GM POWERTRAIN

4T80-E

HYDRA-MATIC

CONTENTS

PREFACE

The Hydra-matic 4T80-E Technician's Guide is intended for automotive technicians that are familiar with the operation of an automatic transaxle or transmission. Technicians or other persons not having automatic transaxle or transmission know-how may find this publication somewhat technically complex if additional instruction is not provided. Since the intent of this book is to explain the fundamental mechanical, hydraulic and electrical operating principles, technical terms used herein are specific to the transmission industry. However, words commonly associated with the specific transaxle or transmission function have been defined in a Glossary rather than within the text of this book.

The Hydra-matic 4T80-E Technician's Guide is also intended to assist technicians during the service, diagnosis and repair of this transaxle. However, this book is not intended to be a substitute for other General Motors service publications that are normally used on the job. Since there is a wide range of repair procedures and technical specifications specific to certain vehicles and transaxle models, the proper service publication must be referred to when servicing the Hydra-matic 4T80-E transaxle.

INTRODUCTION

The Hydra-matic 4T80-E Technician's Guide is another Powertrain publication from the Technician's Guide series of books. The purpose of this publication, as is the case with other Technician's Guides, is to provide complete information on the theoretical operating characteristics of this transmission. Operational theories of the mechanical, hydraulic and electrical components are presented in a sequential and functional order to better explain their operation as part of the system.

In the first section of this book entitled "Principles of Operation", exacting explanations of the major components and their functions are presented. In every situation possible, text describes component operation during the apply and release cycle as well as situations where it has no effect at all. The descriptive text is then supported by numerous graphic illustrations to further emphasize the operational theories presented.

The second major section entitled "Power Flow", blends the information presented in the "Principles of Operation" section into the complete transmission assembly. The transfer of torque from the engine through the transmission is graphically displayed on a full page while a narrative description is provided on a facing half page. The opposite side of the half page contains the narrative description of the hydraulic fluid as it applies components or shifts valves in the system. Facing this partial page is a hydraulic schematic that shows the position of valves, ball check valves, etc., as they function in a specific gear range.

The third major section of this book displays the "Complete Hydraulic Circuit" for specific gear ranges. Fold-out pages containing fluid flow schematics and two dimensional illustrations of major components graphically display hydraulic circuits. This information is extremely useful when tracing fluid circuits for learning or diagnosis purposes.

The "Appendix" section of this book provides additional transmission information regarding lubrication circuits, seal locations, illustrated parts lists and more. Although this information is available in current model year Service Manuals, its inclusion provides for a quick reference guide that is useful to the technician.

Production of the Hydra-matic 4T80-E Technician's Guide was made possible through the combined efforts of many staff areas within the General Motors Powertrain Division. As a result, the Hydra-matic 4T80-E Technician's Guide was written to provide the user with the most current, concise and usable information available regarding this product.

HOW TO USE THIS BOOK

First time users of this book may find the page layout a little unusual or perhaps confusing. However, with a minimal amount of exposure to this format its usefulness becomes more obvious. If you are unfamiliar with this publication, the following guidelines are helpful in understanding the functional intent for the various page layouts:

- Read the following section, "Understanding the Graphics" to know how the graphic illustrations are used, particularly as they relate to the mechanical power flow and hydraulic controls (see Understanding the Graphics page 6).

- Unfold the cutaway illustration of the Hydra-matic 4T80-E (page 8) and refer to it as you progress through each major section. This cutaway provides a quick reference of component location inside the transmission assembly and their relationship to other components.

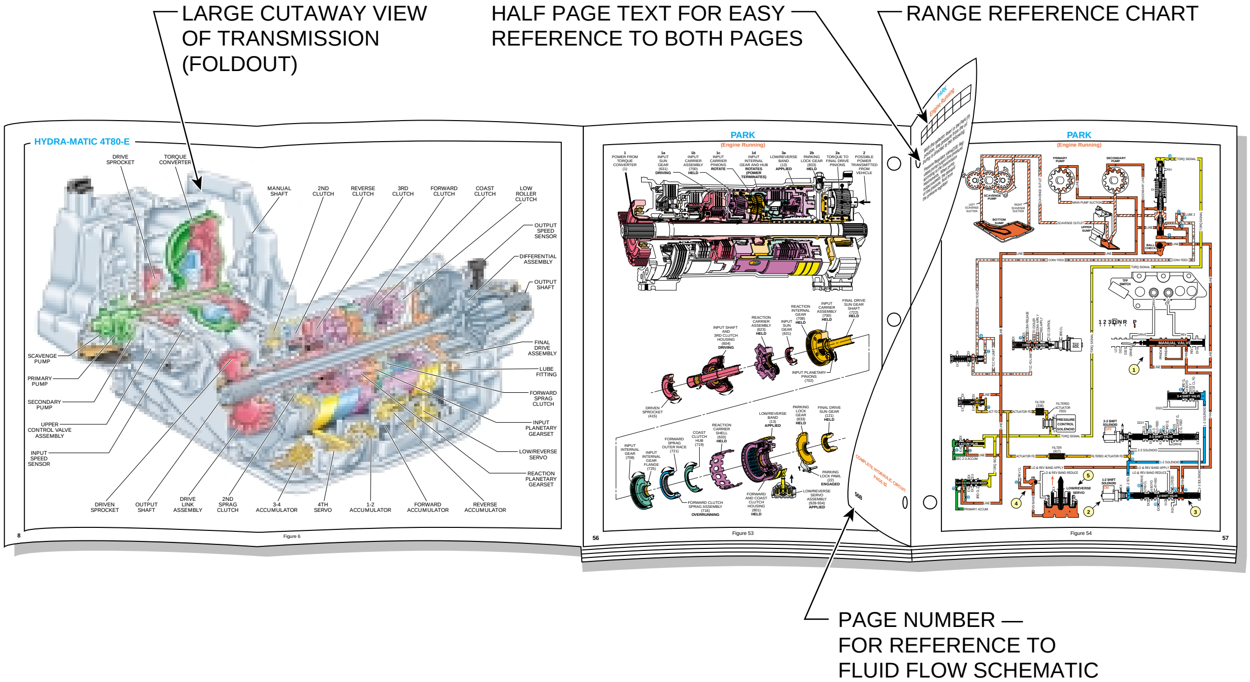
- The Principles of Operation section (beginning on page 9A) presents information regarding the major apply components and hydraulic control components used in this transmission. This section describes "how" specific components work and interfaces with the sections that follow.

- The Power Flow section (beginning on page 53) presents the mechanical and hydraulic functions corresponding to specific gear ranges. This section builds on the information presented in the Principles of Operation section by showing specific fluid circuits that enable the mechanical components to operate. The mechanical power flow is graphically displayed on a full size page and is followed by a half page of descriptive text. The opposite side of the half page contains the narrative description of the hydraulic fluid as it applies components or moves valves in the system. Facing this partial page is a hydraulic schematic which shows the position of valves, ball check valves, etc., as they function in a specific gear range. Also, located at the bottom of each half page is a reference to the Complete Hydraulic Circuit section that follows.

- The Complete Hydraulic Circuits section (beginning on page 81) details the entire hydraulic system. This is accomplished by using a fold-out circuit schematic with a facing page two dimensional fold-out drawing of each component. The circuit schematics and component drawings display only the fluid passages for that specific operating range.

- Finally, the Appendix section contains a schematic of the lubrication flow through the transmission, disassembled view parts lists and transmission specifications. This information has been included to provide the user with convenient reference information published in the appropriate vehicle Service Manuals. Since component parts lists and specifications may change over time, this information should be verified with Service Manual information.

HOW TO USE THIS BOOK



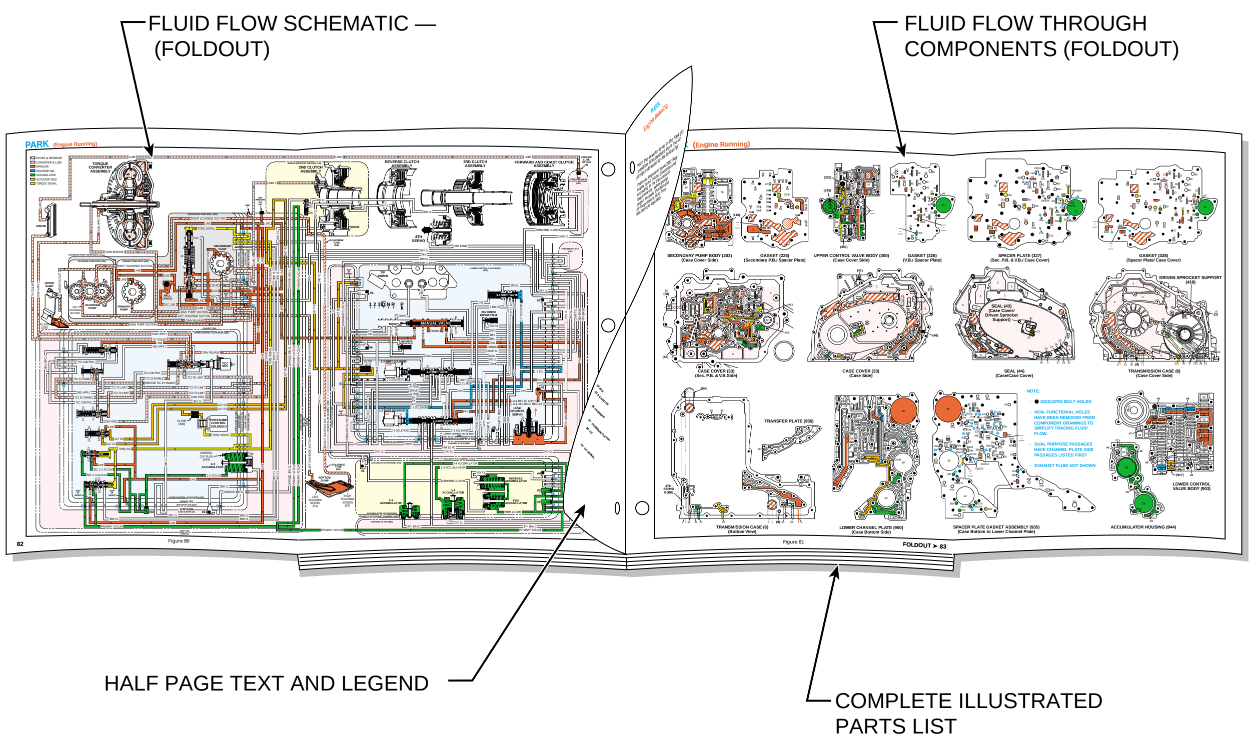


Figure 1

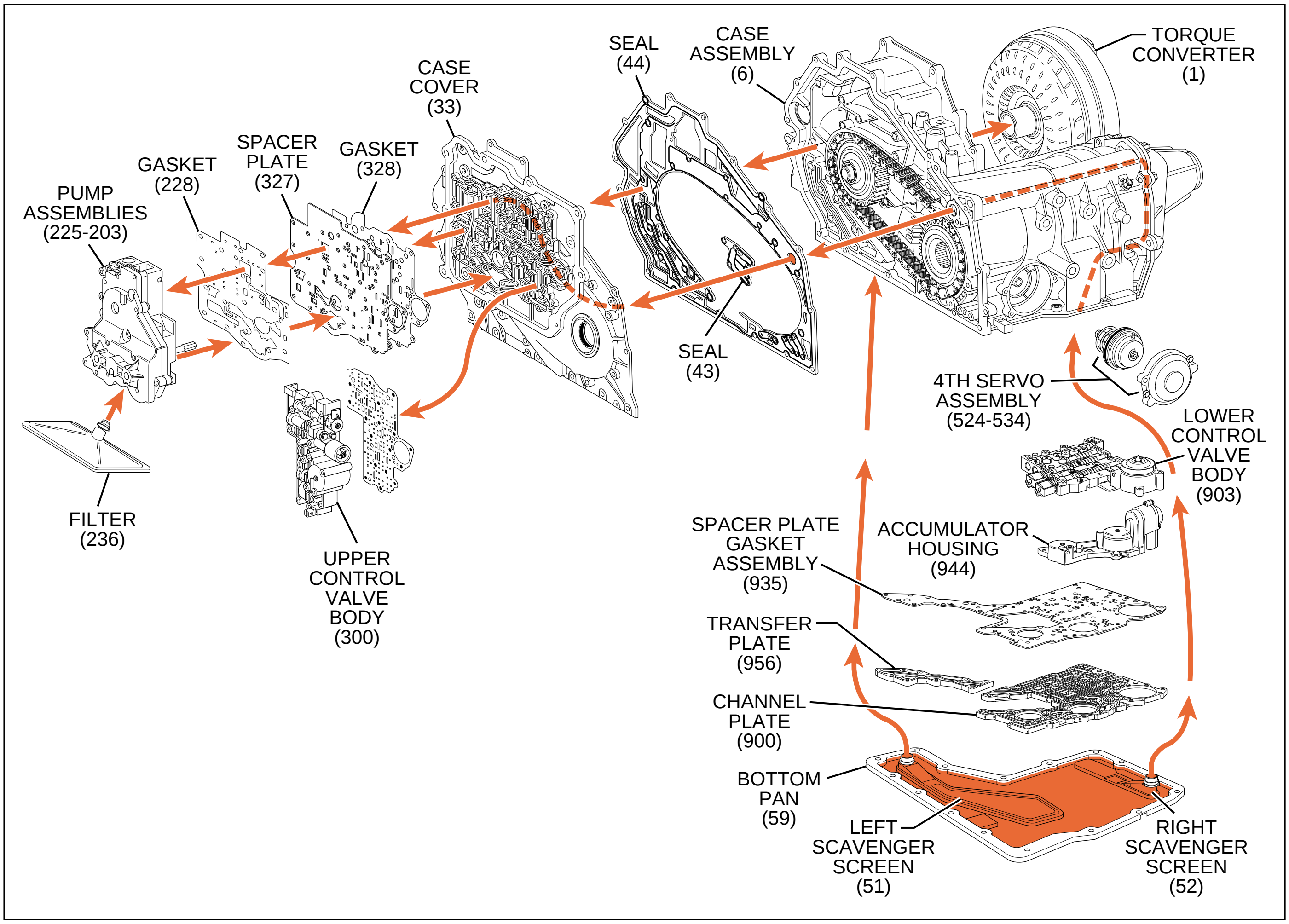


Figure 2

The flow of transmission fluid starts when the scavenge pump gears turn and draw fluid from the bottom pan through two scavenger screens, the scavenge tube, into the upper sump. When the fluid reaches the upper sump, the primary and secondary pumps draw fluid through a filter located behind the side cover before it is routed into the line pressure circuits. This general route for fluid to flow is easily understood by reviewing the illustrations provided in Figure 2. However, fluid may pass between the control valve body, spacer plate, channel plate and other components many times before reaching a valve or applying a clutch. For this reason, the graphics are designed to show the exact location where fluid passes through a component and into other passages for specific gear range operation.

To provide a better understanding of fluid flow in the Hydra-matic 4T80-E transmission, the components involved with hydraulic control and fluid flow are illustrated in three major formats. Figure 3 provides an example of these formats which are:

- A three dimensional line drawing of the component for easier part identification.
- A two dimensional line drawing of the component to indicate fluid passages and orifices.
- A graphic schematic representation that displays valves, ball check valves, orifices and so forth, required for the proper function of the transmission in a specific gear range. In the schematic drawings, fluid circuits are represented by straight lines and orifices are represented by indentations in a circuit. All circuits are labeled and color coded to provide reference points between the schematic drawing and the two dimensional line drawing of the components.
- Figure 4 (page 7B) provides an illustration of a typical valve, bushing and valve train components. A brief description of valve operation is also provided to support the illustration.
- Figure 5 (page 7B) provides a color coded chart that references different fluid pressures used to operate the hydraulic control systems. A brief description of how fluid pressures affect valve operation is also provided.

UNDERSTANDING THE GRAPHICS

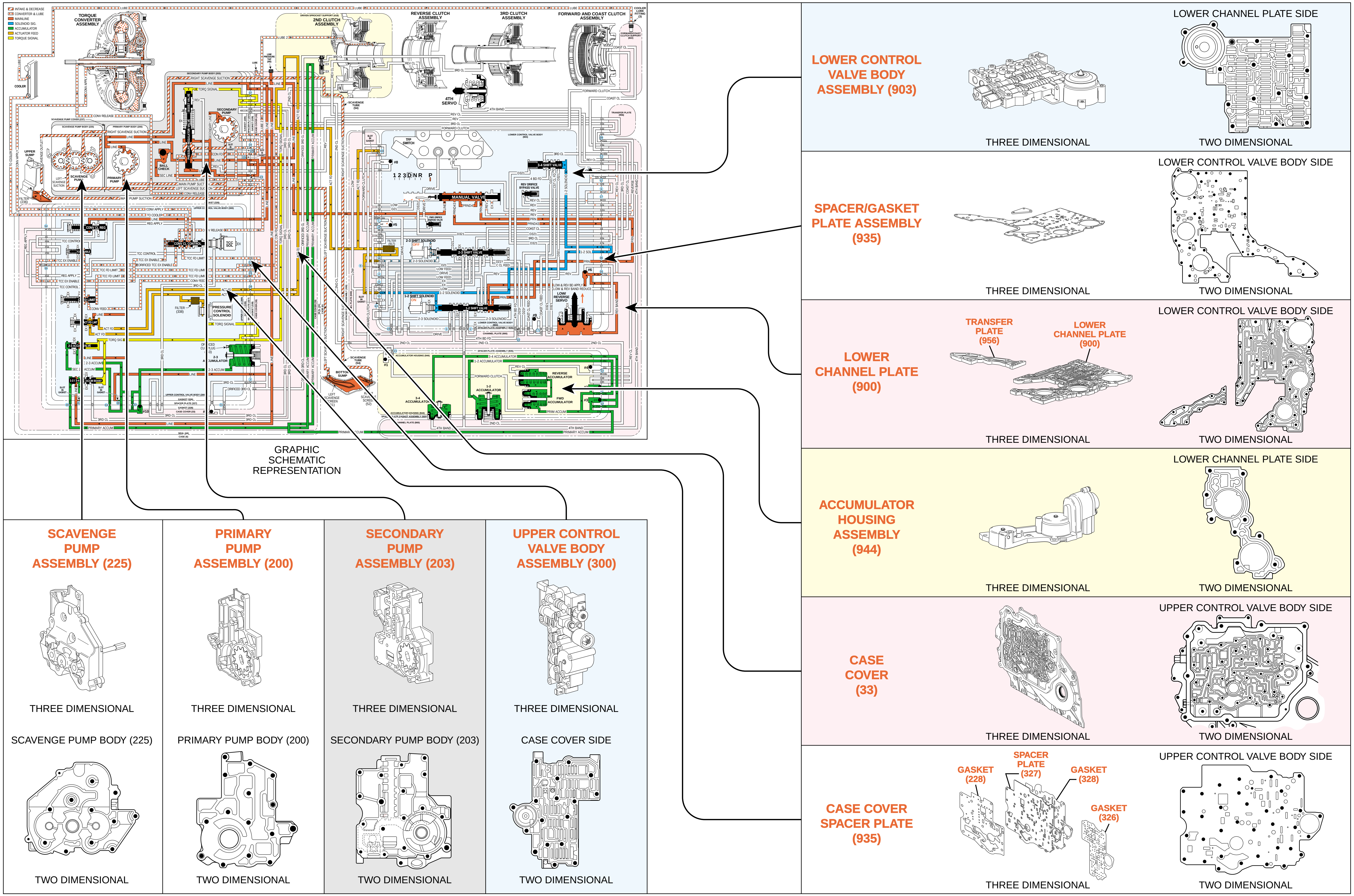


Figure 3

UNDERSTANDING THE GRAPHICS

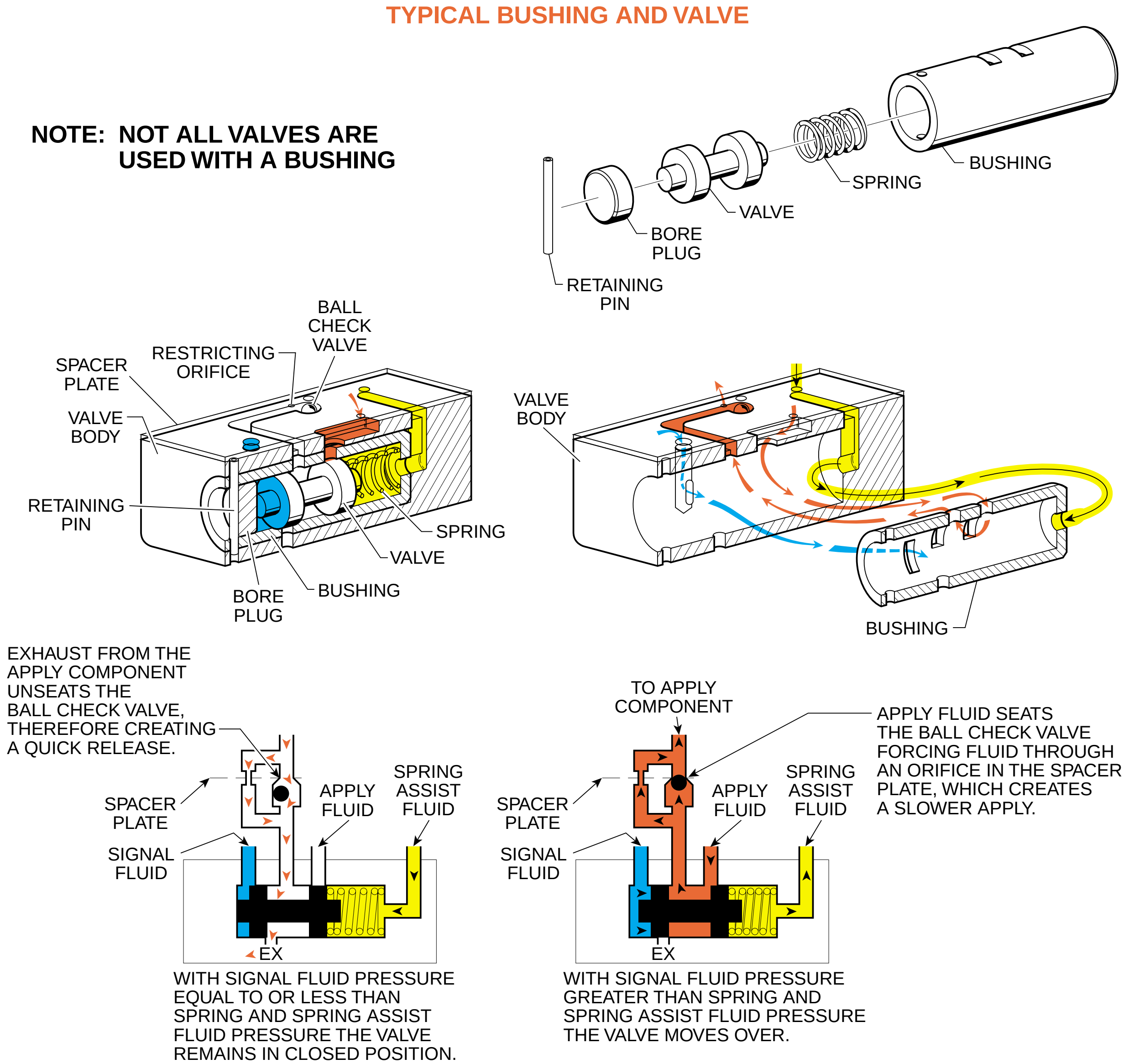
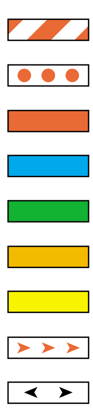
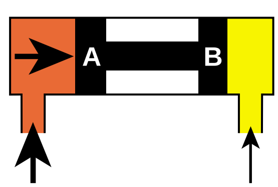


Figure 4

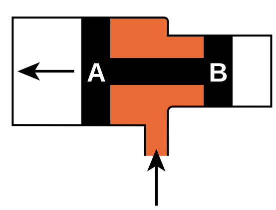
FLUID PRESSURES



- SUCTION
- CONVERTER & LUBE
- MAINLINE
- SOLENOID SIGNAL
- ACCUMULATOR
- ACTUATOR FEED LIMIT
- TORQUE SIGNAL
- EXHAUST
- DIRECTION OF FLOW



WITH EQUAL SURFACE AREAS ON EACH END OF THE VALVE, BUT FLUID PRESSURE "A" BEING GREATER THAN FLUID PRESSURE "B", THE VALVE WILL MOVE TO THE RIGHT.



WITH THE SAME FLUID PRESSURE ACTING ON BOTH SURFACE "A" AND SURFACE "B" THE VALVE WILL MOVE TO THE LEFT. THIS IS DUE TO THE LARGER SURFACE AREA OF "A" THAN "B".

Figure 5

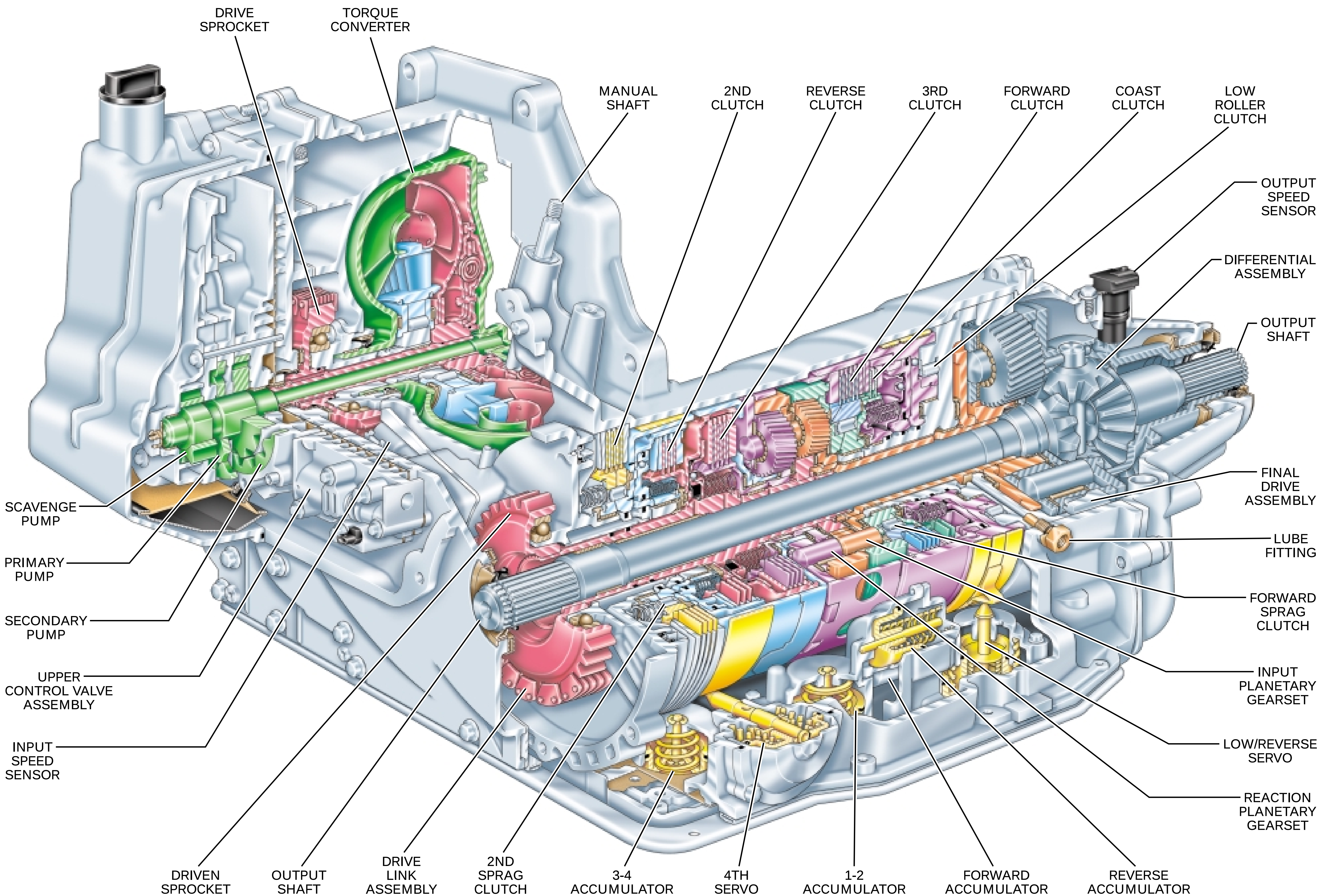

DRIVE SPROCKET
TORQUE CONVERTER
MANUAL SHAFT
2ND CLUTCH
REVERSE CLUTCH
3RD CLUTCH
FORWARD CLUTCH
COAST CLUTCH
LOW ROLLER CLUTCH
OUTPUT SPEED SENSOR
DIFFERENTIAL ASSEMBLY
OUTPUT SHAFT
FINAL DRIVE ASSEMBLY
LUBE FITTING
FORWARD SPRAG CLUTCH
INPUT PLANETARY GEARSET
LOW/REVERSE SERVO
REACTION PLANETARY GEARSET
SCAVENGE PUMP
PRIMARY PUMP
SECONDARY PUMP
UPPER CONTROL VALVE ASSEMBLY
INPUT SPEED SENSOR
DRIVEN SPROCKET
OUTPUT SHAFT
DRIVE LINK ASSEMBLY
2ND SPRAG CLUTCH
3-4 ACCUMULATOR
4TH SERVO
1-2 ACCUMULATOR
FORWARD ACCUMULATOR
REVERSE ACCUMULATOR

Figure 6

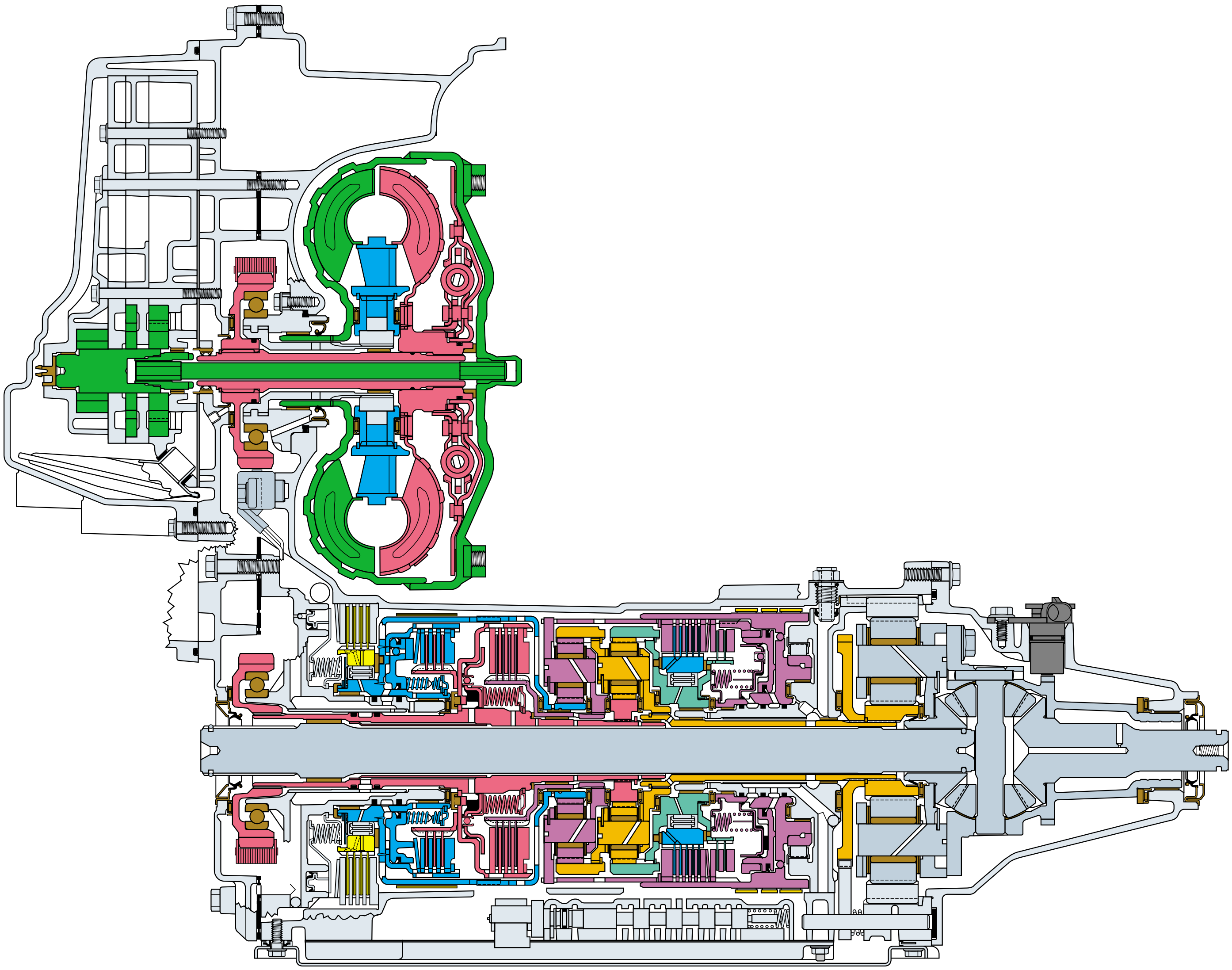


Figure 7

HYDRA-MATIC 4T80-E CROSS SECTIONAL DRAWING

A cross sectional line drawing is typically the standard method for illustrating either an individual mechanical component or a complete transmission assembly. However, unless a person is familiar with all the individual components of the transmission, distinguishing components may be difficult in this type of drawing. For this reason, a three dimensional perspective illustration (shown on page 8) is the primary drawing used throughout this book.

The purpose for this type of illustration is to provide a more exacting graphic representation of each component and to show their relationship to other components within the transmission assembly. It is also useful for understanding the cross sectional line drawing by comparing the same components from the three dimensional perspective illustration. In this regard it becomes an excellent teaching instrument.

Additionally, all the illustrations contained in this book use a color scheme that is consistent throughout this book. In other words, regardless of the type of illustration or drawing, all components have an assigned color and that color is used whenever that component is illustrated. This consistency not only helps to provide for easy component identification but it also enhances the graphic and color continuity between sections.

GENERAL DESCRIPTION

The Hydra-matic 4T80-E is a fully automatic, four speed, front wheel drive transmission. It consists primarily of a four-element torque converter, two planetary gear sets, a hydraulic pressurization and control system, friction and mechanical clutches and, a final drive planetary gear set with a differential assembly.

The four-element torque converter contains a pump, a turbine, a pressure plate splined to the turbine, and a stator assembly. The torque converter acts as a fluid coupling to smoothly transmit power from the engine to the transmission. It also hydraulically provides additional torque multiplication when required. The pressure plate, when applied, provides a mechanical "direct drive" coupling of the engine to the transmission.

The two planetary gear sets provide the four forward gear ratios and reverse. Changing gear ratios is fully automatic and is accomplished through the use of a Powertrain Control Module (PCM). The PCM receives and monitors various electronic sensor inputs and uses this information to shift the transmission at the most optimum time.

When the shift solenoid valves inside the transmission are hydraulically activated they send operating gear range information to the PCM. Gear range information is then used by the PCM to apply and release the torque converter clutch. This allows the engine to deliver the maximum fuel efficiency without sacrificing vehicle performance.

The hydraulic system primarily consists of three gear type pumps, two control valve bodies, a case cover and a channel plate. The pumps maintain the working pressures needed to stroke the servos and clutch pistons that apply or release the friction components. These friction components (when applied or released) support the automatic shifting qualities of the transmission.

The friction components used in this transmission consist of five multiple disc clutches and two bands. The multiple disc clutches combine with three mechanical components, two sprag clutches and a roller clutch, to deliver five different gear ratios through gear sets. The gear sets then transfer torque through the final drive differential and out to the drive axles.

EXPLANATION OF RANGES

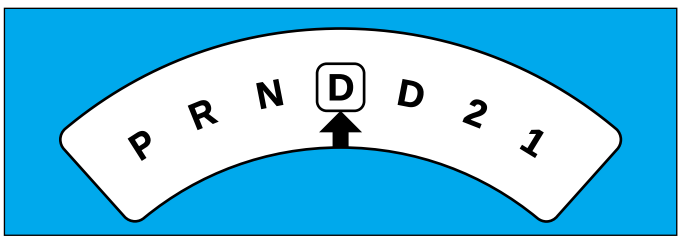


Figure 8

The transmission can be operated in any one of the seven different positions shown on the shift quadrant (Figure 8).

P – Park position enables the engine to be started while preventing the vehicle from rolling either forward or backward. For safety reasons, the vehicle's parking brake should be used in addition to the transmission "Park" position. Since the final drive differential and output shaft are mechanically locked to the case through the parking pawl and final drive internal gear, Park position should not be selected until the vehicle has come to a complete stop.

R – Reverse enables the vehicle to be operated in a rearward direction.

N – Neutral position enables the engine to start and operate without driving the vehicle. If necessary, this position should be selected to restart the engine while the vehicle is moving.

(D) – Overdrive range should be used for all normal driving conditions for maximum efficiency and fuel economy. Overdrive range allows the transmission to operate in each of the four forward gear ratios. Downshifts to a lower gear, or higher gear ratio, are available for safe passing by depressing the accelerator or by manually selecting a lower gear with the shift selector.

The transmission should not be operated in Overdrive when towing a trailer or driving on hilly terrain. Under such conditions that put an extra load on the engine, the transmission should be driven in a lower manual gear selection for maximum efficiency.

D – Manual Third can be used for conditions where it may be desirable to use only three gear ratios. These conditions include towing a trailer and driving on hilly terrain as described above. This range is also helpful for engine braking when descending slight grades. If the vehicle is in fourth gear it will immediately shift to third. Automatic shifting is the same as in Overdrive range for first, second and third gears except that the transmission will not shift into fourth gear.

2 – Manual Second adds more performance for congested traffic and hilly terrain. It has the same starting ratio (first gear) as Manual Third but the transmission is prevented from shifting above second gear at normal throttle opening. Thus, Manual Second can be used to retain second gear for acceleration and engine braking as desired. If the transmission is in third or fourth gear when Manual Second is selected it will immediately shift to second gear depending on vehicle speed.

1 – Manual First can be selected at any vehicle speed. If the transmission is in second, third or fourth gear it will immediately shift into first gear when vehicle speed is below approximately 56 km/h (35 mph). This is particularly beneficial for maintaining maximum engine braking when descending steep grades.

PRINCIPLES OF OPERATION

An automatic transmission is the mechanical component of a vehicle that transfers power (torque) from the engine to the wheels. It accomplishes this task by providing a number of forward gear ratios that automatically change as the speed of the vehicle increases. The reason for changing forward gear ratios is to provide the performance and fuel economy expected from vehicles manufactured today. On the performance end, a gear ratio that develops a lot of torque (through torque multiplication) is required in order to initially start a vehicle moving. Once the vehicle is in motion, less torque is required in order to maintain the vehicle at a certain speed. Once the vehicle has reached a desired speed, fuel economy becomes the important factor and the transmission will shift into overdrive. At this point output speed is greater than input speed, and, input torque is greater than output torque.

Another important function of the automatic transmission is to allow the engine to be started and run without transferring torque to the wheels. This situation occurs whenever Park (**P**) or Neutral (**N**) ranges have been selected. Also, operating the vehicle in a rearward direction is possible whenever Reverse (**R**) range has been selected (accomplished by the gear sets).

The variety of ranges in an automatic transmission are made possible through the interaction of numerous mechanically, hydraulically and electronically controlled components inside the transmission. At the appropriate time and sequence, these components are either applied or released and operate the gear sets at a gear ratio consistent with the driver's needs. The following pages describe the theoretical operation of the mechanical, hydraulic and electrical components found in the Hydra-matic 4T80-E transmission. When an understanding of these operating principles has been attained, diagnosis of these transmission systems is made easier.

MAJOR MECHANICAL COMPONENTS

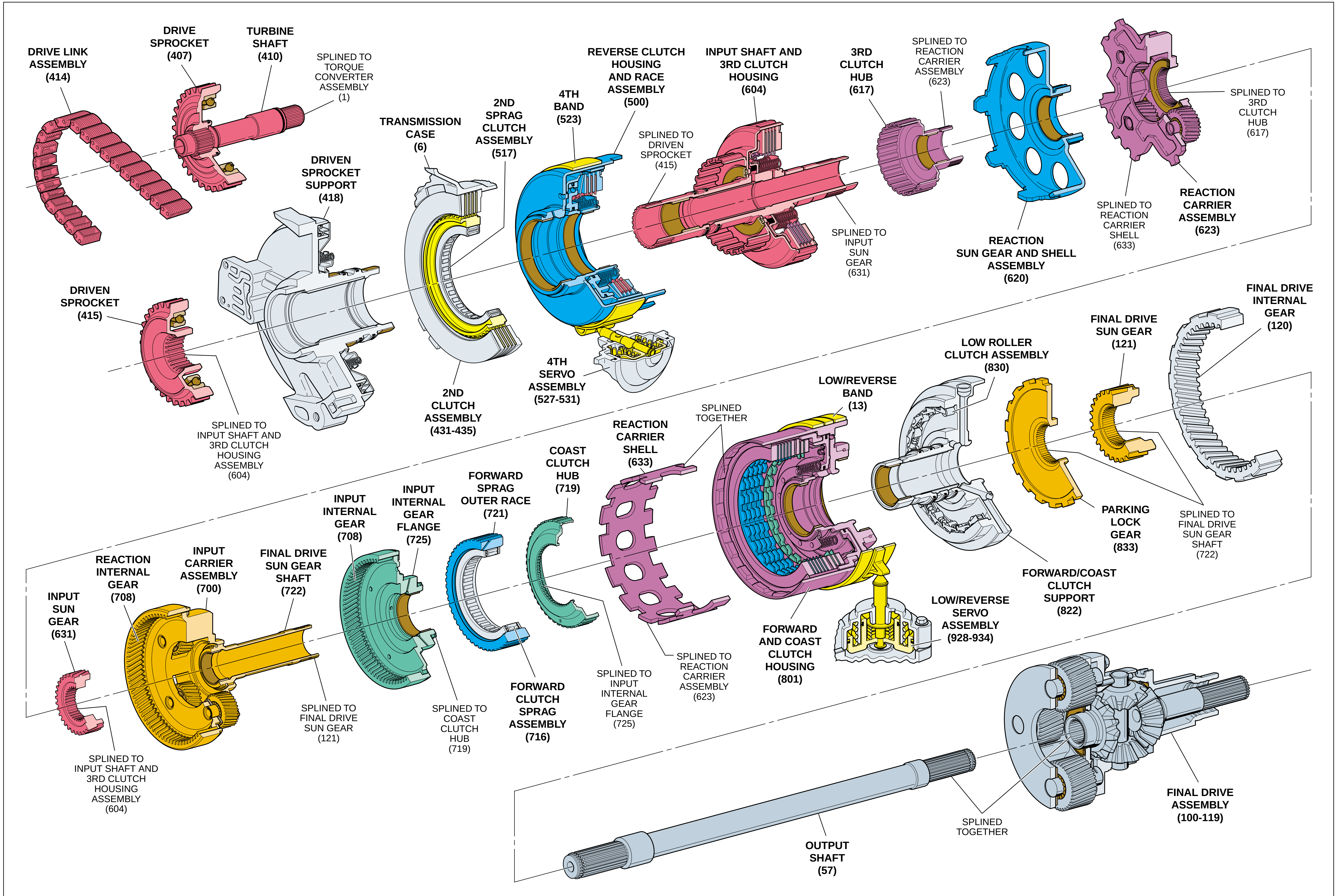


Figure 9

COLOR LEGEND

MAJOR MECHANICAL COMPONENTS

The foldout graphic on page 10 contains a disassembled drawing of the major components used in the Hydra-matic 4T80-E transmission. This drawing, along with the cross sectional illustrations on pages 8 and 8A, shows the major mechanical components and their relationship to each other as a complete assembly. Therefore, color has been used throughout this book to help identify parts that are splined together, rotating at engine speed, held stationary, and so forth. Color differentiation is particularly helpful when using the Power Flow section for understanding the transmission operation.

The color legend below provides the “general” guidelines that were followed in assigning specific colors to the major components. However, due to the complexity of this transmission, some colors (such as grey) were used for artistic purposes rather than being restricted to the specific function or location of that component.

Components held stationary in the case or splined to the case. Examples: Driven Sprocket Support (418), Accumulator Housing (944), Valve Bodies.

Components that rotate at engine speed. Examples: Torque Converter Assembly (1) and Oil Pump Drive Shaft (2).

Components that rotate at turbine speed. Examples: Converter Turbine, Drive Sprocket (407), Driven Sprocket (415) and 3rd Clutch Housing Assembly (604).

Components that rotate at transmission output speed. Examples: Differential Carrier (110), Output Shaft (57).

Components such as the 2nd Clutch Fiber Plates (435), 2nd Sprag Clutch Outer Race (516).

Components such as the Stator in the Torque Converter (1), Reverse Clutch Housing (500).

Components such as the Reaction Carrier (623), Final Drive Sun Gear (722).

Accumulators, Servos and Bands.

All bearings and bushings.

All seals

COLOR LEGEND

APPLY COMPONENTS

The Range Reference Chart on page 11, provides another valuable source of information for explaining the overall function of the Hydra-matic 4T80-E transmission. This chart highlights the major apply components that function in a selected gear range, and the specific gear operation within that gear range.

Included as part of this chart is the same color reference to each major component that was previously discussed. If a component is active in a specific gear range, a word describing its activity will be listed in the column below that component. The row where the activity occurs corresponds to the appropriate transmission range and gear operation.

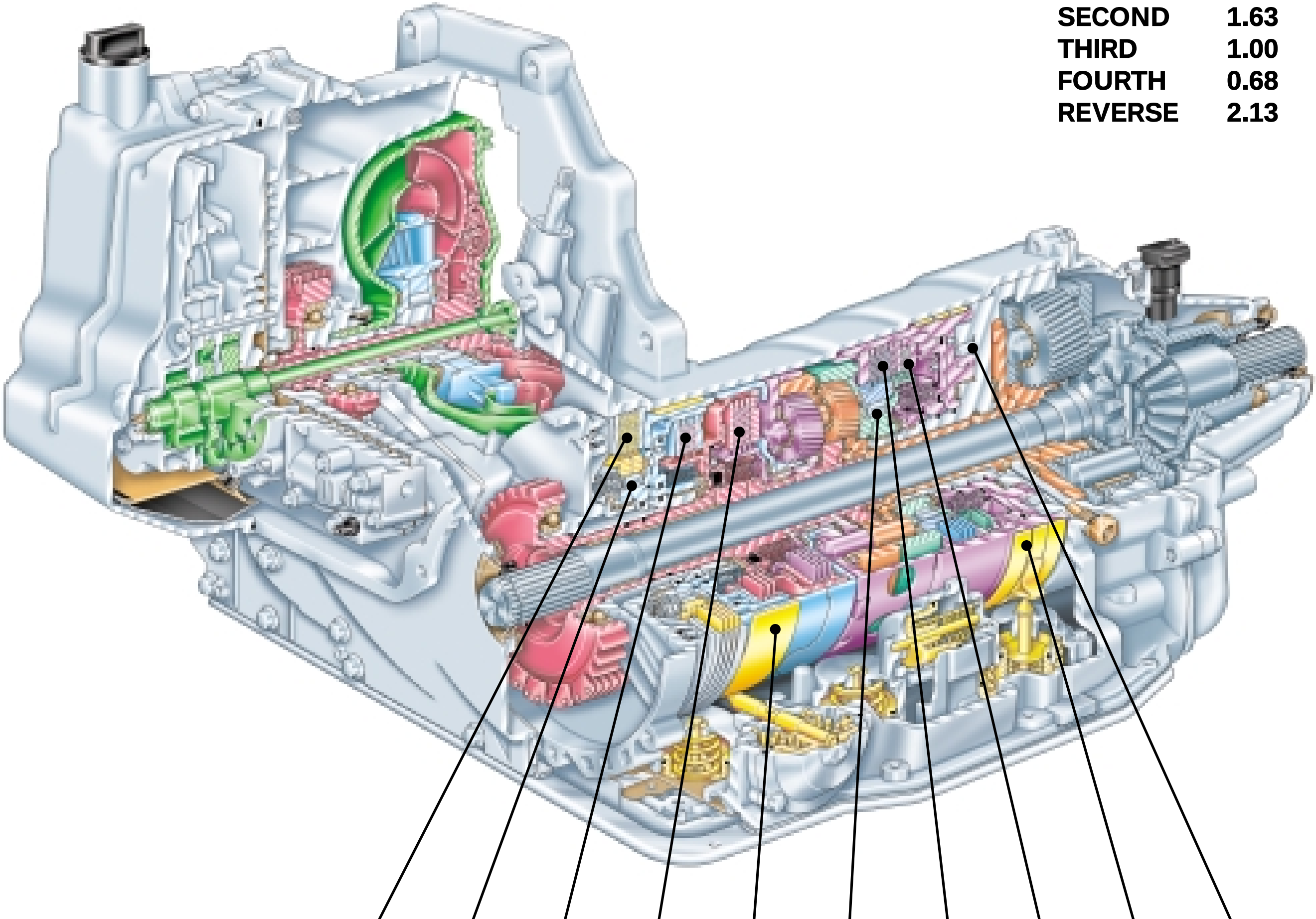
An abbreviated version of this chart can also be found at the top of the half page of text located in the Power Flow section. This provides for a quick reference when reviewing the mechanical power flow information contained in that section.

RANGE REFERENCE CHART

AND SOLENOID'S STATE

4T80-E GEAR RATIOS

FIRST	**2.96**
SECOND	**1.63**
THIRD	**1.00**
FOURTH	**0.68**
REVERSE	**2.13**

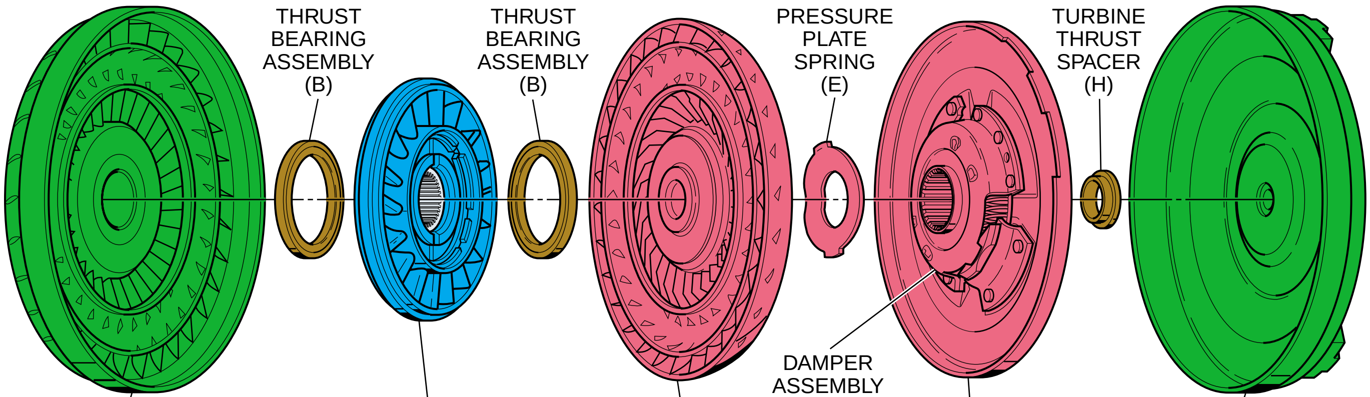


RANGE	GEAR	1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
PARK	N	ON	OFF									APPLIED	
REV	R	ON	OFF			APPLIED						APPLIED	
NEU	N	ON	OFF									APPLIED	
D	1	ON	OFF						HOLDING	APPLIED		APPLIED	HOLDING
	2	OFF	OFF	APPLIED	HOLDING				HOLDING	APPLIED			OVER-RUNNING
	3	OFF	ON	APPLIED	OVER-RUNNING		APPLIED		HOLDING	APPLIED			OVER-RUNNING
	4	ON	ON	APPLIED			APPLIED	APPLIED	OVER-RUNNING	APPLIED			OVER-RUNNING
3	1	ON	OFF						HOLDING	APPLIED		APPLIED	HOLDING
	2	OFF	OFF	APPLIED	HOLDING				HOLDING	APPLIED			OVER-RUNNING
	3	OFF	ON	APPLIED	OVER-RUNNING		APPLIED		HOLDING	APPLIED	APPLIED		OVER-RUNNING
2	1	ON	OFF						HOLDING	APPLIED	APPLIED	APPLIED	HOLDING
	2	OFF	OFF	APPLIED	HOLDING			APPLIED	HOLDING	APPLIED	APPLIED		OVER-RUNNING
	3*	OFF	ON	APPLIED	OVER-RUNNING		APPLIED		HOLDING	APPLIED	APPLIED		OVER-RUNNING
1	1	ON	OFF						HOLDING	APPLIED	APPLIED	APPLIED	HOLDING
	2*	OFF	OFF	APPLIED	HOLDING			APPLIED	HOLDING	APPLIED	APPLIED		OVER-RUNNING
	3*	OFF	ON	APPLIED	OVER-RUNNING		APPLIED		HOLDING	APPLIED	APPLIED		OVER-RUNNING

ON = SOLENOID ENERGIZED
OFF = SOLENOID DE-ENERGIZED
@ THE SOLENOID'S STATE FOLLOWS A SHIFT PATTERN WHICH DEPENDS UPON VEHICLE SPEED AND THROTTLE POSITION. IT DOES NOT DEPEND UPON THE SELECTED GEAR.
* THESE GEARS ARE NOT NORMAL BUT AVAILABLE UNDER SEVERE CONDITIONS.

Figure 10

TORQUE CONVERTER

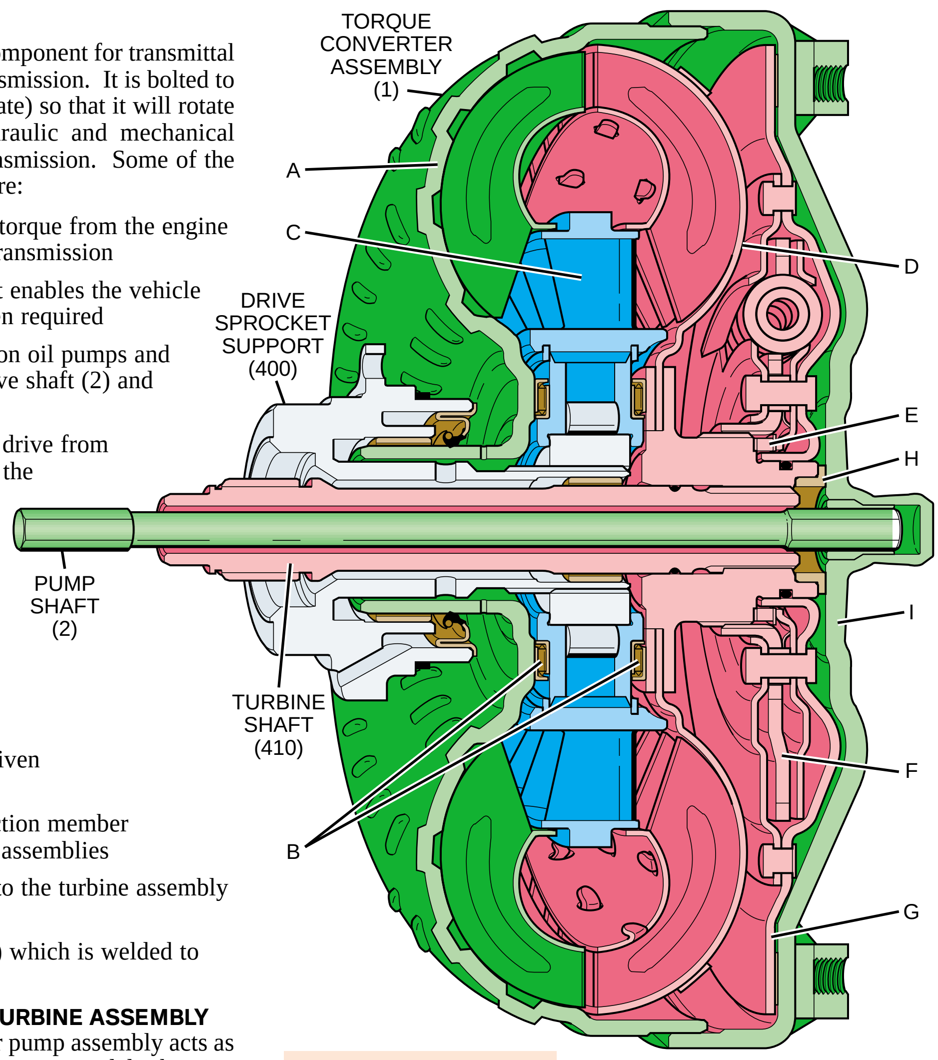


TORQUE CONVERTER:
The torque converter (1) is the primary component for transmittal of power between the engine and the transmission. It is bolted to the engine flywheel (known as the flexplate) so that it will rotate at engine speed, thus providing a hydraulic and mechanical coupling between the engine and the transmission. Some of the major functions of the torque converter are:

- to provide for a smooth conversion of torque from the engine to the mechanical components of the transmission
- to multiply torque from the engine that enables the vehicle to achieve additional performance when required
- to mechanically operate the transmission oil pumps and scavenge pumps through the pump drive shaft (2) and driven shaft (207)
- to provide a mechanical link, or direct drive from the engine to the transmission through the use of a Torque Converter Clutch (TCC)

The torque converter assembly is made up of the following five main sub-assemblies:

- a converter pump assembly (A) which is the driving member
- a turbine assembly (D) which is the driven or output member
- a stator assembly (C) which is the reaction member located between the pump and turbine assemblies
- a pressure plate assembly (G) splined to the turbine assembly to enable direct mechanical drive
- a converter housing cover assembly (I) which is welded to the converter pump assembly



CONVERTER PUMP ASSEMBLY AND TURBINE ASSEMBLY
When the engine is running, the converter pump assembly acts as a centrifugal pump by picking up fluid at its center and discharging it at its rim, between the blades. The force of this fluid then hits the turbine blades and causes the turbine to rotate. As the engine and converter pump increase in RPM, so does the turbine.

PRESSURE PLATE, DAMPER AND CONVERTER HOUSING COVER ASSEMBLIES
The pressure plate is splined to the turbine hub and applies (engages) with the converter cover to provide a mechanical coupling of the engine to the transmission. When the pressure plate assembly is applied, the amount of slippage that occurs through a fluid coupling is reduced (but not eliminated), thereby providing a more efficient transfer of engine torque to the drive wheels.

Torque converter failure could cause loss of drive and or loss of power.

To reduce torsional shock during the apply of the pressure plate to the converter cover, a spring loaded damper assembly (F) is used. The pressure plate is attached to the pivoting mechanism of the damper assembly which allows the pressure plate to rotate independently of the damper assembly up to approximately 45 degrees. During engagement, the springs in the damper assembly cushion the pressure plate engagement and also reduce irregular torque pulses from the engine or road surface.

Figure 11

TORQUE CONVERTER

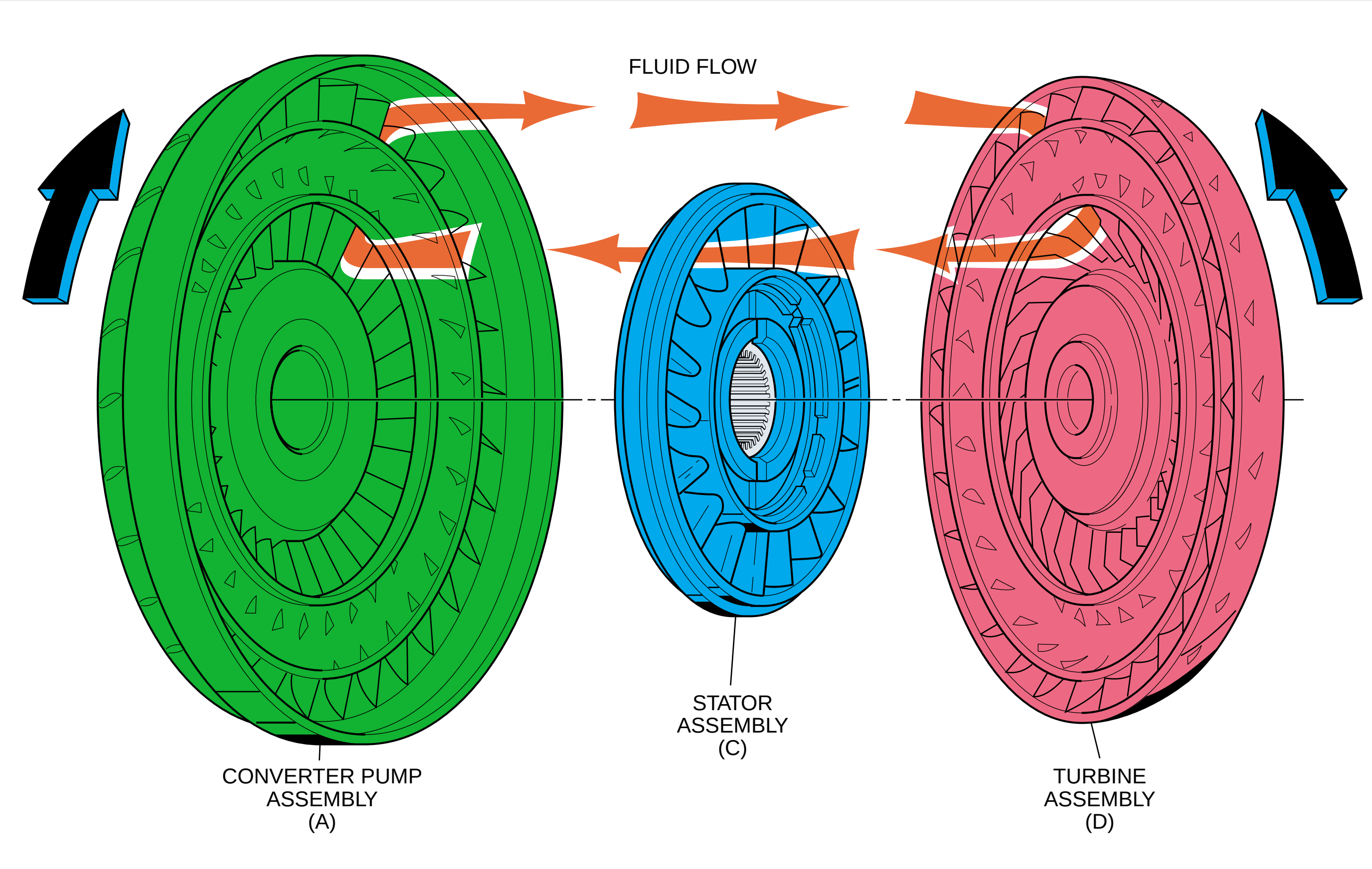


Figure 12

Stator roller clutch failure
- roller clutch freewheels in both directions can cause poor acceleration at low speed.
- roller clutch locks up in both directions can cause poor acceleration at high speed.
- Overheated fluid.

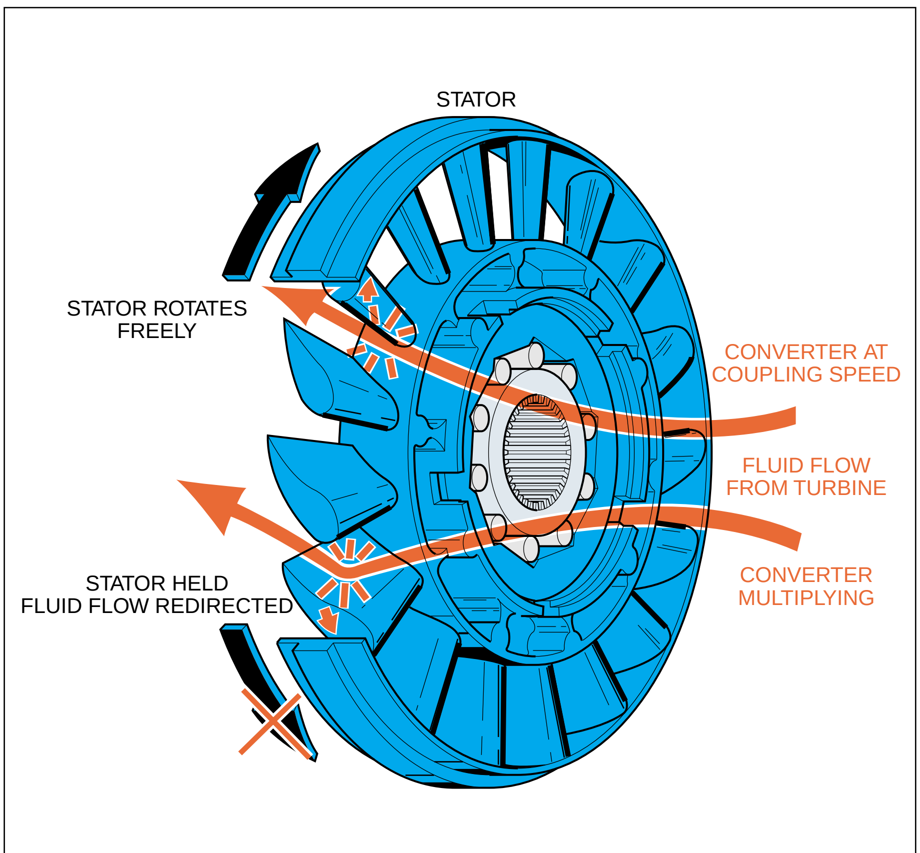


Figure 13

STATOR ASSEMBLY

The stator assembly is located between the pump assembly and turbine assembly, and is mounted on a one-way roller clutch. This one-way roller clutch allows the stator to rotate in one direction and prevents (holds) the stator from rotating in the other direction. The function of the stator is to redirect fluid returning from the turbine in order to assist the engine in turning the converter pump assembly.

At low vehicle speeds when greater torque is needed, fluid from the turbine hits the front side of the stator blades (the converter is multiplying torque). At this time, the one-way roller clutch prevents the stator from rotating in the same direction as the fluid flow, thereby redirecting fluid to assist the engine in turning the converter pump. In this mode, fluid leaving the converter pump has more force to turn the turbine assembly and multiply engine torque.

As vehicle speed increases and less torque is required, centrifugal force acting on the fluid changes the direction of the fluid leaving the turbine such that it hits the back side of the stator blades (converter at coupling speed). When this occurs, the roller clutch overruns and allows the stator to rotate freely. Fluid is no longer being redirected to the converter pump and engine torque is not being multiplied.

RELEASE

When the torque converter clutch is released, fluid is fed into the torque converter by the pump into the converter release fluid passage. The converter release fluid passage is located between the pump shaft (2) and the turbine shaft (410). Fluid travels between the shafts and enters the release side of the pressure plate at the end of the turbine shaft. The pressure plate is forced away from the converter cover and allows the torque converter turbine to rotate at speeds other than engine speed.

The release fluid then flows between the friction element on the pressure plate and the converter cover to enter the apply side of the torque converter. The fluid then exits the torque converter through the apply passage which goes through the drive sprocket support (400) and into the case cover (33). This fluid now travels to the upper control valve body and on to the oil cooler.

APPLY

When the PCM determines that the vehicle is at the proper speed for the torque converter clutch to apply it sends a signal to the TCC solenoid. The TCC solenoid then routes line fluid from the pump to the converter apply passage of the torque converter. The fluid passes between the drive sprocket support and the turbine shaft to a feed hole in the drive sprocket support. Fluid passes through the feed hole in the support and into the torque converter on the apply side of the pressure plate assembly. Converter release fluid is then exhausted out of the torque converter between the turbine shaft and the pump shaft.

Apply fluid pressure forces the pressure plate against the torque converter cover to provide a mechanical link between the engine and the turbine. In vehicles equipped with the Electronically Controlled Capacity Clutch (ECCC) system, the pressure plate does not fully lock to the torque converter cover. It is instead precisely controlled to maintain a small amount of slippage between the engine and the turbine, reducing driveline torsional disturbances.

The TCC apply should occur in fourth gear (also third gear in some applications), and should not apply until the transmission fluid has reached a minimum operating temperature of 8°C (46°F) and the engine coolant temperature reaches 50°C (122°F).

For more information on TCC apply and release, see Overdrive Range – Fourth Gear TCC Released and Applied, pages 70-71.

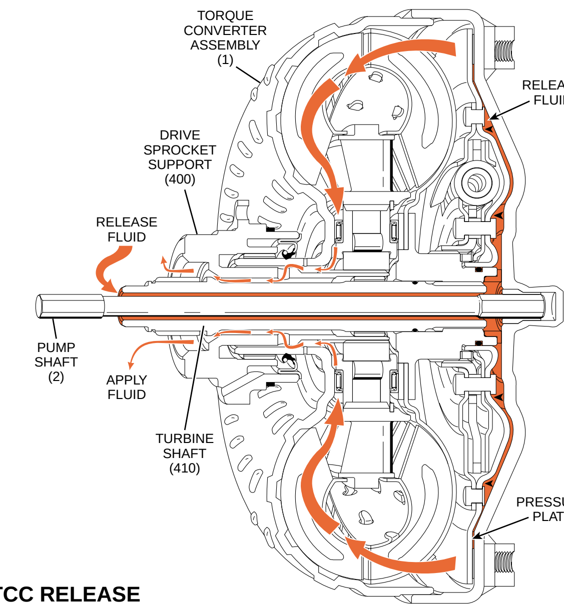
No TCC apply can be caused by:

- TCC solenoid valve assembly (336) malfunction
- Converter clutch control valve (317) stuck or binding
- Converter clutch feed limit valve (312) stuck or binding
- TCC enable valve (322) stuck or binding
- Converter clutch regulator valve (318) stuck or binding
- Spacer plate and gaskets misaligned or incorrect
- Turbine shaft and or seals damaged or missing
- Turbine shaft bushing (402) worn or damaged
- Pressure plate assembly friction material worn or damaged

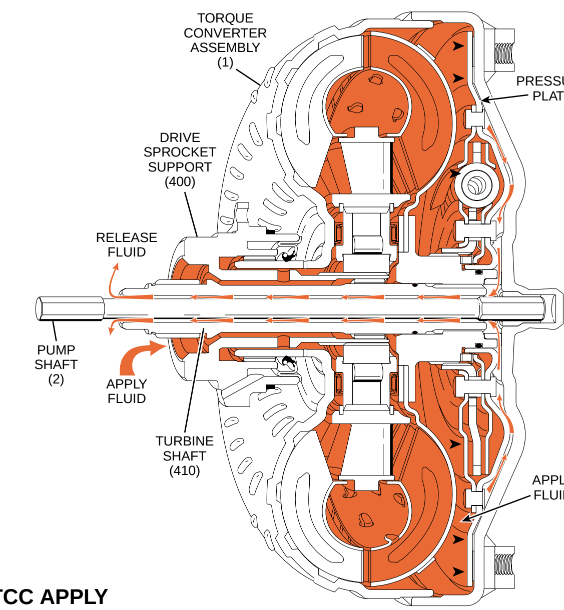
VISCOUS CONVERTER CLUTCH (VCC)
(Some Models)

The viscous converter clutch performs the same function as the torque converter clutch that was explained in the preceding pages. The primary difference between the torque converter clutch and the viscous converter clutch is the silicone fluid that is sealed between the cover and body of the clutch assembly. The viscous silicone fluid provides a smooth apply of the clutch assembly when it engages with the converter cover and also reduces irregular torque pulses from the engine or road surface. When the viscous clutch is applied, there is constant (but minimal) slippage between the rotor and the body. Despite this slippage, (approximately 40 RPM at 97 km/h, or 60 mph) good fuel economy is attained at highway speeds.

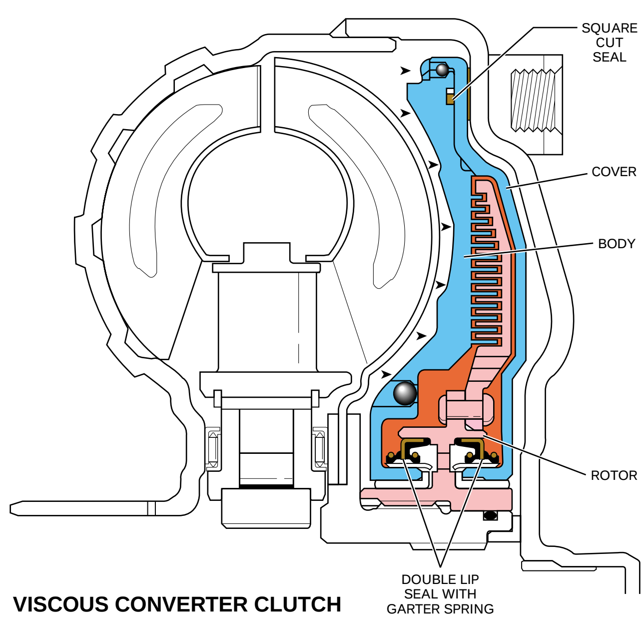
(Refer to the Electrical Components section for information on VCC controls.)



TCC RELEASE



TCC APPLY



VISCOUS CONVERTER CLUTCH

Figure 14

APPLY COMPONENTS

The Apply Components section is designed to explain the function of the hydraulic and mechanical holding devices used in the Hydra-matic 4T80-E transmission. Some of these apply components, such as clutches and bands, are hydraulically "applied" and "released" in order to provide automatic gear range shifting. Other components, such as a roller clutch or sprag clutch, often react to a hydraulically "applied" component by mechanically "holding" or "releasing" another member of the transmission. This interaction between the hydraulically and mechanically applied components is then explained in detail and supported with a graphic illustration. In addition, this section shows the routing of fluid pressure to the individual components and their internal functions when they apply or release.

The sequence in which the components in this section have been discussed coincides with their physical arrangement inside the transmission. This order closely parallels the disassembly sequence used in the Hydra-matic 4T80-E Unit Repair Section located in Section 7 of the appropriate Service Manual. It also correlates with the components shown on the Range Reference Charts that are used throughout the Power Flow section of this book. The correlation of information between the sections of this book helps the user to more clearly understand the hydraulic and mechanical operating principles for this transmission.

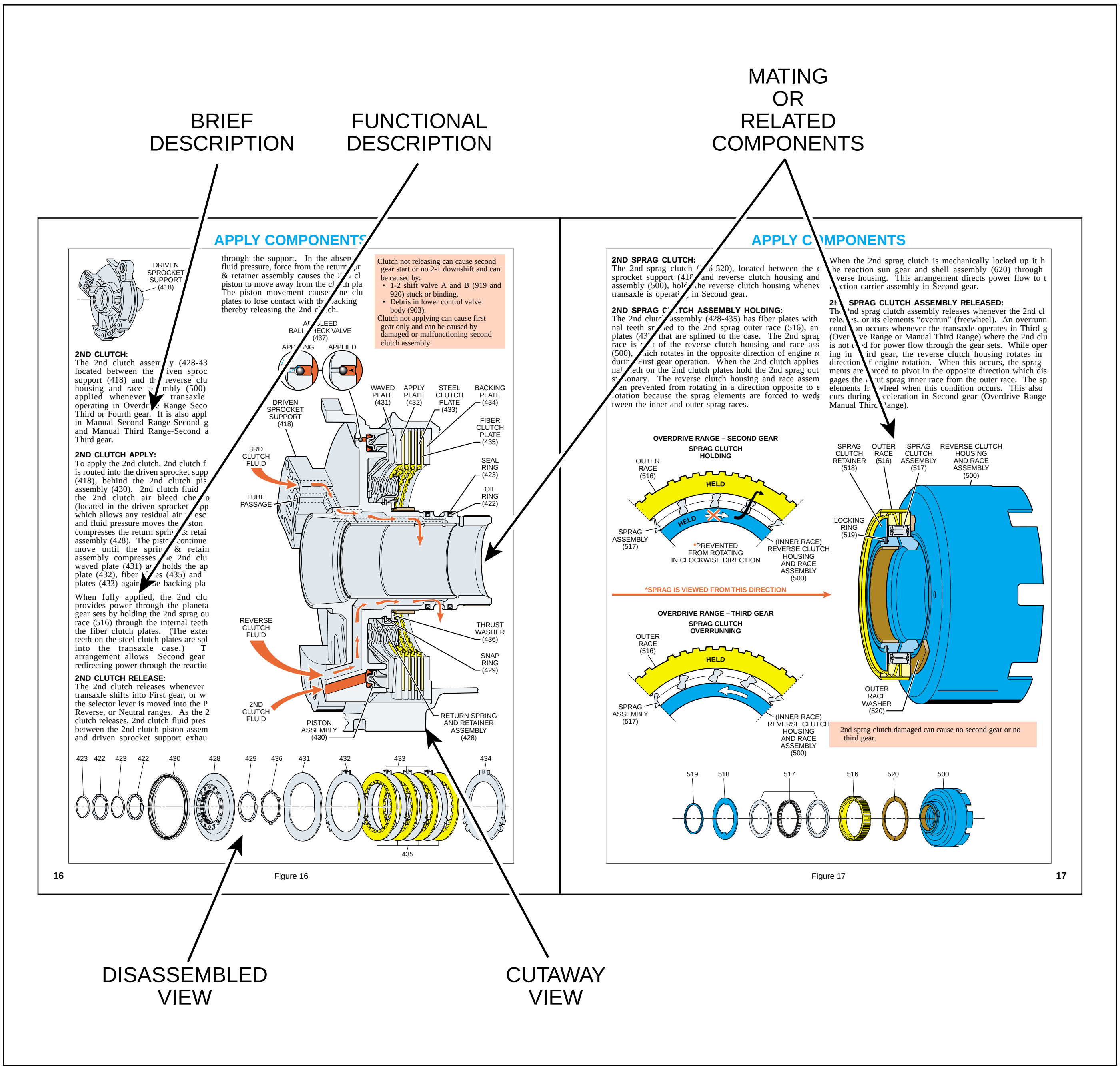
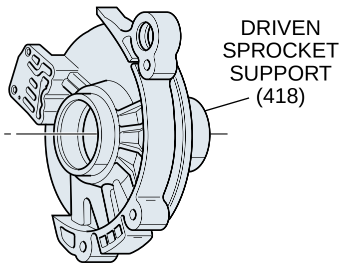


Figure 15



2ND CLUTCH:
The 2nd clutch assembly (428-435), located between the driven sprocket support (418) and the reverse clutch housing and race assembly (500), is applied whenever the transmission is operating in Overdrive Range Second, Third or Fourth gear. It is also applied in Manual Second Range-Second gear and Manual Third Range-Second and Third gear.

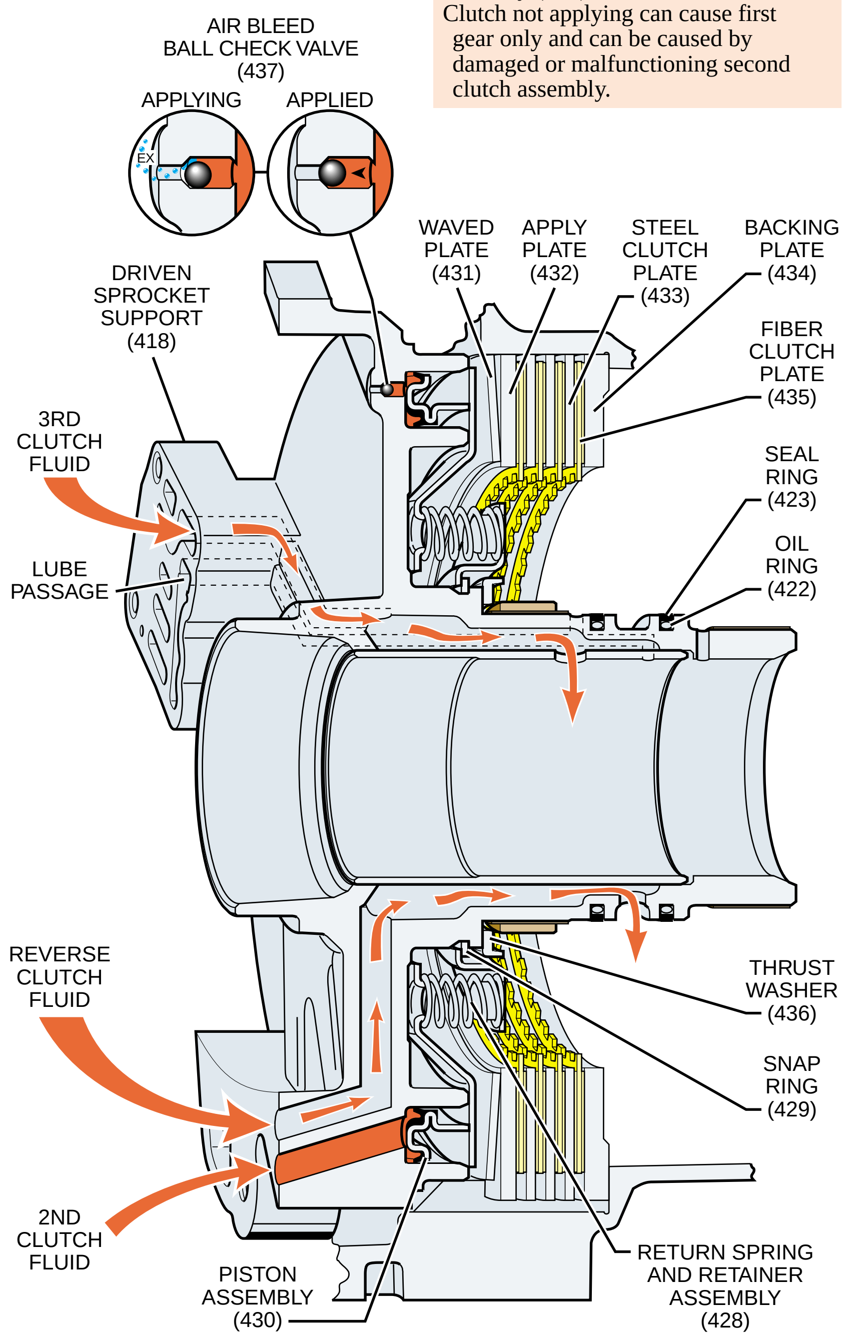
2ND CLUTCH APPLY:
To apply the 2nd clutch, 2nd clutch fluid is routed into the driven sprocket support (418), behind the 2nd clutch piston assembly (430). 2nd clutch fluid seats the 2nd clutch air bleed ball check valve (located in the driven sprocket support which allows any residual air to escape) and fluid pressure moves the piston and compresses the return spring and retainer assembly (428). The piston continues to move until the spring and retainer assembly compresses the 2nd clutch waved plate (431) and holds the apply plate (432), fiber plates (435) and steel plates (433) against the backing plate (434).

When fully applied, the 2nd clutch provides power through the planetary gear sets by holding the 2nd sprag outer race (516) through the internal teeth on the fiber clutch plates. (The external teeth on the steel clutch plates are splined into the transmission case.) This arrangement allows Second gear by redirecting power through the reaction carrier.

2ND CLUTCH RELEASE:
The 2nd clutch releases whenever the transmission shifts into First gear, or when the selector lever is moved into the Park, Reverse, or Neutral ranges. As the 2nd clutch releases, 2nd clutch fluid pressure between the 2nd clutch piston assembly and driven sprocket support exhausts through the support. In the absence of fluid pressure, force from the return spring and retainer assembly causes the 2nd clutch piston to move away from the clutch plates. The piston movement causes the clutch plates to lose contact with the backing plate thereby releasing the 2nd clutch.

Clutch not releasing can cause second gear start or no 2-1 downshift and can be caused by:
- 1-2 shift valve A and B (919 and 920) stuck or binding.
- Debris in lower control valve body (903).

Clutch not applying can cause first gear only and can be caused by damaged or malfunctioning second clutch assembly.



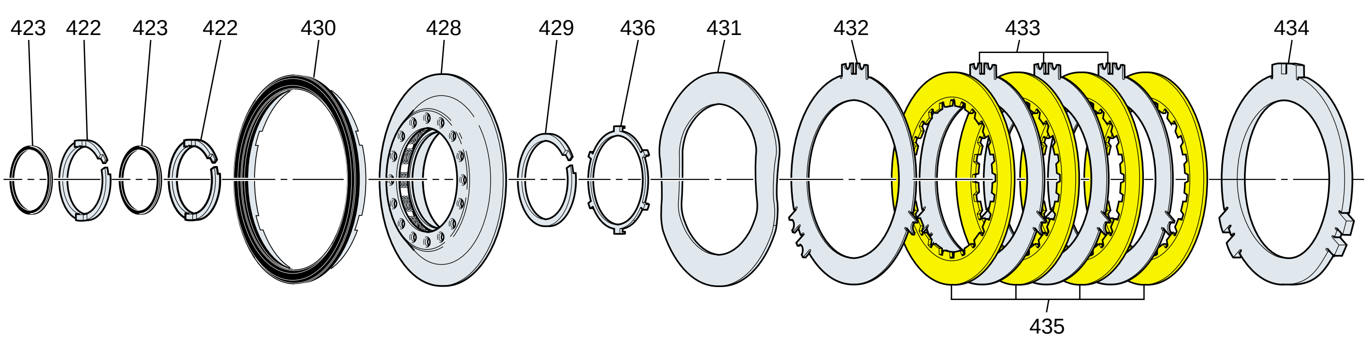


Figure 16

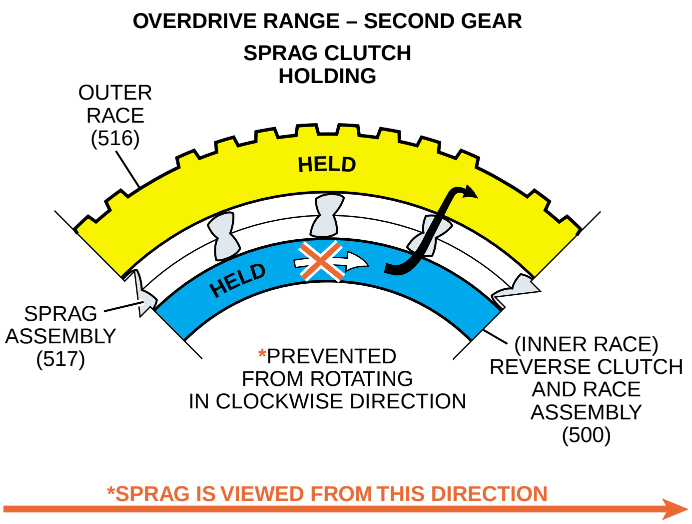
APPLY COMPONENTS

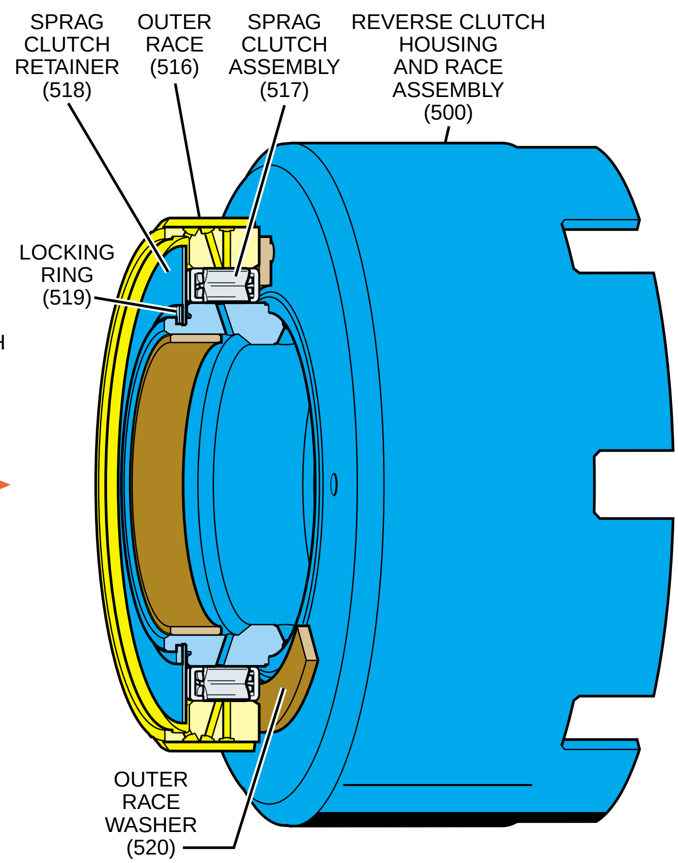
2ND SPRAG CLUTCH:
The 2nd sprag clutch (516-520), located between the driven sprocket support (418) and reverse clutch housing and race assembly (500), holds the reverse clutch housing whenever the transmission is operating in Second gear.

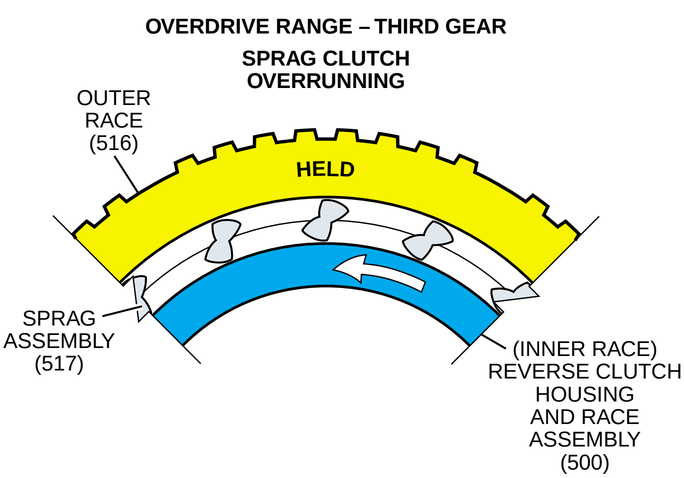
2ND SPRAG CLUTCH ASSEMBLY HOLDING:
The 2nd clutch assembly (428-435) has fiber plates with internal teeth splined to the 2nd sprag outer race (516), and steel plates (433) that are splined to the case. The 2nd sprag inner race is part of the reverse clutch housing and race assembly (500), which rotates in the opposite direction of engine rotation during First gear operation. When the 2nd clutch applies internal teeth on the 2nd clutch plates hold the 2nd sprag outer race stationary. The reverse clutch housing and race assembly is then prevented from rotating in a direction opposite to engine rotation because the sprag elements are forced to wedge between the inner and outer sprag races.

When the 2nd sprag clutch is mechanically locked up it holds the reaction sun gear and shell assembly (620) through the reverse housing. This arrangement directs power flow to the reaction carrier assembly in Second gear.

2ND SPRAG CLUTCH ASSEMBLY RELEASED:
The 2nd sprag clutch assembly releases whenever the 2nd clutch releases, or its elements "overrun" (freewheel). An overrunning condition occurs whenever the transmission operates in Third gear (Overdrive Range or Manual Third Range) where the 2nd clutch is not used for power flow through the gear sets. While operating in Third gear, the reverse clutch housing rotates in the direction of engine rotation. When this occurs, the sprag elements are forced to pivot in the opposite direction which disengages the input sprag inner race from the outer race. The sprag elements freewheel when this condition occurs. This also occurs during deceleration in Second gear (Overdrive Range or Manual Third Range).







2nd sprag clutch damaged can cause no second gear or no third gear.

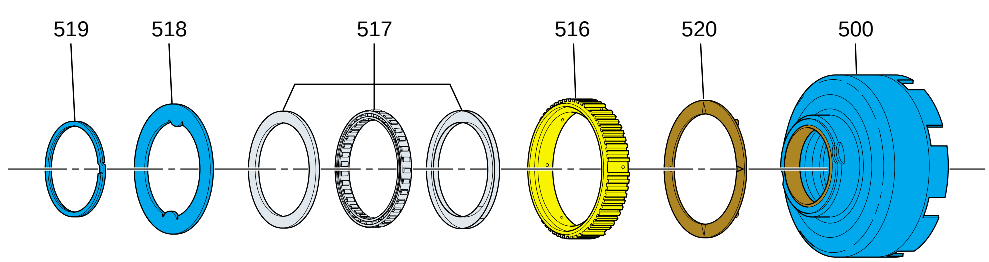
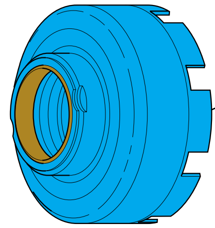


Figure 17

APPLY COMPONENTS



As reverse clutch fluid exhausts through the driven sprocket support, the reverse clutch piston ball check valve is forced off its seat by centrifugal force (rotation of the piston). When the ball check valve unseats, residual reverse clutch fluid is forced to the outer perimeter of the piston and exhausts through the ball check valve seat. (If this fluid did not completely exhaust there could be a partial apply, or drag of the reverse clutch plates.)

No reverse/slips in reverse could be caused by:

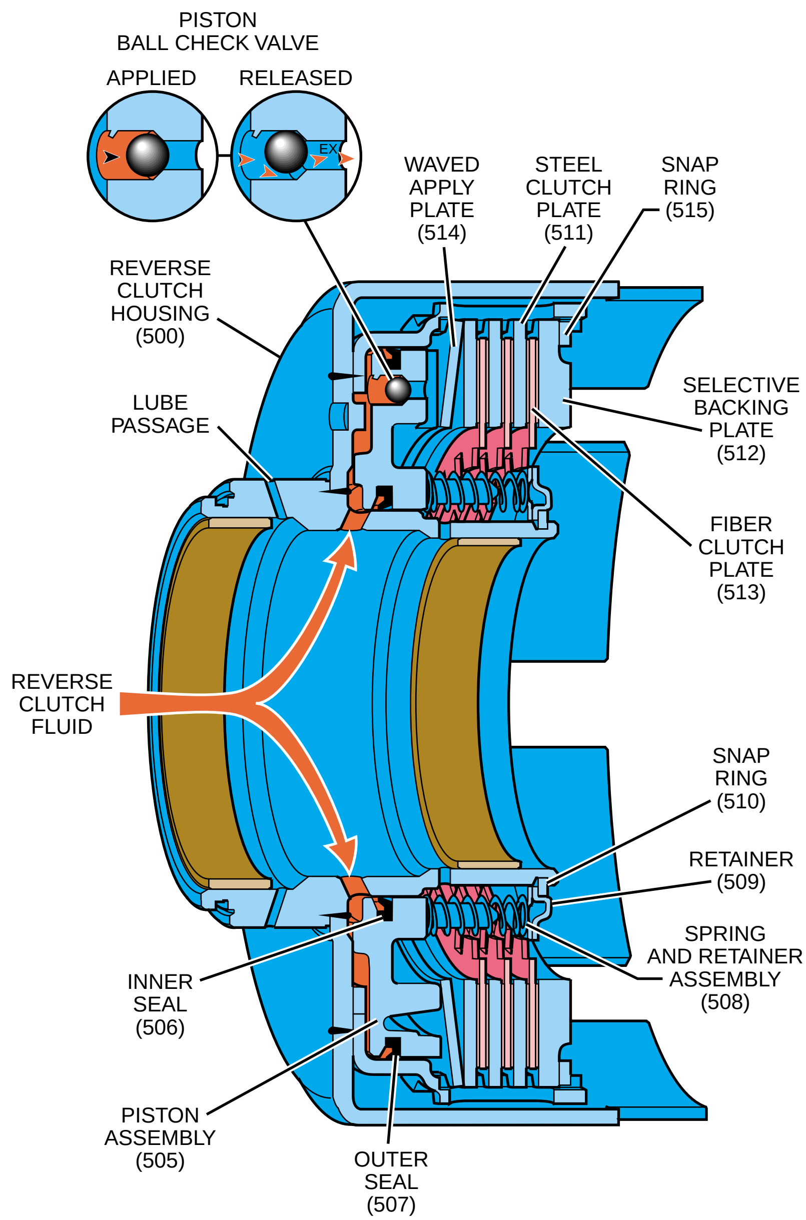
- Porosity in the piston.
- Excessive clutch plate travel.
- Clutch plate snap ring out of grove.
- Return spring snap ring out of groove.
- Waved apply plate installed incorrectly.

REVERSE CLUTCH:
The reverse clutch assembly (505-514), located inside the reverse clutch housing and race assembly (500), is applied only when Reverse range is selected through the gear shift selector lever.

REVERSE CLUTCH APPLY:
To apply the reverse clutch, reverse clutch fluid is routed into the driven sprocket support (418) and follows a passage between the support and support sleeve. Reverse clutch fluid exits the support at a feed hole located between two lands and enters the reverse clutch housing through feed holes located behind the reverse clutch piston assembly (505). Reverse clutch fluid pressure then seats the reverse clutch piston ball check valve, which allows fluid pressure to move the piston and compress the spring and retainer assembly (508). The piston continues to move until the spring and retainer assembly compresses the reverse clutch waved apply plate (514), and holds the steel clutch plates (511) and fiber clutch plates (513) against the selective backing plate (512).

When fully applied, the reverse clutch combines with the low/reverse servo assembly (524-533) and low/reverse band (13) to enable a reverse direction of rotation and power through the gear sets. (See Low/Reverse Servo and Low/Reverse Band description in this section.)

REVERSE CLUTCH RELEASE:
The reverse clutch releases whenever the selector lever is moved into another range and reverse clutch fluid pressure between the housing and reverse clutch piston is forced back through the feed holes into the driven sprocket support. In the absence of fluid pressure, force from the spring and retainer assembly causes the reverse clutch piston to move away from the clutch plates. The piston movement causes the clutch plates to lose contact with the backing plate thereby releasing the reverse clutch.



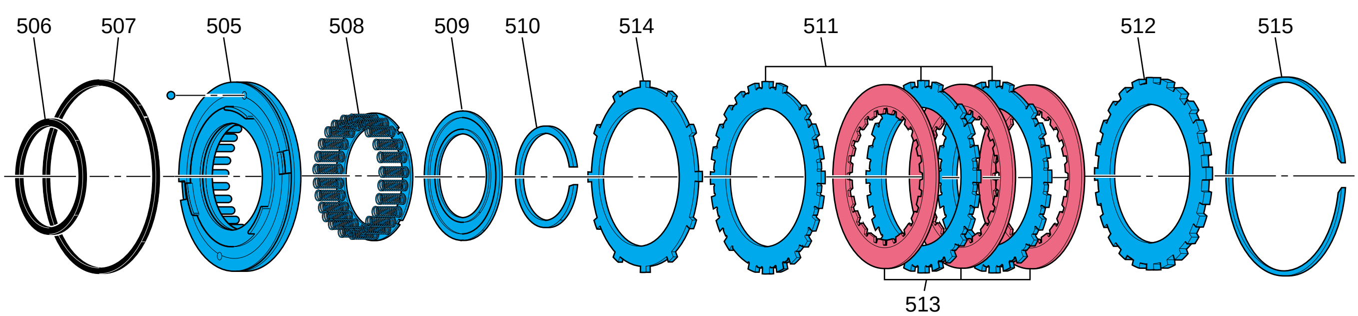
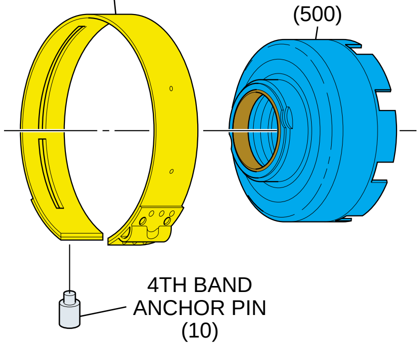


Figure 18



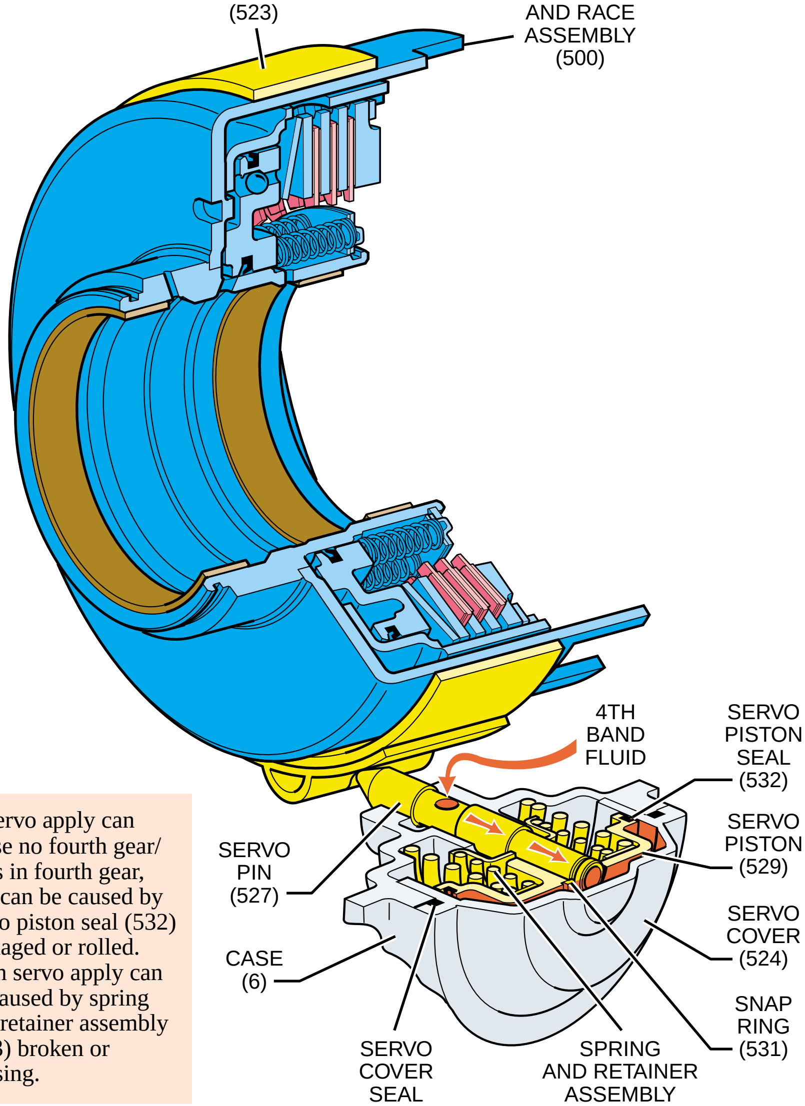
4TH SERVO RELEASE:
The 4th servo releases whenever the transmission shifts out of Fourth gear into a lower gear (excluding Manual Second Range – Second gear). The band releases when 4th band fluid pressure between the servo cover and servo piston is routed up the servo pin and through the case to exhaust from the circuit. Spring force from the spring and retainer assembly moves the 4th servo piston away from the 4th band thereby releasing the band.

4TH BAND:
The 4th band (523), located inside the case, is wrapped around the reverse clutch housing and race assembly (500) and held in position by the 4th band anchor pin (10). When the band is compressed by the 4th servo pin, it holds the reverse clutch housing and race assembly in order to operate the transmission in fourth gear, or for engine compression braking in Manual Second Range – Second gear.

4TH SERVO ASSEMBLY:
The 4th servo assembly (524-533), located near the transmission case cover (33) at the back of the case (6), applies the 4th band (523) in Overdrive Range – Fourth gear or Manual Second Range – Second gear.

4TH SERVO APPLY:
To apply the 4th servo assembly, 4th band fluid is routed through the channel plate (900), case (6) and through a feed hole located in the 4th servo pin (527). 4th band fluid passes through the center of the servo pin and fills the cavity between the servo cover (524) and the servo piston (529). 4th band fluid pressure behind the piston, forces the servo piston and pin to move towards the 4th band. As the servo piston moves it compresses the spring and retainer assembly (533) until the pin travels far enough to compress the 4th band. The band is wrapped around the reverse clutch housing and race assembly and when it is compressed, it holds the housing stationary.

When the transmission is operating in Fourth gear and the 4th band is holding the reverse clutch housing, power is directed through the reaction carrier to the input carrier in order to provide an overdrive gear ratio. When the 4th band is applied for engine compression braking in Manual Second Range – Second gear, the band is used to prevent the reverse clutch housing from rotating and overrunning the 2nd sprag clutch.



No servo apply can cause no fourth gear/ slips in fourth gear, and can be caused by servo piston seal (532) damaged or rolled.
Harsh servo apply can be caused by spring and retainer assembly (533) broken or missing.

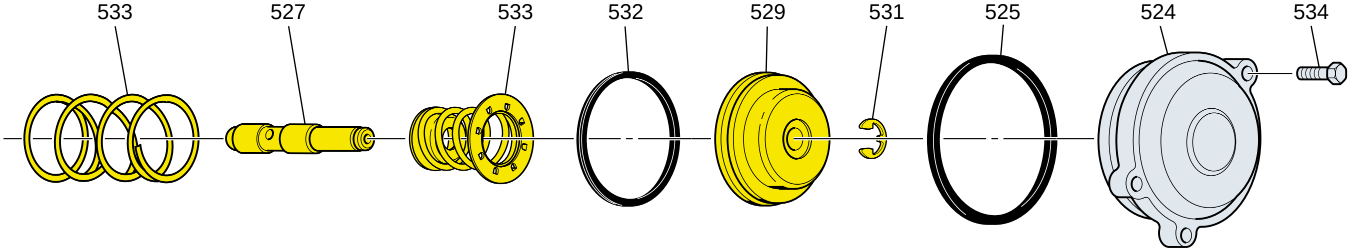
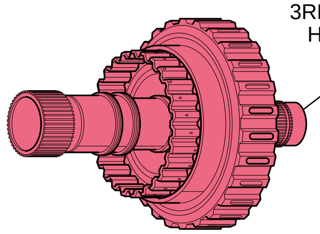


Figure 19

APPLY COMPONENTS



3RD CLUTCH:
The 3rd clutch assembly (606-613), located inside the 3rd clutch housing (604), is applied whenever the transmission is operating in Overdrive Range – Third or Fourth gear and Manual Third Range – Third gear.

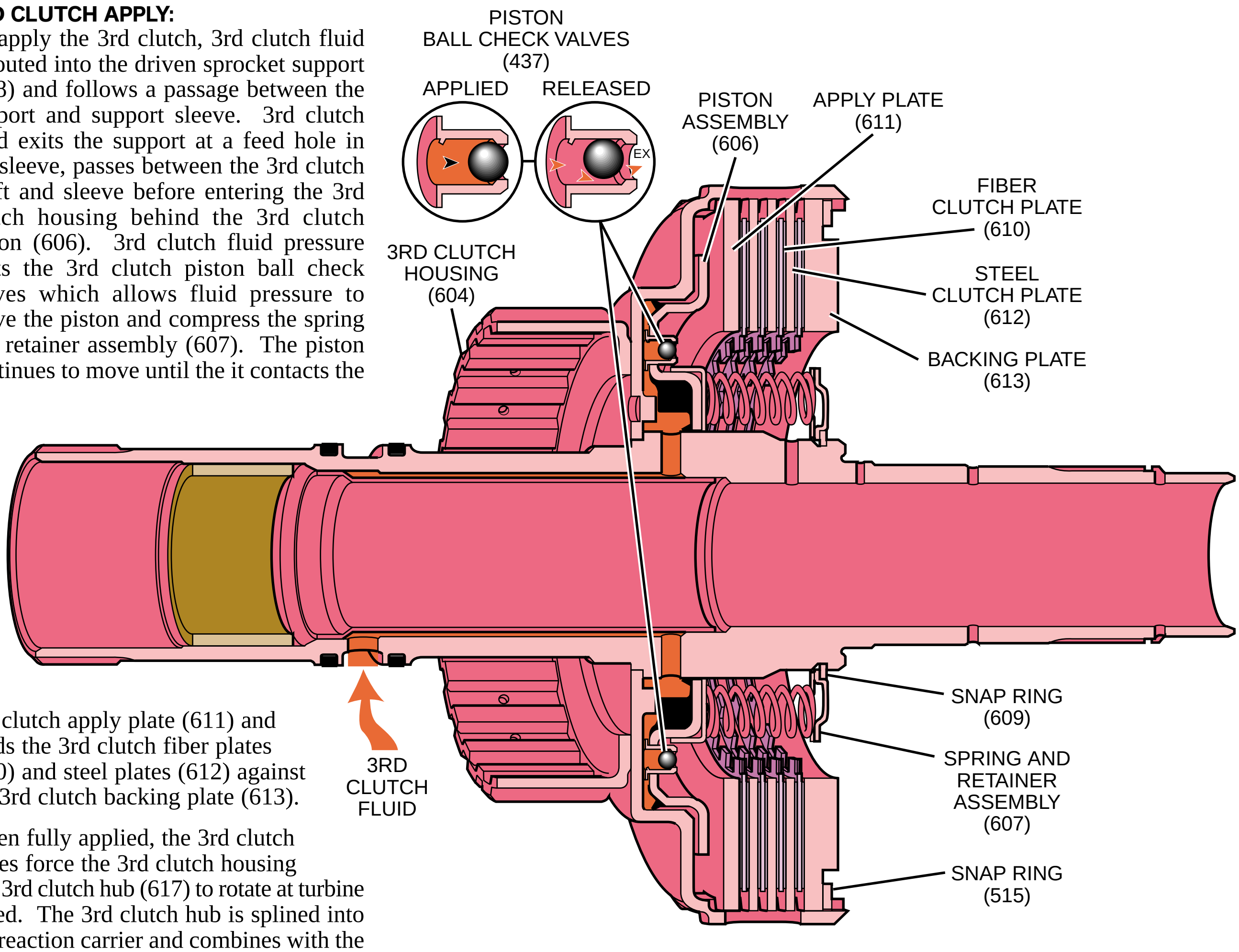
3RD CLUTCH APPLY:
To apply the 3rd clutch, 3rd clutch fluid is routed into the driven sprocket support (418) and follows a passage between the support and support sleeve. 3rd clutch fluid exits the support at a feed hole in the sleeve, passes between the 3rd clutch shaft and sleeve before entering the 3rd clutch housing behind the 3rd clutch piston (606). 3rd clutch fluid pressure seats the 3rd clutch piston ball check valves which allows fluid pressure to move the piston and compress the spring and retainer assembly (607). The piston continues to move until the it contacts the 3rd clutch apply plate (611) and holds the 3rd clutch fiber plates (610) and steel plates (612) against the 3rd clutch backing plate (613).

When fully applied, the 3rd clutch plates force the 3rd clutch housing and 3rd clutch hub (617) to rotate at turbine speed. The 3rd clutch hub is splined into the reaction carrier and combines with the input sun gear (631) to power the gear sets at a 1:1 gear ratio.

3RD CLUTCH RELEASE:
The 3rd clutch releases whenever the transmission downshifts into Second or First gear, or when the selector lever is moved into the Park, Reverse, or Neutral ranges. 3rd clutch fluid pressure between the piston and housing exhausts through the same passages that were used to apply the clutch. In the absence of fluid pressure, force from the spring and retainer assembly causes the 3rd clutch piston to move away from the 3rd clutch apply plate. The piston movement causes the clutch plates to lose contact with the backing plate thereby releasing the 3rd clutch.

As 3rd clutch fluid exhausts through the driven sprocket support, the 3rd clutch piston ball check valves are forced off their seats by centrifugal force (rotation of the piston). When the ball check valves unseat, residual 3rd clutch fluid is forced to the outer perimeter of the piston and exhausts through the ball check valve seats. (If this fluid did not completely exhaust there could be a partial apply, or drag of the 3rd clutch plates.)

Clutch not releasing can cause third gear only.
Clutch not applying can cause no third gear.



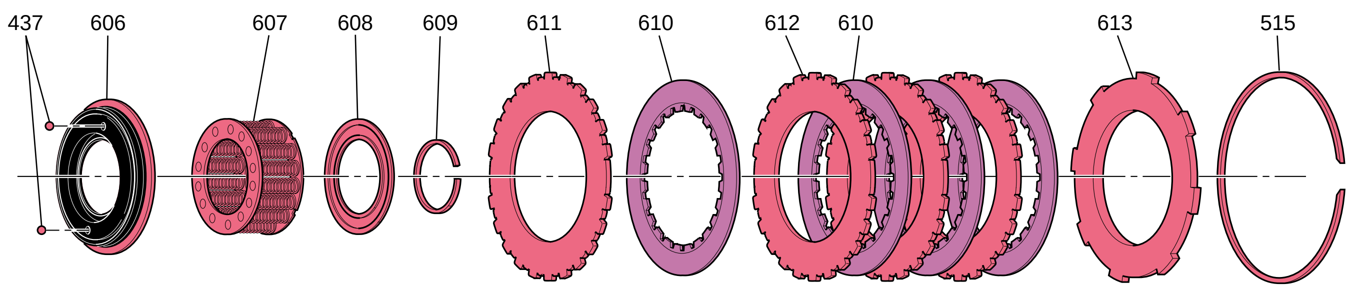


Figure 20

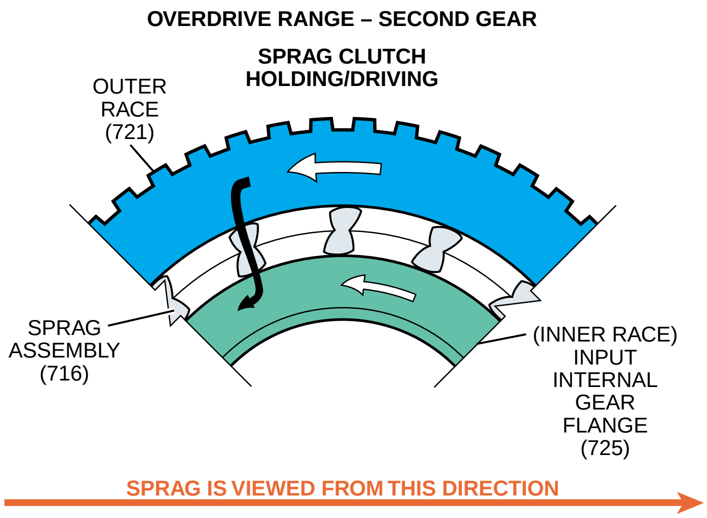
APPLY COMPONENTS

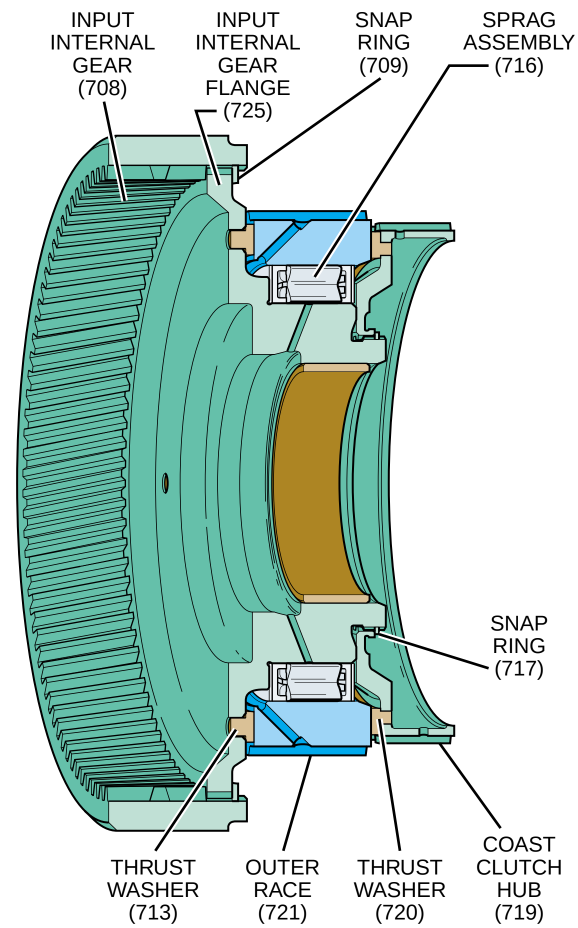
FORWARD SPRAG CLUTCH:
The forward sprag clutch (716-721), located between the input carrier assembly (700) and the coast clutch assembly (812-815), holds, or drives the input internal gear (708) in all forward gear ranges in order to transmit power to the gear sets. The exception is transmission operation in Overdrive Range – Fourth gear when the sprag elements overrun.

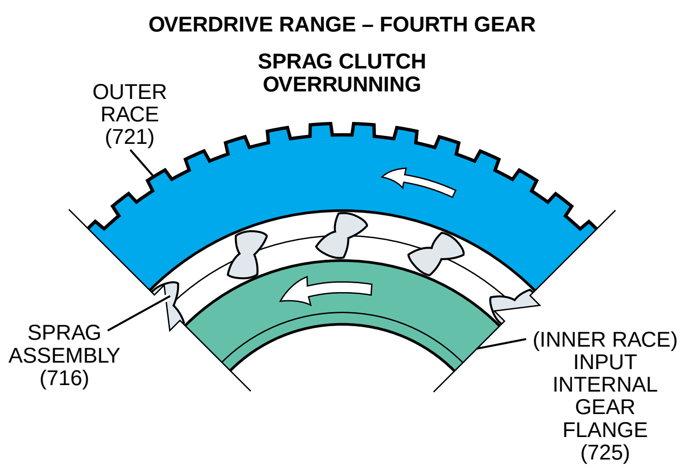
FORWARD SPRAG CLUTCH ASSEMBLY HOLDING:
The forward clutch assembly (815-821) has fiber clutch plates with internal teeth splined to the forward sprag clutch outer race (721), and steel clutch plates splined to the forward and coast clutch housing (801). The forward sprag inner race (725) is part of the input internal gear assembly which affects input carrier function whenever the forward clutch is applied. When the forward clutch applies, internal teeth on the forward clutch fiber plates and external teeth on the forward clutch steel clutch plates link the forward and coast clutch housing to the forward sprag outer race. If the forward sprag inner race is rotating at a slower speed or tries to rotate in a direction opposite of engine rotation, the sprag elements wedge between the inner and outer races. The sprag is then mechanically locked up and either holds, or drives the inner race depending on gear range operation.

When the forward sprag clutch is mechanically locked up it holds, or drives the input internal gear in order to direct power flow through the gear sets. The one exception is when the transmission operates in Overdrive Range – Fourth gear.

FORWARD SPRAG CLUTCH ASSEMBLY RELEASED:
The forward sprag clutch assembly releases whenever the forward clutch releases, or its elements "overrun" (freewheel). An overrunning condition occurs only in Overdrive Range – Fourth gear when the input internal gear (forward sprag inner race) rotates faster than the outer race. The faster rotation of the forward sprag inner race causes the sprag elements to pivot and disengage with the forward sprag outer race. This also occurs sometimes during deceleration. *(In this example the forward clutch is still applied and holding the outer race.)*







If inoperative the forward sprag clutch can cause no forward in any range.

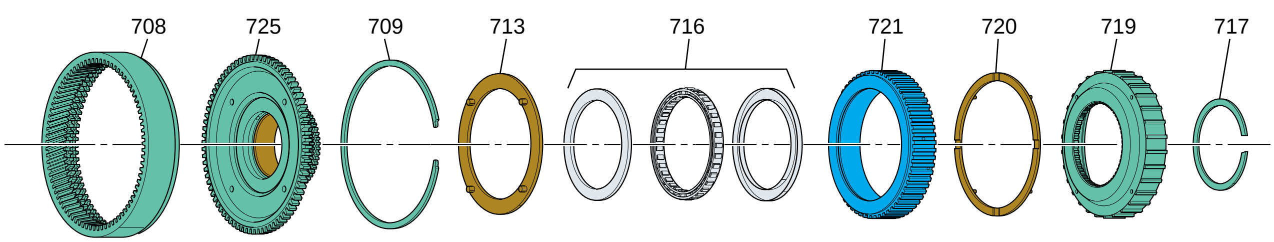
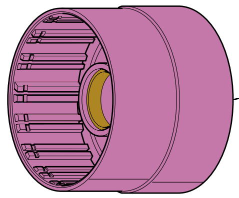


Figure 21



FORWARD CLUTCH:
The forward clutch assembly (807-819), located inside the forward and coast clutch housing (801), is applied whenever the transmission is operating in any forward range.

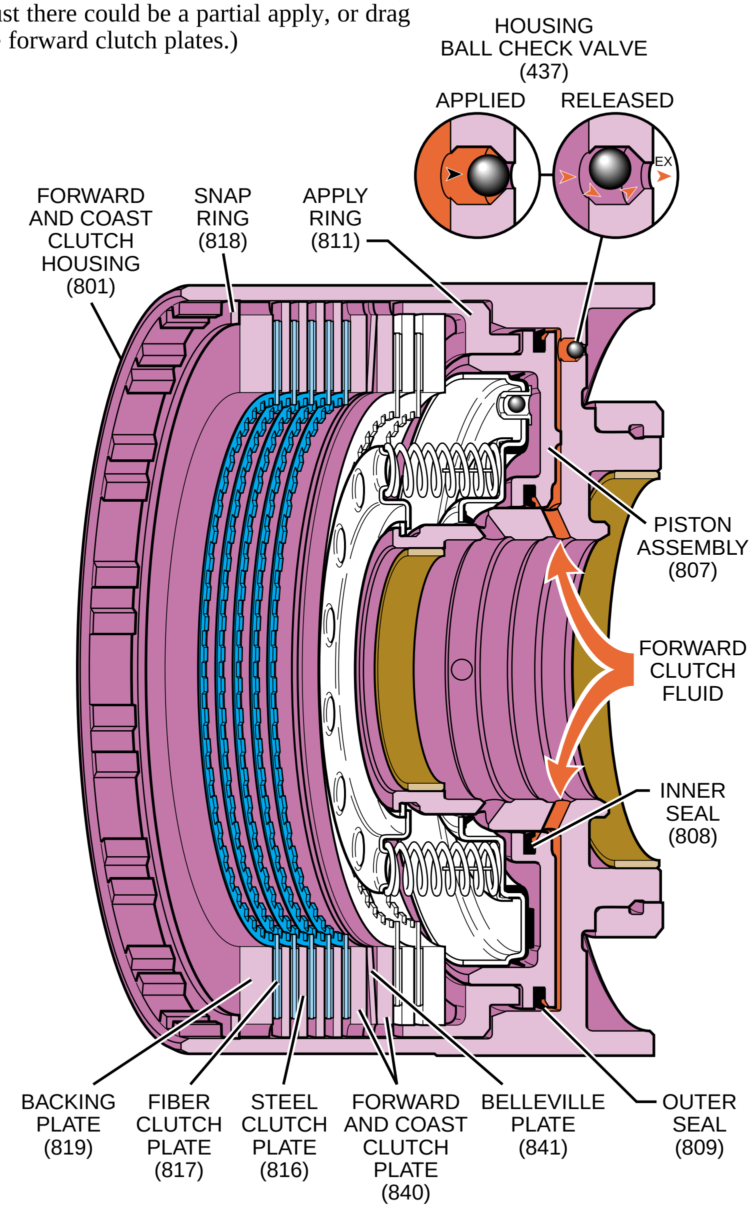
FORWARD CLUTCH APPLY:
To apply the forward clutch, forward clutch fluid is routed into the forward/coast clutch support (822) and follows a passage between the support and an oil transfer sleeve (824). Forward clutch fluid then passes through the support and a feed hole in the forward and coast clutch housing, located behind the forward clutch piston assembly (807). Forward clutch fluid pressure seats the ball check valve (437), located in the forward and coast clutch housing (801), allowing fluid pressure to move the forward clutch piston and forward clutch (apply) ring (811). As the piston moves it compresses the forward clutch release spring assembly (820) until legs on the apply ring contact and hold the forward and coast clutch plates (840), belleville plate (841), fiber plates (817) and steel plates (816) against the backing plate (819).

When fully applied, the forward clutch provides power to the planetary gear sets by holding the forward sprag outer race (721) through the internal fiber clutch teeth. (External teeth on the steel clutch plates are splined to the forward and coast clutch housing.) This arrangement allows the forward sprag elements to hold or overrun, depending on gear and range operation.

FORWARD CLUTCH RELEASED:
The forward clutch releases whenever the selector lever is moved into Park, Reverse or Neutral ranges and forward clutch fluid between the piston and housing exhausts through the forward/coast clutch support. In the absence of fluid pressure, force from the forward clutch release spring assembly causes the forward clutch piston and apply ring to move away from the clutch plates. The piston movement causes the clutch plates to lose contact with the backing plate thereby releasing the forward clutch.

As forward clutch fluid exhausts through the forward/coast clutch support, the forward and coast clutch housing ball check valve is forced off its seat by centrifugal force. When the ball check valve unseats, residual forward clutch fluid is forced to the outer perimeter of the piston and exhausts through the ball check valve seat. (If this fluid did not completely exhaust there could be a partial apply, or drag of the forward clutch plates.)

If inoperative the forward clutch can cause no forward in any range.



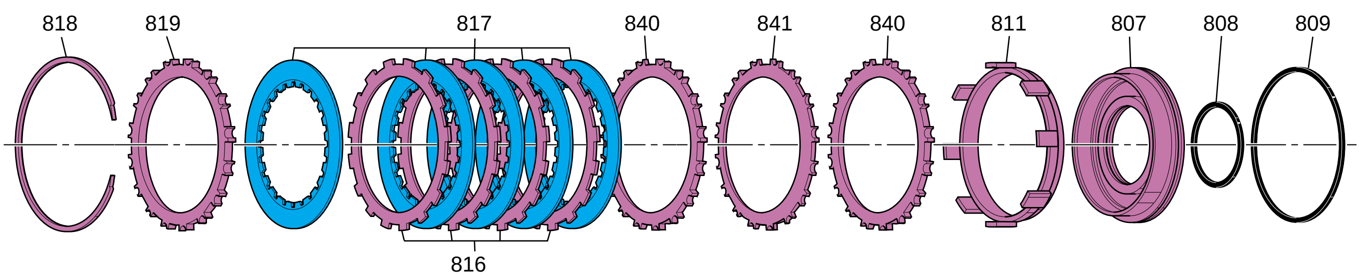
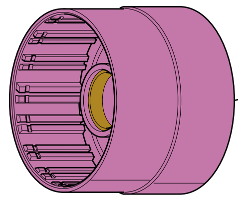


Figure 22



As coast clutch fluid exhausts through the housing and forward/coast clutch support, the piston ball check valve is forced off its seat by centrifugal force. When the ball check valve unseats, residual coast clutch fluid is forced to the outer perimeter of the piston and exhausts through the ball check valve seat. (If this fluid did not completely exhaust there could be a partial apply or drag of the coast clutch plates.)

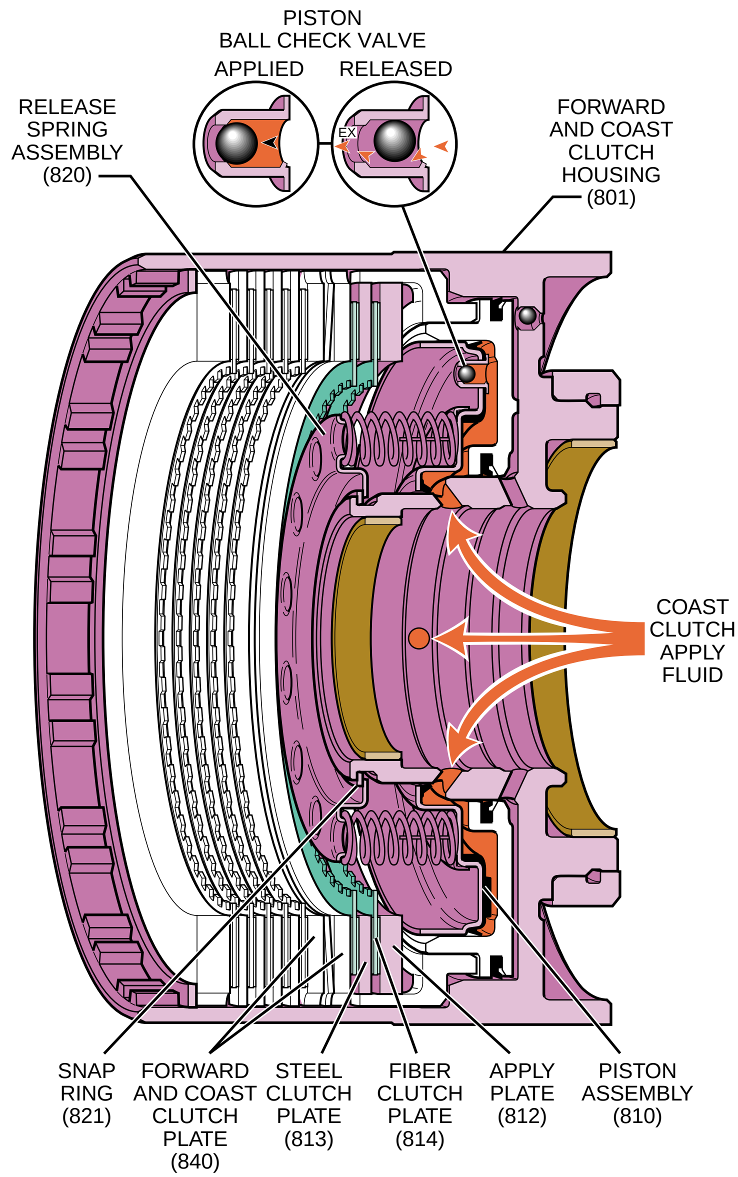
If inoperative the coast clutch can cause no engine braking in Manual 1st, Manual 2nd, or Manual 3rd.

COAST CLUTCH:
The coast clutch assembly (810-820), located inside the forward and coast clutch housing (801), is applied whenever the transmission is operating in a Manual Range (Refer to Range Reference Chart on page 11).

COAST CLUTCH APPLY:
To apply the coast clutch, coast clutch fluid is routed into the forward/coast clutch support (822) and follows a passage between the support and an oil transfer sleeve (824). Coast clutch fluid then passes through a feed hole in the support and a feed hole in the forward and coast clutch housing. As coast clutch fluid enters the housing, between the coast clutch piston (810) and the forward clutch piston (807), it seats the ball check valve (located in the coast clutch piston) and moves the piston towards the coast clutch (apply) plate (812). The piston moves until it contacts the coast clutch (apply) plate and then forces the coast clutch (fiber) plates (814) and steel plate (813) to compress against the forward and coast clutch plates (840).

When fully applied, the coast clutch combines with the forward clutch assembly to hold the forward sprag inner race/input internal gear (725). This arrangement prevents the forward sprag elements from overrunning and provides engine compression braking in the Manual ranges.

COAST CLUTCH RELEASED:
The coast clutch releases whenever the selector lever is moved into Overdrive, Park, Reverse or Neutral ranges and coast clutch fluid pressure between the forward clutch piston (807) and the coast clutch piston (810) exhausts through the forward/coast clutch support. In the absence of fluid pressure, force from the forward clutch release spring assembly (820) causes the coast clutch piston to move away from the clutch plates. The piston movement causes the clutch plates to lose contact with the forward and coast clutch plates thereby releasing the clutch.



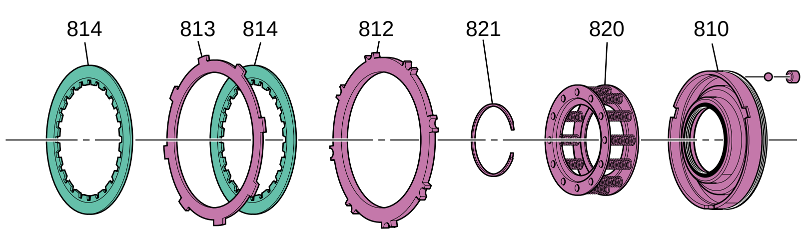
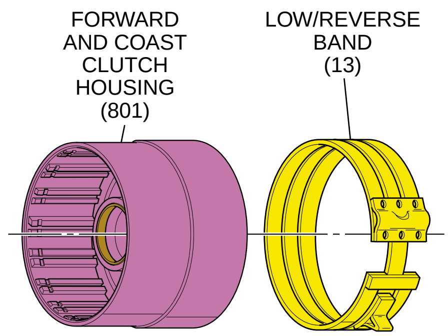


Figure 23

APPLY COMPONENTS



No servo apply can cause no reverse/ slips in reverse, and can be caused by servo piston seals (929, 930) damaged or rolled.
Harsh servo apply can be caused by servo cushion spring (934) broken or missing.

LOW/REVERSE SERVO ASSEMBLY:
The low/reverse servo assembly, located in the lower control valve body (903), applies the low/reverse band in Park, Reverse and Neutral ranges, and First gear in all forward ranges.

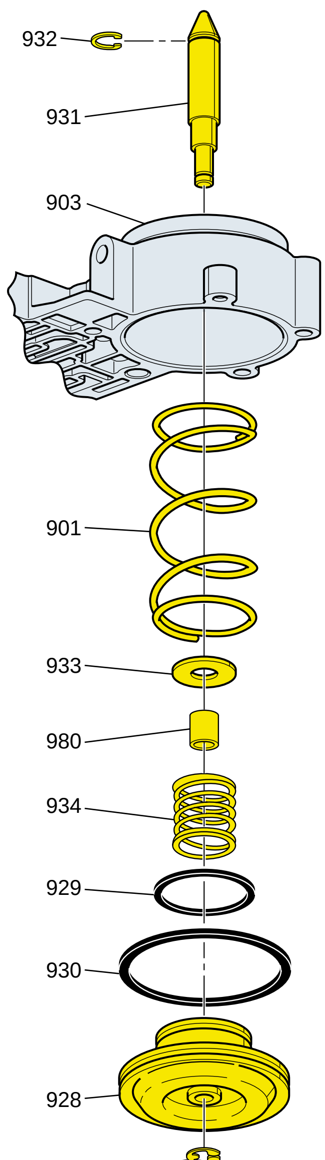
LOW/REVERSE BAND:
The low/reverse band (13), located inside the case, is wrapped around the forward and coast clutch housing and held in position by the low/reverse band anchor pin. When the band is compressed by the low/reverse servo pin, it holds the forward and coast clutch housing stationary.

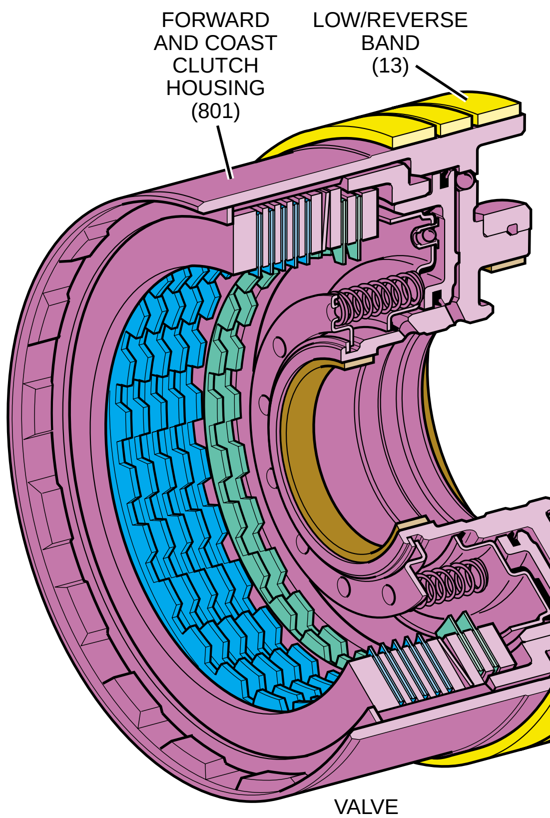
Note: The band is not the primary holding member in First gear acceleration operation (Refer to low roller clutch, page 25.)

LOW/REVERSE SERVO APPLY:
To apply the low/reverse servo assembly, reverse band fluid is routed through a feed hole in the channel plate (900) to the bottom of the low/reverse servo piston (928). Reverse band fluid pressure fills the cavity between the servo piston and channel plate and forces the servo piston and pin (931) to move towards the low/reverse band (13). As the low/reverse servo piston moves, it compresses the return spring (901) and cushion spring (934) until the pin travels far enough to compress the low/reverse band. The low/reverse band is wrapped around the forward and coast clutch housing and when the band compresses, it holds the forward and coast clutch housing stationary.

When the transmission is operating in Park or Neutral ranges, the low/reverse band is the only component holding the forward and coast clutch housing. The reason for applying the band is to hydraulically and mechanically prepare the transmission for a smooth garage shift (range selection from Park or Neutral into Drive or Reverse). In Manual First Range – First gear, the low/reverse band is applied for engine deceleration braking.

LOW/REVERSE SERVO RELEASE:
The low/reverse servo releases, allowing the low/reverse band to release, whenever the transmission shifts into Second, Third or Fourth gears. The band releases when reverse band fluid pressure between the servo piston and channel plate exhausts from the circuit. Spring force from the return spring moves the low/reverse servo piston away from the low/reverse band thereby releasing the band.





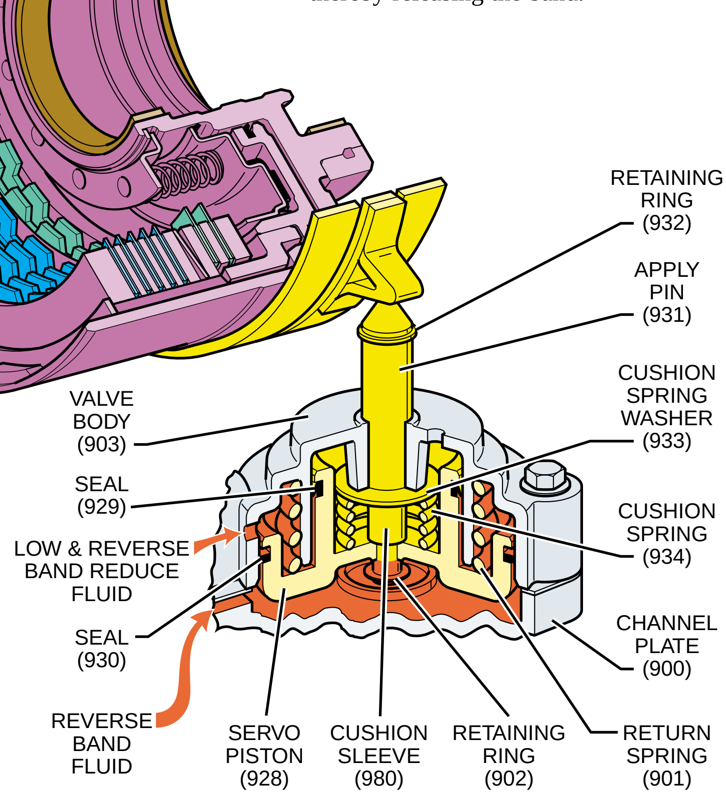
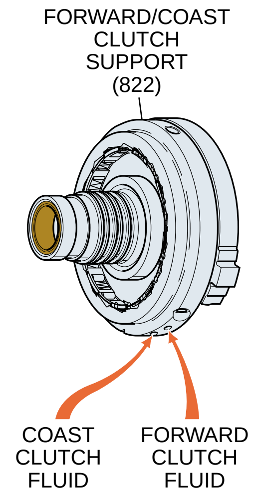


Figure 24

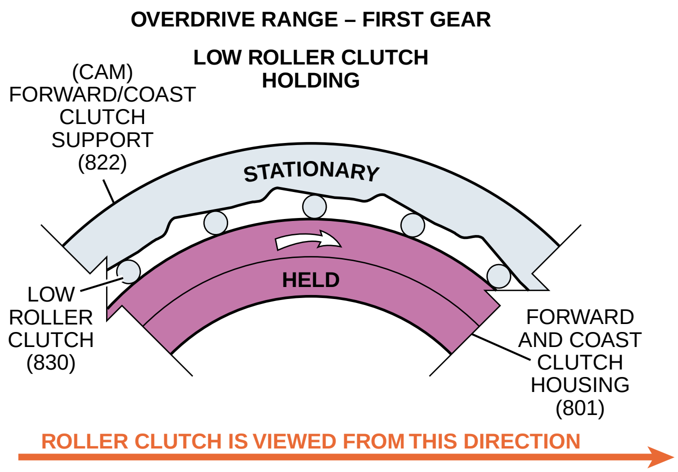
APPLY COMPONENTS

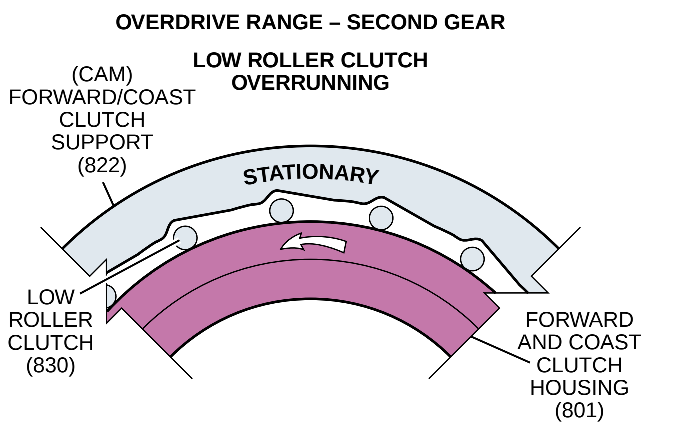


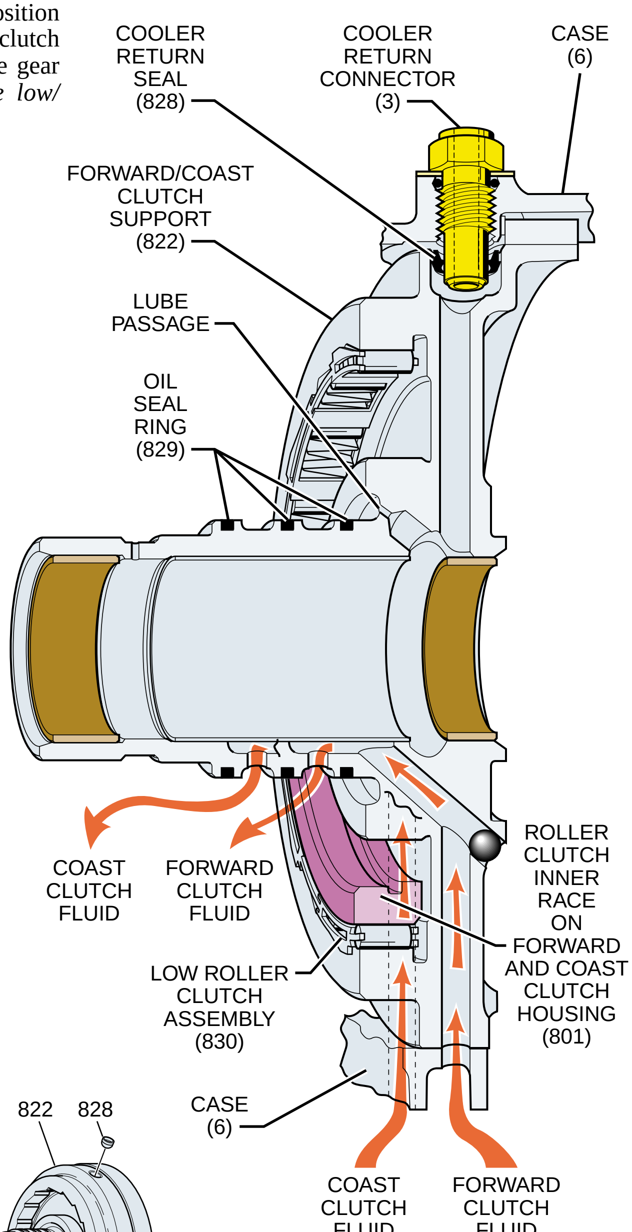
LOW ROLLER CLUTCH:
The low roller clutch assembly is made up of three major components: a cam which is part of the forward/coast clutch support (822), the roller assembly (830), and the inner race which is part of the forward and coast clutch housing (801). The low roller clutch (830), located inside the forward/coast clutch support, is the main component that holds the forward and coast clutch housing whenever the transmission is operating in First gear (Overdrive or Manual ranges).

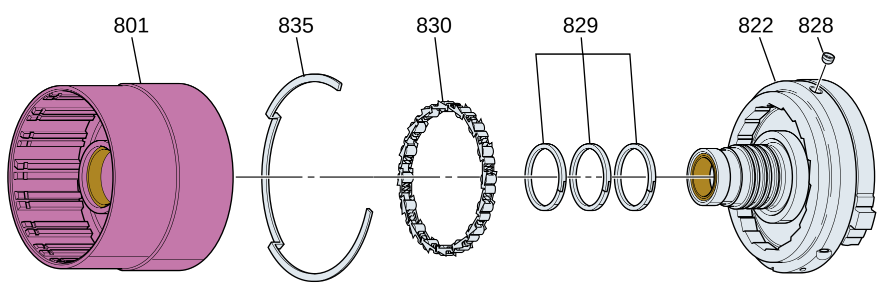
LOW ROLLER CLUTCH HOLDING:
When the transmission is operating in First gear, power flow through the gear sets attempts to rotate the forward and coast clutch housing in the opposite direction of engine rotation. When the housing starts to rotate, the rollers are forced to the narrow end of the cam ramps and wedge between the inner race and ramps. When the rollers are in this position they hold the inner race (forward and reverse clutch housing) stationary and provide power to the gear sets. *Throughout First gear operation the low/reverse band (13) is also applied and partially assists in holding the forward and reverse clutch housing. If, for any reason, the low roller clutch fails to hold, the low/reverse band will allow the vehicle to move.*

LOW ROLLER CLUTCH RELEASE:
The low roller clutch releases when the low/reverse band releases and, power flow through the gear sets drives the forward and reverse clutch housing in the same direction as engine rotation. When these two events occur, the low roller clutch "freewheels" because the inner race (part of the forward and coast clutch housing) rotates towards the wide end of the ramps on the cam. The rollers are also forced to the wide end of the ramps thereby allowing the forward and coast clutch housing to rotate freely. *Overrunning occurs in the low roller clutch during Second, Third or Fourth gear operation.*









Inoperative low support roller clutch assembly can cause slipping in 1st gear under moderate to heavy acceleration.

Figure 25

This page intentionally left blank

PLANETARY GEAR SETS:

Planetary gear sets are commonly used in an automatic transmission and they are the main mechanical devices responsible for automatically changing gear ratios. The physical arrangement of the component parts and their rotation around an axis (center line to the axles) is the primary reason why a planetary gear set was given this name. This arrangement not only provides for a strong and compact transmission component, but it also evenly distributes the energy forces flowing through the gear set. Another benefit gained by this arrangement is that gear clash (a common occurrence with manual transmissions) is eliminated because the gear teeth are always in mesh.

General Component Arrangement and Function:

All planetary gear sets contain at least three main components:

- a sun gear
- a carrier assembly with planet pinion gears, and
- an internal gear.

One of the main components, the sun gear, is located at the center of the planetary gear set and has planet pinion gears revolving around it. These planet pinion gears have gear teeth that are in constant mesh with the sun gear and an internal ring gear that encompasses the entire gear set. Torque from the engine (input torque) is transferred to the gear set and forces at least one of these components to rotate. Since all three main components are in constant mesh with each other, the remaining components are often forced to rotate as a reaction to the input torque. After input torque passes through a gear set, it changes to a lower or higher torque value known as output torque. Output torque then becomes the force that is transmitted to the vehicle's drive axles.

As stated above, when engine torque is transferred through a gear set, the output torque from the gear set either increases or decreases. If output torque is higher than input torque, then the gear set is operating in reduction (1st, 2nd or Reverse gears). On the other hand, if output torque is lower than input torque, then the gear set is operating in overdrive (4th gear). A third possible condition also exits and that is when input torque equals output torque. This condition is called direct drive (3rd gear) because neither reduction nor overdrive occurs through the gear set. To achieve these various operating conditions, specific components of the gear set must provide the input torque while other components must be held stationary. Detailed explanations of these gear set functions are provided on pages 28A and 28B.

Torque vs Speed:

Another transmission operating condition directly affected by input and output torque through a gear set is the relationship of torque with output speed. As an automatic transmission shifts from 1st to 2nd to 3rd to 4th gear, the overall output torque to the wheels decreases as the speed of the vehicle increases (when input speed and input torque are held constant). Higher output torque and lower output speed is used in 1st gear to provide the necessary power for moving heavy loads. However, once the vehicle is moving and the speed of the vehicle increases, less torque is required to maintain that speed. This arrangement provides for a more efficient operation of the powertrain.

Hydra-matic 4T80-E Gear Sets:

The Hydra-matic 4T80-E transmission combines two gear sets that provide five gear ratios (four forward and one reverse) for transferring torque to the drive axles. The five main components used in these gear sets are:

- the reaction sun gear and shell assembly (620)
- the reaction carrier assembly (623)
- the reaction internal gear/input carrier assembly (708/700)
- the input sun gear (631)
- the input internal gear/input internal gear flange (708/725)

Another gear set used in the Hydra-matic 4T80-E transmission is the final drive differential assembly (100-119). Information regarding its purpose and function is discussed on page 30.

Gear set failure can cause noise and loss of drive.

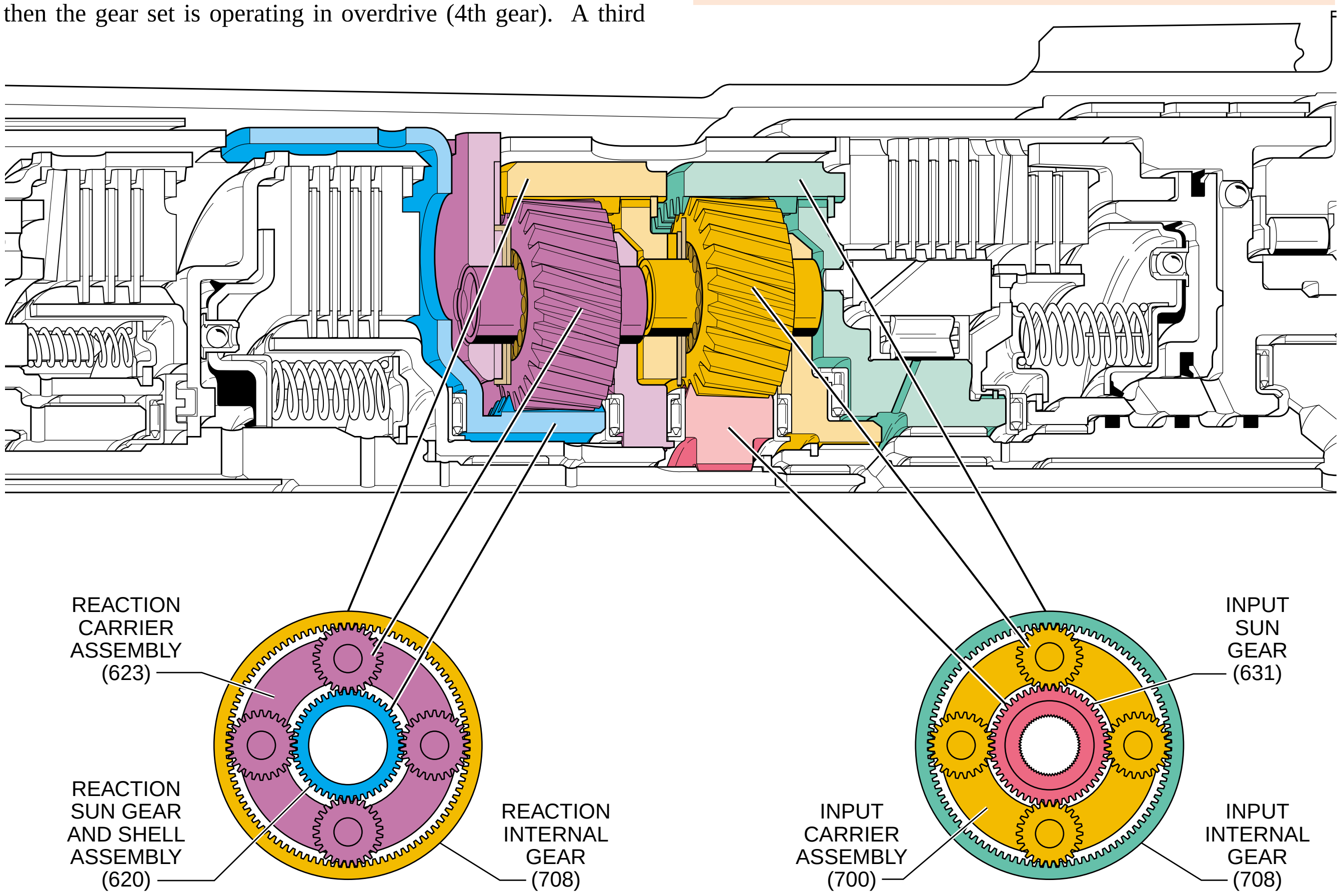
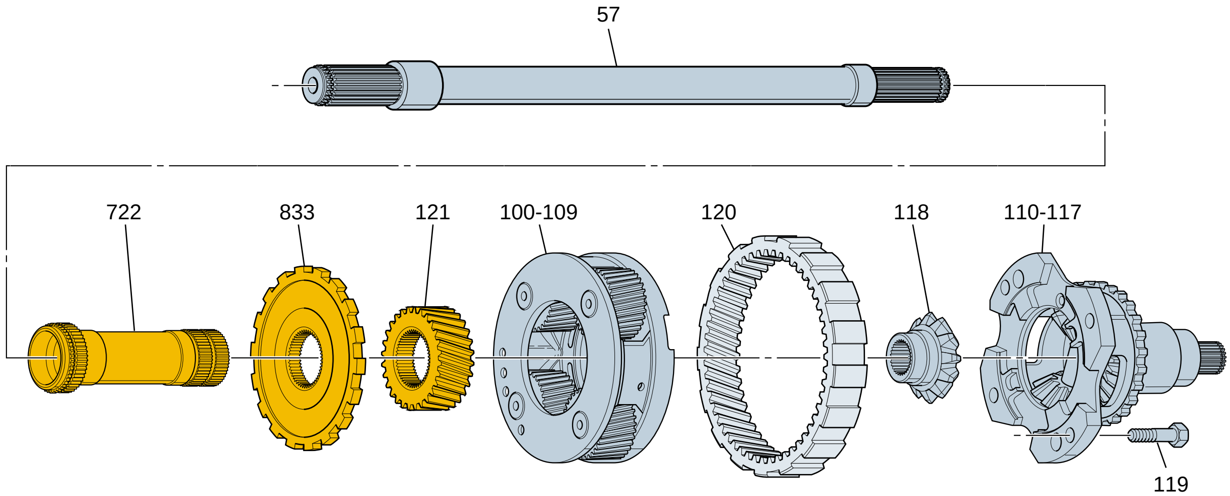
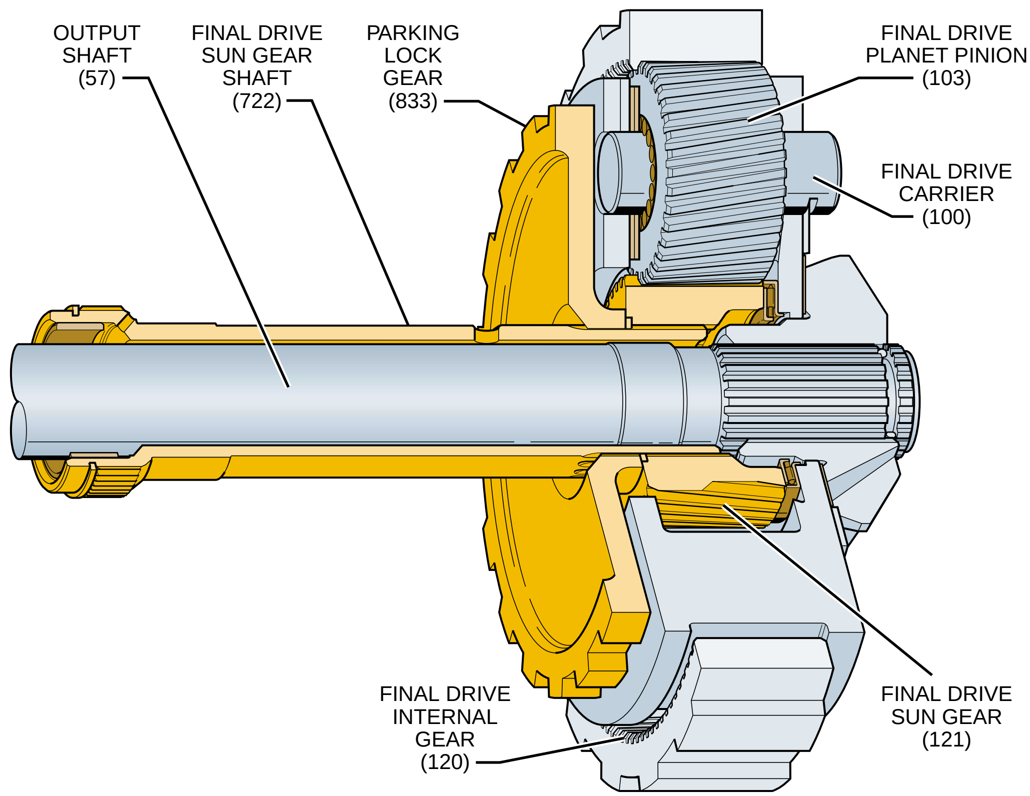


Figure 26

FINAL DRIVE AND DIFFERENTIAL ASSEMBLIES

The Hydra-matic 4T80-E transmission delivers torque from the engine to the drive axles by using a final drive assembly and differential components. These components, located at the output end of the gear train, perform the same function as the rear axle assembly found in all rear wheel drive vehicles.





Final Drive Assembly:

The final drive assembly is a planetary gear set consisting of: a final drive internal gear (120) splined to the case (6), a final drive sun gear (121) splined to the final drive sun gear shaft (722) and, a final drive/differential assembly (100-119).

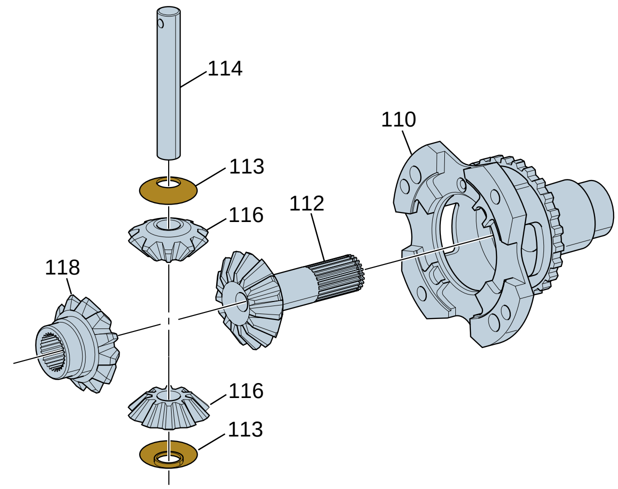
The final drive planetary gear set operates in reduction at all times at a ratio determined by a relationship of the final drive internal gear (120) to the final drive sun gear (121). In all forward gear ranges, the final drive sun gear shaft (722) drives the final drive sun gear (631) in the same direction as engine rotation. Since the final drive sun gear teeth are in mesh with the final drive planetary pinion gears (103), the planetary pinion gears are driven in the opposite direction as they rotate inside the final drive internal gear (120). This causes the final drive/ differential assembly (100-119) to be driven in the same direction as engine rotation, powering the vehicle forward.

The gear ratio of the final drive/differential assembly (100-119) performs the same function as the ring and pinion gears in a rear wheel drive vehicle. It is a fixed ratio that matches a specific engine and vehicle combination in order to meet the performance requirements for all operating conditions.

Figure 29

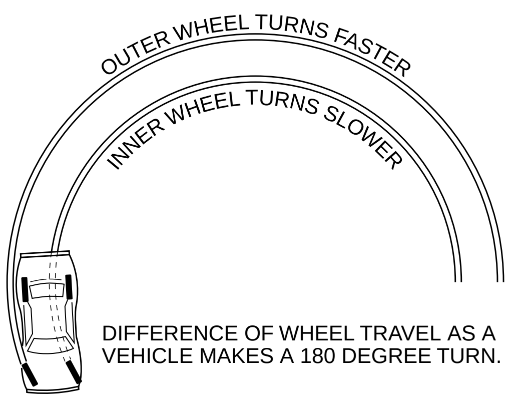
DIFFERENTIAL COMPONENTS

DIFFERENTIAL CARRIER ASSEMBLY:
The final drive/differential assembly (100-119) provides the means for one driving wheel to travel faster than the other when the vehicle is going around corners or curves. The final drive/differential assembly consists of a final drive carrier (100), a differential carrier (110), two differential side gears (112 & 118), two differential pinion gears (116) and, differential pinion shaft (114). One differential side gear (118) is splined to the output shaft (57) that drives the left axle shaft. The right differential side gear (112) is splined to the right drive axle and transfers torque to the right drive axle. The differential pinion gears act as idlers to transfer power from the differential carrier to the differential side gears. The differential pinion gears also balance the power and load between the differential side gears while allowing unequal axle rotation (speeds) when the vehicle is turning.

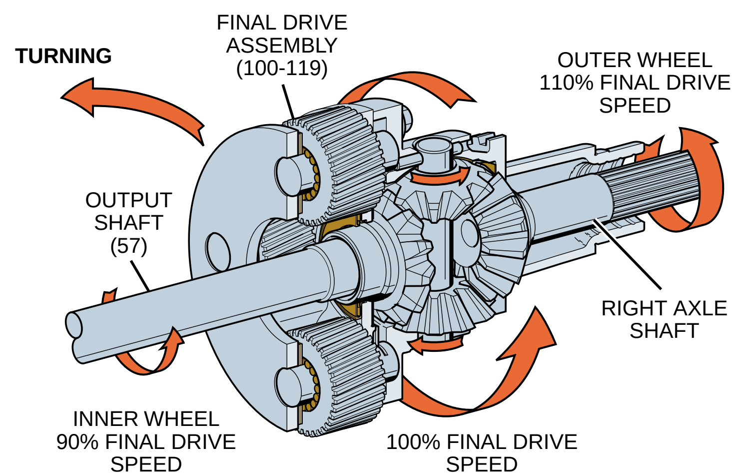


A noise condition, usually a hum (under light throttle or turns), will be associated with a final drive/differential condition.

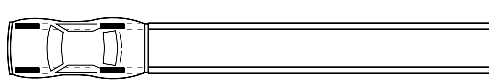
Final drive/differential failure can cause loss of drive.



DIFFERENCE OF WHEEL TRAVEL AS A VEHICLE MAKES A 180 DEGREE TURN.



When the vehicle is driven in a straight line, the differential pinion gears (116), differential side gears (112 & 118) and differential carrier (110) rotate as a fixed unit. The end result is both axle shafts rotate in the same direction as engine rotation for all forward gear ranges.



BOTH WHEELS TURNING AT SAME SPEED

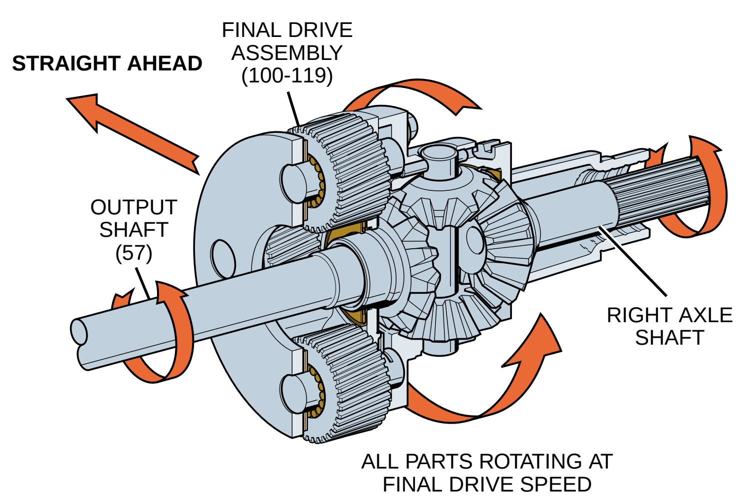
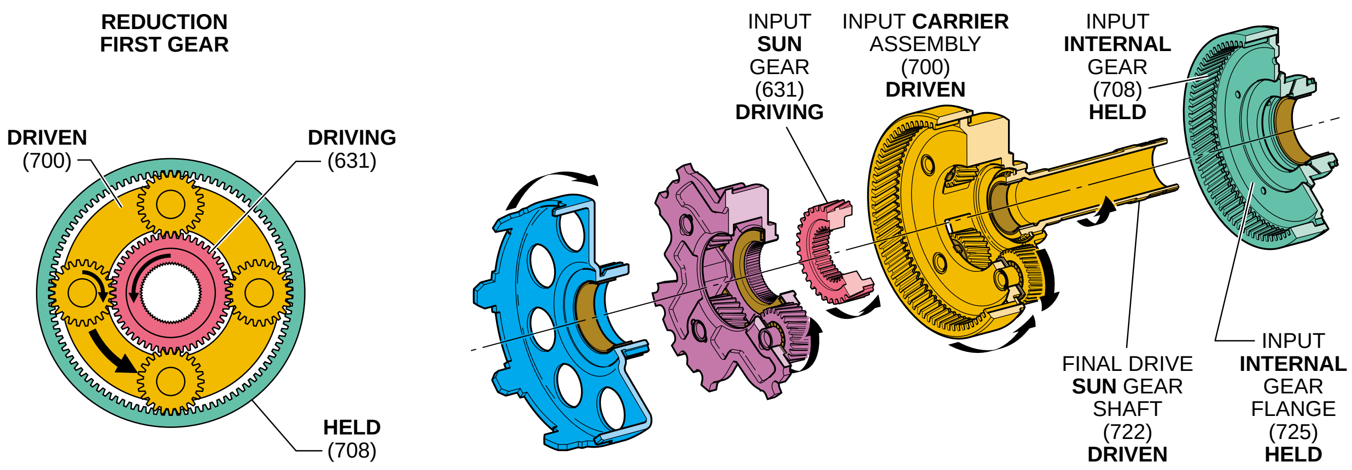


Figure 30

REDUCTION – FIRST GEAR



REDUCTION – SECOND GEAR

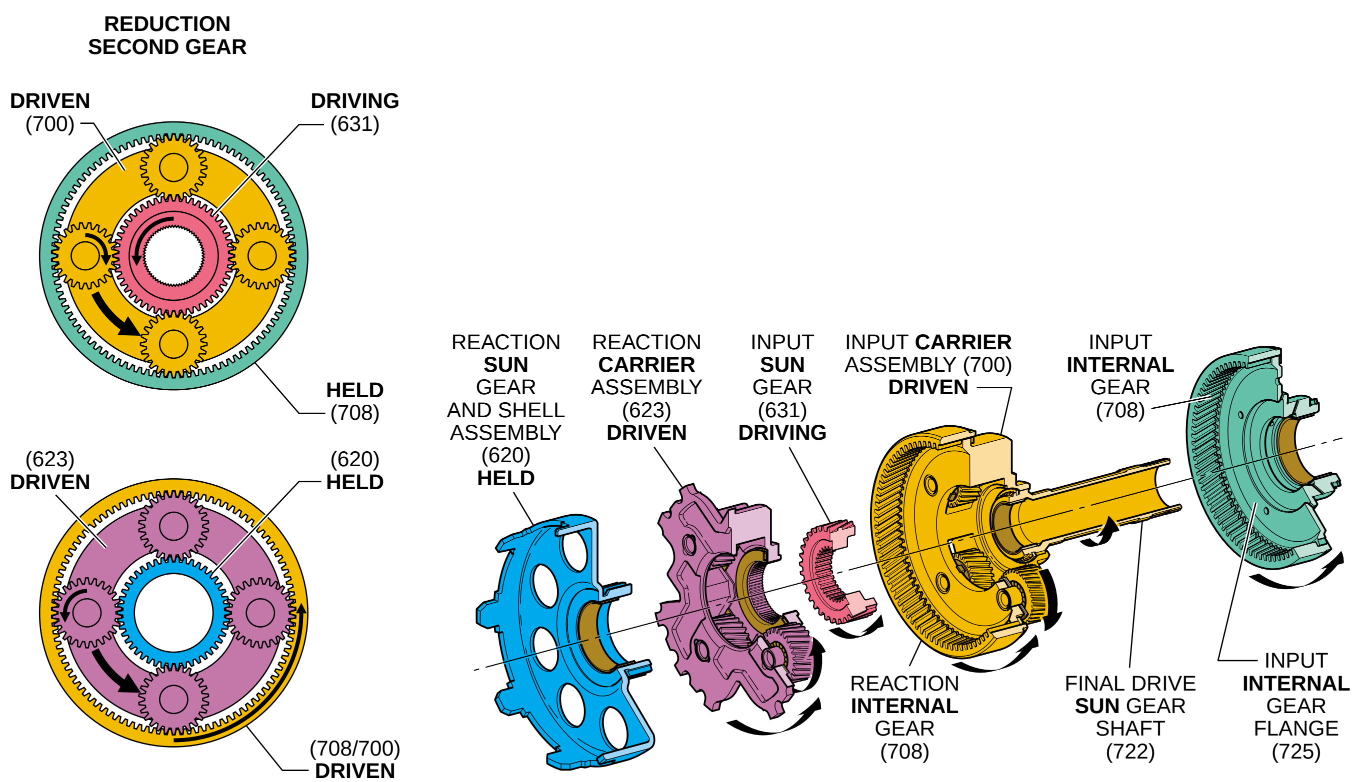


Figure 27

REDUCTION:

Planetary gear set reduction may be defined as the difference between a given input speed (RPM) that results in a lower output speed (RPM). Associated with the lower output speed is a higher output torque that enables the vehicle to begin moving. In the Hydra-matic 4T80-E, planetary gear set reduction occurs whenever the transmission is operating in 1st or 2nd gear, as well as in reverse gear.

FIRST GEAR

Planetary gear set reduction in first gear occurs when engine torque is transferred to the input sun gear (631) and the sun gear becomes the driving member. Torque is then transferred from the input sun gear to the four input planetary pinion gears (702) which rotate inside the input internal gear (708). Since the input internal gear (708) and input internal gear flange (725) are held stationary, the reaction internal gear/input carrier assembly (700) is forced to rotate. (Reaction planetary pinion gears (625) act as idler gears as the reaction internal gear/input carrier assembly rotates.) By using one planetary gear set, the transmission is operating in this mode with a gear reduction of 2.96:1.

SECOND GEAR

Planetary gear set reduction in second gear occurs when the 2nd clutch applies and the 2nd sprag clutch holds the reaction sun gear and shell assembly (620). With the forward clutch applied, the reaction carrier assembly (623), through the reaction carrier shell (633) and forward clutch housing (801), is held together with input internal gear (708). The reaction carrier will walk around the stationary reaction sun gear and shell assembly (620). The input sun gear (631) is the driving member. Because both planetary gear sets are used, the reaction internal gear and input carrier assembly become the output member. During this mode the transmission reduction through the gear set is 1.63:1.

DIRECT DRIVE:

Direct drive may be defined as the operating condition where a given input speed (RPM) equals the output speed by using a 1:1 gear ratio. Direct drive is obtained when any two members of the planetary gear set rotate in the same direction at the same speed and force the third member to rotate at that same speed. In this mode of operation the planetary pinion gears do not rotate on their pins but act as wedges to drive the gear sets as one rotating part. When this occurs, the output speed of the transmission is the same as the input speed from the torque converter turbine. However, output speed will not equal engine speed until the torque converter clutch applies (see torque converter, page 14).

THIRD GEAR

Direct drive occurs in third gear when the 3rd clutch applies and links the input shaft and 3rd clutch housing assembly (604) to the 3rd clutch hub (617). The 3rd clutch plates drive the input internal gear (708) through the 3rd clutch hub (617), reaction carrier assembly (623), reaction carrier shell (633), forward clutch housing (801), and forward sprag clutch assembly (716) while the input sun gear (631) rotates in the same direction and at the same speed. When the gear set through the input carrier assembly (700) is operating in this mode there is no RPM reduction through the gear sets. The transmission is therefore operating in direct drive at a 1:1 gear ratio.

OVERDRIVE:

Overdrive through a gear set may be defined as the operating condition where a given input speed (RPM) is less than the output speed. This mode of operation allows a vehicle to maintain a relatively high road speed while reducing engine speed for improved fuel economy. However, overdrive does result in lower output torque as compared to the input torque to the planetary gear set.

FOURTH GEAR

Overdrive occurs during fourth gear operation when the 4th band (523) applies and holds the reverse clutch housing and race assembly (500). The reaction sun gear and shell assembly (620) is also held because it is tanged into the reverse clutch housing and race assembly. The reaction carrier assembly (623) rotates around the stationary reaction sun gear and shell assembly and its planetary pinions drive the reaction internal gear (708) and input carrier assembly (700). When the planetary gear set is operating in this mode, the transmission is in overdrive at a gear ratio of 0.68:1.

REVERSE DIRECTION OF ROTATION:

A reverse direction of rotation through a planetary gear set is simply defined as the direction of rotation opposite to the gear rotation used as input. This mode of operation allows a vehicle to move in a rearward direction as well as operating the gear set in reduction.

REVERSE GEAR

The planetary gear sets reverse their direction of rotation when the reverse clutch applies and drives the reverse clutch housing and race assembly (500). The reaction sun gear and shell assembly (620) is therefore the driving member because it is tanged into the reverse clutch housing and race assembly. Since the low/reverse band (13) is also applied, it holds the reaction carrier assembly (623) because it is tanged to the forward clutch housing (801) and the reaction carrier shell (633). The reaction carrier planetary pinion gears are forced to rotate in a direction opposite of engine rotation and drive the reaction internal gear/input carrier assembly (700) in the same direction. The result is a reverse direction of engine rotation and reduction through the gear sets at a 2.13:1 ratio.

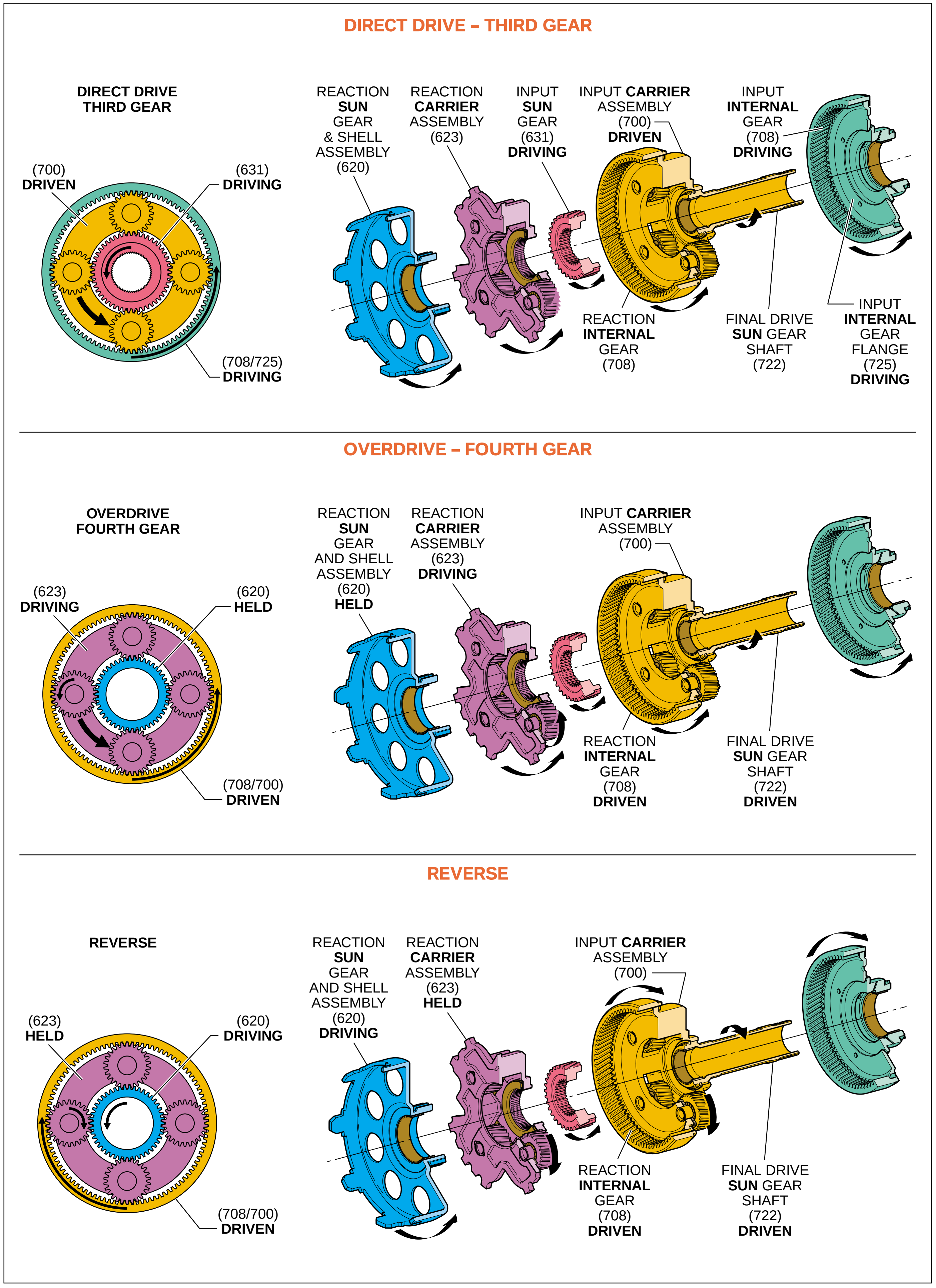


Figure 28

OIL PUMP ASSEMBLIES

The previous sections of this book were used to describe some of the mechanical component operations of the Hydra-matic 4T80-E. In the Hydraulic Control Components section a detailed description of individual components used in the hydraulic system will be presented. These hydraulic control components apply and release the clutch packs and bands to provide automatic shifting of the transmission.

OIL PUMP ASSEMBLIES

There are three pump assemblies that provide the volume of fluid required to operate the hydraulic control components, fluid transfer and lubrication throughout the transmission. These pumps are called the primary pump assembly, the secondary pump assembly and, the scavenger pump assembly. The primary and secondary pump assemblies are positive displacement internal/external rotor type pumps that make up the binary (dual capacity) pump system. These two pumps work together to supply a volume of fluid to the components as the scavenge pump moves fluid from the transmission oil pan (59) to the side cover (29).

Scavenge Pump Assembly:
The scavenge pump assembly is an external/external gear type pump made up of a scavenge pump body (225), scavenge pump cover (237), a scavenge pump drive gear (223), and two scavenge pump driven gears (224). When the engine is running, the oil pump drive shaft (2) is driven by the torque converter cover and rotates at engine speed. The other end of the oil pump drive shaft is assembled into the oil pump driven shaft (207) which also rotates at engine speed. The oil pump driven shaft rotates the scavenge pump drive gear (223) which forces the scavenge pump driven gears (224) to rotate.

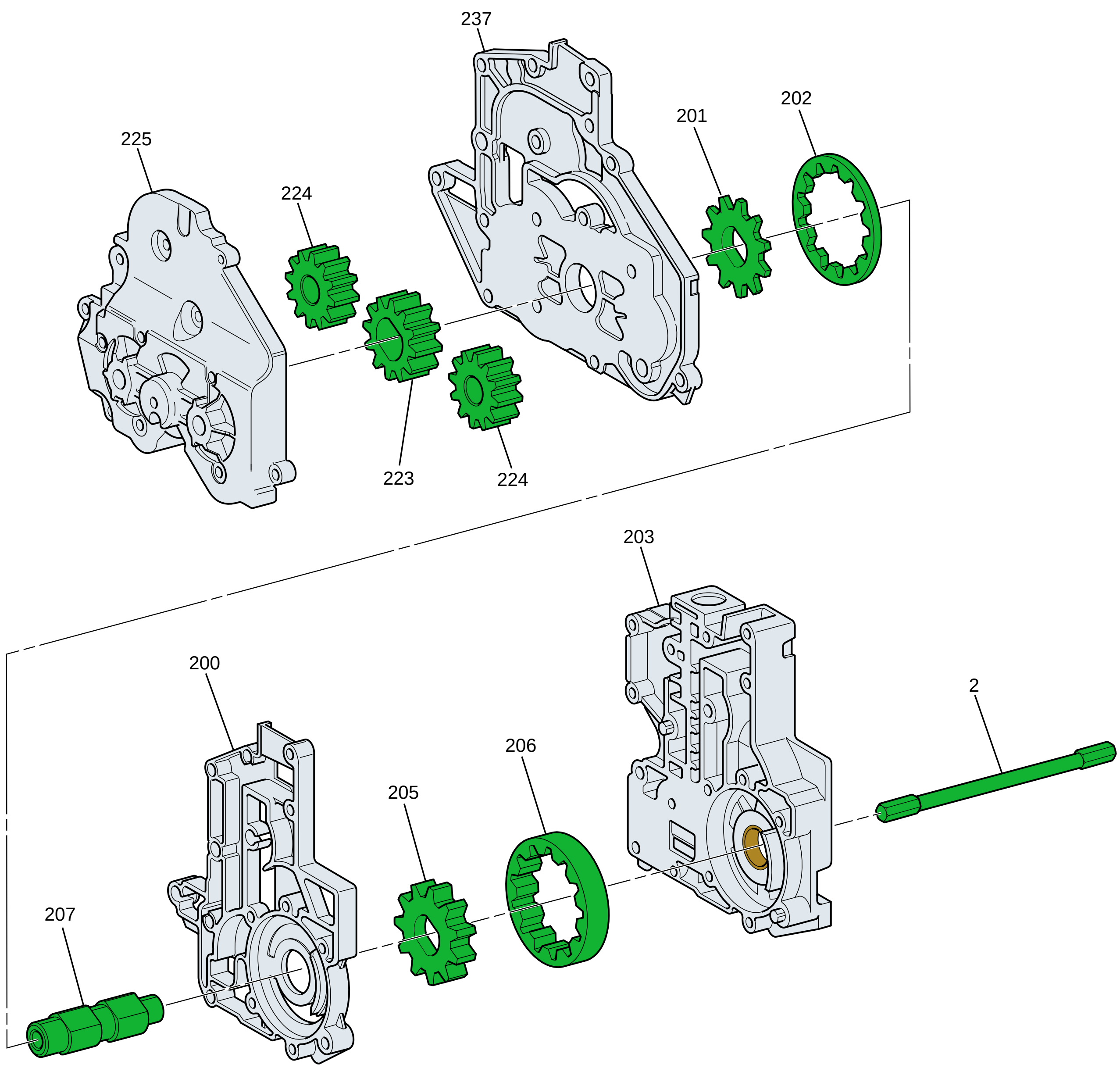


Figure 31

OIL PUMP ASSEMBLIES

As the scavenge external gears rotate, volume is positively displaced, thereby creating a vacuum at the right and left scavenge intake ports. This vacuum allows the higher atmospheric pressure in the transmission oil pan (59) to force fluid through the left and right scavenger case screens (51 & 52). Fluid passing through the left scavenge screen enters the case (6) and is then routed through the transmission case cover (33), the secondary pump body (203), the primary pump body (200) and then to the left scavenge pump driven gear (224). Fluid passing through the right scavenge screen enters the case (6) and then the scavenge tube (54) which routes fluid to the driven sprocket support (418). Right scavenge fluid is then routed through the transmission case cover (33), the secondary pump body (203), the primary pump body (200) and then to the right scavenge pump driven gear (224).

As the teeth on the drive and driven gears rotate, fluid is forced through the pump and into the scavenge outlet passage. The scavenge outlet circuit routes fluid into the side cover (29) where the transmission operating fluid level is maintained.

Primary and Secondary Pump Assemblies:
The primary and secondary pump assemblies are two fixed capacity internal/external gear type pumps that supply fluid to the transmission's hydraulic system. The primary pump assembly is made up of a primary drive gear (201), primary driven gear (202), primary pump body (200) and scavenge pump cover (237). The secondary pump assembly is a larger capacity pump and is made up of a secondary drive gear (205), secondary driven gear (206), secondary pump body (203) and primary pump body (200). When the engine is running, the oil pump drive shaft (2) is driven by the torque converter cover and rotates at engine speed. The other end of the oil pump drive shaft is assembled into the oil pump driven shaft (207) which also rotates at engine speed. The oil pump driven shaft rotates the primary and secondary pump drive gears (202 & 206) which forces the driven gears to rotate.

As the drive and driven gears rotate towards the wide portion of the crescent, volume is positively displaced, thereby creating a vacuum (low atmospheric pressure) at the pump intake port. This vacuum allows the higher atmospheric pressure acting on the fluid in the side cover (29) to force fluid through the main filter (236). Fluid is then routed through the secondary pump body (203) and into the suction side of the secondary pump gears. At the same time fluid is routed through the primary pump body (200) and into the suction side of the primary pump gears.

Through the rotation of drive and driven pump gears, the gear teeth carry the transmission fluid beyond the crescent to the pressure side of the pump gears. (The area where the volume of fluid between the gear teeth decreases.) As the gear teeth come together, fluid from the primary pump is forced into the main line pressure circuit while fluid from the secondary pump is forced into the secondary line circuit. Both main line and secondary line pressures are then routed to the pressure regulator valve (211) which controls the variable line pressures.

When engine speed (RPM) increases, the volume of fluid being supplied to the hydraulic system also increases because of the faster rotation of the pump gears. When the output from both pumps reaches a calibrated maximum, the pressure regulator valve will move far enough against spring force to allow excess fluid to return to the suction side of the pump gears. The result is a control of the pump's delivery rate of fluid to the hydraulic system.

Pump Related Diagnostic Tips

- Transmission Overheating
- Loss of drive
- High or low line pressure

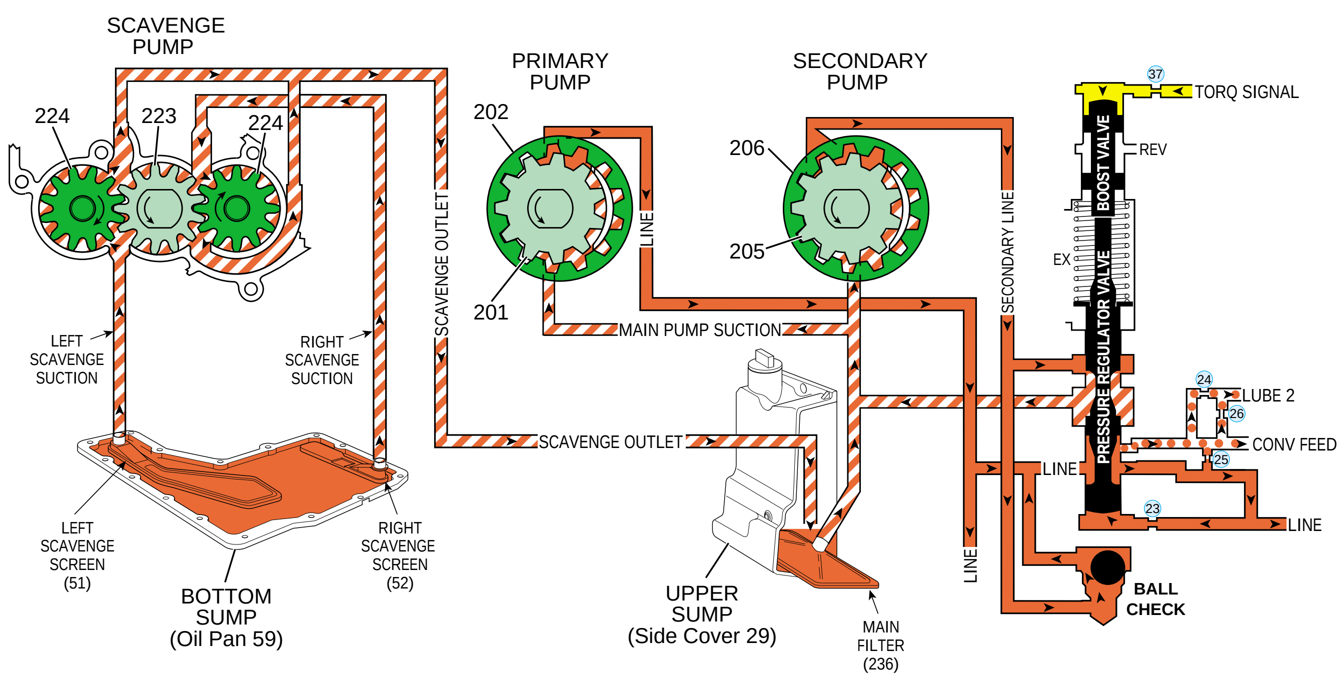


Figure 32

PRESSURE REGULATION

In order for pump output to become pressurized, there needs to be a restriction in the line fluid passage. The main restricting component that controls line pressure is the pressure regulator valve (211) which is located in the secondary pump body (203). Through the binary pump system both the primary pump and the secondary pump provide a constant supply of fluid to the pressure regulator valve. However, secondary pump pressure is only used to supplement (primary) line pressures when fluid demand in the hydraulic system is high. The demand for an increase in capacity occurs during initial engine start up, when the engine is operating at low speed (RPM), during a Park or Neutral to Drive or Reverse gear selection, and during certain full throttle shift maneuvers.

Under operating conditions where the hydraulic system requires more fluid volume and pressure, torque signal fluid increases at the pressure regulator boost valve (213). Fluid pressure combines with the force from the pressure regulator valve spring (212) and moves the pressure regulator valve (211) against line pressure. As the pressure regulator valve moves, a land on the valve reduces secondary line pressure entering the main pump suction circuit. At the same time, the secondary pump cut-off ball (216) unseats and allows secondary line pressure to enter the (main) line circuit that feeds the pressure regulator valve (211) and manual valve (916). These events allow the secondary pump (a larger capacity pump than the primary pump) to maintain pressure in the line circuit.

When demand for the higher volume of fluid decreases, line pressure moves the pressure regulator valve (211) against spring force and torque signal fluid pressure. When the valve moves far enough, secondary line passes through the valve and bleeds into the main pump suction circuit. At the same time, the secondary pump cut-off ball (216) is seated by the (main) line circuit that feeds the pressure regulator valve (211) and the manual valve (916). When these events occur, excess secondary line pressure is bled off while the primary pump maintains the supply of fluid to the hydraulic system.

When Reverse (R) gear is selected, line pressure is boosted by reverse pressure acting on the pressure regulator boost valve (213). The manual valve (916) opens a port to allow line pressure to enter the reverse circuit. Reverse fluid pressure is routed to the pressure regulator boost valve (213) and combines with torque signal fluid and spring force to move the pressure regulator valve (211) against line fluid pressure. The pressure regulator valve (211) limits the amount of secondary line pressure entering the main pump suction circuit as the secondary cut-off ball (216) unseats. Secondary line pressure enters the (main) line circuit to the manual valve and pressure regulation is maintained as described above.

Pressure Regulator Related Diagnostic Tips

A stuck or damaged pressure regulator valve could cause:

- High or low line pressure
- Slipping clutches or bands or harsh apply
- Transmission overheating
- Low or no cooler/lube flow

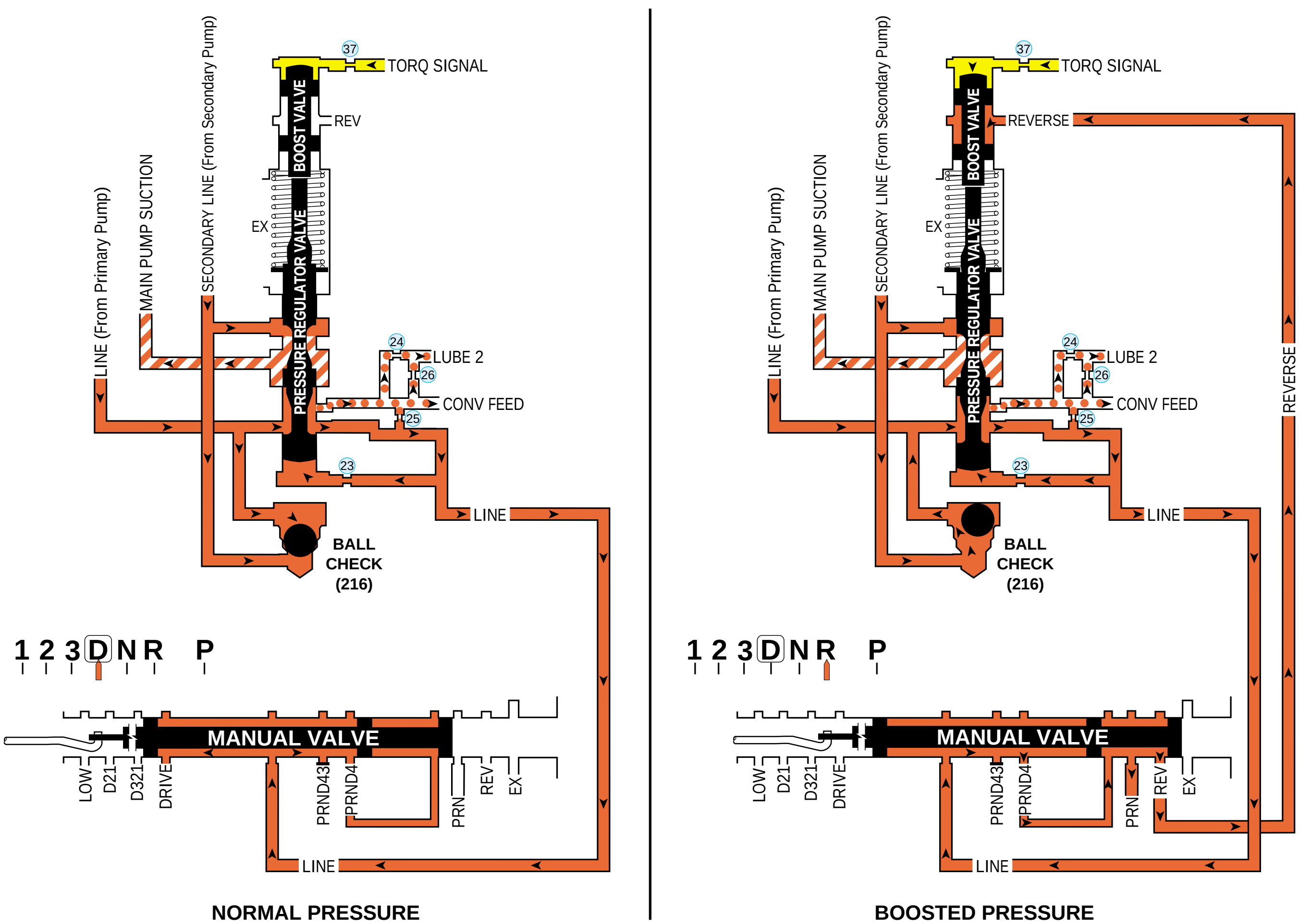


Figure 33

VALVES LOCATED IN THE OIL PUMP ASSEMBLY

Pressure Regulator Valve Train (211-215):
Regulates primary and secondary pump feed that passes through the valve into line pressure. The valve adjusts line pressure in response to changes in torque signal and reverse fluid pressure acting on the pressure regulator boost valve (213). The pressure regulator valve also routes secondary line pressure to main pump suction or line circuit depending on system demands.

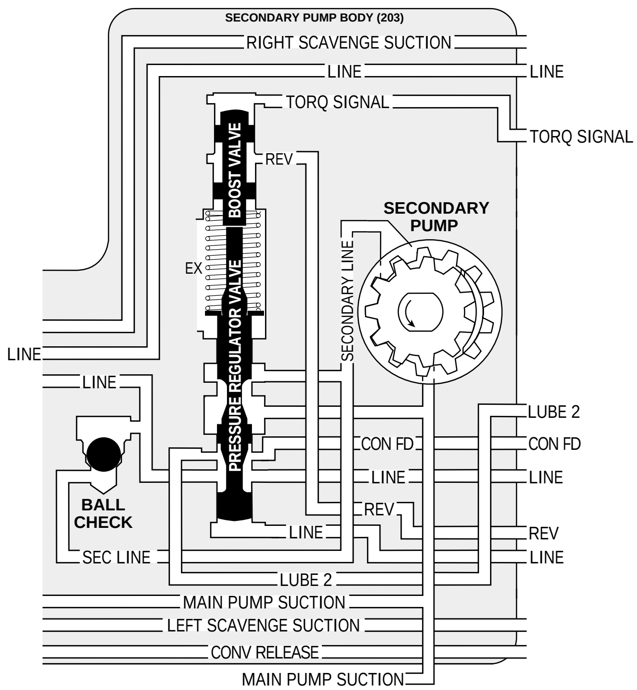
If stuck, missing or binding, the pressure regulator valve or spring may cause:
- High or low line pressure
- Slipping clutches or bands or harsh apply
- Transmission overheating
- Low or no cooler/lube flow

Pressure Regulator Boost Valve (213):
Activated by torque signal fluid from the pressure control solenoid (339) and reverse fluid pressure, it assists pressure regulator valve spring (212) force to adjust line pressures. Whenever torque signal pressure increases or reverse gear range is selected, the pressure regulator boost valve influences the pressure regulator valve position. The pressure regulator valve then responds to the additional forces and this increases line pressures.

If stuck, missing or binding, the pressure regulator boost valve or spring may cause high or low line pressure.

Secondary Pump Cut-off Ball (216):
Seats against secondary line pressure when the line fluid volume required to operate the vehicle is at a minimum. When vehicle operating conditions require higher volume to maintain line pressure, the pressure regulator valve (211) blocks secondary line from entering the main pump suction circuit. Secondary line then unseats the ball check valve and is able to enter the line pressure circuit to boost the volume, thereby maintaining line pressure.

If stuck or missing, the secondary pump cut-off ball may cause high or low line pressure.



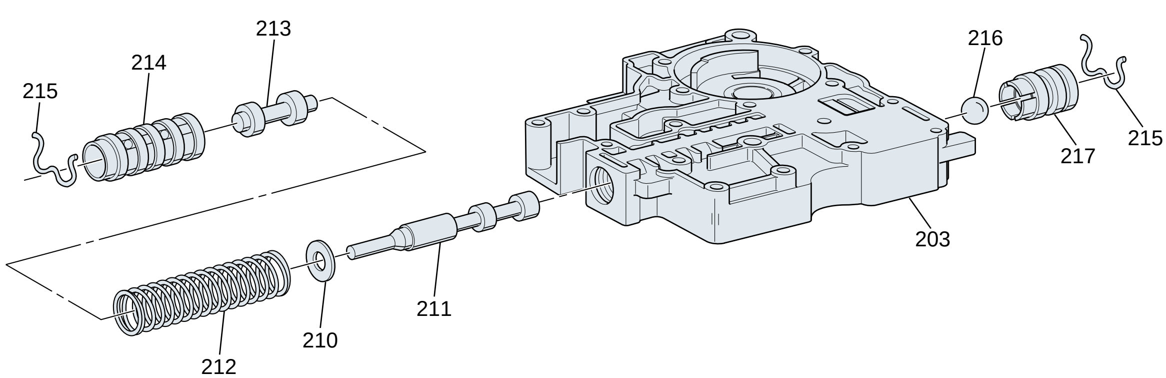


Figure 34

HYDRAULIC CONTROL COMPONENTS

COMPONENTS LOCATED IN THE LOWER CONTROL VALVE BODY

Low/Reverse Servo Assembly:
An apply device that is activated by low & reverse band reduce fluid or reverse band fluid pressure (depending on gear range selection – refer to the Apply Components section). Low & reverse band and/or reverse band fluids stroke the low/reverse servo piston (928) during Park, Reverse and Neutral ranges and First Gear operation. The low/reverse servo apply pin (931) compresses the low/reverse band (13) which then holds the forward and coast clutch housing (801).

A leak at the low/reverse piston seals, or a stuck or binding low/reverse piston could cause:

- No reverse or slips in reverse
- No first gear or slips in first gear
- No Park
- Drives in Neutral

#6 Ball Check Valve and Capsule (979 and 905):
A ball type check valve that seats against the low & reverse band reduce circuit during Park, Reverse and Neutral ranges. While in this position the ball check valve allows low & reverse band apply and/or reverse band fluid to stroke the low/reverse servo piston (928). During Overdrive Range and Manual Range First gear operation the ball check valve is seated against the low & reverse band apply passage by low & reverse band reduce pressure. While in this position the ball check valve allows low & reverse band reduce fluid to be routed to the spring side of the low/reverse servo piston (928).

If stuck or missing, the #6 ball check valve could cause:

- No reverse or slips in reverse
- No first gear or slips in first gear
- No Park
- Drives in Neutral

Reverse Orifice Bypass Valve (921):
A spool valve that is controlled by reverse fluid pressure acting against an opposing spring force. When reverse gear range is selected, under moderate to heavy throttle conditions, reverse fluid pressure moves the valve against spring force. When shifted, the valve opens another feed passage through orifice #17 into the reverse clutch circuit. Reverse fluid is then able to provide an additional feed into the reverse clutch circuit for quickly applying and holding the reverse clutch plates.

- If stuck, missing or binding, the reverse orifice bypass valve or spring could cause harsh or soft reverse clutch apply.

3-4 Shift Valve (912):
A spool valve that is controlled by 1-2 solenoid fluid pressure acting against an opposing spring force and D321 fluid pressure (in manual gear ranges). When upshifted during a 3-4 shift, 3rd clutch fluid passes through the valve, enters the 4th band feed circuit and applies the 4th band. During Manual Range Third gear operation, D321 fluid holds the valve in the downshifted position allowing D321 fluid to pass through the valve, enter the coast clutch feed circuit and apply the coast clutch. During Manual Range Second gear operation, D21Y fluid also passes through the valve to enter the 4th band feed circuit and applies the 4th band. In Manual Range First gear, 1-2 solenoid fluid holds the valve in the upshifted position which allows D21Y fluid to enter the coast clutch feed circuit.

A stuck or binding 3-4 shift valve could cause:

- No fourth gear or slips in fourth gear
- No third gear
- No engine compression braking in manual third gear

1-2 SHIFT VALVE TRAIN (909, 918-920)

1-2 Shift Solenoid (SS) Valve (909):
An ON/OFF type solenoid that receives its voltage supply through the ignition switch. The PCM controls the solenoid by providing a ground to energize it in Park, Reverse, Neutral, First and Fourth gear operation. When energized (ON), its exhaust port closes and 1-2 solenoid fluid pressure increases. 1-2 solenoid fluid pressure acts on both the 1-2 and 3-4 shift valves to help control the shift valve positioning for the appropriate gear range. When de-energized (OFF), 1-2 solenoid fluid exhausts through the solenoid thereby removing a hydraulic force at the 1-2 and 3-4 shift valves. (See the Electrical Components Section for more detail.)

- 1-2 SS valve stuck off or leaking could cause 2nd or 3rd gear only condition.
- 1-2 SS valve stuck on could cause 1st and 4th gears only.

1-2 Shift Valve “A” (919):
A spool valve that responds to 1-2 solenoid fluid pressure that opposes 2-3 solenoid fluid pressure and spring force acting on the 1-2 shift valve “B”. (The 1-2 shift valve “A” is linked to the 1-2 shift valve “B” and both valves operate as if they were a one piece valve.) Depending on the transmission gear range operation, PRN fluid is routed through the valve into the low & reverse band apply circuit and/or, low feed enters the low & reverse band reduce circuit. During Third and Fourth gear operation, 2-3 solenoid fluid assists spring force to hold the valve in the upshifted position.

1-2 Shift Valve “B” (920):
A spool valve that responds to 2-3 solenoid fluid pressure and spring force that opposes 1-2 solenoid fluid pressure acting on the 1-2 shift valve “A”. (The 1-2 shift valve “B” is linked to the 1-2 shift valve “A” and both valves operate as if they were a one piece valve.) Depending on the transmission gear range operation, drive fluid is routed through the valve into the 2nd clutch circuit and/or 4th band feed enters the 4th band circuit.

- 1-2 shift valve (A and B) stuck in the upshift position could cause no 1st gear.
- 1-2 shift valve (A and B) stuck in the downshift position could cause no 2nd or slips in 2nd gear.

2-3 SHIFT VALVE TRAIN (909, 906-908)

2-3 Shift Solenoid (SS) Valve (909):
An ON/OFF type solenoid that receives its voltage supply through the ignition switch. The PCM controls the solenoid by providing a ground to energize it in Third and Fourth gear operation. When energized (ON), its exhaust port closes and 2-3 solenoid fluid pressure increases. 2-3 solenoid fluid pressure acts on both the 2-3 shift valve “D” and the 1-2 shift valve “A” to help control the shift valve positioning for the appropriate gear range. When de-energized (OFF), 2-3 solenoid fluid exhausts through the solenoid thereby removing a hydraulic force at the 1-2 and 2-3 shift valves. (See the Electrical Components Section for more detail.)

- 2-3 SS valve stuck off or leaking could cause no 3rd gear.
- 2-3 SS valve stuck on could cause loss of power or 3rd and 4th gears only.

2-3 Shift Valve “C” (907):
A spool valve that responds to 2-3 solenoid fluid pressure that opposes 2-3 shift valve spring force acting on the 2-3 shift valve “D”. (The 2-3 shift valve “C” is linked to the 2-3 shift valve “D” and both valves operate as if they were a one piece valve.) Depending on the transmission gear range operation, drive fluid is blocked or routed through the valve into the 3rd clutch circuit and coast clutch feed or D21 fluid is routed into the coast clutch circuit.

COMPONENTS LOCATED IN THE LOWER CONTROL VALVE BODY

2-3 Shift Valve "D" (908):
A spool valve that responds to 2-3 shift valve spring force that opposes 2-3 solenoid fluid pressure acting on the 2-3 shift valve "C". (The 2-3 shift valve "D" is linked to the 2-3 shift valve "C" and both valves operate as if they were a one piece valve.) Depending on the transmission gear and range operation, low fluid is blocked or routed through the valve into the low feed circuit, and D21 fluid is blocked or routed into the D21Y circuit.

- 2-3 shift valve (C and D) stuck in the upshift position could cause 3rd gear or 4th gear only.
- 2-3 shift valve (C and D) stuck in the downshift position could cause no 3rd gear.

Forward Orifice Bypass Valve (924):
A spool valve that is controlled by drive fluid pressure acting against an opposing spring force. When any drive range is selected under moderate to heavy throttle conditions, drive fluid pressure shifts the valve against spring force. When shifted, the valve opens another feed passage through orifice #18 into the forward clutch circuit. Drive fluid is then able to provide an additional feed into the forward clutch circuit for quickly applying the forward clutch.

- If stuck, missing or binding, the forward orifice bypass valve or spring could cause harsh or soft forward clutch apply.

Manual Valve (916):
A spool valve that is mechanically linked to the gear selector lever and is fed line pressure from the pressure regulator valve (211). When a range is selected, the manual valve directs line pressure into the various circuits by opening or closing feed passages. The circuits fed by the manual valve are: Reverse, PRN, PRND4, PRND43, Drive D321, D21 and Low.

Stuck, misaligned or damaged, the manual valve and linkage could cause:

- No reverse or slips in reverse
- No first gear or slips in first gear
- No fourth gear or slips in fourth gear
- No Park
- No engine compression braking in all manual ranges
- Drives in Neutral
- No gear selections
- Shift indicator indicates wrong gear selection

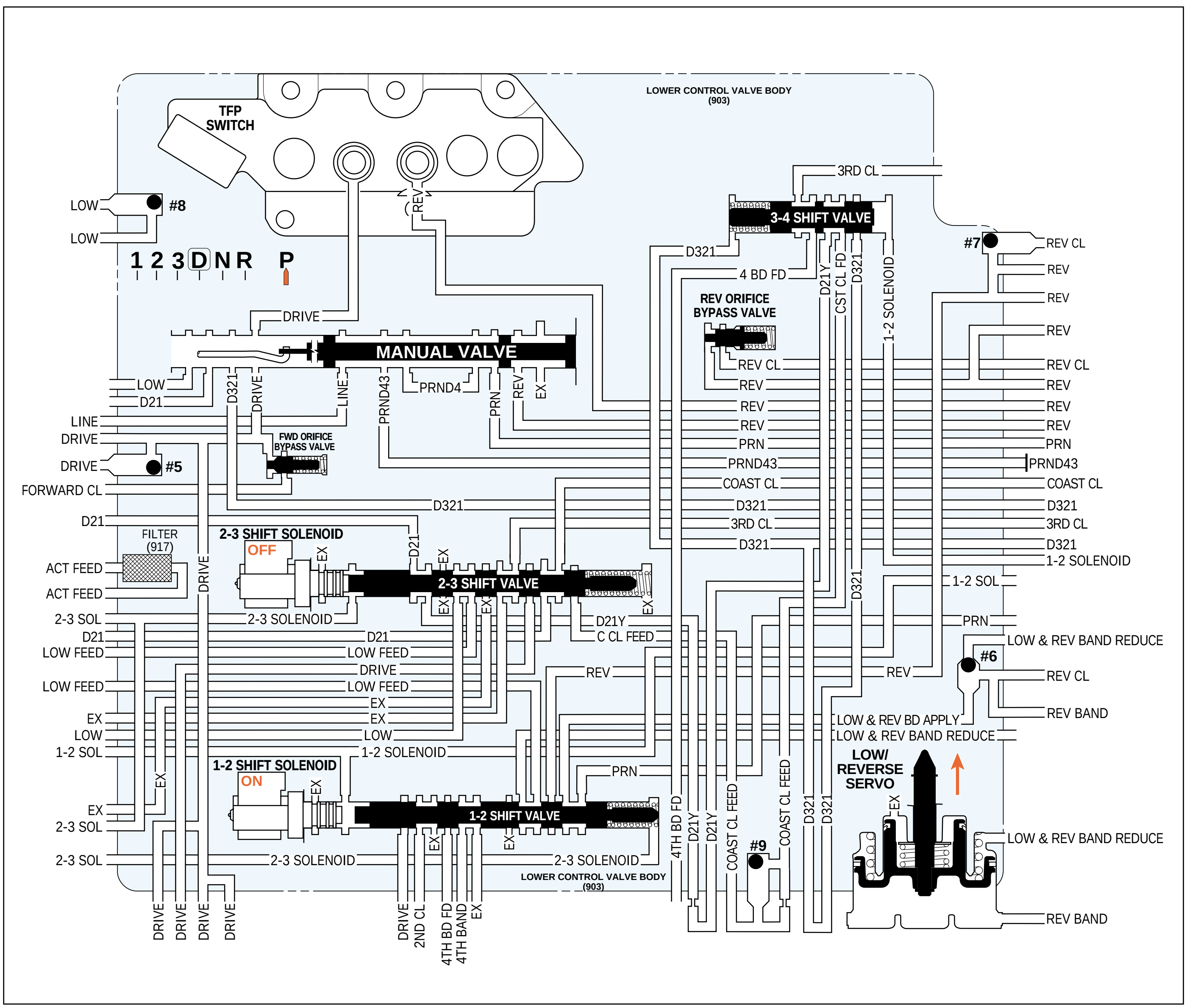


Figure 35

COMPONENTS LOCATED IN THE UPPER CONTROL VALVE BODY

Pressure Control (PC) Solenoid Valve (339):
An electronically controlled pressure regulator that regulates filtered actuator feed pressure entering the torque signal circuit. Torque signal fluid is then routed to the pressure regulator valve (211), the accumulator boost valve (301) and the 2-3 accumulator valve (306) where it is used as a controlling force. (See the Electrical Components section for additional information.)

- A leaking/damaged O-ring or bad electrical connection can cause high or low line pressure.

2-3 Accumulator Assembly (345-351):
A cushioning device that is actuated by orificed 3rd clutch fluid as the 3rd clutch applies. When orificed 3rd clutch fluid strokes the 2-3 accumulator piston (345), resistance from the 2-3 accumulator piston spring (347) and 2-3 accumulator fluid provide the cushioning effect. (See “Accumulators” in the Hydraulic Control Components section for additional information.)

- A leak at the 2-3 accumulator piston seal or porosity in the upper control valve body or case cover could cause no 3rd gear/slips in 3rd gear.
- A stuck 2-3 accumulator piston would cause harsh shifts

Torque Converter Clutch (TCC) Pressure Solenoid Valve (336):
An electronically controlled, pulse width modulated solenoid that controls the apply and release rate of the torque converter clutch. The solenoid regulates 3rd clutch fluid into TCC control fluid pressure that is routed to the converter clutch control valve (317), the converter clutch regulator valve (318) and the TCC enable valve (322). (See the Electrical Components section for additional information.)

- Stuck on, exhaust plugged, would cause no TCC release in 2nd, 3rd or 4th gear.
- Stuck off, leaking o-ring, no voltage, would cause no TCC/slip or soft apply.

Converter Clutch Control Valve (317):
A spool valve that is held in the downshifted position by spring force and TCC exhaust enable fluid pressure when the TCC pressure solenoid valve is OFF. When the TCC pressure solenoid is energized (ON), TCC control fluid shifts the valve against spring force thereby redirecting fluids into the converter apply and “to cooler” circuit. (See the Electrical Components section for additional information.)

- Stuck in the release position would cause no TCC/slip or soft apply.
- Stuck in the apply position would cause apply fluid to exhaust and an overheated torque converter.

Converter Clutch Regulator Valve (318):
A spool valve that is biased by TCC control fluid pressure that opposes spring force at the other end of the valve. When the TCC pressure solenoid valve (336) is activated, the valve regulates line pressure as it passes through the valve and enters the regulated apply circuit.

If stuck, missing or binding, the converter clutch regulator valve or spring could cause:

- TCC stuck on in all gears
- TCC stuck on in 2nd, 3rd and 4th gears
- harsh TCC apply or release
- slip, shudder, rough apply or no apply

Torque Converter Clutch (TCC) Enable Valve (322):
A relay type spool valve that is controlled by TCC control fluid pressure acting against spring force at the other end of the valve. During TCC apply, the valve allows converter release fluid to exhaust through the valve and blocks TCC feed limit. During TCC off, the valve allows TCC feed limit to push the converter clutch control valve toward the TCC pressure solenoid valve (336).

- If stuck, missing or binding, the TCC enable valve or spring may cause incorrect TCC apply or release.

Converter Feed Limit Valve (312):
A spool valve that limits (regulates) converter feed pressure passing through the valve to a maximum of 862 kPa (125 psi). TCC feed limit fluid is then routed to the converter clutch control valve (317) where it enters either the converter release or the “to cooler” circuit (depending on TCC pressure solenoid valve operation).

If stuck, missing or binding, the converter feed limit valve or spring may cause:

- Inadequate lubrication
- Incorrect TCC apply or release
- Converter ballooning

Actuator Feed Limit Valve (309):
A spool valve that limits (regulates) line pressure passing through the valve to a maximum of 793 kPa (115 psi). Actuator feed fluid is then routed to the PC solenoid valve and also to orifice #15, orifice #16 and orifice #40 (1-2 solenoid, 2-3 solenoid and Forward Clutch circuits).

- If stuck in the exhaust position, the actuator feed limit valve or spring could cause 2nd gear only and low line pressure.

2-3 Accumulator Valve (306):
A spool valve that is biased by torque signal fluid as it regulates line pressure into secondary 2-3 accumulator fluid. Secondary 2-3 accumulator fluid from the valve is then routed to ball check valve #10 and through orifice #32 to the spring side of the 2-3 accumulator piston (345).

- If stuck, missing or binding, the 2-3 accumulator valve could cause harsh or soft 2-3 upshifts.

1-2 / 3-4 ACCUMULATOR VALVE TRAIN (301-304B)

Accumulator Boost Valve (301):
A spool valve that is biased by torque signal fluid and moves the 1-2 / 3-4 accumulator valve (302) for regulation of line pressure into primary accumulator fluid. When the 3rd clutch is applied, 3rd clutch fluid is routed to the accumulator boost valve to assist torque signal fluid pressure at the valve. (See “Accumulators” in the Hydraulic Control Components section for additional information.)

1-2 / 3-4 Accumulator Valve (302):
A spool valve that regulates line pressure into primary accumulator fluid pressure based on torque signal and 3rd clutch pressure acting on the accumulator boost valve (301). Primary accumulator fluid is then routed to the forward, reverse, 1-2, and 3-4 accumulator pistons. (See “Accumulators” in the Hydraulic Control Components section for additional information.)

- If stuck, missing or binding, the 1-2 / 3-4 accumulator valve and accumulator boost valve could cause harsh or soft shifts to Reverse, Overdrive Range – First gear, and 1-2 or 3-4 upshifts.

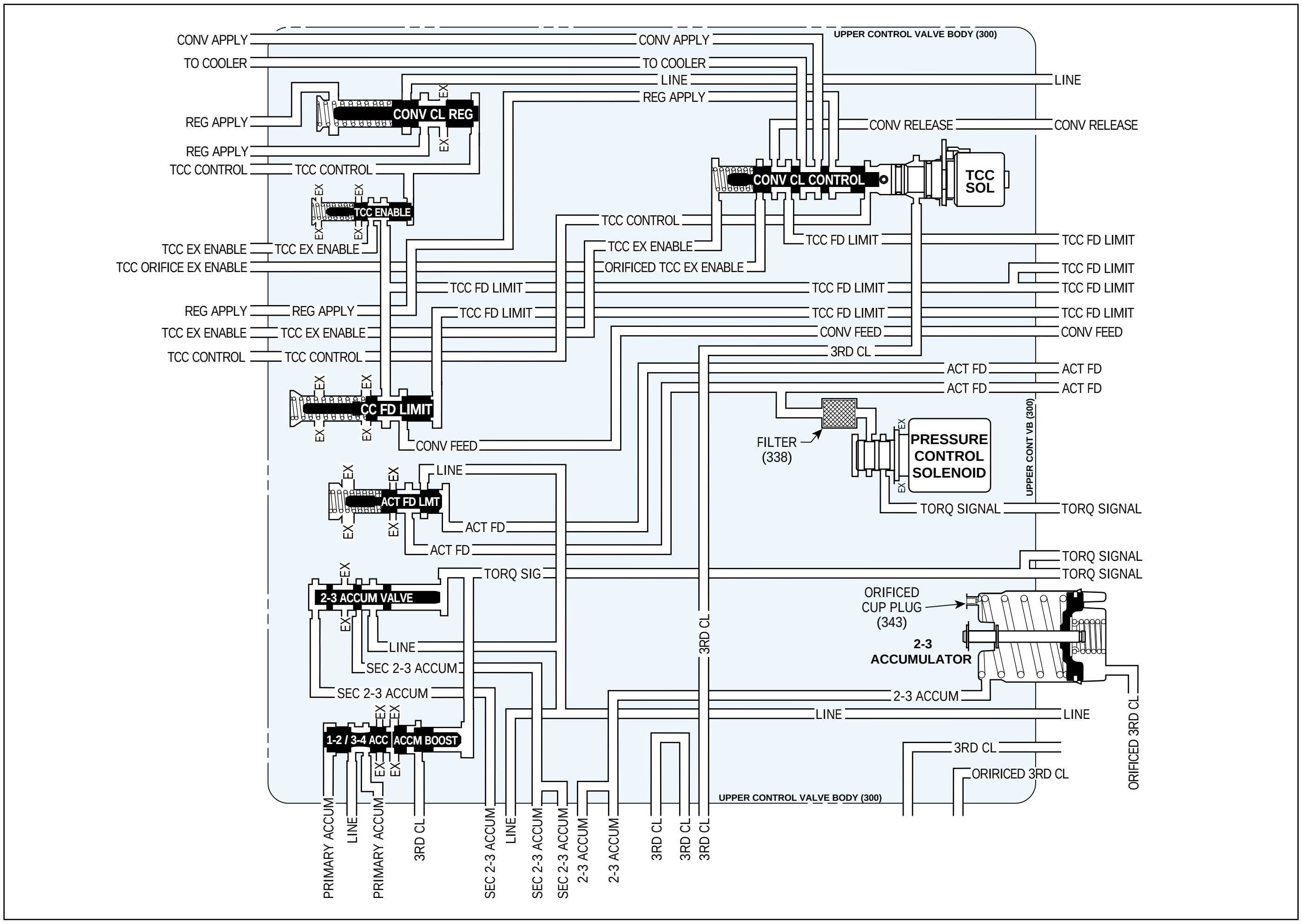


Figure 36

COMPONENTS LOCATED IN THE DRIVEN SPROCKET SUPPORT

3rd Clutch Exhaust Valve Train (424-427):
A spool valve that responds to orificed 3rd clutch fluid acting on one end of the valve and opposing spring force at the other end. During a 2-3 shift, orificed 3rd clutch fluid moves the valve against spring force to allow fluid into the 3rd clutch circuit. 3rd clutch fluid is then routed to the 3rd clutch piston to apply the clutch. During a downshift from Third gear to a lower gear, after most of the pressure is exhausted, spring force moves the valve to the downshifted position and allows 3rd clutch fluid to exhaust at the valve.

- If stuck, missing or binding, the 3rd clutch exhaust valve could cause no 3rd gear or a partial apply or drag of the 3rd clutch plates when the clutch releases.

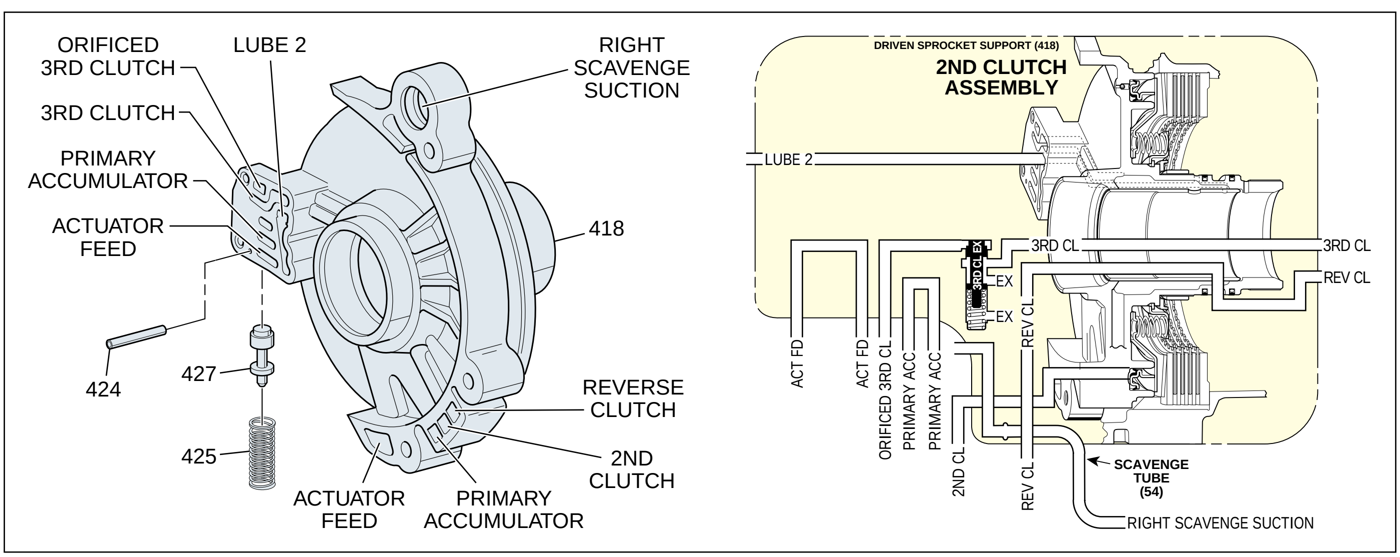


Figure 37

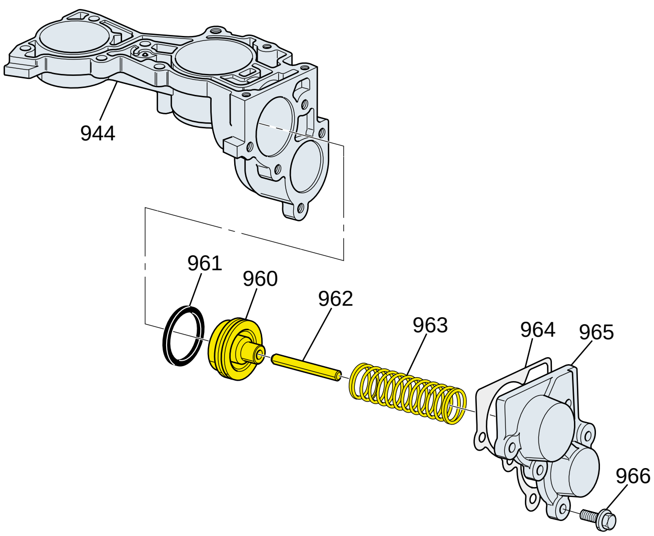
ACCUMULATORS

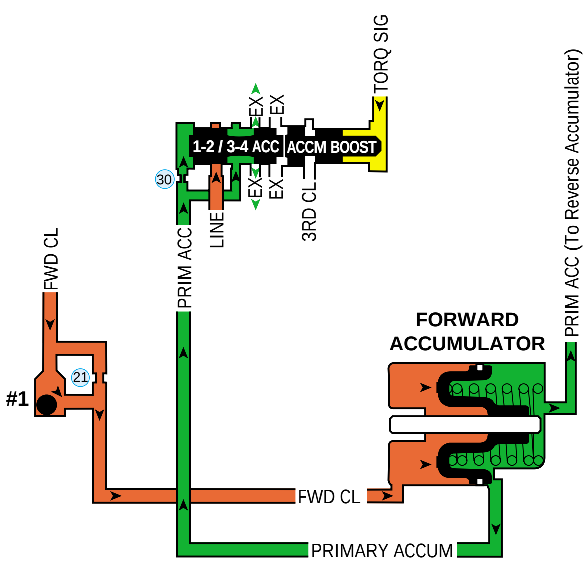
An accumulator is a spring-loaded device that is designed to cushion the engagement of a clutch or band with respect to engine torque. The "cushioning" effect created by an accumulator provides for a more pleasing shift feel as the transmission shifts from one gear ratio to another.

In the Hydra-matic 4T80-E, shift accumulation occurs during 1-2, 2-3 and 3-4 shifts as well as a Park or Neutral to Drive or Reverse gear engagements. During the apply of a clutch, apply fluid starts to compress the clutch piston return springs and compress the clutch plates. When the clearance between the clutch plates is taken up by piston travel and the clutch begins to hold, fluid pressure in the circuit builds up rapidly. The accumulator assembly, using accumulator spring force and accumulator fluid pressure, is designed to absorb some of the clutch apply fluid flow to control pressure and allow for a more gradual apply of the clutch. Without an accumulator in the circuit, the rapid buildup of fluid pressure would cause the clutch to grab quickly and create a harsh shift.

The force of the accumulator spring and pressure in the accumulator circuit are used to control the rate (timing) that apply pressure in the circuit reaches its maximum. Under light throttle conditions, engine torque is at a minimum and the clutches require less force to apply and hold. Under heavy throttle conditions, engine torque is high which requires a greater force to apply and hold the clutch plates. To respond to various operating conditions, the accumulator valves have torque signal fluid acting as a bias at the valves. This arrangement regulates accumulator pressure proportionately to throttle position in order to control shift feel. At a greater throttle position opening, accumulator fluid pressures increase to compensate for higher line pressures and engine torques.

The same principle of shift accumulation also applies to Reverse, First and Fourth gear operation where a band or combination of band and clutch is used. As the band is applied it compresses around a drum which causes fluid pressure in the apply circuit to rise rapidly. In addition to the accumulators used in these circuits, each servo assembly contains a cushion spring to assist in shift feel. Refer to the specific accumulator circuit description for a detailed explanation of its operation.





Forward Accumulator Assembly (960-963):

The forward accumulator assembly is located in the accumulator housing (944) and consists of a piston (960), seal (961), pin (962) and spring (963). The forward accumulator assembly is the primary device for controlling the apply feel of the forward clutch during a Park, Reverse or Neutral to Drive range selection.

Primary accumulator fluid pressure, acting on the spring side of the forward accumulator piston (960), originates at the 1-2/3-4 accumulator valve (302) when line pressure is regulated through the valve. The 1-2/3-4 accumulator valve regulates line pressure into primary accumulator fluid in response to torque signal fluid pressure at the accumulator boost valve (301). Primary accumulator fluid is then routed to end of the 1-2/3-4 accumulator valve through orifice #30. Primary accumulator fluid is also routed to the spring side of the forward accumulator piston (and the spring side of the reverse accumulator piston (946).

After the transmission has been operating in Park, Reverse or Neutral and a forward range is selected, forward clutch fluid is routed to the #1 ball check valve. Forward clutch fluid unseats the ball check valve and is routed to the forward accumulator piston where it strokes the piston against spring force and primary accumulator fluid pressure. When the forward accumulator piston moves down its bore, primary accumulator fluid is forced back through its circuit to the 1-2/3-4 accumulator valve. Primary accumulator fluid is then regulated to exhaust by torque signal fluid acting on the accumulator boost valve (301).

When either Park, Reverse or Neutral range is selected after the transmission has been operating in a drive range, spring force and primary accumulator fluid move the forward accumulator piston. Forward clutch fluid is then forced out of the forward accumulator bore and is routed to the #1 ball check valve where it seats the ball check valve. Forward clutch fluid is then forced through orifice #21 to ball check valve #5 where it unseats the ball check valve. Forward clutch fluid then enters the drive circuit and drive fluid is then routed to the manual valve (916) where it exhausts.

- A leak at the forward accumulator piston seal or porosity in the accumulator housing could cause no forward in overdrive range/slips in overdrive range.
- A stuck forward accumulator piston would cause harsh forward clutch apply.

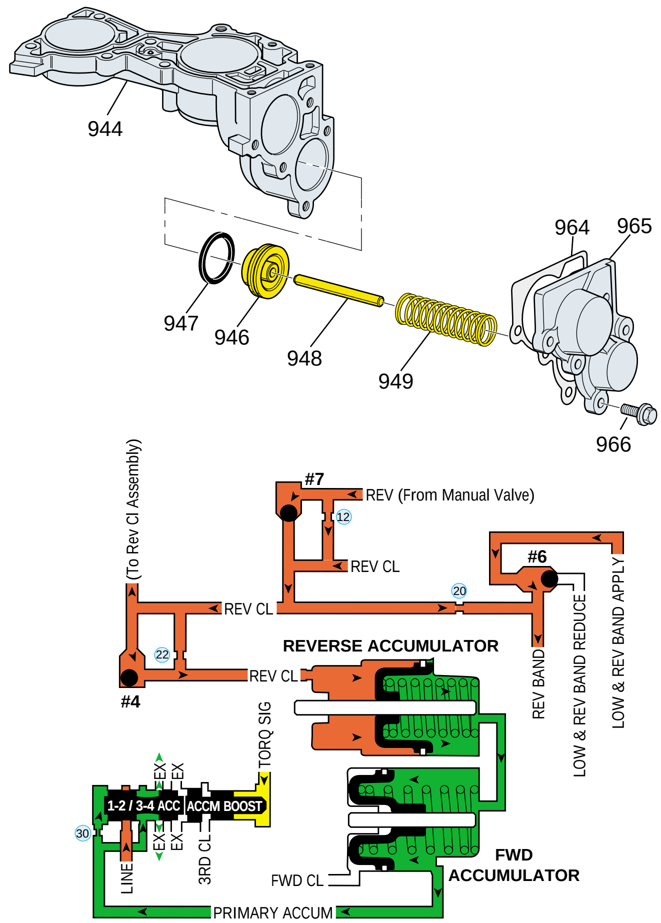
Figure 38

Reverse Accumulator Assembly (946-949):
The reverse accumulator assembly is located in the accumulator housing (944) and consists of a piston (946), seal (947), pin (948) and spring (949). The reverse accumulator assembly is the primary device for controlling the apply feel of the reverse clutch during a Park, Neutral or Drive to Reverse range selection.

As described in the forward accumulator operation, primary accumulator fluid is routed from the 1-2/3-4 accumulator valve through the accumulator housing to the spring side of the reverse accumulator piston. When Reverse range is selected, reverse clutch fluid is routed to the #4 ball check valve. Reverse clutch fluid unseats the ball check valve and is routed to the reverse accumulator piston where it strokes the piston against spring force and primary accumulator fluid pressure. When the reverse accumulator piston moves down its bore, primary accumulator fluid is forced back through its circuit to the 1-2/3-4 accumulator valve. Primary accumulator fluid then exhausts at the 1-2/3-4 accumulator valve based on torque signal fluid pressure acting on the accumulator boost valve (301).

When either Park, Neutral or a drive range is selected after the transmission has been operating in Reverse, spring force and primary accumulator fluid move the reverse accumulator piston. Reverse clutch fluid is then forced out of the reverse accumulator bore and is routed to ball check valve #4 where it seats the ball check valve. Reverse clutch fluid is then forced through orifice #22 and ball check valve #7 where it unseats the ball check valve. Reverse clutch fluid passes through orifice #6 into the reverse circuit which exhausts fluid at the manual valve (916).

- A leak at the reverse accumulator piston seal or porosity in the accumulator housing could cause no reverse/slips in reverse.
- A stuck reverse accumulator piston would cause harsh reverse clutch apply.



1-2 Accumulator Assembly (968-973):
The 1-2 accumulator assembly is located in the accumulator housing (944) and consists of a piston (968), seal (969), pin (970), inner spring assembly (971) and accumulator spring (973). The 1-2 accumulator assembly, 2nd clutch waved plate and 2nd clutch return spring and retainer assembly (428), are the primary devices for controlling the apply feel of the 2nd clutch.

As described in the forward and reverse accumulator operation, primary accumulator fluid is routed from the 1-2/3-4 accumulator valve (302) to ball check valve #2. Primary accumulator fluid seats the ball check valve thereby routing fluid through orifice #14 and into the 1-2 accumulator circuit. 1-2 accumulator fluid is then channeled to the spring side of the 1-2 accumulator piston. As the transmission shifts into 2nd gear, 2nd clutch fluid is routed to the 1-2 accumulator piston and strokes the piston against spring force and 1-2 accumulator pressure. When the 1-2 accumulator piston moves down its bore, 1-2 accumulator fluid is forced back through its circuit to ball check valve #2 and unseats the ball check valve. 1-2 accumulator fluid then feeds into the primary accumulator circuit where it exhausts at the 1-2/3-4 accumulator valve based on torque signal fluid pressure acting on the accumulator boost valve (301).

During a coastdown, throttle induced or manual shift into first gear, 2nd clutch fluid exhausts at the 1-2 shift valve "B" (920). Primary accumulator fluid from the 1-2/3-4 shift valve seats ball check valve #2 allowing fluid to enter the 1-2 accumulator circuit. 1-2 accumulator fluid is then routed to the spring side of the 1-2 accumulator piston and moves the piston into a first gear position.

- A leak at the 1-2 accumulator piston seal or porosity in the accumulator housing could cause no 2nd gear/slips in 2nd gear.
- A stuck 1-2 accumulator piston would cause harsh shifts.

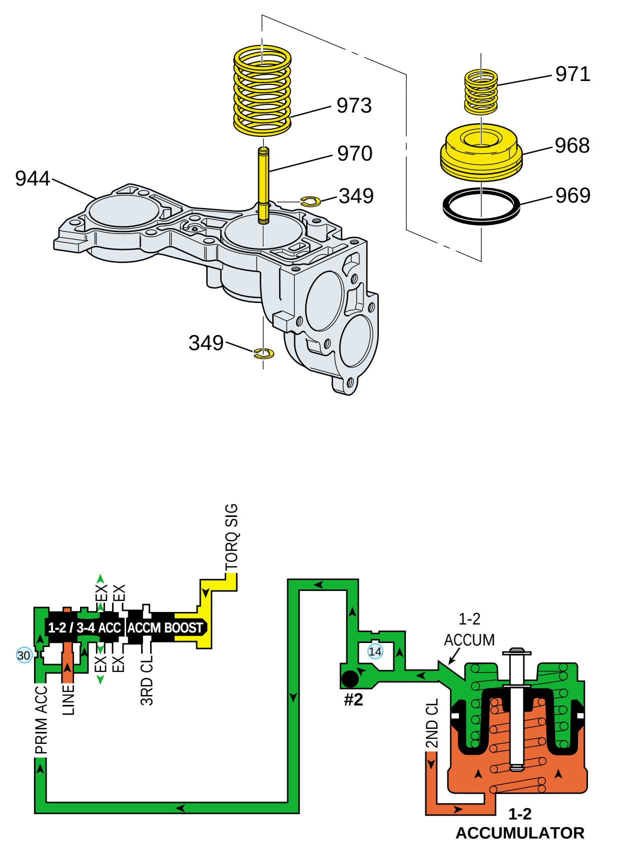
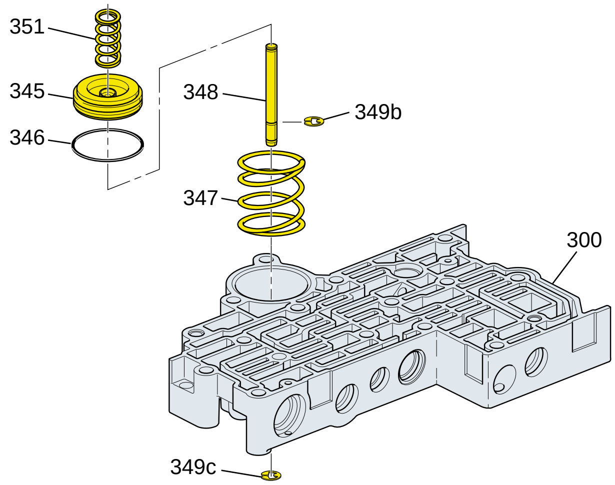
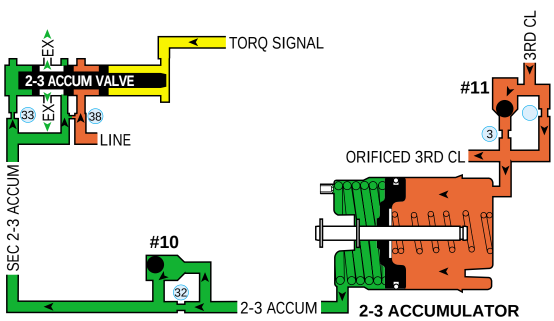


Figure 39





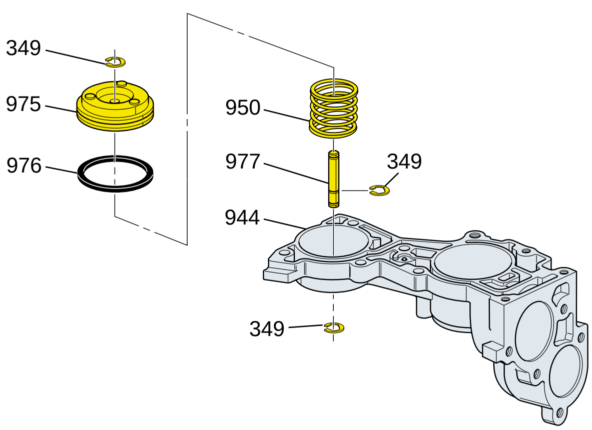
2-3 Accumulator Assembly (345-348):

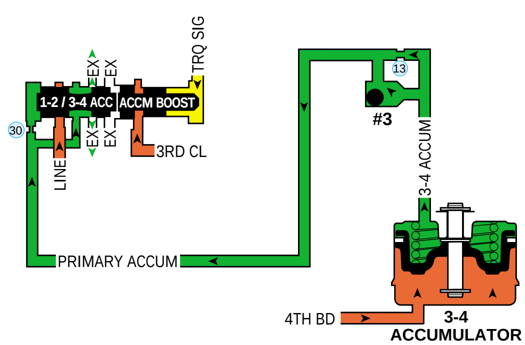
The 2-3 accumulator assembly is located in the upper control valve body (300) and consists of a piston (345), seal (346), pin (348) and spring (347). The 2-3 accumulator assembly and the 3rd clutch spring and retainer assembly (607) are the primary devices for controlling the apply feel of the 3rd clutch.

2-3 accumulator fluid pressure originates at the 2-3 accumulator valve as line pressure, regulated by torque signal and spring force, enters the 2-3 accumulator circuit. 2-3 accumulator fluid is then routed to the end of the 2-3 accumulator valve, through orifice #33, and to ball check valve #10. 2-3 accumulator fluid seats the ball check valve to direct fluid through orifice #32 and to the spring side of the 2-3 accumulator piston (345). As the transmission shifts into 3rd gear, 3rd clutch fluid seats the ball check valve #11 to direct fluid through orifice #31. Orificed 3rd clutch fluid is routed to the 2-3 accumulator piston and strokes the piston against spring force and 2-3 accumulator pressure. When the 2-3 accumulator piston moves down its bore, 2-3 accumulator fluid is forced back through its circuit to ball check valve #10 and unseats the ball check valve. 1-2 accumulator fluid is then routed to the 2-3 accumulator valve where fluid exhausts at a rate based on torque signal pressure and spring force.

During a coastdown, throttle induced or manual shift into second or first gear, 3rd clutch fluid pressure exhausts at the 2-3 shift valve. In the absence of 3rd clutch pressure, the 2-3 accumulator spring and 2-3 accumulator fluid pressure return the 2-3 accumulator piston to a downshifted position. As the piston moves it forces orificed 3rd clutch fluid out of the piston bore to ball check valve #11 where it unseats the ball check valve. Orificed 3rd clutch fluid passes through orifice #3 and the ball check valve seat where it enters the 3rd clutch circuit and exhausts at the 2-3 shift valve.

- A leak at the 2-3 accumulator piston seal or porosity in the accumulator housing could cause no 3rd gear/slips in 3rd gear.
- A stuck 2-3 accumulator piston would cause harsh shifts.





3-4 Accumulator Assembly (950, 975-977):

The 3-4 accumulator assembly is located in the accumulator housing (944) and consists of a piston (975), seal (976), pin (977) and spring (950). The 3-4 accumulator assembly and the 4th servo assembly are the primary devices for controlling the apply feel of the 4th band (523) during a 3-4 shift.

When the engine is running , 3-4 accumulator fluid at the spring side of the 3-4 accumulator piston, is created by line pressure that is regulated through the 1-2/3-4 accumulator valve (302). The 1-2/3-4 accumulator valve regulates line pressure into primary accumulator fluid in response to torque signal fluid pressure at the accumulator boost valve (301). Primary accumulator fluid is then routed to the end of the of the 1-2/3-4 accumulator valve and to ball check valve #3. Primary fluid seats the ball check valve and fluid is then routed through orifice #13 into the 3-4 accumulator circuit which feeds the spring side of the 3-4 accumulator piston.

As the transmission shifts into 4th gear, 4th band fluid is routed to the 4th servo piston and strokes the piston against spring force and holds the 4th band (523). At the same time, 4th band fluid strokes the 3-4 accumulator piston against spring force and 3-4 accumulator fluid pressure. When the 3-4 accumulator piston moves down its bore, 3-4 accumulator fluid is forced back through its circuit to ball check valve #3 and unseats the ball check valve. 3-4 accumulator fluid then enters the primary accumulator circuit which routes fluid to the 1-2/3-4 accumulator valve. Primary accumulator fluid is then routed to the 1-2/3-4 accumulator valve where fluid exhausts at a rate based on torque signal pressure and spring force.

During a coastdown, throttle induced or manual shift into third, second or first gear, 4th band fluid exhausts at the 2-3 shift valve “D” (908). As 4th band fluid pressure exhausts, the 4th servo springs return the servo piston to the downshifted position. At the same time, 3-4 accumulator fluid pressure combines with 3-4 accumulator spring force to move the 3-4 accumulator piston to the downshifted position.

- A leak at the 3-4 accumulator piston seal or porosity in the accumulator housing could cause no 4th gear/slips in 4th gear.
- A stuck 3-4 accumulator piston would cause harsh shifts.

Figure 40

#1 FORWARD CLUTCH:
Located in the accumulator housing (944), it is forced by forward clutch fluid off its seat on the spacer plate (935) when the transmission is operating in any drive gear range. When the ball check valve is unseated, forward clutch fluid is routed to the forward accumulator piston (960) and strokes it against spring force and primary accumulator fluid pressure. Whenever Park, Reverse or Neutral ranges are selected after the transmission was operating in a forward range, Drive fluid is open to exhaust at the manual valve (916). Primary accumulator fluid and forward accumulator spring force combine to move the forward accumulator piston causing forward clutch fluid to seat the ball check valve against the spacer plate (935). Forward clutch fluid is then routed through orifice #21 and eventually into the drive circuit (to exhaust at the manual valve).

#2 PRIMARY ACCUMULATOR/1-2 ACCUMULATOR:
Located in the accumulator housing (944), it is forced by primary accumulator fluid to seat against the spacer plate (935) when the transmission is operating in Park, Reverse or Neutral ranges, or First gear. Primary accumulator fluid is then routed through orifice #14 where it enters the 1-2 accumulator circuit. The ball check valve is forced off its seat by 1-2 accumulator fluid when the 2nd clutch applies and the 1-2 accumulator piston moves down its bore. The unseated ball check valve allows 1-2 accumulator fluid to parallel orifice #14 and enter the primary accumulator circuit (which is regulated to exhaust at the 1-2/3-4 accumulator valve).

#3 PRIMARY ACCUMULATOR/3-4 ACCUMULATOR:
Located in the accumulator housing (944), it is forced by primary accumulator fluid to seat against the spacer plate (935) when the transmission is operating in Park, Reverse or Neutral ranges, or First or Second gears. Primary accumulator fluid is then routed through orifice #13 where it enters the 3-4 accumulator circuit. The ball check valve is forced off its seat by 3-4 accumulator fluid when the 4th band is applied and the 3-4 accumulator piston (975) moves down its bore. The unseated ball check valve allows 3-4 accumulator fluid to parallel orifice #13 and enter the primary accumulator circuit (which is regulated to exhaust at the 1-2/3-4 accumulator valve).

#4 REVERSE CLUTCH:
Located in the accumulator housing (944), it is forced by reverse clutch fluid off its seat on the spacer plate (935) when the transmission is operating in Reverse range. The unseated ball check valve allows reverse clutch fluid to parallel orifice #22 and enter the reverse clutch circuit. The ball check valve is forced to seat against the spacer plate (935) whenever a forward range is selected (after the transmission was operating in reverse). Reverse clutch fluid from the reverse accumulator piston is then routed through orifice #22 and eventually exhausts at the manual valve.

#5 DRIVE/FORWARD CLUTCH:
Located in the lower valve body (903), it is forced by drive fluid to seat against the spacer plate (935) when the transmission is operating in a forward range. Drive fluid is then routed through orifice #1 where it enters the forward clutch circuit. The ball check valve is forced off its seat by forward clutch fluid when the forward clutch releases allowing forward clutch fluid to parallel orifice #1 and enter the drive circuit (which exhausts at the manual valve).

#6 LOW & REVERSE BAND APPLY/REDUCE:
A two way seating ball check valve that is located in the lower control valve body (903). During Park, Reverse and Neutral range operation it is forced by low & reverse band apply fluid to seat against the low & reverse band reduce passage. When in this position, low & reverse band apply fluid is routed through the reverse band circuit to the low/reverse servo assembly and strokes the servo piston.

When the transmission is operating in first gear (or any forward drive range) low & reverse band apply fluid is routed through the 1-2 shift valve "A" (919) and into the PRN circuit. (PRN fluid is directed to the manual valve (916) where it exhausts.) At the same time, low & reverse band reduce fluid, from the 1-2 shift

valve, is routed to the spring side of the low/reverse servo piston to reduce some of the force of the reverse band fluid pressure acting on the servo piston. Low & reverse band reduce fluid is then routed to the ball check valve (and seats it against the low & reverse band apply passage) and into the reverse band circuit.

#7 REVERSE/REVERSE CLUTCH:
Located in the lower control valve body (903), it is forced by reverse fluid to seat on the spacer plate (935) when the transmission is operating in reverse range. Reverse fluid is then routed through orifice #12 where it enters the reverse clutch circuit. The ball check valve is forced off its seat by reverse clutch fluid when the manual valve is moved out of reverse range. The reverse clutch releases and allows reverse clutch fluid to parallel orifice #12 and enter the reverse circuit.

#8 LOW:
Located in the lower control valve body (903), it is forced by low fluid (drive fluid entering the low circuit through orifice #19) to seat on the spacer plate (935) when the transmission is operating in Overdrive Range, Manual Third Range, or Manual Second Range. This allows drive fluid to enter the low & reverse band apply circuit through the 1-2 shift valve in First gear only. The ball check valve is forced off its seat by low fluid pressure when manual first range is selected. Low fluid pressure from the manual valve unseats the ball check valve and provides the feed into the low fluid circuit.

#9 COAST CLUTCH FEED/ORIFICED COAST CLUTCH FEED:
Located in the lower control valve body (903), it is forced on its seat on the spacer plate (935) by coast clutch feed pressure during manual range operation (Manual First, Manual Second or Manual Third). The ball check valve is forced off it's seat on the spacer plate (935) when any another gear range is selected after the transmission has been operating in a manual range. When the coast clutch applies, coast clutch feed fluid seats the ball check valve against the spacer plate (935) thereby routing coast clutch feed fluid through orifice #7.

#10 2-3 ACCUMULATOR/SECONDARY 2-3 ACCUMULATOR:
Located in the case cover (33), it is forced by secondary 2-3 accumulator fluid to seat against the spacer plate (327) in all gears except Third and Fourth gear. Secondary 2-3 accumulator fluid is then routed through orifice #32 where it enters the 2-3 accumulator circuit. The ball check valve is forced off its seat when the 3rd clutch applies and the 2-3 accumulator piston moves down its bore. The unseated ball check valve allows 2-3 accumulator fluid to parallel orifice #32 and enter the secondary 2-3 accumulator circuit.

#11 3RD CLUTCH/ORIFICED 3RD CLUTCH:
Located in the case cover (33), it is forced by 3rd clutch fluid to seat against the spacer plate (327) the transmission is operating in Third or Fourth gear ranges. 3rd clutch fluid is then routed through orifice #31 where it enters the orificed 3rd clutch circuit. The ball check valve is forced off its seat by orificed 3rd clutch fluid when the 3rd clutch releases allowing orificed 3rd clutch fluid to pass through orifice #3 and the ball check valve seat and enter the 3rd clutch circuit.

Ball Check Valves Related Diagnostic Tips

Understanding the design principle of each ball check valve will help in the diagnosis of hydraulic related conditions. For example:

- a harsh shift complaint could be a stuck or missing ball check valve.
- no reverse or slips in reverse could be the #7 ball check valve stuck or missing.
- no engine compression braking in manual first could also be a missing or stuck #7 ball check valve.

BALL CHECK VALVES – LOCATION AND FUNCTION

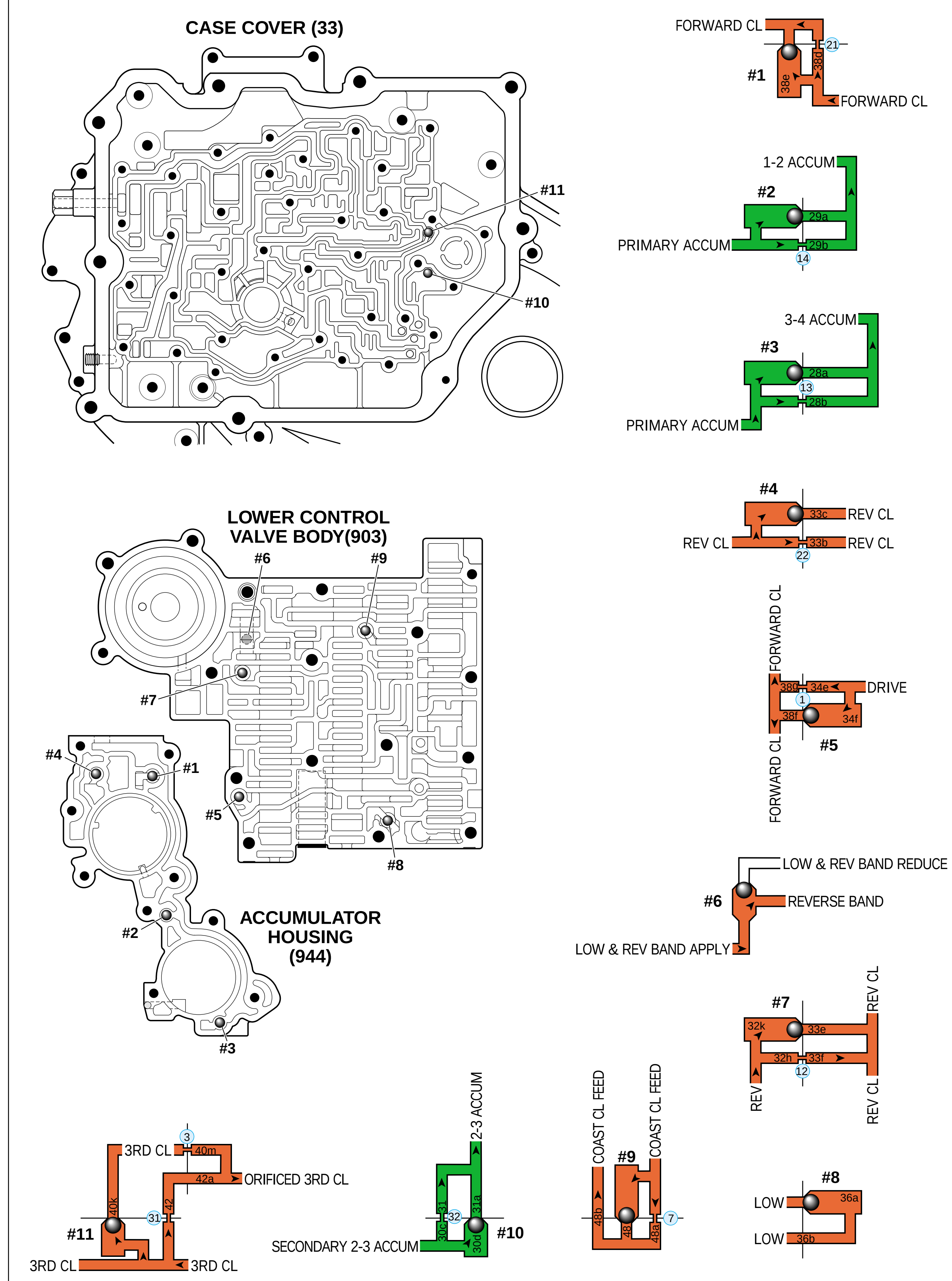


Figure 41

The Hydra-matic 4T80-E transmission incorporates electronic controls that utilize a powertrain control module (PCM). The PCM gathers vehicle operating information from a variety of sensors and control components located throughout the powertrain (engine and transmission). The PCM then processes this information for proper control of the following:

- transmission shift points - through the use of shift solenoids
- transmission shift feel - by adjusting line pressure through the use of a pressure control solenoid valve
- Torque converter clutch (TCC) apply and release feel - through the use of a TCC control solenoid valve

Electronic control of these transmission operating characteristics provides for consistent and precise shift points based on the operating conditions of both the engine and transmission.

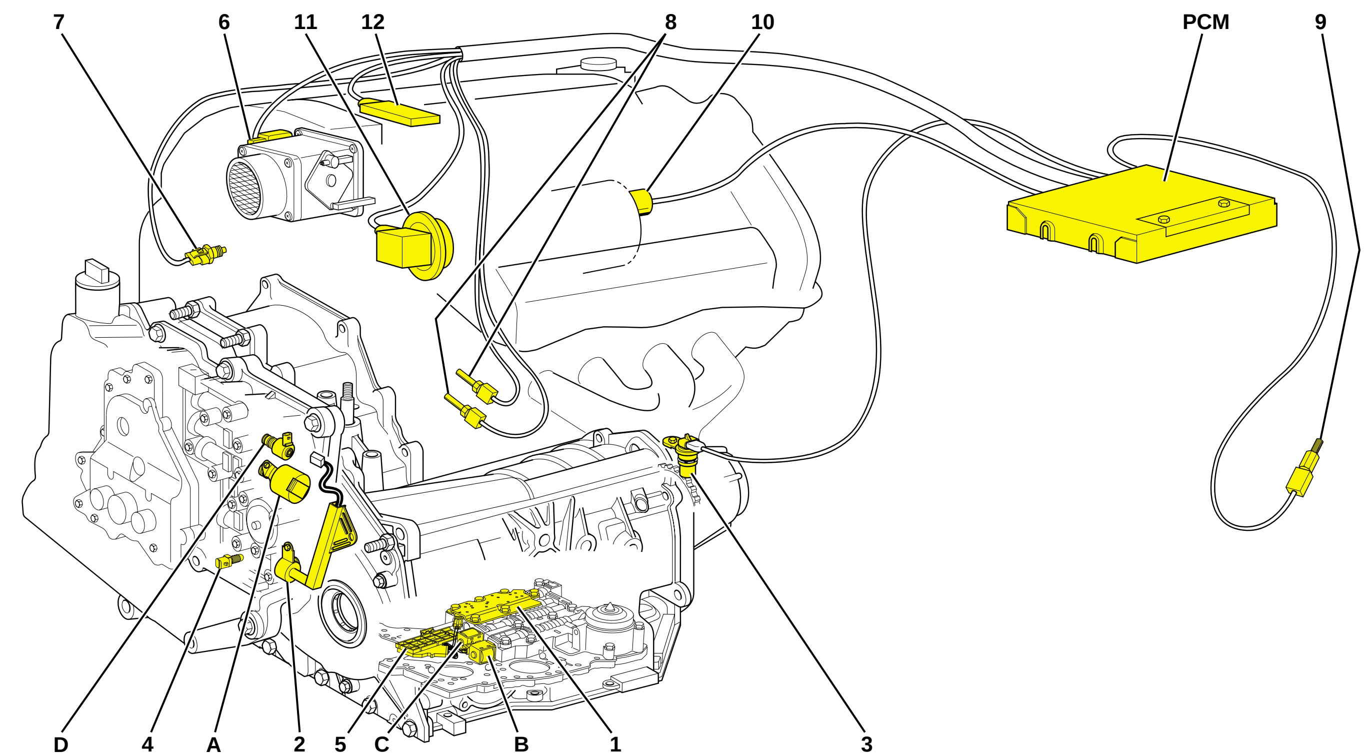
FAIL-SAFE MODE

"Fail-safe mode" is an operating condition where the transmission will partially function if a portion of the electronic control system becomes disabled. For example, if the wiring harness becomes disconnected, the PCM commands the fail-safe mode causing some transmission electrical components to "default" to OFF. While the transmission is operating in the fail-safe mode example given, the following operating changes occur:

- the pressure control solenoid valve is OFF, allowing line pressure to increase to its maximum pressure in order to prevent clutch or band slippage
- the TCC control solenoid valve is OFF, preventing TCC apply
- the shift solenoid valves are OFF, allowing the vehicle to be driven in second gear.

When both shift solenoid valves are OFF, the transmission will operate in Second gear regardless of the forward gear selected (i.e. Overdrive, 3, 2, or 1). However, the transmission will operate in Reverse, if selected, as well as Park and Neutral. (The fail-safe mode described above is only one of the operating modes associated with this transmission. Refer to the appropriate Service Repair Manual when diagnosing these conditions.)

NOTE: This section of the book contains "general" information about electrical components that provide input information to the PCM. Since this "input" information may vary from carline to carline, it is important that the appropriate General Motors Service Manual is used during repair or diagnosis of this transmission.



INPUTS

INFORMATION SENSORS

1. TRANSMISSION FLUID PRESSURE (TFP) MANUAL VALVE POSITION SWITCH
2. TRANSMISSION INPUT SPEED SENSOR (AT ISS)
3. VEHICLE SPEED SENSOR (VSS)
4. TRANSMISSION FLUID TEMPERATURE (TFT) SENSOR
5. INTERNAL MODE SWITCH (IMS)
6. THROTTLE POSITION (TP) SENSOR
7. ENGINE COOLANT TEMPERATURE (ECT) SENSOR
8. CRANKSHAFT POSITION (CKP) SENSORS
9. TORQUE MANAGEMENT BRAKE SWITCH
10. AIR CONDITIONING (A/C) SWITCH
11. CRUISE CONTROL OPERATION
12. MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

ELECTRONIC CONTROLLERS

- POWERTRAIN CONTROL MODULE (PCM)

OUTPUTS

ELECTRONICALLY CONTROLLED TRANSMISSION COMPONENTS

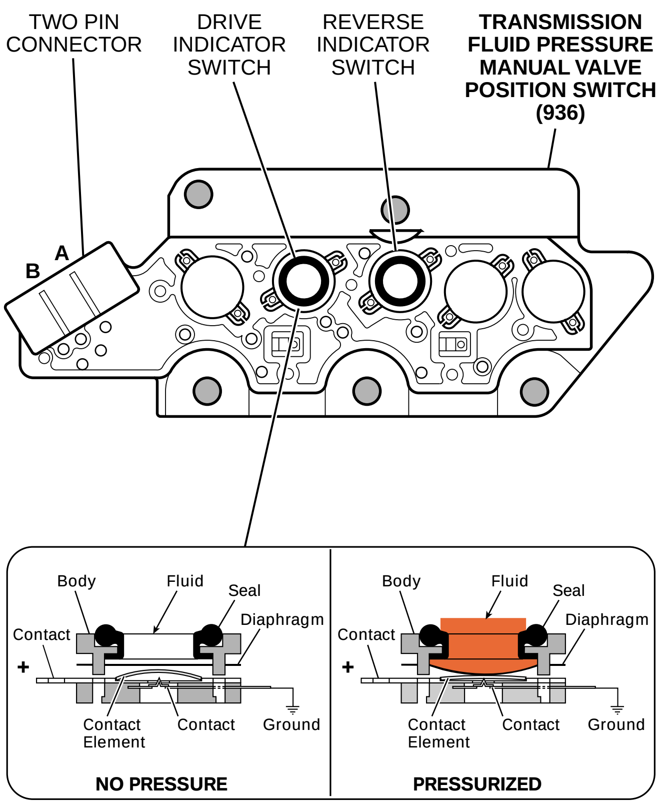
A. PRESSURE CONTROL (PC) SOLENOID

B. 1-2 SHIFT SOLENOID (SS) VALVE

C. 2-3 SHIFT SOLENOID (SS) VALVE

D. TCC CONTROL SOLENOID VALVE

Figure 42



Transmission Fluid Pressure (TFP) Manual Valve Position Switch (936):

The transmission fluid pressure (TFP) manual valve position switch is attached to the lower control valve body and consists of two normally open (N.O.) fluid pressure switches. Drive and reverse fluid pressures are fed from the manual valve to the switches (see hydraulic circuit below) depending on gear selector and manual valve positioning. These fluid pressures determine the digital logic at the electrical pins (A and B) in the TFP manual valve position switch two pin connector. This logic is used by the PCM to determine manual valve position and the gear range (P, R, N (D), 3, 2, 1) the transmission is operating in. The electrical schematic and table below show the circuitry and logic used at the TFP manual valve position switch and electrical connector to signal the powertrain control module (PCM) which range the gear selector lever is in.

Fluid Pressure Switch Operation:

The fluid pressure switches in the TFP manual valve position switch are normally open (contacts not touching) when no fluid pressure is present, thereby stopping electrical current at the switch. When fluid pressure is routed to the switch, it moves the diaphragm and upper contact such that the contact element touches both the positive (+) contact and the ground (⏚) contact. This creates a closed circuit and allows current to flow from the positive contact and through the switch. Depending on the circuit, the closed switch may provide a ground path from one of the two electrical pins.

Example: (Manual Third Range)

The hydraulic and electrical schematics below are shown in the Manual Third position. The Drive switch is pressurized in Manual Third, thereby closing the switch and allowing current to flow from Pin B to ground. This changes the digital logic at Pin B to a "1" and, with the digital logic at Pin A being "0", signals the PCM that the transmission is in Manual Third gear range.

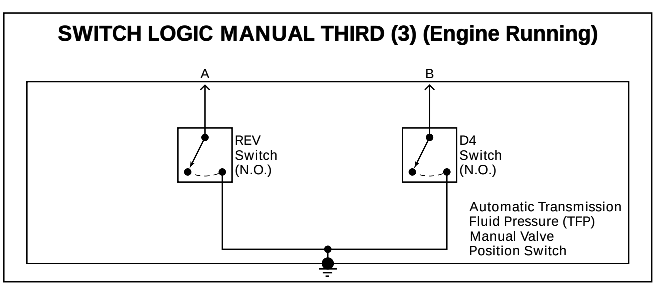
RANGE INDICATOR	FLUID*		CIRCUIT+	
	REV	D4	A	B
Park/Neutral	0	0	0	0
Reverse	1	0	1	0
Overdrive	0	1	0	1
Manual Third	0	1	0	1
Manual Second	0	1	0	1
Manual First	0	1	0	1

*: 1 = Pressurized
0 = Exhausted

+: 1 = Grounded (Resistance <50 ohms, 0 volts)
0 = Open (Resistance >50k ohms, 12 volts)

A Transmission Fluid Pressure Manual Valve Position Switch Assembly malfunction will set a DTC P1810 and the PCM will command the following default actions:

- Maximum line pressure.
- Assume D4 shift pattern.
- Freeze shift adapts.
- TCC on in commanded fourth gear.
- The PCM stores DTC P1810 in PCM history.



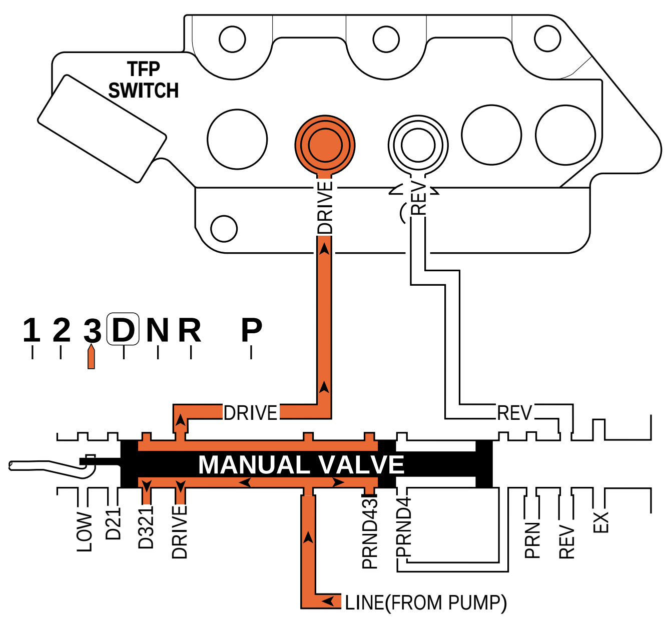
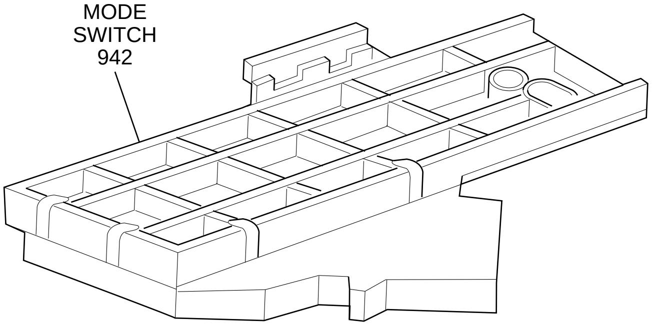
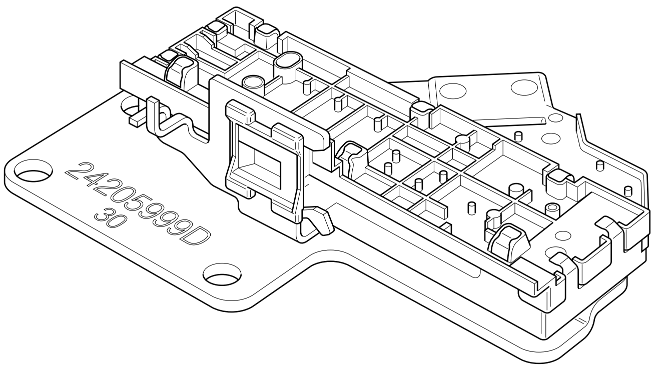


Figure 43





Internal Mode Switch (942)

The internal mode switch (IMS) is a sliding contact electrical switch assembly, attached to the lower control valve body, that corresponds to the PRNDL position selected. Each of the PRNDL positions has a unique ground pattern on the four wires from the PCM. The IMS consists of two major components: the housing, which houses the tracks and makes up the stationary contacts and, the insulator assembly, which makes up the moving contacts and is linked to the detent lever. The range detection is accomplished by securing the moving contacts of the IMS to the detent lever. When the driver selects a PRNDL position, the detent lever inside the transmission rotates. This slides the IMS moving contacts, which in return grounds the four wires in a unique pattern for each gear selection corresponding to the PRNDL position selected. The IMS is electrically connected by five wires (the PCM supplies voltage to four and one wire is a common ground) to the transmission pass through connector.

The information provided to the PCM by the IMS is used for engine controls as well as determining the transmission shift patterns. The input voltage level at the PCM is high (ignition voltage) when the IMS is open and low when the switch is closed to ground. The state of each input is available for display on the scan tool. The four input parameters represented are Signal A, Signal B, Signal C and Signal P (Parity).

If the PCM detects an IMS transitional state between D4 and D3 while the vehicle is in motion, then DTC P1820 sets and the PCM will command the following default actions:

- The PCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the conditions for setting the DTC are met.
- The PCM commands maximum line pressure.
- The PCM assumes a D4 shift pattern.
- The PCM freezes transmission adapt functions.
- The PCM records the operating conditions when the conditions for setting the DTC are met. The PCM stores this information as Freeze Frame and Failure Records.
- The PCM stores DTC P1820 in PCM history during the second consecutive trip in which the conditions for setting the DTC are met.

If the PCM detects an IMS transitional state between NEUTRAL and D4 while the vehicle is in motion, then DTC P1823 sets and the PCM will command the following default actions:

- The PCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the conditions for setting the DTC are met.
- The PCM commands maximum line pressure.
- The PCM assumes a D4 shift pattern.
- The PCM freezes transmission adapt functions.
- The PCM records the operating conditions when the conditions for setting the DTC are met. The PCM stores this information as Freeze Frame and Failure Records.
- The PCM stores DTC P1823 in PCM history during the second consecutive trip in which the conditions for setting the DTC are met.

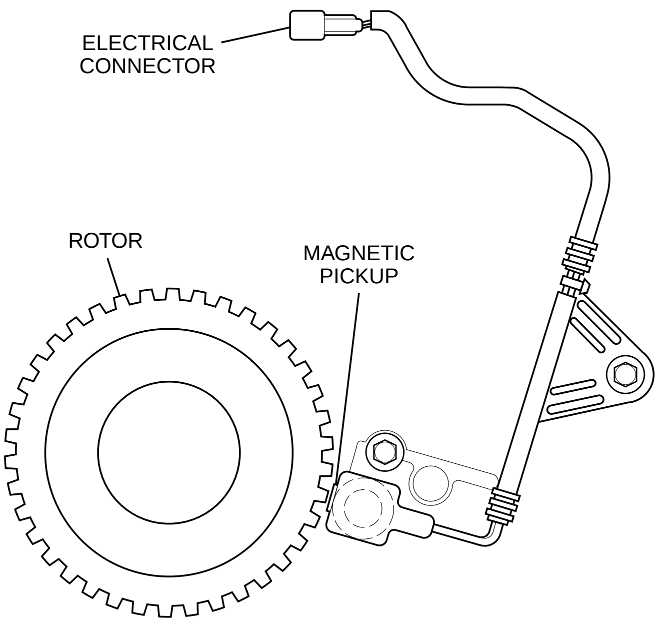
If the PCM detects an IMS transitional state between D2 and D1 while the vehicle is in motion, then DTC P1822 sets and the PCM will command the following default actions:

- The PCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the conditions for setting the DTC are met.
- The PCM commands maximum line pressure.
- The PCM assumes a D4 shift pattern.
- The PCM freezes transmission adapt functions.
- The PCM records the operating conditions when the conditions for setting the DTC are met. The PCM stores this information as Freeze Frame and Failure Records.
- The PCM stores DTC P1822 in PCM history during the second consecutive trip in which the conditions for setting the DTC are met.

If the PCM detects a combination of IMS inputs that are invalid, then DTC P1825 sets and the PCM will command the following default actions:

- The PCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the conditions for setting the DTC are met.
- The PCM commands maximum line pressure.
- The PCM assumes a D4 shift pattern.
- The PCM freezes transmission adapt functions.
- The PCM records the operating conditions when the conditions for setting the DTC are met. The PCM stores this information as Freeze Frame and Failure Records.
- The PCM stores DTC P1825 in PCM history during the second consecutive trip in which the conditions for setting the DTC are met.

Figure 44



TRANSMISSION INPUT SPEED SENSOR

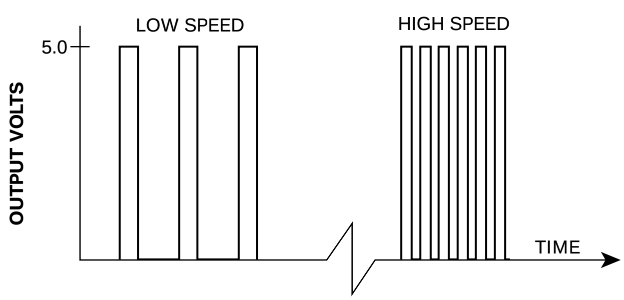
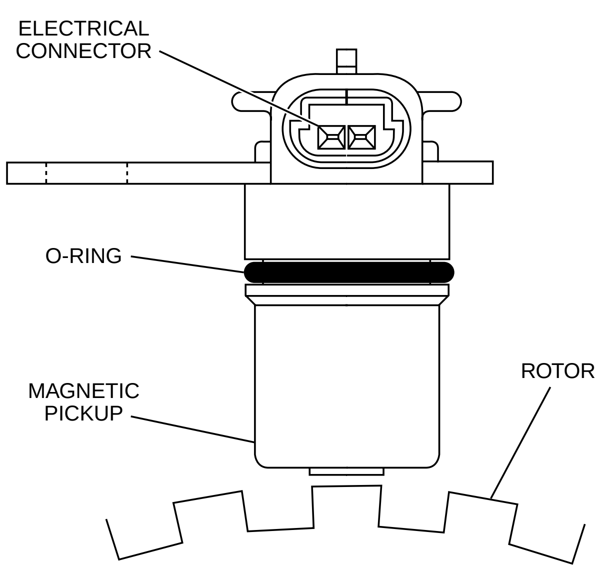


FIGURE A: CONDITIONED SIGNAL

Sensor resistance should measure between 1300 - 1950 ohms at 20°C (68°F). Output voltage will vary with vehicle speed from a minimum of 0.5 Volts AC at 100 RPM, to more than 100 Volts at 8000 RPM.



TRANSMISSION VEHICLE SPEED SENSOR

Automatic Transmission Input (Shaft) Speed (AT ISS) Sensor (14):
The AT ISS sensor is a variable reluctance magnetic pickup that is mounted to the transmission case. The sensor is positioned next to the drive sprocket and has an air gap of 1.143-2.77 mm (0.045-0.109 in) between the sprocket teeth and the magnetic pickup. The sensor consists of a permanent magnet surrounded by a coil of wire. As the drive sprocket rotates, an alternating current (AC) is induced in the coil from the “teeth” on the drive sprocket passing by the magnetic pickup. Therefore, whenever the engine is running, the AT ISS sensor produces an AC voltage signal proportional to engine speed. This signal is sent to the PCM where it is electronically conditioned to a 5 volt square wave form (see Figure A). The square wave form can then be interpreted as transmission input speed by the PCM through the frequency of square waves in a given time frame. The square waves can be thought of as the drive sprocket teeth. Therefore, the more teeth (or waves) that pass by the magnetic pickup in a given time frame, the faster the engine is running. The square wave form is compared to a fixed clock signal internally within the PCM to determine transmission input speed.

If the PCM detects an unrealistically large change in data from the AT ISS, DTC P0716 will set and the PCM will command the following default actions:

- Illuminate the malfunction indicator lamp (MIL).
- Maximum line pressure.
- Inhibit TCC engagement.
- Calculate input speed from vehicle speed and commanded gear.
- DTC P0716 stores in PCM history.

If the PCM detects a low input speed while the vehicle and engine speeds are high, DTC P0717 will set and the PCM will command the following default actions:

- Illuminate the malfunction indicator lamp (MIL).
- Maximum line pressure.
- Inhibit TCC engagement.
- Calculate input speed from vehicle speed and commanded gear.
- DTC P0717 will be stored in PCM history.

Vehicle Speed Sensor (VSS) (130):
The vehicle speed sensor (VSS) operates identically to the AT ISS sensor except that it uses a toothed ring pressed onto the differential carrier (110) as the rotor (reluctor). The VSS is mounted to the transmission case extension and has an air gap of 1.143-2.77 mm (0.045-0.109 in) between the teeth and the magnetic pickup. The VSS sensor square wave form is also compared to a fixed clock signal internally within the PCM to determine actual vehicle speed. The PCM uses transmission input and output speeds to help determine line pressure, transmission shift patterns and TCC/VCC apply pressure and timing. This speed sensor information is also used to calculate turbine speed, gear ratios, and TCC slippage for diagnostic purposes.

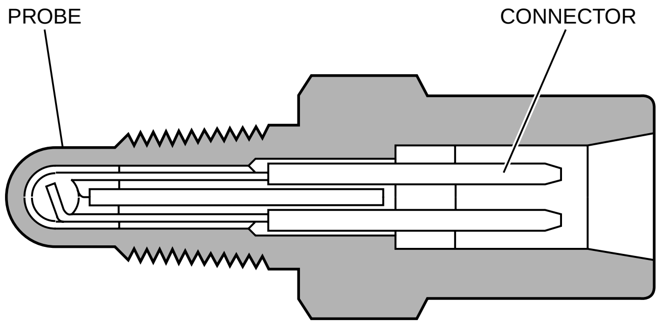
If the PCM detects a low vehicle speed and a high transmission input shaft speed while in a drive range, DTC P0502 will set and the PCM will command the following default actions:

- Illuminate the malfunction indicator lamp (MIL).
- Maximum line pressure.
- Freeze transmission adapt functions.
- Calculate vehicle speed from the AT ISS and commanded gear.
- DTC P0502 stores in PCM history.

If the PCM detects a loss of vehicle speed while the vehicle is in motion, DTC P0503 will set and the PCM will command the following default actions:

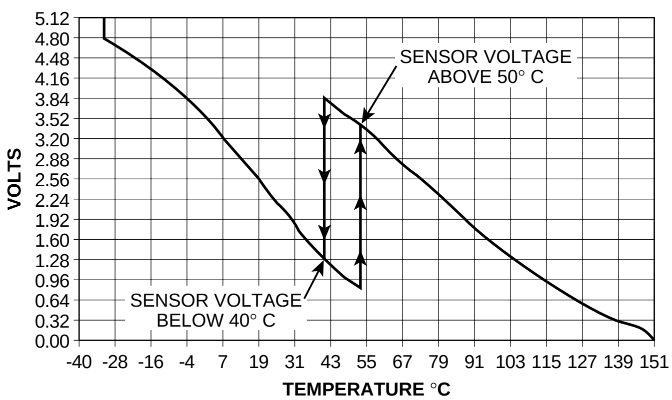
- Illuminate the malfunction indicator lamp (MIL).
- Maximum line pressure.
- Freeze transmission adapt functions.
- Calculate vehicle speed from the AT ISS and commanded gear.
- DTC P0503 stores in PCM history.

Figure 45



TRANSMISSION FLUID TEMPERATURE SENSOR

TFT SENSOR VOLTAGE VS. TEMPERATURE



NOTE:
AN ECM INTERNAL SHUNT WILL COME INTO PLAY AS TEMPERATURE INCREASES BEYOND 50°C. AS TEMPERATURE IS DECREASING, INTERNAL SHUNT COMES OUT AT 40°C. THERE IS A 10° OVERLAP.

If the PCM detects a high transmission fluid temperature for an extended period of time on the TFT sensor circuit, DTC P0218 will set and the PCM will command the following default actions:

- TRANSMISSION HOT message displays on the driver information center (DIC).
- Freeze transmission adapt functions.
- DTC P0218 stores in PCM history.

Transmission Fluid Temperature (TFT) Sensor (350):
The TFT sensor is a negative temperature coefficient thermistor that is attached to the upper control valve body. The TFT sensor provides information to the PCM regarding transmission fluid temperature which is then used to engage or disengage the TCC/VCC. The sensor receives a 5 volt reference signal from the PCM and when transmission fluid temperature is "cold", resistance is high. (Voltage measured across pin terminals L and M of the transmission pass-thru connector will also be high.) As the transmission fluid temperature increases, the resistance through the temperature sensor drops and correspondingly the voltage drops.

When the fluid temperature increases to approximately 50°C (122°F) the circuitry within the PCM uses a shunt to increase the voltage signal to the sensor as resistance values continue to drop (refer to graph). Again, as the fluid temperature continues to increase, resistance and voltage continue to decrease. The purpose of this design is to provide a finer resolution for precise control of TCC/VCC apply and release; temperature compensation on upshifts, downshifts and garage shifts, line pressure adjustments and PCM default code information.

TFT Sensor Hot Mode Operation:
The PCM also controls the apply or release of TCC/VCC through "hot mode ON" or "hot mode OFF" (formerly called "super-hot mode") software programming.

Hot mode ON (Above 130°C [266°F]) commands the TCC to apply (ON) in 3rd gear at 48 km/h (30 mph) with a 0-10% throttle angle, and in 4th gear at 63 km/h (39 mph) with a 0-10% throttle angle. This reduces transmission temperature by reducing heat generated in the torque converter. It also provides maximum cooling by routing transmission fluid directly to the transmission cooler in the engine radiator.

Hot mode OFF (VCC MODELS) (Above 140°C [284°F]) – VCC OFF, inhibits the operation of 4th gear. This is a condition where temperatures are too high for VCC silicone fluid. This operation should allow higher fluid flows through the cooler and converter and less vortex flow in the converter. As both engine and transmission cool off, VCC and 4th are permitted again.

If the PCM detects an intermittent voltage or no voltage change in the TFT sensor circuit, DTC P0711 will set and the PCM will command the following default actions:

- Calculate a default transmission fluid temperature based on engine coolant temperature, intake air temperature and engine run time.
- DTC P0711 stores in PCM history.

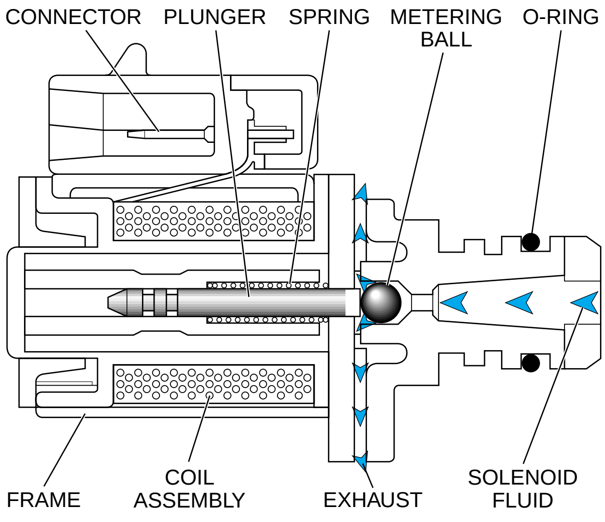
If the PCM detects a continuous short to ground in the TFT sensor circuit, DTC P0712 will set and the PCM will command the following default actions:

- Calculate a default transmission fluid temperature based on engine coolant temperature, intake air temperature and engine run time.
- DTC P0712 stores in PCM history.

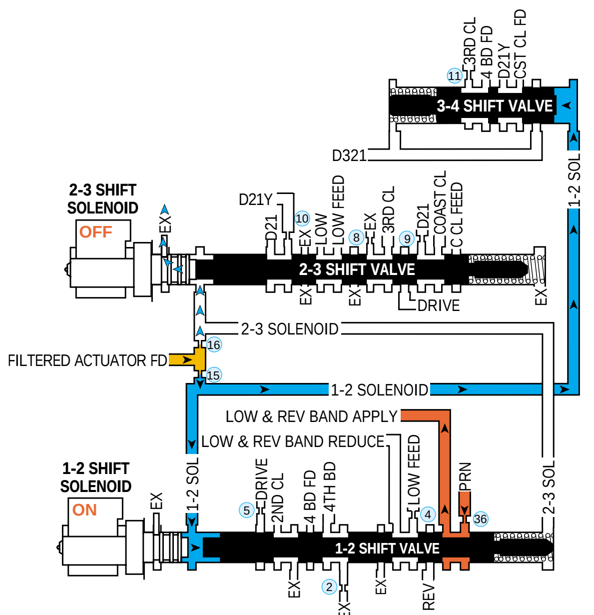
If the PCM detects a continuous open or a short to voltage on the TFT sensor circuit, DTC P0713 will set and the PCM will command the following default actions:

- Calculate a default transmission fluid temperature based on engine coolant temperature, intake air temperature and engine run time.
- DTC P0713 stores in PCM history.

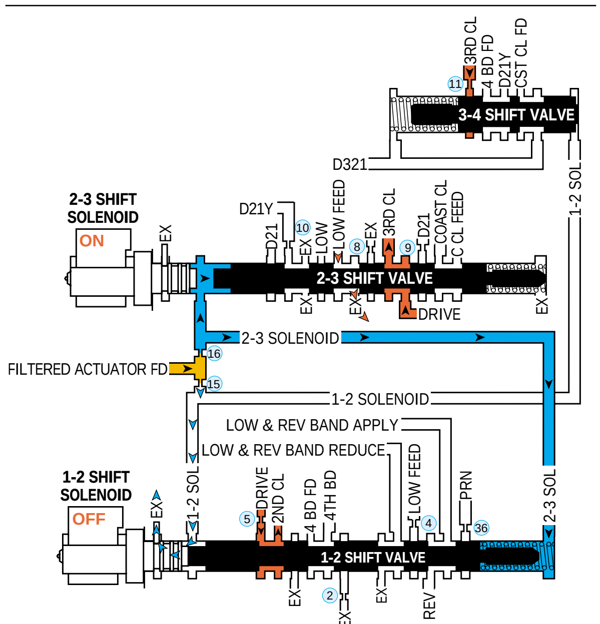
Figure 46



SHIFT SOLENOID VALVE (OFF)



EXAMPLE A: PARK/REVERSE/NEUTRAL/FIRST GEAR



EXAMPLE B: THIRD GEAR

SHIFT SOLENOID VALVES

Description:
The Hydra-matic 4T80-E transmission uses two identical, normally open electronic shift solenoid valves (referred to as 1-2 and 2-3) for controlling upshifts and downshifts in all forward ranges. These shift solenoid valves work together in a combination of ON and OFF sequences to control fluid that is routed to the 1-2 shift valve, 2-3 shift valve and 3-4 shift valve. The PCM monitors numerous inputs and determines the appropriate gear range for the vehicle by commanding the solenoid valves either ON or OFF. Fluid pressure is then routed to the shift valves (or exhausted through the solenoid valves) in order to change the position of a valve and hydraulically enable a gear change. The following table shows the solenoid state combination that is required to obtain each range:

GEAR	1-2 SOLENOID	2-3 SOLENOID
Park, Reverse, Neutral	ON	OFF
Ⓓ First or Man First-1st	ON	OFF
Ⓓ Second or Man Second-2nd	OFF	OFF
Ⓓ Third or Man Third-3rd	OFF	ON
Fourth-4th	ON	ON

Shift Solenoid Valves De-energized (OFF):
The shift solenoid valves are OFF when the PCM opens the path to ground for the solenoid's electrical circuit. When OFF, the solenoid plunger is forced away from the metering ball by a spring. This action allows 1-2 solenoid (or 2-3) fluid to push past the metering ball to exhaust from a port on the side of the solenoid.

Shift Solenoid Valves Energized (ON):
To energize the shift solenoid valves, the PCM provides a path to ground and completes the solenoid's electrical circuit. Electrical current passing through the coil assembly in the solenoid creates a magnetic field that magnetizes the solenoid core. The magnetized core repels the plunger which seats the metering ball against the fluid inlet port. Solenoid signal fluid is then blocked by the metering ball thereby creating a fluid pressure in the 1-2 or 2-3 solenoid fluid circuits.

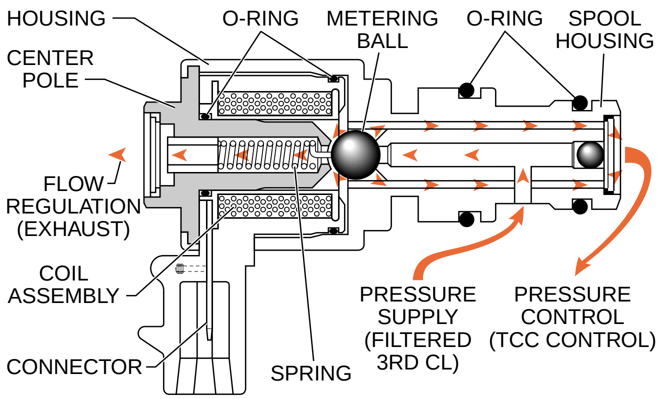
1-2 Shift Solenoid (SS) Valve (909):
The 1-2 SS valve is located at the end of the 1-2 shift valve (920) and controls the position of the 1-2 and 3-4 shift valves. 1-2 solenoid fluid that is routed to the solenoid is created by filtered actuator feed as it passes through orifice #15. When energized in Park, Reverse, Neutral and First gear, the solenoid blocks 1-2 solenoid fluid from exhausting, thereby creating pressure in the 1-2 solenoid fluid circuit. 1-2 solenoid fluid pressure then holds the 1-2 shift valve against spring force in the downshifted position. At the same time, 1-2 solenoid fluid is routed to the 3-4 shift valve (912) where it holds the valve against spring force in the upshifted position. During Fourth gear operation, 2-3 solenoid fluid pressure combines with spring force and holds the 1-2 shift valve in the upshifted position.

When the 1-2 SS valve is de-energized during Second and Third gear operation, 1-2 solenoid fluid exhausts through the solenoid. Spring force acting on the 1-2 shift valve keeps the valve in the upshifted position, and spring force at the 3-4 shift valve keeps the valve in the downshifted position.

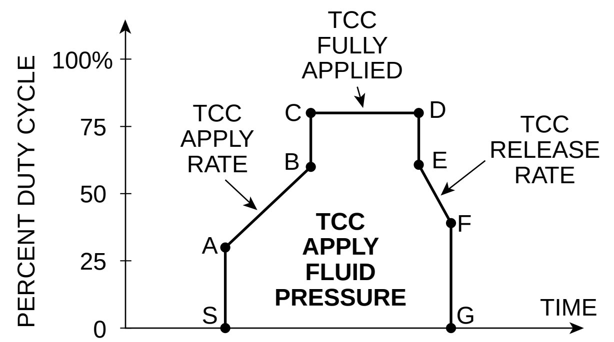
2-3 Shift Solenoid (SS) Valve (909):
The 2-3 SS valve is located at the end of the 2-3 shift valve (908) and controls the position of the 1-2 and 2-3 shift valves. 2-3 solenoid fluid that feeds to the solenoid is created by filtered actuator feed as it passes through orifice #16. When energized in Third and Fourth gear, the solenoid blocks 2-3 solenoid fluid from exhausting thereby creating pressure in the 2-3 solenoid fluid circuit. 2-3 solenoid fluid pressure then holds the 2-3 shift valve against spring force in the upshifted position. At the same time, 2-3 solenoid fluid is routed to the 1-2 shift valve (912) to combine with spring force in holding the valve in the upshifted position.

When the 2-3 SS valve is de-energized during Park, Reverse, Neutral, First and Second gear operation, 2-3 solenoid fluid exhausts through the solenoid. Spring force acting on the 2-3 shift valve keeps the valve in the downshifted position while 1-2 shift valve position is dependent upon 1-2 SS valve state.

Figure 47



TCC SOLENOID VALVE (OFF)



TCC APPLY AND RELEASE

If the PCM detects high torque converter slip when the TCC is commanded ON, DTC P0741 will set and the PCM will command the following default actions:

- Illuminate the malfunction indicator lamp (MIL).
- Inhibit 4th gear if transmission is in hot mode.
- DTC P0741 stores in PCM history.

If the PCM detects a TCC slip from -20 to +150 RPM, when the TCC is commanded OFF, DTC P0742 will set and the PCM will command the following default actions:

- Illuminate the malfunction indicator lamp (MIL).
- Inhibit TCC engagement.
- Freeze transmission adapt functions.
- DTC P0742 stores in PCM history.

Torque Converter Clutch (TCC) Solenoid Valve (336): The TCC solenoid valve is a normally closed, three-port, pulse width modulated (PWM) solenoid used to control the apply and release of the converter clutch. The PCM operates the solenoid with a negative duty cycle at a fixed frequency of 32 Hz to control the rate of TCC apply/release. The solenoid's ability to "ramp" the TCC apply and release pressures results in a smoother TCC operation.

When vehicle operating conditions are appropriate to apply the TCC, the PCM immediately increases the duty cycle to approximately 30% (see point A on graph). The PCM then ramps the duty cycle up to approximately 80% to achieve full TCC apply pressure. The rate at which the PCM increases the duty cycle controls the TCC apply. Similarly, the PCM also ramps down the TCC PWM solenoid valve duty cycle to control TCC release.

There are some operating conditions that prevent or enable TCC apply under various conditions (refer to the Transmission Fluid Temperature sensor description). Also, if the PCM receives a high voltage signal from the brake switch, signalling that the brake pedal is depressed, the PCM immediately releases the TCC.

Note: Duty cycles given are for example only. Actual duty cycles will vary depending on vehicle application and vehicle operating conditions.

TCC solenoid valve resistance should measure between 10 and 11 ohms when measured at 20°C (68°F). The resistance should measure between 13 and 15 ohms at 100°C (212°F).

Torque Converter Clutch (TCC) Solenoid Valve Operation: The TCC solenoid valve is the electronic control component of the TCC apply and release system. The other components are all hydraulic control or regulating valves. The illustration below shows all the valves and the TCC solenoid valve that make up the TCC control system. (For more information on system operation see pages 70 and 71 in the Powerflow section).

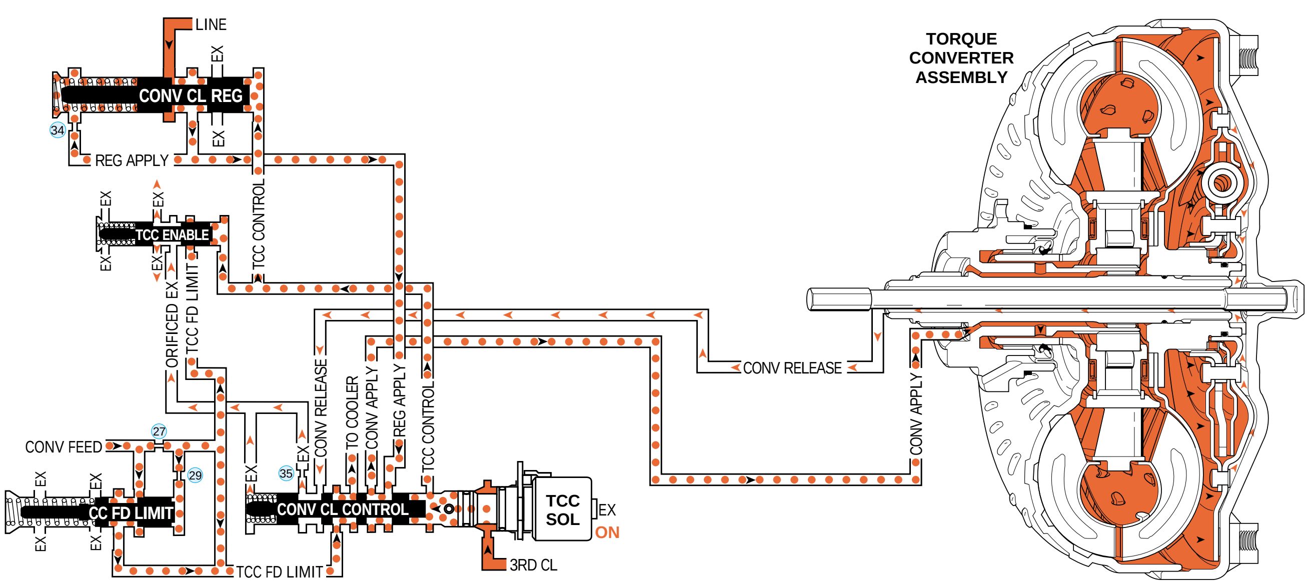


Figure 48

Pressure Control Solenoid Valve (339):
The pressure control (PC) solenoid valve is a precision electronic pressure regulator that controls transmission line pressure based on current flow through its coil windings. As current flow is increased, the magnetic field produced by the coil moves the solenoid's plunger further away from the exhaust port. Opening the exhaust port decreases the output fluid pressure regulated by the PC solenoid valve, which ultimately decreases line pressure. The PCM controls the PC solenoid valve based on various inputs including throttle position, transmission fluid temperature, MAP sensor and gear state.

Duty Cycle, Frequency and Current Flow:
A "duty cycle" may be defined as the percent of time current is flowing through a solenoid coil during each cycle. The number of cycles that occur within a specified amount of time, usually measured in seconds, is called "frequency". Typically, the operation of an electronically controlled pulse width modulated solenoid is explained in terms of duty cycle and frequency.

The PCM controls the PC solenoid valve on a positive duty cycle at a fixed frequency of 292.5 Hz (cycles per second). A higher duty cycle provides a greater current flow through the solenoid. The high (positive) side of the PC solenoid valve electrical circuit at the PCM controls the PC solenoid valve operation. The PCM provides a ground path for the circuit, monitors average current and continuously varies the PC solenoid valve duty cycle to maintain the correct average current flowing through the PC solenoid valve.

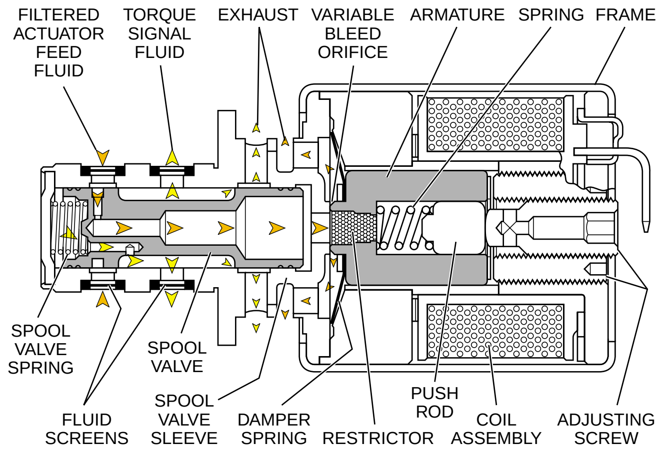
Approximate Duty Cycle	Current	Line Pressure
+ 5%	0.1 Amps	Maximum
+40%	1.1 Amps	Minimum

Pressure control solenoid valve resistance should measure between 3.0 and 8.0 ohms when measured at 20°C (68°F).

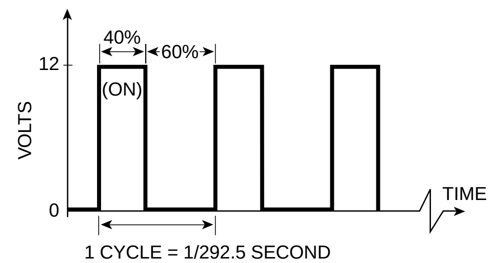
The duty cycle and current flow to the PC solenoid valve are mainly affected by throttle position (engine torque) and they are inversely proportional to throttle angle (engine torque). In other words, as the throttle angle (engine torque increases), the duty cycle is decreased by the PCM which decreases current flow to the PC solenoid valve. Current flow to the PC solenoid valve creates a magnetic field that moves the solenoid armature toward the push rod and against spring force.

Transmission Adapt Function:
Programming within the PCM also allows for automatic adjustments in shift pressure that are based on the changing characteristics of the transmission components. As the apply components within the transmission wear, shift time (time required to apply a clutch or band) increases. In order to compensate for this wear, the PCM adjusts trim pressure by controlling the PC solenoid valve in order to maintain the originally calibrated shift timing. The automatic adjusting process is referred to as "adaptive learning" and it is used to assure consistent shift feel plus increase transmission durability. The PCM monitors the AT ISS sensor and VSS during commanded shifts to determine if a shift is occurring too fast (harsh) or too slow (soft) and adjusts the PC solenoid valve signal to maintain a set shift feel.

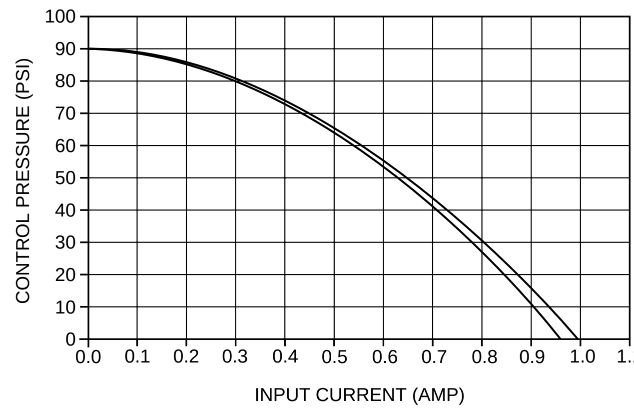
Transmission adapts must be reset whenever the transmission is overhauled or replaced (see appropriate service manual).



PRESSURE CONTROL SOLENOID VALVE



PRESSURE CONTROL SOLENOID VALVE POSITIVE DUTY CYCLE



PRESSURE CONTROL SOLENOID VALVE CURRENT FLOW

A Pressure Control Solenoid electrical condition will set a DTC P0748 and the PCM will command the following default actions:

- SERVICE TRANSMISSION displays on the driver information center (DIC).
- Maximum line pressure.
- Freeze transmission adapt functions.
- DTC P0748 stores in PCM history.

Figure 49

ELECTRICAL COMPONENTS

ELECTRICAL COMPONENTS EXTERNAL TO THE TRANSMISSION

Throttle Position (TP) Sensor: The TP sensor is a potentiometer that is mounted on the throttle body and provides the PCM with information on throttle angle. The PCM provides a 5 volt reference signal and a ground to the TP sensor and the sensor returns a signal voltage that changes with throttle angle. At closed throttle (approximately 0°) the TP sensor output signal is low (below 1 volt) and at wide open throttle (approximately 85°) the TP sensor out signal is high (nearly 5 volts). The PCM uses TP information (throttle valve angle) to modify fuel control, TCC/VCC apply or release, and shift patterns.

Engine Coolant Temperature (ECT) Sensor: The ECT sensor is a thermistor (a resistor that changes value based on temperature) mounted to the engine head or in the engine coolant passage, that provides engine coolant temperature information to the PCM. The PCM supplies a 5 volt reference signal and a ground to the sensor and then measures the voltage signal as coolant temperature changes. At cold coolant temperatures, the ECT sensor resistance is high (voltage is approximately 5 volts) while hot coolant temperatures decrease resistance (voltage will be near zero). The PCM uses ECT sensor information for fuel enrichment, ignition control, canister purge control, idle speed control, TCC Enabling and "Closed Loop" fuel control.

Crankshaft Position (CKP) Sensors: In terms of transmission operation, the sensors (2) provide information to the PCM that indicates engine speed. The PCM then uses this input to determine shift patterns and TCC/VCC apply or release.

Torque Management Brake Switch: The torque management brake switch contains two sets of electrical contacts and one vacuum port. The two sets of electrical contacts are normally closed and are referred to as the "TCC Brake" and "Extended Travel Brake Switch" contacts. The TCC brake switch contacts provide ignition voltage to the torque converter clutch when closed (brakes not applied). When the brakes pedal is depressed the switch contacts open and the PCM opens a path to ground for the TCC electrical circuit to release the TCC.

Air Conditioning (A/C) Switch: When the A/C cycling switch closes, the PCM is signaled that the air conditioning compressor is ON. This signal is used by the PCM to adjust transmission line pressure to compensate for the additional engine load created by the compressor.

Cruise Control Operation: The PCM monitors input signals from the cruise control switch and other cruise control related sensors in order to alter shift patterns and time limits between 2-3, 3-4, 4-3 and 3-2 shifts.

Manifold Absolute Pressure (MAP) Sensor: The MAP sensor measures changes in the intake manifold pressure which result from engine load and speed changes. These changes are converted to a voltage output which is monitored by the PCM in order to adjust line pressure and shift timing.

NOTE: The sensor/switch information presented above is not a complete listing of PCM inputs that may affect transmission operation. Refer to the appropriate General Motors Service Manual for specific electrical diagnosis information.

POWER FLOW

This section of the book describes how torque from the engine is transferred through the Hydra-matic 4T80-E transmission allowing the vehicle to move either in a forward or reverse direction. The information that follows details the specific mechanical operation, electrical, hydraulic and apply components that are required to achieve a gear operating range.

The full size, left hand pages throughout this section contain drawings of the mechanical components used in a specific range and gear. Facing this full page is a half page insert containing a color coded range reference chart at the top. This chart is one of the key items used to understand the mechanical operation of the transmission in each range and gear. The text below this chart provides a detailed explanation of what is occurring mechanically in that range and gear.

The full size, right hand pages contain a simplified version of the Complete Hydraulic Circuit that is involved for that range and gear. Facing this full page is a half page insert containing text and a detailed explanation of what is occurring hydraulically in that range and gear. A page number located at the bottom of the half page of text provides a ready reference to the complete Hydraulic Circuits section of this book if more detailed information is desired.

It is the intent of this section to provide an overall simplified explanation of the mechanical, hydraulic and electrical operation of the Hydra-matic 4T80-E transmission. If the operating principle of a clutch, band or valve is unclear, refer to the previous sections of this book for individual components descriptions.

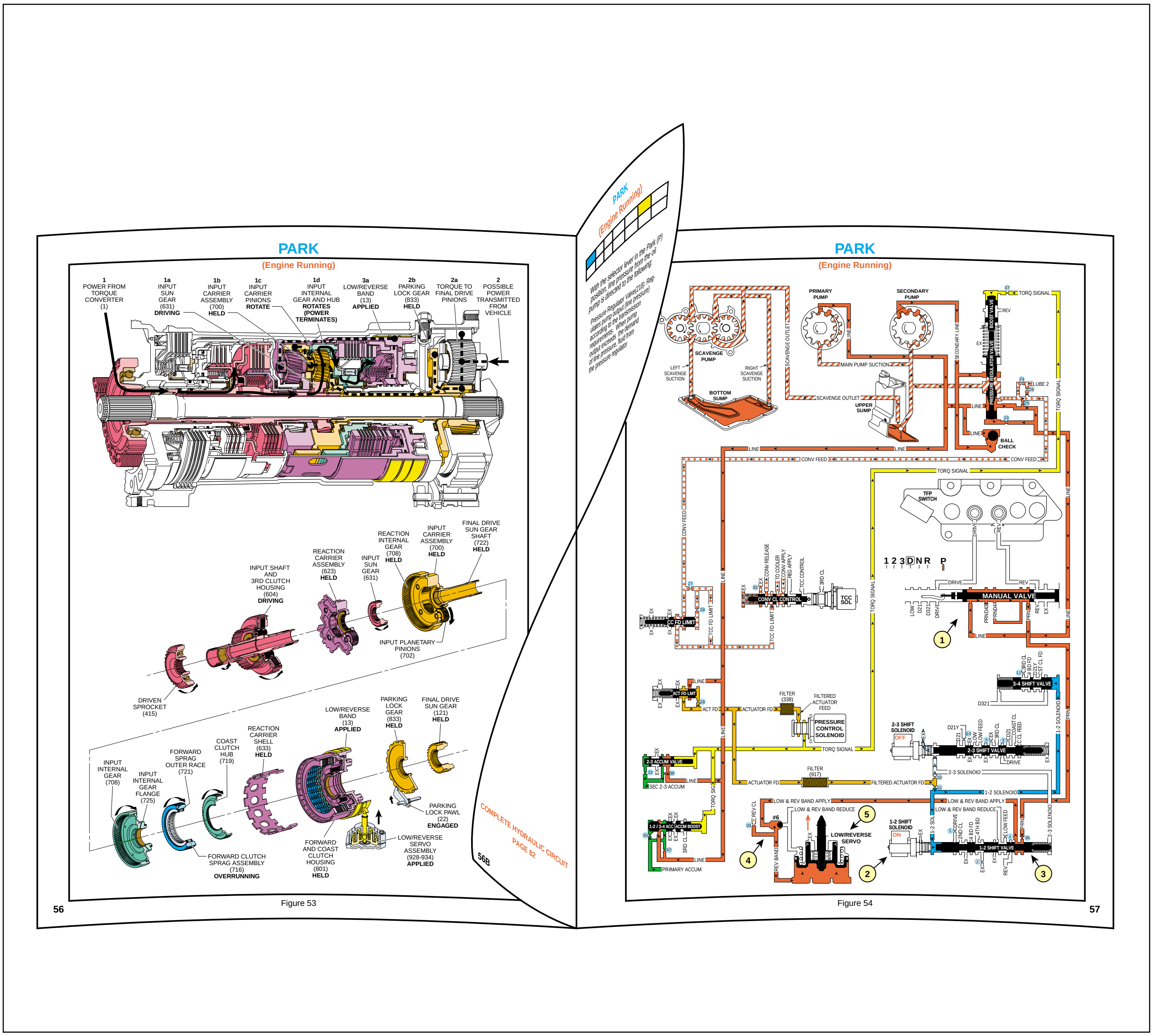


Figure 50

MECHANICAL POWERFLOW FROM THE TORQUE CONVERTER TO THE TURBINE SHAFT

(Engine Running)

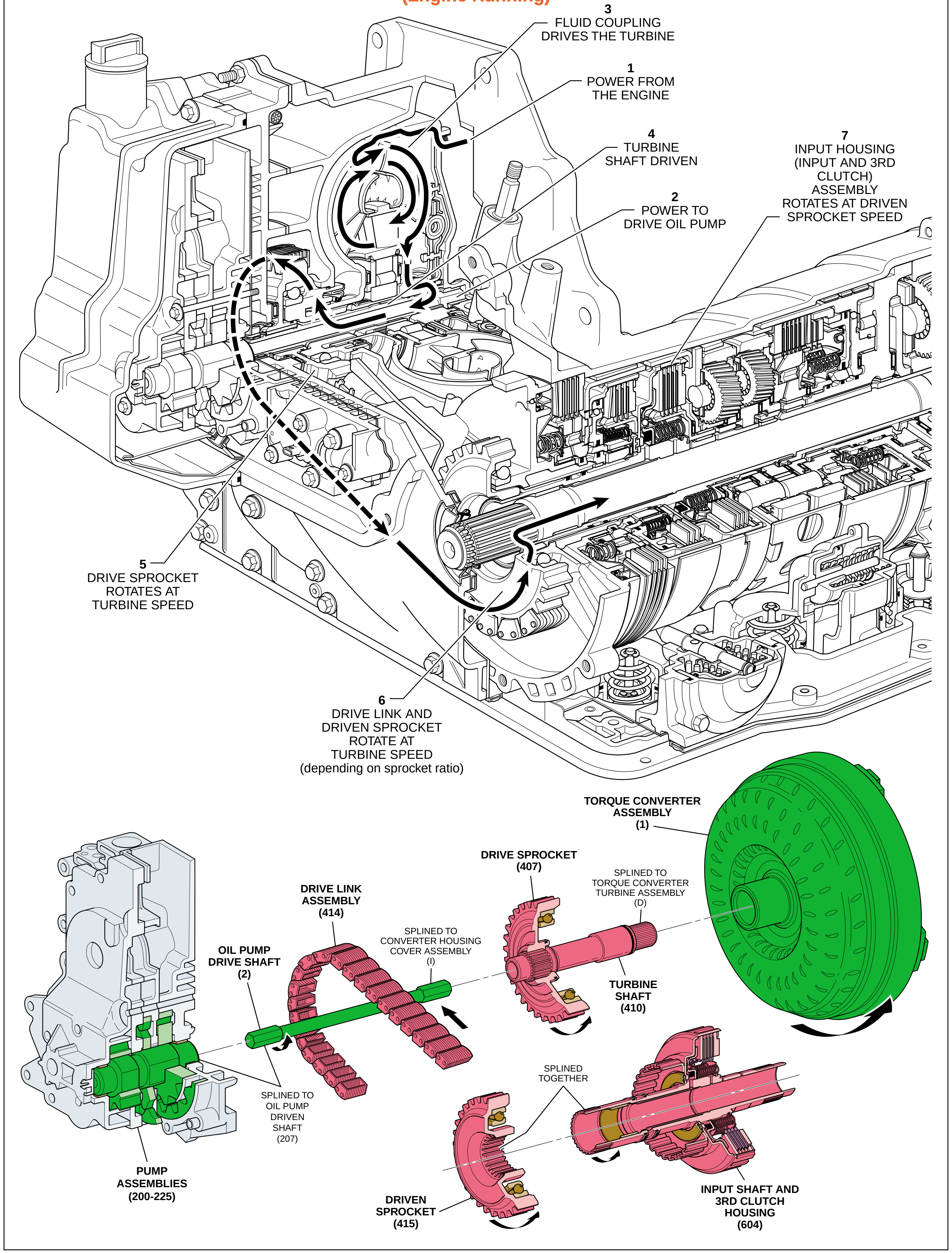


Figure 51

MECHANICAL POWERFLOW FROM THE TORQUE CONVERTER TO THE TURBINE SHAFT

(Engine Running)

The mechanical power flow in the Hydra-matic 4T80-E transmission begins at the point of connection between the torque converter and the engine flywheel. When the engine is running, the torque converter cover (pump) is forced to rotate at engine speed. As the torque converter rotates it multiplies engine torque and transmits it to the turbine shaft (410). The turbine shaft, which is connected to the drive sprocket (407), provides the primary link to the mechanical operation of the transmission.

The Hydra-matic 4T80-E automatic transmission requires a constant supply of pressurized fluid to cool and lubricate all of the components throughout the unit. It also requires a holding force to be applied to the bands and clutches during the various gear range operations. The oil pump assemblies (200-225), the upper control valve body assembly (300), and the lower control valve body assembly (903) provide for the pressurization and distribution of fluid throughout the transmission.

1 Power from the Engine
Torque from the engine is transferred to the transmission through the engine flywheel which is bolted to the torque converter.

2 Power to Drive the Oil Pump
The oil pump drive shaft (2) is splined to the torque converter cover at one end and to the oil pump driven shaft (207) at the other end. The oil pump driven shaft is splined to the oil pump drive gears (202, 205, 223). Therefore, when the engine is running, the oil drive gears also rotate at engine speed.

3 Fluid Coupling Drives the Turbine
Transmission fluid inside the torque converter assembly (1) creates a fluid coupling which in turn drives the torque converter turbine.

4 Turbine Shaft Driven
As the torque converter turbine rotates, the turbine shaft (410), which is splined to the torque converter turbine, is also forced to rotate at turbine speed.

5 Drive Sprocket Rotates at Turbine Speed
The opposite end of the turbine shaft (410) is splined to the drive sprocket (407), which forces the drive sprocket to rotate in the same direction and speed as the torque converter turbine.

6 Drive Link and Driven Sprocket Rotate at Turbine Speed
Teeth on the drive sprocket (407) are in mesh with the drive link assembly (414) and the drive link is also in mesh with the teeth on the driven sprocket (415). When the engine is running, all three components will rotate in the same direction and possibly at the same speed depending on drive and driven sprocket ratio (see basic specifications page 124).

7 Input Housing Rotates at Driven Sprocket Speed
The driven sprocket (415) is splined to the input shaft and 3rd clutch housing assembly (604) and forces the input housing to rotate at driven sprocket speed.

NOTE: To minimize the amount of repetitive text, the remaining mechanical power flow descriptions will begin with the input shaft and 3rd clutch housing assembly (604). The transfer of torque from the engine through the torque converter to the input shaft and 3rd clutch housing is identical in all gear ranges.

HYDRAULIC POWERFLOW – COMMON FUNCTIONS FOR ALL RANGES

(Engine Running)

When the gear selector lever is in the Park (P) position and the engine is running, fluid is drawn into the oil pumps and line pressure is directed to the pressure regulator valve.

1 PRESSURE REGULATION

1a Pressure Regulator Valve:
Regulates pump output (line and secondary line pressures) in response to torque signal fluid pressure acting on the pressure regulator boost valve, spring force, and line pressure acting on the end of the valve. Line pressure is directed to the manual valve, the converter clutch regulator valve, the actuator feed limit valve, the 1-2/3-4 accumulator valve, and the 2-3 accumulator valve. Also, line pressure feeds the converter feed circuit through the pressure regulator valve.

1b Actuator Feed Limit (AFL) Valve:
Line pressure is routed through the valve and into the actuator feed fluid circuit. The valve limits actuator feed fluid pressure to a maximum pressure. Actuator feed fluid is routed to the pressure control solenoid valve, and also feeds the 1-2 solenoid and 2-3 solenoid fluid circuits.

1c Pressure Control (PC) Solenoid Valve:
Controlled by the PCM, the PC solenoid valve regulates filtered actuator feed limit fluid pressure into the torque signal fluid circuit.

2 SHIFT ACCUMULATION

2a 1-2/3-4 Accumulator Valve:
Line pressure is regulated into primary accumulator fluid pressure. This regulation is basically controlled by torque signal fluid pressure acting on one end of the valve and orificed primary accumulator fluid on the other end of the valve.

2b 2-3 Accumulator Valve:
Line pressure is regulated into secondary 2-3 accumulator fluid pressure. This regulation is basically controlled by torque signal fluid pressure acting on one end of the valve and orificed secondary 2-3 accumulator fluid on the other end of the valve.

2c 1-2, 2-3, 3-4, Forward and Reverse Accumulator Assemblies:
Accumulator fluid is routed to each of the accumulator assemblies in preparation for upshifts and downshifts.

3 TORQUE CONVERTER (RELEASED POSITION ONLY)

3a Pressure Regulator Valve:
Line pressure is routed through the pressure regulator valve and into the converter feed fluid circuit. Converter feed fluid is routed to the converter clutch feed limit valve.

3b Converter Clutch Feed Limit Valve:
Converter feed pressure is regulated into TCC feed limit fluid pressure. This regulation is basically controlled by spring force acting on one end of the valve and orificed TCC feed limit fluid on the other end of the valve.

3c Converter Clutch Control Valve:
Spring force and TCC exhaust enable fluid hold the valve in the release position allowing TCC feed limit fluid to enter the converter release circuit. Converter release fluid is routed to the torque converter. Converter apply fluid from the torque converter also passes through the converter clutch control valve into the "to cooler" circuit.

3d TCC Enable Valve:
TCC feed limit pressure is routed through the TCC enable valve into the TCC exhaust enable fluid circuit. TCC exhaust enable fluid is routed to the converter clutch control valve to help keep the valve in the release position until TCC apply.

3e Converter Clutch Regulator Valve:
Line pressure is supplied to the converter clutch regulator valve in preparation for TCC apply.

3f Torque Converter:
Converter release fluid pressure is routed to the torque converter to keep the TCC released. Fluid leaves the converter in the converter apply fluid circuit and returns to the cooler through the converter clutch control valve.

COMMON HYDRAULIC FUNCTIONS FOR ALL RANGES

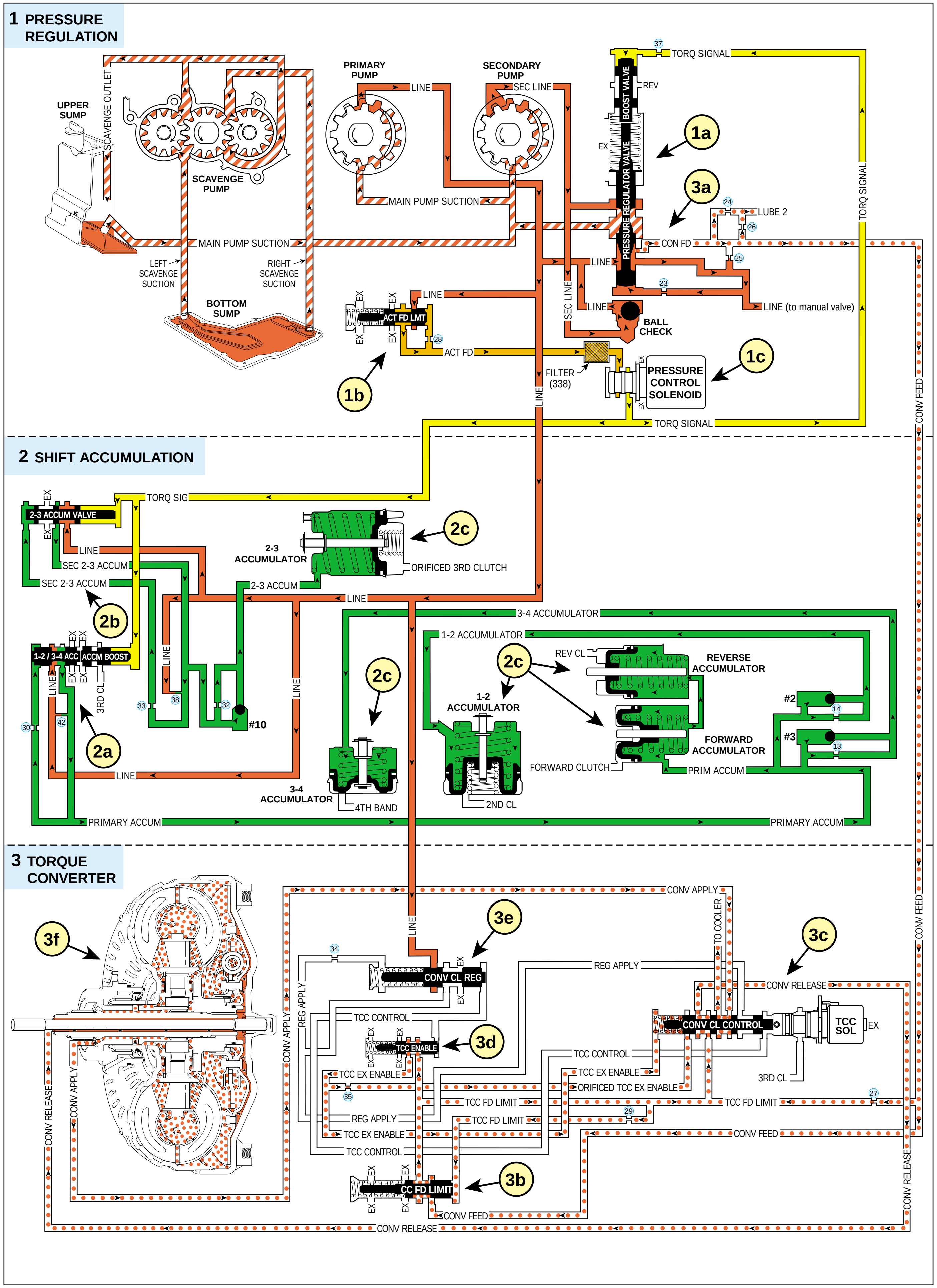


Figure 52

PARK

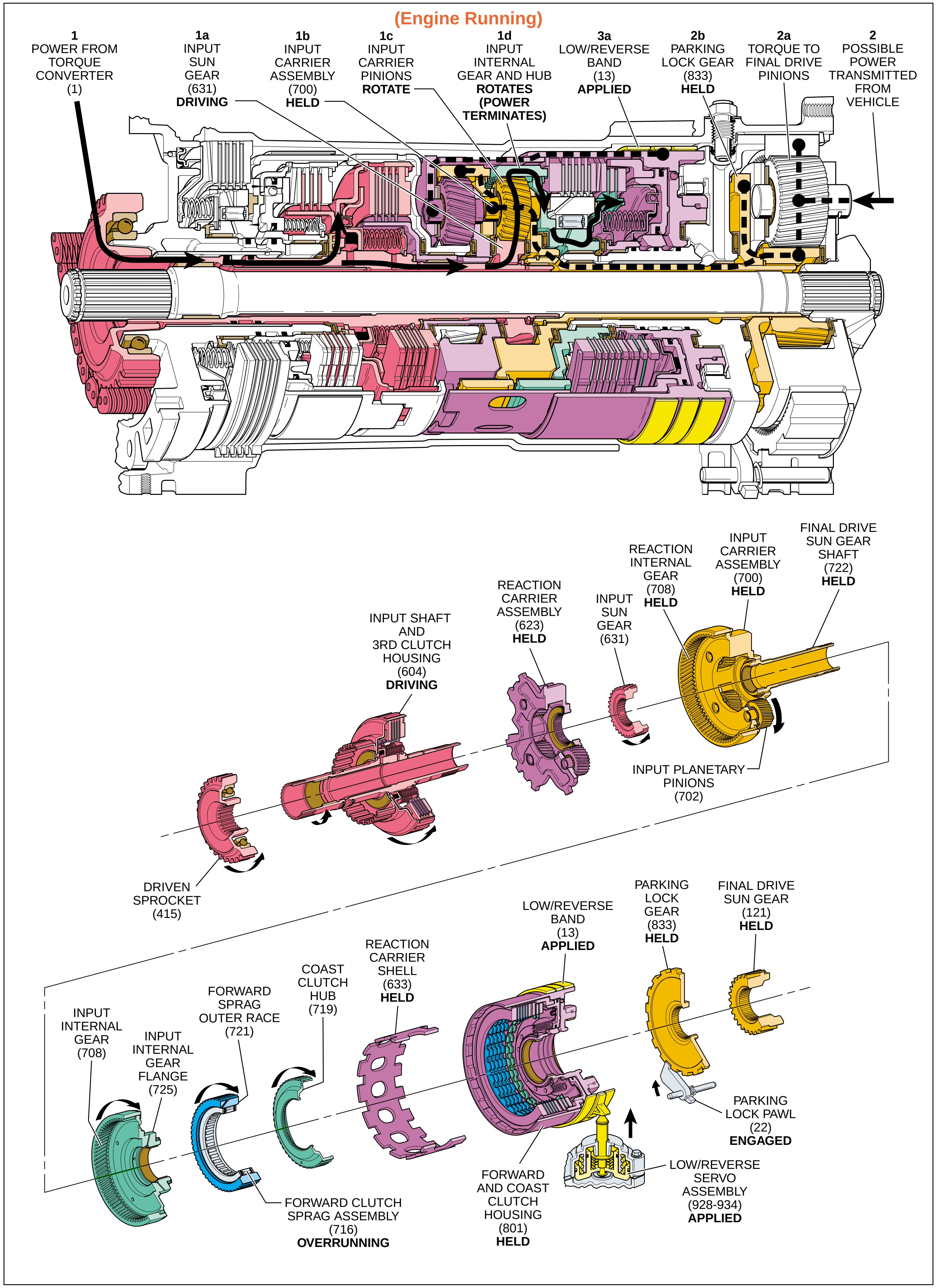


Figure 53

PARK

(Engine Running)

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF									APPLIED	

In Park range, there are three levels of powerflow coexisting. The graphics will follow each flow separately by numerical designation, which relates to the following text.

1 Power from Torque Converter
Power from the torque converter turbine transfers to the driven sprocket (415) which is splined to the input shaft.

1a Input Sun Gear Driving
Power continues from the input shaft and 3rd clutch housing (604) to the input sun gear (631), which then drives the input planetary pinions (702).

1b Input Carrier Assembly Held
The input carrier assembly (700) is held stationary by the final drive sun gear shaft (722) being held by the weight of the vehicle. This forces the input planetary pinions (702) to rotate the opposite direction of the input sun gear (631).

1c Input Carrier Pinions Rotate
The input planetary pinions (702) rotate and force the input internal gear (708) to rotate.

1d Input Internal Gear Rotates/Powerflow Terminates
The input internal gear (708) is splined to the coast clutch hub (719) but, the coast clutch is not applied so powerflow is terminated.

2 Torque from the Vehicle
Possibly Parked on an Incline (Force of Gravity)

2a Torque from Wheels to Planetary Pinions
Torque from the vehicle travels through the wheels to the differential, into the final drive planetary pinions.

2b Parking Gear Locked/Torque Terminated at Final Drive Gear Set
The final drive internal gear is held stationary in the case. The final drive sun gear (121) is held by the parking lock gear (833) which is held by the parking lock pawl (22). Therefore, because two members of the planetary gear set are held stationary, powerflow is terminated.

NOTE: If Park is selected while the vehicle is moving, the parking pawl will ratchet in and out of the lugs on the parking gear until the vehicle slows to approximately 5 km/h (3 mph). At that speed the parking gear will engage and stop the vehicle from moving. The vehicle should be completely stopped before selecting Park range or internal damage to the transmission could occur.

3 Preparation for a Shift into Reverse

3a Low/Reverse Band Applied
The low/reverse band (13) is applied and holds the forward and coast clutch housing (801). The forward and coast clutch housing is tanged to one end of the reaction carrier shell (633). The other end of the reaction carrier shell is tanged to the reaction carrier assembly (623) and prevents the carrier from rotating.

PARK

(Engine Running)

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF									APPLIED	

FLUID PRESSURE DIRECTED IN PREPARATION FOR A SHIFT

1 **Manual Valve:**
Mechanically controlled by the gear selector lever, the manual valve is in the Park (P) position and directs line pressure from the pressure regulator valve into the PRN, PRND4 and PRND43 fluid circuits.

2 **1-2 Shift Solenoid (SS) Valve:**
Energized by the PCM, the 1-2 shift solenoid valve is ON and blocks 1-2 solenoid fluid from exhausting. 1-2 solenoid fluid is routed to the 1-2 shift valve and the 3-4 shift valve.

Note: Refer to Shift Solenoid Valves on page 49 for a description of solenoid and shift valve operation.

3 **1-2 Shift Valve:**
1-2 solenoid fluid moves the 1-2 shift valve against spring force to allow PRN fluid from the manual valve to enter the low & reverse band apply circuit.

4 **#6 Ball Check Valve:**
Low & reverse band apply fluid seats the ball check valve against the low & reverse band reduce circuit and enters the reverse band circuit.

5 **Low/Reverse Servo:**
Reverse band fluid enters the low/reverse servo to apply the low/reverse band.

COMPLETE HYDRAULIC CIRCUIT
Page 82

PARK

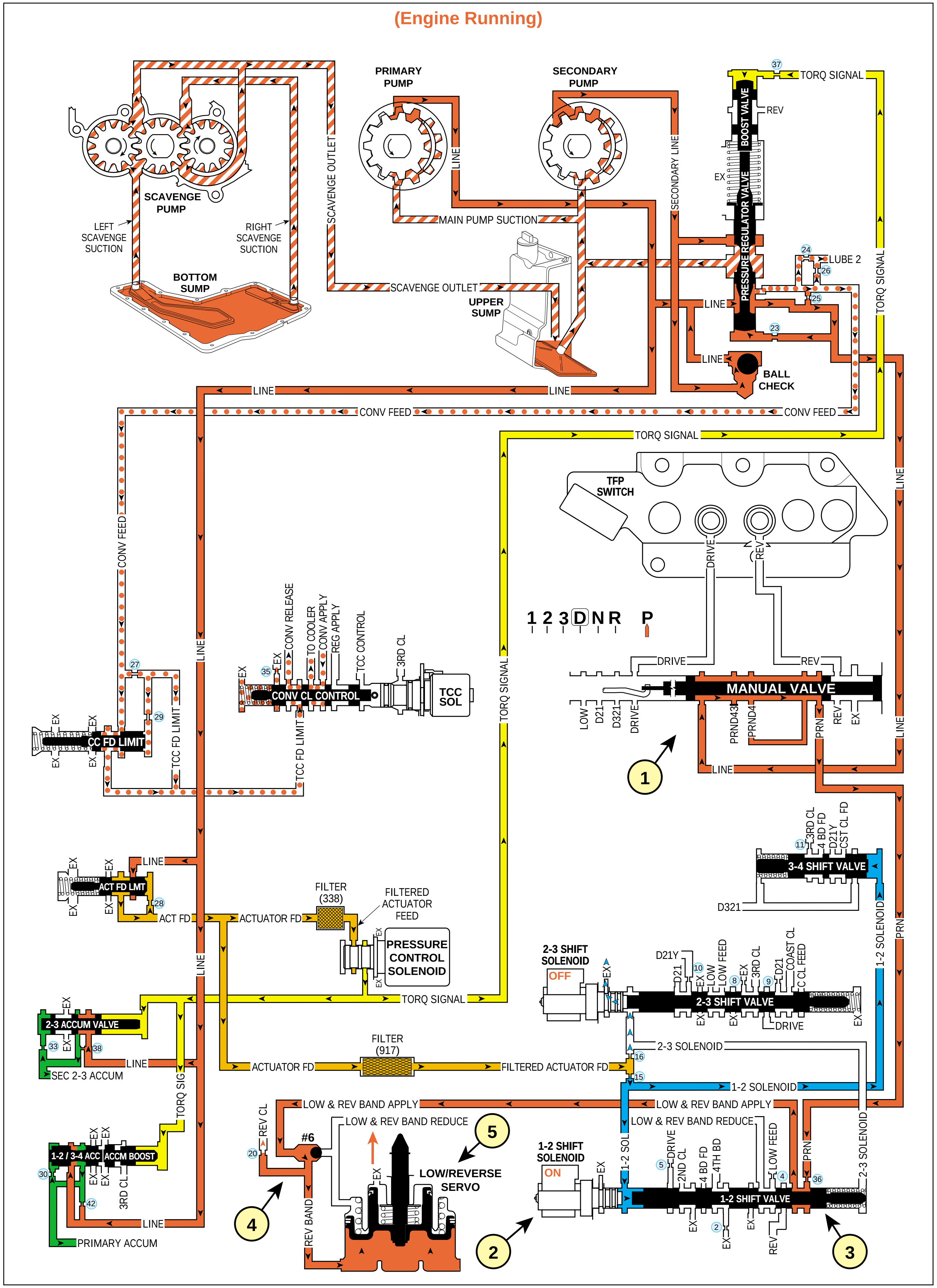


Figure 54

REVERSE

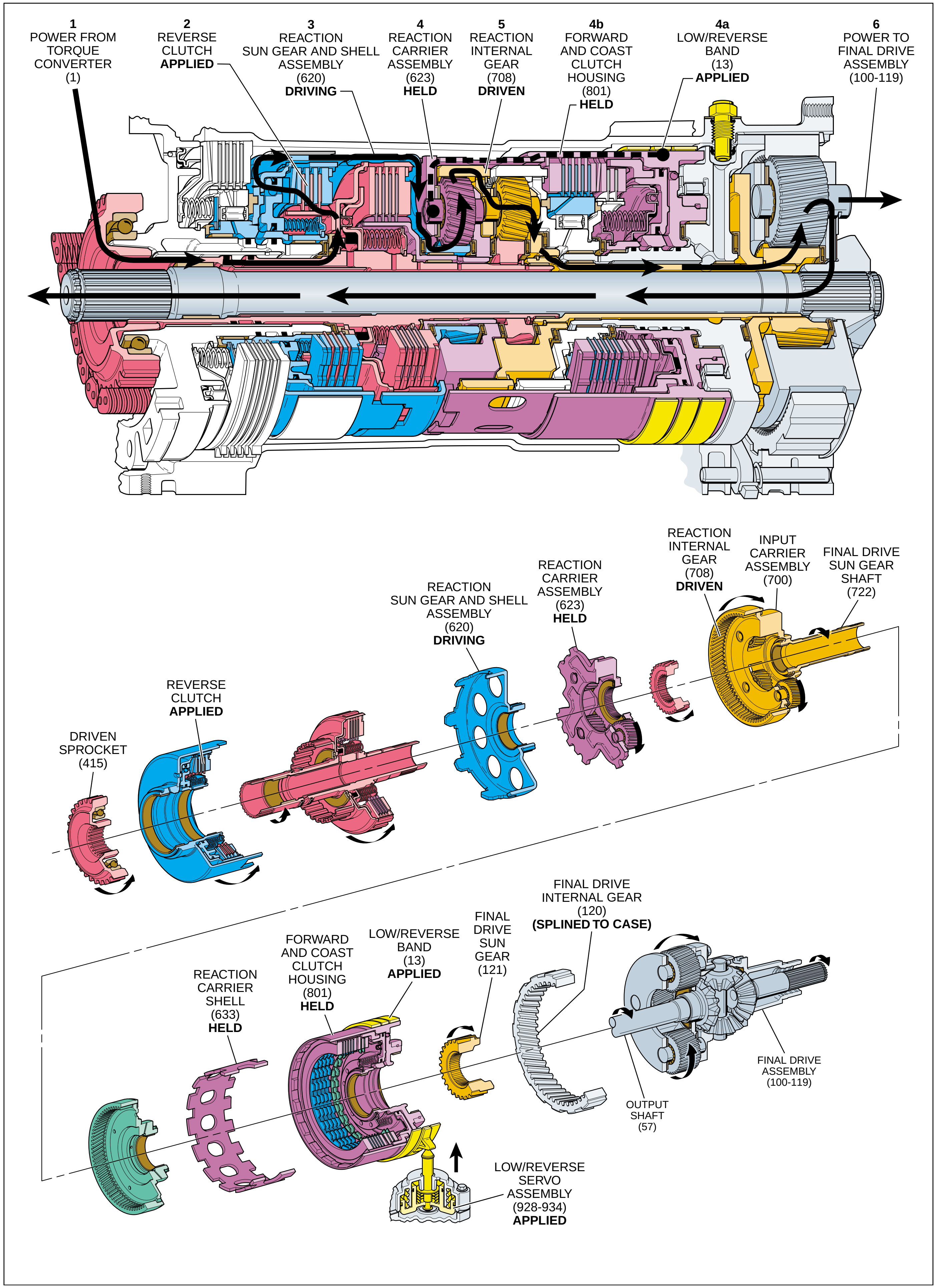


Figure 55

REVERSE

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF			APPLIED						APPLIED	

In Reverse (R), torque from the engine is multiplied through the torque converter (1), the transmission gear train, the final drive assembly and the output shaft (57) thereby sending power to the vehicle's drive axles. The planetary gear sets operate in reduction and in a reverse direction of the input torque. The gear ratio for Reverse gear range is 2.13:1.

- When the gear selector lever is moved into the Reverse (R) gear range, the parking lock pawl (22) disengages from the parking lock gear (833) allowing the final drive sun gear shaft (722) to rotate.
- The manual shaft (16), detent lever (17) and manual valve (916) are also moved into the Reverse gear position in order to channel the transmission fluid.

1 Power from Torque Converter
The driven sprocket (415) is splined to the input shaft and 3rd clutch housing assembly (604) and forces the housing to rotate at driven sprocket speed.

2 Reverse Clutch Applied
The reverse clutch plates (511-514), splined to the input shaft and 3rd clutch housing (604), are applied and force the reverse clutch housing and race assembly (500) to rotate.

3 Reaction Sun Gear and Shell Driving
The reaction sun gear and shell assembly (620) is tanged to the reverse clutch housing (800) and rotates in the same direction and speed as the input shaft and 3rd clutch housing (604). This drives the reaction carrier planetary pinions.

4 Reaction Carrier Assembly Held

4a Low/Reverse Band Applied
The low/reverse band (13) is applied and prevents the forward and coast clutch housing (801) from rotating.

4b Forward and Coast Clutch Housing Held
The forward and coast clutch housing (801) is tanged to one end of the reaction carrier shell (633), which in turn is tanged to the reaction carrier assembly (623). This prevents the reaction carrier from rotating.

Since the reverse clutch is driving the reaction sun gear and shell assembly (620) while the reaction carrier (623) is held, the reaction carrier planet pinion gears (625) are forced to rotate opposite of engine direction.

5 Reaction Internal Gear Driven
The reaction carrier planet pinion gears (625) force the reaction internal gear (708) and input carrier (700) to rotate opposite engine rotation.

6 Power to Final Drive Assembly
The input carrier assembly (700), connected to the final drive sun gear (121) through the final drive sun gear shaft (722), forces the final drive sun gear shaft and sun gear to rotate opposite of engine rotation.

Torque transfers through the final drive sun gear to the final drive planet pinion gears (103).

The final drive planet pinion gears (103) rotate inside the final drive internal gear (120), which is held stationary by the case, and transfers torque to the final drive differential gears (112 and 118).

The output shaft (57), splined into the differential side gear (118), provides the torque to the left hand drive axle while the right differential side gear (112) transfers torque to the right hand drive axle.

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF			APPLIED						APPLIED	

When the gear selector lever is moved to the Reverse (R) position (from the Park position) the following changes occur in the transmission's hydraulic and electrical systems.

1 PRESSURE REGULATION

1a Manual Valve:

With the manual valve in the reverse position, line pressure is directed into the reverse fluid circuit in addition to the PRN, PRND4 and PRND43 fluid circuits already pressurized in Park.

1b Pressure Regulator and Boost Valves:

Reverse fluid at the pressure regulator boost valve boosts line pressure for the additional torque requirements in Reverse. Torque signal fluid pressure from the pressure control (PC) solenoid acting on the pressure regulator boost valve also helps determine line pressure in Reverse depending on throttle position and other PCM input signals.

1c Transmission Fluid Pressure (TFP) Manual Valve Position Switch:

Reverse fluid is routed to the TFP manual valve position switch. The TFP manual valve position switch signals the PCM that the transmission is in Reverse.

2 REVERSE CLUTCH APPLIES

2a Reverse Orifice Bypass Valve:

Reverse fluid moves the valve against spring force to allow a quick feed of reverse fluid into the reverse clutch circuit through orifice #17, in addition to orifice #6.

2b #7 Ball Check Valve:

Reverse fluid seats the #7 ball check valve, forcing reverse fluid through orifice #12 into the reverse clutch fluid circuit.

Note: Remember that the function of an orifice is to control the flow rate of fluid and rate of apply or release of a clutch or band.

2c 1-2 Shift Valve:

Reverse fluid is also routed to the 1-2 shift valve where it stops and is non-functional at this time.

2d #4 Ball Check Valve:

Reverse fluid unseats the #4 ball check valve, allowing reverse clutch fluid to pass unobstructed to the reverse accumulator and the reverse clutch.

2e Reverse Clutch:

Reverse clutch fluid enters the reverse clutch and moves the piston against spring force to apply the reverse clutch plates.

2f Low/Reverse Servo:

Reverse clutch fluid passes through orifice #20 into the reverse band circuit where it assists in holding the reverse band.

3 REVERSE CLUTCH ACCUMULATION

3a Reverse Accumulator:

Reverse clutch fluid is also sent to the reverse accumulator assembly. Reverse clutch fluid moves the reverse accumulator piston against spring force and primary accumulator fluid pressure to cushion the apply of the reverse clutch.

3b 1-2/3-4 Accumulator Valve:

Primary accumulator fluid is forced back through its circuit to the 1-2/3-4 accumulator valve where it exhausts at a controlled rate.

COMPLETE HYDRAULIC CIRCUIT
Page 84

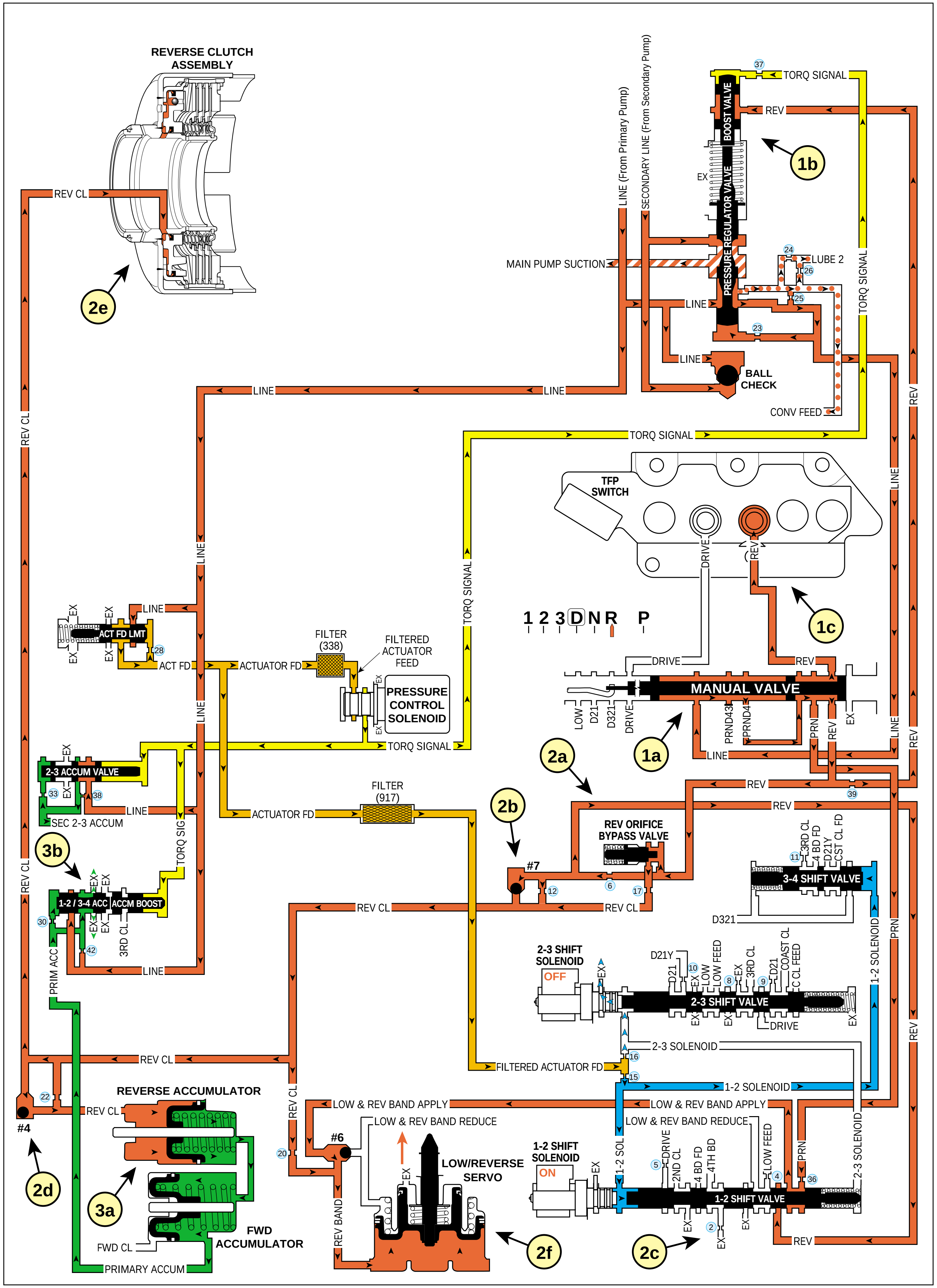


Figure 56

NEUTRAL

(Engine Running)

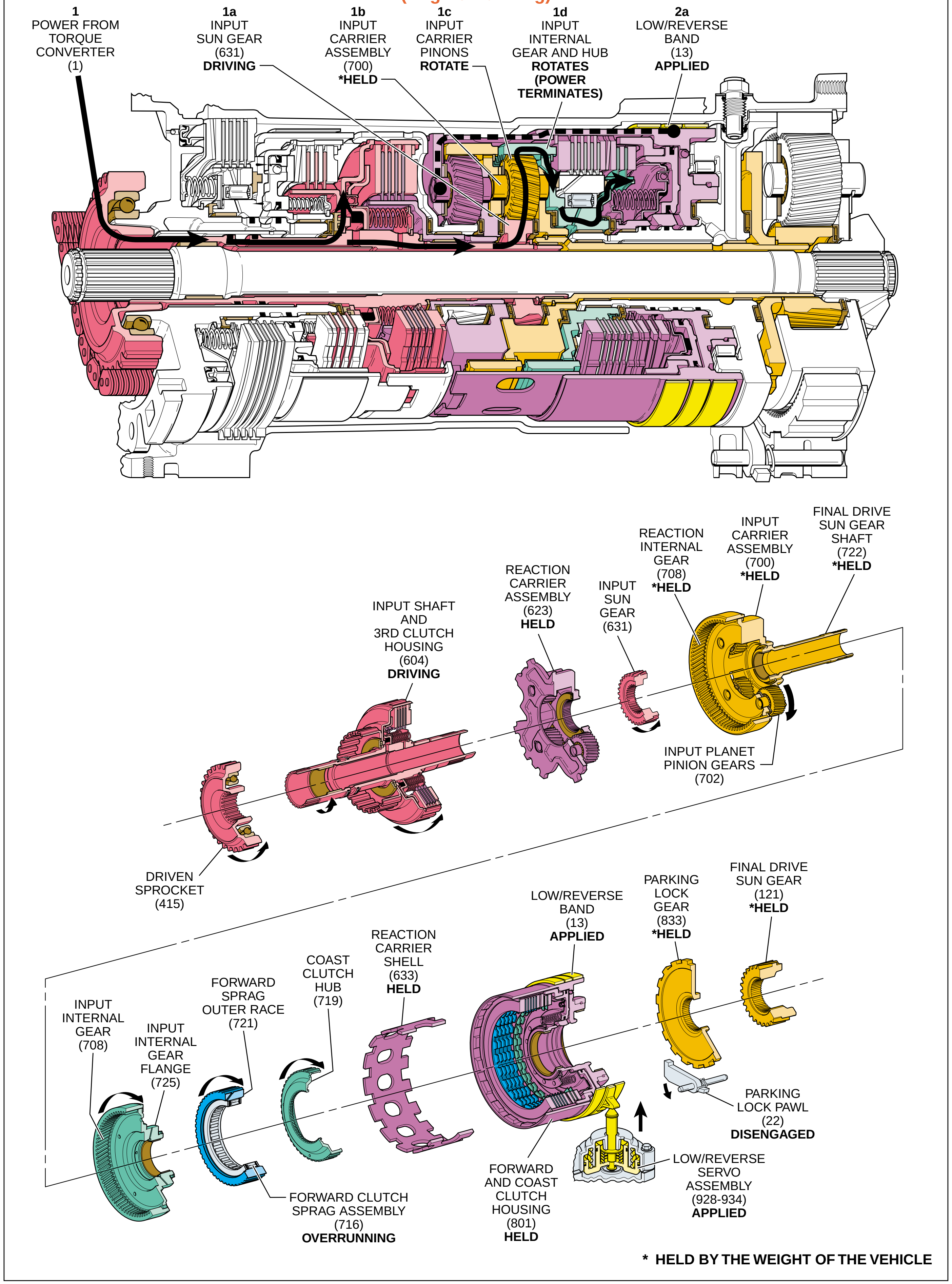


Figure 57

NEUTRAL

(Engine Running)

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF									APPLIED	

When the gear selector lever is placed in the Neutral (N) position, the mechanical power flow through the transmission is similar to Park gear range. The primary difference is that the parking pawl (22) is not engaged with the parking gear (833), which allows the final drive sun gear shaft (722) to rotate freely in either direction. Assuming that the vehicle is on level ground, the weight of the vehicle (transferred through the drive axles) holds the final drive sun gear shaft. Under these conditions, power flow through the transmission is the same as in Park.

- The manual shaft (16), detent lever (17) and manual valve (916) are moved into the Neutral (N) range position.

1 Power from Torque Converter

Power from the torque converter turbine transfers to the driven sprocket (415) which is splined to the input shaft and 3rd clutch housing (604).

1a Input Sun Gear Driving

Power continues from the input shaft and 3rd clutch housing (604) through the input sun gear shaft to the input sun gear (631), which then drives the input planetary pinions.

1b Input Carrier Assembly Held

The input planetary carrier (700) is held stationary by the final drive sun gear shaft (722) being held by the weight of the vehicle. This forces the input planetary pinions (702) to rotate the opposite direction of the input sun gear (631).

1c Input Carrier Pinions Rotate

The input planetary pinions (702) rotate and force the input internal gear (708) and forward clutch sprag inner race (725) to rotate.

1d Input Internal Gear Rotates/Powerflow Terminates

The input internal gear (708) is splined to the coast clutch hub (719) but, the coast clutch is not applied so powerflow is terminated.

2 Preparation for a Shift (Forward or Reverse)

2a Low/Reverse Band Applied

The low/reverse band (13) is applied and holds the forward and coast clutch housing (801). The forward and coast clutch housing is tanged to one end of the reaction carrier shell (633). The other end of the reaction carrier shell is tanged to the reaction carrier assembly (623) and prevents the carrier from rotating.

NOTE: Whenever adjustments or repairs are being performed and the gear selector lever is in Neutral, it is important that the vehicle's parking brake is applied and the wheels are blocked. A slight incline will cause the vehicle to roll either forward or backwards potentially causing injury or damage.

NEUTRAL
(Engine Running)

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF									APPLIED	

When the gear selector lever is moved to the Neutral (N) position, the hydraulic and electrical system operation is identical to Park (P) range. However, if Neutral is selected after the vehicle was operating in Reverse (R), the following changes would occur in the hydraulic system:

1 REVERSE CLUTCH RELEASES

1a Manual Valve:
The manual valve is moved to the Neutral position and blocks line pressure from entering the reverse circuit. The reverse fluid circuit is opened to an exhaust at the manual valve.

1b Reverse Clutch:
Reverse fluid exhausts from the reverse clutch piston and past the manual valve.

1c #7 Ball Check Valve:
Reverse clutch fluid unseats the #7 ball check valve allowing a quick exhaust into the reverse fluid circuit. Reverse fluid then flows through orifice #6 and to the manual valve where it exhausts.

1d Reverse Orifice Bypass Valve:
Reverse fluid exhausts from the reverse orifice bypass valve, allowing spring force to close the valve.

1e Transmission Fluid Pressure (TFP) Manual Valve Position Switch:
Reverse fluid exhausts from the TFP manual valve position switch and past the manual valve, signaling the powertrain control module (PCM) that the transmission is in either Neutral (N) or Park (P).

1f #4 Ball Check Valve:
Reverse clutch fluid, exhausting from the reverse accumulator, seats the #4 ball check valve forcing the fluid to exhaust through orifice #22. This helps to control the release of the reverse clutch.

1g Low/Reverse Servo:
The low/reverse servo remains applied but, the holding force is reduced by the exhaust of reverse clutch fluid pressure.

1h Pressure Regulator Boost Valve:
Reverse fluid exhausts from the pressure regulator boost valve, allowing line pressure to return to the normal operating range as in Park and Overdrive gear ranges.

2 SHIFT ACCUMULATION

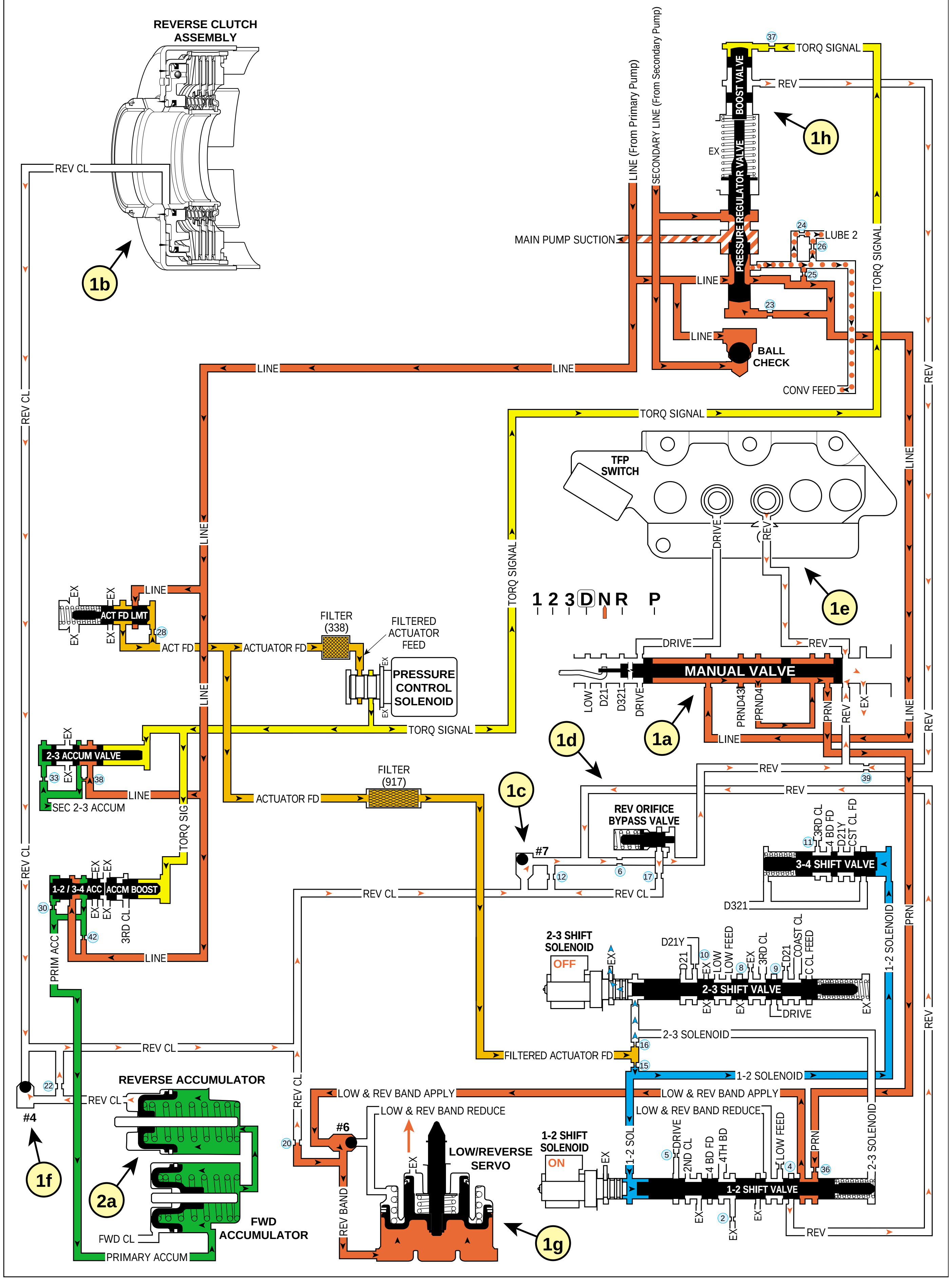
2a Reverse Accumulator:
Reverse clutch fluid also exhausts from the reverse accumulator. Primary accumulator fluid moves the reverse accumulator piston into the release position in preparation for another application of the reverse clutch.

Note: Allowing fluid to bypass an orifice when exhausting ensures a quick release of the clutch or band. This prevents the friction material from "dragging" and creating excess fluid temperatures or damaging the clutch or band.

Note: In Park, Reverse and Neutral the shift solenoid valves are shown in the First gear state. This is the normal operating state when the vehicle is stationary or at low vehicle speeds. However, the PCM will change the shift solenoid states depending on vehicle speed. For example, if Neutral range is selected when the vehicle is operating in Second gear, the shift solenoids will remain in a Second gear state. But with the manual valve in Neutral, line pressure is blocked, drive fluid exhausts and the transmission will shift into Neutral.

COMPLETE HYDRAULIC CIRCUIT
Page 86

NEUTRAL
(Engine Running)



OVERDRIVE RANGE – FIRST GEAR

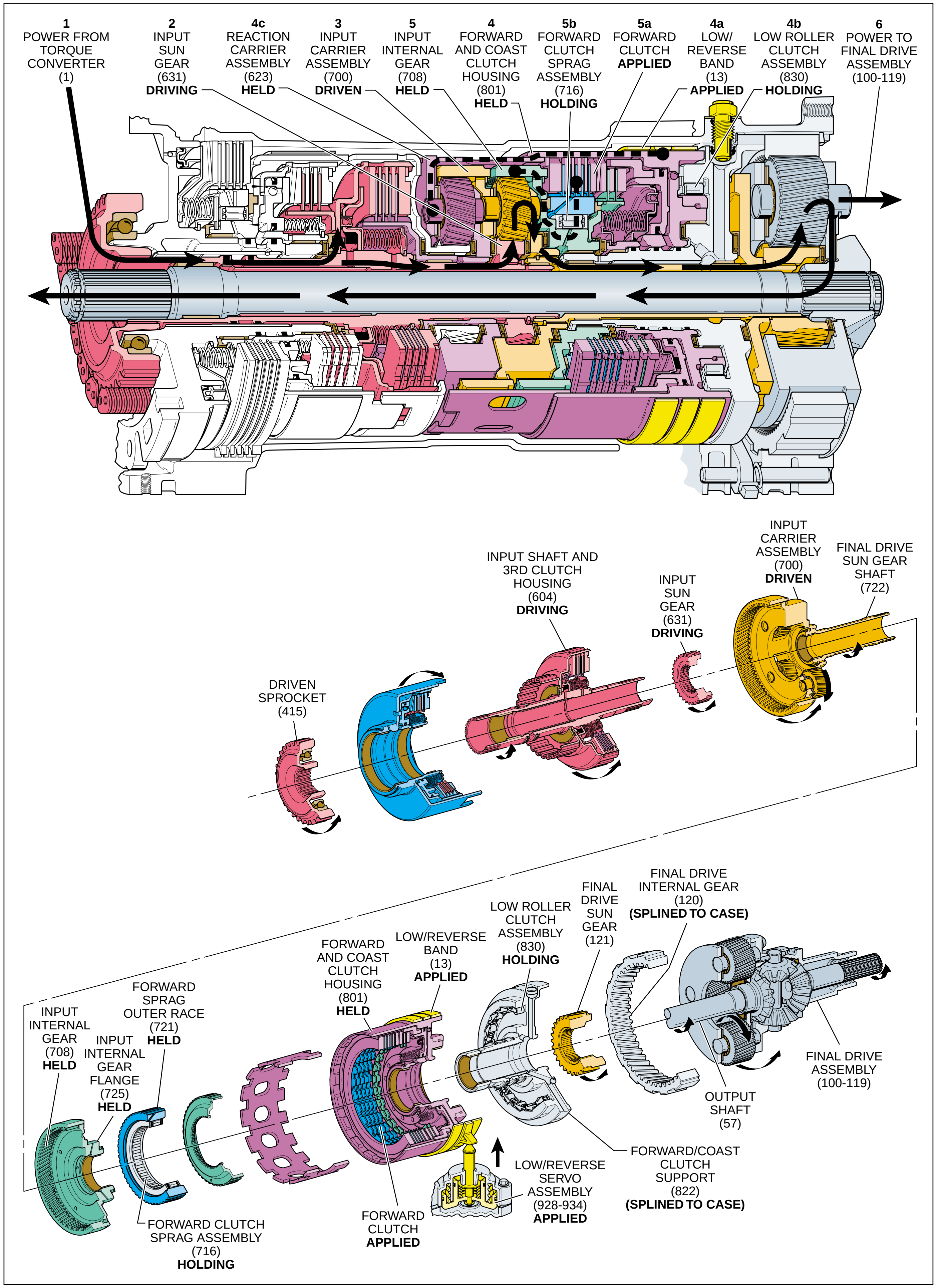


Figure 59

OVERDRIVE RANGE – FIRST GEAR

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF						HOLDING	APPLIED		APPLIED	HOLDING

In Overdrive Range – First Gear Ⓓ, torque from the engine is multiplied through the torque converter (1) and transmission gear sets to the drive axles. The planetary gear sets operate in reduction to achieve a first gear starting ratio of 2.96:1.

- The manual shaft, detent lever and manual valve are moved into Overdrive – the Ⓓ range position on the shift quadrant.

1 Power from Torque Converter
The driven sprocket (415) is splined to the input shaft and 3rd clutch housing assembly (604) and forces the input housing to rotate at driven sprocket speed.

2 Input Sun Gear Driving
Power continues from the input shaft and 3rd clutch housing (604) through the input sun gear shaft to the input sun gear (631), which then drives the input carrier planetary pinions.

3 Input Carrier Assembly Driven
The input sun gear (631), in constant mesh with the input carrier planet pinion gears, forces the input carrier assembly (700) to rotate in the same direction as engine rotation.

4 Forward and Coast Clutch Housing Held

4a Low/Reverse Band Applied
The low/reverse band (13) is applied and assists in preventing the forward and coast clutch housing (801) from rotating.

4b Low Roller Clutch Assembly Holding
The low roller clutch assembly (830) is holding and is the main component that prevents the forward and coast clutch housing (801) from rotating.

4c Reaction Carrier Assembly Held
The forward and coast clutch housing (801) is tanged to one end of the reaction carrier shell (633), which in turn is tanged to the reaction carrier assembly (623). This prevents the reaction carrier from rotating.

5 Input Internal Gear Held

5a Forward Clutch Applied
The forward clutch plates (816-819), splined to the forward and coast clutch housing (801) and the forward sprag outer race (721), hold the sprag outer race.

5b Forward Clutch Sprag Assembly Holding
With the sprag elements in the holding position, the forward clutch sprag inner race (725) and input internal gear (708) are also held.

6 Power to Final Drive Assembly
The input carrier assembly (700), connected to the final drive sun gear (121) through the final drive sun gear shaft (722), forces the final drive sun gear shaft and sun gear to rotate.

Torque transfers through the final drive sun gear to the final drive planet pinion gears (103).

The final drive planet pinion gears (103) rotate inside the final drive internal gear (120), which is held stationary by the case, and transfers torque to the final drive differential gears (112, 116 and 118).

The output shaft (57), splined into the left differential side gear (118), provides the torque to the left hand drive axle while the right differential side gear (112) transfers torque to the right hand drive axle.

When the differential and final drive carrier (110) rotates, the vehicle begins to move and first gear is achieved. As the speed of the vehicle increases, less torque is required to maintain a constant vehicle speed. In order to provide maximum powertrain efficiency, a lower input to output gear ratio is desirable. This lower gear ratio is automatically achieved when the transmission shifts into second gear.

OVERDRIVE RANGE – FIRST GEAR

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF						HOLDING	APPLIED		APPLIED	HOLDING

When the gear selector lever is moved to the Overdrive Range (D) position from the Neutral (N) position the following changes occur to shift the transmission into Overdrive Range – First Gear.

1 MANUAL VALVE

In the Overdrive position the manual valve routes line pressure into the drive fluid circuit. The manual valve also blocks line pressure from entering the PRN fluid circuit and opens the PRN fluid circuit to exhaust.

2 FORWARD CLUTCH APPLIES

2a Forward Orifice Bypass Valve:
Drive fluid moves the valve against spring force to allow a quick feed of drive fluid into the forward clutch circuit through orifice #18, in addition to orifice #1.

2b #5 Ball Check Valve:
Drive fluid seats the #5 ball check valve, forcing drive fluid through orifice #1 into the forward clutch fluid circuit.

Note: *Remember that the function of an orifice is to control the flow rate of fluid and rate of apply or release of a clutch or band.*

2c #1 Ball Check Valve:
Forward clutch fluid unseats the #1 ball check valve, allowing forward clutch fluid to pass unobstructed to the forward accumulator and the forward clutch.

2d Forward Clutch:
Forward clutch fluid is routed to the forward clutch piston to apply the forward clutch plates and obtain a First gear ratio through the transmission gear sets.

2e Transmission Fluid Pressure (TFP) Manual Valve Position Switch:
Drive fluid is routed to the TFP manual valve position switch to signal the powertrain control module (PCM) that the transmission is in Overdrive Range (D).

3 SHIFT ACCUMULATION

3a Forward Accumulator:
Forward clutch fluid is also sent to the forward accumulator assembly. Forward clutch fluid moves the forward accumulator piston against spring force and primary accumulator fluid pressure to cushion the apply of the forward clutch.

3b 1-2/3-4 Accumulator Valve:
Primary accumulator fluid is forced back through its circuit to the 1-2/3-4 accumulator valve where it exhausts at a controlled rate.

4 LOW/REVERSE BAND APPLY

4a #8 Ball Check Valve:
Drive fluid passes through orifice #19 into the low fluid circuit. Low fluid then seats the #8 ball check valve, routing low fluid through the 2-3 shift valve into the low feed fluid circuit.

4b 1-2 Shift Valve:
Low feed fluid is routed through orifice #4 to the 1-2 shift valve where it passes into the low & reverse band reduce circuit.

4c #6 Ball Check Valve:
Low & reverse band reduce fluid seats the #6 ball check valve against the exhausting low & reverse band apply passage and enters the reverse band circuit to keep the low/reverse servo applied.

4d Low/Reverse Servo:
Low & reverse band reduce fluid enters the low/reverse servo to assist spring force in opposing reverse band fluid pressure. This reduces the holding force of the low/reverse band.

5 FLUID PRESSURE DIRECTED IN PREPARATION FOR A SHIFT

5a 1-2 Shift Valve:
Drive fluid is routed through orifice #5 to the 1-2 shift valve in preparation for an upshift to second gear.

5b 2-3 Shift Valve:
Drive fluid is also routed to the 2-3 shift valve in preparation for an upshift to third gear.

COMPLETE HYDRAULIC CIRCUIT
Page 88

OVERDRIVE RANGE – FIRST GEAR

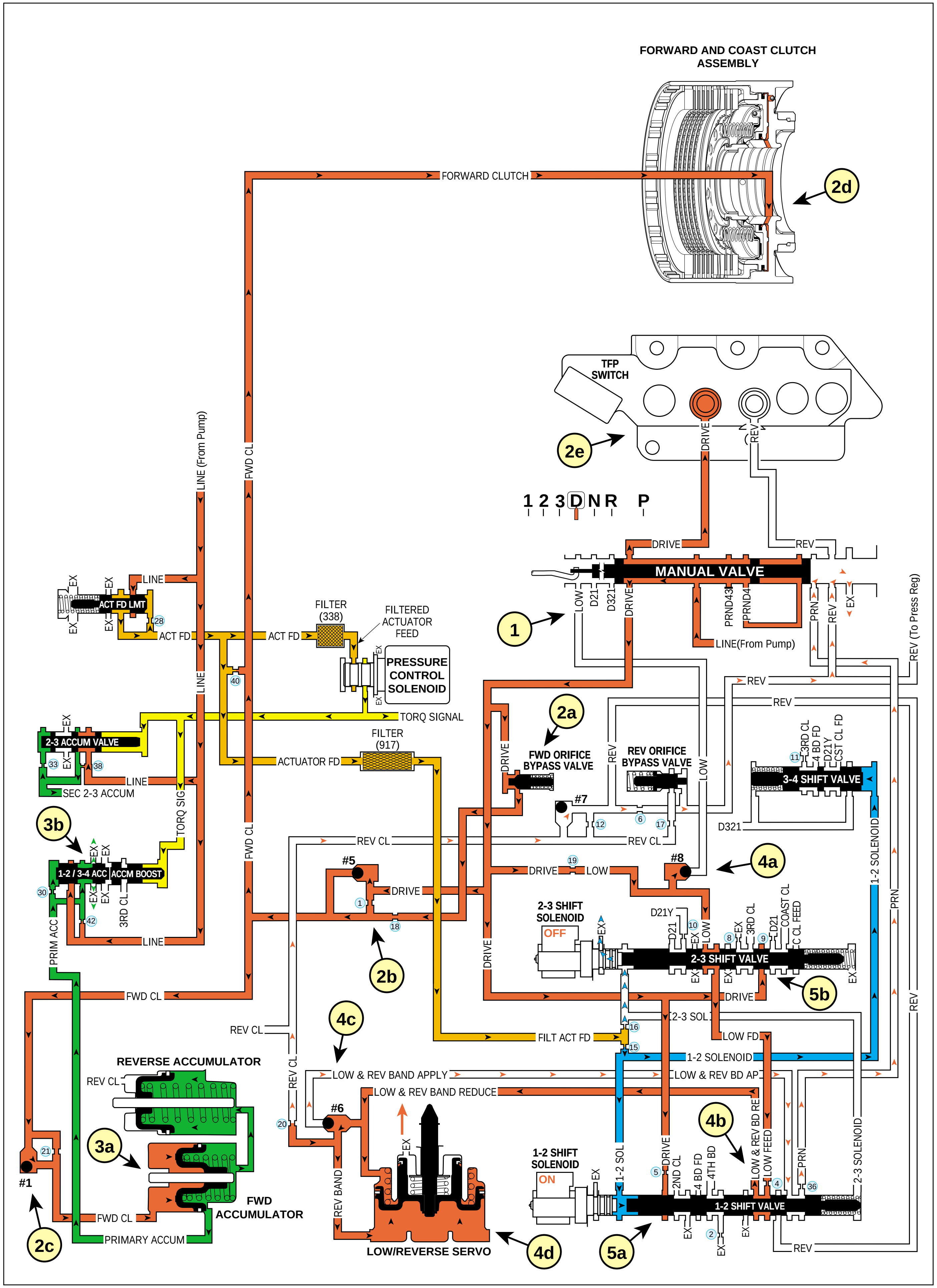


Figure 60

OVERDRIVE RANGE – SECOND GEAR

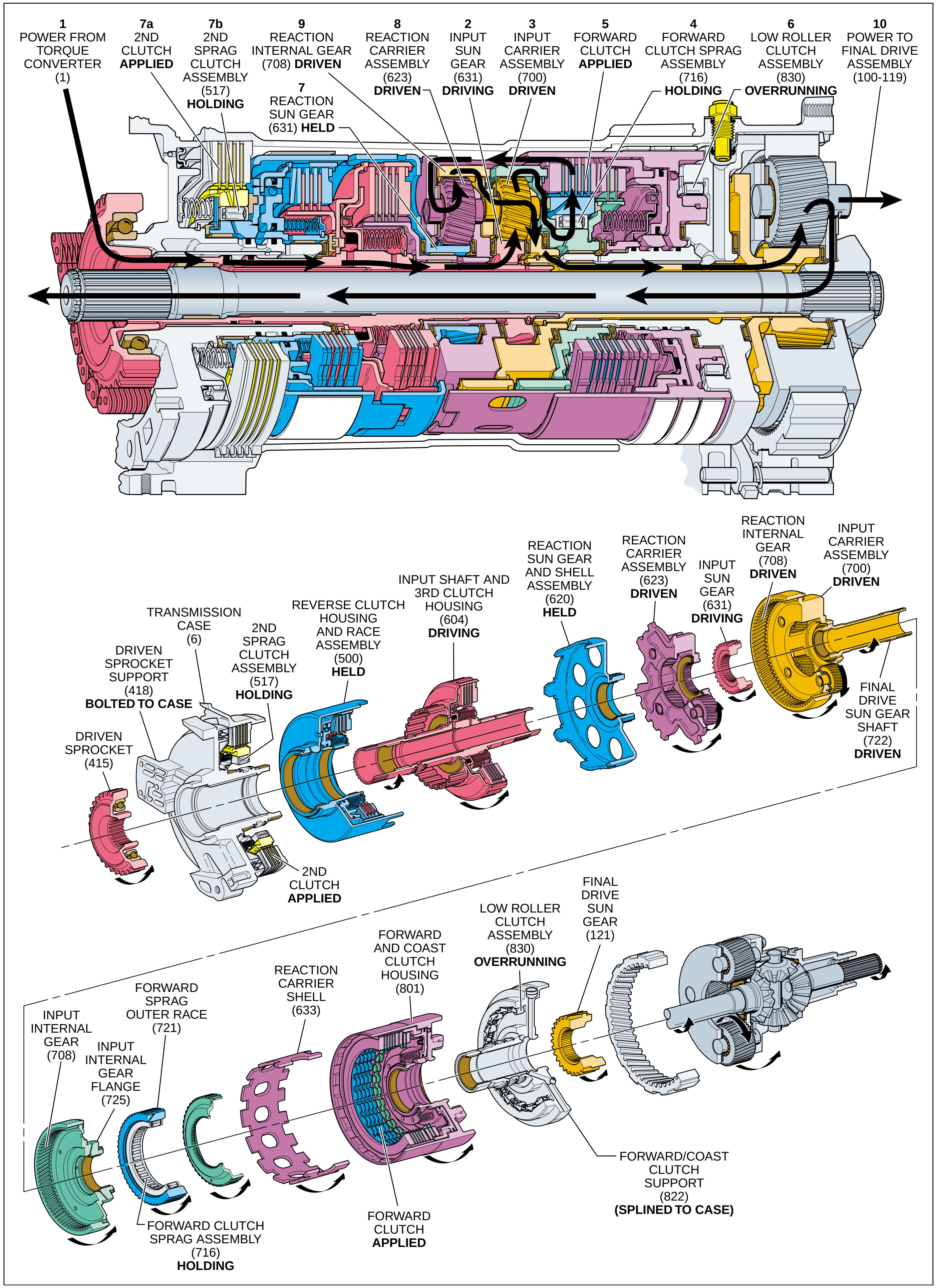


Figure 61

OVERDRIVE RANGE – SECOND GEAR

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	OFF	APPLIED	HOLDING				HOLDING	APPLIED			OVERRUN

As the speed of the vehicle increases, input signals from the vehicle speed sensor (VSS), throttle position (TP) sensor and other sensors are sent to the powertrain control module (PCM). The PCM uses this information to manage engine torque as the transmission shifts from first to second gear. In Overdrive Range – Second gear, the planetary gear sets continue to operate in reduction but at a gear ratio of 1.63:1.

1 Power from Torque Converter
The driven sprocket (415) is splined to the input shaft and 3rd clutch housing assembly (604) and forces the housing to rotate at driven sprocket speed.

2 Input Sun Gear Driving
Power continues from the input shaft and 3rd clutch housing (604) through the input sun gear shaft to the input sun gear (631), which then drives the input carrier planetary pinions.

3 Input Carrier Assembly Driven
The input sun gear (631), in constant mesh with the input carrier planet pinion gears, forces the input carrier assembly (700) to rotate in the same direction as engine rotation.

4 Forward Clutch Sprag Holding
The input internal gear (708), driven by the input carrier pinion gears, forces the forward clutch sprag elements to lock and drive the forward sprag outer race (721).

5 Forward Clutch Applied
The forward clutch plates (816-819), splined to the forward sprag outer race (721) and the forward and coast clutch housing (801), hold the sprag outer race which routes engine torque through the forward and coast clutch housing.

6 Low Roller Clutch Assembly Overrunning
The low roller clutch assembly (830) overruns allowing the forward and coast clutch housing (801) to rotate.

7 Reaction Sun Gear Held

7a 2nd Clutch Applied
The 2nd clutch plates (431-435), splined to the 2nd sprag clutch outer race (516) and the transmission case (6), hold the sprag outer race.

7b 2nd Sprag Clutch Assembly Holding
The 2nd sprag clutch holds the sprag inner race which is part of the reverse clutch housing. The reverse clutch housing and race assembly (500) is tanged to the reaction sun gear and shell assembly (620). This prevents the reaction sun gear from rotating.

8 Reaction Carrier Assembly Driven
The reaction carrier assembly (623), driven by the forward and coast clutch housing (801) through the reaction carrier shell (633), is forced to rotate around the stationary reaction sun gear and shell assembly (620).

9 Reaction Internal Gear Driven
The reaction carrier pinion gears (625), in constant mesh with the reaction internal gear/input carrier assembly (700), force the reaction internal gear/input carrier assembly to rotate.

10 Power to Final Drive Assembly
The reaction internal gear/input carrier assembly (700), splined to the final drive sun gear shaft (722), drives the final drive sun gear (121). Final drive is achieved.

NOTE: To minimize the amount of repetitive text, the remaining description of mechanical power flow from the final drive sun gear (121) to the drive axles is omitted as it is identical to first gear. All of the following forward gear ranges also have the same description of final drive powerflow as first gear.

As the speed of the vehicle increases, less torque multiplication is required to move the vehicle efficiently thus making it desirable to shift the transmission to a lower gear ratio, or third gear.

OVERDRIVE RANGE – SECOND GEAR

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	OFF	APPLIED	HOLDING				HOLDING	APPLIED			OVERRUN

As vehicle speed increases, the powertrain control module (PCM) receives input signals from various engine and transmission sensors. The PCM uses this data to determine the precise moment to de-energize or "turn OFF" the 1-2 shift solenoid (SS) valve. The 1-2 SS valve is OFF when the PCM eliminates the path to ground for that circuit.

1 SECOND CLUTCH APPLIES

1a 1-2 Shift Solenoid (SS) Valve:
The 1-2 SS valve is de-energized, allowing 1-2 solenoid fluid through the open solenoid.

Note: *Filtered actuator feed fluid continues to feed the 1-2 solenoid fluid circuit through orifice #15. However, the exhaust port through the solenoid is larger than orifice #15 to prevent a pressure increase in the 1-2 solenoid fluid circuit.*

1b 1-2 Shift Valve:
With 1-2 solenoid fluid pressure exhausted, 1-2 shift valve spring force moves the 1-2 shift valve into the upshifted position. Drive fluid is routed through the 1-2 shift valve and into the 2nd clutch fluid circuit.

1c Second Clutch:
2nd clutch fluid is routed to the 2nd clutch piston to apply the 2nd clutch plates and obtain a Second gear ratio through the transmission gear sets.

2 SHIFT ACCUMULATION

2a 1-2 Accumulator:
2nd clutch fluid is also sent to the 1-2 accumulator assembly. 2nd clutch fluid pressure, together with 1-2 accumulator inner spring assembly force, moves the 1-2 accumulator piston against 1-2 accumulator spring force and 1-2 accumulator fluid pressure to cushion the apply of the 2nd clutch.

2b #2 Ball Check Valve:
1-2 accumulator fluid, forced out of the 1-2 accumulator when 2nd clutch fluid pressure moves the 1-2 accumulator piston, unseats the #2 ball check valve and enters the primary accumulator fluid circuit.

2c 1-2/3-4 Accumulator Valve:
Primary accumulator fluid is routed back to the 1-2/3-4 accumulator valve. Orificed primary accumulator fluid pressure regulates the accumulator valve against torque signal fluid pressure. This allows excess primary accumulator fluid to exhaust and provides additional control for the second clutch apply.

3 LOW/REVERSE SERVO RELEASES

3a 1-2 Shift Valve:
Low feed fluid is blocked and low & reverse band reduce fluid is opened to an exhaust port at the 1-2 shift valve. This allows reverse band fluid to exhaust from the low/reverse servo, thus releasing the low/reverse band.

COMPLETE HYDRAULIC CIRCUIT
Page 90

OVERDRIVE RANGE – SECOND GEAR

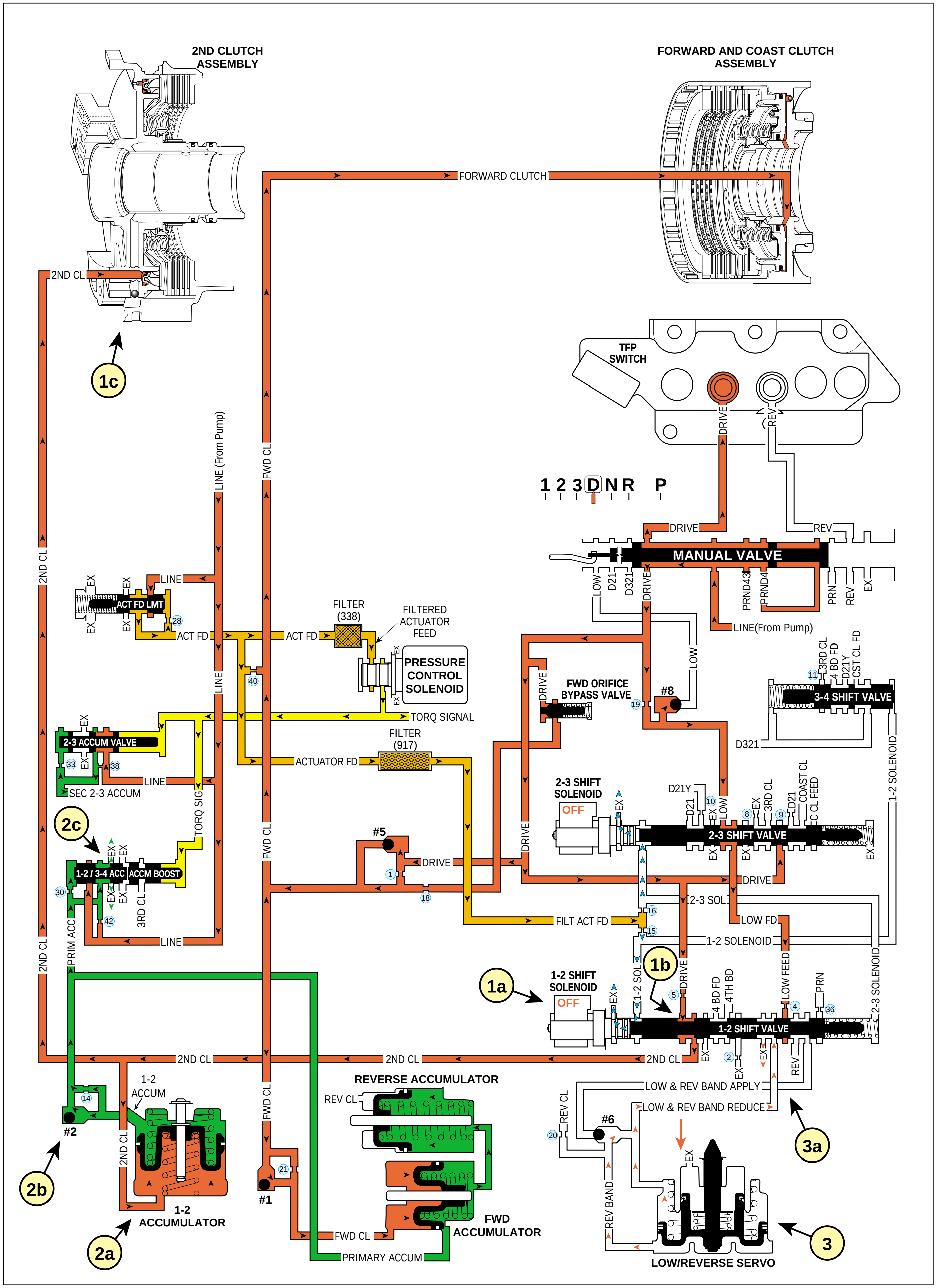


Figure 62

OVERDRIVE RANGE – THIRD GEAR

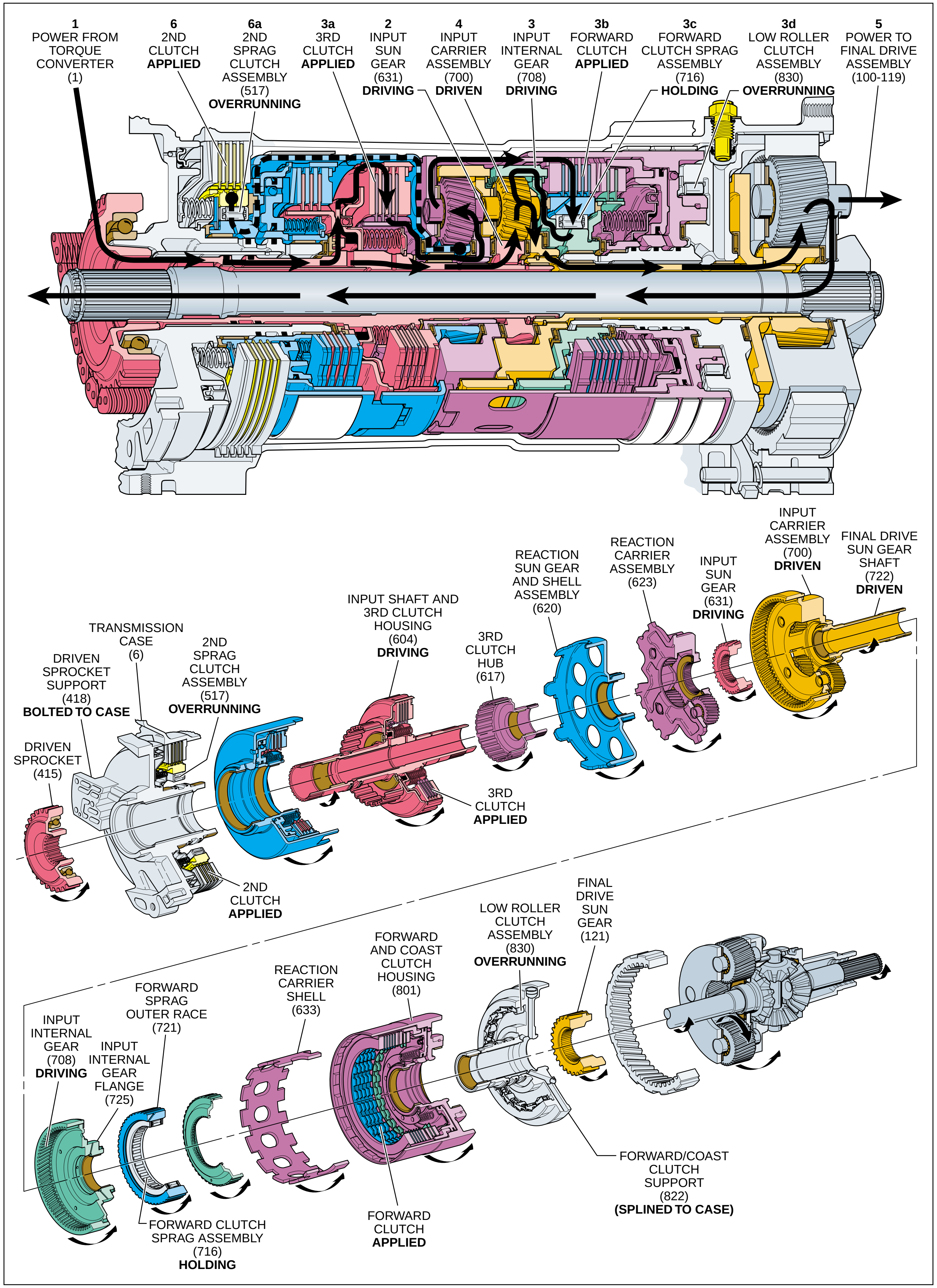


Figure 63

OVERDRIVE RANGE – THIRD GEAR

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	ON	APPLIED	OVERRUN		APPLIED		HOLDING	APPLIED			OVERRUN

As the speed of the vehicle increases, input signals from the vehicle speed sensor (VSS), throttle position (TP) sensor and other sensors are sent to the powertrain control module (PCM). The PCM uses this information to manage engine torque as the transmission shifts from second to third gear. In Overdrive Range – Third gear, both planetary gear sets rotate at the same speed providing a 1:1 direct drive gear ratio to the final drive assembly (100-119).

1 Power from Torque Converter
The driven sprocket (415) is splined to the input shaft and 3rd clutch housing assembly (604) and forces the housing to rotate at driven sprocket speed.

2 Input Sun Gear Driving
Power continues from the input shaft and 3rd clutch housing (604) through the input sun gear shaft to the input sun gear (631), which then drives the input carrier planetary pinions.

3 Input Internal Gear Driving

3a 3rd Clutch Applied
The 3rd clutch plates (610-613) are applied and transfer input shaft and 3rd clutch housing assembly (604) rotation and speed to the forward and coast clutch housing (801) through the 3rd clutch hub (617), the reaction carrier assembly (623), and the reaction carrier shell (633).

3b Forward Clutch Applied
The forward clutch plates (816-819), splined to the forward sprag outer race (721) and the forward and coast clutch housing (801), transfer torque to the input internal gear (708) through the forward sprag elements.

3c Forward Clutch Sprag Holding
The forward sprag outer race (721), driven by the forward and coast clutch housing, forces the forward clutch sprag elements to lock and drive the input internal gear (708).

3d Low Roller Clutch Overrunning
The low roller clutch assembly (830) overruns allowing the forward and coast clutch housing (801) to rotate.

4 Input Carrier Assembly Driven
With the input internal gear (708) and the input sun gear (631) rotating in the same direction and speed, the input carrier planetary pinion gears act as wedges and force the input carrier to rotate in the same direction and speed. When this event occurs the gear sets are operating in direct drive.

5 Power to Final Drive Assembly
The reaction internal gear/input carrier assembly (700), splined to the final drive sun gear shaft (722), drives the final drive sun gear (121). Final drive is achieved.

6 2nd Clutch Applied
The 2nd clutch plates (431-435), splined to the 2nd sprag clutch outer race (516) and the transmission case (6), hold the sprag outer race.

6a 2nd Sprag Clutch Overrunning
Because the reverse clutch housing and race assembly (500) is driven by the reaction sun gear and shell assembly (620), the 2nd sprag clutch assembly (517) overruns and does not affect power flow.

As vehicle speed increases, less torque multiplication is required to operate the engine efficiently thus making it desirable to shift the transmission into an overdrive gear ratio, or fourth gear.

OVERDRIVE RANGE – THIRD GEAR

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	ON	APPLIED	OVERRUN		APPLIED		HOLDING	APPLIED			OVERRUN

As vehicle speed increases, the PCM receives input signals from various engine and transmission sensors. The PCM uses this data to determine the precise moment to energize or "turn ON" the 2-3 shift solenoid (SS) valve. The 2-3 solenoid is ON when the PCM provides a path to ground for that electrical circuit. This prevents 2-3 solenoid fluid from exhausting at the 2-3 SS valve, thereby increasing 2-3 solenoid fluid pressure.

1 3RD CLUTCH APPLIES

1a 2-3 Shift Solenoid (SS) Valve Energized:
2-3 solenoid fluid pressure overcomes 2-3 shift valve spring force and moves the 2-3 shift valve to the upshifted position.

1b 2-3 Shift Valve:
Drive fluid is routed through the 2-3 shift valve and enters the 3rd clutch circuit.

1c #11 Ball Check Valve:
3rd clutch fluid seats the #11 ball check valve, flows through orifice #31 and enters the orificed 3rd clutch circuit.

1d 3rd Clutch Exhaust Valve:
Orificed 3rd clutch fluid moves the 3rd clutch exhaust valve against 3rd clutch exhaust valve spring force and enters the 3rd clutch circuit.

1e 3rd Clutch:
3rd clutch fluid is routed to the 3rd clutch piston to apply the 3rd clutch plates and obtain a Third gear ratio through the transmission gear sets.

2 SHIFT ACCUMULATION

2a 2-3 Accumulator:
3rd clutch fluid is also sent to the 2-3 accumulator assembly. 3rd clutch fluid pressure, together with 2-3 accumulator piston cushion spring force, moves the 2-3 accumulator piston against 2-3 accumulator piston spring force and 2-3 accumulator fluid pressure to cushion the apply of the 3rd clutch.

2b # 10 Ball Check Valve:
2-3 accumulator fluid, forced out of the 2-3 accumulator when orificed 3rd clutch fluid moves the 2-3 accumulator piston, unseats the #10 ball check valve and enters the secondary 2-3 accumulator fluid circuit.

2c 2-3 Accumulator Valve:
Secondary 2-3 accumulator fluid is routed back to the 2-3 accumulator valve. Orificed secondary 2-3 accumulator fluid pressure regulates the 2-3 accumulator valve against torque signal fluid pressure. This allows excess secondary 2-3 accumulator fluid to exhaust and provides additional control for the third clutch apply.

2d Accumulator Boost Valve:
3rd clutch fluid is also routed to the accumulator boost valve. 3rd clutch fluid pressure, together with torque signal fluid pressure, moves the accumulator boost valve and the 1-2/3-4 accumulator valve against orificed primary accumulator fluid pressure to increase the amount of line pressure fed into the primary accumulator circuit.

3 TORQUE CONVERTER CLUTCH RELEASED

3a TCC Solenoid Valve:
3rd clutch fluid is also directed to the TCC solenoid valve. Figure 64 shows the TCC solenoid valve de-energized, thereby blocking 3rd clutch fluid from entering the TCC control circuit at the solenoid. This keeps the torque converter clutch in the released position under normal operating conditions (see page 50 in the Electrical Components section for more information).

4 PREPARATION FOR SHIFT TO FOURTH GEAR:

3rd clutch fluid is also routed through orifice #11 to the 3-4 shift valve in preparation for a shift to 4th gear.

COMPLETE HYDRAULIC CIRCUIT
Page 92

OVERDRIVE RANGE – THIRD GEAR

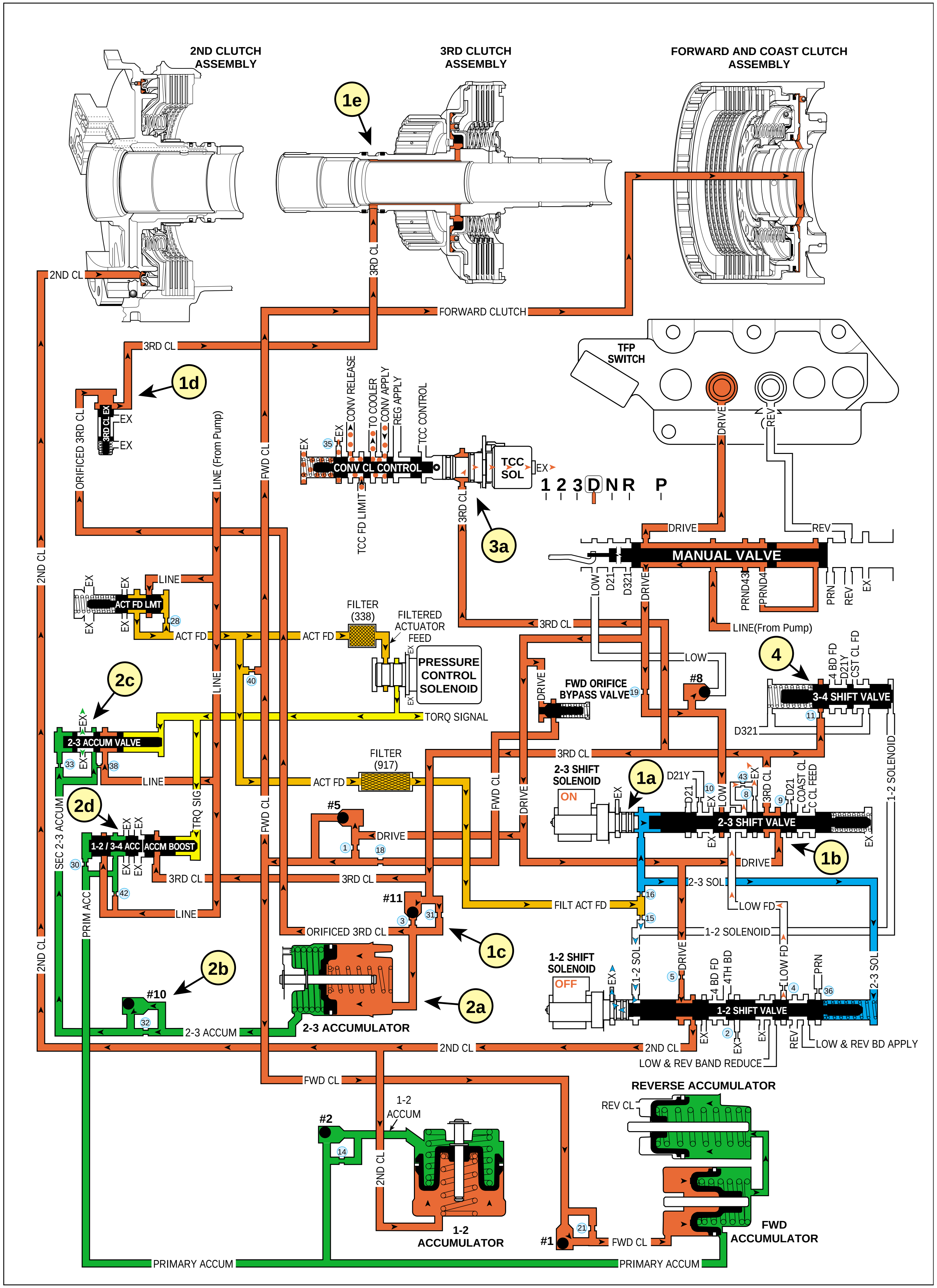


Figure 64

OVERDRIVE RANGE – FOURTH GEAR

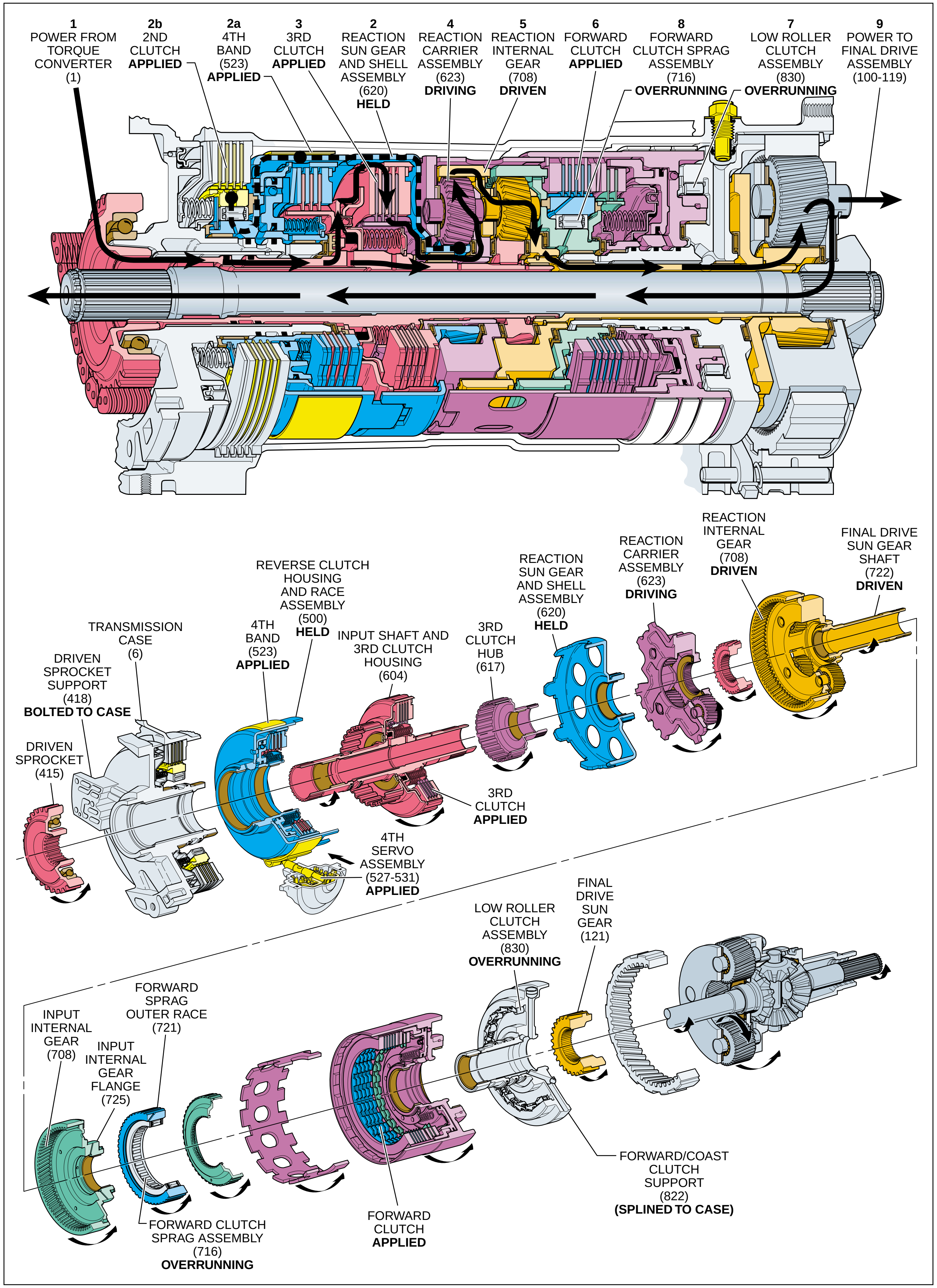


Figure 65

OVERDIVE RANGE – FOURTH GEAR

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	ON	APPLIED			APPLIED	APPLIED	OVERRUN	APPLIED			OVERRUN

As the speed of the vehicle increases, input signals from the vehicle speed sensor (VSS), throttle position (TP) sensor and other sensors are sent to the powertrain control module (PCM). The PCM uses this information to manage engine torque as the transmission shifts from third to fourth gear. In Overdrive Range – Fourth gear, the planetary gear sets operate in overdrive at a gear ratio of 0.68:1. This allows the vehicle to maintain a given road speed with less engine output speed, maximizing engine performance and fuel economy.

1 **Power from Torque Converter**
The driven sprocket (415) is splined to the input shaft and 3rd clutch housing assembly (604) and forces the housing to rotate at driven sprocket speed.

2 **Reaction Sun Gear and Shell Assembly Held**

2a 4th Band Applied
The 4th band (523) applies and holds the reverse clutch housing and race assembly (500), which is also tanged to the reaction sun gear and shell assembly (620).

2b 2nd Clutch Applied/2nd Sprag Clutch Ineffective
The 2nd clutch plates (431-435), splined to the 2nd sprag clutch outer race (516) and the transmission case (6), hold the sprag outer race. Because the reverse clutch housing and race assembly (500) is held stationary by the 4th band (523), the 2nd sprag clutch assembly (517) is ineffective.

3 **3rd Clutch Applied**
The 3rd clutch is applied and directs power flow through the input shaft and 3rd clutch housing (604) to the 3rd clutch hub (617). The 3rd clutch hub drives the reaction carrier assembly (623).

4 **Reaction Carrier Assembly Driving**
The reaction carrier planetary pinion gears (625), driven around the stationary reaction sun gear and shell assembly (620), drive the reaction internal gear/input carrier assembly (708/700).

5 **Reaction Internal Gear Driven**
The reaction carrier is driving at driven sprocket speed but, the planetary pinions force the reaction internal gear/input carrier assembly (708/700) to rotate faster than driven sprocket speed – overdriving the gear set.

6 **Forward Clutch Applied**
The forward clutch plates (816-819) are applied and hold the forward sprag outer race (721).

7 **Low Roller Clutch Overrunning**
The low roller clutch assembly (830) overruns allowing the forward and coast clutch housing (801) to rotate.

8 **Forward Clutch Sprag Overrunning**
The forward sprag outer race (721) is driven by the forward and coast clutch housing but the forward sprag clutch elements are overrunning because the input internal gear (708) is being driven faster than the forward sprag outer race (721).

9 **Power to Final Drive Assembly**
The reaction internal gear/input carrier assembly (700), splined to the final drive sun gear shaft (722), drives the final drive sun gear (121). Final drive is achieved.

Whenever the throttle is released while the vehicle is in motion, the direction of powerflow changes as the wheels provide torque input to the transmission. When the vehicle is operating in Overdrive Range – Fourth gear and the throttle is released, engine compression braking slows the vehicle instead of initiating a coast condition. Since there are no roller or sprag clutches used in driving the vehicle during fourth gear acceleration there are no elements to overrun during coast. Engine RPM may be too low to provide noticeable engine braking.

In fourth gear and with zero throttle, the reaction carrier assembly (623) is driven around the stationary reaction sun gear and shell assembly (620) by the reaction internal gear (708). This attempts to drive the 3rd clutch hub (617) and the input shaft and 3rd clutch housing (604). Since the driven sprocket (415) is splined to the input shaft and 3rd clutch housing (604), engine compression provides resistance to the powerflow input from the wheels.

OVERDRIVE RANGE – FOURTH GEAR

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	ON	APPLIED			APPLIED	APPLIED	OVERRUN	APPLIED			OVERRUN

Overdrive Range – Fourth Gear is used to maximize engine efficiency and fuel economy under most normal driving conditions. In order to shift the transmission into Fourth gear, the PCM receives input signals from engine and transmission sensors. The PCM uses this data to determine the precise moment to energize or "turn ON" the 1-2 shift solenoid (SS) valve. The 1-2 SS valve is ON when the PCM provides a path to ground for that electrical circuit. This prevents 1-2 solenoid fluid from exhausting at the 1-2 SS valve, thereby increasing 1-2 solenoid fluid pressure.

1 4TH BAND APPLY

1a 1-2 Shift Solenoid (SS) Valve Energized:
The normally open 1-2 SS valve is energized by the PCM and blocks 1-2 solenoid fluid from exhausting. 1-2 solenoid fluid pressure is routed to both the 1-2 and 3-4 shift valves.

1b 3-4 Shift Valve:
1-2 solenoid fluid pressure moves the valve against spring force and into the Fourth gear position. 3rd clutch fluid is routed into the 4th band feed fluid circuit.

1c 1-2 Shift Valve:
The 1-2 shift valve remains in the upshifted position because 1-2 solenoid fluid pressure is not great enough to overcome spring force and 2-3 signal fluid pressure. 4th band feed fluid passes through the valve into the 4th band fluid circuit.

1d 4th Servo:
4th band fluid pressure passes through a feed hole in the 4th servo pin and acts on the servo piston to move the servo pin and apply the 4th band.

2 SHIFT ACCUMULATION

2a 3-4 Accumulator:
4th band fluid is also routed to the 3-4 accumulator piston. 4th band fluid pressure moves the piston against spring force and 3-4 accumulator fluid pressure. This action absorbs initial 4th band fluid pressure to cushion the 4th band apply.

2b # 3 Ball Check Valve:
3-4 accumulator fluid, forced out of the 3-4 accumulator when 4th band fluid moves the 3-4 accumulator piston, unseats the #3 ball check valve and enters the primary accumulator fluid circuit.

2c 1-2/3-4 Accumulator Valve:
Primary accumulator fluid is routed back to the 1-2/3-4 accumulator valve. Orificed primary accumulator fluid pressure regulates the 1-2/3-4 accumulator valve against torque signal fluid pressure. This allows excess primary accumulator fluid to exhaust and provides additional control for the 4th band apply.

3 TORQUE CONVERTER CLUTCH RELEASED

3a TCC Solenoid Valve:
Figure 66 shows the TCC solenoid valve de-energized by the PCM. When conditions are appropriate, the PCM energizes the TCC solenoid valve to initiate the TCC apply. The solenoid is pulse width modulated (PWM) to provide a smooth apply of the torque converter clutch (refer to pages 70-71 for a detailed description of TCC apply).

COMPLETE HYDRAULIC CIRCUIT
Page 94

OVERDRIVE RANGE – FOURTH GEAR

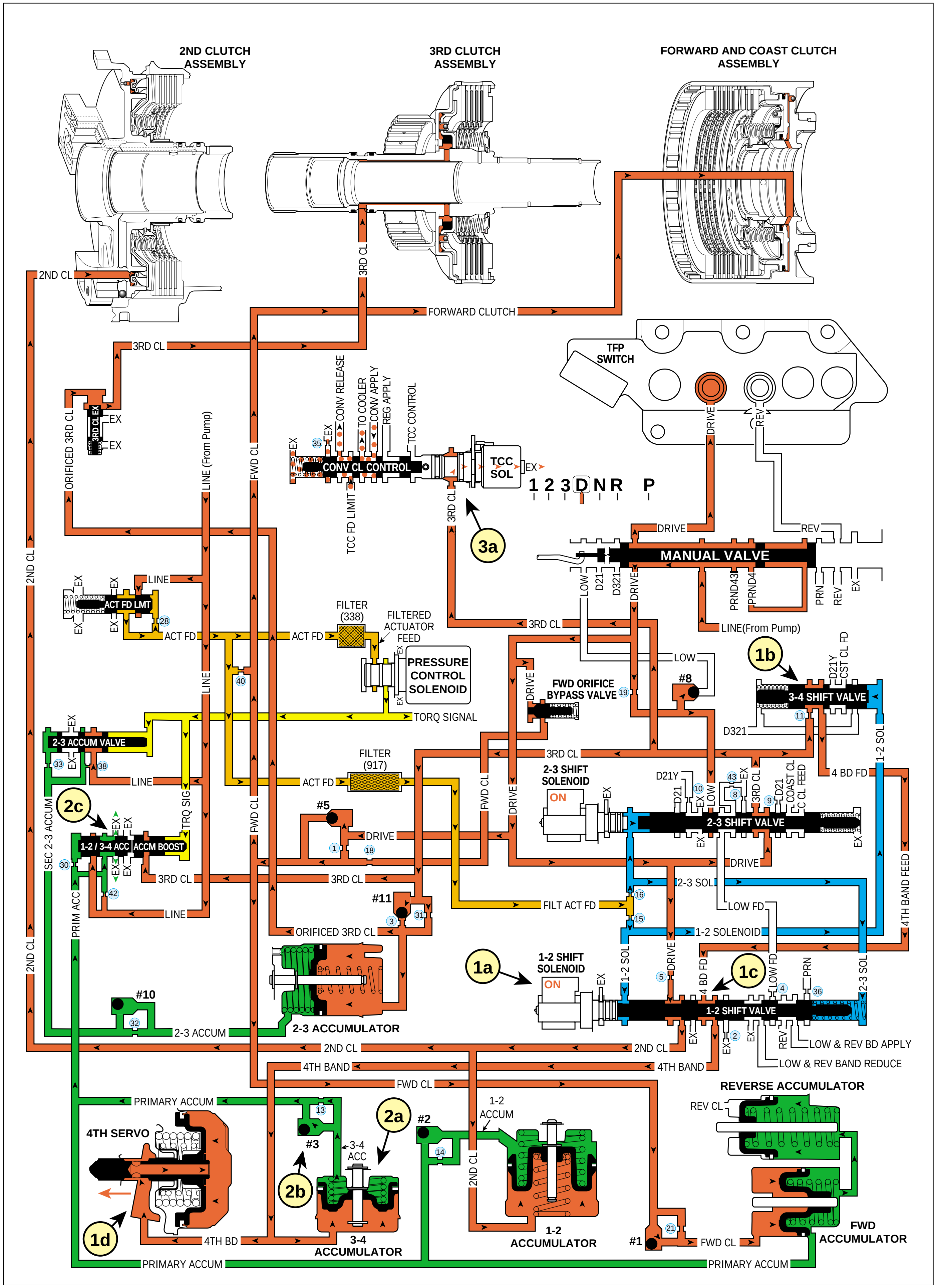


Figure 66

OVERDRIVE RANGE – FOURTH GEAR

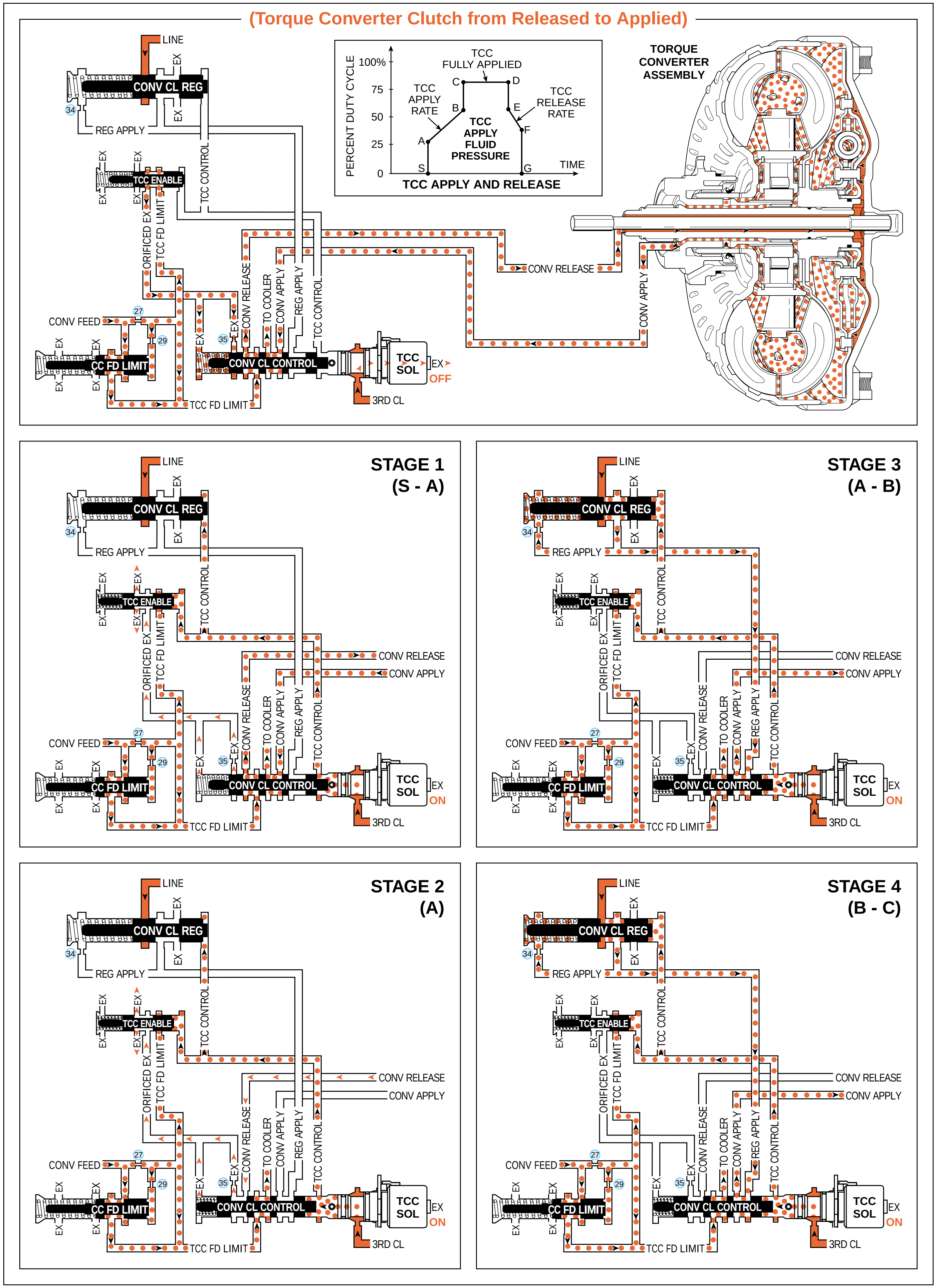


Figure 67

OVERDRIVE RANGE – FOURTH GEAR

(Torque Converter Clutch from Released to Applied)

When the powertrain control module (PCM) determines that the engine and transmission are operating properly to engage the torque converter clutch (TCC), the PCM energizes the torque converter clutch solenoid. The following events occur in order to apply the torque converter clutch:

OFF At this time the Torque Converter Clutch is considered to be disengaged (OFF).

PCM decision to apply TCC/VCC (see page 50, in the Electrical Components section for more information).

Stage 1 The PCM pulses the TCC solenoid duty cycle from point **S** to point **A**. Third clutch fluid at the TCC solenoid is "pulsed" into the TCC control circuit. This causes the TCC control pressure to rise moving the TCC enable valve toward its spring. The TCC control pressure at point **A** is not strong enough to move the converter clutch control valve against TCC feed limit fluid pressure and the spring (316). This stage is designed to exhaust TCC feed limit pressure from behind the converter clutch control valve.

Stage 2 At the end of stage 1, the fluid pressure is exhausted from the orificed exhaust passage. The pressure at point **A** in the TCC control circuit is now strong enough to move the converter clutch control valve to the applied position (toward its spring).

Stage 3 The TCC solenoid duty cycle is ramped up through this stage. As TCC control is increased from point **A** to point **B**, line pressure at the converter clutch regulator valve passes through the valve and enters the regulated apply circuit. The regulated apply pressure starts at "0" and increases for a short time. The pressure value in the regulated apply circuit should now be high enough to fully apply the converter clutch pressure plate. Slip speed should be at the correct value (near "0" on TCC models, a small amount on VCC models).

- Converter apply fluid is routed through the case cover and into the drive sprocket support.
- Converter apply fluid then passes between the drive sprocket support and the turbine shaft to a feed hole in the drive sprocket where it enters the torque converter.
- Converter apply fluid pressure then forces the converter clutch pressure plate against the converter cover.
- As the torque converter clutch applies, fluid from the release side of the converter clutch pressure plate is redirected between the oil pump drive shaft and turbine shaft into the converter release circuit.
- Converter release fluid is routed to the converter clutch control valve which was previously positioned to allow the release fluid to pass through the valve into the orificed exhaust circuit.
- Orificed exhaust is then routed to the TCC enable valve which directs fluid to an open exhaust port.

Stage 4 Now the regulated apply pressure is increased. This is caused by the TCC solenoid duty cycle being increased from point **B** to point **C**. This extra pressure ensures that the apply force on the converter clutch pressure plate is not at the slip threshold, but a little above it. TCC/VCC plate material is therefore protected from damage due to slippage.

- TCC feed limit fluid at the converter clutch control valve passes through the valve and enters the "to cooler" circuit.
- "To cooler" fluid is routed through the case and transferred through cooler lines to a transmission cooler inside the engine radiator.
- Then the fluid exits the cooler as lube and is transferred by cooler lines into the lubrication circuits throughout the transmission.

OVERDRIVE RANGE – FOURTH GEAR

(Torque Converter Clutch from Applied to Released)

When the torque converter clutch pressure plate is applied, it is held against the torque converter cover. Since it is splined to the converter turbine hub, it provides a mechanical coupling (direct drive) of the engine to the transmission gear sets. This mechanical coupling eliminates the small amount of slippage that occurs in the fluid coupling of a torque converter, resulting in a more efficient transfer of engine torque through the transmission and to the drive wheels.

ON At this time the Torque Converter Clutch is considered to be engaged (ON).

PCM decision to release TCC/VCC (see page 50, in the Electrical Components section for more information).

Stage 5 During of this stage, the apply pressure from the converter clutch regulator valve is decreased by the TCC solenoid duty cycle dropping from point **D** to point **E**. The amount of decrease is to bring the apply force on the converter clutch pressure plate to the slip threshold. This gets the converter clutch pressure plate ready for a smooth release.

Stage 6 The TCC solenoid duty cycle is ramped down from point **E** to point **F** through this stage. This action allows the regulated apply pressure to start at the slip threshold, and decrease to near "0" pressure over a very short time to point **F**. The regulated apply pressure value from the converter clutch regulator valve at this duty cycle (point **F**) should fully release the converter clutch pressure plate. Slip speed should be at the maximum value.

Stage 7 Now the TCC Control pressure is decreased by the TCC solenoid duty cycle lowering from point **F** to point **G**. This amount is to allow the converter clutch control valve to move to the released position (away from its spring). Converter fluid flow should now be re-established.

Stage 8 The PCM pulses the TCC solenoid to a value at point **G**, which is "0". This causes the TCC enable valve to move away from its spring. TCC feed limit fluid pressure will combine with the spring (316) helping push the converter clutch control valve to the **OFF** position (if there was any sticking of the converter clutch control valve).

OFF At this time the Torque Converter Clutch is considered to be disengaged (OFF).

(Some PCM calibrations may allow stages 5 - 8 to happen very rapidly in almost a straight line down from point **D** to point **G**.)

The PCM monitors for high TCC slip in second and third gears only. The transmission must be in hot mode or experiencing a wide open throttle maneuver in order for the TCC to be commanded on in second and third gear. If the PCM detects high TCC slip when the TCC is commanded ON, then Diagnostic Trouble Code (DTC) P0741 will set and the PCM will illuminate the malfunction indicator lamp (MIL), inhibit TCC operation, increase line pressure and inhibit 4th gear. The DTC P0741 will then be stored in PCM history. If the PCM detects low TCC slip when the TCC is commanded OFF, then DTC P0742 will set and the PCM will illuminate the malfunction indicator lamp (MIL), increase line pressure and freeze shift adapts. The DTC P0742 will then be stored in PCM history.

COMPLETE HYDRAULIC CIRCUIT
Page 94

OVERDRIVE RANGE – FOURTH GEAR

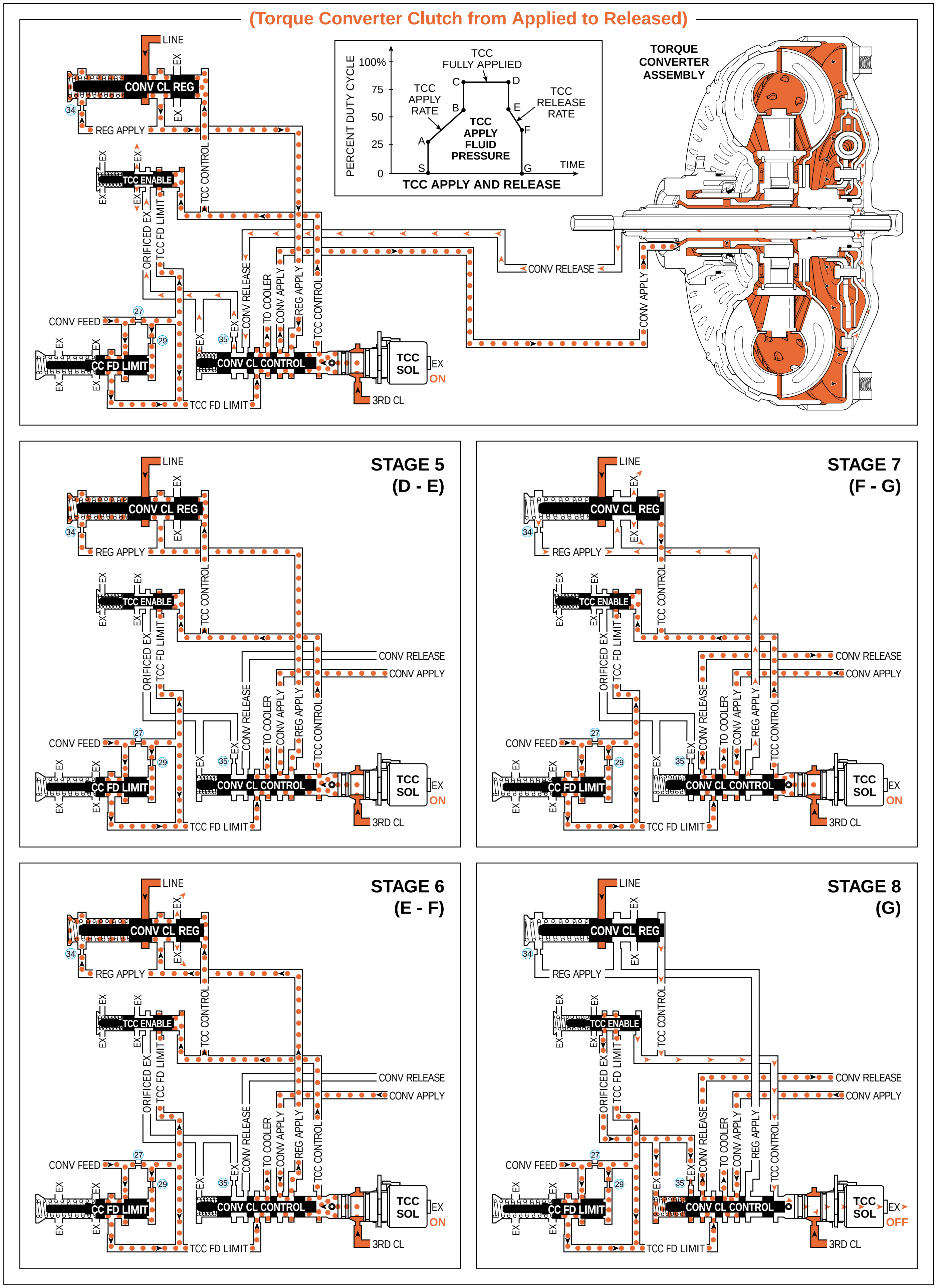


Figure 68

OVERDRIVE RANGE – 4-3 DOWNSHIFT

(Torque Converter Clutch Released)

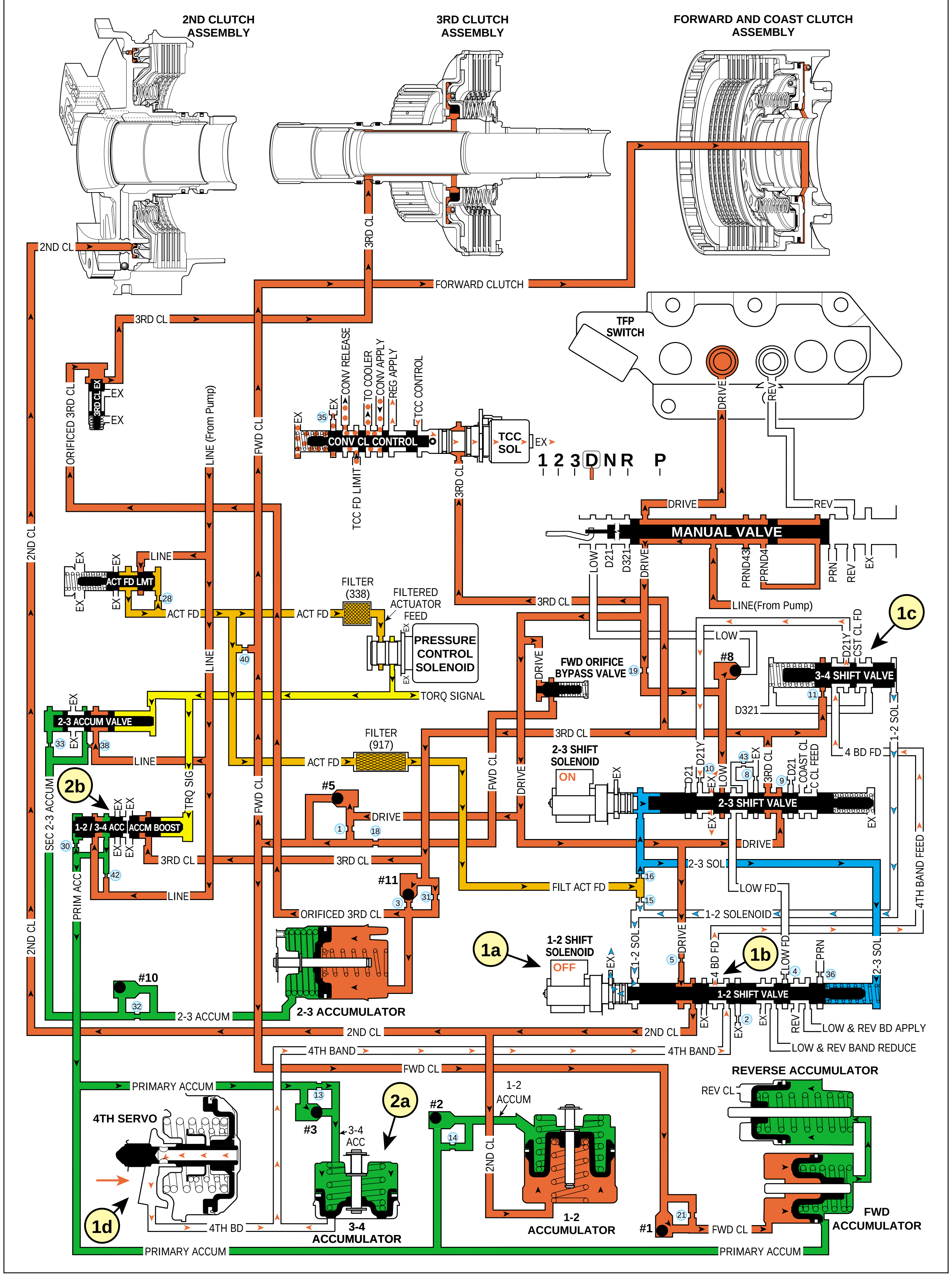


Figure 69

OVERDRIVE RANGE – 4-3 DOWNSHIFT

(Torque Converter Clutch Released)

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	ON	APPLIED	OVERRUN		APPLIED		HOLDING	APPLIED			OVERRUN

A forced 4-3 downshift in Overdrive range occurs by increasing the throttle valve angle (percentage of accelerator pedal travel or throttle position) while the vehicle is operating in Fourth gear. A 4-3 downshift can also occur when the vehicle is decelerating during coast conditions or when load on the vehicle is increased. Also, if the TCC is applied in Fourth gear it will release prior to the transmission making a 4-3 downshift. Under normal operating conditions the PCM will keep the converter clutch released in Third gear. The TCC also releases under minimum and heavy throttle conditions. Figure 69 shows the TCC (PWM) solenoid valve de-energized and the TCC released. Refer to pages 70A and 70B for descriptions of the torque converter clutch hydraulic and electrical circuits during release and apply.

A 4-3 downshift occurs when the PCM receives the appropriate input signals to de-energize or "turn OFF" current supply to the 1-2 shift solenoid (SS) valve (opens the ground path of the circuit). During a 4-3 downshift, the following changes occur to the hydraulic system:

1 4TH BAND RELEASES

1a 1-2 Shift Solenoid (SS) Valve De-energized:
1-2 solenoid fluid exhausts through the 1-2 SS valve and allows the 3-4 shift valve to move to the downshifted position.

1b 1-2 Shift Valve:
The 1-2 shift valve remains in the upshifted position due to 2-3 solenoid fluid pressure and 1-2 shift valve spring force.

1c 3-4 Shift Valve:
Spring force moves the 3-4 shift valve to the downshifted position. This blocks 3rd clutch fluid at the 3-4 shift valve and opens the 4th band feed fluid circuit to exhaust into the D21Y circuit. 4th band feed fluid then passes through orifice #10 and exhausts at the 2-3 shift valve.

1d 4th Servo:
4th band fluid exhausts from the 4th servo and the 3-4 accumulator, thus releasing the 4th band and changing the power flow through the transmission to a Third gear ratio.

2 SHIFT ACCUMULATION

2a 3-4 Accumulator:
3-4 accumulator fluid fills the 3-4 accumulator when 4th band fluid is exhausting. 3-4 accumulator fluid pressure combines with spring force to move the 3-4 accumulator piston to a Third gear position.

2b 1-2/3-4 Accumulator Valve:
The 3-4 accumulator circuit is supplied by primary accumulator fluid through orifice #13 opposite the #3 ball check valve. The 1-2/3-4 accumulator valve regulates line fluid into the primary accumulator circuit.

Note: Remember that the pressure control (PC) solenoid valve controls torque signal fluid pressure in relation to throttle position and other PCM input signals. Torque signal fluid pressure helps control line pressure by acting on the pressure regulator boost valve, thereby increasing line pressure with increased throttle position. Also, torque signal fluid pressure helps regulate line fluid into primary accumulator pressure at the 1-2/3-4 accumulator valve.

COMPLETE HYDRAULIC CIRCUIT
Page 96

OVERDRIVE RANGE – 3-2 DOWNSHIFT

(Valves Shown in Second Gear Position)

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	OFF	APPLIED	HOLDING				HOLDING	APPLIED			OVERRUN

A forced 3-2 downshift occurs by increasing throttle valve angle (percentage of accelerator pedal travel or throttle position) while the vehicle is operating in Third gear. As with a 4-3 downshift, a 3-2 downshift can also occur when the vehicle is decelerating during coast conditions or when load on the vehicle increases.

A 3-2 downshift occurs when the PCM receives the appropriate input signals to de-energize or "turn OFF" current supply to the 2-3 shift solenoid (SS) valve (open the ground path of the circuit). During a 3-2 downshift, the following changes occur to the hydraulic system:

1 3RD CLUTCH RELEASES

1a 2-3 Shift Solenoid (SS) Valve De-energized:
2-3 solenoid fluid exhausts through the 2-3 SS valve and allows the 2-3 shift valve to move to the downshifted position.

1b 2-3 Shift Valve:
2-3 shift valve spring force moves the 2-3 shift valve to the downshifted position. This opens the 3rd clutch circuit to an orificed exhaust.

1c 3rd Clutch Assembly:
3rd clutch fluid exhausts from the 3rd clutch piston, allowing the 3rd clutch plates to release. This changes the power flow through the transmission gear sets from a Third gear to a Second gear ratio.

1d 3rd Clutch Exhaust Valve:
3rd clutch fluid exhausts into the orificed 3rd clutch circuit allowing spring force to move the valve to the downshifted position. This allows 3rd clutch fluid to make a quick exhaust at the valve.

1e #11 Ball Check Valve:
Orificed 3rd clutch fluid unseats the #11 ball check valve and flows into the 3rd clutch circuit to the 2-3 shift valve where it exhausts.

2 SHIFT ACCUMULATION

2a 2-3 Accumulator:
Orificed 3rd clutch fluid in the 2-3 accumulator also exhausts past the #11 ball check valve and into the 3rd clutch circuit. With 3rd clutch fluid exhausting, 2-3 accumulator fluid fills the 2-3 accumulator. 2-3 accumulator fluid pressure and spring force move the 2-3 accumulator piston to a Second gear position.

2b 2-3 Accumulator Valve:
The 2-3 accumulator fluid circuit is supplied by secondary 2-3 accumulator fluid through orifice #32 opposite the #10 ball check valve. The 2-3 accumulator valve regulates line fluid into the secondary 2-3 accumulator circuit.

Note: Remember that the pressure control (PC) solenoid valve controls torque signal fluid pressure in relation to throttle position and other PCM input signals. Torque signal fluid pressure helps control line pressure by acting on the pressure regulator boost valve, thereby increasing line pressure with increased throttle position. Also, torque signal fluid pressure helps regulate line fluid into secondary 2-3 accumulator pressure at the 2-3 accumulator valve.

OVERDRIVE RANGE – 3-2 DOWNSHIFT

(Valves Shown in Second Gear Position)

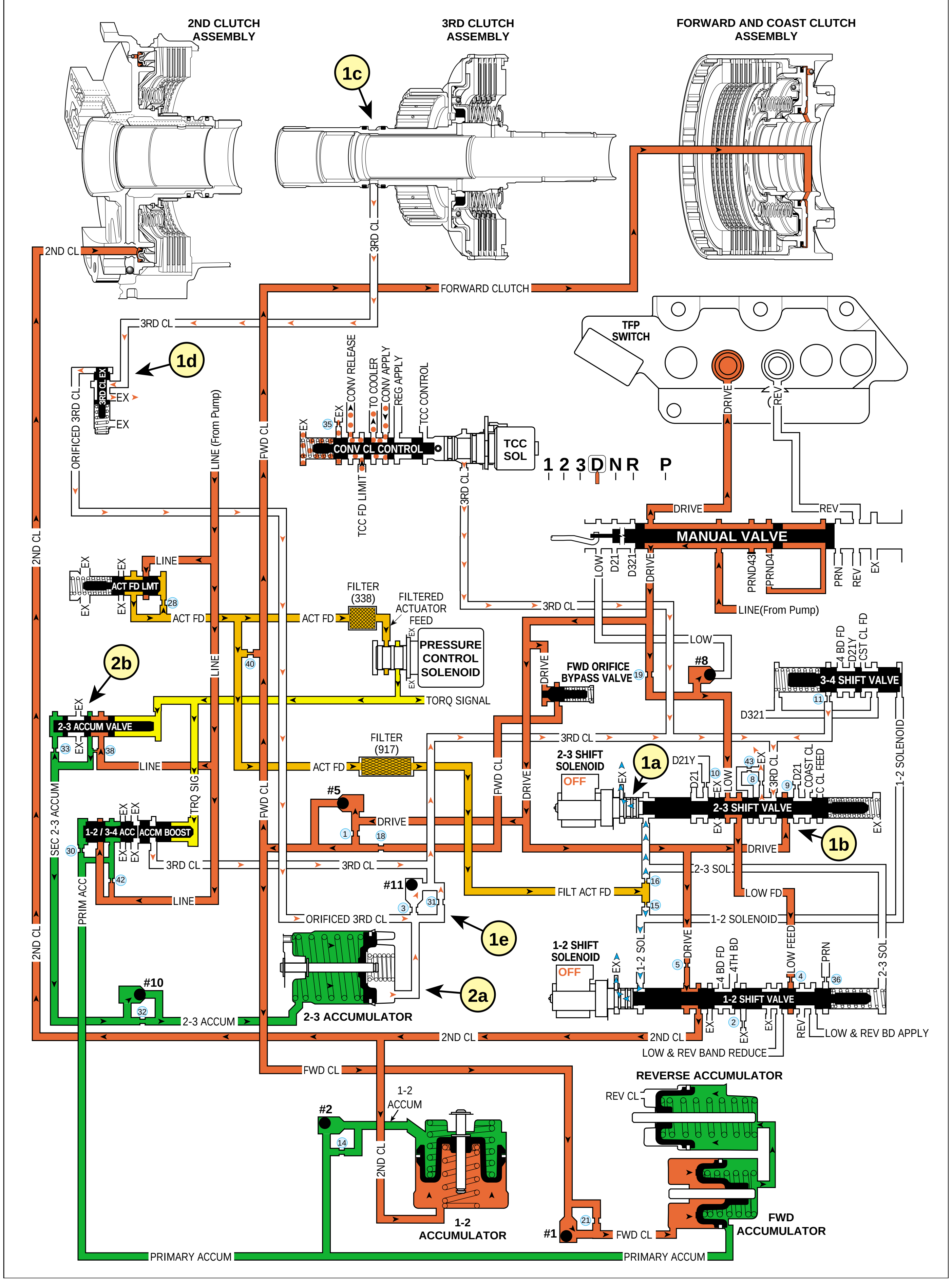


Figure 70

DRIVE RANGE – MANUAL THIRD

(from Overdrive Range – Fourth Gear)

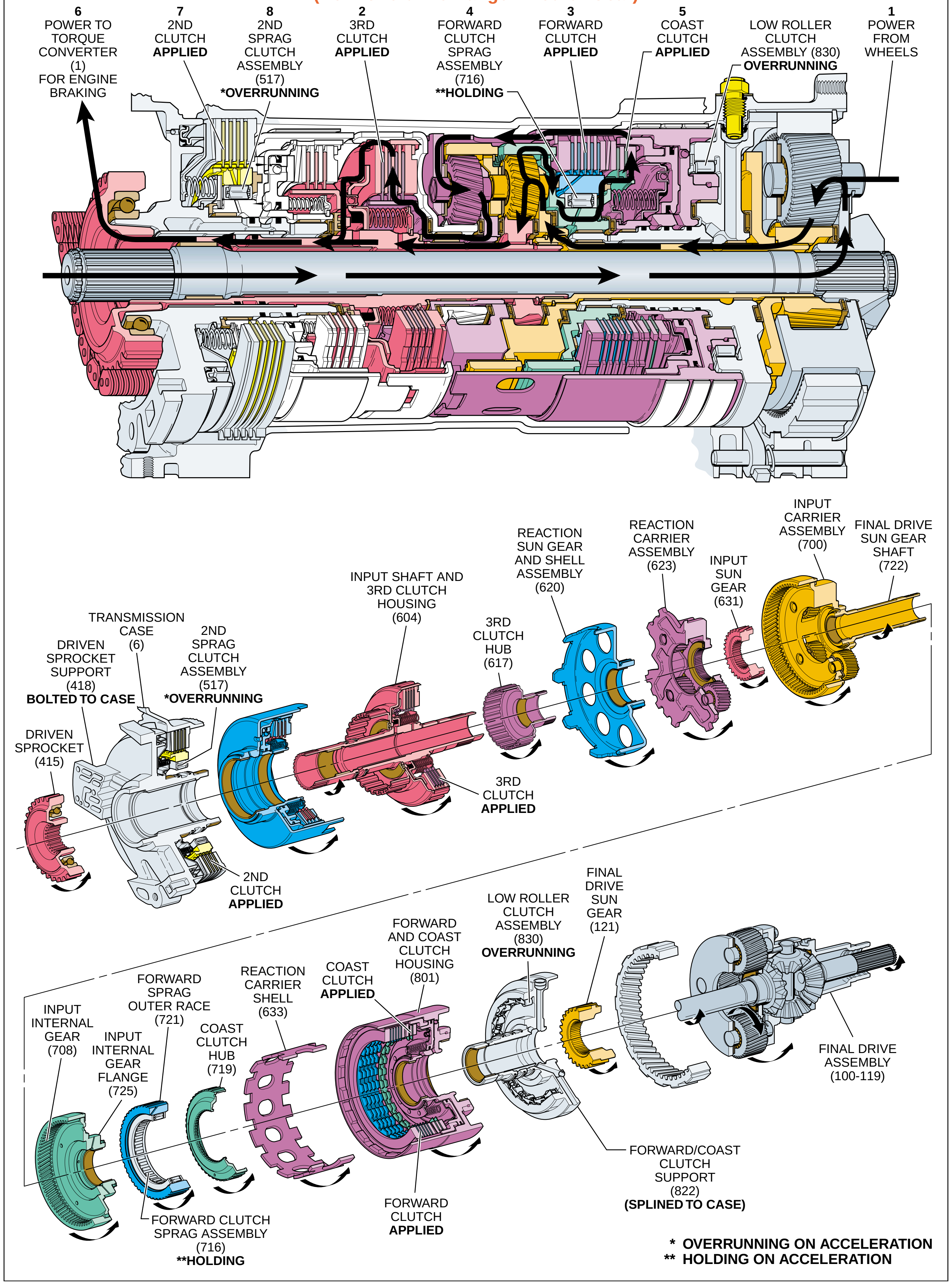


Figure 71

DRIVE RANGE – MANUAL THIRD

(from Overdrive Range – Fourth Gear)

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	ON	APPLIED	OVERRUN		APPLIED		HOLDING	APPLIED	APPLIED		OVERRUN

Drive Range – Manual Third (3) is available to the driver when vehicle operating conditions make it desirable to use only three gear ratios. These conditions include city driving [where speeds are generally below 72 km/h (45 mph)], towing a trailer, or driving in hilly terrain. Manual Third also provides for engine compression braking when descending slight grades and can be used to retain Third gear when ascending slight grades for additional engine performance. Manual Third is also referred to as Drive Range because it has a 1:1 direct drive gear ratio available through the transmission gear sets.

In Manual Third, the transmission can upshift and downshift between First, Second and Third gears in the same manner as Overdrive Range. However, the transmission is prevented from shifting into Fourth gear while operating in this gear selector position. If the transmission is in Overdrive Range – Fourth gear when Manual Third is selected, the transmission will shift immediately into Third gear.

The acceleration power flow for Manual Third is identical to Overdrive Range – Third gear with the exception that the coast clutch is applied to provide engine braking when the throttle is released. Therefore, in the following text, we will discuss and illustrate deceleration (engine braking). You will note that the power flow is backwards from the power flow in Overdrive Range – Third gear, with power coming from the wheels and going to the torque converter.

- The manual shaft (16) ,detent lever (17) and manual valve (916) are moved into the "3" range position – Manual Third.

1 Power from the Wheels
Power from the wheels is transferred back through the transmission from the final drive differential assembly (100-119) to the input shaft and 3rd clutch housing (604). Each of the component's function and rotation direction is the same as during acceleration (compare Figures 63 and 71).

2 3rd Clutch Applied
The 3rd clutch plates (610-613) are applied and connect the input shaft and 3rd clutch housing assembly (604) to the forward and coast clutch housing (801) through the 3rd clutch hub (617), the reaction carrier assembly (623), and the reaction carrier shell (633).

3 Forward Clutch Applied
The forward clutch applies and links the forward sprag outer race (721) to the forward and coast clutch housing (801).

4 Forward Clutch Sprag Holding
During deceleration, the input torque from the wheels to the gear sets attempts to rotate the input internal gear flange (725) faster than the forward sprag outer race (721). This condition would cause the sprag elements to overrun and allow the vehicle to coast freely. The coast clutch prevents this condition from occurring by directing torque through the coast clutch hub (719) to the gear sets and providing engine compression braking.

5 Coast Clutch Applied
The coast clutch plates (812-814) are applied and connect the forward and coast clutch housing (801) to the coast clutch hub (719). The input internal gear/input internal gear flange (708/725) is splined to the coast clutch hub (719). This prevents the forward clutch sprag from overrunning and creates a 1:1 direct drive gear ratio through the gear sets.

6 Power to Torque Converter for Engine Braking
The input shaft and 3rd clutch housing assembly (604) is connected to the turbine shaft through the drive link assembly and the drive and driven sprockets. This creates a mechanical link between the final drive differential assembly and the torque converter turbine. This allows engine compression to slow the vehicle when the throttle is released.

7 2nd Clutch Applied
The 2nd clutch is applied and holds the 2nd sprag clutch outer race (516) stationary to the transmission case (6).

8 2nd Sprag Clutch Overrunning
During deceleration, the input torque from the wheels to the gear sets attempts to rotate the reaction sun gear and shell assembly (620) and the reverse clutch housing and race assembly (523) in a direction opposite of engine rotation. The 2nd sprag clutch elements hold the reverse clutch housing and race assembly (500), and the reaction sun gear and shell assembly (620), to prevent torque loss through the gear sets.

DRIVE RANGE – MANUAL THIRD

(from Overdrive Range – Fourth Gear)

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	ON	APPLIED	OVERRUN		APPLIED		HOLDING	APPLIED	APPLIED		OVERRUN

Drive Range – Manual Third may be selected at any time while the vehicle is being operated in a forward gear range. However, the transmissions hydraulic system prevents the transmission from shifting into Fourth gear regardless of PCM control. When the gear selector lever is moved to Drive Range (3) from Overdrive Range Ⓓ, the manual valve also moves. Changes to the hydraulic and electrical systems are as follows:

1 MANUAL VALVE

Line pressure enters the D321 fluid circuit at the manual valve. Line pressure is blocked by the manual valve from entering the PRND4 fluid circuit. This opens PRND4 fluid to an exhaust port at the manual valve.

2 4TH BAND RELEASES

2a 1-2 Shift Solenoid (SS) Valve De-energized:
1-2 solenoid fluid exhausts through the 1-2 SS valve and allows the 3-4 shift valve to move to the downshifted position.

2b 1-2 Shift Valve:
The 1-2 shift valve remains in the upshifted position due to 2-3 solenoid fluid pressure and 1-2 shift valve spring force.

2c 3-4 Shift Valve:
Spring force moves the 3-4 shift valve to the downshifted position. This blocks 3rd clutch fluid at the 3-4 shift valve and opens the 4th band feed fluid circuit to exhaust into the D21Y circuit. 4th band feed fluid then passes through orifice #10 and exhausts at the 2-3 shift valve.

2d 4th Servo:
4th band fluid exhausts from the 4th servo and the 3-4 accumulator, thus releasing the 4th band and changing the power flow through the transmission to a Third gear ratio.

3 COAST CLUTCH APPLIES

3a 3-4 Shift Valve:
D321 fluid is routed from the manual valve and passes through the 3-4 shift valve into the coast clutch feed circuit. D321 also assists spring force in keeping the 3-4 shift valve in the Third gear position. This hydraulically prevents the transmission from shifting into fourth gear.

3b #9 Ball Check Valve:
Coast clutch feed fluid seats the #9 ball check valve and is forced through orifice #7 to help control coast clutch apply.

3c 2-3 Shift Valve:
Coast clutch feed fluid passes through the 2-3 shift valve into the coast clutch circuit.

3d Coast Clutch Applies:
Coast clutch fluid is directed to the coast clutch piston to apply the coast clutch plates.

4 SHIFT ACCUMULATION – Same as 4-3 Downshift

In Manual Third – Third Gear, the TCC will release if Manual Third was selected while the vehicle was operating in Overdrive Range – Fourth Gear with the TCC applied. However, under normal operating conditions, the converter clutch will re-apply in Manual Third – Third Gear. Refer to pages 70A and 70B for descriptions of TCC release and apply.

In the manual gear ranges, the PCM output signal to the pressure control (PC) solenoid valve increases torque signal fluid pressure further for the added torque requirements during engine compression braking or increased engine load. Torque signal fluid acts on the pressure regulator boost valve to increase line pressure according to vehicle operating conditions.

COMPLETE HYDRAULIC CIRCUIT
Page 98

DRIVE RANGE – MANUAL THIRD

(from Overdrive Range – Fourth Gear)

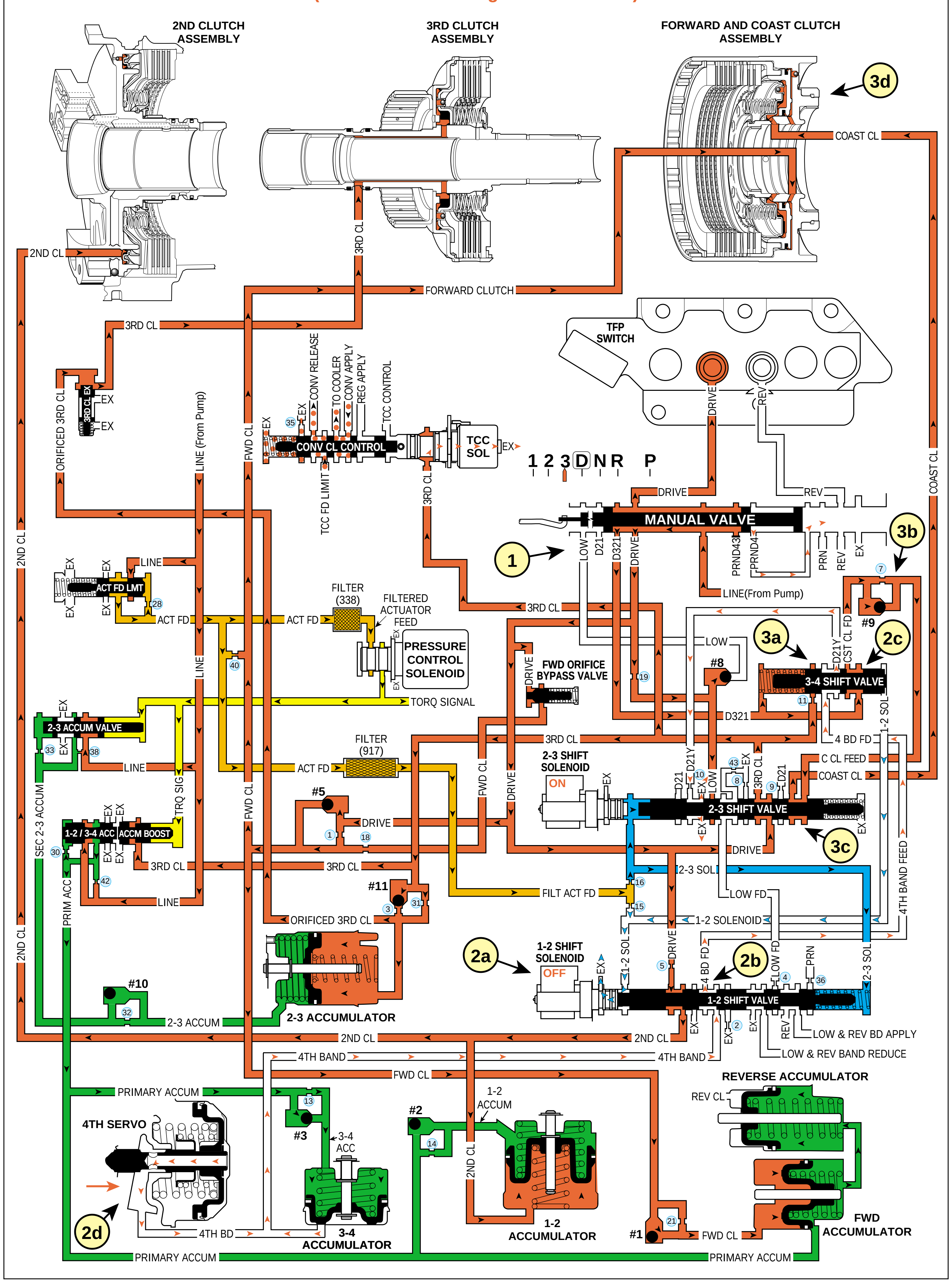


Figure 72

DRIVE RANGE – MANUAL SECOND

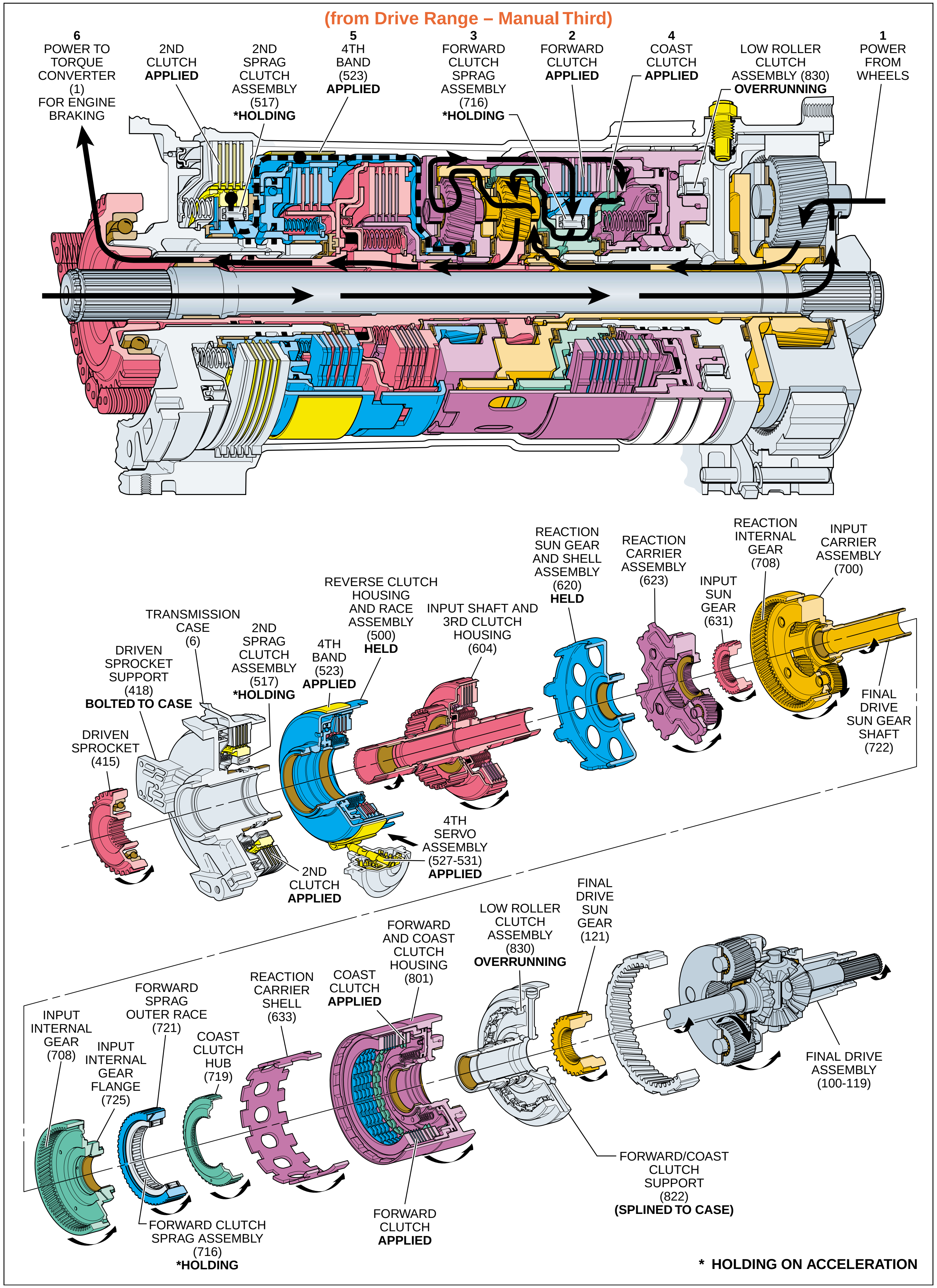


Figure 73

DRIVE RANGE – MANUAL SECOND

(from Drive Range – Manual Third)

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	OFF	APPLIED	HOLDING			APPLIED	HOLDING	APPLIED	APPLIED		OVERRUN

Drive Range – Manual Second (2) is available to the driver when vehicle operating conditions make it desirable to use only two gear ratios. These conditions include descending a steep grade when engine compression braking is need, or to retain Second gear when ascending a steep grade for additional engine performance.

In Manual Second, the transmission can upshift and downshift between First and Second gear but is prevented from shifting into Third and Fourth gear. If the transmission is in Third or Fourth gear when Manual Second is selected, the transmission will shift immediately into Second gear.

The acceleration power flow for Manual Second is identical to Overdrive Range – Second gear with the exception that the 4th band and the coast clutch are applied to provide engine braking when the throttle is released. Therefore, in the following text, we will discuss and illustrate deceleration (engine braking). You will note that the power flow is backwards from the power flow in Overdrive Range – Second gear, with power coming from the wheels and going to the torque converter.

- The manual shaft (16), detent lever (17) and manual valve (916) are moved into the "2" gear position – Manual Second.

1 Power from the Wheels
Power from the wheels is transferred back through the transmission from the final drive differential assembly (100-119) to the input shaft and 3rd clutch housing (604). Each of the component's function and rotation direction is the same as during acceleration (compare Figures 61 and 73).

2 Forward Clutch Applied
The forward clutch plates are applied and connect the reaction carrier assembly (623) to the forward and coast clutch housing (801) through the reaction carrier shell (633). The forward sprag outer race (721) is also linked to the forward and coast clutch housing.

3 Forward Clutch Sprag Holding
During deceleration, the input torque from the wheels to the gear sets attempts to rotate the input internal gear flange (725) faster than the forward sprag outer race (721). This condition would cause the sprag elements to overrun and allow the vehicle to coast freely. The coast clutch prevents this condition from occurring by directing torque through the coast clutch hub (719) to the gear sets and providing engine compression braking.

4 Coast Clutch Applied
The coast clutch plates (812-814) are applied and connect the forward and coast clutch housing (801) to the coast clutch hub (719). The coast clutch hub (719) is splined to the input internal gear/input internal gear flange (708/725). This prevents the forward clutch sprag from overrunning and forces the input carrier pinion gears to drive the input shaft and 3rd clutch housing assembly (604) through the input sun gear (631).

5 4th Band Applied
During deceleration, input torque from the wheels attempts to drive the reaction sun gear and shell assembly (620) in the same direction as engine rotation. This condition would allow the 2nd sprag clutch and the reaction sun gear and shell assembly (620) to freewheel, resulting in a loss of torque through the gear sets. Therefore, the 4th band (523) is applied and holds the reverse clutch housing and race assembly (500) stationary. The reverse clutch housing is tanged to the reaction sun gear and shell assembly (620) and prevents the reaction sun gear from freewheeling. This forces the reaction carrier assembly (623) to rotate around the stationary reaction sun gear, resulting in a 1.63:1 gear ratio through the gear sets.

6 Power to Torque Converter for Engine Braking
The input shaft and 3rd clutch housing assembly (604) is connected to the turbine shaft through the drive link assembly and the drive and driven sprockets. This creates a mechanical link between the final drive differential assembly and the torque converter turbine. This allows engine compression to slow the vehicle when the throttle is released.

DRIVE RANGE – MANUAL SECOND

(from Drive Range – Manual Third)

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	OFF	APPLIED	HOLDING			APPLIED	HOLDING	APPLIED	APPLIED		OVERRUN

Drive Range – Manual Second may be selected at any time while the vehicle is being operated in a forward gear range. However, the transmissions hydraulic system prevents the transmission from shifting above Second gear regardless of PCM control. When the gear selector lever is moved to Manual Second (2) from Drive Range – Manual Third, the manual valve also moves. Changes to the hydraulic and electrical systems are as follows:

1 MANUAL VALVE

Line pressure enters the D21 fluid circuit at the manual valve. Line pressure is blocked by the manual valve from entering the PRND43 fluid circuit. This opens PRND43 fluid to an exhaust port at the manual valve.

2 4TH BAND APPLIES

2a 2-3 Shift Solenoid (SS) Valve:
The 2-3 SS valve is de-energized and 2-3 solenoid fluid exhausts allowing the 2-3 shift valve to return to the downshifted position.

2b 2-3 Shift Valve:
D21 fluid is routed from the manual valve and passes through the 2-3 shift valve and orifice #10 into the D21Y circuit.

2c 3-4 Shift Valve:
D21Y fluid passes through the 3-4 shift valve into the 4th band feed fluid circuit.

2d 1-2 Shift Valve:
4th band feed fluid passes through the 1-2 shift valve into the 4th band fluid circuit.

2e 4th Servo:
4th band fluid pressure passes through a feed hole in the 4th servo pin and acts on the servo piston to move the servo pin and apply the 4th band.

Note: Figure 74 is shown in Second gear with the 2-3 SS valve de-energized. However, if vehicle operating conditions are such that the PCM signals a Third or Fourth gear state, the 2-3 solenoid will be energized. Thus a downshift will not occur until the vehicle speed is low enough.

3 COAST CLUTCH APPLY

3a 2-3 Shift Valve:
D21 fluid passes through orifice #9 and the 2-3 shift valve into the coast clutch circuit to replace coast clutch feed fluid and keep the coast clutch applied.

4 3RD CLUTCH RELEASES

4a 3rd Clutch Assembly:
3rd clutch fluid exhausts from the 3rd clutch piston, allowing the 3rd clutch plates to release. This changes the power flow through the transmission gear sets from a Third gear to a Second gear ratio.

4b 3rd Clutch Exhaust Valve:
3rd clutch fluid exhausts into the orificed 3rd clutch circuit allowing spring force to move the valve to the downshifted position. This allows 3rd clutch fluid to make a quick exhaust at the valve.

4c #11 Ball Check Valve:
Orificed 3rd clutch fluid unseats the #11 ball check valve and flows into the 3rd clutch circuit to the 2-3 shift valve where it exhausts.

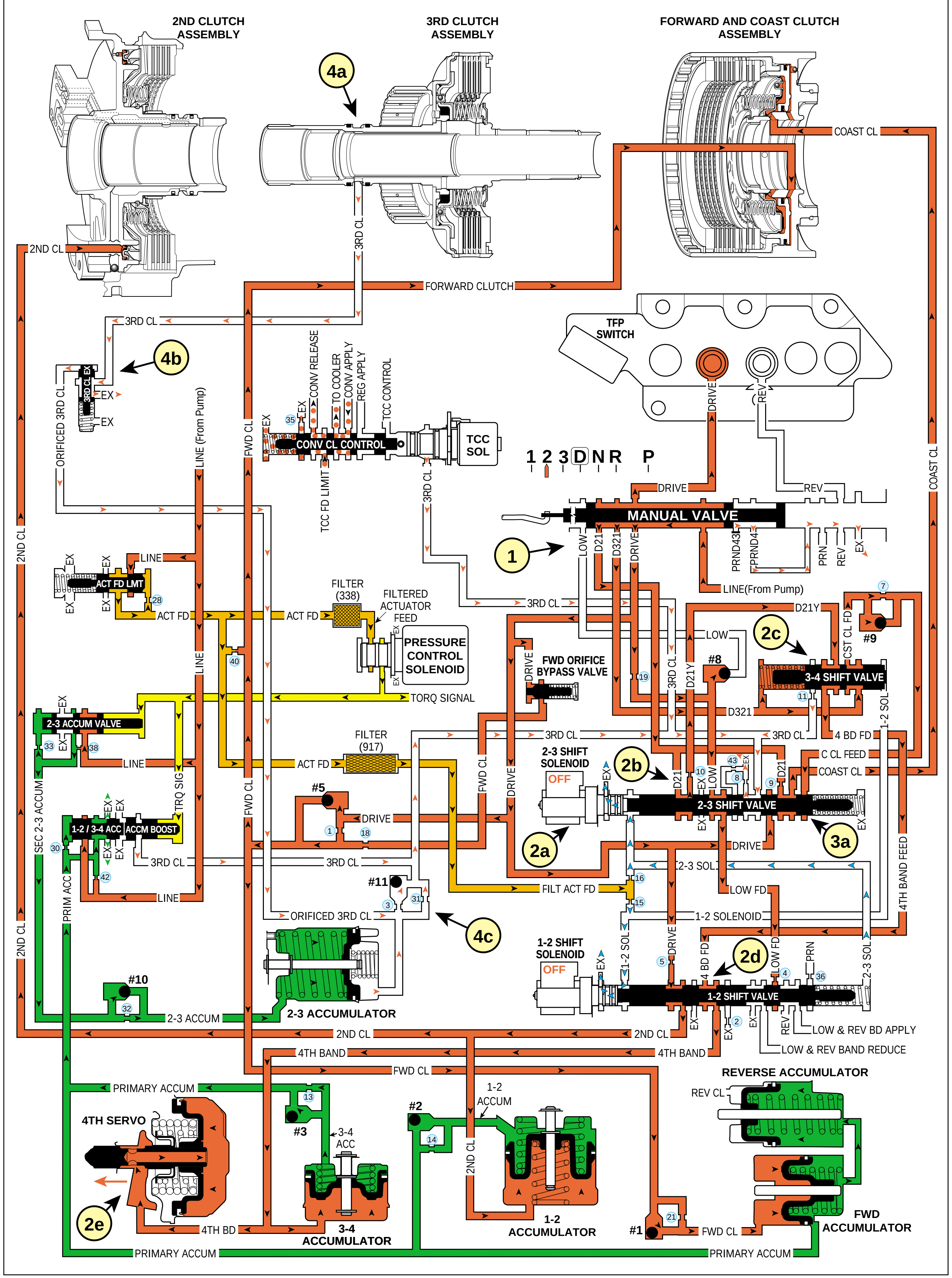
5 SHIFT ACCUMULATION – Same as 3-2 Downshift
page 72B, and Overdrive Range – Fourth Gear page 68B

In Drive Range – Manual Second, the TCC will release if the vehicle was operating in Third or Fourth Gear with the TCC applied. While operating the vehicle in Drive Range – Manual Second, the torque converter clutch will not re-apply.

COMPLETE HYDRAULIC CIRCUIT
Page 100

DRIVE RANGE – MANUAL SECOND

(from Drive Range – Manual Third)



DRIVE RANGE – MANUAL FIRST

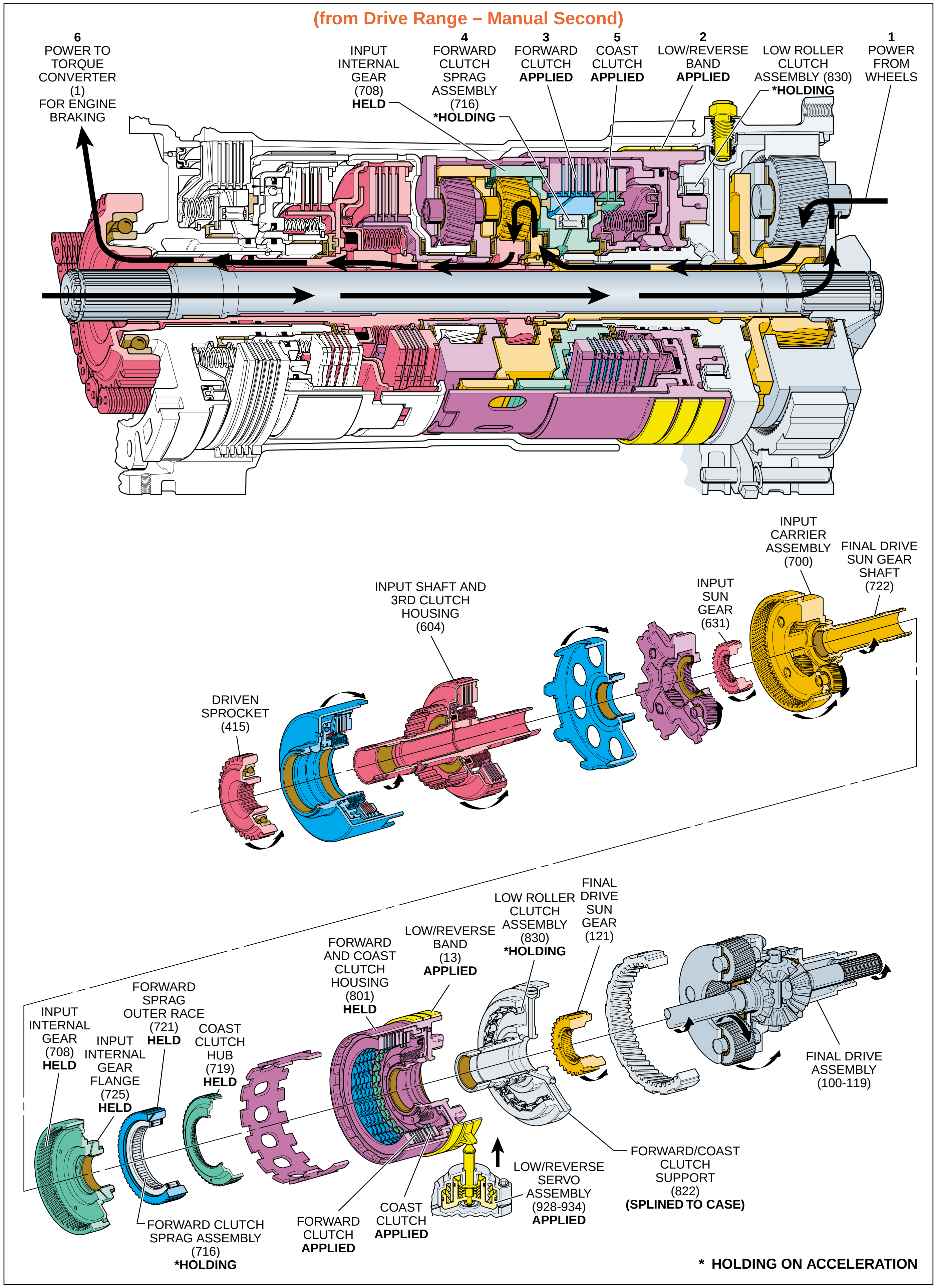


Figure 75

DRIVE RANGE – MANUAL FIRST

(from Drive Range – Manual Second)

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF						HOLDING	APPLIED	APPLIED	APPLIED	HOLDING

Drive Range – Manual First (1) is available to the driver when vehicle operating conditions require maximum engine compression braking for slowing the vehicle, or maximum engine torque transfer to the wheels in a forward gear range. These conditions include descending a steep grade to provide maximum engine compression braking and, to retain First gear when ascending a steep grade or pulling a heavy load for maximum engine power.

While operating in Manual First range the transmission can upshift into second gear at 61 km/h (38 mph), and third gear at 113 km/h (70 mph) and each range has engine braking. If the transmission is operating in any other forward gear range when Manual First is selected, the transmission will not shift into First gear until vehicle speed slows to approximately 56 km/h (35 mph). Power flow during acceleration is the same as Overdrive Range – First Gear with the exception that the coast clutch is applied. Therefore we will look at power flow during deceleration (engine compression braking).

- The manual shaft (16), detent lever (17) and manual valve (916) are moved into the "1" range position – Manual First.

1. **Power from the Wheels**
   Power from the wheels is transferred back through the transmission from the final drive differential assembly (100-119) to the input shaft and 3rd clutch housing (604). Each of the component's function and rotation direction is the same as during acceleration (compare Figures 59 and 75).

2. **Low/Reverse Band Applied**
   The low/reverse band (13) is applied and prevents the forward and coast clutch housing (801) from rotating.

3. **Forward Clutch Applied**
   The forward clutch applies and links the forward sprag outer race (721) to the forward and coast clutch housing (801).

4. **Forward Clutch Sprag Holding**
   During deceleration, the input torque from the wheels to the gear sets attempts to rotate the input internal gear flange (725) faster than the forward sprag outer race (721). This condition would cause the sprag elements to overrun and allow the vehicle to coast freely. The coast clutch prevents this condition from occurring.

5. **Coast Clutch Applied**
   The coast clutch plates (812-814) are applied and connect the forward and coast clutch housing (801) to the coast clutch hub (719). The coast clutch hub (719) is splined to the input internal gear flange (725) and holds, or drives the input internal gear (708) depending on gear range and direction of power flow. This directs torque from the input carrier pinion gears through input sun gear (631) to the input shaft and 3rd clutch housing assembly (604).

6. **Power to Torque Converter for Engine Braking**
   The input shaft and 3rd clutch housing assembly (604) is connected to the turbine shaft through the drive link assembly and the drive and driven sprockets. This creates a mechanical link between the final drive differential assembly and the torque converter turbine. This allows engine compression to slow the vehicle when the throttle is released.

When selecting manual first range to slow the vehicle, the speed of the vehicle provides input through the transmission and attempts to overrun engine speed (RPM). However, engine compression braking slows the vehicle down when the low/reverse band and the coast clutch are applied, resulting in a 2.96:1 gear ratio through the gear sets.

DRIVE RANGE – MANUAL FIRST

(from Drive Range – Manual Second)

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF						HOLDING	APPLIED	APPLIED	APPLIED	HOLDING

Drive Range – Manual First (1) may be selected at any time while the vehicle is being operated in a forward gear range. However, the transmission will not downshift into First gear until vehicle speed is below approximately 56 km/h (35 mph). At higher speeds, the PCM will keep the 1-2 shift solenoid (SS) valve de-energized and the transmission will operate in a Manual First – Second or Third Gear condition until vehicle speed slows sufficiently.

When the gear selector lever is moved to Manual First (1) from Manual Second (2), the manual valve also moves. With vehicle speed low enough, the following changes occur to the hydraulic and electrical systems:

1 MANUAL VALVE

Line pressure enters the low fluid circuit at the manual valve.

2 LOW/REVERSE BAND APPLIES

2a 1-2 Shift Solenoid (SS) Valve:
The normally open 1-2 SS valve is energized the PCM and blocks 1-2 solenoid fluid from exhausting. 1-2 solenoid fluid pressure moves the 1-2 shift valve to the downshifted position.

2b #8 Ball Check Valve:
Low fluid from the manual valve unseats the #8 ball check valve allowing fluid to continue through the low circuit.

2c 2-3 Shift Valve:
Low fluid passes through the 2-3 shift valve and enters the low feed circuit.

2d 1-2 Shift Valve:
Low feed fluid is routed through orifice #4 and the 1-2 shift valve into the low & reverse band reduce circuit.

2e #6 Ball Check Valve:
Low & reverse band reduce fluid seats the #6 ball check valve against the low & reverse band apply circuit allowing fluid and enters the reverse band circuit.

2f Low/Reverse Servo:
Reverse band fluid pressure enters the low/reverse servo and acts on the servo piston to move the servo pin and apply the low/reverse band.

3 4TH BAND RELEASES

3a 4th Servo:
4th band fluid exhausts from the 4th servo piston and the 3-4 accumulator, thus releasing the 4th band.

3b 1-2 Shift Valve:
4th band fluid passes through the 1-2 shift valve and exhausts through orifice #2. 4th band feed fluid passes through the 3-4 shift valve and orifice #11 to the 2-3 shift valve where it exhausts.

4 2ND CLUTCH RELEASES

4a 2nd Clutch Assembly:
2nd clutch fluid exhausts from the 2nd clutch piston and the 1-2 accumulator, allowing the 2nd clutch plates to release. This changes the power flow through the transmission gear sets from a Second gear to a First gear ratio.

4b 1-2 Shift Valve:
2nd clutch fluid exhausts through the 1-2 shift valve.

5 SHIFT ACCUMULATION

5a 1-2 Accumulator:
1-2 accumulator fluid fills the 1-2 accumulator when 2nd clutch fluid exhausts.

5b 3-4 Accumulator:
3-4 accumulator fluid fills the 3-4 accumulator when 4th band fluid exhausts.

As in Manual Third and Manual Second, the PCM output signal to the pressure control (PC) solenoid valve increases torque signal fluid pressure further for the added torque requirements during engine compression braking or maximum engine torque transfer.

COMPLETE HYDRAULIC CIRCUIT
Page 102

DRIVE RANGE – MANUAL FIRST

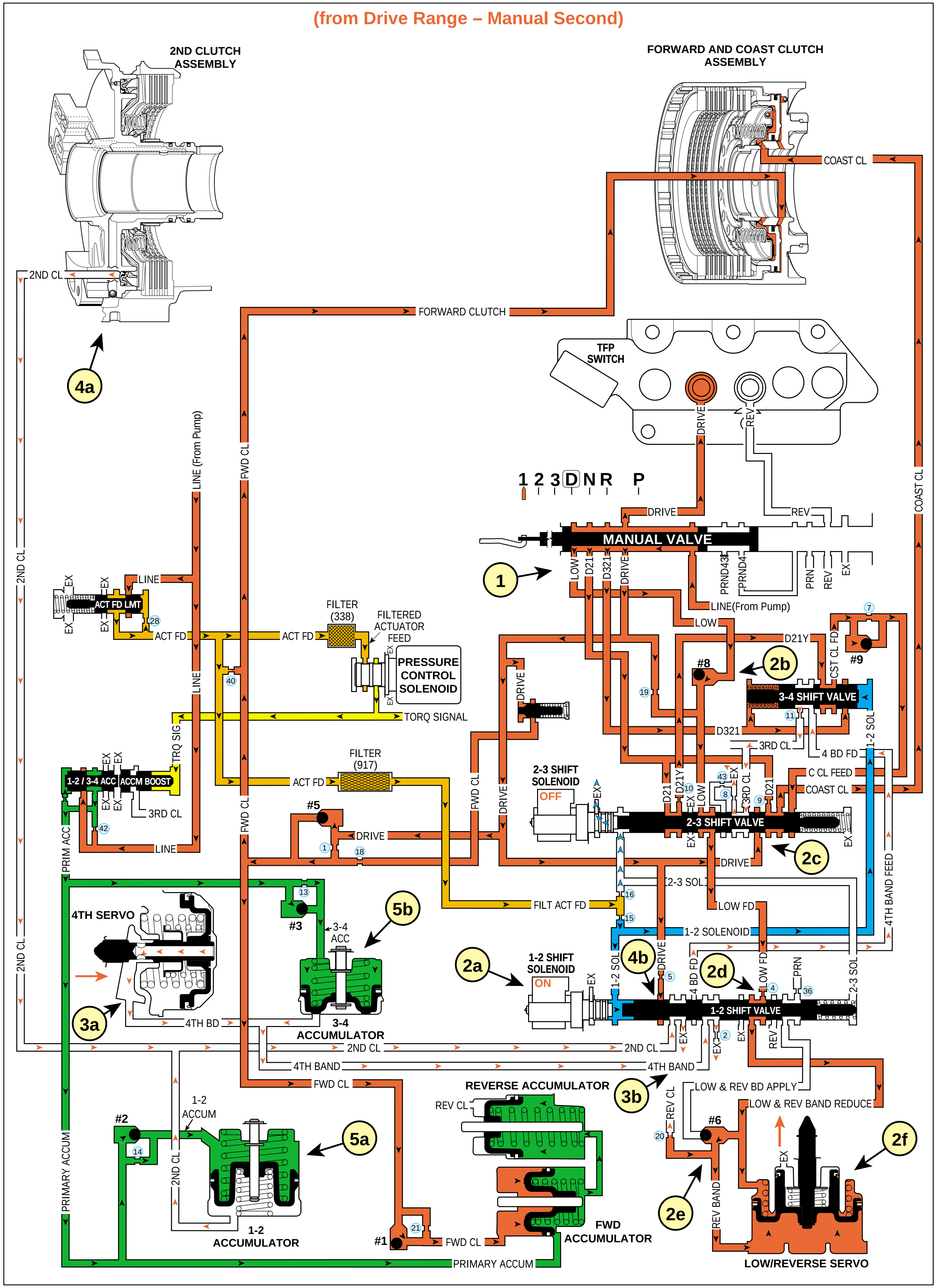


Figure 76

OPERATING CONDITIONS

RANGE REFERENCE CHART

				1	2	3	4	5	6	7	8	9	10
RANGE	**GEAR**	**1-2 SHIFT SOL**	**2-3 SHIFT SOL**	**2ND CLUTCH**	**2ND SPRAG**	**REVERSE CLUTCH**	**3RD CLUTCH**	**4TH BAND**	**FORWARD SPRAG**	**FORWARD CLUTCH**	**COAST CLUTCH**	**LOW/REV. BAND**	**LOW ROLLER**
PARK	N	ON	OFF									APPLIED	
REV	R	ON	OFF			APPLIED						APPLIED	
NEU	N	ON	OFF									APPLIED	
(D)	1	ON	OFF						HOLDING	APPLIED		APPLIED	HOLDING
	2	OFF	OFF	APPLIED	HOLDING				HOLDING	APPLIED			OVER-RUNNING
	3	OFF	ON	APPLIED	OVER-RUNNING		APPLIED		HOLDING	APPLIED			OVER-RUNNING
	4	ON	ON	APPLIED			APPLIED	APPLIED	OVER-RUNNING	APPLIED			OVER-RUNNING
3	1	ON	OFF						HOLDING	APPLIED		APPLIED	HOLDING
	2	OFF	OFF	APPLIED	HOLDING				HOLDING	APPLIED			OVER-RUNNING
	3	OFF	ON	APPLIED	OVER-RUNNING		APPLIED		HOLDING	APPLIED	APPLIED		OVER-RUNNING
2	1	ON	OFF						HOLDING	APPLIED	APPLIED	APPLIED	HOLDING
	2	OFF	OFF	APPLIED	HOLDING			APPLIED	HOLDING	APPLIED	APPLIED		OVER-RUNNING
	3*	OFF	ON	APPLIED	OVER-RUNNING		APPLIED		HOLDING	APPLIED	APPLIED		OVER-RUNNING
1	1	ON	OFF						HOLDING	APPLIED	APPLIED	APPLIED	HOLDING
	2*	OFF	OFF	APPLIED	HOLDING			APPLIED	HOLDING	APPLIED	APPLIED		OVER-RUNNING
	3*	OFF	ON	APPLIED	OVER-RUNNING		APPLIED		HOLDING	APPLIED	APPLIED		OVER-RUNNING

ON = SOLENOID ENERGIZED
OFF = SOLENOID DE-ENERGIZED
@ THE SOLENOID'S STATE FOLLOWS A SHIFT PATTERN WHICH DEPENDS UPON VEHICLE SPEED AND THROTTLE POSITION. IT DOES NOT DEPEND UPON THE SELECTED GEAR.
* THESE GEARS ARE NOT NORMAL BUT AVAILABLE UNDER SEVERE CONDITIONS.

EXPECTED OPERATING CONDITION IF COMPONENT IN COLUMN NUMBER IS INOPERATIVE:

COLUMN #	CONDITION
1	NO 2ND GEAR IN (D) OR D3 RANGE.
2	NO 2ND GEAR IN (D) OR D3 RANGE.
3	NO REVERSE GEAR – ALL DRIVE RANGES OK.
4	NO 3RD OR 4TH GEAR.
5	NO 4TH GEAR OR MANUAL 2ND ENGINE BRAKING.
6	NO DRIVE IN (D) OR D3 RANGE. MAY SLIP IN MANUAL RANGES UNDER MODERATE TO HEAVY ACCELERATION.
7	NO DRIVE IN (D) OR D3 RANGE. MAY SLIP IN MANUAL RANGES UNDER MODERATE TO HEAVY ACCELERATION.
8	NO ENGINE BRAKING IN MANUAL 1ST, MANUAL 2ND, MANUAL 3RD.
9	NO REVERSE – NO ENGINE BRAKING IN MANUAL 1ST OR MANUAL 2ND - 1ST GEAR.
10	SLIPS IN 1ST GEAR UNDER MODERATE TO HEAVY ACCELERATION.

SHIFT SOLENOID VALVE ELECTRICAL CONDITIONS

If the PCM detects a continuous open or short to ground in the shift solenoid or shift solenoid circuits the following actions occur:

1-2 DTC P1842
- The PCM illuminates the malfunction indicator lamp (MIL).
- The PCM commands maximum line pressure.
- The PCM inhibits 3-2 downshifts above 50 km/h (31 mph).
- The PCM freezes transmission adapt functions.
- The PCM stores DTC P1842 in PCM history.

2-3 DTC P1845
- The PCM illuminates the malfunction indicator lamp (MIL).
- The PCM commands an immediate landing to 2nd gear.
- The PCM commands maximum line pressure.
- The PCM inhibits TCC engagement.
- The PCM freezes transmission adapt functions.
- The PCM stores DTC P1845 in PCM history.

Figure 77

COMPLETE HYDRAULIC CIRCUITS

The hydraulic circuitry of the Hydra-matic 4T80-E transmission is better understood when fluid flow can be related to the specific components in which the fluid travels. In the Power Flow section, a simplified hydraulic schematic was given to show what hydraulically occurs in a specific gear range. The purpose was to isolate the hydraulics used in each gear range in order to provide the user with a basic understanding of the hydraulic system.

In contrast, this section shows a complete hydraulic schematic with fluid passages active in the appropriate component for each gear range. This is accomplished using two opposing foldout pages that are separated by a half page of supporting information.

The left side foldout contains the complete color coded hydraulic circuit used in that gear range along with the relative location of valves, ball check valves and orifices within specific components. A broken line is also used to separate components such as the pump, control valve body, channel plate and case to assist the user when following the hydraulic circuits as they pass between them. The half page of information facing this foldout lists possible conditions and component diagnostic tips. Always refer to the appropriate vehicle platform service manual when diagnosing specific concerns.

The right side foldout shows a two-dimensional line drawing of the fluid passages within each component. The active fluid passages for each gear range are appropriately colored to correspond with the hydraulic schematic used for that range. The half page of information facing this foldout identifies the various fluid circuits with numbers that correspond to the circuit numbers used on the foldout page.

For a more complete understanding of the different hydraulic systems used in a specific gear range, refer to the Hydraulic Control Components section and/or Power Flow section.

Due to the large number of components in the 4T80-E pump circuit, they will only be shown once. All ranges are the same as shown in Figure 79.

PASSAGE A IS LOCATED IN THE SCAVENGE PUMP BODY (WHITE AREA)
PASSAGE B IS LOCATED IN THE PRIMARY PUMP BODY (WHITE AREA)
PASSAGE C IS LOCATED IN THE SECONDARY PUMP BODY (LIGHT GREY AREA)
PASSAGE D IS LOCATED IN THE UPPER CONTROL VALVE BODY (LIGHT BLUE AREA)
PASSAGE E IS LOCATED ON THE SPACER PLATE (DASHED LINE)
PASSAGE F IS LOCATED IN THE CASE COVER (LIGHT RED AREA)
PASSAGE G IS LOCATED IN THE DRIVEN SPROCKET SUPPORT (LIGHT YELLOW AREA)
PASSAGE H IS LOCATED IN THE CASE (WHITE AREA)
PASSAGE I IS LOCATED IN THE FORWARD/COAST CLUTCH SUPPORT (LIGHT RED AREA)
PASSAGE J IS LOCATED IN THE LOWER CHANNEL PLATE (LIGHT RED AREA)
PASSAGE K IS LOCATED IN THE TRANSFER PLATE (LIGHT RED AREA)
PASSAGE L IS LOCATED ON THE SPACER PLATE/GASKET ASSEMBLY (DASHED LINE)
PASSAGE M IS LOCATED IN THE LOWER CONTROL VALVE BODY (LIGHT BLUE AREA)
PASSAGE N IS LOCATED IN THE ACCUMULATOR HOUSING (LIGHT YELLOW AREA)

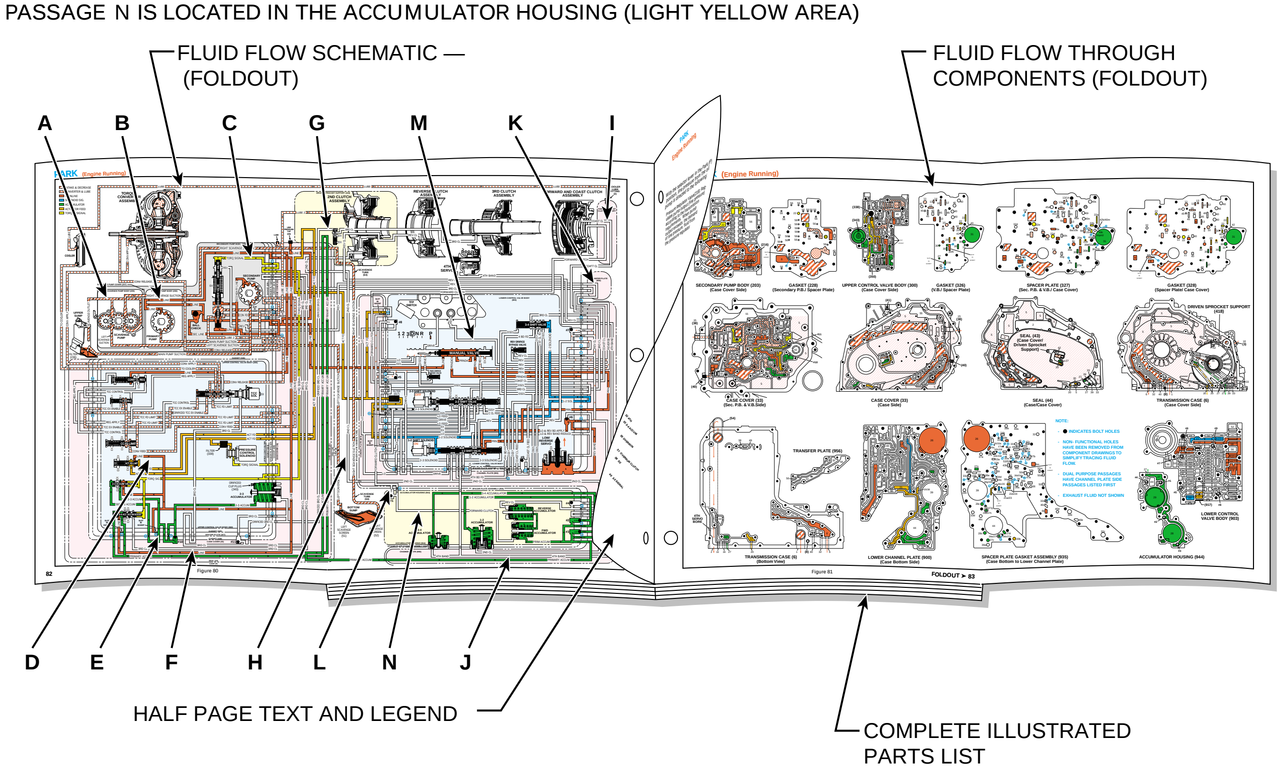
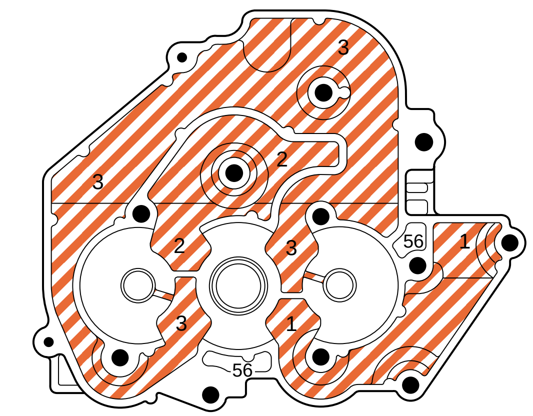
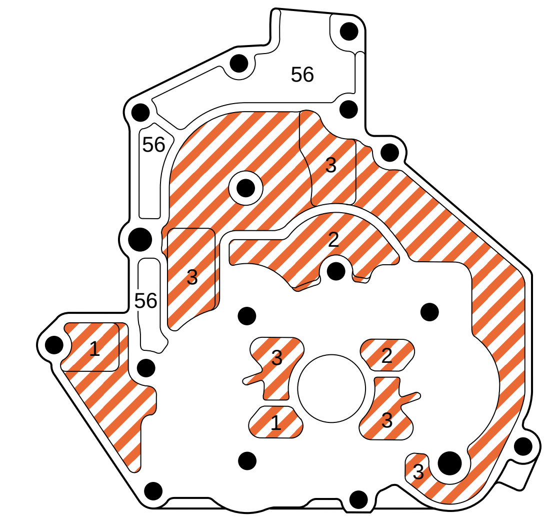


Figure 78

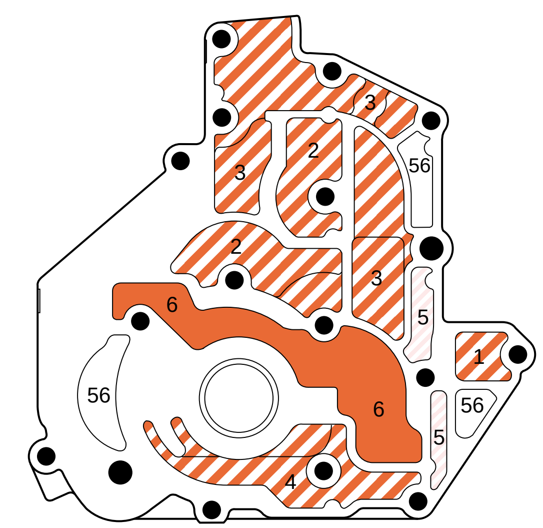
PUMP PASSAGES – ALL RANGES



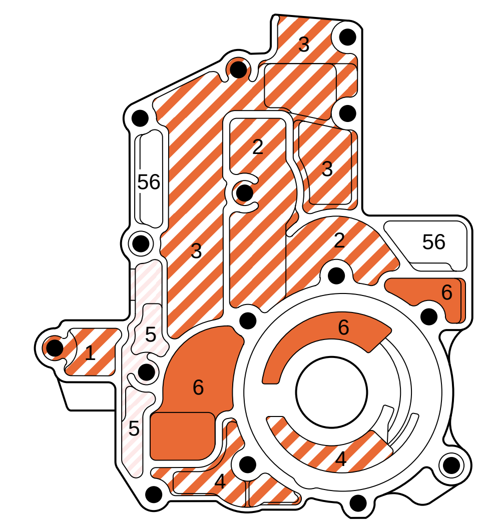
SCAVENGE PUMP BODY (225)
(Scavenge Pump Cover Side)



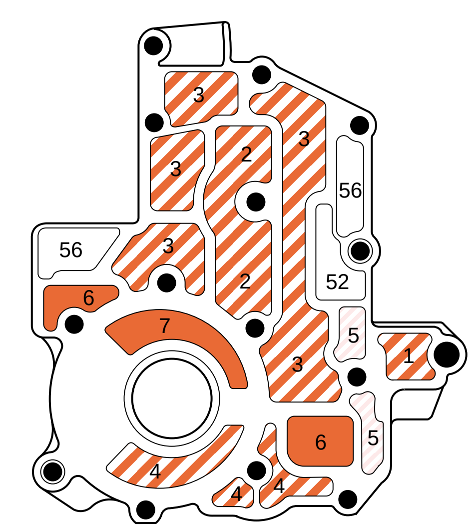
SCAVENGE PUMP COVER (237)
(Scavenge Pump Body Side)



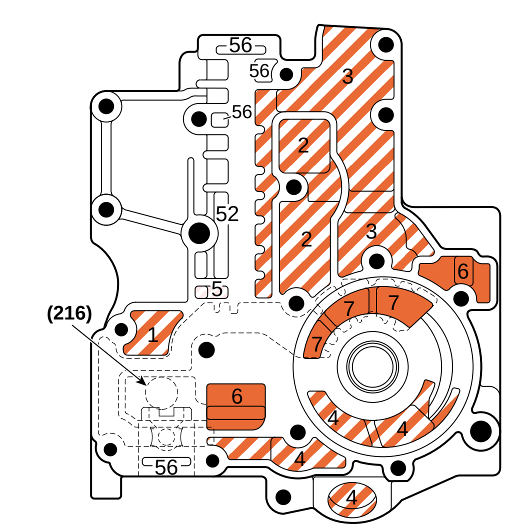
SCAVENGE PUMP COVER (237)
(Primary Pump Body Side)



PRIMARY PUMP BODY (200)
(Scavenge Pump Cover Side)



PRIMARY PUMP BODY (200)
(Secondary Pump Body Side)



SECONDARY PUMP BODY (203)
(Primary Pump Body Side)

Figure 79

PARK (Engine Running)

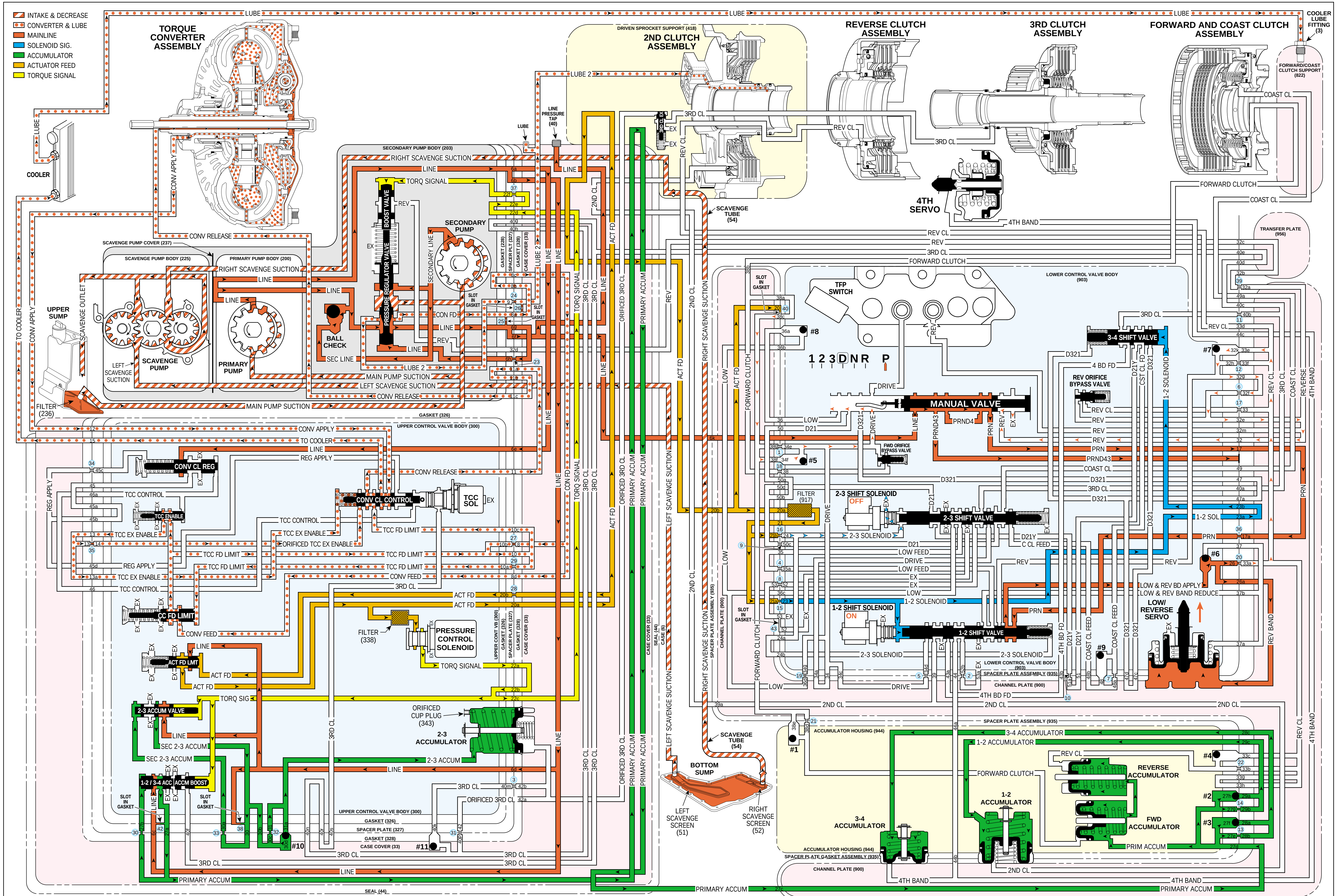


Figure 80

PARK
(Engine Running)

The following conditions and component problems could happen in any gear range, and are only some of the possibilities recommended to diagnose hydraulic problems. Always refer to the appropriate vehicle platform service manual when diagnosing specific concerns.

HIGH OR LOW LINE PRESSURE

- Pressure Regulator Valve (211), Springs (212) and Boost Valve (213)
  - Stuck, damaged (missing springs)
- Secondary Pump Cut-off Ball (216)
  - Stuck or missing
- Pressure Control Solenoid Valve (339)
  - Leak, o-rings damaged
  - Loose connector, pins damaged
  - Contaminated
- TFP Manual Valve Position Switch (936)
  - Loose connector
  - Damaged or missing o-ring
- Left Scavenge Screen (51)
  - Clogged, broken, loose
- Right Scavenge Screen (52)
  - Clogged, broken, loose
- Transmission Oil Filter (236)
  - Clogged, broken, loose
- Scavenge Tube (54)
  - Clogged, broken, loose
- Scavenge Tube and Screens Seal (53)
  - Leaking
- Filter Seal (209)
  - Leaking
- Cooler Lines
  - Clogged or restricted
- Scavenge, Primary and Secondary Pump Assemblies (200-237)
  - Damaged, sticking, porosity, leaking
- Oil Pump Drive Shaft (2)
  - Damaged
- Oil Pump Driven Shaft (207)
  - Damaged
- Transmission Case (6), Case Cover (33), Upper Control Valve Body (300), Lower Control Valve Body (903)
  - Porosity, leaking circuits
  - Flatness of machined surfaces

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF									APPLIED	

PARK

(Engine Running)

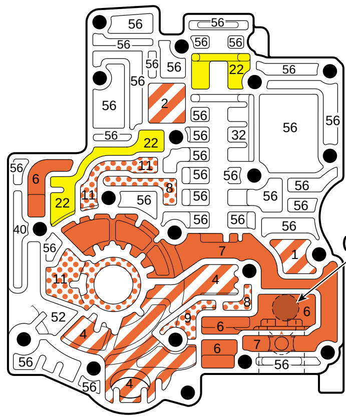
PASSAGES

1	LEFT SCAVENGE SUCTION
2	RIGHT SCAVENGE SUCTION
3	SCAVENGE OUTLET
4	MAIN PUMP SUCTION
5	SUMP
6	LINE
7	SECONDARY LINE
8	CONVERTER FEED
9	LUBE 2
10	TCC FEED LIMIT
11	CONVERTER RELEASE
12	CONVERTER APPLY
13	TCC EXHAUST ENABLE
14	ORIFICED TCC EXHAUST ENABLE
15	TO COOLER
16	LUBE
17	PRN
18	PRND4
19	PRND43
20	ACTUATOR FEED
21	FILTERED ACTUATOR FEED
22	TORQUE SIGNAL
23	1-2 SOLENOID
24	2-3 SOLENOID
25	LOW & REVERSE BAND APPLY
26	REVERSE BAND
27	PRIMARY ACCUMULATOR
28	3-4 ACCUMULATOR
29	1-2 ACCUMULATOR
30	SECONDARY 2-3 ACCUMULATOR
31	2-3 ACCUMULATOR
32	REVERSE
33	REVERSE CLUTCH
34	DRIVE
35	LOW FEED
36	LOW
37	LOW & REVERSE BAND REDUCE
38	FORWARD CLUTCH
39	2ND CLUTCH
40	3RD CLUTCH
42	ORIFICED 3RD CLUTCH
43	4TH BAND FEED
44	4TH BAND
45	REGULATED APPLY
46	TCC CONTROL
47	D321
48	COAST CLUTCH FEED
49	COAST CLUTCH
50	D21
51	D21 Y
52	EXHAUST
53	ORIFICED EXHAUST
54	DRAIN
55	OVERFLOW
56	VOID

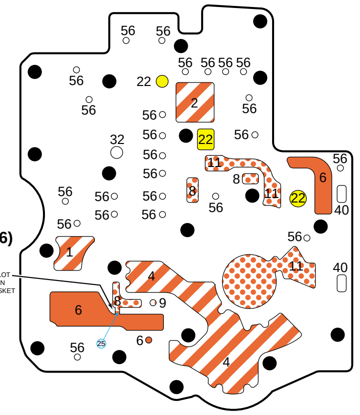
COMPONENTS (   )

(3)	COOLER CONNECTOR
(8)	OIL DRAIN PLUG
(40)	CASE COVER OIL TEST PLUG
(41)	TRANSMISSION VENT ADAPTER
(54)	SCAVENGE TUBE
(65)	BALL CHECK VALVES, #1, 2, 3, 4, 5, 7, 8, 9, 10 & 11
(216)	SECONDARY PUMP CUT-OFF BALL
(338)	PRESSURE CONTROL SOLENOID FILTER AND SEAL
(343)	ORIFICED CUP PLUG
(350)	TEMPERATURE SENSOR
(917)	SOLENOID SCREEN ASSEMBLY
(979)	BALL (0.375 DIAMETER) #6

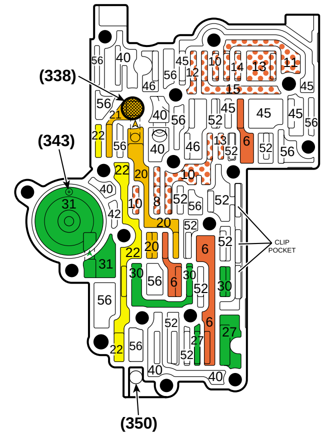
PARK (Engine Running)



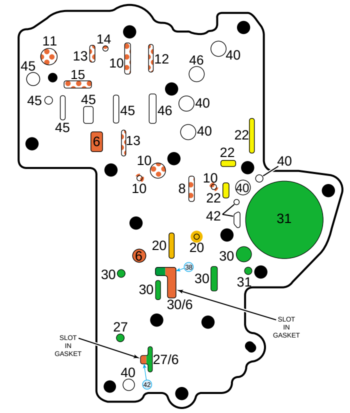
SECONDARY PUMP BODY (203)
(Case Cover Side)



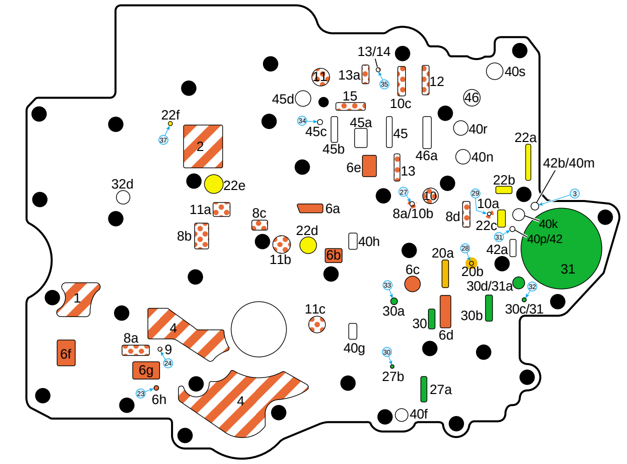
GASKET (228)
(Secondary P.B./ Spacer Plate)



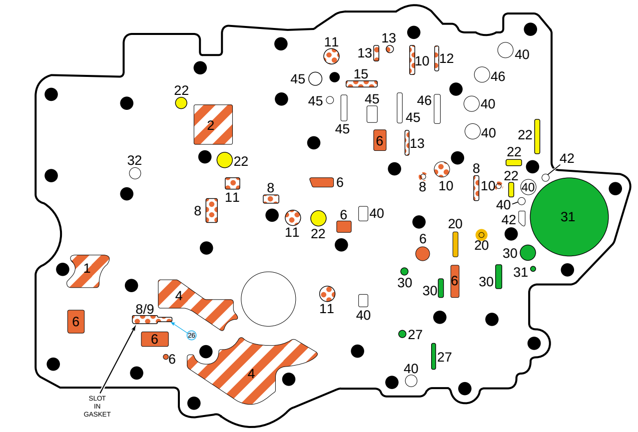
UPPER CONTROL VALVE BODY (300)
(Case Cover Side)



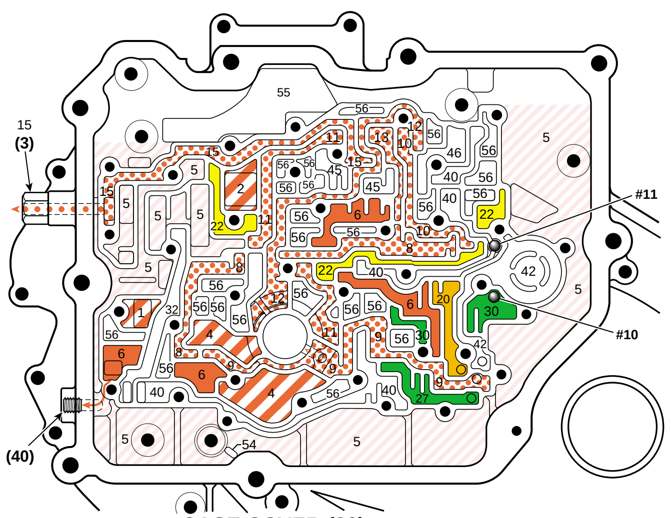
GASKET (326)
(V.B./ Spacer Plate)



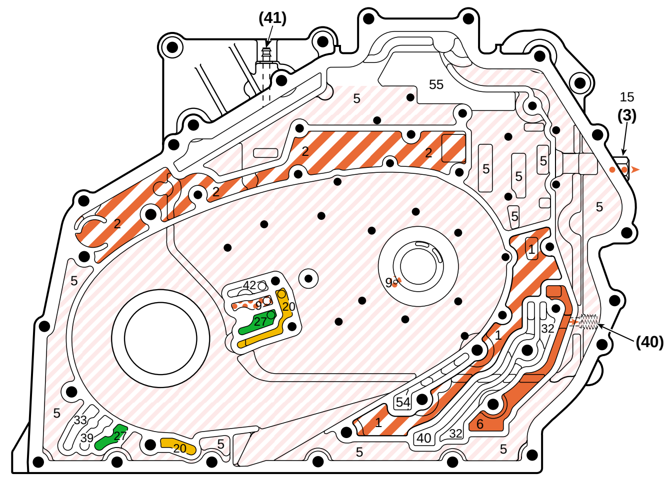
SPACER PLATE (327)
(Sec. P.B. & V.B./ Case Cover)



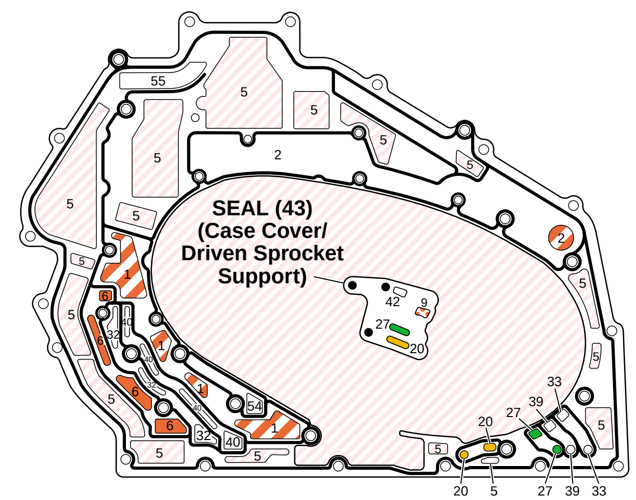
GASKET (328)
(Spacer Plate/ Case Cover)



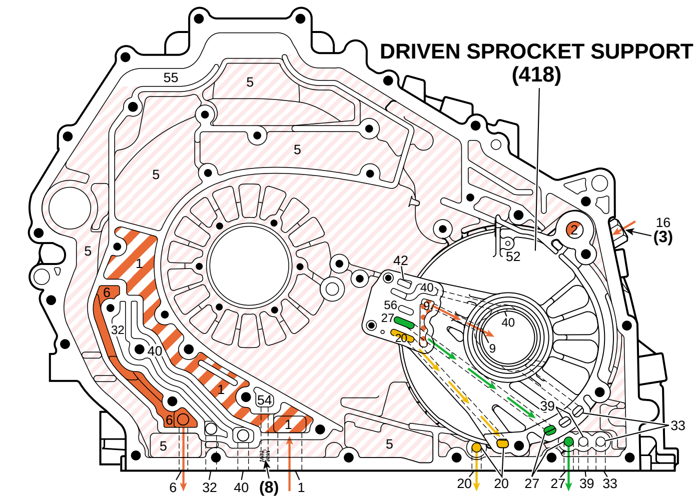
CASE COVER (33)
(Sec. P.B. & V.B.Side)



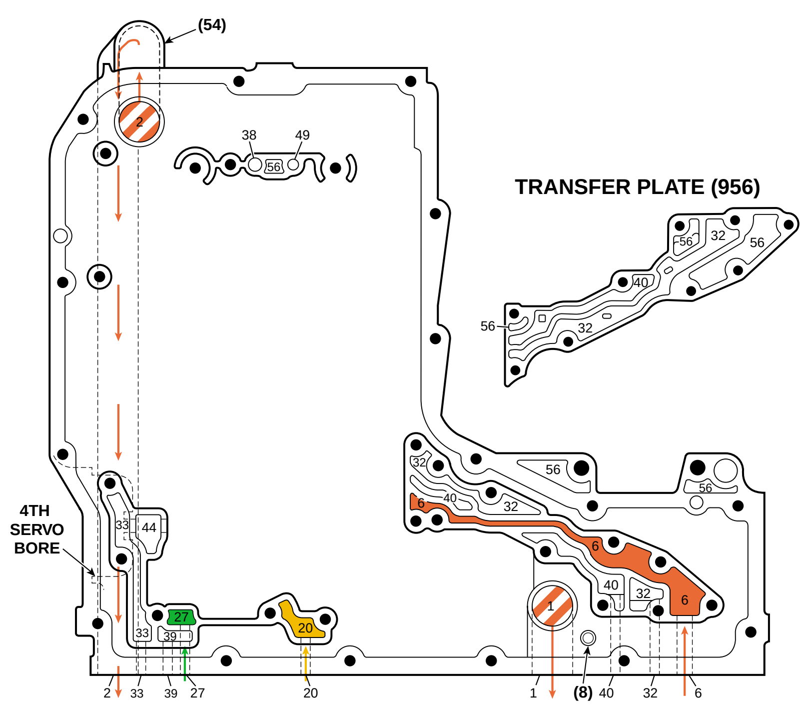
CASE COVER (33)
(Case Side)



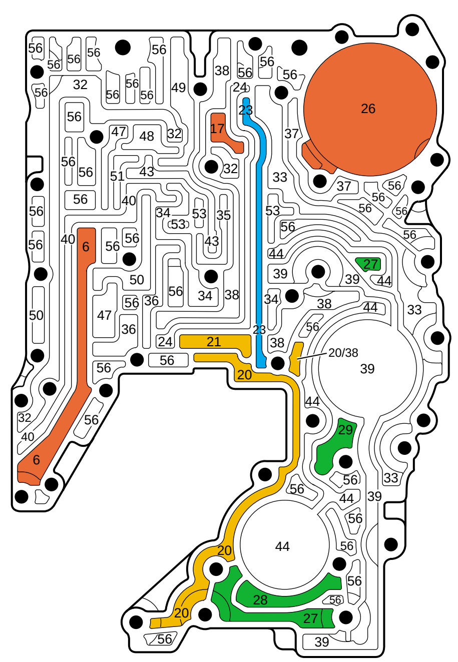
SEAL (44)
(Case/Case Cover)



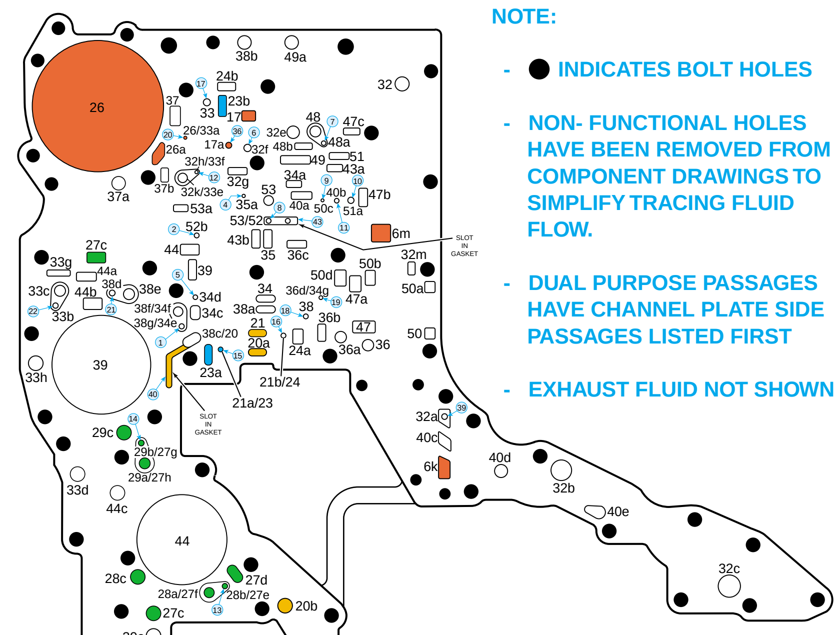
TRANSMISSION CASE (6)
(Case Cover Side)



TRANSMISSION CASE (6)
(Bottom View)



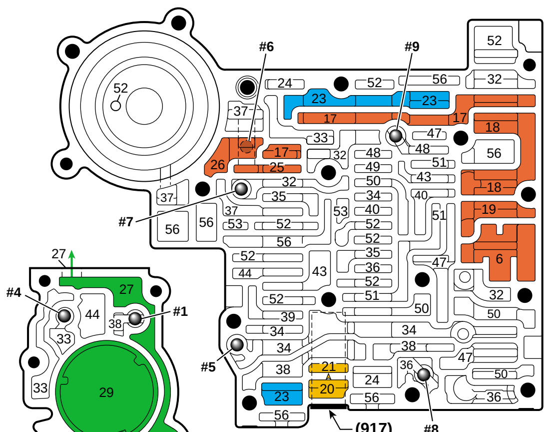
LOWER CHANNEL PLATE (900)
(Case Bottom Side)



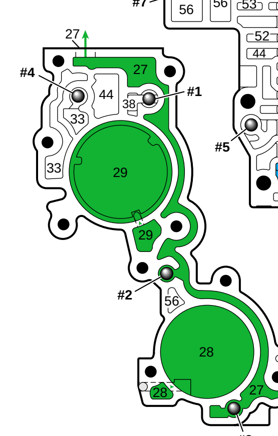
SPACER PLATE GASKET ASSEMBLY (935)
(Case Bottom to Lower Channel Plate)

NOTE:

- ● INDICATES BOLT HOLES
- NON- FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE PASSAGES LISTED FIRST
- EXHAUST FLUID NOT SHOWN



LOWER CONTROL
VALVE BODY (903)



ACCUMULATOR HOUSING (944)

Figure 81

REVERSE

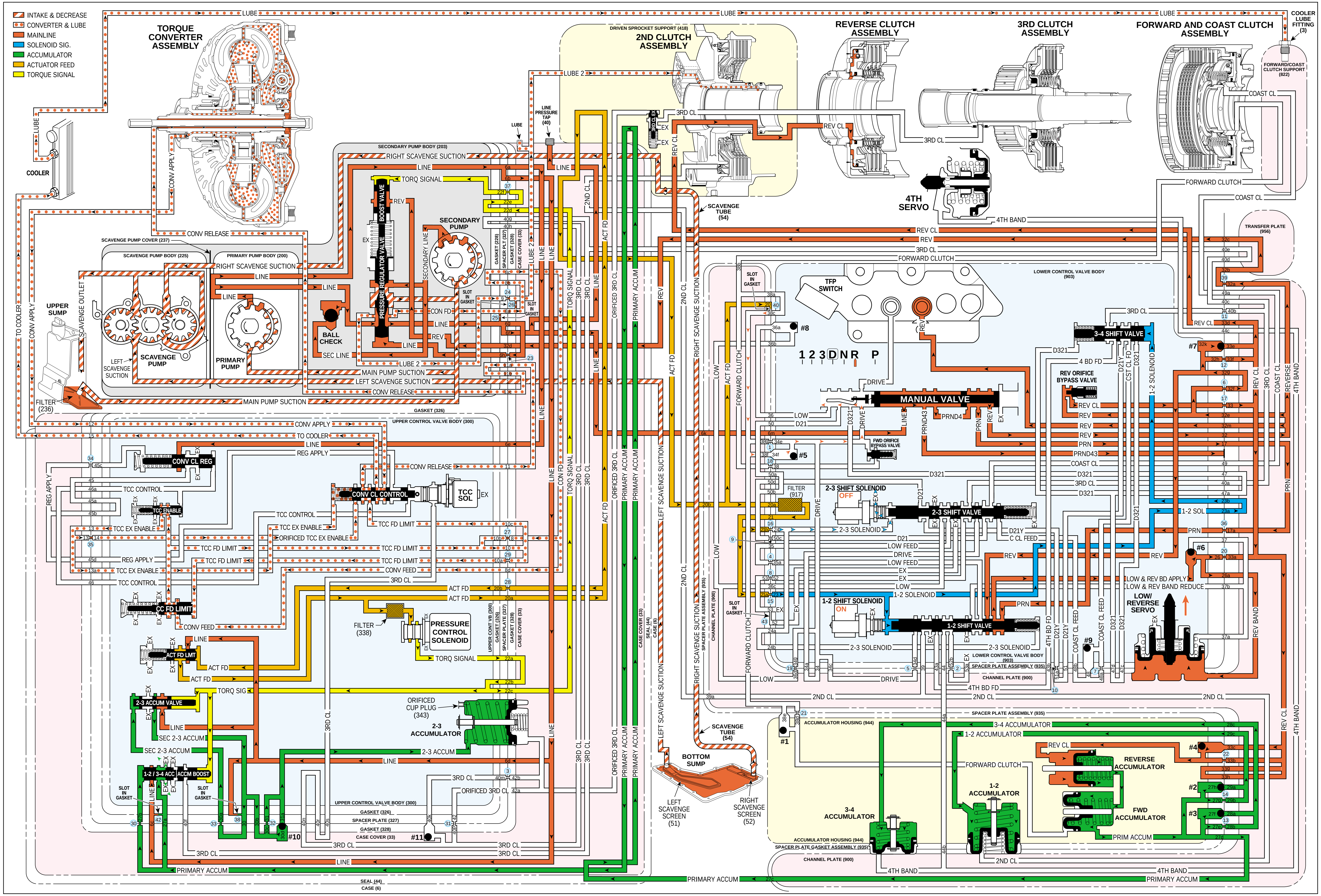


Figure 82

NO REVERSE OR SLIPS IN REVERSE

- Manual Valve (916) / Shift Linkage
  - Misaligned or stuck
- Reverse Orifice Bypass Valve
  - Stuck, damaged, broken
- #7 Ball Check Valve
  - Stuck
  - Missing
- Low/Reverse Servo Assembly
  - Servo piston seals (929, 930) missing or damaged
  - Servo piston (928) damaged or stuck in case bore
  - Servo piston return spring (901) missing or damaged
  - Servo piston cushion spring (934) missing or damaged
  - Servo apply pin (931) not engaged to low/reverse band (13)
  - Low/reverse band (13) worn or burned
  - Low/reverse band assembly (13) disengaged from anchor pin (9)
  - Low/reverse band anchor pin (9) loose or missing
- Torque Converter Assembly
  - Torque converter assembly (1) stator clutch not holding
- Drive Link Assembly
  - Drive link assembly (414) broken or drive/driven sprockets (407/415) damaged
- Reverse Clutch Assembly
  - Reverse clutch housing (500) damaged or leaking
  - Reverse clutch piston inner/outer seals (506/507) missing or damaged
  - Reverse clutch piston assembly (505) damaged, ball check valve missing or leaking
  - Reverse clutch plates (511-514) worn
- Fluid Level
  - Low
- Fluid Pressure
  - Low [See Park (Engine Running) page 82A]
- TFP Manual Valve Position Switch (936)
  - Malfunction (Electrical or Hydraulic)

ENGINE STALLS IN REVERSE

- Cooler Lines
  - Pinched

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF			APPLIED						APPLIED	

REVERSE

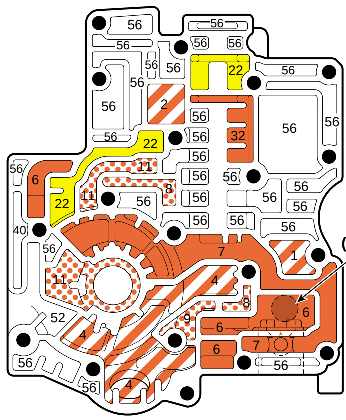
PASSAGES

1	LEFT SCAVENGE SUCTION
2	RIGHT SCAVENGE SUCTION
3	SCAVENGE OUTLET
4	MAIN PUMP SUCTION
5	SUMP
6	LINE
7	SECONDARY LINE
8	CONVERTER FEED
9	LUBE 2
10	TCC FEED LIMIT
11	CONVERTER RELEASE
12	CONVERTER APPLY
13	TCC EXHAUST ENABLE
14	ORIFICED TCC EXHAUST ENABLE
15	TO COOLER
16	LUBE
17	PRN
18	PRND4
19	PRND43
20	ACTUATOR FEED
21	FILTERED ACTUATOR FEED
22	TORQUE SIGNAL
23	1-2 SOLENOID
24	2-3 SOLENOID
25	LOW & REVERSE BAND APPLY
26	REVERSE BAND
27	PRIMARY ACCUMULATOR
28	3-4 ACCUMULATOR
29	1-2 ACCUMULATOR
30	SECONDARY 2-3 ACCUMULATOR
31	2-3 ACCUMULATOR
32	REVERSE
33	REVERSE CLUTCH
34	DRIVE
35	LOW FEED
36	LOW
37	LOW & REVERSE BAND REDUCE
38	FORWARD CLUTCH
39	2ND CLUTCH
40	3RD CLUTCH
42	ORIFICED 3RD CLUTCH
43	4TH BAND FEED
44	4TH BAND
45	REGULATED APPLY
46	TCC CONTROL
47	D321
48	COAST CLUTCH FEED
49	COAST CLUTCH
50	D21
51	D21 Y
52	EXHAUST
53	ORIFICED EXHAUST
54	DRAIN
55	OVERFLOW
56	VOID

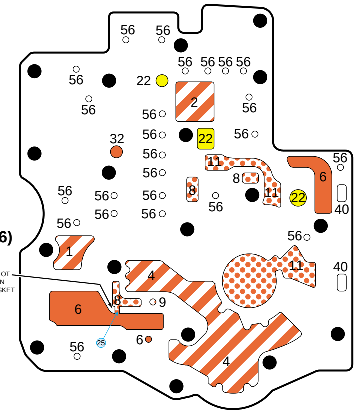
COMPONENTS (   )

(3)	COOLER CONNECTOR
(8)	OIL DRAIN PLUG
(40)	CASE COVER OIL TEST PLUG
(41)	TRANSMISSION VENT ADAPTER
(54)	SCAVENGE TUBE
(65)	BALL CHECK VALVES, #1, 2, 3, 4, 5, 7, 8, 9, 10 & 11
(216)	SECONDARY PUMP CUT-OFF BALL
(338)	PRESSURE CONTROL SOLENOID FILTER AND SEAL
(343)	ORIFICED CUP PLUG
(350)	TEMPERATURE SENSOR
(917)	SOLENOID SCREEN ASSEMBLY
(979)	BALL (0.375 DIAMETER) #6

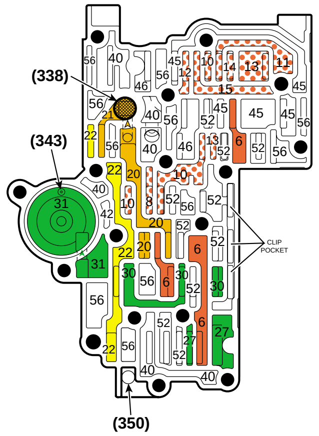
REVERSE



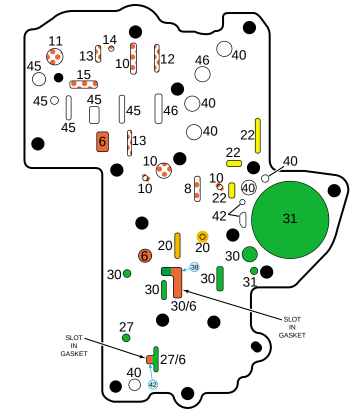
SECONDARY PUMP BODY (203)
(Case Cover Side)



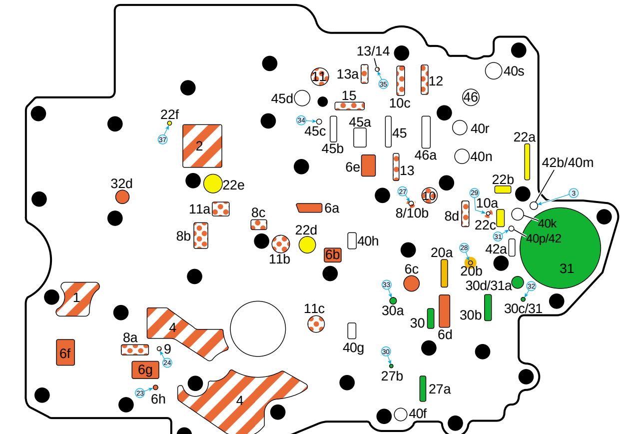
GASKET (228)
(Secondary P.B./ Spacer Plate)



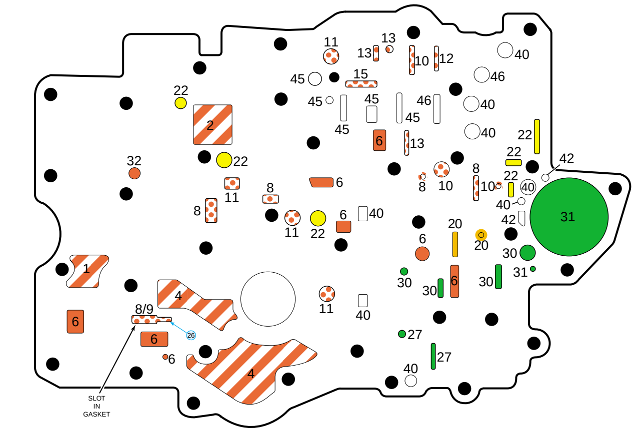
UPPER CONTROL VALVE BODY (300)
(Case Cover Side)



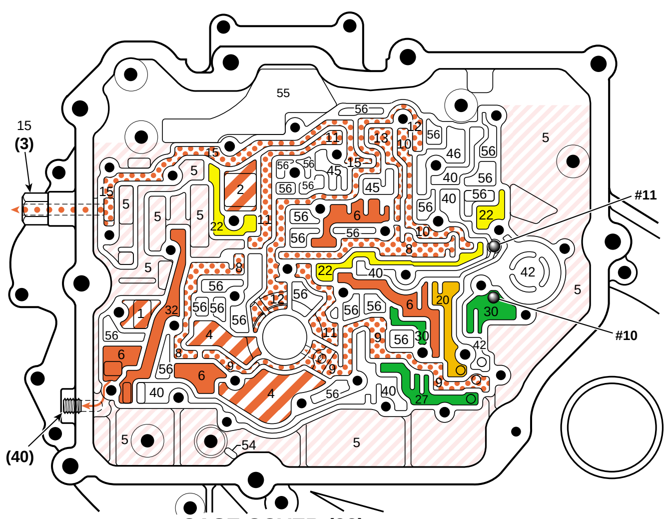
GASKET (326)
(V.B./ Spacer Plate)



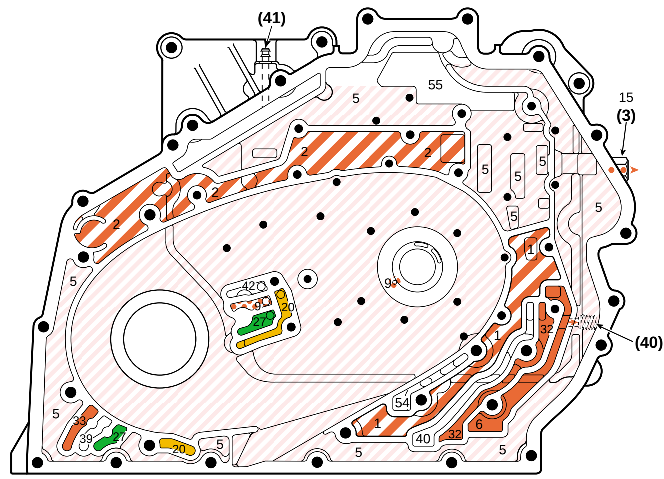
SPACER PLATE (327)
(Sec. P.B. & V.B./ Case Cover)



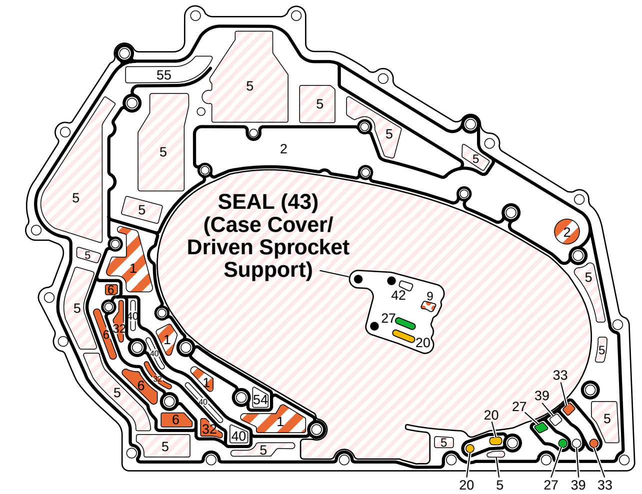
GASKET (328)
(Spacer Plate/ Case Cover)



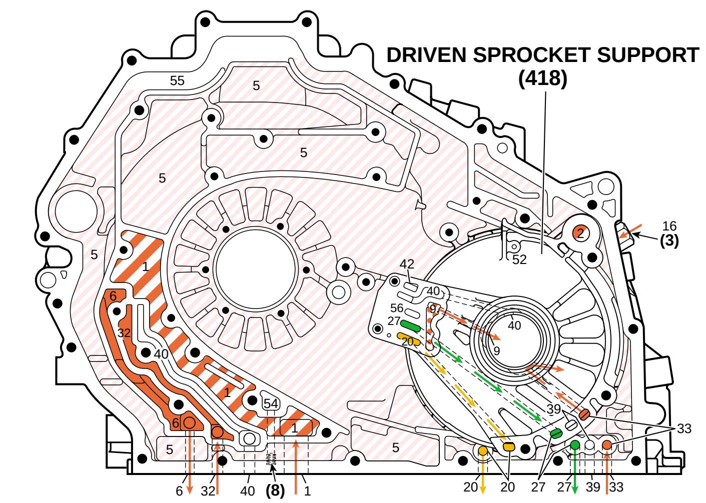
CASE COVER (33)
(Sec. P.B. & V.B.Side)



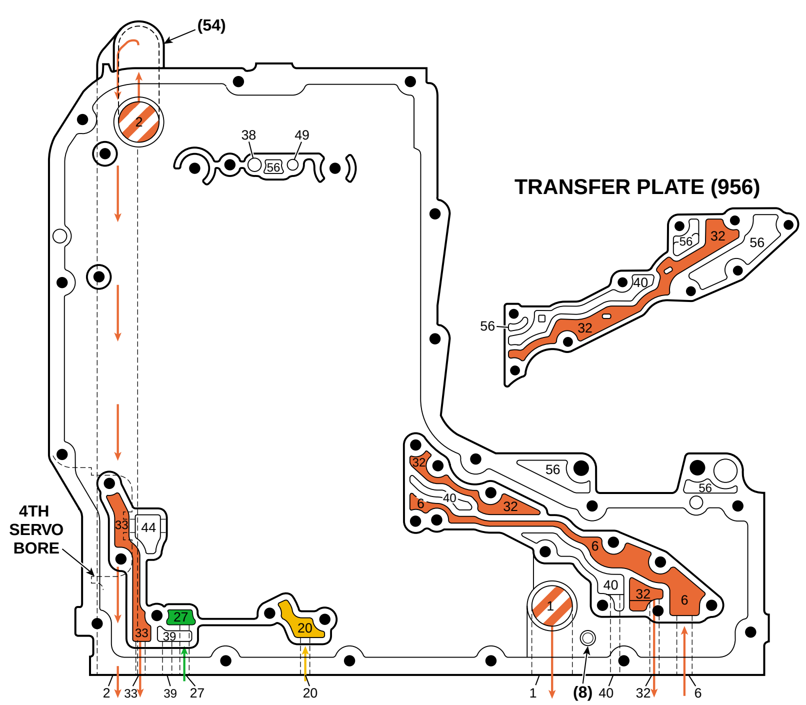
CASE COVER (33)
(Case Side)



SEAL (44)
(Case/Case Cover)

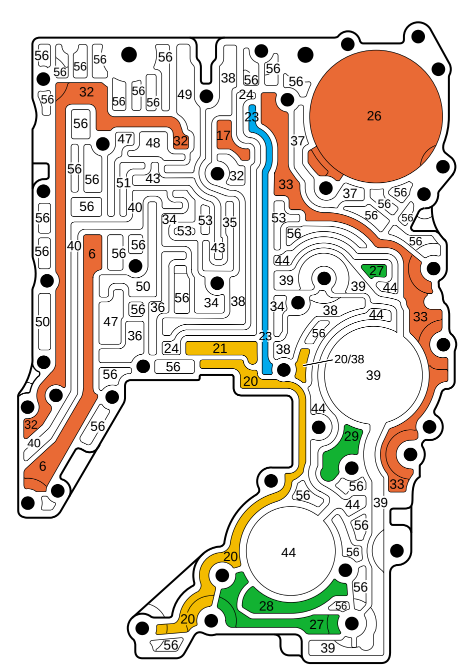


TRANSMISSION CASE (6)
(Case Cover Side)

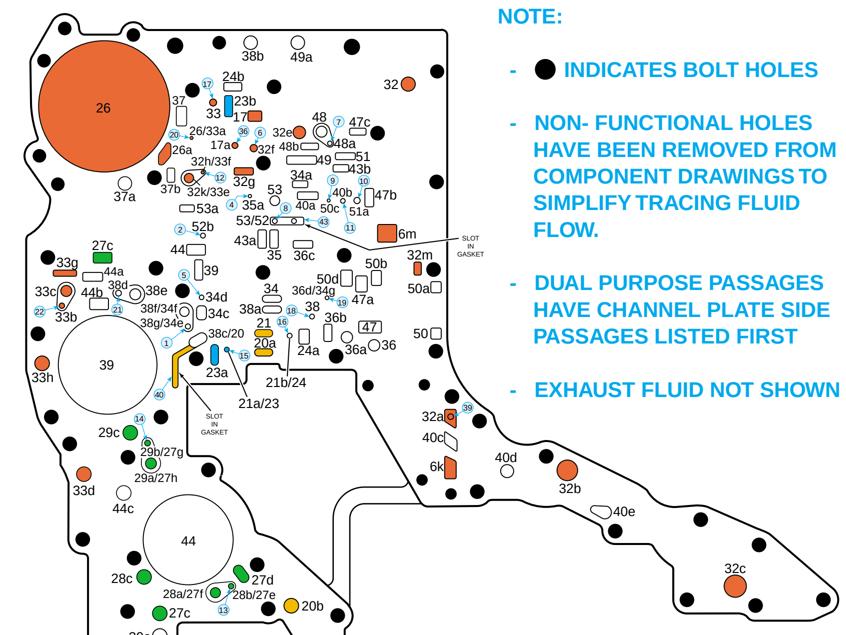


TRANSFER PLATE (956)

TRANSMISSION CASE (6)
(Bottom View)



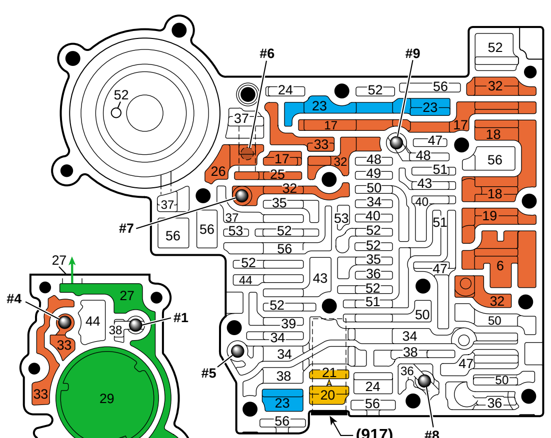
LOWER CHANNEL PLATE (900)
(Case Bottom Side)



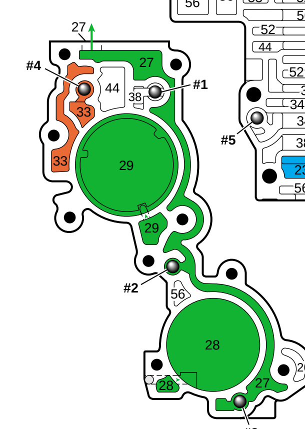
SPACER PLATE GASKET ASSEMBLY (935)
(Case Bottom to Lower Channel Plate)

NOTE:

- ● INDICATES BOLT HOLES
- NON- FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE PASSAGES LISTED FIRST
- EXHAUST FLUID NOT SHOWN



LOWER CONTROL VALVE BODY (903)



ACCUMULATOR HOUSING (944)

Figure 83

NEUTRAL (Engine Running)

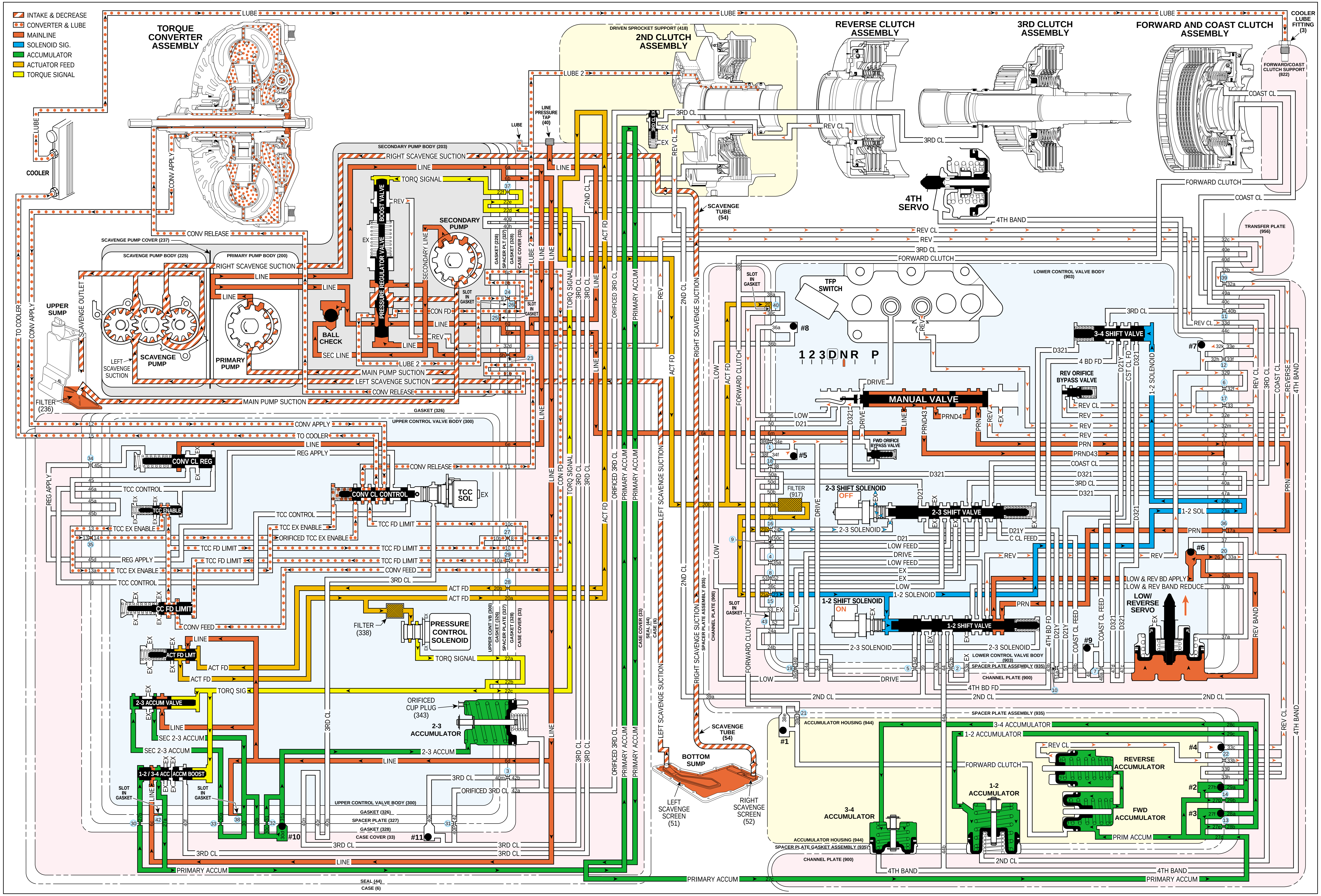


Figure 84

NEUTRAL
(Engine Running)

DRIVES IN NEUTRAL

- Manual Valve (916) / Shift Linkage
  - Misaligned or stuck
- Forward Clutch
  - Not releasing
- Reverse Clutch
  - Not releasing
- Low/Reverse Band (13)
  - Not releasing

ENGINE STALLS IN NEUTRAL

- TCC System
  - Stuck On or dragging

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF									APPLIED	

NEUTRAL
(Engine Running)

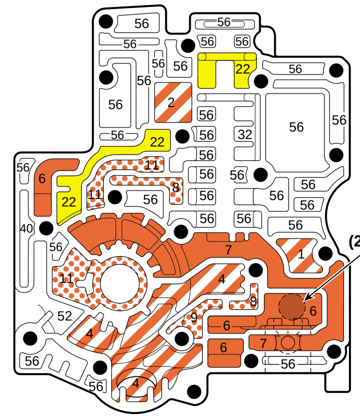
PASSAGES

1 LEFT SCAVENGE SUCTION
2 RIGHT SCAVENGE SUCTION
3 SCAVENGE OUTLET
4 MAIN PUMP SUCTION
5 SUMP
6 LINE
7 SECONDARY LINE
8 CONVERTER FEED
9 LUBE 2
10 TCC FEED LIMIT
11 CONVERTER RELEASE
12 CONVERTER APPLY
13 TCC EXHAUST ENABLE
14 ORIFICED TCC EXHAUST ENABLE
15 TO COOLER
16 LUBE
17 PRN
18 PRND4
19 PRND43
20 ACTUATOR FEED
21 FILTERED ACTUATOR FEED
22 TORQUE SIGNAL
23 1-2 SOLENOID
24 2-3 SOLENOID
25 LOW & REVERSE BAND APPLY
26 REVERSE BAND
27 PRIMARY ACCUMULATOR
28 3-4 ACCUMULATOR
29 1-2 ACCUMULATOR
30 SECONDARY 2-3 ACCUMULATOR
31 2-3 ACCUMULATOR
32 REVERSE
33 REVERSE CLUTCH
34 DRIVE
35 LOW FEED
36 LOW
37 LOW & REVERSE BAND REDUCE
38 FORWARD CLUTCH
39 2ND CLUTCH
40 3RD CLUTCH
42 ORIFICED 3RD CLUTCH
43 4TH BAND FEED
44 4TH BAND
45 REGULATED APPLY
46 TCC CONTROL
47 D321
48 COAST CLUTCH FEED
49 COAST CLUTCH
50 D21
51 D21 Y
52 EXHAUST
53 ORIFICED EXHAUST
54 DRAIN
55 OVERFLOW
56 VOID

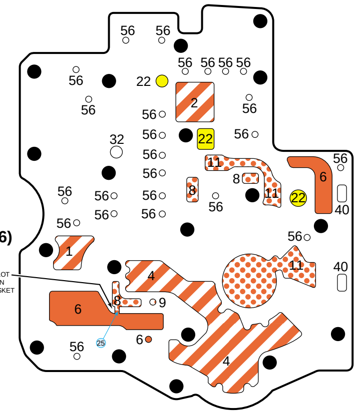
COMPONENTS ( )

(3) COOLER CONNECTOR
(8) OIL DRAIN PLUG
(40) CASE COVER OIL TEST PLUG
(41) TRANSMISSION VENT ADAPTER
(54) SCAVENGE TUBE
(65) BALL CHECK VALVES, #1, 2, 3, 4, 5, 7, 8, 9, 10 & 11
(216) SECONDARY PUMP CUT-OFF BALL
(338) PRESSURE CONTROL SOLENOID FILTER AND SEAL
(343) ORIFICED CUP PLUG
(350) TEMPERATURE SENSOR
(917) SOLENOID SCREEN ASSEMBLY
(979) BALL (0.375 DIAMETER) #6

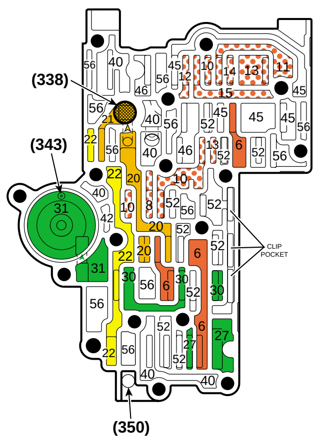
NEUTRAL (Engine Running)



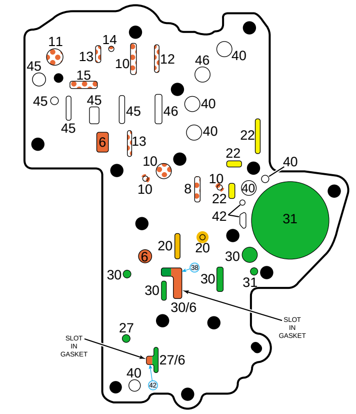
SECONDARY PUMP BODY (203)
(Case Cover Side)



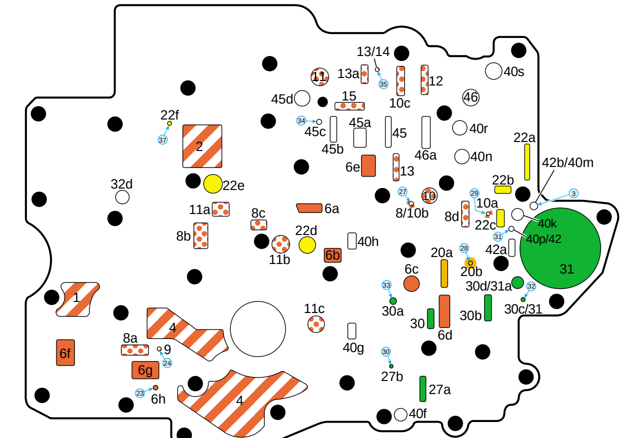
GASKET (228)
(Secondary P.B./ Spacer Plate)



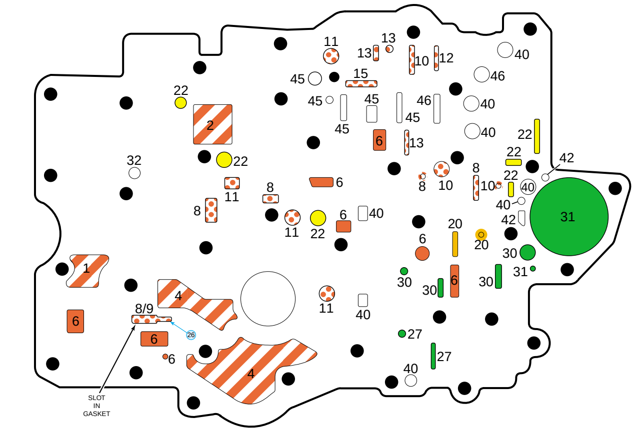
UPPER CONTROL VALVE BODY (300)
(Case Cover Side)



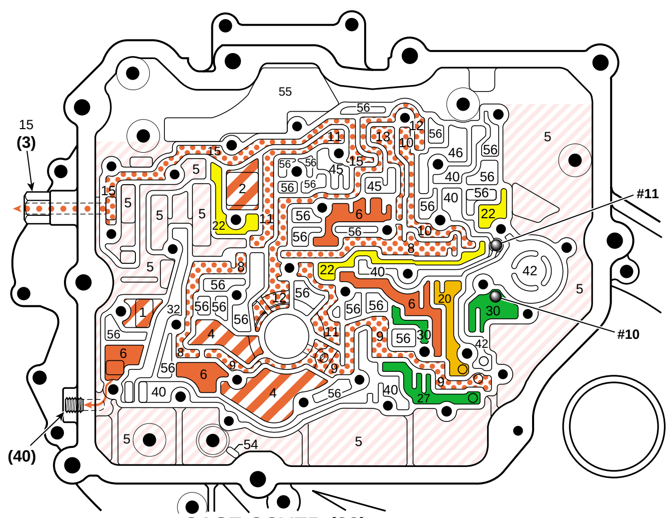
GASKET (326)
(V.B./ Spacer Plate)



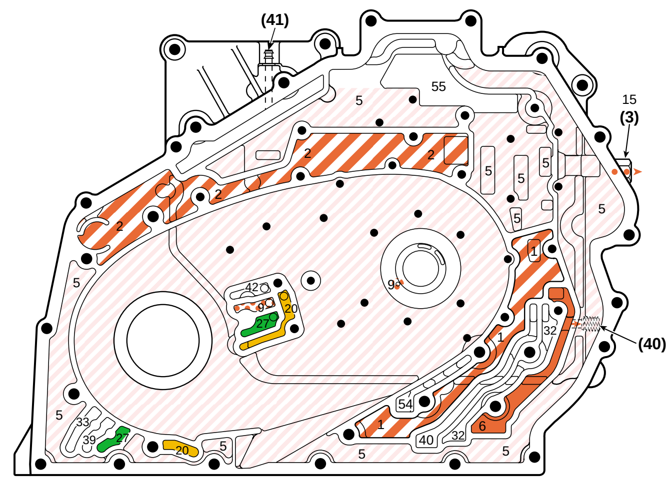
SPACER PLATE (327)
(Sec. P.B. & V.B./ Case Cover)



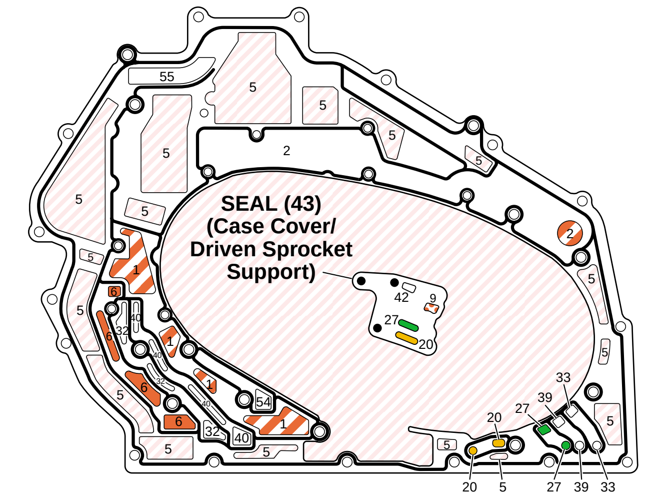
GASKET (328)
(Spacer Plate/ Case Cover)



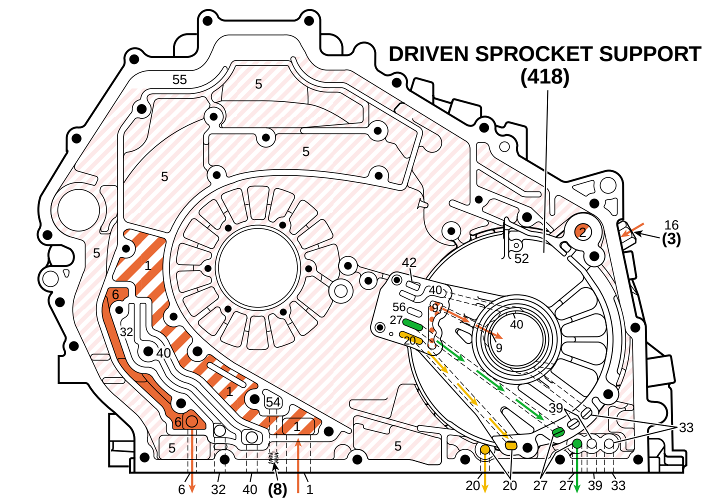
CASE COVER (33)
(Sec. P.B. & V.B.Side)



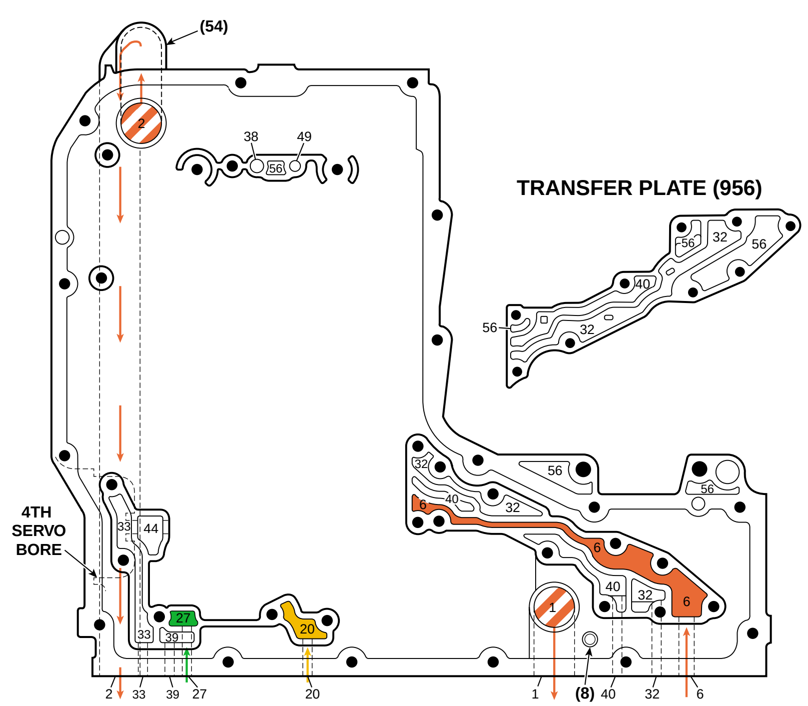
CASE COVER (33)
(Case Side)



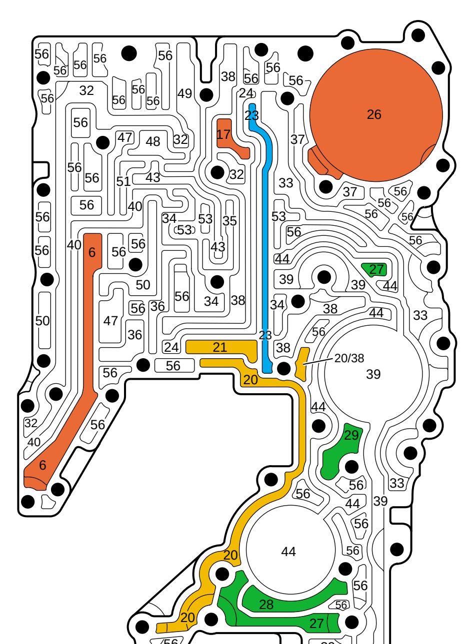
SEAL (44)
(Case/Case Cover)



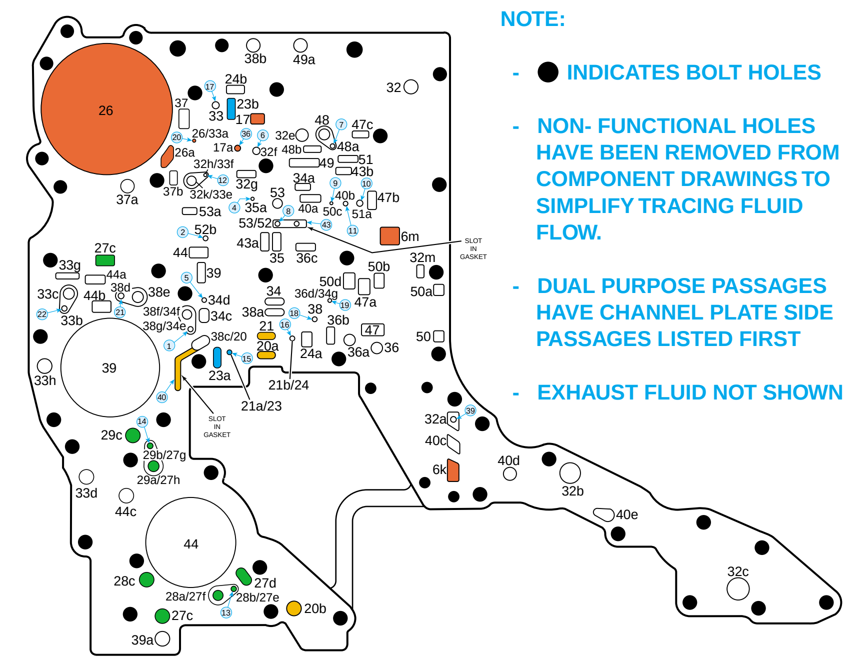
TRANSMISSION CASE (6)
(Case Cover Side)



TRANSMISSION CASE (6)
(Bottom View)



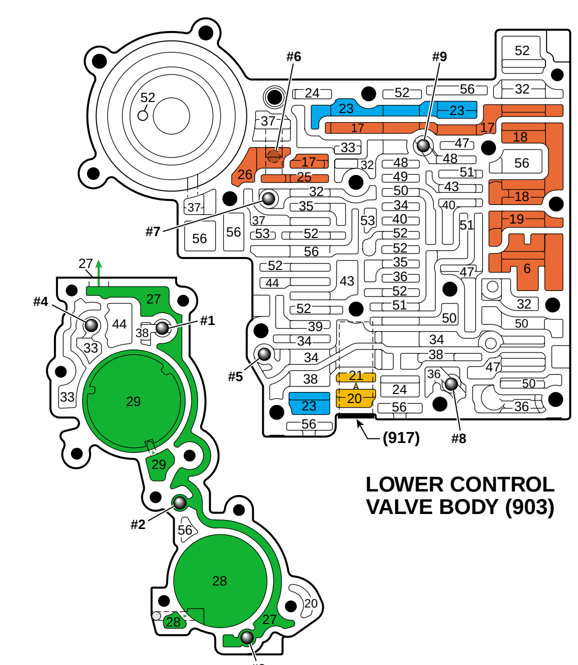
LOWER CHANNEL PLATE (900)
(Case Bottom Side)



SPACER PLATE GASKET ASSEMBLY (935)
(Case Bottom to Lower Channel Plate)

NOTE:

- ● INDICATES BOLT HOLES
- NON- FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE PASSAGES LISTED FIRST
- EXHAUST FLUID NOT SHOWN



LOWER CONTROL
VALVE BODY (903)

ACCUMULATOR HOUSING (944)

Figure 85

OVERDRIVE RANGE – FIRST GEAR

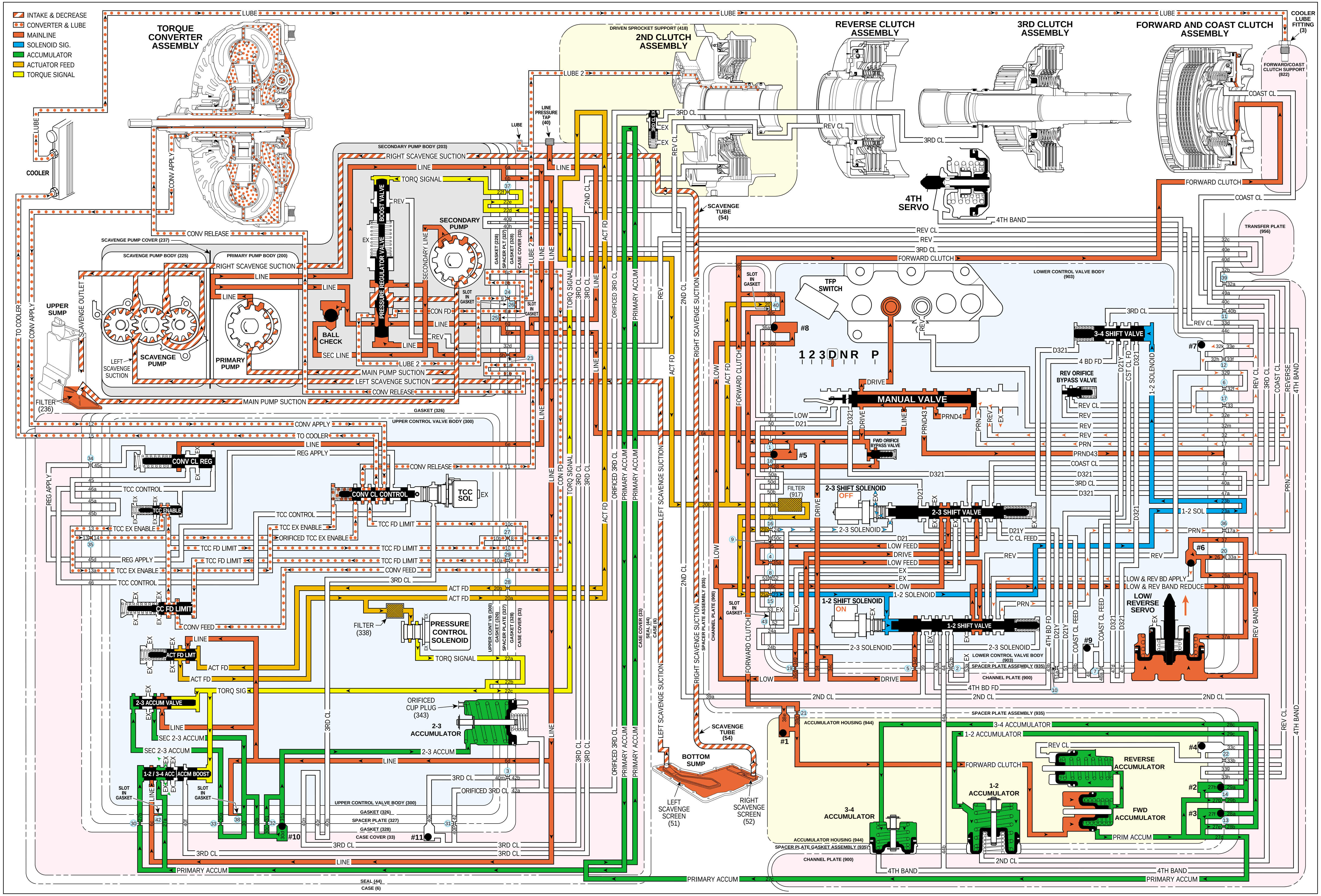


Figure 86

NO FIRST GEAR/SLIPS IN FIRST

- Manual Valve (916) / Shift Linkage
  - Misaligned or stuck
- Forward Orifice Bypass Valve
  - Stuck, damaged, broken
- #5 Ball Check Valve
  - Stuck
  - Missing
- Forward Clutch
  - Forward and coast clutch housing (801) damaged or leaking
  - Forward and coast clutch housing ball check valve (437) missing or leaking
  - Forward clutch piston inner/outer seals (808/809) missing or damaged
  - Forward clutch piston (807) damaged
  - Forward clutch plates (816, 817, 819, 840, 841) worn
- 1-2 Shift Solenoid Valve (909)
  - Failed “OFF”, leaking
- 1-2 Shift Valve (919, 920)
  - Stuck in upshifted position
- 2-3 Shift Solenoid Valve (910)
  - Stuck “ON”, plugged
- 2-3 Shift Valve (907, 908)
  - Stuck in upshifted position
- Torque Converter (1)
  - Stator roller clutch not holding
- Line Pressure
  - Low [See Park (Engine Running) page 82A]
- TFP Manual Valve Position Switch (936)
  - Malfunction (Electrical or Hydraulic)

ENGINE STALLS IN DRIVE

- Cooler Lines
  - Pinched

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF						HOLDING	APPLIED		APPLIED	HOLDING

OVERDRIVE RANGE – FIRST GEAR

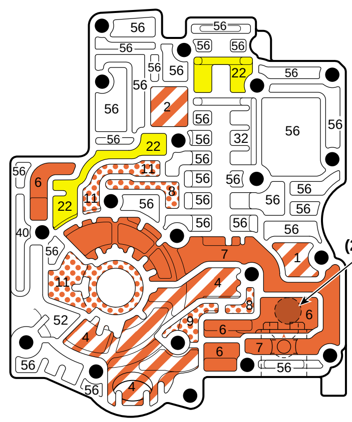
PASSAGES

1 LEFT SCAVENGE SUCTION
2 RIGHT SCAVENGE SUCTION
3 SCAVENGE OUTLET
4 MAIN PUMP SUCTION
5 SUMP
6 LINE
7 SECONDARY LINE
8 CONVERTER FEED
9 LUBE 2
10 TCC FEED LIMIT
11 CONVERTER RELEASE
12 CONVERTER APPLY
13 TCC EXHAUST ENABLE
14 ORIFICED TCC EXHAUST ENABLE
15 TO COOLER
16 LUBE
17 PRN
18 PRND4
19 PRND43
20 ACTUATOR FEED
21 FILTERED ACTUATOR FEED
22 TORQUE SIGNAL
23 1-2 SOLENOID
24 2-3 SOLENOID
25 LOW & REVERSE BAND APPLY
26 REVERSE BAND
27 PRIMARY ACCUMULATOR
28 3-4 ACCUMULATOR
29 1-2 ACCUMULATOR
30 SECONDARY 2-3 ACCUMULATOR
31 2-3 ACCUMULATOR
32 REVERSE
33 REVERSE CLUTCH
34 DRIVE
35 LOW FEED
36 LOW
37 LOW & REVERSE BAND REDUCE
38 FORWARD CLUTCH
39 2ND CLUTCH
40 3RD CLUTCH
42 ORIFICED 3RD CLUTCH
43 4TH BAND FEED
44 4TH BAND
45 REGULATED APPLY
46 TCC CONTROL
47 D321
48 COAST CLUTCH FEED
49 COAST CLUTCH
50 D21
51 D21 Y
52 EXHAUST
53 ORIFICED EXHAUST
54 DRAIN
55 OVERFLOW
56 VOID

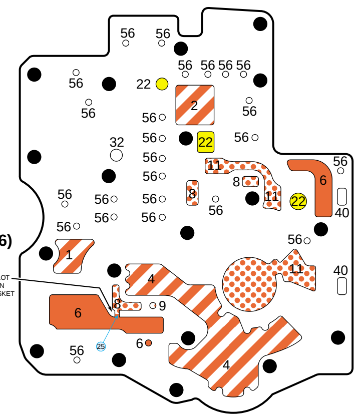
COMPONENTS (   )

(3) COOLER CONNECTOR
(8) OIL DRAIN PLUG
(40) CASE COVER OIL TEST PLUG
(41) TRANSMISSION VENT ADAPTER
(54) SCAVENGE TUBE
(65) BALL CHECK VALVES, #1, 2, 3, 4, 5, 7, 8, 9, 10 & 11
(216) SECONDARY PUMP CUT-OFF BALL
(338) PRESSURE CONTROL SOLENOID FILTER AND SEAL
(343) ORIFICED CUP PLUG
(350) TEMPERATURE SENSOR
(917) SOLENOID SCREEN ASSEMBLY
(979) BALL (0.375 DIAMETER) #6

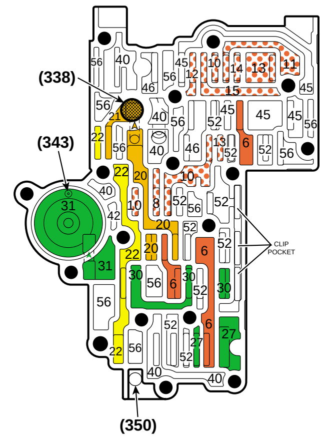
OVERDRIVE RANGE – FIRST GEAR



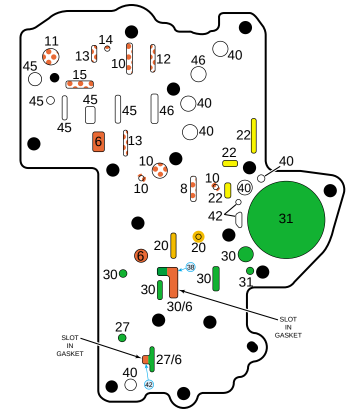
SECONDARY PUMP BODY (203)
(Case Cover Side)



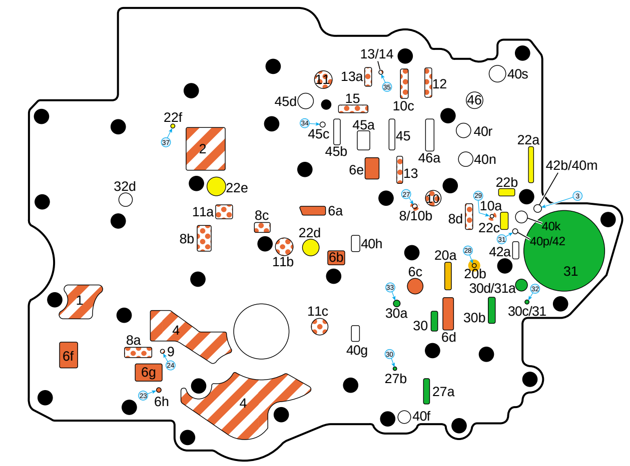
GASKET (228)
(Secondary P.B./ Spacer Plate)



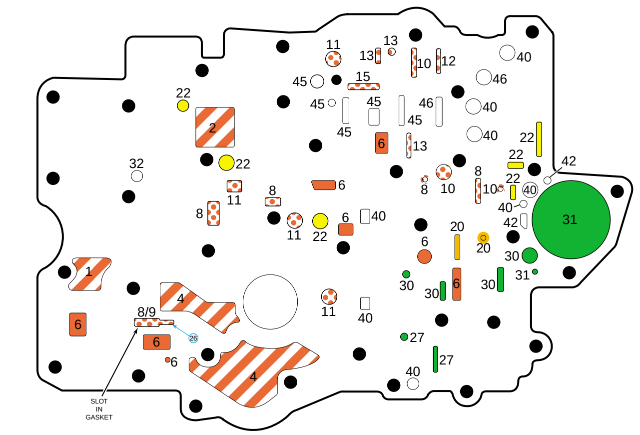
UPPER CONTROL VALVE BODY (300)
(Case Cover Side)



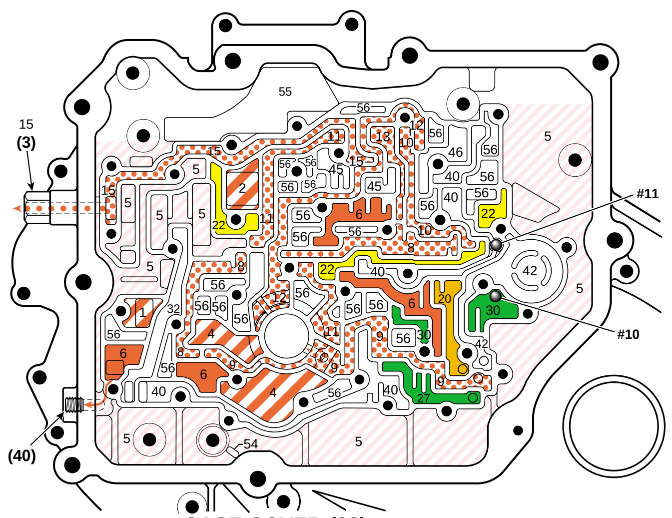
GASKET (326)
(V.B./ Spacer Plate)



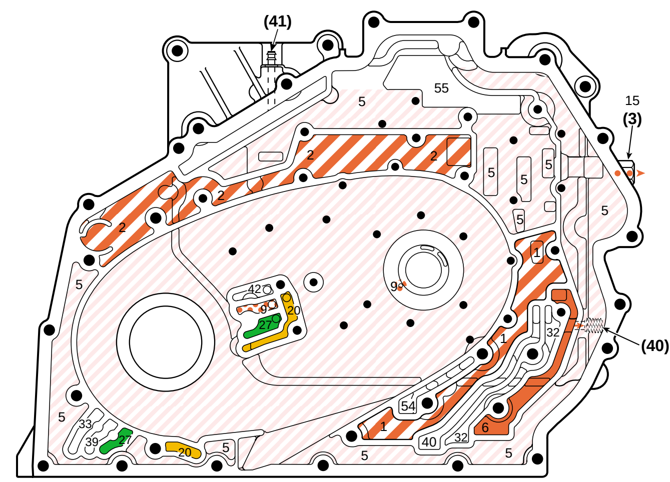
SPACER PLATE (327)
(Sec. P.B. & V.B./ Case Cover)



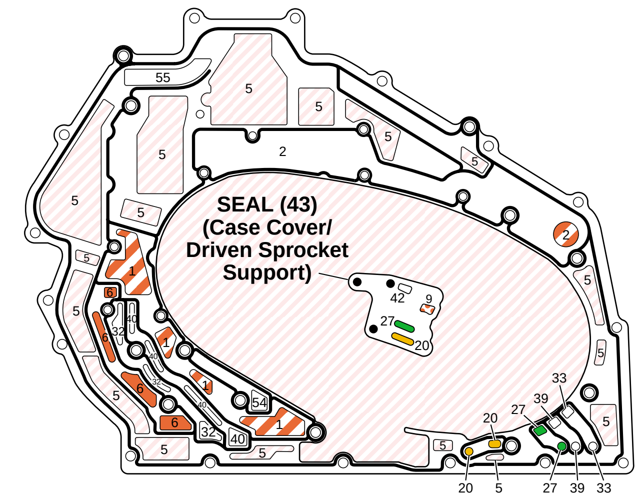
GASKET (328)
(Spacer Plate/ Case Cover)



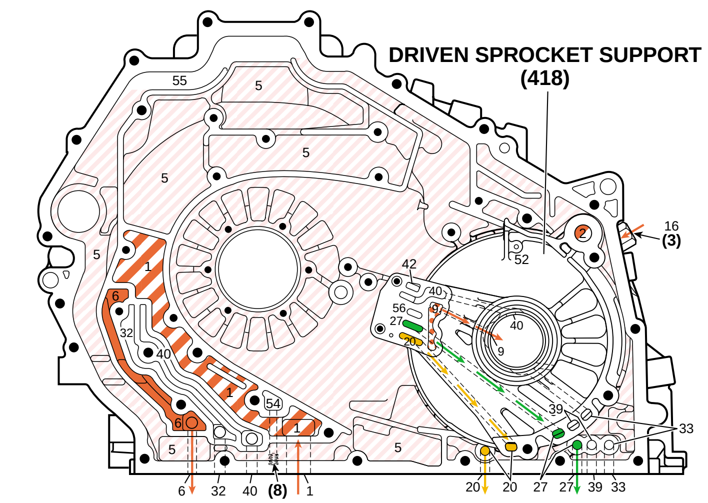
CASE COVER (33)
(Sec. P.B. & V.B.Side)



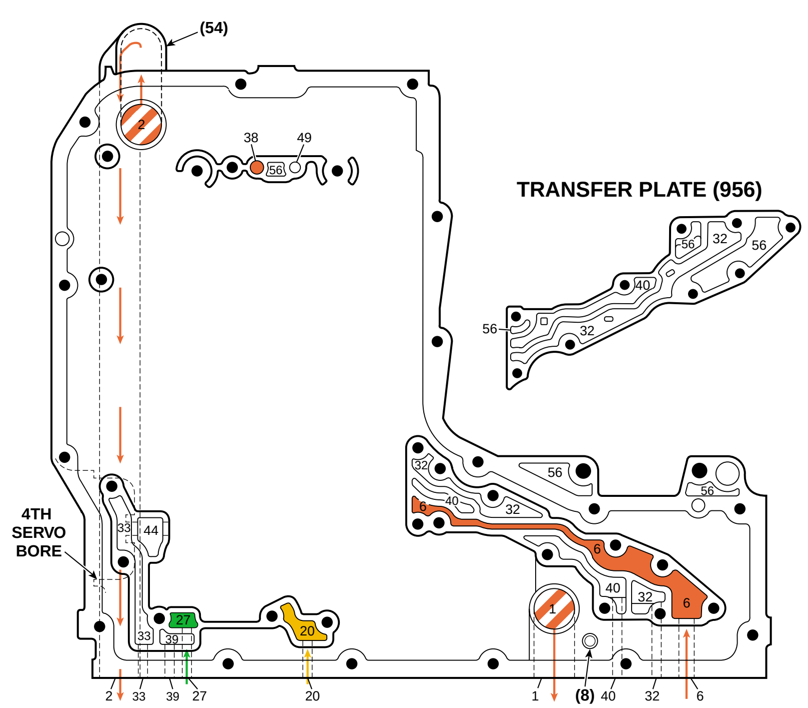
CASE COVER (33)
(Case Side)



SEAL (44)
(Case/Case Cover)

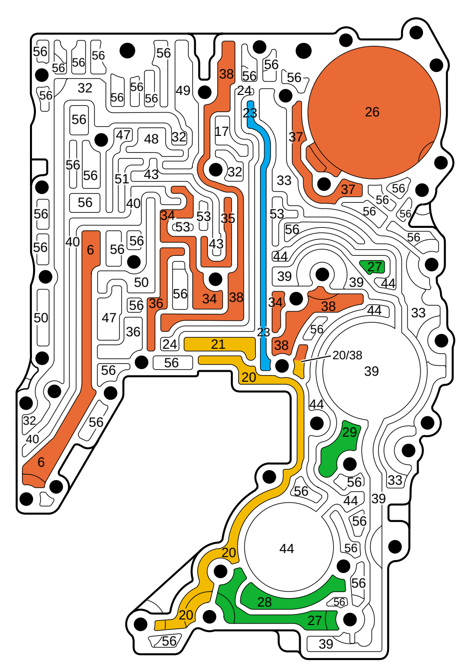


TRANSMISSION CASE (6)
(Case Cover Side)

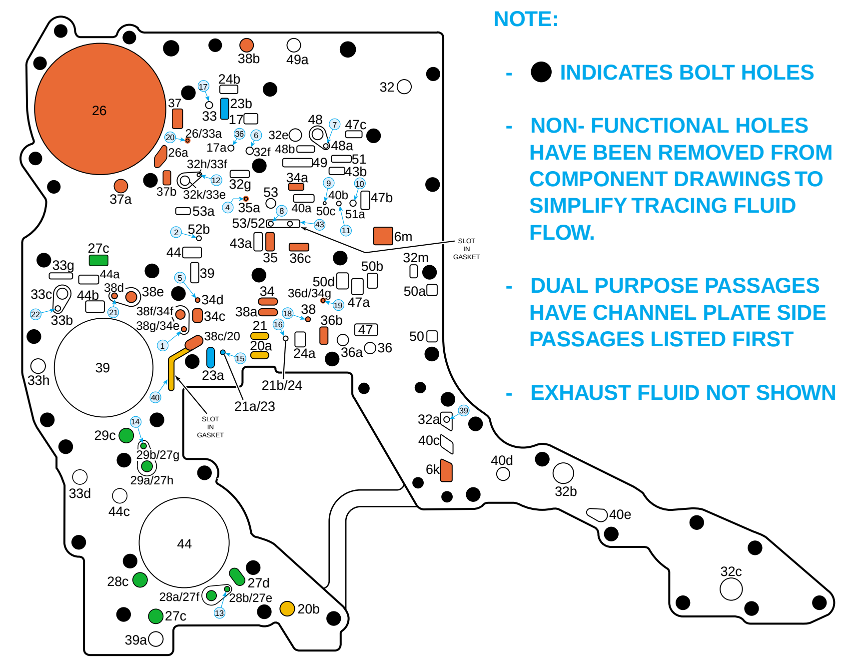


TRANSFER PLATE (956)

TRANSMISSION CASE (6)
(Bottom View)



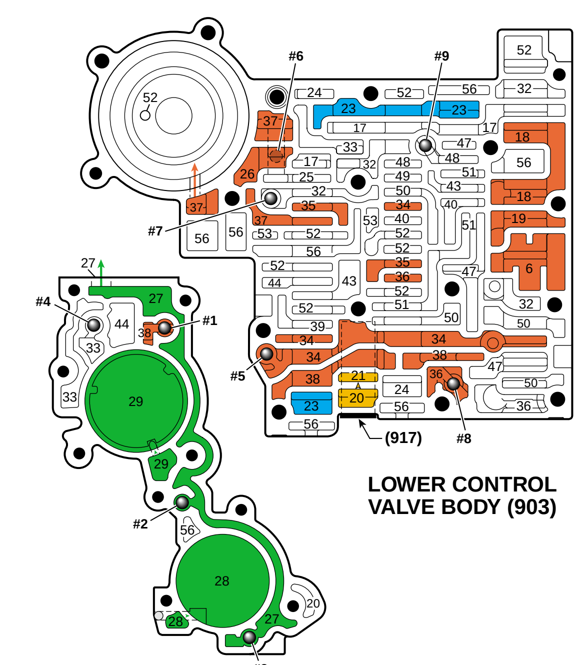
LOWER CHANNEL PLATE (900)
(Case Bottom Side)



SPACER PLATE GASKET ASSEMBLY (935)
(Case Bottom to Lower Channel Plate)

NOTE:

- ● INDICATES BOLT HOLES
- NON- FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE PASSAGES LISTED FIRST
- EXHAUST FLUID NOT SHOWN



LOWER CONTROL VALVE BODY (903)

ACCUMULATOR HOUSING (944)

Figure 87

OVERDRIVE RANGE – SECOND GEAR

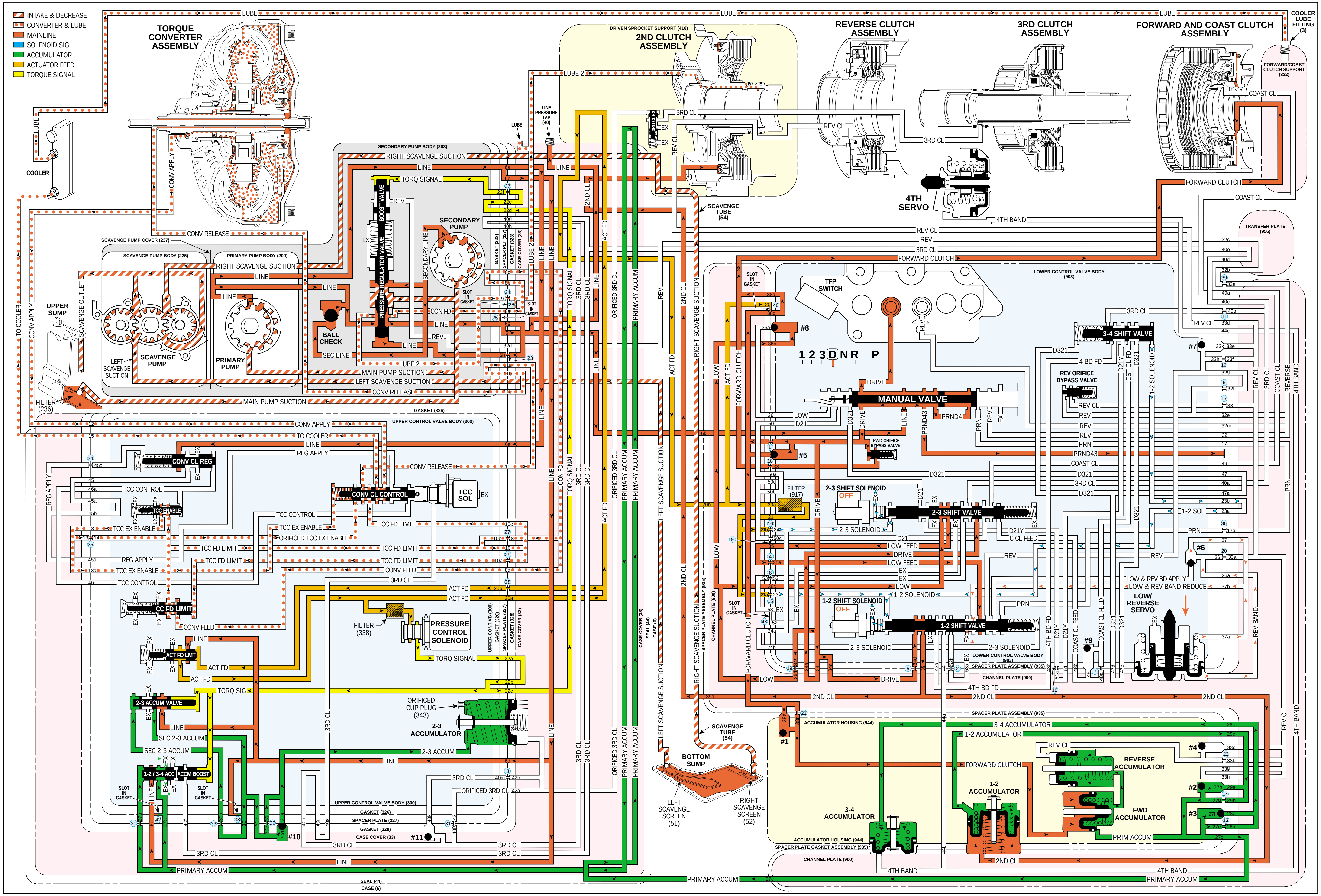


Figure 88

OVERDRIVE RANGE – SECOND GEAR

NO SECOND GEAR/SLIPS IN SECOND

- 2nd Clutch Assembly
  - 2nd clutch plates (431-435) worn, damaged or misassembled
  - 2nd clutch piston assembly (430) damaged, seals leaking
  - 2nd clutch snap ring (429) missing or not seated
  - Return spring and retainer assembly (428) damaged
  - Driven sprocket support ball check valve (437) missing or damaged
  - Driven sprocket support (418) damaged, leaking
- 2nd Clutch Fluid Routing
  - Fluid leak or restriction
  - Control Valve Bodies, Gaskets and Spacer Plates; Channel Plate and Gasket; Case Cover and Gaskets; and Driven Sprocket Support – Porosity, misaligned, loose, restriction, fluid leak across channels
- 1-2 Shift Solenoid Valve (909)
  - Stuck "ON", plugged
- 1-2 Shift Valve (919, 920)
  - Stuck in upshifted position
- Line Pressure
  - Low [See Park (Engine Running) page 82A]
- TFP Manual Valve Position Switch (936)
  - Malfunction (Electrical or Hydraulic)

HARSH SHIFT

- Line Pressure
  - High [See Park (Engine Running) page 82A]
- 1-2 Accumulator Assembly
  - Springs or piston binding; no accumulation
  - Misassembled (upside down) 1-2 accumulator assembly
  - Leak at piston seal
  - #2 ball check valve missing or mislocated
  - Debris in the accumulator passages
- Upper Control Valve Body Assembly
  - 1-2/3-4 accumulator valve (302) stuck or binding

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	OFF	APPLIED	HOLDING				HOLDING	APPLIED			OVERRUN

OVERDRIVE RANGE – SECOND GEAR

PASSAGES

1 LEFT SCAVENGE SUCTION
2 RIGHT SCAVENGE SUCTION
3 SCAVENGE OUTLET
4 MAIN PUMP SUCTION
5 SUMP
6 LINE
7 SECONDARY LINE
8 CONVERTER FEED
9 LUBE 2
10 TCC FEED LIMIT
11 CONVERTER RELEASE
12 CONVERTER APPLY
13 TCC EXHAUST ENABLE
14 ORIFICED TCC EXHAUST ENABLE
15 TO COOLER
16 LUBE
17 PRN
18 PRND4
19 PRND43
20 ACTUATOR FEED
21 FILTERED ACTUATOR FEED
22 TORQUE SIGNAL
23 1-2 SOLENOID
24 2-3 SOLENOID
25 LOW & REVERSE BAND APPLY
26 REVERSE BAND
27 PRIMARY ACCUMULATOR
28 3-4 ACCUMULATOR
29 1-2 ACCUMULATOR
30 SECONDARY 2-3 ACCUMULATOR
31 2-3 ACCUMULATOR
32 REVERSE
33 REVERSE CLUTCH
34 DRIVE
35 LOW FEED
36 LOW
37 LOW & REVERSE BAND REDUCE
38 FORWARD CLUTCH
39 2ND CLUTCH
40 3RD CLUTCH
42 ORIFICED 3RD CLUTCH
43 4TH BAND FEED
44 4TH BAND
45 REGULATED APPLY
46 TCC CONTROL
47 D321
48 COAST CLUTCH FEED
49 COAST CLUTCH
50 D21
51 D21 Y
52 EXHAUST
53 ORIFICED EXHAUST
54 DRAIN
55 OVERFLOW
56 VOID

COMPONENTS ( )

(3) COOLER CONNECTOR
(8) OIL DRAIN PLUG
(40) CASE COVER OIL TEST PLUG
(41) TRANSMISSION VENT ADAPTER
(54) SCAVENGE TUBE
(65) BALL CHECK VALVES, #1, 2, 3, 4, 5, 7, 8, 9, 10 & 11
(216) SECONDARY PUMP CUT-OFF BALL
(338) PRESSURE CONTROL SOLENOID FILTER AND SEAL
(343) ORIFICED CUP PLUG
(350) TEMPERATURE SENSOR
(917) SOLENOID SCREEN ASSEMBLY
(979) BALL (0.375 DIAMETER) #6

OVERDRIVE RANGE – SECOND GEAR

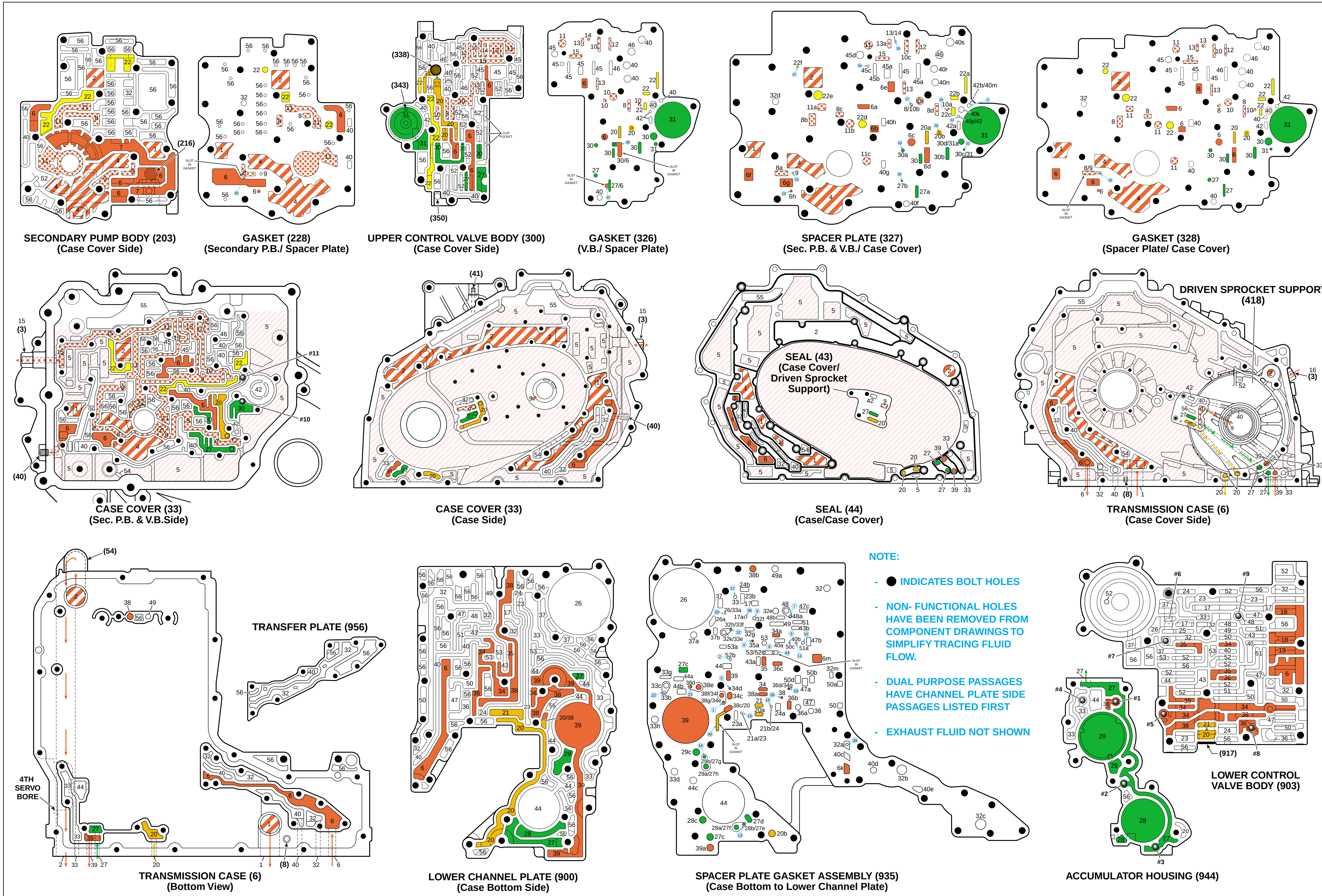


Figure 89

OVERDRIVE RANGE – THIRD GEAR

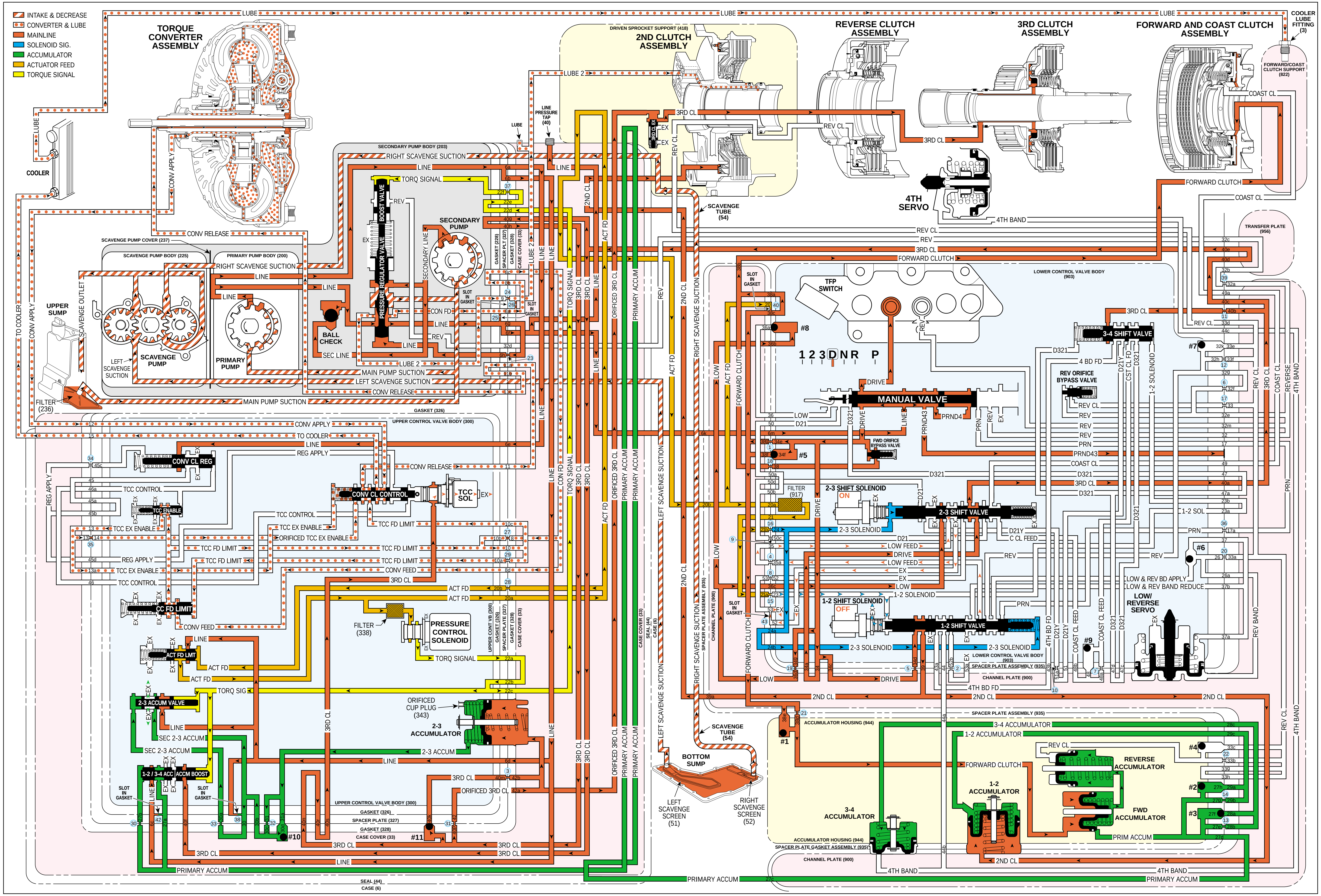


Figure 90

OVERDRIVE RANGE – THIRD GEAR

NO THIRD GEAR/SLIPS IN THIRD

- 3rd Clutch Assembly
  - Input shaft oil seal rings (614) missing or damaged
  - 3rd clutch piston (606) damaged, seals leaking
  - 3rd clutch piston ball check valve assembly missing or leaking
  - 3rd clutch plates (610-613) worn, damaged or misassembled
  - 3rd clutch snap ring (515) missing or not seated
  - Spring and retainer assembly (607) damaged
  - Return spring snap ring (609) missing or not seated
  - 3rd clutch housing (604) damaged, leaking
- Third Clutch Fluid Routing
  - Fluid leak or restriction
  - Control Valve Bodies, Gaskets and Spacer Plates; Channel Plate and Gasket; Case Cover and Gaskets; and Driven Sprocket Support – Porosity, misaligned, loose, restriction, fluid leak across channels
  - Input Shaft – Oil Seal Rings leaking – Oil Transfer Sleeve damaged, misaligned
- 2-3 Shift Solenoid Valve (910)
  - Failed “OFF”, leaking
- 2-3 Shift Valve (907, 908)
  - Stuck in downshifted position
- 3-4 Shift Valve (912)
  - Stuck in upshifted position
- #11 Ball Check Valve
  - Stuck
  - Missing
- 3rd Clutch Exhaust Valve (427)
  - Stuck, damaged, broken
- Line Pressure
  - Low [See Park (Engine Running) page 82A]
- TFP Manual Valve Position Switch (936)
  - Malfunction (Electrical or Hydraulic)

HARSH SHIFT

- Line Pressure
  - High [See Park (Engine Running) page 82A]
- 2-3 Accumulator Assembly
  - Springs or piston binding; no accumulation
  - Misassembled (upside down) 2-3 accumulator assembly
  - Leak at piston seal
  - #10 ball check valve missing or mislocated
  - Debris in the accumulator passages
- Upper Control Valve Body Assembly
  - 2-3 accumulator valve (306) stuck or binding

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	ON	APPLIED	OVERRUN		APPLIED		HOLDING	APPLIED			OVERRUN

OVERDRIVE RANGE – THIRD GEAR

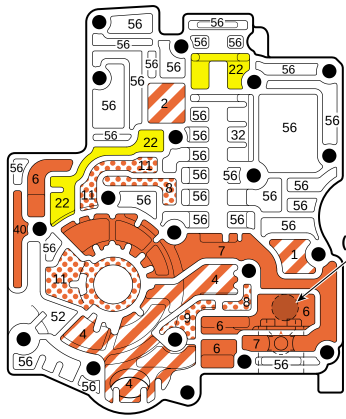
PASSAGES

1	LEFT SCAVENGE SUCTION
2	RIGHT SCAVENGE SUCTION
3	SCAVENGE OUTLET
4	MAIN PUMP SUCTION
5	SUMP
6	LINE
7	SECONDARY LINE
8	CONVERTER FEED
9	LUBE 2
10	TCC FEED LIMIT
11	CONVERTER RELEASE
12	CONVERTER APPLY
13	TCC EXHAUST ENABLE
14	ORIFICED TCC EXHAUST ENABLE
15	TO COOLER
16	LUBE
17	PRN
18	PRND4
19	PRND43
20	ACTUATOR FEED
21	FILTERED ACTUATOR FEED
22	TORQUE SIGNAL
23	1-2 SOLENOID
24	2-3 SOLENOID
25	LOW & REVERSE BAND APPLY
26	REVERSE BAND
27	PRIMARY ACCUMULATOR
28	3-4 ACCUMULATOR
29	1-2 ACCUMULATOR
30	SECONDARY 2-3 ACCUMULATOR
31	2-3 ACCUMULATOR
32	REVERSE
33	REVERSE CLUTCH
34	DRIVE
35	LOW FEED
36	LOW
37	LOW & REVERSE BAND REDUCE
38	FORWARD CLUTCH
39	2ND CLUTCH
40	3RD CLUTCH
42	ORIFICED 3RD CLUTCH
43	4TH BAND FEED
44	4TH BAND
45	REGULATED APPLY
46	TCC CONTROL
47	D321
48	COAST CLUTCH FEED
49	COAST CLUTCH
50	D21
51	D21 Y
52	EXHAUST
53	ORIFICED EXHAUST
54	DRAIN
55	OVERFLOW
56	VOID

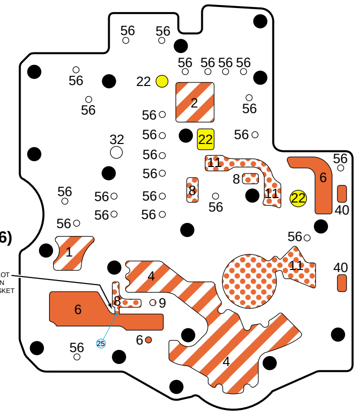
COMPONENTS (   )

(3)	COOLER CONNECTOR
(8)	OIL DRAIN PLUG
(40)	CASE COVER OIL TEST PLUG
(41)	TRANSMISSION VENT ADAPTER
(54)	SCAVENGE TUBE
(65)	BALL CHECK VALVES, #1, 2, 3, 4, 5, 7, 8, 9, 10 & 11
(216)	SECONDARY PUMP CUT-OFF BALL
(338)	PRESSURE CONTROL SOLENOID FILTER AND SEAL
(343)	ORIFICED CUP PLUG
(350)	TEMPERATURE SENSOR
(917)	SOLENOID SCREEN ASSEMBLY
(979)	BALL (0.375 DIAMETER) #6

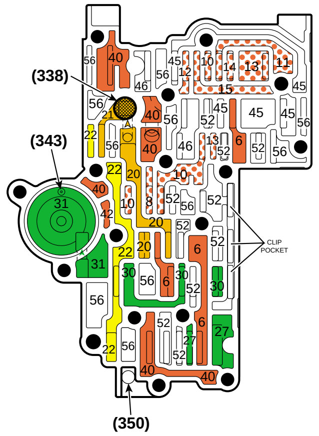
OVERDRIVE RANGE – THIRD GEAR



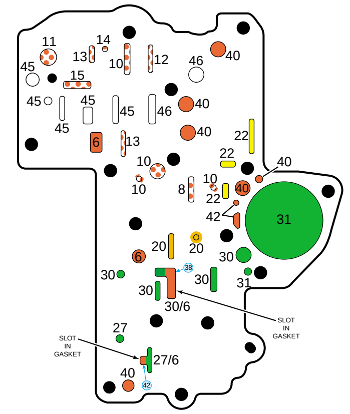
SECONDARY PUMP BODY (203)
(Case Cover Side)



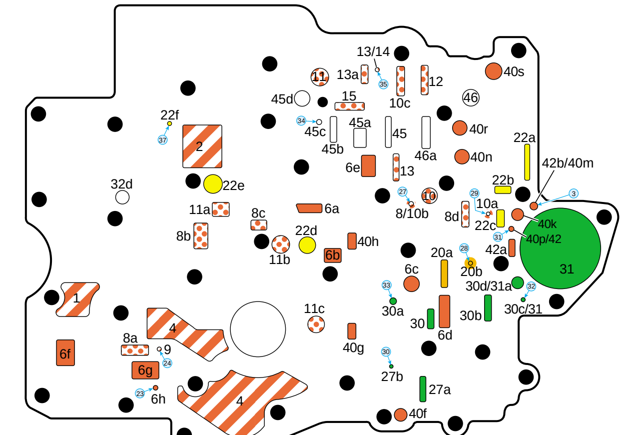
GASKET (228)
(Secondary P.B./ Spacer Plate)



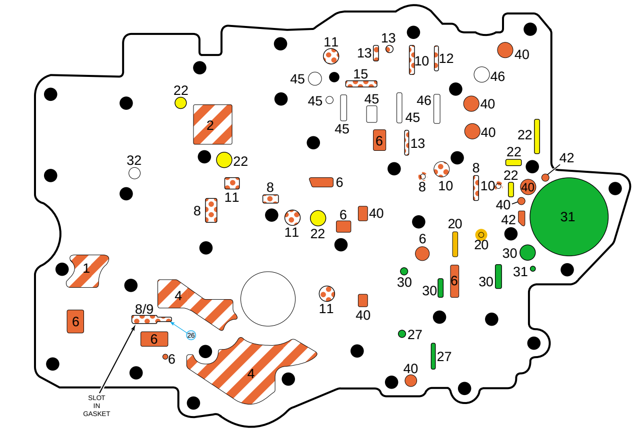
UPPER CONTROL VALVE BODY (300)
(Case Cover Side)



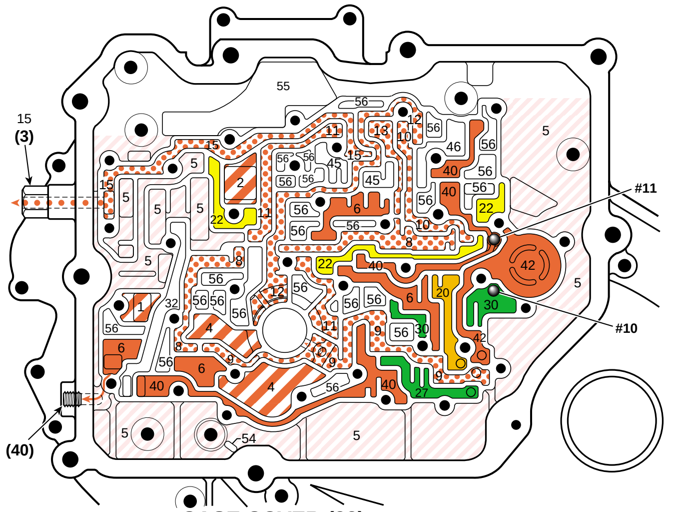
GASKET (326)
(V.B./ Spacer Plate)



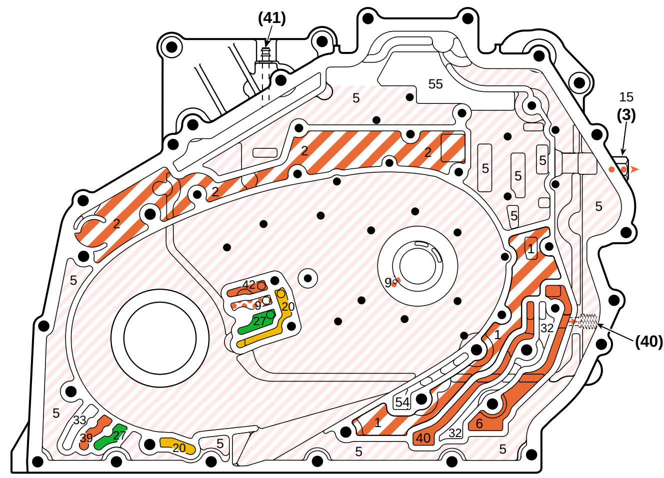
SPACER PLATE (327)
(Sec. P.B. & V.B./ Case Cover)



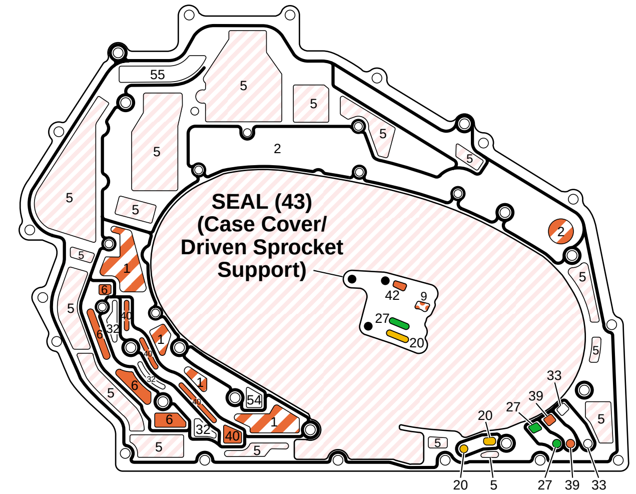
GASKET (328)
(Spacer Plate/ Case Cover)



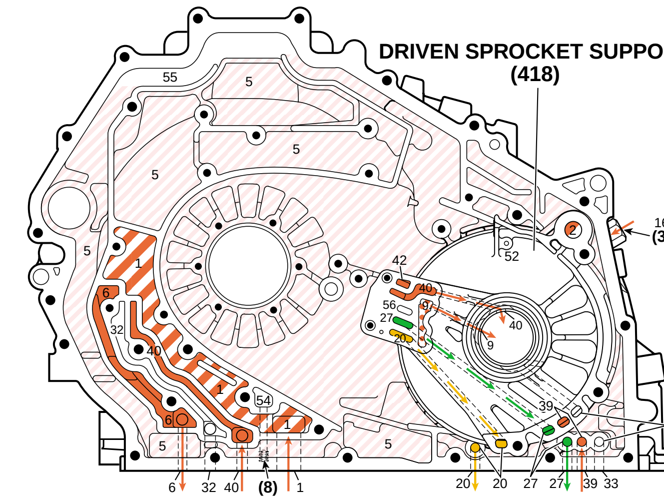
CASE COVER (33)
(Sec. P.B. & V.B.Side)



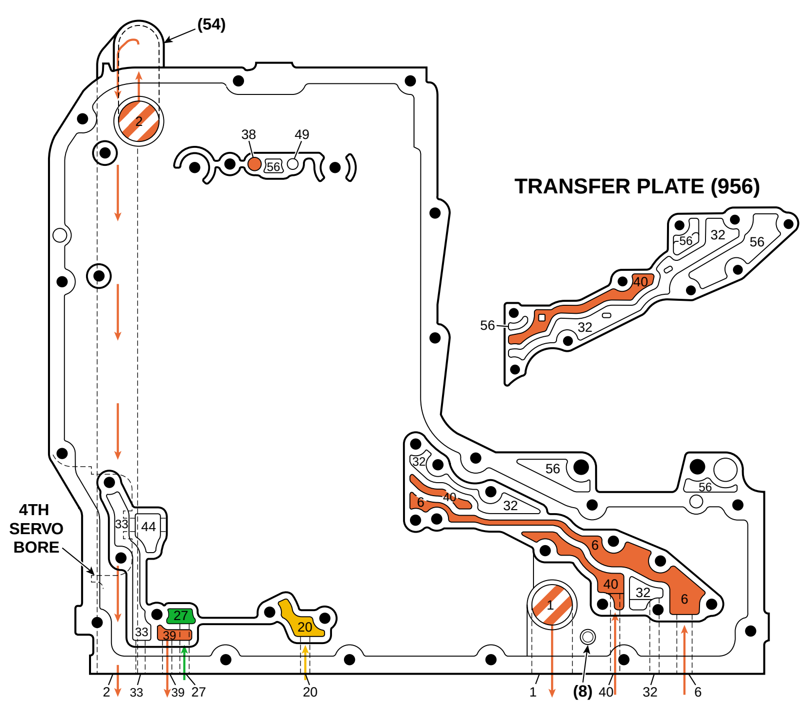
CASE COVER (33)
(Case Side)



SEAL (44)
(Case/Case Cover)

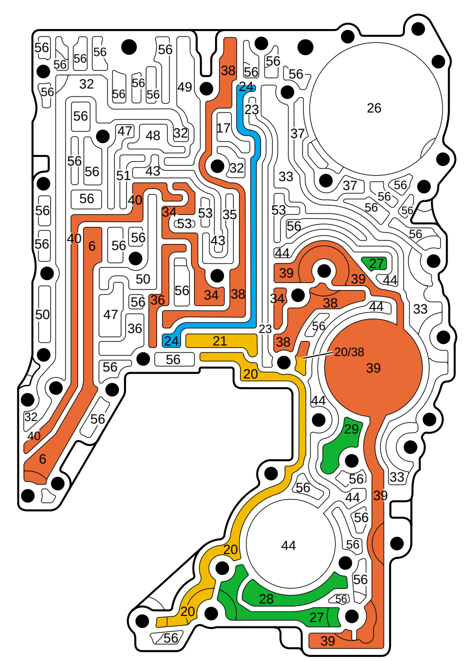


TRANSMISSION CASE (6)
(Case Cover Side)

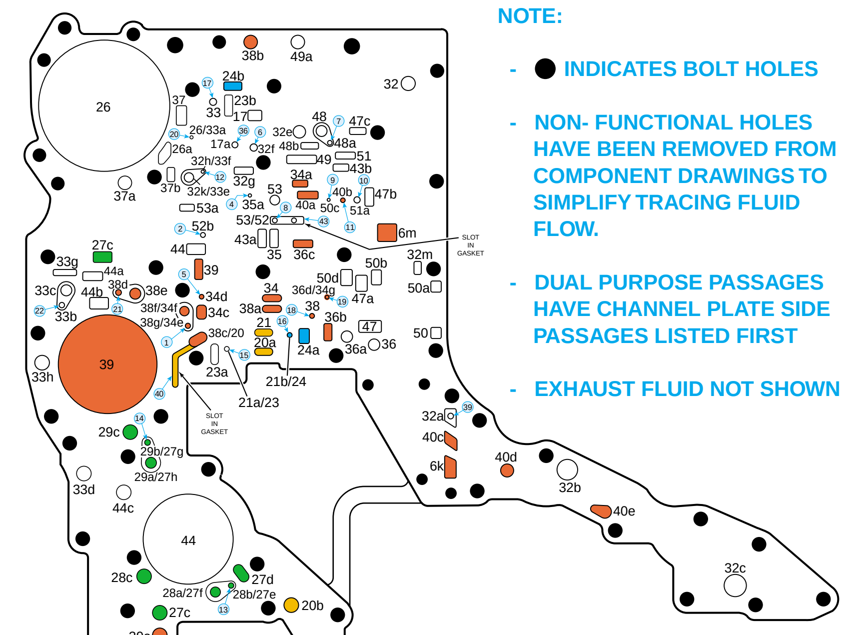


TRANSFER PLATE (956)

TRANSMISSION CASE (6)
(Bottom View)



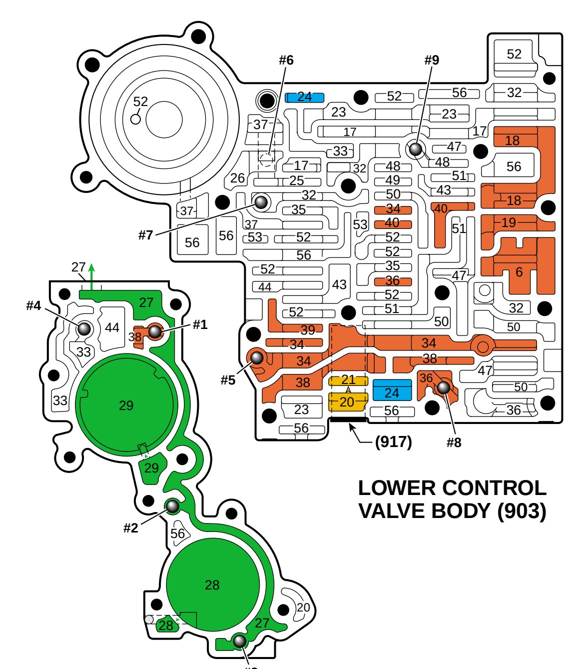
LOWER CHANNEL PLATE (900)
(Case Bottom Side)



SPACER PLATE GASKET ASSEMBLY (935)
(Case Bottom to Lower Channel Plate)

NOTE:

- ● INDICATES BOLT HOLES
- NON- FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE PASSAGES LISTED FIRST
- EXHAUST FLUID NOT SHOWN



LOWER CONTROL VALVE BODY (903)

ACCUMULATOR HOUSING (944)

OVERDRIVE RANGE – FOURTH GEAR (Torque Converter Clutch Applied)

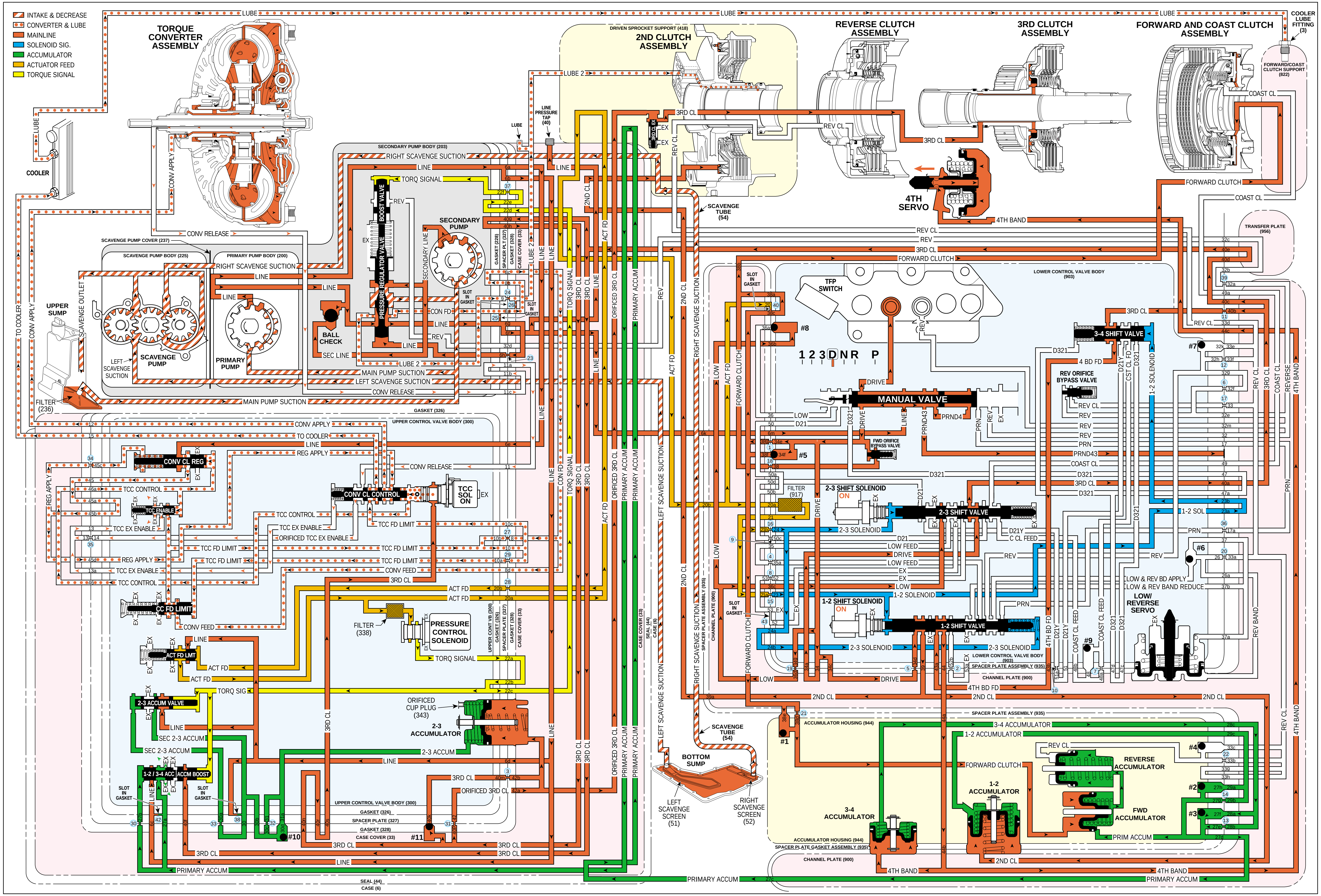


Figure 92

OVERDRIVE RANGE – FOURTH GEAR

(Torque Converter Clutch Applied)

NO FOURTH GEAR/SLIPS IN FOURTH

- 4th Servo Assembly
  - Servo piston seal (532) missing or damaged
  - Servo piston (529) damaged or stuck in case bore
  - Servo piston spring and retainer assembly (533) missing or damaged
  - Servo apply pin (527) not engaged to 4th band (523)
  - 4th band (523) worn or burned
  - 4th band assembly (523) disengaged from anchor pin (10)
  - 4th band anchor pin (10) loose or missing

- 4th Servo Fluid Routing
  - Fluid leak or restriction
  - Lower Control Valve Body, Gaskets and Spacer Plate; Channel Plate and Gasket; and Accumulator Housing – Porosity, misaligned, loose, restriction, fluid leak across channels

- 1-2 Shift Solenoid Valve (909)
  - Failed "OFF", leaking

- 3-4 Shift Valve (912)
  - Stuck in downshifted position

- Manual Valve (916) / Shift Linkage
  - Misaligned or stuck

- Line Pressure
  - Low [See Park (Engine Running) page 82A]

- TFP Manual Valve Position Switch (936)
  - Malfunction (Electrical or Hydraulic)

HARSH SHIFT

- Line Pressure
  - High [See Park (Engine Running) page 82A]

- 3-4 Accumulator Assembly
  - Spring or piston binding; no accumulation
  - Misassembled (upside down) 3-4 accumulator assembly
  - Leak at piston seal
  - #3 ball check valve missing or mislocated
  - Debris in the accumulator passages

- Upper Control Valve Body Assembly
  - 1-2/3-4 accumulator valve (302) stuck or binding

NO TCC APPLY OR RELEASE

- See Overdrive Range – 4-3 Downshift page 96A.

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	ON	APPLIED			APPLIED	APPLIED	OVERRUN	APPLIED			OVERRUN

OVERDRIVE RANGE – FOURTH GEAR
(Torque Converter Clutch Applied)

PASSAGES

1 LEFT SCAVENGE SUCTION
2 RIGHT SCAVENGE SUCTION
3 SCAVENGE OUTLET
4 MAIN PUMP SUCTION
5 SUMP
6 LINE
7 SECONDARY LINE
8 CONVERTER FEED
9 LUBE 2
10 TCC FEED LIMIT
11 CONVERTER RELEASE
12 CONVERTER APPLY
13 TCC EXHAUST ENABLE
14 ORIFICED TCC EXHAUST ENABLE
15 TO COOLER
16 LUBE
17 PRN
18 PRND4
19 PRND43
20 ACTUATOR FEED
21 FILTERED ACTUATOR FEED
22 TORQUE SIGNAL
23 1-2 SOLENOID
24 2-3 SOLENOID
25 LOW & REVERSE BAND APPLY
26 REVERSE BAND
27 PRIMARY ACCUMULATOR
28 3-4 ACCUMULATOR
29 1-2 ACCUMULATOR
30 SECONDARY 2-3 ACCUMULATOR
31 2-3 ACCUMULATOR
32 REVERSE
33 REVERSE CLUTCH
34 DRIVE
35 LOW FEED
36 LOW
37 LOW & REVERSE BAND REDUCE
38 FORWARD CLUTCH
39 2ND CLUTCH
40 3RD CLUTCH
42 ORIFICED 3RD CLUTCH
43 4TH BAND FEED
44 4TH BAND
45 REGULATED APPLY
46 TCC CONTROL
47 D321
48 COAST CLUTCH FEED
49 COAST CLUTCH
50 D21
51 D21 Y
52 EXHAUST
53 ORIFICED EXHAUST
54 DRAIN
55 OVERFLOW
56 VOID

COMPONENTS (   )

(3) COOLER CONNECTOR
(8) OIL DRAIN PLUG
(40) CASE COVER OIL TEST PLUG
(41) TRANSMISSION VENT ADAPTER
(54) SCAVENGE TUBE
(65) BALL CHECK VALVES, #1, 2, 3, 4, 5, 7, 8, 9, 10 & 11
(216) SECONDARY PUMP CUT-OFF BALL
(338) PRESSURE CONTROL SOLENOID FILTER AND SEAL
(343) ORIFICED CUP PLUG
(350) TEMPERATURE SENSOR
(917) SOLENOID SCREEN ASSEMBLY
(979) BALL (0.375 DIAMETER) #6

OVERDRIVE RANGE – FOURTH GEAR (Torque Converter Clutch Applied)

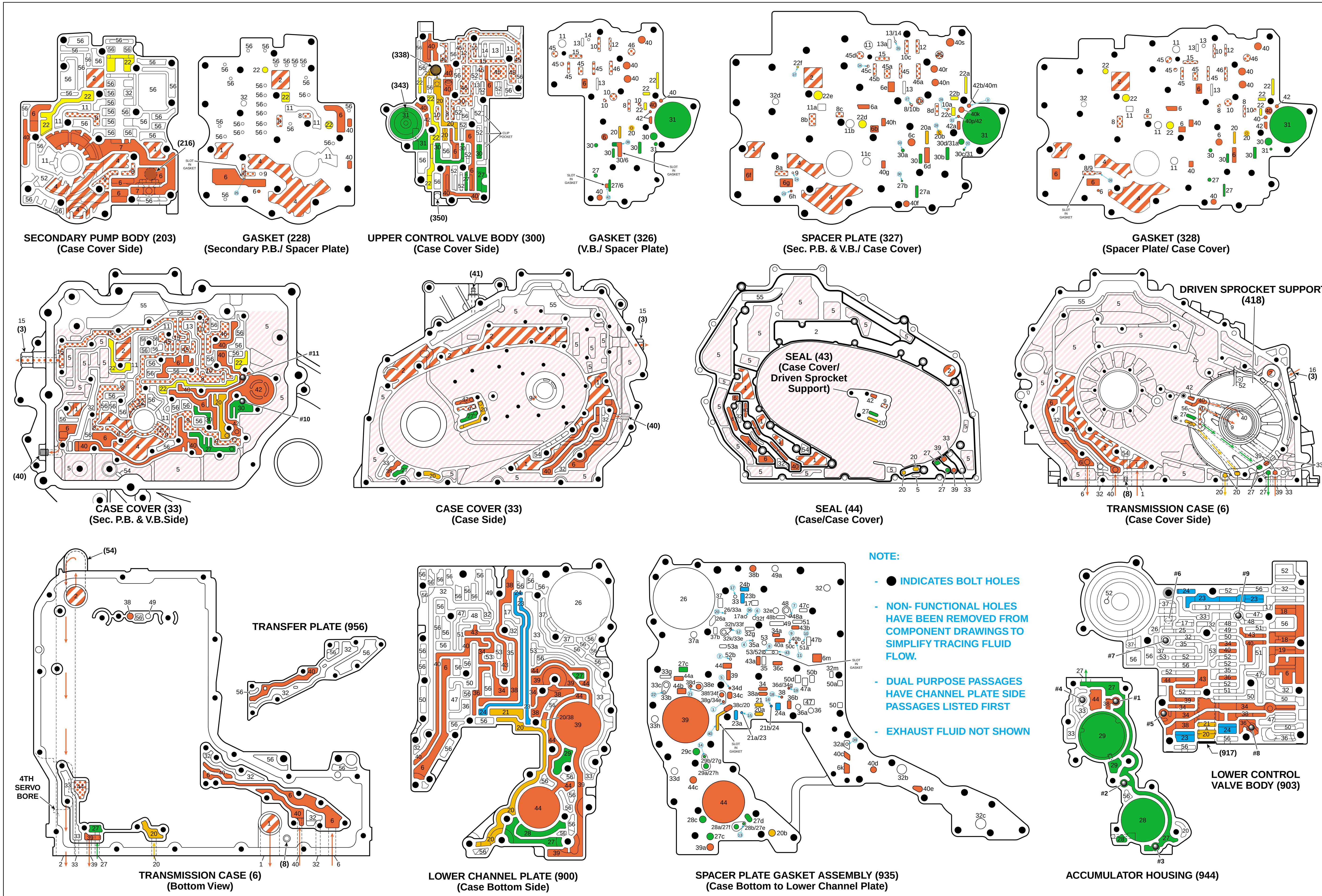


Figure 93

OVERDRIVE RANGE – 4-3 DOWNSHIFT (Torque Converter Clutch Released)

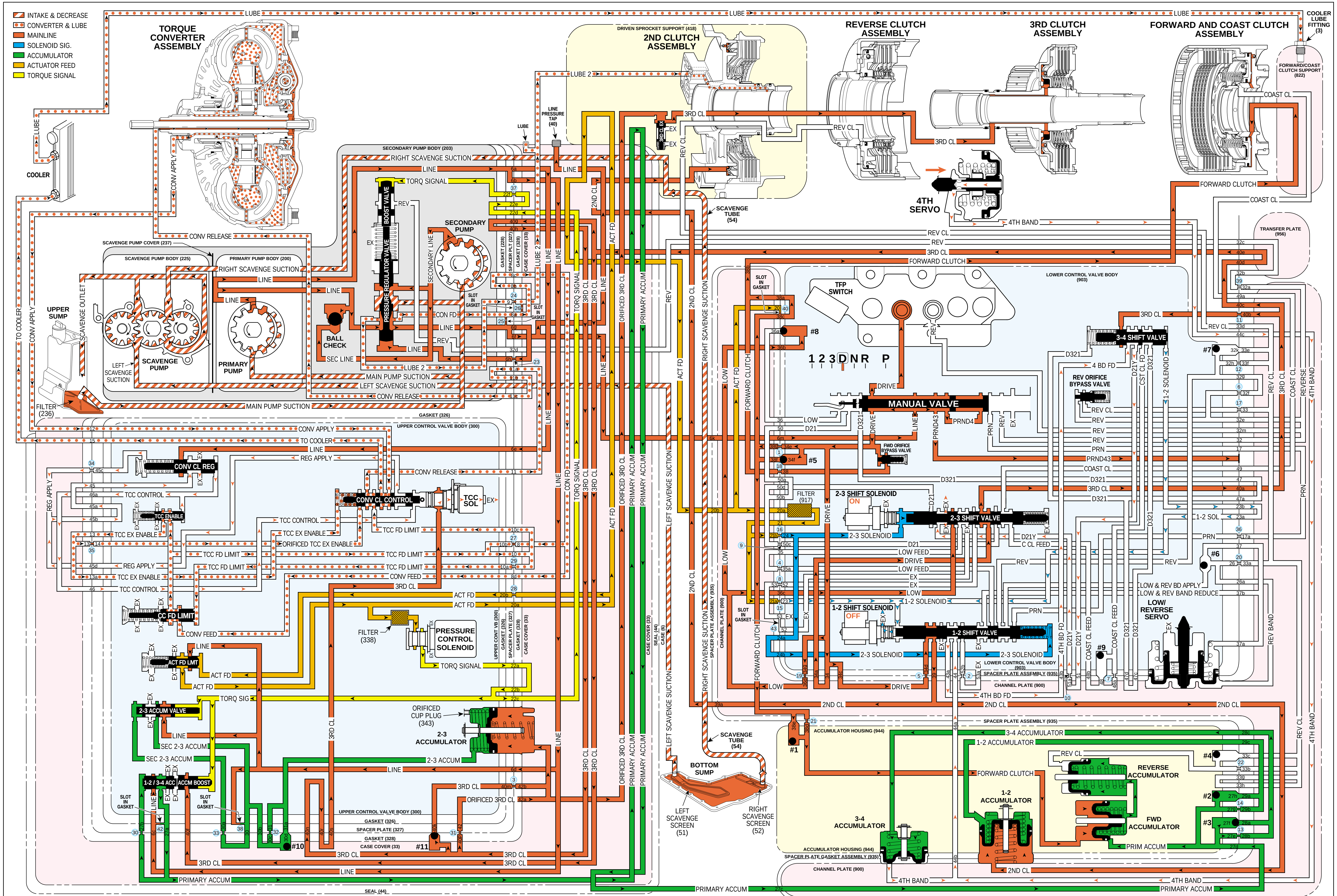


Figure 94

OVERDRIVE RANGE – 4-3 DOWNSHIFT
(Torque Converter Clutch Released)

NO THIRD GEAR/SLIPS IN THIRD

See Overdrive Range – Third Gear (page 92A) for possible faults and conditions related to normal third gear operation.

NO TCC APPLY / SLIPPING / SOFT APPLY

- TCC Pressure Solenoid Valve (336)
  - Failed “OFF” – O-ring leaking
  - No voltage to solenoid
  - Poor electrical connection
- Wiring Harness (12)
  - Pinched wire (electrical short)
  - Damaged electrical connector
- PCM
  - No signal to solenoid
- Brake Switch
  - Not functioning (open)
- Pressure Regulator Valve (211)
  - Stuck, binding
- Torque Converter Assembly (1)
  - Internal failure
- TCC Fluid Circuits
  - Leaks
- Converter Clutch Feed Limit Valve (312)
  - Stuck, binding
- Converter Clutch Control Valve (317)
  - Stuck in TCC release position
- Converter Clutch Regulator Valve (318)
  - Stuck, binding
- Fluid Level or Pressure
  - Low
- Cooler Lines
  - Plugged

NO TCC RELEASE

- TCC Pressure Solenoid Valve (336)
  - Internal failure
  - Fluid exhaust plugged
  - External Ground
- Torque Converter Assembly (1)
  - Internal Failure
- Converter Clutch Control Valve (317)
  - Stuck in TCC apply position
- TCC Enable Valve (322)
  - Stuck, binding

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	ON	APPLIED	OVERRUN		APPLIED		HOLDING	APPLIED			OVERRUN

OVERDRIVE RANGE – 4-3 DOWNSHIFT
(Torque Converter Clutch Released)

PASSAGES

1	LEFT SCAVENGE SUCTION
2	RIGHT SCAVENGE SUCTION
3	SCAVENGE OUTLET
4	MAIN PUMP SUCTION
5	SUMP
6	LINE
7	SECONDARY LINE
8	CONVERTER FEED
9	LUBE 2
10	TCC FEED LIMIT
11	CONVERTER RELEASE
12	CONVERTER APPLY
13	TCC EXHAUST ENABLE
14	ORIFICED TCC EXHAUST ENABLE
15	TO COOLER
16	LUBE
17	PRN
18	PRND4
19	PRND43
20	ACTUATOR FEED
21	FILTERED ACTUATOR FEED
22	TORQUE SIGNAL
23	1-2 SOLENOID
24	2-3 SOLENOID
25	LOW & REVERSE BAND APPLY
26	REVERSE BAND
27	PRIMARY ACCUMULATOR
28	3-4 ACCUMULATOR
29	1-2 ACCUMULATOR
30	SECONDARY 2-3 ACCUMULATOR
31	2-3 ACCUMULATOR
32	REVERSE
33	REVERSE CLUTCH
34	DRIVE
35	LOW FEED
36	LOW
37	LOW & REVERSE BAND REDUCE
38	FORWARD CLUTCH
39	2ND CLUTCH
40	3RD CLUTCH
42	ORIFICED 3RD CLUTCH
43	4TH BAND FEED
44	4TH BAND
45	REGULATED APPLY
46	TCC CONTROL
47	D321
48	COAST CLUTCH FEED
49	COAST CLUTCH
50	D21
51	D21 Y
52	EXHAUST
53	ORIFICED EXHAUST
54	DRAIN
55	OVERFLOW
56	VOID

COMPONENTS (   )

(3)	COOLER CONNECTOR
(8)	OIL DRAIN PLUG
(40)	CASE COVER OIL TEST PLUG
(41)	TRANSMISSION VENT ADAPTER
(54)	SCAVENGE TUBE
(65)	BALL CHECK VALVES, #1, 2, 3, 4, 5, 7, 8, 9, 10 & 11
(216)	SECONDARY PUMP CUT-OFF BALL
(338)	PRESSURE CONTROL SOLENOID FILTER AND SEAL
(343)	ORIFICED CUP PLUG
(350)	TEMPERATURE SENSOR
(917)	SOLENOID SCREEN ASSEMBLY
(979)	BALL (0.375 DIAMETER) #6

OVERDRIVE RANGE – 4-3 DOWNSHIFT (Torque Converter Clutch Released)

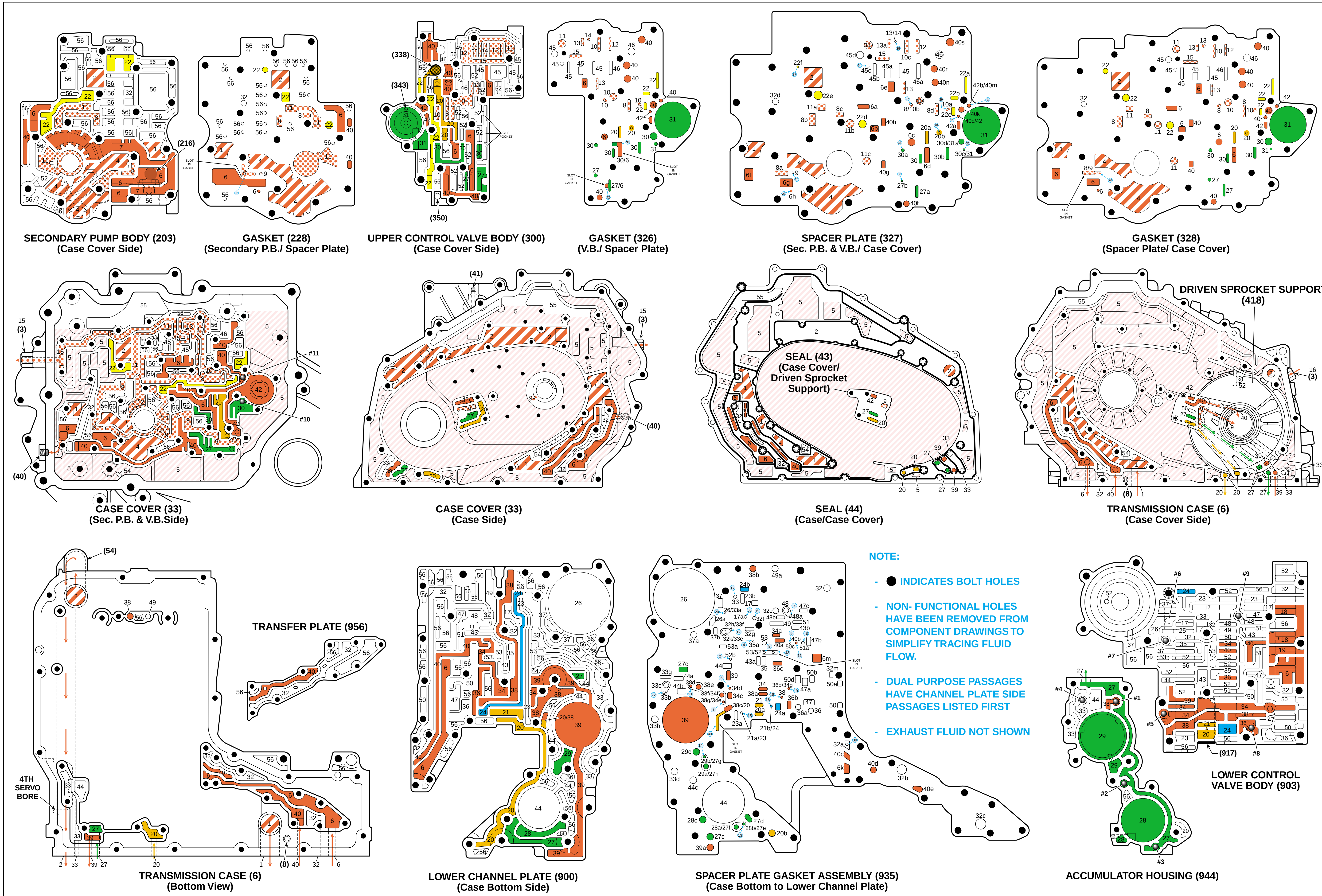


Figure 95

MANUAL THIRD – THIRD GEAR (from Overdrive Range – Fourth Gear)

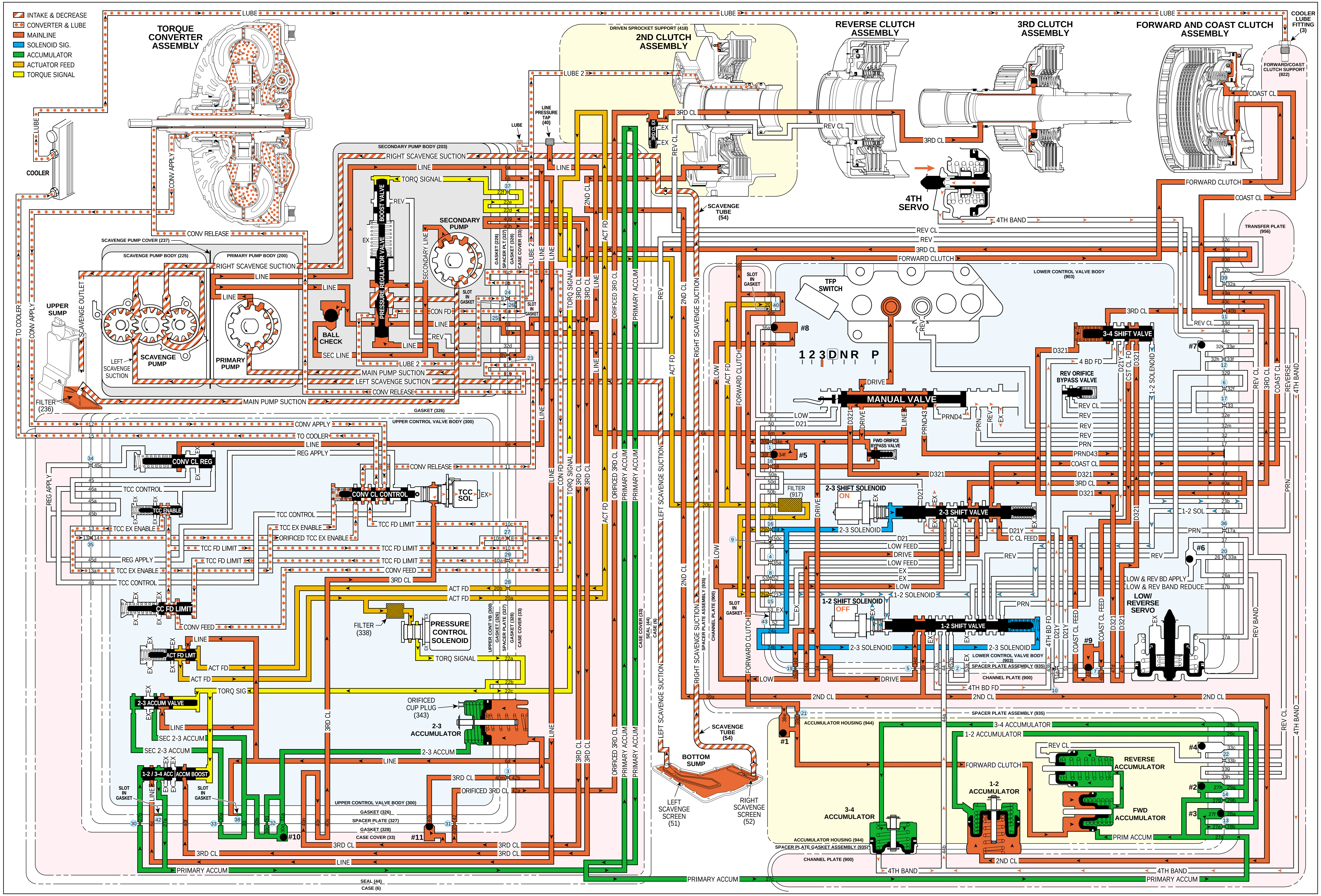


Figure 96

MANUAL THIRD – THIRD GEAR

(from Overdrive Range – Fourth Gear)

NO THIRD GEAR/SLIPS IN THIRD

See Overdrive Range – Third Gear (page 92A) for possible faults and conditions related to normal third gear operation.

NO ENGINE COMPRESSION BRAKING

- Coast Clutch
  - Coast Clutch Piston Assembly (810) – Binding, cracked, leaking
  - Coast Clutch Piston Ball Check Valve – Missing, leaking
  - Coast Clutch Plates (812-814, 840, 841) – Friction material worn, splines broken
  - Release Spring Assembly (820) – Binding, broken
  - Return Spring Snap Ring (821) missing or not seated
  - Forward/Coast Clutch Support (822) – Damaged, cracked, fluid feed holes restricted, Oil Seal Rings leaking, Oil Transfer Sleeve damaged or misaligned
- Coast Clutch Fluid Routing
  - Lower Control Valve Body, Gaskets and Spacer Plate; Channel Plate and Gasket; Forward/Coast Clutch Support – Porosity, misaligned, loose, fluid restriction, fluid leak across channels
  - Forward/Coast Clutch Support Seals – Leaking
- Fluid Level or Pressure
  - Low [See Park (Engine Running) page 82A]
- TFP Manual Valve Position Switch (936)
  - Malfunction (Electrical or Hydraulic)
- 3-4 Shift Valve (912)
  - Stuck in 4th gear position (No coast clutch apply)
- Manual Valve (916) / Shift Linkage
  - Misaligned or stuck

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	ON	APPLIED	OVERRUN		APPLIED		HOLDING	APPLIED	APPLIED		OVERRUN

MANUAL THIRD – THIRD GEAR
(from Overdrive Range – Fourth Gear)

PASSAGES

1	LEFT SCAVENGE SUCTION
2	RIGHT SCAVENGE SUCTION
3	SCAVENGE OUTLET
4	MAIN PUMP SUCTION
5	SUMP
6	LINE
7	SECONDARY LINE
8	CONVERTER FEED
9	LUBE 2
10	TCC FEED LIMIT
11	CONVERTER RELEASE
12	CONVERTER APPLY
13	TCC EXHAUST ENABLE
14	ORIFICED TCC EXHAUST ENABLE
15	TO COOLER
16	LUBE
17	PRN
18	PRND4
19	PRND43
20	ACTUATOR FEED
21	FILTERED ACTUATOR FEED
22	TORQUE SIGNAL
23	1-2 SOLENOID
24	2-3 SOLENOID
25	LOW & REVERSE BAND APPLY
26	REVERSE BAND
27	PRIMARY ACCUMULATOR
28	3-4 ACCUMULATOR
29	1-2 ACCUMULATOR
30	SECONDARY 2-3 ACCUMULATOR
31	2-3 ACCUMULATOR
32	REVERSE
33	REVERSE CLUTCH
34	DRIVE
35	LOW FEED
36	LOW
37	LOW & REVERSE BAND REDUCE
38	FORWARD CLUTCH
39	2ND CLUTCH
40	3RD CLUTCH
42	ORIFICED 3RD CLUTCH
43	4TH BAND FEED
44	4TH BAND
45	REGULATED APPLY
46	TCC CONTROL
47	D321
48	COAST CLUTCH FEED
49	COAST CLUTCH
50	D21
51	D21 Y
52	EXHAUST
53	ORIFICED EXHAUST
54	DRAIN
55	OVERFLOW
56	VOID

COMPONENTS (   )

(3)	COOLER CONNECTOR
(8)	OIL DRAIN PLUG
(40)	CASE COVER OIL TEST PLUG
(41)	TRANSMISSION VENT ADAPTER
(54)	SCAVENGE TUBE
(65)	BALL CHECK VALVES, #1, 2, 3, 4, 5, 7, 8, 9, 10 & 11
(216)	SECONDARY PUMP CUT-OFF BALL
(338)	PRESSURE CONTROL SOLENOID FILTER AND SEAL
(343)	ORIFICED CUP PLUG
(350)	TEMPERATURE SENSOR
(917)	SOLENOID SCREEN ASSEMBLY
(979)	BALL (0.375 DIAMETER) #6

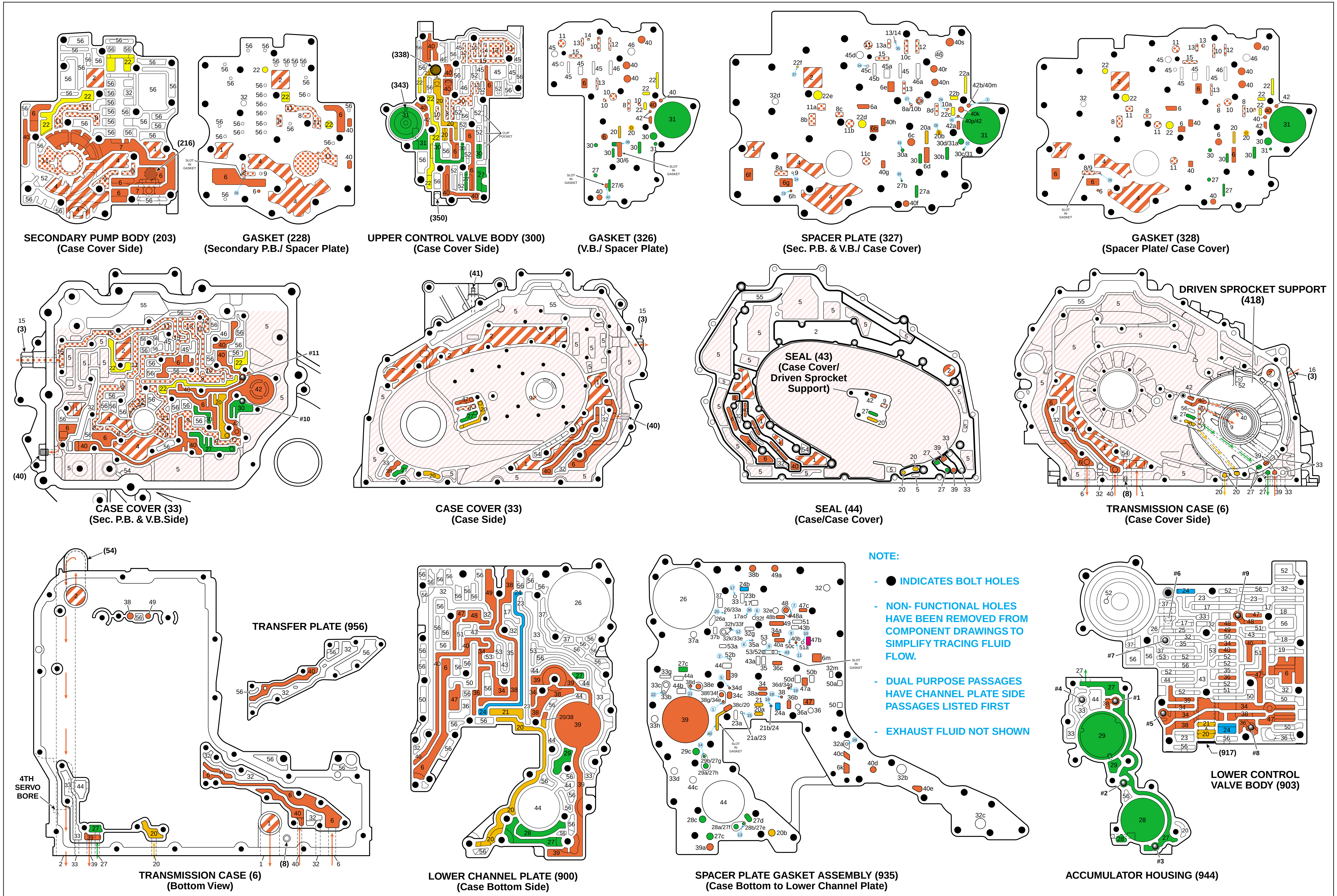

SECONDARY PUMP BODY (203)
(Case Cover Side)
GASKET (228)
(Secondary P.B./ Spacer Plate)
UPPER CONTROL VALVE BODY (300)
(Case Cover Side)
GASKET (326)
(V.B./ Spacer Plate)
SPACER PLATE (327)
(Sec. P.B. & V.B./ Case Cover)
GASKET (328)
(Spacer Plate/ Case Cover)
CASE COVER (33)
(Sec. P.B. & V.B.Side)
CASE COVER (33)
(Case Side)
SEAL (43)
(Case Cover/
Driven Sprocket
Support)
SEAL (44)
(Case/Case Cover)
DRIVEN SPROCKET SUPPORT
(418)
TRANSMISSION CASE (6)
(Case Cover Side)
TRANSFER PLATE (956)
4TH
SERVO
BORE
TRANSMISSION CASE (6)
(Bottom View)
LOWER CHANNEL PLATE (900)
(Case Bottom Side)
SPACER PLATE GASKET ASSEMBLY (935)
(Case Bottom to Lower Channel Plate)
NOTE:
- ● INDICATES BOLT HOLES
- NON- FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE PASSAGES LISTED FIRST
- EXHAUST FLUID NOT SHOWN
LOWER CONTROL
VALVE BODY (903)
ACCUMULATOR HOUSING (944)

Figure 97

MANUAL SECOND – SECOND GEAR (from Manual Third – Third Gear)

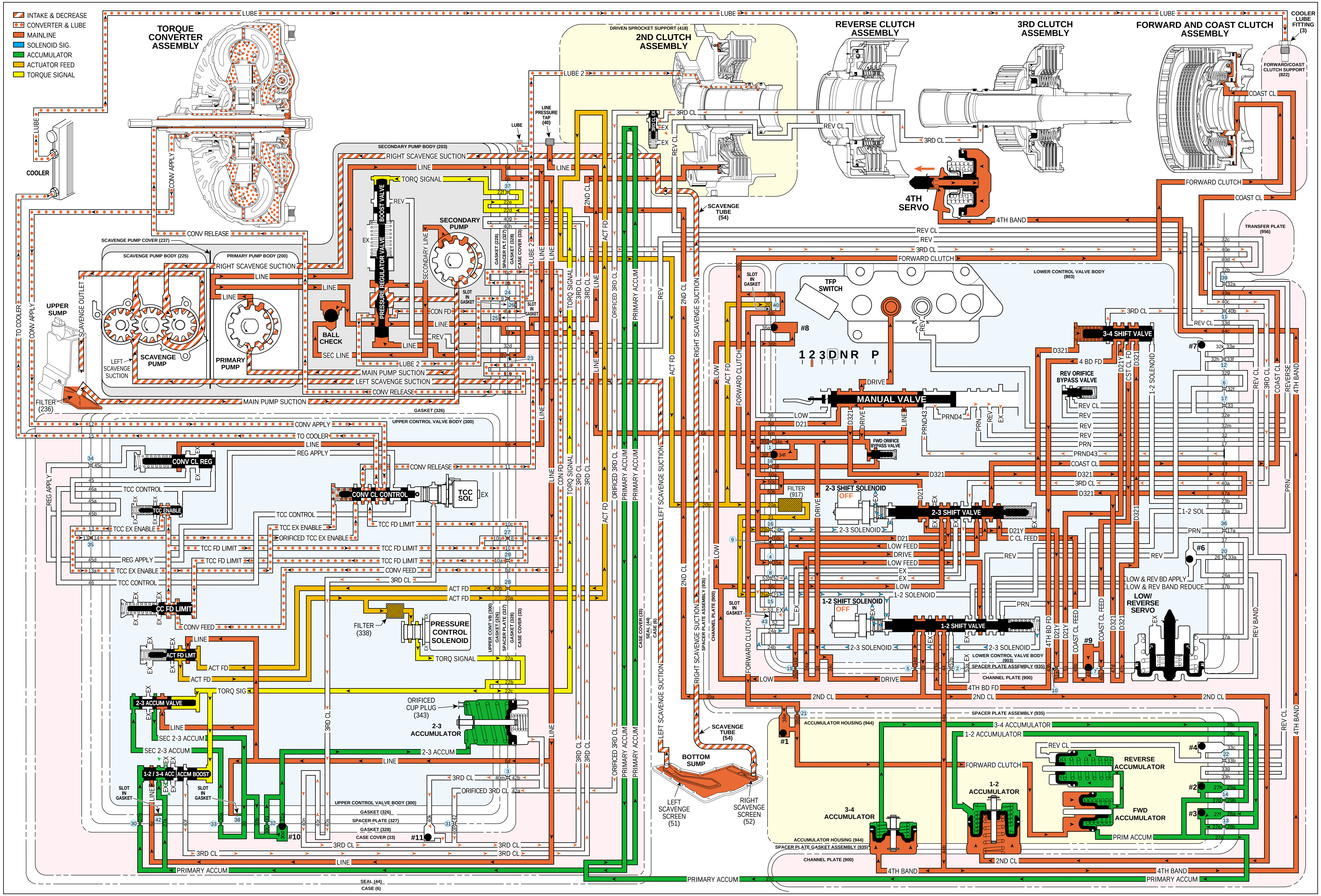


Figure 98

MANUAL SECOND – SECOND GEAR

(from Manual Third – Third Gear)

NO MANUAL SECOND GEAR

See Overdrive Range – Second Gear (page 90A) for possible faults and conditions related to normal second gear operation.

NO ENGINE COMPRESSION BRAKING

- Coast Clutch
  - No apply / slipping (See Manual Third page 98A)

- 4th Servo
  - No apply / slipping
  - Servo piston seal (532) missing or damaged
  - Servo piston (529) damaged or stuck in case bore
  - Servo piston spring and retainer assembly (533) binding or broken
  - Servo apply pin (527) not engaged to 4th band (523)
  - 4th band (523) worn or burned
  - 4th band assembly (523) disengaged from anchor pin (10)
  - 4th band anchor pin (10) loose or missing

- 4th Servo Fluid Routing
  - Fluid leak or restriction
  - Lower Control Valve Body, Gaskets and Spacer Plate; Channel Plate and Gasket; and Accumulator Housing – Porosity, misaligned, loose, restriction, fluid leak across channels

- Fluid Level or Pressure
  - Low [See Park (Engine Running) page 82A]

- TFP Manual Valve Position Switch (936)
  - Malfunction (Electrical or Hydraulic)

- 2-3 Shift Valve (907, 908)
  - Stuck in third gear position

- Manual Valve (916) / Shift Linkage
  - Misaligned or stuck

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
OFF	OFF	APPLIED	HOLDING			APPLIED	HOLDING	APPLIED	APPLIED		OVERRUN

MANUAL SECOND – SECOND GEAR
(from Manual Third – Third Gear)

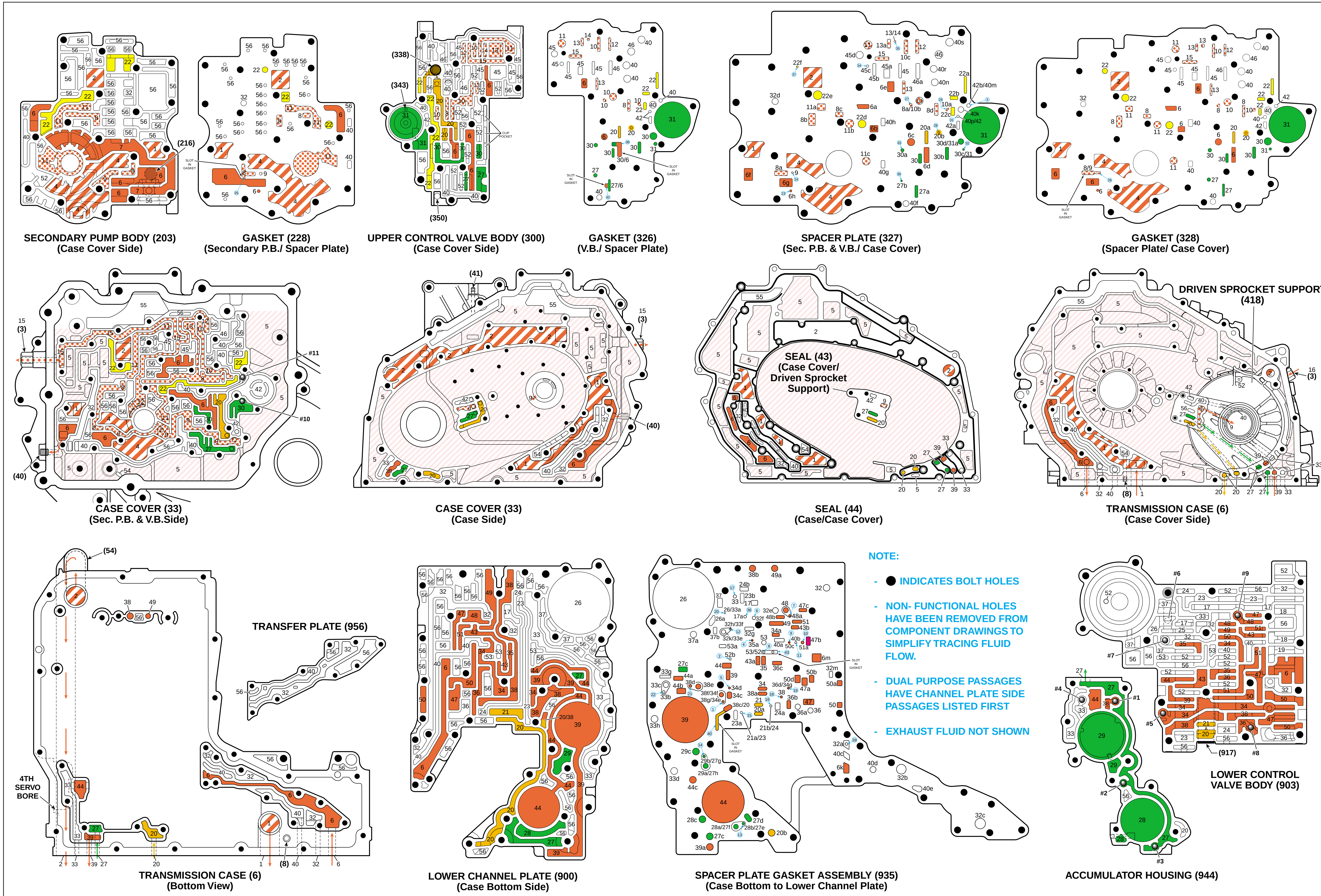
PASSAGES

1 LEFT SCAVENGE SUCTION
2 RIGHT SCAVENGE SUCTION
3 SCAVENGE OUTLET
4 MAIN PUMP SUCTION
5 SUMP
6 LINE
7 SECONDARY LINE
8 CONVERTER FEED
9 LUBE 2
10 TCC FEED LIMIT
11 CONVERTER RELEASE
12 CONVERTER APPLY
13 TCC EXHAUST ENABLE
14 ORIFICED TCC EXHAUST ENABLE
15 TO COOLER
16 LUBE
17 PRN
18 PRND4
19 PRND43
20 ACTUATOR FEED
21 FILTERED ACTUATOR FEED
22 TORQUE SIGNAL
23 1-2 SOLENOID
24 2-3 SOLENOID
25 LOW & REVERSE BAND APPLY
26 REVERSE BAND
27 PRIMARY ACCUMULATOR
28 3-4 ACCUMULATOR
29 1-2 ACCUMULATOR
30 SECONDARY 2-3 ACCUMULATOR
31 2-3 ACCUMULATOR
32 REVERSE
33 REVERSE CLUTCH
34 DRIVE
35 LOW FEED
36 LOW
37 LOW & REVERSE BAND REDUCE
38 FORWARD CLUTCH
39 2ND CLUTCH
40 3RD CLUTCH
42 ORIFICED 3RD CLUTCH
43 4TH BAND FEED
44 4TH BAND
45 REGULATED APPLY
46 TCC CONTROL
47 D321
48 COAST CLUTCH FEED
49 COAST CLUTCH
50 D21
51 D21 Y
52 EXHAUST
53 ORIFICED EXHAUST
54 DRAIN
55 OVERFLOW
56 VOID

COMPONENTS ( )

(3) COOLER CONNECTOR
(8) OIL DRAIN PLUG
(40) CASE COVER OIL TEST PLUG
(41) TRANSMISSION VENT ADAPTER
(54) SCAVENGE TUBE
(65) BALL CHECK VALVES, #1, 2, 3, 4, 5, 7, 8, 9, 10 & 11
(216) SECONDARY PUMP CUT-OFF BALL
(338) PRESSURE CONTROL SOLENOID FILTER AND SEAL
(343) ORIFICED CUP PLUG
(350) TEMPERATURE SENSOR
(917) SOLENOID SCREEN ASSEMBLY
(979) BALL (0.375 DIAMETER) #6

MANUAL SECOND – SECOND GEAR (from Manual Third – Third Gear)



MANUAL FIRST – FIRST GEAR (from Manual Second – Second Gear)

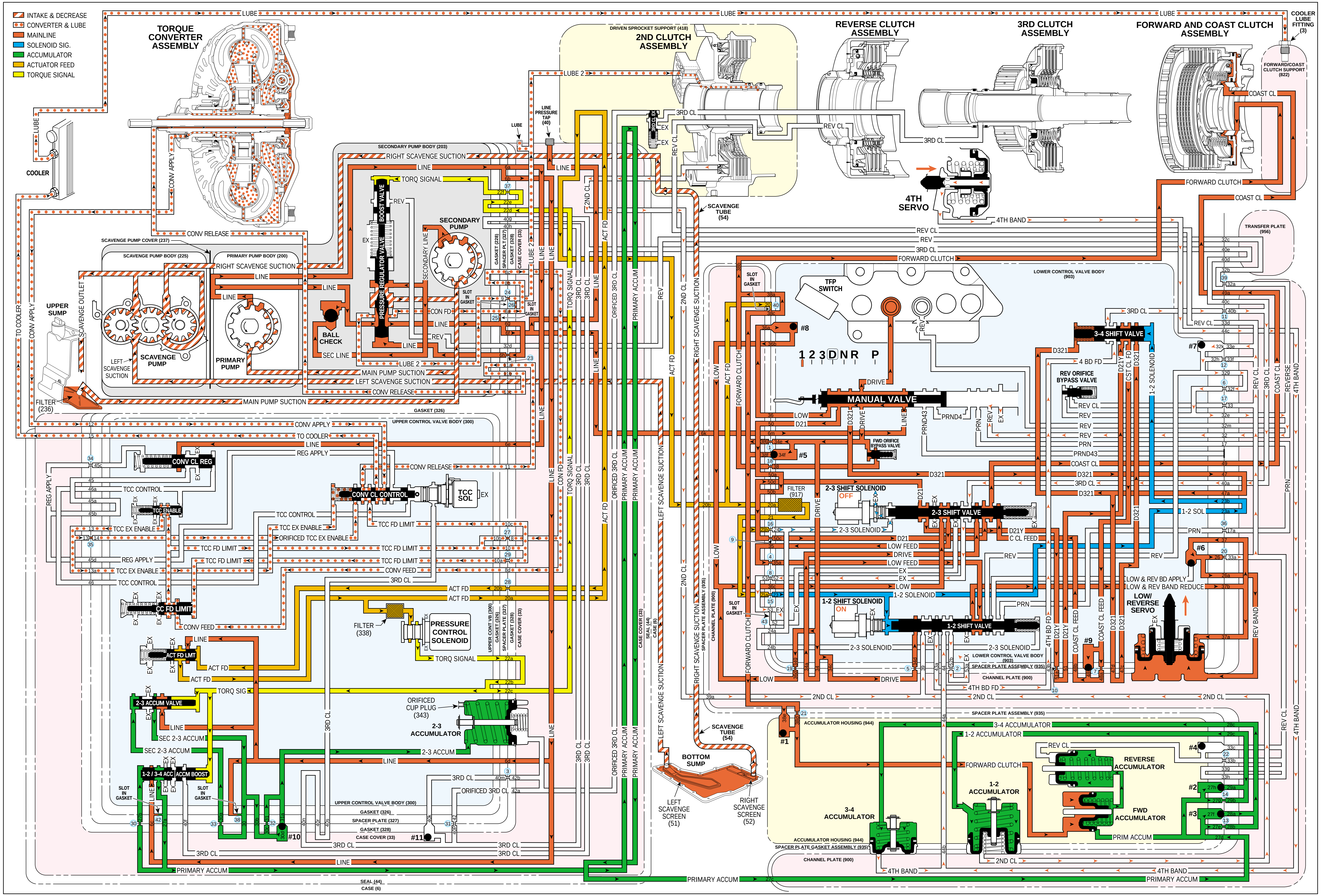


Figure 100

MANUAL FIRST – FIRST GEAR
(from Manual Second – Second Gear)

NO MANUAL FIRST GEAR

See Overdrive Range – First Gear (page 88A) for possible faults and conditions related to normal first gear operation.

NO ENGINE COMPRESSION BRAKING

- Coast Clutch
  - No apply / slipping (See Manual Third page 98A)
- Low/Reverse Servo Assembly
  - Servo piston seals (929, 930) missing or damaged
  - Servo piston (928) damaged or stuck in case bore
  - Servo piston return spring (901) missing or damaged
  - Servo piston cushion spring (934) missing or damaged
  - Servo apply pin (931) not engaged to low/reverse band (13)
  - Low/reverse band (13) worn or burned
  - Low/reverse band assembly (13) disengaged from anchor pin (9)
  - Low/reverse band anchor pin (9) loose or missing
- Low/Reverse Servo Fluid Routing
  - Fluid leak or restriction
  - Lower Control Valve Body, Spacer/Gasket Plate Assembly; and Channel Plate – Porosity, misaligned, loose, restriction, fluid leak across channels
- Fluid Level or Pressure
  - Low [See Park (Engine Running) page 82A]
- TFP Manual Valve Position Switch (936)
  - Malfunction (Electrical or Hydraulic)
- 1-2 Shift Valve (919, 920)
  - Stuck in third gear position
- Manual Valve (916) / Shift Linkage
  - Misaligned or stuck

1-2 SHIFT SOL	2-3 SHIFT SOL	2ND CLUTCH	2ND SPRAG	REVERSE CLUTCH	3RD CLUTCH	4TH BAND	FORWARD SPRAG	FORWARD CLUTCH	COAST CLUTCH	LOW/REV. BAND	LOW ROLLER
ON	OFF						HOLDING	APPLIED	APPLIED	APPLIED	HOLDING

MANUAL FIRST – FIRST GEAR
(from Manual Second – Second Gear)

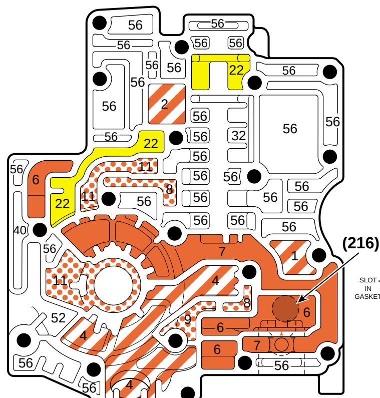
PASSAGES

1 LEFT SCAVENGE SUCTION
2 RIGHT SCAVENGE SUCTION
3 SCAVENGE OUTLET
4 MAIN PUMP SUCTION
5 SUMP
6 LINE
7 SECONDARY LINE
8 CONVERTER FEED
9 LUBE 2
10 TCC FEED LIMIT
11 CONVERTER RELEASE
12 CONVERTER APPLY
13 TCC EXHAUST ENABLE
14 ORIFICED TCC EXHAUST ENABLE
15 TO COOLER
16 LUBE
17 PRN
18 PRND4
19 PRND43
20 ACTUATOR FEED
21 FILTERED ACTUATOR FEED
22 TORQUE SIGNAL
23 1-2 SOLENOID
24 2-3 SOLENOID
25 LOW & REVERSE BAND APPLY
26 REVERSE BAND
27 PRIMARY ACCUMULATOR
28 3-4 ACCUMULATOR
29 1-2 ACCUMULATOR
30 SECONDARY 2-3 ACCUMULATOR
31 2-3 ACCUMULATOR
32 REVERSE
33 REVERSE CLUTCH
34 DRIVE
35 LOW FEED
36 LOW
37 LOW & REVERSE BAND REDUCE
38 FORWARD CLUTCH
39 2ND CLUTCH
40 3RD CLUTCH
42 ORIFICED 3RD CLUTCH
43 4TH BAND FEED
44 4TH BAND
45 REGULATED APPLY
46 TCC CONTROL
47 D321
48 COAST CLUTCH FEED
49 COAST CLUTCH
50 D21
51 D21 Y
52 EXHAUST
53 ORIFICED EXHAUST
54 DRAIN
55 OVERFLOW
56 VOID

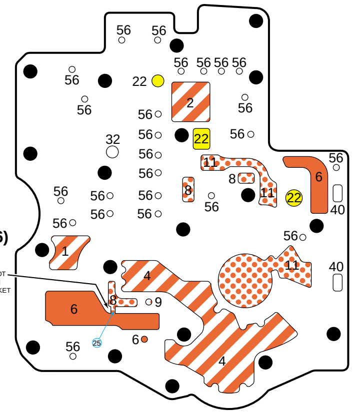
COMPONENTS ( )

(3) COOLER CONNECTOR
(8) OIL DRAIN PLUG
(40) CASE COVER OIL TEST PLUG
(41) TRANSMISSION VENT ADAPTER
(54) SCAVENGE TUBE
(65) BALL CHECK VALVES, #1, 2, 3, 4, 5, 7, 8, 9, 10 & 11
(216) SECONDARY PUMP CUT-OFF BALL
(338) PRESSURE CONTROL SOLENOID FILTER AND SEAL
(343) ORIFICED CUP PLUG
(350) TEMPERATURE SENSOR
(917) SOLENOID SCREEN ASSEMBLY
(979) BALL (0.375 DIAMETER) #6

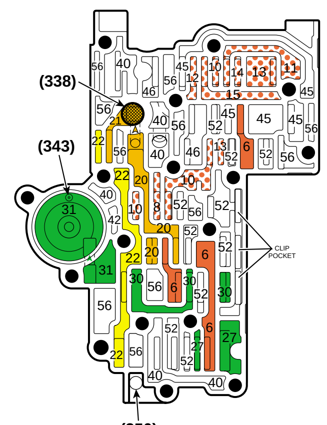
MANUAL FIRST – FIRST GEAR (from Manual Second – Second Gear)



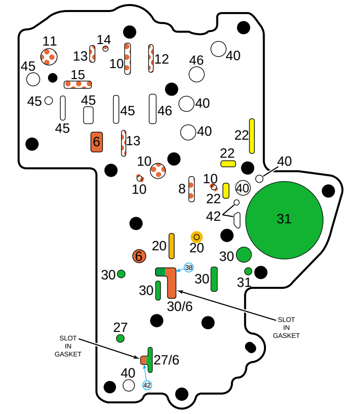
SECONDARY PUMP BODY (203)
(Case Cover Side)



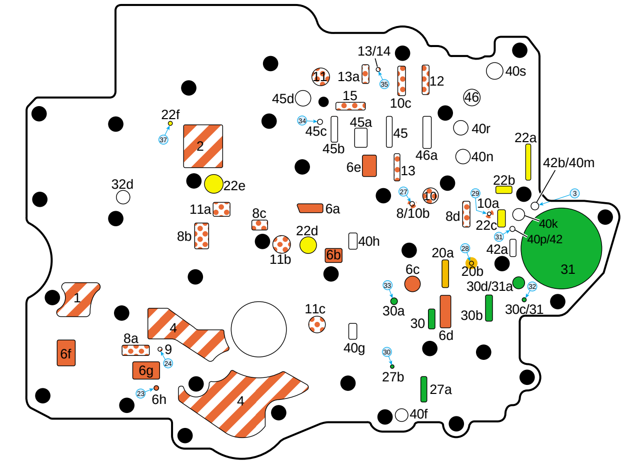
GASKET (228)
(Secondary P.B./ Spacer Plate)



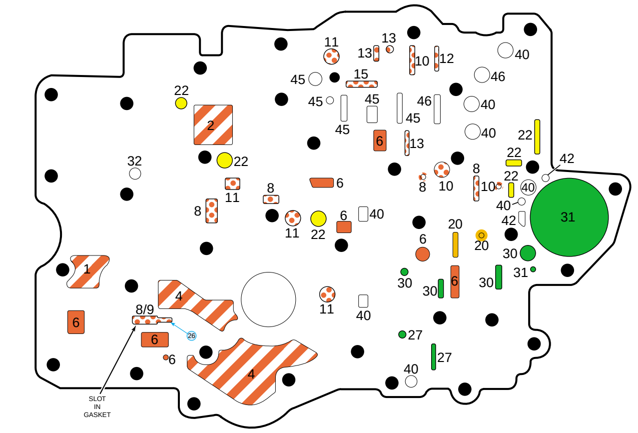
UPPER CONTROL VALVE BODY (300)
(Case Cover Side)



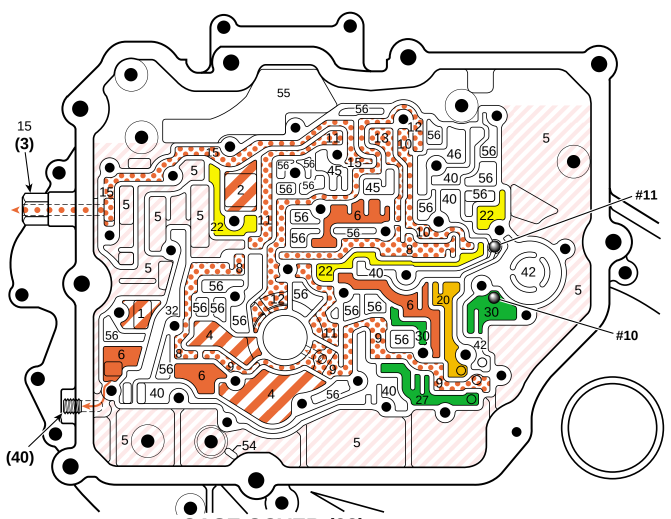
GASKET (326)
(V.B./ Spacer Plate)



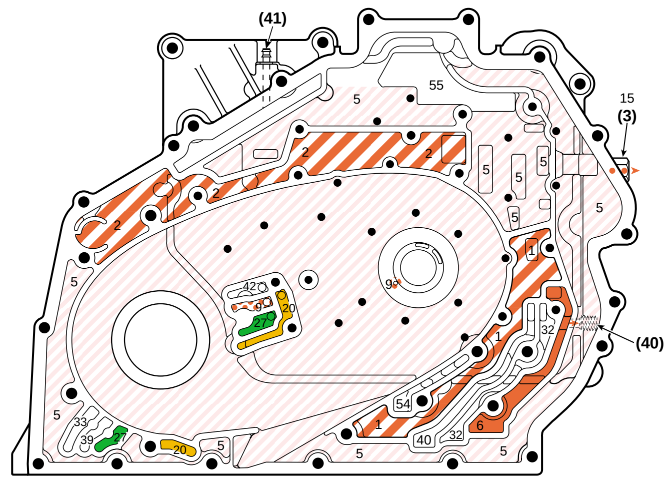
SPACER PLATE (327)
(Sec. P.B. & V.B./ Case Cover)



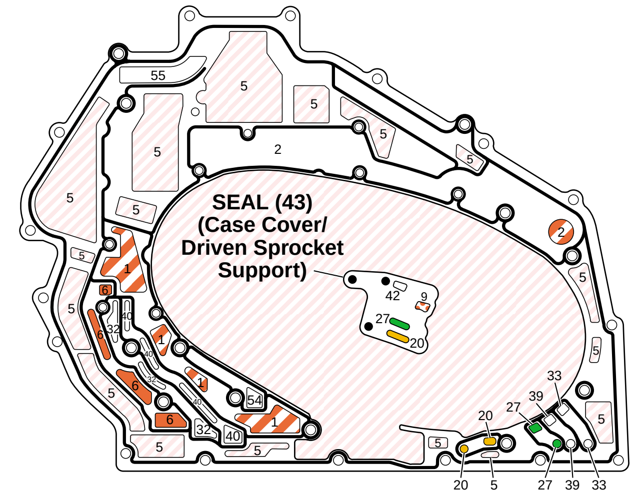
GASKET (328)
(Spacer Plate/ Case Cover)



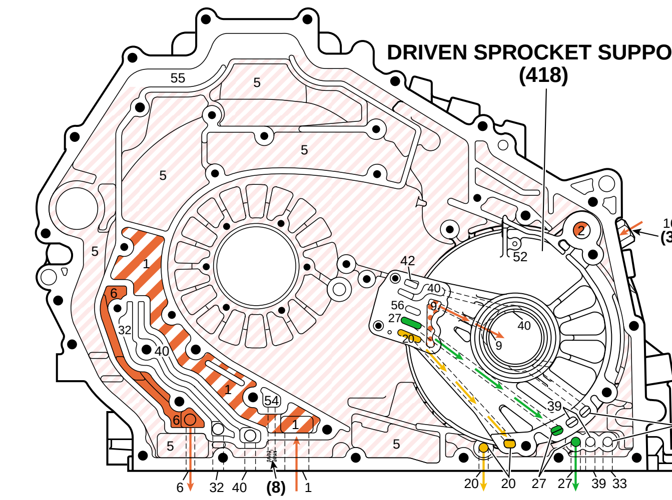
CASE COVER (33)
(Sec. P.B. & V.B.Side)



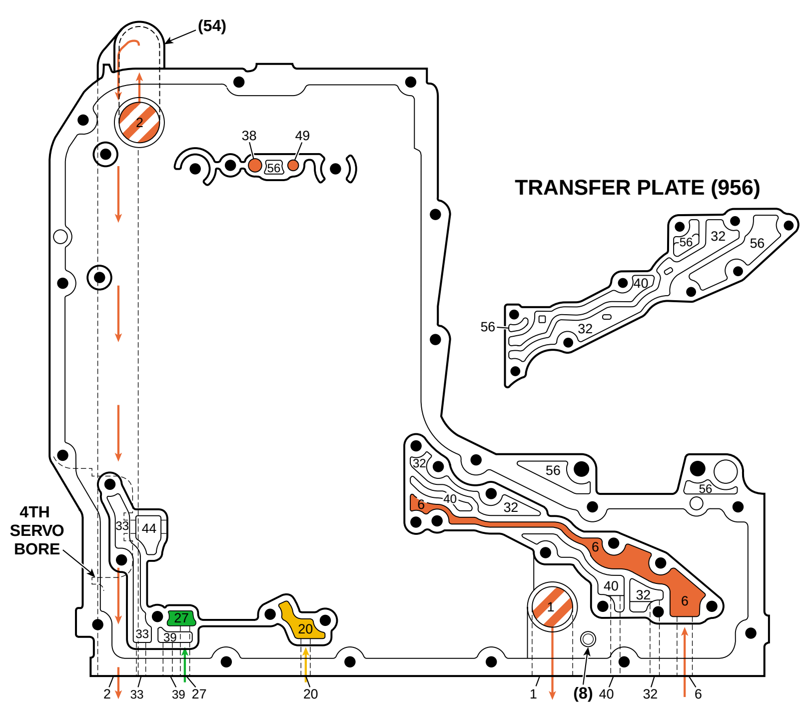
CASE COVER (33)
(Case Side)



SEAL (44)
(Case/Case Cover)

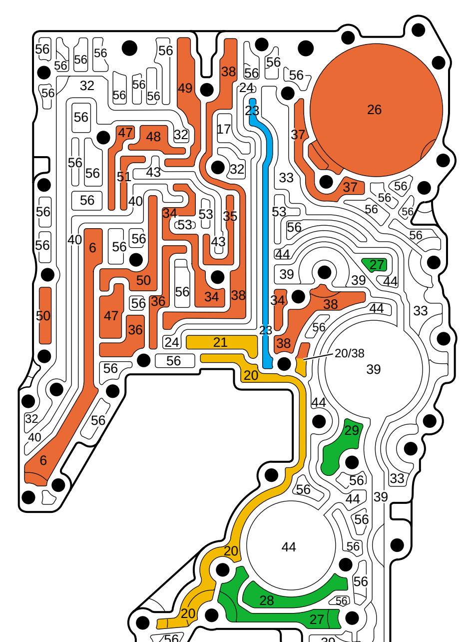


TRANSMISSION CASE (6)
(Case Cover Side)

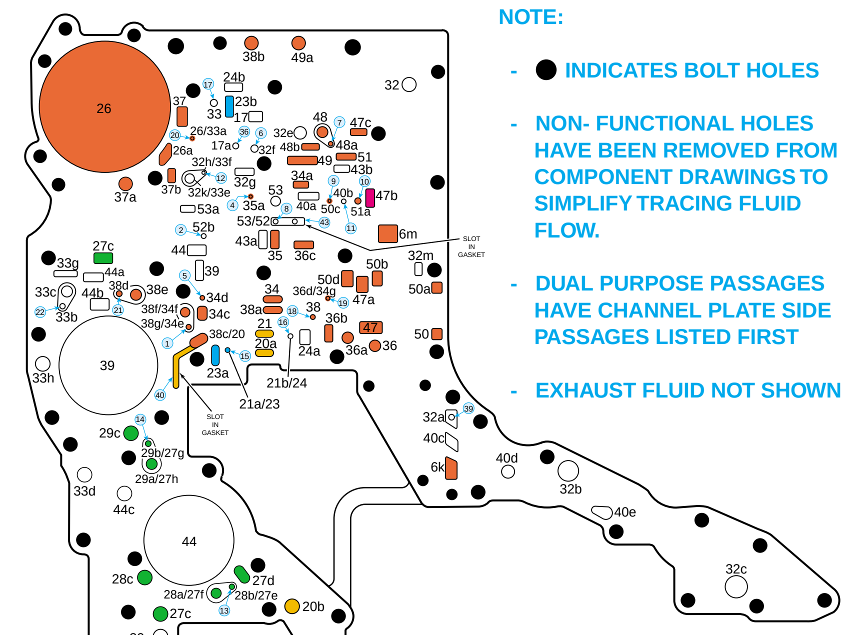


TRANSFER PLATE (956)

TRANSMISSION CASE (6)
(Bottom View)



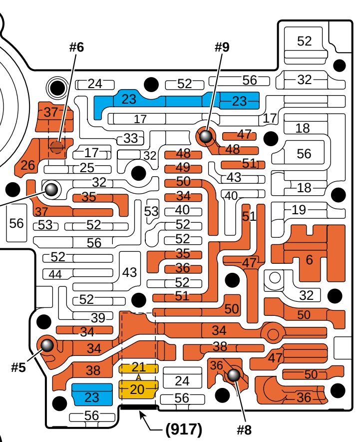
LOWER CHANNEL PLATE (900)
(Case Bottom Side)



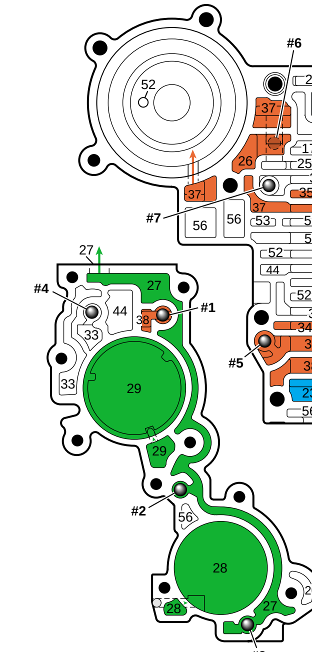
SPACER PLATE GASKET ASSEMBLY (935)
(Case Bottom to Lower Channel Plate)

NOTE:

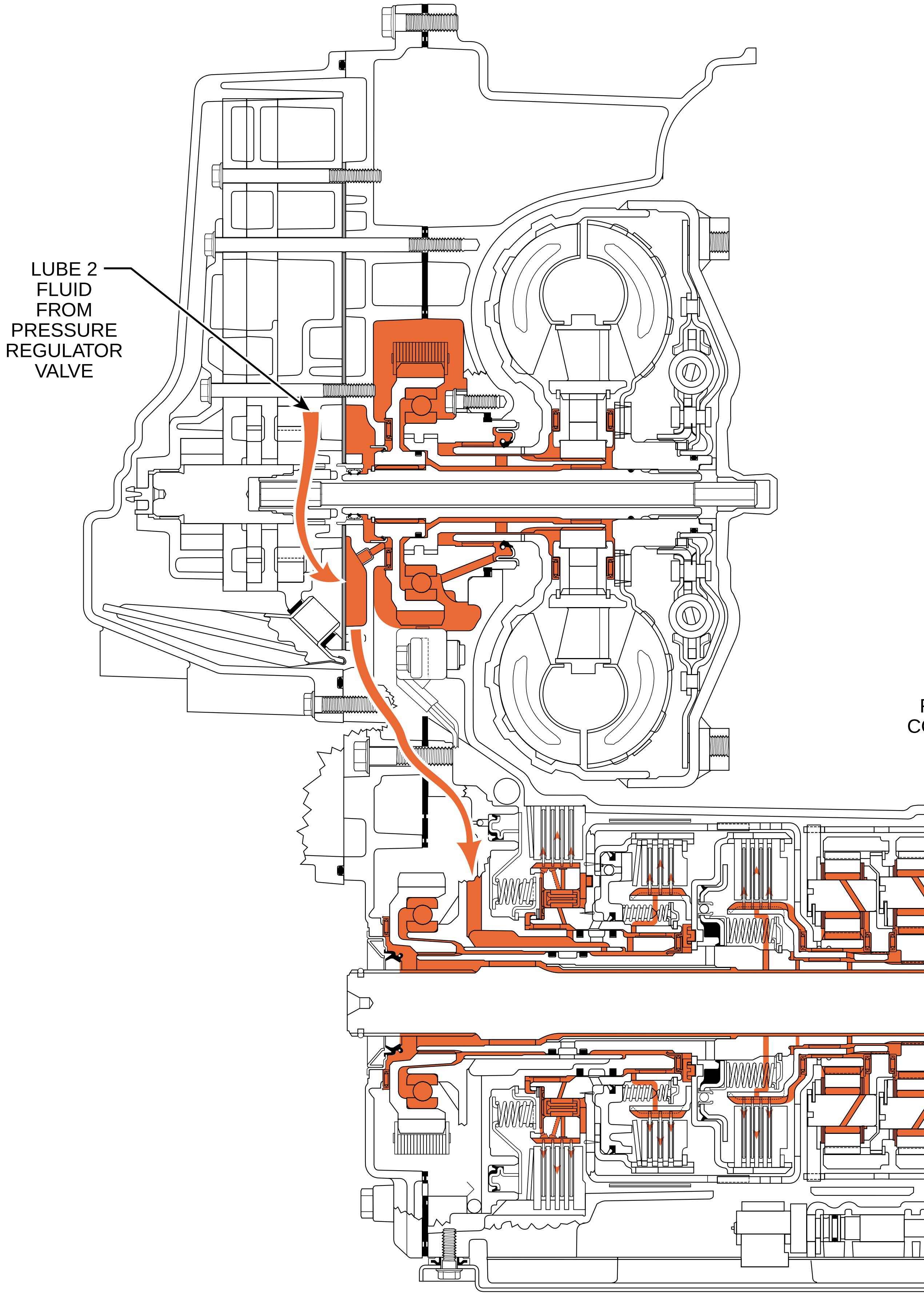
- ● INDICATES BOLT HOLES
- NON- FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE PASSAGES LISTED FIRST
- EXHAUST FLUID NOT SHOWN



LOWER CONTROL VALVE BODY (903)



ACCUMULATOR HOUSING (944)



COOLER AND LUBRICATION CIRCUITS

- Line pressure from the primary pump assembly (200-202) is directed to the pressure regulator valve (211) located in the secondary pump body (203).
- Line pressure passes through the pressure regulator valve (211) and orifice #25 where it enters the converter feed circuit.
- Converter feed fluid is routed to the converter feed limit valve (312) and enters the TCC feed limit circuit. At the same time converter feed passes through orifice #24 and #26 where it enters the lube 2 circuit. (See Lubrication Circuits below.)
- TCC feed limit fluid is directed to the converter clutch control valve (317) where it passes through the valve and enters the converter release circuit.
- Converter release fluid is routed through the upper control valve body (300), case cover (33) and secondary pump body (203) before it is fed between the oil pump drive shaft (2) and turbine shaft (410).
- Converter release fluid flows along the oil pump drive shaft (2) and turbine shaft (410) to the release side of the torque converter clutch plate.
- Release fluid passes around the torque converter clutch plate and enters the apply fluid side of the plate.
- Apply fluid from the torque converter (1) is then routed back to the converter clutch control valve (317) where it passes through the valve and enters the "to cooler" circuit.
- Fluid in the "to cooler" circuit is routed through the case cover (33) and cooler connector (3) to the transmission cooler located inside the radiator.

LUBRICATION CIRCUITS

- The lube circuit begins at the transmission cooler when fluid is routed through the cooler lines to the cooler (return) connector (3).
- Lube passes through the cooler connector (3) and enters the forward/coast clutch support (822) to provide lubrication for the components located on the right side of the transmission.
- Lube "2" fluid (generated from the converter feed circuit through orifice #24 and #26) is routed through the transmission case cover (33) and driven sprocket support (418).
- After lube 2 passes through the driven sprocket support (418) it provides lubrication for the components located on the left side of the transmission.

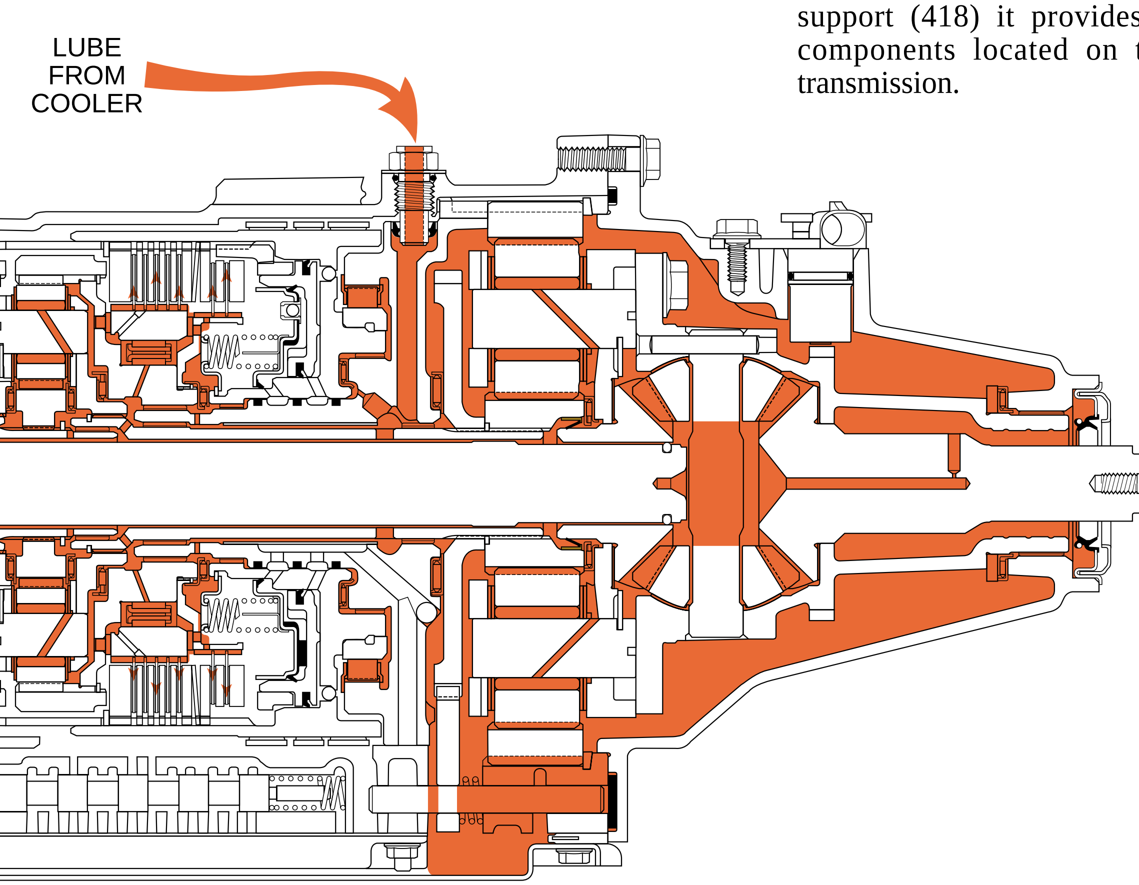
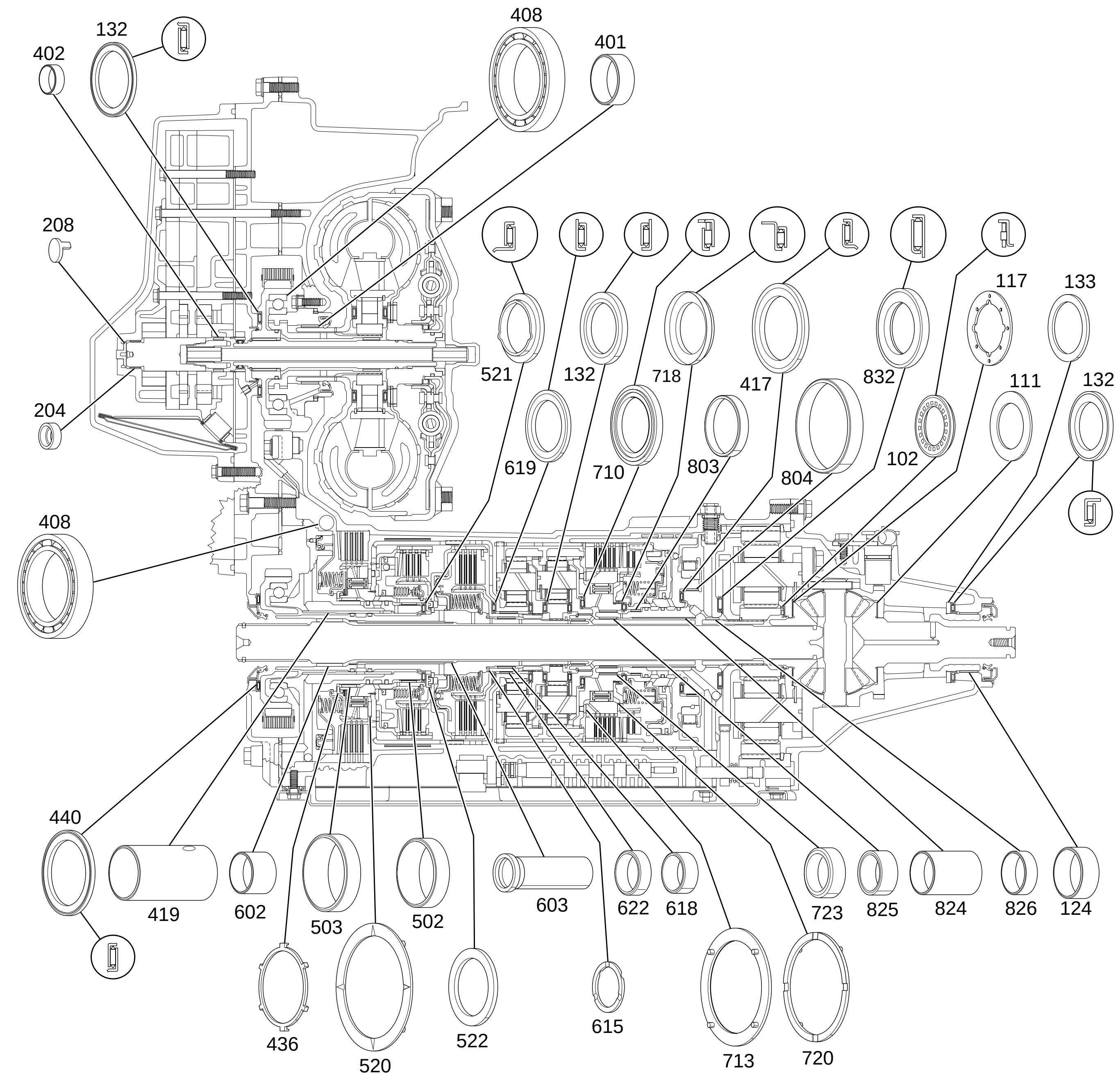


Figure 102

Bushing, Bearing and Washer Locations

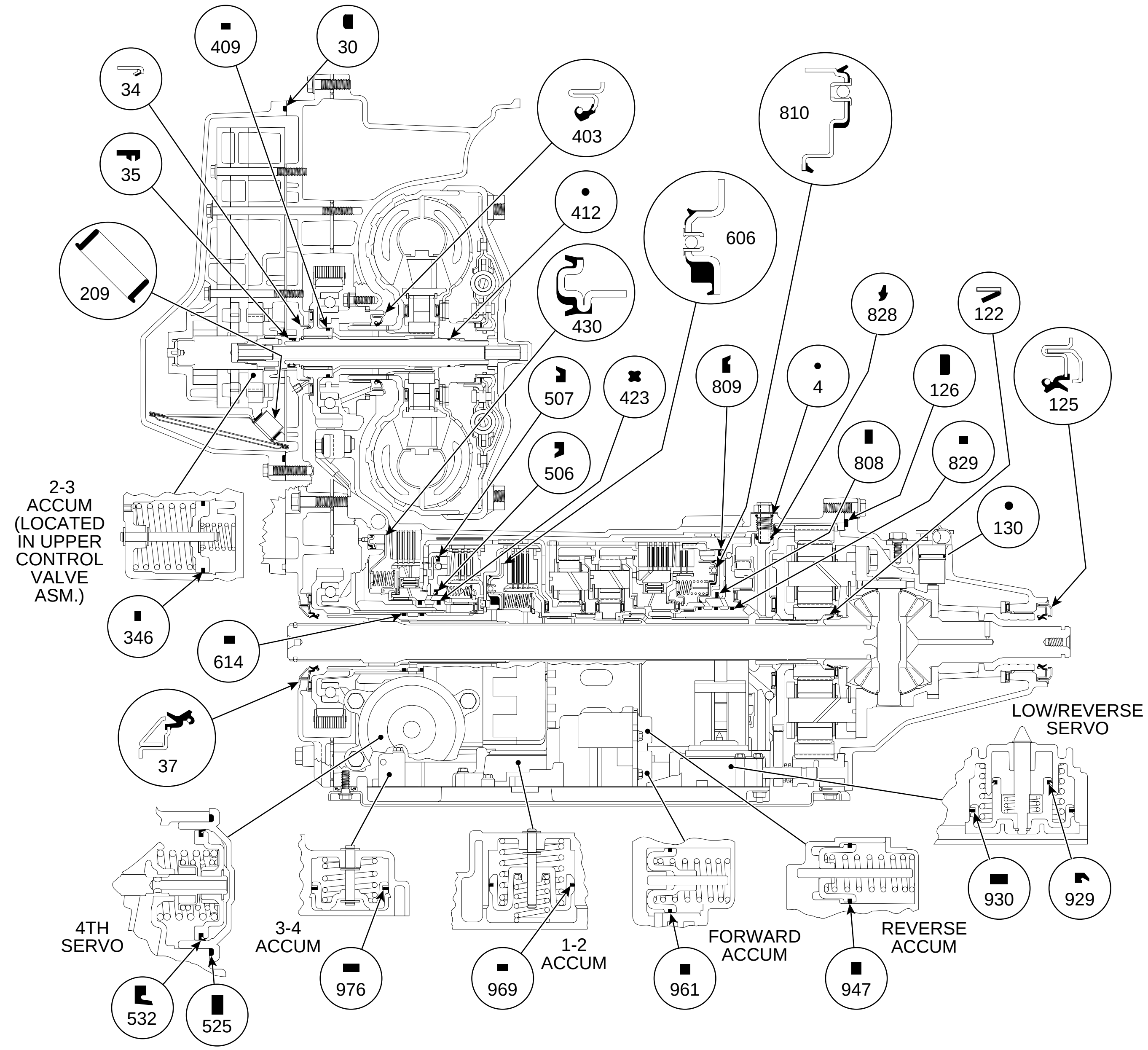


102 FINAL DRIVE SUN GEAR/FINAL DRIVE CARRIER THRUST BEARING
111 RIGHT DIFFERENTIAL THRUST WASHER
117 LEFT DIFFERENTIAL THRUST WASHER
124 CASE EXTENSION BUSHING
132 THRUST BEARING ASSEMBLY
133 DIFFERENTIAL CARRIER/CASE EXTENSION SELECTIVE THRUST WASHER
204 SCAVENGE PUMP BUSHING
208 OIL PUMP DRIVEN SHAFT THRUST WASHER
401 CONVERTER HUB BUSHING
402 FRONT STATOR SHAFT BUSHING
408 BALL BEARING (2)
417 THRUST BEARING
419 OIL TRANSFER SLEEVE
436 SUPPORT/REVERSE CLUTCH THRUST WASHER
440 THRUST BEARING
502 SMALL BUSHING
503 LARGE BUSHING
520 2ND CLUTCH OUTER RACE WASHER
521 THRUST BEARING
522 DRIVEN SPROCKET SUPPORT SELECTIVE THRUST WASHER
602 INPUT SHAFT BUSHING
603 INPUT SHAFT/OIL TRANSFER SLEEVE
615 INPUT SHAFT/3RD HUB THRUST WASHER
618 HUB BUSHING
619 THRUST BEARING ASSEMBLY
622 REACTION SUN GEAR BUSHING
710 THRUST BEARING ASSEMBLY
713 FLANGE TO OUTER RACE THRUST WASHER
718 FLANGE/FORWARD CLUTCH HOUSING THRUST BEARING
720 RACE/COAST CLUTCH HUB THRUST WASHER
723 INPUT FLANGE BUSHING
803 SMALL HOUSING BUSHING
804 LARGE HOUSING BUSHING
824 OIL TRANSFER SLEEVE
825 LEFT SUPPORT/SUN SHAFT BUSHING
826 RIGHT SUPPORT/SUN SHAFT BUSHING
832 FORWARD CLUTCH SUPPORT/PARK GEAR THRUST BEARING

WH15580-4T80-E

Figure 103

Seal Locations



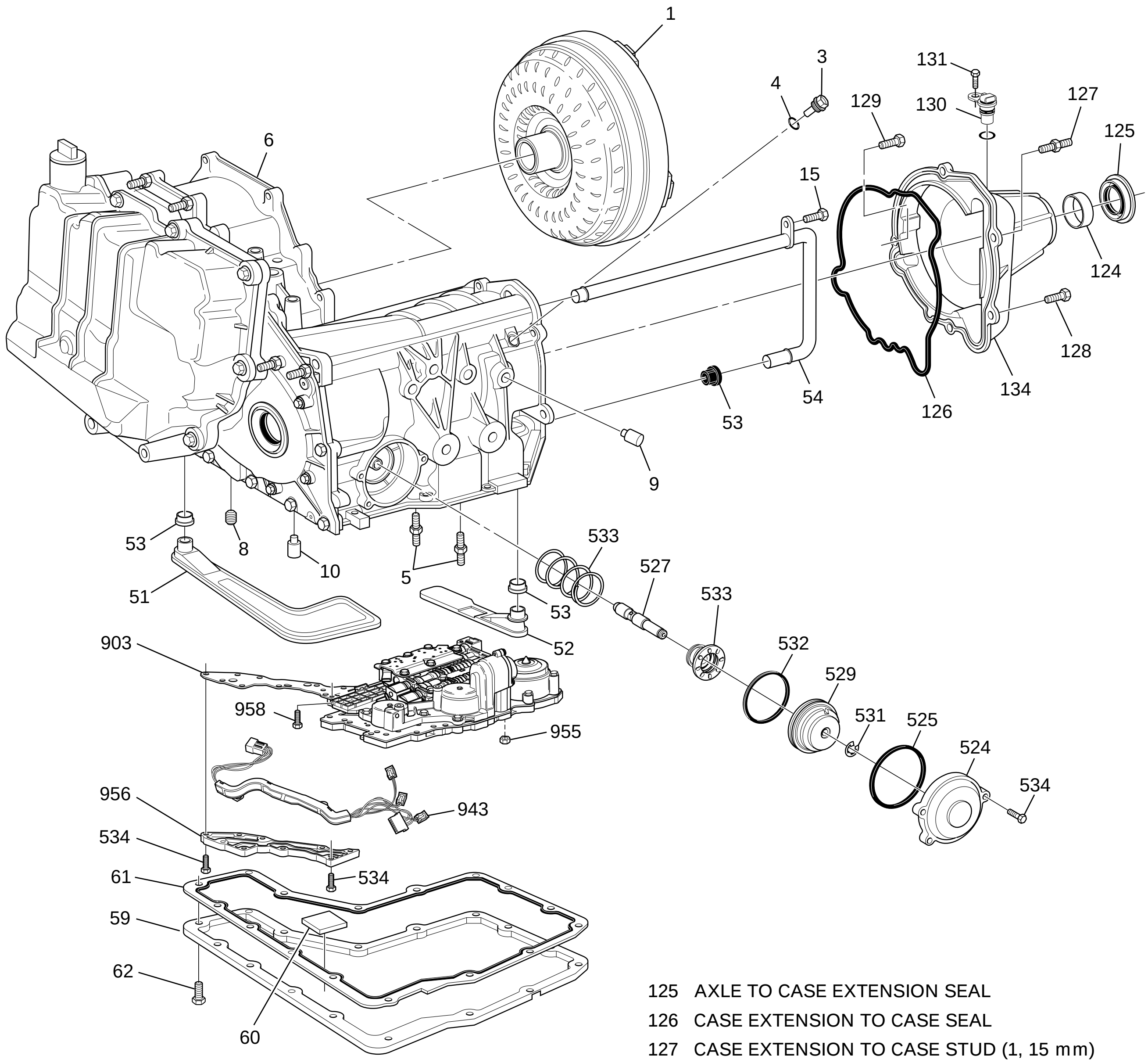
4	RETURN COOLER CONNECTOR O-RING
30	SIDE COVER TO CASE COVER GASKET
34	CASE COVER TO DRIVE SPROCKET SEAL
35	CASE COVER TO TURBINE SHAFT SEAL
37	AXLE CASE COVER SEAL
122	FINAL DRIVE SUN GEAR SEAL
125	AXLE TO CASE EXTENSION SEAL
126	CASE EXTENSION TO CASE SEAL
130	OUTPUT SPEED SENSOR ASSEMBLY
209	FILTER SEAL
346	2-3 ACCUMULATOR PISTON SEAL
403	CONVERTER HUB ASSEMBLY SEAL
409	DRIVE SPROCKET OIL SEAL RING
412	O-RING SEAL
423	4 LOBE SEAL RING (2)
430	2ND CLUTCH PISTON ASSEMBLY
506	INNER SEAL
507	OUTER SEAL
525	SERVO COVER SEAL
532	4TH SERVO PISTON SEAL
606	THIRD CLUTCH PISTON ASSEMBLY
614	OIL SEAL RING (2)
808	FORWARD CLUTCH PISTON INNER SEAL
809	FORWARD CLUTCH PISTON OUTER SEAL
810	COAST CLUTCH PISTON ASSEMBLY
828	COOLER RETURN SEAL
829	SUPPORT/HOUSING OIL SEAL RING (3)
929	SMALL LOW/REVERSE SERVO SEAL
930	LARGE LOW/REVERSE SERVO SEAL
947	REVERSE ACCUMULATOR SEAL
961	FORWARD ACCUMULATOR SEAL
969	1-2 ACCUMULATOR SEAL
976	3-4 ACCUMULATOR SEAL

YH614318-4T80-E

Figure 104

ILLUSTRATED PARTS LIST

Case and Associated Parts (1 of 3)

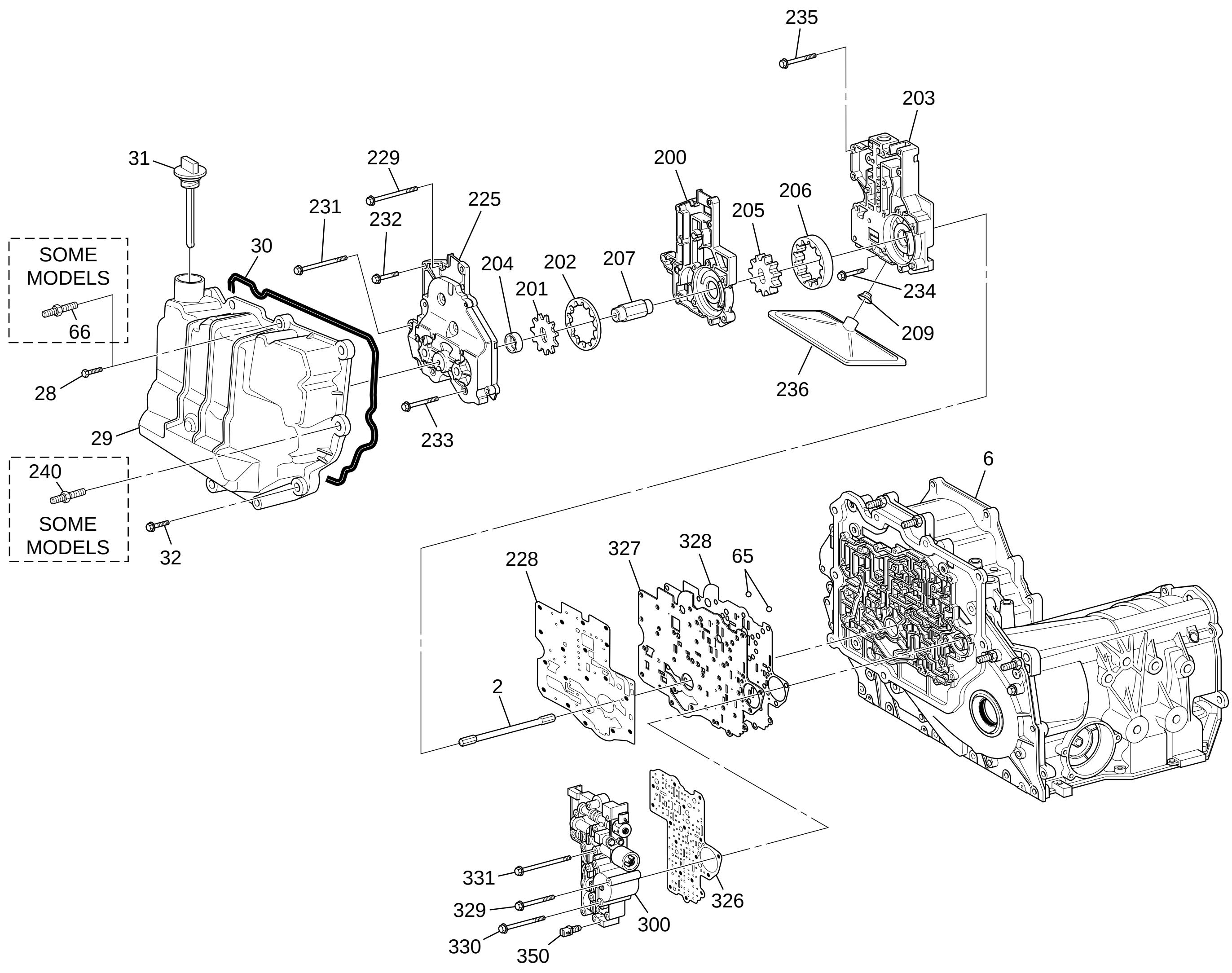


1	TORQUE CONVERTER ASSEMBLY	125	AXLE TO CASE EXTENSION SEAL
3	COOLER RETURN CONNECTOR (CASE) (1, 19 mm)	126	CASE EXTENSION TO CASE SEAL
4	COOLER RETURN CONNECTOR O-RING	127	CASE EXTENSION TO CASE STUD (1, 15 mm)
5	CASE TO FORWARD CLUTCH SUPPORT STUD (2, 13 mm)	128	CASE EXTENSION TO CASE BOLT (4, 13 mm)
6	TRANSMISSION CASE	129	CASE EXTENSION TO CASE BOLT (1, 10 mm)
8	OIL DRAIN PLUG – BOTTOM PAN TO CASE COVER	130	OUTPUT SPEED SENSOR ASSEMBLY
9	LOW/REVERSE BAND ANCHOR PIN	131	OUTPUT SPEED SENSOR BOLT (1)
10	4TH BAND ANCHOR PIN	134	TRANSMISSION CASE EXTENSION
15	BOLT (4, 8 mm)	524	4TH SERVO COVER
51	LEFT SCAVENGE SCREEN	525	SERVO COVER SEAL
52	RIGHT SCAVENGE SCREEN	527	4TH SERVO PIN
53	SCAVENGE TUBE AND SCREENS SEAL	529	4TH SERVO PISTON
54	SCAVENGE TUBE	531	SNAP RING
59	TRANSMISSION OIL PAN	532	4TH SERVO PISTON SEAL
60	CHIP COLLECTOR MAGNET	533	4TH SERVO SPRING AND RETAINER ASSEMBLY
61	OIL PAN GASKET	534	BOLT (23, 10 mm)
62	BOTTOM PAN TO CASE BOLT (16, 10 mm)	903	CHANNEL PLATE, CONTROL VALVE BODY AND ACCUMULATOR HOUSING ASSEMBLY
124	CASE EXTENSION BUSHING	943	EXTENSION WIRING HARNESS
		955	CHANNEL PLATE TO CASE NUT (2, 10 mm)
		956	OIL TRANSFER PLATE
		958	CHANNEL PLATE TO CASE BOLT (2, 10 mm)

YH509736-4T80-E

Figure 105

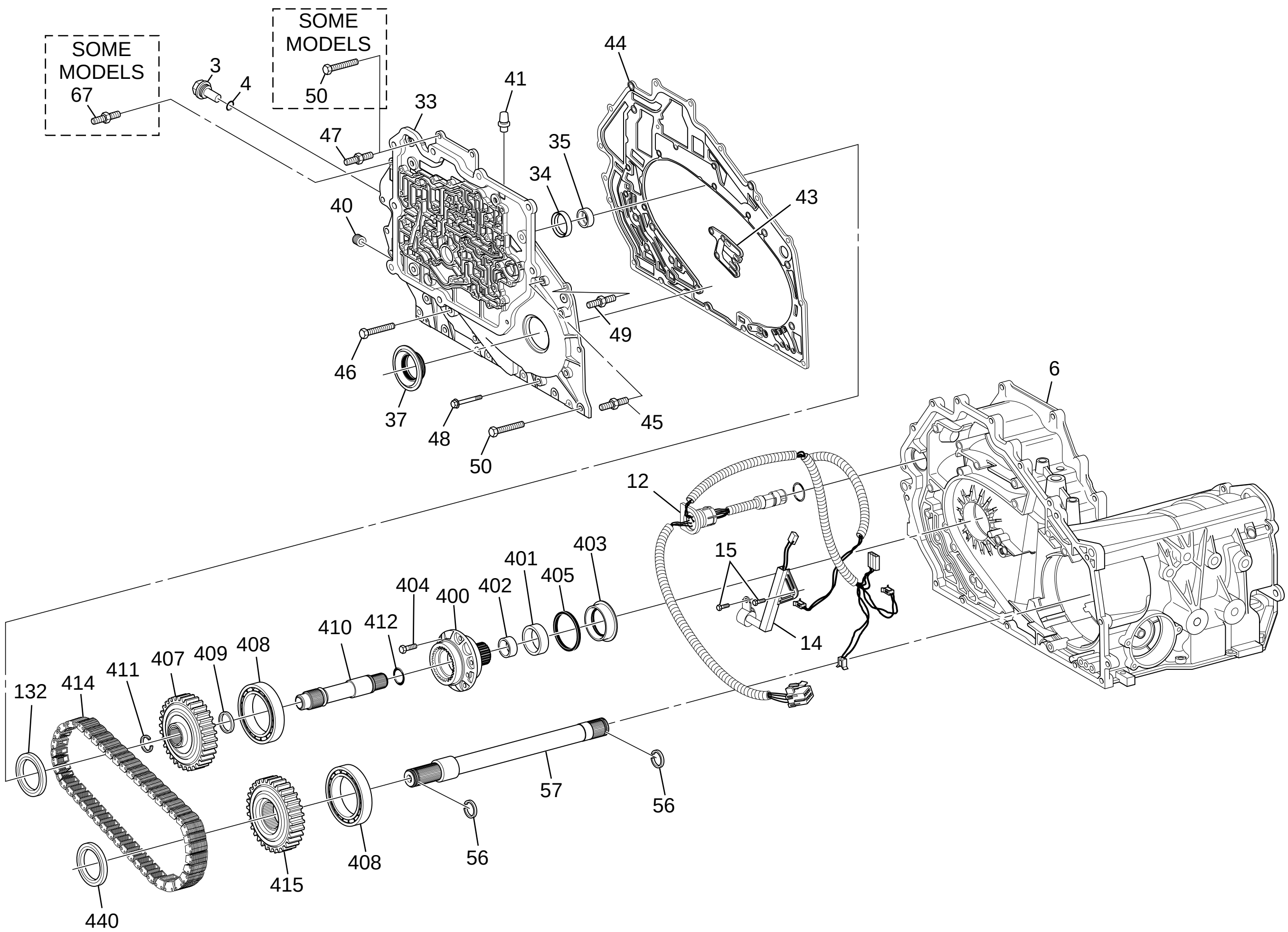
Case and Associated Parts (2 of 3)



2 OIL PUMP DRIVE SHAFT
6 TRANSMISSION CASE
28 SIDE COVER TO CASE COVER BOLT (8, 15 mm)
29 SIDE COVER
30 SIDE COVER TO CASE COVER GASKET
31 FLUID LEVEL INDICATOR
32 SIDE COVER TO CASE COVER BOLT (1, 13 mm)
65 BALL CHECK VALVE (10)
66 SIDE COVER TO CASE COVER STUD (SOME MODELS)
200 PRIMARY PUMP BODY
201 PRIMARY PUMP DRIVE GEAR
202 PRIMARY PUMP DRIVEN GEAR
203 SECONDARY PUMP BODY
204 SCAVENGE PUMP BUSHING
205 SECONDARY PUMP DRIVE GEAR
206 SECONDARY PUMP DRIVEN GEAR
207 OIL PUMP DRIVEN SHAFT
209 FILTER SEAL
225 SCAVENGE PUMP BODY ASSEMBLY
228 SECONDARY PUMP BODY TO SPACER PLATE GASKET
229 BOLT (4, 8 mm)
231 PUMP ASSEMBLY TO CASE BOLT (2, 8 mm)
232 PUMP ASSEMBLY TO CASE COVER BOLT (5, 8 mm)
233 PUMP ASSEMBLY TO CASE COVER BOLT (5, 8 mm)
234 SECONDARY PUMP TO CASE COVER BOLT (1, 8 mm)
235 SECONDARY PUMP TO CASE BOLT
236 TRANSMISSION OIL FILTER
240 AUXILIARY CONTROL VALVE BODY COVER STUD (SOME MODELS)
300 UPPER CONTROL VALVE BODY ASSEMBLY
326 VALVE BODY TO SPACER PLATE GASKET
327 CASE COVER ASSEMBLY SPACER PLATE
328 SPACER PLATE TO CASE COVER GASKET
329 UPPER VALVE BODY TO CASE COVER BOLT (9, 8 mm)
330 UPPER VALVE BODY TO CASE COVER BOLT (2, 8 mm)
331 BOLT (6, 8 mm)
350 TEMPERATURE SENSOR (1, 17 mm)

YH509743-4T80-E

Figure 106

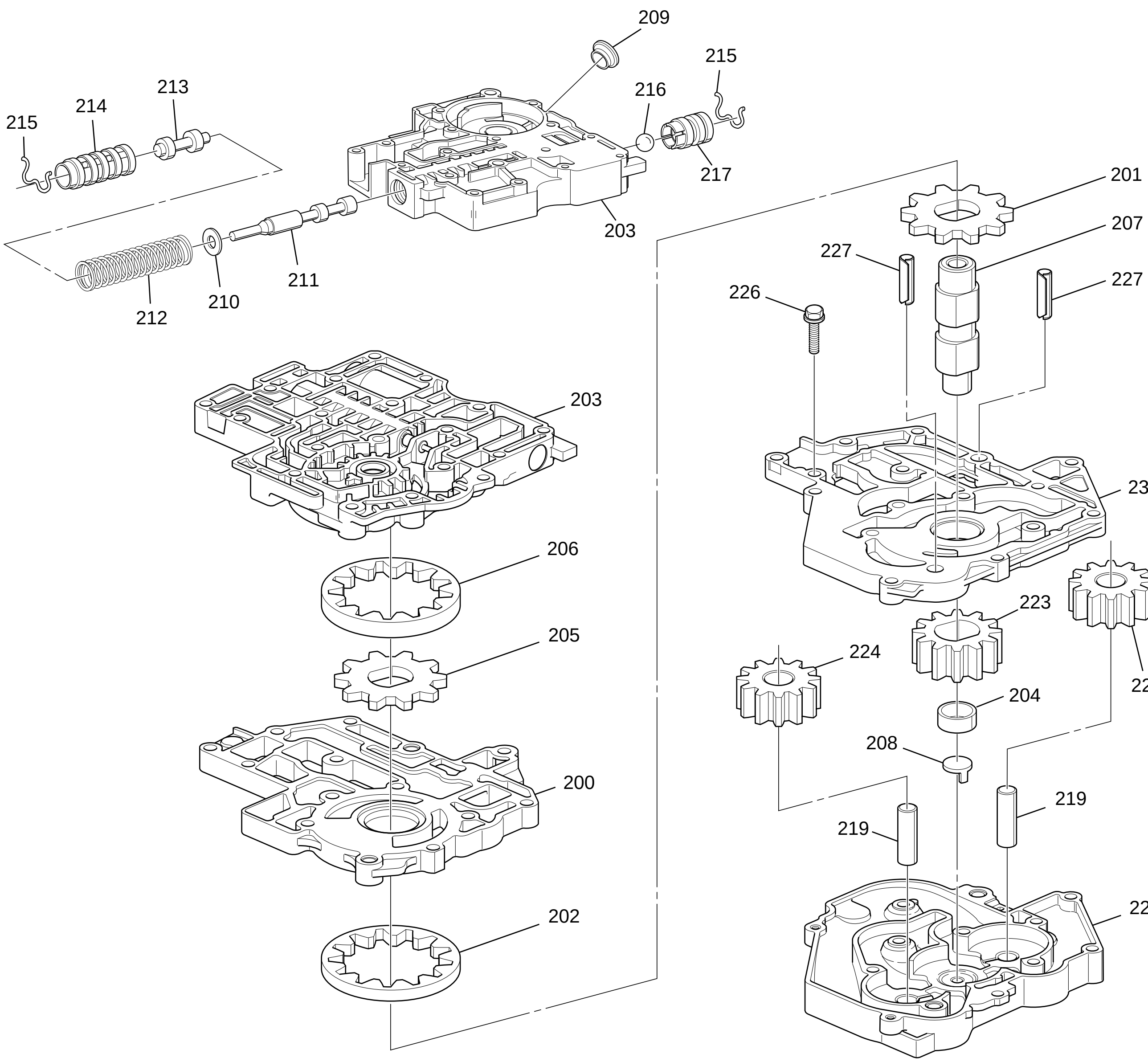


3 QUICK DISCONNECT COOLER CONNECTOR (CASE) (1, 19 mm)
4 QUICK DISCONNECT COOLER CONNECTOR O-RING
6 TRANSMISSION CASE
12 WIRING ASSEMBLY HARNESS
14 INPUT SPEED SENSOR ASSEMBLY
15 BOLT (4, 8 mm)
33 TRANSMISSION CASE COVER
34 CASE COVER TO DRIVE SPROCKET SEAL
35 CASE COVER TO TURBINE SHAFT SEAL
37 CASE COVER AXLE SEAL
40 CASE COVER OIL TEST PLUG – #40 TORX®
41 TRANSMISSION VENT ADAPTER
43 SPROCKET SUPPORT TO CASE COVER GASKET
44 CASE TO CASE COVER GASKET
45 CASE COVER TO CASE STUD (1, 13 mm)
46 CASE COVER TO CASE BOLT (8, 10 mm)
47 CASE COVER TO CASE STUD (2, 13 mm)
48 CASE COVER TO DRIVEN SPROCKET SUPPORT BOLT (3, 10 mm)
49 CASE COVER TO CASE STUD (1, 10 mm)
50 CASE COVER TO CASE BOLT (11, 13 mm)
56 OUTPUT SHAFT SNAP RING (3)
57 OUTPUT SHAFT
67 CASE COVER TO CASE STUD (1, 13 mm)
132 THRUST BEARING
400 DRIVE SPROCKET SUPPORT
401 CONVERTER HUB BUSHING
402 FRONT STATOR SHAFT BUSHING
403 CONVERTER HUB ASSEMBLY SEAL ASSEMBLY
404 DRIVE SPROCKET SUPPORT TO CASE BOLT (6, 8 mm)
405 DRIVE SPROCKET SUPPORT TO CASE SEAL
407 DRIVE SPROCKET
408 BALL BEARING (2)
409 DRIVE SPROCKET OIL SEAL RING
410 TURBINE SHAFT
411 SNAP RING
412 O-RING SEAL
414 DRIVE LINK ASSEMBLY
415 DRIVEN SPROCKET
440 THRUST BEARING

ZH750765-4T80-E

Figure 107

Scavenge, Primary and Secondary Pump Assemblies

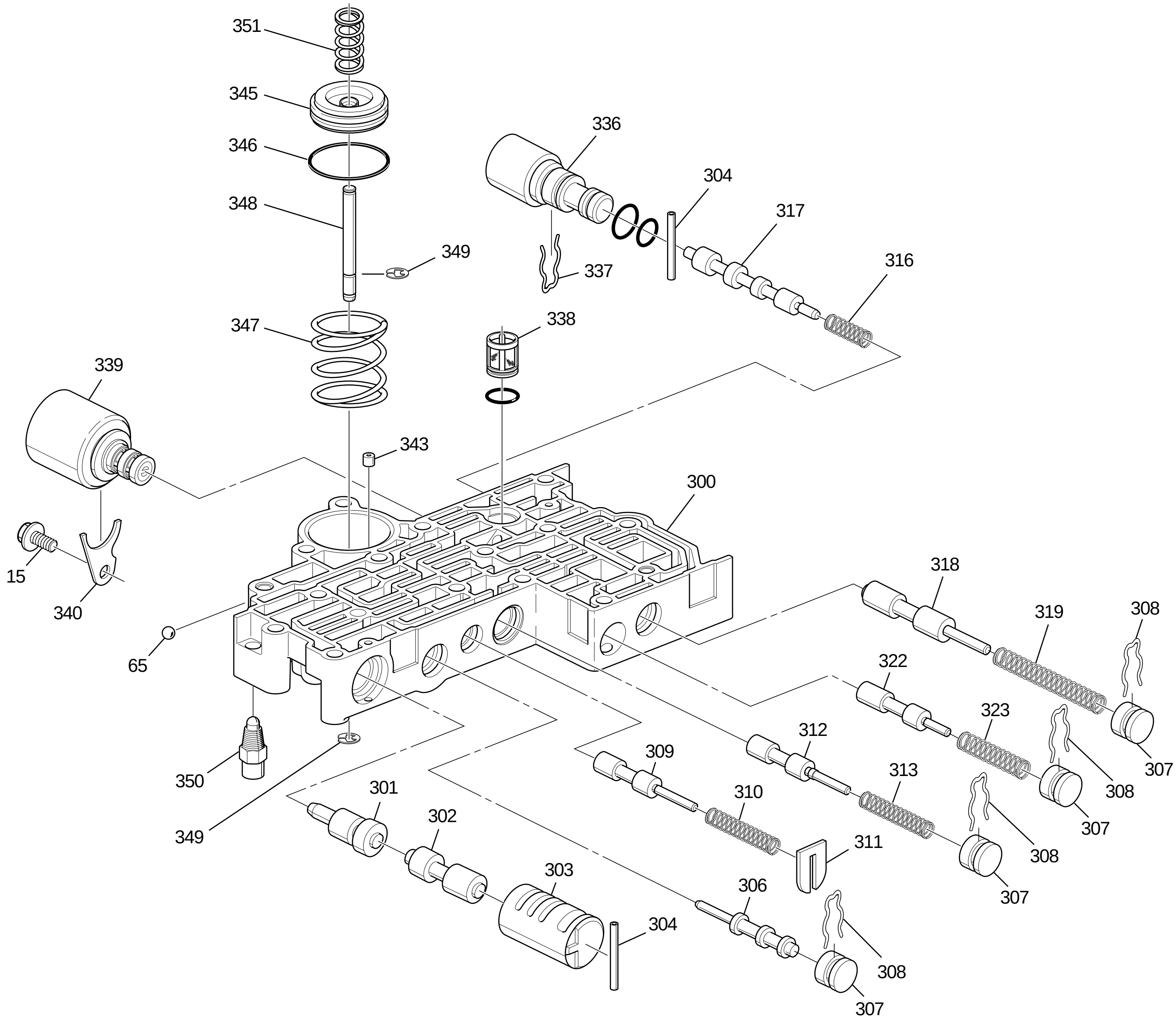


200	PRIMARY PUMP BODY	213	PRESSURE REGULATOR BOOST VALVE
201	PRIMARY PUMP DRIVE GEAR	214	PRESSURE REGULATOR BOOST VALVE SLEEVE
202	PRIMARY PUMP DRIVEN GEAR	215	RETAINER CLIP (2)
203	SECONDARY PUMP BODY	216	SECONDARY PUMP CUT-OFF BALL
204	SCAVENGE PUMP BUSHING	217	PUMP BALL SEAT
205	SECONDARY PUMP DRIVE GEAR	219	SCAVENGE DRIVEN GEAR PIN
206	SECONDARY PUMP DRIVEN GEAR	223	SCAVENGE PUMP DRIVE GEAR
207	OIL PUMP DRIVEN SHAFT ASSEMBLY	224	SCAVENGE PUMP DRIVEN GEAR (2)
208	OIL PUMP DRIVEN SHAFT THRUST WASHER	225	SCAVENGE PUMP BODY
209	FILTER SEAL	226	PUMP COVER TO SCAVENGER COVER BOLT (2)
210	PRESSURE REGULATOR SPRING RETAINER	227	DOWEL BUSHINGS (2)
211	PRESSURE REGULATOR VALVE	237	SCAVENGE PUMP COVER
212	PRESSURE REGULATOR VALVE SPRING		

WH15548-4T80-E

Figure 108

Upper Control Valve Body Assembly

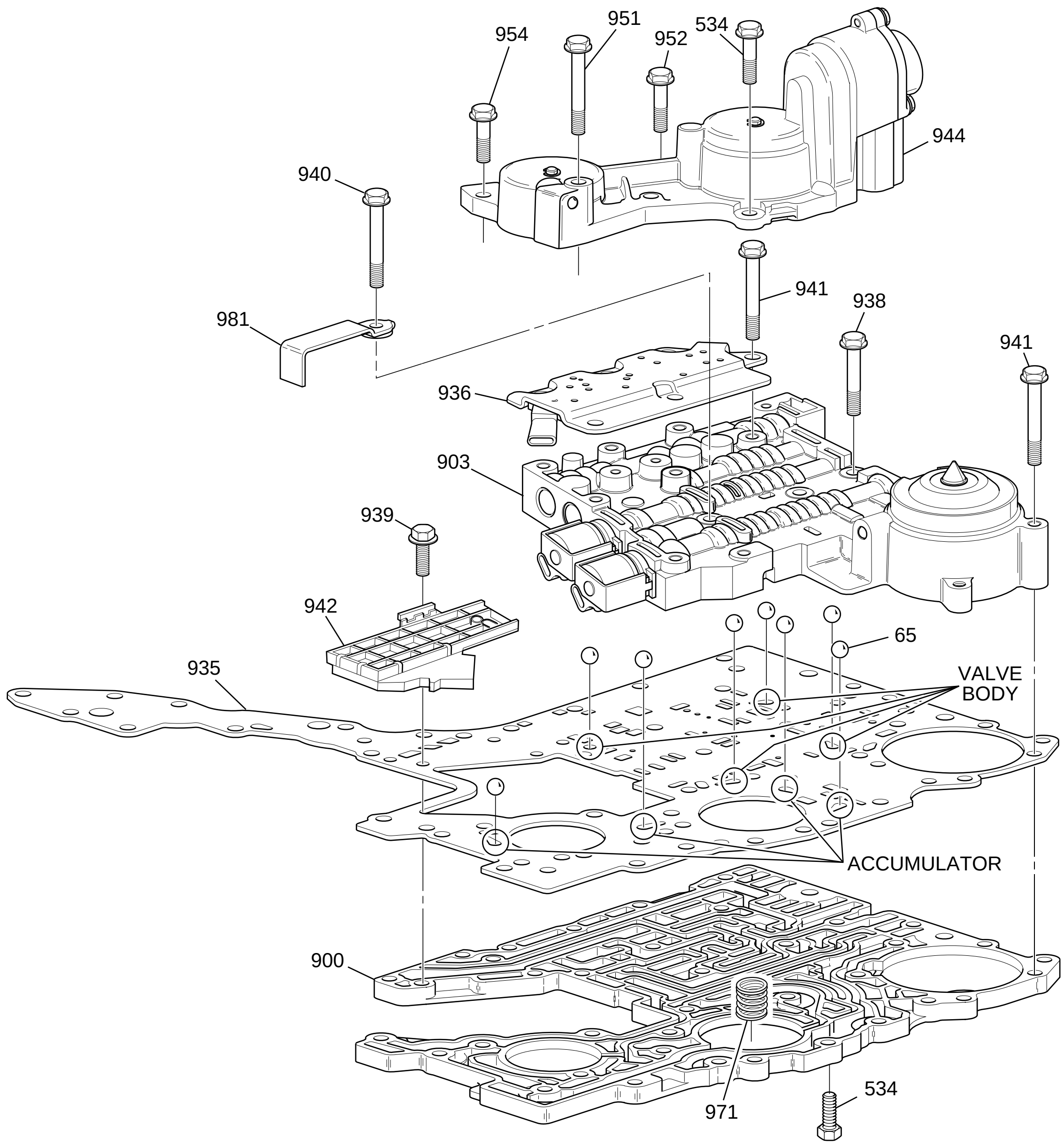


15	CLAMP BOLT	318	CONVERTER REGULATOR VALVE
65	OIL HOLE PLUG BALL	319	CONVERTER CLUTCH REGULATOR SPRING
300	UPPER CONTROL VALVE BODY	322	TCC ENABLE VALVE
301	ACCUMULATOR BOOST VALVE	323	TCC ENABLE VALVE SPRING
302	1-2 / 3-4 ACCUMULATOR VALVE	336	TCC PRESSURE SOLENOID
303	1-2 / 3-4 ACCUMULATOR VALVE BUSHING	337	SPRING RETAINER CLIP
304	COILED SPRING PIN (2)	338	PRESSURE CONTROL SOLENOID FILTER AND SEAL
306	2-3 ACCUMULATOR VALVE	339	PRESSURE CONTROL SOLENOID (FORCE MOTOR)
307	BORE PLUG (4)	340	PC SOLENOID CLAMP (FORCE MOTOR CLAMP)
308	RETAINER CLIP (4)	343	ORIFICED CUP PLUG
309	ACTUATOR FEED LIMIT VALVE	345	2-3 ACCUMULATOR PISTON
310	ACTUATOR FEED LIMIT SPRING	346	2-3 ACCUMULATOR PISTON SEAL
311	SPRING RETAINER PLATE	347	2-3 ACCUMULATOR PISTON SPRING
312	CONVERTER FEED LIMIT VALVE	348	2-3 ACCUMULATOR PIN
313	CONVERTER FEED LIMIT SPRING	349	SNAP RING
316	CONVERTER CLUTCH CONTROL SPRING	350	TEMPERATURE SENSOR
317	CONVERTER CLUTCH CONTROL VALVE	351	2-3 ACCUMULATOR PISTON CUSHION SPRING

XH15550-4T80-E

Figure 109

Lower Channel Plate, Control Valve Body and Accumulator Housing Assembly

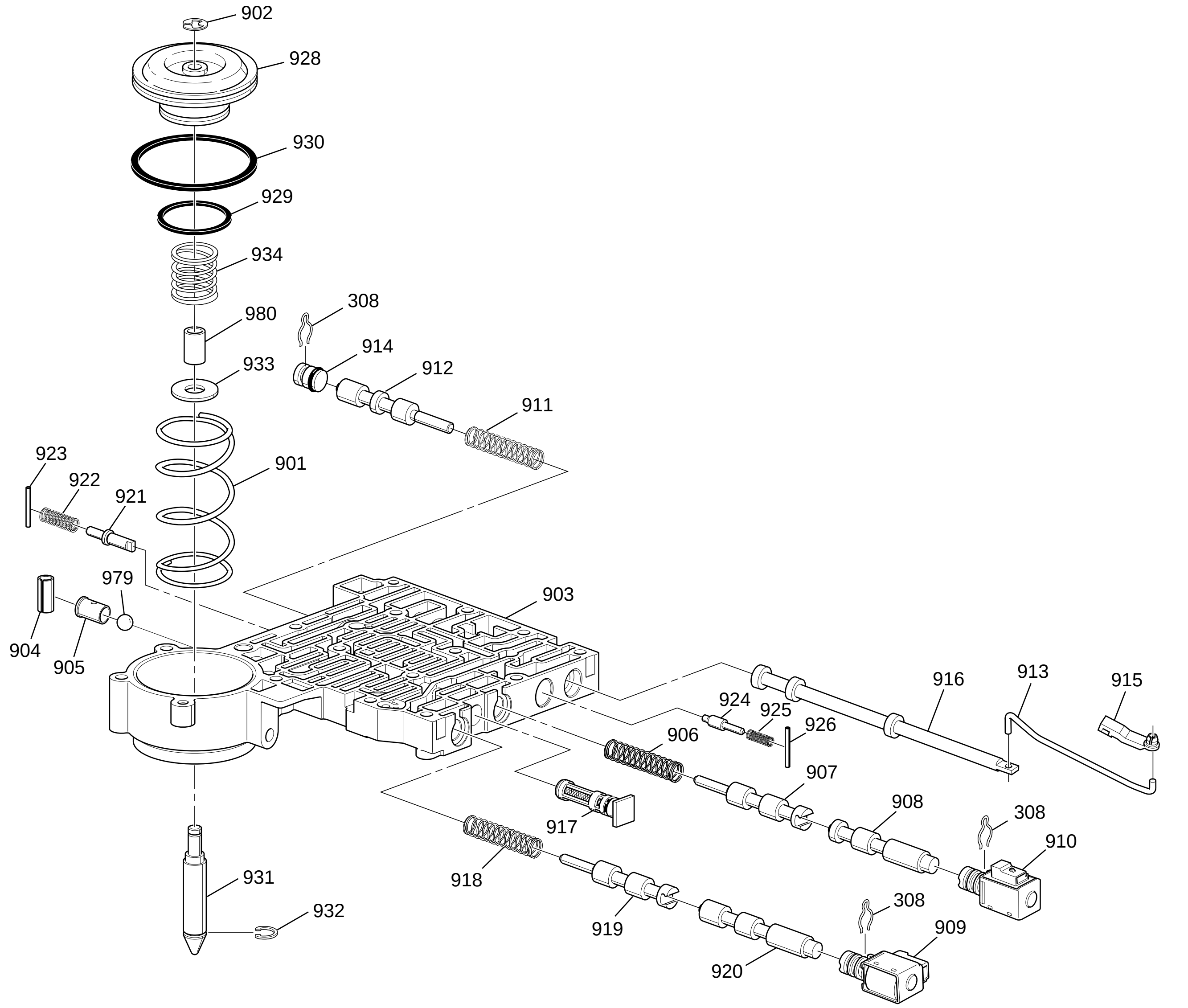


65	BALL CHECK VALVES (8)	940	LCVB TO CHANNEL PLATE BOLT (2, 10 mm)
534	CHANNEL PLATE TO LCVB BOLT (1, 10 mm) – CHANNEL PLATE TO ACCUMULATOR HOUSING BOLT (3, 10 mm) – ACCUMULATOR HOUSING TO CHANNEL PLATE BOLT (1, 10 mm)	941	LCVB TO CHANNEL PLATE BOLT (8, 10 mm)
900	LOWER CHANNEL PLATE	942	INTERNAL MODE SWITCH (IMS)
903	CHANNEL PLATE/CONTROL VALVE AND HOUSING ASSEMBLY	944	ACCUMULATOR HOUSING
935	SPACER/GASKET PLATE ASSEMBLY	951	ACCUMULATOR ASSEMBLY TO CHANNEL PLATE BOLT (1, 10 mm)
936	TRANSMISSION FLUID PRESSURE MANUAL VALVE POSITION SWITCH	952	ACCUMULATOR ASSEMBLY TO CHANNEL PLATE BOLT (3, 10 mm)
938	LCVB TO CHANNEL PLATE BOLT (5, 10 mm)	954	ACCUMULATOR ASSEMBLY TO CHANNEL PLATE BOLT (1, 10 mm)
939	SPACER PLATE SUPPORT TO CHANNEL PLATE BOLT (3, 8 mm)	971	1-2 ACCUMULATOR INNER SPRING ASSEMBLY
		981	PRESSURE CONTROL SOLENOID VALVE FLUID FILTER RETAINER

YH509759-4T80-E

Figure 110

Lower Control Valve Body Assembly

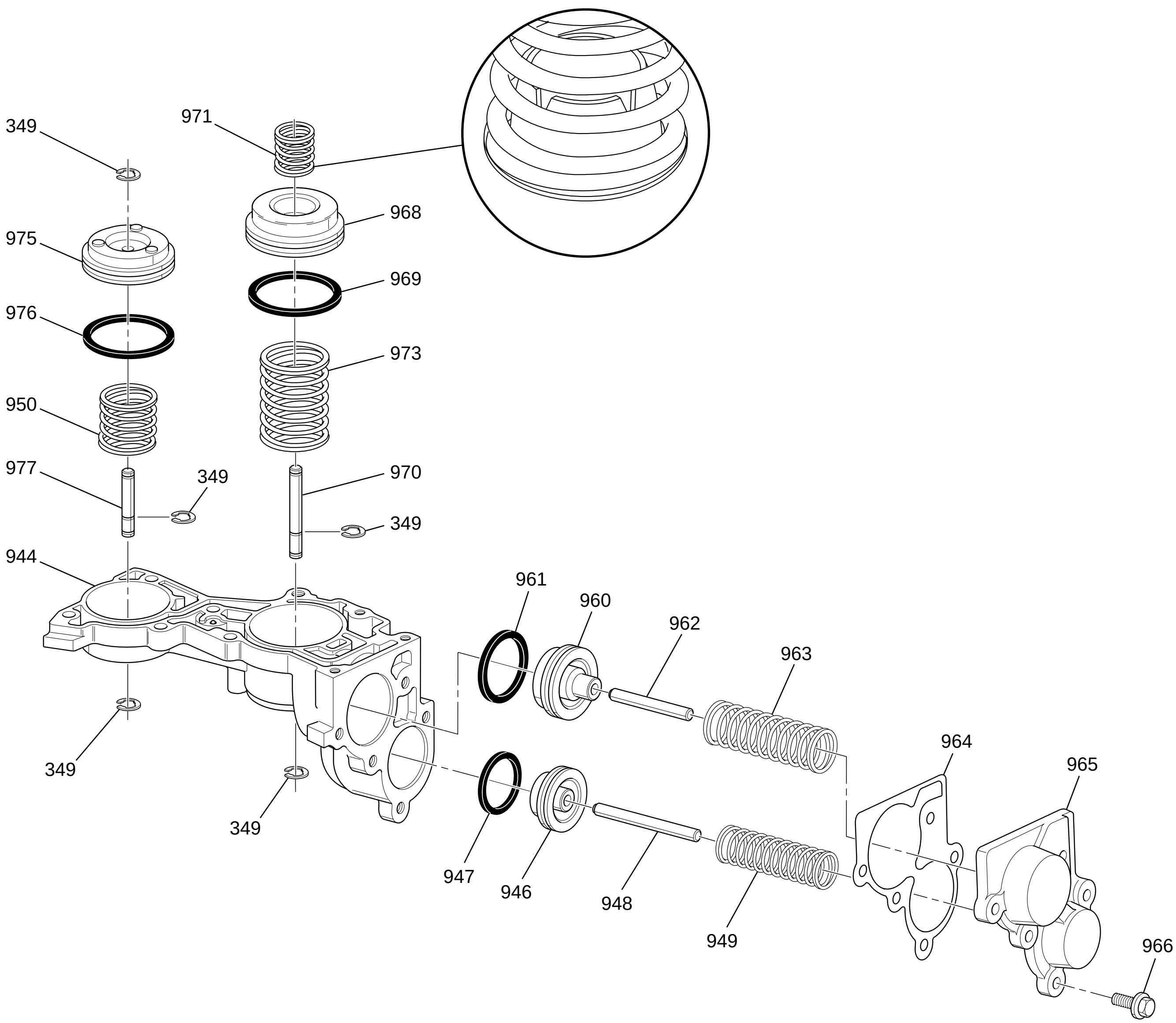


308	RETAINER CLIP (3)	918	1-2 SHIFT VALVE SPRING
901	RETURN SPRING	919	1-2 SHIFT VALVE A
902	RETAINING RING	920	1-2 SHIFT VALVE B
903	LOWER CONTROL VALVE BODY	921	REVERSE ORIFICE BYPASS VALVE
904	SPRING RETAINER	922	REVERSE ORIFICE BYPASS VALVE SPRING
905	BALL CHECK CAPSULE	923	COILED SPRING FLAG PIN
906	2-3 SHIFT VALVE SPRING	924	FORWARD ORIFICE BYPASS VALVE
907	2-3 SHIFT VALVE C	925	FORWARD ORIFICE BYPASS VALVE SPRING
908	2-3 SHIFT VALVE D	926	COILED SPRING FLAG PIN
909	1-2 SHIFT SOLENOID VALVE	928	LOW/REVERSE SERVO PISTON
910	2-3 SHIFT SOLENOID VALVE	929	LOW/REVERSE SERVO SEAL (SMALL)
911	3-4 SHIFT VALVE SPRING	930	LOW/REVERSE SERVO SEAL (LARGE)
912	3-4 SHIFT VALVE	931	LOW/REVERSE SERVO APPLY PIN
913	MANUAL VALVE LINK	932	RETAINING RING
914	BORE PLUG	933	SERVO CUSHION SPRING WASHER
915	MANUAL VALVE LINK RETAINER	934	SERVO CUSHION SPRING
916	MANUAL VALVE	979	BALL (0.375 DIAMETER)
917	SOLENOID SCREEN ASSEMBLY	980	LOW/REVERSE CUSHION SLEEVE

YH509765-4T80-E

Figure 111

Accumulator Assembly

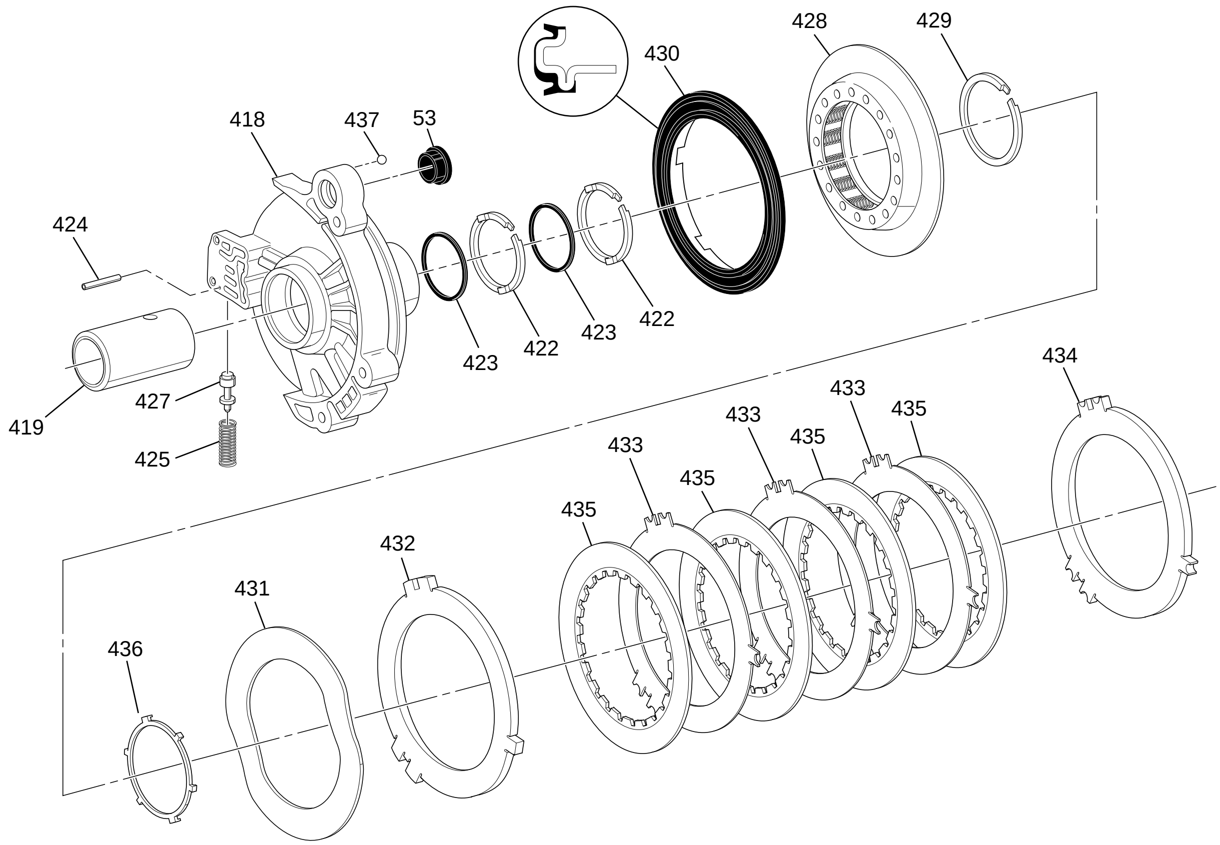


349	SNAP RING (6)	965	ACCUMULATOR HOUSING COVER
944	ACCUMULATOR HOUSING	966	COVER BOLT (5, 8 mm)
946	REVERSE ACCUMULATOR PISTON	968	1-2 ACCUMULATOR PISTON
947	REVERSE ACCUMULATOR PISTON SEAL	969	1-2 ACCUMULATOR PISTON SEAL
948	REVERSE ACCUMULATOR PIN	970	1-2 ACCUMULATOR PIN
949	REVERSE ACCUMULATOR SPRING	971	1-2 ACCUMULATOR INNER SPRING ASSEMBLY
950	3-4 ACCUMULATOR SPRING	973	1-2 ACCUMULATOR SPRING
960	FORWARD ACCUMULATOR PISTON	975	3-4 ACCUMULATOR PISTON
961	FORWARD ACCUMULATOR SEAL	976	3-4 ACCUMULATOR PISTON SEAL
962	FORWARD ACCUMULATOR PIN	977	3-4 ACCUMULATOR PIN
963	FORWARD ACCUMULATOR SPRING		
964	ACCUMULATOR HOUSING COVER GASKET		

WH186641-4T80-E

Figure 112

Driven Sprocket Support and 2nd Clutch Assembly

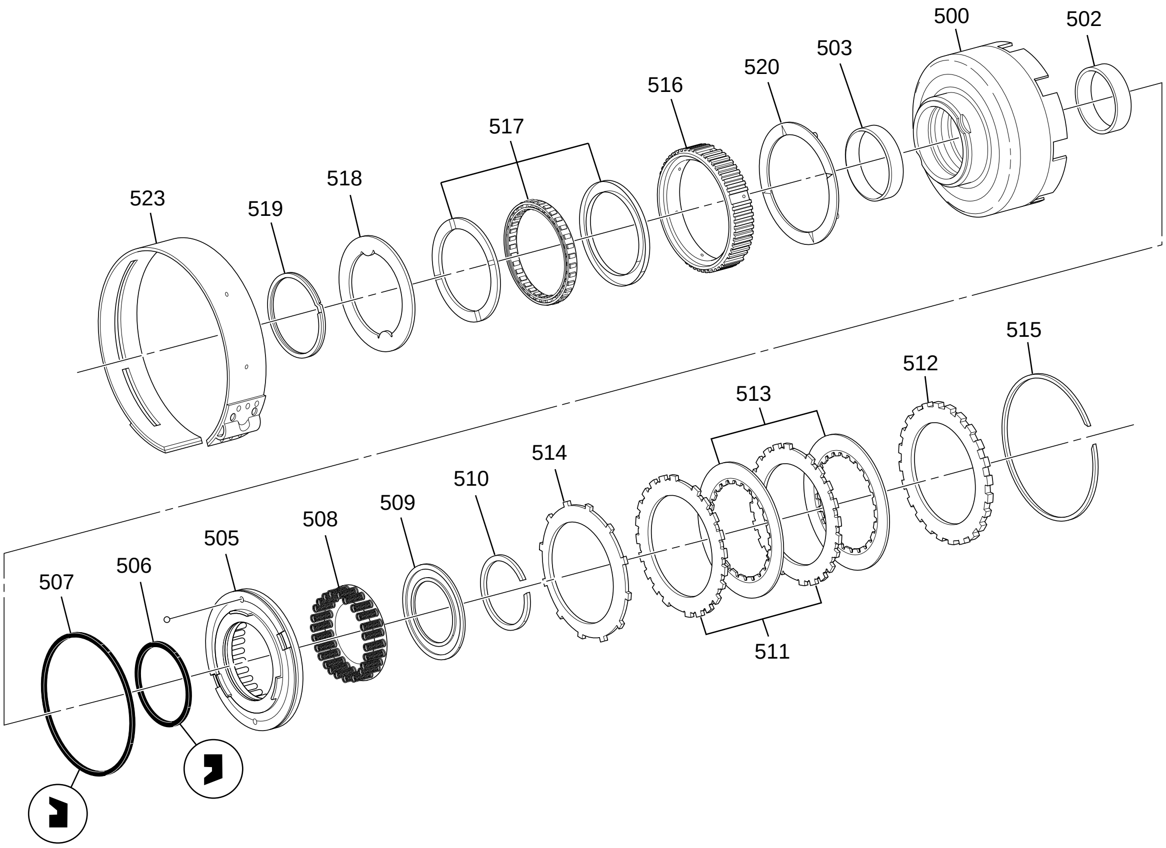


53 SCAVENGER TUBE SEAL
418 DRIVEN SPROCKET SUPPORT
419 OIL TRANSFER SLEEVE
422 OIL RING (2)
423 4 LOBE SEAL RING (2)
424 SPRING PIN
425 3RD CLUTCH EXHAUST VALVE SPRING
427 3RD CLUTCH EXHAUST VALVE
428 2ND CLUTCH RETURN SPRING AND RETAINER ASSEMBLY
429 2ND CLUTCH/DRIVEN SPROCKET SNAP RING
430 2ND CLUTCH PISTON ASSEMBLY
431 2ND CLUTCH WAVED PLATE
432 2ND CLUTCH APPLY PLATE
433 2ND CLUTCH STEEL PLATE (3)
434 2ND CLUTCH BACKING PLATE
435 2ND CLUTCH FIBER PLATE (4)
436 SUPPORT/REVERSE CLUTCH THRUST WASHER
437 0.1875 DIAMETER BALL CHECK VALVE

ZH750766-4T80-E

Figure 113

Reverse Clutch and 2nd Sprag Clutch Assemblies

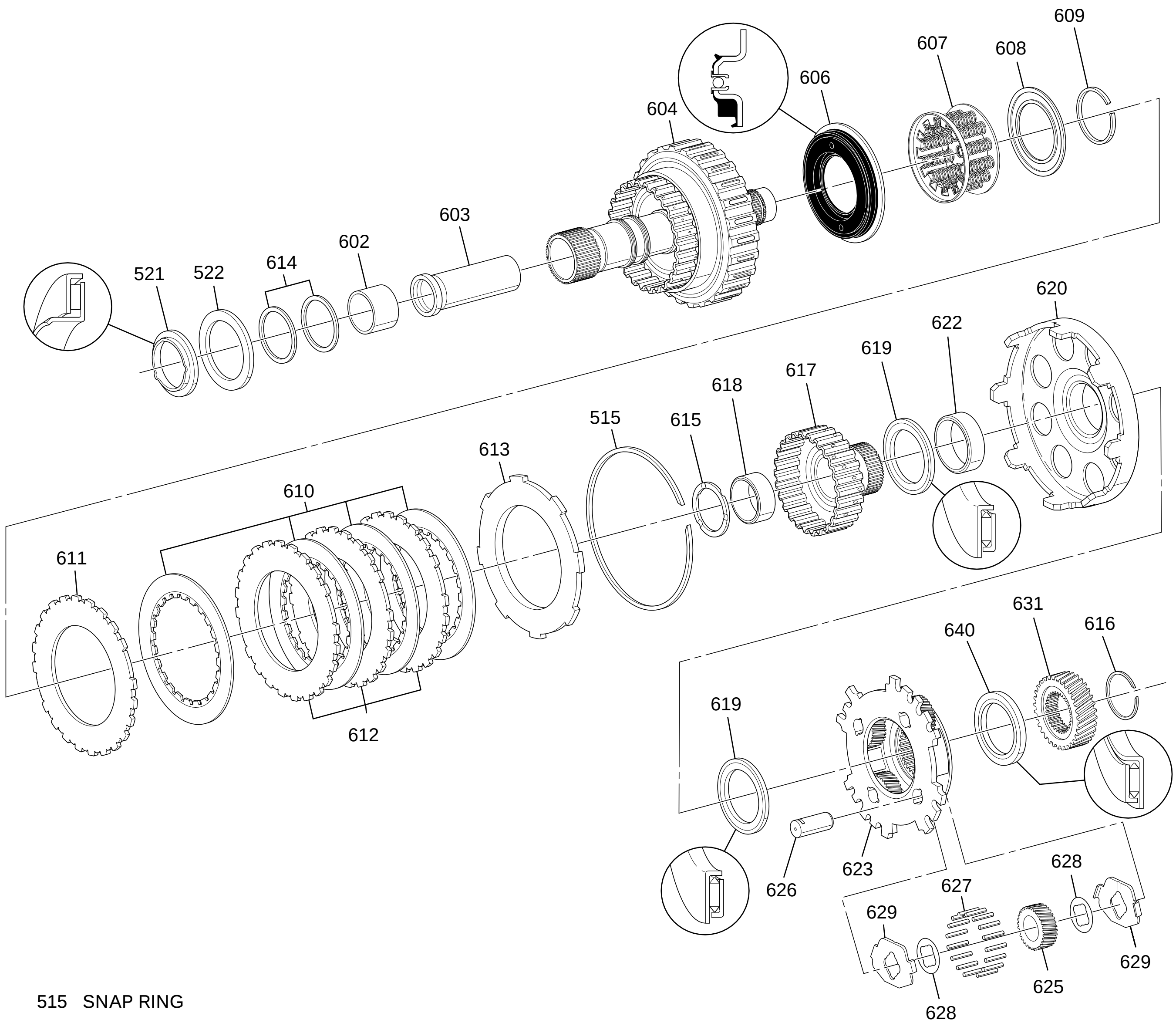


500 REVERSE CLUTCH HOUSING AND RACE ASSEMBLY
502 BUSHING (SMALL)
503 BUSHING (LARGE)
505 REVERSE CLUTCH PISTON ASSEMBLY
506 SEAL (INNER)
507 SEAL (OUTER)
508 SPRING AND RETAINER ASSEMBLY
509 SNAP RING RETAINER
510 RETURN SPRING SNAP RING
511 REVERSE CLUTCH PLATE (STEEL) (2)
512 REVERSE CLUTCH BACKING PLATE (SELECTIVE)
513 REVERSE CLUTCH PLATE ASSEMBLY (FIBER) (2)
514 WAVED PLATE (APPLY)
515 SNAP RING
516 2ND SPRAG RACE (OUTER)
517 2ND SPRAG CLUTCH ASSEMBLY
518 2ND SPRAG CLUTCH RETAINER
519 LOCKING RING
520 2ND CLUTCH OUTER RACE WASHER
523 4TH BAND

YH412932-4T80-E

Figure 114

3rd Clutch and Reaction Carrier Assembly

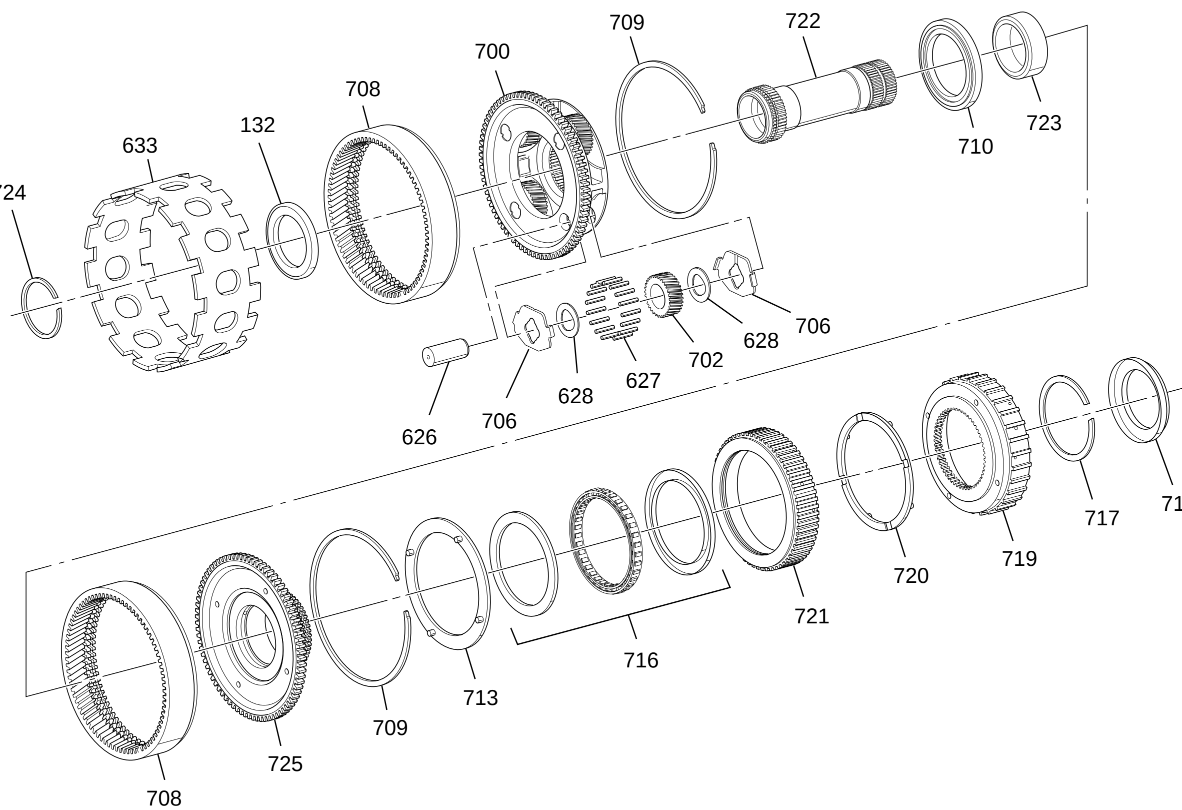


515 SNAP RING
521 THRUST BEARING ASSEMBLY
522 DRIVEN SPROCKET SUPPORT THRUST WASHER (SELECTIVE)
602 INPUT SHAFT BUSHING
603 INPUT SHAFT/OIL TRANSFER SLEEVE
604 3RD CLUTCH HOUSING
606 3RD CLUTCH PISTON ASSEMBLY
607 SPRING AND RETAINER ASSEMBLY
608 SNAP RING RETAINER
609 RETURN SPRING SNAP RING
610 3RD CLUTCH PLATE ASSEMBLY (FIBER) (4)
611 3RD CLUTCH APPLY PLATE (STEEL)
612 3RD CLUTCH PLATE (STEEL) (3)
613 3RD CLUTCH BACKING PLATE
614 OIL SEAL RING (2)
615 INPUT SHAFT/3RD HUB THRUST WASHER
616 INPUT SHAFT/INPUT SUN GEAR SNAP RING
617 3RD CLUTCH HUB
618 HUB BUSHING
619 HUB/GEAR AND SHELL THRUST BEARING ASSEMBLY (2)
620 REACTION SUN GEAR AND SHELL ASSEMBLY
622 REACTION SUN GEAR BUSHING
623 REACTION CARRIER
625 PLANET PINION (4)
626 PLANET PINION PIN (4)
627 ROLLER BEARING NEEDLE (68)
628 STEEL PINION THRUST WASHER (8)
629 BRONZE PINION THRUST WASHER (8)
631 INPUT SUN GEAR
640 INPUT SUN GEAR TO REACTION CARRIER THRUST BEARING

YH15563-4T80-E

Figure 115

Input Carrier and Forward Sprag Clutch Assemblies

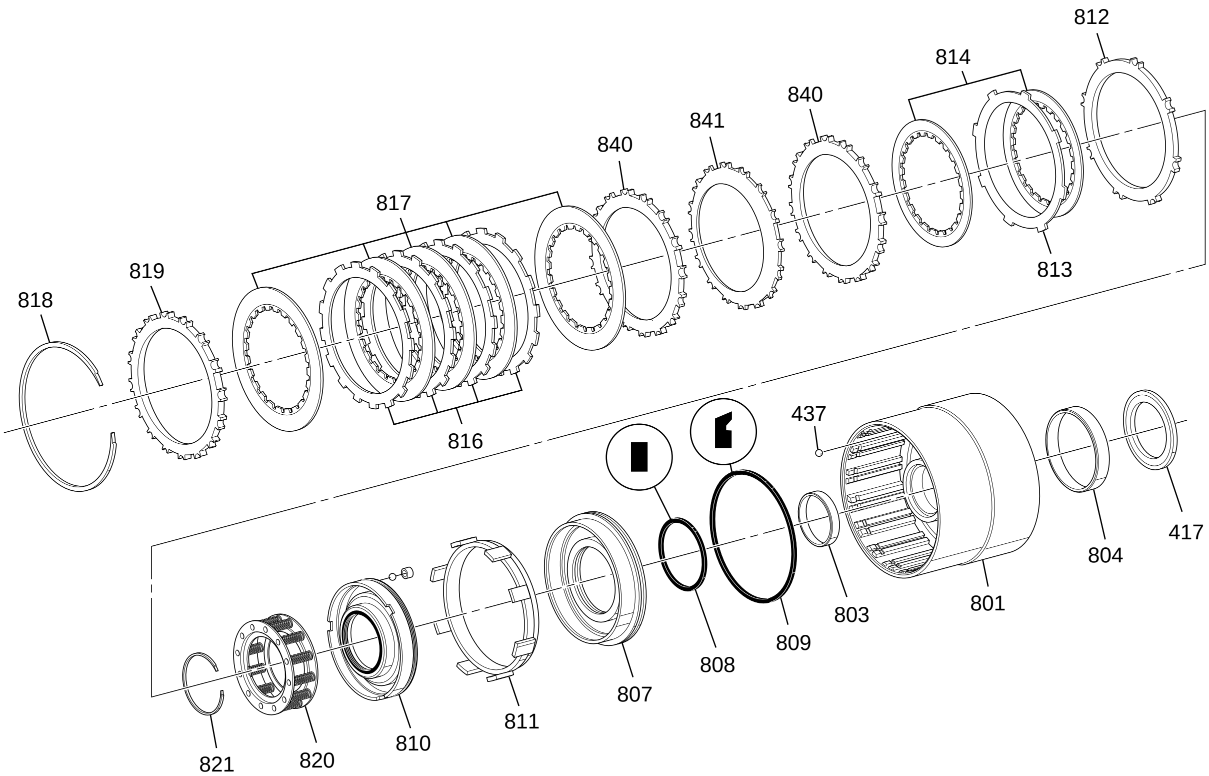


132 THRUST BEARING ASSEMBLY
626 PLANET PINION PIN (4)
627 ROLLER BEARING NEEDLE (68)
628 STEEL PINION THRUST WASHER (8)
633 REACTION CARRIER SHELL
700 INPUT CARRIER ASSEMBLY
702 PLANET PINIONS (4)
706 BRONZE THRUST WASHER (8)
708 INTERNAL GEAR (2)
709 SNAP RING (2)
710 THRUST BEARING ASSEMBLY
713 THRUST WASHER (FLANGE TO OUTER RACE)
716 FORWARD CLUTCH SPRAG ASSEMBLY
717 SNAP RING (COAST CLUTCH HUB RETAINER)
718 THRUST BEARING (FLANGE/FORWARD CLUTCH HOUSING)
719 COAST CLUTCH HUB
720 THRUST WASHER (RACE/COAST CLUTCH HUB)
721 FORWARD SPRAG RACE (OUTER)
722 FINAL DRIVE SUN GEAR SHAFT
723 INPUT FLANGE BUSHING
724 SNAP RING (FINAL DRIVE SHAFT/INPUT CARRIER)
725 INPUT INTERNAL GEAR FLANGE

WH15564-4T80-E

Figure 116

Forward Clutch Assembly

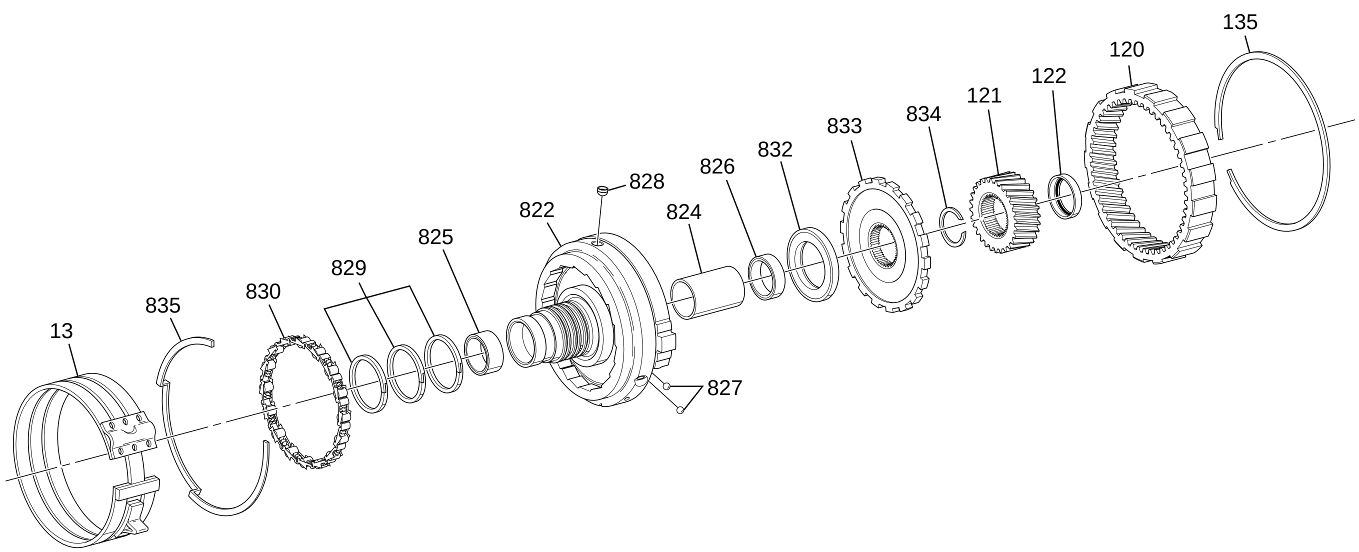


YH15569-4T80-E

417	THRUST BEARING	813	COAST CLUTCH PLATE (STEEL)
437	0.1875 DIAMETER BALL CHECK VALVE	814	COAST CLUTCH PLATE (FIBER) (2)
801	FORWARD AND COAST CLUTCH HOUSING	816	FORWARD CLUTCH PLATE (STEEL) (4)
803	HOUSING BUSHING (SMALL)	817	FORWARD CLUTCH PLATE (FIBER) (5)
804	HOUSING BUSHING (LARGE)	818	SNAP RING (FORWARD CLUTCH BACKING PLATE)
807	FORWARD CLUTCH PISTON	819	FORWARD CLUTCH BACKING PLATE
808	SEAL (INNER)	820	FORWARD CLUTCH RELEASE SPRING ASSEMBLY
809	SEAL (OUTER)	821	SNAP RING (FORWARD RETURN SPRING ASSEMBLY/ HOUSING)
810	COAST CLUTCH PISTON ASSEMBLY	840	FORWARD AND COAST CLUTCH PLATE (2)
811	FORWARD CLUTCH RING (APPLY)	841	FORWARD AND COAST CLUTCH PLATE (BELLEVILLE)
812	COAST CLUTCH PLATE (APPLY)		

Figure 117

Forward Clutch Support Assembly

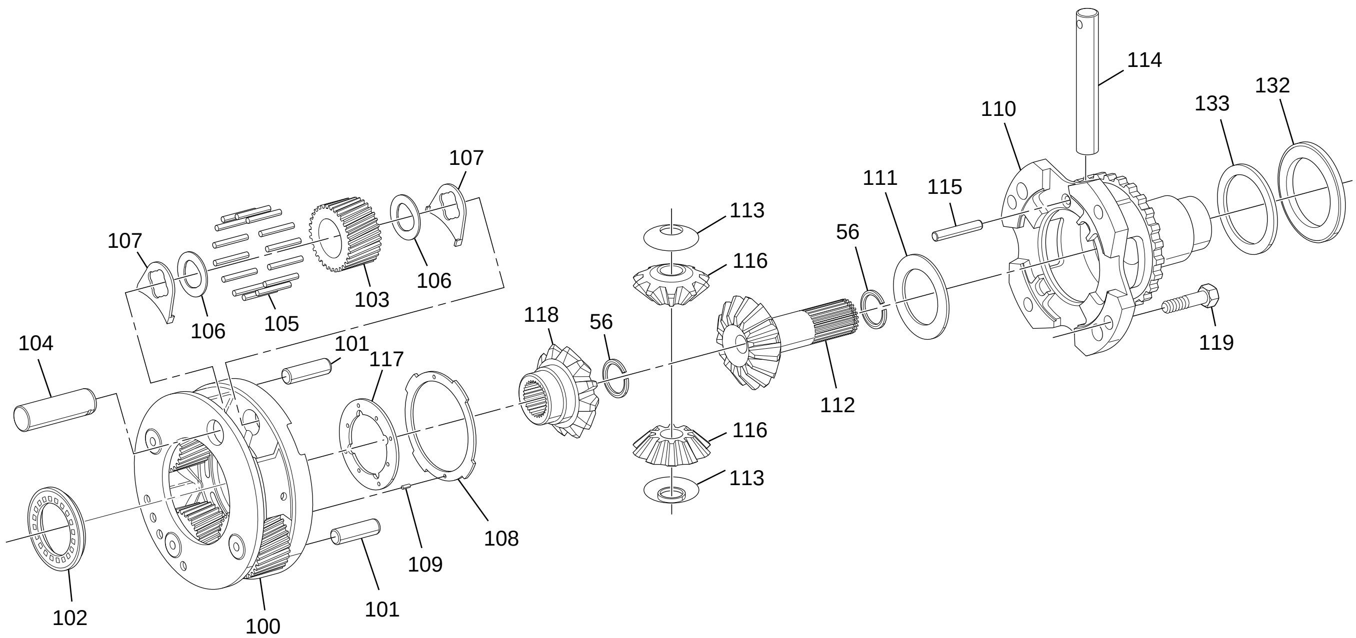


13	LOW/REVERSE BAND	827	OIL HOLE PLUG BALL (2)
120	FINAL DRIVE INTERNAL GEAR	828	COOLER RETURN SEAL
121	FINAL DRIVE SUN GEAR	829	SUPPORT/HOUSING OIL SEAL RING
122	FINAL DRIVE SUN GEAR SEAL	830	LOW ROLLER CLUTCH ASSEMBLY
135	SNAP RING	832	FORWARD CLUTCH SUPPORT/PARK GEAR THRUST BEARING
822	FORWARD/COAST CLUTCH SUPPORT	833	PARKING LOCK GEAR
824	OIL TRANSFER SLEEVE	834	FINAL DRIVE SHAFT TO PARK GEAR SNAP RING
825	LEFT SUPPORT/SUN SHAFT BUSHING	835	SUPPORT/CASE FRETTING RING
826	RIGHT SUPPORT/SUN SHAFT BUSHING		

WH15572-4T80-E

Figure 118

Final Drive Assembly

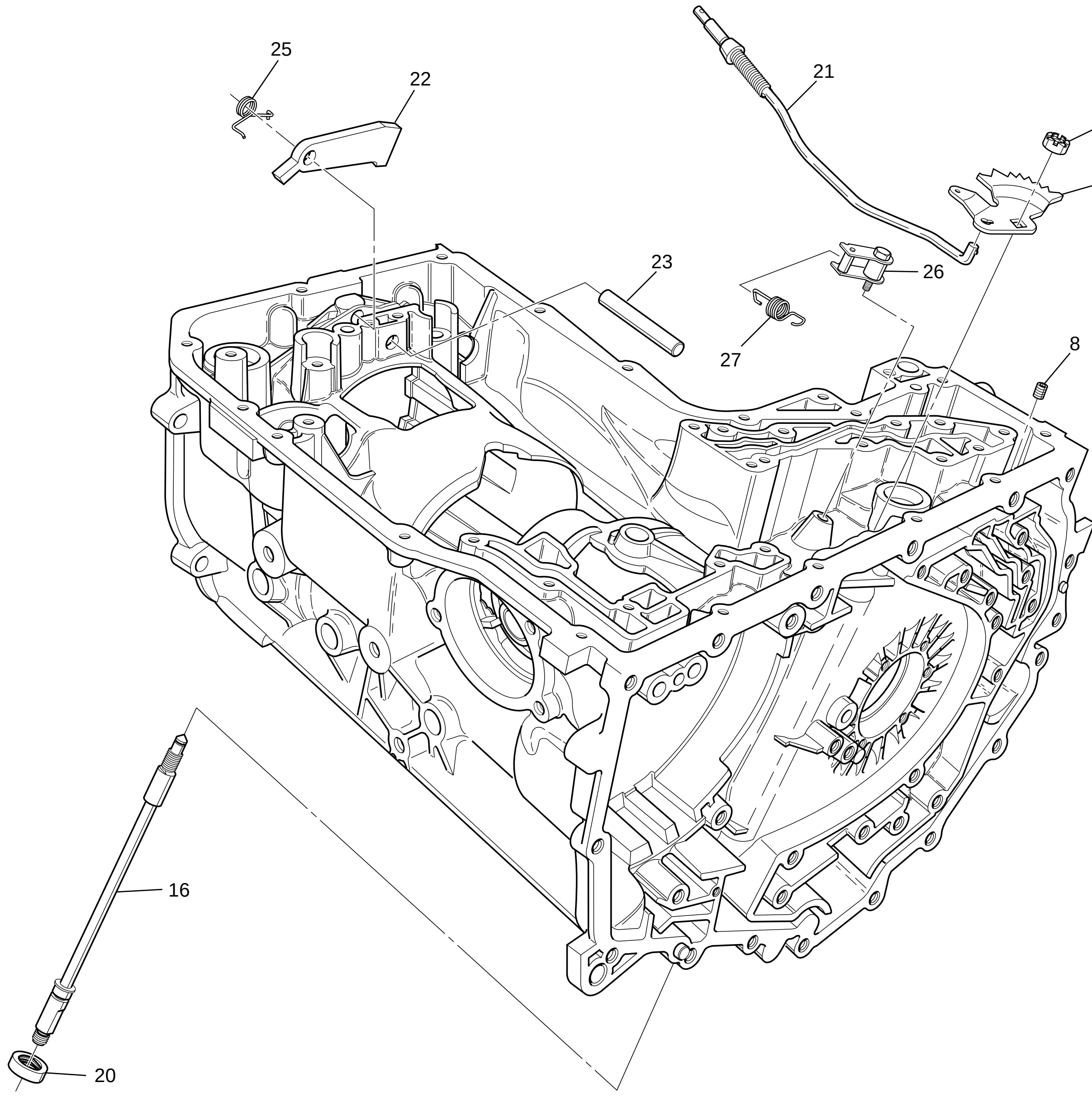


56	OUTPUT SHAFT SNAP RING	111	RIGHT DIFFERENTIAL THRUST WASHER
100	FINAL DRIVE CARRIER	112	RIGHT DIFFERENTIAL SIDE GEAR
101	DIFFERENTIAL CARRIER DOWEL (2)	113	DIFFERENTIAL PINION THRUST WASHER (2)
102	SUN GEAR/CARRIER THRUST BEARING	114	DIFFERENTIAL PINION SHAFT
103	FINAL DRIVE PLANET PINION (4)	115	DIFFERENTIAL SHAFT RETAINING PIN
104	FINAL DRIVE PLANET PINION PIN (4)	116	DIFFERENTIAL PINION GEARS (2)
105	ROLLER NEEDLE BEARINGS (76)	117	LEFT DIFFERENTIAL THRUST WASHER
106	FINAL DRIVE PINION STEEL THRUST WASHERS (8)	118	LEFT DIFFERENTIAL SIDE GEAR
107	FINAL DRIVE PINION BRONZE THRUST WASHERS (8)	119	DIFFERENTIAL CARRIER TO FINAL DRIVE CARRIER BOLT
108	FINAL DRIVE CARRIER RETAINER	132	THRUST BEARING ASSEMBLY
109	ROLLED PIN	133	DIFFERENTIAL CARRIER/CASE EXTENSION SELECTIVE THRUST WASHER
110	DIFFERENTIAL CARRIER		

WH15575-4T80-E

Figure 119

Parking Pawl, Actuator Assembly and Manual Shaft



8 DRAIN PLUG
16 MANUAL SHAFT
17 INSIDE DETENT LEVER
18 MANUAL SHAFT TO DETENT LEVER NUT
20 MANUAL SHAFT SEAL
21 PARK LOCK ACTUATOR ASSEMBLY
22 PARKING LOCK PAWL
23 PARKING PAWL PIVOT PIN
25 PARKING PAWL RETURN SPRING
26 DETENT LEVER AND ROLLER ASSEMBLY
27 DETENT SPRING

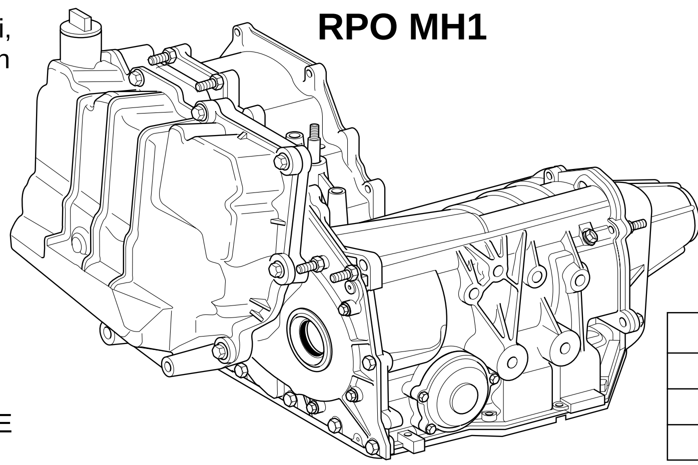
XH412934-4T80-E

Figure 120

HYDRA-MATIC 4T80-E TRANSMISSION

RPO MH1

Produced at: Ypsilanti, Michigan U.S.A.



HYDRA-MATIC 4T80-E (FOUR-SPEED)

Vehicles used in:

	DIVISION	MODEL
E	Cadillac	Eldorado
G	Oldsmobile	Aurora
K	Cadillac	Concours/Seville
Ksp	Cadillac	DeVille

Transmission Drive
Transverse Front Wheel Drive

Transmission Type
4T80-E = 4: Four Speed
T: Transverse Mount
80: Product Series
E: Electronically Controlled

High Capacity Automatic Overdrive with Torque Converter Clutch Assembly.

Transfer Design
2-Axis Design, Link Chain Assembly

Current Engine Range
4.0 L to 5.0 L Gasoline

Control Systems
Shift Pattern – Solenoid Control
Shift Quality – Pressure Control Solenoid
Torque Converter Clutch – Pulse Width Modulated Solenoid Control

Additional transmission and engine sensors are provided depending on transmission/powertrain application.

Gear Ratios

1st	2.960
2nd	1.626
3rd	1.000
4th	0.681
Rev	2.130

Maximum Engine Torque
413 N•m (305 lb ft)

Maximum Gearbox Torque
625 N•m (461 lb ft)

The maximum torque limits are only to be used as a guide and may not be applicable under certain conditions.

Maximum Shift Speed (Restricted)

1-2	6,500 RPM
2-3	6,500 RPM
3-4	6,500 RPM

The maximum shift speed allowed in each engine application must be calculated.

Maximum Gross Vehicle Weight
2,150 kg (4,750 lb)

Transmission Fluid Type
DEXRON® III

Converter Size
265 mm (Reference)

Transmission Fluid Capacities (Approximate)
Bottom Pan Removal: 10.4 liters (11.0 quarts)
Complete Overhaul: 12.00 liters (12.6 quarts)
Dry: 14.26 liters (15.0 quarts)

(Dry Sump Design-Internal Drain)

Transmission Weight
Dry: 121 kg (266.75 lb)
Wet: 133 kg (293.21 lb)

Chain Ratios*
39/39

*Designates the number of teeth on the drive/driven sprockets, respectively.

Final Drive Ratios
3.11, 3.48, 3.71

Transmission Packaging Information**
Center Distance
249.25 mm (Reference)
Engine Mounting Face to Side Cover
325.34 mm
Engine Mounting Face to Differential
458.5 mm (Reference)
Overall Length
783.84 mm (Reference)
Engine Centerline to Bottom Pan
208.3 mm (Reference)
Engine Mounting Face to Converter Lug
Determined by Customer

** All dimensions shown are nominal.

7 Position Quadrant
(P, R, N, (D), 3, 2, 1)

Pressure Taps Available
Line Pressure

Information may vary with application. All information, illustrations and specifications contained in this brochure are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

HYDRA-MATIC PRODUCT DESIGNATION SYSTEM

The product designation system used for all Hydra-matic transaxles and transmissions consists of a series of numbers and letters that correspond with the special features incorporated in that product line. The first character is a number that designates the number of forward gear ranges available in that unit. For example: 4 = four forward gear ranges.

The second character is a letter that designates how the unit is mounted in the vehicle. When the letter "T" is used, it designates that the unit is transversely mounted and is used primarily for front wheel drive vehicles. The letter "L" designates that it is longitudinally mounted in the vehicle and it is used primarily for rear wheel drive vehicles. The letter "M" designates that the unit is a manual transaxle or transmission but not specific to a front or rear wheel drive vehicle application.

The third and fourth characters consists of a set of numbers, (i.e. "80"), that designate the transaxle or transmission "Series" number. This number signifies the relative torque capacity of the unit.

The fifth character designates the major features incorporated into this unit. For example, the letter "E" designates that the unit has electronic controls.

By using this method of classification, the Hydra-matic 4T80-E is a 4-speed, transversely mounted, 80 series unit, with electronic controls.

HYDRA-MATIC 4T80-E

HYDRA-MATIC	4	T	80	E
	Number of Speeds: 3 4 5 V (CVT)	Type: T - Transverse L - Longitudinal M - Manual	Series: Based on Relative Torque Capacity	Major Features: E - Electronic Controls A - All Wheel Drive HD - Heavy Duty

Accumulator: A component of the transmission that absorbs hydraulic pressure during the apply of a clutch or band. Accumulators are designed to control the quality of a shift from one gear range to another.

Adaptive Learning: Programming within the PCM that automatically adjusts hydraulic pressures in order to compensate for changes in the transmission (i.e. component wear).

Applied: An apply component that is holding another component to which it is splined or assembled with. Also referred to as "engaged".

Apply Components: Hydraulically operated clutches, servos, bands, and mechanical one-way roller or sprag clutches that drive or hold members of a planetary gear set.

Apply Plate: A steel clutch plate in a clutch pack located next to the (apply) piston.

Backing Plate: A steel plate in a clutch pack that is usually the last plate in that clutch assembly (farthest from the clutch piston).

Ball Check Valve: A spherical hydraulically controlled component (usually made of steel) that either seals or opens fluid circuits. It is also referred to as a check valve or checkball.

Band: An apply component that consists of a flexible strip of steel and friction material that wraps around a drum. When applied, it tightens around the drum and prevents the drum from rotating.

Brake Switch: An electrical device that provides signals to the Powertrain Control Module (PCM) based on the position of the brake pedal. The PCM uses this information to apply or release the torque converter clutch (TCC).

Centrifugal Force: A force that is imparted on an object (due to rotation) that increases as that object moves further away from a center/point of rotation.

Clutch Pack: An assembly of components generally consisting of clutch plates, an apply plate and a backing plate.

Clutch Plate: A hydraulically activated component that has two basic designs: (1) all steel, or (2) a steel core with friction material bonded to one or two sides of the plate.

Component: Any physical part of the transaxle/ transmission.

Control Valve Body: A machined metal casting that contains valve trains and other hydraulically controlled components that shift the transmission.

Converter: (See Torque Converter)

Coupling Speed: The speed at which a vehicle is traveling and no longer requires torque multiplication through the torque converter. At this point the stator free wheels to allow fluid leaving the turbine to flow directly to the pump. (See torque converter)

De-energize(d): To interrupt the electrical current that flows to an electronically controlled device making it electrically inoperable.

Direct Drive: A condition in a gear set where the input speed and torque equals the output speed and torque. The gear ratio through the gear set is 1:1.

Downshift: A change in a gear ratio where input speed and torque increases.

Duty Cycle: In reference to an electronically controlled solenoid, it is the amount of time (expressed as a percentage) that current flows through the solenoid coil.

Energize(d): To supply a current to an electronically controlled device enabling it to perform its designed function.

Engine Compression Braking: A condition where compression from the engine is used with the transaxle/transmission to decrease vehicle speed. Braking (slowing of the vehicle) occurs when a lower gear ratio is manually selected by moving the gear selector lever.

Exhaust: The release of fluid pressure from a hydraulic circuit. (The words exhausts and exhausting are also used and have the same intended meaning.)

Fail-Safe Mode: A condition whereby a component (i.e. engine or transmission) will partially function even if its electrical system is disabled.

Fluid: Generally considered a liquid or gas. In this publication fluid refers primarily to "transaxle/ transmission fluid".

Fluid Pressure: A pressure (in this textbook usually transaxle/transmission fluid) that is consistent throughout its circuit.

Force: A measurable effort that is exerted on an object (component).

Freewheeling: A condition where power is lost through a driving or holding device (i.e. roller or sprag clutches).

Friction Material: A heat and wear resistant fibrous material bonded to clutch plates and bands.

Gear: A round, toothed device that is used for transmitting torque through other components.

Gear Range: A specific speed to torque ratio at which the transmission is operating (i.e. 1st gear, 2nd gear etc.)

Gear Ratio: Revolutions of an input gear as compared to the revolutions of an output gear. It can also be expressed as the number of teeth on a gear as compared to the number of teeth on a gear that it is in mesh with.

Hydraulic Circuit: A fluid passage which often includes the mechanical components in that circuit designed to perform a specific function.

Input: A starting point for torque, revolutions or energy into another component of the transmission.

Internal Gear: The outermost member of a gear set that has gear teeth in constant mesh with planetary pinion gears of the gear set.

Internal Leak: Loss of fluid pressure in a hydraulic circuit.

Land (Valve Land): The larger diameters of a spool valve that contact the valve bore or bushing.

Line Pressure: The main fluid pressure in a hydraulic system created by the pump and pressure regulator valve.

Manual Valve: A spool valve that distributes fluid to various hydraulic circuits and is mechanically linked to the gear selector lever.

Orifice: A restricting device (usually a hole in the spacer plate) for controlling pressure build up into another circuit.

Overdrive: An operating condition in the gear set allowing output speed to be higher than input speed and output torque to be lower than input torque.

Overrunning: The function of a one-way mechanical clutch that allows the clutch to freewheel during certain operating conditions of the transmission.

Pinion Gear: A small toothed gear that meshes with a larger gear.

Planet Pinion Gears: Pinion gears (housed in a carrier) that are in constant mesh with a circumferential internal gear and centralized sun gear.

Planetary Gear Set: An assembly of gears that consists of an internal gear, planet pinion gears with carrier, and a sun gear.

Powertrain Control Module: An electronic device that manages most of the electrical systems throughout the vehicle.

Pressure: A measurable force that is exerted on an area and expressed as kilopascals (kPa) or pounds per square inch (psi).

Pulse Width Modulated: An electronic signal that continuously cycles the ON and OFF time of a device (such as a solenoid) while varying the amount of ON time.

Race (Inner or Outer): A highly polished steel surface that contacts bearings or sprag elements.

Reduction (Gear Reduction): An operating condition in the gear set allowing output speed to be lower than input speed and output torque to be higher than input torque.

Residual Fluid Pressure: Excess pressure contained within an area after the supply pressure has been terminated.

Roller Clutch: A mechanical clutch (holding device) consisting of roller bearings assembled between inner and outer races.

Servo: A spring loaded device consisting of a piston in a bore that is operated (stroked) by hydraulic pressure to apply or release a band.

Solenoid Valve: An electronic device used to control transmission shift patterns or regulate fluid pressure.

Spool Valve: A cylindrical hydraulic control device, having a variety of land and valley diameters, used to control fluid flow.

Sprag Clutch: A mechanical clutch (holding device) consisting of figure eight like elements assembled between inner and outer races.

Throttle Position: The travel of the throttle plate that is expressed in percentages.

Torque: A measurable twisting force expressed in terms of Newton- meters (N•m), pounds feet (lbs ft) or pounds inches (lbs in).

Torque Converter: A component of an automatic transmission, (attached to the engine flywheel) that transfers torque from the engine to the transmission through a fluid coupling.

ABBREVIATIONS

LIST OF ABBREVIATIONS WHICH MAY BE USED IN THIS BOOK

AC - Alternating Current
A/C - Air Conditioning
ACC or ACCUM - Accumulator
ACT FD - Actuator Feed (circuit)
APP - Apply

BD - Band
BST - Boost

°C - Degrees Celsius
CKP - Crankshaft Position Sensor
CL - Clutch
CONV - Converter
CST CL - Coast Clutch (circuit)
CTS - Coolant Temperature Switch

D21 - Drive 21 (circuit)
D321 - Drive 321 (circuit)

ECT - Engine Coolant Temperature Sensor
EX - Exhaust (circuit)

°F - Degrees Fahrenheit
FD - Feed (circuit)
FILT ACT FD - Filtered Actuator Feed
FWD CL - Forward Clutch

Hg - Mercury
Hz - Hertz

IMS - Internal Mode Switch

KMH - Kilometers Per Hour
kPa - KiloPascals

LBS. FT. - Pounds Foot
LBS. IN. - Pounds Inch
LOW FD - Low Feed (circuit)
LOW & REV BD APPLY - Low & Reverse Band Apply

MAF - Mass Air Flow Sensor
MAP - Manifold Absolute Pressure
MM - Millimeter(s)
MPH - Miles Per Hour
MTV - Modulated Throttle Valve

N - Neutral
N.C. - Normally Closed
N•m - Newton Meters
N.O. - Normally Open

P - Park
PCM - Powertrain Control Module
PRESS REG - Pressure Regulator
PRN - Park, Reverse, Neutral (circuit)
PRND43 - Park, Reverse, Neutral, Drive 43 (circuit)
PRND4 - Park, Reverse, Neutral, Drive 4 (circuit)
PSI - Pounds per Square Inch
PWM - Pulse Width Modulated

R - Reverse
REG - Regulator
REL - Release (circuit)
REV - Reverse
RET - Return (circuit)
RPM - Revolutions per Minute

SCAV - Scavenge
SIG - Signal
SOL - Solenoid

TCC - Torque Converter Clutch
TCC CONT - Torque Converter Clutch Control (circuit)
TCC SIG - Torque Converter Clutch Signal
TFP - Transmission Fluid Pressure Manual Valve Position Switch
TISS - Transmission Input Speed Sensor
TOSS - Transmission Output Speed Sensor
TPS - Throttle Position Sensor
TRANS - Transaxle or Transmission
TRQ SIG - Torque Signal

V - Volts
VCC - Viscous Converter Clutch
VSS - Vehicle Speed Sensor

2ND CL - Second Clutch
3RD CL - Third Clutch
4TH BD FD - Fourth Band Feed

INDEX

NOTES

NOTES