HYDRA-MATIC

GM POWERTRAIN

4T40-E

CONTENTS

PREFACE

The Hydra-matic 4T40-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 4T40-E Technician's Guide is 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 4T40-E transaxle.

All information contained in this book is based on the latest data available at the time of publication approval. The right is reserved to make product or publication changes, at any time, without notice.

INTRODUCTION

The Hydra-matic 4T40-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 transaxle. 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 transaxle assembly. The transfer of torque from the engine through the transaxle 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, checkballs, 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 transaxle 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 4T40-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 4T40-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 4T40-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 transaxle 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 transaxle. 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, checkballs, 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 transaxle, disassembled view parts lists and transaxle 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

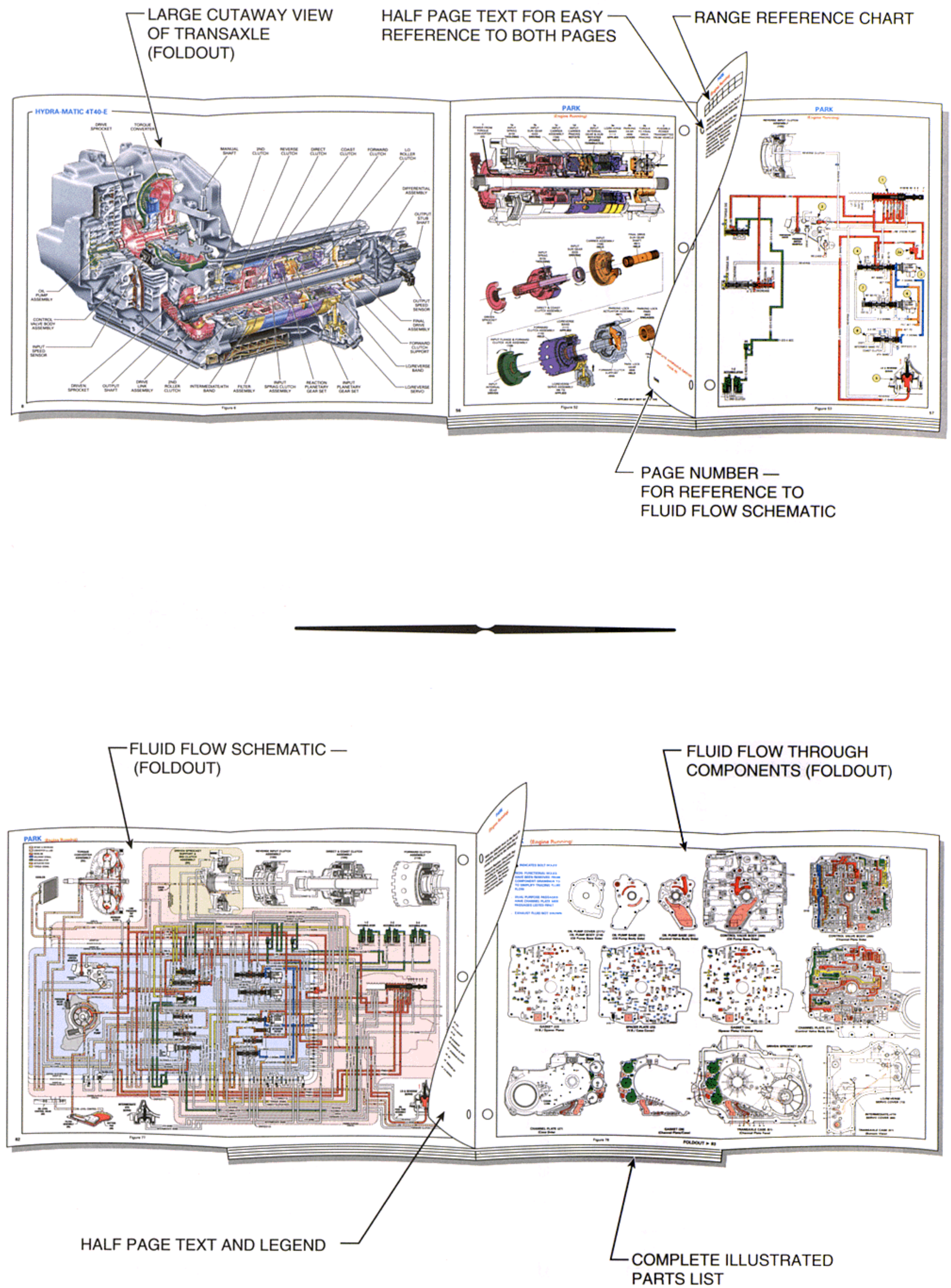


Figure 1

UNDERSTANDING THE GRAPHICS

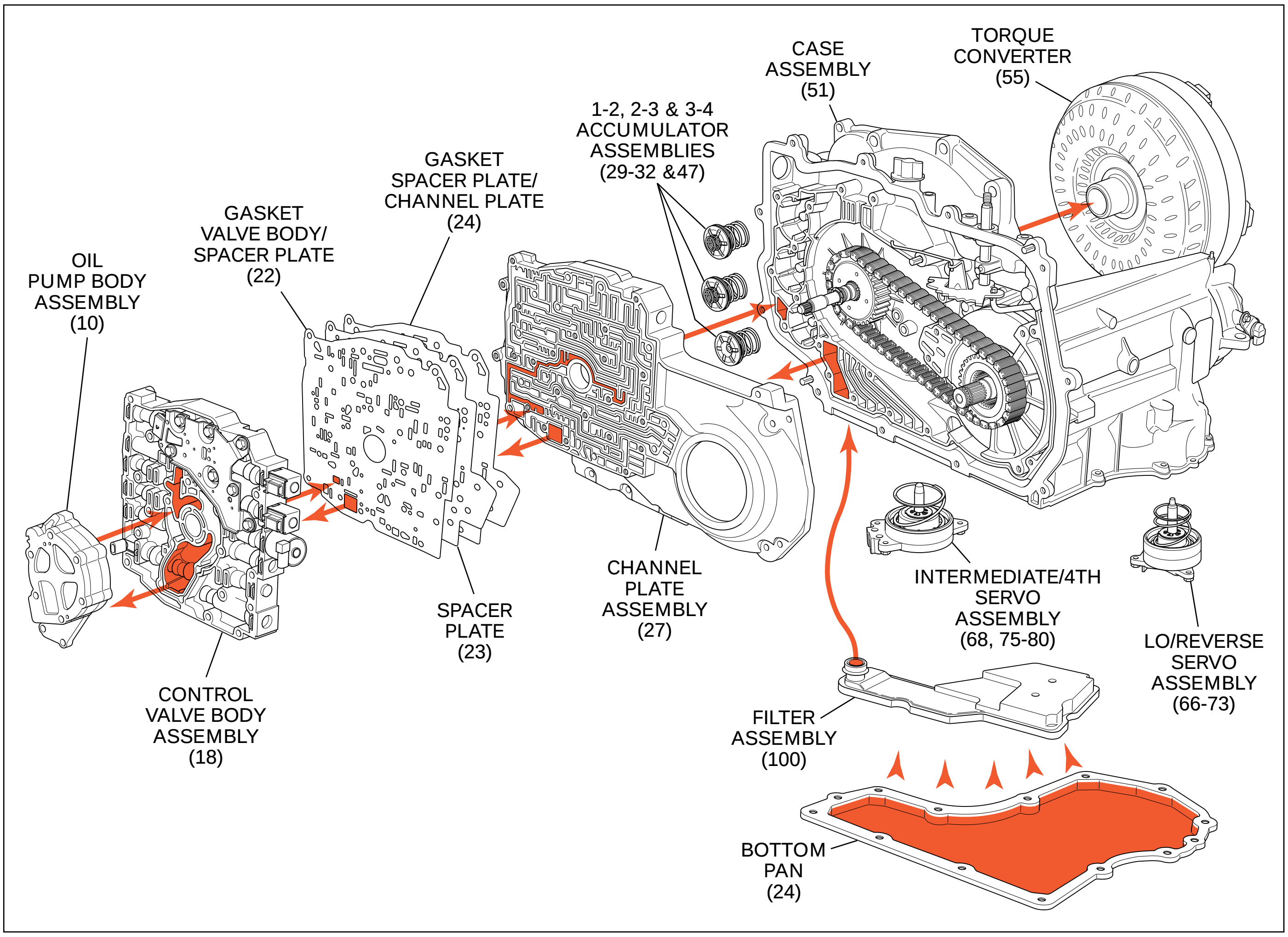


Figure 2

The flow of transaxle fluid starts in the bottom pan and is drawn through the filter, case assembly, channel plate assembly, spacer plate and gaskets, control valve assembly and into the oil pump assembly. This is a basic concept of fluid flow that is easily understood by reviewing the illustrations provided in Figure 2. However, fluid may pass between the 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 4T40-E transaxle, the components involved with hydraulic control and fluid flow are illustrated in three major formats. Figure 3 (page 7-7A) 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, checkballs, orifices and so forth, required for the proper function of the transaxle 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 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

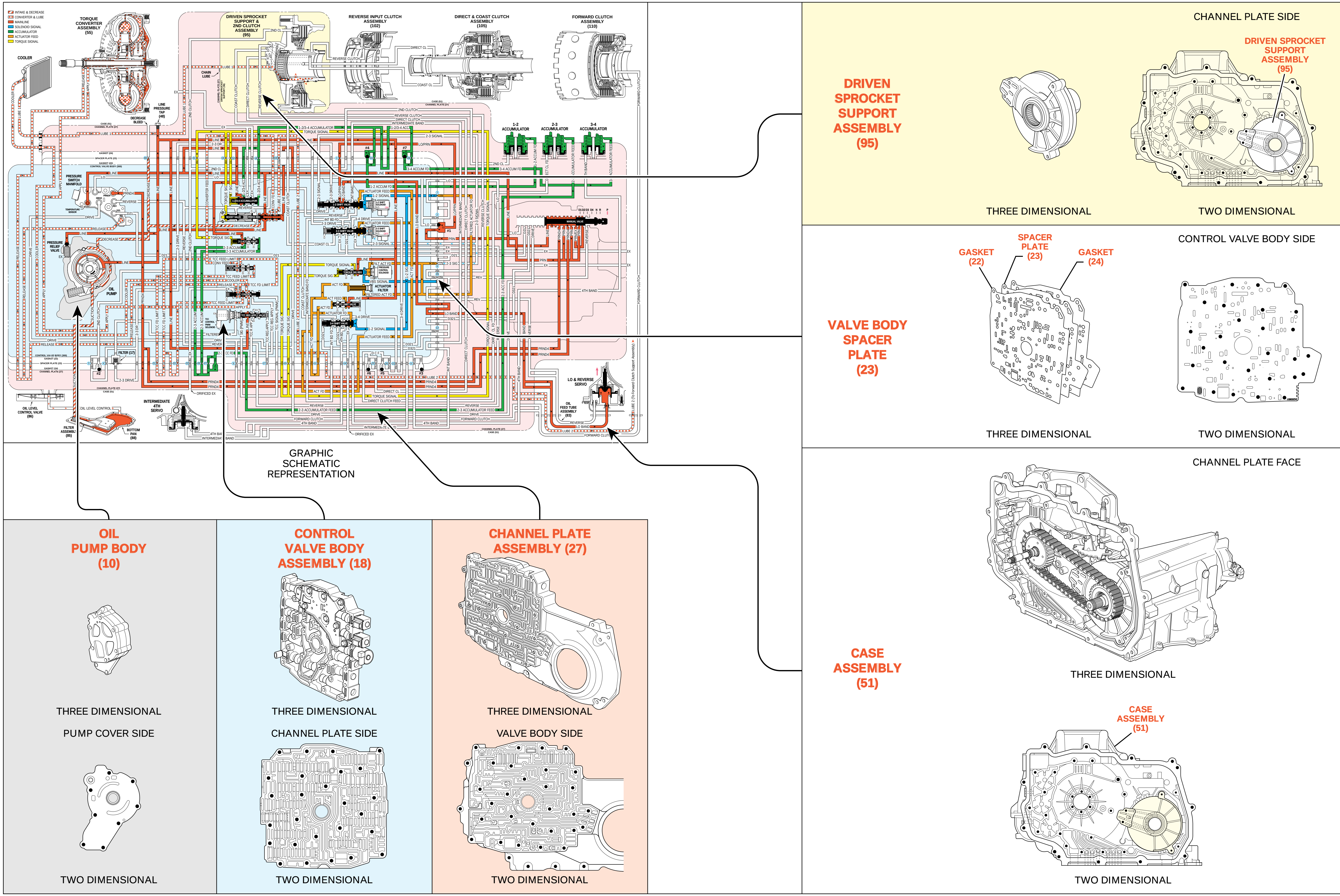
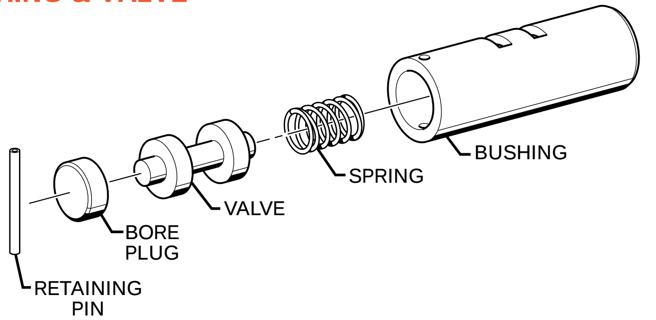


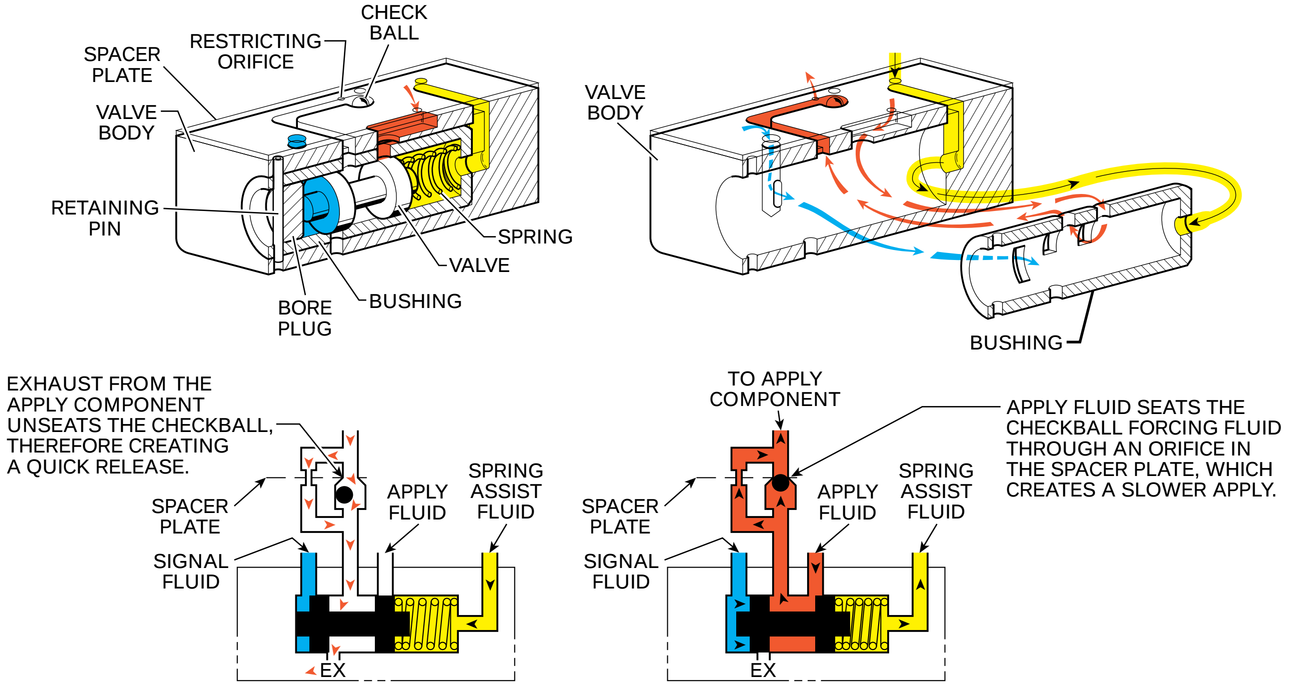
Figure 3

UNDERSTANDING THE GRAPHICS

TYPICAL BUSHING & VALVE

NOTE: NOT ALL VALVES ARE USED WITH A BUSHING





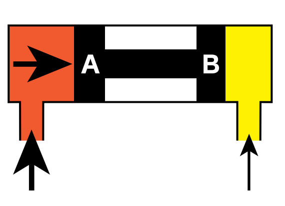
WITH SIGNAL FLUID PRESSURE EQUAL TO OR LESS THAN SPRING AND SPRING ASSIST FLUID PRESSURE THE VALVE REMAINS IN CLOSED POSITION.

WITH SIGNAL FLUID PRESSURE GREATER THAN SPRING AND SPRING ASSIST FLUID PRESSURE THE VALVE MOVES OVER.

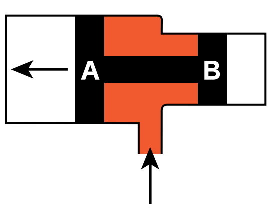
Figure 4

FLUID PRESSURES

- INTAKE & DECREASE
- CONVERTER & LUBE
- MAINLINE
- SOLENOID SIGNAL
- ACCUMULATOR
- ACUATOR FEED
- 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

HYDRA-MATIC 4T40-E

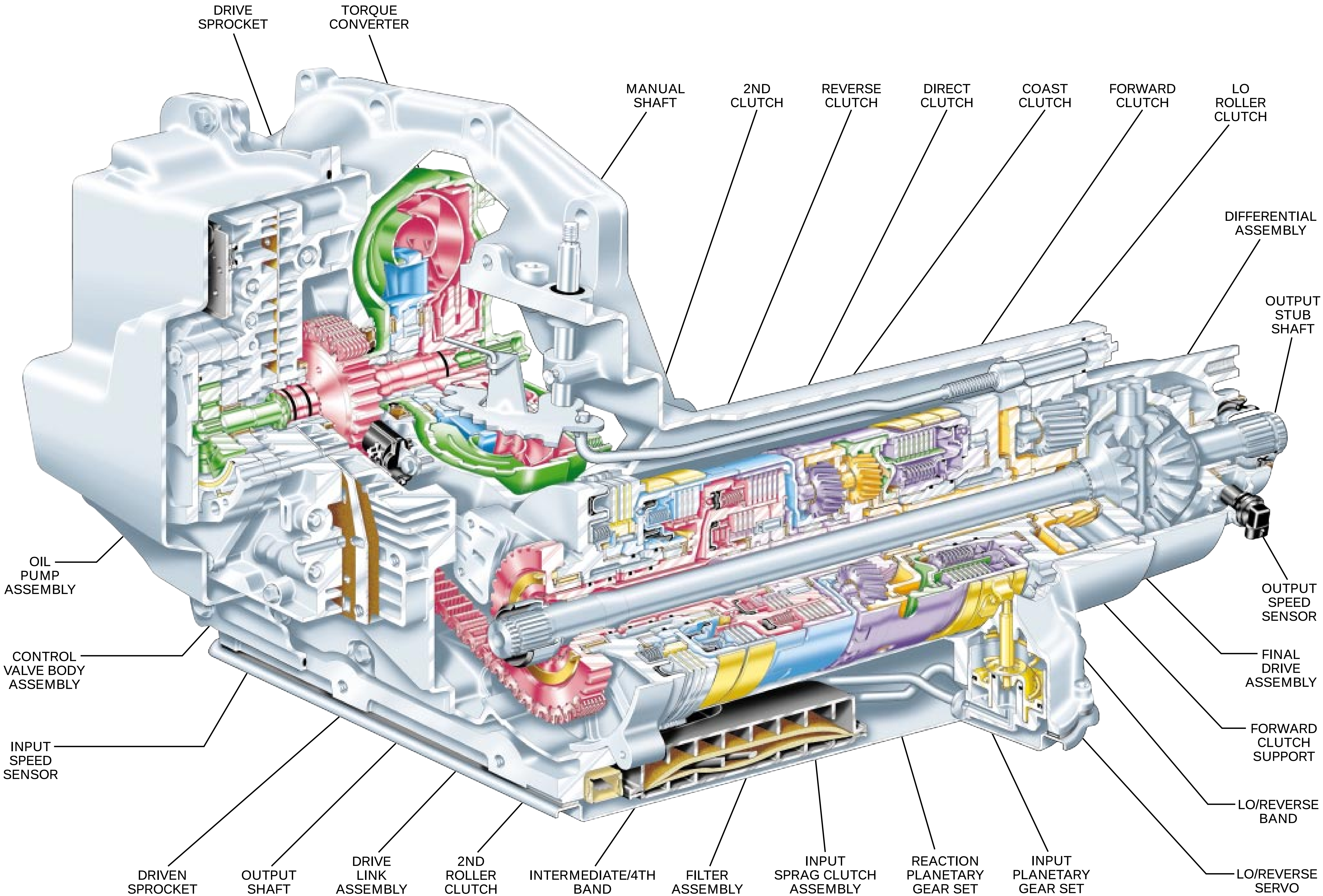


Figure 6

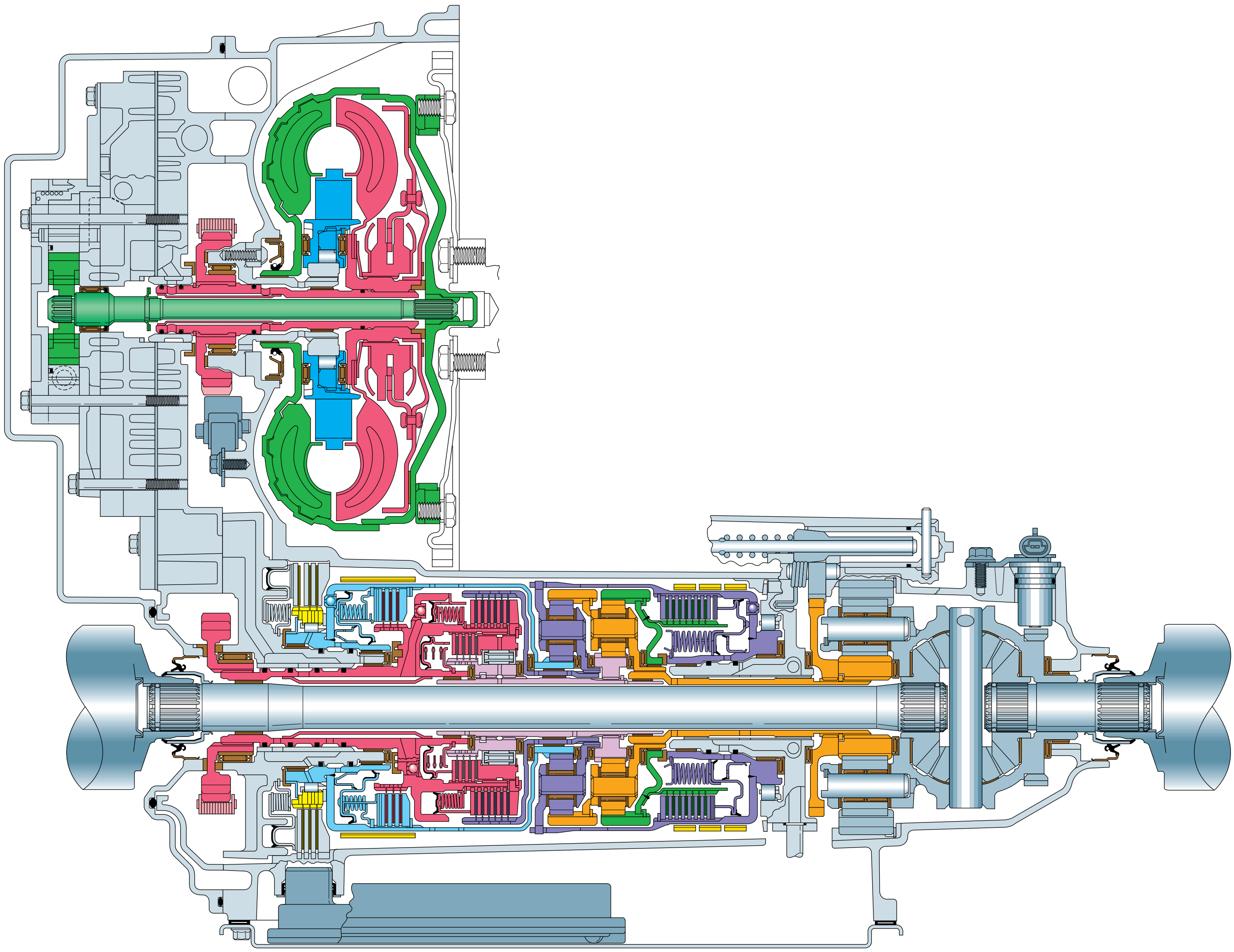


Figure 7

HYDRA-MATIC 4T40-E CROSS SECTIONAL DRAWING

A cross sectional line drawing is typically the standard method for illustrating either an individual mechanical component or a complete transaxle assembly. However, unless a person is familiar with all the individual components of the transaxle, 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 transaxle 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 4T40-E is a fully automatic, four speed, front wheel drive transaxle. 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 transaxle. 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 transaxle.

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 transaxle at the optimum time.

The PCM commands shift solenoids, within the transaxle, on and off to control shift timing. The PCM also controls the apply and release of the torque converter clutch which allows the engine to deliver the maximum fuel efficiency without sacrificing vehicle performance.

The hydraulic system primarily consists of a vane type pump, control valve body and channel plate. The pump maintains 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 transaxle.

The friction components used in this transaxle consist of five multiple disc clutches and two bands. The multiple disc clutches combine with three mechanical components, two roller clutches and a sprag 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

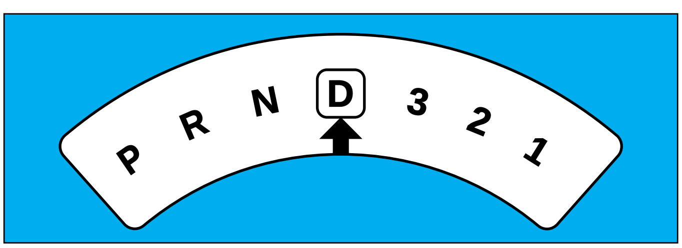


Figure 8

The transaxle 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 transaxle "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 transaxle to operate in each of the four forward gear ratios. When operating in the Overdrive range, shifting to a lower or higher gear ratio is accomplished by depressing the accelerator.

It is not recommended that the transaxle be operated in Overdrive range when pulling heavy loads or driving on extremely hilly terrain. Typically these conditions put an extra load on the engine, therefore the transaxle should be driven in a lower manual range selection for maximum efficiency.

3 – Manual Third should be used when driving conditions dictate that it is desirable to use only three gear ratios. These conditions include towing a trailer or 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 when Manual Third is selected. Automatic shifting is the same as in Overdrive range for first, second and third gears except the transaxle will not shift into fourth gear.

2 – Manual Second should be used when driving conditions dictate that it is more desirable to use only two gear ratios. It has the same starting ratio (first gear) as Manual Third but the transaxle is prevented from shifting above second gear at normal throttle opening. If the transaxle is in third or fourth gear, when Manual Second is selected, it will shift to second gear below approximately 100 kmh (62 mph). Manual Second can be selected for engine braking as required.

1 – Manual First can be selected at any vehicle speed. If the transaxle is in second, third or fourth gear it will shift into first gear below approximately 60 kmh (37 mph). This is particularly beneficial for maintaining maximum engine braking when descending steep grades.

PRINCIPLES OF OPERATION

An automatic transaxle 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 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, economy becomes the important factor and the transaxle 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 transaxle 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**) range has 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 transaxle are made possible through the interaction of numerous mechanically, hydraulically and electronically controlled components inside the transaxle. 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 4T40-E transaxle. When an understanding of these operating principles has been attained, diagnosis of these transaxle systems is made easier.

MAJOR MECHANICAL COMPONENTS

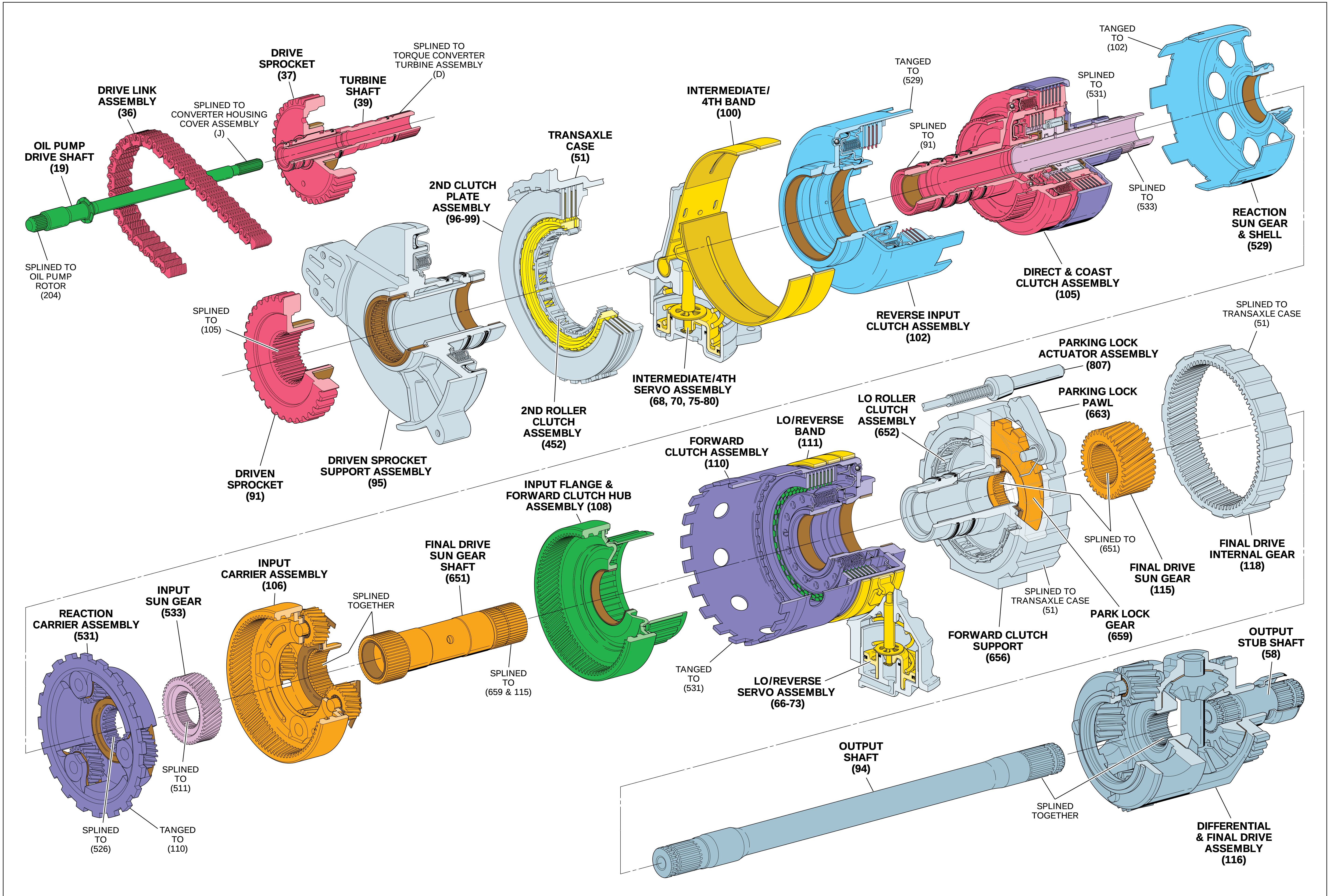


Figure 9

COLOR LEGEND

MAJOR MECHANICAL COMPONENTS

The foldout graphic on page 10 contains a disassembled drawing of the major components used in the Hydra-matic 4T40-E transaxle. 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 transaxle 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 transaxle, 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 (95), Control Valve Body Asssembly (18).

Components that rotate at engine speed. Examples: Torque Converter Assembly (55) and Oil Pump Drive Shaft (19), Input Flange & Forward Clutch Hub Assembly (108).

Components that rotate at turbine speed. Examples: Converter Turbine, Drive Sprocket (37), Driven Sprocket (91) and Direct & Coast Clutch and Input Shaft Housing Assembly (502).

Components that rotate at transaxle output speed. Examples: Differential Carrier (116), Output Shaft (94).

Components such as the 2nd Clutch Fiber Plates (98), 2nd Roller Clutch Cam (451).

Components such as the Stator in the Torque Converter (55).

Components such as the Reverse Clutch Housing (454) and the Reaction Carrier Shaft Shell (526).

Components such as the Input Sun Gear Shaft and Inner Race Assembly (511), Input Sun Gear (533).

Components such as the Input Carrier (106), Forward Clutch Assembly (110).

Components such as the Reaction Carrier (531), Final Drive Sun Gear (115).

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 4T40-E transaxle. This chart highlights the major apply components that function in a selected gear range, and the specific gear operation within that gear range.

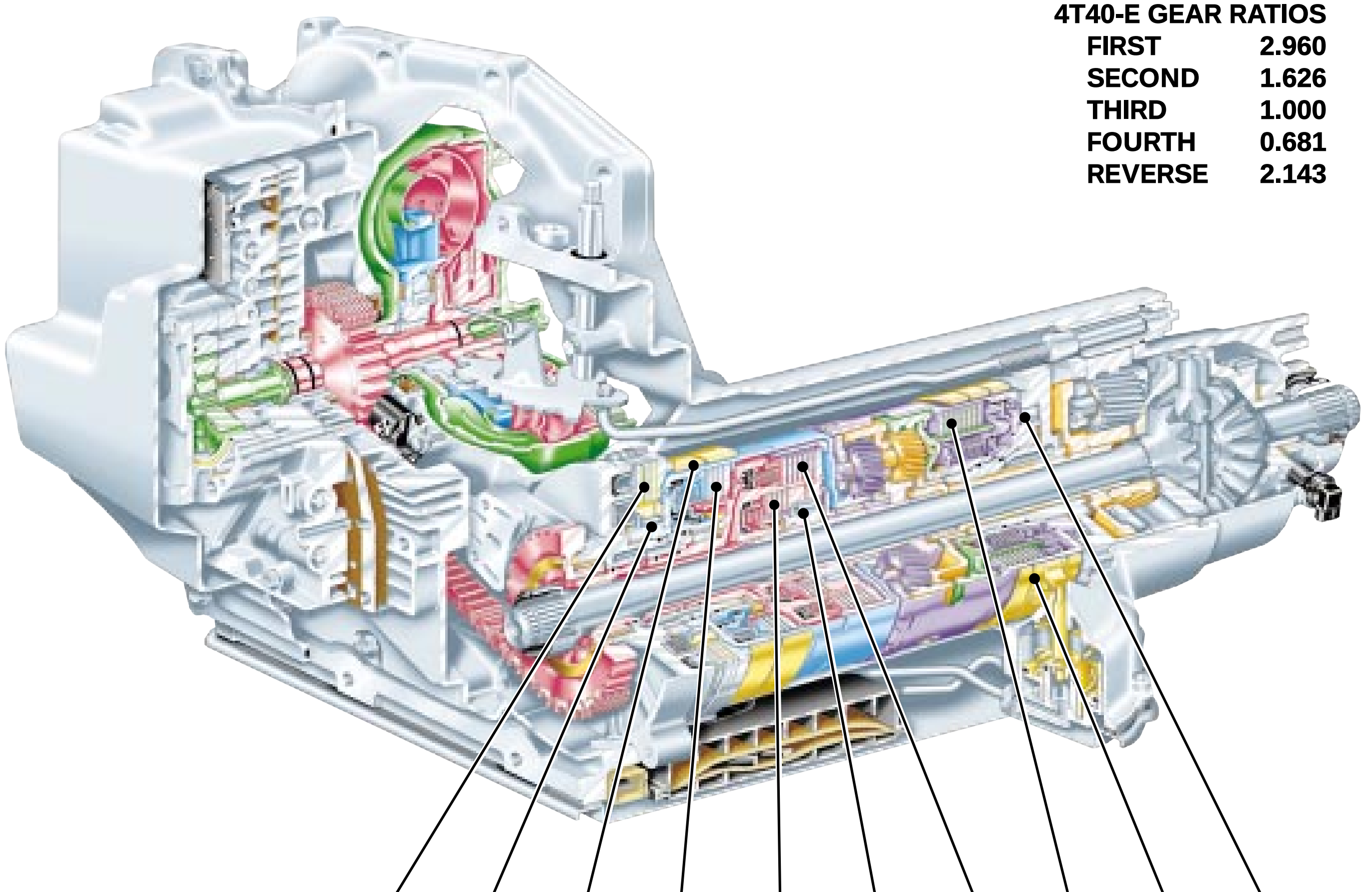
Included as part of this chart is the same color reference to each major component that was previously discussed. If a component is active in a specific gear range, a word describing its activity will be listed in the column below that component. The row where the activity occurs corresponds to the appropriate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

An abbreviated version of this chart can also be found at the top of the half pages of text located in the Power Flow section and at the bottom of the half pages of text located in the Complete Hydraulic Circuits section. This provides for a quick reference when reviewing the mechanical power flow information contained in those sections.

RANGE REFERENCE CHART

4T40-E GEAR RATIOS

FIRST	2.960
SECOND	1.626
THIRD	1.000
FOURTH	0.681
REVERSE	2.143

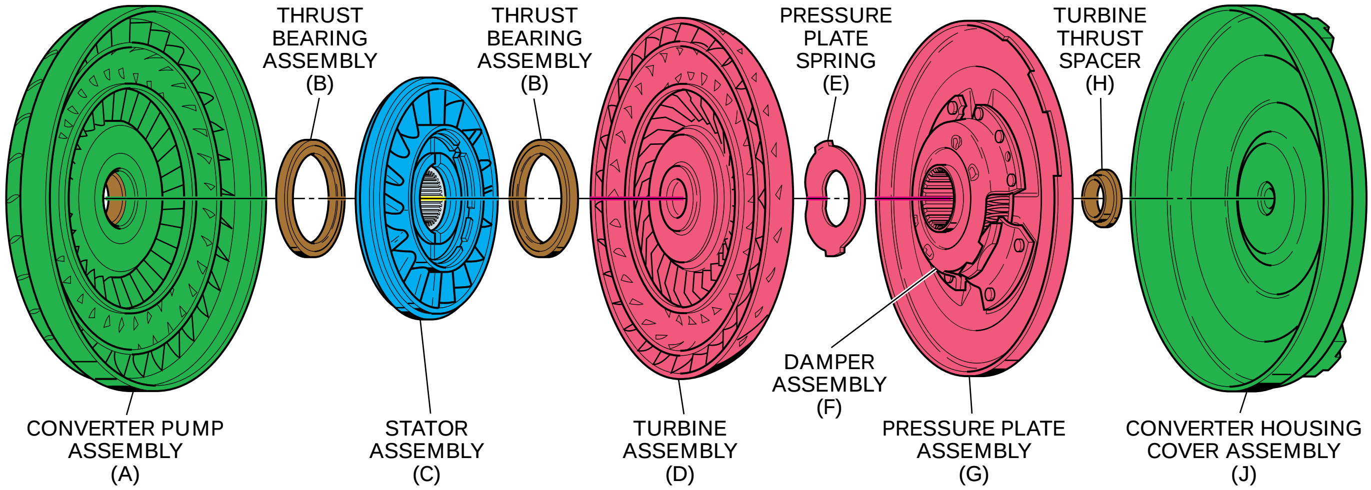


RANGE	GEAR	SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
PARK	N	ON	OFF						HOLDING*			APPLIED	
REV	R	ON	OFF				APPLIED					APPLIED	
NEU	N	ON	OFF						HOLDING*			APPLIED	
(D)	1st	ON	OFF						HOLDING		APPLIED		HOLDING
	2nd	OFF	OFF	APPLIED	HOLDING				HOLDING		APPLIED		OVER-RUNNING
	3rd	OFF	ON	APPLIED*	OVER-RUNNING				HOLDING	APPLIED	APPLIED		OVER-RUNNING
	4th	ON	ON	APPLIED*		APPLIED			OVER-RUNNING	APPLIED	APPLIED*		OVER-RUNNING
3	1st	ON	OFF					APPLIED	HOLDING		APPLIED		HOLDING
	2nd	OFF	OFF	APPLIED	HOLDING			APPLIED	HOLDING		APPLIED		OVER-RUNNING
	3rd	OFF	ON	APPLIED*	OVER-RUNNING			APPLIED	HOLDING	APPLIED	APPLIED		OVER-RUNNING
2	1st	ON	OFF					APPLIED	HOLDING		APPLIED		HOLDING
	2nd	OFF	OFF	APPLIED	HOLDING	APPLIED		APPLIED	HOLDING		APPLIED		OVER-RUNNING
	3rd**	OFF	ON	APPLIED*	OVER-RUNNING			APPLIED	HOLDING	APPLIED	APPLIED		OVER-RUNNING
1	1st	ON	OFF					APPLIED	HOLDING		APPLIED	APPLIED	HOLDING
	2nd***	OFF	OFF	APPLIED	HOLDING	APPLIED		APPLIED	HOLDING		APPLIED		OVER-RUNNING
	3rd**	OFF	ON	APPLIED*	OVER-RUNNING			APPLIED	HOLDING	APPLIED	APPLIED		OVER-RUNNING

ON = SOLENOID ENERGIZED
OFF = SOLENOID DE-ENERGIZED
* = APPLIED WITH NO LOAD.
** = MANUAL FIRST AND SECOND – THIRD GEAR IS ONLY AVAILABLE ABOVE APPROXIMATELY 100 km/h (62 mph).
*** = MANUAL FIRST – SECOND GEAR IS ONLY AVAILABLE ABOVE APPROXIMATELY 60 km/h (37 mph).
NOTE: MANUAL FIRST – THIRD GEAR IS ALSO POSSIBLE AT HIGH VEHICLE SPEED AS A SAFETY FEATURE.

Figure 10

TORQUE CONVERTER



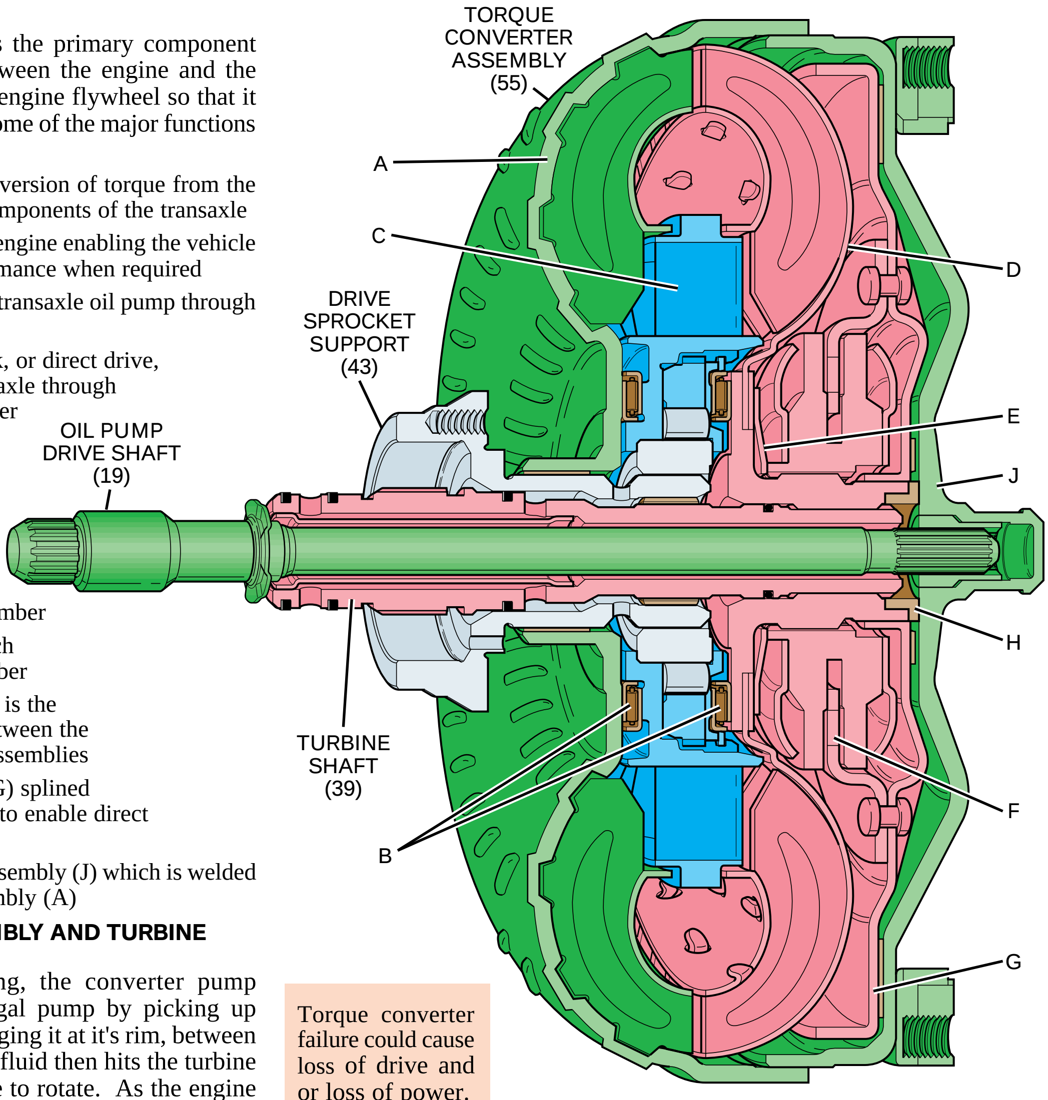
TORQUE CONVERTER

The torque converter (55) is the primary component for transmittal of power between the engine and the transaxle. It is bolted to the engine flywheel so that it will rotate at engine speed. 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 transaxle
- to multiply torque from the engine enabling the vehicle to achieve additional performance when required
- to mechanically operate the transaxle oil pump through the pump drive shaft (19)
- to provide a mechanical link, or direct drive, from the engine to the transaxle through the use of a Torque Converter Clutch (TCC)

The torque converter assembly is made up of the following five main subassemblies:

- 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 (A) and turbine (D) assemblies
- a pressure plate assembly (G) splined to the turbine assembly (D) to enable direct mechanical drive
- a converter housing cover assembly (J) which is welded to the converter pump assembly (A)



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 it's center and discharging it at it's 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 RPM, so does the turbine.

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

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 transaxle. When the pressure plate assembly is applied, the small amount of slippage that occurs through a fluid coupling is eliminated, thereby providing a more efficient transfer of engine torque to the drive wheels.

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

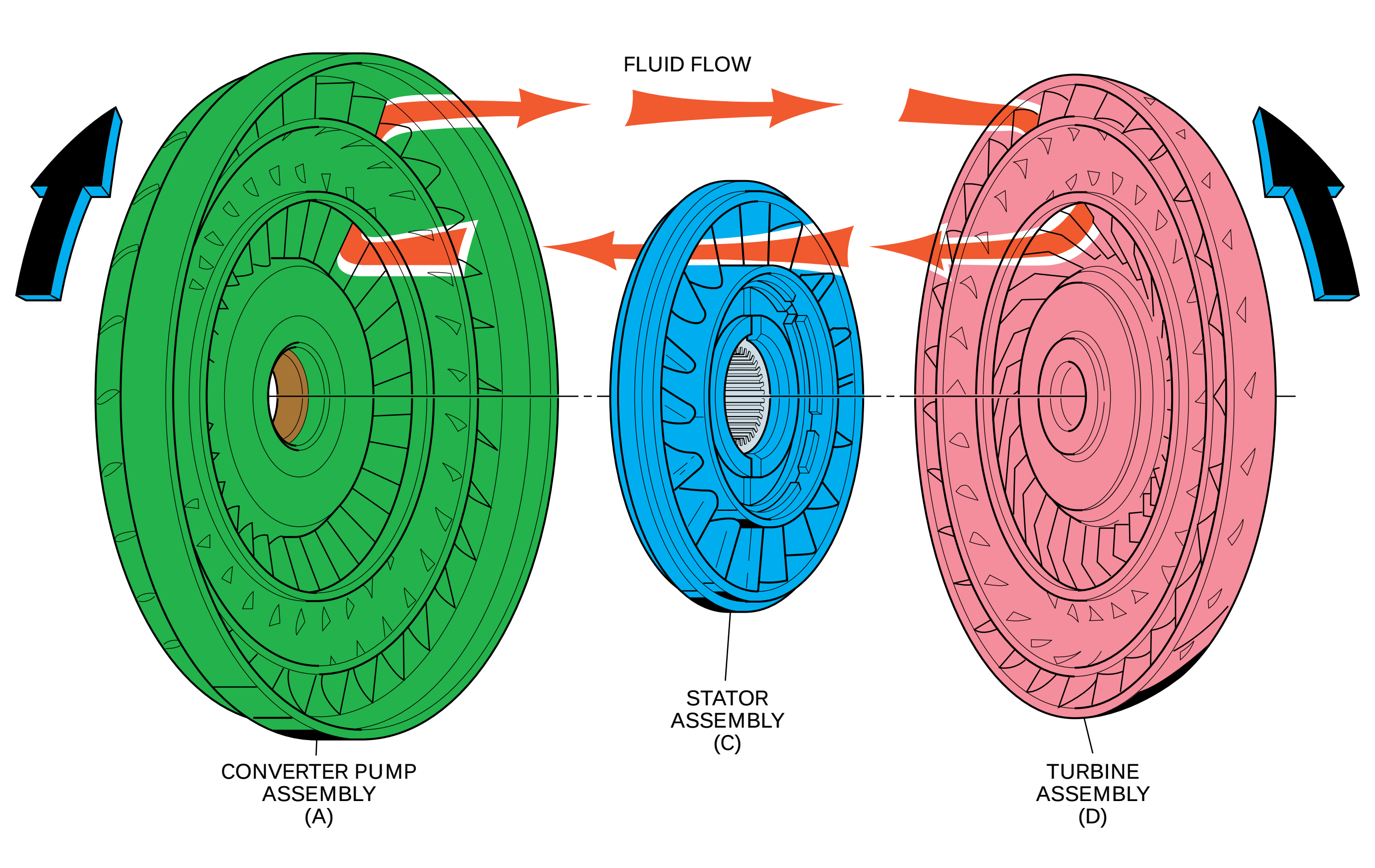


Figure 12

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.

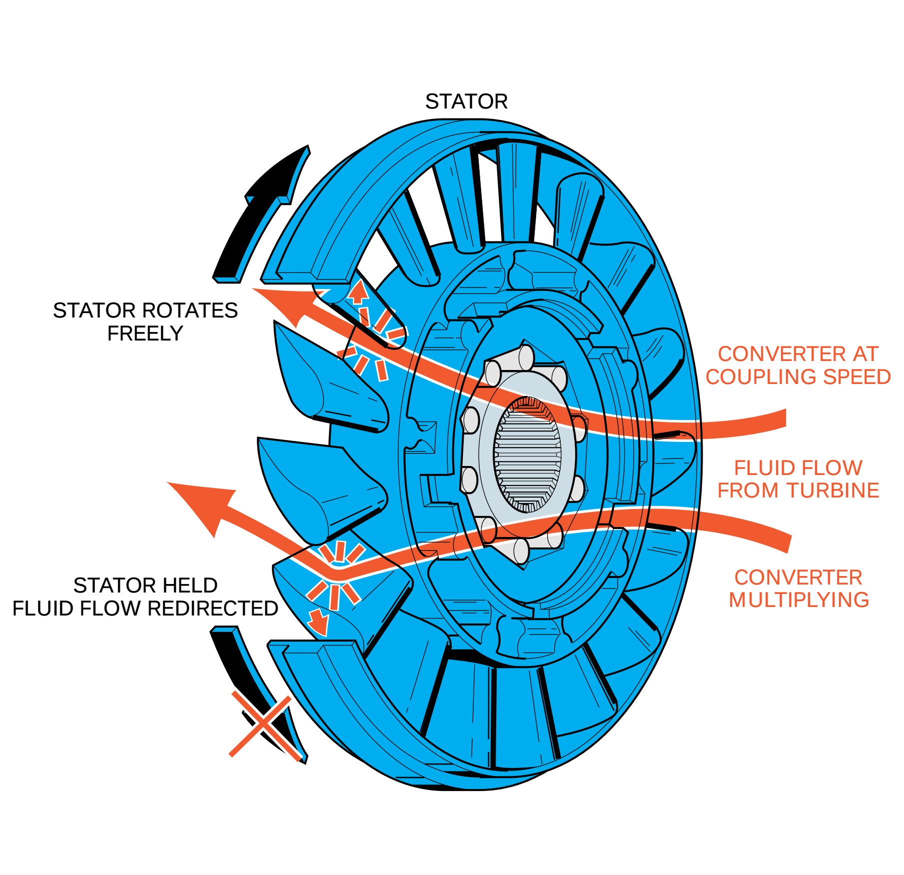


Figure 13

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.

TORQUE CONVERTER

RELEASE

When the torque converter clutch is released, fluid is fed into the torque converter by the pump into the release fluid passage. The release fluid passage is located between the oil pump drive shaft (19) and the turbine shaft (39). 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 into the drive sprocket support and on through an oil sleeve within the turbine shaft. This fluid now travels to the valve body and on to the oil cooler.

Once the TCC is applied there is no torque converter fluid coupling assistance. Engine or driveline vibration could be unnoticeable before TCC engagement.

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 PWM solenoid. The TCC PWM solenoid then routes line fluid from the pump to the apply passage of the torque converter. The apply passage is a hole between two seals on the turbine shaft. The fluid flows inside the turbine shaft within an oil sleeve, then out of the sleeve and into the converter hub/drive sprocket support. Fluid passes through a hole in the support and into the torque converter on the apply side of the pressure plate assembly.

Apply fluid pressure forces the pressure plate against the torque converter cover to provide a mechanical link between the engine and the turbine. Release fluid is then routed out of the torque converter between the turbine shaft and the pump shaft.

The TCC apply should occur in fourth gear (also third gear in some applications), and should not apply until the transaxle 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.

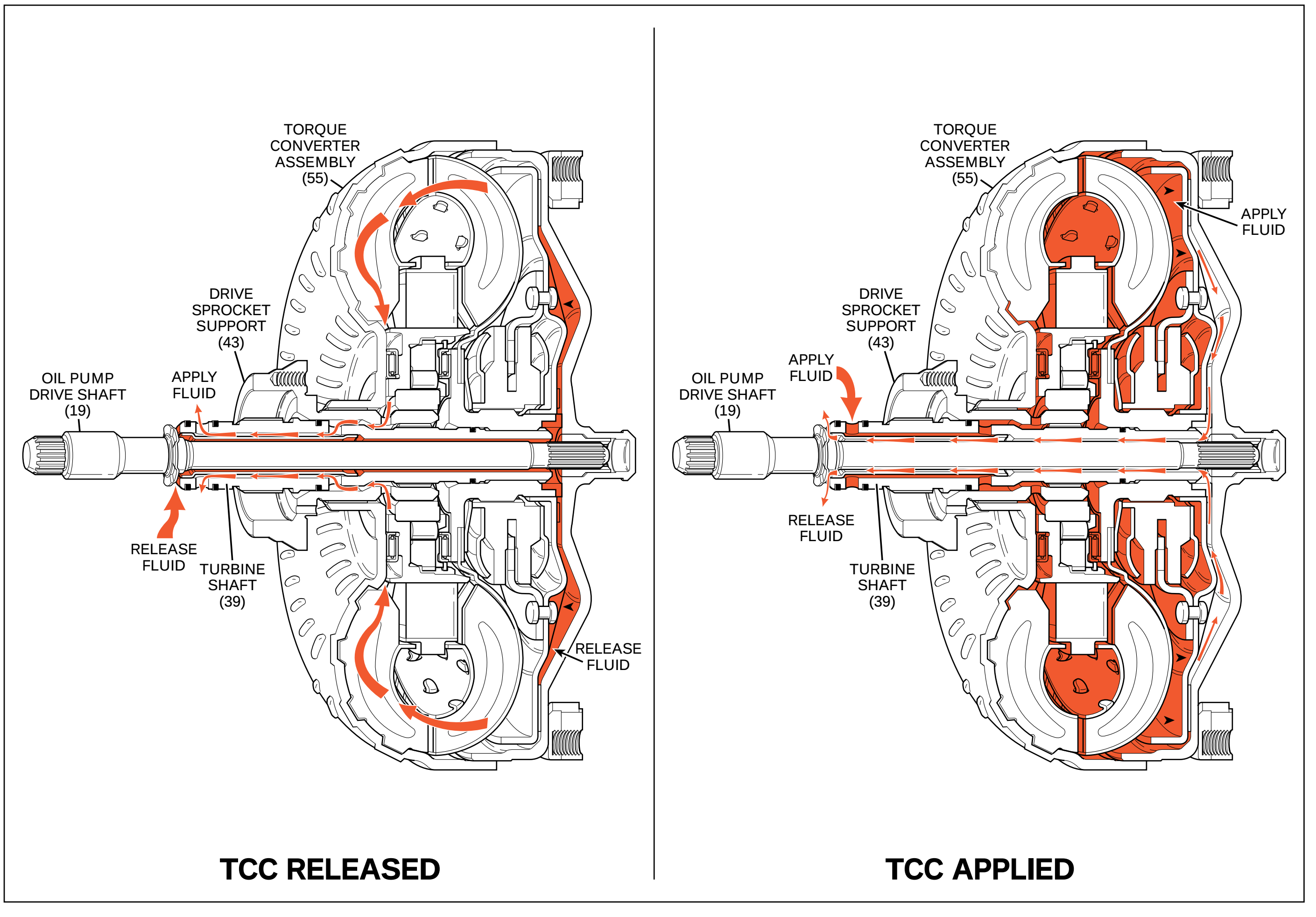


Figure 14

APPLY COMPONENTS

The primary function of any apply component is to hold or cause to drive, a member of a planetary gear set.

The "Apply Components" section is designed to explain the function of the hydraulic and mechanical holding devices used in the Hydra-matic 4T40-E transaxle. 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 transaxle. This interaction between the hydraulically and mechanically applied components is 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 operation when the component applies or releases.

The sequence in which the components in this section have been discussed coincides with their physical arrangement inside the transaxle. This order closely parallels the disassembly sequence used in the Hydra-matic 4T40-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 transaxle.

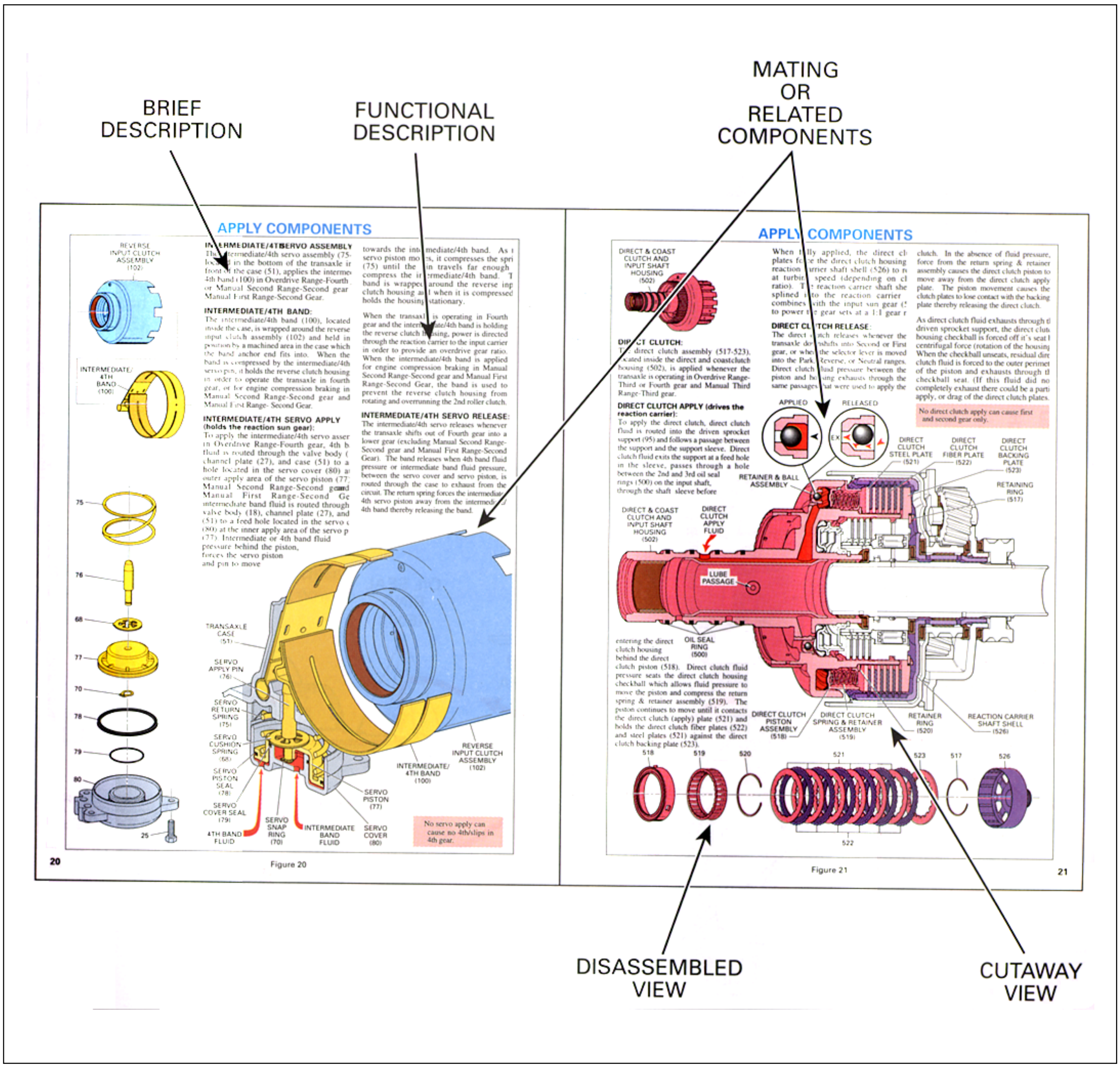


Figure 15

Driven Sprocket Support

Along with being the housing for the 2nd clutch and a support for the driven sprocket, the driven sprocket support acts as a stationary fluid routing component, delivering fluid to rotating components. This is accomplished through a series of passages and seals within the sprocket support, the reverse clutch assembly and the direct and coast clutch assembly.

Reverse Clutch Fluid Passage
Reverse clutch fluid flows through the driven sprocket support, exits through a hole, between the oil seal rings (403), and enters the reverse clutch housing to apply the reverse clutch.

Lube 1 Fluid Passages
Lube 1 fluid travels through the driven sprocket support and exits through a hole to lubricate bushings and parts in this region of the transaxle.

Lube 1 fluid also travels through another passage in the driven sprocket support to a hole, between the first and second oil seal rings (500), in the input housing shaft. This fluid lubricates the bushings in this area of the transaxle (see Lubrication Points page 104).

Direct Clutch Apply Fluid
Direct clutch apply fluid travels through the driven sprocket support to a hole in the input shaft, between the 2nd and 3rd oil seal rings (500), and into the direct clutch housing to apply the piston.

Coast Clutch Apply Fluid
This fluid travels through the driven sprocket support to a hole in the input shaft, between the 3rd and 4th oil seal rings (500), and on to the coast clutch to apply the piston.

Worn or improperly installed oil seal rings can greatly affect the apply force and lubrication capabilities of the fluid in the transaxle.

Damaged or leaking seals (500) can cause no third gear/slips in third, or no coast clutch apply/slipping in all manual ranges.

Porosity or leaking 2nd clutch piston seals can cause no second/ slips in second.

Damaged or leaking seals (403) can cause no reverse gear/slips in reverse.

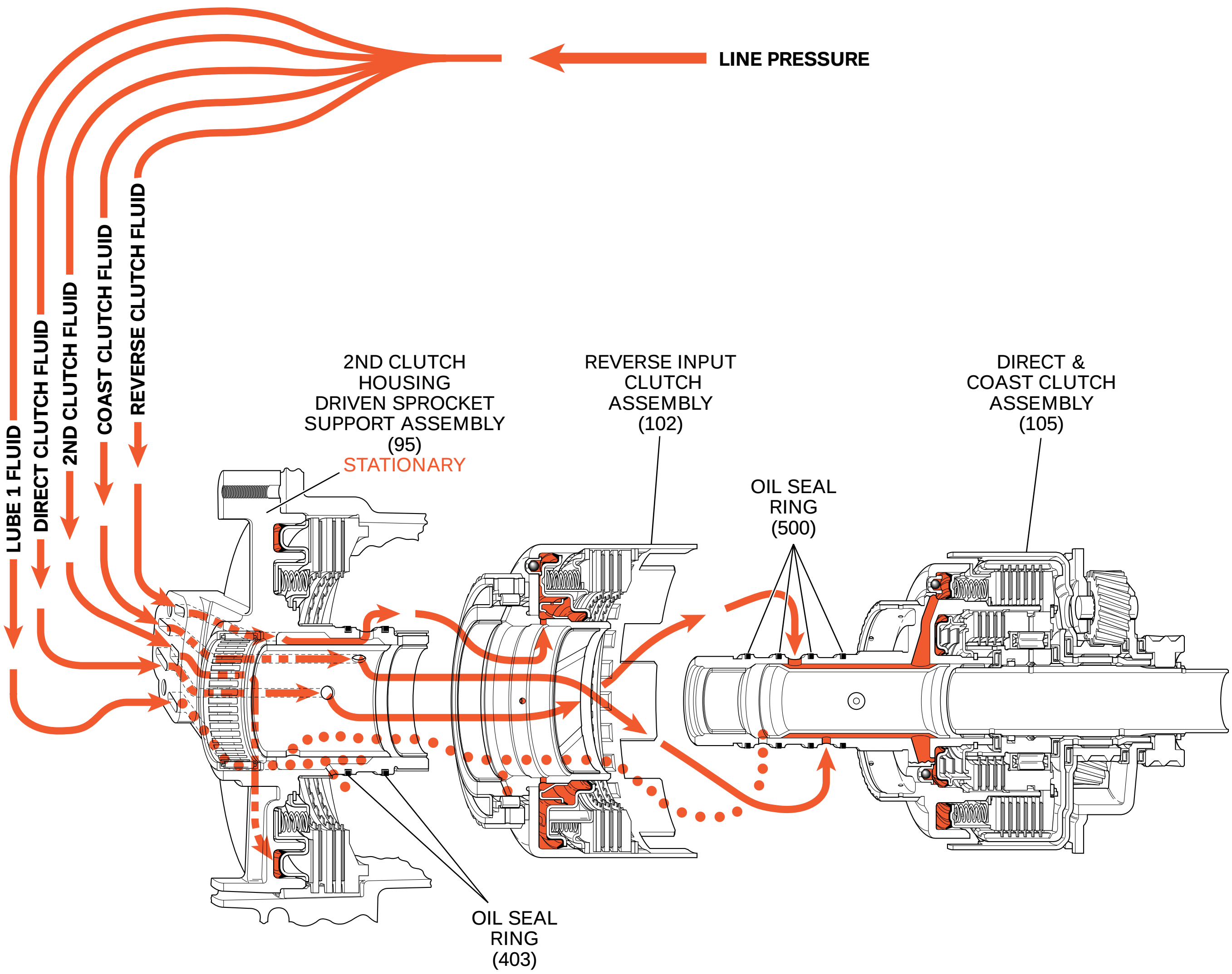
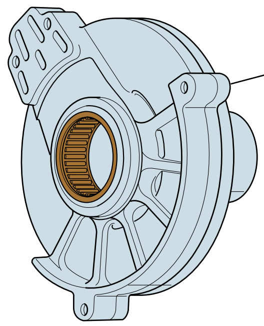


Figure 16

APPLY COMPONENTS



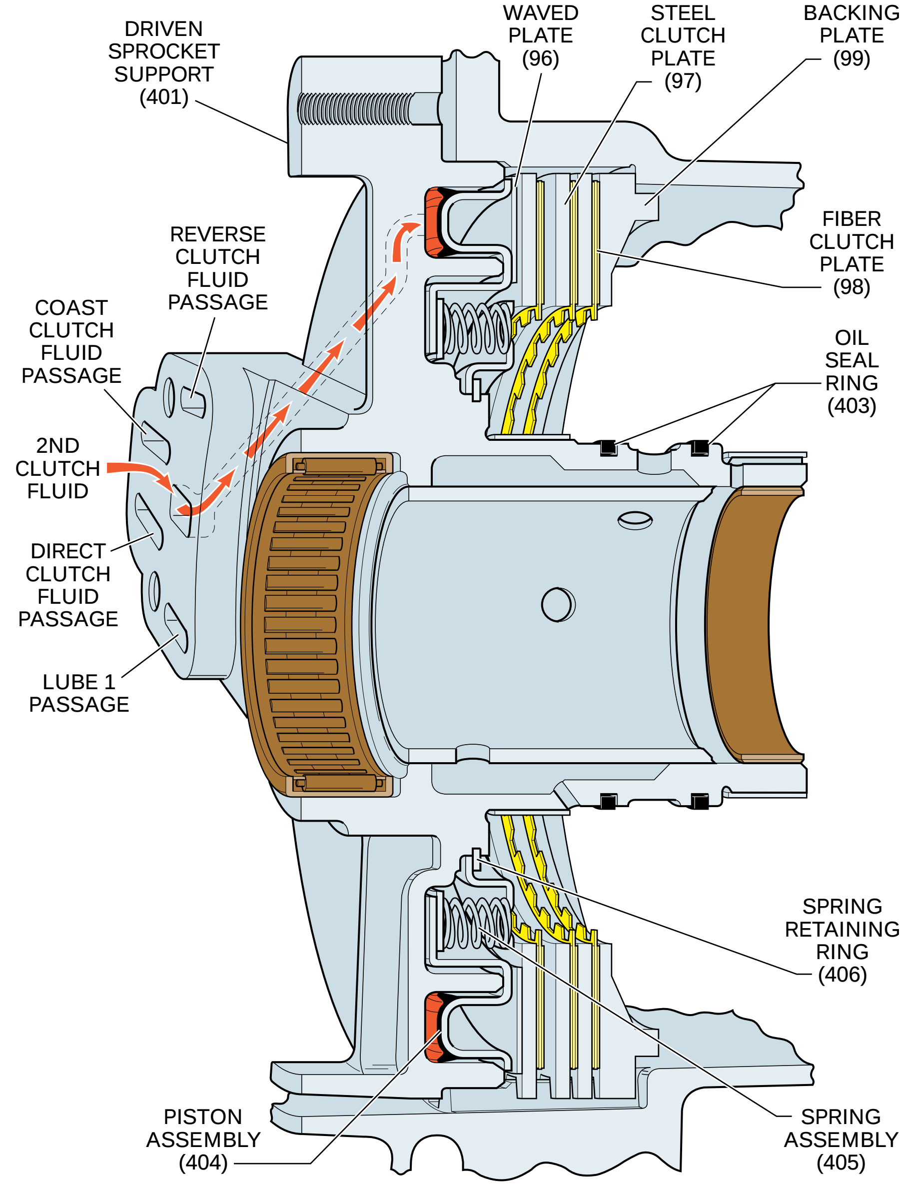
2ND CLUTCH RELEASE:
The 2nd clutch releases whenever the transaxle shifts into First gear, or when the selector lever is moved into the Park, Reverse, or Neutral ranges. As the 2nd clutch releases, 2nd clutch fluid pressure between the 2nd clutch piston assembly and driven sprocket support exhausts through the support. In the absence of fluid pressure, force from the spring 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.

Component failure can cause no second/slips in second.

2ND CLUTCH:
The 2nd clutch assembly (404-406 & 96-99), located between the driven sprocket support (401) and the reverse clutch housing and race assembly (102), is applied whenever the transaxle is operating in Overdrive Range Second, Third or Fourth gear. It is also applied in Manual Second Range-Second gear and Third gear, Manual Third Range-Second and Third gear and Manual First Range-Second and Third gear.

2ND CLUTCH APPLY:
To apply the 2nd clutch, 2nd clutch fluid is routed into the driven sprocket support (401) behind the 2nd clutch piston assembly (404). Fluid pressure moves the piston and compresses the spring assembly (405). The piston continues to move until it compresses the 2nd clutch waved plate (96) and holds the fiber plates (98) and steel plates (97) against the backing plate (99).

When fully applied, the 2nd clutch provides power through the planetary gear sets by holding the 2nd roller clutch cam (451) through the internal teeth on the fiber clutch plates. (The external teeth on the steel clutch plates are splined into the transaxle case.) This arrangement allows Second gear by redirecting power through the reaction carrier.



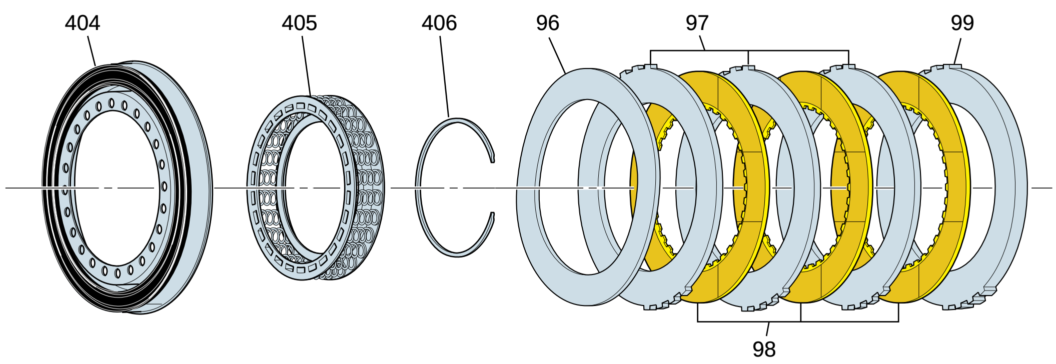


Figure 17

2ND ROLLER CLUTCH:

The 2nd roller clutch (450-452), located between the driven sprocket support (401) and reverse clutch housing (454), holds the reverse clutch housing whenever the transaxle is operating in Second gear.

2ND ROLLER CLUTCH ASSEMBLY HOLDING (the reaction sun gear):

The 2nd clutch assembly (96-99 & 404-406) has fiber plates with internal teeth splined to the 2nd roller clutch cam (451), and steel plates that are splined to the case. The 2nd roller clutch inner race is part of the reverse clutch housing (454), which rotates in the opposite direction of engine rotation during First gear operation. When the 2nd clutch applies, internal teeth on the 2nd clutch fiber plates hold the 2nd roller clutch cam stationary. The reverse clutch housing is then prevented from rotating in a direction opposite to engine rotation because the rollers are forced to wedge between the inner race and lowest part of the cam ramps.

When the 2nd roller clutch is mechanically locked up, it holds the reaction sun gear and shell assembly (529) through the reverse clutch housing. This arrangement directs power flow to the reaction carrier assembly in Second gear.

2ND ROLLER CLUTCH ASSEMBLY RELEASED:

The 2nd roller clutch assembly releases whenever the 2nd clutch releases, or its rollers “overrun” (freewheel). An overrunning condition occurs whenever the transaxle operates in Third gear 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 rollers are forced to rotate in the opposite direction which disengages the inner race from the outer cam. The rollers freewheel when this condition occurs.

> Roller clutch damaged, not holding can cause no Overdrive range second/slips in second.
>
> Note: Manual second will be available.

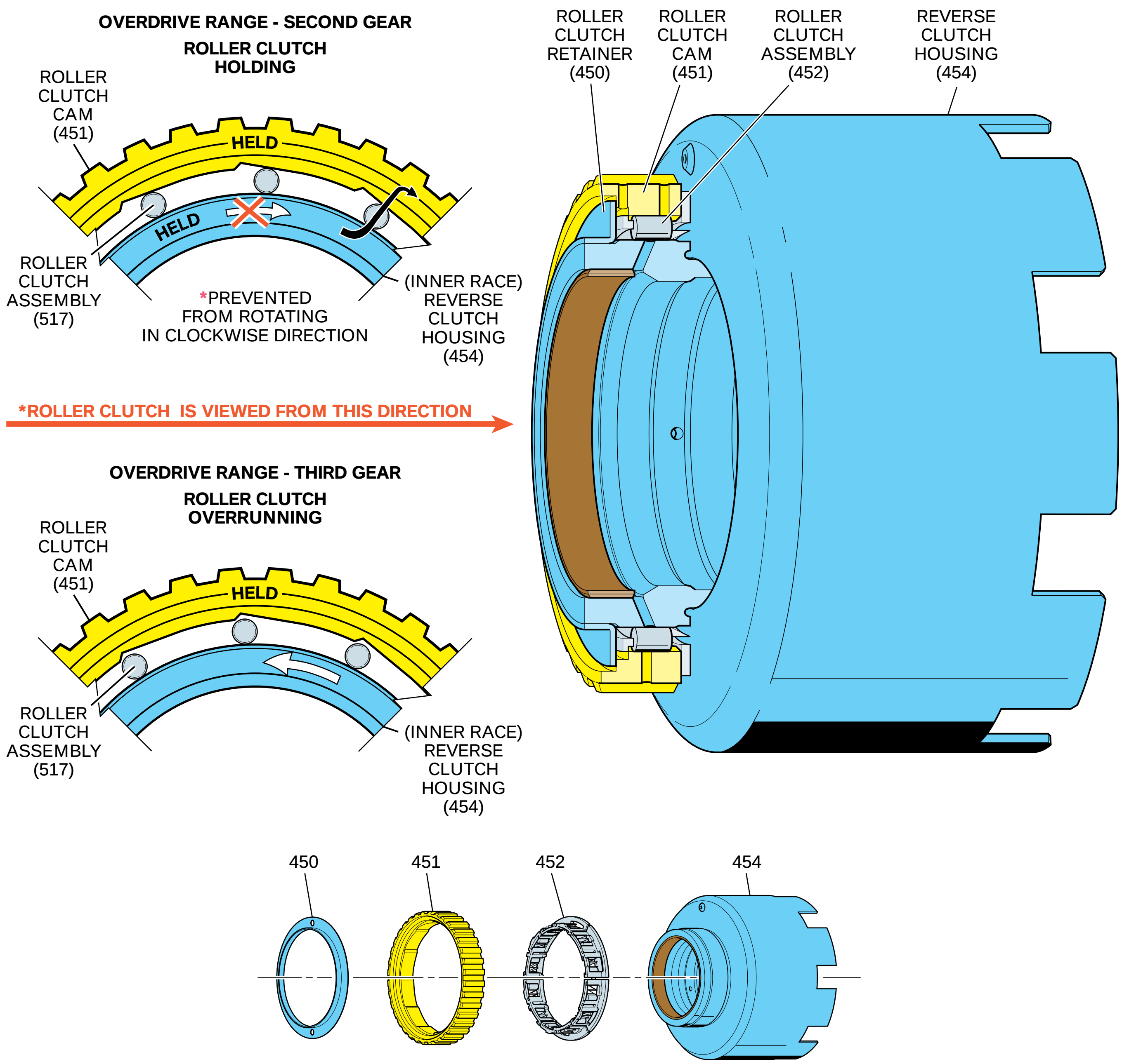
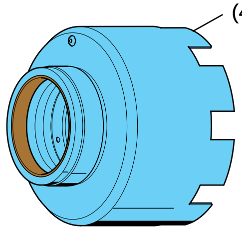


Figure 18



REVERSE CLUTCH:
The reverse input clutch assembly (102), is applied only when Reverse range is selected through the gear shift selector lever, but the reverse clutch housing acts as part of the holding member of the reaction sun gear.

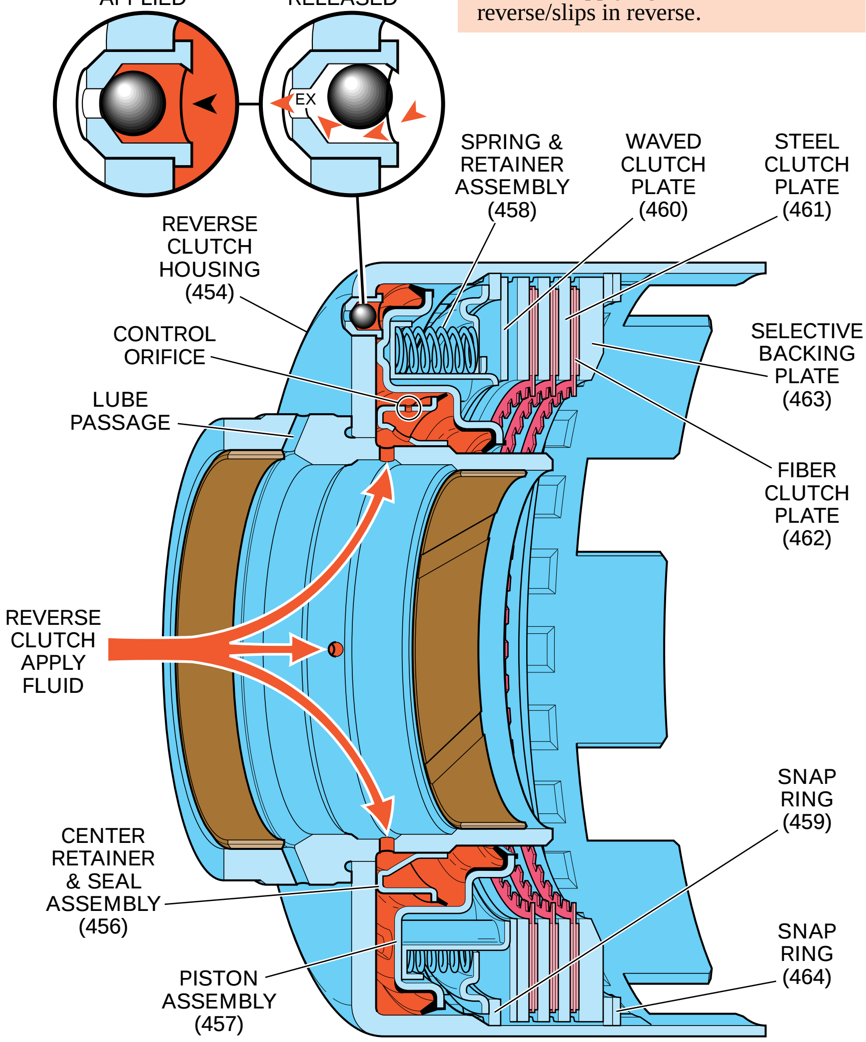
REVERSE CLUTCH APPLY (drives the reaction sun gear):
To apply the reverse clutch, reverse clutch fluid is routed into the driven sprocket support (401) and follows a passage between the support and support sleeve. Reverse clutch fluid exits the support at a feed hole located between two oil seal rings (403) and enters the reverse clutch housing through feed holes located in the reverse clutch housing between the two bearing surfaces. Reverse clutch fluid then enters the inner apply area between the piston (457) and center retainer & seal assembly (456). The center retainer & seal assembly (456) has an orifice that allows fluid to enter the outer area of the piston. This orifice system allows a controlled rate of apply to create a smoother shift feel. Reverse clutch fluid compresses the air trapped in the outer piston area until fluid and air pressure seat the ball, which allows fluid pressure to move the piston and compress the spring & retainer assembly (458). The piston continues to move until the spring & retainer assembly compresses the reverse clutch waved plate (460), and holds the steel clutch plates (461) and fiber clutch plates (462) against the selective backing plate (463).

When fully applied, the reverse clutch combines with the lo/reverse servo assembly (66-73) and lo/reverse band (111) to enable a reverse direction of rotation and power through the gear sets. (See Lo/Reverse Servo and Lo/Reverse Band description on page 25.)

REVERSE CLUTCH RELEASE:
The reverse clutch releases whenever the selector lever is moved into another range and reverse clutch fluid, between the housing and reverse clutch piston, is forced back through the feed holes into the driven sprocket support. Release fluid is allowed to slip by the outer portion of the center retainer & seal assembly (456) to allow a quick release. 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.

With the clutch released, the reverse clutch ball capsule is forced off it's seat by centrifugal force (rotation of the housing). When the checkball unseats, residual reverse clutch fluid is forced to the outer perimeter of the piston and exhausts through the checkball seat. (If this fluid did not completely exhaust there could be a partial apply, or drag of the reverse clutch plates.)

Clutch not releasing can cause drive in neutral.
Clutch not applying can cause no reverse/slips in reverse.



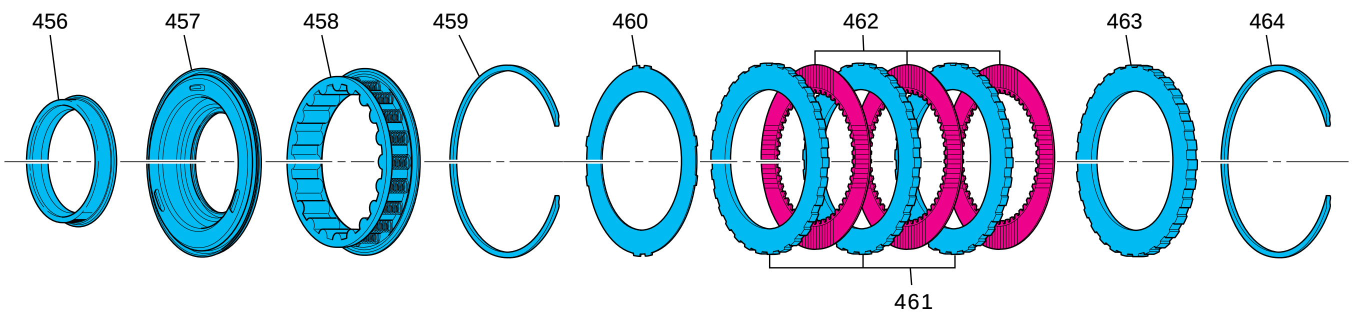
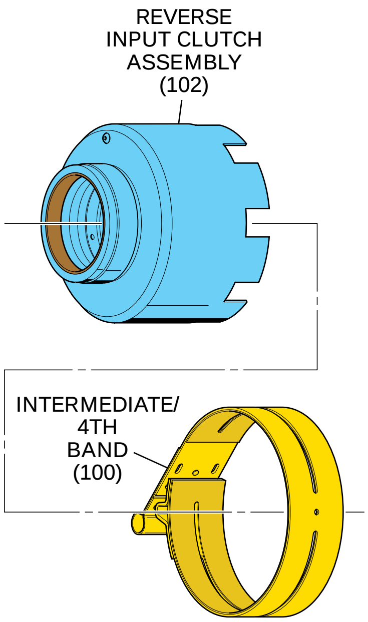
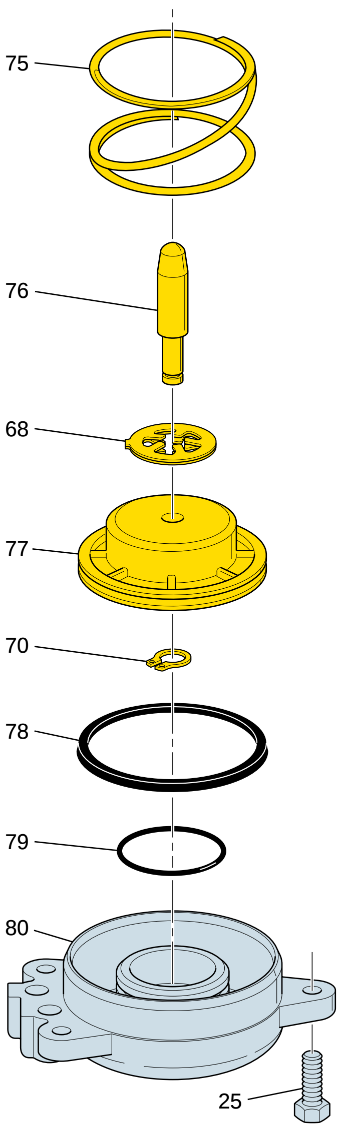


Figure 19





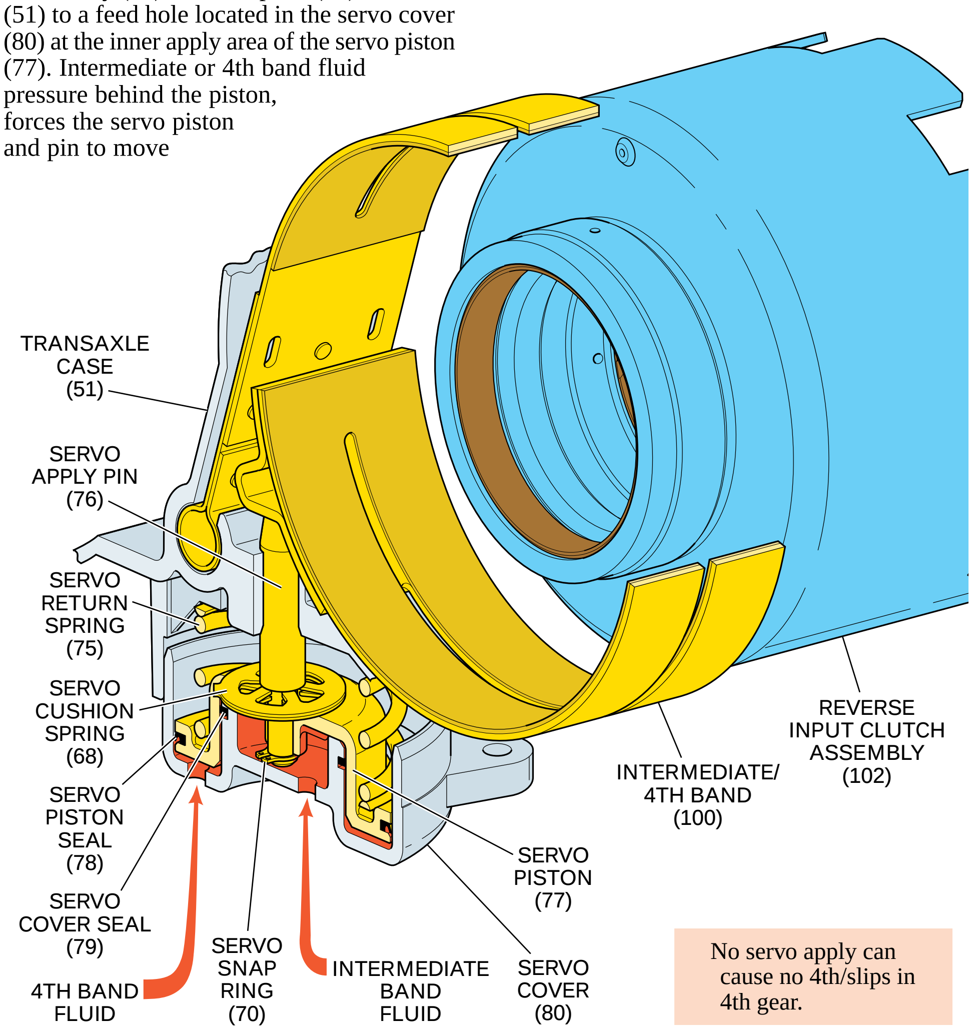
INTERMEDIATE/4TH SERVO ASSEMBLY:
The intermediate/4th servo assembly (75-80), located in the bottom of the transaxle in the front of the case (51), applies the intermediate/4th band (100) in Overdrive Range-Fourth gear or Manual Second Range-Second gear and Manual First Range-Second Gear.

INTERMEDIATE/4TH BAND:
The intermediate/4th band (100), located inside the case, is wrapped around the reverse input clutch assembly (102) and held in position by a machined area, in the case, in which the band anchor end fits. When the band is compressed by the intermediate/4th servo pin, it holds the reverse clutch housing in order to operate the transaxle in fourth gear, or for engine compression braking in Manual Second Range-Second gear and Manual First Range- Second Gear.

INTERMEDIATE/4TH SERVO APPLY (holds the reaction sun gear):
To apply the intermediate/4th servo assembly in Overdrive Range-Fourth gear, 4th band fluid is routed through the valve body (18), channel plate (27), and case (51) to a feed hole located in the servo cover (80) at the outer apply area of the servo piston (77). In Manual Second Range-Second gear and Manual First Range-Second Gear, intermediate band fluid is routed through the valve body (18), channel plate (27), and case (51) to a feed hole located in the servo cover (80) at the inner apply area of the servo piston (77). Intermediate or 4th band fluid pressure behind the piston, forces the servo piston and pin to move towards the intermediate/4th band. As the servo piston moves, it compresses the spring (75) until the pin travels far enough to compress the intermediate/4th band. The band is wrapped around the reverse input clutch housing and when it is compressed, it holds the housing stationary.

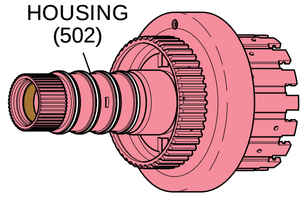
When the transaxle is operating in Fourth gear and the intermediate/4th band is holding the reverse clutch housing, power is directed through the reaction carrier to the input carrier in order to provide an overdrive gear ratio. When the intermediate/4th band is applied for engine compression braking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

INTERMEDIATE/4TH SERVO RELEASE:
The intermediate/4th servo releases whenever the transaxle shifts out of Fourth gear into a lower gear (excluding Manual Second Range-Second gear and Manual First Range-Second Gear). The band releases when 4th band fluid pressure or intermediate band fluid pressure, between the servo cover and servo piston, is routed through the case to exhaust from the circuit. The return spring forces the intermediate/4th servo piston away from the intermediate/4th band thereby releasing the band.



No servo apply can cause no 4th/slips in 4th gear.

Figure 20



DIRECT CLUTCH:
The direct clutch assembly (517-523), located inside the direct and coast clutch housing (502), is applied whenever the transaxle is operating in Overdrive Range-Third or Fourth gear and Manual First, Second or Third Range-Third gear.

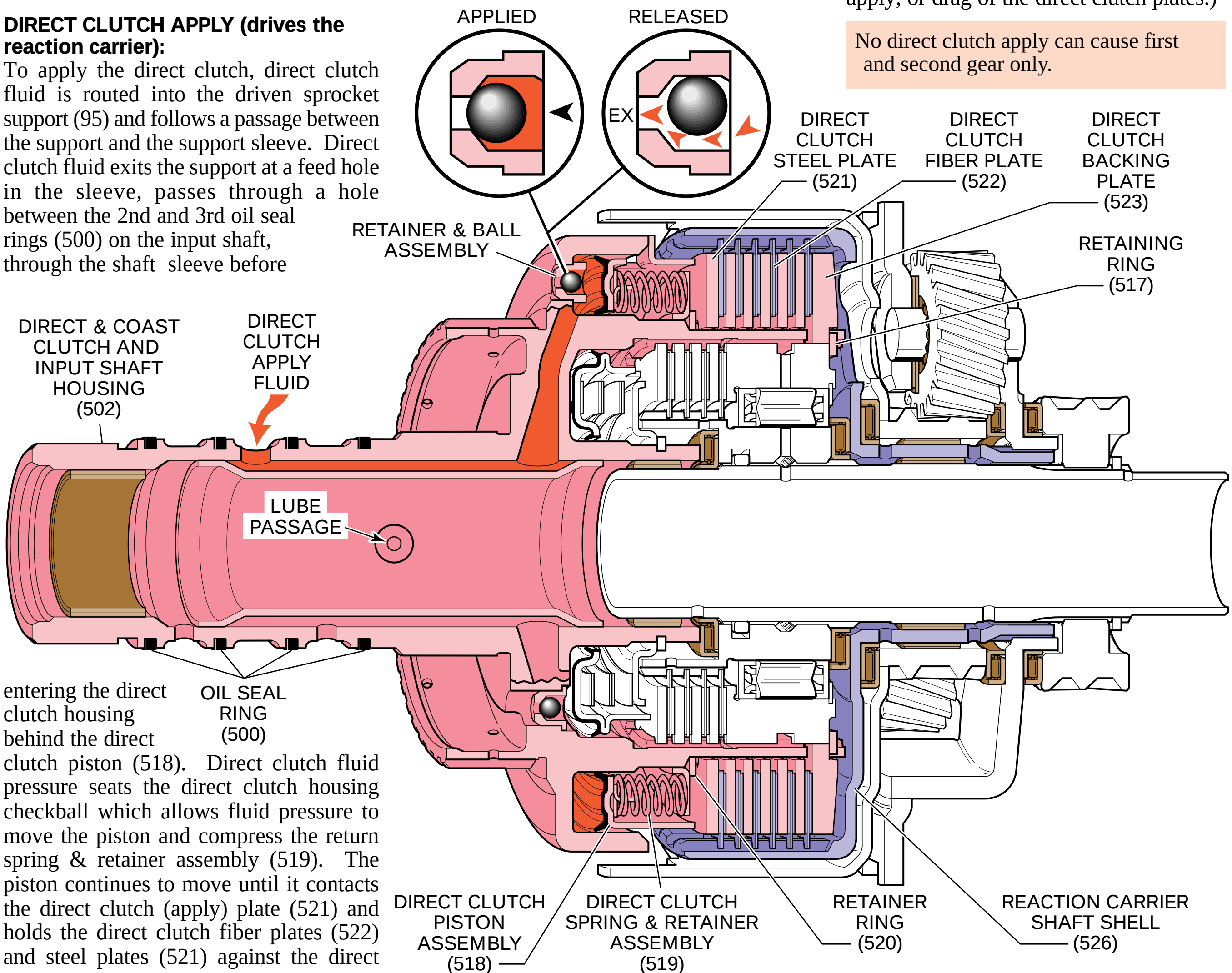
DIRECT CLUTCH APPLY (drives the reaction carrier):
To apply the direct clutch, direct clutch fluid is routed into the driven sprocket support (95) and follows a passage between the support and the support sleeve. Direct clutch fluid exits the support at a feed hole in the sleeve, passes through a hole between the 2nd and 3rd oil seal rings (500) on the input shaft, through the shaft sleeve before entering the direct clutch housing behind the direct clutch piston (518). Direct clutch fluid pressure seats the direct clutch housing checkball which allows fluid pressure to move the piston and compress the return spring & retainer assembly (519). The piston continues to move until it contacts the direct clutch (apply) plate (521) and holds the direct clutch fiber plates (522) and steel plates (521) against the direct clutch backing plate (523).

When fully applied, the direct clutch plates force the direct clutch housing and reaction carrier shaft shell (526) to rotate at turbine speed (depending on chain ratio). The reaction carrier shaft shell is splined into the reaction carrier and combines with the input sun gear (533) to power the gear sets at a 1:1 gear ratio.

DIRECT CLUTCH RELEASE:
The direct clutch releases whenever the transaxle downshifts into Second or First gear, or when the selector lever is moved into the Park, Reverse, or Neutral ranges. Direct 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 return spring & retainer assembly causes the direct clutch piston to move away from the direct clutch apply plate. The piston movement causes the clutch plates to lose contact with the backing plate thereby releasing the direct clutch.

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

No direct clutch apply can cause first and second gear only.



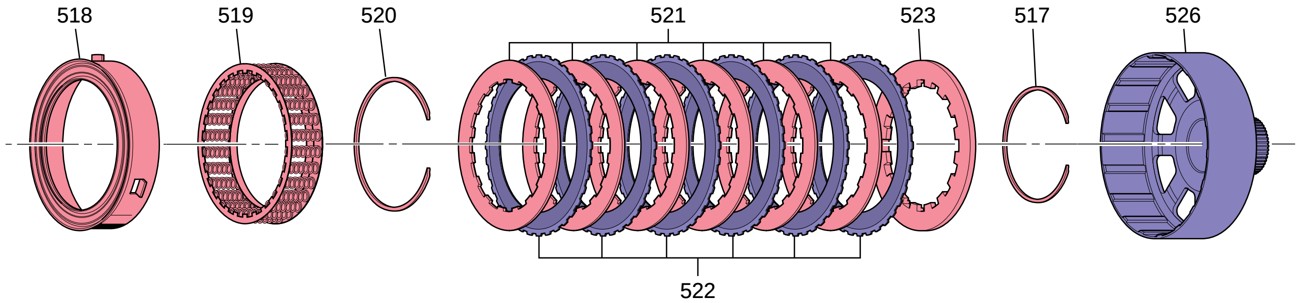
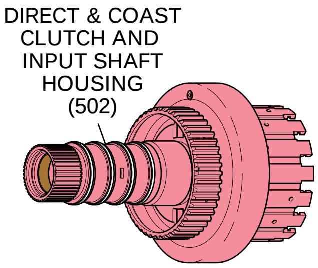


Figure 21

APPLY COMPONENTS



COAST CLUTCH:
The coast clutch assembly (504-512 & 517), located inside the direct and coast clutch input shaft housing (502), is applied whenever the transaxle is operating in a Manual Range (Refer to Range Reference Chart on page 11).

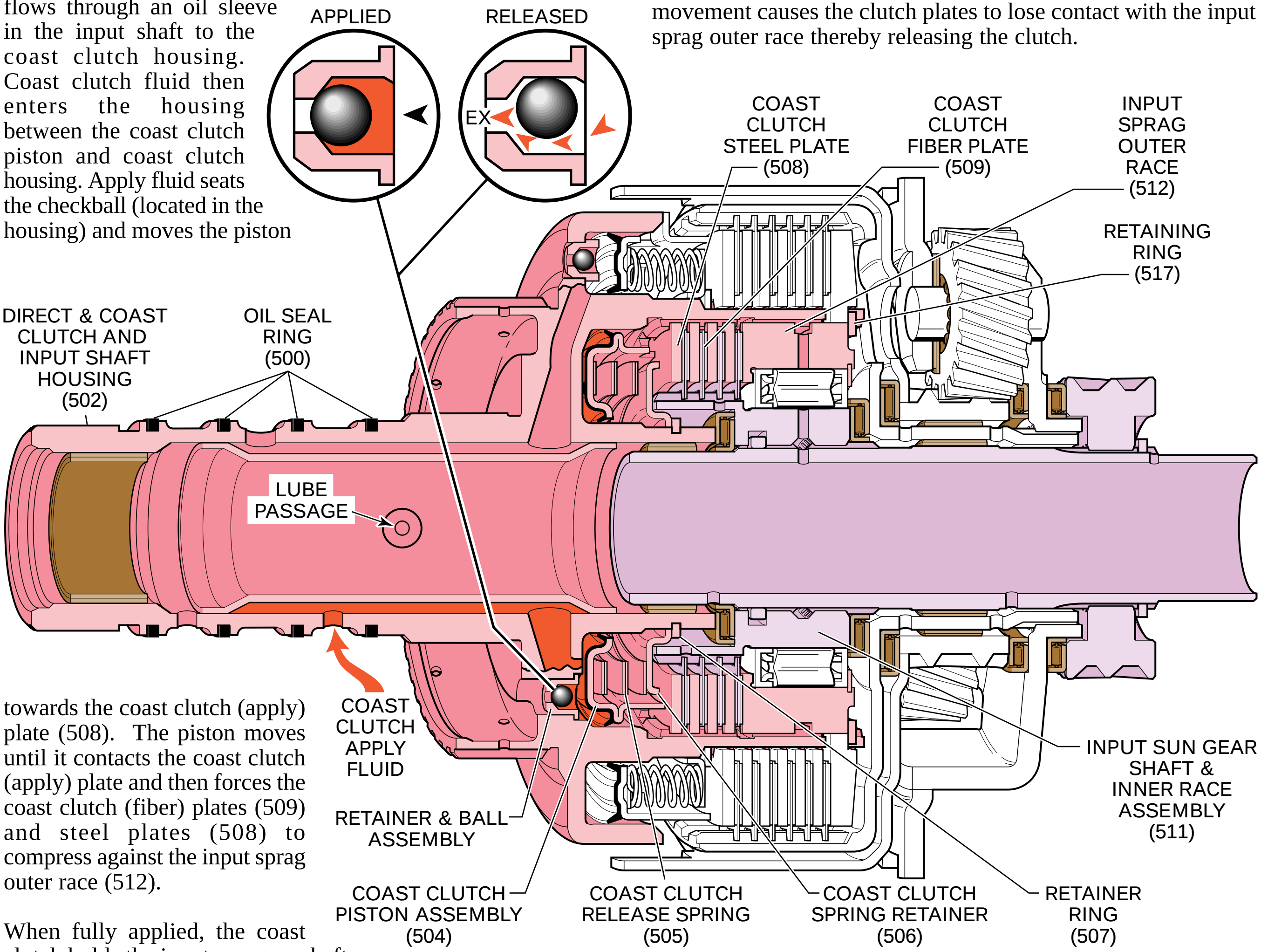
The coast clutch is responsible for holding the mechanical link from the gearsets to the engine in all manual ranges to achieve engine compression braking. In Overdrive Ranges First, Second and Third the transaxle is allowed to coast (through the input sprag overrunning) when the throttle is reduced and vehicle speed is greater than engine speed.

No coast clutch apply can cause no engine braking in all manual ranges.

COAST CLUTCH APPLY (drives the input sun gear during acceleration and allows engine compression braking during deceleration):
To apply the coast clutch, coast clutch fluid is routed into the driven sprocket support (95) and follows a passage between the support and an oil transfer sleeve. Coast clutch fluid then passes through a feed hole in the support and a feed hole between the 3rd and 4th oil seal rings (500) on the input shaft. The fluid then flows through an oil sleeve in the input shaft to the coast clutch housing. Coast clutch fluid then enters the housing between the coast clutch piston and coast clutch housing. Apply fluid seats the checkball (located in the housing) and moves the piston towards the coast clutch (apply) plate (508). The piston moves until it contacts the coast clutch (apply) plate and then forces the coast clutch (fiber) plates (509) and steel plates (508) to compress against the input sprag outer race (512).

When fully applied, the coast clutch holds the input sun gear shaft and inner race assembly, which is splined to the input sun gear. This arrangement prevents the input sprag elements from overrunning to provide 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 (504) and coast clutch housing exhausts through the direct & coast clutch and input shaft. In the absence of fluid pressure, force from the coast clutch release spring assembly (505) causes the coast clutch piston to move away from the clutch plates. The piston movement causes the clutch plates to lose contact with the input sprag outer race thereby releasing the clutch.



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

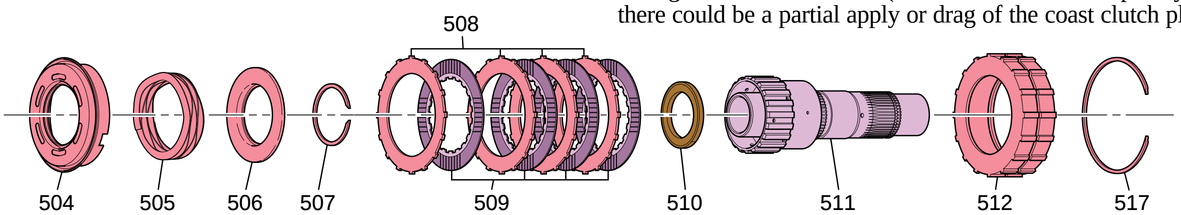


Figure 22

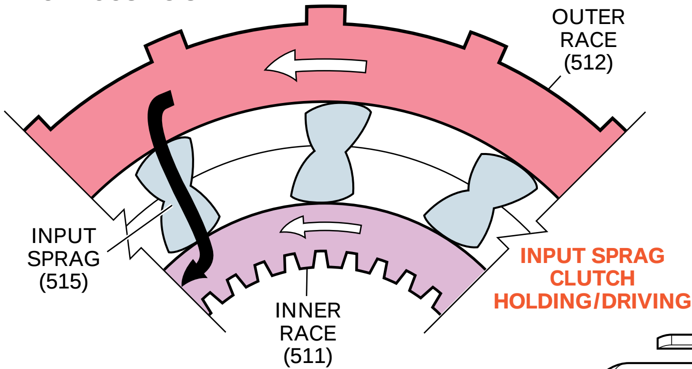
APPLY COMPONENTS

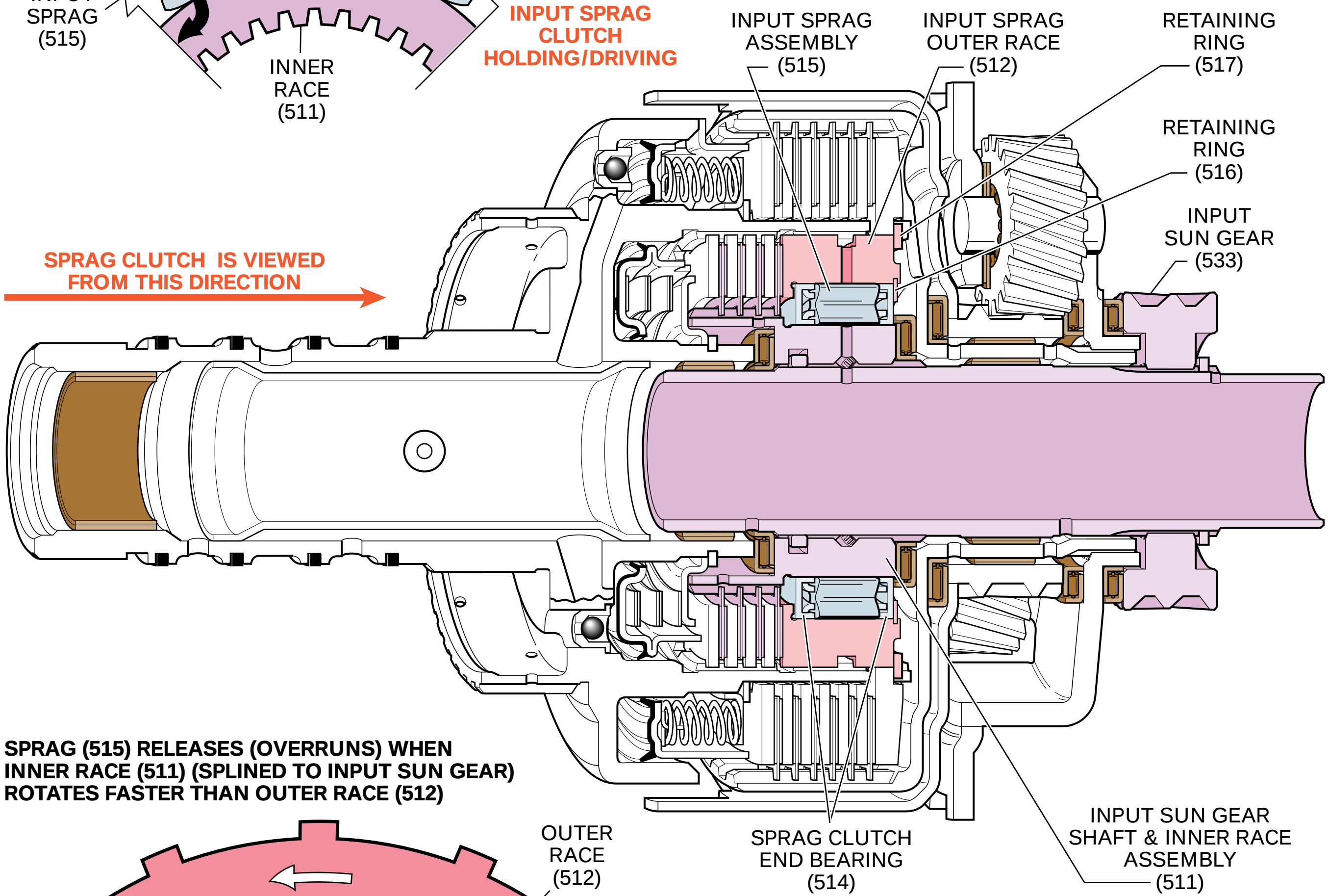
INPUT SPRAG:
The input sprag assembly (515), located between the input sprag outer race (512) [splined to the direct & coast clutch and input shaft housing (502)] and the input sun gear shaft & inner race assembly (511), drives (transfers torque) the input sun gear (533) in all forward gear ranges (except 4th gear) in order to transmit power to the gear sets. The sprag clutch is also designed to allow the vehicle to coast in all overdrive gear ranges (except 4th gear).

INPUT SPRAG ASSEMBLY HOLDING (drives the input sun gear):
The outer race (512) of the input sprag is splined to the direct & coast clutch and input shaft housing (502). The inner race is part of the input sun gear shaft assembly with the input sun gear splined to the other end. When the engine is running the direct and coast clutch and input shaft housing is always rotating. The input sprag holds when the housing is rotating, but is only effective when the transaxle is in the overdrive gear ranges (except 4th gear). In the manual ranges the coast clutch is applied and transfers the torque. When the input sprag holds, it drives the input sun gear in order to direct power flow through the gear sets.

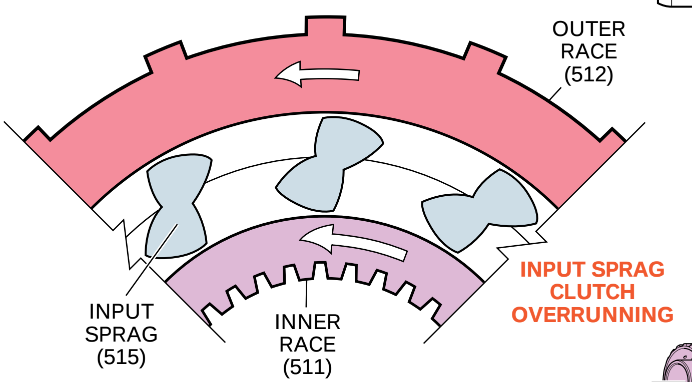
INPUT SPRAG RELEASED (allows coasting in overdrive gear ranges):
The input sprag assembly releases (overruns) whenever the vehicle speed is greater than engine speed (occurs during deceleration and in 4th gear). This is to allow coasting instead of engine braking when in the overdrive gear ranges (except fourth gear). An overrunning condition occurs only in the Overdrive Ranges when the input sun gear (input sprag inner race) rotates faster than the outer race. The faster rotation of the inner race causes the sprag elements to pivot and disengage with the outer race.

OUTER RACE (512) HELD - SPRAG (515) FORCES INNER RACE (511) TO ROTATE AT INPUT HOUSING SPEED





SPRAG (515) RELEASES (OVERRUNS) WHEN INNER RACE (511) (SPLINED TO INPUT SUN GEAR) ROTATES FASTER THAN OUTER RACE (512)



Input sprag clutch failure, not holding can cause no first, second or third gear/slips in first, second or third gear.

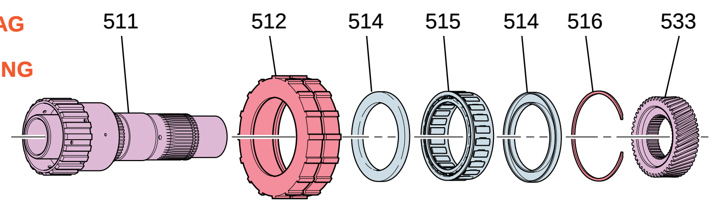
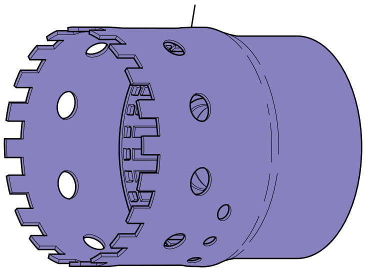


Figure 23



FORWARD CLUTCH:
The forward clutch assembly (600-608), located inside the forward clutch housing (609), is applied whenever the transaxle is operating in any forward range.

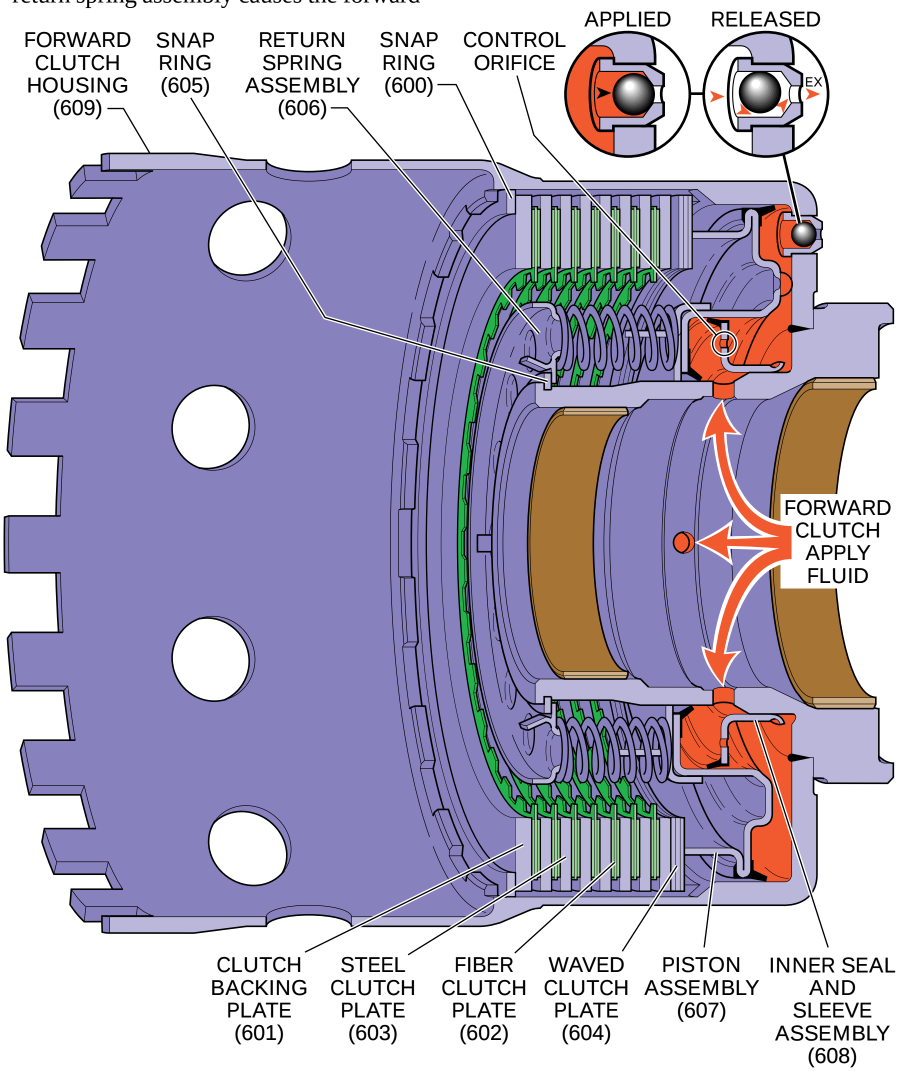
FORWARD CLUTCH APPLY (holds the input internal gear/drives the reaction carrier):
To apply the forward clutch, forward clutch fluid is routed into the forward clutch support (656) and follows a passage between the support and an oil transfer sleeve. Forward clutch fluid then passes from a hole in the support, between the oil seal rings, into a feed hole in the forward clutch housing, located between the two bearing surfaces. Forward clutch fluid then enters the inner apply area between the piston (607) and the seal and sleeve assembly (608). The seal and sleeve assembly (608) has an orifice that allows fluid to enter the outer area of the piston. This orifice system allows a controlled rate of apply to create a smoother shift feel. Forward clutch fluid compresses the air trapped in the outer piston area until fluid and air pressure seat the ball, which allows fluid pressure to move the forward clutch piston (607). As the piston moves, it compresses the forward clutch return spring assembly (606) until legs on the piston contact and hold the forward clutch waved plate (604), steel plates (603), and fiber plates (602) against the backing plate (601).

When fully applied, the forward clutch holds the input flange and forward clutch hub assembly (108) through the internal teeth on the fiber clutch plates. (External teeth on the steel clutch plates are splined to the forward clutch housing.) In first gear the forward clutch housing will be held by the lo roller clutch assembly or the lo/reverse band.

FORWARD CLUTCH RELEASED (no power transmitted through the input internal gear):
The forward clutch releases whenever the selector lever is moved into Park, Reverse or Neutral ranges (in Neutral the forward clutch releases only below a certain vehicle speed) and forward clutch fluid between the piston and housing exhausts through the forward clutch support. Release fluid is allowed to slip by the outer portion of the lip seal to allow a quick release. In the absence of fluid pressure, force from the forward clutch return spring assembly causes the forward 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 forward clutch.

With the clutch released, the forward clutch housing ball capsule is forced off it's seat by centrifugal force (rotation of the housing). When the checkball unseats, residual forward clutch fluid is forced to the outer perimeter of the piston and exhausts through the checkball seat.

If this fluid did not completely exhaust there could be a partial apply, or drag of the forward clutch plates.



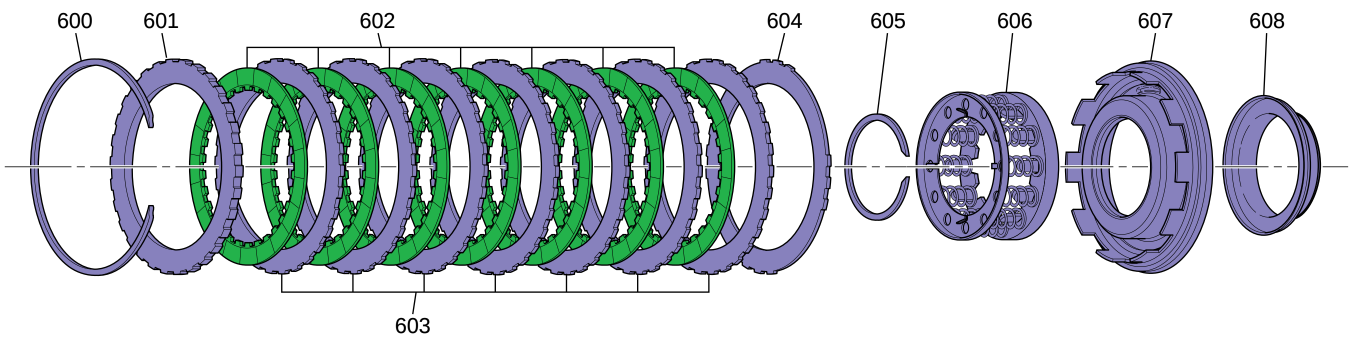


Figure 24

APPLY COMPONENTS

LO/REVERSE SERVO ASSEMBLY:
The lo/reverse servo assembly (66-73), located in the bottom of the transaxle in the rear of the case (51), applies the lo/reverse band in Park, Reverse and Neutral ranges, and Manual First Range - First gear.

LO/REVERSE BAND:
The lo/reverse band (111), located inside the case, is wrapped around the forward clutch housing and held in position by the lo/reverse band anchor pin (64). When the band is compressed by the lo/reverse servo pin, it holds the forward clutch housing stationary. *[Note: The band is not the primary holding member in Manual First Range - First gear acceleration operation (Refer to lo roller clutch, page 26.)]*

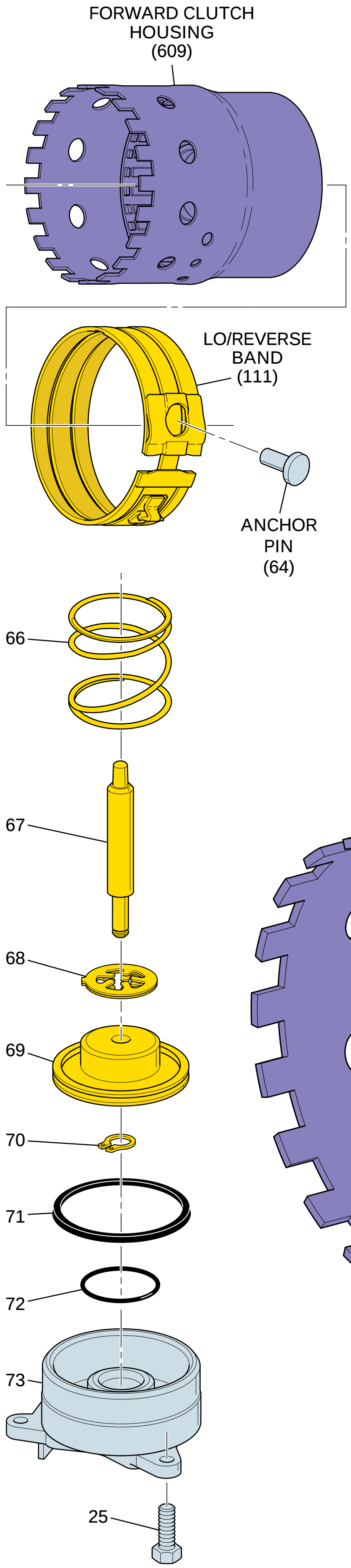
LO/REVERSE SERVO APPLY (holds the input internal gear in conjunction with the forward clutch/holds the reaction carrier):
To apply the lo/reverse servo assembly, reverse and/or lo band fluid is routed through a feed hole in the channel plate (27) to the bottom of the case (51) to the oil feed tube assembly (83). Fluid then flows through either the reverse or lo band feed tube to the servo cover (73). Reverse fluid enters the outer portion of the piston and lo band fluid enters the inner portion of the piston. Fluid pressure fills the cavity(s) between the servo piston and cover and forces the servo piston (69) and pin (67) to move towards the lo/reverse band (111). As the lo/reverse servo piston moves, it compresses the return spring (66) until the pin travels far enough to compress the lo/reverse band. When the band compresses, it holds the forward clutch housing stationary.

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

LO/REVERSE SERVO RELEASE:
The lo/reverse servo releases, allowing the lo/reverse band to release, whenever the transaxle shifts out of P, R, N or Manual First Range - First Gear. The band releases when reverse and/or lo band fluid pressure between the servo piston and servo cover exhausts from the circuit. Spring force from the return spring moves the lo/reverse servo piston away from the lo/reverse band thereby releasing the band.

No apply of the lo/reverse servo can cause:

- No reverse or slips in reverse
- No engine braking in Manual First range.



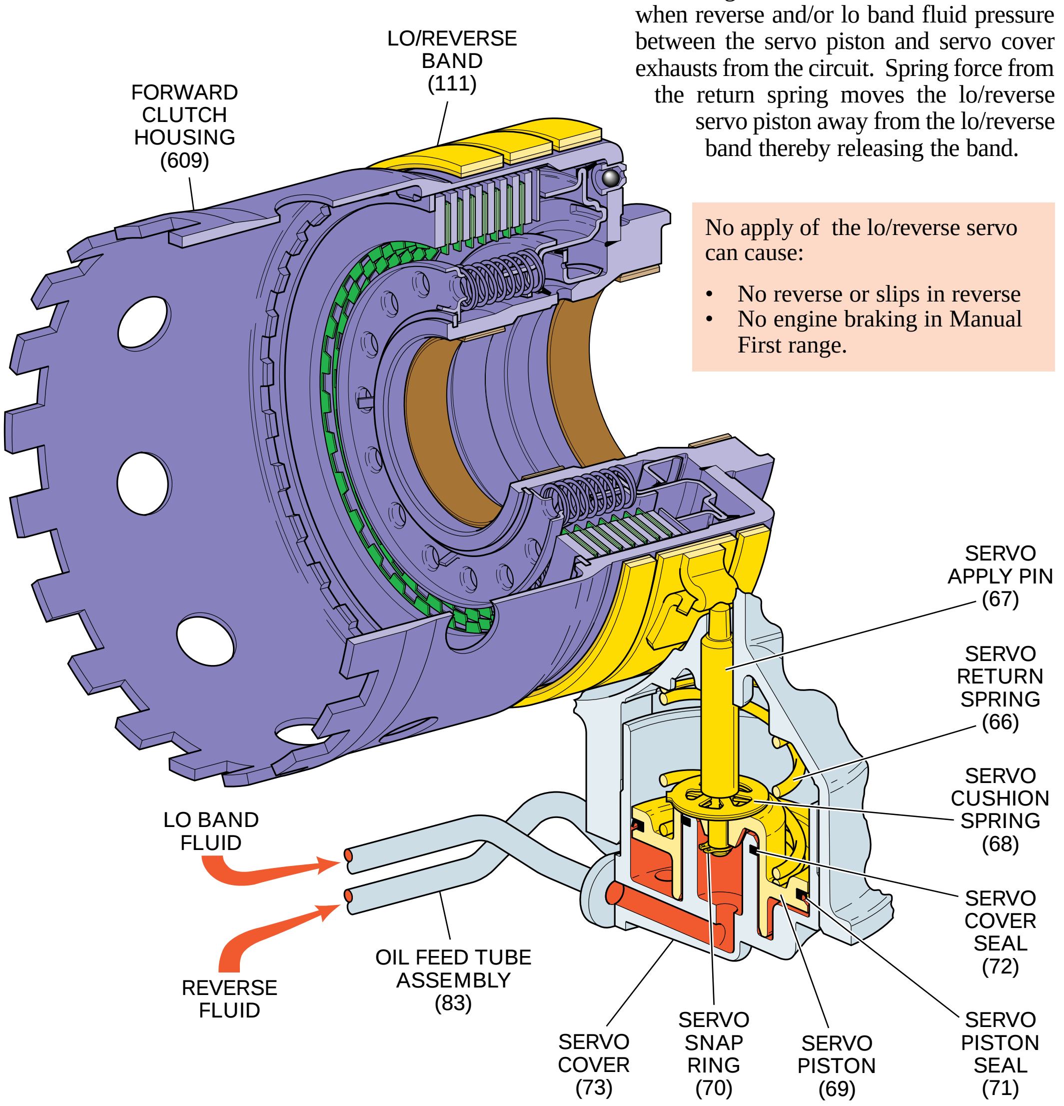


Figure 25

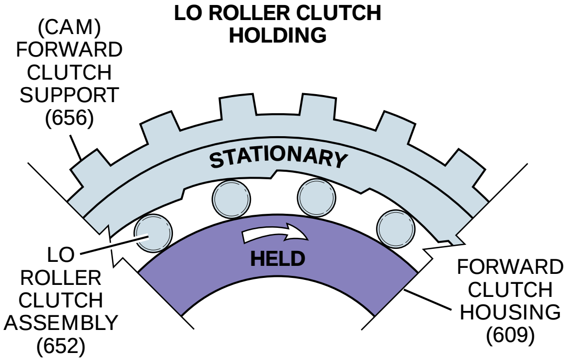
LO ROLLER CLUTCH:
The lo roller clutch assembly is made up of three major components: a cam which is part of the forward clutch support (656), the roller assembly (652), and the inner race which is part of the forward clutch housing (609). The lo roller clutch (652), located inside the forward clutch support, is the main component that holds the forward clutch housing whenever the transaxle is operating in First gear (Overdrive or Manual ranges).

LO ROLLER CLUTCH HOLDING (holds the input internal gear in conjunction with the forward clutch):
When the transaxle is operating in First gear, power flow through the gear sets attempts to rotate the forward 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 clutch housing) stationary and provide power to the gear sets.

LO ROLLER CLUTCH RELEASE:
The lo roller clutch releases when power flow through the gear sets drives the forward clutch housing in the same direction as engine rotation. When these two events occur, the lo roller clutch "freewheels" because the inner race (part of the forward 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 clutch housing to rotate freely. *Overrunning occurs in the lo roller clutch during Second, Third or Fourth gear operation.*

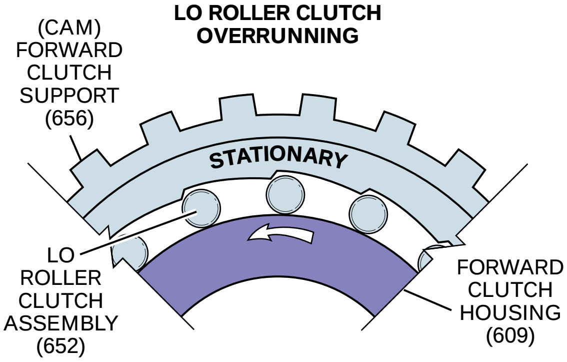
Lo roller clutch not holding can cause no first gear (except in Manual First Range).

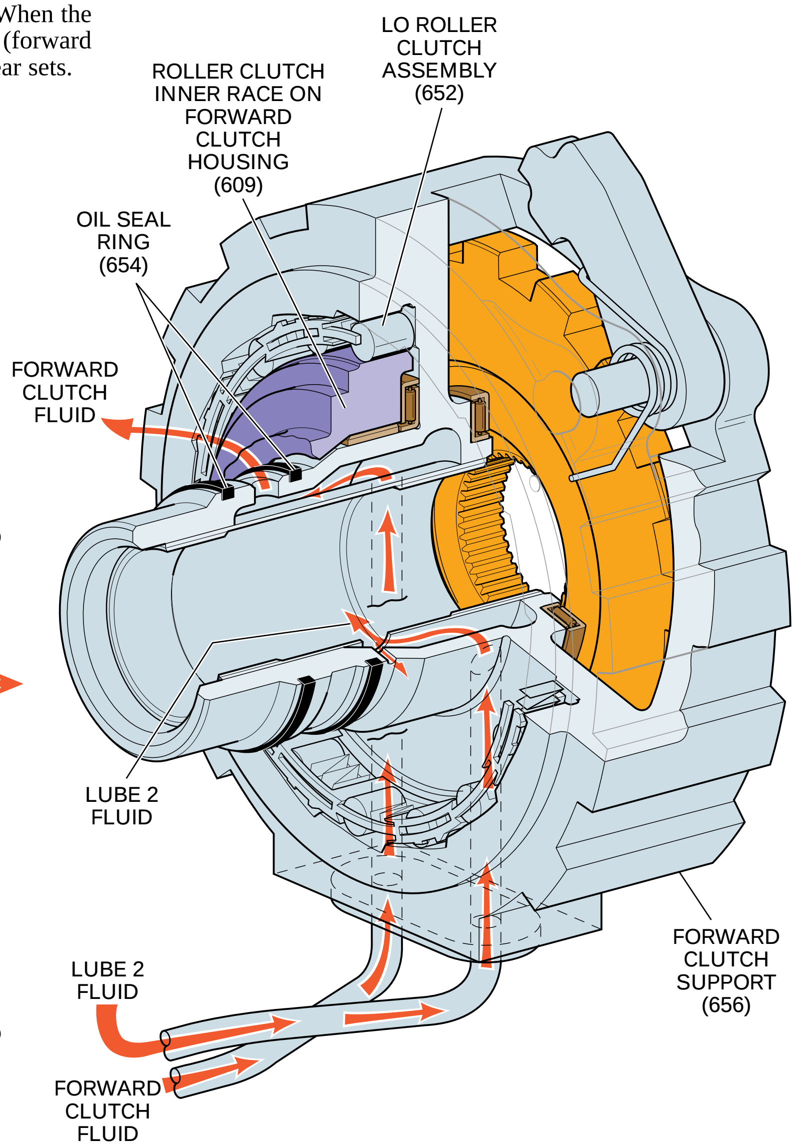
OVERDRIVE RANGE - FIRST GEAR



ROLLER CLUTCH IS VIEWED FROM THIS DIRECTION

OVERDRIVE RANGE - SECOND GEAR





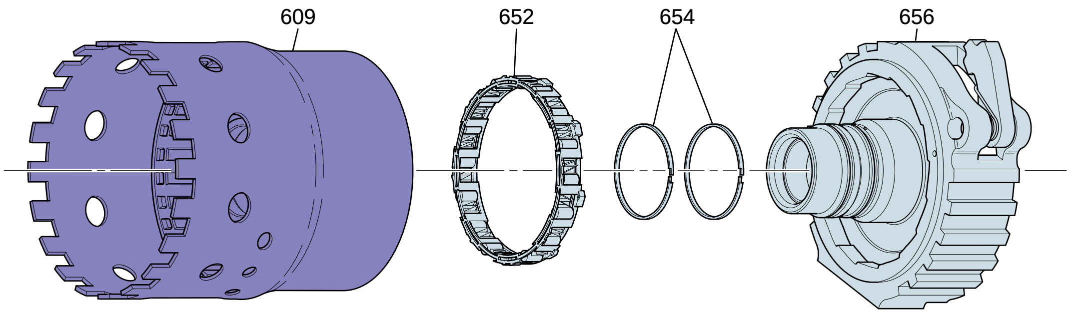


Figure 26

PLANETARY GEAR SETS:

Planetary gear sets are commonly used in an automatic transaxle and they are the main mechanical devices responsible for automatically changing gear ratios. The physical arrangement of the component parts of the gear set 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 physical arrangement not only provides for a strong and compact transaxle 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 transaxles, 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 (typically 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 exists 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.

Torque vs Speed

Another transaxle operating condition directly affected by input and output torque through a gear set is the relationship of torque with output speed. As an automatic transaxle 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 economical operation of the powertrain.

Hydra-matic 4T40-E Gear Sets:

The Hydra-matic 4T40-E transaxle combines two gear sets that provide five gear ratios (four forward and one reverse) for transferring torque to the drive axles. The five major assemblies used in these gear sets are:

- the reaction sun gear & shell assembly (529)
- the reaction carrier assembly (531)
- the reaction internal gear/input carrier assembly (560/562)
- the input sun gear (533)
- the input internal gear/input internal gear flange (560/577)

Another gear set used in the Hydra-matic 4T40-E transaxle is the final drive differential assembly (116). Information regarding its purpose and function is discussed on page 30.

Gearset failure can cause loss of drive.

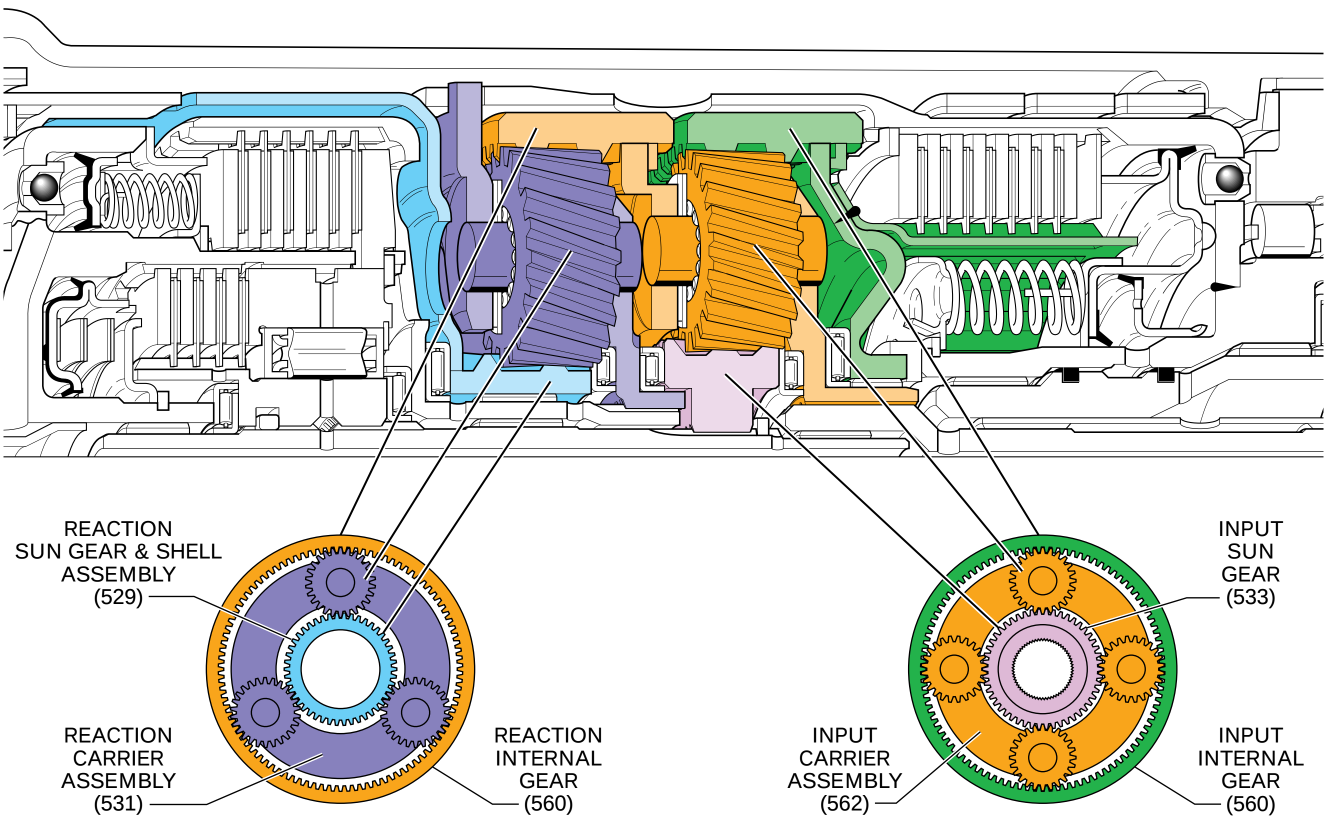
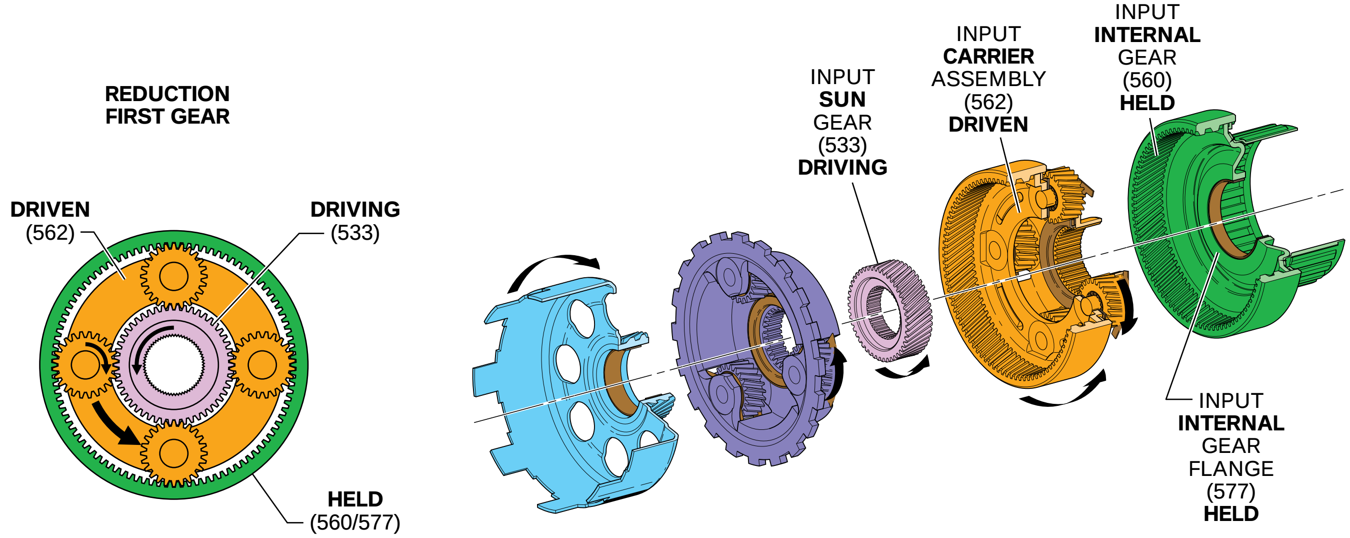


Figure 27

REDUCTION – FIRST GEAR



REDUCTION – SECOND GEAR

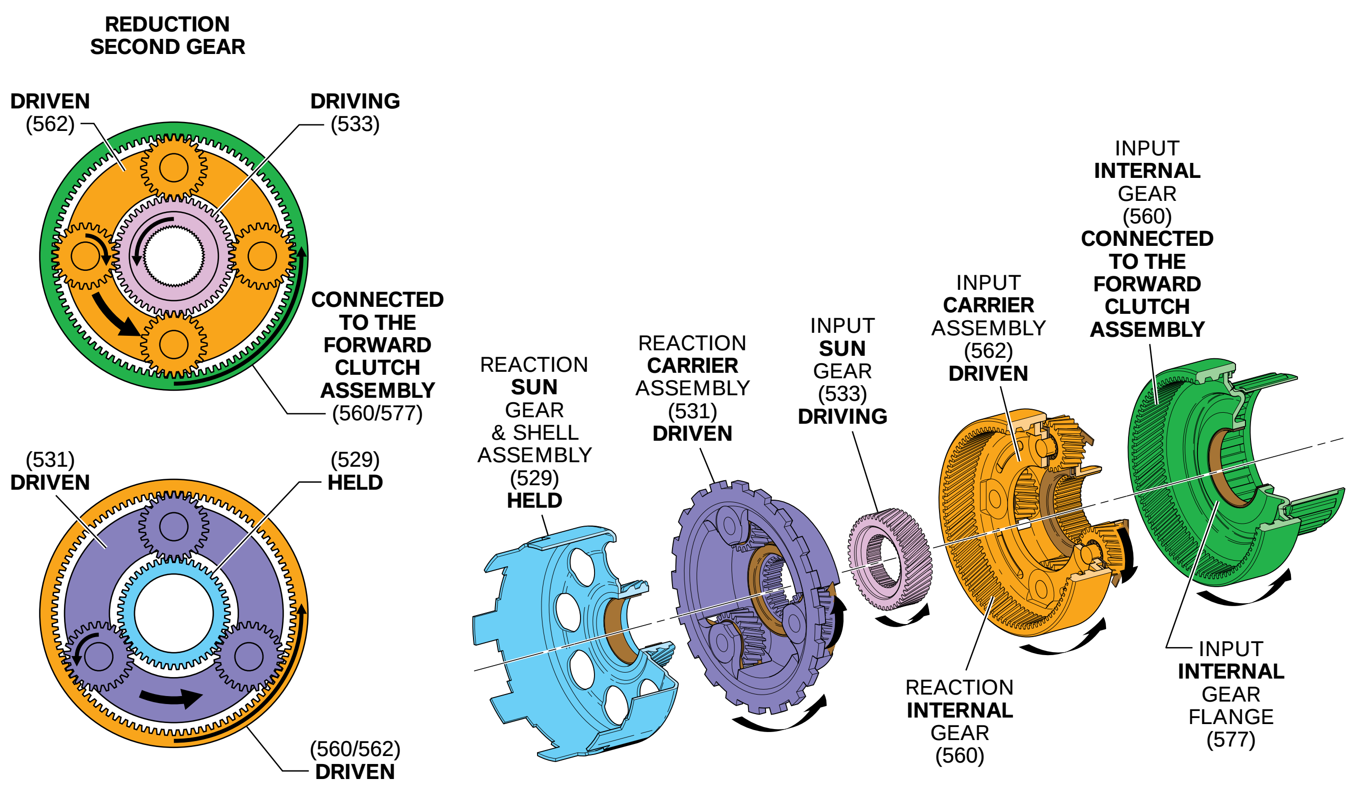


Figure 28

PLANETARY GEAR SETS

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 4T40-E, planetary gear set reduction occurs whenever the transaxle 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 (533) and the sun gear becomes the driving member. Torque is then transferred from the input sun gear to the four input planetary pinion gears (568) which rotate inside the input internal gear (560). Since the input internal gear (560) and input internal gear flange (577) are held stationary, the reaction internal gear/input carrier assembly (562) is forced to rotate. (Reaction planetary pinion gears (556) act as idler gears as the reaction internal gear/input carrier assembly rotates.) By using one planetary gear set, the transaxle is operating in this mode with a gear reduction of 2.960:1.

SECOND GEAR

Planetary gear set reduction in second gear occurs when the 2nd clutch applies and the 2nd roller clutch holds the reaction sun gear & shell assembly (529). With the forward clutch applied, the reaction carrier assembly (531), through the forward clutch housing (609), is held together with the input internal gear (560). The reaction carrier will walk around the stationary reaction sun gear & shell assembly. The input sun gear (533) 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 transaxle reduction through the gear set is 1.626:1.

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 transaxle 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 direct clutch applies and links the input shaft & direct clutch housing assembly (502) to the reaction carrier shaft shell (526). The direct clutch plates drive the input internal gear (560) through the reaction carrier assembly (531), reaction carrier shell (526), forward clutch housing (609), and forward clutch assembly (110) while the input sun gear (533) rotates in the same direction and at the same speed. When the gear set through the input carrier assembly (106) is operating in this mode there is no rpm reduction through the gear sets. The transaxle 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 intermediate/4th band (100) applies and holds the reverse input clutch assembly (102). The reaction sun gear & shell assembly (529) is also held because it is tanged into the reverse input clutch housing. The reaction carrier assembly (531) rotates around the stationary reaction sun gear & shell assembly and its planetary pinions drive the reaction internal gear and input carrier assembly (106). When the planetary gear set is operating in this mode, the transaxle is in overdrive at a gear ratio of 0.681:1.

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 input clutch housing & race assembly (102). The reaction sun gear & shell assembly (529) is therefore the driving member because it is tanged into the reverse input clutch housing. Since the lo/reverse band (111) is also applied, it holds the reaction carrier assembly (531) because it is tanged to the forward clutch housing (609). 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 (106) in the same direction. The result is a reverse direction of rotation from that of engine input. Reduction through the gear sets is at a 2.143:1 ratio.

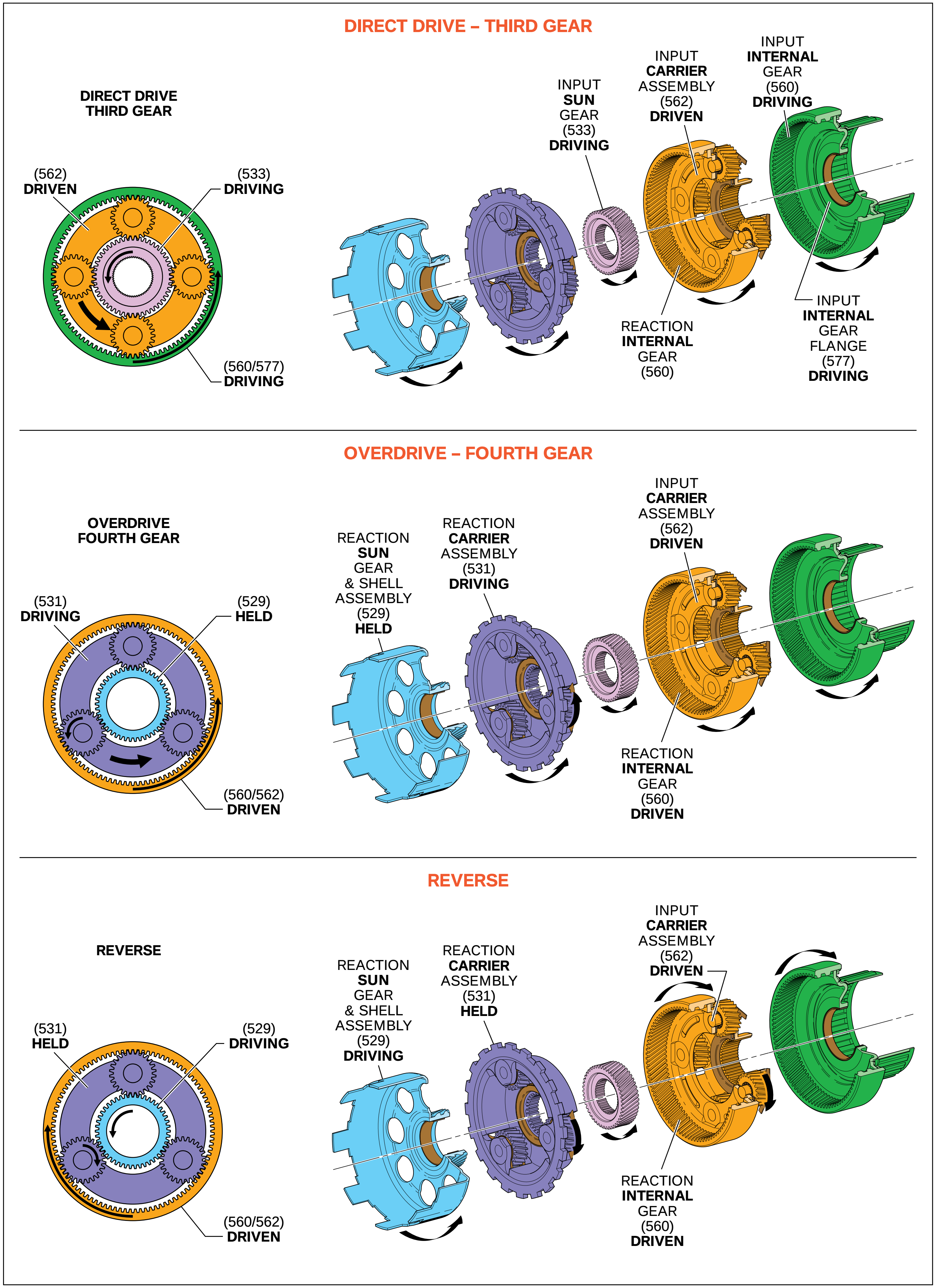
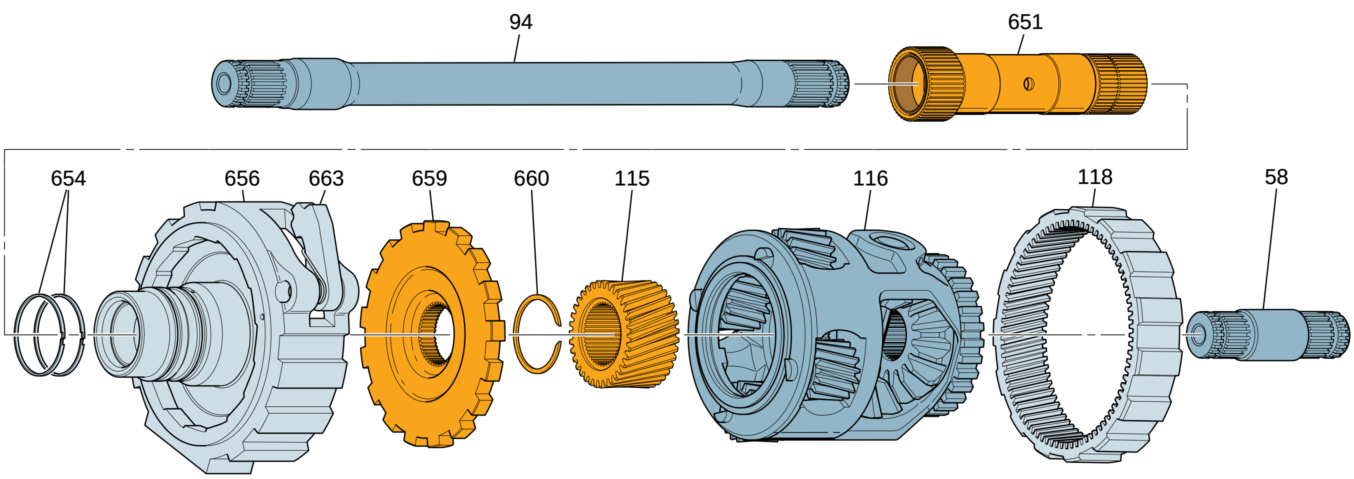


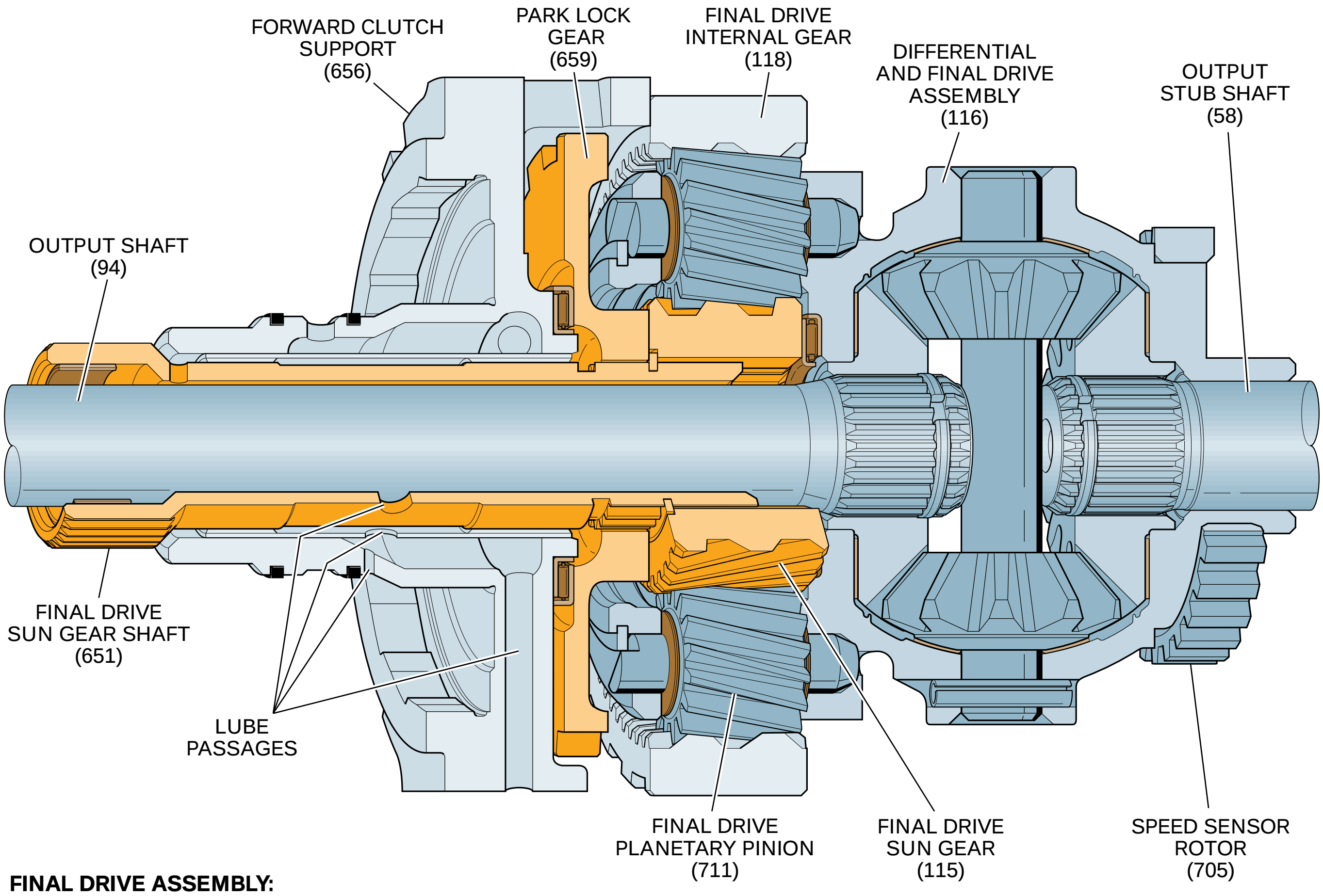
Figure 29

FINAL DRIVE COMPONENTS



FINAL DRIVE AND DIFFERENTIAL ASSEMBLIES

The Hydra-matic 4T40-E transaxle 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 rear wheel drive vehicles.



FINAL DRIVE ASSEMBLY:

The final drive assembly is a planetary gear set consisting of a final drive internal gear (118) which is splined to the case, a final drive sun gear (115) which is splined to the final drive sun gear shaft (651) and, a differential and final drive assembly (116).

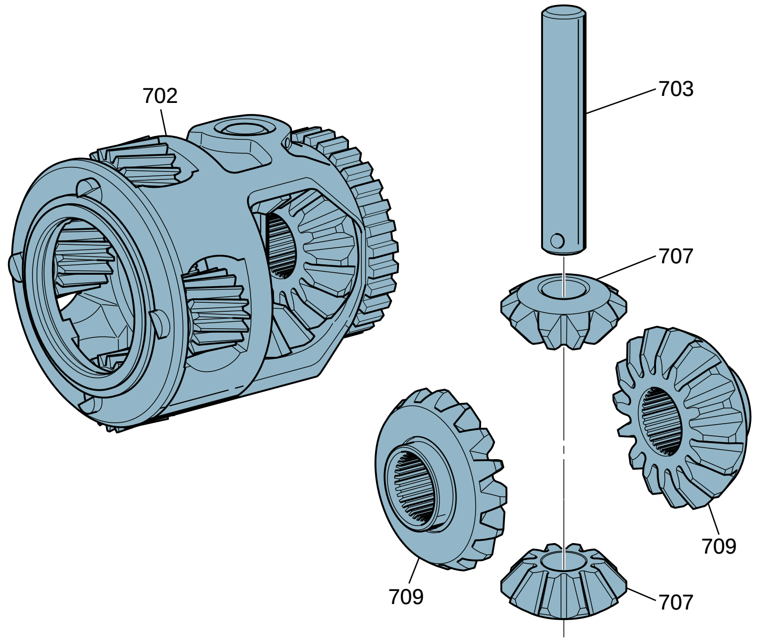
The final drive planetary gear set operates in reduction at all times at a ratio determined by a relationship of the final drive internal gear (118) to the final drive sun gear (115). In all forward gear ranges, the final drive sun gear shaft (651) drives the final drive sun gear (115) in the same direction as engine rotation. Since the final drive sun gear teeth are in mesh with the final drive planetary pinion gears (711), the planetary pinion gears are driven in the opposite direction as they rotate inside the final drive internal gear (118). This causes the differential and final drive assembly (116) to be driven in the same direction as engine rotation, powering the vehicle forward.

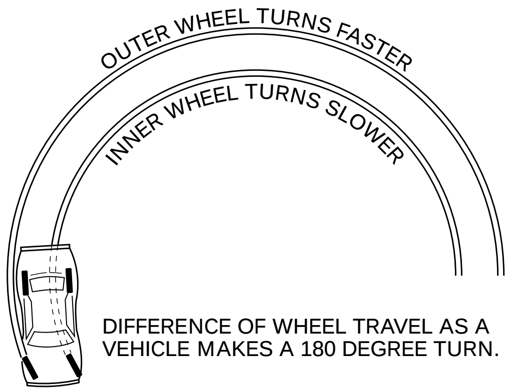
The gear ratio of the differential and final drive assembly (116) performs the same function as the ring and pinion gears in a rear wheel drive vehicle. It is a fixed ratio that matches a specific engine and vehicle combination in order to meet the performance requirements for all operating conditions.

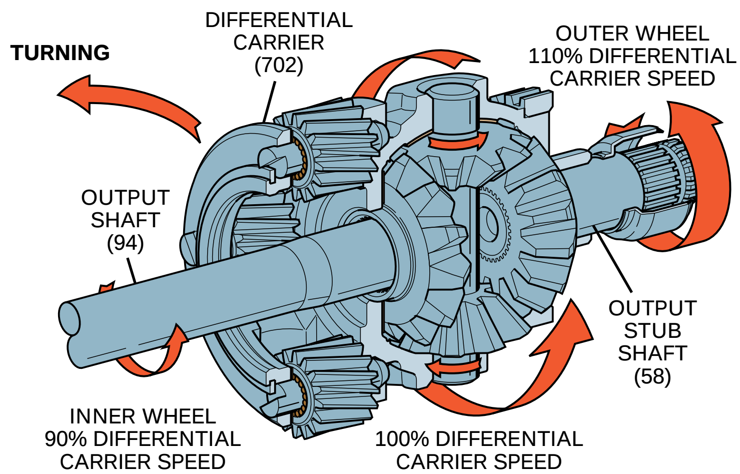
Figure 30

DIFFERENTIAL CARRIER ASSEMBLY:
The (final drive) differential carrier assembly (702) provides the means for allowing one driving wheel to travel faster than the other when the vehicle is going around corners or curves. (The wheel on the outside of the curve has to turn faster.) The differential carrier assembly (702) consists of: a differential and final drive carrier assembly; four bevelled gears (707 & 709); and a differential pinion shaft (703). Two bevelled gears, the differential side gears (709), are connected to the axle shafts. The left hand axle shaft is splined to the output shaft (94), which is splined to the left differential side gear. The right hand axle is splined to the stub shaft (58), which is splined to the right differential side gear. The other two bevelled gears, the differential pinion gears (707), act as idlers to transfer the power from the differential carrier (702) to the differential side gears (709). The differential pinion gears (707) also balance the power load between the differential side gears (709) while allowing unequal axle rotation speeds when the vehicle is in a curve.

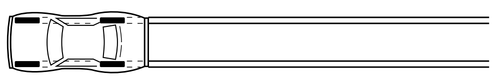
Final drive/differential failure can cause loss of drive.







When the vehicle is driven in a straight line, the differential pinion gears (707), differential side gears (709) and differential carrier (702) 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.



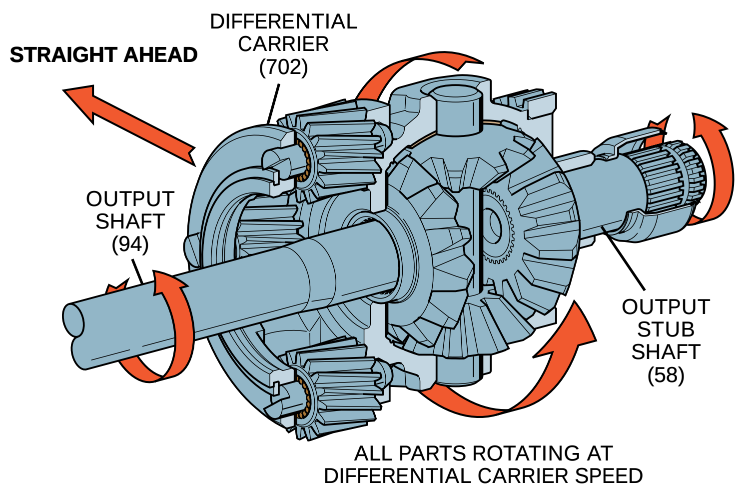


Figure 31

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HYDRAULIC CONTROL COMPONENTS

The previous sections of this book were used to describe some of the mechanical component operation of the Hydra-matic 4T40-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 transaxle.

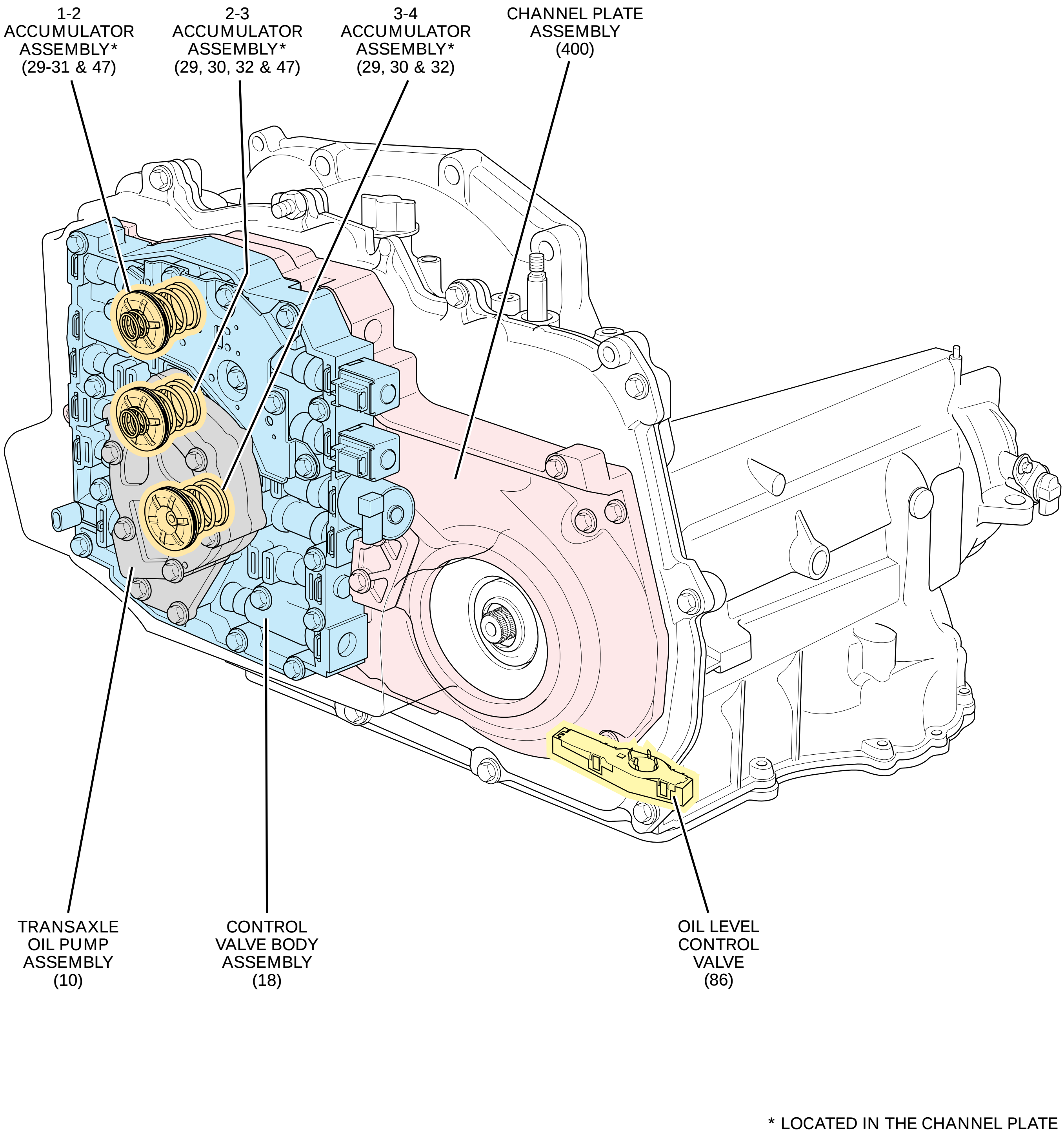
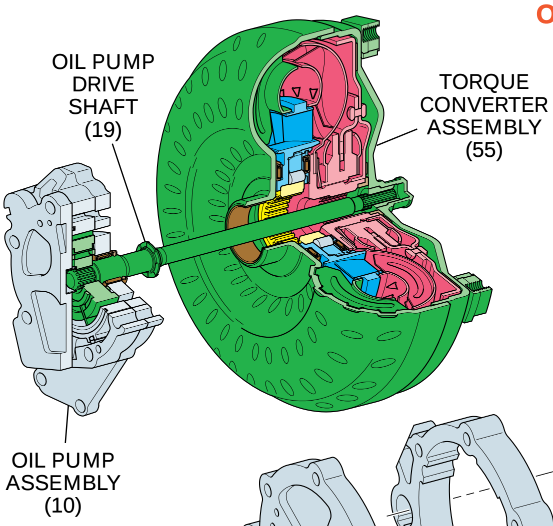


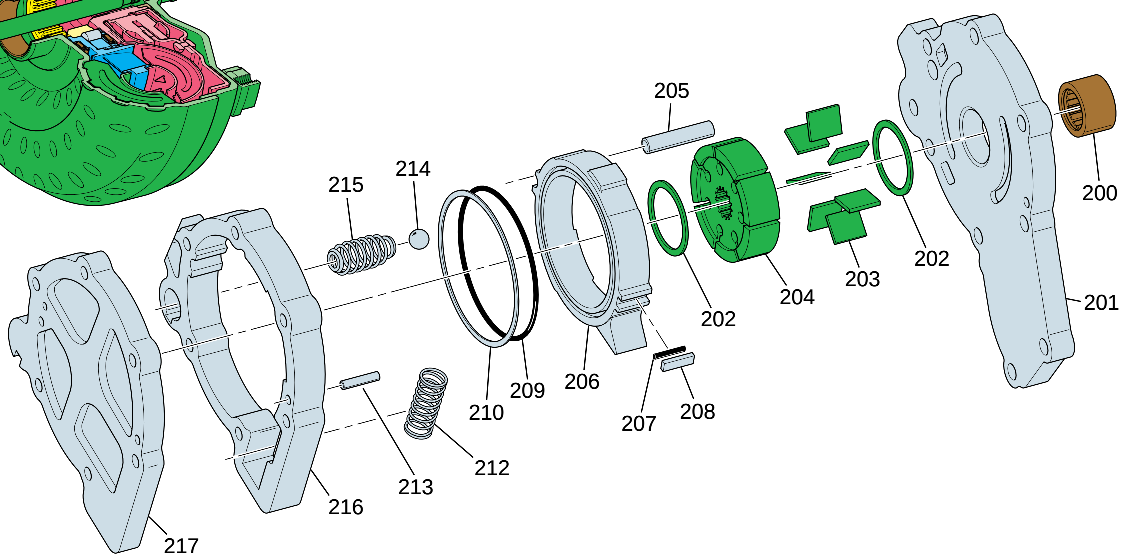
Figure 32

OIL PUMP ASSEMBLY



Pump Related Diagnostic Tips

- Loss of drive
- High or low line pressure
- High pitched whine - RPM sensitive

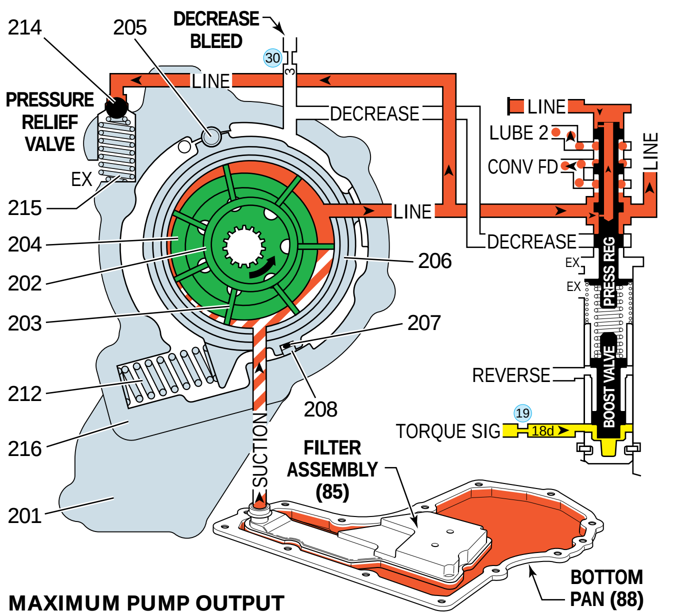


The oil pump assembly (10) contains a variable displacement vane type pump located in the oil pump body (216). When the engine is running, the oil pump drive shaft assembly (19), which is splined to the torque converter cover, turns the oil pump rotor (204) at engine speed. As the oil pump rotor (204) and pump vanes (203) begin to rotate, the volume of fluid between the vanes expands to it's maximum, creating a vacuum at the pump intake port. This vacuum allows atmospheric pressure (acting on the fluid in the sump) to prime the pump quickly and pressurize the hydraulic system when the engine is running.

Fluid from the transaxle oil pan is drawn through the filter assembly and into the pump intake circuit. Fluid is then forced to rotate around the oil pump slide (206) to the pump outlet where the clearance between the oil pump slide (206) and oil pump rotor (204) decreases. Transaxle fluid is then forced out of the pump into the line fluid passage and called line pressure thereby providing the main supply of fluid to the various components and hydraulic circuits in the transaxle. Since the pump assembly (10) is bolted to the control valve body assembly (18), it also functions as a device that transfers fluids to other components within the transaxle.

The events described above occur when the pump is operating with maximum output. Since most normal driving conditions do not require maximum output, a calibrated decrease pressure from the pressure regulator valve (328) is applied to the backside of the oil pump slide (206). Decrease pressure moves the slide against the force of the pump priming spring to lower the output of the pump. When the pump priming spring (212) is compressed and the oil pump slide contacts the oil pump body, minimum pump output occurs.

The pressure relief ball (214) and spring (215) prevent line pressure from exceeding 1,690-2,480 kPa (245-360 psi).



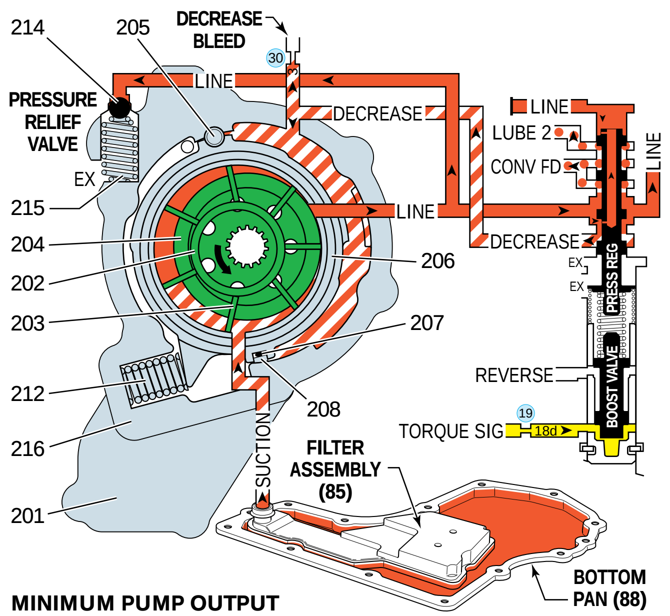


Figure 33

HYDRAULIC CONTROL COMPONENTS

PRESSURE REGULATION

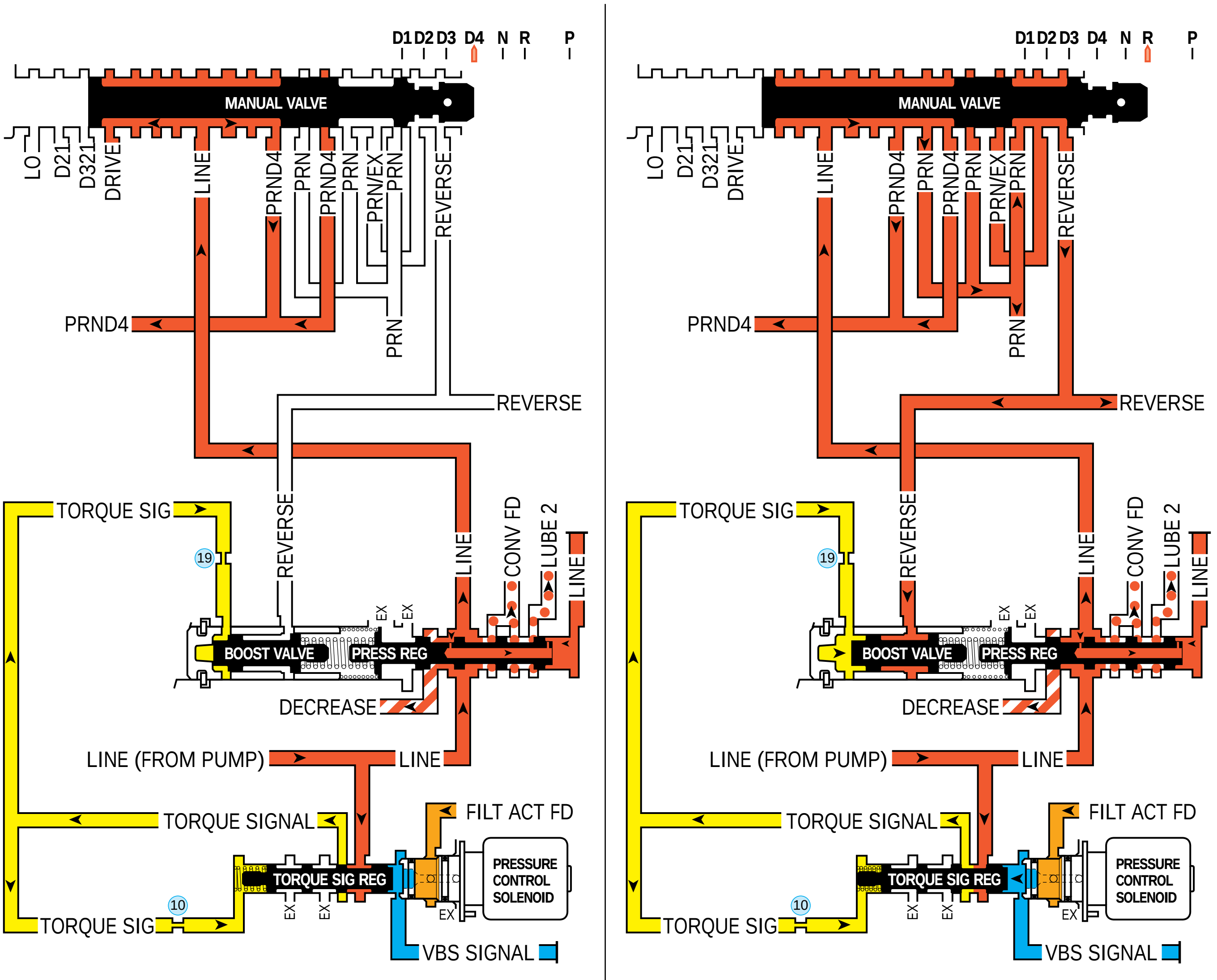
The main component that is used to control line pressure is the pressure regulator valve (328), located in the valve body (18). When the pump is operating at maximum output line pressure from the pump moves the pressure regulator valve against spring force. This allows line pressure to quickly fill the converter feed passage and also enter the decrease passage. Decrease fluid pressure acts on the pump slide to overcome the spring force of the pump priming spring (212) and moves the slide. As the slide moves towards the center of the pump body (216), clearance on the intake side of the oil pump slide (206) and oil pump rotor (204) decreases. This movement of the oil pump slide lowers the pump output capacity to maintain proper line pressures.

The position of the oil pump slide and pressure regulator valve constantly change depending on vehicle operation and the amount of fluid pressure and volume needed to operate the transaxle. The fluid pressure required to apply clutches and bands also varies in relation to throttle opening and engine torque. The pressure control solenoid (312) provides the means to regulate line pressure in response to PCM command.

Pressure Regulator Related Diagnostic Tips

A stuck or damaged pressure regulator valve could cause:

- High or low line pressure
- Slipping clutches or bands
- Low or no cooler/lube flow

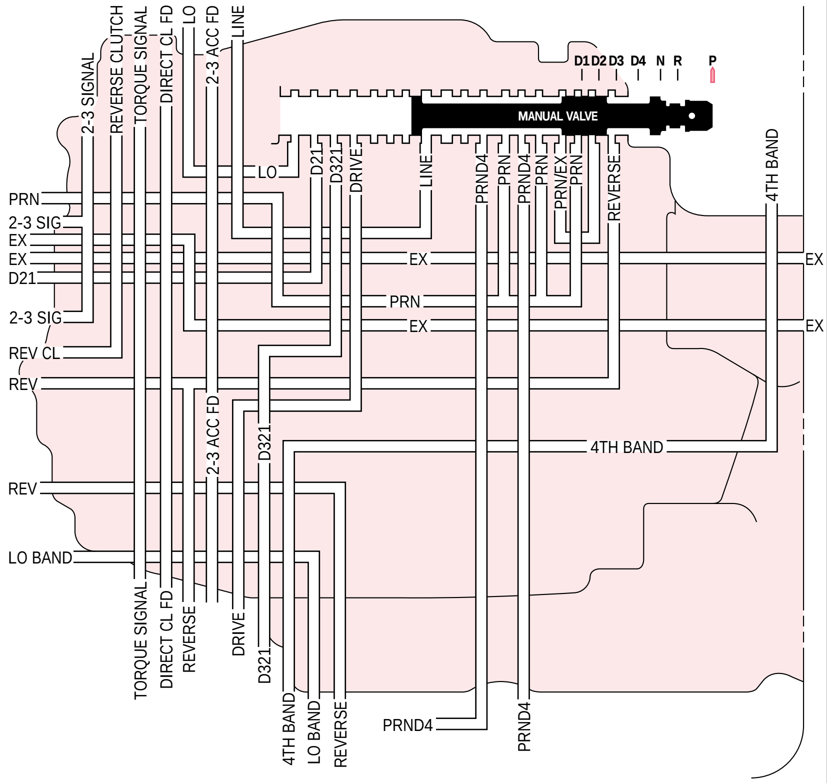


NORMAL PRESSURE **BOOSTED PRESSURE (REVERSE)**

Figure 34

VALVES LOCATED IN THE CHANNEL PLATE

MANUAL VALVE (404):
The manual valve (800) is fed by line pressure from the pressure regulator valve and is mechanically linked to the gear selector lever. When a gear range is selected, the manual valve directs line pressure into the various circuits by opening and closing feed passages. The circuits that are fed by the manual valve are: Reverse, PRN, PRN/EX, PRND4, Drive, D321, D21 and Lo.



Manual Valve Related Diagnostic Tips

Stuck, misaligned or damaged 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

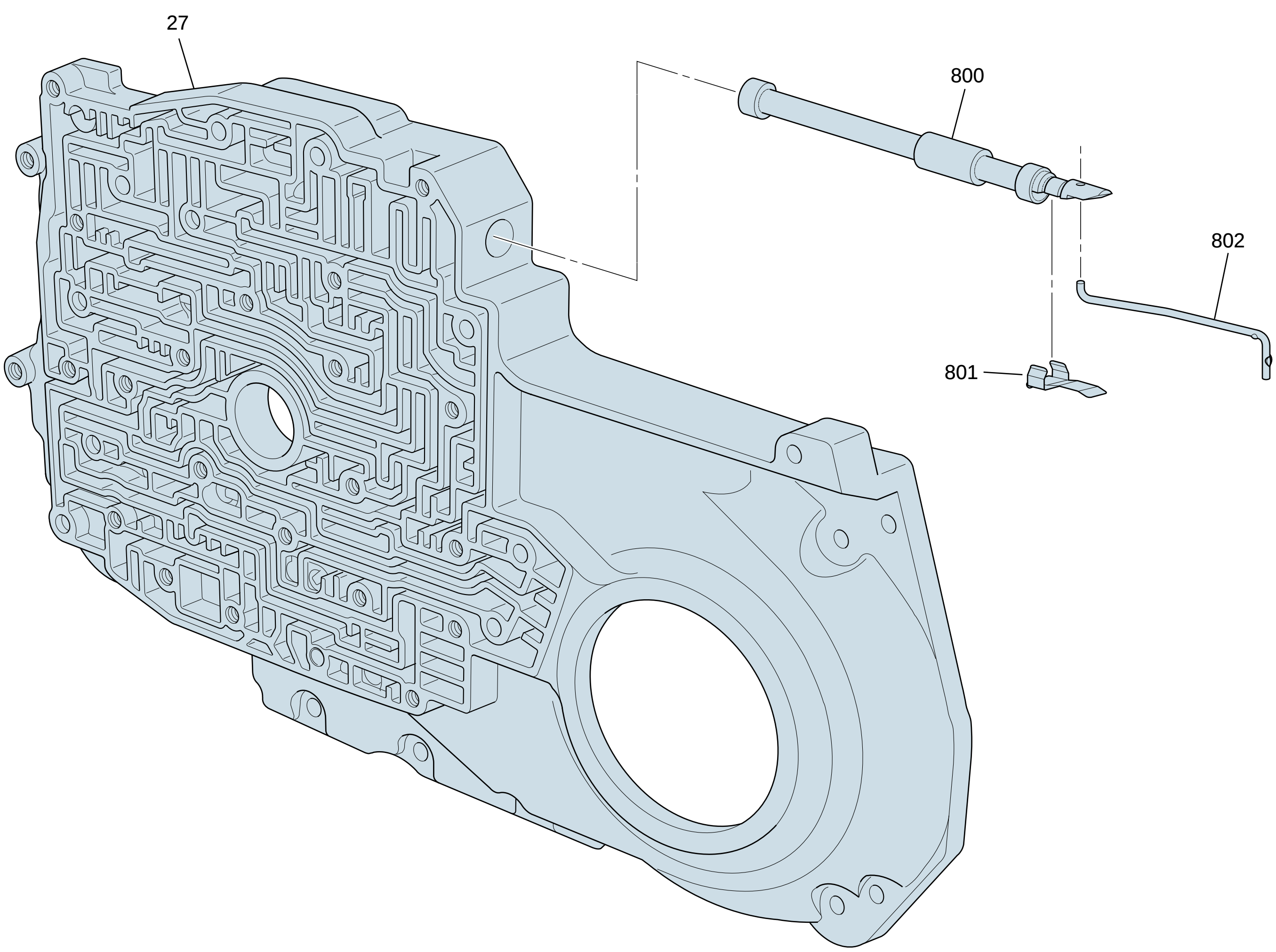


Figure 35

ACCUMULATORS

In the Hydra-matic 4T40-E, accumulators are used in the 2nd, Direct and 4th clutch apply circuits to control shift feel. An accumulator is a spring-loaded device that absorbs a certain amount of fluid pressure in a circuit to cushion clutch engagement according to engine torque. The clutch apply fluid pressure acts against spring force and Torque Signal biased accumulator pressure to act like a shock absorber.

During the apply of the 2nd and Direct clutch packs apply fluid overcomes the clutch piston return springs and begins to compress the clutch plates. When the clearance between the clutch plates is taken up by piston travel and the clutch begins to apply, pressure in the circuit builds up rapidly. Without an accumulator in the circuit, this rapid buildup of fluid pressure would cause the clutch to grab very quickly and create a harsh shift. However, accumulator spring force and accumulator fluid pressure is designed to absorb some of the clutch apply fluid pressure allowing for a more gradual apply of the clutch. The same principle is true for the Fourth band. An accumulator is used to soften the servo piston apply to avoid a harsh apply of the band around the drum.

The force of the accumulator spring and accumulator fluid pressure together control the rate at which a clutch applies. In the Hydra-matic 4T40-E, accumulator pressure varies in proportion to the torque signal pressure acting on the accumulator valves. Therefore, when torque signal pressure is high, accumulator pressure will be high. Likewise, when torque signal pressure is low, accumulator pressure will be low. Since torque signal pressure is a function of throttle position and engine torque (through the pressure control solenoid), the accumulator valves regulate accumulator fluid pressure in proportion to throttle position and engine torque to control shift feel.

The three accumulators used in the 4T40-E are all located between the case (51) and the channel plate (27).

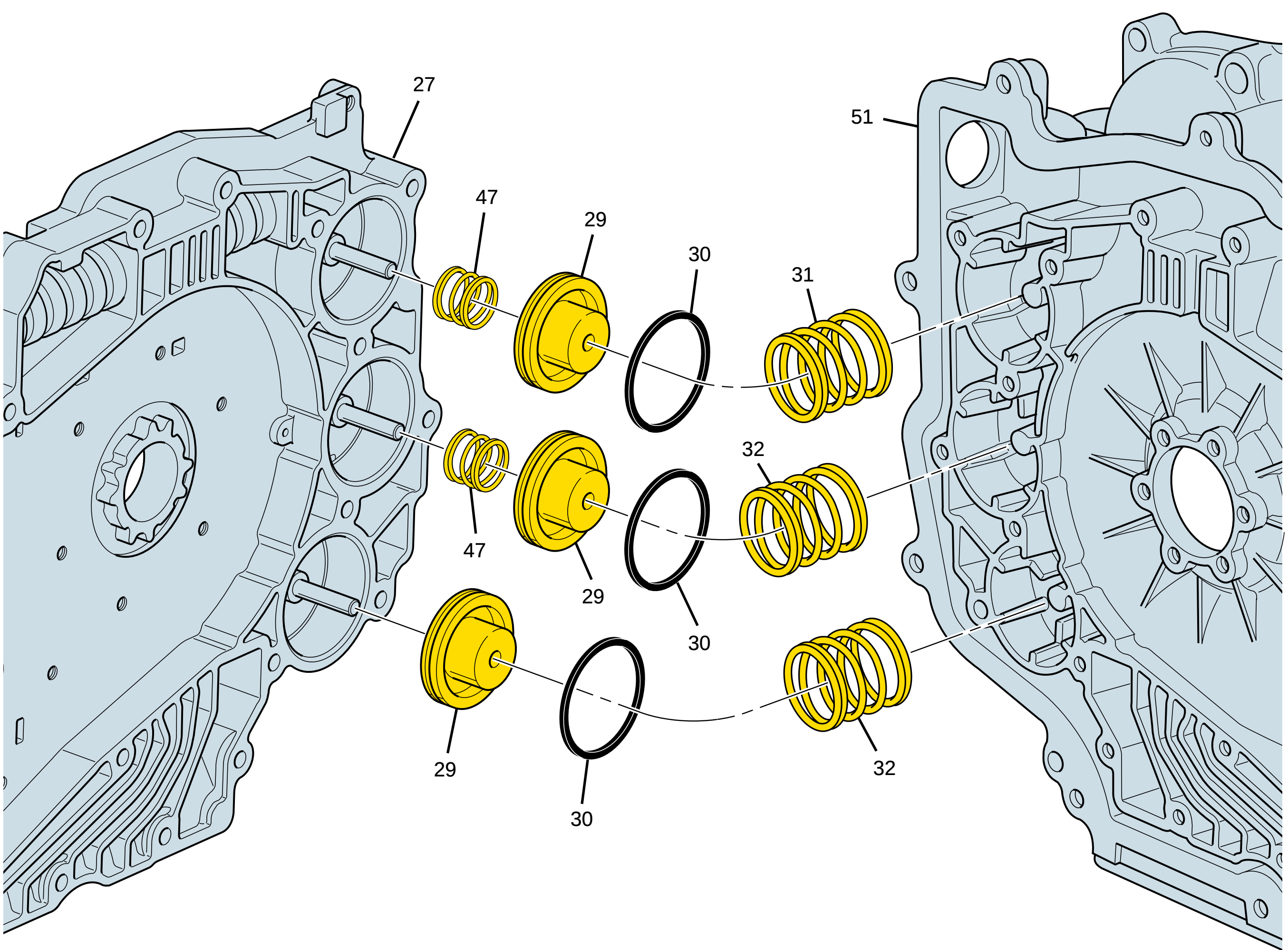


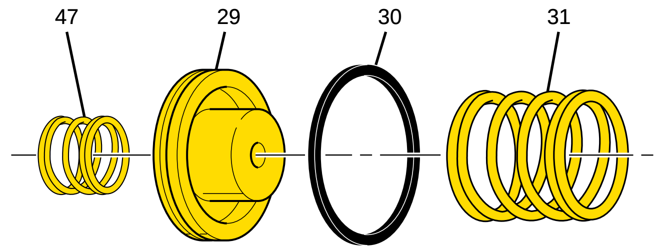
Figure 36

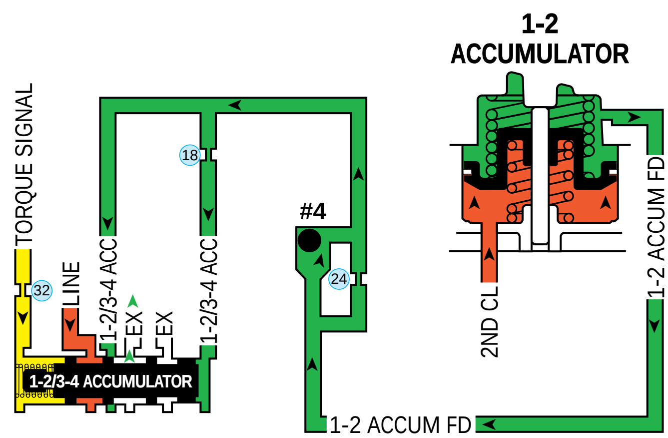
ACCUMULATORS

1-2 ACCUMULATOR ASSEMBLY (29-31, 47):
Shift feel for a 1-2 shift and durability of the 2nd clutch is largely dependent upon 2nd clutch fluid pressure used to apply the clutch. To control 2nd clutch apply pressure and shift feel, a 1-2 accumulator assembly (29-31, 47) and 1-2 accumulator fluid pressure is used in addition to the 2nd clutch wave plate (96).

Fluid pressure in the 1-2 accumulator passage occurs when line fluid pressure is regulated at the 1-2/3-4 accumulator valve (323) by torque signal fluid pressure and spring force. Regulated line fluid pressure is then directed into the 1-2/3-4 accumulator passage where it is routed through orifice #18 to the other end of the accumulator valve where it will oppose torque signal fluid pressure and spring force to regulate 1-2/3-4 accumulator fluid pressure. 1-2/3-4 accumulator fluid is also routed to checkball #4 which now seats and forces the fluid through orifice #24 before entering the 1-2 accumulator housing on the return spring side of the piston.

When the 2nd clutch applies during a 1-2 shift, 2nd clutch fluid pressure is fed to the 1-2 accumulator piston (29) and compresses the 1-2 accumulator return spring (31). When this occurs, 1-2 accumulator fluid is forced out of the accumulator housing, unseats checkball #4 and then goes back to the 1-2/3-4 accumulator valve where it exhausts. Torque signal fluid pressure and spring force at the 1-2/3-4 accumulator valve regulate exhausting 1-2 accumulator fluid to control 2nd clutch apply.





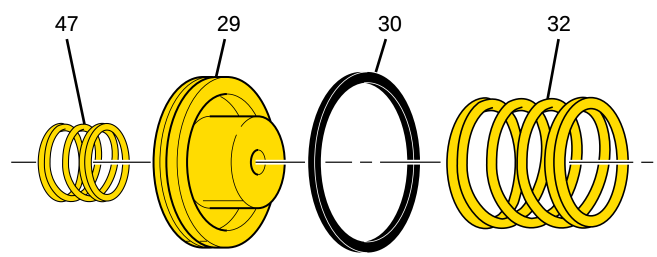
1-2 Accumulator Related Diagnostic Tips

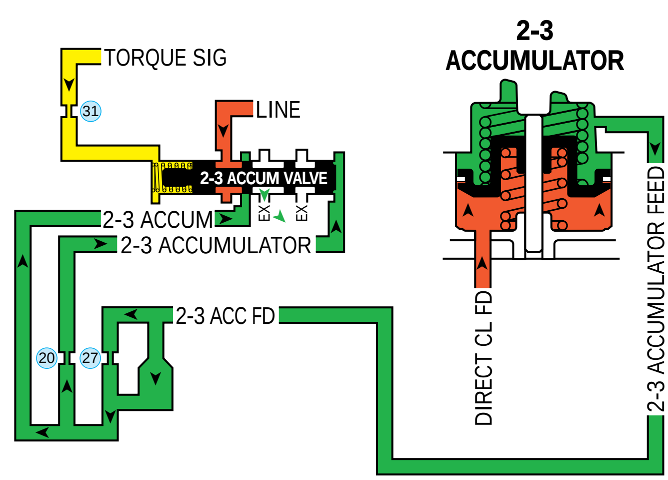
- A leak at the accumulator piston seal or porosity in the case or channel plate could cause no second gear/slips in second gear
- A stuck accumulator piston would cause harsh shifts

2-3 ACCUMULATOR ASSEMBLY (29, 30, 32, 47):
Shift feel for a 2-3 shift and durability of the direct clutch is regulated the same as 1-2 shift feel, except the accumulator spring (32) is calibrated for 3rd gear. To control direct clutch apply pressure and shift feel, a 2-3 accumulator assembly (29, 30, 32, 47) and 2-3 accumulator fluid pressure is used.

Fluid pressure in the 2-3 accumulator passage occurs when line fluid pressure is regulated at the 2-3 accumulator valve (330) by torque signal fluid pressure and spring force. Regulated line fluid pressure is then directed into the 2-3 accumulator passage where it is routed through orifice #20 to the other end of the accumulator valve where it will oppose torque signal fluid pressure and spring force to regulate 2-3 accumulator fluid pressure. 2-3 accumulator fluid is also routed to the 1-2 accumulator housing on the return spring side of the piston.

When the direct clutch applies during a 2-3 shift, direct clutch fluid pressure is fed to the 2-3 accumulator piston (29) and compresses the 2-3 accumulator return spring (32). When this occurs, 2-3 accumulator fluid is forced out of the accumulator housing, and goes back to the 2-3 accumulator valve where it exhausts. Torque signal fluid pressure and spring force at the 2-3 accumulator valve regulate exhausting 2-3 accumulator fluid to control direct clutch apply.





2-3 Accumulator Related Diagnostic Tips

- A leak at the accumulator piston seal or porosity in the case or channel plate could cause no third gear/slips in third gear
- A stuck accumulator piston would cause harsh shifts

Figure 37

ACCUMULATORS

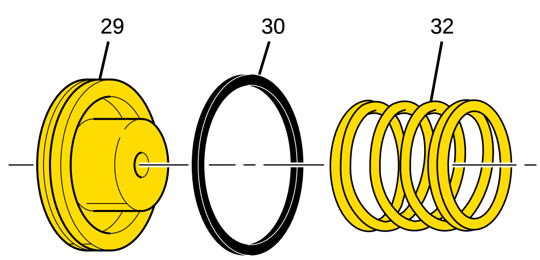
3-4 ACCUMULATOR ASSEMBLY (29, 30, 32):
Shift feel for a 3-4 shift and durability of the intermediate/4th band is regulated in the same way as 1-2 and 2-3 shift feel. In fact, it shares the 1-2/3-4 accumulator valve and fluid circuit with the 1-2 accumulator up to their respective checkballs. It is able to use the same valve and circuit because the 1-2 shift has already occurred and the second clutch is now holding, so there will be no pressure interference from 3-4 accumulator regulation.

Fluid pressure in the 3-4 accumulator passage occurs when line fluid pressure is regulated at the 1-2/3-4 accumulator valve (323) by torque signal fluid pressure and spring force. Regulated line fluid pressure is then directed into the 1-2/3-4 accumulator passage where it is routed through orifice #18 to the other end of the accumulator valve where it will oppose torque signal fluid pressure and spring force to regulate 3-4 accumulator fluid pressure. 3-4 accumulator fluid is also routed to checkball #7 which now seats and forces the fluid through orifice #28 before entering the 3-4 accumulator housing on the return spring side of the piston.

When the intermediate/4th servo applies during a 3-4 shift, 4th band fluid pressure is fed to the 3-4 accumulator piston (29) and compresses the 3-4 accumulator return spring (32). When this occurs, 3-4 accumulator fluid is forced out of the accumulator housing, and goes back to the 1-2/3-4 accumulator valve where it exhausts. Torque signal fluid pressure and spring force at the 1-2/3-4 accumulator valve regulate exhausting 1-2/3-4 accumulator fluid to control intermediate/4th servo apply.

3-4 Accumulator Related Diagnostic Tips

- A leak at the accumulator piston seal or porosity in the case or channel plate could cause no fourth gear/slips in fourth gear
- A stuck accumulator piston would cause harsh shifts



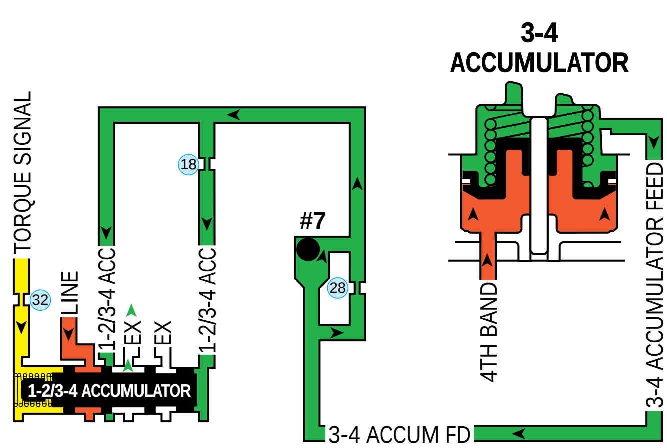


Figure 38

HYDRAULIC CONTROL COMPONENTS

VALVES LOCATED IN THE VALVE BODY

1-2/3-4 Accumulator Valve (323):
The 1-2/3-4 accumulator is biased by torque signal fluid pressure on one end and 1-2/3-4 accumulator fluid pressure on the other. The valve allows line fluid to enter the 1-2/3-4 accumulator fluid circuit and also allows 1-2/3-4 accumulator fluid to exhaust when the 1-2 or 3-4 accumulators are stroked.

- If stuck, the 1-2/3-4 accumulator valve could cause harsh or soft 1-2 or 3-4 upshifts.

PRESSURE REGULATOR VALVE TRAIN (324-328)

Pressure Regulator Valve (328):
The pressure regulator valve (328) regulates line pressure to: the manual valve, the converter feed circuit and the decrease passage to regulate pump output.

- A stuck pressure regulator valve could cause harsh or soft shifts
- Slipping or soft TCC apply

Pressure Regulator Boost Valve (325):
Acted on by reverse fluid from the manual valve and torque signal fluid, it moves against pressure regulator valve spring (326) pressure. Torque signal fluid increases line pressure in response to a high percentage of throttle travel. In reverse range, reverse fluid moves the valve to boost line pressures.

2-3 Accumulator Valve (330):
The 2-3 accumulator is biased by torque signal fluid pressure on one end and 2-3 accumulator fluid pressure on the other. The valve allows line fluid to enter the 2-3 accumulator fluid circuit and also allows 2-3 accumulator fluid to exhaust when the 2-3 accumulator is stroked.

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

CONVERTER CLUTCH VALVE SYSTEM

TCC Feed Limit Valve (332):
The torque converter clutch feed limit valve limits the maximum fluid pressure in the TCC feed limit fluid circuit and the torque converter.

- Stuck valve could cause low cooler/lube flow.

TCC Control Valve (334):
The torque converter clutch control valve is basically an on/off control valve. It is held in the TCC off position by spring force and is shuttled to the on position by TCC signal fluid pressure.

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

TCC Regulated Apply Valve (339):
Regulates line pressure into the TCC regulated apply circuit during TCC apply. Filtered 2-3 drive fluid pressure through the TCC PWM solenoid acts on one end, and TCC regulated apply fluid and spring force on the other.

- Stuck in the release position would cause no TCC/soft/slip apply.
- Stuck in the apply position would cause soft/harsh TCC applies.

TCC Control PWM Solenoid (335):
An electronically controlled pressure regulator that regulates filtered 2-3 drive fluid pressure into the TCC signal fluid circuit to shuttle the TCC control valve to the apply position. Regulated filtered 2-3 drive fluid pressure also shuttles the TCC regulator apply valve to allow line pressure into the TCC regulated apply circuit for a controlled apply and release of the torque converter clutch.

- 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.

1-2 SHIFT VALVE TRAIN (301-305)

1-2 Shift Solenoid (305):
The 1-2 Shift Solenoid (305) is a normally open 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. When energized (ON), it's exhaust port closes and, depending on range, 1-2 signal fluid shuttles the 1-2 shift valve.

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

1-2 Shift Valve (302):
The 1-2 shift valve responds to 1-2 signal fluid pressure, force from the 1-2 shift valve spring (301) and 2-3 signal fluid pressure. Directs fluid for 1-2 and 2-1 shifts.

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

2-3 SHIFT VALVE TRAIN (303-307)

2-3 Shift Solenoid (305):
The 2-3 Shift Solenoid (305) is a normally open 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. When energized (ON), it's exhaust port closes and, depending on range, 2-3 signal fluid shuttles the 2-3 shift valve.

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

2-3 Shift Valve (307):
The 2-3 shift valve (307) is controlled by 2-3 signal fluid pressure, force from the 2-3 shift valve spring (306) and actuator feed fluid pressure. Directs fluid for 2-3 and 3-2 shifts.

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

TORQUE SIGNAL REGULATOR VALVE TRAIN (308-312)

Torque Signal Regulator Valve (309):
Regulates torque signal fluid, fed by line fluid pressure. The pressure control solenoid, a variable bleed solenoid, acts on one end of the valve (relative to throttle position) against torque signal fluid and spring pressure on the other end.

- A stuck torque signal regulator valve can cause high or low line pressure.

HYDRAULIC CONTROL COMPONENTS

VALVES LOCATED IN THE VALVE BODY

Pressure Control Solenoid (312):
An electronically controlled pressure regulator that regulates the torque signal regulator valve against torque signal fluid and spring force.

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

Actuator Feed Limit Valve (315):
Is a spool type regulating valve that regulates line fluid pressure into actuator feed fluid pressure. Actuator feed fluid then feeds the shift solenoids after passing through a filter.

- If stuck in the exhaust position it could cause 2nd gear only and low line pressure.

3-4 Shift Valve (319):
The 3-4 shift valve (319) is controlled by 1-2 signal fluid pressure on one end of the valve and D321 fluid and spring (318) pressure at the other. When conditions are correct for a fourth gear shift the 1-2 solenoid is energized and 1-2 signal fluid pressure shuttles the 3-4 shift valve to allow 3-4 drive fluid to enter into the 4th band fluid circuit to apply the intermediate/4th servo.

- 3-4 shift valve stuck in the upshift position could cause no 3rd or slips in 3rd gear.
- 3-4 shift valve stuck in the downshift position could cause no 4th or slips in 4th gear.

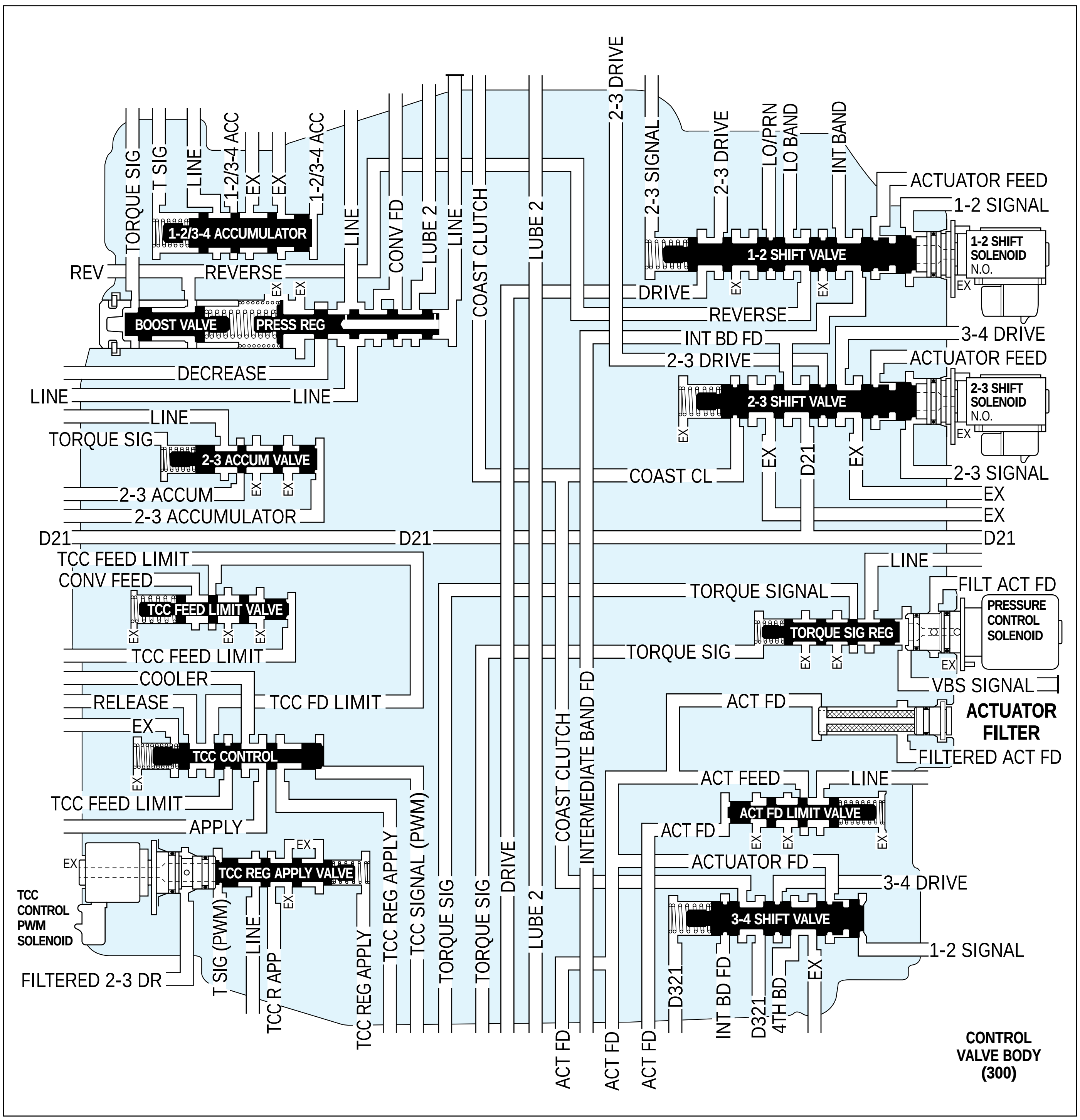


Figure 39

HYDRAULIC CONTROL COMPONENTS

CHECKBALL LOCATION AND FUNCTION

All of the checkballs in the 4T40-E are located in the channel plate, on the spacer plate side. Checkball #1 is used for direction control, while all of the other checkballs are designed to control shift feel, in conjunction with an orifice in the spacer plate.

#1 - Lo/PRN:
In Park, Reverse and Neutral this checkball directs PRN fluid to the Lo/PRN circuit. In manual first it directs Lo fluid to the Lo/PRN circuit.

#2 - 2-3 Drive/2nd Clutch:
Orificed 2-3 Drive fluid seats the checkball during a 1-2 upshift forcing fluid to pass through orifice #3 for a controlled apply of the second clutch. When 2nd fluid exhausts during a 2-1 downshift it unseats the checkball for a quick release of the second clutch.

#3 - Intermediate Band:
In manual second, Intermediate Band fluid seats the checkball and fluid must pass through orifice #8. When the manual valve is moved to any other gear range after being in second gear, in Manual Second or Manual First Ranges, the checkball will be unseated and exhausting Intermediate Band fluid will bypass the #8 orifice.

#4 - 1-2 Accumulator:
This checkball is seated during a 2-1 downshift, therefore 1-2 Accumulator fluid is forced to pass through orifice #24. During a 1-2 upshift the 1-2 accumulator is stroked by second clutch fluid. This forces 1-2 accumulator fluid to unseat the checkball and bypass orifice #24.

Checkball Related Diagnostic Tips

Understanding the design principle of each checkball will help in the diagnosis of hydraulic related problems. For example:

- a harsh shift complaint could be a stuck or missing checkball
- no reverse or slips in reverse could be the #1 checkball stuck or missing.
- no engine compression braking in manual first could also be a missing or stuck checkball #1.

#5 - Direct Clutch Feed:
This checkball is used for shift apply control. It is seated by 3-4 Drive fluid during a 2-3 upshift. 3-4 Drive fluid is forced through orifice #26, into the Direct Clutch Feed circuit. The checkball is unseated during a 3-2 downshift and fluid exhausts quickly, as it has already been controlled by checkball #6, which is designed for release control.

#6 - Direct Clutch Exhaust:
This checkball is used for shift release control by seating during a 3-2 downshift to control exhausting Direct Clutch fluid. The exhausting fluid then flows through orifice #25.

#7 - 3-4 Accumulator:
This checkball is seated by 3-4 Accumulator fluid during a 4-3 downshift, thus forcing 3-4 Accumulator fluid to pass through orifice #26. During a 3-4 upshift the 3-4 accumulator is stroked by 4th Band fluid. This forces 3-4 Accumulator fluid to unseat the checkball and bypass orifice #26.

HYDRAULIC CONTROL COMPONENTS

CHECKBALL LOCATION AND FUNCTION

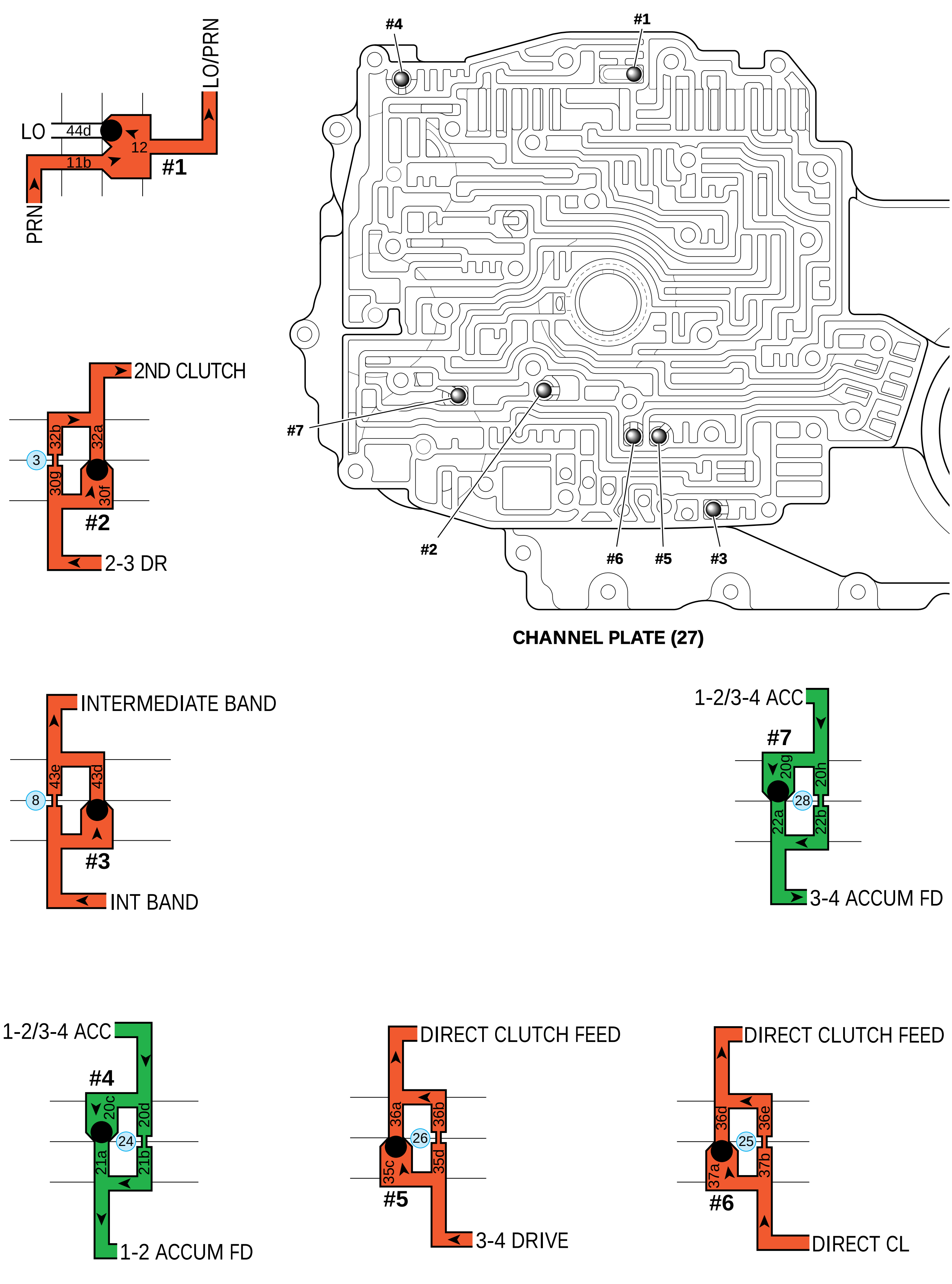
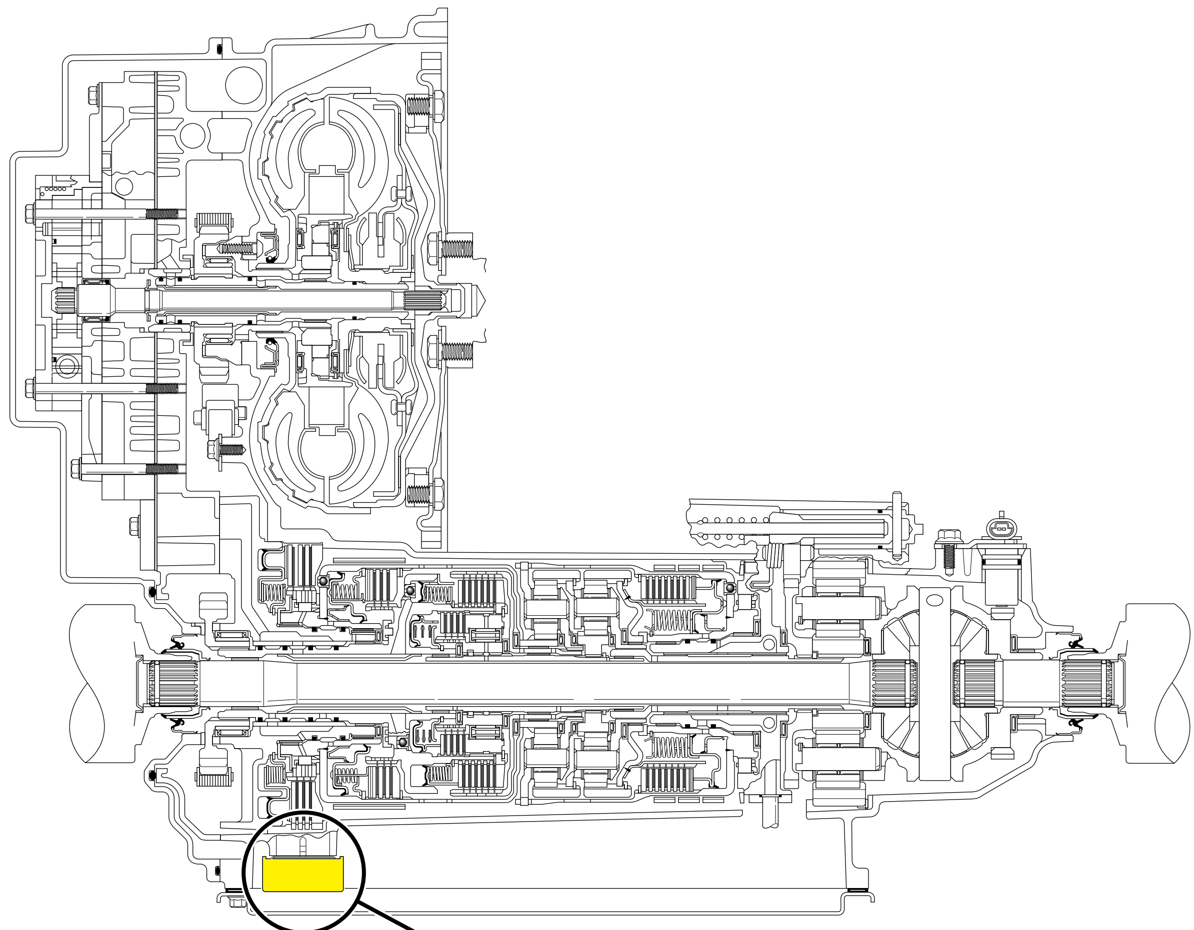
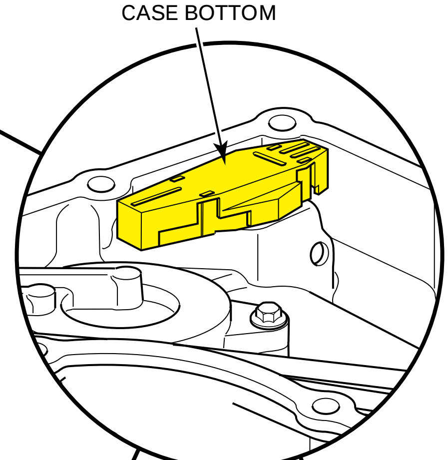


Figure 40

HYDRAULIC CONTROL COMPONENTS

THERMOSTATIC ELEMENTS





OIL LEVEL CONTROL VALVE:

The Oil Level Control Valve (86) is located on the case bottom pan side, and is designed to control the fluid level in the case side cover pan (1). At low temperatures, the thermostatic element exerts little pressure on the thermostatic element plate allowing fluid to drain into the sump. As the temperature of the fluid increases, the thermostatic element begins to apply pressure to the thermostatic element plate, thereby trapping fluid in the case side cover pan (1). This level of transaxle fluid is required in order to maintain the operation of the hydraulic system in the transaxle.

It should be noted that when checking the fluid level in a Hydra-matic 4T40-E transaxle, it will be higher when the transaxle is cold. Conversely, the fluid level will drop when checked at operating temperatures. This event is a result of the case Oil Level Control Valve (86) functioning as explained.

Oil Level Control Valve Related Diagnostic Tips

A damaged or loose oil level control valve could cause fluid foaming or incorrect fluid level.

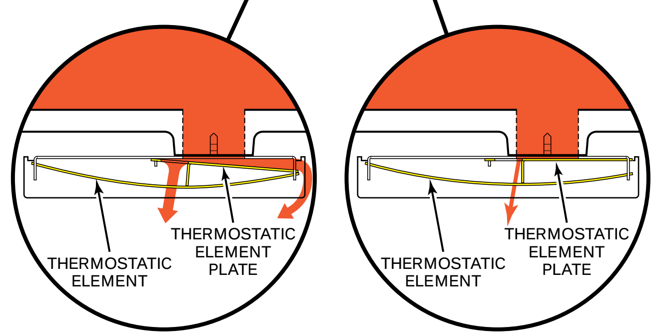


Figure 41

ELECTRICAL COMPONENTS

The Hydra-matic 4T40-E transaxle 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 transaxle). The PCM then processes this information for proper control of the following:

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

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

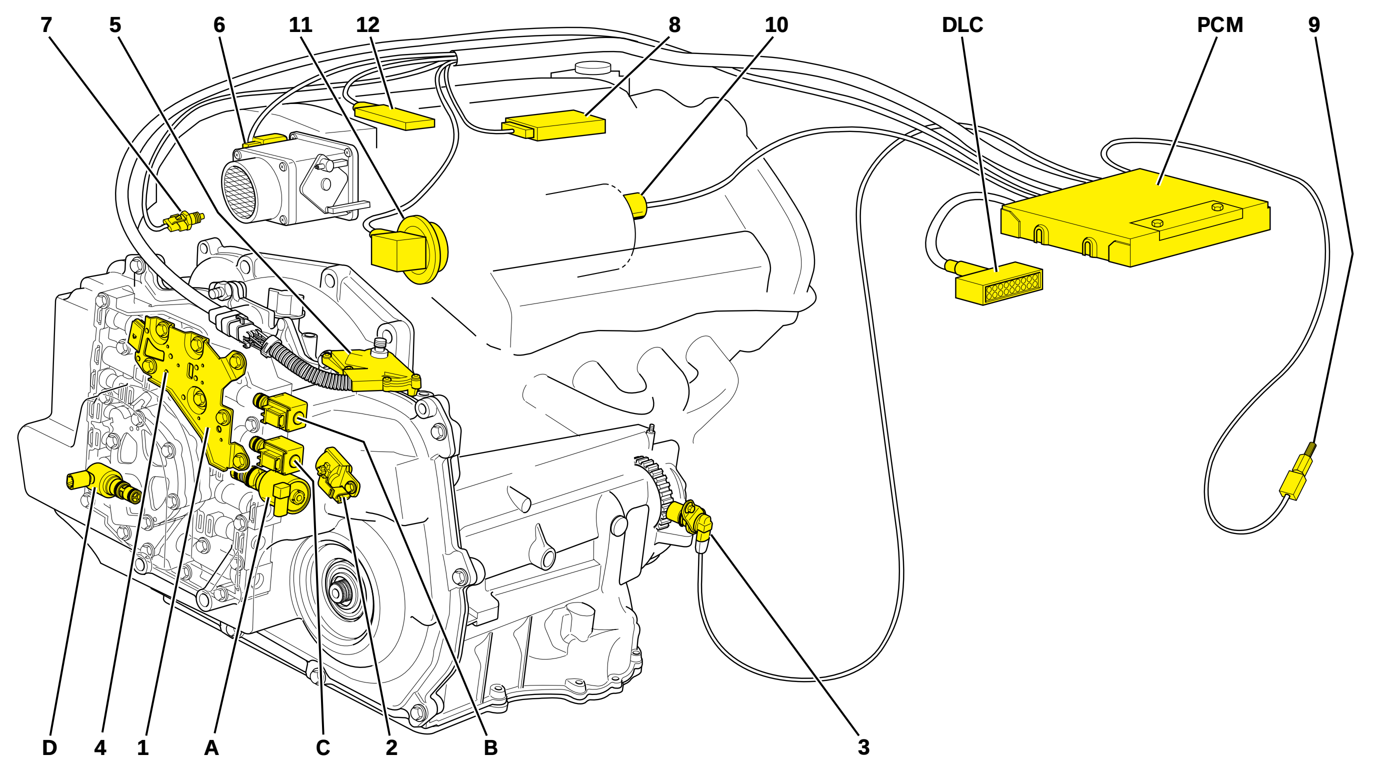
FAIL-SAFE MODE

"Fail-safe mode" is an operating condition where the transaxle 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 transaxle electrical components to "default" to OFF. While the transaxle is operating in the fail-safe mode example given, the following operating changes occur:

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

When both shift solenoids are OFF, the transaxle will operate in Second gear regardless of the forward gear selected (i.e. Overdrive, 3, 2, or 1). However, the transaxle 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 transaxle. 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 transaxle.



INPUTS

INFORMATION SENSORS

1. TRANSAXLE FLUID PRESSURE SWITCH ASM. (PSA)
2. TRANSAXLE INPUT SPEED (TISS) SENSOR
3. TRANSAXLE VEHICLE SPEED SENSOR (VSS)
4. TRANSAXLE FLUID TEMPERATURE (TFT) SENSOR
5. TRANSAXLE RANGE SWITCH
6. THROTTLE POSITION SENSOR (TPS)
7. ENGINE COOLANT TEMPERATURE SENSOR (ECT)
8. ENGINE SPEED (IGNITION MODULE)
9. TCC BRAKE SWITCH
10. AIR CONDITIONING (A/C) SWITCH
11. CRUISE CONTROL INFORMATION
12. MANIFOLD ABSOLUTE PRESSURE SENSOR (MAP)

ELECTRONIC CONTROLLERS

- POWERTRAIN CONTROL MODULE (PCM)
- DIAGNOSTIC LINK CONNECTOR (DLC)

OUTPUTS

ELECTRONICALLY CONTROLLED TRANSAXLE COMPONENTS

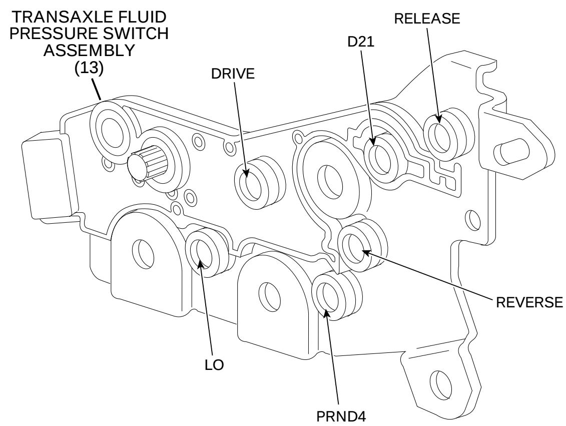
A. PRESSURE CONTROL SOLENOID (PCS)

B. 1-2 SHIFT SOLENOID

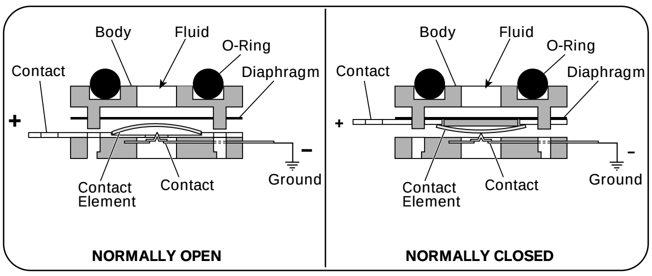
C. 2-3 SHIFT SOLENOID

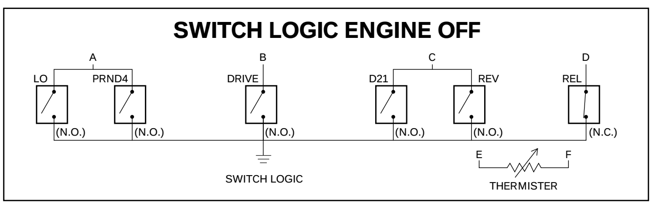
D. TCC CONTROL (PWM) SOLENOID

Figure 42



A Transaxle Fluid Pressure Switch Assembly malfunction will set a DTC P1810 and the PCM will command the following default actions:
- DTC P1810 will be stored in PCM history.
- Freeze shift adapts.
- Assume D4 shift pattern.
- Inhibit TCC engagement.
- Elevate line pressure.

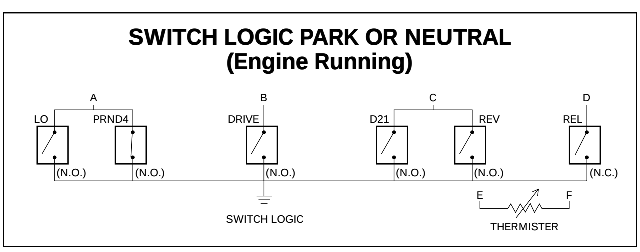




RANGE INDICATOR	FLUID*					CIRCUIT+		
	REV	PRND4	DR	D21	LO	A	B	C
Park/Neutral	0	1	0	0	0	1	0	0
Reverse	1	1	0	0	0	1	0	1
Overdrive	0	1	1	0	0	1	1	0
Manual Third	0	0	1	0	0	0	1	0
Manual Second	0	0	1	1	0	0	1	1
Manual First	0	0	1	1	1	1	1	1

*: 1 = Pressurized
0 = Exhausted

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



Transaxle Fluid Pressure Switch Assembly (13)

The pressure switch assembly (PSA) is attached to the valve body and contains six fluid pressure switches and the transaxle temperature sensor (refer to the separate description of the temperature sensor). Five of the fluid pressure switches (PRND4, DRIVE, LO, D21, REV) are normally open and are used to indicate the position of the manual valve. The PCM uses this information to control line pressure, TCC apply and release and shift solenoid operation.

The RELEASE pressure switch is a normally closed pressure switch. This switch is used as a diagnostic tool to confirm that the TCC is actually OFF when it has been commanded OFF by the PCM.

Each fluid pressure switch produces either an open or ground to the PCM depending on the presence of fluid pressure at the switches. The sequence of open and closed switches produces a combination of voltage readings that are monitored by the PCM (see chart and switch logic diagram). The PCM measures PSA signal voltage from each pin to ground and compares the voltage to a PSA combination chart stored in the PCM memory. If the PCM does not recognize the switch sequence a diagnostic code will be set as a result. A diagnostic code may also be set if the PSA switch sequence indicates a gear range selection that conflicts with other sensory inputs to the PCM.

Normally Open Pressure Switch Operation: (PRND4, DRIVE, LO, D21, REV)

When the engine is started and fluid is routed to a switch, fluid pressure moves a diaphragm and contact element until the contact touches both the positive (+) and ground (⏚) contacts. The switch is now in a closed position and it allows current to flow from the positive contact through the switch to ground. The completed circuit changes the switch state thereby electronically signalling the PCM the position of the manual valve.

Normally Closed Pressure Switch Operation: (RELEASE)

The release switch is in a closed position and allows current to flow from the positive contact through the switch to ground when no fluid is present. Release fluid pressure moves the diaphragm to disconnect the positive and ground contacts, opening the switch and stopping current flow.

Example: (Park or Neutral Range)

The hydraulic and electrical schematics below illustrate the system operation when the manual valve is positioned in the Park position. As shown, the PRND4 switch has fluid pressure holding it in the closed position allowing current to flow through Pin "A" (transaxle pass-thru connector pin) to ground. When the circuit is closed, the digital logic signal in the PCM is "1" indicating that the circuit is grounded. The normally closed RELEASE switch has fluid pressure holding it open, the digital logic signal in the PCM is "0". Thus when Pins "B", "C" and "D" are open and Pin "A" is grounded, the PCM interprets the manual valve position as being in Park or Neutral and that the TCC is released.

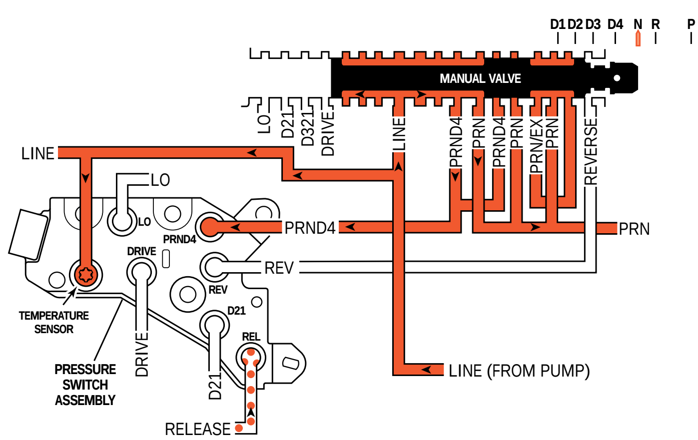
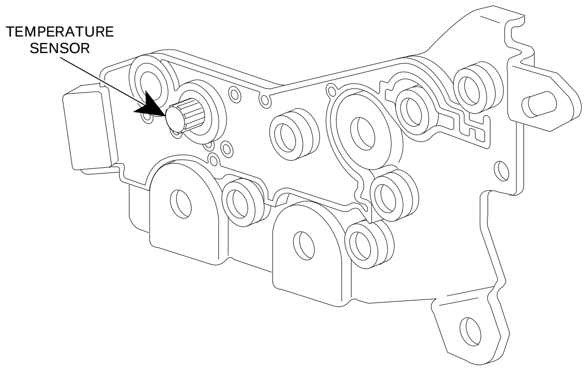


Figure 43



Transaxle Fluid Temperature Sensor

The temperature sensor is a negative temperature coefficient thermistor (temperature sensitive resistor) that provides information to the PCM regarding transmission fluid temperature. The temperature sensor is integrated in the pressure switch assembly (PSA) which is bolted to the valve body. The sensor monitors pressurized main line fluid from the inside of the valve body to determine the operating temperature of the transaxle fluid. The sensor, similar to each of the PSA fluid pressure switches, uses an o-ring seal to maintain fluid pressure in the valve body.

The internal electrical resistance of the sensor varies in relation to the operating temperature of the transmission fluid (see chart). The PCM sends a 5 volt reference signal to the temperature sensor and measures the voltage drop in the electrical circuit. A lower fluid temperature creates a higher resistance in the temperature sensor, thereby measuring a higher voltage signal.

The PCM measures this voltage as another input to help control line pressure, shift schedules and TCC apply. When transaxle fluid temperature reaches 140°C (284°F) the PCM enters “hot mode”. Above this temperature the PCM modifies transmission shift schedules and TCC apply in an attempt to reduce fluid temperature by reducing transmission heat generation. During hot mode the PCM applies the TCC more often in Third and Fourth gears (TCC is also applied in 2nd gear in some models). Also, the PCM will perform 2-3 and 3-4 shifts earlier to help reduce fluid heat generation.

Transmission Fluid Temperature Sensor Circuit Low Input will set a DTC P0712 and the PCM will command the following default actions:

- DTC P0712 will be stored in PCM history.
- Freeze shift adapts.
- Transaxle will assume a default temperature.

Transmission Fluid Temperature Sensor Circuit High Input will set a DTC P0713 and the PCM will command the following default actions:

- DTC P0713 will be stored in PCM history.
- Freeze shift adapts.
- Transaxle will assume a default temperature.

Transmission Fluid Over Temperature will set a DTC P1812 and the PCM will command the following default actions:

- DTC P1812 will be stored in PCM history.
- Freeze shift adapts.

TRANSAXLE SENSOR – TEMPERATURE TO RESISTANCE TO VOLTAGE (approximate)

°C	R low (ohms)	R high (ohms)
0	7987	10859
10	4934	6407
20	3106	3923
30	1991	2483
40	1307	1611
50	878	1067
60	605	728
70	425	507
80	304	359
90	221	259
100	163	190

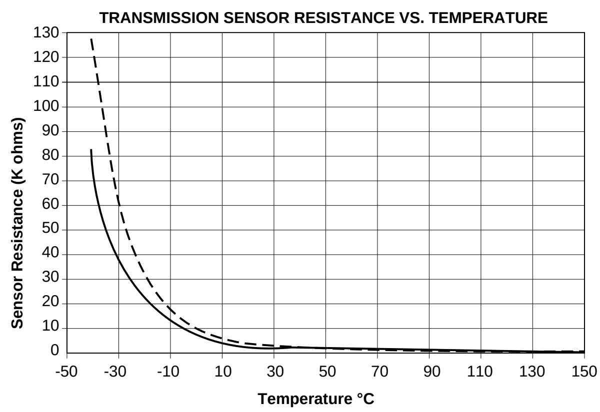
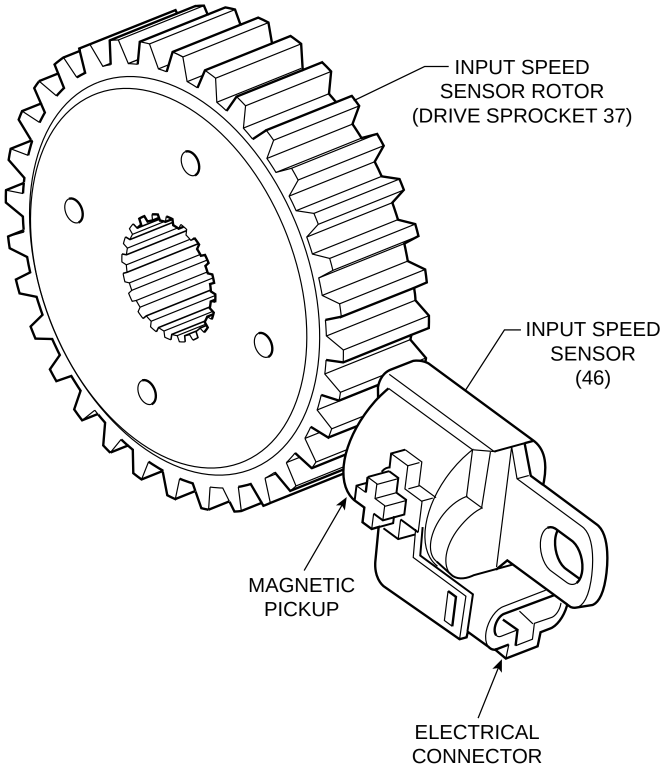


Figure 44



Sensor resistance should measure between 625 - 725 ohms at 20°C (68°F). Output voltage will vary with vehicle speed from a minimum of 0.5 Volts AC at 550 RPM, to 200 Volts at 7000 RPM.

Transaxle Input Speed Sensor (46):
The Transaxle Input Speed (TISS) sensor is a magnetic inductive pickup that relays information relative to transaxle input speed to the PCM. This information is used to calculate the appropriate operating gear ratios and TCC slippage.

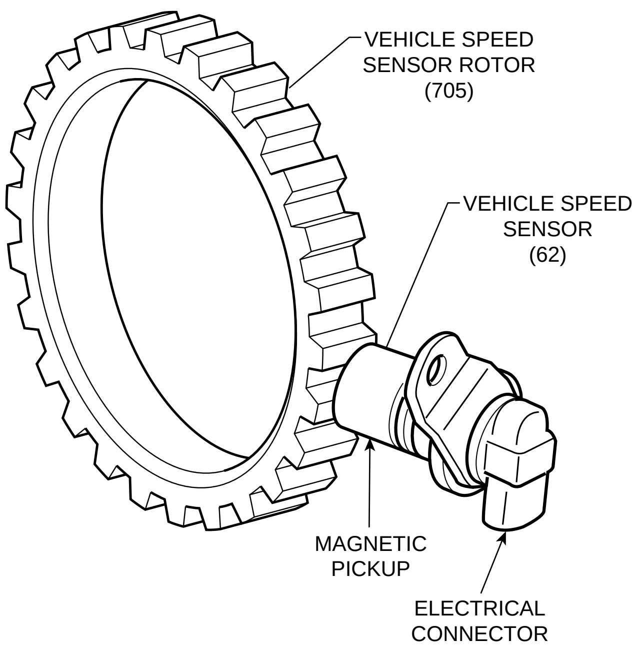
The input speed sensor mounts on the transaxle case under the channel plate and next to the drive sprocket. An air gap of 0.26 - 2.90 mm (0.010 - 0.114 inch) is maintained between the sensor and the teeth on the drive sprocket. The sensor consists of a permanent magnet surrounded by a coil of wire. As the drive sprocket is driven by the turbine shaft, an AC signal is induced in the input speed sensor. Higher engine speeds induce a higher frequency and voltage measurement at the sensor.

Input/Turbine Speed Sensor Circuit Range/Performance will set DTC P0716 and and the PCM will command the following default actions:

- DTC P0716 will be stored in PCM history.
- Inhibit TCC engagement.
- Freeze shift adapts.
- Maximum line pressure.

Input/Turbine Speed Sensor Circuit No Signal will set DTC P0717 and and the PCM will command the following default actions:

- DTC P0717 will be stored in PCM history.
- Inhibit TCC engagement.
- Freeze shift adapts.
- Maximum line pressure.



Vehicle Speed Sensor (62):
The Vehicle Speed Sensor (VSS) is a magnetic inductive pickup that relays information relative to vehicle speed to the PCM. Vehicle speed information is used by the PCM to control shift pattern, line pressure, and TCC apply and release.

The vehicle speed sensor mounts in the case at the speed sensor rotor which is pressed onto the differential. An air gap of 0.27 - 1.57 mm (0.011 - 0.062 inch) is maintained between the sensor and the teeth on the speed sensor rotor. The sensor consists of a permanent magnet surrounded by a coil of wire. As the differential rotates, an AC signal is induced in the vehicle speed sensor. Higher vehicle speeds induce a higher frequency and voltage measurement at the sensor.

Vehicle Speed Sensor (VSS) Circuit Low Input will set DTC P0502 and and the PCM will command the following default actions:

- DTC P0502 will be stored in PCM history.
- Inhibit TCC engagement.
- Freeze shift adapts.
- Maximum line pressure.
- Immediate landing to 2nd gear.

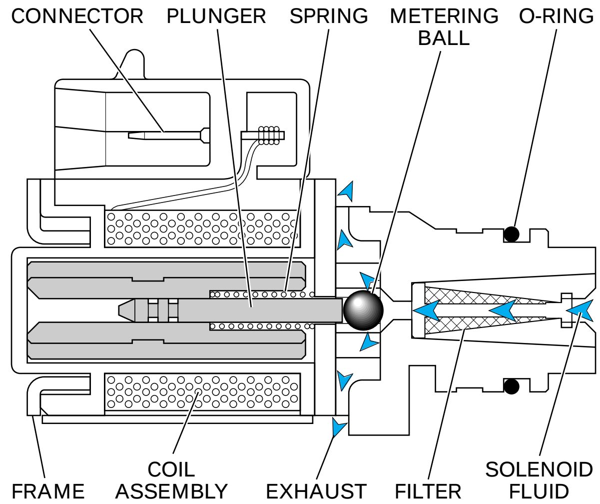
Sensor resistance should measure between 1500 - 1750 ohms at 20°C (68°F). Output voltage will vary with vehicle speed from a minimum of 0.5 Volts AC at 25 RPM, to 200 Volts at 1728 RPM.

Figure 45

SHIFT SOLENOIDS

Description:
The Hydra-matic 4T40-E transaxle uses two identical, normally open electronic shift solenoids (referred to as 1-2 and 2-3) for controlling upshifts and downshifts in all forward ranges. These shift solenoids 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 ratio for the vehicle by commanding the solenoids either ON or OFF. Fluid pressure is then routed to the shift valves (or exhausted through the solenoids) 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 gear:

GEAR	SOLENOID “A”	SOLENOID “B”
Park, Reverse, Neutral	ON	OFF
First	ON	OFF
Second	OFF	OFF
Third	OFF	ON
Fourth	ON	ON



4T40-E SHIFT SOLENOID (OFF)

Shift Solenoids De-energized (OFF):
The shift solenoids 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 the 1-2 or 2-3 signal fluid to push past the metering ball to exhaust from a port on the side of the solenoid.

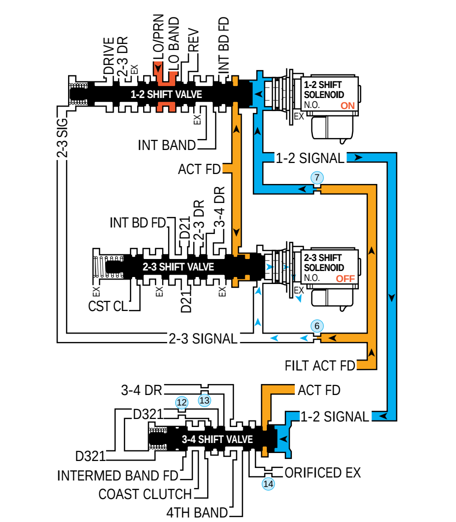
Shift Solenoids Energized (ON):
To energize the shift solenoids, the PCM provides a path to ground and completes the solenoid’s electrical circuit. Electrical current passing through the coil assembly in the solenoid creates a magnetic field that magnetizes the solenoid core. The magnetized core repels 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 signal fluid circuits.

1-2 Shift Solenoid (305):
The 1-2 shift solenoid is located at the end of the 1-2 shift valve (302) and controls the position of the 1-2 and 3-4 shift valves. 1-2 signal fluid that is routed to the solenoid is created by filtered actuator feed as it passes through orifice #7. When energized in Park, Reverse, Neutral and First gear, the solenoid blocks 1-2 signal fluid from exhausting thereby creating pressure in the 1-2 signal fluid circuit. 1-2 signal fluid pressure then holds the 1-2 shift valve against spring force in the downshifted position. At the same time, 1-2 signal fluid is routed to the 3-4 shift valve (319) where it holds the valve against spring force in the upshifted position. During Fourth gear operation, 2-3 signal fluid pressure combines with spring force and holds the 1-2 shift valve in the upshifted position.

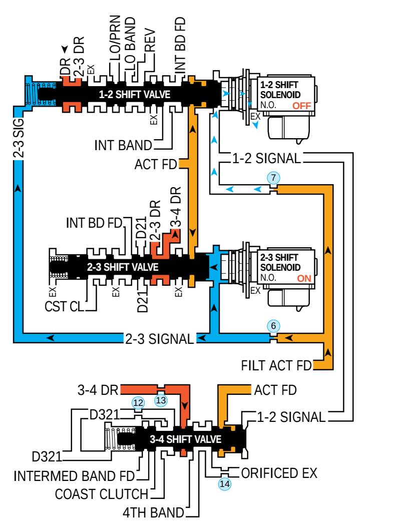
When the1-2 shift solenoid is de-energized during Second and Third gear operation, 1-2 signal fluid exhausts through the solenoid. Spring force acting on the 1-2 shift valve keeps the valve in the upshifted position, and spring force at the 3-4 shift valve keeps the valve in the downshifted position.

2-3 Shift Solenoid (305):
The 2-3 shift solenoid is located at the end of the 2-3 shift valve (307) and controls the position of the 1-2 and 2-3 shift valves. 2-3 signal fluid that feeds to the solenoid is created by filtered actuator feed as it passes through orifice #6. When energized in Third and Fourth gear, the solenoid blocks 2-3 signal fluid from exhausting thereby creating pressure in the 2-3 signal fluid circuit. 2-3 signal fluid pressure then holds the 2-3 shift valve against spring force in the upshifted position. At the same time, 2-3 signal fluid is routed to the 1-2 shift valve (302) to combine with spring force in holding the valve in the upshifted position.

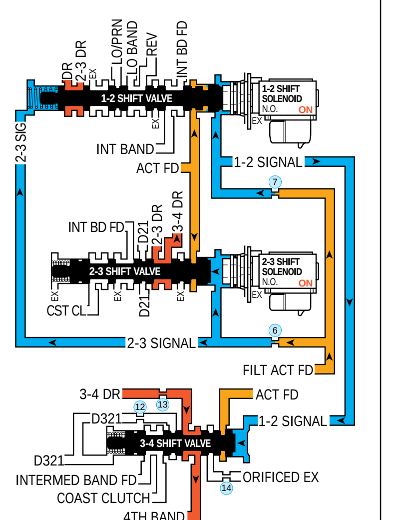
When the 2-3 shift solenoid is de-energized during Park, Reverse, Neutral, First and Second gear operation, 2-3 signal fluid exhausts through the solenoid. Spring force acting on the 2-3 shift valve keeps the valve in the downshifted position while 1-2 shift valve position is dependent upon the 1-2 shift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



PARK/REVERSE/NEUTRAL/FIRST GEAR

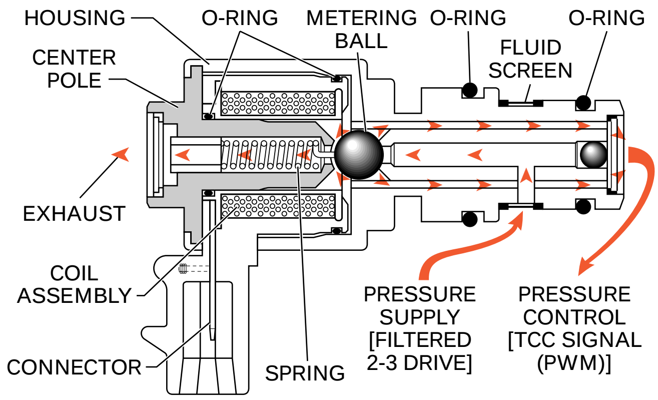


THIRD GEAR

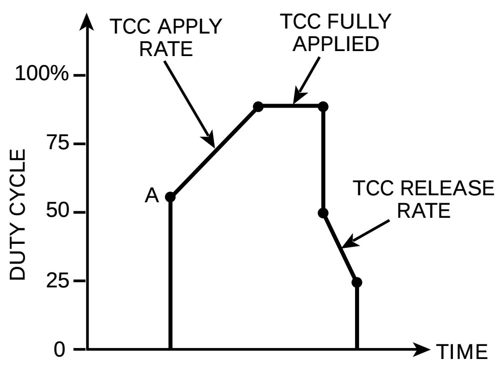


FOURTH GEAR

Figure 46



TCC CONTROL PWM SOLENOID



Torque Converter Clutch Control PWM Solenoid (335):
The TCC Control PWM solenoid is a normally closed, pulse width modulated (PWM) solenoid used to control the apply and release of the converter clutch. The PCM operates the solenoid with a varying duty cycle at a fixed frequency of 42 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 68% (see point A on graph). The PCM then ramps the duty cycle up to approximately 93% 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 solenoid duty cycle to control TCC release. There are some operating conditions that prevent or enable TCC apply under various conditions (refer to the 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 Control PWM solenoid resistance should measure between 10.4 and 10.8 ohms when measured at 20°C (68°F). The resistance should measure approximately 16 ohms at 150°C (300°F).

Torque Converter Clutch Circuit Stuck Off will set a DTC P0741 and the PCM will command the following default actions:
- DTC P0741 will be stored in PCM history.
- Inhibit TCC engagement.

Torque Converter Clutch Circuit Stuck On will set a DTC P0742 and the PCM will command the following default actions:
- DTC P0742 will be stored in PCM history.
- Freeze shift adapts.
- TCC commanded on always.

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

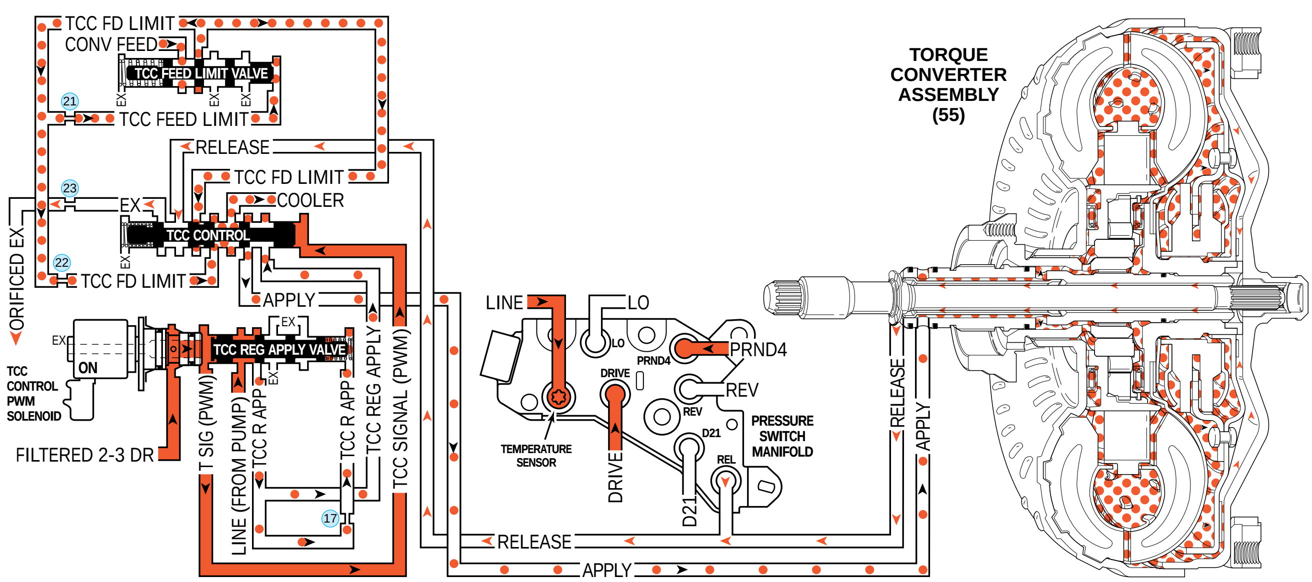
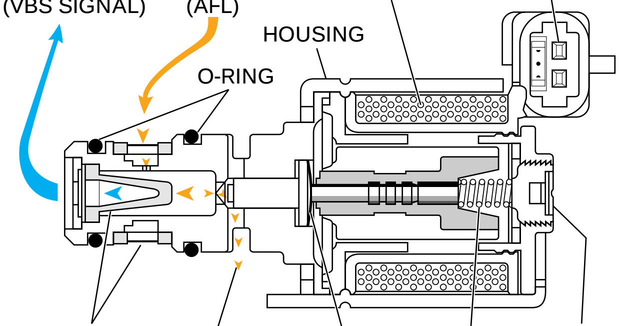


Figure 47

Transaxle Pressure Control Solenoid (312):
The pressure control solenoid (PCS) is a precision electronic pressure regulator that controls transaxle 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 PCS, which ultimately decreases line pressure. The PCM controls the PCS based on various inputs including throttle position, fluid temperature, MAP sensor and gear state.

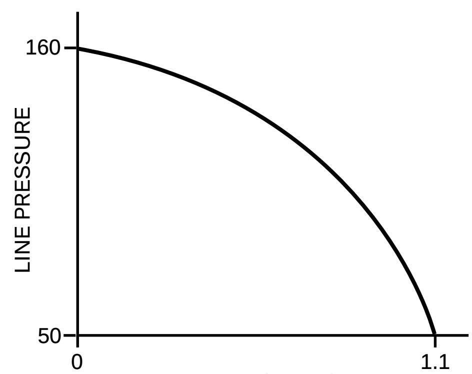


PRESSURE CONTROL SOLENOID

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 PCS on a positive duty cycle at a fixed frequency of 614 Hz (cycles per second). Duty cycle is defined as the percent of time current is flowing through the solenoid coil during each cycle. A higher duty cycle provides a greater current flow through the solenoid. The high (positive) side of the PCS electrical circuit at the PCM controls the PCS operation. The PCM provides a ground path for the circuit, monitors average current and continuously varies the PCS duty cycle to maintain the correct average current flowing through the PCS.

Approximate Duty Cycle	Current	Line Pressure
+ 5%	.02 Amps	Maximum
+40%	1.1 Amps	Minimum



Pressure control solenoid resistance should measure between 3.5 and 4.6 ohms when measured at 20°C (68°F).

The duty cycle and current flow to the PCS 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 PCS. Current flow to the PCS creates a magnetic field that moves the solenoid armature toward the push rod and against spring force.

Transaxle Adapt Function:
Programming within the PCM also allows for automatic adjustments in shift pressure that are based on the changing characteristics of the transaxle components. As the apply components within the transaxle 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 PCS 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 transaxle durability. The PCM monitors the TISS sensor and VSS during commanded shifts to determine if a shift is occurring too fast (harsh) or too slow (soft) and adjusts the Transaxle Pressure Control Solenoid signal to maintain a set shift feel.

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

- DTC P0748 will be stored in PCM history.
- Freeze shift adapts.
- Maximum line pressure.

Figure 48

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This section of the book describes how torque from the engine is transferred through the Hydra-matic 4T40-E transaxle 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 transaxle 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 4T40-E transaxle. If the operating principle of a clutch, band or valve is unclear, refer to the previous sections of this book for individual components descriptions.

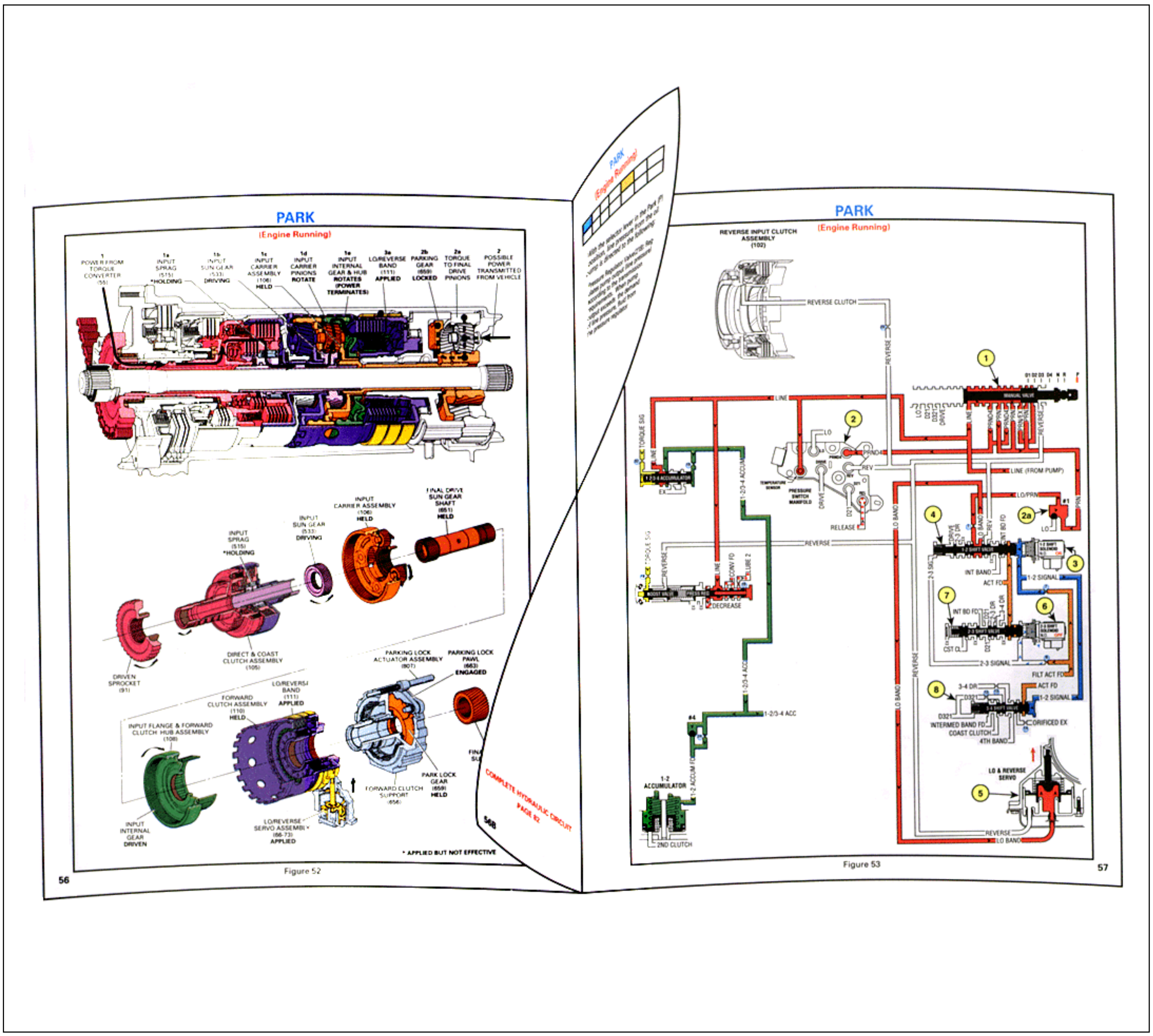


Figure 49

MECHANICAL POWERFLOW FROM THE TORQUE CONVERTER TO THE DRIVEN SPROCKET

(Engine Running)

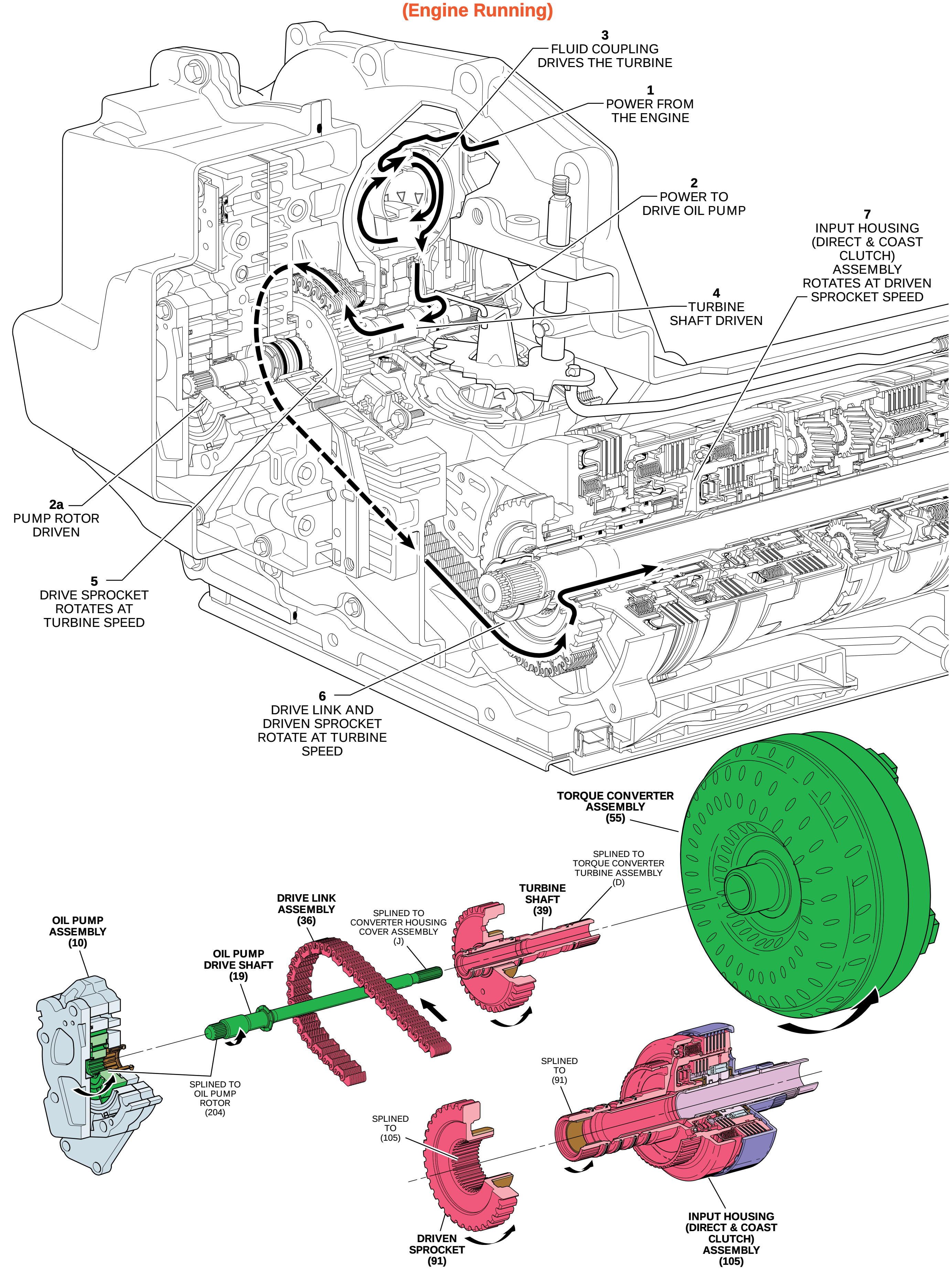


Figure 50

MECHANICAL POWERFLOW FROM THE TORQUE CONVERTER TO THE DRIVEN SPROCKET

(Engine Running)

The mechanical power flow in the Hydra-matic 4T40-E transaxle 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 (39). The turbine shaft, which is connected to the drive sprocket (37), thus provides the primary link to the mechanical operation of the transaxle.

1 Power from the Engine
Torque from the engine is transferred to the transaxle through the engine flywheel which is bolted to the engine crankshaft.

2 Power to Drive the Oil Pump
The oil pump drive shaft (19) is splined to the torque converter cover at one end and to the pump rotor (204) at the other end.

2a Pump Rotor Driven
When the engine is running, the oil pump drive shaft (19) and the pump rotor (204) are forced to rotate at engine speed.

3 Fluid Coupling Drives the Turbine
Transaxle fluid inside the torque converter (55) 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 (39), 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 (39) is splined to the drive sprocket (37), 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 (37) are in mesh with the drive link assembly (36) and the drive link is also in mesh with the teeth on the driven sprocket (91). 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 118).

7 Input Housing Assembly Rotates at Driven Sprocket Speed
The driven sprocket (91) is splined to the input shaft & direct/coast clutch housing assembly (502) 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 driven sprocket (91). The transfer of torque from the engine through the torque converter and to the driven sprocket 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 pump and line pressure is directed to the pressure regulator valve.

1 PRESSURE REGULATION

1a Pressure Regulator Valve:
Regulates pump output (line pressure) in response to torque signal fluid pressure acting on the boost valve, spring force, and line pressure acting on the end of the valve. Line pressure is directed to the manual valve, both accumulator valves, torque signal regulator valve, TCC regulated apply valve, the temperature sensor in the pressure switch assembly (PSA) and the actuator feed limit valve. Also, line pressure feeds the converter feed and lube 2 fluid 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, each of the shift valves, and also feeds the 1-2 signal and 2-3 signal fluid circuits.

1c Pressure Control Solenoid (PCS):
Controlled by the PCM, the PCS regulates filtered actuator feed fluid pressure acting on the end of the torque signal regulating valve.

1d Torque Signal Regulating Valve:
Regulates line pressure into the torque signal fluid circuit. This regulation is controlled by regulated VBS signal fluid pressure from the PCS. Torque signal fluid pressure is routed to the accumulator valves and the boost valve to control shift feel.

2 SHIFT ACCUMULATION

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

2b 1-2, 2-3 and 3-4 Accumulator Assemblies:
Accumulator fluid is routed to each of the accumulator assemblies in preparation for upshifts and downshifts. The fluid routed to the 1-2 and 3-4 accumulators is orificed by the #4 and #7 checkballs. The 2-3 accumulator fluid circuit does not use a checkball to orifice accumulator fluid to the 2-3 accumulator.

3 TORQUE CONVERTER (RELEASED POSITION ONLY)

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

3b TCC Feed Limit Valve:
Converter feed fluid is routed through the valve and into the TCC feed limit fluid circuit. The TCC feed limit valve limits the maximum fluid pressure in the TCC feed limit fluid circuit and the torque converter.

3c TCC Regulated Apply Valve:
Spring force holds the valve in the release position, thereby blocking line pressure.

3d TCC Control Valve:
Spring force holds the valve in the release position and TCC feed limit fluid is routed into the release fluid circuit. Also, fluid returning from the converter in the apply fluid circuit is routed through the valve and into the cooler fluid circuit.

3e Torque Converter:
Release fluid pressure is routed to the torque converter to keep the TCC released. Fluid leaves the converter in the apply fluid circuit.

COMMON HYDRAULIC FUNCTIONS FOR ALL RANGES

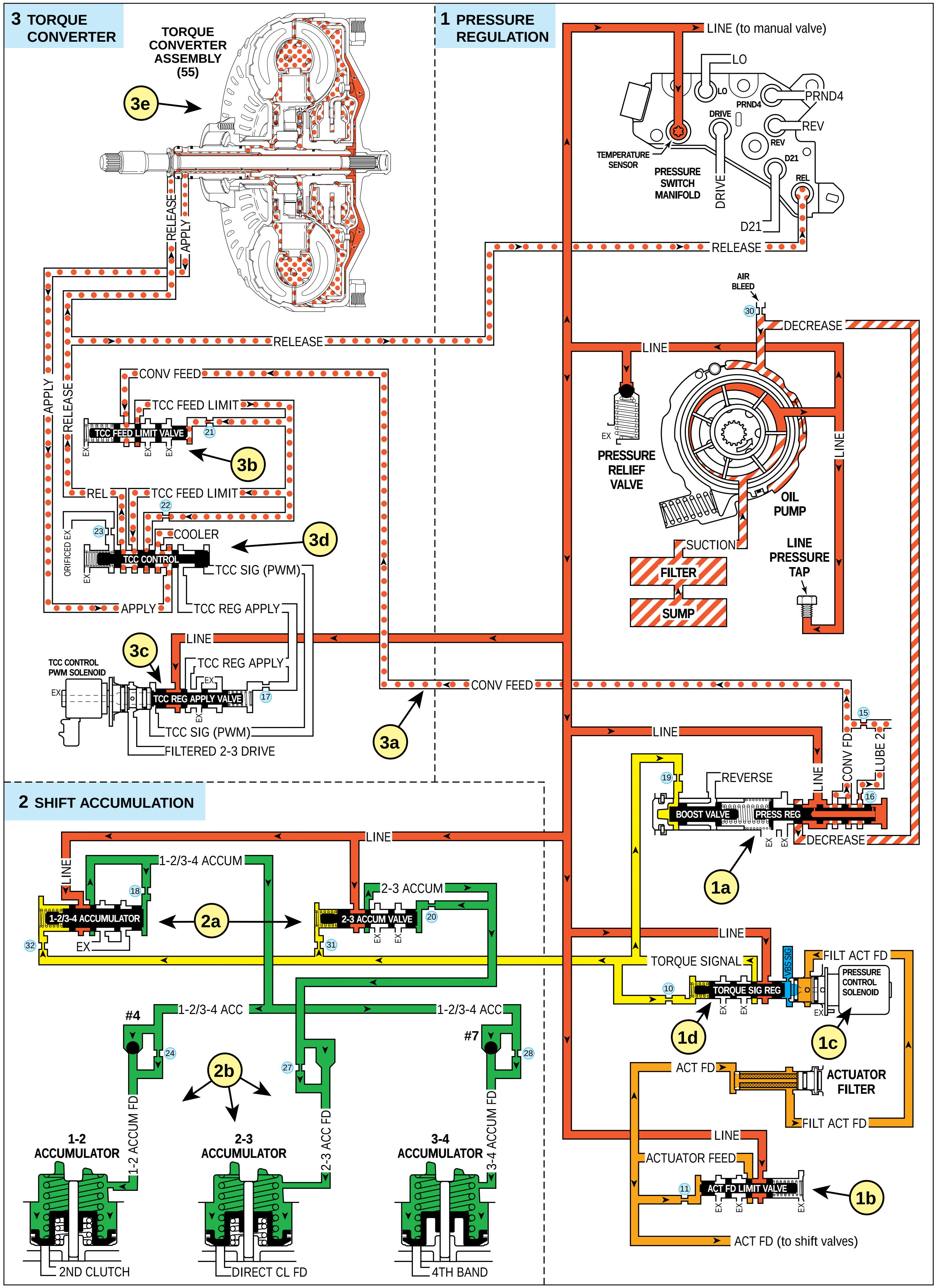
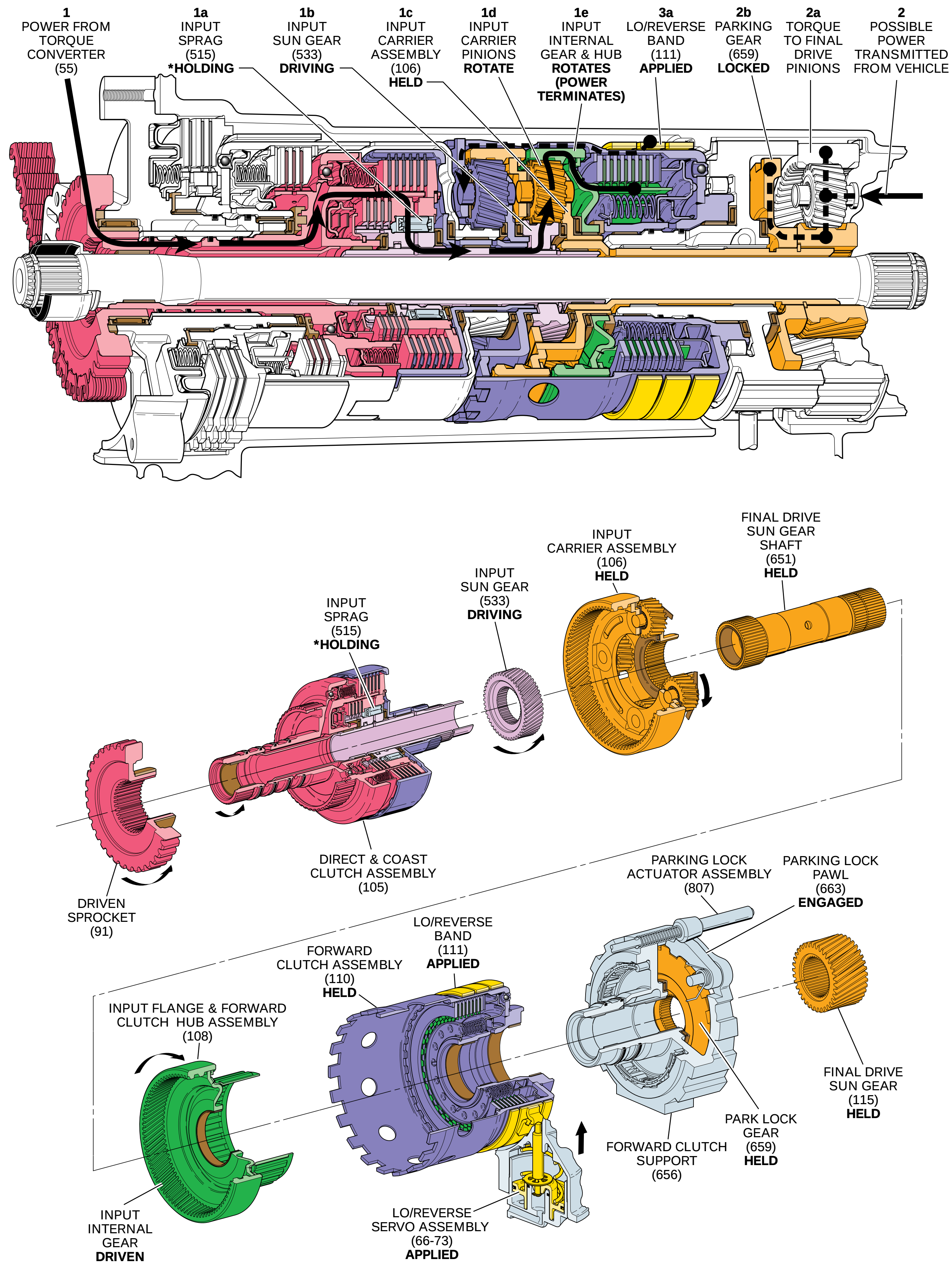


Figure 51

PARK

(Engine Running)



*APPLIED BUT NOT EFFECTIVE

Figure 52

PARK

(Engine Running)

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
ON	OFF						HOLDING *			APPLIED	

* APPLIED BUT NOT EFFECTIVE

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 (91) which is splined to the input shaft.

1a Input Sprag Holding
Power continues from the input shaft and direct and coast clutch housing (502) to the input sprag (515). The input sprag holds when torque comes from the engine, and overruns when torque comes from the wheels, allowing the vehicle to coast.

1b Input Sun Gear Driving
Power continues from the sprag through the input sun gear shaft to the input sun gear, which then drives the input planetary pinions.

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

1d Input Carrier Pinions Rotate
The input planetary pinions rotate and force the input internal gear to rotate.

1e Input Internal Gear Rotates/Powerflow Terminates
The input internal gear is splined to the forward clutch hub but the forward 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 and the final drive sun gear is held by the parking lock gear which is held by the parking lock pawl. 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 transaxle could occur.

3 Preparation for a shift into reverse

3a Lo/Reverse Band Applied
The lo/reverse band is applied and holds the forward clutch housing. The forward clutch housing is tanged to one end of the reaction carrier which prevents the carrier from rotating.

PARK
(Engine Running)

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
ON	OFF						HOLDING *			APPLIED	

* APPLIED BUT NOT EFFECTIVE

LO/REVERSE BAND APPLIES

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

2 Pressure Switch Assembly (PSA):
PRND4 fluid is routed to the PRND4 fluid pressure switch in the PSA and the PSA signals the PCM that the transaxle is in the Park (P) or Neutral (N) position. Also, line pressure is routed to the temperature sensor in the PSA.

2a #1 Checkball
PRN fluid shuttles the #1 checkball to block the LO passage. The fluid pressure enters the LO/PRN passage and continues to the 1-2 Shift valve through orifice #1.

3 1-2 Shift Solenoid:
Energized by the PCM, the normally open 1-2 shift solenoid is ON and blocks 1-2 signal fluid from exhausting. 1-2 Signal fluid pressure acts on the 1-2 and 3-4 shift valves.

4 1-2 Shift Valve:
1-2 Signal fluid pressure holds the valve in the downshifted position against spring force. Lo/PRN fluid is routed through the 1-2 shift valve and into the lo band fluid circuit.

5 Lo & Reverse Servo:
Lo band fluid is routed to the inner area of the servo piston. Lo band fluid pressure moves the servo piston and pin assembly against spring force to apply the lo/reverse band.

6 2-3 Shift Solenoid:
The normally open 2-3 shift solenoid is OFF and 2-3 signal fluid is exhausted through the solenoid.

7 2-3 Shift Valve:
Spring force holds the 2-3 shift valve in the downshifted position.

8 3-4 Shift Valve:
1-2 Signal fluid pressure holds the 3-4 shift valve against spring force during the First and Fourth gear command.

COMPLETE HYDRAULIC CIRCUIT
Page 82

PARK

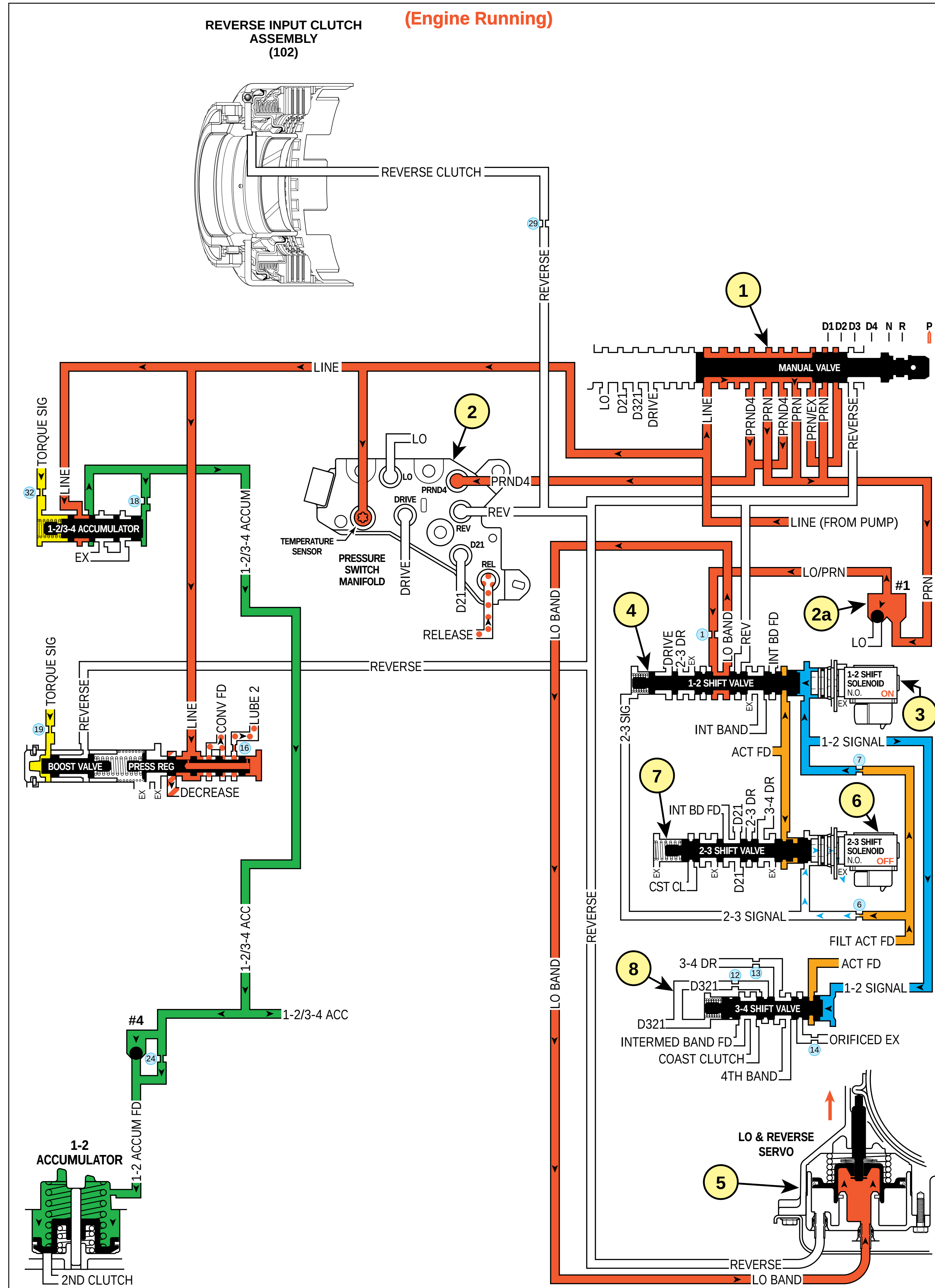


Figure 53

REVERSE

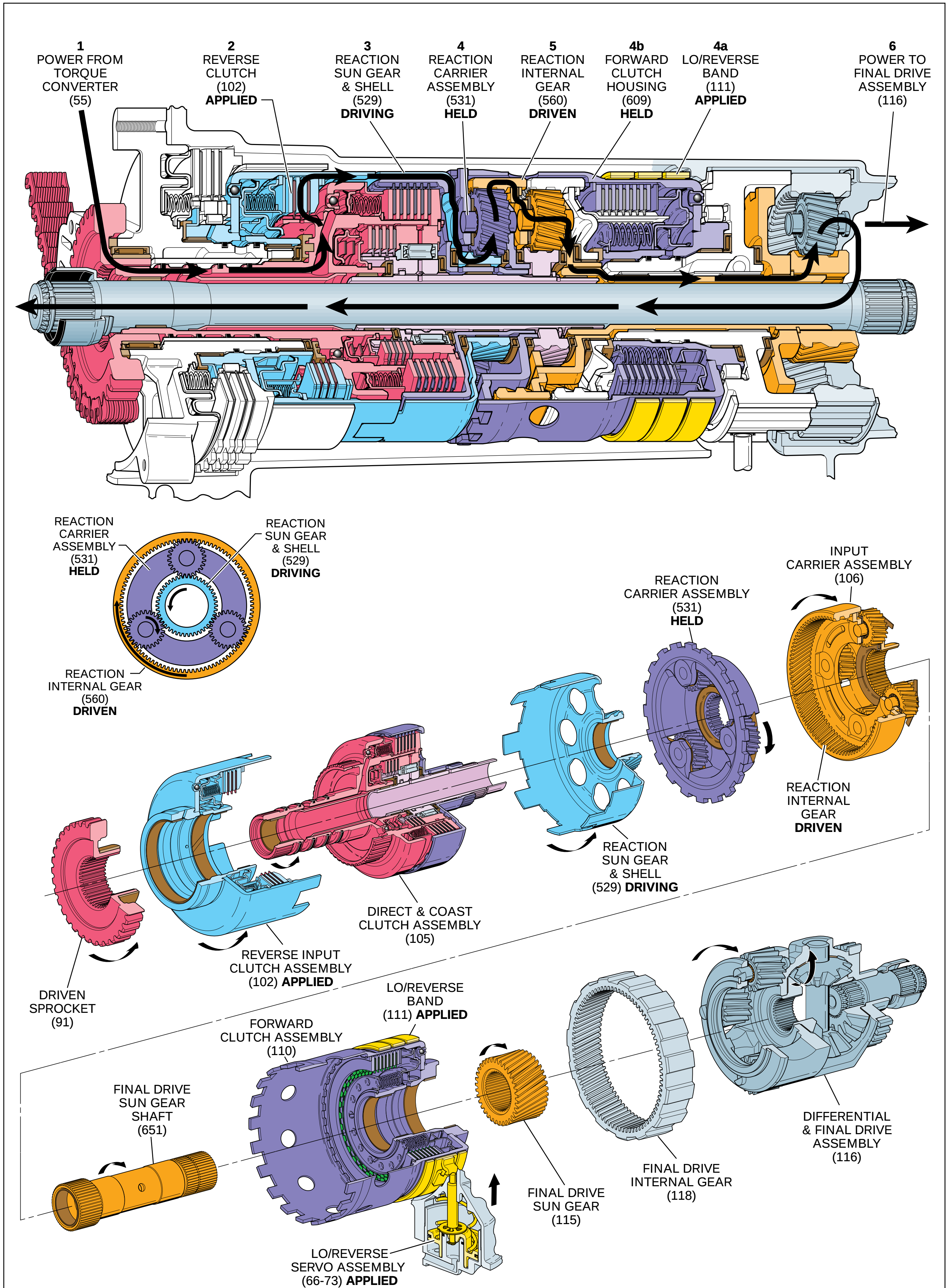


Figure 54

REVERSE

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
ON	OFF				APPLIED					APPLIED	

In Reverse (R), torque from the engine is multiplied through the torque converter (55), the transaxle gear train, the final drive assembly and the output shaft (94) 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 2.14:1.

- When the gear selector lever is moved into the Reverse (R) gear range, the parking pawl disengages from the parking gear (659) allowing the final drive sun gear shaft (651) to rotate.
- The manual shaft and detent lever assembly (806) and manual valve (800) are also moved into the Reverse gear position in order to channel the transaxle fluid.

1 Power from Torque Converter

The driven sprocket (91) is splined to the input shaft and direct & coast clutch housing assembly (502) and forces the housing to rotate at driven sprocket speed.

2 Reverse Clutch Applied

The reverse clutch plates (460-463), splined to the input shaft and direct & coast clutch housing (502), force the reverse clutch housing (454) to rotate.

3 Reaction Sun Gear & Shell Driving

The reaction sun shell is tanged to the reverse clutch housing and rotates in the same direction and speed as the input shaft and direct & coast clutch housing.

4 Reaction Carrier Assembly Held

4a Lo/Reverse Band Applied

The lo/reverse band (111) is applied and prevents the forward clutch housing (609) from rotating.

4b Forward Clutch Housing Held

The forward clutch housing (609) is tanged to one end of the reaction carrier assembly (531) which prevents the reaction carrier from rotating.

Since the reverse clutch is driving the reaction sun shell (529) while the reaction carrier (531) is held, the reaction carrier planet pinion gears (556) are forced to rotate opposite of engine direction.

5 Reaction Internal Gear Driven

The reaction carrier planet pinion gears (556) force the reaction internal gear (560) and input carrier (562) to rotate opposite engine rotation.

6 Power to Final Drive Assembly

The input carrier assembly (106), connected to the final drive sun gear (115) through the final drive sun gear shaft (651), 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 (711).

The final drive planet pinion gears (711) rotate inside the final drive internal gear (118), which is held stationary by the case, and transfers torque to the final drive differential gears (707 & 709).

The output shaft (94), splined into the differential side gear (709), provides the torque to the left hand drive axle while the right differential side gear (709) transfers torque to the output stub shaft (58) and then to the right hand drive axle.

REVERSE

When the gear selector lever is moved to the Reverse (R) position (from the Park position) the following changes occur in the transaxle'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 PRND4 and PRN fluid circuits already pressurized in Park.

1b Pressure Regulator and Boost Valves:
Reverse fluid is routed to the boost valve and assists torque signal fluid pressure. The addition of reverse fluid pressure increases the operating range of line pressure in Reverse.

1c Pressure Switch Assembly:
Reverse fluid is routed through the 1-2 shift valve and to the PSA. The PSA signals the PCM that the transaxle is in Reverse.

2 REVERSE CLUTCH APPLIES

Reverse Clutch:
Reverse clutch fluid pressure applies the reverse clutch.

3 LO & REVERSE BAND REMAINS APPLIED

3a 1-2 Shift Solenoid:
The PCM keeps the solenoid energized in Reverse and 1-2 signal fluid pressure acts on the 1-2 shift valve.

3b 1-2 Shift Valve:
1-2 Signal fluid pressure keeps the 1-2 shift valve in the downshifted position. Lo/PRN fluid continues to feed the lo band fluid circuit.

3c Lo & Reverse Servo:
Reverse fluid is routed to the outer area of the servo to increase the servo apply force in Reverse.

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REVERSE

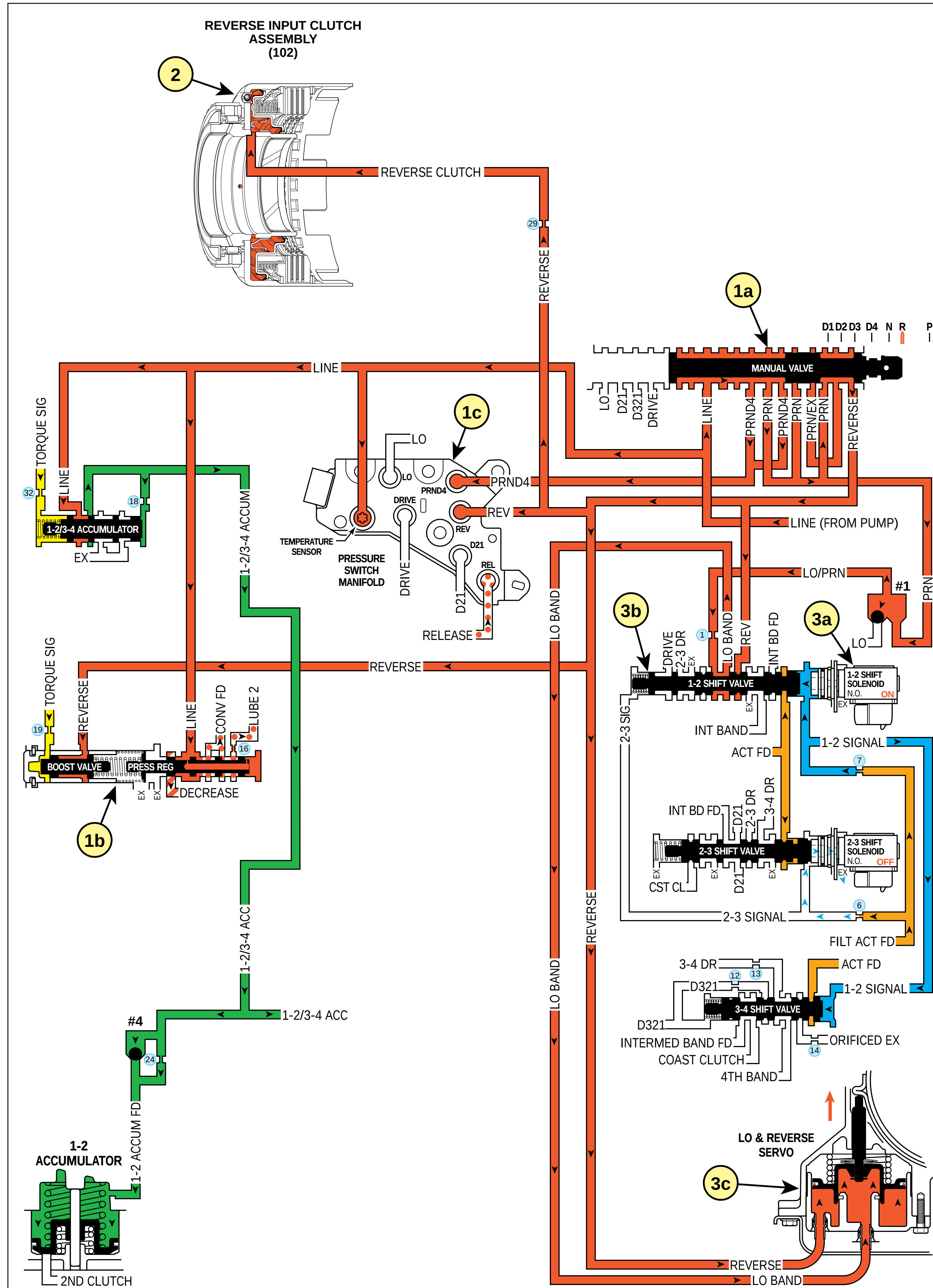

Figure 55

NEUTRAL

(Engine Running)

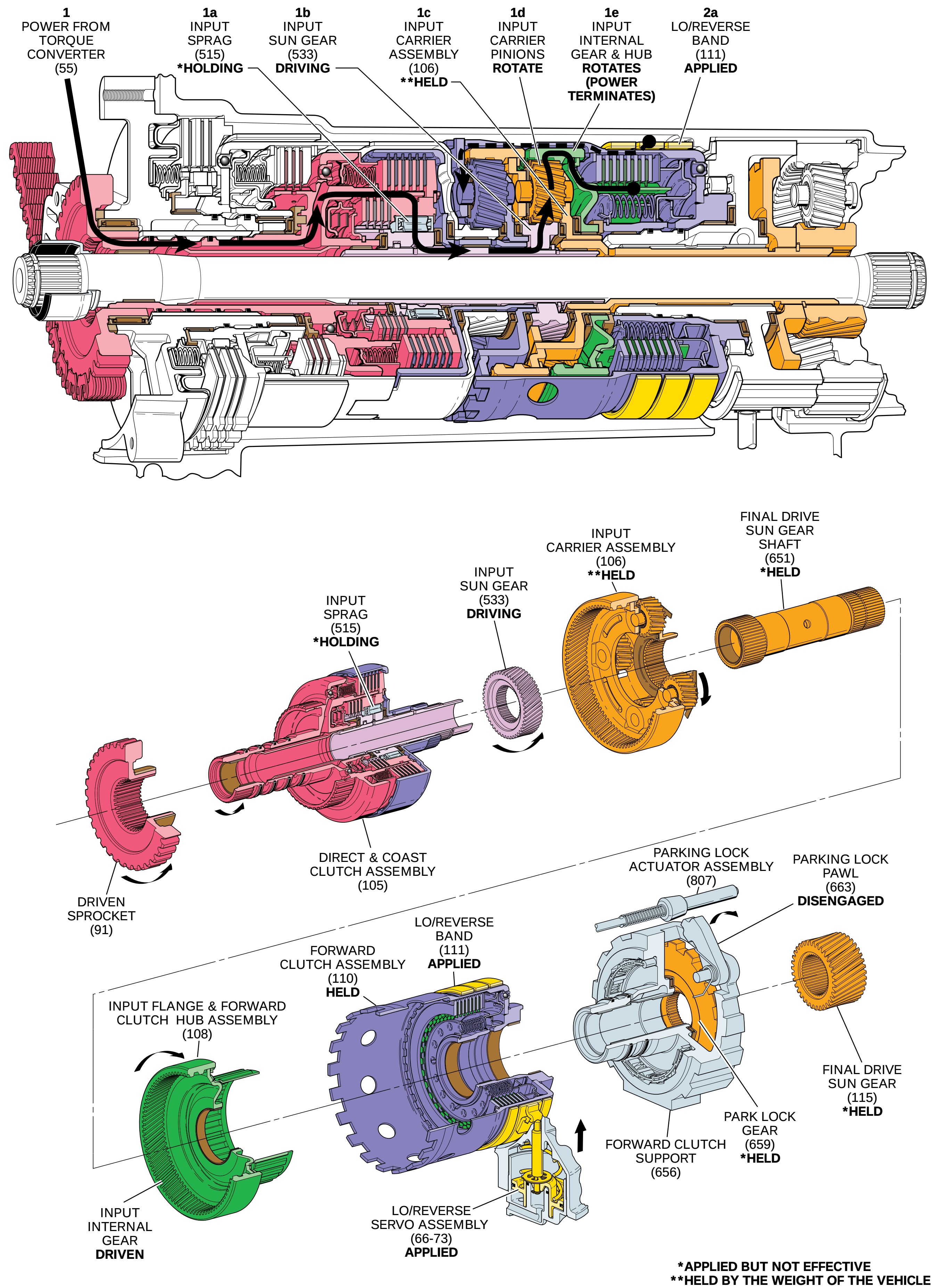

Figure 56

NEUTRAL

(Engine Running)

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
ON	OFF						HOLDING *			APPLIED	

* APPLIED BUT NOT EFFECTIVE

When the gear selector lever is placed in the Neutral (N) position, the mechanical power flow through the transaxle is similar to Park gear range. The primary difference is the parking pawl (663) is not engaged with the parking gear (659), which allows the final drive sun gear shaft (651) 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 transaxle is the same as in Park.

- The manual shaft and detent lever assembly (806) and manual valve (800) are moved into Neutral (N) range position.

1 Power from Torque Converter
Power from the torque converter turbine transfers to the driven sprocket (91) which is splined to the input shaft.

1a Input Sprag Holding
Power continues from the input shaft and direct and coast clutch housing (502) to the input sprag (515). The input sprag holds when torque comes from the engine, and overruns when torque comes from the wheels, allowing the vehicle to coast.

1b Input Sun Gear Driving
Power continues from the sprag through the input sun gear shaft to the input sun gear, which then drives the input planetary pinions.

1c Input Carrier Assembly Held
The input planetary carrier (106) is held stationary by the final drive sun gear shaft being held by the weight of the vehicle. This forces the input planetary pinions to rotate the opposite direction of the sun gear.

1d Input Carrier Pinions Rotate
The input planetary pinions rotate and force the input internal gear to rotate.

1e Input Internal Gear Rotates/Powerflow Terminates
The input internal gear is splined to the forward clutch hub but the forward clutch is not applied so powerflow is terminated.

2 Preparation for a shift (forward or reverse)

2a Lo/Reverse Band Applied
The lo/reverse band is applied and holds the forward clutch housing. The forward clutch housing is tanged to one end of the reaction carrier which 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)

When the gear selector lever is moved from the Reverse position to the Neutral position the following changes occur to the hydraulic and electrical systems.

1 REVERSE CLUTCH RELEASES

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

1b Reverse Clutch:
Reverse fluid exhausts from the reverse clutch and the clutch releases, shifting the transaxle into Neutral.

1c Boost Valve:
Reverse fluid exhausts from the boost valve and line pressure regulation returns to the normal operating range.

1d Pressure Switch Assembly:
Reverse fluid pressure exhausts from the PSA, thereby signalling the PCM that the transaxle is in Neutral (N) or Park (P).

2 LO & REVERSE BAND REMAINS APPLIED

2a 1-2 Shift Solenoid:
As in Park and Reverse, the solenoid is energized and 1-2 signal fluid pressure acts on the 1-2 shift valve.

2b 1-2 Shift Valve:
1-2 Signal fluid pressure keeps the 1-2 shift valve in the downshifted position. Lo/PRN fluid continues to feed the lo band fluid circuit.

2c Lo & Reverse Servo:
Reverse fluid exhausts from the servo. However, lo band fluid pressure continues to act on the inner area of the servo piston to keep the band applied.

Note: *In Park, Reverse and Neutral the shift solenoids 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.*

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NEUTRAL

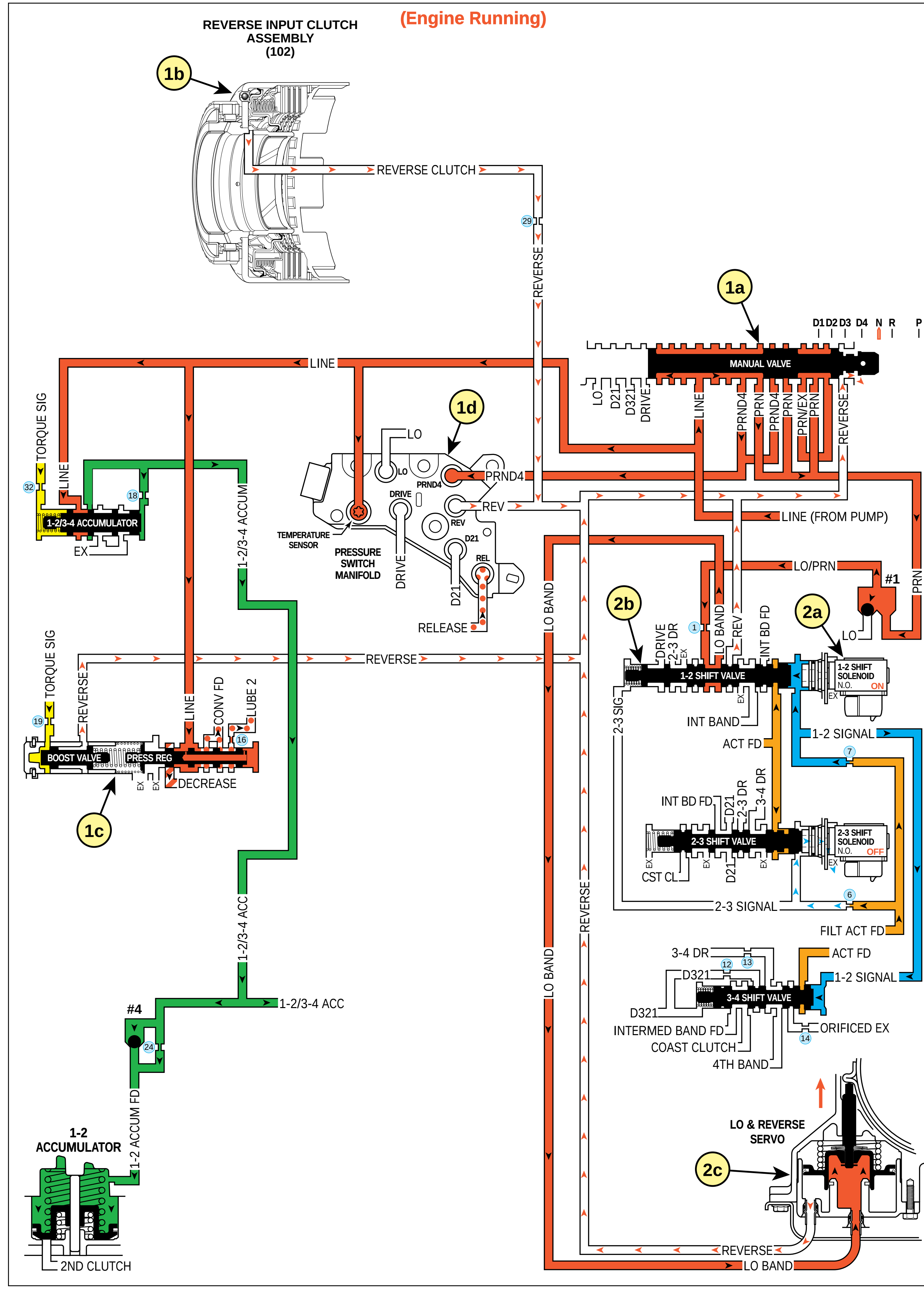

Figure 57

OVERDRIVE RANGE - FIRST GEAR

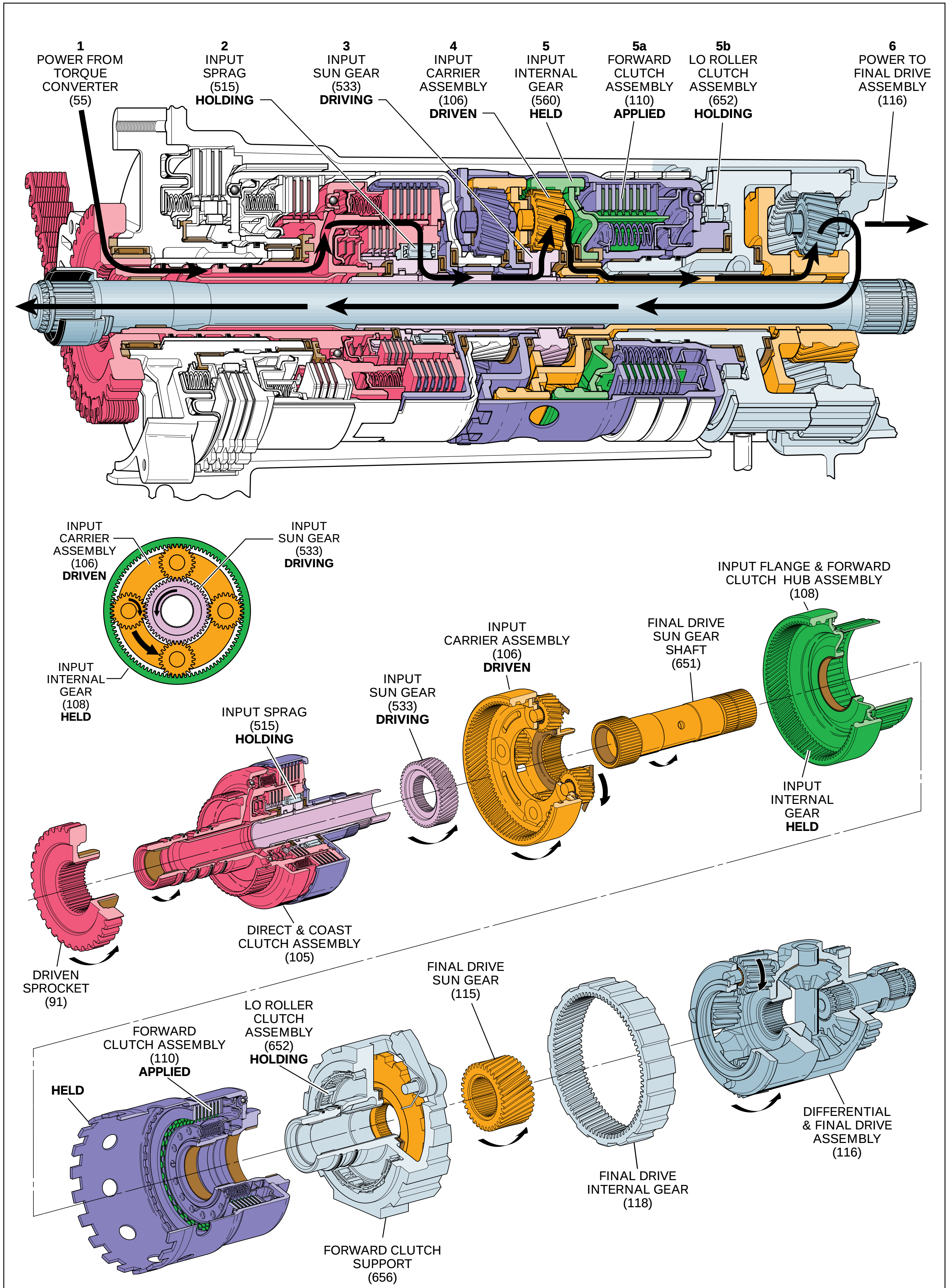

Figure 58

OVERDRIVE RANGE - FIRST GEAR

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
ON	OFF						HOLDING		APPLIED		HOLDING

In Overdrive Range - First Gear Ⓓ, torque from the engine is multiplied through the torque converter (55) and transaxle 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 (91) is splined to the input shaft and direct & coast clutch housing assembly (502) and forces the housing to rotate at driven sprocket speed.

The input shaft and direct & coast clutch housing assembly (502) is splined to the input sprag outer race (512) and rotates both components in the same direction (engine rotation) and at the same speed.

2 Input Sprag Holding

The sprag clutch (515) holds and power transfers to the input sun gear shaft and inner race assembly (511).

3 Input Sun Gear Driving

The input sun gear shaft and inner race assembly is splined to the input sun gear (533) and rotates both components in the same direction (engine rotation) and at the same speed.

4 Input Carrier Assembly Driven

Teeth on the input sun gear (533), in constant mesh with the input carrier planet pinion gears (568), force the input carrier assembly (106) to rotate in the same direction as engine rotation.

5 Input Internal Gear Held

5a Forward Clutch Applied

The forward clutch plates (601-604), splined to the forward clutch housing (609) and the input flange and forward clutch hub (577), hold the input internal gear (560) which is splined to the input flange and forward clutch hub.

5b Lo/Reverse Band Released/Lo Roller Clutch Holding

The lo/reverse band (111) is released and the forward clutch housing (609) would be able to rotate, but at this point the lo roller clutch is holding and prevents the forward clutch housing from rotating.

6 Power to Final Drive Assembly

The input carrier assembly (106), connected to the final drive sun gear (115) through the final drive sun gear shaft (651), 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 (711).

The final drive planet pinion gears (711) rotate inside the final drive internal gear (118), which is held stationary by the case, and transfers torque to the final drive differential gears (707 & 709).

The output shaft (94), splined into the differential side gear (709), provides the torque to the left hand drive axle while the right differential side gear (709) transfers torque to the right hand drive axle.

When the differential and final drive carrier (116) 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 transaxle shifts into second gear.

OVERDRIVE RANGE - FIRST GEAR

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

1 MANUAL VALVE:

In the Overdrive position the manual valve routes line pressure into the DRIVE and PRND4 fluid circuits. The manual valve also blocks line pressure from entering the PRN fluid circuit and opens the PRN fluid circuit to exhaust.

2 LO & REVERSE BAND RELEASES

2a Lo & Reverse Servo:
Lo band fluid pressure exhausts from the servo, thereby releasing the servo and the lo & reverse band.

3 FORWARD CLUTCH APPLIES

3a Forward Clutch:
Drive fluid is orificed into the forward clutch fluid circuit. Forward clutch fluid pressure applies the forward clutch.

3b 1-2 Shift Solenoid:
In first gear 1-2 shift solenoid remains energized by the PCM and 1-2 signal fluid pressure acts on the 1-2 shift valve.

3c 1-2 Shift Valve:
1-2 Signal fluid pressure keeps the 1-2 shift valve in the downshifted position against spring force. Drive fluid is routed through the 1-2 shift valve.

3d Pressure Switch Assembly:
Drive fluid is routed to the PSA and the PSA signals the PCM that the transaxle is in the Overdrive range.

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OVERDRIVE RANGE - FIRST GEAR

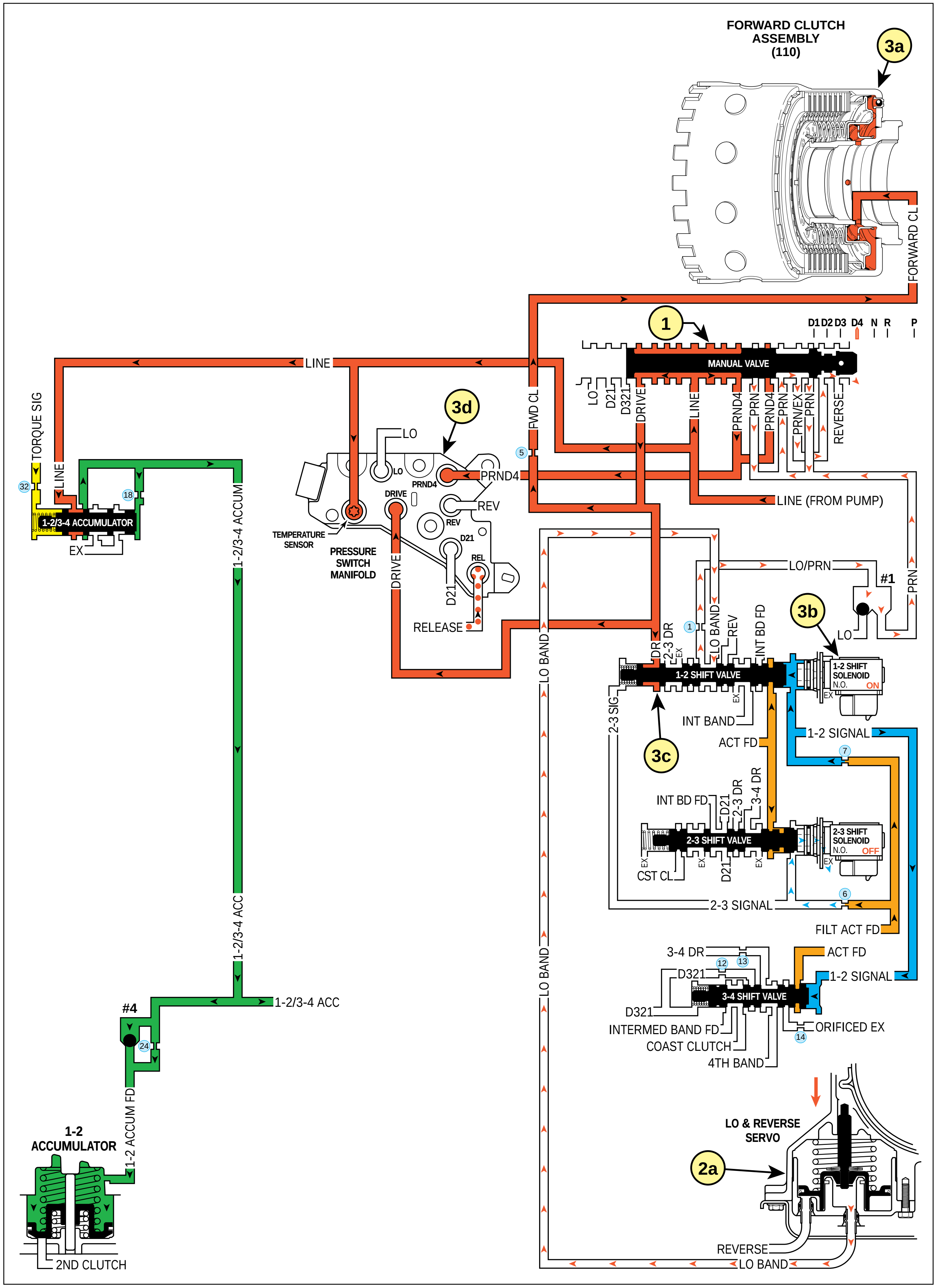

Figure 59

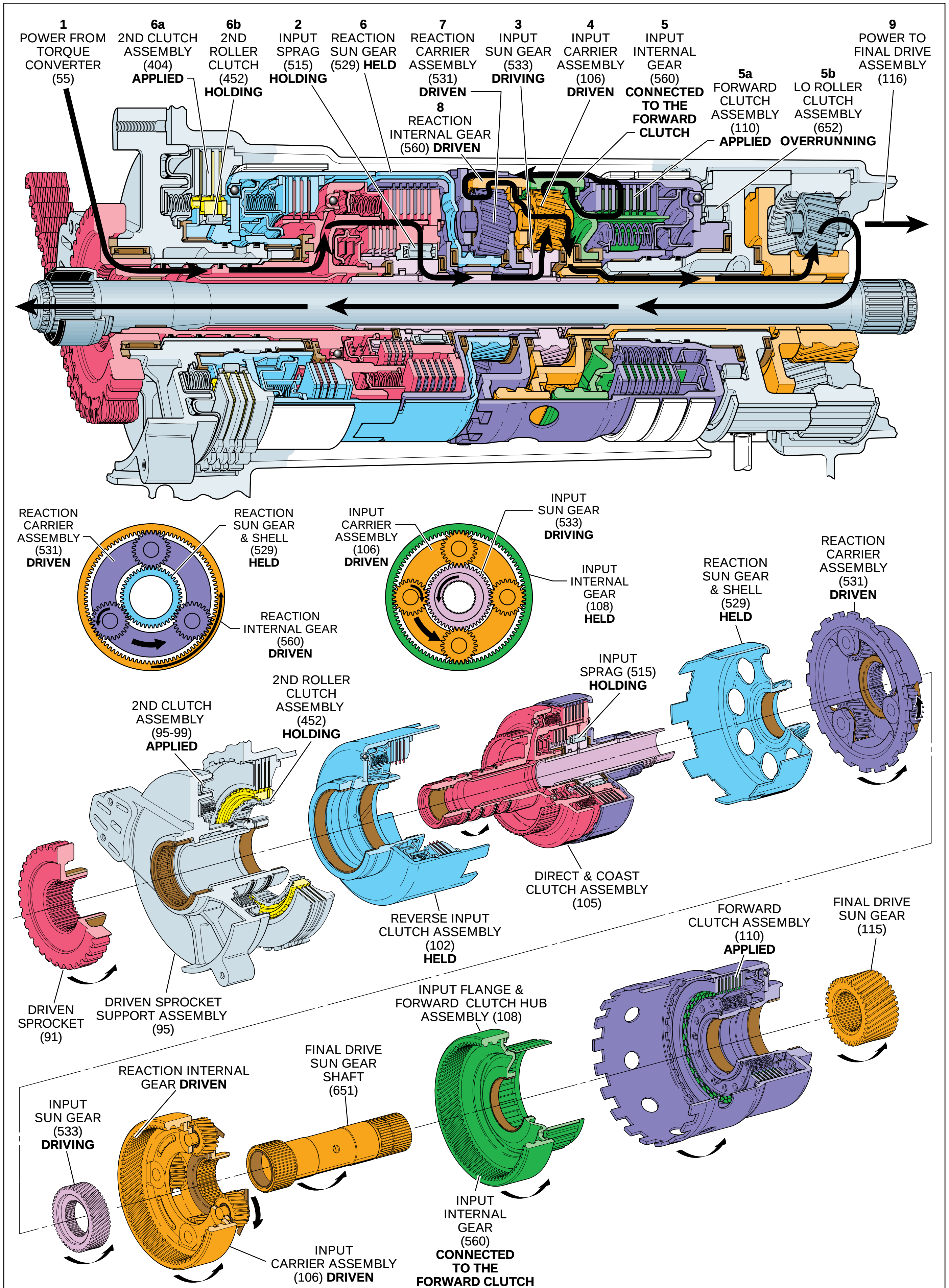

Figure 60

OVERDRIVE RANGE - SECOND GEAR

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
OFF	OFF	APPLIED	HOLDING				HOLDING		APPLIED		OVER-RUNNING

As the speed of the vehicle increases, input signals from the vehicle speed sensor (VSS), throttle position sensor (TPS) and other sensors are sent to the powertrain control module (PCM). The PCM uses this information to manage engine torque as the transaxle 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 1.62:1.

1 Power from Torque Converter

The driven sprocket (91) is splined to the input shaft and direct & coast clutch housing assembly (502) and forces the housing to rotate at driven sprocket speed.

The input shaft and direct & coast clutch housing assembly (502) is splined to the input sprag outer race (512) and rotates both components in the same direction (engine rotation) and at the same speed.

2 Input Sprag Holding

The sprag clutch (515) holds and power transfers to the input sun gear shaft and inner race assembly (511).

3 Input Sun Gear Driving

The input sun gear shaft and inner race assembly is splined to the input sun gear (533) and rotates both components in the same direction (engine rotation) and at the same speed.

4 Input Carrier Assembly Driven

Teeth on the input sun gear (533), in constant mesh with the input carrier planet pinion gears (568), force the input carrier assembly (106) to rotate in the same direction as engine rotation.

5 Input Internal Gear (Connected to the Forward Clutch)

5a Forward Clutch Applied

When applied, the forward clutch plates (601-604), splined to the forward clutch housing (609) and the input flange and forward clutch hub (577), connect to the input internal gear (560) which is splined to the input flange and forward clutch hub. Engine torque is transferred through the hub to the forward clutch housing.

5b Lo Roller Clutch Overruns

The lo roller clutch (652) overruns allowing the forward clutch housing (609) to rotate.

6 Reaction Sun Gear Held

6a 2nd Clutch Applied

The 2nd clutch plates (96-99), splined to the 2nd roller clutch cam (451) and the case (51), hold the roller clutch outer cam.

6b 2nd Roller Clutch Holding

The inner race of the 2nd roller clutch is part of the reverse clutch housing. The reverse clutch housing (454) is tanged to the reaction sun shell (529). The 2nd roller clutch holds and prevents the reaction sun gear from rotating.

7 Reaction Carrier Assembly Driven

The reaction carrier assembly, driven by the forward clutch housing (609), is forced to rotate around the stationary reaction sun shell/gear (529).

8 Reaction Internal Gear Driven

The reaction carrier pinion gears (556), in constant mesh with the reaction internal gear/input carrier assembly (106), force the reaction internal gear/input carrier assembly to rotate.

9 Power to Final Drive Assembly

The reaction internal gear/input carrier assembly (106), splined to the final drive sun gear shaft (651), drives the final drive sun gear (115). 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 (115) 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 transaxle to a lower gear ratio, or third gear.

OVERDRIVE RANGE - SECOND GEAR

As vehicle speed increases and operating conditions become appropriate, the PCM de-energizes the 1-2 shift solenoid to shift the transaxle into Second gear. The manual valve remains in the Overdrive (D) position and line pressure is routed into the DRIVE and PRND4 fluid circuits.

1 SECOND CLUTCH APPLIES

1a 1-2 Shift Solenoid:
The normally open shift solenoid is de-energized and 1-2 signal fluid exhausts through the open solenoid.

Note: *Filtered actuator feed fluid continues to feed the 1-2 signal fluid circuit through orifice #7. However, the exhaust port through the solenoid is larger than orifice #7 to prevent a pressure increase in the 1-2 signal fluid circuit.*

1b 1-2 Shift Valve:
With 1-2 signal fluid pressure exhausted, spring force moves the valve into the upshifted position and drive fluid is routed into the 2-3 drive fluid circuit. Drive fluid also continues to the PSA.

1c #2 Checkball (Second Clutch Apply):
2-3 drive fluid seats the #2 checkball, forces 2-3 drive fluid through the #3 orifice and feeds the 2nd clutch fluid circuit. The #3 orifice helps control the apply feel of the second clutch.

1d Second Clutch:
2nd clutch fluid pressure applies the Second clutch to shift the transaxle into Second gear.

2 SHIFT ACCUMULATION

2a 1-2 Accumulator:
2nd clutch fluid is also routed to the 1-2 accumulator piston. 2nd clutch fluid pressure, in addition to 1-2 assist spring force, moves the piston against spring force and 1-2 accumulator feed fluid pressure. This action absorbs initial 2nd clutch fluid pressure to cushion the second clutch apply. The movement of the 1-2 accumulator piston forces some accumulator fluid out of the accumulator.

2b 1-2 Accumulator Valve:
1-2 accumulator feed fluid forced from the 1-2 accumulator unseats the #4 checkball and is routed back to the 1-2 accumulator valve. This pressure forces the 1-2 accumulator valve against spring force and torque signal fluid pressure to regulate the exhaust of excess accumulator fluid. This regulation provides additional control for the second clutch apply. *Figure 37 shows the exhaust of accumulator fluid during the shift by the arrow directions in the accumulator fluid circuit.*

2c 2-3 Shift Solenoid:
2-3 Shift solenoid remains OFF in Second gear and 2-3 signal fluid exhausts through the normally open solenoid.

2d 2-3 Shift Valve:
Spring force keeps the 2-3 shift valve in the downshifted position. In this position the valve blocks 2-3 drive fluid in preparation for the upshift to Third gear.

TCC Control - Pulse Width Modulated (PWM) Solenoid:
Filtered 2-3 drive fluid is routed to the TCC control solenoid. Under normal operating conditions the TCC control solenoid is OFF in Second gear and blocks filtered 2-3 drive fluid from entering the TCC signal fluid circuit.

Torque Converter Clutch:
With the TCC control solenoid OFF the converter clutch is released in Second gear.

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OVERDRIVE RANGE - SECOND GEAR

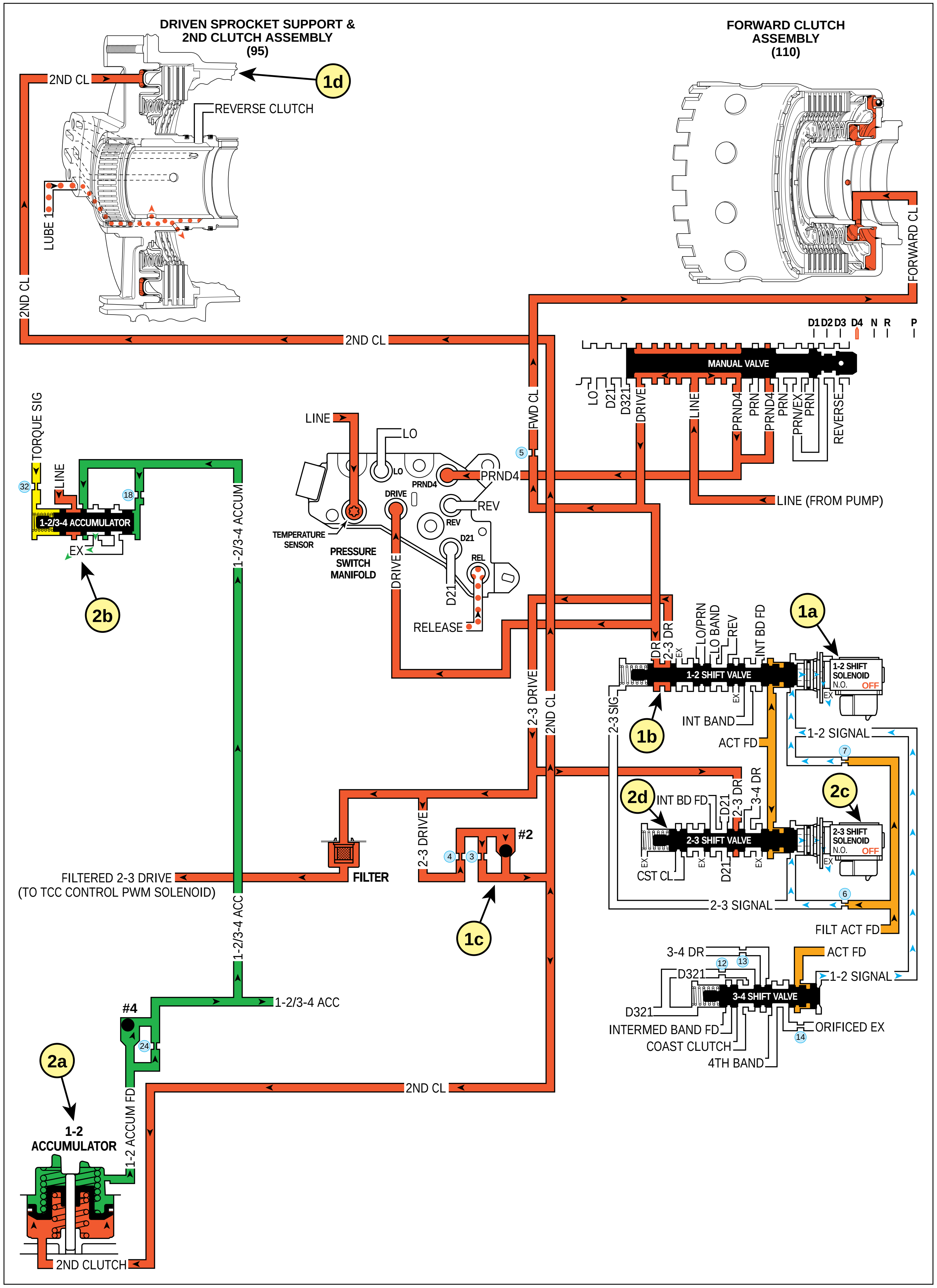

Figure 61

OVERDRIVE RANGE - THIRD GEAR

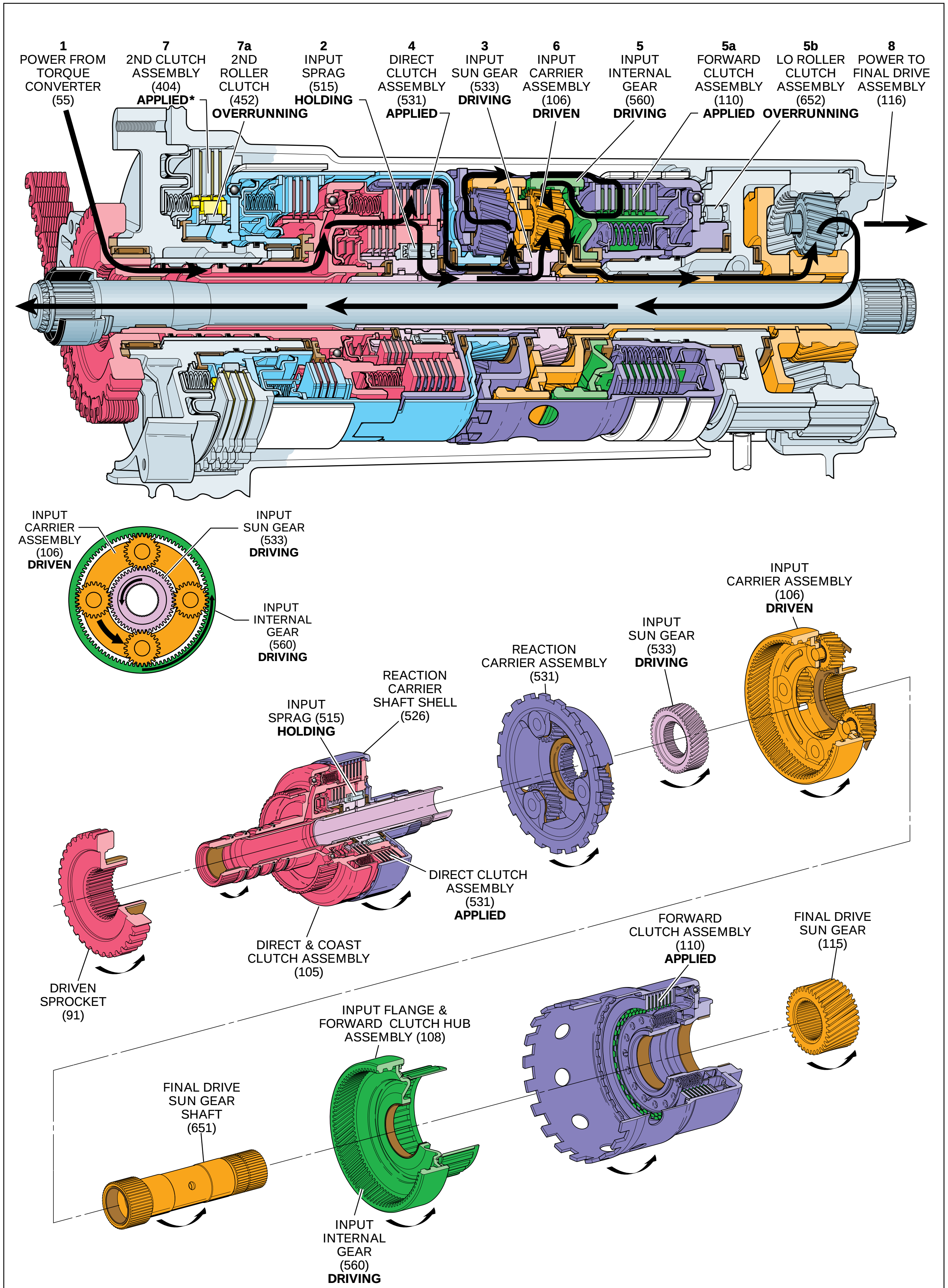

Figure 62

OVERDRIVE RANGE - THIRD GEAR

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
OFF	ON	APPLIED *	OVER-RUNNING				HOLDING	APPLIED	APPLIED		OVER-RUNNING

As the speed of the vehicle increases, input signals from the vehicle speed sensor (VSS), throttle position sensor (TPS) and other sensors are sent to the powertrain control module (PCM). The PCM uses this information to manage engine torque as the transaxle shifts from second to third gear. In third gear, the input internal gear (560) and the input sun gear (533) rotate at the same speed providing a 1:1 gear ratio to the final drive assembly (116).

1 Power from Torque Converter

The driven sprocket (91) is splined to the input shaft and direct & coast clutch housing assembly (502) and forces the housing to rotate at driven sprocket speed.

The input shaft and direct & coast clutch housing assembly (502) is splined to the input sprag outer race (512) and rotates both components in the same direction (engine rotation) and at the same speed (turbine speed).

2 Input Sprag Holding

The sprag clutch (515) holds and power transfers to the input sun gear shaft and inner race assembly (511).

3 Input Sun Gear Driving

The input sun gear shaft and inner race assembly is splined to the input sun gear (533) and rotates both components in the same direction (engine rotation) and at the same speed.

4 Direct Clutch Applied

The direct clutch applies and directs power flow through the input shaft and direct & coast clutch housing (502) and direct clutch plates (521-523).

The direct clutch plates, splined to the reaction carrier shaft shell (526), force the reaction carrier shaft shell to rotate at the same speed as the input shaft and direct & coast clutch housing assembly (502).

The reaction carrier shaft shell (526), splined to the reaction carrier assembly (531), forces the carrier to rotate in the same direction and speed as the input shaft and direct & coast clutch housing assembly (502).

Torque transfers through the reaction carrier to the forward clutch housing (609).

5 Input Internal Gear Driving

5a Forward Clutch Applied

Engine torque is transferred from the forward clutch housing, through the forward clutch plates (601-604), splined to the forward clutch housing (609) and the input flange and forward clutch hub (577), to drive the input internal gear (560).

5b Lo Roller Clutch Overrunning

The inner race of the lo roller clutch is part of the forward clutch housing. The housing and race assembly rotates in the direction that allows the lo roller clutch assembly (652) to overrun.

6 Input Carrier Assembly Driven

With the input internal gear and input sun gear rotating in the same direction and at the same speed, the input carrier assembly (106) is forced to rotate in the same direction and speed. When this event occurs the gear sets are operating in direct drive.

7 2nd Clutch Applied

The 2nd clutch is applied but the 2nd roller clutch elements are overrunning.

7a 2nd Roller Clutch Overrunning

The reverse clutch housing and race assembly (454) is driven by the reaction sun gear & shell assembly (529) in the opposite direction of holding.

8 Power to Final Drive Assembly

The reaction internal gear/input carrier assembly (106), splined to the final drive sun gear shaft (651), drives the final drive sun gear (115). Final drive is achieved.

OVERDRIVE RANGE - THIRD GEAR

As vehicle speed increases and operating conditions become appropriate, the PCM energizes the 2-3 shift solenoid to shift the transaxle into Third gear. The manual valve remains in the Overdrive (D) position and line pressure continues to feed the DRIVE and PRND4 fluid circuits.

1 DIRECT CLUTCH APPLIES

1a 2-3 Shift Solenoid:
The normally open shift solenoid is energized by the PCM and blocks 2-3 signal fluid from exhausting. 2-3 Signal fluid pressure is routed to both the 1-2 and 2-3 shift valves.

1b 2-3 Shift Valve:
2-3 Signal fluid pressure moves the valve against spring force to initiate the 2-3 upshift. 2-3 drive fluid is routed through the valve and into the 3-4 drive fluid circuit.

1c #5 Checkball (Direct Clutch Apply):
3-4 drive fluid pressure seats the #5 checkball and 3-4 drive fluid is forced through the #26 orifice and into the direct clutch feed fluid circuit. The #26 orifice helps control the direct clutch apply.

1d Direct Clutch:
Direct clutch fluid pressure applies the direct clutch and the transaxle shifts into Third gear.

1e 3-4 Shift Valve:
3-4 drive fluid is also routed to the 3-4 shift valve in preparation for a 3-4 upshift.

2 SHIFT ACCUMULATION

2a 2-3 Accumulator:
Direct clutch feed fluid is also routed to the 2-3 accumulator piston. This fluid pressure moves the piston against spring force and 2-3 accumulator feed fluid pressure. This action absorbs initial direct clutch fluid pressure to cushion the direct clutch apply. The movement of the 2-3 accumulator piston forces some accumulator fluid out of the accumulator.

2b 2-3 Accumulator Valve:
Excess 2-3 accumulator feed fluid is routed back to the 2-3 accumulator valve. This fluid pressure moves the accumulator valve against spring force and torque signal fluid pressure to regulate the exhaust of excess accumulator fluid. This regulation provides additional control for the direct clutch apply. *Figure 37 shows the exhaust of accumulator fluid during the shift by the arrow directions in the accumulator fluid circuit.*

Note: *The 2-3 accumulator fluid circuit does not include a checkball. However, a checkball pocket is included in the channel plate casting.*

2c Pressure Switch Assembly:
Release fluid pressure routed to the PSA signals the PCM that the TCC is released.

Torque Converter Clutch:
Under normal operating conditions the TCC is released in Third gear. However, TCC apply could vary depending on vehicle application and may be calibrated to apply in Overdrive Range - Third Gear.

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OVERDRIVE RANGE - THIRD GEAR

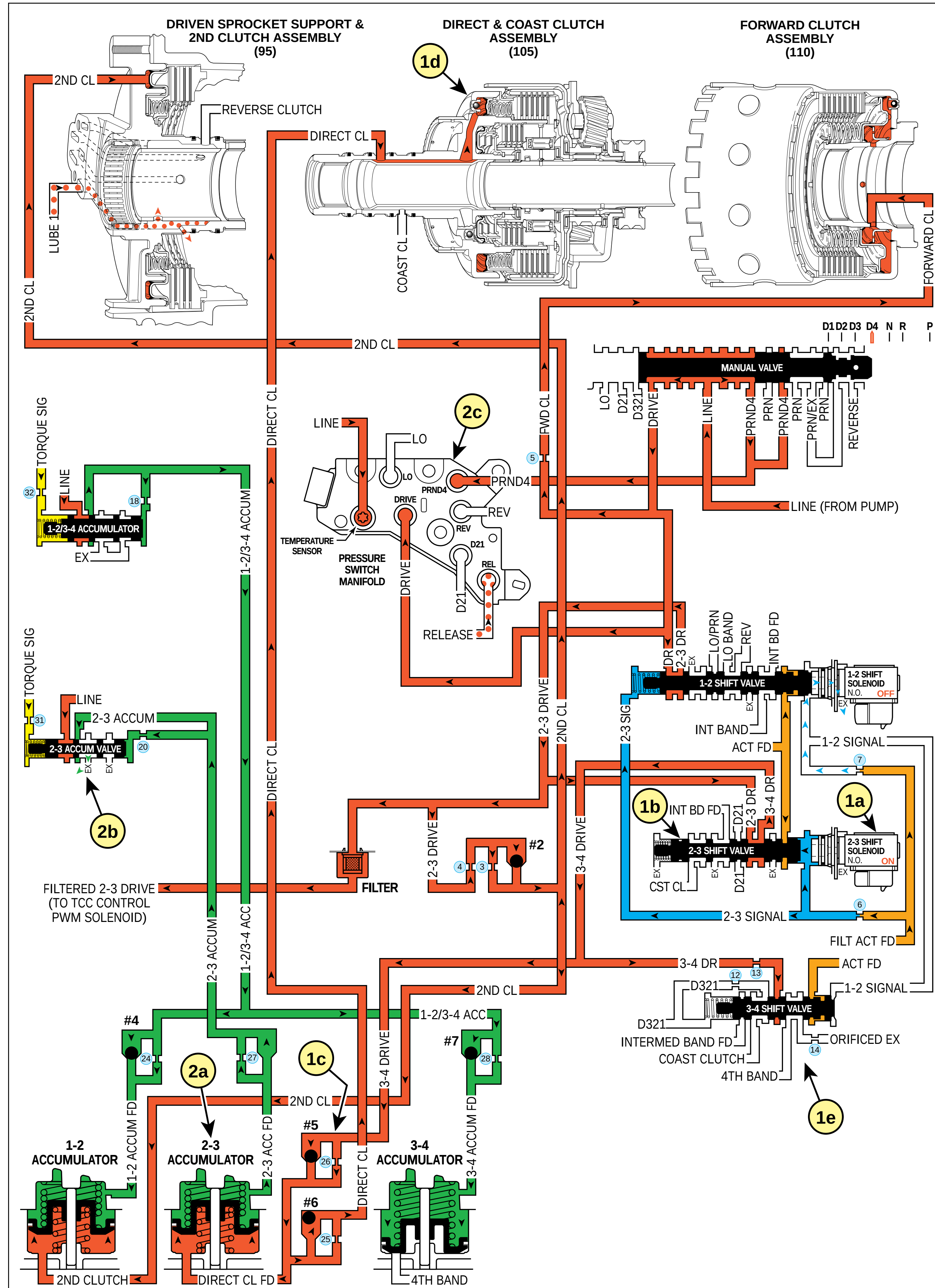

Figure 63

OVERDRIVE RANGE - FOURTH GEAR

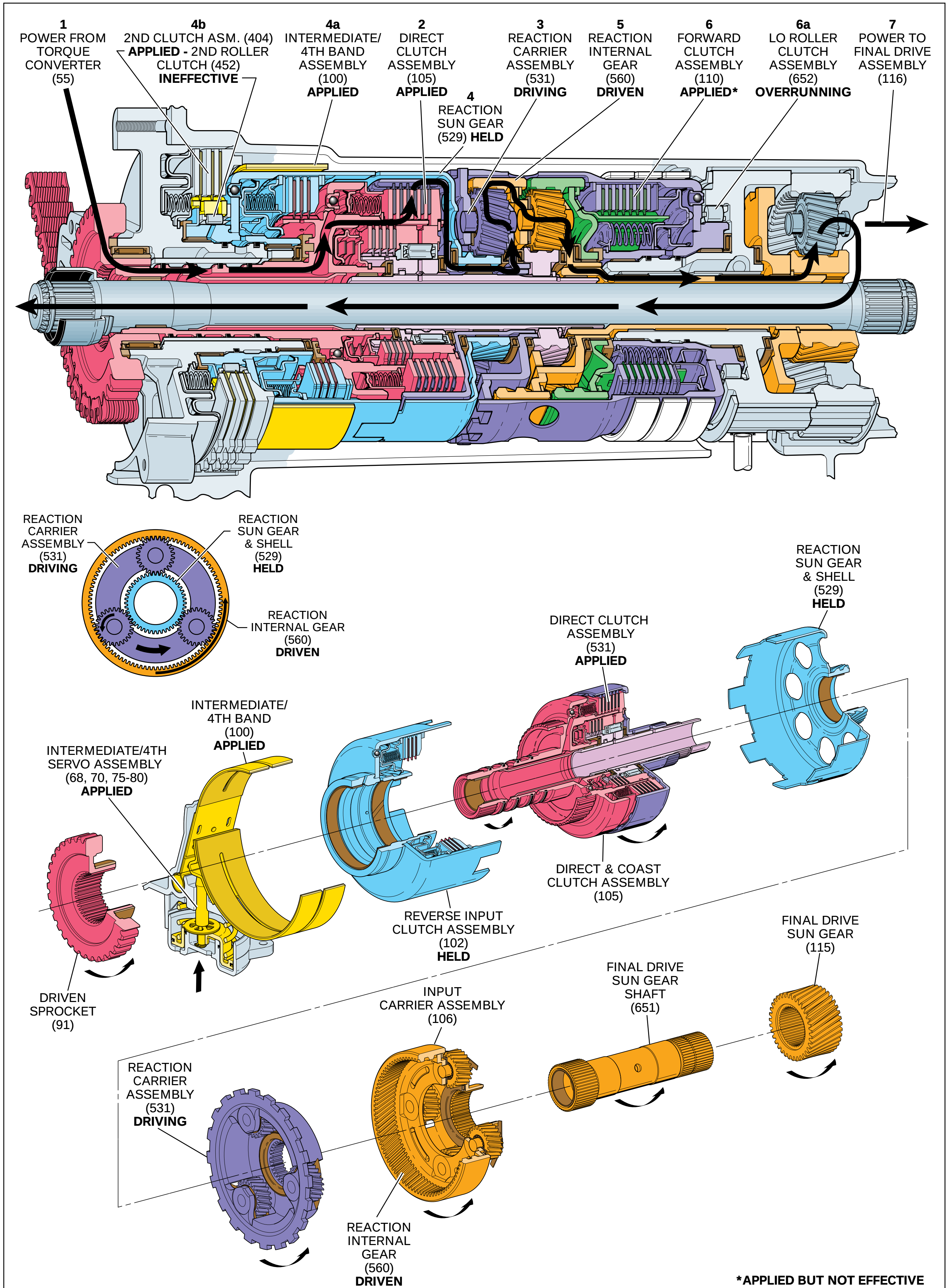

Figure 64

OVERDIVE RANGE - FOURTH GEAR

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
ON	ON	APPLIED		APPLIED			OVER-RUNNING	APPLIED	APPLIED *		OVER-RUNNING

As the speed of the vehicle increases, input signals from the vehicle speed sensor (VSS), throttle position sensor (TPS) and other sensors are sent to the powertrain control module (PCM). The PCM uses this information to manage engine torque as the transaxle shifts from third to fourth gear. The transaxle is now operating in overdrive at a gear ratio of 0.68:1.

1 Power from Torque Converter
The driven sprocket (91) is splined to the input shaft and direct & coast clutch housing assembly (502) and forces the housing to rotate at driven sprocket speed.

2 Direct Clutch Applied
The direct clutch is applied and directs power flow through the input shaft and direct & coast clutch housing (502) and direct clutch plates (521-523).

The direct clutch plates, splined to the reaction carrier shaft shell (526), force the reaction carrier shaft shell to rotate at the same speed as the input shaft and direct & coast clutch housing assembly (502).

3 Reaction Carrier Driving
The reaction carrier shaft shell (526), splined to the reaction carrier assembly (531), forces the carrier to rotate in the same direction and speed as the input shaft and direct & coast clutch housing assembly (502).

4 Reaction Sun Gear & Shell Held.

4a Intermediate/4th Band Applied
The intermediate/4th band (100) applies and holds the reverse clutch housing (454), which is also tanged into the reaction sun gear & shell (529).

4b 2nd Clutch Applied/2nd Roller Clutch Ineffective
The 2nd clutch is applied but the 2nd roller clutch is ineffective because the reverse clutch housing (102) is held stationary by the intermediate/4th band.

5 Reaction Internal Gear Driven
Torque transfers through the reaction carrier to the reaction carrier pinions which walk around the stationary reaction sun gear. The reaction carrier is driving at driven sprocket speed and the planetary pinions drive the reaction internal gear faster than driven sprocket speed.

6 Forward Clutch Applied
The forward clutch is applied but ineffective because the reaction sun gear & shell (529) is driving the reaction carrier assembly.

7 Power to Final Drive Assembly
The reaction internal gear/input carrier assembly (106), splined to the final drive sun gear shaft (651), drives the final drive sun gear (115). 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 transaxle. 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 (531) is driven around the stationary reaction sun gear & shell assembly (529) by the reaction internal gear (560). This attempts to drive the reaction carrier shaft shell (526) which is held to the input shaft and direct & coast clutch housing (502) by the direct clutch being applied. Since the driven sprocket (91) is splined to the input shaft, engine compression provides resistance to the powerflow input from the wheels.

OVERDRIVE RANGE - FOURTH GEAR

When operating conditions are appropriate, the PCM energizes the 1-2 shift solenoid to shift the transaxle into Fourth gear. In addition, the TCC is applied in Fourth gear. The manual valve remains in the Overdrive position and line pressure continues to feed the DRIVE and PRND4 fluid circuits.

1 INTERMEDIATE/4TH BAND APPLIED

1a 1-2 Shift Solenoid:
The normally open shift solenoid is energized by the PCM and blocks 1-2 signal fluid from exhausting. 1-2 Signal fluid pressure is routed to both the 1-2 and 3-4 shift valves.

1b 1-2 Shift Valve:
1-2 Signal fluid pressure does not affect the 1-2 shift valve. Spring force and 2-3 signal fluid pressure keep the 1-2 shift valve in the upshifted position.

1c 3-4 Shift Valve:
1-2 Signal fluid pressure moves the valve against spring force and into the Fourth gear position. 3-4 drive fluid is routed into the 4th band fluid circuit.

1d Intermediate/4th Servo:
4th band fluid pressure acts on the outer area of the servo piston to move the servo pin and apply the Intermediate/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 feed fluid pressure. This action absorbs initial 4th band fluid pressure to cushion the intermediate/4th band apply. The movement of the 3-4 accumulator piston forces some accumulator fluid out of the accumulator.

2b 3-4 Accumulator Valve:
3-4 accumulator feed fluid forced from the 3-4 accumulator unseats the #7 checkball and is routed back to the 1-2/3-4 accumulator valve. This pressure forces the 1-2/3-4 accumulator valve against spring force and torque signal fluid pressure to regulate the exhaust of excess accumulator fluid. This regulation provides additional control for the intermediate/4th band apply. *Figure 38 shows the exhaust of accumulator fluid during the shift by the arrow directions in the accumulator fluid circuit.*

TORQUE CONVERTER CLUTCH APPLIED

TCC Control Solenoid:
When conditions are appropriate, the PCM energizes the TCC control solenoid to initiate the TCC apply. The solenoid is pulse width modulated (PWM) to provide a smooth TCC apply. (See Overdrive Range – Fourth Gear TCC Released & Applied pages 70-71.)

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OVERDRIVE RANGE - FOURTH GEAR

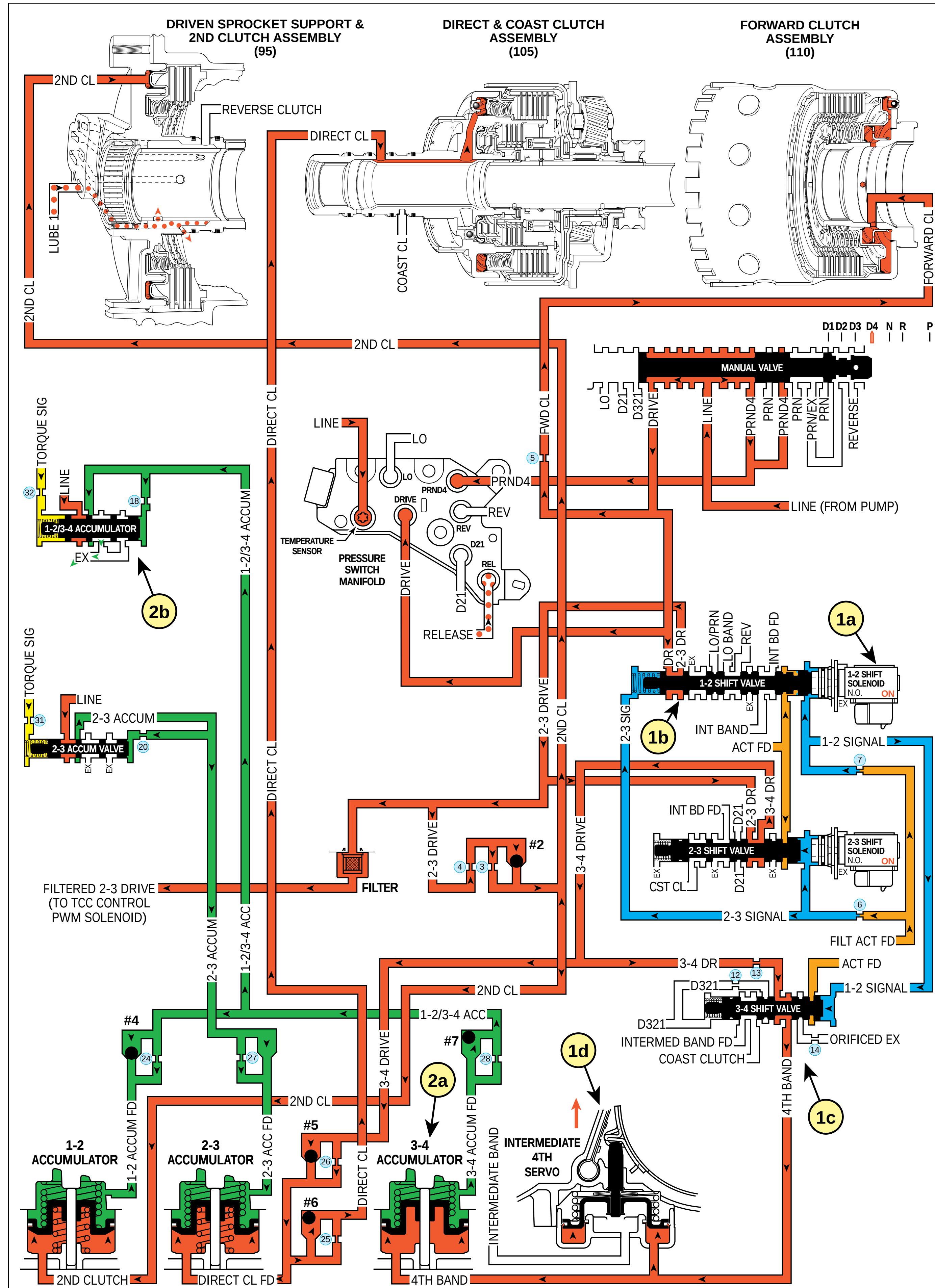

Figure 65

OVERDRIVE RANGE - FOURTH GEAR

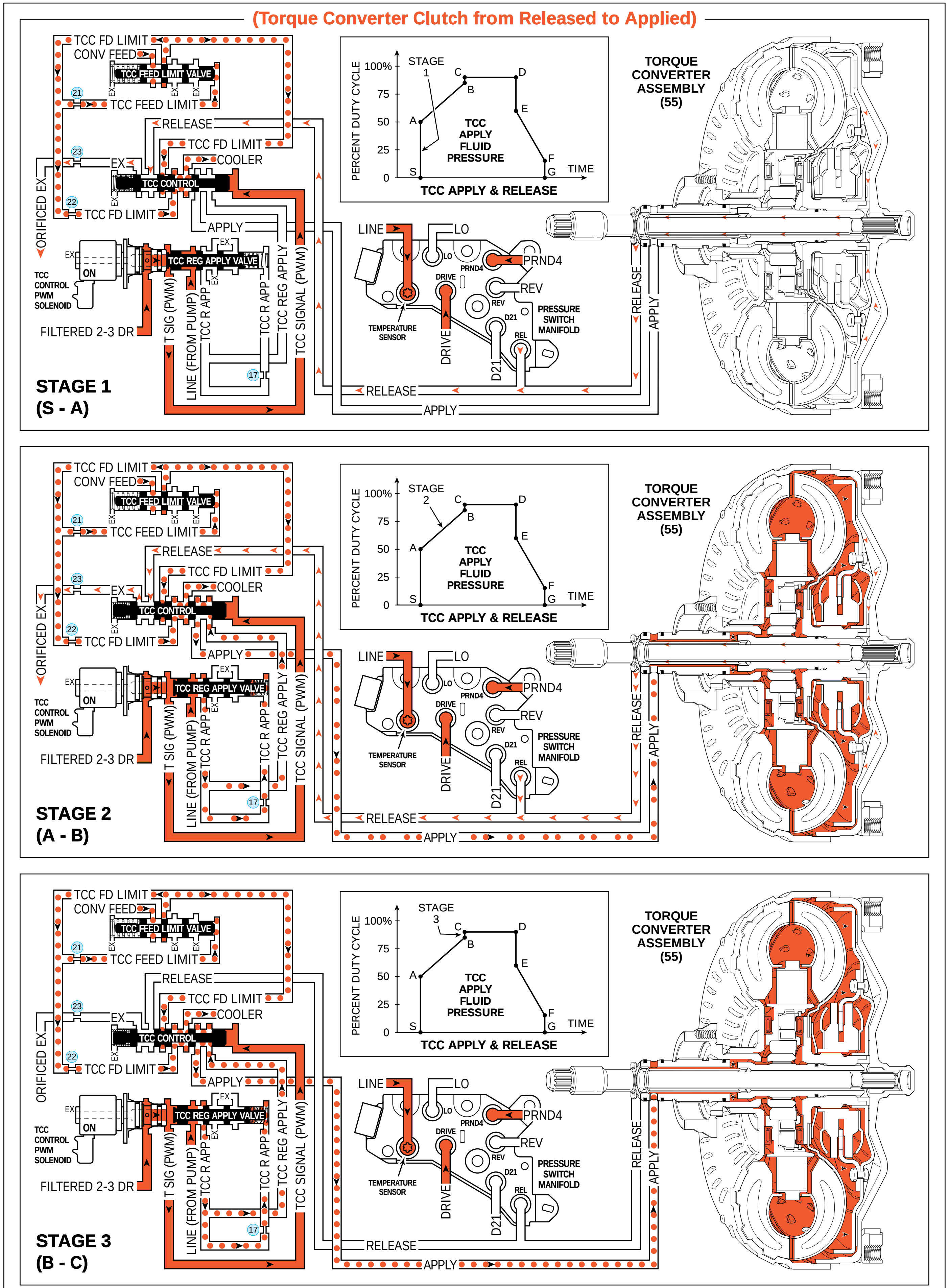

Figure 66

OVERDRIVE RANGE - FOURTH GEAR

(Torque Converter Clutch from Released to Applied)

When the Powertrain Control Module (PCM) determines that the engine and transaxle are operating properly to engage the Torque Converter Clutch (TCC), the PCM energizes the torque converter clutch control (PWM) 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 (see page 50, in the Electrical Components section, for more information).

Stage 1 The PCM pulses the TCC control PWM solenoid to approximately 50% duty cycle from point **S** to point **A**. Filtered 2-3 Drive fluid at the TCC control solenoid is "pulsed" into the TCC Signal fluid circuit. The TCC Signal fluid pressure at point **A** is strong enough to move the Converter Clutch Control valve against the spring. With the TCC Control valve in the apply position Release fluid can exhaust and TCC Regulator Apply fluid is sent to the Torque Converter Clutch. This stage is designed to move the TCC Control valve from the released to the applied position; there is not enough pressure to apply the TCC.

Stage 2 The TCC control solenoid duty cycle is ramped up from point **A** to point **B** to approximately 85%. Line pressure from the pump is also able to enter the TCC Regulated Apply circuit at the TCC Regulator Valve. 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").

Stage 3 Now the Regulated Apply pressure is increased. This is caused by the TCC control solenoid duty cycle being increased from point **B** to point **C,** approximately 90%. 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 plate material is therefore protected from damage due to slippage.

TCC Release Switch

The Torque Converter Clutch (TCC) release switch is part of the Pressure Switch Assembly (PSA) that is mounted to the valve body. The switch is a normally closed switch. The purpose of the switch is to provide a signal to the Powertrain Control Module (PWM) that the TCC is released. This is accomplished by the Release fluid pressure acting on the switch contact and opening the circuit. When the voltage is high the PCM recognizes that the TCC is not engaged. When the release fluid pressure is low the switch is in the normally closed state, the TCC is in the engaged position.

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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 transaxle 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 transaxle and to the drive wheels.

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

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

Stage 4 During this stage, the apply pressure from the Converter Clutch Regulator valve is decreased by the TCC control solenoid duty cycle dropping from point **D** to point **E,** approximately 60%. This reduces 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 5 The TCC control 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 6 The PCM pulses the TCC control solenoid to a value of "0". Now the TCC Regulator Valve and the Converter Clutch Control valve return to the released position (away from their springs). Release fluid is now directed back to the torque converter. This stage is designed to move the TCC Control valve to the released position.

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

Release fluid pressure also opens the normally closed TCC release switch located in the Pressure Switch Assembly (PSA). The switch sends a signal to the PCM that the TCC is released. If the switch does not open, the PCM will command the TCC on in 2nd, 3rd, and 4th gears with 100% duty cycle to the TCC control (PWM) Solenoid. Also a Diagnostic Trouble Code (DTC) 742 will set and the PCM will illuminate the Malfunction Indicator Lamp (MIL). The DTC 742 will then be stored in PCM history and the PCM will freeze shift adapts from being updated.

(Some PCM calibrations may allow stages 4 - 6 to happen very rapidly in almost a straight line down from point **D** to point **G**.)

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OVERDRIVE RANGE - FOURTH GEAR

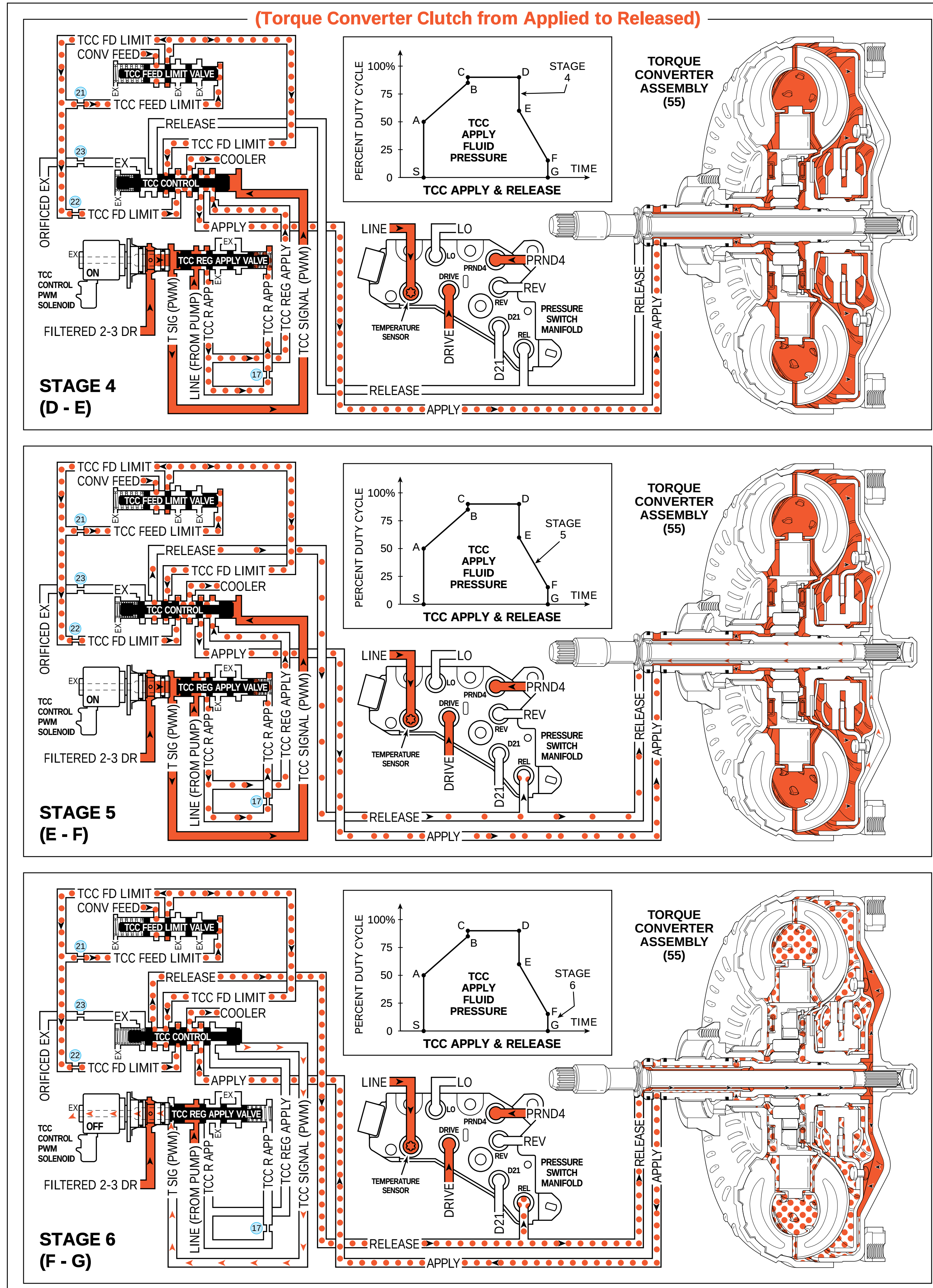

Figure 67

OVERDRIVE RANGE - 4-3 DOWNSHIFT

(Torque Converter Clutch Released)

When the transaxle is operating in Overdrive Range - Fourth Gear a forced 4-3 downshift will occur if there is a significant increase in throttle position. At minimum throttle, vehicle speed will decrease gradually (coastdown) and the PCM will command a 4-3 downshift. The PCM will also initiate a 4-3 downshift if engine load is increased with throttle position remaining the same (for example, driving up a steep hill).

1 LINE PRESSURE INCREASES

1a Pressure Control Solenoid (PCS):
During the downshift, except for a coastdown, the PCM senses the increase in throttle position or engine load and decreases the PCS duty cycle. The decrease in duty cycle increases output fluid pressure from the PCS, thereby increasing torque signal fluid pressure at the torque signal regulator valve.

1b Pressure Regulator Valve:
Increased torque signal fluid pressure acting on the boost valve increases line pressure at the pressure regulator valve.

2 INTERMEDIATE / 4TH BAND RELEASES

2a 1-2 Shift Solenoid:
The PCM de-energizes the normally open solenoid and 1-2 signal fluid exhausts.

2b 3-4 Shift Valve:
1-2 Signal fluid pressure exhausts from the 3-4 shift valve and spring force moves the valve into the Third gear position. This opens the 4th band fluid circuit to an orificed exhaust to help control the band release.

2c Intermediate / 4th Servo:
4th band fluid exhausts from the servo and spring force moves the servo to the release position, thereby releasing the band.

2d 3-4 Accumulator:
4th band fluid exhausts from the accumulator. Spring force and 3-4 accumulator feed fluid pressure move the accumulator piston to the Third gear position.

2e 1-2/3-4 Accumulator Valve:
The accumulator valve regulates line pressure into the 1-2/3-4 accumulator fluid circuit to fill the 3-4 accumulator. This regulation is basically controlled by torque signal fluid pressure. Increased torque signal fluid pressure regulates accumulator fluid to a higher pressure.

2f #7 Checkball (3-4 Accumulator):
1-2/3-4 Accumulator fluid pressure seats the #7 checkball and forces accumulator fluid through orifice #28.

TORQUE CONVERTER CLUTCH

The PCM commands TCC release prior to initiating a 4-3 downshift. When the TCC is in the release position release fluid pressure is routed to the pressure switch assembly. This fluid pressure signals the PCM that the TCC is in the release position. The TCC is not applied under normal operating conditions in Third gear (except for some applications)

3-2 and 2-1 DOWNSHIFTS

Refer to the Manual range explanations for a description of the 3-2 and 2-1 downshifts with respect to the clutches releasing.

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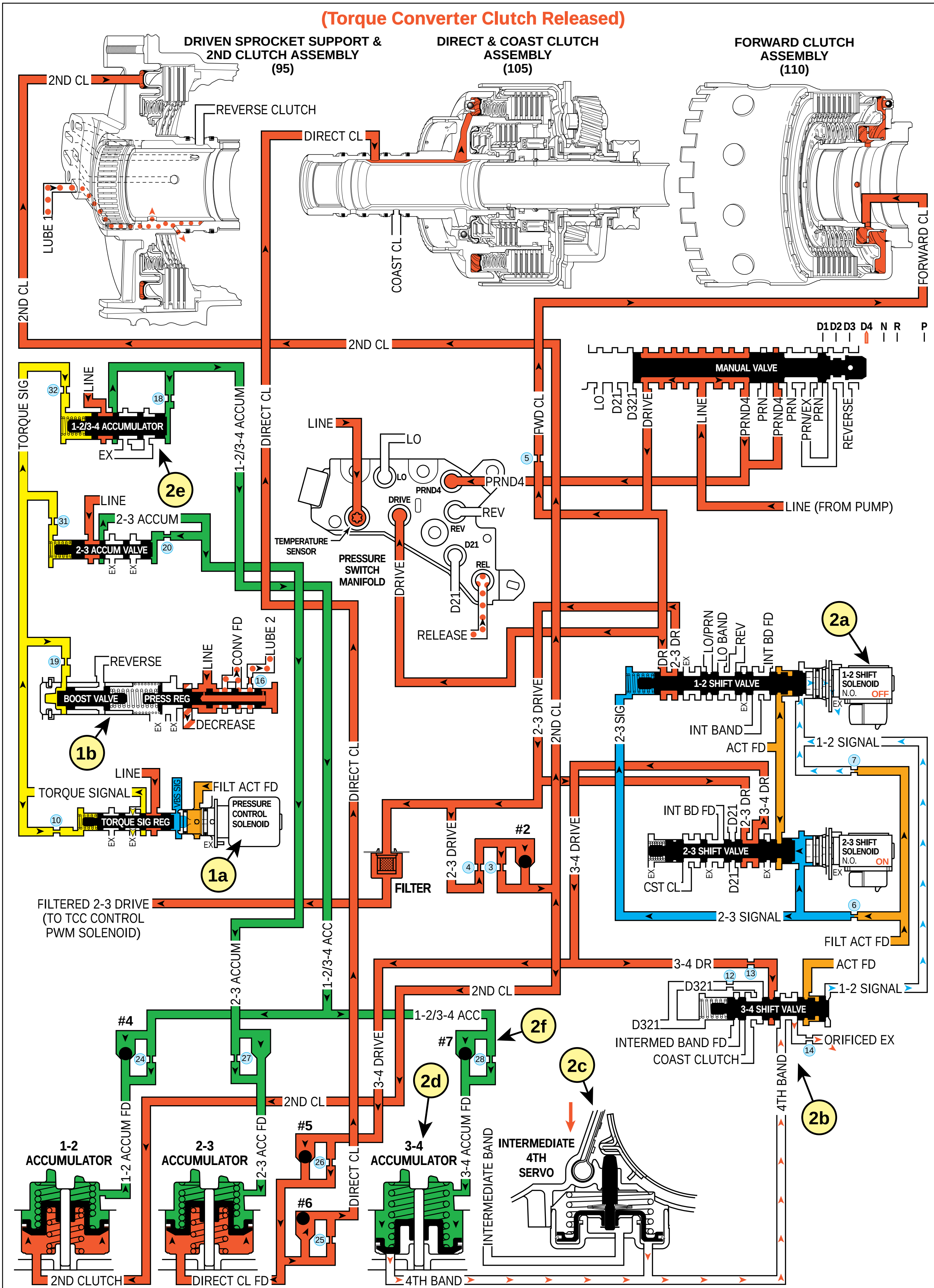
OVERDRIVE RANGE - 4-3 DOWNSHIFT



MANUAL THIRD - THIRD GEAR

(From Overdrive Range - Fourth Gear; Engine Compression Braking Shown)

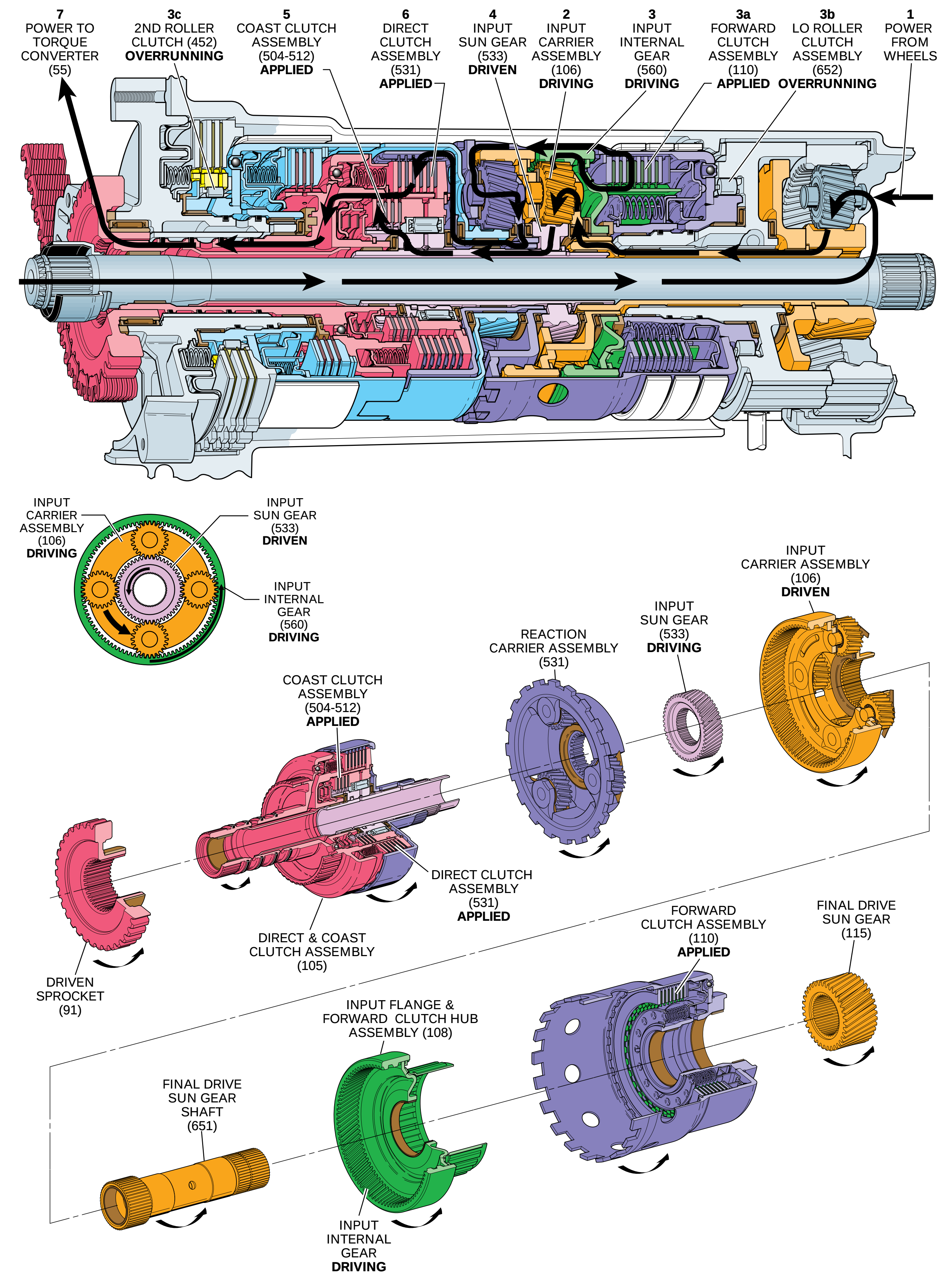


Figure 69

MANUAL THIRD - THIRD GEAR

(From Overdrive Range - Fourth Gear)

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
OFF	ON	APPLIED *	OVER-RUNNING			APPLIED	HOLDING	APPLIED	APPLIED		OVER-RUNNING

Manual Third - Third gear (3) is available to the driver when vehicle operating conditions make it desirable to use only three gear ratios. Some of these conditions include city driving, where speeds are generally below 72 kmh (45 mph), towing a trailer, or driving in hilly terrain. Manual Third gear also provides for engine compression breaking when descending slight grades and provides a direct drive ratio of 1:1 through the gear sets.

When Manual Third range is selected, the transaxle can automatically upshift or downshift between first, second and third gear. However, the transaxle is prevented from shifting into fourth gear while operating in this mode. If the transaxle is in Overdrive Range - Fourth gear when Manual Third is selected for engine braking, the transaxle will shift immediately into third gear.

The acceleration powerflow for Manual Third is exactly the same as Overdrive Range Third gear, therefore we will discuss and illustrate deceleration (engine braking). You will note that the powerflow is backwards from the powerflow in Overdrive Range Third gear, with power coming from the wheels and going to the torque converter.

- The manual shaft and detent lever assembly (806) and manual valve (800) are moved into the "3" range position - manual third.

  If manual third range is selected for engine compression braking after the vehicle was operating in overdrive range fourth gear, the Int/4th band releases. When the band is released the reverse clutch housing and the reaction sun gear & shell assembly rotate.

1 Power from the Wheels

Power from the wheels travels through the final drive differential assembly to the final drive sun gear shaft.

2 Input Carrier Assembly Driving

Power continues to the input carrier assembly, which is splined to the final drive sun gear shaft.

3 Input Internal Gear Driving

At the input carrier the torque drives the input internal gear which is splined to the forward clutch hub. The input internal gear drives the reaction carrier shaft shell.

3a Forward Clutch Assembly Applied

The forward clutch applies and holds the input flange and forward clutch hub assembly (108). Torque is now transferred to the forward clutch housing (609) through the forward clutch plates (601-604). The forward clutch assembly is now rotating at the same speed as the input from the wheels through the final drive assembly.

3b Lo Roller Clutch Overrunning

The forward clutch is rotating in the direction that allows the lo roller clutch to overrun, so torque continues to the reaction carrier assembly which is splined to the reaction carrier shaft shell.

3c 2nd Roller Clutch Overrunning

The 2nd clutch is applied but ineffective since the 2nd roller clutch will overrun. Power then goes from the reaction carrier to the direct clutch housing.

4 Input Sun Gear Driven

Torque delivered through the input carrier assembly forces the input sun gear, which is traveling at a slower speed, to try to speed up.

5 Coast Clutch Assembly Applied

This is where the key element of manual third comes into play. The coast clutch holds the inner race of the input sprag which would normally overrun in a coast situation. Now, power can flow through the coast clutch and the input shaft assembly to the torque converter for engine compression braking.

6 Direct Clutch Assembly Applied

The direct clutch is applied so power from the input internal gear also goes to the input shaft.

7 Power to Torque Converter

With two members of the same gear set driving we have a 1:1 ratio through the gear sets to the torque converter for engine braking.

MANUAL THIRD - THIRD GEAR

(From Overdrive Range - Fourth Gear)

A manual 4-3 downshift is accomplished by moving the gear selector lever to the Manual Third (3) position. In Manual Third the transaxle is hydraulically prevented from upshifting into Fourth gear under any conditions. Also, the coast clutch is applied in all manual ranges to provide engine compression braking when appropriate. The following information explains the additional changes during a Manual 4-3 downshift as compared to a forced 4-3 downshift. *Refer to Overdrive Range – 4-3 Downshift for a complete description of a 4-3 downshift.*

1 FOURTH GEAR HYDRAULICALLY PREVENTED

1a Manual Valve:
The manual valve moves into the Manual Third (3) position and line pressure enters the D321 fluid circuit. Also, the manual valve blocks line pressure from the PRND4 fluid circuit and PRND4 fluid exhausts past the manual valve.

1b 3-4 Shift Valve:
D321 fluid pressure assists spring force to keep the valve in the Third gear position under any conditions. This opens the 4th band fluid circuit to an orificed exhaust and the intermediate / 4th band releases, thereby preventing Fourth gear.

Note: *The operating states for the shift solenoids follow normal operation, depending on vehicle driving conditions. Figure 46 shows the solenoids in the Third gear position.*

1c Pressure Switch Assembly:
PRND4 fluid exhausts from the PSA and the PSA signals the PCM that the manual valve is in the Manual Third position.

2 COAST CLUTCH APPLIES

2a 3-4 Shift Valve:
D321 fluid is routed through the 3-4 shift valve and into the coast clutch fluid circuit.

2b Coast Clutch:
Coast clutch fluid pressure applies the coast clutch. With the coast clutch applied, engine compression braking is available in Manual Third - Third Gear to slow the vehicle when the throttle is released.

MANUAL THIRD – SECOND and FIRST GEARS

The transmission operates the same in Manual Third as in Overdrive range with the exception of Fourth gear being prevented. The transaxle will upshift and downshift between First, Second and Third gears as in Overdrive range. However, engine compression braking is not available in Overdrive Range – Third, First and Second gears and the vehicle will coast when the throttle is released.

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MANUAL THIRD - THIRD GEAR

(From Overdrive Range - Fourth Gear)

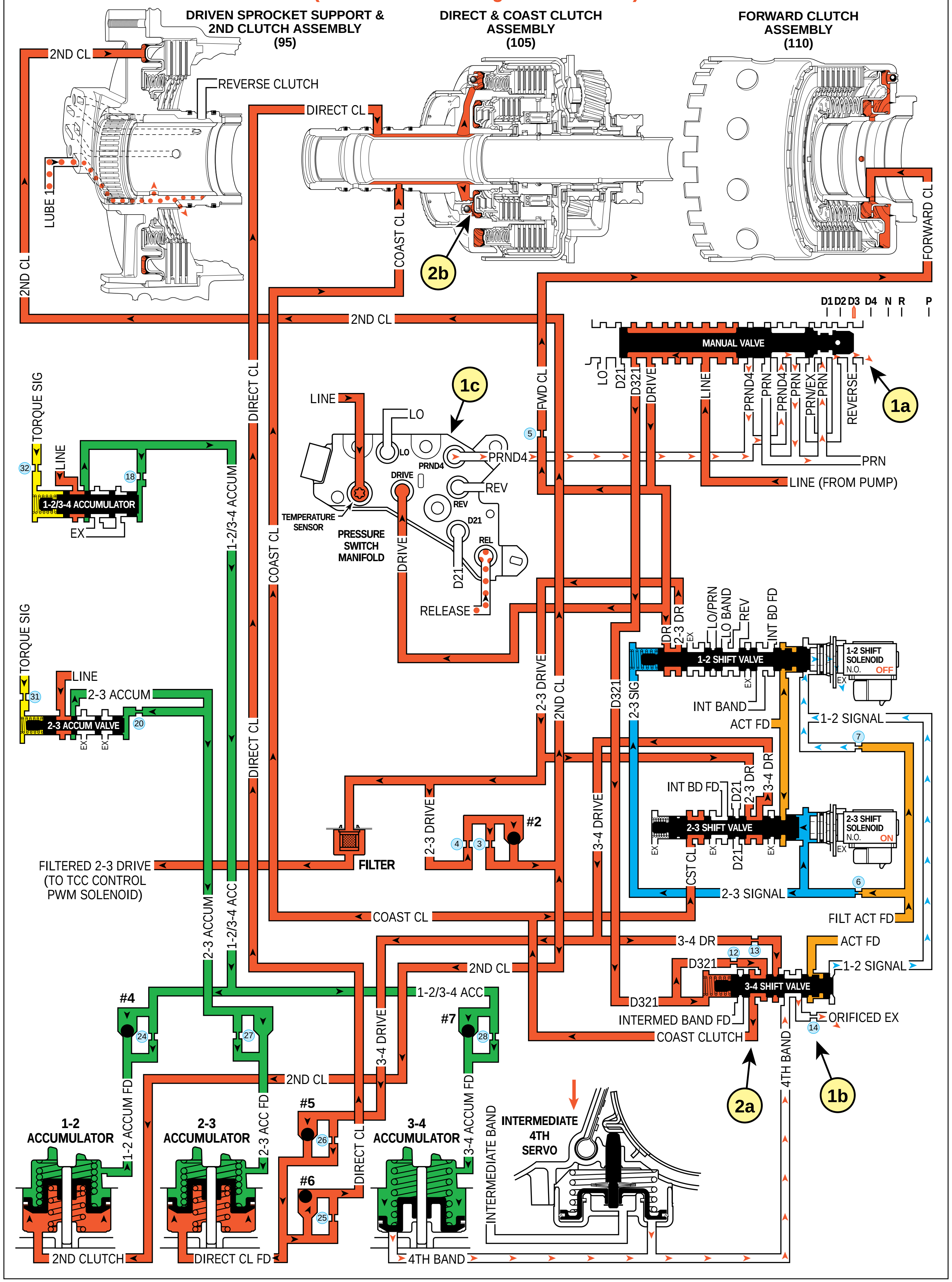

Figure 70

MANUAL SECOND - SECOND GEAR

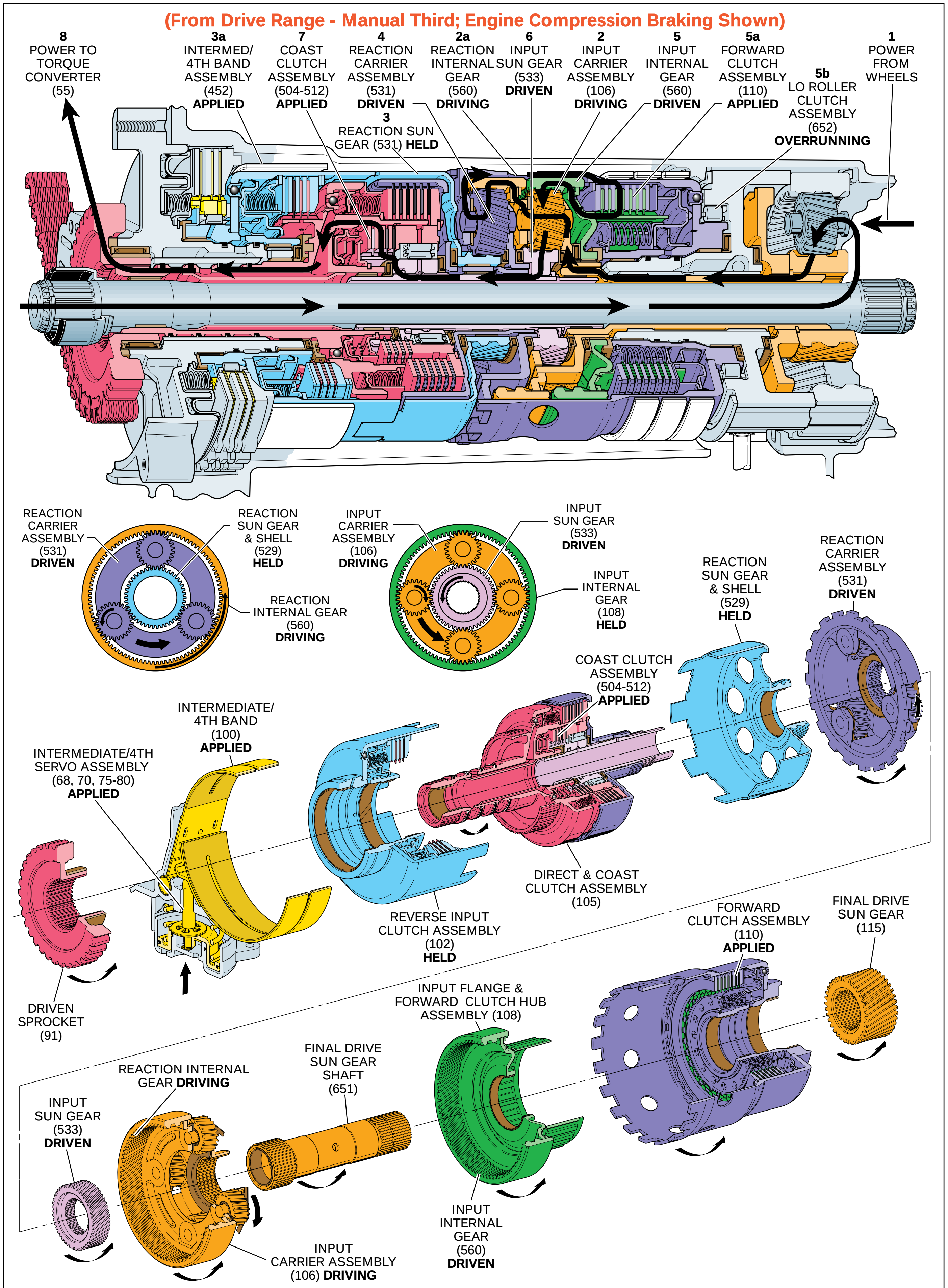

Figure 71

MANUAL SECOND - SECOND GEAR

(From Manual Third - Third Gear)

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
OFF	OFF	APPLIED	HOLDING	APPLIED		APPLIED	HOLDING		APPLIED		OVER-RUNNING

Manual Second – Second Gear (2) is available when vehicle operating conditions or road conditions make it desirable to use only two gear ratios. Some of these vehicle operating conditions include descending a steep grade to provide engine compression braking or, ascending a steep grade for additional engine performance.

When manual second gear range is selected, the transaxle will upshift and downshift between first, second and third gear but, it is prevented from shifting into fourth gear. If the transaxle is operating in Manual Third or Overdrive Range – Fourth gear when Manual Second is selected, the transaxle will shift immediately into second gear [below 113 kmh (70 mph)]. Power flow through the transaxle is the same as described in Overdrive Range - Second gear with the exception that the intermediate/4th band and coast clutch are applied, which allows the transmission to achieve engine braking during deceleration instead of coasting.

The mechanical power flow graphics show the transfer of power through the components during deceleration. When selecting Manual Second to slow the vehicle, vehicle speed provides the input from the wheels through the transaxle and attempts to overrun engine speed (rpm). However, engine compression braking slows the vehicle when the coast clutch and 4th band are applied, resulting in a 1.62:1 gear ratio through the gear sets.

- The manual shaft and detent lever assembly (806) and manual valve (800) are moved into manual second - the "2" range position on the shift quadrant.

1 Power from the Wheels

During deceleration, input torque from the wheels is transferred from the wheels through the final drive assembly (116) to the final drive sun gear shaft (651).

2 Input Carrier Assembly Driving

2a Reaction Internal Gear Driving

The final drive sun gear shaft forces the input carrier assembly (106) and reaction internal gear (560) to rotate and transfer torque to the reaction carrier assembly (531).

3 Reaction Sun Gear & Shell Held

3a Intermediate/4th Band Applied

During deceleration, input torque from the wheels tries to rotate the reverse clutch housing & race assembly (102) in the same direction as engine rotation. This condition would allow the 2nd roller clutch elements and the reaction sun gear & shell assembly to freewheel, resulting in a loss of torque through the gear sets. Therefore, the intermediate/4th band is applied and holds the sun gear during acceleration and deceleration.

4 Reaction Carrier Assembly Driven

The reaction carrier assembly rotates around the stationary reaction sun gear & shell assembly (529) and transfers torque through the reaction carrier to the forward clutch housing (609).

5 Input Internal Gear Driven

5a Forward Clutch Assembly Applied

Torque from the reaction carrier transferred to the forward clutch housing passes through the forward clutch plates (601-604), then drives the input internal gear (560) at a reduced speed from the final drive.

5b Lo Roller Clutch Overrunning

The forward clutch is rotating in the direction that allows the lo roller clutch to overrun, so torque continues to the input carrier planetary pinions.

6 Input Sun Gear Driven

The input internal gear drives the input carrier planetary pinions which will now drive the input sun gear at a reduced rate of speed but, still faster than engine speed.

7 Coast Clutch Assembly Applied

The coast clutch holds the inner race of the input sprag which would normally overrun in a coast situation. Now power can flow through the coast clutch and on to the input shaft assembly.

8 Power to Torque Converter

From the input shaft, power continues to the torque converter for engine compression braking.

MANUAL SECOND - SECOND GEAR

(From Manual Third - Third Gear)

A manual 3-2 downshift is initiated by moving the gear selector lever to the Manual Second (2) position. However, the transaxle will not downshift into Second gear until vehicle speed is below approximately 113 Km/h (70 mph). At higher vehicle speeds, the PCM will keep the 2-3 shift solenoid energized (ON) and the transaxle will operate in Manual Second - Third Gear as a safety precaution. In Manual Second, the transaxle is hydraulically prevented from upshifting into Fourth gear under any conditions. Also, the coast clutch remains applied as in Manual Third and provides engine compression braking in Third and Second gears. The transaxle upshifts and downshifts between First and Second gears as in Overdrive range.

1 MANUAL VALVE:
Line pressure is routed into the D21 fluid circuit when the selector lever is moved into the Manual Second (2) position.

2 2-3 SHIFT SOLENOID:
The PCM de-energizes the 2-3 shift solenoid. With the solenoid OFF, 2-3 signal fluid exhausts through the 2-3 shift solenoid.

3 2-3 SHIFT VALVE:
Spring force moves the 2-3 shift valve into the Second gear position when 2-3 signal fluid exhausts. D21 fluid continues through the valve and is also routed into the intermediate band feed fluid circuit. 3-4 drive fluid, which feeds the direct clutch, exhausts past the 2-3 shift valve.

4 DIRECT CLUTCH RELEASES

- **4a Direct Clutch:** Direct clutch fluid exhausts and the direct clutch releases.
- **4b #6 Checkball (Direct Clutch Release):** Exhausting direct clutch fluid seats the #6 checkball and is forced through the #25 orifice to help control the direct clutch release.
- **4c 2-3 Accumulator:** Direct clutch feed fluid exhausts from the 2-3 accumulator, unseats the #5 checkball, enters the 3-4 drive circuit and exhausts past the 2-3 shift valve. 2-3 accumulator feed fluid fills the 2-3 accumulator as direct clutch feed fluid exhausts.
- **4d 2-3 Accumulator Valve:** The accumulator valve regulates line pressure into the 2-3 accumulator fluid circuit to fill the 2-3 accumulator. This regulation is basically controlled by torque signal fluid pressure. Accumulator fluid pressure is regulated to a higher pressure with greater torque signal fluid pressure.

5 INTERMEDIATE / 4TH BAND APPLIES

- **5a 1-2 Shift Valve:** 1-2 Shift solenoid is OFF, when the PCM commands Second gear, and spring force holds the 1-2 shift valve in the upshifted position. Intermediate band feed fluid is routed through the valve and into the intermediate band fluid circuit.
- **5b #3 Checkball (Intermediate Band Apply):** Intermediate band fluid pressure seats the #3 checkball and is forced through the #8 orifice. This orifice helps control the intermediate band apply.
- **5c Intermediate/4th Servo:** Intermediate band fluid pressure is routed to the inner area of the intermediate/4th servo piston. This fluid pressure moves the servo piston and apply pin to apply the intermediate/4th band. The band provides engine compression braking in Manual Second – Second Gear.

6 PRESSURE CONTROL

- **6a Pressure Switch Assembly:** D21 fluid from the manual valve is routed to the PSA. The PSA signals the PCM that the manual valve is in the Manual Second position.
  Pressure Control Solenoid: The PCM decreases the PCS duty cycle to increase the operating range of torque signal fluid pressure in Manual Second. This provides increased line pressure for the additional torque requirements during engine compression braking and increased engine load in Manual Second.
  Torque Converter Clutch: The PCM will release the TCC before downshifting into Manual Second. The TCC will not re-apply in Second gear under normal operating conditions.

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MANUAL SECOND - SECOND GEAR

(From Manual Third - Third Gear)

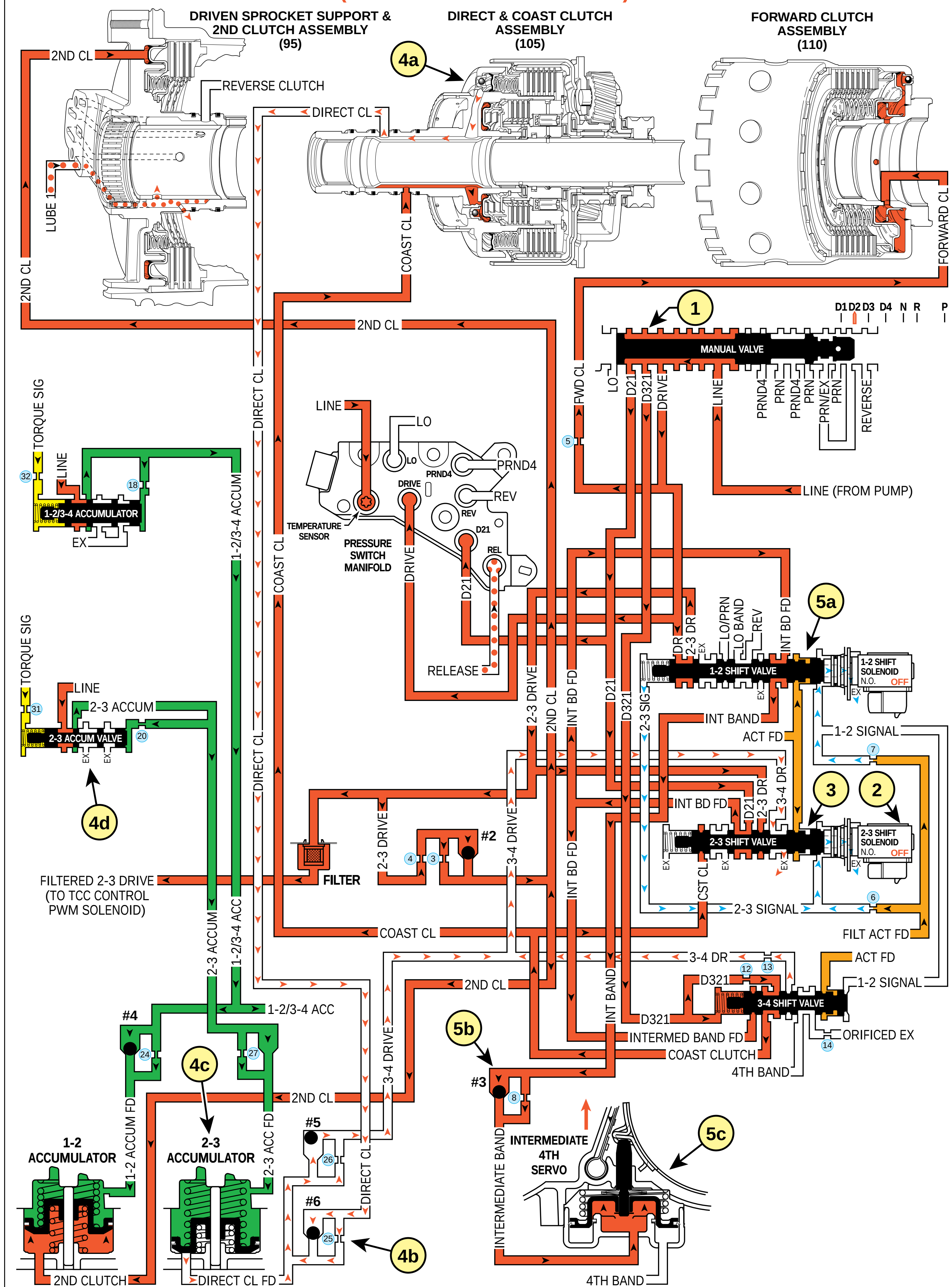


Figure 72

MANUAL FIRST - FIRST GEAR

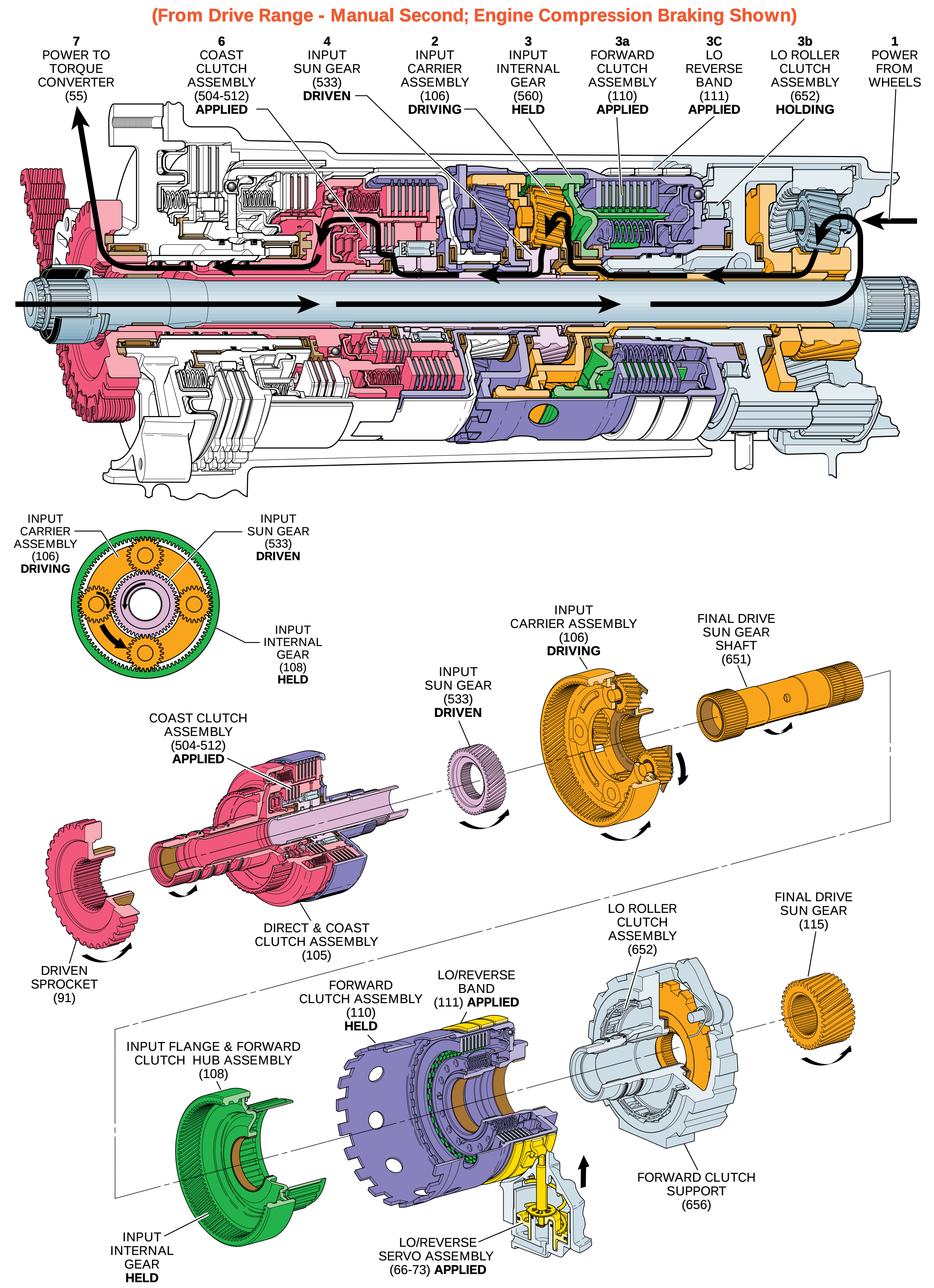


Figure 73

MANUAL FIRST - FIRST GEAR

(From Manual Second - Second Gear)

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
ON	OFF					APPLIED	HOLDING		APPLIED	APPLIED	HOLDING

Manual First – First Gear (1) is available 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. Some of these vehicle operating conditions include descending a steep grade to provide maximum engine compression braking or, for ascending a steep grade for maximum engine power. Manual First range should also be used to start the vehicle in motion when pulling a heavy load.

While operating in manual first range the transaxle 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 transaxle is operating in any other forward gear range when manual first is selected, the transaxle will not shift into first gear until vehicle speed slows to approximately 56 km/h (35 mph). Power flow through the transaxle is the same as overdrive range first gear with the exception that the coast clutch and the lo/reverse band are applied. Therefore we will look at powerflow from deceleration (engine compression braking).

- The manual shaft and detent lever assembly (806) and manual valve (800) are moved into manual first - the "1" range position on the shift quadrant.

  If manual first range is selected for engine compression braking after the vehicle was operating in manual second gear, the 2nd clutch and intermediate/4th band release.

1 Power from the Wheels
During deceleration, input torque from the wheels is transferred from the wheels through the final drive assembly (116) to the final drive sun gear shaft (651).

2 Input Carrier Driving
Torque transfers from the final drive sun gear shaft to the input carrier and to the input carrier planetary pinion gears.

3 Input Internal Gear Held

3a Forward Clutch Applied
The forward clutch is applied and links the input internal gear with the forward clutch housing.

3b Lo Roller Clutch Holding
The lo roller clutch is holding and prevents the forward clutch housing from rotating during acceleration.

3c Lo/Reverse Band Applied
The lo/reverse band is applied and holds the forward clutch housing from rotating during deceleration.

4 Input Sun Gear Driven
The input sun gear is splined to the input sun gear shaft and inner race assembly (511). The coast clutch hub is part of this assembly.

6 Coast Clutch Assembly Applied
The coast clutch holds the inner race of the coast clutch sprag which would normally overrun in a coast situation. Now power can flow through the coast clutch and on to the input shaft assembly.

7 Power to Torque Converter
From the input shaft, power continues to the torque converter for engine compression braking.

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

MANUAL FIRST - FIRST GEAR

(From Manual Second - Second Gear)

A manual 2-1 downshift is initiated by moving the gear selector lever to the Manual First (1) position. However, the transaxle will not downshift into First gear until vehicle speed is below approximately 61 km/h (38 mph). At higher vehicle speeds the PCM will keep the 1-2 shift solenoid de-energized (OFF) and the transaxle will operate in Manual First - Second or Third Gear. In Manual First the transaxle is hydraulically prevented from upshifting into Fourth gear under any conditions. Also, the coast clutch remains applied, as in Manual Third and Manual Second, and provides engine compression braking in First, Second and Third gears.

1 MANUAL VALVE:
Line pressure is routed into the LO fluid circuit when the selector lever is moved into the Manual First (1) position. Line pressure continues to feed the Drive, D321 and D21 fluid circuits as in Manual Second.

2 PRESSURE SWITCH ASSEMBLY:
LO fluid pressure is routed to the PSA and the PSA signals the PCM that the manual valve is in the Manual First position.

3 #1 CHECKBALL (LO/PRN):
LO fluid pressure seats the #1 checkball against the PRN fluid circuit and fills the LO/PRN fluid circuit. LO/PRN fluid is routed to the 1-2 shift valve.

4 1-2 SHIFT SOLENOID:
The 1-2 Shift solenoid is energized by the PCM when vehicle speed is below approximately 61 km/h (38 mph). 1-2 Signal fluid is blocked from exhausting through the solenoid.

5 1-2 SHIFT VALVE:
1-2 Signal fluid pressure shifts the valve into the downshifted position, against spring force, and the following changes occur:

- The 2-3 drive fluid circuit is open to exhaust past the valve.
- Intermediate band fluid is exhausted past the valve.
- LO/PRN fluid is routed into the lo band fluid circuit.

6 SECOND CLUTCH RELEASES

6a Second Clutch:
2nd clutch fluid exhausts from behind the clutch piston through the 2-3 drive fluid circuit. This releases the 2nd clutch and the transaxle operates in First gear.

6b 1-2 Accumulator:
2nd clutch fluid exhausts from the 1-2 accumulator, exhausts past the #2 checkball and through the 2-3 drive fluid circuit. 1-2 accumulator feed fluid fills the 1-2 accumulator as 2nd clutch fluid exhausts.

6c 1-2/3-4 Accumulator Valve:
The accumulator valve regulates line pressure into the 1-2/3-4 accumulator fluid circuit to fill the 1-2 accumulator. This regulation is basically controlled by torque signal fluid pressure. Accumulator fluid pressure is regulated to a higher pressure with greater torque signal fluid pressure.

TCC Control Solenoid:
Filtered 2-3 drive fluid exhausts from the solenoid through the 2-3 drive fluid circuit.

7 INTERMEDIATE/4TH BAND RELEASES

7a Intermediate/4th Servo:
Intermediate Band fluid exhausts from the servo piston, spring force moves the piston and apply pin and the intermediate/4th band releases. However, the intermediate/4th band remains applied in Manual First - Second Gear to achieve engine compression braking.

8 LO/REVERSE BAND APPLIES

8a Lo/Reverse Servo:
Lo band fluid pressure is routed to the inner area of the lo/reverse servo to apply the lo/reverse band. The lo/reverse band provides engine compression braking when the throttle is released in Manual First - First Gear.

Note: *Manual First - Third Gear is also possible at high speeds as a safety feature.*

COMPLETE HYDRAULIC CIRCUIT
Page 102

MANUAL FIRST - FIRST GEAR

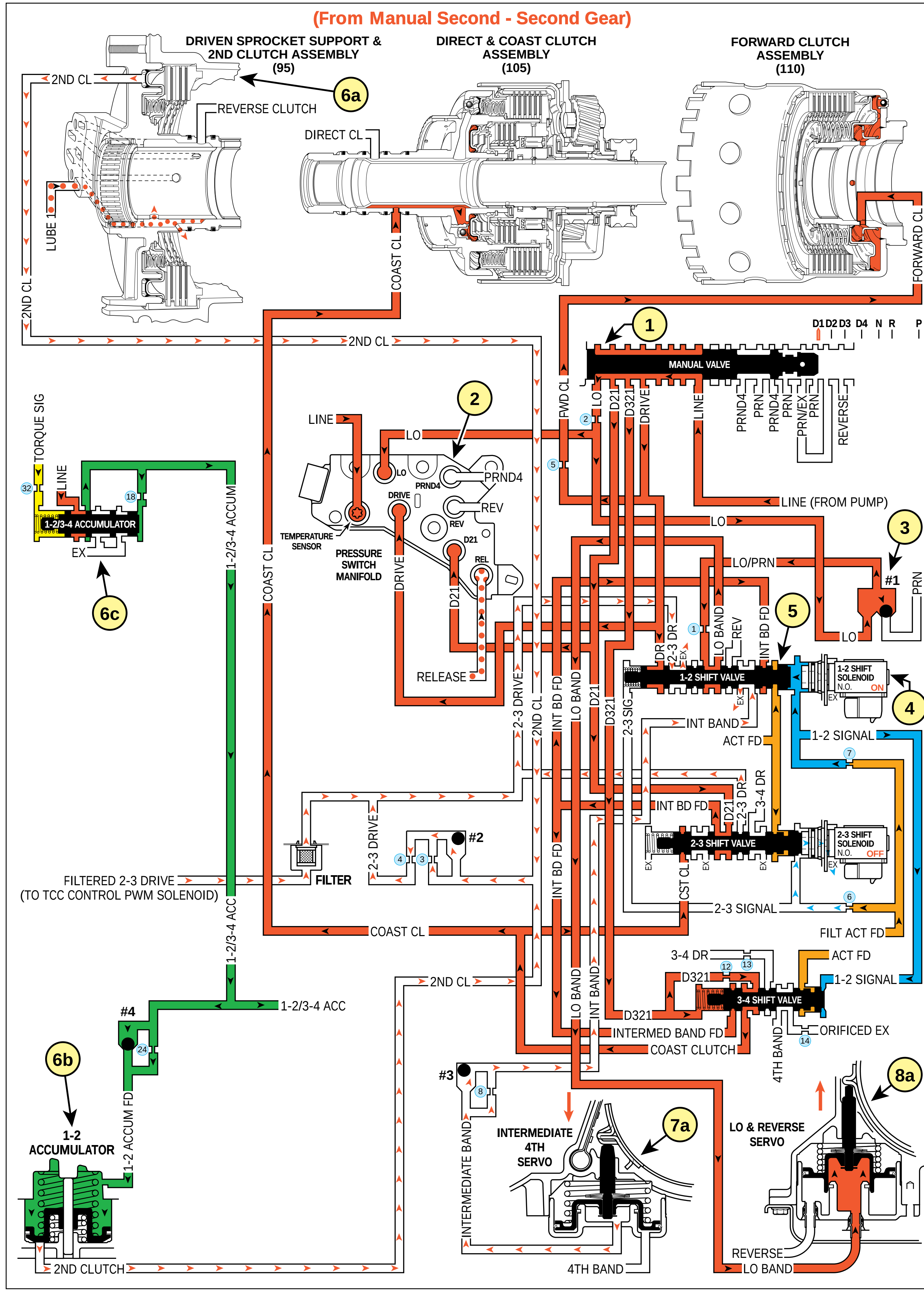


Figure 74

OPERATING CONDITIONS

RANGE REFERENCE CHART

				1	2	3	4	5	6	7	8	9	10
RANGE	**GEAR**	**SHIFT "A" SOL**	**SHIFT "B" SOL**	**2ND CLUTCH**	**2ND ROLLER CLUTCH**	**INT/4TH BAND**	**REVERSE CLUTCH**	**COAST CLUTCH**	**INPUT SPRAG**	**DIRECT CLUTCH**	**FORWARD CLUTCH**	**LO/REV. BAND**	**LO ROLLER CLUTCH**
PARK	N	ON	OFF						HOLDING*			APPLIED	
REV	R	ON	OFF				APPLIED					APPLIED	
NEU	N	ON	OFF						HOLDING*			APPLIED	
(D)	1st	ON	OFF						HOLDING		APPLIED		HOLDING
	2nd	OFF	OFF	APPLIED	HOLDING				HOLDING		APPLIED		OVER-RUNNING
	3rd	OFF	ON	APPLIED*	OVER-RUNNING				HOLDING	APPLIED	APPLIED		OVER-RUNNING
	4th	ON	ON	APPLIED*		APPLIED			OVER-RUNNING	APPLIED	APPLIED*		OVER-RUNNING
3	1st	ON	OFF					APPLIED	HOLDING		APPLIED		HOLDING
	2nd	OFF	OFF	APPLIED	HOLDING			APPLIED	HOLDING		APPLIED		OVER-RUNNING
	3rd	OFF	ON	APPLIED*	OVER-RUNNING			APPLIED	HOLDING	APPLIED	APPLIED		OVER-RUNNING
2	1st	ON	OFF					APPLIED	HOLDING		APPLIED		HOLDING
	2nd	OFF	OFF	APPLIED	HOLDING	APPLIED		APPLIED	HOLDING		APPLIED		OVER-RUNNING
	3rd**	OFF	ON	APPLIED*	OVER-RUNNING			APPLIED	HOLDING	APPLIED	APPLIED		OVER-RUNNING
1	1st	ON	OFF					APPLIED	HOLDING		APPLIED	APPLIED	HOLDING
	2nd***	OFF	OFF	APPLIED	HOLDING	APPLIED		APPLIED	HOLDING		APPLIED		OVER-RUNNING
	3rd**	OFF	ON	APPLIED*	OVER-RUNNING			APPLIED	HOLDING	APPLIED	APPLIED		OVER-RUNNING

ON = SOLENOID ENERGIZED
OFF = SOLENOID DE-ENERGIZED
* = APPLIED WITH NO LOAD.
** = MANUAL FIRST AND SECOND – THIRD GEAR IS ONLY AVAILABLE ABOVE APPROXIMATELY 100 km/h (62 mph).
*** = MANUAL FIRST – SECOND GEAR IS ONLY AVAILABLE ABOVE APPROXIMATELY 60 km/h (37 mph).
NOTE: MANUAL FIRST – THIRD GEAR IS ALSO POSSIBLE AT HIGH VEHICLE SPEED AS A SAFETY FEATURE.

EXPECTED OPERATING CONDITION IF COMPONENT IN COLUMN NUMBER IS INOPERATIVE:

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

Figure 75

COMPLETE HYDRAULIC CIRCUITS

The hydraulic circuitry of the Hydra-matic 4T40-E transaxle 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, checkballs and orifices within specific components. A broken line is also used to separate components such as the pump, 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 identifies the components involved in this gear range and a description of how they function.

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.

PASSAGE A IS LOCATED IN THE OIL PUMP BODY (GREY AREA)
PASSAGE B IS LOCATED IN THE CONTROL VALVE BODY (LIGHT BLUE AREA)
PASSAGE C IS LOCATED ON THE SPACER PLATE (DASHED LINE)
PASSAGE D IS LOCATED IN THE CHANNEL PLATE (LIGHT RED AREA)
PASSAGE E IS LOCATED IN THE DRIVEN SPROCKET SUPPORT (LIGHT YELLOW AREA)
PASSAGE F IS LOCATED IN THE CASE (WHITE AREA)

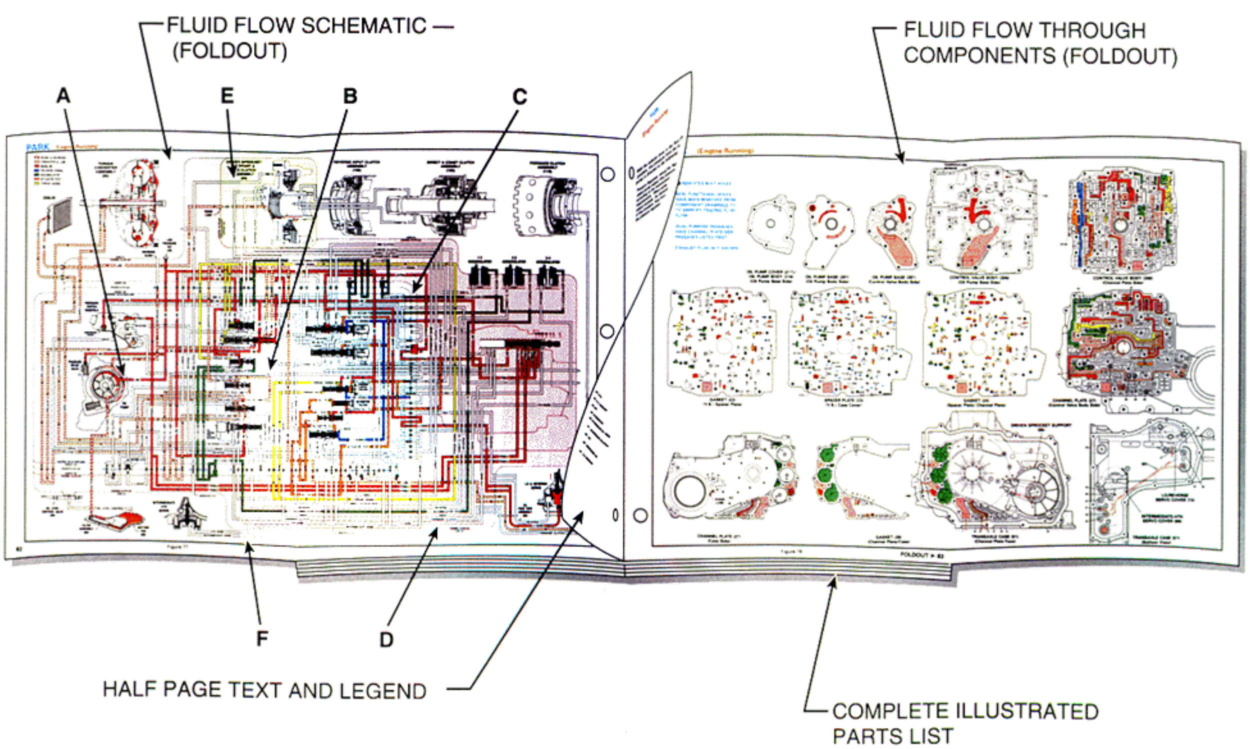


Figure 76

PARK (Engine Running)

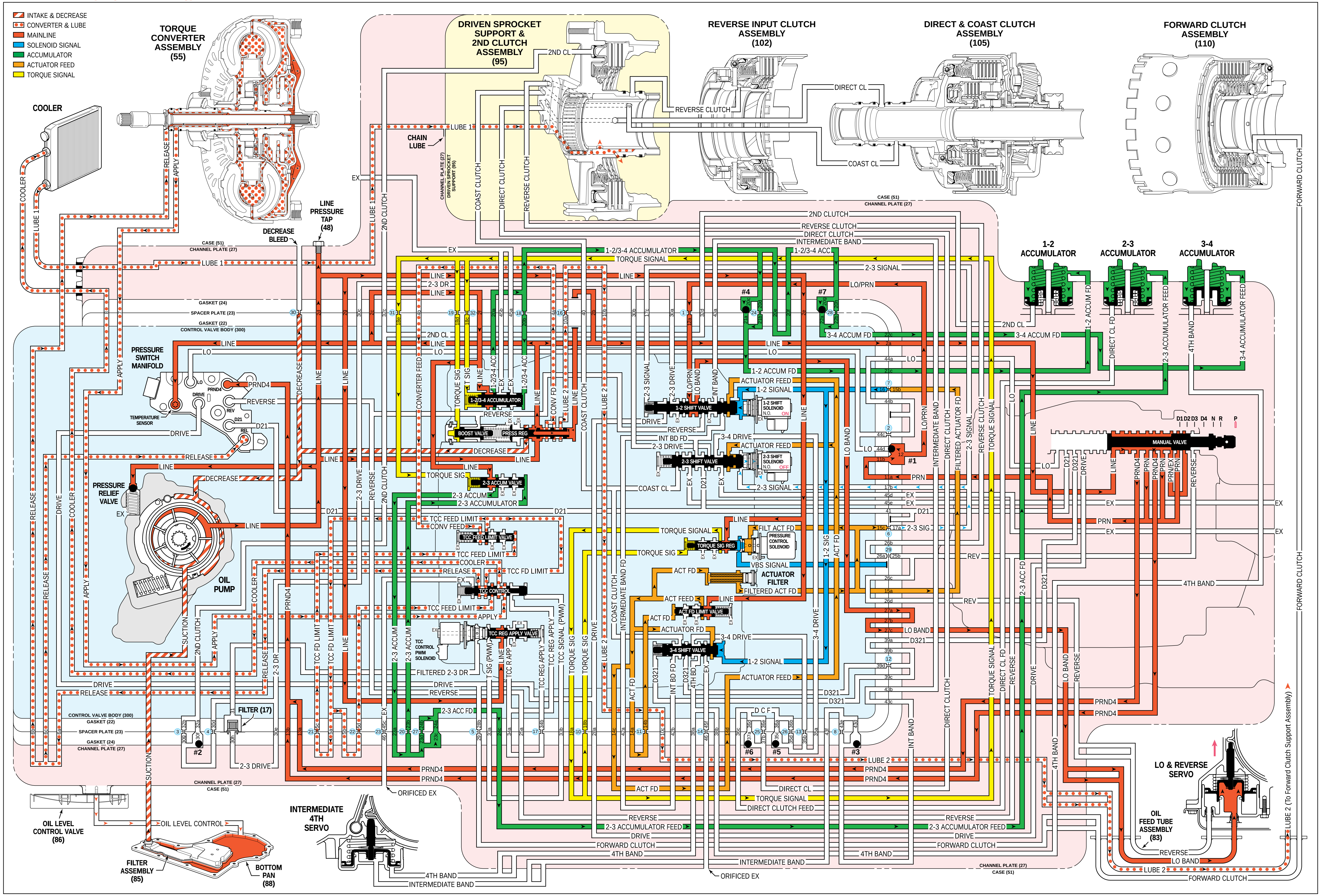


Figure 77

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 (328), Springs (326, 327) and Boost Valve (325)**
  – Stuck.
- **Pressure Control Solenoid (312)**
  – Leak, o-rings damaged.
  – Loose connector, pins damaged.
  – Contaminated.
- **Torque Signal Regulator Valve (309)**
  – Stuck.
- **Pressure Switch Assembly (13)**
  – Loose connector.
  – Damaged or missing o-ring.
- **Oil Filter (85)**
  – Clogged, broken, loose.
- **Oil Filter Seal (84)**
  – Leaking.
- **Cooler Lines**
  – Clogged or restricted.
- **Cooler Line Seals (49)**
  – Leaking.
- **Oil Pump (10)**
  – Damaged, sticking, porosity, leaking.
- **Oil Pump Drive Shaft (19)**
  – Damaged.
- **Pressure Relief Valve (214)**
  – Damaged spring, ball missing.
- **Transaxle Case (51), Valve Body (18), Channel Plate (27)**
  – Porosity, leaking circuits.
  – Flatness of machined surfaces.

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
ON	OFF						HOLDING *			APPLIED	

* APPLIED BUT NOT EFFECTIVE

PARK

(Engine Running)

PASSAGES

1	SUCTION
2	LINE
3	DECREASE
4	CONVERTER FEED
5	TCC FEED LIMIT
6	RELEASE
7	APPLY
8	COOLER
9	LUBE 1
10	LUBE 2
11	PRN
12	LO/PRN
13	PRND4
14	ACTUATOR FEED
15	FILTERED ACTUATOR FEED
16	1-2 SIGNAL
17	2-3 SIGNAL
18	TORQUE SIGNAL
19	VBS SIGNAL
20	1-2/3-4 ACCUMULATOR
21	1-2 ACCUMULATOR FEED
22	3-4 ACCUMULATOR FEED
23	2-3 ACCUMULATOR
24	2-3 ACCUMULATOR FEED
25	REVERSE
26	REVERSE CLUTCH
27	LO BAND
28	DRIVE
29	FORWARD CLUTCH
30	2-3 DRIVE
31	FILTERED 2-3 DRIVE
32	2ND CLUTCH
33	TCC SIGNAL (PWM)
34	TCC REGULATED APPLY
35	3-4 DRIVE
36	DIRECT CLUTCH FEED
37	DIRECT CLUTCH
38	4TH BAND
39	D321
40	COAST CLUTCH
41	D21
42	INTERMEDIATE BAND FEED
43	INTERMEDIATE BAND
44	LO
45	EXHAUST
46	ORIFICED EXHAUST
47	VOID
48	OIL LEVEL CONTROL

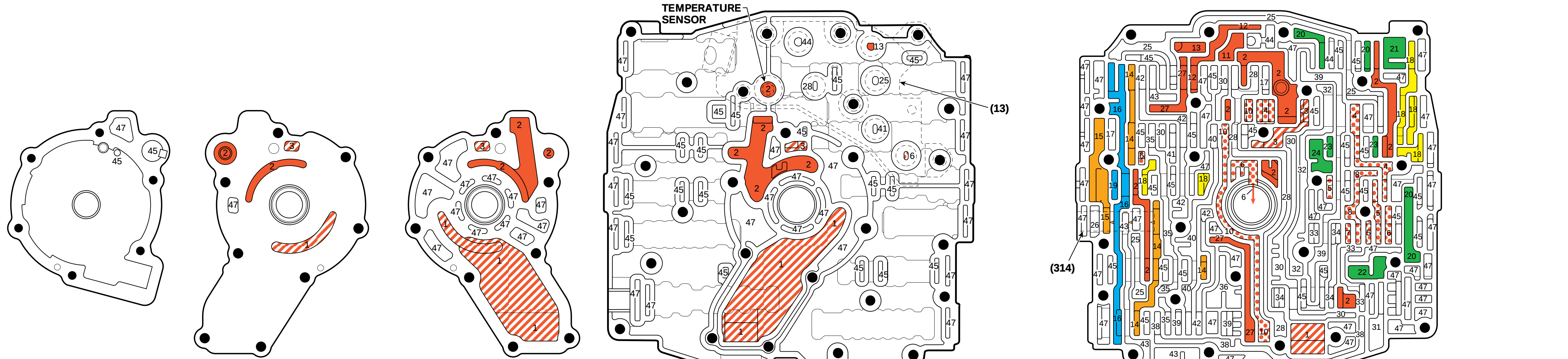
COMPONENTS (   )

(13)	TRANSAXLE FLUID PRESSURE SWITCH ASSEMBLY (PSA)
(17)	FILTER
(26)	CHECKBALLS #1, 2, 3, 4, 5, 6 & 7
(48)	PLUG, LINE PRESSURE TAP
(83)	TUBE ASSEMBLY, OIL FEED
(314)	FILTER, ACTUATOR OIL

PARK (Engine Running)

NOTE:

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



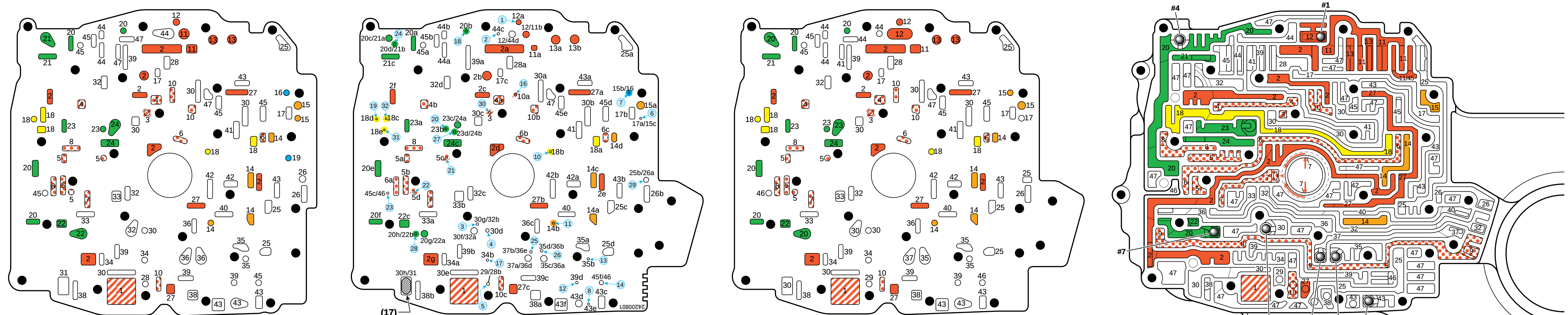
OIL PUMP COVER (217)/ OIL PUMP BODY (216) (Oil Pump Base Side)

OIL PUMP BASE (201) (Oil Pump Body Side)

OIL PUMP BASE (201) (Control Valve Body Side)

CONTROL VALVE BODY (300) (Oil Pump Base Side)

CONTROL VALVE BODY (300) (Channel Plate Side)

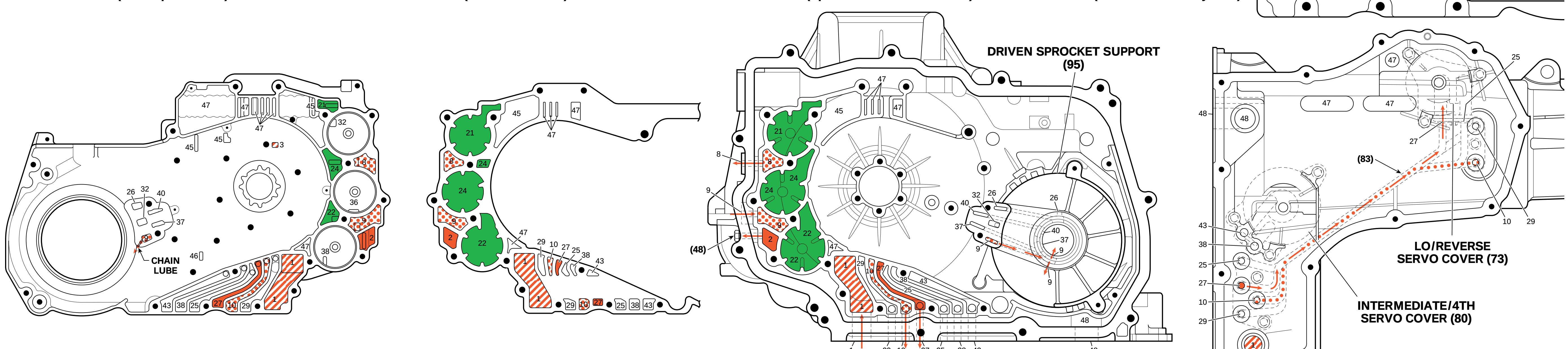


GASKET (22) (V.B./ Spacer Plate)

SPACER PLATE (23) (V.B./ Case Cover)

GASKET (24) (Spacer Plate/ Channel Plate)

CHANNEL PLATE (27) (Control Valve Body Side)



CHANNEL PLATE (27) (Case Side)

GASKET (28) (Channel Plate/Case)

TRANSAXLE CASE (51) (Channel Plate Face)

TRANSAXLE CASE (51) (Bottom View)

Figure 78

REVERSE

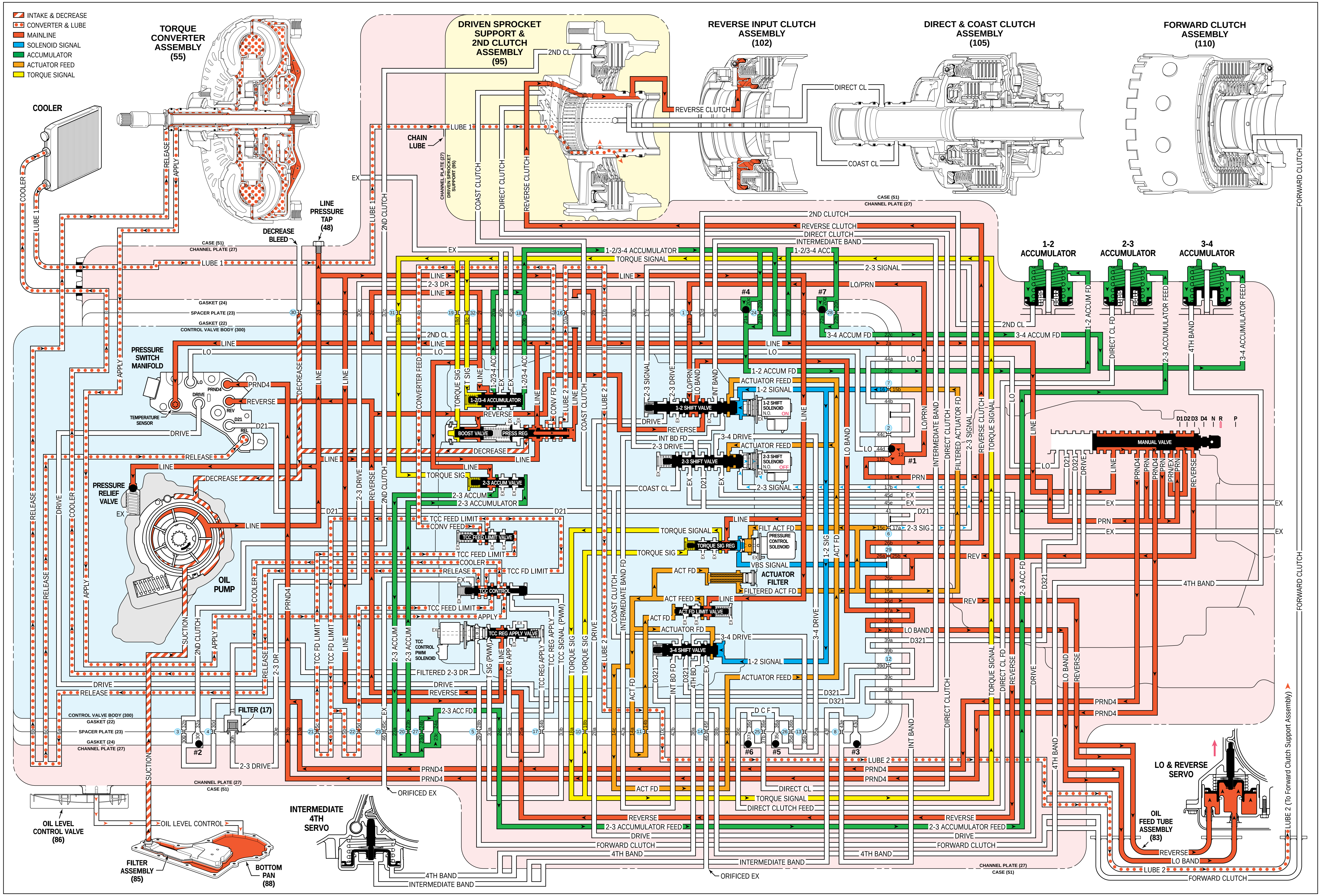


Figure 79

REVERSE

NO REVERSE OR SLIPS IN REVERSE

- **Reverse Clutch**
  - Piston and Seal Assembly (457) – Binding, cracked, leaking.
  - Inner Seal (456) – Leaking, orifice plugged.
  - Clutch Plates (460-463) – Friction material worn, splines broken.
  - Snap Rings (459, 464) – Out of position.
  - Housing (454) – Cracked, feed holes plugged, tangs broken.
  - Housing Retainer and Ball Assembly – Missing, out of position, plugged.
  - Springs (458) – Binding, broken.

- **Reverse Clutch Fluid Routing**
  - Fluid leak / restriction.
  - Driven Sprocket Support (95) – Seal rings leaking, porosity, damaged, misaligned.
  - Channel Plate & Gasket, and Valve Body, Gaskets and Spacer Plate – Porosity, fluid leak across channels, misaligned, damaged, fluid restriction.

- **Lo & Reverse Band and Servo**
  - Servo Piston (69) – Broken, binding.
  - Servo Piston Seals (71, 72) – Leaking.
  - Servo Pin (67) and Springs (66, 68) – Binding, broken.
  - Servo Cover (73) – Broken, loose, leaking.
  - Lo & Reverse Band (111) – Broken, worn, out of position.
  - Anchor Pin (64) – Broken.
  - Fluid Feed Tubes (83) – Broken, bent, plugged, seal rings missing / leaking.
  - Transaxle Case (51) – Porosity, fluid leak or restriction.

- **Shift Linkage**
  - Disconnected, misaligned.

- **Manual Valve (800) and Link (802)**
  - Disconnected, misaligned.

- **#1 Checkball (LO/PRN)**
  - Missing (No Lo Band Fluid).

- **Fluid Level**
  - Low.

- **Fluid Pressure**
  - Low (See PARK page 82A).

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
ON	OFF				APPLIED					APPLIED	

REVERSE

PASSAGES

1 SUCTION
2 LINE
3 DECREASE
4 CONVERTER FEED
5 TCC FEED LIMIT
6 RELEASE
7 APPLY
8 COOLER
9 LUBE 1
10 LUBE 2
11 PRN
12 LO/PRN
13 PRND4
14 ACTUATOR FEED
15 FILTERED ACTUATOR FEED
16 1-2 SIGNAL
17 2-3 SIGNAL
18 TORQUE SIGNAL
19 VBS SIGNAL
20 1-2/3-4 ACCUMULATOR
21 1-2 ACCUMULATOR FEED
22 3-4 ACCUMULATOR FEED
23 2-3 ACCUMULATOR
24 2-3 ACCUMULATOR FEED
25 REVERSE
26 REVERSE CLUTCH
27 LO BAND
28 DRIVE
29 FORWARD CLUTCH
30 2-3 DRIVE
31 FILTERED 2-3 DRIVE
32 2ND CLUTCH
33 TCC SIGNAL (PWM)
34 TCC REGULATED APPLY
35 3-4 DRIVE
36 DIRECT CLUTCH FEED
37 DIRECT CLUTCH
38 4TH BAND
39 D321
40 COAST CLUTCH
41 D21
42 INTERMEDIATE BAND FEED
43 INTERMEDIATE BAND
44 LO
45 EXHAUST
46 ORIFICED EXHAUST
47 VOID
48 OIL LEVEL CONTROL

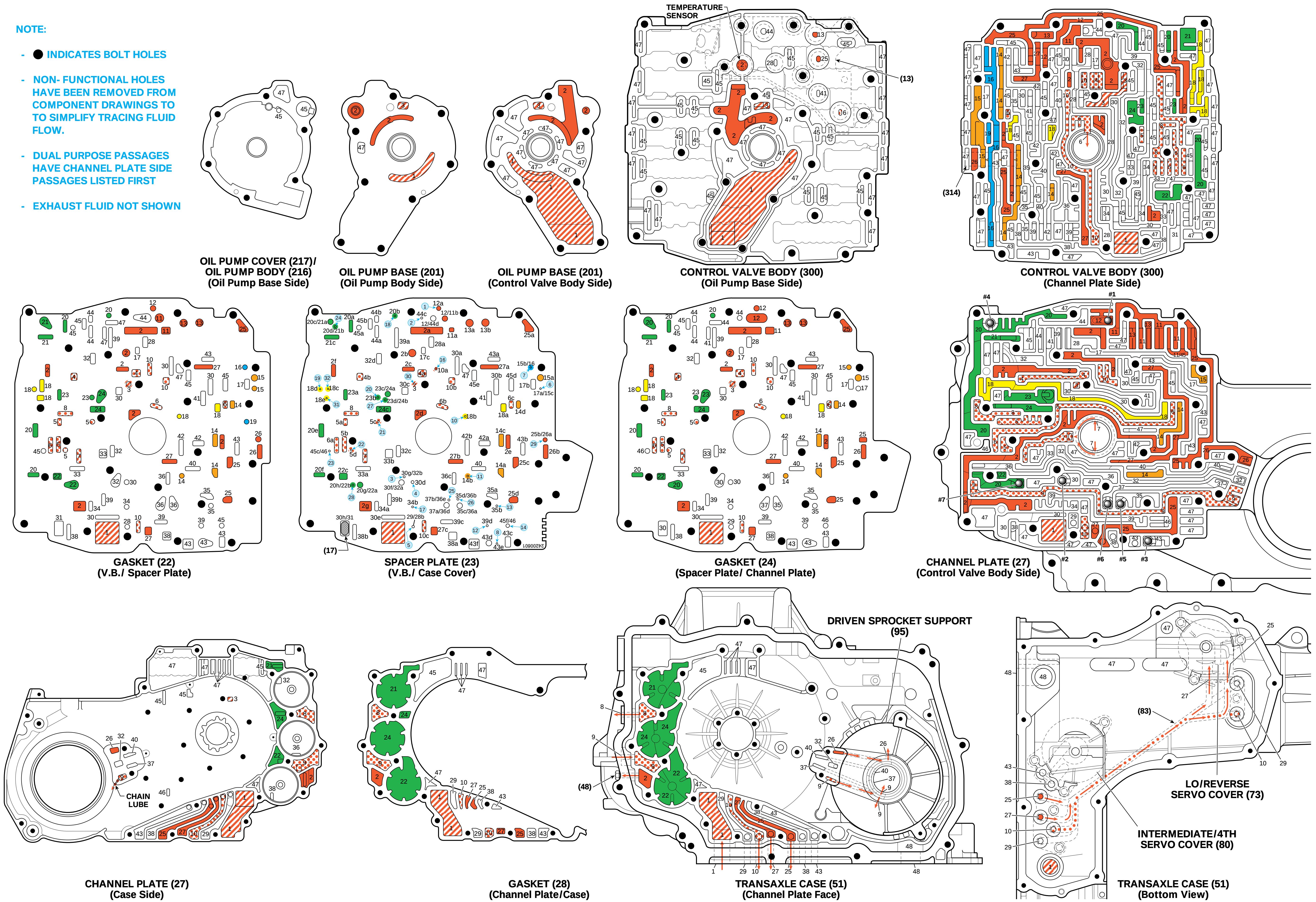
COMPONENTS (   )

(13) TRANSAXLE FLUID PRESSURE SWITCH ASSEMBLY (PSA)
(17) FILTER
(26) CHECKBALLS #1, 2, 3, 4, 5, 6 & 7
(48) PLUG, LINE PRESSURE TAP
(83) TUBE ASSEMBLY, OIL FEED
(314) FILTER, ACTUATOR OIL

REVERSE

NOTE:

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



OIL PUMP COVER (217)/ OIL PUMP BODY (216) (Oil Pump Base Side)

OIL PUMP BASE (201) (Oil Pump Body Side)

OIL PUMP BASE (201) (Control Valve Body Side)

CONTROL VALVE BODY (300) (Oil Pump Base Side)

CONTROL VALVE BODY (300) (Channel Plate Side)

GASKET (22) (V.B./ Spacer Plate)

SPACER PLATE (23) (V.B./ Case Cover)

GASKET (24) (Spacer Plate/ Channel Plate)

CHANNEL PLATE (27) (Control Valve Body Side)

CHANNEL PLATE (27) (Case Side)

GASKET (28) (Channel Plate/Case)

TRANSAXLE CASE (51) (Channel Plate Face)

TRANSAXLE CASE (51) (Bottom View)

Figure 80

NEUTRAL (Engine Running)

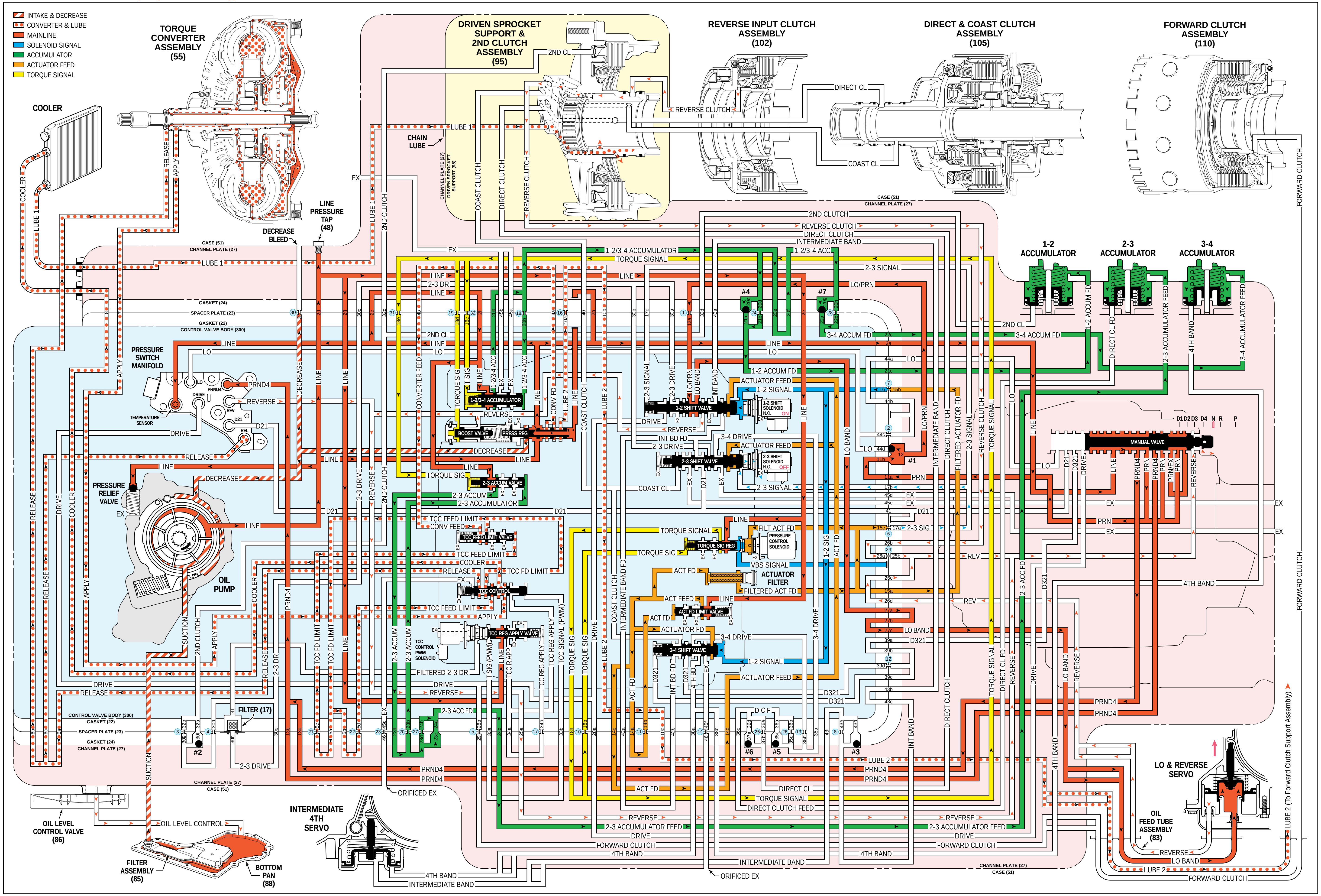


Figure 81

NEUTRAL
(Engine Running)

DRIVES IN NEUTRAL

- **Forward Clutch**
  - Not releasing.
- **Reverse Clutch and Lo & Reverse Servo**
  - Both not releasing.
- **Manual Valve (800) / Shift Linkage**
  - Misaligned.

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
ON	OFF						HOLDING *			APPLIED	

* APPLIED BUT NOT EFFECTIVE

NEUTRAL
(Engine Running)

PASSAGES

1 SUCTION
2 LINE
3 DECREASE
4 CONVERTER FEED
5 TCC FEED LIMIT
6 RELEASE
7 APPLY
8 COOLER
9 LUBE 1
10 LUBE 2
11 PRN
12 LO/PRN
13 PRND4
14 ACTUATOR FEED
15 FILTERED ACTUATOR FEED
16 1-2 SIGNAL
17 2-3 SIGNAL
18 TORQUE SIGNAL
19 VBS SIGNAL
20 1-2/3-4 ACCUMULATOR
21 1-2 ACCUMULATOR FEED
22 3-4 ACCUMULATOR FEED
23 2-3 ACCUMULATOR
24 2-3 ACCUMULATOR FEED
25 REVERSE
26 REVERSE CLUTCH
27 LO BAND
28 DRIVE
29 FORWARD CLUTCH
30 2-3 DRIVE
31 FILTERED 2-3 DRIVE
32 2ND CLUTCH
33 TCC SIGNAL (PWM)
34 TCC REGULATED APPLY
35 3-4 DRIVE
36 DIRECT CLUTCH FEED
37 DIRECT CLUTCH
38 4TH BAND
39 D321
40 COAST CLUTCH
41 D21
42 INTERMEDIATE BAND FEED
43 INTERMEDIATE BAND
44 LO
45 EXHAUST
46 ORIFICED EXHAUST
47 VOID
48 OIL LEVEL CONTROL

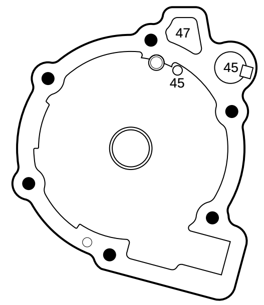
COMPONENTS ( )

(13) TRANSAXLE FLUID PRESSURE SWITCH ASSEMBLY (PSA)
(17) FILTER
(26) CHECKBALLS #1, 2, 3, 4, 5, 6 & 7
(48) PLUG, LINE PRESSURE TAP
(83) TUBE ASSEMBLY, OIL FEED
(314) FILTER, ACTUATOR OIL

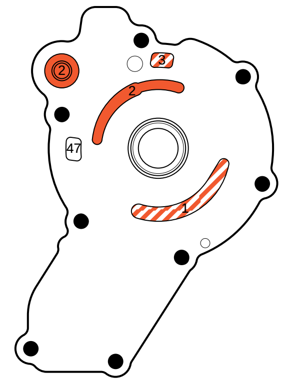
NEUTRAL (Engine Running)

NOTE:

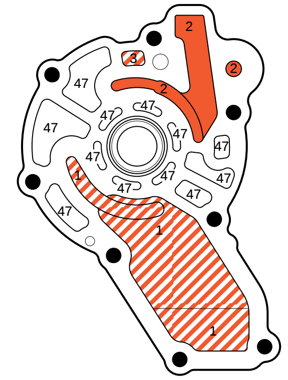
- ● INDICATES BOLT HOLES
- NON- FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE PASSAGES LISTED FIRST
- EXHAUST FLUID NOT SHOWN



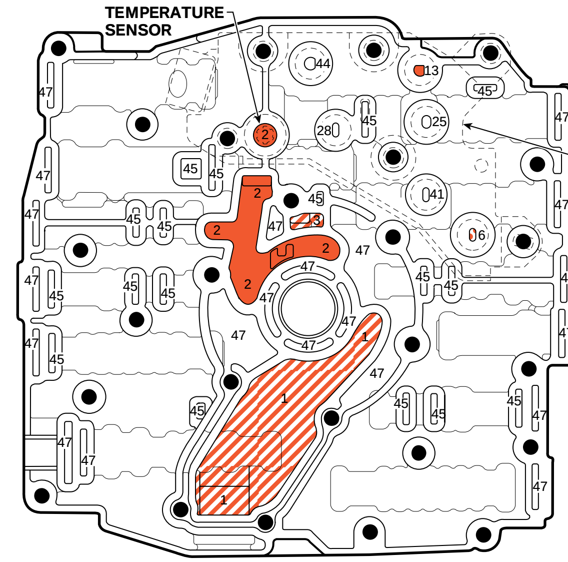
OIL PUMP COVER (217)/
OIL PUMP BODY (216)
(Oil Pump Base Side)



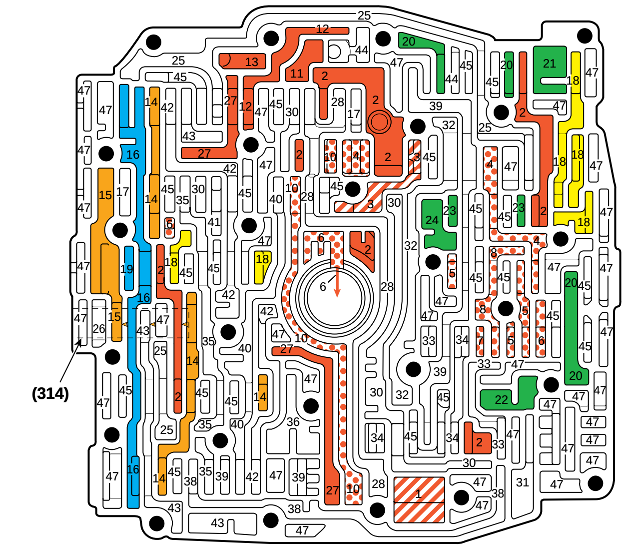
OIL PUMP BASE (201)
(Oil Pump Body Side)



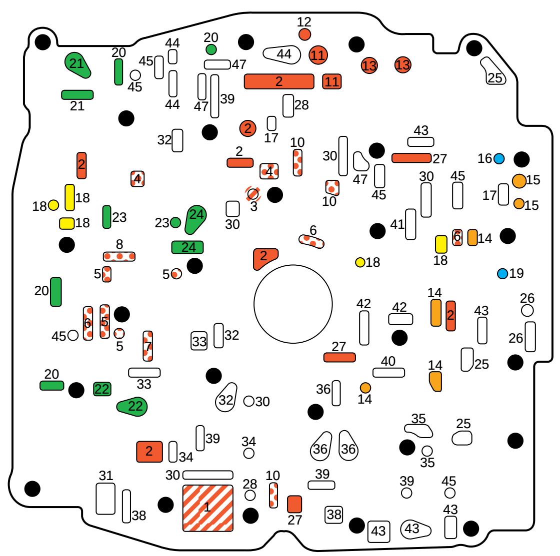
OIL PUMP BASE (201)
(Control Valve Body Side)



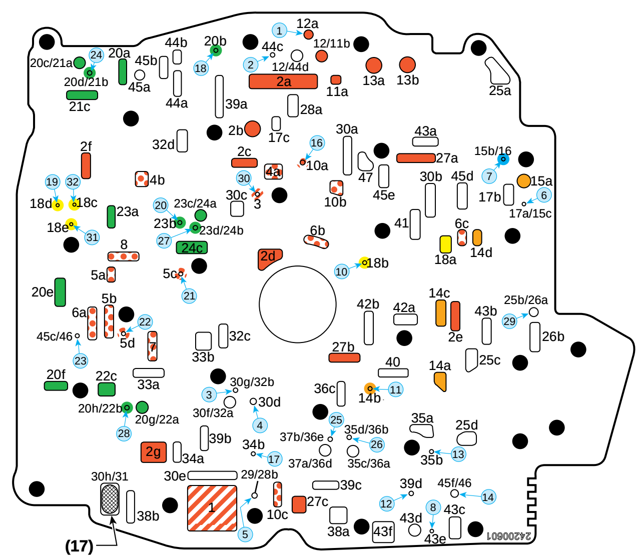
CONTROL VALVE BODY (300)
(Oil Pump Base Side)



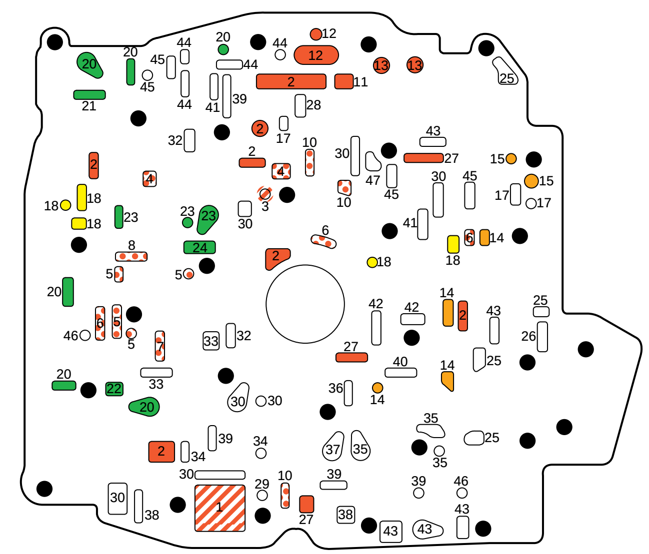
CONTROL VALVE BODY (300)
(Channel Plate Side)



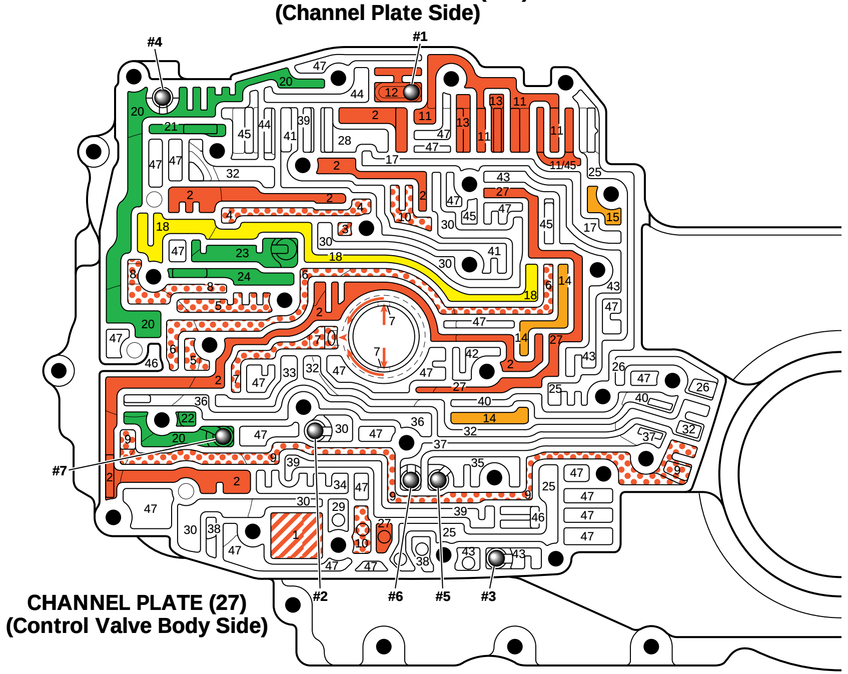
GASKET (22)
(V.B./ Spacer Plate)



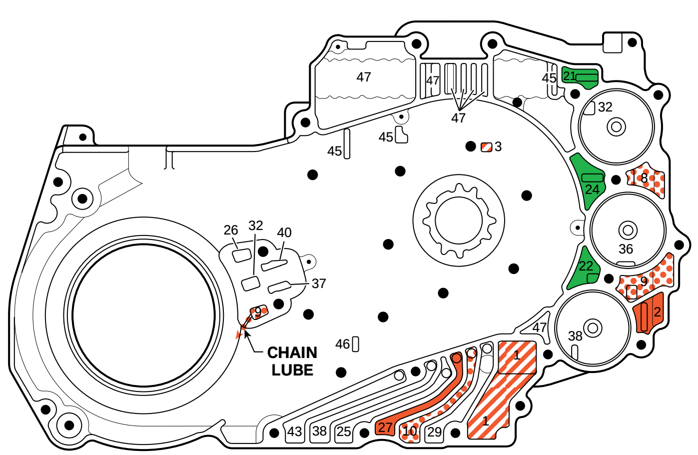
SPACER PLATE (23)
(V.B./ Case Cover)



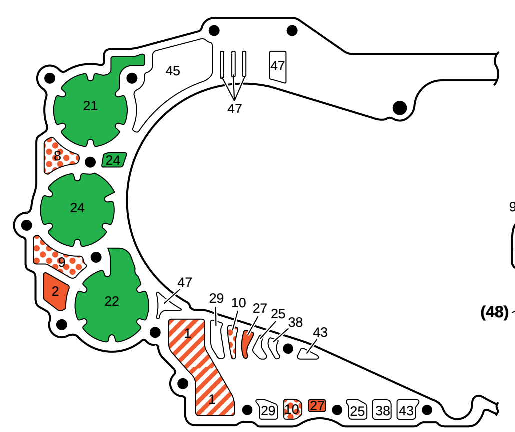
GASKET (24)
(Spacer Plate/ Channel Plate)



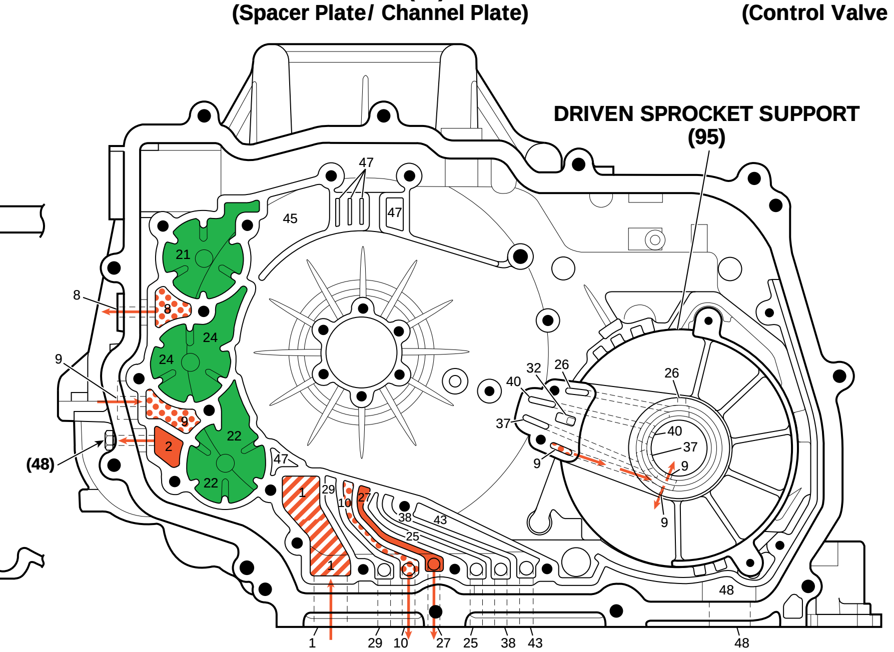
CHANNEL PLATE (27)
(Control Valve Body Side)



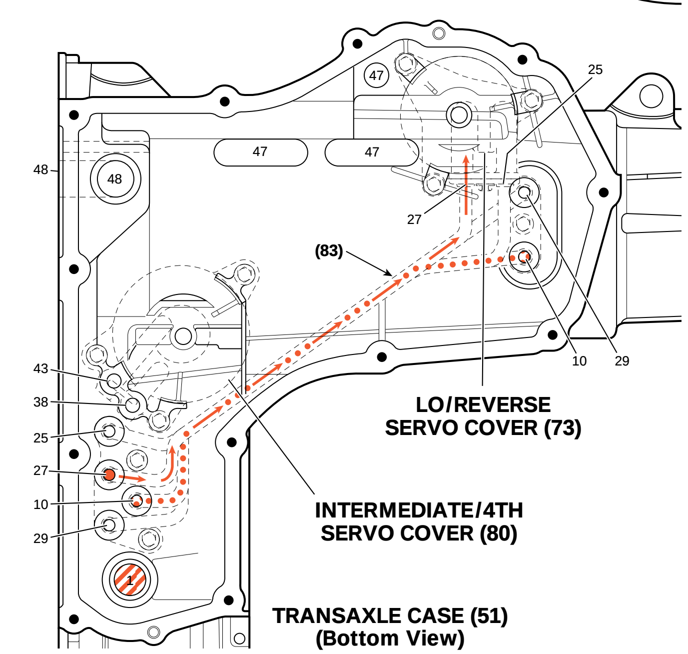
CHANNEL PLATE (27)
(Case Side)



GASKET (28)
(Channel Plate/Case)



TRANSAXLE CASE (51)
(Channel Plate Face)



TRANSAXLE CASE (51)
(Bottom View)

Figure 82

OVERDRIVE RANGE – FIRST GEAR

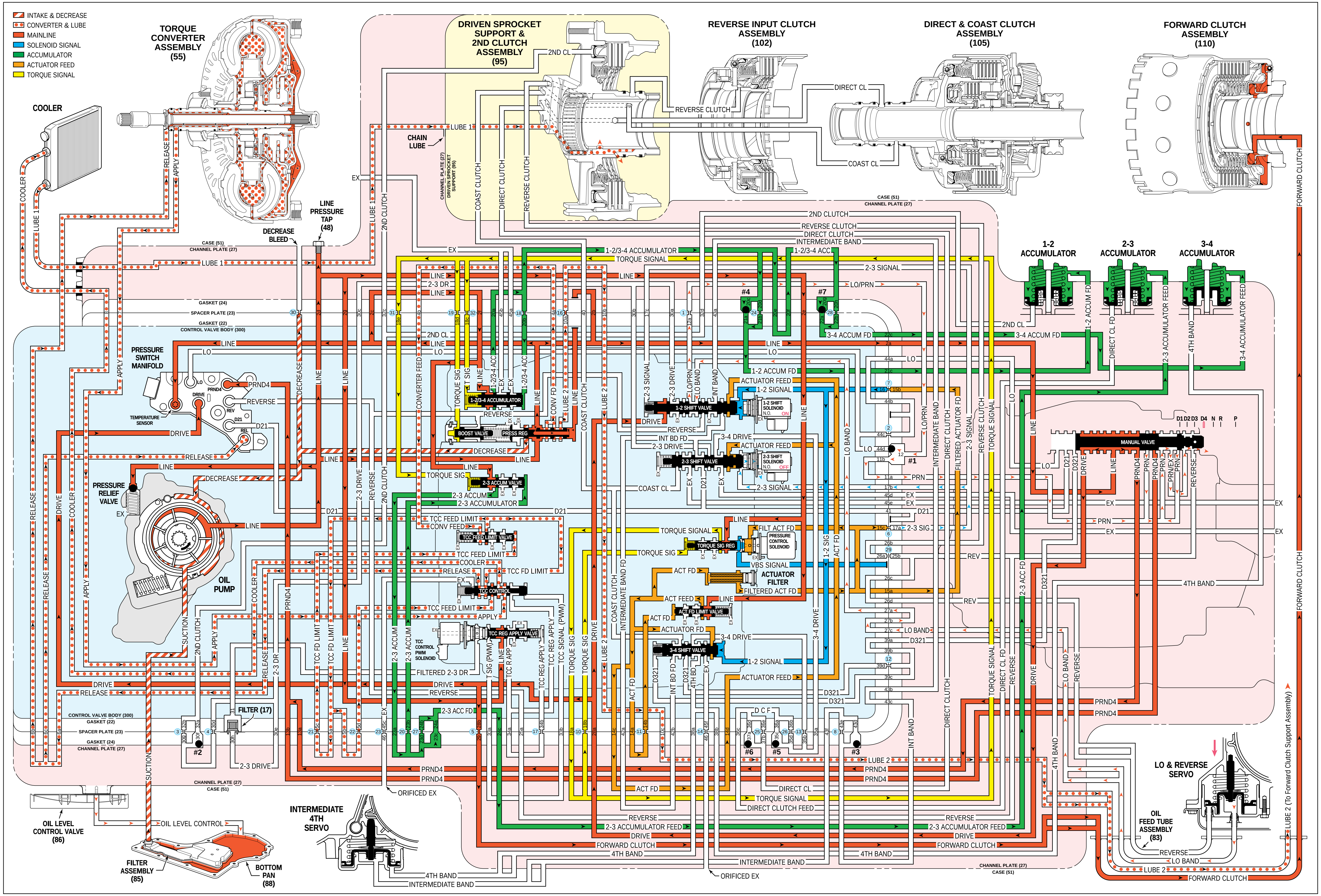


Figure 83

OVERDRIVE RANGE - FIRST GEAR

NO FIRST GEAR/SLIPS IN FIRST

- **Forward Clutch**
  - Piston and Seal Assembly (607) – Binding, cracked, leaking.
  - Inner Seal (608) – Leaking, orifice plugged.
  - Clutch Plates (601-604) – Splines broken, friction material worn.
  - Snap Rings (600, 605) – Out of position.
  - Housing (609) – Cracked, feed holes plugged.
  - Housing Retainer and Ball Assembly – Missing, out of position, plugged.
  - Springs (606) – Binding, broken.

- **Forward Clutch Fluid Routing**
  - Fluid leak or restriction.
  - Oil Feed Tubes (83) – Bent, broken, seal rings leaking, plugged.
  - Forward Clutch Support (114) – Porosity, seal rings leaking, damaged, feed holes plugged.
  - Channel Plate (27) and Gasket (28) – Porosity, misaligned, fluid leak across channels or restriction.
  - PSA (13) – Drive switch o-ring leaking.

- **1-2 Shift Solenoid (305)**
  - Failed “OFF”, leaking.

- **1-2 Shift Valve (302)**
  - Stuck in upshifted position.

- **2-3 Shift Solenoid (305)**
  - Failed “ON”, exhaust plugged.

- **Manual Valve (800) / Shift Linkage**
  - Misaligned.

- **Torque Converter (55)**
  - Stator roller clutch not holding.

- **Line Pressure**
  - Low (See PARK page 82A).

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
ON	OFF						HOLDING		APPLIED		HOLDING

OVERDRIVE RANGE - FIRST GEAR

PASSAGES

1	SUCTION
2	LINE
3	DECREASE
4	CONVERTER FEED
5	TCC FEED LIMIT
6	RELEASE
7	APPLY
8	COOLER
9	LUBE 1
10	LUBE 2
11	PRN
12	LO/PRN
13	PRND4
14	ACTUATOR FEED
15	FILTERED ACTUATOR FEED
16	1-2 SIGNAL
17	2-3 SIGNAL
18	TORQUE SIGNAL
19	VBS SIGNAL
20	1-2/3-4 ACCUMULATOR
21	1-2 ACCUMULATOR FEED
22	3-4 ACCUMULATOR FEED
23	2-3 ACCUMULATOR
24	2-3 ACCUMULATOR FEED
25	REVERSE
26	REVERSE CLUTCH
27	LO BAND
28	DRIVE
29	FORWARD CLUTCH
30	2-3 DRIVE
31	FILTERED 2-3 DRIVE
32	2ND CLUTCH
33	TCC SIGNAL (PWM)
34	TCC REGULATED APPLY
35	3-4 DRIVE
36	DIRECT CLUTCH FEED
37	DIRECT CLUTCH
38	4TH BAND
39	D321
40	COAST CLUTCH
41	D21
42	INTERMEDIATE BAND FEED
43	INTERMEDIATE BAND
44	LO
45	EXHAUST
46	ORIFICED EXHAUST
47	VOID
48	OIL LEVEL CONTROL

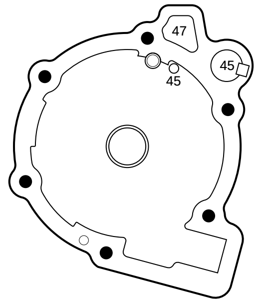
COMPONENTS (   )

(13)	TRANSAXLE FLUID PRESSURE SWITCH ASSEMBLY (PSA)
(17)	FILTER
(26)	CHECKBALLS #1, 2, 3, 4, 5, 6 & 7
(48)	PLUG, LINE PRESSURE TAP
(83)	TUBE ASSEMBLY, OIL FEED
(314)	FILTER, ACTUATOR OIL

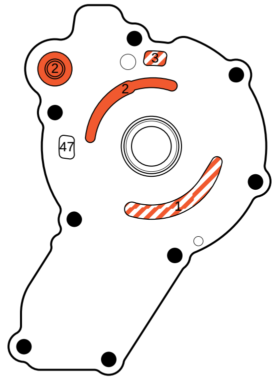
OVERDRIVE RANGE – FIRST GEAR

NOTE:

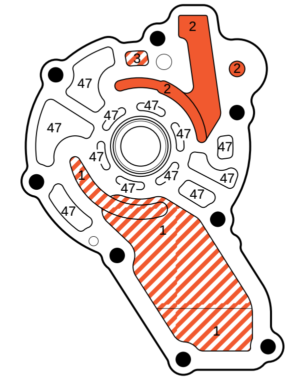
- ● INDICATES BOLT HOLES
- NON- FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE PASSAGES LISTED FIRST
- EXHAUST FLUID NOT SHOWN



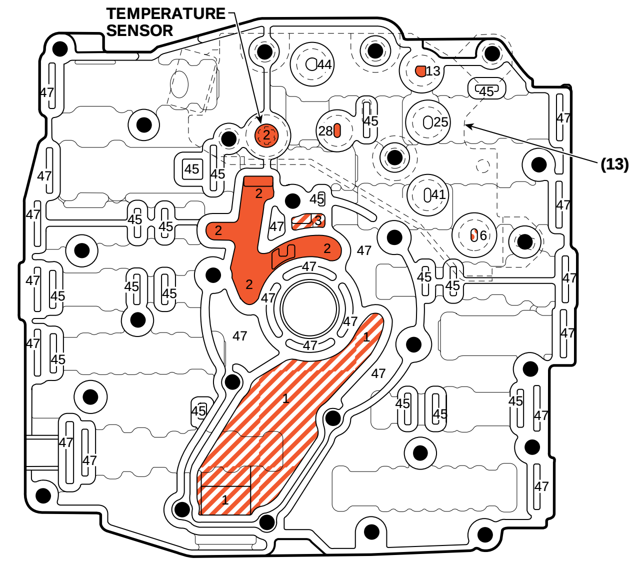
OIL PUMP COVER (217)/
OIL PUMP BODY (216)
(Oil Pump Base Side)



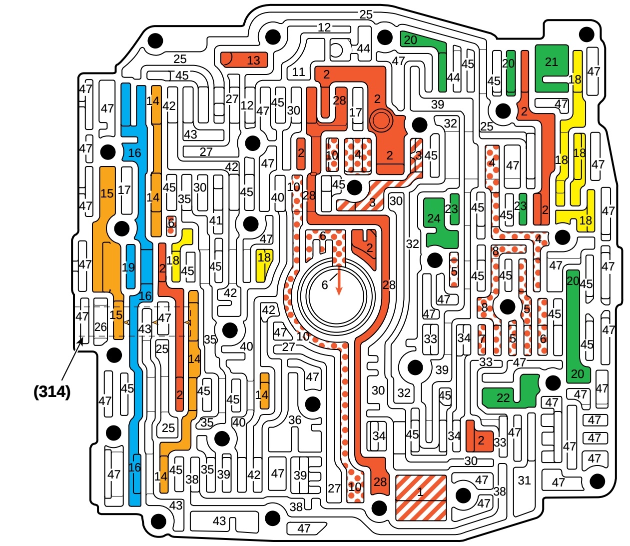
OIL PUMP BASE (201)
(Oil Pump Body Side)



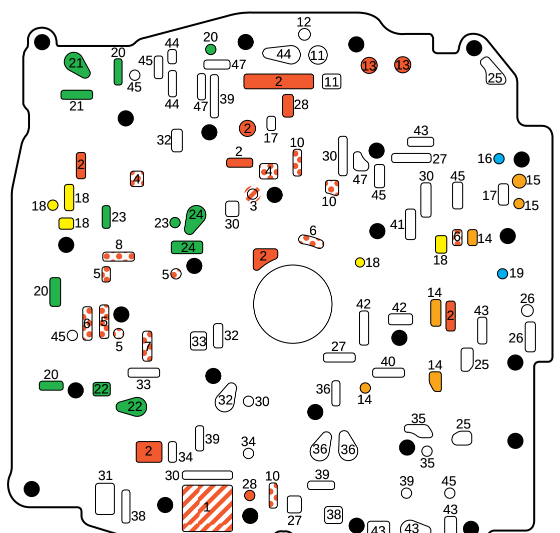
OIL PUMP BASE (201)
(Control Valve Body Side)



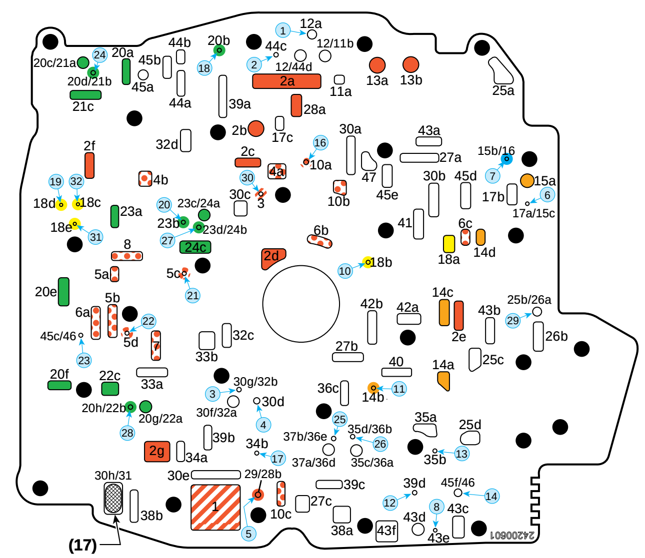
CONTROL VALVE BODY (300)
(Oil Pump Base Side)



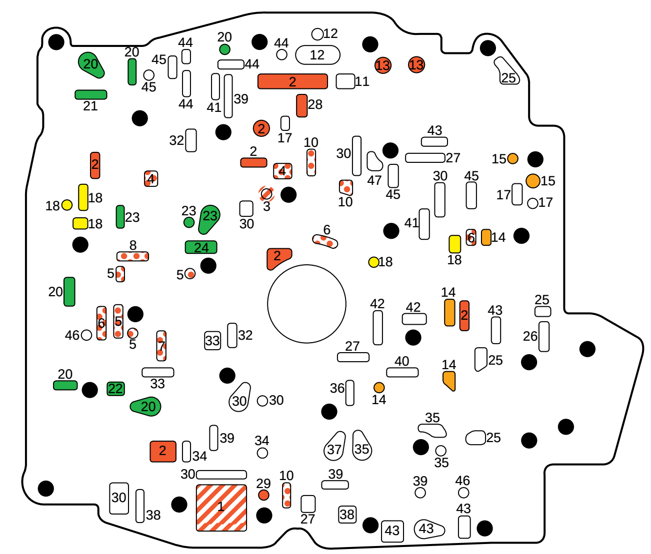
CONTROL VALVE BODY (300)
(Channel Plate Side)



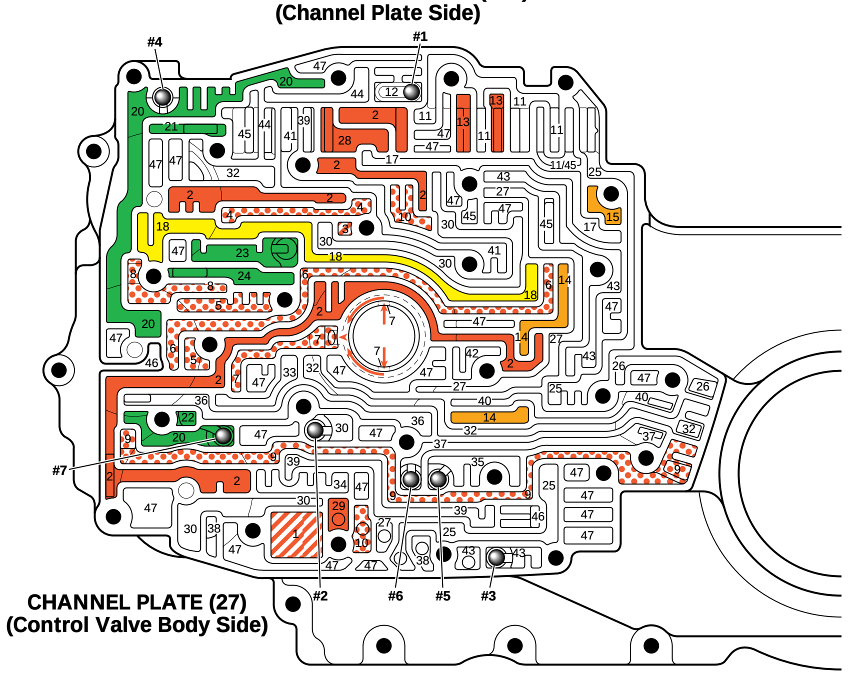
GASKET (22)
(V.B./ Spacer Plate)



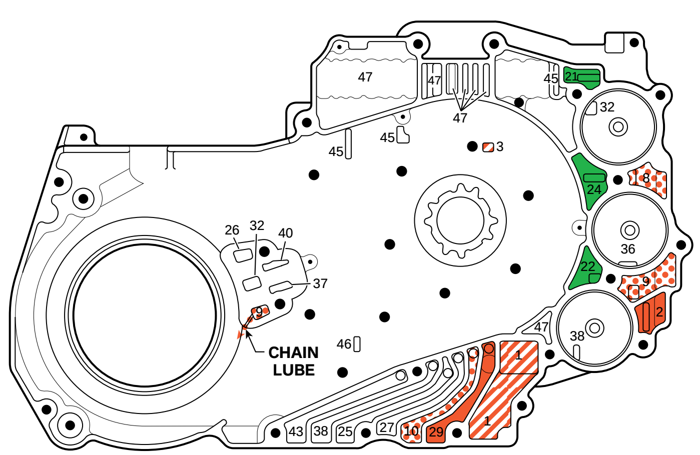
SPACER PLATE (23)
(V.B./ Case Cover)



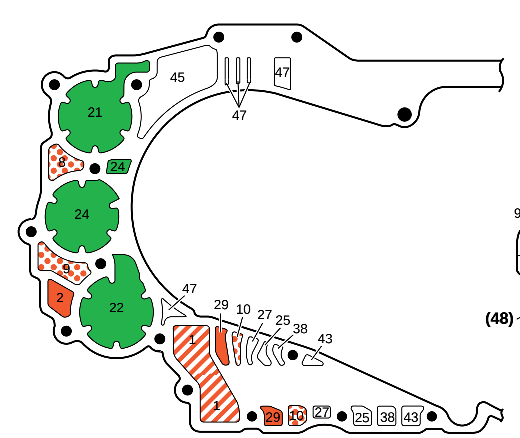
GASKET (24)
(Spacer Plate/ Channel Plate)



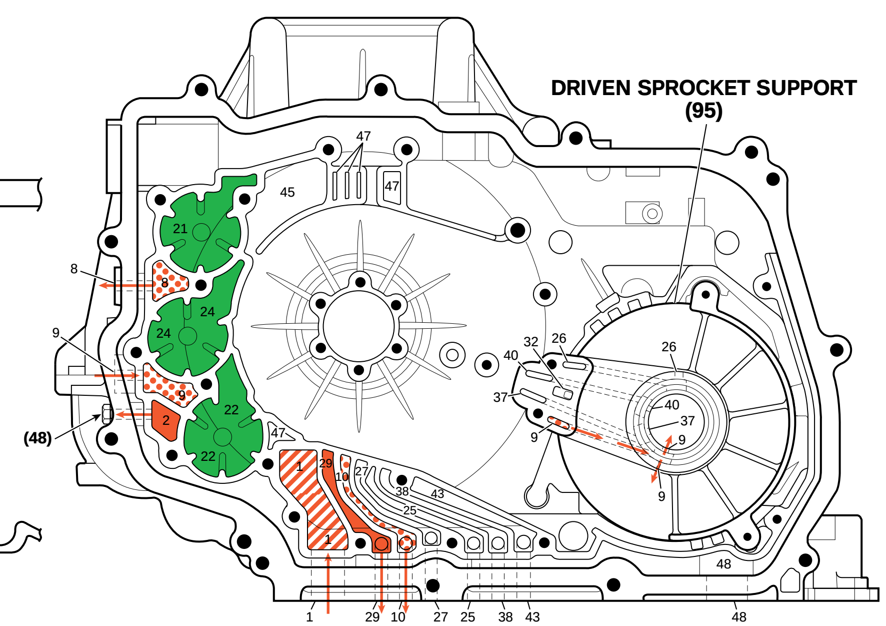
CHANNEL PLATE (27)
(Control Valve Body Side)



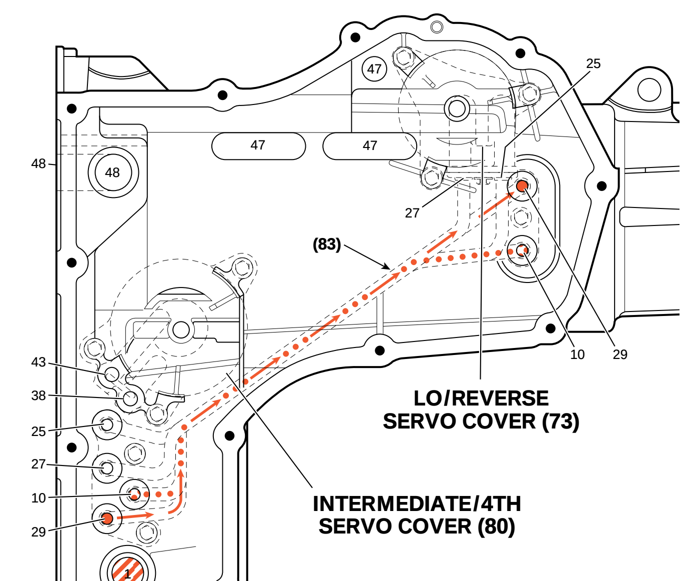
CHANNEL PLATE (27)
(Case Side)



GASKET (28)
(Channel Plate/Case)



TRANSAXLE CASE (51)
(Channel Plate Face)



TRANSAXLE CASE (51)
(Bottom View)

Figure 84

OVERDRIVE RANGE – SECOND GEAR

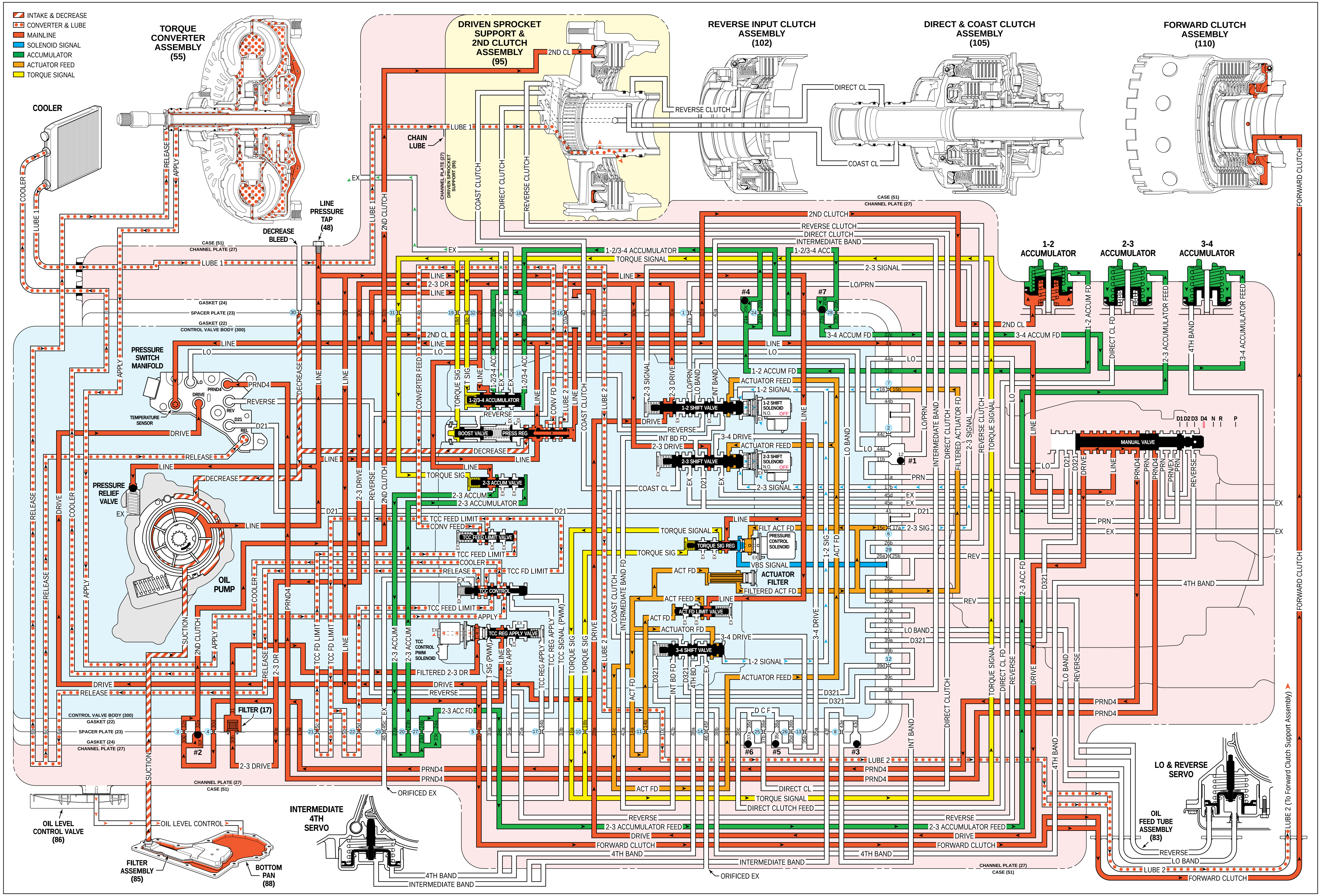


Figure 85

OVERDRIVE RANGE - SECOND GEAR

NO SECOND GEAR/SLIPS IN SECOND

- **2nd Clutch**
  - Piston and Seal Assembly (404) – Binding, cracked, leaking.
  - Clutch Plates (96-99) – Friction material worn, splines broken.
  - Snap Ring (406) – Out of position.
  - Springs (405) – Binding, broken.
  - Driven Sprocket Support (95) – Damaged, leaking, porosity.

- **2nd Clutch Fluid Routing**
  - Fluid leak or restriction.
  - Valve Body, Gaskets & Spacer Plate; Channel Plate & Gasket; and Driven Sprocket Support – Porosity, misaligned, loose, restriction, fluid leak across channels.

- **1-2 Shift Solenoid (305)**
  - Stuck "ON", plugged.

- **Forward Clutch**
  - Low Capacity shows up in Second Gear.

- **Line Pressure**
  - Low (See PARK page 82A).

- **1-2 Accumulator (29-31)**
  - Leak at piston seal.
  - Channel plate / case porosity.

- **1-2 Accumulator Valve (323)**
  - Stuck.

- **2-3 Shift Valve (306)**
  - Stuck in upshifted position.

- **PSA**
  - Malfunction (Electrical or Hydraulic)

HARSH SHIFT

- **Line Pressure**
  - High (See PARK page 82A).

- **Accumulator**
  - Spring or piston binding; no accumulation
  - Accumulator valve stuck.

SECOND GEAR ONLY

- **1-2 Shift Valve**
  - Stuck in downshifted position.

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
OFF	OFF	APPLIED	HOLDING				HOLDING		APPLIED		OVER-RUNNING

OVERDRIVE RANGE - SECOND GEAR

PASSAGES

1	SUCTION
2	LINE
3	DECREASE
4	CONVERTER FEED
5	TCC FEED LIMIT
6	RELEASE
7	APPLY
8	COOLER
9	LUBE 1
10	LUBE 2
11	PRN
12	LO/PRN
13	PRND4
14	ACTUATOR FEED
15	FILTERED ACTUATOR FEED
16	1-2 SIGNAL
17	2-3 SIGNAL
18	TORQUE SIGNAL
19	VBS SIGNAL
20	1-2/3-4 ACCUMULATOR
21	1-2 ACCUMULATOR FEED
22	3-4 ACCUMULATOR FEED
23	2-3 ACCUMULATOR
24	2-3 ACCUMULATOR FEED
25	REVERSE
26	REVERSE CLUTCH
27	LO BAND
28	DRIVE
29	FORWARD CLUTCH
30	2-3 DRIVE
31	FILTERED 2-3 DRIVE
32	2ND CLUTCH
33	TCC SIGNAL (PWM)
34	TCC REGULATED APPLY
35	3-4 DRIVE
36	DIRECT CLUTCH FEED
37	DIRECT CLUTCH
38	4TH BAND
39	D321
40	COAST CLUTCH
41	D21
42	INTERMEDIATE BAND FEED
43	INTERMEDIATE BAND
44	LO
45	EXHAUST
46	ORIFICED EXHAUST
47	VOID
48	OIL LEVEL CONTROL

COMPONENTS ( )

(13)	TRANSAXLE FLUID PRESSURE SWITCH ASSEMBLY (PSA)
(17)	FILTER
(26)	CHECKBALLS #1, 2, 3, 4, 5, 6 & 7
(48)	PLUG, LINE PRESSURE TAP
(83)	TUBE ASSEMBLY, OIL FEED
(314)	FILTER, ACTUATOR OIL

OVERDRIVE RANGE – SECOND GEAR

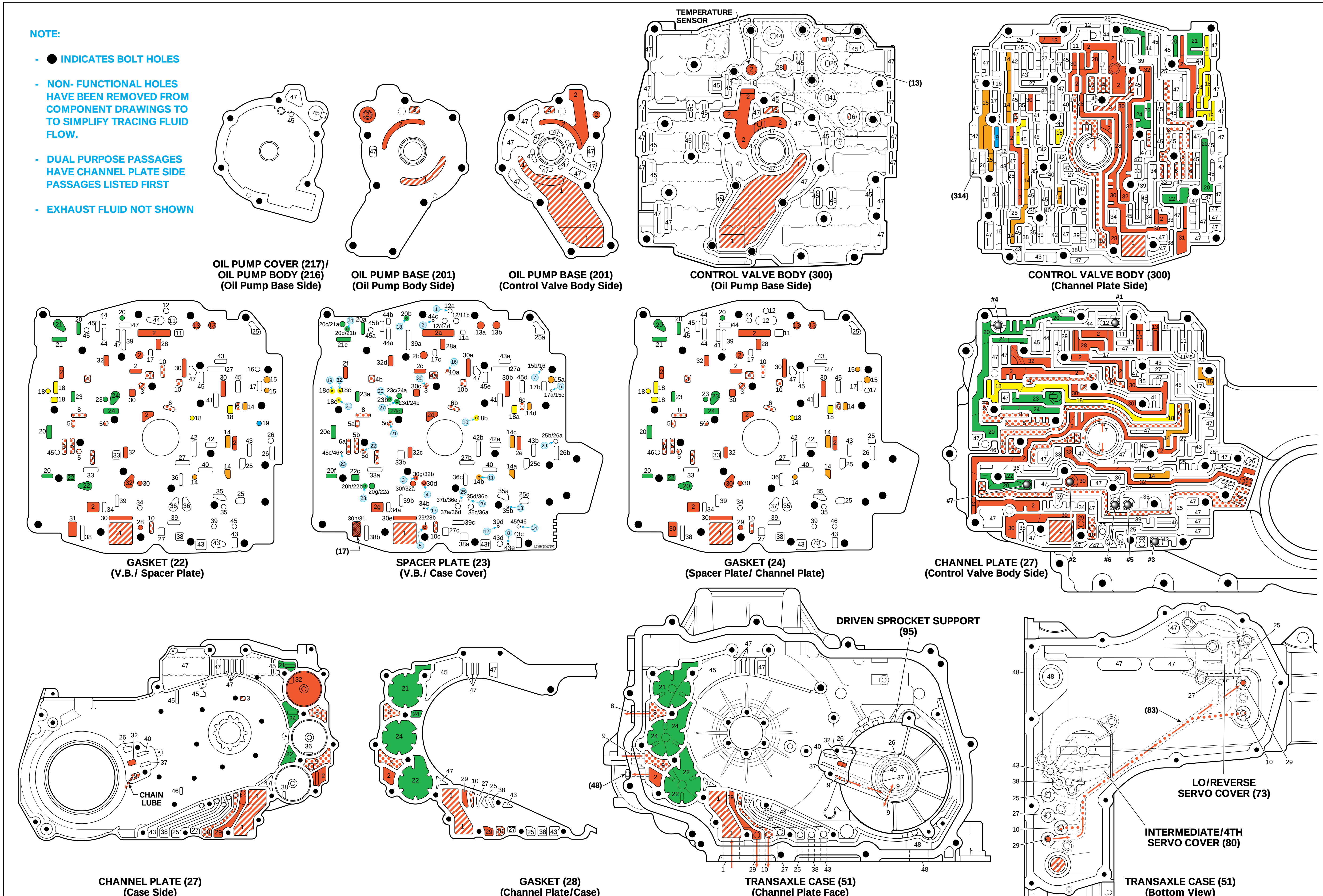


Figure 86

OVERDRIVE RANGE – THIRD GEAR

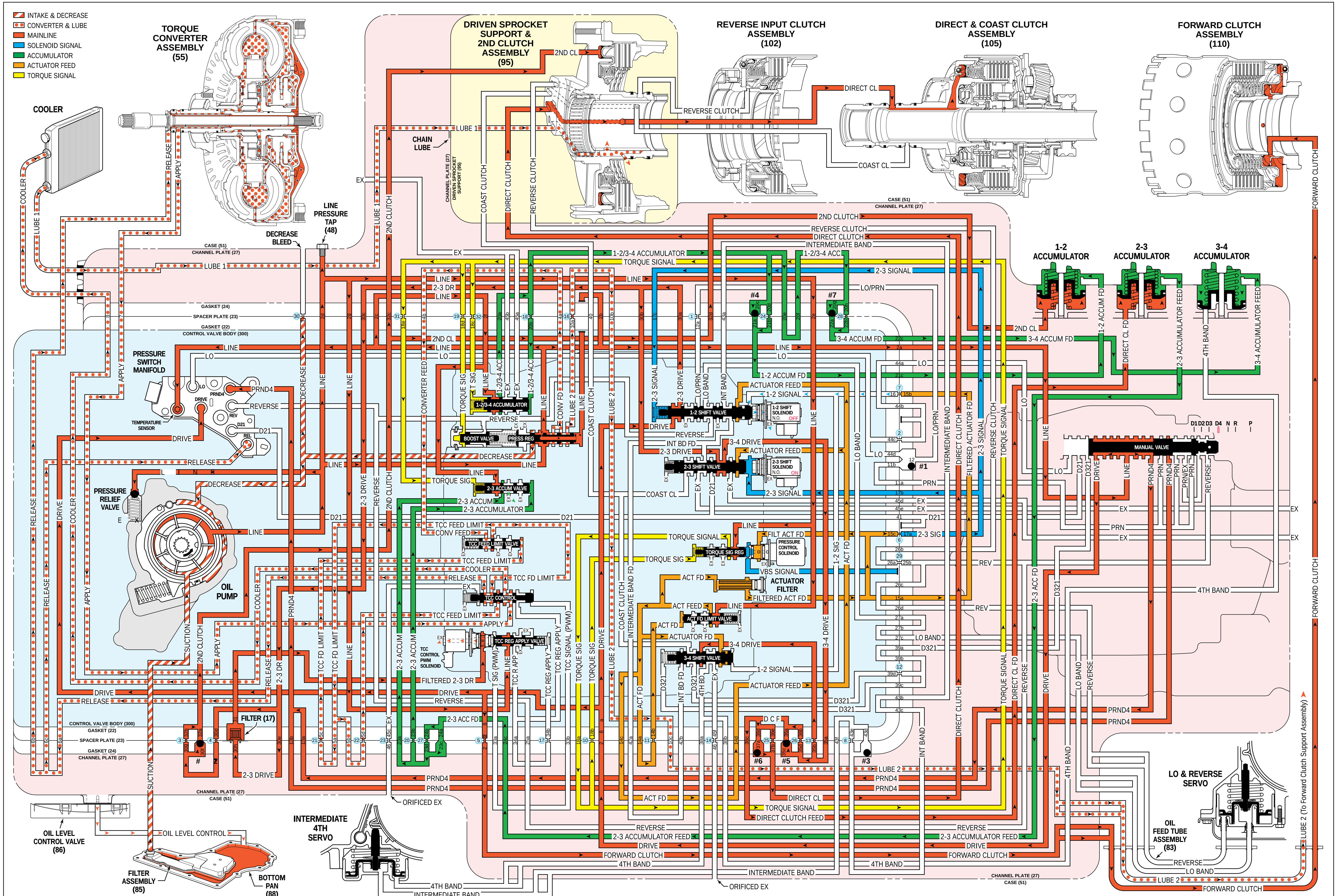


Figure 87

OVERDRIVE RANGE - THIRD GEAR

NO THIRD GEAR/SLIPS IN THIRD

- **Direct Clutch**
  - Piston and Seal Assembly (518) – Binding, cracked, leaking.
  - Clutch Plates (521 - 523) – Friction material worn, splines broken.
  - Snap Rings (517, 520) – Out of position.
  - Springs (519) – Binding, broken.
  - Direct & Coast Housing and Input Shaft (520) – Damaged, cracked, feed holes restricted.
  - Housing Retainer and Ball Assembly – Missing, plugged.

- **Direct Clutch Fluid Routing**
  - Valve Body, Gaskets & Spacer Plate; Channel Plate & Gasket; Driven Sprocket Support – Porosity, misaligned, loose, fluid restriction, fluid leak across channels.
  - Driven Sprocket Support Seals – Leaking.
  - Input Shaft – Seals leaking – Sleeve damaged; misaligned.

- **2-3 Shift Solenoid (305)**
  - Stuck “OFF”, leaking.

- **2-3 Accumulator**
  - Leak at piston seal.
  - Channel plate / case porosity.

- **2-3 Accumulator Valve (330)**
  - Stuck.

- **Line Pressure**
  - Low (See PARK page 82A).

- **3-4 Shift Valve (319)**
  - Stuck in upshifted position.

- **PSA (13)**
  - Malfunction (Electrical or Hydraulic).

HARSH SHIFT

- **Line Pressure**
  - High (See PARK page 82A).

- **Accumulator**
  - 2-3 Spring broken or piston binding; no accumulation
  - 2-3 Accumulator valve stuck.

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
OFF	ON	APPLIED *	OVER-RUNNING				HOLDING	APPLIED	APPLIED		OVER-RUNNING

OVERDRIVE RANGE - THIRD GEAR

PASSAGES

1	SUCTION
2	LINE
3	DECREASE
4	CONVERTER FEED
5	TCC FEED LIMIT
6	RELEASE
7	APPLY
8	COOLER
9	LUBE 1
10	LUBE 2
11	PRN
12	LO/PRN
13	PRND4
14	ACTUATOR FEED
15	FILTERED ACTUATOR FEED
16	1-2 SIGNAL
17	2-3 SIGNAL
18	TORQUE SIGNAL
19	VBS SIGNAL
20	1-2/3-4 ACCUMULATOR
21	1-2 ACCUMULATOR FEED
22	3-4 ACCUMULATOR FEED
23	2-3 ACCUMULATOR
24	2-3 ACCUMULATOR FEED
25	REVERSE
26	REVERSE CLUTCH
27	LO BAND
28	DRIVE
29	FORWARD CLUTCH
30	2-3 DRIVE
31	FILTERED 2-3 DRIVE
32	2ND CLUTCH
33	TCC SIGNAL (PWM)
34	TCC REGULATED APPLY
35	3-4 DRIVE
36	DIRECT CLUTCH FEED
37	DIRECT CLUTCH
38	4TH BAND
39	D321
40	COAST CLUTCH
41	D21
42	INTERMEDIATE BAND FEED
43	INTERMEDIATE BAND
44	LO
45	EXHAUST
46	ORIFICED EXHAUST
47	VOID
48	OIL LEVEL CONTROL

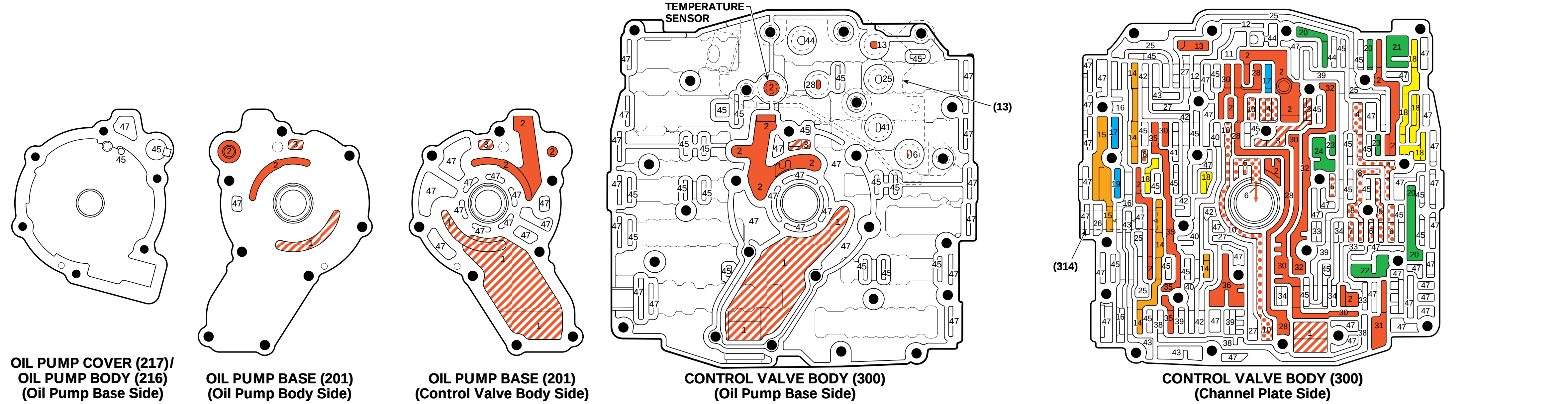
COMPONENTS (   )

(13)	TRANSAXLE FLUID PRESSURE SWITCH ASSEMBLY (PSA)
(17)	FILTER
(26)	CHECKBALLS #1, 2, 3, 4, 5, 6 & 7
(48)	PLUG, LINE PRESSURE TAP
(83)	TUBE ASSEMBLY, OIL FEED
(314)	FILTER, ACTUATOR OIL

OVERDRIVE RANGE – THIRD GEAR

NOTE:

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



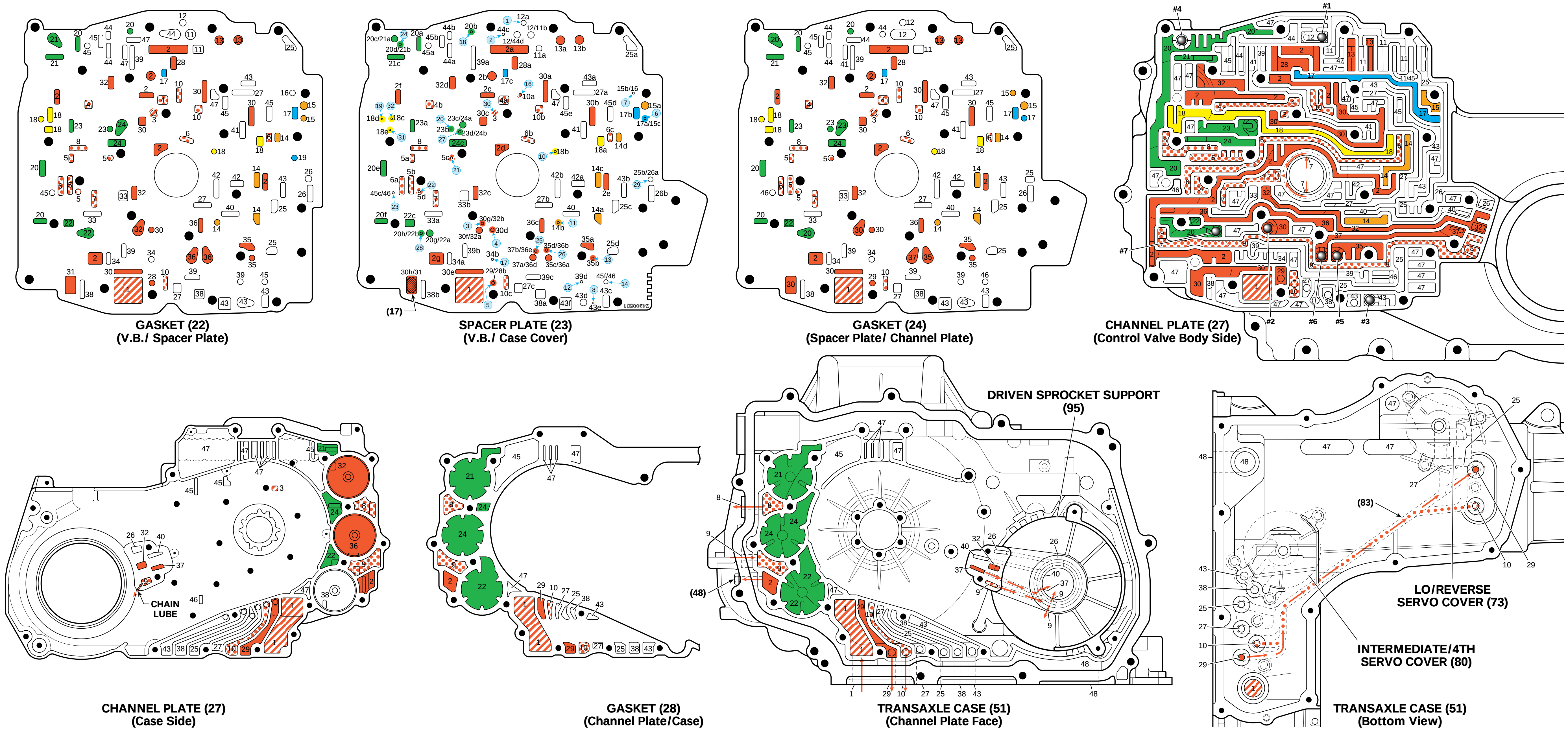


Figure 88

OVERDRIVE RANGE – FOURTH GEAR (Torque Converter Clutch Applied)

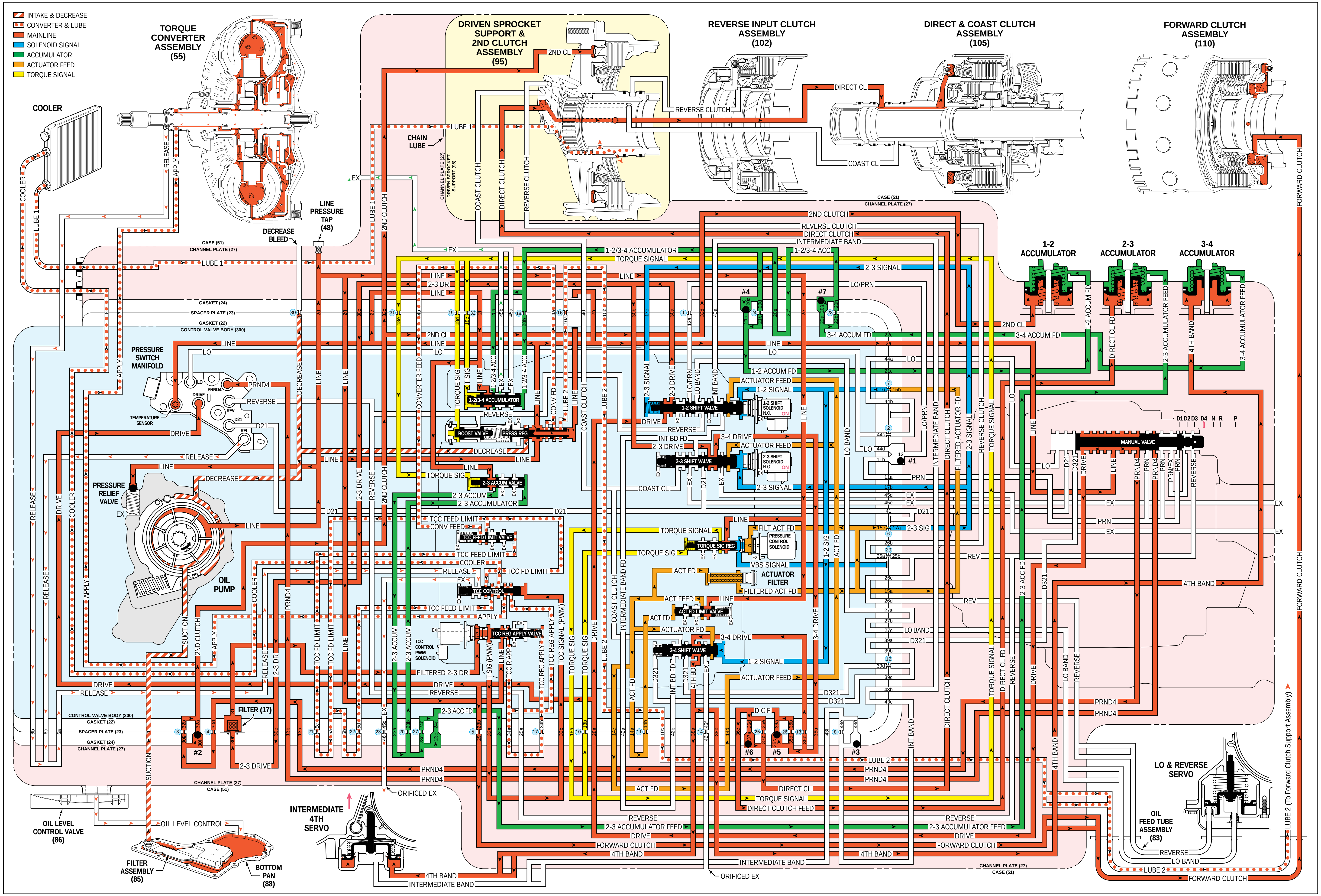


Figure 89

OVERDRIVE RANGE - FOURTH GEAR

(Torque Converter Clutch Applied)

NO FOURTH GEAR/SLIPS IN FOURTH

- **Intermediate / 4th Band & Servo**
  - No apply / slipping.
  - Servo Piston (77) – Broken, binding.
  - Servo Piston Seals (78, 79) – Leaking.
  - Servo Pin (76) and Springs (75, 68) – Binding, broken.
  - Servo Cover (80) – Broken, loose, leaking.
  - Band (100) – Broken, worn, out of position.
  - Case (51) – Cracked at band seat.
- **Band Apply Fluid Routing**
  - Valve Body, Gaskets & Spacer Plate; Channel Plate; Case – Porosity, misaligned, loose, fluid restriction, fluid leak across channels.
- **1-2 Shift Solenoid (305)**
  - Stuck “OFF”, leaking.
- **3-4 Shift Valve (319)**
  - Stuck in downshifted position.
- **Manual Valve (800)**
  - Misaligned (in Manual Third).
- **3-4 Accumulator**
  - Leak at piston seal.
  - Channel plate / case porosity.
- **3-4 Accumulator Valve (323)**
  - Stuck.
- **Line Pressure**
  - Low (See PARK page 82A).
- **Direct Clutch**
  - Low capacity will cause failure in Fourth gear.
- **PSA**
  - Malfunction (Hydraulic or Electrical)

HARSH SHIFT

- **Line Pressure**
  - High (See PARK page 82A).
- **Accumulator**
  - Spring broken or piston binding; no accumulation
  - Accumulator valve stuck.

NO TCC APPLY OR RELEASE

- **See 4-3 downshift page 96A.**

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
ON	ON	APPLIED		APPLIED			OVER-RUNNING	APPLIED	APPLIED *		OVER-RUNNING

OVERDRIVE RANGE - FOURTH GEAR

(Torque Converter Clutch Applied)

PASSAGES

1	SUCTION
2	LINE
3	DECREASE
4	CONVERTER FEED
5	TCC FEED LIMIT
6	RELEASE
7	APPLY
8	COOLER
9	LUBE 1
10	LUBE 2
11	PRN
12	LO/PRN
13	PRND4
14	ACTUATOR FEED
15	FILTERED ACTUATOR FEED
16	1-2 SIGNAL
17	2-3 SIGNAL
18	TORQUE SIGNAL
19	VBS SIGNAL
20	1-2/3-4 ACCUMULATOR
21	1-2 ACCUMULATOR FEED
22	3-4 ACCUMULATOR FEED
23	2-3 ACCUMULATOR
24	2-3 ACCUMULATOR FEED
25	REVERSE
26	REVERSE CLUTCH
27	LO BAND
28	DRIVE
29	FORWARD CLUTCH
30	2-3 DRIVE
31	FILTERED 2-3 DRIVE
32	2ND CLUTCH
33	TCC SIGNAL (PWM)
34	TCC REGULATED APPLY
35	3-4 DRIVE
36	DIRECT CLUTCH FEED
37	DIRECT CLUTCH
38	4TH BAND
39	D321
40	COAST CLUTCH
41	D21
42	INTERMEDIATE BAND FEED
43	INTERMEDIATE BAND
44	LO
45	EXHAUST
46	ORIFICED EXHAUST
47	VOID
48	OIL LEVEL CONTROL

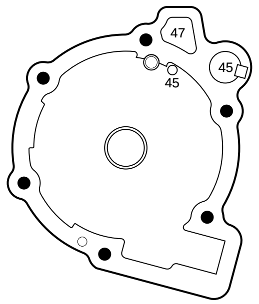
COMPONENTS (   )

(13)	TRANSAXLE FLUID PRESSURE SWITCH ASSEMBLY (PSA)
(17)	FILTER
(26)	CHECKBALLS #1, 2, 3, 4, 5, 6 & 7
(48)	PLUG, LINE PRESSURE TAP
(83)	TUBE ASSEMBLY, OIL FEED
(314)	FILTER, ACTUATOR OIL

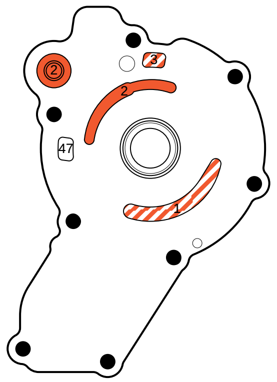
OVERDRIVE RANGE – FOURTH GEAR (Torque Converter Clutch Applied)

NOTE:

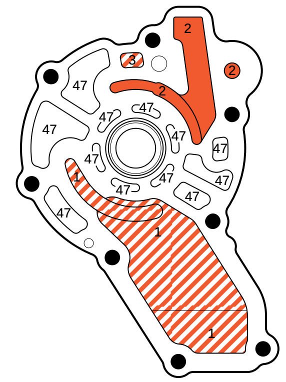
- ● INDICATES BOLT HOLES
- NON- FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE PASSAGES LISTED FIRST
- EXHAUST FLUID NOT SHOWN



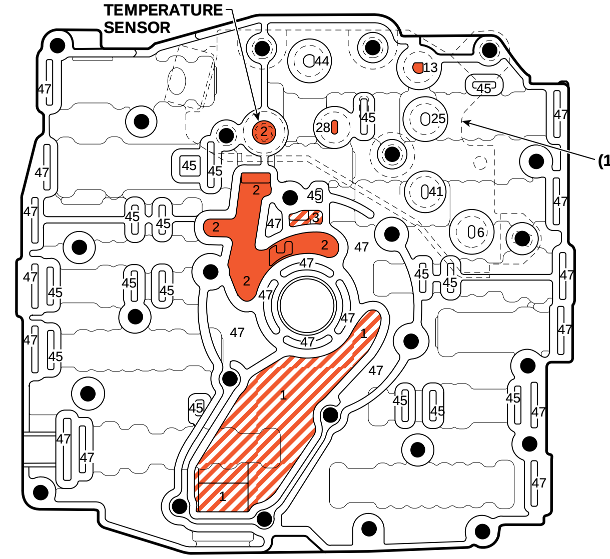
OIL PUMP COVER (217)/
OIL PUMP BODY (216)
(Oil Pump Base Side)



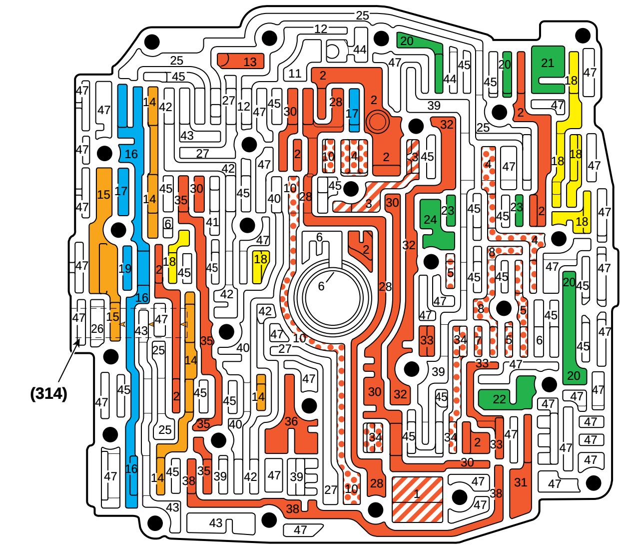
OIL PUMP BASE (201)
(Oil Pump Body Side)



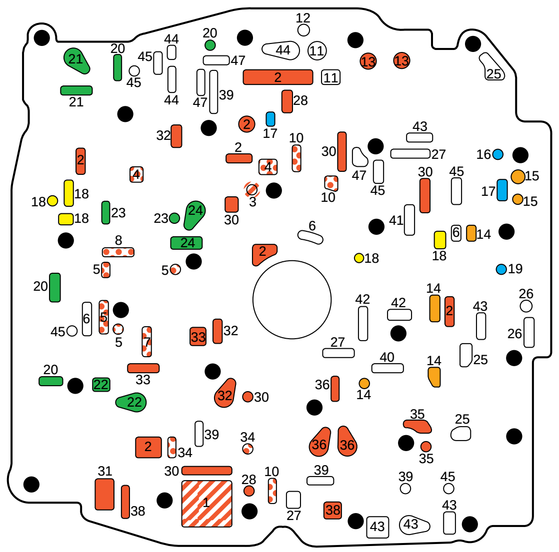
OIL PUMP BASE (201)
(Control Valve Body Side)



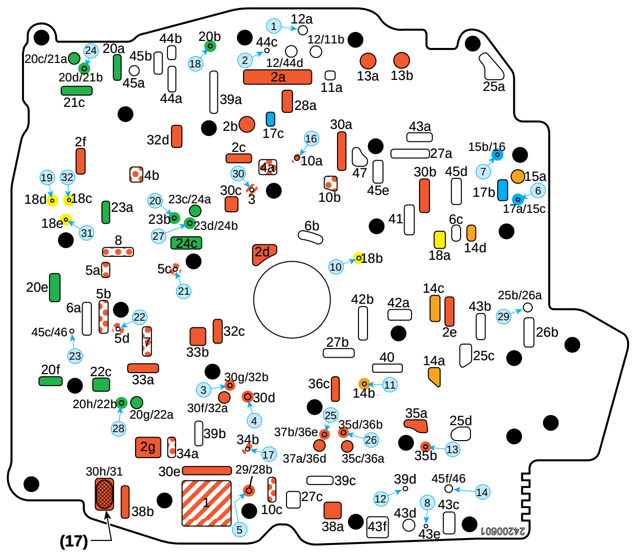
CONTROL VALVE BODY (300)
(Oil Pump Base Side)



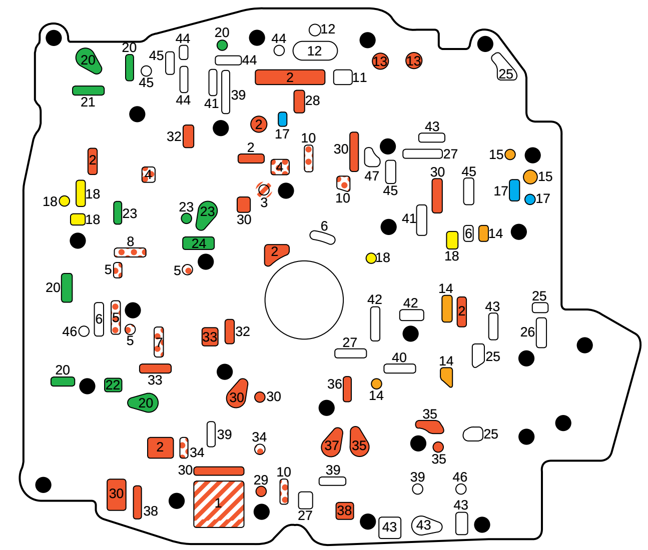
CONTROL VALVE BODY (300)
(Channel Plate Side)



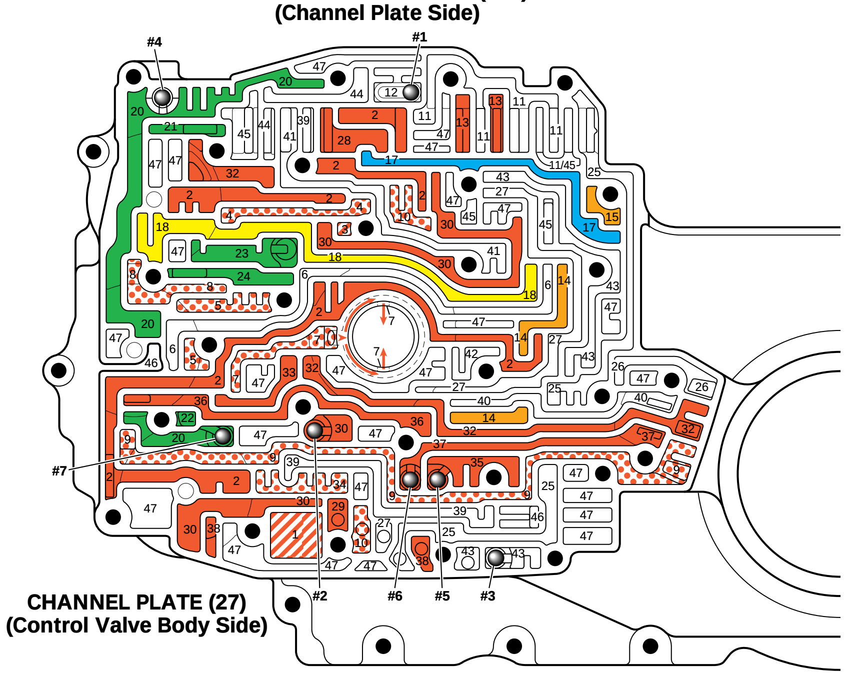
GASKET (22)
(V.B./ Spacer Plate)



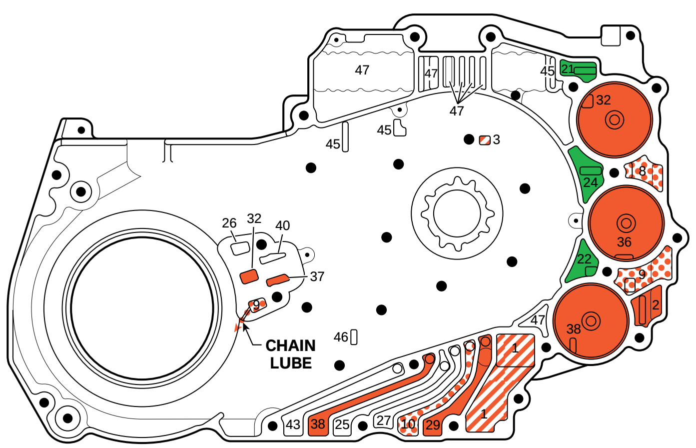
SPACER PLATE (23)
(V.B./ Case Cover)



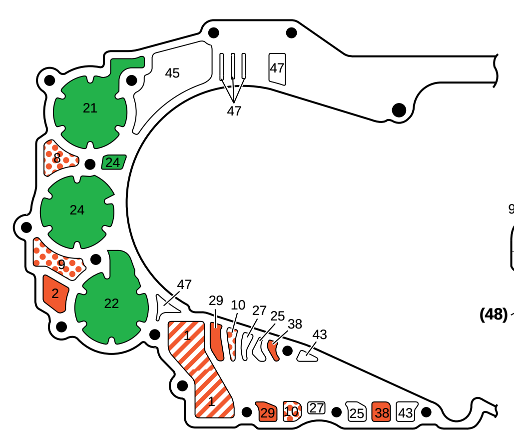
GASKET (24)
(Spacer Plate/ Channel Plate)



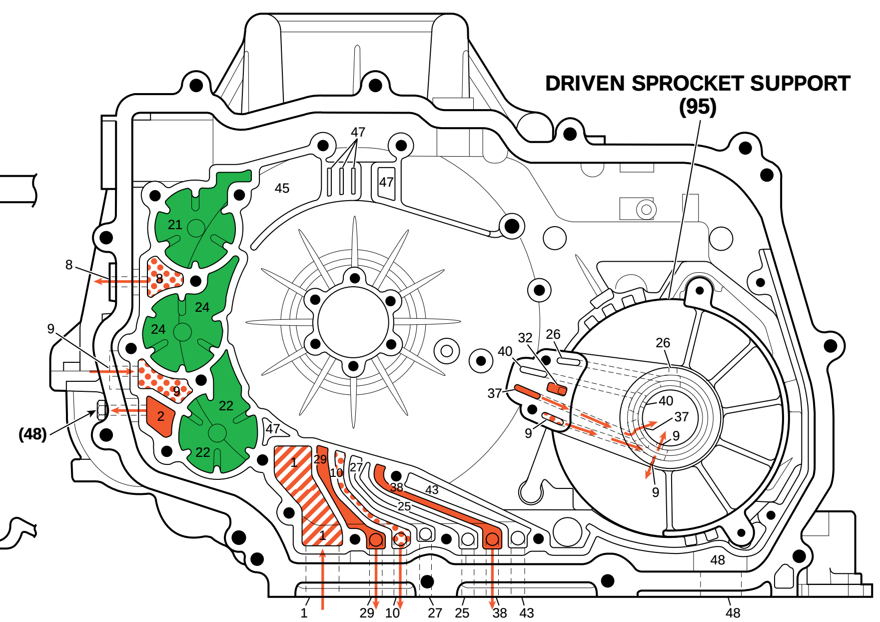
CHANNEL PLATE (27)
(Control Valve Body Side)



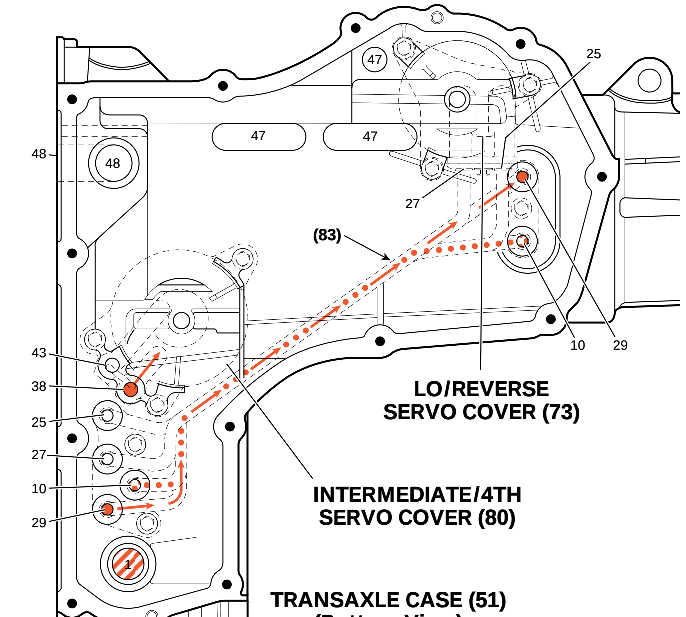
CHANNEL PLATE (27)
(Case Side)



GASKET (28)
(Channel Plate/Case)



TRANSAXLE CASE (51)
(Channel Plate Face)



TRANSAXLE CASE (51)
(Bottom View)

Figure 90

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

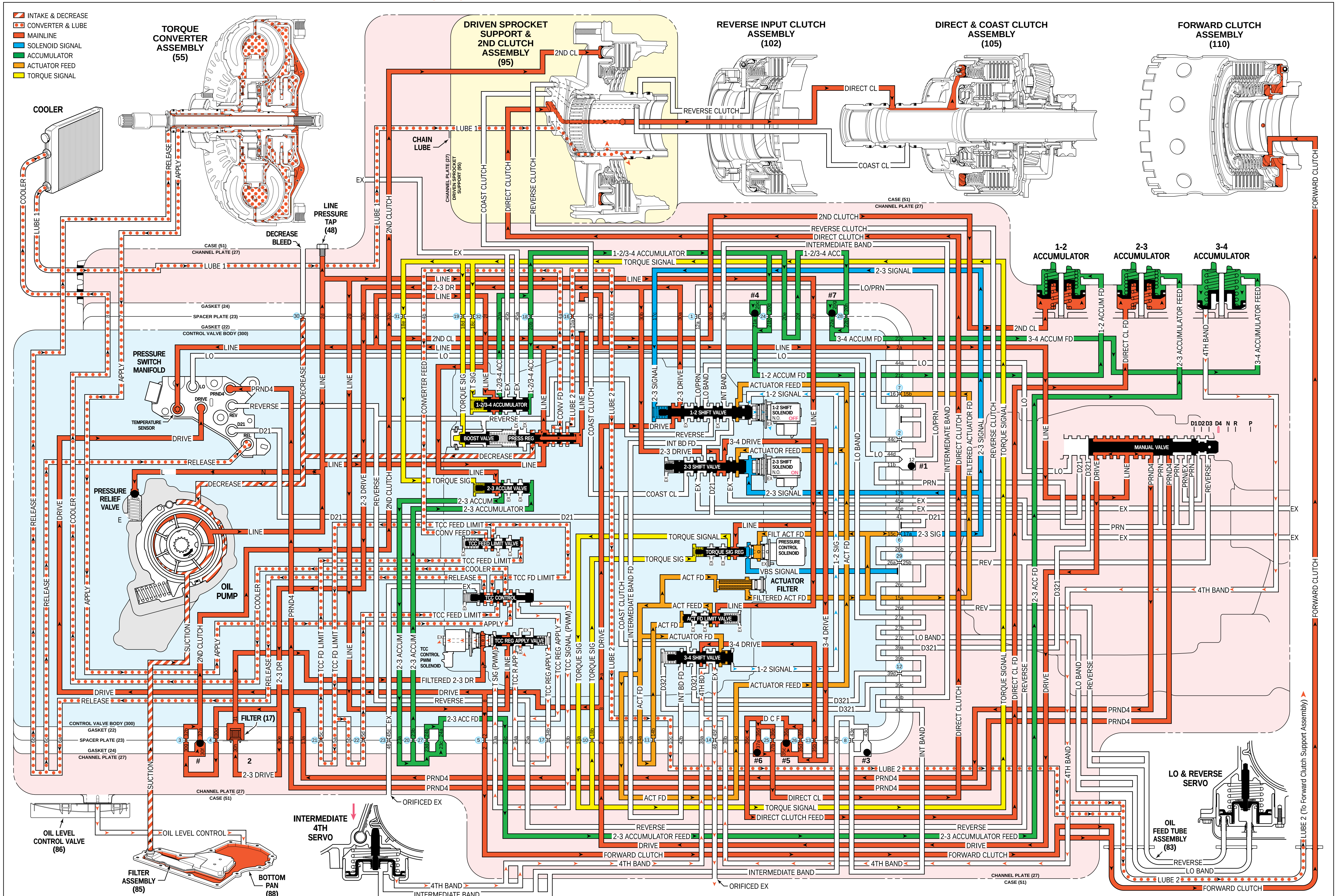


Figure 91

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 Solenoid (335)**
  - Stuck "OFF" – O-ring leaking.
  - No voltage to solenoid.
  - Poor electrical connection.
- **Wiring Harness (11)**
  - Pinched wire (electrical short).
  - Damaged electrical connector.
- **PCM**
  - No signal to solenoid.
- **Brake Switch**
  - Not functioning (open).
- **Pressure Regulator Valve**
  - Stuck.
- **Torque Converter (55)**
  - Internal failure.
- **TCC Fluid Circuits**
  - Leaks.
  - Plugged Release Exhaust Orifice #23.
- **TCC Regulated Apply Valve (339) and TCC Control Valve (334)**
  - Stuck in TCC release position.
- **TCC Feed Limit Valve**
  - Stuck.
- **Fluid Level or Pressure**
  - Low.
- **Cooler Lines**
  - Plugged.

NO TCC RELEASE

- **TCC Solenoid (335)**
  - Internal failure.
  - Fluid exhaust plugged.
  - External Ground.
- **Torque Converter (55)**
  - Internal Failure.
- **TCC Regulated Apply Valve (339) and TCC Control Valve (334)**
  - Stuck in TCC apply position.

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
OFF	ON	APPLIED *	OVER-RUNNING				HOLDING	APPLIED	APPLIED		OVER-RUNNING

OVERDRIVE RANGE - 4-3 DOWNSHIFT

(Torque Converter Clutch Released)

PASSAGES

1 SUCTION
2 LINE
3 DECREASE
4 CONVERTER FEED
5 TCC FEED LIMIT
6 RELEASE
7 APPLY
8 COOLER
9 LUBE 1
10 LUBE 2
11 PRN
12 LO/PRN
13 PRND4
14 ACTUATOR FEED
15 FILTERED ACTUATOR FEED
16 1-2 SIGNAL
17 2-3 SIGNAL
18 TORQUE SIGNAL
19 VBS SIGNAL
20 1-2/3-4 ACCUMULATOR
21 1-2 ACCUMULATOR FEED
22 3-4 ACCUMULATOR FEED
23 2-3 ACCUMULATOR
24 2-3 ACCUMULATOR FEED
25 REVERSE
26 REVERSE CLUTCH
27 LO BAND
28 DRIVE
29 FORWARD CLUTCH
30 2-3 DRIVE
31 FILTERED 2-3 DRIVE
32 2ND CLUTCH
33 TCC SIGNAL (PWM)
34 TCC REGULATED APPLY
35 3-4 DRIVE
36 DIRECT CLUTCH FEED
37 DIRECT CLUTCH
38 4TH BAND
39 D321
40 COAST CLUTCH
41 D21
42 INTERMEDIATE BAND FEED
43 INTERMEDIATE BAND
44 LO
45 EXHAUST
46 ORIFICED EXHAUST
47 VOID
48 OIL LEVEL CONTROL

COMPONENTS ( )

(13) TRANSAXLE FLUID PRESSURE SWITCH ASSEMBLY (PSA)
(17) FILTER
(26) CHECKBALLS #1, 2, 3, 4, 5, 6 & 7
(48) PLUG, LINE PRESSURE TAP
(83) TUBE ASSEMBLY, OIL FEED
(314) FILTER, ACTUATOR OIL

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

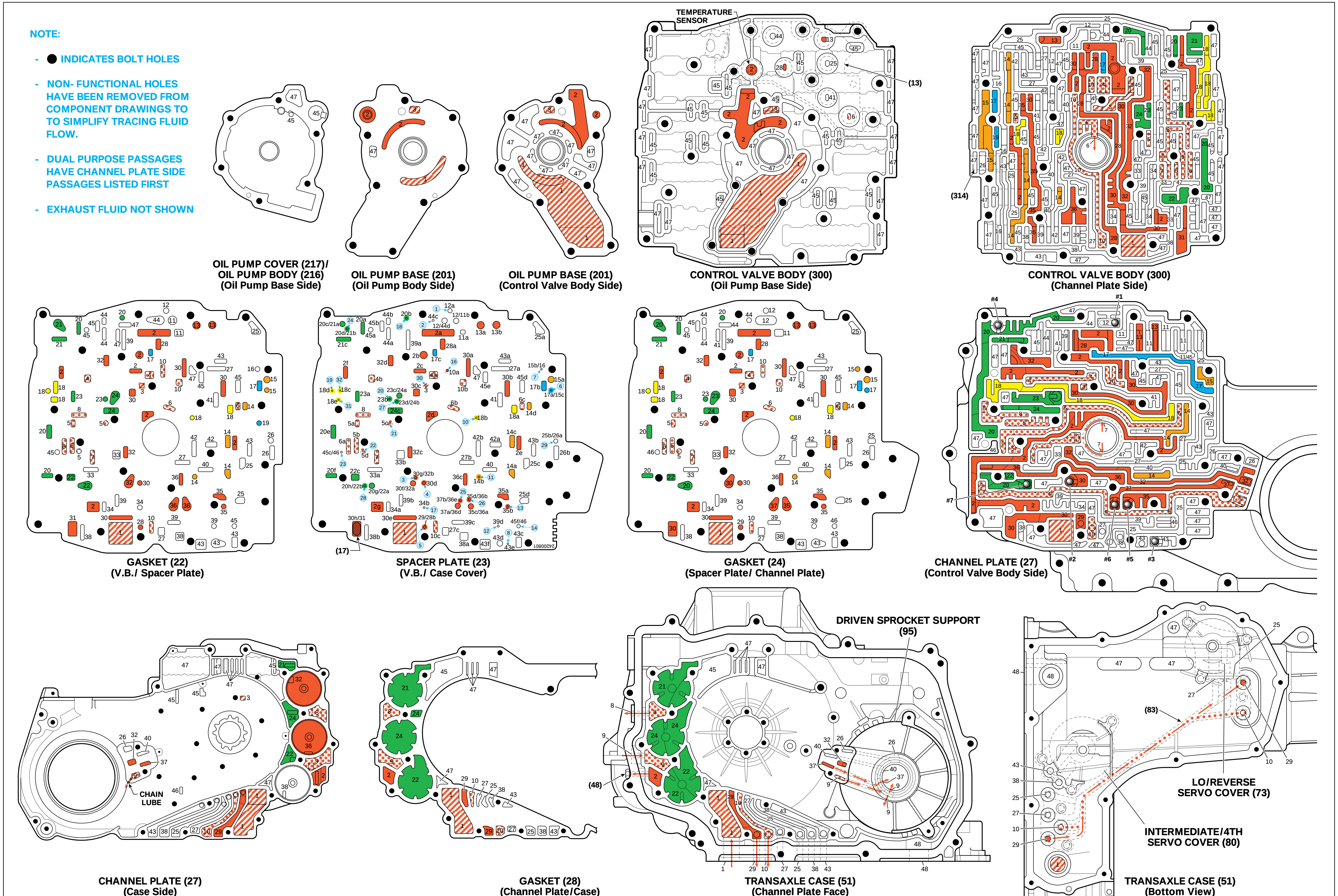


Figure 92

MANUAL THIRD – THIRD GEAR (From Overdrive Range – Fourth Gear)

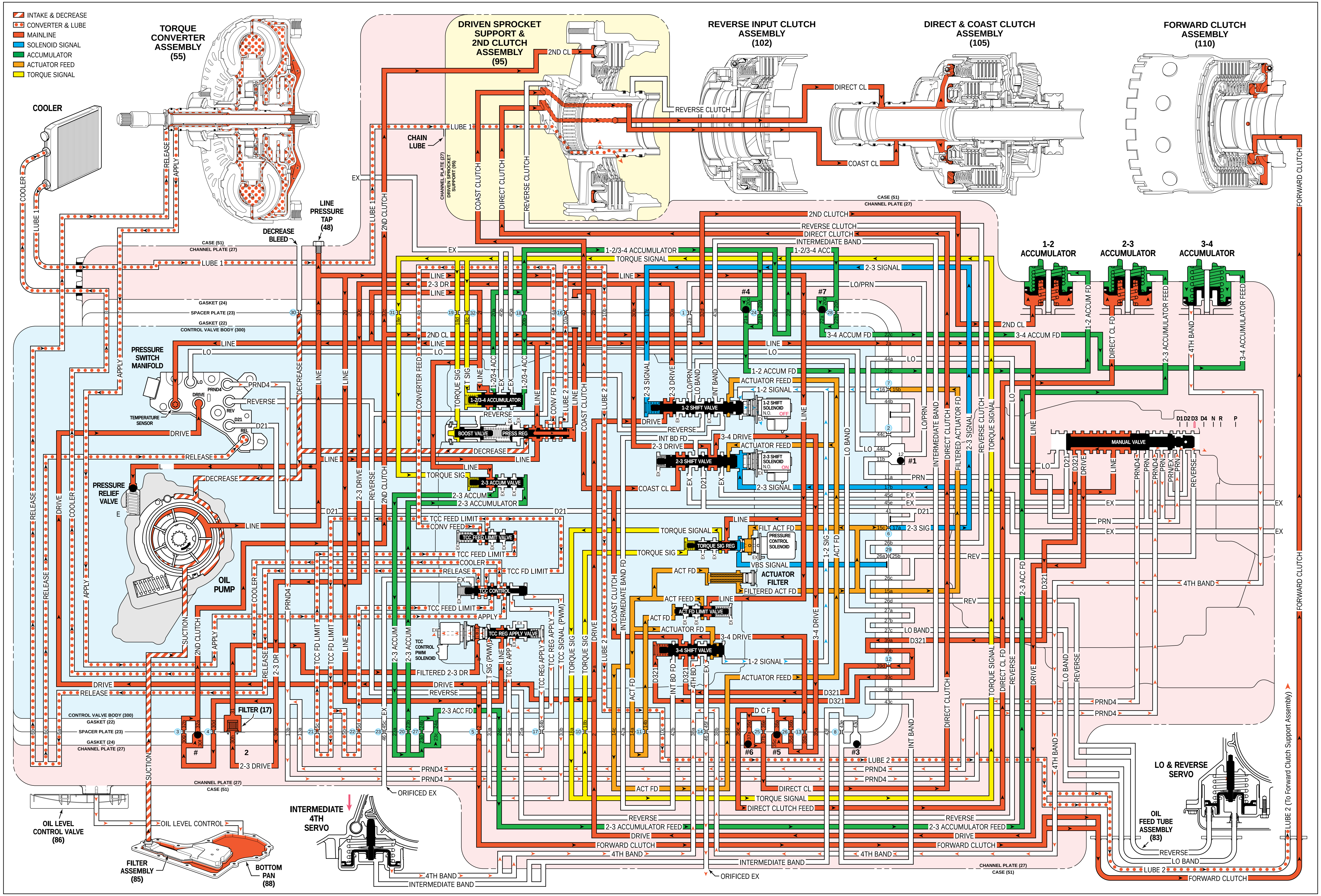


Figure 93

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**
  - Piston and Seal Assembly (504) – Binding, cracked, leaking.
  - Clutch Plates (508, 509) – Friction material worn, splines broken.
  - Springs (505) – Binding, broken.
  - Direct & Coast Clutch Housing and Input Shaft (502) – Damaged, cracked, fluid feed holes restricted, seal rings leaking.
  - Housing Retainer and Ball Assembly – Missing, loose, plugged.

- **Coast Clutch Fluid Routing**
  - Valve Body Gaskets and Spacer Plate; Channel Plate and Gasket; Driven Sprocket Support – Porosity, misaligned, loose, fluid restriction, fluid leak across channels.
  - Driven Sprocket Support Seals – Leaking.
  - Input Shaft (502) – Seals leaking, Sleeve damaged, misaligned.

- **Fluid Level or Pressure**
  - Low (See PARK page 82A).

- **3-4 Shift Valve (319)**
  - Stuck in 4th gear position. (No coast clutch apply).

- **Manual Valve (800) / Shift Linkage**
  - Misaligned.

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
OFF	ON	APPLIED *	OVER-RUNNING			APPLIED	HOLDING	APPLIED	APPLIED		OVER-RUNNING

MANUAL THIRD - THIRD GEAR

(From Overdrive Range - Fourth Gear)

PASSAGES

1 SUCTION
2 LINE
3 DECREASE
4 CONVERTER FEED
5 TCC FEED LIMIT
6 RELEASE
7 APPLY
8 COOLER
9 LUBE 1
10 LUBE 2
11 PRN
12 LO/PRN
13 PRND4
14 ACTUATOR FEED
15 FILTERED ACTUATOR FEED
16 1-2 SIGNAL
17 2-3 SIGNAL
18 TORQUE SIGNAL
19 VBS SIGNAL
20 1-2/3-4 ACCUMULATOR
21 1-2 ACCUMULATOR FEED
22 3-4 ACCUMULATOR FEED
23 2-3 ACCUMULATOR
24 2-3 ACCUMULATOR FEED
25 REVERSE
26 REVERSE CLUTCH
27 LO BAND
28 DRIVE
29 FORWARD CLUTCH
30 2-3 DRIVE
31 FILTERED 2-3 DRIVE
32 2ND CLUTCH
33 TCC SIGNAL (PWM)
34 TCC REGULATED APPLY
35 3-4 DRIVE
36 DIRECT CLUTCH FEED
37 DIRECT CLUTCH
38 4TH BAND
39 D321
40 COAST CLUTCH
41 D21
42 INTERMEDIATE BAND FEED
43 INTERMEDIATE BAND
44 LO
45 EXHAUST
46 ORIFICED EXHAUST
47 VOID
48 OIL LEVEL CONTROL

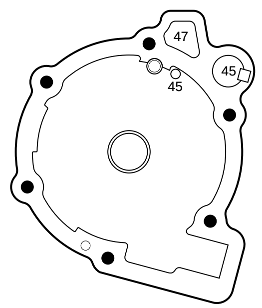
COMPONENTS ( )

(13) TRANSAXLE FLUID PRESSURE SWITCH ASSEMBLY (PSA)
(17) FILTER
(26) CHECKBALLS #1, 2, 3, 4, 5, 6 & 7
(48) PLUG, LINE PRESSURE TAP
(83) TUBE ASSEMBLY, OIL FEED
(314) FILTER, ACTUATOR OIL

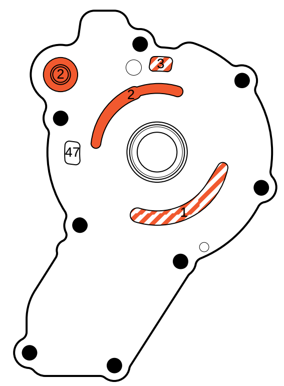
MANUAL THIRD – THIRD GEAR (From Overdrive Range – Fourth Gear)

NOTE:

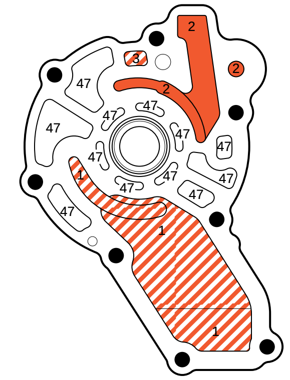
- ● INDICATES BOLT HOLES
- NON- FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE PASSAGES LISTED FIRST
- EXHAUST FLUID NOT SHOWN



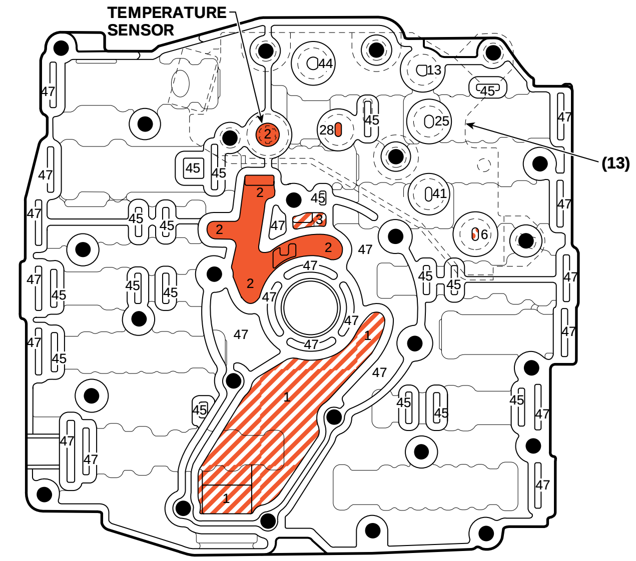
OIL PUMP COVER (217)/ OIL PUMP BODY (216) (Oil Pump Base Side)



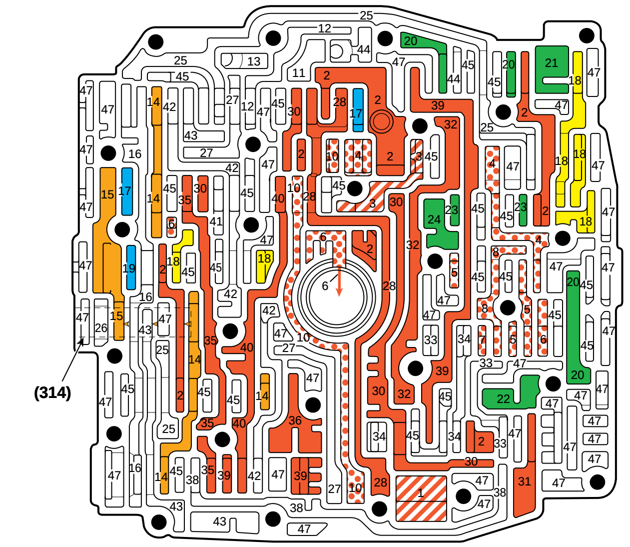
OIL PUMP BASE (201) (Oil Pump Body Side)



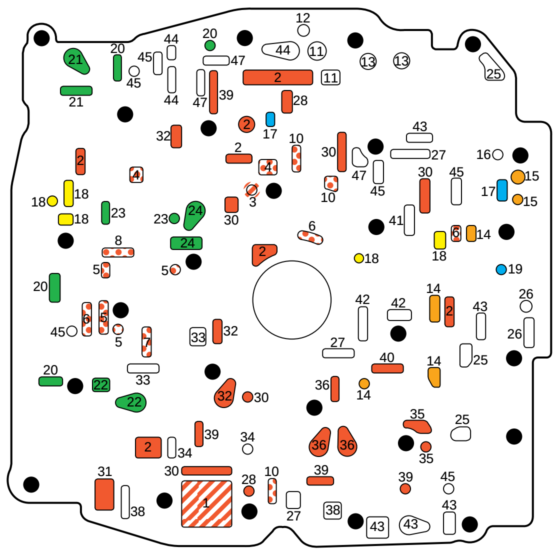
OIL PUMP BASE (201) (Control Valve Body Side)



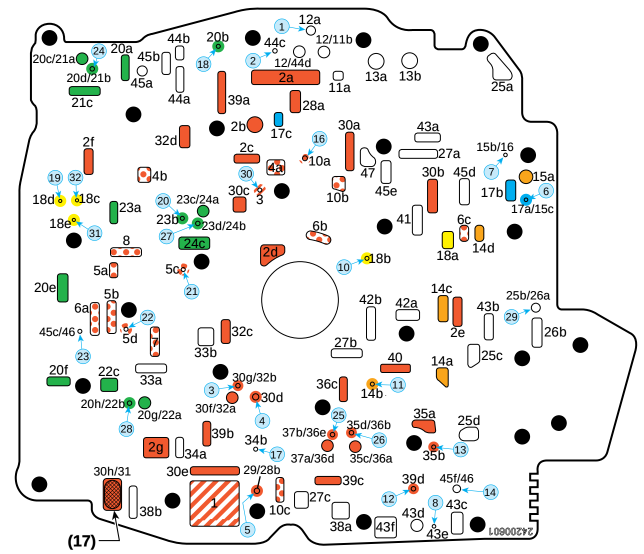
CONTROL VALVE BODY (300) (Oil Pump Base Side)



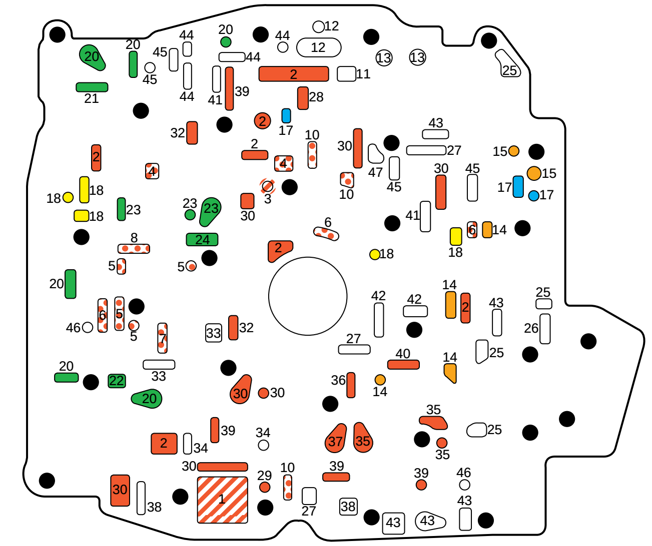
CONTROL VALVE BODY (300) (Channel Plate Side)



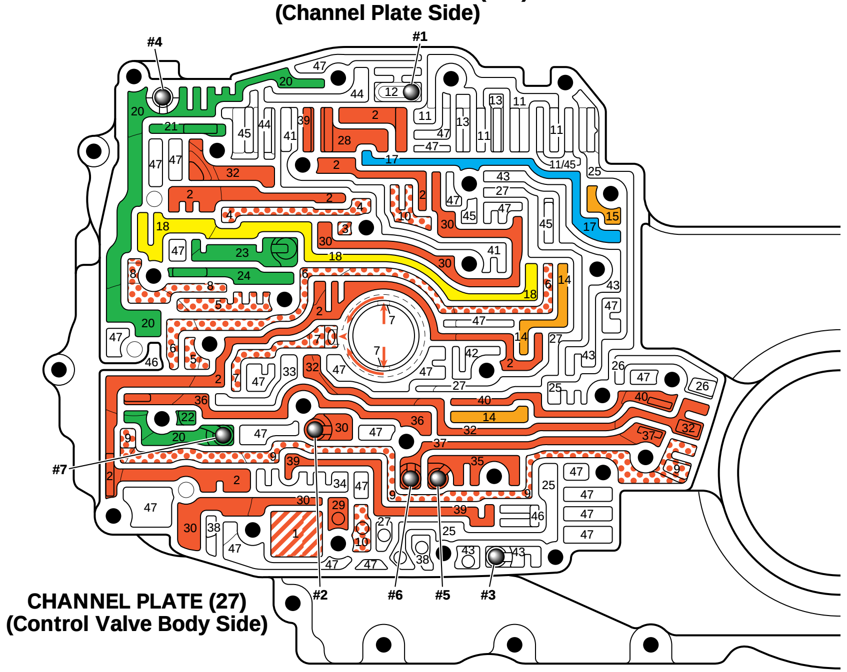
GASKET (22) (V.B./ Spacer Plate)



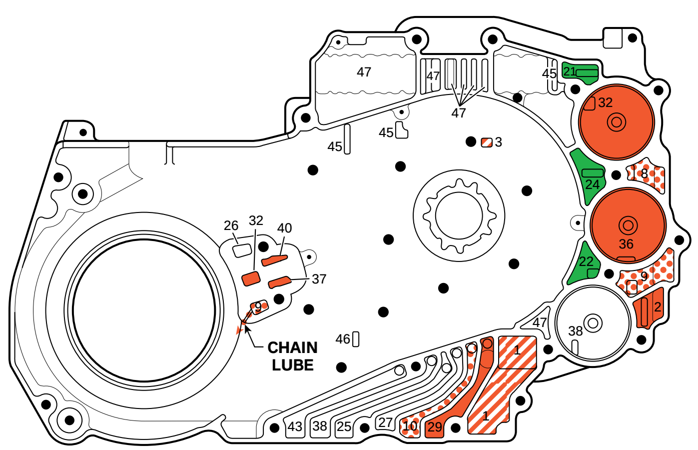
SPACER PLATE (23) (V.B./ Case Cover)



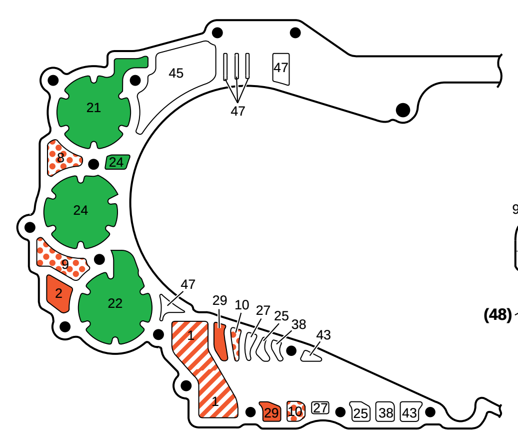
GASKET (24) (Spacer Plate/ Channel Plate)



CHANNEL PLATE (27) (Control Valve Body Side)

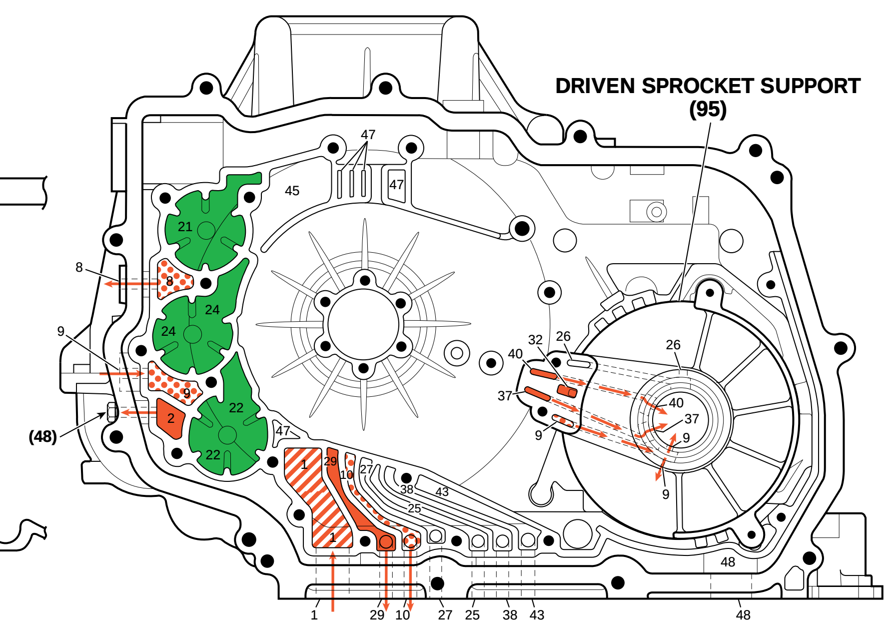


CHANNEL PLATE (27) (Case Side)

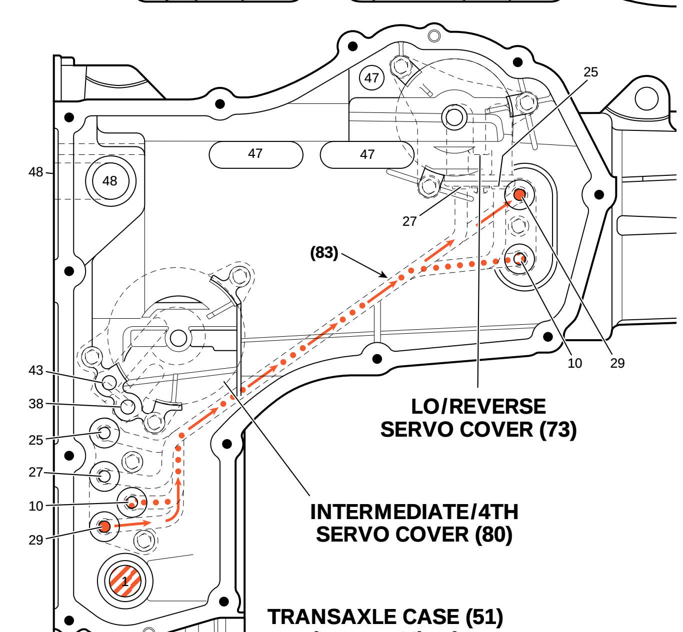


GASKET (28) (Channel Plate/Case)

DRIVEN SPROCKET SUPPORT (95)



TRANSAXLE CASE (51) (Channel Plate Face)



TRANSAXLE CASE (51) (Bottom View)

Figure 94

MANUAL SECOND – SECOND GEAR (From Manual Third – Third Gear)

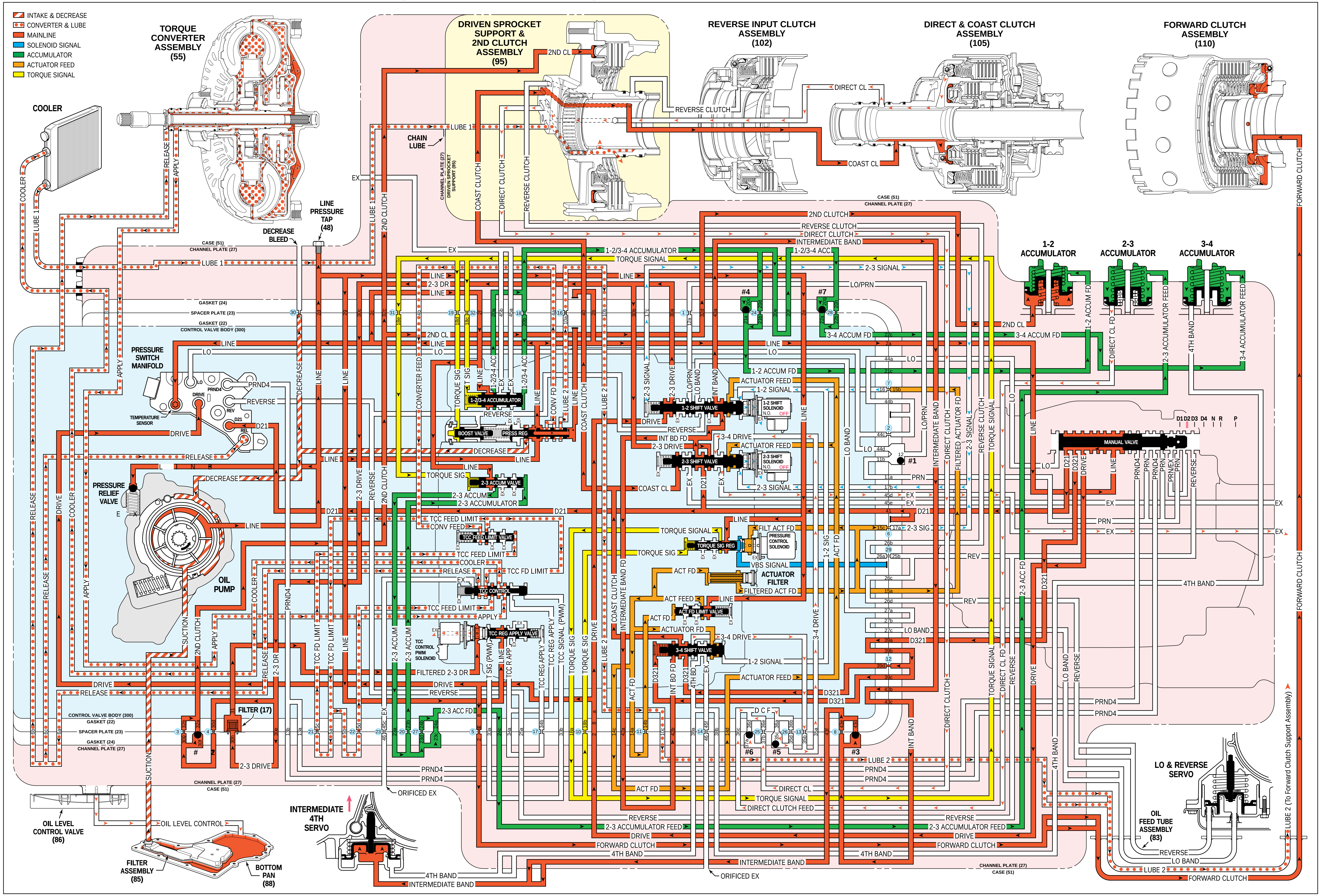


Figure 95

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)
- **Intermediate / 4th Band & Servo**
  - No apply / slipping.
  - Servo Piston (77) – Broken, binding.
  - Servo Piston Seals (78, 79) – Leaking.
  - Servo Pin (76) and Springs (75, 68) – Binding, broken.
  - Servo Cover (80) – Broken, loose, leaking.
  - Band (100) – Broken, worn, out of position.
  - Case (51) – Cracked at band seat.
- **Band Apply Fluid Routing**
  - Valve Body, Gaskets & Spacer Plate; Channel Plate; Case – Porosity, misaligned, loose, fluid restriction, fluid leak across channels.
- **Pressure Switch Assembly (13)**
  - Leaking, inoperative.

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
OFF	OFF	APPLIED	HOLDING	APPLIED		APPLIED	HOLDING		APPLIED		OVER-RUNNING

MANUAL SECOND - SECOND GEAR
(From Manual Third - Third Gear)

PASSAGES

1 SUCTION
2 LINE
3 DECREASE
4 CONVERTER FEED
5 TCC FEED LIMIT
6 RELEASE
7 APPLY
8 COOLER
9 LUBE 1
10 LUBE 2
11 PRN
12 LO/PRN
13 PRND4
14 ACTUATOR FEED
15 FILTERED ACTUATOR FEED
16 1-2 SIGNAL
17 2-3 SIGNAL
18 TORQUE SIGNAL
19 VBS SIGNAL
20 1-2/3-4 ACCUMULATOR
21 1-2 ACCUMULATOR FEED
22 3-4 ACCUMULATOR FEED
23 2-3 ACCUMULATOR
24 2-3 ACCUMULATOR FEED
25 REVERSE
26 REVERSE CLUTCH
27 LO BAND
28 DRIVE
29 FORWARD CLUTCH
30 2-3 DRIVE
31 FILTERED 2-3 DRIVE
32 2ND CLUTCH
33 TCC SIGNAL (PWM)
34 TCC REGULATED APPLY
35 3-4 DRIVE
36 DIRECT CLUTCH FEED
37 DIRECT CLUTCH
38 4TH BAND
39 D321
40 COAST CLUTCH
41 D21
42 INTERMEDIATE BAND FEED
43 INTERMEDIATE BAND
44 LO
45 EXHAUST
46 ORIFICED EXHAUST
47 VOID
48 OIL LEVEL CONTROL

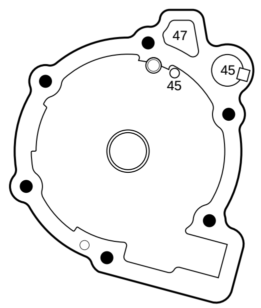
COMPONENTS ( )

(13) TRANSAXLE FLUID PRESSURE SWITCH ASSEMBLY (PSA)
(17) FILTER
(26) CHECKBALLS #1, 2, 3, 4, 5, 6 & 7
(48) PLUG, LINE PRESSURE TAP
(83) TUBE ASSEMBLY, OIL FEED
(314) FILTER, ACTUATOR OIL

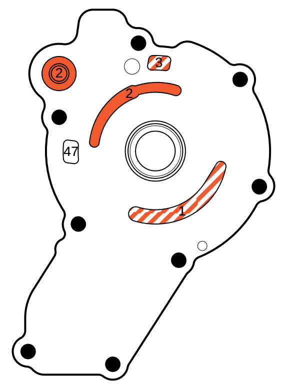
MANUAL SECOND – SECOND GEAR (From Manual Third – Third Gear)

NOTE:

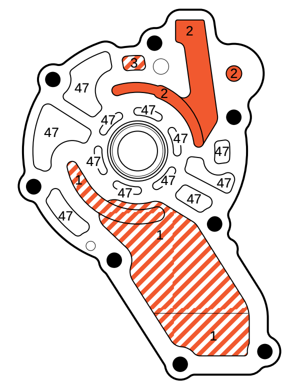
- ● INDICATES BOLT HOLES
- NON- FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE PASSAGES LISTED FIRST
- EXHAUST FLUID NOT SHOWN



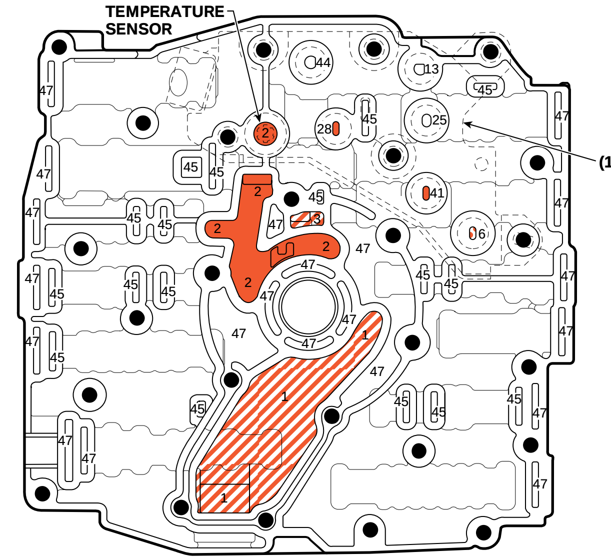
OIL PUMP COVER (217)/
OIL PUMP BODY (216)
(Oil Pump Base Side)



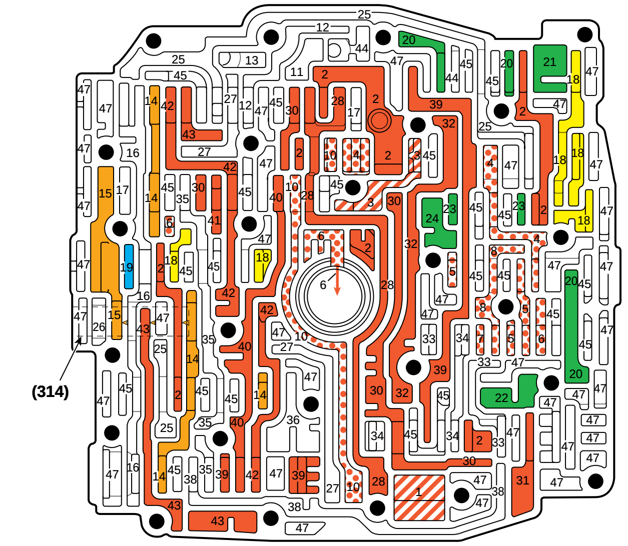
OIL PUMP BASE (201)
(Oil Pump Body Side)



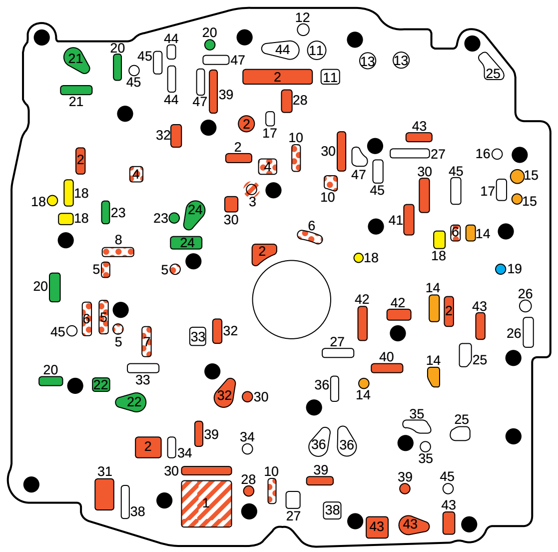
OIL PUMP BASE (201)
(Control Valve Body Side)



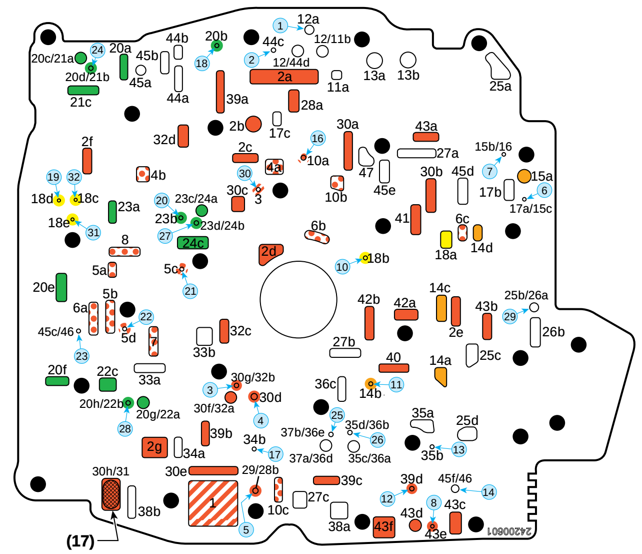
CONTROL VALVE BODY (300)
(Oil Pump Base Side)



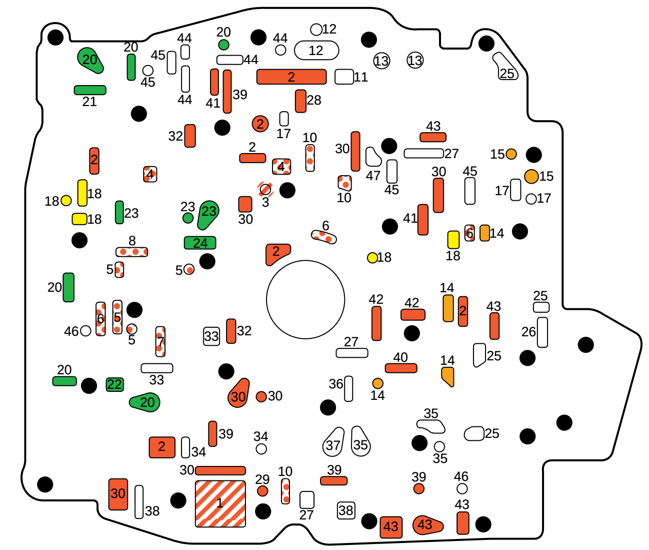
CONTROL VALVE BODY (300)
(Channel Plate Side)



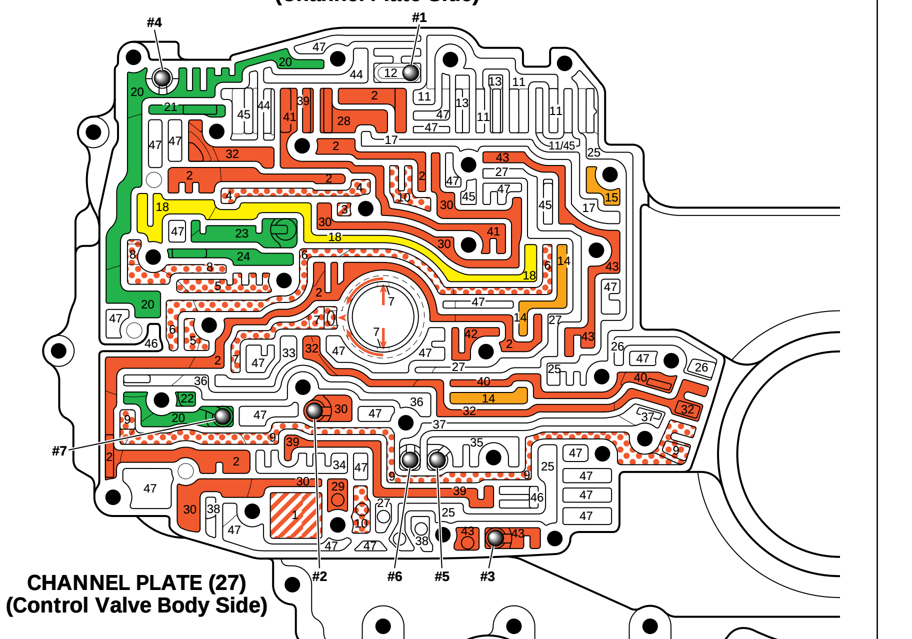
GASKET (22)
(V.B./ Spacer Plate)



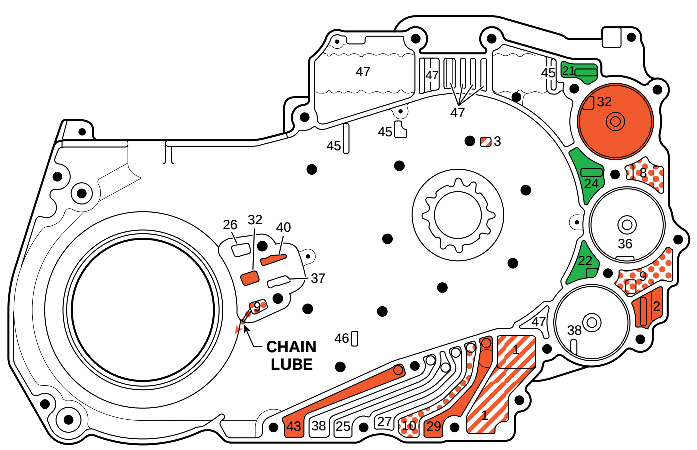
SPACER PLATE (23)
(V.B./ Case Cover)



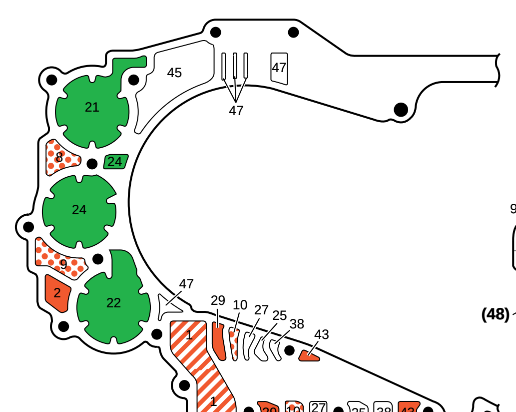
GASKET (24)
(Spacer Plate/ Channel Plate)



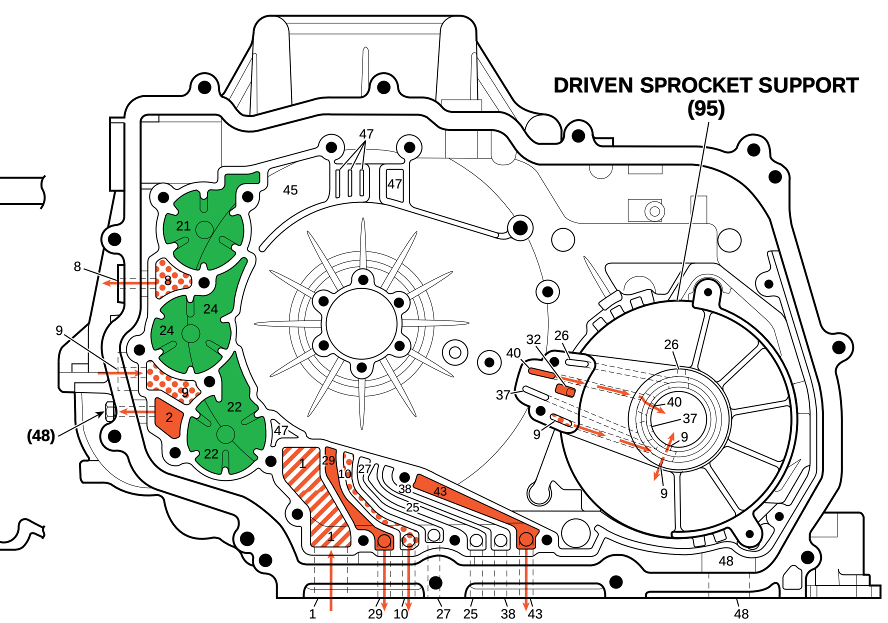
CHANNEL PLATE (27)
(Control Valve Body Side)



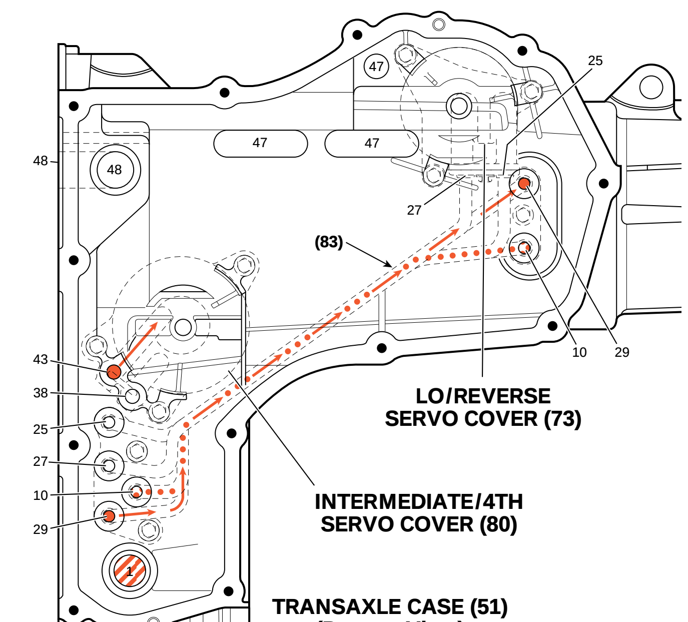
CHANNEL PLATE (27)
(Case Side)



GASKET (28)
(Channel Plate/Case)



TRANSAXLE CASE (51)
(Channel Plate Face)



TRANSAXLE CASE (51)
(Bottom View)

Figure 96

MANUAL FIRST – FIRST GEAR (From Manual Second – Second Gear)

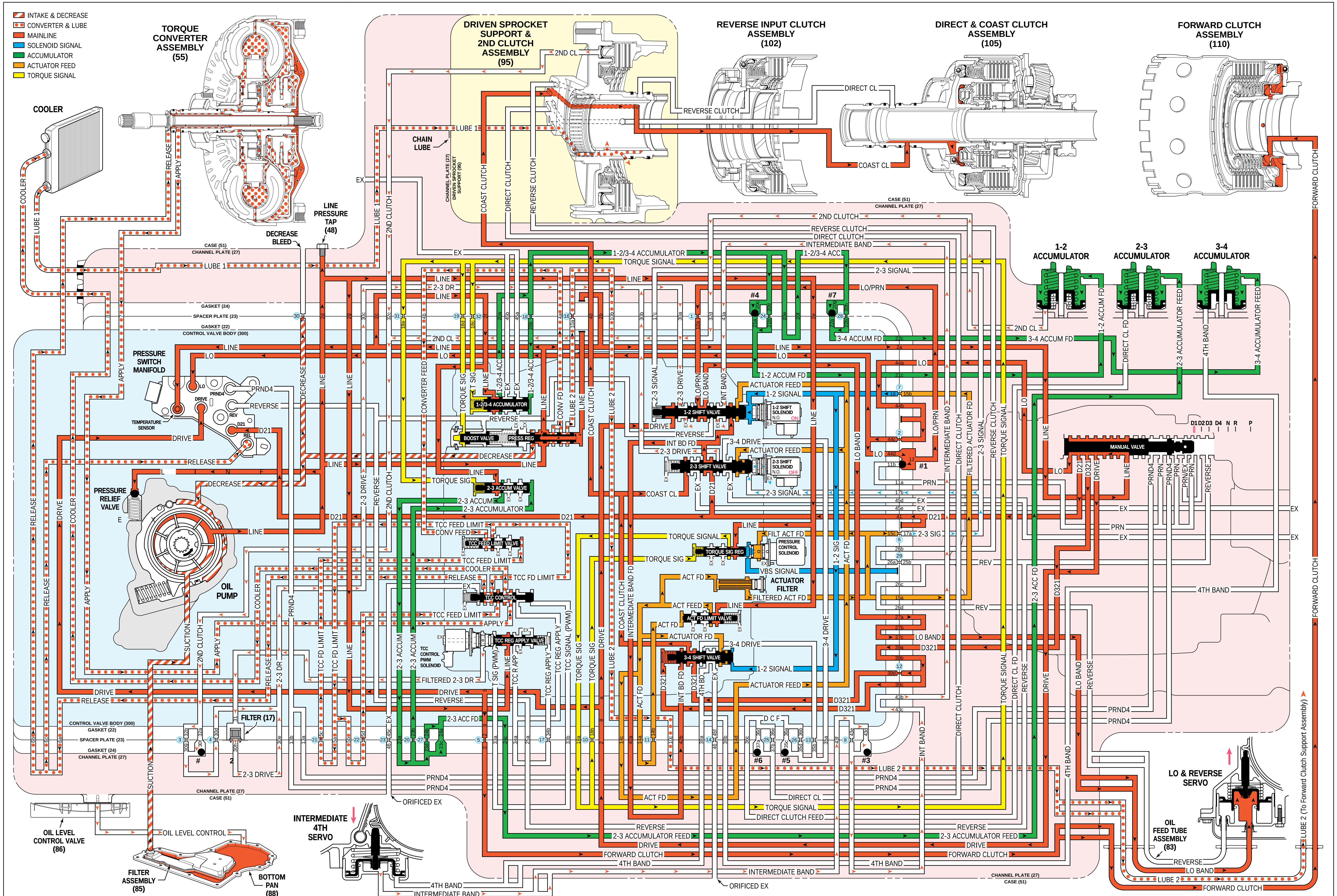


Figure 97

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)
- **Lo & Reverse Band and Servo**
  - Servo Piston (69) – Broken, binding.
  - Servo Piston Seals (71, 72) – Leaking.
  - Servo Pin (67) and Springs (66, 68) – Binding, broken.
  - Servo Cover (73) – Broken, loose, leaking.
  - Lo & Reverse Band (111) – Broken, worn, out of position.
  - Anchor Pin (64) – Broken.
  - Fluid Feed Tubes (83) – Broken, bent, plugged, seal rings missing / leaking.
  - Transaxle Case (51) – Porosity, fluid leak or restriction.
- **Pressure Switch Assembly (13)**
  - Leaking, inoperative.
- **#1 Checkball (LO/PRN)**
  - Missing.

SHIFT "A" SOL	SHIFT "B" SOL	2ND CLUTCH	2ND ROLLER CLUTCH	INT/4TH BAND	REVERSE CLUTCH	COAST CLUTCH	INPUT SPRAG	DIRECT CLUTCH	FORWARD CLUTCH	LO/REV. BAND	LO ROLLER CLUTCH
ON	OFF					APPLIED	HOLDING		APPLIED	APPLIED	HOLDING

MANUAL FIRST - FIRST GEAR
(From Manual Second - Second Gear)

PASSAGES

1 SUCTION
2 LINE
3 DECREASE
4 CONVERTER FEED
5 TCC FEED LIMIT
6 RELEASE
7 APPLY
8 COOLER
9 LUBE 1
10 LUBE 2
11 PRN
12 LO/PRN
13 PRND4
14 ACTUATOR FEED
15 FILTERED ACTUATOR FEED
16 1-2 SIGNAL
17 2-3 SIGNAL
18 TORQUE SIGNAL
19 VBS SIGNAL
20 1-2/3-4 ACCUMULATOR
21 1-2 ACCUMULATOR FEED
22 3-4 ACCUMULATOR FEED
23 2-3 ACCUMULATOR
24 2-3 ACCUMULATOR FEED
25 REVERSE
26 REVERSE CLUTCH
27 LO BAND
28 DRIVE
29 FORWARD CLUTCH
30 2-3 DRIVE
31 FILTERED 2-3 DRIVE
32 2ND CLUTCH
33 TCC SIGNAL (PWM)
34 TCC REGULATED APPLY
35 3-4 DRIVE
36 DIRECT CLUTCH FEED
37 DIRECT CLUTCH
38 4TH BAND
39 D321
40 COAST CLUTCH
41 D21
42 INTERMEDIATE BAND FEED
43 INTERMEDIATE BAND
44 LO
45 EXHAUST
46 ORIFICED EXHAUST
47 VOID
48 OIL LEVEL CONTROL

COMPONENTS ( )

(13) TRANSAXLE FLUID PRESSURE SWITCH ASSEMBLY (PSA)
(17) FILTER
(26) CHECKBALLS #1, 2, 3, 4, 5, 6 & 7
(48) PLUG, LINE PRESSURE TAP
(83) TUBE ASSEMBLY, OIL FEED
(314) FILTER, ACTUATOR OIL

MANUAL FIRST – FIRST GEAR

(From Manual Second – Second Gear)

NOTE:

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

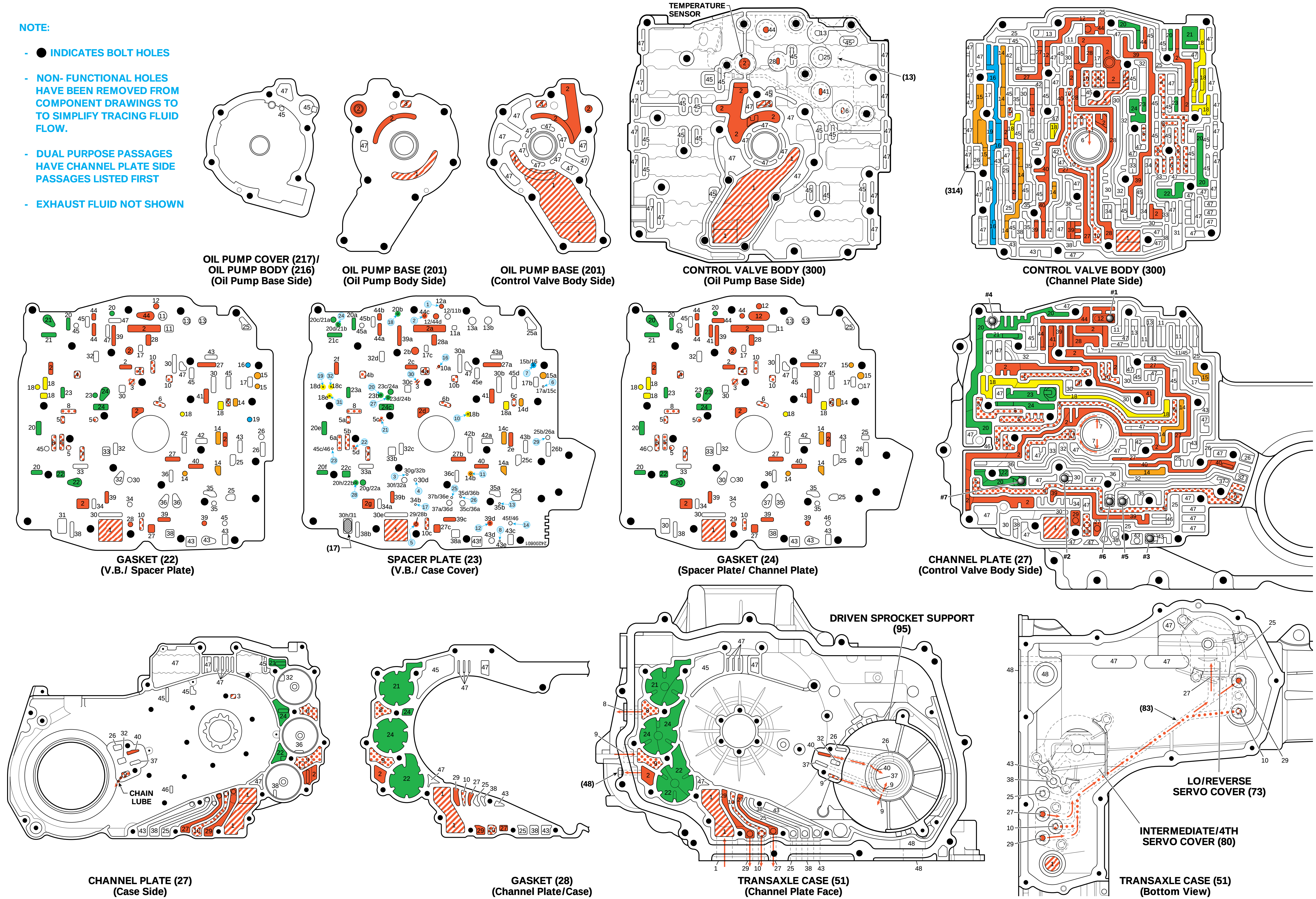


Figure 98

LUBRICATION POINTS

COOLER AND LUBRICATION CIRCUITS

- Line pressure from the oil pump assembly (10) is directed to the pressure regulator valve (328) located in the control valve body assembly (18).
- Line pressure passes through the pressure regulator valve (328) where it enters the converter feed circuit.
- Converter feed fluid is routed to the TCC feed limit valve (332) and enters the TCC feed limit circuit.
- TCC feed limit fluid is directed to the TCC control valve (334) where it passes through the valve and enters the release circuit.
- Release fluid is routed through the control valve body (18), channel plate (27) and case (51) before it is fed between the oil pump drive shaft (19) and turbine shaft (39).
- Release fluid flows along the oil pump drive shaft (19) and turbine shaft (39) 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 (55) is then routed back to the TCC control valve (334) where it passes through the valve and enters the cooler circuit.
- Fluid in the cooler circuit is routed through the spacer plate (23), into the channel plate (27), into the case (51) and through the cooler lines to the transaxle cooler located inside the radiator.

LUBRICATION CIRCUITS

- The lube 1 circuit begins at the transaxle cooler when fluid is routed through the cooler lines to the case (51).
- Lube 1 passes into the case (51) and enters the driven sprocket support assembly (95) to provide lubrication for the components located on the left side of the transaxle.
- Lube 2 fluid (generated from line pressure at the pressure regulator valve) is routed through the spacer plate (23) at orifice #16, into the channel plate (27), into the case (51), through the oil feed tube assembly (83) and into the forward clutch support assembly (114).
- After lube 2 passes into the forward clutch support assembly (114) it provides lubrication for the components located on the right side of the transaxle.

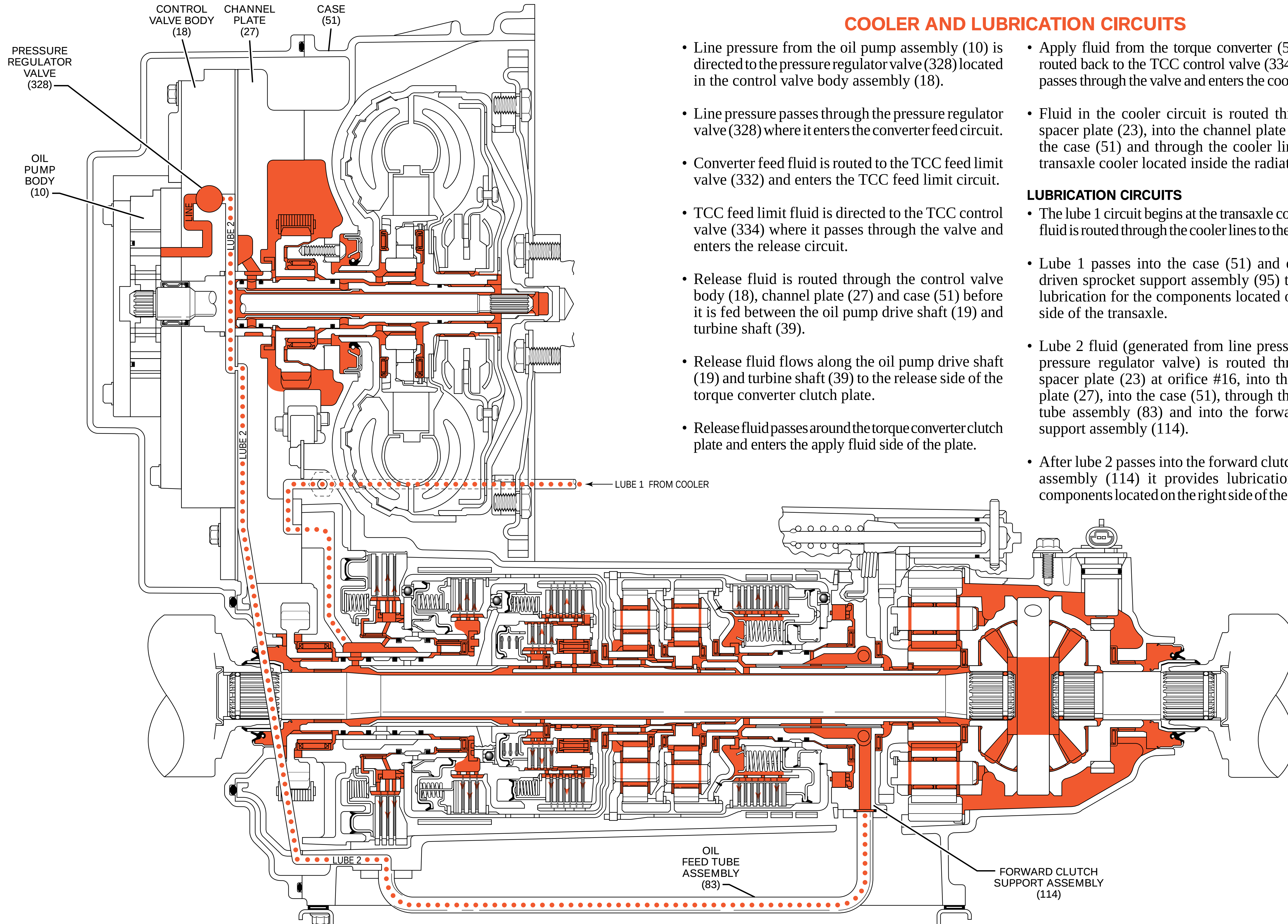
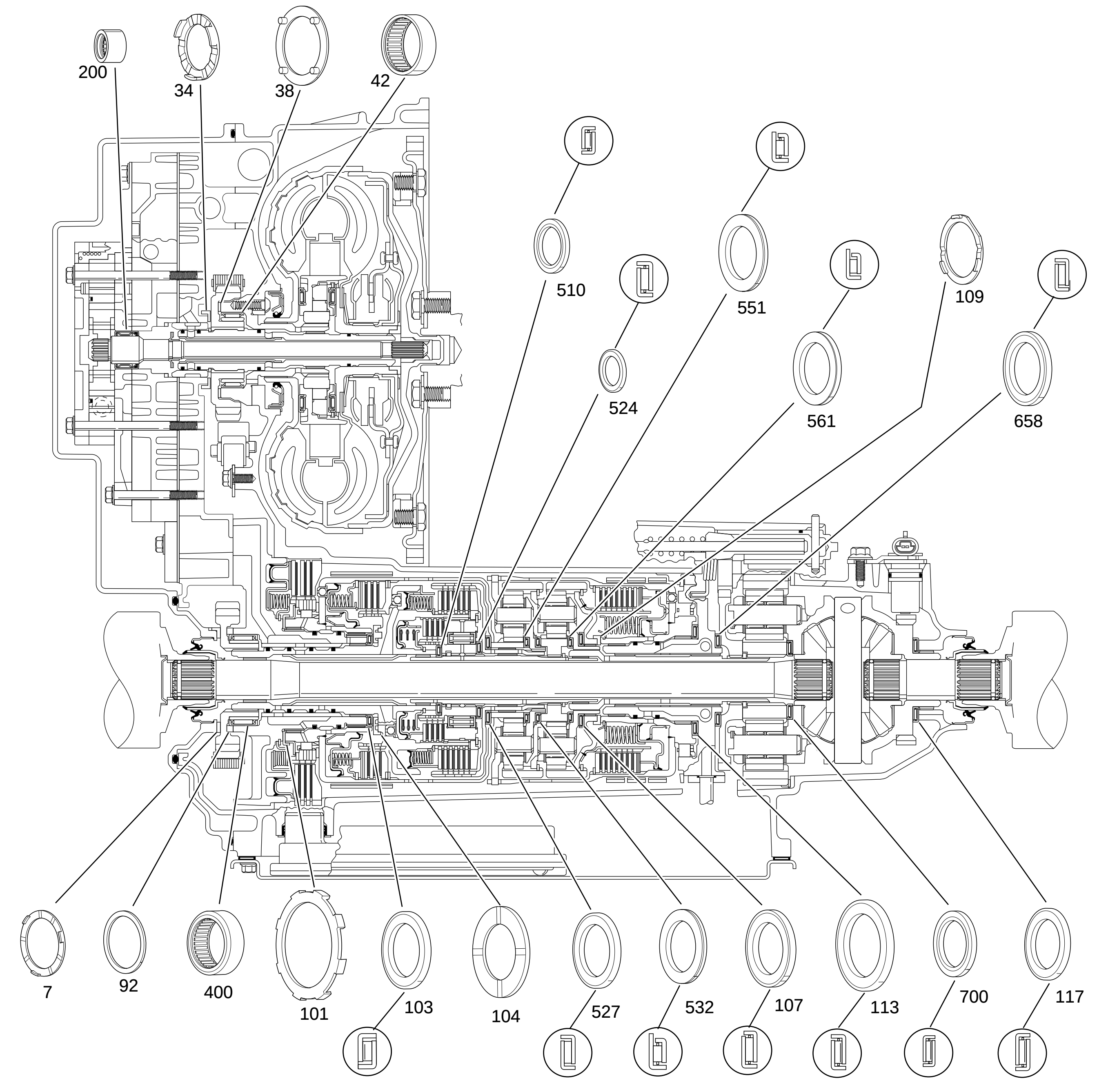


Figure 99

BUSHING, BEARING & WASHER LOCATIONS



7 WASHER, THRUST (SIDE COVER TO DRIVEN SPROCKET)	117 BEARING, THRUST
34 WASHER, THRUST (CHANNEL PLATE TO DRIVE SPROCKET)	200 BEARING & SEAL ASSEMBLY, OIL PUMP
38 WASHER, THRUST (DRIVE SPROCKET TO SUPPORT)	400 BEARING, DRIVEN SPROCKET SUPPORT
42 BEARING, DRIVE SPROCKET SUPPORT	510 BEARING, THRUST
92 WASHER, THRUST (DRIVEN SPROCKET TO SUPPORT)	524 BEARING, THRUST
101 WASHER, THRUST (SUPPORT TO REVERSE INPUT CLUTCH)	527 BEARING, THRUST (CARRIER SHAFT TO SHELL)
103 BEARING, THRUST	532 BEARING, THRUST (REACTION CARRIER TO SUN GEAR)
104 WASHER, THRUST (SELECTIVE)	551 BEARING, THRUST
107 BEARING, THRUST	561 BEARING, THRUST
109 WASHER, THRUST	658 BEARING, THRUST (FORWARD SUPPORT TO PARK GEAR)
113 BEARING, THRUST	700 BEARING, THRUST

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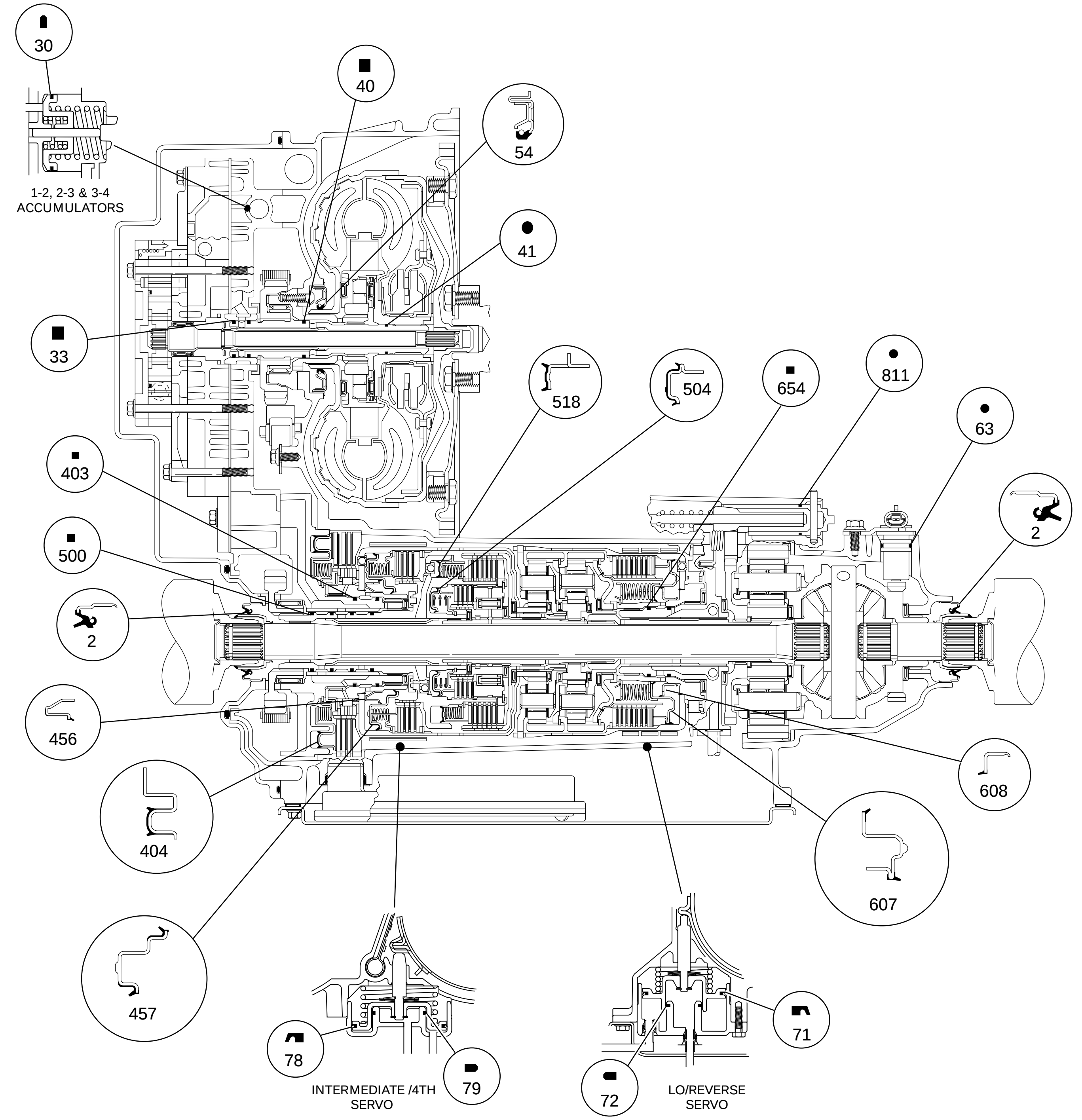
Figure 100

SEAL LOCATIONS



2	SEAL, AXLE OIL	403	RING, OIL SEAL
30	SEAL, ACCUMULATOR PISTON (1-2, 2-3 AND 3-4)	404	PISTON ASSEMBLY, 2ND CLUTCH
39	SHAFT, TURBINE	456	RETAINER & SEAL ASSEMBLY, REVERSE CLUTCH CENTER
40	SEAL, O-RING (TURBINE SHAFT TO SUPPORT)	457	PISTON ASSEMBLY, REVERSE CLUTCH
41	SEAL, O-RING (TORQUE CONVERTER)	500	RING, OIL SEAL - INPUT SHAFT
54	SEAL, CONVERTER	504	PISTON ASSEMBLY, COAST CLUTCH
63	SEAL, O-RING (OUTPUT SPEED SENSOR)	518	PISTON ASSEMBLY, DIRECT CLUTCH
71	SEAL, SERVO PISTON (LO/REVERSE)	607	PISTON ASSEMBLY, FORWARD CLUTCH
72	SEAL, SERVO COVER (LO/REVERSE)	608	SEAL AND SLEEVE ASSEMBLY,FORWARD CLUTCH INNER
78	SEAL, SERVO PISTON (INTERMEDIATE/4TH)	654	RING, OIL SEAL (FORWARD CLUTCH SUPPORT)
79	SEAL, SERVO COVER (INTERMEDIATE/4TH)	811	SEAL, ACTUATOR GUIDE

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Figure 101

ILLUSTRATED PARTS LIST

CASE AND ASSOCIATED PARTS

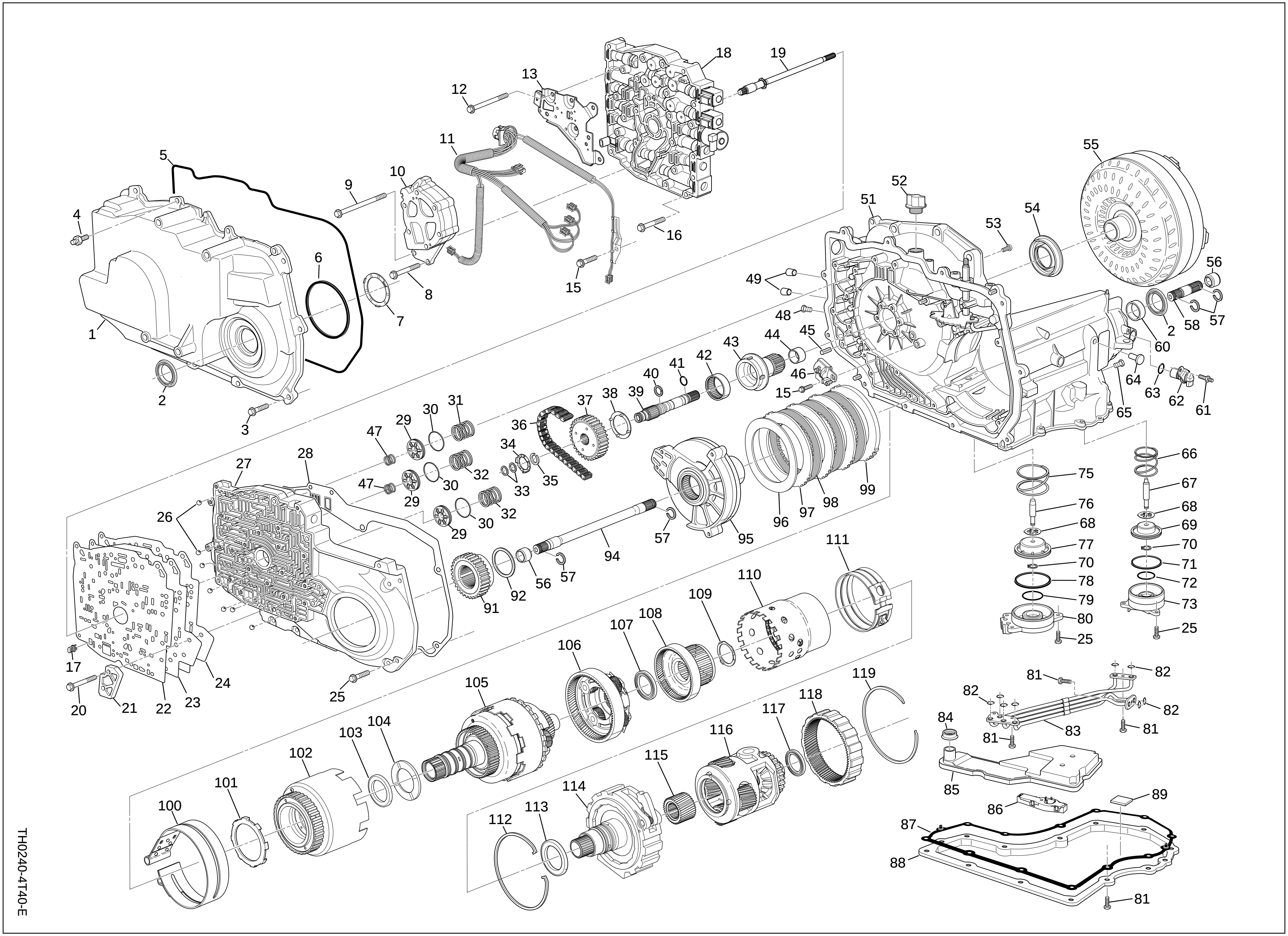

Figure 102

CASE AND ASSOCIATED PARTS

1 COVER, SIDE (STRUCTURAL)
2 SEAL, AXLE OIL
3 BOLT, SIDE COVER
4 STUD, SIDE COVER
5 GASKET, SIDE COVER
6 GASKET, SIDE COVER OIL LEVEL CONTROL
7 WASHER, THRUST (SIDE COVER TO DRIVEN SPROCKET)
8 BOLT, OIL PUMP
9 BOLT, OIL PUMP
10 PUMP ASSEMBLY, TRANSAXLE OIL
11 WIRING ASSEMBLY, TRANSAXLE
12 BOLT, PRESSURE SWITCH ASSEMBLY
13 PRESSURE SWITCH ASSEMBLY (PSA)
15 BOLT, WIRING HARNESS BRACKET
BOLT, INPUT SPEED SENSOR
16 BOLT, VALVE BODY
17 FILTER
18 BODY ASSEMBLY, CONTROL VALVE
19 SHAFT, OIL PUMP DRIVE
20 BOLT, SPACER PLATE SUPPORT
21 SUPPORT, SPACER PLATE
22 GASKET, VALVE BODY TO SPACER PLATE
23 PLATE, VALVE BODY SPACER
24 GASKET, SPACER PLATE TO CHANNEL PLATE
25 BOLT, CHANNEL PLATE
BOLT, SERVO COVER
26 CHECKBALLS (7)
27 PLATE, CHANNEL
28 GASKET, CASE TO CHANNEL PLATE
29 PISTON, ACCUMULATOR (1-2, 2-3 AND 3-4)
30 SEAL, ACCUMULATOR PISTON (1-2, 2-3 AND 3-4)
31 SPRING, 1-2 ACCUMULATOR PISTON
32 SPRING, 2-3 AND 3-4 ACCUMULATOR PISTON
33 SEAL, (TURBINE SHAFT TO CHANNEL PLATE SLEEVE)
34 WASHER, THRUST (CHANNEL PLATE TO DRIVE SPROCKET)
35 RING, SNAP (TURBINE SHAFT TO DRIVE SPROCKET)
36 LINK ASSEMBLY, DRIVE
37 SPROCKET, DRIVE
38 WASHER, THRUST (DRIVE SPROCKET TO SUPPORT)
39 SHAFT, TURBINE
40 SEAL, (TURBINE SHAFT TO SUPPORT)
41 SEAL, O-RING (TORQUE CONVERTER)
42 BEARING, DRIVE SPROCKET SUPPORT
43 SUPPORT, DRIVE SPROCKET
44 BUSHING, DRIVE SPROCKET SUPPORT
45 PIN, DOWEL (CHANNEL PLATE TO CASE)
46 SENSOR, INPUT SPEED
47 SPRINGS, 1-2 AND 2-3 ACCUMULATOR PISTON CUSHION
48 PLUG, LINE PRESSURE TAP
49 SEAL, COOLER PIPE
51 CASE, TRANSAXLE
52 CAP, VENT
53 SCREW, DRIVE SPROCKET SUPPORT
54 SEAL, CONVERTER
55 TORQUE CONVERTER ASSEMBLY
56 SLEEVE, OUTPUT/STUB SHAFT
57 RING, OUTPUT/STUB SHAFT SNAP
58 SHAFT, OUTPUT STUB
60 BUSHING, CASE TO FINAL DRIVE
61 STUD, OUTPUT SPEED SENSOR
62 SENSOR, OUTPUT SPEED
63 SEAL, O-RING (OUTPUT SPEED SENSOR)
64 PIN, BAND ANCHOR - LO/REVERSE
65 PLUG, OIL LEVEL CONTROL
66 SPRING, SERVO RETURN (LO/REVERSE)
67 PIN, SERVO APPLY (LO/REVERSE)
68 SPRING, SERVO CUSHION
69 PISTON, SERVO (LO/REVERSE)
70 RING, SERVO SNAP
71 SEAL, SERVO PISTON (LO/REVERSE)
72 SEAL, SERVO COVER (LO/REVERSE)
73 COVER, SERVO (LO/REVERSE)
75 SPRING, SERVO RETURN (INTERMEDIATE/4TH)
76 PIN, SERVO APPLY (INTERMEDIATE/4TH)
77 PISTON, SERVO (INTERMEDIATE/4TH)
78 SEAL, SERVO PISTON (INTERMEDIATE/4TH)
79 SEAL, SERVO COVER (INTERMEDIATE/4TH)
80 COVER, SERVO (INTERMEDIATE/4TH)
81 BOLT, TUBE ASSEMBLY
BOLT, BOTTOM PAN
82 SEAL, OIL FEED TUBE ASSEMBLY
83 TUBE ASSEMBLY, OIL FEED
84 SEAL, TRANSAXLE OIL FILTER
85 FILTER ASSEMBLY, TRANSAXLE OIL
86 VALVE, OIL LEVEL CONTROL
87 GASKET, TRANSAXLE BOTTOM PAN
88 PAN, TRANSAXLE OIL
89 MAGNET, CHIP COLLECTOR
91 SPROCKET, DRIVEN
92 WASHER, THRUST (DRIVEN SPROCKET TO SUPPORT)
94 SHAFT, OUTPUT
95 SUPPORT ASSEMBLY, DRIVEN SPROCKET
96 PLATE, 2ND CLUTCH WAVED
97 PLATE, 2ND CLUTCH STEEL
98 PLATE, 2ND CLUTCH FIBER
99 PLATE, 2ND CLUTCH BACKING
100 BAND, INTERMEDIATE/4TH
101 WASHER, THRUST (SUPPORT TO REVERSE INPUT CLUTCH)
102 CLUTCH ASSEMBLY, REVERSE INPUT
103 BEARING, THRUST
104 WASHER, THRUST (SELECTIVE)
105 CLUTCH ASSEMBLY, DIRECT & COAST
106 CARRIER ASSEMBLY, INPUT
107 BEARING, THRUST
108 INPUT FLANGE & FORWARD CLUTCH HUB ASSEMBLY
109 WASHER, THRUST
110 CLUTCH ASSEMBLY, FORWARD
111 BAND, LO/REVERSE
112 RING, SNAP (FORWARD CLUTCH SUPPORT TO CASE)
113 BEARING, THRUST
114 SUPPORT ASSEMBLY, FORWARD CLUTCH
115 GEAR, SUN (FINAL DRIVE)
116 DIFFERENTIAL AND FINAL DRIVE ASSEMBLY
117 BEARING, THRUST
118 GEAR, FINAL DRIVE INTERNAL
119 RING, FRETTING (INTERNAL GEAR TO CASE)

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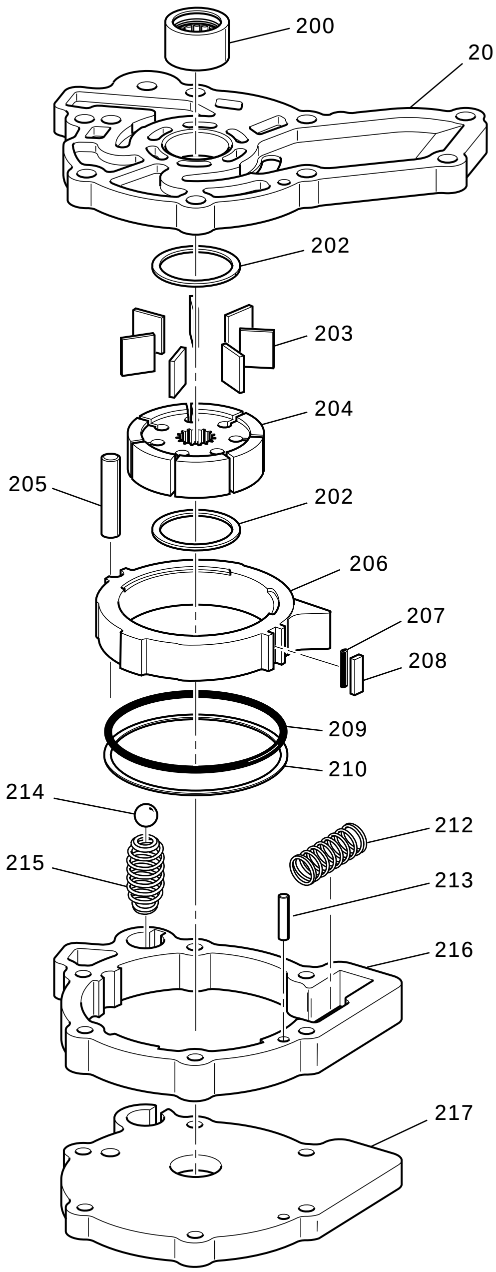
Figure 103

OIL PUMP ASSEMBLY



200 BEARING & SEAL ASSEMBLY, OIL PUMP
201 BASE, OIL PUMP
202 RING, OIL PUMP VANE
203 VANE, OIL PUMP
204 ROTOR, OIL PUMP
205 PIN, PIVOT (OIL PUMP SLIDE)
206 SLIDE, OIL PUMP
207 SUPPORT, OIL PUMP SLIDE SEAL
208 SEAL, OIL PUMP SLIDE
209 SEAL, O-RING (OIL PUMP SLIDE)
210 RING, FLUID SEAL (SLIDE TO BODY)
212 SPRING, OIL PUMP PRIMING
213 PIN, LOCATING
214 BALL, PRESSURE RELIEF
215 SPRING, PRESSURE RELIEF
216 BODY, OIL PUMP
217 COVER, PUMP

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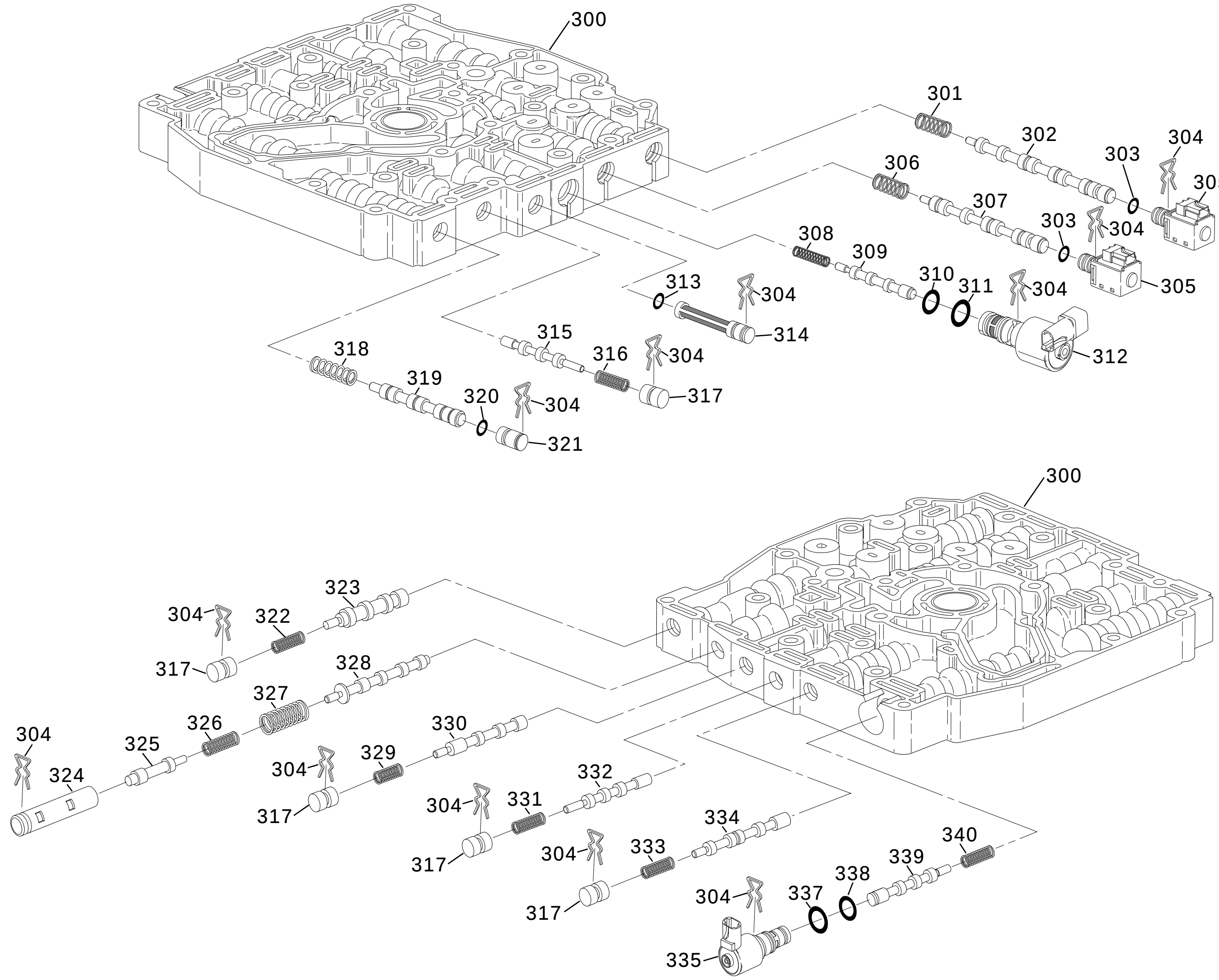
Figure 104

CONTROL VALVE ASSEMBLY



300 BODY, CONTROL VALVE ASSEMBLY
301 SPRING, 1-2 SHIFT VALVE
302 VALVE, 1-2 SHIFT
303 O-RING, SHIFT SOLENOID A AND B
304 RETAINER CLIP
305 SOLENOID, SHIFT (A AND B)
306 SPRING, 2-3 SHIFT VALVE
307 VALVE, 2-3 SHIFT
308 SPRING, TORQUE SIGNAL REGULATOR VALVE
309 VALVE, TORQUE SIGNAL REGULATOR
310 O-RING, PRESSURE CONTROL SOLENOID
311 O-RING, PRESSURE CONTROL SOLENOID
312 SOLENOID, PRESSURE CONTROL
313 O-RING, ACTUATOR OIL FILTER
314 FILTER, ACTUATOR OIL
315 VALVE, ACTUATOR FEED LIMIT
316 SPRING, ACTUATOR FEED LIMIT VALVE
317 PLUG, BORE
318 SPRING, 3-4 SHIFT VALVE
319 VALVE, 3-4 SHIFT
320 O-RING, 3-4 SHIFT VALVE PLUG
321 PLUG, BORE
322 SPRING, 1-2/3-4 ACCUMULATOR VALVE
323 VALVE, 1-2/3-4 ACCUMULATOR
324 BUSHING, PRESSURE REGULATOR BOOST
325 VALVE, PRESSURE REGULATOR BOOST
326 SPRING, ISOLATOR
327 SPRING, PRESSURE REGULATOR VALVE
328 VALVE, PRESSURE REGULATOR
329 SPRING, 2-3 ACCUMULATOR VALVE
330 VALVE, 2-3 ACCUMULATOR
331 SPRING, TCC FEED LIMIT VALVE
332 VALVE, TCC FEED LIMIT
333 SPRING, TCC CONTROL VALVE
334 VALVE, TCC CONTROL
335 SOLENOID, TCC CONTROL
337 O-RING, TCC CONTROL SOLENOID
338 O-RING, TCC CONTROL SOLENOID
339 VALVE, TCC REGULATED APPLY
340 SPRING, TCC REGULATED APPLY VALVE

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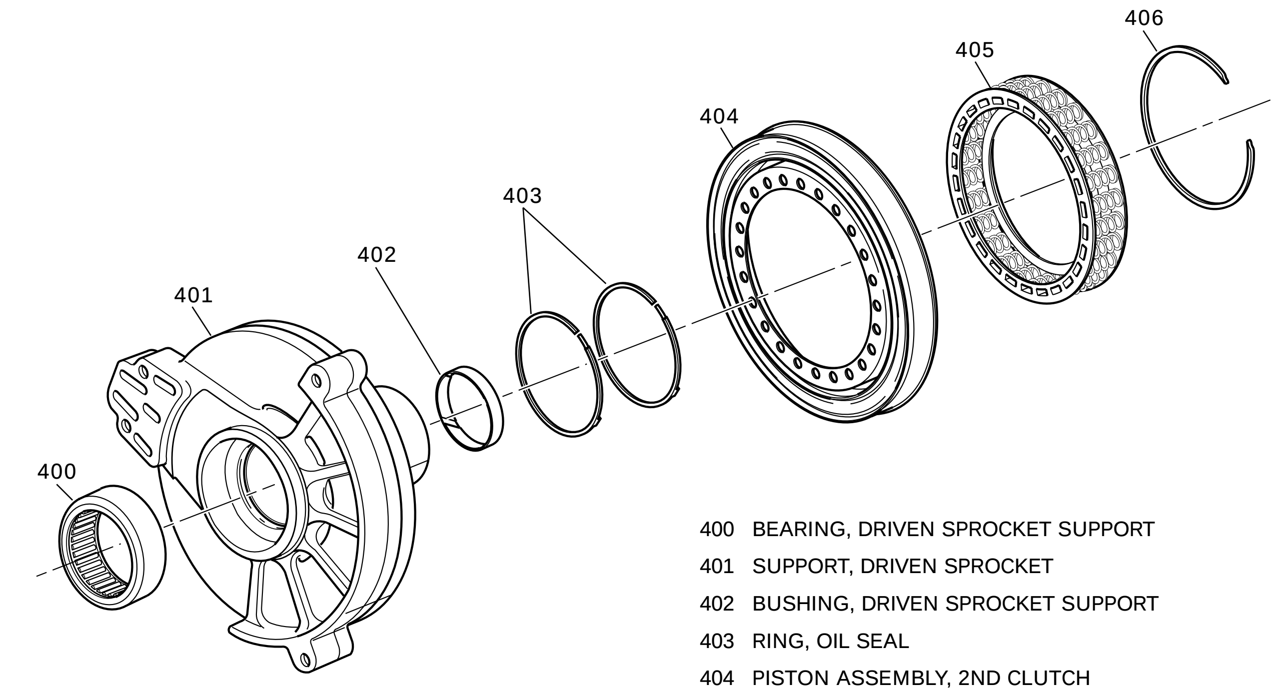
Figure 105

DRIVEN SPROCKET SUPPORT ASSEMBLY/2ND CLUTCH



400 BEARING, DRIVEN SPROCKET SUPPORT
401 SUPPORT, DRIVEN SPROCKET
402 BUSHING, DRIVEN SPROCKET SUPPORT
403 RING, OIL SEAL
404 PISTON ASSEMBLY, 2ND CLUTCH
405 SPRING ASSEMBLY, 2ND CLUTCH
406 RING, 2ND CLUTCH SPRING RETAINING

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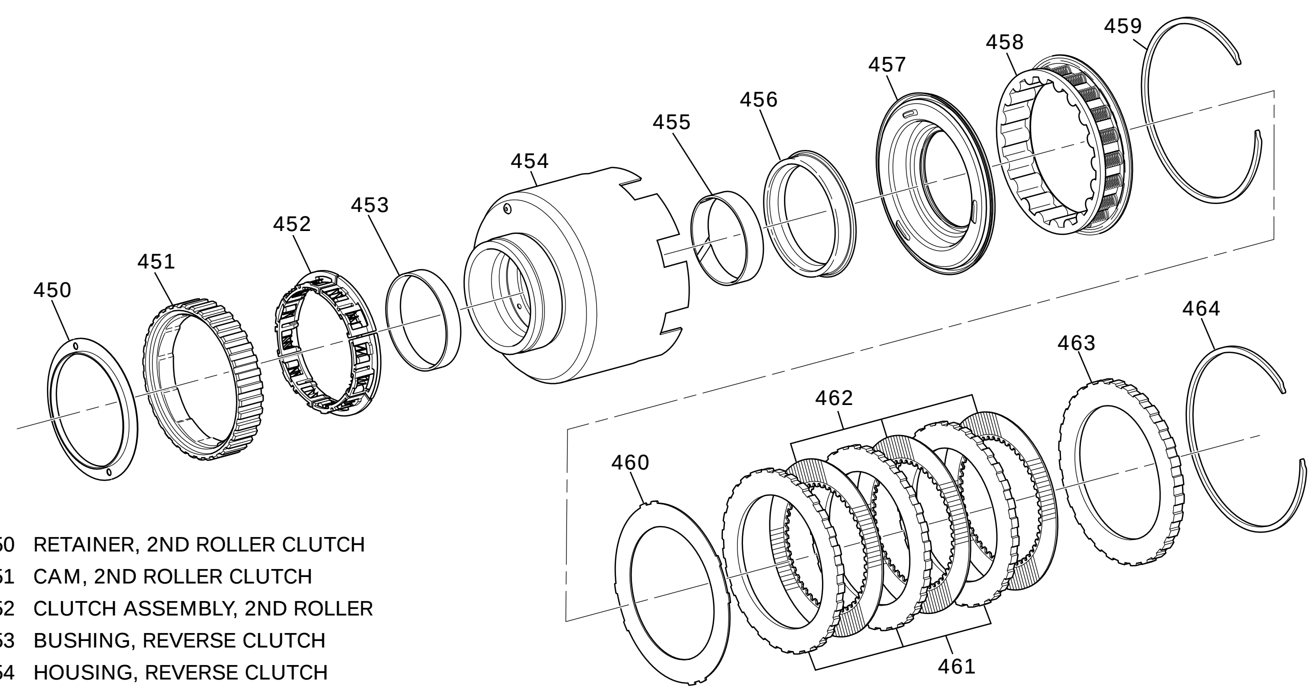
Figure 106

REVERSE INPUT CLUTCH ASSEMBLY



450 RETAINER, 2ND ROLLER CLUTCH
451 CAM, 2ND ROLLER CLUTCH
452 CLUTCH ASSEMBLY, 2ND ROLLER
453 BUSHING, REVERSE CLUTCH
454 HOUSING, REVERSE CLUTCH
455 BUSHING, REVERSE CLUTCH
456 RETAINER & SEAL ASSEMBLY, REVERSE CLUTCH CENTER
457 PISTON ASSEMBLY, REVERSE CLUTCH
458 SPRING & RETAINER ASSEMBLY, REVERSE CLUTCH
459 RING, SNAP (REVERSE CLUTCH SPRING RETAINER)
460 PLATE, REVERSE CLUTCH (WAVED)
461 PLATE, REVERSE CLUTCH (STEEL)
462 PLATE, REVERSE CLUTCH (FIBER)
463 PLATE, REVERSE CLUTCH (BACKING)
464 RING, SNAP (REVERSE CLUTCH)

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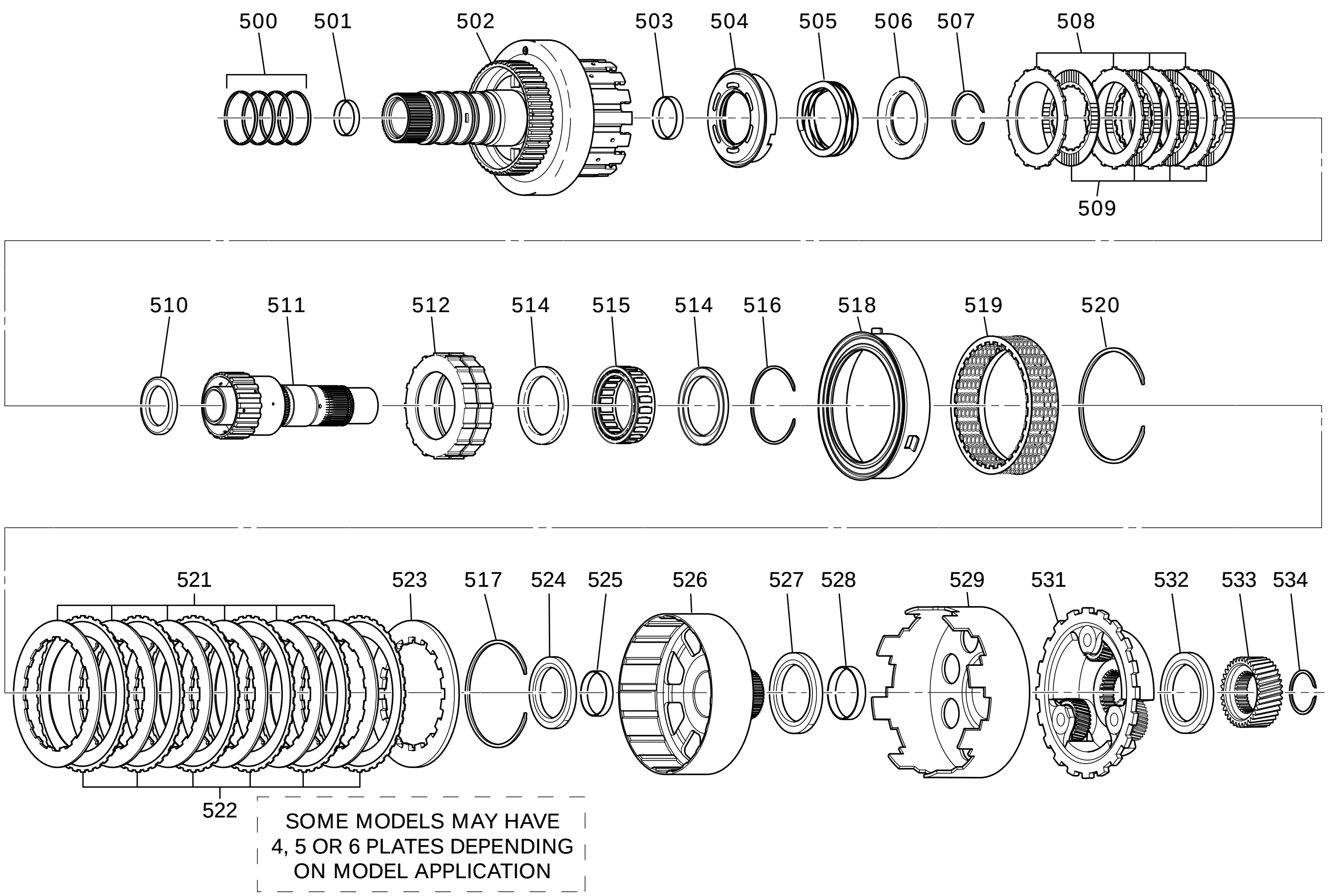
Figure 107

DIRECT AND COAST CLUTCH ASSEMBLIES



500 RING, OIL SEAL - INPUT SHAFT
501 BUSHING, INPUT SHAFT
502 HOUSING, DIRECT & COAST CLUTCH AND INPUT SHAFT
503 BUSHING, DIRECT CLUTCH HOUSING TO OUTPUT SHAFT
504 PISTON ASSEMBLY, COAST CLUTCH
505 SPRING, COAST CLUTCH RELEASE
506 RETAINER, COAST CLUTCH SPRING
507 RING, SNAP (COAST CLUTCH SPRING RETAINER)
508 PLATE, COAST CLUTCH (STEEL)
509 PLATE, COAST CLUTCH (FIBER)
510 BEARING, THRUST
511 SHAFT AND INNER RACE ASSEMBLY, INPUT SUN GEAR
512 RACE, OUTER (INPUT SPRAG)
514 END BEARINGS, SPRAG CLUTCH (2)
515 SPRAG ASSEMBLY, INPUT
516 RING, SNAP (OUTER RACE TO SPRAG ASSEMBLY)
517 RING, SNAP (DIRECT/COAST CLUTCH RETAINING)
518 PISTON ASSEMBLY, DIRECT CLUTCH
519 SPRING AND RETAINER ASSEMBLY, DIRECT CLUTCH
520 RING, DIRECT CLUTCH SPRING RETAINER
521 PLATE, DIRECT CLUTCH (STEEL)
522 PLATE, DIRECT CLUTCH (FIBER)
523 PLATE, DIRECT CLUTCH (BACKING)
524 BEARING, THRUST
525 BUSHING, REACTION CARRIER SHAFT
526 SHELL, REACTION CARRIER SHAFT
527 BEARING, THRUST (CARRIER SHAFT TO SHELL)
528 BUSHING, REACTION SUN GEAR
529 SHELL, REACTION SUN
531 CARRIER ASSEMBLY, REACTION
532 BEARING, THRUST (REACTION CARRIER TO SUN GEAR)
533 GEAR, INPUT SUN
534 RING, SNAP

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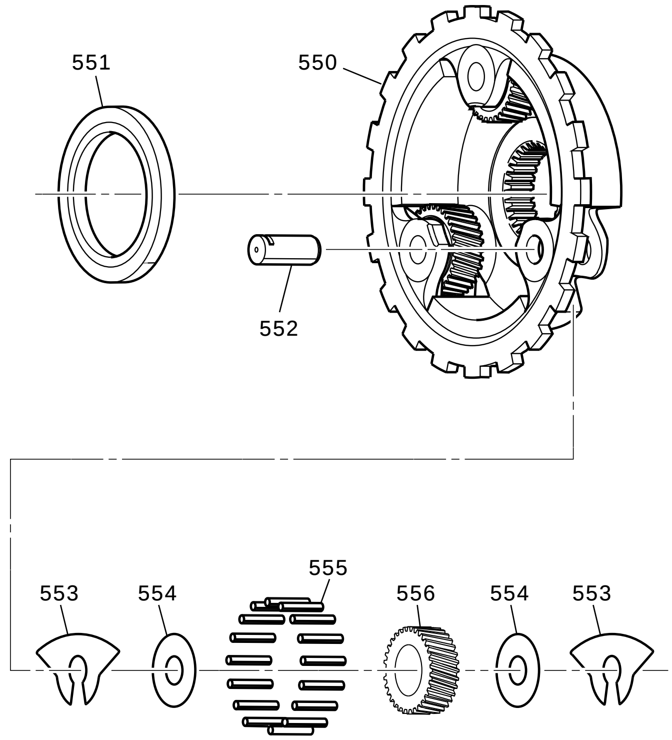
Figure 108

REACTION CARRIER ASSEMBLY



550 CARRIER, REACTION
551 BEARING, THRUST
552 PIN, PLANET PINION
553 WASHER, PINION THRUST REACTION
554 WASHER, PINION THRUST INNER
555 ROLLER NEEDLE BEARING
556 GEAR, REACTION PLANET PINION

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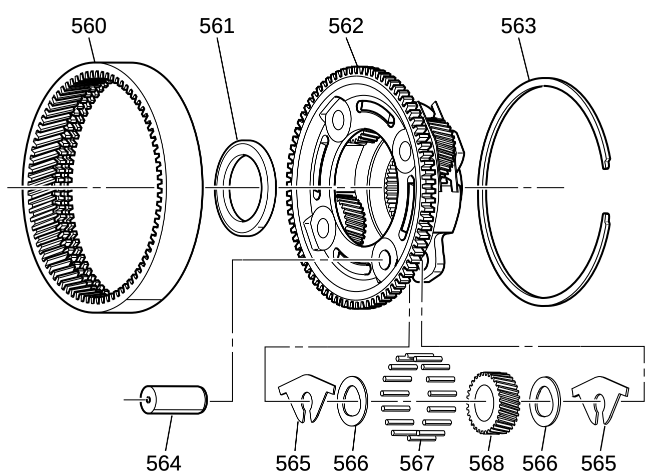
Figure 109

INPUT CARRIER ASSEMBLY

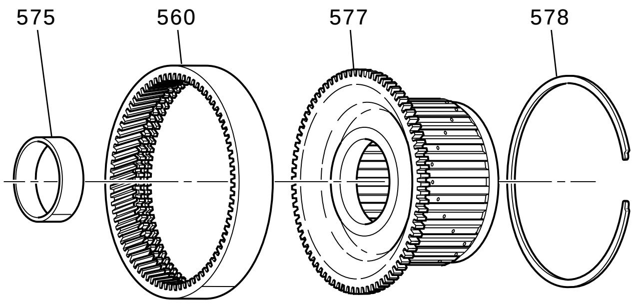


560 GEAR, INTERNAL (INPUT AND REACTION)
561 BEARING, THRUST
562 CARRIER, INPUT
563 RING, SNAP (INPUT CARRIER TO INTERNAL GEAR)
564 PIN, PLANET PINION
565 WASHER, PINION THRUST INPUT
566 WASHER, PINION THRUST INNER
567 ROLLER NEEDLE BEARING
568 GEAR, PINION

SH0248-4T40-E

Figure 110

INPUT INTERNAL GEAR AND FORWARD CLUTCH HUB

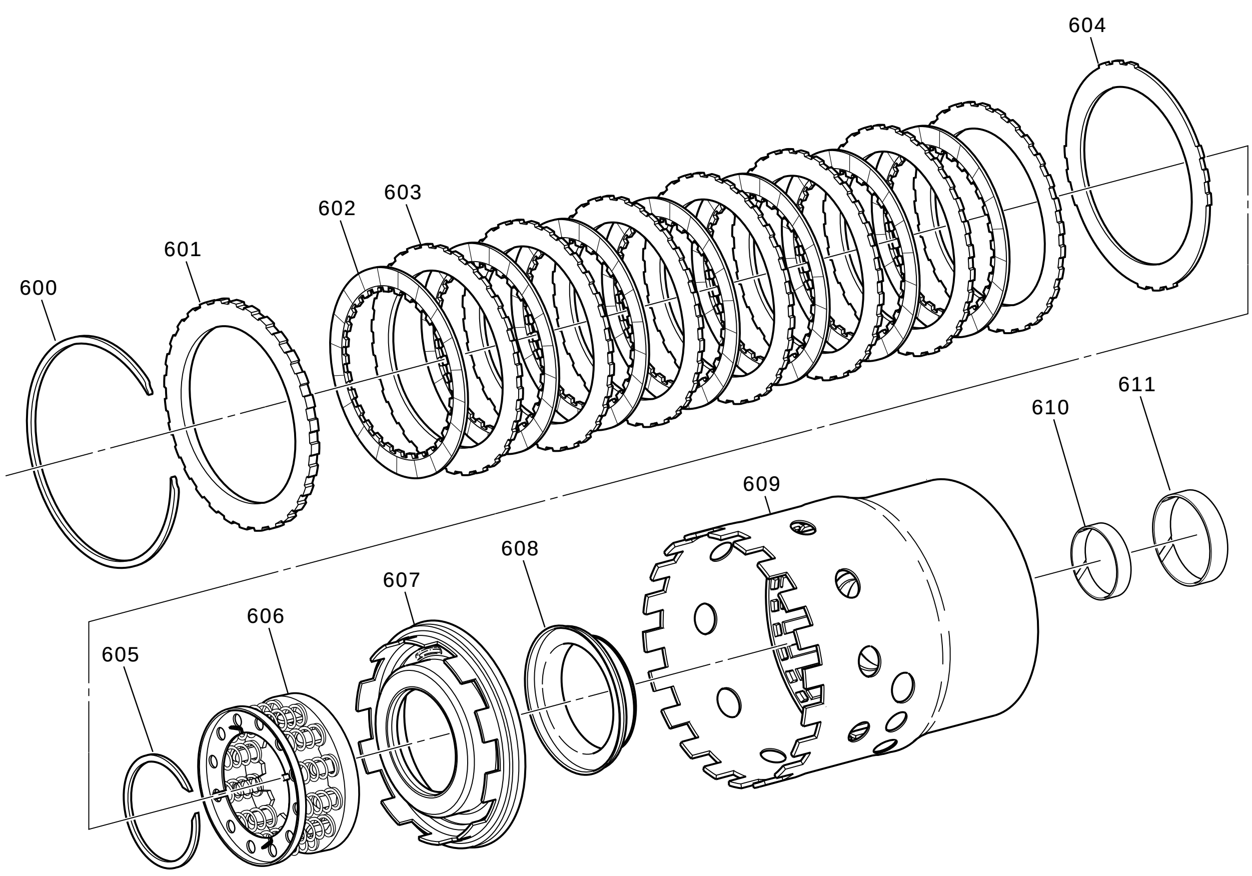


575 BUSHING, INPUT FLANGE
560 GEAR, INTERNAL (INPUT AND REACTION)
577 INPUT FLANGE AND FORWARD CLUTCH HUB
578 RING, SNAP (INPUT INTERNAL GEAR TO INPUT FLANGE)

SH0249-4T40-E

Figure 111

FORWARD CLUTCH ASSEMBLY



600 RING, SNAP (FORWARD CLUTCH)
601 PLATE, FORWARD CLUTCH (BACKING)
602 PLATE, FORWARD CLUTCH (FIBER)
603 PLATE, FORWARD CLUTCH (STEEL)
604 PLATE, FORWARD CLUTCH (WAVED)
605 RING, SNAP (FORWARD CLUTCH SPRING ASSEMBLY)
606 SPRING ASSEMBLY, FORWARD CLUTCH RETURN
607 PISTON ASSEMBLY, FORWARD CLUTCH
608 SEAL AND SLEEVE ASSEMBLY,FORWARD CLUTCH INNER
609 HOUSING, FORWARD CLUTCH
610 BUSHING, FORWARD CLUTCH SUPPORT
611 BUSHING, FORWARD CLUTCH SUPPORT

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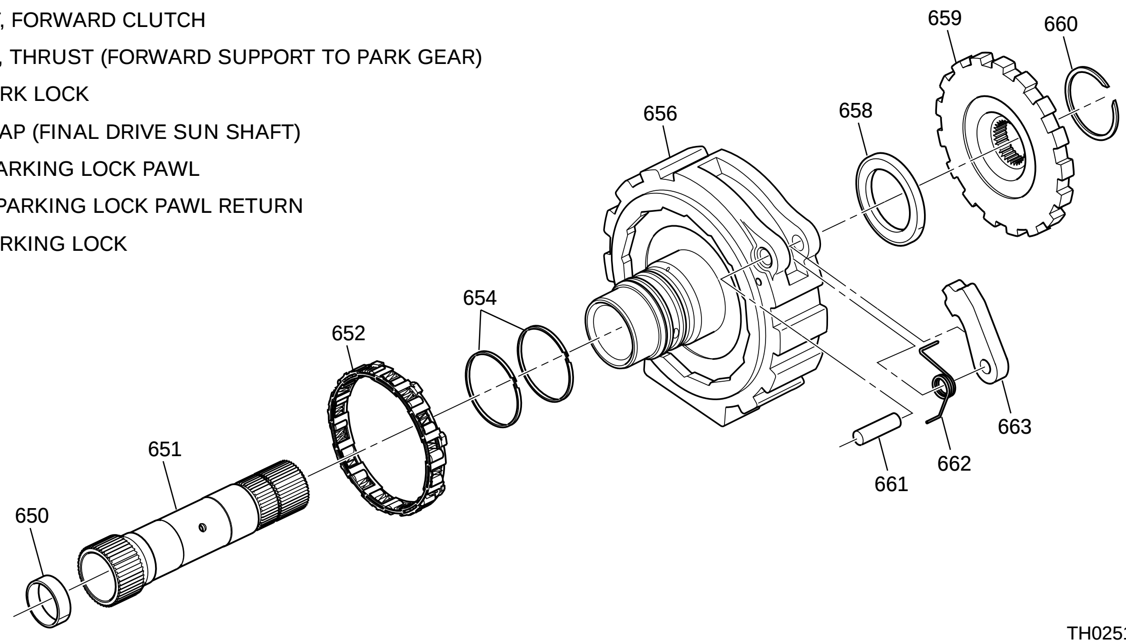
Figure 112

FORWARD CLUTCH SUPPORT ASSEMBLY

650 BUSHING, FINAL DRIVE SUN SHAFT
651 SHAFT, FINAL DRIVE SUN
652 CLUTCH ASSEMBLY, LO ROLLER
653 BEARING, THRUST
654 RING, OIL SEAL (FORWARD CLUTCH SUPPORT)
656 SUPPORT, FORWARD CLUTCH
658 BEARING, THRUST (FORWARD SUPPORT TO PARK GEAR)
659 GEAR, PARK LOCK
660 RING, SNAP (FINAL DRIVE SUN SHAFT)
661 SHAFT, PARKING LOCK PAWL
662 SPRING, PARKING LOCK PAWL RETURN
663 PAWL, PARKING LOCK

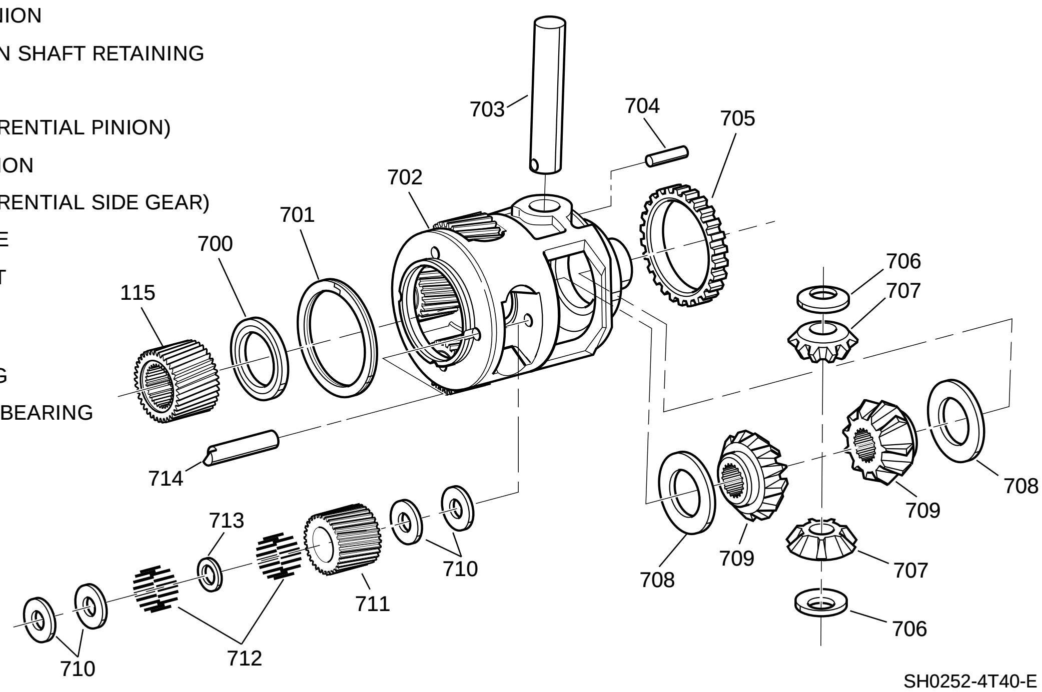


TH0251-4T40-E

Figure 113

FINAL DRIVE AND DIFFERENTIAL ASSEMBLY

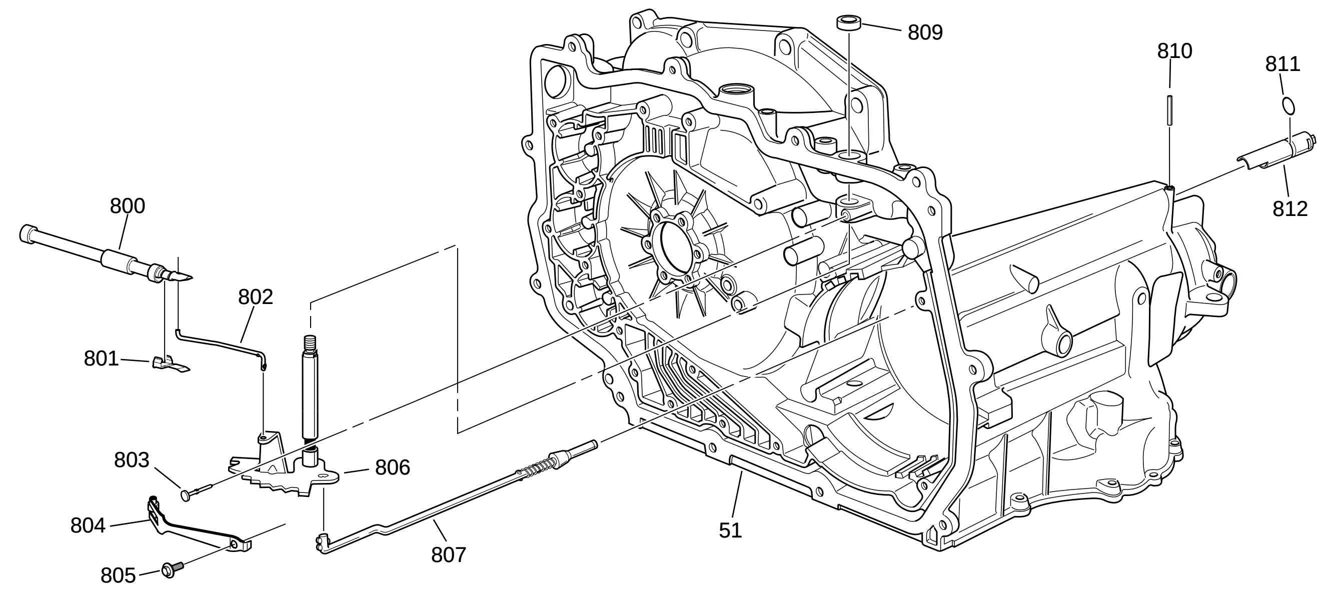
700 BEARING, THRUST
701 RING, SPIRAL PIN RETAINING
702 CARRIER, DIFFERENTIAL & FINAL DRIVE
703 SHAFT, DIFFERENTIAL PINION
704 PIN, DIFFERENTIAL PINION SHAFT RETAINING
705 ROTOR, SPEED SENSOR
706 WASHER, THRUST (DIFFERENTIAL PINION)
707 GEAR, DIFFERENTIAL PINION
708 WASHER, THRUST (DIFFERENTIAL SIDE GEAR)
709 GEAR, DIFFERENTIAL SIDE
710 WASHER, PINION THRUST
711 GEAR, PINION (FINAL DRIVE PLANET)
712 ROLLER NEEDLE BEARING
713 SPACER, PINION NEEDLE BEARING
714 PIN, PLANET PINION



SH0252-4T40-E

Figure 114

MANUAL SHAFT, PARKING PAWL AND ACTUATOR ASSEMBLY



51 CASE, TRANSAXLE
800 VALVE, MANUAL
801 CLIP, MANUAL VALVE TO LINK
802 LINK, MANUAL VALVE TO DETENT LEVER
803 PIN, MANUAL SHAFT TO CASE
804 SPRING AND ROLLER ASSEMBLY, MANUAL DETENT
805 BOLT, SPRING AND ROLLER ASSEMBLY TO CHANNEL PLATE
806 MANUAL SHAFT AND DETENT LEVER ASSEMBLY
807 PARKING LOCK ACTUATOR ASSEMBLY
809 SEAL, MANUAL SHAFT TO CASE
810 PIN, SPRING (ACTUATOR GUIDE)
811 SEAL, ACTUATOR GUIDE
812 ACTUATOR GUIDE

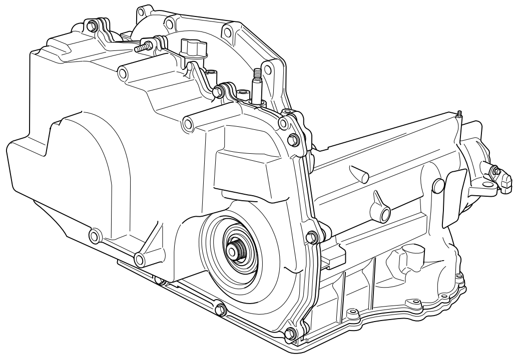
TH0253-4T40-E

Figure 115

HYDRA-MATIC 4T40-E TRANSAXLE

RPO MN4

Produced at: Windsor, Ontario
Canada



HYDRA-MATIC 4T40-E
(FOUR-SPEED)

Vehicles used in:

	CHEVROLET	PONTIAC
J Body	CAVALIER	SUNFIRE

Current GM NAO Vehicle Platforms
J

Current Engine Range
2.4L Gasoline

Transaxle Drive
Transverse Front Wheel Drive

Transaxle Type
4T40-E = 4: Four Speed
T: Transverse Mount
40: Product Series
E: Electronically Controlled

Automatic Overdrive with a Torque Converter Clutch Assembly.

Gear Ratios

1st	2.960
2nd	1.626
3rd	1.000
4th	0.681
Rev	2.143

Maximum Gross Vehicle Weight
1,860 Kg (4,100 LB)

Transaxle Fluid Capacity (Approximate)
Bottom Pan Removal: 7.0L (7.4 qt)
Complete Overhaul: 9.5L (10.0 qt)
Dry: 12.7L (13.4 qt)

Transaxle Fluid Type
Dexron®-III

Transaxle Weight
Dry: 74.7 Kg (164 LB)
Wet: 85.0 Kg (187 LB)

Converter Size
245 mm (Reference)
(Diameter of Torque Converter Turbine)

Seven Position Quadrant
(P, R, N, OD , 3, 2, 1)

Pressure Taps Available
Line Pressure

Case Material
Die Cast Aluminum

Chain Ratios*	35/35	33/37	32/38
Final Drive Ratios	**Overall Final Drive Ratios Available**		
3.05	3.05	3.42	3.63
3.29	3.29	3.69	3.91

*Designates the number of teeth on the drive/driven sprockets, respectively.

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. "40"), 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 4T40-E is a 4-speed, transversely mounted, 40 series unit, with electronic controls.

HYDRA-MATIC 4T40-E

HYDRA-MATIC	4	T	40	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

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GLOSSARY OF TECHNICAL TERMS

Accumulator: A component of the transaxle that absorbs hydraulic pressure during the apply of 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 transaxle (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).

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.

Checkball: 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.

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 transaxle.

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 transaxle) 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).

GLOSSARY OF TECHNICAL TERMS

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 a race and a cam.

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: An electronic device used to control transaxle 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/ - Air Conditioning
ACC or ACCUM - Accumulator
ACT FD - Actuator Feed (circuit)
APP - Apply
ASM - Assembly

BD - Band

°C - Degrees Celsius
CL - Clutch
CONV - Converter
CST CL - Coast Clutch (circuit)
CTS - Coolant Temperature Switch

DCF - Direct Clutch Feed (circuit)
DLC - Diagnostic Link Connector
DR - Drive (circuit)
DTC - Diagnostic Trouble Code
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

INT BAND - Intermediate Band (circuit)
INT BD FD - Intermediate Band Feed (circuit)

KMH - Kilometers Per Hour
kPa - KiloPascals

LBS. FT. - Pounds Foot
LBS. IN. - Pounds Inch
LIM - Limit (circuit)

MAF - Mass Air Flow Sensor
MAP - Manifold Absolute Pressure Sensor
MM - Millimeter(s)
MPH - Miles Per Hour

N - Neutral
N.C. - Normally Closed
N.m - Newton Meters
N.O. - Normally Open

P - Park
PCM - Powertrain Control Module
PCS - Pressure Control Solenoid
PRESS REG - Pressure Regulator
PRN - Park, Reverse, Neutral (circuit)
PRND4 - Park, Reverse, Neutral, Drive 4 (circuit)
PSA - Pressure Switch Assembly
PSI - Pounds per Square Inch
PWM - Pulse Width Modulated

R - Reverse
REG - Regulated (circuit)
REL - Release (circuit)
REV - Reverse
RPM - Revolutions per Minute

SIG - Signal
SOL - Solenoid

TCC - Torque Converter Clutch
TCC R APP - TCC Regulated Apply (circuit)
TFT - Transaxle Fluid Temperature Sensor
TISS - Transaxle Input Speed Sensor
TOSS - Transaxle Output Speed Sensor
TPS - Throttle Position Sensor
TRANS - Transaxle or Transmission
T SIG - Torque Signal
T SIG (PWM) - Torque Signal (PWM)

V - Volts
VSS - Vehicle Speed Sensor

2ND CL - Second Clutch

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