SERVICE REPAIR

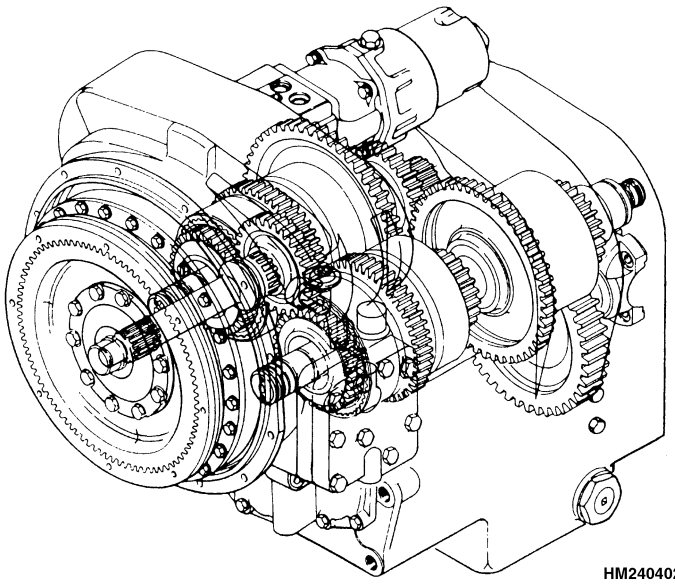
MANUAL

HYSTER

THREE-SPEED POWERSHIFT TRANSMISSION

DESCRIPTION AND OPERATION

H17.00-32.00C (H360-700C) [C008];
H20.00-32.00F (H440-700F/FS) [E008]



HM240402

HYSTER

PART NO. 897240

1300 SRM 375

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!

TABLE OF CONTENTS

This section is for the following models:

H17.00-32.00C (H360-700C) [C008];
H20.00-32.00F (H440-700F/FS) [E008]

"THE
QUALITY
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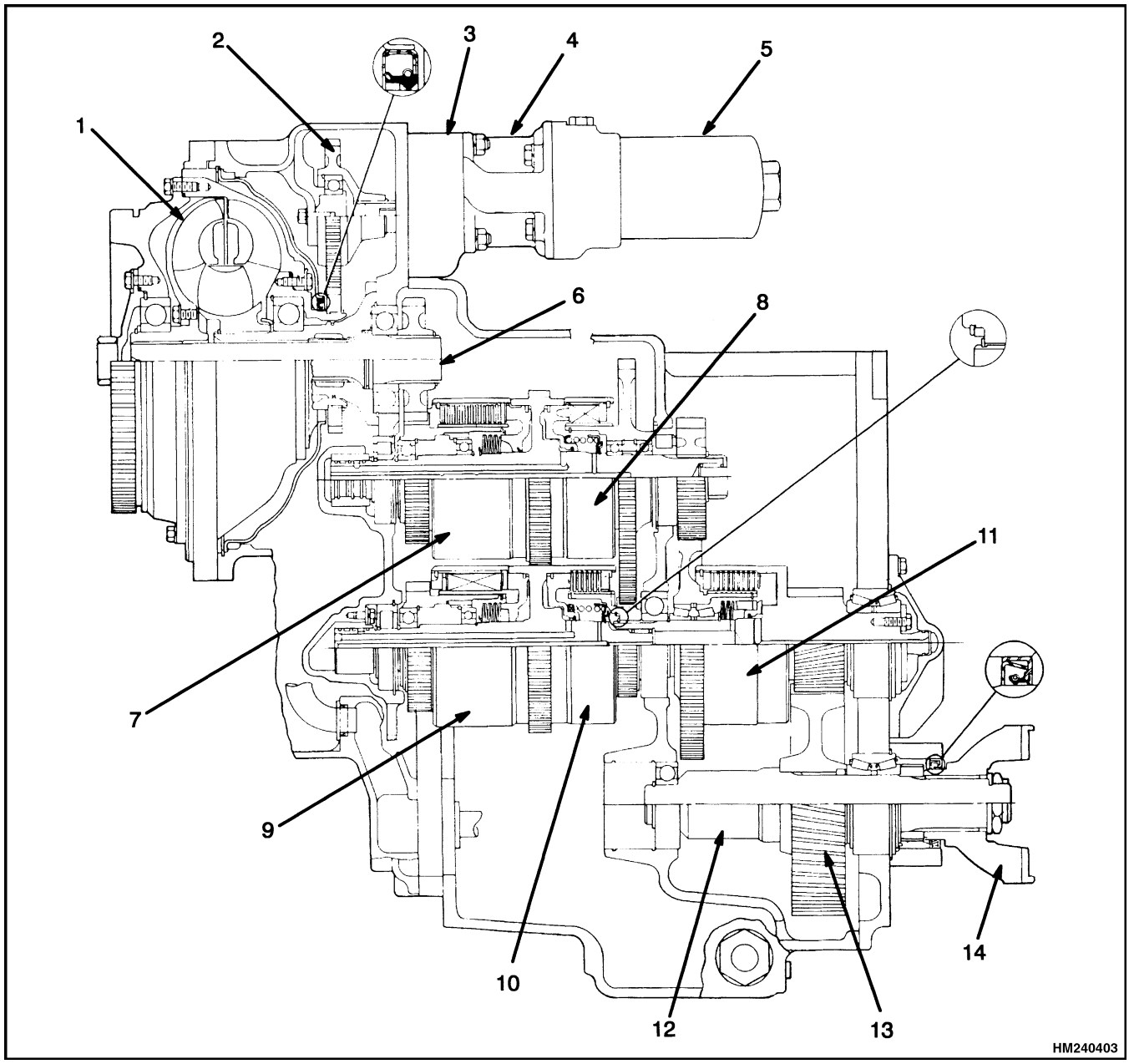
HYSTER
APPROVED
PARTS

General

This section has two parts. The first part describes the mechanical components of the transmission. The second part describes the hydraulic operation of the transmission. See Figure 1.



1. TORQUE CONVERTER
2. DRIVE GEAR FOR HYDRAULIC PUMP
3. PRESSURE REGULATOR VALVE
4. TRANSMISSION OIL PUMP
5. OIL FILTER
6. INPUT SHAFT
7. FORWARD CLUTCH
8. THIRD-SPEED CLUTCH
9. REVERSE CLUTCH
10. SECOND-SPEED CLUTCH
11. FIRST-SPEED CLUTCH
12. OUTPUT SHAFT
13. OUTPUT GEAR
14. OUTPUT YOKE

Figure 1. Transmission

Mechanical Description

GENERAL

The parts of the transmission are installed in the torque converter housing and the transmission housing. The torque converter and the drive gears for the hydraulic pumps are inside of the torque converter housing. The modulator valve, manifold block, and the hydraulic pumps are installed on the outside of the torque converter housing. The clutch and shaft assemblies are installed in the transmission housing. The shift control valve is installed to the frame of the lift truck.

TORQUE CONVERTER

Description

The torque converter is installed between the engine and the transmission and has two functions. See Figure 2. The torque converter works as a fluid clutch and multiplies the torque from the engine as needed. The torque converter has three main parts: an impeller, a turbine, and a stator.

Operation

The oil pump for the transmission sends oil to the oil filter, shift control valve, modulator valve, the torque converter, and the lubrication circuit. See Figure 3. Oil for the torque converter flows between the stator tube and the input shaft. The centrifugal force of the moving impeller causes the oil to flow from the inner edge to the outer edge of the impeller. This oil then flows toward the outer blades of the turbine and returns to the inner blades of the turbine. The oil then leaves the turbine and enters the stator going in the opposite direction of engine rotation. The blades of the stator change the direction of the oil so that oil leaves the stator going in the direction of engine rotation. This oil enters the impeller and helps the impeller increase the output torque from the torque converter.

The turbine is installed in the torque converter between the cover and the impeller. The input shaft for the transmission fits in the splines of the turbine. The input shaft rotates when the turbine rotates.

The stator is installed in the torque converter between the turbine and the impeller. The stator fits on the splines of the stator tube and does not move. The stator tube is fastened to the torque converter housing.

The impeller cover is connected to the engine flywheel by a ring gear or by a flexible drive plate. The impeller is connected to the impeller cover. When the engine and impeller rotate, a gear on the hub of the impeller turns the drive gears for the hydraulic pumps. There is one pump for the transmission and four pumps for the hydraulic system of the lift truck.

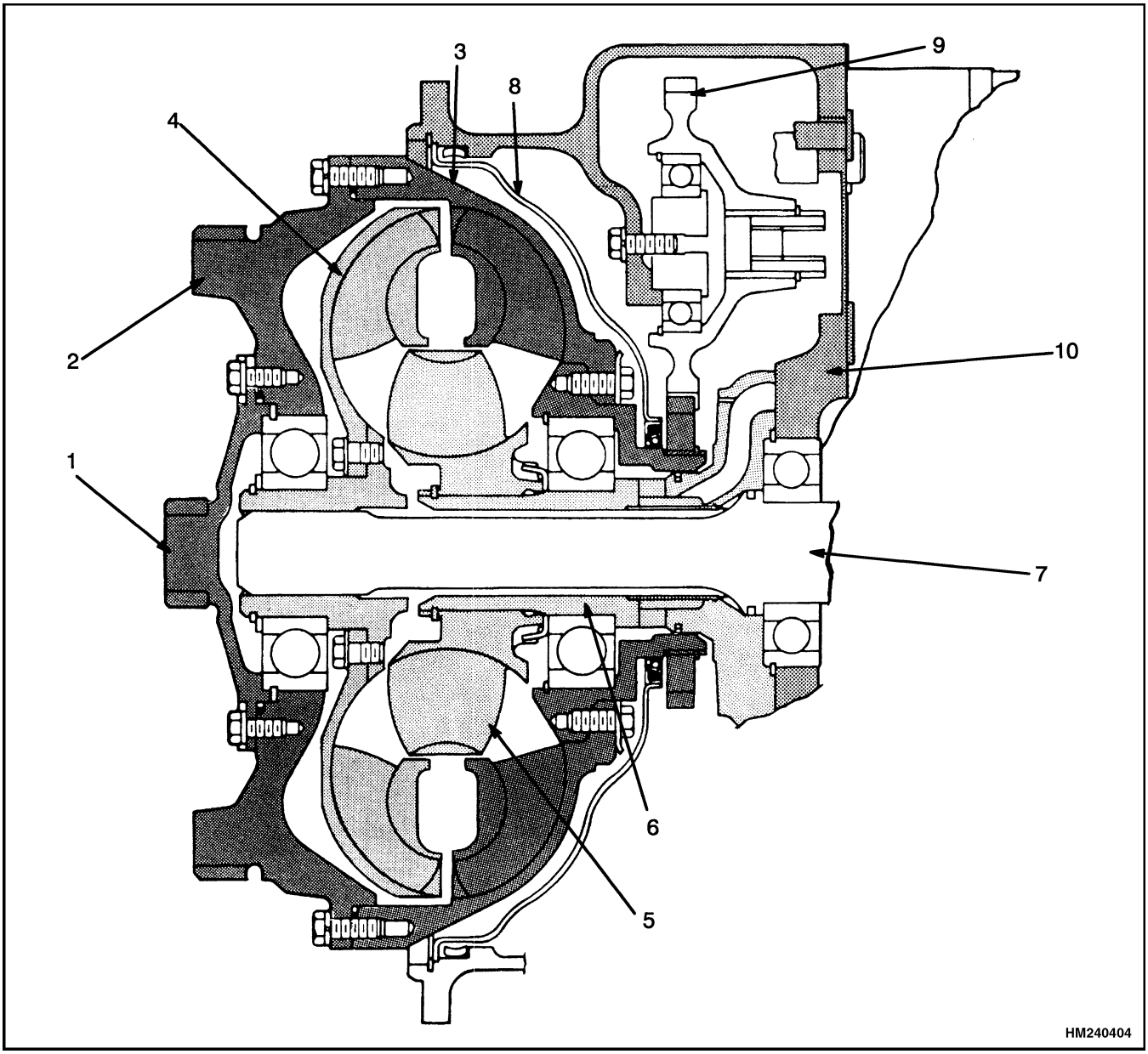
CLUTCH ASSEMBLIES

Description

Each of the five clutch assemblies in the transmission has a housing, a piston, and friction discs and separator plates. See Figure 4. Two types of pistons are used. The friction discs and separator plates are installed in the housing in a sequence. Each friction disc is next to a separator plate. The separator plates have a smooth surface while the friction discs have a friction material on the surface. The hub in each clutch assembly engages with the inner teeth of the friction discs. The outer teeth of the separator plates engage with the grooves in the housing. A pressure plate holds the friction discs and separator plates in the housing. Two types of spring assemblies are used to keep the piston retracted against the housing. A coil spring is used as the return spring in the second- and third-speed clutches. Belleville washers are used in the spring assemblies for the forward-, reverse-, and first-speed clutches. The Belleville washers have a stronger force than the coil springs that helps during the inching/declutch operation. There is enough clearance in the clutch assembly to let the friction discs rotate when the clutch is not engaged.

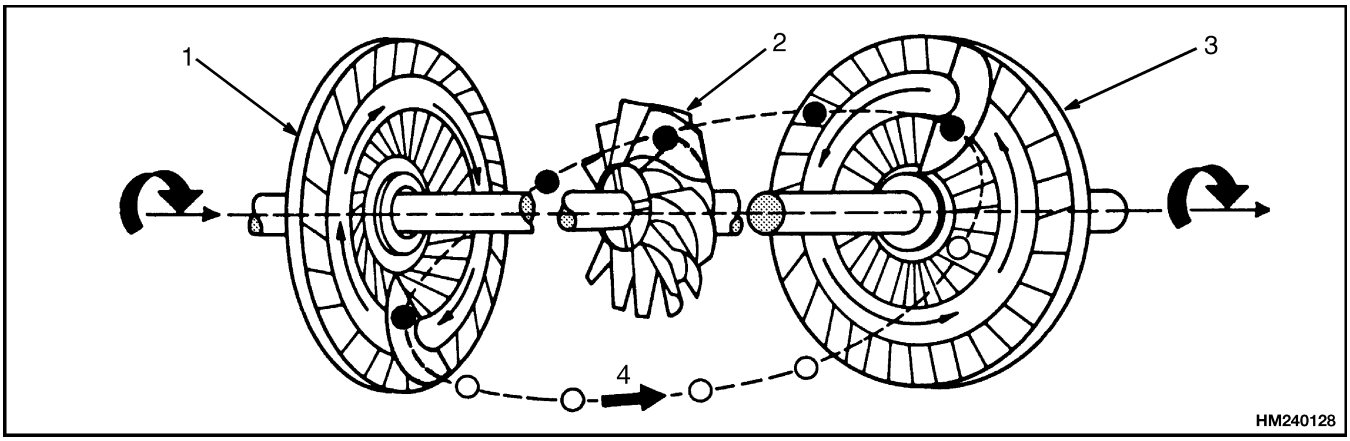
Operation

Each shaft in the transmission has oil passages that connect the clutch assemblies to the modulator valve. There are also oil passages for the lubrication of the clutch assemblies. Seal rings on each shaft seal the oil passages to the torque converter housing. When a clutch assembly is actuated, oil flows from the modulator valve, through the shaft to the piston. The oil flows behind the piston and pushes the piston against the separator plates and friction discs. The clutch assembly is now engaged and the shaft, gears, and clutch assembly rotate as one unit.



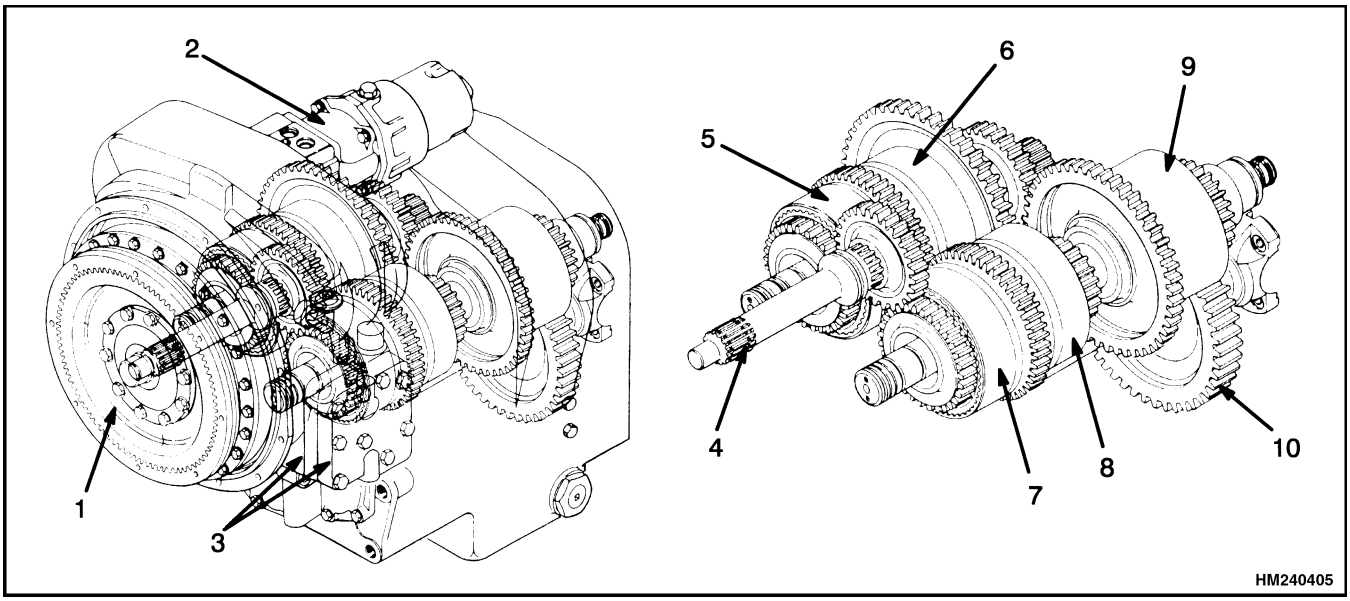
1. BEARING COVER
2. IMPELLER COVER
3. IMPELLER
4. TURBINE
5. STATOR
6. STATOR TUBE
7. INPUT SHAFT
8. OIL BAFFLE
9. GEAR FOR HYDRAULIC PUMP
10. TORQUE CONVERTER HOUSING

Figure 2. Torque Converter



1. TURBINE
2. STATOR
3. IMPELLER
4. OIL FLOW

Figure 3. Torque Converter Operation

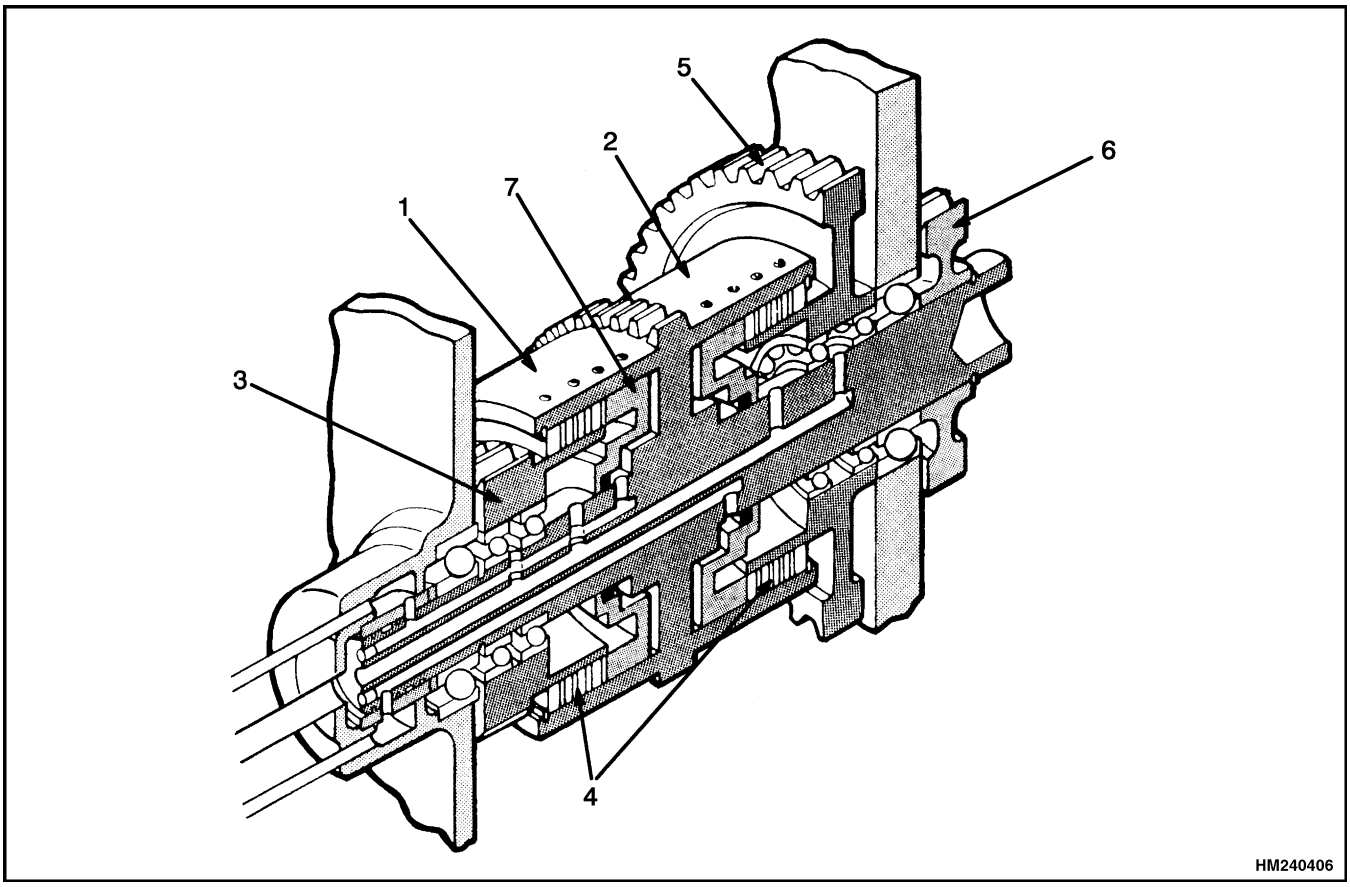


1. TORQUE CONVERTER
2. TRANSMISSION PUMP
3. MANIFOLD BLOCK AND MODULATOR VALVE
4. INPUT SHAFT
5. FORWARD CLUTCH
6. THIRD-SPEED CLUTCH
7. REVERSE CLUTCH
8. SECOND-SPEED CLUTCH
9. FIRST-SPEED CLUTCH
10. OUTPUT GEAR AND SHAFT

Figure 4. Clutch Assemblies

FORWARD SHAFT

The forward shaft has the clutch assemblies for forward and third speed. See Figure 5. The housing for both clutch assemblies is welded to the shaft. The forward clutch assembly has the forward gear and clutch hub, a piston, 12 friction discs, and 12 separator plates. The forward gear and clutch hub rotate on the shaft on ball bearings. The third-speed clutch has the third-speed gear and clutch hub, a piston, six friction discs, and six separator plates. The third-speed gear and clutch hub rotate on ball bearings.



1. FORWARD CLUTCH HOUSING
2. THIRD-SPEED CLUTCH HOUSING
3. FORWARD GEAR AND CLUTCH HUB
4. FRICTION DISCS AND SEPARATOR PLATES
5. THIRD-SPEED GEAR AND CLUTCH HUB
6. FIRST-SPEED DRIVE GEAR
7. PISTON

Figure 5. Forward Shaft

REVERSE SHAFT

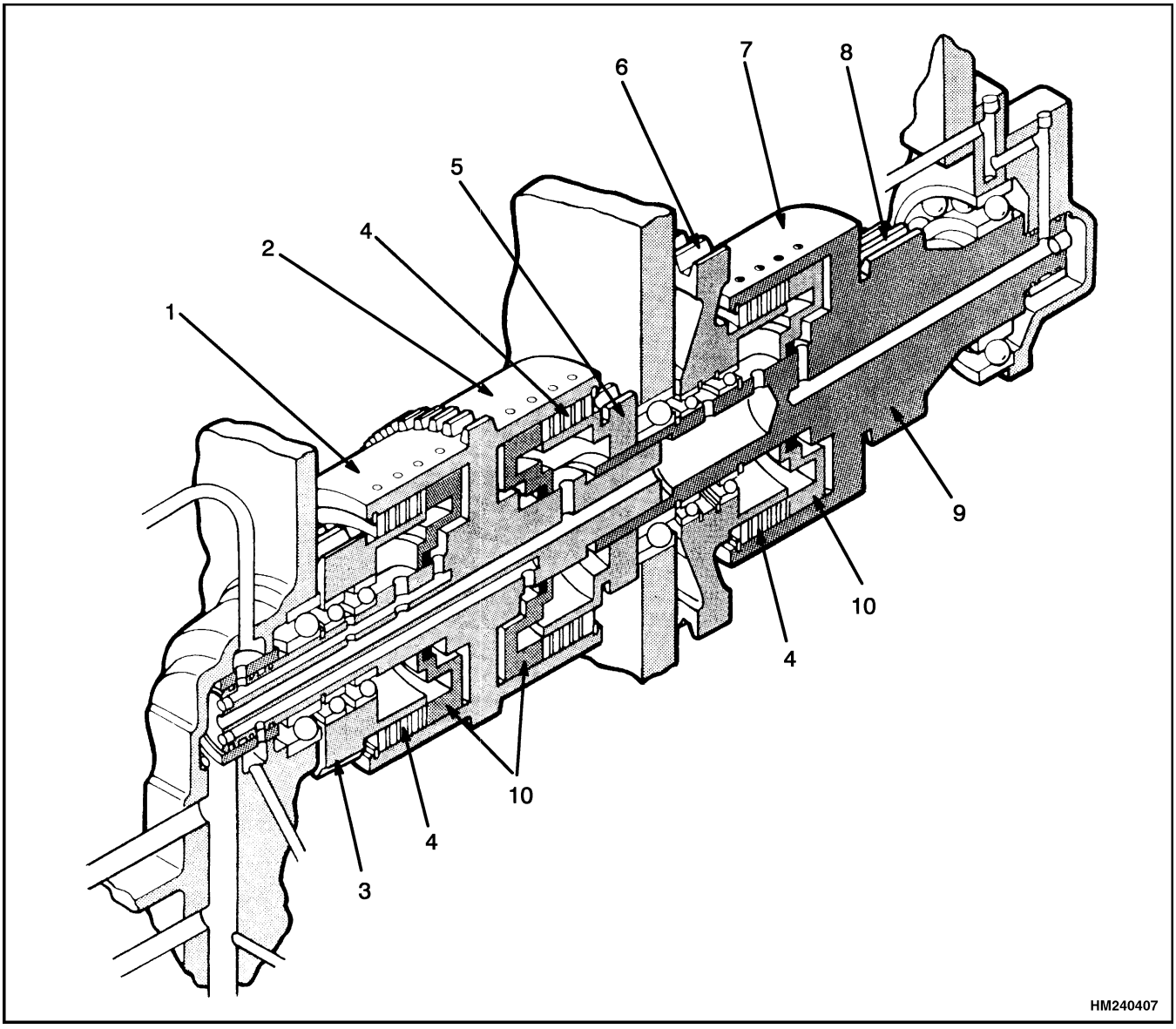
The reverse shaft has the clutch assemblies for reverse and second speed. See Figure 6. The housing for both clutch assemblies is welded to the shaft. The reverse clutch assembly has the reverse gear and clutch hub, a piston, 12 friction discs, and 12 separator plates. The reverse gear and clutch hub rotate on the shaft on ball bearings. The second-speed clutch has the second-speed gear and clutch hub, a piston, six friction discs, and six separator plates. The second-speed gear and clutch hub rotate on needle rollers and a ball bearing.

FIRST SPEED SHAFT

The first-speed shaft has the gears and the clutch assembly for first speed. See Figure 6. The clutch assembly has the first-speed gear and clutch hub, a piston, nine friction discs, and nine separator plates. The first speed shaft rotates on tapered roller bearings.

OUTPUT SHAFT

The output shaft has the output gear and the output yoke. See Figure 1. The output gear is driven by a gear on the first-speed shaft. The output shaft rotates on tapered roller bearings and a ball bearing.



1. REVERSE CLUTCH HOUSING
2. SECOND-SPEED CLUTCH HOUSING
3. REVERSE GEAR AND CLUTCH HUB
4. FRICTION DISCS AND SEPARATOR PLATES
5. SECOND-SPEED GEAR AND CLUTCH HUB
6. FIRST-SPEED GEAR AND CLUTCH HUB
7. FIRST-SPEED CLUTCH HOUSING
8. DRIVE GEAR FOR OUTPUT SHAFT
9. FIRST-SPEED SHAFT
10. PISTON

Figure 6. Reverse Shaft and First Speed Shaft

Hydraulic Operation

SUMP, FILTER, AND PUMP

The transmission housing is also the sump since it has the oil supply for the transmission. See Figure 7. The oil filter is installed in a housing with the oil pump and pressure regulator valve. The oil filter has a replaceable element and a bypass valve. The bypass valve permits oil to flow past the oil filter when it has a restriction. The oil pump is installed on the torque converter housing with the pressure regulator valve. The pump is driven by idler gears that are driven by the torque converter. The oil pump pulls oil from the sump through the suction tube. The oil then goes through the oil filter and the pressure regulator valve. At the pressure regulator valve the oil flows to the shift control valve and the torque converter circuit. Oil in the torque converter circuit flows through the torque converter and oil cooler to the lubrication circuit.

SHIFT CONTROL VALVE

The shift control valve is installed on the frame of the lift truck near the transmission. See Figure 8. Four solenoid valves and five spools within the valve body control the flow of oil between the shift control valve and the transmission. There are solenoid valves for **FORWARD**, **REVERSE**, **FIRST** speed, and **SECOND** speed. **THIRD** speed is selected when the solenoids for **FIRST** and **SECOND** speed are not activated. The oil for the shift control valve flows from the transmission pump and regulator and through the manifold block to the valve. At the shift control valve the supply oil flows to all of the spools in the valve body.

Solenoid Valves

The solenoid valves are installed in the body for the shift control valve. See Figure 8. The solenoid valves control the flow of oil to the direction and the range spools. There is a solenoid valve for each of the following functions: (1) **FORWARD**, (2) **REVERSE**, (3) **FIRST** speed, and (4) **SECOND** speed. The solenoid valves are operated and controlled by switches in the range selector assembly. For models H20.00-32F **(with auto shift APC 100)**, the switches in the gear selector are connected to the APC 100 (Automatic Power Control 100). The output signals of this controller operate the solenoid valves. When a solenoid is not energized, the passage for the solenoid is open to the drain circuit. When a solenoid is energized, the spool in the solenoid moves up and closes the passage to the drain circuit. At the same time, the solenoid opens the passage from the supply circuit to the passage for the range or direction spool.

Inching Spool

The movement of the inching spool is controlled by the inching pedal. See Figure 8. On the H17.00-32.00C (H370-700C) models, the inching pedal actuates an air cylinder to control the inching spool. On the H20.00-32.00F (H440-700F) models, the movement of the inching spool is controlled by hydraulic pressure from the brake system. When the operator pushes on the inching pedal, the air cylinder or hydraulic pressure pushes the guide for the inching spool into the valve body. When the guide is pushed, the inching spool moves downward and decreases the flow of oil to the direction spools. At the same time, the inching spool lets some oil from the engaged clutch flow to the drain circuit. When the inching spool is completely depressed, it stops the flow of oil to the direction spools. During this same period the passages to the clutch pistons are open to the drain circuit.

For Models H20.00-32.00F **(with auto shift APC 100)**, the inching/brake pedal function is replaced by a declutch/brake pedal function. Slightly pushing this pedal applies braking; further pushing will activate a pressure switch and will fully disengage the transmission via the APC 100 (Automatic Power Control 100).

Direction Spools

The two direction spools fit in the same bore in the valve body. See Figure 8. A spring fits between the spools to keep them in the closed position for **NEUTRAL**. The forward or the reverse spool moves to the open position when the solenoid for **FORWARD** or **REVERSE** is energized. The oil that flows by the direction spools goes to the modulator valve and then the clutch assemblies.

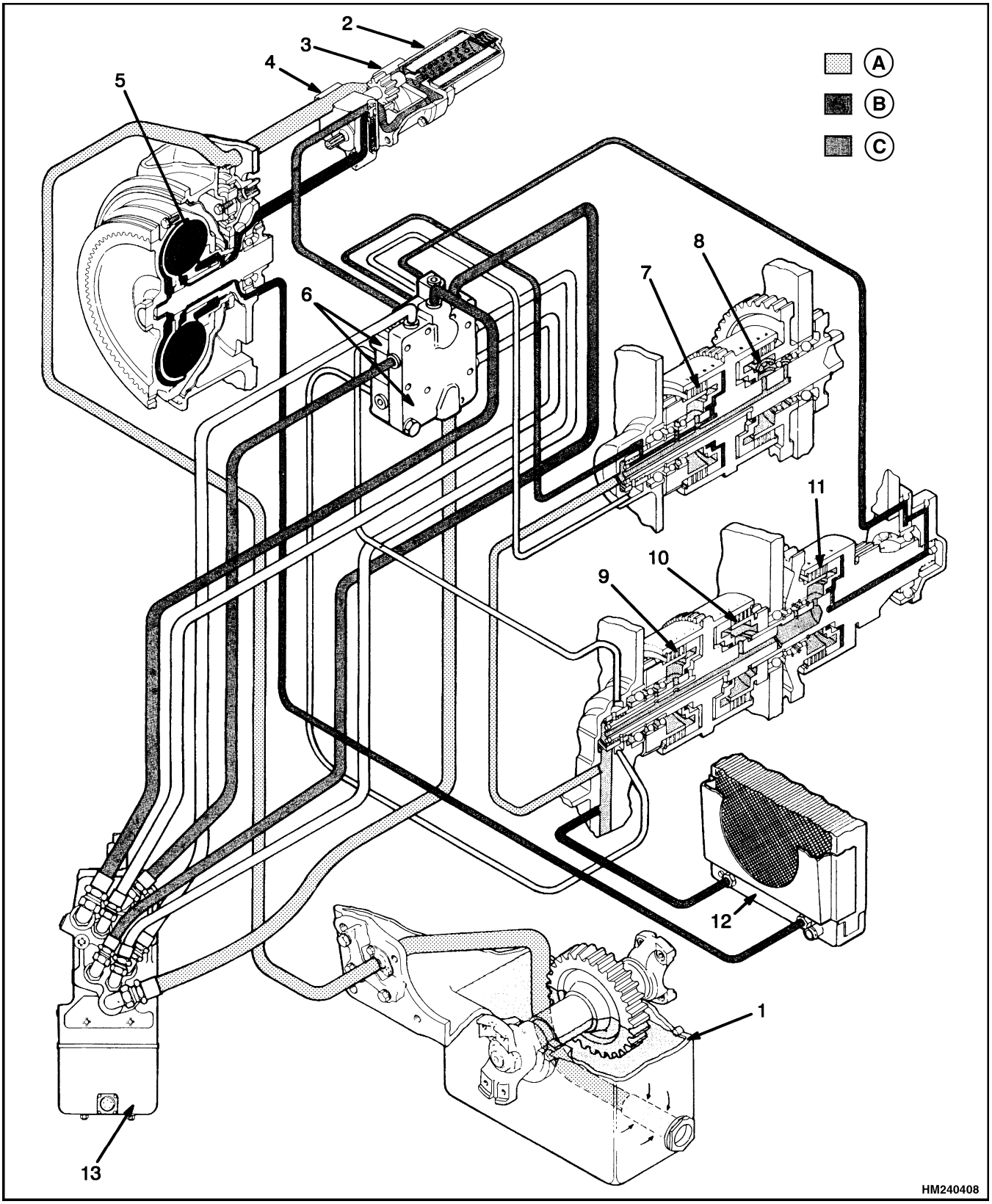


Figure 7. Hydraulic Operation of Transmission

Legend for Figure 7

NOTE: SHOWN IN FORWARD-FIRST.

A. SUCTION, DRAIN, AND LUBRICATION

B. LOW PRESSURE

C. HIGH PRESSURE

1. TRANSMISSION PUMP
2. OIL FILTER
3. OIL PUMP
4. PRESSURE REGULATOR VALVE
5. TORQUE CONVERTER
6. MODULATOR VALVE AND MANIFOLD BLOCK
7. FORWARD CLUTCH
8. THIRD-SPEED CLUTCH
9. REVERSE CLUTCH
10. SECOND-SPEED CLUTCH
11. FIRST-SPEED CLUTCH
12. OIL COOLER
13. SHIFT CONTROL VALVE

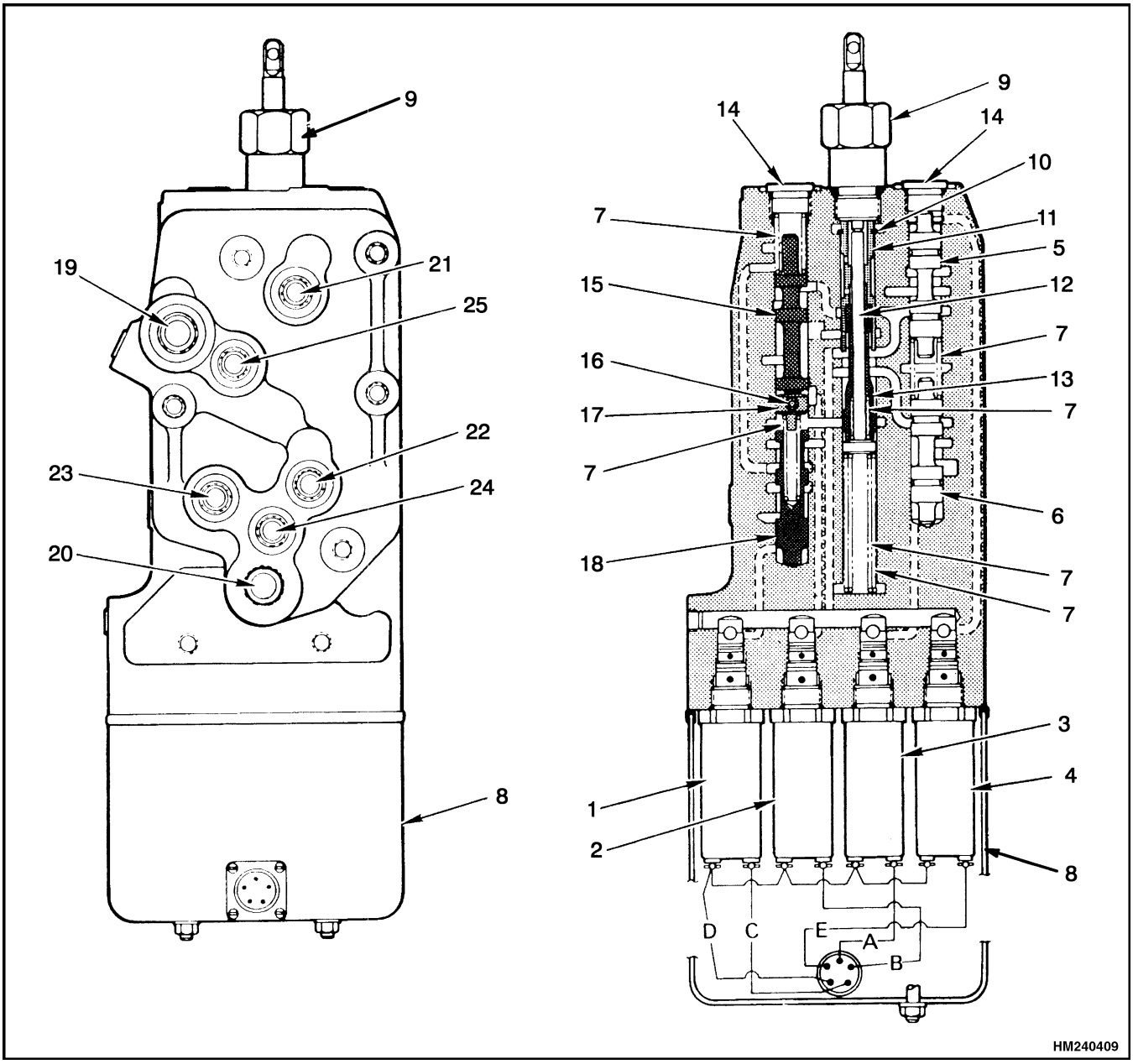


Figure 8. Shift Control Valve

Legend for Figure 8

1. FIRST-SPEED SOLENOID
2. SECOND-SPEED SOLENOID
3. REVERSE SOLENOID
4. FORWARD SOLENOID
5. FORWARD SPOOL
6. REVERSE SPOOL
7. SPRING
8. COVER
9. PLUNGER ASSEMBLY H17.00-32.00C (H370-700C) ONLY
10. SNAP RING
11. SLEEVE
12. GUIDE
13. INCHING SPOOL
14. PLUG
15. THIRD SPEED SPOOL
16. ROLL PIN
17. STOP
18. FIRST- AND SECOND-SPEED SPOOL
19. SUPPLY PORT (IN)
20. DRAIN (OUT)
21. FORWARD PORT
22. REVERSE PORT
23. FIRST-SPEED PORT
24. SECOND-SPEED PORT
25. THIRD-SPEED PORT

Range Spools

The two range spools fit in the same bore in the valve body. See Figure 8. When the transmission is in the **NEUTRAL** position, a spring keeps the spool for first and second speed in the closed position. In **NEUTRAL**, a spring keeps the spool for third speed in the open position. The clutch for third speed is engaged during **NEUTRAL**, while the first and second speed clutches are open to the drain circuit. The range spools change positions when the solenoids for first or second speed are energized.

MODULATOR VALVE AND MANIFOLD BLOCK

The modulator valve controls the action of the forward and reverse clutches. See Figure 9. There is a regulator spool and an accumulator for each direction clutch. Oil from the shift control valve flows to the modulator valve.

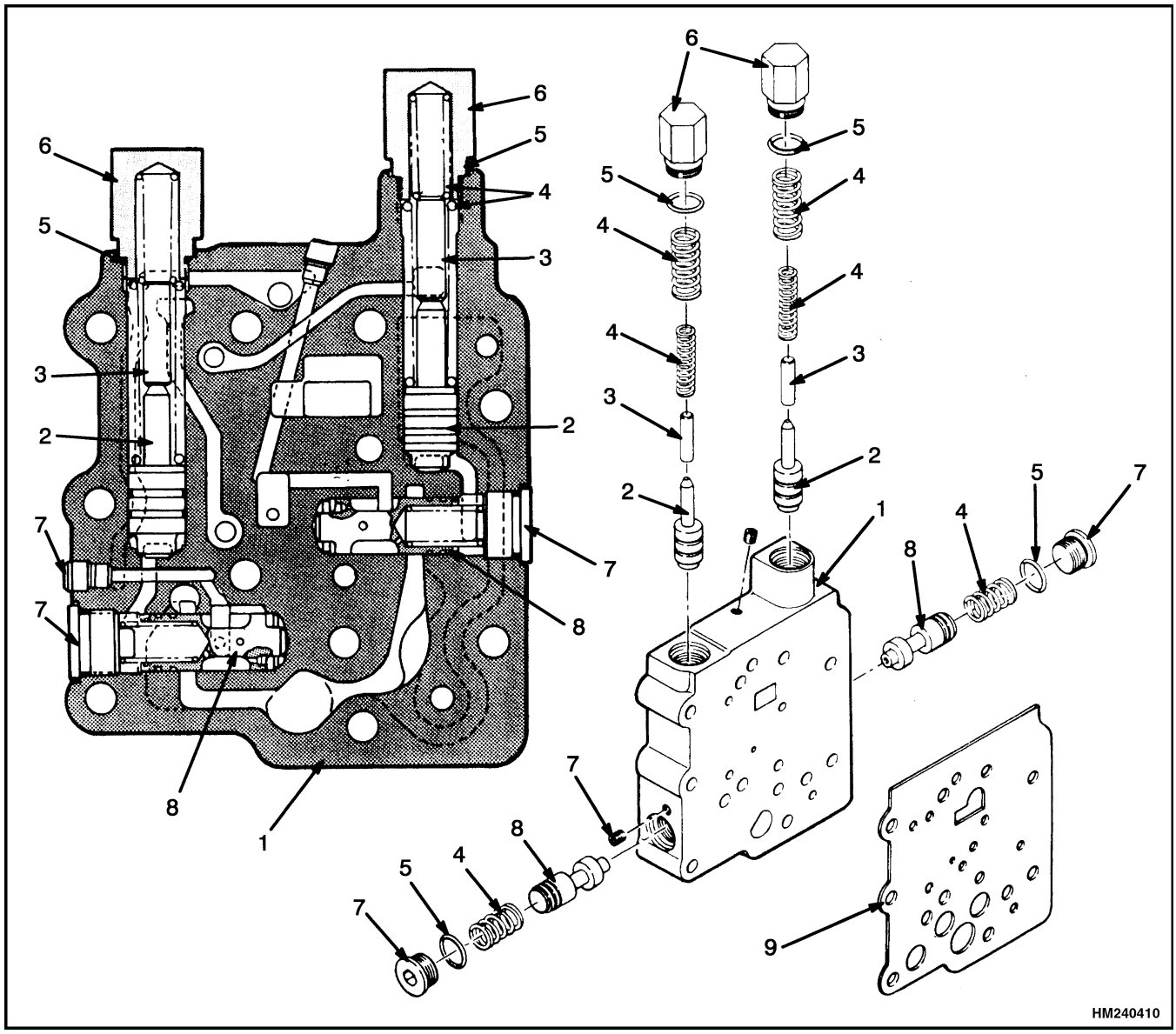
Operation

When the forward solenoid is energized, oil flows by the forward direction spool to the modulator valve. See Figure 10. The oil that flows by the forward direction spool is controlled by the inching spool. At the modulator valve, oil flows to the regulator spool for **FORWARD**. Oil also flows to the spring cavity for the reverse accumulator. At the regulator spool the oil flows through the dampener orifice. The oil pressure moves the regulator spool to open the passage to the drain circuit. The time required to move the regulator spool to open the drain passage permits the clutch supply passages to quickly fill with oil. (This time is shown as the pressure spike in the graph.)

The movement of the regulator spool to keep the drain passage open is opposed by the accumulator and regulator spool springs. There is an initial pressure of approximately 138 kPa (20 psi) on side A of the regulator spool.

The 138 kPa (20 psi) is shown as the horizontal line on the graph. The pressure on side A of the regulator spool is always 69 kPa (10 psi) higher than the pressure on side B of the spool. The difference in pressure is caused by the spring for the regulator spool. Because of the difference in pressures, oil flows through the regulator orifice to side B of the spool.

The 69 kPa (10 psi) supply of oil through the regulator orifice controls the time it takes to fill the accumulator cavity. (This time is shown as the rising slope on the graph.) As the accumulator cavity begins to fill with oil, the pressure against the regulator spool increases. The regulator spool closes the passage to the drain circuit. When the accumulator spool is against its stop, the pressure on both sides of the regulator spool is the same. The clutch pressure increases quickly to the system pressure. (This time is shown as the vertical line on the graph.) The procedure to engage the clutch takes less than 2 seconds.



1. VALVE BODY
2. ACCUMULATOR SPOOL
3. PIN
4. SPRING
5. O-RING
6. CAP
7. PLUG
8. REGULATOR SPOOL
9. GASKET

Figure 9. Modulator Valve

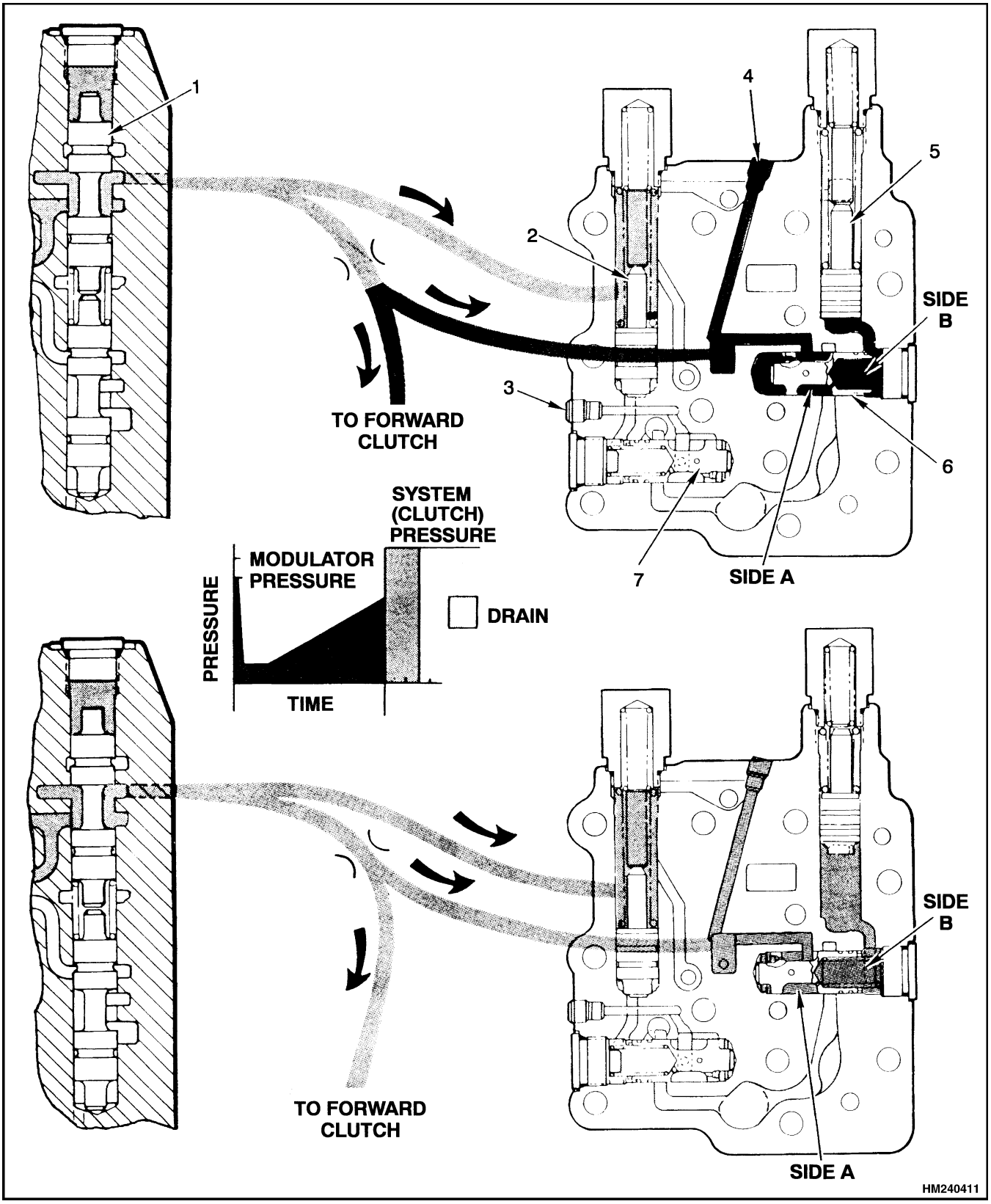


Figure 10. Modulator Valve Operation

Legend for Figure 10

1. FORWARD SPOOL
2. REVERSE ACCUMULATOR
3. REVERSE CLUTCH PRESSURE
4. FORWARD CLUTCH PRESSURE
5. FORWARD ACCUMULATOR
6. FORWARD REGULATOR SPOOL
7. REVERSE REGULATOR SPOOL

TRANSMISSION CONTROL SYSTEM H17.00-32.00C (H370-700C)

The transmission control system uses a range selector lever. See Figure 11 and Figure 12. The range selector lever is installed to the left of the operator on the seat bracket. The lever moves a switch that selects the range and direction for the transmission. The lever and switch have seven positions: **NEUTRAL**, three **FORWARD** ranges, and three **REVERSE** ranges.

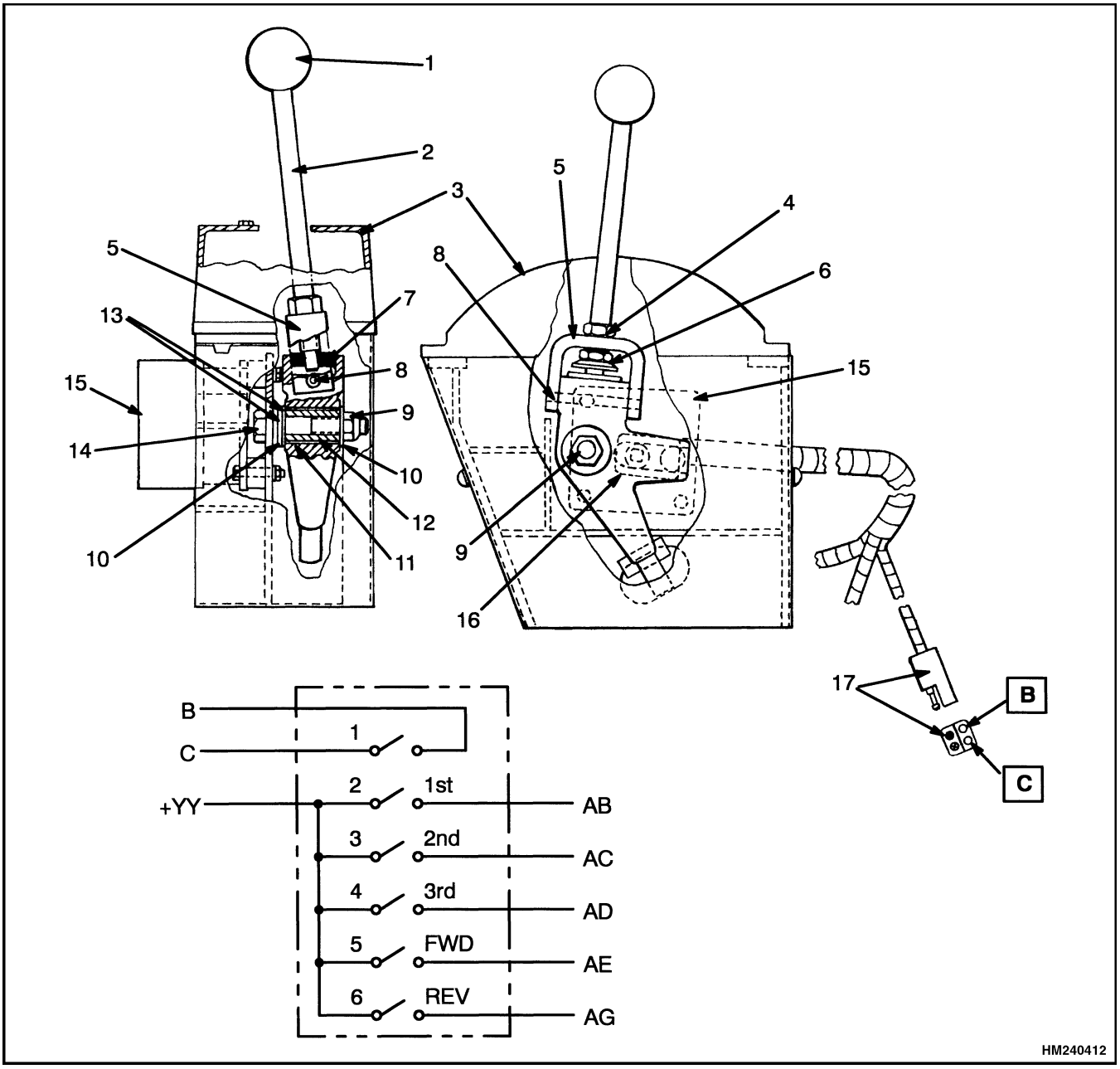
A gate on the lever housing helps prevent moving the lever farther than one position at a time. When the range is selected, electricity flows from the center terminal to the contacts for that range and direction solenoid valves. A wiring harness connects the switch assembly to the solenoid valves.

TRANSMISSION CONTROL SYSTEM H20.00-32.00F (H440-700F) (WITHOUT AUTO SHIFT APC 100)

The transmission control system uses a range selector lever and a direction lever. See Figure 13 and Figure 14. These levers are installed on the left side of the steering column.

Each lever is connected to a shaft that actuates two switches. The direction lever actuates one switch when moved to the **FORWARD** or **REVERSE** position. The second switch is actuated when the lever is moved to the **NEUTRAL** position. The range lever actuates one of the other of two switches, as the lever is moved between the ranges **1**, **2** or **3**. There are seven combinations for the lever and switch positions; three **FORWARD**, three **REVERSE** and the **NEUTRAL** position. When the range shaft is in **3**rd, a direction change cannot be made. The interlock bushing on the range shaft prevents the interlock bushing on the direction shaft from moving past the interlock ball.

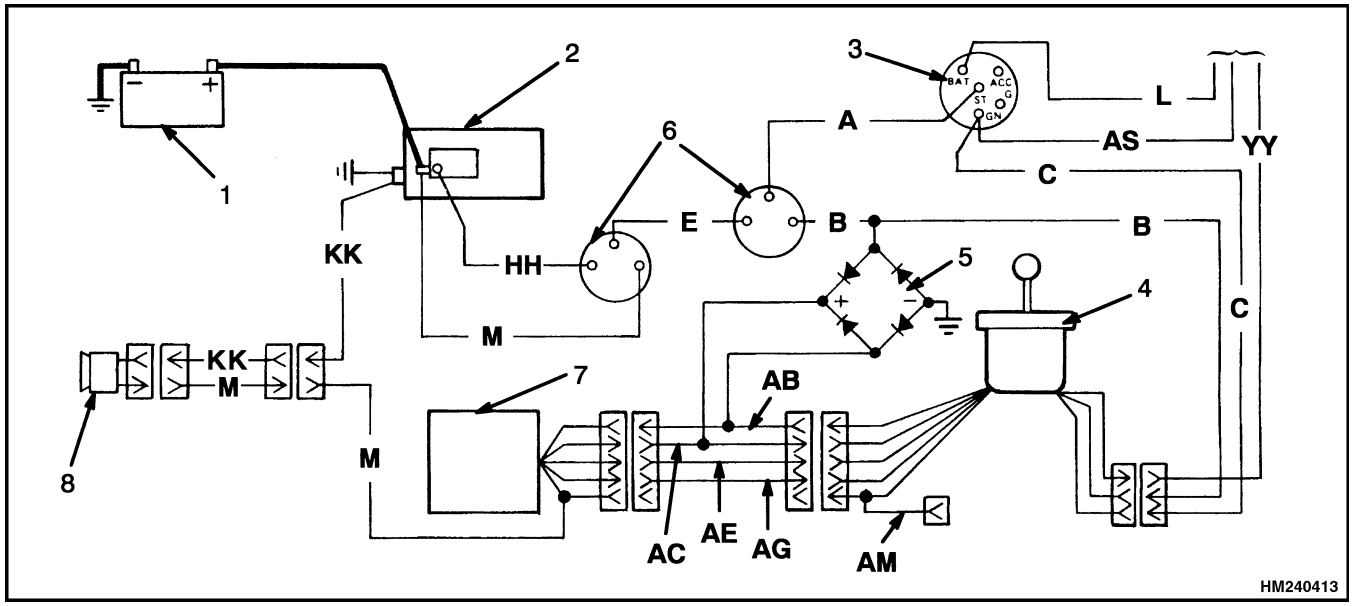
When switches are actuated by the position of the levers, electrical current flows to the contacts of the correct direction or range solenoid valves on the shift control valve. A wiring harness connects the switches to the solenoid valves. See the electrical schematic for the switch assembly contacts.



Lever Position	Contacts Closed	Lever Position	Contacts Closed
F3	4, 5	R1	2, 6
F2	3, 5	R2	3, 6
F1	2, 5	R3	4, 6
N	1		

1. KNOB
2. LEVER
3. COVER
4. UPPER NUT
5. YOKE
6. LOWER NUT
7. RUBBER BUSHING
8. PIN
9. NUT
10. THRUST WASHER
11. BUSHING
12. SPACER
13. WASHER
14. BOLT
15. SWITCH
16. SWITCH CRANK
17. 4-PIN CONNECTOR

Figure 11. Transmission Control Assembly H17.00-32.00C (H370-700C)



Wire Codes											
A	=	Yellow	M	=	Green	AE	=	Blue	AR	=	Orange
B	=	Red	P	=	Orange	AG	=	Green	AS	=	Black
C	=	Green	X	=	White	AM	=	Green	HH	=	Orange
E	=	Blue	AB	=	Green	AN	=	Black	KK	=	Black
L	=	White	AC	=	Yellow	AP	=	White	YY	=	Blue

1. BATTERY
2. STARTER
3. KEY SWITCH
4. TRANSMISSION CONTROL ASSEMBLY
5. DIODE BLOCK
6. SOLENOID SWITCH
7. SHIFT CONTROL VALVE
8. REVERSE ALARM

Figure 12. Transmission Control Assembly Electrical Schematic H17.00-32.00C (H370-700C)