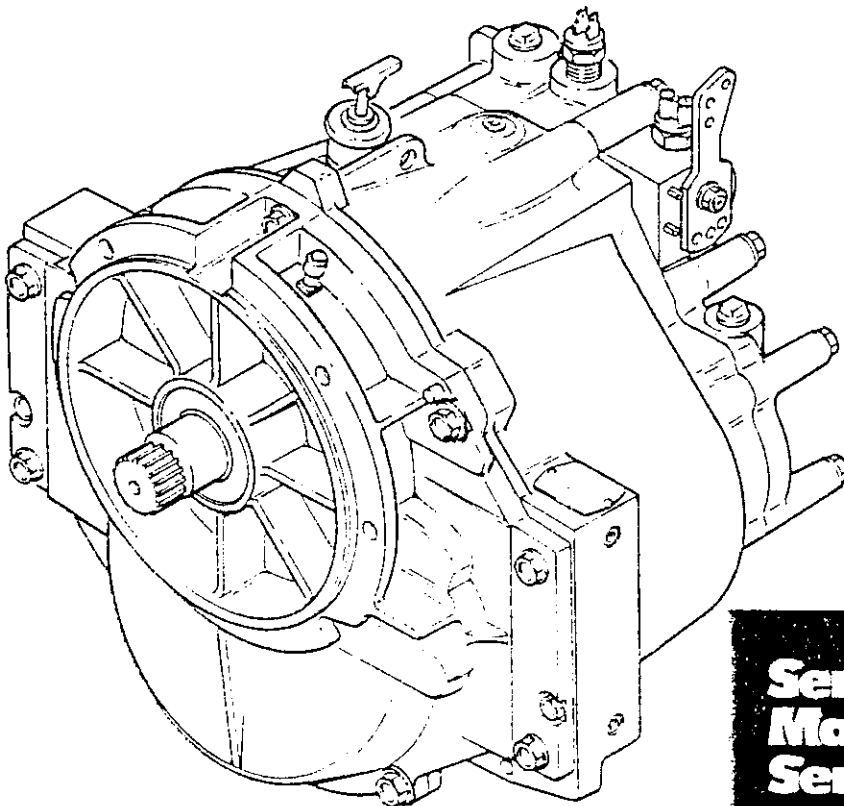


TO BE  
UPDATED



## Series 5000 Marine Transmission Service Manual



**BorgWarner**  
**Marine & Industrial Transmissions**

**Velvet Drive**  
BY BORG-WARNER

**MARINE TRANSMISSIONS**

1200

## Contents

Section		Page
1	INTRODUCTION AND DESCRIPTION	
	1-1. Introduction .....	1-1
	1-8. Description .....	1-2
2	IN-BOAT SERVICE AND TROUBLESHOOTING	
	2-1. Maintenance .....	2-1
	2-9. Troubleshooting .....	2-2
	2-12. Removal and Installation .....	2-3
3	DISASSEMBLY	
	3-1. General Information .....	3-1
	3-4. Removal and Installation of Transmission .....	3-1
	3-6. Transmission Disassembly .....	3-1
4	CLEANING, INSPECTION, REPAIR OR REPLACEMENT	
	4-1. Cleaning .....	4-1
	4-5. Inspection .....	4-1
	4-10. Parts Replacement .....	4-2
5	ASSEMBLY	
	5-1. General Information .....	5-1
	5-4. Transmission Assembly .....	5-1
P	PARTS .....	P-1
T	SPECIAL TOOLS .....	T-1

# 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) manufactured by Borg-Warner Marine and Industrial Transmissions, P.O. Box 2688, Muncie, IN 47307.

1-3. **SCOPE.** As you will see in the Table of Contents, this manual provides information for maintenance, troubleshooting, removal, disassembly, cleaning, inspection, repair or replacement, assembly and installation of the transmission.

1-4. Section P of the manual contains an illustrated parts list. The arrangement of the exploded view illustrations is described in the introduction to Section P.

Each detail 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.

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

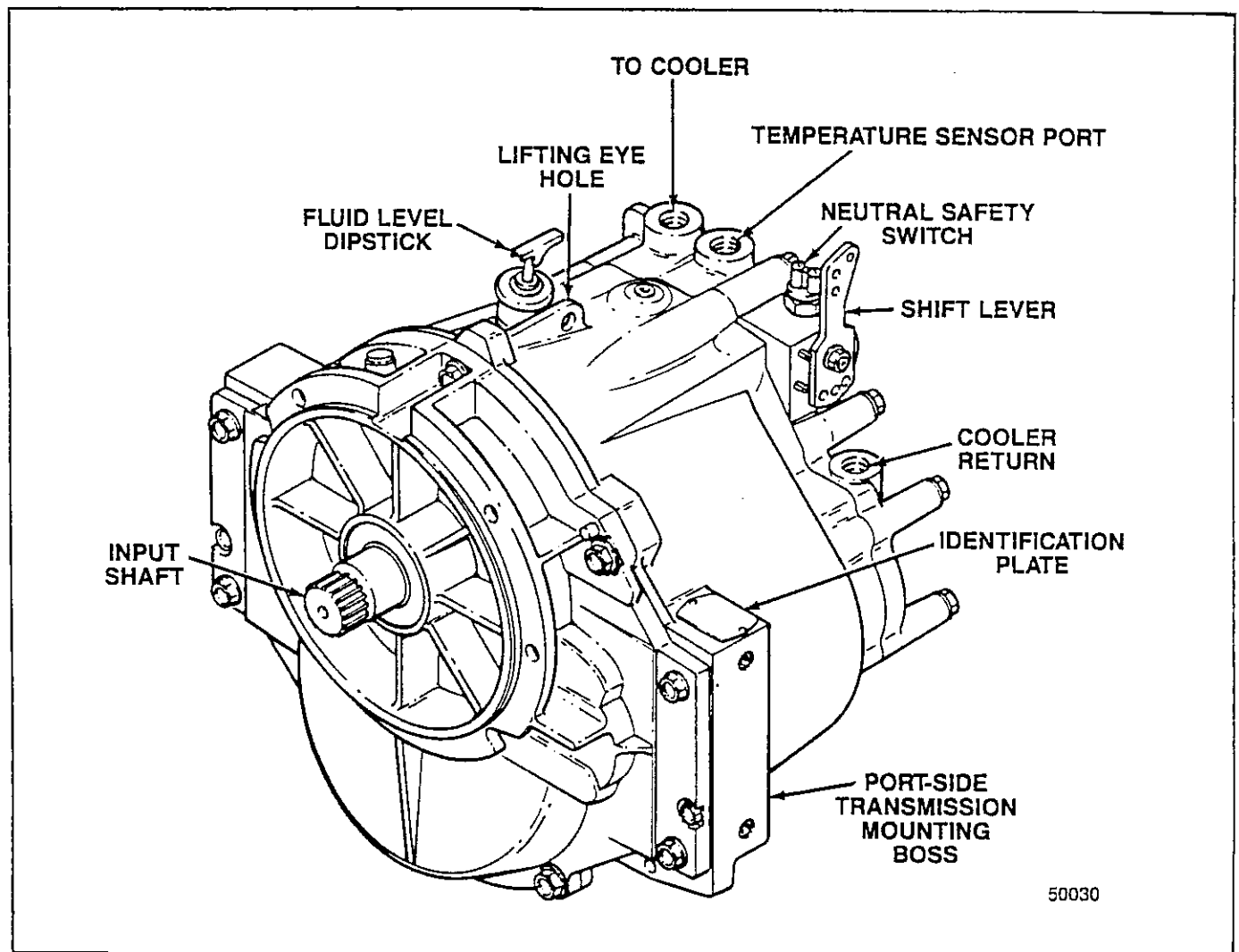


Figure 1-1. 5000 Series Marine Transmission

**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
NP	Not Procurable
OD	Outside Diameter
PN	Part Number
QTY	Quantity
Ref	Reference

## 1-8. DESCRIPTION

**1-9. GENERAL DESCRIPTION.** The Borg-Warner Series 5000 Velvet Drive® 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, intermediate and output shafts are supported by tapered roller bearings. Needle bearings are used between the shafts and clutch gears on the input and intermediate 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 down-angle transmission, specifically designed for twin engine applications that require nearly horizontal engine installation. Its full reversing feature eliminates the need for opposite rotating engines. Thus, the relationship between the transmission control lever position and forward or reverse boat movement is determined by the type of propeller (right-hand or left-hand) being driven (automotive rotation engines only—will not operate behind marine rotation).

**1-12. DESCRIPTION OF OPERATION.** The input shaft assembly is directly geared to the intermediate shaft assembly (see figure 1-2). 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 gear. Thus, with the transmission in neutral and the engine running, the input and intermediate shafts rotate in opposite directions with the output shaft stationary. When the control lever is moved to one of the drive positions, hydraulic pressure from the pump is directed to the clutch piston on either the input or intermediate shaft assembly. This engages the clutch on that shaft assembly and causes the clutch gear to turn the output shaft gear in one direction. When the control lever is returned to neutral, hydraulic pressure is released, springs relax the clutch, and the clutch gear “floats” on the needle bearings with the output shaft stationary. When the control lever is moved in the other direction, the other shaft clutch engages the clutch gear to turn the output shaft in the opposite direction.

**Table 1-2. General Specifications**

ASSEMBLY NO.	RATIO	FLUID CAPACITY* QTS/LITERS	DRY WEIGHT LBS/KGS
2001-000-001	1.00:1	2.01/1.90	100/45
2001-000-002	1.25:1	2.01/90	100/45
2001-000-003	1.50:1	2.01/1.90	100/45
2001-000-004	2.00:1	2.01/1.90	100/45
2001-000-005	2.45:1	2.01/1.90	100/45
2001-000-005	2.80:1	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 connecting lines.

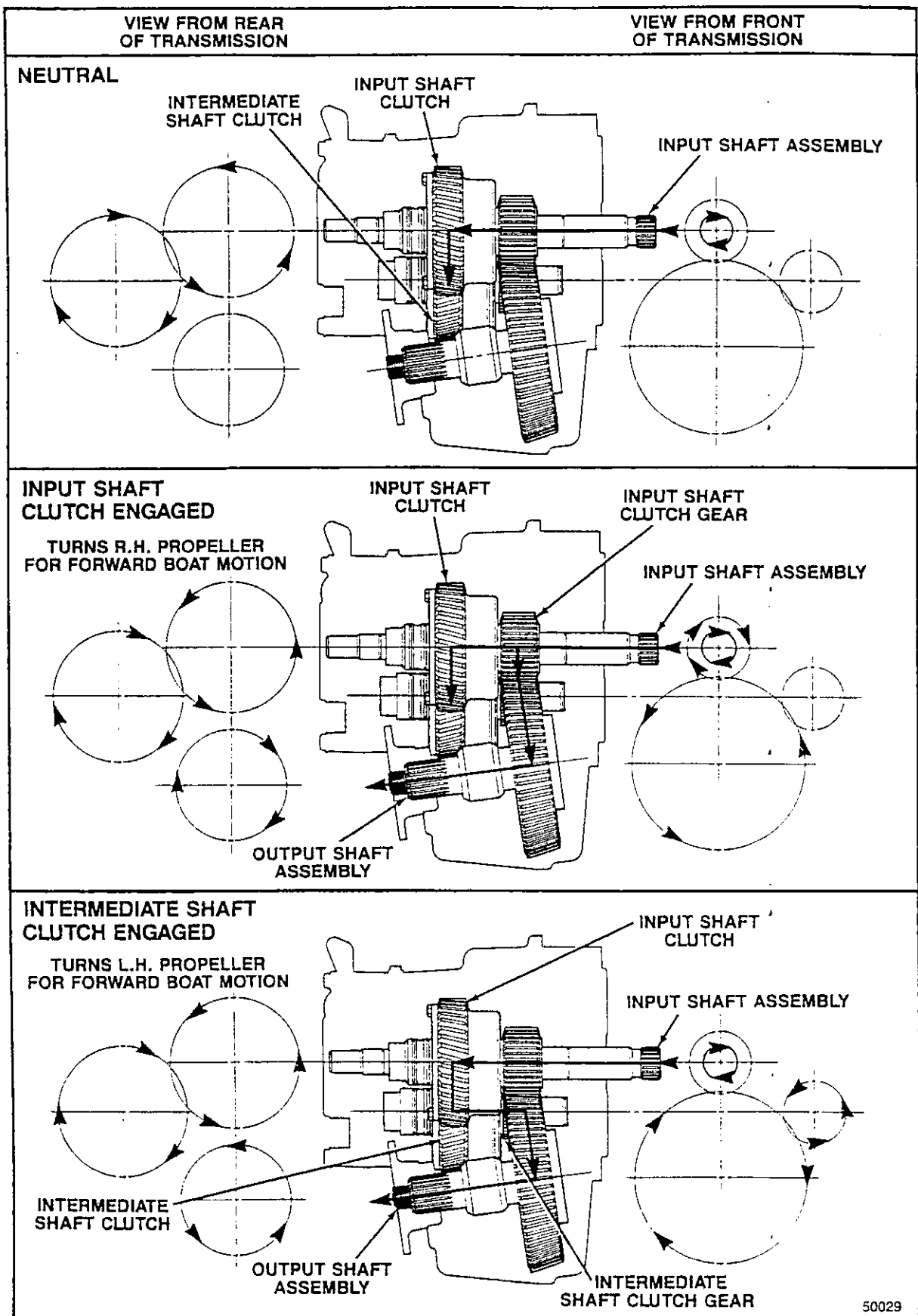


Figure 1-2. Series 5000 Transmission Operation

## Section 2

# In-Boat Service And Troubleshooting

### 2-1. MAINTENANCE

**2-2. GENERAL.** The periodic maintenance required for the Borg-Warner 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 is other reason to believe that the transmission has overheated, change the fluid immediately.

**2-4. APPROVED TRANSMISSION FLUID.** Dexron II, Type F, or any transmission fluid which meets Detroit Diesel Allison C3 or Caterpillar TO-2 specification is recommended. Do not mix different brands or types of transmission fluid.

### 2-5. CHECKING TRANSMISSION FLUID LEVEL.

The transmission should be at operating temperature (190°F max) to get an accurate fluid level reading. The fluid will expand when heated and significantly 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.

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 signs of water or other contaminants. Smell for signs of burnt (overheated) fluid. If noted, change fluid (refer to paragraph 2-8).	X		
Change transmission fluid (refer to paragraph 2-8).			X
Check control linkage and shift lever for proper operation. 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
Check transmission for signs of fluid leakage. Torque transmission bolts to specifications (refer to Section 5).		X	X
Check that transmission and adapter or bell housing mounting bolts are tight. Torque to specifications (refer to paragraph 2-16).			X

**2-6. WARM FLUID LEVEL CHECK.** With the engine at operating temperature, place the shift lever in neutral and shut down the engine. Remove the dipstick 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.

**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 as described above and put a cold full mark on the dipstick.

**2-8. 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.

1. Place a suitable container near the oil (fluid) cooler return port (103) (see figure 2-1).

2. Remove the cooler line from the transmission return port (103). Drain all fluid from the return line into the container. Reconnect the cooler return line and torque fittings to 25-35 lb-ft (34-47 Nm).

3. Remove the dipstick (1).

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).

## 2-9. TROUBLESHOOTING

**2-10. GENERAL.** In the event of operating difficulty, it is recommended that the transmission (engine) be shut down. If the problem is within the transmission, it may be necessary to remove and disassemble, or partially disassemble, the transmission to accurately pinpoint the source of trouble. Specific inspection procedures for detail parts of the transmission are provided in Section 4.

**2-11. TROUBLESHOOTING CHART.** Table 2-2 lists troubles which may be encountered along with possible causes and corrections.

Table 2-2. Troubleshooting Chart

PROBLEM	PROBABLE CAUSE	CORRECTION
No forward or reverse	Low fluid level	Fill to proper level
	Low oil pressure due to leakage	Find and repair leak. If leakage is internal, remove and repair transmission
	Broken input or output shaft	Remove and repair transmission
	Transmission control valve incorrectly positioned	Adjust shift linkage
	Damaged shift linkage	Repair shift linkage
	Cavitation of propeller	Use lower engine speed or change propeller
No forward	Broken propeller	Repair or replace propeller
	Transmission control valve incorrectly positioned	Adjust shift linkage
	Forward clutch failure	Remove and repair transmission
	Leakage in forward clutch circuit	Remove and repair transmission

Table 2-2. Troubleshooting Chart (Cont)

PROBLEM	PROBABLE CAUSE	CORRECTION
No reverse	Transmission control valve incorrectly positioned	Adjust shift linkage
	Reverse clutch failure	Remove and repair transmission
	Leakage in reverse clutch circuit	Remove and repair transmission
No neutral (engine may stall at idle)	Shift linkage out of adjustment	Adjust shift linkage
	Clutch plates not releasing	Remove and repair transmission
Transmission overheats	Cooler water flow restricted	Reverse flush cooler and water lines. Replace components that cannot be cleaned out.
	Cooler size too small for application	Install larger cooler
	Cooler hose size too restrictive	Install larger ID cooler hoses and fittings
	Low fluid level	Fill to proper level

## 2-12. REMOVAL AND INSTALLATION

**2-13. 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 with the engine off (see figure 2-1):

1. Disconnect negative battery terminal.
2. Disconnect electrical connectors from neutral switch (205) and temperature sensor (101) (if used) on transmission.
3. Remove the cooler outlet and return lines from the transmission ports (102 and 103). Drain all fluid from the lines into a suitable container.
4. Remove the dipstick (1).
5. 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)
6. Disconnect shift linkage from transmission control lever (209).
7. Remove coupling nuts and bolts and separate propeller shaft coupling flange from the transmission output flange (18).
8. Remove rear mounts, raise and support engine.
9. 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.

10. Remove all hardware attaching transmission to flywheel housing.

11. Move transmission straight back away from engine to completely disengage spline on input shaft (329).

12. Carefully lift out transmission.

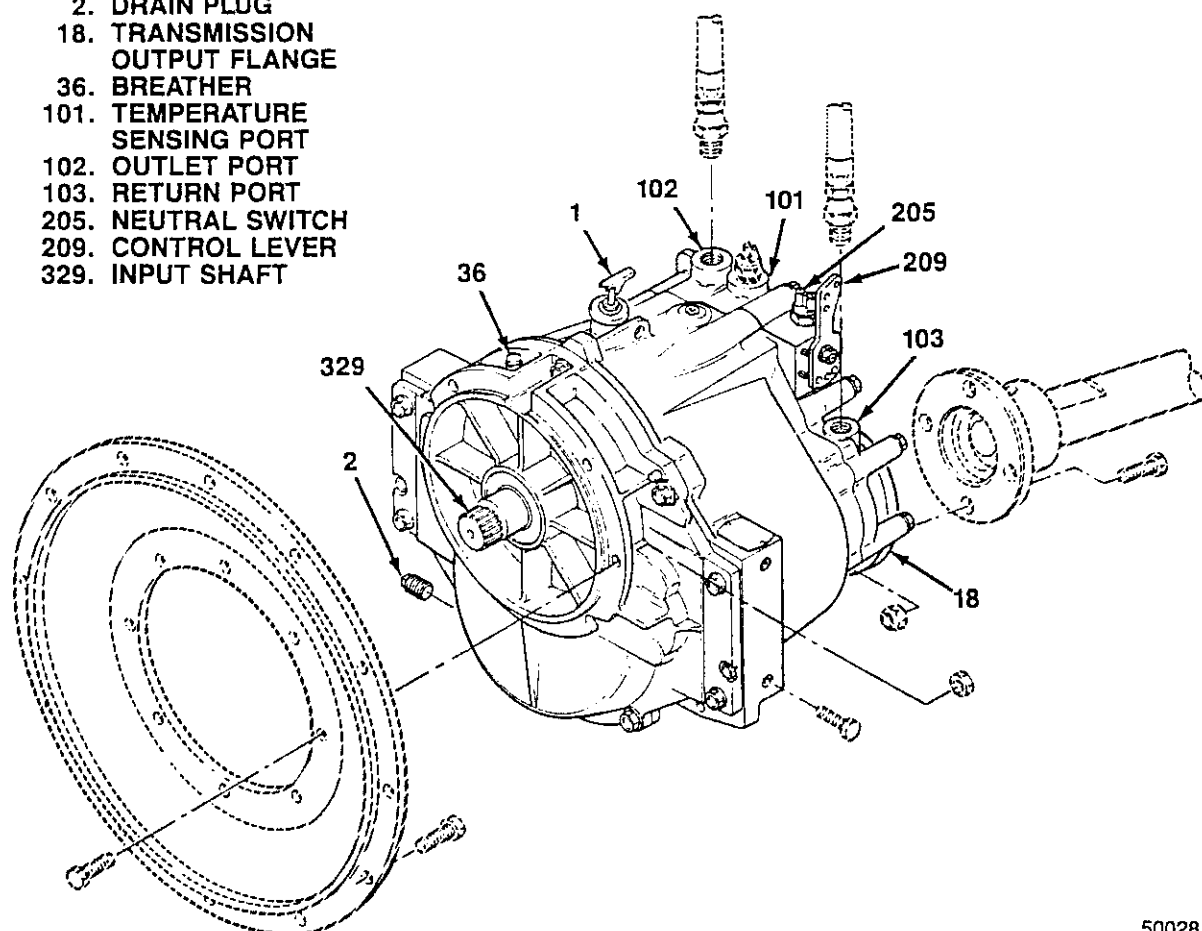
**2-14. REPAIR/OVERHAUL OF TRANSMISSION.** Refer to Sections 3 through 5 for disassembly, inspection, repair, parts replacement and assembly of the transmission.

**2-15. INSTALLATION OF TRANSMISSION.** Refer to the OEM manual for specific instructions regarding enclosures, mounts, supports, shift linkage and other components related to the transmission. With transmission supported in a suitable manner, proceed as follows (see figure 2-1):

1. Apply a thin film of high temperature grease to spline on transmission input shaft (329).
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 (329). Install and torque hardware per OEM specifications. Remove hoist.
4. With the boat in the water, connect coupling flanges and check alignment as follows:
  - a. Engage propeller shaft coupling flange pilot with transmission output flange (18).
  - b. With the flange faces in contact, maximum gap shall not exceed 0.003 inch.
  - c. Rotate transmission flange through one complete revolution, stopping each 90 degrees to check the clearance with the feeler gage. Repeat this procedure with the propeller shaft flange.



1. DIPSTICK
2. DRAIN PLUG
18. TRANSMISSION  
OUTPUT FLANGE
36. BREATHER
101. TEMPERATURE  
SENSING PORT
102. OUTLET PORT
103. RETURN PORT
205. NEUTRAL SWITCH
209. CONTROL LEVER
329. INPUT SHAFT




50028

Figure 2-1. Transmission Installation

d. Alignment is satisfactory when the flanges are within 0.003 in. (0.076 mm) of parallel.

e. If alignment is unsatisfactory, adjustment is required. This adjustment shall be done only at the motor 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.

f. When alignment is satisfactory, install coupling flange bolts and nuts. Torque to OEM specifications.

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

5. Connect shift linkage to transmission control lever (209). The shift lever at the helm must agree with the control lever on the transmission. Adjust the shift linkage if required.

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 2-8.

8. Connect electrical connectors to neutral switch (205) and temperature sensor (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 as would be the case for overhaul. 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 2-12.

## 3-6. TRANSMISSION DISASSEMBLY

3.7. REMOVAL OF VALVE AND PUMP ASSEMBLY. Make sure that the transmission shift lever is in the neutral (center) position. With the transmission in its approximate installed position, begin disassembly as follows (See figure 3-1):

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

2. Remove seven bolts (3) and pull valve and pump assembly (4) from case assembly (41), keeping mount-

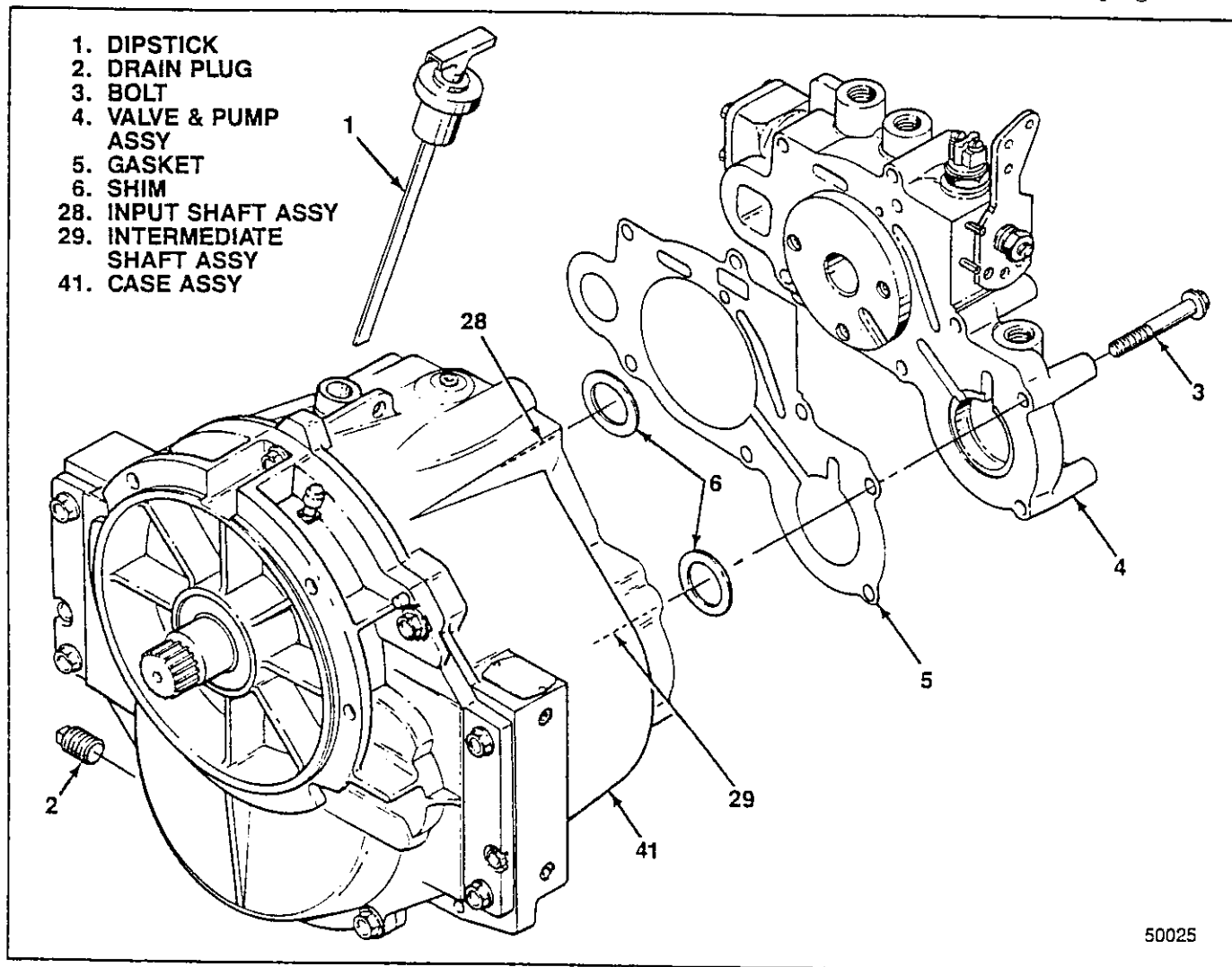


Figure 3-1. Valve and Pump Assembly

ing faces parallel until pump clears end of input shaft assembly (28).

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

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

5. Remove shim(s) (6) from outer bearing races at input shaft assembly (28) and intermediate shaft assembly (29).

**3-8. REMOVAL OF ADAPTER AND BEARING CUP ASSEMBLY.** Position the transmission with the pump (just removed) end down. Support the transmission on wooden blocks to provide clearance for exposed end of input shaft and balance transmission. Proceed as follows (see figure 3-2):

1. Remove two bolts (7), five bolts (8), four bolts (9) and four washers (10).

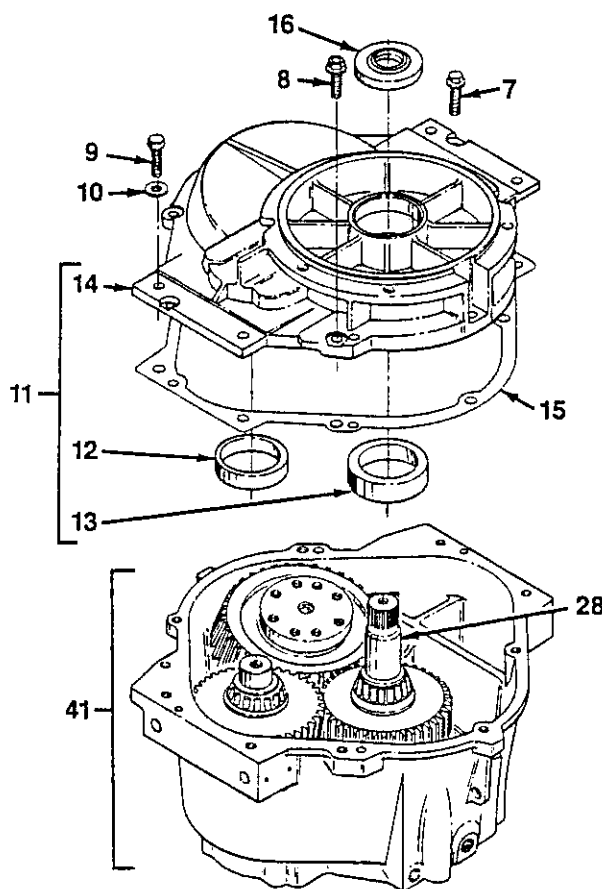
2. Pull adapter and bearing cup assembly (11) straight up off of case assembly (41) until adapter and bearing cup assembly clears end of input shaft assembly (28).

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

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

5. Remove oil seal (16) from adapter and magnet assembly (14).

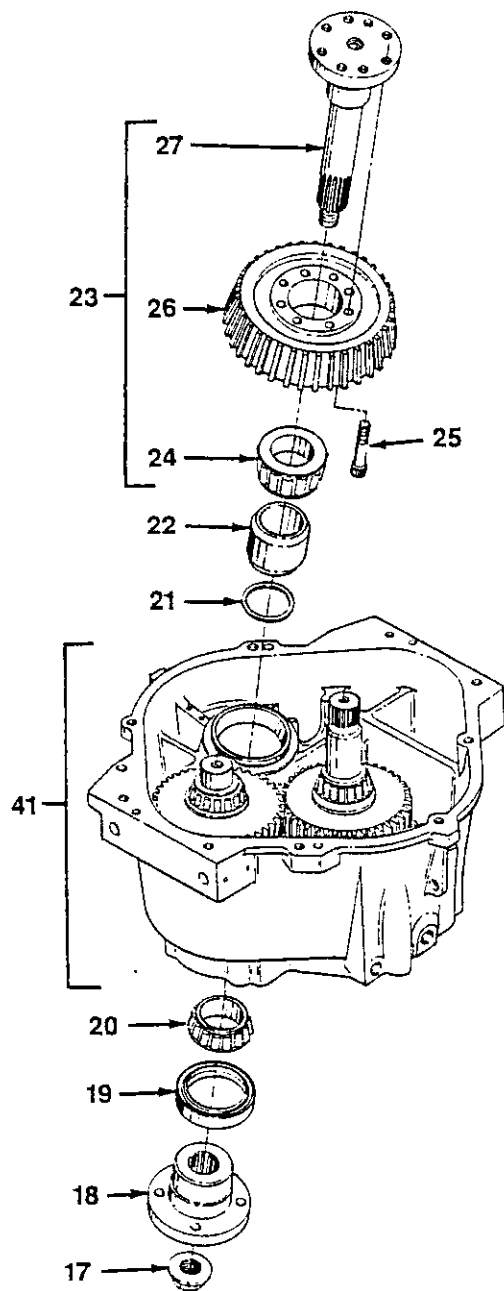
- 7. BOLT
- 8. BOLT
- 9. BOLT
- 10. WASHER
- 11. ADAPTER & BEARING CUP ASSY
- 12. BEARING CUP
- 13. BEARING CUP
- 14. ADAPTER & MAGNET ASSY
- 15. GASKET
- 16. OIL SEAL
- 28. INPUT SHAFT ASSY
- 41. CASE ASSY



50023

Figure 3-2. Adapter and Bearing Cup Assembly

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



50019

Figure 3-3. Output Shaft Assembly

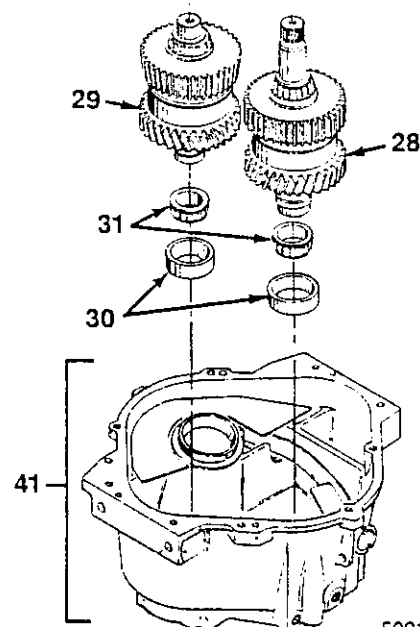
**3-9. REMOVAL OF OUTPUT SHAFT ASSEMBLY.** With transmission on its bottom or side, proceed as follows (see figure 3-3):

1. Holding output flange (18) with coupling wrench T-5005, remove lock nut (17). Remove output flange (18). Remove sealant from output flange, nut and end of output shaft (27) as required.
2. Pull oil seal (19) and bearing cone (20).
3. Remove shim(s) (21) and sleeve (22) now or after output shaft assembly (23) is removed.
4. Grasp output gear (26) and remove output shaft assembly (23).
5. Using suitable puller, remove bearing cone (24) from output shaft (27).
6. Remove eight bolts (25) and output gear (26) from output shaft (27).

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

1. Pull input shaft assembly (28) and intermediate shaft assembly (29) straight up out of case assembly (41).
2. Remove two bearing cups (30) and cones (31) from pump end of case assembly (41).
3. Refer to paragraph 3-16 for disassembly of input shaft assembly. Refer to paragraph 3-20 for disassembly of intermediate shaft assembly.

- 28. INPUT SHAFT ASSY
- 29. INTERMEDIATE SHAFT ASSY
- 30. BEARING CUP
- 31. BEARING CONE
- 41. CASE ASSY



50018

Figure 3-4. Input and Intermediate Shaft Assemblies

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

1. Remove two bolts (32), oil baffle (33) and suction tube assembly (34). Remove o-ring (35) from groove on suction tube assembly.

2. Do not remove breather (36), screws (37), identification tag (38) or dipstick tube (39) unless replacement is required. Save old identification tag for reference when marking new tag.

3. Do not remove pipe plugs (40).

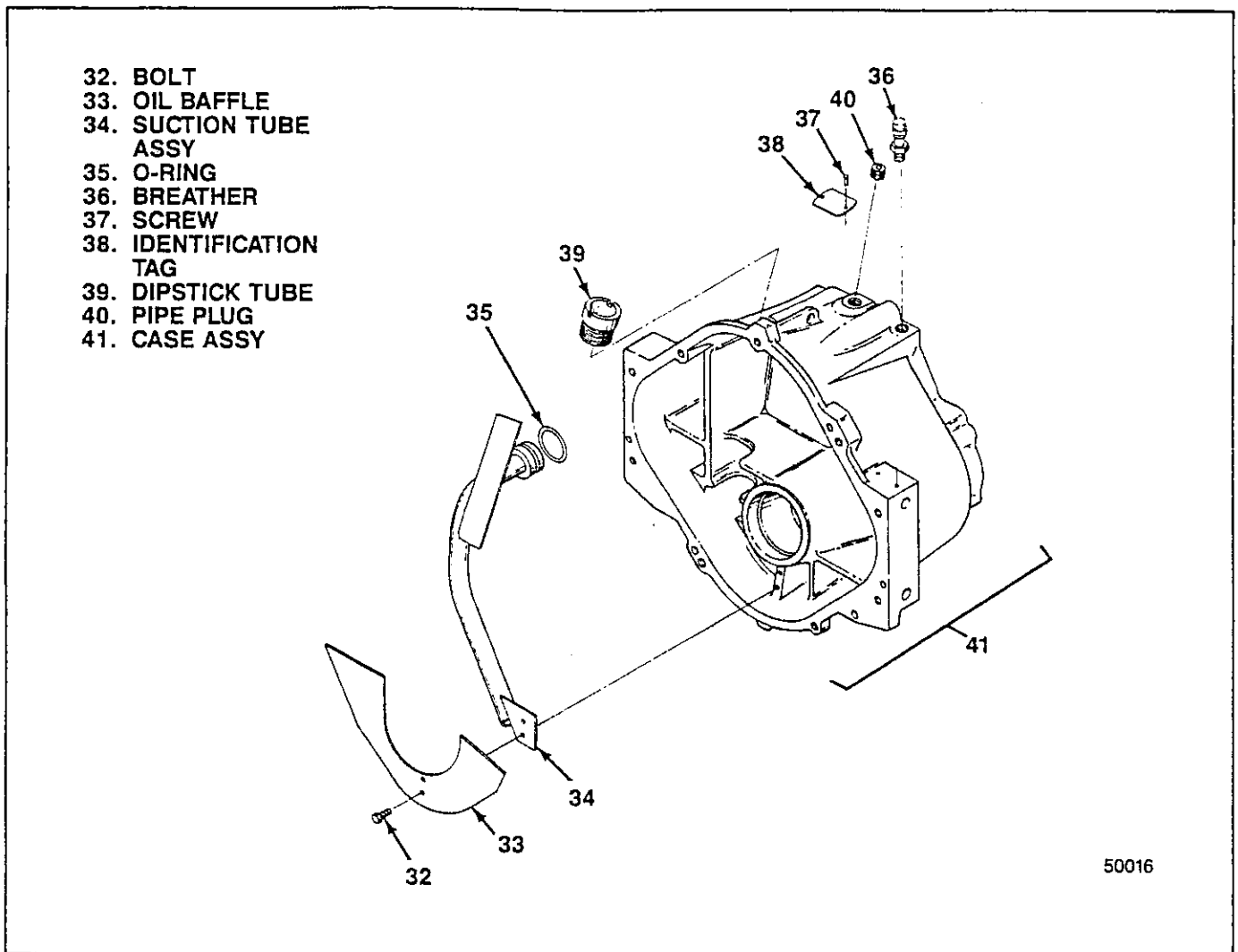


Figure 3-5. Case Components

**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 removal tools.
2. Press or drive bearing cups (44 and 45) from transmission case (46) using care not to damage case.

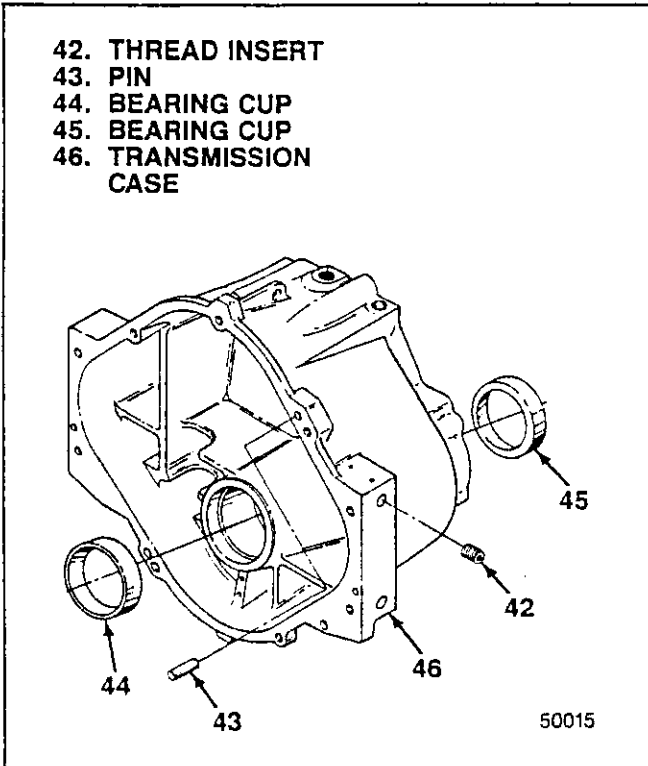


Figure 3-6. Case Assembly

### 3-13. DISASSEMBLY OF VALVE AND PUMP ASSEMBLY

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

1. Remove three bolts (201) and pump assembly (202). Do not disassemble pump assembly. It contains matched parts and must be replaced as an assembly if necessary.
2. Remove switch assembly (203).
3. Holding control 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), control lever (207), ball (208) and spring (209).

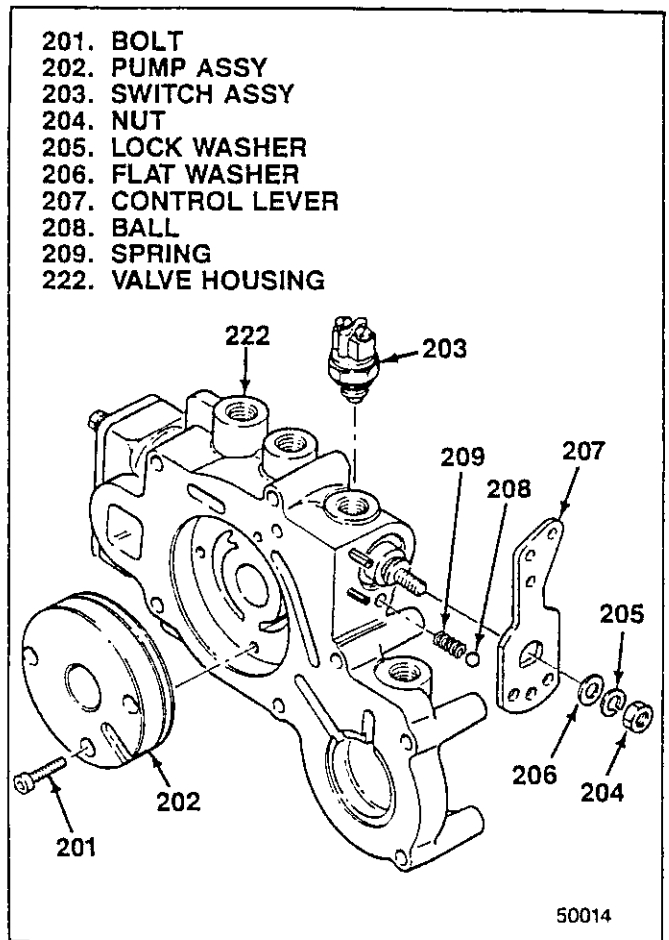


Figure 3-7. Pump, Switch and Control Lever

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



**CAUTION:** Control valve (211), valve piston (218), sleeve (219) and mating bores in valve housing (222) are highly finished. Use care not to scratch or otherwise damage these surfaces. Otherwise fluid leakage and shifting malfunction may result.

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. Do not remove ball (213) pressed into control valve (211).
4. Remove six bolts (214), cover plate (215) and gasket (216). If necessary to scrape gasket, defer this until after valve and pump assembly is completely disassembled.
5. Remove spring (217), valve piston (218), sleeve (219) and filter and screen assembly (220) from valve housing (222).
7. Remove pins (221) only if replacement is required.

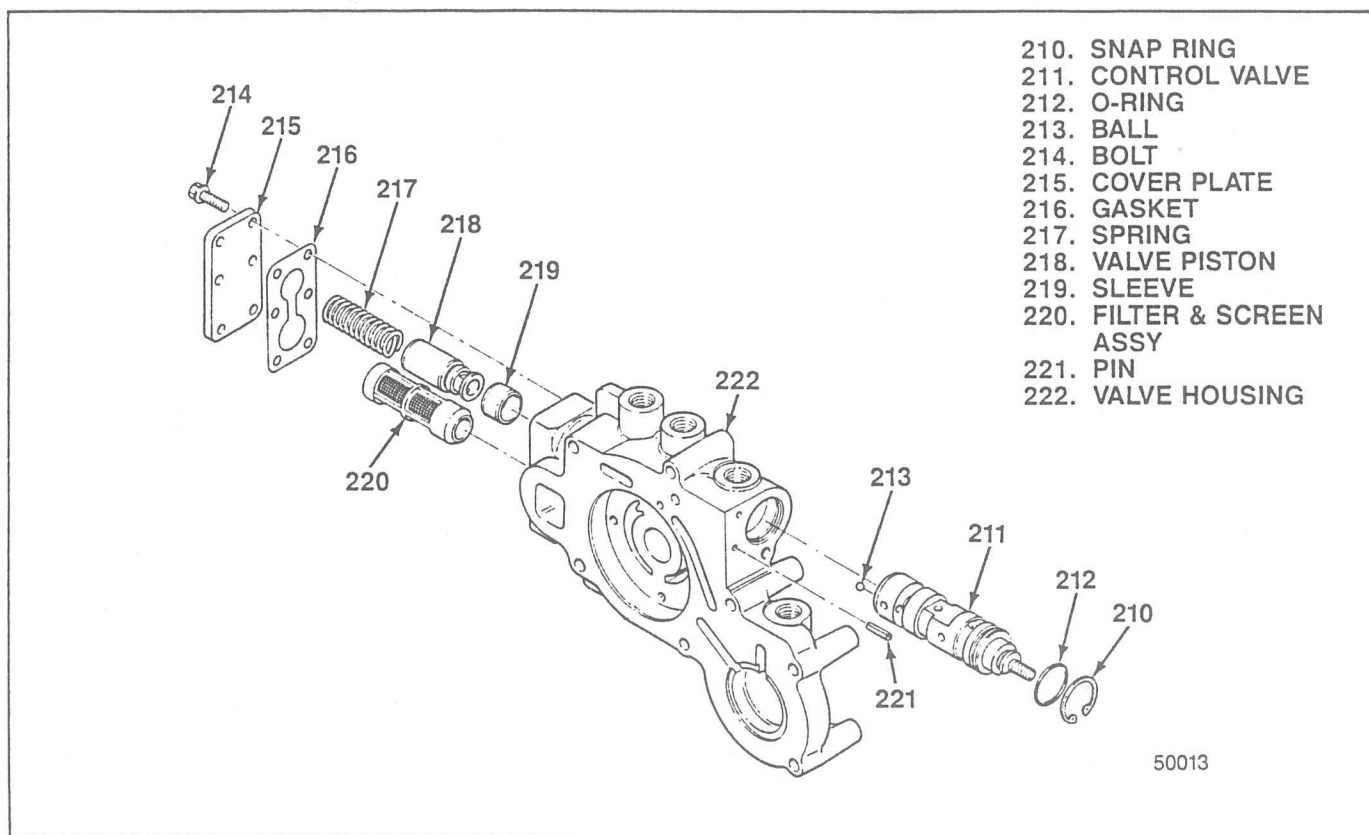


Figure 3-8. Control Valve, Piston and Filter

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

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

1. Use suitable puller behind clutch gear (304) to pull bearing cone (301) from input shaft (329). Use care not to damage gear teeth.
2. Remove thrust washer (302), spacer (303) and clutch gear (304).
3. Remove snap ring (305), three needle bearings (306) and snap ring (307) from input shaft (329).

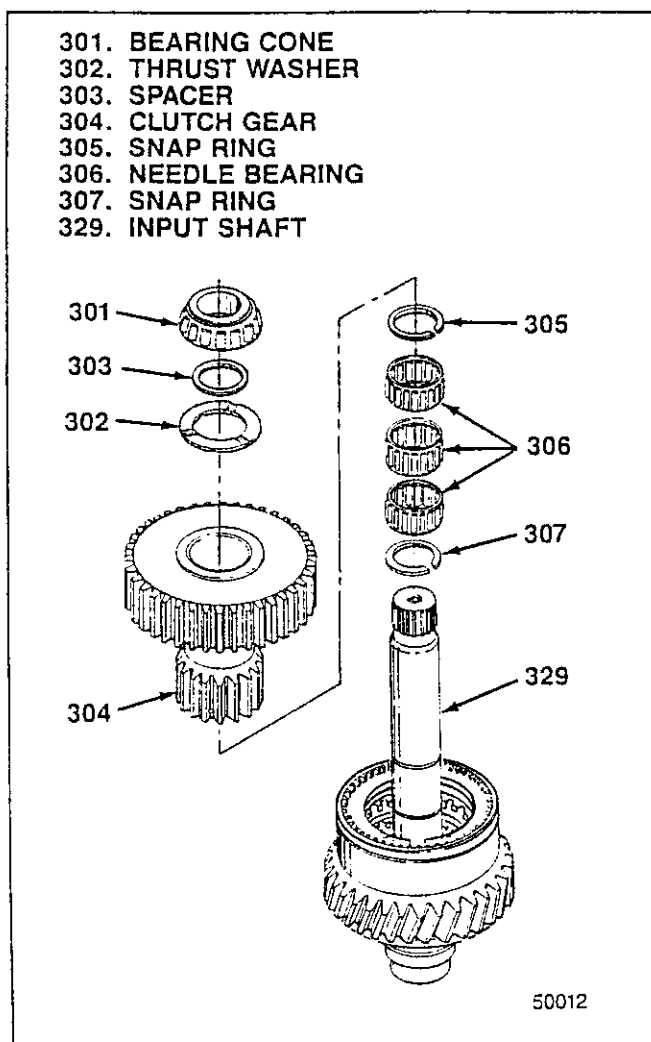


Figure 3-9. Input Clutch Gear and Bearings

#### 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), backing plate (309) and one clutch plate (310).
2. Alternately remove eight clutch disc assemblies (311) and seven clutch discs (312).
3. Remove remaining clutch plate (310).

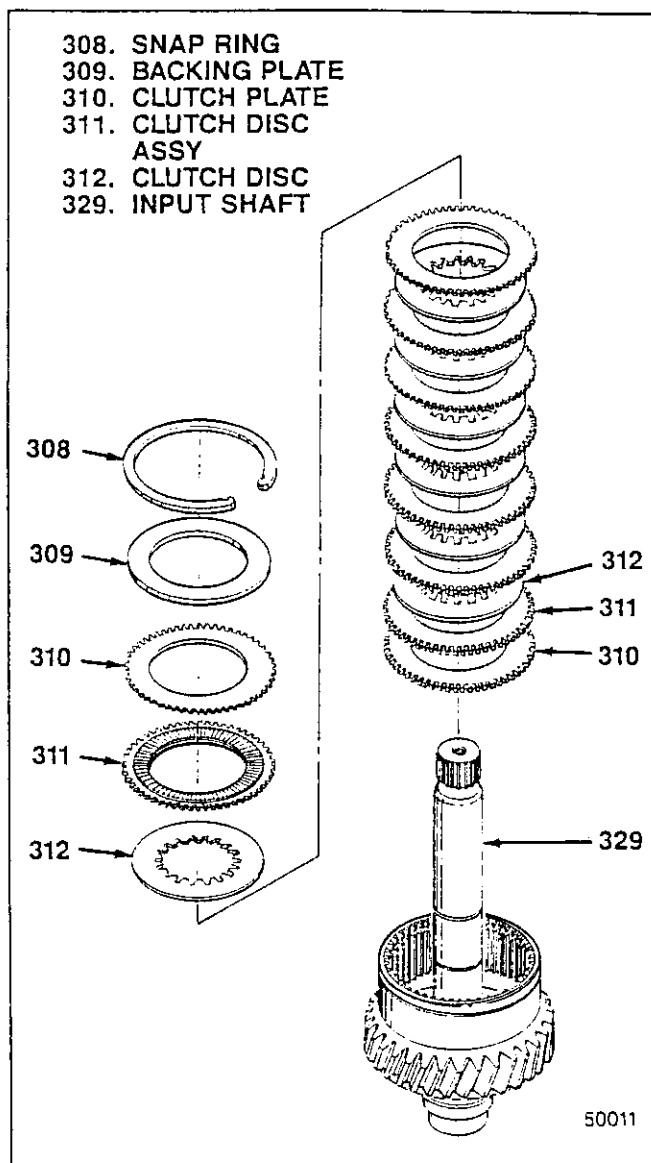


Figure 3-10. Input Clutch Group



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



**CAUTION:** OD and ID of clutch piston (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. Otherwise fluid leakage and shifting malfunction may result.

1. Bend down tabs on lock plates (314). Remove twelve bolts (313) and six lock plates (314).
2. Remove clutch gear cylinder (315) from input shaft (329).

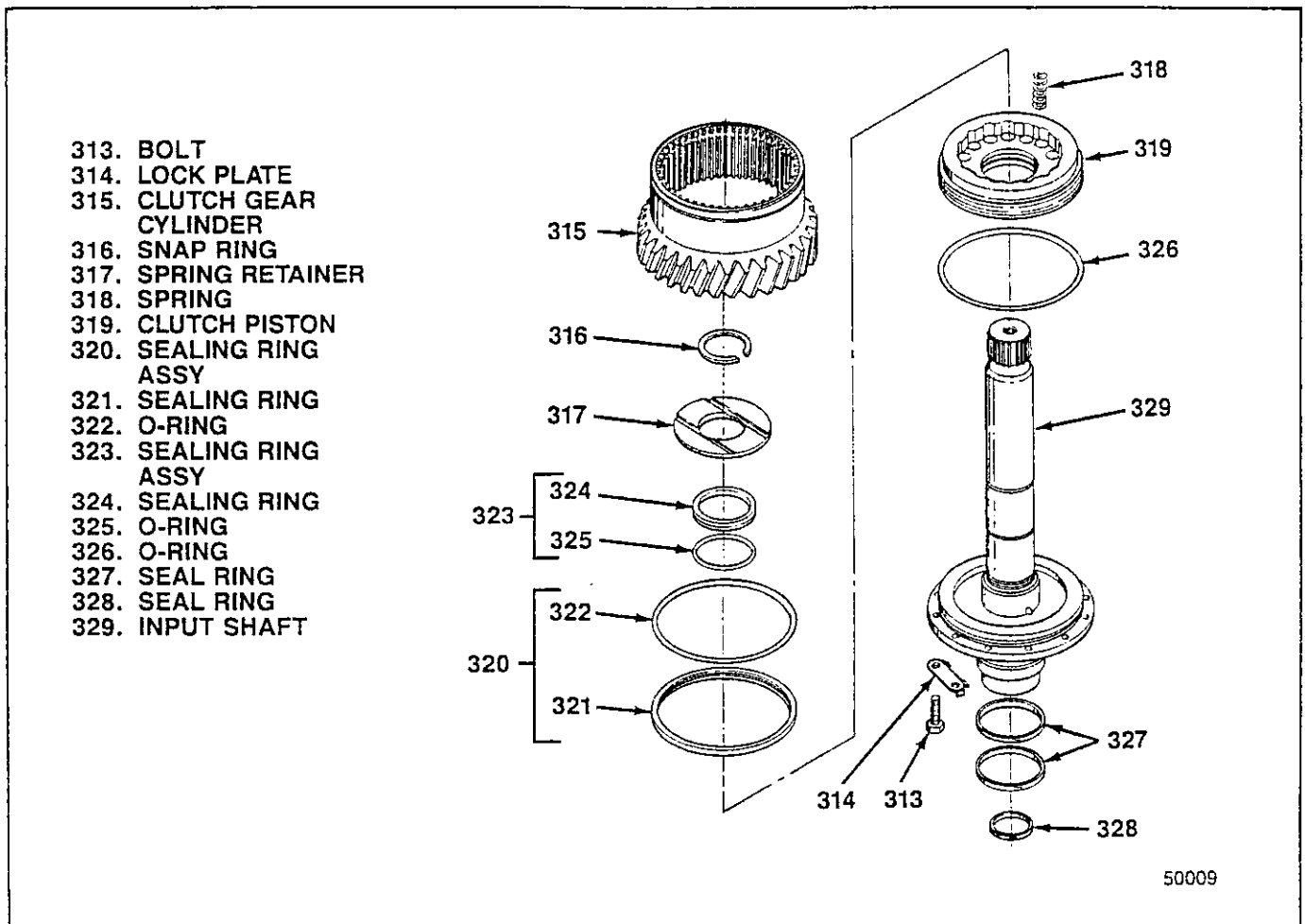


Figure 3-11. Input Clutch Cylinder and Piston

3. 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) slightly. Remove snap ring (316).

4. Slowly release arbor press, allowing springs (318) to expand. Remove assembly tool, spring retainer (317) and sixteen springs (318). Remove shaft assembly from arbor press and holding fixture.

5. Remove clutch piston (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.

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

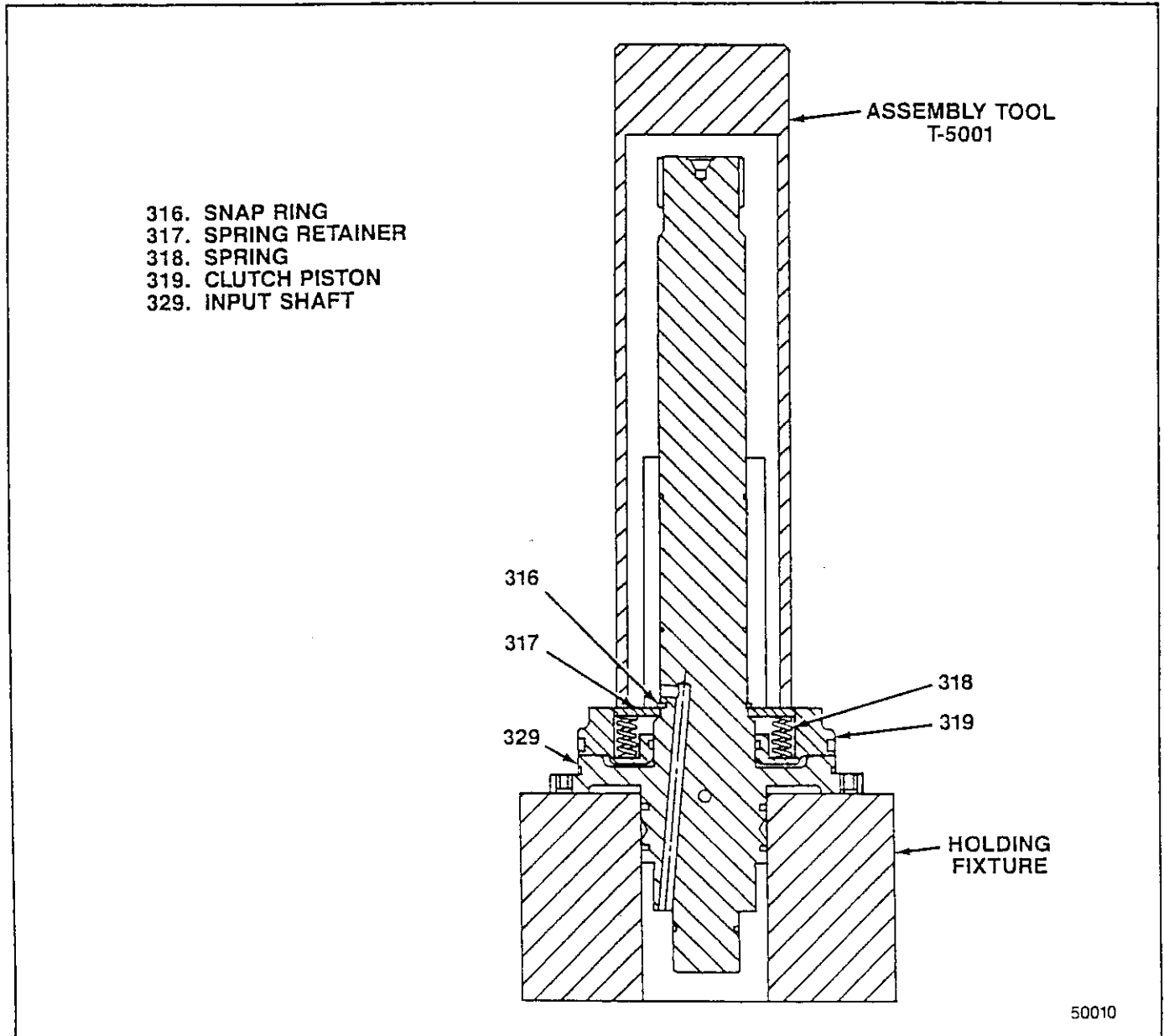


Figure 3-12. Removing Snap Ring

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

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

1. Remove snap ring (401).
2. Use suitable puller behind clutch gear (403) to pull bearing cone (402) from intermediate shaft (427). Use care not to damage gear teeth. Remove clutch gear.
3. Remove three needle bearings (404) and snap ring (405) from intermediate shaft (427).

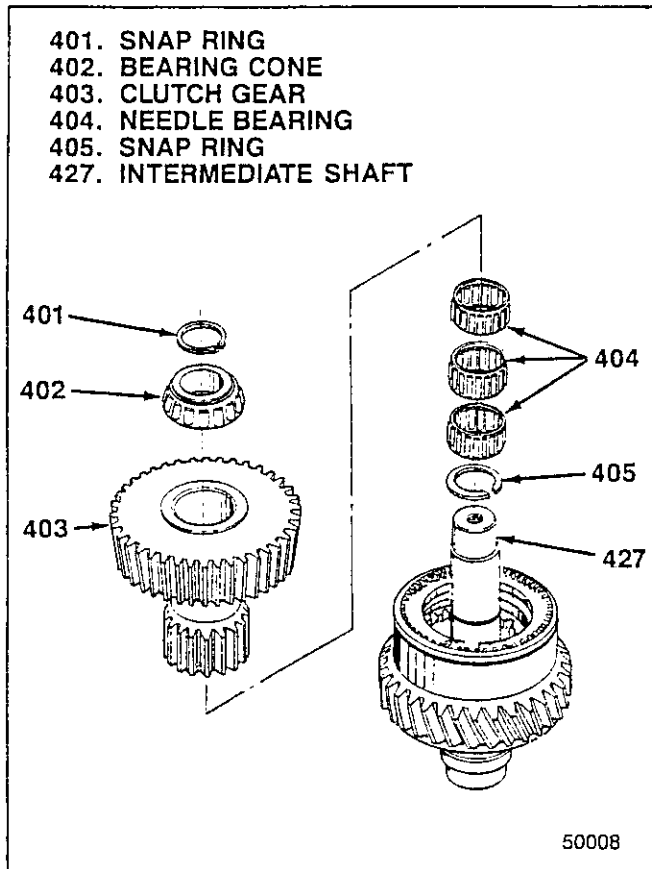


Figure 3-13. Intermediate Clutch Gear and Bearings

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

1. Remove snap ring (406), backing plate (407) and one clutch plate (408).
2. Alternately remove eight clutch disc assemblies (409) and seven clutch discs (410).
3. Remove remaining clutch plate (408).

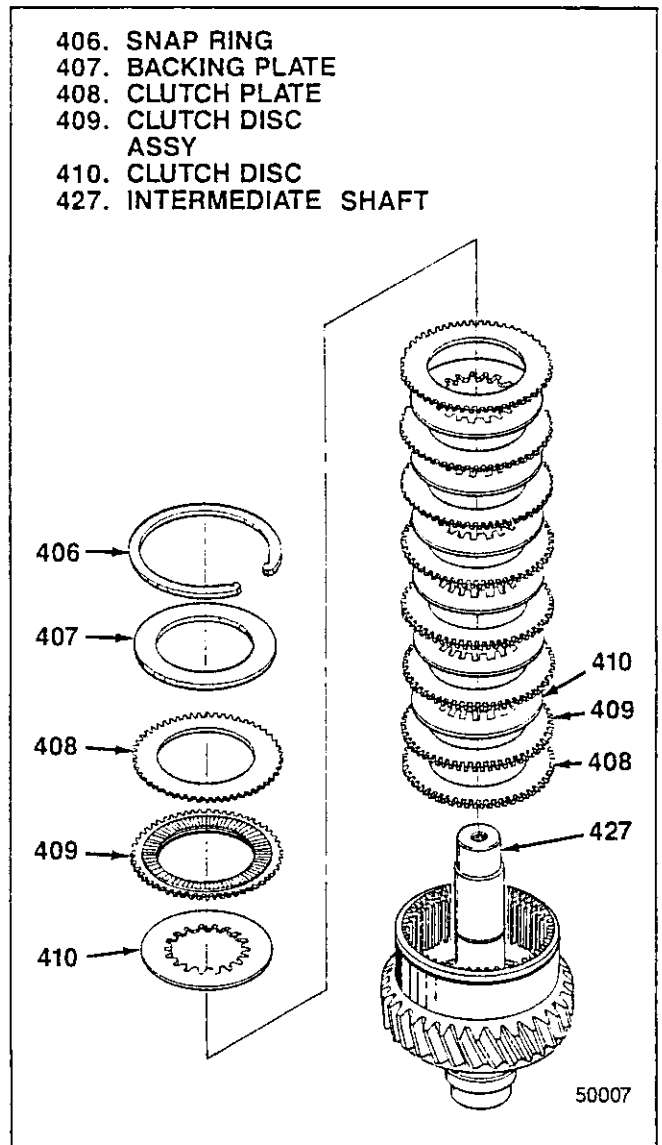


Figure 3-14. Intermediate Clutch Group

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



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

1. Bend down tabs on lock plates (412). Remove twelve bolts (411) and six lock plates (412).

2. Remove clutch gear cylinder (413) from intermediate shaft (427).

3. Support intermediate 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) slightly. Remove snap ring (414).

4. Slowly release arbor press, allowing springs (417) to expand. Remove assembly tool, thrust washer (415), spring retainer (416) and sixteen springs (417). Remove shaft assembly from arbor press and holding fixture.

5. Remove clutch piston (418) from intermediate 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 intermediate shaft (427).

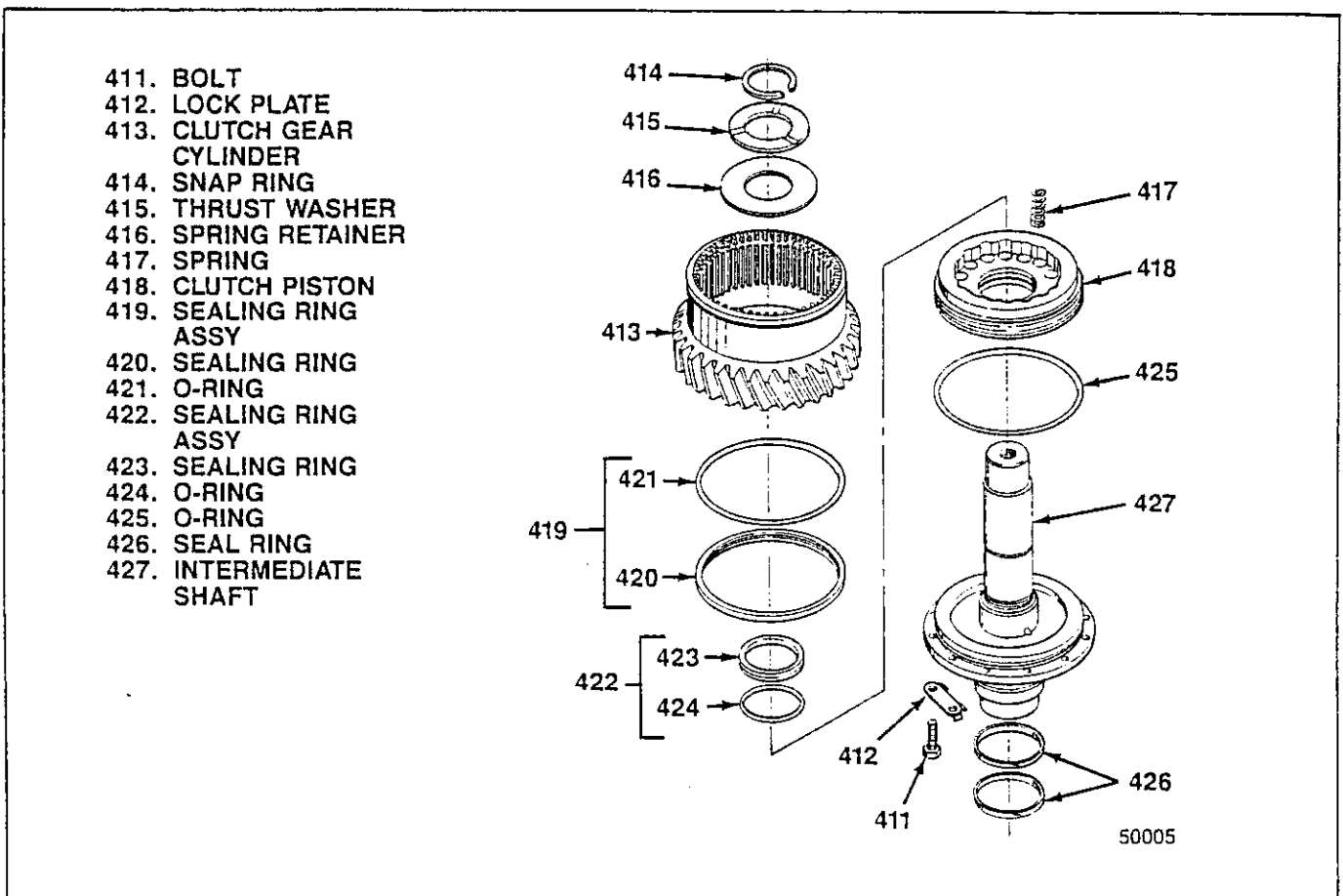
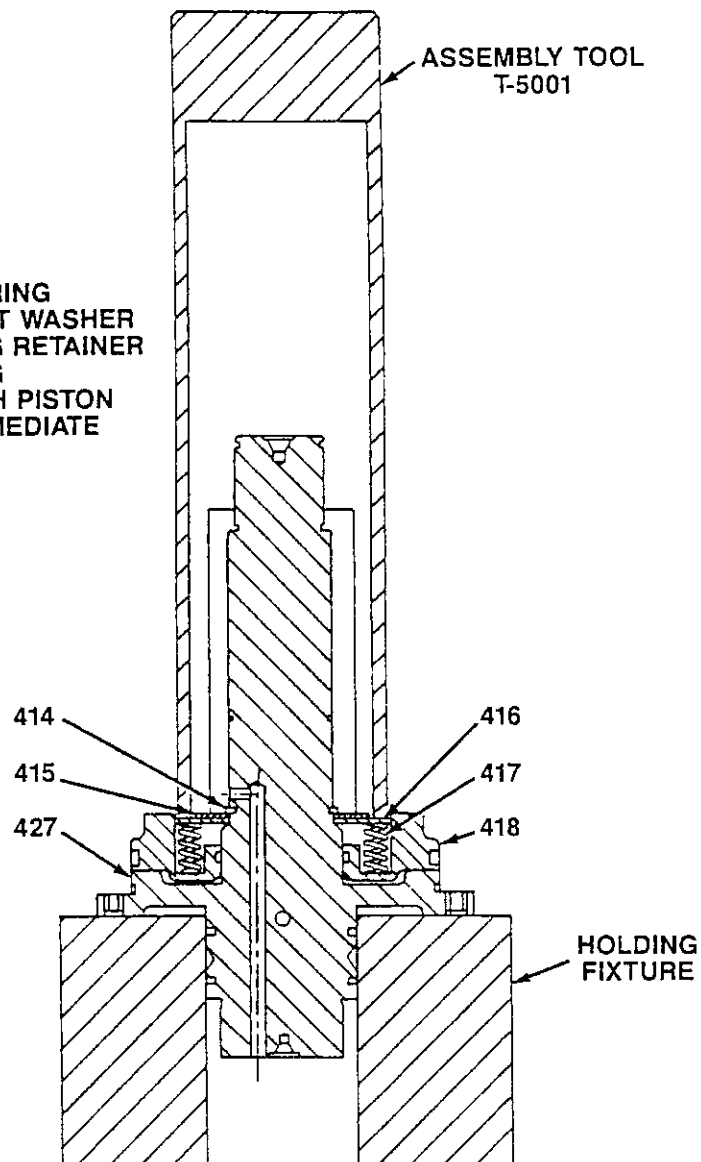


Figure 3-15. Intermediate Clutch Cylinder and Piston

- 414. SNAP RING
- 415. THRUST WASHER
- 416. SPRING RETAINER
- 417. SPRING
- 418. CLUTCH PISTON
- 427. INTERMEDIATE SHAFT



50006

Figure 3-16. Removing Snap Ring

# Section 4

## Cleaning, Inspection, Repair or Replacement

### 4-1. CLEANING

**NOTE:** Prior to cleaning adapter 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, powder-like 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, except neutral switch (205), in 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. Wipe neutral switch with solvent-dampened cloth.

**4-3. DRYING CLEANED PARTS.** Dry parts with low pressure (20 psi 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). Rotating or spinning dry, unlubricated bearings could 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.

**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 shall be replaced.

b. Check gear teeth for chips. Gears with chipped or broken teeth part must be replaced.

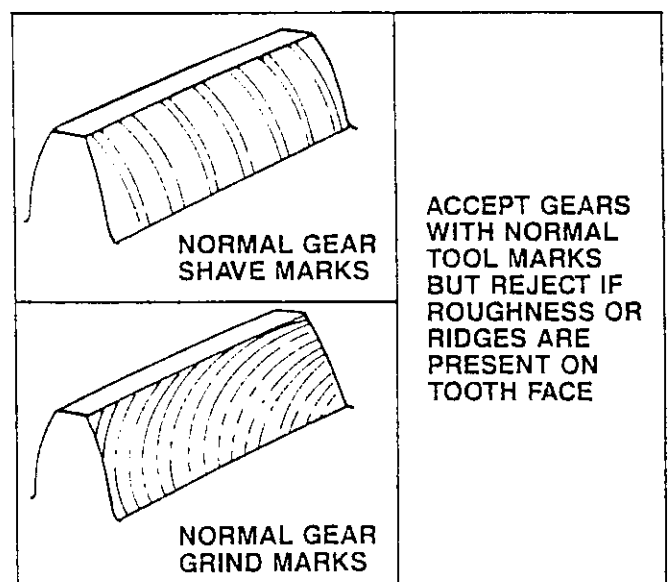


Figure 4-1. Normal Gear Tooth Tool Marks

**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 fol-

lowing 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 or cones are replaced, bearings must be reshimmed at assembly.

Table 4-1. Inspection

PART (INDEX NO.)	INSPECTION	ACCEPT/REJECT
All parts (including all springs)	Check for cracks Check for distortion	Replace parts with cracks  Replace parts that are bent, distorted or out of round
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
Adapter & magnet assy (14), case (46) and valve housing (225)	Check mating faces for burrs or other damage that would prevent proper seating of mating faces	Remove small burrs per paragraph 4-12. Otherwise, replace damaged parts or assemblies
Adapter & bearing cup assy (11)	Check bearing cups (12 and 13) for chipping, galling, scoring or other damage	Replace damaged bearing cups. If bores in adapter 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. Rollers must rotate smoothly without side or end play	Replace damaged bearing cones  Replace bearing cones with 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

Table 4-1. Inspection (Cont)

PART (INDEX NO.)	INSPECTION	ACCEPT/REJECT
Suction tube assy (34)	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 and bearing cup assy (41)	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 assembly.  Replace thread inserts. If not repairable, replace assembly
Pump assy (202)	Visually check for damage or excessive wear  Performance	Replace damaged pump  If trouble analysis indicates pump malfunction, replace—do not attempt to repair—pump
Neutral switch (203)	Test switch to be open when plunger depressed; closed when plunger released	Replace damaged switch
Control lever (207) and 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), sleeve (219) and mating bores in valve housing (222)	Check for scratches, 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 parts that cannot be made serviceable by cleaning
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 and races for chipping, galling scoring or other damage	Replace damaged bearings



Table 4-1. Inspection (Cont)

PART (INDEX NO.)	INSPECTION	ACCEPT/REJECT
Clutch disc assemblies (311 & 409) and clutch discs (312 & 410), backing plates (309 & 407) and clutch plates (310 & 408)	Check mating faces for scoring or warping	Replace if scored or damaged. Mating faces must be smooth. Clutch discs and plates must be flat
Clutch disc assemblies (311 & 409) and clutch discs (312 & 410), backing plates (309 & 407) and clutch plates (310 & 408) (Cont)	Check splines per paragraph 4-9	Paragraph 4-9
Clutch pistons (319 and 418) and mating sealing surfaces in clutch gear cylinders (315 & 413) and on input and intermediate shafts (329 & 427)	Check for scratches, 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 intermediate 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

# 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 petrolatum to help hold them in place during assembly.

5-3. LUBRICATION DURING ASSEMBLY. Lubricate all internal parts, not coated with petrolatum, 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. INTERMEDIATE SHAFT ASSEMBLY

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

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

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

- 411. BOLT
- 412. LOCK PLATE
- 413. CLUTCH GEAR CYLINDER
- 414. SNAP RING
- 415. THRUST WASHER
- 416. SPRING RETAINER
- 417. SPRING
- 418. CLUTCH PISTON
- 419. SEALING RING ASSY
- 420. SEALING RING
- 421. O-RING
- 422. SEALING RING ASSY
- 423. SEALING RING
- 424. O-RING
- 425. O-RING
- 426. SEAL RING
- 427. INTERMEDIATE SHAFT

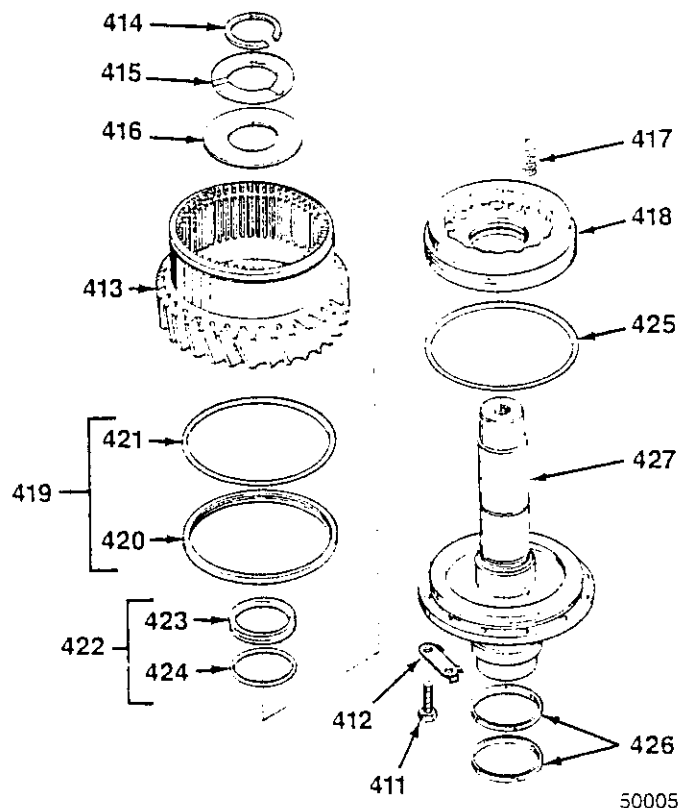


Figure 5-1. Intermediate Clutch Cylinder and Piston

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

4. Support intermediate shaft with piston, o-rings and seal rings (418 through 427) in suitable holding fixture (see figure 5-2) in arbor press.

5. Install sixteen springs (417) in holes in clutch piston (418). Install spring retainer (416) and thrust washer (415). Expand snap ring (414) and slide onto shaft up against thrust washer.

6. Using assembly tool T-5001, press down on spring retainer (416) to compress springs (417) 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.

7. Install clutch gear cylinder (413) over clutch piston (418) and onto intermediate shaft (427). Align bolt holes and install six lock plates (412) and twelve bolts (411). Torque bolts to 6-8 lb-ft (8-11 Nm) and so that bolt head flats are aligned with lock plate tabs. Bend up lock plate tabs against bolt head flats.

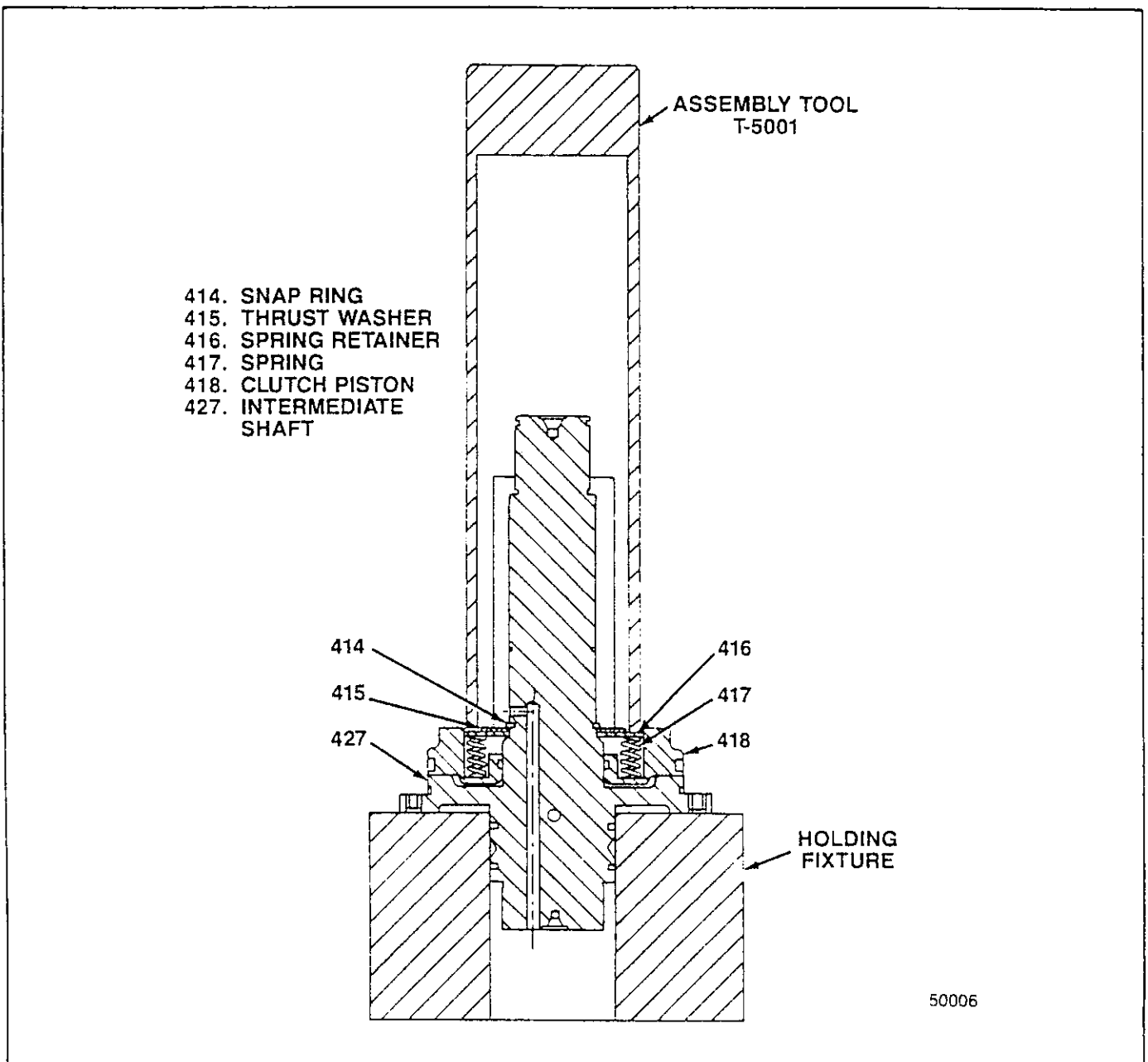


Figure 5-2. Installing Snap Ring

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 clutch plate (408) over intermediate 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 remaining clutch plate (408) and backing plate (407).
4. Secure clutch group in clutch gear cylinder (413) with snap ring (406).

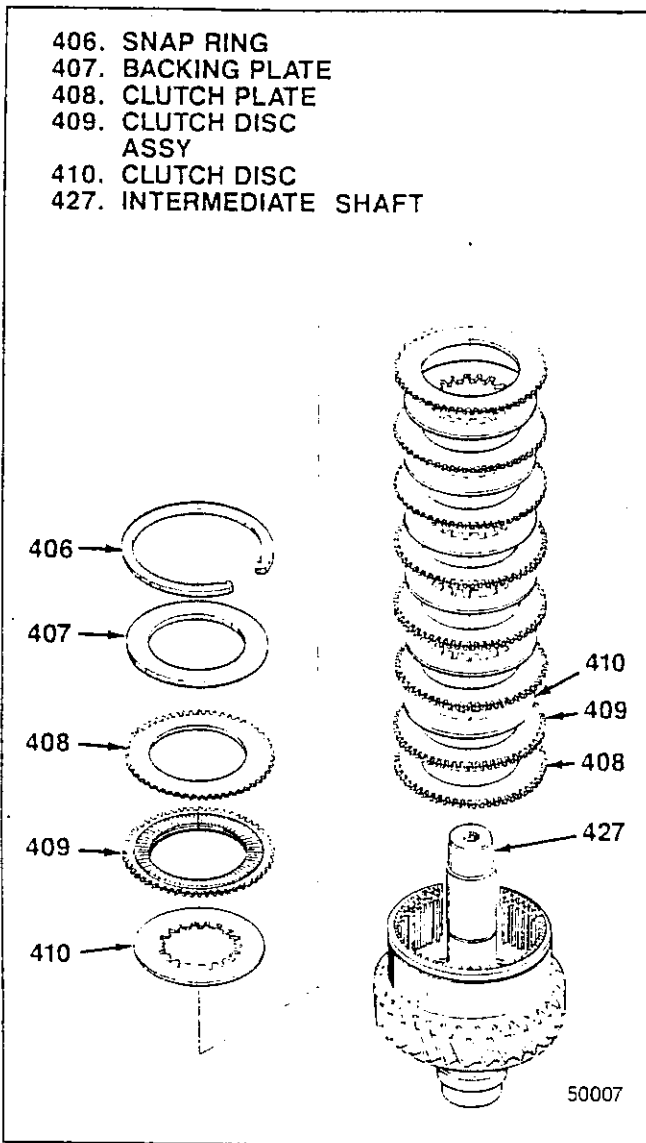


Figure 5-3. Intermediate Clutch Group

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) and three needle bearings (404) on intermediate shaft (427).
2. Align splines on clutch discs previously installed and install clutch gear (403). Make sure clutch gear is fully installed, engaging all clutch discs. Outside end of gear should be flush to below shoulder on intermediate shaft (427).
3. Position shaft assembly on holding fixture in arbor press. Using bearing drift T-5002, press bearing cone (402) on shaft to seat on shaft shoulder.
4. Install snap ring (401) in groove in intermediate shaft (427).

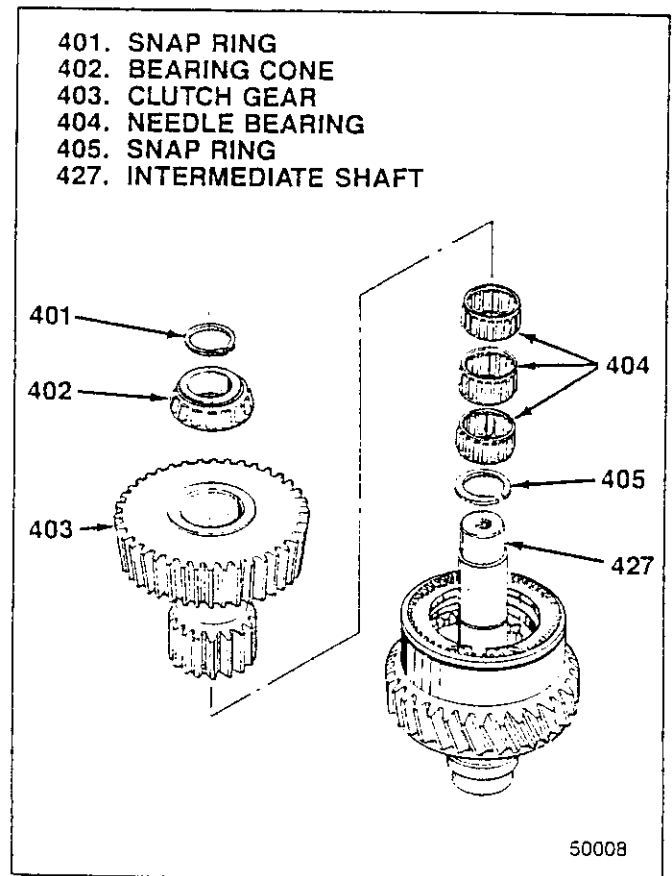


Figure 5-4. Intermediate Clutch Gear and Bearings

## 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) and lock in place.

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

3. Install clutch piston (318) on input shaft (329) with sixteen spring holes facing away from shaft flange. Seat piston against shaft flange.

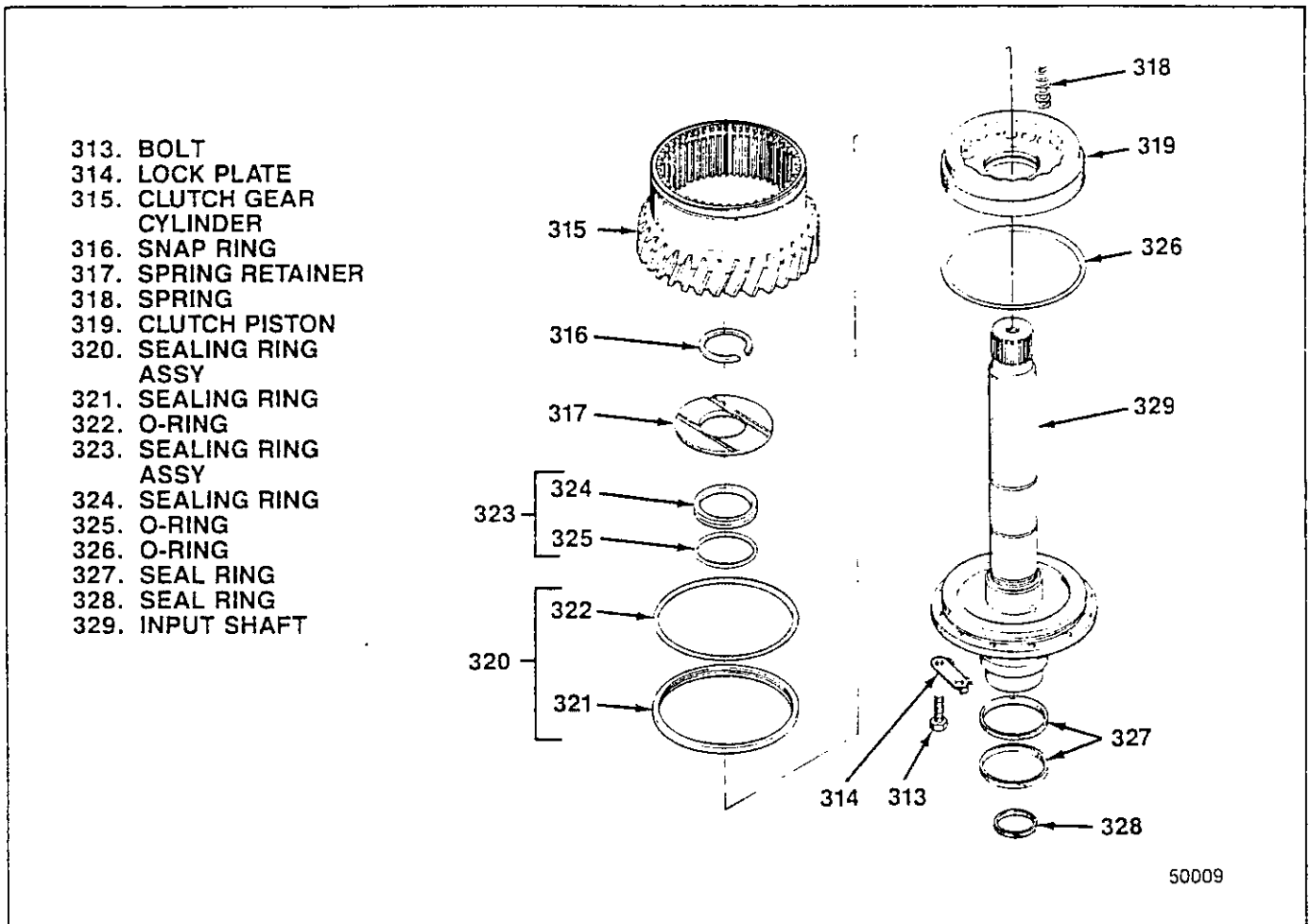


Figure 5-5. Input Clutch Cylinder and Piston

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.

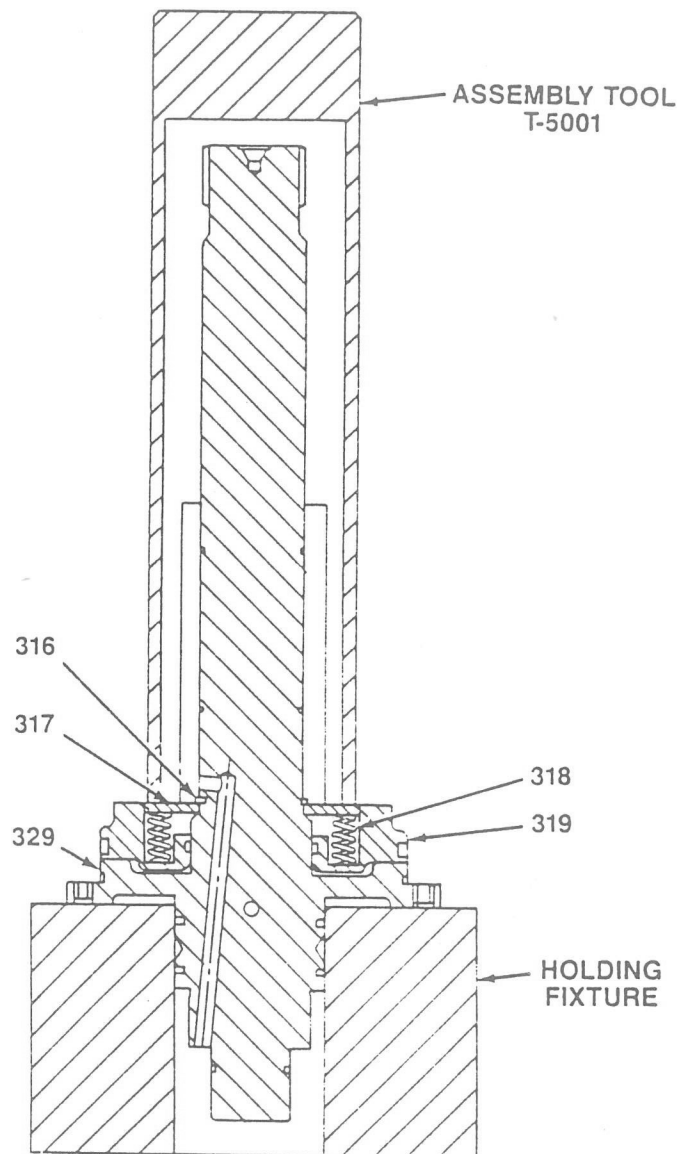
5. Install sixteen springs (318) in holes in clutch piston (319). Install spring retainer (317). Expand snap ring (316) and slide onto shaft up against thrust washer.

6. Using assembly tool T-5001, press down on spring retainer (317) to compress springs (318) 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.

7. Install clutch gear cylinder (315) over clutch piston (319) and onto input shaft (329). Align bolt holes and install six lock plates (314) and twelve bolts (313). Torque bolts to 6-8 lb-ft (8-11 Nm) and so that bolt head flats are aligned with lock plate tabs. Bend up lock plate tabs against bolt head flats.

- 316. SNAP RING
- 317. SPRING RETAINER
- 318. SPRING
- 319. CLUTCH PISTON
- 329. INPUT SHAFT



50010

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 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 remaining clutch plate (310) and backing plate (309).
4. Secure clutch group in clutch gear cylinder (315) with snap ring (308).

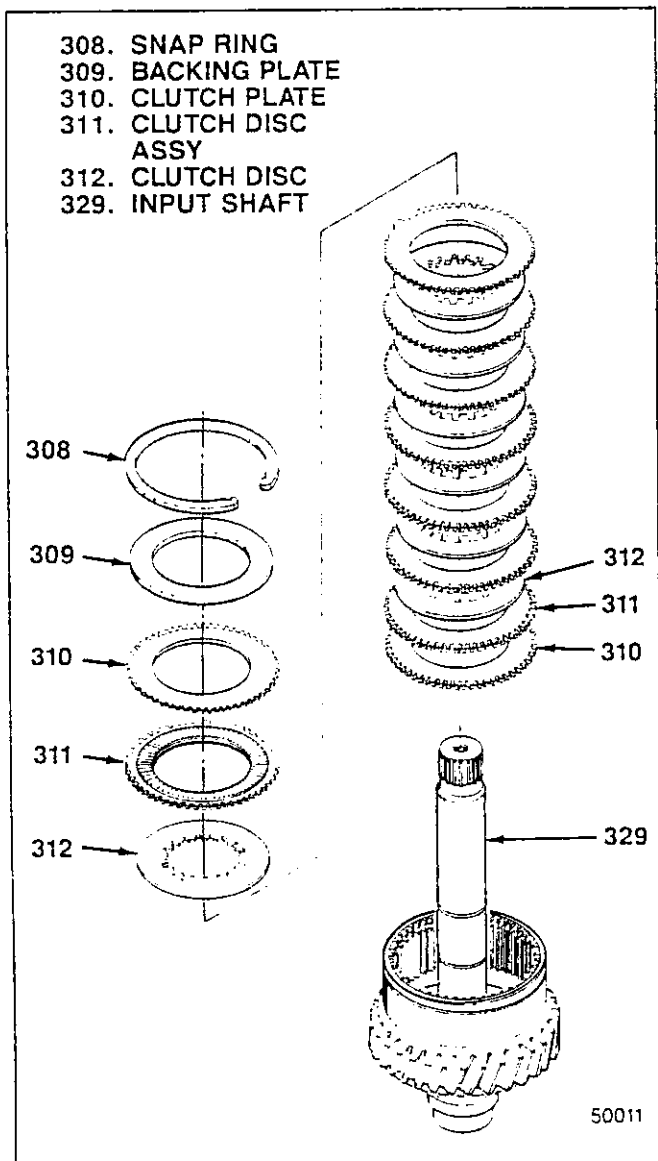


Figure 5-7. Input Clutch Group

**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), three needle bearings (306) and snap ring (305) on input shaft (329).
2. Align splines on clutch discs previously installed and install clutch gear (304). Make sure clutch gear is fully installed, engaging all clutch discs. Outside end of gear should be flush to below snap ring (305) in input shaft (329).
3. Install spacer (303) and thrust washer (302).
4. Position shaft assembly on holding fixture in arbor press. Using bearing drift T-5003, press bearing cone (301) on shaft to seat on spacer (303) against snap ring (305).

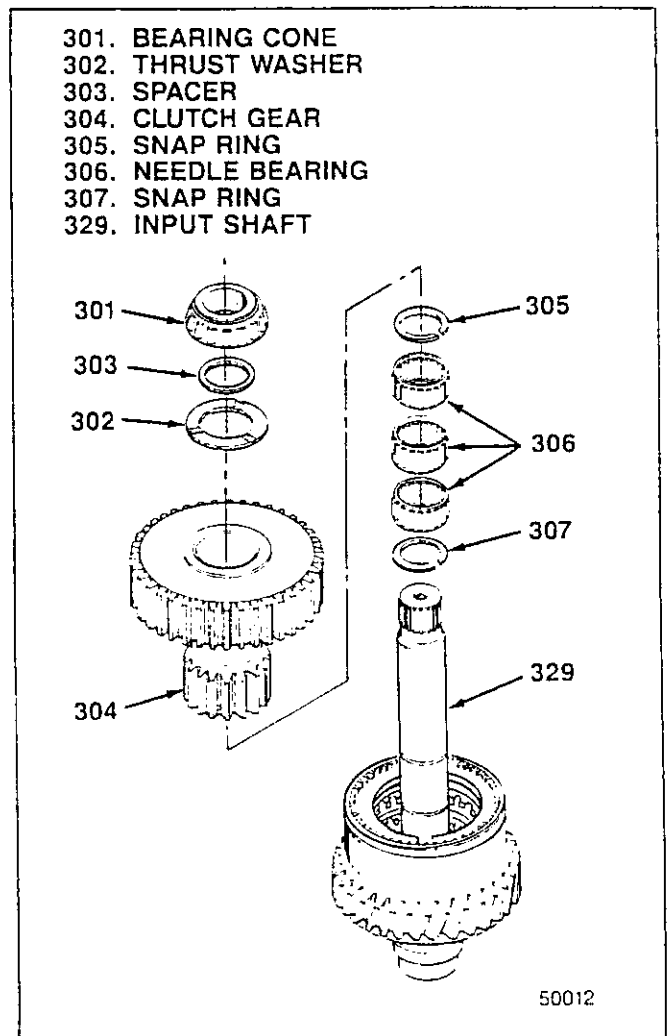


Figure 5-8. Input Clutch Gear and Bearings

## 5-12. VALVE AND PUMP ASSEMBLY

### 5-13. FILTER, PISTON AND CONTROL VALVE ASSEMBLY. Assemble as follows (see figure 5-9):

1. If removed, press in new pins (221).
2. Install filter and screen assembly (220), chamfered end first, into valve housing (222).
3. Install sleeve (219) on end of valve piston (218) and install these parts in valve housing (222), sleeve end first. Install spring (217).

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) [with ball (213)] and install control valve in valve housing (222). Install snap ring (210).

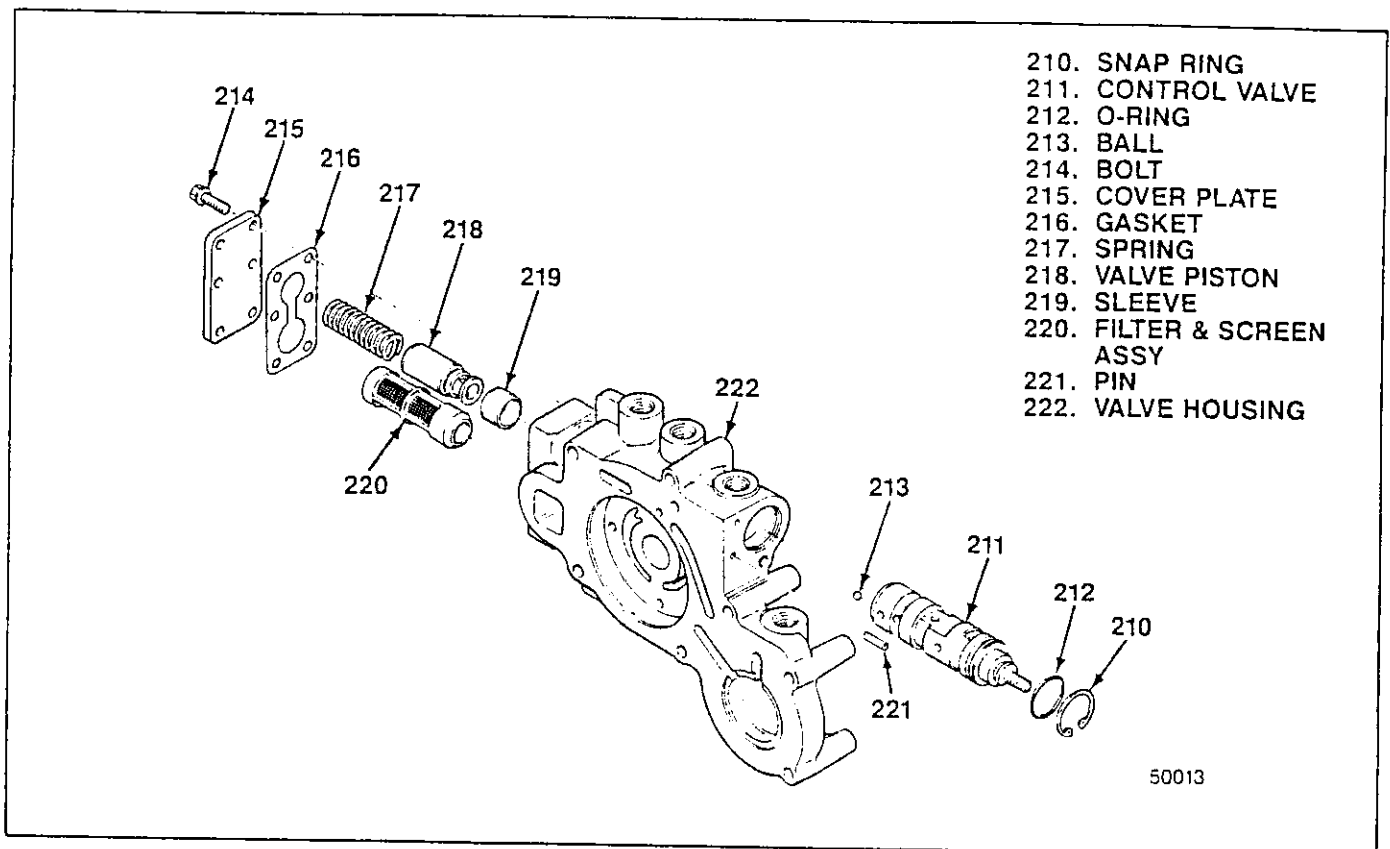


Figure 5-9. Filter, Piston and Control Valve



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

1. Temporarily install control 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 control lever (207). Holding control lever in place, 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 housing (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).

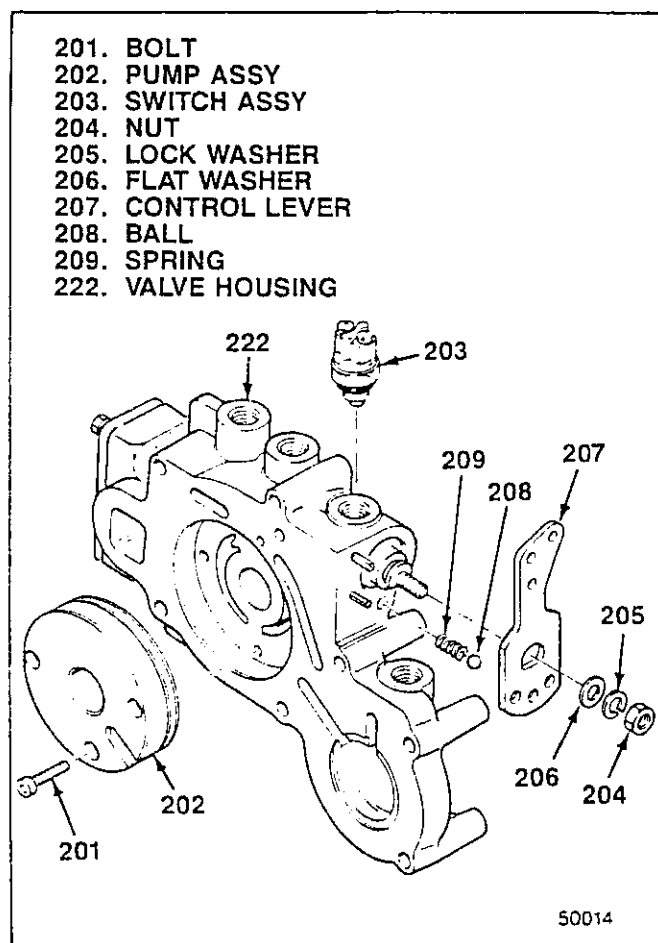


Figure 5-10. Control Lever, Switch and Pump

## 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. 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).

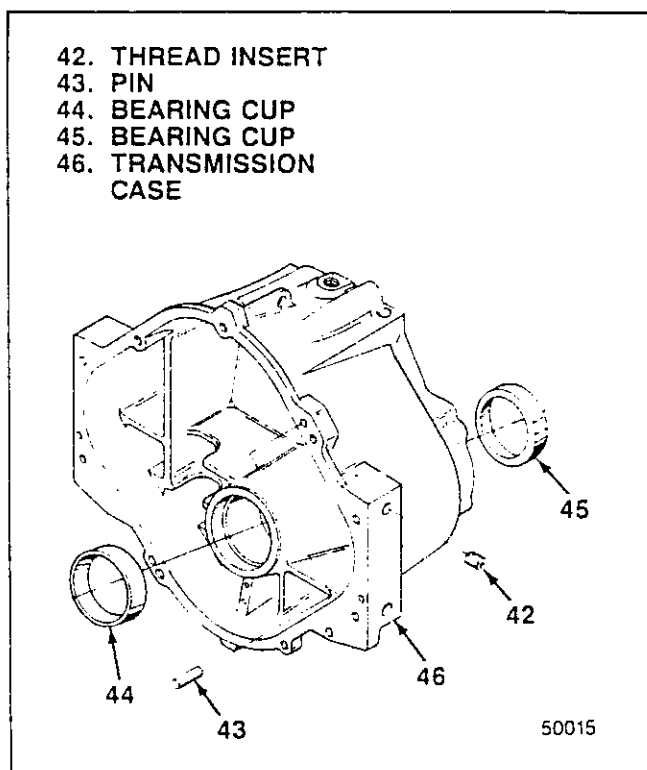


Figure 5-11. Case Assembly

**5-18. CASE COMPONENTS ASSEMBLY.** Assemble parts as follows (see figure 5-12):

1. If replaced, thread new dipstick tube (39) into case assembly (41) to dimension shown in figure 5-13.
2. If replaced, install new identification tag (38) with screws (37).
3. Install breather (36).

4. Install o-ring (35) in groove on suction tube assembly (34). Position suction tube assembly in case assembly (41), inserting end with o-ring in case opening.

5. Position oil baffle (33) in case assembly (41). Align bolt holes in oil baffle, suction tube assembly (34) and case. Apply Loctite 242 (blue) to threads of two bolts (32). Install bolts securing suction tube assembly and oil baffle. Torque bolts to 4-6 lb-ft (5-7 Nm).

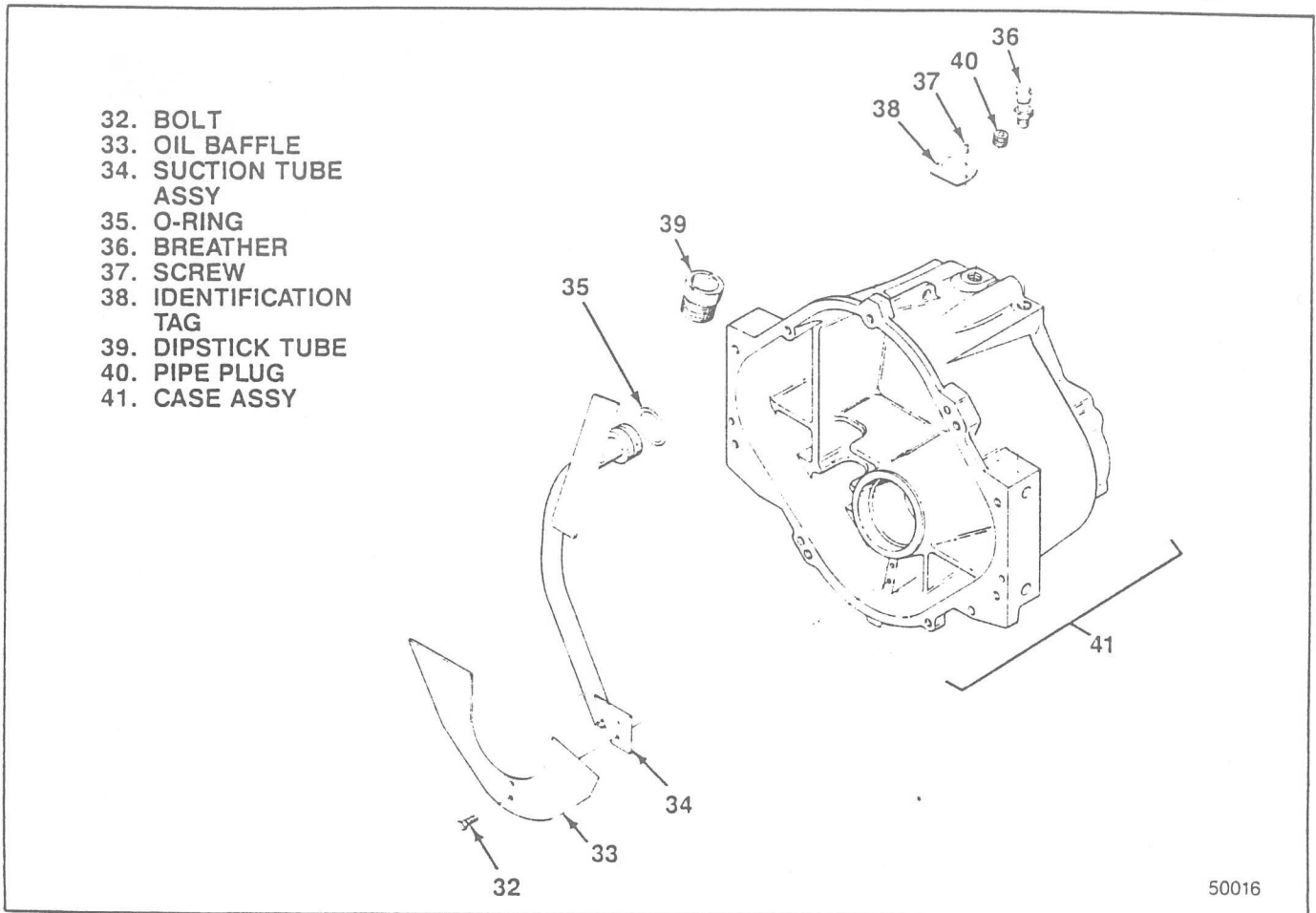


Figure 5-12. Case Components

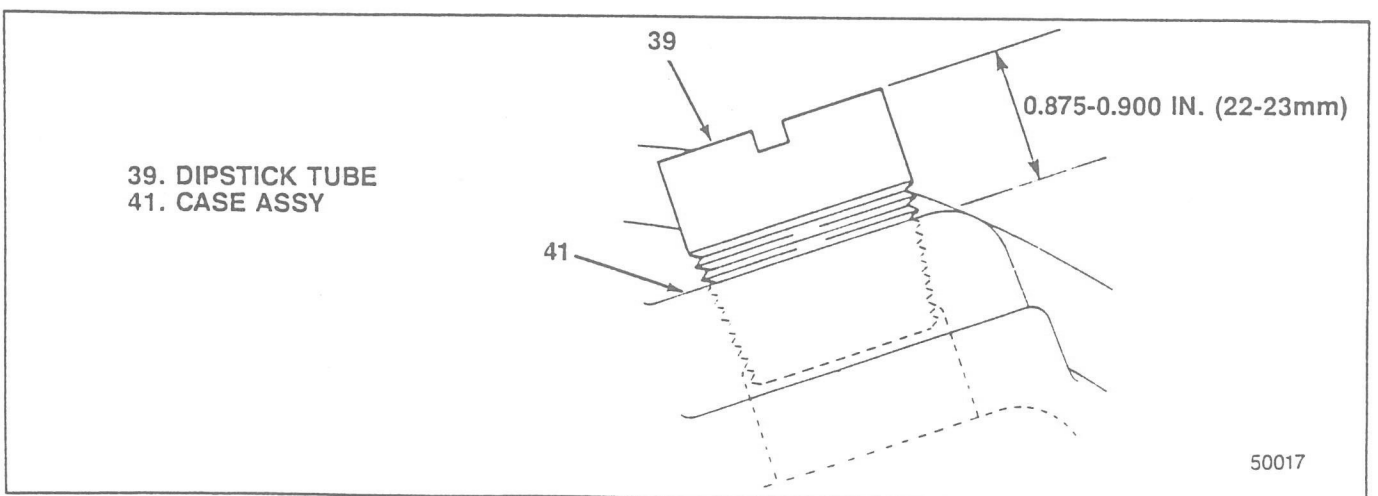


Figure 5-13. Dipstick Tube Installation

**5-19. INSTALLATION OF INTERMEDIATE AND INPUT SHAFT ASSEMBLIES.** Using intermediate shaft assembly as assembled in paragraph 5-4 and input shaft assembly as assembled in paragraph 5-8, proceed as follows (see figure 5-14):

1. Position one bearing cone (31) and one bearing cup (30) in cavity at pump end of case assembly (41). Install intermediate shaft assembly (29), guiding shaft end through bearing cone.
2. Position one bearing cone (31) and one bearing cup (30) in cavity at pump end of case assembly (41). Install input shaft assembly (28), guiding shaft end through bearing cone and engaging gear with that on intermediate shaft assembly (29).

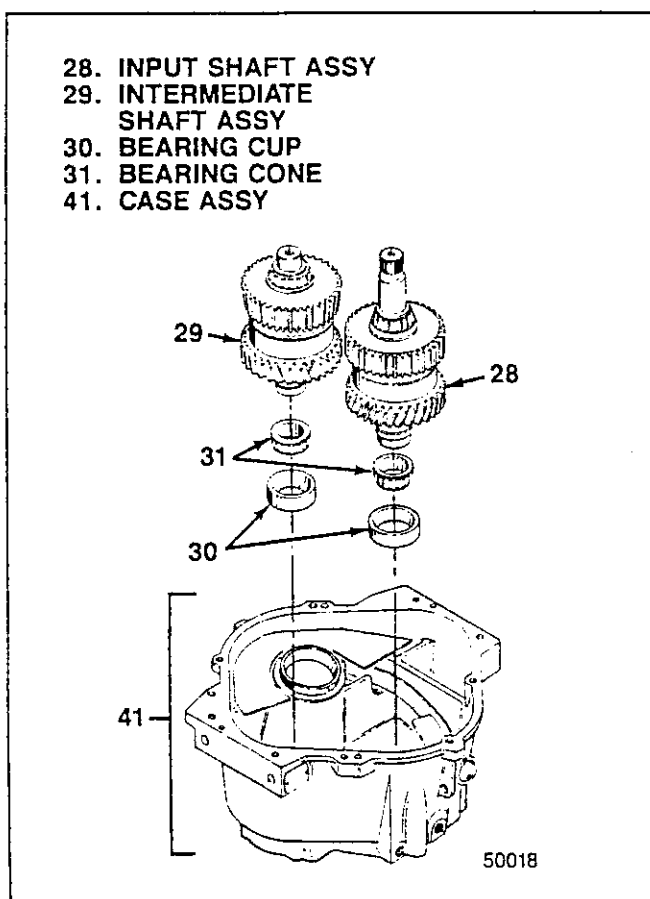


Figure 5-14. Input and Intermediate Shaft Assemblies

**5-20. OUTPUT SHAFT ASSEMBLY.** Assemble and install output shaft assembly as follows (see figure 5-15):

1. Install output gear (26) on output shaft (27) and align bolt holes. Before assembly, apply Loctite 271 (red) to threads of each of eight bolts (25). Install bolts and torque to 18-24 lb-ft (24-33 Nm).
2. Using bearing drift T-5004, press bearing cone (24) onto output shaft (27) to bottom on shaft shoulder.

**NOTE:** The following step is mandatory if bearing cups or cones have been replaced.

17. LOCK NUT
18. OUTPUT FLANGE
19. OIL SEAL
20. BEARING CONE
21. SHIM
22. SLEEVE
23. OUTPUT SHAFT ASSY
24. BEARING CONE
25. BOLT
26. OUTPUT GEAR
27. OUTPUT SHAFT
41. CASE ASSY

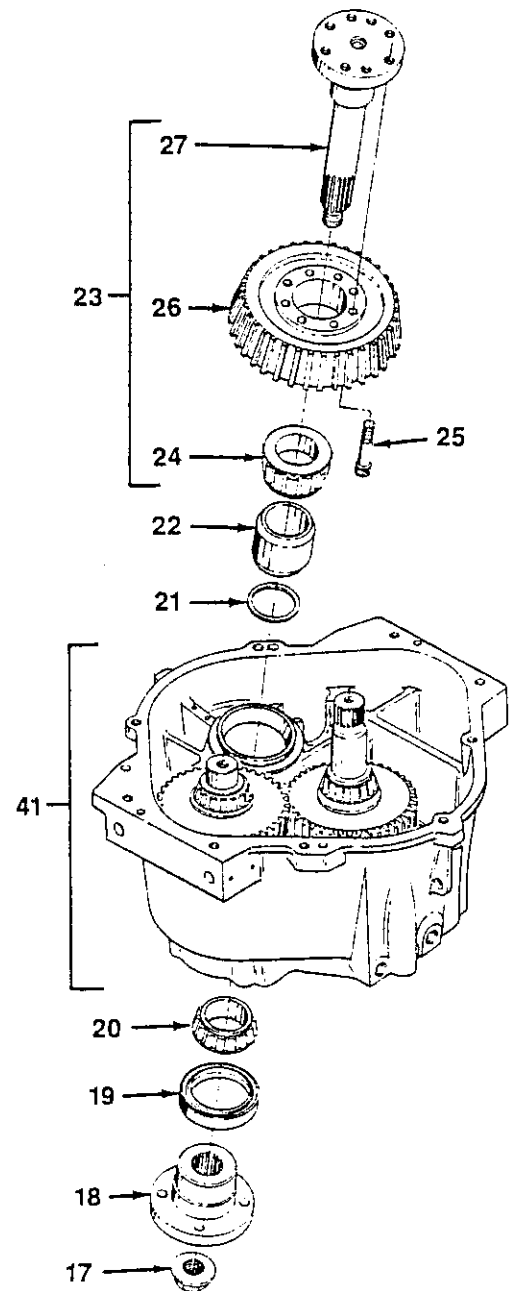


Figure 5-15. Output Shaft Assembly

3. Determine thickness of shim(s) (21) required as follows:

a. Temporarily install output flange (18) and lock nut (17) onto output shaft assembly (23). Holding output flange with coupling wrench T-5005, torque nut to 250 lb-ft (339 Nm). Holding shaft assembly with nut end down, measure and record dimension A as shown in figure 5-16.

b. Stack bearing cone (20) and sleeve (22). Measure and record dimension B as shown in figure 5-16.

c. Calculate T, the thickness of shim(s) (21) required, as follows:

$$T = A - B + 0.0041 \text{ in., or}$$

$$T = A + B + 0.105 \text{ mm}$$

d. Select shim(s) of thickness  $T \pm 0.0010 \text{ in. } (\pm 0.025 \text{ mm})$ .

e. Remove lock nut (17) and output flange (18).

4. Assemble sleeve (22) and shim(s) selected in step 3 on output shaft assembly (23), with thinnest shim(s) against sleeve, thickest shim(s) to bear against bearing cone (20) when installed.

5. Install output shaft assembly (23) in case assembly (41), engaging gears of both input and intermediate shaft assemblies previously installed.

6. Install bearing cone (20) over output shaft assembly (23) and into cup in case assembly (41).

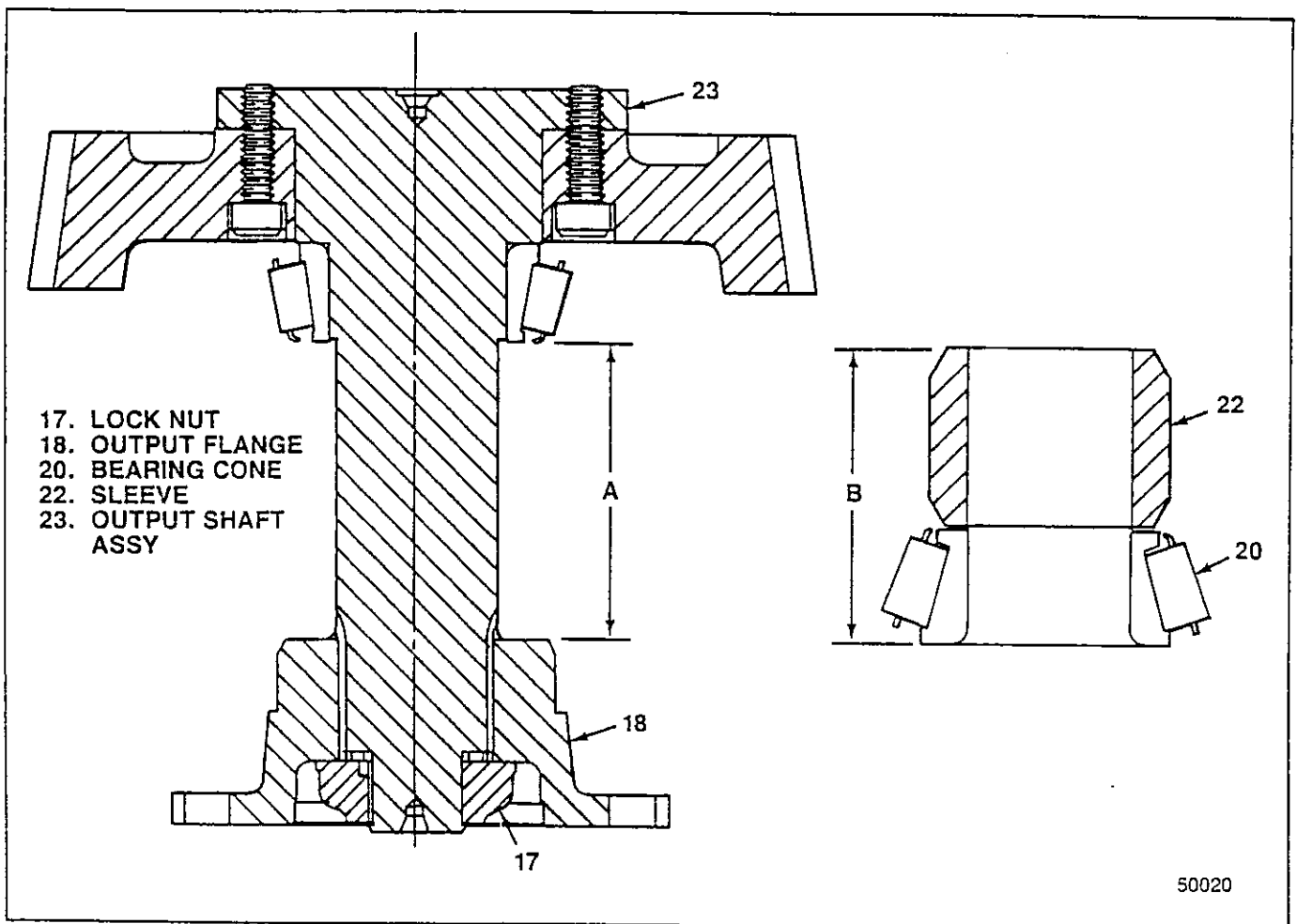


Figure 5-16. Determining Output Shaft Shim Thickness

7. Position oil seal (19) as shown in figure 5-17 and press in to bottom in case assembly (41).

8. Install output flange (18). Apply Loctite 598 (black) to face of washer portion of lock nut (17) and install lock nut. Holding output flange with coupling wrench T-5005, torque nut to 250 lb-ft (339 Nm).

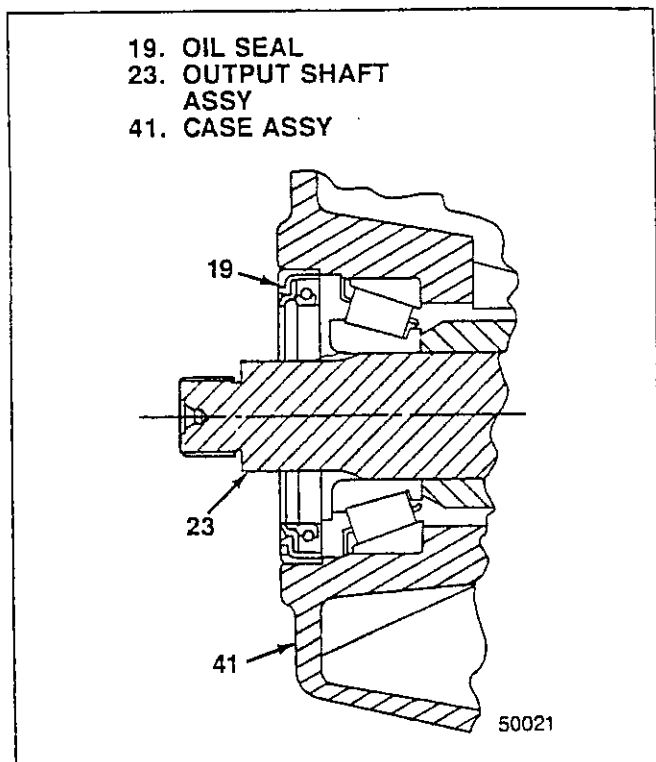


Figure 5-17. Output Shaft Oil Seal

#### 5-21. ASSEMBLY AND INSTALLATION OF ADAPTER AND BEARING CUP ASSEMBLY. Proceed as follows (see figure 5-18):

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

2. Position new oil seal (16) as shown in figure 5-19 and press into adapter and bearing cup assembly (11) so that outside face of oil seal is flush with outside face of adapter and bearing cup assembly.

3. Position transmission assembly with pump end down and install gasket (15) and adapter and bearing cup assembly (11). Attach with bolts and torque as follows:

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

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

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

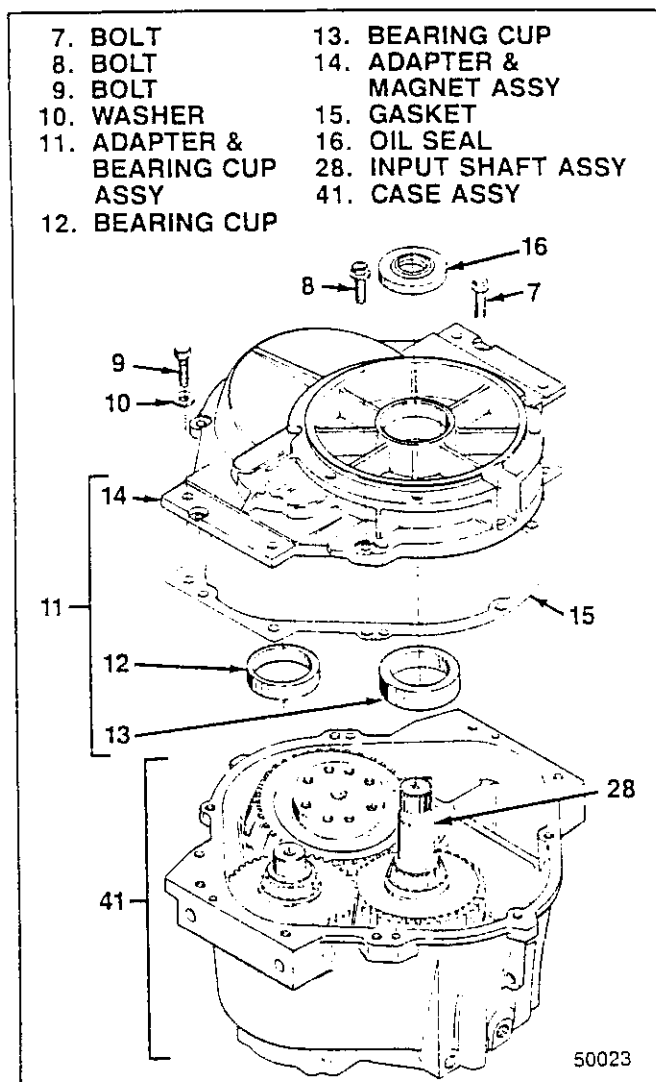


Figure 5-18. Adapter and Bearing Cup Assembly

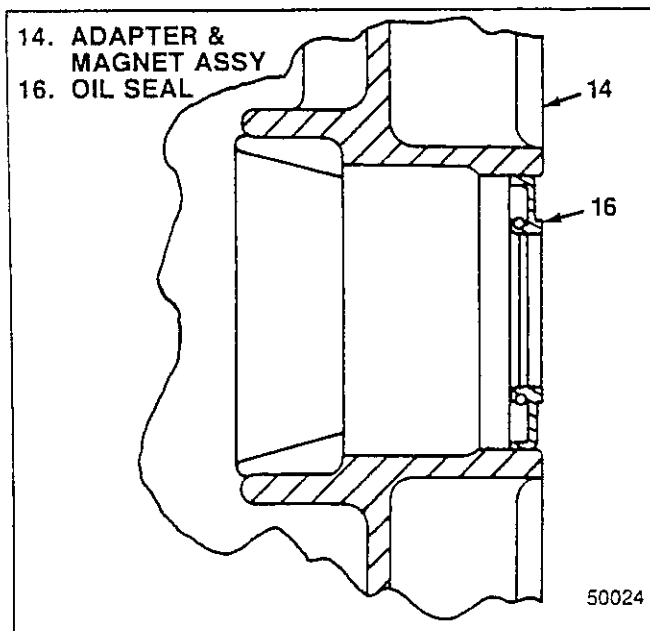


Figure 5-19. Input Shaft Oil Seal

**5-22. INSTALLING VALVE AND PUMP ASSEMBLY.** Position transmission assembly with pump end up and proceed as follows (see figure 5-20):

**NOTE:** The following steps 1 and 2 are mandatory if bearing cups or cones have been replaced.

1. Position gasket (5) on pump mounting face of case assembly (41) and determine thickness of shim(s) (6) to be used at intermediate shaft bearing as follows:

a. Push down firmly on intermediate shaft assembly (29) and bearing cup (30) (see figure 5-21) 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)].

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

$$T_1 = C + 0.0018 \text{ in., or}$$

$$T_1 = C + 0.046 \text{ mm}$$

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 intermediate 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 assembly (41), 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 5-22) to make sure parts are seated.

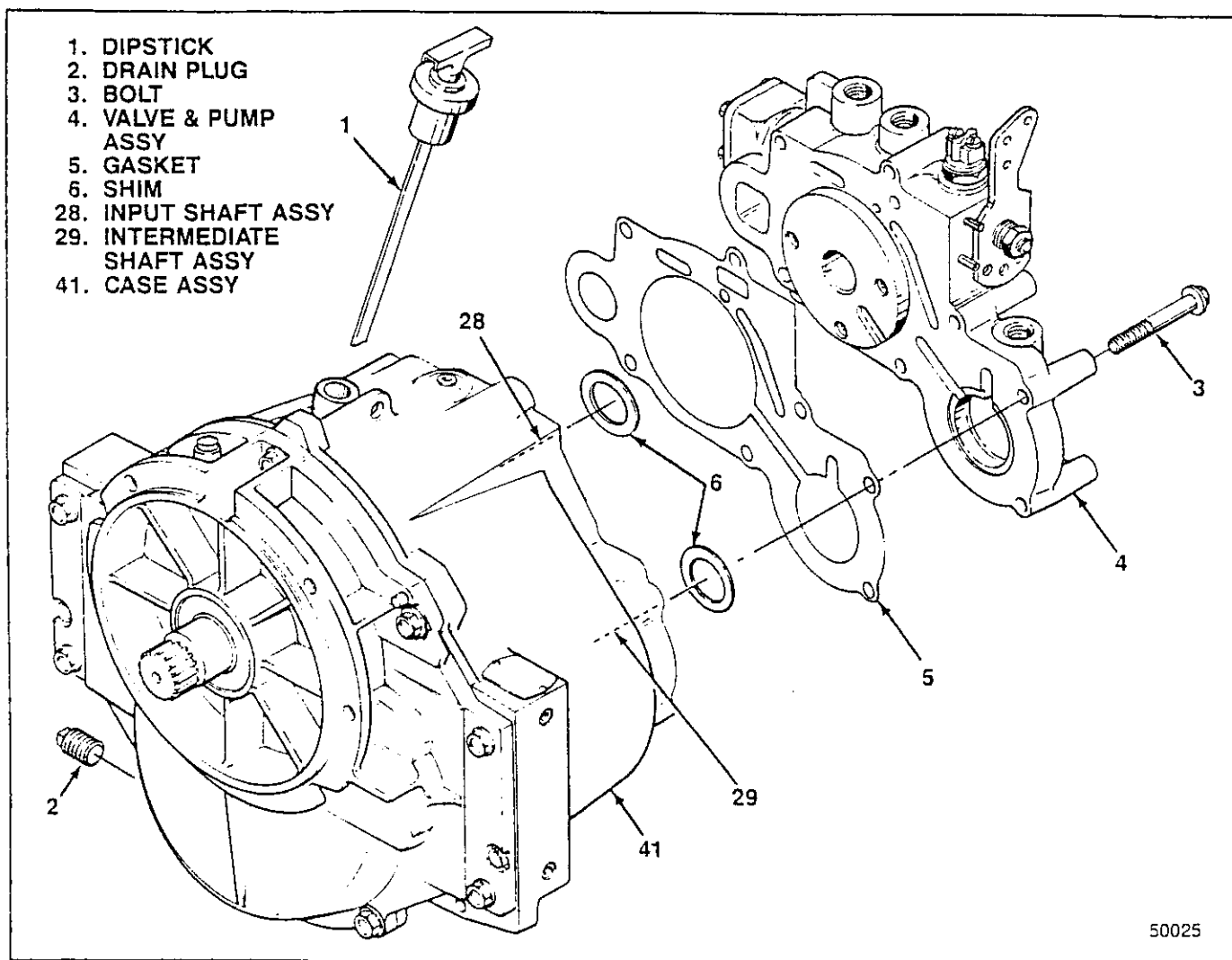
b. Measure and record dimension D as shown in figure 5-22 [from top face of gasket (5) to top face of bearing cup (30)].

c. On valve and pump assembly (4), measure and record dimension E as shown in figure 5-22.

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

$$T_2 = D - E + 0.0018 \text{ in., or}$$

$$T_2 = D - E + 0.046 \text{ mm}$$



**Figure 5-20. Valve and Pump Assembly**

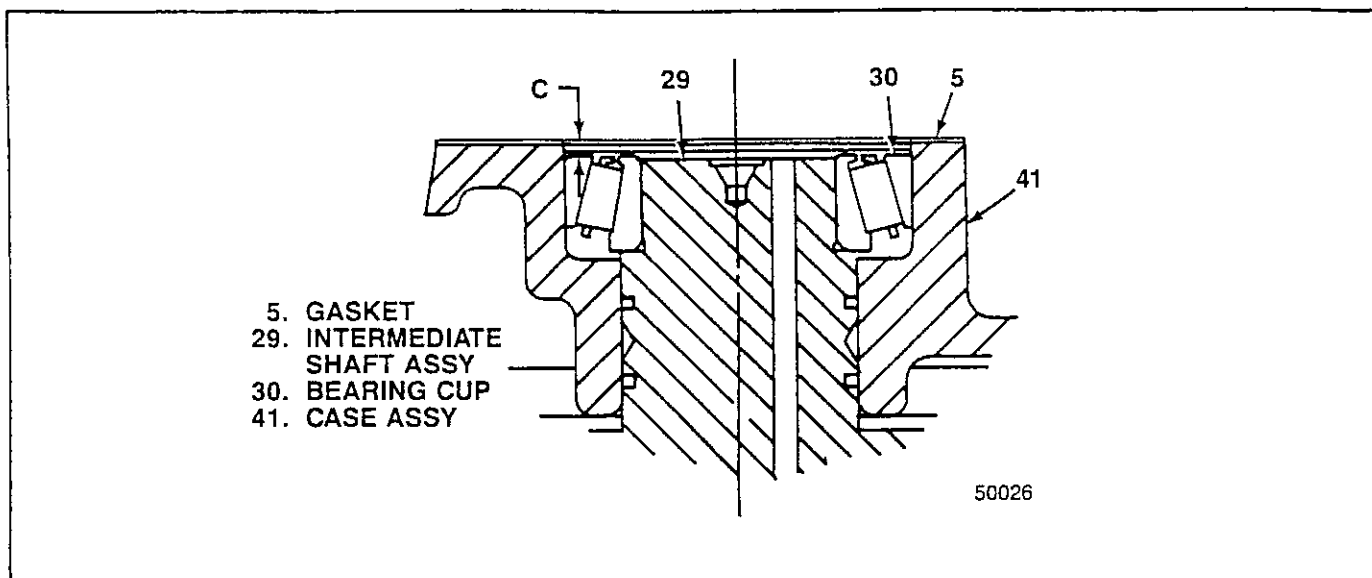


Figure 5-21. Determining Intermediate Shaft Bearing Thickness

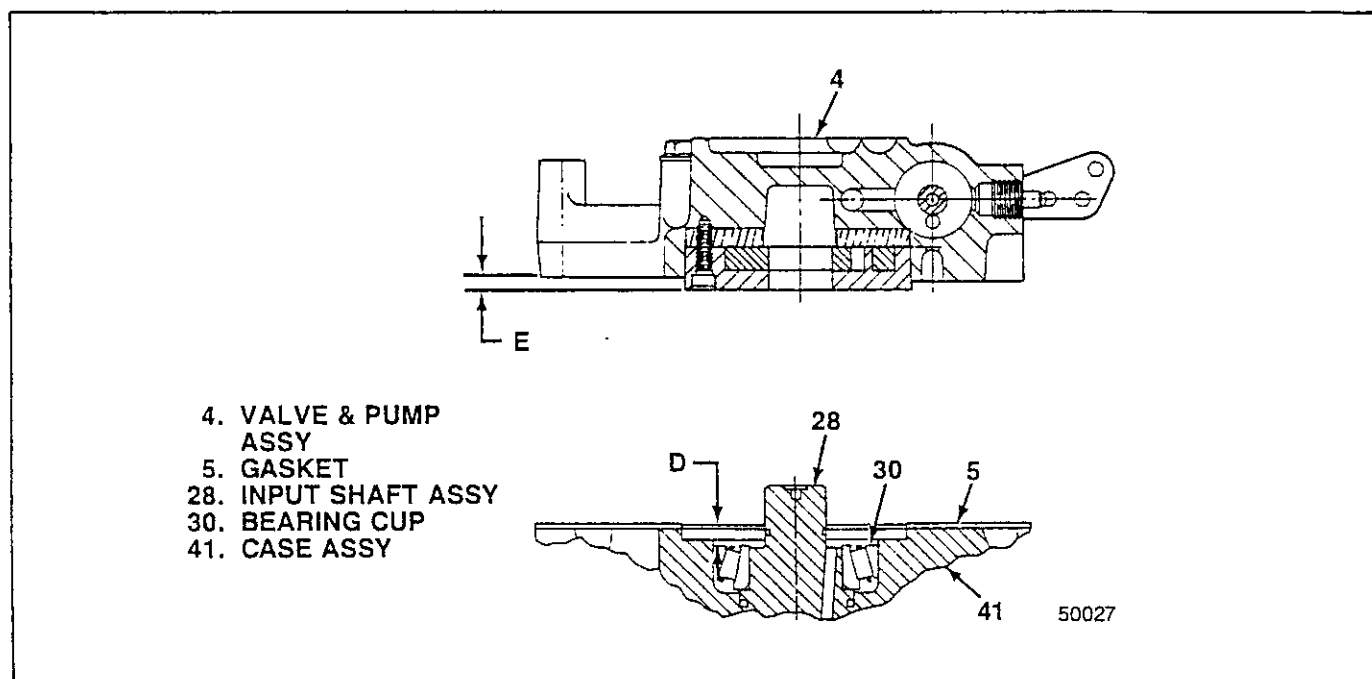


Figure 5-22. Determining Input Shaft Bearing Shim Thickness

e. Select shim(s) of thickness  $T_2 \pm 0.0010$  in. ( $\pm 0.025$  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 (1).

Table 5-1. Torque Values

PART (INDEX NO.)	TORQUE IN LB-FT	TORQUE IN Nm
Drain plug (2)	20-25	27-34
Bolt (3)	24-34	33-46
Bolt (7)	14-16	19-22
Bolt (8)	24-34	33-46
Bolt (9)	40-50	54-68
Lock Nut (17)	250	339
Bolt (25)	18-24	24-33
Bolt (32)	4-6	5-7
Bolt (201)	6-8	8-11
Switch Assy (203)	20-25	27-34
Nut (204)	14-16	19-22
Bolt (214)	4-5	5-7
Bolt (313)	6-8	8-11
Bolt (411)	6-8	8-11



# Section P

## Parts

## Contents

FIGURE NO.	DESCRIPTION	TRANSMISSION APPLICATION
P-1	Transmission Assembly	2001-000-001 thru -006
P-2	Valve and Pump Assembly	2001-000-001 thru -006
P-3	Input Shaft Assembly	2001-000-001 thru -006
P-4	Intermediate Shaft Assembly	2001-000-001 thru -006

### P-1. INTRODUCTION.

P-2. This section lists, describes and illustrates replacement parts for the Borg-Warner 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 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 parentheses if the part is used only on a specific model or models.

P-5. The QTY column designates the number of parts used at the location defined by the index number. Letter symbols AR 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.

NP - Not procurable.

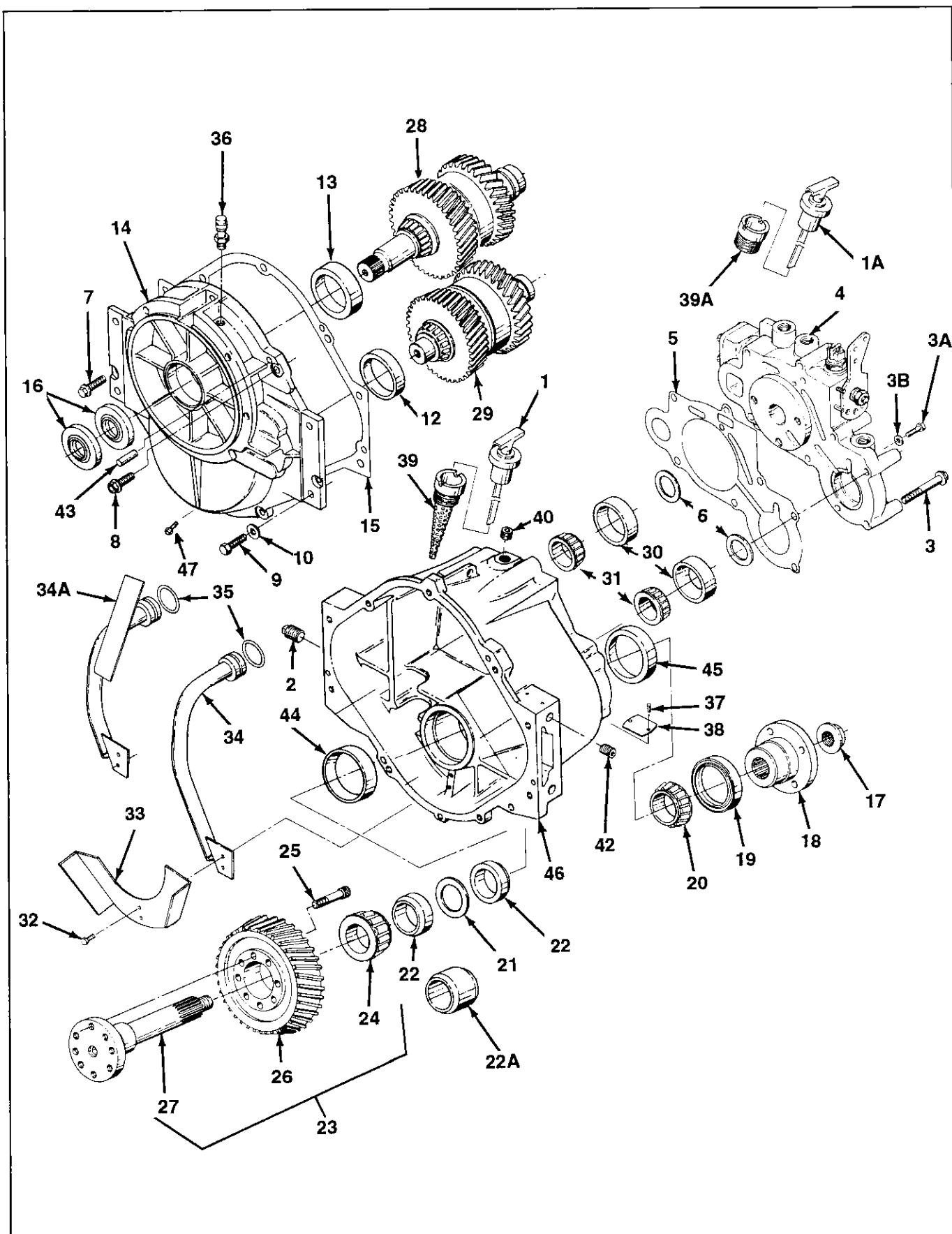


Figure P-1. Transmission Assembly

## 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)	
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

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
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 Production 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

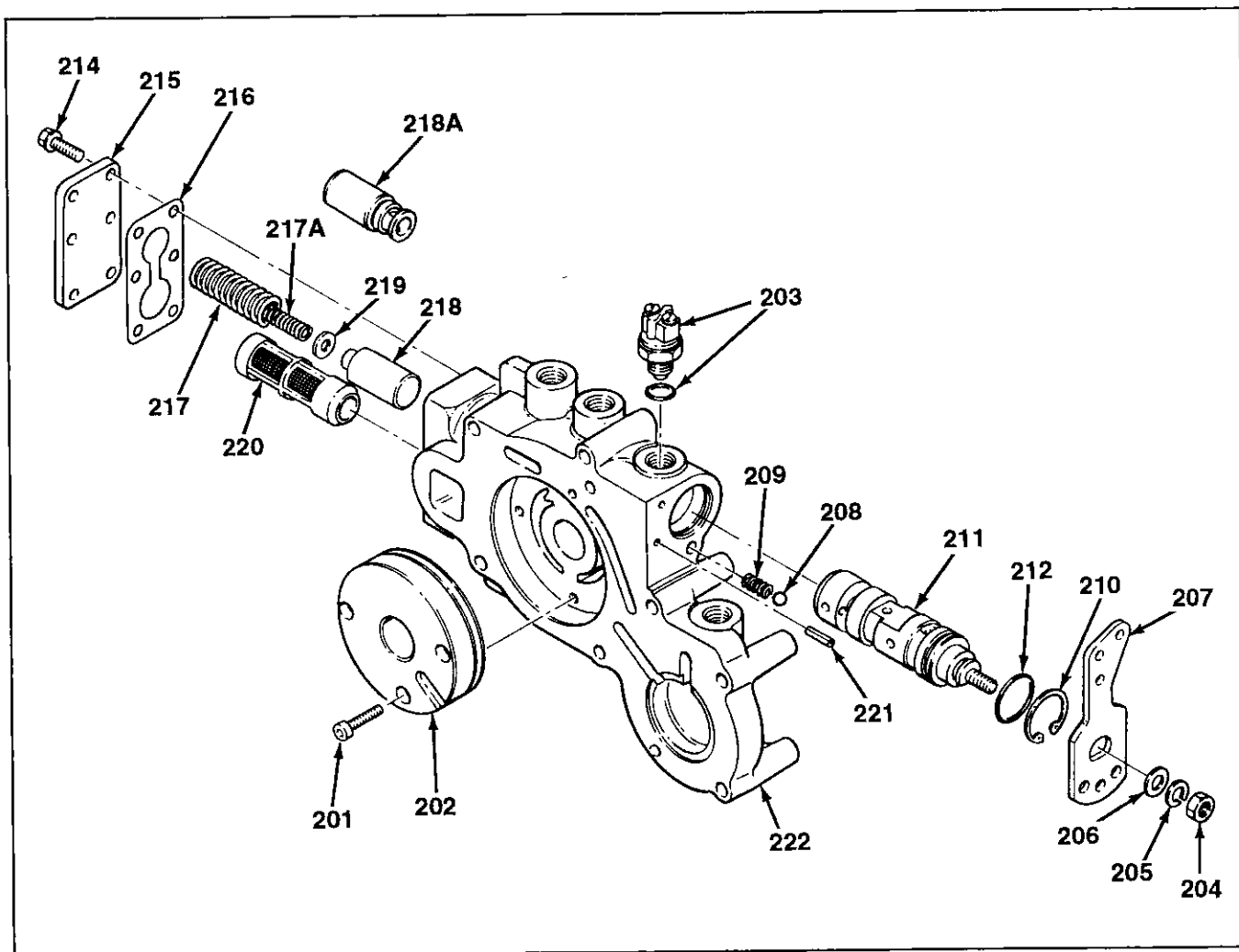


Figure P-2. Valve and Pump Housing Assembly

## 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

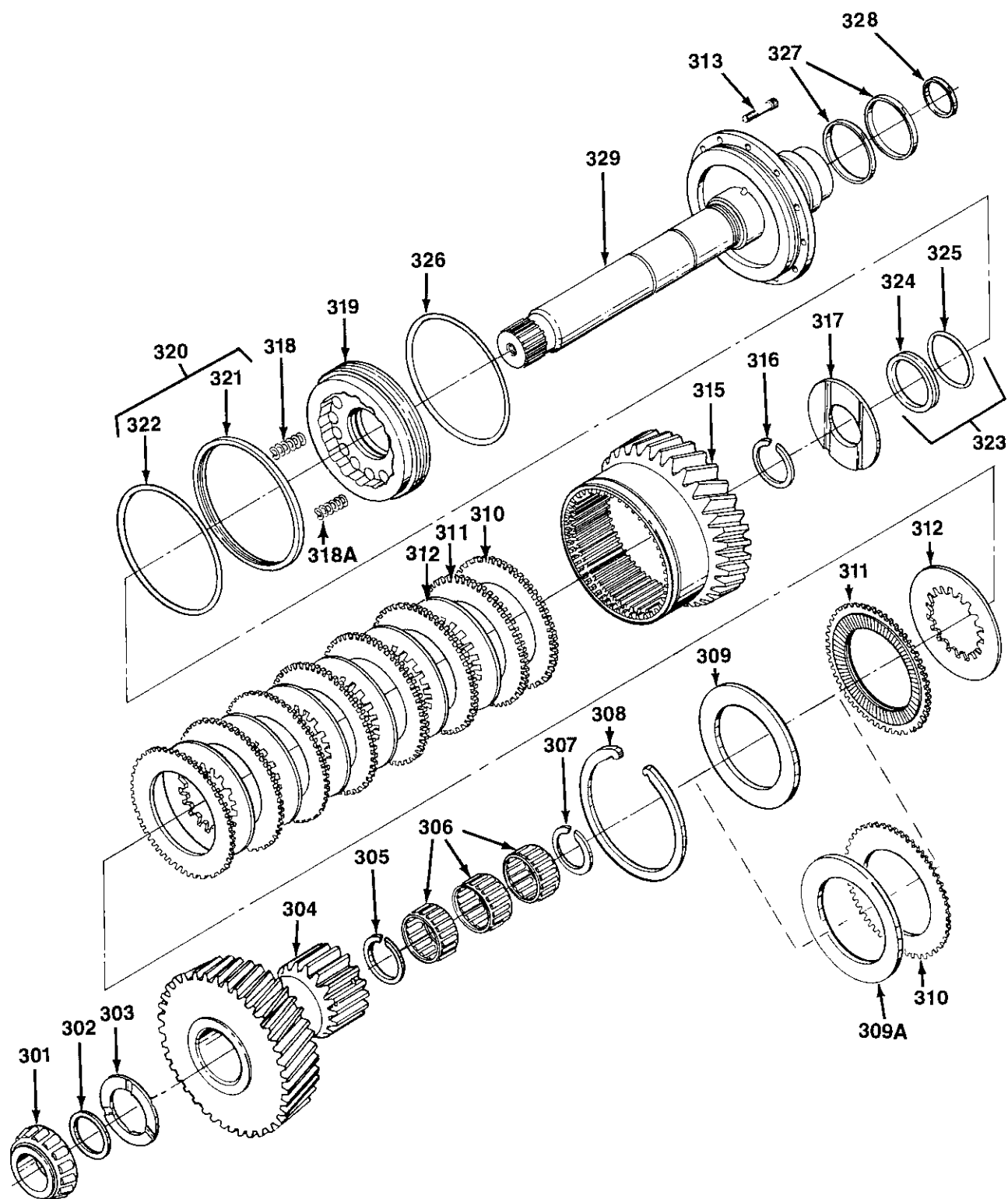


Figure P-3. Input Shaft Assembly

### PARTS LIST FOR FIGURE P-3

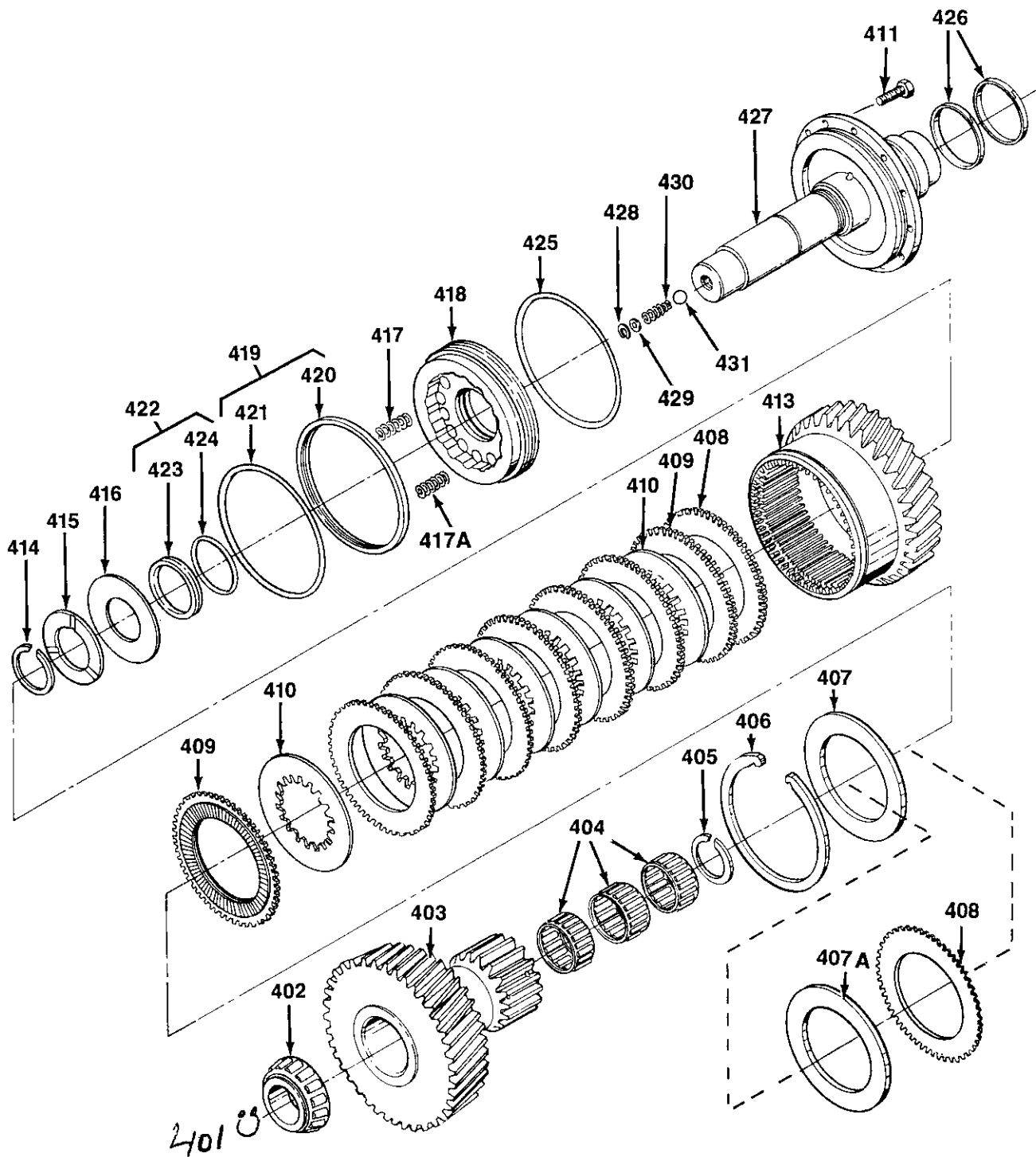
INDEX NO.	PART NUMBER	DESCRIPTION	QTY
Fig P-3	2001-689-001	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-001, -R01)	Ref
	2001-689-002	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-002, -R02)	Ref
	2001-689-003	SHAFT ASSY, Input (28, figure P-1) (Transmission 2001-000-003, -R03)	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



401 = SNAPPING 1000-139-072

Figure P-4. Lay Shaft Assembly

# PARTS LIST FOR FIGURE P-4

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
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

INDEX NO.	PART NUMBER	DESCRIPTION	QTY
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