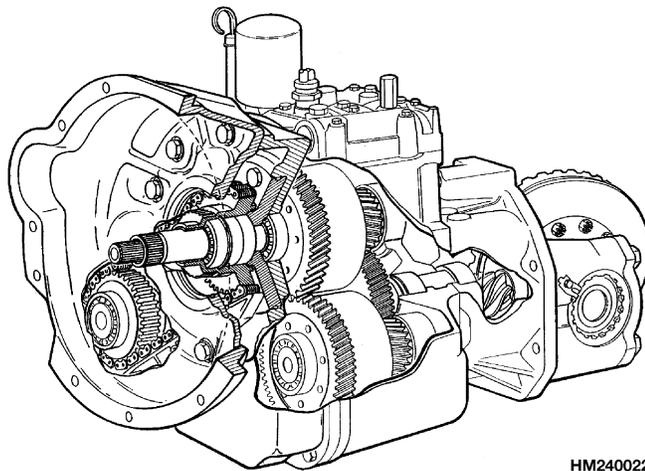


# **SINGLE-SPEED POWERSHIFT TRANSMISSION**

## **TROUBLESHOOTING AND REPAIR**

**S/H2.00/2.50/3.00/3.20XM  
(S/H40/45/50/60/65XM)  
[D187, D177];  
H2.00/2.50/3.20XM  
(H45/50/55/60/65XM) [H177]**



HM240022

# ***HYSTER***

# SAFETY PRECAUTIONS

## MAINTENANCE AND REPAIR

- When lifting parts or assemblies, make sure all slings, chains, or cables are correctly fastened, and that the load being lifted is balanced. Make sure the crane, cables, and chains have the capacity to support the weight of the load.
- Do not lift heavy parts by hand, use a lifting mechanism.
- Wear safety glasses.
- **DISCONNECT THE BATTERY CONNECTOR** before doing any maintenance or repair on electric lift trucks.
- Disconnect the battery ground cable on internal combustion lift trucks.
- Always use correct blocks to prevent the unit from rolling or falling. See **HOW TO PUT THE LIFT TRUCK ON BLOCKS** in the **Operating Manual** or the **Periodic Maintenance** section.
- Keep the unit clean and the working area clean and orderly.
- Use the correct tools for the job.
- Keep the tools clean and in good condition.
- Always use **HYSTER APPROVED** parts when making repairs. Replacement parts must meet or exceed the specifications of the original equipment manufacturer.
- Make sure all nuts, bolts, snap rings, and other fastening devices are removed before using force to remove parts.
- Always fasten a **DO NOT OPERATE** tag to the controls of the unit when making repairs, or if the unit needs repairs.
- Be sure to follow the **WARNING** and **CAUTION** notes in the instructions.
- Gasoline, Liquid Petroleum Gas (LPG), Compressed Natural Gas (CNG), and Diesel fuel are flammable. Be sure to follow the necessary safety precautions when handling these fuels and when working on these fuel systems.
- Batteries generate flammable gas when they are being charged. Keep fire and sparks away from the area. Make sure the area is well ventilated.

**NOTE:** The following symbols and words indicate safety information in this manual:



### **WARNING**

**Indicates a condition that can cause immediate death or injury!**



### **CAUTION**

**Indicates a condition that can cause property damage!**

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This section is for the following models:

S/H2.00/2.50/3.00/3.20XM (S/H40/45/50/60/65XM) [D187, D177];  
H2.00/2.50/3.20XM (H45/50/55/60/65XM) [H177]

**"THE  
QUALITY  
KEEPERS"**

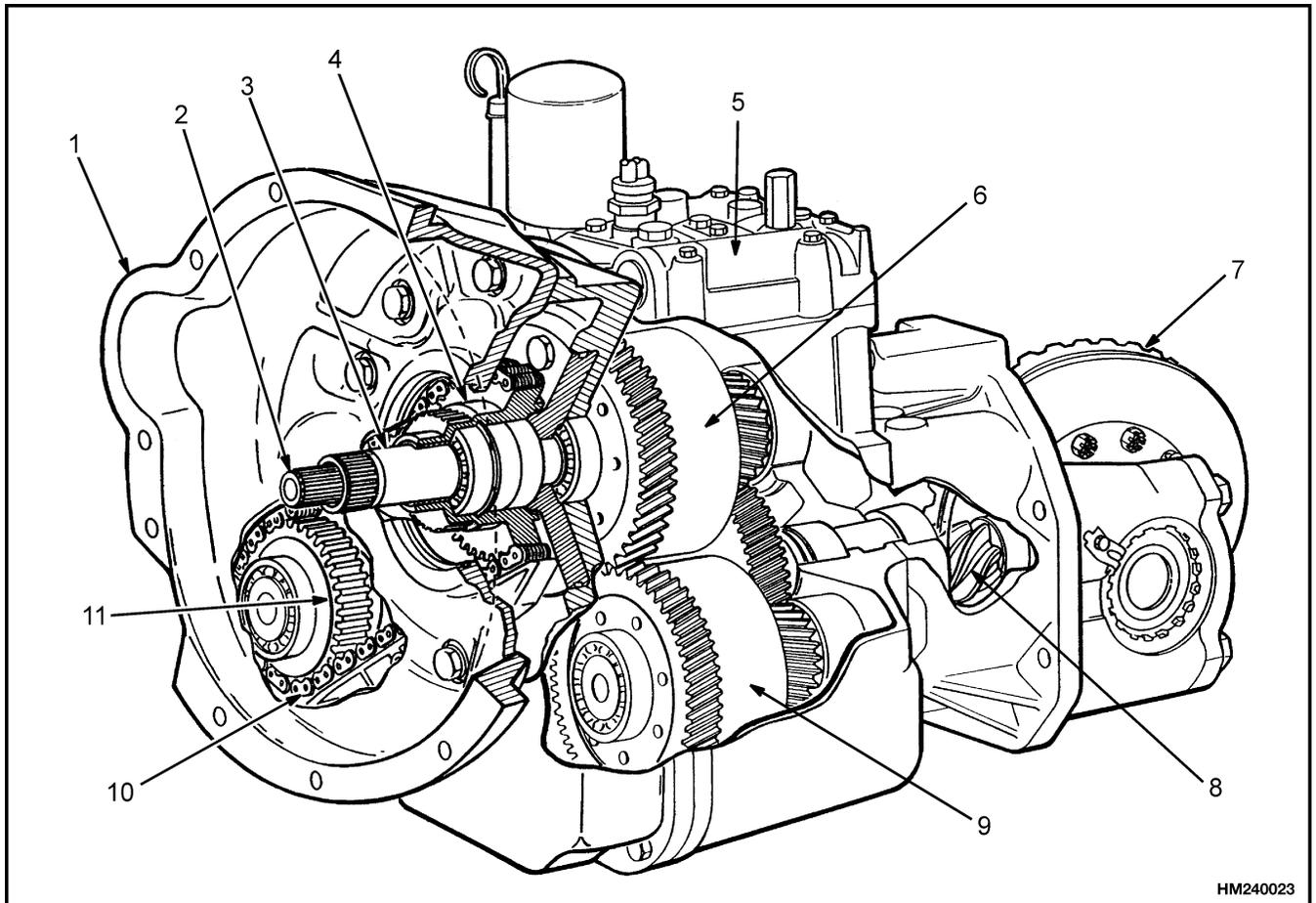
**HYSTER  
APPROVED  
PARTS**

## General

This section has the repair procedures for the following parts of the transmission: the oil pump and pump drive assembly, clutch assemblies, control valve, and differential. The torque converter cannot be repaired and must be replaced as a complete assembly.

The engine and transmission are normally removed as a unit for repairs. The engine can be removed

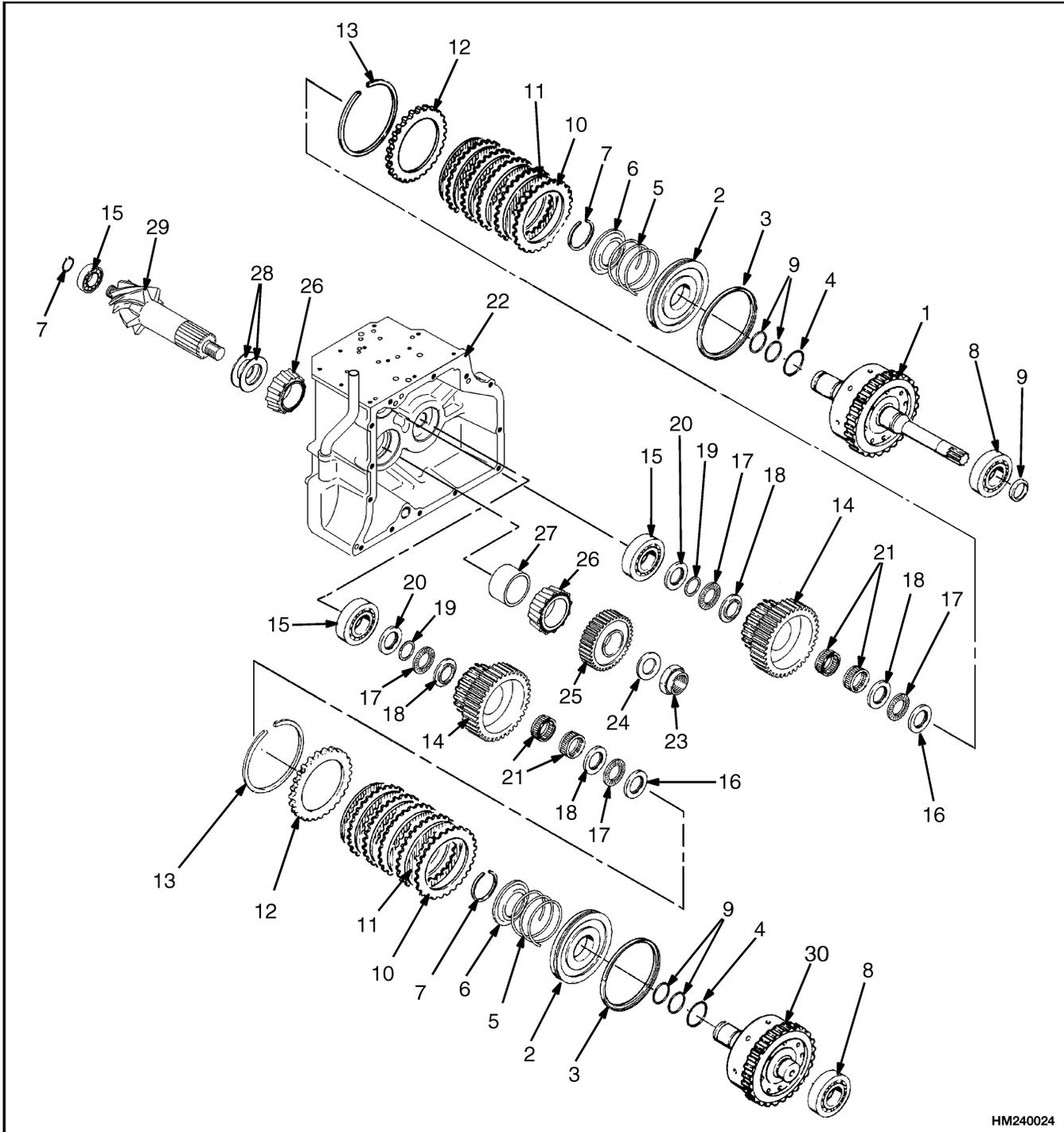
separately for repairs. See the section **Frame 100 SRM 505** for the procedures to remove and install the engine and transmission. See the section **Single-Speed Powershift Transmission (Description and Operation) 1300 SRM 500** for additional information on the operation of this transmission. See Figure 1, Figure 2, and Figure 3.



**NOTE:** H2.00-3.20XM (H40-65XM) SHOWN. S2.00-3.20XM (S40-65XM) SIMILAR.

- |                             |                             |
|-----------------------------|-----------------------------|
| 1. TORQUE CONVERTER HOUSING | 7. RING GEAR                |
| 2. INPUT SHAFT              | 8. PINION                   |
| 3. STATOR                   | 9. COUNTER (REVERSE) CLUTCH |
| 4. DRIVE SPROCKET           | 10. CHAIN                   |
| 5. CONTROL VALVE            | 11. PUMP SPROCKET           |
| 6. INPUT (FORWARD) CLUTCH   |                             |

*Figure 1. Transmission*



HM240024

**Figure 2. Transmission Clutch Assemblies (Lift Trucks Without Exedy Clutch Assemblies)**

*Legend for Figure 2*

- |  |   |
|--|---|
| 1. INPUT (FORWARD) CLUTCH SHAFT ASSEMBLY | 17. THRUST WASHER BEARING                   |
| 2. CLUTCH PISTON                         | 18. THRUST WASHER                           |
| 3. PISTON SEAL                           | 19. SNAP RING                               |
| 4. SEAL RING                             | 20. THRUST WASHER                           |
| 5. CLUTCH SPRING                         | 21. NEEDLE BEARINGS, HUB                    |
| 6. RETAINER, SPRING                      | 22. TRANSMISSION HOUSING                    |
| 7. SNAP RING*                            | 23. NUT                                     |
| 8. BALL BEARING                          | 24. WASHER                                  |
| 9. SEAL RING                             | 25. OUTPUT GEAR                             |
| 10. SEPARATOR DISC                       | 26. BEARING CONE                            |
| 11. FRICTION DISC                        | 27. SPACER                                  |
| 12. PRESSURE PLATE                       | 28. SHIMS                                   |
| 13. SNAP RING                            | 29. PINION                                  |
| 14. OUTPUT GEAR                          | 30. COUNTER (REVERSE) CLUTCH SHAFT ASSEMBLY |
| 15. BALL BEARING*                        |   |
| 16. THRUST WASHER                        |   |

\*H2.00-3.20XM (H40-65XM) ONLY

## Transmission Removal



### WARNING

Make sure the engine and transmission are held so that they will not fall and cause an injury and damage to the equipment.



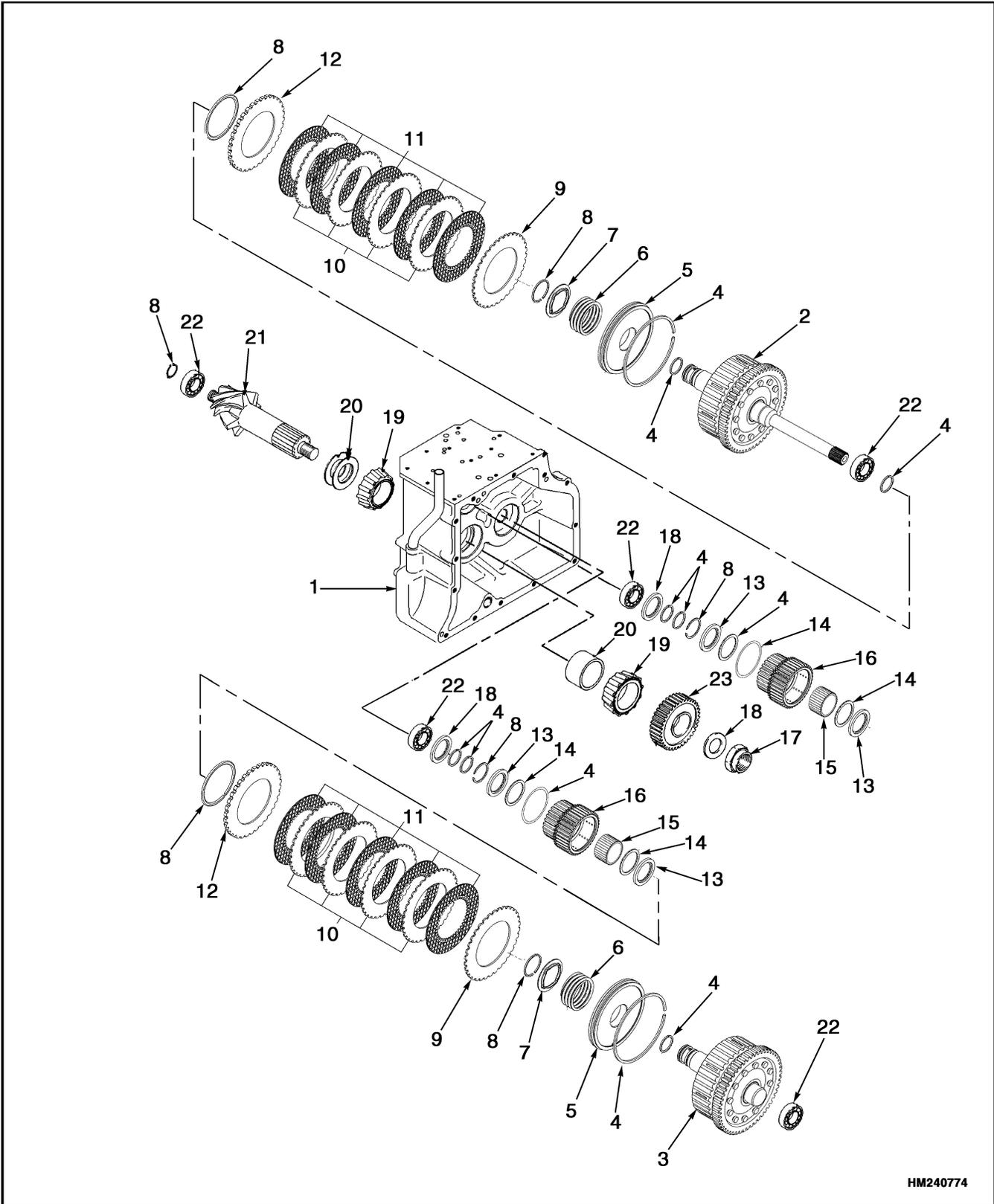
### CAUTION

Be careful that you do not damage parts of the torque converter or transmission when the transmission is separated from the engine. Keep the transmission and engine in alignment until they are completely separated so

that parts of the transmission are not damaged. Use a crane or lifting device to separate the transmission from the engine.

**NOTE:** Remove the transmission and engine as a unit as described in the **Frame 100 SRM 505** section.

Put the engine and transmission on solid blocks on a work surface. Remove the capscrews that hold the torque converter housing to the engine. Carefully separate the transmission from the engine. Be careful not to damage the torque converter or drive plate. See Figure 1, Figure 2, and Figure 3.



HM240774

Figure 3. Transmission With Exedy Clutch Assemblies

*Legend for Figure 3*

- |  |                           |
|--|---------------------------|
| 1. TRANSMISSION HOUSING                    | 12. PRESSURE PLATE        |
| 2. INPUT (FORWARD) CLUTCH SHAFT ASSEMBLY   | 13. THRUST WASHER         |
| 3. COUNTER (REVERSE) CLUTCH SHAFT ASSEMBLY | 14. NEEDLE THRUST BEARING |
| 4. SEAL RING                               | 15. NEEDLE BEARING        |
| 5. PISTON                                  | 16. OUTPUT GEAR           |
| 6. SPRING                                  | 17. NUT                   |
| 7. SPRING GUIDE                            | 18. WASHER                |
| 8. SNAP RING                               | 19. BEARING CONE          |
| 9. CONICAL PLATE                           | 20. SPACER                |
| 10. SEPARATOR PLATE                        | 21. PINION                |
| 11. FRICTION PLATE                         | 22. BALL BEARING          |
|  | 23. OUTPUT GEAR           |

**Torque Converter and Housing Repair****REMOVE****CAUTION**

Be careful that you do not damage parts of the torque converter or transmission when the transmission is separated from the engine. Keep the transmission and engine in alignment until they are completely separated so that parts of the transmission are not damaged. Use a crane or lifting device to separate the transmission from the engine.

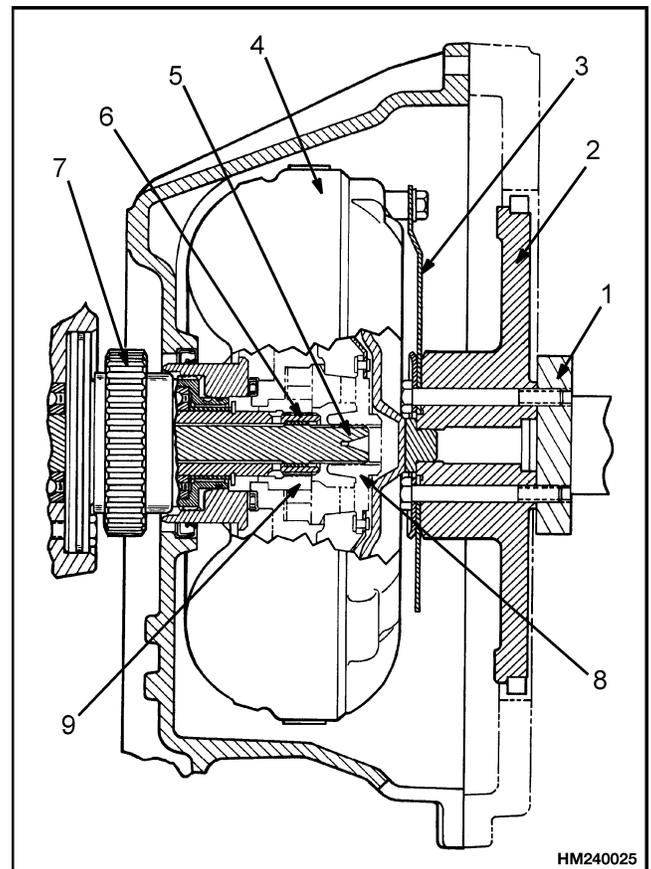
**NOTE:** The torque converter cannot be repaired.

1. Remove the capscrews that hold the drive plate to the torque converter. See Figure 4 and Figure 5. Remove the torque converter.
2. Remove the capscrews that hold the torque converter housing to the front cover. Remove the housing. Make sure the pump drive sprocket stays in the front cover of the transmission.

**INSTALL**

**NOTE:** If the flywheel was removed, see the **Engine** section for your forklift, for the correct installation procedures.

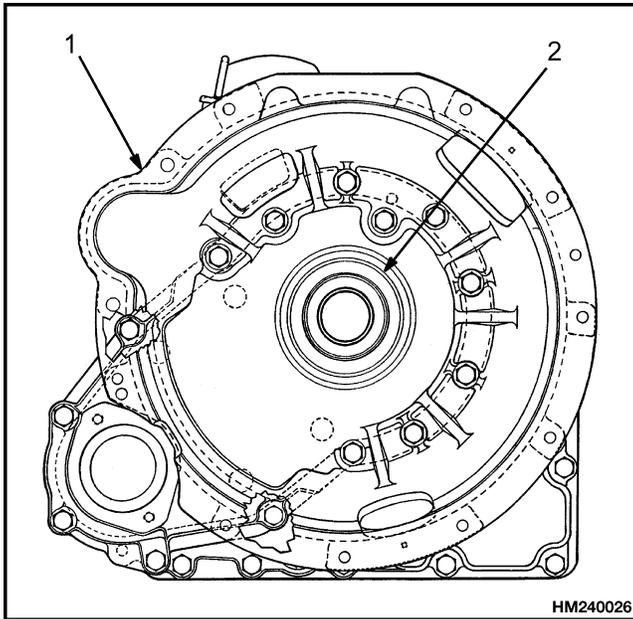
1. Install the oil seal in the torque converter housing. See Figure 4 and Figure 5. Make sure the lip of the seal is toward the transmission. Make sure the dowel pins are installed in the front cover. Use a gasket sealant and install the torque converter housing on the front cover. Tighten the capscrews for the housing to 38 N•m (28 lbf ft).



**NOTE:** GM 2.2L ENGINE SHOWN.

- |                          |                   |
|--------------------------|-------------------|
| 1. CRANKSHAFT            | 6. STATOR SUPPORT |
| 2. FLYWHEEL              | 7. DRIVE SPROCKET |
| 3. DRIVE PLATE           | 8. TURBINE        |
| 4. IMPELLER              | 9. STATOR CLUTCH  |
| 5. INPUT (FORWARD) SHAFT |                   |

**Figure 4. Torque Converter Arrangement**



1. TORQUE  
CONVERTER  
HOUSING

2. OIL SEAL

**Figure 5. Torque Converter Housing**

2. On GM 2.2L, GM3.0L, and Mazda M4-2.0G engines, install the torque converter as follows:
  - a. Install the torque converter onto the input (forward) shaft and stator support of the transmission. Make sure the splines are aligned.
  - b. Lubricate the pilot hole in the flywheel and the pilot hub on the torque converter with antiseize compound.

- c. Install the transmission to the engine. Install the capscrews at the transmission housing. Tighten the M10 capscrews to 38 N•m (28 lbf ft) and the M12 capscrews to 66 N•m (49 lbf ft).
  - d. Use the access hole in the torque converter housing and install the capscrews for the drive plate. Tighten the capscrews to 45 N•m (33 lbf ft). On Mazda M4-2.0G engines, tighten the capscrews through the hole in the flywheel.
3. On Isuzu C240 and 4JB1 engines, install the torque converter as follows:
  - a. Install the drive plate on the torque converter. Tighten the capscrews to 45 N•m (33 lbf ft).
  - b. Install the torque converter onto the input shaft and stator support of the transmission. Make sure the splines are aligned.
  - c. Lubricate the pilot hole in the flywheel and the pilot hub on the torque converter with antiseize compound.
  - d. Install the transmission to the engine. Install the capscrews at the transmission housing. Tighten the M10 capscrews to 38 N•m (28 lbf ft) and the M12 capscrews to 66 N•m (49 lbf ft).
  - e. Use the access hole in the torque converter housing and install the capscrews for the drive plate. Tighten the capscrews to 45 N•m (33 lbf ft).

## Transmission Pump Repair

### REMOVE

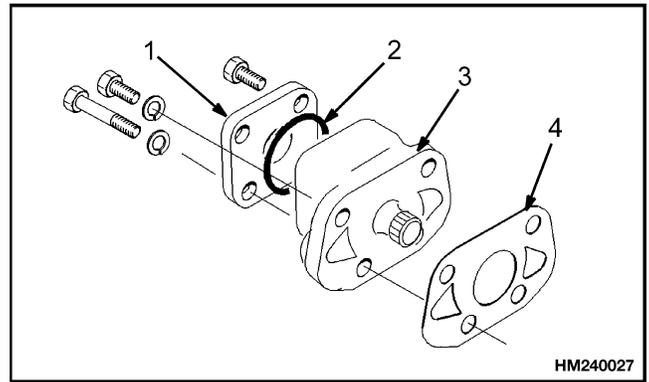
Remove the capscrews that hold the pump to the transmission housing. See Figure 6 and Figure 8.

### REPAIR

Parts for repair of the pump are not available.

### INSTALL

Install the gasket and the pump on the transmission housing. See Figure 8. Make sure the pump shaft is aligned with the pump drive sprocket. Install and tighten the capscrews.



- |           |           |
|-----------|-----------|
| 1. COVER  | 3. PUMP   |
| 2. O-RING | 4. GASKET |

*Figure 6. Transmission Pump*

## Front Cover and Pump Drive Repair

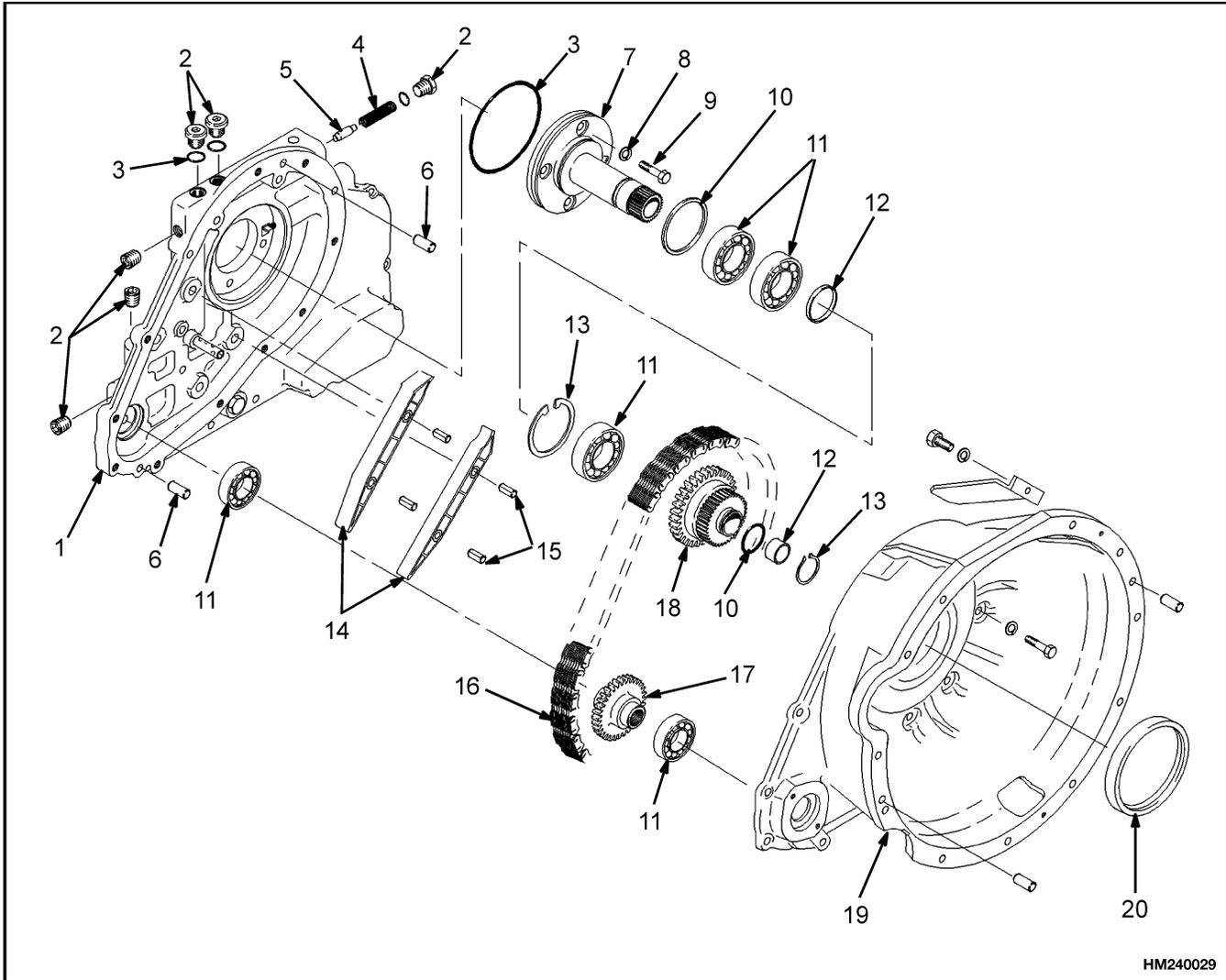
### REMOVE AND DISASSEMBLE

1. Remove the capscrews that hold the torque converter housing to the front cover. See Figure 7 and Figure 8. Remove the torque converter housing, making sure the pump sprocket stays in the front cover. Remove the transmission pump from the front cover.
2. Remove the snap ring and spacer from the stator support. Remove the chain blocks from the front cover. Carefully pull the sprockets, chain, and bearings from the front cover as a unit.
3. Remove the stator support from the front cover. See Figure 9.

4. The front cover is held in alignment with the transmission housing with dowel pins. Use a soft hammer to loosen the front cover from the transmission housing. Do not use a pry bar between the sealing surfaces. Remove the front cover from the transmission housing.

### ASSEMBLE AND INSTALL

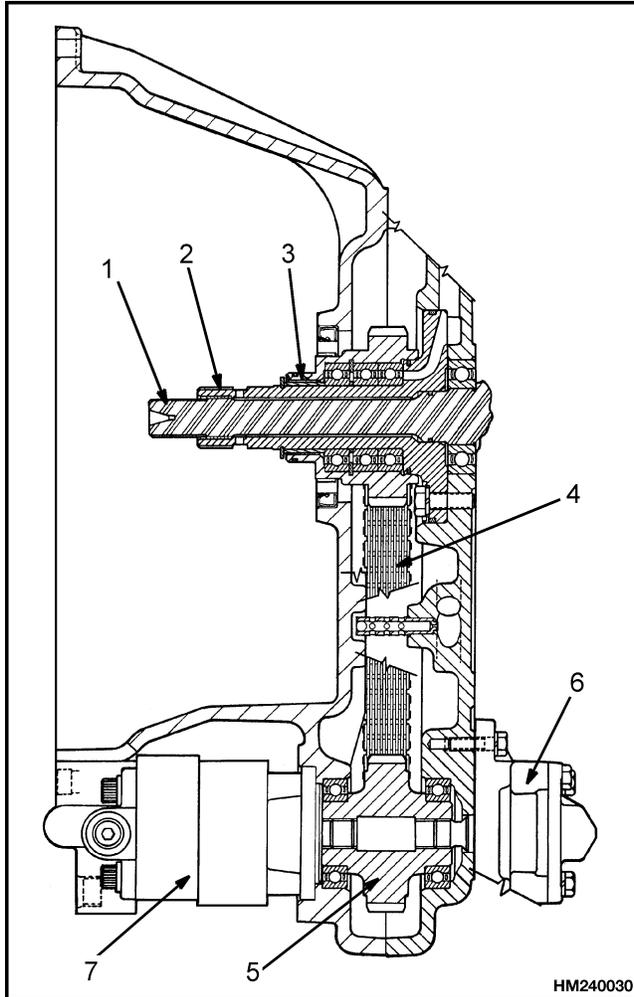
1. Install the relief valves and plugs in the front cover. See Figure 7, Figure 8, and Figure 10. Make sure the parts are installed in the correct ports. Make sure the ball bearings are installed correctly on the clutch shafts.
2. Install the front cover using a new gasket and a gasket sealant. Install the M10 × 1.5 capscrews and tighten them to 38 N•m (28 lbf ft).



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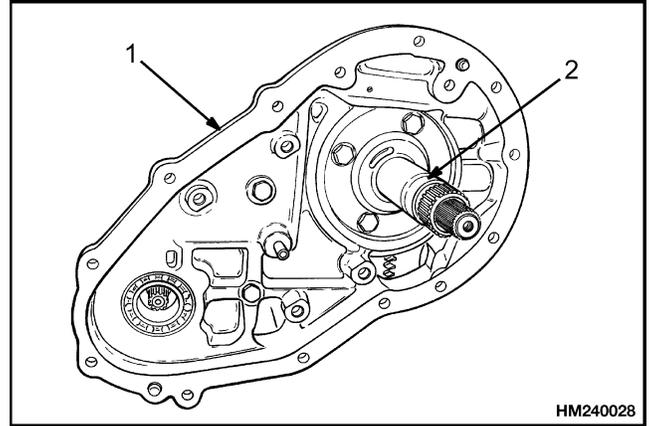
- |                   |                              |
|-------------------|------------------------------|
| 1. FRONT COVER    | 11. BEARING                  |
| 2. PLUG           | 12. SPACER                   |
| 3. O-RING         | 13. SNAP RING                |
| 4. SPRING         | 14. CHAIN BLOCK              |
| 5. RELIEF SPOOL   | 15. PIN                      |
| 6. DOWEL PIN      | 16. CHAIN                    |
| 7. STATOR SUPPORT | 17. PUMP SPROCKET            |
| 8. LOCKWASHER     | 18. DRIVE SPROCKET           |
| 9. CAPSCREW       | 19. TORQUE CONVERTER HOUSING |
| 10. SEAL RING     | 20. OIL SEAL                 |

**Figure 7. Front Cover Arrangement**



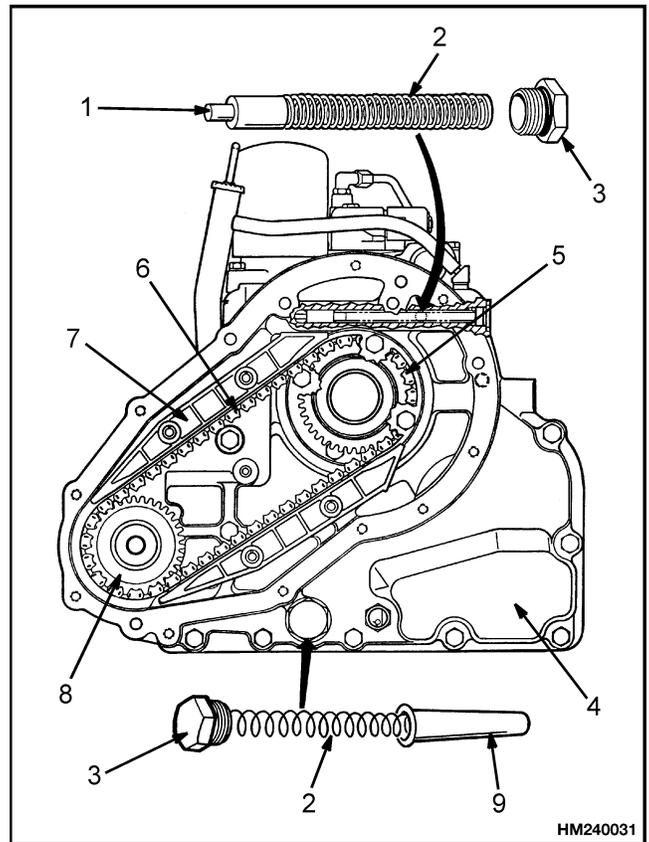
- |                          |                          |
|--------------------------|--------------------------|
| 1. INPUT (FORWARD) SHAFT | 5. PUMP SPROCKET         |
| 2. STATOR SUPPORT        | 6. TRANSMISSION PUMP     |
| 3. DRIVE SPROCKET        | 7. HYDRAULIC SYSTEM PUMP |
| 4. CHAIN                 |                          |

**Figure 8. Pump Drive Arrangement**



- |                |                   |
|----------------|-------------------|
| 1. FRONT COVER | 2. STATOR SUPPORT |
|----------------|-------------------|

**Figure 9. Stator Support**



- |                                       |                   |
|---------------------------------------|-------------------|
| 1. RELIEF VALVE FOR TRANSMISSION PUMP | 5. DRIVE SPROCKET |
| 2. SPRING                             | 6. CHAIN          |
| 3. PLUG                               | 7. CHAIN BLOCK    |
| 4. FRONT COVER                        | 8. PUMP SPROCKET  |
|                                       | 9. SCREEN         |

**Figure 10. Transmission Front Cover**



*Legend for Figure 11*

- |                    |                           |
|--------------------|---------------------------|
| 1. CLUTCH HOUSING  | 12. PRESSURE PLATE        |
| 2. CLUTCH PISTON   | 13. SNAP RING             |
| 3. PISTON SEAL     | 14. OUTPUT GEAR           |
| 4. SEAL RING       | 15. BALL BEARING          |
| 5. CLUTCH SPRING   | 16. THRUST WASHER         |
| 6. RETAINER SPRING | 17. THRUST NEEDLE BEARING |
| 7. SNAP RING       | 18. THRUST WASHER         |
| 8. BALL BEARING    | 19. SNAP RING             |
| 9. SEAL RING       | 20. THRUST WASHER         |
| 10. SEPARATOR DISC | 21. NEEDLE BEARINGS       |
| 11. FRICTION DISC  |                           |



*Legend for Figure 12*

- |                                   |                    |                           |
|-----------------------------------|--------------------|---------------------------|
| 1. INPUT (FORWARD) SHAFT ASSEMBLY | 6. SNAP RING       | 12. NEEDLE THRUST BEARING |
| 2. PISTON                         | 7. CONICAL PLATE   | 13. NEEDLE BEARING        |
| 3. SEAL RING                      | 8. SEPARATOR PLATE | 14. OUTPUT GEAR           |
| 4. SPRING                         | 9. FRICTION PLATE  | 15. WASHER                |
| 5. SPRING GUIDE                   | 10. PRESSURE PLATE | 16. BALL BEARING          |
|                                   | 11. THRUST WASHER  | 17. INPUT CLUTCH HOUSING  |

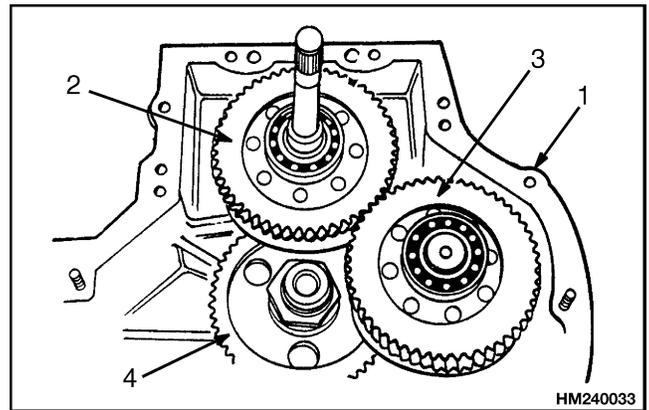
**REMOVE AND DISASSEMBLE**

The Input (forward) clutch assembly is shown in Figure 11 and Figure 12. The procedures are similar for removal and disassembly of the Counter (reverse) clutch assembly.

**NOTE:** Do not remove the output gear from the pinion shaft unless the differential must be repaired.

**STEP 1.**

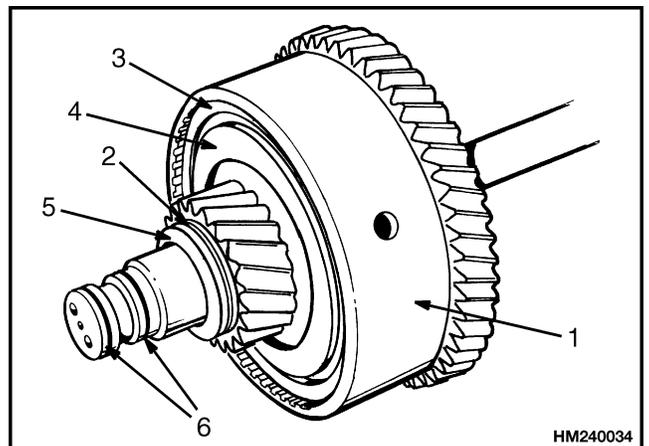
Remove the torque converter housing and front cover from the transmission housing. Pull the Input (forward) clutch assembly straight from the transmission housing. Remove the Counter (reverse) clutch assembly. Do not damage the seal rings on the end of the clutch shafts.



1. TRANSMISSION HOUSING
2. INPUT (FORWARD) CLUTCH ASSEMBLY
3. COUNTER (REVERSE) CLUTCH ASSEMBLY
4. OUTPUT GEAR

**STEP 2.**

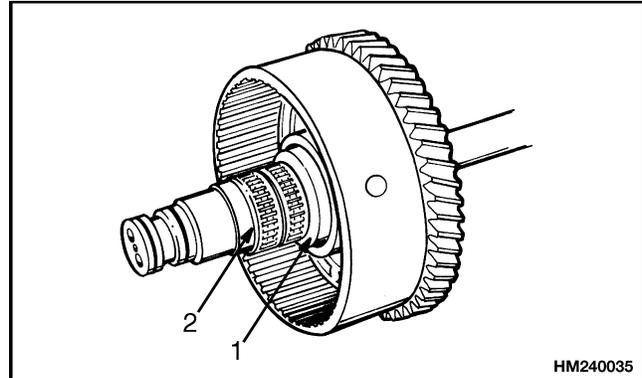
If the ball bearing did not stay in the transmission case, remove it from the clutch shaft. Remove the special thrust washer. Remove the snap ring, thrust washers, and thrust needle bearing. Remove the output gear from the clutch assembly. Remove the large snap ring, then remove the pressure plate. For lift truck without Exedy clutch assemblies, remove the friction discs and separator plates. For lift trucks with Exedy clutch assemblies, remove the conical plate, the friction discs and separator plates. See Figure 12.



1. OUTPUT GEAR
2. THRUST BEARING ASSEMBLY
3. SNAP RING
4. PRESSURE PLATE
5. SNAP RING
6. SEAL RINGS

**STEP 3.**

Remove the needle bearings from the shaft. Remove the other set of thrust washers and thrust needle bearing.



1. THRUST ASSEMBLY
2. NEEDLE BEARINGS

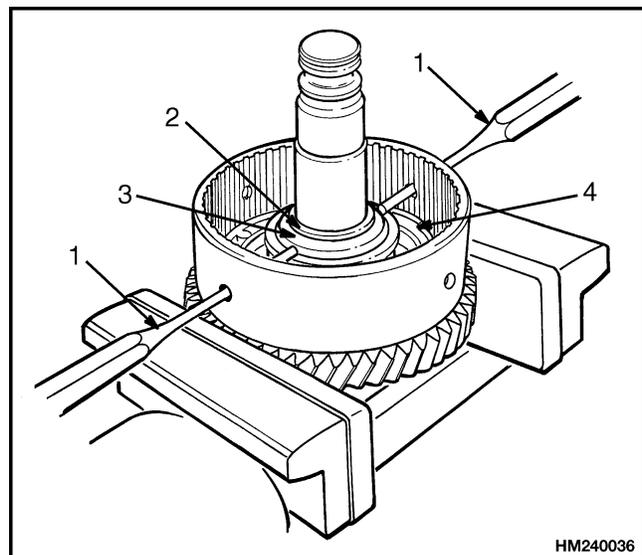
**WARNING**

The spring for the clutch is compressed. Make sure the spring and spring retainer cannot cause injury when the snap ring is removed.

**NOTE:** Some service people make a special bracket so that the spring and retainer can be compressed in a press to remove the snap ring.

**STEP 4.**

Remove the piston only if there is a problem with the piston or seals. Use two punches to push the spring retainer down. Remove the snap ring for the retainer. Remove the retainer, spring, and piston. Pull the piston from the clutch housing. Remove the seal from the circumference of the piston and the seal ring from the shaft.



1. PUNCH
2. SNAP RING
3. SPRING RETAINER
4. PISTON

**INSPECT**

1. Inspect the gears for the clutch assemblies and the differential gears for wear or damage.

2. Check all parts that have splines for damage to the splines. Check for notches worn in the splines.

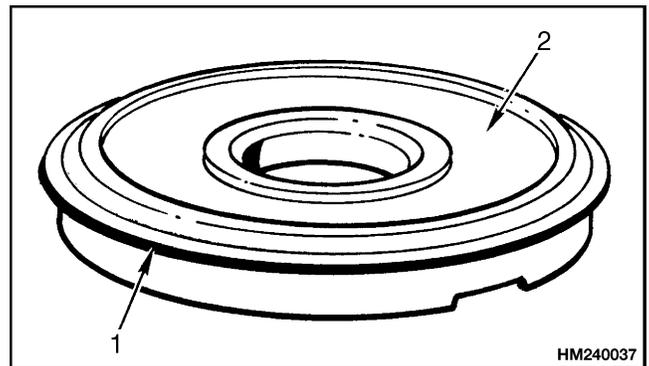
3. Inspect the friction discs for burned lining or bent surfaces. Check for small holes in the lining. Replace the friction discs if one-half the depth of the oil grooves is worn away or the discs are damaged. For lift truck without Exedy clutch assemblies, discard a friction disc that has a thickness less than 2.16 mm (0.085 in.) For lift truck models with Exedy clutch assemblies, discard a friction disc that has a thickness less than 2.50 mm (0.098 in.).
- NOTE:** Conical plates are only used on transmissions with Exedy clutch assemblies.
4. The conical and separator plates must not be bent, have damaged surfaces, or have large blue areas from too much heat.
5. Inspect the bearings for wear or damage.
6. Inspect the piston for damage. Make sure the sealing surfaces are good. Make sure the orifice is clean.
7. Check for grooves or other damage on the machined surfaces of the shaft. Check the seal rings for damage and wear. Check the seal ring surfaces in the housing for damage.

## ASSEMBLE

Assemble the Input (forward) clutch assembly as shown in the following steps.

### STEP 1.

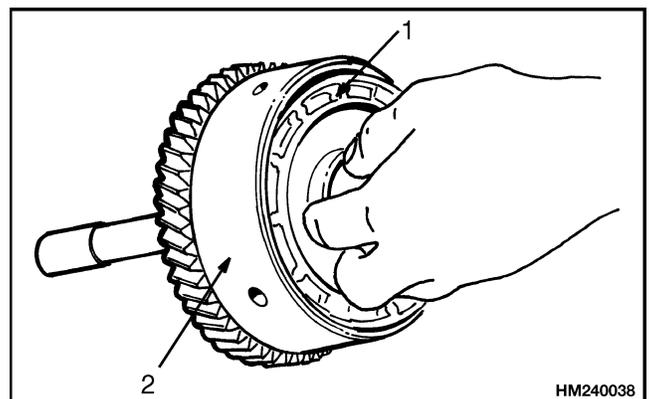
Lubricate all parts with transmission oil. Install the seal ring on the shaft and the seal in the piston. The lip of the seal must be toward the clutch housing.



1. PISTON SEAL
2. PISTON

### STEP 2.

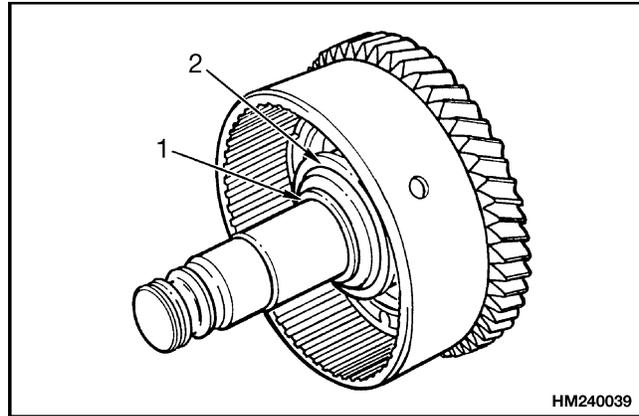
Put a strong rubber band on the piston seal to compress the lip of the piston seal for approximately 15 minutes. Remove the rubber band and quickly install piston in the clutch housing before the lip seal expands. Make sure the piston seal is not damaged during installation. A damaged piston seal will prevent the correct operation of the transmission and will require complete disassembly again for repairs.



1. PISTON
2. CLUTCH HOUSING

**STEP 3.**

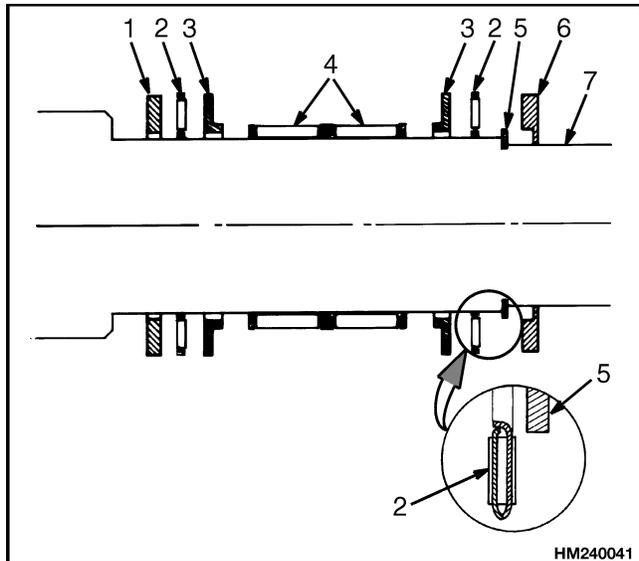
Install the spring and retainer in the clutch housing. Compress the spring so that the snap ring can be installed. Install the snap ring that holds the retainer on the shaft.



1. SNAP RING
2. SPRING RETAINER

**STEP 4.**

Install the thrust washer assembly on the clutch shaft, see the needle bearing arrangement illustrations in this step. Install the two sets of needle bearings for the hub on the shaft.

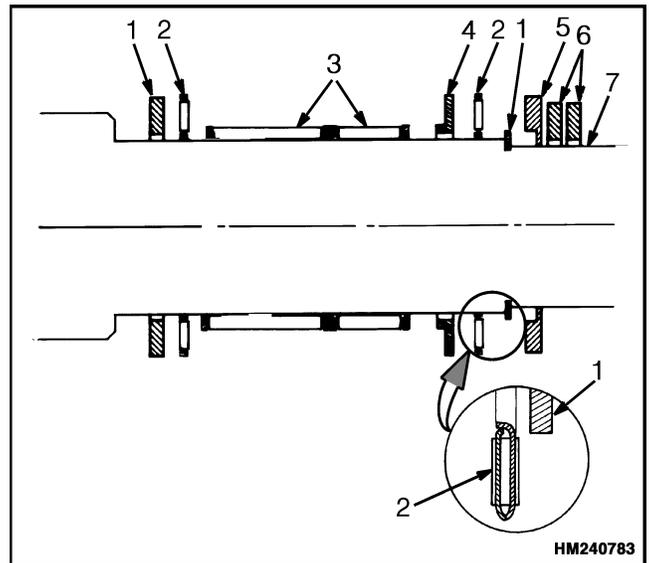


**NOTE:** Arrangement shown for lift trucks without Exedy clutch assemblies

1. THRUST WASHER
2. THRUST NEEDLE BEARING
3. THRUST WASHER\*
4. NEEDLE BEARINGS (OUTPUT GEAR)\*
5. SNAP RING
6. THRUST WASHER
7. CLUTCH SHAFT

\*ARRANGEMENT OF NEEDLE BEARINGS IN CLUTCH

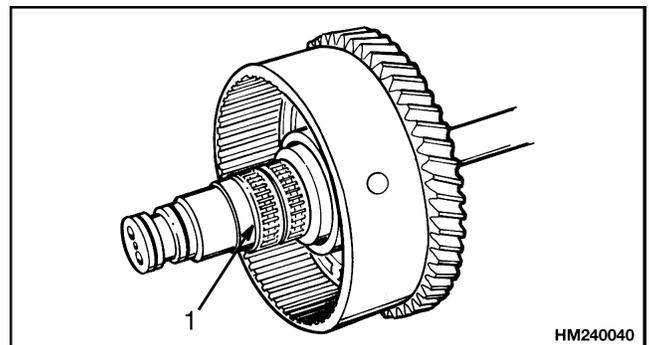
## STEP 4. (Continued)



**NOTE:** Arrangement shown for lift trucks with Exedy clutch assemblies

1. THRUST WASHER
2. THRUST NEEDLE BEARING
3. NEEDLE BEARING (OUTPUT GEAR)\*
4. SEAL
5. SNAP RING
6. SEAL RING
7. CLUTCH SHAFT

\*ARRANGEMENT OF NEEDLE BEARINGS IN CLUTCH



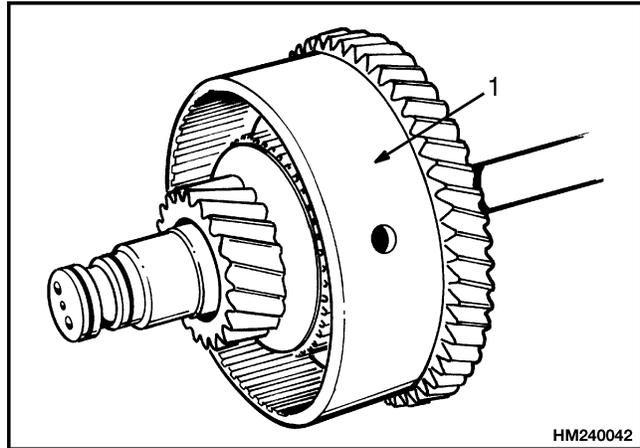
**NOTE:** Arrangement of needle bearings in clutch.

1. NEEDLE BEARINGS (OUTPUT GEAR)

**NOTE:** Make sure the orientation of the thrust needle bearing and the snap ring is the same as shown in the arrangement in STEP 4.

**STEP 5.**

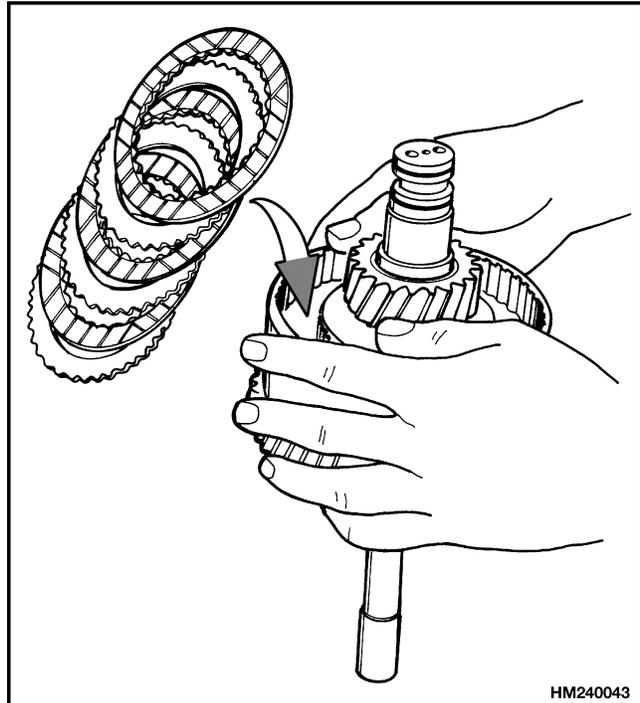
Install the output gear on the clutch shaft. Install the second thrust washer and thrust needle bearings (for lift trucks with Exedy clutch packs, there is only one thrust needle bearing). Install the snap ring. See the thrust washer and thrust bearing arrangement in STEP 4.



1. OUTPUT GEAR

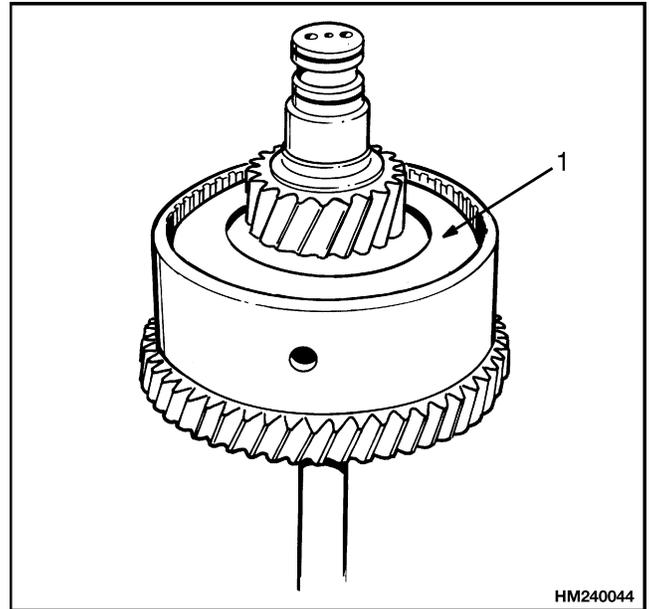
**STEP 6.**

For lift trucks with Exedy clutch assemblies, install the conical plate (see Figure 12). For all lift trucks, install the separator plates and friction discs. Begin with a separator plate against the piston and finish with a friction disc against the pressure plate.



**STEP 7.**

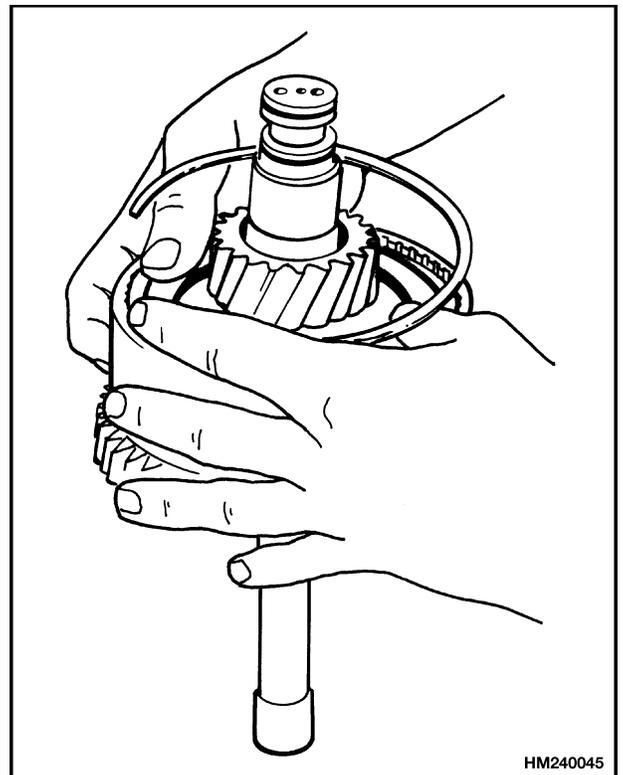
Install the pressure plate.



1. PRESSURE PLATE

**STEP 8.**

Install the snap ring. For lift truck models without Exedy clutch assemblies, after assembly is complete, there must be 0.64 to 2.74 mm (0.025 to 0.108 in.) clearance in the clutch assembly. For lift trucks with Exedy clutches, there must be 1.6 to 2.0 mm (0.063 to 0.079 in.) clearance in the clutch assembly. Put a straight edge across the clutch housing and measure the movement of the pressure plate in the clutch housing.



**STEP 9.**

Install the ball bearings on the end of the clutch shaft that goes into the front cover of the transmission. Install the seal rings on the shaft.

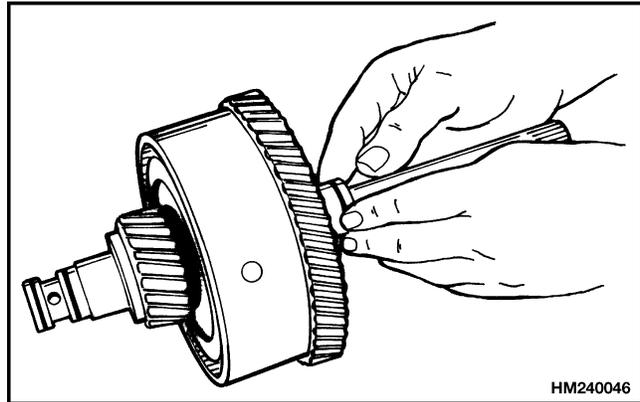
**STEP 10.**

Make sure the special thrust washer is installed after the snap ring as shown in STEP 4. Install the ball bearing in the transmission housing.

**STEP 11.**

For lift trucks without Exedy clutch assemblies, install the seal rings. The Input (forward) clutch has one seal ring on the input shaft and two seal rings on the output end of the clutch shaft. The Counter (reverse) clutch only has two seal rings on the output end of the clutch shaft.

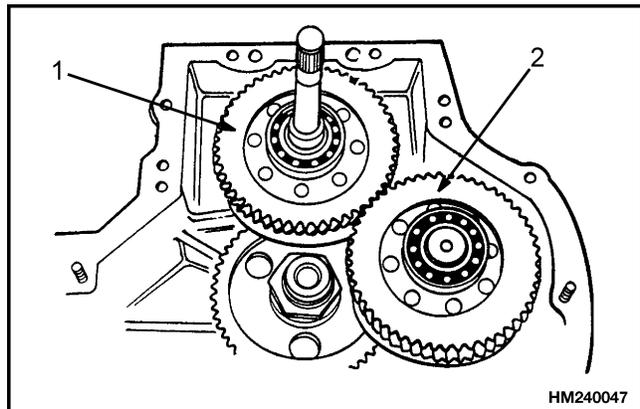
For lift trucks with Exedy clutch assemblies, install the seal rings. The Input (forward) clutch has one seal ring on both the input end and output end of the clutch shaft. The Counter (reverse) clutch only has one seal ring on the output end of the clutch shaft.

**STEP 12.**

Install the Input (forward) and Counter (reverse) clutch assemblies in the transmission housing. Make sure the seal rings are not damaged when the clutch shafts are installed in the transmission housing.

**STEP 13.**

Install the front cover, chain drive arrangement, and the torque converter housing as described in the sections Torque Converter and Housing Repair and Front Cover and Pump Drive Repair.



1. INPUT (FORWARD) CLUTCH ASSEMBLY
2. COUNTER (REVERSE) CLUTCH ASSEMBLY

**INSTALL**

1. Install the torque converter as described in the procedures for the Torque Converter and Housing Repair.
2. Install the transmission to the engine. Install the capscrews at the transmission housing.

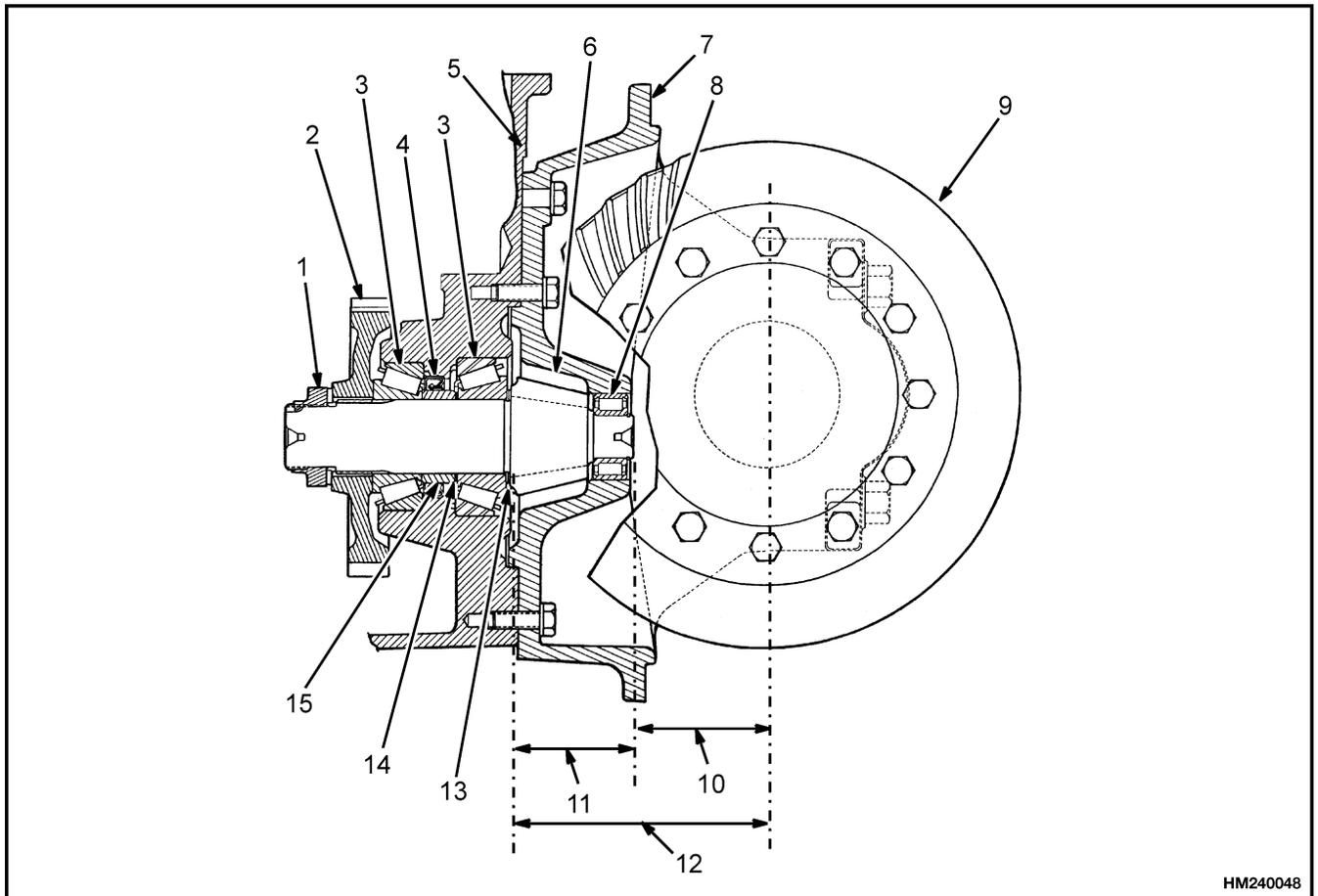
Tighten the M10 capscrews to 38 N•m (28 lbf ft) and the M12 capscrews to 66 N•m (49 lbf ft).

3. Install the engine and transmission as a unit as described in the **Frame** 100 SRM 505 section.

## Differential Repair

### REMOVE AND DISASSEMBLE

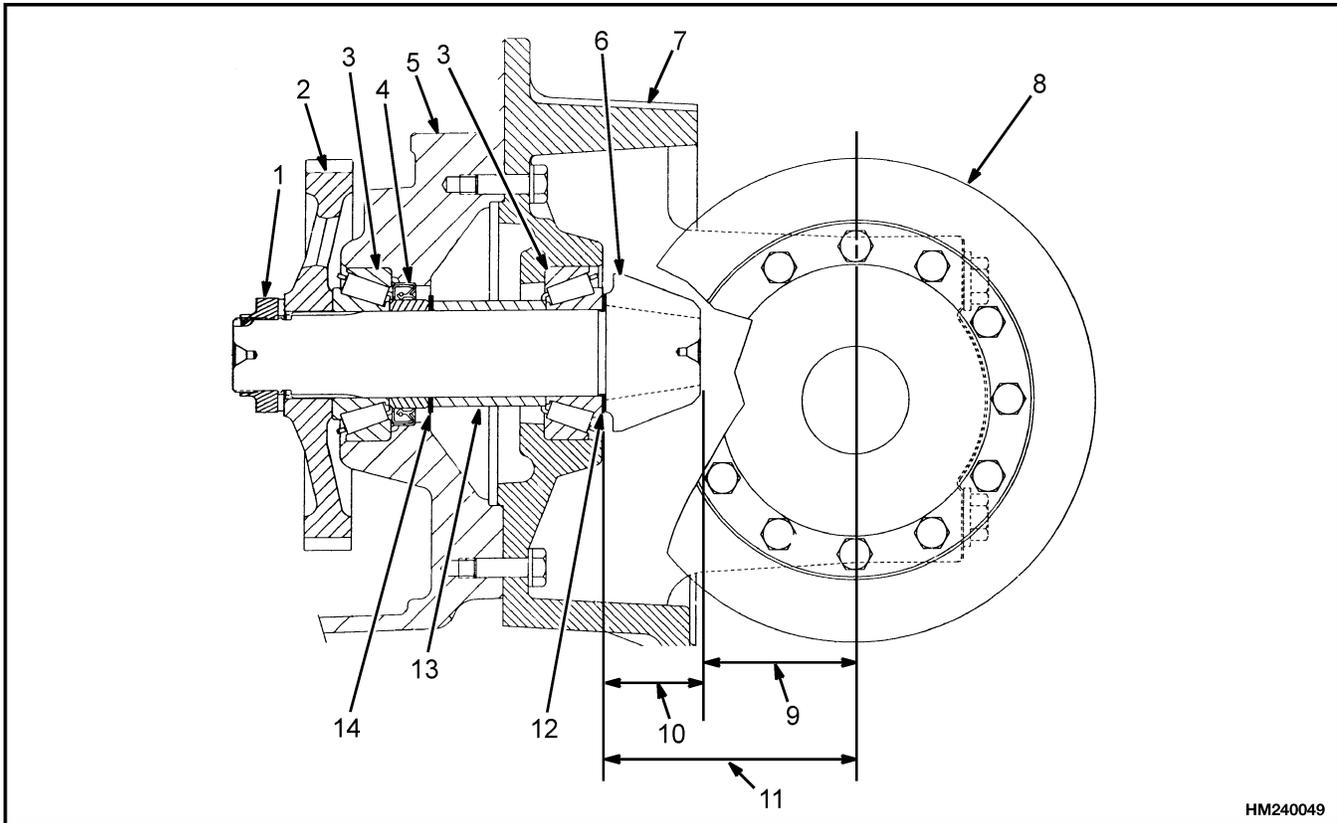
1. Disassemble only the parts of the differential that must be repaired. If the ring gear and pinion are not to be replaced, check the contact pattern before disassembly. The pattern and gear clearance are used as references for assembly. See the Assemble and Install section for the procedures.
2. Loosen the thrust bolt for the ring gear. See Figure 13 or Figure 14. Make a note of the positions of the adjustment nuts for the ring gear. Remove the bearing caps, adjustment nuts, and differential assembly.
3. Remove the differential housing from the transmission housing.
4. The nut for the output gear is held in position by a punchmark. The part of the nut with the punchmark must be removed before the nut can be removed. The nut is tightened to 750 N•m (553 lbf ft).



HM240048

- |                         |  |
|-------------------------|--|
| 1. PINION NUT           | 9. RING GEAR   |
| 2. OUTPUT GEAR          | 10. PINION DEPTH 81.0 mm (3.189 in.) PLUS OR MINUS VARIATION |
| 3. BEARING              | 11. 73.50 to 74.50 mm (2.894 to 2.933 in.)                   |
| 4. OIL SEAL             | 12. GAUGE DISTANCE = 155.0 mm (6.102 in.)                    |
| 5. TRANSMISSION HOUSING | 13. SHIMS FOR GAUGE DISTANCE                                 |
| 6. PINION               | 14. SHIMS FOR ROTATING TORQUE                                |
| 7. DIFFERENTIAL HOUSING | 15. SPACER   |
| 8. PILOT BEARING        |  |

**Figure 13. Ring Gear and Pinion Arrangement H2.00-3.20XM (H40-65XM)**



HM240049

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li>1. PINION NUT</li> <li>2. OUTPUT GEAR</li> <li>3. BEARING</li> <li>4. OIL SEAL</li> <li>5. TRANSMISSION HOUSING</li> <li>6. PINION</li> <li>7. DIFFERENTIAL HOUSING</li> <li>8. RING GEAR</li> </ul> | <ul style="list-style-type: none"> <li>9. PINION DEPTH 80.1 mm (3.154 in.) PLUS OR MINUS VARIATION</li> <li>10. 49.1 mm (1.933 in.)</li> <li>11. GAUGE DISTANCE = 129.20 mm (5.087 in.)</li> <li>12. SHIMS FOR GAUGE DISTANCE</li> <li>13. SPACER</li> <li>14. SHIMS FOR ROTATING TORQUE</li> </ul> |
|---|---|

**Figure 14. Ring Gear and Pinion Arrangement S2.00-3.20XM (S40-65XM)**

**NOTE:** Some service people make a special tool from a discarded gear to hold the output gear when the nut is being installed or removed from the pinion shaft.

- 5. Use a hammer and soft driver to remove the pinion from the output gear and the transmission housing. Make a note of the shim and spacer arrangement. If the pinion will not be replaced, the shim and spacer arrangement will be approximately the same when the differential is assembled again.
- 6. Remove the bearings, oil seal, shims, and spacer from the transmission housing.

- 7. Disassemble the differential as needed to make repairs. Remove the ring gear from the differential case. Remove the bolts from the differential halves and remove the spider gears and axle gears.

**INSPECT**

- 1. Check the pinion and ring gear for wear. Inspect the spider gears and axle gears for worn teeth. Inspect the cross for wear where the gears turn. The cross and the holes for the cross in the differential case must fit tightly.
- 2. Check all bearings for wear and damage. Replace a worn or damaged part.

## ASSEMBLE AND INSTALL

**NOTE:** If the ring gear and pinion are worn or damaged, they must be replaced as a set. Always check that the gears are a matched set. The location of the marks are shown in Figure 15.

**NOTE:** The pinion variation number is used to adjust the depth of the pinion in the carrier. This procedure is described in the following paragraphs. The pinion variation numbers can be indicated in hundredths of millimeters or thousandths of an inch. If the pinion cone variation number is indicated as examples  $+01$  or  $-02$ , the measurement is in millimeters. If the pinion cone variation number is indicated as examples  $+3$  or  $-5$ , the measurement is in inches. The pinion variation number is indicated on the end of the pinion. See Figure 15.

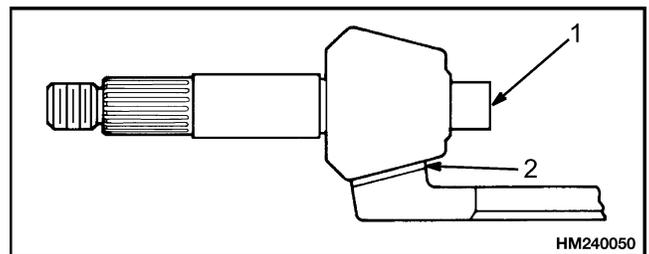
### 1. Install new ring and pinion assembly as follows:

- a. The pinion and ring gear are made in sets. Both the ring gear and pinion must have the same numbers. When pinion bearings are replaced or the ring gear and pinion are replaced, the shim arrangement must be adjusted for the new parts. Most service people do not have the equipment used by the manufacturer to find the shim arrangement before the differential is assembled. Service people must often make more than one adjustment before the clearances are correct. The differential must be disassembled for adjustment and assembled again for checks. The adjustments are correct when the gear clearance and the contact pattern between the pinion and ring gear are correct and the preload on the pinion bearings is correct.
- b. Look at the pinion variation number on the pinion that is being replaced.

The dimension on the end of the pinion is the variation from the standard Gauge Distance. The Gauge Distance is the distance from the center of the ring gear to the bearing shoulder on the back of the pinion. See Figure 13 or Figure 14. Shims must be added,

or removed from, between the pinion and the outer bearing to adjust for manufacturing tolerances.

- c. If it is necessary to measure the gauge distance, do the following: Measure the length of the pinion (distance from the end of the pinion to the bearing shoulder, Figure 13 or Figure 14). When the pinion is installed, measure the distance from the end of the pinion to the centerline of the bearing retainer, Figure 13. These two measurements must equal the gauge distance of 155 mm (6.10 in.). Add or remove shims. (Figure 13 or Figure 14) to obtain this dimension.
- d. Look at the number on the pinion that was removed. Subtract variation number that is on the new pinion. The remainder is the amount of shim thickness that must be adjusted from the shim set on the pinion that was removed. For examples, see Table 1. In examples 3 and 4, you can see that a negative number shows that shims must be removed. Examples 1 and 2 show that shims must be added to the original shim set. Use this shim set as a reference. The final adjustment of the shim set is according to the contact pattern on the ring gear teeth. See Table 2.



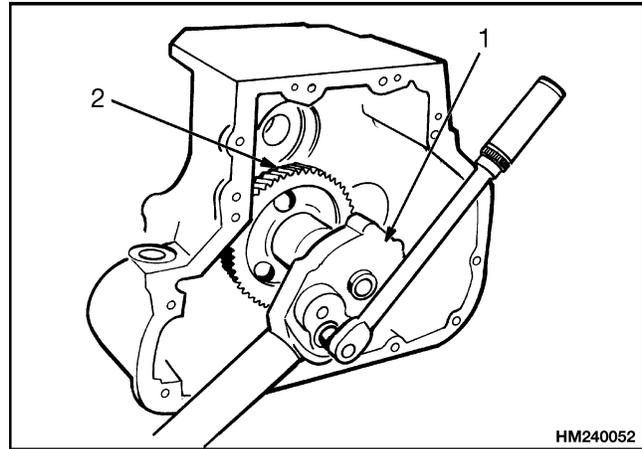
**NOTE:** H2.00-3.20XM (H40-65XM) SHOWN. S2.00-3.20XM (S40-65XM) SIMILAR.

1. MOUNTING DISTANCE AND VARIATION
2. GEAR CLEARANCE

**Figure 15. Identification for Gear Sets**

**Table 1. Adjustment of Shims for Pinion Assembly**

<b>EXAMPLES</b>	<b>1</b>	<b>2</b>
Number of OLD PINION minus the number on the NEW PINION	+0.31 -(+0.26)	+0.31 -(+0.26)
SHIMS to be REMOVED FROM or ADDED TO the OLD SET	+0.05 mm <b>Add</b>	+0.57 mm <b>Add</b>
<b>EXAMPLES</b>	<b>3</b>	<b>4</b>
Number on OLD PINION minus the number on the NEW PINION	+0.26 -(+0.31)	-0.26 -(+0.31)
SHIMS to be REMOVED FROM or ADDED TO the OLD SET	-0.05 mm <b>Remove</b>	-0.57 mm <b>Remove</b>



1. TORQUE WRENCH    2. OUTPUT GEAR

**Figure 16. Nut Installation**

**2. Install pinion assembly as follows:**

- a. If a new pinion or pilot bearing is being installed, use a press to install the pilot bearing. Install the snap ring.
- b. Install the shims on the pinion. Use a press to install the outer bearing cone. Install the shims and spacer on the pinion.
- c. Install a new oil seal in the transmission housing. Install the bearing cups in the transmission housing. Install the pinion in the transmission housing. Install the inner bearing cone on the pinion. Install the output gear.
- d. Install and tighten the pinion nut to 750 N•m (553 lbf ft). Measure the preload on the pinion bearings. The preload is correct when the rotating torque is 1.2 to 3.4 N•m (11 to 30 lbf in).
- e. Add or subtract shims to adjust the preload on the pinion bearings. When the adjustments are correct, tighten the nut to 750 N•m (553 lbf ft). See Figure 16. When all adjustments are complete, lock the nut in position. Use a punch to push the flange of the nut into the bottom of the groove in the shaft.

- f. Use an adhesive sealant and install the differential housing on the transmission housing. Tighten the capscrews to 38 N•m (28 lbf ft).

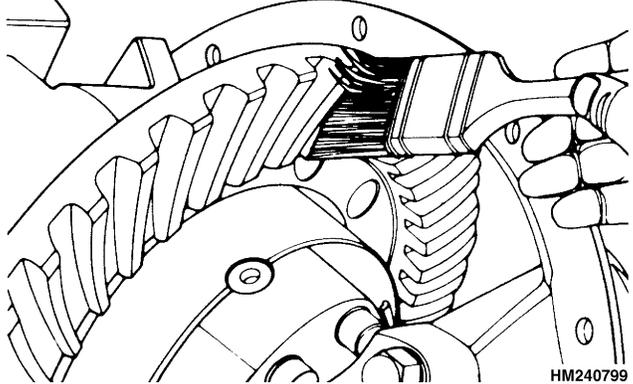
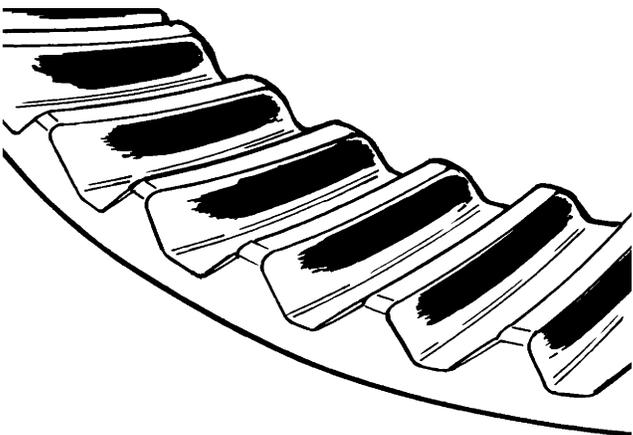
**3. Assemble differential and ring gear assembly as follows:**

- a. If the ring gear was removed from the differential case, put the ring gear in hot water that is 82 to 105°C (180 to 220°F) for approximately 10 minutes. Remove the ring gear from the water and put it on the differential case. See Figure 17. Do not use a press or a hammer to install the ring gear. Apply Loctite® 277 to the threads of the bolts. Tighten the bolts in a cross pattern. Tighten the bolts to 142 N•m (105 lbf ft) for H2.00-3.20XM (H40-65XM) units. Tighten the bolts to 111 N•m (82 lbf ft) for S2.00-3.20XM (S40-65XM) units.

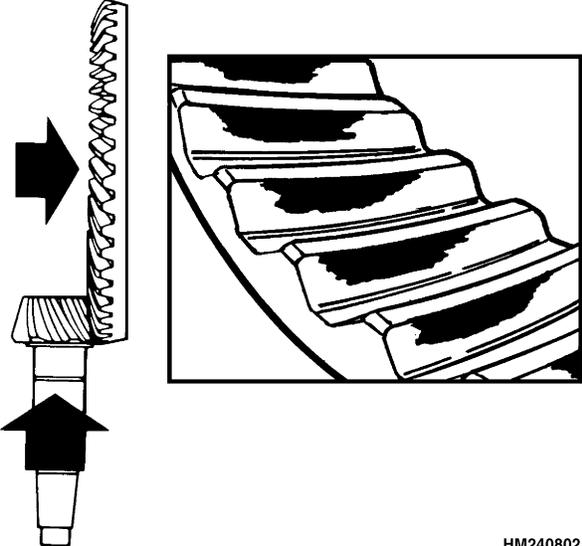
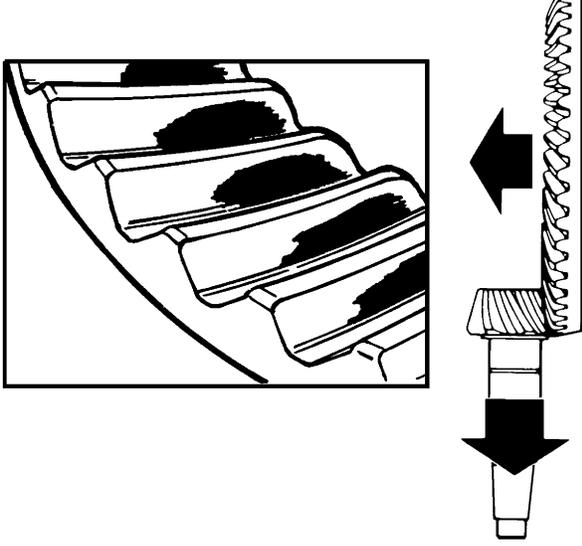
**NOTE:** Install bronze side of thrust washers facing the side gear.

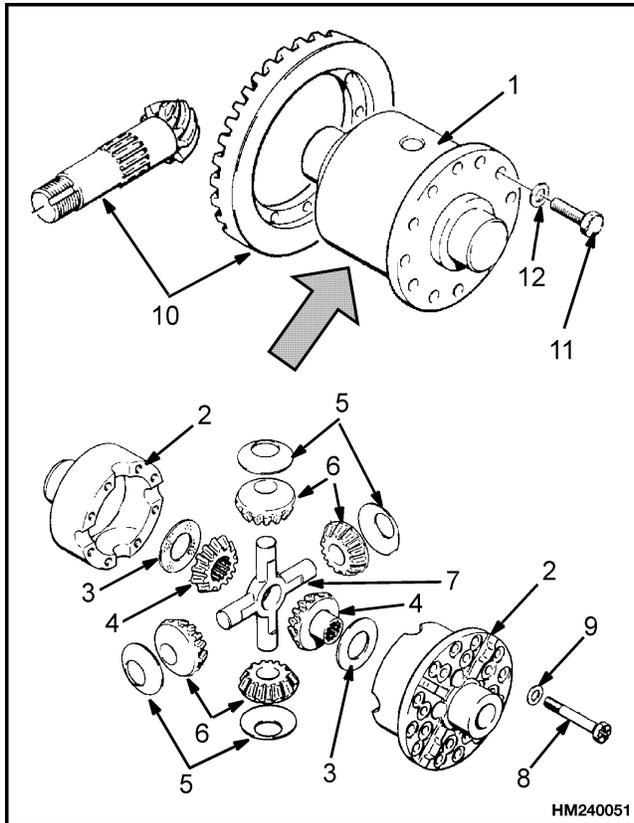
- b. Lubricate and install a side gear and thrust washer in the differential case as shown in Figure 18.
- c. Install the spider (cross), differential pinions, and thrust washers into the differential case as shown in Figure 19.
- d. Install the second side gear and thrust washer over the spider and differential pinions as shown in Figure 20.

**Table 2. Ring and Pinion Tooth Contact Adjustment**

<p>1. Apply a colored dye or grease to approximately 12 of the ring gear teeth.</p>	 <p style="text-align: right;">HM240799</p>
<p>2. Rotate ring gear forward and backward so that the 12 gear teeth go past the drive six times to get to the contact patterns. Repeat if needed to get a clearer pattern.</p>	
<p>3. Check the tooth contact pattern on the ring gear. Make sure that the pattern is checked on the side of the tooth where the pinion applies the force.</p>	
<p><b>Correct Tooth Contact</b></p>	
<p>The contact area is the center between the top and bottom of the tooth. The contact area is toward the inner circumference of the ring gear.</p>	<p><b>NOTE:</b> Normal pattern during adjustment shown.</p>  <p style="text-align: right;">HM240800</p>
<p>The contact area is the center between the top and the bottom of the tooth. The contact area will be almost the full length of the tooth.</p>	<p><b>NOTE:</b> Wear pattern from operation shown.</p>  <p style="text-align: right;">HM240801</p>

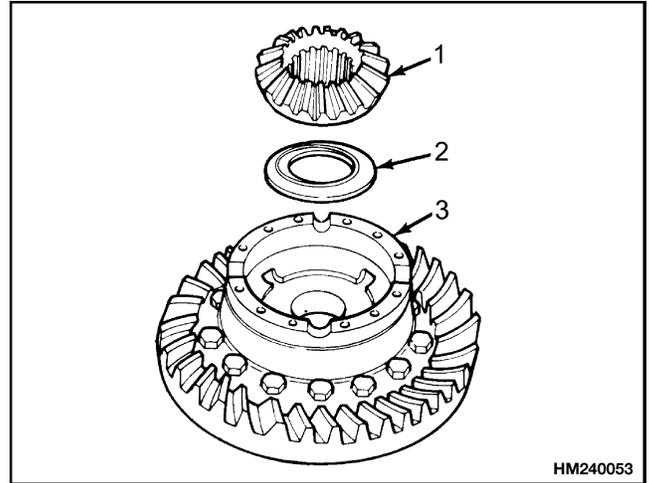
**Table 2. Ring and Pinion Tooth Contact Adjustment (Continued)**

<b>Incorrect Tooth Contact</b>	
<p>The pinion is too far away from the center of the gear. Add shims to move pinion toward ring gear. Check that the clearance is correct. Some movement of ring gear away from pinion may be necessary.</p>	 <p style="text-align: right;">HM240802</p>
<p>The pinion is too close to the center of the ring gear. Remove shims to move pinion away from the ring gear. Check that the clearance is correct. Some movement of the ring gear toward the pinion may be necessary.</p>	 <p style="text-align: right;">HM240879</p>



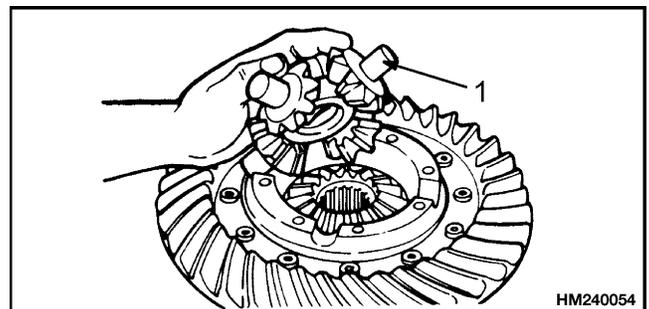
- |                           |                          |
|---------------------------|--------------------------|
| 1. DIFFERENTIAL ASSEMBLY  | 6. SPIDER GEAR (4)       |
| 2. CASE                   | 7. SPIDER (CROSS)        |
| 3. SIDE GEAR WASHER (2)   | 8. CAPSCREW (8)          |
| 4. DIFFERENTIAL SIDE GEAR | 9. WASHER (8)            |
| 5. THRUST WASHER (4)      | 10. RING GEAR AND PINION |
|                           | 11. BOLT (12)            |
|                           | 12. HARDENED WASHER (12) |

**Figure 17. Differential Assembly**



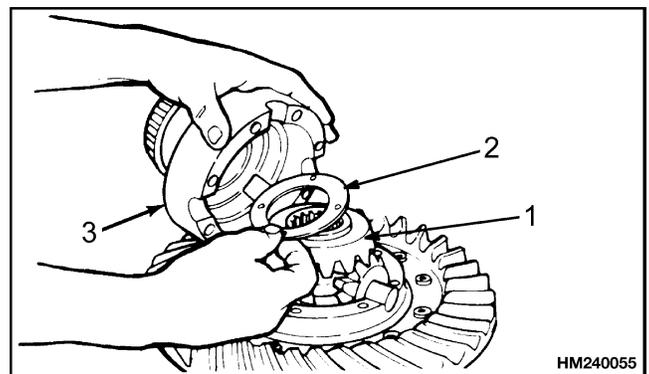
- |                  |                      |
|------------------|----------------------|
| 1. SIDE GEAR     | 3. DIFFERENTIAL CASE |
| 2. THRUST WASHER |                      |

**Figure 18. Thrust Washer and Side Gear Installation**



- |   |
|---|
| 1. SPIDER, DIFFERENTIAL PINIONS, AND THRUST WASHERS |
|---|

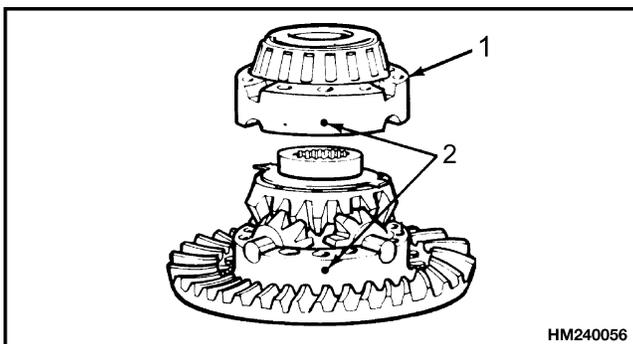
**Figure 19. Spider (Cross), Differential Pinions, and Thrust Washers Installation**



- |                  |                      |
|------------------|----------------------|
| 1. SIDE GEAR     | 3. DIFFERENTIAL CASE |
| 2. THRUST WASHER |                      |

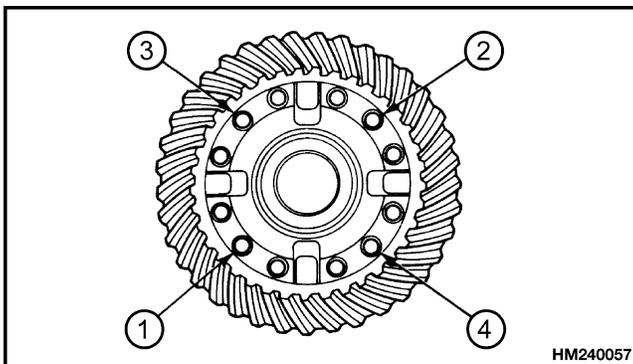
**Figure 20. Second Side Gear and Thrust Washer Installation**

- e. Put the second half of the differential case over the first half and the gears as shown in Figure 21. Make sure the marks are aligned.
- f. Install four capscrews in a cross pattern as shown in Figure 22. Tighten the capscrews to 71 N•m (52 lbf ft) for H2.00-3.20XM (H40-65XM) units. Tighten the capscrews to 50 N•m (37 lbf ft) for S2.00-3.20XM (S40-65XM) units. Install the remainder of the capscrews and tighten them in a cross pattern.
- g. Install the bearing cones on the differential case. See Figure 23.

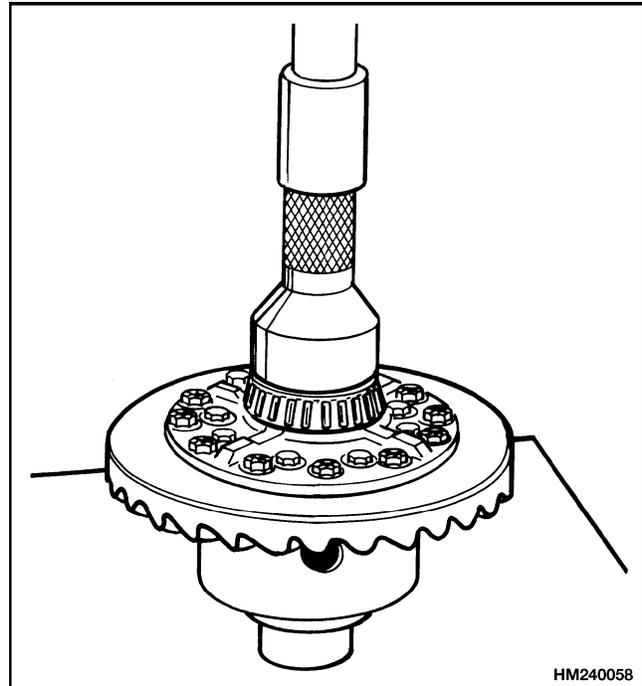


- 1. DIFFERENTIAL CASE
- 2. ALIGNMENT MARKS

**Figure 21. Second Half of Differential Case Installation**

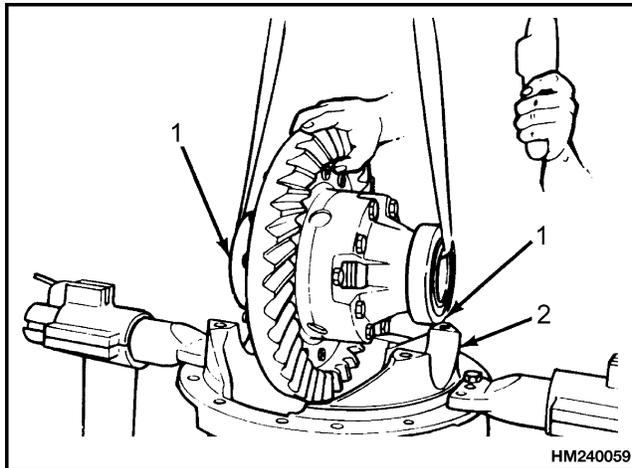


**Figure 22. Tighten Capscrews in Cross Pattern**



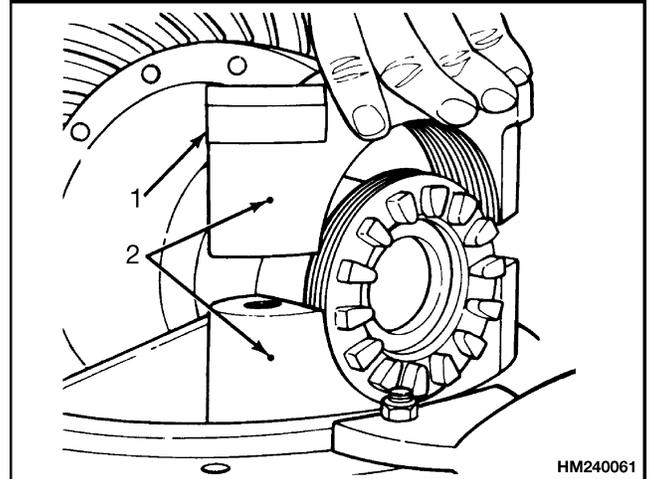
**Figure 23. Bearing Cones Installation**

- h. Apply axle lubricant on the inner diameter of the bearing cups and on both bearing cones that are installed on the differential. Do not permit lubricant on the outer diameter of the bearing cups or the bearing bores of the differential housing.
- i. Install the differential assembly into the differential housing. See Figure 24. The bearing cups must fit correctly into the bores of the housing.
- j. Install the two bearing adjustment nuts into position in the housing bores. See Figure 25. Use your hand to tighten each adjusting ring against the bearing cup.
- k. Align the marks on the bearing caps with the marks on the housing. See Figure 26. Only tighten the capscrews for the bearing caps so that the adjustment nuts can be installed, held in alignment, and rotated for adjustment.



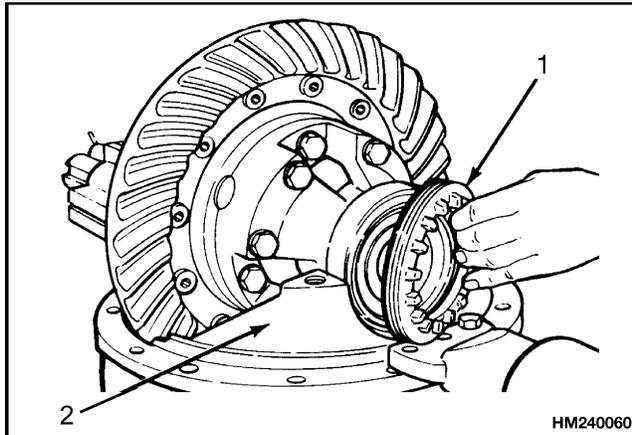
1. BEARING CUP      2. HOUSING

**Figure 24. Differential Assembly Into Housing Installation**



1. BEARING CAP      2. ALIGNMENT MARKS

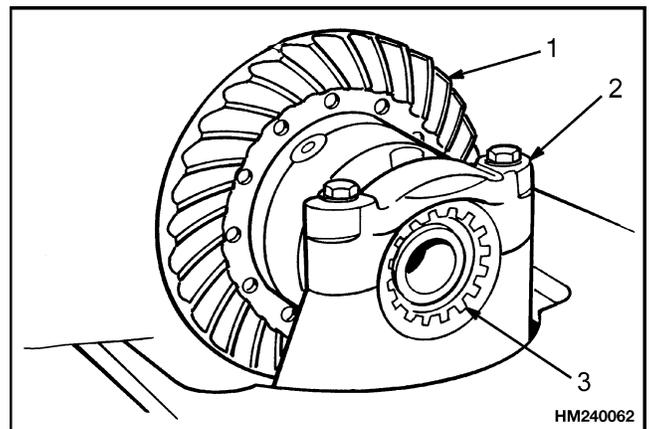
**Figure 26. Bearing Caps Installation**



1. ADJUSTMENT NUT      2. HOUSING

**Figure 25. Adjustment Nuts Installation**

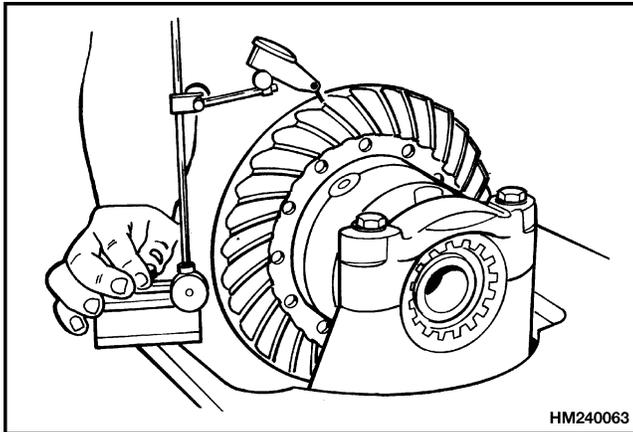
1. Tighten the adjustment nuts to 14 N•m (10 lbf ft) to remove the clearance between the adjustment nuts and the bearings. See Figure 27. Make sure there is clearance between the ring gear and pinion. Loosen the adjustment nut only until there is zero clearance between the bearings and the adjustment nuts. Tighten one adjustment nut four notches more than zero clearance to put a preload on the bearings.



1. RING GEAR      3. ADJUSTMENT NUT  
2. BEARING CAP

**Figure 27. Bearing Caps and Adjustment Nuts Installation**

- m. Check the clearance between the ring gear and pinion. The ring gear and pinion must have a clearance of 0.20 to 0.28 mm (0.008 to 0.011 in.). See Figure 28. Move the ring gear toward the pinion to decrease the clearance. Move the ring gear away from the pinion to increase the clearance.



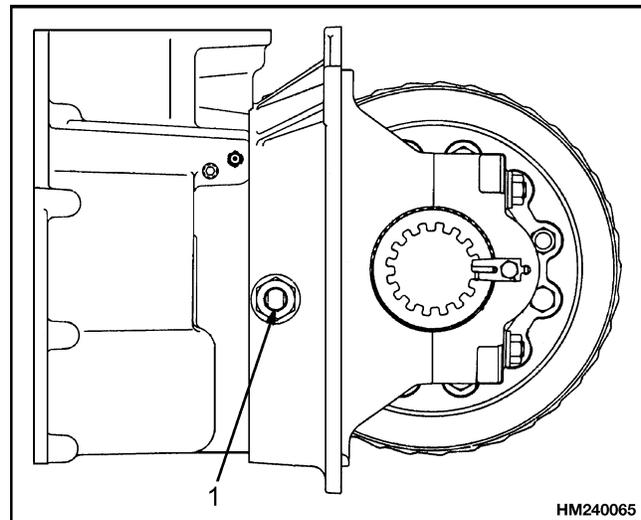
**Figure 28. Clearance Check Between Ring Gear and Pinion**

- n. Loosen one adjustment nut the same amount as the other adjustment nut is tightened to adjust the clearance between the ring gear and pinion. When the clearance is correct, tighten the capscrews for the bearing caps to 175 N•m (129 lbf ft) for H2.00-3.20XM (H40-65XM) units. For S2.00-3.20XM (S40-60XM) units, tighten the capscrews for the bearing caps to 110 N•m (81 lbf ft).
- o. Check the pattern on the teeth of the ring gear by applying grease to the teeth. Put a pry bar between the ring gear and the housing to keep the ring gear from turning freely. Turn the pinion shaft. Compare the pattern on the ring gear teeth with the patterns shown in Ring and Pinion Tooth Contact Adjustment. Adjust the gear clearances as necessary. An adjustment of the pinion to move the contact pattern also normally requires an adjustment of the ring gear clearance as described in Step m.

- p. Install the retainers for the adjustment nuts. Tighten the capscrews for the retainers to 19 N•m (14 lbf ft).

**NOTE:** If adjustment of the thrust bolt (Figure 29) is required when the differential is installed, turn the thrust bolt clockwise until it contacts the ring gear. Then loosen the thrust bolt counterclockwise 1/6 of a turn. Tighten the lock nut to 68 to 95 N•m (50 to 72 lbf ft).

- q. Install the thrust bolt. See Figure 29. Tighten the thrust bolt until it touches the ring gear. Loosen the bolt until there is 0.25 to 0.38 mm (0.010 to 0.015 in.) clearance between the bolt and the ring gear. Tighten the lock nut to 68 to 95 N•m (50 to 72 lbf ft).



**NOTE:** H2.00-3.20XM (H40-65XM) SHOWN. S2.00-3.20XM (S40-65XM) SIMILAR.

- 1. THRUST BOLT

**Figure 29. Thrust Bolt Adjustment**

## Control Valve Repair

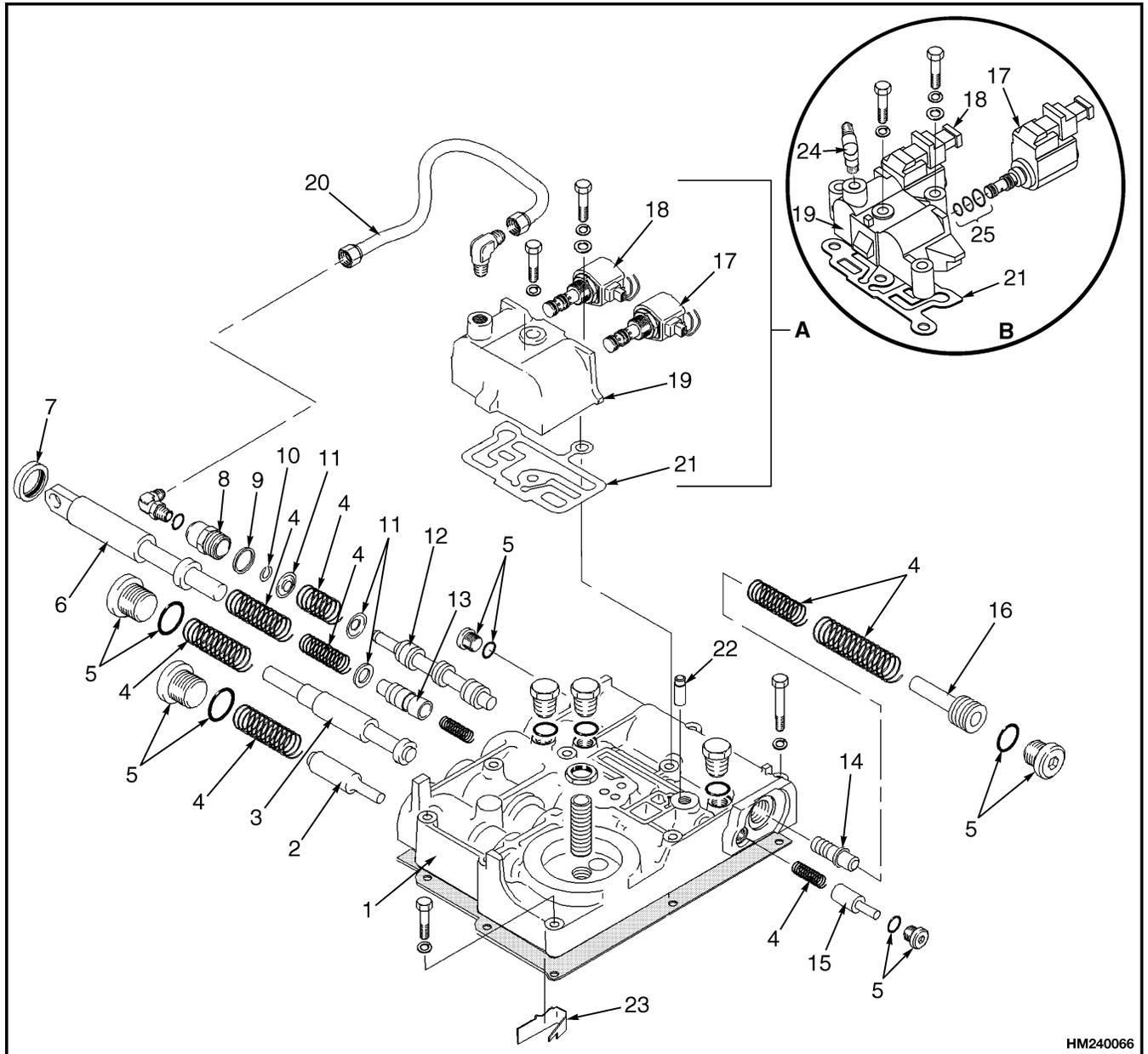
### REMOVE AND DISASSEMBLE

Clean the area around the control valve. Remove the transmission filter.

1. Disconnect the inching linkage at the control valve. See Figure 30 and Figure 31. Disconnect

the wires from the solenoids. Remove the manifold from the control valve. Remove the tube for the direction spool.

2. Remove the capscrews that hold the control valve to the transmission. Remove the control valve. Put a cover on top of the transmission to keep dirt from getting inside of transmission.



HM240066

**A. OLD STYLE MANIFOLD VALVE ASSEMBLY**

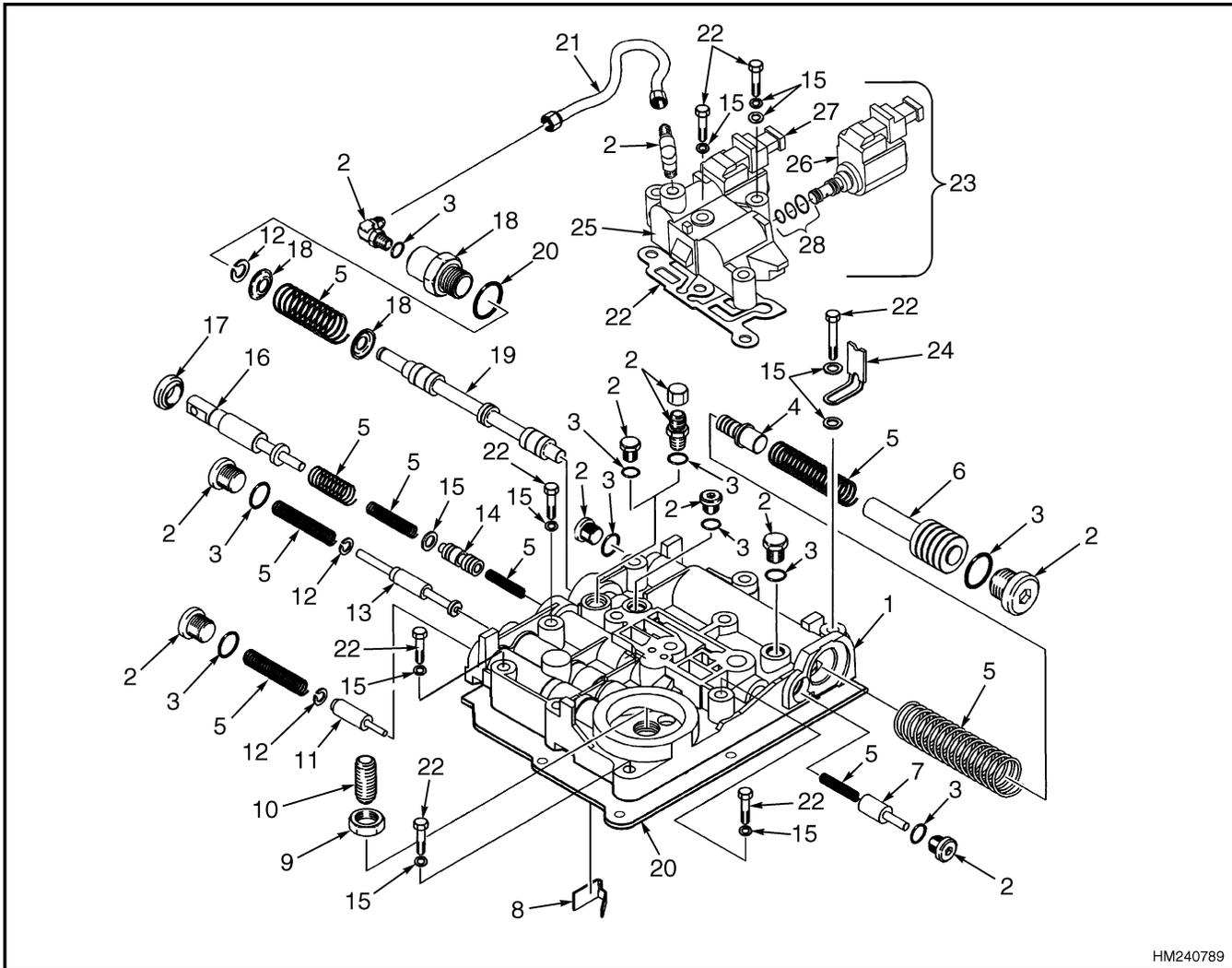
**B. NEW STYLE MANIFOLD VALVE ASSEMBLY**

- 1. VALVE BODY
- 2. PRESSURE REGULATOR, TORQUE CONVERTER
- 3. PRESSURE REGULATOR, CLUTCH
- 4. SPRING
- 5. PLUG AND O-RING
- 6. INCHING SPOOL PLUNGER
- 7. OIL SEAL

- 8. FITTING
- 9. COPPER GASKET
- 10. SNAP RING
- 11. SPRING CAP
- 12. DIRECTION SPOOL
- 13. INCHING SPOOL
- 14. MODULATOR REGULATOR
- 15. QUICK-DUMP VALVE
- 16. MODULATOR PISTON

- 17. FORWARD SOLENOID
- 18. REVERSE SOLENOID
- 19. MANIFOLD
- 20. TUBE
- 21. GASKET
- 22. PIN
- 23. STOP FOR INCHING SPOOL
- 24. FITTING
- 25. SEAL RINGS

**Figure 30. Control Valve (Older Lift Truck Models)**



HM240789

- |                          |                               |
|--------------------------|-------------------------------|
| 1. CONTROL VALVE BODY    | 15. WASHER                    |
| 2. FITTING               | 16. PLUNGER                   |
| 3. O-RING                | 17. OIL SEAL                  |
| 4. TRIMMER SPOOL         | 18. CAP                       |
| 5. SPRING                | 19. FORWARD AND REVERSE SPOOL |
| 6. ACCUMULATOR SPOOL     | 20. GASKET                    |
| 7. DUMP SPOOL            | 21. TUBE                      |
| 8. INCHING STOP          | 22. CAPSCREW                  |
| 9. NUT                   | 23. MANIFOLD VALVE ASSEMBLY   |
| 10. NIPPLE               | 24. STRAP                     |
| 11. REGULATOR SPOOL      | 25. MANIFOLD VALVE            |
| 12. SNAP RING            | 26. REVERSE SOLENOID          |
| 13. PACK REGULATOR SPOOL | 27. FORWARD SOLENOID          |
| 14. INCHING SPOOL        | 28. SEAL RING                 |

**Figure 31. Control Valve (Newer Lift Truck Models)**

3. Remove the solenoids from the manifold.



### WARNING

**There are compressed springs under the plugs in the control valve. Carefully remove the plugs so that the compressed springs do not cause injury.**

4. Remove the cap for the direction spool. Remove the direction spool.
5. Remove the clip used for the stop from under the inching spool. Remove the inching spool plunger and spring. Push the inching spool against its spring and remove the retainer washer from the bottom of the control valve.
6. Carefully remove the plug for the modulator piston. Remove the modulator piston, springs, and modulator regulator.
7. Carefully remove the plug for the clutch pressure regulator. Remove the spool and the spring.
8. Carefully remove the plug for the pressure regulator for the torque converter. Remove the spring and spool.
9. Carefully remove the plug for the modulator valve. Remove the spool and spring.

### INSPECT

1. Make sure there are no scratches or damage on the spools or in the bores.
2. Check that the springs are not bent or damaged.
3. Make sure the spools move freely in their bores.
4. Make sure the orifice in the modulator valve and the orifice in the valve body at the clutch pressure regulator are clean.

### ASSEMBLE AND INSTALL

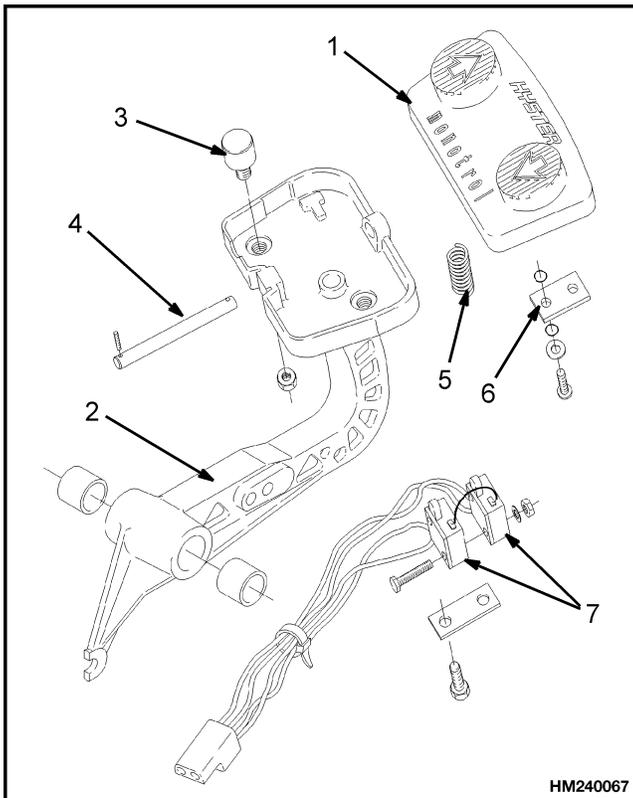
Lubricate the parts of the control valve with clean transmission oil during assembly.

1. Install the spool and spring for the pressure regulator for the torque converter. See Figure 30 and Figure 31. Install the plug with a new O-ring.
2. Install the spool and spring for the clutch pressure regulator. Install the plug with a new O-ring.
3. Install the modulator regulator and springs. Install the small plug for the modulator regulator. Install the modulator piston and install the large plug with a new O-ring.
4. Install the spring and modulator valve. Install the plug.
5. Install a new oil seal. Install the spring, inching spool, and washer. Install the two springs and the inching plunger. Install the clip used for the inching plunger stop.
6. Install the centering spring, spring caps, and snap ring on the direction spool. Install the direction spool in the bore. Install the fitting and copper washer for the direction spool.
7. Use new O-rings and install the solenoids in the manifold.
8. Install the control valve on the transmission. Install the gasket and manifold. Tighten the capscrews for the control valve and manifold to 19 N•m (14 lbf ft) torque. Make sure the ground wires for the solenoids are installed with the capscrew for the manifold.
9. Connect the tube assembly to the direction spool fitting.

## MONOTROL® Pedal Repair

### REMOVE AND DISASSEMBLE

1. Disconnect the wires at the transmission. Remove the capscrew that holds the pedal to the bracket, then remove the pedal. See Figure 32.



- |                |                 |
|----------------|-----------------|
| 1. PEDAL PAD   | 5. SPRING       |
| 2. PEDAL FRAME | 6. MAGNET PLATE |
| 3. MAGNET      | 7. SWITCH       |
| 4. PIVOT SHAFT |                 |

**Figure 32. MONOTROL Pedal**

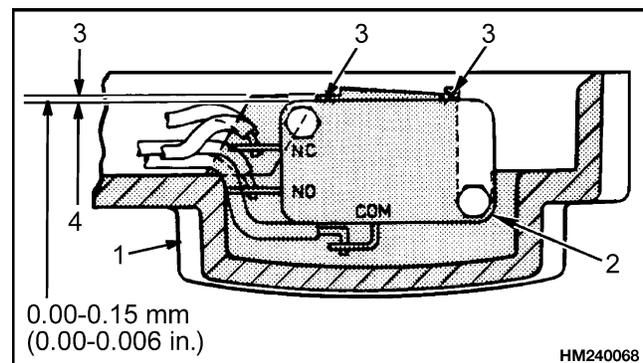
2. Remove the straps that hold the wires to the pedal. Loosen the setscrews in the pedal pad three to four turns and remove the pivot pin. Remove the pedal pad and spring.
3. Remove the retainer for the wires. Loosen the screws for the switches, then remove the switches and wires.

4. If necessary, remove the lock nuts for the magnets, then remove the magnets from the pedal frame. Make sure the screws are tight in the magnets. Use a thread-locking compound on the screws if they are loose in the magnets.

### ASSEMBLE AND INSTALL

**NOTE:** These sealed switches can only be repaired as an assembly.

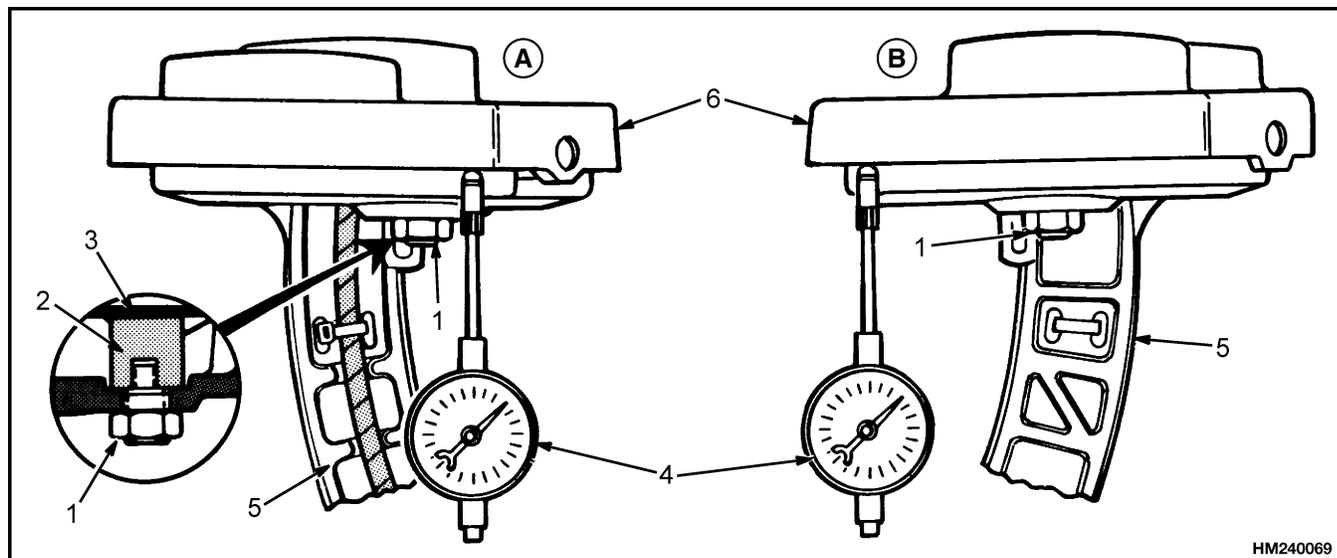
1. Install the switches and wires in the pedal pad. See Figure 32. Align the surface of the switches with the machined surface of the mount in the pedal pad. The switches must be even with or below the alignment surface as shown in Figure 33. Install the retainer for the wires.
2. Put the wires through the hole in the pedal frame. Install the spring and pedal pad on the pedal frame. Install the pivot pin. Apply a thread-locking compound to the setscrews. Install and tighten the setscrews. Use straps to hold the wires to the pedal frame.



- |                      |
|----------------------|
| 1. PEDAL PAD         |
| 2. SWITCH            |
| 3. SURFACE OF MOUNT  |
| 4. SURFACE OF SWITCH |

**Figure 33. MONOTROL Pedal Switches**

3. Do the following procedure to check and adjust the pedal assembly (see Figure 34):
  - a. Put the pedal assembly in a vise. Use a dial indicator to measure the movement of the pedal pad.

**A. FORWARD**

1. LOCK NUT
2. MAGNET
3. PLATE

**B. REVERSE**

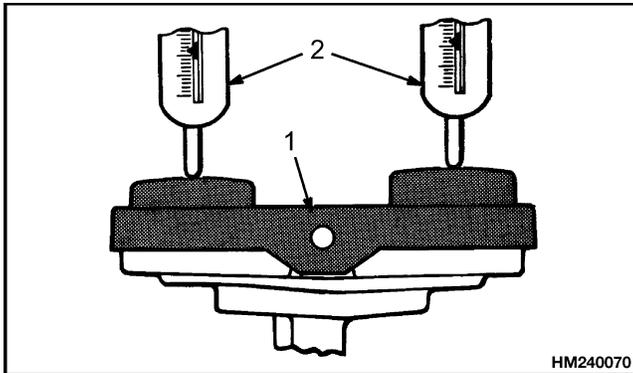
4. DIAL INDICATOR
5. PEDAL FRAME
6. PEDAL PAD

**Figure 34. MONOTROL Pedal Adjustment**

- b.** Push the reverse side of the pedal. Put the dial indicator on the reverse side of the pedal pad as shown. Loosen the lock nut and rotate the screw for the magnet counterclockwise until it stops. Set the dial indicator to zero. Rotate the screw for the magnet clockwise until the gauge needle moves 0.25 mm (0.01 in.) from zero. This adjustment makes sure the magnet is in contact with the plate in the pedal pad. Rotate the screw for the magnet counterclockwise until the gauge needle indicates zero. Rotate the screw for the magnet clockwise until the gauge needle indicates 0.05 mm (0.002 in.) movement. Tighten the lock nut to 5.2 N•m (46 lbf in) without changing the adjustment.
- c.** Push on the forward side of the pedal. Put the dial indicator on the forward side of the pedal pad as shown. Loosen the lock nut and rotate the screw for the magnet counterclockwise until it stops. Set the dial indicator to zero. Rotate the screw for the magnet clockwise until the gauge needle moves 0.25 mm (0.01 in.) from zero. This adjustment makes sure the magnet is in contact
- with the plate in the pedal pad. Rotate the screw for the magnet counterclockwise until the gauge needle indicates zero. Rotate the screw for the magnet clockwise until the gauge needle indicates 0.05 mm (0.002 in.) movement. Tighten the lock nut to 5.2 N•m (46 lbf in) without changing the adjustment.
- d.** Use an ohmmeter to check the operation of the switches. When the forward side of the pedal is depressed, there must be a complete circuit between the red (battery) and black (forward solenoid) wires. When the reverse side of the pedal is depressed, there must be a complete circuit between the red (battery) and yellow (reverse solenoid) wires.
- e.** Push on the forward side of the pedal. Put the dial indicator on the forward side of the pedal pad as shown. Connect an ohmmeter between the red and black wires. Check that there is a complete circuit between the wires. Push on the reverse side of the pedal. The pedal must move 1.00 mm (0.039 in.) minimum from the forward position before the circuit is disconnected.

**NOTE:** It is important for the correct operation of the MONOTROL pedal that the magnets have the correct strength.

4. Test the strength of the magnets as follows (see Figure 35):
  - a. Put the pedal assembly in a vise. Use a spring scale to change the pedal from the forward and reverse positions as shown in Figure 35.

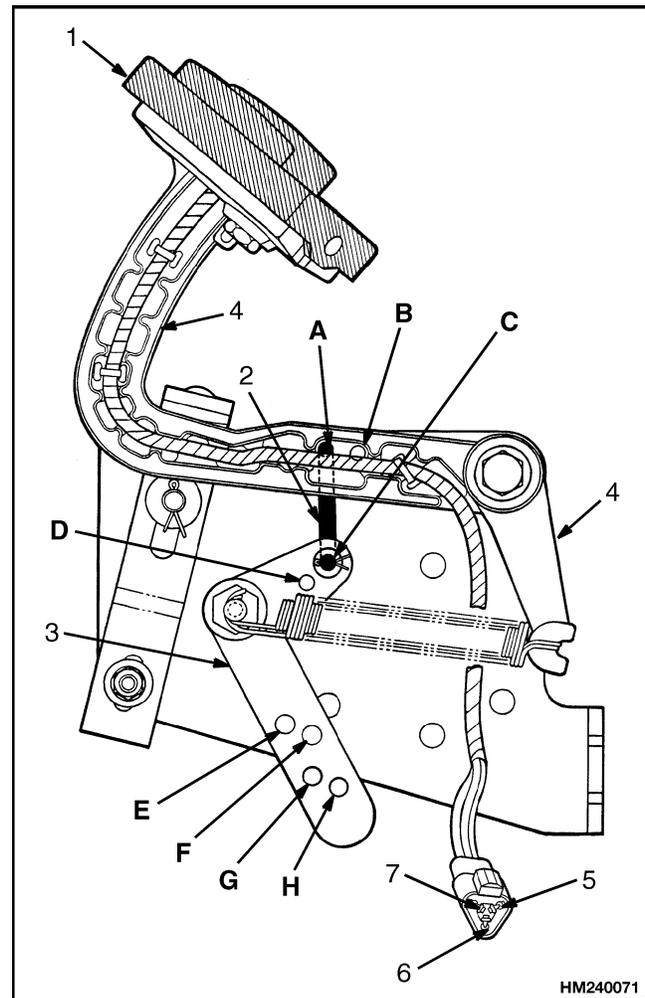


1. PEDAL PAD                      2. SPRING SCALE

**Figure 35. Magnets Check for MONOTROL Pedal**

- b. When pushing on the spring scale, it must take 13.3 to 31.1 N (3.0 to 7.0 lbf ft) to change from forward to reverse and reverse to forward positions. If the force is not within the specifications, replace the magnet(s).
5. With the pad located in either forward or reverse, check to ensure a minimum of 2.0 mm (0.079 in.) total pad travel when changed to the opposite position. If 2.0 mm (0.079 in.) is not obtained, do the adjustment again. If 2.0 mm (0.079 in.) is still not obtained, replace the pedal pad.
6. Install the capscrew, washers, tube, and nut that hold the pedal assembly to the bracket. Connect the link between the pedal and the crank as shown in Figure 36 or Figure 37.

7. Install the pedal return springs. Make sure the throttle cable is connected to the correct position as shown in Figure 36 or Figure 37.



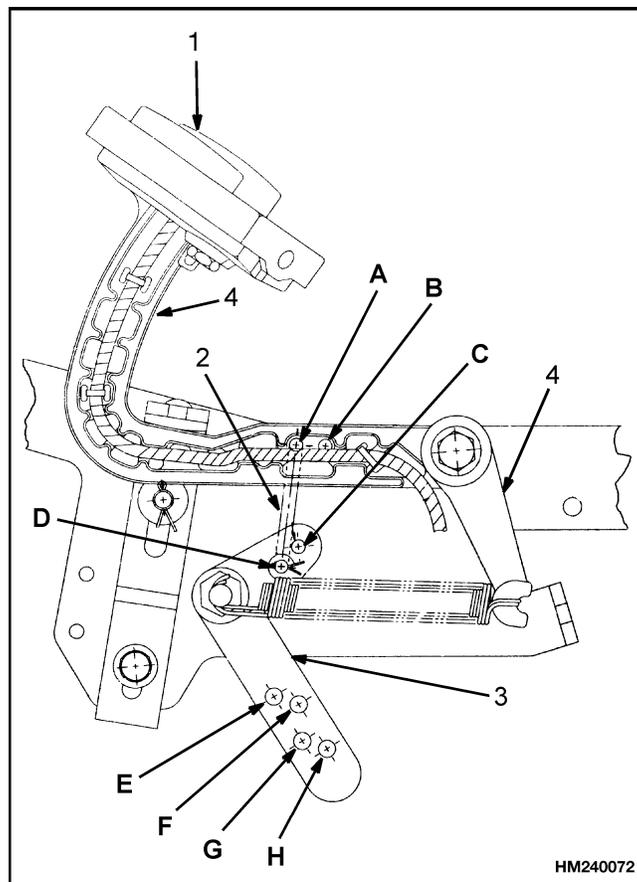
**Figure 36. MONOTROL Pedal H2.00-3.20XM (H40-65XM)**

**Legend for Figure 36**

- A. MAZDA M4-2.0G (GASOLINE & LPG)  
GM 2.2L (GASOLINE & LPG)  
GM 3.0L (GASOLINE & LPG)  
ISUZU 4JB1 (DSL)
- B. GM 2.2L (GASOLINE & LPG)  
ISUZU C240 (DSL)
- C. MAZDA M4-2.0G (GASOLINE & LPG)  
ISUZU 4JB1 (DSL)  
ISUZU C240 (DSL)
- D. GM 2.2L (GASOLINE & LPG)  
GM 3.0L (GASOLINE & LPG)  
MAZDA M4-2.0G (LPG)\*
- E. GM 3.0L (GASOLINE & LPG)  
ISUZU 4JB1 (DSL)  
ISUZU C240 (DSL)
- F. GM 2.2L (GASOLINE & LPG)
- G. MAZDA M4-2.0G (GASOLINE)\*  
MAZDA M4-2.0G (GASOLINE & LPG)
- H. MAZDA M4-2.0G (LPG)\*

\*EARLY (BEFORE JUNE 1994) UNITS ONLY.

- 1. PEDAL PAD
- 2. LINK
- 3. CRANK
- 4. PEDAL FRAME
- 5. FORWARD SOLENOID (BLACK WIRE)
- 6. BATTERY (RED WIRE)
- 7. REVERSE SOLENOID (YELLOW WIRE)



- |                |                |
|----------------|----------------|
| A. ALL ENGINES | E. ALL ENGINES |
| B. NOT USED    | F. NOT USED    |
| C. NOT USED    | G. NOT USED    |
| D. ALL ENGINES | H. NOT USED    |
| 1. PEDAL PAD   | 3. CRANK       |
| 2. LINK        | 4. PEDAL FRAME |

**Figure 37. MONOTROL Pedal S2.00-3.20XM (S40-65XM)**

## Direction Control Lever Repair

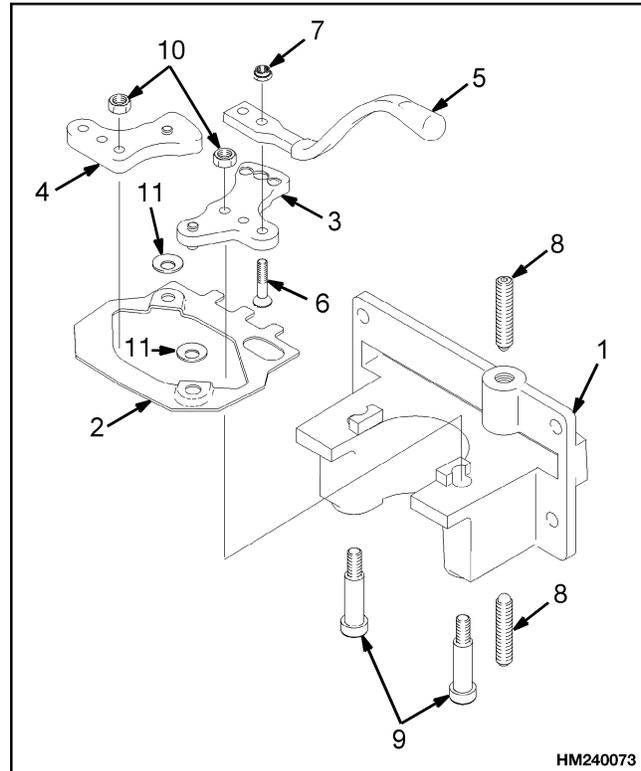
### REMOVE AND DISASSEMBLE

1. Remove the steering wheel. See Figure 38.
2. Remove the back cover from the steering column. If equipped, remove the turn signal switch.
3. Disconnect the wires at the switches for the transmission lever. Make sure the wires have identification marks for correct installation.
4. Remove the capscrews that hold the bracket for the control lever to the steering housing. Remove the control lever assembly and the switches.
5. Disassemble the control lever assembly as necessary.

### ASSEMBLE AND INSTALL

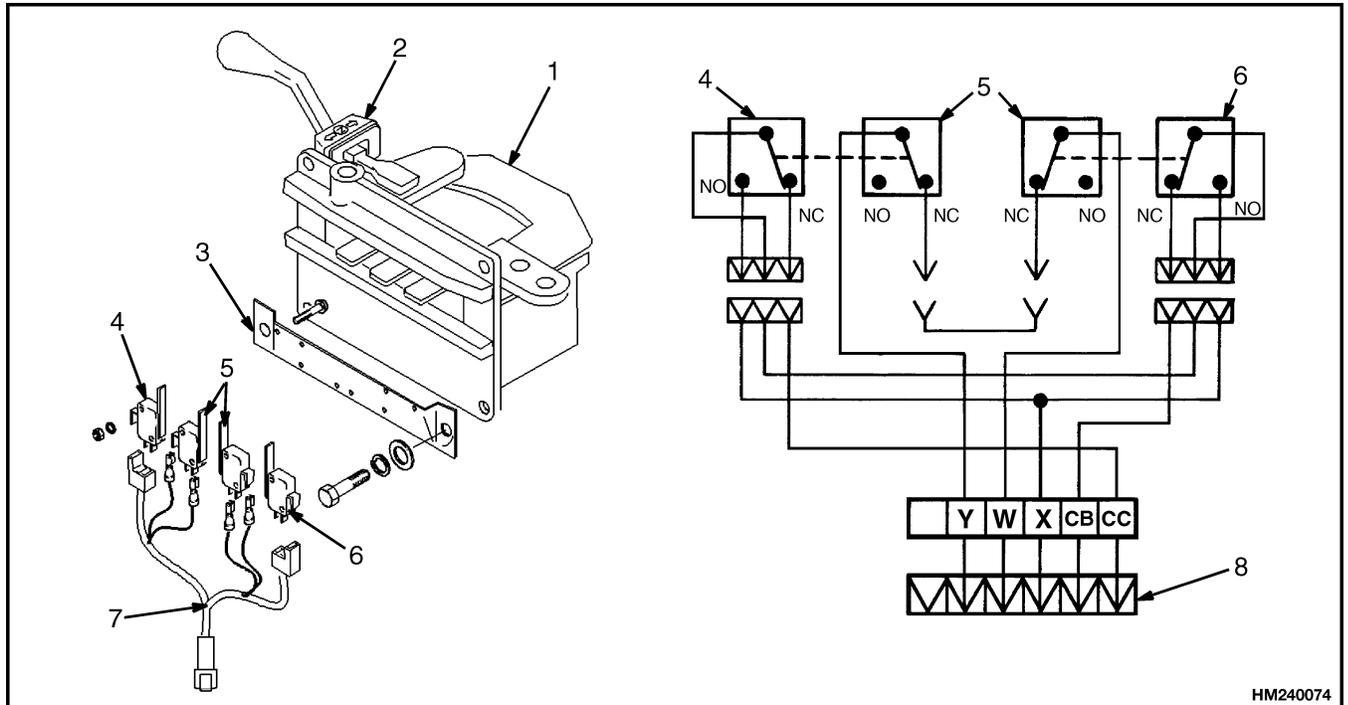
1. Assemble the control lever assembly as shown in Figure 38. Tighten the nuts that hold the control lever to the crank to 6.3 N•m (56 lbf in). Make sure the spring washers are between the cranks and the actuator plate. Tighten the nuts for the cranks to 7.9 N•m (70 lbf in). Install the detent plungers until they touch the crank, then loosen one turn. Fill the detent areas with multipurpose grease.
2. Install the four switches on the switch plate as shown in Figure 39.
3. Use the four capscrews and install the control lever assembly and the switches on the steering housing.
4. Connect the wires to the switches as shown in Figure 39.
5. Start the lift truck and operate the direction control lever in forward and reverse to make sure the lever operates correctly.

6. If equipped, install the turn signal switch. Install the back cover on the steering housing. Install the steering wheel. Tighten the nut for the steering wheel to 40 to 54 N•m (30 to 40 lbf ft).



- |                   |                   |
|-------------------|-------------------|
| 1. MOUNT          | 7. LOCK NUT       |
| 2. ACTUATOR PLATE | 8. DETENT PLUNGER |
| 3. DETENT CRANK   | 9. SHOULDER BOLT  |
| 4. CRANK          | 10. NUT           |
| 5. LEVER          | 11. SPRING WASHER |
| 6. BOLT           |                   |

**Figure 38. Direction Control Lever**



HM240074

**COLOR CODES:** Y = WHITE, W = GREEN, X = RED, CB = LIGHT GREEN, CC = ORANGE/BLACK

- |                           |                                     |
|---------------------------|-------------------------------------|
| 1. CONTROL LEVER ASSEMBLY | 5. NEUTRAL START SWITCH             |
| 2. DIRECTION INDICATOR    | 6. FORWARD CONTROL SWITCH           |
| 3. SWITCH PLATE           | 7. WIRING HARNESS                   |
| 4. REVERSE CONTROL SWITCH | 8. CONNECTOR TO COWL WIRING HARNESS |

*Figure 39. Direction Control Lever*

## Stall Test

The stall test checks the condition of the engine, transmission clutches, and stator clutch in the torque converter. If the engine is not operating correctly, the stall speed will be lower than the stall speed shown in the specification. If the stator clutch does not hold, the oil in the torque converter flows into the impeller in the direction opposite of engine rotation. This reverse flow of oil prevents the engine from reaching the correct rpm. If the engine speed is greater than the stall speed shown in the specification, the transmission clutches are not holding or the wheels are turning. The transmission clutches will not hold if the clutch pressure is not great enough or the clutches are worn.



### CAUTION

**Do not hold the throttle open for more than 15 seconds at a time. Permit the engine to operate at idle speed for 2 minutes between tests.**

**Release the accelerator immediately if the engine speed increases to the speed limit of the governor.**

**NOTE:** Make sure the governor is adjusted correctly.

**NOTE:** The wheels must not turn during the stall speed test.

Do a stall test to check the operation of the transmission clutches. The engine and hydraulic oil must be at operating temperature. Put a capacity load on the forks to prevent the wheels from turning. Do not apply the inching/brake pedal or the parking brake. These controls will release the clutches in the transmission. Connect a tachometer to the engine. Put the lift truck against an object that cannot move. Start the engine, put the transmission in **FORWARD**, and slowly push the accelerator pedal to full throttle. See Table 3 for stall speeds.

**Table 3. Stall Speeds**

Stall Speed (New Engine)	
Mazda M4-2.0G (Gasoline)	2000 to 2100 rpm
Mazda M4-2.0G (LPG)	2000 to 2100 rpm
GM 2.2L (Gasoline)	2260 to 2360 rpm
GM 2.2L (LPG)	2260 to 2360 rpm
GM 3.0L (Gasoline)	2325 to 2350 rpm
GM 3.0L (LPG)	2180 to 2230 rpm
GM 3.0L (Dual Fuel)	2180 to 2230 rpm
Isuzu C240	2150 to 2250 rpm
Isuzu 4JB1	1870 to 1970 rpm
Isuzu 4JG2	1835 to 1935 rpm

If the stall speed is 50 to 200 rpm below the specification, the engine is not operating at full power. Check the ignition timing, air filter, fuel system, and compression.

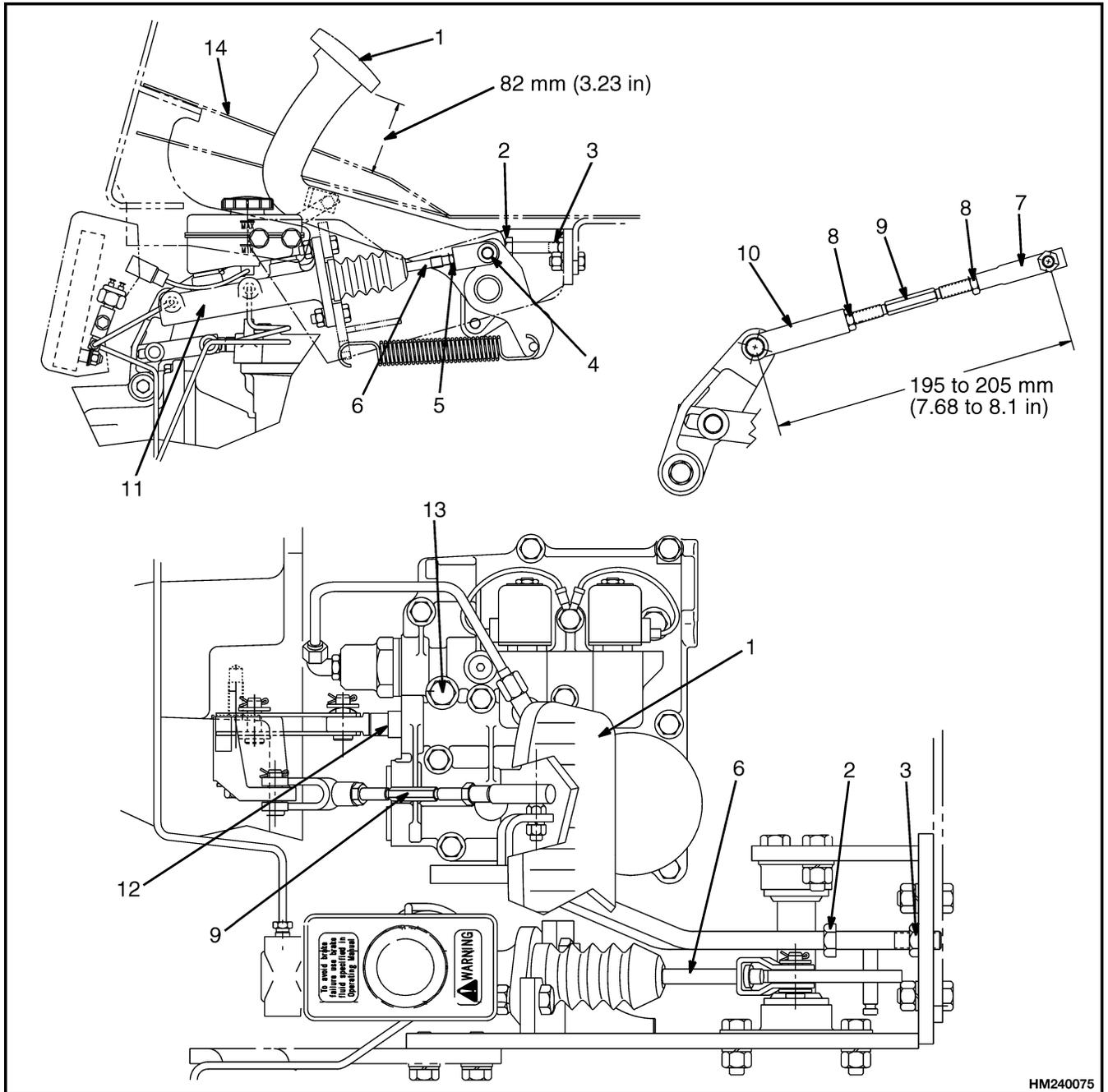
If the engine speed is 250 to 500 rpm below the specification, the stator clutch is damaged. The torque converter must be replaced as a unit. If the governor is not adjusted correctly, the results will be wrong.

If the stall speed is greater than the specification, the engaged clutch is not holding or the converter is damaged. Put the transmission in **REVERSE** to test the other clutch assembly. If the engine rpm is greater than the specification in either direction, do the pressure checks to check for the possible cause.

## Inching/Brake Pedal Adjustment

The following adjustment procedure gives a small amount of transmission inching as the brakes are applied (known as inching/brake overlap). This overlap makes the inching function smooth on a surface that has a minor slope. As the inching/brake pedal is depressed, inching/brake overlap occurs. The brakes start to apply, and the transmission clutch packs begin to disengage.

1. Check and adjust the inching/brake pedal if the control valve was removed for repairs.
2. If the lift truck has been operated for more than 25 hours since the brake shoes were installed, and the operation of the brakes is normal, go to Step 5.
3. If the lift truck has new brake shoes, adjust the brake shoes as described in Step 4.
4. Do the following procedure to adjust the brake shoes:
  - a. Put blocks at either side of the steer tires to prevent forward or reverse movement of the lift truck. Put the lift truck on solid blocks so that the drive wheels can be removed. Remove the drive wheels.
  - b. Use an adjuster tool (or a screwdriver) to rotate the adjuster wheel so that the teeth of the wheel move downward. This adjustment moves the brake shoes. Move the brake shoes so that the brake drum will not rotate.
  - c. Push the automatic adjuster lever away from the adjuster wheel with a small screwdriver. Use the adjuster tool to loosen the adjuster wheel approximately 10 teeth for the H40-65XM or 20 teeth for the S40-65XM.
  - d. Install the drive wheels. Remove the lift truck from the blocks. Operate the lift truck in the forward and reverse directions. Stop the lift truck 10 times in each direction. This procedure causes the brake shoes to wear a small amount and fit the brake drums better.
5. Do the following procedure to adjust the inching operation (see Figure 40 or Figure 41):
  - a. Remove the floor plate. Check that the inching link is connected at the upper hole in the pedal. Loosen both lock nuts (8) on the inching link. Adjust the length of the link to 195 to 205 mm (7.68 to 8.1 in.) for the H40-65XM or 411.5 to 414.5 mm (16.2 to 16.3 in.) for the S40-65XM. Make sure the threads of the link are engaged equally with the ball joint and the clevis. Do not tighten lock nuts (8) at this time.



HM240075

- |                        |   |
|------------------------|---|
| 1. INCHING/BRAKE PEDAL | 8. LOCK NUT                               |
| 2. CAPSCREW            | 9. INCHING LINK                           |
| 3. LOCK NUT            | 10. CLEVIS                                |
| 4. PIN                 | 11. MASTER CYLINDER                       |
| 5. LOCK NUT            | 12. INCHING SPOOL                         |
| 6. PUSH ROD            | 13. CHECK PORT FOR INPUT (FORWARD) CLUTCH |
| 7. BALL JOINT          | 14. MODULE PLATE                          |

**Figure 40. Inching/Brake Pedal Adjustment H2.00-3.20XM (H40-65XM)**

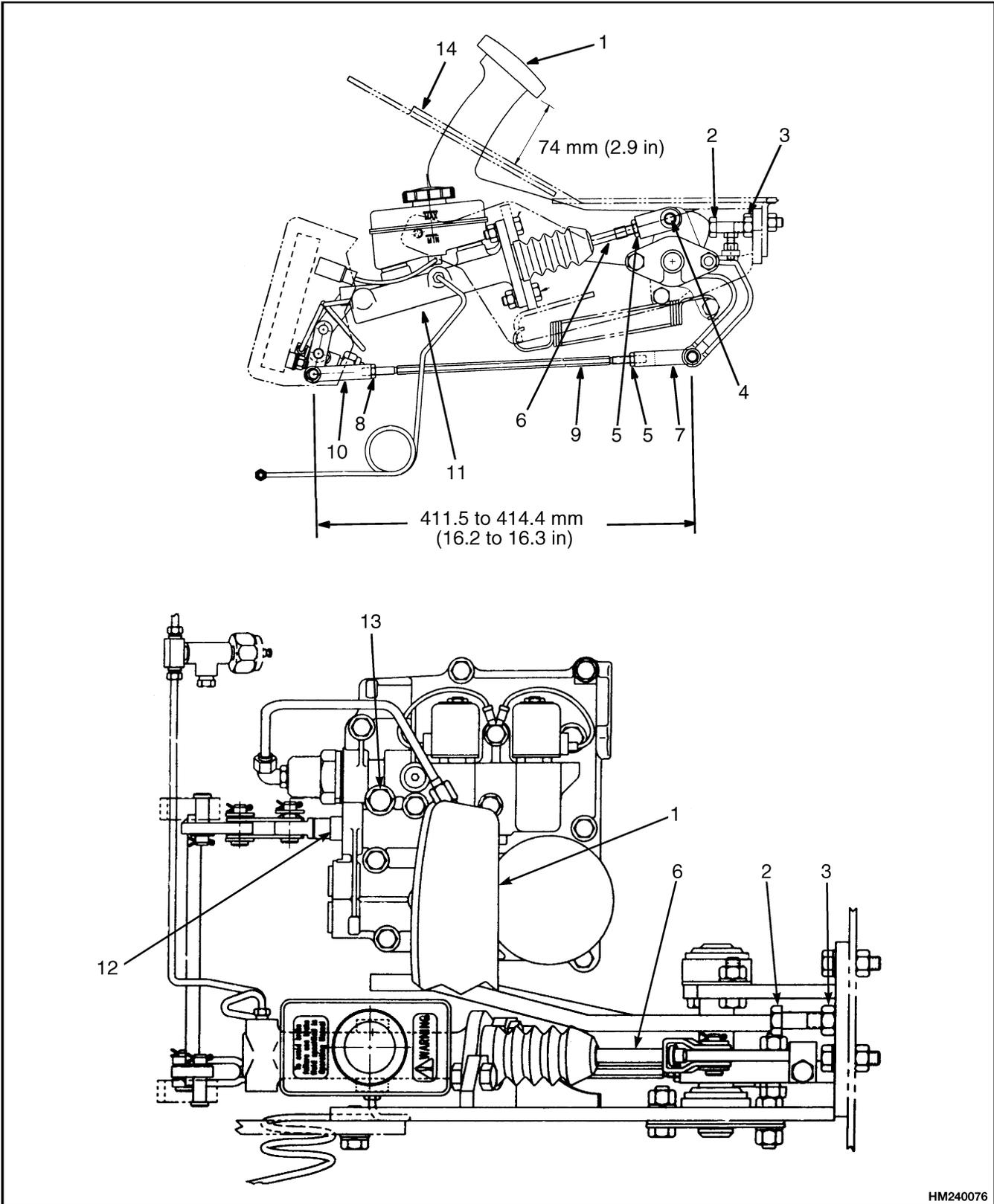


Figure 41. Inching/Brake Pedal Adjustment S2.00-3.20XM (S40-65XM)

*Legend for Figure 41*

- |  |   |
|--|---|
| <ol style="list-style-type: none"> <li>1. INCHING/BRAKE PEDAL</li> <li>2. STOP CAPSCREW</li> <li>3. LOCK NUT</li> <li>4. PIN</li> <li>5. LOCK NUT</li> <li>6. PUSH ROD</li> <li>7. BALL JOINT</li> </ol> | <ol style="list-style-type: none"> <li>8. LOCK NUT</li> <li>9. INCHING LINK</li> <li>10. CLEVIS</li> <li>11. MASTER CYLINDER</li> <li>12. INCHING SPOOL</li> <li>13. CHECK PORT FOR INPUT (FORWARD) CLUTCH</li> <li>14. MODULE FLOOR PLATE</li> </ol> |
|--|---|

- b. Adjust the height of the inching/brake pedal to 82 mm (3.23 in.) for the H40-65XM and 74 mm (2.9 in.) for the S40-65XM. Use the capscrew to change the pedal height. Tighten the lock nut (3) when complete. Be sure to measure the pedal height from the top of the module plate to the bottom edge of the pedal pad.
- c. Loosen the lock nut (5) on the push rod for the master cylinder. Rotate the push rod clockwise until the pin in the rod end just touches the hole in the pedal. Rotate the push rod 1/8 turn counterclockwise to give clearance for the pin. Tighten the lock nut (3). This clearance lets the brake fully return when the pedal is released.
- d. Put the lift truck on blocks so that the drive wheels do not touch the ground or any other object. Put blocks at either side of the steer tires to prevent forward or reverse movement of the lift truck. Apply the parking brake.
- e. Install a gauge that can measure 2000 kPa (300 psi) at test port for forward clutch pressure.
- f. Start the engine. Move the transmission control lever or the MONOTROL pedal to the **FORWARD** position. Release the parking brake.
- g. Adjust the inching link (9) until the pressure of the Input (forward) clutch is 725 to 860 kPa (105 to 125 psi) for older lift truck models and 862 to 1000 kPa (125 to 145 psi) for newer lift truck models, at an engine speed of approximately 2000 rpm. The

transmission oil must be at a temperature of 50 to 80°C (120 to 180°F).

- h. Turn the inching link clockwise (viewed from the rear of the truck) until the clutch pressure at the check port decreases to 620 kPa (90 psi) at 2000 rpm of engine speed, for older lift trucks and 276 kPa (40 psi) for newer lift trucks. Now, rotate the link counterclockwise four turns. Tighten the two lock nuts for the link. **CHECK THE PRESSURE OF THE FORWARD CLUTCH AGAIN.** The correct pressure is 725 to 860 kPa (105 to 125 psi) for older lift truck models and 862 to 1000 kPa (125 to 145 psi) for newer lift truck models. Turn the ignition switch to **OFF** to stop the engine.

**NOTE: Decrease the inching/brake overlap** if too much force is required on the inching/brake pedal to keep the lift truck from moving (at high engine speed) while on level ground.

To decrease the overlap, loosen the two lock nuts (8) on the inching link. Turn the link clockwise (as viewed from the rear of the lift truck) as much as 1-1/2 turns. Tighten the lock nuts when adjustment is complete.

**Increase the inching/brake overlap** to reduce any movement when the transmission disengages and the brakes are applied.

To increase the overlap, loosen the lock nuts (8) on the inching link. Turn the link counterclockwise (as viewed from the rear of the truck) as much as 1-1/2 turns. Tighten the lock nuts (8) when adjustment is complete.

## Neutral Start Switch, MONOTROL Pedal Adjustment H2.00-3.20XM (H40-65XM)

**NOTE:** Before the neutral start switch is adjusted, make sure the adjustments for the clearance of the brake shoes and the inching/brake pedal overlap are correct.

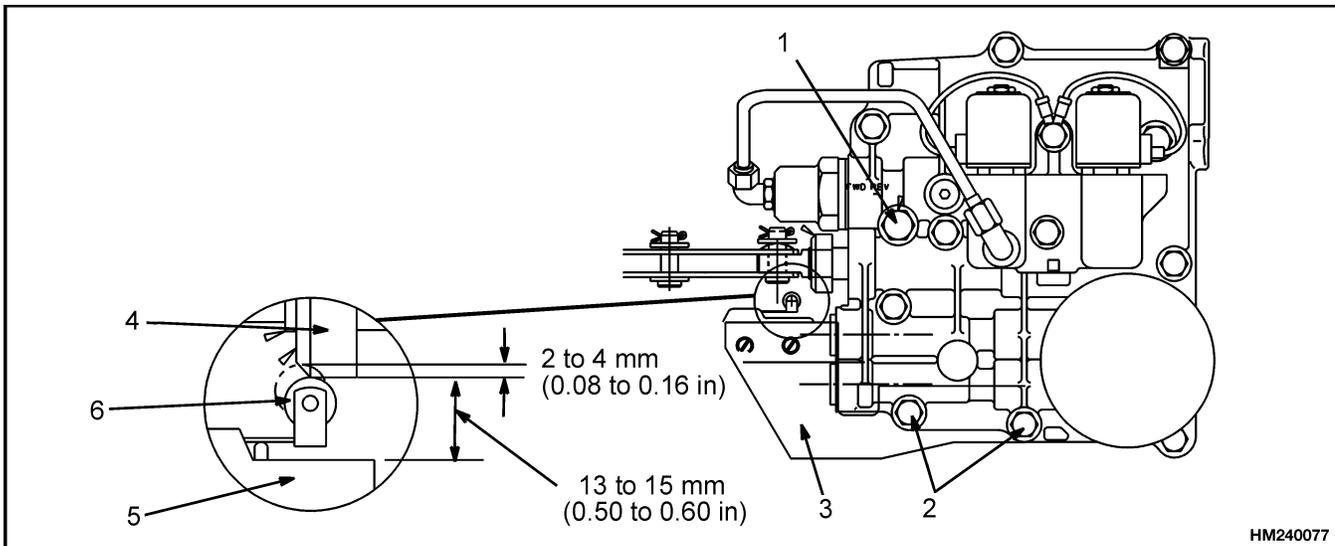
1. Put the lift truck on blocks so that the drive wheels do not touch the ground or any other object. Put blocks at either side of the steer tires to prevent forward or reverse movement of the lift truck.
2. Apply the parking brake.
3. Install a gauge that can measure 2000 kPa (300 psi) at test port for the Input (forward) clutch. See Figure 42.
4. Start the engine. Push on the left side of the MONOTROL pedal to put the transmission in **FORWARD**. Release the parking brake.
5. Loosen both capscrews that fasten the bracket for the neutral start switch to the transmission control valve. Do not loosen the two small screws that hold the switch to the bracket.

**NOTE:** This adjustment permits the inching spool to move an additional 2 to 4 mm (0.08 to 0.16 in.) inside the bore of the transmission control valve before the switch is actuated.

6. Push on the brake pedal until the gauge indicates 0 to 48 kPa (0 to 7 psi) of pressure for the Input (forward) clutch.
7. Hold the brake pedal to maintain the pressure in Step 6. Move the switch bracket so the switch roller touches leading edge of the outside diameter of the neutral start disc. See Figure 42.
8. Adjust the switch bracket [13 to 15 mm (0.50 to 0.60 in.)] so that the switch roller moves enough to actuate the switch.

**NOTE:** The first movement of the switch, also called free movement, is 2 to 4 mm (0.08 to 0.16 in.). The switch must move this distance before it will actuate.

9. Tighten the capscrews for the switch bracket to 19 N•m (14 lbf ft).



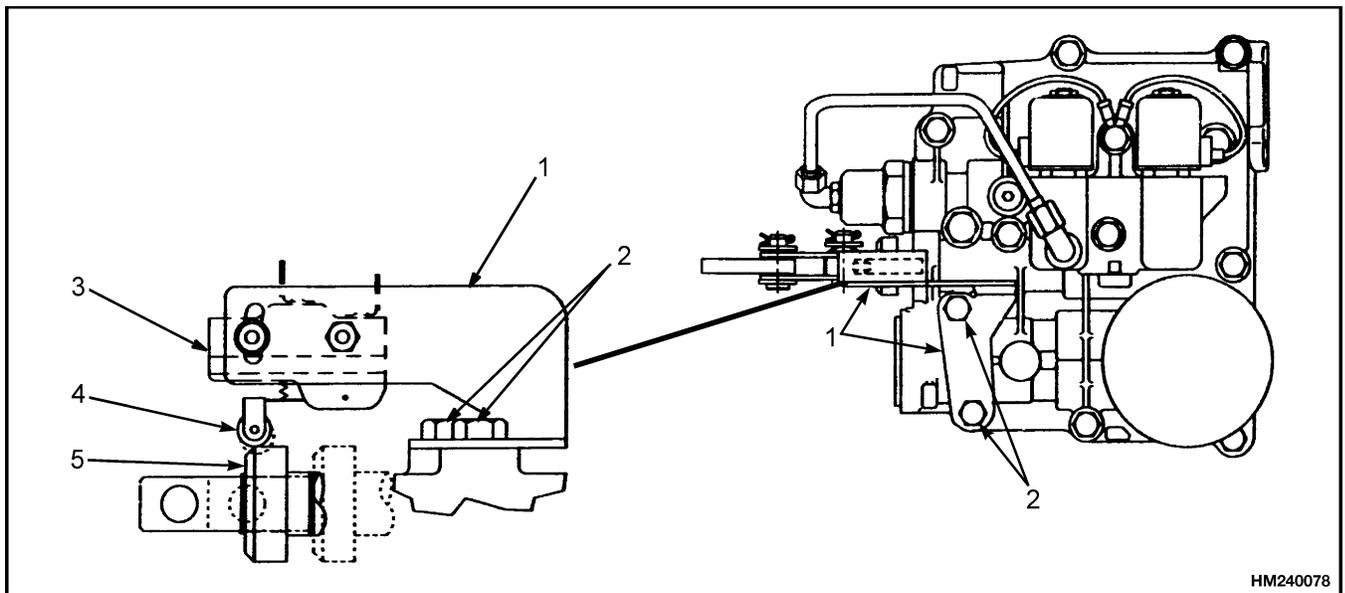
- |   |                         |
|---|-------------------------|
| 1. TEST PORT FOR INPUT (FORWARD) CLUTCH | 4. NEUTRAL START DISC   |
| 2. CAPSCREWS                            | 5. NEUTRAL START SWITCH |
| 3. SWITCH BRACKET                       | 6. SWITCH ROLLER        |

**Figure 42. H2.00-3.20XM (H40-65XM) Neutral Start Switch Adjustment (MONOTROL Only)**

## Neutral Start Switch, MONOTROL Pedal Adjustment S2.00-3.20XM (S40-65XM)

**NOTE:** Before the neutral start switch is adjusted, make sure the adjustments for the clearance of the brake shoes and the inching/brake pedal overlap are correct.

1. Disconnect the wire harness from the neutral start switch. Connect an ohmmeter or other continuity checker to the switch contacts. See Figure 43.
2. Loosen the nuts that fasten the switch to the bracket. Loosen the capscrews that fasten the bracket to the control valve. The switch and the bracket must move freely.
3. Move the inching spool of the control valve to the fully extended position.
4. Adjust the switch bracket so that the roller of the switch is on the forward corner of the disc of the inching spool. See Figure 43. Tighten the capscrews that fasten the bracket without moving the bracket. Tighten the capscrews to 19 N•m (14 lbf ft).
5. Slowly rotate the neutral start switch down until the meter indicates that the switch contacts close. Hold the switch in this position and tighten the nuts so that the switch cannot move. Connect the wire harness connectors to the switch contacts.



- |                         |                       |
|-------------------------|-----------------------|
| 1. SWITCH BRACKET       | 4. SWITCH ROLLER      |
| 2. BRACKET CAPSCREWS    | 5. NEUTRAL START DISC |
| 3. NEUTRAL START SWITCH |                       |

**Figure 43. S2.00-3.20XM (S40-65XM) Neutral Start Switch Adjustment (MONOTROL Only)**

## Neutral Start Switch Test, MONOTROL<sup>®</sup> Pedal

After the adjustment of the neutral start switch is complete, do the following tests to check for the correct operation of the neutral start switch.

### 1. TEST 1.

- a. Turn the ignition switch to **OFF**.
- b. Release the parking brake. Apply a force of 111 to 133 N (25 to 35 lbf) to the inching/brake pedal.
- c. Turn the ignition switch to the **START** position and start the engine. The drive wheels

must not rotate until the force on the brake pedal is reduced.

### 2. TEST 2.

- a. Turn the ignition switch to **OFF**.
- b. Release the parking brake. Do not apply force to the inching/brake pedal.
- c. Turn the ignition switch to the **START** position. The starter will not energize if the operation of the neutral start switch is correct. The engine must not start.

## Oil Pressure Checks

See Troubleshooting - Pressure Tests for reasons that cause pressures that are not according to the specifications. Test Ports 1 to 6 are shown in Table 4. These test ports are normally used to check the operation of the transmission. Test Ports 5 and 6 can be used for additional troubleshooting of the oil cooler and the modulator. Install the four 0 to 2000 kPa (0 to 300 psi) pressure gauges in the test ports shown in Table 4. None of the relief valves or regulators in this transmission are adjustable. The pressure tests are for troubleshooting. Before checking the oil pressures, do the following:

1. Operate the lift truck until the engine and transmission are at normal operating temperatures. Connect a tachometer to the engine. When the engine is at the normal operating temperature, make sure the engine will operate at the governor speed limit:

Mazda M4-2.0G (Gasoline)	2600 to 2700 rpm
Mazda M4-2.0G (LPG)	2600 to 2700 rpm
GM 2.2L (Gasoline)	2800 to 2900 rpm
GM 2.2L (LPG)	2800 to 2900 rpm
GM 3.0L (Gasoline)	2800 to 2850 rpm
GM 3.0L (LPG)	2800 to 2850 rpm
GM 3.0L (Dual Fuel)	2800 to 2850 rpm
Isuzu C240	2600 to 2700 rpm
Isuzu 4JB1	2100 to 2200 rpm
Isuzu 4JG2	2100 to 2200 rpm

2. Start the engine and tilt the mast backward. Put blocks under the outer mast channels. Tilt the mast forward to raise the wheels from the surface.
3. All oil pressures are checked with the engine operating at 2000 rpm. The operating temperature of the transmission oil is 50 to 65°C (120 to 150°F).

### RELIEF VALVE FOR TRANSMISSION PUMP CHECK, TEST PORT 1

Apply the parking brake (direction control lever only). Put the direction control lever in **NEUTRAL**. For older lift truck models, if the pressure from the transmission is not 965 to 1310 kPa (140 to 190 psi), see Troubleshooting. For newer lift truck models, if the pressure from the transmission is not 1103 to 1310 kPa (160 to 190 psi), see Troubleshooting.

### CLUTCH PRESSURE CHECK, TEST PORTS 2 AND 3

1. Put the transmission in **FORWARD**. For older lift truck models, if the pressure is not 724 to 860 kPa (105 to 125 psi), see Troubleshooting. For newer lift truck models, if the pressure is not 862 to 1000 kPa (125 to 145 psi), see Troubleshooting.
2. Run the engine at 2000 rpm and push the inching pedal down. The clutch pressure must decrease to approximately zero pressure when the inching pedal is fully pushed down.

3. Put the transmission in **REVERSE**. For older lift truck models, if the pressure is not 724 to 860 kPa (105 to 125 psi), see Troubleshooting. For newer lift truck models, if the pressure is not 862 to 1000 kPa (125 to 145 psi), see Troubleshooting.
4. Run the engine at 2000 rpm and push the inching pedal down. The clutch pressure must decrease to approximately zero pressure when the inching pedal is fully pushed down.

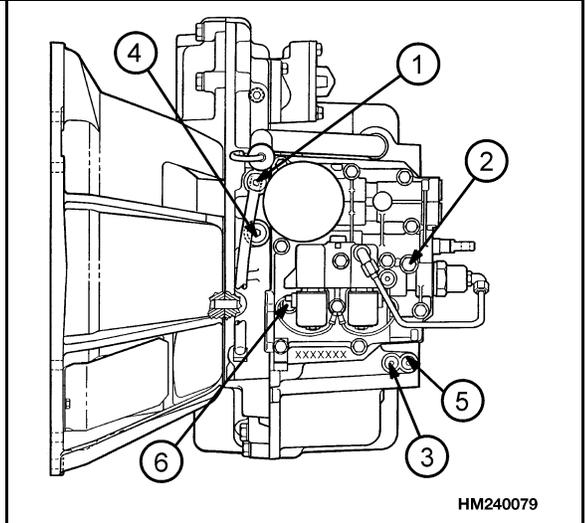
**Table 4. Transmission Oil Pressures Test Ports**

Pressure	Port 1 Transmission Pump	Port 2 Input (Forward) Clutch	Port 3 Counter (Reverse) Clutch	Port 4 Torque Converter	Port 5 Lubrication Pressure	Port 6 Modulator Pressure
kPa (psi)	OLDER MODELS 954 to 1170 (140 to 170) NEWER MODELS 1103 to 1310 (160 to 190)	OLDER MODELS 724 to 860 (105 to 125) NEWER MODELS 862 to 1000 (125 to 145)	OLDER MODELS 724 to 860 (105 to 125) NEWER MODELS 862 to 1000 (125 to 145)	OLDER MODELS 724 to 860 (105 to 120) NEWER MODELS 724 to 827 (105 to 120)	ALL MODELS 105 to 175 (15 to 25)	ALL MODELS Pressure Variation

**NOTE:** All pressures are measured at 2000 rpm with oil temperature at 50 to 65°C (120 to 150°F).

The difference in the Input (forward) and Counter (reverse) clutch pressures must not be more than 70 kPa (10 psi).

- Test Port 1 - Pressure from Transmission Pump
- Test Port 2 - Pressure to Input (Forward) Clutch
- Test Port 3 - Pressure to Counter (Reverse) Clutch
- Test Port 4 - Oil Pressure to Torque Converter
- Test Port 5 - Oil Pressure from Oil Cooler
- Test Port 6 - Modulator Pressure



5. The difference in the Input (forward) and Counter (reverse) clutch pressures cannot be more than 70 kPa (10 psi). A larger difference in clutch pressures indicates a problem.

**TORQUE CONVERTER REGULATOR CHECK, TEST PORT 4**

Apply the parking brake. Run the engine at 2000 rpm and push the inching pedal fully down. For older models, if the pressure is not 724 to 860 kPa (105 to 125 psi), see Troubleshooting. For newer models, if the pressure is not 724 to 827 kPa (105 to 120 psi), see Troubleshooting.

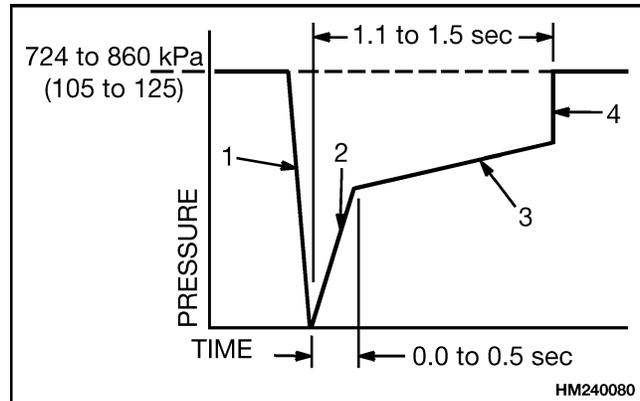
**LUBRICATION CIRCUIT OIL PRESSURE CHECK, TEST PORT 5**

Remove the plug at Test Port 5 and install a 0 to 500 kPa (0 to 70 psi) gauge. The transmission oil must be at the operating temperature of 50 to 65°C (120 to 150°F). Apply the parking brake (direction control lever only). Put the direction control lever in the **NEUTRAL** position. Run the engine at 2000 rpm. The correct pressure is 105 to 175 kPa (15 to 25 psi).

### MODULATOR PRESSURE CHECK, TEST PORT 6

This test checks the operation of the modulator. When the direction spool is moved from one direction to another, the modulator causes a 1.0- to 1.5-second delay in the application of the clutch for the new direction. The changes in modulator pressure are shown in Figure 44.

Install a 0 to 2000 kPa (0 to 300 psi) gauge in Test Port 6 and operate the engine at 1500 to 2000 rpm. Check the pressure on the gauge when you change the position of the direction spool. Use a stop watch to measure the operation of the modulator. A pressure gauge will not operate quickly enough to show the complete variation shown in Figure 44, but it will indicate the decrease and increase of pressure in the modulator. If the operation of the modulator is not correct, the control valve must be disassembled for repairs.



1. CLUTCH DISENGAGES
2. OTHER CLUTCH FILLS WITH OIL
3. MODULATOR CONTROLS INCREASE IN PRESSURE
4. OTHER CLUTCH ENGAGED

*Figure 44. Pressure Variation in Modulator for One Cycle*

## Troubleshooting

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Engine will not start.	The transmission is not in <b>NEUTRAL</b> or the parking brake is not applied.	Use correct starting procedure.
	The parking brake is applied. The switch in the parking brake is damaged.	Release the brake or install a new switch.
	The neutral start switch is damaged or needs adjustment.	Repair or adjust switch.
	The neutral start switch(es) at the direction control lever is damaged or not connected.	Repair switch(es).
Transmission is too hot.	Inching and operating the lift truck with loads greater than capacity.	Use correct load.
	Oil level is not correct.	Make sure oil level is correct.
	Clutch does not engage completely.	Check oil pressure or clutch parts.
	Clutch pressure is too low.	Check for cause of low pressure.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Transmission is too hot. (Cont.)	Worn or wrong friction discs or separator plates.	Install new parts.
	Oil cooler circuit has a restriction or damage.	Clean oil lines and oil cooler.
	Oil cooler in radiator has a restriction.	Clean or repair oil cooler.
	The torque converter is damaged.	Install a new torque converter.
	Clutch discs are bent or are not fully releasing.	Install new clutch discs.
	Oil pump is worn or damaged.	Install new oil pump.
	Clutch assembly will not disengage completely because piston orifice has a restriction.	Clean piston orifice.
Bubbles in the oil fill tube.	Air leak on the suction side of the oil pump.	Check pump mounting.
	Oil level is not correct.	Make sure oil level is correct.
	Oil is too hot.	Let oil become cool.
	The torque converter is damaged.	Install a new torque converter.
Lift truck will not move in either direction.	Oil level is too low.	Make sure oil level is correct.
	Axle shaft(s) or differential is damaged.	Repair as necessary.
	Brakes are not released.	Release brakes.
	Forward and reverse solenoids do not operate.	Repair solenoids or circuit.
	Transmission pump is damaged.	Install a new pump.
	Pressure regulators are in the open position.	Check regulators and springs.
	Direction spool will not move.	Repair linkage.
	Torque converter is disconnected from the flywheel.	Install capscrews for drive plate or torque converter.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Lift truck will not move in either direction. (Cont.)	Tube to direction spool is damaged or disconnected.	Connect or install new tube.
	Switch(es) at direction control lever are damaged or not connected.	Connect wires or install new switch(es).
	Control valve gasket is damaged.	Install a new gasket.
	Control valve is damaged.	Repair control valve.
Lift truck moves in one direction only.	Worn or broken seal rings causing clutch assembly not to engage.	Install new seal rings.
	Clutch parts are damaged.	Install new parts.
	Clutch not holding.	Check clutch pressure.
	Clutch not releasing.	Check clutch operation.
	Control valve gasket is damaged.	Install a new gasket.
	Control valve is damaged.	Repair control valve.
Clutches do not engage.	Transmission pump is damaged.	Install a new pump.
	Control valve gasket is damaged.	Install a new gasket.
	Clutch piston does not move.	Check clutch operation.
	Clutch piston seal has a leak.	Install a new piston seal.
	Modulator valve has a leak.	Repair modulator valve.
	Direction spool does not move freely.	Check solenoids or install a new spool.
	Friction discs are bent or damaged.	Install new friction discs.
	Regulator valves are damaged.	Install new regulator valves.
	O-ring on clutch shaft is damaged.	Install new O-ring.
	O-rings for solenoid valve stems in the control valve are damaged.	Install new O-rings.
	Parts in the control valve are damaged.	Install new parts.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Inching operation is not smooth.	Brakes are not correctly adjusted.	Adjust brakes.
	Inching spool or plunger does not move freely.	Check linkage or install a new spool or plunger.
	Broken spring(s) for inching spool or plunger.	Install new spring(s).
	Clutch piston does not move freely.	Check piston operation.
	Control valve has leaks.	Repair control valve.
	Clutch discs are bent or burned.	Install new clutch discs.
	Inching linkage is not adjusted correctly.	Adjust linkage.

## Troubleshooting - Pressure Tests

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
All pressures are too low.	Oil level is not correct.	Make sure oil level is correct.
	Worn oil pump.	Install new pump.
	Pressure regulators are open.	Repair regulators.
	Leaks inside the transmission.	Install new seal rings.
Pressure at the relief valve for the transmission pump regulator is not correct.	Oil level is not correct.	Make sure oil level is correct.
	Worn oil pump.	Install new pump.
	Oil filter has a restriction.	Install new oil filter.
	Spring for main pressure regulator is damaged.	Install new spring.

PROBLEM	POSSIBLE CAUSE	PROCEDURE OR ACTION
Pressure at the torque converter check port is not correct.	Pressure for the relief valve of the transmission pump is not correct.	Install new parts to get correct pressure.
	Spring or spool for the torque converter regulator is damaged.	Install new parts.
	There is a restriction in the circuit for the torque converter.	Clean oil cooler and oil lines.
Clutch pressure is not correct.	Pressure for the relief valve of the transmission pump is not correct.	Install new parts to get correct pressure.
	Clutch regulator is damaged.	Install new parts.
	Linkage for the inching spool is not adjusted correctly.	Adjust linkage.
	Seals for clutch piston leak.	Install new seals.
	Clutch spring is damaged.	Install new spring.
Pressure at the oil cooler regulator is not correct.	Check for problems at the torque converter regulator. Spring for the cooler regulator is damaged.	Install springs or regulators.
	The oil cooler has a restriction.	Clean oil lines and oil cooler.



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