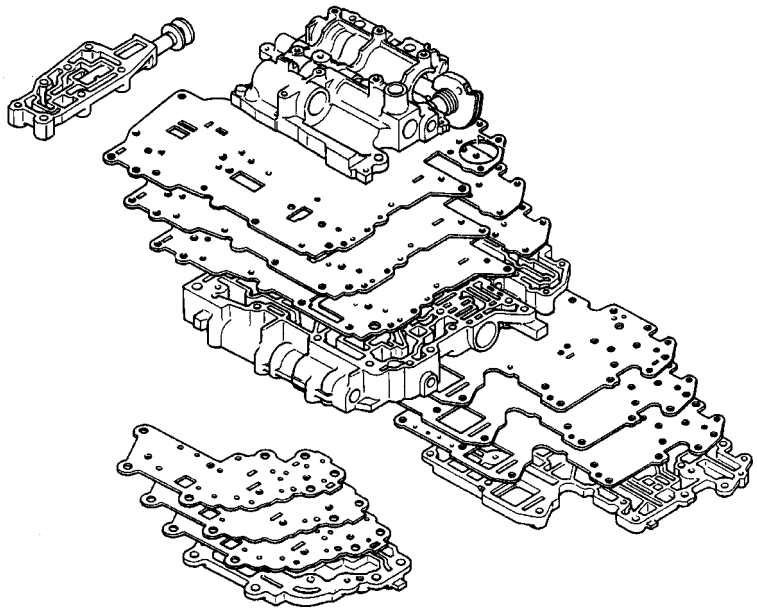
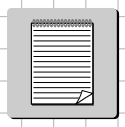
Section 3

Valve Body Circuits



Lesson Objectives

1. Describe the function of pressure control valves.
2. Describe the function of shift control valves.
3. Describe the function of timing (sequential) valves.
4. Describe the function of pressure modulating valves.
5. Explain the effect that throttle pressure and governor pressure have on the shift valves and clutch application.



Notes

Valve Body Introduction

The valve body consists of an upper valve body, a lower valve body, a manual valve body and various covers. The body halves are separated by a separator plate which contains openings that control the flow of fluid between valve circuits. The valves control fluid pressure and switch fluid from one passage to another. Hydraulic circuits extend to the transmission housing and are connected either by direct mounting or through oil tube passages.

The valves are a precision fit to their bore in the body, and their position in the bore is determined by a balance between spring tension and hydraulic pressure. Hydraulic pressure within the valve body will vary based on throttle position or pressure modulating valves. In the case of a non-ECT transmission, pressure also varies based on vehicle speed through the governor valve.

In order to understand what the many valves do in the valve body, they have been separated by function as listed below:

- Pressure control valves
- Hydraulic control valves
- Timing (Sequencing) valves
- Pressure modulating valves

Valve Body

The body halves are separated by a separator plate which contains openings that control the flow of fluid between valve circuits.

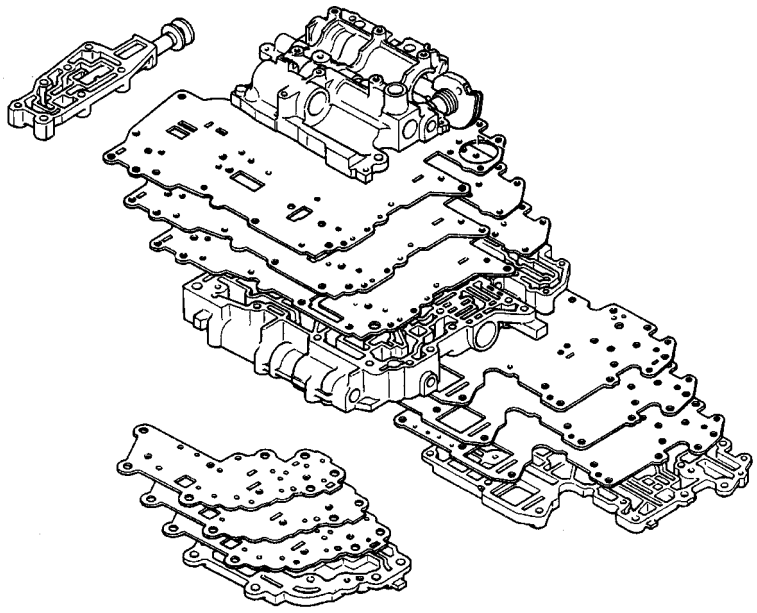


Fig. 3-01
T2731073

Pressure Control Valves

Pressure control valves regulate hydraulic pressure within the transmission. Hydraulic pressure is required to lubricate and remove heat from the fluid. Pressure is also necessary to apply the clutches, brakes, and bands that hold planetary gear components of the transmission. There are times when high pressure is necessary and other times when it is not. The primary concern with high pressure is that engine power is lost and excessive heat is generated. Heat breaks down the transmission fluid and robs it of its properties. Additional load on the engine affects fuel economy, so by regulating pressure less load is placed on the engine.

Primary Regulator Valve

This valve adjusts the pressure from the oil pump to all the hydraulic circuits in the transmission. The purpose of the valve is to reduce engine load and power loss. High pressure causes hard shifting and creates more heat reducing fluid life. By reducing pressure, less power is required to rotate the pump and less heat is generated.

Pressure has a direct effect on the holding force of clutches and brakes. It should be higher when accelerating the vehicle and lower as the vehicle picks up speed.

The output of the valve is called “line pressure,” the highest oil pressure in the transmission. Line pressure is shown in the color red in Toyota publications. It is used to apply most clutches and brakes.

The position of the primary regulator valve is determined by throttle pressure, line pressure and spring tension. Spring tension pushes the valve up for higher line pressure. Line pressure is routed to the top of the valve and counters spring tension to reduce line pressure. The overall effect is a balance between line pressure and spring tension.

At the base of the valve, throttle pressure is applied to push the valve upward, increasing line pressure. The greater the throttle opening, the greater line pressure becomes as the pressure regulator valve bleeds off less pressure from the oil pump. This is why adjustment of the throttle cable results in a change in shift feel due to the change in line pressure.

Primary Regulator Valve

The position of the primary regulator valve is determined by throttle pressure, line pressure and spring tension.

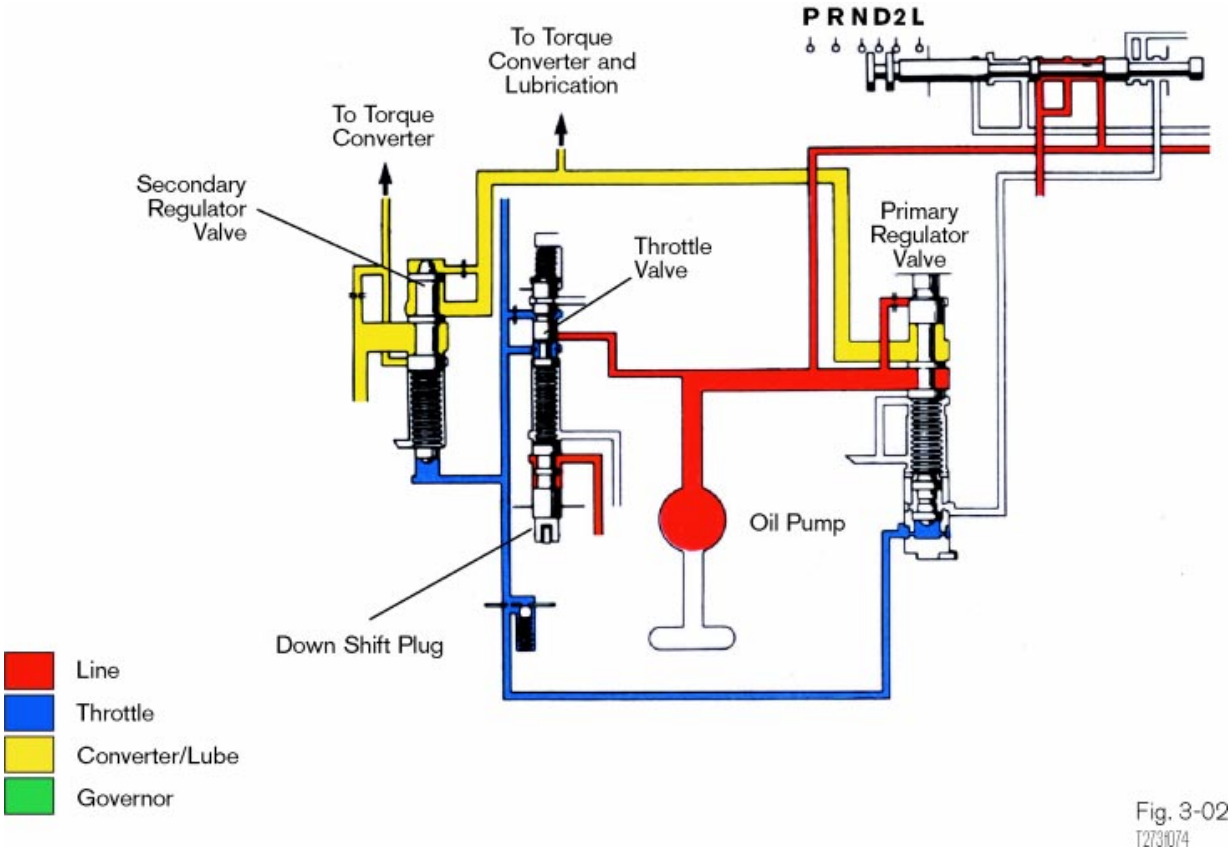


Fig. 3-02
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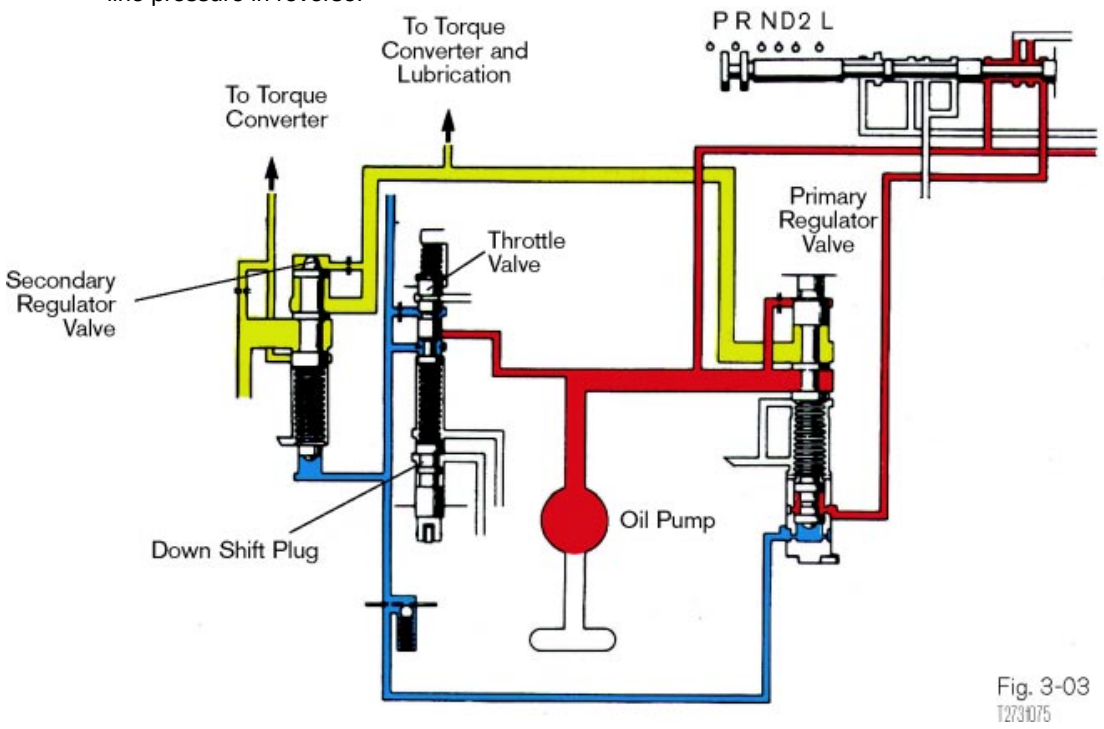
Primary Regulator Valve In R-Range

Line pressure from the manual valve is directed to the bottom of the valve, increasing line pressure in reverse.



Line pressure is also increased when reverse gear is selected. Line pressure from the manual valve is directed to the bottom of the valve pushing it upward, increasing line pressure by as much as 50%.

Secondary Regulator Valve

This valve regulates pressure to the torque converter and lubrication pressure. Spring tension pushes the valve upward to increase converter pressure. Converter pressure acts on the top of the valve to create a balance between it and spring tension. In some applications throttle pressure is used to assist the spring in increasing converter pressure. Increased secondary regulator pressure provides for a firmer application of the lock-up clutch under higher torque conditions.

Secondary regulator pressure, cooler and lubrication circuits are shown in yellow in Toyota publications.

Oil Cooler Bypass Valve

This valve prevents excessive pressure in the circuit to the oil cooler. The circuit is a low pressure system which routes oil through the cooler in the tank of the radiator and back to the sump of the transmission. The valve is spring loaded in the closed position and opens when pressure exceeds the spring rate.

Oil Cooler Bypass

The valve is spring loaded in the closed position and opens when pressure exceeds the spring rate.

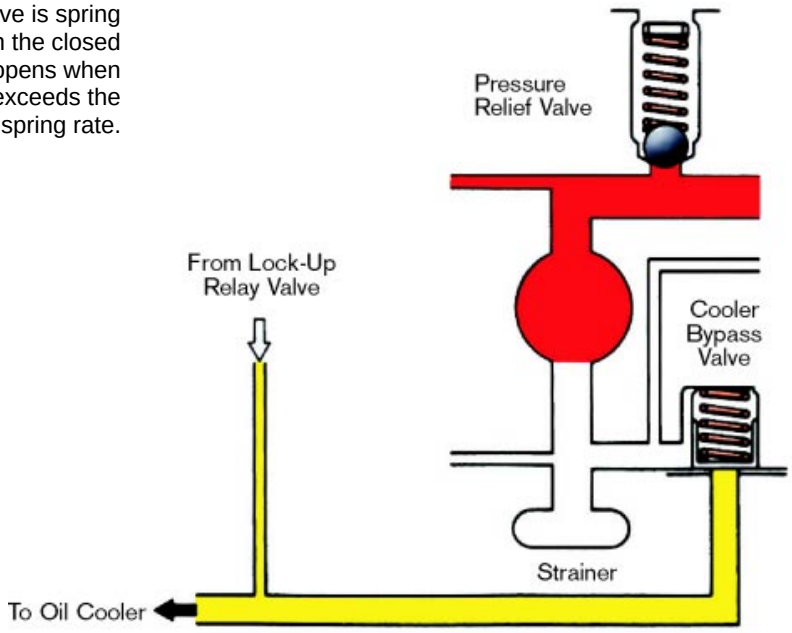


Fig. 3-04
T2731076

Pressure Relief Valve

This valve regulates the oil pump pressure so that it does not rise above a predetermined maximum value. A calibrated spring is used to control the pressure by holding the valve against its seat.

Governor Valve

This valve is found on all non-ECT transmissions. It is mounted on the output shaft of rear-wheel drive transmissions or is driven from the drive gear on the differential drive pinion/output shaft on front-wheel drive transmissions. It balances the line pressure routed from the manual valve and the centrifugal force of the governor weights to produce hydraulic pressure in proportion to vehicle speed. The greater the speed of the output shaft, the greater the governor pressure.

Below 10 mph, centrifugal force is low and line pressure entering through the drilled passage in the valve to the base of the valve pushes the valve upward blocking the line pressure passage and opening the drain at the top land.

Governor Valve

Line pressure to the base of the valve moves it upward, opening the drain port. Centrifugal force does not begin to push the valve down until approximately 10 mph.

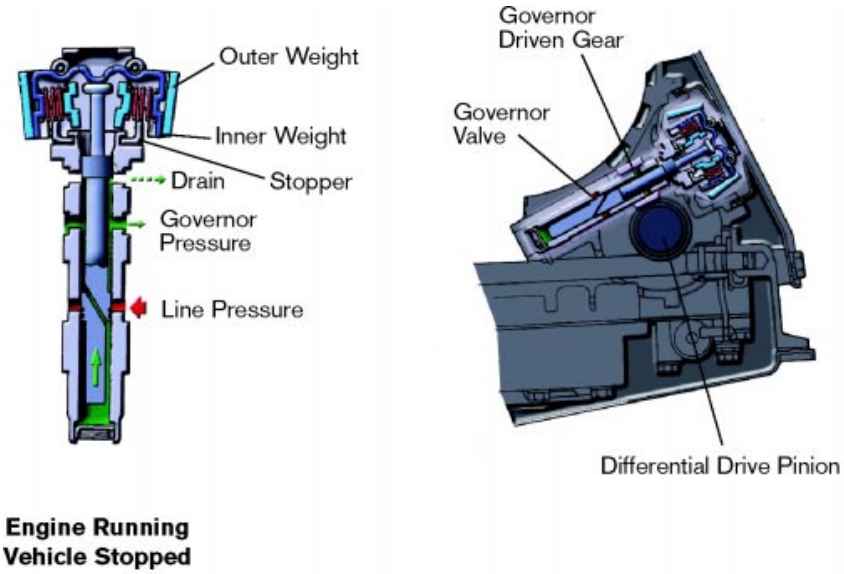


Fig. 3-05
T2731077

As vehicle speed increases, the weights move outward and the governor valve is pushed down by the lever of the inner weights. The governor valve position is balanced between centrifugal force acting on the lever at the top of the valve and governor pressure at the base of the valve.

As the governor rpm increases (middle and high speed) the outer weight movement is limited by the stopper of the governor body. Increased governor pressure acting on the base of the valve works against spring tension. With increased rpms, the centrifugal force of the inner weight and spring tension places additional force to push the valve down.

Governor pressure shown in Toyota publications is always green.

Governor Valve

Governor pressure increases as weights move outward by centrifugal force.

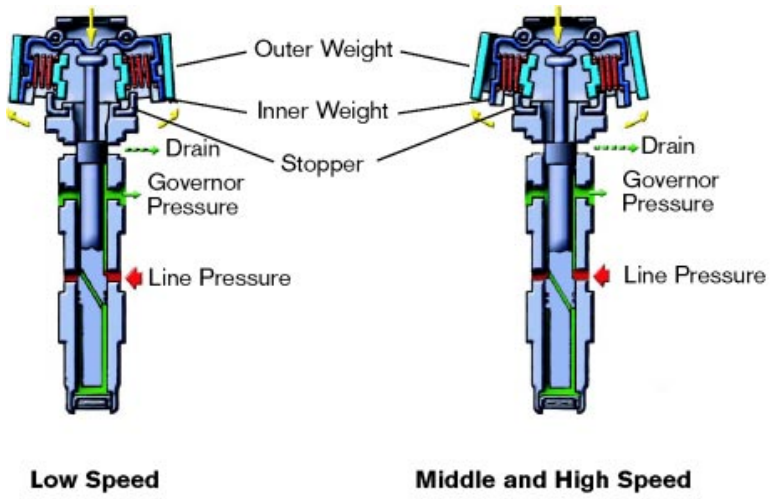


Fig. 3-06
T2731078

Throttle Valve

Throttle pressure is produced in response to throttle opening angle. When the accelerator pedal is depressed, the downshift plug pushes the throttle valve upward by means of the spring, creating throttle pressure. The throttle valve supplies throttle pressure to each shift valve and acts in opposition to governor pressure. This is why throttle cable adjustment affects shift timing in non-ECT transmissions.

Throttle pressure also affects line pressure either directly or through throttle modulator pressure. Hydraulic pressure affected by throttle opening is directed to the base of the pressure regulator valve to increase line pressure when engine torque is increased. Additional line pressure serves to provide additional holding force at the holding devices to prevent slippage.

Throttle pressure shown in Toyota publications is always blue.

Throttle Valve

Throttle pressure is provided to each shift valve to counter governor pressure.

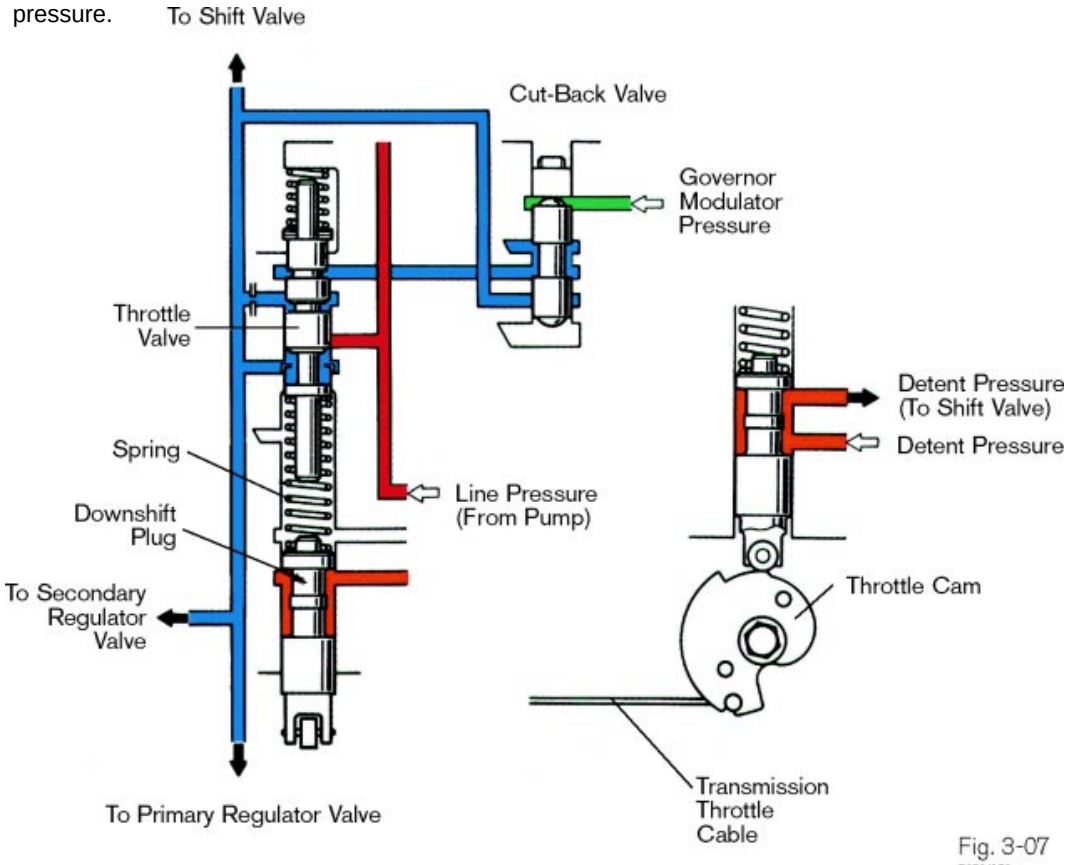


Fig. 3-07
T2731079

Shift Control Valves

Shift control valves are responsible for directing fluid to different passages in the transmission. They can be manually controlled, solenoid controlled, or hydraulically controlled. They block hydraulic passages while other lands of the valve open passages.

Manual Valve

This valve directs line pressure to various passages in the valve body. It is linked to the driver's selector lever and shifts the transmission into and out of the P, R, N, D, 2 and L-ranges as directed by the driver. As the valve moves to the right, it exposes passages to line pressure which will determine the gear selected. The various positions of the valve are maintained by a detent mechanism which also provides feedback to the driver.

Manual Valve

Directs line pressure to various passages in the valve body.

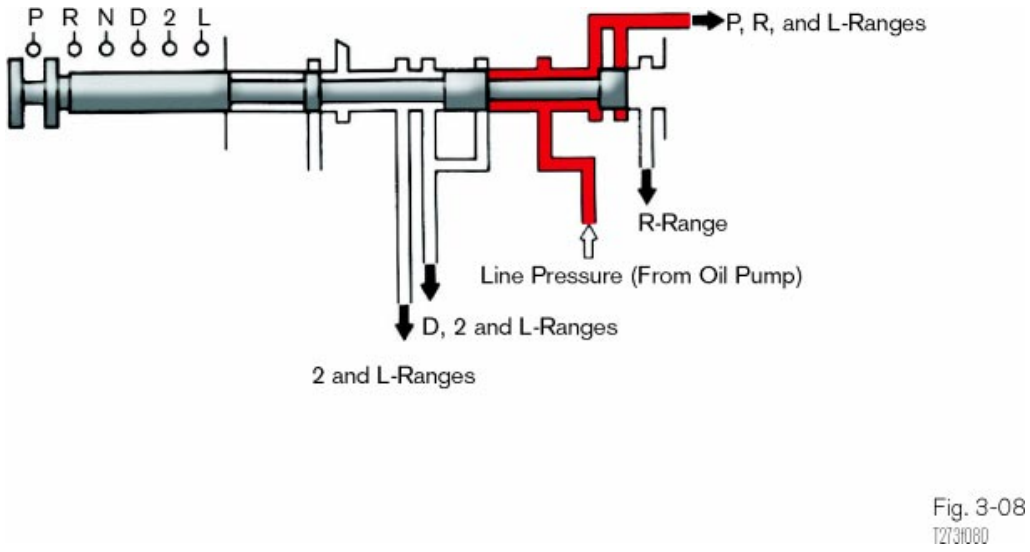


Fig. 3-08
T273I080

1-2 Shift Valve

This valve controls shifting between first and second gears based on governor and throttle pressures. The valve is held in position by a calibrated spring located between the low coast shift valve and the 1-2 shift valve. When governor pressure is low, but throttle pressure is high, this valve is pushed down by throttle pressure and spring tension. As long as there is no governor pressure, there will be no upshift and if throttle pressure is low, upshifts will be early. In first gear the *forward clutch* (C1) is applied through the manual valve, and the *No. 2 one-way clutch* (F2) is holding. Line pressure is blocked by the valve from the *second brake* (B2) and the transmission is held in first gear.

As vehicle speed increases, governor pressure overcomes throttle pressure and spring tension at the 1-2 shift valve. The circuit to the second brake piston opens, causing the transmission to shift to second gear. When the shift valve moves up it covers the throttle pressure passage. The downshift occurs when coasting to a stop as spring tension overcomes governor pressure. This happens at such a low speed that it is hardly noticeable.

A forced downshift from second to first gear occurs when the downshift plug at the base of the throttle valve opens to allow detent regulator pressure to act on the top of the 1-2 shift valve. This forces the shift valve down, which opens the second brake piston to a drain and the downshift occurs as the *second brake* releases.

When the selector is placed in the L range, low modulator pressure is applied to the top of the low coast shift valve, holding the 1-2 shift valve in the first gear position.

1-2 Shift Valve

Controls line pressure to the 2nd brake (B2) and the 2-3 shift valve.

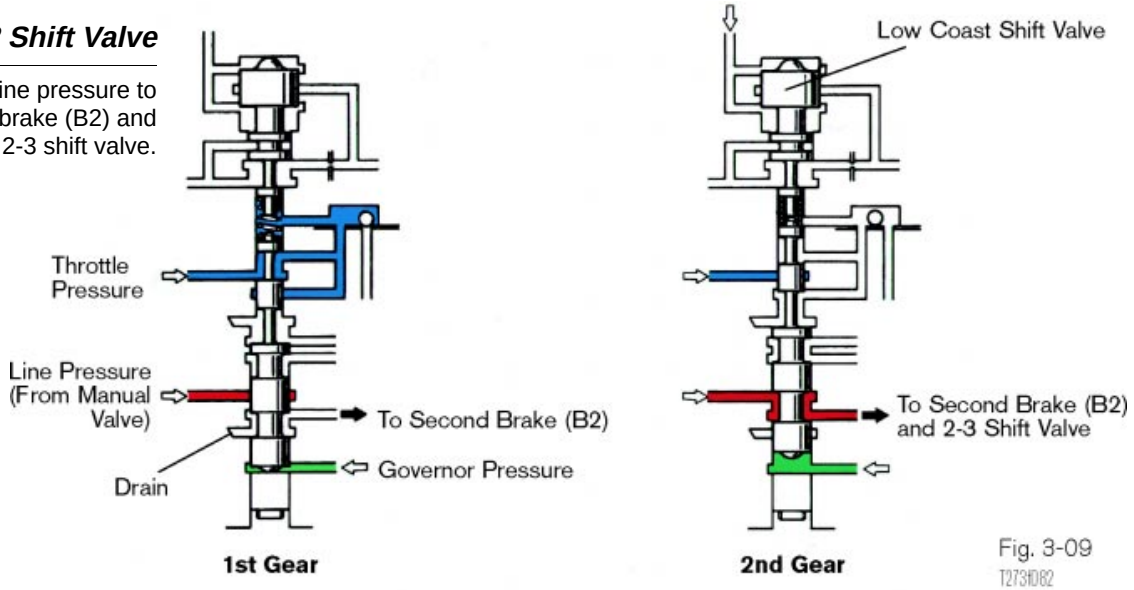


Fig. 3-09
T2731D82

2-3 Shift Valve

This valve controls shifting between second and third gears based on throttle and governor pressures. The valve is positioned by a calibrated spring located between the intermediate shift valve and the 2-3 shift valve. When governor pressure is low, but throttle pressure is high, such as under acceleration, this valve is pushed down by throttle pressure and spring tension, holding the transmission in second gear.

When governor pressure rises with increased vehicle speed, this valve is moved upward against throttle pressure and spring tension opening the passage to the *direct clutch* (C2) piston and causing a shift into third gear. As throttle pressure increases with throttle opening, throttle pressure at the top of the 2-3 shift valve causes the valve to move downward, closing the passage to the *direct clutch* (C2). The pressure in the *direct clutch* drains and the transmission is downshifted into second gear.

In the event that the accelerator is depressed at or near full throttle, the cam at the base of the throttle valve pushes the detent valve upward. This allows detent pressure to assist throttle pressure at the top of the 2-3 shift valve pushing down on the valve, resulting in faster valve movement.

In addition, take note that the line pressure which applies the *direct clutch* (C2) comes through the 1-2 shift valve. So if the 1-2 shift valve is stuck there will be no 2nd gear, but also no third gear because the *direct clutch* cannot be applied.

2-3 Shift Valve

Controls line pressure to the direct clutch (C2). This line pressure comes through the 1-2 shift valve in the second gear position.

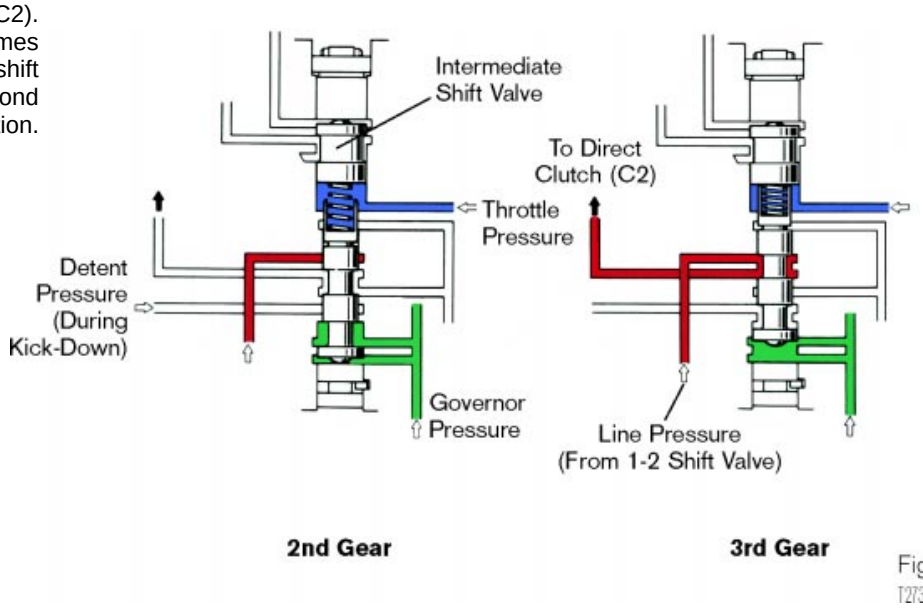


Fig. 3-10
T2731084

When the gear selector is placed in the 2-range, line pressure from the manual valve acts on the intermediate shift valve. The 2-3 shift valve descends causing a downshift into second gear and preventing an upshift to third gear. Also, line pressure passes through the second modulator valve and 1-2 shift valve and acts on the *second coast brake* (B1) to effect engine braking.

3-4 Shift Valve

This valve controls shifting between third and forth gears based on governor and throttle pressures. The valve is held in position by a calibrated spring located at the top of the 3-4 shift valve which transfers the tension and holds the 3-4 shift valve down. Line pressure controlled by the 3-4 shift valve comes from the oil pump directly. Whenever the pump is turning, pressure is directed through the 3-4 shift valve to either the *overdrive direct clutch* (C0) or the *overdrive brake* (B0). When the *overdrive direct clutch* is applied, the overdrive unit is in direct drive. When the *overdrive brake* is applied, the overdrive unit is in overdrive.

When governor pressure is low, but throttle pressure is high, this valve is pushed down by throttle pressure and spring tension. When vehicle speed increases, governor pressure rises. At some point it overcomes throttle pressure and moves the valve upward, diverting line pressure from the *overdrive direct clutch* (C0) to the *overdrive brake* (B0) and resulting in an upshift to overdrive.

3-4 Shift Valve

Controls line pressure to the overdrive brake (B0) and overdrive direct clutch (C0).

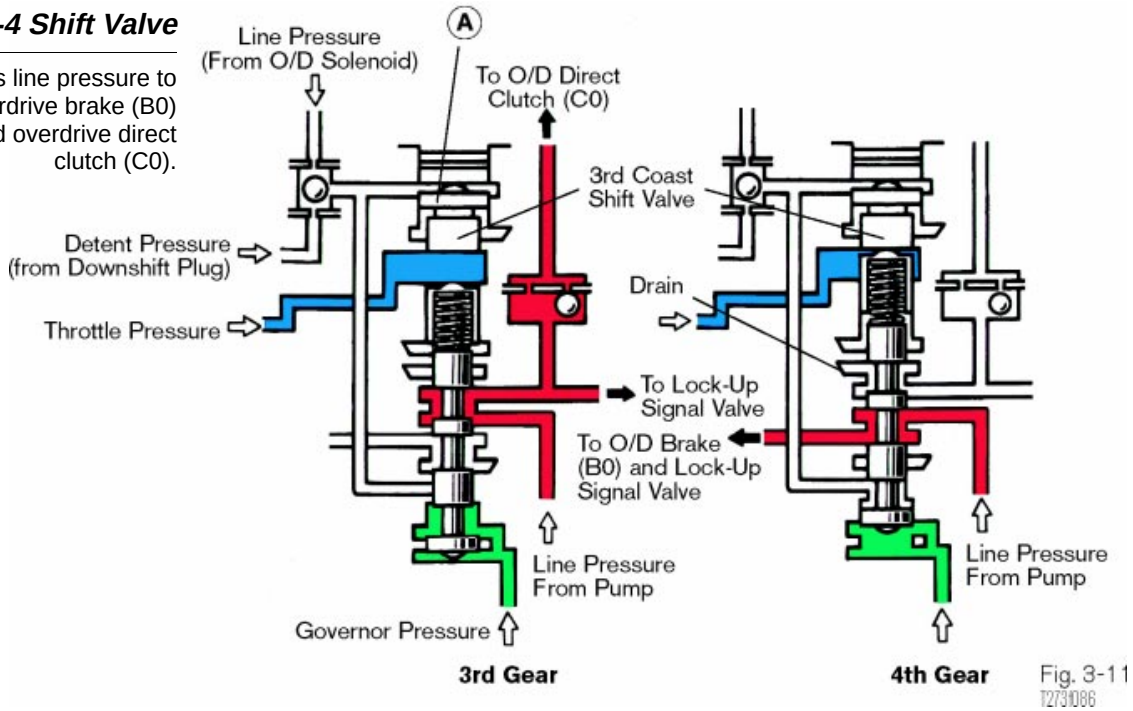


Fig. 3-11

Downshift Plug

The downshift plug is located below the throttle valve. It is actuated by the throttle cam in response to engine throttle movement when the driver presses down on the accelerator, opening it more than 85%. It is used in a governor-controlled transmission to enhance downshifting rather than relying on throttle pressure alone to overcome governor pressure and move the shift valve down. The net result is that a downshift occurs at a higher vehicle speed than if relying on throttle pressure alone.

When the throttle is opened 85% or more, the downshift valve moves upward and detent regulator pressure is directed to each shift valve to counter governor pressure. Detent pressure provides added force in addition to throttle pressure and spring tension to move the valve downward against governor pressure. Depending on the vehicle speed, governor pressure may be great enough to allow the 1-2 shift valve and 2-3 shift valve to remain up, whereas the 3-4 shift valve may immediately move downward to cause a 4 to 3 downshift.

Downshift Plug

Enhances downshifting rather than relying on throttle pressure alone to overcome governor pressure in a forced downshift.

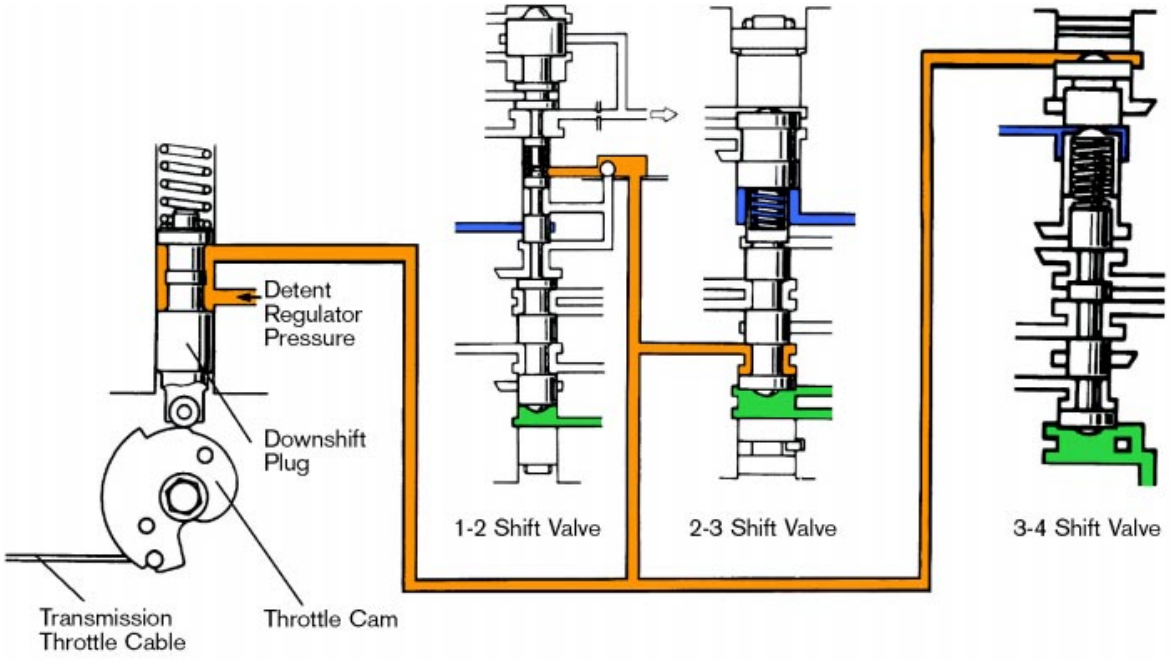


Fig. 3-12
T2731087

Timing Valves

These valves are responsible to finesse the quality of transmission shift characteristics. In some cases the applied clutch is a dual piston application and one is applied before the other. In other cases the pressure which applies a holding device or forces a shift valve to downshift is reduced to enhance the application.

D-2 Downshift Timing Valve

This valve serves to prevent a direct downshift from overdrive to second gear in the A-40 Series transmissions. If the shift selector lever is put into 2-range while the vehicle is running in overdrive, the transmission automatically shifts into third gear for a moment before shifting into second. This is to avoid shift shock that would occur if the transmission went directly from overdrive into second gear. After the line pressure acting on the intermediate shift valve is switched from the *overdrive brake* (B0) to the *overdrive direct clutch* (C0), it acts on the 2-3 shift valve causing it to shift from third gear to second gear.

When the selector is shifted from D-range, line pressure from the manual valve is applied to the area between the upper and middle land of the timing valve and to the top of the third coast shift valve. This causes the 3-4 shift valve to move down, and the *direct clutch* (C2) is applied to give us third gear. The same pressure applying the direct clutch also acts on the top of the timing valve which directs pressure to the top of the intermediate shift valve, resulting in a downshift to second gear.

D-2 Downshift Timing Valve

Requires a downshift to 3rd gear before going into manual second in a manual downshift.

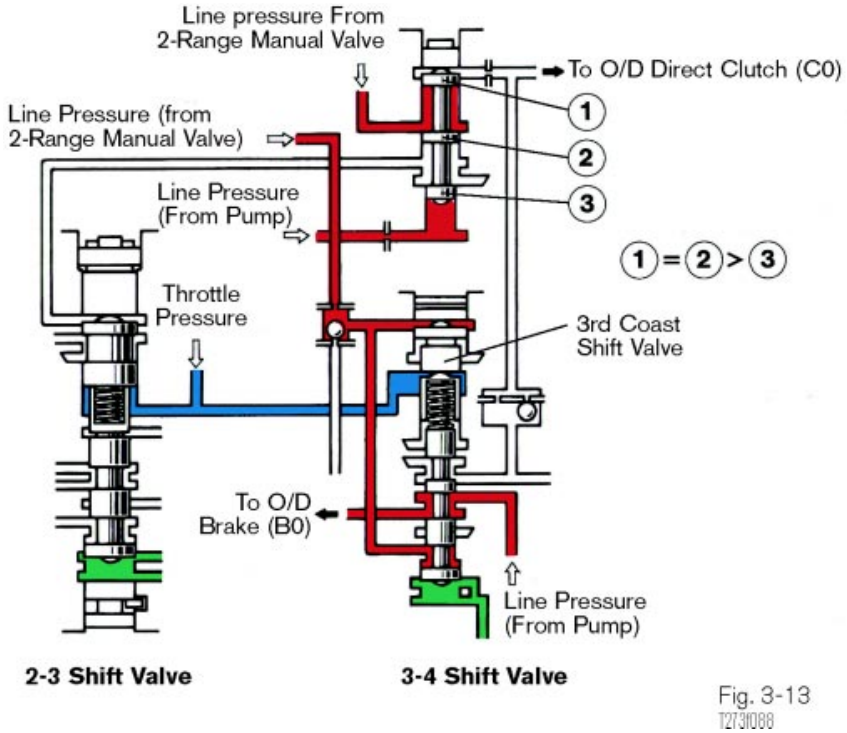


Fig. 3-13
T2T31088

Reverse Clutch and Brake Sequencing Valves

The sequencing valves control the timing of the application of the double piston *direct clutch* (C2) and *1st and reverse brake* (B3) found in the A-40 series transmissions. Remember that line pressure is increased in reverse. A sequencing valve reduces shift shock when the transmission is shifted into reverse. Although each clutch is controlled with a separate sequencing valve, the operation of the *direct clutch* is explained.

When moving the selector to the R-range, the passage to the outer piston of the *direct clutch* (C2) is blocked by the sequencing valve. As pressure builds and the inner piston begins to apply, the valve moves to the left compressing the spring. Line pressure is applied to the outer piston for full engagement of the *direct clutch*. Staggering the engagement of the two pistons softens the engagement of the *direct clutch*.

Reverse Clutch Sequencing Valve

Reduces shift shock when the transmission is shifted into reverse.

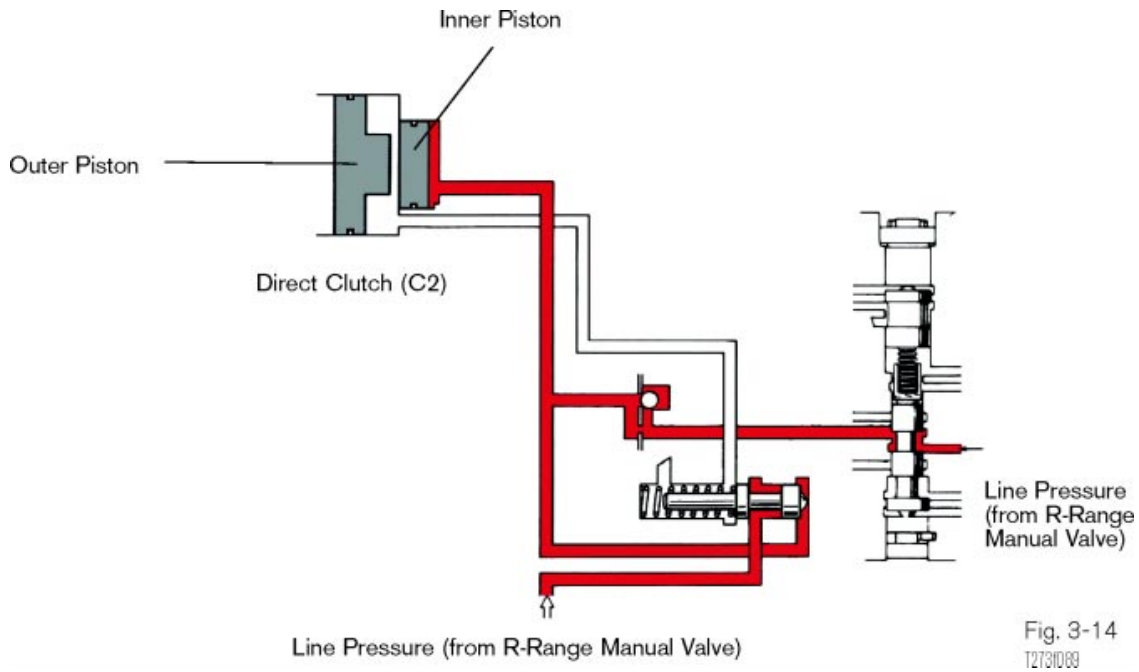


Fig. 3-14
T2T31D89

Accumulators

The accumulators act to cushion shifting shock. These valves are basically pistons located in a bore with a heavy calibrated spring to counter hydraulic pressure. They are located in the hydraulic circuit between the shift valve and the holding device. When the shift valve moves, fluid is directed to the circuit of the holding device. As the piston begins to compress the clutch return springs, pressure in the circuit begins to build. As pressure builds, it acts to load the spring in

the accumulator. Pressure in the circuit cannot reach its potential until the spring is compressed and the piston is seated. The pressure builds more slowly and the clutch engagement is softened.

Clutch application can be tailored even more closely by providing hydraulic pressure to the spring side of the accumulator. Line pressure applying the holding device has to overcome spring tension and additional fluid pressure and therefore, higher pressure is exerted on the holding device before full pressure is applied. Hydraulic pressure to the accumulator is controlled by the accumulator control valve, or electronically controlled solenoid.

Pressure Modulating Valves

Pressure modulating valves change controlling pressures to tailor operational characteristics of the automatic transmission. Line pressure, throttle pressure and governor pressure, all have an effect on how the automatic transmission operates. Modulator valves further reduce these controlling pressures to finesse the transmission's operation.

Accumulator Control Valve

This valve modifies line pressure from the pump to the accumulators based on engine load. It reduces shift shock by lowering the back pressure of the *direct clutch* (C2) accumulator and *2nd brake* (B2) accumulator when the throttle opening is small. The valve is balanced between throttle pressure and spring tension at it's base and metered line pressure at the top of the valve.

Accumulator Control Valve

Modifies line pressure to the accumulators based on engine load.

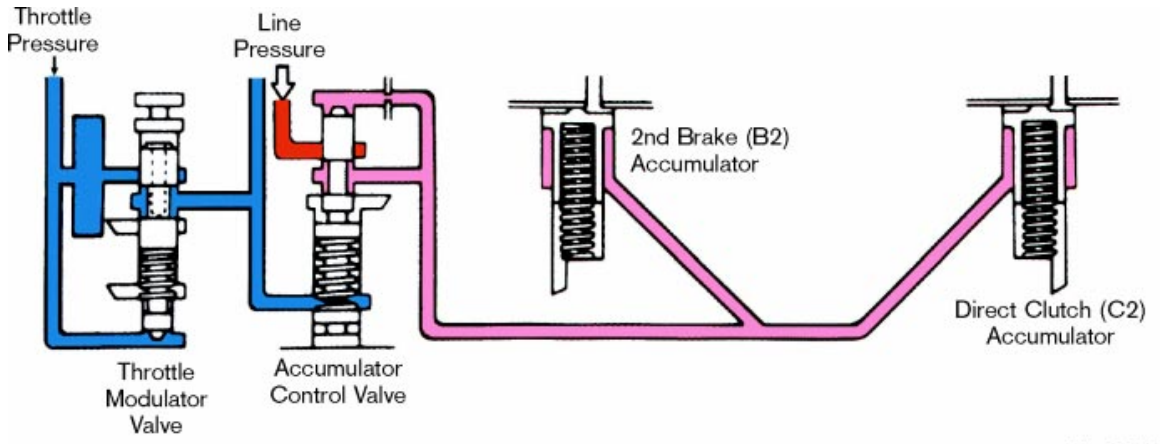


Fig. 3-15
T273090

Since the torque produced by the engine is low when the throttle opening is small, accumulator back pressure is reduced. This prevents shift shock when the brakes and clutches are applied. Conversely, engine torque is high when the throttle angle is large during moderate to heavy acceleration. Not only is line pressure increased, but throttle pressure acting at the base of the accumulator control valve increases back pressure to the accumulators. Accumulator pressure is increased to prevent slippage when the clutches and brakes are applied.

Governor Modulator Valve

The governor modulator valve works in conjunction with the cut-back valve to reduce engine load at high speed. It modifies governor pressure to the cut-back valve as the vehicle speed component.

Cut-Back Valve

The cut-back valve modifies throttle pressure based on vehicle speed. Lowering line pressure prevents unnecessary power loss at the transmission oil pump during higher speeds.

Detent Regulator Valve

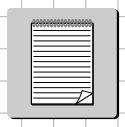
The detent regulator valve modifies line pressure to the Down-Shift Plug during kick-down to stabilize the hydraulic pressure acting on the 1-2, 2-3, and 3-4 shift valves. Detent pressure provides a pressure in addition to throttle pressure to improve downshift response.

Intermediate Modulator Valve

In 2-range, the intermediate modulator valve reduces line pressure from the intermediate shift valve. The second modulator pressure acts on the *2nd coast brake* (B1) through the 1-2 shift valve to reduce shifting shock.

Low Coast Modulator Valve

The low coast modulator valve reduces line pressure from the manual valve to reduce shock when the gear selector is moved to the L-range. The low coast modulator pressure pushes the low coast shift valve down and applies the *1st and reverse brake* (B3) to buffer the shock.



Notes