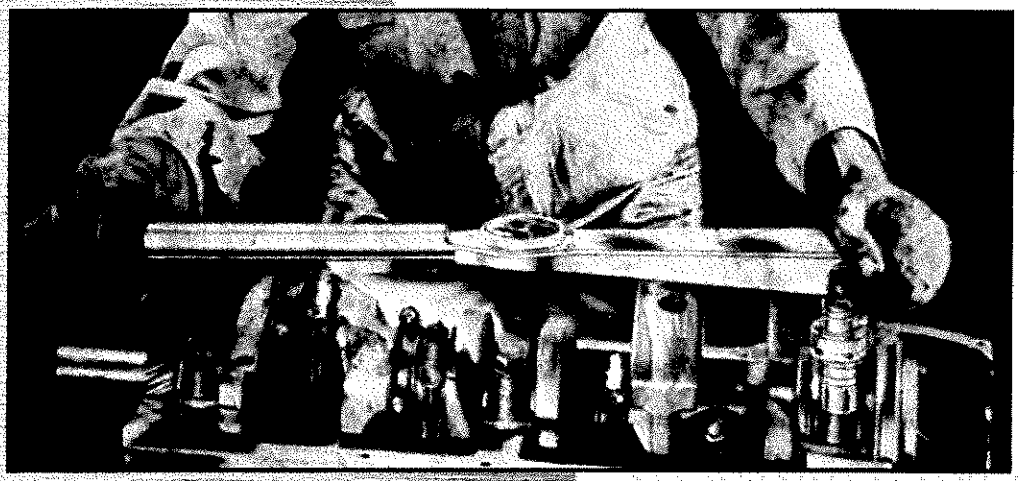


Caterpillar

Service Manual

7155 Truck Transmission S/n 56K1 & Up

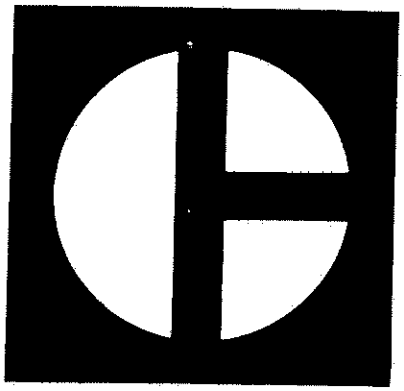
JENSALES

CT-S-7155 TRAN

Service Manual

NOTES

FORM NO. SENR7002



SERVICE MANUAL

7155 TRANSMISSION

SERIAL NUMBERS
56K1-UP

INTRODUCTION

This publication has instructions and procedures for the subject on the front cover. The information, specifications, and illustrations in this publication are on the basis of information that was current at the time this issue was written.

Correct operation, maintenance, test and repair procedures will give this product a long service life. Before starting a test, repair or rebuild job, the serviceman must read the respective sections of the Service Manual, and know all the components he will work on.

Your safety, and the safety of others, is at all times very important. When you see this symbol  or this symbol  in the manual, you must know that caution is needed for the procedure next to it. The symbols are warnings. To work safely, you must understand the job you do. Read all instructions to know what is safe and what is not safe.

It is very important to know the weight of parts. Do not lift heavy parts by hand. Use a hoist. Make sure heavy parts have a good stability on the ground. A sudden fall can cause an accident. When lifting part of a machine, make sure the machine has blocks at front and rear. Never let the machine hang on a hoist, put blocks or stands under the weight.

When using a hoist, follow the recommendation in the manual. Use correct lift tools as shown in illustrations to get the correct balance of the component you lift. This makes your work safer at all times.

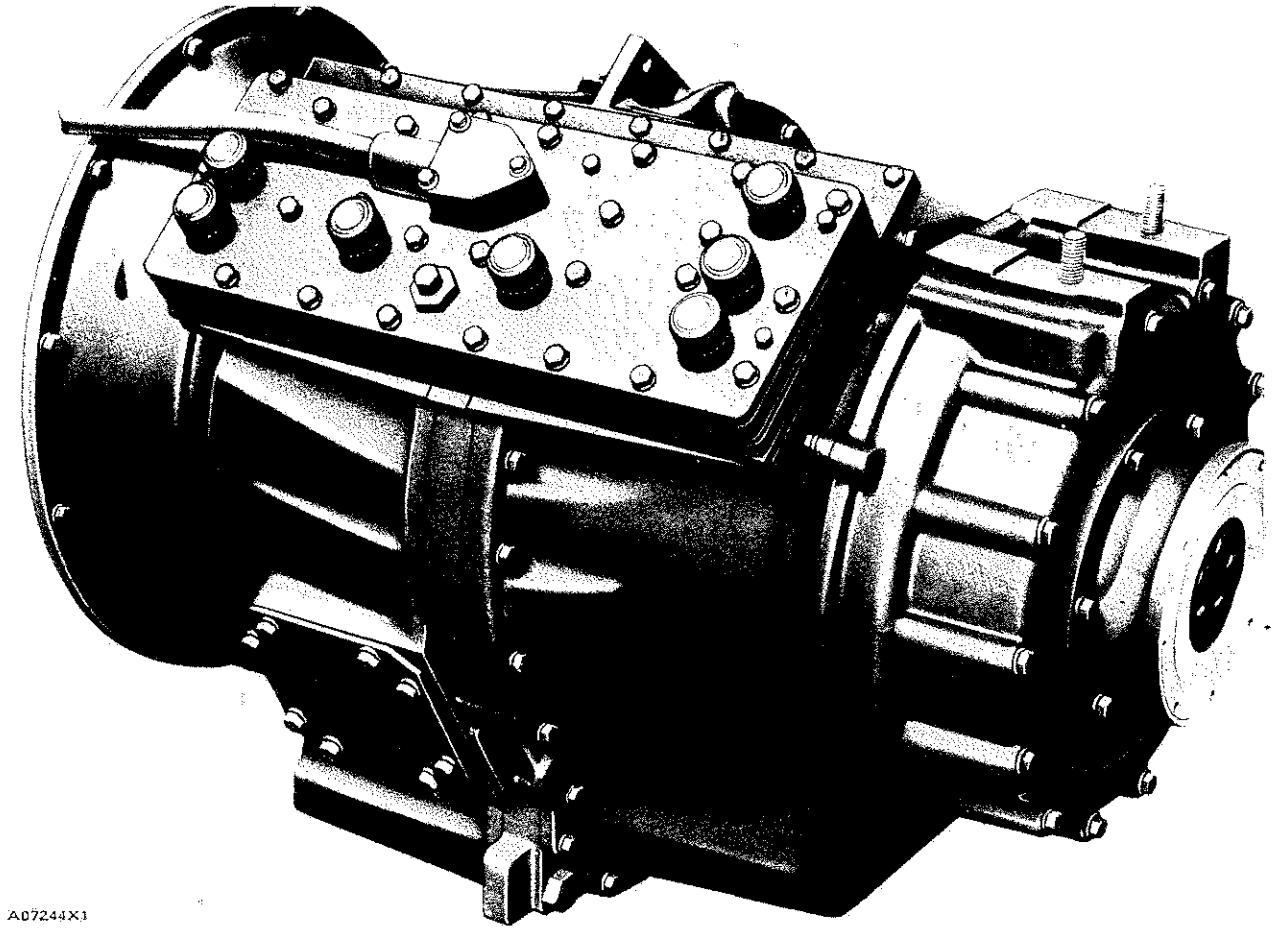
SYSTEMS OPERATION

TESTING AND ADJUSTING

DISASSEMBLY AND ASSEMBLY

SPECIFICATIONS

GENERAL INFORMATION



7155 TRANSMISSION

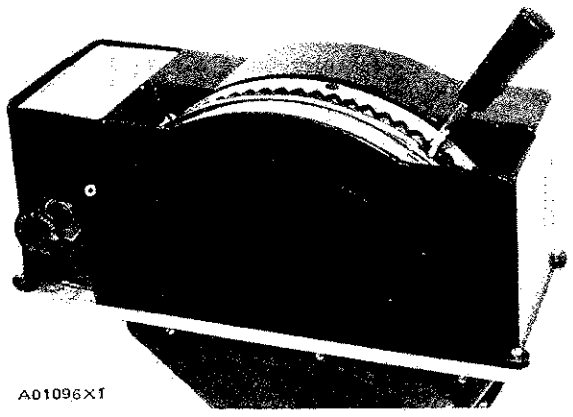
The 7155 Transmission is a 16 speed, mechanical drive transmission. The operator controls the gear ratio selection by moving the lever of the ratio selector in the truck cab. The shift is made automatically in the transmission when an order (air pressure) is sent from the ratio selector in the truck cab to the control group in the transmission.

This shift is made by the following method:

1. The gear section of the transmission is temporarily disconnected from the engine and the rear wheels of the truck.
2. The rotation of the gear section is stopped.
3. The gear couplings are moved for a new gear ratio.
4. The gear section is given rotation again.
5. The gear section of the transmission is connected to the engine and to the rear wheels of the truck again. The shift is now complete.

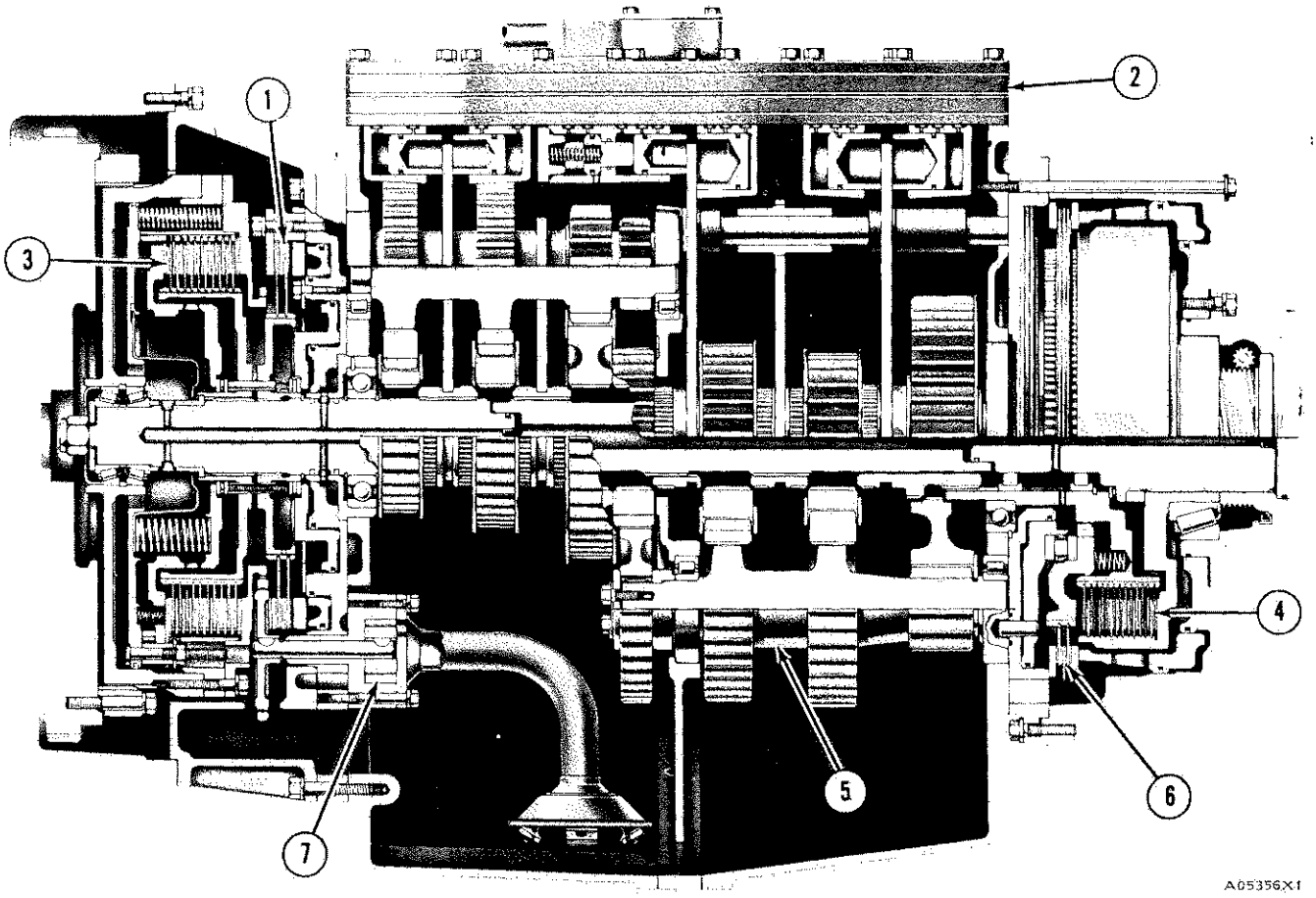
This method of making a shift is known as "stop and go".

When starting to move the truck from a stop, a clutch in the front of the transmission gradually (and automatically) engages as the engine rpm has an increase. This clutch has no mechanical control (clutch pedal).



RATIO SELECTOR

TRANSMISSION COMPONENTS



TRANSMISSION COMPONENTS

1. Input brake. 2. Transmission control. 3. Input clutch. 4. Output clutch. 5. Gear group. 6. Output brake. 7. Oil pump.

INPUT CLUTCH GROUP

The input clutch group (3) connects the engine flywheel to the transmission input shaft. The clutch group has several plates and discs that are made cool by oil. The input clutch is engaged by oil pressure. This oil pressure is made by centrifugal force (the force of rotation) on the oil in the clutch. The force of engagement has an increase as the engine rpm has an increase. The input clutch is released by air pressure. When the clutch is engaged, power is sent from the engine to the input shaft of the transmission.

INPUT BRAKE GROUP

The input brake group (1) is connected to the input shaft of the transmission. The input brake works in combination with the output brake (6) to stop the rotation of the gear group (5). The input brake has a plate and two discs that are made cool by oil. Air pressure is used to activate or engage the brake. Spring force is used to release the brake and to hold it out of the engaged condition. When the brake is activated, the rotation of the gear group is stopped.

GEAR GROUP

The gear group (5) is made up of two sections with three countershafts in each section. A center gear set is engaged with the three countershafts. The torque is divided and sent through the three countershafts. Reverse idlers are on the front of the rear countershafts.

All gears are constantly engaged. Shift collars, moved by forks, cause the connection between the center shaft (with splines on the outside) and the center gears (with splines on the inside). The result is the selection of the desired gear ratio or transmission speed.

The gear group has 16 different forward speeds and two speeds in reverse.

OUTPUT BRAKE GROUP

The output brake group (6) is connected to the gear group of the transmission. The output brake works in combination with the input brake (1) to stop the rotation of the gear group (5). The output brake has a plate and two discs that are made cool by oil. Air pressure is used to activate or engage the brake. Spring force is used to release the brake and hold it out of the engaged condition. When the brake is activated, the rotation of the gear group is stopped.

OUTPUT CLUTCH GROUP

The output clutch group (4) connects the gear group of the transmission to the output shaft of the transmission. The clutch group has several plates and discs that are made cool by oil. The output clutch is engaged by air pressure. Spring force is used to release the clutch. When the clutch is engaged, power is sent from the gear group of the transmission to the output shaft and to the drive line of the truck.

TRANSMISSION CONTROL GROUP

The transmission control group (2) has air cylinders that move the shift forks. These air cylinders are activated in the correct sequence for the desired transmission speed by air pressure sent from the ratio selector (8).

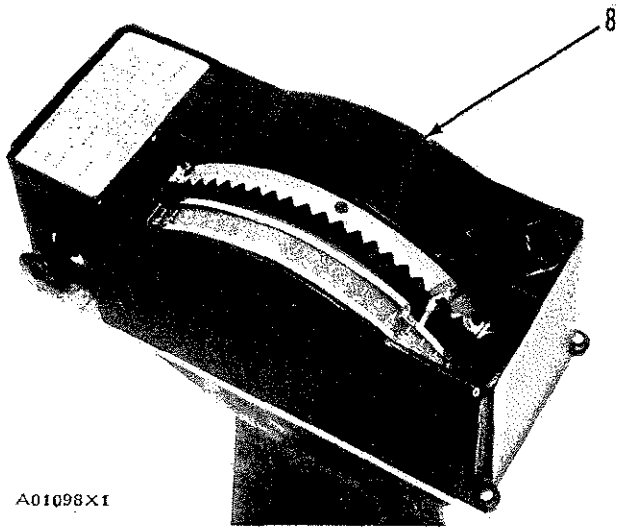
OIL PUMP

The oil pump (7) is driven through a connection to the flywheel of the engine. The oil pump has three functions:

1. To give oil to fill the input clutch [centrifugal force (the force of rotation) works on this oil].
2. To give oil for the lubrication of the clutches and brakes and to keep them cool.
3. To give oil for the lubrication of the gear group and to keep it cool.

RATIO SELECTOR

The ratio selector (8) is in the truck cab and is connected to the transmission with an air line. The operator moves the lever of the ratio selector to make the selection of the desired gear ratio or transmission speed. The ratio selector then sends an order (air pressure) through the air line to the transmission control (2).



RATIO SELECTOR

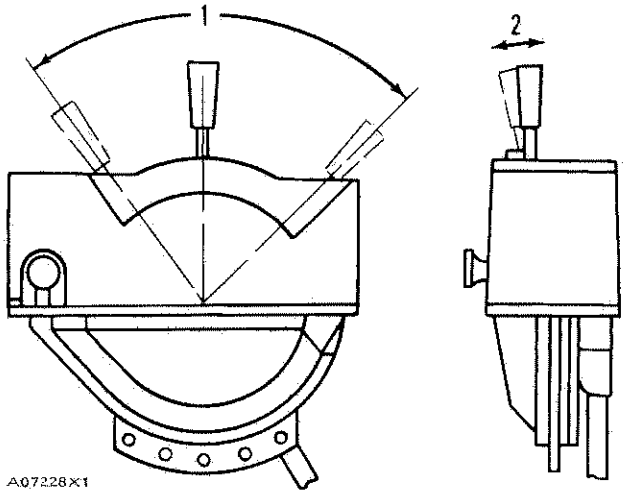
8. Ratio selector.

TRANSMISSION OPERATION

When starting to move the truck from a stop, the input clutch is engaged by centrifugal force (the force of rotation) working on the oil in the piston area of the input clutch. This clutch starts to engage at approximately 775 rpm and it is fully engaged at approximately 1000 rpm. The selection of a correct gear ratio (transmission speed) must be made to prevent a long period of time in the 775 to 1000 rpm range. Long periods of time (approximately 12 seconds) will cause high clutch wear.

The output clutch is held in the fully engaged condition by air pressure. This clutch is used to transfer torque to the drive line of the truck.

When the truck is moving, the operator changes the gear ratio (transmission speed) by moving the selector lever of the ratio selector in the truck cab. The selector lever has two basic movements: forward or backward (1) and to the side (2).



SELECTOR LEVER MOVEMENT

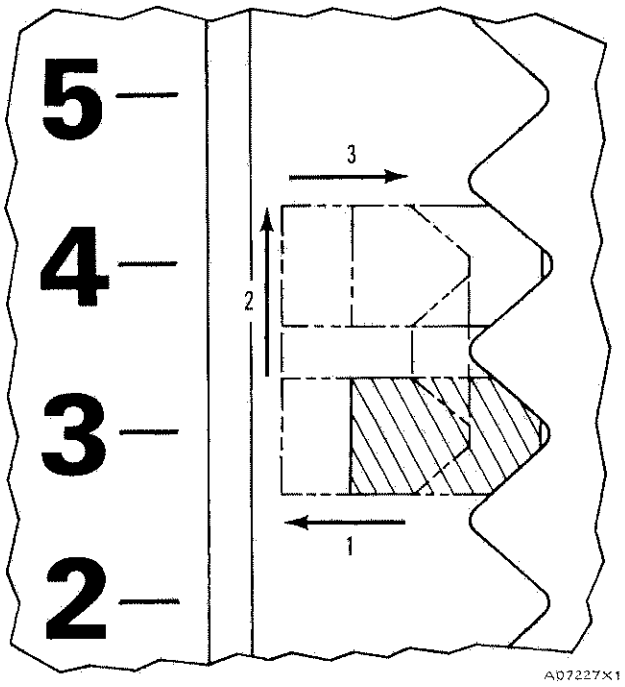
1. Forward or backward. 2. To the side.

A. The movement to the outside (3) removes the selector lever from the present speed detent and engages the shift inhibitor. The shift inhibitor is a mechanical unit in the ratio selector that prevents the operator from making a shift through more detents at one time than would be usable. The inhibitor controls the shifts to two step shifts (1st to 3rd, 3rd to 5th) up to 11th speed and to give one step shifts (12th to 13th, 13th to 14th) from 11th through 16th speed. The inhibitor has the same control when a shift is made in the down direction. Make reference to SHIFT INHIBITOR.

The shift inhibitor can be removed from operation by pulling the selector lever up. This will let the operator make a shift through as many detents as necessary. This procedure is useful when using the service brakes or making a shift to a starting ratio after a sudden stop.

B. The movement of the selector lever in the forward (4) or backward direction makes the selection of the desired ratio as controlled by the inhibitor.

C. The movement to the inside (5) engages the selector lever in the new detent position, releases the shift inhibitor, and gives an order to the transmission control to change from the present gear ratio (transmission speed) to the new gear ratio.



SELECTOR LEVER MOVEMENT

3. To the outside. 4. Forward. 5. To the inside.

After the transmission control gets the order from the ratio selector, it causes the following sequence of operations in the transmission:

A. The input clutch and the output clutch are released by sending air pressure to the input clutch and removing air pressure from the output clutch.

B. The input brake and the output brake are activated by sending air pressure to their respective pistons. The rotation of the gear section is stopped.

C. Shift forks are moved by air cylinders in the transmission control. The shift forks move the gear couplings toward their new positions for the gear ratio (transmission speed) selection made by the operator.

D. The input brake is now released. The friction of the input clutch which is still not engaged causes the rotation of the gear set against the rear brake which is still activated. This action causes any couplings that were not in alignment before to now engage. An indication that the gear couplings are engaged correctly is sent to the transmission control.

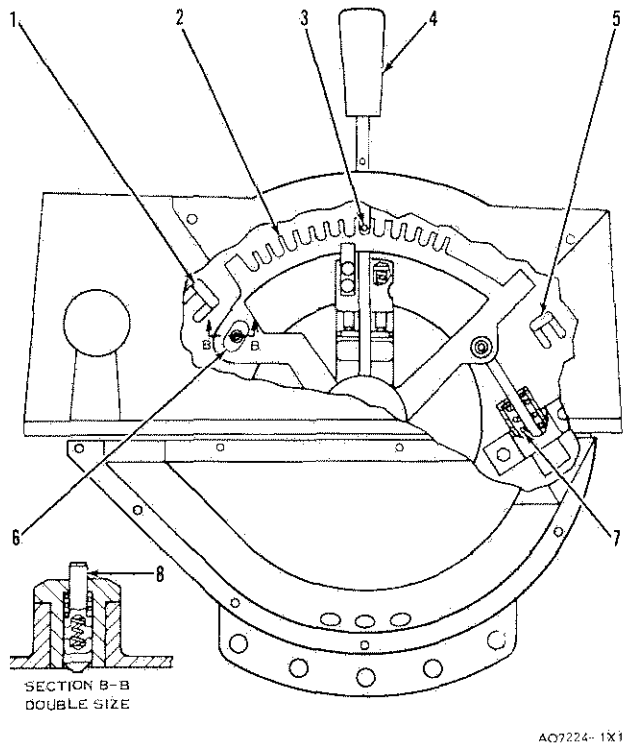
NOTE: If the transmission control does not get the indication that the gear couplings are engaged correctly in Step D, the output brake is released. This lets the friction of the input and the output clutches which are still not engaged give an increase to the rotation of the gear set. This action lets couplings that are held in a not fully engaged condition become completely engaged. This action also gives a reduction in the difference in the speeds of rotation across a gear coupling to let it become engaged. An indication that the gear couplings are now engaged correctly is sent to the transmission control.

E. After getting the indication that all gear couplings have engaged correctly, the transmission control releases the output brake. Next, the input clutch is engaged by removing the air pressure from it. Then the transmission control sends air pressure to the output clutch to engage it.

F. The shift is now complete. The time necessary for a shift is from .6 to 1.0 seconds.

SHIFT INHIBITOR

When the selector lever (4) is moved toward the side, the pin (3) in the selector lever engages in a tooth in the inhibitor plate (2). As the selector lever is moved forward or backward for a new ratio selection, the pin (3) moves the inhibitor plate with the selector lever. The inhibitor plate can move until it makes contact with pad (1) or pad (5). The inhibitor plate stops the selector lever from moving any farther. The location of the pads (1) and (5) let the selector lever be moved two steps at a time (for example: 3rd to 5th speed).



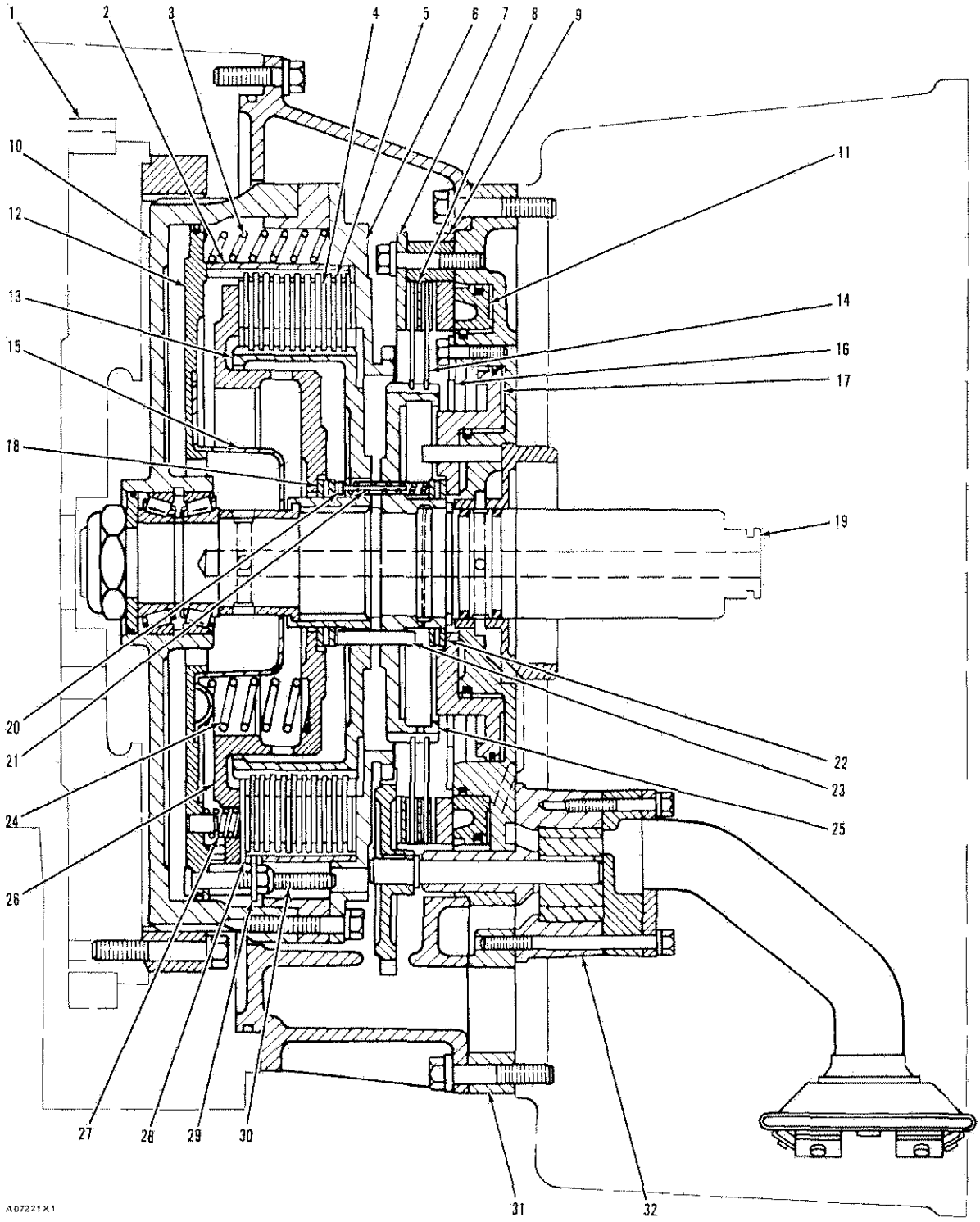
SHIFT INHIBITOR

1. Pad. 2. Inhibitor plate. 3. Pin. 4. Selector lever. 5. Pad. 6. Slot. 7. Spring. 8. Plunger.

After the selector lever (4) is in its new detent in the ratio selector, the pin (3) is out of the tooth, and the spring (7) moves the inhibitor plate back to the center position.

When the ratio selector is in 11th speed or above, a cam plate in the ratio selector moves the plunger (8) up into slot (6) in the inhibitor plate. This plunger stops the movement of the inhibitor plate after each step (for example: 12th to 13th speed).

INPUT CLUTCH AND INPUT BRAKE



INPUT CLUTCH AND INPUT BRAKE IN NORMAL OPERATION

1. Flywheel.
2. Hub.
3. Spring.
4. Disc.
5. Plate.
6. Plate.
7. Plate.
8. Plate.
9. Plate
10. Adapter.
11. Piston.
12. Piston.
13. Hub.
14. Disc.
15. Deflector.
16. Ring.
17. Piston.
18. Thrust bearing.
19. Input shaft.
20. Pin
21. Spring.
22. Thrust bearing.
23. Pin.
24. Spring.
25. Hub.
26. Plate.
27. Spring.
28. Plate.
29. Washer.
30. Bolt.
31. Plate.
32. Oil pump.

INPUT CLUTCH

The input clutch connects the engine flywheel to the transmission input shaft (19). This clutch uses ten discs (4) with a friction material of "red paper" and ten steel plates (5). The clutch plates and discs are made cool by oil.

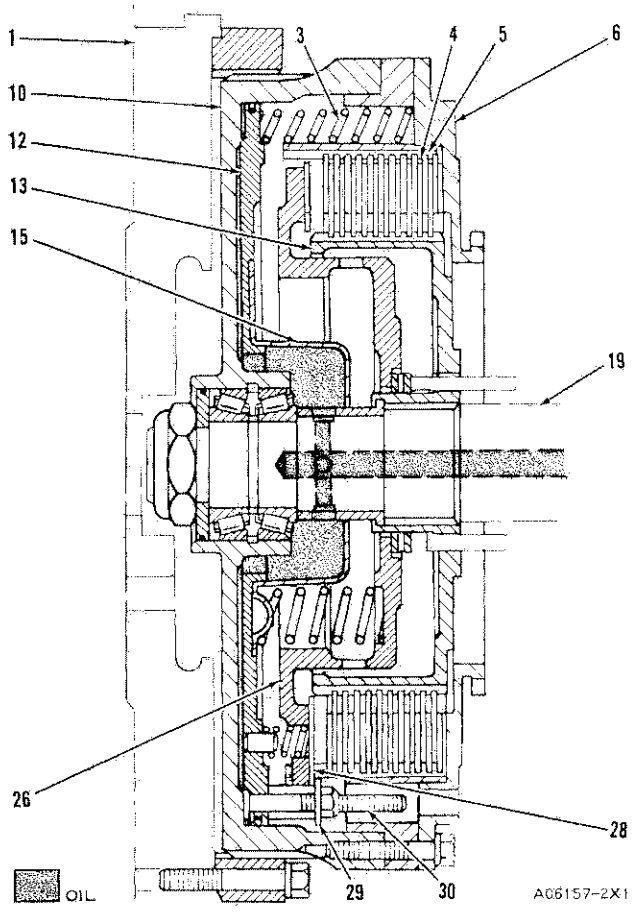
All the components of the input clutch except the hub (13) and the discs (4) are connected to and turn with the engine flywheel. The discs and the hub are connected to the transmission input shaft (19).

At low idle, 16 springs (3) hold the piston (12) against the adapter (10). In this position, the washers (29) on the four bolts (30) hold plate (26) and plate (28) away from the clutch plates (5) and discs (4). The plates are free to turn in relation to the discs and the power from the engine does not go to the input shaft (19).

An oil pump (32), turned constantly by a gear on plate (6), sends oil through the center of the input shaft. This oil goes into a reservoir made by the deflector (15) and into the small space between the piston (12) and the adapter (10). The pressure of this oil is approximately 6 psi (0.4 kg/cm^2).

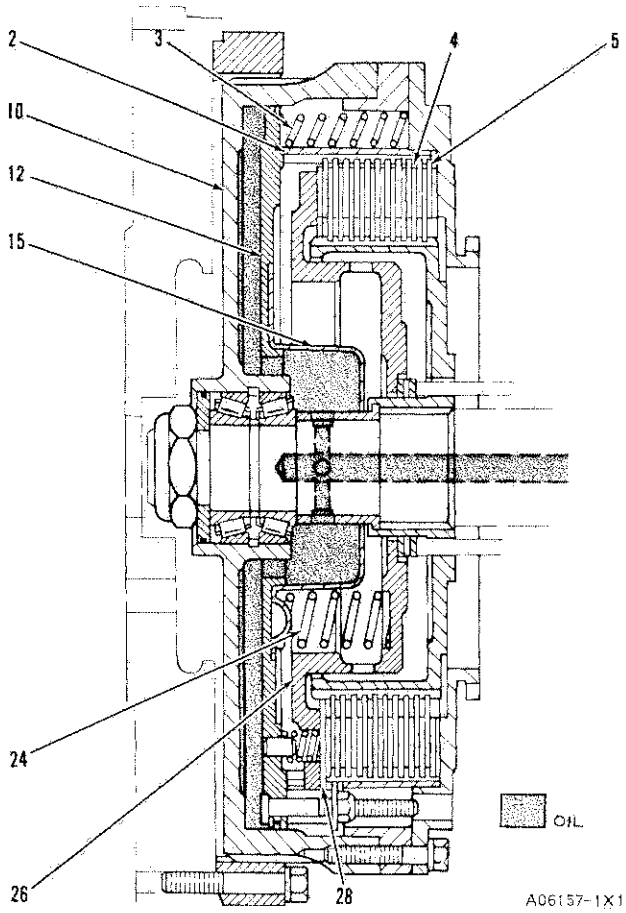
As the engine rpm has an increase (above approximately 775 rpm), centrifugal force (the force of rotation) causes the oil in the deflector (15) and in the space between the piston (12) and the adapter (10) to have an increase in pressure. This oil pressure moves the piston (12) to the right and causes the compression of springs (3). The piston will move until it makes contact with hub (2) at approximately 1200 rpm.

As the piston (12) is moved to the right, plate (26) is moved toward the clutch plates (5) and discs (4). After plate (28) makes contact with the clutch plate, any more movement of the piston causes the compression of the 16 springs (24). The compression of these springs is the force that holds the clutch plates and discs together.



INPUT CLUTCH (NOT ENGAGED)

1. Flywheel. 3. Spring. 4. Disc. 5. Plate. 6. Plate. 10. Adapter. 12. Piston. 13. Hub. 15. Deflector. 19. Input shaft. 26. Plate. 28. Plate. 29. Washer. 30. Bolt.



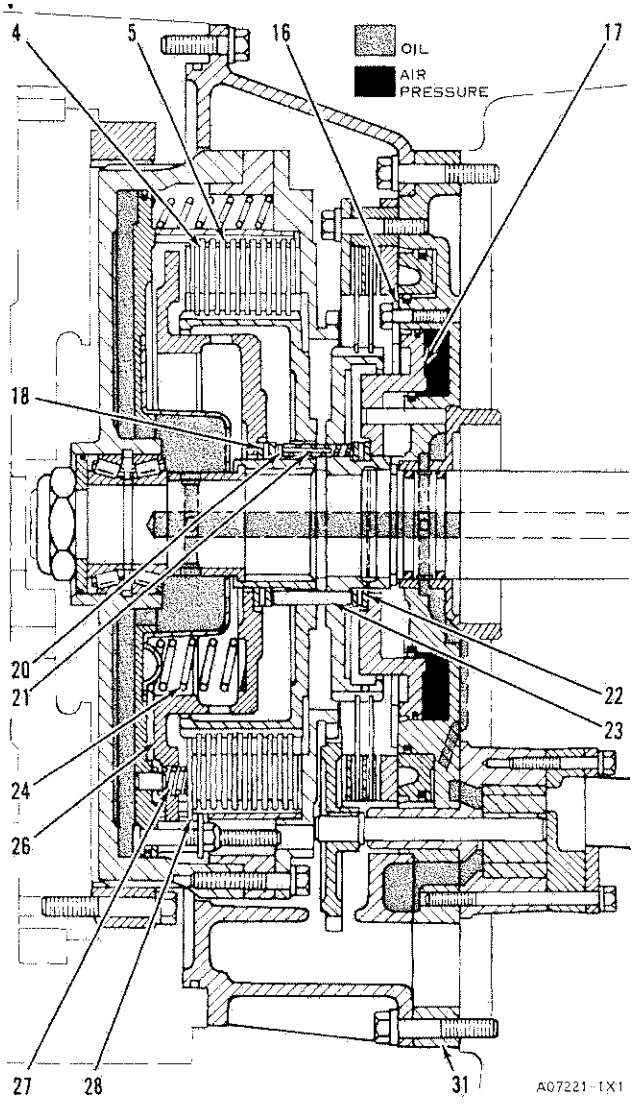
INPUT CLUTCH (ENGAGED)

2. Hub. 3. Spring. 4. Disc. 5. Plate. 10. Adapter. 12. Piston. 15. Deflector. 24. Spring. 26. Plate. 28. Plate.

In this position, the clutch is fully engaged and power from the engine is sent to the input shaft of the transmission.

While making a shift, the input clutch must be taken out of the engaged condition. Before moving the gear couplings, the transmission control sends air pressure through plate (31) to a space behind piston (17). This air pressure moves the piston (17) to the left until it makes contact with ring (16). As the piston (17) is moved to the left it pushes the eight pins (23) toward plate (26).

NOTE: The four pins (20) and springs (21) keep the thrust bearings (18) and (22) in contact with their races when the piston (17) does not have air pressure.



INPUT CLUTCH RELEASED DURING A SHIFT

4. Disc. 5. Plate. 16. Ring. 17. Piston. 18. Thrust bearing. 20. Pin. 21. Spring. 22. Thrust bearing. 23. Pin. 24. Spring. 26. Plate. 27. Spring. 28. Plate. 31. Plate.

After the eight pins (23) make contact with the plate (26), more movement of piston (17) causes plate (26) to move away from the clutch plates (5) and discs (4) and to give the 16 springs (24) more compression. The clutch is now released.

Four light springs (27) hold plate (28) in contact with the clutch plates (5) and discs (4) during a shift. This causes a small amount of friction in the clutch to give aid for gear coupling changes.

After the gear couplings are moved, the transmission control removes the air pressure from behind piston (17). The force of springs (24) causes the plate (26) to move to the right. The clutch is now engaged again.

The movement of plate (26) and the force of springs (24) cause the piston (17) to move back to its original position.

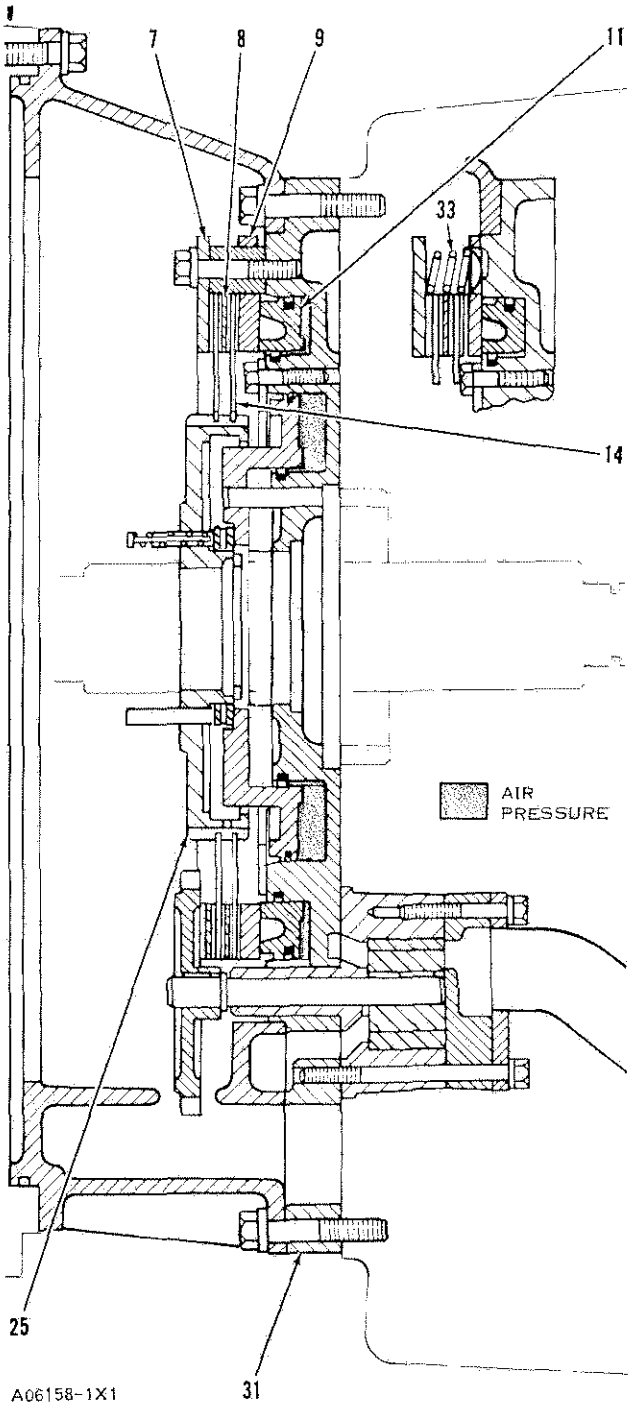
INPUT BRAKE

The input brake is connected to the input shaft of the transmission. It works in combination with the output brake to stop the rotation of the gear group. The input brake uses two discs (14) with a "paper" friction material and one steel plate (8). The discs and plate are made cool by oil.

The hub (25) and the discs (14) are connected to and turn with the input shaft. Plates (7), (8), and (9) are held in a stationary position. Eight springs (33) push against plate (7) to keep the discs and plates apart. In this position, the discs are free to turn in relation to the plates and the input shaft can turn freely.

While making a shift, the input brake must be activated. Before moving the gear couplings, the transmission control sends air pressure through plate (31) to a space behind piston (11). This air pressure moves the piston (11) to the left until the discs and plates are pushed together. Now the input shaft can not turn and the gear group is stopped.

After the gear couplings are moved, the transmission control removes the air pressure from behind piston (11). The force of springs (33) causes the discs and plates to move apart and the piston (11) to move back to its original position. Now the input shaft is free to turn again.



INPUT BRAKE (ACTIVATED)

7. Plate. 8. Plate. 9. Plate. 11. Piston. 14. Disc. 25. Hub. 31. Plate. 33. Spring.

LUBRICATION

A gerotor type oil pump (32) turns constantly with the engine flywheel. The output of the oil pump is:

29.0 U.S. gpm (109.8 lit/min) at 2000 engine rpm.
14.8 U.S. gpm (56.0 lit/min) at 1000 engine rpm.

The pump flow is divided as follows at 1000 engine rpm:

8.9 U.S. gpm (33.7 lit/min) to input clutch.
4.0 U.S. gpm (15.1 lit/min) to gear section.
1.2 U.S. gpm (4.5 lit/min) to output clutch.
.7 U.S. gpm (2.7 lit/min) to input brake.

At approximately 1200 engine rpm or 12 psi (0.8 kg/cm^2) oil pressure, a priority valve opens in the transmission to cause an increase in flow to the gear section. The pump flow is as follows at 2000 engine rpm:

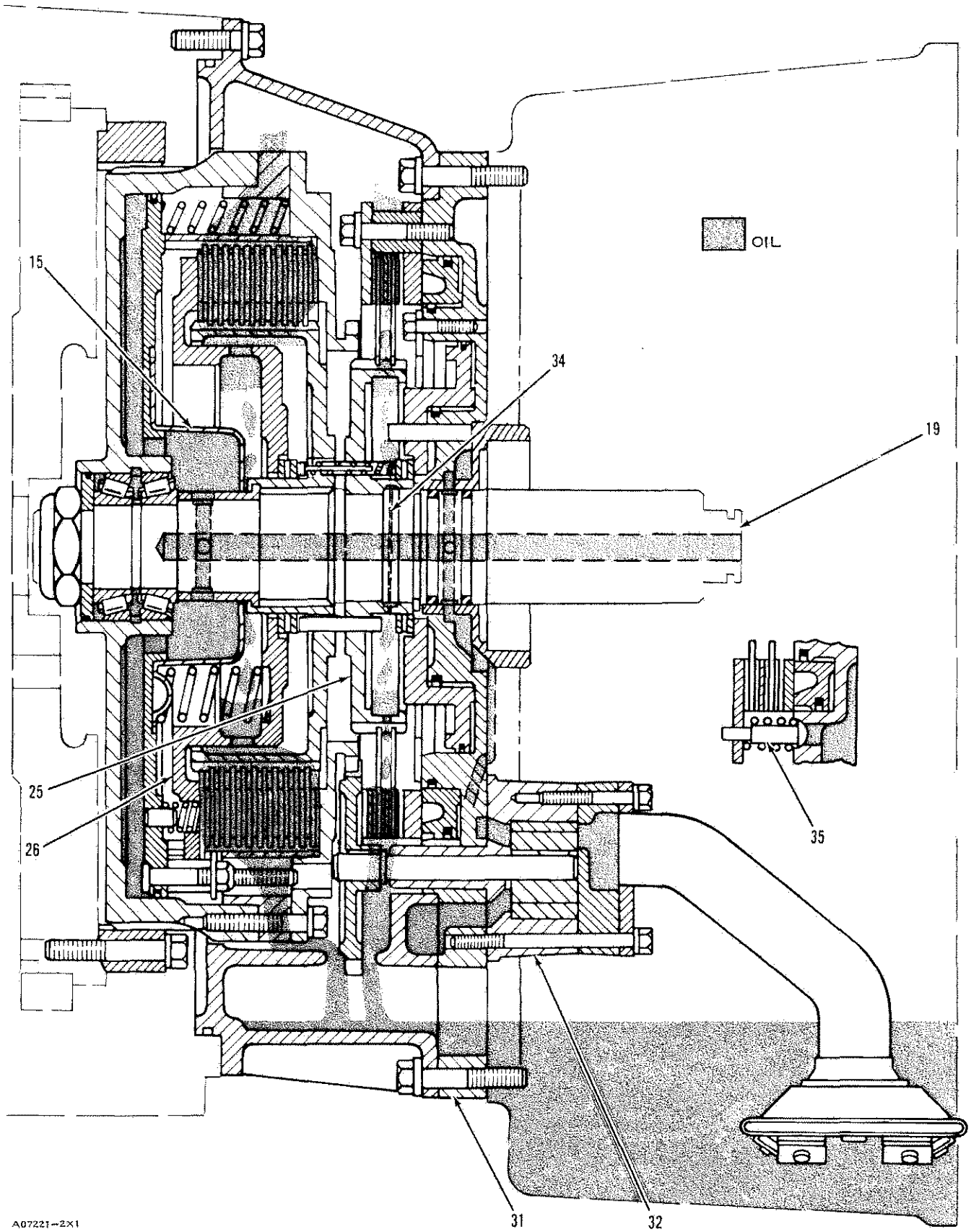
14.0 U.S. gpm (53.0 lit/min) to input clutch.
12.0 U.S. gpm (45.4 lit/min) to gear section.
2.0 U.S. gpm (7.6 lit/min) to output clutch.
1.0 U.S. gpm (3.8 lit/min) to input brake.

The normal oil pressure in the system is approximately 25 psi (1.8 kg/cm^2). A relief valve (35) in plate (31) will open at approximately 35 to 40 psi (2.5 to 2.8 kg/cm^2) to prevent cold oil from causing high oil pressure.

The oil for the lubrication of the input clutch and brake is sent from the oil pump (32) through a passage in plate (31) to a hole in the center of the input shaft (19).

The oil for the input clutch goes into a reservoir made by the deflector (15). When the input clutch is full, oil can go out of the reservoir through notches in the deflector (15). This oil goes out through holes in plate (26) to make the clutch cool.

The oil for the input brake goes through two small holes (34) in the input shaft and out through holes in hub (25) to make the brake cool.



LUBRICATION OF INPUT CLUTCH AND BRAKE

15. Deflector. 19. Input shaft. 25. Hub. 26. Plate. 31. Plate. 32. Oil pump. 34. Hole. 35. Relief valve.

GEAR GROUP

DESIGN

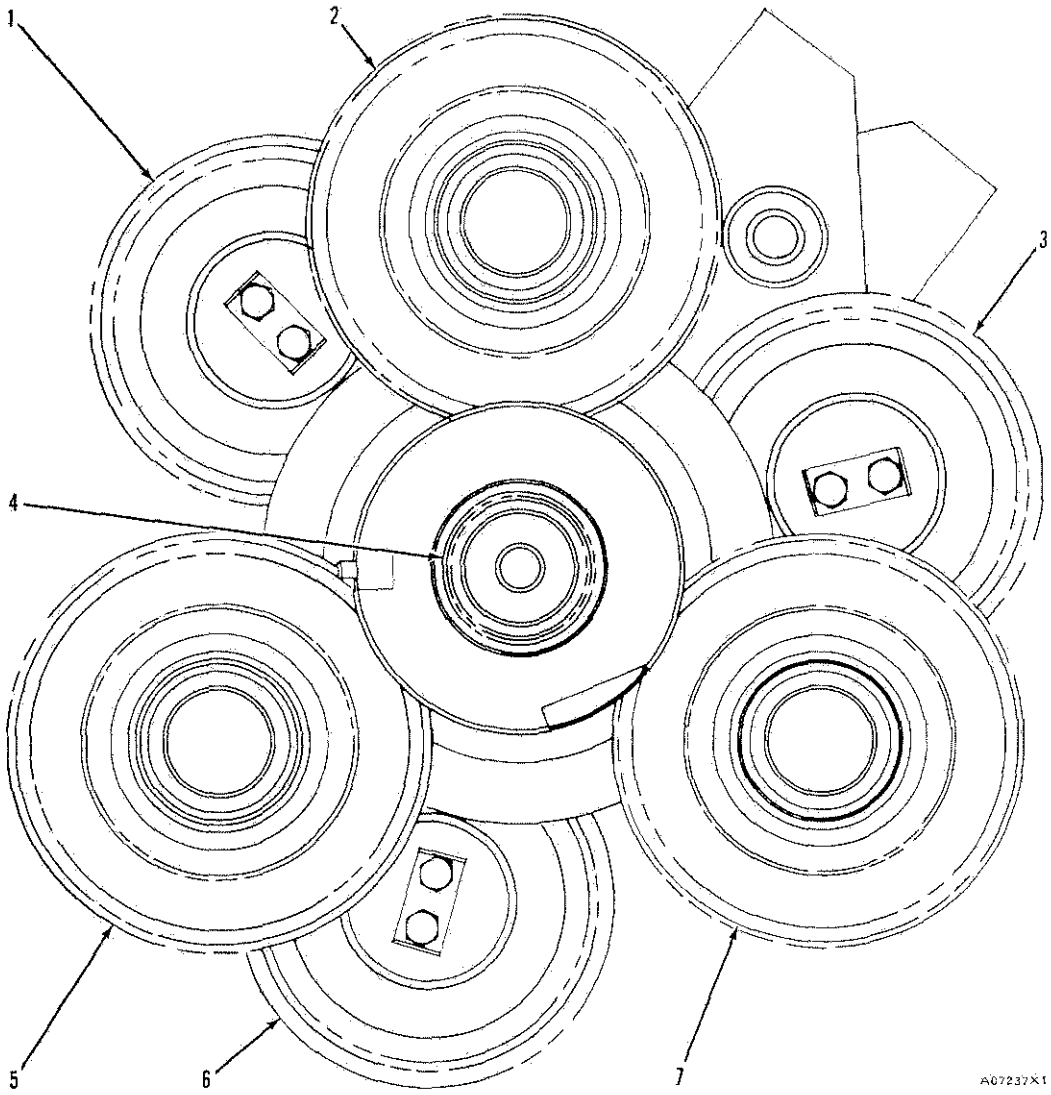
The gear group has two arrangements. There is the basic direct drive arrangement and the optional overdrive arrangement.

The direct drive arrangement gives a 17.23 to 1 reduction in 1st gear with a one to one ratio in 16th gear.

The overdrive arrangement gives a 14.48 to 1 reduction in 1st gear with a .875 to 1 ratio in 16th gear.

Both arrangements look and operate the same. The only differences are the number of teeth on some of the gears and the sequence of shift fork movement for a given gear selection.

The gear group has a three countershaft design. The front section of the transmission has a set of three countershafts (2), (5), and (7) (all three countershafts are the same) with the same distance between each countershaft and the main transmission shaft (4). The rear section of the transmission has a set of three countershafts (1), (3), and (6) (all three countershafts are the same) with the same distance between each countershaft and the main transmission shaft (4).



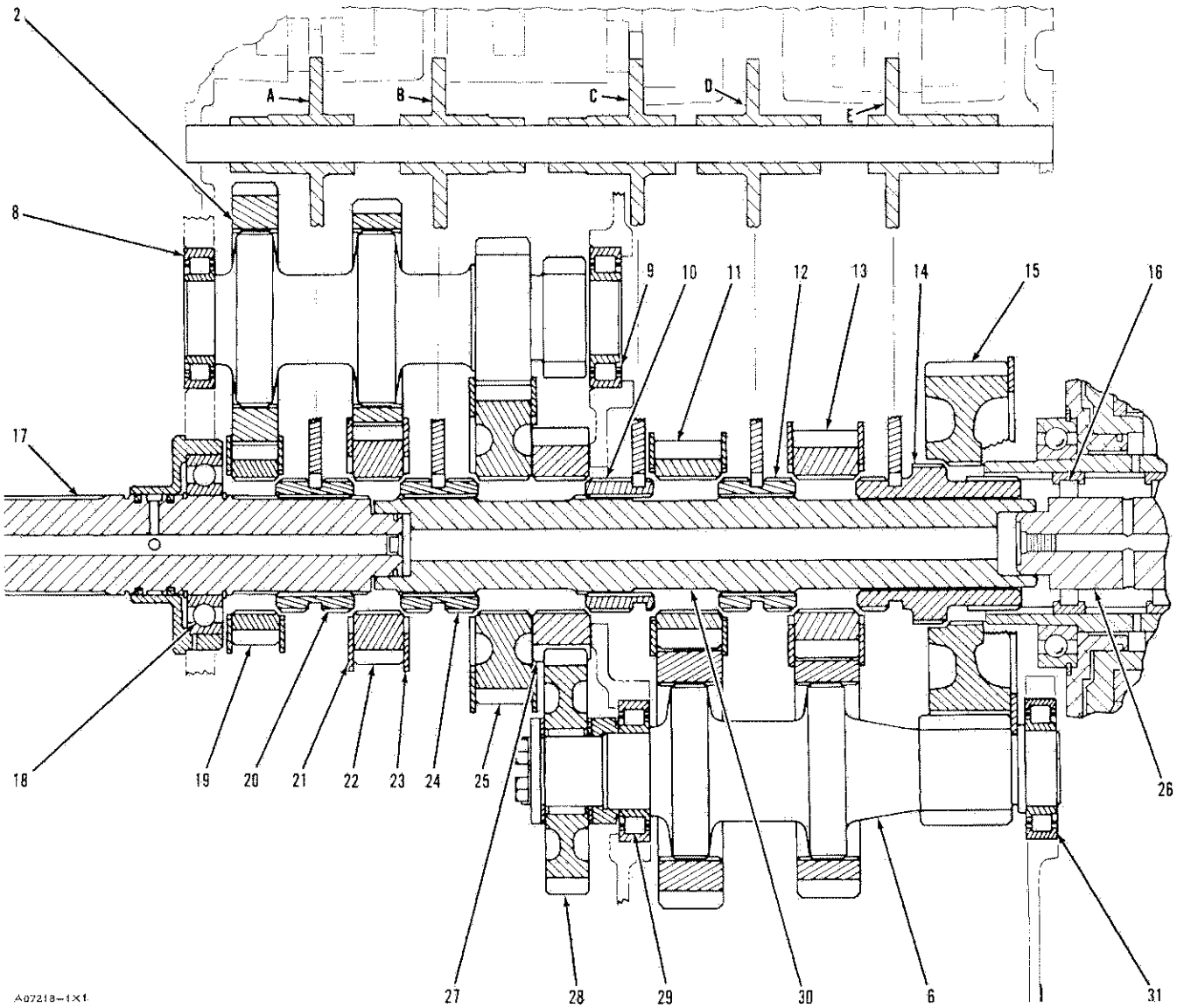
GEAR GROUP (FRONT VIEW)

1. Countershaft. 2. Countershaft. 3. Countershaft. 4. Main shaft. 5. Countershaft. 6. Countershaft. 7. Countershaft.

A set of three main shaft gears (19), (22), and (25) are engaged with the front set of three countershafts (2). A set of three main shaft gears (11), (13), and (15) are engaged with the rear set of three countershafts (6). A main shaft gear (27) is engaged with the reverse idler gears (28).

The six countershafts have support from roller bearings (8), (9), (29), and (31) in the transmission case. The main shafts have support from a ball bearing (18) on the output shaft (26).

The three main shaft gears in each section of the transmission have radial support by their location between the three countershafts. These main shaft gears get axial support from side plates (21) and (23) that make contact with the sides of the countershaft gears.



GEAR GROUP

2. Countershaft.
6. Countershaft.
8. Roller bearing.
9. Rollear bearing.
10. Sliding collar.
11. Main shaft gear.
12. Sliding collar.
13. Main shaft gear.
14. Sliding collar.
15. Main shaft gear.
16. Roller bearing.
17. Input shaft.
18. Ball bearing.
19. Main shaft gear.
20. Sliding collar.
21. Side plate.
22. Main shaft gear.
23. Side plate.
24. Sliding collar.
25. Main shaft gear.
26. Output shaft.
27. Main shaft gear.
28. Reverse idler gear.
29. Roller bearing.
30. Intermediate shaft.
31. Roller bearing.
A. Shift fork.
B. Shift fork.
C. Shift fork.
D. Shift fork.
E. Shift fork.

OPERATION

Five shift forks (A), (B), (C), (D), and (E) are moved by air cylinders in the transmission control. A positive sequence of movement of the shift forks gives a positive gear ratio. These shift forks move sliding collars (20), (24), (10), (12), and (14). The sliding collars are connected to the main shafts with splines. By moving a sliding collar into engagement with a main shaft gear, power can be sent either to the countershafts from the main shaft or to the main shaft from the countershafts.

Shift forks (A), (D), and (E) can move to either the right or the left. Shift fork (B) can move to the right, to the left, or be held in the center position. Shift fork (C) can be held in the center position or move to the right. The following charts show the position of each of the five shift forks for each gear ratio (speed) available.

Power comes through the input clutch to the input shaft (17). Shift fork (A) causes sliding collar (20) to engage with either main shaft gear (19) or main shaft gear (22) and power is sent to and divided between the three countershafts (2). The countershafts turn in the opposite direction to the input shaft. Shift fork (B) causes sliding collar (24) to engage with either main shaft gear (22) or main shaft gear (25) and power is sent from the countershafts (2) to the intermediate shaft (30). The intermediate shaft is now turning in the same direction as the input shaft. When sliding collar (20) is engaged with main shaft gear (22) and sliding collar (24) also is engaged with main shaft gear (22), power goes straight through the front section of the transmission to the intermediate shaft (30).

Shift fork (D) causes sliding collar (12) to engage with either main shaft gear (11) or main shaft gear (13) and power is sent to and divided between the three countershafts (6). The countershafts turn in the opposite direction to the intermediate and input shafts. Shift fork (E) causes sliding collar (14) to engage with either main shaft gear (13) or main shaft gear (15) and power is sent from the countershafts (6) through the output clutch to the output shaft (26). The output shaft is now turning in the same direction as the input shaft. When sliding collar (12) is engaged with main shaft gear (13) and sliding collar (14) also is engaged with main shaft gear (13), power goes straight through the rear section of the transmission to the output clutch.

DIRECT DRIVE ARRANGEMENT

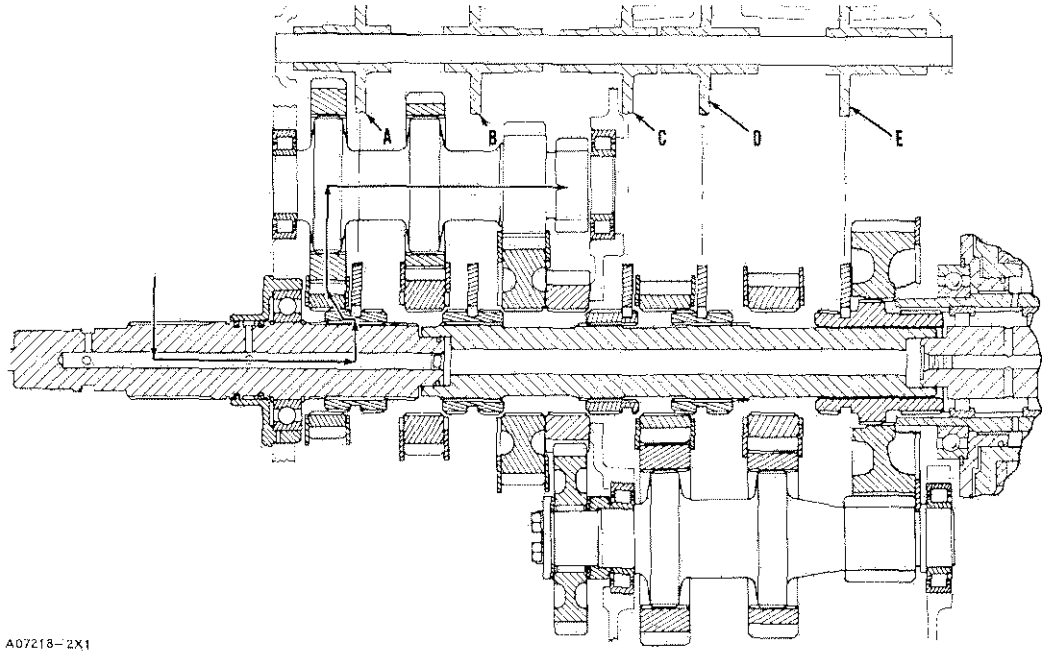
SPEED	SHIFT FORK POSITION				
	A	B	C	D	E
1	←	→	CENTER	←	→
2	←	→	CENTER	→	→
3	→	→	CENTER	←	→
4	→	→	CENTER	→	→
5	←	←	CENTER	←	→
6	←	←	CENTER	→	→
7	→	←	CENTER	←	→
8	→	←	CENTER	→	→
9	←	→	CENTER	←	←
10	←	→	CENTER	→	←
11	→	→	CENTER	←	←
12	→	→	CENTER	→	←
13	←	←	CENTER	←	←
14	←	←	CENTER	→	←
15	→	←	CENTER	←	←
16	→	←	CENTER	→	←
N	←	CENTER	CENTER	←	→
R1	←	CENTER	←	←	→
R2	→	CENTER	←	→	→

NOTE: ← toward front of transmission.
→ toward rear of transmission.

OVERDRIVE ARRANGEMENT

SPEED	SHIFT FORK POSITION				
	A	B	C	D	E
1	←	→	CENTER	→	→
2	←	→	CENTER	←	→
3	→	→	CENTER	→	→
4	→	→	CENTER	←	→
5	←	←	CENTER	→	→
6	←	←	CENTER	←	→
7	→	←	CENTER	→	→
8	→	←	CENTER	←	→
9	←	→	CENTER	→	←
10	←	→	CENTER	←	←
11	→	→	CENTER	→	←
12	→	→	CENTER	←	←
13	←	←	CENTER	→	←
14	←	←	CENTER	←	←
15	→	←	CENTER	→	←
16	→	←	CENTER	←	←
N	←	CENTER	CENTER	→	→
R1	←	CENTER	←	→	→
R2	→	CENTER	←	←	→

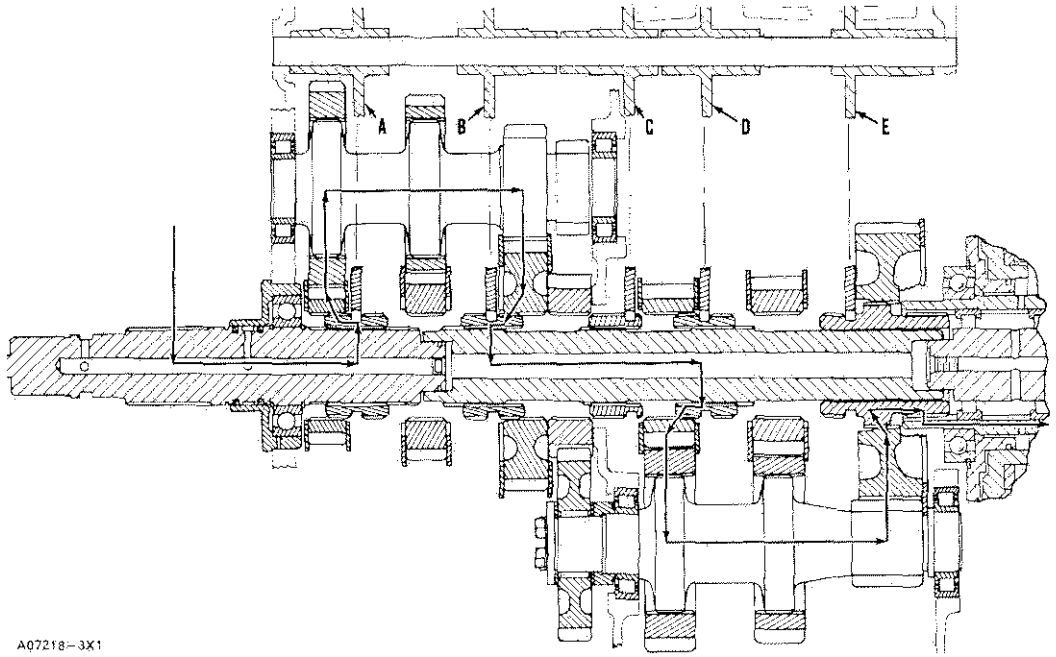
Power flow diagrams for some typical gear selections are shown below. These diagrams are for the direct drive arrangement. Diagrams for the overdrive arrangement are similar with the difference being the sequence of shift fork movement for a given gear selection. Make reference to the charts for shift fork position.



A07218-2X1

NEUTRAL (DIRECT DRIVE)

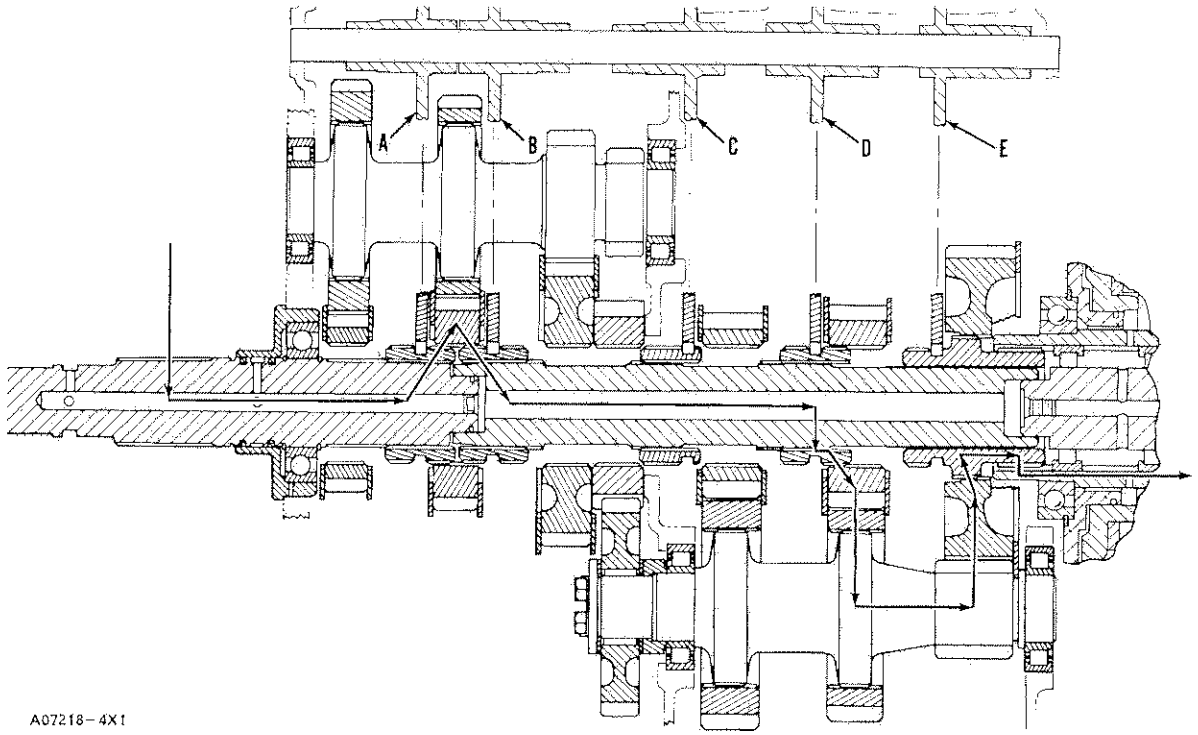
SHIFT FORK POSITION				
A	B	C	D	E
←	CENTER	CENTER	←	→



A07218-3X1

1st SPEED (DIRECT DRIVE)

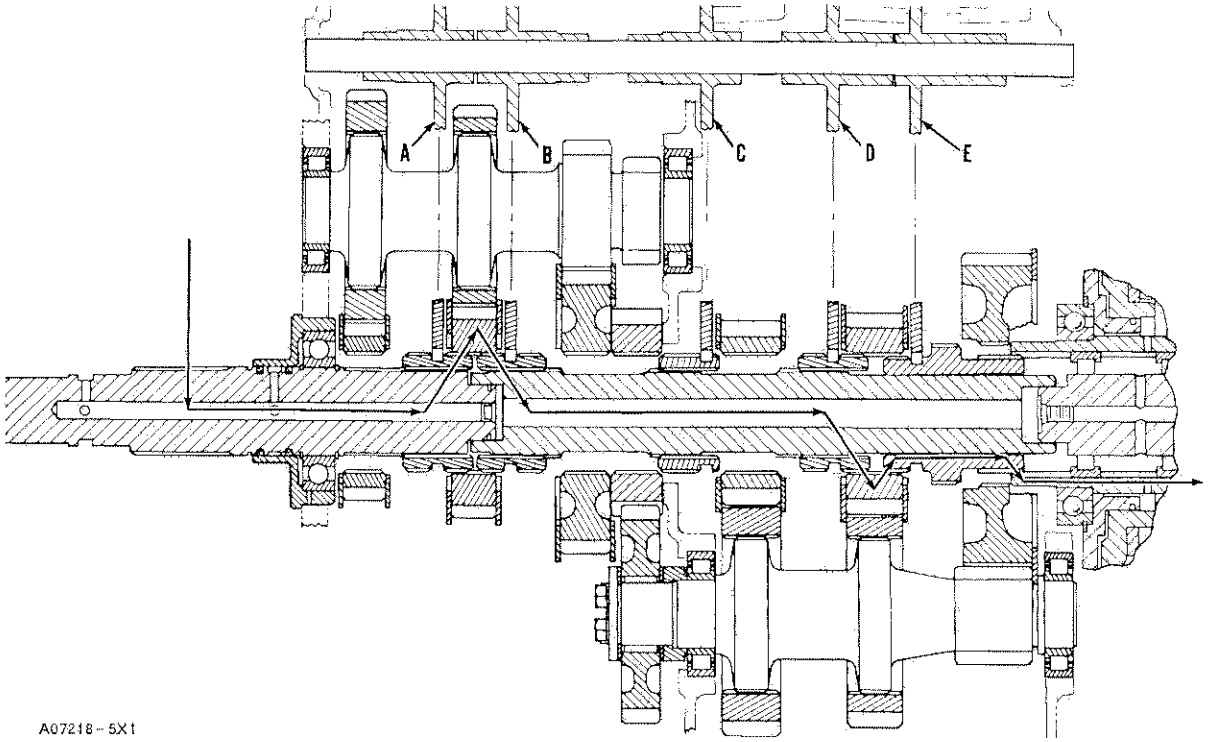
SHIFT FORK POSITION				
A	B	C	D	E
←	→	CENTER	←	→



A07218-4X1

8th SPEED (DIRECT DRIVE)

SHIFT FORK POSITION				
A	B	C	D	E
→	←	CENTER	→	→



A07218-5X1

16th SPEED (DIRECT DRIVE)

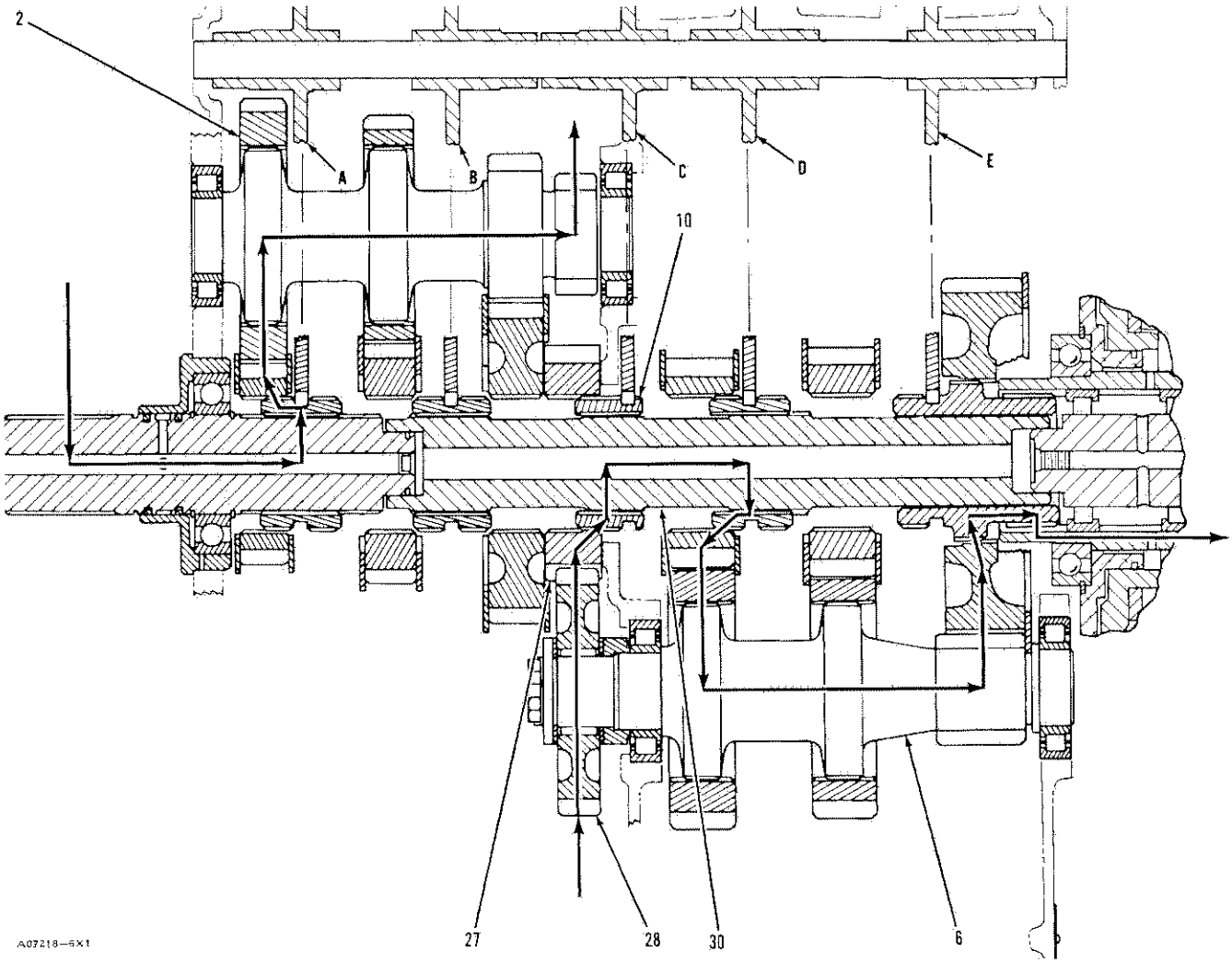
SHIFT FORK POSITION				
A	B	C	D	E
→	←	CENTER	→	←

In REVERSE, shift fork (B) is held in its center position and shift fork (C) is moved to the left to engage collar (10) with main shaft gear (27). The main shaft gear (27) is in engagement with the three reverse idler gears (28). The reverse idler gears (28) are in engagement with the front countershafts (2) which are turning in the opposite direction to the input shaft.

Power is sent from the front countershaft through the reverse idler gears (28). The reverse idler gears are turning in the same direction as the input shaft. From the reverse idler gears, power is sent through the main shaft gear (27) and through the sliding collar (10) to the intermediate shaft (30). The intermediate shaft is now turning in the opposite direction to the input shaft.

The gear connections for shift forks (D) and (E) are the same as in the earlier explanation except the direction of rotation is in the opposite direction.

NOTE: The reverse idler gears (28) are installed (on bearings) on the rear countershafts (6) but do not send power to the rear countershafts.



REVERSE - 1 (DIRECT DRIVE)

SHIFT FORK POSITION				
A	B	C	D	E
←	CENTER	←	←	→

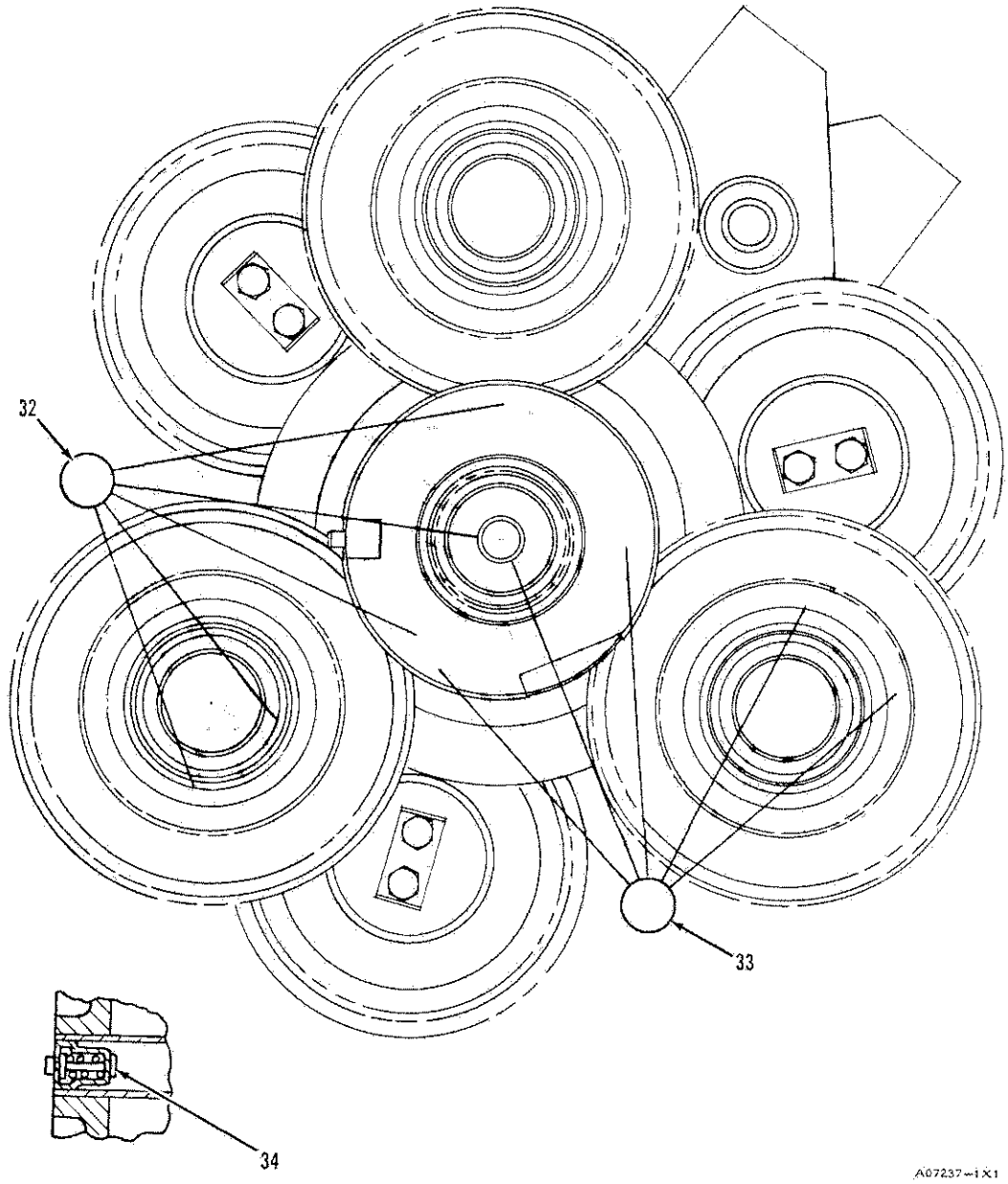
2. Countershaft. 6. Countershaft. 10. Sliding collar. 27. Main shaft gear. 28. Reverse idler gear. 30. Intermediate shaft.

LUBRICATION

The oil pump sends oil through passages in the front transmission case to two tubes (32) and (33) that are installed parallel to the main shaft of the transmission. Each tube has eight small holes drilled in it. When pressure oil is in the tube, it will come out through these small holes and give lubrication to the gears and bearings of the gear group.

Tube (32) gets oil at a rate of 4.0 U.S. gpm (15.1 lit/min) at 1000 engine rpm. A priority valve (34) in tube (33) opens at approximately 1200 engine rpm (12-13 psi [0.8 to 0.9 kg/cm^2] oil pressure). This priority valve keeps extra oil to the input clutch at low engine rpm. After the priority valve has opened in tube (33), oil pressure is in both tubes.

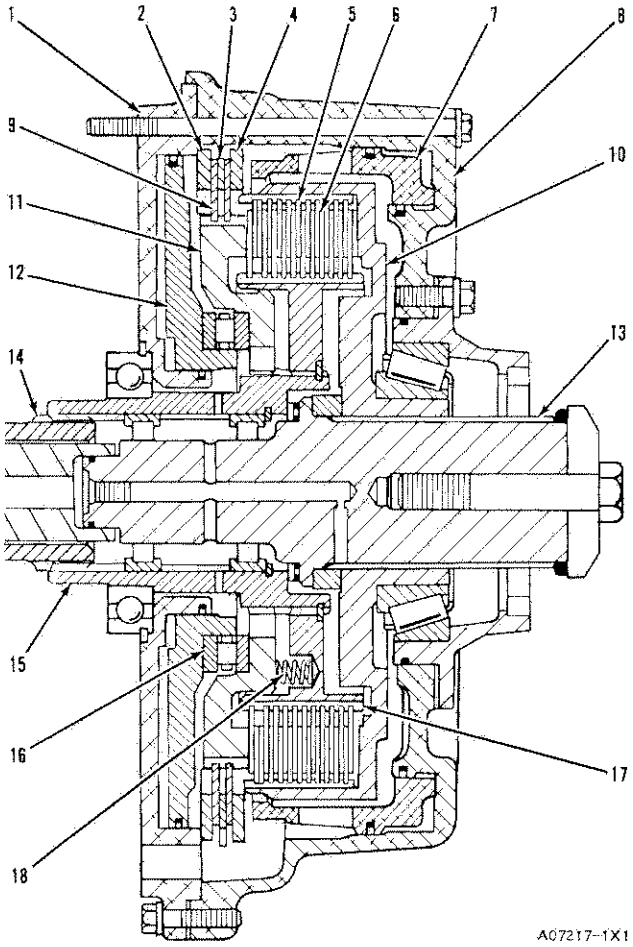
The flow of oil to the gear group (from both tubes) is 12.0 U.S. gpm (45.4 lit/min) at 2000 engine rpm.



GEAR GROUP LUBRICATION

32. Tube. 33. Tube. 34. Priority valve.

OUTPUT CLUTCH AND OUTPUT BRAKE



OUTPUT CLUTCH AND BRAKE

1. Plate.
2. Plate.
3. Plate.
4. Plate.
5. Plate.
6. Disc.
7. Piston.
8. Cover.
9. Disc.
10. Hub.
11. Plate.
12. Piston.
13. Output shaft.
14. Gear group.
15. Hub.
16. Thrust bearing.
17. Ring.
18. Spring.

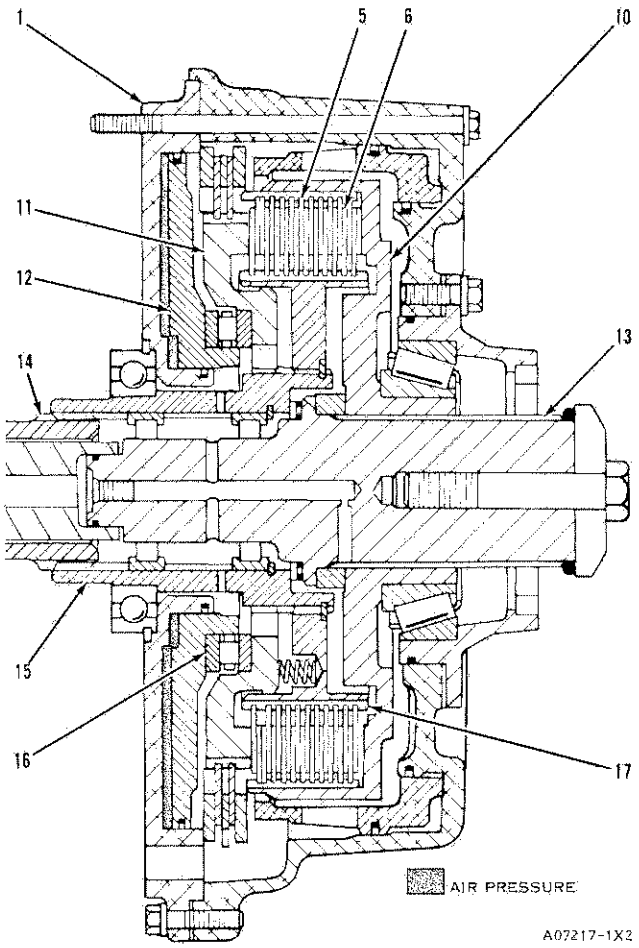
OUTPUT CLUTCH

The output clutch connects the gear group (14) of the transmission to the output shaft (13). This clutch uses 13 discs (6) with a "paper" friction material and 12 or more (for the adjustment of clutch thickness) steel plates (5). The clutch discs and plates are made cool by oil.

The hub (15), ring (17), discs (6), and plate (11) are connected to and turn with the gear group (14). The plates (5) and hub (10) are connected to the output shaft (13) of the transmission.

The clutch is engaged by air pressure (sent from the transmission control) working between plate (1) and piston (12). This air pressure moves the piston to the right.

As the piston (12) that does not turn moves to the right, it moves the turning plate (11) through a thrust bearing (16). This plate (11) will move to the right until the plates (5) and discs (6) of the clutch are held together. Now the hub (10) is connected to the ring (17) and power can go from the gear group (14) to the output shaft (13) of the transmission.

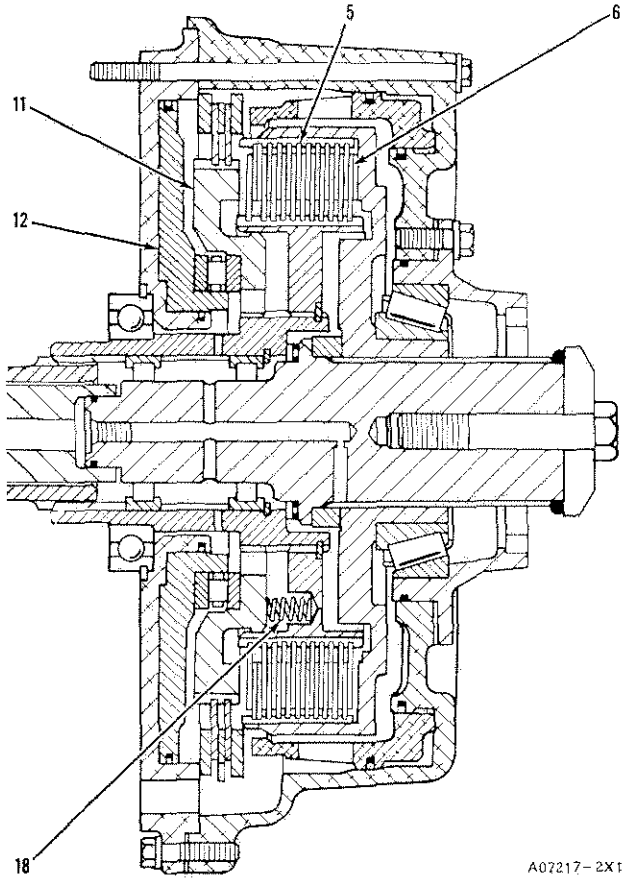


OUTPUT CLUTCH ENGAGED

1. Plate. 5. Plate. 6. Disc. 10. Hub. 11. Plate. 12. Piston. 13. Output shaft. 14. Gear group. 15. Hub. 16. Thrust bearing. 17. Ring.

The pressure of the air sent to the output clutch is controlled by a pressure regulator. The pressure in 1st through 4th speed is 92 psi (6.5 kg/cm^2), in 5th through 8th speed it is 74 psi (5.2 kg/cm^2), in 9th through 12th speed it is 37 psi (2.6 kg/cm^2), and in 13th through 16th speed it is 19 psi (1.4 kg/cm^2). The air pressure is higher when the torque sent through the clutch is higher (the lower the gear ratio, the higher the torque). The pressure regulator keeps the output clutch from getting more air pressure than necessary.

When making a shift, the output clutch must be released. Before moving the gear couplings, the transmission control removes the air pressure from the piston (12). With no air pressure on the piston, the 24 springs (18) can move the plate (11) to the left away from the clutch plate (5) and discs (6). Now the clutch plates and discs can move apart and the plates (6) are free to turn in relation to the discs (5).



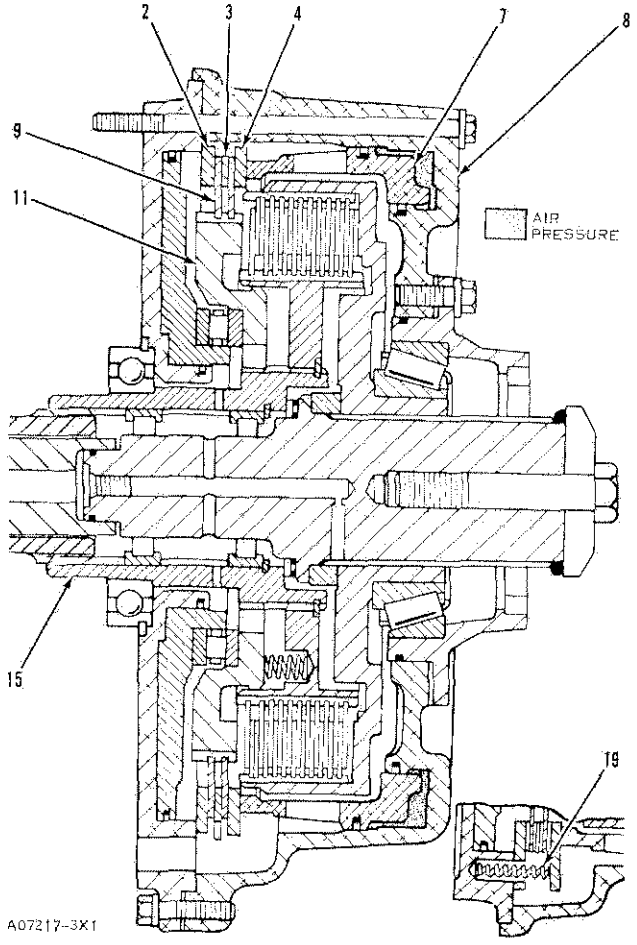
OUTPUT CLUTCH RELEASED DURING A SHIFT

5. Plate. 6. Disc. 11. Plate. 12. Piston. 18. Spring.

OUTPUT BRAKE

The output brake works in combination with the input brake to stop the rotation of the gear group. The output brake uses two discs (9) with a "paper" friction material and one steel plate (3). The discs and plate are made cool by oil.

The hub (15), plate (11), and discs (9) are connected to and turn with the gear group. Plates (2), (3), and (4) are held in a stationary position. The 12 springs (19) push against plate (4) to keep the discs and plates apart. In this position, the discs are free to turn in relation to the plates and the gear group can turn freely.



OUTPUT BRAKE ACTIVATED

2. Plate. 3. Plate. 4. Plate. 7. Piston. 8. Cover. 9. Disc. 11. Plate. 15. Hub. 19. Spring.

While making a shift, the input brake must be activated. Before moving the gear couplings, the transmission control sends air pressure through cover (8) to a space behind piston (7). This air pressure moves the piston (7) to the left until the discs and plates are pushed together. Now the gear group can not turn.

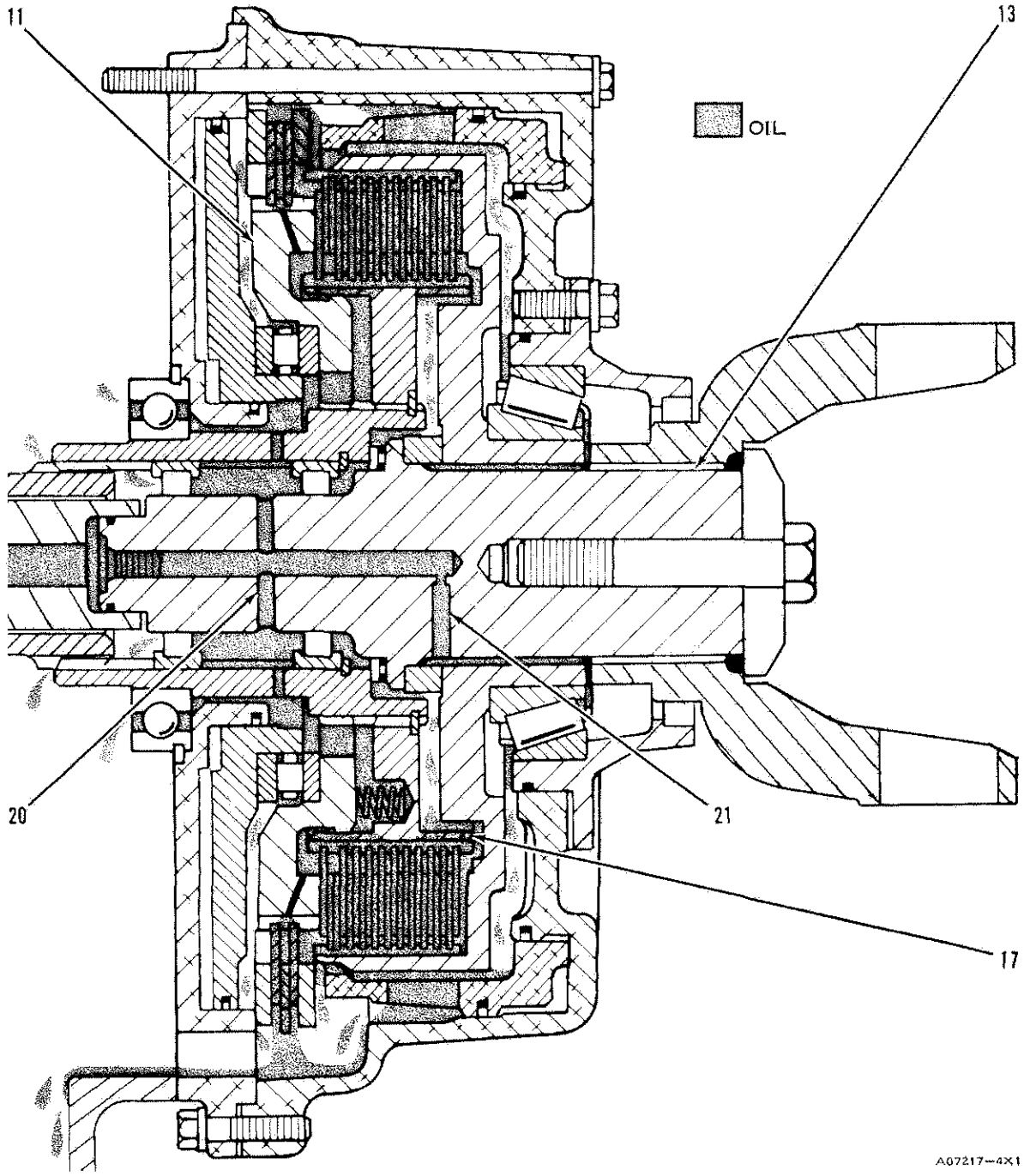
After the gear couplings are moved, the transmission control removes the air pressure from behind piston (7). The force of springs (19) causes the discs and plates to move apart and the piston (9) to move back to its original position. Now the gear group is free to turn again.

LUBRICATION

Oil for lubrication and cooling of the output clutch and brake is sent through the center of the transmission shaft to the center of the output shaft (13) at a rate of 1.2 U.S. gpm (4.5 lit/min) at 1000 engine rpm and 2.0 U.S. gpm (7.6 lit/min) at 2000 engine rpm.

Two holes (20) in the output shaft give oil for the lubrication of the ball, roller, and thrust bearings in the output clutch. After this oil has given lubrication to the bearings, it goes through holes in ring (17) and plate (11) to make the output clutch and brake cool.

Hole (21) in the output shaft gives oil for the lubrication of the rear bearing.



LUBRICATION OF THE OUTPUT CLUTCH AND BRAKE

11. Plate. 13. Output shaft. 17. Ring. 20. Holes. 21. Hole.

TRANSMISSION CONTROL AND RATIO SELECTOR

The complete transmission (clutches, brakes, and gear section) is controlled by air pressure. This air pressure comes from the normal air system of the truck. The air is controlled and given direction by two position, three way valves and single and double check valves. The valves are connected to passages, orifices, air cylinders, and closed volumes to make the air system of the transmission.

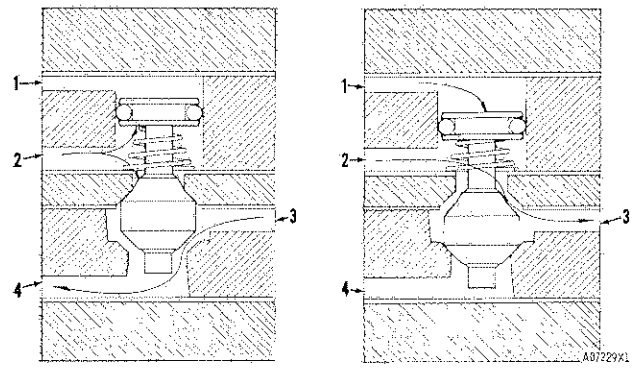
TWO POSITION, THREE WAY VALVES

There are two basic types of three way valves: one pilot operated and the other mechanically operated.

Pilot Operated Valve

The pilot operated type can have three different designs.

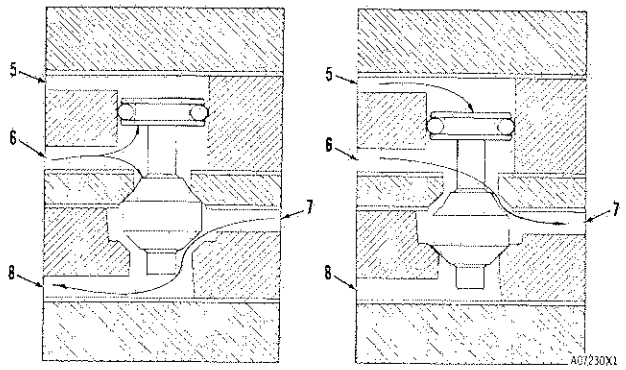
1. Normally closed valve with a spring. When the valve is closed, the working passage (3) is open to the exhaust passage (4) and the supply passage (2) is closed. When air is put into the pilot passage (1), the valve opens and the supply passage (2) is connected to the working passage (3). The exhaust passage (4) is now closed and air can go through the valve to the working passage.



CLOSED OPEN
NORMALLY CLOSED VALVE WITH A SPRING

1. Pilot passage. 2. Supply passage. 3. Working passage. 4. Exhaust passage.

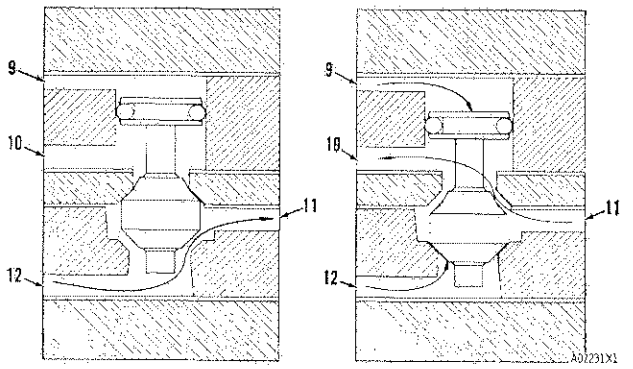
2. Normally closed valve with no spring. Air pressure in the supply passage (6) holds the valve closed. When the valve is closed, the working passage (7) is open to the exhaust passage (8) and the supply passage (6) is closed. When air is put into the pilot passage (5), the valve opens and the supply passage (6) is connected to the working passage (7). The exhaust passage (8) is now closed and air can go through the valve to the working passage.



CLOSED OPEN
NORMALLY CLOSED VALVE WITH NO SPRING

5. Pilot passage. 6. Supply passage. 7. Working passage. 8. Exhaust passage.

3. Normally open valve. Air pressure in the supply passage (12) holds the valve open. When the valve is open, the supply passage (12) is connected to the working passage (11). The exhaust passage (10) is closed and air can go through the valve to the working passage. When air is put into pilot passage (9), the valve closes and the working passage (11) is connected to the exhaust passage (10). The supply passage (12) is closed and air in the working passage (11) goes out the exhaust passage (10).

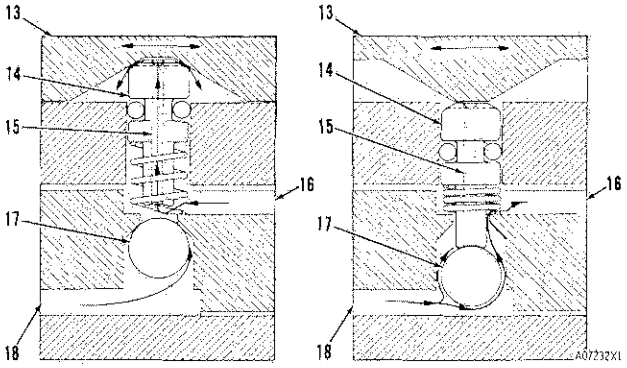


OPEN CLOSED
NORMALLY OPEN VALVE

9. Pilot passage. 10. Exhaust passage. 11. Working passage. 12. Supply passage.

Mechanically Operated Valve

The mechanically operated valve is normally closed. In the closed position, the air in the supply passage (18) is stopped by the ball (17). The air in the working passage (16) goes out through the exhaust passage (15) in the stem (14). When the valve is mechanically opened by a cam plate (13) or a plunger, the ball closes the exhaust passage (15) in the stem (14). The air in the supply passage (18) goes around the ball (17) and to the working passage (16).



CLOSED OPEN

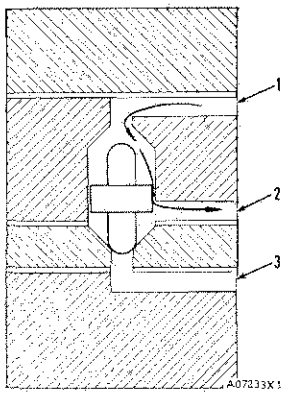
MECHANICALLY OPERATED VALVE

13. Cam plate. 14. Stem. 15. Exhaust passage. 16. Working passage. 17. Ball. 18. Supply passage.

CHECK VALVES

Double Check Valve

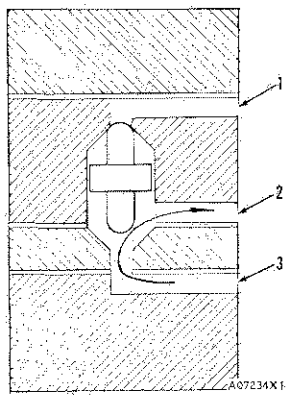
When supply passage (1) has air pressure and supply passage (3) does not have air pressure, the check valve lets air in supply passage (1) go around the check valve and to the working passage (2). The air from supply passage (1) can not go to supply passage (3).



DOUBLE CHECK VALVE

1. Supply passage. 2. Working passage. 3. Supply passage.

When supply passage (3) has air pressure and supply passage (1) does not have air pressure, the check valve will move to let the air pressure from supply passage (3) go around the check valve and to the working passage (2). The air from supply passage (3) can not go to supply passage (1).

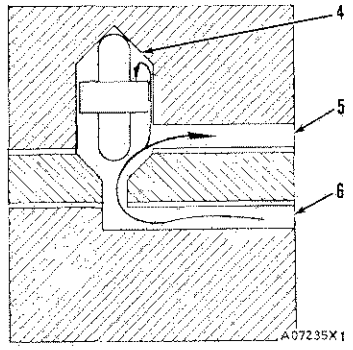


DOUBLE CHECK VALVE

1. Supply passage. 2. Working passage. 3. Supply passage.

Single Check Valve

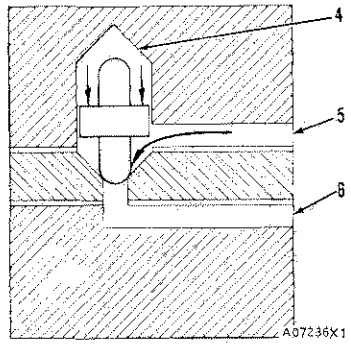
Air pressure in the supply passage (6) moves the check valve up and goes to the working passage (5). This air pressure also goes around the check valve and fills the area (4) above the valve.



SINGLE CHECK VALVE

4. Area. 5. Working passage. 6. Supply passage.

When air pressure is taken away from the supply passage (6), the air pressure in the area (4) above the valve will move the valve down. This prevents the air pressure in the working passage (5) from going to the supply passage (6).



SINGLE CHECK VALVE

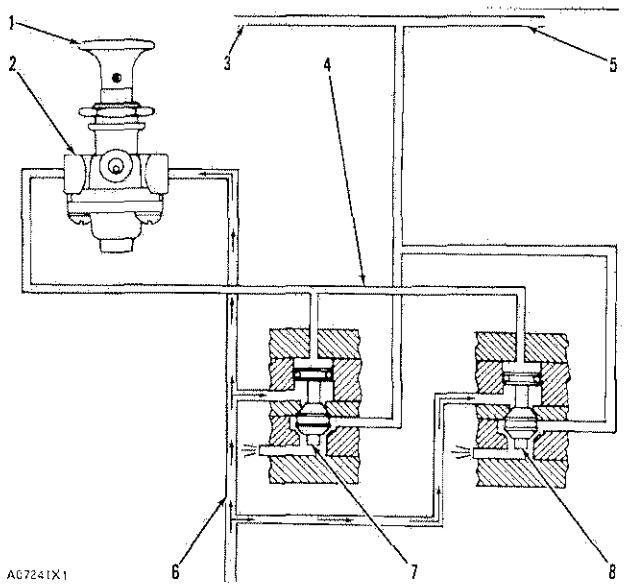
4. Area. 5. Working passage. 6. Supply passage.

AIR CHARGING SYSTEM

AIR CHARGING SYSTEM

The air system of this transmission must have a minimum of 60 psi (4.2 kg/cm^2) air pressure to operate correctly. An air control valve (2) in the ratio selector lets supply air go to the transmission controls after the handle (1) is pushed in. The handle will not keep in if the air pressure is less than 60 psi (4.2 kg/cm^2).

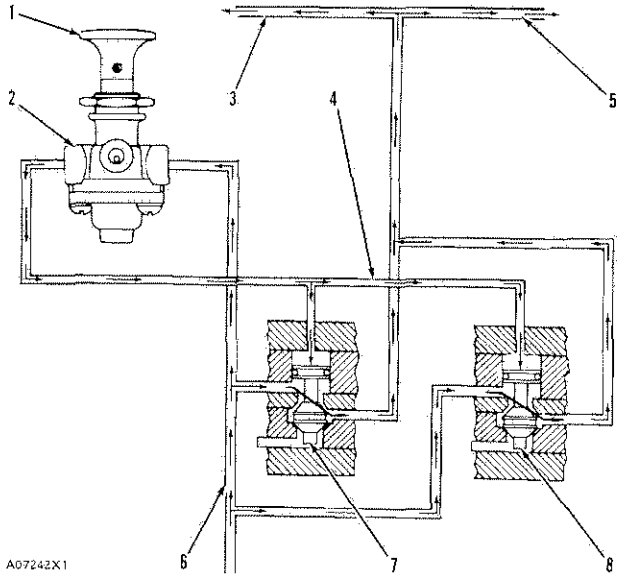
Supply air from the truck air system comes in line (6) which goes to two normally closed valves (7) and (8) and to the air control valve (2). With less than 60 psi (4.2 kg/cm^2) air pressure, the handle will not keep in and no air pressure can go to the pilot passages of the normally closed valves (7) and (8). The supply air can not go through the normally closed valves to the transmission controls.



AIR CHARGING SYSTEM WITH LESS THAN 60 psi (4.2 kg/cm^2) AIR PRESSURE

1. Handle. 2. Air control valve. 3. Line to ratio selector. 4. Line. 5. Line to transmission control group. 6. Supply line. 7. Normally closed valve. 8. Normally closed valve.

When there is more than 60 psi (4.2 kg/cm^2) air pressure in the air system of the truck, the handle of the air control valve (2) will keep in. This lets pilot pressure go through line (4) to the two normally closed valves (7) and (8) to open them. With these valves open, supply air can go through them to the ratio selector (3) and to the transmission control group (5).



AIR CHARGING SYSTEM WITH MORE THAN 60 psi (4.2 kg/cm^2) AIR PRESSURE

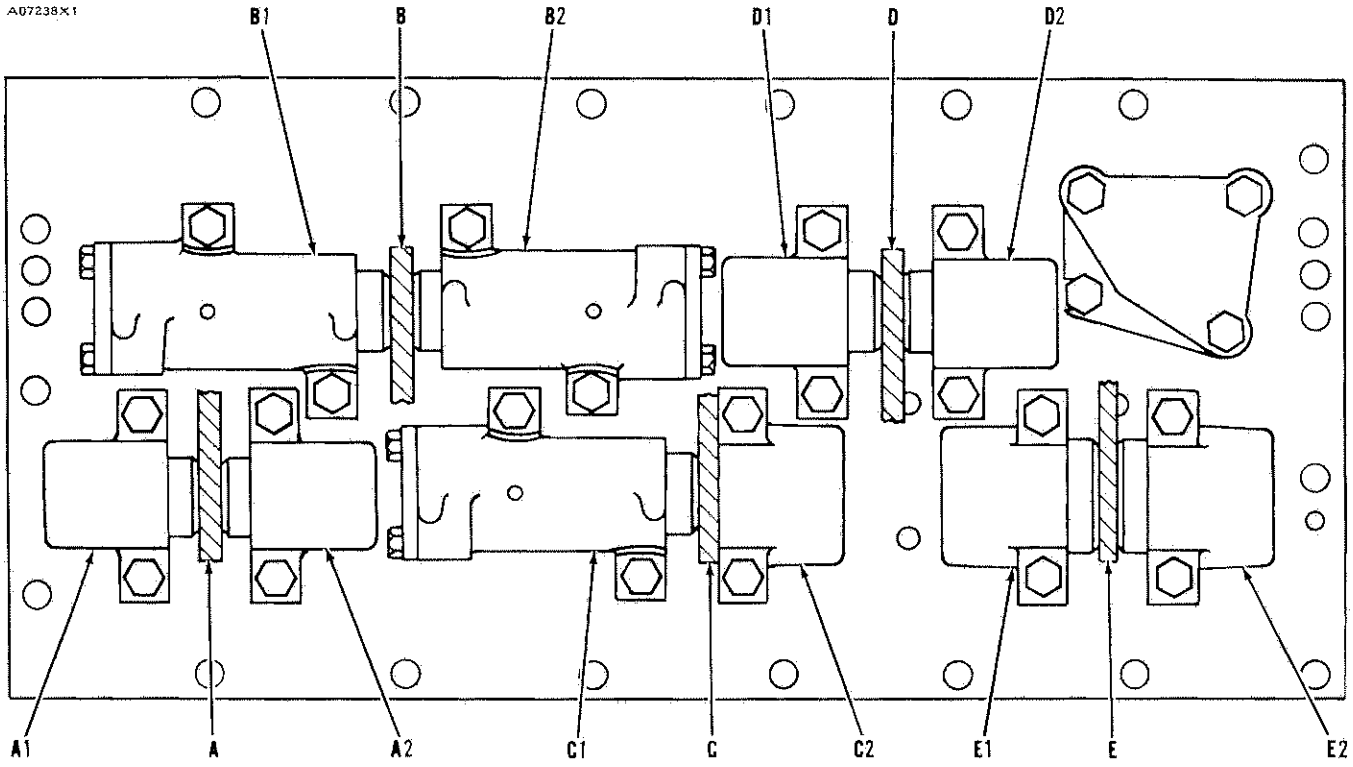
1. Handle. 2. Air control valve. 3. Line to ratio selector. 4. Line. 5. Line to transmission control group. 6. Supply line. 7. Normally closed valve. 8. Normally closed valve.

AIR SYSTEM FOR SHIFT FORKS

AIR SYSTEM FOR SHIFT FORKS

Shift forks (A), (B), (C), (D), and (E) are moved toward either the front or the rear of the transmission in a positive sequence to give the desired gear ratio or transmission speed. Make reference to the charts for shift fork position on page 17.

Two air cylinders are used to move each shift fork. For example: Cylinder (A1) moves shift fork (A) toward the rear of the transmission and cylinder (A2) moves shift fork (A) toward the front of the transmission. An explanation of the air system for shift forks (A), (D), and (E) is given below. The air system for shift forks (B) and (C) is similar to the air system for shift forks (A), (D), and (E) with some added controls. An explanation of the air system for shift forks (B) and (C) will be given later.



AIR CYLINDERS FOR SHIFT FORKS

A. Shift fork.
A1. Air cylinder (moves shift fork A toward the rear).
A2. Air cylinder (moves shift fork A toward the front).
B. Shift fork.
B1. Air cylinder (moves the shift fork B toward the rear).
B2. Air cylinder (moves shift fork B toward the front).
C. Shift fork.
C1. Air cylinder (moves shift fork C toward the rear).
C2. Air cylinder (moves shift fork C toward the front).
D. Shift fork.
D1. Air cylinder (moves shift fork D toward the rear).
D2. Air cylinder (moves shift fork D toward the front).
E. Shift fork.
E1. Air cylinder (moves shift fork E toward the rear).
E2. Air cylinder (moves shift fork E toward the front).

AIR SYSTEM FOR SHIFT FORKS (A), (D), AND (E)

The shift fork (20) is moved to the desired location by the application of pressure air to one of the air cylinders (16) or (17) that work in opposite directions. The other air cylinder is open to exhaust. Each air cylinder has its own supply valve. One valve (7) is normally open while the other valve (10) is normally closed. Both supply valves are pilot operated by a mechanically operated valve (4) in the ratio selector.

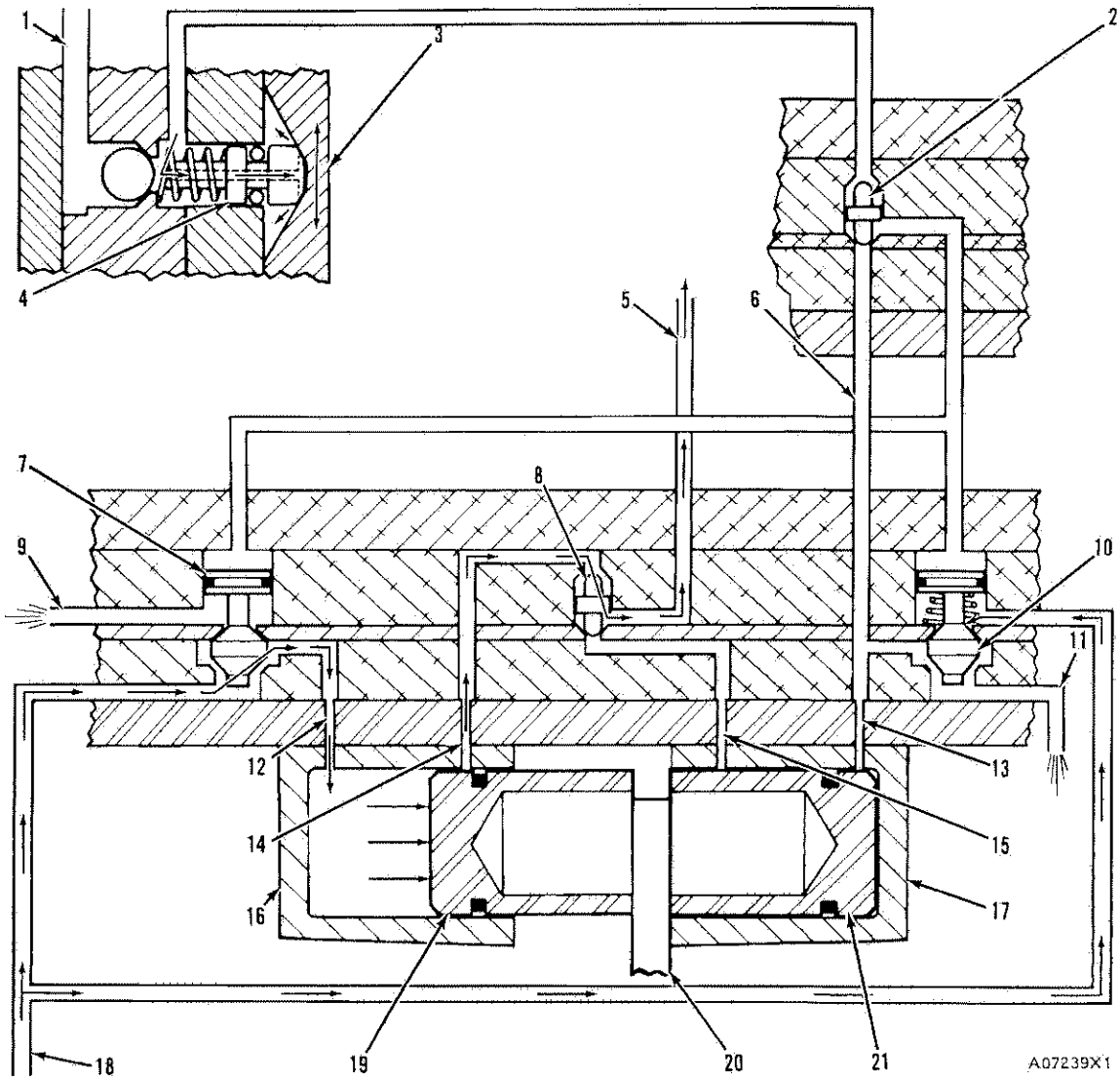
When the mechanically operated valve is opened by the cam plate (3) in the ratio selector, one position of the shift fork is given. When the mechanically operated valve is closed, the other position of the shift fork is given.

Mechanically Operated Valve is Closed

When the mechanically operated valve (4) is closed, no pilot pressure air is sent to the supply valves (7) or (10). Pressure air in the supply line (18) goes through the normally open valve (7), through hole (12) in the air cylinder (16), to the piston (19). This pressure air moves the piston and the shift fork (20) to the right (toward the rear of the transmission).

Air cylinder (17) is connected to exhaust (11) through hole (13) and through the normally closed valve (10).

After the piston (19) has moved completely to the right, it opens hole (14). This hole lets pressure air from the air cylinder go around the double check valve (8), through line (5), to the sensing circuit. (Make reference to SENSING CIRCUIT). The pressure air from hole (14) gives the indication that the shift fork (20) has moved completely and the sliding collar in the gear group has engaged correctly.



AIR SYSTEM FOR SHIFT FORKS (A), (D), AND (E) WITH MECHANICALLY OPERATED VALVE: CLOSED

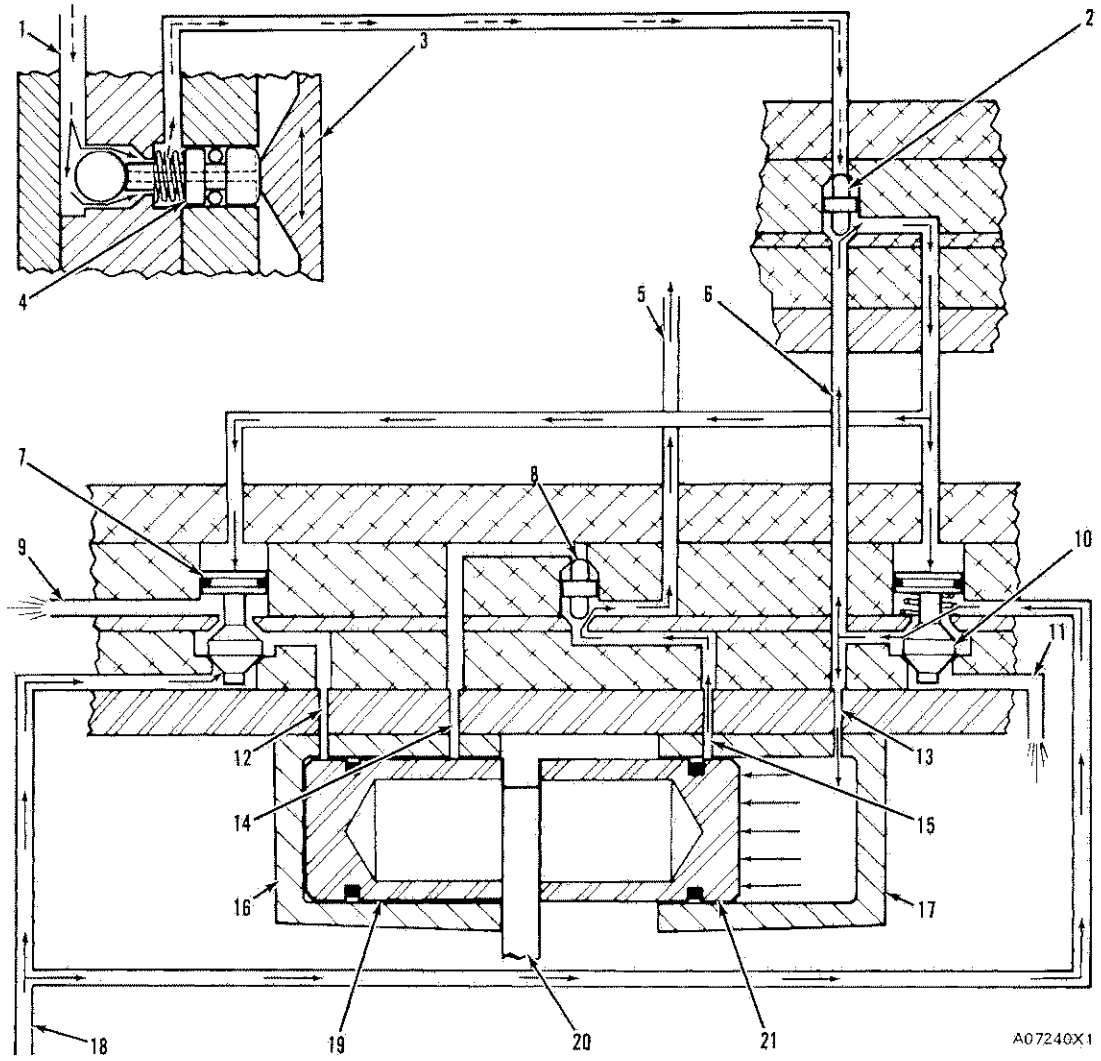
1. Pilot supply line.
2. Double check valve.
3. Cam plate.
4. Mechanically operated valve.
5. Line.
6. Line.
7. Normally open valve.
8. Double check valve.
9. Exhaust.
10. Normally closed valve.
11. Exhaust.
12. Hole.
13. Hole.
14. Hole.
15. Hole.
16. Air cylinder.
17. Air cylinder.
18. Supply line.
19. Piston.
20. Shift fork.
21. Piston.

Mechanically Operated Valve is Open

When the mechanically operated valve is opened by the cam plate (3), pilot pressure air is sent around the double check valve (2) to the supply valves (7) and (10). The pilot pressure air opens the normally closed valve (10) to let pressure air from the supply line (18) go through the valve (10). This pressure air goes through hole (13) in the air cylinder (17) to the piston (21). This pressure air moves the piston and shift fork (20) to the left (toward the front of the transmission).

The pilot pressure air closes the normally open valve (7) to connect air cylinder (16) to exhaust (9) through hole (12).

The pressure air from supply line (18) that goes through valve (10) also goes up line (6) to the double check valve (2). This air moves the check valve up to prevent air from going back to the mechanically operated valve. After moving the check valve up, the air goes around the valve and back to the pilot side of valves (7) and (10) to hold them in their present positions. The pilot air (1) to the mechanically operated valve can now be removed.



AIR SYSTEM FOR SHIFT FORKS (A), (D), AND (E) WITH MECHANICALLY OPERATED VALVE: OPEN

1. Pilot supply line.
2. Double check valve.
3. Cam plate.
4. Mechanically operated valve.
5. Line.
6. Line.
7. Normally open valve.
8. Double check valve.
9. Exhaust.
10. Normally closed valve.
11. Exhaust.
12. Hole.
13. Hole.
14. Hole.
15. Hole.
16. Air cylinder.
17. Air cylinder.
18. Supply line.
19. Piston.
20. Shift fork.
21. Piston.

The pressure air in supply line (18) goes to exhaust between each shift. This lets the normally open valve (7) and the normally closed valve (10) go back to their original positions.

After the piston (21) has moved completely to the left, it opens hole (15). This hole lets pressure air from the air cylinder go around the double check valve (8) through line (5), to the sensing circuit. (Make reference to: SENSING CIRCUIT.) The pressure air from hole (15) gives the indication that shift fork (20) has moved completely and the sliding collar in the gear group has engaged correctly.

AIR SYSTEM FOR SHIFT FORKS (B) AND (C)

Shift fork (C) controls the reverse coupling. It must be in the center position in all forward speeds. Shift fork (B) can be moved to any of three positions. This fork can move its coupling either toward the front or the rear of the transmission to work in combination with the other couplings to give different forward speeds. Shift fork (B) must be held in the center position for reverse speeds.

The air system for shift forks (B) and (C) has in its design a system to prevent the gear coupling on shift fork (B) and the coupling on shift fork (C) from being engaged at the same time.

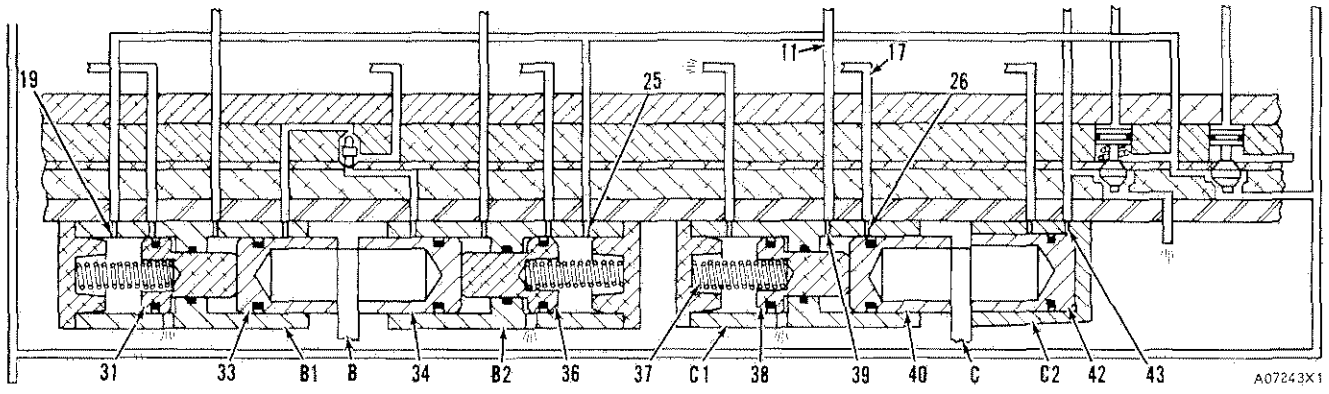
Air cylinders (B1) and (B2) have small pistons (31) and (36) behind each main piston (33) and (34). When air is sent through holes (19) and (25), the small pistons (31) and (36) move shift fork (B) to its center position.

Pressure air from the transmission supply line (11) is constantly sent through hole (39) in air cylinder (C1). This pressure air works against piston (40) to hold shift fork (C) against air cylinder (C2). This keeps the coupling on shift fork (C) out of the engaged condition.

After piston (40) has moved completely to the right, it opens hole (26). This hole lets pressure air from the air cylinder go through line (17) to valve (13) in the sensing circuit. (Make reference to SENSING CIRCUIT.) The air pressure from hole (26) gives the indication that shift fork (C) has moved completely and the reverse coupling is not engaged.

When the selector lever is put in a reverse position, pressure air is sent through hole (43). Piston (42) in air cylinder (C2) has double the working area of piston (40) in air cylinder (C1). Because piston (42) has double the force of piston (40), pressure air on piston (42) can move shift fork (C) to the left. This movement of shift fork (C) to the left engages the reverse coupling on shift fork (C).

NOTE: The spring (37) and piston (38) are used to hold the reverse coupling out of the engaged position when pressure air is not yet available.



AIR CYLINDERS FOR SHIFT FORKS (B) AND (C)

11. Transmission supply line.
17. Line.
19. Hole.
25. Hole.
26. Hole.
31. Piston.
33. Piston.
34. Piston.
36. Piston.
37. Spring.
38. Piston.
39. Hole.
40. Piston.
42. Piston.
43. Hole.
B. Shift fork.
B1. Air cylinder.
B2. Air cylinder.
C. Shift fork.
C1. Air cylinder.
C2. Air cylinder.

Mechanically operated valves (B3) and (C3) in the ratio selector control the movement of shift forks (B) and (C). In the forward speeds, the mechanically operated valve (B3) for shift fork (B) can be opened to give one shift fork position or closed to give the other shift fork position. In reverse speeds, the mechanically operated valve (B3) for shift fork (B) is closed and the mechanically operated valve (C3) for shift fork (C) is open.

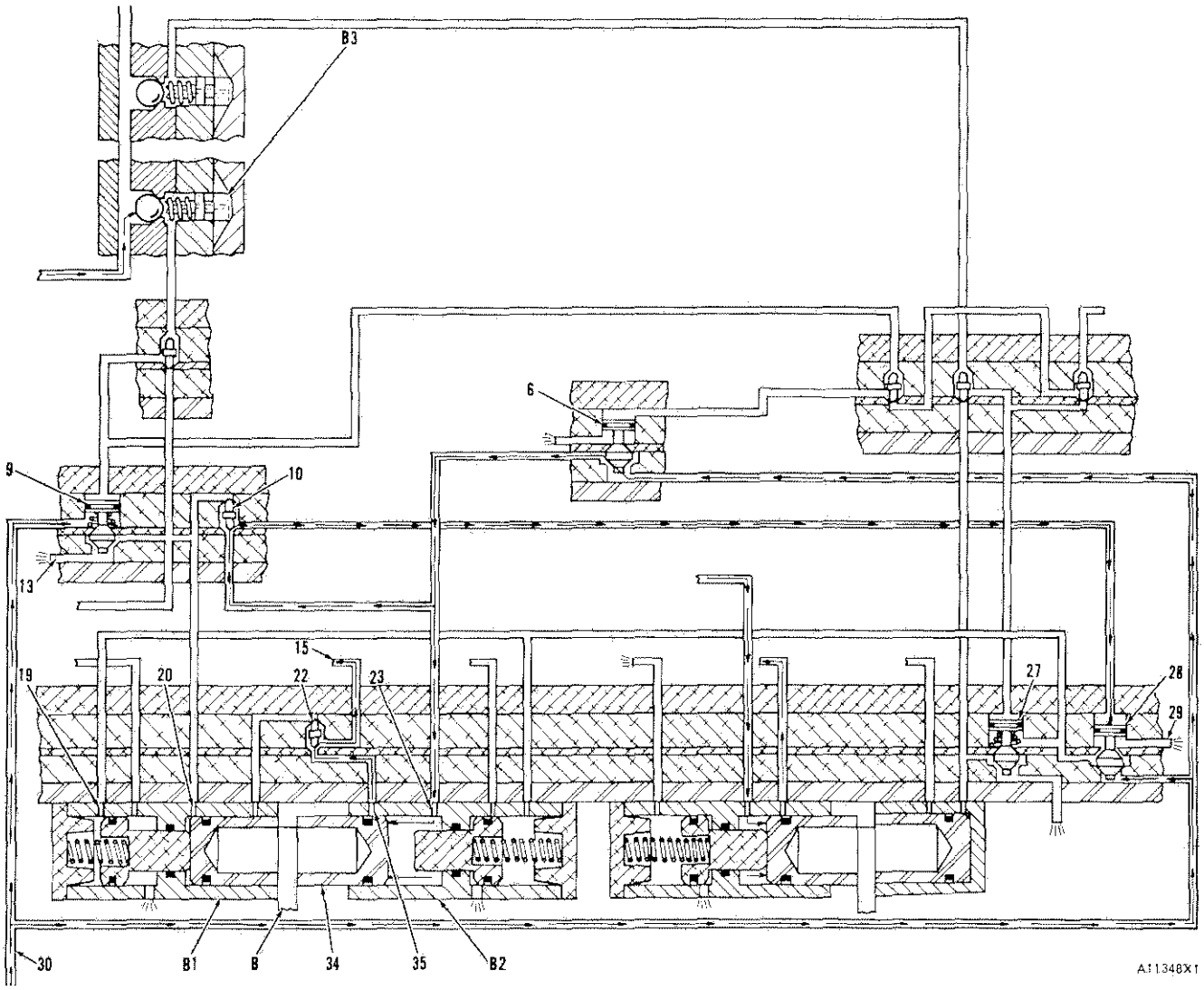
FORWARD: Mechanically Operated Valve (B3) is Closed

When the mechanically operated valve (B3) is closed, pressure air from supply line (30) goes through the normally open valve (6), through hole (23) in air cylinder (B2) to the piston (34). This pressure air moves the piston and shift fork (B) to the left (toward the front of the transmission).

The pressure air from the normally open valve (6) also goes through the double check valve (10) to close the normally open valve (28). This prevents air from getting into the reverse circuit.

Hole (20) of air cylinder (B1) is connected to exhaust (13) through the normally closed valve (9). Hole (19) of air cylinder (B1) is connected to exhaust (29) through the closed (at present) valve (28).

After the piston (34) has moved completely to the left, it opens hole (35). This hole lets pressure air from the air cylinder go around the double check valve (22), through line (15), and to valve (13) in the sensing circuit. (Make reference to SENSING CIRCUIT.) The pressure air from hole (35) gives the indication that shift fork (B) has moved completely and the sliding collar in the gear group has engaged correctly.



FORWARD: MECHANICALLY OPERATED VALVE (B3) IS CLOSED

6. Normally open valve.
9. Normally closed valve.
10. Double check valve.
13. Exhaust.
15. Line.
19. Hole.
20. Hole.
22. Double check valve.
23. Hole.
27. Normally closed valve.
28. Normally open valve.
29. Exhaust.
30. Supply line.
34. Piston.
35. Hole.
B. Shift fork.
B1. Air cylinder.
B2. Air cylinder.
B3. Mechanically operated valve.

FORWARD: Mechanically Operated Valve (B3) is Open

When the mechanically operated valve (B3) is opened by the cam plate (1) in the ratio selector, pilot pressure air is sent around the double check valve (3) to supply valves (9) and (6). The pilot pressure air opens the normally closed valve (9) to let pressure air from the supply line (30) go through valve (9). This pressure air goes through hole (20) in air cylinder (B1) to the piston (33). This pressure air moves the piston and shift fork (B) to the right (toward the rear of the transmission).

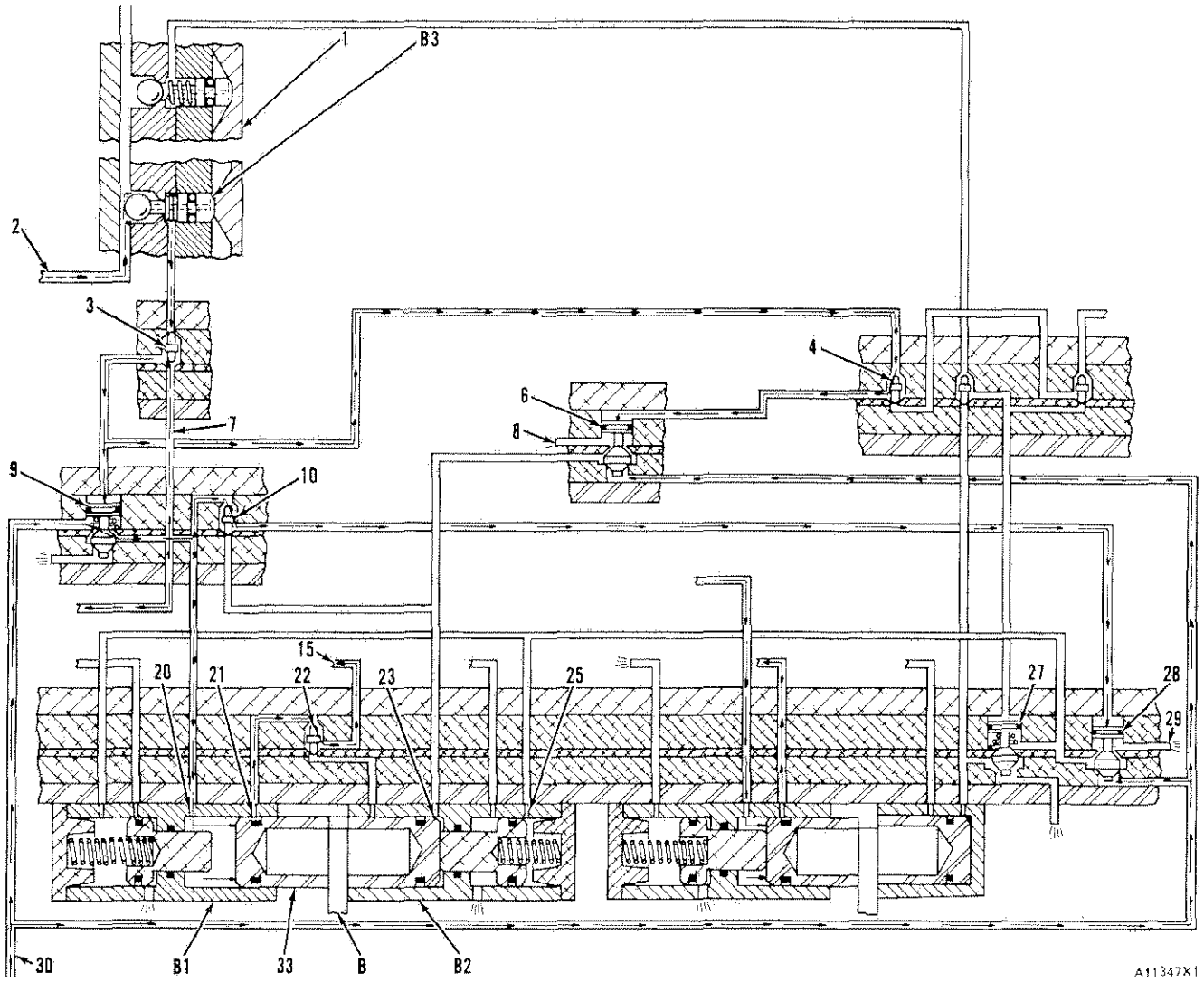
The pressure air that goes to hole (20) in air cylinder (B1) also goes around the double check valve (10) to close the normally open valve (28). This prevents air from getting into the reverse circuit.

The pilot pressure goes around the double check valve (4) and closes the normally open valve (6) to connect hole (23) of air cylinder (B2) to exhaust (8). Hole (25) of air cylinder (B2) is connected to exhaust (29) through the closed (at present) valve (28).

The pressure air that goes through valve (9) to air cylinder (B1) also goes up line (7) to the double check valve (3). This air moves the check valve up to prevent air from going back to the mechanically operated valve (B3). After moving the check valve up, the air goes around the valve and back to the pilot sides of valves (9) and (6) to hold them in their present positions. The pilot air (2) to the mechanically operated valve can now be removed.

The pressure air in supply line (30) goes to exhaust between each shift. This lets the normally open valve (6) and the normally closed valve (9) go back to their original positions.

After the piston (33) has moved completely to the right, it opens hole (21). This hole lets pressure air from the air cylinder go around the double check valve (22) through line (15) to valve (13) in the sensing circuit. (Make reference to SENSING CIRCUIT.) The pressure air from hole (21) gives the indication that shift fork (B) has moved completely and the sliding collar in the gear group has engaged correctly.



FORWARD: MECHANICALLY OPERATED VALVE (B3) IS OPEN

1. Cam plate.
2. Pilot air supply.
3. Double check valve.
4. Double check valve.
6. Normally open valve.
7. Line.
8. Exhaust.
9. Normally closed valve.
10. Double check valve.
15. Line.
20. Hole.
21. Hole.
22. Double check valve.
23. Hole.
25. Hole.
27. Normally closed valve.
28. Normally open valve.
29. Exhaust.
30. Supply line.
33. Piston.
B. Shift fork.
B1. Air cylinder.
B2. Air cylinder.
B3. Mechanically operated valve.

REVERSE: Mechanically Operated Valve (C3) is Open

When the mechanically operated valve (C3) is opened by the cam plate (1), pilot pressure air is sent around the double check valve (5) to supply valve (27), and around double check valves (4) and (44) to supply valve (6). The pilot pressure air closes the normally open valve (6) to connect hole (23) of air cylinder (B2) to exhaust (8) and to prevent air from getting into the forward circuit. This pilot pressure air also opens the normally closed valve (27) to let pressure air from supply line (30) (through the normally open valve [28]) go to the air cylinder (C2).

The pressure air from valve (27) goes through hole (43) in air cylinder (C2) to piston (42). This pressure air on the larger piston (42) works against the pressure air and spring force on the smaller piston (40).

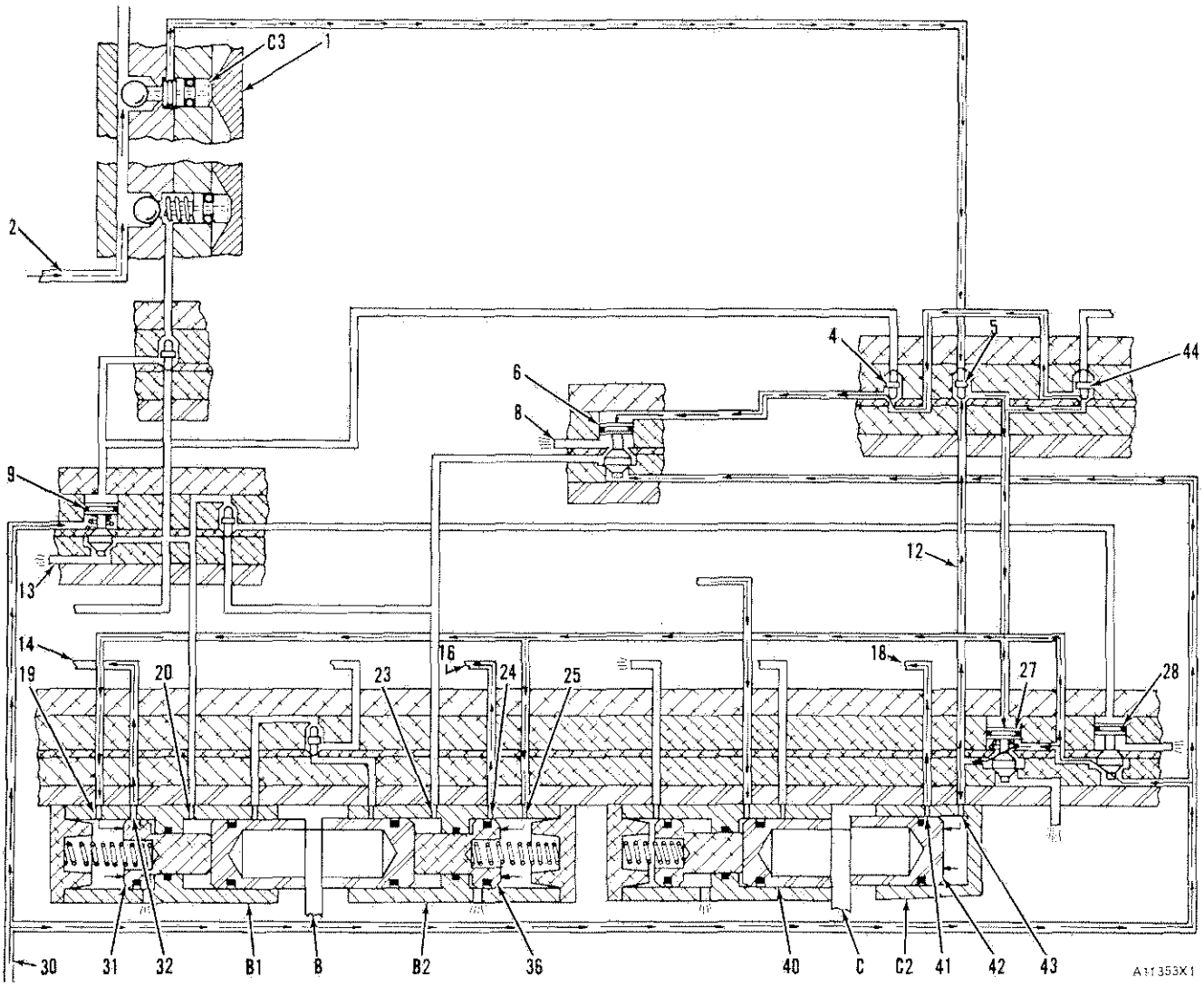
At the same time, pressure air is sent from normally open valve (28) through holes (19) and (25) in air cylinders (B1) and (B2) to pistons (31) and (36). This pressure air moves the pistons and shift fork (B) to its center position. Hole (20) of air cylinder (B1) is connected to exhaust (13) through the normally closed valve (9).

After the pistons (31) and (36) have moved completely, holes (32) and (24) are opened. These holes let pressure air from the air cylinders (B1) and (B2) go through lines (14) and (16) to valve (9) in the sensing circuit. (Make reference to SENSING CIRCUIT.) The pressure air from holes (32) and (24) gives the indication that shift fork (B) has moved to its center position and the sliding collar in the gear group is not engaged.

After the pressure of the air on piston (42) gets to one half of its maximum operating pressure, piston (42) and fork (C) start to move to the left. When the piston (42) has moved completely to the left, it opens hole (41). This hole lets pressure air from the air cylinder go through line (18) to valve (11) in the sensing circuit. (Make reference to SENSING CIRCUIT.) The pressure air from hole (42) gives the indication that shift fork (C) has moved completely and the sliding collar for reverse has engaged correctly.

The pressure air that goes through valve (27) to air cylinder (C2) also goes up line (12) to the double check valve (5). This air moves the check valve up to prevent air from going back to the mechanically operated valve (C3). After moving the check valve up, the air goes around the valve and back to the pilot sides of valve (27) and (6) to hold them in their present positions. The pilot air (2) to the mechanically operated valve can now be removed.

The pressure air in supply line (30) goes to exhaust between each shift. This lets the normally open valve (6) and the normally closed valve (27) go back to their original positions.



REVERSE: MECHANICALLY OPERATED VALVE (C3) IS OPEN

1. Cam plate.
2. Pilot air supply.
4. Double check valve.
5. Double check valve.
6. Normally open valve.
8. Exhaust.
9. Normally closed valve.
12. Line.
13. Exhaust.
14. Line.
16. Line.
18. Line.
19. Hole.
20. Hole.
23. Hole.
24. Hole.
25. Hole.
27. Normally closed valve.
28. Normally open valve.
30. Supply line.
31. Piston.
32. Hole.
36. Piston.
40. Piston.
41. Hole.
42. Piston.
43. Hole.
44. Double check valve.
B. Shift fork.
B1. Air cylinder.
B2. Air cylinder.
C. Shift fork.
C2. Air cylinder.
C3. Mechanically operated valve.

MECHANICALLY OPERATED VALVE POSITION

These normally closed valves control the air cylinders for the shift forks. Valve (A3) controls shift fork (A), valve (B3) controls shift fork (B), valve (C3) controls shift fork (C), valve (D3) controls shift fork (D), valve (E3) controls shift fork (E), and valve (N) is for NEUTRAL.

The following charts show only when the given valve is open for a given transmission speed.

DIRECT DRIVE ARRANGEMENT						
SPEED	MECHANICALLY OPERATED VALVE					
	A3	B3	C3	D3	E3	N
1	OPEN	OPEN		OPEN	OPEN	
2	OPEN	OPEN			OPEN	
3		OPEN		OPEN	OPEN	
4		OPEN			OPEN	
5	OPEN			OPEN	OPEN	
6	OPEN				OPEN	
7				OPEN	OPEN	
8					OPEN	
9	OPEN	OPEN		OPEN		
10	OPEN	OPEN				
11		OPEN		OPEN		
12		OPEN				
13	OPEN			OPEN		
14	OPEN					
15				OPEN		
16						
N	OPEN			OPEN	OPEN	OPEN
R1	OPEN		OPEN	OPEN	OPEN	
R2			OPEN		OPEN	

OVERDRIVE ARRANGEMENT						
SPEED	MECHANICALLY OPERATED VALVE					
	A3	B3	C3	D3	E3	N
1	OPEN	OPEN			OPEN	
2	OPEN	OPEN		OPEN	OPEN	
3		OPEN			OPEN	
4		OPEN		OPEN	OPEN	
5	OPEN				OPEN	
6	OPEN			OPEN	OPEN	
7					OPEN	
8				OPEN	OPEN	
9	OPEN	OPEN				
10	OPEN	OPEN		OPEN		
11		OPEN				
12		OPEN		OPEN		
13	OPEN					
14	OPEN			OPEN		
15						
16				OPEN		
N	OPEN				OPEN	OPEN
R1	OPEN		OPEN		OPEN	
R2			OPEN	OPEN	OPEN	

AIR SYSTEM IN NEUTRAL

When the selector lever is put in the NEUTRAL position, cam plate (2) opens the mechanically operated valve (1). This valve sends pilot pressure air around the double check valve (4) to the normally closed valve (5). The pilot pressure opens the normally closed valve (5) to let pressure air from supply line (6) go through valve (5), around double check valve (4), and through line (3) to valve (22) in the shift cycle circuit. (Make reference to SHIFT CYCLE CIRCUIT.)

Valve (22) in the shift cycle circuit is a normally open valve that sends pressure air to the output clutch to engage it. When line (3) has pressure air, valve (22) in the shift cycle circuit is closed and the pressure air in the output clutch goes to exhaust. The output clutch can not engage with the selector lever in the NEUTRAL position.

The pressure air from line (3) also goes around double check valves (8) and (10) to close the normally open valve (9). This opens hole (17) in air cylinder (B2) to exhaust (11) through valve (9).

The pressure air from valve (5) also moves the double check valve (4) up to prevent air from going back to the mechanically operated valve (1). After moving the check valve up, the air goes around the valve and back to the pilot side of valve (5) to hold it in its present position. The pilot air (7) to the mechanically operated valve can now be removed.

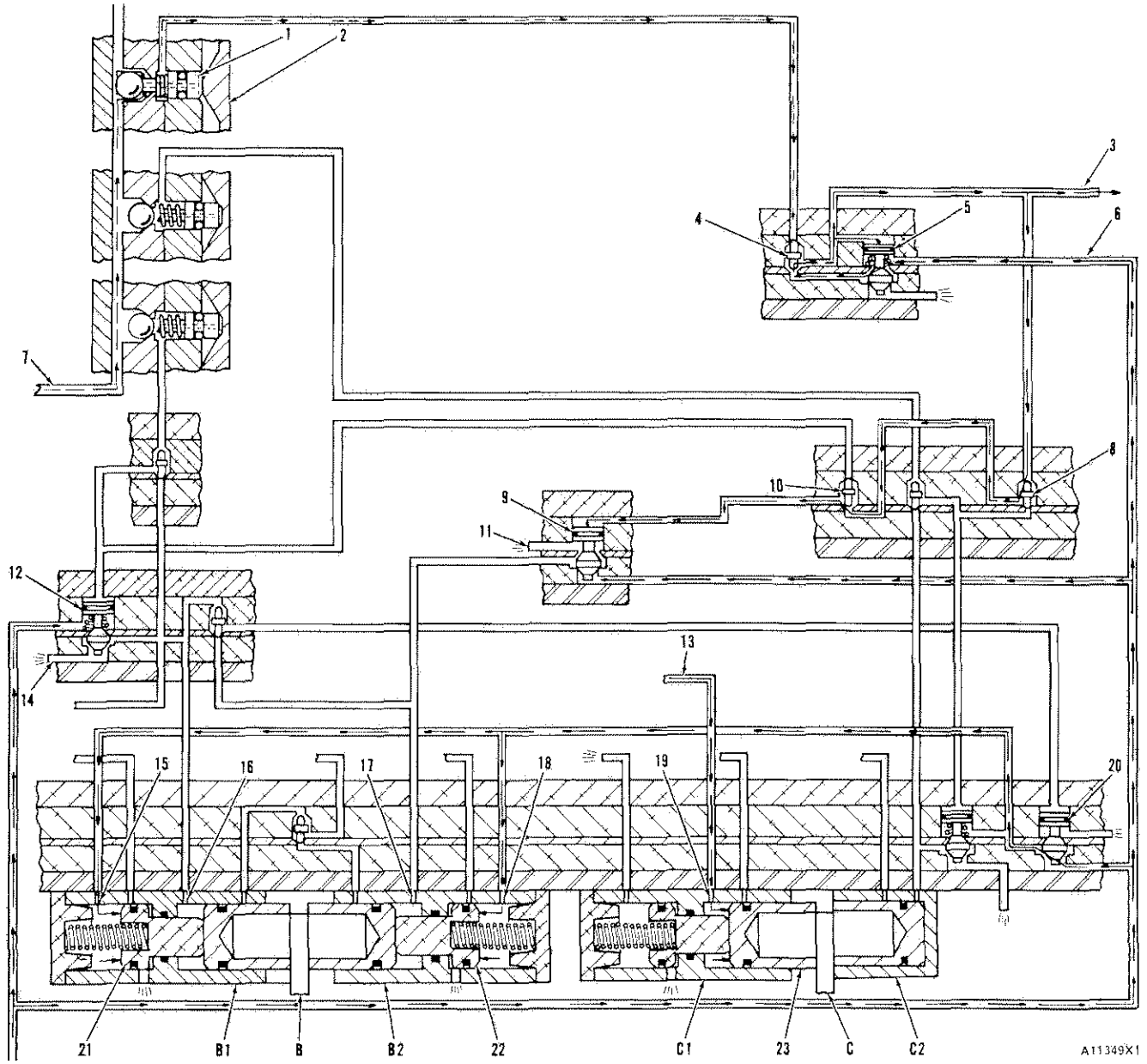
The pressure air in supply line (6) goes to exhaust between each shift. This lets the normally closed valve (5) and the normally open valve (9) go back to their original positions.

At the same time, pressure air is sent from the normally open valve (20) through holes (15) and (18) in air cylinders (B1) and (B2) to pistons (21) and (22). This pressure air moves the pistons and shift fork (B) to its center position. In the center position, the sliding collar on shift fork (B) is not engaged with the gear group. Hole (16) of air cylinder (B1) is connected to exhaust (14) through the normally closed valve (12).

Pressure air from the transmission supply line (13) is constantly sent through hole (19) in air cylinder (C1). This pressure air works against piston (23) to hold shift fork (C) against air cylinder (C2). This keeps the coupling on shift fork (C) out of the engaged condition.

As can be seen from the above explanation, the power connection through the transmission is broken in two ways:

1. Power can not go through output clutch.
2. Power can not go through gear group.



AIR SYSTEM IN NEUTRAL

1. Mechanically operated valve.
2. Cam plate.
3. Line.
4. Double check valve.
5. Normally closed valve.
6. Supply line.
7. Pilot air.
8. Double check valve.
9. Normally open valve.
10. Double check valve.
11. Exhaust.
12. Normally closed valve.
13. Transmission supply line.
14. Exhaust.
15. Hole.
16. Hole.
17. Hole.
18. Hole.
19. Hole.
20. Normally open valve.
21. Piston.
22. Piston.
23. Piston.
B. Shift fork.
B1. Air cylinder.
B2. Air cylinder.
C. Shift fork.
C1. Air cylinder.
C2. Air cylinder.

SENSING CIRCUIT

The sensing circuit gives protection to the gear coupling teeth by keeping the clutches from being engaged until all gear couplings are fully engaged. The sensing circuit also keeps the clutches from being engaged if:

1. During a shift from FORWARD to REVERSE, the forward coupling does not come out of the engaged condition.
2. During a shift from REVERSE to FORWARD, the reverse coupling does not come out of the engaged condition.

The sensing circuit is a pilot pressure source going through a series of normally closed valves to open another normally closed valve (19). This valve (19) must be opened to let the clutches engage. Any valve in the series of normally closed valves will stop the pilot pressure to valve (19) until the valve in the series gets pilot pressure from its pair of air cylinders.

The pilot pressure source can come from one of two places. In forward speeds, the pilot source comes from hole (26) in air cylinder (C1). In reverse speeds, the pilot pressure source comes from hole (41) in air cylinder (C2). [Make reference to AIR SYSTEM FOR SHIFT FORKS (B) AND (C).]

Sensing Circuit (Forward)

In forward speeds, pressure air from hole (26) in air cylinder (C1) is sent through line (2) to normally closed valve (13). This pressure air gives the indication that the gear collar on shift fork (C) is not engaged. This pressure air is also sent through line (12) and around check valve (11) to the normally closed valve (10).

Pressure air is sent from valve (22) through line (1) to open valve (13). This pressure air gives the indication that the gear collar on shift fork (B) is engaged correctly.

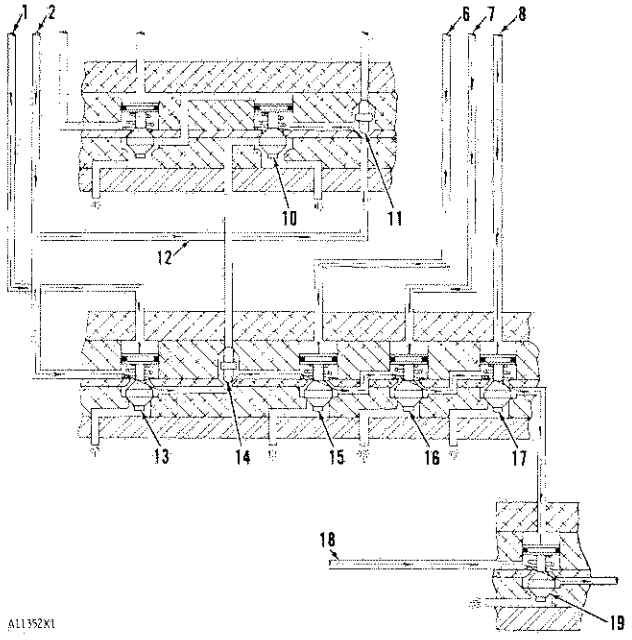
When valve (13) is opened, pressure air from line (2) can go through valve (13) and around check valve (14) to valve (15).

Pressure air from air cylinders (A1) and (A2) is sent through line (6) to open valve (15). This pressure air gives the indication that the gear collar on shift fork (A) is engaged correctly. The pressure air from line (2) can now go through valve (15) to valve (16).

Pressure air from air cylinders (E1) and (E2) is sent through line (7) to open valve (16). This pressure air gives the indication that the gear collar on shift fork (E) is engaged correctly. The pressure air from line (2) can now go through valve (16) to valve (17).

Pressure air from air cylinders (D1) and (D2) is sent through line (8) to open valve (17). This pressure air gives the indication that the gear collar on shift fork (D) is engaged correctly. The pressure air from line (2) can now go through valve (17) to open valve (19).

When valve (19) is open, pressure air from supply line (18) can go on to engage the clutches.



SENSING CIRCUIT (FORWARD)

1. Line from valve (22).
2. Line from hole (26) in air cylinder (C1).
6. Line from air cylinders (A1) and (A2).
7. Line from air cylinders (E1) and (E2).
8. Line from air cylinders (D1) and (D2).
10. Normally closed valve.
11. Check valve.
12. Line
13. Normally closed valve.
14. Check valve.
15. Normally closed valve.
16. Normally closed valve.
17. Normally closed valve.
18. Supply line.
19. Normally closed valve.

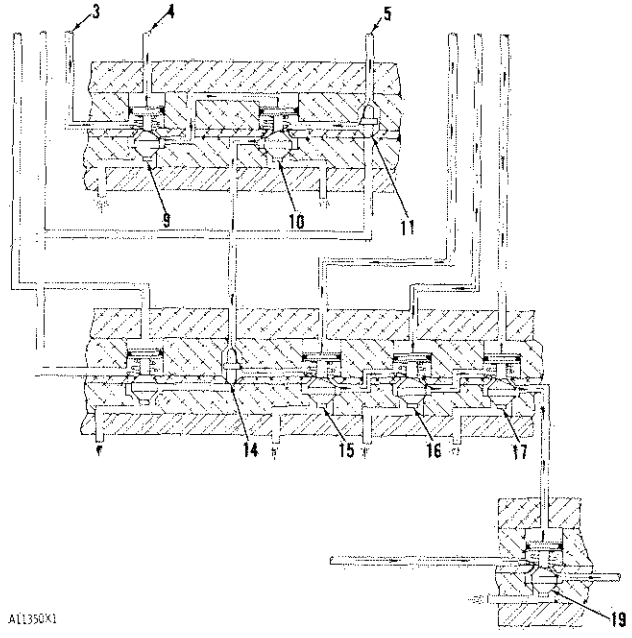
Sensing Circuit (Reverse)

In reverse speeds, pressure air from hole (41) in air cylinder (C2) is sent through line (5) and around check valve (11) to valve (10). This pressure air gives the indication that the gear collar on shift fork (C) is engaged.

Pressure air is sent from hole (32) in air cylinder (B1) through line (4) to open valve (9). Pressure air is sent from hole (24) in air cylinder (B2) through line (3) and through valve (9) to open valve (10). Pressure air in lines (3) and (4) gives the indication that the gear collar on shift fork (B) is not engaged.

When valve (10) is opened, pressure air from line (5) can go through the valve and around check valve (14) to valve (15).

Valves (15), (16), (17), and (19) are opened in the same way and with the same results as in the forward direction.



SENSING CIRCUIT (REVERSE)

3. Line from hole (24) in air cylinder (B2).
4. Line from hole (32) in air cylinder (B1).
5. Line from hole (41) in air cylinder (C2).
9. Normally closed valve.
10. Normally closed valve.
11. Check valve.
14. Check valve.
15. Normally closed valve.
16. Normally closed valve.
17. Normally closed valve.
19. Normally closed valve.

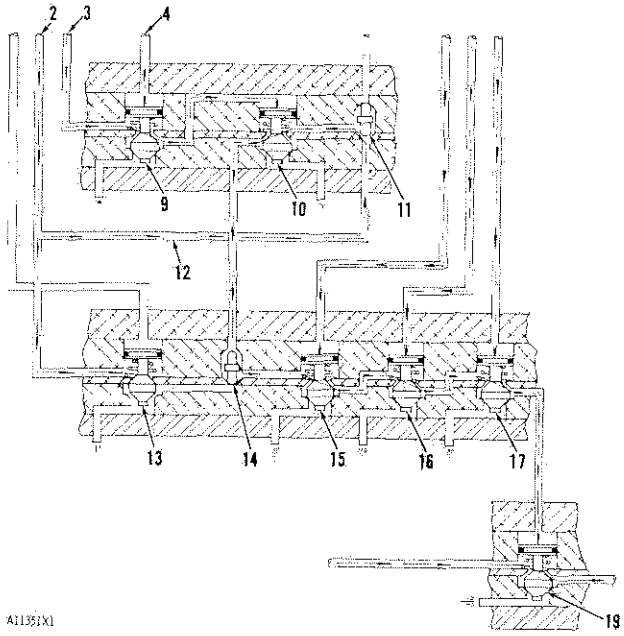
Sensing Circuit (Neutral)

In NEUTRAL, pressure air from hole (26) in air cylinder (C1) is sent through line (2), through line (12), and around check valve (11) to valve (10). This pressure air gives the indication that the gear collar on shift fork (C) is not engaged. This pressure air is also sent to valve (13).

Pressure air is sent from hole (32) in air cylinder (B1) through line (4) to open valve (9). Pressure air is sent from hole (24) in air cylinder (B2) through line (3) and through valve (9) to open valve (10). Pressure air lines (3) and (4) give the indication that the gear collar on shift fork (B) is not engaged.

When valve (10) is opened, pressure air from line (12) can go through the valve and around check valve (14) to valve (15).

Valves (15), (16), (17), and (19) are opened in the same way and with the same results as in the forward or reverse directions.



SENSING CIRCUIT (NEUTRAL)

2. Line from hole (26) in air cylinder (C1).
3. Line from hole (24) in air cylinder (B2).
4. Line from hole (32) in air cylinder (B1).
9. Normally closed valve.
10. Normally closed valve.
11. Check valve.
12. Line.
13. Normally closed valve.
14. Check valve.
15. Normally closed valve.
16. Normally closed valve.
17. Normally closed valve.
19. Normally closed valve.

PRESSURE REGULATOR

The output clutch is engaged by pressure air working against springs in the clutch. The pressure of this air is controlled by a pressure regulator. The pressure in 1st through 4th speed is 92 psi (6.5 kg/cm^2), in 5th through 8th speed is 74 psi (5.2 kg/cm^2), in 9th through 12th speed is 37 psi (2.6 kg/cm^2), and in 13th through 16th speed is 19 psi (1.4 kg/cm^2).

The air pressure is higher when the torque sent through the clutch is higher (the lower the gear ratio, the higher the torque). The pressure regulator keeps the output clutch from getting more air pressure than necessary.

Pressure air comes from the transmission supply line (3), through orifice (8) to valve (6). When the air pressure in line (5) to the output clutch is less than the pressure setting in the valve, supply air can go through the valve to line (5). As the air pressure to the output clutch becomes the same as the pressure regulator setting, piston (7) is moved down by pressure air against the force of spring (12). Valve (6) moves down with piston (7) to stop supply air from going through the regulator to line (5) and to the output clutch.

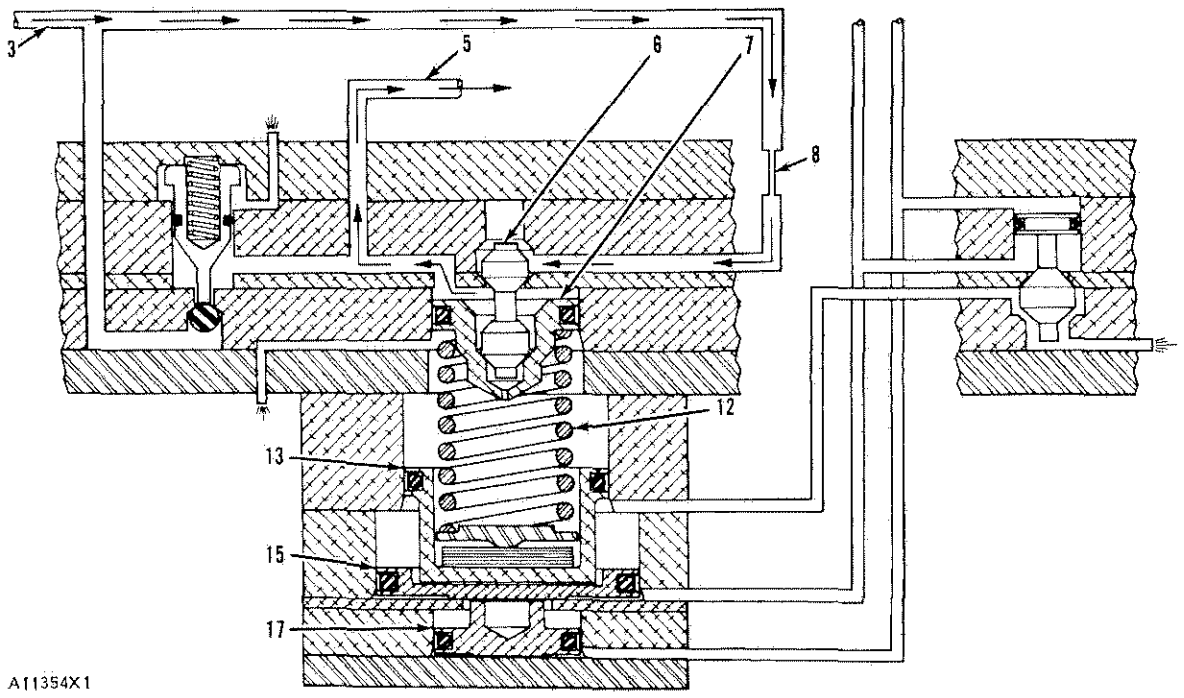
If the air pressure in line (5) to the output clutch has a decrease, the spring force moves piston (7) up and opens the valve (6).

The pressure regulator uses the pilot pressure from the mechanically operated valves (B3) and (E3) to change its pressure setting. Make reference to MECHANICALLY OPERATED VALVE POSITION to see in what speeds each valve (B3) and (E3) is open to send pilot pressure.

In all the transmission speeds, the mechanically operated valves send pilot pressure through a series of valves before getting to the pressure regulator. Make reference to AIR SYSTEM FOR SHIFT FORKS (A), (D), AND (E) and make reference to AIR SYSTEM FOR SHIFT FORKS (B) AND (C).

13th Through 16th Speed

In 13th through 16th speed, neither valve (B3) nor valve (E3) is open. Pistons (13), (15), and (17) are against their lower stops and spring (12) is in its longest assembled condition. In this condition, the pressure setting is 19 psi (1.4 kg/cm^2).



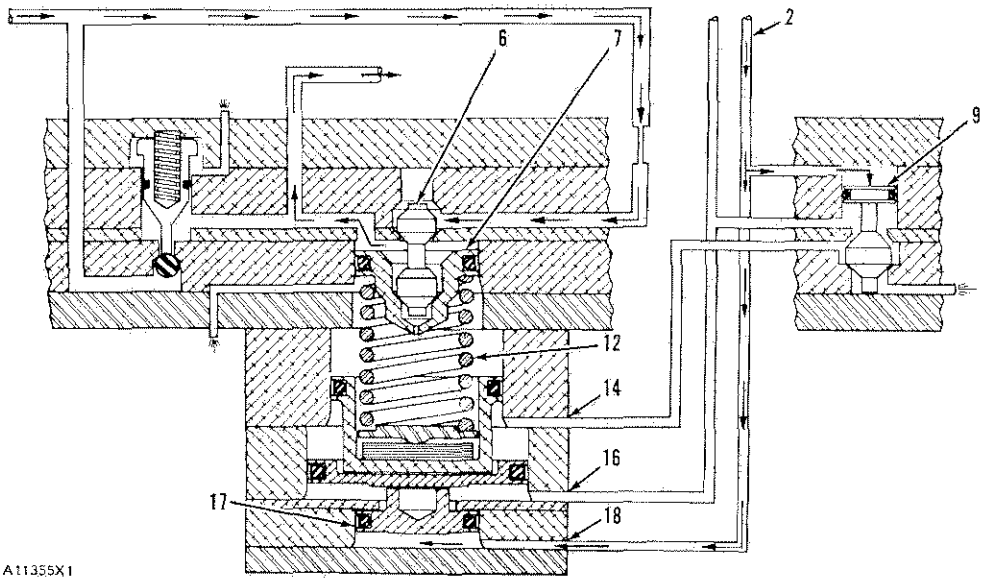
PRESSURE REGULATOR IN 13th THROUGH 16th SPEED

3. Transmission supply line.
5. Line to output clutch.
6. Valve.
7. Piston.
8. Orifice.
12. Spring.
13. Piston.
15. Piston.
17. Piston.

9th Through 12th Speed

In 9th through 12th speed, valve (B3) is open. Pressure air from valve (B3) comes down line (2) to the normally closed valve (9) and to hole (18) in the pressure regulator. This pressure air opens the normally closed valve (9) to connect hole (16) to hole (14) through valve (9).

The pressure air to hole (18) in the pressure regulator moves piston (17) up against its upper stop. This movement gives spring (12) more compression and increases the spring force on piston (7). It now takes more air pressure to move piston (7) down and close valve (6). In this condition, the pressure setting is 37 psi (2.6 kg/cm^2).

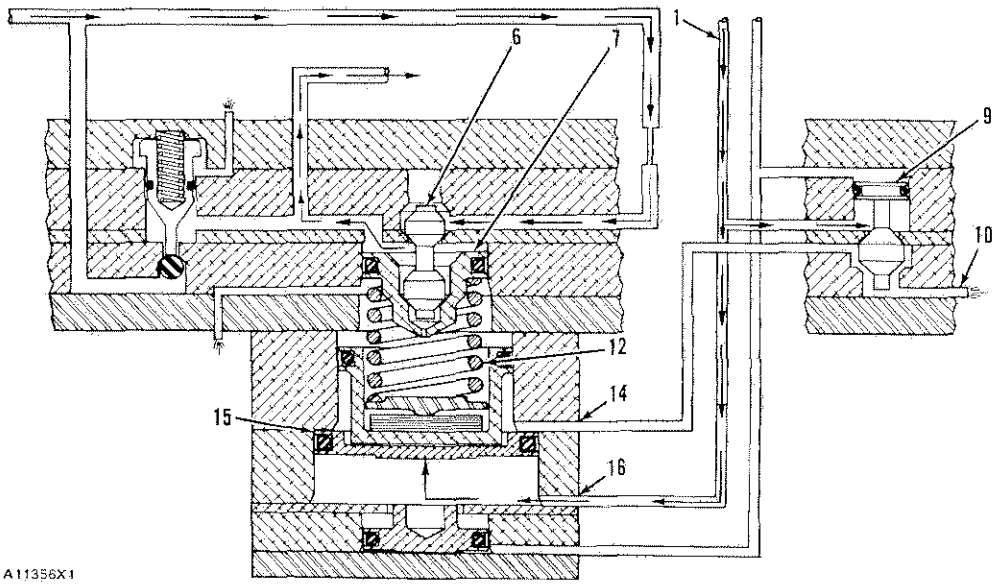


PRESSURE REGULATOR IN 9th THROUGH 12th SPEED

2. Line from valve (B3).
6. Valve.
7. Piston.
9. Normally closed valve.
12. Spring.
14. Hole.
16. Hole.
17. Piston.
18. Hole.

5th Through 8th Speed

In 5th through 8th speed, valve (E3) is open. Pressure air from valve (E3) comes down line (1) to the normally closed valve (9) and to hole (16) in the pressure regulator. The pressure air from line (1) is stopped by valve (9). Hole (14) in the pressure regulator is open to exhaust (10) through valve (9).



PRESSURE REGULATOR IN 5th THROUGH 8th SPEED

1. Line from valve (E3).
6. Valve.
7. Piston.
9. Normally closed valve.
10. Exhaust.
12. Spring.
14. Hole.
15. Piston.
16. Hole.

The pressure air to hole (16) in the pressure regulator moves piston (15) up against its upper stop. This movement gives spring (12) more compression and increases the spring force on piston (7). It now takes more air pressure to move piston (7) down and close valve (6). In this condition, the pressure setting is 74 psi (5.2 kg/cm^2).

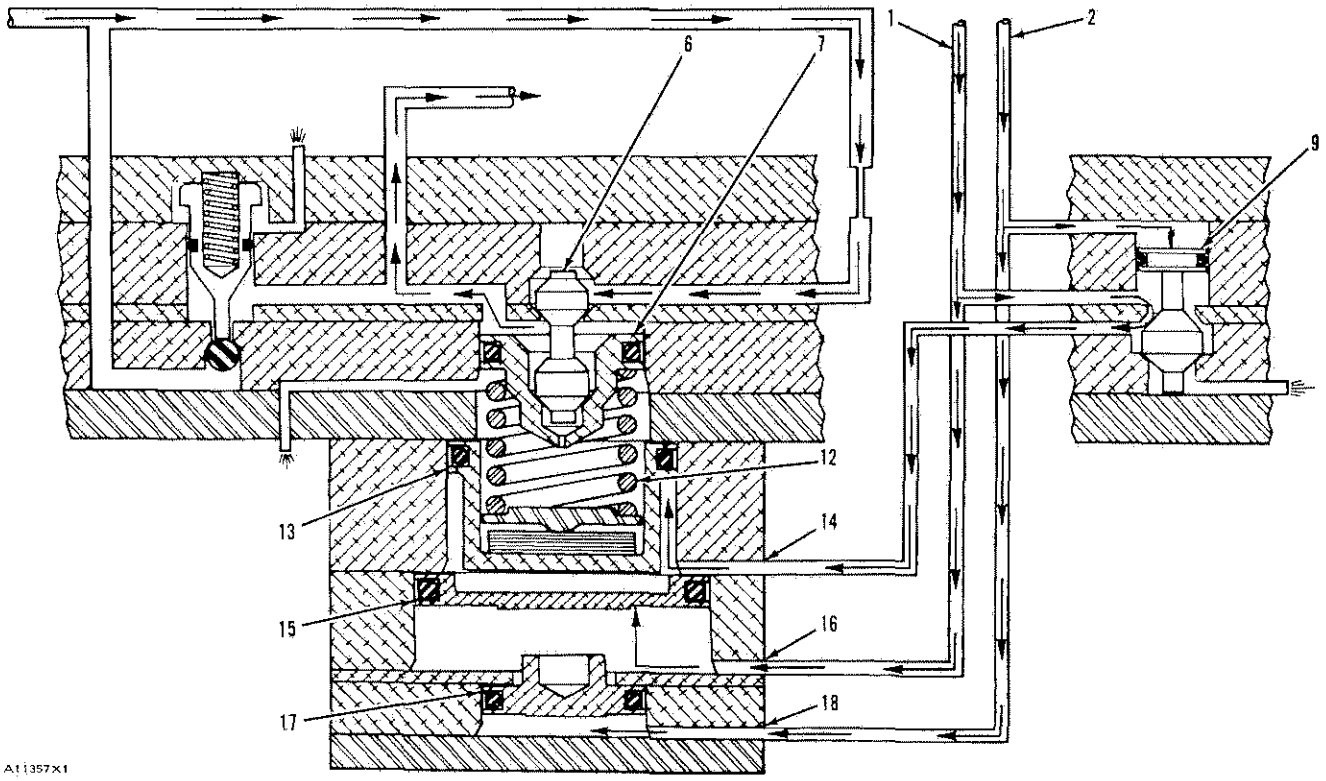
The reverse speeds also have this pressure setting.

1st Through 4th Speed

In 1st through 4th speed, both valve (B3) and (E3) are open. Pressure air from valve (B3) comes down line (2) to open the normally closed valve (9) and to hole (18) in the pressure regulator. The pressure air to hole (18) moves piston (17) up against its upper stop. This movement has no effect on the operation of the regulator in 1st through 4th speeds.

The pressure air from valve (E3) comes down line (1), through valve (9) to hole (14) in the pressure regulator. The pressure air in line (1) also goes to hole (16) in the pressure regulator to move piston (15) up against its upper stop. This movement has no effect on the operation of the pressure regulator in 1st through 4th speeds.

The pressure air to hole (14) in the pressure regulator moves piston (13) up against its upper stop. This movement gives spring (12) more compression and increases the spring force on piston (7). It now takes more air pressure to move piston (7) down and close valve (6). In this condition, the pressure setting is 92 psi (6.5 kg/cm^2).



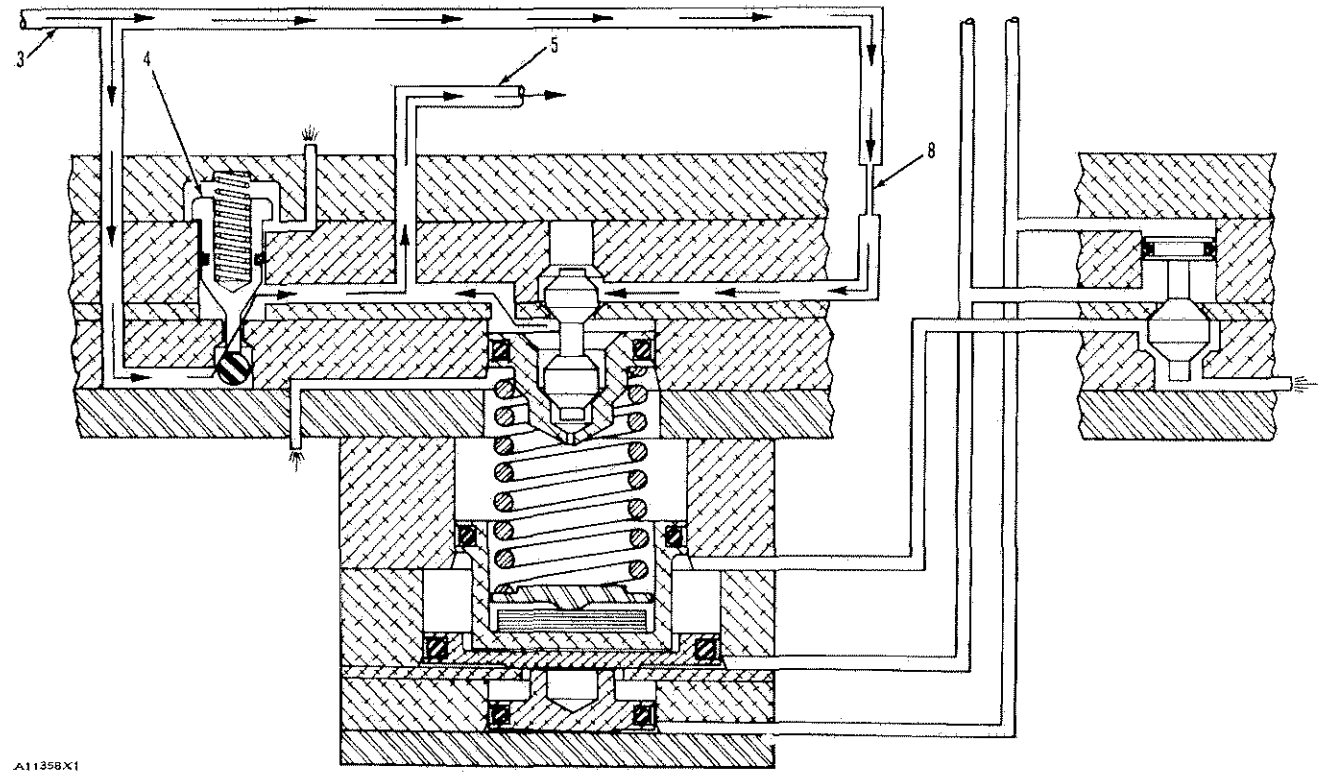
PRESSURE REGULATOR IN 1st THROUGH 4th SPEED

1. Line from valve (E3).
2. Line from valve (B3).
6. Valve.
7. Piston.
9. Normally closed valve.
12. Spring.
13. Piston.
14. Hole.
15. Piston.
16. Hole.
17. Piston.
18. Hole.

QUICK FILL VALVE

The quick fill valve (4) lets pressure air from the transmission supply line (3) go around the ball to line (5) and to the output clutch. This valve gives a passage for pressure air to directly fill the output clutch from the transmission supply line. This lets the output clutch fill more rapidly than if the pressure air for the output clutch came through only orifice (8) and the pressure regulator.

When the air pressure in the output clutch becomes 6 psi (0.4 kg/cm²), the quick fill valve closes. With the quick fill valve closed, the pressure air now must go through orifice (8) and through the pressure regulator to increase the air pressure to the output clutch.



QUICK FILL VALVE

3. Transmission supply line. 4. Quick fill valve. 5. Line to output clutch. 8. Orifice.

RATIO SELECTION

To make a ratio selection (change from one transmission speed to another) the ratio selector and the transmission control must do the following:

1. Keep the present gear ratio while the operator is making the next gear ratio selection. This is done by keeping the supply air to the air system for the shift forks.
2. Get the air system for the shift forks ready to make a new gear ratio selection. This is done by the removal of the supply air to the air system for the shift forks.
3. Begin the shift cycle. This is started by the removal of the supply air to the air system for the shift forks.

NOTE: A rotation lock is activated to prevent the movement of the selector lever until the shift cycle is complete.

4. Release the input clutch by sending pressure air to it. Release the output clutch by the removal of the pressure air to it.
5. Activate the input and output brakes by sending pressure air to them.
6. Give enough time between the brake application and the movement of the shift forks to be sure the gear rotation has completely stopped.
7. Move shift forks by letting the supply air go to the air system for the shift forks.
8. Release the input brake by the removal of pressure air to it.

9. Release the output brake (after giving enough time for the shift forks to move) by the removal of pressure air to it.
10. Keep the clutches released until all shift forks have moved. This is done by the sensing circuit. Make reference to SENSING CIRCUIT.
11. Engage the input clutch by the removal of pressure air to it.
12. Engage the output clutch by sending pressure air to it.
13. Hold pilot pressure air in the air system for the shift forks. Make reference to AIR SYSTEM FOR SHIFT FORKS.
14. Remove the pilot pressure air from the mechanical valves in the ratio selector.
15. Release the rotation lock to let the selector lever be moved for the next shift. The ratio selection is now complete.

SHIFT CYCLE CIRCUIT

After a shift cycle is complete, pressure air in the shift cycle circuit is as shown in the schematic on the following page.

Pressure air comes from the transmission supply line (77) to the supply line (4) for the air system for the shift forks. Make reference to AIR SYSTEM FOR SHIFT FORKS.

Pressure air from the sensing circuit (make reference to SENSING CIRCUIT) opens the normally closed valve (20) to let pressure air from the transmission supply line (77) open the normally closed valves (37), (38), (39), and (40). With these valves open, pressure air can come from the transmission supply line (77) through the quick fill valve (51) and the pressure regulator (52) to the line (53) for the output clutch. (Make reference to QUICK FILL VALVE and PRESSURE REGULATOR.) Pressure air to the output clutch engages the clutch. Make reference to OUTPUT CLUTCH.

Pressure air to line (15) for the input clutch goes to exhaust (16) through the normally open valve (12). The input clutch is now engaged by oil. Make reference to INPUT CLUTCH.

Pressure air to the line (58) for the input brake goes to exhaust (65) through the normally closed valve (57). The input brake is not activated. Make reference to INPUT BRAKE.

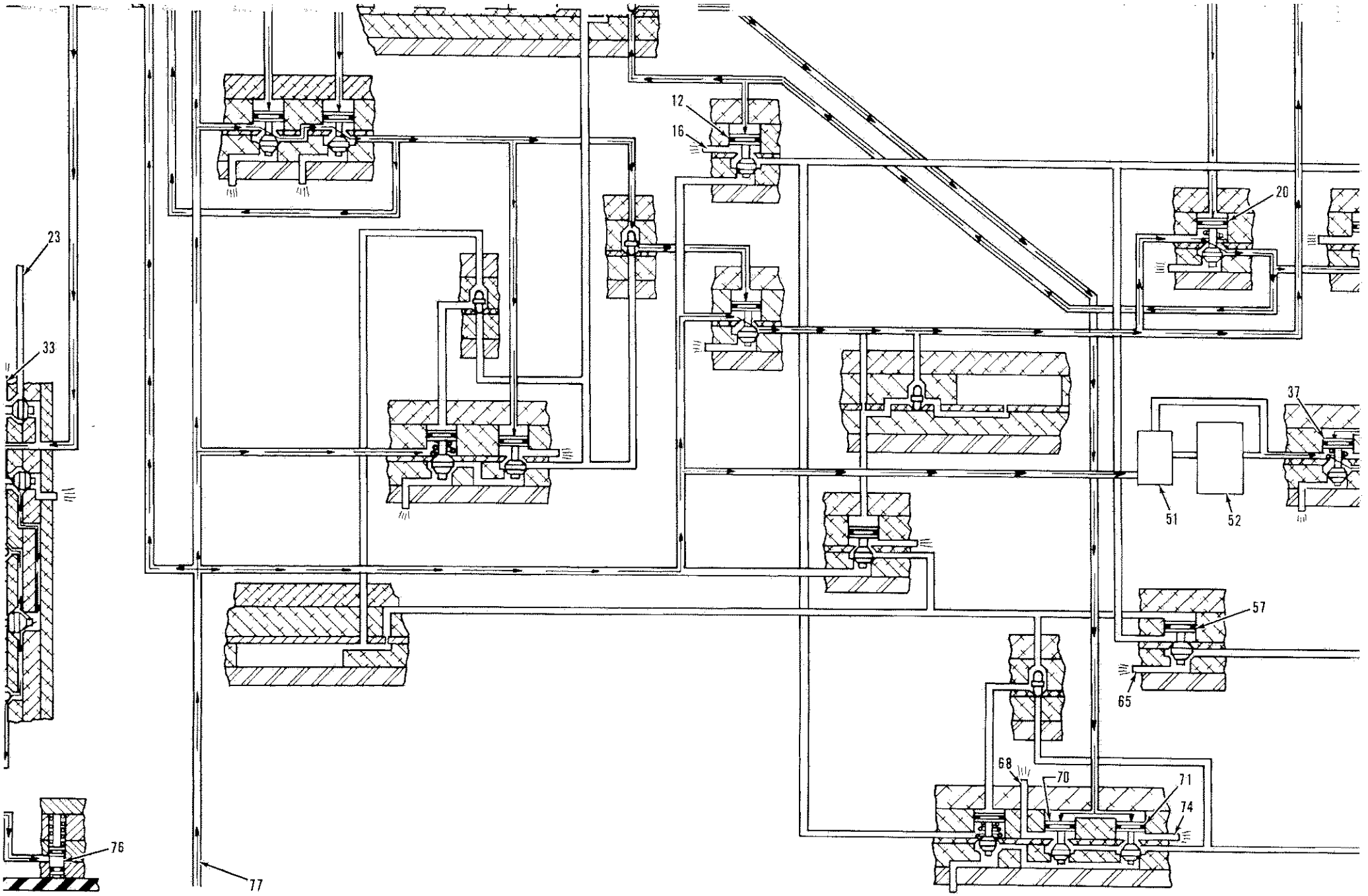
Pressure air to the line (75) for the output brake goes to exhaust (68) and (74) through the normally open valves (70) and (71). The output brake is not activated. Make reference to OUTPUT BRAKE.

Pilot air to the line (23) for the mechanically operated valves in the ratio selector goes to exhaust (33) through the normally open valve (45).

Pressure air goes through line (55) to hold the rotation lock (72) out of the engaged condition.

Pressure air goes to the neutral lock (76) to hold it out of the engaged condition. The ratio selector must be in the NEUTRAL position before the engine can be started. This neutral lock is engaged until enough pressure air is available to move the neutral lock (76) out of the engaged condition. This prevents making a shift until enough pressure air is available to the transmission control. The neutral lock is held out of the engaged condition through the remainder of the transmission operation.

With the shift cycle circuit in the position shown, a shift is complete and the truck is moving down the road. The shift cycle circuit is now ready for the next shift.



SHIFT CYCLE CIRCUIT IN NORMAL OPERATION (AFTER A SHIFT IS COMPLETE)

3. Line from sensing circuit.
4. Supply line to shift forks.
12. Normally open valve.
15. Line for input clutch.
16. Exhaust.
20. Normally closed valve.
23. Line to mechanically operated valve.
33. Exhaust.
37. Normally closed valve.
38. Normally closed valve.
39. Normally closed valve.
40. Normally closed valve.
45. Normally open valve.
51. Quick fill valve.
52. Pressure regulator.
53. Line for output clutch.
55. Line.
57. Normally closed valve.
58. Line for input brake.
65. Exhaust.
70. Normally open valve.
71. Normally open valve.
72. Rotation lock.
74. Exhaust.
75. Line for output brake.
76. Neutral lock.

MISSION OPERATION.)

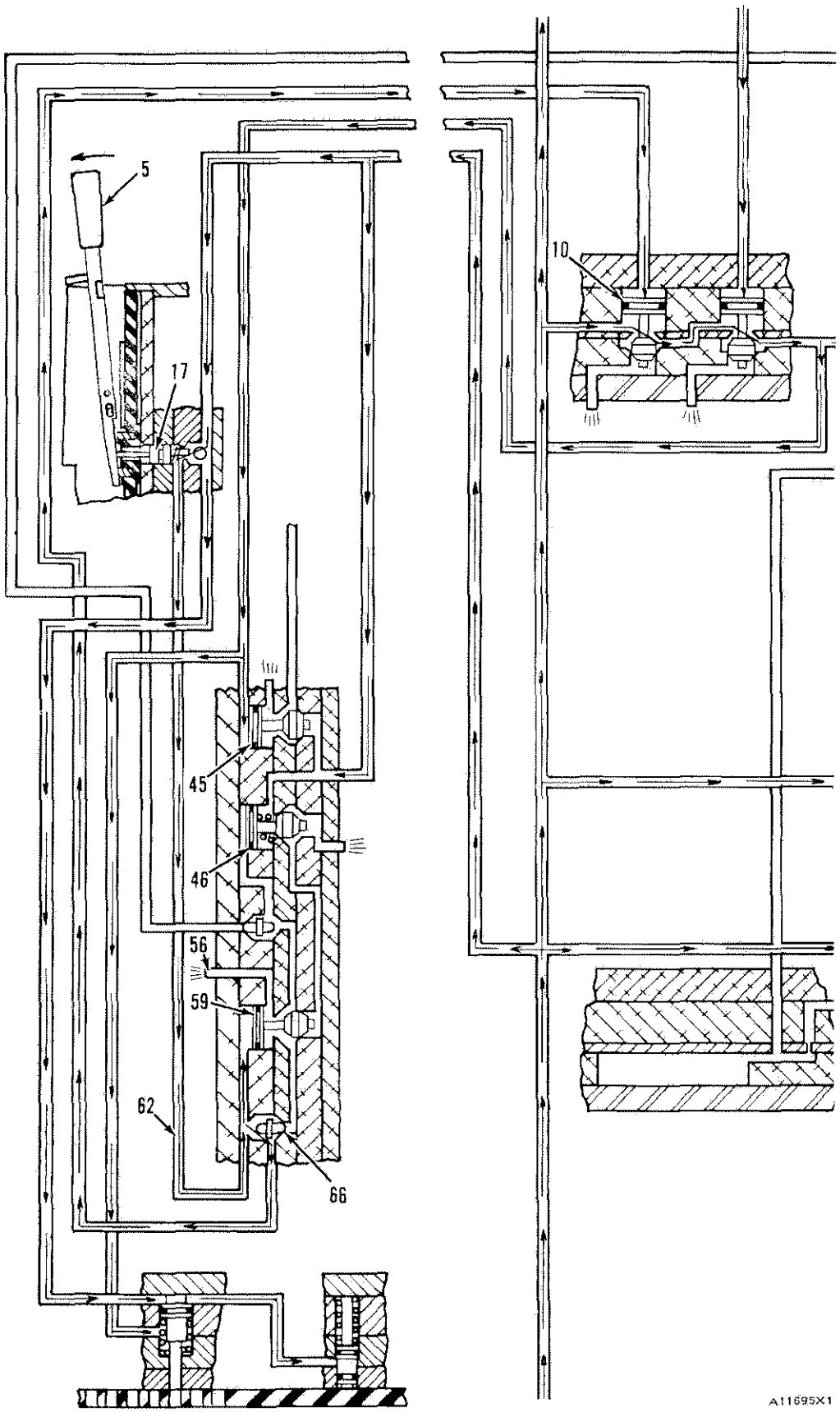
When the selector lever (5) is mo
the normally closed shift valve (17) i
sure air is sent through line (62) to
mally open valve (59). Pressure a
around the double check valve (6
mally closed valve (10). This holds v

With the normally open valve (5
pilot pressure air that holds the n
valve (46) open goes to exhaust (56
(59). This lets valve (46) close.

When valve (46) is closed, the
from valve (46) to hold valve (10) o
and valve (10) is held open by the pi
he shift valve (17). This lets the shi
valve (10) to keep the transmissio
ratio.

The selector lever is now move
backward) to the desired gear rat
ment opens the mechanically oper
the shift forks in the correct seque
desired gear ratio. Pressure air is n
the mechanically operated valves fo
because valve (45) is still closed.

5. Selector lever.
10. Normally closed valve.
17. Normally closed shift valve.
45. Normally open valve.
46. Normally closed valve.
56. Exhaust.
59. Normally open valve.
62. Line.
66. Double check valve.

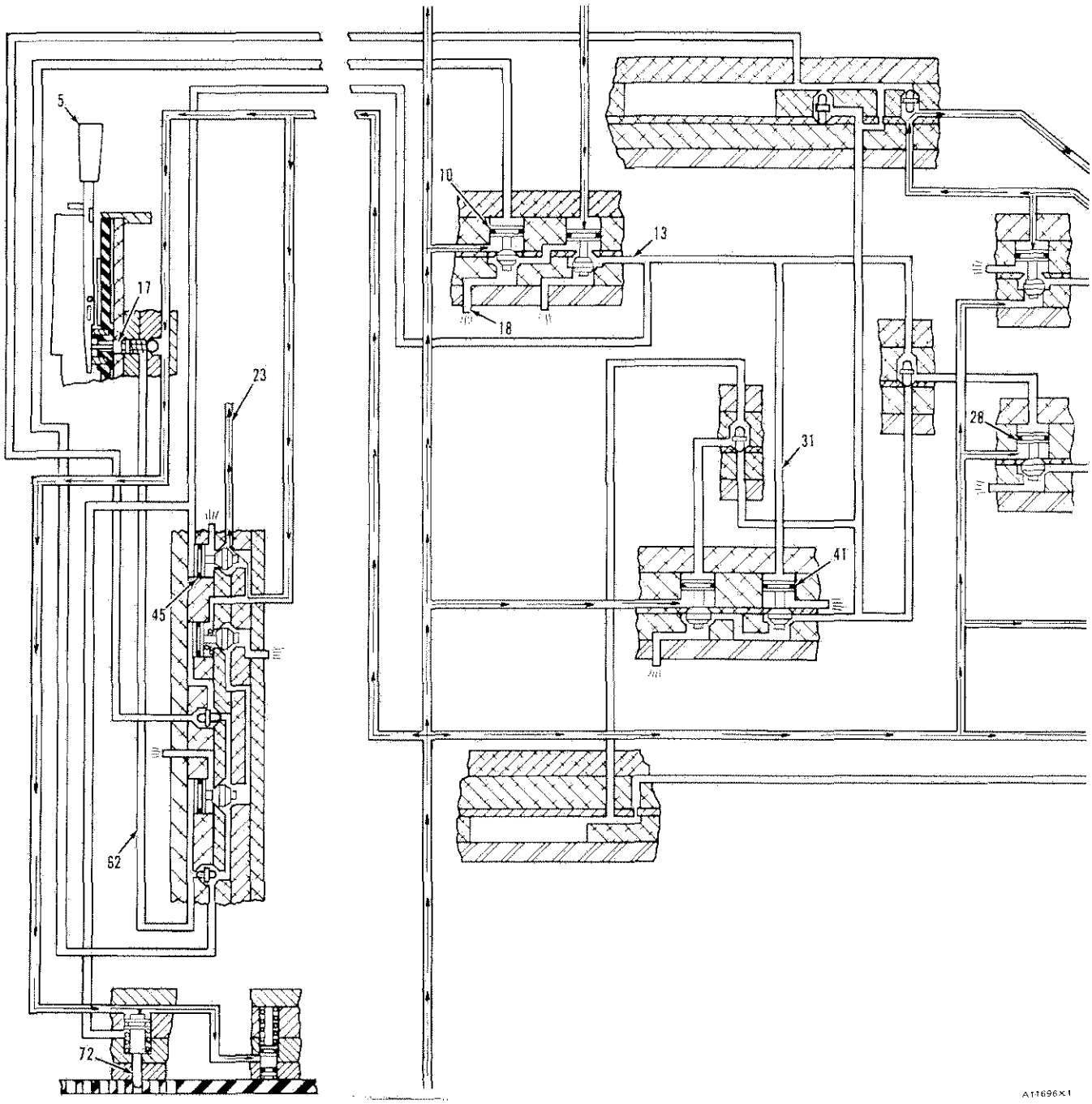


SHIFT CYCLE CIRCUIT DURING A SHIFT (AFTER THE SELECTOR LEVER HAS MOVED OUT OF THE DETENT IN THE RATIO SELECTOR)

After the selector lever (5) is moved to the desired ratio, it is moved into the detent in the ratio selector by spring force. This movement closes the shift valve (17) and lets the pressure air in line (62) go to exhaust through the shift valve. This removes the pilot pressure from the normally closed valve (10) and lets it close.

When valve (10) is closed, the pressure air in line (13) goes to exhaust (18) through valve (10). This lets the normally open valve (45) open to send pilot pressure air through line (23) to the mechanically operated valves for the shift forks. Also when the pressure air in line (13) goes to exhaust, the pressure air from the spring side of the rotation lock (72) is removed. This lets the rotation lock engage to prevent any farther movement of the selector lever until the shift cycle is complete.

Also when valve (10) is closed, the pressure air in line (31) goes to exhaust (18) through valve (10). This removes the pilot pressure from the normally open valve (41) to let it open. Also when the pressure air in line (13) goes to exhaust, the pilot pressure that holds the normally closed valve (28) open is removed and valve (28) closes.



SHIFT CYCLE CIRCUIT DURING A SHIFT (AFTER SELECTOR LEVER HAS MOVED BACK INTO DETENT)

5. Selector lever.
10. Normally closed valve.
13. Line.
17. Normally closed shift valve.
18. Exhaust.
23. Line to mechanically operated valves.
28. Normally closed valve.
31. Line.
41. Normally open valve.
45. Normally open valve.
62. Line.
72. Rotation lock.

When valve (28) is closed, the pressure air in the supply line (4) for the air system for the shift forks goes to exhaust (36) through valve (28). This removes all the pressure air from the air system for the shift forks to make the system ready for a new set of orders from the mechanically operated valves in the ratio selector. Also when the pressure air in the supply line (4) goes to exhaust, the pilot pressure in line (1) from the air system for the shift forks is removed from the normally closed valve (11). This lets valve (11) close to prevent starting a second shift cycle before the first cycle is complete.

When there is no pressure air to the air system for the shift forks, the sensing circuit lets the normally closed valve (20) close. This lets the pressure air in lines (19) and (24) go to exhaust (29) through valve (20). When the pressure air in these lines go to exhaust, the pilot pressure is removed from the normally open valves (12), (70), and (71).

The pressure air from the transmission supply line (77) can now open valve (12) and go directly to line (15) for the input clutch. This pressure air can now release the input clutch.

The pressure air from the transmission supply line that goes through valve (12) also goes around the double check valve (9) to close the normally open valve (22). When valve (22) is closed, the pilot pressure that holds the normally closed valves (37), (38), (39), and (40) open is sent to exhaust (21) through valve (22). This lets valves (37), (38), (39), and (40) close and the pressure air in line (53) to the output clutch goes to exhaust through these valves. Now spring force in the output clutch can release the output clutch.

The pressure air from the transmission supply line that goes through valve (12) also goes to the supply side of the normally closed valves (48), (73), and (57).

The pilot pressure that holds the normally open valve (48) closed is let go to exhaust (36) through orifice (42) and valve (28). The orifice (42) gives a delay in the time necessary to open valve (48). This delay lets the clutches release fully before the brakes are activated.

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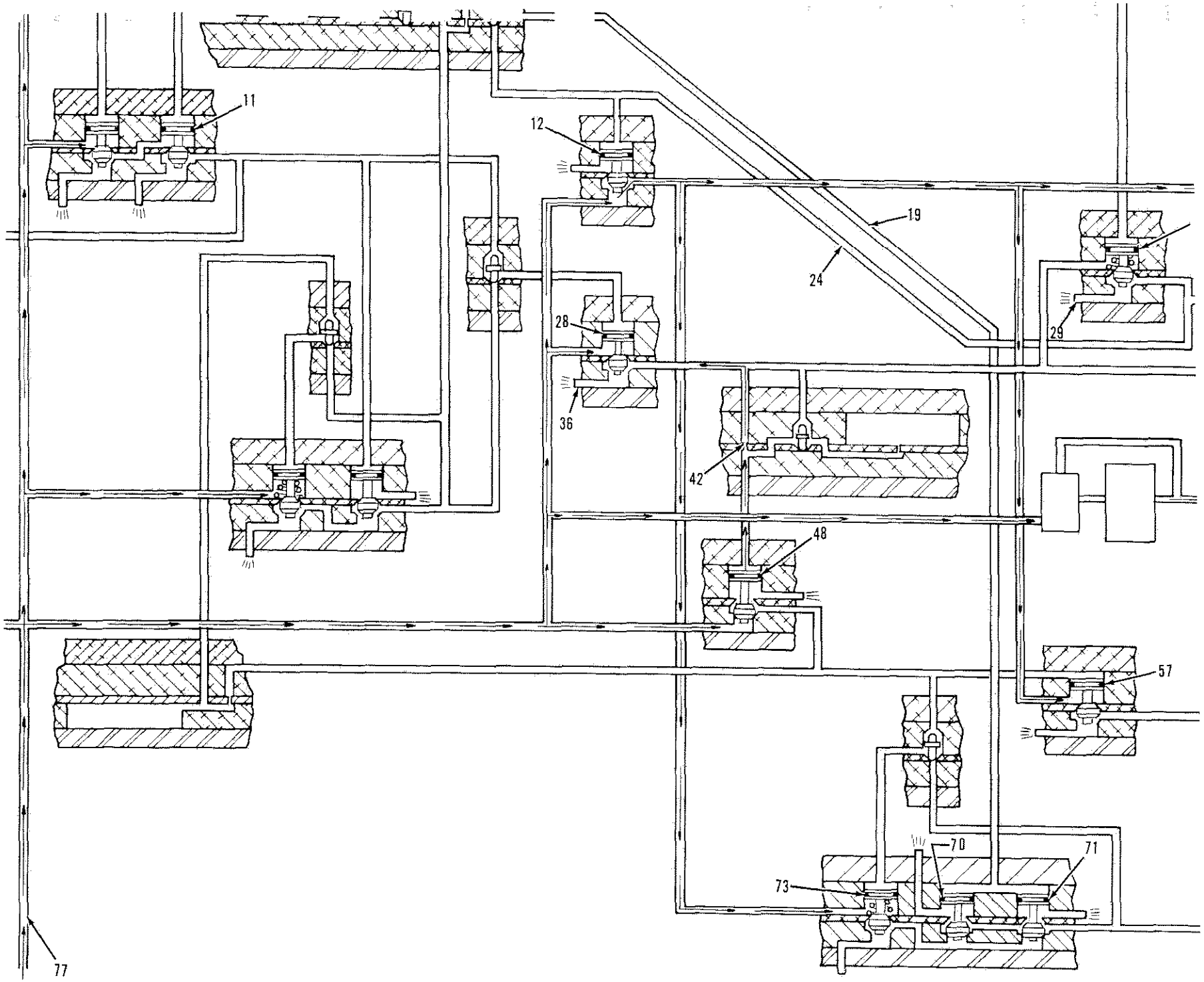
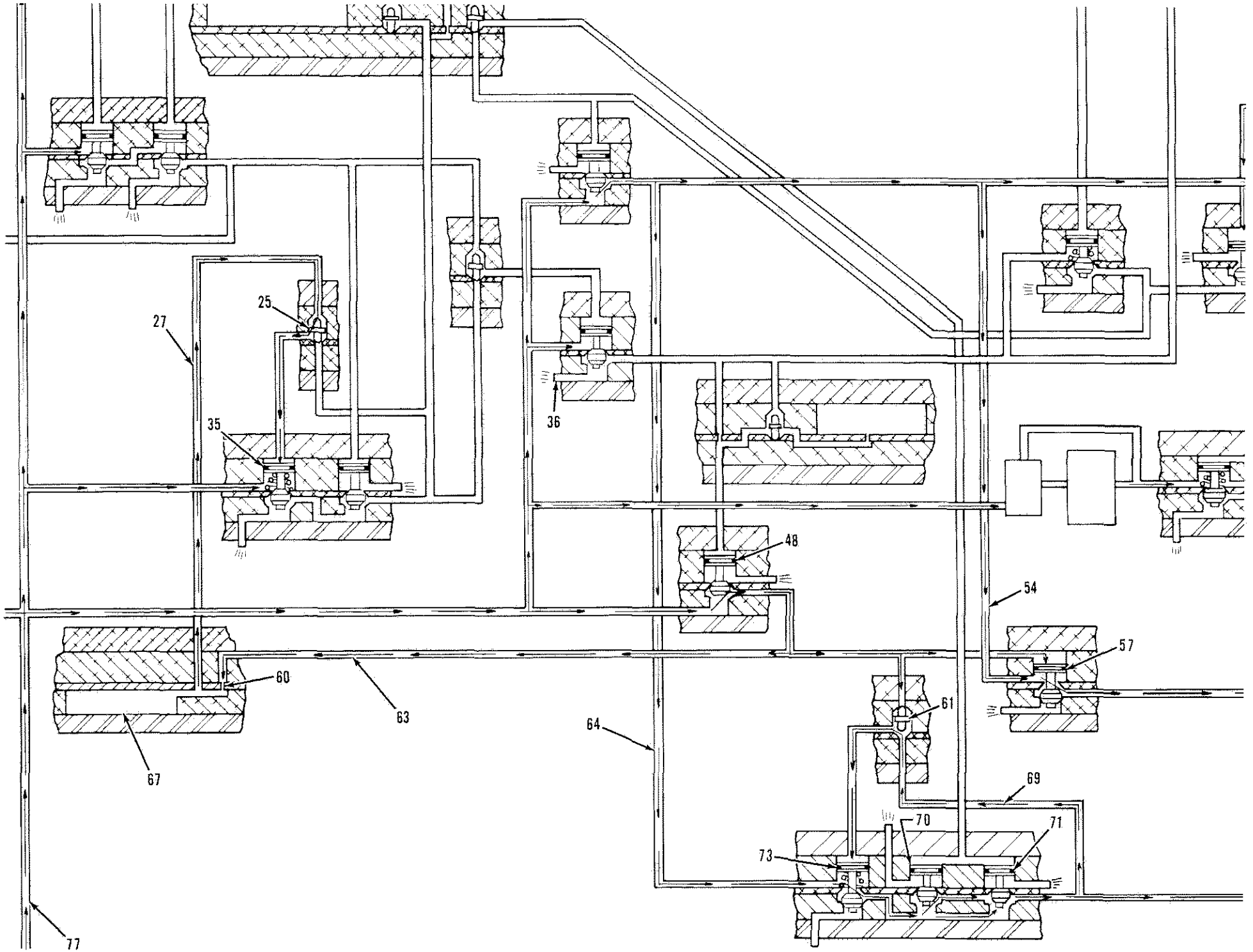


SHIFT CYCLE CIRCUIT DURING A SHIFT [AFTER VALVE (28) IS CLOSED]



SHIFT CYCLE CIRCUIT DURING A SHIFT [AFTER VALVE (48) OPENS]

When the pilot pressure that holds the normally open valve (48) closed goes completely to exhaust (36), valve (48) can open. When valve (48) opens, pressure air from the transmission supply line (77) can go through valve (48), around the double check valve (61), to open the normally closed valve (73). When valve (73) is open, pressure air from line (64) can go through valve (73), through the normally open valves (70) and (71) to line (75) for the output brake. This pressure air can now activate the output brake.

The pressure air that goes through valve (73) is sent through line (69) to move the double check valve (61) up. This check valve movement lets pressure air from line (64) hold valve (73) open. The pilot pressure from valve (48) to valve (73) is not necessary to keep valve (73) open.

Also, when valve (48) opens, pressure air from the transmission supply line (77) can go through valve (48) to open the normally closed valve (57). When valve (57) is open, pressure air from line (54) can go through valve (57) to the line (58) for the input brake. This pressure air can now activate the input brake.

Now both clutches are released and both brakes are activated. The gear group of the transmission has no rotation.

The pressure air from valve (48) to (73) and (57) also can go through line (63), through orifice (60), to volume (67). As the pressure air fills volume (67), there is a gradual increase in pressure in line (27). This pressure air goes around the double check valve (25) to the pilot side of the normally closed valve (35). When the pressure of the air is high enough, valve (35) will open.

When valve (35) opens, pressure air from the transmission supply line (77) can go through the normally open valve (41), through line (34) to move the double check valve (25) up. This check valve movement lets pressure air from the transmission supply line (77) hold valve (35) open. The pilot pressure from volume (67) to valve (35) is not necessary to keep valve (35) open.

The pressure air from valve (35) goes around the double check valve (26) to open the normally closed valve (28).

When valve (28) is opened, pressure air from the transmission supply line (77) can go through valve (28) to supply line (4) for the air system for the shift forks. Pressure air in the air system for the shift forks moves the shift forks to their new positions as ordered by the mechanically operated valves in the ratio selector.

When the air system for the shift forks has pressure air, pilot pressure in line (1) from the air system for the shift forks opens the normally closed valve (11).

The pressure air that goes to line (4) also goes to the supply side of the normally closed valve (20) and to line (30). The pressure air from line (30) goes around the check valve (44) through orifice (43) to fill volume (32). As the pressure air fills volume (32), there is a gradual increase in pressure to the pilot side of the normally open valve (48). When the pressure of the air is high enough, valve (48) will close.

When valve (48) closes, the pilot air that holds valve (57) open goes to exhaust (50) through valve (48). This lets the pressure air in line (58) to the input brake go to exhaust (65) through valve (57). The input brake is now released.

The pressure air from valve (35) can also go up line (14), through orifice (8) to fill volume (7). As the pressure air fills volume (7), there is a gradual increase in pressure around the double check valve (6) to line (19) and to line (2). When the pressure of the air in line (19) is high enough, the normally open valves (70) and (71) will close.

When valves (70) and (71) are closed, the pressure air in line (75) to the output brake goes to exhaust (68) and (74) through valves (70) and (71). The output brake is now released.

If valve (20) is opened by pressure air from the sensing circuit before volume (7) is filled, the pressure air from valve (20) will move check valve (6) up and send pressure air directly to valves (70) and (71) to close them. When valve (20) is opened, the time delay caused by volume (7) has no effect.

Pressure air also goes through line (2) to the ratio selector.

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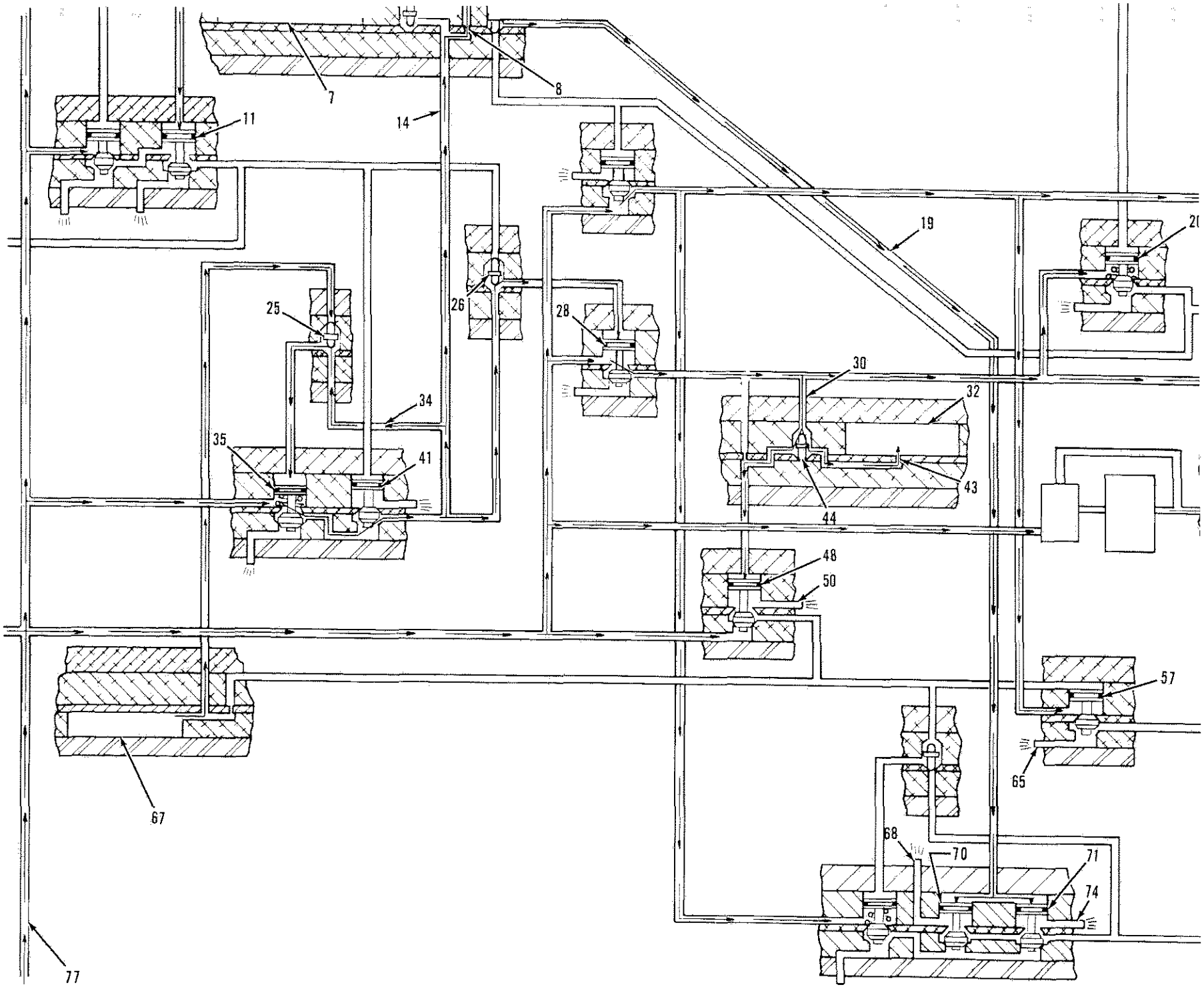
supply line.



SHIFT CYCLE CIRCUIT DURING A SHIFT [AFTER VALVE (35) OPENS]

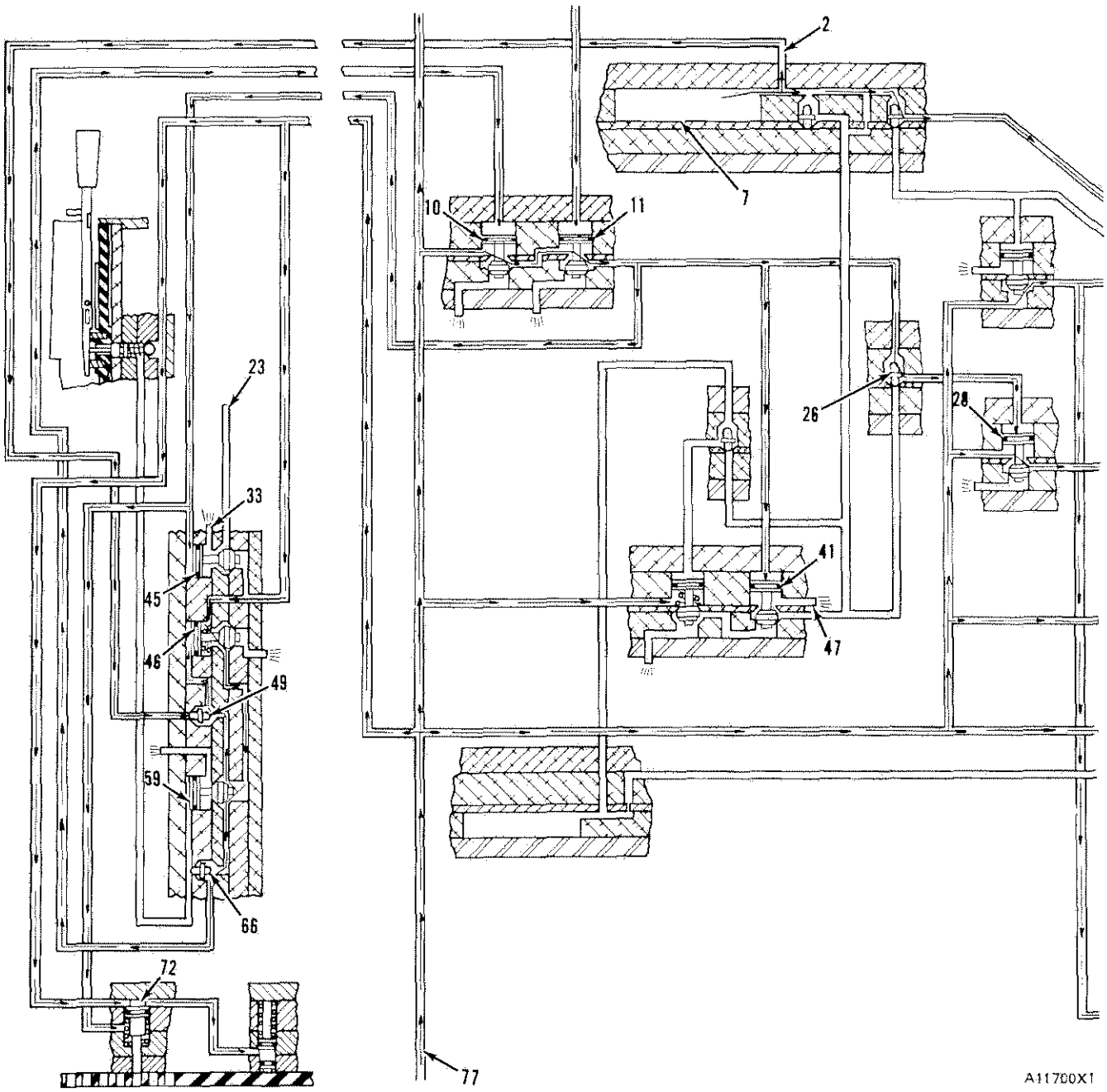
supply line (77) go through the normally
valve (59) to move the double check valve (4
This check valve movement lets pressure air
the transmission supply line (77) hold valve
open. The pilot pressure from line (2) to valv
is not necessary to keep valve (46) open.

The pressure air that goes through valve
also moves the double check valve (66) up an
to the pilot side of the normally closed valve
This pressure air opens valve (10) to let press
from the transmission supply line (77) go th
valve (11) to close the normally open valve
When valve (41) is closed, the pressure air i
ume (7) goes to exhaust (47) through valve (4

The pressure air that goes through valve
also goes around double check valve (26) t
pilot side of valve (28). This pressure air tak
place of the original pilot pressure from valv
(now sent to exhaust) to hold valve (28) open

The pressure air that goes through valve
also goes to the pilot side of the normally
valve (45). This pressure air closes valve (4
lets the pilot pressure in line (23) to the m
ically operated valves for the shift forks go
haust (33) through valve (45).

The pressure air to valve (45) also goes
rotation lock (72) to release it.



SHIFT CYCLE CIRCUIT DURING A SHIFT [AFTER VALVE (46) OPENS]

2. Line.
7. Volume.
10. Normally closed valve.
11. Normally closed valves.
23. Line to mechanically operated valves.
25. Double check valve.
28. Normally closed valve.
33. Exhaust.
41. Normally open valve.
45. Normally open valve.
46. Normally closed valve.
47. Exhaust.
49. Double check valve.
59. Normally open valve.
66. Double check valve.
72. Rotation lock.
77. Transmission supply line.

When all the shift forks have moved correctly, the sensing circuit will send pressure air through line (3) to the pilot side of the normally closed valve (20). This pressure air will open valve (20).

When valve (20) is open, pressure air is sent through valve (20) to the supply side of the normally open valve (22), to the pilot side of the normally open valve (12), and around the double check valve (6) to the pilot sides of the normally open valves (70) and (71).

The pressure air to the pilot side of valve (12) closes valve (12) and lets the pressure air in line (15) to the input clutch go to exhaust (16) through valve (12). Now the input clutch can engage.

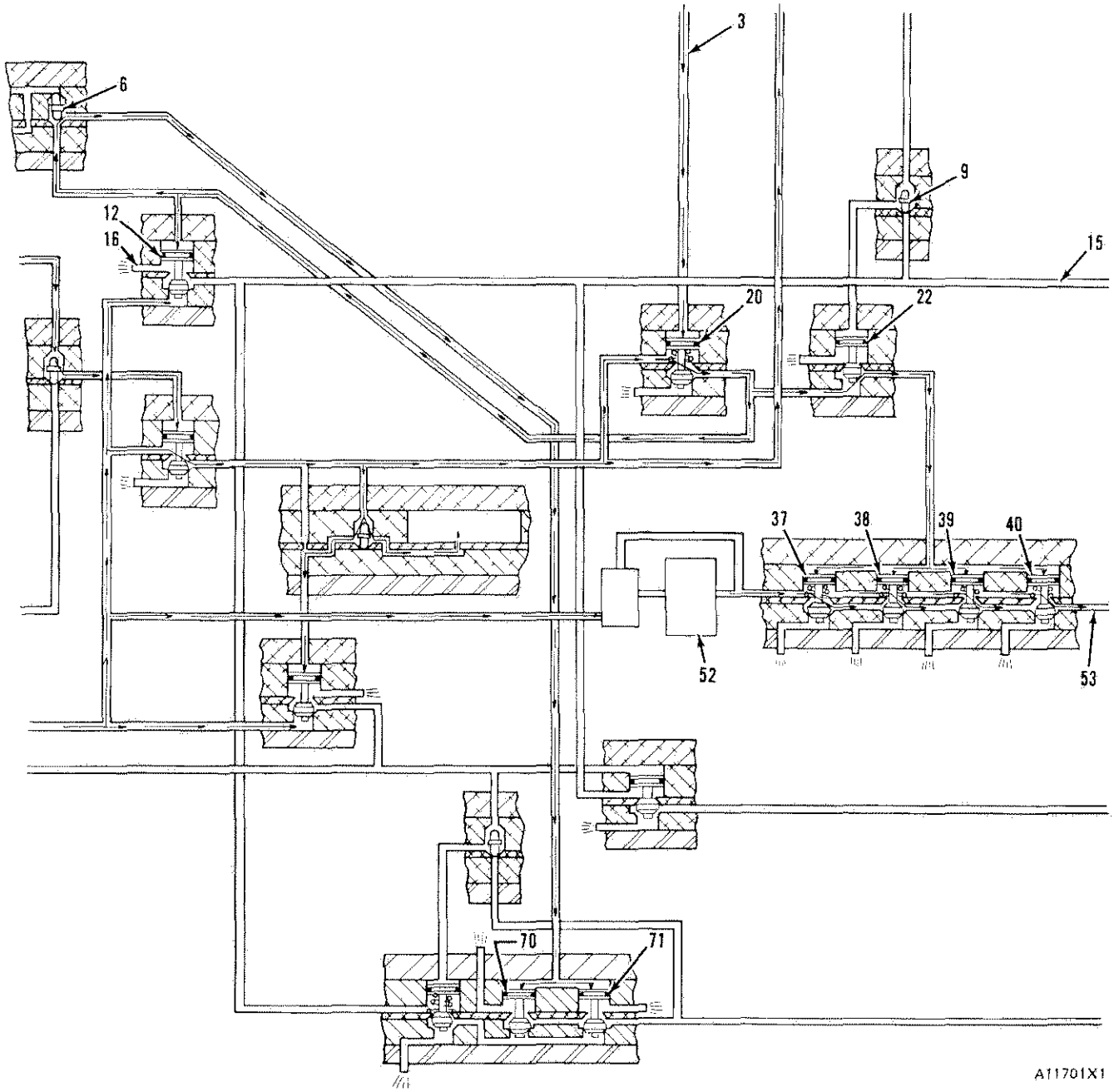
When the pressure air in line (15) to the input clutch goes to exhaust, the pressure air that goes to the pilot side of the normally open valve (22) can go to exhaust (16) through check valve (9) and through valve (12).

The pressure air from valve (20) can now open valve (22) and go to the pilot sides of the normally closed valves (37), (38), (39), and (40). This pressure air opens these valves and lets pressure air from the pressure regulator (52) go through these valves to line (53) to the output clutch. This pressure air will engage the output clutch.

NOTE: Valve (22) does not open until the air pressure in line (15) to the input clutch has been lowered to 50% of the system pressure. This delay lets the input clutch engage before the output clutch engages.

The pressure air that is sent to the pilot sides of valves (70) and (71) takes the place of the original pilot pressure from valve (41) (now sent to exhaust) to hold valves (70) and (71) closed.

The shift is now complete and the shift cycle circuit is now ready for the next shift.



SHIFT CYCLE CIRCUIT AFTER SHIFT IS COMPLETE

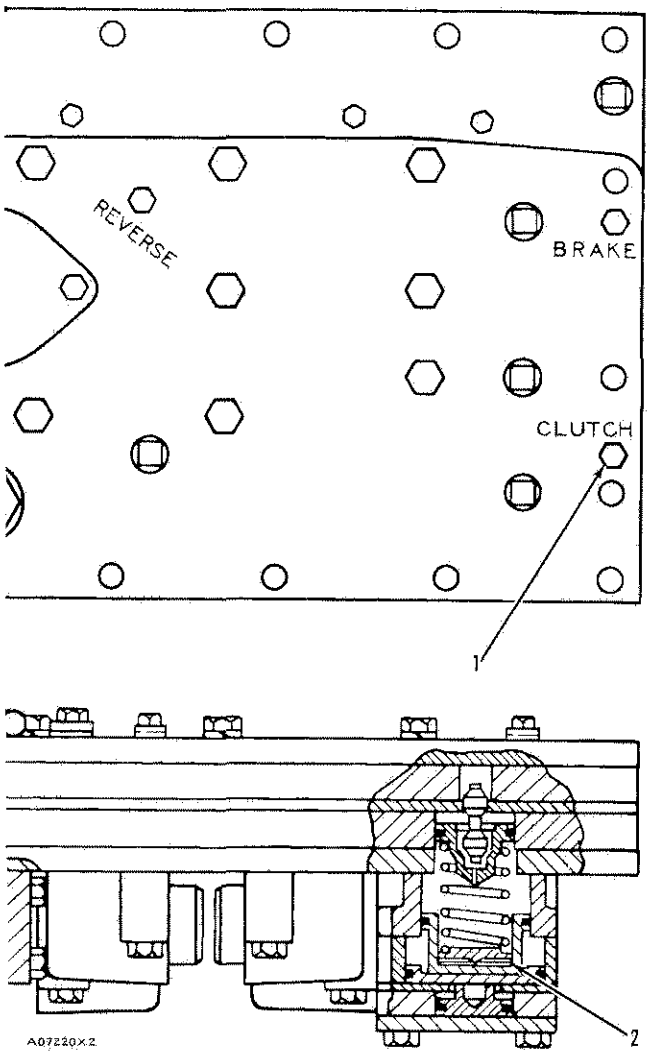
3. Line from sensing circuit.
6. Double check valve.
9. Double check valve.
12. Normally open valve.
15. Line for input clutch.
16. Exhaust.
20. Normally closed valve.
22. Normally open valve.
37. Normally closed valve.
38. Normally closed valve.
39. Normally closed valve.
40. Normally closed valve.
52. Pressure regulator.
53. Line for output clutch.
70. Normally open valve.
71. Normally open valve.

PRESSURE REGULATOR ADJUSTMENT

1. Connect an air pressure gauge to the gauge hole (1) for the output clutch.
2. Start the engine.
3. Put the selector lever in 16th speed.
4. The pressure reading must be 19 ± 2 psi (1.4 ± 0.1 kg/cm²) with 120 psi (8.4 kg/cm²) air pressure (truck air) to the transmission control.
5. The air pressure to the output clutch can be adjusted by the addition or removal of shims (2) in the pressure regulator.

PRESSURE CHANGE TO THE OUTPUT CLUTCH BY THE ADDITION OF REMOVAL OF ONE SHIM				
Shim Part No.	Thickness		Change In	
	in.	mm	psi	kg/cm²
9N1574	.010	0.25	1	0.07
9N1575	.030	0.76	3	0.21

NOTE: With 90 psi (6.3 kg/cm²) air pressure (shop air) to the transmission control, the pressure reading must be 22.4 ± 2 psi (1.6 ± 0.1 kg/cm²).



PRESSURE ADJUSTMENT FOR OUTPUT CLUTCH

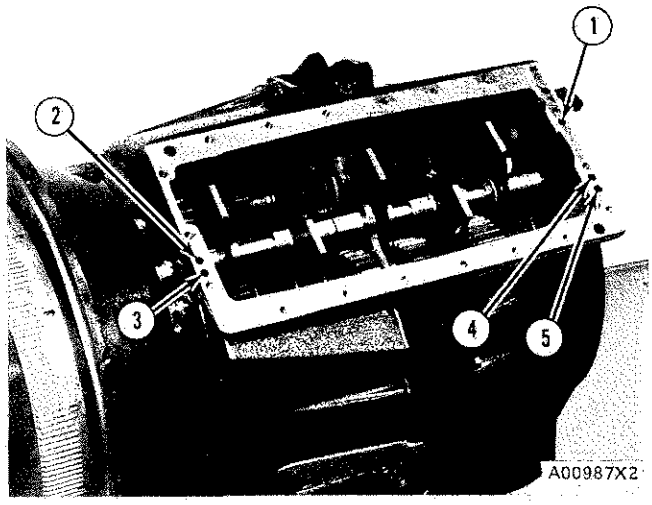
1. Gauge hole. 2. Shims.

AIR TESTS FOR CLUTCHES AND BRAKES

Shop air can be put into the transmission housing to operate the clutches and brakes one at a time. This test is used to find leaks in a clutch or brake. It does not test the transmission controls for correct operation.

Remove the transmission controls and put pressure air into the correct hole for each clutch or brake one at a time. A large air leak inside the transmission gives the indication that the specific clutch or brake has damaged seals. Make the necessary repairs.

NOTE: There are two holes (4) and (5) that go to the output clutch. One of these holes must have a plug on it during the test of the output clutch.

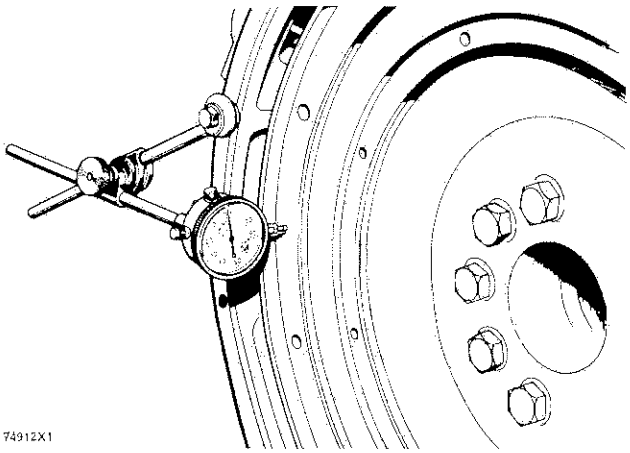


AIR HOLES FOR CLUTCHES AND BRAKES

1. Output brake hole. 2. Input clutch hole. 3. Input brake hole. 4. Output clutch hole. 5. Output clutch hole.

FACE RUNOUT (axial eccentricity) OF THE FLYWHEEL

1. Install the dial indicator as shown. Put a force on the crankshaft the same way before the indicator is read so the crankshaft end clearance (movement) is always removed.

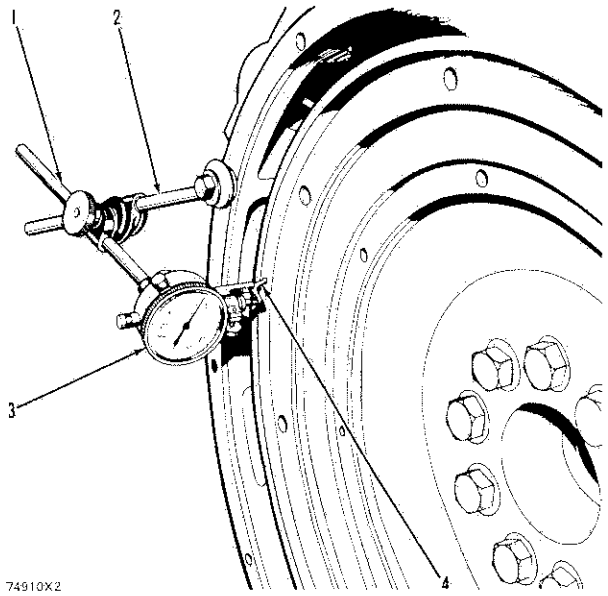


CHECKING FACE RUNOUT OF THE FLYWHEEL

2. Set the dial indicator to read .000 in. (0.0 mm).
3. Turn the flywheel and read the indicator every 90°.
4. The difference between the lower and higher measurements taken at all four points must not be more than .006 in. (0.15 mm), which is the maximum permissible face runout (axial eccentricity) of the flywheel.

BORE RUNOUT (radial eccentricity) OF THE FLYWHEEL

1. Install the dial indicator (3) and make an adjustment of the universal attachment (4) so it makes contact as shown.
2. Set the dial indicator to read .000 in. (0.0 mm).
3. Turn the flywheel and read the indicator every 90°.
4. The difference between the lower and higher measurements taken at all four points must not be more than .006 in. (0.15 mm), which is the maximum permissible bore runout (radial eccentricity) of the flywheel.
5. Runout (eccentricity) of the bore for the pilot bearing for the flywhel clutch, must not exceed .005 in. (0.13 mm).



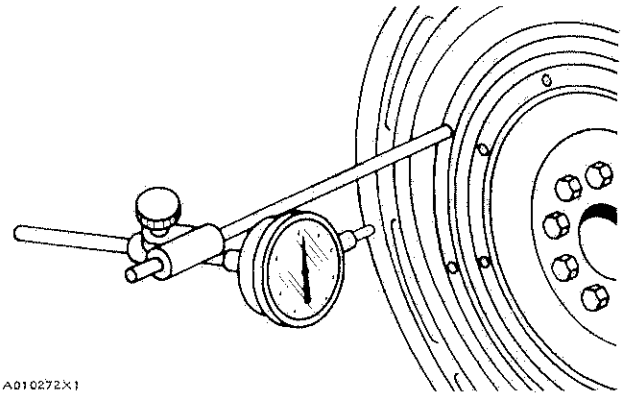
CHECKING BORE RUNOUT OF THE FLYWHEEL

1. 7H1945 Holding Rod. 2. 7H1645 Holding Rod. 3. 7H1942 Indicator. 4. 7H1940 Universal Attachment.

FACE RUNOUT (axial eccentricity) OF THE FLYWHEEL HOUSING

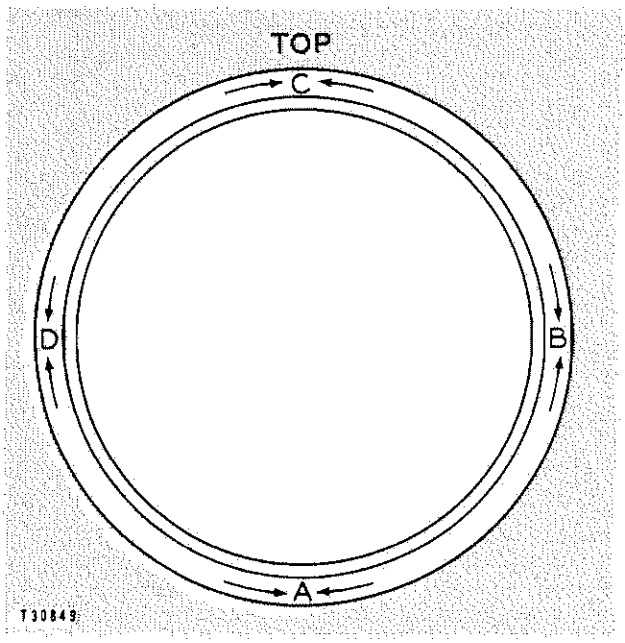
If any method other than given here is used, always remember bearing clearances must be removed to get correct measurements.

1. Fasten a dial indicator to the crankshaft flange so the anvil of the indicator will touch the face of the flywheel housing.



CHECKING FACE RUNOUT OF THE FLYWHEEL HOUSING

2. Put a force on the crankshaft toward the rear before reading the indication at each point.
3. With dial indicator set at .000 in. (0.0 mm) at location (A), turn the crankshaft and read the indicator at locations (B), (C) and (D).



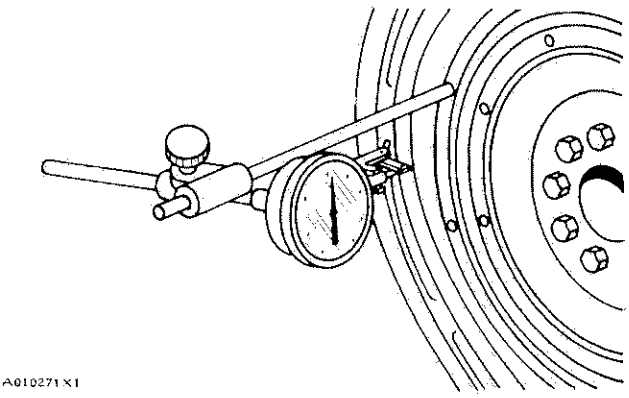
CHECKING FACE RUNOUT OF THE FLYWHEEL HOUSING

A. Bottom. B. Right side. C. Top. D. Left side.

4. The difference between lower and higher measurements taken at all four points must not be more than .012 in. (0.30 mm), which is the maximum permissible face runout (axial eccentricity) of the flywheel housing.

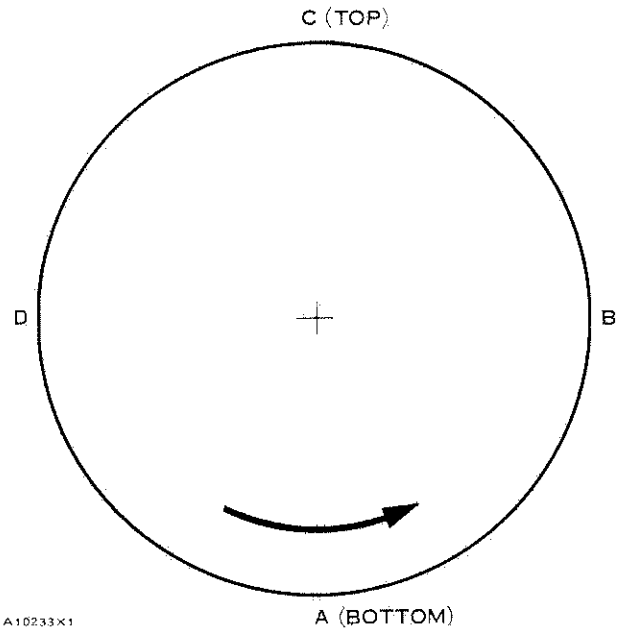
BORE RUNOUT (radial eccentricity) OF THE FLYWHEEL HOUSING

1. Fasten the dial indicator as shown so the anvil of the indicator will touch the bore of the flywheel housing.



CHECKING BORE RUNOUT OF THE FLYWHEEL HOUSING

2. With the dial indicator in position at (C), adjust the dial indicator to "0" (zero). Push the crankshaft up against the upper main bearing. Write the measurement for the bearing clearance on line 1 in column (C) of the chart.



CHECKING BORE RUNOUT OF THE FLYWHEEL HOUSING

3. Divide the measurement from Step 2 by 2. Write this number on line 1 in columns (B) and (D) of the chart.

4. Turn the crankshaft to put the dial indicator at (A). Adjust the dial indicator to "0" (zero).

5. Turn the crankshaft counterclockwise to put the dial indicator at (B). Write the measurement on the chart.

6. Turn the crankshaft counterclockwise to put the dial indicator at (C). Write the measurement on the chart.

7. Turn the crankshaft counterclockwise to put the dial indicator at (D). Write the measurement on the chart.

8. Add lines I and II by columns.

CHART FOR DIAL INDICATOR MEASUREMENTS

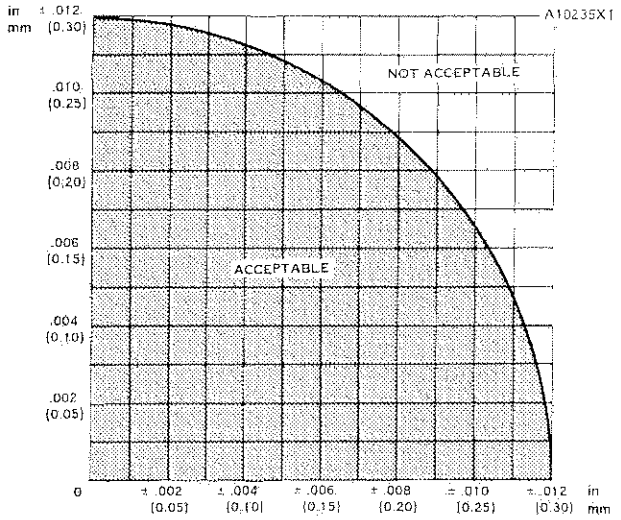
		Position of dial indicator			
	Line No.	A	B	C	D
Correction for bearing clearance	I	0			
Dial Indicator Reading	II	0			
Total of Line 1 & 2	III	0	**	*	**

*Total Vertical eccentricity (out of round).
**Subtract the smaller No. from the larger No. The difference is the total horizontal eccentricity.

A10234X1

9. Subtract the smaller number from the larger number in line III in columns (B) and (D) of the chart. The result is the horizontal runout. Line III, column (C) is the vertical runout.

10. On the graph below, find the point of intersection of the lines for vertical and horizontal eccentricity.



11. If the point of intersection is in the range marked "acceptable" on the graph, the bore is in alignment. If the point of intersection is in the range marked "not acceptable" on the graph, do Step 12.

12. Loosen the bolts holding the flywheel housing to the cylinder block. Hit the flywheel housing lightly with a hammer to put it in the correct position. Tighten the bolts holding the flywheel housing to the cylinder block and do Steps 1 through 11 again.

TROUBLESHOOTING

These troubleshooting procedures are limited to those that can be done with normal shop tools. Development work is being done on a special test box. When the box is available, new troubleshooting procedures will be given to make the job easier and faster.

NOTE: The transmission must be at operating temperature before good test indications can be given. A cold transmission can give indications that problems are present. These indications can go away when the transmission is warm (above approximately 100°F (38°C). Let the engine run for approximately 10 minutes with the transmission in NEUTRAL. The transmission must feel warm to the hand before tests can be done.

CAUTION: Do not operate the engine at high idle with the transmission in gear and the truck brakes activated. This action will cause damage to the input clutch.

Since the 9N1681 Manifold Group of the transmission controls is to have replacement as a unit, no troubleshooting of the components of the 9N1681 Manifold Group is given.

WARNING: For safer tests the drive wheels of the truck must be off the ground to prevent movement of the truck.

NOTE: Shifts are normally made with the truck moving down the road and the driveshaft turning. Some times the gears will not engage correctly when the driveshaft is not turned. If a complete shift is not made (gears do not engage correctly) during a test, turn the driveshaft by hand before going on to the next part of the test.

CAUTION: A direct drive ratio selector must be used with a direct drive transmission. An overdrive ratio selector must be used with an overdrive transmission. Do not mix the ratio selector and the transmission.

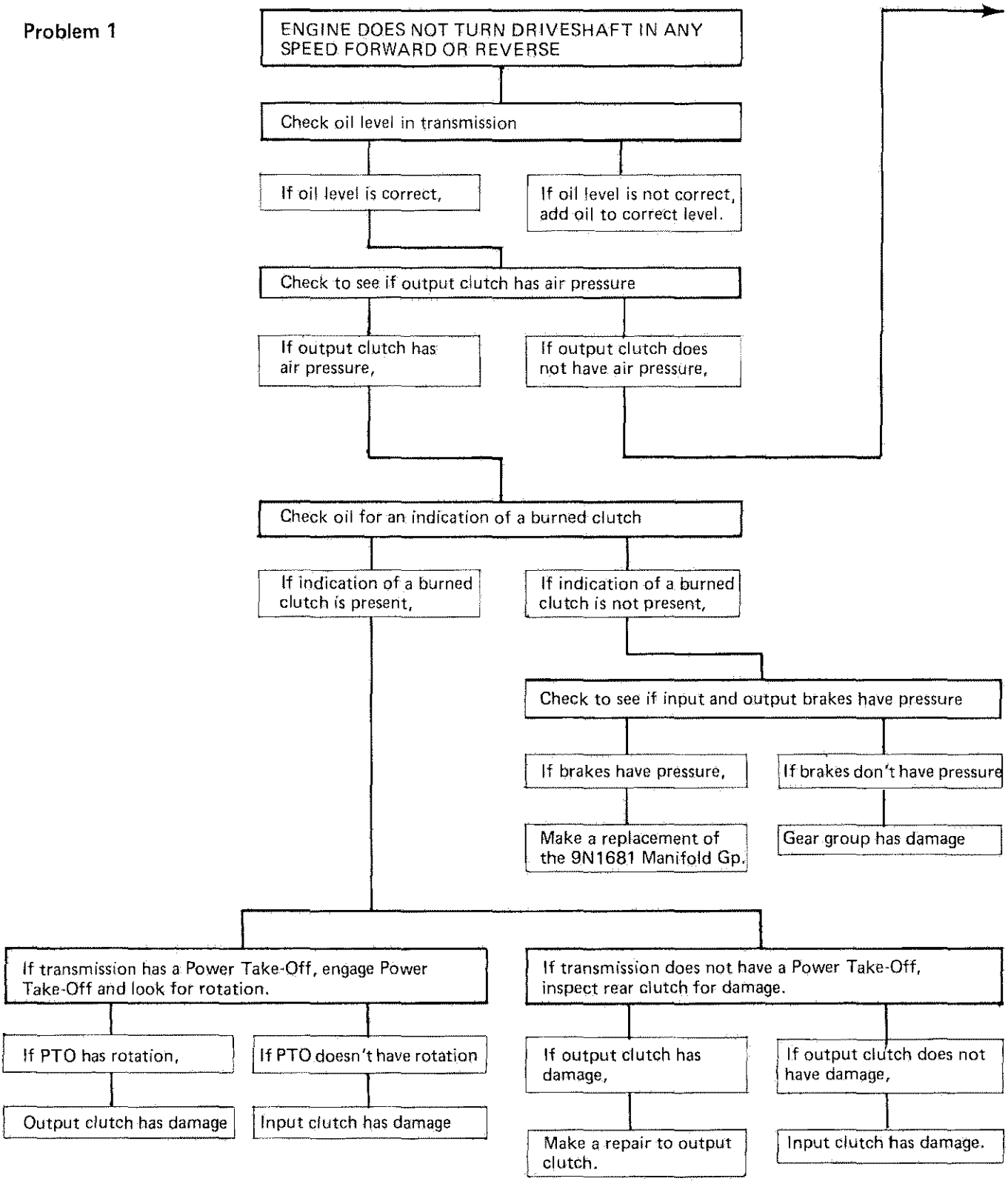
NOTE: Air pressure gauges are necessary and must have a range of 0 to 150 psi (0 to 10.5 kg/cm^2). All gauge holes in the transmission control have 1/8-27 NPTF thread. The volume for the air in these gauges can cause an increase in shift times.

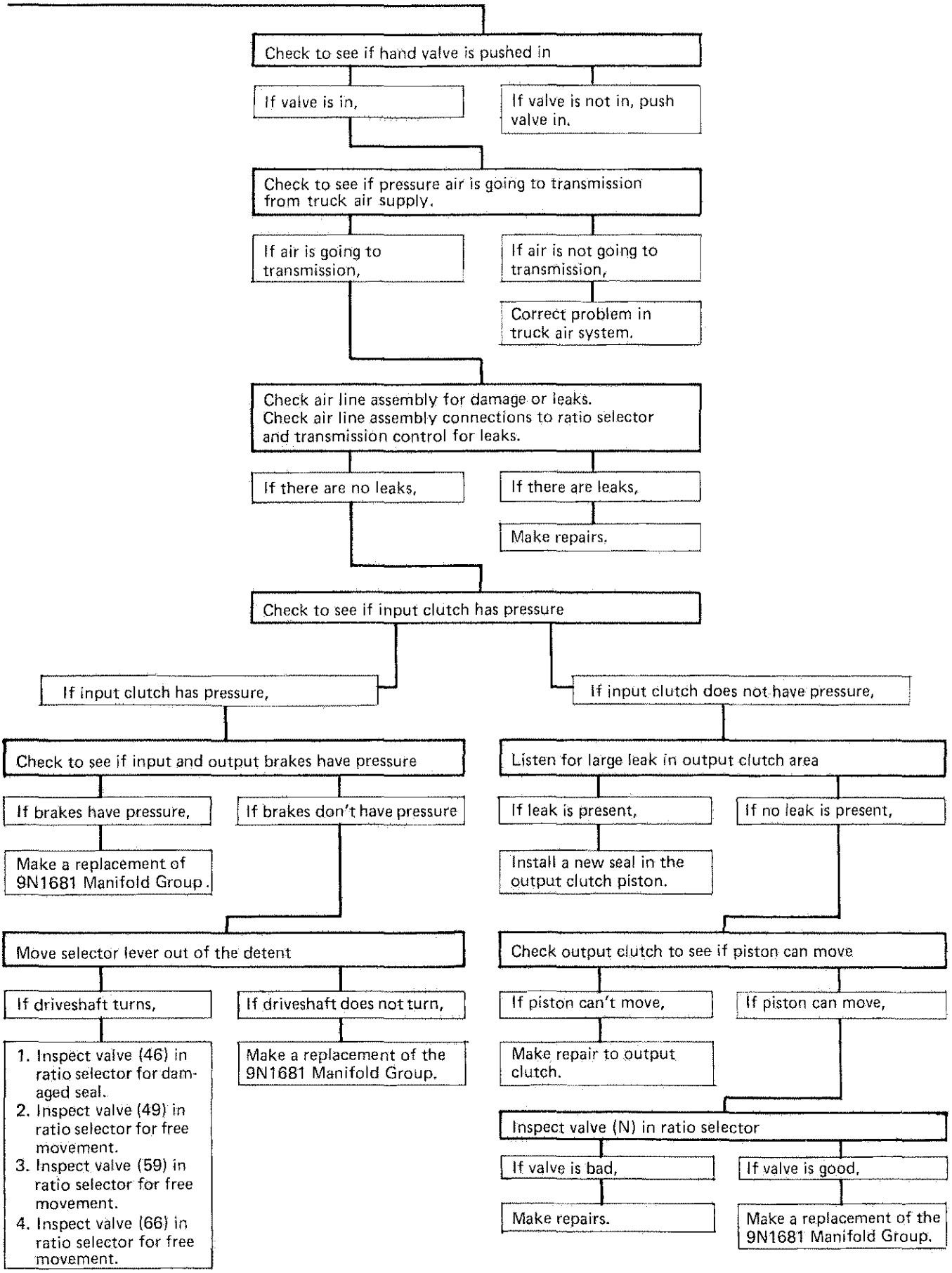
ILLUSTRATIONS OF COMPONENT LOCATIONS

PROBLEM INDEX

DIRECT DRIVE AND OVERDRIVE

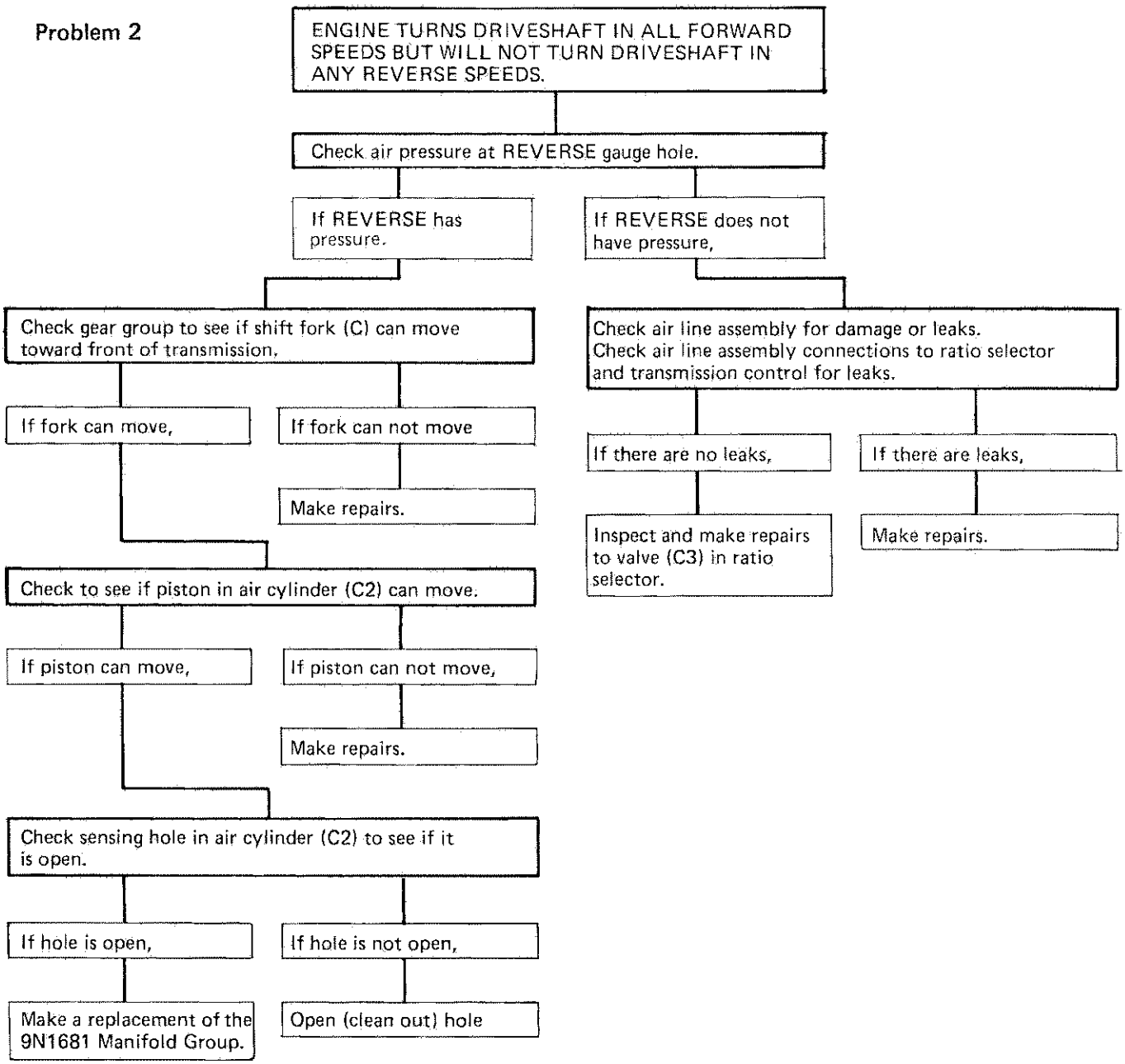
Problem 1




Check to see if hand valve is pushed in
If valve is in,
If valve is not in, push valve in.
Check to see if pressure air is going to transmission from truck air supply.
If air is going to transmission,
If air is not going to transmission,
Correct problem in truck air system.
Check air line assembly for damage or leaks. Check air line assembly connections to ratio selector and transmission control for leaks.
If there are no leaks,
If there are leaks,
Make repairs.
Check to see if input clutch has pressure
If input clutch has pressure,
If input clutch does not have pressure,
Check to see if input and output brakes have pressure
If brakes have pressure,
If brakes don't have pressure
Make a replacement of 9N1681 Manifold Group.
Move selector lever out of the detent
If driveshaft turns,
If driveshaft does not turn,
1. Inspect valve (46) in ratio selector for damaged seal.
2. Inspect valve (49) in ratio selector for free movement.
3. Inspect valve (59) in ratio selector for free movement.
4. Inspect valve (66) in ratio selector for free movement.
Make a replacement of the 9N1681 Manifold Group.
Listen for large leak in output clutch area
If leak is present,
If no leak is present,
Install a new seal in the output clutch piston.
Check output clutch to see if piston can move
If piston can't move,
If piston can move,
Make repair to output clutch.
Inspect valve (N) in ratio selector
If valve is bad,
If valve is good,
Make repairs.
Make a replacement of the 9N1681 Manifold Group.

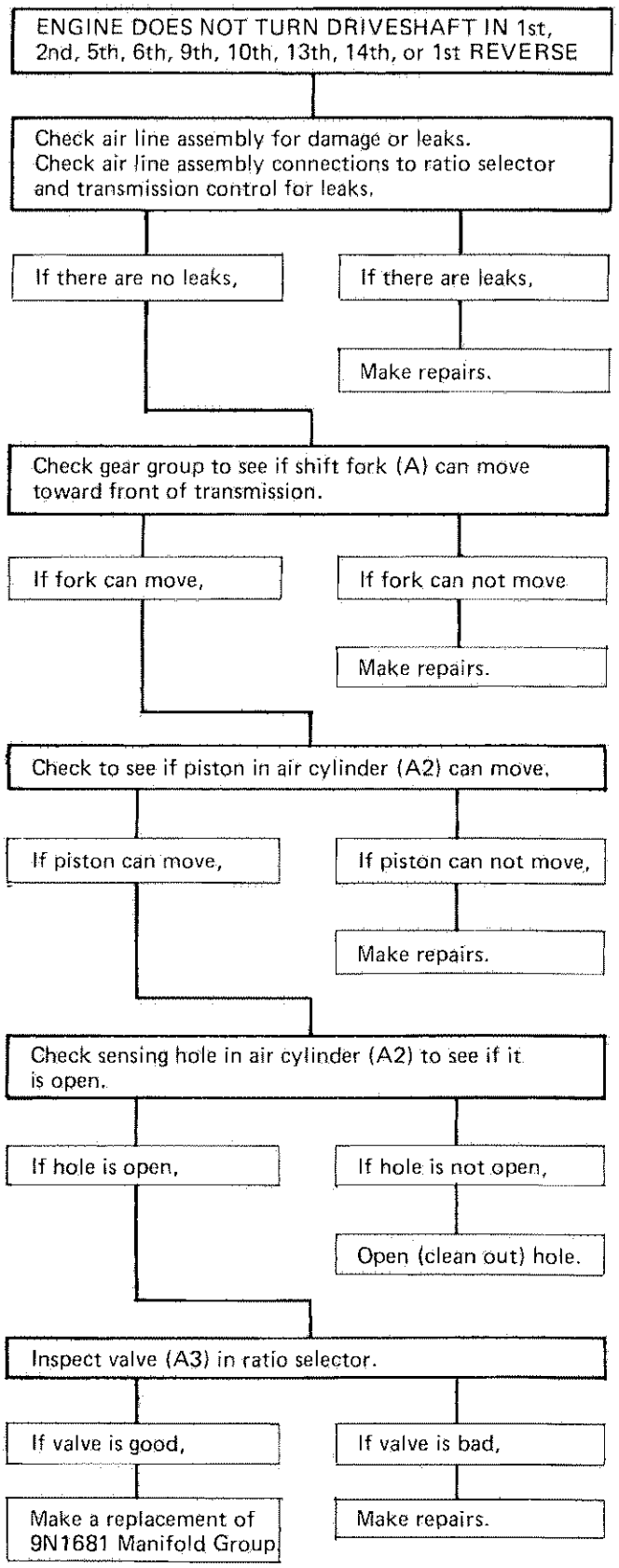
DIRECT DRIVE AND OVERDRIVE

Problem 2



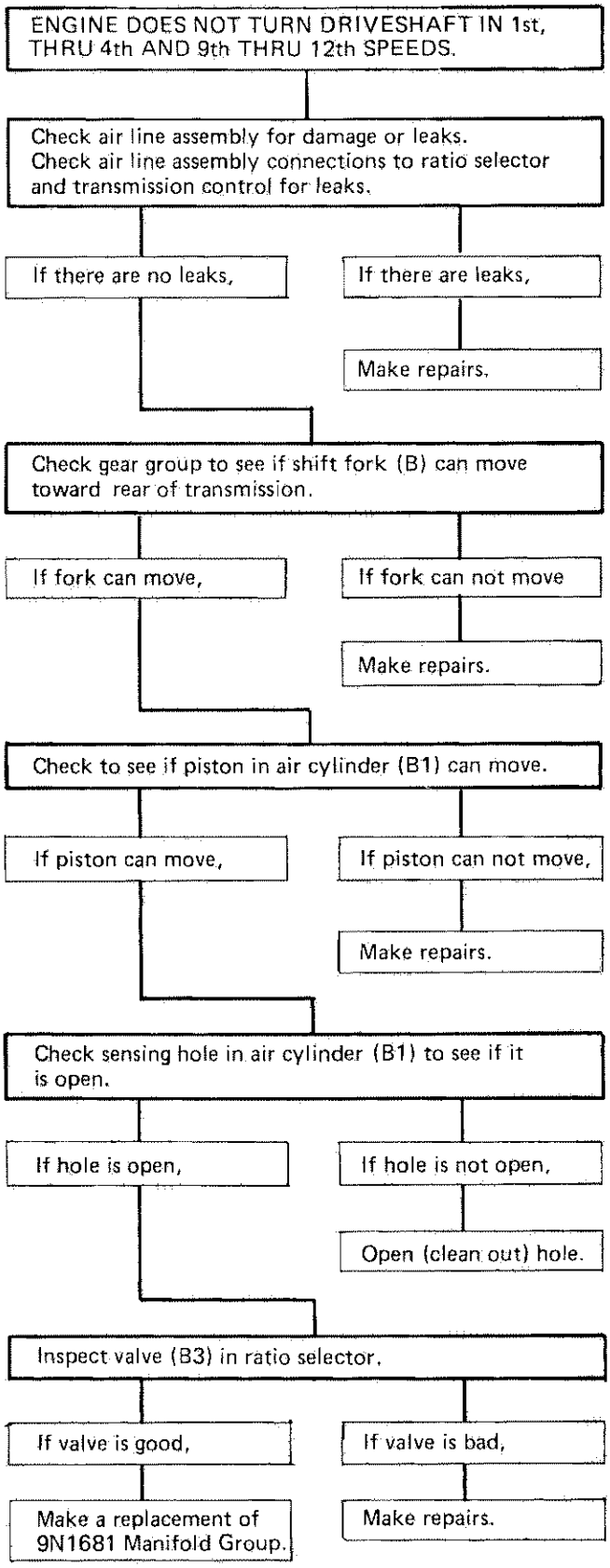
DIRECT DRIVE AND OVERDRIVE

Problem 3



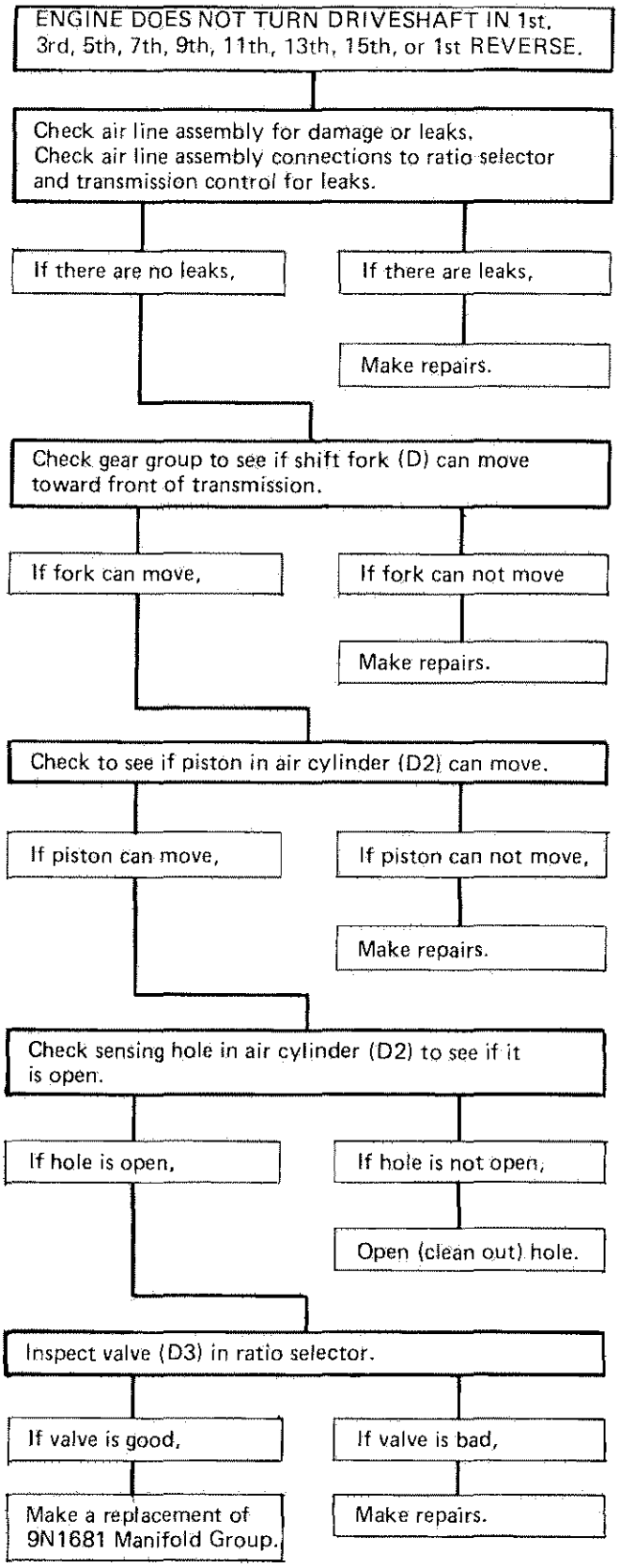
DIRECT DRIVE AND OVERDRIVE

Problem 4



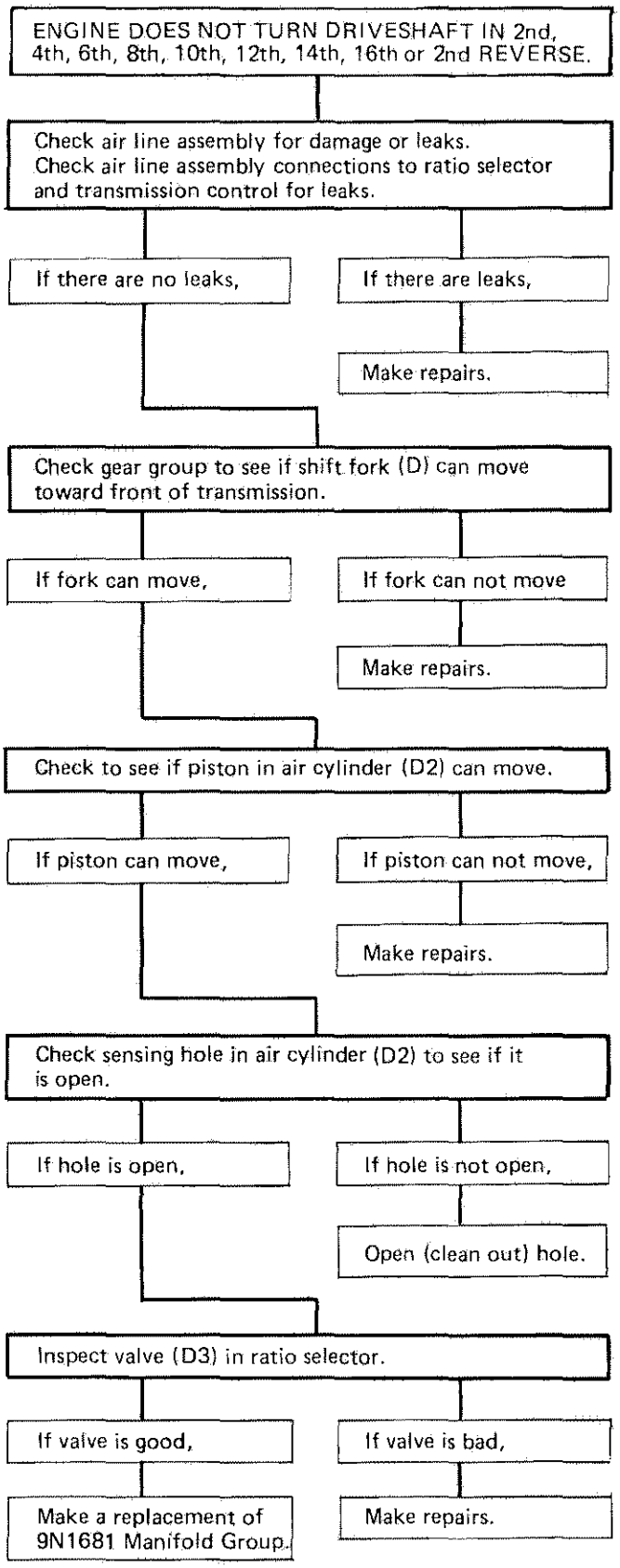
DIRECT DRIVE ONLY

Problem 5



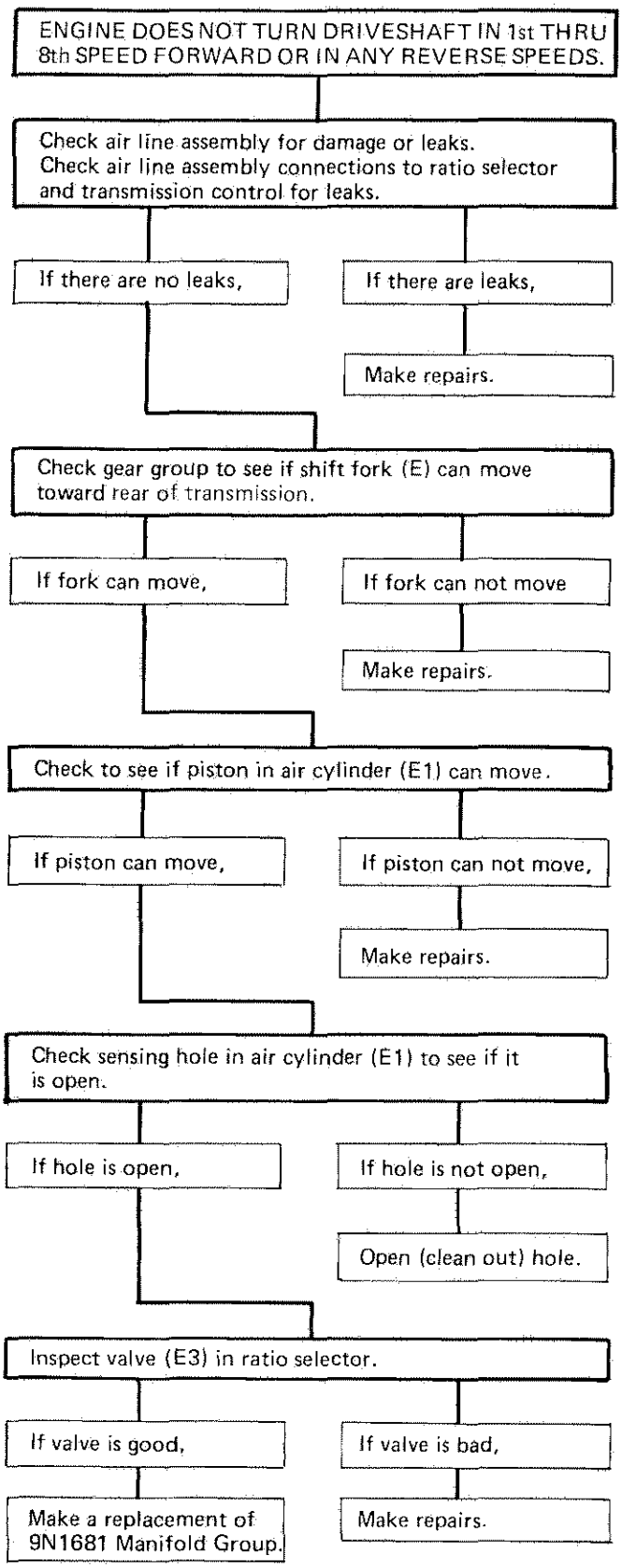
OVERDRIVE ONLY

Problem 6



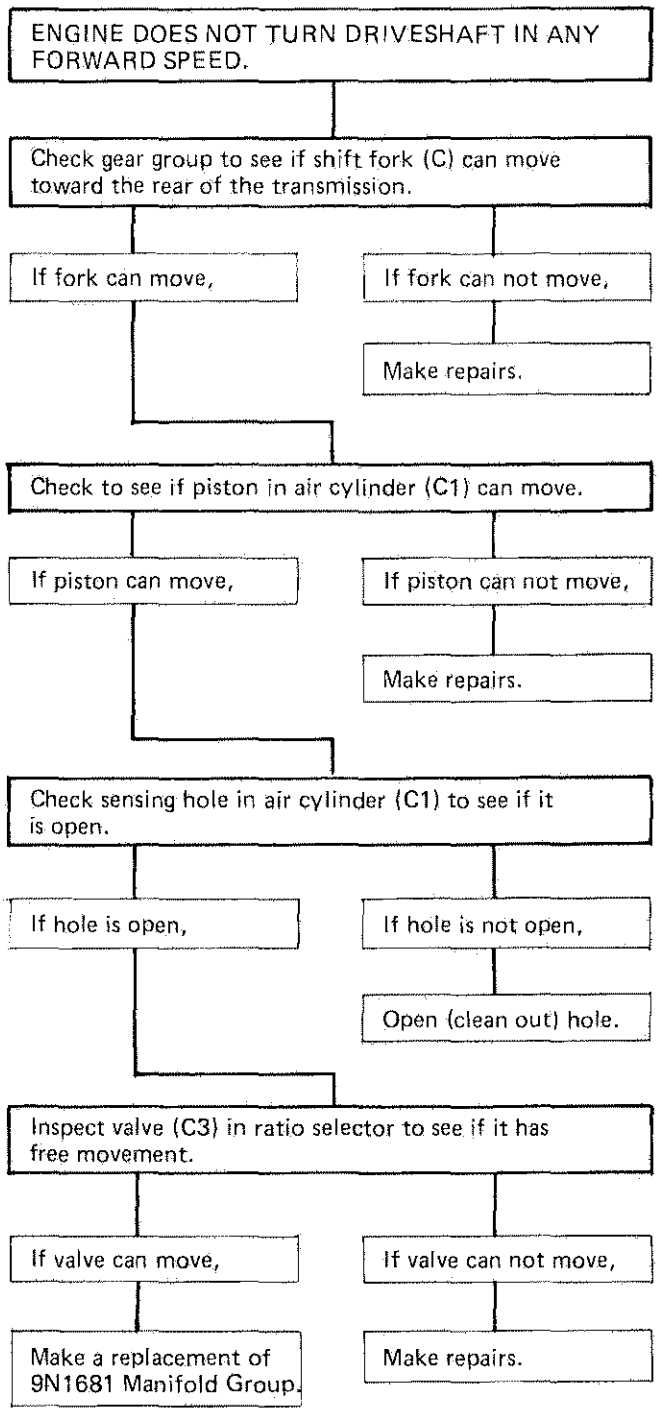
DIRECT DRIVE AND OVERDRIVE

Problem 7



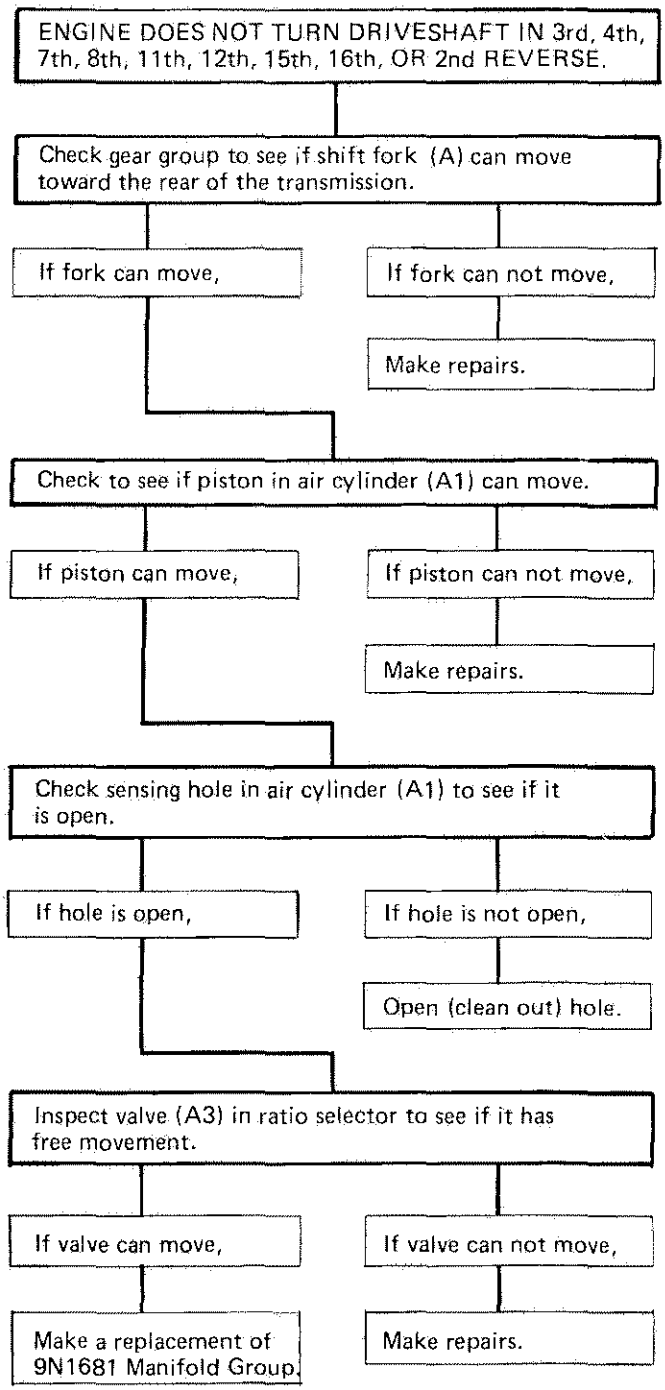
DIRECT DRIVE AND OVERDRIVE

Problem 8



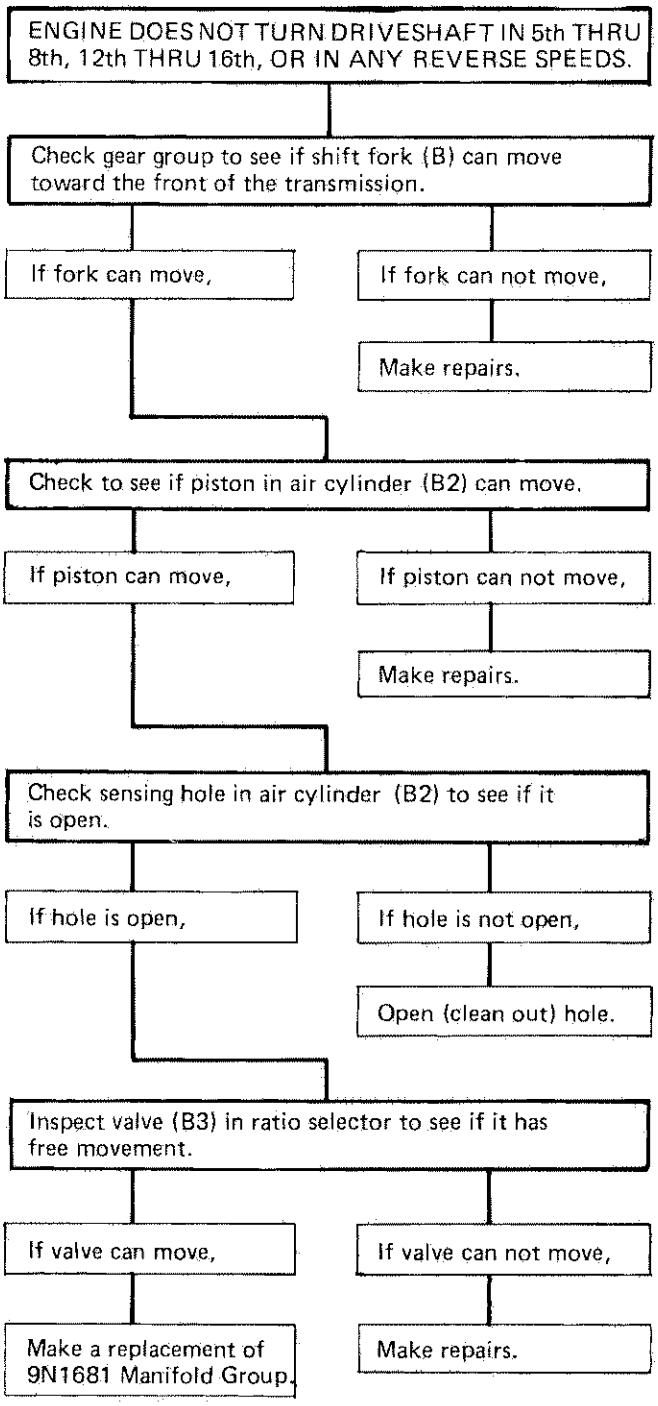
DIRECT DRIVE AND OVERDRIVE

Problem 9



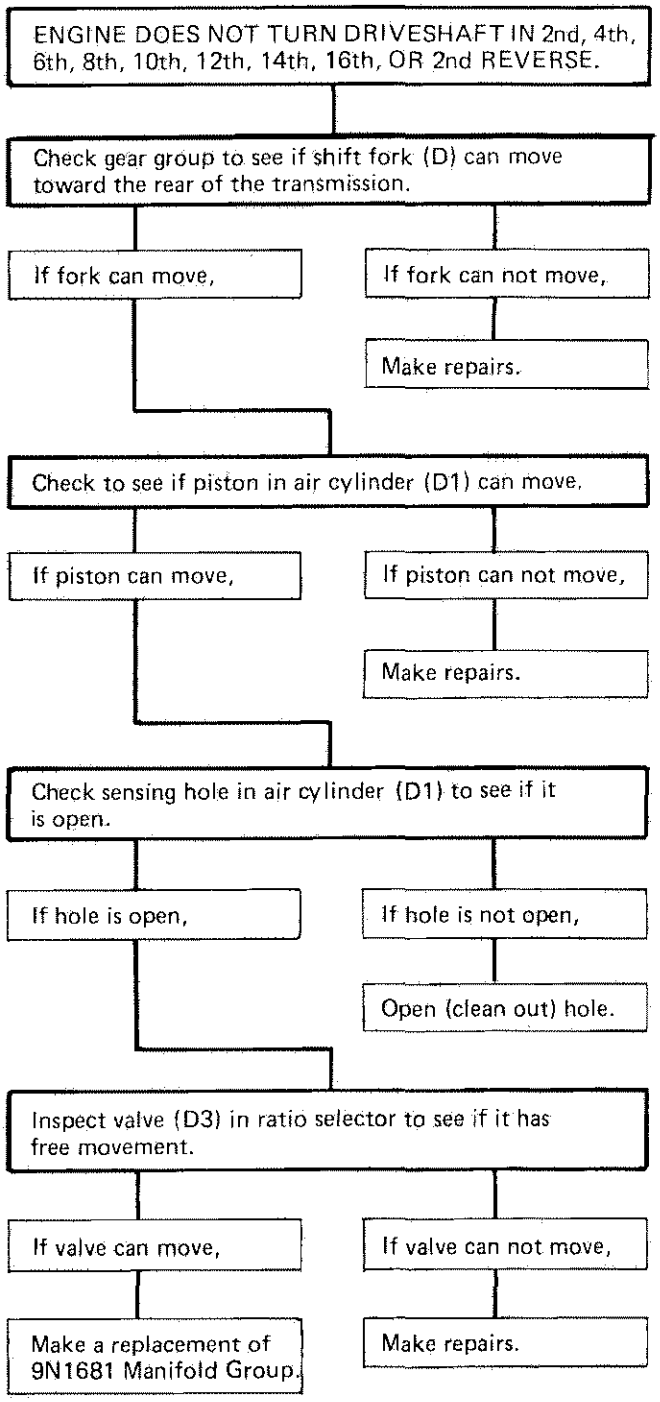
DIRECT DRIVE AND OVERDRIVE

Problem 10



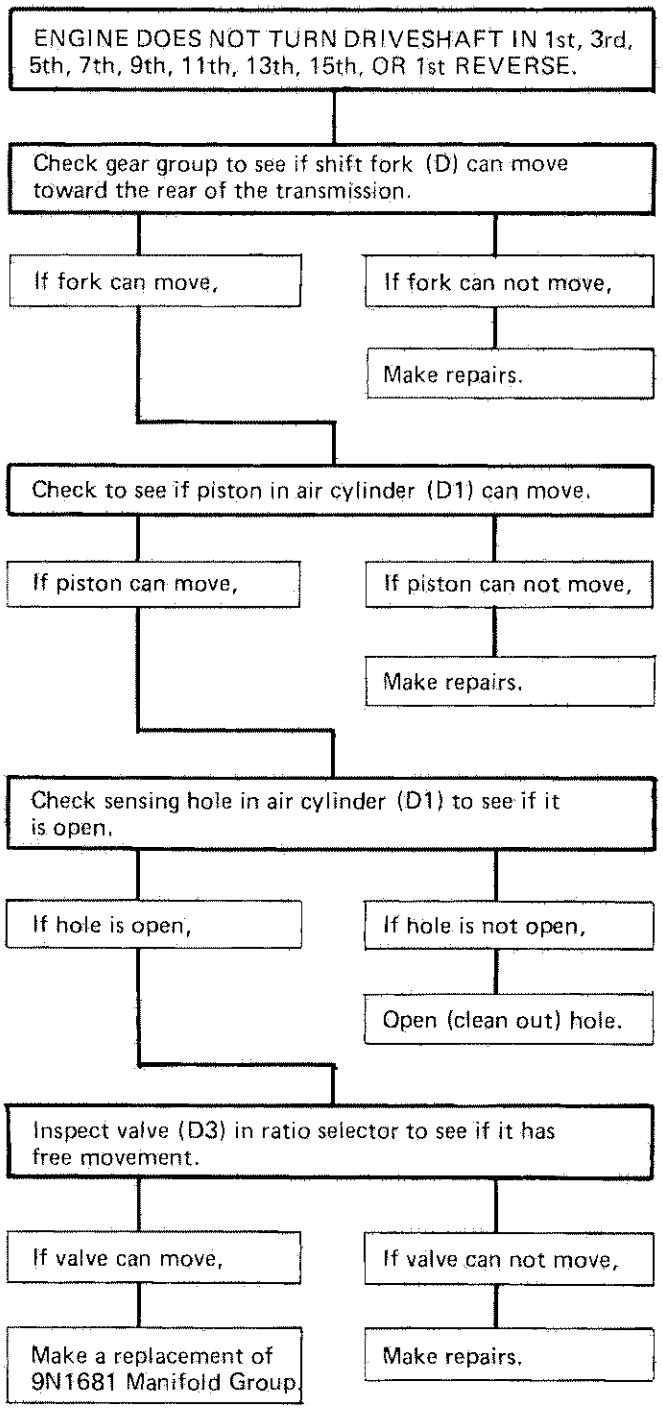
DIRECT DRIVE ONLY

Problem 11



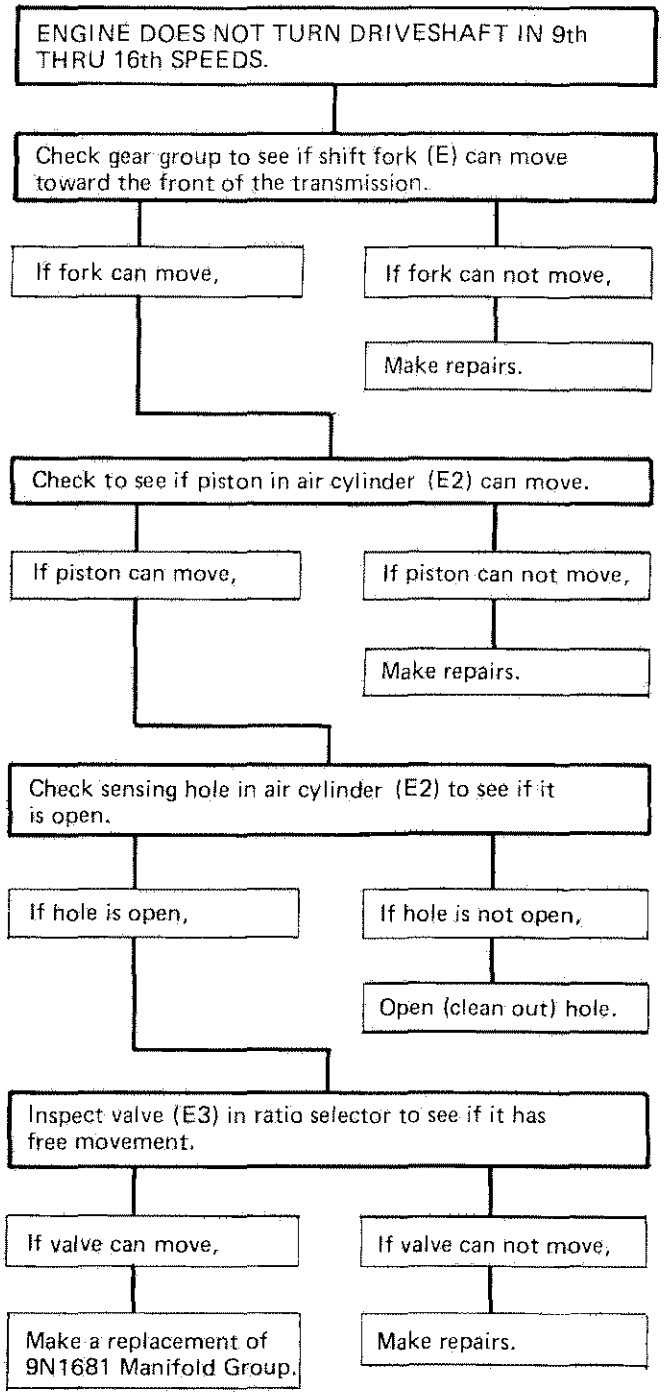
OVERDRIVE ONLY

Problem 12



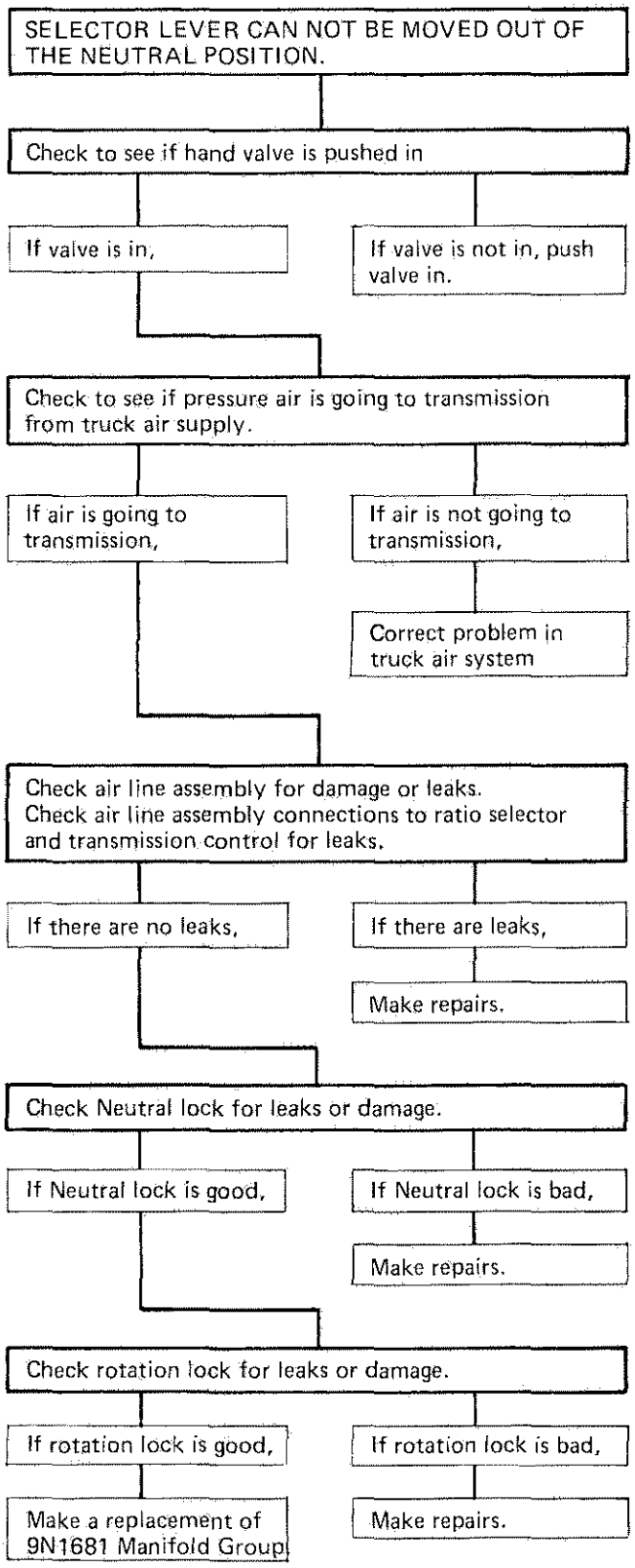
DIRECT DRIVE AND OVERDRIVE

Problem 13



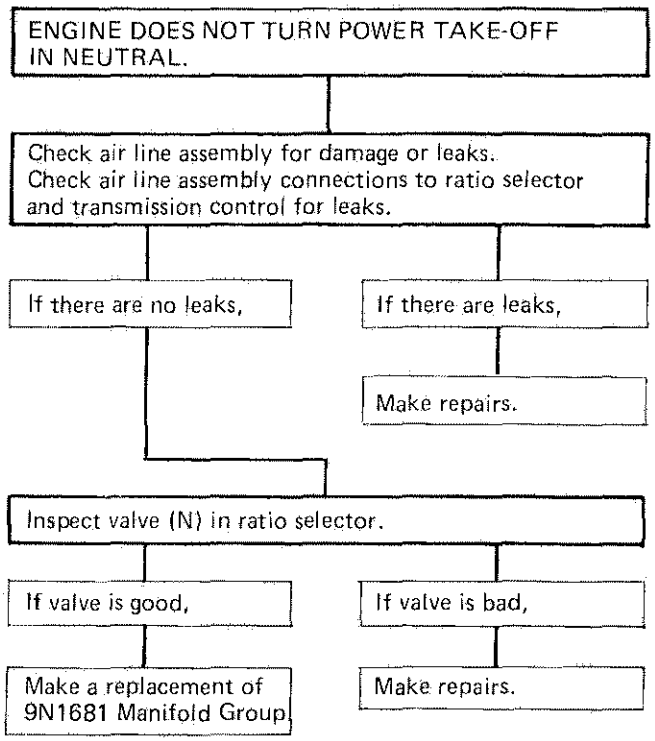
DIRECT DRIVE AND OVERDRIVE

Problem 14



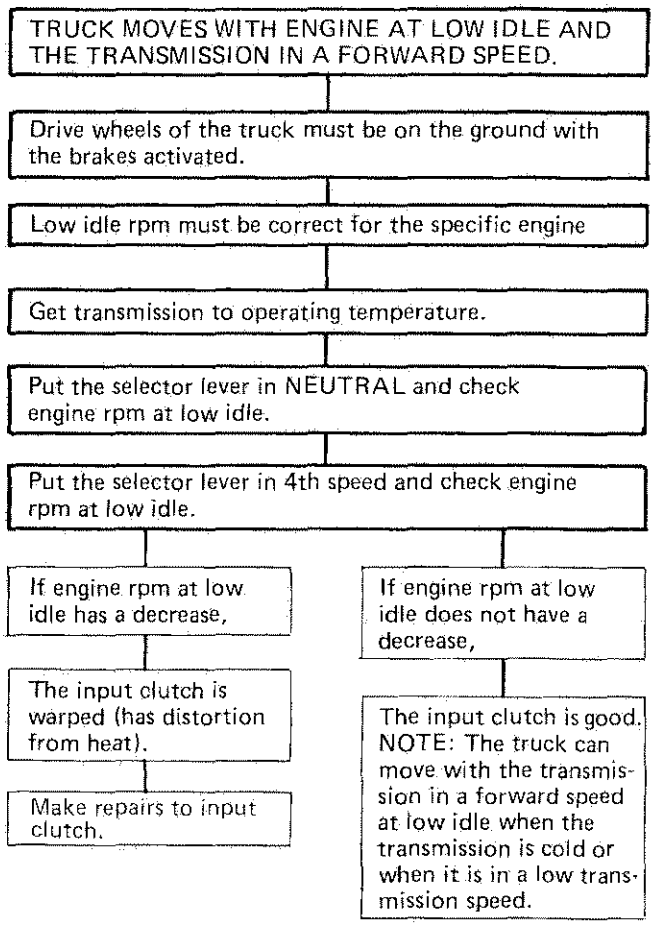
DIRECT DRIVE AND OVERDRIVE

Problem 15



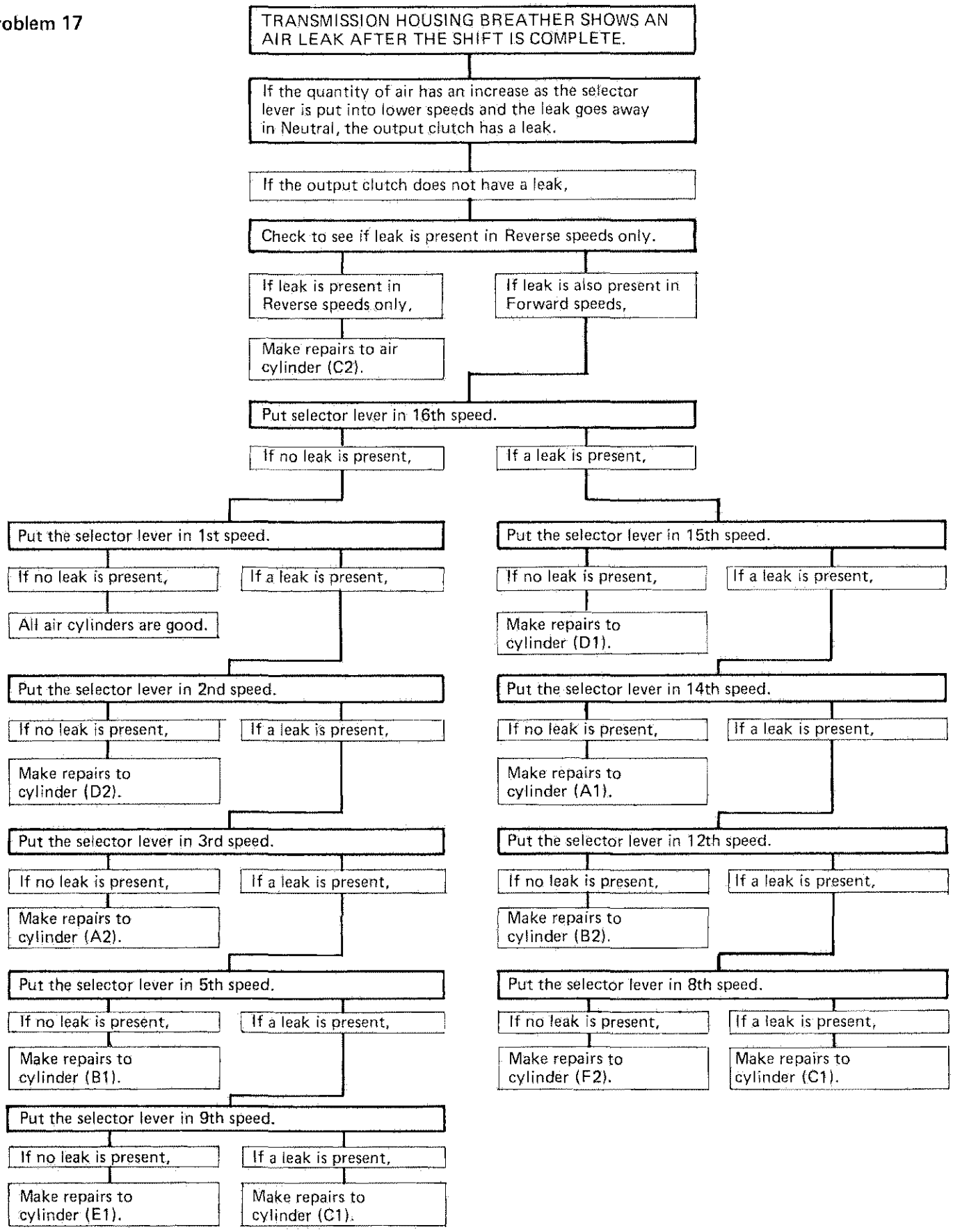
DIRECT DRIVE AND OVERDRIVE

Problem 16



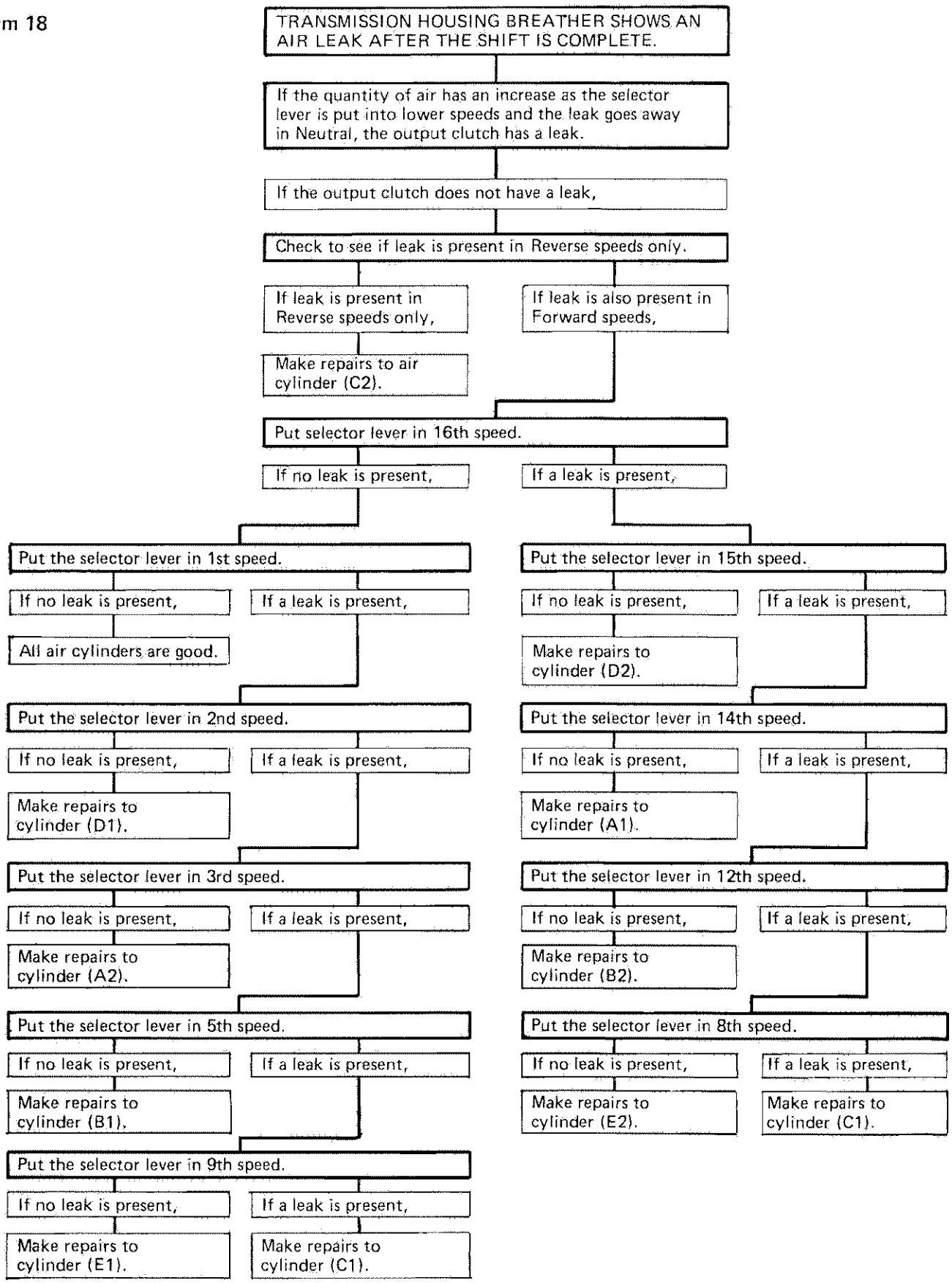
DIRECT DRIVE ONLY

Problem 17



OVERDRIVE ONLY

Problem 18



DIRECT DRIVE AND OVERDRIVE

Problem 19

WHEN THE SELECTOR LEVER IS MOVED FROM 1ST SPEED THROUGH EACH DETENT TOWARD 16TH SPEED, THE TRANSMISSION GOES FROM 2ND SPEED, TO 1ST SPEED, TO 4TH SPEED, TO 3RD SPEED, TO 6TH SPEED AND SO ON.

The wrong ratio selector has been installed. The ratio selector (direct drive or overdrive) must be the same as the transmission (direct drive or overdrive).

Install the correct ratio selector.

DIRECT DRIVE AND OVERDRIVE

Problem 20

TRANSMISSION FEELS LIKE IT IS ENGAGED, THEN NOT ENGAGED, THEN ENGAGED AGAIN. TRANSMISSION ALSO HAS NOISE.

Flywheel or flywheel housing is not in alignment.

Make reference to FLYWHEEL AND FLYWHEEL HOUSING.

DIRECT DRIVE AND OVERDRIVE

Problem 21

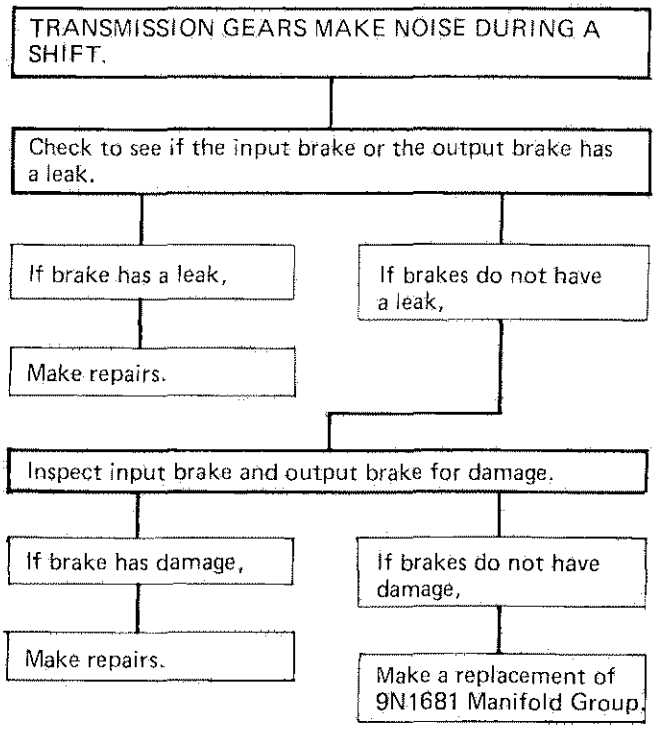
TRANSMISSION HAS A DECREASE IN OIL LEVEL WITH AN INCREASE IN THE OIL LEVEL IN THE ENGINE.

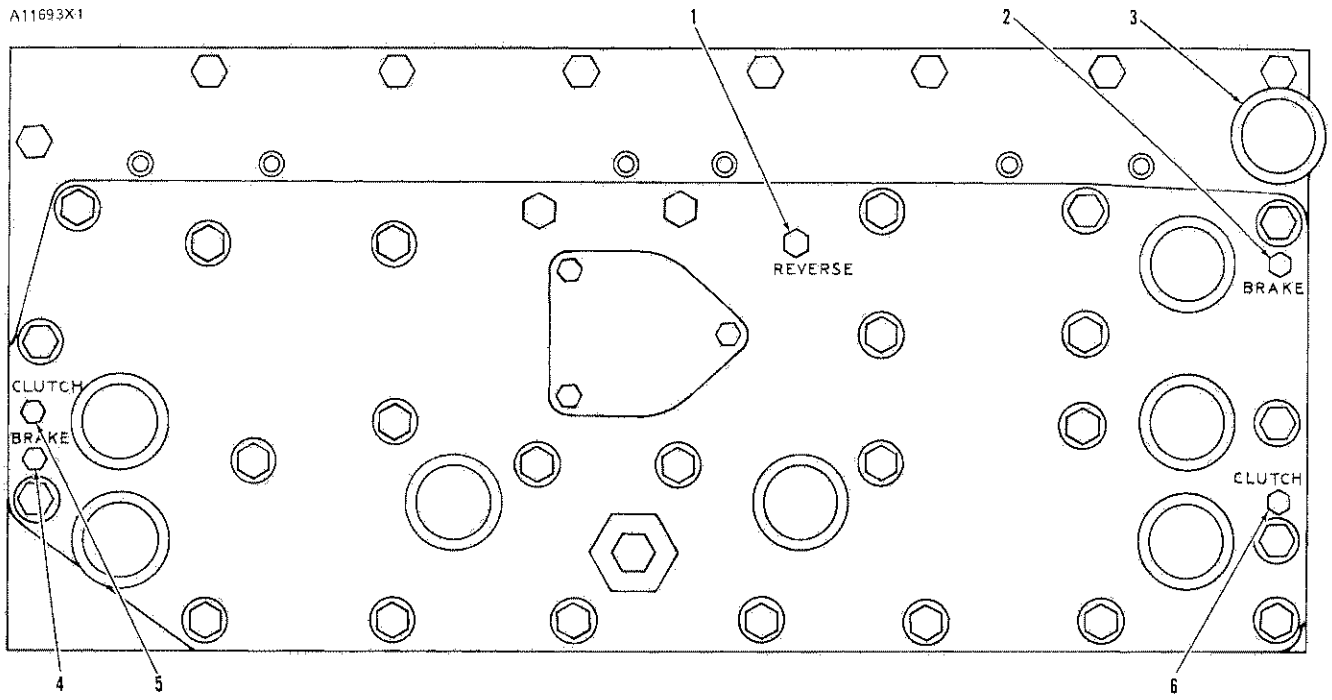
The breather for the transmission housing is not open. This does not let pressure air in the transmission housing get out through the breather. This causes the pressure air to push the transmission oil out of the transmission through the rear crankshaft seal and into the engine.

Make a replacement of the breather for the transmission housing.

DIRECT DRIVE AND OVERDRIVE

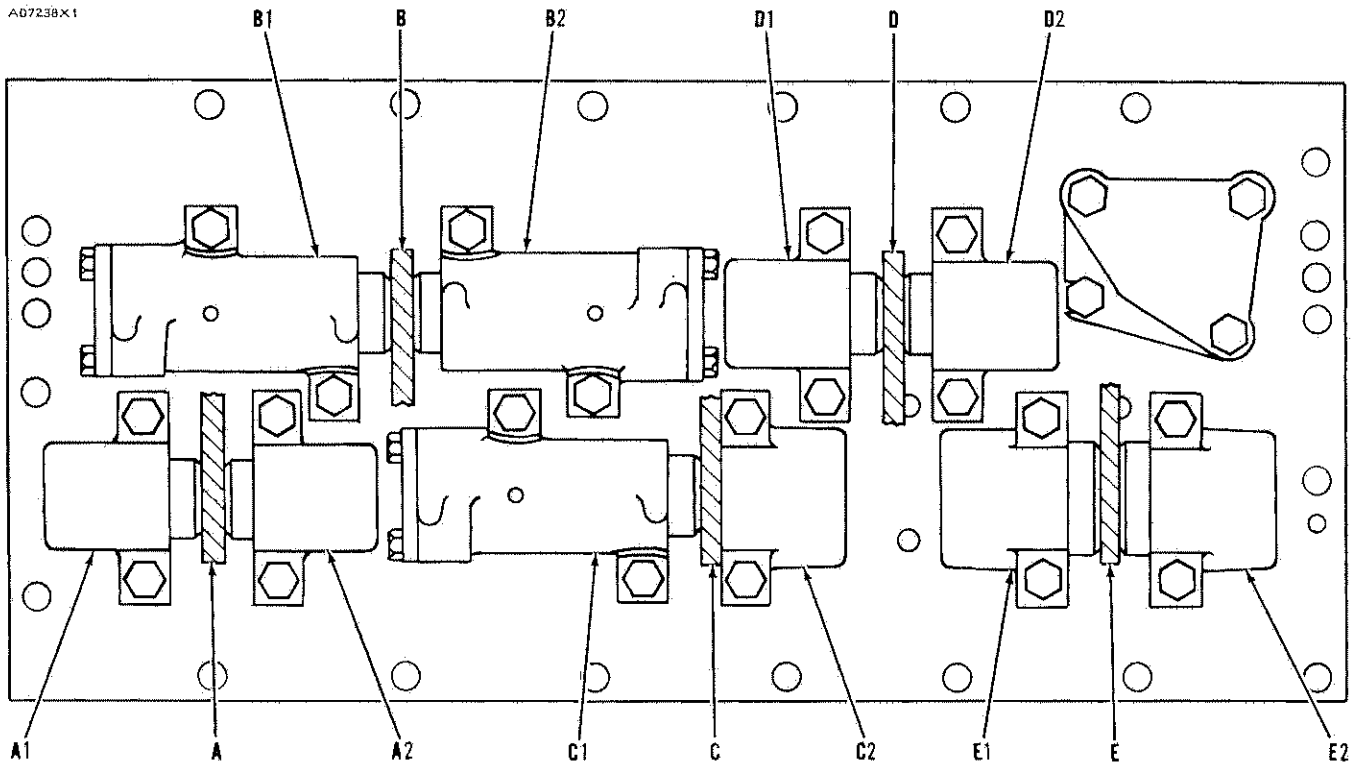
Problem 22





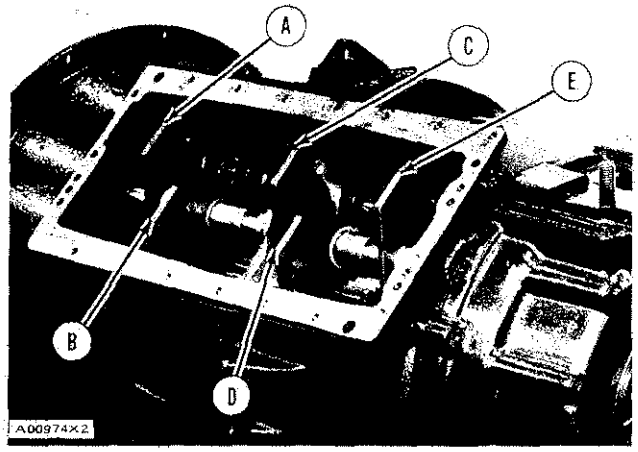
GAUGE HOLE AND BREATHER LOCATION

1. Reverse gauge hole. 2. Output brake gauge hole. 3. Breather for transmission housing. 4. Input brake gauge hole. 5. Input clutch gauge hole. 6. Output clutch gauge hole.

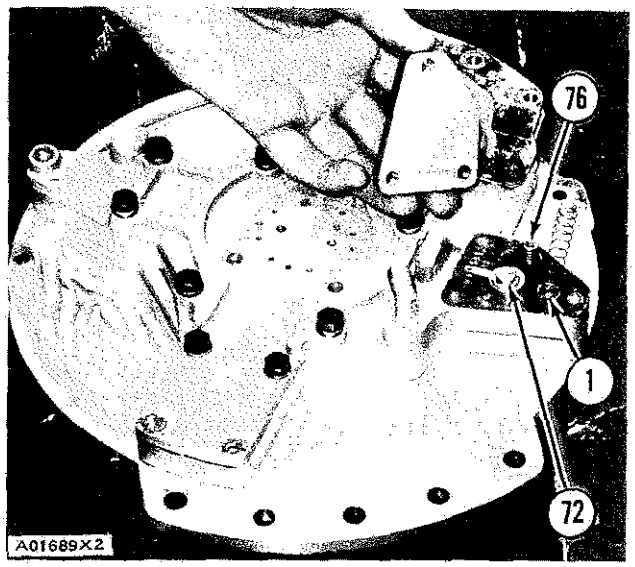


AIR CYLINDERS FOR SHIFT FORKS

A. Shift fork
A1. Air Cylinder (moves shift fork A toward the rear)
A2. Air Cylinder (moves shift fork A toward the front)
B. Shift fork
B1. Air Cylinder (moves shift fork B toward the rear)
B2. Air Cylinder (moves shift fork B toward the front)
C. Shift fork
C1. Air Cylinder (moves shift fork C toward the rear)
C2. Air Cylinder (moves shift fork C toward the front)
D. Shift fork
D1. Air Cylinder (moves shift fork D toward the rear)
D2. Air Cylinder (moves shift fork D toward the front)
E. Shift fork
E1. Air Cylinder (moves shift fork E toward the rear)
E2. Air Cylinder (moves shift fork E toward the front)

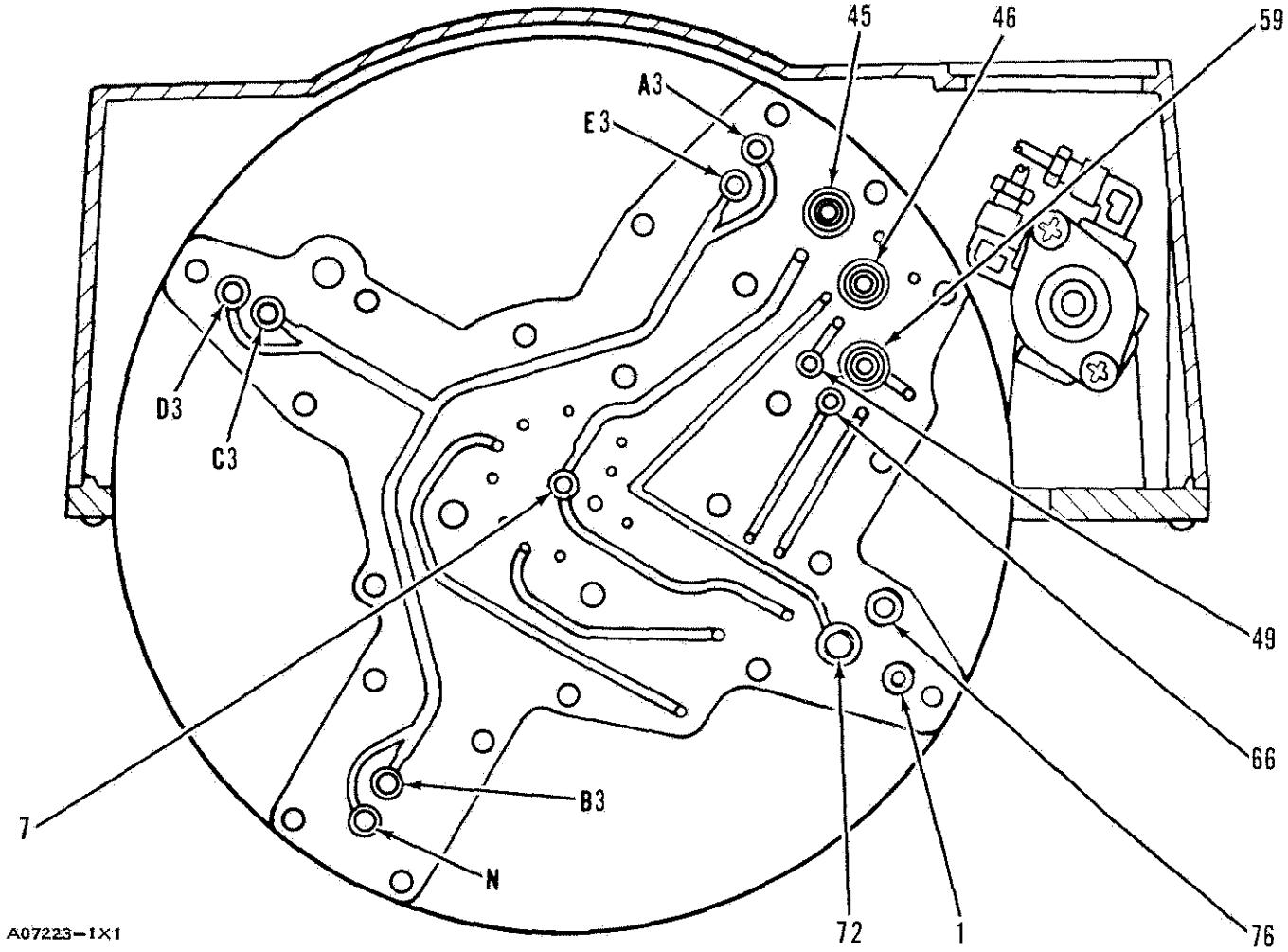


SHIFT FORKS



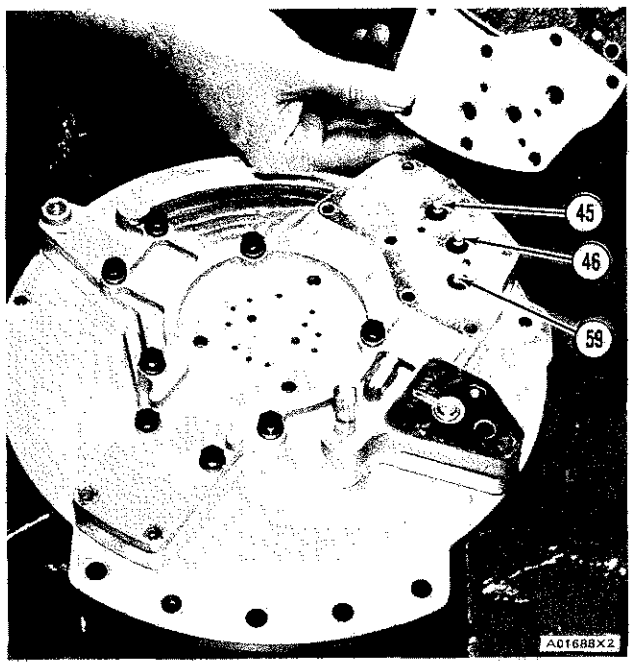
VALVES IN RATIO SELECTOR

1. Detent only. 72. Rotation lock. 76. Neutral lock.



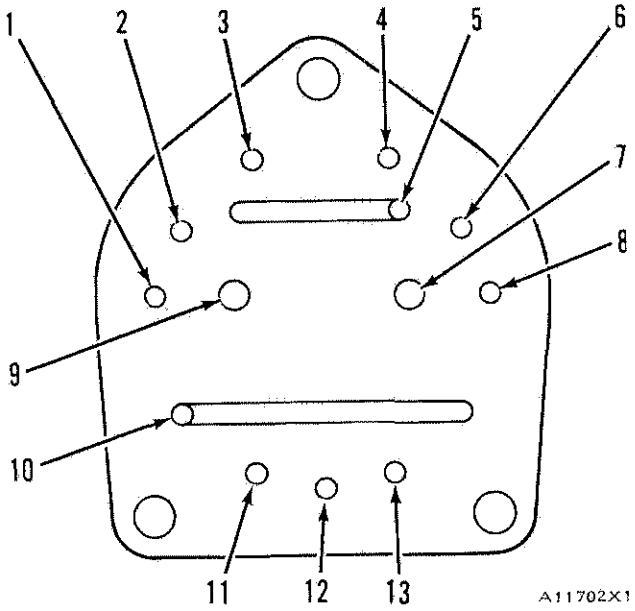
VALVES IN RATIO SELECTOR

A3.	Mechanically operated valve.	N.	Mechanically operated valve.	49.	Double check valve.
B3.	Mechanically operated valve.	1.	Detent only.	59.	Normally open valve.
C3.	Mechanically operated valve.	17.	Shift valve.	66.	Double check valve.
D3.	Mechanically operated valve.	45.	Normally open valve.	72.	Rotation lock.
E3.	Mechanically operated valve.	46.	Normally closed valve.	76.	Neutral lock.



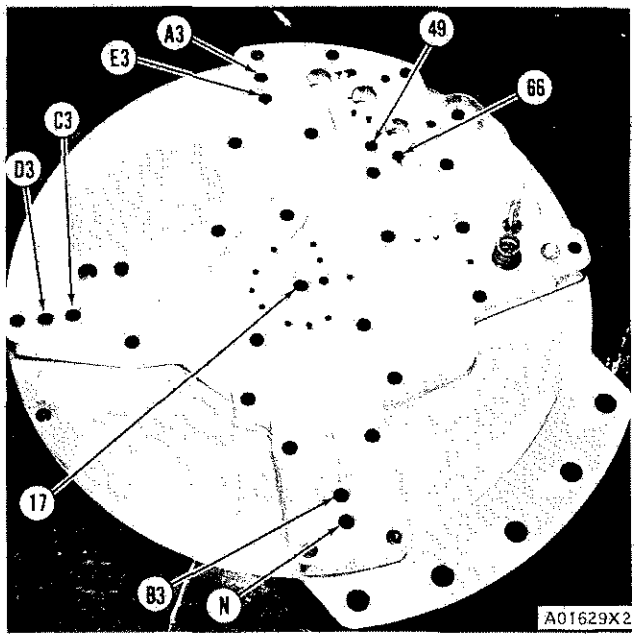
VALVES IN RATIO SELECTOR

45. Normally open valve. 46. Normally closed valve. 59. Normally open valve.



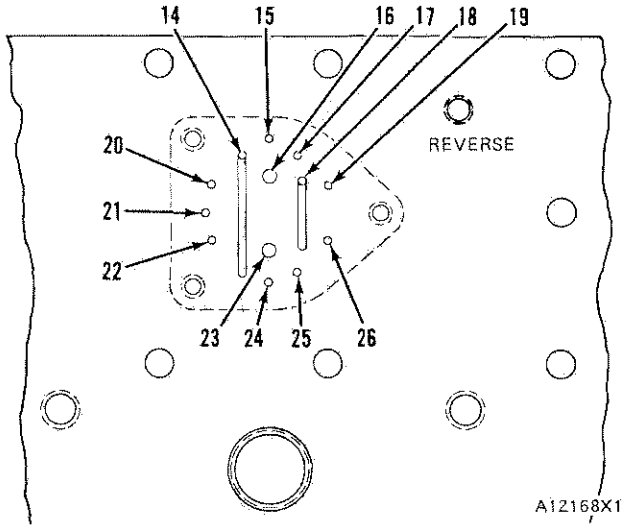
AIR HOLES IN FLANGE OF RATIO SELECTOR

1. From supply ports of valves (7) and (8) of charging circuit to hand valve.
2. From mechanical valve (D3) in ratio selector.
3. From mechanical valve (E3) in ratio selector.
4. From mechanical valve (A3) in ratio selector.
5. From check valve (49) in ratio selector.
6. From working side of valve (11) in transmission control to pilot side of valve (45) in ratio selector.
7. Exhaust line from ratio selector to transmission control.
8. From check valve (66) in ratio selector to pilot side of valve (10) in transmission control.
9. From main transmission air supply to ratio selector.
10. From mechanical valve (C3) in ratio selector.
11. From mechanical valve (N) in ratio selector.
12. From hand valve to pilot side of valves (7) and (8) in charging circuit.
13. From mechanical valve (B3) in ratio selector.



VALVES IN RATIO SELECTOR

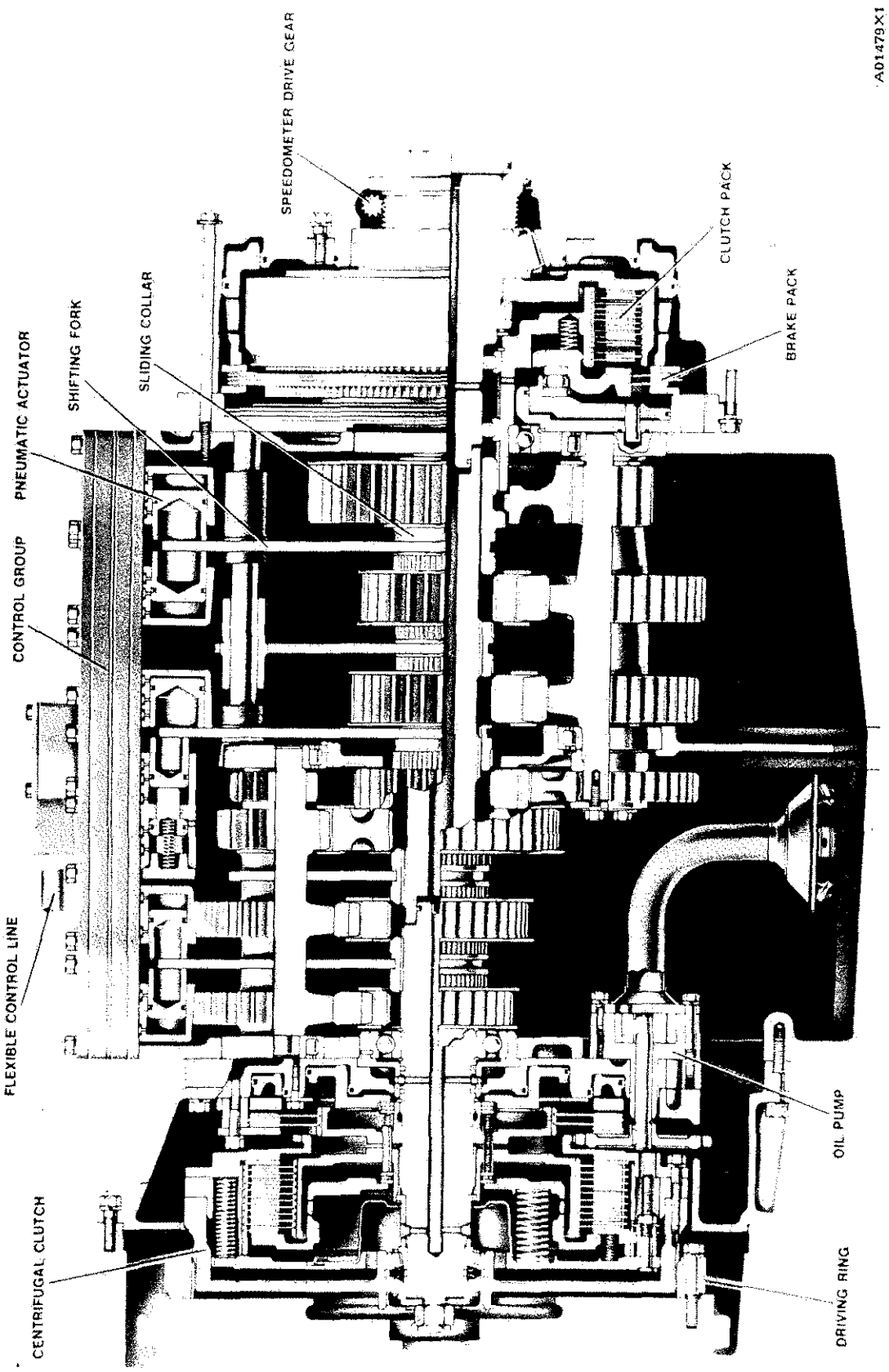
A3. Mechanically operated valve. B3. Mechanically operated valve. C3. Mechanically operated valve. D3. Mechanically operated valve. E3. Mechanically operated valve. N. Mechanically operated valve. 17. Shift valve. 49. Double check valve. 66. Double check valve.



AIR HOLES IN FLANGE IN TRANSMISSION CONTROL

14. From mechanical valve (C3) in ratio selector.
15. From check valve (66) in ratio selector to pilot side of valve (10) in transmission control.
16. Exhaust line from ratio selector to transmission control.
17. From working side of valve (11) in transmission control to pilot side of valve (45) in ratio selector.
18. From check valve (49) in ratio selector.
19. From mechanical valve (A3) in ratio selector.
20. From mechanical valve (B3) in ratio selector.
21. From hand valve to pilot side of valves (7) and (8) in charging circuit.
22. From mechanical valve (N) in ratio selector.
23. From main transmission air supply to ratio selector.
24. From supply ports of valves (7) and (8) of charging circuit to hand valve.
25. From mechanical valve (D3) in ratio selector.
26. From mechanical valve (E3) in ratio selector.

TRANSMISSION GEARS AND CLUTCHES



TRANSMISSION GEARS AND CLUTCHES

DISASSEMBLE TRANSMISSION GEARS AND CLUTCHES 15–3150

Tools Needed		A	B	C	D
8B7548	Puller Assembly	1	1		
8B7551	Bearing Pulling Attachment	1			
8H684	Wrench	1	1		
8B7560	Step Plate	1	1		
8H663	Bearing Pulling Attachment		1		
1P531	Handle			1	
1P502	Drive Plate			1	
1P481	Drive Plate			1	
FT901	Bracket				1

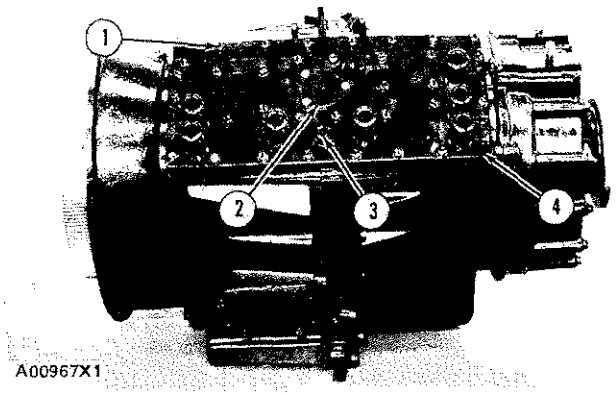
1. Remove the oil from the transmission.
2. Install plate (2) and plug (3) on the transmission control.
3. Thoroughly clean the outside of the transmission.
4. Remove bolts (1) from around the outside of the transmission control. Remove transmission control (4) and the gasket from the transmission.
5. Remove the plate and plug from the transmission control that were installed in Step 2.
6. Remove bolts (5) that hold the transmission control together. Remove plate (6) from the manifold group. Remove the gasket from the plate. Remove the strainer from the plate and clean it.
7. Remove manifold group (7) from plate (10). Remove piston (8) from the manifold group.

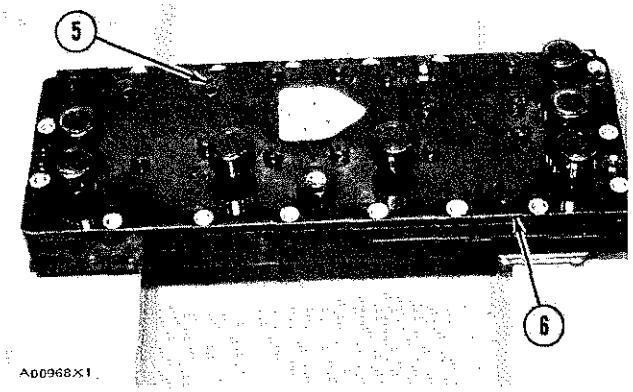
NOTE: The manifold group is serviced as a unit.

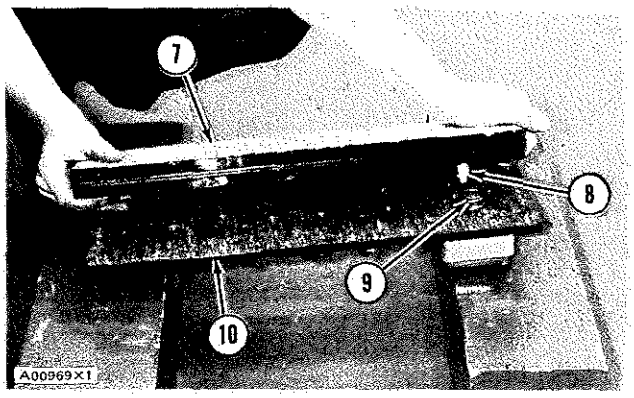
8. Remove spring (9) and the gasket from the plate.
9. Put identification on the actuators as to their location on plate (10) for use during installation.

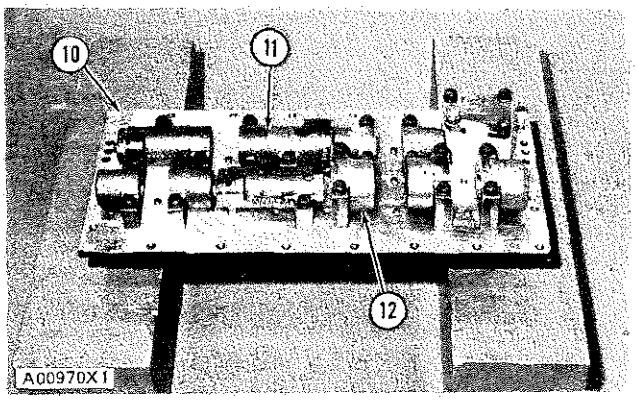
NOTE: Actuators must be installed in their original locations at assembly.

10. Remove the bolts. Remove seven actuators (12) and three actuators (11) from the plate.







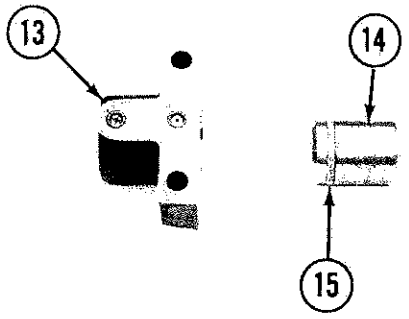


TRANSMISSION GEARS AND CLUTCHES

11. Remove piston (14) from housing (13). Remove the O-ring seals from the housing.

12. Remove ring (15) and the O-ring seal that is under the ring from the piston.

13. Do Steps 11 and 12 for the other six actuators.

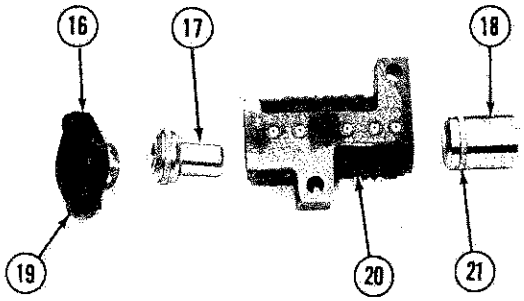


A00971X1

14. Remove bolts (19) and cover (16) from the housing. Remove the O-ring seal from the cover.

15. Remove pistons (17) and (18) from housing (20). Remove ring (21) and the O-ring seal that is under the ring from the two pistons.

16. Remove the O-ring seals from the housing.

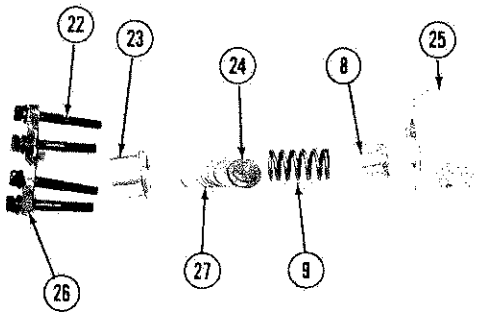


A00972X1

17. Do Steps 14 through 16 for the other two actuators.

18. Remove bolts (22) that hold the pressure regulator to the transmission control. Remove the pressure regulator.

19. Remove plate (26) from housing (25). Remove piston (23) from the housing. Remove shims (27) and pivot (24) from the piston. Remove the ring and the O-ring seal from pistons (23) and (8).



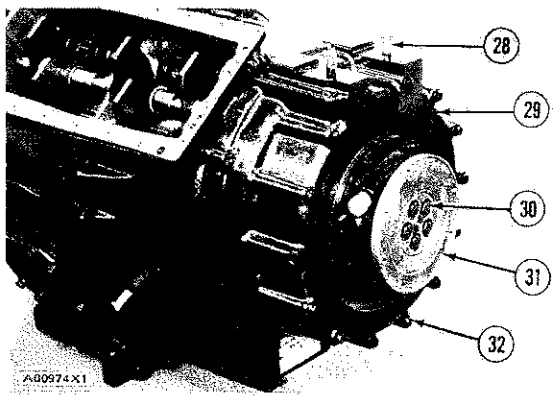
A00973X1

NOTE: Later valves have more pistons.

NOTE: Spring (9) and piston (8) were removed in Steps 7 and 8.

20. Remove bolts (30). Remove adapter (31).

21. Put tool (D) in position on stud (28). Install a nut to hold it. Fasten a hoist to tool (D).

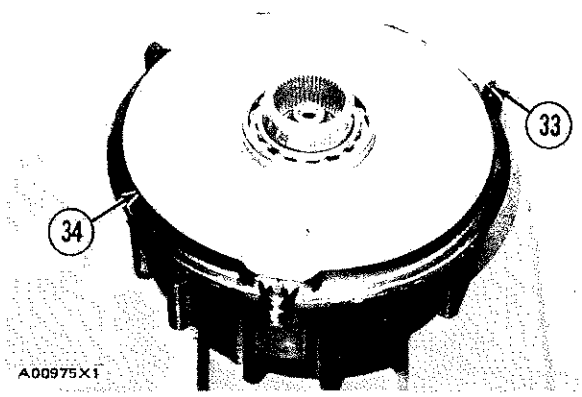


A00974X1

22. Remove bolts (32). Remove rear clutch (29). Weight is 215 lb. (97.5 kg).

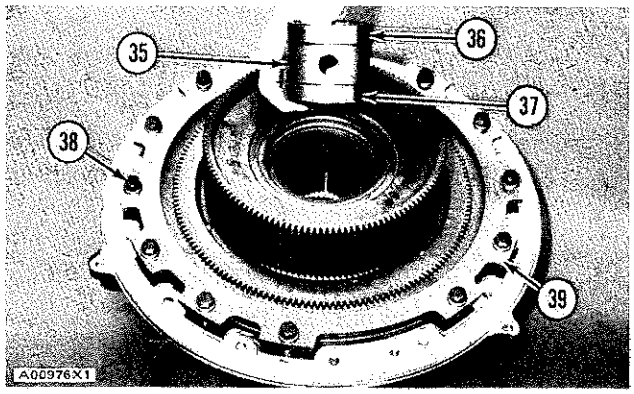
TRANSMISSION GEARS AND CLUTCHES

23. Remove bolts (33) that hold the rear brake to the rear clutch.



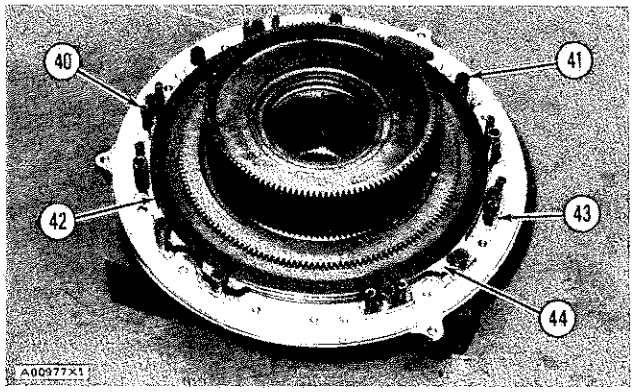
24. Install two 3/8"–16 NC forged eyebolts in the rear brake. Fasten a hoist to the eyebolts. Remove rear brake (34).

25. Remove the snap ring that holds the bearings. Remove bearing (36), spacer (35), and bearing (37) from the hub.



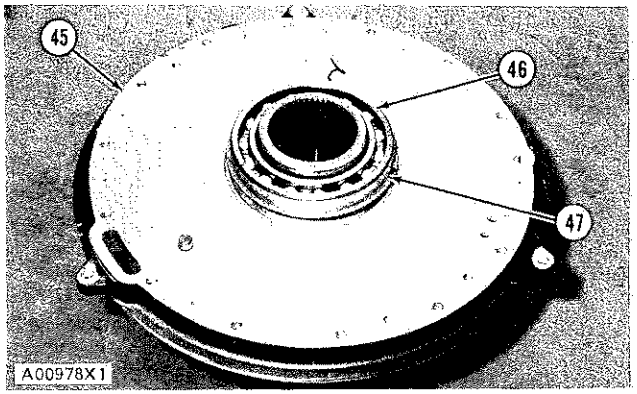
26. Remove bolts (38). Remove plate (39).

27. Remove springs (40) and spacers (41).



28. Remove disc (42), plate (44), disc, and plate (43).

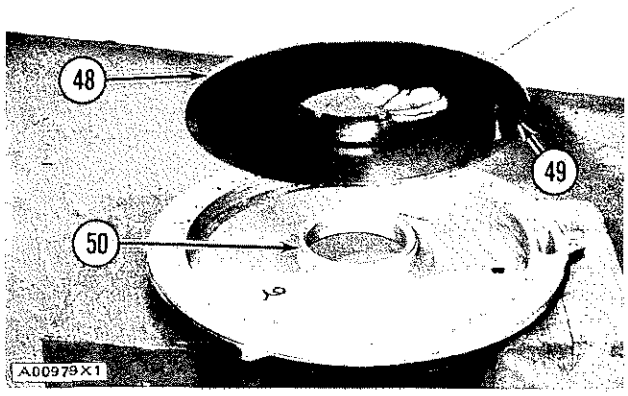
29. Turn the cover and hub over. Remove the hub from cover (45) and bearing (46) with a soft hammer.



30. Remove the bearing from the cover. Remove snap ring (47) from the bearing.

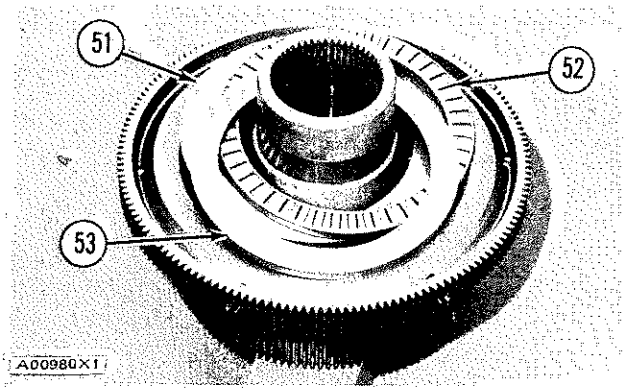
TRANSMISSION GEARS AND CLUTCHES

31. Remove piston (49) from the cover by hitting the dowel with a hammer and punch.



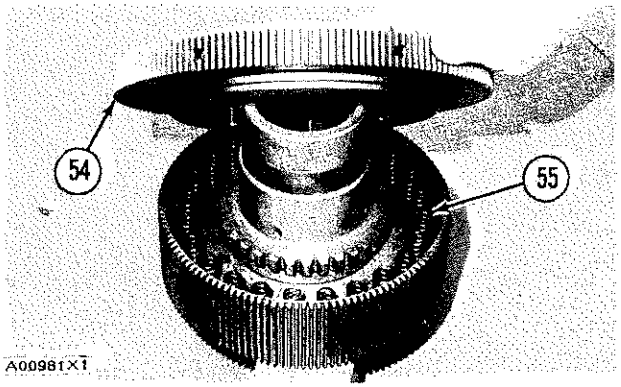
32. Remove ring (48) and the O-ring seal that is under the ring from the piston.

33. Remove ring (50) and the O-ring seal that is under the ring from the cover.



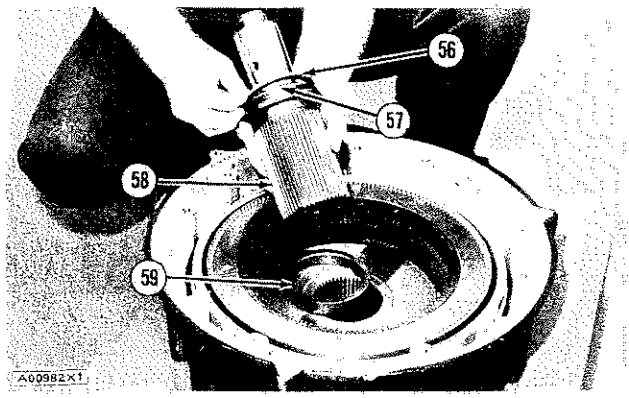
34. Remove race (53), bearing (52), and race (51) from the hub.

35. Remove plate (54) from the hub.



36. Remove springs (55) from the hub.

37. Remove shaft (58) and ring (59) from the hub in the rear clutch.



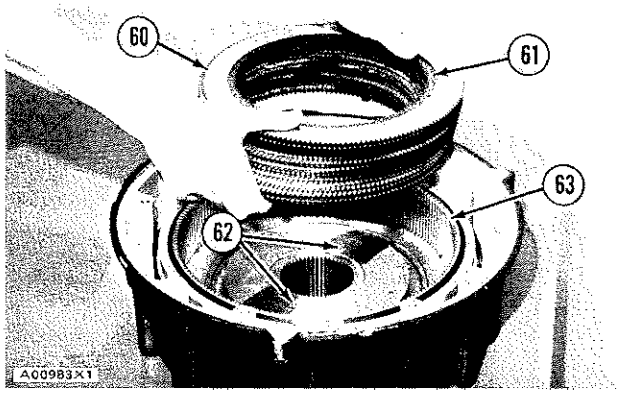
38. Remove race (56) and bearing (57) from the shaft.

TRANSMISSION GEARS AND CLUTCHES

39. Remove thirteen plates (60) and thirteen discs (61) from the hub.

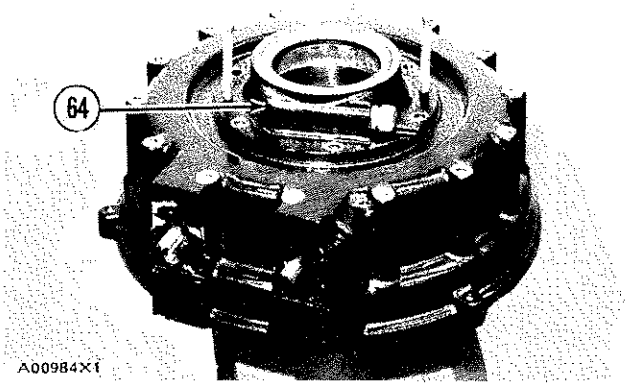
40. Remove hub (63) from the cover.

41. Remove the bearing cone from the hub by hitting it with a hammer and punch through holes (62).



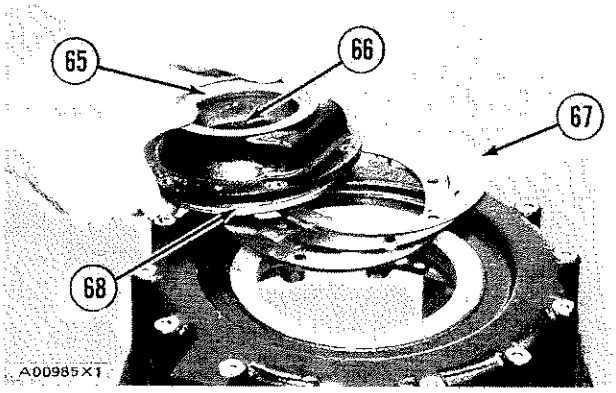
42. Turn the cover over and remove the bolts that hold the retainer.

43. Install two 3/8"—16 NC forcing screws in the retainer. Remove retainer (64) with the forcing screws.



44. Remove shims (67) and O-ring seal (68) from the retainer. Keep the shims with retainer for use during installation.

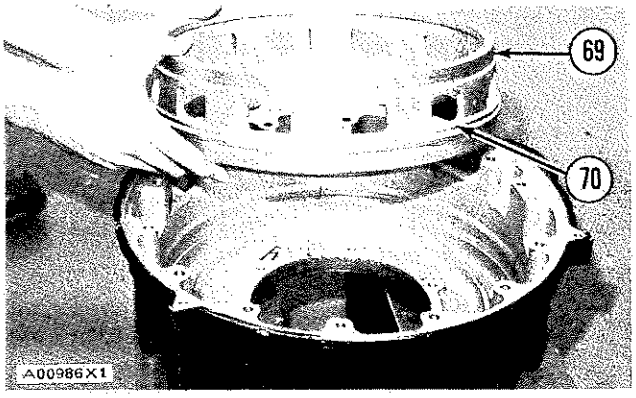
45. Remove bearing cup (66) and seal (65) from the retainer.



46. Turn the cover over and remove piston (69) from the cover.

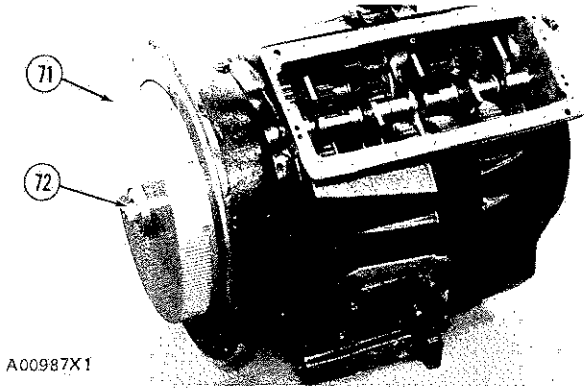
47. Remove ring (70) and the O-ring seal that is under the ring from the piston.

48. Remove the ring and the O-ring seal that is under the ring from the cover.

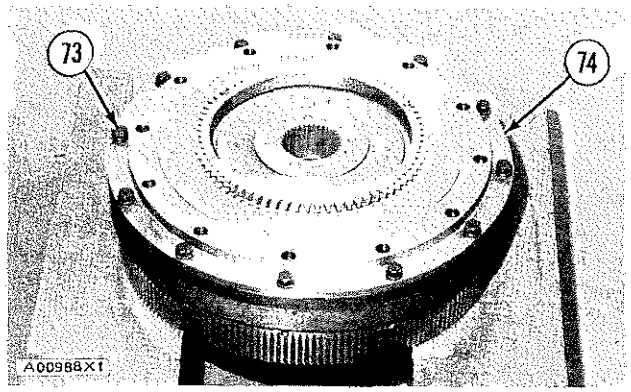


TRANSMISSION GEARS AND CLUTCHES

49. Put the shifting forks in a position that prevents the gears from turning.

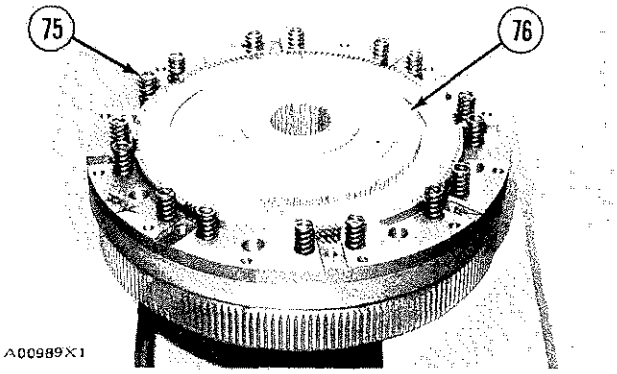


50. Remove nut (72). Put a strap around the front clutch. Fasten a hoist to the strap. Remove front clutch (71). Weight is 160 lb. (72.6 kg).



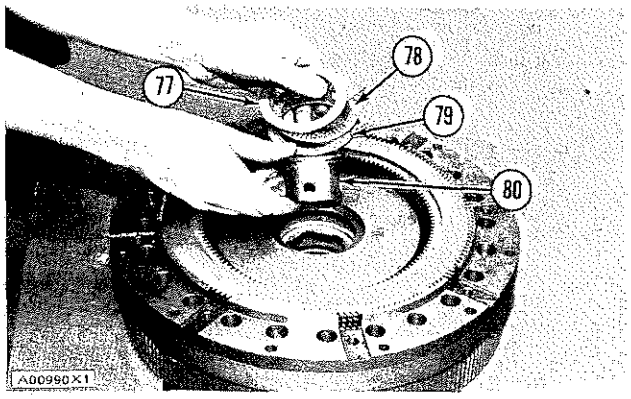
51. Put the front clutch in position on blocks with the front side down.

52. Remove bolts (73). Remove plate (74) from the hub.



53. Remove springs (75) from the hub.

54. Remove hub (76).



55. Remove race (77), bearing (78), and race (79) from the plate.

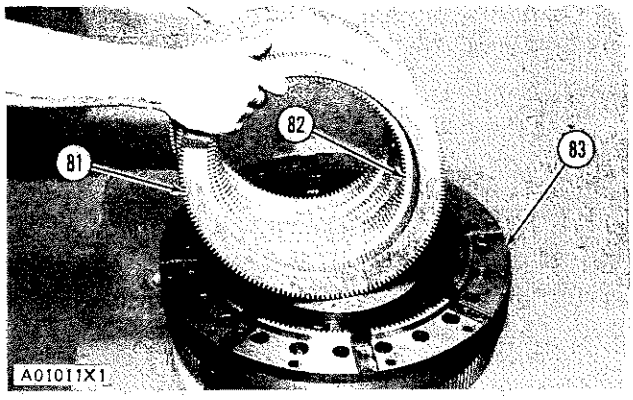
56. Remove sleeve (80) from the deflector.

TRANSMISSION GEARS AND CLUTCHES

57. Remove ten plates (81) and ten discs (82) from the hub.

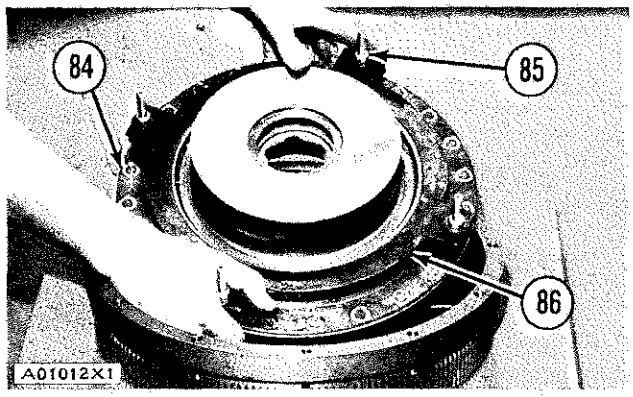
58. Remove hub (83) from the adapter.

59. Remove piston assembly (84) from the adapter.



60. Remove nuts (85) and the washers. Remove plate (86) from the plate.

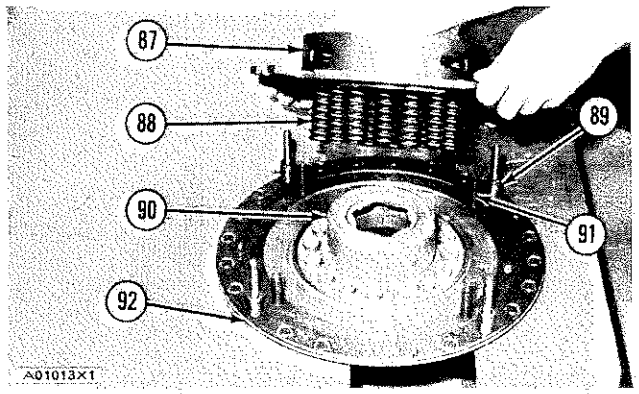
61. Remove plate (87) from the piston. Remove springs (88) from the plate.



62. Remove springs (91) and sleeves (89) from the piston.

63. Remove deflector (90) from the piston.

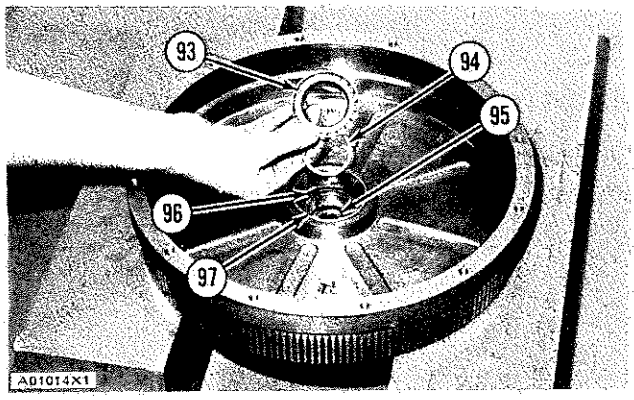
64. Remove ring (92) and the O-ring seal that is under the ring from the piston.



65. Remove bearing cone (93) and spacer (94) from the adapter.

66. Remove the deflector and washer (95) from the adapter with a hammer and punch. Remove bearing cone (96).

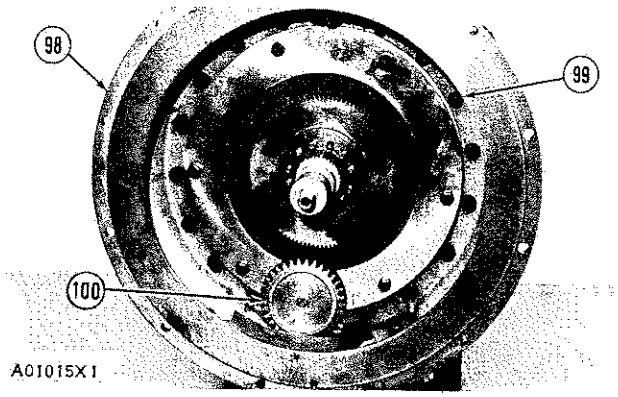
67. Remove two bearing cups (97) and the spacer from the adapter.



TRANSMISSION GEARS AND CLUTCHES

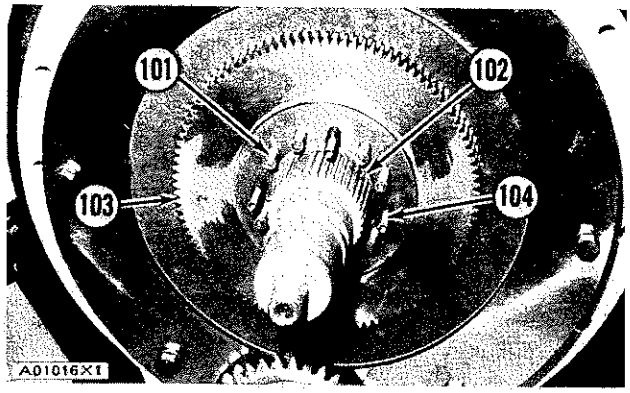
68. Install a 1/2"–13 NC forged eyebolt in housing (98). Fasten a hoist to the eyebolt.

69. Remove bolts (99) that hold housing (98).



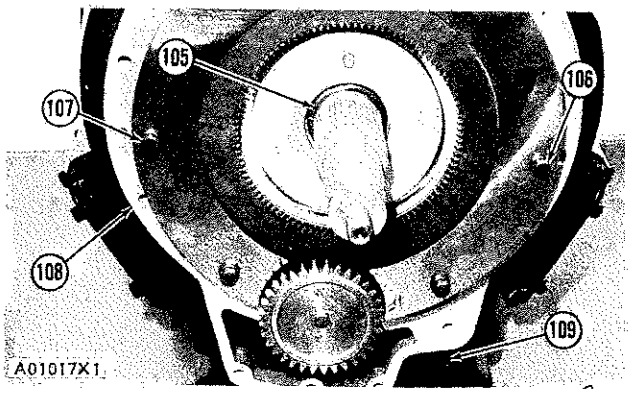
NOTE: There are three bolts on the outside of the housing at the bottom which must be removed.

70. Remove housing (98). The housing must be turned to miss gear (100). Weight of the housing is 50 lb. (22.7 kg).



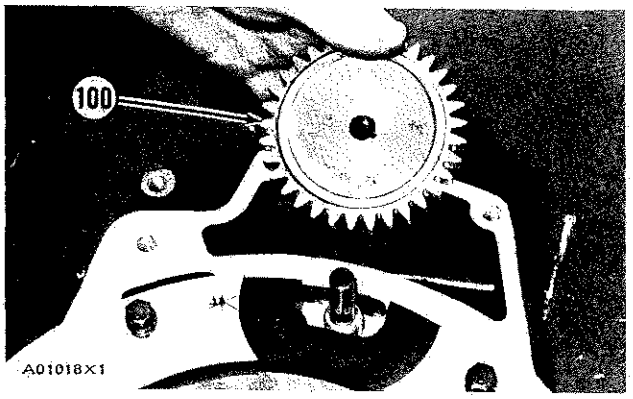
71. Remove four springs (104) and sleeves from the hub. Remove eight pins (101) from the hub.

72. Remove snap ring (102) from the shaft. Remove hub (103) from the front brake. Remove the two races and bearing from the shaft.



73. Remove snap ring (105) from the shaft.

74. Remove bolt (109). Remove bolts (106) and (107) from the front brake. Remove front brake (108).

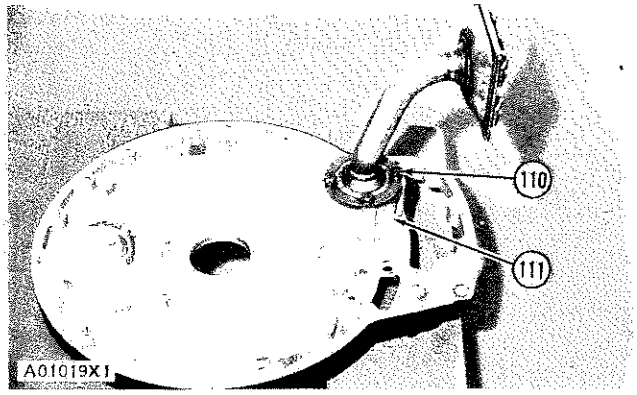


75. Remove gear (100) from the shaft.

TRANSMISSION GEARS AND CLUTCHES

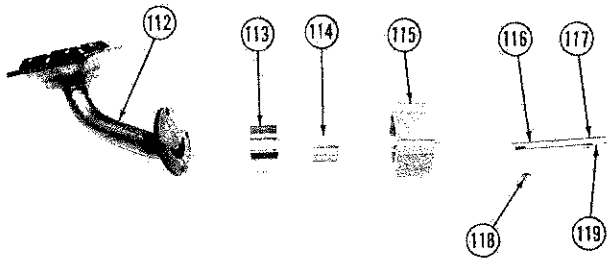
76. Turn the front brake over.

77. Remove three bolts (110) from around the bottom of the oil pump. Remove oil pump (111) from the front brake.



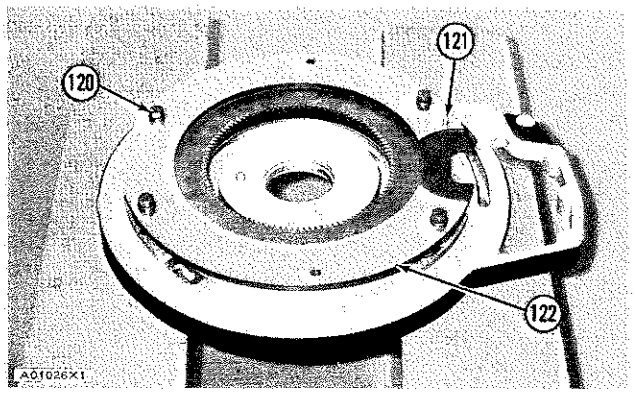
78. Remove the bolt that holds the tube to the housing. Remove tube (112).

79. Remove gears (113) and (114) from housing (115).



80. Remove key (118) from the shaft. Remove shaft (116) from the housing. Remove key (119) and snap ring (117) from the shaft.

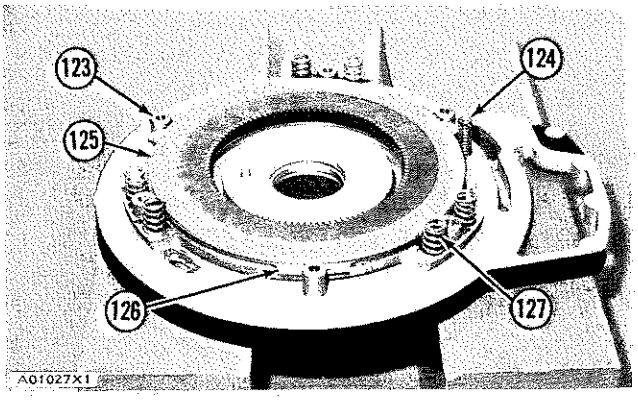
81. Remove the cotter pin from valve (121).



82. Remove bolts (120). Remove plate (122).

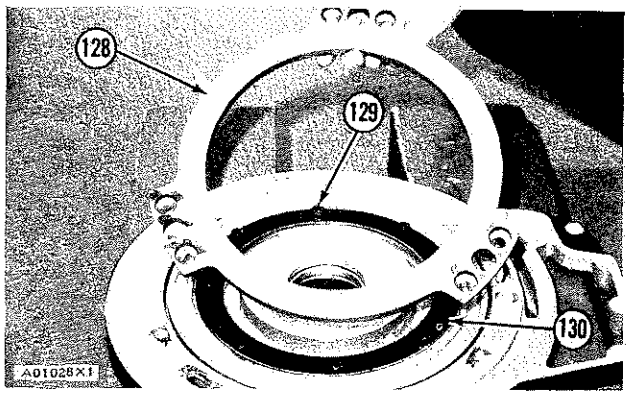
83. Remove spring (124) and the valve from the plate. Remove springs (127) and spacers (123) from the plate.

84. Remove disc (125), plate (126), and the disc from the plate.



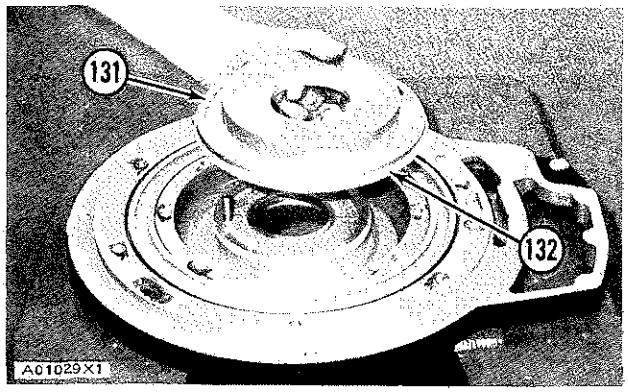
TRANSMISSION GEARS AND CLUTCHES

85. Remove plate (128) from the plate.



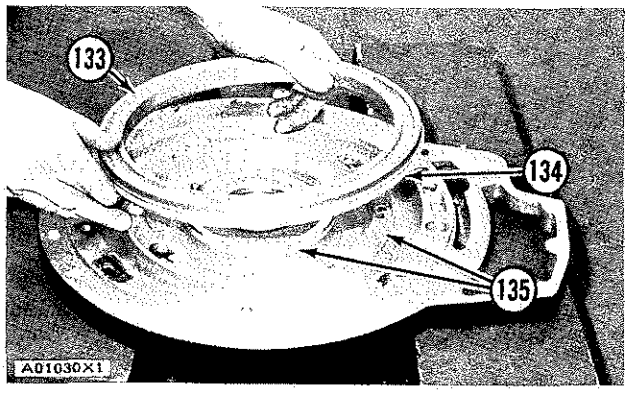
86. Remove bolts (129) and ring (130) from the plate.

87. Remove piston (131) from the plate.



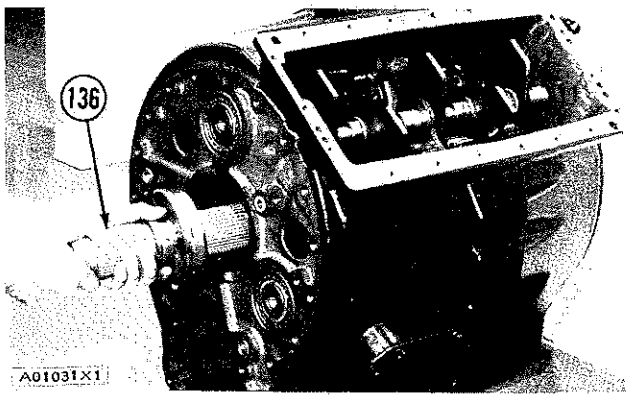
88. Remove ring (132) and the O-ring seal that is under the ring from the piston.

89. Remove piston (133) from the plate by hitting it lightly with a hammer and punch from the other side of the plate.



90. Remove ring (134) and the O-ring seal that is under the ring from the piston.

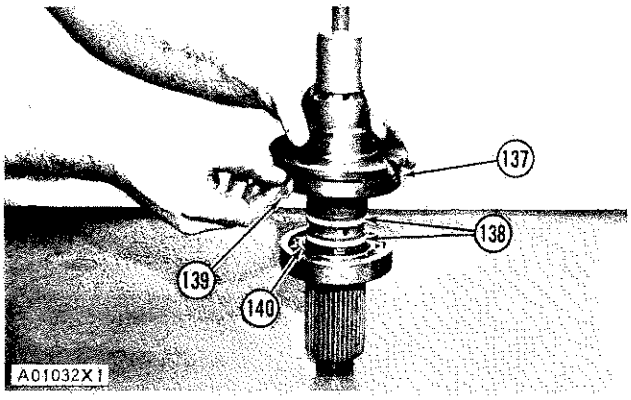
91. Remove two rings (135) and the two O-ring seals that are under the rings from the plate.



92. Remove shaft (136) from the front case.

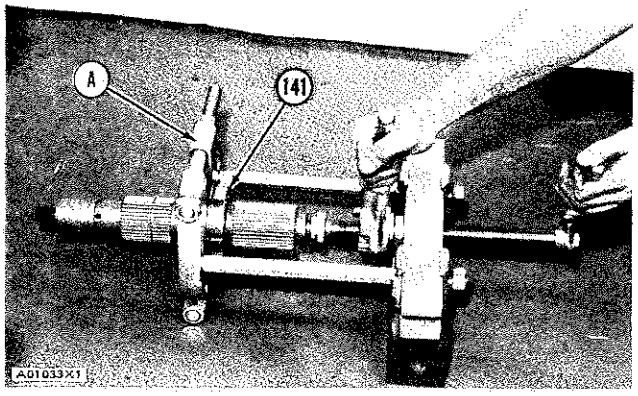
TRANSMISSION GEARS AND CLUTCHES

93. Remove three keepers (139) from the retainer. Remove retainer (137).



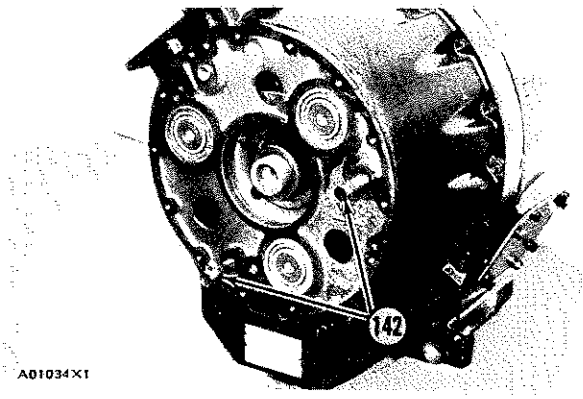
94. Remove rings (138) from the shaft.

95. Remove snap ring (140) and the snap ring on the other side of the bearing.



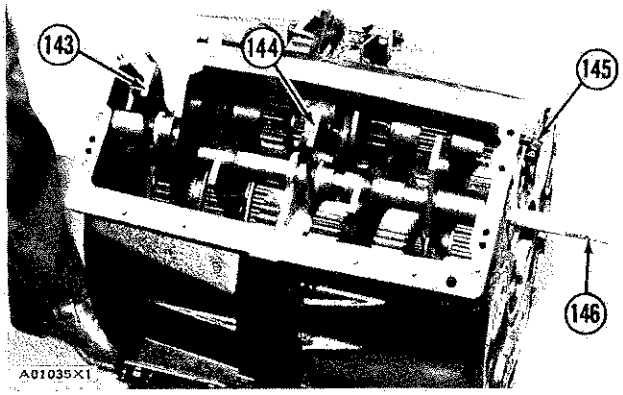
96. Remove bearing (141) from the shaft with tooling (A).

97. Remove spray tubes (142) from the back of the transmission.



98. Pull rail (146) out of the transmission.

99. Put identification on the shifting forks as to their location in the transmission. Remove four shifting forks (143).



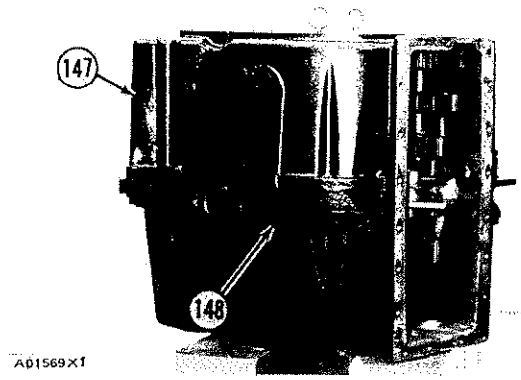
NOTE: Shifting fork (144) will not come out until a separation of the cases is made.

100. Remove fitting (145) from the rear case.

TRANSMISSION GEARS AND CLUTCHES

101. Install two 3/8"–16 NC forged eyebolts in the front case. Fasten a hoist to the eyebolts. Put the transmission in position on the rear case as shown.

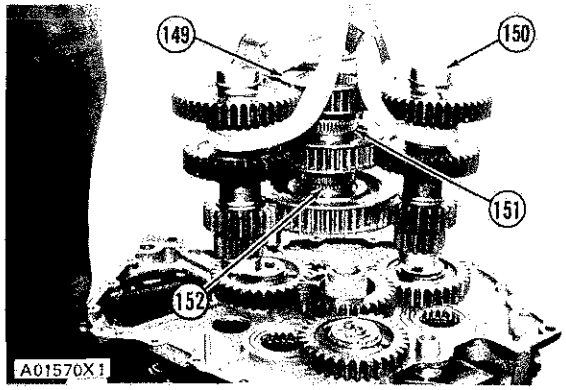
CAUTION: The shaft in the center can fall from the rear of the transmission.



102. Remove bolts (148) that hold the cases together. Fasten a hoist to the eyebolts. Remove front case (147). Weight is 90 lb. (40.8 kg). Remove the three bearings from the front case with tooling (C).

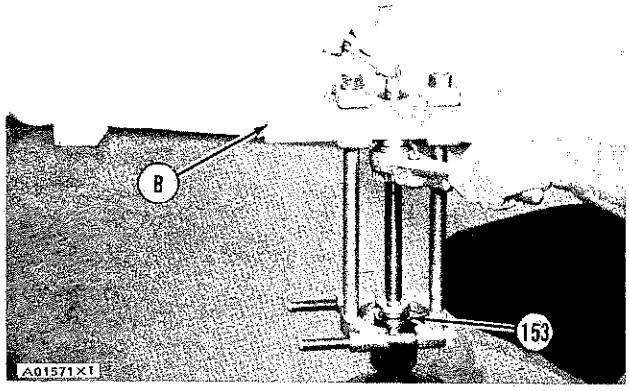
103. Put a mark with paint on the three countershafts and gear (149) to show location of the countershafts in the gear.

104. Put a strap or rope around the three countershafts. Fasten a hoist to the strap or rope. Remove three countershafts (150) and the three gears as a unit.



105. Put the countershafts and gears on the floor. Make a separation of the countershafts from the gears. Remove collars (151) and (152) from the bottom two gears.

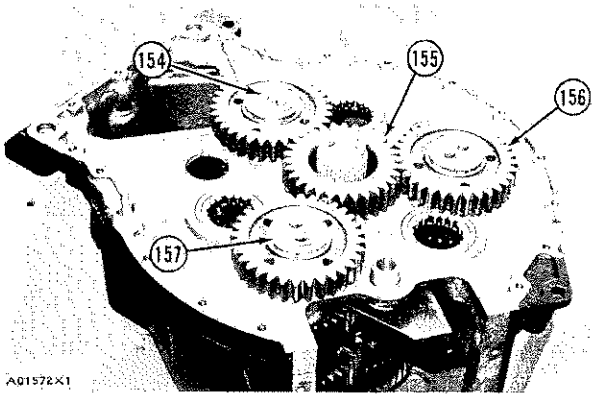
106. Remove bearing race (153) from each end of the three countershafts with tooling (B).



107. Remove gear (155).

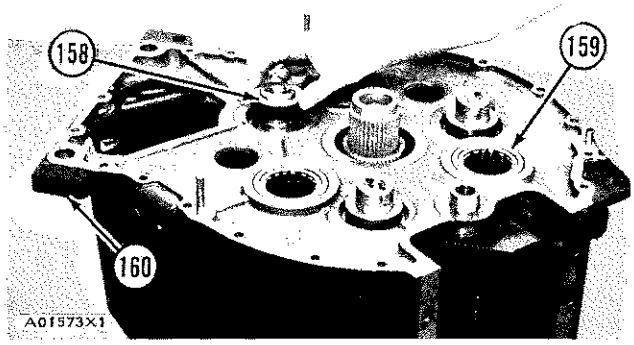
108. Bend the locks away from the bolts. Remove bolts (154) and washers (157) from the gears. Remove the thrust washers that are under washers (157).

109. Remove three gears (156) and the thrust washers that are under the gears. Remove the rollers from each gear.



TRANSMISSION GEARS AND CLUTCHES

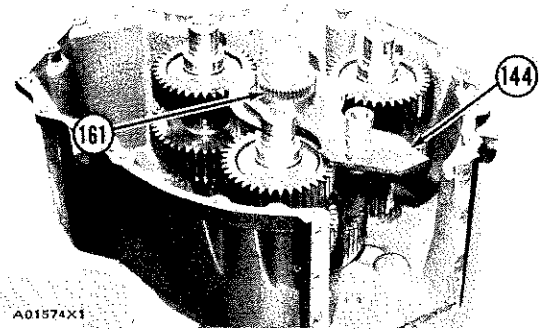
110. Remove spacers (158) from the three countershafts.



111. Remove plate (160) from the rear case.

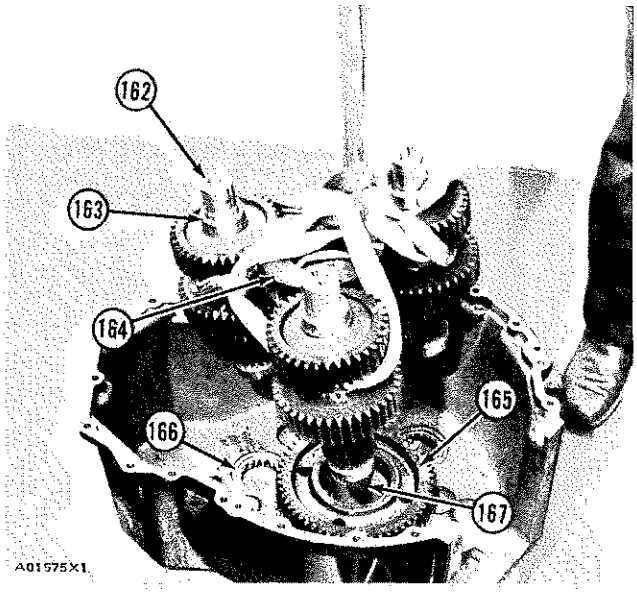
112. Remove three bearings (159) from the plate with tooling (C).

113. Remove shifting fork (144). Remove collar (161) from the shaft.



114. Put a mark with paint on the three countershafts and gear (164) to show location of the countershafts in the gear.

115. Put a strap or rope around the three countershafts. Fasten a hoist to the strap or rope. Remove three countershafts (162) and the gears as a unit.



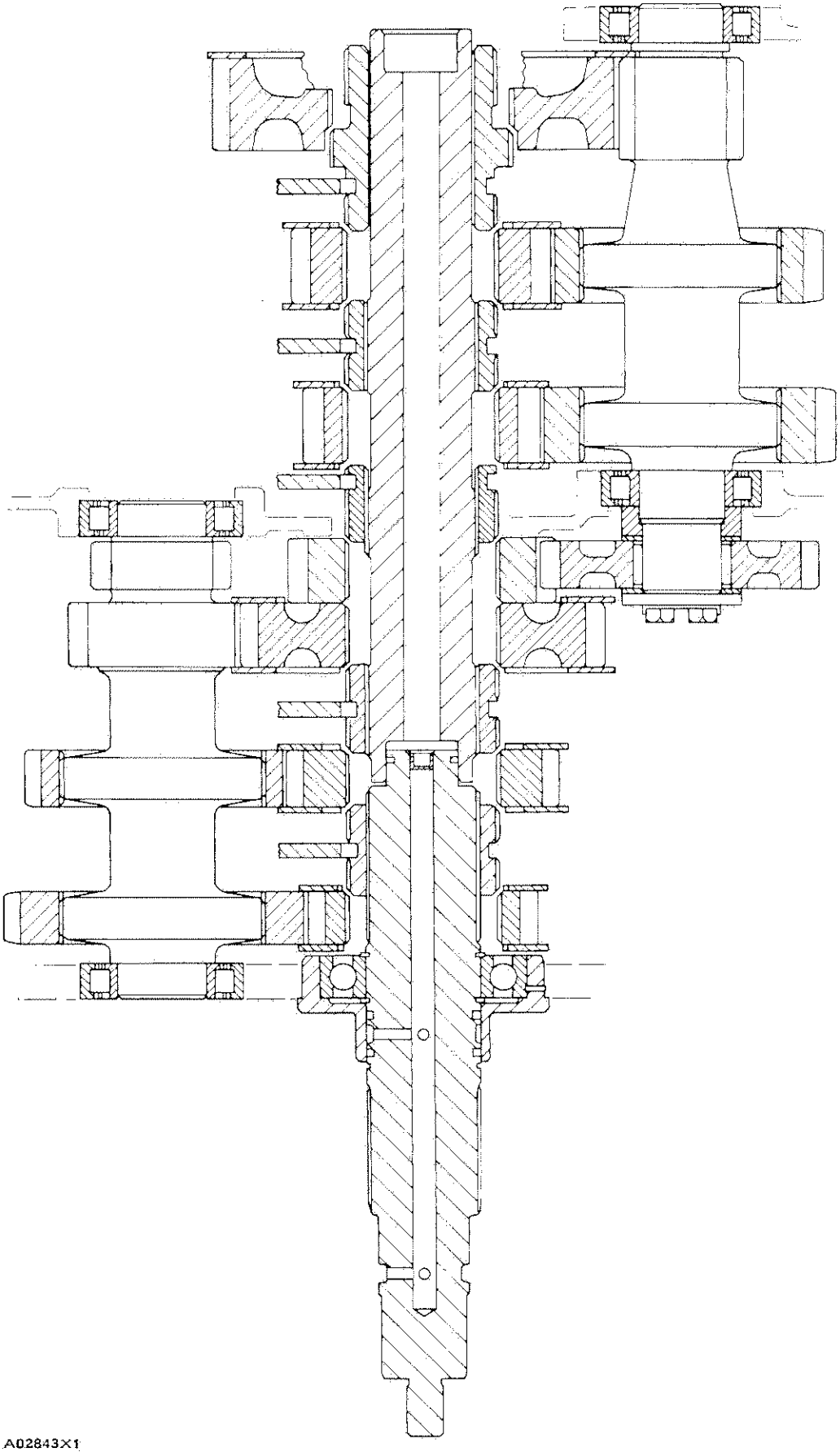
116. Put the countershafts and gears on the floor. Make a separation of the countershafts from the gears. Remove the collar from the gear in the center.

117. Remove bearing race (163) from each end of the three countershafts with tooling (B).

118. Remove gear (165) and shaft (167). Remove the collar from the shaft.

119. Remove three bearings (166) from the rear case with tooling (C).

MAINSHAFT, COUNTERSHAFTS AND GEARS



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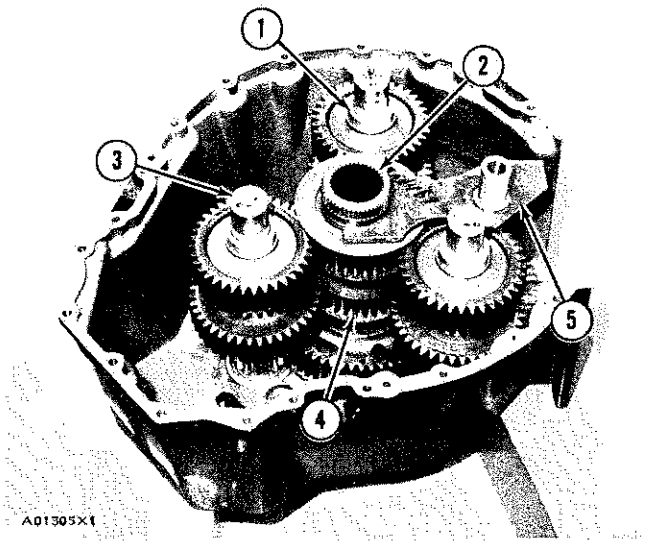
TRANSMISSION GEARS AND CLUTCHES

ASSEMBLE TRANSMISSION GEARS AND CLUTCHES 16–3150

Tools Needed		A	B	C	D
1P531	Handle	1	1		
1P502	Drive Plate	1			
1P481	Drive Plate	1			
1P525	Drive Plate		1		
7/16" – 14 NC 8" long bolt				1	
8S2328	Indicator Group			1	
2P8260	Installer Group			1	
FT901	Bracket				1



1. Install the three bearings in the rear case with tooling (A).

2. Heat the races in oil to a temperature of 275°F (135°C). Install bearing race (1) on each end of the three countershafts.

3. Install the collar in gear (4). Put the three countershafts in position on the three gears. Use the marks that were put on the countershafts and the top gear during removal to put the components in correct alignment.

4. Put a strap or rope around the three countershafts. Fasten a hoist to the strap or rope. Put three countershafts (3) and the three gears in position in the rear case.

5. Put collar (2) in position in the gear. Put shifting fork (5) in position on the collar.

6. Install three bearings (12) in plate (8) with tooling (A).

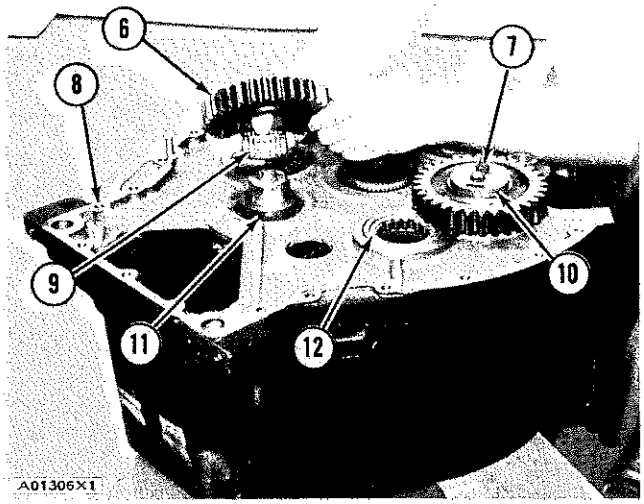
7. Put 7M7260 Liquid Gasket on the surfaces of the rear case and the plate that come in contact with each other.

8. Put plate (8) in position on the rear case.

9. Install spacers (11) on the three countershafts. Install the thrust washers on the three spacers.

10. Install roller (9) in three gears (6). Install the gears on the three countershafts.

11. Install the thrust washers and washer (10) on the gears. Install the locks and bolts (7) that hold the washer. Bend the locks against the bolts.



TRANSMISSION GEARS AND CLUTCHES

12. Put gear (15) in position on the plate.

13. Heat the bearing races in oil to a temperature of 275°F (135°C). Install bearing race (14) on each end ot the three countershafts.

14. Install collars (16) in the two gears. Put the three countershafts in position on the three gears. Use the marks that were put on the countershafts and the top gear during removal to put the components in correct alignment.

15. Put a strap or rope around the three countershafts. Fasten a hoist to the strap or rope. Put three countershafts (13) and the three gears in position in the plate.

16. Install three bearings (17) in the front case with tooling (A).

17. Put 7M7260 Liquid Gasket on the surfaces of the front case and the plate that come in contact with each other.

18. Install two 3/8"–16 NC forged eyebolts in the front case. Fasten a hoist to the eyebolts. Put front case (18) in position on plate (8). Install the bolts that hold the rear case and the front case together.

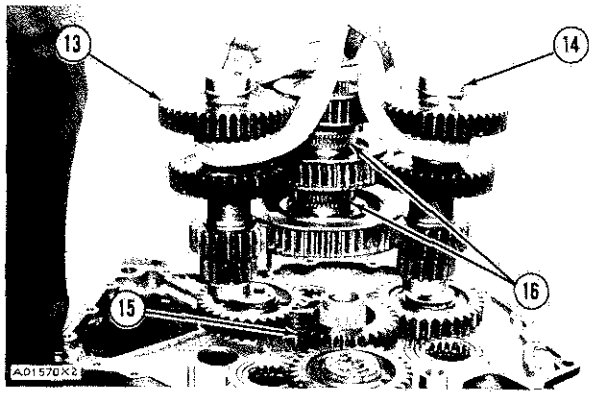
19. Put the transmission in a horizontal position as shown with a hoist.

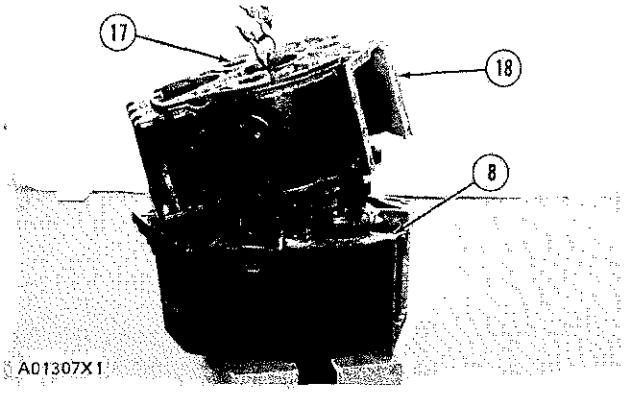
20. Install spray tubes (19) in the transmission. Make sure the pins on the tubes are in alignment with the notch in the rear case.

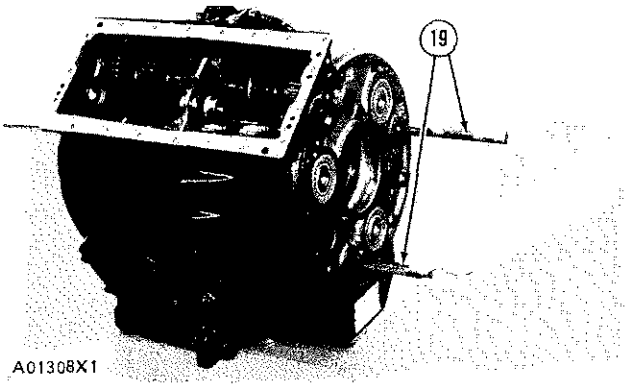
21. Install collar (21) on the shaft.

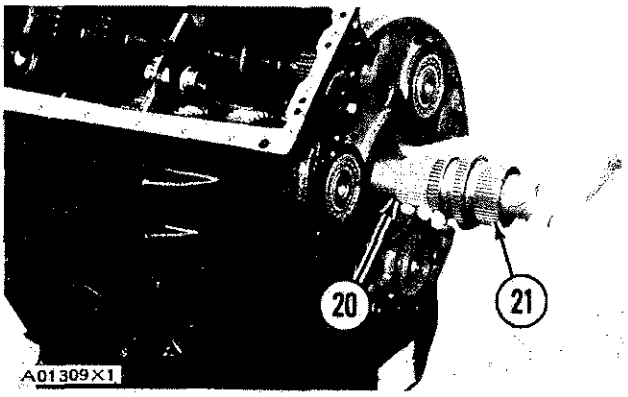
22. Put shaft (20) in position in the gears.

NOTE: The shaft is installed at the rear of the transmission.









TRANSMISSION GEARS AND CLUTCHES

23. Put four shifting forks (22) in position on their correct collars.

24. Install rail (23) that holds the shifting forks in position.

25. Install snap ring (28) on the shaft.

26. Heat the bearing in oil to a temperature of 275°F (135°C). Install bearing (27) on the shaft. Make sure the groove in the bearing is toward the end of the shaft which has threads on it. Install the snap ring on the shaft on the other side of the bearing.

27. Install rings (25) on the shaft.

28. Put retainer (24) in position on the bearing. Install three keepers (26) that hold the retainer to the bearing.

29. Install the shaft in the front case of the transmission.

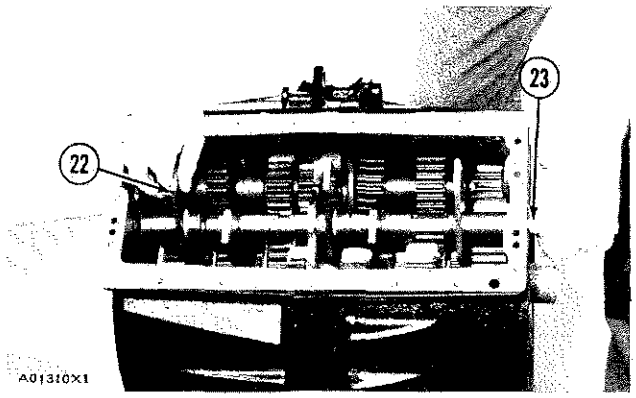
30. Put a small amount of 4L7464 Silicone Grease on the O-ring seals and the rings.

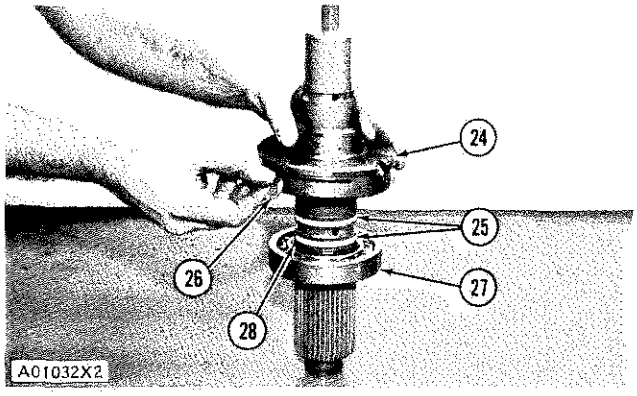
31. Install the O-ring seals and rings (30) in the plate and the piston.

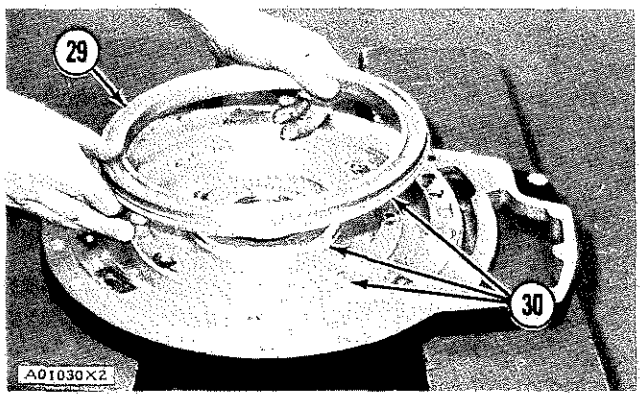
32. Install piston (29) in the plate.

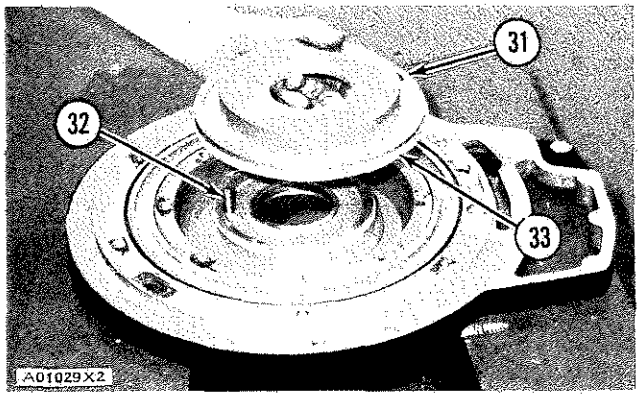
33. Install the O-ring seal and ring (33) in the piston.

34. Install piston (31) in the plate. Make sure the hole in the piston is in alignment with dowel (32).

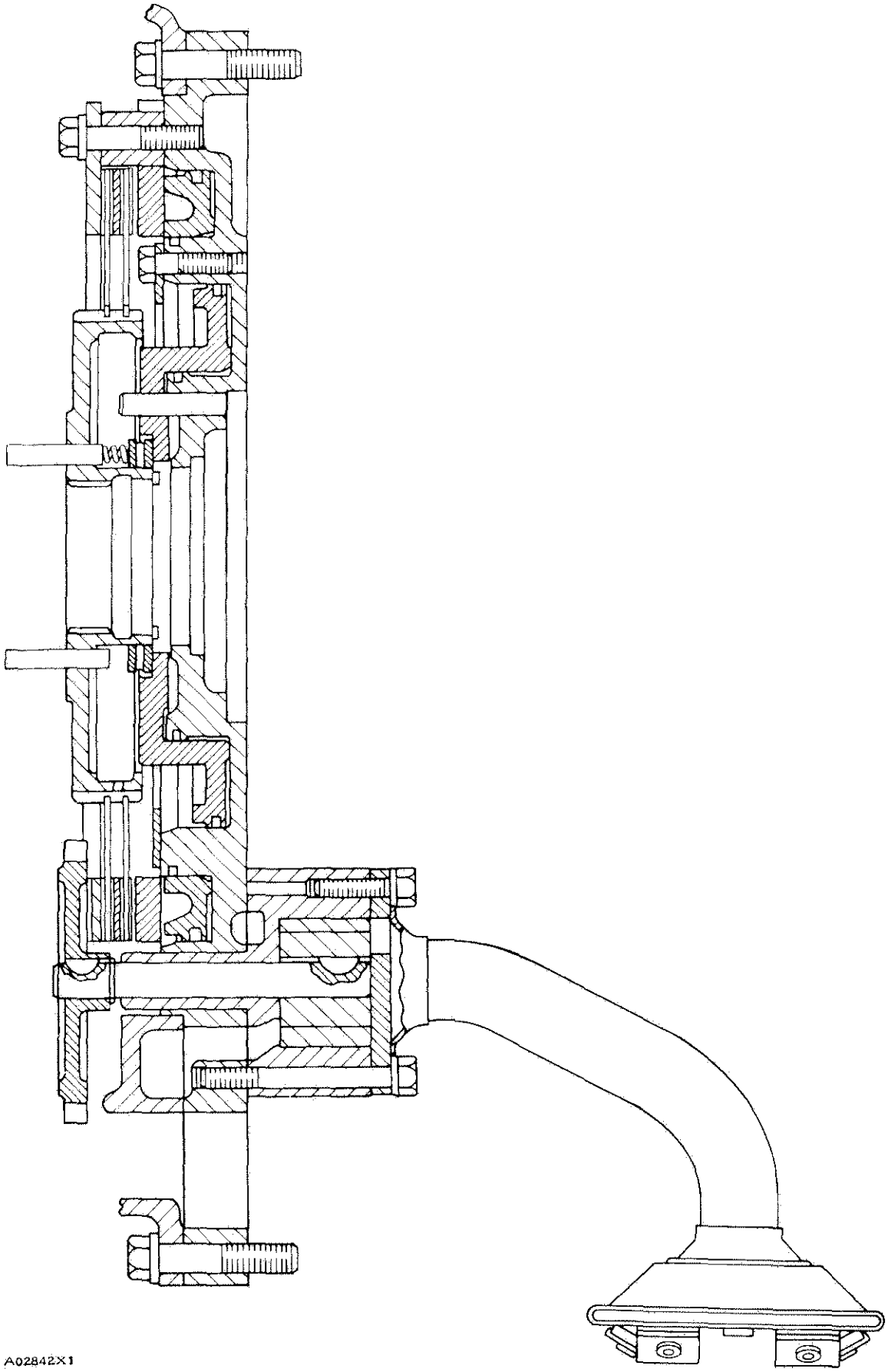








FRONT BRAKE



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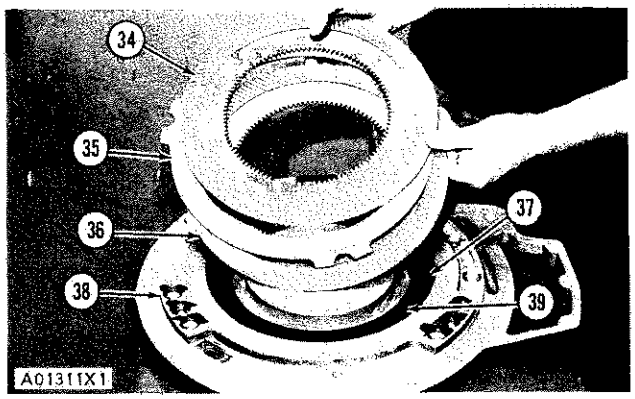
TRANSMISSION GEARS AND CLUTCHES

35. Put ring (37) in position on the plate. Install bolts (39) that hold it.

36. Put plate (38) in position on the plate.

37. Put SAE 30 oil on the two discs.

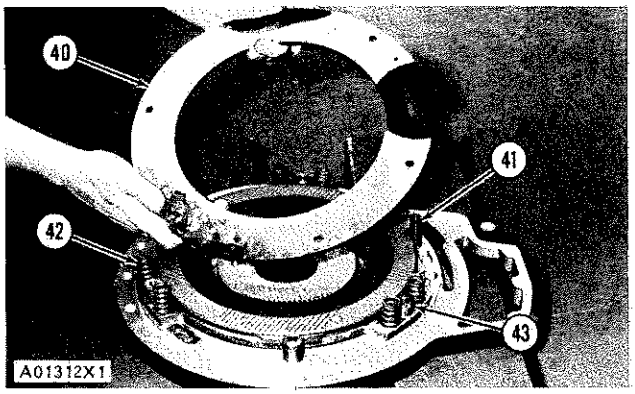
38. Put disc (34), plate (35) and disc (36) in position on plate (38).



39. Put springs (42) and spacers (43) in position on the plate.

40. Put the valve and spring (41) in position in the plate.

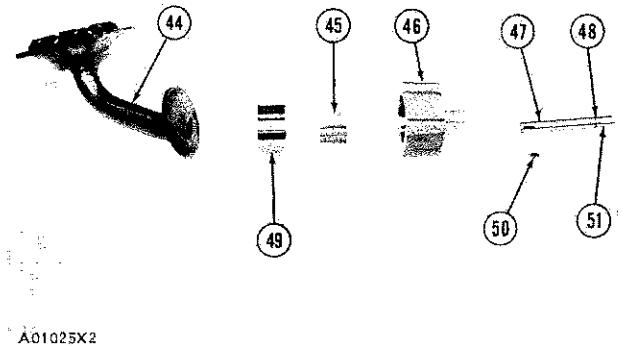
41. Put plate (40) in position on the springs and spacers. Install the bolts that hold the plate. Install the cotter pin in the valve.



NOTE: Be sure springs (42) stay in the vertical position when plate (40) is installed.

42. Install snap ring (48) and key (51) on the shaft. Put shaft (47) in position in housing (46). Install key (50) on the shaft.

43. Put gear (45) in position in the housing. Make sure the notch in the gear is in alignment with key on the shaft. Put gear (49) in position in the housing.

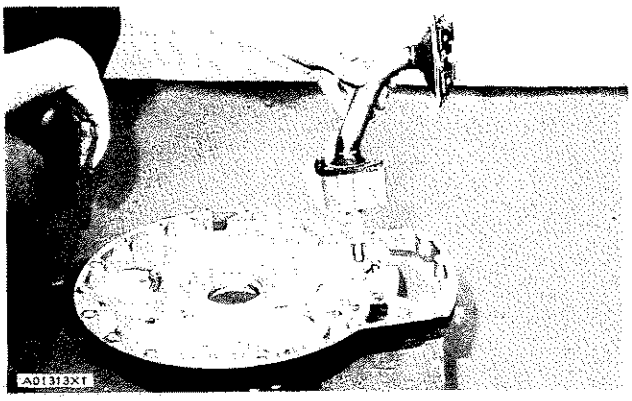


44. Put tube (44) in position on the housing. Install the one bolt that holds it.

45. Put 7M7260 Liquid Gasket on the surfaces of the oil pump and the plate that come in contact with each other.

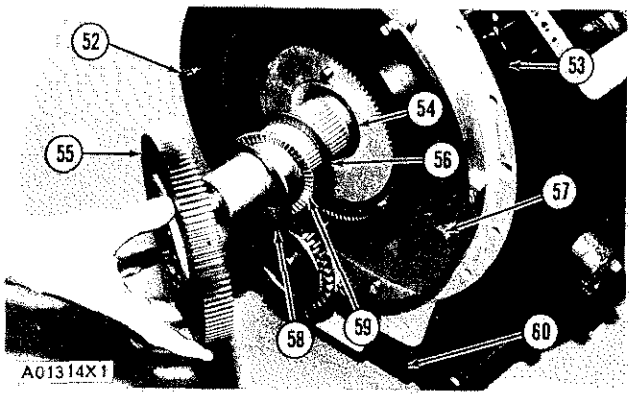
46. Put the oil pump in position on the plate. Install the bolts that hold it.

47. Turn the plate over and install the gear on the shaft of the oil pump.



TRANSMISSION GEARS AND CLUTCHES

48. Put front brake (53) in position on the front case. Install bolts (52), (57), and (60) that hold the front brake to the front case. Tighten bolts (52) and (57) to a torque of 36 ± 2 lb.ft. (5.0 ± 0.3 mkg).

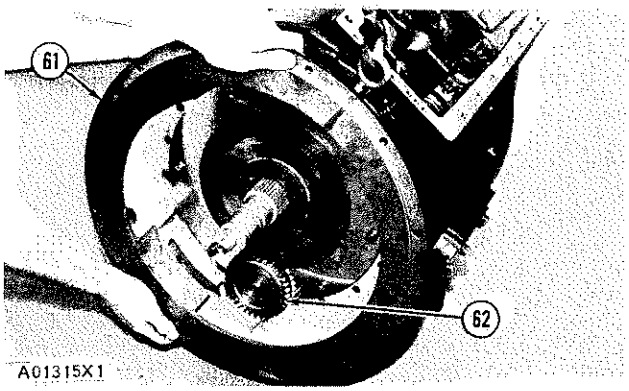


49. Install snap ring (54) on the shaft. Put bearing race (56), bearing (59), and bearing race (58) in position in the piston.

50. Put hub (55) in position on the shaft. Install the snap ring that holds the hub on the shaft.

51. Put 7M7260 Liquid Gasket on the surfaces of the housing and the front brake that come in contact with each other.

52. Install a 1/2"—13 NC forged eyebolt in the housing. Fasten a hoist to the eyebolt. Put housing (61) in position on the front brake. The housing must be turned to miss gear (62).

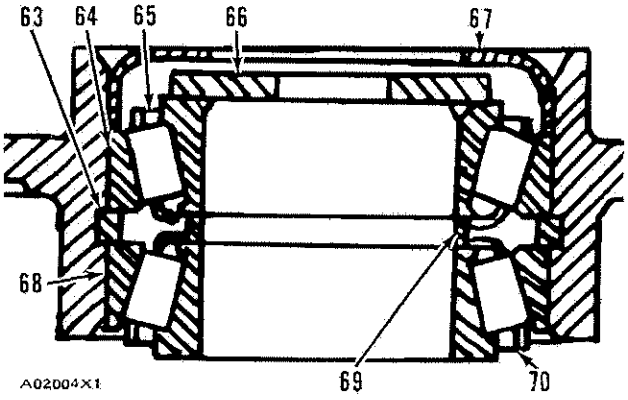


53. Install the bolts that hold the housing to the front brake. Tighten the three long bolts to a torque of 55 ± 5 lb.ft. (7.6 ± 0.7 mkg).

54. Install spacer (63) in the adapter.

55. Lower the temperature of the two bearing cups. Install bearing cups (64) and (68) in the adapter.

56. Put bearing cone (65) and washer (66) in position in the adapter. Install deflector (67) in the adapter.

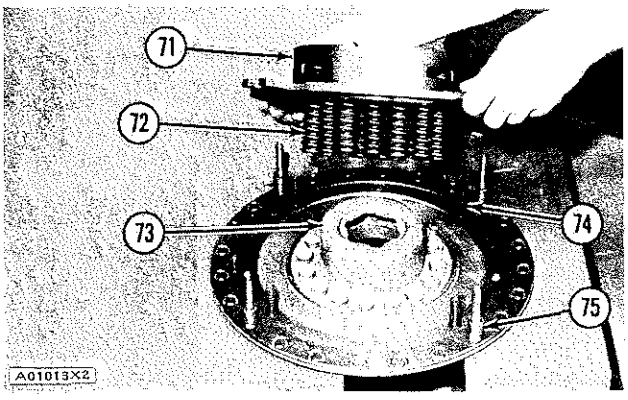


57. Install spacer (69) and bearing cone (70) in the adapter.

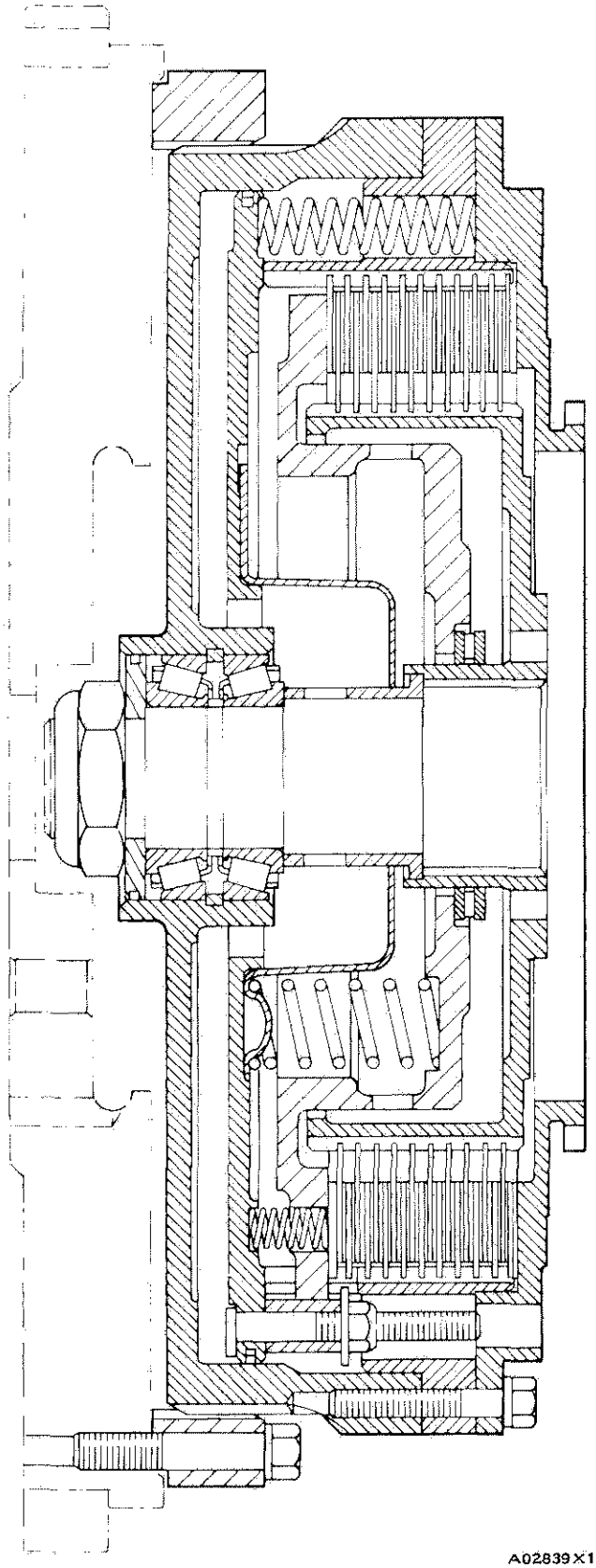
58. Put 7M7260 Liquid Gasket on the surfaces of the deflector and the piston that come in contact with each other. Install deflector (73) on the piston.

59. Put springs (74) and sleeves (75) in position on the piston.

60. Install springs (72) in the plate. Put plate (71) in position on the piston.



FRONT CLUTCH



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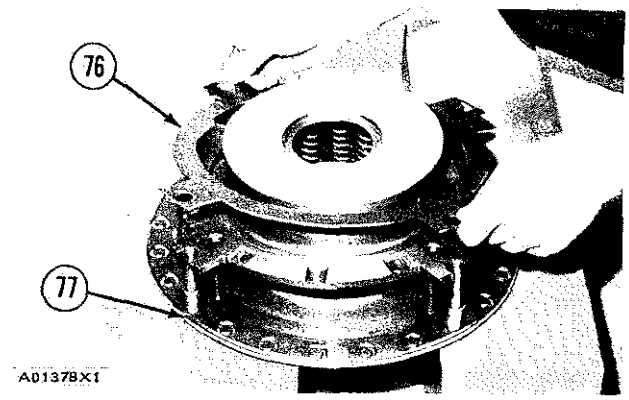
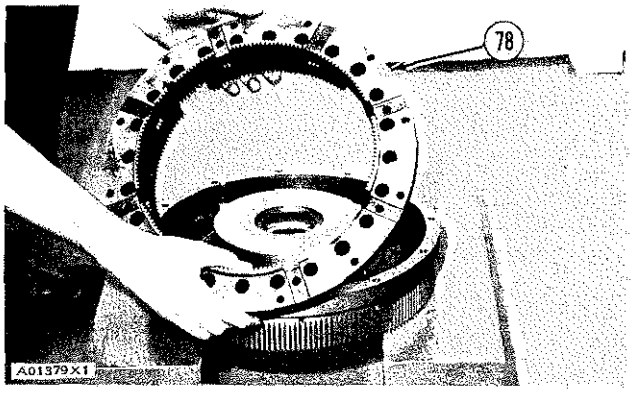
TRANSMISSION GEARS AND CLUTCHES

61. Put plate (76) in position on the plate. Install the washers and nuts that hold the two plates to the piston.



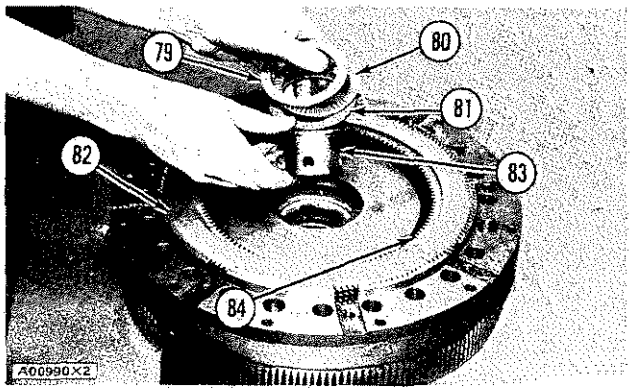
62. Put a small amount of 4L7464 Silicone Grease on the O-ring seal and the ring.

63. Install the O-ring seal and ring (77) on the piston.



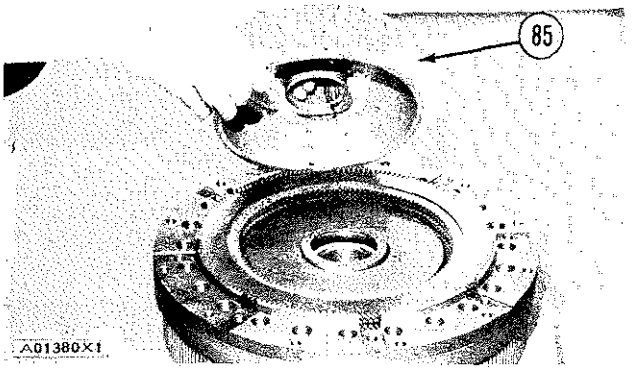
64. Put the piston assembly in position in the adapter.

65. Put hub (78) in position on the adapter.



66. Install ten plates (82) and ten discs (84) starting with a plate in the hub. Install a disc between each plate.

67. Install sleeve (83) in the deflector.



68. Install race (81), bearing (80), and race (79) on the plate.

69. Put hub (85) in position on the discs.

TRANSMISSION GEARS AND CLUTCHES

70. Put springs (87) in position in the plate.

71. Put plate (86) in position on the springs. Install the bolts that hold the plate.

72. Install four springs (89) and sleeves in the hub. Install eight pins (90) in the hub.

NOTE: Two pins must be installed between each spring and sleeve.

73. Put a strap around the front clutch. Fasten a hoist to the strap. Put front clutch (88) in position on the shaft. Make sure two splines (91) that have a weld between them are in correct alignment with the splines in the front clutch. Install the nut that holds the front clutch on the shaft.

NOTE: The shifting forks must be put in a position that prevents the front clutch from turning to tighten the nut.

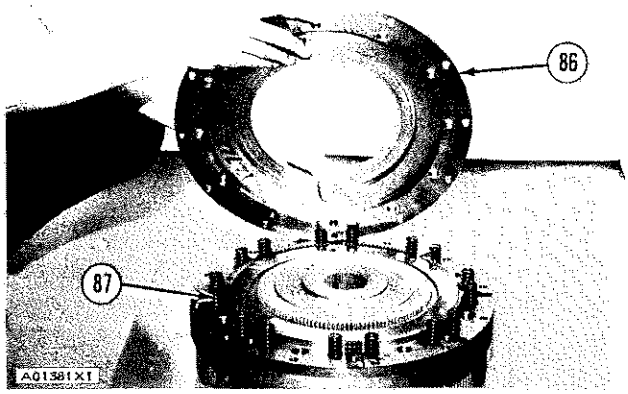
74. Put a small amount of 4L7464 Silicone Grease on the O-ring seals and the rings.

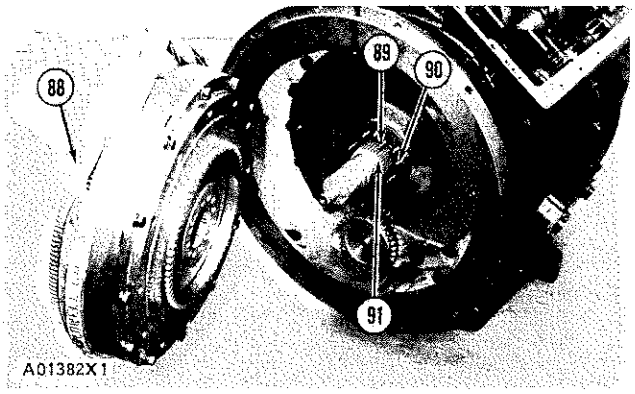
75. Install the O-ring seal and ring (93) in the piston and rear clutch case.

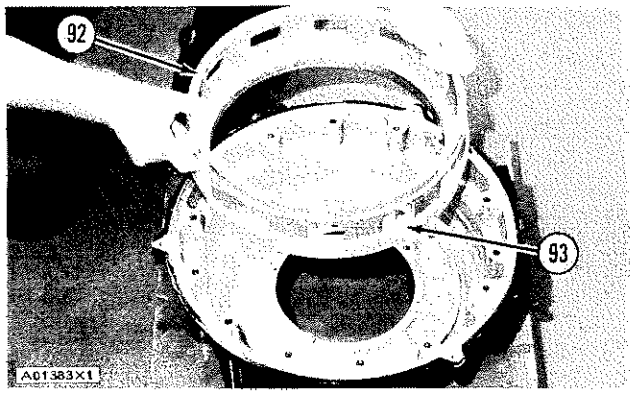
76. Install piston (92) in the case.

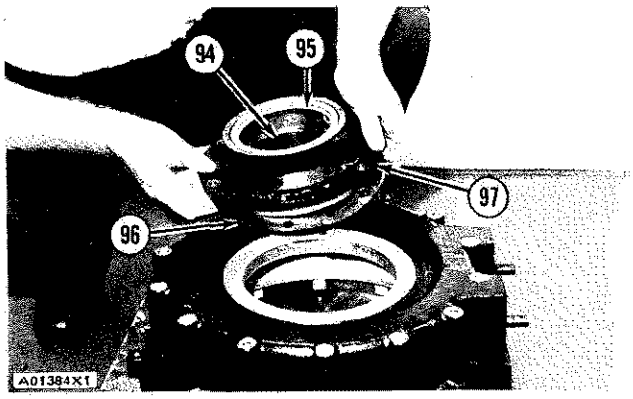
77. Lower the temperature of the bearing cup. Install bearing cup (94) in the retainer. Install seal (95) in the retainer with tooling (B). Install the lip of the seal toward the inside of the retainer. Install the O-ring seal on the retainer.

78. Install original amount of shims (96) and retainer (97) on the case. Install the bolts that hold the retainer.



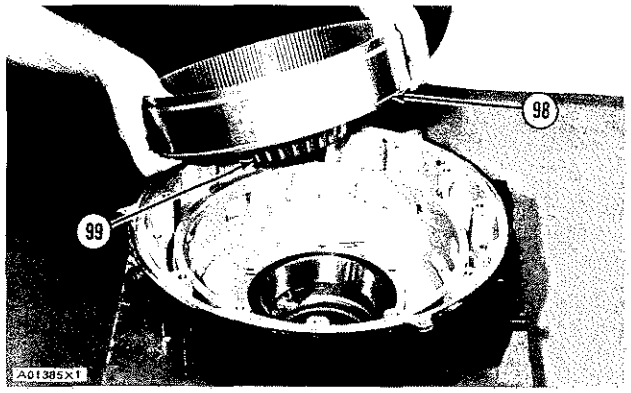






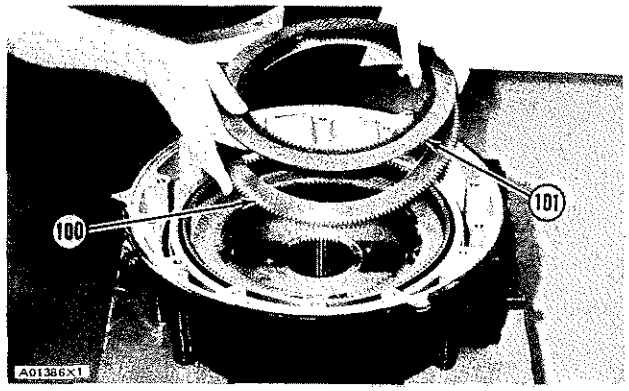
TRANSMISSION GEARS AND CLUTCHES

79. Heat the bearing cone in oil to a temperature of 275°F (135°C). Install bearing cone (99) on the hub.

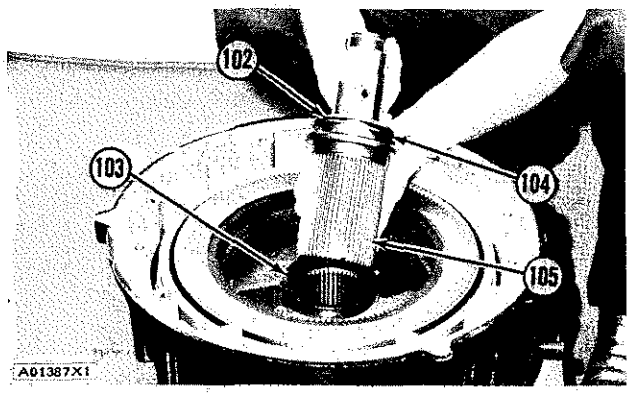


80. Put hub (98) in position in the case.

81. Install thirteen discs (101) and thirteen plates (100) in the hub starting with a disc. Install a plate between each disc.

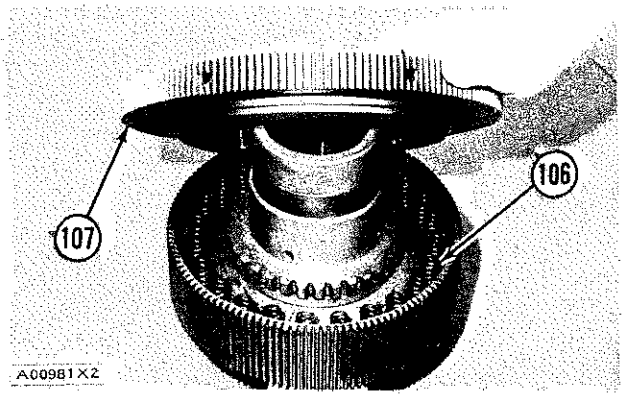


82. Put ring (103) in position on the hub.



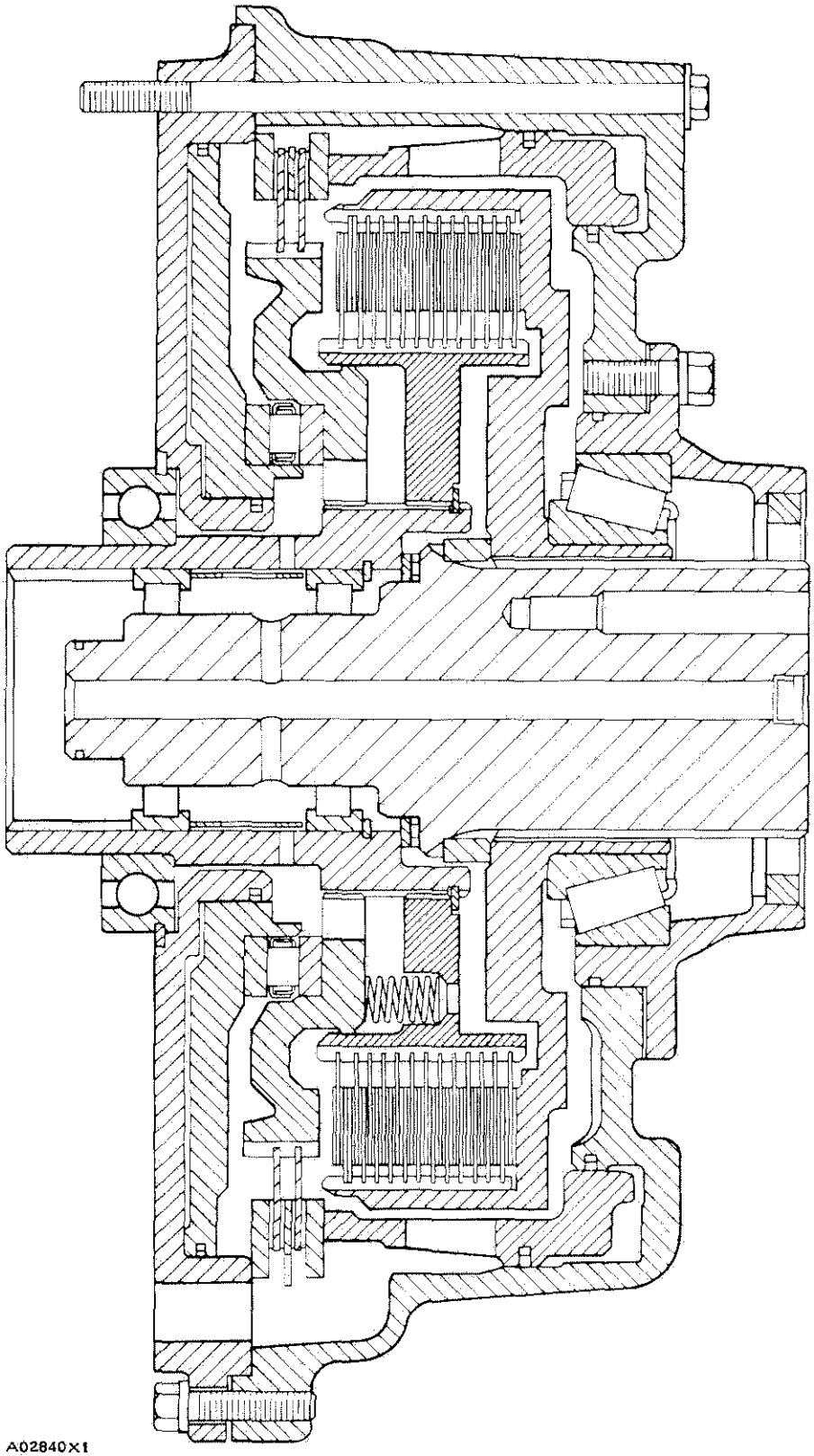
83. Install shaft (105) in the hub. Install bearing (104) and race (102) on the shaft.

84. Install springs (106) in the hub.



85. Put plate (107) in position on the hub.

REAR CLUTCH



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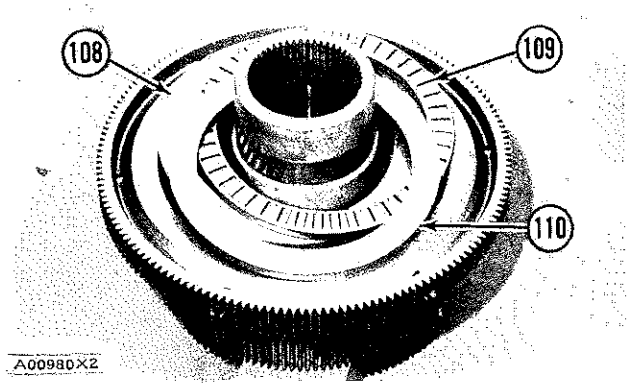
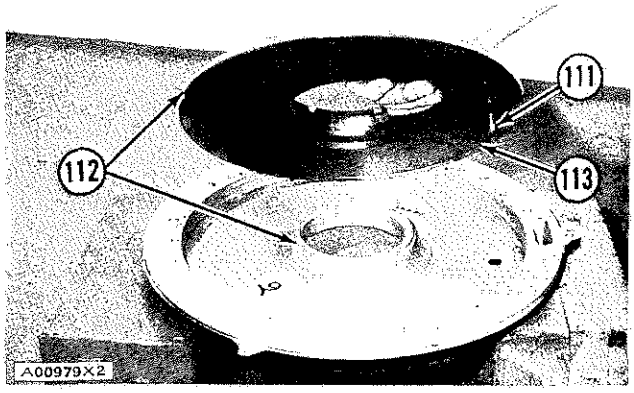
TRANSMISSION GEARS AND CLUTCHES

86. Install race (108), bearing (109), and race (110) on the hub.



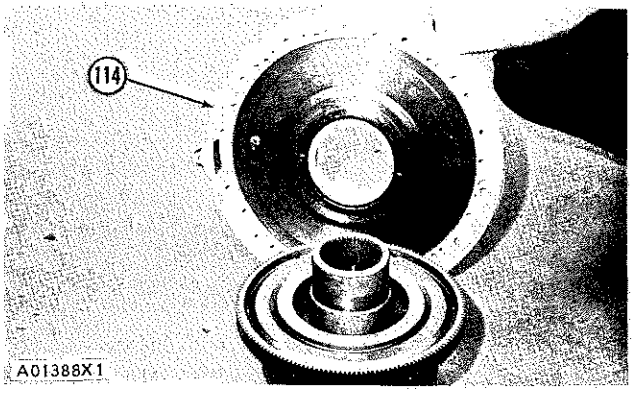
87. Put a small amount of 4L7464 Silicone Grease on the O-ring seals and the rings.

88. Install the O-ring seal and ring (112) in the piston and the cover.



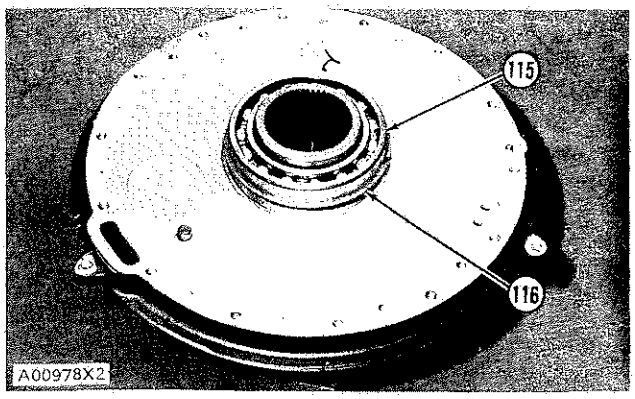
89. Install piston (113) in the cover. Make sure dowel (111) is in alignment with the hole in the cover.

90. Install cover (114) on the hub.



91. Install snap ring (116) on the bearing.

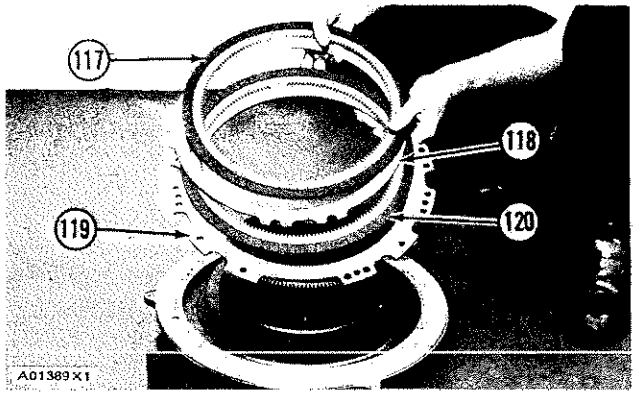
92. Heat bearing (115) in oil to a temperature of 150°F (66°C). Install the bearing on the hub.



93. Turn the hub and cover over.

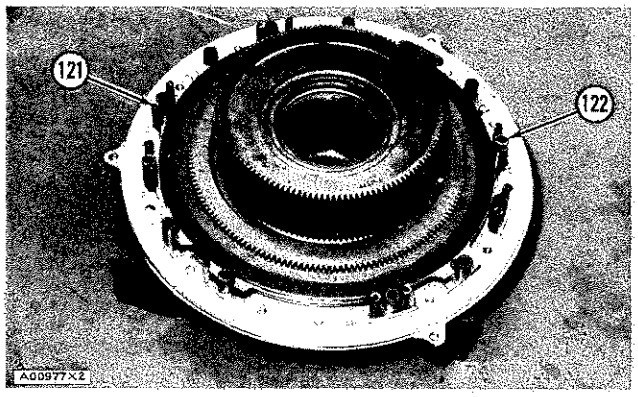
TRANSMISSION GEARS AND CLUTCHES

94. Put plate (119) in position on the cover.



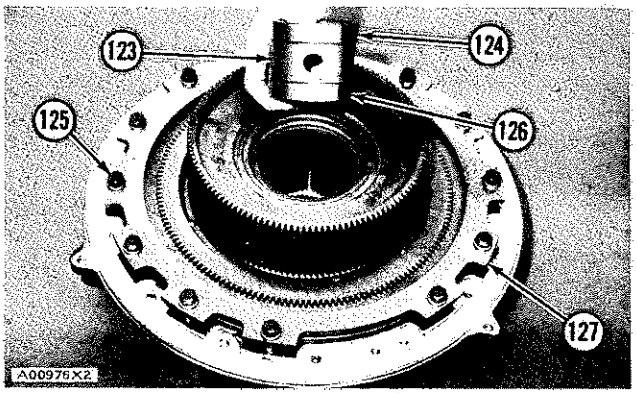
95. Put disc (120), plate (118) and disc (117) in position on the plate.

96. Put springs (121) in position in the plate.



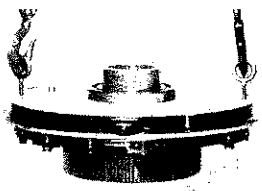
97. Put spacers (122) in position in the plate.

98. Put plate (127) in position on the springs and spacers. Install bolts (125) that hold it.

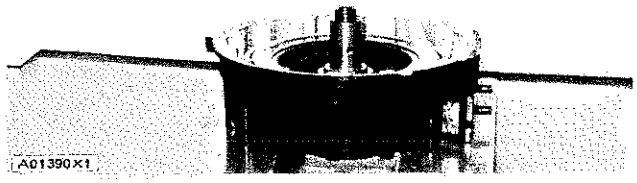


99. Put bearing (126), spacer (123) and bearing (124) in position in the hub. Install the snap ring that holds the bearings and spacer.

100. Put 7M7260 Liquid Gasket on the surfaces of the cover and the rear clutch case that come in contact with each other.



101. Install two 3/8"–16 NC forged eyebolts in the cover. Fasten a hoist to the eyebolts. Put the rear brake in position on the rear clutch. Make sure the discs are in alignment with the splines on the hub. Install the bolts that hold the rear brake to the rear clutch.



TRANSMISSION GEARS AND CLUTCHES

102. Install fitting (128) in the rear case.

103. Put 7M7260 Liquid Gasket on the surfaces of the rear clutch and the rear case that come in contact with each other.

104. Put tool (D) in position on the stud on the rear clutch. Install a nut to hold it. Fasten a hoist to tool (D).

105. Put rear clutch (129) in position on the rear case. Install the bolts that hold it.

106. Remove one bolt from the retainer. Install tooling (C) as shown.

107. Check the end clearance of shaft (105) by moving the shaft in and out with the installer group of tooling (C). End clearance must be .000 ± .002 in. (.000 ± .051 mm). Add or remove shims from under retainer (97) to get the correct end clearance. Remove tooling (C) and install the bolt in the retainer. Remove tool (D).

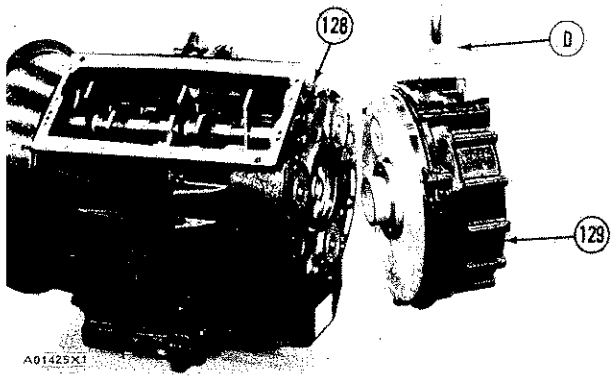
108. Put the shims in position in adapter (130). The shims are used to fill the gap between the adapter and the shaft.

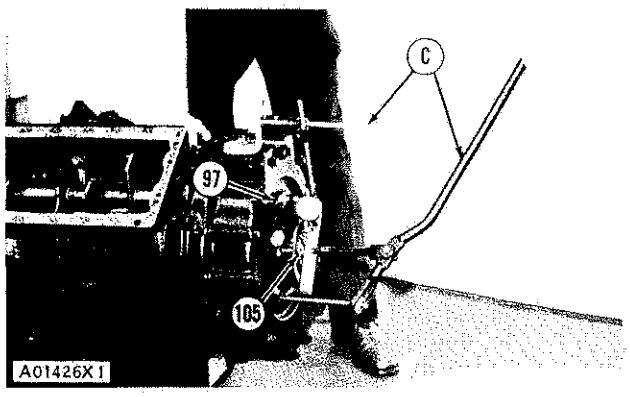
109. Put adapter (130) in position on the shaft. Install the bolts that hold it.

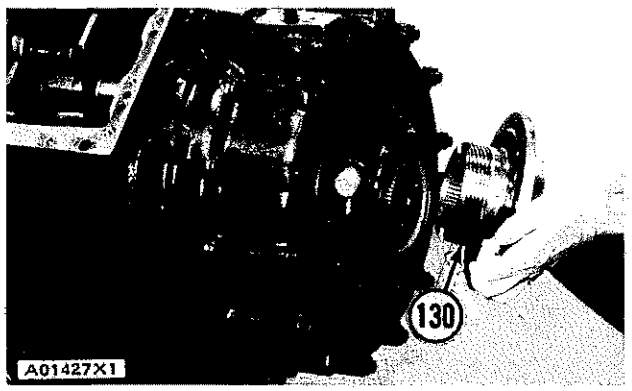
110. Put a small amount of 4L7464 Silicone Grease on the O-ring seals. Install the O-ring seal and the ring on pistons (132) and (134).

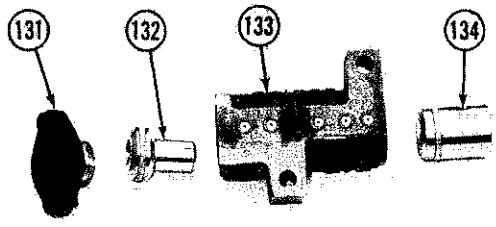
111. Put pistons (132) and (134) in position in housing (133). Install the O-ring seal on the cover. Put cover (131) in position on the housing. Install the bolts that hold it. Install the O-ring seals on the housing.

112. Do Steps 110 and 111 for the other two actuators.







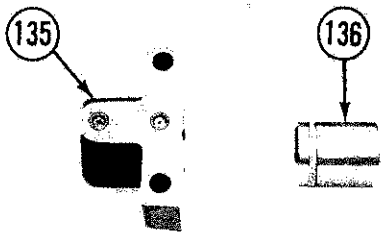


TRANSMISSION GEARS AND CLUTCHES

113. Put a small amount of 4L7464 Silicone Grease on the O-ring seal. Install the O-ring seal and the ring on piston (136).

114. Put piston (136) in position in housing (135). Install the O-ring seals on the housing.

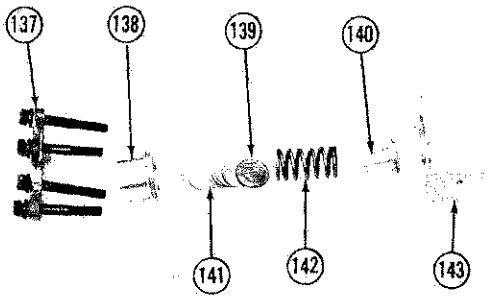
115. Do Steps 113 and 114 for the other six actuators.



A00971X2

116. Put a small amount of 4L7464 Silicone Grease on the O-ring seals. Install the O-ring seal and the ring on pistons (138) and (140).

117. Put shims (141) and pivot (139) in position in piston (138). Put spring (142) in position in piston (138).



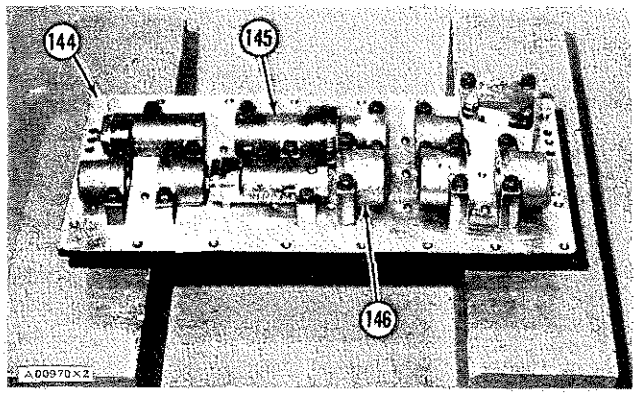
A00973X2

NOTE: Later valves have more pistons.

118. Put the parts from Step 117 in position in housing (143). Put plate (137) in position on the housing.

119. Put the pressure regulator in position on plate (144) of the transmission control. Install the bolts that hold the pressure regulator.

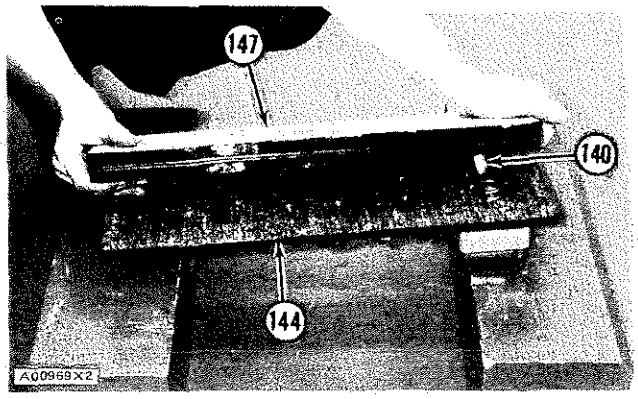
120. Put seven actuators (146) and three actuators (145) in their correct position on plate (144). Install the bolts that hold the actuators.



121. Turn plate (144) over and install the gasket on it.

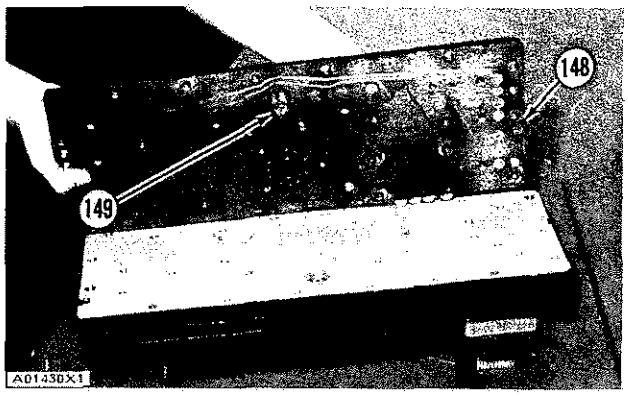
122. Put piston (140) in position in the manifold group.

123. Put manifold group (147) in position on the plate.



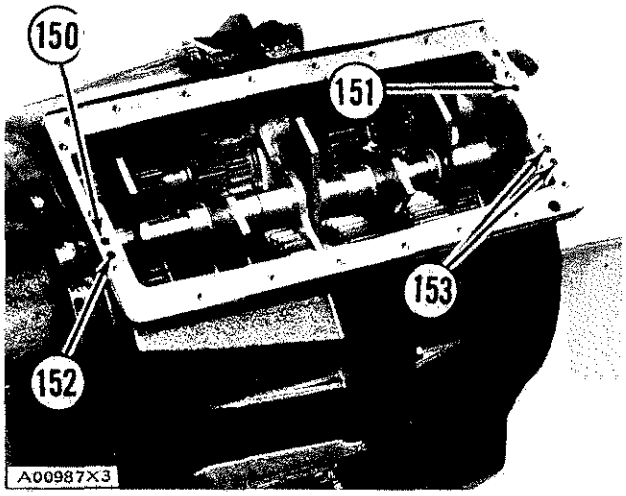
TRANSMISSION GEARS AND CLUTCHES

124. Install the gasket on plate (148). Install strainer (140) in the plate.



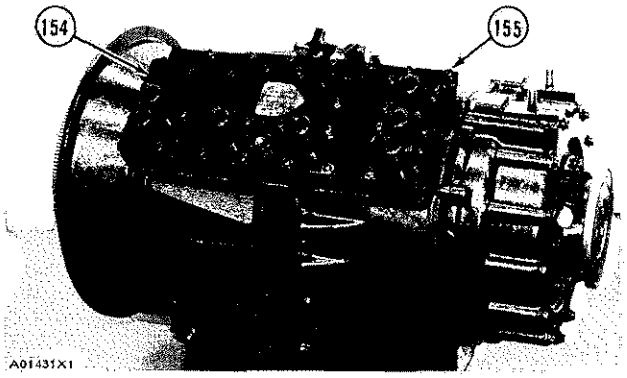
125. Put plate (148) in position on the manifold group. Install the bolts that hold the transmission control together.

126. Put shop air into the clutches and brakes through the housing to test for leaks. Use hole (150) to test front clutch, hole (152) for front brake, hole (151) for rear brake and holes (153) for rear clutch. One hole (153) must have a plug to test the rear clutch.



127. A large leak gives indication of a damaged seal. The specific clutch or brake that shows a leak will have to be repaired.

128. Put the gasket in position on the transmission.



129. Put transmission control (154) in position on the transmission. Install bolts (155) that hold it.

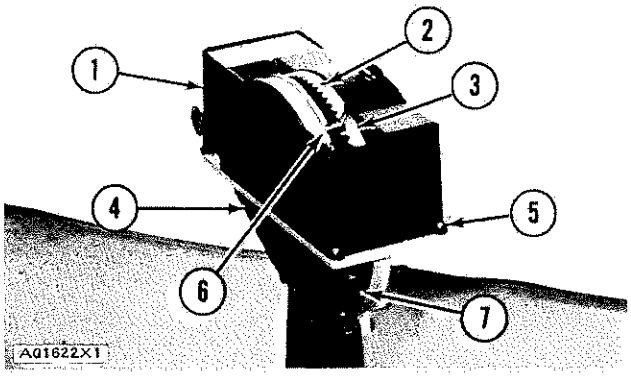
TRANSMISSION RATIO SELECTOR

DISASSEMBLE TRANSMISSION RATIO SELECTOR 15–3157

1. Remove screws (2). Remove gate (3).

2. Disconnect the white wire from the terminal strip. Remove indicator (6) from the lever.

3. Remove screws (5). Remove housing (1).

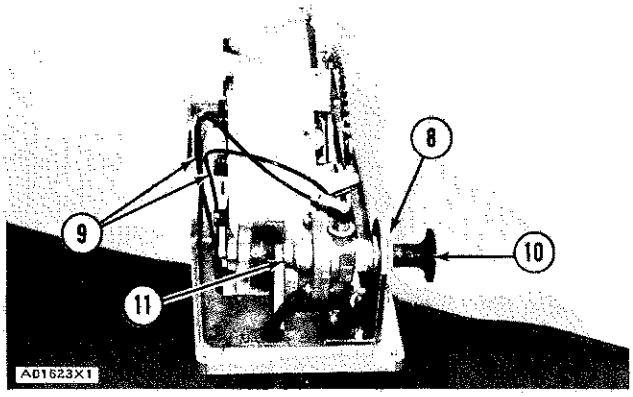


4. Remove screws (7). Remove shield (4).

5. Disconnect air lines (9) from the plate.

6. Remove the pin that holds the knob to the valve with a hammer and punch. Remove knob (10).

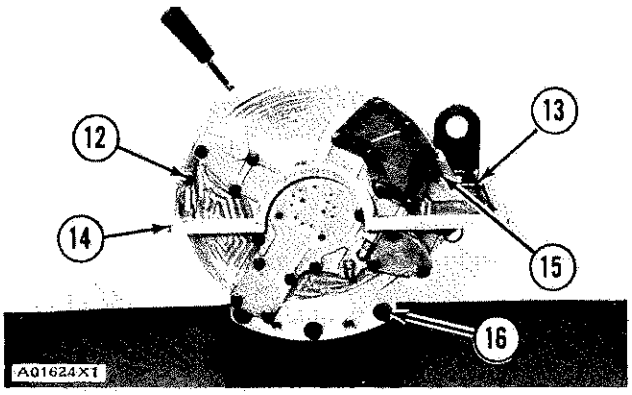
7. Remove nut (8). Remove valve (11).



8. Disconnect wires (13) from the terminal strip.

9. Remove bolts (16) and the nuts. Remove the selector from the pedestal.

10. Remove the nuts and bolts (12) and (15). Remove bracket (14) from the bottom of the selector.

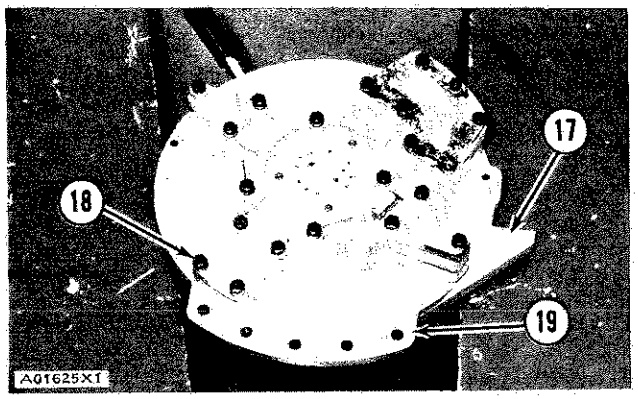


11. Remove seven bolts (18) around the outside of the plate.

12. Make a separation of plate (19) from cover (17).

CAUTION: There is a ball between the plate and cover that is free to fall when the separation is made.

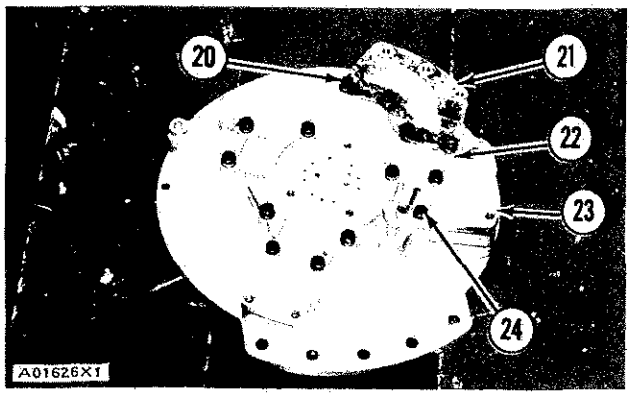
13. Remove the ball from the cover.



TRANSMISSION RATIO SELECTOR

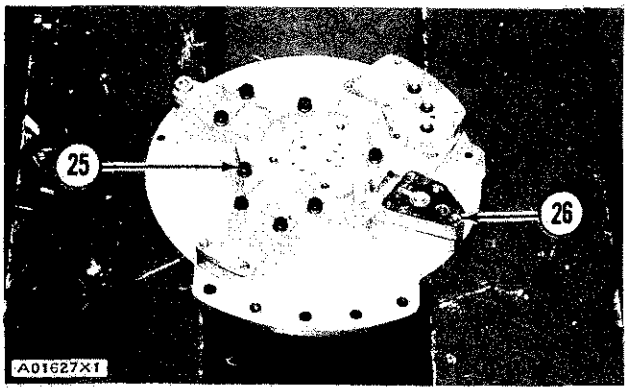
14. Remove bolts (24). Remove cover (23) from the plate. Remove the gasket and the two springs that are under the cover.

15. Remove bolts (20). Remove cover (21) and plate (22). Remove the gasket from the cover and the plate.



16. Remove bolts (25). Remove plate (26) from the housing.

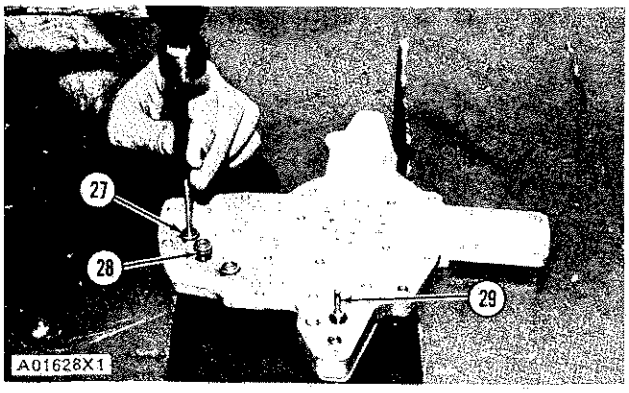
17. Remove the valves from pistons (27) with a hammer and punch. Remove the O-ring seals from the pistons.



NOTE: There is a spring (28) under the piston that is in the center.

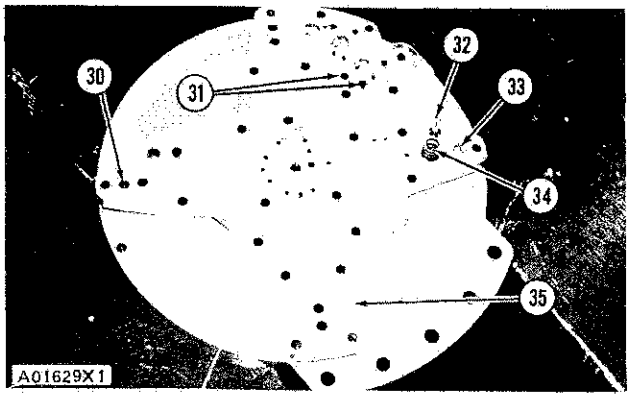
18. Remove plunger (29) from the plate. Remove the O-ring seal from the plunger.

19. Remove the gasket from the plate.



20. Remove plungers (32) and (33) from the housing. Remove the O-ring seals from the plungers. Remove spring (34) from the housing.

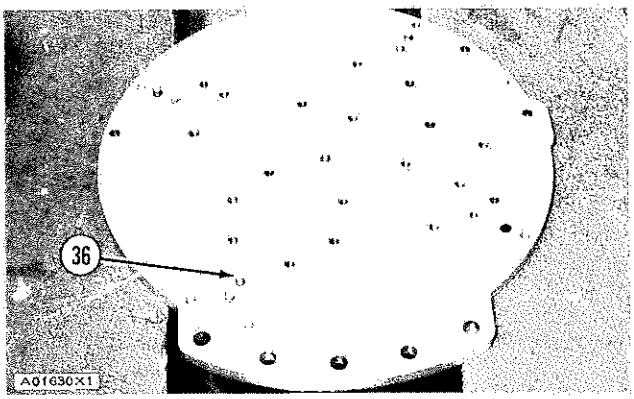
21. Remove valves (31) from the housing.



22. Remove housing (35) from the plate. Remove seven balls (30) from the housing.

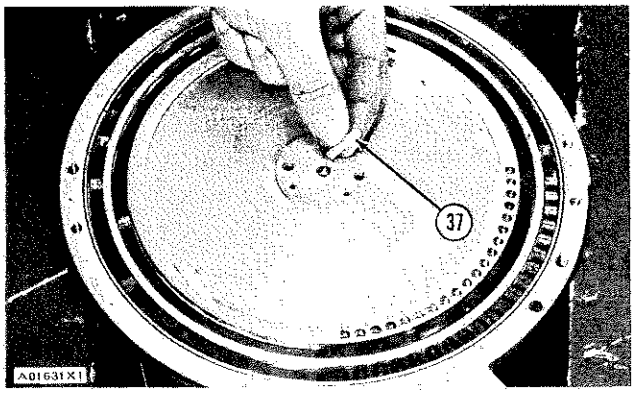
TRANSMISSION RATIO SELECTOR

23. Remove seven springs (36) and the seven stems from the plate.



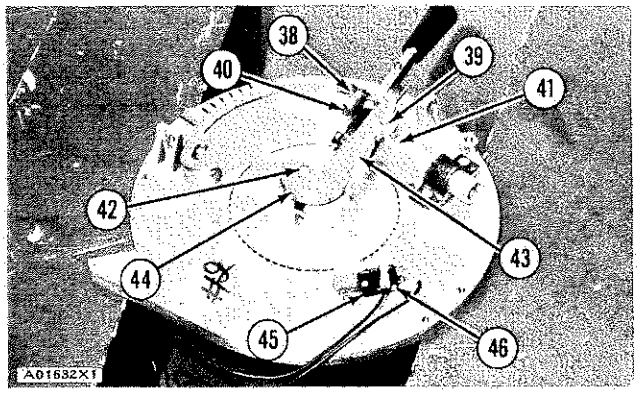
24. Remove the O-ring seal from the stems.

25. Remove plunger (37) from the cover.



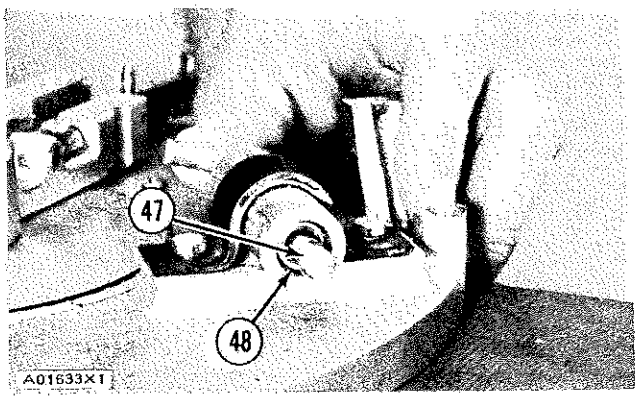
26. Turn the cover over.

27. Remove the nuts and screws (46). Remove switch (45).



28. Remove screws (38) and guide (40). Remove the snap ring and bushing (39) from rod (41). Move the rod free of the plate.

29. Remove screws (42) and retainer (44). Remove plate (43).

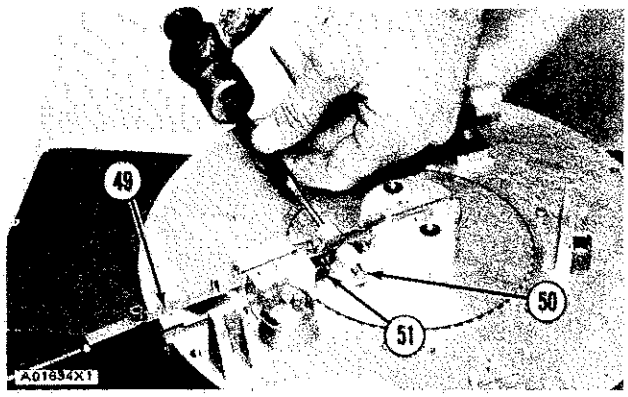


30. Remove snap ring (47) from the rod. Remove the rod from the housing.

31. Remove spiral snap ring (48) from the housing. Remove the washers and the spring from the housing.

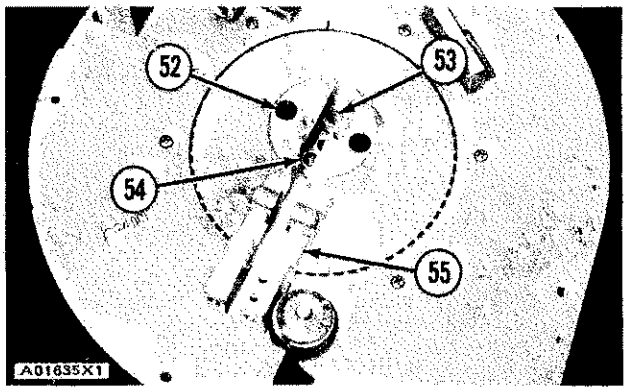
TRANSMISSION RATIO SELECTOR

32. Remove dowel (50) from the base with a hammer and punch.



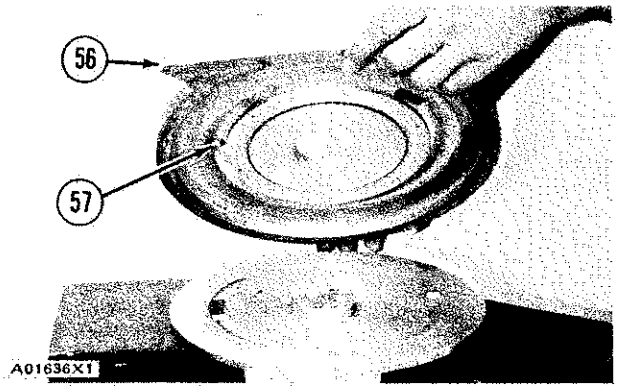
33. Remove lever (49). Remove pins (51) and the springs from the base.

34. Remove spring (54) from the base.



35. Remove bolts (52). Remove base (55) from the cover. Remove spring (53).

36. Lift cover (56) off of the plate.

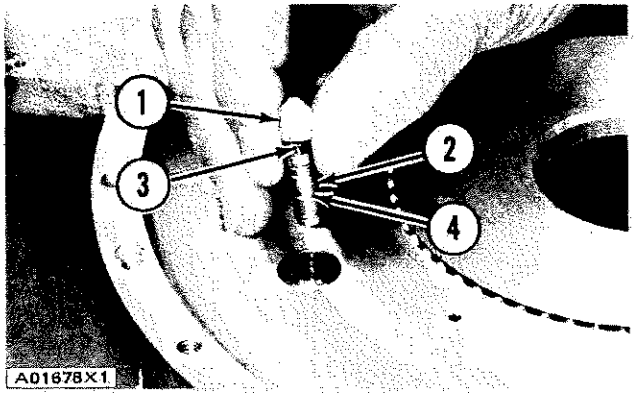


37. Remove follower (57), spring, plunger, and the spring from the cover.

TRANSMISSION RATIO SELECTOR

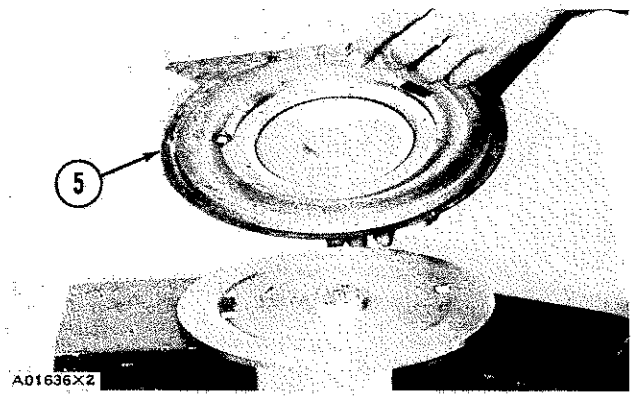
ASSEMBLE TRANSMISSION RATIO SELECTOR 16–3157

1. Put spring (4) in position on plunger (2). Put the plunger in position in the cover.



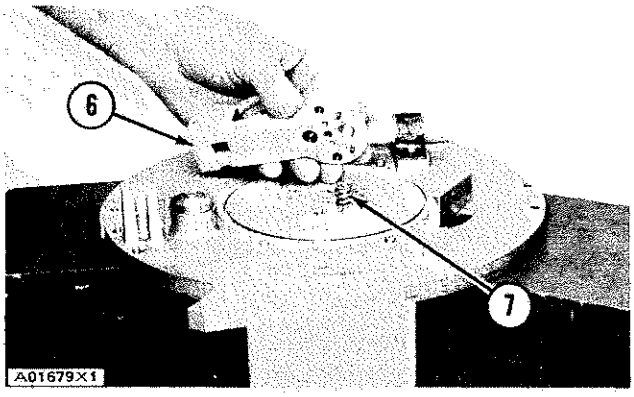
2. Install spring (3) and follower (1) in the cover.

3. Put cover (5) in position on the plate.



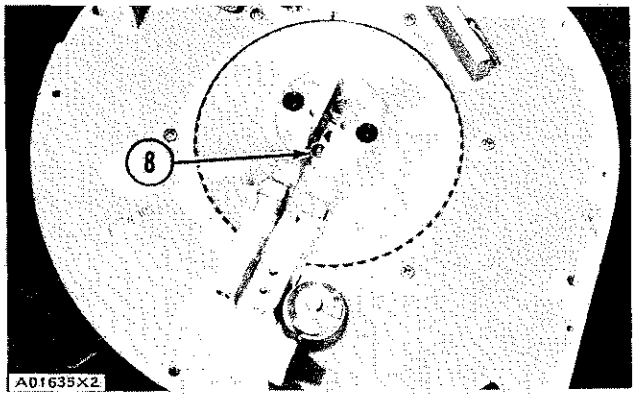
4. Put spring (7) in position in the plate.

5. Put base (6) in position on the plate. Make sure the dowels in base are in alignment with the holes in the plate. Install the bolts that hold the base.



6. Install spring (8) in the base.

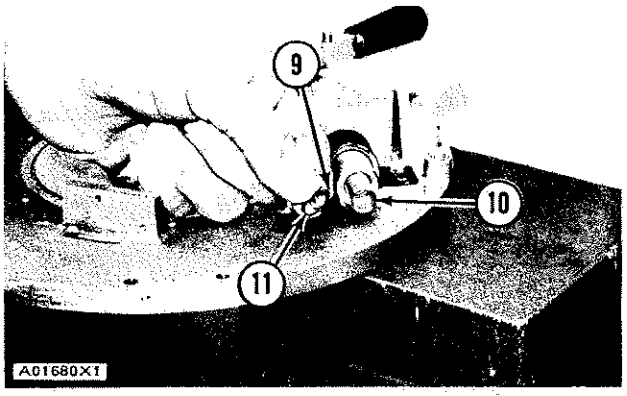
7. Put the two springs and two pins in position in the base.



8. Put the lever in position on the base. Install the dowel that holds it.

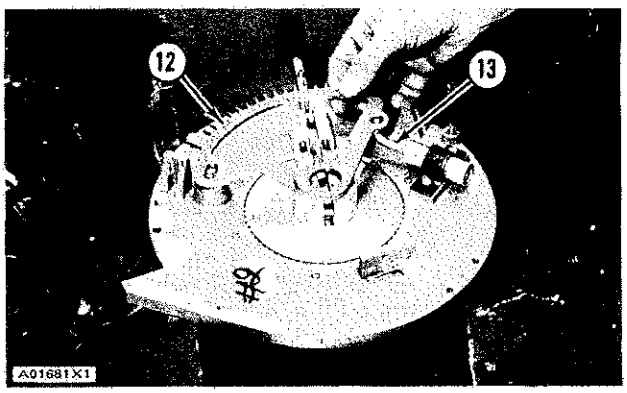
TRANSMISSION RATIO SELECTOR

9. Put the washer and spring (10) in position in the housing. Put washer (9) in position in the housing. Install spiral snap ring (11) that holds the washer and spring in the housing.



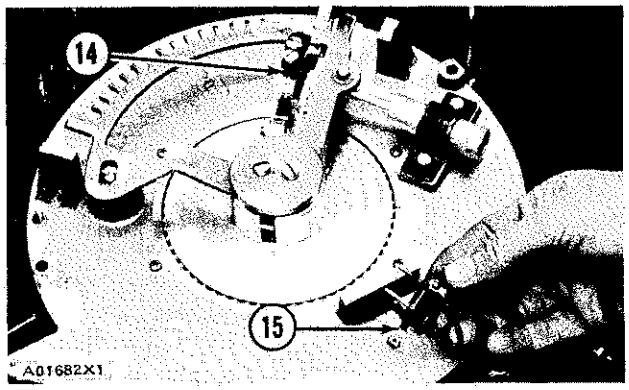
10. Put the rod in position in the housing. Install the snap ring on the rod.

11. Put plate (12) in position on the base and the rod.



12. Put the retainer in position on the plate. Install the screws that hold it.

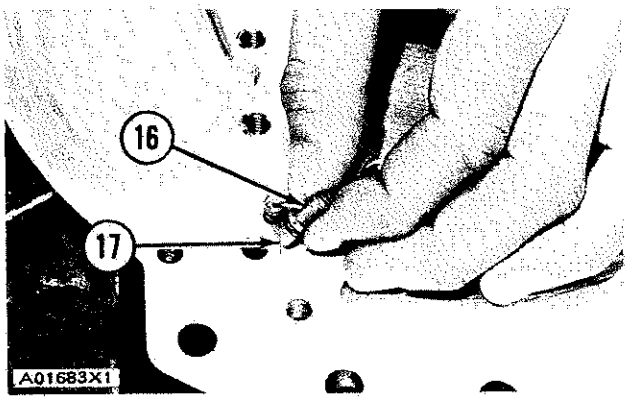
13. Install the bushing and the snap ring on rod (13).



14. Put guide (14) in position on the base. Install the screws that hold it.

15. Put switch (15) in position on the cover. Install the screws and nuts that hold it.

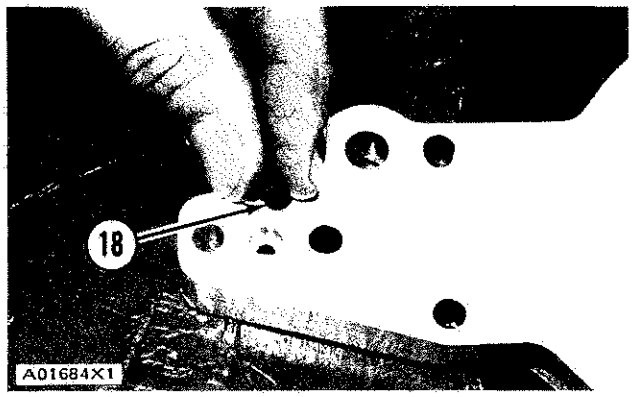
16. Install the O-ring seal on the stem.



17. Put seven stems (17) in their correct position in the plate. Put seven springs (16) in position on the stems.

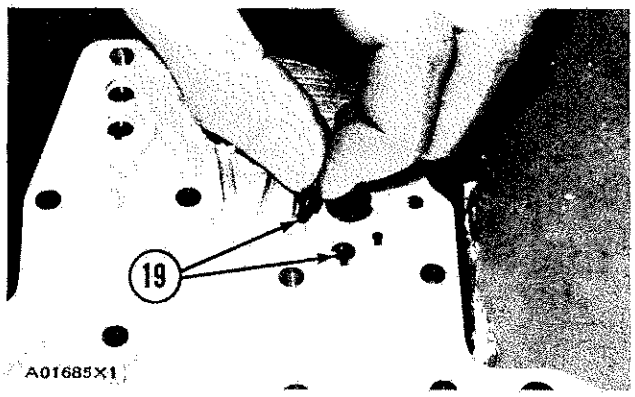
TRANSMISSION RATIO SELECTOR

18. Put seven balls (18) in their correct locations in the housing.



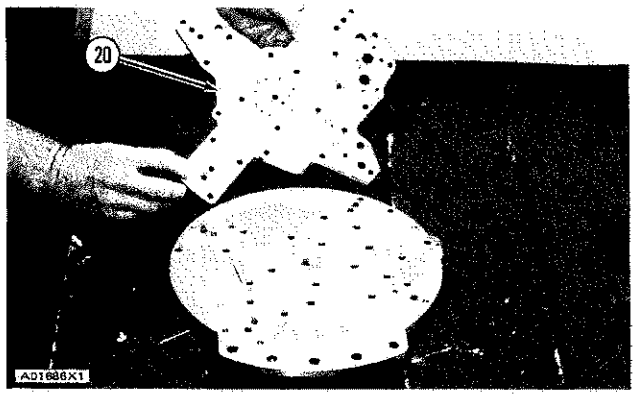
19. Put valves (19) in position in the housing.

20. Put housing (20) and a gasket in position on the plate. Make sure the springs in the plate are below the balls in the housing.



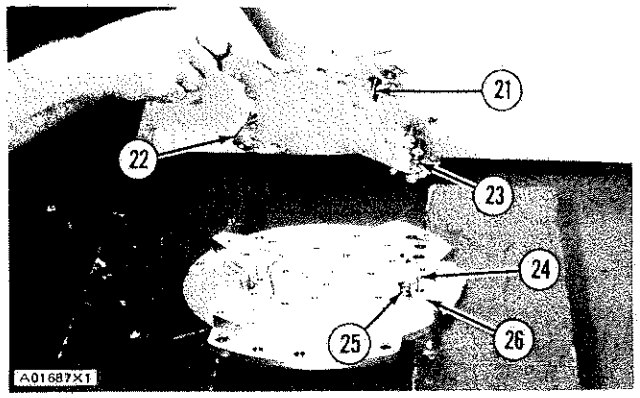
21. Install the O-ring seals on the plungers. Put plungers (24) and (26) in position in the housing. Put spring (25) in position in the housing.

22. Put the three valves in position in the plate. Install pistons (23) on the valves. Install the O-ring seals on the pistons.



NOTE: There is a spring under the piston that is in the center of the three valves.

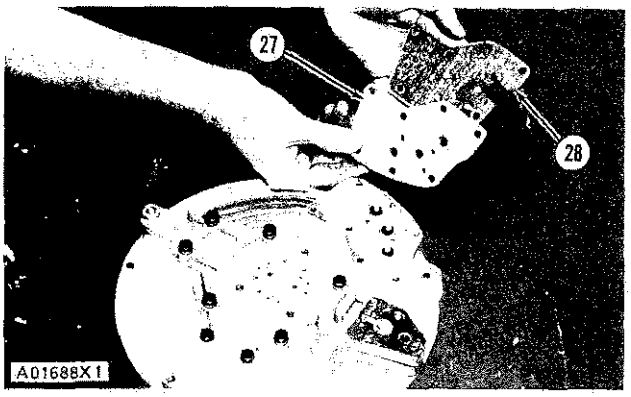
23. Install the O-ring seal on the plunger. Put plunger (21) into position in the plate.



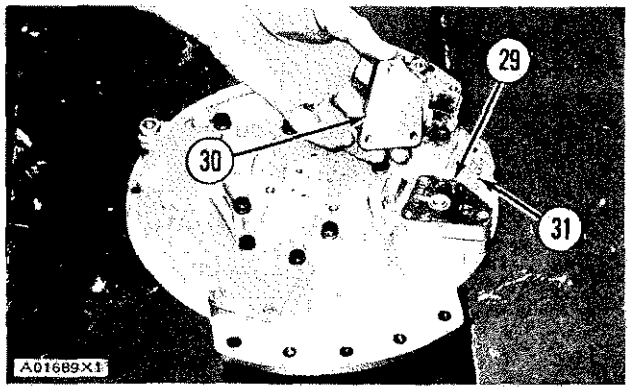
24. Put plate (22) and a gasket in position on the housing. Install the bolts that hold it.

TRANSMISSION RATIO SELECTOR

25. Put plate (27) and a gasket in position on the plate.

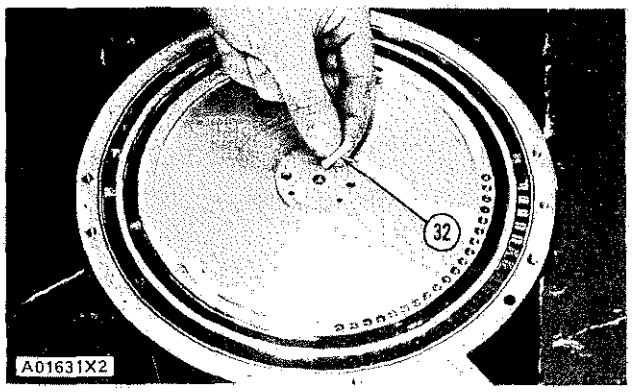


26. Put cover (28) and a gasket in position on plate (27). Install the bolts that hold the cover and plate.



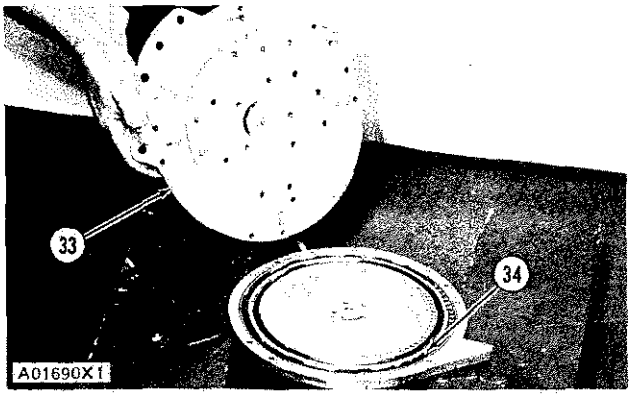
27. Put springs (29) and (31) into position in the plate.

28. Put cover (30) and a gasket in position on the plate. Install the bolts that hold the cover.



29. Put plunger (32) into position in the cover.

30. Put ball (34) in position on the cover.

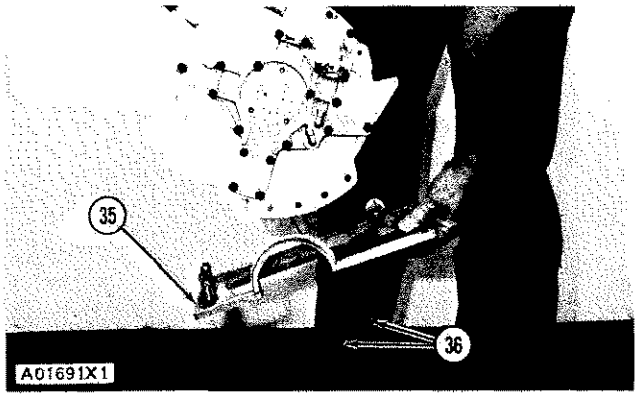


31. Put plate (33) in position on the cover. Install the bolts that hold the plate to the cover.

TRANSMISSION RATIO SELECTOR

32. Put bracket (35) in position on the selector. Install the bolts and nuts that hold it.

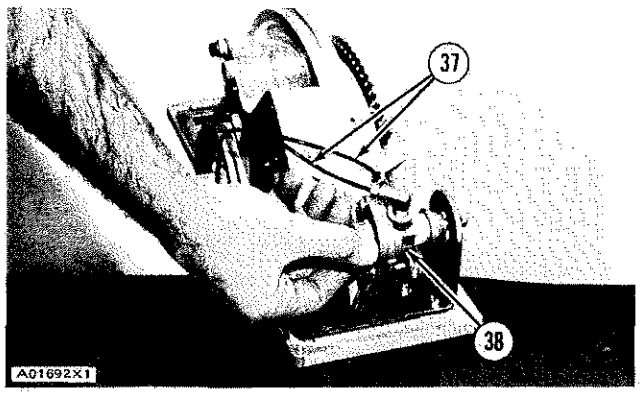
33. Put wires (36) through the hole in the bracket. Connect the wires to their correct location on the terminal strip.



34. Put the selector in position on the pedestal. Install the bolts and nuts that hold it.

35. Put valve (38) in position on the bracket. Install the nut that holds it.

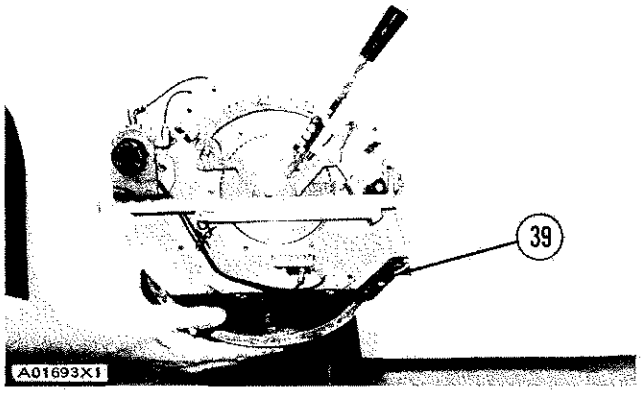
36. Put the knob in position on the valve. Install the pin that holds it.



37. Connect air lines (37) to their correct location on the plate.

38. Put shield (39) in position on the selector. Install the screws that hold it.

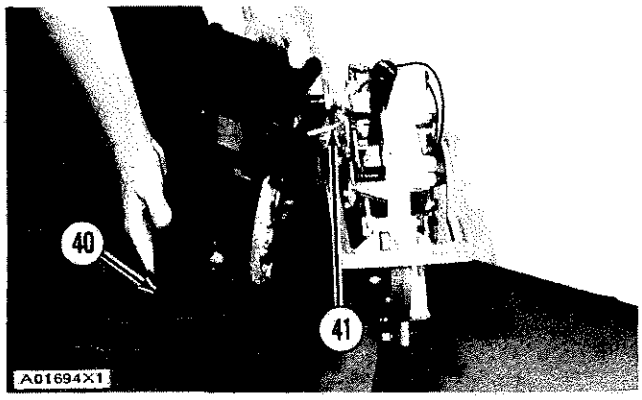
39. Put wire (41) through the hole in the bracket. Connect the wire to its correct location on the terminal strip.



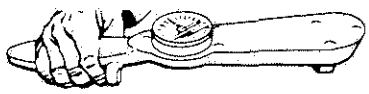
40. Put housing (40) in position on the bracket. Install the screws that hold it.

41. Put the gate in position on the top of the housing. Install the screws that hold it.

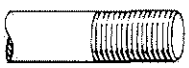
42. Install the indicator in the lever.



GENERAL TIGHTENING TORQUE FOR BOLTS, NUTS AND TAPERLOCK STUDS

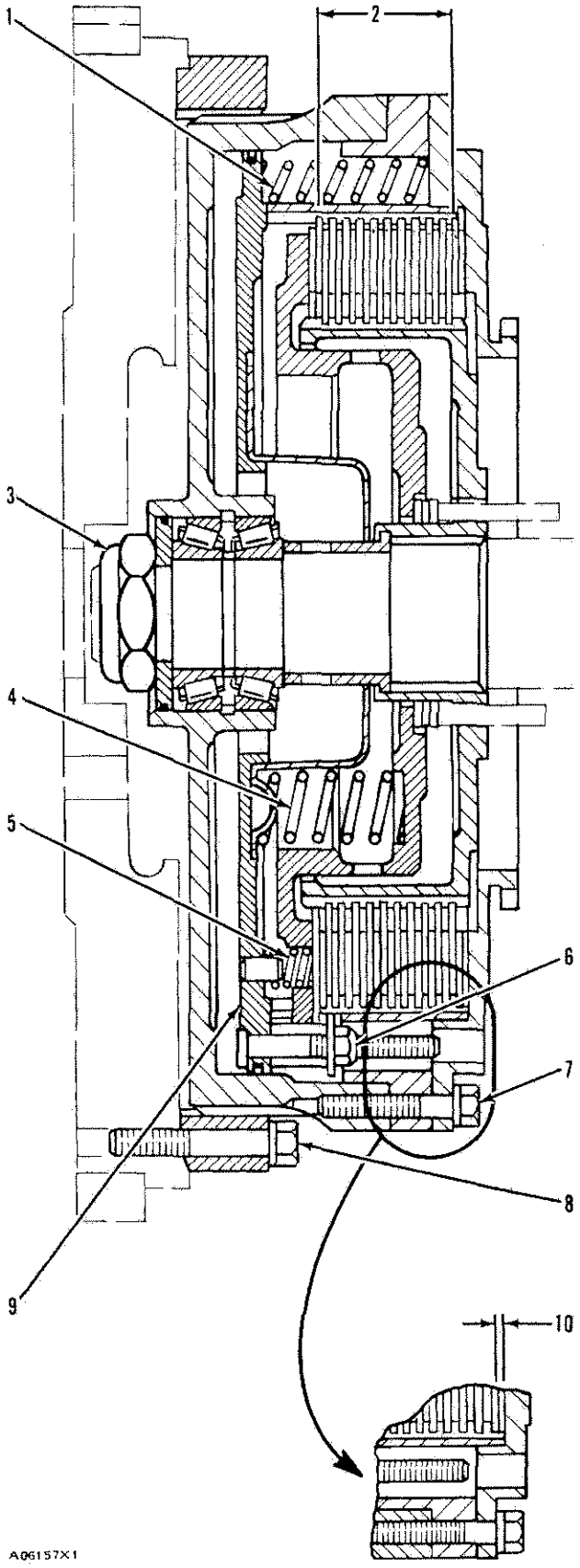


The following charts give the standard torque values for bolts, nuts and taperlock studs of SAE Grade 5 or better quality. Exceptions are given in the Specifications.

THREAD DIAMETER		STANDARD TORQUE	
inches	**millimeters**	**lb. ft.**	**mkg**
Standard thread 		Use these torques for bolts and nuts with standard threads.	
1/4	6.35	9 ± 3	1.24 ± 0.4
5/16	7.94	18 ± 5	2.5 ± 0.7
3/8	9.53	32 ± 5	4.4 ± 0.7
7/16	11.11	50 ± 10	6.9 ± 1.4
1/2	12.70	75 ± 10	10.4 ± 1.4
9/16	14.29	110 ± 15	15.2 ± 2.0
5/8	15.88	150 ± 20	20.7 ± 2.8
3/4	19.05	265 ± 35	36.6 ± 4.8
7/8	22.23	420 ± 60	58.1 ± 8.3
1	25.40	640 ± 80	88.5 ± 11.1
1 1/8	28.58	800 ± 100	110.6 ± 13.8
1 1/4	31.75	1000 ± 120	138 ± 16.6
1 3/8	34.93	1200 ± 150	166 ± 20.7
1 1/2	38.10	1500 ± 200	207 ± 27.7
		Use these torques for bolts and nuts on hydraulic valve bodies.	
5/16	7.94	13 ± 2	1.8 ± 0.3
3/8	9.53	24 ± 2	3.3 ± 0.3
7/16	11.11	39 ± 2	5.4 ± 0.3
1/2	12.70	60 ± 3	8.3 ± 0.4
5/8	15.88	118 ± 4	16.3 ± 0.5
Taperlock stud 		Use these torques for studs with Taperlock threads.	
1/4	6.35	5 ± 2	0.69 ± 0.3
5/16	7.94	10 ± 3	1.4 ± 0.4
3/8	9.53	20 ± 3	2.8 ± 0.4
7/16	11.11	30 ± 5	4.1 ± 0.7
1/2	12.70	40 ± 5	5.5 ± 0.7
9/16	14.29	60 ± 10	8.3 ± 1.4
5/8	15.88	75 ± 10	10.4 ± 1.4
3/4	19.05	110 ± 15	15.2 ± 2.0
7/8	22.23	170 ± 20	23.5 ± 2.8
1	25.40	260 ± 30	35.9 ± 4.1
1 1/8	28.58	320 ± 30	44.2 ± 4.1
1 1/4	31.75	400 ± 40	55 ± 5.5
1 3/8	34.93	480 ± 40	66 ± 5.5
1 1/2	38.10	550 ± 50	76 ± 7

T95416-5

FRONT CLUTCH GROUP
(9N1806)



(1) 9N1659 Spring (16 used with empty space every 90°):
- Length under test force ..... 3.00 in. (76.2 mm)
- Test force ..... 61.95 lb. (28.110 kg)
- Free length after test ..... 4.028 in. (102.31 mm)
- Outside diameter ..... .713 in. (18.11 mm)

(2) Thickness of ten new discs and ten new plates ..... 2.250 ± .070 in. (57.15 ± 1.78 mm)
- Thickness of one new 9N1655 Disc ..... .120 ± .004 in. (3.05 ± 0.10 mm)
- Thickness of one new 9N1656 Plate ..... .105 ± .003 in. (2.67 ± 0.08 mm)

(3) Torque for nut ..... 275 ± 25 lb.ft. (38.0 ± 3.5 mkg)

(4) 9N1644 Spring (16 used):
- Length under test force ..... 2.34 in. (59.4 mm)
- Test force ..... 87.8 ± 4.4 lb. (39.82 ± 2.0 kg)
- Free length after test ..... 4.25 in. (107.95 mm)
- Outside diameter ..... 1.095 in. (27.81 mm)

(5) 9N1646 Spring (4 used):
- Length under test force ..... .72 in. (18.3 mm)
- Test force ..... 1.064 lb. (0.4826 kg)
- Free length after test ..... 1.42 in. (36.1 mm)
- Outside diameter ..... .480 in. (12.19 mm)

(6) Torque for four nuts ..... 36 ± 2 lb.ft. (5.0 ± 0.3 mkg)

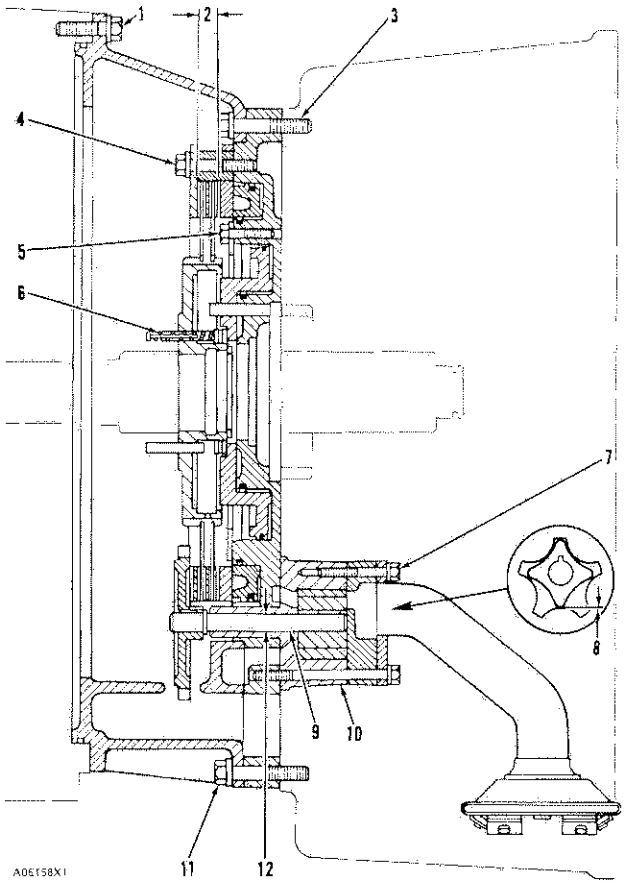
(7) Torque for 12 bolts ..... 36 ± 2 lb.ft. (5.0 ± 0.3 mkg)

(8) Torque for 12 bolts ..... 55 ± 5 lb.ft. (7.6 ± 0.7 mkg)

(10) With piston (9) forward, use 9N1654 Plates (11) as necessary to get a clearance of ..... .130 ± .030 in. (3.30 ± 0.76 mm)

NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

BRAKE GROUP
(9N1807)



(1) Torque for 12 bolts ..... 55 ± 5 lb.ft. (7.6 ± 0.7 mkg)

(2) Thickness of two new discs and one new plate ..... .488 ± .013 in. (12.40 ± 0.33 mm)

Thickness of one new 9N1683 Disc ..... .184 ± .005 in. (4.67 ± 0.13 mm)

Thickness of one new 9N1629 Plate ..... .120 ± .003 in. (3.05 ± 0.08 mm)

(3) Torque for 18 bolts ..... 55 ± 5 lb.ft. (7.6 ± 0.7 mkg)

(4) Torque for six bolts ..... 36 ± 2 lb.ft. (5.0 ± 0.3 mkg)

(5) Torque for eight bolts ..... 22 ± 2 lb.ft. (3.0 ± 0.3 mkg)

(6) 9N1622 Spring (4 used):

Length under test force ..... 1.95 in. (49.53 mm)

Test force ..... 6.15 lb. (2.790 kg)

Free length after test ..... 2.250 in. (57.15 mm)

Outside diameter ..... .240 in. (6.10 mm)

(7) Torque for four bolts ..... 22 ± 2 lb.ft. (3.0 ± 0.3 mkg)

(8) Clearance in new gerotor assembly when installed on shaft (9) and in housing (10) ..... .002 to .006 in. (0.05 to 0.15 mm)

(11) Torque for four bolts ..... 55 ± 5 lb.ft. (7.6 ± 0.7 mkg)

(12) Diameter of shaft (new) ..... .5608 ± .0003 in. (14.244 ± 0.008 mm)

Bore in bearing (new) ..... .5630 ± .0005 in. (14.300 ± 0.013 mm)

(13) 9N1610 Spring (8 used):

Length under test force ..... .90 in. (22.9 mm)

Test force ..... 42.00 lb. (19.051 kg)

Free length after test ..... 1.425 in. (36.20 mm)

Outside diameter ..... .823 in. (20.90 mm)

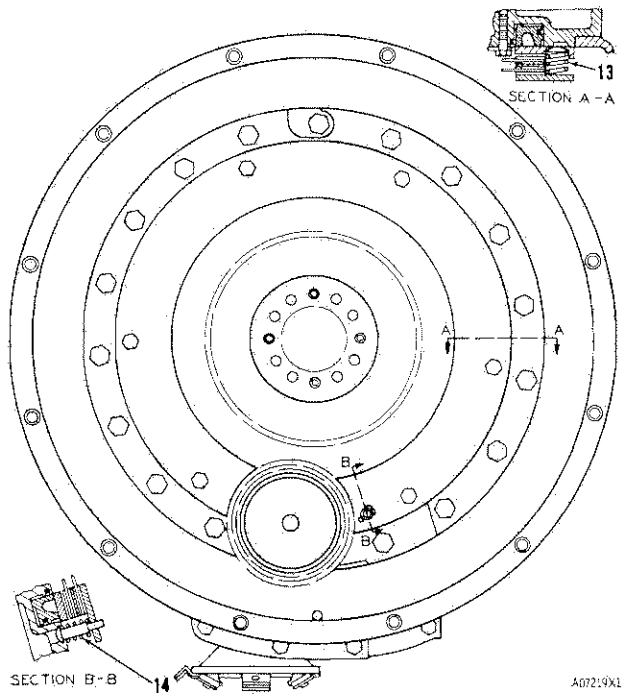
(14) 9N1626 Spring:

Length under test force ..... 1.08 in. (27.43 mm)

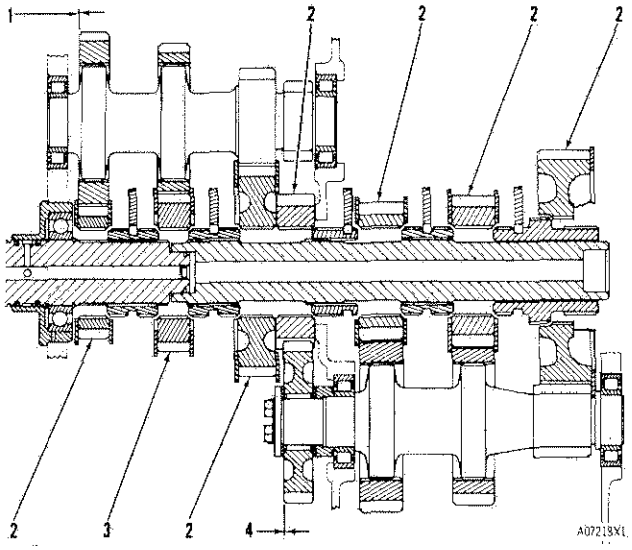
Test force ..... 8.25 lb. (3.742 kg)

Free length after test ..... 1.565 in. (39.75 mm)

Outside diameter ..... .562 in. (14.27 mm)



TRANSMISSION GEAR GROUP
(9N1809 and 9N1810)



(1) End play for six countershafts ... .006 in. (0.15 mm) minimum

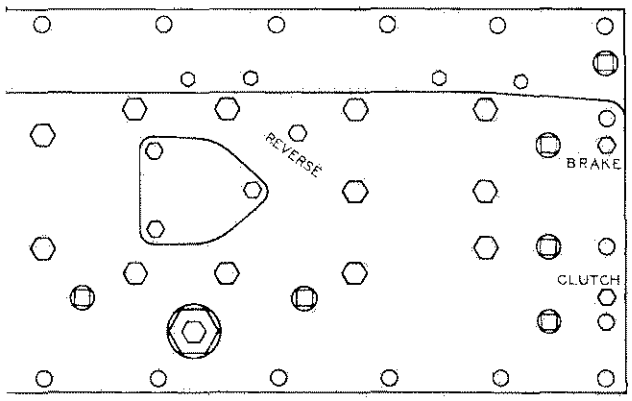
(2) Backlash (free movement) for gear set ..... .004 in. (0.10 mm) minimum

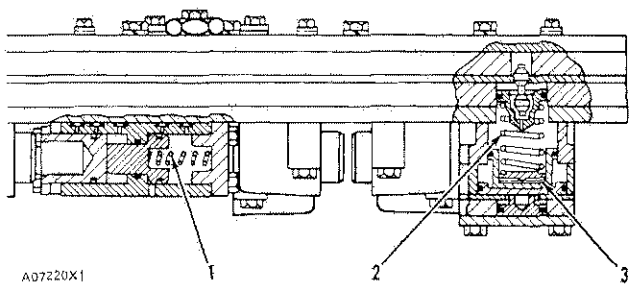
(3) Backlash (free movement) for gear set ..... .008 in. (0.20 mm) minimum

(4) End play for three gears ..... .010 in. (0.25 mm) minimum

NOTE: The above dimensions are necessary for correct operation. These dimensions have no adjustment.

TRANSMISSION CONTROL GROUP
(9N1811)





(1) 9N1457 Spring (3 used):

Length under test force ..... 1.61 in. (40.9 mm)

Test force ..... 11.87 lb. (5.384 kg)

Free length after test ..... 2.50 in. (63.5 mm)

Outside diameter ..... .480 ± .008 in. (12.19 ± 0.20 mm)

(2) 9N1577 Spring:

Length under test force ..... 1.826 in. (46.38 mm)

Test force ..... 38.91 lb. (17.650 kg)

Free length after test ..... 2.128 in. (54.05 mm)

Outside diameter ..... 1.183 in. (30.05 mm)

(3) Thickness of one 9N1574 Shim ..... .010 in. (0.25 mm)

One 9N1574 Shim will change the pressure to the rear clutch (with the transmission in 16th SPEED) by ..... 1 psi (0.07 kg/cm^2)

Thickness of one 9N1575 Shim ..... .030 in. (0.76 mm)

One 9N1575 Shim will change the pressure to the rear clutch (with the transmission in 16th SPEED) by ..... 3 psi (0.21 kg/cm^2)

NOTE: FOR TORQUE VALUES NOT GIVEN, SEE THE FIRST PAGE OF SPECIFICATIONS FOR GENERAL TIGHTENING TORQUES

REAR CLUTCH GROUP
(9N1813)

(1) Thickness of two new discs and one new plate ..... 458 ± .013 in. (11.63 ± 0.33 mm)

Thickness of one new 9N1684 Disc ..... .184 ± .005 in. (4.67 ± 0.13 mm)

Thickness of one new 9N1536 Plate ..... .090 ± .003 in. (2.29 ± 0.08 mm)

(2) Torque for 14 bolts ..... 36 ± 2 lb.ft. (5.0 ± 0.3 mkg)

(3) Torque for six bolts ..... 55 ± 5 lb.ft. (7.6 ± 0.7 mkg)

(4) Torque for bolt after the installation of the yoke ..... 300 ± 30 lb.ft. (41.5 ± 4.1 mkg)

(5) 9N1647 Spring and 9N1653 Spring (install one 9N1647 Spring, then one 9N1653 Spring, then one 9N1647 Spring, until 12 of each spring are installed).

9N1647 Spring (12 used):

Length under test force ..... .800 in. (20.32 mm)

Test force ..... 18.0 lb. (8.16 kg)

Free length after test ..... .860 in. (21.84 mm)

Outside diameter ..... .600 in. (15.24 mm)

9N1653 Spring (12 used):

Length under test force ..... .98 in. (24.9 mm)

Test force ..... 25.0 lb. (11.34 kg)

Free length after test ..... 1.208 in. (30.68 mm)

Outside diameter ..... .600 in. (15.24 mm)

(6) End play for the shaft ..... .000 ± .002 in. (.000 ± 0.05 mm)

Use the following procedure to get end play:

1. Assemble the rear clutch group minus the spring (5).
2. Install the rear clutch group on the transmission case.
3. Remove all shims (8) from retainer (7).
4. Install the retainer (7) and tighten bolts (3) to a torque of ..... 15 lb.in. (17 cm.kg)
5. Turn the shaft to be sure that the bearings are against their seats.
6. Again tighten the bolts (3) to a torque of ..... 15 lb.in. (17 cm.kg)
7. Measure distance between the retainer (7) and the cover (9). Make a record of this distance.
8. Install shims (8) of the thickness found in Step 7.
9. Remove rear clutch group from the transmission case and install the springs (5).

(10) Torque for three bolts ..... 18 ± 2 lb.ft. (2.5 ± 0.3 mkg)

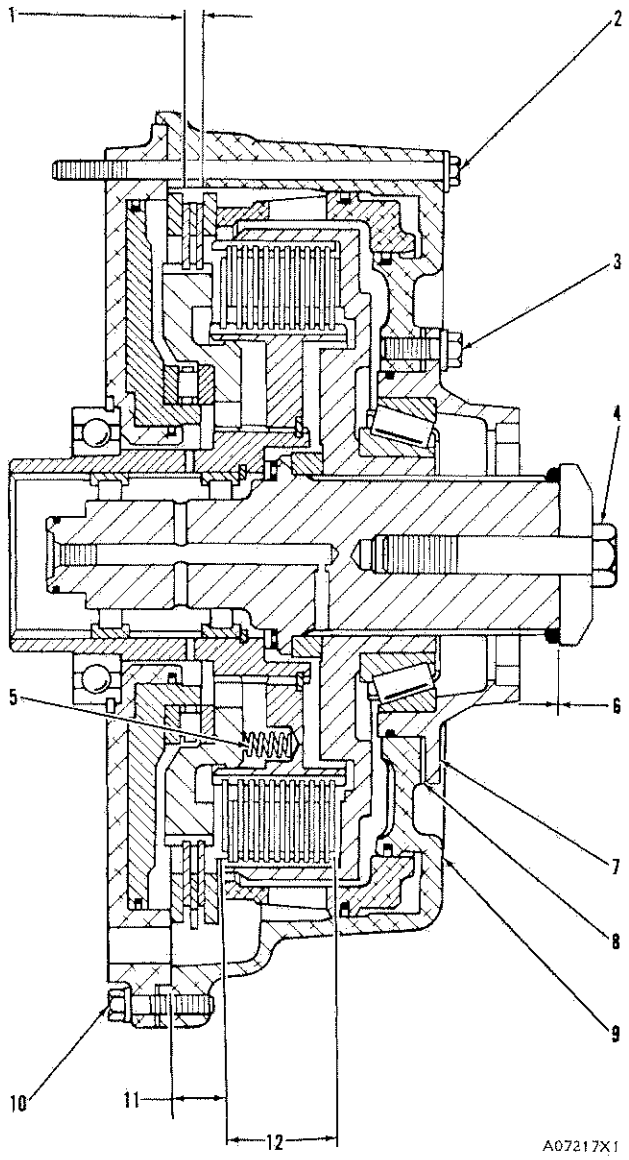
(11) Distance from face of cover (9) to front clutch disc ..... 1.00 to 1.06 in. (25.4 to 26.9 mm)

Use 9N1654 Plates as necessary between front clutch disc (9N1538) and plate (9N1654) to give this distance.

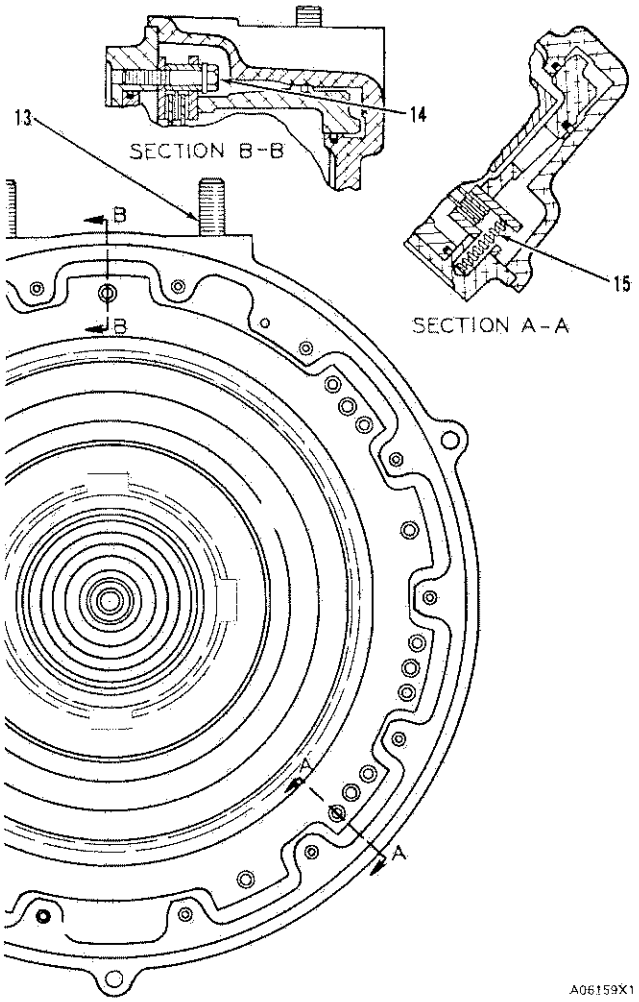
(12) Clutch pack uses 13–9N1538 Discs and 12–9N1654 Plates plus the number of 9N1654 Plates necessary to give dimension (11).

Thickness of one new 9N1538 Disc ..... .120 ± .004 in. (3.05 ± 0.10 mm)

Thickness of one new 9N1654 Plate ..... .060 ± .003 in. (1.52 ± 0.08 mm)



Rear Clutch Group (Cont.)



(13) Torque for two studs ..... 75 ± 10 lb.ft. (10.4 ± 1.4 mkg)

(14) Torque for 12 bolts ..... 36 ± 2 lb.ft. (5.0 ± 0.3 mkg)

(15) 4B184 Spring (12 used):

Length under test force ..... 1.75 in. (44.5 mm)

Test force ..... 13.6 to 15.1 lb. (6.17 to 6.88 kg)

Free length after test ..... 2.09 in. (53.1 mm)

Outside diameter ..... .38 in. (9.7 mm) maximum

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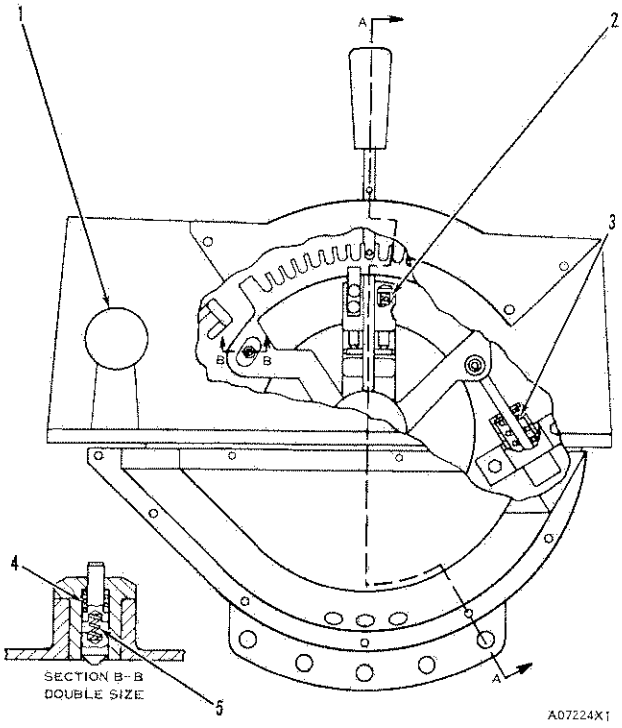
TRANSMISSION RATIO SELECTOR
(9N1802 and 9N1803)



(1) 9N1760 Valve:

Valve must release (control handle must come out) when the air pressure to the ratio selector becomes less than ..... 60 ± 5 psi (4.2 ± 0.4 kg/cm²)

(2) 9N1789 Spring (two used):

Length under test force ..... .875 in. (22.23 mm)
Test force ..... 1.24 lb. (0.562 kg)
Free length after test ..... 1.25 in. (31.8 mm)
Outside diameter ..... .240 in. (6.10 mm)

(3) 9N1758 Spring:

Length under test force ..... 1.850 in. (46.99 mm)
Test force ..... 1.00 ± .10 lb. (0.454 ± 0.045 kg)
Free length after test ..... 2.69 in. (68.3 mm)
Outside diameter ..... .47 in. (11.9 mm)

(4) 9N1773 Spring:

Length under test force ..... .375 in. (9.53 mm)
Test force ..... .650 lb. (0.2948 kg)
Free length after test ..... .56 in. (14.2 mm)
Outside diameter ..... .300 in. (7.62 mm)

(5) 9N1759 Spring:

Length under test force ..... .187 in. (4.75 mm)
Test force ..... 3.5 lb. (1.59 kg)
Free length after test ..... .31 in. (7.9 mm)
Outside diameter ..... .180 in. (4.57 mm)

Transmission Ratio Selector (Cont.)

(6) 9N1772 Spring:

Length under test force ..... .75 in. (19.1 mm)

Test force ..... 8.6 lb. (3.90 kg)

Free length after test ..... .88 in. (22.4 mm)

Outside diameter ..... .375 in. (9.53 mm)

(7) 9N1720 Spring:

Length under test force ..... .563 in. (14.30 mm)

Test force ..... 35 ± 1.8 lb. (15.9 ± 0.82 kg)

Free length after test ..... .674 in. (17.12 mm)

Outside diameter ..... .440 in. (11.18 mm)

(8) 9N1565 Conical Spring (spring is not shown, part of 9N1742 Plate Assembly):

Length under test force ..... .28 in. (7.1 mm)

Test force ..... 1.76 lb. (0.798 kg)

Free length after test ..... .50 in. (12.7 mm)

Outside diameter (large end) ..... .438 ± .008 in. (11.13 ± 0.20 mm)

Outside diameter (small end) ..... .250 ± .008 in. (6.35 ± 0.20 mm)

(9) 9N1747 Spring (seven used):

Length under test force ..... .200 in. (5.08 mm)

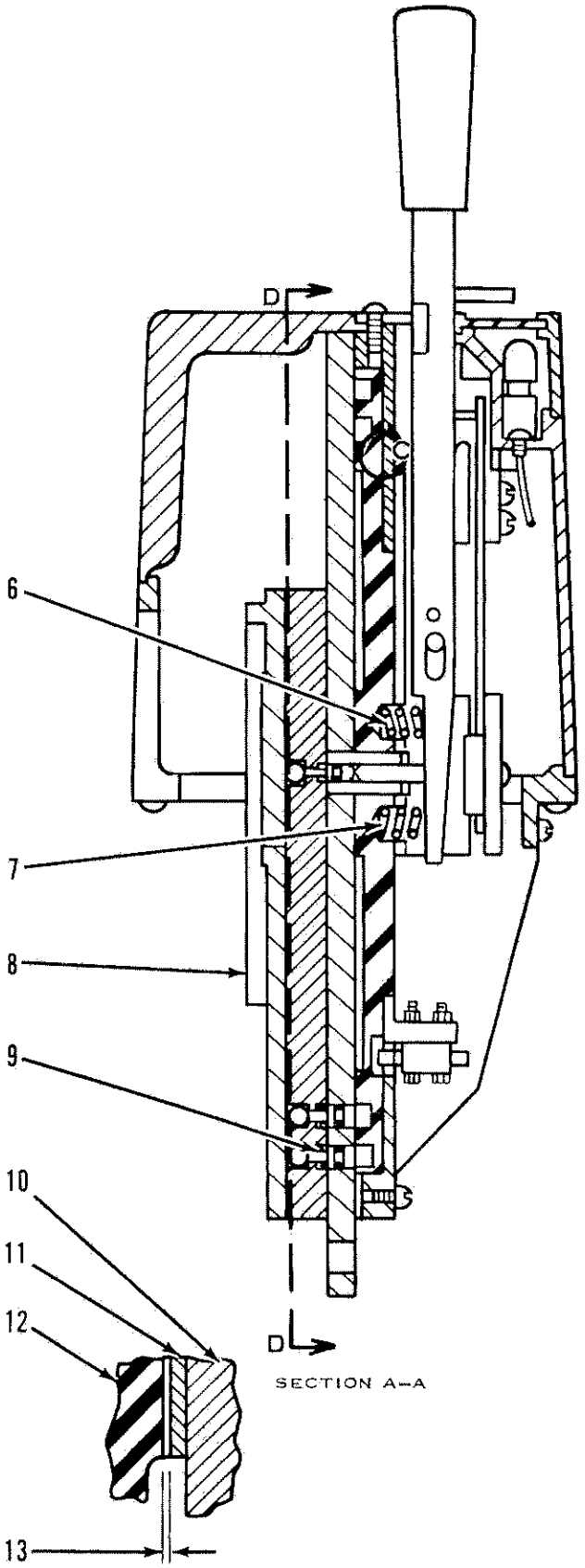
Test force ..... 1.1 lb. (0.50 kg)

Free length after test ..... .32 in. (8.13 mm)

Outside diameter ..... .240 in. (6.10 mm)

(13) Clearance between the 9N1785 Plate (12) and the 9N1730 Cover (10) ..... .001 + .020 or - .000 in. (0.03 + 0.51 or - 0.00 mm)

Use 9N1780 Shims (11) as necessary to give this clearance.



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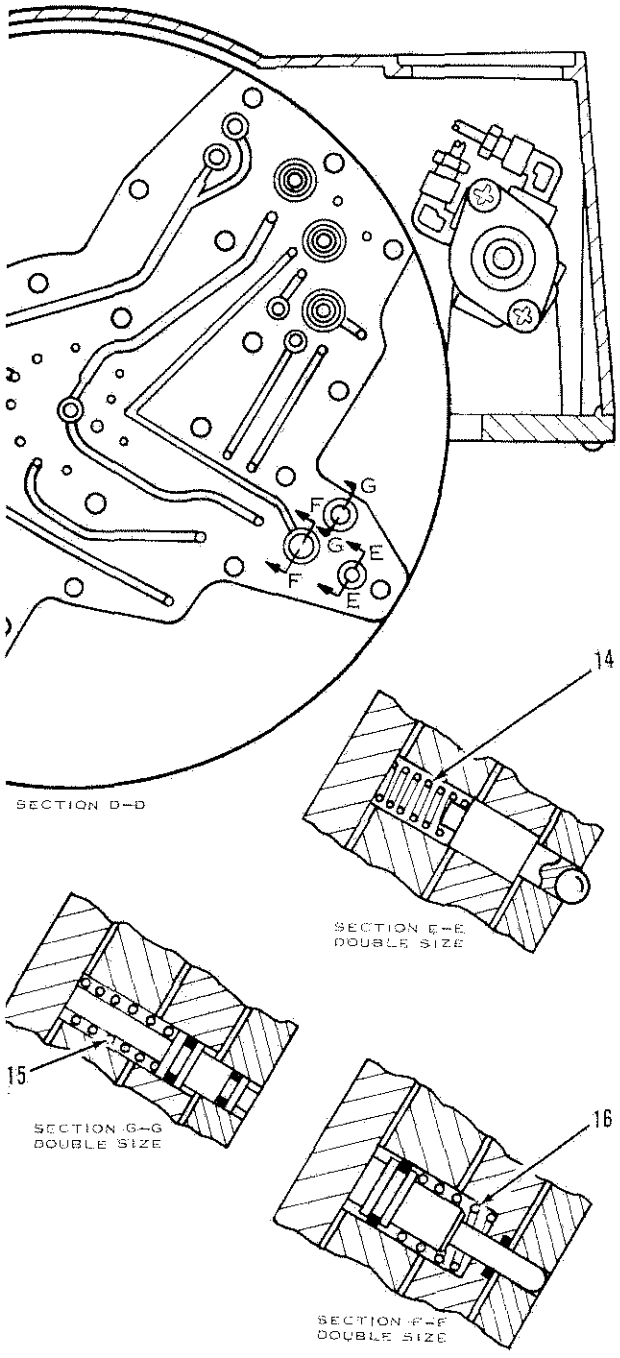
Transmission Ratio Selector (Cont.)



(14) 9N1751 Spring:

Length under test force:	.562 in. (14.27 mm)
Test force	2.63 ± .13 lb. (1.193 ± 0.059 kg)
Free length after test	2.89 in. (73.41 mm)
Outside diameter	.356 ± .008 in. (9.04 ± 0.20 mm)

(15) 9N1752 Spring:

Length under test force	.94 in. (23.88 mm)
Test force	1.84 lb. (0.835 kg)
Free length after test	1.20 in. (30.5 mm)
Outside diameter	.284 in. (7.21 mm)

(16) 9N1741 Spring:

Length under test force	.606 in. (16.76 mm)
Test force	5.6 lb. (2.54 kg)
Free length after test	.75 in. (19.1 mm)
Outside diameter	.466 ± .013 in. (11.84 ± 0.33 mm)

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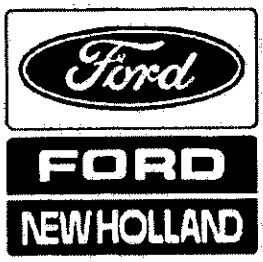
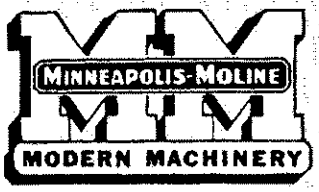
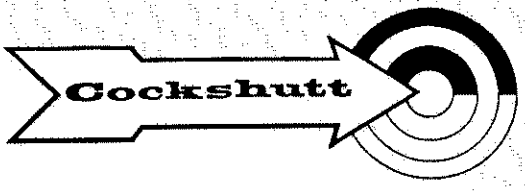
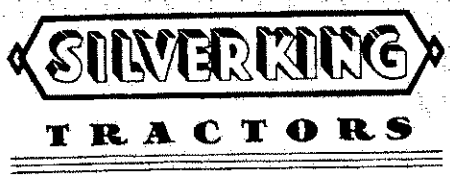
NOTES









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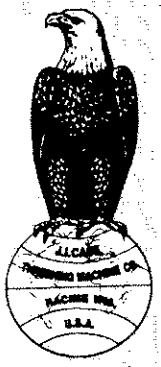

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