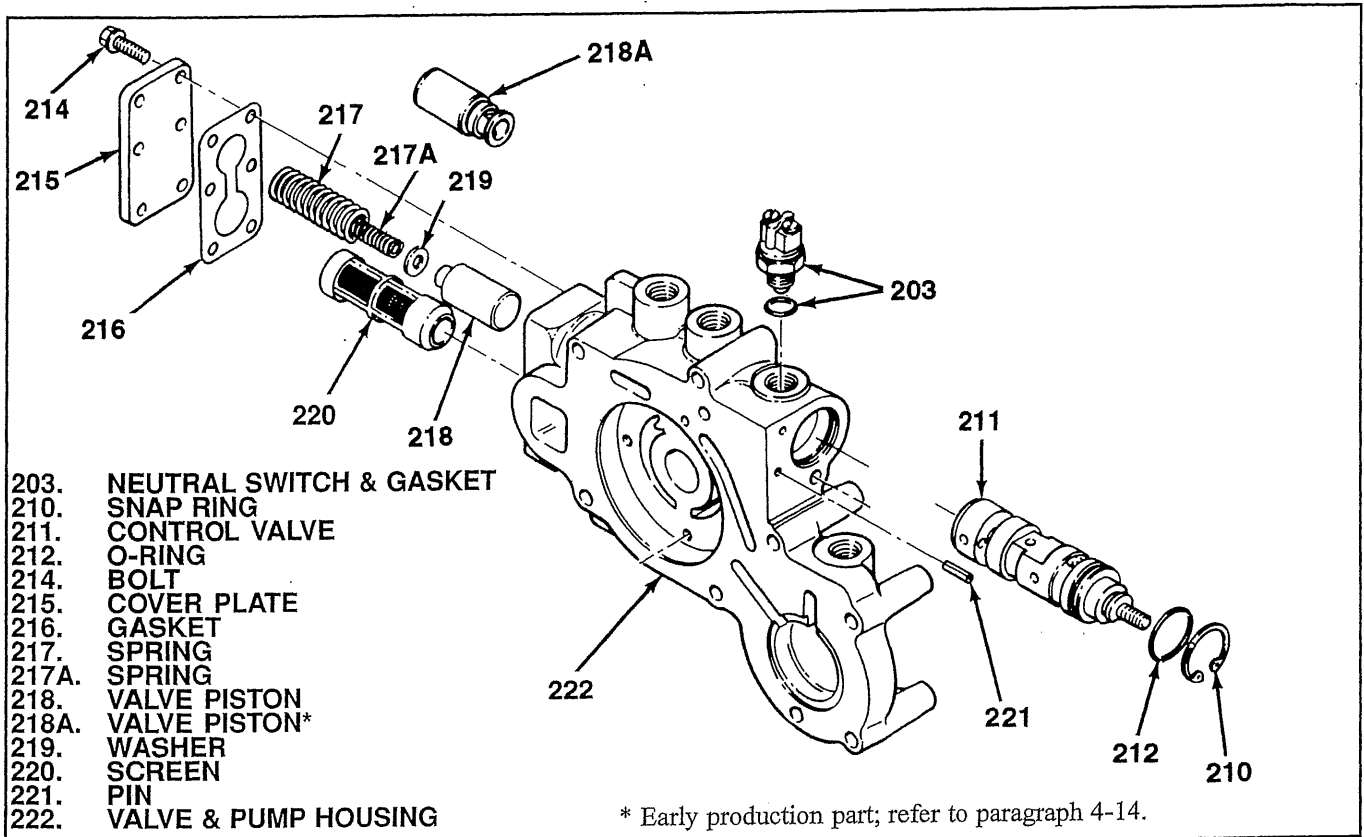


Figure 5-9. Filter, Piston and Control Valve

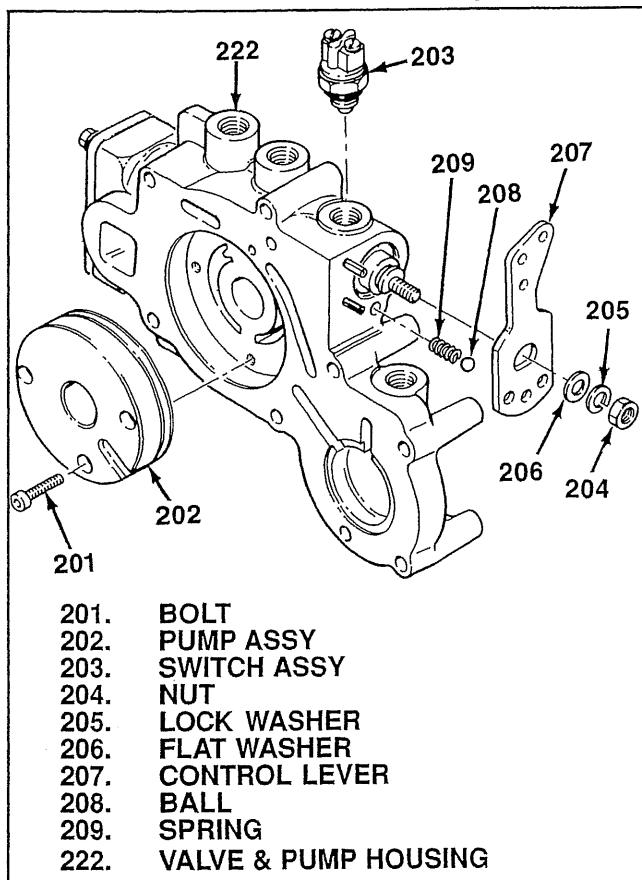


Figure 5-10. Control Lever, Switch and Pump

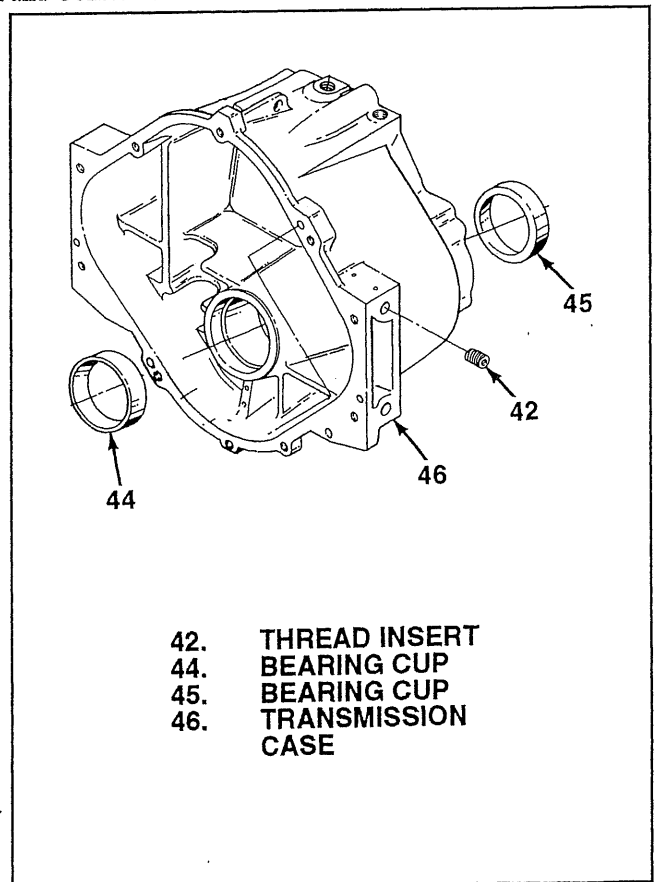


Figure 5-11. Case Assembly

**5-18. OUTPUT SHAFT ASSEMBLY.** It is necessary to establish output shaft bearing preload before assembling the input and lay shaft components in the case. Assemble and temporarily install output shaft assembly as follows (see figure 5-12).

1. Place bearing cone (20) in cup and insert seal (19). Rotate and support case (46) so the open cavity is facing up.

2. Assemble output shaft (27) and output gear (26) using a suitable press. This is best done by using 4 guide pins equally spaced in place of bolts (25). Once in place remove the guide pins and apply Loctite 271® (red) to the threads of each of the eight bolts (25). Install bolts and torque to 18-24 lb-ft (24-33 Nm).

3. Using suitable press and drift T-5004, press bearing cone (24) onto output shaft (27) to bottom on shaft shoulder.

4. To determine proper thickness of shim(s) (21) required proceed as follows:

a. Assemble one sleeve (22) on output shaft (27) with the small end facing bearing (24). Place shims totaling 0.050 (1.27mm) inch on shaft followed by a second sleeve (22). Assemble the second sleeve so the large end of both sleeves face each other with the shims between.

**NOTE: If a single sleeve (22A) was originally used it should be discarded and replaced with two sleeves (22) described in step (a) above. Also, do not use the smaller shims used with sleeve (22A).**

b. Insert output shaft assembly (23) into case (46) being careful not to drop the two sleeves (22) and shims (21) from shaft. Once inserted the seal will temporarily hold the sleeves and shims in place.

c. Install flange (18), and hold with coupling wrench T-5005. Tighten flange nut (17) to 50 ft-lbs (68 Nm) torque. Rotate the case as assembled so the flange is on the top.

d. Rotate the flange 3 or 4 complete revolutions to insure the output shaft assembly (23) is resting squarely in bearing cup (45).

e. Mount a dial indicator as shown in figure 5-13.

**NOTE: It is extremely important these next three steps are followed exactly:**

1. The magnetic base of the dial indicator is firmly mounted on the flange.
2. The dial indicator shaft is parallel to output shaft center line.
3. The exact point of dial indicator shaft contact with the case is marked and maintained throughout this procedure.

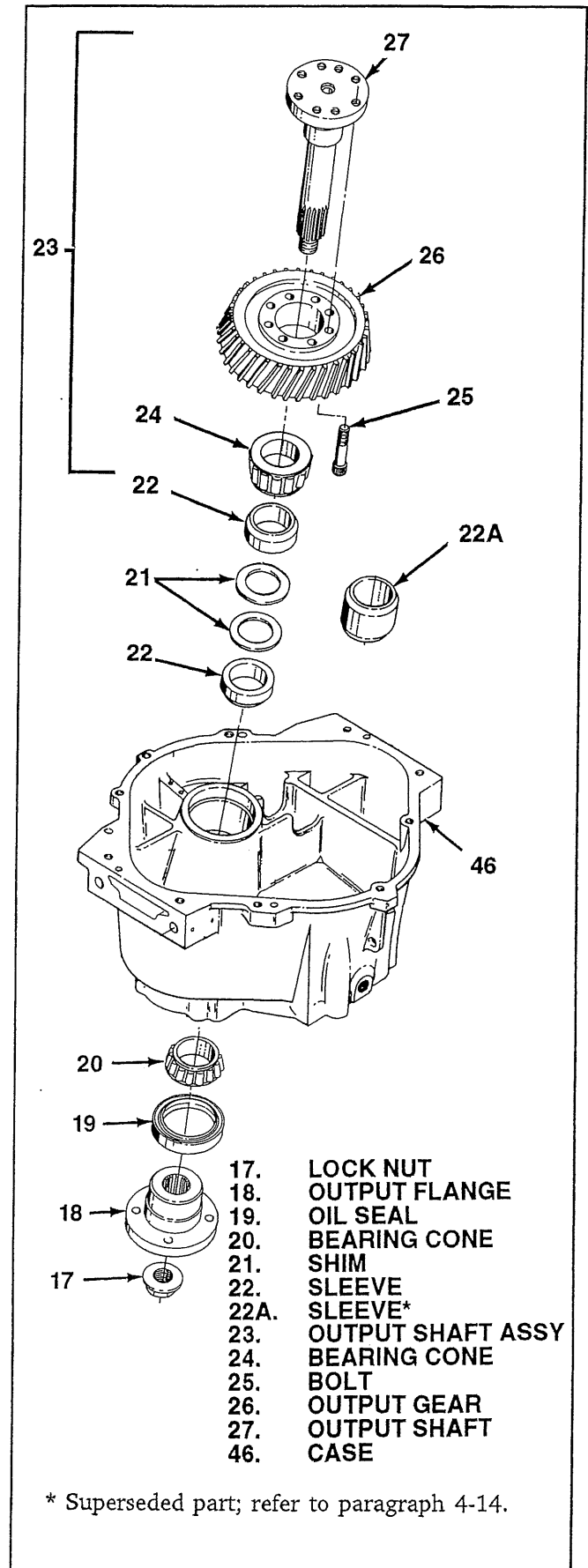


Figure 5-12. Output Shaft Assembly

f. Turn the dial indicator to zero. (0.000).

g. Raise the flange as far as possible using suitable leverage. Hold the shaft assembly in this upward position and take a second reading. Make sure the dial indicator shaft touches the case IN THE EXACT POINT AS IT WAS WHEN ZEROED. Step "g" should be repeated several times with a repetitive reading to insure a proper reading is taken.

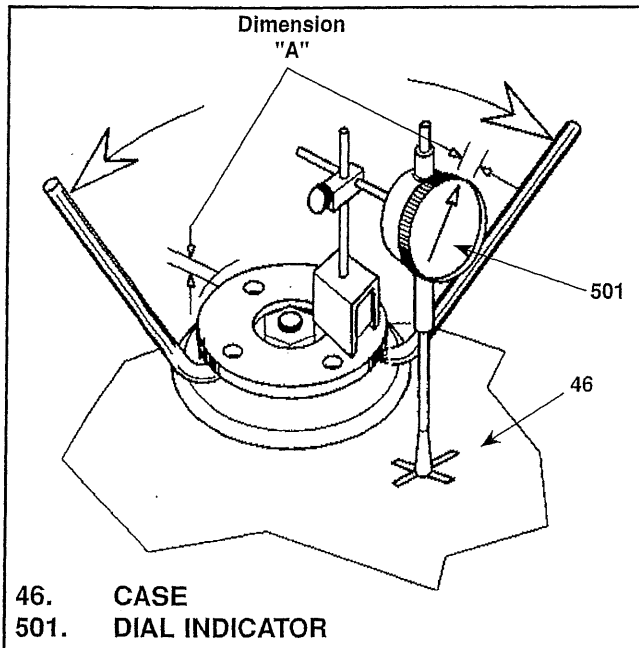


Figure 5-13. Magnetic Base Dial Indicator

We will call this reading DIMENSION "A"

h. The proper bearing preload is 0.004 inch 0.102mm. Calculate the required shim (21) thickness as follows:

	Formula in/mm	Example in/mm
- Shims temporarily installed in step "a" above	0.050/1.270	0.050/1.270
- Subtract desired preload	<u>- 0.004/-0.102</u>	<u>- 0.004/-0.102</u>
Sub total		0.046/1.168
- Subtract Dimension "A"	<u>- 0.???</u>	<u>- 0.010/0.254</u>
- Proper amount to be installed when output shaft is ultimately installed.	+ 0.XXX	0.036 in/.914mm

In the example above 0.036/0.914 inch is the proper amount of shims to be used when transmission is reassembled.

**NOTE: Reducing the amount of shims will increase pre-load.**

i. Remove flange (18) and flange nut (17) from output shaft (27) and lift output shaft assembly (23) from case (46). Make sure all temporary shims (21) are retrieved from case (46) cavity. Set output shaft assembly (23), two sleeves (22) and shims (21) calculated in paragraph 5-18 step "h" aside to be installed later as a matched set.

**CAUTION** If the clearing achieved in step 4g is negligible, increase the initial shim build up in step 4a to .070 inch (1.778 mm), and proceed as instructed in steps 4a through 4g, altering all your calculations accordingly.

## 5-19. LAY SHAFT AND INPUT SHAFT

**ASSEMBLIES.** Using lay shaft assembly as assembled in paragraph 5-4, input shaft assembly as assembled in paragraph 5-8 (see figure 5-15) and output shaft as assembled in paragraph 5-18 step "i" proceed as follows (see figure 5-16).

**NOTE:** If oil pick up tube (34A see figure 5-15) is used, perform step "2" before step "1".

1. Install oil pick up tube (34), oil baffle (33) and secure with two bolts (32). Use Loctite ® 242 on bolts (32).

2. Position lay shaft/clutch assembly (29) and input shaft/clutch assembly (28) in case (46). (see figure 5-15).

3. Check to make sure the garter spring is correctly positioned on the output seal (19) (see figure 5-17). Coat the large diameter of both sleeves

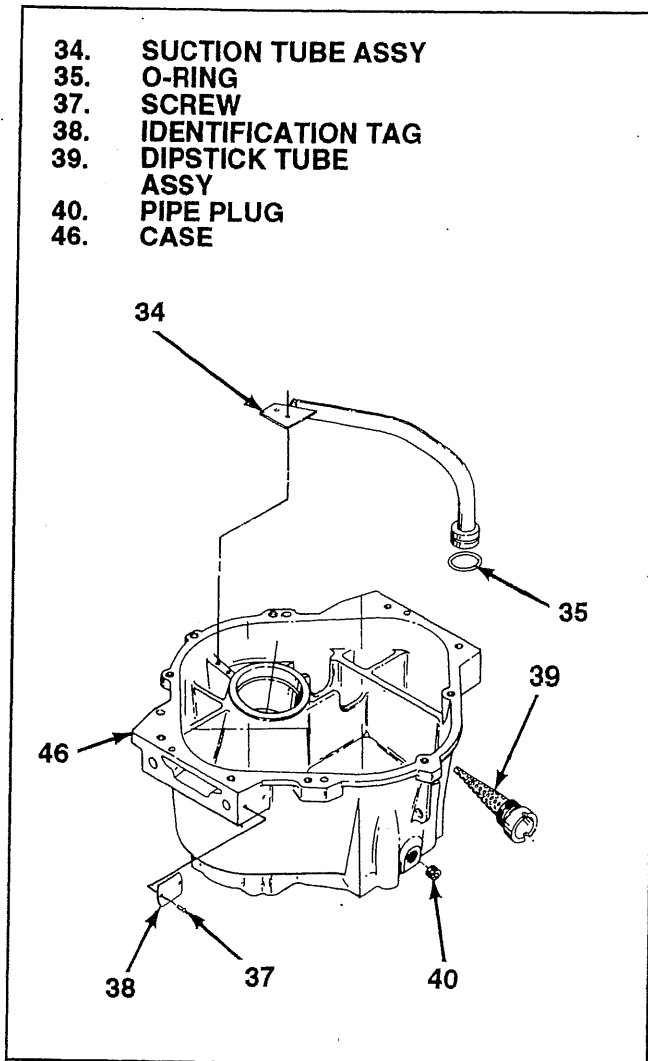


Figure 5-14. Case Components

(22) and shims (21) established in 5-18 step "h" with cup grease. Place sleeves (22) and shims (21) in case (46) cavity, resting on bearing cone (20) and seal (19) as illustrated in figure 5-17.

**NOTE:** The total shim and sleeve (22) thickness installed at this point must be the same thickness as established in 5-19 step "h".

4. Carefully insert output shaft/gear as illustrated in figure 5-16.

5. Install output flange (18) and flange nut (17) to hold assembly in place. It can be tightened later.

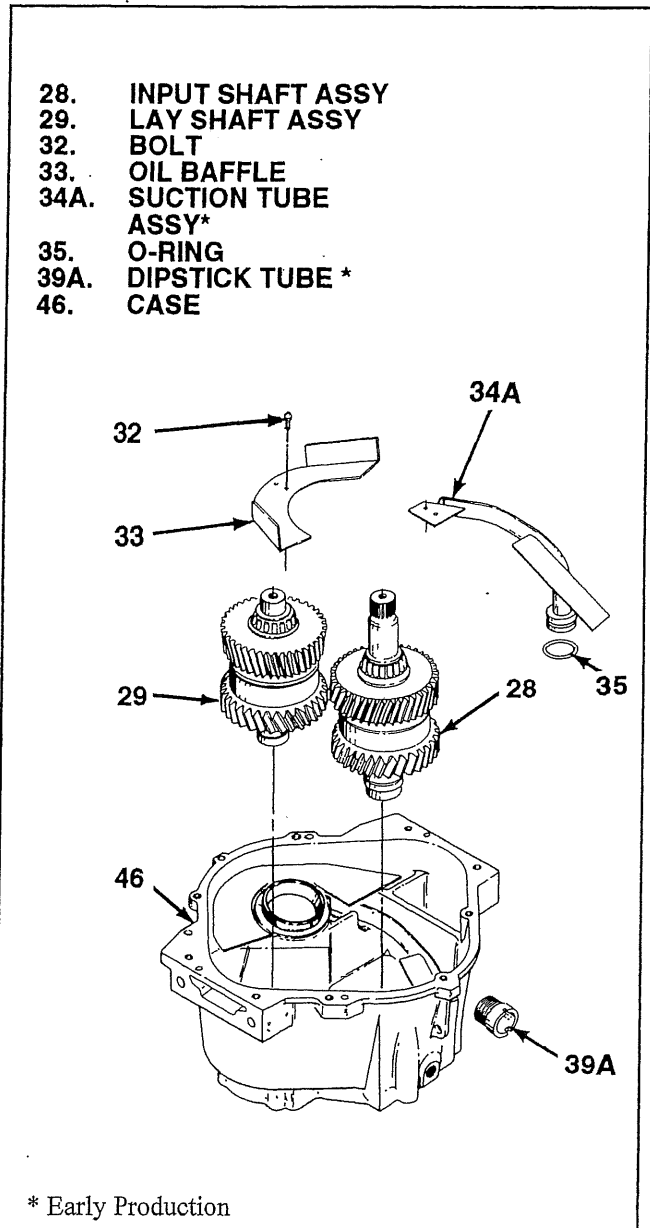


Figure 5-15. Input and Lay Shaft Assemblies

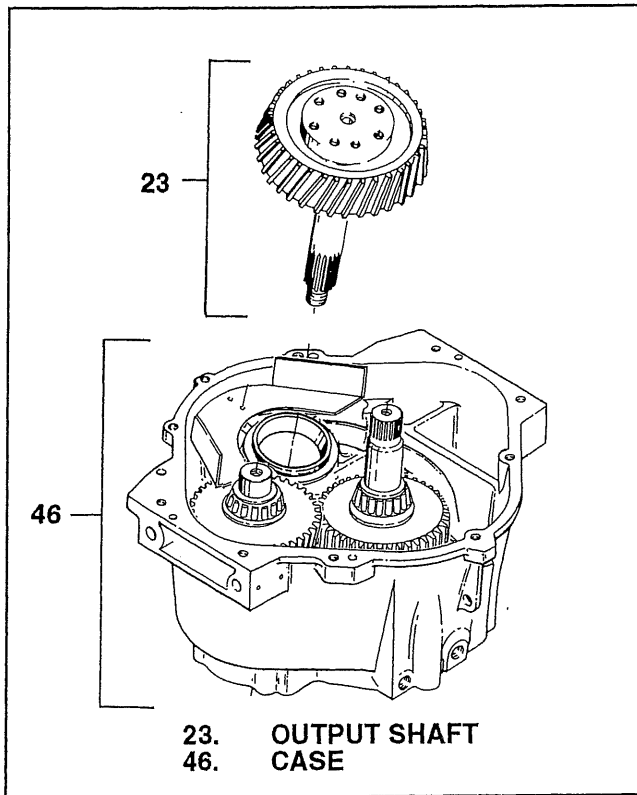


Figure 5-16. Installing Output Shaft/Gear Assembly

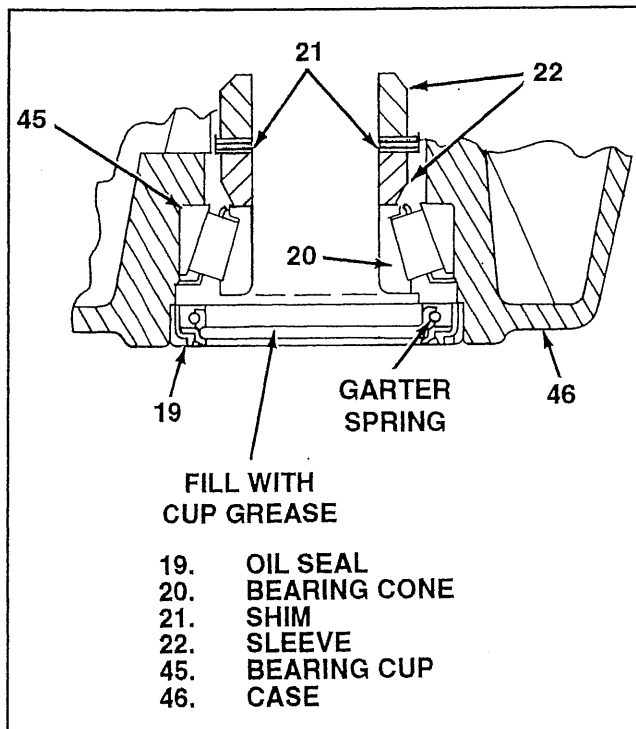


Figure 5-17. Placement of Sleeves and Shims for Assembly

**5-20. ASSEMBLY AND INSTALLATION OF CASE COVER ASSEMBLY.** Assemble as follows (see figure 5-18):

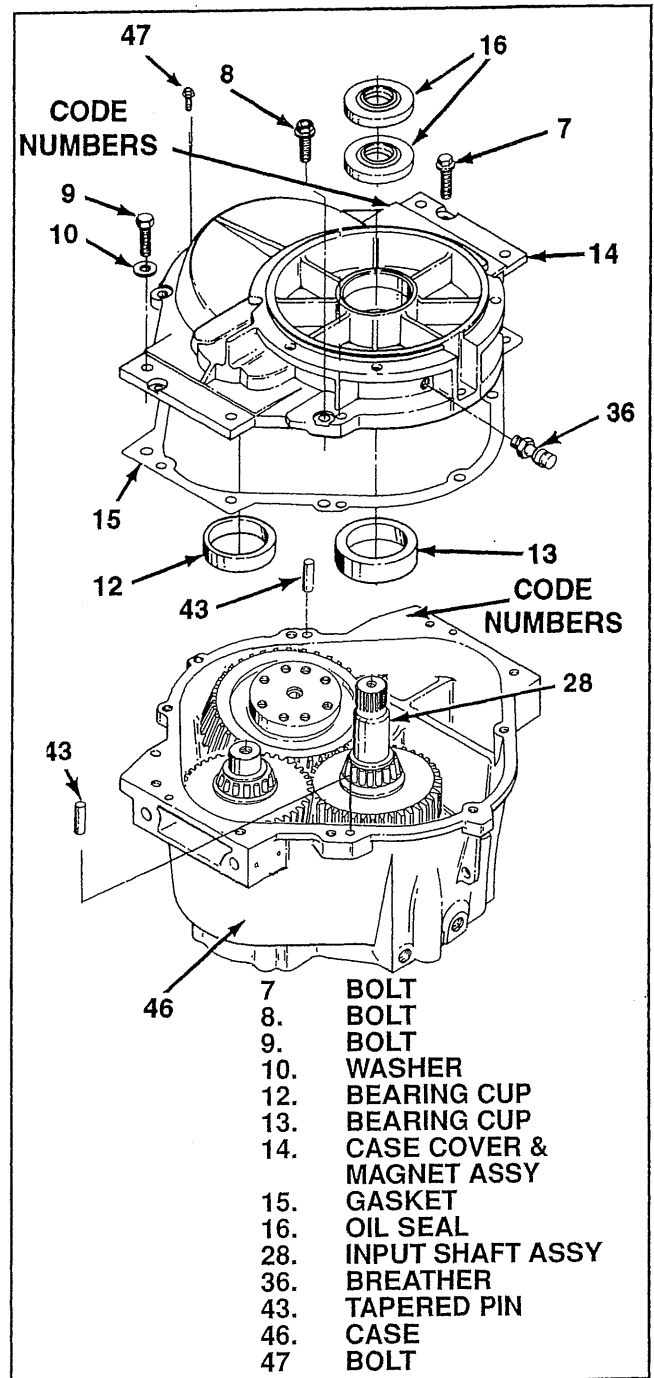


Figure 5-18. Case Cover and Bearing Cup Assembly

**NOTE:** Case cover and magnet assembly (14) and case (46) are a matched set as specified in paragraph 4-15. Check the code numbers as shown in figure 5-18 to make sure a matched set is being assembled. A mismatched case (46) and case cover and magnet assembly (14) may result in severe transmission damage.

1. If removed, press in new bearing cups (12 and/or 13) to bottom in case cover and magnet assembly (14).

2. Position two new oil seals (16) as shown in figure 5-19 and press into case cover and magnet assembly (14) so that outside face of outside oil seal is flush with outside face of cover. Fill cavity between oil seals with grease.

3. Position transmission assembly with pump end down and position gasket (15) on face of case (46). A light coating of petroleum jelly may be used to hold gasket in place.

4. Position case cover and magnet assembly (14) on gasket (15) on case (46). Align holes and install tapered pins (43) using finger pressure only at this time.

5. Start bolts (7, 8, 9 and 47) hand tight. Use Loctite ® 222 on bolt 47.

6. Lightly tap tapered pins (43) to position cover and hand tighten bolts to snug gasket (15).

7. Firmly tap tapered pins (43) to seat them.

8. Tighten bolts in sequence shown in figure 5-20 diagram to the following final torque:

A. bolt (8) 24-34 lb-ft (33-46 Nm)

B. bolt (9) 40-50 lb-ft (54-68 Nm)  
with washers (10)

C. bolt (47) 4-6 lb-ft ( 5-7 Nm)

D. bolt (7) 14-16 lb-ft (19-22 Nm)

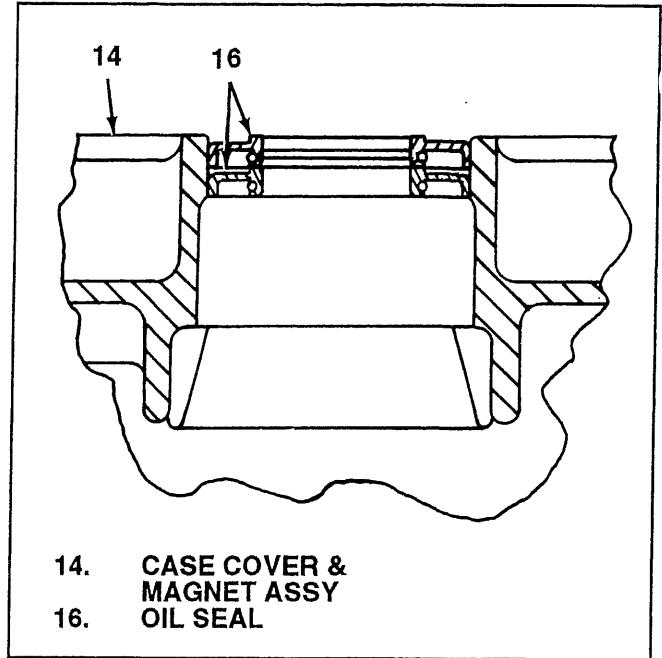


Figure 5-19. Input Shaft Oil Seals

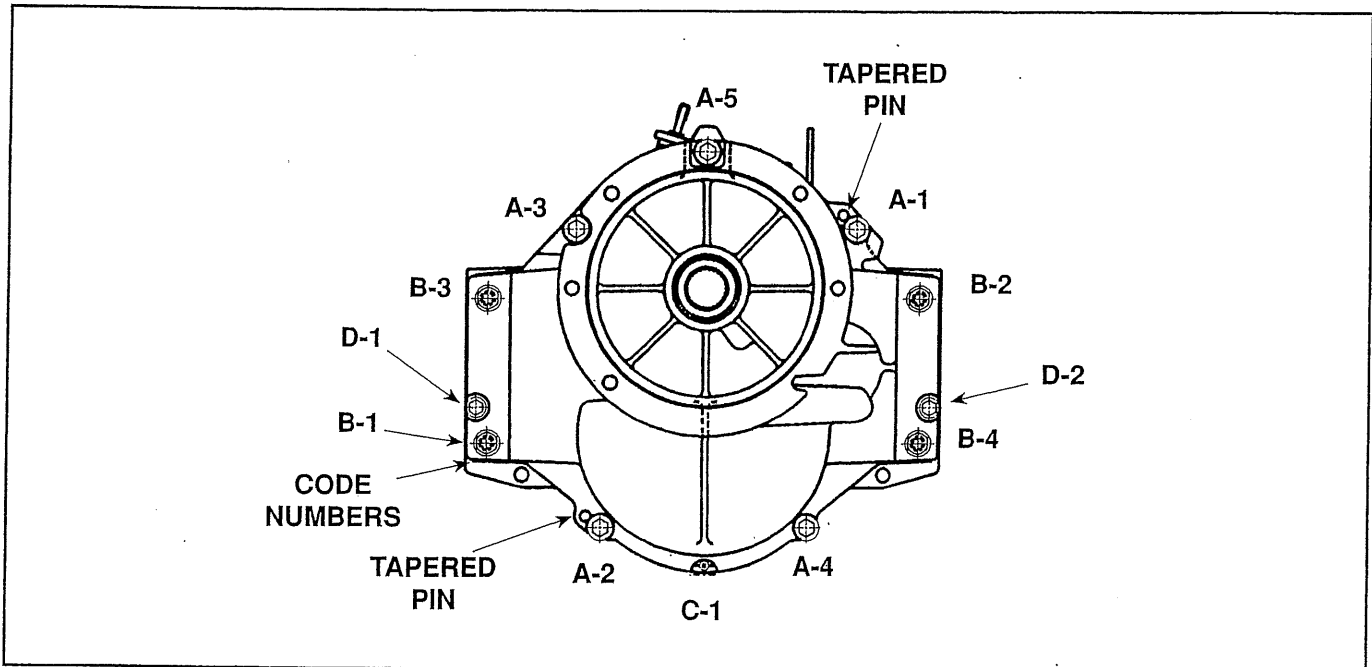


Figure 5-20. Torque Sequence

**5-21. INSTALLING VALVE AND PUMP HOUSING ASSEMBLY.**

Position transmission assembly with pump end up and proceed as follows (see figure 5-21):

**NOTE: Steps 1 and 2 are mandatory.**

1. Install bearing cone (31) and bearing cup (30). Position new gasket (5) on pump mounting face of case (46) and determine thickness of shim(s) (6) to be used at lay shaft bearing as follows:

a. Push down firmly on lay shaft assembly (29) and bearing cup (30) (see figure 5-22) to make sure parts are seated.

b. Measure and record dimension C as shown in figure 5-22 [from top face of gasket (5) to top face of bearing cup (30)].

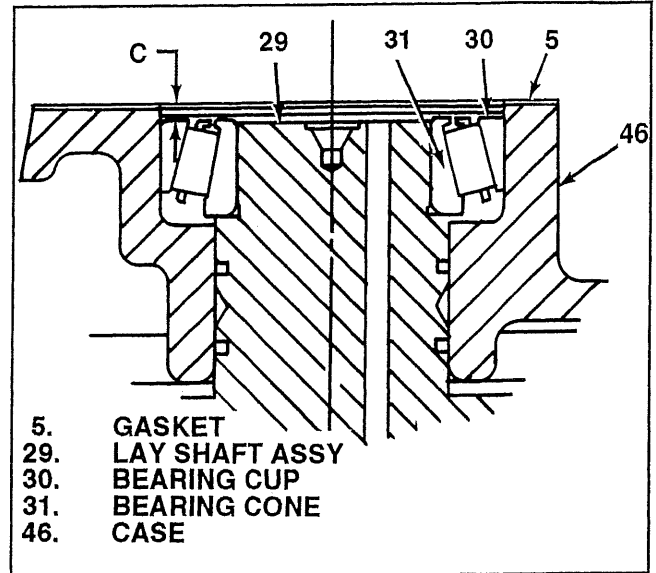


Figure 5-22. Determining Lay Shaft Bearing Shim Thickness

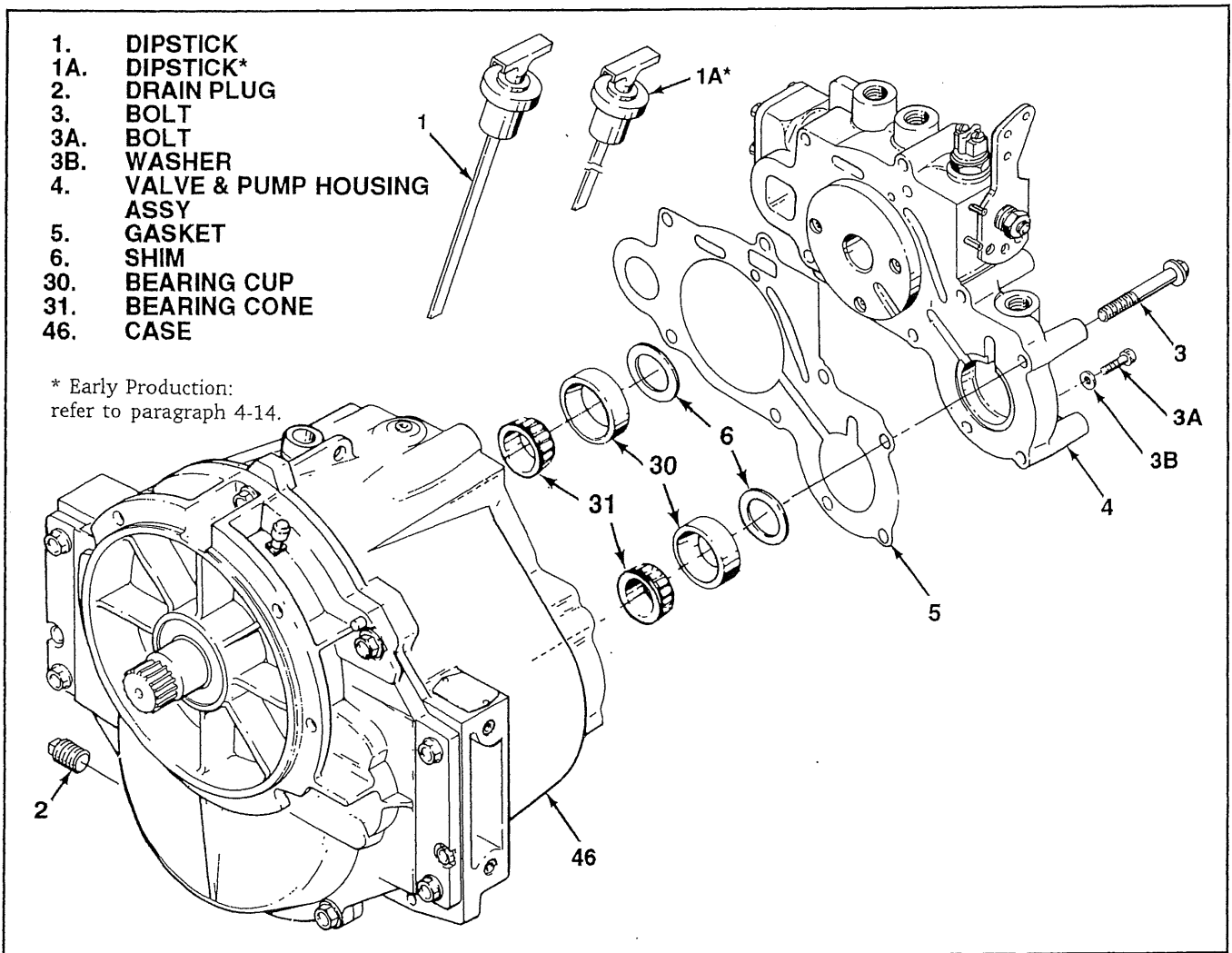


Figure 5-21. Valve and Pump Housing Assembly

c. Calculate  $T_1$ , the thickness of shim(s) (6) required at lay shaft bearing, as follows:

$$T_1 = C + 0.004 \text{ in. (0.102 mm)}$$

d. Select shim(s) of thickness  $T_1 \pm 0.0010 \text{ in. } (\pm 0.025 \text{ mm})$  and install on face of bearing cup (30) at lay shaft. Install thinnest shim(s) down against bearing cup, thickest shim(s) up to bear against valve and pump assembly (4) when installed.

2. With gasket (5) in position on pump mounting face of case (46), determine thickness of shim(s) (6) to be used at input shaft bearing as follows:

a. Push down firmly on input shaft assembly (28) and bearing cup (30) (see figure 5-23) to make sure parts are seated.

b. Measure and record dimension D as shown in figure 5-23 [from top face of gasket (5) to top face of bearing cup (30)].

c. On valve and pump assembly (4), measure and record dimension E as shown in figure 5-23.

d. Calculate  $T_2$ , the thickness of shim(s) (6) required at input shaft bearing, as follows:

$$T_2 = D - E + 0.004 \text{ in. (0.102 mm)}$$

e. Select shim(s) of thickness  $T_2 \pm 0.0010 \text{ in. } (\pm 0.025 \text{ mm})$  and install on face of bearing cup (30) at input shaft. Install thinnest shim(s) down against bearing cup, thickest shim(s) up to bear against valve and pump assembly (4) when installed.

3. With gasket (5) in position on pump mounting face of case assembly (41), install valve and pump assembly (4) and attach with seven bolts (3). Torque bolts to 24-34 lb-ft (33-46 Nm).

4. Install drain plug (2) and torque to 20-25 lb-ft (27-34 Nm).

5. Install dipstick tube assembly (39 or 39A) to a height of 0.875-0.900 (22-23mm). Install dipstick (1 or 1A). (See figure 5-24)

6. If breather (36, figure 5-18) was replaced install new breather with silicone sealant and seat with seating tool T-5006 as shown in figure 5-25.

7. Tighten output flange nut to 225-275 lb-ft (311-380 Nm).

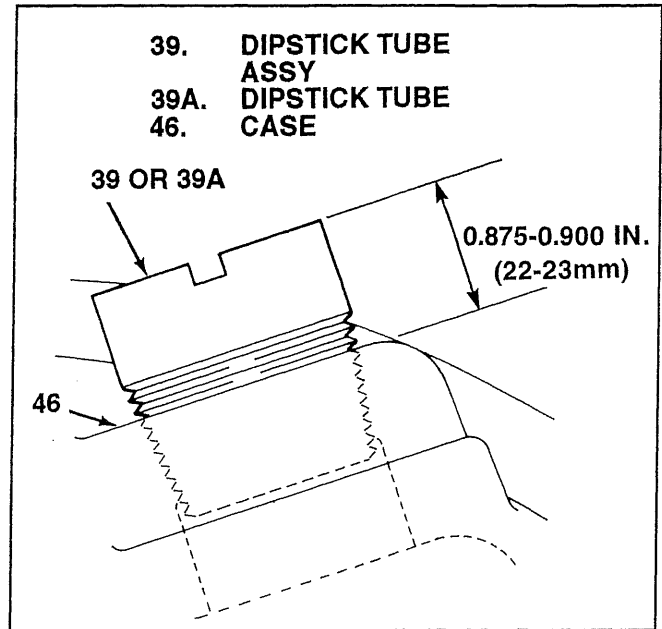


Figure 5-24. Dipstick Tube Installation

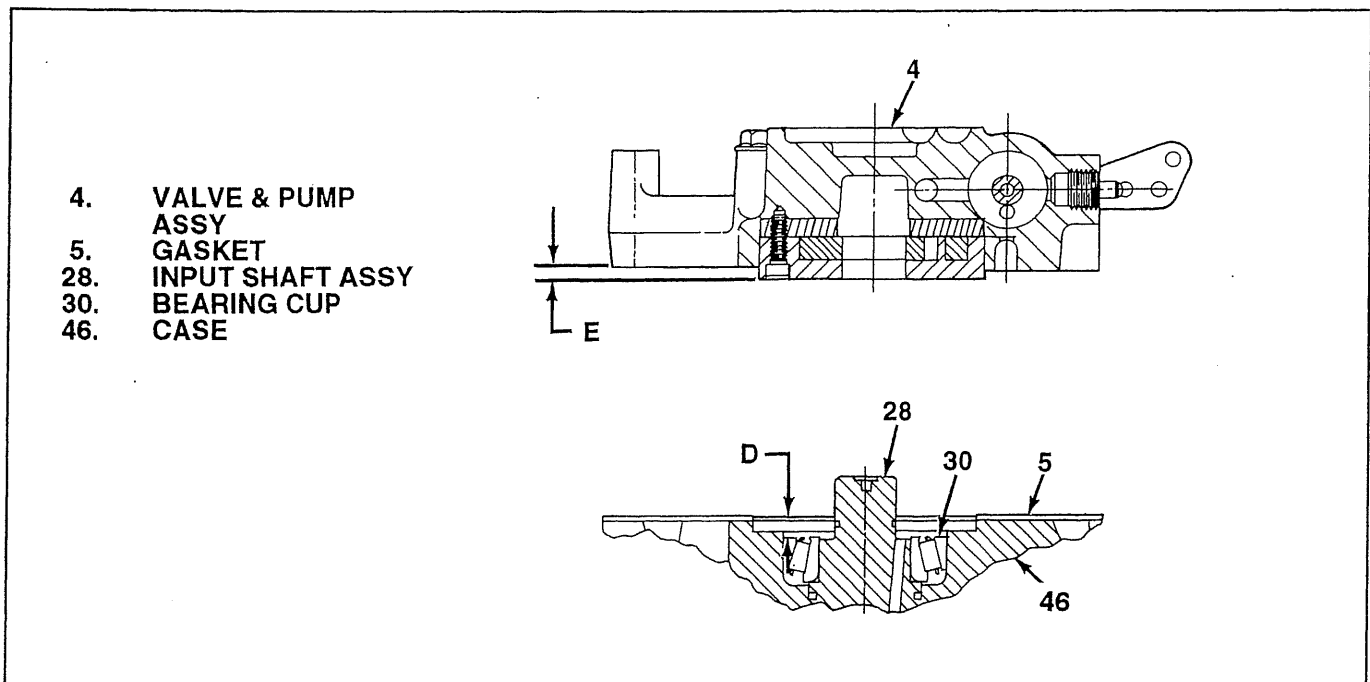


Figure 5-23. Determining Input Shaft Bearing Shim Thickness



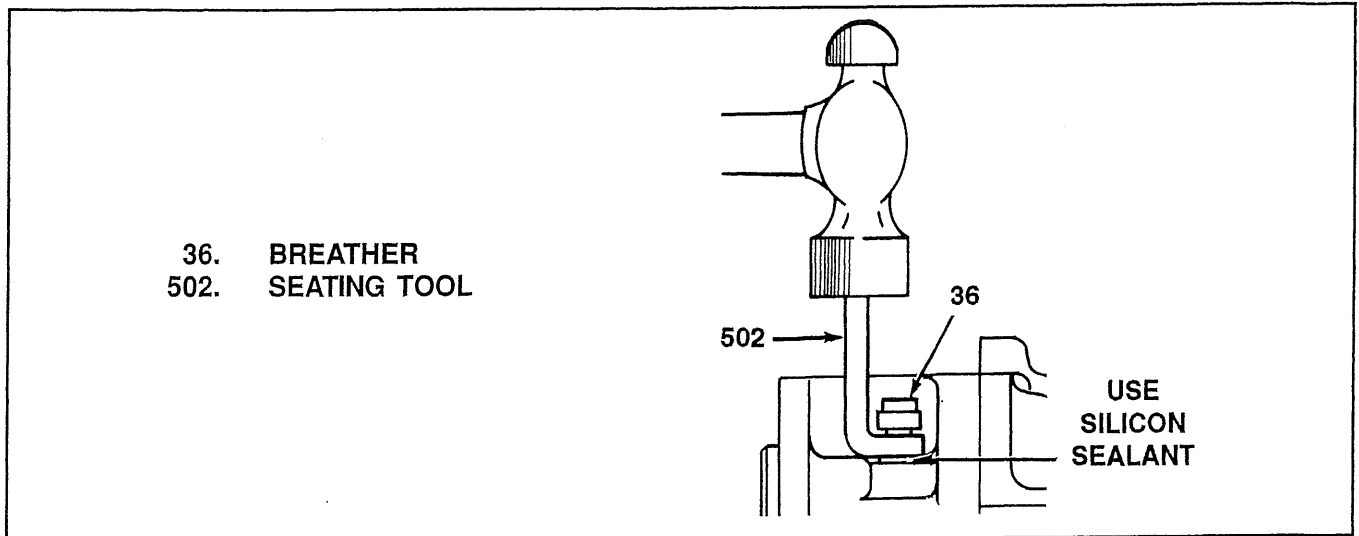


Figure 5-25. Breather Installation

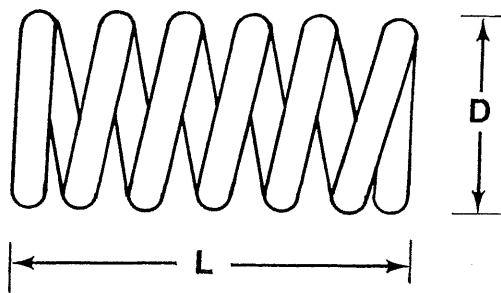
Table 5-1. Torque Values

PART (INDEX No.)	TORQUE IN LB-FT	TORQUE IN Nm
Drain plug (2)	20-25	27-34
Bolt (3) (with Loctite* 242)	34-38	47-53
Bolt (7)	14-16	19-22
Bolt (8)	24-34	33-46
Bolt (9)	40-50	54-68
Flange Nut (17) (with nylon insert)	225-275	311-380
Bolt (25) (with Loctite* 271)	18-24	24-33
Bolt (32) (with Loctite* 242)	4-6	5-7
Bolt (47) (with Loctite* 222)	4-6	5-7
Bolt (201)	6-8	8-11
Switch Assy (203)	20-25	27-34
Nut (204)	14-16	9 22
Bolt (214)	4-5	5-7
Bolt (313) (with pre-applied Loctite*)	16-18	22-25
Bolt (411) (with pre-applied Loctite*)	16-18	22-25

\* Loctite is registered trademark of Loctite Corporation.

Table 5-2. Spring Table

Index No.	Part Number	Description	Diameter mm (inch)	Free Length mm (inch)
209	71-42	Detent Ball Spring	7.9 (0.31)	25.8 (1.02)
217	71-242	Clutch Pressure Control Spring	4.0 (0.16)	16.7 (0.66)
217A	2001-156-004	Clutch Pressure Control Spring	12.2 (0.48)	63.5 (2.50)
318 417	2001-156-001	Clutch Return Spring	8.7 (0.34)	17.5 (0.69)
318A 417A	2001-156-003	Clutch Return Spring	7.9 (0.31)	24.9 (0.98)
430	72P-273	Relief Valve Spring	15.0 (0.59)	50.8 (2.00)



# Section P Parts

## Transmission Applications 2001-000-001 thru -016 AND 2001-000-R01 thru -R06 Contents

Figure No.	Description
P-1	Transmission Assembly
P-2	Valve and Pump Housing Assembly
P-3	Input Shaft Assembly
P-4	Lay Shaft Assembly

### P-1. INTRODUCTION

P-2. This section lists, describes and illustrates replacement parts for the Series 5000 Velvet Drive® Marine Transmission. The exploded view illustration has a corresponding parts list. Index numbers are used to key each part in the exploded views to the parts list and service instructions in the preceding sections of this manual.

P-3. The PART NUMBER column in the parts list gives the part number which can be used to order replacement parts. More than one part number is listed for some index numbers. For shims, select as required to meet the assembly requirements specified in Section 5. For other parts, read the description column to determine part applicability.

P-4. The DESCRIPTION column gives the part nomenclature used, not only in the list but also in the service instructions. Part applicability is given in parenthesis if the part is used only on a specific model or models

P-5. The QTY column designates the number or

parts used at the location defined by the index number. Letter symbols may be used in this column to designate specific information as follows:

AR - As Required. This is used for selective fit parts, determined as specified in Assembly, Section 5.

Ref - Reference. This is used for subassemblies where the quantity required is listed on the main assembly parts list, figure P-1.

NSS - Not Sold Separately. Parts which are available only as an assembly.

LH - Left Hand Gear

RH - Right Hand Gear

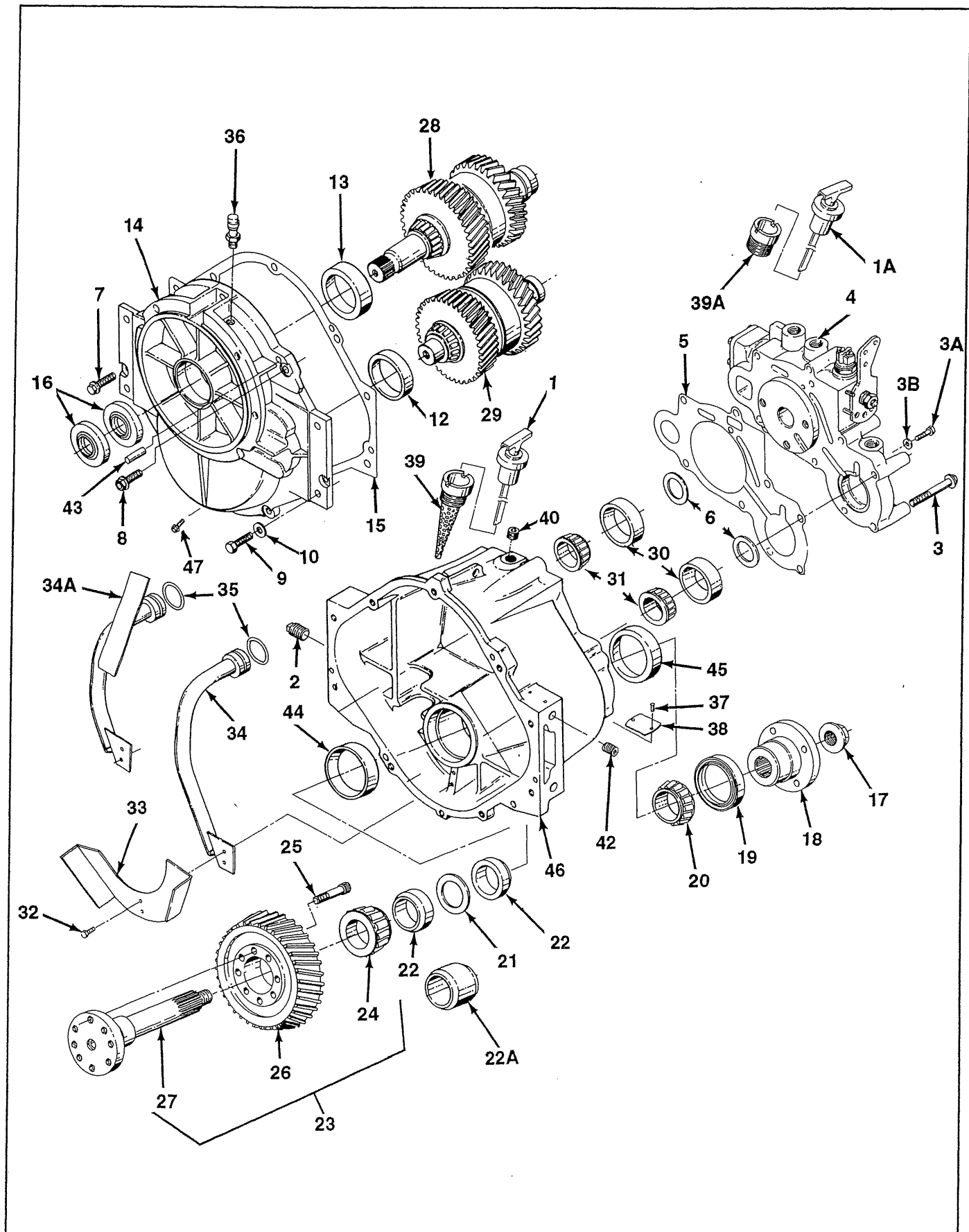


Figure P-1. Transmission Assembly

### PARTS LIST FOR FIGURE P-1

INDEX NO.	PART NUMBER	DESCRIPTION	QTY	
Fig P-1	2001-000-001,-R01	TRANSMISSION ASSY, S5000 Marine, 1.00: 1 (1054: 1) ratio	1	
	2001-000-002,-R02	TRANSMISSION ASSY, S5000 Marine, 1.25:1 (1.303:1) ratio	1	
	2001-000-003, -R03	TRANSMISSION ASSY, S5000 Marine, 1.50: 1 (1.586: 1) ratio	1	
	2001-000-004, R-04	TRANSMISSION ASSY, S5000 Marine, 2.00:1 (2.040:1) ratio	1	
	2001-000-005, -R05	TRANSMISSION ASSY, S5000 Marine, 2.50:1 (2.455:1) ratio	1	
	2001-000-006, -R06	TRANSMISSION ASSY, S5000 Marine, 2.80:1 (2.800:1) ratio	1	
	2001-000-011	TRANSMISSION ASSY, S5000 Marine, 1.00:1 (1054:1) ratio	1	
	2001-000-012	TRANSMISSION ASSY, S5000 Marine, 1.25:1 (1.303:1) ratio	1	
	2001-000-013	TRANSMISSION ASSY, S5000 Marine, 1.50:1 (1.586:1) ratio	1	
	2001-000-014	TRANSMISSION ASSY, S5000 Marine, 2.00:1 (2.040:1) ratio	1	
	2001-000-015	TRANSMISSION ASSY, S5000 Marine, 2.50:1 (2.455:1) ratio	1	
	2001-000-016	TRANSMISSION ASSY, S5000 Marine, 2.80:1 (2.800:1) ratio	1	
	1	2001-559-002	. DIPSTICK (Late Production, After 5/1/93)	1
	1A	2001-599-001	. DIPSTICK (Early Production, Ending 5/1/93)	1
2	444583	. PLUG, Drain	1	
3	1000-183-088	. BOLT, Hex head, M10 x 1.5 x 70	7	
3A	2000-183-001	. BOLT, M5 x 0.8 x 30	1	
3B	2000-047-001	. WASHER	1	
4	2001-736-002	. VALVE & PUMP ASSY (See figure P-2)	1	
5	2001-045-002	. GASKET	1	
6	1000-037-058	. SHIM, 0.076 mm (0.0030 in.) thick	AR	
	1000-037-059	. SHIM, 0.127 mm (0.0050 in.) thick	AR	
	1000-037-060	. SHIM, 0.178 mm (0.0070 in.) thick	AR	
	1000-037-061	. SHIM, 0.229 mm (0.0090 in.) thick	AR	
	1000-037-062	. SHIM, 0.508 mm (0.0200 in.) thick	AR	
	1000-037-063	. SHIM, 0.760 mm (0.0300 in.) thick	AR	
	1000-037-064	. SHIM, 1.106 mm (0.0400 in.) thick	AR	
	1000-037-065	. SHIM, 1.270 mm (0.0500 in.) thick	AR	
	1000-037-066	. SHIM, 1.524 mm (0.0600 in.) thick	AR	
	1000-037-067	. SHIM, 1.778 mm (0.0700 in.) thick	AR	
7	11502693	. BOLT, Hex head, M8 x 1.25 x 20	2	
8	1300-183-018	. BOLT, Hex head, M10 x 1.5 x 30	5	
9	1000-183-092	. BOLT, Hex head, M12 x 1.75 x 35	4	
10	120395	. WASHER	4	
12	1000-133-051	. CUP, Bearing	1	
13	1000-133-053	. CUP, Bearing	1	
14		. CASE COVER & MAGNET ASSY	NSS	
15	2001-045-001	. GASKET	1	
16	1000-044-065	. SEAL, Oil	2	

**PARTS LIST FOR FIGURE P-1**

<b>INDEX NO.</b>	<b>PART NUMBER</b>	<b>DESCRIPTION</b>	<b>QTY</b>
17	1000-149-034	. NUT, Flange	1
18	2001-031-001	. FLANGE, output	1
19	1000-044-066	. SEAL, Oil	1
20	1000-133-004	. CONE, Bearing	1
21	2000-037-001	. SHIM, 0.076 mm (0.003 in.) THICK	AR
	2000-037-002	. SHIM, 0.127 mm (0.005 in.) THICK	AR
	2000-037-003	. SHIM, 0.178 mm (0.007 in.) THICK	AR
	2000-037-004	. SHIM, 0.229 mm (0.009 in.) THICK	AR
	2000-037-005	. SHIM, 0.280 mm (0.011 in.) THICK	AR
	2000-037-006	. SHIM, 0.483 mm (0.019 in.) THICK	AR
22	2001-103-003	. SLEEVE (Supersedes 2001-103-001)	2
22A	2001-103-001	. SLEEVE (Superseded by Two 2001-103-003)	1
23	2001-671-001	. SHAFT ASSY, Output (Transmission 2001-000-001, -R01 & -011)	1
	2001-671-002	. SHAFT ASSY, Output (Transmission 2001-000-002, -R02 & -012)	1
	2001-671-003	. SHAFT ASSY, Output (Transmission 2001-000-003, -R03 & -013)	1
	2001-671-004	. SHAFT ASSY, Output (Transmission 2001-000-004, -R04 & -014)	1
	2001-671-005	. SHAFT ASSY, Output (Transmission 2001-000-005, -R05 & -015)	1
	2001-671-006	. SHAFT ASSY, Output (Transmission 2001-000-006, R-06 & -016)	1
24	1000-133-048	.. CONE, Bearing	1
25	1000-183-086	.. BOLT, Socket head, M8 x 1.25 x 30	8
26	2001-070-007	.. GEAR, Output, 39 Teeth (Transmission 2001-000-001, -R01 & -011)	1
	2001-070-008	.. GEAR, Output, 43 Teeth (Transmission 2001-000-002, R02 & -012)	1
	2001-070-009	.. GEAR, Output, 46 Teeth (Transmission 2001-000-003, -R03 & -013)	1
	2001-070-010	.. GEAR, Output, 51 Teeth (Transmission 2001-000-004, -R04 & -014)	1
	2001-070-011	.. GEAR, Output, 54 Teeth (Transmission 2001-000-005, R-05 & -015)	1
	2001-070-012	.. GEAR, Output, 56 Teeth (Transmission 2001-000-006, R-06 & -016)	1
27	2001-171-001	.. SHAFT, Output	1
28	2001-689-001	. SHAFT ASSY, Input (See figure P-3) (Transmission 2001-000-001, -R01)	1
	2001-689-002	. SHAFT ASSY, Input (See figure P-3) (Transmission 2001-000-002, -R02)	1
	2001-689-003	. SHAFT ASSY, Input (See figure P-3) (Transmission 2001-000-003, -R03)	1
	2001-689-004	. SHAFT ASSY, Input (See figure P-3) (Transmission 2001-000-004, -R04)	1
	2001-689-005	. SHAFT ASSY, Input (See figure P-3) (Transmission 2001-000-005, -R05)	1

## PARTS LIST FOR FIGURE P-1

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
28	2001-689-006	SHAFT ASSY, Input (See figure P-3) (Transmission 2001-000-006, -R06)	1
	2001-689-011	SHAFT ASSY, Input (See figure P-3) (Transmission 2001-000-011)	1
	2001-689-012	SHAFT ASSY, Input (See figure P-3) (Transmission 2001-000-012)	1
	2001-689-013	SHAFT ASSY, Input (See figure P-3) (Transmission 2001-000-013)	1
	2001-689-014	SHAFT ASSY, Input (See figure P-3) (Transmission 2001-000-014)	1
	2001-689-015	SHAFT ASSY, Input (See figure P-3) (Transmission 2001-000-015)	1
	2001-689-016	SHAFT ASSY, Input (See figure P-3) (Transmission 2001-000-016)	1
29	2001-567-001	SHAFT ASSY, Lay (See figure P-4) (Transmission 2001-000-001, -R01)	1
	2001-567-002	SHAFT ASSY, Lay (See figure P-4) (Transmission 2001-000-002, -R02)	1
	2001-567-003	SHAFT ASSY, Lay (See figure P-4) (Transmission 2001-000-003, -R03)	1
	2001-567-004	SHAFT ASSY, Lay (See figure P-4) (Transmission 2001-000-004, -R04)	1
	2001-567-005	SHAFT ASSY, Lay (See figure P-4) (Transmission 2001-000-005, -R05)	1
	2001-567-006	SHAFT ASSY, Lay (See figure P-4) (Transmission 2001-000-006, -R06)	1
	2001-567-011	SHAFT ASSY, Lay (See figure P-4) (Transmission 2001-000-011)	1
	2001-567-012	SHAFT ASSY, Lay (See figure P-4) (Transmission 2001-000-012)	1
	2001-567-013	SHAFT ASSY, Lay (See figure P-4) (Transmission 2001-000-013)	1
	2001-567-014	SHAFT ASSY, Lay (See figure P-4) (Transmission 2001-000-014)	1
	2001-567-015	SHAFT ASSY, Lay (See figure P-4) (Transmission 2001-000-015)	1
	2001-567-016	SHAFT ASSY, Lay (See figure P-4) (Transmission 2001-000-016)	1
30	1000-133-009	CUP, Bearing	2
31	1000-133-010	CONE, Bearing	2
32	11503875	BOLT, Hex head, M6 x 1.0 x 102	2
33	2001-036-001	BAFFLE, Oil (Transmission 2001-000-005, -R05 & -015)	1
	2001-036-002	BAFFLE, Oil (Transmission 2001-000-004, -R04 & -014)	1
	2001-036-003	BAFFLE, Oil (Transmission 2001-000-006, -R06 & -016)	1
	2001-036-004	BAFFLE, Oil (Transmission 2001-000-003, -R03 & -013)	1
	2001-036-005	BAFFLE, Oil (Transmission 2001-000-002, -R02 & -012)	1
	2001-036-006	BAFFLE, Oil (Transmission 2001-000-001, -R01 & -011)	1
34	2001-534-002	TUBE ASSY, Suction (Late Production Starting 5/1/93)	1
34A	2001-534-001	TUBE ASSY, Suction (Early Producdon Ending 5/1/93)	1
35	1000-141-214	O-RING	1

### PARTS LIST FOR FIGURE P-1

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
36	4740A	. BREATHER	1
37	1000-183-077	. RIVET	2
38		. TAG, Identification	NSS
39	2001-535-001	. TUBE ASSY, Dipstick (Late Production Starting 5/1/93)	1
39A	2001-034-003	. TUBE, Dipstick (Early Production Ending 5/1/93)	1
40	444668	. PLUG, Pipe	2
42	2001-241-003	. INSERT, Thread	8
43	1000-043-030	. PIN, Tapered	2
44	1000-133-049	. CUP, Bearing	1
45	1000-133-003	. CUP, Bearing	1
46		. CASE, Transmission	NSS
47	1000-183-096	. BOLT, Socket Head, M5 X 0.8X25	1

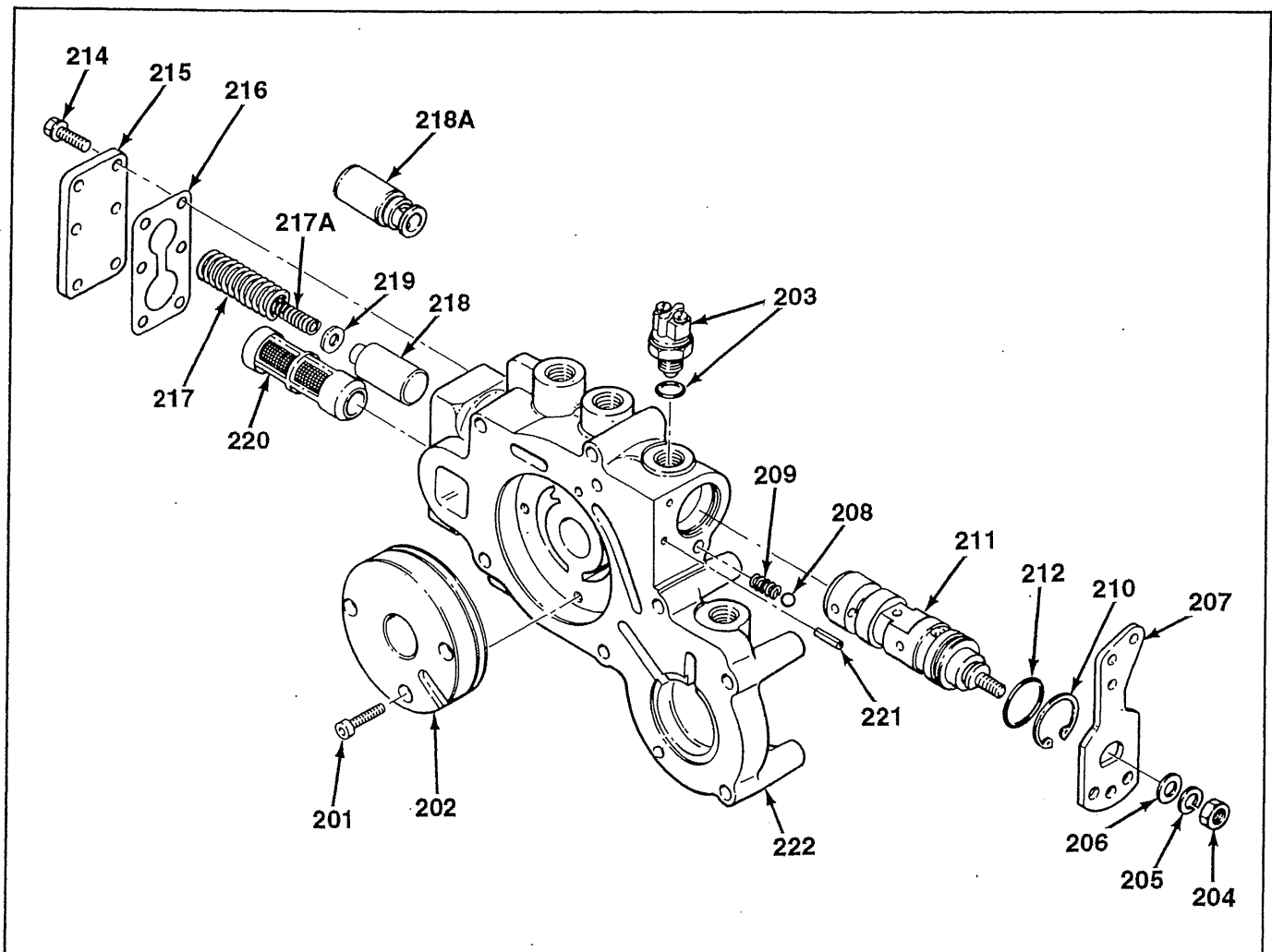


Figure P-2. Valve and Pump Housing Assembly



## PARTS LIST FOR FIGURE P-2

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
Fig P-2	2001-736-001	VALVE & PUMP HOUSING ASSY (4, figure P-1) (Transmission 2001-000-001 thru -016)	Ref
201	1000-183-087	. BOLT, Socket head, M6 x 1.0 x 25	3
202	2001-508-001	. PUMP ASSY	1
203	1000-640-004	. SWITCH ASSY	1
204	11505919	. NUT, Hex, M8 x 1.25	1
205	120124	. WASHER, Lock	1
206	120393	. WASHER, Flat	1
207	2001-098-001	. LEVER, Control	1
208	453632	. BALL, Steel	1
209	71-42	. SPRING	1
210	1000-139-071	. RING, Snap	1
211	2001-239-001	. VALVE, Control	1
212	1000-141-123	. O-RING	1
214	1000-183-090	. BOLT, Hex head,	6
215	2001-039-001	. PLATE, Cover	1
216	2001-045-003	. GASKET	1
217	71-242	. SPRING M6 x 1.0 x 16	1
217A	2001-156-004	. SPRING (Used in addition to spring (:21/) with valve piston (218) and washer (219) only)	1
218	2001-124-004	. PISTON, Valve (Late Production)	1
218A	2001-124-002	. PISTON, Valve (Early Production)	1
219	1000-053-024	. WASHER	1
220	2001-238-001	. SCREEN	1
221	9422127	. PIN, Spring	2
222	See Note (2)	. HOUSING, Valve	NSS

Note (2): Not Sold Separately. Order complete valve and pump housing assembly Part No. 2001-736-002.

Table P-2. Gaskets, Seals and Snap Rings Kit  
PART NO. 2001-410-001

INDEX NO.	PART NUMBER	DESCRIPTION	QUANTITY
321 & 420	1000-016-019	Sealing Ring	2
324 & 423	1000-016-020	Sealing Ring	2
328	1000-016-021	Sealing Ring	1
16	1000-044-065	Oil seal	2
19	1000-044-066	Oil seal	1
305, 307 & 405	1000-139-068	Snap Ring	5
308 & 406	1000-139-069	Snap Ring	2
210	1000-139-071	Snap Ring	1
326 & 425	1000-141-045	O-Ring	2
212	1000-141-123	O-Ring	1
325 & 424	1000-141-130	O-Ring	2
35	1000-141-214	O-Ring	1
322 & 421	1000-141-241	O-Ring	2
327 & 426	2000-016-050	Sealing Ring	4
428	2000-139-001	Sealing Ring	1
15	2001-045-001	Gasket	1
5	2001-045-002	Gasket	1
216	2001-045-003	Gasket	1

Table P-1. Shim Assortment Kit  
PART NO. 2001-410-003

INDEX NO.	PART NUMBER	DESCRIPTION	QUANTITY
6	1000-037-058	Shim, 0.076 mm (0.003 in.) thick	3
6	1000-037-059	Shim, 0.127 mm (0.005 in.) thick	3
6	1000-037-060	Shim, 0.178 mm (0.007 in.) thick	3
6	1000-037-061	Shim, 0.229 mm (0.009 in.) thick	3
6	1000-037-062	Shim, 0.508 mm (0.020 in.) thick	3
6	1000-037-063	Shim, 0.760 mm (0.030 in.) thick	3
21	2000-037-002	Shim, 0.127 mm (0.005 in.) thick	3
21	2000-037-003	Shim, 0.178 mm (0.007 in.) thick	3
21	2000-037-004	Shim, 0.229 mm (0.009 in.) thick	3
21	2000-037-005	Shim, 0.280 mm (0.011 in.) thick	3

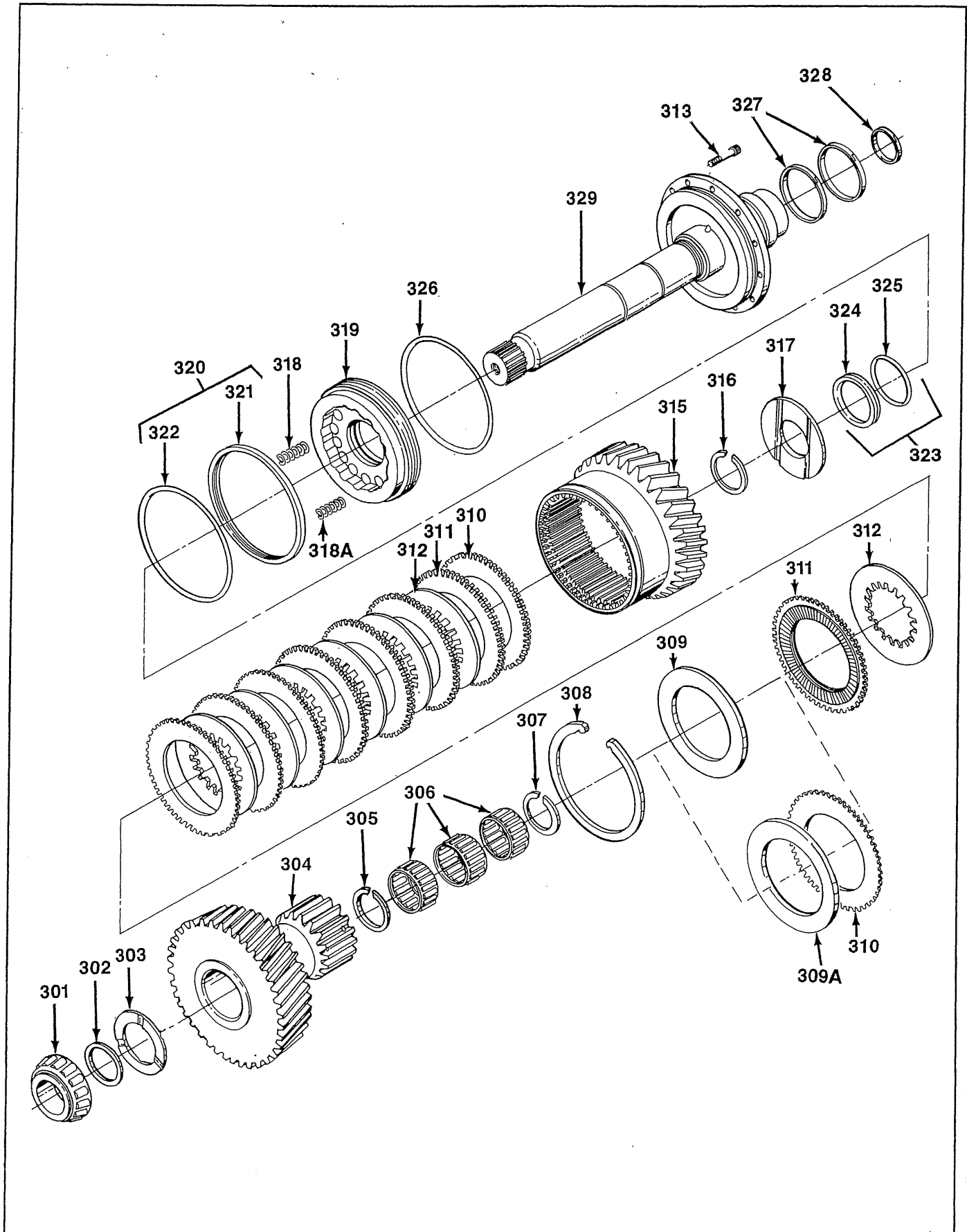


Figure P-3. Input Shaft Assembly

### PARTS LIST FOR FIGURE P-3

INDEX NO.	PART NUMBER	DESCRIPTION	QTY	
Fig P-3	2001-689-001	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-001, -R01)	Ref	
	2001-689-002	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-002, -R02)	Ref	
	2001-689-003	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-003, -R03)	Ref	
	2001-689-004	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-004, -R04)	Ref	
	2001-689-005	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-005, -R05)	Ref	
	2001-689-006	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-006, -R06)	Ref	
	2001-689-011	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-011)	Ref	
	2001-689-012	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-012)	Ref	
	2001-689-013	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-013)	Ref	
	2001-689-014	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-014)	Ref	
	2001-689-015	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-015)	Ref	
	2001-689-016	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-016)	Ref	
	301	1000-133-052	. CONE, Bearing	1
	302	2001-053-001	. SPACER	1
303	1000-193-022	. WASHER, Thrust	1	
301	2001-080-024	. GEAR, Clutch, 20 tooth (Transmission 2001-000-006, -R06 & -016)	1	
	2001-080-022	. GEAR, Clutch, 22 tooth (Transmission 2001-000-005, -R05 & -015)	1	
	2001-080-020	. GEAR, Clutch, 25 tooth (Transmission 2001-000-004, -R04 & -014)	1	
	2001-080-018	. GEAR, Clutch, 29 tooth (Transmission 2001-000-003, -R03 & -013)	1	
	2001-080-016	. GEAR, Clutch, 33 tooth (Transmission 2001-000-002, -R02 & -012)	1	
	2001-080-014	. GEAR, Clutch, 37 tooth (Transmission 2001-000-001, -R01 & -011)	1	
305	1000-139-068	. RING, Snap	1	
306	1000-132-055	. BEARING, Needle	3	
307	1000-139-068	. RING, Snap	1	
308	1000-139-069	. RING, Snap	1	
309	2001-062-003	. PLATE, Backing, 5.00 mm (0.200 in.) thick (Supersedes 2001-062-001)	1	
309A	2001-062-001	. PLATE, Backing, 3.00 mm (0.112 in.) thick (Superseded by 2001-062-003)	1	
310	2001-062-002	. PLATE, Clutch (2 used when 2001-062-001 is used)	1	
311	2001-666-001	. DISC ASSY, Clutch (drive)	8	
312	2001-166-002	. DISC, Clutch (driven)	7	

**PARTS LIST FOR FIGURE P-3**

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
313	2000-183-002	. BOLT, M6 x 1.0 x 20	12
315	2001-125-001	. CYLINDER, Clutch Gear (RH)	1
316	1000-139-068	. RING, Snap	1
317	2001-040-001	. RETAINER, Spring	1
318	2001-156-001	. SPRING (Transmission 2001-000-001 thru -006)	4
	2001-156-001	. SPRING (Transmission 2001-000-011 thru -016)	16
318A	2001-156-003	. SPRING (Transmission 2001-000-001 thru -006)	12
319	2001-624-001	. PISTON ASSY, Clutch (Supersedes piston 2001-124-001)	1
320	1000-516-019	. RING ASSY, Sealing	1
321	1000-016-019	. . RING, Sealing	1
322	1000-141-241	. . O-RING	1
323	1000-516-020	. RING ASSY, Sealing	1
324	1000-016-020	. . RING, Sealing	1
325	1000-149-130	. . O-RING	1
326	1000-141-045	. O-RING	1
327	2000-016-050	. RING, Oil seal (Supersedes 4806B)	2
328	1000-016-021	. RING, Seal (steel)	1
329	2001-189-001	. SHAFT, Input (Transmission 2001-000-001 thru -016)	1

Table 4-3. Clutch Rebuild Kit  
PART NO. 2001-410-002

INDEX NO.	PART NUMBER	DESCRIPTION	QUANTITY
306 & 404	1000-132-055	Needle bearing	3
305 & 405	1000-139-068	Snap ring	3
308 & 406	1000-139-069	Snap ring	1
318 & 417	1016-156-003	Spring	12
415	1000-193-019	Thrust washer	1
303	1000-193-022	Thrust washer	1
327 & 426	2000-016-050	Seal ring	2
313 & 411	2000-183-002	Bolt	12
317	2001-040-001	Spring retainer	1
416	2001-040-003	Spring retainer	1
302	2001-053-001	Spacer	1
309 & 407	2001-062-003	Backing plate	1
318 & 417	2001-156-001	Spring	16
312 & 410	2001-166-002	Driven disc	7
311 & 409	2001-666-001	Drive disc assembly	8

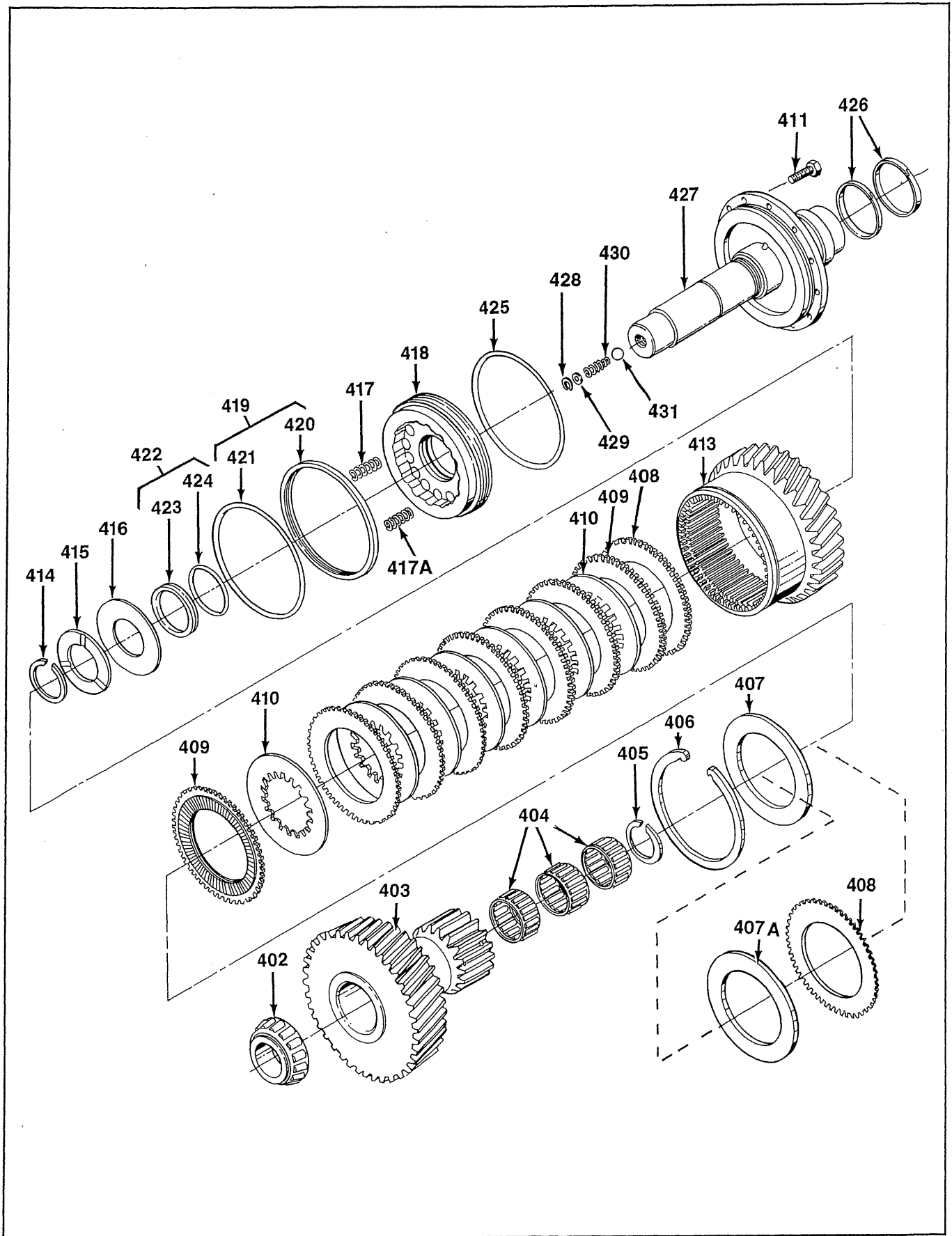


Figure P-4. Lay Shaft Assembly

**PARTS LIST FOR FIGURE P-4**

<b>INDEX NO.</b>	<b>PART NUMBER</b>	<b>DESCRIPTION</b>	<b>QTY</b>	
Fig P-4	2001-567-001	SHAFT ASSY, Lay (29, figure P-1) (Transmission 2001-000-001, -R01)	Ref	
	2001-567-002	SHAFT ASSY, Lay (29, figure P-1) (Transmission 2001-000-002, -R02)	Ref	
	2001-567-003	SHAFT ASSY, Lay (29, figure P-1) (Transmission 2001-000-003, -R03)	Ref	
	2001-567-004	SHAFT ASSY, Lay (29, figure P-1) (Transmission 2001-000-004, -R04)	Ref	
	2001-567-005	SHAFT ASSY, Lay (29, figure P-1) (Transmission 2001-000-005, -R05)	Ref	
	2001-567-006	SHAFT ASSY, Lay (29, figure P-1) (Transmission 2001-000-006, -R06)	Ref	
	2001-567-011	SHAFT ASSY, Lay (29, figure P-1) (Transmission 2001-000-011)	Ref	
	2001-567-012	SHAFT ASSY, Lay (29, figure P-1) (Transmission 2001-000-012)	Ref	
	2001-567-013	SHAFT ASSY, Lay (29, figure P-1) (Transmission 2001-000-013)	Ref	
	2001-567-014	SHAFT ASSY, Lay (29, figure P-1) (Transmission 2001-000-014)	Ref	
	2001-567-015	SHAFT ASSY, Lay (29, figure P-1) (Transmission 2001-000-015)	Ref	
	2001-567-016	SHAFT ASSY, Lay (29, figure P-1) (Transmission 2001-000-006)	Ref	
	402	1000-133-050	. CONE, Bearing	1
	403	2001-080-023	. GEAR, Clutch, 20 Teeth (Transmission 2001-000-006, -R06 & -016)	1
		2001-080-021	. GEAR, Clutch, 22 Teeth (Transmission 2001-000-005, -R05 & -015)	1
	2001-080-019	. GEAR, Clutch, 25 Teeth (Transmission 2001-000-004, -R04 & -014)	1	
	2001-080-017	. GEAR, Clutch, 29 Teeth (Transmission 2001-000-003, -R03 & -013)	1	
	2001-080-015	. GEAR, Clutch, 33 Teeth (Transmission 2001-000-002, -R02 & -012)	1	
	2001-080-013	. GEAR, Clutch, 37 Teeth (Transmission 2001-000-001, -R01 & -011)	1	
404	1000-132-055	. BEARING, Needle	3	
405	1000-139-068	. RING, Snap	1	
406	1000-139-069	. RING, Snap	1	
407	2001-062-003	. PLATE, Backing, 5.00 mm (0.200 in.) thick (Supersedes 2001-062-001)	1	
407A	2001-062-001	. PLATE, Backing, 3.00 mm (0.120 in.) thick (Superseded by 2001-062-003)	1	
408	2001-062-002	. PLATE, Clutch, Steel (2 used when 2001-062-001 is used)	1	
409	2001-666-001	. DISC ASSY, Clutch (drive)	8	
410	2001-166-002	. DISC, Clutch (driven)	7	
411	2000-183-002	. BOLT, M6 x 1.0 x 20	12	
413	2001-125-002	. CYLINDER, Clutch Gear (LH)	1	
414	1000-139-068	. RING, Snap	1	



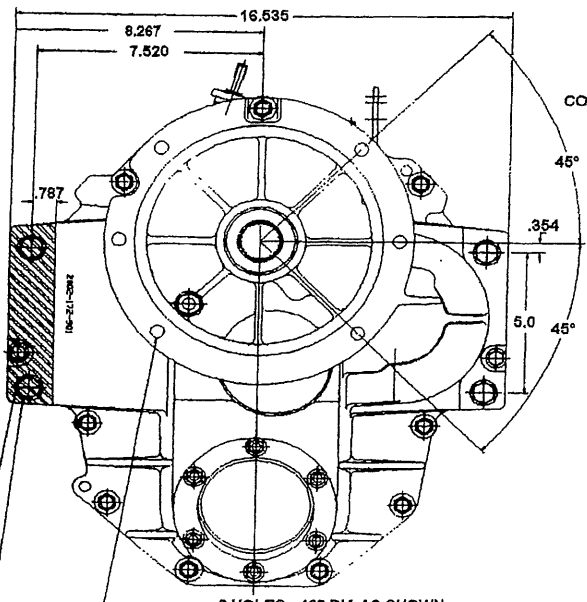
**PARTS LIST FOR FIGURE P-4**

<b>INDEX NO.</b>	<b>PART NUMBER</b>	<b>DESCRIPTION</b>	<b>QTY</b>
415	1000-193-019	. WASHER, Thrust	1
416	2001-040-003	. RETAINER, Spring (Supersedes 2001-040-001)	1
417	2001-156-001	. SPRING (Transmission 2001-000-001 thru-006 AND 2001-000-R01 thru R06)	4
	2001-156-001	. SPRING (Transmission 2001-000-001 thru -016)	16
417A	2001-156-003	. SPRING (Transmission 2001-000-011 thru-006)	12
418	2001-624-001	. PISTON ASSY, Clutch (Supersedes piston 2001-124-001)	1
419	1000-516-019	. RING ASSY, Sealing	1
420	1000-016-019	. . RING, Sealing	1
421	1000-141-241	. . O-RING	1
422	1000-516-020	. RING ASSY, Sealing	1
423	1000-016-020	. . RING, Sealing	1
424	1000-149-130	. . O-RING	1
425	1000-141-045	. O-RING	1
426	2000-016-050	. RING, Oil seal (Supersedes 4806B)	1
427	2001-067-001	. SHAFT, Lay (Transmission 2001-000-001 thru -016)	1
428	2000-139-001	. RING, Snap	1
429	2000-053-001	. SPACER	1
430	72P-273	. SPRING	1
431	453595	. BALL	1



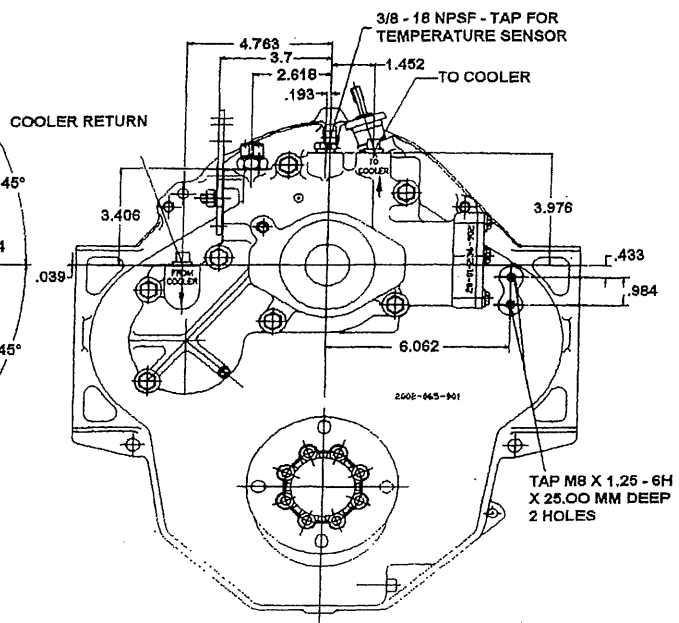
# Contents

Installation Drawing	2
Introduction	3
Assembly Specifications	4
Cover Torque Specifications	7
Bolt Size and Torque Specifications	9
Valve and Pump Housing Torque Specifications	11
Special Tools	12
Parts Section	13
Main Case Assembly	14
Intermediate Shaft Assembly Identification	18
Valve and Pump Assembly	18
Clutch Assemblies	20
Kit, Gasket and Seals	23
Kit, Clutch	24



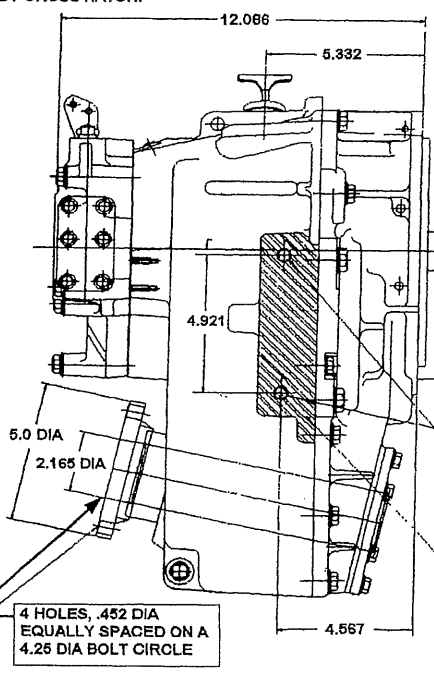
6 HOLES, .468 DIA AS SHOWN, LOCATED ON A 9.25 DIA BOLT CIRCLE  
TAP M12 X 1.75 - 6H X 20.00 MM DEEP  
2 HOLES - EACH SIDE.

MACHINED SURFACE FOR MOUNT SHOWN BY CROSS HATCH.



RIGHT HAND PROPELLER LEFT HAND PROPELLER

← MOVE →

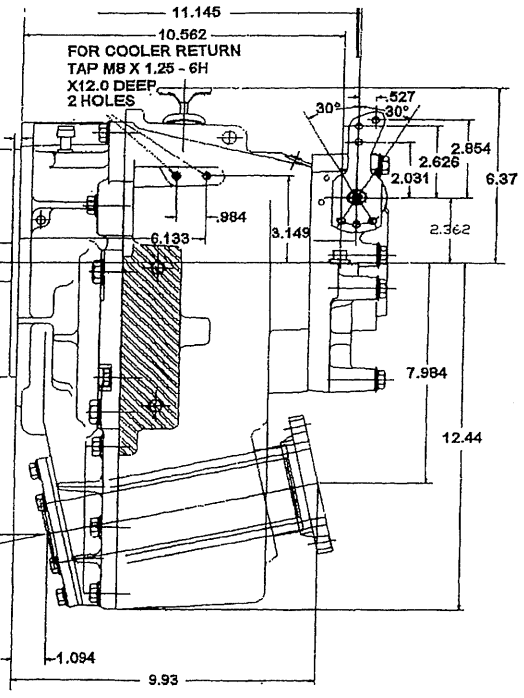


INPUT SPLINE DATA  
26 TEETH - INVOLUTE  
20/40 DIAMETRIAL PITCH  
30° PRESSURE ANGLE  
33.02 PITCH DIAMETER

TAP M12 X 1.75 - 6H X 20.00 DEEP.  
2 HOLES - EACH SIDE

MACHINED SURFACE FOR MOUNT SHOWN BY CROSS HATCH TYPICAL FOR BOTH SIDES.

SAE 510 flange. Pilot bore 2.5001 / 2.499 inch diameter.



INSTALLATION DRAWING

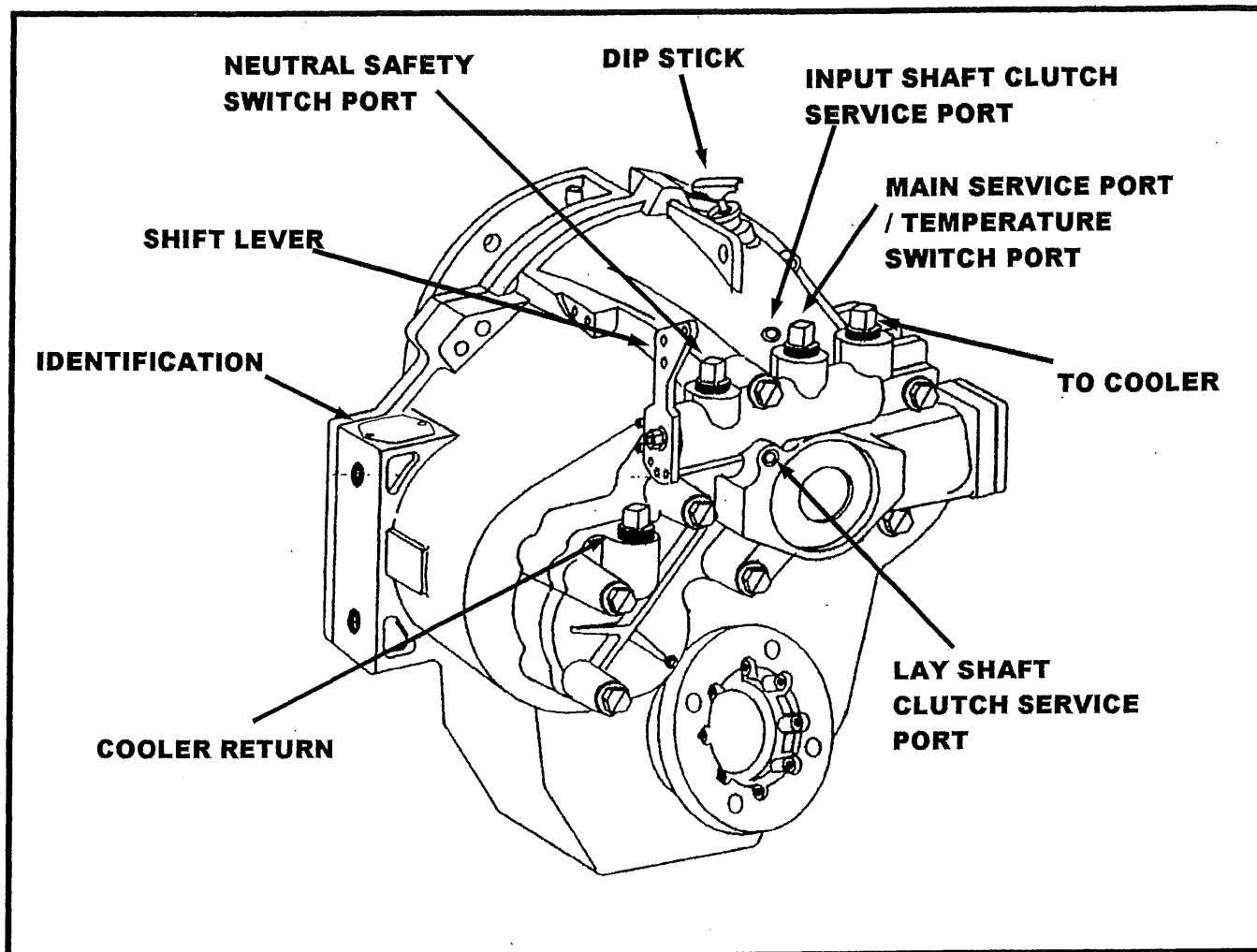


Figure 1-1. Series 5000 V-drive Marine Transmission

## INTRODUCTION

**PURPOSE AND SCOPE.** This manual contains preliminary information to help the technician service the Velvet-Drive® S5000 V-drive transmission (see figure 1-1) and is designed to be used in conjunction with the **Series 5000 Marine Transmission Service Manual (Form 1351/4-95)**. Service procedures for clutch and valve and pump assembly are located in Form 1351/4-95.

Service parts for the S5000 V-drive are included in the "P" section of this supplement. Parts for the S5000 down angle model are included in Service Manual 1351.

**GENERAL DESCRIPTION.** The Velvet Drive® Series 5000 V-Drive is a single-speed, forward/reverse, hydraulic-shift transmission. The gear ratio varies from model to model and is listed in Table 1-1.

The input (131), lay (132), intermediate (140), and output (153) shafts are supported by tapered roller bearings. Needle bearings (708) are used between the shafts and clutch gears on the input and lay shaft assemblies. Helical gearing is used throughout. The transmission has separate, multi-disc clutches for each direction of output shaft rotation.

ASSEMBLY No	NORMINAL RATIO FORWARD & REVERSE	ACTUAL RATIO FORWARD & REVERSE	FLUID CAPACITY* QT/LITER	DRY WEIGHT LB/KG
2002-000-002	1.25:1	1.2800:1	3/2.8	133/60.4
2002-000-003	1.50:1	1.5030:1	3/2.8	133/60.4
2002-000-004	2.00:1	1.9862:1	3/2.8	133/60.4
2002-000-005	2.50:1	2.4960:1	3/2.8	133/60.4

\* Approximate, depending on angle of transmission installation, for transmission only. Capacity given does not include oil (fluid) cooler and connecting lines.

Table 1-1 Assembly Specifications

**APPLICATION.** The Series 5000 V-drive transmission has a 12 degree down angle. A hollow output shaft is used to permit the propeller shaft to extend through the body of the transmission, thus simplifying shaft alignment. **It will only operate on engines with counter clockwise rotation (viewed from the flywheel end).** This is commonly termed automotive rotation. The Series 5000 V-drive transmission's full reversing feature eliminates the need for opposite rotation engines. Thus, a right-hand or left-hand propeller can be used with a left-hand engine.

#### BEARING PRELOAD

**Clutch service, and input and lay shaft preload procedures are similar to those used in the S5000 down angle and are described in detail in Service Manual Form 1351/4-95.** Output shaft (153) and intermediate shaft (140) bearing pre-load procedures are different than those used in previous models.

**INTERMEDIATE SHAFT BEARING PRELOAD** If the intermediate bearings have an acceptable wear pattern and are otherwise in good condition, it is recommended this procedure be passed over, and the shaft and bearing cone assembly be reinstalled as removed. **However, if any bearing cone or cup has been removed, a re-calibration of**

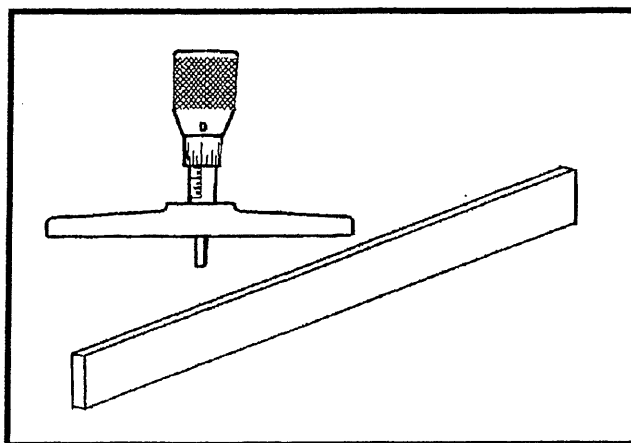


Figure 1-2  
Depth micrometer and straight edge.

**the intermediate pre-load must be performed.**

**PROCEDURE** A depth micrometer with extensions to reach six (6) inches, and a straight edge bar (figure 1-2) are required. **It is extremely important the straight edge is true and has no bends.**

1. Remove both bearing cups (137 & 142) and shims (138) from the casing (160) and cover (129). A heat lamp or suitable substitute will be required. Usually ten minutes with a 600 watt lamp will do the trick.
2. Measure the distance from the gasket surface to the bearing cup seat in the case as shown in figure 1-3.
  - a. Place a cover gasket (130) on case surface. Use petroleum jelly to hold in place.

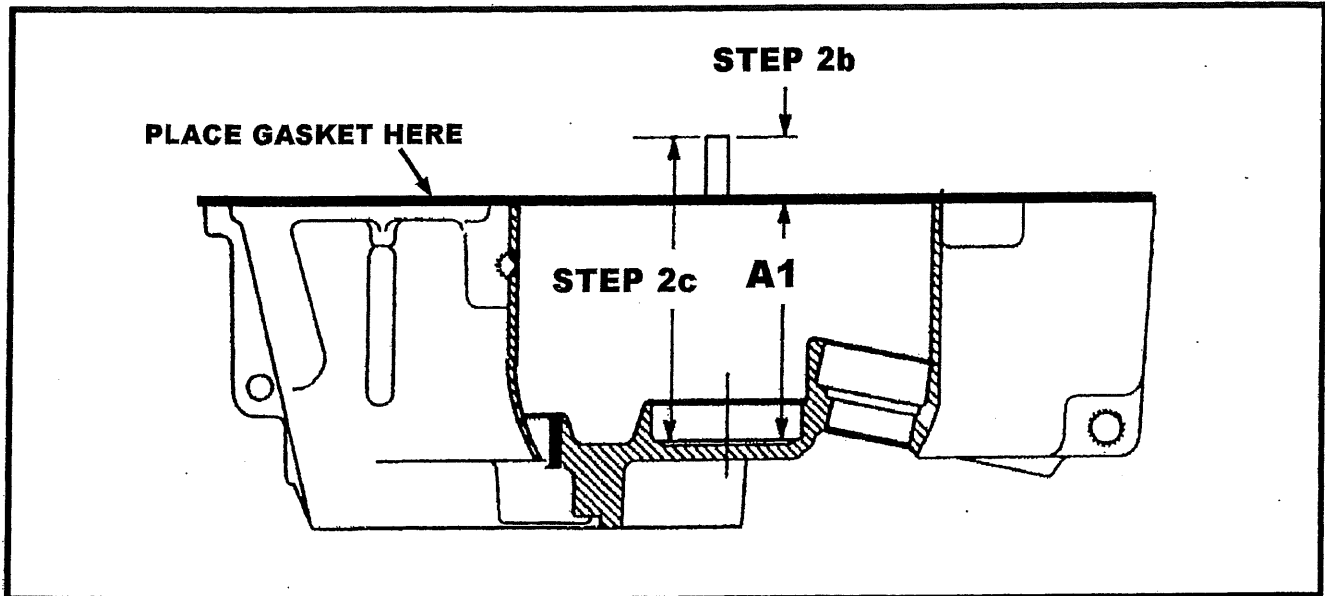


Figure 1-3 Case cut away

- b. Place the straight edge across the gasket surface (Step 2b).
  - c. Measure from the straight edge to the bearing seat (Step 2c).
  - d. Subtract the straight edge thickness from the measurement determined in "Step 2c". This will become measurement "A1".
3. Measure the distance from the cover gasket surface (**do not use a gasket to make this measurement**) to the bearing cup seat in the cover as shown in figure 1-4.
- e. Place the straight edge across the cover surface (Step 3e).

- f. Measure from the straight edge to the bearing seat (Step 3f).
  - g. Subtract the straight edge thickness from the measurement determined in Step 3f. This will be measurement "A2".
4. **Add measurements A1 and A2 determined in 2d and 3g above. This will be the total distance between the intermediate shaft bearing seats in an assembled case and cover (figure 1-5) This is measurement "A".**
5. Press the two bearing cones (139 & 141) on the intermediate shaft (140), place cups

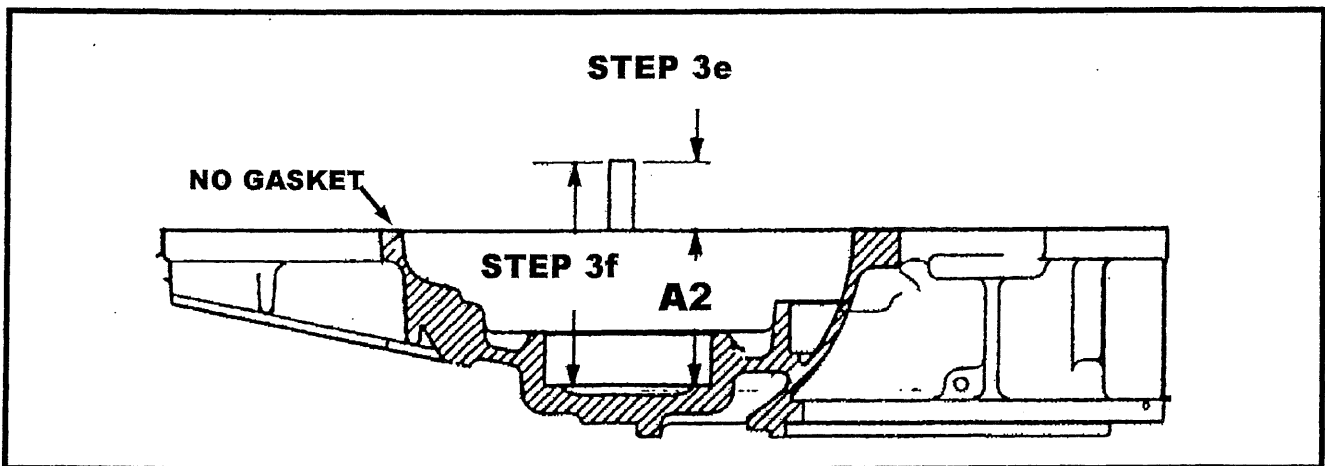


Figure 1-4 Cover cut away

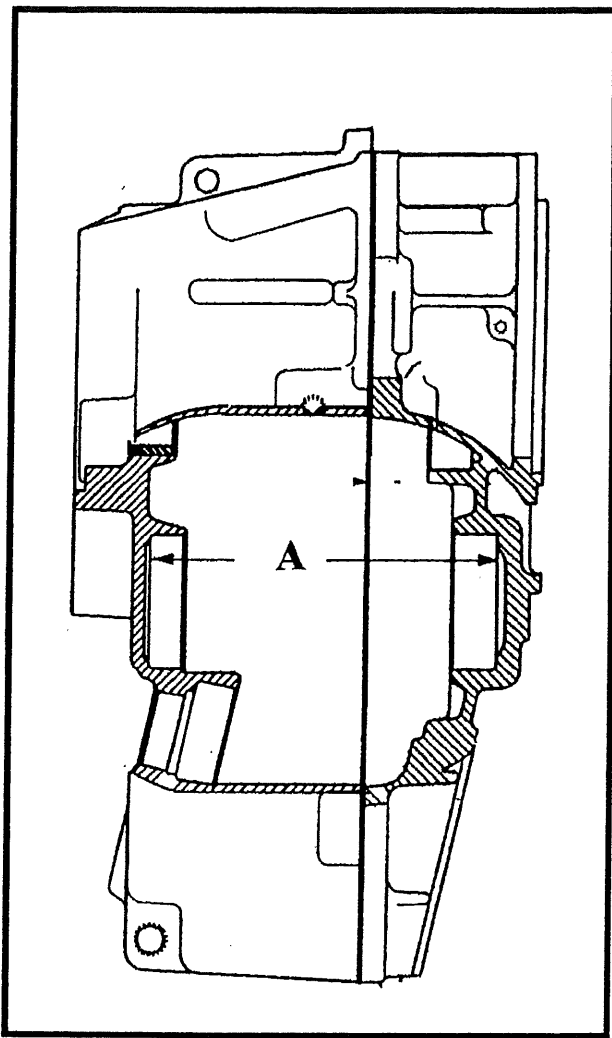


Figure 1-5. Assembled case and cover cutaway.

(137 & 142) on the cones and clamp with moderate pressure to assure proper bearing to roller seating (figure 1-6).

6. Measure the distance across the two cups with a seven (7) inch micrometer. **This is measurement "B"** as illustrated in figure 1-6.

7. **Subtract** the measurement taken in step 6 (measurement **B**) **from** the measurement taken in step 4 (measurement "A").

8. **Add .009 inch (.007-.010inch)** to the measurement determined in step 7. **This will be the shim thickness needed to achieve proper intermediate shaft pre-load (B1 in figure 1-6).**

9. Place the shims (138) determined in step

(8) in the cover (129) bearing pocket and install bearing cup (137) over them.

10. Install intermediate bearing cup (142) in the case (160).

11. Install output shaft bearing cup (156) and output seal (117) in case (160) and rotate case so that the gasket surface is up.

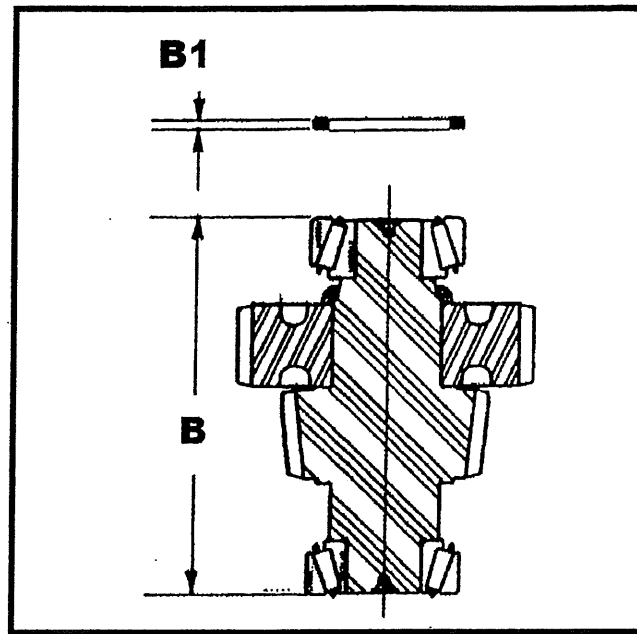


Figure 1-6. Intermediate shaft with bearing

12. Press bearing cones (152 & 155) on output shaft (153) and insert into case (160).

**Be careful not to upset the garter string behind the seal's lip.**

13. Position oil shield assembly (146 (including screw 147, magnet 148 & nut 149)) over output shaft gear.

14. Install O-ring (145) on pick-up tube (144) using petroleum jelly and install pick-up tube assembly into case (160). Secure pick-up tube and oil shield with bolt (143) using Loctite ®.

15. Position input clutch assembly (131) and lay clutch assembly (132) into case (160). Make sure the clutch gears are resting at the same level

16. Insert intermediate shaft assembly (140) into case (160).

17. Position gasket (130) on case (160). Use



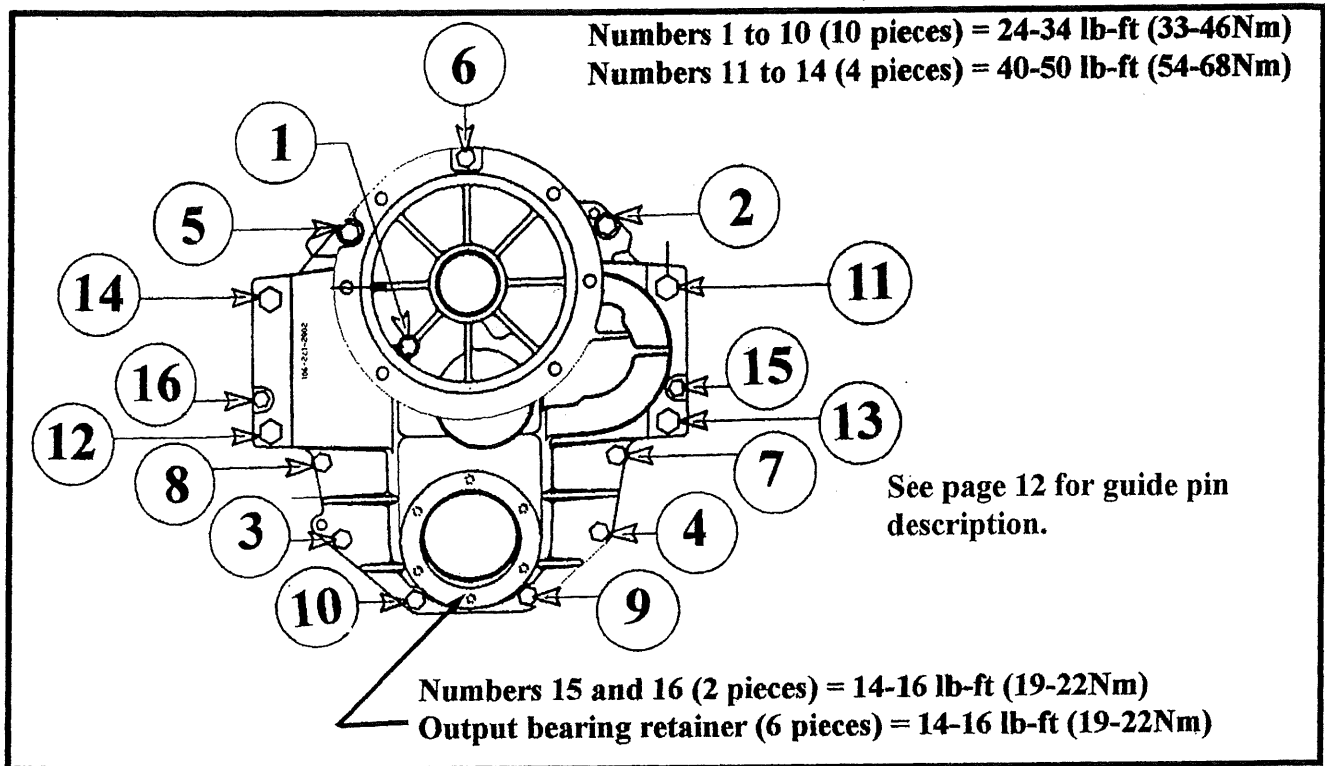


Figure 1-7. Torque sequence and specifications

petroleum jelly to hold gasket. Do not use sealer of any kind.

18. Place cover (129) on gasket and install guide pins into the two (2) roll pin (123) locations. See figure 1-7.

19. Install bolts (124, 125, 127 & 128) and washers (126) finger tight only. Use RTV sealer on bolt (127).

20. Remove guide pins and install roll pins (123) through cover (129) and case (160).

21. Tighten bolts as described in figure 1-7.

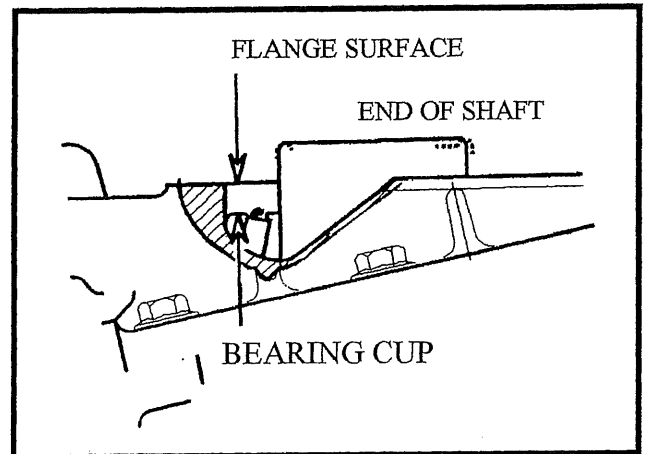


Figure 1-8. Measure to cup.

#### OUTPUT SHAFT BEARING PRELOAD

1. Arrange the transmission assembly in a position that assures the output shaft is in a vertical position (figure 1-9).

2. Install seal (120) and O-ring (121) in bearing retainer (119).

3. Install the output bearing cup (151) insuring the bearing cup is properly seated.

4. Measure the distance from the bearing cup (151) to the cover surface and record (figure 1-8).

5. Measure the distance between the two bearing retainer (119) surfaces as shown in figure 1-10 and record.

6. Subtract the measurement found in step 4 from that found in step 5.

7. Add .009 inch (.007-.010inch) to the measurement determined in step 6. This is the total thickness of the shim pack (122) to be placed on the output bearing cup.

8. Place the shims determined in step 7 on

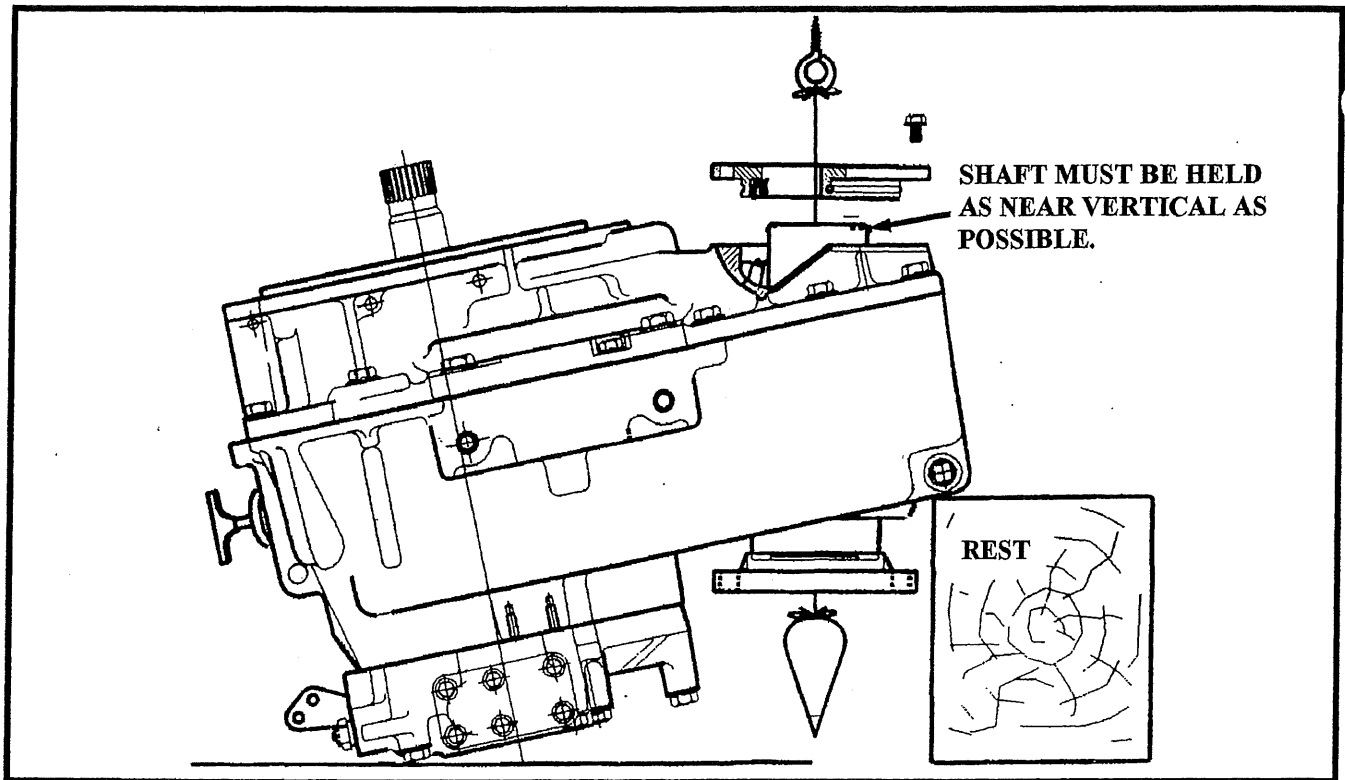


Figure 1-9. Case positioning for output bearing preload adjustment

face of bearing cup (151) and place retainer (119) in position

9. Install retainer (119) assembly with bolts (118). Torque to 14-16 lb-ft (19-22 Nm).

10. Install dip-stick tube (102), pump and valve assembly (107) as described in Form 1351/4-95

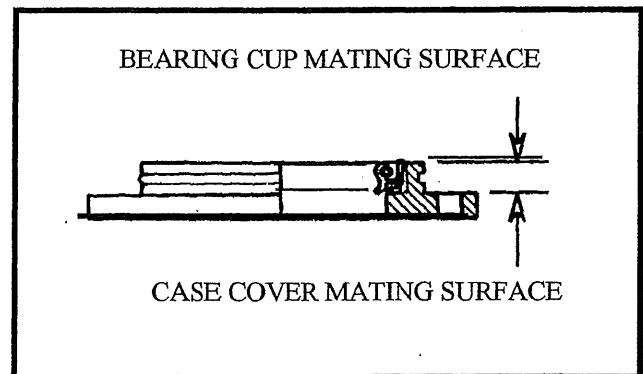


Figure 1-10. Measure taken from bearing retainer.

## PUMP & VALVE DISASSEMBLY

### GENERAL INFORMATION

**There are two distinctly different pump and control valve assemblies used on the S5000 V-drive transmission. The two designs are interchangeable as complete assemblies, but for the most part their internal parts are different. The manual control valve (212), spring (217) and screen (222) are the only common internal parts.**

1. The GEROTOR type is the latest design and quickly discernible by placing a magnet against the steel cover plate (215) see Figure 1-11.

2. The CRESCENT type is the earlier design and has an aluminum cover plate (215) which will not attract a magnet.

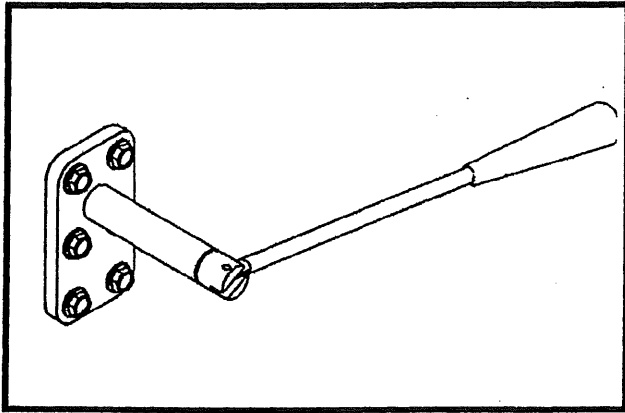


Figure 1-11  
Identification of pump type.

### DISASSEMBLY OF VALVE AND PUMP HOUSING ASSEMBLY

#### REMOVAL OF PUMP, CONTROL VALVE, SWITCH AND TRANSMISSION SHIFT LEVER. Proceed as follows (see figure 1-12):

1. Remove the neoprene o-ring (201) see Figure 1-12, three bolts (202) and pump

assembly (203). The pump contains matched parts and must be replaced as an assembly.

2. Remove switch assembly (204) and temperature sensor (if used).

3. Holding transmission shift lever (208) to prevent control valve (212) from turning and ball (209) and spring (210) from dropping out, remove nut (205). Remove lock washer (206), flat washer (207), shift lever (208), ball (209) and spring (210).

4. Remove lock ring (211) and slide valve (212) from housing (107). Temporarily reinstall lever (208) for better leverage.

5. Remove pins (223) only if pin replacement is required.

#### REMOVAL OF PRESSURE CONTROL VALVE AND SCREEN. Proceed as follows (see figure 1-12);

1. Remove six bolts (214), cover plate (215), gasket (216), spring(s) (217 and/or 218).

INDEX	NO	APPLICATION	PART NO	DESCRIPTION	LB-FT	NM	REM.
128	9	COVER TO MAIN CASE	1300-183-018	M10 x 1.50 x 31.0 mm	32 - 36	43 - 49	
125	4	COVER TO MAIN CASE	1000-183-092	M12 x 1.75 x 35.0mm	40 - 50	54 - 68	
124, 118	8	COVER / FLANGE	11502693	M8 x 1.25 x 20.0mm	14 - 16	19 - 22	# 271
127	1	COVER TO MAIN CASE	1300-183-007	M10 x 1.50 x 110.0mm	32 - 36	43 - 49	# 242
114	8	FLANGE TO SHAFT	1000-183-093	M8 x 1.25 x 20.0mm	32 - 36	43 - 49	
104	7	VALVE BODY TO CASE	1000-183-088	M10 x 1.50 x 70.0mm	34 - 38	47 - 53	
105	1	VALVE BODY TO CASE	2000-183-001	M5 x 0.8 x 30.0mm	4 - 6	5 - 7	
143	2	OIL BAFFLE TO CASE	1000-183-090	M6 x 1.0 x 16.0mm	4 - 6	5 - 7	
202	3	OIL PUMP TO HOUSING	1000-183-087	M6 x 1.0 x 25.4mm	6 - 8	8 - 11	
204	1	NEUTRAL SWITCH	1000-640-004	9/16 x 18 UNF	20 - 25	27 - 34	
205	1	NUT, CONTROL VALVE	11505919	M8 x 1.25 mm	14 - 16	19 - 22	
214	6	END COVER, VALVE	1000-183-090	M6 x 1.0 x 16.0mm	4 - 6	5 - 7	
714	24	CLUTCH CYLINDER	2000-183-002	M6 x 1.0 x 20.0mm	16 - 18	22 - 25	##
103	1	DRAIN PLUG	444583	3/8 x 18 DRYSEAL NPSF	20 - 25	27 - 34	

# LOCTITE (R) NUMBER, ## PREAPPLIED LOCTITE

Table 1-2 Torque specifications



shift lever (208), flat washer (207), lock washer (206) and nut (205). Torque nut to 14-16 lb-ft (19-22 Nm).

8. Position pump assembly (203) in valve and pump housing assembly (107) with counter bored holes for bolt heads facing out. Align all three bolt holes and install bolts (202). Torque bolts to 6-8 lb-ft (8-11 Nm).

### INSTALLATION OF VALVE AND PUMP ASSEMBLY

**Determine input and lay shaft bearing preload as described in section 5-21, page 5-13 of the S5000 Down-Angle Service Manual (Form 1351/4-95)**

Attach the valve and pump assembly (107) as follows.

1. Align the male flats on input shaft (733) with the female flats in the pump (203) by placing pump housing assembly over shaft with an oscillating motion until the mating

surfaces come together.

2. Install two guide pins (figure 1-13) in case (160) on opposite sides of the pump mounting surface. Remove the pump assembly from the transmission case.

3. Position gasket (108) on mounting surface.

4. Install o-ring (201) in groove around pump (203) (o-ring not required with crescent pump).

5. Position shim packs (109) determined in section 5-21, page 5-13 of S5000 Down-Angle Service Manual (Form 1351/4-95) on bearing cups (110 & 111).

6. Carefully slide the pump assembly over the guide pins and finger tight five bolts (104), remove the guide pins and finger tight the two remaining bolts (104).

**TIGHTENING VALVE AND PUMP ASSEMBLY.** Use the following steps to tighten the valve and pump assembly.

1. First, tighten bolts (104) to 15 lb/ft using

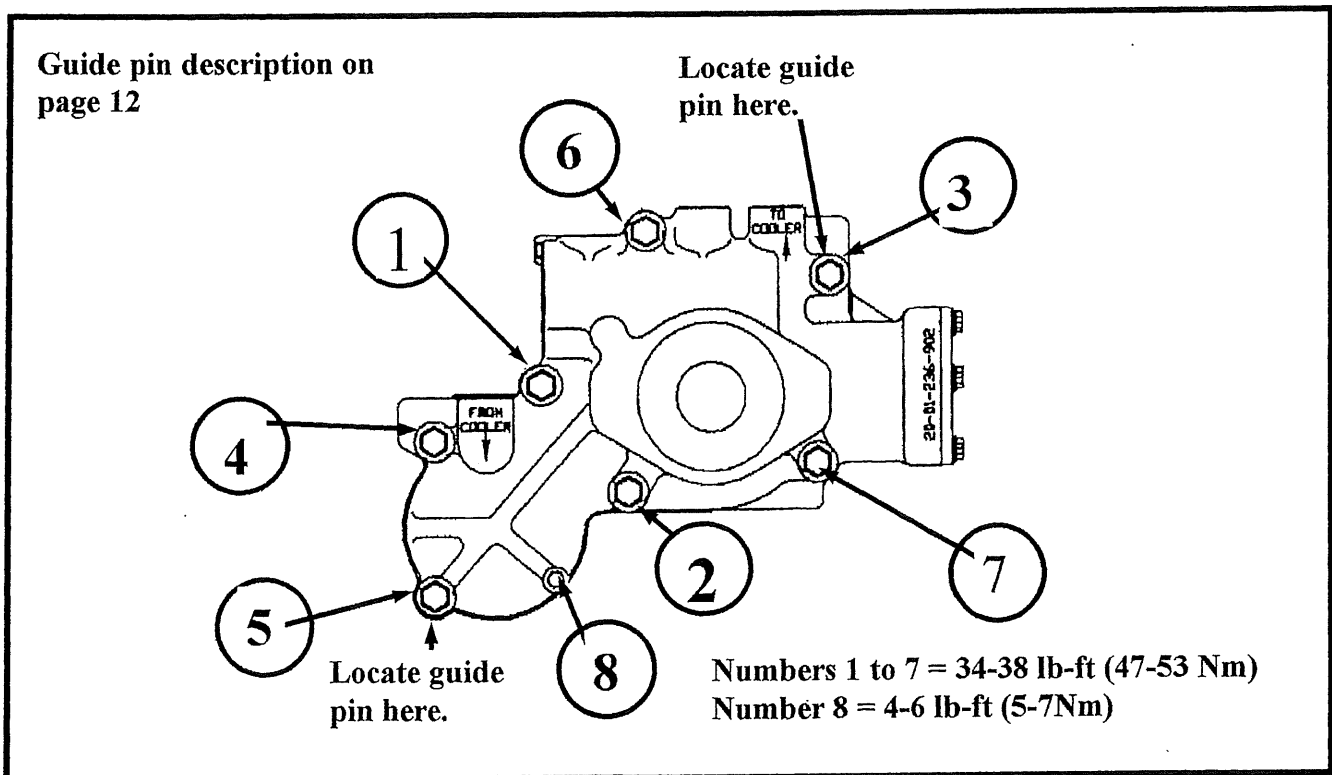
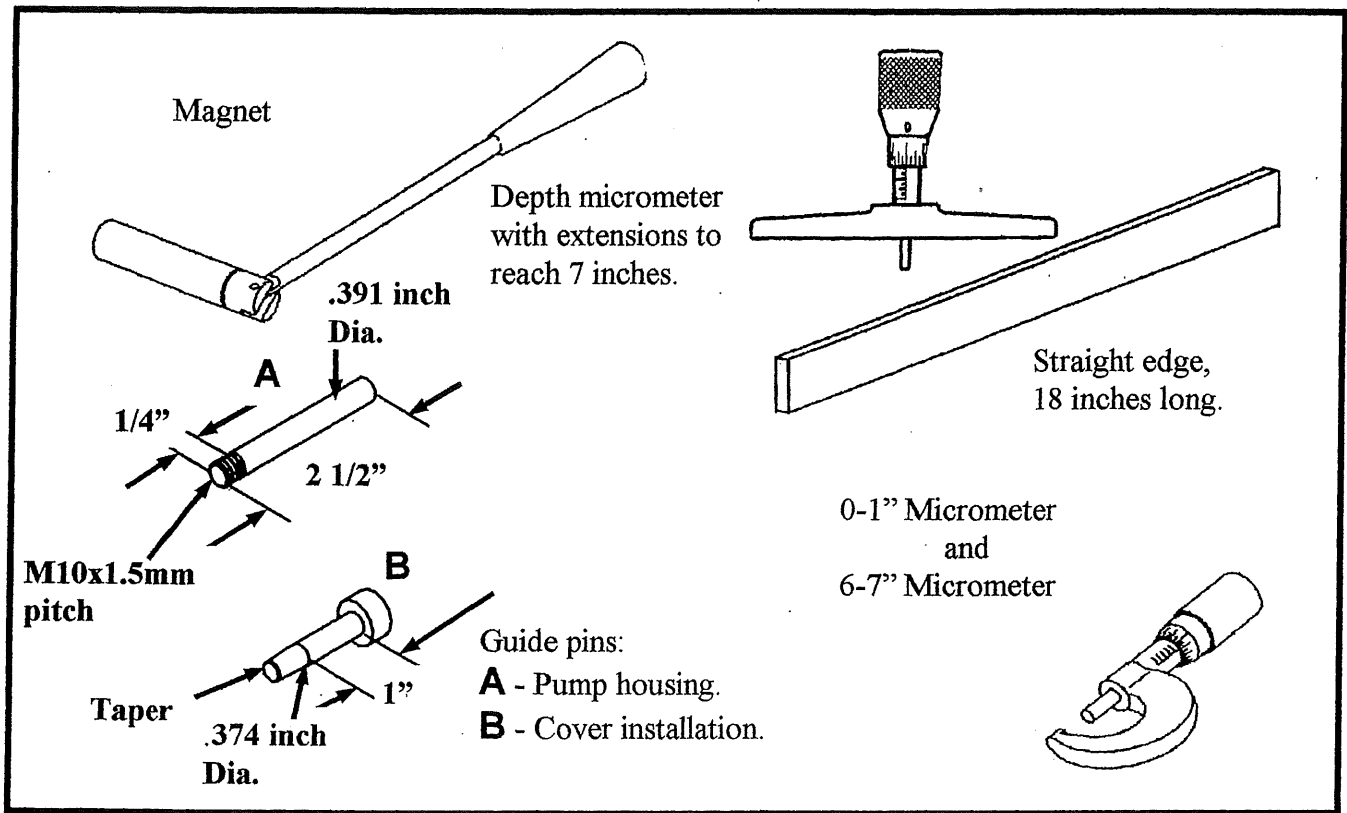


Figure 1-13 Pump housing bolt tightening sequence.



T-1, Special Tools

**Notes:**

---



---



---



---



---



---



---



---



---



---



---



---



---



---



---



---



---



---



---



---



---



---

# Section P

## Parts

### Transmission Applications 2002-000-002 thru -005

#### Contents

Figure No.	Description
P-1	Transmission Assembly
P-2	Valve and Pump Assembly
P-3	Clutch Assembly

#### P-1. INTRODUCTION

P-2 This section lists, describes and illustrates replacement parts for the Series 5000 V-Drive, Velvet Drive ® Marine Transmission. The exploded view illustration has a corresponding parts list. Index numbers are used to key each part in the exploded views to the parts list and service instructions in the preceding sections of this supplement.

P-3 The PART NUMBER column in the parts list gives the part number which can be used to order replacement parts. More than one part number is listed for some index numbers. For shims, select as required to meet the assembly requirements specified in the appropriate service section. For other parts, read the description column to determine part applicability.

P-4 The DESCRIPTION column gives the part nomenclature used, not only in the list but also in the service instructions. Part applicability is given in parenthesis if the parts used only on a specific model or models.

P-5 The QTY column designates the number of parts used at each location defined by the index number. Letter symbols may be used in this column to designate specific information as follows.

AR - As Required. This is used for selective fit parts, determined as specified in the assembly instructions.

Ref - Reference. This is used for subassemblies where the quantity required is listed on the main assembly parts list, figure P-1

NSS No Sold/Service Separately. Parts which are available only as an assembly.

LH - Left Hand Gear

RH - Right Hand Gear

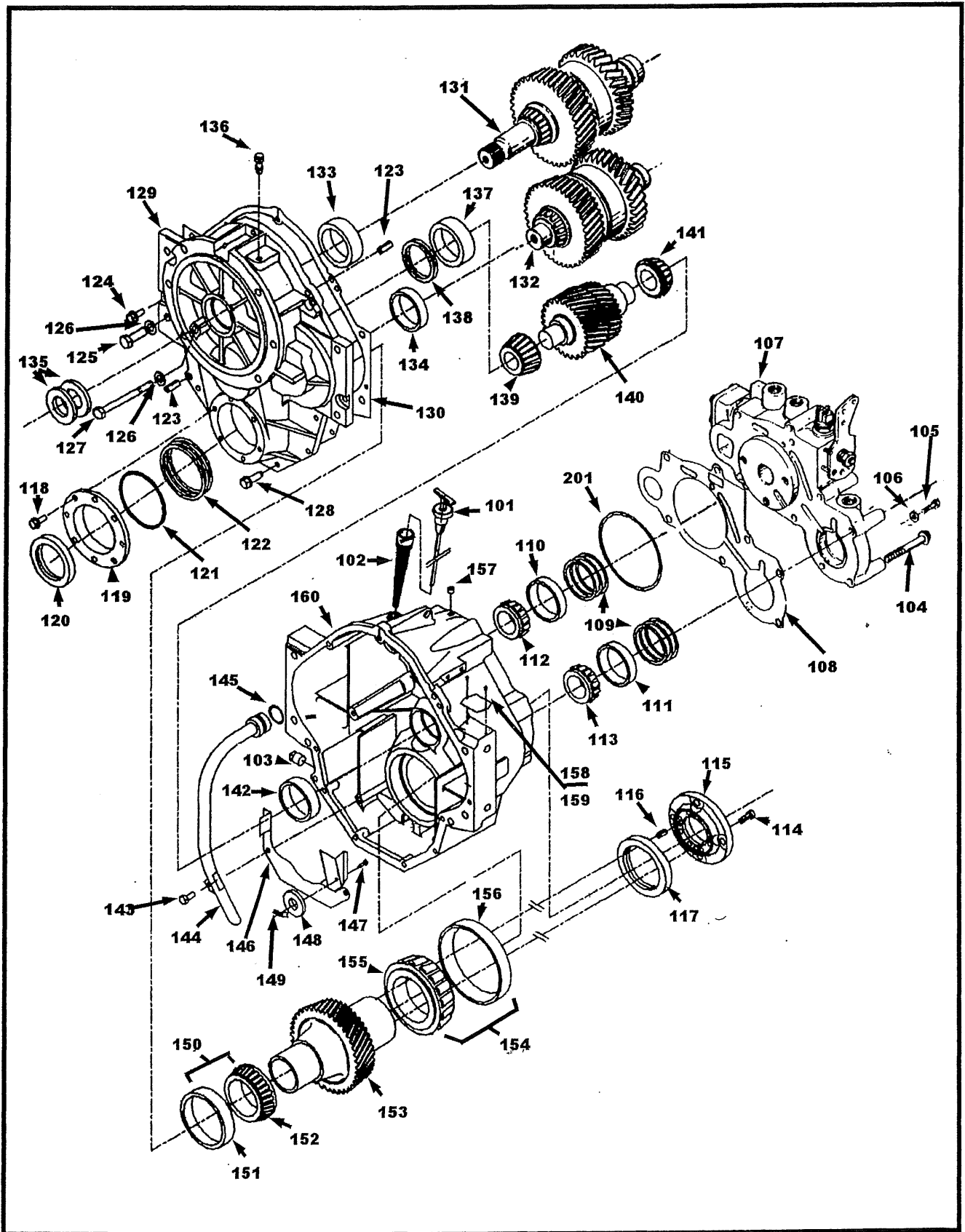


Figure P-1. V-drive Transmission Assembly



PARTS LIST FOR FIGURE P-1

INDEX NO	PART NUMBER	DESCRIPTION	QTY
	1000-037-059	SHIM, 0.0050 in. (0.127 mm) thick	AR
101	2002-559-003	DIP STICK	1
102	2001-535-001	DIP STICK TUBE	1
103	444583	DRAIN PLUG	1
104	1000-183-088	BOLT, Hex head, M10 x 1.5 x 70	7
105	2000-183-001	BOLT, Hex head, M5 x 0.8 x 001	1
106	2000-047-001	WASHER	1
107	2001-736-002	VALVE & PUMP ASSY (See figure P-2)	1
108	2001-045-002	GASKET, Pump	1
109	SHIMS, INPUT AND LAY SHAFT PRELOAD		
	1000-037-058	SHIM, 0.0030 in. (0.076 mm) thick	AR
	1000-037-060	SHIM, 0.0070 in. (0.178 mm) thick	AR
	1000-037-061	SHIM, 0.0090 in. (0.229 mm) thick	AR
	1000-037-062	SHIM, 0.0200 in. (0.508 mm) thick	AR
	1000-037-063	SHIM, 0.0300 in. (0.760 mm) thick	AR
	1000-037-064	SHIM, 0.0400 in. (1.106 mm) thick	AR
	1000-037-065	SHIM, 0.0500 in. (1.270 mm) thick	AR
	1000-037-066	SHIM, 0.0600 in. (1.524 mm) thick	AR
	1000-037-067	SHIM, 0.0700 in. (1.778 mm) thick	AR
110	1000-133-009	BEARING CUP, Input shaft, pump side	1
111	1000-133-009	BEARING CUP, Lay shaft, pump side	1
112	1000-133-010	BEARING CONE, Input shaft, cover side	1
113	1000-133-010	BEARING CONE, Lay shaft, cover side	1
114	1000-183-093	BOLT, Flange	8
115	2002-031-001	FLANGE	1
116	2002-043-001	PIN	4
117	2000-044-004	SEAL, Output flange side.	1
118	11502693	BOLT, Bearing retainer, output.	6
119	2002-039-001	BEARING RETAINER, Output	1
120	2000-044-003	SEAL, Output retainer.	1
121	2000-141-500	O-RING, Output bearing retainer.	1
122	SHIMS, OUTPUT SHAFT PRELOAD		
	2002-037-001	SHIM, 0.0098 in. (0.250 mm) thick	AR
	2002-037-002	SHIM, 0.0198 in. (0.500 mm) thick	AR
	2002-037-003	SHIM, 0.0295 in. (0.750 mm) thick	AR
	2002-037-004	SHIM, 0.0393 in. (1.000 mm) thick	AR
	2002-037-005	SHIM, 0.0040 in. (0.102 mm) thick	AR
	2002-037-006	SHIM, 0.0070 in. (0.178 mm) thick	AR
123	2002-043-002	PIN, Roll	2

PARTS LIST FOR FIGURE P-1

INDEX NO	PART NUMBER	DESCRIPTION	QTY
124	11502693	BOLT, Hex head, M8 x 1.25 x 20	2
125	1000-183-092	BOLT, Hex head, M12 x 1.75 x 35	4
126	120395	WASHER	5
127	1300-183-007	BOLT, Hex head, M10 x 1.5 x 110.0 mm	1
128	1300-183-018	BOLT, Hex head, M10 x 1.5 x 30 mm	9
129	2002-172-001	COVER, Case	1
130	2002-045-002	GASKET, Cover	1
131	2002-689-001	INPUT SHAFT & CLUTCH ASSM.*** (35T*, 1.2800:1 Ratio transmission.)	1
	2002-689-002	INPUT SHAFT & CLUTCH ASSM.*** (33T*, 1.5030:1 Ratio transmission.)	1
	2002-689-003	INPUT SHAFT & CLUTCH ASSM.*** (29T*, 1.9862:1 Ratio transmission.)	1
	2002-689-004	INPUT SHAFT & CLUTCH ASSM.*** (25T*, 2.4960:1 Ratio transmission.)	1
132	2002-567-001	LAY SHAFT & CLUTCH ASSM.*** (35T*, 1.2800:1 Ratio transmission.)	1
	2002-567-002	LAY SHAFT & CLUTCH ASSM.*** (33T*, 1.5030:1 Ratio transmission.)	1
	2002-567-003	LAY SHAFT & CLUTCH ASSM.*** (29T*, 1.9862:1 Ratio transmission.)	1
	2002-567-004	LAY SHAFT & CLUTCH ASSM.*** (25T*, 2.4960:1 Ratio transmission.)	1
133	1000-133-053	BEARING CUP, Input shaft, cover side	1
134	1000-133-051	BEARING CUP, Lay shaft, cover side	1
135	1000-044-065	SEAL, Input shaft.	2
136	A4740G	VENT	1
137	1000-133-053	BEARING CUP, Intermediate, cover	1
138	SHIMS, INTERMEDIATE SHAFT PRELOAD		
	2002-037-011	SHIM, 0.003 in. +/- (0.076 mm +/-) thick	AR
	2002-037-012	SHIM, 0.005 in. +/- (0.126 mm +/-) thick	AR
	2002-037-013	SHIM, 0.007 in. +/- (0.172 mm +/-) thick	AR
	2002-037-014	SHIM, 0.009 in. +/- (0.228 mm +/-) thick	AR
	2002-037-015	SHIM, 0.020 in. +/- (0.505 mm +/-) thick	AR
	2002-037-016	SHIM, 0.030 in. +/- (0.752 mm +/-) thick	AR
	2002-037-017	SHIM, 0.040 in. +/- (1.016 mm +/-) thick	AR
	2002-037-018	SHIM, 0.050 in. +/- (1.270 mm +/-) thick	AR
	2002-037-019	SHIM, 0.060 in. +/- (1.526 mm +/-) thick	AR
	2002-037-020	SHIM, 0.070 in. +/- (1.777 mm +/-) thick	AR

PARTS LIST FOR FIGURE P-1

INDEX NO	PART NUMBER	DESCRIPTION	QTY
139	2000-133-075	BEARING CONE, Intermediate, cover	1
140	2002-584-001	INTERMIT. SHAFT, 28T**. 1.2800:1 ratio	1
	2002-584-002	INTERMIT. SHAFT, 31T**. 1.5030:1 ratio	1
	2002-584-003	INTERMIT. SHAFT, 36T**. 1.9862:1 ratio	1
	2002-584-004	INTERMIT. SHAFT, 39T**. 2.4960:1 ratio	1
141	2000-133-071	BEARING CONE, Intermediate, case	1
142	2000-133-070	BEARING CUP, Intermediate, case	1
143	1000-183-090	BOLT, oil shield and pick-up tube.	1
144	2002-534-001	PICK-UP TUBE, oil.	1
145	1000-141-214	O-RING, pick-up tube.	1
146	2002-036-001	SHIELD, oil.	1
147	2000-183-009	SCREW, magnet attach.	1
148	4915	MAGNET	1
149	1332-149-003	SPRING NUT, flat.	1
150	2000-633-002	BEARING, output cover side cone & cup.	1
151	2000-133-072	BEARING CUP, output cover side.	1
152	2000-133-073	BEARING CONE, output cover side.	1
153	2002-070-001	GEAR, output.	1
154	2000-633-001	BEARING, output case side cone & cup.	1
155	2000-133-069	BEARING CONE, output case side.	1
156	2000-133-068	BEARING CUP, output case side.	1
157	444685	PIPE PLUG, input clutch service port.	1
158	1000-183-077	RIVET, name plate.	2
159		NAME PLATE	NSS
160	2002-065-001	CASE	

\* Driven gear.

\*\* Driving gear.

\*\*\* See table on Page 18.

TRANS. MODEL/RATIO ***	INPUT-GEAR ***	INPUT-ASSY ***	LAY-GEAR ***	LAY-ASSY ***	INTER. GEAR # OF TEETH ***	INTER. ASSY NUMBER ***
2002-002 / 1.2800:1	2002-085-001 (35 TEETH)	2002-689-001	2002-085-001 (35 TEETH)	2002-567-001	28 TEETH	2002-584-001
2002-003 / 1.5030:1	2002-085-002 (33 TEETH)	2002-689-002	2002-085-002 (33 TEETH)	2002-567-002	31 TEETH	2002-584-002
2002-004 / 1.9862:1	2002-085-003 (29 TEETH)	2002-689-003	2002-085-003 (29 TEETH)	2002-567-003	36 TEETH	2002-584-003
2002-005 / 2.4960:1	2002-085-004 (25 TEETH)	2002-689-004	2002-085-004 (25 TEETH)	2002-567-004	39 TEETH	2002-584-004

Table P-1. INPUT, LAY AND INTERMIATE GEAR IDENTIFICATION.

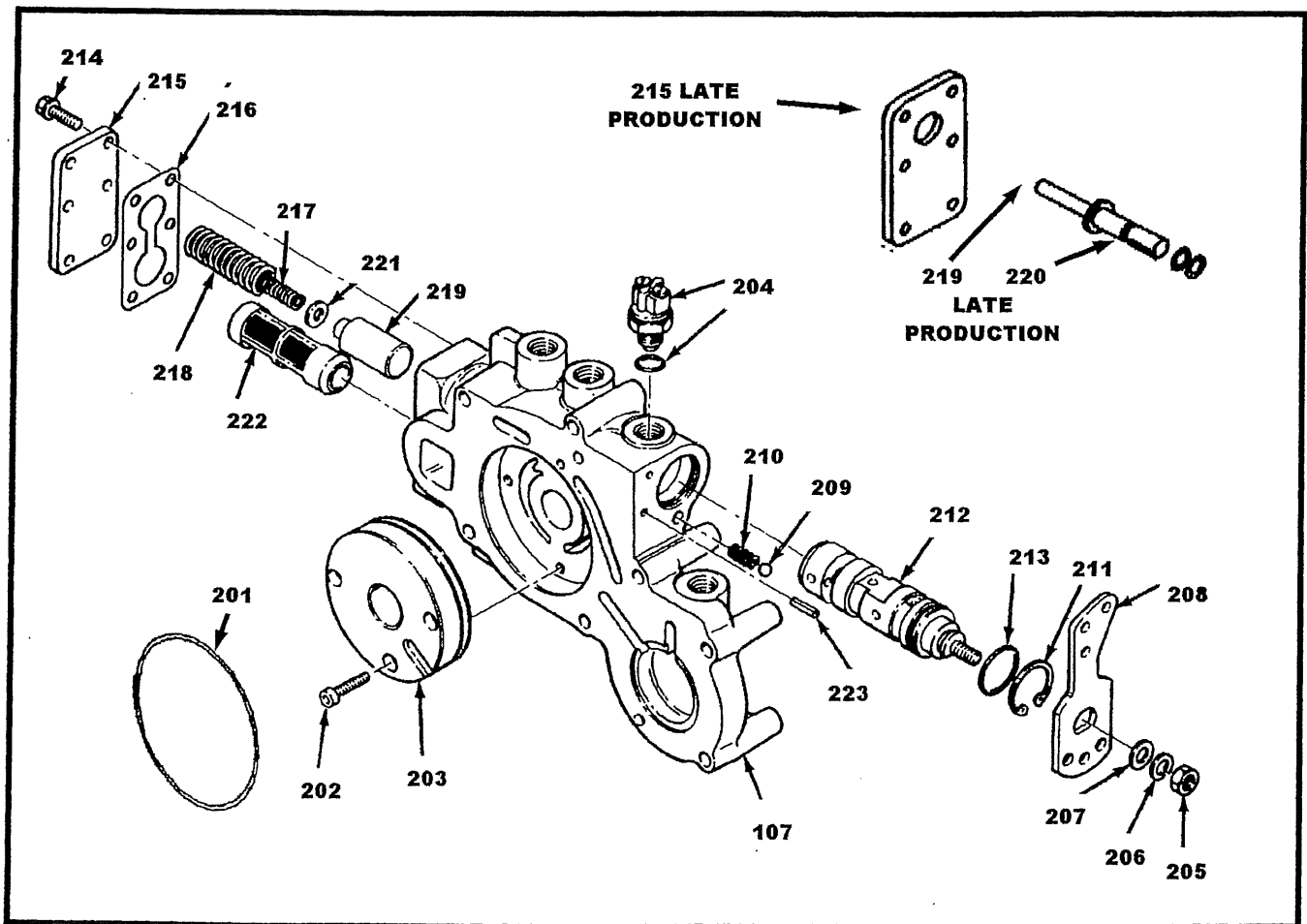


Figure P-2. Valve and Pump Assembly

PARTS LIST FOR FIGURE P-2

INDEX NO	PART NUMBER	DESCRIPTION	QTY
107	2001-736-003	VALVE & PUMP ASSM. COMP.(Gerotor)	1
	2001-736-002	VALVE & PUMP ASSM. COMP.(Crest.)	1
201	2000-141-501	O-RING (Pump body GEROTOR ONLY)	1
202	1000-183-087	BOLT, Pump	3
203	2002-508-001	PUMP, GEROTOR	1
	2001-508-001	PUMP, CRESCENT	1
204	1000-640-004	NEUTRAL SW & O-RING	1
	1000-140-007	NEUTRAL SWITCH ONLY	1
	1000-141-046	O-RING ONLY (neutral switch)	1
205	11505919	NUT	1
206	120214	WASHER, LOCK	1
207	120393	WASHER, PLAIN	1
208	2001-098-001	LEVER, CONTROL	1
209	453632	BALL, DETENT	1
210	71-42	SPRING, DETENT BALL	1
211	1000-139-071	SNAP RING	1
212	2001-139-001	VALVE ASSM	1
213	1000-141-123	O-RING	1
214	1000-183-090	BOLT	6
215	2001-039-002	COVER PLATE, STEEL (Gerotor pump)	1
	2001-039-001	COVER PLATE, ALUMINUM (Cres pump)	1
216	2001-045-003	GASKET, COVER PLATE	1
217	2001-156-004	SPRING (Small Diameter)	1
218	2001-156-005	SPRING (Used with gerotor pump only.)	1
	71-242	SPRING (Used with crescent pump only.)	1
219	2002-124-001	PISTON (Used with gerotor pump only.)	1
	2001-124-004	PISTON (Late production, cres pump.)	1
220	2000-141-502	O-RING, PISTON (Gerotor only)	2
221	1000-053-024	SPACER, PISTON SPRING	1
222	2001-238-001	SCREEN, OIL	1
223	9422127	PIN, LEVER STOP	1
224		VALVE & PUMP HOUSING	NSS

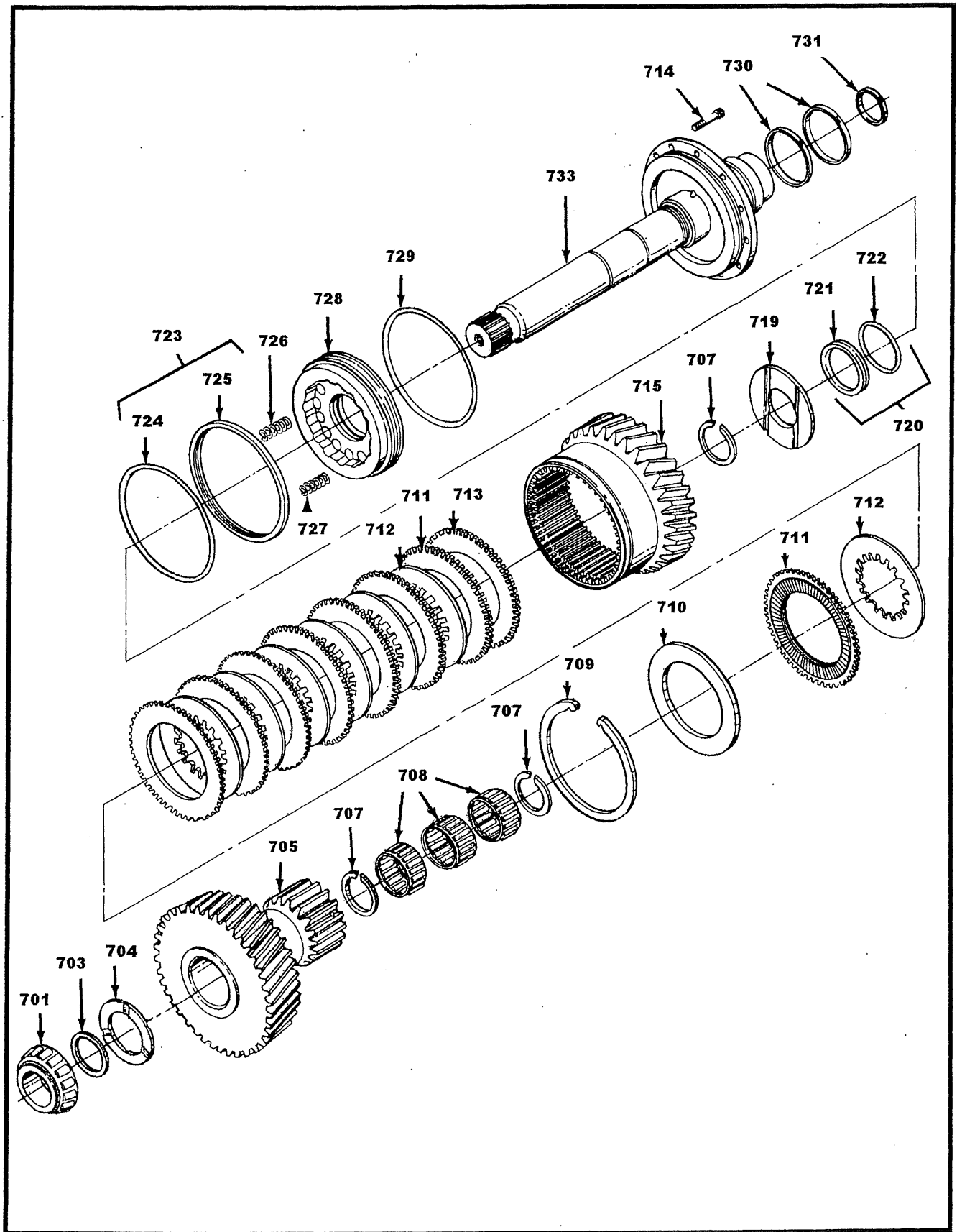


Figure P-3. Input Shaft Assembly

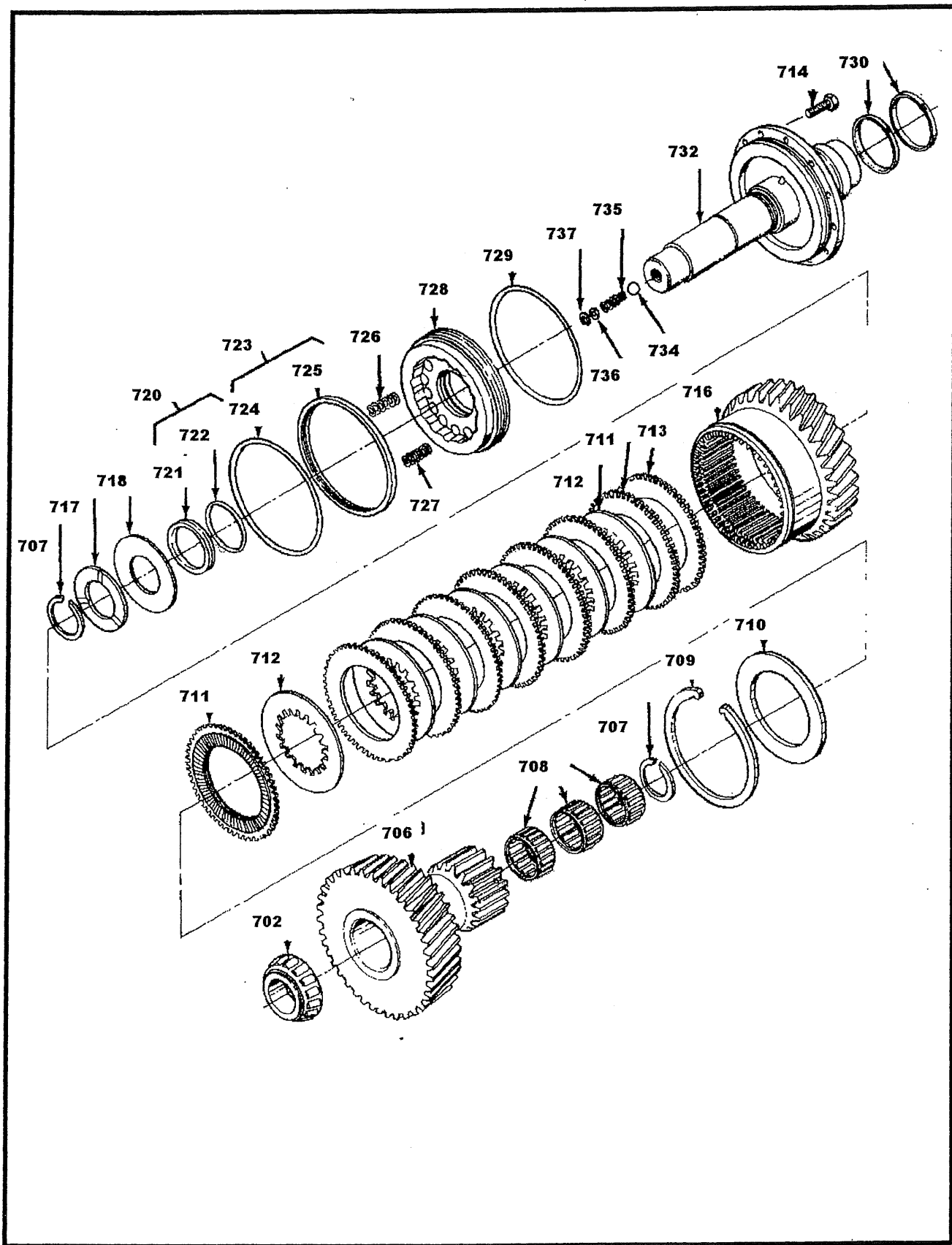


Figure P-4. Lay Shaft Assembly

PARTS LIST FOR FIGURE P-3

INDEX NO	PART NUMBER	DESCRIPTION	QTY	
			INPUT	LAY
701	1000-133-052	BEARING CONE	1	
702	1000-133-050	BEARING CONE		1
703	2001-053-001	SPACER	1	
704	1000-193-022	THRUST WASHER	1	
705-706	2002-085-001	GEAR 35T (Used in 1.2800:1 ratio)	1	1
	2002-085-002	GEAR 33T (Used in 1.5030:1 ratio)	1	1
	2002-085-003	GEAR 29T (Used in 1.9862:1 ratio)	1	1
	2002-085-004	GEAR 25T (Used in 2.4960:1 ratio)	1	1
707	1000-139-068	SNAP RING	4	2
708	1000-132-055	BEARING	3	3
709	1000-139-069	SNAP RING	1	1
710	2001-062-003	PRESSURE PLATE, REACTION	1	1
711	2001-666-001	CLUTCH PLATE, BRONZE	8	8
712	2001-166-002	CLUTCH PLATE, STEEL	7	7
713	2001-062-002	SPACER PLATE, STEEL BACKING	1	1
714	2000-183-002	BOLT ( )	12	12
715	2001-125-001	CYLINDER / CLUTCH GEAR (R)	1	
716	2001-125-002	CYLINDER / CLUTCH GEAR (LH)		1
717	1000-193-019	THRUST WASHER		1
718	2001-040-003	SPRING RETAINER (Flat)		1
719	2001-040-001	SPRING RETAINER (Grooves)	1	
720	1000-516-020	SEAL ASSM (Includes 721 & 722)	1	1
721	1000-016-020	SEAL (Inner, teflon)	1	1
722	1000-141-130	O-RING (Inner seal)	1	1
423	1000-516-019	SEAL ASSM (Includes 724 & 725)	1	1
724	1000-141-241	O-RING (Outer seal)	1	1
725	1000-016-019	SEAL (Outer, teflon)	1	1
726	2001-156-001	SPRING (Short heavy wire.)	4	4
727	1016-156-003	SPRING (Longer light wire.)	12	12
728	2001-624-001	PISTON, CLUTCH	1	1
729	1000-141-045	O-RING (Shaft to ring gear.)	1	1
730	2000-016-050	RINGS, SEALING	2	2
731	1000-016-021	RING, SEALING	1	
732	2001-067-001	SHAFT, LAY		1
733	2001-189-001	SHAFT, INPUT	1	
734	453595	BALL (Pressure relief)		1
735	72P-273	SPRING (Pressure relief)		1
736	2000-053-001	WASHER (Pressure relief)		1
737	2000-139-001	SNAP RING (Pressure relief)		1



## GASKET AND SEAL KIT 2002-410-001

The index numbers have been arranged so that the parts used in each area of the transmission are shown together.

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
108	2001-045-002	Gasket, pump	1
117	2000-044-004	Output seal, (flange)	1
120	2000-044-003	Output seal, (retainer)	1
130	2002-045-002	Gasket, case cover.	1
135	1000-044-065	Seal, input shaft	2
145	1000-141-214	O-ring	1
201	2000-141-501	O-ring	1
211	1000-139-071	Snap ring	1
213	1000-141-123	O-ring, control valve.	1
216	2001-045-003	Gasket, screen cover plate.	1
707	1000-139-068	Snap ring	6
709	1000-139-069	Snap ring	2
721	1000-016-020	Seal, piston small Tef.	2
722	1000-141-130	O-ring	2
724	1000-144-241	O-ring	2
725	1000-016-019	Seal, piston large Tef.	2
729	1000-141-045	O-ring, shaft to ring gear.	2
730	2000-016-050	Sealing ring, steel	2
731	1000-016-021	Sealing ring, piston	2
737	2000-139-001	Snap ring	1

## CLUTCH KIT 2001-410-002

The parts in this kit will service one (1) clutch. Two (2) kits are required if both clutches are to be serviced.

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
708	1000-132-055	Needle bearing	3
707	1000-139-068	Snap ring	3
709	1000-139-069	Snap ring	1
727	1016-156-003	Spring	12
717	1000-193-019	Thrust washer	1
704	1000-193-022	Thrust washer	1
730	2000-016-050	Sealing ring	2
714	2000-183-002	Bolt	12
719	2001-040-001	Spring retainer	1
718	2001-040-003	Spring retainer	1
703	2001-053-001	Spacer	1
710	2001-062-003	Backing plate	1
726	2001-156-001	Spring	16**
712	2001-166-002	Clutch disk (steel)	7
711	2001-666-001	Clutch disk (bronze)	8

\*\* Only four (4) 2001-156-001 clutch springs are used in the S5000 V-drive models.

Distributed by:

---

***Velvet Drive***<sup>®</sup>  
TRANSMISSIONS

Division of Regal-Beloit Corporation

P.O. Box 238 1208 Old Norris Road Liberty, SC 29657  
Phone (864) 843-9234 Fax (864) 843-1276  
[www.velvetdrive.com](http://www.velvetdrive.com)