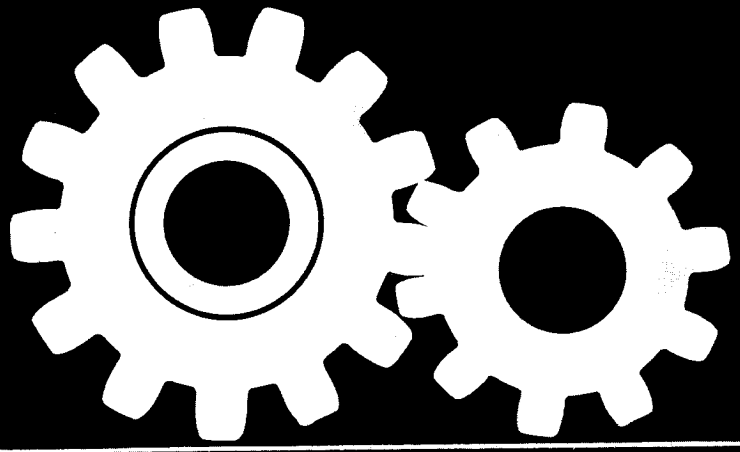
TRANSMISSION MODULATION MANUAL



CLARK

Construction Machinery

CLARK TRANSMISSION MODULATION MANUAL

PUBLICATION NO. 3284

THEORY OF OPERATION and TROUBLESHOOTING GUIDE

2M 846 KE

THEORY OF OPERATION

TRANSMISSION MODULATOR VALVE OPERATIONAL DESCRIPTION

Both directional clutch assemblies are controlled by individual modulator valves. The pressure rise at side "A" of the regulator spool is the same as that applying the clutch piston. Supply flow to the clutch and modulator is limited by a flow limiting orifice. From this limited flow the regulator spool drains flow to the vent port. The regulator spool restricts flow through the vent port to build clutch pressure at a predetermined rate. Once the vent flow is shut off, only minimal flow passes through the flow limiting orifice to make up for normal spool and clutch leakages. Pressure on either side of the orifice is virtually identical and full regulated system pressure is applied at the clutch piston.

When forward direction is selected the oil under pressure enters the port on the "A" side of the regulator spool. This passes through the dampening orifice. The pressure force on the spool area shifts the spool to the right exposing the vent port. The time required to shift the regulator spool over to expose the vent port shows up as a pressure spike at the beginning of the pressure versus time chart.

The movement of the regulator spool is opposed by the regulator and accumulator springs. This provides an initial low pressure head of approximately 20 psi [137,9 Kpa] on the "A" side of the spool. This 20 psi [137,9 Kpa] is represented as a horizontal line on the pressure versus time chart immediately following the spike. Oil flows through the regulator spool orifice due to a pressure imbalance. Pressure at side "A" is constantly 10 psi [68,9 Kpa] higher than side "B" as a result of the added force of the side "B" spring.

The 10 psi [68,9 Kpa] supply through the regulator spool orifice gives a controlled flow rate. This controlled flow establishes the time it takes to fill the accumulated cavity.

As the accumulator cavity is filled, the accumulator spool is forced against the accumulator springs. As the springs compress their force increases causing the hydraulic pressure in the accumulator cavity and "B" side of the regulator spool to increase. Pressure on the "A" side of the regulator spool increases with the opposing force on the "B" side.

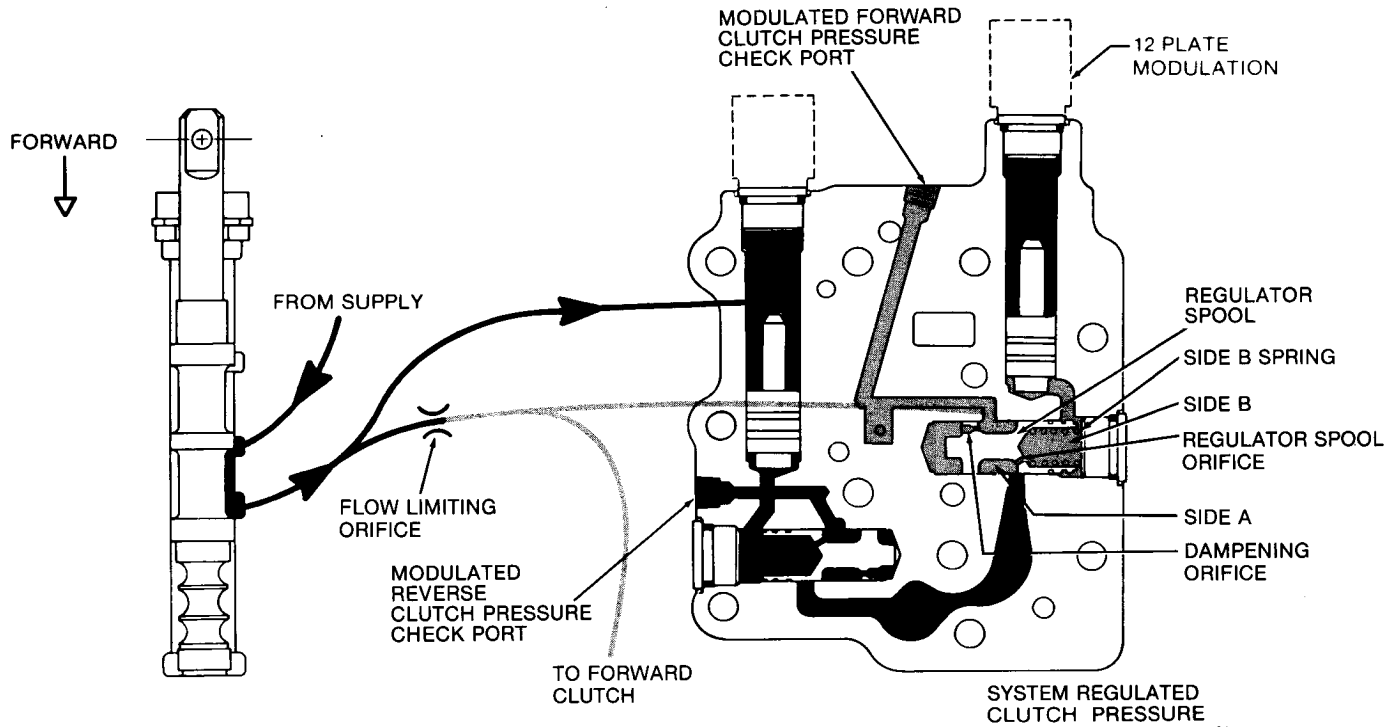
This causes the rising slope in the clutch pressure versus time chart. The rate of this rise is controlled by the accumulator spring force. Once the accumulator spool is stroked to its limit, pressure on "A" and "B" side of the regulator spool is balanced since no flow passes through the regulator spool orifice. The regulator spool spring pushes the regulator spool to the left shutting off the vent flow. The clutch and modulator pressure rapidly rise to the system regulated clutch supply pressure setting. This is the vertical line on the clutch pressure versus time chart.

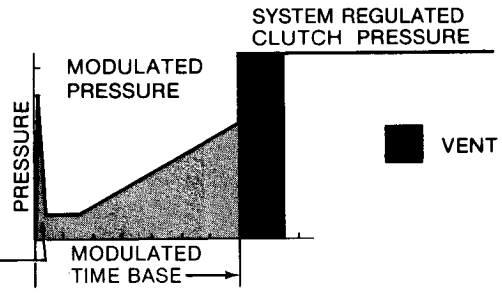
The entire modulator sequence of events occurs in less than two seconds. The steady rise of clutch pressure increases the clutch driving torque which results in a smooth clutch application.

When forward direction is selected the reverse clutch and modulator are vented through the control valve to the transmission sump. The reverse accumulator cavity is vented back through the regulator spool orifice. To hasten the reset time of the accumulator, immediately preparing the transmission for a directional shift, full system regulated clutch supply pressure from the forward control valve is directed to the spring cavity of the reverse accumulator.

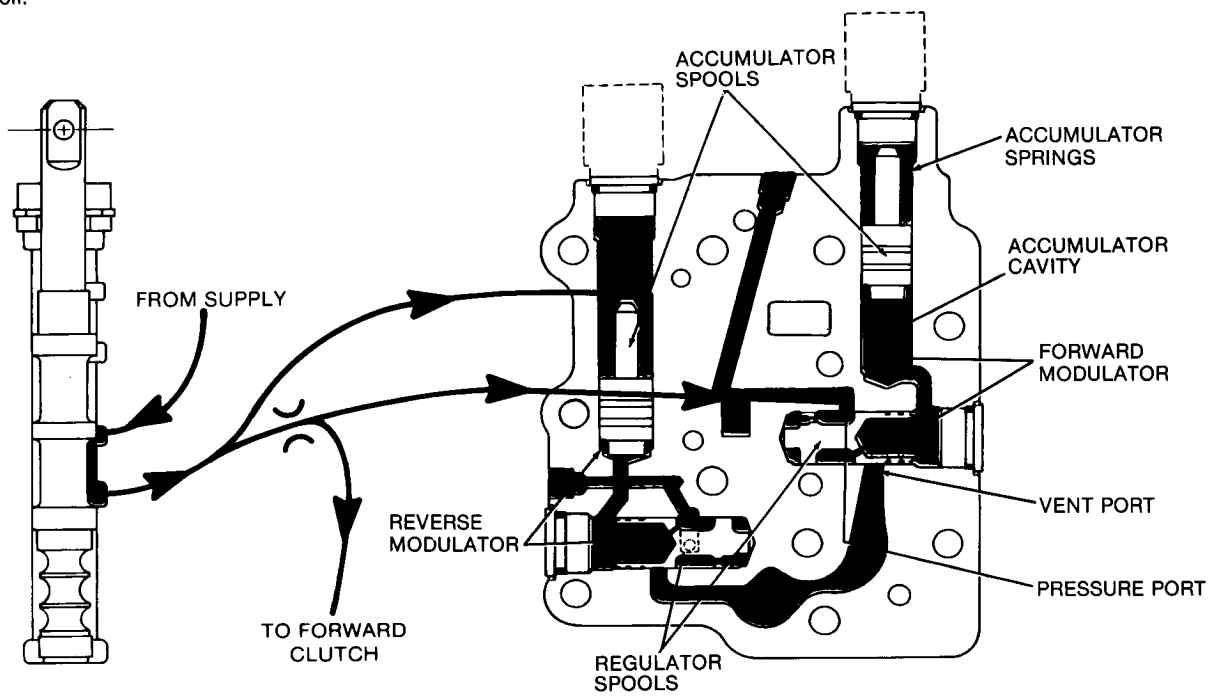
When reverse direction is selected the reverse clutch and modulator function through the same sequence of events as the forward clutch and modulator. This same sequence of events also applies to the lock-up modulators. (See last page for the modulated lock-up plumbing diagram).

28000 SERIES MODULATION

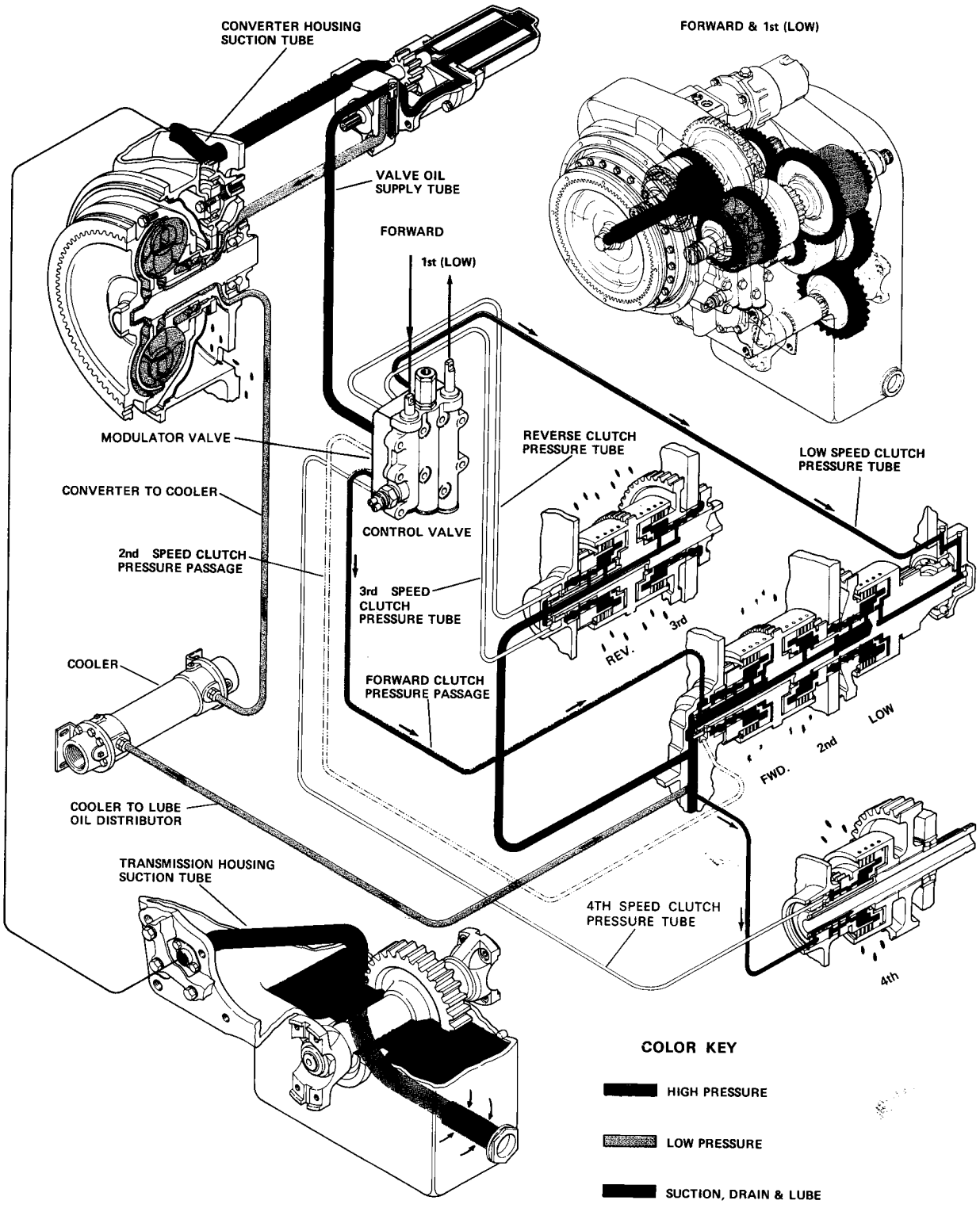




This pressure spike is time required for spools to react.
The spike pressure is used to quickly fill the clutch pressure supply passages with oil.



CLARK



28000 SERIES TRANSMISSION PLUMBING DIAGRAM

Trouble Shooting Guide — Modulated Transmissions

I Introduction

Standard Clark Service manual pressure and flow check procedures are not adequate for modulated transmission assemblies. However, relatively simple procedures may be employed to assist in trouble shooting these transmissions. These procedures are written to assist in leakage checks and to enable isolation of problem areas.

II Modulated Transmission Design

A. Modulated Transmission Concepts

1. A complete modulation circuit is provided for each clutch being modulated. Included are a differential pressure regulator and a spring loaded accumulator. Such a valve circuit is shown schematically by Figure 1.
2. All modulator circuits are in hydraulic parallel to clutch supply lines. They do not interrupt the circuit at any time. A flow limiting orifice is designed into each modulation valve assembly. Consequently conventional regulated pressure ports, often noted as clutch pressure ports no longer indicate actual clutch pressure for forward and reverse clutches.
3. With the exception of the 18000 transmission all current modulated transmission directional clutch pistons employ a fixed bleed orifice. Due to the combination of clutch leakage, piston bleed orifice flow rate, and flow limiting orifices, directional clutch pressure will be slightly lower than regulated pressure.

B. Pressure Gage Ports

1. Refer to figures 2, 3 and 4 for locations of directional clutch pressure check ports.
2. Note that the **control valve** forward and reverse check ports of 18000 and 28000 transmissions **cannot** be used to check actual clutch pressures of modulated units.
3. The 4000, 5000, 8000 and 16000 transmission control valve ports **can** be used to check directional clutch pressure.

C. Pre-Test Study

1. Proper transmission identification is required prior to test. For example the 28000 transmission check out procedures are different for an R model and HR model. Modulated 28000 transmissions are available with standard length directional clutches (6 friction discs) and extended directional clutch (12 friction disc) assemblies.
2. Modulated transmission pump size should be determined prior to test. Higher capacity pumps are used for 28000, 4000, 5000, 8000 and 16000 modulated transmissions.

III Transmission Leakage Studies

A. Clutch Pressure Study (Technique #1)

1. Locate gage ports for regulated, forward clutch, and reverse clutch pressures. A 400 PSI [2758,0 Kpa] gage is recommended for use at these ports.
2. Warm system up to operating temperature (180 to 200° F [82,2-93,3° C] at converter outlet). **Always use parking brake when making pressure checks.**

3. At idle (assumed to be 650-800 RPM) measure and record directional clutch pressures in forward and reverse (use 3rd or 4th range). At idle, with the direction control in neutral, measure and record system regulated clutch pressure, in all ranges, 1, 2, 3, 4.

4. Use following table to evaluate data. Note that data indicates 2nd clutch repair is required.

Example (Extended Clutch R28423)

Clutch Dir. — Range	System Regulated Clutch Pressure PSI	Kpa	Mod. Clutch Pressure Fwd. PSI	Kpa	Rev. PSI	Kpa
Fwd. — 4th	255	[1758,1]	240	[1654,7]	0	
Rev. — 4th	255	[1758,1]	0		240	[1654,7]
Neut. — 1	255	[1758,1]	0		0	
Neut. — 2	**235**	[1620,2]	0		0	
Neut. — 3	255	[1758,1]	0		0	
Neut. — 4	255	[1758,1]	0		0	

Table No. 1
Clutch Pressure Study at Idle

Due to the combination of clutch leakage, piston bleed orifice flow rate, and flow limiting orifices, directional (fwd. and rev.) clutch pressure will be up to 20 psi [137,9 Kpa], lower than the system regulated clutch pressure.

Trans. Model	Direction Clutch Configuration	Conv. GPM	*Charge Pump Assembly Liters	Aux. GPM	Liters	System Regulated Clutch Pressure PSI	Kpa	Maximum Range Clutch Reg. Pressure Difference PSI	Kpa
18000	Std-8 disc	16	[60,5]			180 - 220	[1241,1 - 1516,8]	5	[34,4]
R28000	Std-6 disc	21	[79,4]			240 - 280	[1654,7 - 1930,5]	5	[34,4]
HR28000	Std-6 disc	20	[75,7]			240 - 280	[1654,7 - 1930,5]	5	[34,4]
R28000	Ext-12 disc	21	[79,4]	18	[68,1]	240 - 280	[1654,7 - 1930,5]	5	[34,4]
HR28000	Ext-12 disc	20	[75,7]	21	[79,4]	240 - 280	[1654,7 - 1930,5]	5	[34,4]
R28000	Ext-12 disc	21	[79,4]	15	[56,7]	240 - 280	[1654,7 - 1930,5]	5	[34,4]
HR28000	Ext-12 disc	20	[75,7]	15	[56,7]	240 - 280	[1654,7 - 1930,5]	5	[34,4]
4000	Ext.10 disc	40	[151,4]			240 - 280	[1654,7 - 1930,5]	5	[34,4]
5000	Ext-16 disc	50	[189,2]			180 - 220	[1241,1 - 1516,8]	5	[34,4]
8000	Ext-16 disc	65	[246,0]			180 - 220	[1241,1 - 1516,8]	5	[34,4]
16000	Ext-16 disc	80	[302,8]			180 - 220	[1241,1 - 1516,8]	5	[34,4]

* Some 28000 units are set up with auxiliary lube pump.

B. Lube Pressure Study (Technique #2)

1. Locate lube pressure port. (Refer to Figures 2 and 3). Install pressure gage. (100 PSI [689,4 Kpa] max. range). **Always use parking brake when making pressure checks.**
2. Warm transmission to operating temperature (180-200° F). [82,2-93,3° C].
3. Stall converter at **full throttle**, taking care not to overheat converter by extended stall.
4. Place directional control in neutral at **full throttle**. Measure and record lube pressure in all ranges.

Example (Extended Clutch R28423)

Dir. — Range	Lube Pressure	Kpa
Fwd. — 4th	42	[289,5]
Rev. — 4th	41	[282,6]
Neut. — 1	43	[296,4]
Neut. — 2	**30**	[206,8]
Neut. — 3	42	[289,5]
Neut. — 4	42	[289,5]

Note: Example data indicates leaking in 2nd clutch.

5. Refer to table 2 and evaluate data.

Table No. 2
*Full Throttle Lube Pressure Study

Trans. Model	Direction Clutch Configuration	Charge Pump Assembly Conv. GPM	Liters	Aux. GPM	Liters	Minimum Lube Pressure PSI	Kpa	Maximum Diff. In Lube Pressure PSI	Kpa
18000	Std-8 disc	16	[60,5]			15	[103,4]	8	[55,1]
R28000	Std-6 disc	21	[79,4]			12	[82,7]	5	[34,4]
HR28000	Std-6 disc	20	[75,7]			20	[137,9]	5	[34,4]
R28000	Ext-12 disc	21	[79,4]	18	[68,1]	35	[241,3]	5	[34,4]
HR28000	Ext-12 disc	20	[75,7]	21	[79,4]	50	[344,7]	5	[34,4]
R28000	Ext-12 disc	21	[79,4]	15	[56,7]	35	[241,3]	5	[34,4]
HR28000	Ext-12 disc	20	[75,7]	15	[56,7]	45	[310,2]	5	[34,4]
4000	Ext.10 disc	40	[151,4]			16	[110,3]	5	[34,4]
5000	Ext-16 disc	50	[189,2]			14	[96,5]	5	[34,4]
8000	Ext-16 disc	65	[246,0]			24	[165,4]	5	[34,4]
16000	Ext-16 disc	80	[302,8]			20	[137,9]	5	[34,4]

*Full throttle range applicable (2200-2800 RPM)

IV Techniques for Problem Isolation

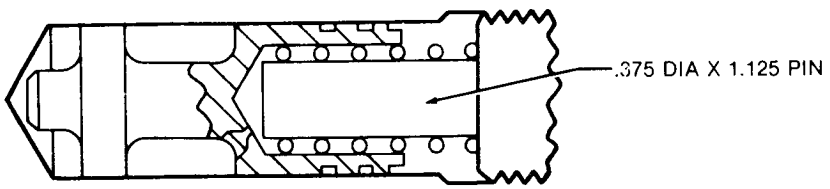
A. Transmission Malfunctions

1. Low Pressure (Clutch & Lube)

A typical failure would be a lack of propulsion due to little or no pressure in forward or reverse clutches.

The lack of acceptable directional clutch pressure may be due to clutch leakage or due to modulator malfunction. To isolate proceed as follows.

a. Install .375 dia. x 1.125 [9,525 x 28,575 mm] pin inside modulator regulator spool. This blocks valve shut.



b. If pressure at clutch increases to acceptable level, assume clutch is good. Assume modulator malfunction.

c. If pressure remains low, assume clutch is leaking.

ALWAYS REMOVE PIN AFTER TEST. DO NOT ATTEMPT TO ELIMINATE MODULATION BY BLOCKING REGULATOR SHUT. DIFFERENT CLUTCHES ARE REQUIRED TO ELIMINATE MODULATION SAFELY.

2. **Harsh Shift or Excessively Delayed Shift**

   If modulation is ineffective, problem could be associated with modulator or with clutch. If problem is in modulator, a regulator or accumulator spool may be bound up. Accumulator spring breakage is also possible. To study, observe action of a directional clutch pressure gage. On a modulated clutch you should note a distinct pause in application of pressure. If clutch pressure remains at a low level with the engine at idle and doesn't rise, repair of the modulator valve or clutch pack is indicated.

B. Modulation Valve Service

1. Only the springs should be replaced when servicing modulation valve assemblies. If regulator or accumulator spools are damaged replace the complete valve assembly.
2. The modulation valve assemblies can be cleaned. The regulator spool orifice (approximately .030 [0.76 mm] diameter) should be checked for dirt. Spools should all be free to move in their respective bores.
3. Flow limiting orifices of modulated 4000, 5000 and 8000 modulations are incorporated in the directional valve spools. Consequently special control valve assemblies are required.

MODULATION VALVE SCHEMATIC

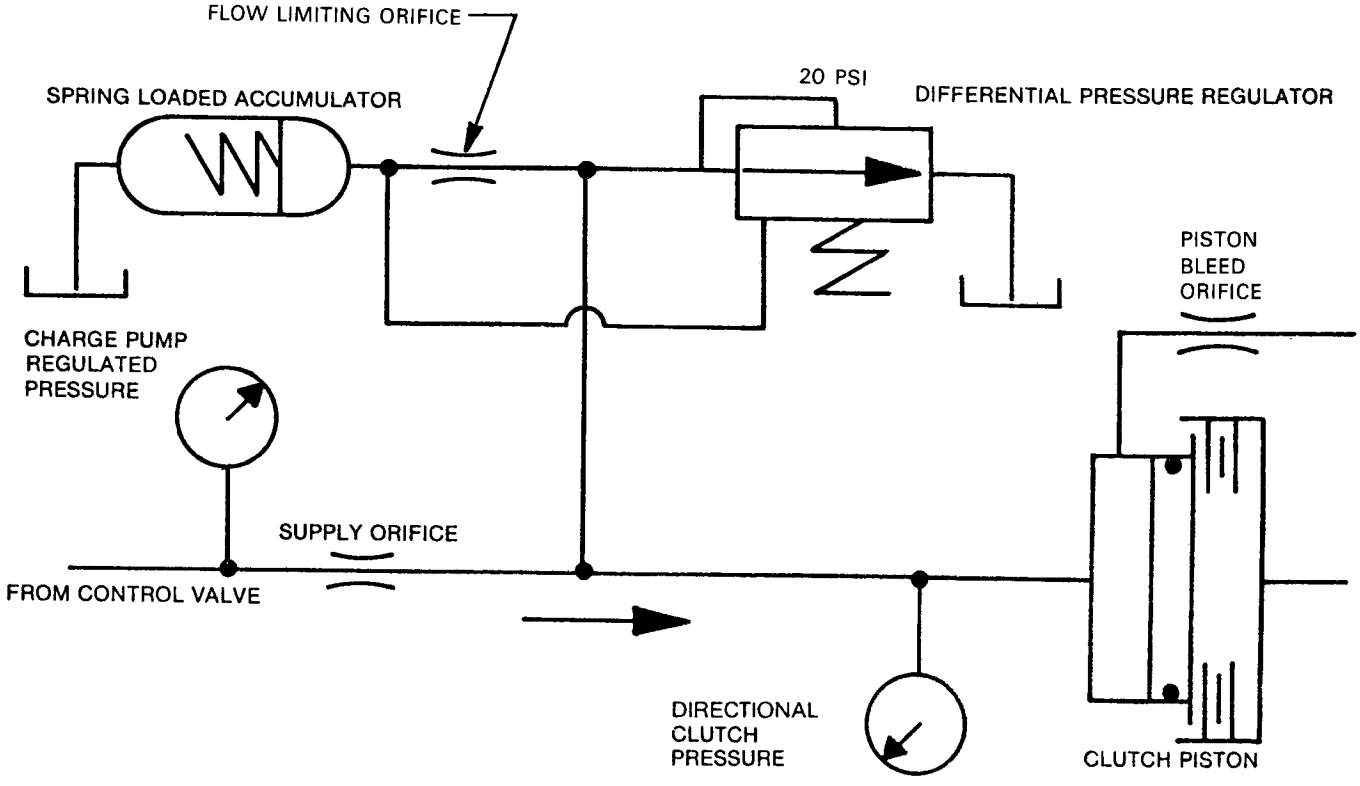
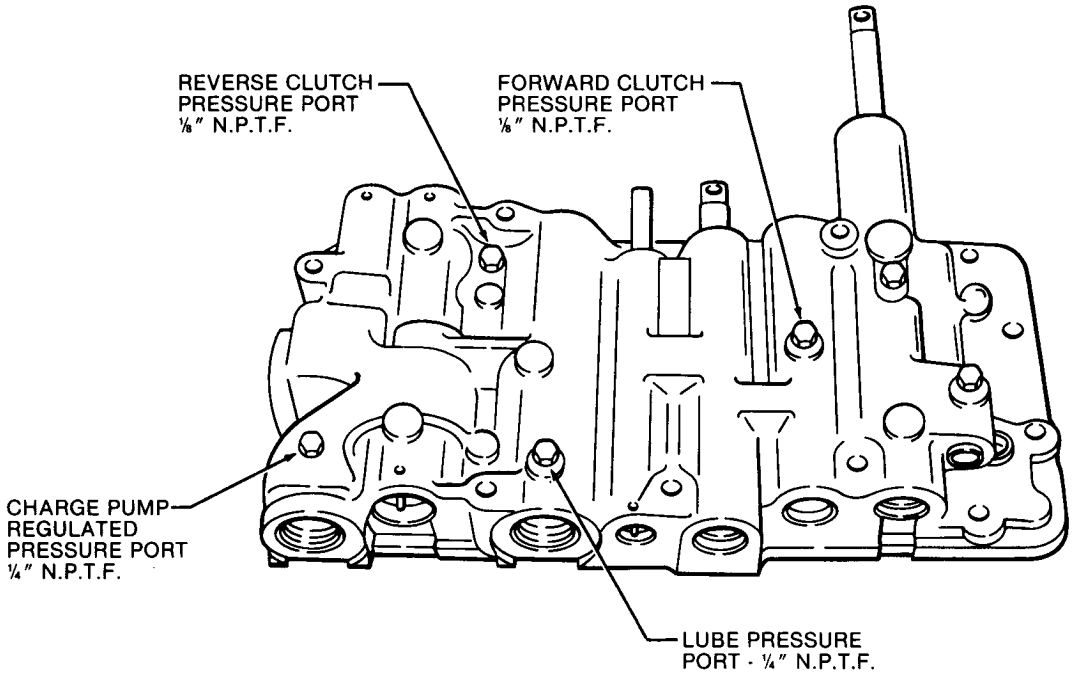
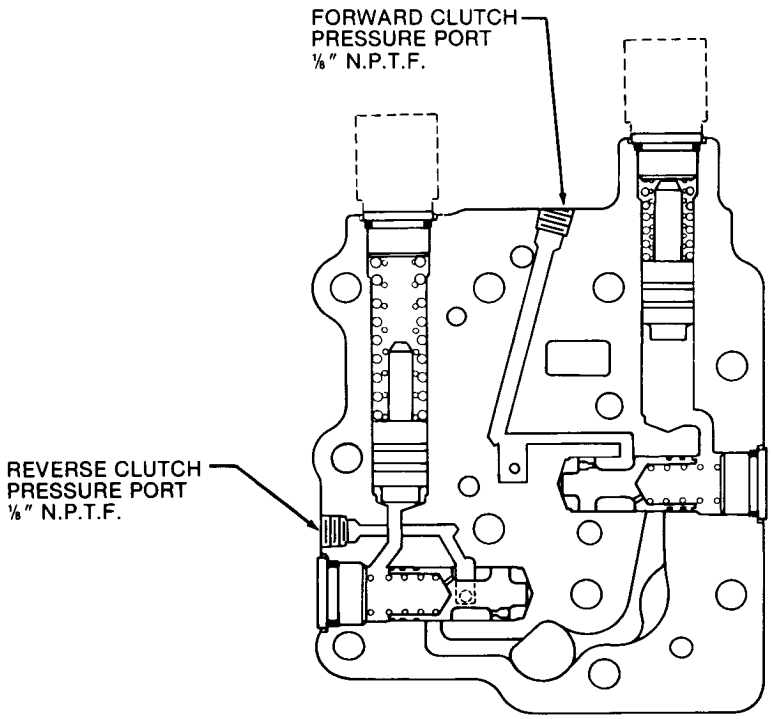


FIGURE 1

4000 - 5000 - 8000 - 16000 CHECK PORTS



MODULATED 28000 TRANSMISSION



NOTE: DO NOT USE 28000 CONTROL VALVE PORTS FOR MODULATED TRANSMISSION DIRECTIONAL CLUTCH PRESSURES

FIGURE 2

18000 MODULATED TRANSMISSION
CHECK PORTS

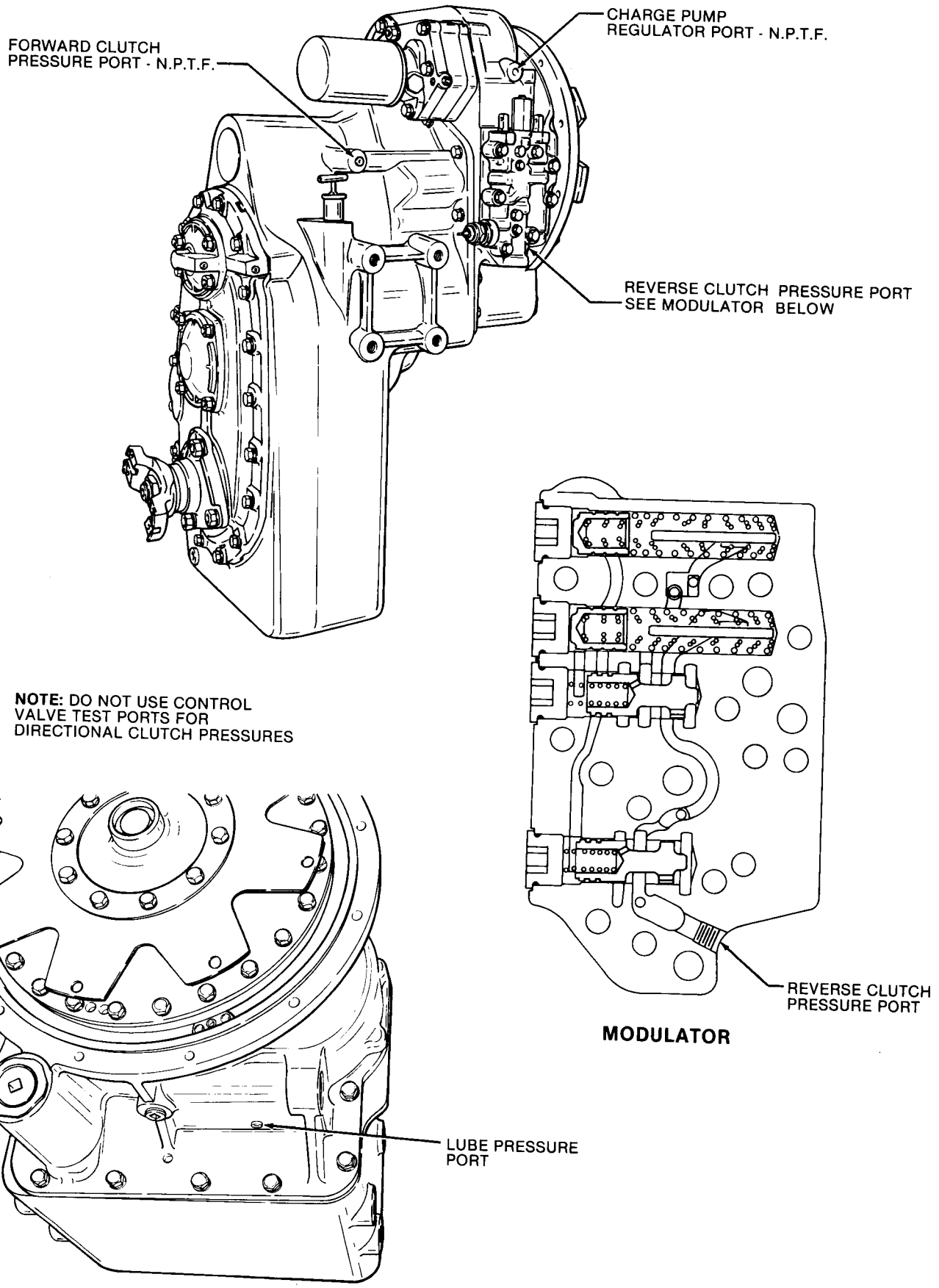
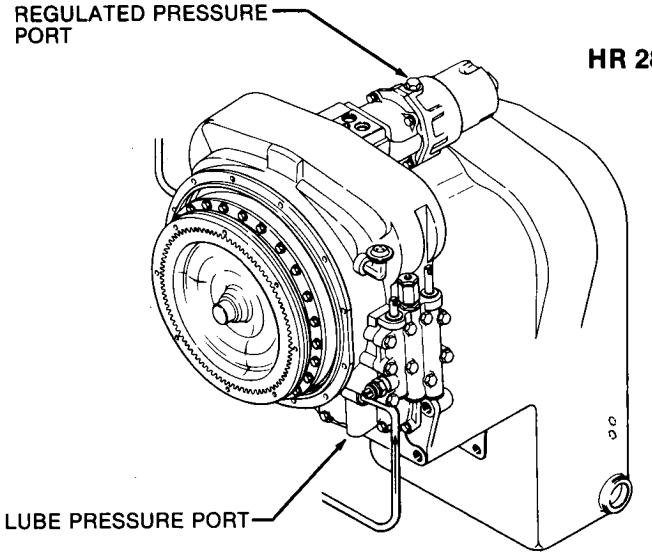


FIGURE 3

TEST PORT LOCATIONS
MODULATED 28000 TRANSMISSIONS



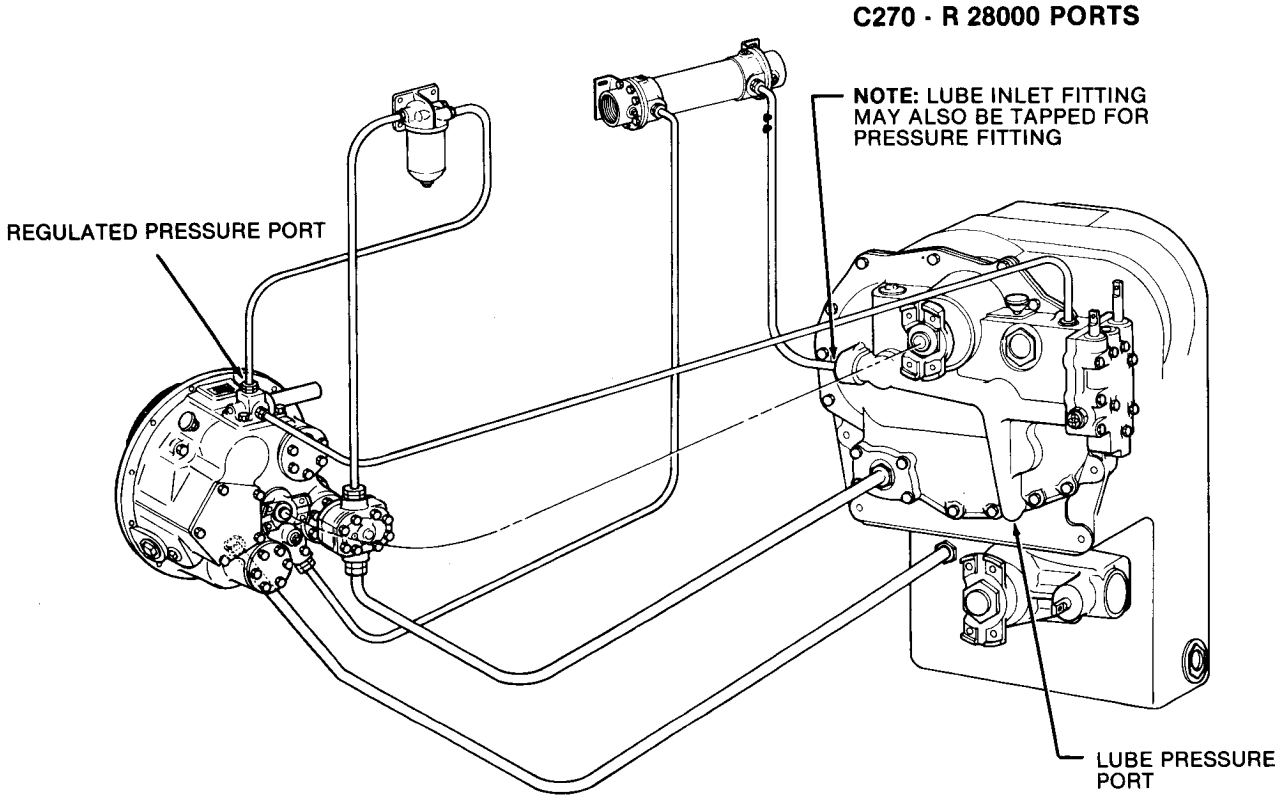
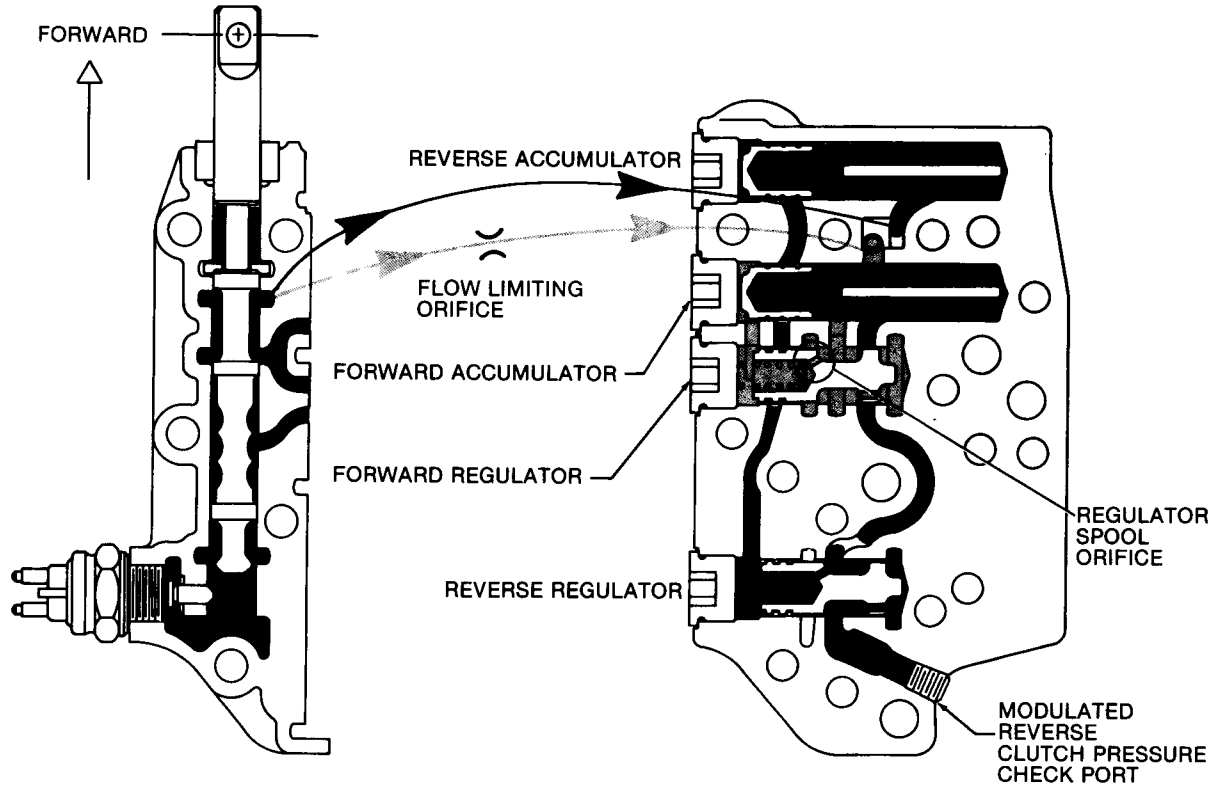
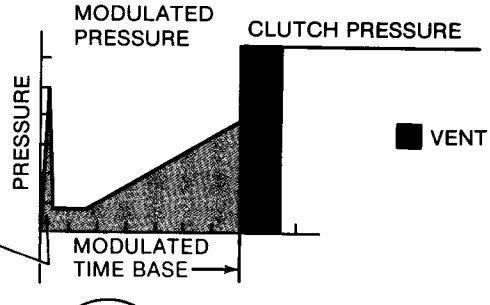


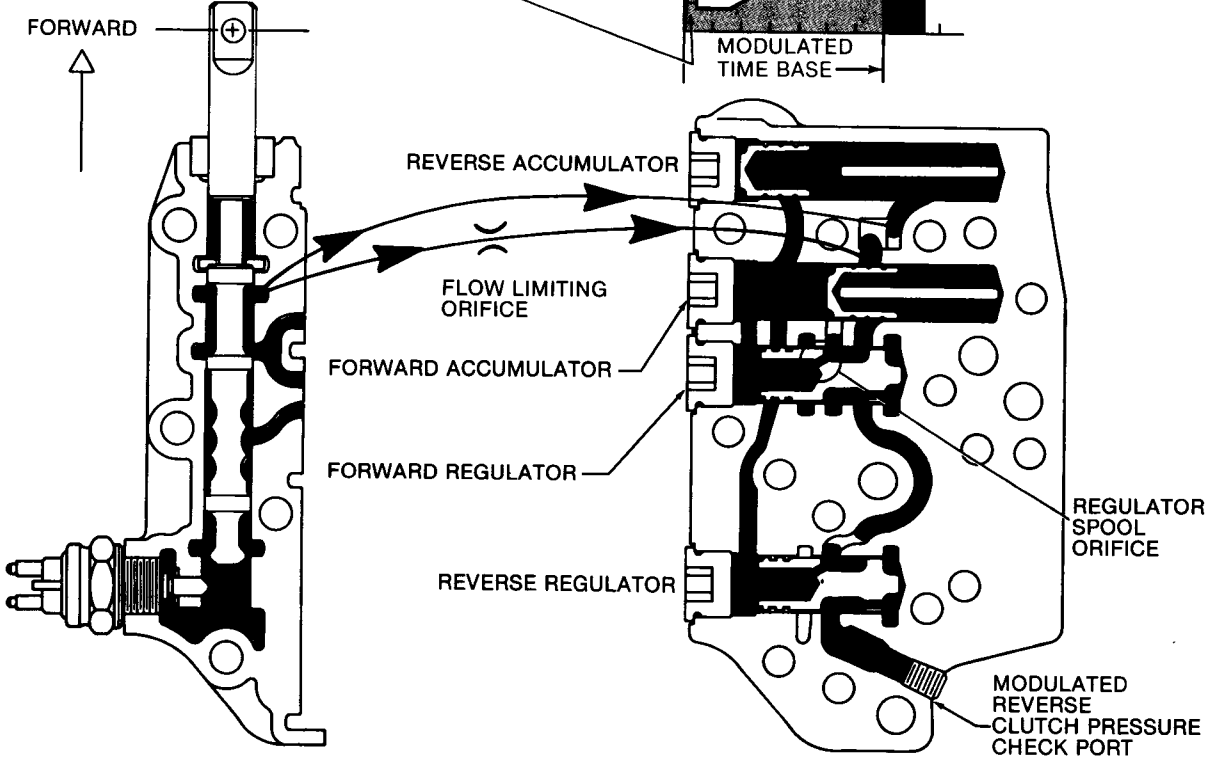
FIGURE 4

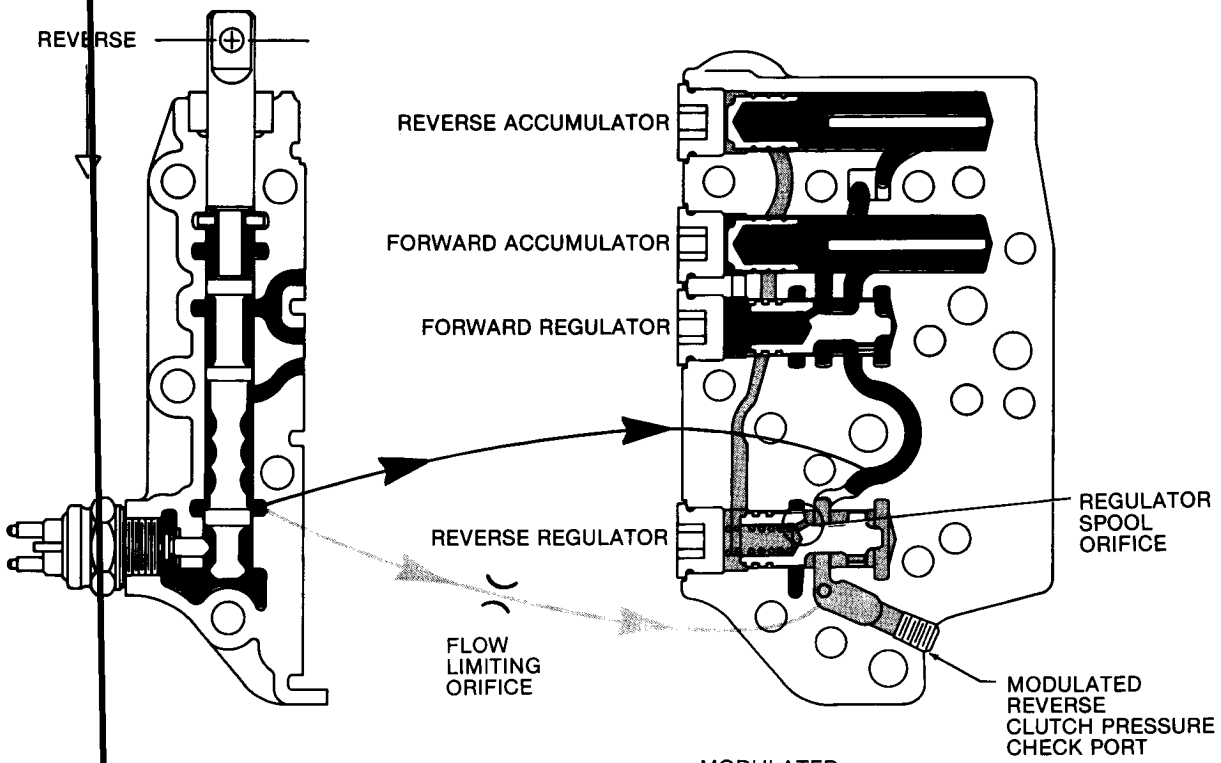
18000 SERIES MODULATION

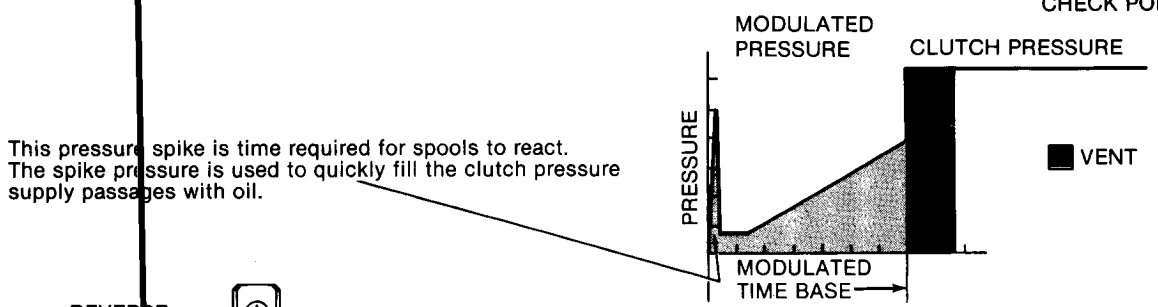


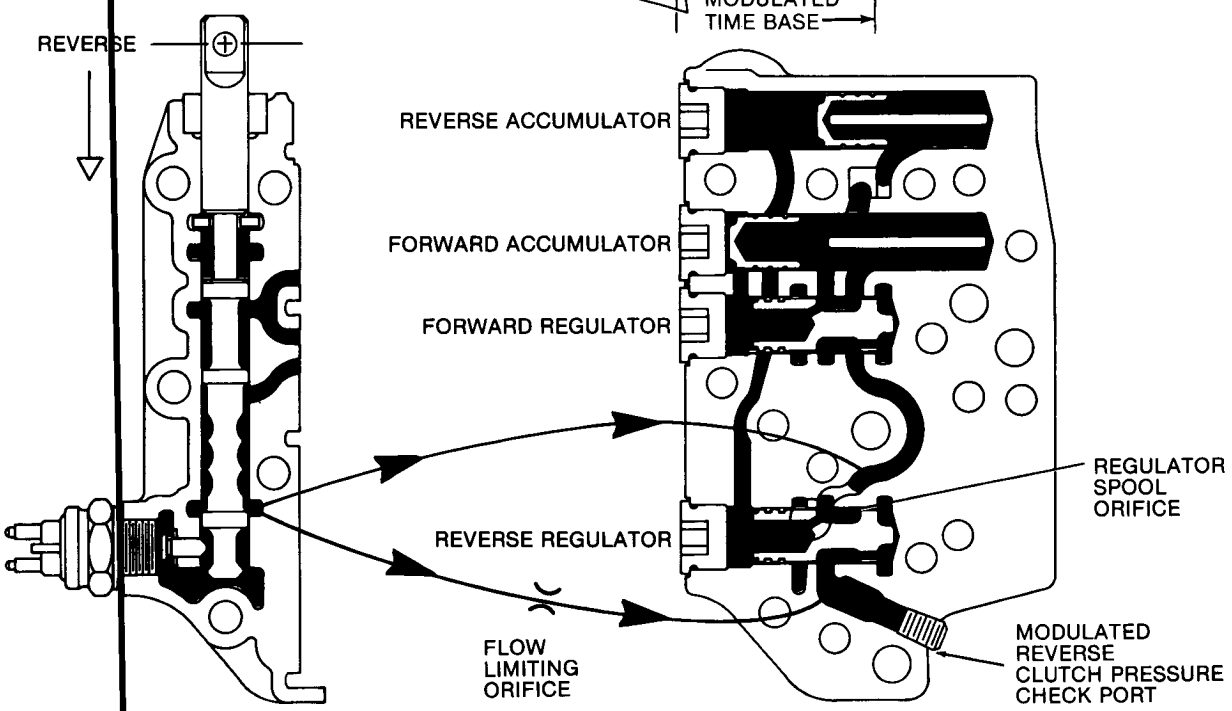
This pressure spike is time required for spools to react. The spike pressure is used to quickly fill the clutch pressure supply passages with oil.





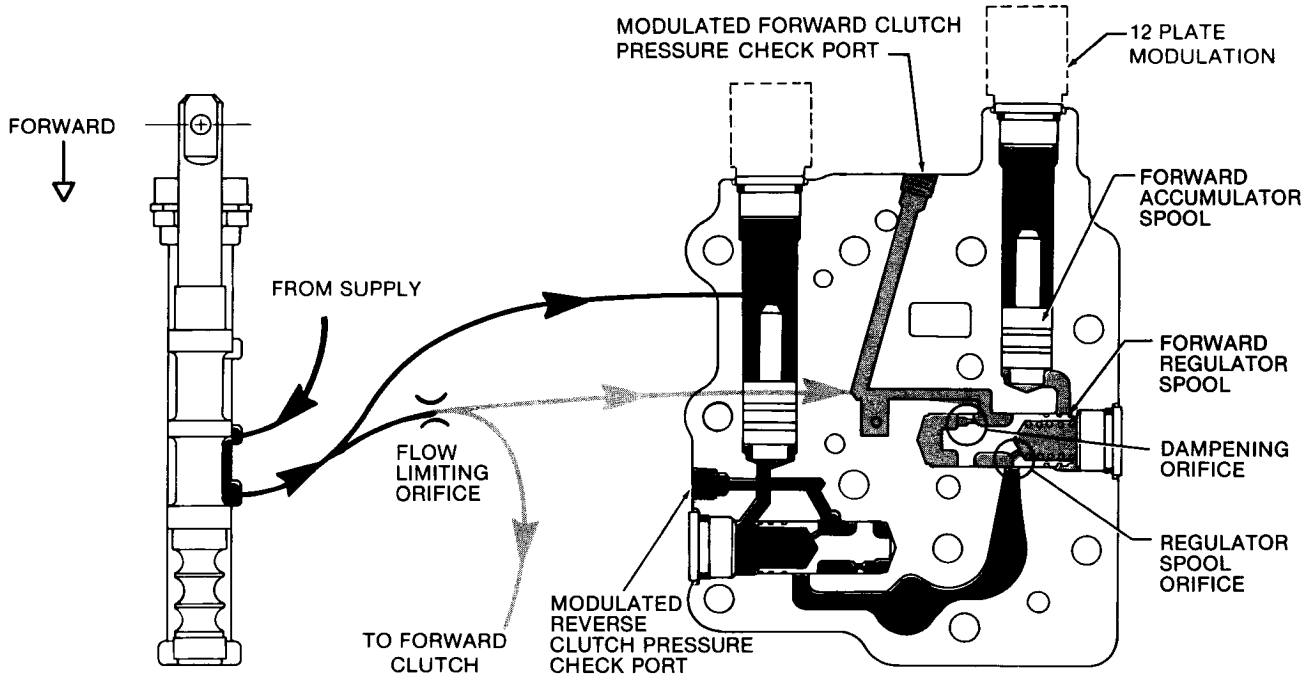

REVERSE
REVERSE ACCUMULATOR
FORWARD ACCUMULATOR
FORWARD REGULATOR
REGULATOR SPOOL ORIFICE
REVERSE REGULATOR
FLOW LIMITING ORIFICE
MODULATED REVERSE CLUTCH PRESSURE CHECK PORT

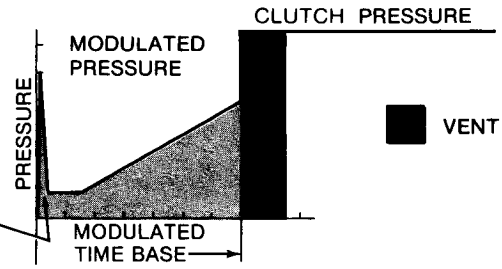

MODULATED PRESSURE
CLUTCH PRESSURE
PRESSURE
VENT
MODULATED TIME BASE
This pressure spike is time required for spools to react. The spike pressure is used to quickly fill the clutch pressure supply passages with oil.


REVERSE
REVERSE ACCUMULATOR
FORWARD ACCUMULATOR
FORWARD REGULATOR
REGULATOR SPOOL ORIFICE
REVERSE REGULATOR
FLOW LIMITING ORIFICE
MODULATED REVERSE CLUTCH PRESSURE CHECK PORT

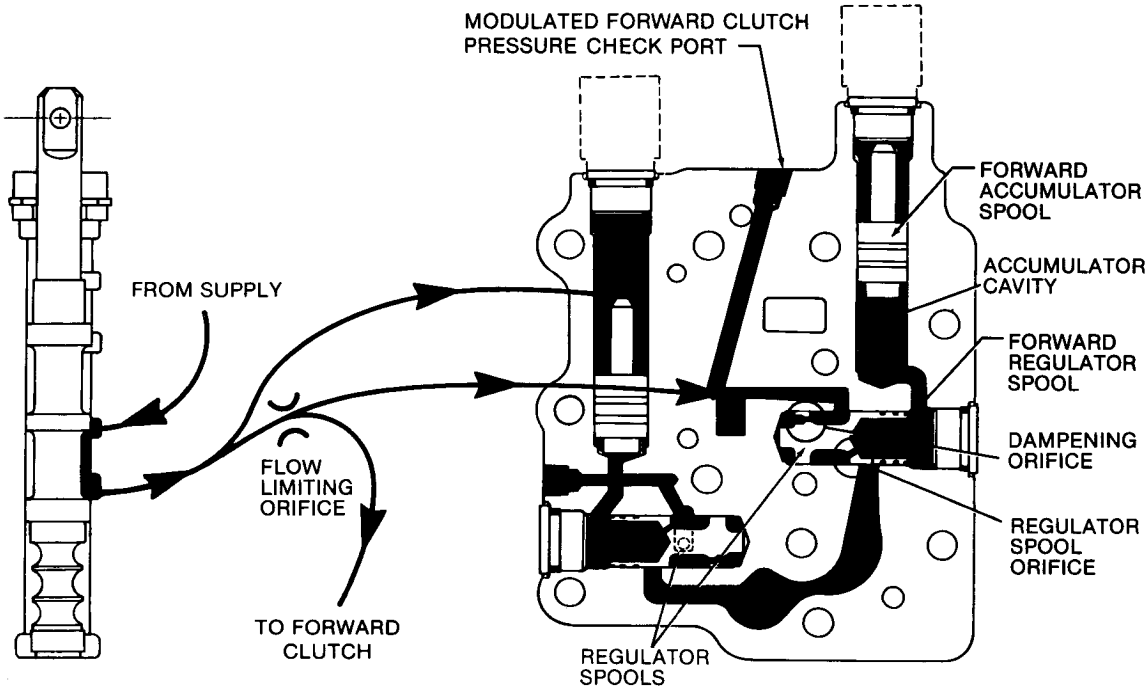
CLARK

28000 SERIES MODULATION



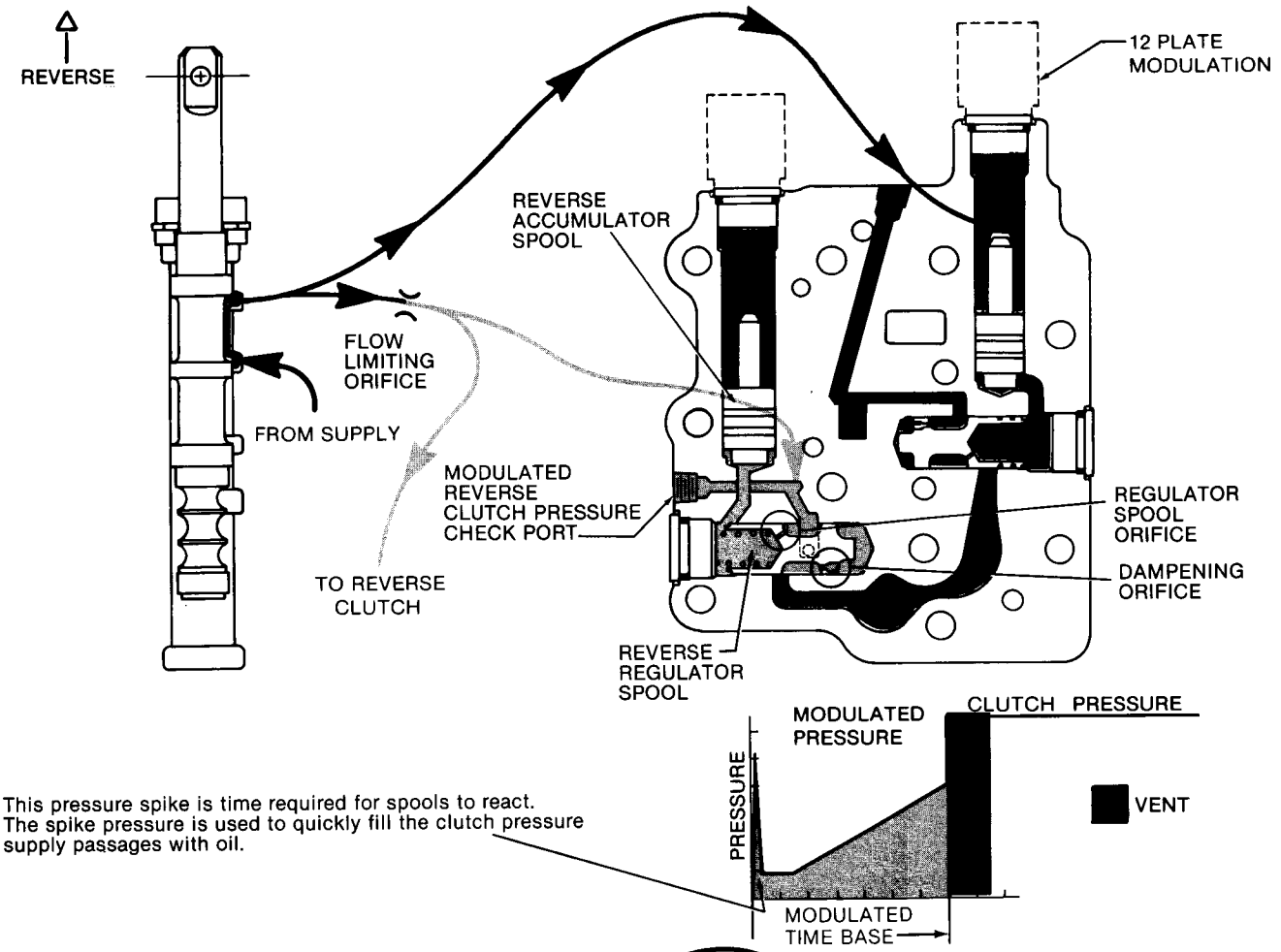


This pressure spike is time required for spools to react. The spike pressure is used to quickly fill the clutch pressure supply passages with oil.

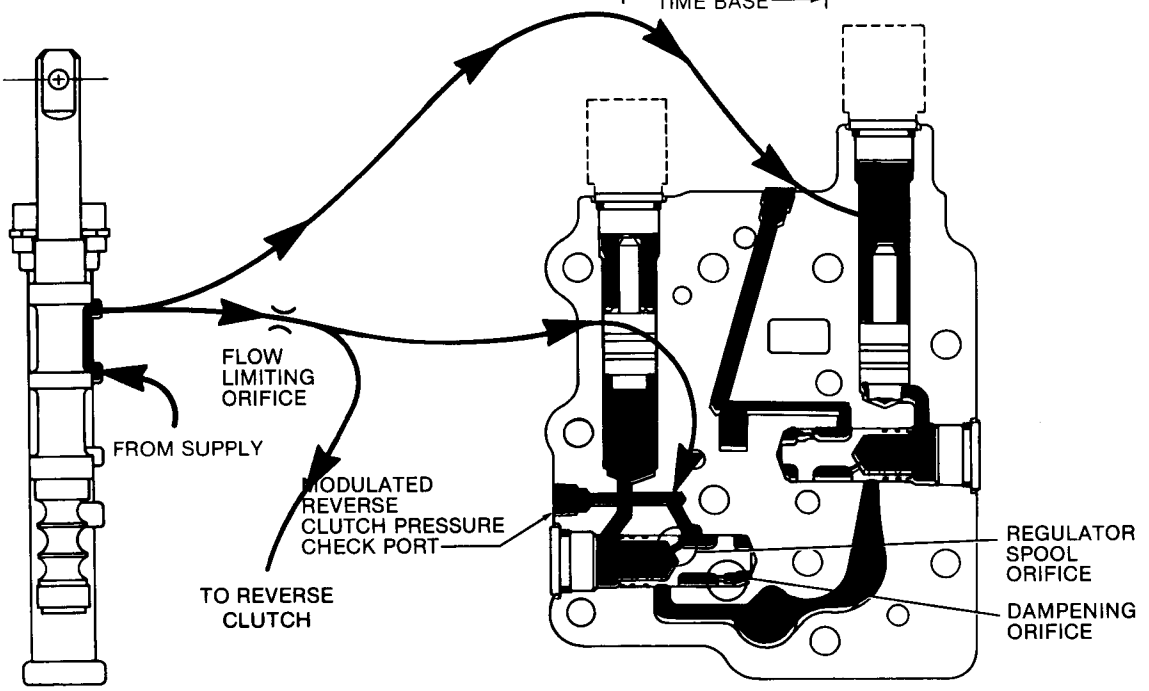


OVER FOR REVERSE MODULATION

28000 SERIES MODULATION

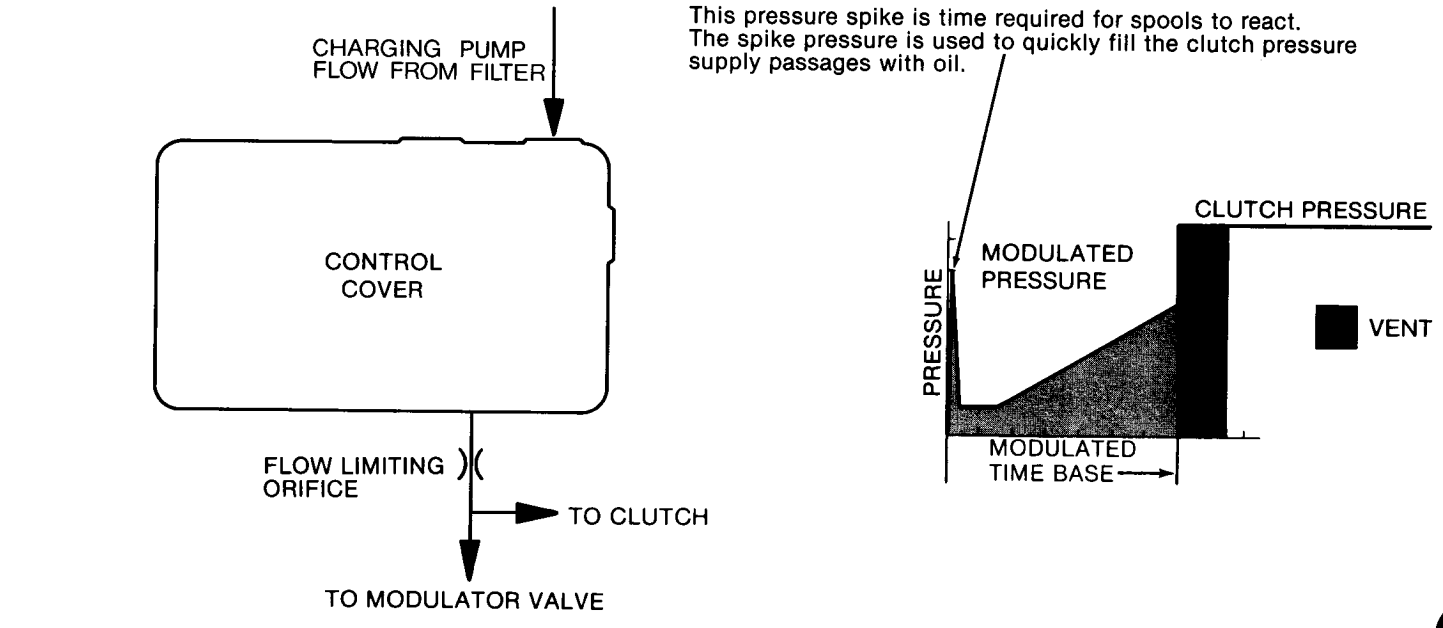


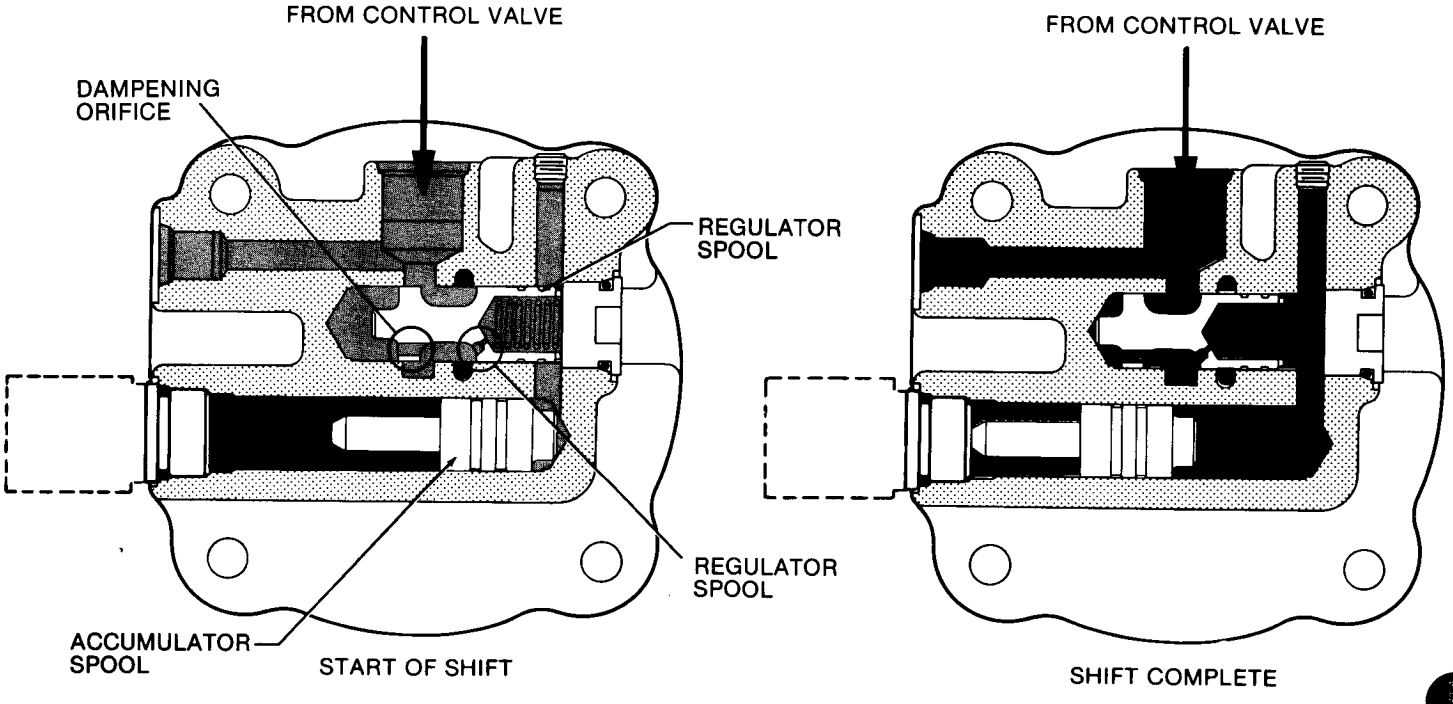
This pressure spike is time required for spools to react. The spike pressure is used to quickly fill the clutch pressure supply passages with oil.



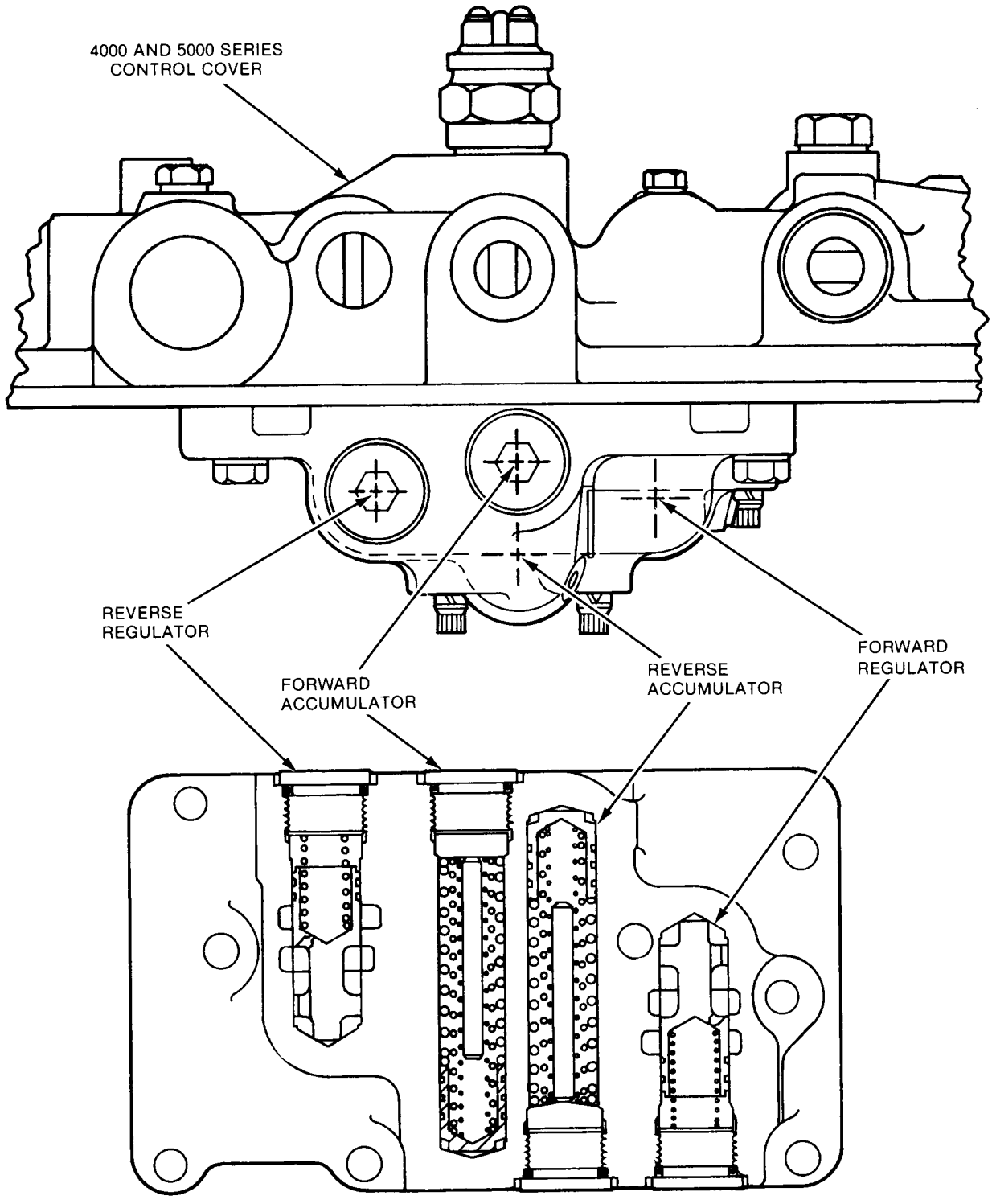
CLARK

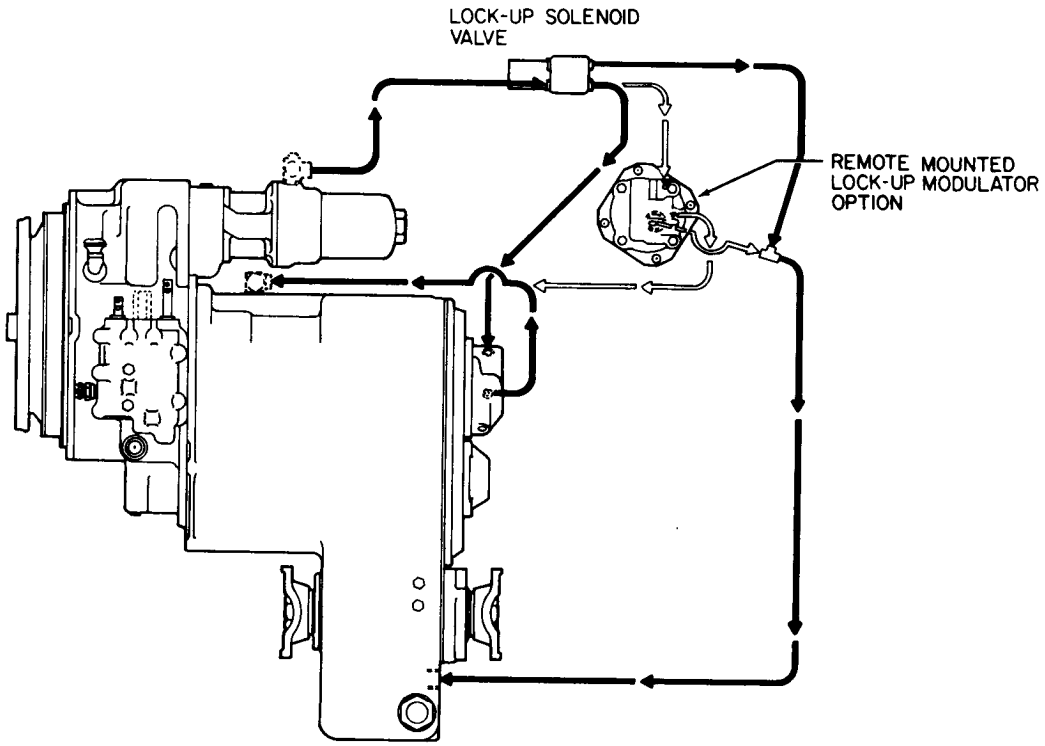
8000 AND 16000 SERIES MODULATION





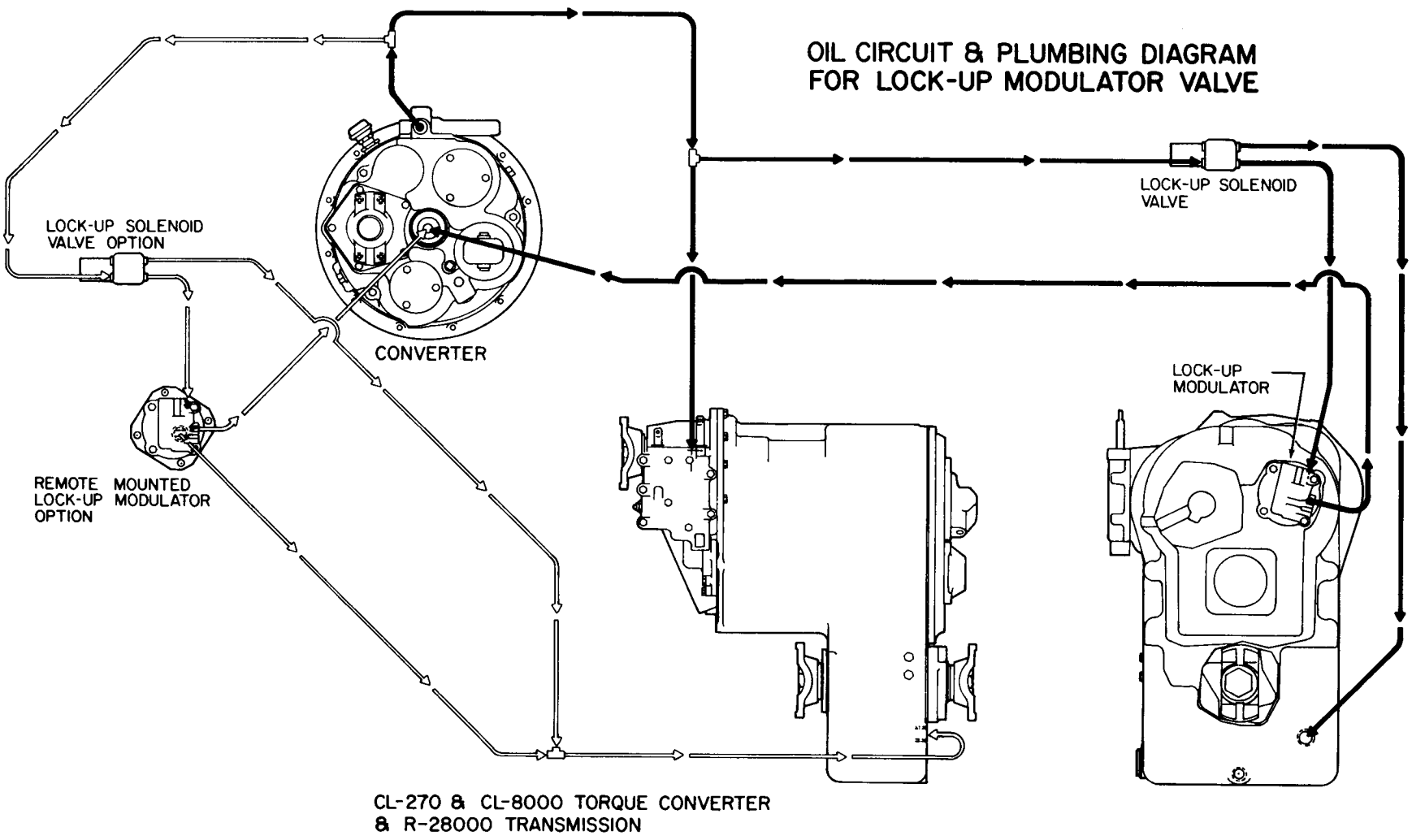
4000 and 5000 SERIES MODULATION





LHR-28000 TRANSMISSION

OIL CIRCUIT & PLUMBING DIAGRAM FOR LOCK-UP MODULATOR VALVE


OIL CIRCUIT & PLUMBING DIAGRAM
FOR LOCK-UP MODULATOR VALVE
LOCK-UP SOLENOID
VALVE
LOCK-UP SOLENOID
VALVE OPTION
CONVERTER
LOCK-UP
MODULATOR
REMOTE MOUNTED
LOCK-UP MODULATOR
OPTION
CL-270 & CL-8000 TORQUE CONVERTER
& R-28000 TRANSMISSION