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AUTOMOTIVE DIESEL MAINTENANCE 2. UNIT IX, AUTOMATIC TRANSMISSIONS--HYDRAULIC SYSTEM (PART I).
HUMAN ENGINEERING INSTITUTE, CLEVELAND, OHIO
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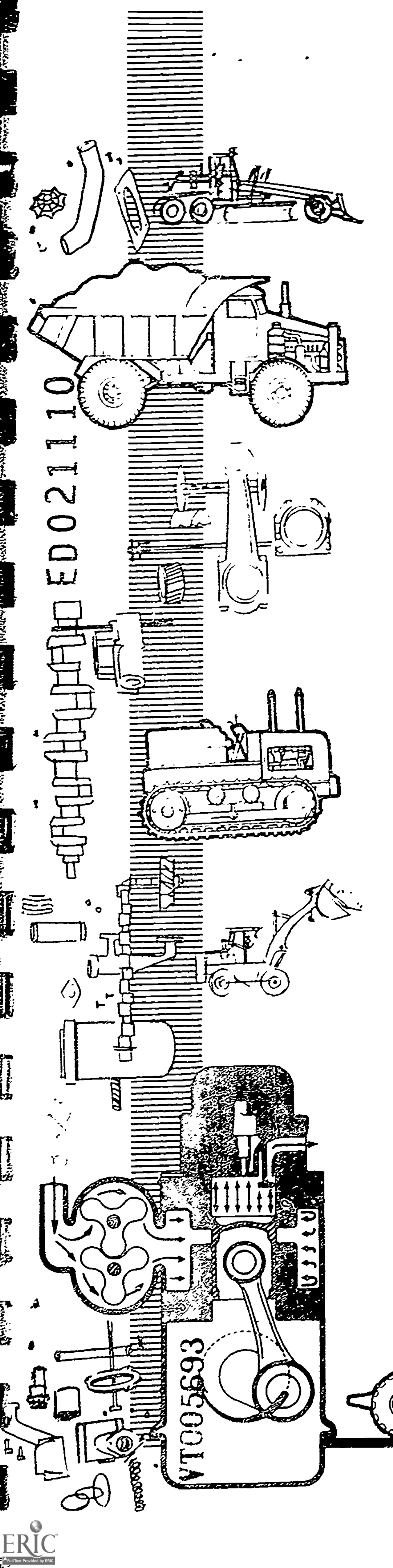
THIS MODULE OF A 25-MODULE COURSE IS DESIGNED TO DEVELOP AN UNDERSTANDING OF THE OIL FLOW WITHIN HYDRAULIC TRANSMISSIONS USED ON DIESEL POWERED VEHICLES. TOPICS ARE GENERAL DESCRIPTION, HYDRAULIC CIRCUITS, AND BRAKE HYDRAULIC CIRCUIT AND OPERATION. THE MODULE CONSISTS OF A SELF-INSTRUCTIONAL PROGRAMED TRAINING FILM "LEARNING ABOUT THE ALLISON TORQMATIC HYDRAULIC SYSTEM (PART II)" AND OTHER MATERIALS. SEE VT 005 685 FOR FURTHER INFORMATION. MODULES IN THIS SERIES ARE AVAILABLE AS VT 005 685 - VT 005 709. MODULES FOR "AUTOMOTIVE DIESEL MAINTENANCE 1" ARE AVAILABLE AS VT 005 655 - VT 005 684. THE 2-YEAR PROGRAM OUTLINE FOR "AUTOMOTIVE DIESEL MAINTENANCE 1 AND 2" IS AVAILABLE AS VT 006 006. THE TEXT MATERIAL, TRANSPARENCIES, PROGRAMED TRAINING FILM, AND THE ELECTRONIC TUTOR MAY BE RENTED (FOR $1.75 PER WEEK) OR PURCHASED FROM THE HUMAN ENGINEERING INSTITUTE, HEADQUARTERS AND DEVELOPMENT CENTER, 2341 CARNEGIE AVENUE, CLEVELAND, OHIO 44115. (HC)

STUDY AND READING MATERIALS

AUTOMOTIVE DIESEL MAINTENANCE 2



AUTOMATIC TRANSMISSIONS - HYDRAULIC SYSTEM (PART I)

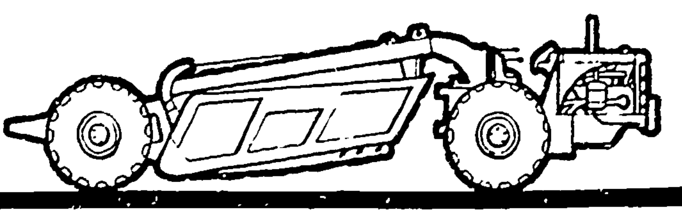
UNIT IX

SECTION A GENERAL DESCRIPTION

SECTION B HYDRAULIC CIRCUITS

SECTION C BRAKE HYDRAULIC CIRCUIT AND OPERATION

AM 2-9
6/2/67



HUMAN ENGINEERING INSTITUTE

This unit describes in detail the oil flow through the CLBT 5960 Allison Transmission. Each component which plays a role in this system will be discussed.

SECTION A -- GENERAL DESCRIPTION

The transmission hydraulic system is primarily self-contained. The external lines are: the oil cooler inlet and outlet lines, main oil pressure transfer tube, lube oil lines and the scavenge pump discharge tube.

Major components of the system are: input driven charging and scavenge pump; the main regulator valve; range control valve assembly, containing the intermediate trimmer and neutral trimmer valves; the brake (retarder) control valve, containing the torque limiter valve; and the lock-up body, containing the flow and lock-up shift valves.

The input driven pressure pump is mounted on the converter housing and is driven by the converter accessory drive gear train. The gear train consists of a drive gear attached to the converter pump, idler gear and accessory driven gear. The pump is driven at engine speed and has a capacity of 54 gpm at 2100 engine rpm. Pressurized oil is supplied by the pump to the transmission clutches, transmission lube and converter.

SECTION B -- HYDRAULIC CIRCUITS

NOTE: Refer to Figure 1 (Allison color foldout sheet), unless otherwise specified, during the following discussion.

MAIN REGULATOR VALVE -- The main regulator valve regulates the oil pressure for the transmission clutches and directs the overage to the converter.

The input driven charging pump brings oil from the transmission sump and directs it to the main pressure regulator valve. The check valve, which is found on the converter housing face, prevents a reverse flow of oil, when the unit is traveling in a reverse direction.

Under normal operation, the oil will flow into the main regulator valve and through the filters. If the filter elements are clogged, or the oil is exceptionally heavy, the oil will open the bypass valve and dump unfiltered oil into the main regulator valve.

The main regulator valve contains a dash-pot valve, which consists of a small ball and spring. As the oil flows through the regulator valve, the dash-pot valve is unseated, allowing oil to flow behind the regulator valve. This oil acts as a cushion and absorbs shock as the regulator valve flutters back and forth. As oil flows through the valve and into the main oil line, the oil acts against the regulator spring. This compresses the spring and shifts the valve over, allowing excess main oil to flow into the converter IN line; see Figure 2. When the pressure is dissipated, spring pressure moves the regulator valve back to its original position, shutting off the converter IN oil.

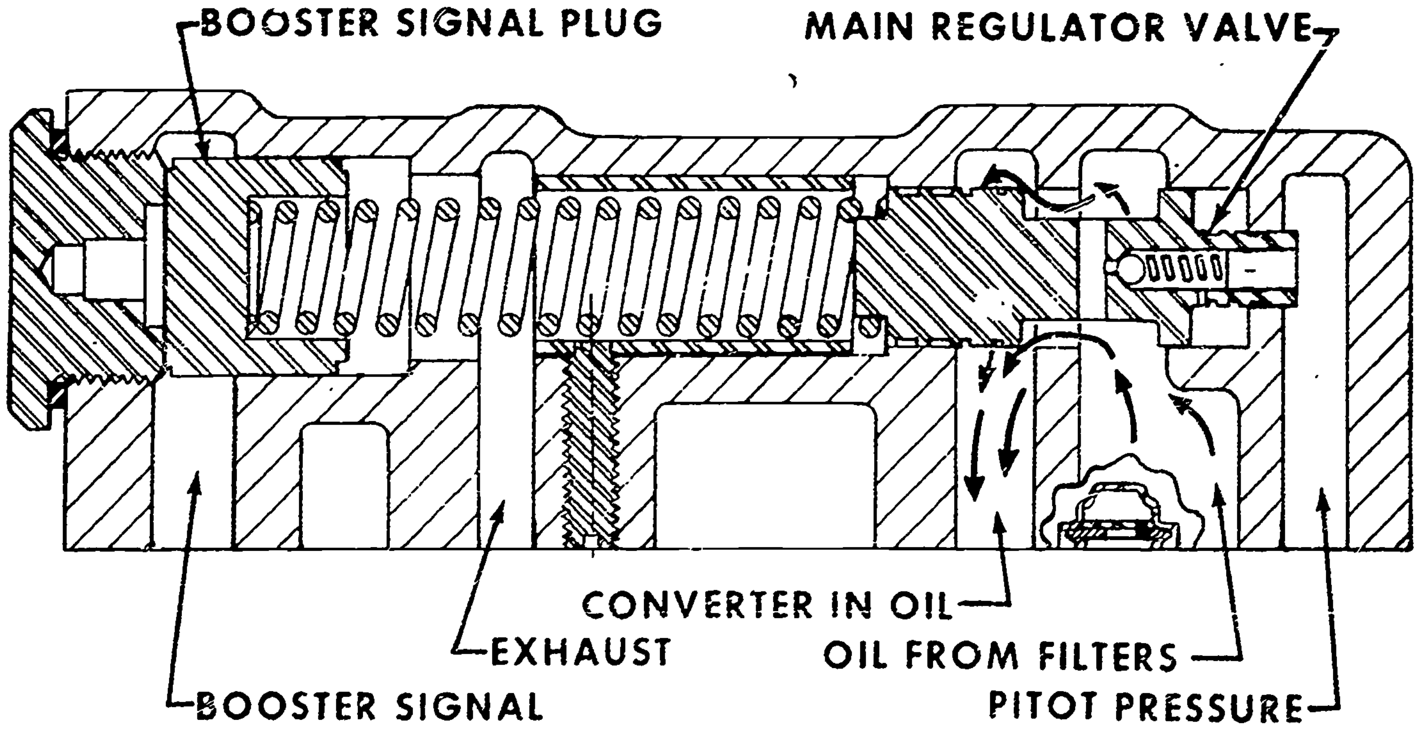


Fig. 2 Main pressure regulator valve in dump position

Two other hydraulic circuits (pitot and booster signal) have governing effects on the main regulator valve.

Pitot oil pressure is fed through a small orifice in the converter IN line. This oil flows into the pitot can, which is pressed on the splitter low drum. As the can revolves, oil is thrown by centrifugal force against the OD of the can. The revolving oil is then thrown against the pitot tube, forcing a small amount of the oil into the tube. Oil flows through the pitot feed line and into the main regulator valve, around the anti-spring end of the lock-up shift valve and is dead-ended in the lock-up shift valve; see Figure 1.

At the main regulator valve, pitot pressure is exerted on the valve, which slightly compresses the regulator spring, thus requiring less main pressure to shift the valve into its dumping position; see Figure 2.

Pitot pressure is proportional to turbine shaft speed. Therefore, at higher turbine shaft speeds more pitot pressure is exerted on the regulator valve, decreasing the amount of main pressure to the clutches as requirements are lessened due to increasing speed and decreasing torque. The pitot pressure ranges from 0 - 90 psi.

Pitot pressure is also exerted on the .75 psi differential check valve, located in the pitot-main oil passage. Pitot pressure can rise and main pressure can fall until pitot pressure exceeds the main pressure by 0.75 psi. At this point, pitot pressure will escape into the main pressure circuit at the check valve, and afterward will, for all practical purposes, remain balanced. The possibility of pitot pressure exceeding main pressure is very remote. This can occur, in some instances, where the engine over-speeds and drives the turbine shaft at exceedingly high speeds.

Booster signal pressure is the other factor which affects main oil pressure. This pressure influences main oil pressure in first and reverse gear ranges only.

When the control valve is in one of the previously mentioned positions, the booster signal feed line is opened, permitting oil to flow into the spring end of the regulator valve. Oil pressure is exerted on the booster plug, which compresses the spring and forces the regulator valve to regulate at higher pressures. Figure 3 illustrates the effects that pitot and booster signal pressure have on main pressure in different gear ranges.

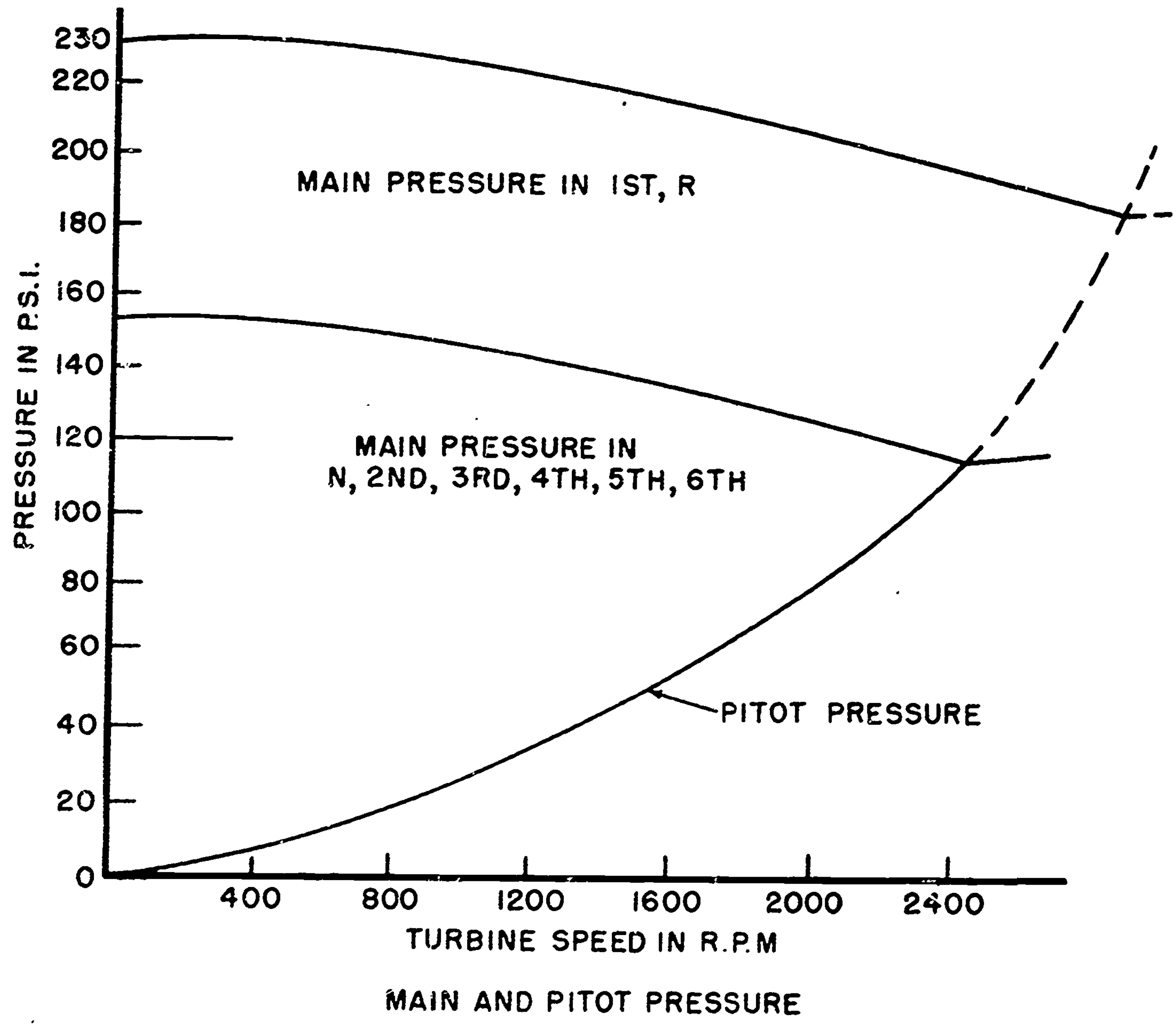


Fig. 3 Pressure curves

Regulated main oil flows into the control valve body. Oil flow through the valve body is dependent on control valve position. This will be covered later in this unit.

CONVERTER SYSTEM -- The converter IN oil is the overage main oil that is dumped into converter IN line by the main pressure regulator valve. Oil flows into the converter through the ground sleeve and pump hub bearing and into the cavity between the pump and stator. It continues to flow through the converter elements and out between the ground sleeve and turbine shaft.

The converter IN passage incorporates a safety blow-off valve which prevents the converter IN pressure from exceeding 80 psi. Oil pressure in excess of 80 psi is dumped back into transmission sump.

Between the converter IN and the converter OUT passage is the converter bypass valve. During high speed operation, the converter does not require the amount of oil being directed to it. Therefore, when converter IN pressure exceeds converter OUT pressure by 3 psi the valve opens, allowing excessive converter IN oil to bypass the torque converter.

Converter OUT oil flows through the oil cooler, where it is cooled. The oil continues its flow to the secondary converter pressure regulator valve. This valve works against a spring pressure and will exhaust to sump any oil in excess of 22.5 psi coming from the converter through the cooler.

Located in the converter housing between the oil cooler return and the converter IN pressure passage, is the converter IN check valve. This valve will not allow converter IN pressure to drop lower than 20.5 psi. Oil pressure on the cooler side of the valve is regulated at 22.5 psi by the converter pressure regulator valve. Oil pressure on the opposite side of the valve is opposed by converter IN pressure and a 2 psi valve spring. If converter IN oil pressure should drop below 20.5 psi, oil from the oil cooler, regulated at 22.5 psi by the converter regulator valve, opens the valve and maintains a minimum converter IN pressure of 20.5 psi. Thus, oil is allowed to recirculate to the converter from the cooler.

TRANSMISSION LUBE SYSTEM -- Transmission lube oil is taken from the converter IN line through a drilled hole in the converter ground sleeve and flows through the center of the turbine shaft, splitter shaft and transmission output shaft. The oil passage in the transmission output shaft is not drilled completely through. Radially drilled oil passages in the shaft provide lubrication for the planetary gearing. Oil is thrown out by centrifugal force to lubricate the clutch plates and intermediate needle bearings and planetary spindle. Positive feed is maintained to all other spindles and bearings, and a pressure drop exists across all feed lines; see Figure 1.

PITOT SYSTEM -- The pitot system has two functions in the transmission hydraulic system: (1) to reduce main pressure at higher turbine shaft speeds and (2) to shift the converter into lock-up.

FLOW VALVE -- The purpose of the flow valve is to carry the lock-up clutch pressure oil to the sump whenever a shift is made.

Main oil flows into the lock-up valve body and then flows around the flow valve and also behind it. The oil then flows through an orifice and into the main oil passage leading to the other end of the flow valve and also to the control valve. Oil passes through the small check valve orifice and slowly fills the cavity behind the valve, thus retaining the valve in its normal position. See Figure 4.

When a shift is made, the oil required to fill the clutch being applied, reduces the pressure on the control valve side of the flow valve orifice. Simultaneously, the pressure on the check valve end of the flow valve is reduced and full line pressure on the opposite end of the valve will move the valve against the plug. This allows line pressure to bypass the flow valve orifice and flow directly to the piston housing of the clutch being applied, permitting the shift to be made with full main pressure and assuring quick clutch engagement. The lock-up clutch feed oil is blocked off and lock-up clutch passage is open to sump. See Figure 5.

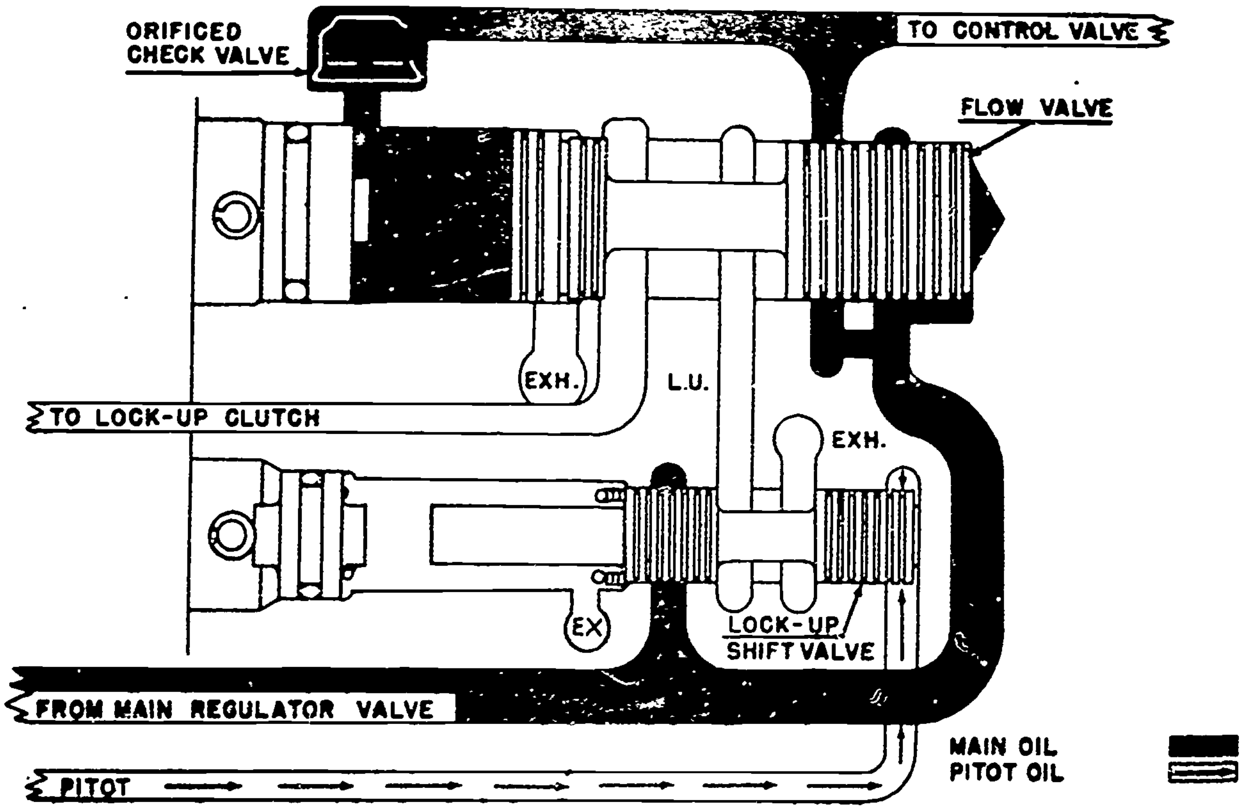


Fig. 4 Flow valve in closed position

Once the clutch needs are satisfied, oil once again flows through the orifice in the check valve and slowly fills the cavity behind the flow valve. Since this end of the valve has a greater area than the other end of the valve, the effective force from the oil pressure will also be greater; the valve will be shifted to its normal position when the effective force on the larger end

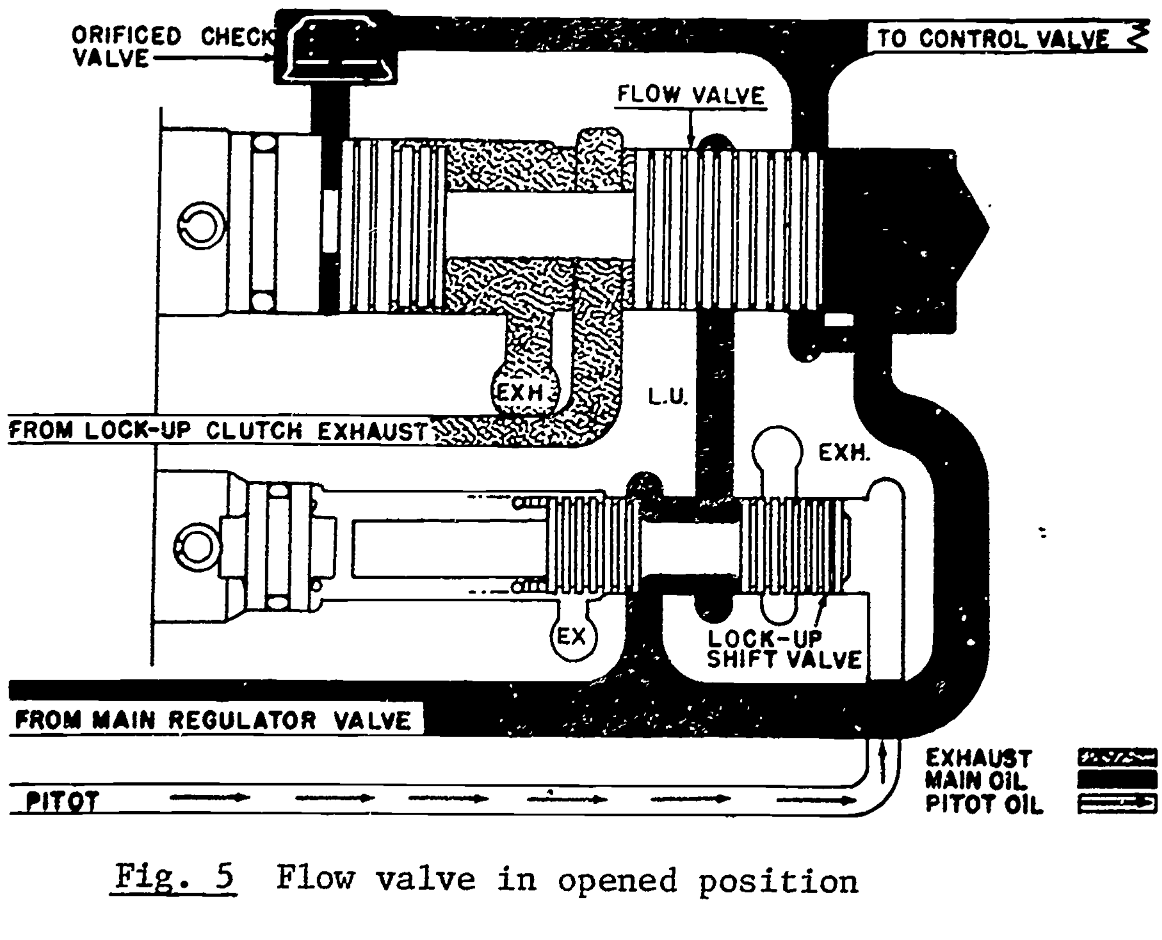


Fig. 5 Flow valve in opened position

of the valve overcomes the force on the smaller end. This once again provides an orificed oil flow to the applied clutches.

The orifice in the valve body is designed to replace oil lost through normal piston seal leakage.

LOCK-UP SHIFT VALVE -- The lock-up shift valve, which is located in the lock-up valve body, is shifted hydraulically and is dependent on turbine shaft speed (pitot pressure). Lock-up occurs in all ranges.

Main oil flows into the valve body and around the center of the lock-up valve. Pitot oil flows into the valve body, and around the right hand end of the valve. Spring pressure acts on the left hand end of the valve.

As turbine shaft rpm increases, pitot pressure also increases since it is proportional to turbine shaft rpm. When pitot pressure becomes high enough, it overcomes the spring pressure and moves the lock-up valve against the plug, allowing main oil pressure to flow into the lock-up clutch feed line. See Figure 6. The oil pressure actuates the lock-up piston which, in turn, locks the turbine to the engine flywheel.

When turbine shaft rpm drops sufficiently, spring pressure overcomes pitot pressure and shifts the valve out of lock-up, breaking the connection between main oil and lock-up feed lines. The lock-up feed line is now connected to sump allowing the lock-up to return to sump and release the clutch. The shift out of lock-up occurs when the turbine shaft speed drops to about 1570 rpm.

Shifting into another speed range also disengages the lock-up clutch because lock-up feed oil is dumped into sump, as discussed previously in the flow valve discussion.

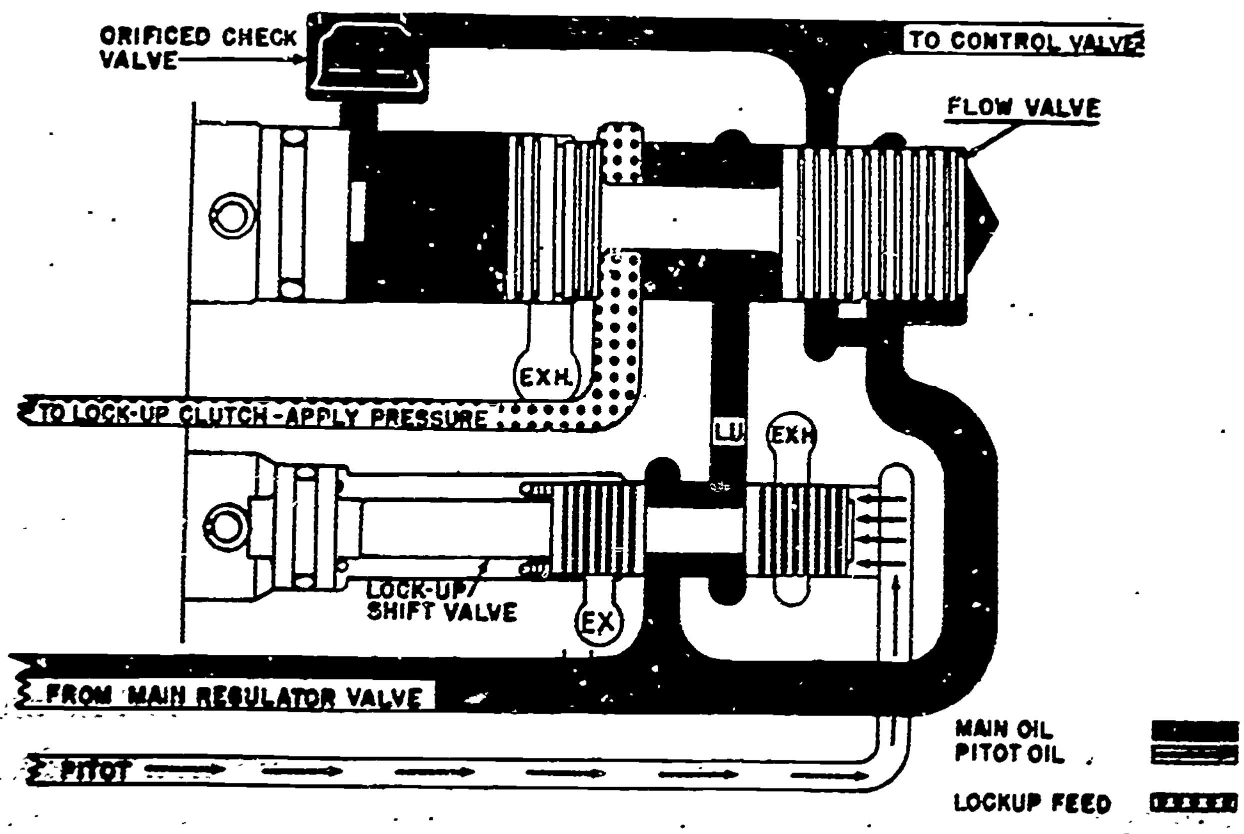


Fig. 6 Lock-up shift valve in opened position

SIX SPEED MANUAL CONTROL VALVE -- The control valve is an eight position, spool type valve, mounted vertically on the right side of the transmission housing. The vertical mounting prevents the valve from shifting due to cab flexing. Contained within the valve housing is the intermediate trimmer valve and neutral trimmer valve; see Figure 1. The function and operation of both valves will be brought out during discussion of the oil flow to the various speed ranges.

NEUTRAL -- In this valve position, main oil flows into the low splitter feed line and to the neutral trimmer valve. Neutral signal pressure flows to the opposite end of the neutral trimmer valve assembly, moving the trimmer plug against the trimmer valve. This positions the trimmer valve so that it produces the trimmer action desired when shifting from neutral to first or reverse range. All other range feed lines are open to exhaust and return to sump.

FIRST RANGE -- When the shift is made from neutral to first range, the neutral signal passage of the neutral trimmer valve is opened to exhaust, allowing main oil pressure to move the trimmer valve to the right, opening the exhaust port momentarily. Main pressure passes through the orifice in the trimmer valve, moving the trimmer plug against its stop. Oil pressure builds up beneath the trimmer valve until it is equal to main pressure. Then, spring pressure will move the trimmer valve and close the trimmer valve exhaust.

When the control valve is shifted to the first range position, main pressure is directed to the low splitter and low pistons. At the same time, oil flows into the booster signal feed line, which helps maintain main pressure at a higher level.

SECOND RANGE -- In this valve position, the oil flows to the low clutch remains the same. The low splitter clutch passage is opened to exhaust, and main pressure is directed to the splitter high clutch, applying high splitter piston. However, booster signal is opened to exhaust, thus requiring less main pressure to apply the high splitter clutch.

THIRD RANGE -- In the third range position, main pressure oil flow is directed to the splitter low clutch, applying the low splitter piston; and to the intermediate clutch, applying the intermediate piston. Simultaneously, the high splitter and low clutches are exhausted. Before the intermediate piston is applied, the main pressure must pass through an orificed passage and to the intermediate trimmer valve.

Pressure against the trimmer valve moves the valve, allowing main pressure to partially exhaust to sump, and applying pressure to the intermediate piston. Oil is forced through the orificed opening in the trimmer valve. When the combined pressure of the valve springs and the main oil pressure on the inner surface of the trimmer valve exceeds the oil pressure on the face of the valve, the valve shifts to the right, closing the exhaust port and sending full main pressure to the intermediate piston. This action prevents shock loading to intermediate clutches and allows for smoother shifting.

FOURTH RANGE -- In this range, oil continues to flow to the intermediate piston (intermediate clutch). The low splitter clutch is exhausted, and the high splitter clutch feed is opened by the control valve, allowing oil to enter the splitter high range piston housing.

FIFTH RANGE -- In this range, oil is directed to the high piston (high range clutch) and to the low splitter piston (splitter low clutch), thereby applying these clutches. Simultaneously, the high splitter and intermediate clutches are exhausted.

SIXTH RANGE -- In this range, oil continues to flow to the high piston (high range clutch). The high splitter clutch feed is opened by the control valve, allowing oil to enter the splitter high range piston housing, and the low splitter clutch is then exhausted.

REVERSE RANGE -- When the control valve is shifted to this position, the neutral signal passage of the neutral trimmer valve is opened to exhaust, allowing main oil pressure to move the trimmer valve to the right, opening the exhaust port momentarily. Main pressure passes through the orifice in the trimmer valve, moving the trimmer plug against its stop. Oil pressure builds up beneath the trimmer valve until is is equal to main pressure. Then, spring pressure will move the trimmer valve and close the trimmer valve exhaust.

At the same time, main oil pressure is being directed to the splitter low and reverse range pistons, applying these clutches. Main pressure also is being directed to the signal feed line, which unseats the booster plug in the main regulator and increases the main pressure, thus applying greater pressure against the low splitter and reverse range pistons.

SECTION C -- BRAKE HYDRAULIC CIRCUIT AND OPERATION

NOTE: This circuit is sometimes referred to as the "RETARDER" circuit.

OIL FLOW -- Converter OUT oil flows from the converter and into the cooler circuit. Regardless of the brake valve position, excess converter OUT oil flows into the oil cooler.

With the brake valve OFF oil flows around the valve and through the secondary converter pressure regulator valve and into exhaust. If the brake valve is ON, oil will enter the brake cavity at 22.5 psi.

The secondary converter pressure regulator valve assures rapid filling of the brake cavity and also guarantees that brake IN oil will enter the brake at 22.5 psi.

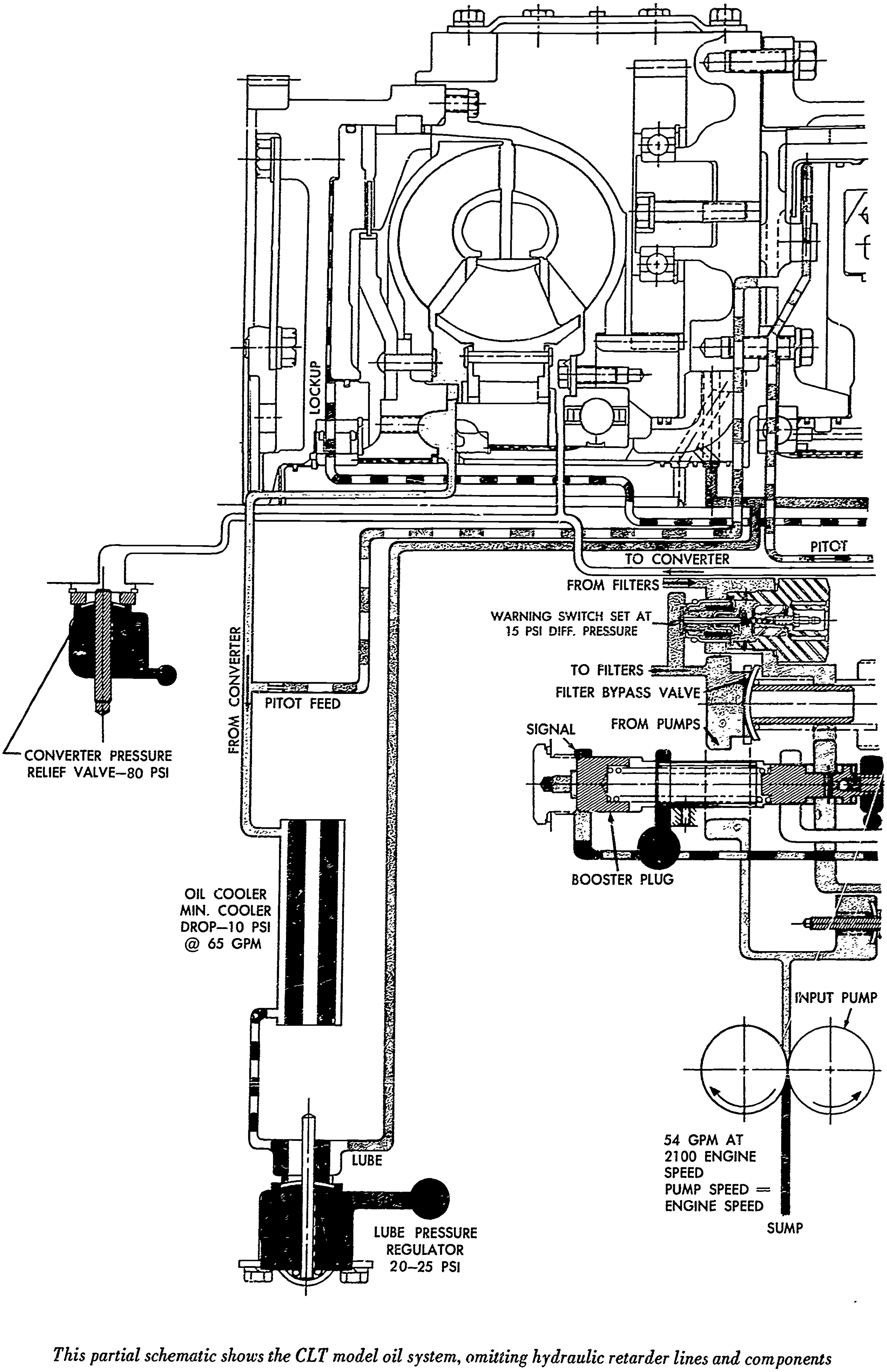
With the brake valve in the ON position, oil from the cooler enters the brake valve and flows simultaneously against the secondary converter regulator valve and into the brake feed line. The secondary converter regulator valve regulates brake fill pressure at 22.5 psi. Oil with pressure in excess of 22.5 psi will be dumped into exhaust.

Brake feed oil enters the brake cavity near the ID and the movement of the brake rotor forces the oil out and into the brake OUT line. Brake OUT oil acts on the 50 psi torque limiter valve, which regulates torque absorption at 1200 foot pounds.

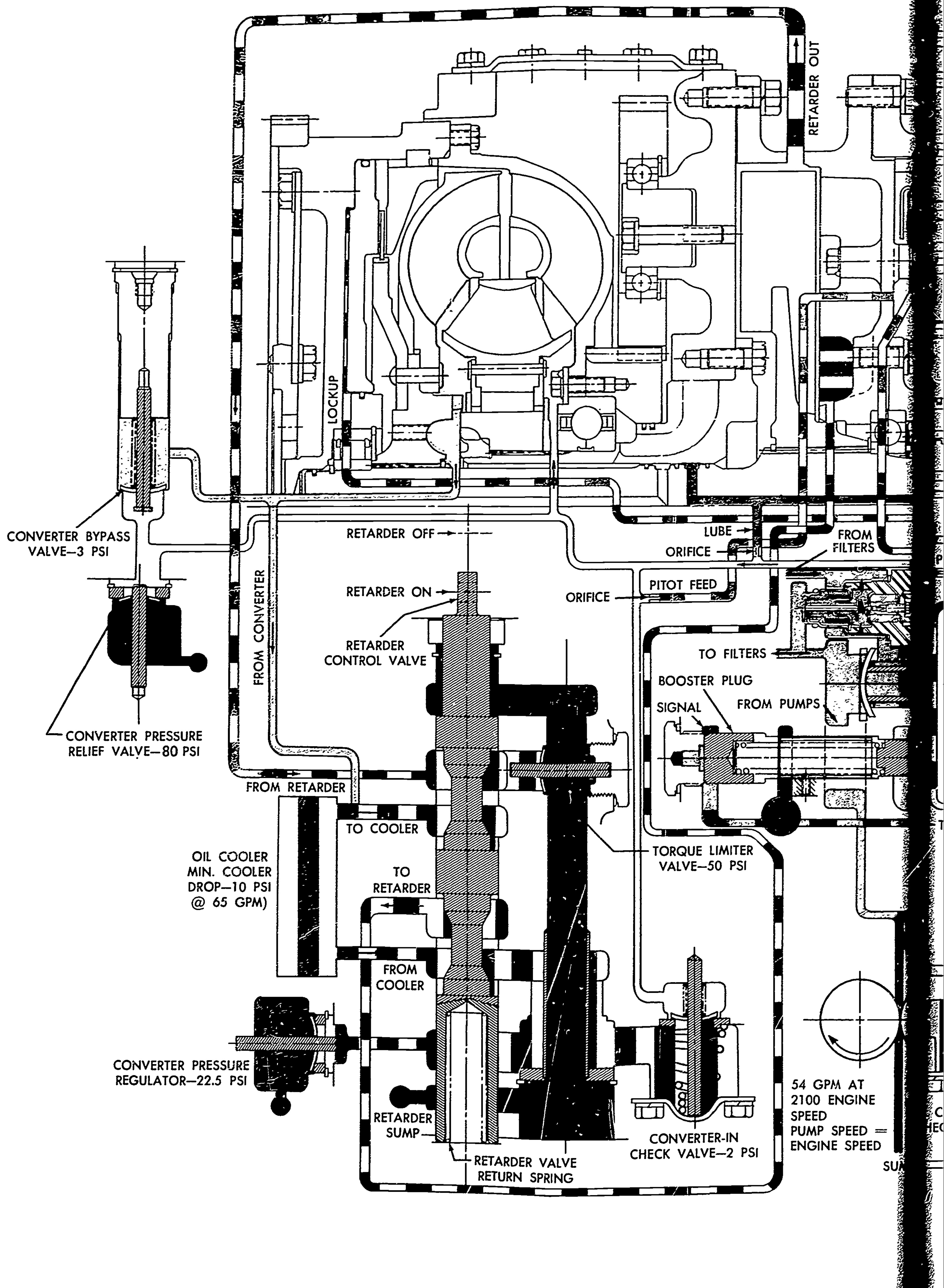
If the brake attempts to absorb torque in excess of 1200 foot pounds (over 50 psi), the excess oil flows through the torque limiter valve and into the brake sump. With the brake absorbing less than 1200 foot pounds of torque (less than 50 psi), the oil flows into the oil cooler, where it is cooled and then flows back into the brake feed line. This cycle is repeated until the brake valve is returned to the OFF position.

BRAKE OPERATION -- The brake can be applied in any gear. When approaching a downgrade, select the gear which will provide a safe descending speed and will not overspeed the engine. When in doubt, start down the grade in low gear. As the unit picks up speed, move the brake apply lever to the full on position. If this is not sufficient, apply the service brakes to provide additional braking action until the transmission can be safely downshifted.

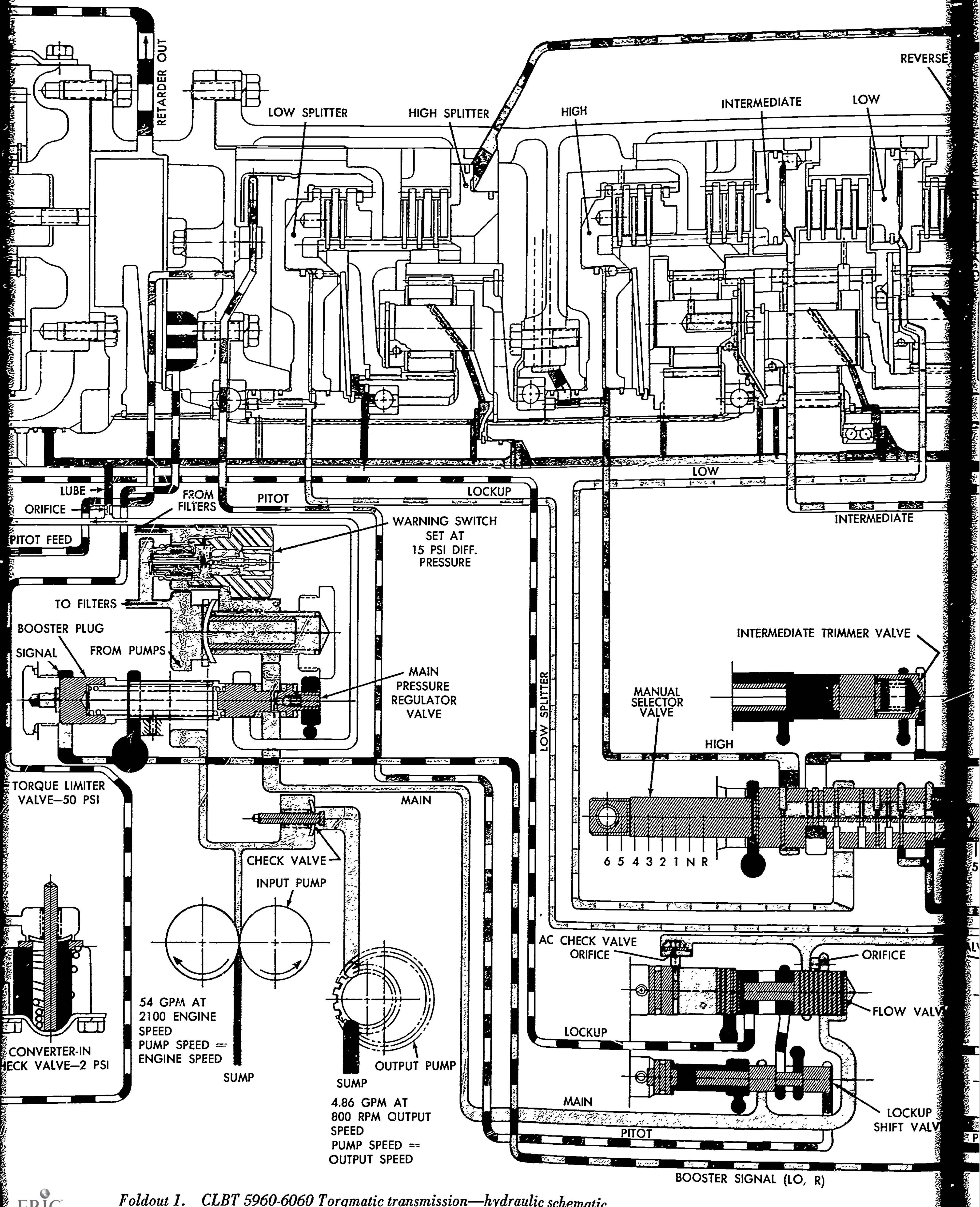
CAUTION: The transmission must NOT be shifted while the brake is applied.



This partial schematic shows the CLT model oil system, omitting hydraulic retarder lines and components



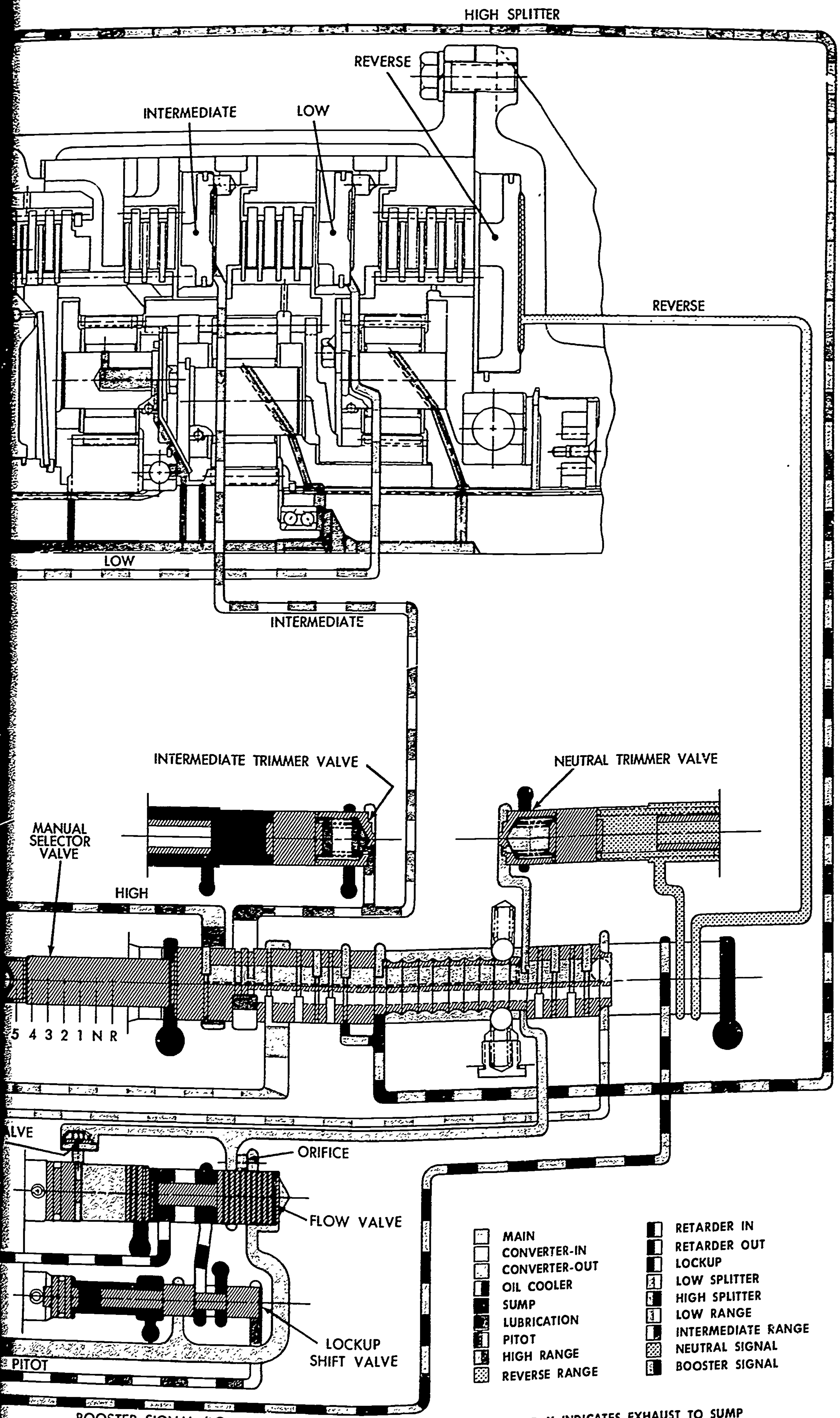
Foldout 1. CLBT



Foldout 1. CLBT 5960-6060 Torqmatic transmission—hydraulic schematic

fold-out 1

hydraulic system schematic



DIDACTOR PLATES FOR AM 2-9D

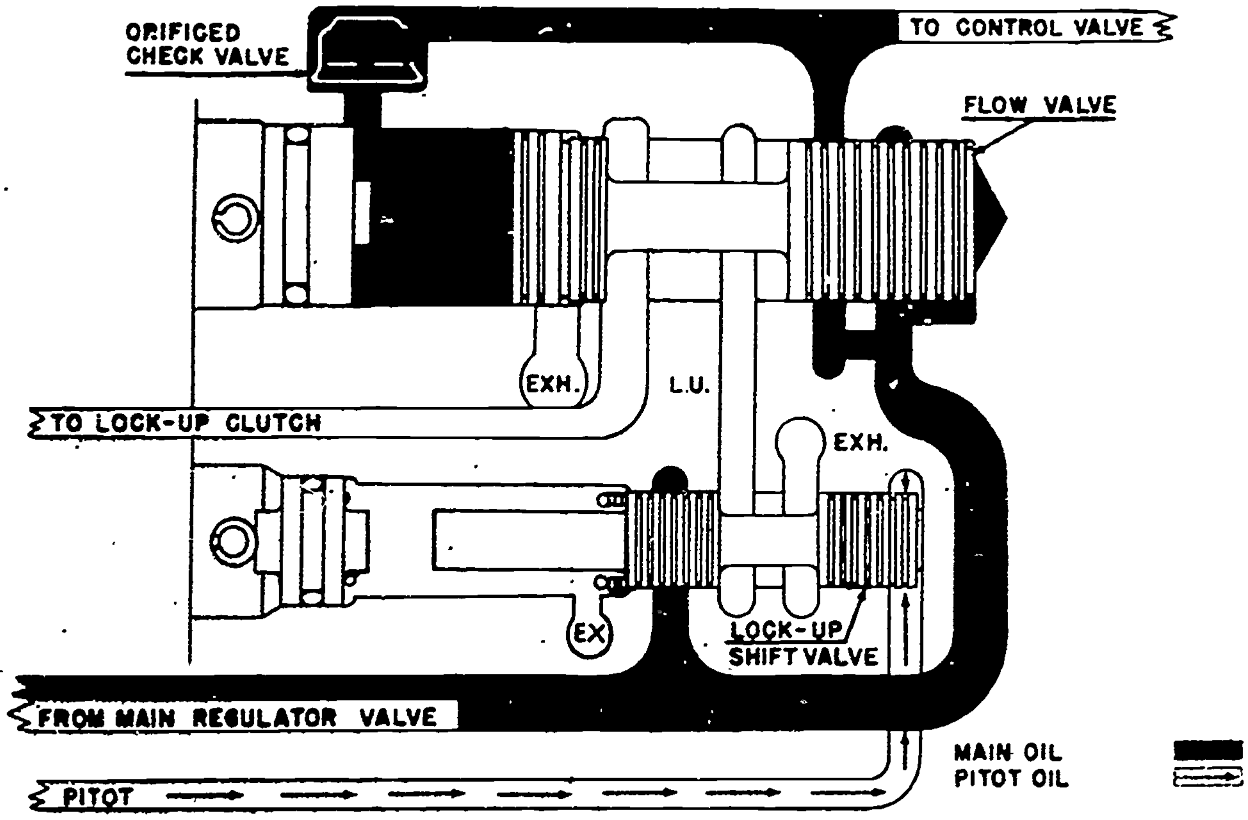


Plate I

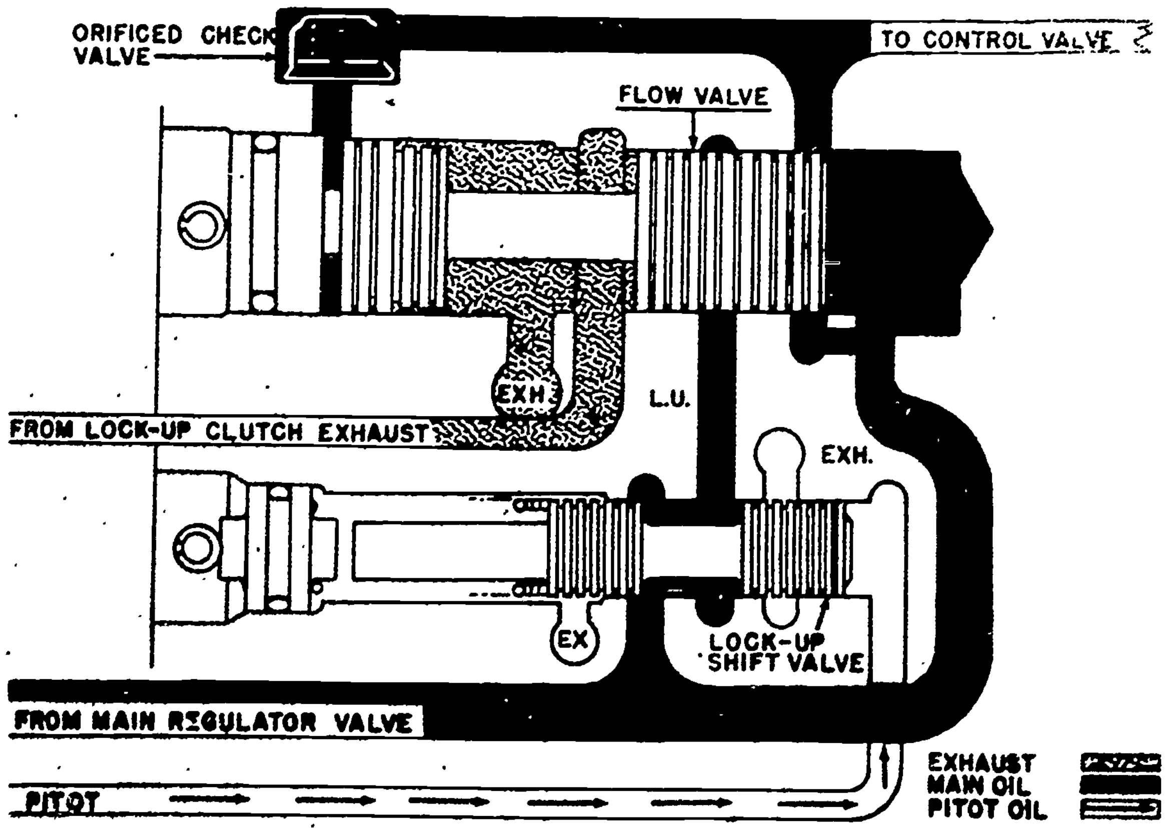


Plate II

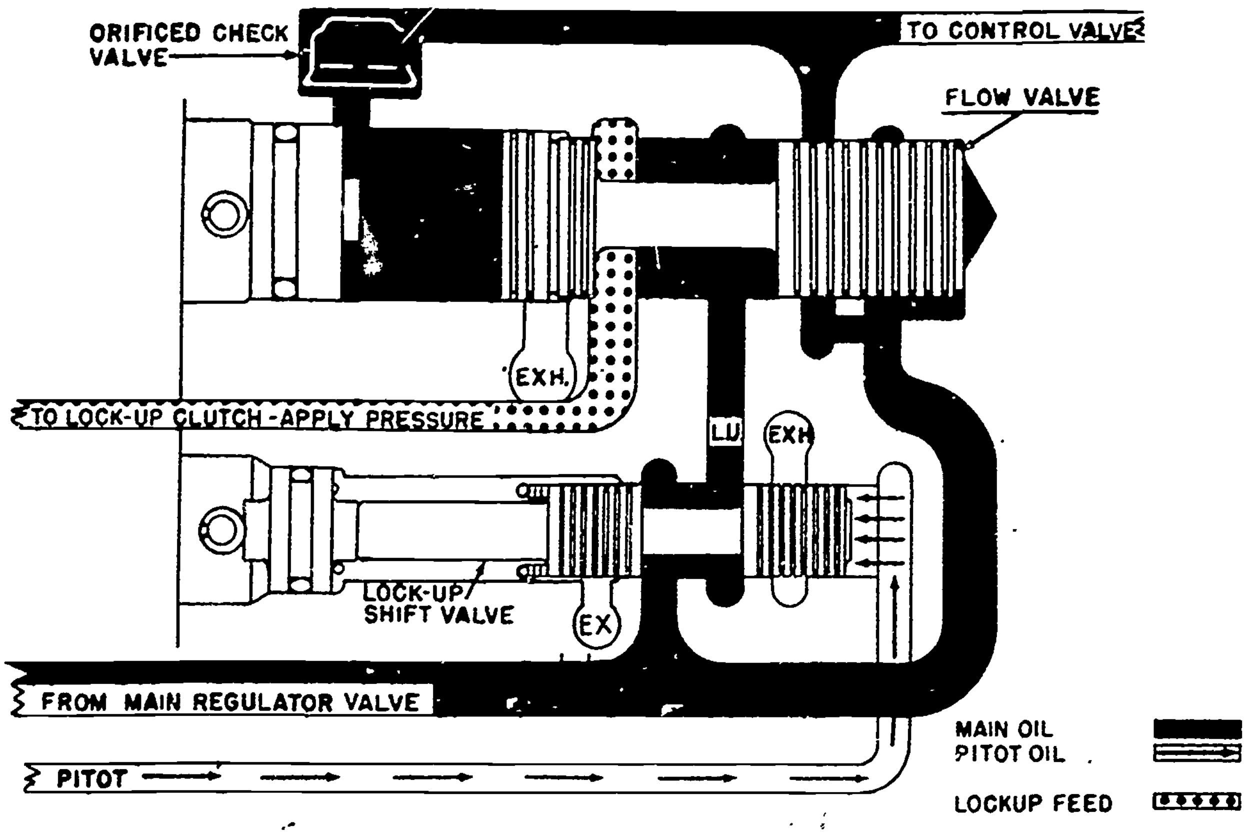

ORIFICED CHECK VALVE
TO CONTROL VALVE
FLOW VALVE
EXH.
TO LOCK-UP CLUTCH-APPLY PRESSURE
LU
EXH
LOCK-UP SHIFT VALVE
EX
FROM MAIN REGULATOR VALVE
PITOT
MAIN OIL
PITOT OIL
LOCKUP FEED

Plate III

1

AM 2-9D
8/18/67

LEARNING ABOUT THE ALLISON TORQMATIC TRANSMISSION HYDRAULIC SYSTEM

Human Engineering Institute

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Press A 2

Check to be sure that timer is OFF.

2

This film unit continues with the discussion of the Torqmatic hydraulic system. All eight positions of the transmission will be covered in relation to what occurs in the hydraulic system.

Read each frame carefully and take your time before answering the questions.

NOTE. Figure 1 (fold-out) in AM 2-9 will be referred to in this film -- have it available as you review this lesson.

Press A 3

1-2

3

NEUTRAL RANGE HYDRAULIC ACTION-- (refer to Figure 1 in AM 2-9 as you read through the following frames.)

When the manual selector valve is shifted to neutral while the engine is idling, the hydraulic system responds as follows: oil is drawn from the sump and forced into the hydraulic circuit. The oil flows through the filters, then to the main pressure regulator valve. From the regulator valve, oil flows to the lock-up shift valve and to the flow valve.

NOTE: Read this again before going to the next frame.

Press A 4

1-3

4

Main oil pressure to the lock-up shift valve is stopped at the valve. When oil reaches the flow valve it must flow through an orifice. The oil then flows through an orifice in a check valve to the opposite end of the flow valve. Oil also is directed to the manual selector valve. When oil is required beyond the flow valve, the oil pressure decreases at the end of the flow valve opposite incoming main pressure.

NOTE: Read this again before going to the next frame.

Press A 5

1-4

5

The pressure acting on the flow valve moves it in a direction which bypasses the orifice, allowing oil to flow unrestricted through the valve. When the valve moves. any oil at the end of the valve opposite the orifice will be displaced by the valve movement, will unseat the check valve at that end and flow into the main circuit beyond the flow valve.

NOTE: Read this again before going to the next frame.

Press A 6

1-5

6

Looking at Figure 1 in AM 2-9, with the engine idling and the shift lever in neutral, oil flows first to the ___(1)___, then to the ___(2)___, and on to the ___(3)___ where it is stopped.

A. (1) flow valve (2) check valve (3) filters 7
B. (1) filters (2) flow valve (3) lock-up shift valve 7
C. Neither of the sequences in A or B is correct 8

1-6

7

No. Oil first goes to the filters, then to the main pressure regulator, then to the lock-up shift valve. Read the last few frames again and follow the flow carefully on the figure in Unit AM 2-9.

Press A 3

1-7

8

Correct. Oil first flows from the sump to the filters, then to the main pressure regulator valve, then to the lock-up shift valve.

When oil reaches the flow valve it flows ________________.

A. unrestricted through the valve 9
B. through two orifices 11
C. around the valve to the selector valve 10

1-8

9

No. The oil cannot flow unrestricted through this valve unless the valve moves, due to more pressure on one end than the other.

Try this question again. Press A 8

1-9

10

No. The oil flows into this valve through two orifices, an orifice at one end and an orifice check valve at the other.

Press A 11

1-10

11

OK. Continuing to the manual selector valve, oil fills the bore around a portion of the valve and flows into the lateral drilled passages and fills a drilled passage of the valve.

In neutral position the manual selector valve has three outlets -- one to the neutral trimmer valve, one to the end of the neutral trimmer valve and plug and the other to the low splitter clutch cavity. Main oil at the trimmer valve flows through the orifice in the trimmer valve to the area between the valve and valve plug.

Press A 12

1-11

12

As oil pressure increases in the circuit, several results occur simultaneously. The low splitter clutch is applied. Pressure equalizes in the main line at both sides of the flow valve and seats the check valve at the larger diameter end. Oil begins flowing through the orifice in the check valve.

This flow, acting on a larger area at that end of the valve than is acted upon at the other end, causes the valve to move in the direction of its smaller diameter end. The valve moves the limit of its travel in that direction.

It remains in that position until a shift is made to another gear, and oil must flow to another clutch piston cavity. Press A 13

1-12

13

In the neutral position, oil flows to the manual selector valve. There are three outlets in this position: one of these is the ____________.

A. high splitter cavity 14

B. low clutch pack 14

C. neutral trimmer valve 15

1-13

14

No. We said oil flows from the selector valve to the low splitter clutch cavity; also to the neutral trimmer valve -- which is the correct answer to the last question.

Take another look at this question.

Press A 13

1-14

15

Correct.

As pressure is increased in this circuit, several things occur simultaneously; one is ____________.

A. the check valve located at the flow valve is unseated 16

B. pressure is equalized at both sides of the flow valve 17

C. oil is stopped at the orifice in the check valve 16

1-15

16

No. The correct answer is that pressure is equalized at both sides of the flow valve which seats the check valve at the larger diameter end.

Press A 17

1-16

17

OK. As the pressure is equalized at both sides of the flow valve, the check valve is seated. This action causes the valve to move to the smaller diameter end, where it stays until a shift is made.

This action of the flow valve occurs every time there is a sufficient flow of oil through it. However, the flow valve has no purpose other than to disengage the lock-up clutch when a shift is made. At such times, the movement of the flow valve opens ports which exhausts lock-up clutch apply pressure to sump, which shuts off its oil supply. Therefore, it is evident that the primary purpose of the flow valve is to automatically place the transmission in converter operation, during a range shift, either up or down.

Press A 18 1-17

18

Look at Plate I. Which of the following statements applies to this hydraulic schematic?

A. Lock-up clutch pressure is being applied. 19

B. A shift has just been made. 20

C. The flow valve is hydraulically stable. 21

1-18

19

No. Look at Plate I again. The line marked L. U. shows no flow going through it. The lock-up shift valve is also closed. Try this question again.

Press A 18

1-19

20

No. Remember, we said that if a shift has just been made, the clutch pack demanding main oil pressure would relieve the pressure at the check valve end of the flow valve. If this were true, the flow valve piston would travel toward the check valve end. Plate I does not indicate this.

Try the question again. Press A 18

1-20

21

Correct. Main oil pressure has stabilized the flow valve by slowly filling the gap behind the valve. In this condition, the valve is in its normal position.

Look at Plate II. Which one of the following statements applies to this hydraulic schematic?

A. Full main pressure is being applied to one of the clutch packs. 24

B. The lock-up clutch is engaged. 22

C. The transmission is in neutral. 23

1-21

22

No. Look at Plate II again. The flow valve piston is blocking the L. U. (lock-up) path and lock-up pressure is flowing to sump.

Try this question again. Press A 21

1-22

23

No. Look at Plate II. Full main pressure is flowing past the flow valve to the control valve This means a clutch pack is requiring pressure (in addition to one of the splitter clutch packs). This diagram indicates that a shift has just been made.

Press A 24

1-23

24

OK. Full main pressure is bypassing the flow valve to the control valve, indicating that a shift has just been made. Lock-up clutch pressure is being exhausted to sump.

Once the clutch needs are satisfied, oil flows again through the orifice in the check valve and slowly fills the cavity behind the flow valve.

Press A 26 2-24

X(c) = 25

25

The correct answer to the last question is that full main pressure is being applied to one of the clutch packs (in addition to one of the splitter clutch packs).

You have missed one or more of the questions in this sequence of material. Before continuing, review this material again, read carefully, and take your time in answering the questions.

Press A 3

1-25

26

Since the check valve end of the flow valve is of a larger diameter than the other end, more effective oil pressure is applied, moving the valve piston to the other end. This once again provides orificed oil flow to the applied clutches.

Look at Plate III. In your opinion, which of the following statements describes the status of the transmission?

A. Clutch pressure has not been satisfied. 27

B. The converter is performing as a fluid flywheel (all parts are turning as a unit). 29

C. Maximum torque is being exerted through the drive wheels. 28

2-26

27

No. You are incorrect. Notice in Plate II that main pressure is flowing past the flow valve; this occurs when a shift has just been executed and full main pressure is being exerted to the clutch pack(s).

Please try this question again. Press A 26

2-27

28

No. As indicated in Plate III, lock-up pressure is being exerted. When this happens the vehicle's speed has stabilized and the clutches are being held by orificed pressure only. During this time, MINIMUM torque is being exerted, not maximum.

Press A 29

2-28

29

OK. The converter is turning as a unit, indicating low torque is being applied and the clutch packs are being energized by orificed pressure only.

When we talk of the orifice pressure being applied to the clutch pack(s), we are referring to the __________ __________.

A. orifice at the check valve end of the flow valve 30

B. orifice at the smaller end of the flow valve 31

C. Neither A or B answer is correct. 30

2-29

30

No. You are incorrect. Orificed clutch pressure means the plunger has moved to the smaller end of the flow valve, as in Plate III. Oil pressure through the orifice at the small end of the flow valve is enough to satisfy clutch pressure once the initial demand has been taken care of.

Press A 31

2-30

31

OK. The orifice at the smaller end of the flow valve is not supplying enough main pressure to maintain clutch pressure.

Remember that the primary purpose of the flow valve is to place the transmission in converter operation automatically. When this occurs, maximum main oil pressure is being applied.

No action of the neutral signal trimmer valve or valve plug has occurred as a result of the increase in main oil pressure.

Press A 32

2-31

32

When the main pressure circuit is charged, pressure continues to build up in the main pressure line until a point is reached that regulates and maintains that pressure. Oil flowing into a lateral drilled passage of the main pressure regulator valve flows into a central passage, unseats a spring-loaded steel ball check valve and flows out of the valve through a second lateral passage. The point at which oil leaves the valve is between a land on the valve and the valve body.

Press A 33

2-32

33

Pressure, building up at this point, tends to move the valve toward the booster plug against spring pressure. When it moves sufficiently to uncover the port that supplies the converter with oil, all oil in excess of other demands flows to the converter, charging it. The circuit which supplies oil to the converter supplies oil through an orifice to the lubrication circuit, and also through an orifice to the fluid velocity governor.

Press A 34

2-33

34

Oil from the converter flows through the oil cooler to the converter pressure regulator valve. As we learned earlier, if this pressure exceeds 22.5 psi, the converter pressure regulator will open and exhaust the excess oil to sump.

The converter _______ charged before other demands of the main oil pressure circuit are satisfied.

A. is 35
B. is not 36

2-34

35

No. Remember, we said that as pressure builds up in the circuit, the booster plug is moved and a port is uncovered in the main pressure regulator valve. As the port is uncovered, oil is supplied to the converter after other demands have been satisfied.

Press A 36

2-35

36

Good. The converter is charged with main oil pressure after other needs are satisfied, namely the clutch packs.

The same circuit that supplies oil to the converter, also supplies oil to the ___(1)___ and the ___(2)___.

A. (1) oil cooler (2) booster plug 37
B. (1) retarder (2) lubrication circuit 37
C. (1) fluid velocity governor (2) lubrication circuit 38

2-36

37

You have chosen the wrong answer. We said the circuit that charges the converter also charges the lubrication circuit and the fluid velocity governor. See Figure 1 in AM 2-9.

Press A 38

2-37

38

OK. Check Figure 1 in AM 2-9. Notice the solid green detail and the green and white detail, both being fed from the solid yellow line.

In the neutral position, there will be a pressure in the pitot tube line proportional to the speed of the governor collector ring which is attached to the low splitter clutch housing. At idle, this pressure will exert only a negligible force at the end of the lock-up shift valve.

2-38

Press A 39

39

At higher speeds, as the converter approaches coupling phase (when the converter turbine is turning almost at the same speed as the converter pump) less charging oil is needed in the converter. Therefore, excess converter oil pressure opens the converter bypass valve and flows into the converter-out oil line. The converter-in line also connects with a pressure relief valve set at 80 psi; see Figure 1 in AM 2-9.

As we learned before, if pressure in this line goes beyond 80 psi, this valve opens, and exhausts the oil to sump.

Press A 40

2-39

40

As turbine speed increases, pitot pressure directed to the lock-up shift valve increases. Pitot pressure at one end of the lock-up shift valve overcomes spring pressure at the opposite end, allowing main oil pressure to flow to the flow valve. Oil flows through a portion of the flow valve to the lock-up clutch, applying the clutch.

The transmission is now operating in low splitter gear lock-up.

Press A 41

2-40

41

More oil is likely to be flowing in the converter-out line when ______________________.

A. the converter is functioning as a coupling 44

B. the lock-up circuit is not actuated 42

C. the converter pressure relief valve is closed 43

2-41

42

No. When the lock-up circuit is not activated, the converter is multiplying torque from engine output. During this time, more oil is needed by the converter than is needed when it is performing as a fluid coupling.

Press A 44

2-42

43

No. The answer we want here is -- more oil is likely to be flowing in the converter-out line when the converter is acting as a coupling and not as a converter.

Press A 44

2-43

44

OK. The converter-out line is likely to be carrying more oil when the converter is in the coupling phase, rather than in the converter phase.

FIRST RANGE HYDRAULIC ACTION -- In first (low) range, the hydraulic action is the same as described for neutral, with the following exceptions:

1. the low range clutch is activated,
2. the oil in the neutral signal line is exhausted to sump.

Press A 46 X (c) - 45

3-44

45

The correct answer to the last question is: more oil is flowing in the converter-out line when the converter is in the fluid coupling phase.

You have missed one or more of the questions in this sequence. Before going on, review the last few frames --read carefully and take your time in answering the questions.

Press A 24

2-45

46

When the shift was made from neutral range to first range, the neutral signal line, which was charged with main oil pressure, is exhausted to sump. The absence of this oil at the neutral trimmer valve plug allows the neutral trimmer valve to function, thus assuring a smooth and more gradual application of the low range clutch.

Press A 47

3-46

47

In low range, the low range clutch is activated along with the ______________ clutch.

A. intermediate 48

B. low splitter 50

C. lock-up 49

3-47

48

No. The intermediate range clutch packs are for ranges two through six. These cannot be activated alone; one of the splitter clutches also has to be activated. Remember, two clutch packs have to be activated before movement of the vehicle can occur. In this case, it is the low range and low splitter clutch which are activated in the first range.

Press A 50

3-48

49

No. Lock-up would occur only if the vehicle operator kept the vehicle in low range, and if close to maximum speed in that range was attained. Usually this situation does not occur, because ranges are changed rapidly, this doesn't give the pitot pressure a chance to build up and to activate the lock-up valve.

Try this question again. Press A 47

3-49

50

OK. In low range the low splitter clutch and the low planetary clutch are activated.

SECOND RANGE HYDRAULIC ACTION -- In second range, the hydraulic action is the same as in neutral range, except as follows: (1) the low range clutch is activated; (2) the high splitter clutch is activated; and (3) the neutral signal oil line is not charged. All other cavities are exhausted to sump.

Press A 52 3-50

52

In both first and second ranges the low range clutch pack is activated. The difference is between the splitter clutches. In second, the high splitter is activated; in low, the low splitter.

As in the other ranges, lock-up is possible to obtain; however, the turbine has to closely match the rpm of the pump before this will happen.

Press A 54 3-52

54

If an upshift is made to third range, the intermediate range trimmer valve functions for the application of the intermediate range clutch.

If the transmission is operating in lock-up when an upshift or downshift is made, the lock-up clutch is momentarily disengaged until the shift is made, due to the action of the flow valve.

Press A 59 3-54

59

Remember, we said every time a shift is made from one range to another, the converter is taken out of lock-up to compensate for torque requirements.

The component in the transmission hydraulic system that provides for this is called the ______________.

A. flow valve 60
B. lock-up shift valve 60
C. pitot pressure 60

3-59

60

Actually all three are correct; the pilot pressure, flow valve, and lock-up shift valve work together to provide lock-up of the converter. The movement of the flow valve allows pressure to flow from the lock-up valve to the flow valve and on to the lock-up circuit. See Figure 1 in AM 2-9.

Press A 61 3-60

61

THIRD RANGE HYDRAULIC ACTION -- In third range, the hydraulic action is the same as described in neutral range, except that the intermediate range clutch is applied and the neutral signal line oil is exhausted to sump, and as in neutral, the low splitter clutch is applied. All other clutch cavities are exhausted to sump.

Press A 62 3-61

62

When a shift is made to fourth range or a shift is made from fourth to third range, the intermediate range trimmer valve functions to assure a smooth and gradual application of the intermediate range clutch. The orifice in the intermediate range clutch apply line prevents the intermediate range clutch from disengaging quickly.

Thus, when a shift is made to a range other than third or fourth, that range clutch is partially applied before the intermediate clutch is fully disengaged, reducing shift shock, and maintaining continuous torque output during a range shift.

Press A 63 3-62

63

As in neutral range, with an increase in pitot pressure the lock-up clutch is applied. Thus the transmission is operating in third range lock-up.

As in the first and second range, when operating in lock-up, a shift to another range momentarily disengages the lock-up clutch until the shift is made.

FOURTH RANGE HYDRAULIC ACTION -- In fourth range, the hydraulic action is the same as in neutral range except as follows: the intermediate range and high splitter clutches are applied, and the neutral signal line is exhausted to sump. All other clutch cavities are exhausted to sump.

Press A 64

3-63

64

The difference in application between third and fourth ranges is that the ____________ is not applied.

A. intermediate range clutch 65
B. high splitter clutch 66
C. Neither A or B is correct 65

3-64

65

No. The intermediate clutch pack is applied in both third and fourth ranges. The difference between the two is that the high splitter clutch is applied in fourth gear whereas the low splitter clutch is applied in third gear.

Press A 66

3-65

66

OK. The high splitter clutch is activated in fourth gear, as opposed to the low splitter clutch in third gear. Let's continue with fourth gear.

When a shift is made from third range to fourth range, or fourth to third, the only hydraulic action occurring at the selector valve is the directing of oil to the high splitter or low splitter clutch. The intermediate range clutch is applied when operating in either of these ranges.

Press A 68 X(C)-67

4-66

67

The answer to the last question is that the high splitter clutch is activated in fourth gear, whereas the low splitter clutch is activated in third gear.

You have missed one or more of the questions in this last sequence. Read these frames again and take your time in answering the questions.

Press A 44

3-67

68

As in neutral range, with an increase in pitot pressure, the lock-up clutch is applied. The transmission is now operating in fourth range lock-up.

FIFTH RANGE HYDRAULIC ACTION -- In fifth range, the hydraulic action is the same as in neutral range except that the high range clutch is applied and the neutral signal line is exhausted to sump. As in neutral range, the low splitter clutch is applied. All other clutch cavities are exhausted to sump.

SIXTH RANGE HYDRAULIC ACTION -- In sixth range. the hydraulic action is the same as neutral range except that the high range clutch and the high splitter are applied and the neutral signal line is exhausted to sump. All other clutch cavities are exhausted to sump.

Press A 69

4-68

69

When a shift is made from sixth to fifth range or from fifth to sixth range, the only hydraulic action which occurs at the selector valve is the directing of oil to the high splitter clutch, since the high range clutch is applied when operating in either of these ranges.

As in neutral range, with an increase in pitot pressure, the lock-up clutch is applied. The transmission is now operating in sixth range lock-up.

Press A 70

4-69

70

Which of the following statements describes what is occurring when the transmission is in fifth or sixth range?

A. Both ranges utilize the high splitter clutch. 71
B. Both ranges utilize the high range clutch. 72
C. Both ranges utilize the low splitter clutch. 71

4-70

71

No. If both ranges used the high splitter clutch there would be no difference between the wheel revolutions in one gear than the other. The same would be true if the low splitter clutch were used in both ranges.

The correct combination is that both ranges use the high range clutch but in fifth gear the low splitter is used and in sixth gear, the high splitter is used.

Press A 72

4-71

72

OK. Both ranges use the high range clutch. The difference in ratio is provided by the low splitter clutch (fifth range) and the high splitter clutch (sixth range). The gear ratio for the fifth range is 1.00 : 1.

This means there is no difference between the input to the transmission and the output. In sixth range the ratio is .67 : 1. This means that ______________.

A. the drive shaft is turning faster than the crankshaft 74

B. the drive shaft is turning slower than the crankshaft 73

C. more torque is being applied through the transmission than there is in fifth gear 73

4-72

73

No. When the engine crankshaft is turning faster than the driveshaft, the vehicle is in 1st, 2nd, 3rd, 4th or reverse. It is in these speeds where a multiplication of torque is needed. In 5th or 6th range there is a relatively small amount of torque required.

Press A 74

4-73

74

OK. When the transmission is in sixth range the vehicle is said to be in "overdrive". Just as in an automobile, more speed can be obtained in this range, with less engine effort.

REVERSE RANGE HYDRAULIC ACTION -- In reverse range, the hydraulic action is the same as in neutral range except as follows: the reverse range clutch is applied, the booster signal line is charged and the neutral signal oil line is exhausted to sump. All other clutch activities are exhausted to sump.

Press A 75

4-74

75

When the booster signal oil line is charged, the main-pressure regulator valve increases main oil pressure while operating in reverse.

When the shift was made from neutral range to reverse range, the neutral signal line which was charged with main oil pressure is exhausted to sump. The absence of this oil at the neutral trimmer valve plug allows the neutral trimmer valve to function, thus assuring a smooth and more gradual application of the reverse range clutch.

Press A 76

4-75

76

As in neutral range, with an increase in turbine speed, the lock-up clutch is applied. The transmission is now operating in reverse range lock-up.

In reverse range, the gear ratio differential is the greatest of all the gears. In the 5960 Allison Transmission, it is 5.12:1. This means that for every revolution the driveshaft is making, the crankshaft is turning 5.12 times. Remember, the first number (5.12) refers to the input whether it be the driveshaft through the differential to the wheels, or from the engine through the transmission to the driveshaft.

Press A 83

4-76

83

LOCK-UP SHIFT VALVE -- Flow of oil to and from the lock-up clutch piston cavity is controlled by the lock-up clutch shift valve. See Figure 1 in AM 2-9.

The shift valve is a spool-type valve. Movement of the valve in its bore opens or closes ports, which determines whether the lock-up clutch is engaged or disengaged. This valve is located in the lock-up valve body.

Press A 84

4-83

84

Working in conjunction with the lock-up shift valve is the spool-type flow valve, located in the lock-up valve body. Its function is to override the lock-up shift valve so as to disengage the lock-up clutch when shifts are made, up or down. The movement of the valve exhausts lock-up clutch apply pressure to sump.

It is necessary to disengage the lock-up clutch when shifting because ______________.

A. there are varying degrees of torque required in the different ranges 86

B. lock-up clutch pressure must be released to move the manual control valve 85

C. oil in the lock-up circuit is required for the planetary clutch pistons 85

4-84

85

No. The lock-up clutch must be released when shifting occurs, because of the varying degrees of torque that are required when going from one range to another.

Press A 86

4-85

86

OK. The lock-up clutch is activated only when the turbine and pump almost equal each other in rpm. If the clutch were continually activated, the converter would serve as a fluid coupling--defeating the purpose of the converter.

In a previous film we said the intermediate range clutch trimmer valve has to do with smooth application of the intermediate range clutch. This valve is best described as a ____________.

A. safety device that acts as a sump for this circuit 87
B. device that retains a part of the hydraulic pressure going to the intermediate range clutch 87
C. device that prevents initial full main pressure from activating the intermediate range clutch 88

4-86

87

No. This valve acts as a buffer in this hydraulic circuit. It prevents the initial full force of the main pressure from activating the intermediate clutch suddenly. The main pressure is applied eventually, but the shock is removed by this valve.

Press A 88

4-87

88

OK. This valve prevents jerking of the vehicle when the intermediate ranges are selected by the operator.

Another valve that prevents jerking in other ranges is called the neutral trimmer valve.

The pitot circuit is best described as a ____________.

A. governor 90
B. pump 89
C. clutch 89

4-88

89

No. The answer we want here is governor. As you recall, it is called the fluid velocity governor. Its purpose is to provide the pressure necessary to actuate the lock-up shift valve.

Press A 90

4-89

90

OK. The pitot circuit provides the pressure necessary to actuate the lock-up valve.

The pitot pressure line is activated when ____________ ____________.

A. a shift from one range to another is made 91
B. the turbine almost equals the pump speed 93
C. maximum torque is being applied in any range 92

4-90

91

No. You will recall that when a shift is made, the flow valve moves, and shuts off the lock-up flow of oil pressure. This action allows the converter to operate as a torque multiplier.

Press A 93

4-91

92

No. When the converter is multiplying torque, as it does immediately after a shift change, the pitot line is deactivated until the speed is equalized in that range and the turbine speed almost matches the pump speed.

Press A 93

4-92

93

OK. The pitot pressure line is activated when the turbine in the converter reaches an rpm which almost matches pump rpm.

In 3rd range forward, the gear ratio is 2.01:1; this means that the ______________.

A. intermediate range planetary is turning over twice the speed that the driveshaft is turning 94
B. driveshaft is turning over twice the speed of the rear axle 94
C. crankshaft is turning over twice the speed of the transmission output flange 95

4-93

94

No. The correct answer is that the crankshaft is turning over twice the speed of the output flange of the transmission.

Press A 95

4-94

95

Congratulations. You have done well. That completes this film lesson on the CLBT 5960 hydraulic system.

Press REWIND.

X (c)- 96

4-95

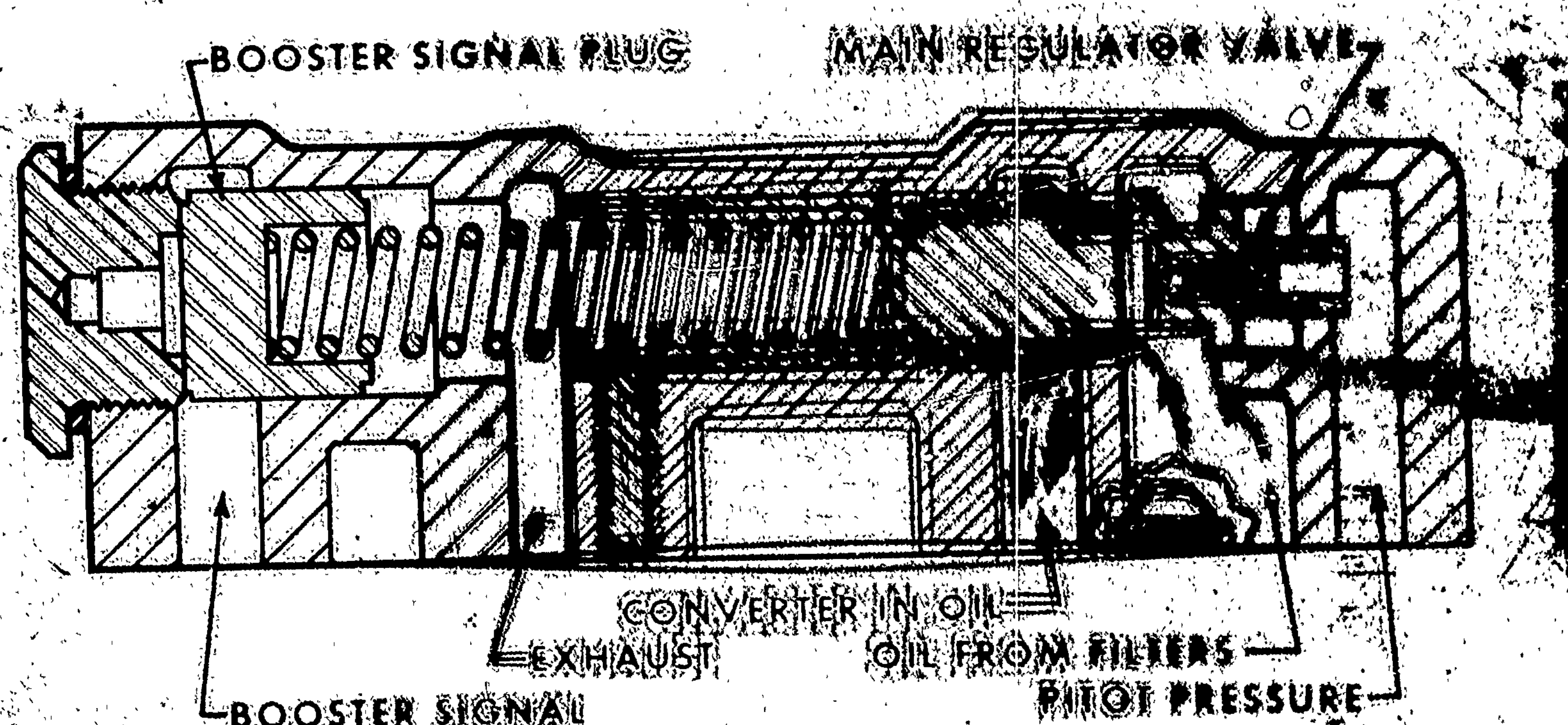
96

The answer to the last question is that the crankshaft is turning over twice the speed of the transmission output flange.

You have missed one or more of the questions in this sequence of material. Please review the last few frames carefully and take your time in answering the questions.

Press A 66

4-96



Main pressure regulator valve in dump position

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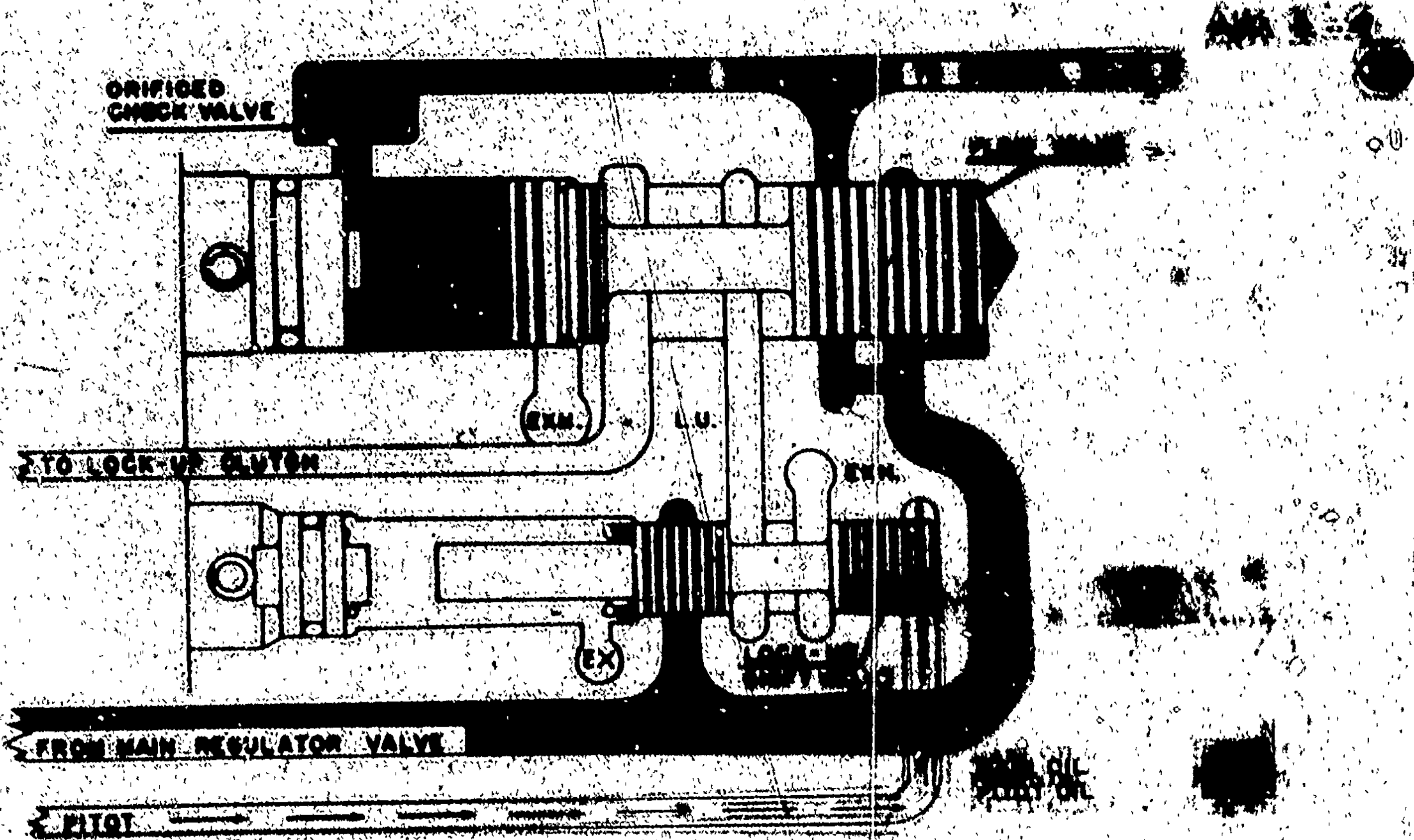
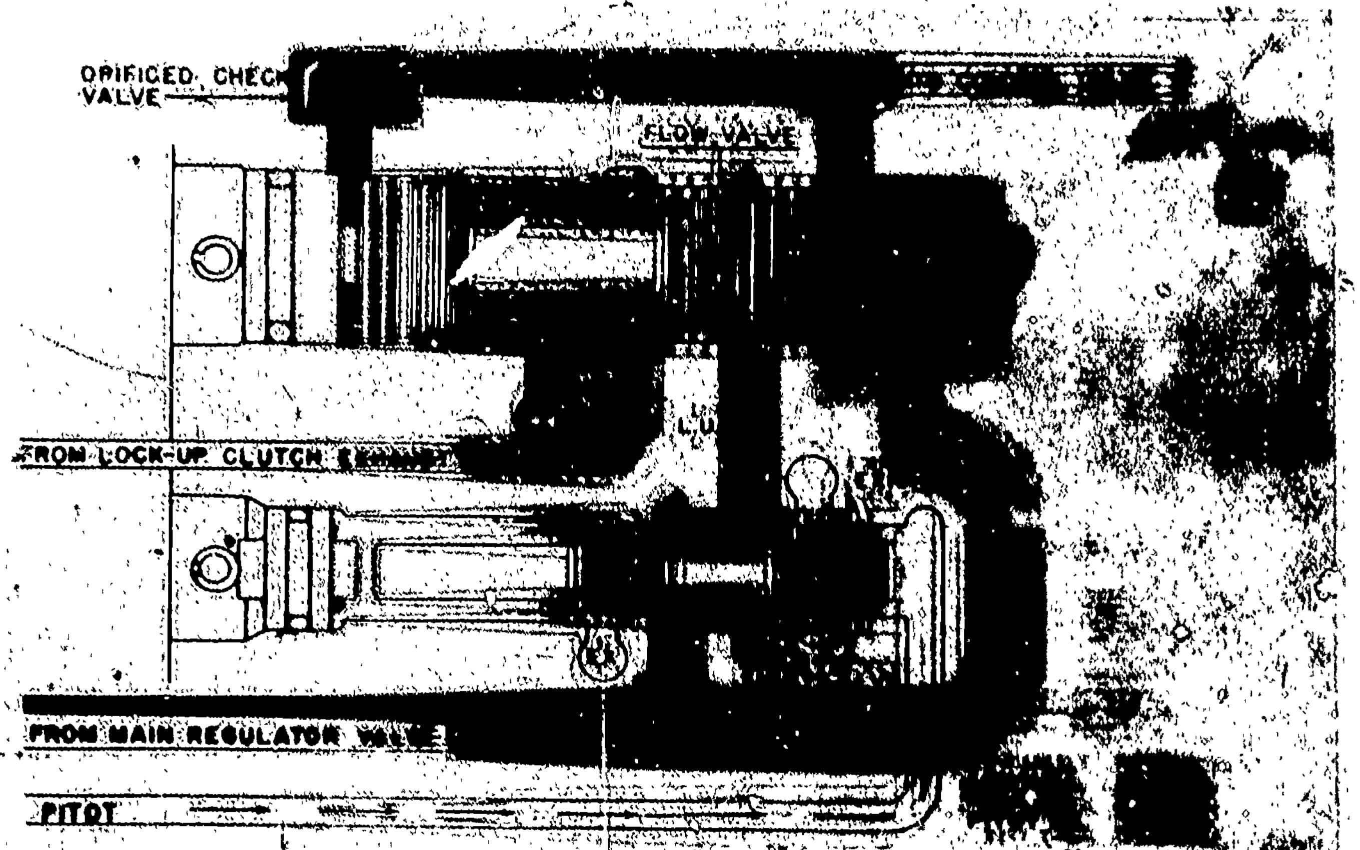
Cleveland Ohio 44115



Flow valve in closed position



Flow valve in opened position

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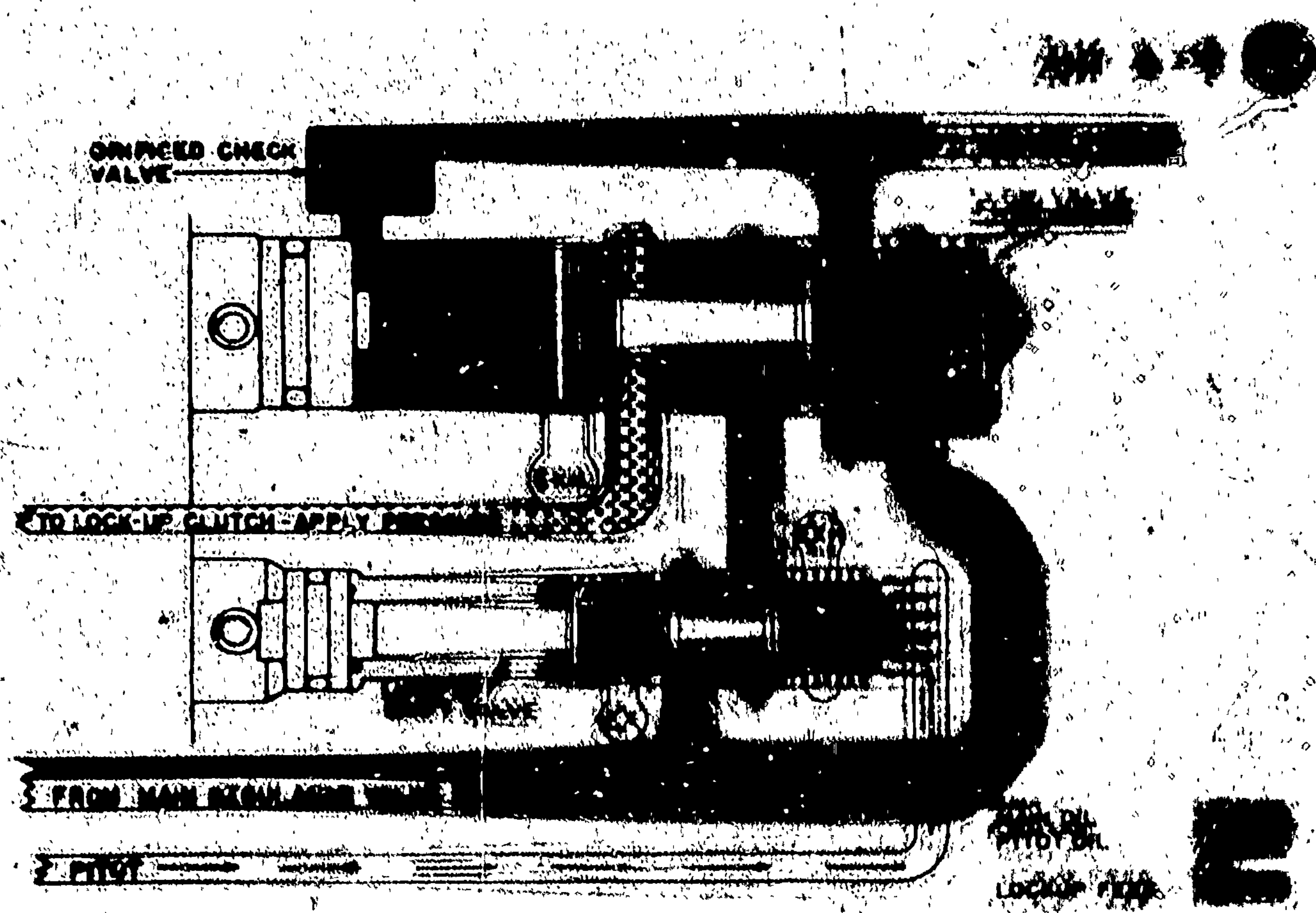
ENGINEERING
INSTITUTE

Carnegie Ave
Ohio 44115



Lock-up shift valve in opened position

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INSTRUCTOR'S GUIDE

Title of Unit: AUTOMATIC TRANSMISSIONS - HYDRAULIC SYSTEM (PART I)

AM 2-9
6/2/67

OBJECTIVES:

1. To cover in detail the oil flow through a CLBT 5960 Allison Transmission. Each component that contributes in this flow path will also be discussed.
2. To follow the oil flow through each range when the transmission is shifted.
3. To cover the transmission brake operation, and precautions to observe when operating the brake.

LEARNING AIDS suggested:

VU CELLS:

AM 2-9 (1) Main pressure regulator valve in dump position

AM 2-9 (2) Flow valve in closed position

AM 2-9 (3) Flow valve in opened position

AM 2-9 (4) Lock-up shift valve in opened position

NOTE TO INSTRUCTOR:

There should be Allison wall charts, training films, slides, etc., at your center. If not, contact your local Allison distributor for these and other aids he may have available for use.

QUESTIONS FOR DISCUSSION AND GROUP PARTICIPATION:

1. How is the input pressure pump driven?
2. At what speed is the input pump driven?
3. At what points in the transmission is oil from the input pump supplied?
4. What two functions does the main regulator valve perform?
5. Under what conditions does oil flow behind the main regulator valve?
6. When is the maximum amount of pitot pressure applied on the regulator valve?
7. When pitot pressure exceeds main pressure, what is happening?

8. When does booster signal pressure effect main oil pressure?
9. When will the converter IN passage blow-off valve open?
10. When does oil bypass the converter?
11. Where does converter OUT oil go from the converter?
12. How are parts of the transmission such as planetary gearing lubricated?
13. What is the purpose of the flow valve? Discuss its operation.
14. Discuss oil flow during each shift change.
15. How does the brake hydraulic system operate?
16. What precautions should be used when applying the brake (transmission)?