GM POWERTRAIN

4T65-E

HYDRA-MATIC

CONTENTS

INTRODUCTION 3
HOW TO USE THIS BOOK 4
UNDERSTANDING THE GRAPHICS 6
TRANSMISSION CUTAWAY VIEW (FOLDOUT) 8
GENERAL DESCRIPTION 9
PRINCIPLES OF OPERATION 9A
- MAJOR MECHANICAL COMPONENTS (FOLDOUT) 10
- RANGE REFERENCE CHART 11
- TORQUE CONVERTER 12
- APPLY COMPONENTS 15
- PLANETARY GEAR SETS 27
- HYDRAULIC CONTROL COMPONENTS 33
- ELECTRICAL COMPONENTS 45

POWER FLOW 53
COMPLETE HYDRAULIC CIRCUITS 81
LUBRICATION POINTS 104
THRUST WASHER LOCATIONS 105
BUSHING LOCATIONS 106
BEARING LOCATIONS 107
LIP SEAL LOCATIONS 108
SQUARE AND O-RING SEAL LOCATIONS 109
GASKET LOCATIONS 110
ILLUSTRATED PARTS LIST 111
BASIC SPECIFICATIONS 122
PRODUCT DESIGNATION SYSTEM 123
GLOSSARY 124
ABBREVIATIONS 126
INDEX 127

PREFACE

The Hydra-matic 4T65-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 4T65-E Technician's Guide is also intended to assist technicians during the service, diagnosis and repair of this transaxle. However, this book is not intended to be a substitute for other General Motors service publications that are normally used on the job. Since there is a wide range of repair procedures and technical specifications specific to certain vehicles and transaxle models, the proper service publication must be referred to when servicing the Hydra-matic 4T65-E transaxle.

© COPYRIGHT 1997 POWERTRAIN GROUP
General Motors Corporation

ALL RIGHTS RESERVED

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.

No part of any GM Powertrain publication may be reproduced, stored in any retrieval system or transmitted in any form or by any means, including but not limited to electronic, mechanical, photocopying, recording or otherwise, without the prior written permission of Powertrain Group of General Motors Corporation. This includes all text, illustrations, tables and charts.

INTRODUCTION

The Hydra-matic 4T65-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 4T65-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 4T65-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 4T65-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.

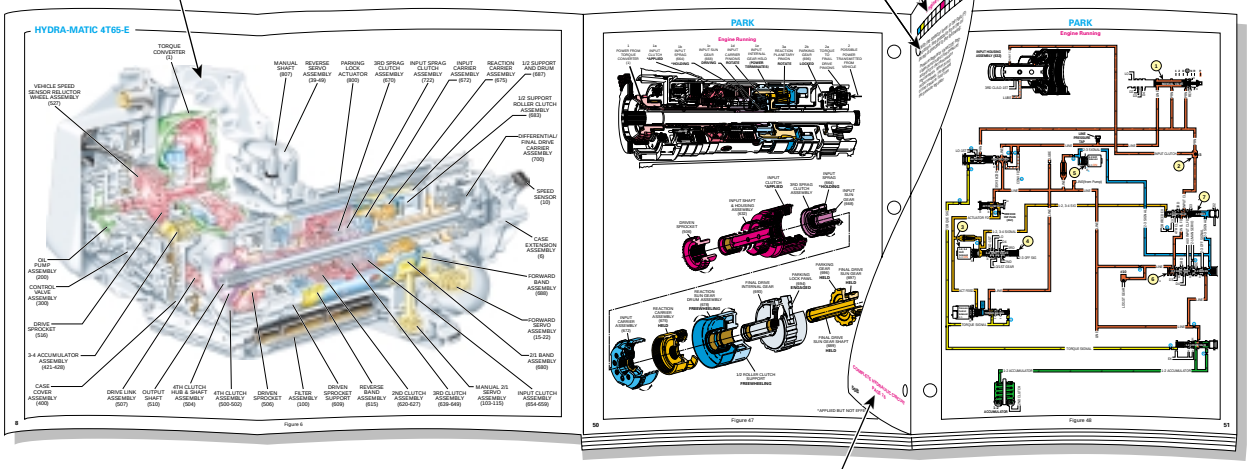
- The Principles of Operation section (beginning on page 9A) presents information regarding the major apply components and hydraulic control components used in this transaxle. This section describes "how" specific components work and interfaces with the sections that follow.

- 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



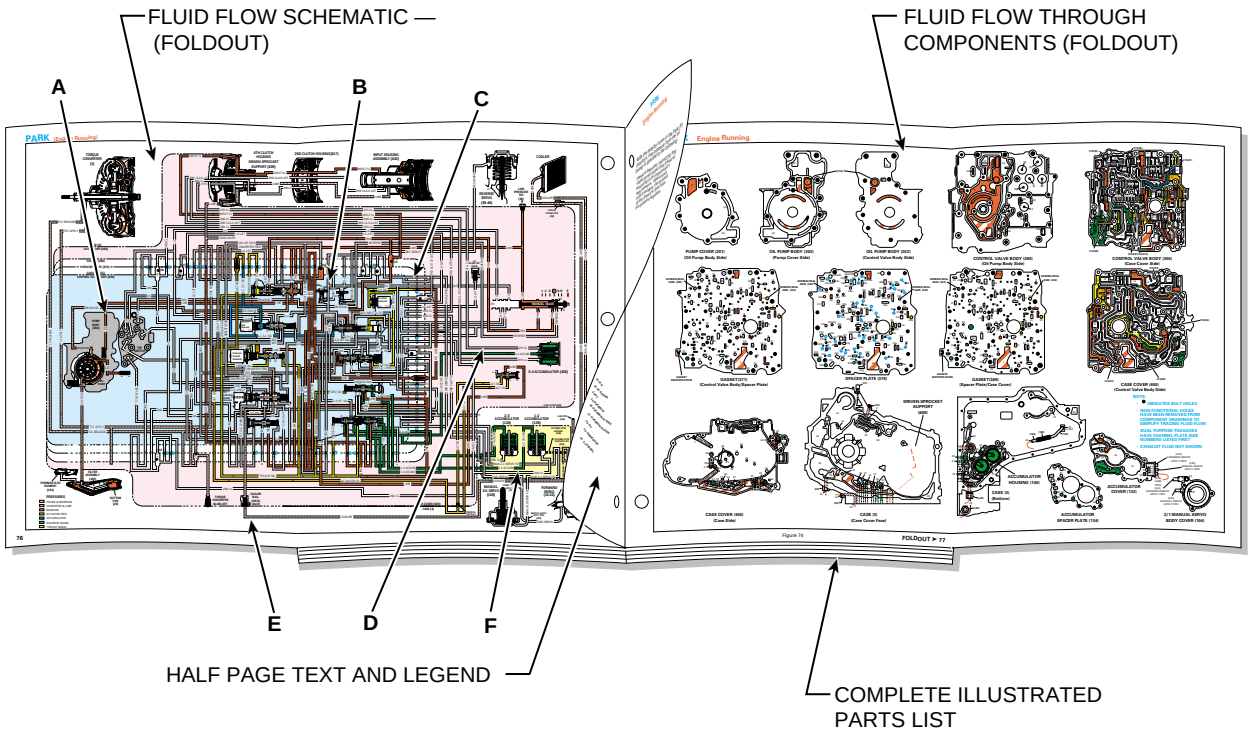


Figure 1

UNDERSTANDING THE GRAPHICS

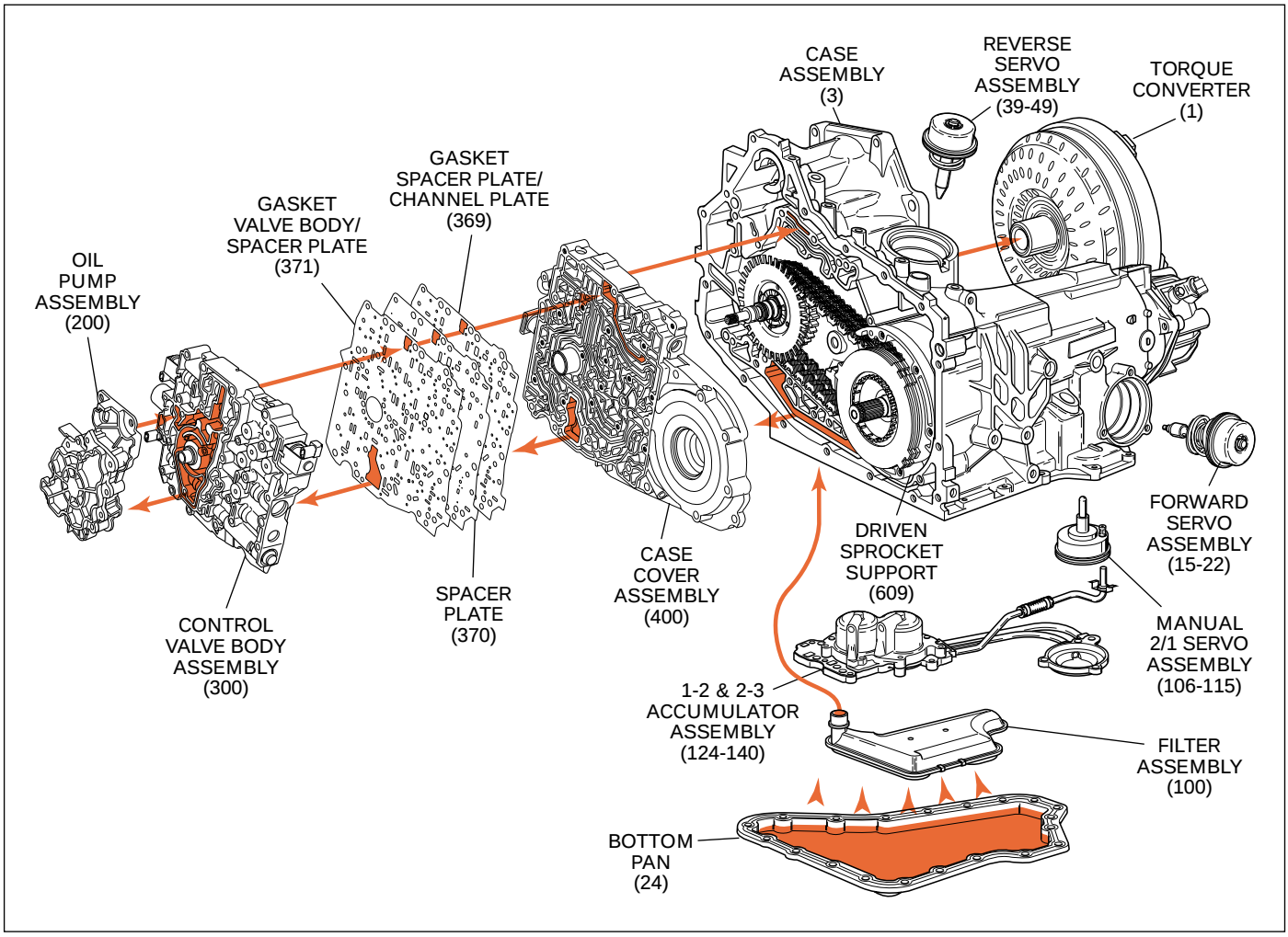


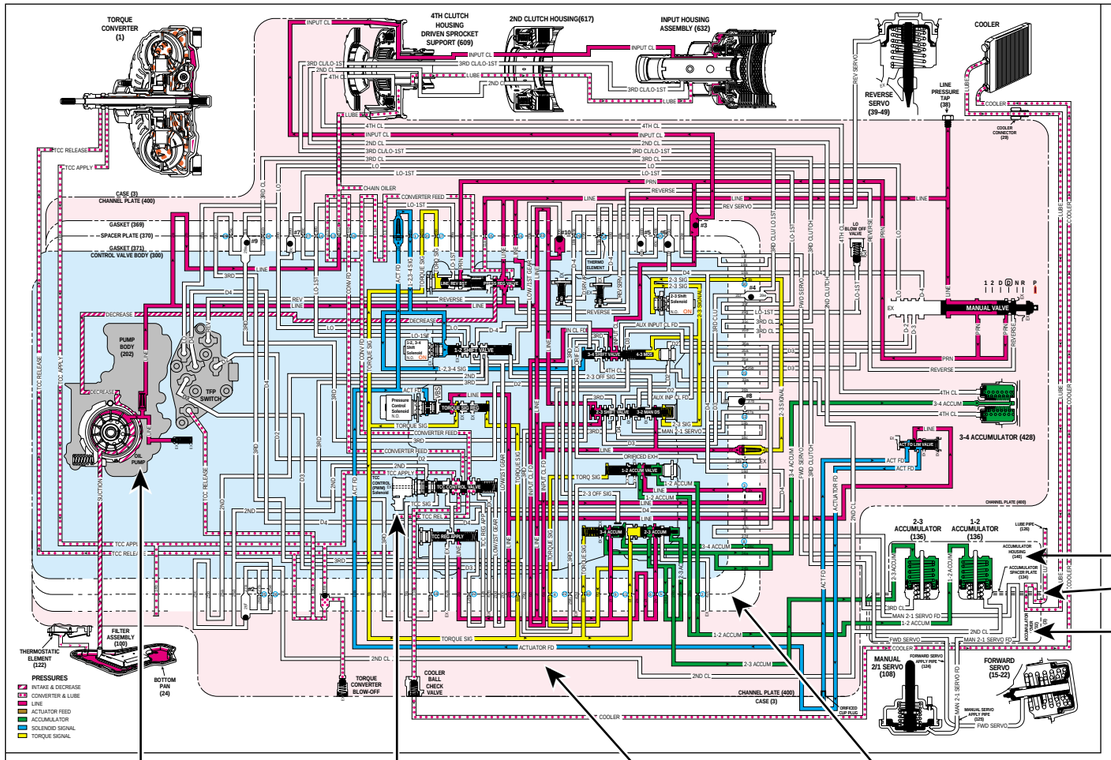
Figure 2

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 oil pump assembly. This is a basic concept of fluid flow that can be 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 4T65-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:

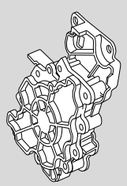
- A three dimensional line drawing of the component for easier part identification.
- A two dimensional line drawing of the component to indicate fluid passages and orifices.
- A graphic schematic representation that displays valves, checkballs, orifices and so forth, required for the proper function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

UNDERSTANDING THE GRAPHICS



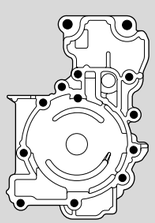
GRAPHIC SCHEMATIC REPRESENTATION

OIL PUMP BODY (202)



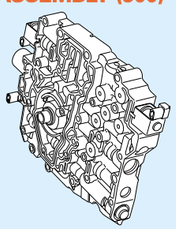
THREE DIMENSIONAL

PUMP COVER SIDE



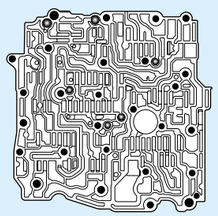
TWO DIMENSIONAL

CONTROL VALVE BODY ASSEMBLY (300)



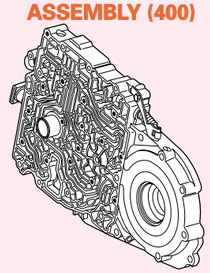
THREE DIMENSIONAL

CASE COVER SIDE



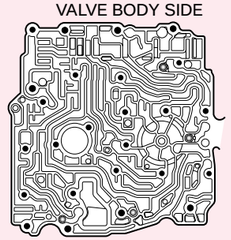
TWO DIMENSIONAL

CASE COVER ASSEMBLY (400)



THREE DIMENSIONAL

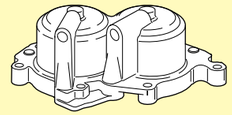
VALVE BODY SIDE



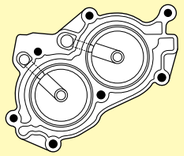
TWO DIMENSIONAL

ACCUMULATOR HOUSING ASSEMBLY (140)

ACCUMULATOR COVER SIDE



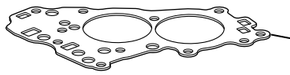
THREE DIMENSIONAL



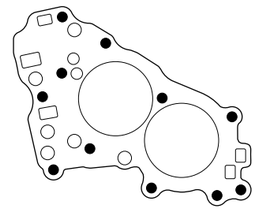
TWO DIMENSIONAL

ACCUMULATOR SPACER PLATE (134)

ACCUMULATOR HOUSING SIDE



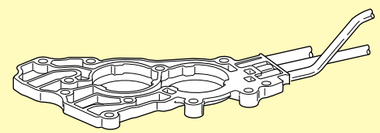
THREE DIMENSIONAL



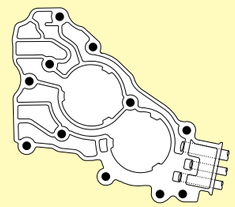
TWO DIMENSIONAL

ACCUMULATOR COVER (132)

ACCUMULATOR HOUSING SIDE

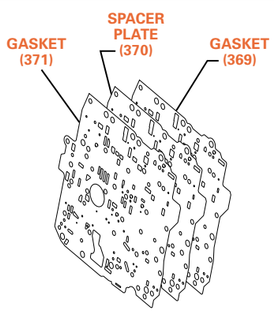


THREE DIMENSIONAL



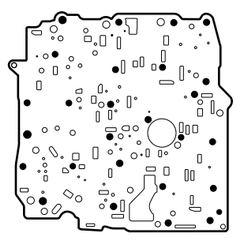
TWO DIMENSIONAL

VALVE BODY SPACER PLATE (370)



THREE DIMENSIONAL

CONTROL VALVE BODY SIDE



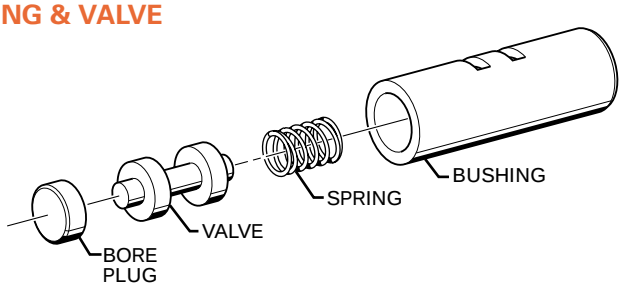
TWO DIMENSIONAL

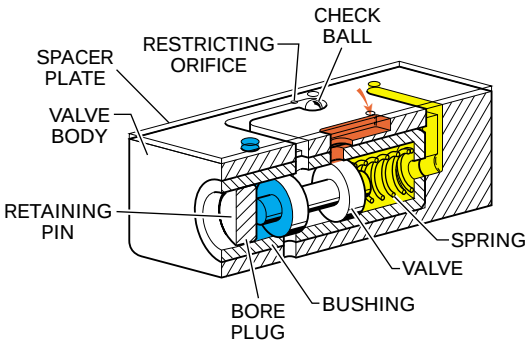
Figure 3

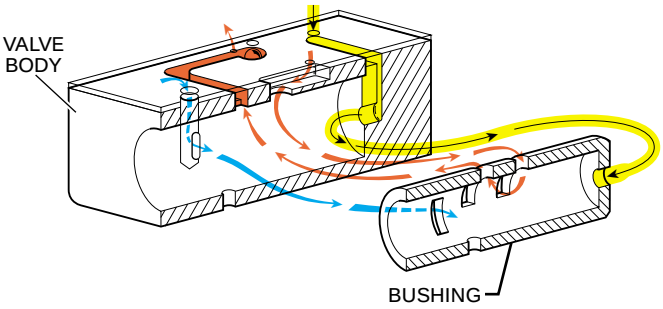
FOLDOUT ➤ 7

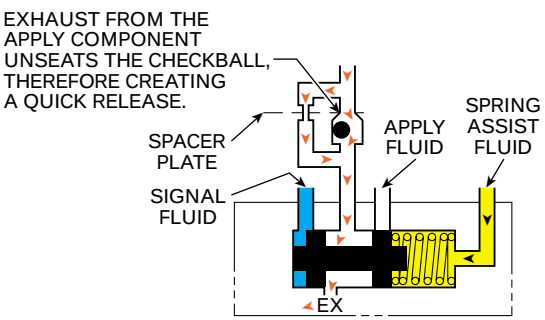
FOLDOUT ➤ 7A

TYPICAL BUSHING & VALVE

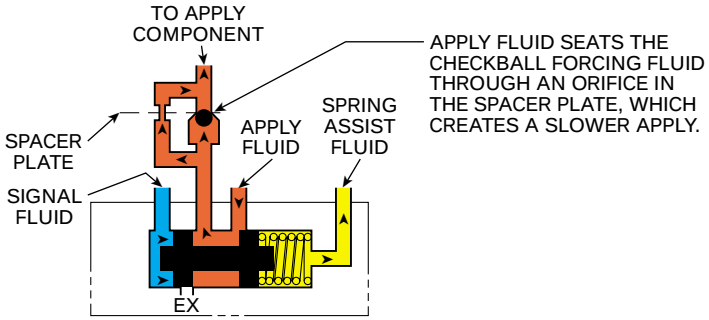








WITH SIGNAL FLUID PRESSURE EQUAL TO OR LESS THAN SPRING AND SPRING ASSIST FLUID PRESSURE THE VALVE REMAINS IN CLOSED POSITION.

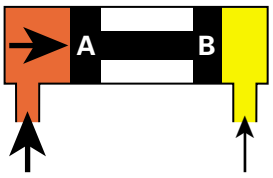


WITH SIGNAL FLUID PRESSURE GREATER THAN SPRING AND SPRING ASSIST FLUID PRESSURE THE VALVE MOVES OVER.

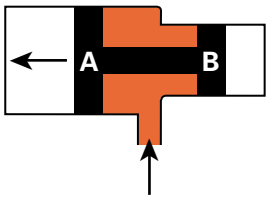
Figure 4

FLUID PRESSURES

- **INTAKE & DECREASE**
- **CONVERTER & LUBE**
- **LINE**
- **ACTUATOR FEED**
- **ACCUMULATOR**
- **SOLENOID SIGNAL**
- **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 4T65-E

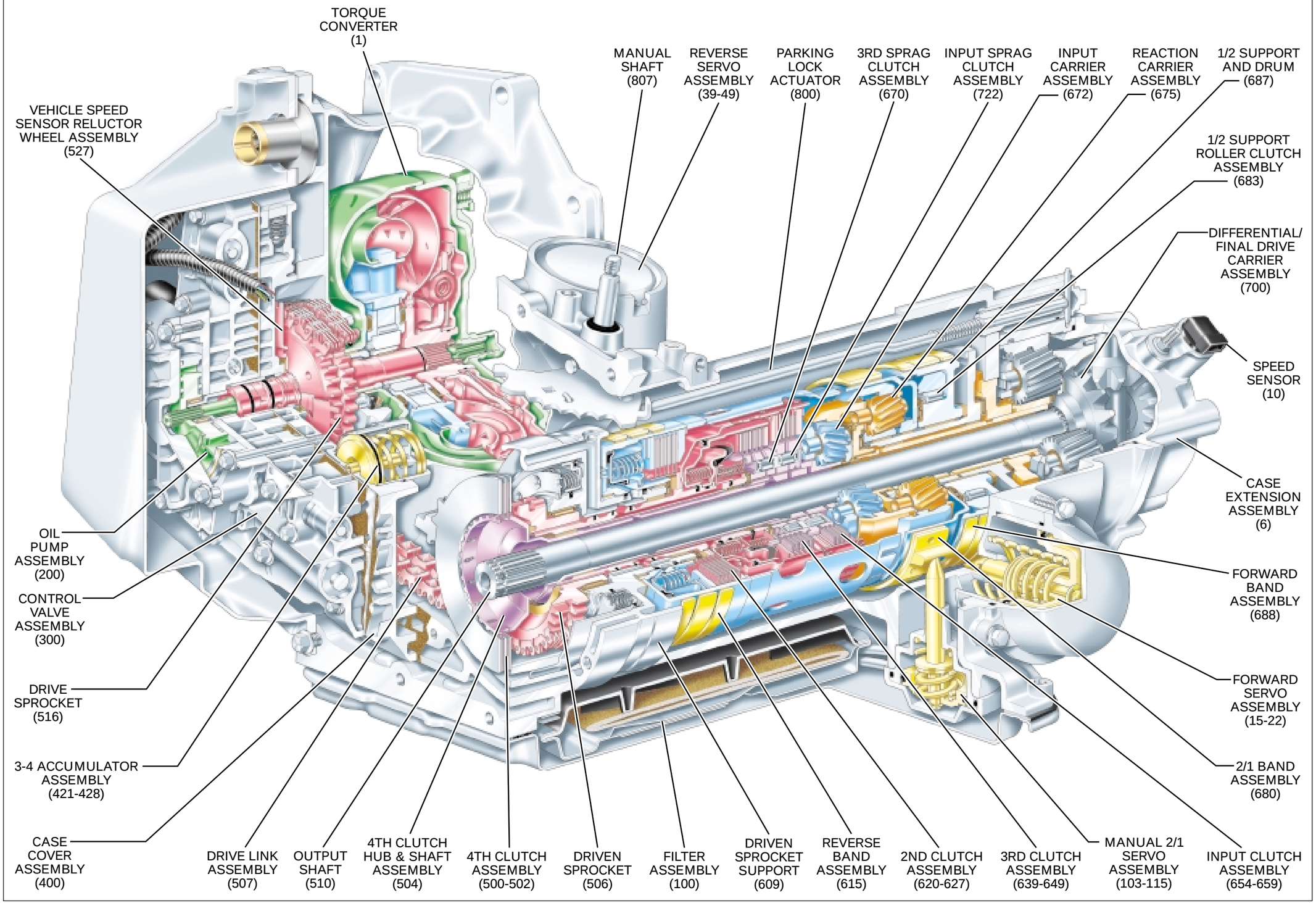


Figure 6

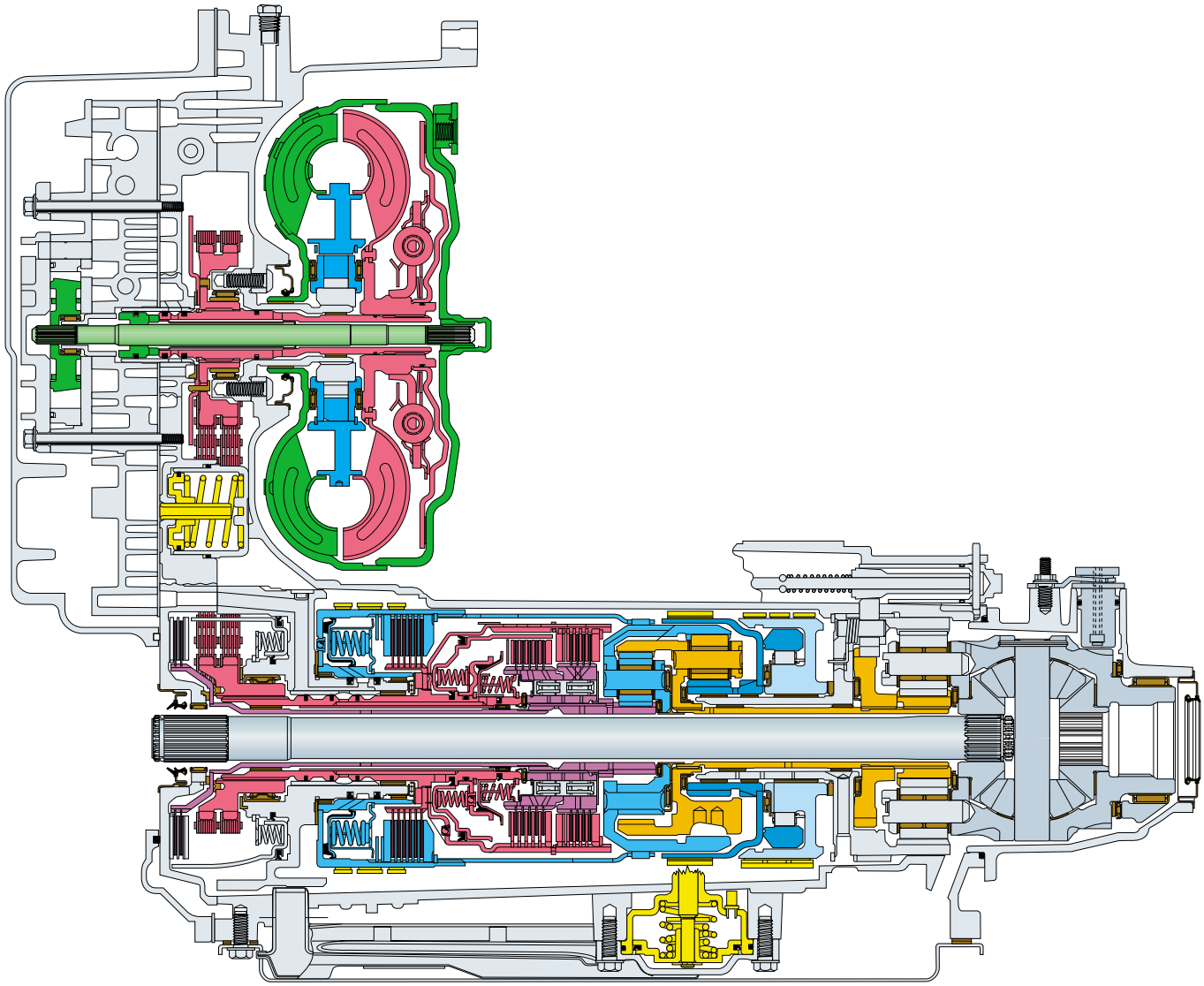


Figure 7

HYDRA-MATIC 4T65-E CROSS SECTIONAL VIEW

This illustration is a typical engineering cross sectional drawing of the Hydra-matic 4T65-E transaxle that has been used sparingly in this publication. Unless an individual is familiar with this type of drawing, it may be difficult to use when locating or identifying a component in the transaxle. For this reason, the three dimensional graphic illustration on page 8 has been the primary drawing used throughout this publication. It also may be used to assist in the interpretation of the engineering drawing when locating a component in the transaxle.

These illustrations, and others used throughout the book, use a consistent coloring of the components in order to provide an easy reference to a specific component. Colors then remain the same from section to section, thereby supporting the information contained in this book.

GENERAL DESCRIPTION

The Hydra-matic 4T65-E is a fully automatic four speed front wheel drive electronically controlled 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 GEAR RANGES

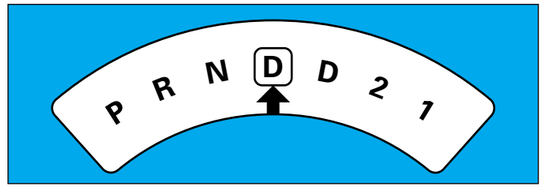


Figure 8

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" positions. 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. Downshifts to a lower gear, or higher gear ratio, are available for safe passing by depressing the accelerator or by manually selecting a lower gear with the shift selector.

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

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

2 – Manual Second adds more performance for congested traffic and hilly terrain. It has the same starting ratio (first gear) as Manual Third but prevents the transaxle from shifting above second gear. Thus, Manual Second can be used to retain second gear for acceleration and engine braking as desired. Manual Second can be selected at any vehicle speed but will not downshift into second gear until the vehicle speed drops below approximately 100 km/h (62 mph).

1 – Manual First can be selected at any vehicle speed. If the transaxle is in third or fourth gear it will immediately shift into second gear. When the vehicle speed slows to below approximately 60 km/h (37 mph) the transaxle will then shift into first gear. 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 4T65-E transaxle. When an understanding of these operating principles has been attained, diagnosis of these transaxle systems is made easier.

MAJOR MECHANICAL COMPONENTS

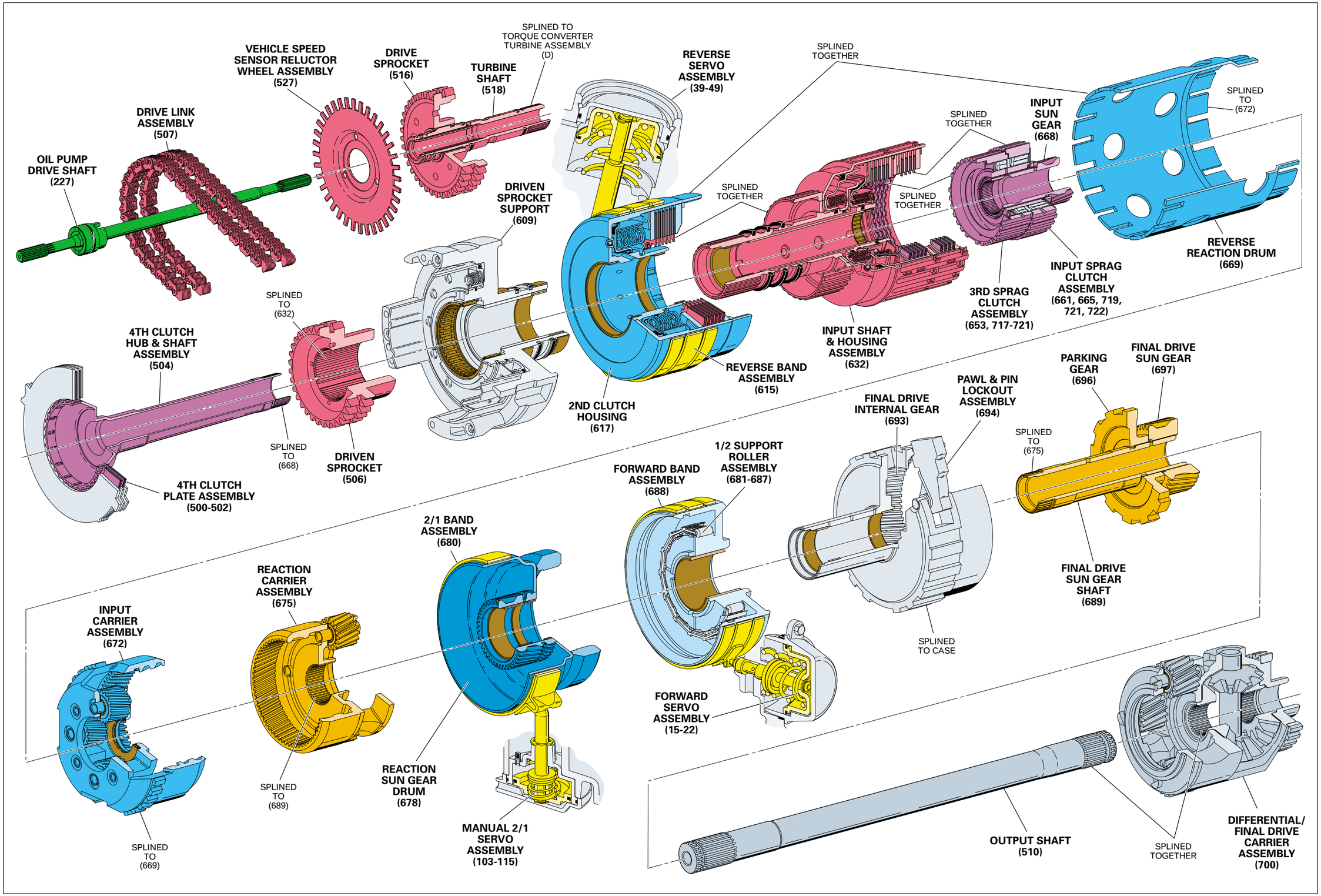


Figure 9

COLOR LEGEND

MAJOR MECHANICAL COMPONENTS

The fold-out graphic on page 10 contains a disassembled drawing of the major components used in the Hydra-matic 4T65-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 (609), Final Drive Internal Gear (693) and Valve Body (300).



Components that rotate at engine speed. Examples: Torque Converter Assembly (1) and Oil Pump Drive Shaft (227).



Components that rotate at turbine speed. Examples: Converter Turbine, Drive Sprocket (516), Driven Sprocket (506) and Input Shaft and Housing Assembly (632).



Components that rotate at transaxle output speed. Examples: Differential/Final Drive Carrier (700), Output Shaft (510).



Components such as the Stator in the Torque Converter (1), 2nd Clutch Housing (217), Reverse Reaction Drum (669) and Input Carrier Assembly (672).



Components such as the Reaction Sun Gear Drum (678) and 1/2 Support Inner Race (681).



Components such as the 1/2 Support Outer Race (687).



Components such as the Reaction Carrier Assembly (675), Parking Gear (696) and Final Drive Sun Gear (697).



Accumulators, Servos and Bands.



All bearings and bushings.



All seals

COLOR LEGEND

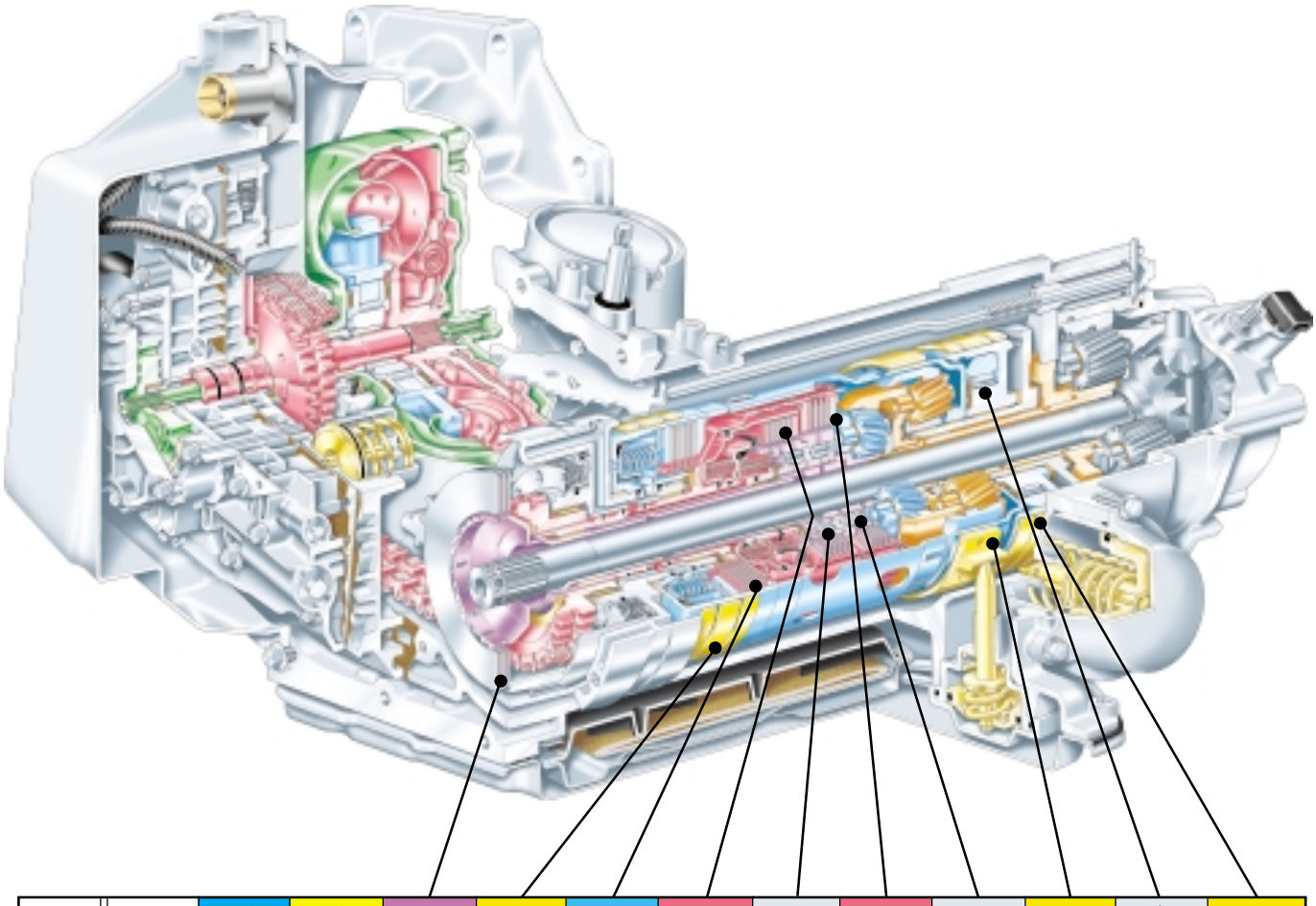
APPLY COMPONENTS

The Range Reference Chart on page 11, provides another valuable source of information for explaining the overall function of the Hydra-matic 4T65-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 page of text located in the Power Flow section. This provides for a quick reference when reviewing the mechanical power flow information contained in that section.

RANGE REFERENCE CHART



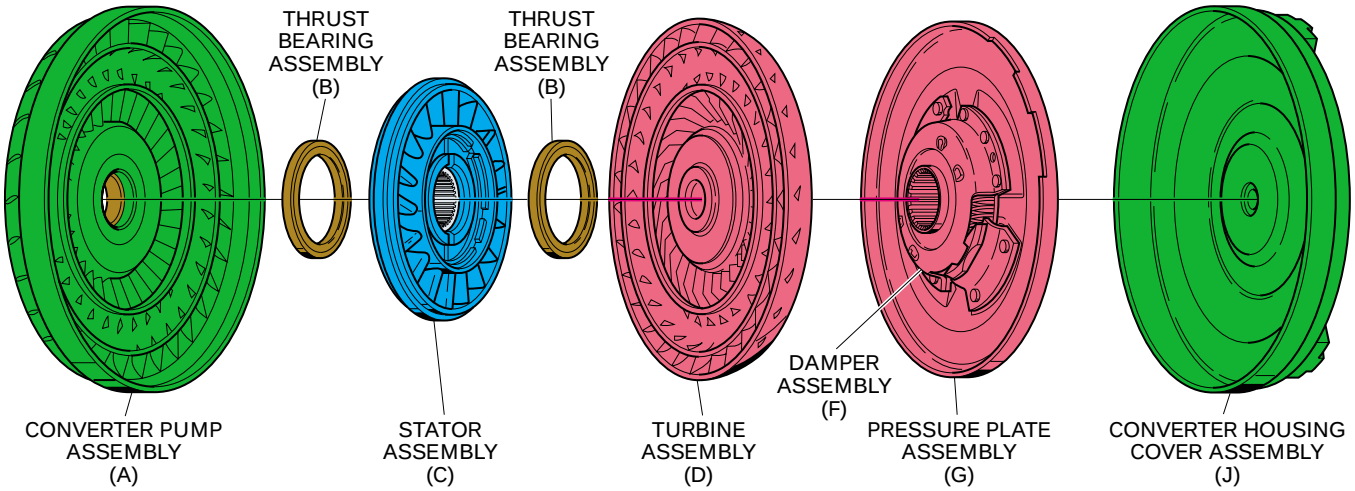
RANGE	GEAR	1-2, 3-4 SHIFT SOLENOID VALVE	2-3 SHIFT SOLENOID VALVE	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
P-N		ON	ON						*	*			
Ⓓ	1st	ON	ON						APPLIED	HOLDING		HOLDING	APPLIED
	2nd	OFF	ON			APPLIED			*	OVERRUN		HOLDING	APPLIED
	3rd	OFF	OFF			APPLIED	APPLIED	HOLDING				OVERRUN	*
	4th	ON	OFF	APPLIED		APPLIED	*	OVERRUN				OVERRUN	*
D	3rd	@ OFF	@ OFF			APPLIED	APPLIED	HOLDING	APPLIED	HOLDING		OVERRUN	*
	2nd	@ OFF	@ ON			APPLIED			*	OVERRUN		HOLDING	APPLIED
	1st	@ ON	@ ON						APPLIED	HOLDING		HOLDING	APPLIED
2	2nd	@ OFF	@ ON			APPLIED			*	OVERRUN	APPLIED	HOLDING	APPLIED
	1st	@ ON	@ ON						APPLIED	HOLDING	APPLIED	HOLDING	APPLIED
1	1st	@ ON	@ ON				APPLIED	HOLDING	APPLIED	HOLDING	APPLIED	HOLDING	APPLIED
R	REVERSE	ON	ON		APPLIED				APPLIED	HOLDING			

*APPLIED OR HOLDING WITH NO LOAD (NOT TRANSMITTING TORQUE)

ON = SOLENOID ENERGIZED
OFF = SOLENOID DE-ENERGIZED
@ THE SOLENOID'S STATE FOLLOWS A SHIFT PATTERN WHICH DEPENDS UPON VEHICLE SPEED, THROTTLE POSITION AND SELECTED GEAR RANGE.

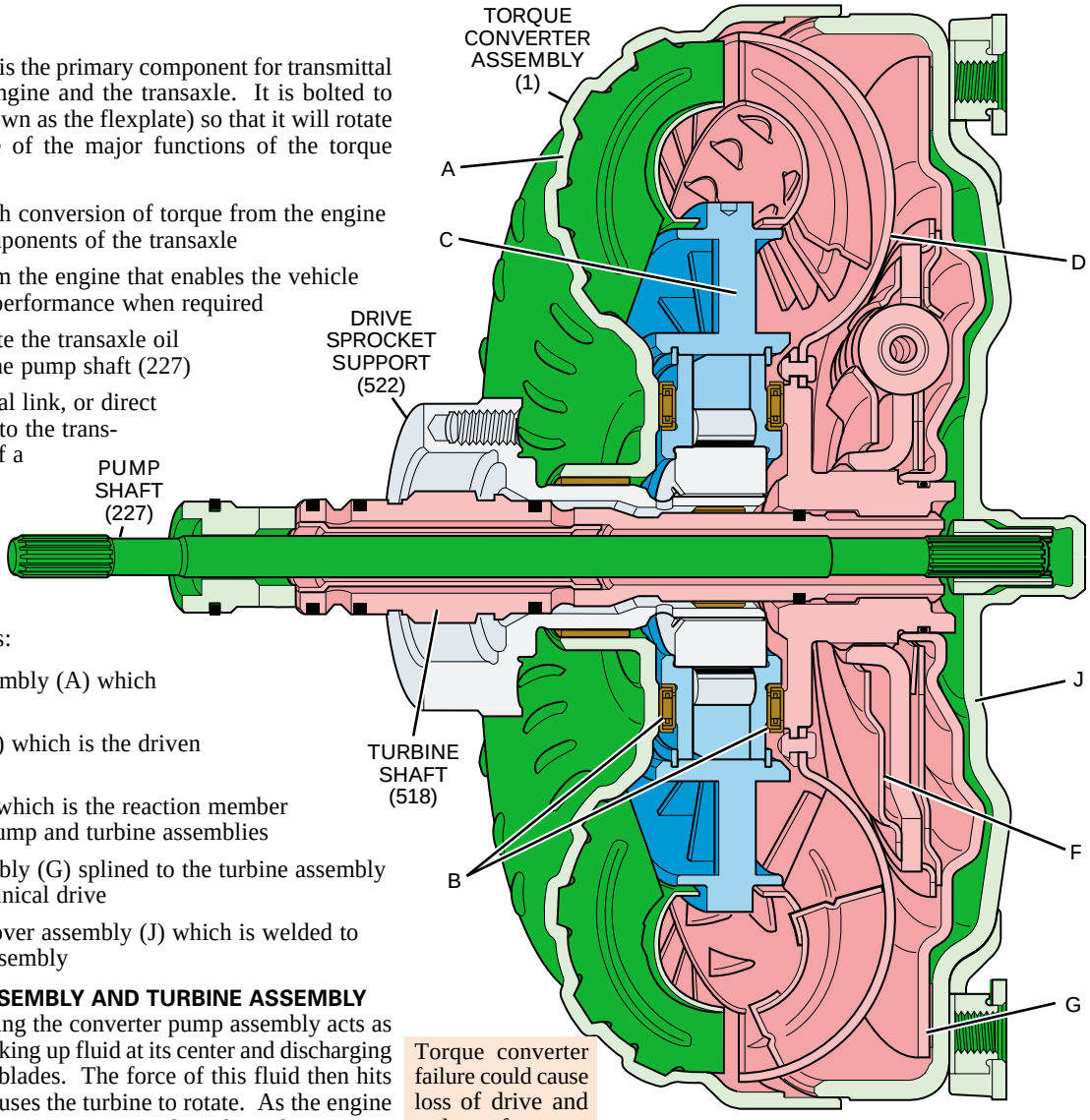
Figure 10

TORQUE CONVERTER



TORQUE CONVERTER:
The torque converter (1) is the primary component for transmittal of power between the engine and the transaxle. It is bolted to the engine flywheel (known as the flexplate) 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 that enables the vehicle to achieve additional performance when required
- to mechanically operate the transaxle oil pump (200) through the pump shaft (227)
- 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 sub-assemblies:

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

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

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 amount of slippage that occurs through a fluid coupling is reduced (but not elimanted), 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

TORQUE CONVERTER

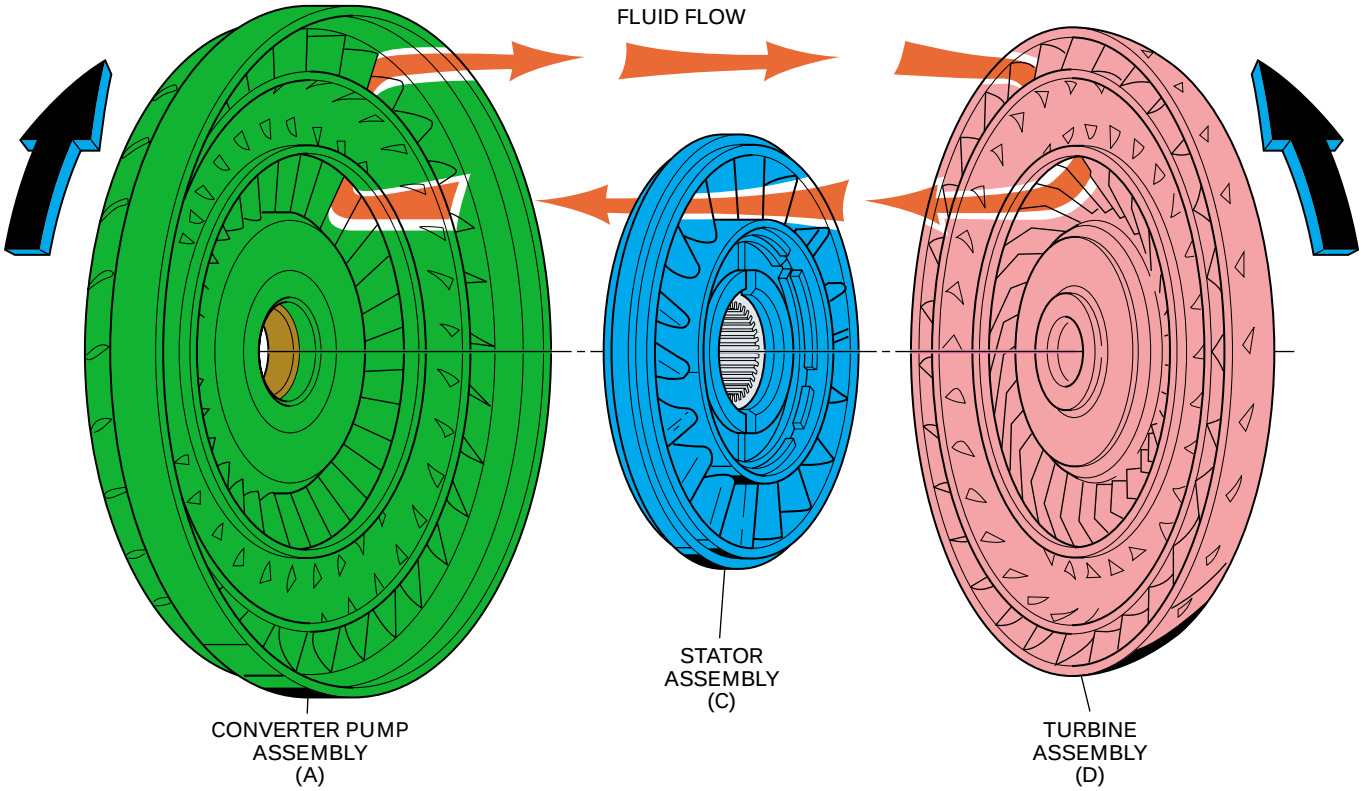


Figure 12

Stator roller clutch failure

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

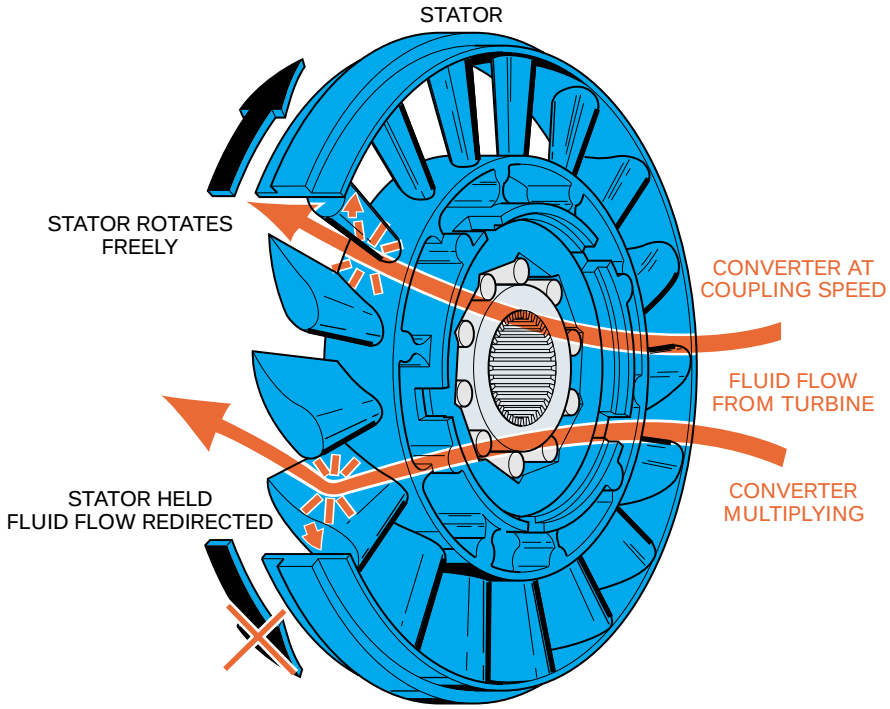


Figure 13

STATOR ASSEMBLY

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

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

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

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 (227) and the turbine shaft (518). 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 (522) and on through an oil sleeve within the turbine shaft. This fluid now travels to the valve body and on to the oil cooler.

No TCC apply can be caused by:

- TCC PWM solenoid valve assembly (334) malfunction.
- TCC control valve (335) stuck or binding
- TCC regulator apply valve (327) stuck or binding
- # 10 ball check valve (372) missing or mislocated
- Spacer plate and gaskets misaligned or incorrect
- TCC blowoff ball valve (420B) or spring (418) damaged or not seating
- Turbine shaft and or seals damaged or missing
- Turbine shaft bushing (523) worn or damaged
- Pressure plate assembly friction material worn or damaged

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. Release fluid is then routed out of the torque converter between the turbine shaft and the pump shaft.

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

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

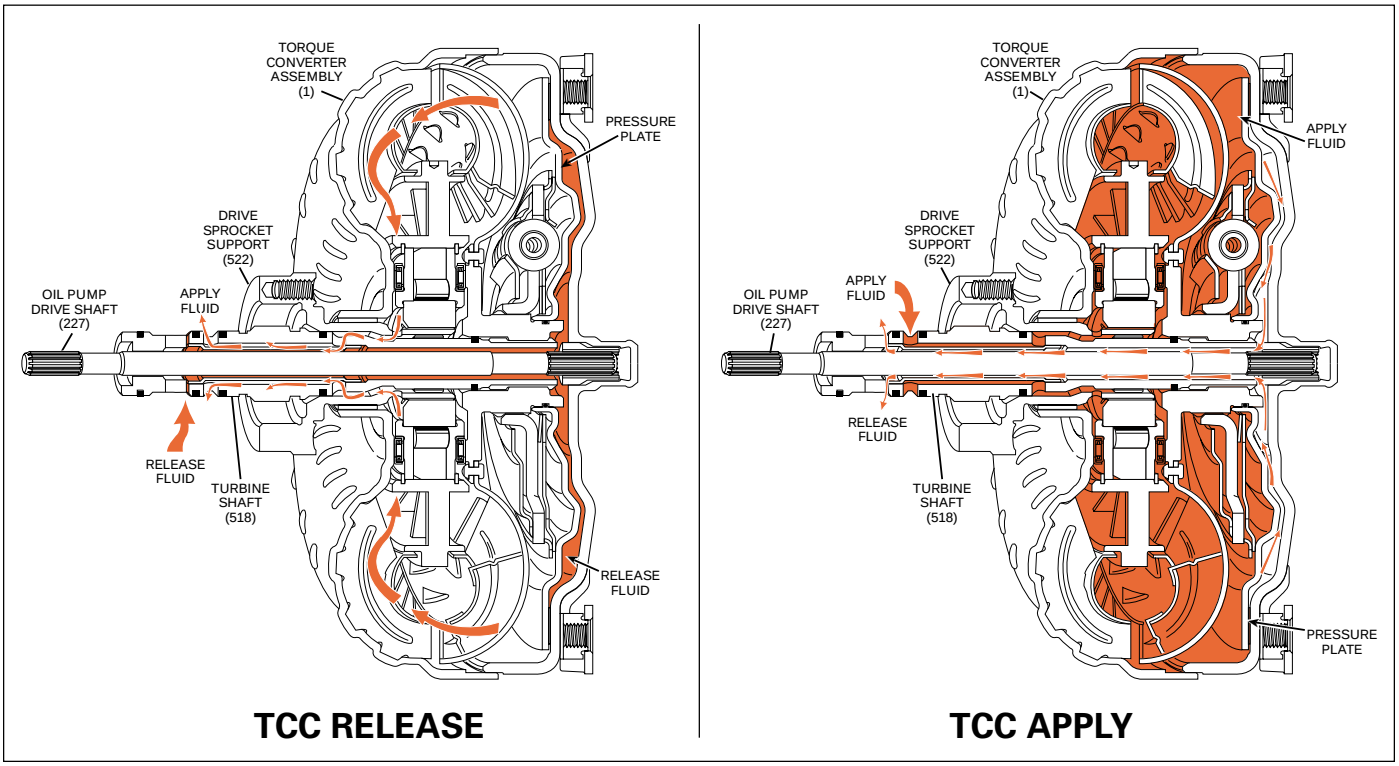


Figure 14

APPLY COMPONENTS

The Apply Components section is designed to explain the function of the hydraulic and mechanical holding devices used in the Hydra-matic 4T65-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 then explained in detail and supported with a graphic illustration. In addition, this section shows the routing of fluid pressure to the individual components and their internal functions when it 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 4T65-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 more clearly understand the hydraulic and mechanical operating principles for this transaxle.

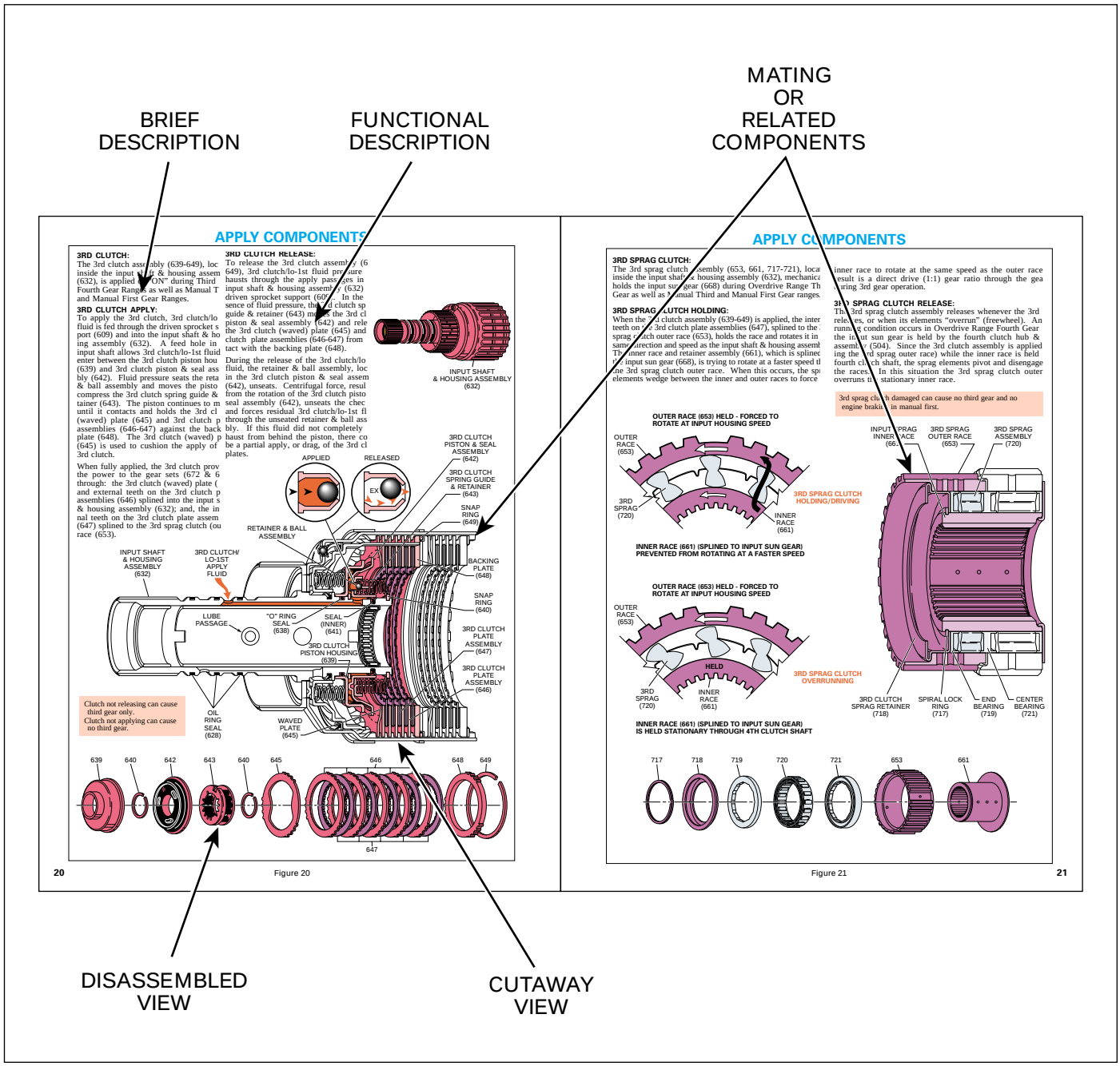


Figure 15

APPLY COMPONENTS

DRIVEN SPROCKET SUPPORT:
The driven sprocket support (609), located behind the case cover (400) and nested inside the "barrel" of the case (3), is the primary component for fluid distribution to the clutch packs. A cup bearing assembly (606) is pressed into the housing and provides support for the driven sprocket (506). The driven sprocket support also serves as the housing for the 4th clutch piston assembly (603-604) and the 4th clutch piston return spring assembly (602).

HYDRAULIC FEED CIRCUITS:

LUBE (front):
Whenever the engine is running, line pressure from the pump assembly (200) is fed through an orifice in the valve body spacer plate (370), through the case cover assembly (400) and to the driven sprocket support. Lube enters the driven sprocket support housing and is routed between the housing and a sleeve where it feeds the lubrication circuit. See LUBRICATION CIRCUITS, page 104.

INPUT CLUTCH FEED:
Input clutch fluid from the control valve assembly (300) is routed through the case cover and into the driven sprocket support. Input clutch fluid then passes through the driven sprocket support sleeve and into a drilled hole located between two seals in the input shaft & housing assembly (632). Input clutch fluid pressure then forces the input clutch piston to move and apply the clutch. See INPUT CLUTCH APPLY, page 22.

2ND CLUTCH FEED:
2nd clutch fluid from the control valve assembly is routed through the case cover and into the driven sprocket support. 2nd clutch fluid then passes between the driven sprocket support housing and sleeve, and exits the housing at a groove located between two seals. The seals ride on the inner diameter of the 2nd clutch housing (617) which allows 2nd clutch fluid to enter the housing and apply the clutch. See 2ND CLUTCH APPLY, page 19.

3RD CLUTCH FEED:
3rd clutch/lo-1st fluid from the control valve assembly is routed through the case cover and into the driven sprocket support. 3rd clutch/lo-1st fluid then passes through the driven sprocket support sleeve and into a drilled hole located between two seals in the input shaft & housing assembly (632). 3rd clutch/lo-1st fluid travels between the input shaft and sleeve, then enters the 3rd clutch piston housing (639) to apply the clutch. See 3RD CLUTCH APPLY, page 20.

4TH CLUTCH FEED:
4th clutch fluid from the control valve assembly is routed through the case cover and into the driven sprocket support. 4th clutch fluid then passes through a hole in the support that is located behind the 4th clutch piston to apply the clutch. See 4TH CLUTCH APPLY, page 17.

Damaged or leaking seals (628) can cause sliping/delay/no engagement of reverse, first, or third, and possible harsh or soft 2-3/3-2 shift feel.

Damaged or leaking seals (612 & 613) can cause sliping/delay/no engagement of second and possible harsh or soft 1-2 shift feel.

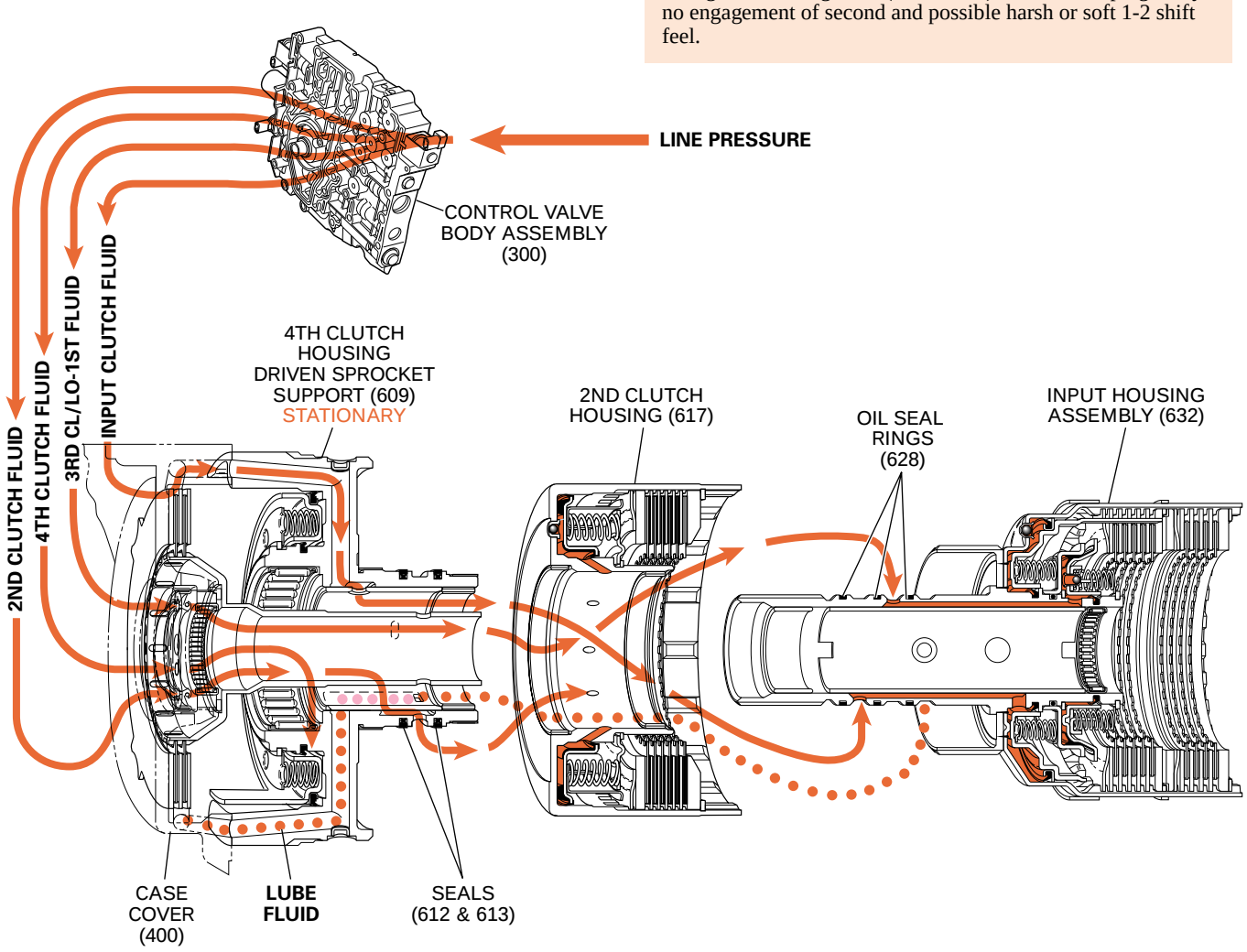
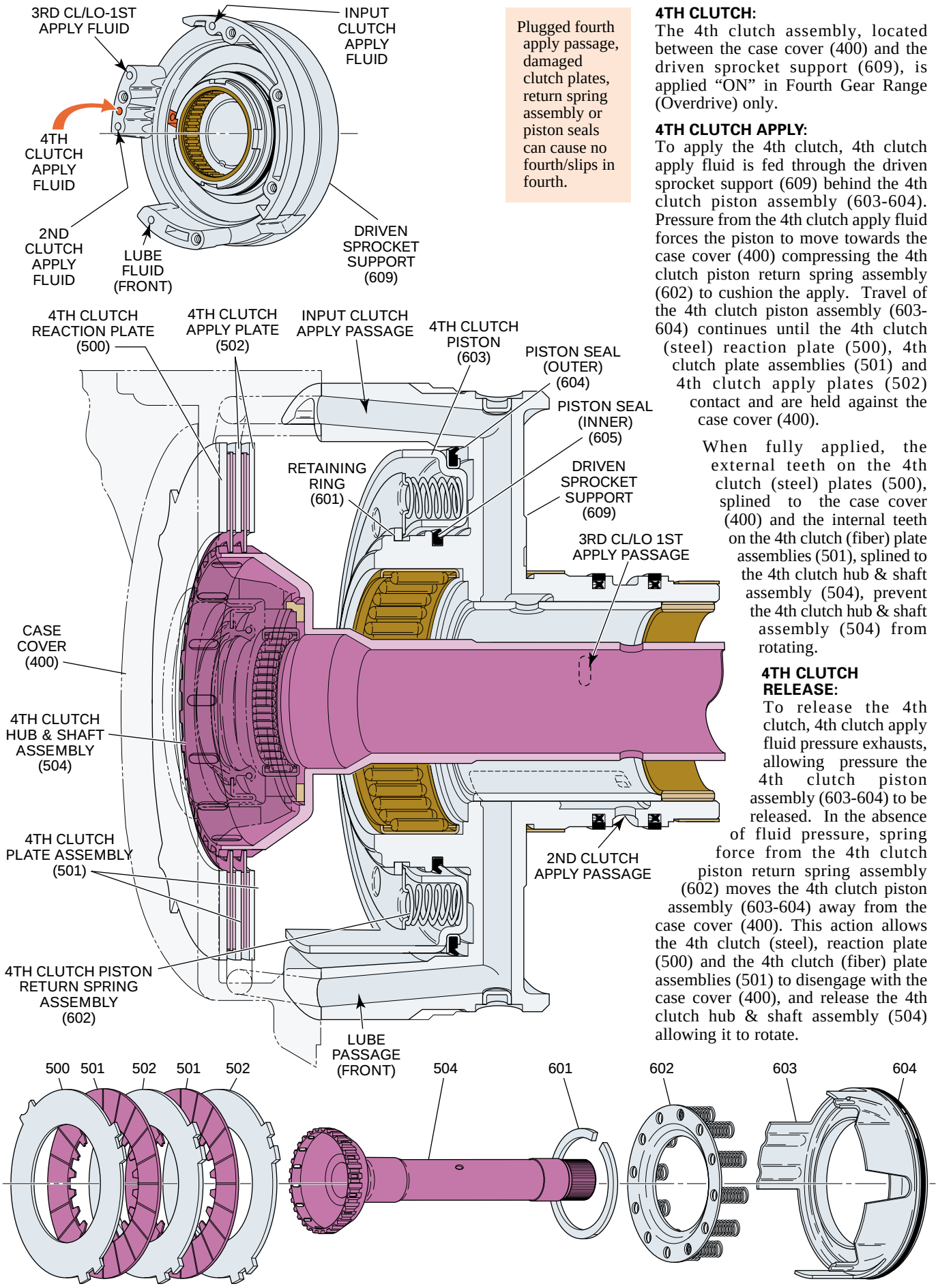


Figure 16

APPLY COMPONENTS



Plugged fourth apply passage, damaged clutch plates, return spring assembly or piston seals can cause no fourth/slips in fourth.

4TH CLUTCH:
The 4th clutch assembly, located between the case cover (400) and the driven sprocket support (609), is applied "ON" in Fourth Gear Range (Overdrive) only.

4TH CLUTCH APPLY:
To apply the 4th clutch, 4th clutch apply fluid is fed through the driven sprocket support (609) behind the 4th clutch piston assembly (603-604). Pressure from the 4th clutch apply fluid forces the piston to move towards the case cover (400) compressing the 4th clutch piston return spring assembly (602) to cushion the apply. Travel of the 4th clutch piston assembly (603-604) continues until the 4th clutch (steel) reaction plate (500), 4th clutch plate assemblies (501) and 4th clutch apply plates (502) contact and are held against the case cover (400).

When fully applied, the external teeth on the 4th clutch (steel) plates (500), splined to the case cover (400) and the internal teeth on the 4th clutch (fiber) plate assemblies (501), splined to the 4th clutch hub & shaft assembly (504), prevent the 4th clutch hub & shaft assembly (504) from rotating.

4TH CLUTCH RELEASE:
To release the 4th clutch, 4th clutch apply fluid pressure exhausts, allowing pressure the 4th clutch piston assembly (603-604) to be released. In the absence of fluid pressure, spring force from the 4th clutch piston return spring assembly (602) moves the 4th clutch piston assembly (603-604) away from the case cover (400). This action allows the 4th clutch (steel), reaction plate (500) and the 4th clutch (fiber) plate assemblies (501) to disengage with the case cover (400), and release the 4th clutch hub & shaft assembly (504) allowing it to rotate.

Figure 17

APPLY COMPONENTS

REVERSE SERVO ASSEMBLY:
The reverse servo assembly (39-49), located near the top of the transaxle case (3), applies the reverse band assembly (615) when Reverse Gear Range is selected.

REVERSE SERVO APPLY:
To apply the reverse servo assembly (39-49), reverse servo apply fluid is fed through the case (3) between the servo cover (40) and the reverse servo piston (44). Pressure from the reverse servo apply fluid forces the piston and selective apply pin (48) to move towards the reverse band assembly (615). This movement compresses the reverse servo cushion spring (45) return spring (49) and reverse servo cushion spring (47) allowing the apply pin (48) to compress the reverse band assembly (615). When the band is compressed, the 2nd clutch housing (617) is held stationary. Reverse Gear engagement feel is controlled by: the reverse servo cushion spring (45) and return spring (49); the reverse servo cushion spring (47); the apply pin (48); the reverse band assembly (615) and second clutch housing (617).

REVERSE SERVO RELEASE:
To release the reverse servo assembly (39-49), reverse servo fluid pressure exhausts through the same apply passage in the case, allowing pressure at the reverse servo piston (44) to be released. Spring force from: the return spring (49); reverse servo cushion spring (45); and, the reverse servo cushion spring (47), move the reverse servo piston (44) and apply pin (48) away from the reverse band assembly (615) to release the band. When released, the 2nd clutch housing (617) can rotate as required for other gear ranges.

REVERSE BAND:
The reverse band assembly (615), located under the reverse servo assembly (39-49), is applied or "ON" during Reverse Gear Range only. The band wraps around the second clutch housing (617) and is held in position by the band anchor pin (117). When compressed by the reverse servo assembly (39-49), it holds the 2nd clutch housing (617), reverse reaction drum (669) and input carrier assembly (672) allowing the transaxle to operate in Reverse.

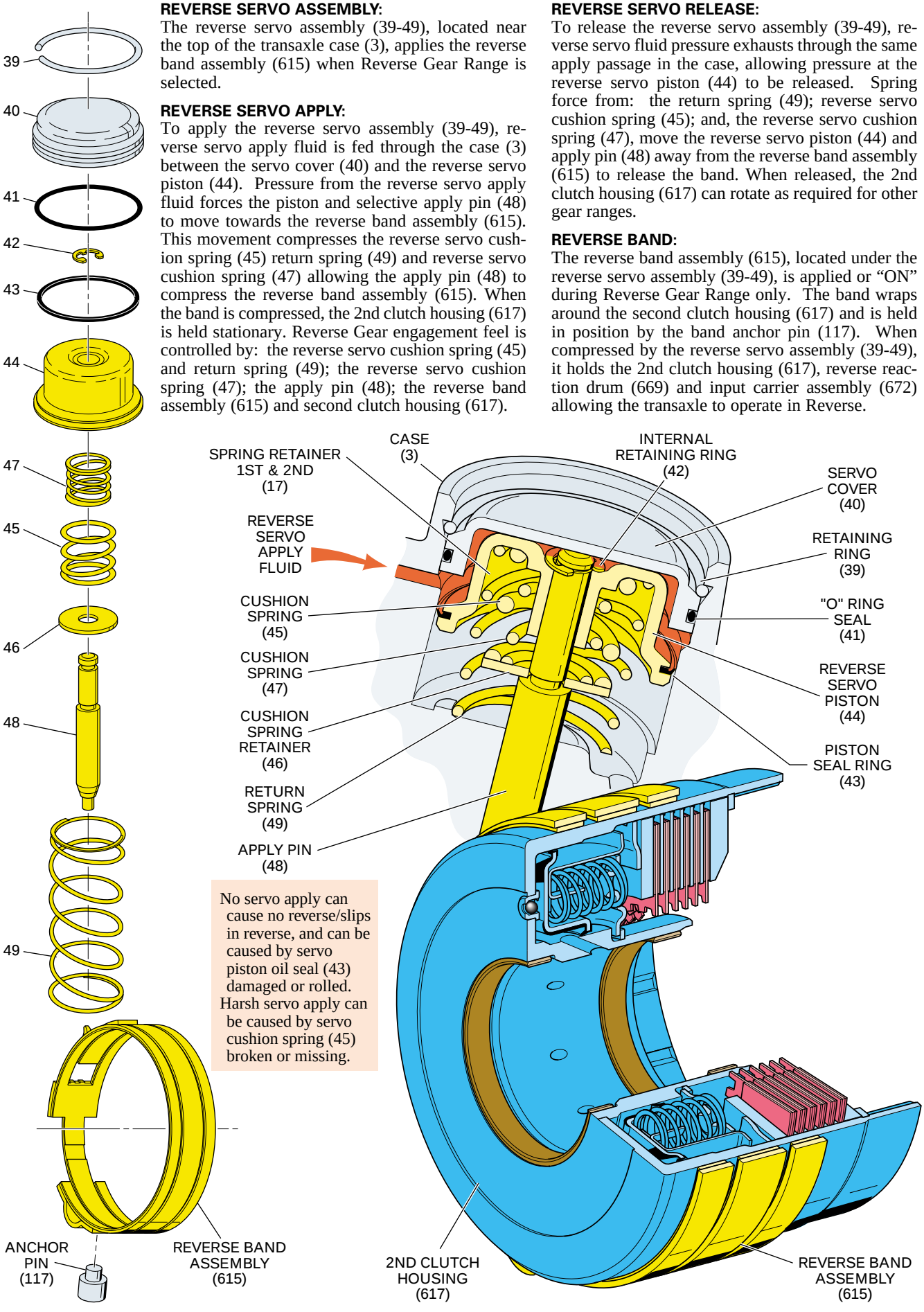
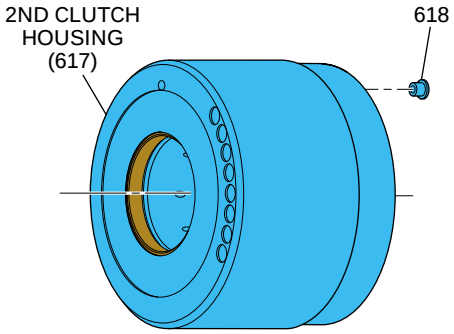


Figure 18

APPLY COMPONENTS



2ND CLUTCH:
The 2nd clutch assembly (617-627), located between the driven sprocket support (609) and the input clutch assembly (631-659), is applied or "ON" during Second, Third and Fourth Gear Ranges as well as Manual Third and Manual Second Gear Ranges.

2ND CLUTCH APPLY:
To apply the 2nd clutch, 2nd clutch apply fluid is fed through the driven sprocket support (609) to the inner hub of the 2nd clutch housing (617). Feed holes in the hub allows 2nd clutch apply fluid to enter the 2nd clutch housing (617) behind the 2nd clutch piston (620); seats the retainer and ball assembly (618) and moves the piston to compress the apply ring & release spring assembly (621). The piston continues to move, compressing the 2nd clutch wave plate (623), until the 2nd clutch apply plate (716), 2nd clutch reaction plates (625) and 2nd clutch plate assemblies (624) are held against the backing support ring plate (626).

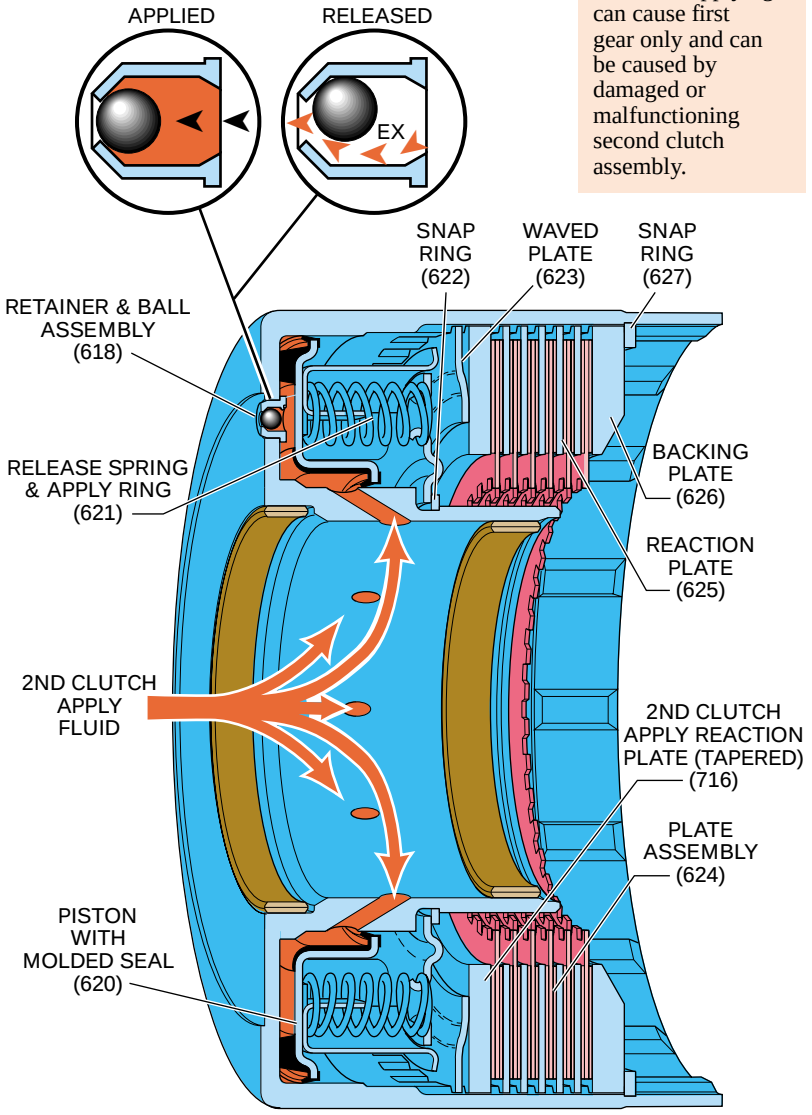
When fully applied, the 2nd clutch provides the power to the gear sets (672 & 675) through the: waved plate (623); (steel) tapered apply reaction plate (716); (steel) reaction plates (625) external teeth splined to the 2nd clutch housing (617); and, the 2nd clutch plate assemblies (624) internal teeth splined to the hub on the input housing assembly (631-659).

2ND CLUTCH RELEASE:
To release the 2nd clutch assembly (621-627), 2nd clutch apply fluid pressure exhausts through the apply passages in the inner hub of the 2nd clutch housing (617) and driven sprocket support (609). In the absence of fluid pressure, the apply ring & release spring assembly (621) move the 2nd clutch piston (620) and releases the 2nd clutch reaction plates (625 & 716) and 2nd clutch plate assemblies (624) from contact with the backing support ring plate (626).

During the release of the 2nd clutch fluid, the retainer & ball assembly (618), located in the 2nd clutch housing (617), unseats. Centrifugal force, resulting from the rotation of the 2nd clutch housing (617), unseats the checkball and forces residual 2nd clutch fluid to the outside of the piston housing and through the unseated retainer & ball assembly (618). If this fluid did not completely exhaust from behind the piston, there could be a partial apply, or drag, of the 2nd clutch plates.

Clutch not releasing can cause second gear start or no 2-1 downshift and can be caused by:
- 1-2 shift valve (318) stuck or binding.
- Debris in control valve body (301).

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



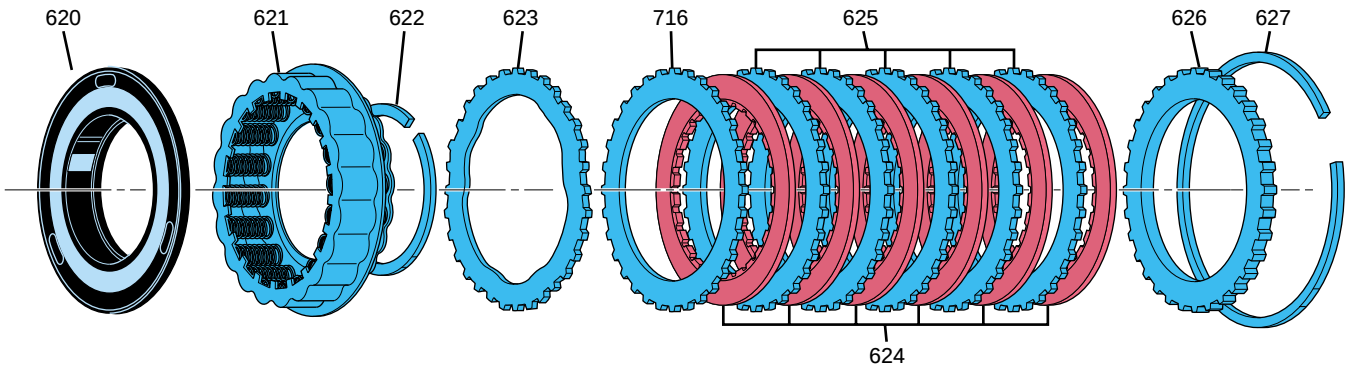


Figure 19

APPLY COMPONENTS

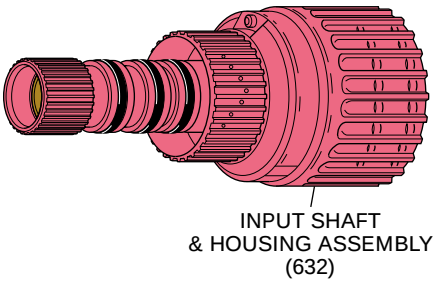
3RD CLUTCH:
The 3rd clutch assembly (639-649), located inside the input shaft & housing assembly (632), is applied or "ON" during Third and Fourth Gear Ranges as well as Manual Third and Manual First Gear Ranges.

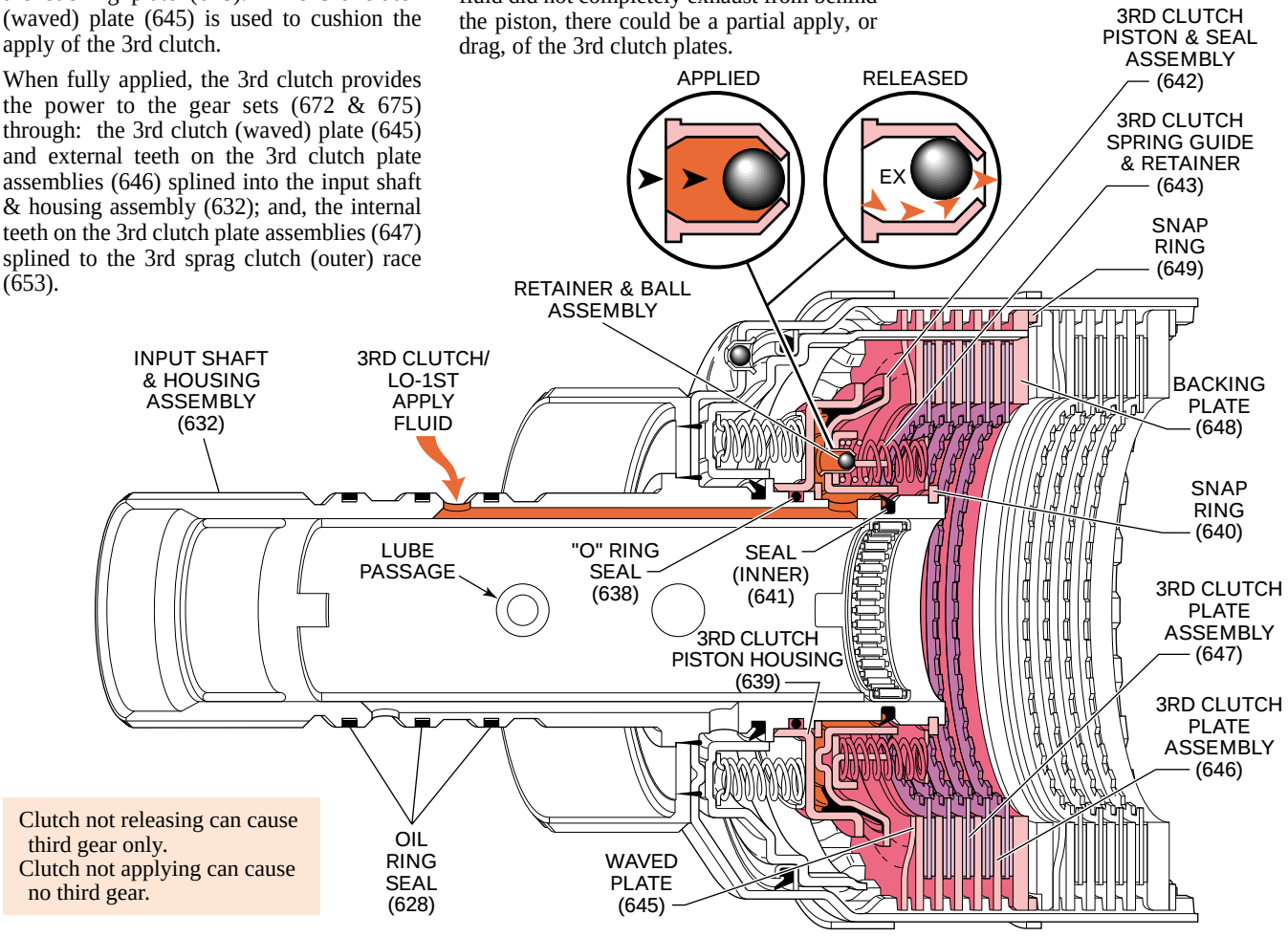
3RD CLUTCH APPLY:
To apply the 3rd clutch, 3rd clutch/lo-1st fluid is fed through the driven sprocket support (609) and into the input shaft & housing assembly (632). A feed hole in the input shaft allows 3rd clutch/lo-1st fluid to enter between the 3rd clutch piston housing (639) and 3rd clutch piston & seal assembly (642). Fluid pressure seats the retainer & ball assembly and moves the piston to compress the 3rd clutch spring guide & retainer (643). The piston continues to move until it contacts and holds the 3rd clutch (waved) plate (645) and 3rd clutch plate assemblies (646-647) against the backing plate (648). The 3rd clutch (waved) plate (645) is used to cushion the apply of the 3rd clutch.

When fully applied, the 3rd clutch provides the power to the gear sets (672 & 675) through: the 3rd clutch (waved) plate (645) and external teeth on the 3rd clutch plate assemblies (646) splined into the input shaft & housing assembly (632); and, the internal teeth on the 3rd clutch plate assemblies (647) splined to the 3rd sprag clutch (outer) race (653).

3RD CLUTCH RELEASE:
To release the 3rd clutch assembly (639-649), 3rd clutch/lo-1st fluid pressure exhausts through the apply passages in the input shaft & housing assembly (632) and driven sprocket support (609). In the absence of fluid pressure, the 3rd clutch spring guide & retainer (643) moves the 3rd clutch piston & seal assembly (642) and releases the 3rd clutch (waved) plate (645) and 3rd clutch plate assemblies (646-647) from contact with the backing plate (648).

During the release of the 3rd clutch/lo-1st fluid, the retainer & ball assembly, located in the 3rd clutch piston & seal assembly (642), unseats. Centrifugal force, resulting from the rotation of the 3rd clutch piston & seal assembly (642), unseats the checkball and forces residual 3rd clutch/lo-1st fluid through the unseated retainer & ball assembly. If this fluid did not completely exhaust from behind the piston, there could be a partial apply, or drag, of the 3rd clutch plates.





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

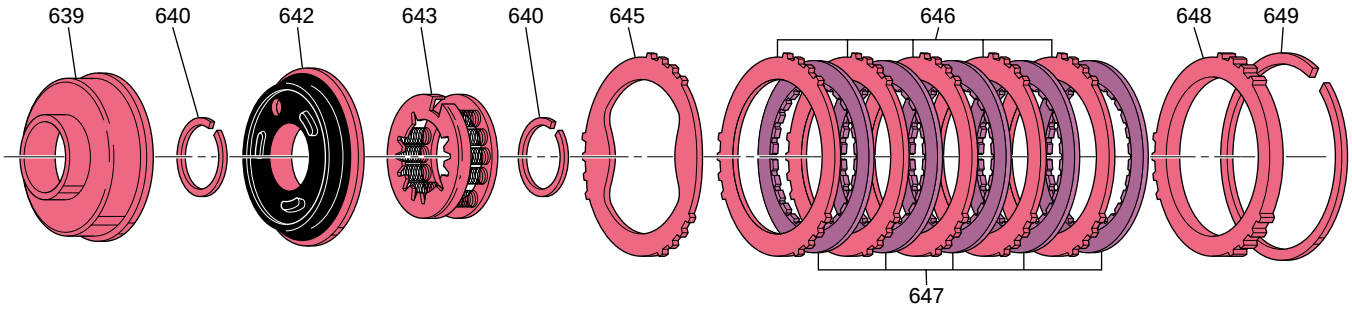


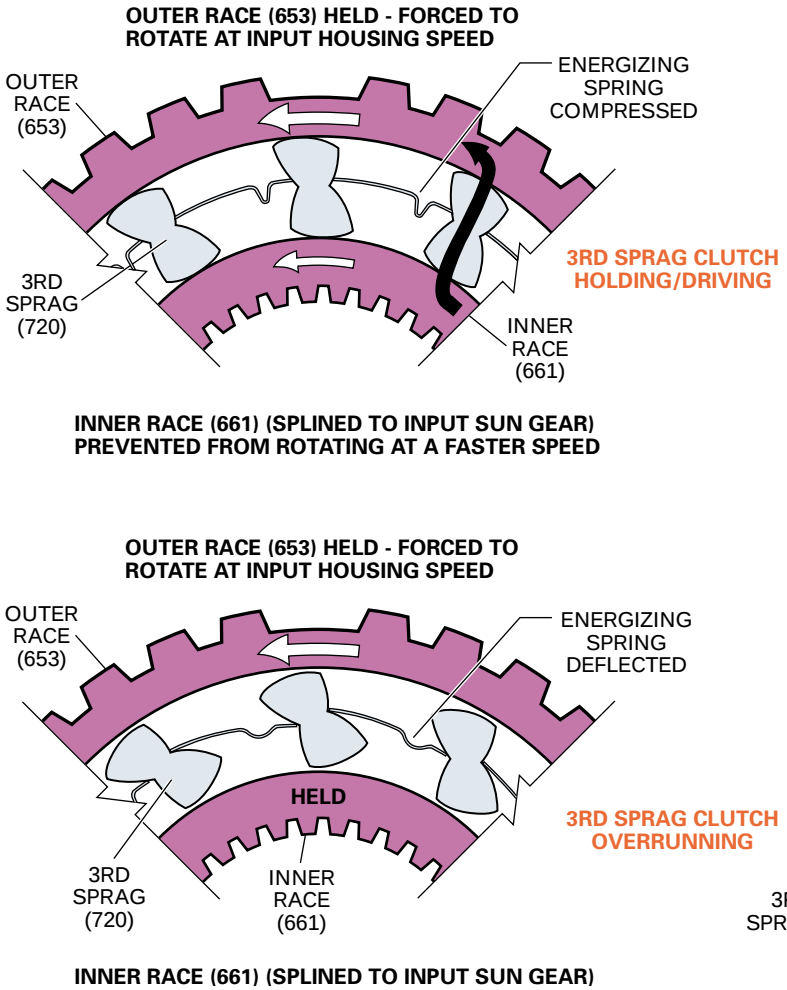
Figure 20

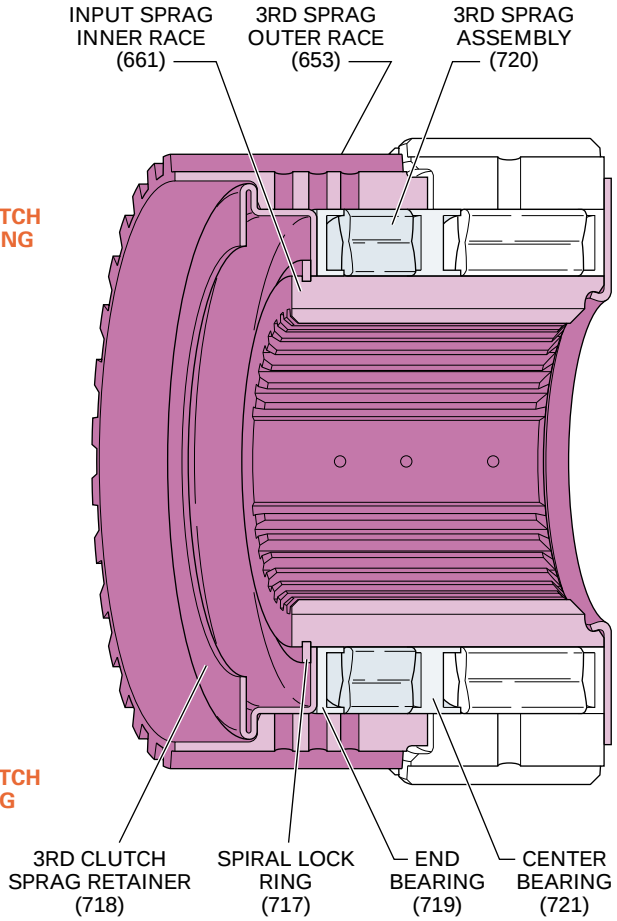
3RD SPRAG CLUTCH:
The 3rd sprag clutch assembly (653, 661, 717-721), located inside the input shaft & housing assembly (632), mechanically holds the input sun gear (668) during Overdrive Range Third Gear as well as Manual Third and Manual First Gear ranges.

3RD SPRAG CLUTCH HOLDING:
When the 3rd clutch assembly (639-649) is applied, the internal teeth on the 3rd clutch plate assemblies (647), splined to the 3rd sprag clutch outer race (653), holds the race and rotates it in the same direction and speed as the input shaft & housing assembly. The inner race and retainer assembly (661), which is splined to the input sun gear (668), is trying to rotate at a faster speed than the 3rd sprag clutch outer race. When this occurs, the sprag elements which are suspended between the inner and outer race with energizing springs, wedge between the inner and outer races to force the inner race to rotate at the same speed as the outer race. The result is a direct drive (1:1) gear ratio through the gear sets during 3rd gear operation.

3RD SPRAG CLUTCH RELEASE:
The 3rd sprag clutch assembly releases whenever the 3rd clutch releases, or when its elements "overrun" (freewheel). An overrunning condition occurs in Overdrive Range Fourth Gear when the input sun gear is held by the fourth clutch hub & shaft assembly (504). Since the 3rd clutch assembly is applied (driving the 3rd sprag outer race) while the inner race is held by the fourth clutch shaft, the sprag elements pivot (energizing spring deflects) and disengage from the races. In this situation the 3rd sprag clutch outer race overruns the stationary inner race.

3rd sprag clutch damaged can cause no third gear and no engine braking in manual first.





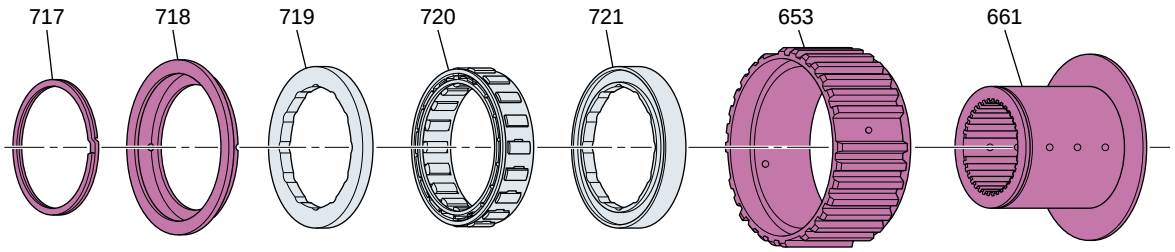
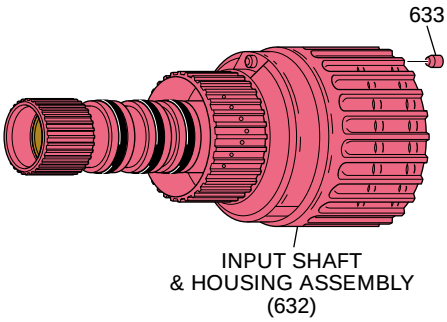


Figure 21

APPLY COMPONENTS

INPUT CLUTCH:
The input clutch assembly (637-640 & 654-659), located inside the input shaft & housing assembly (632), is applied or "ON" in First and Second Gear Ranges, as well as Manual Third, Manual Second, Manual First and Reverse Gear Ranges.

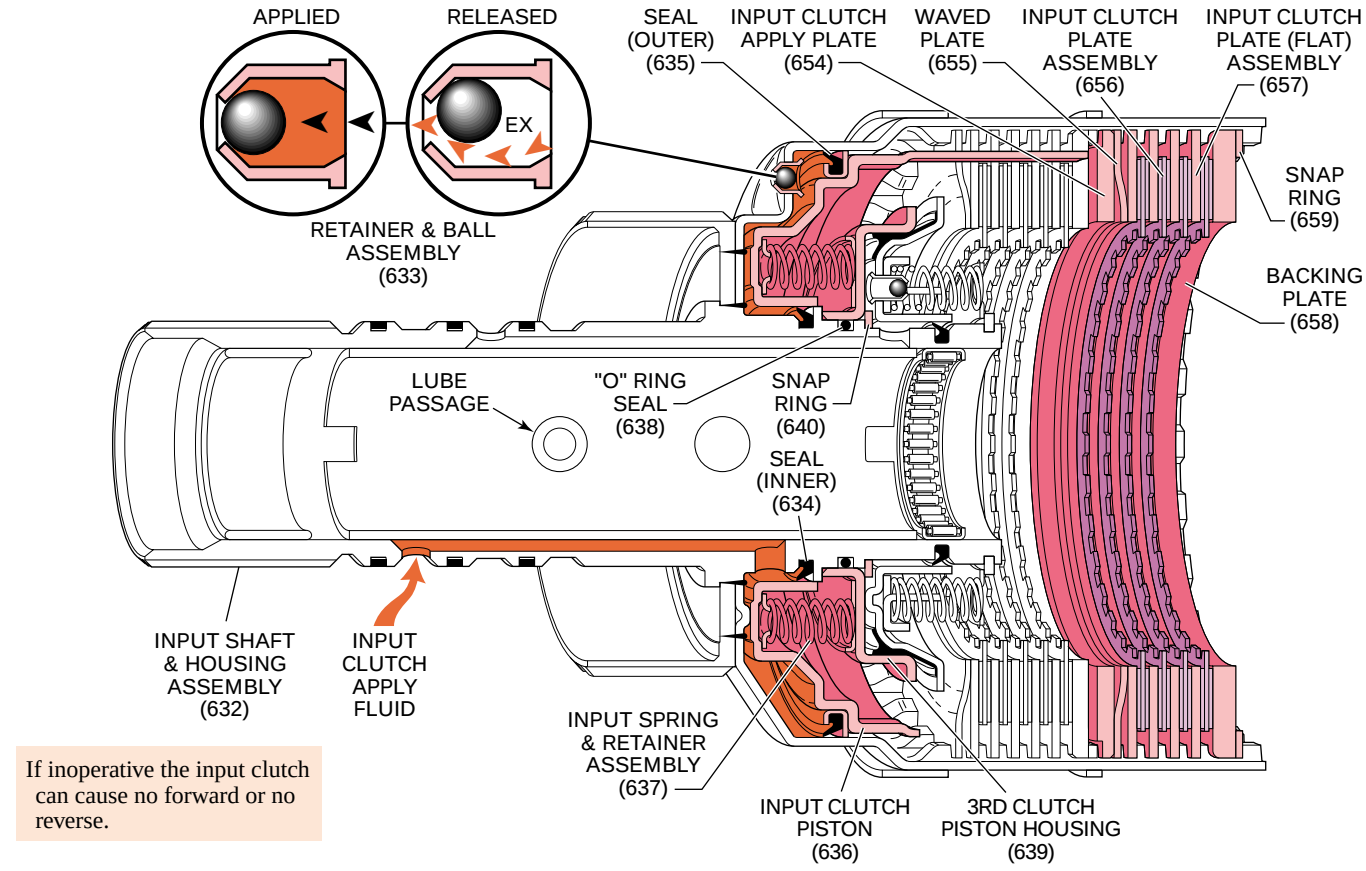


INPUT CLUTCH APPLY:
To apply the input clutch, input clutch fluid is fed through the driven sprocket support (609) and into the input shaft & housing assembly (632). A feed hole in the input shaft allows input clutch fluid to enter between the input clutch piston assembly (635-636) and input shaft & housing assembly (632). Fluid pressure seats the retainer & ball assembly (633) and moves the piston to compress the input spring & retainer assembly (637). The piston continues to move until it contacts the input clutch apply plate (654), compresses the input clutch (waved) plate (655) to cushion the apply, and, holds the input clutch plates (656 & 657) against the backing clutch plate (658) and snap ring (659).

When fully applied, the input clutch provides the power to the gear sets (672 & 675) through: the external teeth on the input clutch (waved) plate (655) and input clutch (steel) plates (657) splined to the input shaft & housing assembly (632); and, the internal teeth on the input clutch (fiber) plate assemblies (656) splined to the sprag outer race (665).

INPUT CLUTCH RELEASE:
To release the input clutch assembly (637-640 & 654-659), input clutch fluid pressure exhausts through the apply passage in the input shaft & housing assembly (632) and driven sprocket support (609). In the absence of fluid pressure, the input spring & retainer assembly (637) moves the input clutch piston assembly (635-636) and releases the input clutch apply plate (654), input clutch (waved) plate (655), and the input clutch plates (656 & 657) from the backing clutch plate (658) and snap ring (659).

During the release of the input clutch fluid, the retainer & ball assembly (633), located in the input clutch housing (632), unseats. Centrifugal force, resulting from the rotation of the input shaft & housing assembly (632), forces residual input clutch fluid to the outer perimeter of the piston housing and through the unseated retainer & ball assembly (633). If this fluid did not completely exhaust, there could be a partial apply, or drag, of the input clutch plates.



If inoperative the input clutch can cause no forward or no reverse.

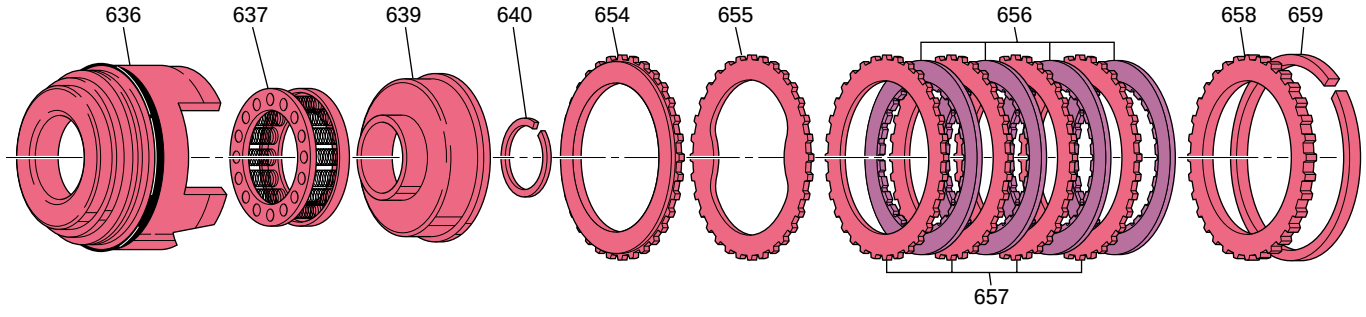


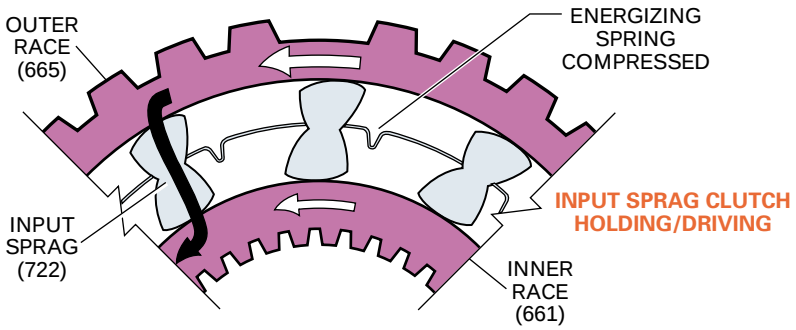
Figure 22

INPUT SPRAG CLUTCH:
The input clutch sprag assembly (661, 665, 719, 721 & 722), located inside the input shaft & housing assembly ((632), mechanically holds the input sun gear (668) during Overdrive Range First Gear as well as Manual Third, Manual First and Reverse Gear Ranges.

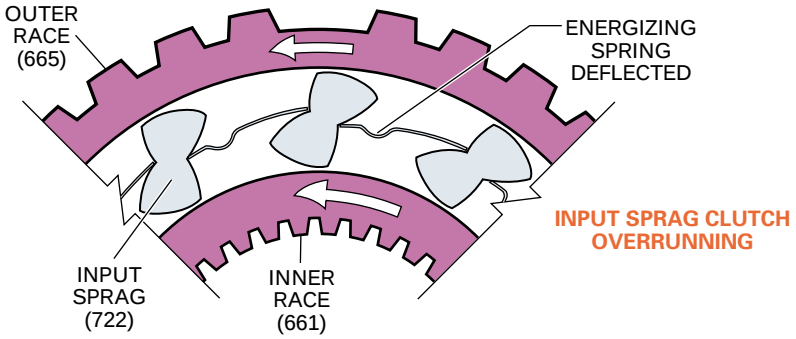
INPUT SPRAG CLUTCH HOLDING:
The input clutch assembly (637-640 & 654-659) is applied when the internal teeth on the input clutch (fiber) plate assemblies (656) - splined to the input sprag clutch outer race (665) - drive the outer race in the same direction and speed as the input shaft & housing assembly (632). The inner race and retainer assembly (661) is splined to the input sun gear (668) which is held stationary by the weight of the vehicle. Since the outer race of the sprag is forced to rotate while the inner race is stationary, the sprag elements which are suspended between the inner and outer race with energizing springs, wedge between the inner and outer races. This results in a mechanical lock-up of the sprag elements which forces the input sun gear to rotate at the same speed as the input shaft & housing assembly. Power is now provided to the planetary gear sets (672 & 675) during Overdrive Range First Gear, Manual First and Reverse Gear ranges.

INPUT SPRAG CLUTCH RELEASE:
The input sprag clutch assembly releases whenever the input clutch releases or when its elements "overrun" (freewheel). An overrunning condition occurs in Overdrive Second Gear Range or Manual Second Gear Range when the inner race and retainer assembly rotates faster than the input sprag clutch outer race. When this occurs, the sprag elements pivot (energizing spring deflects) and disengage the power flow from the outer race to the inner race.

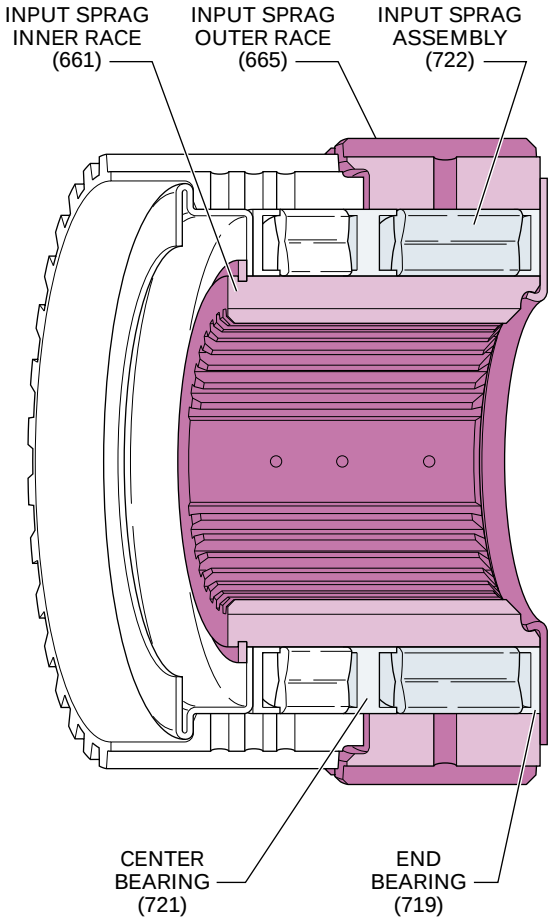
OUTER RACE (665) HELD - SPRAG (722) FORCES INNER RACE (661) TO ROTATE AT INPUT HOUSING SPEED

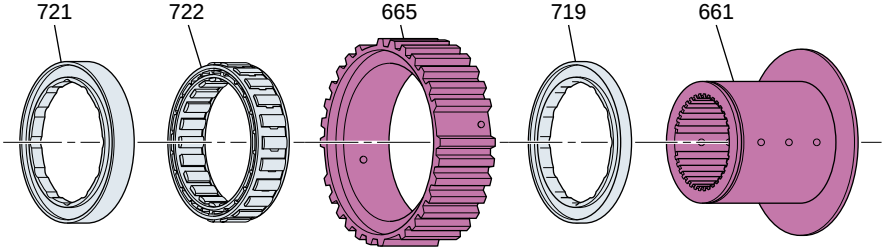


SPRAG (722) RELEASES (OVERRUNS) WHEN INNER RACE (661) (SPLINED TO INPUT SUN GEAR) ROTATES FASTER THAN THE OUTER RACE (665)



INNER RACE (661) (SPLINED TO INPUT SUN GEAR) ROTATES FASTER THAN OUTER RACE (665)

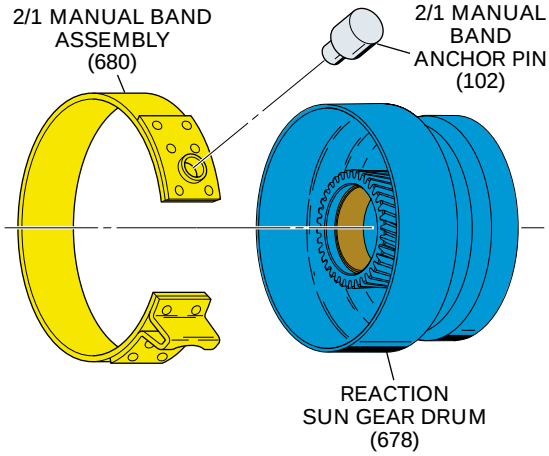




If inoperative the input sprag clutch can cause no forward and no reverse.

Figure 23

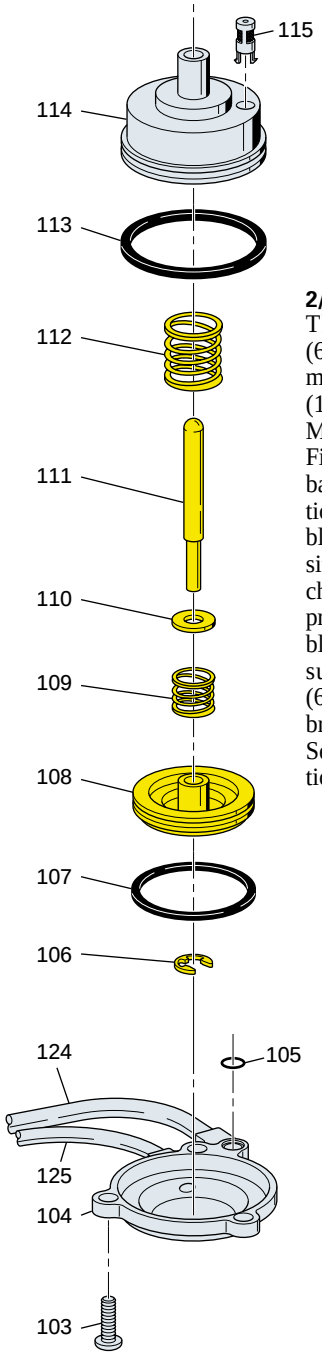
APPLY COMPONENTS



2/1 MANUAL SERVO ASSEMBLY:
The 2/1 manual servo assembly (104-116), located in the bottom of the case assembly (3), applies the 2/1 manual band assembly (680) when Manual Second and Manual First Gear Ranges are selected.

2/1 MANUAL SERVO APPLY:
To apply the 2/1 manual servo assembly (104-116), fluid in the manual 2/1 servo feed passage passes through the case (3) and manual servo apply pipe (125) to the 2/1 manual servo piston (108). Fluid pressure between the 2/1 manual servo body cover (104) and 2/1 manual servo piston (108) forces the piston and 2/1 manual apply pin (111) to move towards the 2/1 band assembly (680). This movement compresses the 2/1 manual servo cushion spring (109) and 2/1 manual servo return spring (112) allowing the apply pin (111) to compress the 2/1 band assembly (680). When the band is compressed, the reaction sun gear & drum assembly (678) is held stationary. 2/1 manual servo apply feel is primarily controlled by the 2/1 manual cushion spring (109) and the 2/1 manual return spring (112).

2/1 MANUAL SERVO RELEASE:
To release the 2/1 manual servo assembly (104-116), the gear selector lever must be positioned in a gear range other than Manual Second or Manual First Gear Range. This allows manual 2/1 servo feed fluid to exhaust through the apply passages and release pressure between the 2/1 manual servo piston (108) and the 2/1 manual servo body cover (104). Spring force from the 2/1 manual servo return spring (112) and 2/1 manual servo cushion spring (109) moves the 2/1 manual servo piston (108) and apply pin (111) away from the 2/1 band assembly (680) to release the band. When released, the reaction sun gear & drum assembly (678) can rotate if Park or Neutral Gear has been selected.



An inoperative 2/1 manual servo assembly can cause no engine braking in manual second (second gear) and manual first (first gear).

2/1 BAND ASSEMBLY:
The 2/1 band assembly (680), located above the 2/1 manual servo assembly (103-115), is applied during Manual Second and Manual First Gear Ranges only. The band wraps around the reaction sun gear drum assembly (678) and is held in position by the 2/1 band anchor pin (102). When compressed, the 2/1 band assembly (680) holds the reaction sun gear drum assembly (678) to provide engine braking for Manual First & Second Gear Range Operation only.

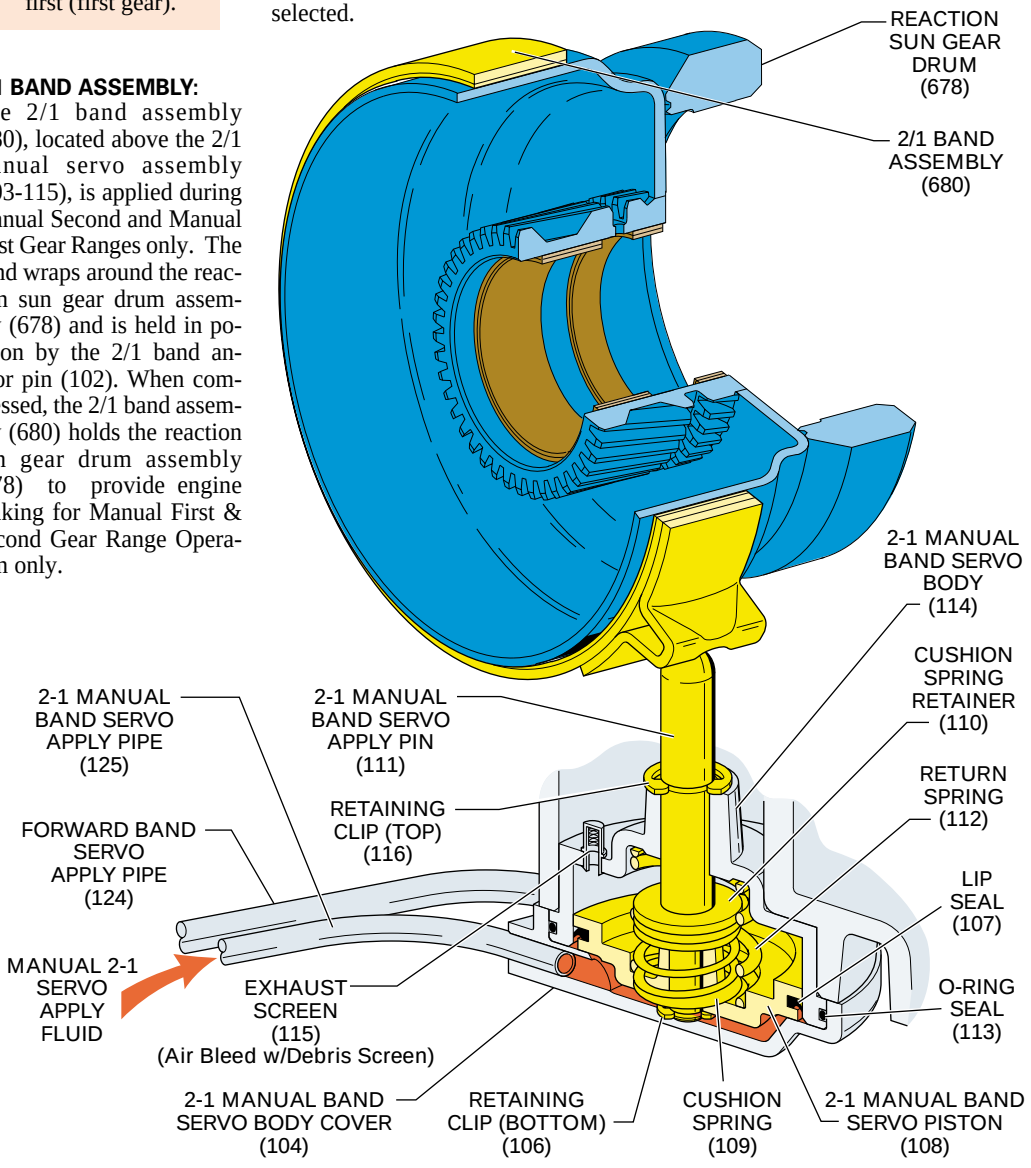


Figure 24

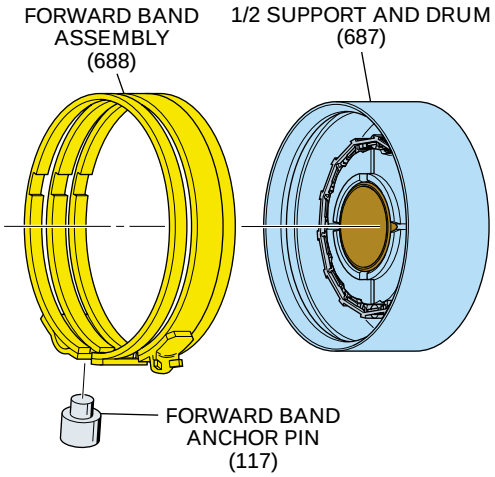
APPLY COMPONENTS

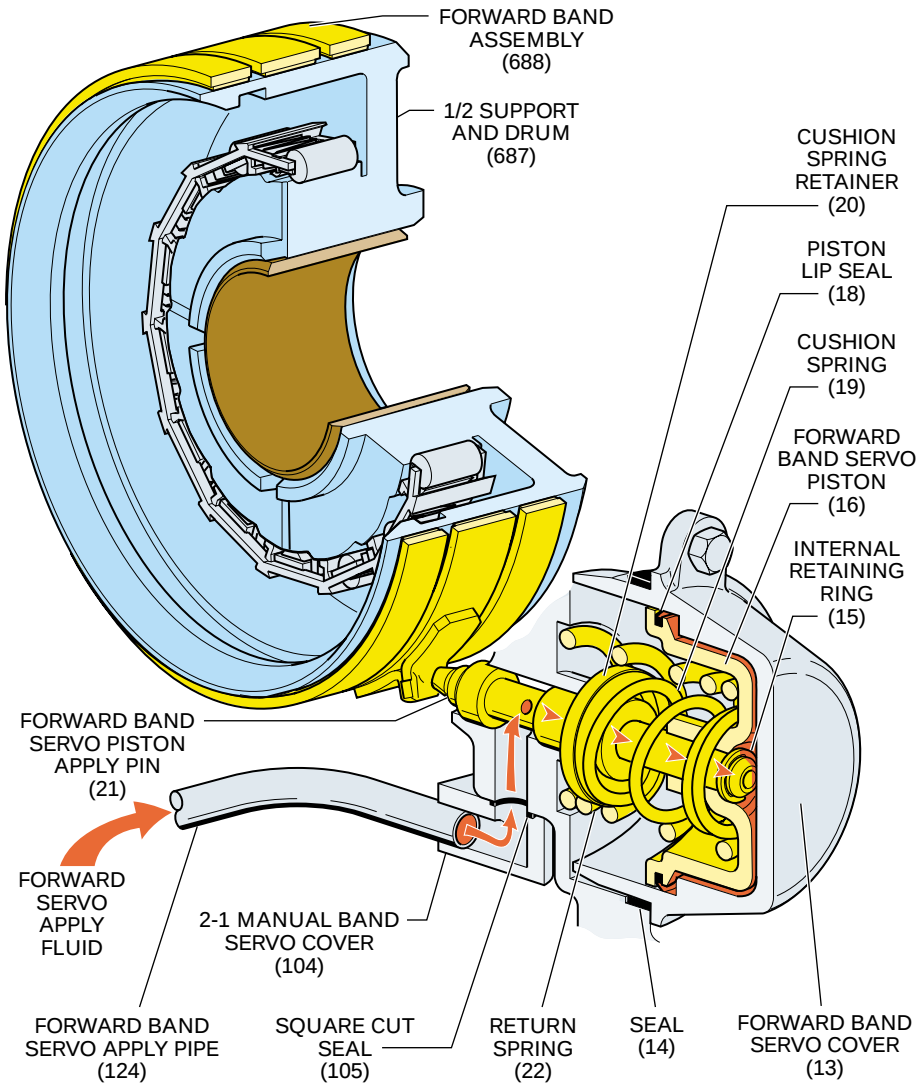
FORWARD BAND ASSEMBLY:
The forward band assembly (688), located behind the forward servo assembly (12-22), is applied or "ON" during all forward gear ranges. The band wraps around the 1/2 support roller clutch assembly (681-687) and is held in position by the band anchor pin (117). When compressed by the forward servo assembly (12-22), it holds the 1/2 support roller clutch assembly (681-687) allowing the transaxle to operate in all forward drive ranges.

FORWARD SERVO APPLY:
To apply the forward servo assembly (12-22), drive servo apply fluid is fed through the case (3), into the forward band apply pin (21) and between the forward servo cover (13) and forward servo piston (16). Pressure from the drive servo apply fluid forces the piston and forward band apply pin (21) to move towards the forward band assembly (688). The forward servo piston (16) compresses the forward servo cushion spring (19) and servo return spring (22) allowing the forward band apply pin (21) to compress the forward band assembly (688). When the band is compressed, the 1/2 support roller clutch assembly (681-687) is held stationary. Forward gear engagement feel is controlled by: the forward servo cushion spring (19); the servo return spring (22); and, the forward band apply pin (21).

FORWARD SERVO RELEASE:
To release the forward servo assembly (12-22), drive servo apply fluid pressure between the forward servo piston (16) and forward servo cover (13) exhausts through the forward band apply pin (21) and through the apply passage in the case (3). Spring force from the servo return spring (22) and forward servo cushion spring (19) move the forward servo piston (16) and forward band apply pin (21) away from the forward band assembly (688), releasing the band. When released, the 1/2 support roller clutch assembly (681-687) will rotate.

If inoperative, the forward servo assembly can cause no forward in overdrive range and manual third. Forward will be available in manual second and manual first.





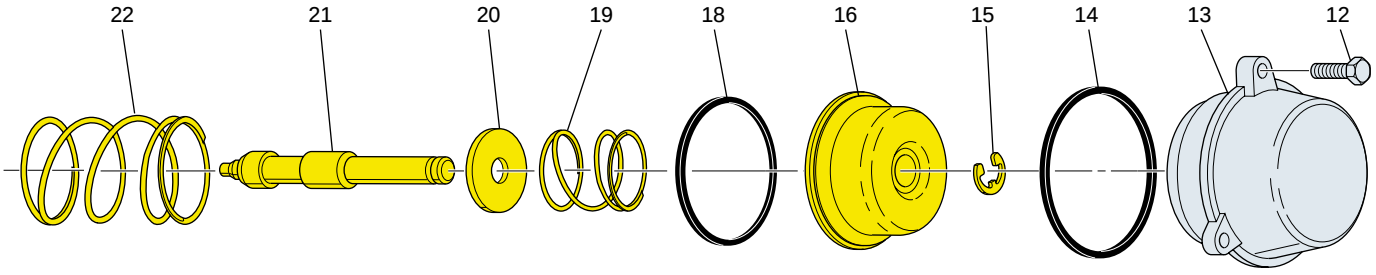
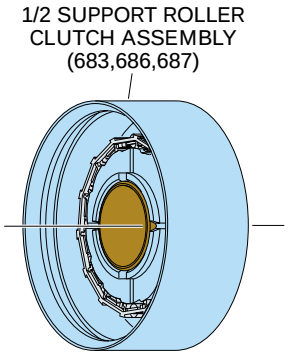


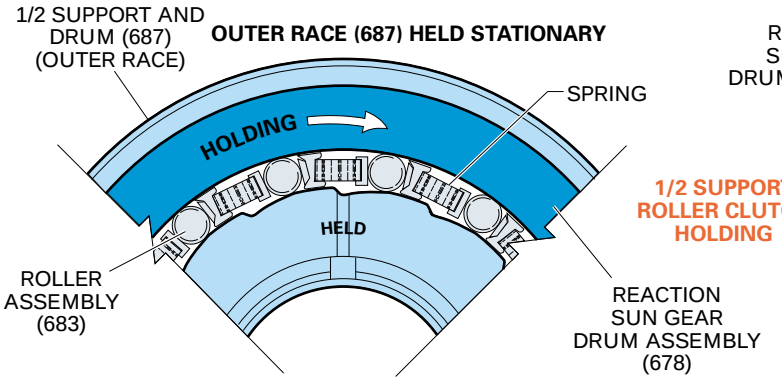
Figure 25



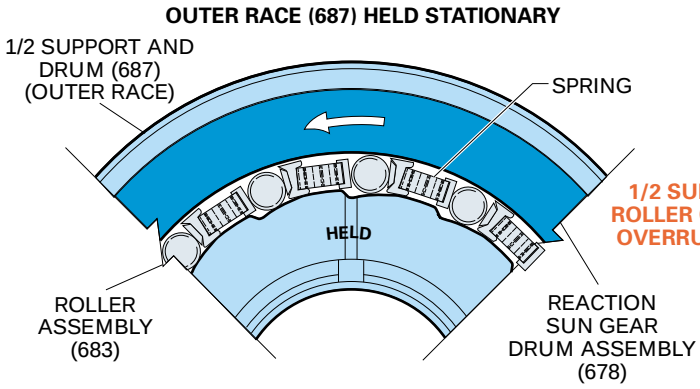
1/2 SUPPORT ROLLER CLUTCH ASSEMBLY
The 1/2 support roller clutch assembly (683), located between the reaction sun gear drum (678) and 1/2 support and drum (687), holds the reaction sun gear drum (678) during Overdrive Range First and Second Gear Ranges.

1/2 SUPPORT ROLLER CLUTCH HOLDING:
In Park, Neutral and Reverse Gear Ranges, the 1/2 support roller clutch assembly (683) and the reaction sun gear drum (678) rotate freely in the opposite direction of the driven sprocket (506). When the forward band assembly (688) is applied it stops the rotation of the 1/2 support and drum assembly. Since the reaction sun gear drum (678) is attached to the outer race, the roller assembly (683) is forced to the narrow end of the ramp and wedges between the inner race and outer race. When this occurs, the reaction sun gear drum (678) is held to provide power flow through the reaction carrier (675).

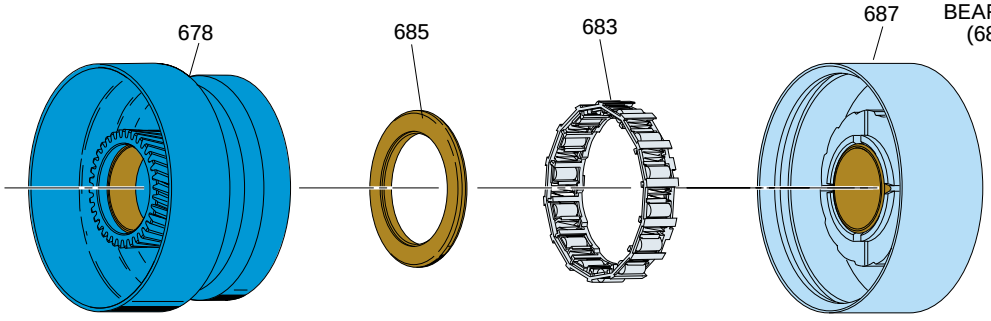
1/2 SUPPORT ROLLER CLUTCH RELEASE:
The 1/2 support roller clutch assembly (683 & 687) releases when it "overruns" or when the forward band assembly (688) is not "Applied". An overrunning condition occurs when the transaxle is in Overdrive Third or Fourth Gear Range and also in Manual Third Gear Range. Power flow through the reaction carrier assembly (675) causes the reaction sun gear drum and outer race (678) to rotate, moving the 1/2 support roller clutch rollers to the wide end of the ramp. When this occurs, the 1/2 support roller clutch (683) releases and the 1/2 support outer race overruns the stationary 1/2 support roller clutch inner race (687).

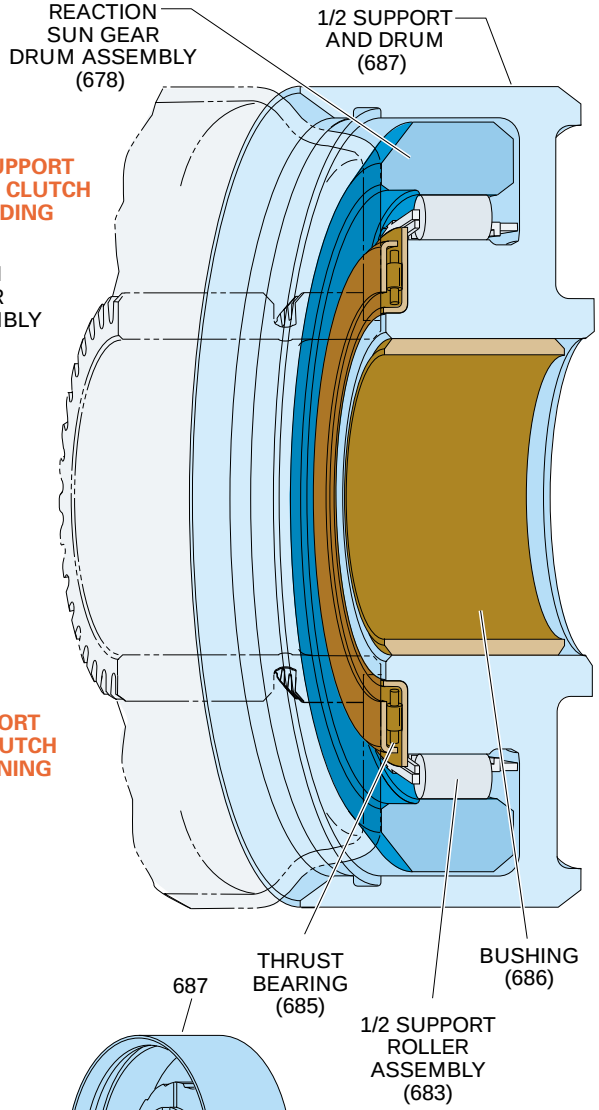


INNER RACE (687) HOLDING - PREVENTS THE REACTION SUN GEAR DRUM (678) FROM ROTATING OPPOSITE TO INPUT HOUSING ROTATION



OUTER RACE (678) ROTATES AS THE INNER RACE (687) REMAINS STATIONARY





Inoperative 1/2 support roller clutch assembly can cause no forward in overdrive range and manual third. Forward will be available in manual second and manual first.

Figure 26

PLANETARY GEAR SETS

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 its component parts and their rotation around an axis (center line to the axles) is the primary reason why a planetary gear set was given this name. This arrangement not only provides for a strong and compact 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 transmissions) is eliminated because the gear teeth are always in mesh.

General Component Arrangement and Function:
All planetary gear sets contain at least three main components:

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

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

As stated above, when engine torque is transferred through a gear set, the output torque from the gear set either increases or decreases. If output torque is higher than input torque, then the gear set is operating in reduction (1st and 2nd gear ranges). On the other hand, if output torque is lower than input torque, then the gear set is operating in overdrive (4th gear). A third possible condition also exits and that is when input torque equals output torque. This condition is called direct drive because neither reduction nor overdrive occurs through the gear set. To achieve these various operating conditions, specific components of the gear set must provide the input torque while other components must be held stationary. Detailed explanations of these gear set functions are provided on pages 28 and 29.

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 efficient operation of the powertrain.

Hydra-matic 4T65-E Gear Sets:
The Hydra-matic 4T65-E transaxle combines two gear sets that provide five gear ratios (four forward and one reverse) for transferring torque to the drive axles. The four main components used in these gear sets are:

- the input sun gear (668)
- the input carrier assembly (672) with an internal gear for the reaction carrier
- the reaction carrier assembly (675) with an internal gear for the input carrier, and
- the reaction sun gear and drum assembly (678).

Another gear set used in the Hydra-matic 4T65-E transaxle is the differential/final drive carrier assembly (700). Information regarding its purpose and function is discussed on page 30.

Gearset failure can cause noise and loss of drive.

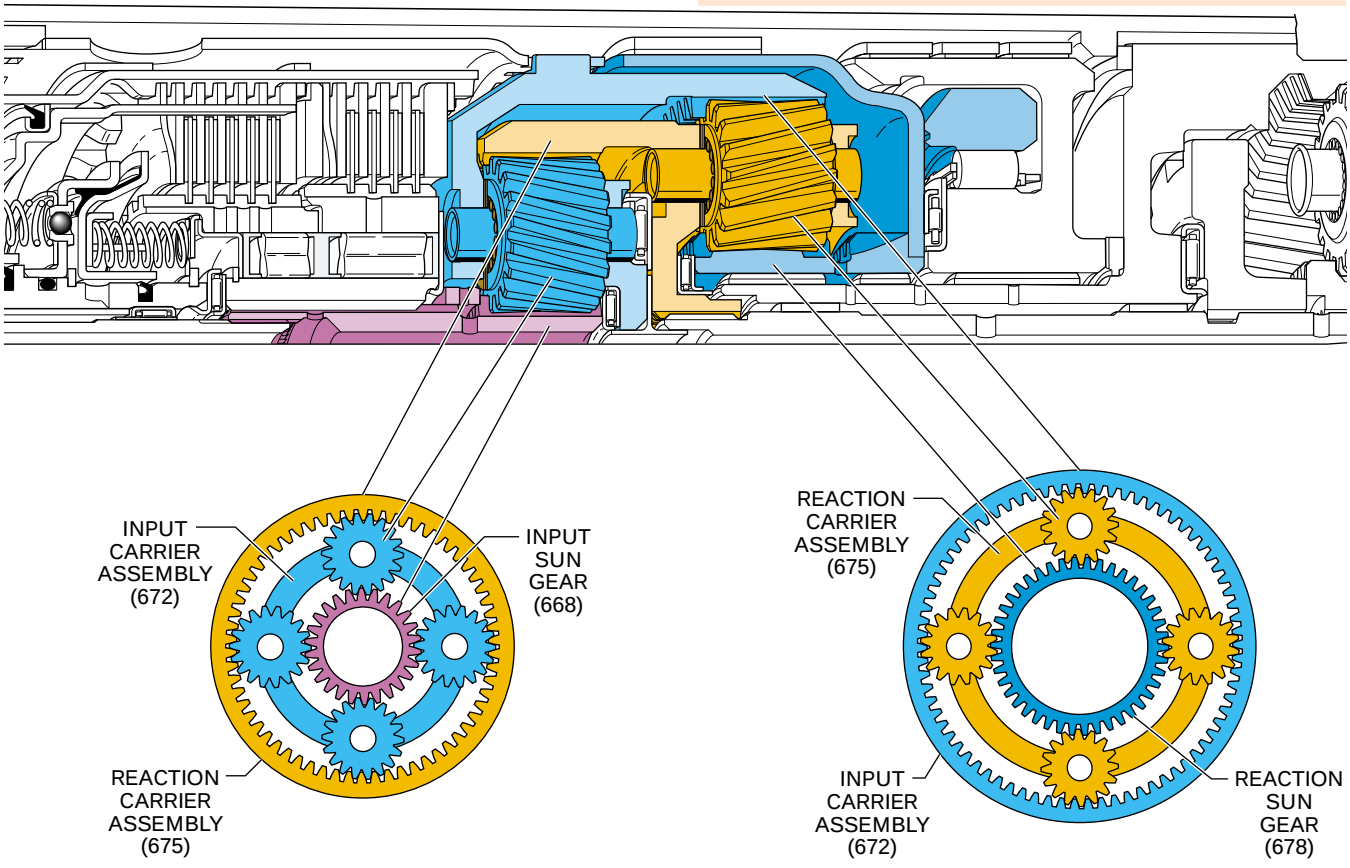


Figure 27

PLANETARY GEAR SETS

REDUCTION:
Increasing the torque is generally known as operating in reduction because there is always a decrease in the speed of the output member proportional to the increase in the output torque. Stated in another way, with a constant input speed, the output torque increases as the output speed decreases.

Reduction occurs in First Gear and Second Gear Ranges, when the reaction sun gear drum assembly (678) is held stationary through the 1/2 support roller clutch assembly (683-687). The planetary pinions on the reaction carrier assembly (675) are forced to rotate in a counterclockwise direction and "walk" around the stationary reaction sun gear drum assembly (678). This rotation of the reaction carrier assembly (675) allows the transaxle to operate in gear reduction.

DIRECT DRIVE:
Direct drive is obtained when any two members of the planetary gear set rotate in the same direction at the same speed forcing the third member to also rotate at the same speed. In this mode of operation the planetary pinion gears do not rotate on their pins, but act as wedges to drive the entire gear set as one rotating part. Thus, the output speed of the transaxle is the same as the input speed from the torque converter turbine. Output speed will equal engine speed when the torque converter clutch is applied (see torque converter, page 12).

Direct drive occurs in Overdrive Range Third Gear when the second clutch assembly (617-627) drives the input carrier assembly (672) while the third sprag clutch assembly (653, 661, 717,-721) prevents the input sun gear (668) from turning faster than turbine speed. With these two members of the planetary gear set rotating in the same direction and at the same speed the transaxle is operating in direct drive.

OVERDRIVE:
Operating a transaxle in overdrive enables the output speed of the transaxle to be greater than the input speed. This mode of operation allows a vehicle to maintain a relatively high road speed with a reduced engine speed to improve fuel economy. When the transaxle is operating in overdrive, the output speed increases while the output torque decreases proportionally.

Overdrive occurs in Overdrive Range Fourth Gear when the input sun gear (668) is held stationary by the fourth clutch shaft (504) and power is applied to the input carrier assembly (672). The input carrier planetary pinions "walk" around the stationary input sun gear (668) driving the reaction carrier assembly (675) faster than the input carrier assembly (672). The transaxle is now capable of operating in overdrive.

REVERSE:
A planetary gear set reverses its direction of rotation when the input carrier is held stationary and power is applied to a sun gear. This causes the planet pinions to act as idler gears thus driving the output member in the opposite direction.

Reverse direction of rotation occurs in Reverse Gear Range when the input carrier assembly (672) is held stationary through the reverse band assembly (615) and reverse reaction drum (669). The input sun gear (668) provides the power to the input carrier pinion gears thus driving the reaction carrier assembly (675) in the opposite direction. The transaxle is now operating in reverse.

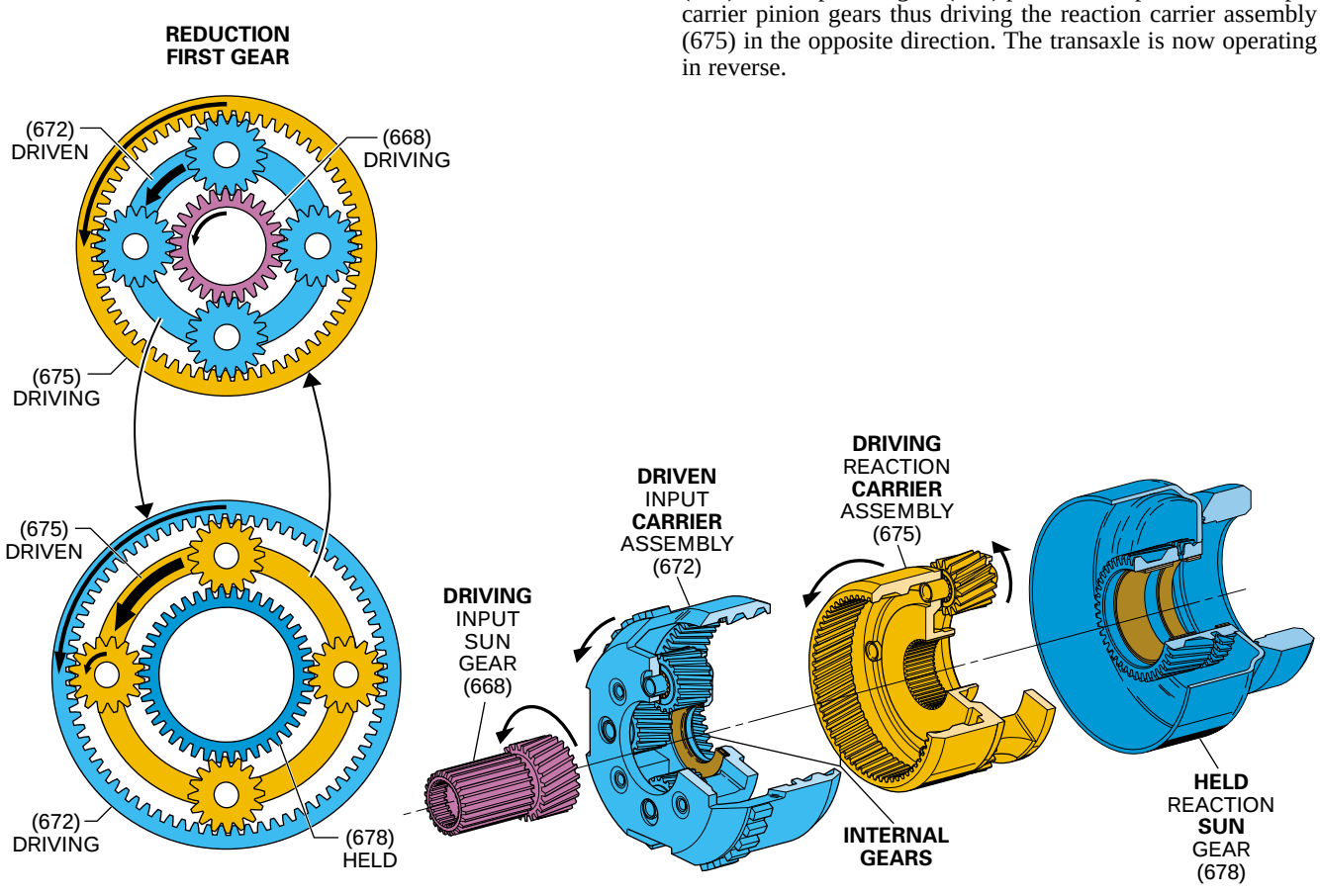


Figure 28

PLANETARY GEAR SETS

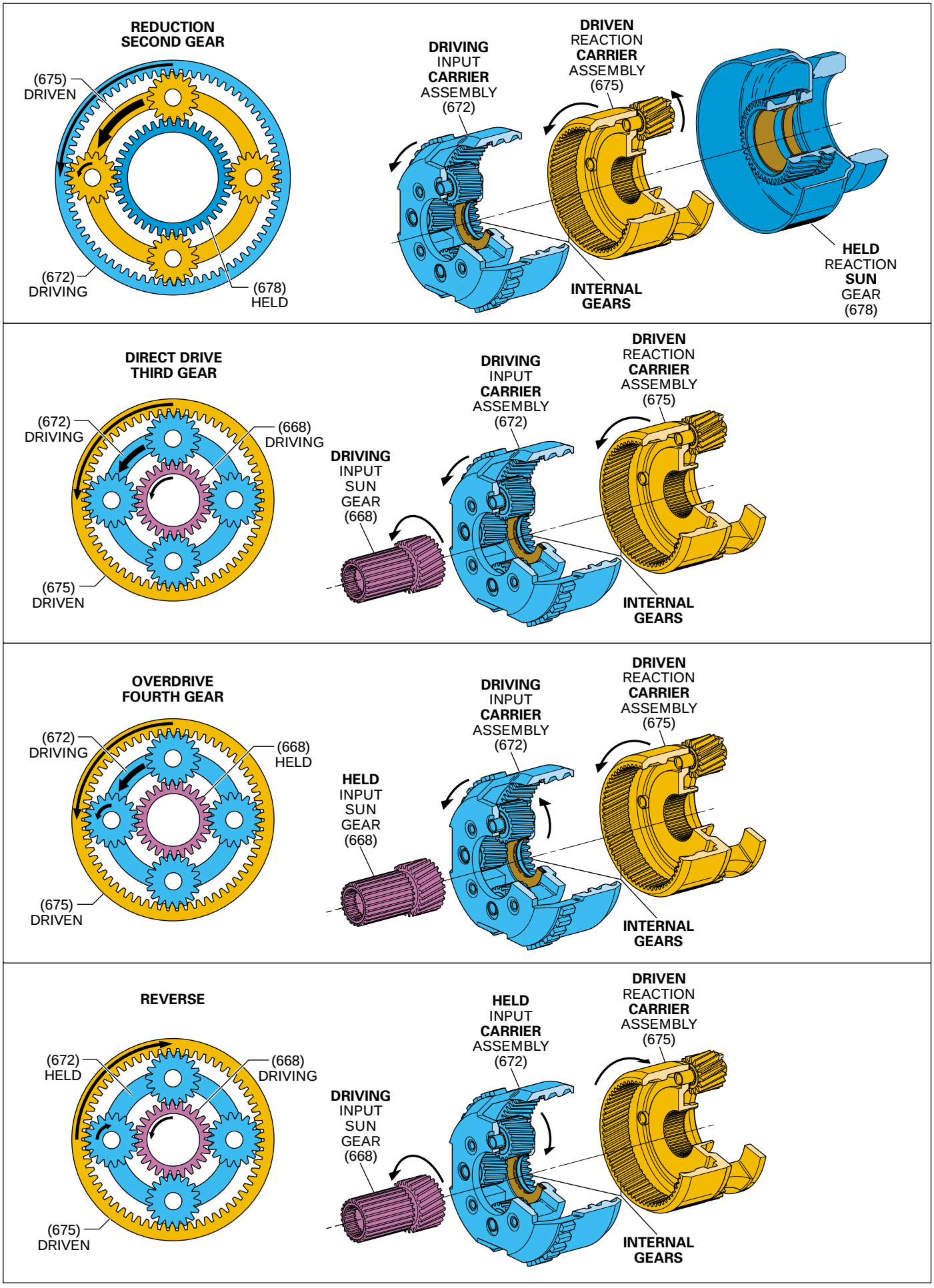
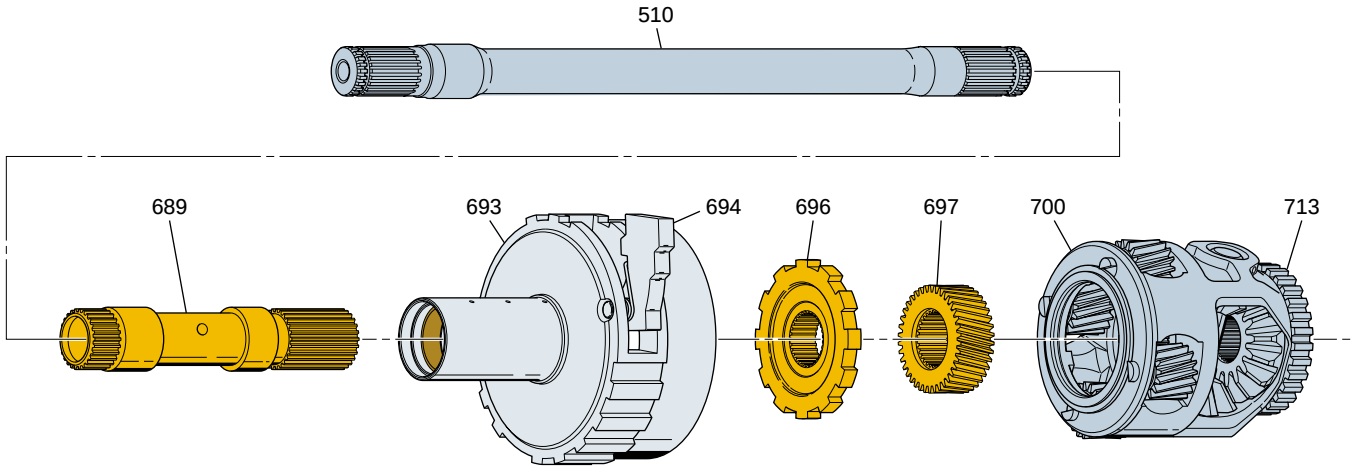
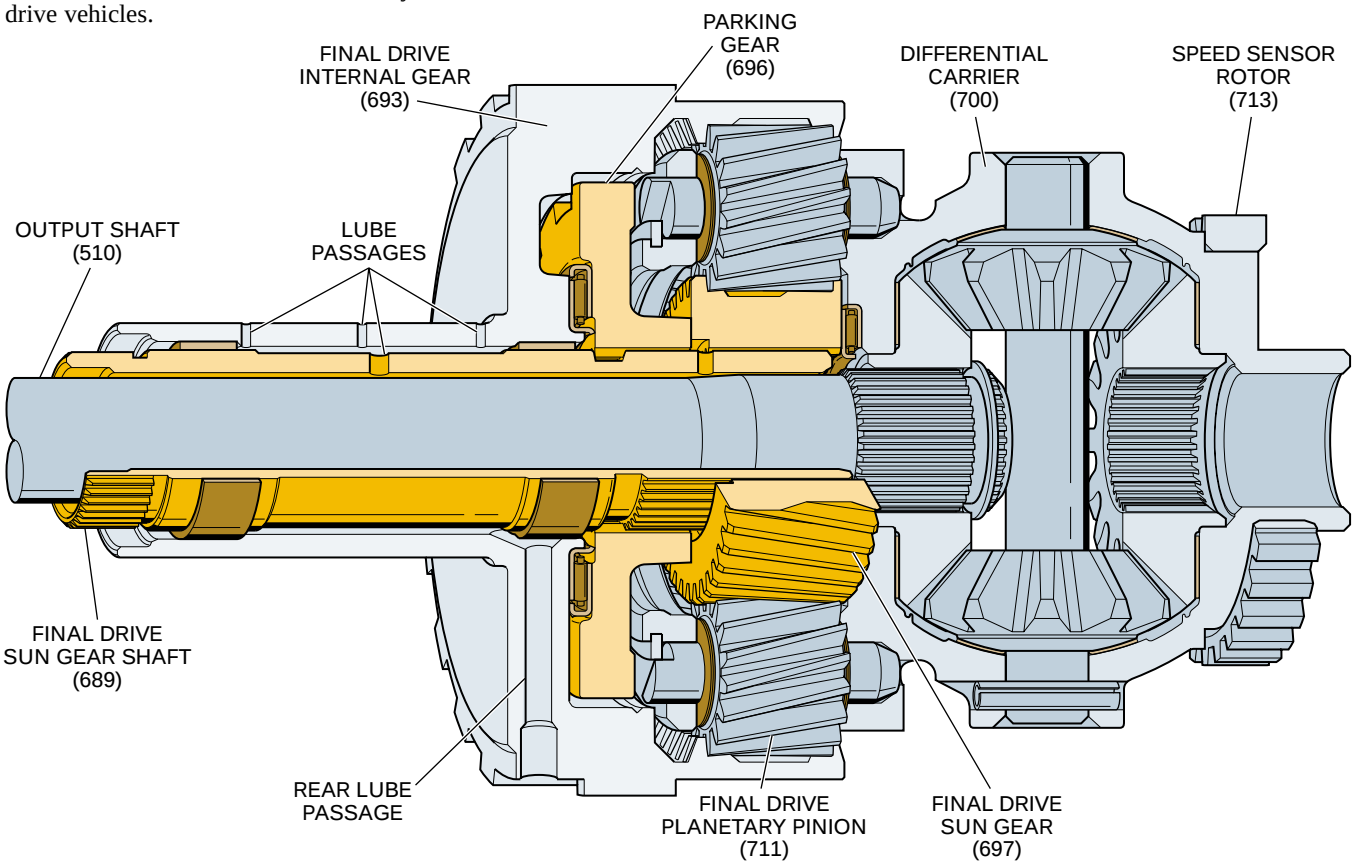


Figure 29

FINAL DRIVE COMPONENTS



FINAL DRIVE AND DIFFERENTIAL ASSEMBLIES:
All Hydra-matic transaxles (transversely mounted to the body) are required to transfer the power from the final drive sun gear shaft (689) to the drive axles of the vehicle. This is accomplished by the final drive and differential components located at the output end of the gear train. These components perform the same function as the rear axle assembly found in all rear wheel drive vehicles.



FINAL DRIVE ASSEMBLY:
The final drive assembly is a planetary gear set consisting of: a final drive internal gear (693) splined to the case (3); a final drive sun gear (697) splined to the final drive sun gear shaft (689); and, the final drive planetary pinions located in the differential and final drive carrier assembly (700).

The final drive planetary gear set operates in reduction at all times. Power through the final drive sun gear shaft (689) drives the final drive sun gear (697) in the same direction as engine rotation, but forces the final drive planetary pinion gears (711) to rotate in the opposite direction inside the final drive internal gear (693). Since the final drive internal gear (693) is held stationary by the case (3), the differential and final drive carrier assembly (700) rotates in the same direction as engine rotation.

The gear ratio of the final drive and differential assemblies performs the same functions as the ring and pinion gears in a conventional rear axle unit. It is a fixed final drive axle ratio that is required to match the engine power and drive train to the vehicle requirements for all normal operating conditions.

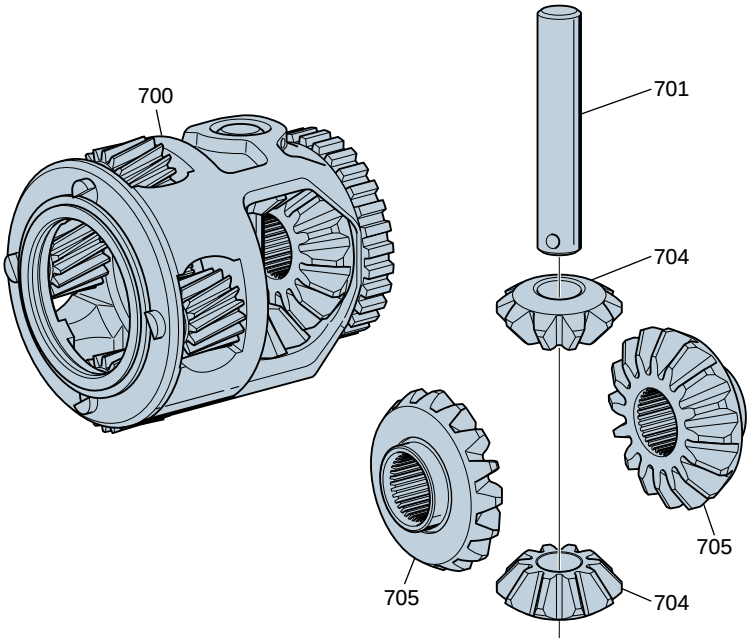
Figure 30

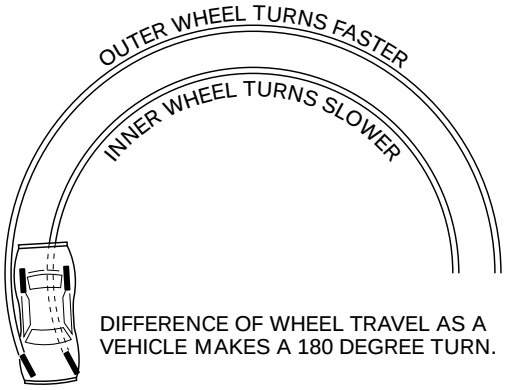
DIFFERENTIAL COMPONENTS

DIFFERENTIAL CARRIER ASSEMBLY:
The (final drive) differential carrier assembly (700) 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 (700) consists of: a differential and final drive carrier assembly; four bevelled gears; and, a differential pinion shaft (701). Two bevelled gears, the differential side gears (705), are splined to the axle shafts (the left hand axle shaft is splined to the output shaft (510) which connects with the side gear). The other two bevelled gears, the differential pinion gears (704), act as idlers to transfer the power from the differential carrier (700) to the differential side gears (705). The differential pinion gears (704) also balance the power load between the differential side gears (705) while allowing unequal axle rotation speeds when the vehicle is in a curve.

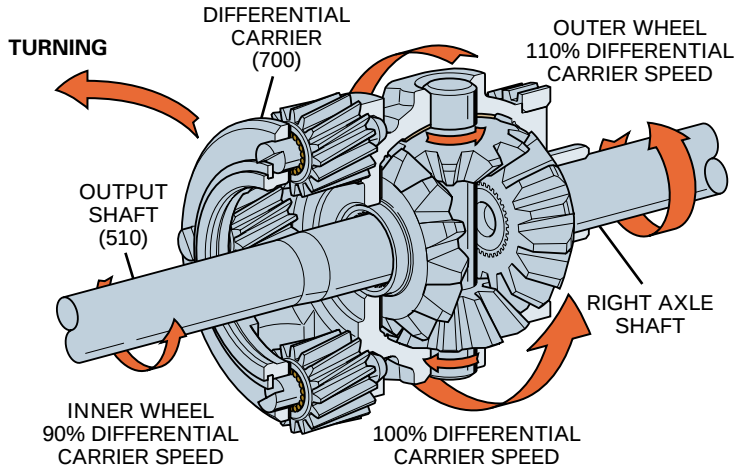
A noise condition, usually a hum (under light throttle or turns), will be associated with a final drive/differential condition.

Final drive/differential failure can cause loss of drive.

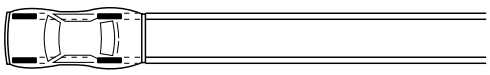




DIFFERENCE OF WHEEL TRAVEL AS A VEHICLE MAKES A 180 DEGREE TURN.



When the vehicle is driven in a straight line, the differential pinion gears (704), differential side gears (705) and differential carrier (700) rotate as a fixed unit. The end result is both axle shafts rotate in the same direction as engine rotation for all forward gear ranges.



BOTH WHEELS TURNING AT SAME SPEED

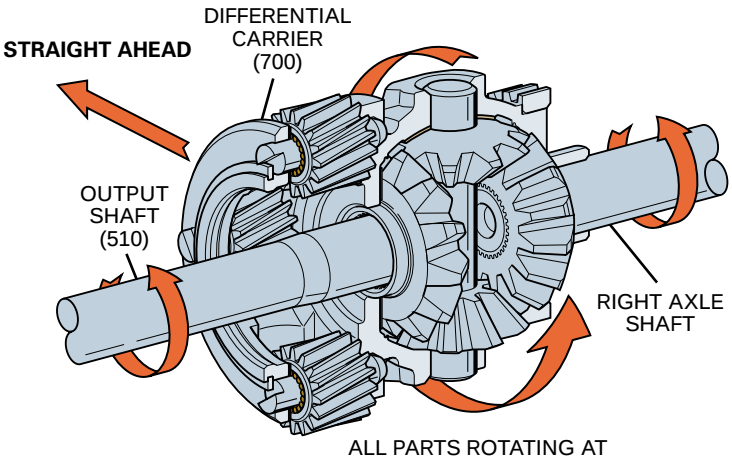


Figure 31

NOTES

HYDRAULIC CONTROL COMPONENTS

The previous sections of this book were used to describe some of the mechanical component operation of the Hydra-matic 4T65-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.

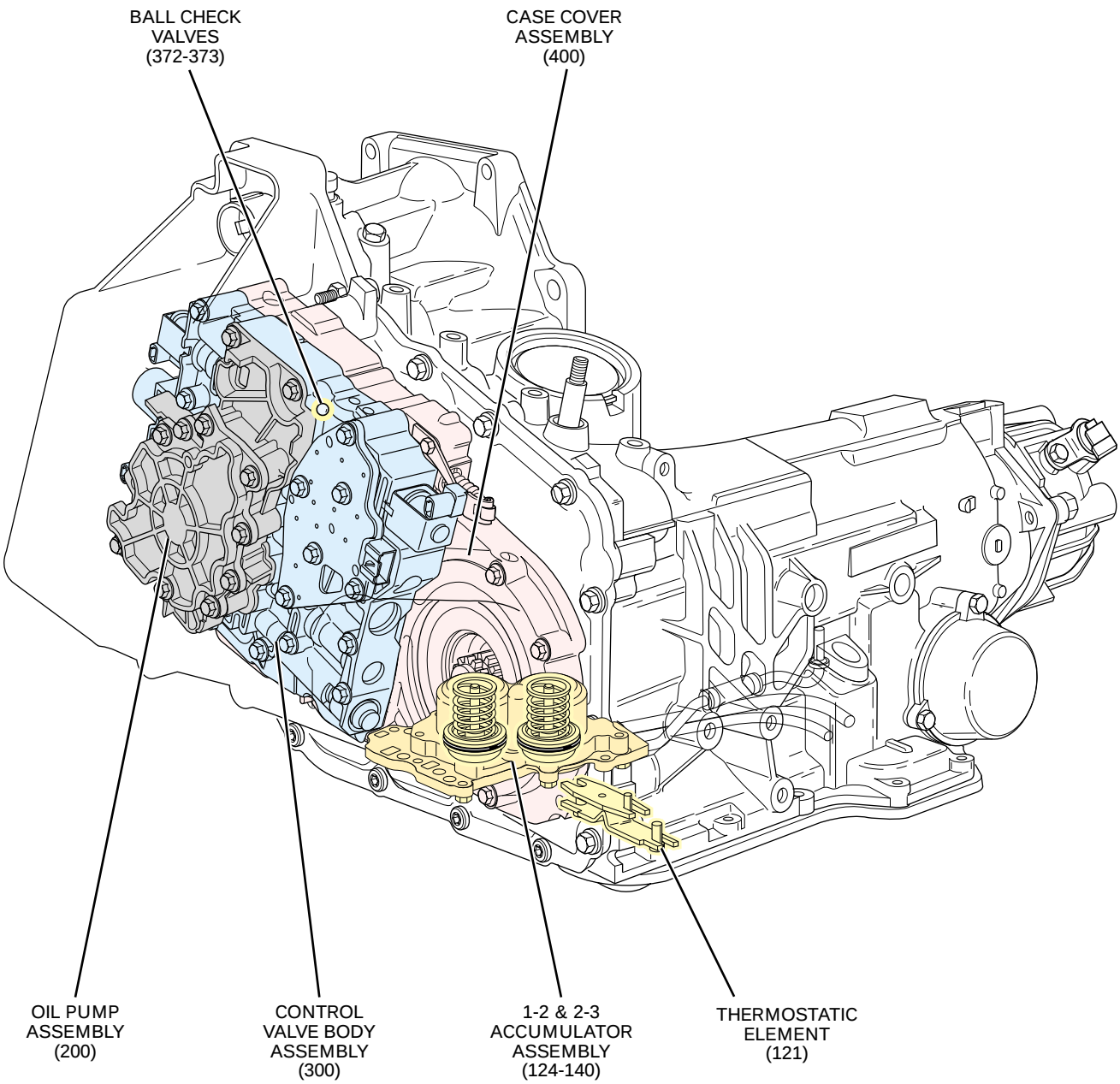
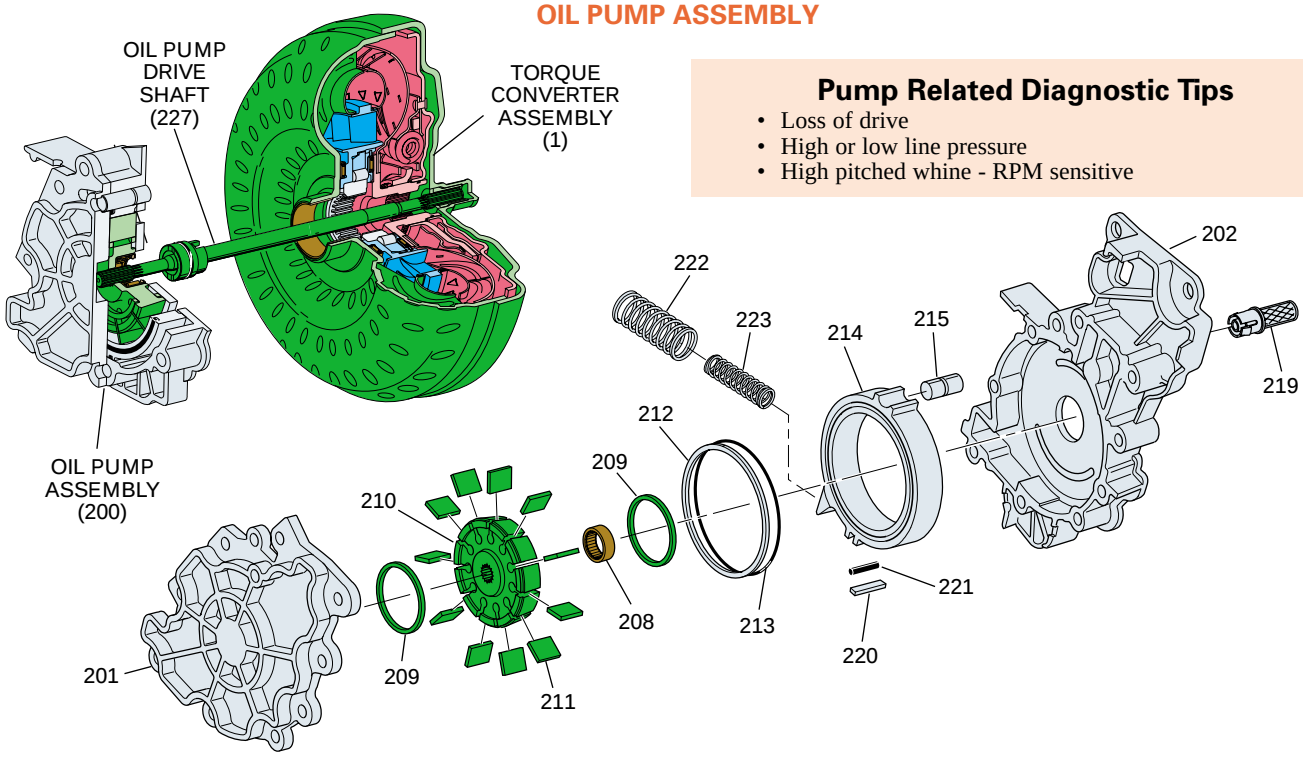


Figure 32

HYDRAULIC CONTROL COMPONENTS

OIL PUMP ASSEMBLY



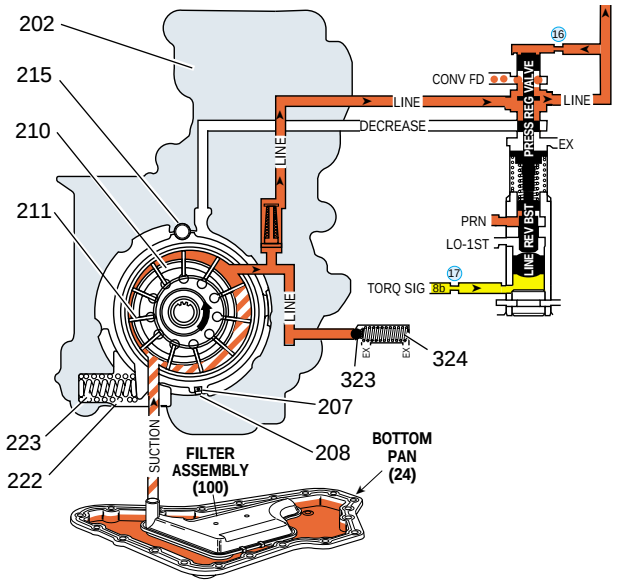
Pump Related Diagnostic Tips

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

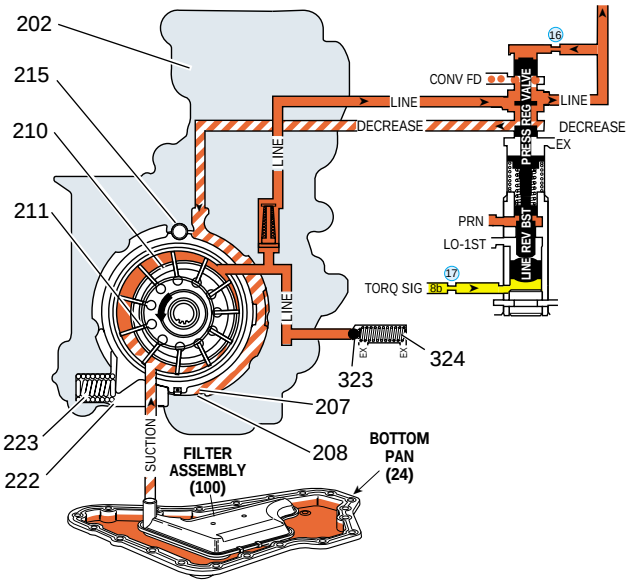
The oil pump assembly (200) contains a variable displacement vane type pump located in the oil pump body (202). When the engine is cranking, the oil pump drive shaft assembly (227), which is splined to the converter cover, turns the oil pump rotor (210) at cranking speed. As the oil pump rotor (210) and pump vanes (211) begin to rotate, the volume of fluid between the vanes is at its 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 (24) is drawn through the filter assembly (100) and into the pump intake circuit. Fluid is then forced to rotate around the oil pump slide (214) to the pump outlet where the clearance between the oil pump slide and oil pump rotor 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 curcuits in the transaxle. Since the pump assembly is bolted to the control valve assembly (300), 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 (313) is applied to the backside of the oil pump slide. Decrease pressure moves the slide against pump priming spring pressure to lower the output of the pump. When the pump priming springs (222-223) are compressed and the oil pump slide contacts the oil pump body, minimum pump output occurs.



MAXIMUM PUMP OUTPUT



MINIMUM PUMP OUTPUT

Figure 33

PRESSURE REGULATION

The main component that is used to control line pressure is the pressure regulator valve (313), located in the valve body (300). 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 springs (222, 223) and moves the slide. As the slide moves towards the center of the pump body (202), clearance on the intake side of the oil pump slide (214) and oil pump rotor (210) 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 (322) and the torque signal regulator valve provide 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 or harsh apply
- Low or no cooler/lube flow

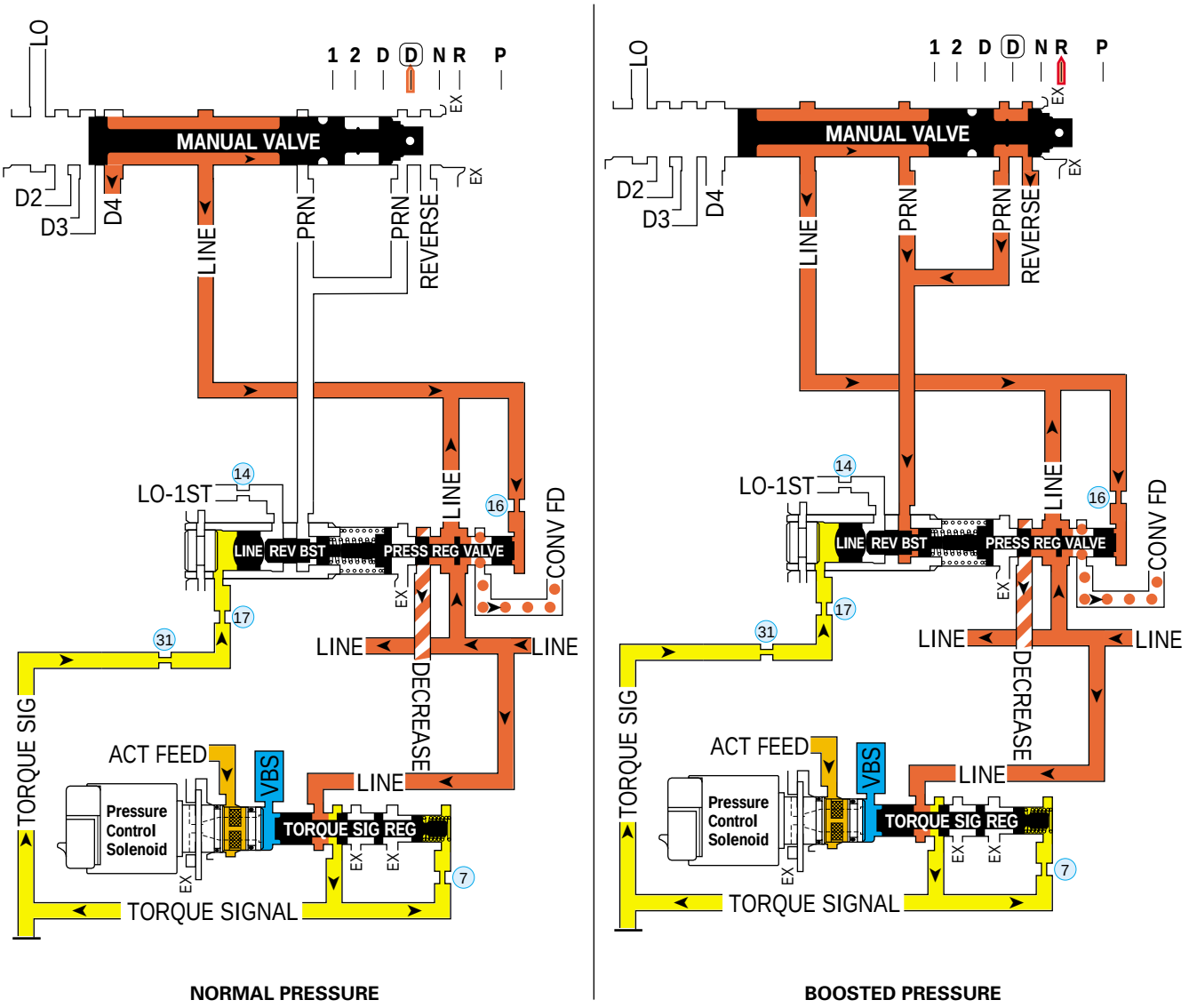


Figure 34

HYDRAULIC CONTROL COMPONENTS

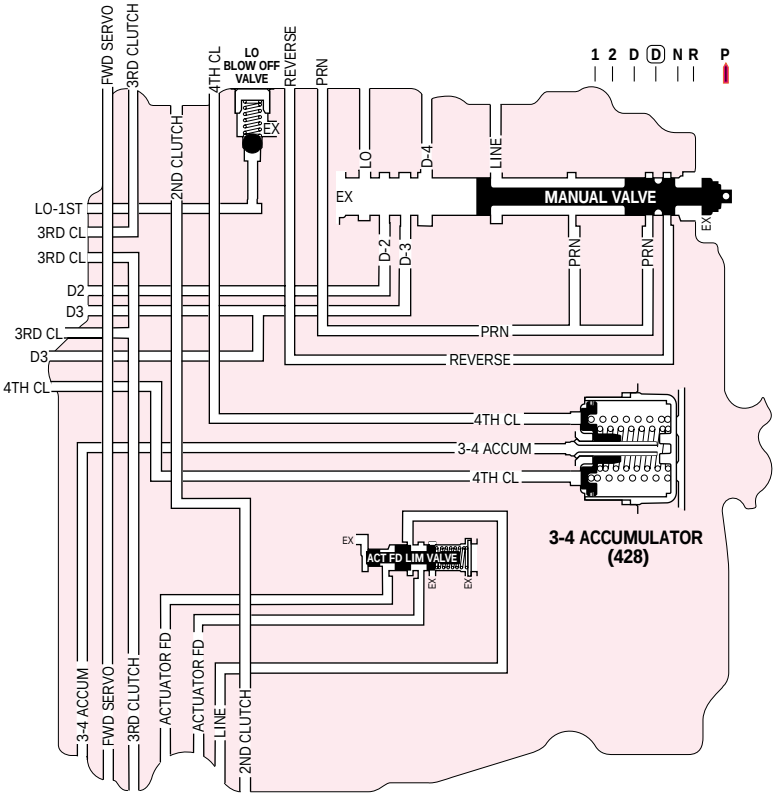
VALVES LOCATED IN CASE COVER

MANUAL VALVE (404):
The manual valve 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, D4, D3, D2 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



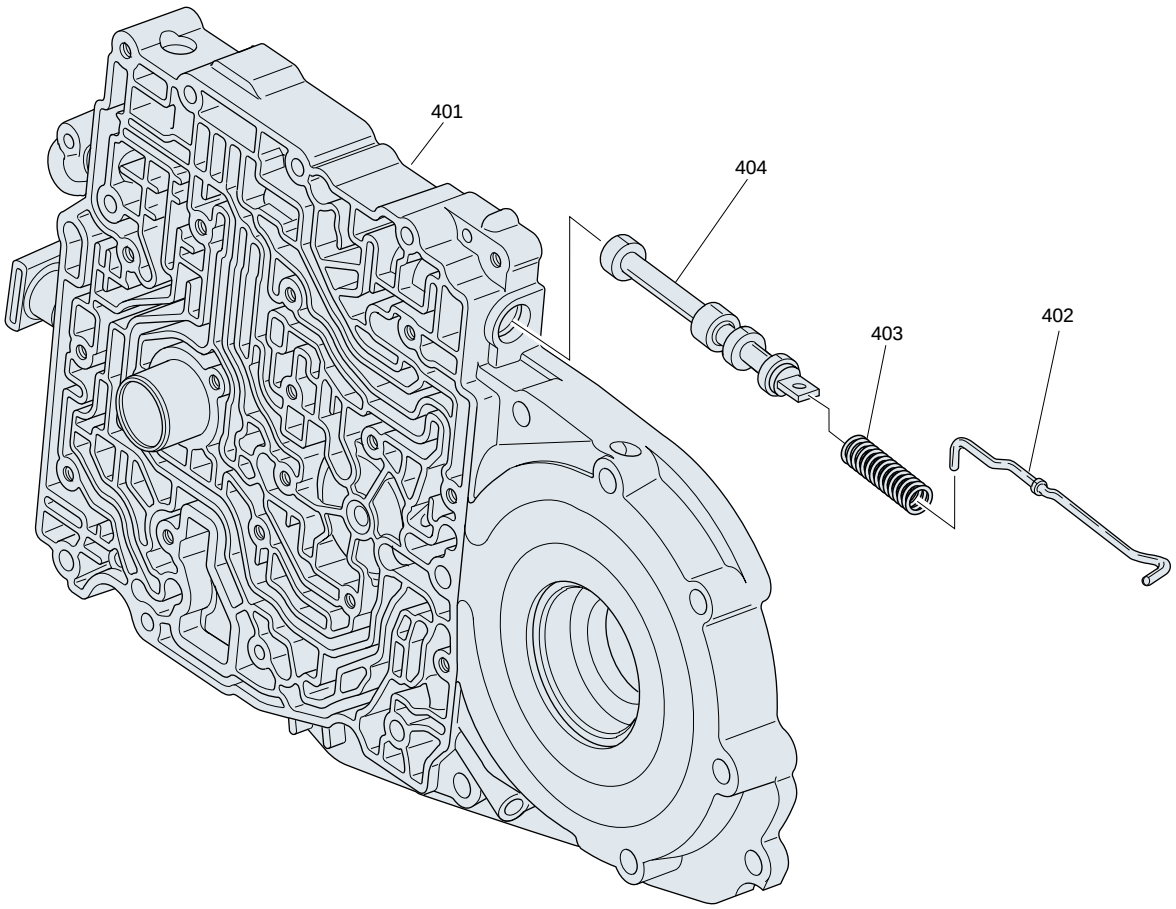


Figure 35

HYDRAULIC CONTROL COMPONENTS

VALVES LOCATED IN CASE COVER

LO BLOW OFF VALVE LINEUP (405, 406 & 420A):
The lo blow off valve (420A) is a pressure relief valve that exhausts excess lo-1st fluid pressures above 448 kPa (65 psi) in the 3rd clutch apply circuit.

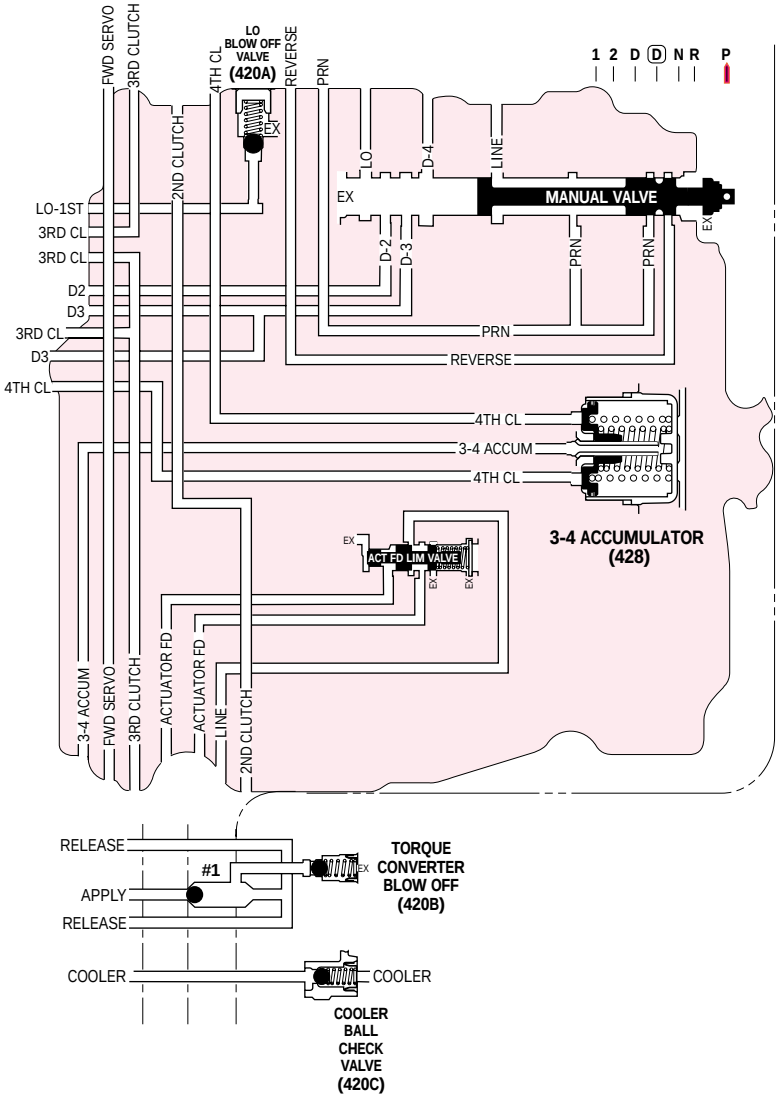
> Damaged/missing valve, spring or spring retainer can cause incorrect line pressure.

TCC BLOW OFF BALL CHECK VALVE LINEUP (417, 418 & 420B):
The TCC blow off ball check valve (420B) is held closed by spring force from the TCC blow off spring (418). If converter clutch release or apply fluid pressure exceeds 690 kPa (100 psi), the ball check valve moves against spring force to exhaust the excess pressure.

> Damaged/not seating valve or spring can cause converter clutch slips, shudders, rough TCC apply or no TCC apply. Also could cause delayed Park to Reverse/Drive engagement.

COOLER BLOW OFF BALL CHECK VALVE LINEUP (407, 417 & 420C):
The cooler blow off ball check valve (420C) is held closed by spring force from the cooler blow off spring (407). If cooler fluid pressure exceeds 690 kPa (100 psi), the ball check valve moves against spring force to exhaust the excess pressure.

ACTUATOR FEED LIMIT VALVE TRAIN (414-416):
The actuator feed limit valve is a spool type regulating valve that regulates line fluid pressure into actuator feed fluid pressure. Actuator feed fluid then feeds the pressure control solenoid and the shift solenoids after passing through a filter (screen assembly 382).



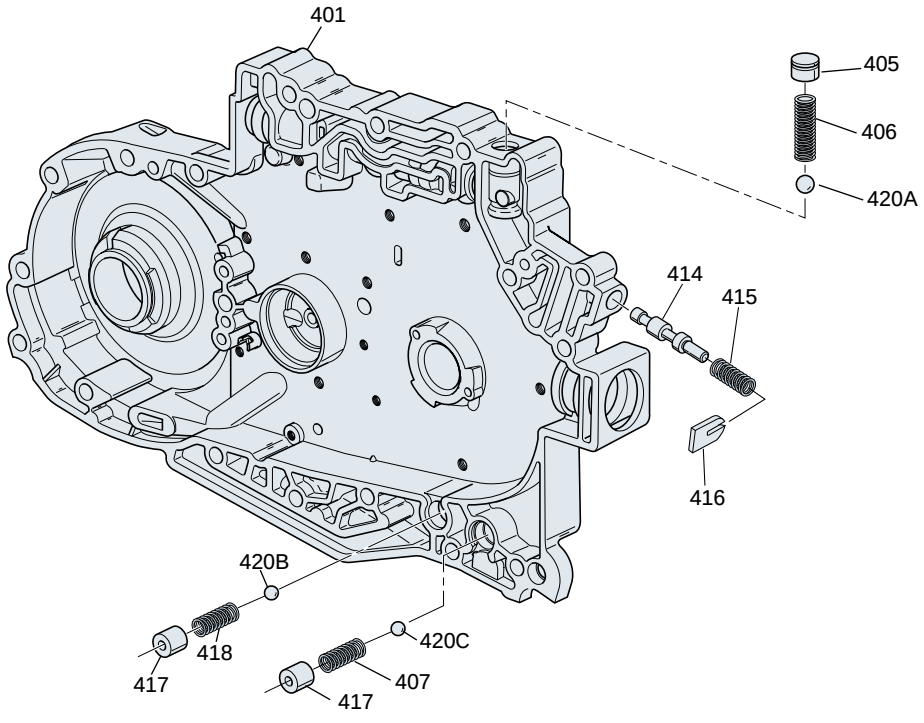


Figure 36

HYDRAULIC CONTROL COMPONENTS

ACCUMULATORS

In the Hydra-matic 4T65-E, accumulators are used in the 2nd, 3rd 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 fluid biased accumulator pressure to act like a shock absorber.

During the apply of the 2nd, 3rd and 4th 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 force of the accumulator spring and accumulator fluid pressure together control the rate at which a clutch applies. In the Hydra-matic 4T65-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 regulated by the pressure control solenoid, (which is controlled by throttle position through the PCM), the accumulator valves regulate accumulator fluid pressure in proportion to throttle position to control shift feel.

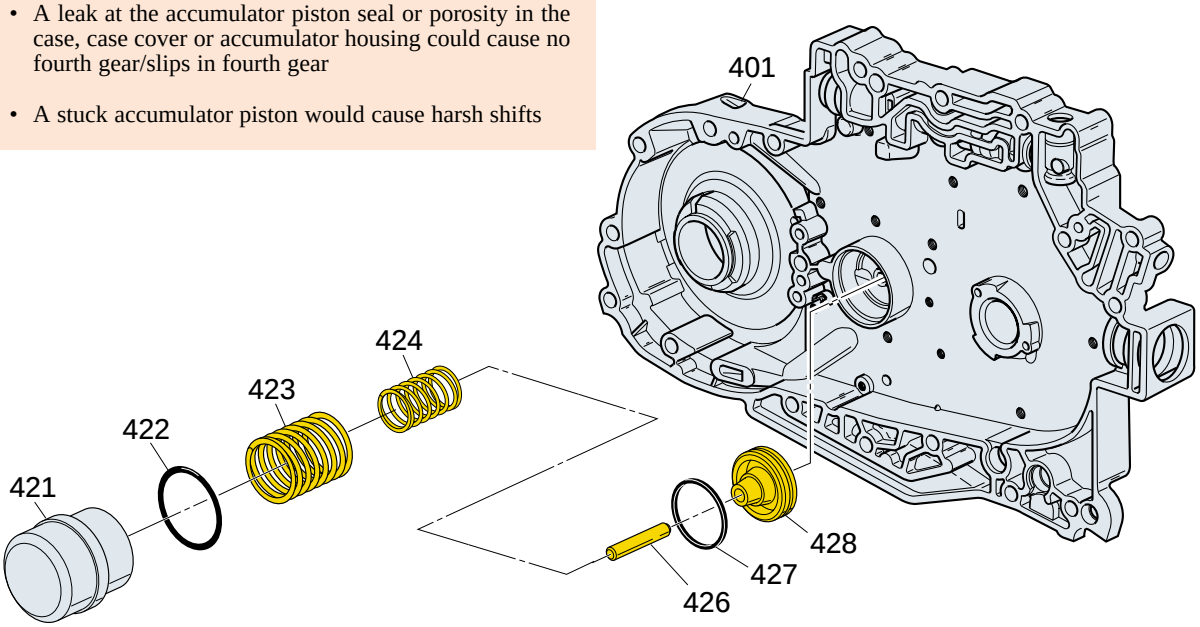
3-4 ACCUMULATOR ASSEMBLY (421-428):
Shift feel for a 3-4 shift and durability of the 4th clutch is largely dependent upon 4th clutch fluid pressure used to apply the clutch. To control 4th clutch apply pressure and shift feel, a 3-4 accumulator assembly (421-428) and 3-4 accumulator pressure is used.

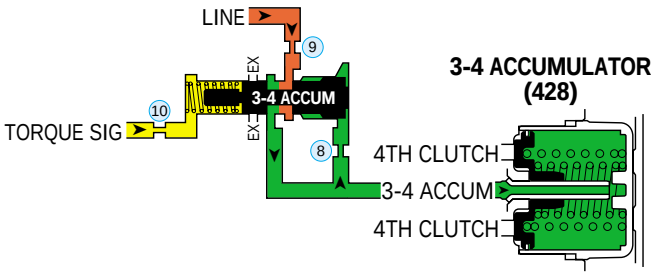
Fluid pressure in the 3-4 accumulator passage occurs when Line fluid pressure is regulated at the 3-4 accumulator valve (350) by torque signal fluid pressure and spring force. Regulated Line fluid pressure is then directed into the 3-4 accumulator circuit, through the hollow 3-4 accumulator pin (426) to the spring side of the 3-4 accumulator piston (428).

When the 4th clutch applies during a 3-4 shift, 4th clutch pressure is fed to the 3-4 accumulator piston (428) and compresses the 3-4 accumulator springs (423-424). When this occurs, 3-4 accumulator fluid is forced out of the 3-4 accumulator cannister (421) back to the 3-4 accumulator valve (341) where it exhausts. Again, torque signal fluid pressure and spring force at the 3-4 accumulator valve (341) regulates exhausting 3-4 accumulator fluid to control the 4th clutch apply.

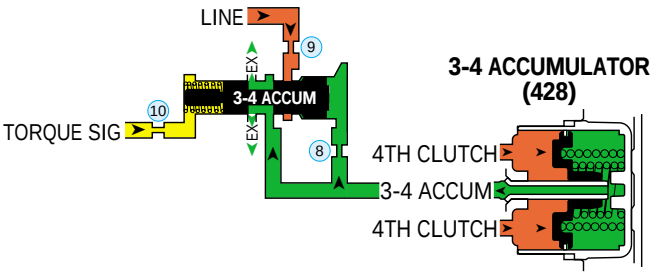
Accumulator Related Diagnostic Tips

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





4TH CLUTCH RELEASED



4TH CLUTCH APPLIED

Figure 37

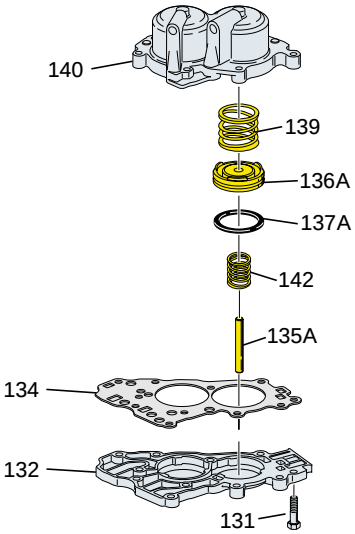
HYDRAULIC CONTROL COMPONENTS

ACCUMULATORS

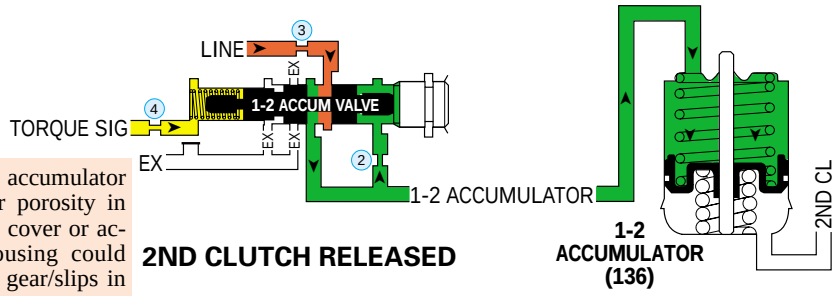
1-2 ACCUMULATOR ASSEMBLY (135A-137A, 139 & 142):
Shift feel for a 1-2 shift and durability of the 2nd clutch is largely dependent upon 2nd clutch fluid pressure used to apply the clutch. To control 2nd clutch apply pressure and shift feel, a 1-2 accumulator assembly and 1-2 accumulator fluid pressure is used in addition to the 2nd clutch wave plate (623).

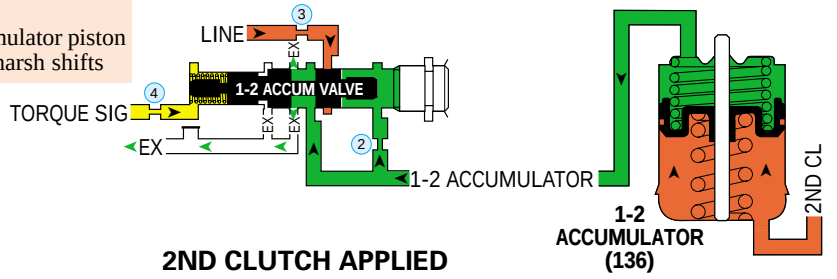
Fluid pressure in the 1-2 accumulator passage occurs when Line fluid pressure is regulated at the (primary) 1-2 accumulator valve (350) by torque signal fluid pressure and spring force. Regulated Line fluid pressure is then directed into the 1-2 accumulator fluid passage where it is routed through orifice #2 to the other end of the accumulator valve where it will oppose torque signal fluid pressure and spring force to regulate 1-2 accumulator fluid pressure. 1-2 accumulator pressure is also routed to the spring side of the 1-2 accumulator piston (136).

When the 2nd clutch applies during a 1-2 shift, 2nd clutch pressure is fed to the 1-2 accumulator piston (136A) and compresses the 1-2 accumulator spring (139). When this occurs, 1-2 accumulator fluid is forced out of the accumulator housing (140) back to the 1-2 accumulator valve (350) where it exhausts. Torque signal fluid pressure and spring force at the 1-2 accumulator valve regulate exhausting 1-2 accumulator fluid to control 2nd clutch apply.



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

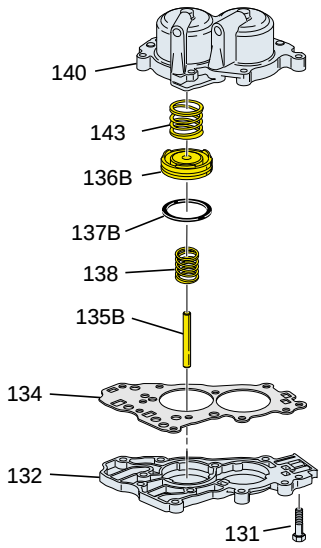




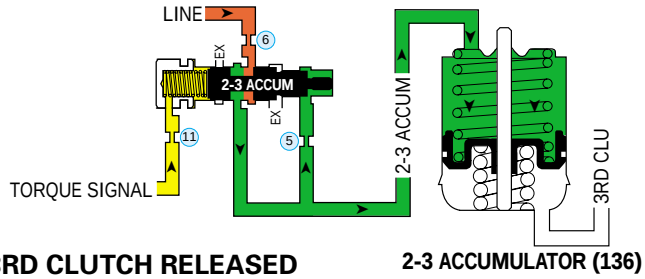
2-3 ACCUMULATOR ASSEMBLY (135B-138 & 143):
The 2-3 accumulator assembly functions basically the same as the 1-2 accumulator assembly. To control 3rd clutch apply pressure and shift feel, a 2-3 accumulator assembly and 2-3 accumulator pressure is used in addition to the 3rd clutch waved plate (645).

Fluid pressure in the 2-3 accumulator passage occurs when Line fluid pressure is regulated at the 2-3 accumulator valve (344) by torque signal fluid pressure. Regulated Line fluid pressure is then directed into the 2-3 accumulator fluid passage to the spring side of the 2-3 accumulator piston (136B).

When the 3rd clutch applies during a 2-3 shift, 3rd clutch pressure is fed to the 2-3 accumulator piston (136B) and compresses the 2-3 accumulator spring (143). When this occurs, 2-3 accumulator fluid is forced out of the accumulator housing (140) back to the 2-3 accumulator valve (344) where it exhausts. Torque signal fluid pressure and spring force at the 2-3 accumulator valve (344) regulate exhausting 2-3 accumulator fluid to control 3rd clutch apply.



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



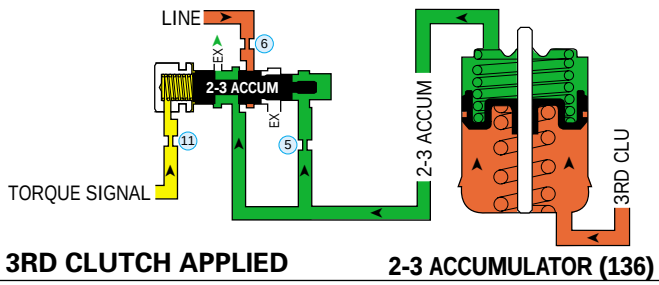


Figure 38

HYDRAULIC CONTROL COMPONENTS

VALVES LOCATED IN THE VALVE BODY

PRESSURE REGULATOR VALVE TRAIN (302-313)

Pressure Regulator Valve (313):
The pressure regulator valve (313) directs line pressure to: the manual valve; the converter feed circuit to control hydraulic apply and release of the converter clutch; the decrease passage to regulate pump output.

- If stuck, missing or binding pressure regulator valve or spring could cause incorrect line pressure

Reverse Boost Valve (310):
Acted on by PRN fluid from the manual valve (404) and lo-1st fluid, it moves against pressure regulator valve spring (311 & 312) pressure. This increases line pressure in Park, Reverse and Neutral in response to a high percentage of throttle travel. In Manual First gear range, lo-1st fluid moves the valve to boost line pressures.

Line Boost Valve (304):
Acted on by torque siganl fluid pressure, it moves against the reverse boost valve (310) and pressure regulator spring force (311, 312) to increase line pressure. Its function is in response to changes in throttle position (through pressure control solenoid valve response to PCM signals).

1-2 SHIFT VALVE TRAIN (314-318)

1-2, 3-4 Shift Solenoid Valve Assembly (315A):
The 1-2 Shift Solenoid Valve assembly (315) is an ON/OFF type solenoid that receives its voltage supply through the ignition switch. The PCM controls the solenoid by providing a ground to energize it in: Park, Reverse, Neutral, Overdrive Range First and Fourth Gear, and also Manual First Gear. When energized (ON), its exhaust port closes, moves the 1-2 shift valve and allows filtered line pressure to enter the 1-2, 3-4 signal fluid passage. When the PCM removes the ground, the solenoid is OFF allowing line pressure to exhaust through the solenoid.

- A faulty (stuck on) 1-2, 3-4 Shift Solenoid Valve assembly can cause 1st and 4th gear only.
- A faulty (stuck off) 1-2, 3-4 Shift Solenoid Valve assembly can cause 2nd and 3rd gear only.

1-2 Shift Valve (318):
The 1-2 shift valve responds to 1-2, 3-4 signal fluid pressure, force from the 1-2 shift valve spring (317) and 2-3 off signal fluid pressure. Depending on the position of the valve, it will route D-4 fluid into the 2nd fluid passage or lo fluid into the lo-1st fluid passage.

- A stuck or binding 1-2 shift valve can cause 1st or 2nd gear only, or slipping/ no 1st or 2nd gear.

LINE PRESSURE RELIEF VALVE (324):
Prevents line pressure from exceeding 1,690-2,480 kPa (245-360 psi). Excess line pressure unseats the ball check valve allowing it to exhaust.

TORQUE SIGNAL REGULATOR VALVE TRAIN (320-322)

Pressure Control Solenoid Valve Assembly (322):
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.

Torque Signal Regulator Valve (321):
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.

TCC CONTROL (PWM) SOLENOID VALVE (334):
An electronically controlled pressure regulator that regulates 2nd clutch fluid pressure into the TCC signal fluid circuit to shuttle the TCC control valve to the apply position. Regulated TCC signal 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.
- Stuck off, leaking o-ring, no voltage, would cause no TCC/slip or soft apply.

TCC Control Valve (335):
When the TCC PWM solenoid is OFF, the TCC control valve (335) is held in the released position by the TCC spring (336). In this position, converter feed pressure enters the torque converter clutch release circuit and apply fluid flows around the valve into the cooler circuit. When the TCC PWM solenoid (334) is ON, TCC signal fluid moves the valve against spring force. When shifted, it directs regulated line fluid (TCC regulated apply) into the apply passage; converter feed fluid into the cooler passage, and, allows converter release fluid to exhaust.

If stuck, missing or binding the TCC regulator apply valve or spring could cause:
- TCC stuck on in all gears
- TCC stuck on in 2nd, 3rd and 4th gears
- harsh TCC apply or release
- no TCC apply

TCC REGULATOR APPLY VALVE TRAIN (326-328):
The TCC regulator apply valve (327) is biased by TCC signal and TCC regulated apply fluid pressures in order to regulate line pressure passing through the valve. TCC regulated apply fluid pressure acting on the end of the valve combines with the spring force from the TCC regulator apply valve spring (326). In this manner, line pressure is regulated before it is routed to the converter TCC valve (335).

If stuck, missing or binding the TCC regulator apply valve or spring could cause:
- TCC stuck on in all gears
- TCC stuck on in 2nd, 3rd and 4th gears
- harsh TCC apply or release
- slip, shudder, rough apply or no apply

FORWARD SERVO BOOST VALVE (367B):
Held by spring force, it opens during hard acceleration to allow D-4 fluid to enter the drive servo apply passage, by-passing the feed orifice. This provides for a quick fill of the forward servo apply passage and quick apply of the forward band assembly to prevent slippage during abusive shifts from Park or Neutral to Drive.

REVERSE SERVO BOOST VALVE (367A):
Held by spring force, it opens during hard acceleration to allow reverse fluid to enter the reverse servo passage, by-passing the feed orifice. This provides for a quick fill of the reverse servo passage and quick apply of the reverse band to prevent band slippage during abusive shifts from Park or Neutral to Reverse.

2-3 SHIFT SOLENOID VALVE (315B):
The 2-3 Shift Solenoid Valve is an ON/OFF type solenoid that receives its voltage supply through the ignition switch. The PCM controls the solenoid by providing a ground to energize it in: Park, Reverse. Neutral, Overdrive Range First and Second Gear; and also Manual Second and Manual First Gear Ranges. When energized (ON), its exhaust port closes, allowing filtered line pressure into the 2-3 signal fluid passage. When the PCM removes the ground, the solenoid is OFF allowing line pressure to exhaust through the solenoid.

- A faulty (stuck on) 2-3 Shift Solenoid Valve assembly can cause 1st and 2nd gear only.
- A faulty (stuck off) 2-3 Shift Solenoid Valve assembly can cause 3rd and 4th gear only.

3-4 / 4-3 SHIFT VALVE TRAIN (359-362)

3-4 Shift Valve (362):
The 3-4 shift valve is controlled by 1-2, 3-4 signal fluid pressure on one end of the valve and the 4-3 manual downshift valve (360) at the other. When downshifted, input clutch feed pressure can apply or release the input clutch depending on the gear range. When upshifted by 2-3 signal fluid pressure, 3rd fluid is allowed to enter the 4th clutch circuit to apply the 4th clutch.

- A stuck or binding 34 Shift Valve can cause slipping or no 4th gear.

4-3 Manual Downshift Valve (360):
The 4-3 manual downshift valve is controlled by 2-3 signal fluid pressure acting on one side of the valve and spring force from the 4-3 manual downshift valve spring

HYDRAULIC CONTROL COMPONENTS

VALVES LOCATED IN THE VALVE BODY

(361) on the other side. When the 2-3 solenoid is ON, 2-3 signal fluid pressure moves the valve against spring force to hold the 3-4 shift valve (362) in the downshift position.

2-3 / 3-2 SHIFT VALVE TRAIN (353-357)

3-2 Manual Downshift Valve (356):
The 3-2 manual downshift valve is controlled by 2-3 signal fluid pressures and spring force from the 3-2 downshift valve spring (355). When the 2-3 solenoid is ON, 2-3 signal fluid pressure moves the valve against the 2-3 shift valve (357) to prevent a 2-3 upshift.

2-3 Shift Valve (357):
The 2-3 shift valve (357) is controlled by line pressure acting on one end of the valve and the 3-2 downshift valve (356) at the other end. Depending on the position of the manual valve, 1-2, 3-4 solenoid (315A) and the 2-3 solenoid (315B) state (ON or OFF), the 2-3 shift valve (357) directs: line pressure into the input clutch feed passage, D4 pressure into the auxiliary unput clutch feed passage, D3 into the input clutch feed passage, D2 into the into the manual 2-1 servo passage, and 3rd fluid to exhaust at the valve.

- A stuck or binding 2-3 Shift Valve can cause slipping or no 3rd gear.

1-2 ACCUMULATOR VALVE TRAIN (350-351)

1-2 Accumulator Valve (350):
The 1-2 accumulator valve is biased by torque signal fluid pressure and spring force acting on one end of the valve and 1-2 accumulator accumulator fluid pressure at the other end. It regulates the amount of line fluid passing through the valve and entering the 1-2 accumulator circuit.

3-4 ACCUMULATOR AND 2-3 ACCUMULATOR VALVE TRAIN (340-346)

3-4 Accumulator Valve (341):
The 3-4 accumulator valve is biased by torque signal fluid pressure and spring force from the 3-4 accumulator spring (351)on one end of the valve and 3-4 accumulator fluid on the other end. It regulates the amount of line pressure passing through the valve and entering the 3-4 accumulator circuit.

2-3 Accumulator Valve (344):
The 2-3 accumulator valve regulates 2-3 accumulator pressure in proportion to torque signal fluid pressure and spring force from the 2-3 accumulator spring (346). It regulates the amount of line pressure entering into the 2-3 accumulator circuit.

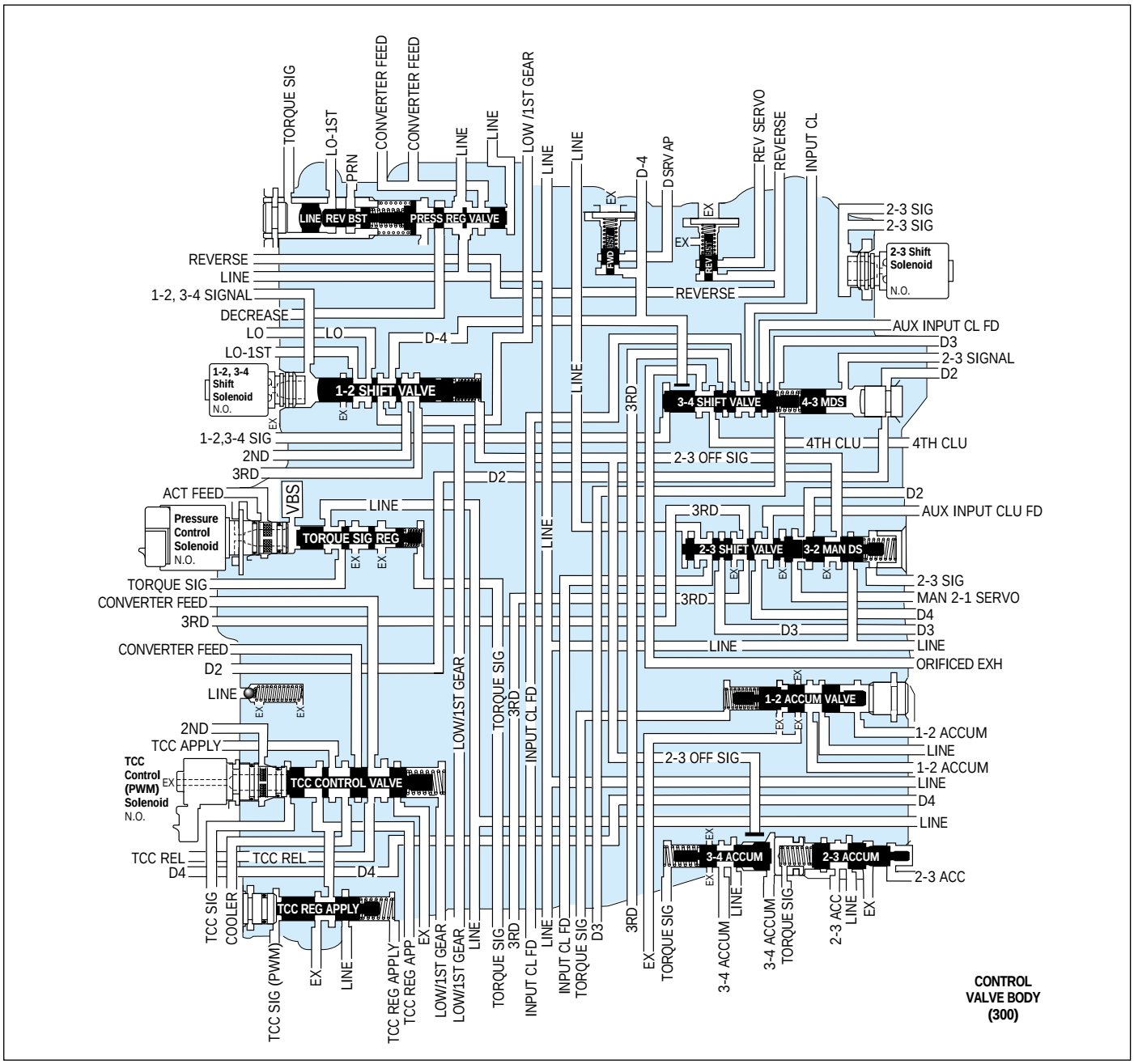


Figure 39

HYDRAULIC CONTROL COMPONENTS

BALL CHECK VALVES LOCATION AND FUNCTION

#1 CONVERTER CLUTCH RELEASE/APPLY:
Located in the case cover (400), it directs either release or apply fluid pressures to the TCC blow off ball check valve in the case cover.

#2 2ND CLUTCH:
Located in the case cover (400), it directs 2nd (apply) fluid through orifice 25 on the spacer plate into the 2nd clutch passage. When the 2nd clutch releases, it seats in the case cover (400) forcing 2nd clutch fluid through orifice 26 and into the 2nd fluid passage.

#3 INPUT CLUTCH / PRN:
Located in the case cover (400), it blocks the PRN passage to direct input clutch fluid to the input clutch during the appropriate gear range. In Park, Reverse or Neutral gear ranges, PRN fluid unseats the ball check valve and also feeds the input clutch.

#4 3RD CLUTCH / LO-1ST:
Located in the case cover (400), during Overdrive Range Third Gear, it seats against the lo-1st passage allowing 3rd clutch fluid into the 3rd clutch/lo-1st passage to apply the 3rd clutch. During a 3-2 shift, it allows 3rd clutch/lo-1st fluid to exhaust into the 3rd clutch fluid passage. In Drive Range - Manual First, it seats against 3rd clutch fluid allowing lo-1st fluid to enter the 3rd clutch/lo-1st fluid passage to apply the 3rd clutch.

#5 REVERSE / REVERSE SERVO FEED:
Located in the valve body (300), it blocks the reverse servo feed passage forcing reverse fluid through an orifice before entering the reverse servo feed passage. When the manual valve is moved out of Reverse gear range, the ball check valve unseats allowing reverse servo fluid to exhaust through the reverse fluid passage.

#6 D-4 / SERVO APPLY:
Located in the valve body (300), it blocks the forward servo apply passage and forces D-4 fluid pressure to the forward servo feed orifice on the spacer plate (370). When the manual valve is moved from Drive Range to Park or Neutral or Reverse, the ball check valve unseats to allow for a quick exhaust of the servo apply fluid and release of the forward band assembly.

#7 LO / LO-1ST:
Located in the valve body (300), it blocks the lo-1st passage when Drive Range Manual First gear is selected and sends lo fluid pressure to the 1-2 shift valve where it passes through the valve and is forced through orifice 27 into the lo-1st fluid circuit .

#8 D2 / MANUAL 2-1 SERVO FEED:
Located in the valve body (300), it is fed by D-2 fluid from the manual valve and seated against orificed manual 2-1 servo feed fluid at the spacer plate. D-2 fluid is then directed to the 2-3 shift valve (357) where it enters the 2-1 manual servo feed passage and is forced through orifice 13. When the 2-1 manual band servo releases the ball check valve unseats and fluid exhausts without going through orifice 13.

#9 3RD / 3RD CLUTCH:
Located in the valve body, it forces 3rd fluid through feed orifice 24 into the 3rd clutch passage during apply of the 3rd clutch. When the 3rd clutch releases, 3rd clutch fluid seats the ball check valve against the 3rd passage, forcing fluid through orifice 28 and into the 3rd fluid passage to the 2-3 shift valve (357) where it exhausts.

#10 LINE / 4TH CLUTCH:
Located in the valve body, it is seated against the lo/1st gear passage during all forward ranges except first and directs line fluid through orifice 33. In drive range first gear or manual first lo/1st gear fluid pressure unseats the ball check valve and bypasses orifice 33 to send fluid to the input clutch apply passage.

Ball Check Valves Related Diagnostic Tips

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

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

HYDRAULIC CONTROL COMPONENTS

BALL CHECK VALVES LOCATION AND FUNCTION

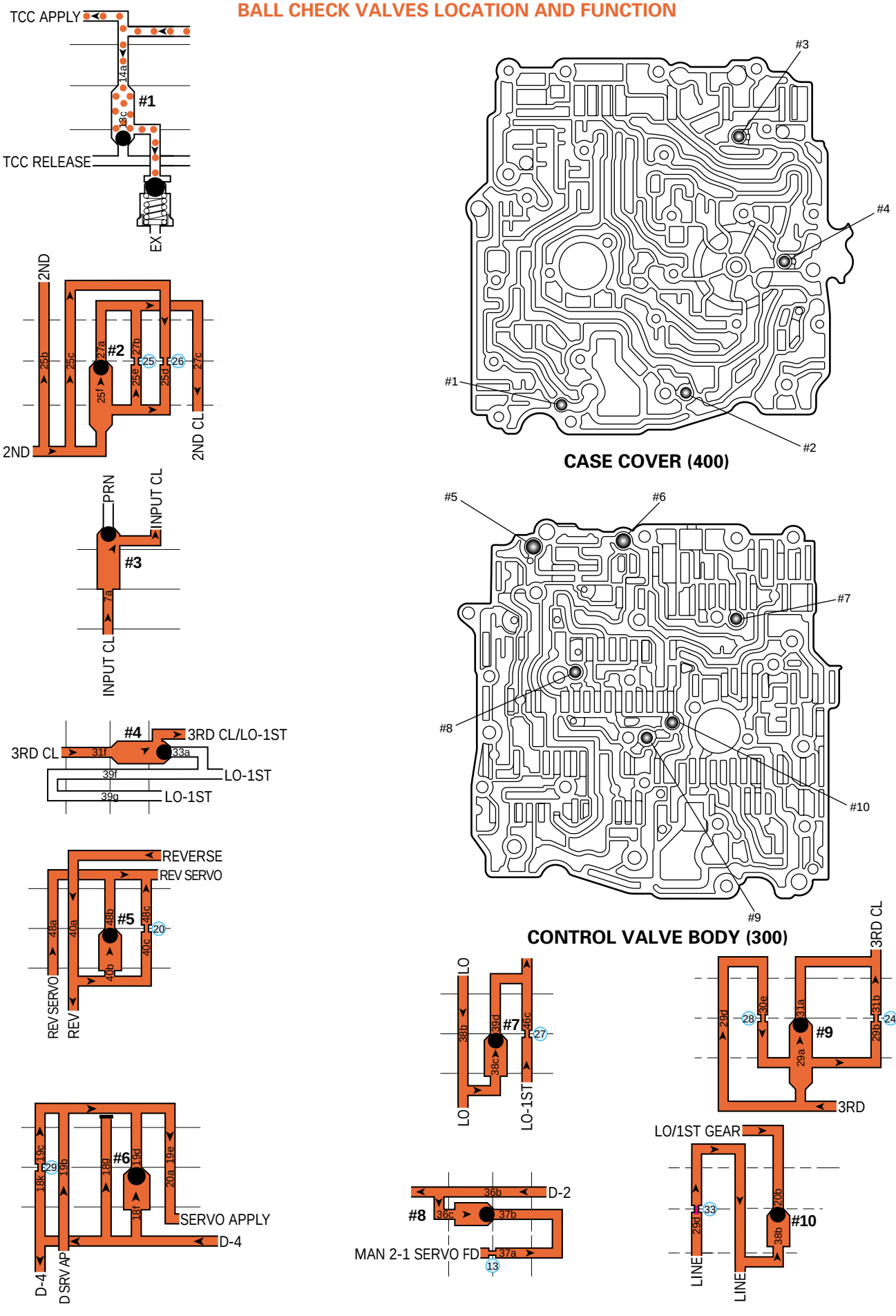
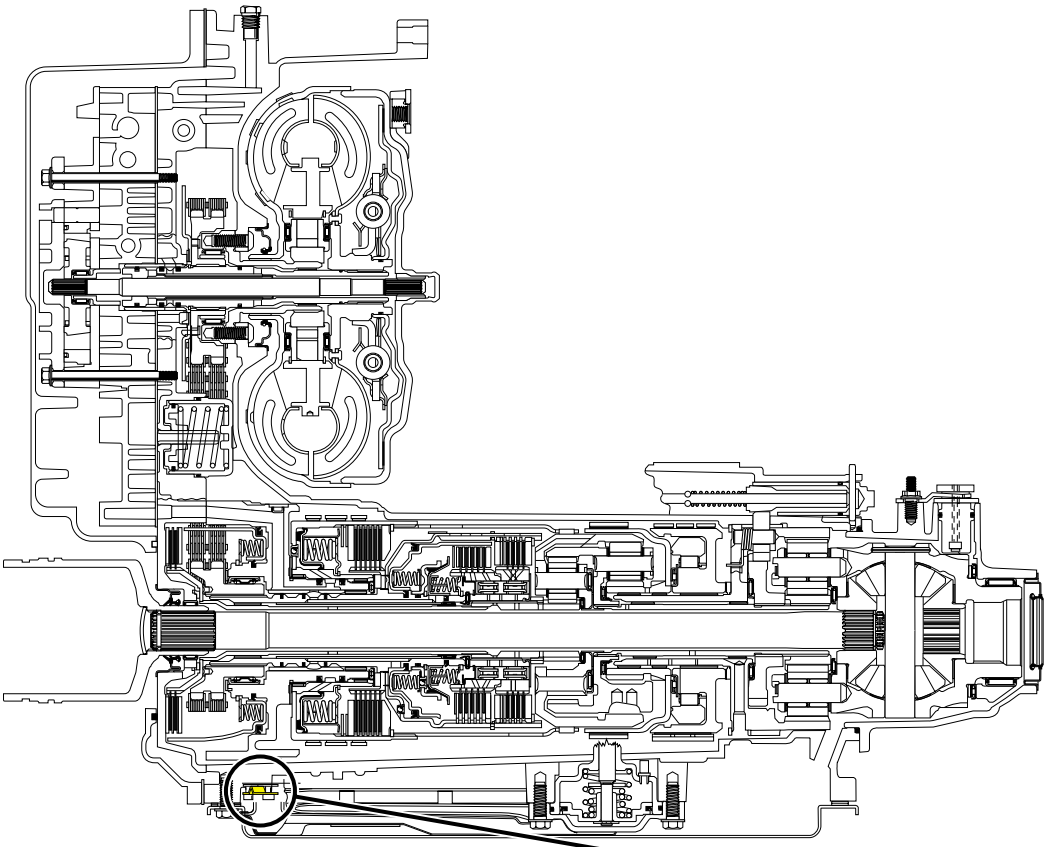


Figure 40

THERMOSTATIC ELEMENT



THERMOSTATIC ELEMENT:
The thermostatic element (121) is located on the case and is designed to control the fluid level in the case side cover pan (53). This thermostatic element contains a temperature sensitive strip of metal that reacts to fluid temperature changes and open or close a fluid passage. At low temperatures, the thermostatic element exerts little pressure on the thermostatic element plate (122) 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. 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 4T65-E transaxle, it will be higher on the fluid level indicator when the transaxle is cold. Conversely, the fluid level will drop when checked at operating temperatures. This event is a result of the case thermostatic element functioning as explained.

A damaged or loose thermostatic element could cause fluid foaming or incorrect fluid level.

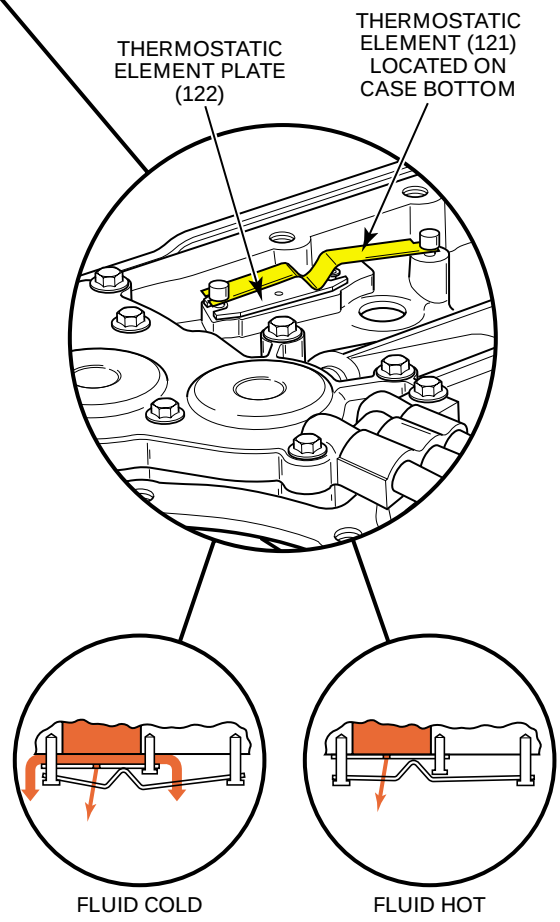


Figure 41

ELECTRICAL COMPONENTS

The Hydra-matic 4T65-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 third gear.

When both shift solenoids are OFF, the transaxle will operate in third 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.

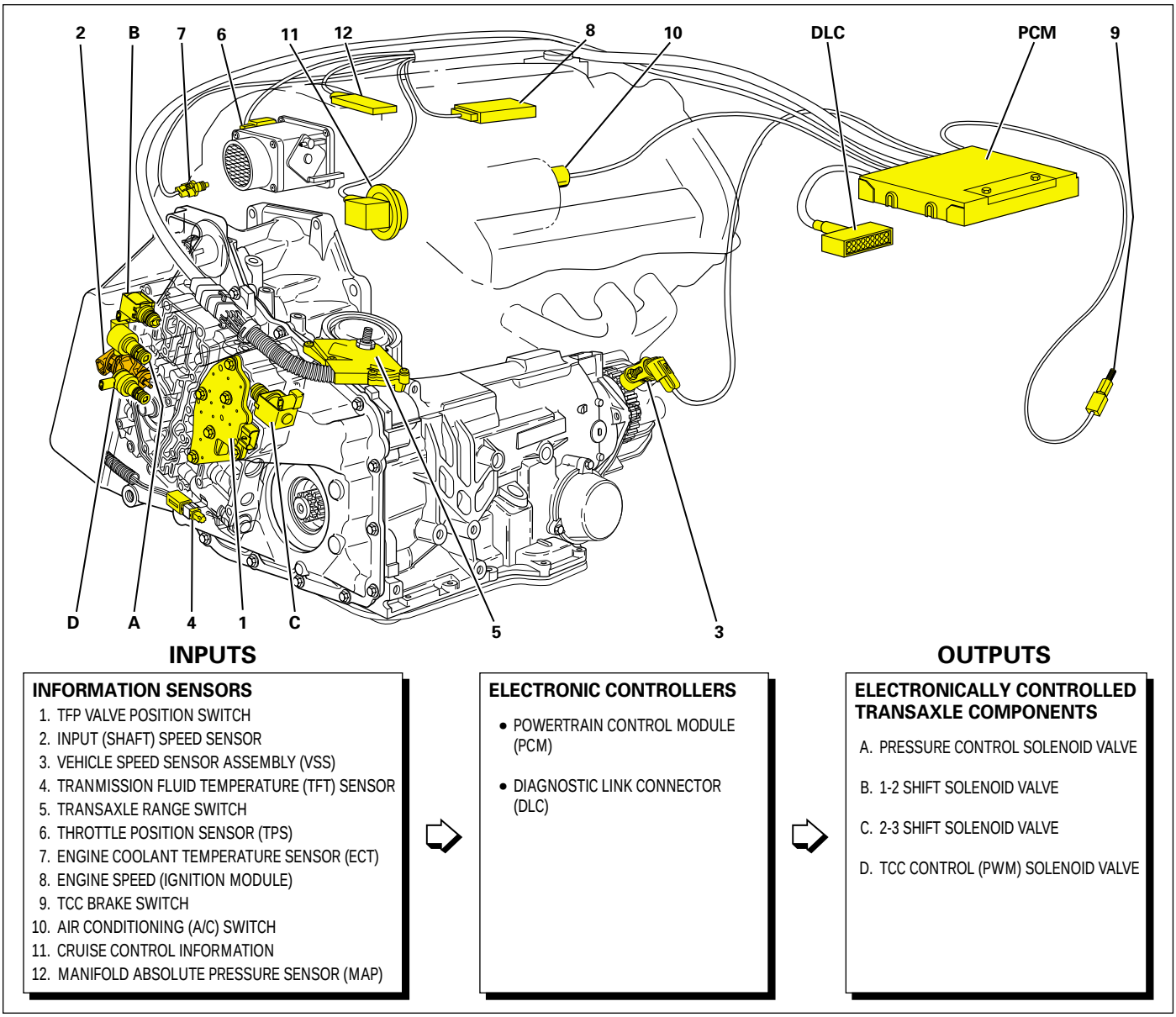
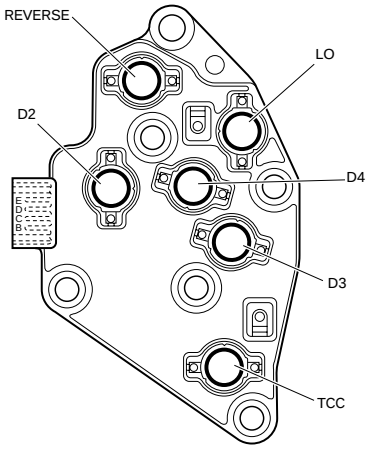
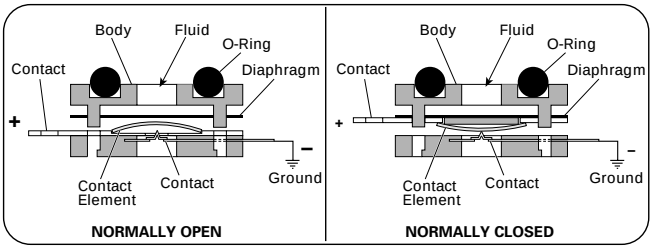


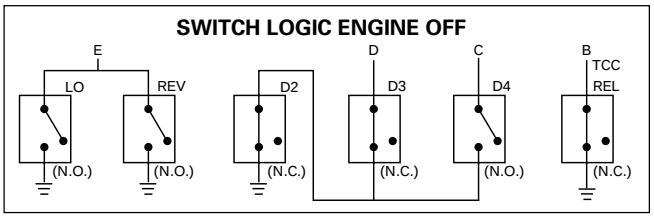
Figure 42



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.
- Maximum line pressure.

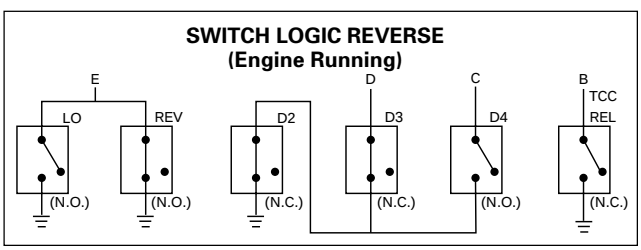




RANGE INDICATOR	FLUID*					CIRCUIT+		
	REV	D4	D3	D2	LO	E	D	C
Park/Neutral	0	0	0	0	0	0	1	0
Reverse	1	0	0	0	0	1	1	0
Overdrive	0	1	0	0	0	0	1	1
Manual Third	0	1	1	0	0	0	0	1
Manual Second	0	1	1	1	0	0	0	0
Manual First	0	1	1	1	1	1	0	0

*: 1 = Pressurized
0 = Exhausted

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



Automatic Transmission Fluid Pressure Manual Valve Position Switch (TFP Val. Position Sw.) (395)

The TFP Val. Position Sw. is attached to the valve body and contains six fluid pressure switches. Three of the fluid pressure switches (D4, , LO, and REV) are normally open, while the other three (D3, D2 and TCC Release) are normally closed. These six switches 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 a 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 table and switch logic diagram). The PCM measures TFP Val. Position Sw. signal voltage from each pin to ground and compares the voltage to a TFP Val. Position Sw. combination table 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 TFP Val. Position Sw. switch sequence indicates a gear range selection that conflicts with other sensory inputs to the PCM.

Normally Open Pressure Switch Operation: (D4, LO, and 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: (D3, D2 and TCC RELEASE)

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

Example: (Reverse Range)

The hydraulic and electrical schematics below illustrate the system operation when the manual valve is positioned in the Reverse position. As shown, the REV switch has fluid pressure holding it in the closed position allowing current to flow through Pin “E” (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 Reverse and that the TCC is released.

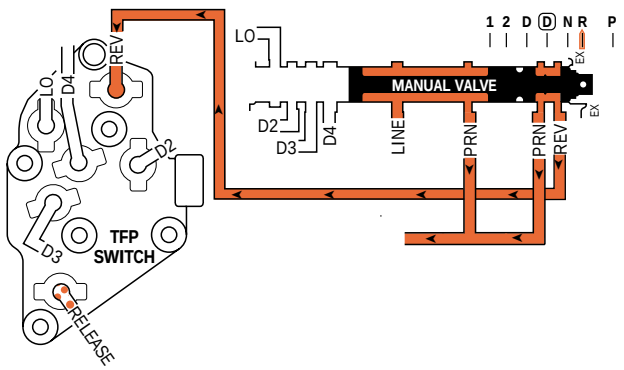


Figure 43

SHIFT SOLENOID VALVES

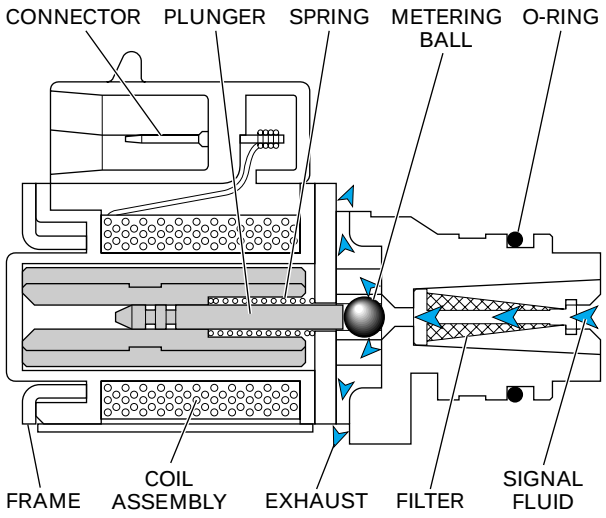
Description:
The Hydra-matic 4T65-E transaxle uses two identical, normally open electronic exhaust valves (referred to as 1-2, 3-4 SS Valve and 2-3 SS Valve) for controlling upshifts and downshifts in all forward ranges. These shift solenoid valves work together in a combination of ON and OFF sequences to control fluid that is routed to the 1-2, 3-4 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 RANGE	1-2, 3-4 SS VALVE	2-3 SS VALVE
Park/Reverse/Neutral	ON	ON
First	ON	ON
Second	OFF	ON
Third	OFF	OFF
Fourth	ON	OFF

Shift Solenoids De-energized (OFF):
The shift solenoid valves are OFF when the PCM opens the path to ground for the solenoid's electrical circuit. When OFF, the solenoid valve plunger is forced away from the metering ball by a spring. This action allows the 1-2, 3-4 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 solenoid valves, the PCM provides a path to ground and completes the solenoid's electrical circuit. Electrical current passing through the coil assembly in the solenoid creates a magnetic field that magnetizes the solenoid core. The magnetized core repels the plunger which seats the metering ball against the fluid inlet port. Solenoid signal fluid is then blocked by the metering ball thereby creating a fluid pressure in the 1-2, 3-4 or 2-3 signal fluid circuits.

1-2, 3-4 Shift Solenoid Valve (315A):
The 1-2, 3-4 shift solenoid valve is located at the end of the 1-2 shift valve (318) and controls the position of the 1-2 and 3-4 shift valves. 1-2, 3-4 signal fluid that is routed to the solenoid is created by filtered actuator feed as it passes through orifice #1. When energized, the solenoid blocks 1-2, 3-4 signal fluid from exhausting thereby creating pressure in the 1-2, 3-4 signal fluid circuit. 1-2, 3-4 signal fluid pressure then holds the 1-2 shift valve against spring force in the downshifted position. At the same time, 1-2, 3-4 signal fluid is routed to the 3-4 shift valve (362) 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 the 1-2, 3-4 Shift Solenoid valve is de-energized during Second and Third gear operation, 1-2, 3-4 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 Valve (315B):
The 2-3 shift solenoid valve is located in a bore in the valve body and controls the position of the 2-3, 3-4 and 4-3 shift valves. 2-3 signal fluid that feeds to the solenoid is created by filtered line fluid as it passes through orifice #30. When energized in First and Second 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 in the upshifted position against line fluid pressure. At the same time, 2-3 signal fluid is routed to the 4-3 manual downshift valve (360) holding the valve in the upshifted position.

When the 2-3 shift solenoid is de-energized during Third and Fourth 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 the 3-4 shift valve position is dependent upon the 1-2, 3-4 Shift Solenoid valve state.

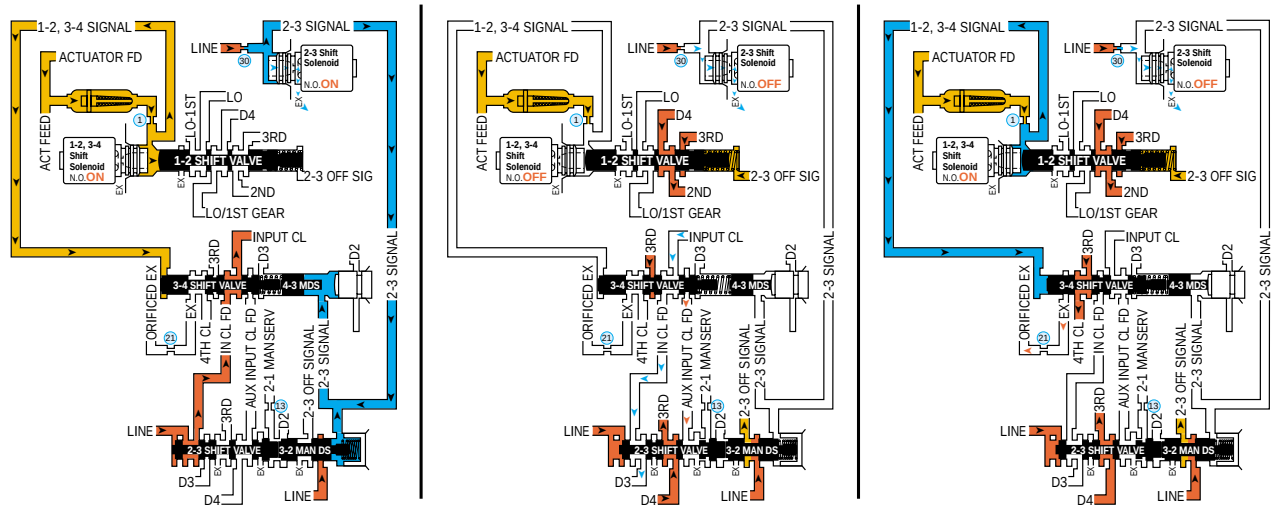
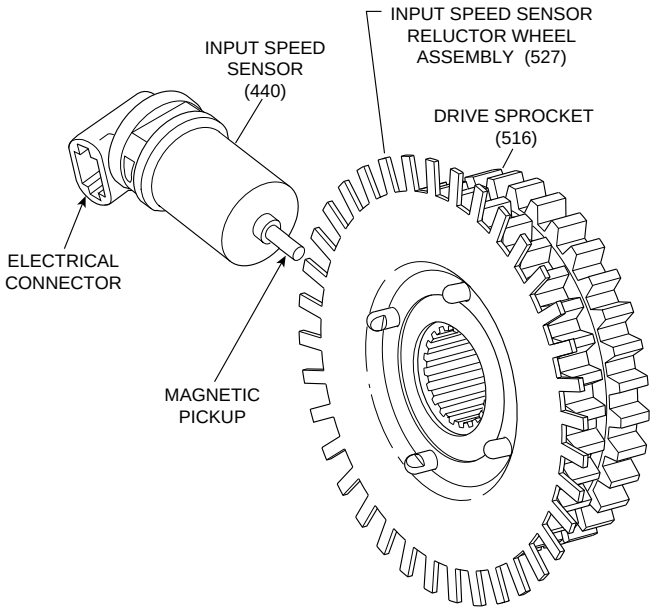


Figure 44

SPEED SENSORS



Automatic Transmission Input (Shaft) Speed Sensor (440):
The Automatic Transmission Input (Shaft) Speed Sensor (A/T ISS) is a magnetic inductive pickup that relays information relative to transaxle input speed to the PCM. The PCM uses A/T ISS information in order to control line pressure, TCC apply and release, and transmission shift patterns. This information is also used to calculate the appropriate operating gear ratios and TCC slippage.

The A/T ISS mounts on the case cover under the side cover and next to the drive sprocket. An air gap of 0.08 - 2.12 mm (0.032 - 0.834 inch) is maintained between the sensor and the teeth on the reluctor wheel assembly. The sensor consists of a permanent magnet surrounded by a coil of wire. As the reluctor wheel assembly is driven by the drive sprocket/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.

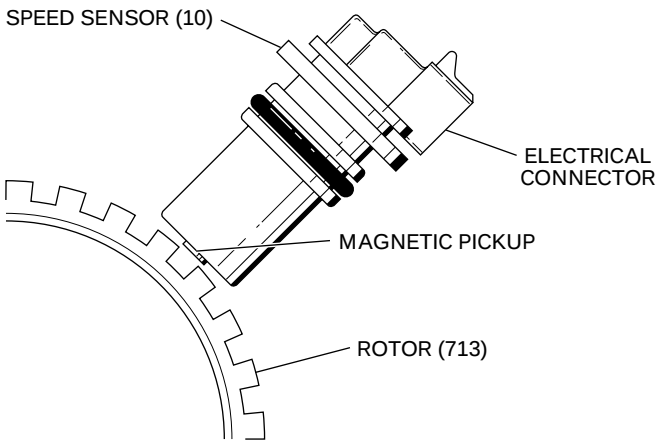
Sensor resistance should measure between 893 - 1127 ohms at 20°C (68°F). Output voltage will vary with vehicle speed from a minimum of 0.5 Volts AC at 300 RPM, to 200 Volts at 6000 RPM.

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

- DTC P0716 stores in PCM history.
- Freeze shift adapts.

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

- DTC P0717 will be stored in PCM history.
- Freeze shift adapts.



SPEED SENSOR ASSEMBLY (10)

Vehicle Speed Sensor (10):
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.

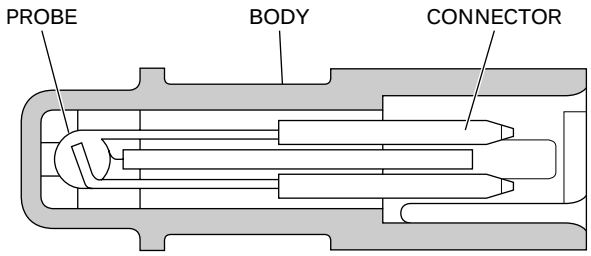
Vehicle Speed Sensor (VSS) Circuit Low Input will set DTC P0502 and the PCM will command the following default actions:

- DTC P0502 stores in PCM history.
- Maximum line pressure.
- Freeze shift adapts.
- Calibrate VSS from ISS and commanded gear.

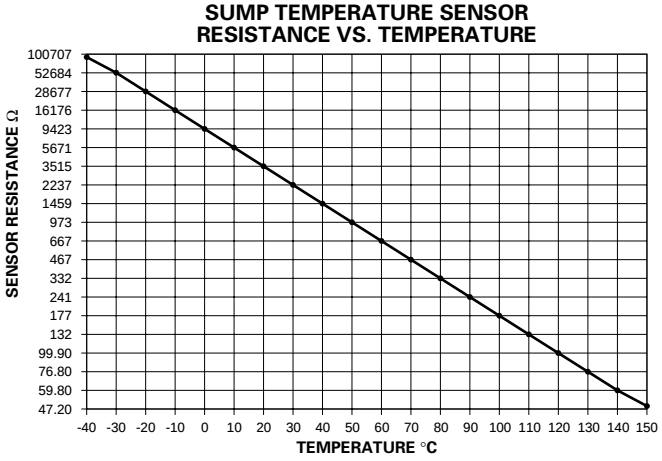
Sensor resistance should measure between 981 - 1471 ohms at 20°C (68°F). Output voltage will vary with vehicle speed from a minimum of 0.5 Volts AC at 25 RPM, to 200 Volts at 1728 RPM.

Figure 45

AUTOMATIC TRANSMISSION FLUID TEMPERATURE SENSOR



SUMP TEMPERATURE SENSOR (391)



TEMPERATURE SENSOR:
The Automatic Transmission Fluid Temperature (TFT) sensor (391) is incorporated into the wiring harness and clips to the valve body spacer plate (370). This type sensor monitors transmission fluid temperatures in the side cover.

SENSOR FUNCTION AND TCC/VCC OPERATION:
The TFT sensor is a negative temperature coefficient thermistor (temperature sensitive resistor) that provides transmission fluid temperature information to the PCM. The PCM sends a 5 volt reference signal to the sensor and measures the voltage drop in the circuit. The internal resistance of the sensor changes as the operating temperature of the transmission fluid changes. 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 in order to help control line pressure, shift schedules, and TCC apply. When the transmission fluid temperature reaches 130°C (266°F), the PCM enters hot mode. Above this temperature the PCM modifies the transmission shift schedules and the TCC apply in an attempt to reduce the fluid temperature by reducing the transmission heat generation. During hot mode the PCM applies the TCC at all times in Third and Fourth gears. Also, the PCM performs the 2-3 and the 3-4 shifts earlier in order to help reduce heat generation.

The PCM stays in hot mode until the temperature drops below 120°C (248°F).

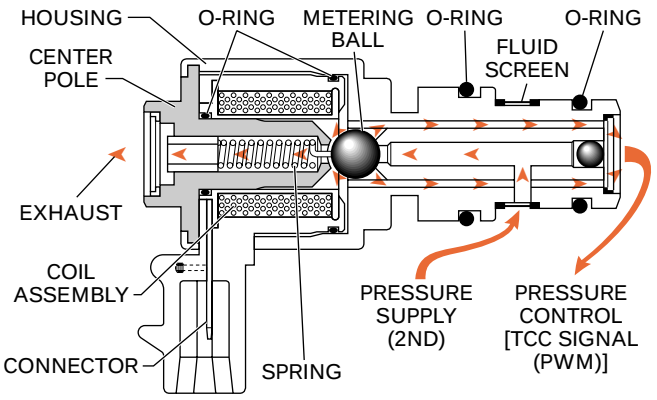
Transmission Fluid Overtemperature will set a DTC P0218 and the PCM will command the following default actions:
- DTC P0218 stores in PCM history.
- Freeze shift adapts.

Transmission Fluid Temperature Sensor Circuit Performance will set a DTC P0711 and the PCM will command the following default actions:
- DTC P0711 stores in PCM history.
- Freeze shift adapts.
- The PCM calculates a default TFT from the ECT and IAT.

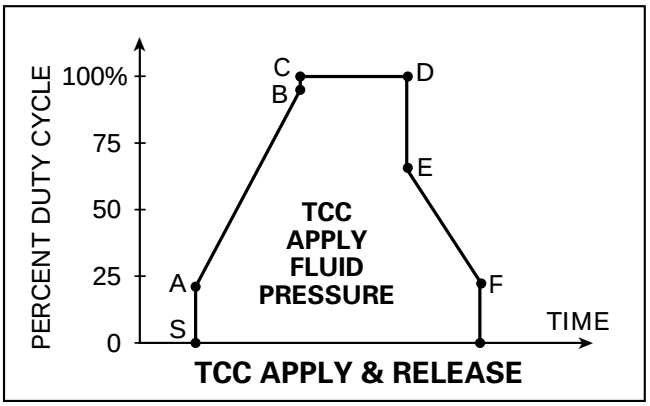
Transmission Fluid Temperature Sensor Circuit Low Input will set a DTC P0712 and the PCM will command the following default actions:
- DTC P0712 stores in PCM history.
- Freeze shift adapts.
- The PCM calculates a default TFT from the ECT and IAT.

Transmission Fluid Temperature Sensor Circuit High Input will set a DTC P0713 and the PCM will command the following default actions:
- DTC P0713 stores in PCM history.
- Freeze shift adapts.
- The PCM calculates a default TFT from the ECT and IAT.

Figure 46



TCC CONTROL PWM SOLENOID



Torque Converter Clutch System Stuck Off will set a DTC P0741 and the PCM will command the following default actions:

- DTC P0741 stores in PCM history.
- Freeze shift adapts.
- Inhibit TCC engagement.
- Inhibit 4th gear in Hot Mode.

Torque Converter Clutch System Stuck On will set a DTC P0742 and the PCM will command the following default actions:

- DTC P0742 stores in PCM history.
- Freeze shift adapts.
- TCC commanded On at maximum capacity.

Torque Converter Clutch Control PWM Solenoid Valve (334): The TCC Control PWM solenoid valve 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 negative duty cycle at a fixed frequency of 32 Hz to control the rate of TCC apply/release. The solenoid's ability to "ramp" the TCC apply and release pressures results in a smoother TCC operation.

When vehicle operating conditions are appropriate to apply the TCC, the PCM immediately increases the duty cycle to approximately 22% (see point A on graph). The PCM then ramps the duty cycle up to approximately 98% to achieve full TCC apply pressure (in vehicles equipped with the Electronically Controlled Clutch Capacity (ECCC) system, the pressure plate does not fully lock to the torque converter cover). 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 Automatic Transmission Fluid Temperature sensor description). Also, if the PCM receives a high voltage signal from the brake switch, signalling that the brake pedal is depressed, the PCM immediately releases the TCC.
Note: Duty cycles given are for example only. Actual duty cycles will vary depending on vehicle application and vehicle operating conditions.

TCC Control PWM solenoid valve 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 Control PWM Solenoid Operation: The TCC Control PWM Solenoid valve 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).

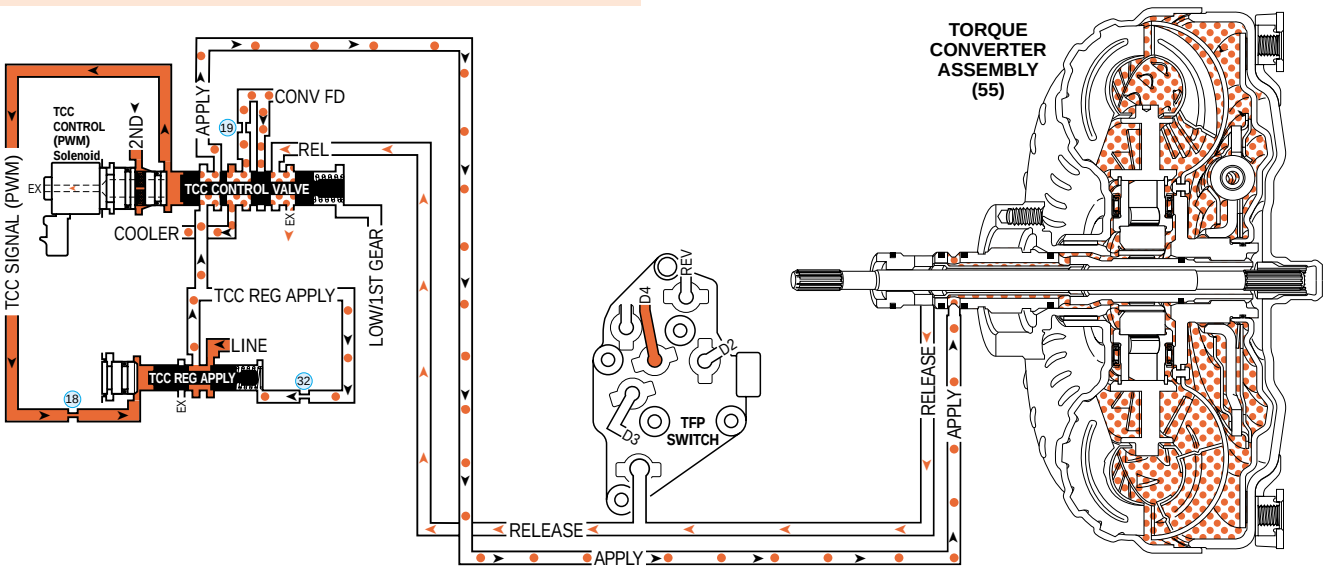


Figure 47

Pressure Control Solenoid Valve (322):
The Pressure Control Solenoid Valve (PC Sol. Valve) is a precision electronic pressure regulator that controls transmission line pressure based on current flow through its coil windings. As current flow is increased, the magnetic field produced by the coil moves the solenoid's plunger further away from the exhaust port. Opening the exhaust port decreases the output fluid pressure regulated by the PC Sol. Valve, which ultimately decreases line pressure. The PCM controls the PC Sol. Valve based on various inputs including throttle position, fluid temperature, MAP sensor and gear state.

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

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

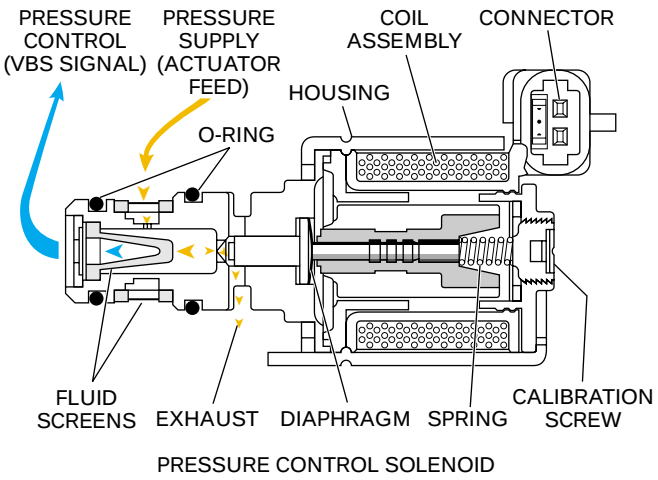
Approximate Duty Cycle	Current	Line Pressure
+ 5%	0.02 Amps	Maximum
+40%	1.1 Amps	Minimum

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

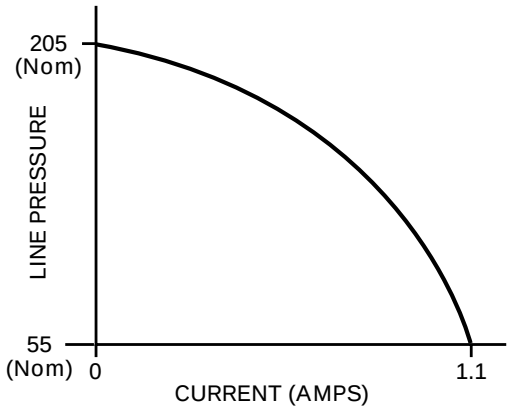
The duty cycle and current flow to the PC Sol. Valve are mainly affected by throttle position (engine torque) and they are inversely proportional to throttle angle (engine torque). In other words, as the throttle angle (engine torque increases), the duty cycle is decreased by the PCM which decreases current flow to the PC Sol. Valve. Current flow to the PC Sol. Valve 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 A/T ISS sensor and VSS during commanded shifts to determine if a shift is occurring too fast (harsh) or too slow (soft) and adjusts the PC Sol. Valve signal to maintain a set shift feel.

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



PRESSURE CONTROL SOLENOID



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

- DTC P0748 stores in PCM history.
- Freeze shift adapts.
- Maximum line pressure.

Figure 48

NOTES

This section of the book describes how torque from the engine is transferred through the Hydra-matic 4T65-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 4T65-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.

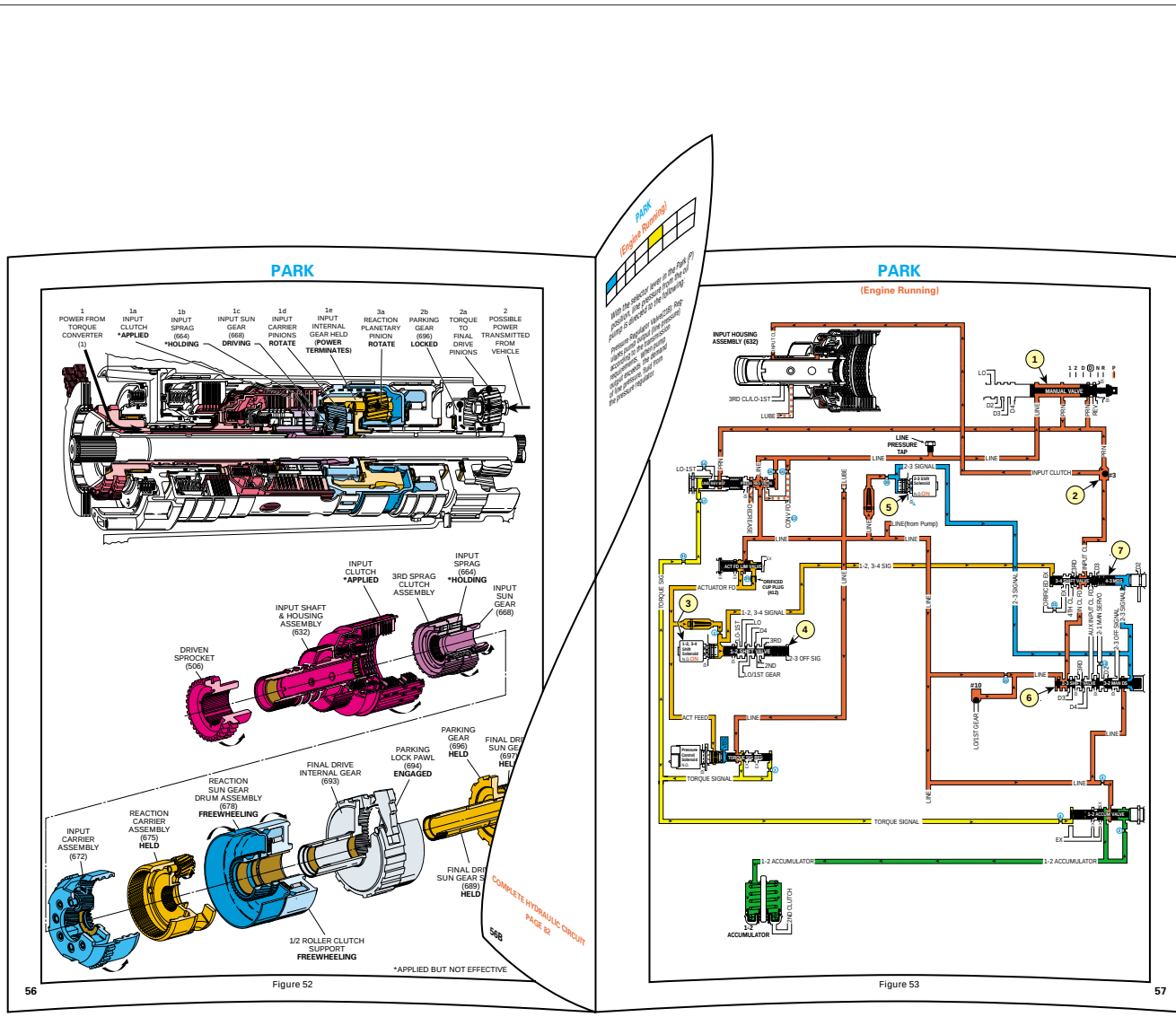


Figure 49

MECHANICAL POWERFLOW FROM THE TORQUE CONVERTER TO THE DRIVEN SPROCKET

(Engine Running)

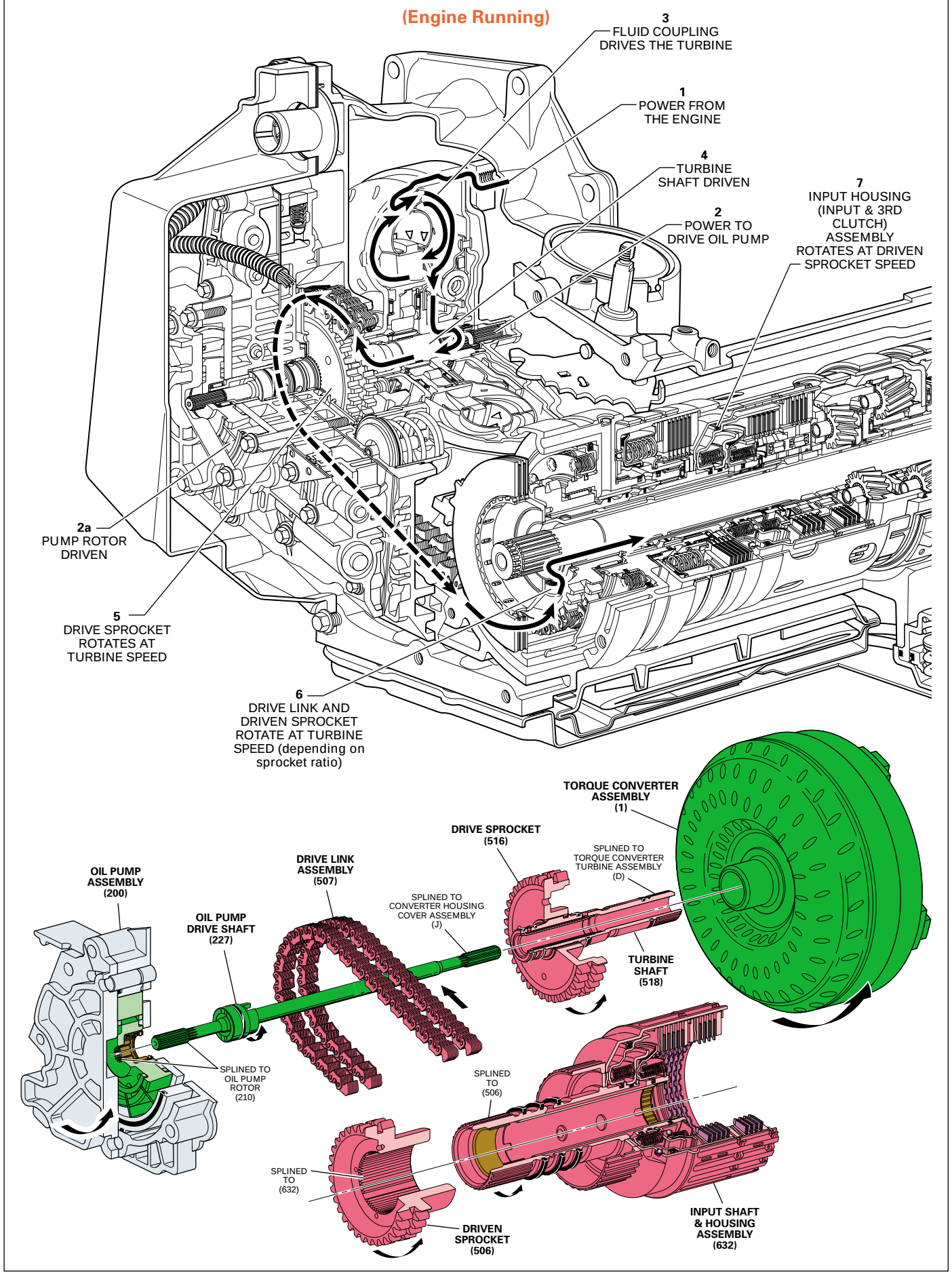


Figure 50

MECHANICAL POWERFLOW FROM THE TORQUE CONVERTER TO THE DRIVEN SPROCKET

(Engine Running)

The mechanical power flow in the Hydra-matic 4T65-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 (518). The turbine shaft, which is connected to the drive sprocket (516), 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 (227) is splined to the torque converter cover at one end and to the pump rotor (210) at the other end.

2a Pump Rotor Driven
When the engine is running, the oil pump drive shaft (227) and the pump rotor (210) are forced to rotate at engine speed.

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

4 Turbine Shaft Driven
As the torque converter turbine rotates, the turbine shaft (518), 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 (518) is splined to the drive sprocket (516), 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 (516) are in mesh with the dual drive link assembly (507) and the drive link is also in mesh with the teeth on the driven sprocket (506). 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 122).

7 Input Housing Assembly Rotates at Driven Sprocket Speed
The driven sprocket (506) is splined to the input housing and shaft assembly (632) 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 (506). 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 line reverse boost valve, spring force, and line pressure acting on the end of the valve. Line pressure is directed to the manual valve, the accumulator valves, the 3-2 manual downshift valve, torque signal regulator valve, the TCC regulated apply valve, and the actuator feed limit valve. Also, line pressure feeds the converter feed, lube circuit, and the 2-3 signal 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, and also feeds the 1-2, 3-4 signal fluid circuit.

1c Pressure Control Solenoid Valve (PC Sol. Valve):
Controlled by the PCM, the PC Sol. valve regulates actuator feed fluid pressure acting on the end of the torque signal regulator valve.

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

2 SHIFT ACCUMULATION

2a 1-2, 2-3 and 3-4 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 and accumulator fluid which is orificed into the other 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.

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 control valve.

3b TCC Control Valve:
Spring force holds the valve in the release position and converter feed 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.

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

3d 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 and returns to the cooler through the TCC control valve.

COMMON HYDRAULIC FUNCTIONS FOR ALL RANGES

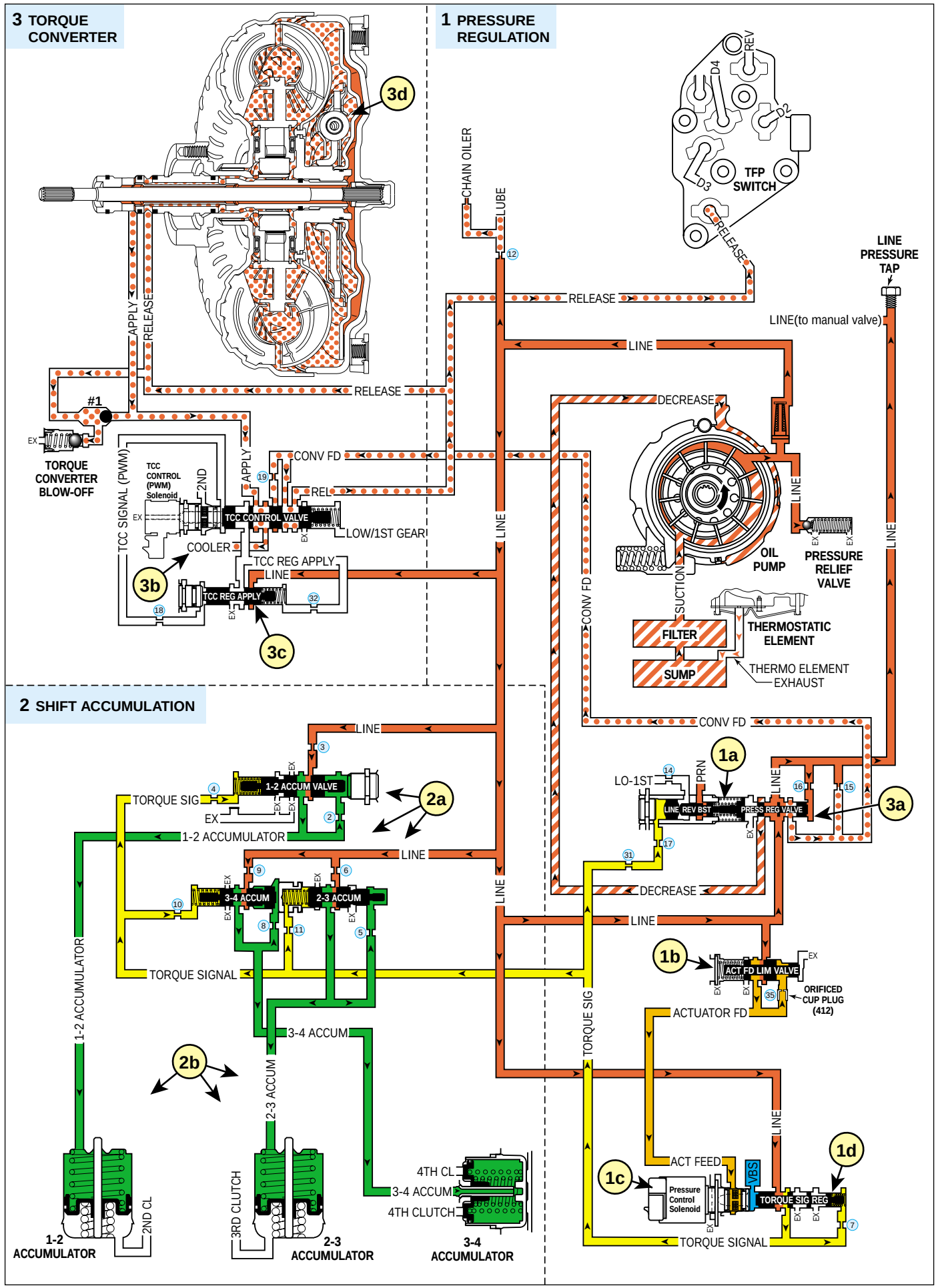


Figure 51

PARK

(Engine Running)

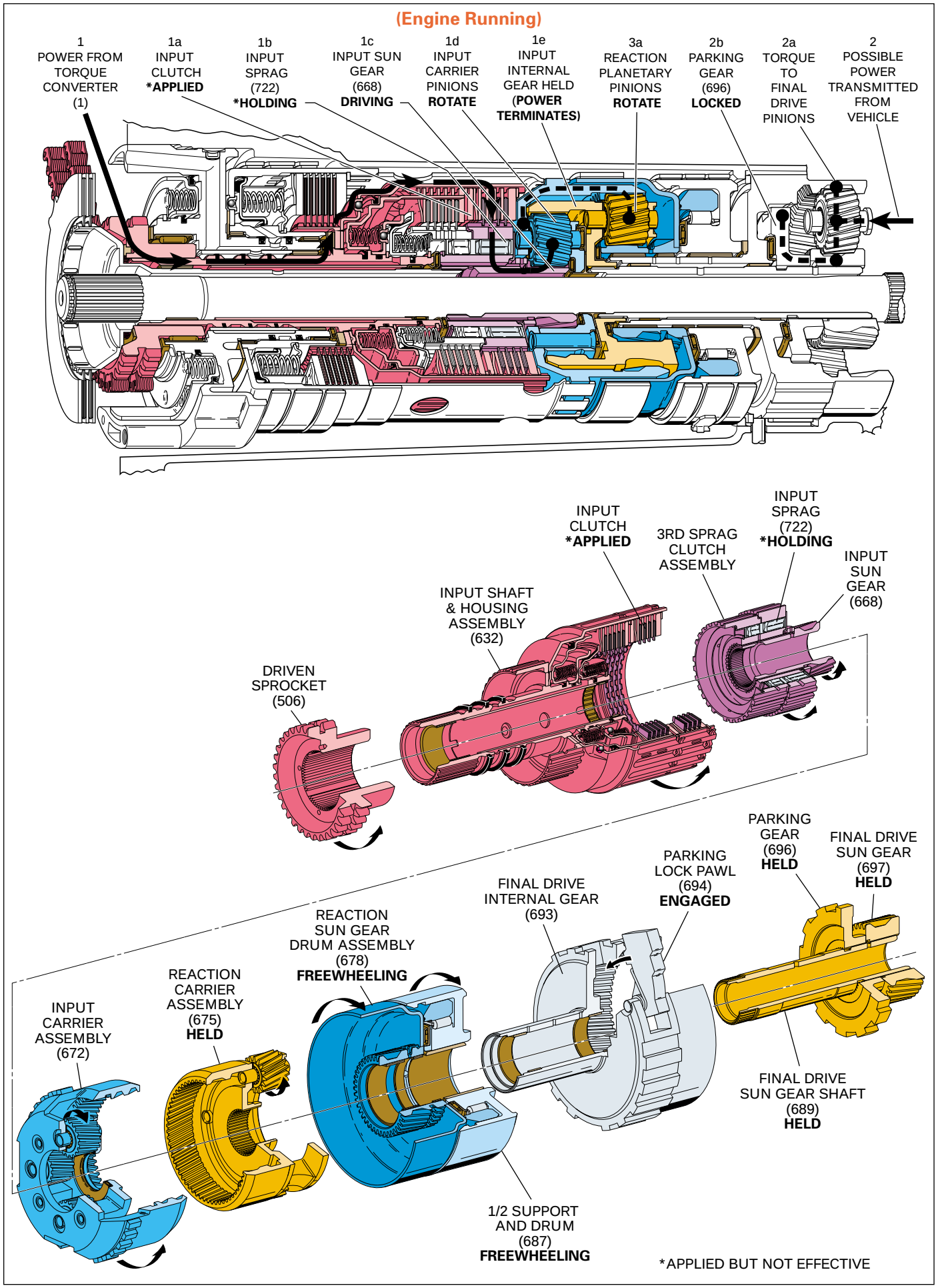


Figure 52

PARK

(Engine Running)

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	ON						*	HOLDING *			

* 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 (506) which is splined to the input shaft and housing assembly.

1a Input Clutch Applied
The input clutch is applied and holds the outer race of the input sprag assembly which forces the input sprag to rotate.

1b Input Sprag Holding
The input sprag holds when torque comes from the engine, and overruns when torque comes from the wheels, allowing the vehicle to coast.

1c Input Sun Gear Driving
Power continues from the sprag through the input sun gear (668), which then drives the input planetary pinions.

1d Input Carrier Pinions Rotate
Teeth on the input sun gear (668) are in mesh with the planet pinion gears in the input carrier assembly (672) forcing them to rotate.

1e Input Internal Gear Held/Powerflow Terminates
The input internal gear/reaction carrier is splined to the final drive sun gear shaft, which is held stationary by the parking gear which is also splined to the final drive sun gear shaft. The input carrier pinions are rotating but the input internal gear/reaction carrier is held, powerflow terminates.

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 Overdrive First

3a Reaction Planetary Pinions Rotate
The reaction planetary pinions rotate and drive the reaction sun gear and drum assembly. The 1/2 support roller clutch outer race is attached to the reaction sun gear and drum assembly and locks up the roller clutch which forces the 1/2 support and drum to rotate. When the vehicle is shifted into the overdrive range the forward band is the only element that needs to apply to achieve forward motion.

The manual linkage must be adjusted properly so the indicator quadrants in the vehicle correspond with the manual shift detent lever (802) in the transaxle. If not properly adjusted, an internal leak between fluid passages at the manual valve can cause a clutch or band to slip, or it may cause the transaxle not to hold in Park. Refer to the appropriate General Motors Service Manual for the proper manual linkage adjustment procedures.

PARK

(Engine Running)

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	ON						*	HOLDING *			

* APPLIED BUT NOT EFFECTIVE

INPUT CLUTCH 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 PRN fluid circuits.

2 # 3 Ball Check Valve
PRN fluid is then routed to the pressure regulator valve and to the #3 ball check valve where it enters the input clutch fluid circuit.

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

4 1-2 Shift Valve:
1-2, 3-4 signal fluid pressure moves the 1-2 shift valve against spring pressure and the fluid is also directed to the 3-4 shift valve.

5 2-3 Shift Solenoid Valve:
Energized by the PCM, the normally open 2-3 shift solenoid is ON and blocks 2-3 signal fluid from exhausting. The 2-3 signal fluid circuit leads to the 4-3 manual downshift valve and the 3-2 manual downshift valve.

6 2-3 Shift Valve:
Spring force and 2-3 signal fluid pressure force the 3-2 manual downshift valve against the 2-3 shift valve and hold it in the downshift position. In this position line pressure is routed into the input clutch feed circuit and directed to the 3-4 shift valve.

7 3-4 Shift Valve:
2-3 signal fluid pressure moves the 4-3 manual downshift valve against spring pressure and holds the 3-4 shift valve in the downshift position. In this position input clutch feed fluid enters the input clutch fluid circuit and is directed to the #3 ball check valve where it joins with PRN fluid of equal pressure and applies the input clutch.

COMPLETE HYDRAULIC CIRCUIT
Page 82

PARK

Engine Running

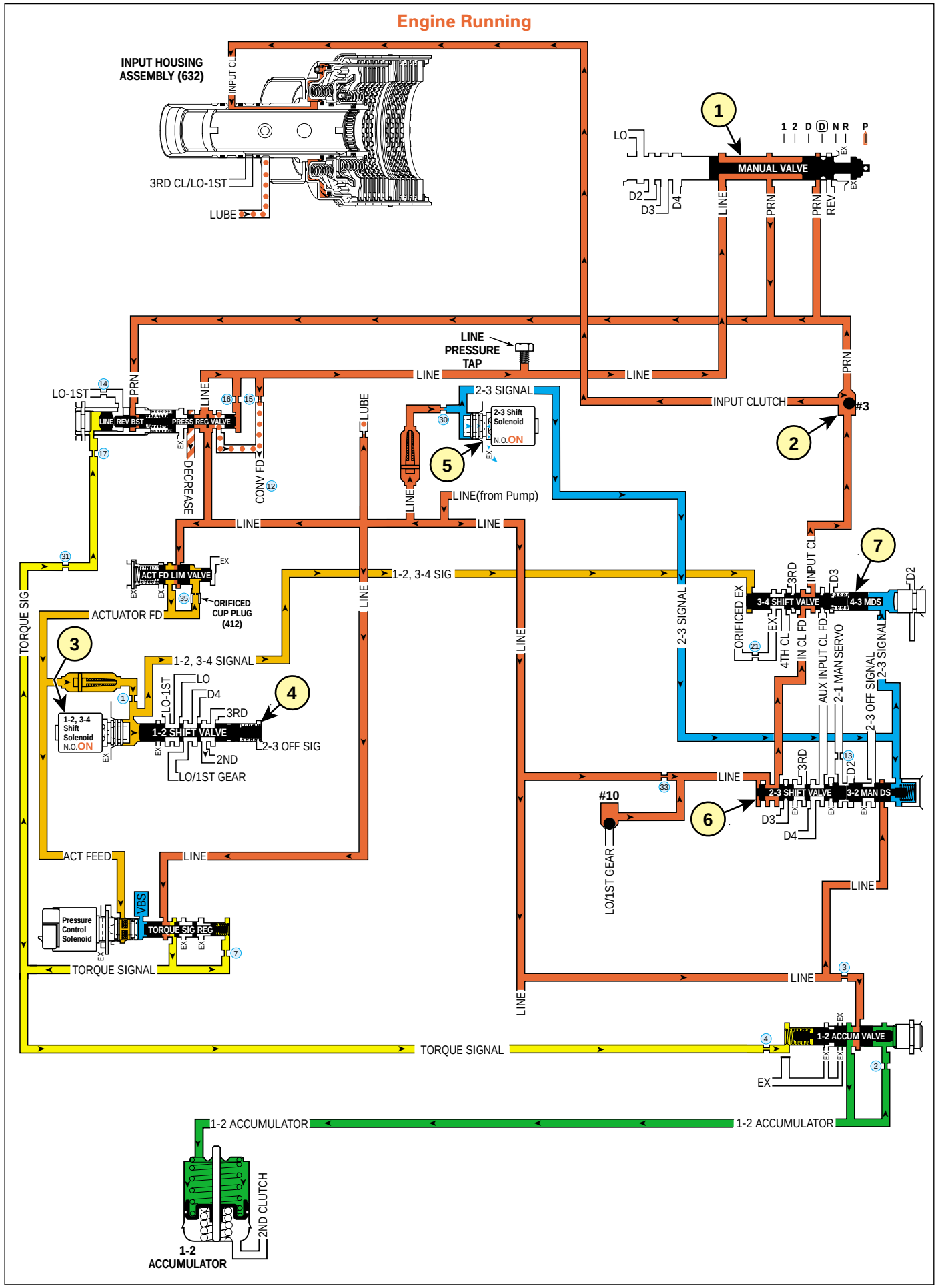


Figure 53

REVERSE

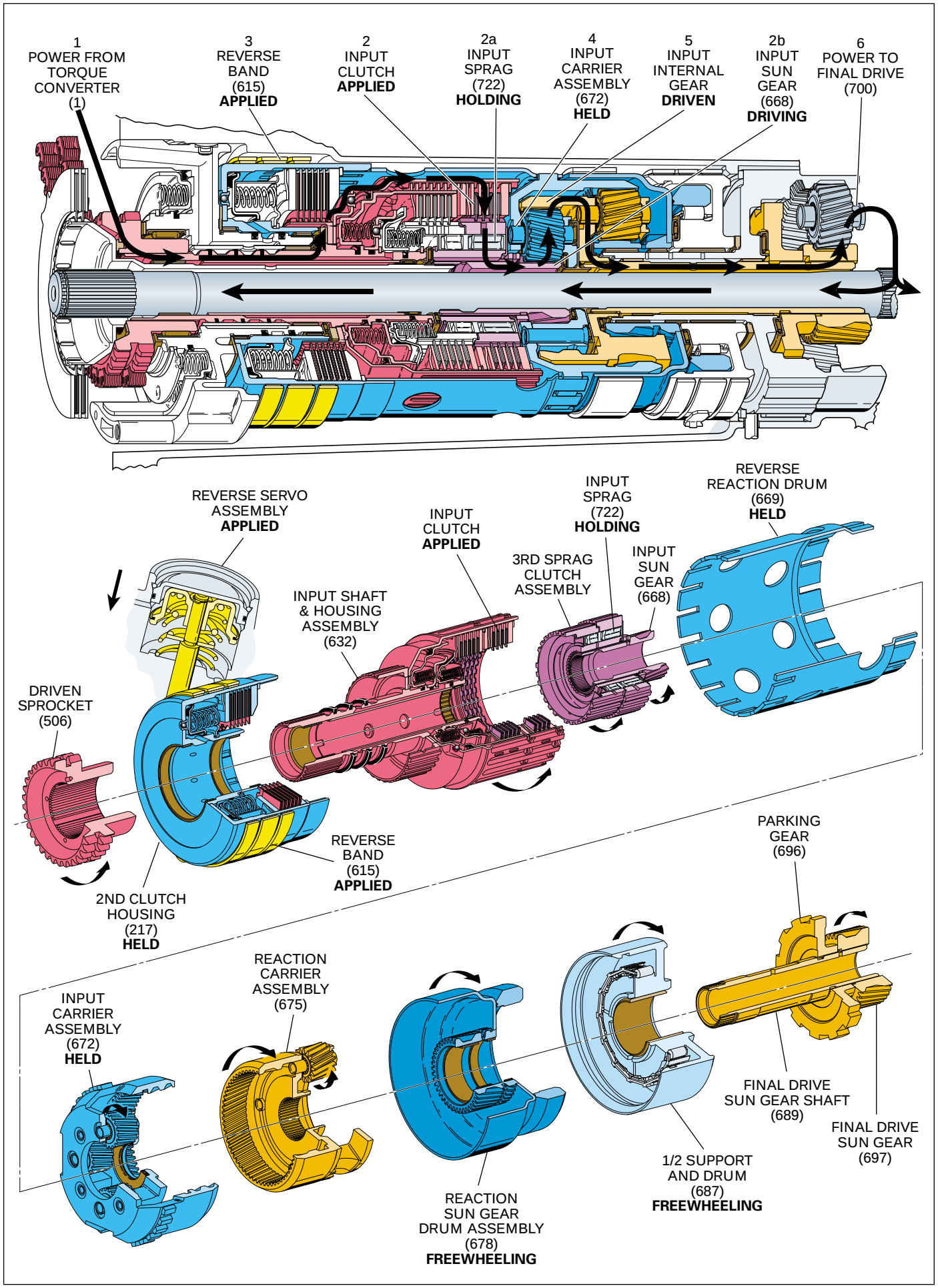


Figure 54

REVERSE

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	ON		APPLIED				APPLIED	HOLDING			

* APPLIED BUT NOT EFFECTIVE

In Reverse (R), torque from the engine is multiplied through the torque converter (1), the transaxle gear train, the final drive assembly and the output shaft (510), 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 2.385:1.

- When the gear selector lever is moved into the Reverse (R) gear range, the parking pawl disengages from the parking gear (696) allowing the final drive sun gear shaft (689) to rotate.

- The manual shaft and detent lever assembly (802 & 807) and manual valve (404) are also moved into the Reverse gear position in order to channel the transmission fluid.

1 Power from Torque Converter
The driven sprocket (506) is splined to the input shaft and housing assembly (632) and forces the housing to rotate at driven sprocket speed.

2 Input Clutch Applied
The input clutch is applied and holds the outer race of the input sprag assembly which forces the input sprag to rotate.

2a Input Sprag Holding
The input sprag holds when torque comes from the engine, and overruns when torque comes from the wheels, allowing the vehicle to coast.

2b Input Sun Gear Driving
Power continues from the input sprag through the input sun gear (668), which then drives the input carrier planetary pinions.

3 Reverse Band Applied
The reverse band (615) is applied, holding the 2nd clutch housing (617).

4 Input Carrier Assembly Held
The reverse reaction drum (669), splined on one end to the 2nd clutch housing (617) and the other end to the input carrier assembly (672), is held and prevents the input carrier assembly (672) from rotating.

5 Input Internal Gear Driven

Teeth on the input sun gear (668), in mesh with the planet pinion gears in the input carrier assembly (672), drive the pinion gears and input internal gear, which is part of the reaction carrier assembly (675), in the reverse direction of forward gear rotation.

6 Power to Final Drive Assembly
The final drive sun gear shaft (689), splined to the reaction carrier assembly (675) at one end and the final drive sun gear (697) at the other end, drives the differential assembly (700) in reverse direction.

REVERSE

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	ON		APPLIED				APPLIED	HOLDING			

* APPLIED BUT NOT EFFECTIVE

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 PRN fluid circuit already pressurized in Park.

1b Pressure Regulator and Boost Valves:
PRN fluid at the line reverse boost valve and assists torque signal fluid pressure against line pressure and spring force. The addition of PRN fluid pressure increases the operating range of line pressure in Reverse.

1c # 5 Ball Check Valve:
Located in the valve body, it blocks the reverse servo feed passage forcing reverse fluid through orifice #20 in the spacer plate into the reverse servo passage.

1d Fluid Pressure Manual Valve Position Switch Assembly (TFP Val. Position Sw.):
Reverse fluid is routed to the Fluid Pressure Manual Valve Position Switch Assembly (TFP Val. Position Sw.). The TFP Val. Position Sw. signals the PCM that the transaxle is in Reverse.

2 REVERSE BAND APPLIES

2a Reverse Boost Valve:
Opens under hard acceleration (high line pressure/high throttle position) to allow reverse fluid to by-pass the feed orifice #20 and enter the reverse servo passage. This provides for a quick apply of the reverse band to prevent band slippage during abusive shifts from Park or Neutral to Reverse.

2b Reverse Band Servo:
Reverse servo clutch fluid pressure from the Reverse Boost Valve and orifice #20 applies the reverse servo piston which applies the reverse band to hold the second clutch housing.

3 INPUT CLUTCH REMAINS APPLIED

3a 1-2, 3-4 Shift Solenoid Valve:
The PCM keeps the solenoid energized in Reverse and 1-2, 3-4 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 downshift position.

3c 2-3 Shift Solenoid Valve:
Still energized by the PCM, the normally open 2-3 shift solenoid is ON and blocks 2-3 signal fluid from exhausting and directs 2-3 signal fluid to the 4-3 Manual Downshift Valve and the 3-2 Manual Downshift Valve.

3d 2-3 Shift Valve:
Spring force and 2-3 signal fluid pressure keep the 3-2 manual downshift valve against the 2-3 shift valve and hold it in the downshift position. In this position line pressure is routed into the input clutch feed circuit and directed to the 3-4 shift valve.

4d 3-4 Shift Valve:
2-3 signal fluid pressure holds the 4-3 manual downshift valve against spring pressure and holds the 3-4 shift valve in the downshift position. Input clutch feed fluid enters the input clutch fluid circuit and is directed to the #3 ball check valve where it joins with PRN fluid of equal pressure and keeps the input clutch applied.

COMPLETE HYDRAULIC CIRCUIT
Page 84

REVERSE

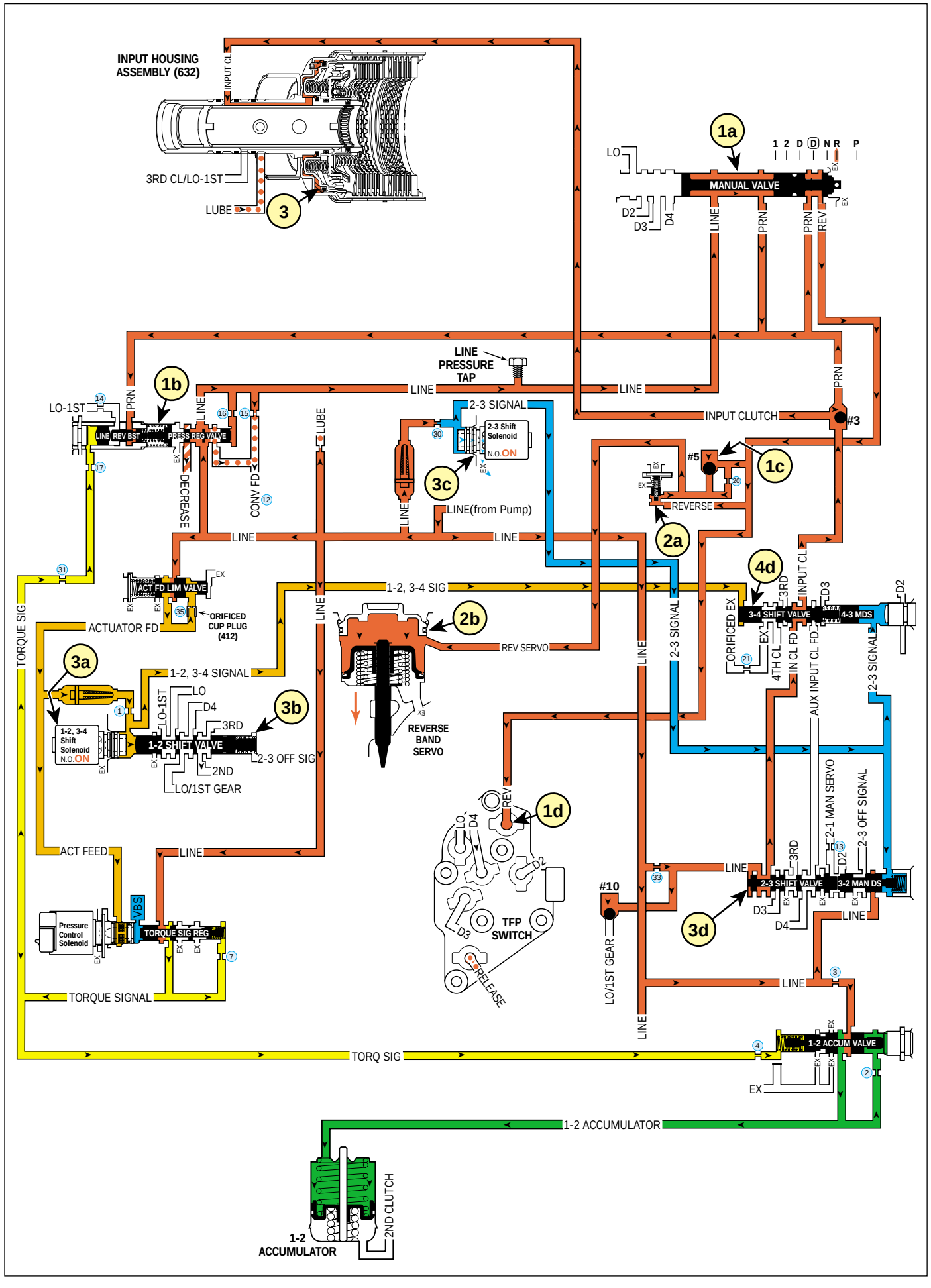


Figure 55

NEUTRAL

(Engine Running)

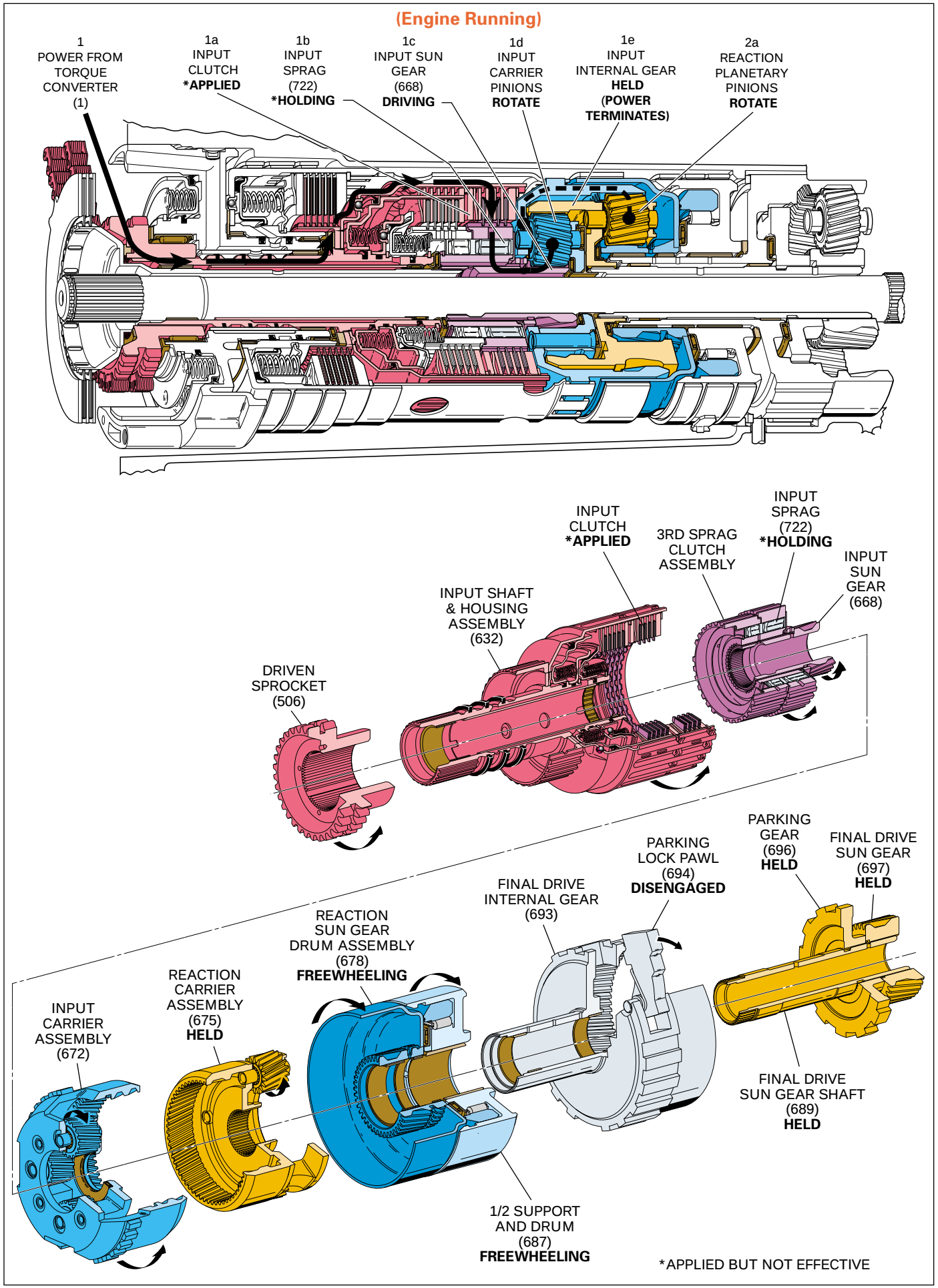


Figure 56

NEUTRAL

(Engine Running)

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	ON						APPLIED *	HOLDING *			

* 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 (694) is not engaged with the parking gear (696), which allows the final drive sun gear shaft (689) 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 (802 & 807) and manual valve (404) are moved into Neutral (N) range position.

1 Power from Torque Converter
Power from the torque converter turbine transfers to the driven sprocket (506) which is splined to the input shaft and housing assembly.

1a Input Clutch Applied
The input clutch is applied and holds the outer race of the input sprag assembly which forces the input sprag to try to rotate.

1b Input Sprag Holding
The input sprag holds when torque comes from the engine, and overruns when torque comes from the wheels, allowing the vehicle to coast.

1c Input Sun Gear Driving
Power continues from the input sprag through the input sun gear (668), which then drives the input carrier planetary pinions.

1d Input Carrier Pinions Rotate
Teeth on the input sun gear (668) are in mesh with the planet pinion gears in the input carrier assembly (672), forcing them to rotate.

1e Input Internal Gear Held/Powerflow Terminates
The input internal gear/reaction carrier is splined to the final drive sun gear shaft, which is held stationary by the weight of the vehicle. The input carrier pinions are rotating but the input internal gear/reaction carrier is held, powerflow terminates.

2 Preparation for a shift into Overdrive First

2a Reaction Planetary Pinions Rotate
The reaction planetary pinions rotate and drive the reaction sun gear and drum assembly. The 1/2 support roller clutch outer race is attached to the reaction sun gear and drum assembly and locks up the roller clutch which forces the 1/2 support and drum to rotate. When the vehicle is shifted into the overdrive range, the forward band is the only element that needs to apply to achieve forward motion.

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

NEUTRAL

(Engine Running)

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	ON						*	HOLDING *			

* APPLIED BUT NOT EFFECTIVE

When the gear selector lever is moved to Neutral (N), the hydraulic system operates in the same manner as Park (P) range. If 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 BAND 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 Band Servo:
Reverse fluid exhausts from the reverse band servo and force from the reverse servo return spring releases the reverse band shifting the transaxle into Neutral.

1c # 5 Ball Check Valve:
Reverse fluid forces the #5 ball check valve off its seat allowing reverse servo fluid to bypass orifice #20 which allows a quick release of the reverse band.

1d Fluid Pressure Manual Valve Position Switch Assembly (TFP Val. Position Sw.):
Reverse fluid pressure exhausts from the TFP Val. Position Sw., thereby signalling the PCM that the transaxle is in Neutral (N) or Park (P).

2 INPUT CLUTCH REMAINS APPLIED

The input clutch remains applied but becomes ineffective as the reverse band releases.

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.*

COMPLETE HYDRAULIC CIRCUIT
Page 86

NEUTRAL

Engine Running

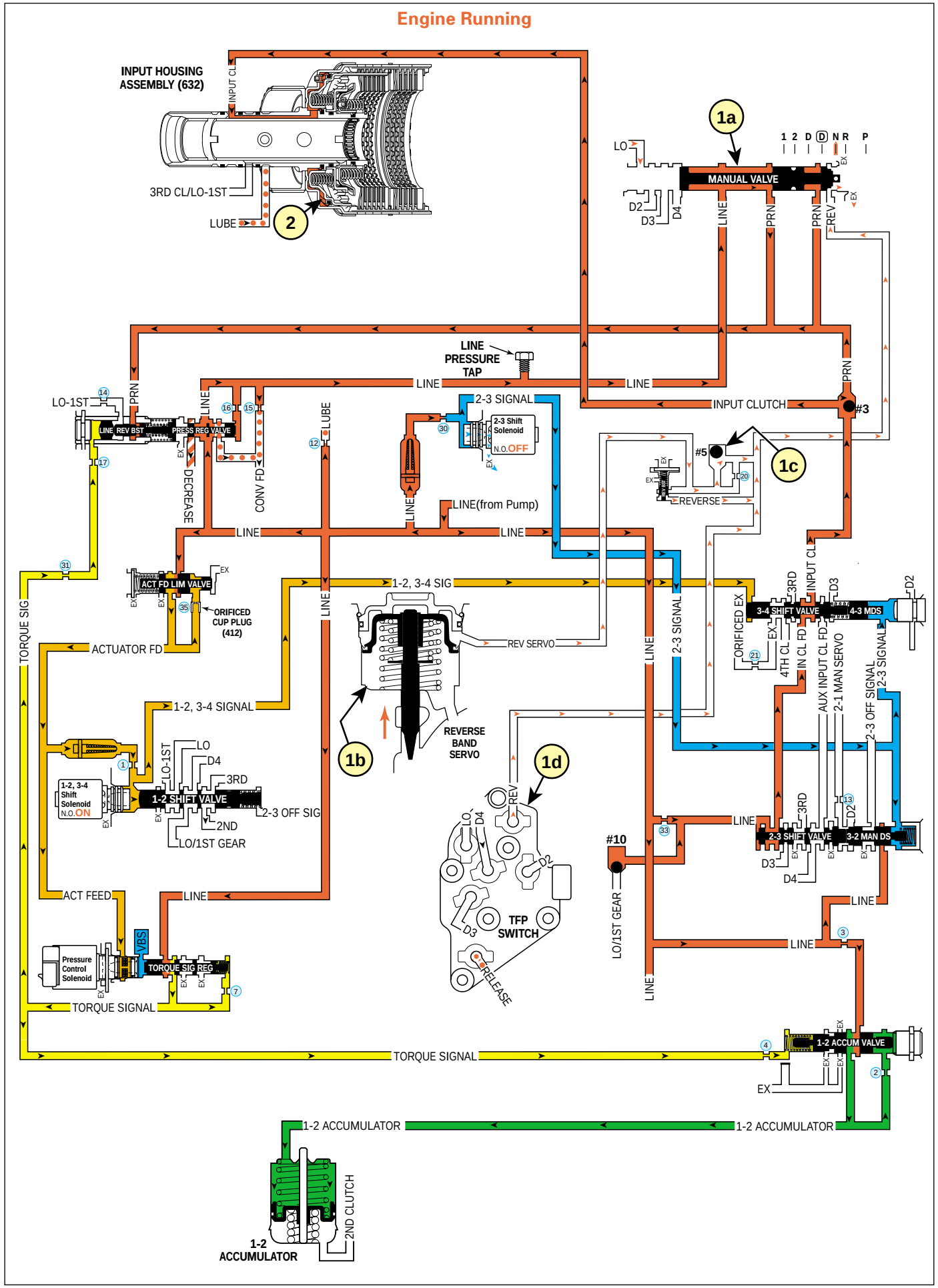


Figure 57

OVERDRIVE RANGE – FIRST GEAR

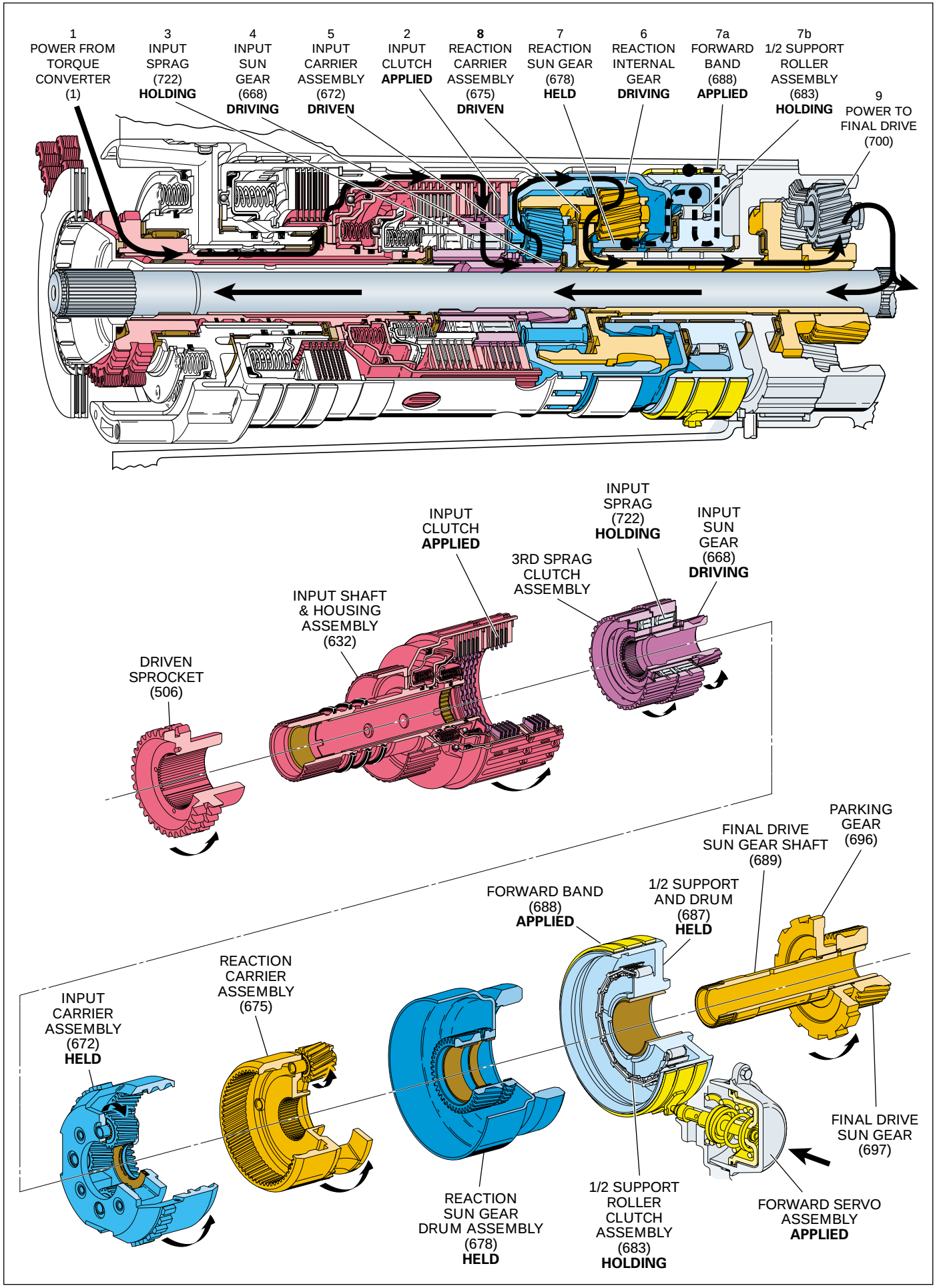


Figure 58

OVERDRIVE RANGE - FIRST GEAR

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	ON						APPLIED	HOLDING		HOLDING	APPLIED

* APPLIED BUT NOT EFFECTIVE

In Overdrive Range - First Gear Ⓓ, torque from the engine is multiplied through the torque converter (1) and transaxle gear sets to the drive axles. The planetary gear sets operate in reduction to achieve a first gear starting ratio of 2.921:1.

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

1 Power from Torque Converter
Power from the torque converter turbine transfers to the driven sprocket (506) which is splined to the input shaft and housing assembly.

2 Input Clutch Applied
The input clutch is applied and holds the outer race of the input sprag assembly which forces the input sprag to try to rotate.

3 Input Sprag Holding
The input sprag holds when torque comes from the engine, and overruns when torque comes from the wheels, allowing the vehicle to coast.

4 Input Sun Gear Driving
Power continues from the input sprag through the input sun gear (668), which then drives the input carrier planetary pinions.

5 Input Carrier Assembly Driven
Teeth on the input sun gear (668) are in mesh with the planet pinion gears in the input carrier assembly (672) forcing the carrier to rotate.

6 Reaction Internal Gear Driving
The reaction internal gear, part of the input carrier assembly (672), is in mesh with the planet pinion gears in the reaction carrier assembly (675), forcing the carrier to rotate around the reaction sun gear drum assembly (678).

7 Reaction Sun Gear Held

7a Forward Band Applied
The forward band (688) is applied, holding the 1-2 support roller clutch assembly (683).

7b 1/2 Support Roller Clutch Assembly Holding
In Overdrive Range - First Gear, the direction of rotation of the reaction carrier assembly (675) forces the reaction sun gear drum assembly (678) to try to rotate in the opposite direction. The 1/2 support roller clutch assembly (683) holds the 1/2 support outer race [part of the reaction sun gear drum assembly (678)], against this rotation thereby holding the reaction sun gear drum assembly (678).

8 Reaction Carrier Assembly Driven
The reaction carrier assembly (675), splined to the final drive sun gear shaft (689), provides the power flow to the final drive differential through the final drive sun gear (697).

9 Power to Final Drive Assembly
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 (693), which is held stationary by the case, and transfers torque to the final drive differential side gears (705).

The output shaft (510), splined into the differential side gear (705), provides the torque to the left hand drive axle while the right differential side gear (705) transfers torque to the right hand drive axle.

When the differential and final drive carrier (700) rotates, the vehicle begins to move and first gear is achieved. As the speed of the vehicle increases, less torque multiplication 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

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	ON						APPLIED	HOLDING		HOLDING	APPLIED

* APPLIED BUT NOT EFFECTIVE

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 D4 fluid circuit. The manual valve also blocks line pressure from entering the PRN fluid circuit and opens the PRN fluid circuit to exhaust.

1a # 3 Ball Check Valve:
When PRN fluid exhausts, input clutch fluid moves the #3 ball check valve and seats it against the PRN fluid passage.

1b Fluid Pressure Manual Valve Position Switch Assembly (TFP Val. Position Sw.):
D4 fluid is routed to the TFP Val. Position Sw. and the TFP Val. Position Sw. signals the PCM that the transaxle is in the Overdrive range.

2 FORWARD BAND APPLIES

2a # 6 Ball Check Valve:
Located in the valve body, this ball check valve seats and forces D4 fluid to go through feed orifice #29 to control apply of the forward servo under light or normal throttle conditions.

2b Forward Servo Boost Valve:
Opens under high line pressure (high throttle position) allowing D4 fluid to by-pass the feed orifice #29 to enter the forward servo passage. This provides for a quick fill of the servo passage and quick apply of the forward band assembly (688) to prevent slippage during abusive shifts from Park or Neutral to Drive.

2c Forward Band Servo Applies:
Applies and holds the forward band during all forward gear drive ranges.

3 INPUT CLUTCH REMAINS APPLIED
The input clutch remains applied from Neutral to Drive and becomes effective as the forward band applies.

3a 1-2, 3-4 Shift Solenoid Valve:
In first gear the 1-2, 3-4 Shift Solenoid Valve remains energized by the PCM and 1-2, 3-4 signal fluid pressure holds the 1-2 shift valve in the downshifted position.

3b 1-2 Shift Valve:
In the downshift position D4 fluid passes through the 1-2 shift valve into the lo/1st gear fluid circuit and unseats the #10 ball check valve.

3c # 10 Ball Check Valve:
Located in the valve body this ball check valve unseats and allows lo/1st gear fluid to bypass orifice #33 and increases the fluid volume feeding the input clutch feed circuit.

3d 2-3 Shift Solenoid Valve:
Energized (ON) by the PCM, high pressure in the 2-3 signal fluid circuit holds the 2-3 and 3-4 shift valves in the downshift position.

COMPLETE HYDRAULIC CIRCUIT
Page 88

OVERDRIVE RANGE – FIRST GEAR

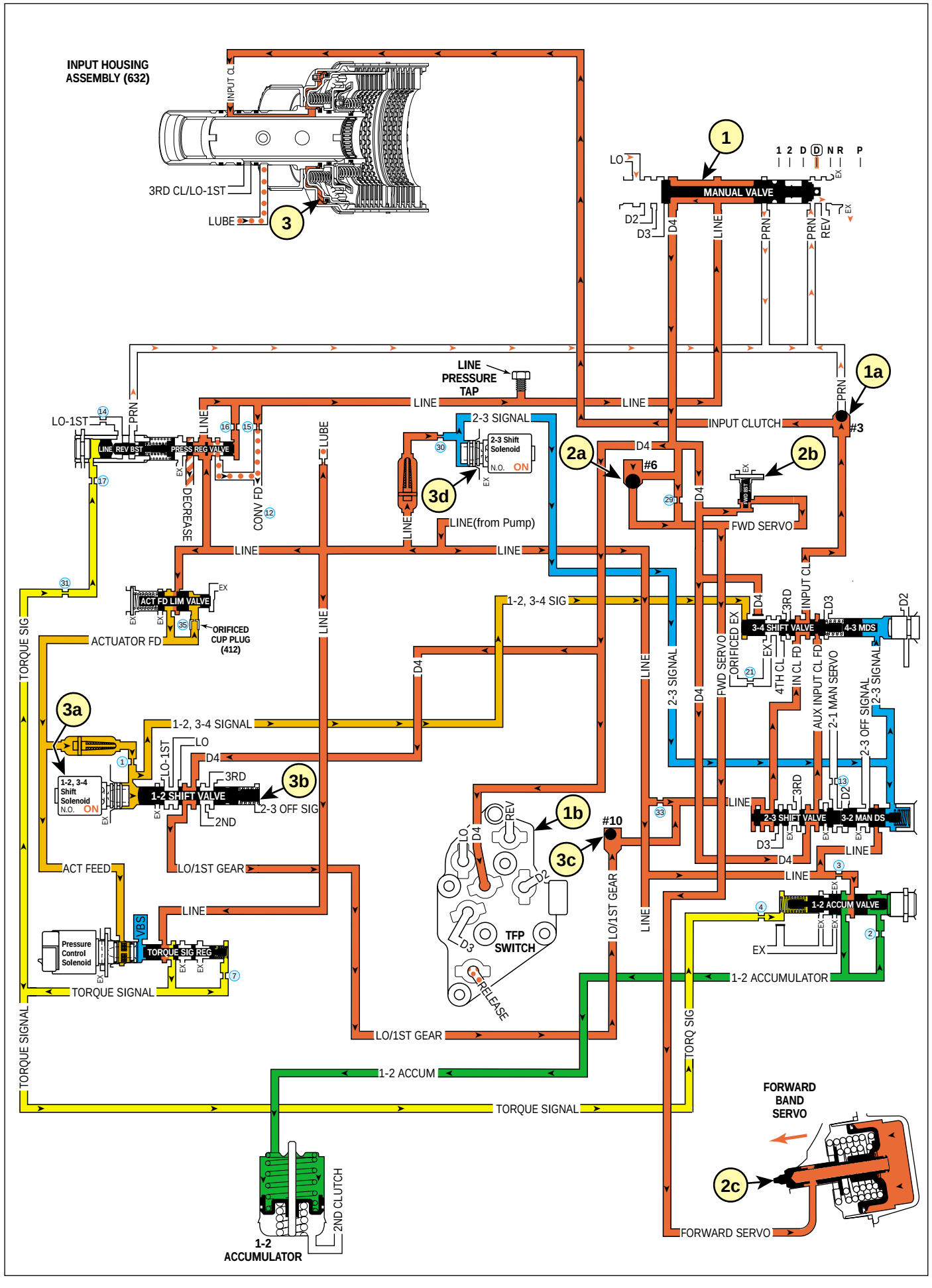


Figure 59

OVERDRIVE RANGE – SECOND GEAR

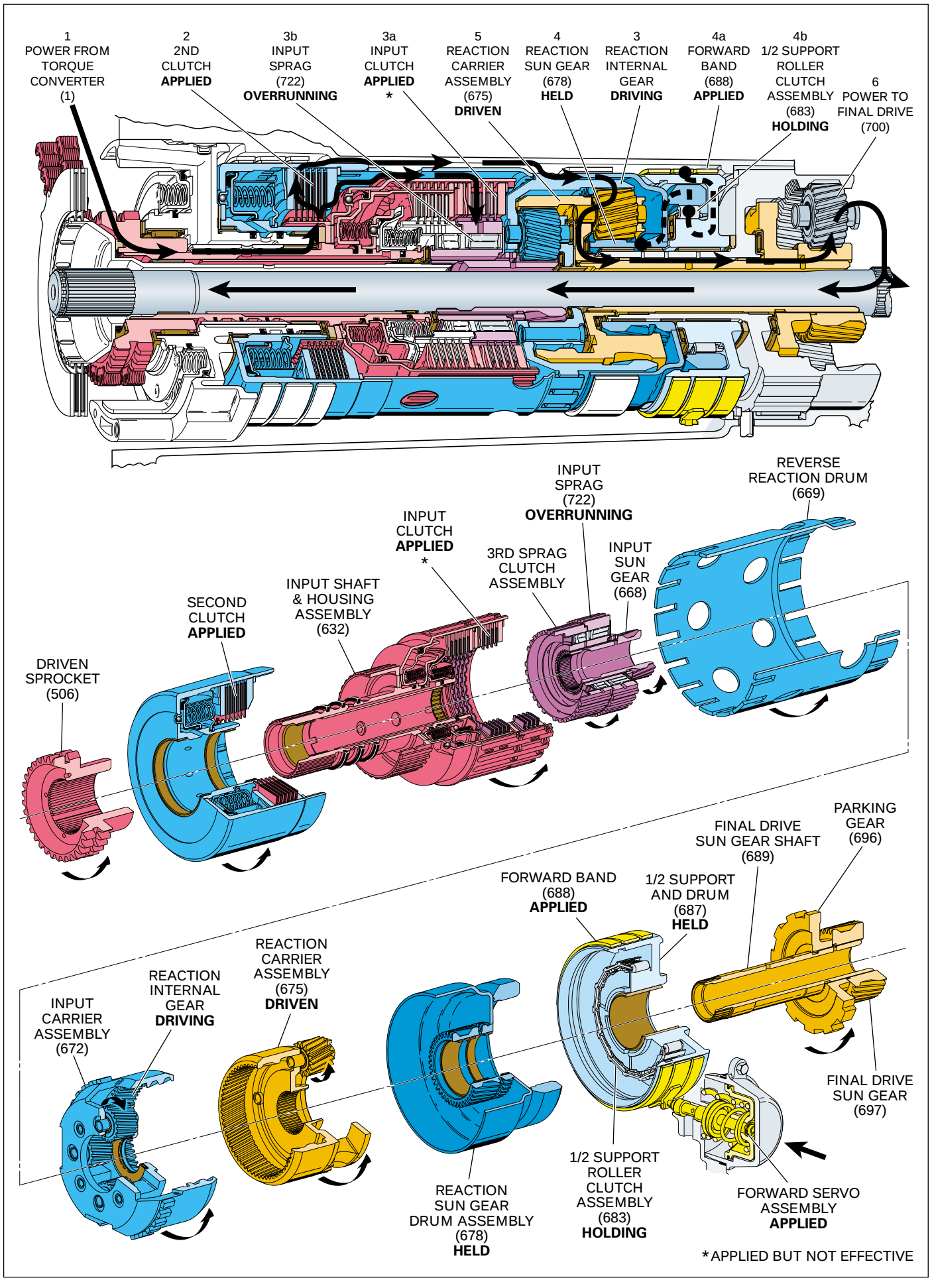


Figure 60

OVERDRIVE RANGE - SECOND GEAR

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
OFF	ON			APPLIED			*	OVERRUN		HOLDING	APPLIED

* APPLIED BUT NOT EFFECTIVE

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 1.57:1.

1 Power from Torque Converter
The driven sprocket (506), splined to the input shaft and housing assembly (632), transmits engine torque to the housing and forces it to rotate.

2 Second Clutch Applied
The second clutch plates (624), splined onto the input housing hub, redirect the power flow into the 2nd clutch assembly (617-627).

3 Reaction Internal Gear Driving
The reverse reaction drum (669) splined to the 2nd clutch housing (617) on one end and the reaction internal gear at the other end, transfers the power to the gear sets. The reaction internal gear is part of the input carrier assembly (672).

3a Input Clutch Applied but Not Effective
Although the input clutch is applied, power through the input clutch plates (646-647) is terminated at the input sprag outer race (665) because it is overrunning.

3b Input Sprag Overrunning
Overrunning occurs as the input carrier pinion gears drive (rotate) the input sun gear (668) faster than the rotation of the input carrier assembly (672).

4 Reaction Sun Gear Held

4a Forward Band Applied
The forward band (688) is applied, holding the 1/2 support roller clutch assembly (683).

4b 1/2 Support Roller Clutch Assembly Holding
In Overdrive Range - First Gear, the direction of rotation of the reaction carrier assembly (675) forces the reaction sun gear drum assembly (678) to try to rotate in the opposite direction. The 1/2 support roller clutch assembly (683) holds the 1/2 support outer race [part of the reaction sun gear drum assembly (678)], against this rotation thereby holding the reaction sun gear drum assembly (678).

5 Reaction Carrier Assembly Driven
The reaction internal gear, in mesh with the planet pinion gears in the reaction carrier assembly (675), forces the reaction carrier to rotate around the reaction sun gear drum assembly (678).

6 Power to Final Drive Assembly
The reaction carrier assembly, splined to the final drive sun gear shaft (689), provides the power flow to the final drive differential through the final drive sun gear (697). 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 (697) to the drive axles is omitted as it is identical to 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

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
OFF	ON			APPLIED			*	OVERRUN		HOLDING	APPLIED

* APPLIED BUT NOT EFFECTIVE

As vehicle speed increases and operating conditions become appropriate, the PCM de-energizes the 1-2, 3-4 Shift Solenoid to shift the transaxle into Second gear. The manual valve remains in the Overdrive Ⓓ position and line pressure is routed into the D4 fluid circuit.

1 SECOND CLUTCH APPLIES

1a 1-2 Shift Solenoid:
The normally open shift solenoid is de-energized and 1-2, 3-4 signal fluid exhausts through the open solenoid.

Note: *Filtered actuator feed fluid continues to feed the 1-2, 3-4 signal fluid circuit through orifice #1. However, the exhaust port through the solenoid is larger than orifice #1 to prevent a pressure increase in the 1-2, 3-4 signal fluid circuit.*

1b 1-2 Shift Valve:
With 1-2, 3-4 signal fluid pressure exhausted, spring force moves the valve into the upshifted position and D4 fluid is routed into the 2nd fluid circuit. D4 fluid also continues to the TFP Val. Position Sw..

1c #2 Ball Check Valve (Second Clutch Apply):
2nd fluid seats the #2 ball check valve, and is then forced through the #25 orifice and feeds the 2nd clutch fluid circuit. The 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 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 fluid forced from the 1-2 accumulator 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 38 shows the exhaust of accumulator fluid during the shift by the arrow directions in the accumulator fluid circuit.*

3 Torque Converter Clutch Released

3a TCC Control - Pulse Width Modulated (PWM) Solenoid:
2nd clutch fluid is routed to the TCC control PWM solenoid. Under normal operating conditions, the TCC control PWM solenoid is OFF in Second gear and blocks 2nd clutch fluid from entering the TCC signal (PWM) fluid circuit. However, TCC apply could vary depending on vehicle application and may be calibrated to apply in Overdrive Range - Second Gear.

3b 2-3 Shift Solenoid Valve:
2-3 Shift Solenoid Valve remains ON in Second gear. 2-3 signal fluid pressure keeps the 2-3 shift valve in the downshifted position.

COMPLETE HYDRAULIC CIRCUIT
Page 90

OVERDRIVE RANGE – SECOND GEAR

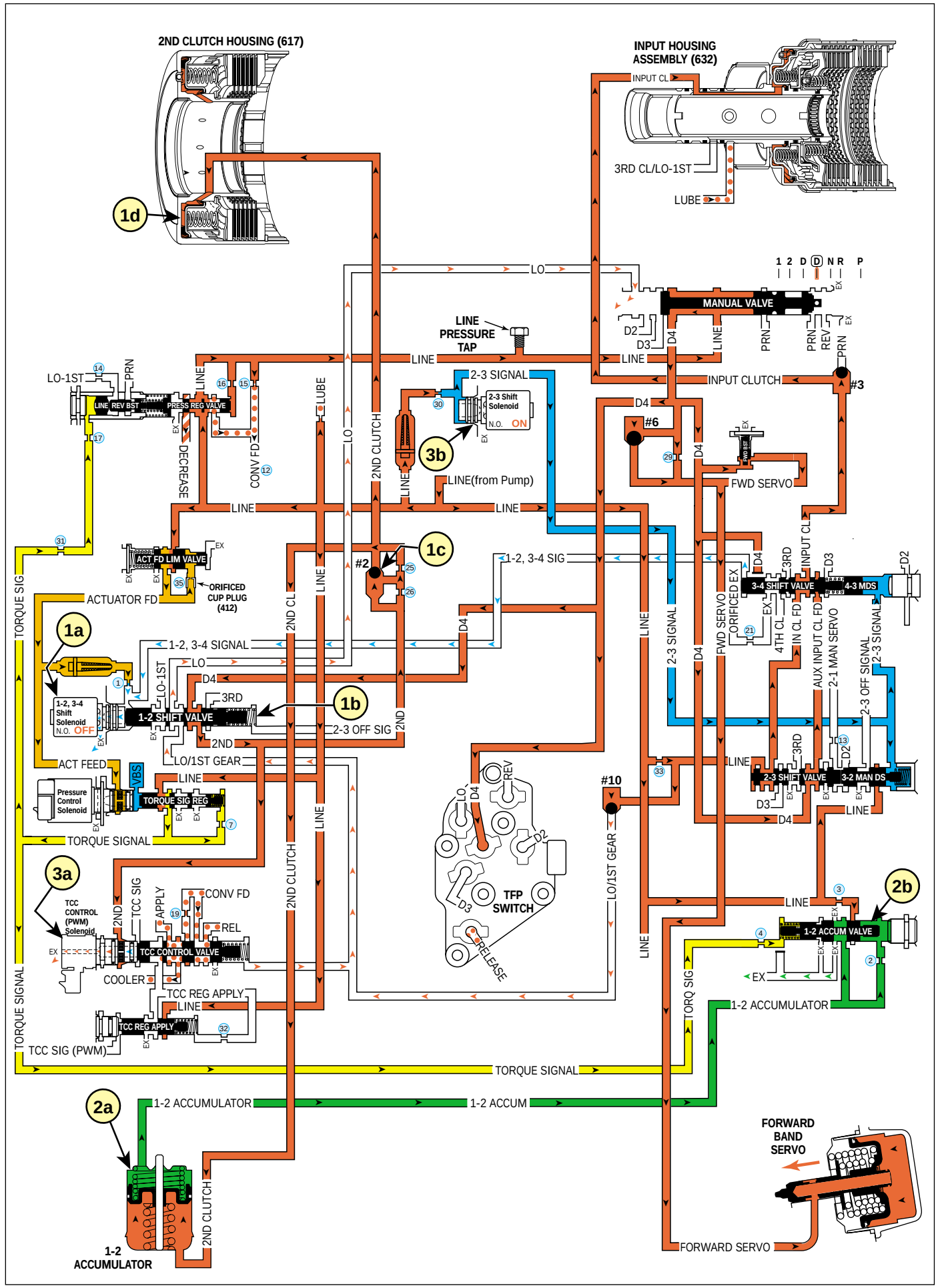


Figure 61

OVERDRIVE RANGE – THIRD GEAR

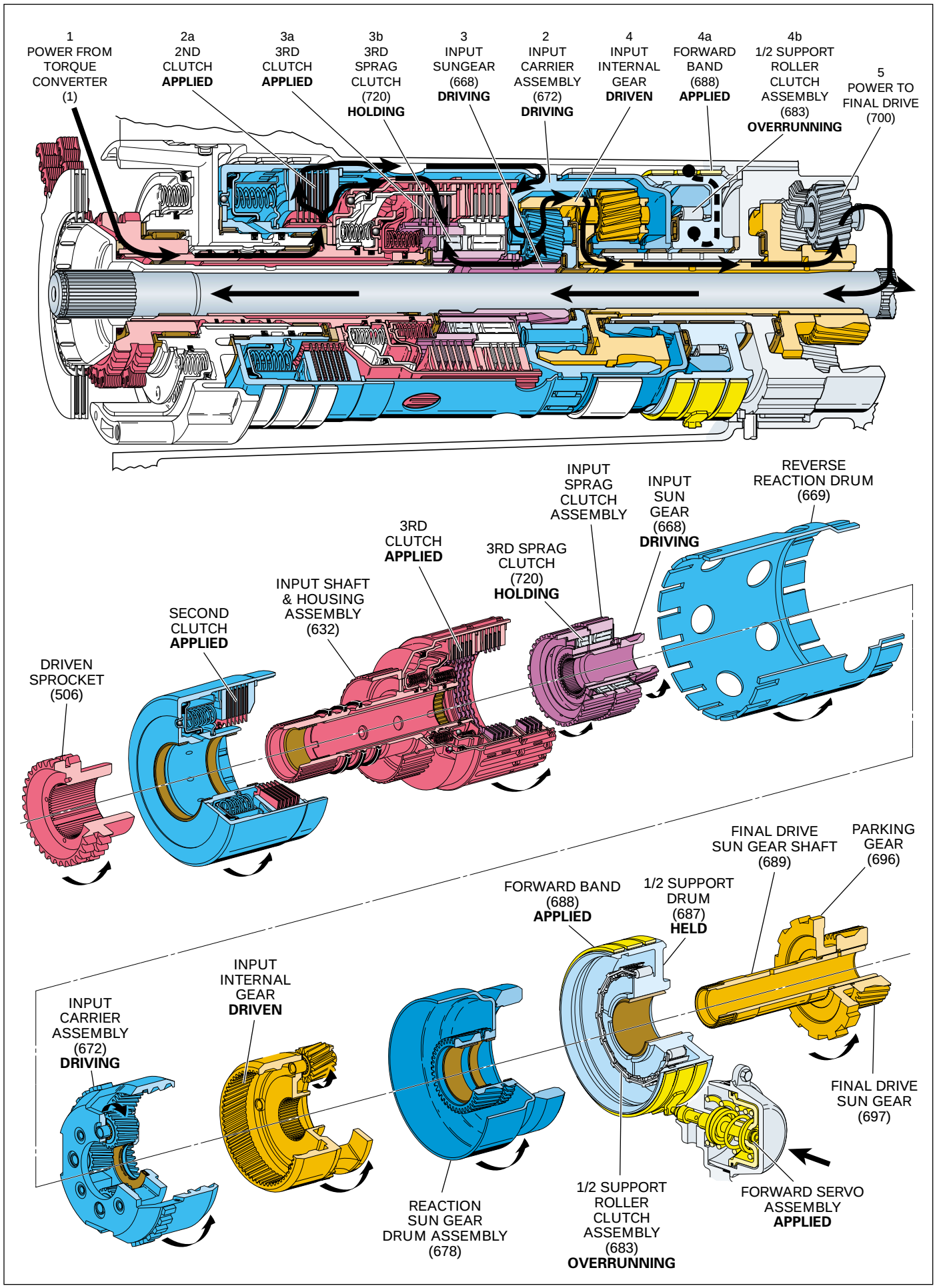


Figure 62

OVERDRIVE RANGE - THIRD GEAR

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
OFF	OFF			APPLIED	APPLIED	HOLDING				OVERRUN	*

* APPLIED BUT NOT EFFECTIVE

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, both planetary gear sets rotate at the same speed providing for a 1:1 gear ratio to the final drive differential (700).

1 Power from Torque Converter
The driven sprocket (506), splined to the input shaft and housing assembly (632) transmits engine torque to the housing and forces it to rotate.

2 Input Carrier Assembly Driving

2a 2nd Clutch Applied
The 2nd clutch is applied and directs power flow through the reverse reaction drum (669) to the input carrier assembly (672).

3 Input Sun Gear Driving

3a 3rd Clutch Applied
The 3rd clutch is also applied directing power flow to the 3rd clutch plates (645-648).

3b 3rd Sprag Clutch Holding

The 3rd clutch plates (645-648), splined onto the 3rd sprag clutch outer race (653), force the sprag elements to hold input and 3rd clutch sprag inner race (661).

The input and 3rd clutch sprag inner race (661), splined to the input sun gear (668), holds the sun gear and forces it to rotate at the same speed as the input shaft and housing assembly (632).

4 Input Internal Gear Driven

With the input carrier assembly (672) being driven by the reverse reaction drum (669) and the input sun gear (668), the input internal gear, which is part of the reaction carrier (675), is forced to rotate at the same speed and direction of rotation. Therefore, reduction through the gear set does not exist.

4a Forward Band Applied
The forward band (688) is applied, holding the 1/2 support roller clutch inner race (687).

4b 1/2 Support Roller Clutch Assembly Overruns
The reaction carrier pinion gears are in mesh with the reaction sun gear drum assembly (678) and force it to rotate at the same speed and direction of rotation as the gear sets. The 1/2 support roller clutch outer race overruns because it is part of the reaction sun gear drum assembly (678).

5 Power to Final Drive Assembly
The input internal gear/reaction carrier assembly (675), splined to the final drive sun gear shaft (689), provides the power flow to the final drive sun gear (697) which is splined to the other end of the sun gear shaft.

In Overdrive Range - Third Gear, letting up on the throttle will allow engine rpm to drop as the vehicle continues to move at approximately the same speed. This results in loss of torque to the 3rd sprag clutch inner race (661) and allows the input carrier assembly (672) and roller clutch to freewheel. In this situation, engine compression braking is not obtainable.

In Overdrive Range - Third Gear, the transaxle is operating in a direct 1:1 gear ratio between converter turbine speed and the final drive sun gear (697) speed.

As vehicle speed increases, less torque multiplication is required to operate the engine efficiently therefore making it desirable to shift to an overdrive ratio.

OVERDRIVE RANGE - THIRD GEAR

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
OFF	OFF			APPLIED	APPLIED	HOLDING				OVERRUN	*

* APPLIED BUT NOT EFFECTIVE

As vehicle speed increases and operating conditions become appropriate, the PCM de-energizes the 2-3 shift solenoid valve to shift the transaxle into Third gear. The manual valve remains in the Overdrive Ⓓ position and line pressure continues to feed the D4 fluid circuit.

1 THIRD CLUTCH APPLIES

1a 2-3 Shift Solenoid Valve:
The normally open shift solenoid valve is de-energized by the PCM and allows 2-3 signal fluid to exhaust.

1b 2-3 Shift Valve:
With 2-3 signal fluid exhausting, Line fluid pressure move the 2-3 shift valve against spring force to initiate the 2-3 upshift. D4 fluid is routed through the valve and into the 3rd fluid circuit.

1c #9 Ball Check Valve (Third Clutch Apply/Release):
Located in the valve body, 3rd fluid pressure seats the #9 ball check valve and 3rd fluid is forced through the #24 orifice into the 3rd clutch fluid circuit. The orifice helps control the third clutch apply.

1d #4 Ball Check Valve (Lo 1st/3rd Clutch Lo-1st):
Located in the case cover, the #4 ball check valve routes 3rd clutch fluid into the 3rd clutch/lo-1st circuit and blocks it from entering the lo 1st circuit.

1e Third Clutch:
3rd clutch/lo-1st fluid pressure applies the third clutch and the transaxle shifts into Third gear.

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

2 SHIFT ACCUMULATION

2a 2-3 Accumulator:
3rd clutch fluid is also routed to the 2-3 accumulator piston. This fluid pressure moves the piston against spring force and 2-3 accumulator fluid pressure. This action absorbs initial 3rd clutch fluid pressure to cushion the third 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 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 third clutch apply. *Figure 38 shows the exhaust of accumulator fluid during the shift by the arrow directions in the accumulator fluid circuit.*

3 INPUT CLUTCH RELEASES

In third gear the input clutch is released allowing input clutch apply fluid to exhaust through the 3-4 shift valve, into the input clutch feed passage. At the 2-3 shift valve, exhausting input clutch apply fluid is directed into the D3 passage and out the manual valve.

3a TFP Valve Position Switch:
Release fluid pressure routed to the TFP Valve Position Switch 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.

COMPLETE HYDRAULIC CIRCUIT
Page 92

OVERDRIVE RANGE – THIRD GEAR

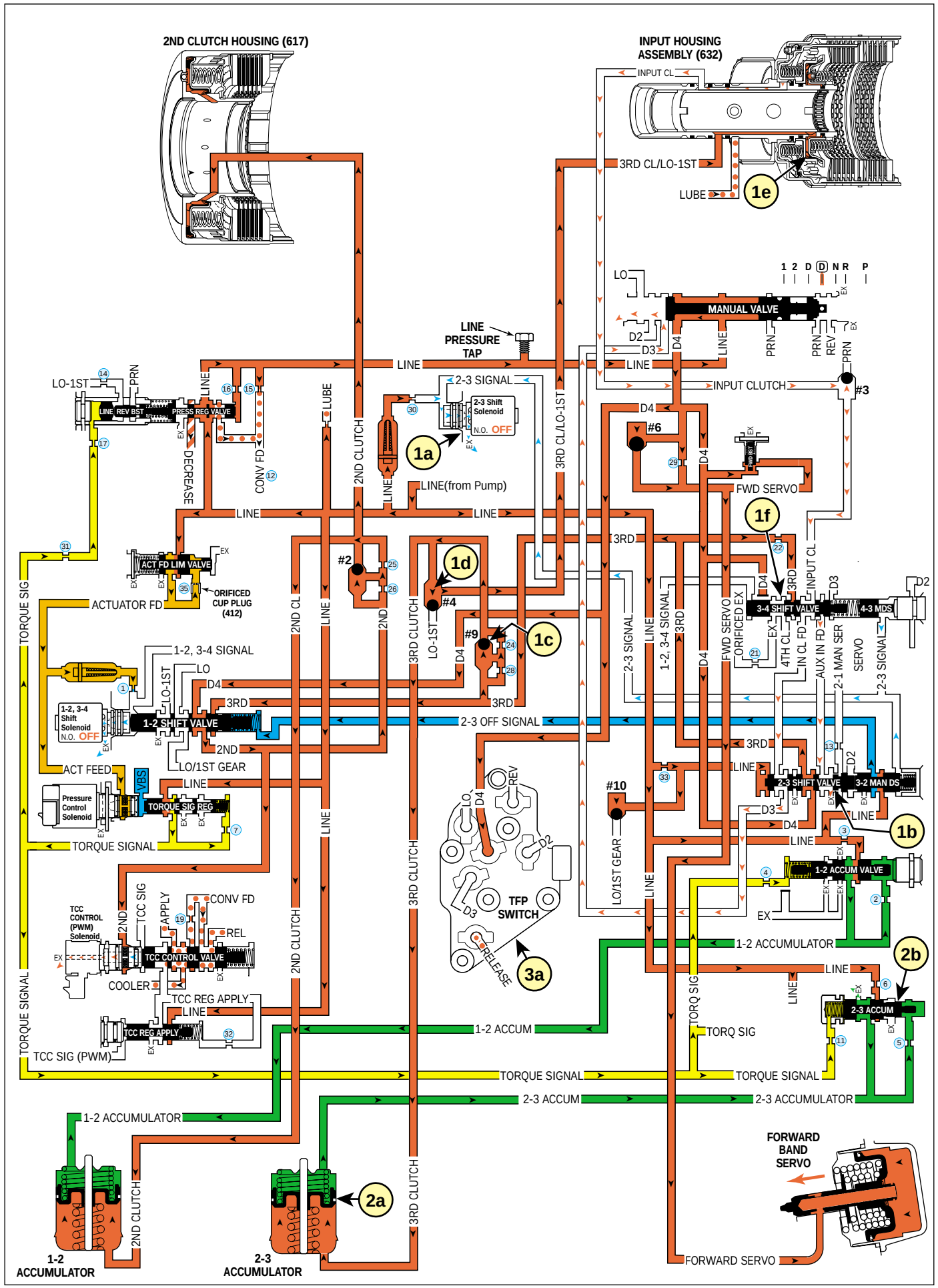


Figure 63

OVERDRIVE RANGE – FOURTH GEAR

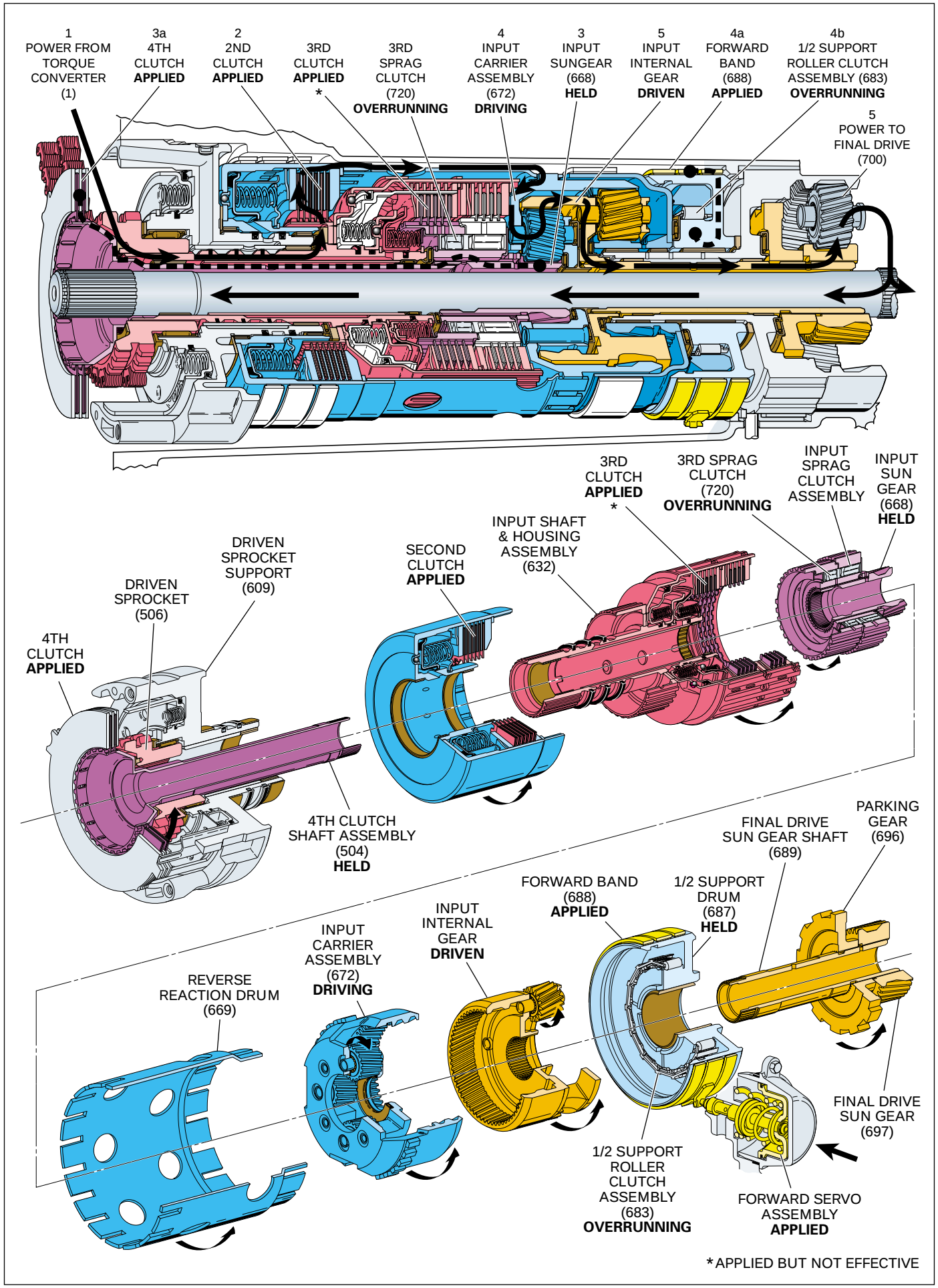


Figure 64

OVERDRIVE RANGE - FOURTH GEAR

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	OFF	APPLIED		APPLIED	*	OVERRUN				OVERRUN	*

* APPLIED BUT NOT EFFECTIVE

As the speed of the vehicle increases, input signals from the VSS, TPS and other sensors are sent to the PCM. The PCM uses this information to determine the precise moment to shift the transaxle into Fourth Gear. In Fourth Gear, the input carrier assembly (672) provides an overdrive ratio of .71:1 through the gear set to the final drive differential (700).

1 Power from Torque Converter
The driven sprocket (506), splined to the input shaft and housing assembly (632) transmits torque to the housing and forces it to rotate.

2 2nd Clutch Applied
With the 2nd clutch applied, power flow is directed through the reverse reaction drum (669) to the input carrier assembly (672), as previous described in Third Gear range.

3 Input Sun Gear Held

3a 4th Clutch Applied
The 4th clutch plates (500-502) are splined to the 4th clutch hub & shaft assembly (504) and to the case cover (400). When the 4th clutch applies, it holds the 4th clutch hub & shaft assembly (504) and the input sun gear (668) which is splined to the 4th clutch shaft.

4 Input Carrier Assembly Driving
The input carrier assembly (672) rotates around the stationary input sun gear (668).

4 Input Internal Gear Driven
The input carrier pinion gears force the input internal gear/ reaction carrier assembly (675) to rotate in the same direction but, at a faster speed.

4a Forward Band Applied
The forward band (688) is applied, holding the 1/2 support roller clutch inner race (687).

4b 1/2 Support Roller Clutch Assembly Overruns
The reaction carrier pinion gears are in mesh with the reaction sun gear drum assembly (678) and force it to rotate at the same speed and direction of rotation as the gear sets. The 1/2 support roller clutch outer race overruns because it is part of the reaction sun gear drum assembly (678).

5 Power to Final Drive Assembly
The reaction carrier assembly (675), splined to the final drive sun gear shaft (689), provides the power flow to the final drive sun gear (697) which is splined to the other end of the final drive sun gear shaft (689).

In fourth and third gear overdrive ranges, the forward band is applied only for preparation for a downshift into second gear, which will make the shift timing easier having this component already applied.

OVERDRIVE RANGE - FOURTH GEAR

(Torque Converter Clutch Released)

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	OFF	APPLIED		APPLIED	*	OVERRUN				OVERRUN	*

* APPLIED BUT NOT EFFECTIVE

When operating conditions are appropriate, the PCM energizes the 1-2, 3-4 shift solenoid valve to shift the transaxle into Fourth gear. In addition, the TCC is applied in Fourth gear (see the following pages for details of TCC apply). The manual valve remains in the Overdrive position and line pressure continues to feed the D4 fluid circuit.

1 4TH CLUTCH APPLIED

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

1b 1-2 Shift Valve:
1-2, 3-4 signal fluid pressure does not affect the 1-2 shift valve. Spring force and 2-3 off signal fluid pressure keep the 1-2 shift valve in the upshifted position.

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

1d 4th Clutch:
4th clutch fluid pressure is routed to the 3-4 accumualtor and then to the 4th clutch apply piston.

2 SHIFT ACCUMULATION

2a 3-4 Accumulator:
4th clutch fluid, routed to the 3-4 accumulator moves the piston against spring force and 3-4 accumulator fluid pressure. This action absorbs initial 4th clutch fluid pressure to cushion the 4th clutch 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 fluid forced from the 3-4 accumulator is routed back to the 3-4 accumulator valve. This pressure forces the 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 4th clutch apply. *Figure 37 shows the exhaust of accumulator fluid during the shift by the arrow directions in the accumulator fluid circuit.*

TORQUE CONVERTER CLUTCH APPLIED

TCC Control (PWM) Solenoid:
When conditions are appropriate, the PCM energizes the TCC control (PWM) 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.)

COMPLETE HYDRAULIC CIRCUIT
Page 94

OVERDRIVE RANGE – FOURTH GEAR

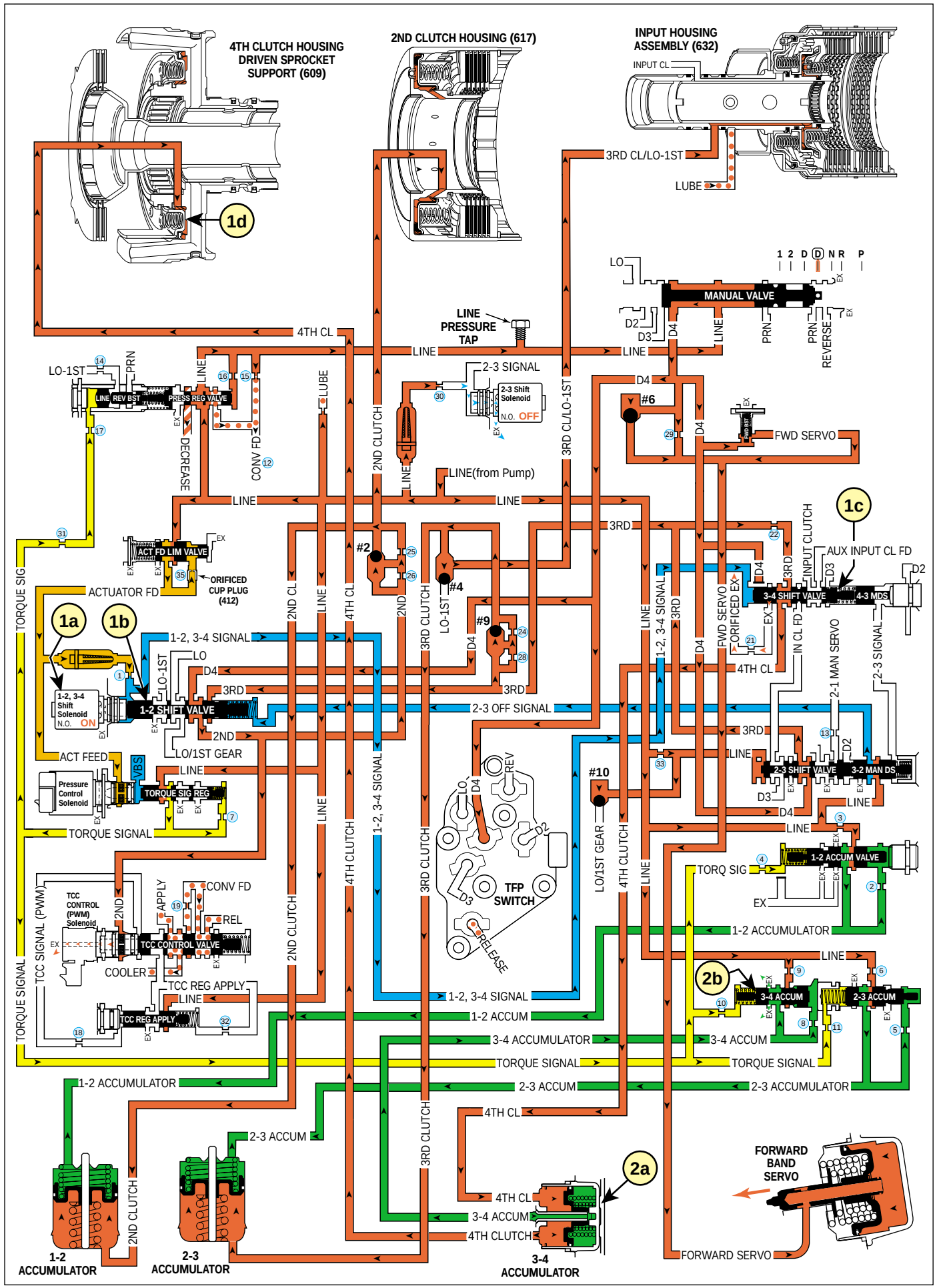
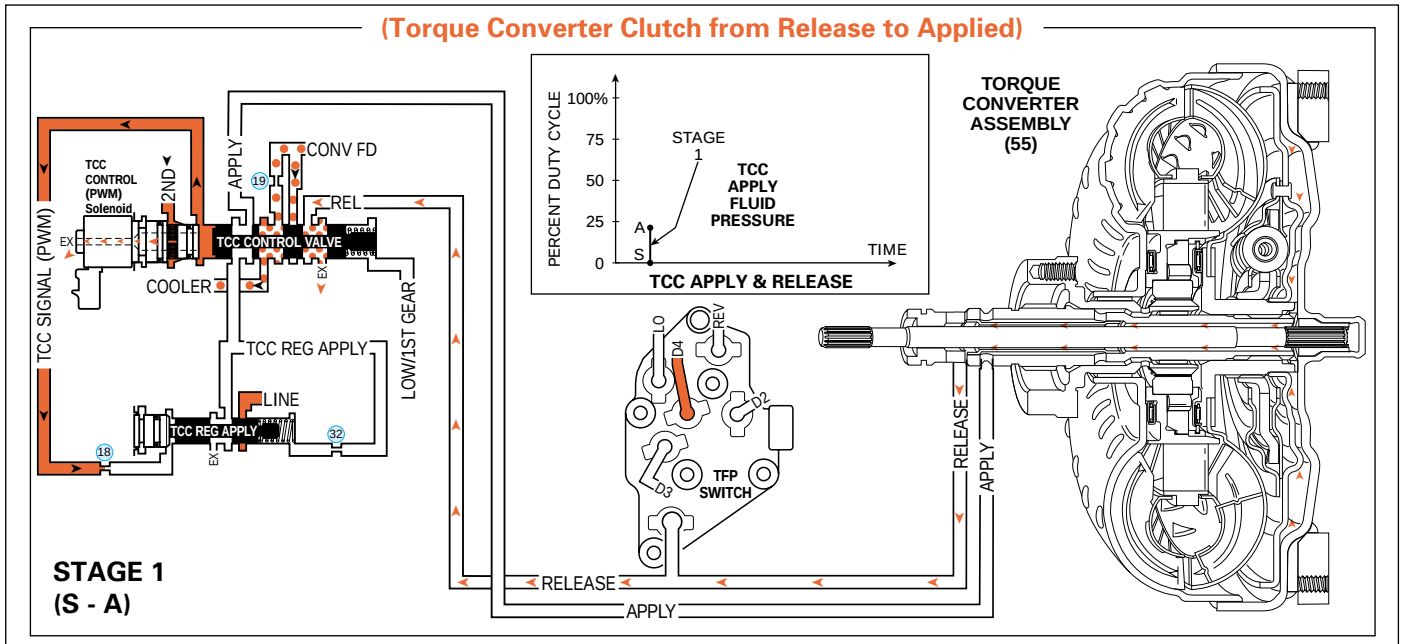
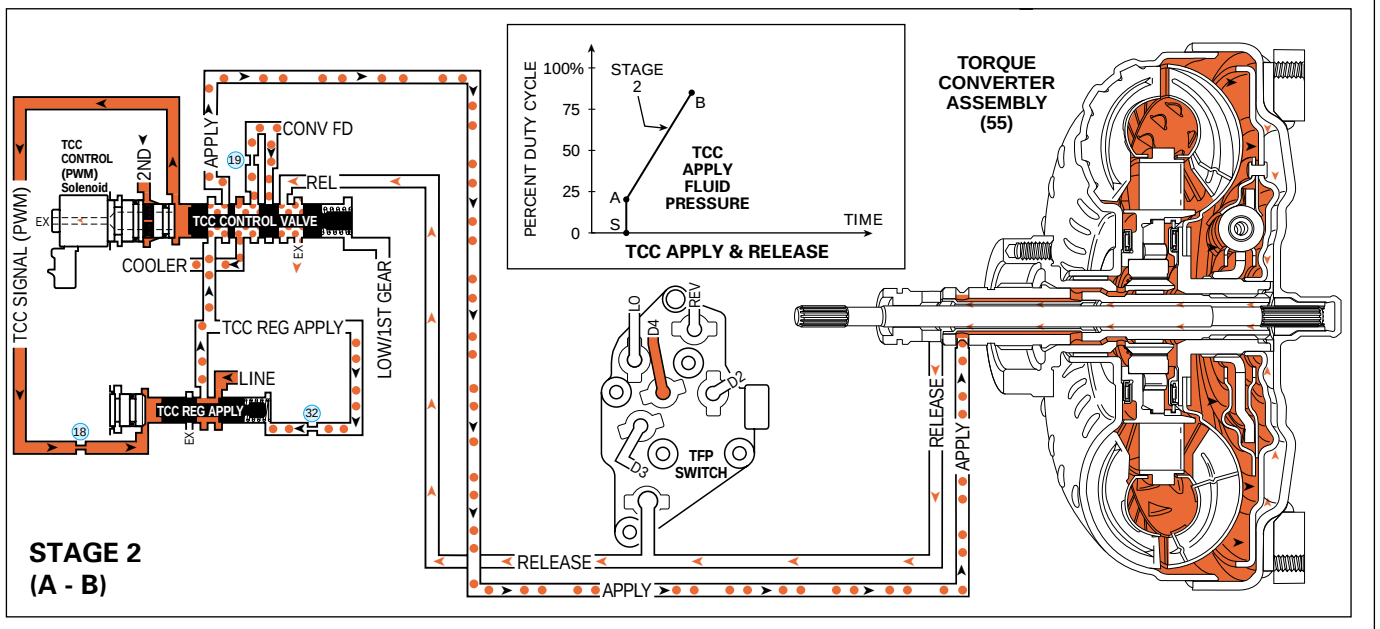


Figure 65

OVERDRIVE RANGE - FOURTH GEAR

(Torque Converter Clutch from Release to Applied)





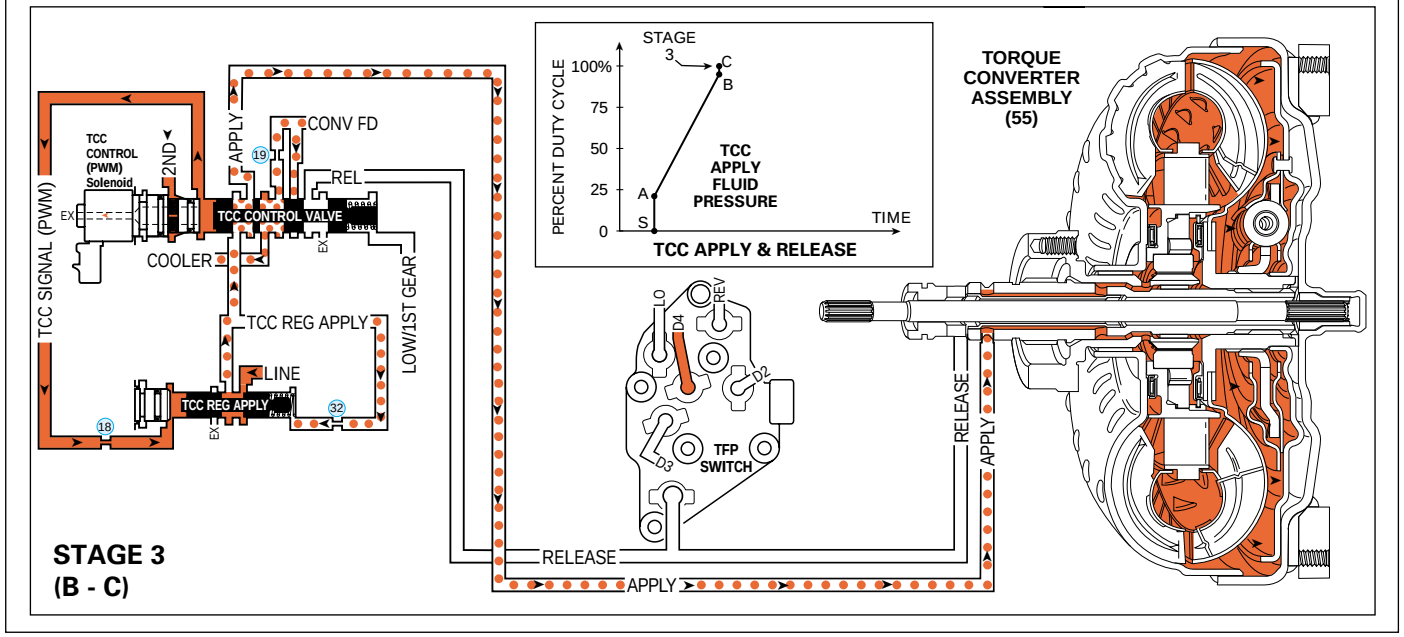


Figure 66

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 TCC 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 47, in the Electrical Components section, for more information).

Stage 1 The PCM pulses the TCC control (PWM) solenoid to approximately 22% duty cycle from point **S** to point **A**. 2nd fluid at the TCC control (PWM) solenoid is "pulsed" into the TCC Signal (PWM) fluid circuit. The TCC Signal (PWM) fluid pressure at point **A** is strong enough to move the TCC control valve against the spring. With the TCC Control valve in the apply position, Release fluid can exhaust. 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 (PWM) solenoid duty cycle is ramped up from point **A** to point **B** to approximately 98%. TCC signal (PWM) fluid pressure passes through orifice #18 and is now strong enough to move the TCC regulator apply valve against spring force. Line pressure from the pump enters the TCC Regulated Apply circuit at the TCC Regulator Valve. TCC Regulated Apply fluid is routed through the TCC Regulator Valve and through the TCC Control Valve into the Apply circuit. The pressure value in the Regulated Apply circuit should now be high enough to fully apply the TCC pressure plate. Slip speed should be at the correct value (near "0").

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

Stage 3 Now the Regulated Apply pressure is increased. This is caused by the TCC control (PWM) solenoid duty cycle being increased from point **B** to point **C,** to approximately 98%. This extra pressure ensures that the apply force on the TCC 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 Automatic Transmission Fluid Pressure Manual Valve Position Switch (TFP Val. Position SW.) 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 (PCM) 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, signaling that the TCC is in the engaged position.

OVERDRIVE RANGE - FOURTH GEAR

(Torque Converter Clutch from Applied to Released)

When the TCC 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 47, in the Electrical Components section, for more information).

Stage 4 During this stage, the apply pressure from the TCC Regulator valve is decreased by the TCC control (PWM) solenoid duty cycle dropping from point **D** to point **E,** to approximately 60%. Spring force pushes the valve back and closes off the flow of line fluid feeding the TCC Regulated Apply circuit. This reduces the apply force on the TCC pressure plate to the slip threshold. This gets the TCC pressure plate ready for a smooth release.

Stage 5 The TCC control (PWM) solenoid duty cycle is ramped down from point **E** to point **F** through this stage. This action allows the TCC 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 TCC Regulator valve at this duty cycle (point **F**) should fully release the TCC pressure plate. Slip speed should be at the maximum value.

Stage 6 The PCM pulses the TCC control (PWM) solenoid to a value of "0". Now the TCC Control valve returns to the released position (away from the spring). 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 Automatic Transmission Fluid Pressure Manual Valve Position Switch (TFP Val. Position Sw.). 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) P0742 will set and the PCM will illuminate the Malfunction Indicator Lamp (MIL). The DTC P0742 will then be stored in PCM history and the PCM will freeze shift adapts from being updated. If the PCM detects an illegal combination on any range inputs (OFF, OFF, OFF or OFF, OFF, ON) then DTC P1810 will set. DTC P1810 is Transmission Fluid Presure Manual Valve Position Switch circuit malfunction.

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

OVERDRIVE RANGE - FOURTH GEAR

(Torque Converter Clutch from Applied to Release)

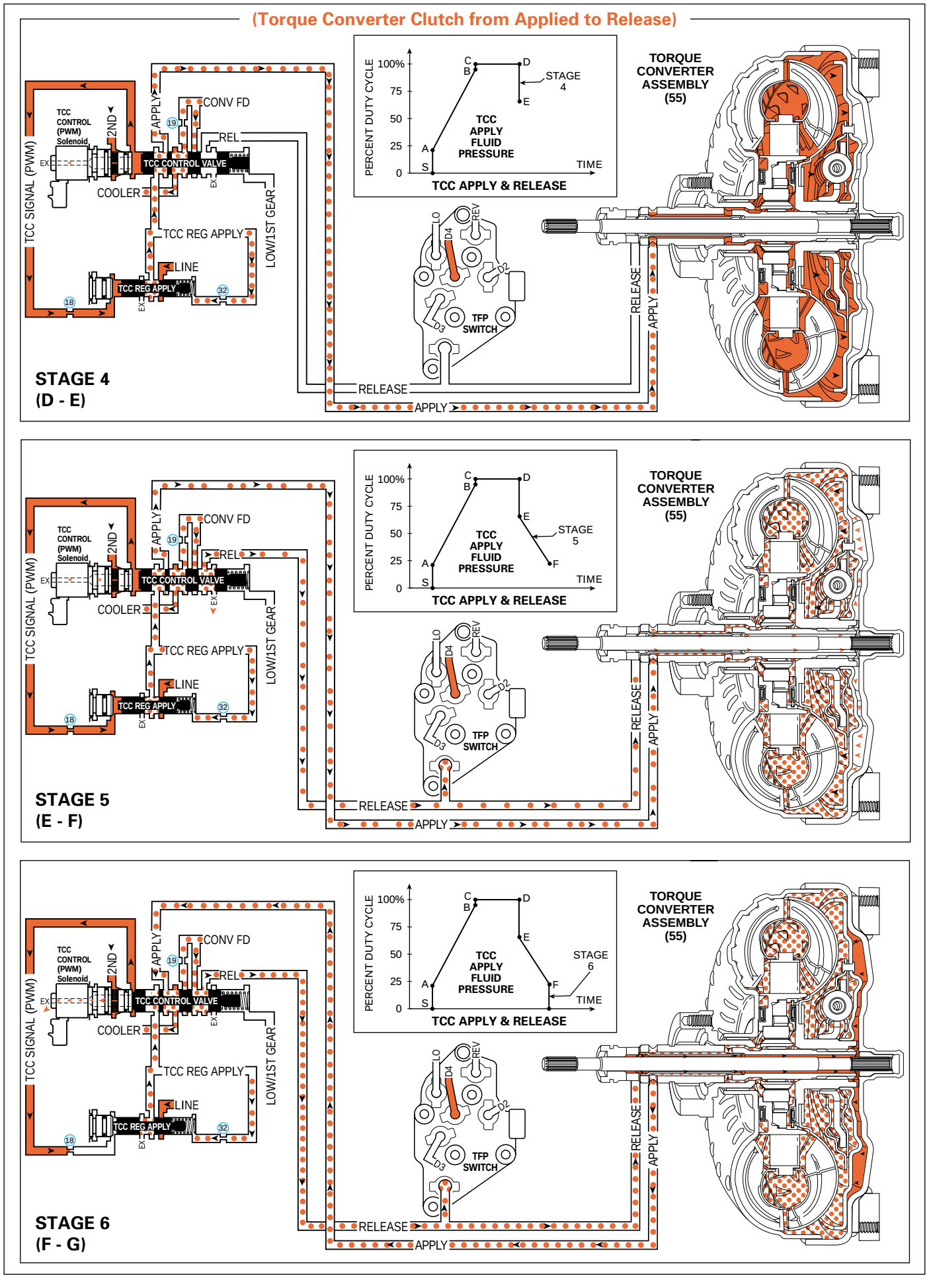


Figure 67

OVERDRIVE RANGE - 4-3 DOWNSHIFT

(Torque Converter Clutch Released)

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
OFF	OFF			APPLIED	APPLIED	HOLDING				OVERRUN	*

* APPLIED BUT NOT EFFECTIVE

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

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

2 4TH CLUTCH RELEASES

2a 1-2, 3-4 Shift Solenoid Valve:
The PCM de-energizes the normally open solenoid and 1-2, 3-4 signal fluid exhausts.

2b 3-4 Shift Valve:
1-2, 3-4 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 clutch fluid circuit to an orificed exhaust to help control the clutch release.

2c 3-4 Accumulator:
4th clutch fluid exhausts through and from the accumulator. Spring force and 3-4 accumulator fluid pressure move the accumulator piston to the Third gear position.

2d 3-4 Accumulator Valve:
The accumulator valve regulates line pressure into the 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.

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 TFP Valve Position Switch. 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.

COMPLETE HYDRAULIC CIRCUIT
Page 96

OVERDRIVE RANGE – 4-3 DOWNSHIFT

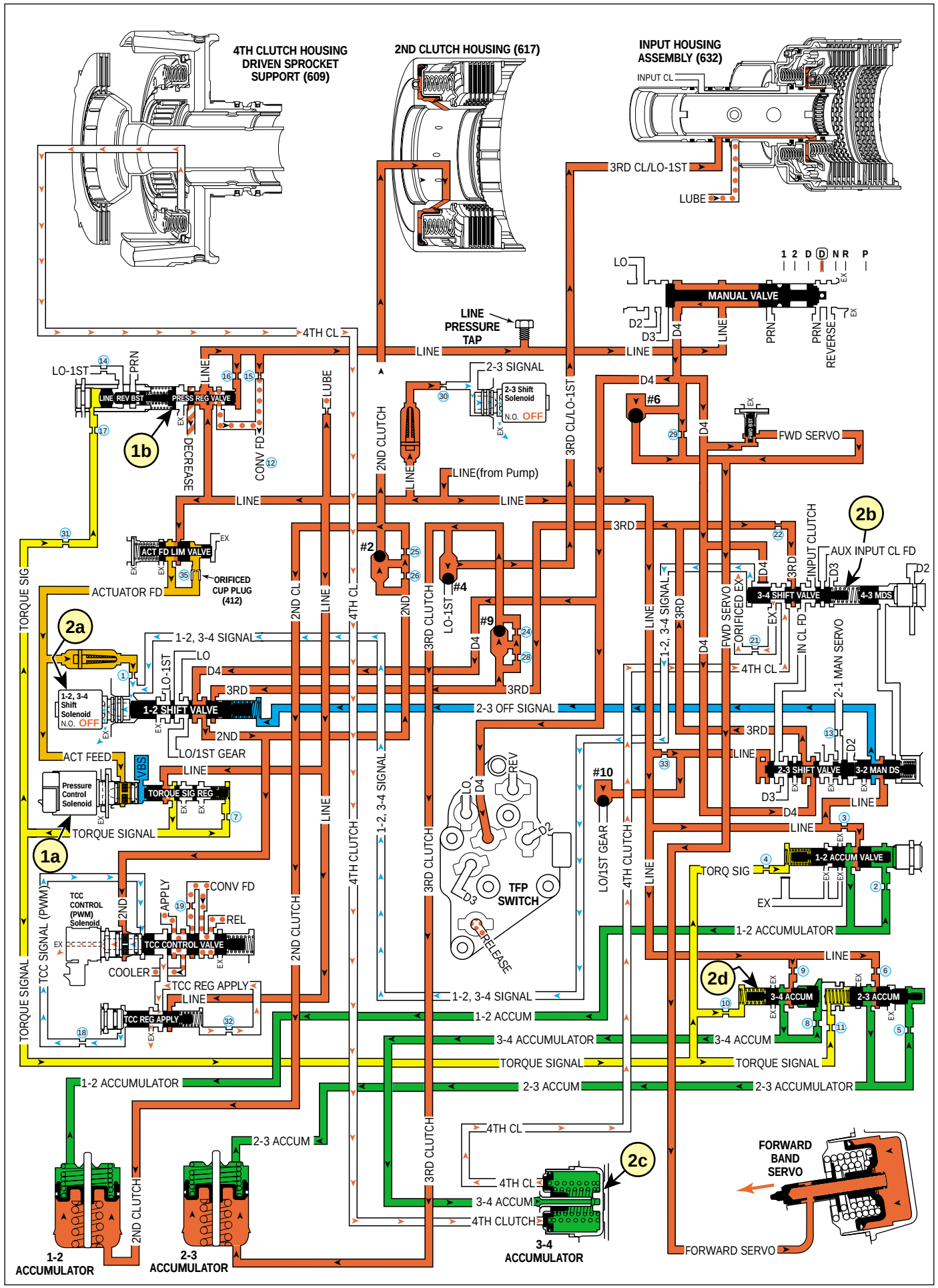


Figure 68

MANUAL THIRD – THIRD GEAR

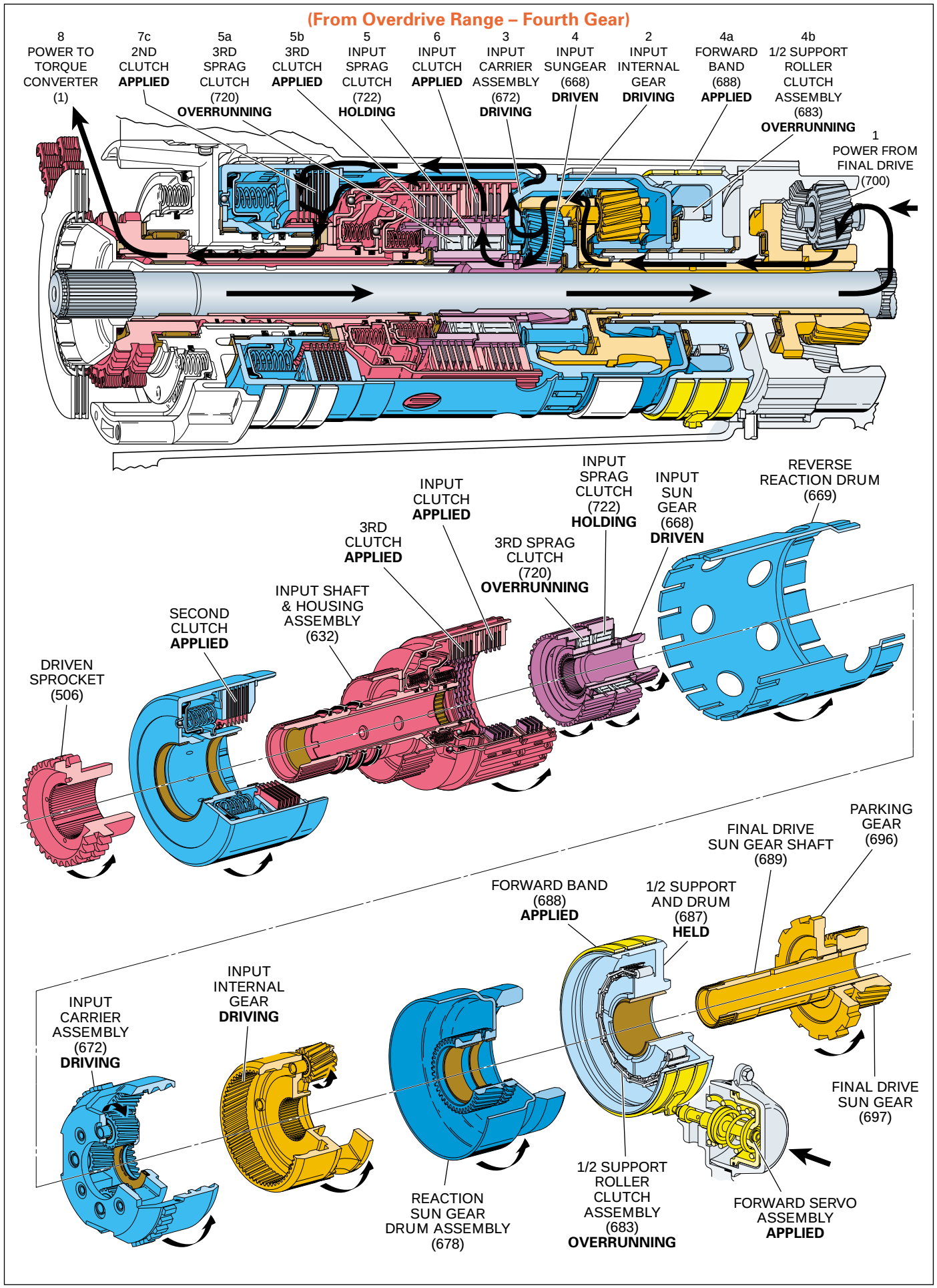


Figure 69

MANUAL THIRD - THIRD GEAR

(From Overdrive Range - Fourth Gear)

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
@OFF	@OFF			APPLIED	APPLIED	HOLDING	APPLIED	HOLDING		OVERRUN	*

* APPLIED BUT NOT EFFECTIVE

@The solenoid state follows a shift pattern which depends upon vehicle speed, throttle position and selected gear range

Manual Third - Third gear (D) 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 braking 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 gears. 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 the same as Overdrive Range Third gear except the input clutch is applied, 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 (807) and manual valve (404) are in the Manual Third (D) position.

The 4th clutch plates (500-502) release allowing the 4th clutch hub & shaft assembly (504) to rotate at the same speed and direction as the input sun gear (668).

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 Internal Gear Driving
Power continues to the input internal gear/reaction carrier assembly, which is splined to the final drive sun gear shaft.

3 Input Carrier Assembly Driving
The input internal gear which is in mesh with the input carrier planetary pinions, force the pinions to rotate. The rotating pinions drive the carrier.

4 Input Sun Gear Driven
The rotating input carrier pinions also drive the input sun gear which is splined to the inner hub of the input sprag.

5 Input Sprag Clutch Holding
During deceleration, the input torque, from the wheels to the gear set, tries to force the input sun gear (668) to rotate in a direction opposite to the input shaft and housing assembly (632). The input sprag clutch assembly prevents this from occurring by holding the input sun gear (668) and forcing it to rotate in the same direction and speed as the input housing. When this occurs, engine compression provides braking for the vehicle.

5a 3rd Sprag Clutch Overrunning
During deceleration, the 3rd sprag clutch overruns allowing the input sprag assembly to slow down the input sun gear (668).

5b 3rd Clutch Applied
The 3rd clutch is applied but, during decceleration the 3rd sprag clutch is overrunning, thus no power is transfered through the 3rd clutch plates.

6 Input Clutch Applied
The input clutch is also applied and transfers torque to the input housing through the input clutch plates.

7 2nd Clutch Applied
Power flows from the input carrier assembly (672) through the reverse reaction drum (669) to the 2nd clutch assembly which is applied and directs power to the input housing.

8 Power to Torque Converter
With two members of the same gear set driving, we have a 1:1 ratio through the gear sets and input housing to the torque converter for engine braking.

MANUAL THIRD - THIRD GEAR

(From Overdrive Range - Fourth Gear)

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
@OFF	@OFF			APPLIED	APPLIED	OVERRUN	APPLIED	HOLDING		OVERRUN	*

* APPLIED BUT NOT EFFECTIVE
@The solenoid state follows a shift pattern which depends upon vehicle speed, throttle position and selected gear range

A manual 4-3 downshift is accomplished by moving the gear selector lever to the Manual Third (D) position. In Manual Third the transaxle is hydraulically prevented from upshifting into Fourth gear under any conditions. Also, the input clutch is applied and the input sprag clutch holds to provide engine compression braking instead of coasting. 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 (D) position and line pressure enters the D3 fluid circuit.

1b 2-3 Shift Valve:
D3 fluid pressure enters the input clutch feed passage through the 2-3 shift valve and is directed to the 3-4 shift valve.

1c 3-4 Shift Valve:
D3 fluid pressure assists spring force to move the valve to the Third gear position. This opens the 4th clutch fluid circuit to an orificed exhaust and the 4th clutch releases, thereby preventing Fourth gear.

1d Fluid Pressure Manual Valve Position Switch Assembly (TFP Val. Position Sw.):
D3 fluid is routed to the TFP Val. Position Sw. and the TFP Val. Position Sw. signals the PCM that the manual valve is in the Manual Third position.

1e 1-2, 3-4 Shift Solenoid Valve:
The PCM de-energizes the normally open solenoid and 1-2, 3-4 signal fluid exhausts through the solenoid. However, this does not have to occur to acheive a manual 4-3 downshift.

Note: *The operating states for the shift solenoids follow normal operation, depending on vehicle driving conditions. Figure 44 shows the solenoids in the Third gear position.*

2 INPUT CLUTCH APPLIES

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

2b Input Clutch:
Input clutch fluid pressure applies the input clutch. With the input clutch applied, the input sprag clutch holds when output speed is greater than input speed, creating engine compression braking.

Accumulation is the same as 4-3 downshift.

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.

COMPLETE HYDRAULIC CIRCUIT
Page 98

MANUAL THIRD - THIRD GEAR

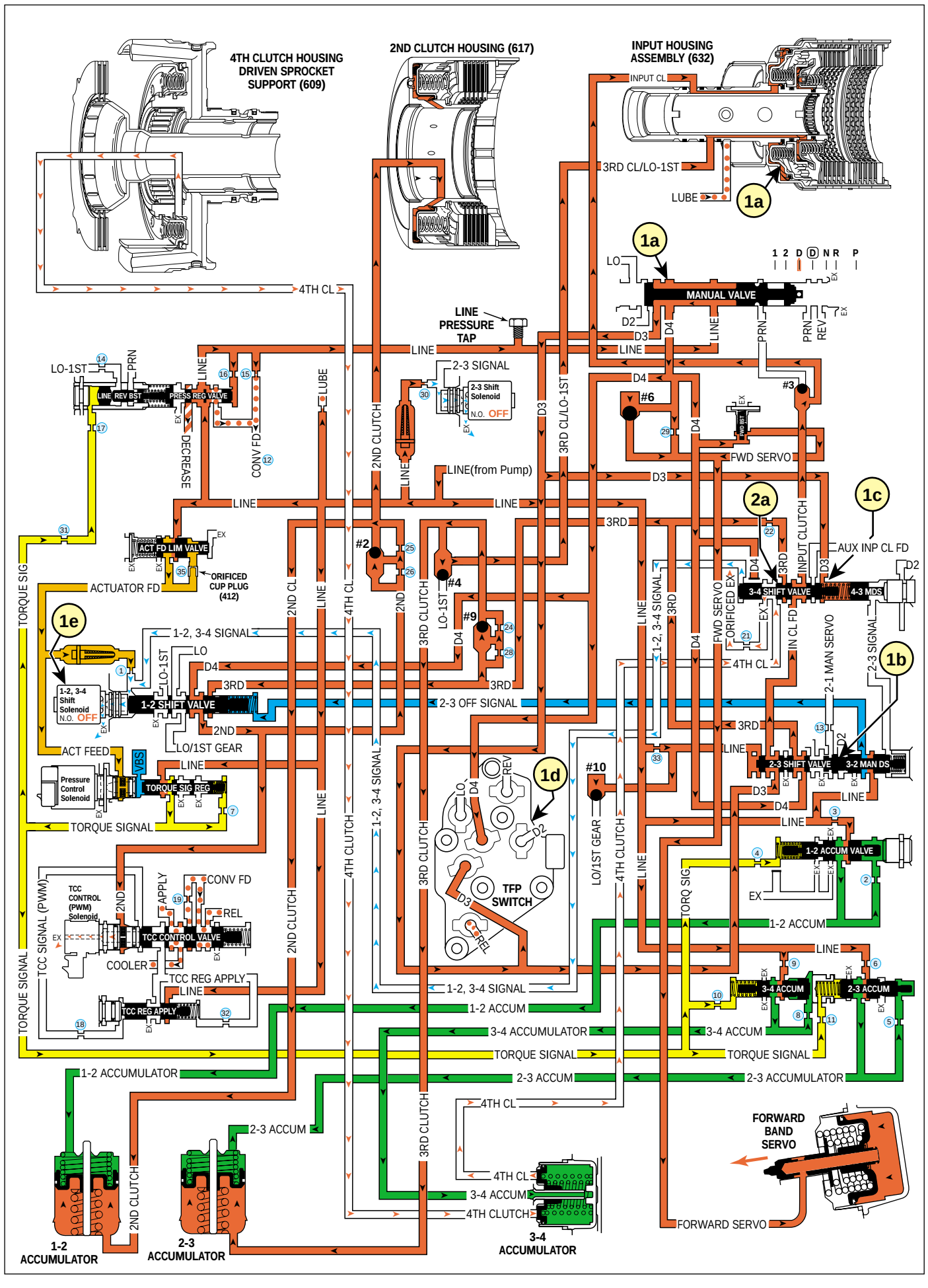


Figure 70

MANUAL SECOND – SECOND GEAR

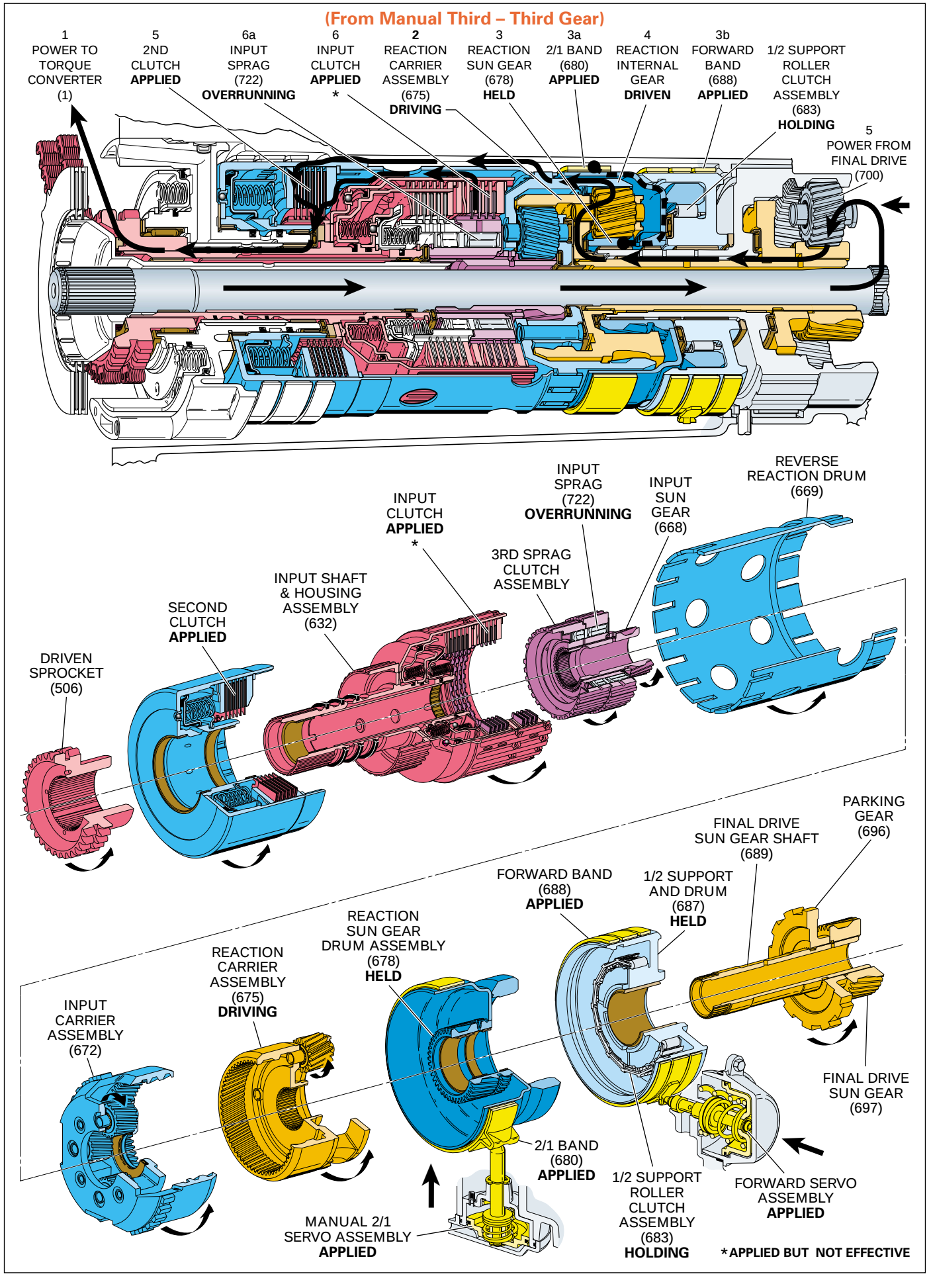


Figure 71

MANUAL SECOND - SECOND GEAR

(From Manual Third - Third Gear)

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
@OFF	@ON			APPLIED			*	OVERRUN	APPLIED	HOLDING	APPLIED

* APPLIED BUT NOT EFFECTIVE
@The solenoid state follows a shift pattern which depends upon vehicle speed, throttle position and selected gear range

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 2/1 band is 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 2/1 band is applied, resulting in a 1.57:1 gear ratio through the gear sets.

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

2 Reaction Carrier Assembly Driving
Power continues to the reaction carrier assembly, which is splined to the final drive sun gear shaft.

3 Reaction Sun Gear Held

3a 2/1 Band Applied
The 2/1 manual band (680) is applied to hold the reaction sun gear drum assembly (678), to achieve engine braking. The 1/2 support roller clutch would allow coasting if the 2/1 band didn't apply and hold the sun gear.

3b Forward Band Applied
The forward band (688) is applied, holding the 1-2 support roller clutch (683) but, is not effective.

4 Reaction Internal Gear Driven
The reaction internal gear, which is part of the input carrier assembly (672), is forced to rotate by the reaction carrier pinions (675), which are rotating around the stationary reaction sun gear drum assembly (678).

5 2nd Clutch Applied
Power flows from the input carrier assembly (672) through the reverse reaction drum (669) to the 2nd clutch assembly which is applied and directs power to the input housing.

4 Input Sun Gear Driven
The rotating input carrier pinions also drive the input sun gear which is splined to the inner hub of the input sprag.

5 Input Sprag Clutch Holding
During deceleration, the input torque from the wheels to the gear set force the input sun gear (668) to rotate faster than the input shaft and housing assembly (632). The input clutch is applied and holding the outer sprag race but, the sprag is overrunning, thus the input clutch is ineffective.

8 Power to Torque Converter
From the input housing, 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 valve 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 2/1 band applies and the 1/2 support roller clutch holds providing engine compression braking in Second gear. The transaxle upshifts and downshifts between First and Second gears as in Overdrive range.

1 MANUAL VALVE:
Line pressure is routed into the D2 fluid circuit when the selector lever is moved into the Manual Second (2) position.

2 2-3 SHIFT SOLENOID VALVE:
The PCM energizes the 2-3 shift solenoid. With the solenoid ON, 2-3 signal fluid is routed to the 2-3 and 4-3 manual downshift valves.

2a 3-2 MANUAL DOWNSHIFT VALVE:
2-3 signal fluid and spring force move the 3-2 manual downshift and the 2-3 shift valve into the Second gear position and prevents the 2-3 shift valve from upshifting. D2 fluid is routed through the valve into the 2-1 manual servo fluid circuit.

3 THIRD CLUTCH RELEASES

3a Third Clutch: 3rd clutch fluid exhausts at the 2-3 shift valve and the direct clutch releases.

3b #4 Ball Check Valve (Third Clutch/Lo 1st): Exhausting 3rd clutch/lo 1st fluid seats the #4 ball check valve and is routed to the #9 ball check valve.

3c #9 Ball Check Valve (Third/Third Clutch)
Exhausting 3rd clutch fluid seats the #9 ball check valve and forces the fluid through orifice #28 for a controlled release of the third clutch.

3d 2-3 Accumulator: Third clutch fluid exhausts from the 2-3 accumulator, and is routed through the #28 orifce.

3e 2-3 Accumulator Valve: The accumulator valve regulates line pressure into the 2-3 accumulator fluid circuit to fill the 2-3 accumulator.

4 2/1 MANUAL BAND APPLIES

4a 1-2 Shift Valve: The 1-2, 3-4 Shift Solenoid Valve is OFF when the PCM commands Second gear, and spring force holds the 1-2 shift valve in the upshifted position.

4b #8 Ball Check Valve (D2/2/1 Manual Servo)
Located in the valve body, it is seated by D2 fluid and forces D2 to pass through the 2-3 shift valve and through orifice #13 into the 2-1 manual servo circuit.

4c 2/1 Manual Band Servo: 2-1 manual servo fluid pressure is routed to the 2/1 manual band servo piston. This fluid pressure moves the servo piston and apply pin to apply the band. The band provides engine compression braking in Manual Second – Second Gear.

5 PRESSURE CONTROL

5a Fluid Pressure Manual Valve Position Switch Assembly (TFP Val. Position Sw.): D2 fluid is routed to the TFP Val. Position Sw. and the TFP Val. Position Sw. signals the PCM that the manual valve is in the Manual Second position.

5b Pressure Control Solenoid: The PCM decreases the PC Sol. Valve 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.

COMPLETE HYDRAULIC CIRCUIT
Page 100

MANUAL SECOND - SECOND GEAR

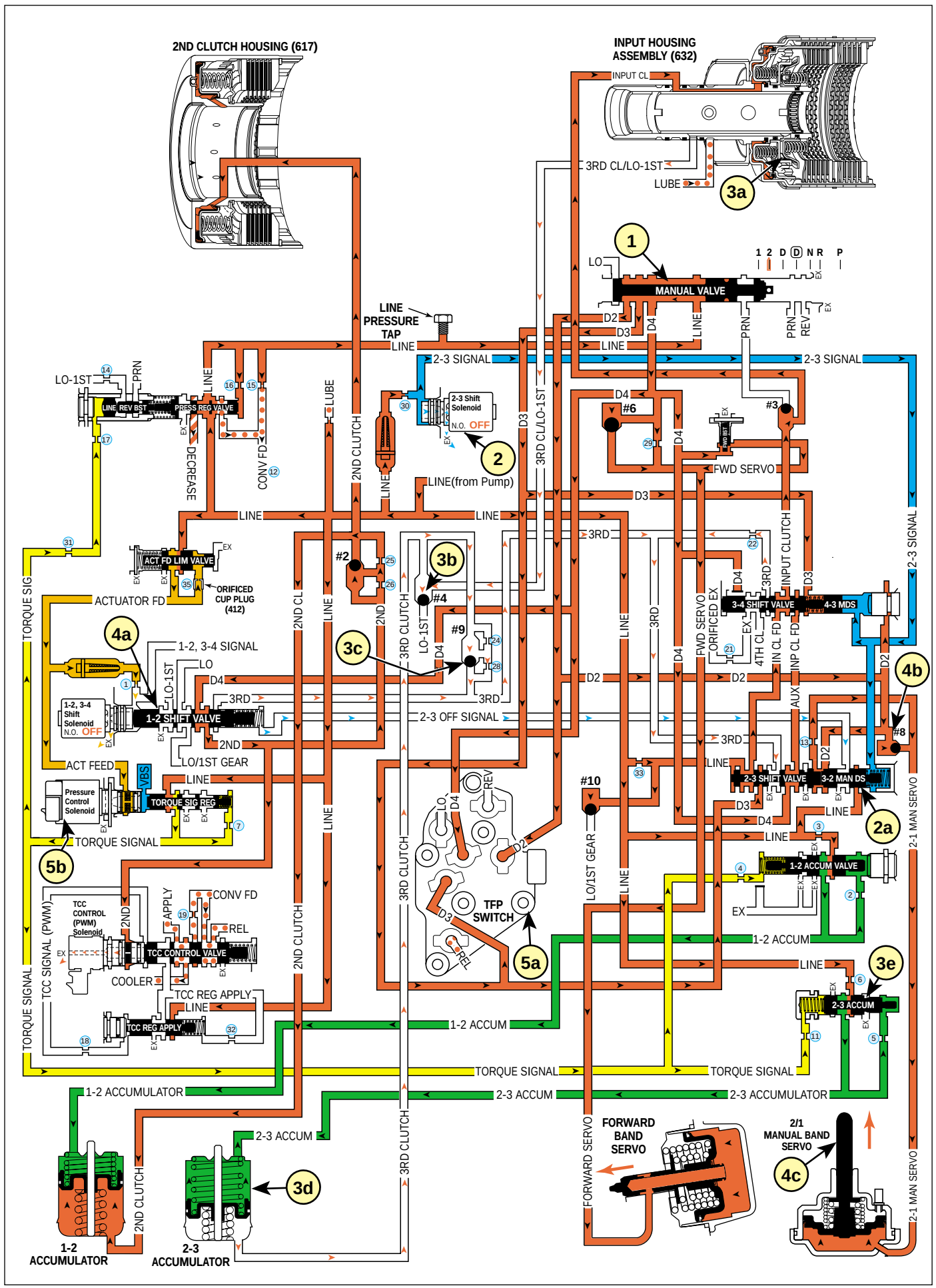


Figure 72

MANUAL FIRST - FIRST GEAR

(From Manual Second – Second Gear)

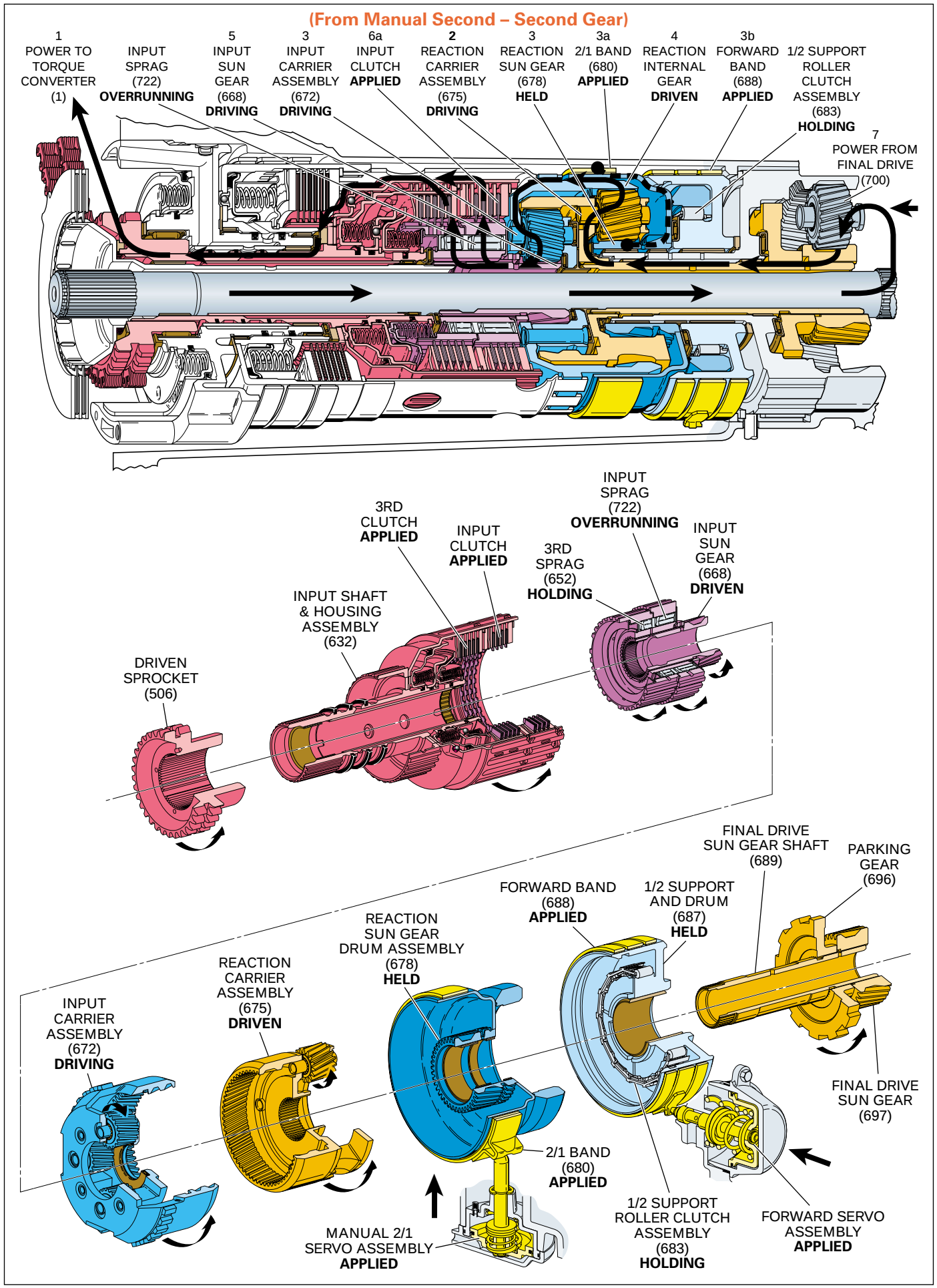


Figure 73

MANUAL FIRST - FIRST GEAR

(From Manual Second - Second Gear)

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
@ON	@ON				APPLIED	HOLDING	APPLIED	HOLDING	APPLIED	HOLDING	APPLIED\

* APPLIED BUT NOT EFFECTIVEE

@The solenoid state follows a shift pattern which depends upon vehicle speed, throttle position and selected gear range

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 third clutch and the 2/1 band are applied. Therefore we will look at powerflow from deceleration (engine compression braking).

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

2 Reaction Carrier Assembly Driven
Power continues to the reaction carrier assembly, which is splined to the final drive sun gear shaft.

3 Reaction Sun Gear Held

3a 2/1 Manual Band Applied
The 2/1 manual band (680) is applied to hold the reaction sun gear drum assembly (678), to achieve engine braking. The 1/2 support roller clutch would allow coasting if the 2/1 band didn't apply and hold the sun gear.

3b Forward Band Applied
The forward band (688) is applied, holding the 1-2 support roller clutch (683) but, is not effective.

4 Reaction Internal Gear Driven
The reaction internal gear, which is part of the input carrier assembly (672), is forced to rotate by the reaction carrier pinions (675), which are rotating around the stationary reaction sun gear drum assembly (678).

5 Input Sun Gear Driven
Planet pinion gears in the input carrier assembly (672) are in mesh with the teeth on the input sun gear (668), forcing the sun gear to rotate.

6 3rd Clutch Applied
The 3rd clutch is applied and holds the 3rd sprag clutch outer race (653). During deceleration, the 3rd sprag clutch holds and prevents the input sun gear (668) from turning faster than the input housing, thus creating engine braking.

Note: During acceleration, the 3rd sprag clutch is ineffective in the transfer of engine torque through the input sun gear (668).

6a Input Clutch Applied
The input clutch is also applied but, during deceleration, the input sprag clutch is not effective for engine compression braking. During acceleration, the input sprag elements are holding to transfer engine torque to the input sun gear (668), forcing it to rotate.

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

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, 3-4 shift solenoid valve 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 2/1 manual band servo remains applied, as in Manual Second, and provides engine compression braking.

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 D4, D3 and D2 fluid circuits as in Manual Second.

2 Fluid Pressure Manual Valve Position Switch Assembly (TFP Val. Position Sw.):
Lo fluid is routed to the TFP Val. Position Sw. and the TFP Val. Position Sw. signals the PCM that the manual valve is in the Manual First position.

3 #7 BALL CHECK VALVE (LO/LO 1ST):
Lo fluid pressure seats the #7 ball check valve against the lo-1st fluid circuit and fluid is routed to the 1-2 shift valve.

4 #4 BALL CHECK VALVE (3RD CLUTCH/LO 1ST):
Lo-1st fluid pressure seats the #4 ball check valve against the 3rd clutch fluid circuit and fluid is routed to the 3rd clutch/lo -1st circuit.

5 3RD CLUTCH APPLIES
3rd clutch/lo - 1st fluid applies the 3rd clutch and the 3rd sprag clutch holds and prevents coasting and allows engine compression braking.

5a Pressure Regulator Valve:
Lo fluid from the 1-2 shift valve is sent to the line presure boost valve to boost line pressure.

5b Lo Blow Off Valve:
A relief valve that will exhaust excess Lo fluid pressure above 448 kPa (65 psi) in the 3rd clutch apply circuit.

6 1-2, 3-4 SHIFT SOLENOID VALVE:
The 1-2, 3-4 Shift Solenoid Valve is energized by the PCM when vehicle speed is below approximately 61 km/h (38 mph). 1-2, 3-4 Signal fluid is blocked from exhausting through the solenoid.

7 1-2 SHIFT VALVE:
1-2, 3-4 signal fluid pressure shifts the valve into the downshifted position, against spring force, and the following changes occur:

- The 2nd fluid circuit is open to exhaust past the valve into the 3rd fluid circuit.
- D4 fluid is routed into the lo-1st gear circuit.
- LO fluid is routed into the lo-1st fluid circuit.

8 SECOND CLUTCH RELEASES

8a Second Clutch:
2nd clutch fluid exhausts from behind the clutch piston through the 2nd clutch fluid circuit. This releases the 2nd clutch and the transaxle operates in First gear.

8b #2 Ball Check Valve (2nd/2nd clutch):
Located in the case cover, exhausting 2nd clutch fluid seats the #2 ball check valve against the 2nd fluid circuit and forces the exhausting fluid through orifice #26 for a controlled release.

8c 1-2 Accumulator:
2nd clutch fluid exhausts from the 1-2 accumulator, and 1-2 accumulator fluid fills the 1-2 accumulator as 2nd clutch fluid exhausts.

8d TCC Control (PWM) Solenoid:
2nd clutch fluid exhausts from the solenoid.

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

COMPLETE HYDRAULIC CIRCUIT
Page 102

MANUAL FIRST - FIRST GEAR

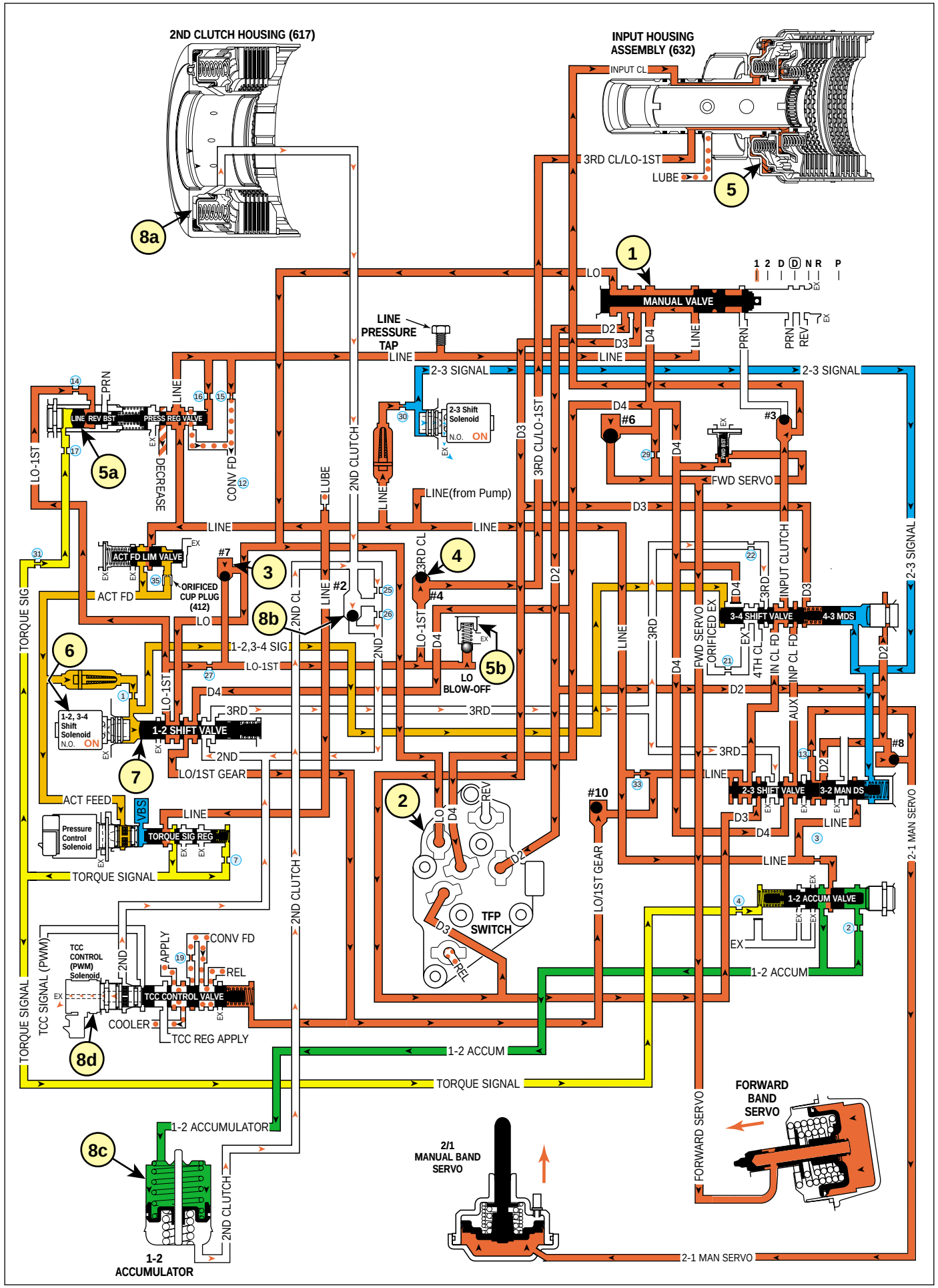


Figure 74

OPERATING CONDITIONS

RANGE REFERENCE CHART

RANGE	GEAR	1-2, 3-4 SHIFT SOLENOID VALVE	2-3 SHIFT SOLENOID VALVE	1 4TH CLUTCH	2 REVERSE BAND	3 2ND CLUTCH	4 3RD CLUTCH	5 3RD SPRAG CLUTCH	6 INPUT CLUTCH	7 INPUT SPRAG CLUTCH	8 2/1 BAND	9 1/2 SUPPORT ROLLER CLUTCH	10 FORWARD BAND
PARK		ON	ON						*	*			
REV	REVERSE	ON	ON		APPLIED				APPLIED	HOLDING			
NEUT		ON	ON						*	*			
Ⓓ	1st	ON	ON						APPLIED	HOLDING		HOLDING	APPLIED
	2nd	OFF	ON			APPLIED			*	OVERRUN		HOLDING	APPLIED
	3rd	OFF	OFF			APPLIED	APPLIED	HOLDING				OVERRUN	*
	4th	ON	OFF	APPLIED		APPLIED	*	OVERRUN				OVERRUN	*
D	3rd	@ OFF	@ OFF			APPLIED	APPLIED	HOLDING	APPLIED	HOLDING		OVERRUN	*
	2nd	@ OFF	@ ON			APPLIED			*	OVERRUN		HOLDING	APPLIED
	1st	@ ON	@ ON						APPLIED	HOLDING		HOLDING	APPLIED
2	2nd	@ OFF	@ ON			APPLIED			*	OVERRUN	APPLIED	HOLDING	APPLIED
	1st	@ ON	@ ON						APPLIED	HOLDING	APPLIED	HOLDING	APPLIED
1	1st	@ ON	@ ON				APPLIED	HOLDING	APPLIED	HOLDING	APPLIED	HOLDING	APPLIED

*APPLIED BUT NOT EFFECTIVE

ON = SOLENOID ENERGIZED
OFF = SOLENOID DE-ENERGIZED
@ THE SOLENOID'S STATE FOLLOWS A SHIFT PATTERN WHICH DEPENDS UPON VEHICLE SPEED, THROTTLE POSITION AND SELECTED GEAR RANGE.

EXPECTED OPERATING CONDITION IF COMPONENT IN COLUMN NUMBER IS INOPERATIVE:

COLUMN #	CONDITION
1	NO 4TH GEAR.
2	NO REVERSE GEAR – ALL FORWARD DRIVE RANGES OK.
3	NO 2ND GEAR – GOES TO NEUTRAL WHEN COMMANDED TO 3RD GEAR.
4	NO 3RD GEAR – NO ENGINE BRAKING IN MANUAL 1ST.
5	NO 3RD GEAR – NO ENGINE BRAKING IN MANUAL 1ST.
6	NO FORWARD – NO REVERSE.
7	NO FORWARD – NO REVERSE.
8	NO ENGINE BRAKING IN MANUAL 2ND (2ND GEAR) OR MANUAL 1ST (1ST GEAR).
9	NO FORWARD – REVERSE OK, FORWARD OK IN MANUAL 2ND OR MANUAL 1ST.
10	NO FORWARD – REVERSE OK, FORWARD OK IN MANUAL 2ND OR MANUAL 1ST.

SHIFT SOLENOID VALVE ELECTRICAL CONDITIONS:

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

1-2, 3-4 DTC P0753
- The PCM commands maximum line pressure.
- The PCM disables shift adapts.
- The PCM inhibits downshifts to 2nd gear if the vehicle speed is greater than 48 km/h (30 mph).
- The PCM illuminates the Malfunction Indicator Lamp (MIL).

2-3 DTC P0758
- The PCM commands maximum line pressure.
- The PCM disables shift adapts.
- The PCM commands 3rd gear.
- The PCM illuminates the Malfunction Indicator Lamp (MIL).
- The PCM inhibits Torque Converter Clutch.

Figure 75

COMPLETE HYDRAULIC CIRCUITS

The hydraulic circuitry of the Hydra-matic 4T65-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, case cover and case to assist the user when following the hydraulic circuits as they pass between them. The half page of information facing this foldout lists possible conditions and component diagnostic tips. Always refer to the appropriate vehicle platform service manual when diagnosising specific concerns.

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

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

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 CASE COVER (LIGHT RED AREA)
PASSAGE E IS LOCATED IN THE DRIVEN SPROCKET SUPPORT (LIGHT YELLOW AREA)
PASSAGE F IS LOCATED IN THE CASE (WHITE AREA)

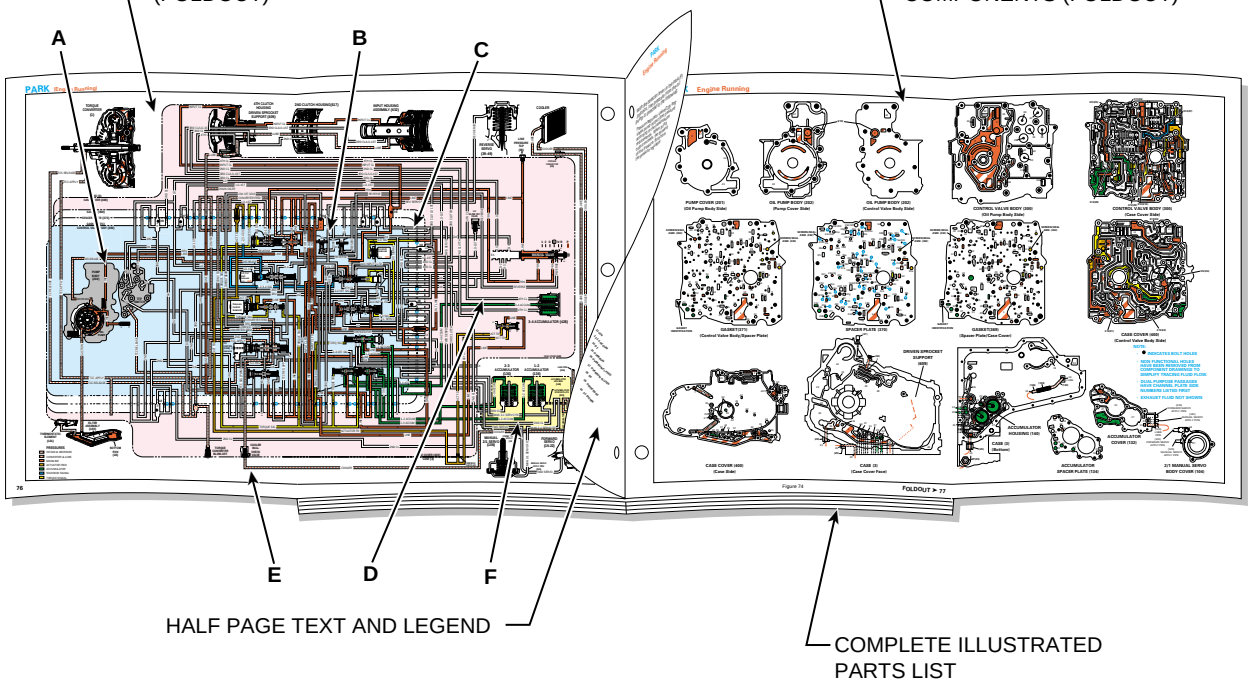


Figure 76

PARK (Engine Running)

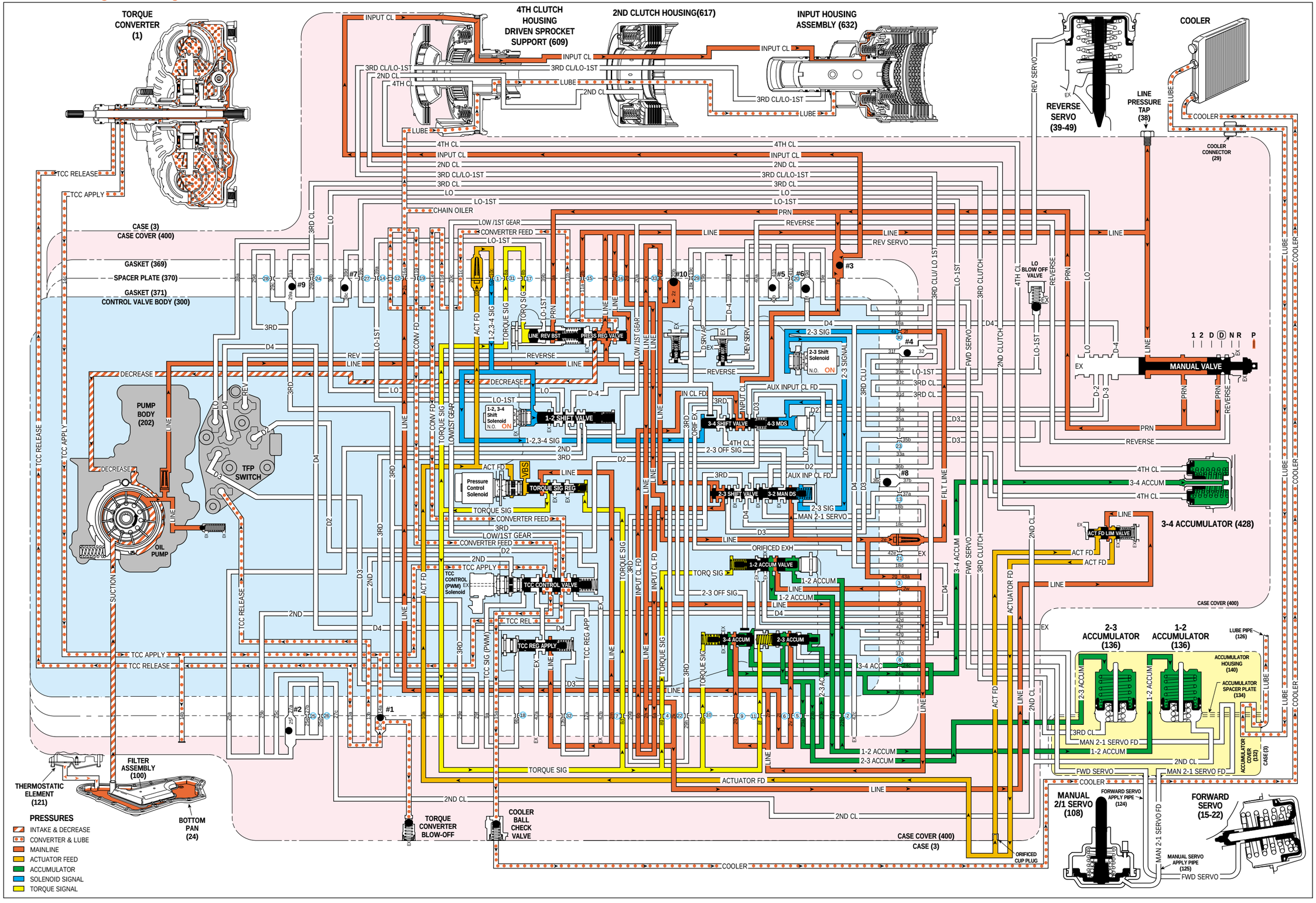


Figure 77

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 (313), Springs (311, 312) and Boost Valve (310)**
  - – Stuck, damaged (missing springs).
- **Pressure Control Solenoid Valve (322)**
  - – Leak, o-rings damaged.
  - – Loose connector, pins damaged.
  - – Contaminated.
- **Torque Signal Regulator Valve (321)**
  - – Stuck, or valve retainer (314) missing.
- **TFP Valve Position Switch (395)**
  - – Loose connector.
  - – Damaged or missing o-ring.
- **Oil Filter (100)**
  - – Clogged, broken, loose.
- **Oil Filter Seal (101)**
  - – Leaking.
- **Cooler Lines**
  - – Clogged or restricted.
- **Cooler Line Seals (49)**
  - – Leaking.
- **Oil Pump (200)**
  - – Damaged, sticking, porosity, leaking.
- **Oil Pump Drive Shaft (227)**
  - – Damaged.
- **Line Pressure Relief Valve (324)**
  - – Damaged spring, ball missing.
- **Transaxle Case (3), Valve Body (301), Case Cover (401)**
  - – Porosity, leaking circuits.
  - – Flatness of machined surfaces.

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	ON						*	HOLDING *			

* APPLIED BUT NOT EFFECTIVE

PARK
Engine Running

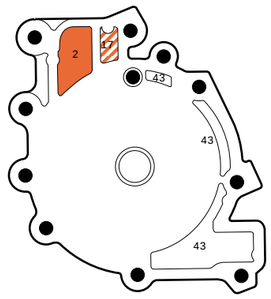
PASSAGES

1	SUCTION
2	LINE
3	PRN
4	2-3 SIGNAL
5	1-2, 3-4 SIGNAL
6	INPUT CLUTCH FEED
7	INPUT CLUTCH
8	TORQUE SIGNAL
9	TCC SIGNAL (PWM)
10	ACTUATOR FEED
11	CONVERTER FEED
12	TCC REGULATED APPLY
13	TCC RELEASE
14	TCC APPLY
15	COOLER
16	LUBE/LINE
17	DECREASE
18	D-4
19	FORWARD SERVO
20	LO/1ST GEAR
21	AUXILIARY INPUT CLUTCH FEED
22	1-2 ACCUMULATOR
23	2-3 ACCUMULATOR
24	3-4 ACCUMULATOR
25	2ND
26	2ND EXHAUST
27	2ND CLUTCH
28	2-3 OFF SIGNAL
29	3RD
30	3RD/EXHAUST
31	3RD CLUTCH
32	3RD CLUTCH/LO -1ST
33	4TH CLUTCH
34	4TH CLUTCH EXHAUST
35	D3
36	D2
37	MANUAL 2-1 SERVO
38	LO
39	LO-1ST
40	REVERSE
41	REVERSE SERVO
42	EXHAUST
43	CASTING VOID

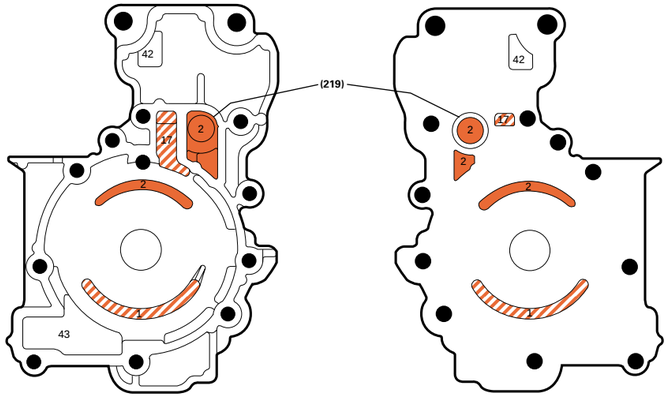
COMPONENTS ( )

(28)	COOLER LINE CHECKBALL ASSEMBLY
(29)	COOLER LINE CONNECTOR
(37)	VENT ASSEMBLY
(38)	PLUG, PIPE
(124)	PIPE, FORWARD SERVO APPLY
(125)	PIPE, MANUAL SERVO APPLY
(126)	PIPE, LUBE OIL
(219)	SCREEN ASSEMBLY, OIL PUMP PRESSURE
(372)	CHECKBALLS #1, #2, #3, #4, #7, #8, #9, #10
(373)	CHECKBALL #5, #6
(382)	SCREEN ASSEMBLY

PARK (Engine Running)

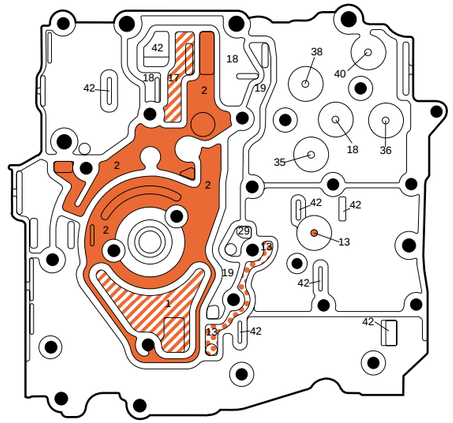


PUMP COVER (201)
(Oil Pump Body Side)

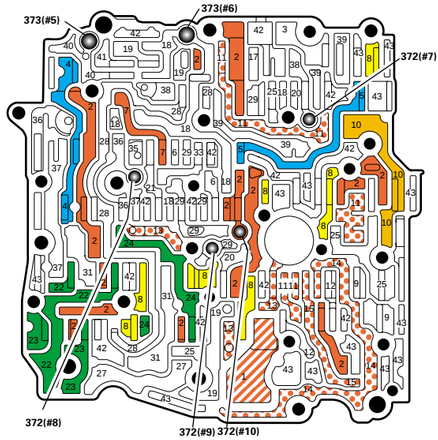


OIL PUMP BODY (202)
(Pump Cover Side)

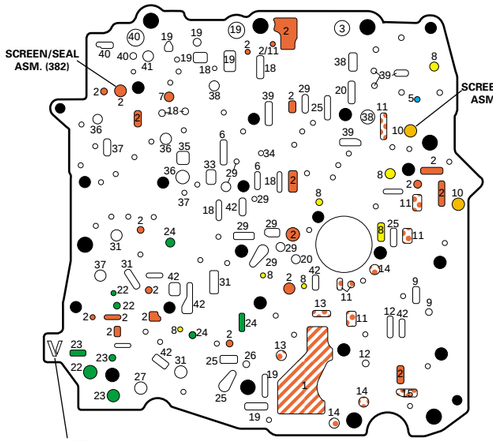
OIL PUMP BODY (202)
(Control Valve Body Side)



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

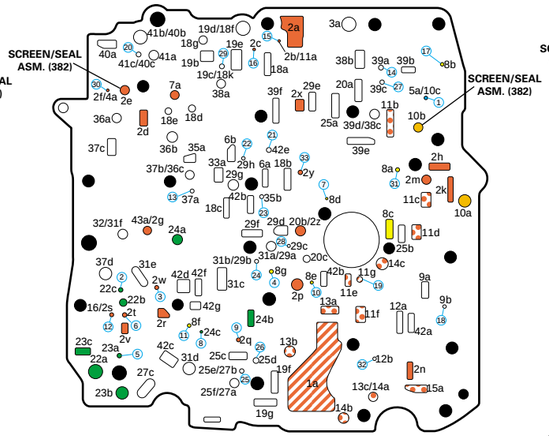


CONTROL VALVE BODY (300)
(Case Cover Side)

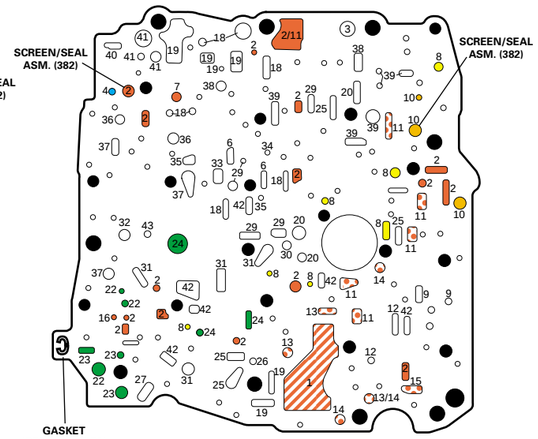


GASKET IDENTIFICATION

GASKET(371)
(Control Valve Body/Spacer Plate)

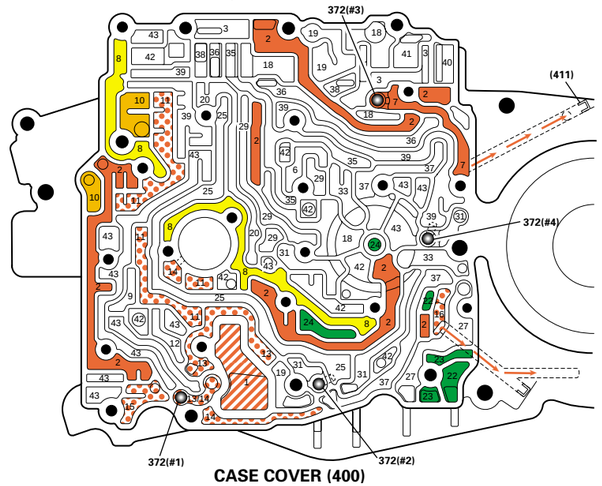


SPACER PLATE (370)



GASKET IDENTIFICATION

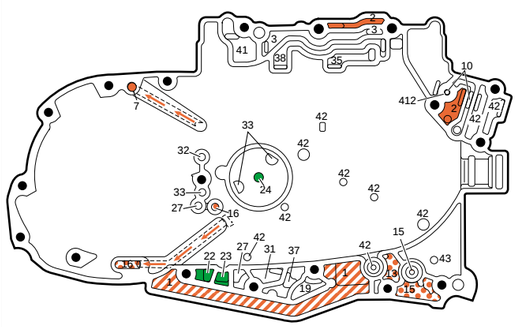
GASKET(369)
(Spacer Plate/Case Cover)



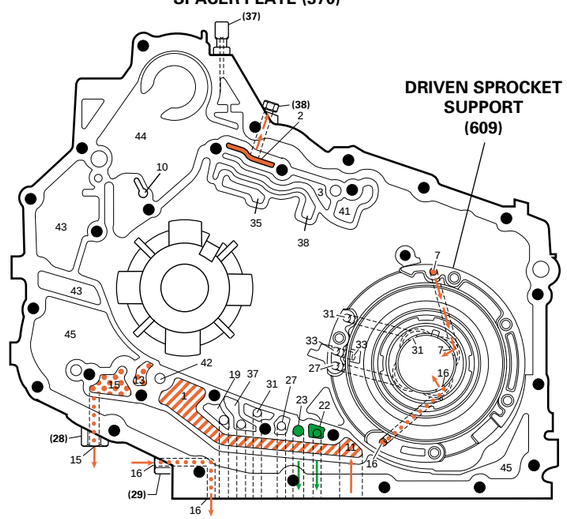
CASE COVER (400)
(Control Valve Body Side)

NOTE:

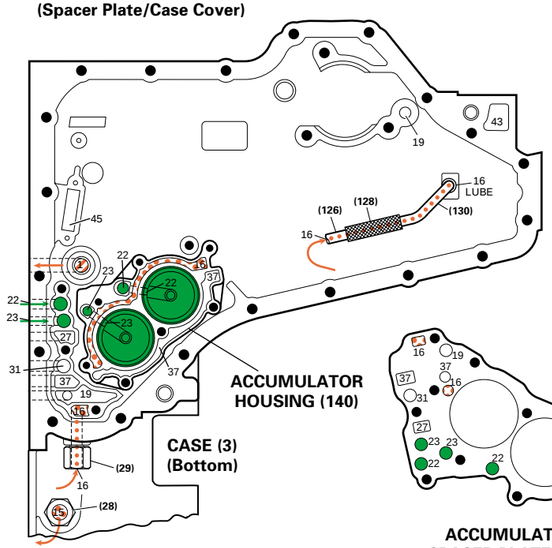
- ● INDICATES BOLT HOLES
- NON FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE NUMBERS LISTED FIRST
- EXHAUST FLUID NOT SHOWN



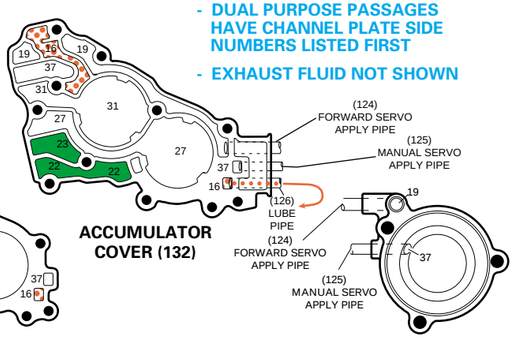
CASE COVER (400)
(Case Side)



CASE (3)
(Case Cover Face)



ACCUMULATOR SPACER PLATE (134)



ACCUMULATOR COVER (132)

2/1 MANUAL SERVO BODY COVER (104)

Figure 78

FOLDOUT ➤ 83

REVERSE

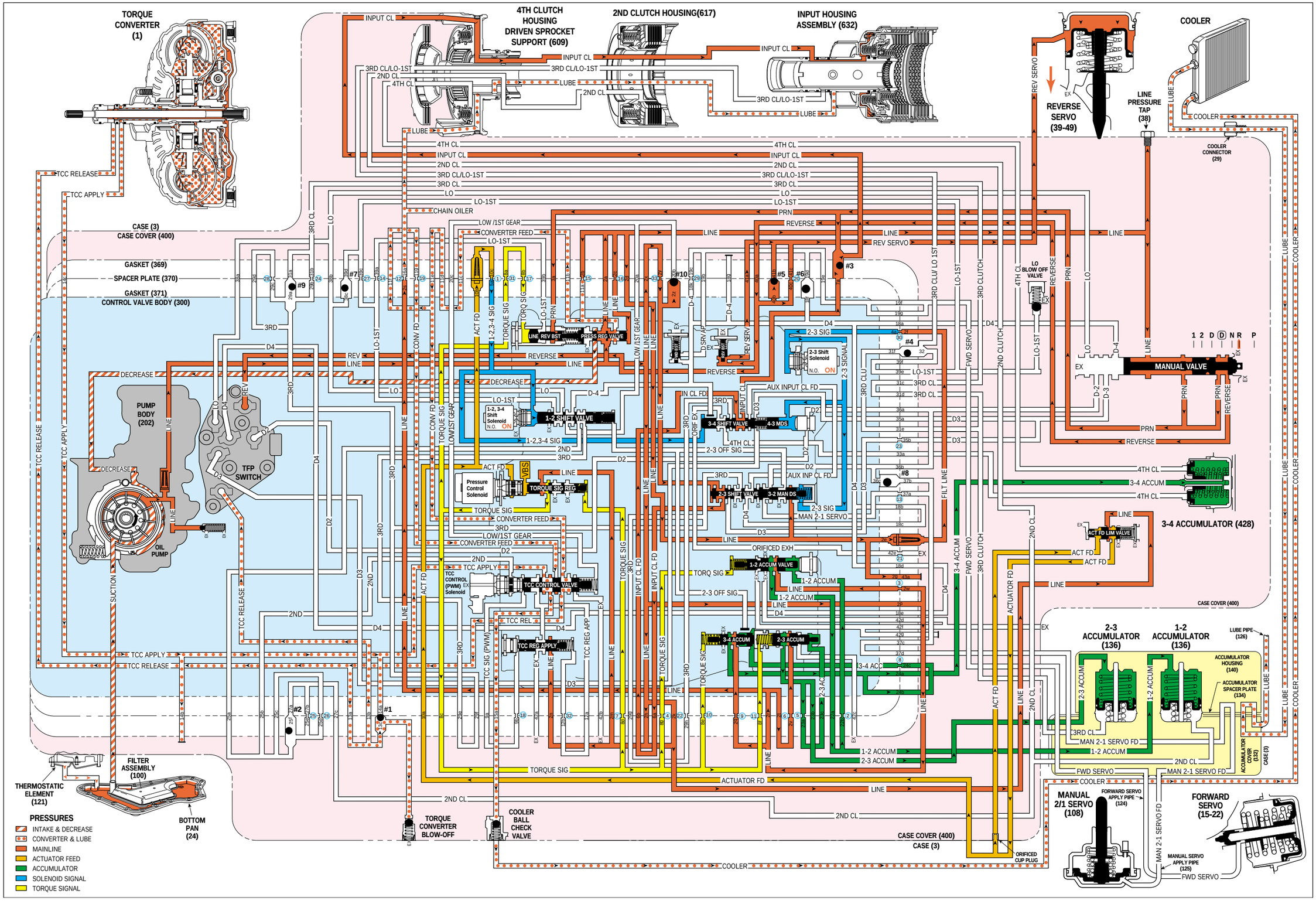


Figure 79

REVERSE

NO REVERSE OR SLIPS IN REVERSE

- **Manual Linkage**
  - Misadjusted
- **Oil Filter Assembly**
  - Oil filter assembly (100) missing, plugged
  - Damaged oil filter seal assembly (101) missing or damaged
- **Reverse Band Servo Assembly**
  - Servo piston oil seal ring (43) missing or damaged
  - Servo piston (44) damaged or stuck in case bore
  - Servo piston cushion springs (45, 47) or retainer (46) missing or damaged
  - Servo piston pin (48) not engaged to reverse band assembly (615)
  - Reverse band assembly (615) worn or burned
  - reverse band assembly (615) disengaged from anchor pin (117B)
  - band anchor pin (117B) loose or missing
- **Torque Converter Assembly**
  - Torque converter assembly (1) stator clutch not holding
- **Drive Link Assembly**
  - Drive link assembly (507) broken or drive/driven sprockets (516/506) damaged.
- **Input Clutch Assembly**
  - Input clutch sprag assembly (722) damaged or misassembled
  - Input clutch housing oil seal rings (628) missing or damaged
  - Input clutch housing ball check valve assembly (633) missing or damaged
  - Input clutch piston inner/outer seals (634/635) missing or damaged
  - Input clutch piston (636) damaged
  - Input clutch plates (654-658) worn
- **Fluid Level**
  - Low.
- **Fluid Pressure**
  - Low (See PARK page 82A).

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	ON		APPLIED				APPLIED	HOLDING			

* APPLIED BUT NOT EFFECTIVE

REVERSE

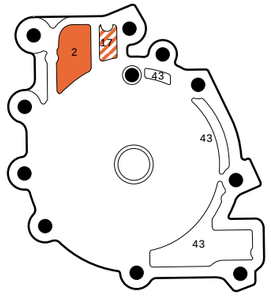
PASSAGES

1	SUCTION
2	LINE
3	PRN
4	2-3 SIGNAL
5	1-2, 3-4 SIGNAL
6	INPUT CLUTCH FEED
7	INPUT CLUTCH
8	TORQUE SIGNAL
9	TCC SIGNAL (PWM)
10	ACTUATOR FEED
11	CONVERTER FEED
12	TCC REGULATED APPLY
13	TCC RELEASE
14	TCC APPLY
15	COOLER
16	LUBE/LINE
17	DECREASE
18	D-4
19	FORWARD SERVO
20	LO/1ST GEAR
21	AUXILIARY INPUT CLUTCH FEED
22	1-2 ACCUMULATOR
23	2-3 ACCUMULATOR
24	3-4 ACCUMULATOR
25	2ND
26	2ND EXHAUST
27	2ND CLUTCH
28	2-3 OFF SIGNAL
29	3RD
30	3RD/EXHAUST
31	3RD CLUTCH
32	3RD CLUTCH/LO -1ST
33	4TH CLUTCH
34	4TH CLUTCH EXHAUST
35	D3
36	D2
37	MANUAL 2-1 SERVO
38	LO
39	LO-1ST
40	REVERSE
41	REVERSE SERVO
42	EXHAUST
43	CASTING VOID

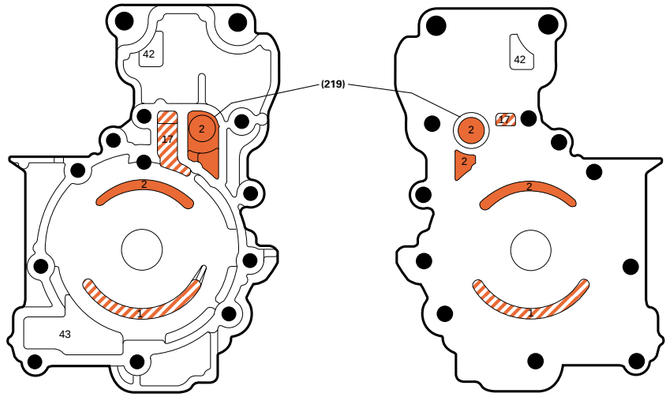
COMPONENTS ( )

(28)	COOLER LINE CHECKBALL ASSEMBLY
(29)	COOLER LINE CONNECTOR
(37)	VENT ASSEMBLY
(38)	PLUG, PIPE
(124)	PIPE, FORWARD SERVO APPLY
(125)	PIPE, MANUAL SERVO APPLY
(126)	PIPE, LUBE OIL
(219)	SCREEN ASSEMBLY, OIL PUMP PRESSURE
(372)	CHECKBALLS #1, #2, #3, #4, #7, #8, #9, #10
(373)	CHECKBALL #5, #6
(382)	SCREEN ASSEMBLY

REVERSE

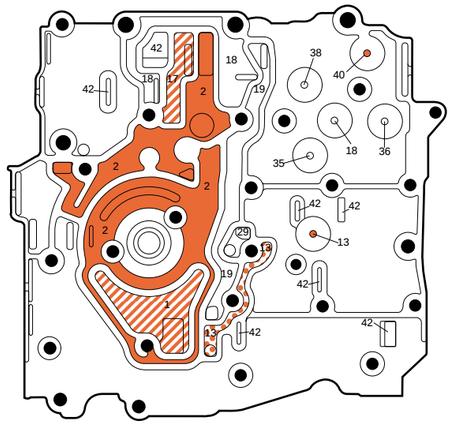


PUMP COVER (201)
(Oil Pump Body Side)

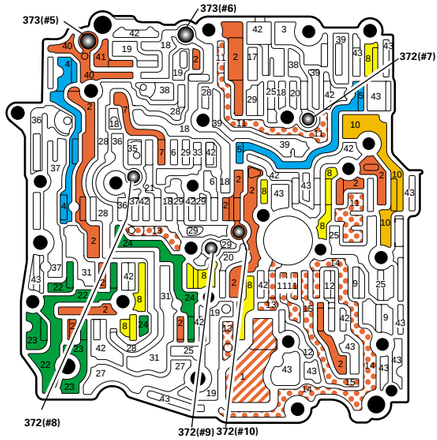


OIL PUMP BODY (202)
(Pump Cover Side)

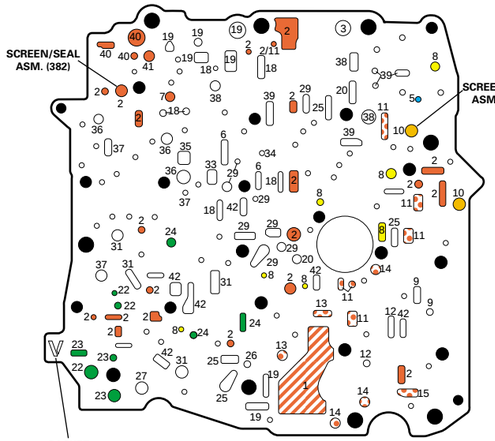
OIL PUMP BODY (202)
(Control Valve Body Side)



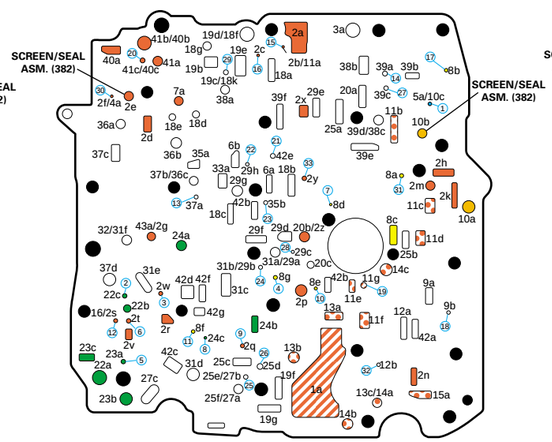
CONTROL VALVE BODY (300)
(Oil Pump Body Side)



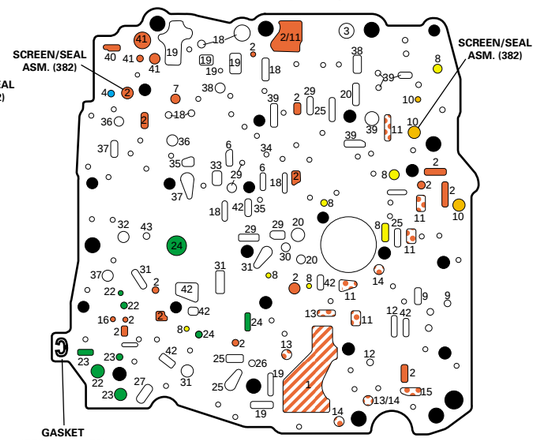
CONTROL VALVE BODY (300)
(Case Cover Side)



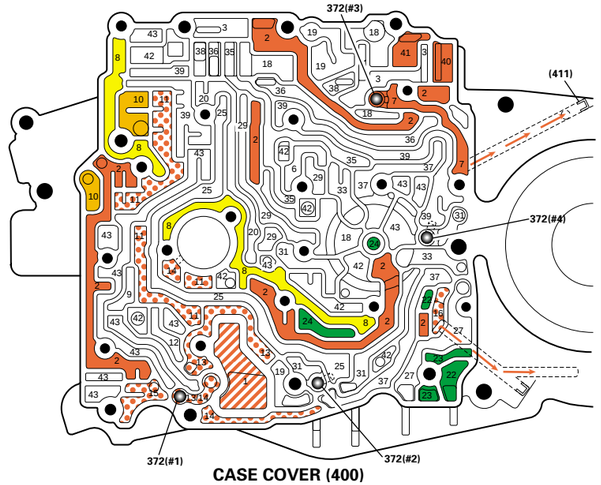
GASKET(371)
(Control Valve Body/Spacer Plate)



SPACER PLATE (370)



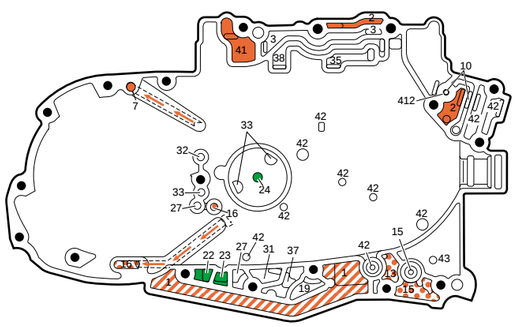
GASKET(369)
(Spacer Plate/Case Cover)



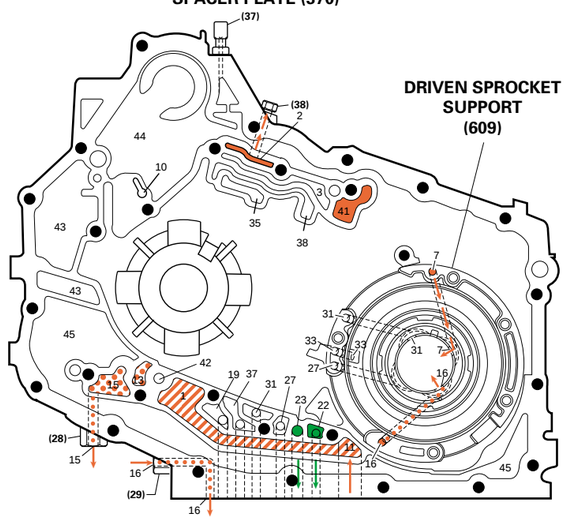
CASE COVER (400)
(Control Valve Body Side)

NOTE:

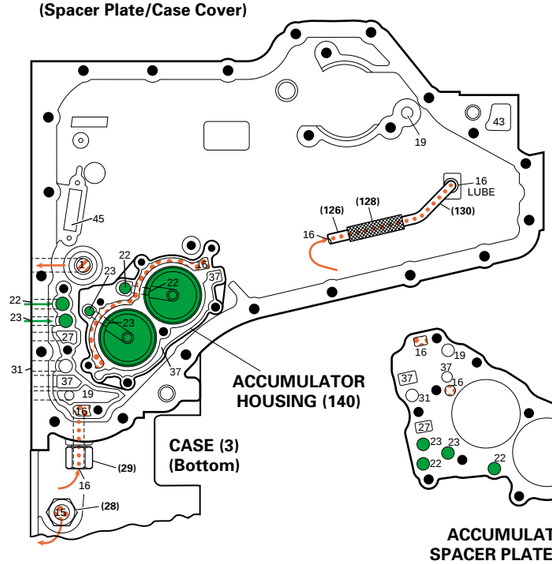
- ● INDICATES BOLT HOLES
- NON FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE NUMBERS LISTED FIRST
- EXHAUST FLUID NOT SHOWN



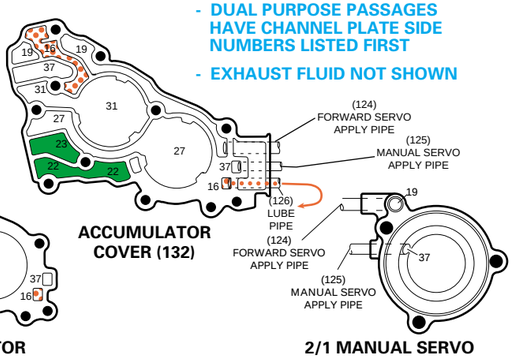
CASE COVER (400)
(Case Side)



CASE (3)
(Case Cover Face)



ACCUMULATOR SPACER PLATE (134)



ACCUMULATOR COVER (132)

2/1 MANUAL SERVO BODY COVER (104)

Figure 80

FOLDOUT ➤ 85

NEUTRAL (Engine Running)

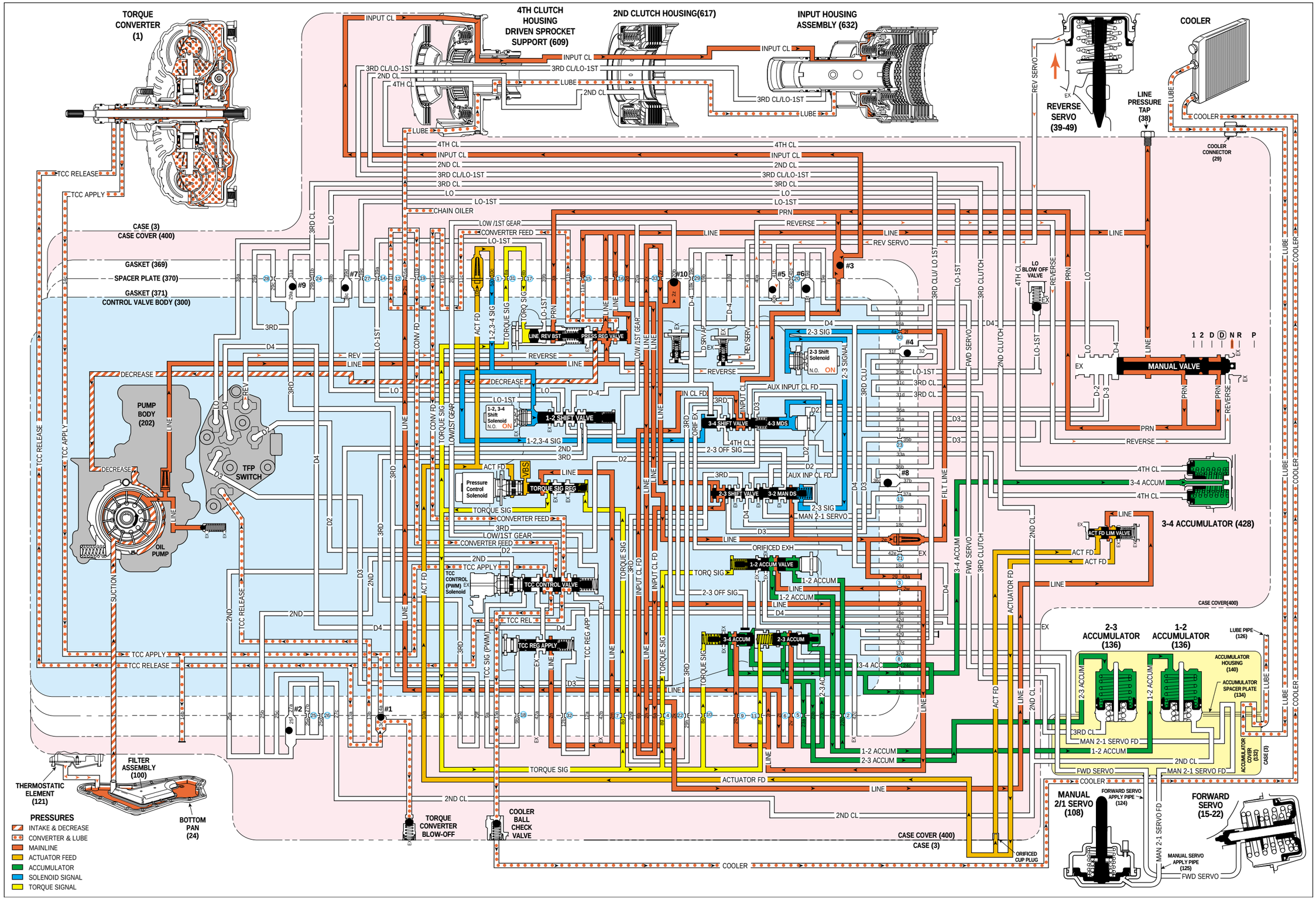


Figure 81

NEUTRAL
(Engine Running)

DRIVES IN NEUTRAL

- **Forward Band**
  - Not releasing.
- **Reverse Band**
  - Not releasing.
- **Manual Valve (404) / Shift Linkage**
  - Misaligned.

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	ON						*	HOLDING *			

* APPLIED BUT NOT EFFECTIVE

NEUTRAL
Engine Running

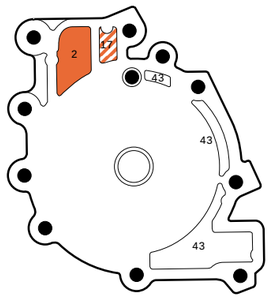
PASSAGES

1	SUCTION
2	LINE
3	PRN
4	2-3 SIGNAL
5	1-2, 3-4 SIGNAL
6	INPUT CLUTCH FEED
7	INPUT CLUTCH
8	TORQUE SIGNAL
9	TCC SIGNAL (PWM)
10	ACTUATOR FEED
11	CONVERTER FEED
12	TCC REGULATED APPLY
13	TCC RELEASE
14	TCC APPLY
15	COOLER
16	LUBE/LINE
17	DECREASE
18	D-4
19	FORWARD SERVO
20	LO/1ST GEAR
21	AUXILIARY INPUT CLUTCH FEED
22	1-2 ACCUMULATOR
23	2-3 ACCUMULATOR
24	3-4 ACCUMULATOR
25	2ND
26	2ND EXHAUST
27	2ND CLUTCH
28	2-3 OFF SIGNAL
29	3RD
30	3RD/EXHAUST
31	3RD CLUTCH
32	3RD CLUTCH/LO -1ST
33	4TH CLUTCH
34	4TH CLUTCH EXHAUST
35	D3
36	D2
37	MANUAL 2-1 SERVO
38	LO
39	LO-1ST
40	REVERSE
41	REVERSE SERVO
42	EXHAUST
43	CASTING VOID

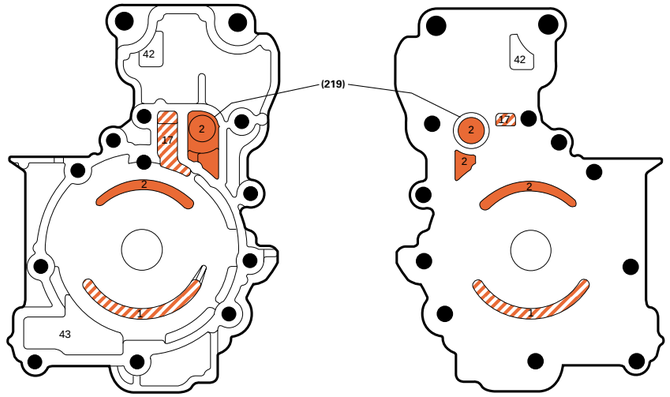
COMPONENTS ( )

(28)	COOLER LINE CHECKBALL ASSEMBLY
(29)	COOLER LINE CONNECTOR
(37)	VENT ASSEMBLY
(38)	PLUG, PIPE
(124)	PIPE, FORWARD SERVO APPLY
(125)	PIPE, MANUAL SERVO APPLY
(126)	PIPE, LUBE OIL
(219)	SCREEN ASSEMBLY, OIL PUMP PRESSURE
(372)	CHECKBALLS #1, #2, #3, #4, #7, #8, #9, #10
(373)	CHECKBALL #5, #6
(382)	SCREEN ASSEMBLY

NEUTRAL (Engine Running)

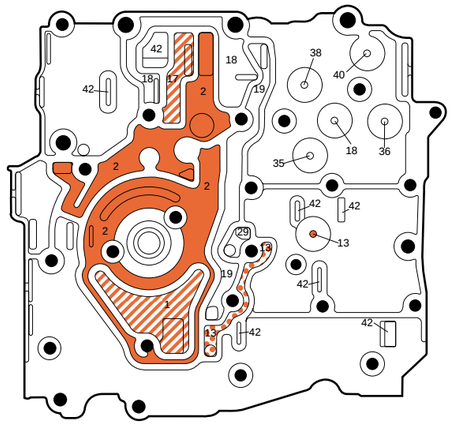


PUMP COVER (201)
(Oil Pump Body Side)

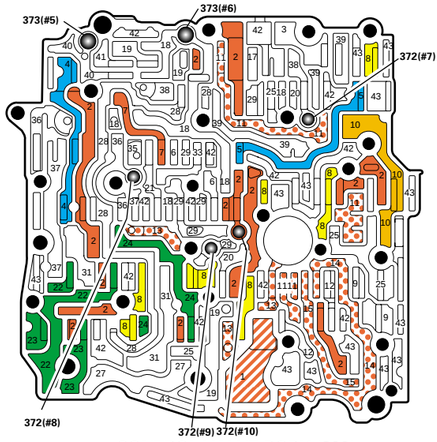


OIL PUMP BODY (202)
(Pump Cover Side)

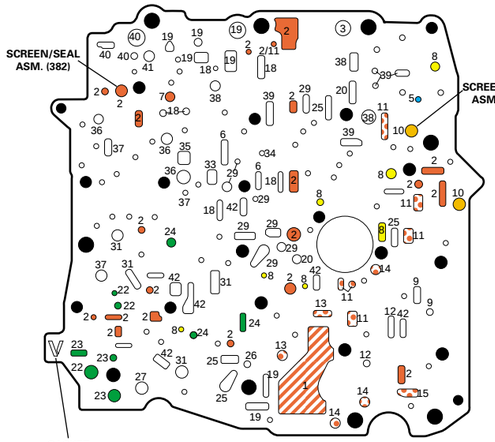
OIL PUMP BODY (202)
(Control Valve Body Side)



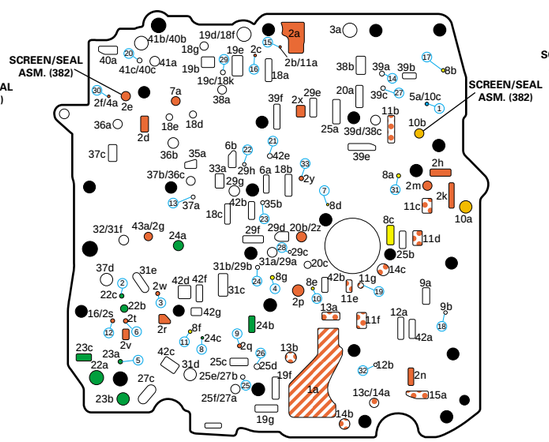
CONTROL VALVE BODY (300)
(Oil Pump Body Side)



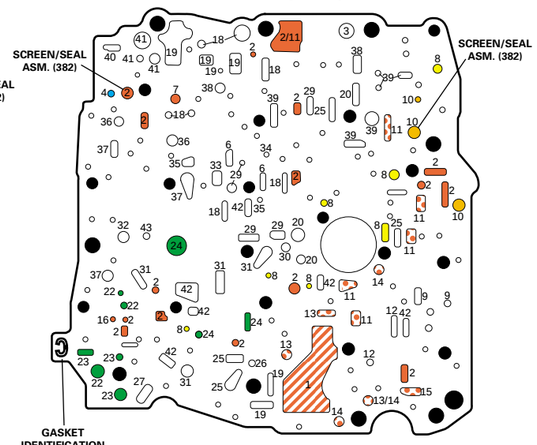
CONTROL VALVE BODY (300)
(Case Cover Side)



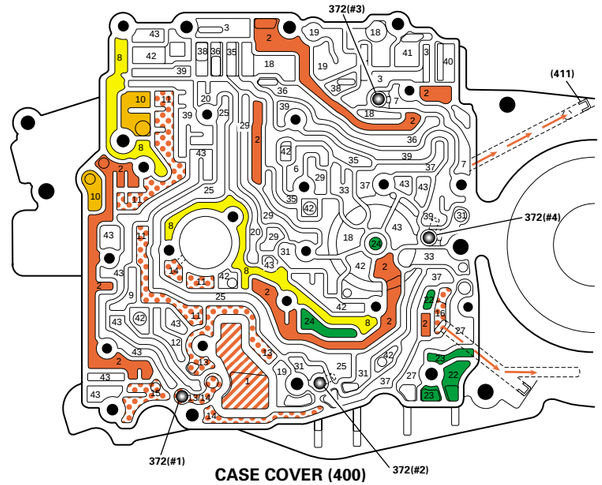
GASKET(371)
(Control Valve Body/Spacer Plate)



SPACER PLATE (370)



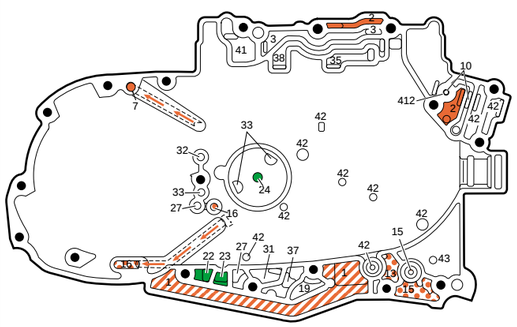
GASKET(369)
(Spacer Plate/Channel Plate)



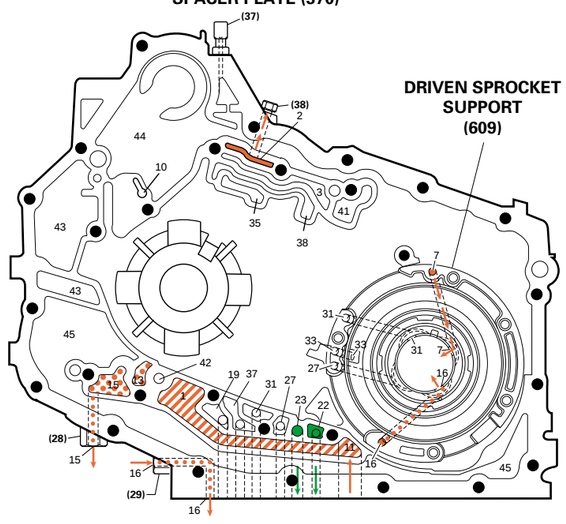
CASE COVER (400)
(Control Valve Body Side)

NOTE:

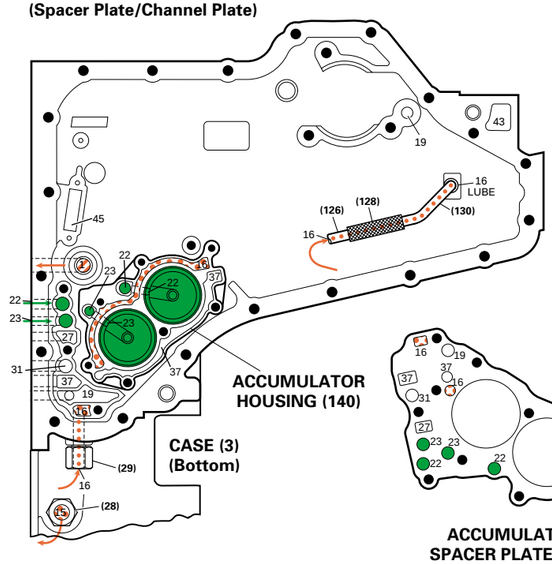
- ● INDICATES BOLT HOLES
- NON FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE NUMBERS LISTED FIRST
- EXHAUST FLUID NOT SHOWN



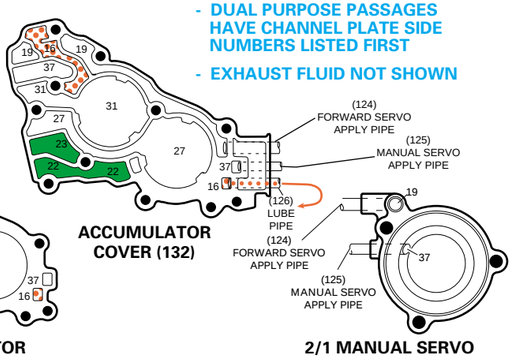
CASE COVER (400)
(Case Side)



CASE (3)
(Case Cover Face)



ACCUMULATOR SPACER PLATE (134)



ACCUMULATOR COVER (132)

2/1 MANUAL SERVO BODY COVER (104)

Figure 82

FOLDOUT ➤ 87

OVERDRIVE RANGE – FIRST GEAR

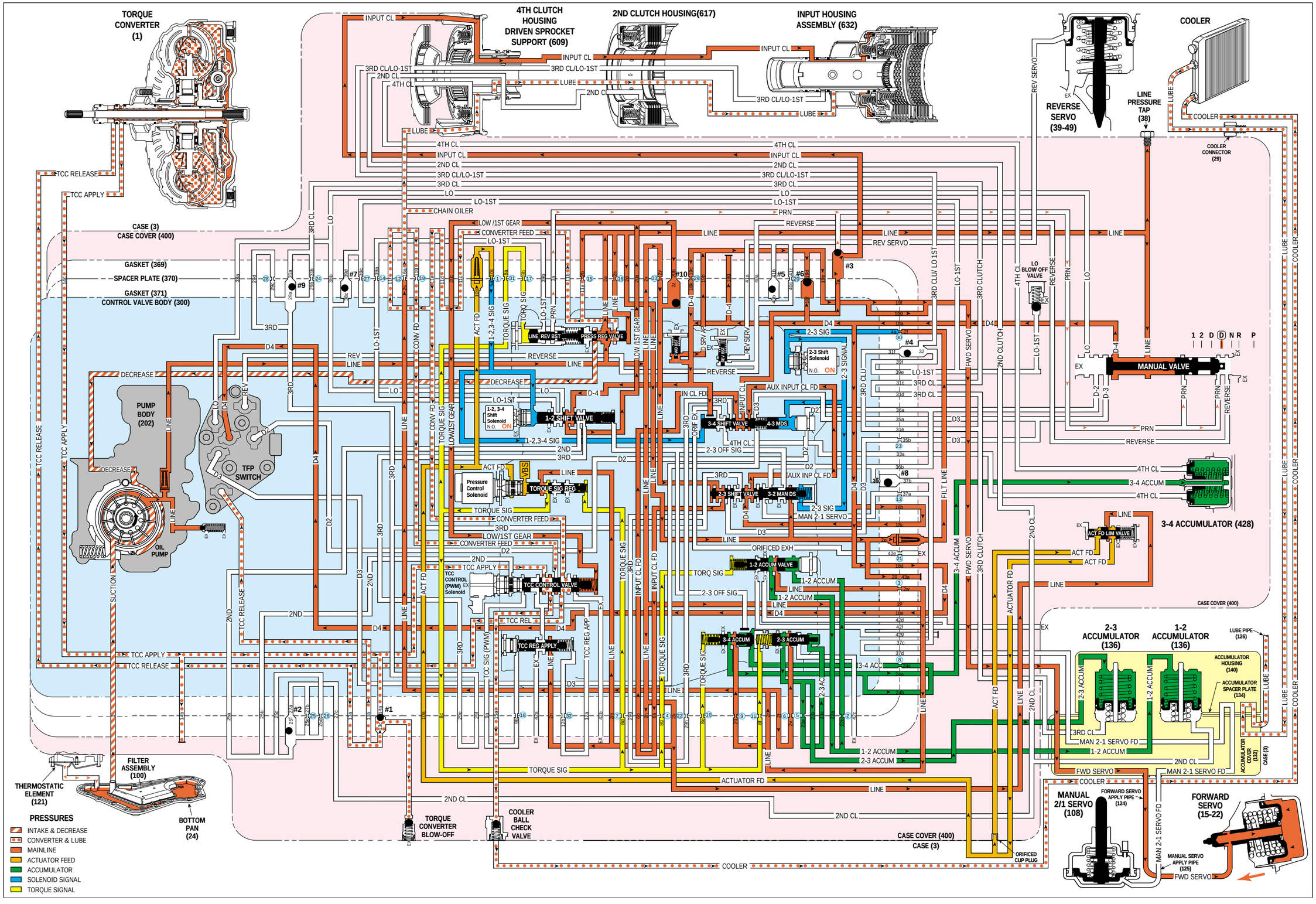


Figure 83

OVERDRIVE RANGE - FIRST GEAR

NO FIRST GEAR/SLIPS IN FIRST

- **Forward Band Servo Assembly**
  - Servo piston oil seal ring (18), missing or damaged.
  - Servo piston (16) is stuck in the servo cover (13) or damaged.
  - The servo piston cushion spring (19) or retainer (20), missing or damaged.
  - The sevo piston pin (21) is not engaged to the forward band assembly.
  - Forward band assembly (688) is worn or burned.
  - Forward band assembly (688) is disengaged from the anchor pin (117A).
  - The band anchor pin (117A) is loose or missing.

- **Accumulator and Manual 2-1 Band Servo Assembly**
  - Forward band servo oil pipe (124), loose or damaged.
  - Manual 2-1 band servo cover (104) loose, leaking.
  - Manual 2-1 band servo cover gasket (105) missing or damaged.
  - Accumulator cover spacer plate assembly (134) damaged.

- **1-2, 3-4 Solenoid Valve (315)**
  - Failed “OFF”, leaking.

- **1-2 Shift Valve (318)**
  - Stuck in upshifted position.

- **Manual Valve (404) / Shift Linkage**
  - Misaligned.

- **Torque Converter (1)**
  - Stator roller clutch not holding.

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

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	ON						APPLIED	HOLDING		HOLDING	APPLIED

* APPLIED BUT NOT EFFECTIVE

OVERDRIVE RANGE - FIRST GEAR

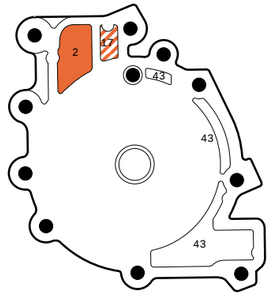
PASSAGES

1	SUCTION
2	LINE
3	PRN
4	2-3 SIGNAL
5	1-2, 3-4 SIGNAL
6	INPUT CLUTCH FEED
7	INPUT CLUTCH
8	TORQUE SIGNAL
9	TCC SIGNAL (PWM)
10	ACTUATOR FEED
11	CONVERTER FEED
12	TCC REGULATED APPLY
13	TCC RELEASE
14	TCC APPLY
15	COOLER
16	LUBE/LINE
17	DECREASE
18	D-4
19	FORWARD SERVO
20	LO/1ST GEAR
21	AUXILIARY INPUT CLUTCH FEED
22	1-2 ACCUMULATOR
23	2-3 ACCUMULATOR
24	3-4 ACCUMULATOR
25	2ND
26	2ND EXHAUST
27	2ND CLUTCH
28	2-3 OFF SIGNAL
29	3RD
30	3RD/EXHAUST
31	3RD CLUTCH
32	3RD CLUTCH/LO -1ST
33	4TH CLUTCH
34	4TH CLUTCH EXHAUST
35	D3
36	D2
37	MANUAL 2-1 SERVO
38	LO
39	LO-1ST
40	REVERSE
41	REVERSE SERVO
42	EXHAUST
43	CASTING VOID

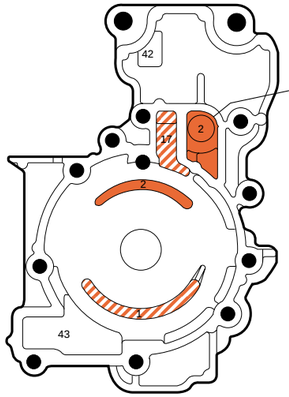
COMPONENTS ( )

(28)	COOLER LINE CHECKBALL ASSEMBLY
(29)	COOLER LINE CONNECTOR
(37)	VENT ASSEMBLY
(38)	PLUG, PIPE
(124)	PIPE, FORWARD SERVO APPLY
(125)	PIPE, MANUAL SERVO APPLY
(126)	PIPE, LUBE OIL
(219)	SCREEN ASSEMBLY, OIL PUMP PRESSURE
(372)	CHECKBALLS #1, #2, #3, #4, #7, #8, #9, #10
(373)	CHECKBALL #5, #6
(382)	SCREEN ASSEMBLY

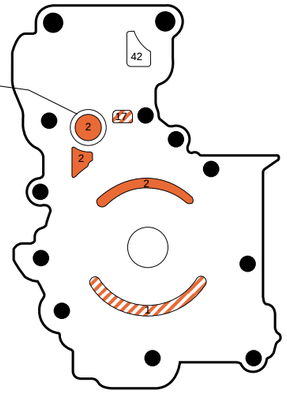
OVERDRIVE RANGE – FIRST GEAR



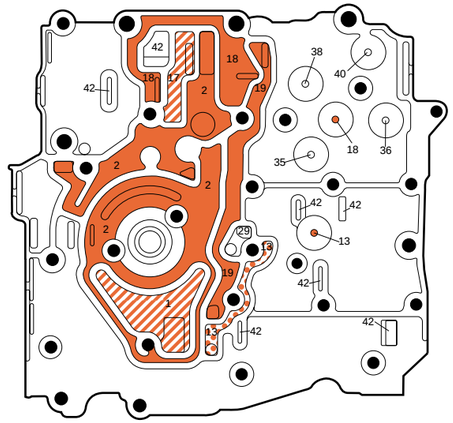
PUMP COVER (201)
(Oil Pump Body Side)



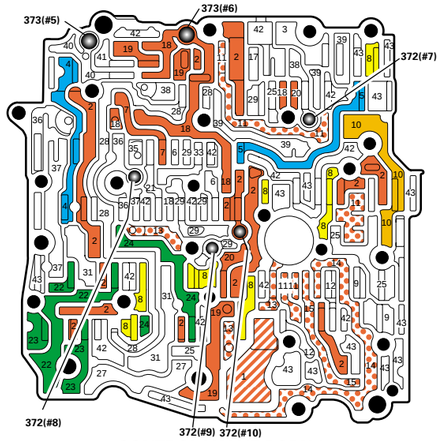
OIL PUMP BODY (202)
(Pump Cover Side)



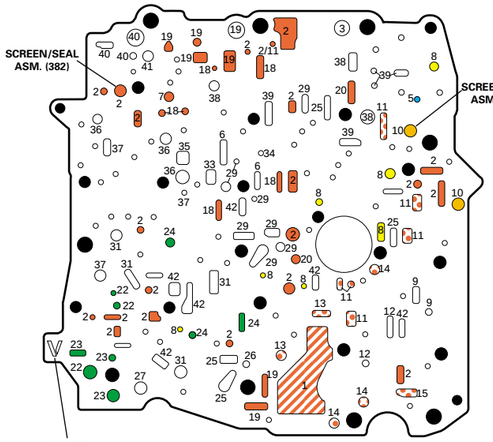
OIL PUMP BODY (202)
(Control Valve Body Side)



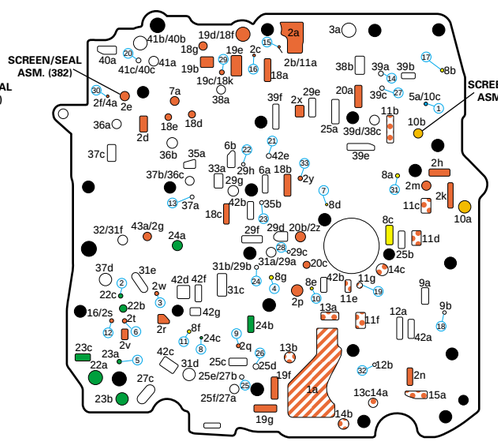
CONTROL VALVE BODY (300)
(Oil Pump Body Side)



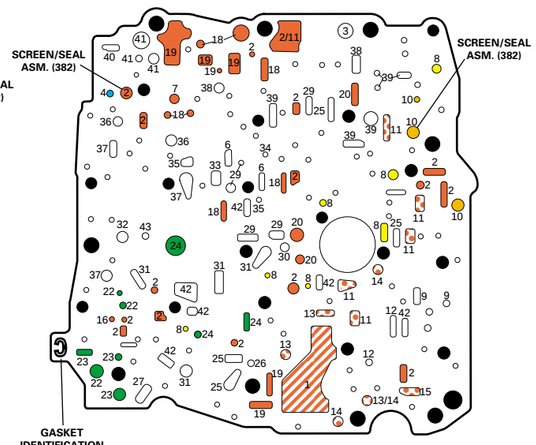
CONTROL VALVE BODY (300)
(Case Cover Side)



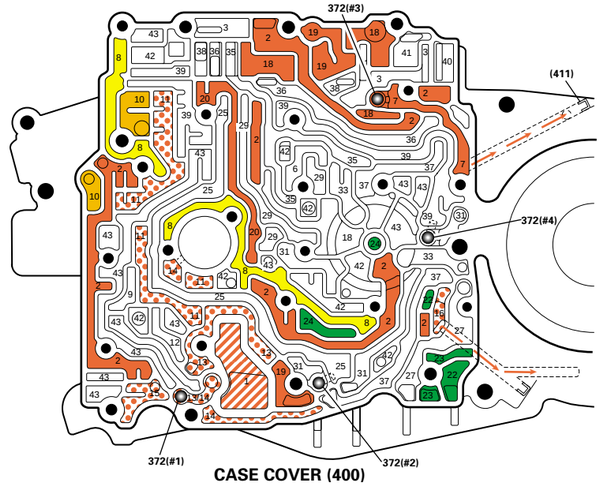
GASKET(371)
(Control Valve Body/Spacer Plate)



SPACER PLATE (370)



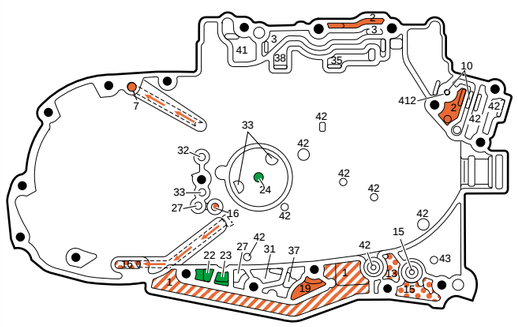
GASKET(369)
(Spacer Plate/Case Cover)



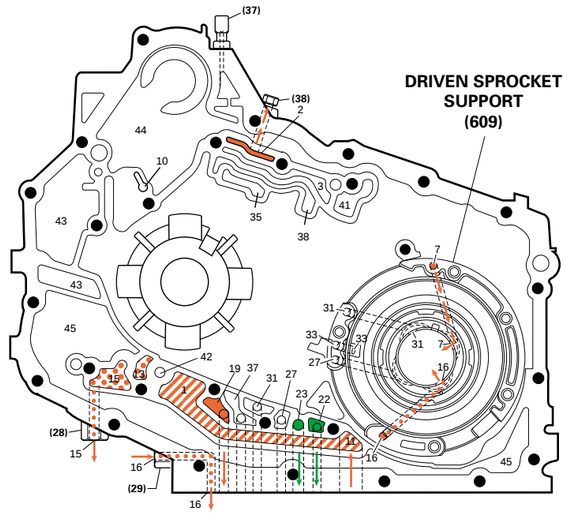
CASE COVER (400)
(Control Valve Body Side)

NOTE:

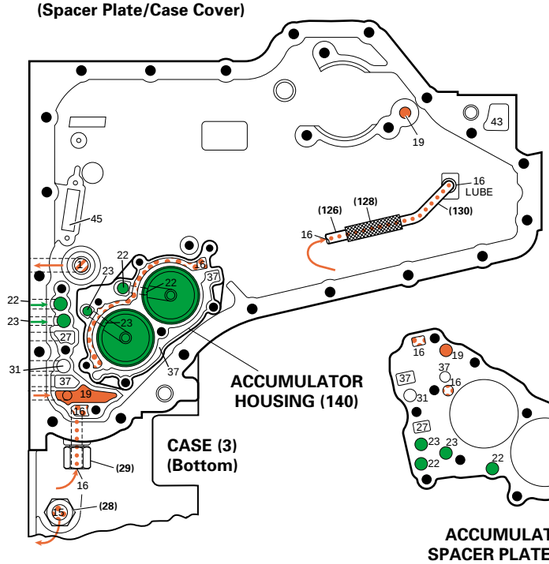
- ● INDICATES BOLT HOLES
- NON FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE NUMBERS LISTED FIRST
- EXHAUST FLUID NOT SHOWN



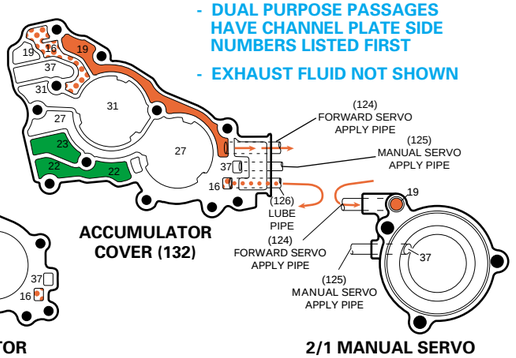
CASE COVER (400)
(Case Side)



CASE (3)
(Case Cover Face)



ACCUMULATOR SPACER PLATE (134)



ACCUMULATOR COVER (132)

2/1 MANUAL SERVO BODY COVER (104)

Figure 84

FOLDOUT ➤ 89

OVERDRIVE RANGE – SECOND GEAR

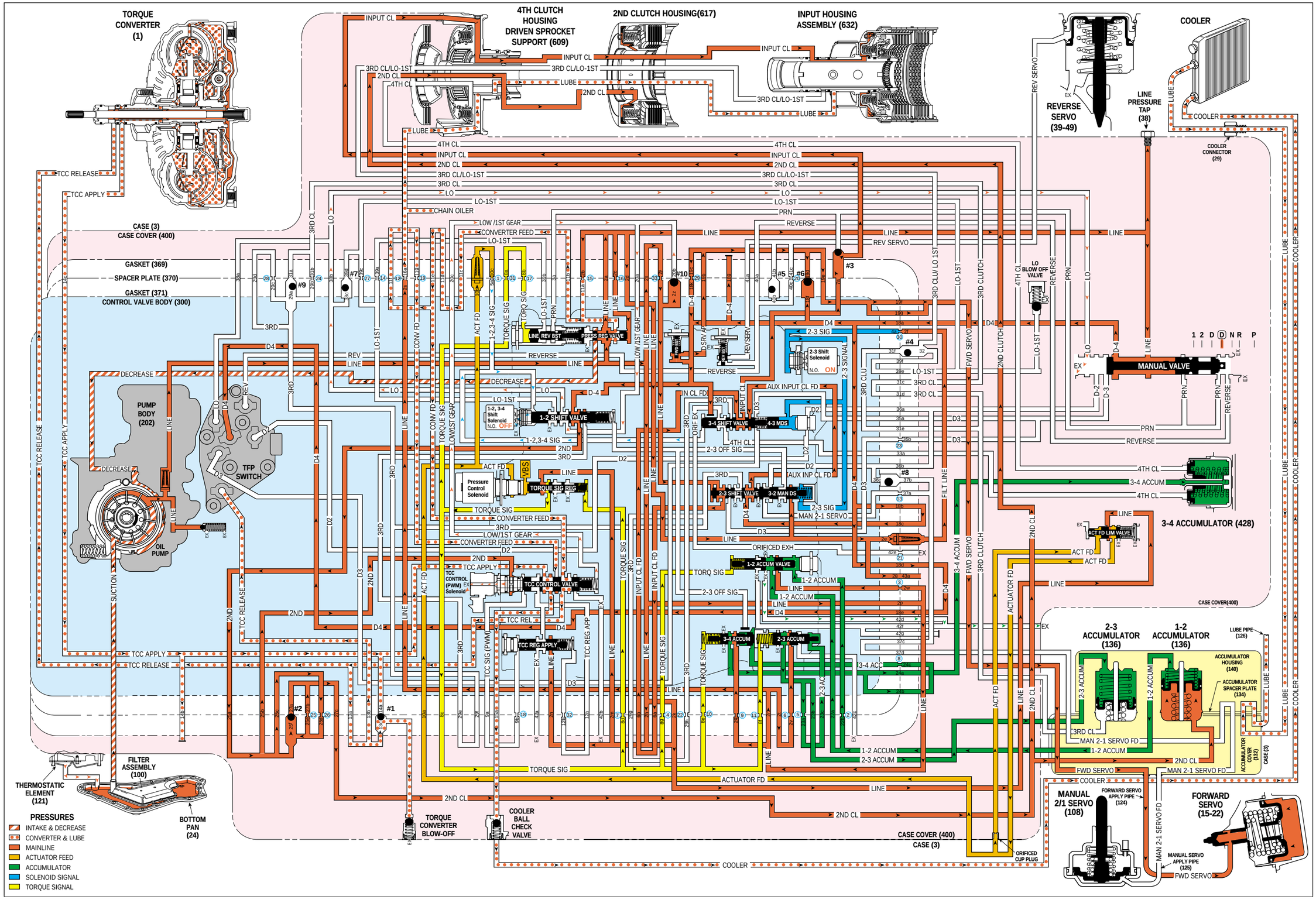


Figure 85

OVERDRIVE RANGE - SECOND GEAR

NO SECOND GEAR/SLIPS IN SECOND

- **2nd Clutch Assembly**
  - Second clutch backing plate retaining ring (627) missing or not seated.
  - Second clutch backing plate (626) missing or misassembled.
  - Clutch plates (623-625), worn damaged or misassembled.
  - Second clutch spring retaining ring (622) missing or not seated.
  - Spring assembly (621) damaged.
  - Second clutch housing ball check valve (618), missing or damaged.
  - Second clutch housing assembly (617) damaged.

- **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.

- **Driven Sprocket Support Assembly**
  - Second clutch housing oil seal rings (613) damaged.
  - Four lobe oil seal rings (612) damaged.
  - Second clutch housing bushings (616, 619) worn or damaged.

- **1-2, 3-4 Shift Solenoid Valve (315)**
  - Stuck “ON”, plugged.

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

- **TFP Valve Position Switch**
  - Malfunction (Electrical or Hydraulic)

HARSH SHIFT

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

- **1-2 Accumulator Assembly**
  - Spring or piston binding; no accumulation
  - Accumulator valve stuck.
  - Misassembled (upside down) 1-2 accumulator assembly.
  - Debris in the accumulator passages.

- **Control Valve Body Assembly**
  - #2 Check Ball missing or mislocated.
  - 1-2 accumulator valve (341) stuck or binding.
  - 2-3 accumulator valve bushing (345), bore plug (343) or retainers (342, 385) missing or damaged.

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
OFF	ON			APPLIED			*	OVERRUN		HOLDING	APPLIED

* APPLIED BUT NOT EFFECTIVE

OVERDRIVE RANGE - SECOND GEAR

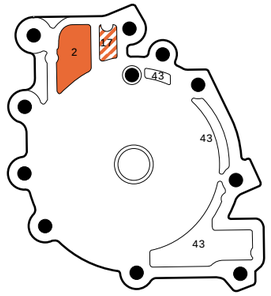
PASSAGES

1	SUCTION
2	LINE
3	PRN
4	2-3 SIGNAL
5	1-2, 3-4 SIGNAL
6	INPUT CLUTCH FEED
7	INPUT CLUTCH
8	TORQUE SIGNAL
9	TCC SIGNAL (PWM)
10	ACTUATOR FEED
11	CONVERTER FEED
12	TCC REGULATED APPLY
13	TCC RELEASE
14	TCC APPLY
15	COOLER
16	LUBE/LINE
17	DECREASE
18	D-4
19	FORWARD SERVO
20	LO/1ST GEAR
21	AUXILIARY INPUT CLUTCH FEED
22	1-2 ACCUMULATOR
23	2-3 ACCUMULATOR
24	3-4 ACCUMULATOR
25	2ND
26	2ND EXHAUST
27	2ND CLUTCH
28	2-3 OFF SIGNAL
29	3RD
30	3RD/EXHAUST
31	3RD CLUTCH
32	3RD CLUTCH/LO -1ST
33	4TH CLUTCH
34	4TH CLUTCH EXHAUST
35	D3
36	D2
37	MANUAL 2-1 SERVO
38	LO
39	LO-1ST
40	REVERSE
41	REVERSE SERVO
42	EXHAUST
43	CASTING VOID

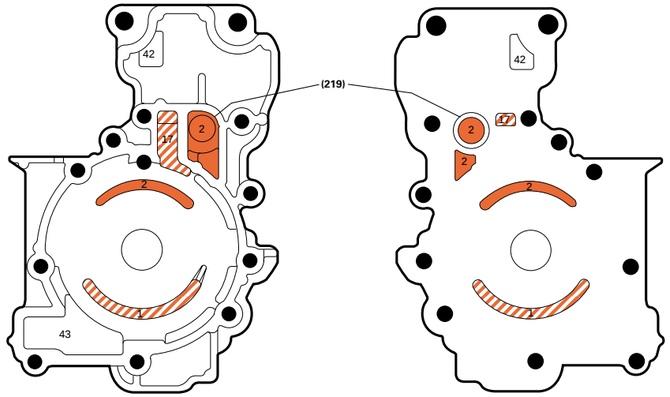
COMPONENTS ( )

(28)	COOLER LINE CHECKBALL ASSEMBLY
(29)	COOLER LINE CONNECTOR
(37)	VENT ASSEMBLY
(38)	PLUG, PIPE
(124)	PIPE, FORWARD SERVO APPLY
(125)	PIPE, MANUAL SERVO APPLY
(126)	PIPE, LUBE OIL
(219)	SCREEN ASSEMBLY, OIL PUMP PRESSURE
(372)	CHECKBALLS #1, #2, #3, #4, #7, #8, #9, #10
(373)	CHECKBALL #5, #6
(382)	SCREEN ASSEMBLY

OVERDRIVE RANGE – SECOND GEAR

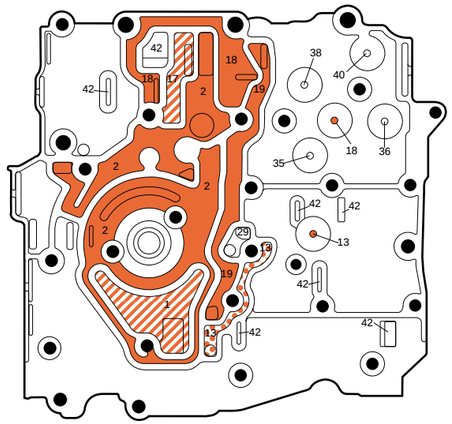


PUMP COVER (201)
(Oil Pump Body Side)

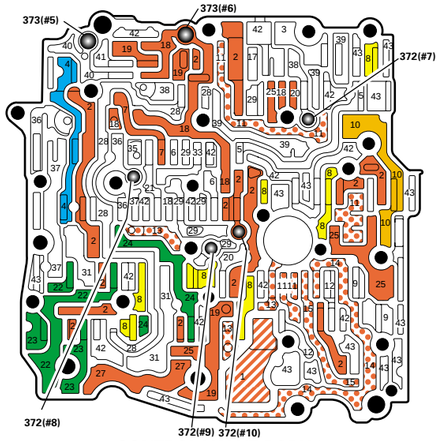


OIL PUMP BODY (202)
(Pump Cover Side)

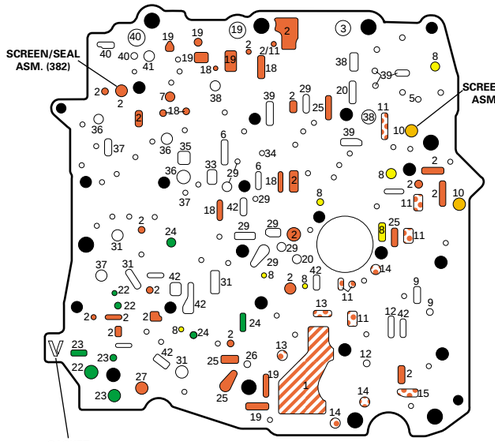
OIL PUMP BODY (202)
(Control Valve Body Side)



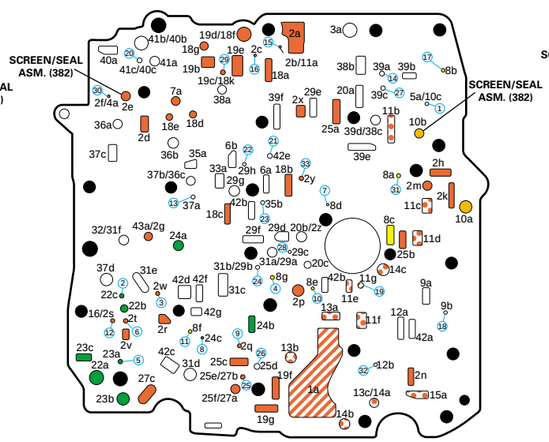
CONTROL VALVE BODY (300)
(Oil Pump Body Side)



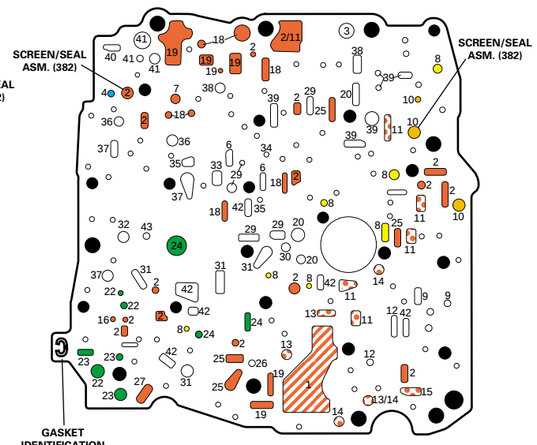
CONTROL VALVE BODY (300)
(Case Cover Side)



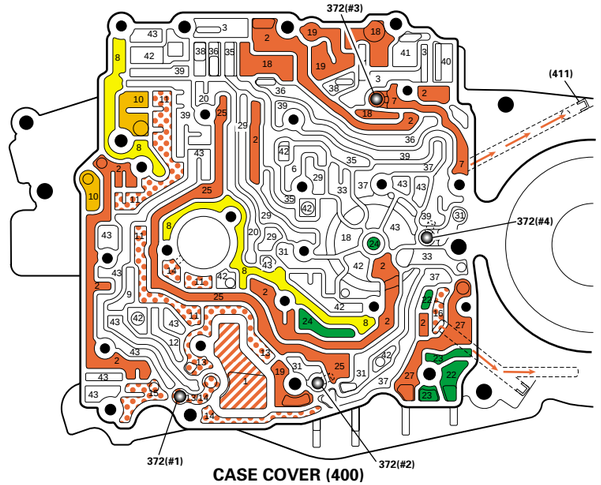
GASKET(371)
(Control Valve Body/Spacer Plate)



SPACER PLATE (370)



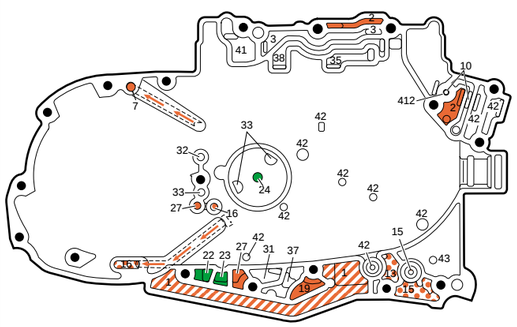
GASKET(369)
(Spacer Plate/Case Cover)



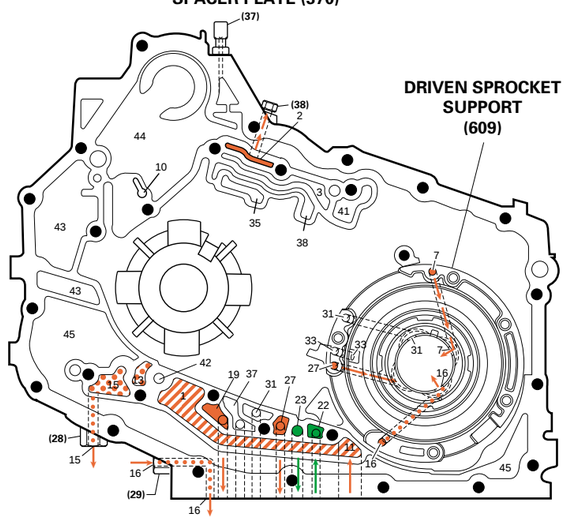
CASE COVER (400)
(Control Valve Body Side)

NOTE:

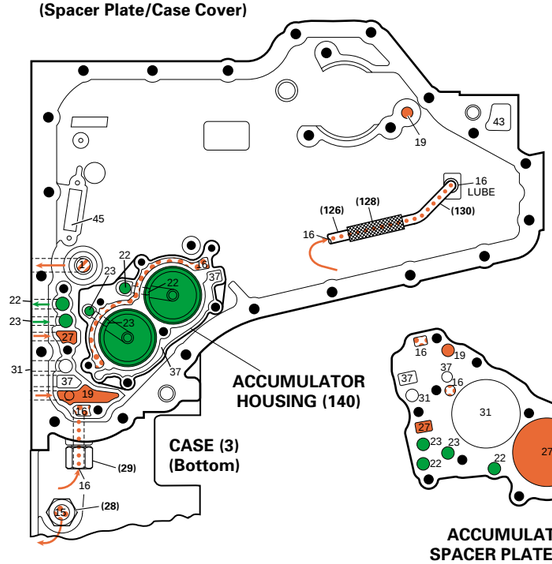
- ● INDICATES BOLT HOLES
- NON FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE NUMBERS LISTED FIRST
- EXHAUST FLUID NOT SHOWN



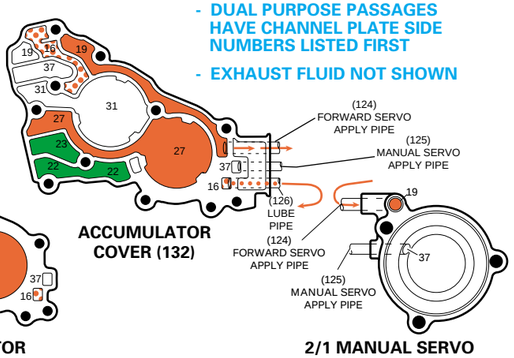
CASE COVER (400)
(Case Side)



CASE (3)
(Case Cover Face)



ACCUMULATOR SPACER PLATE (134)



ACCUMULATOR COVER (132)

2/1 MANUAL SERVO BODY COVER (104)

Figure 86

FOLDOUT ➤ 91

OVERDRIVE RANGE – THIRD GEAR

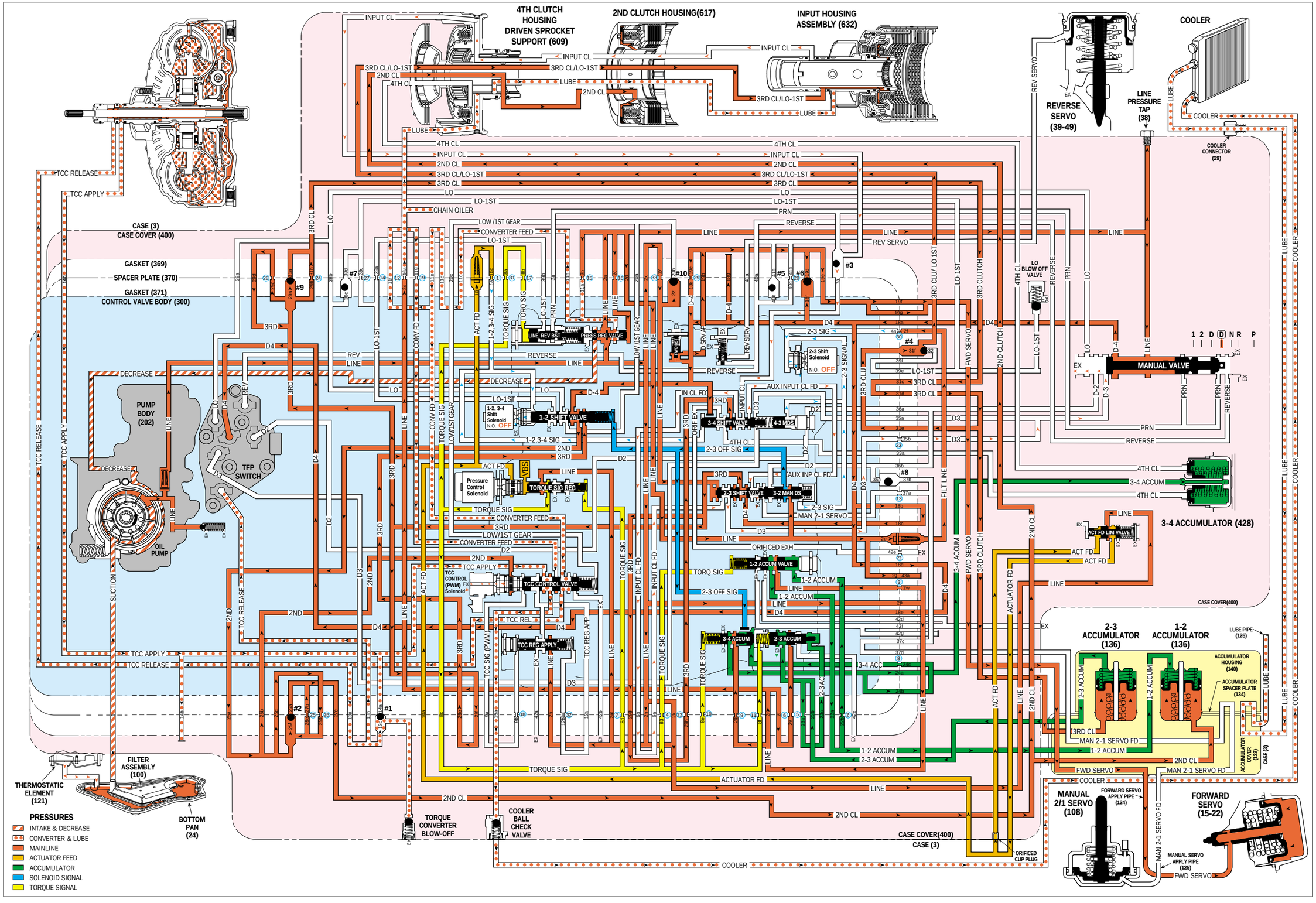


Figure 87

OVERDRIVE RANGE - THIRD GEAR

NO THIRD GEAR/SLIPS IN THIRD

- **Third Clutch Assembly**
  - Input clutch housing oil seal rings (628) missing or damaged.
  - Third clutch ball check valve assembly (724), missing or damaged.
  - Third clutch piston (642) is damaged.
  - Third clutch piston inner seal (641) missing or damaged.
  - Third clutch plates (645-648) are worn or misassembled.
- **Third 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 Valve (315)**
  - Stuck “ON”, leaking.
- **2-3 Accumulator**
  - Leak at piston seal.
  - Channel plate / case porosity.
- **2-3 Accumulator Valve (344)**
  - Stuck.
- **Line Pressure**
  - Low (See PARK page 82A).
- **3-4 Shift Valve (362)**
  - Stuck in upshifted position.
- **TFP Valve Position Switch (395)**
  - Malfunction (Electrical or Hydraulic).

THIRD GEAR ONLY

- **Control Valve Body Assembly**
  - Debris in the valve body.
  - Spacer plate and gaskets misassembled.

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
OFF	OFF			APPLIED	APPLIED	HOLDING				OVERRUN	*

* APPLIED BUT NOT EFFECTIVE

OVERDRIVE RANGE - THIRD GEAR

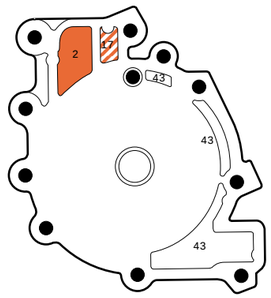
PASSAGES

1	SUCTION
2	LINE
3	PRN
4	2-3 SIGNAL
5	1-2, 3-4 SIGNAL
6	INPUT CLUTCH FEED
7	INPUT CLUTCH
8	TORQUE SIGNAL
9	TCC SIGNAL (PWM)
10	ACTUATOR FEED
11	CONVERTER FEED
12	TCC REGULATED APPLY
13	TCC RELEASE
14	TCC APPLY
15	COOLER
16	LUBE/LINE
17	DECREASE
18	D-4
19	FORWARD SERVO
20	LO/1ST GEAR
21	AUXILIARY INPUT CLUTCH FEED
22	1-2 ACCUMULATOR
23	2-3 ACCUMULATOR
24	3-4 ACCUMULATOR
25	2ND
26	2ND EXHAUST
27	2ND CLUTCH
28	2-3 OFF SIGNAL
29	3RD
30	3RD/EXHAUST
31	3RD CLUTCH
32	3RD CLUTCH/LO -1ST
33	4TH CLUTCH
34	4TH CLUTCH EXHAUST
35	D3
36	D2
37	MANUAL 2-1 SERVO
38	LO
39	LO-1ST
40	REVERSE
41	REVERSE SERVO
42	EXHAUST
43	CASTING VOID

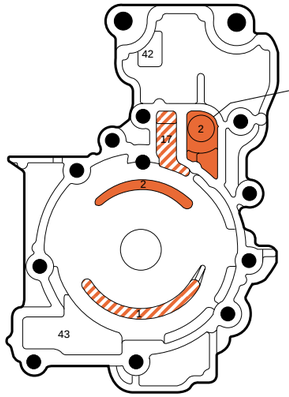
COMPONENTS ( )

(28)	COOLER LINE CHECKBALL ASSEMBLY
(29)	COOLER LINE CONNECTOR
(37)	VENT ASSEMBLY
(38)	PLUG, PIPE
(124)	PIPE, FORWARD SERVO APPLY
(125)	PIPE, MANUAL SERVO APPLY
(126)	PIPE, LUBE OIL
(219)	SCREEN ASSEMBLY, OIL PUMP PRESSURE
(372)	CHECKBALLS #1, #2, #3, #4, #7, #8, #9, #10
(373)	CHECKBALL #5, #6
(382)	SCREEN ASSEMBLY

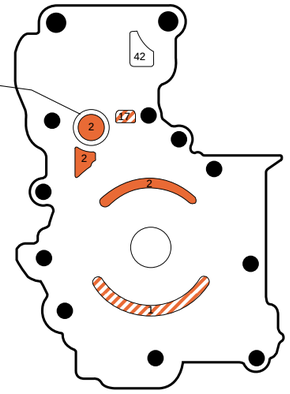
OVERDRIVE – RANGE THIRD GEAR



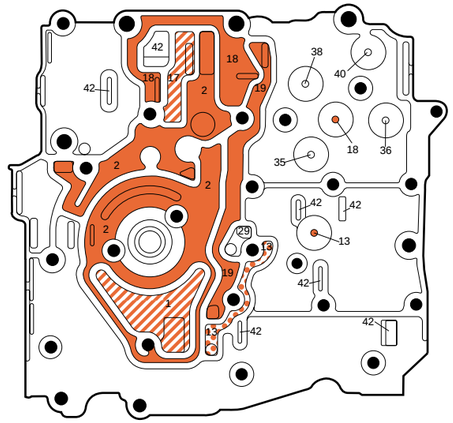
PUMP COVER (201)
(Oil Pump Body Side)



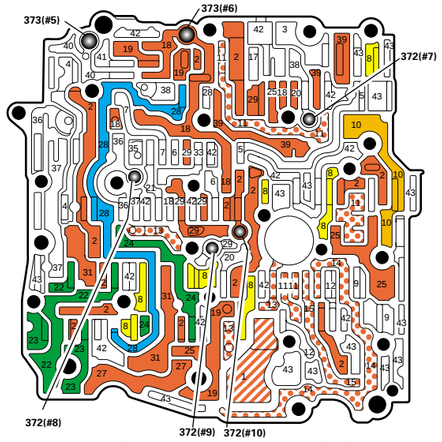
OIL PUMP BODY (202)
(Pump Cover Side)



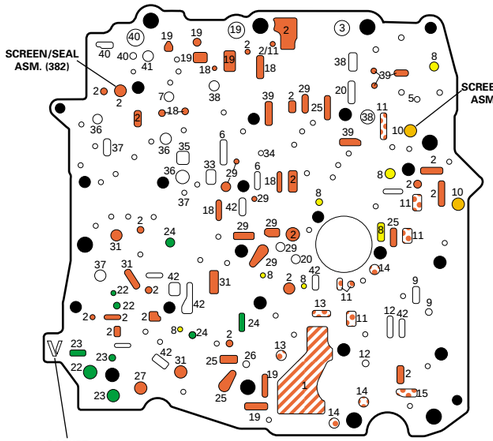
OIL PUMP BODY (202)
(Control Valve Body Side)



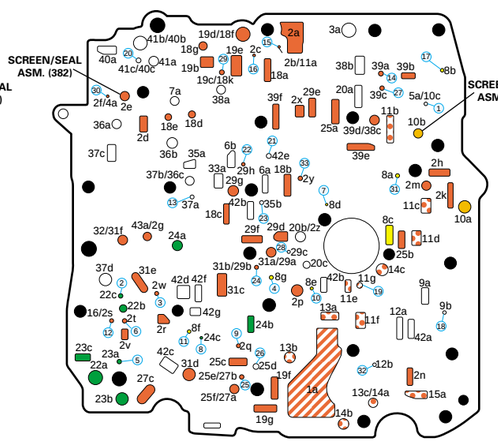
CONTROL VALVE BODY (300)
(Oil Pump Body Side)



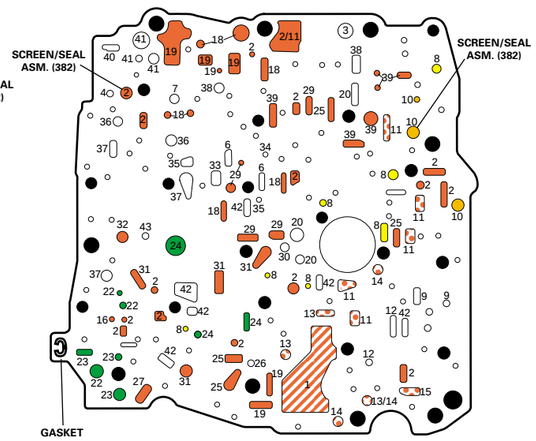
CONTROL VALVE BODY (300)
(Case Cover Side)



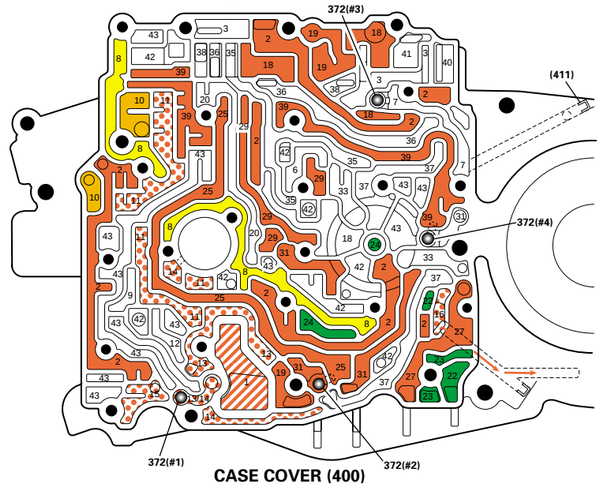
GASKET(371)
(Control Valve Body/Spacer Plate)



SPACER PLATE (370)



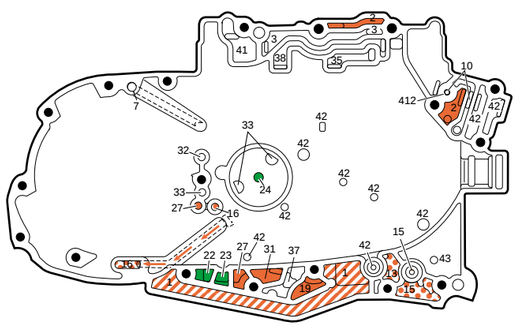
GASKET(369)
(Spacer Plate/Case Cover)



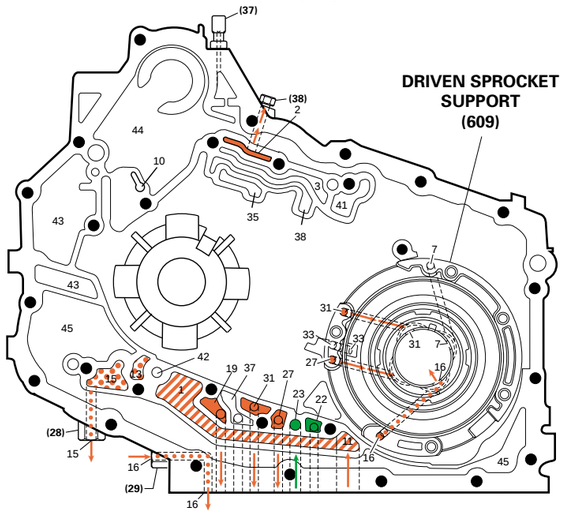
CASE COVER (400)
(Control Valve Body Side)

NOTE:

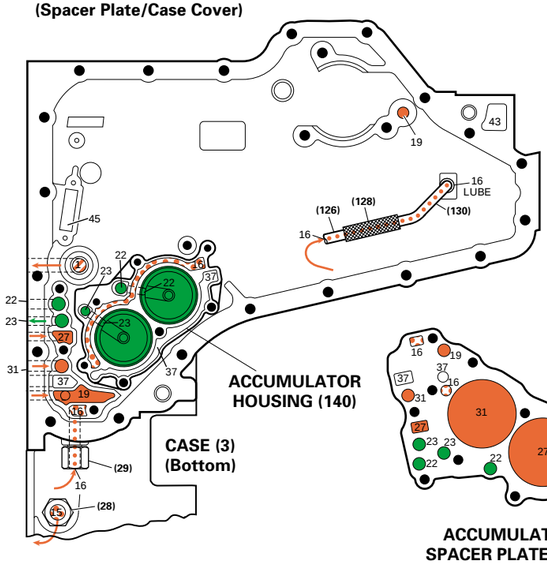
- ● INDICATES BOLT HOLES
- NON FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE NUMBERS LISTED FIRST
- EXHAUST FLUID NOT SHOWN



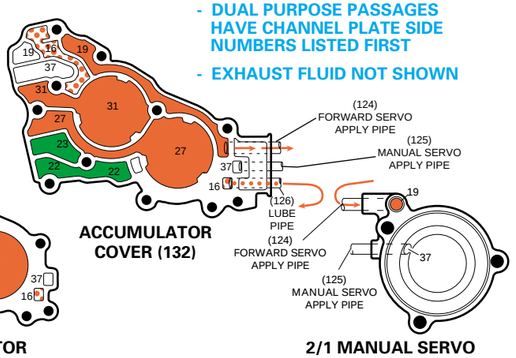
CASE COVER (400)
(Case Side)



CASE (3)
(Case Cover Face)



ACCUMULATOR SPACER PLATE (134)



ACCUMULATOR COVER (132)

2/1 MANUAL SERVO BODY COVER (104)

Figure 88

FOLDOUT ➤ 93

OVERDRIVE RANGE – FOURTH GEAR (Torque Converter Clutch Applied)

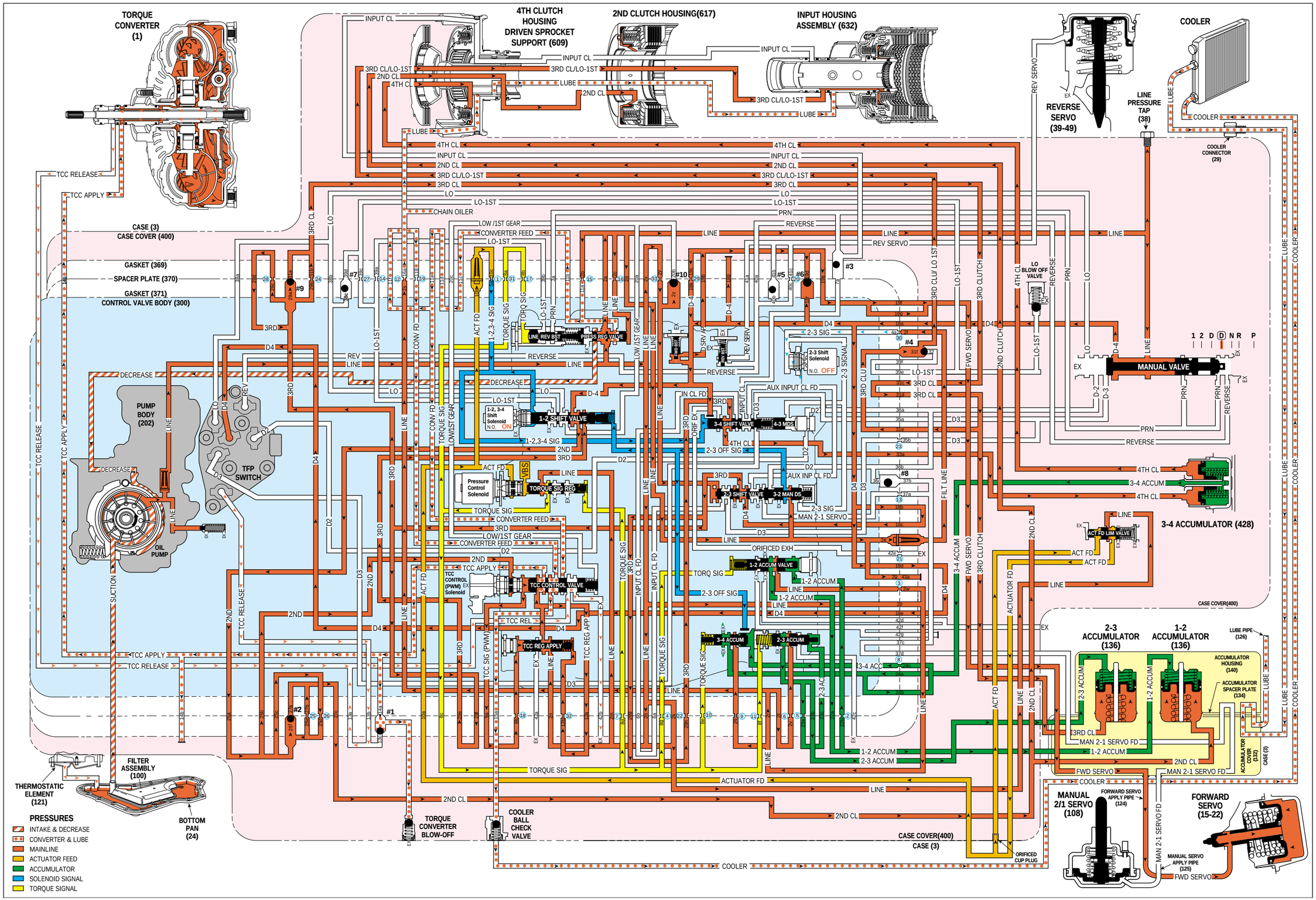


Figure 89

OVERDRIVE RANGE - FOURTH GEAR

(Torque Converter Clutch Applied)

NO FOURTH GEAR/SLIPS IN FOURTH

- **Fourth Clutch Assembly**
  - – Clutch plates (500-502) worn or damaged.
  - – Fourth clutch spring retaining ring (601), missing or not seated.
  - – Piston (603) damaged.
  - – Piston Seals (604, 605) worn or damaged.
  - – Spring assembly (602) damaged.
  - – Servo Cover (80) – Broken, loose, leaking.
  - – Band (100) – Broken, worn, out of position.
  - – Case (51) – Cracked at band seat.
- **Fourth Clutch Fluid Routing**
  - – Valve Body, Gaskets & Spacer Plate; Channel Plate; Case – Porosity, misaligned, loose, fluid restriction, fluid leak across channels.
- **Driven Sprocket Support Assembly**
  - – Third clutch oil passage plugged.
- **1-2, 3-4 Shift Solenoid Valve (315)**
  - – Stuck “OFF”, leaking.
- **3-4 Shift Valve (362)**
  - – Stuck in downshifted position.
- **Manual Valve (404)**
  - – 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).
- **TFP Valve Position Switch (395)**
  - – Malfunction (Hydraulic or Electrical)

FOURTH GEAR ONLY

- **Control Valve Body Assembly**
  - – Debris in the valve body.
  - – Spacer plate and gaskets misassembled.

NO TCC APPLY OR RELEASE

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

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
ON	OFF	APPLIED		APPLIED	*	OVERRUN				OVERRUN	*

* APPLIED BUT NOT EFFECTIVE

OVERDRIVE RANGE - FOURTH GEAR

(Torque Converter Clutch Applied)

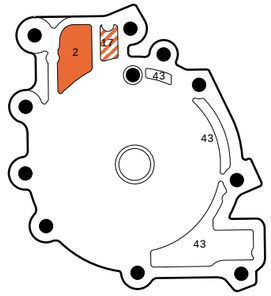
PASSAGES

1	SUCTION
2	LINE
3	PRN
4	2-3 SIGNAL
5	1-2, 3-4 SIGNAL
6	INPUT CLUTCH FEED
7	INPUT CLUTCH
8	TORQUE SIGNAL
9	TCC SIGNAL (PWM)
10	ACTUATOR FEED
11	CONVERTER FEED
12	TCC REGULATED APPLY
13	TCC RELEASE
14	TCC APPLY
15	COOLER
16	LUBE/LINE
17	DECREASE
18	D-4
19	FORWARD SERVO
20	LO/1ST GEAR
21	AUXILIARY INPUT CLUTCH FEED
22	1-2 ACCUMULATOR
23	2-3 ACCUMULATOR
24	3-4 ACCUMULATOR
25	2ND
26	2ND EXHAUST
27	2ND CLUTCH
28	2-3 OFF SIGNAL
29	3RD
30	3RD/EXHAUST
31	3RD CLUTCH
32	3RD CLUTCH/LO -1ST
33	4TH CLUTCH
34	4TH CLUTCH EXHAUST
35	D3
36	D2
37	MANUAL 2-1 SERVO
38	LO
39	LO-1ST
40	REVERSE
41	REVERSE SERVO
42	EXHAUST
43	CASTING VOID

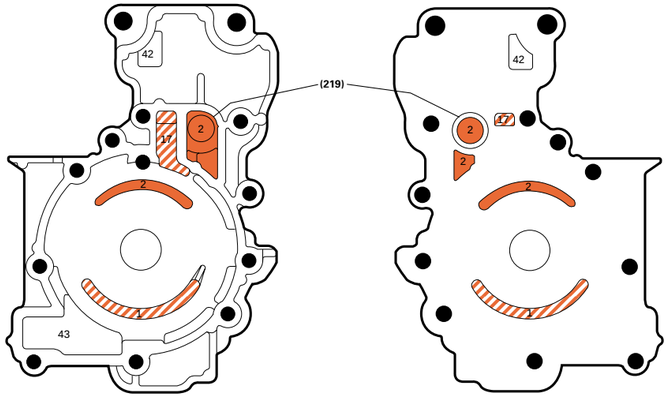
COMPONENTS ( )

(28)	COOLER LINE CHECKBALL ASSEMBLY
(29)	COOLER LINE CONNECTOR
(37)	VENT ASSEMBLY
(38)	PLUG, PIPE
(124)	PIPE, FORWARD SERVO APPLY
(125)	PIPE, MANUAL SERVO APPLY
(126)	PIPE, LUBE OIL
(219)	SCREEN ASSEMBLY, OIL PUMP PRESSURE
(372)	CHECKBALLS #1, #2, #3, #4, #7, #8, #9, #10
(373)	CHECKBALL #5, #6
(382)	SCREEN ASSEMBLY

OVERDRIVE RANGE – FOURTH GEAR (Torque Converter Clutch Applied)

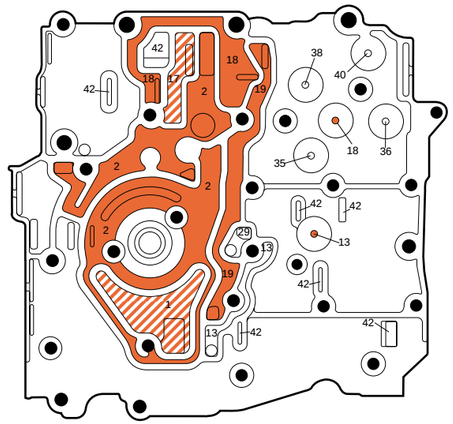


PUMP COVER (201)
(Oil Pump Body Side)

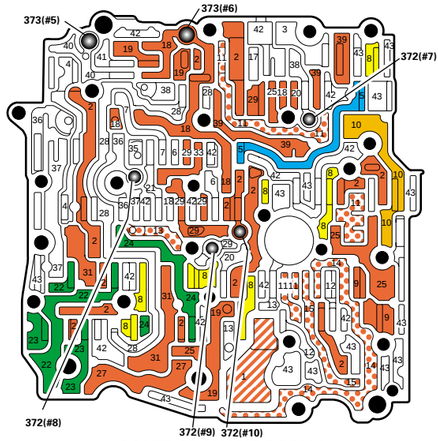


OIL PUMP BODY (202)
(Pump Cover Side)

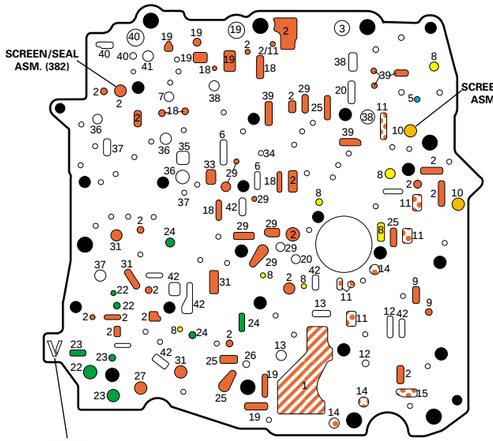
OIL PUMP BODY (202)
(Control Valve Body Side)



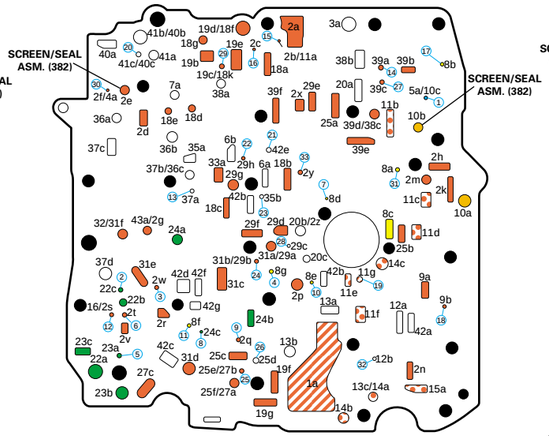
CONTROL VALVE BODY (300)
(Oil Pump Body Side)



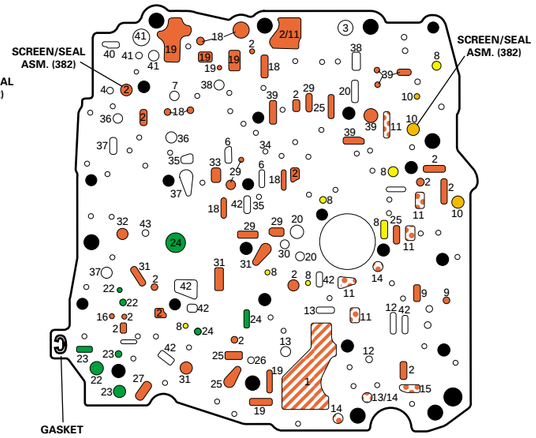
CONTROL VALVE BODY (300)
(Case Cover Side)



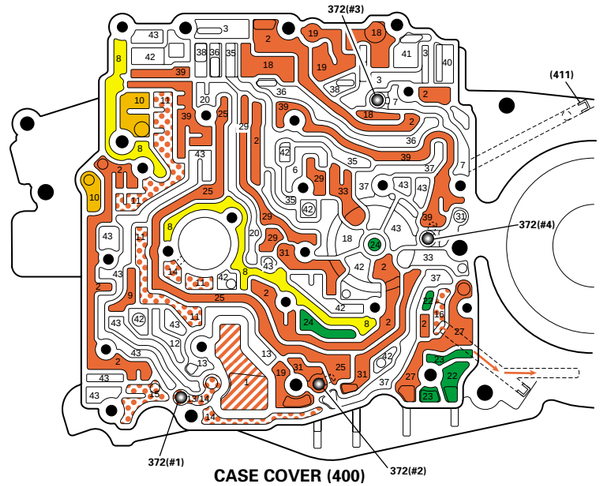
GASKET(371)
(Control Valve Body/Spacer Plate)



SPACER PLATE (370)



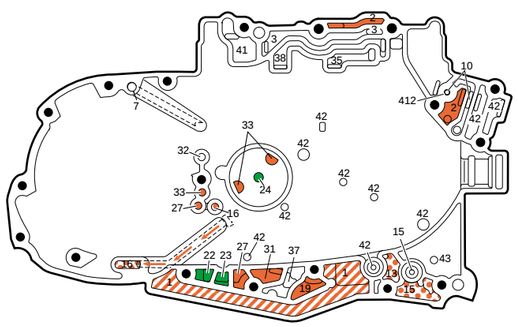
GASKET(369)
(Spacer Plate/Case Cover)



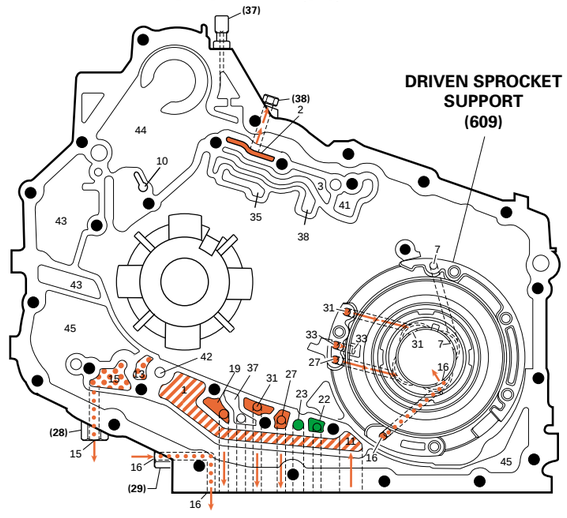
CASE COVER (400)
(Control Valve Body Side)

NOTE:

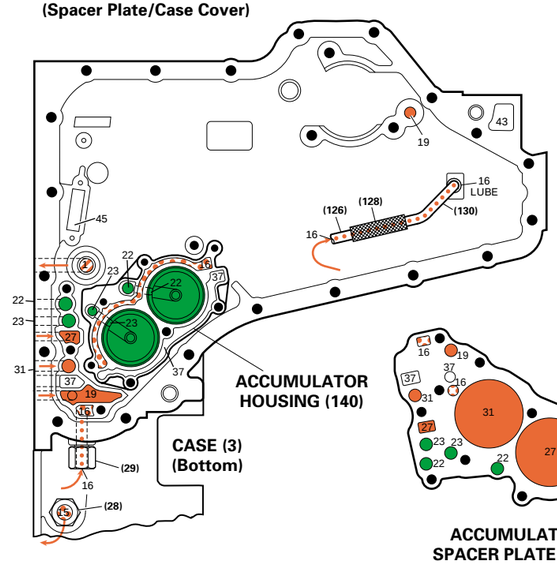
- ● INDICATES BOLT HOLES
- NON FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE NUMBERS LISTED FIRST
- EXHAUST FLUID NOT SHOWN



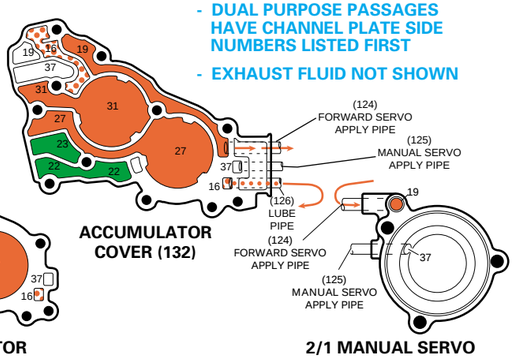
CASE COVER (400)
(Case Side)



CASE (3)
(Case Cover Face)



ACCUMULATOR SPACER PLATE (134)



ACCUMULATOR COVER (132)

2/1 MANUAL SERVO BODY COVER (104)

Figure 90

FOLDOUT ➤ 95

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

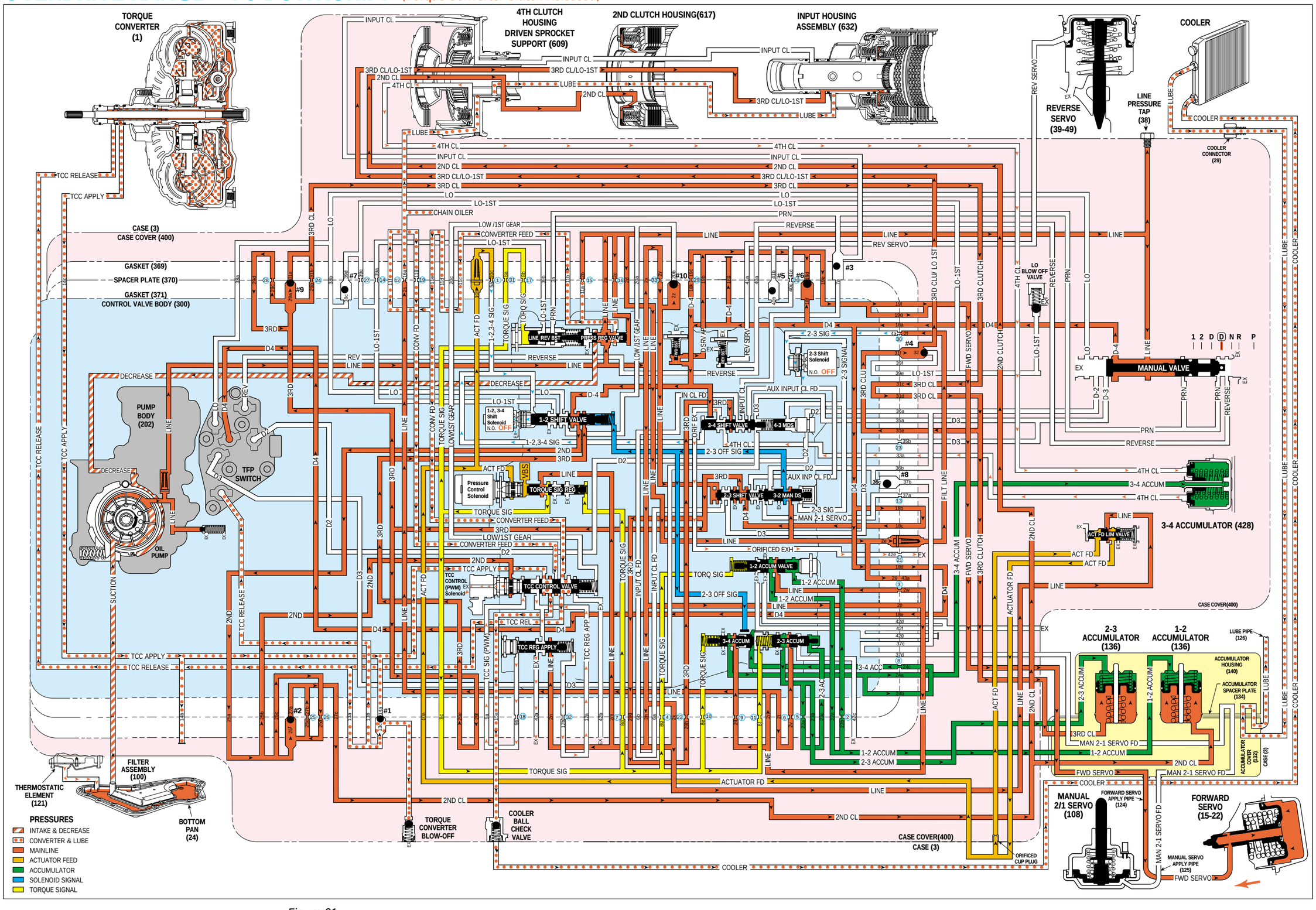


Figure 91

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 PWM Solenoid Valve (334)**
  - Stuck “OFF” – O-ring leaking.
  - No voltage to solenoid.
  - Poor electrical connection.
- **Wiring Harness (224)**
  - Pinched wire (electrical short).
  - Damaged electrical connector.
- **PCM**
  - No signal to solenoid.
- **Brake Switch**
  - Not functioning (open).
- **Pressure Regulator Valve (313)**
  - Stuck.
- **Torque Converter (1)**
  - Internal failure.
- **TCC Fluid Circuits**
  - Leaks.
- **TCC Regulator Apply Valve (327)**
  - Stuck in TCC release position.
- **Turbine Shaft Assembly (518)**
  - Turbine shaft O-ring seal (520) is damaged or missing.
  - Turbine shaft oil seal rings (513, 519) damaged or missing.
  - Turbine shaft is damaged.
- **Fluid Level or Pressure**
  - Low.
- **Cooler Lines**
  - Plugged.

NO TCC RELEASE

- **TCC PWM Solenoid Valve (334)**
  - Internal failure.
  - Fluid exhaust plugged.
  - External Ground.
- **Torque Converter (1)**
  - Internal Failure.
- **TCC Regulator Apply Valve (327)**
  - Stuck in TCC apply position.

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
OFF	OFF			APPLIED	APPLIED	HOLDING				OVERRUN	*

* APPLIED BUT NOT EFFECTIVE

OVERDRIVE RANGE - 4-3 DOWNSHIFT

(Torque Converter Clutch Released)

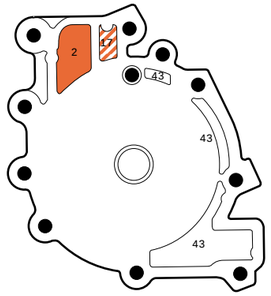
PASSAGES

1	SUCTION
2	LINE
3	PRN
4	2-3 SIGNAL
5	1-2, 3-4 SIGNAL
6	INPUT CLUTCH FEED
7	INPUT CLUTCH
8	TORQUE SIGNAL
9	TCC SIGNAL (PWM)
10	ACTUATOR FEED
11	CONVERTER FEED
12	TCC REGULATED APPLY
13	TCC RELEASE
14	TCC APPLY
15	COOLER
16	LUBE/LINE
17	DECREASE
18	D-4
19	FORWARD SERVO
20	LO/1ST GEAR
21	AUXILIARY INPUT CLUTCH FEED
22	1-2 ACCUMULATOR
23	2-3 ACCUMULATOR
24	3-4 ACCUMULATOR
25	2ND
26	2ND EXHAUST
27	2ND CLUTCH
28	2-3 OFF SIGNAL
29	3RD
30	3RD/EXHAUST
31	3RD CLUTCH
32	3RD CLUTCH/LO -1ST
33	4TH CLUTCH
34	4TH CLUTCH EXHAUST
35	D3
36	D2
37	MANUAL 2-1 SERVO
38	LO
39	LO-1ST
40	REVERSE
41	REVERSE SERVO
42	EXHAUST
43	CASTING VOID

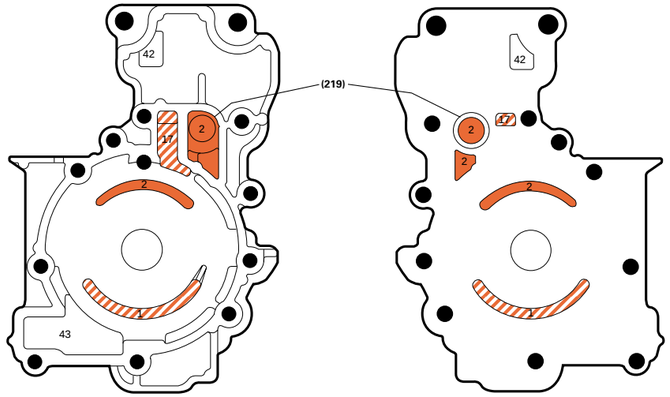
COMPONENTS ( )

(28)	COOLER LINE CHECKBALL ASSEMBLY
(29)	COOLER LINE CONNECTOR
(37)	VENT ASSEMBLY
(38)	PLUG, PIPE
(124)	PIPE, FORWARD SERVO APPLY
(125)	PIPE, MANUAL SERVO APPLY
(126)	PIPE, LUBE OIL
(219)	SCREEN ASSEMBLY, OIL PUMP PRESSURE
(372)	CHECKBALLS #1, #2, #3, #4, #7, #8, #9, #10
(373)	CHECKBALL #5, #6
(382)	SCREEN ASSEMBLY

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

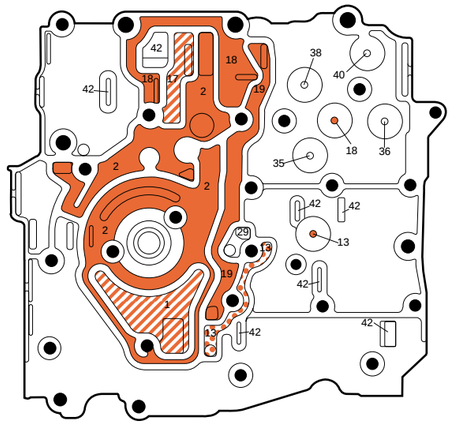


PUMP COVER (201)
(Oil Pump Body Side)

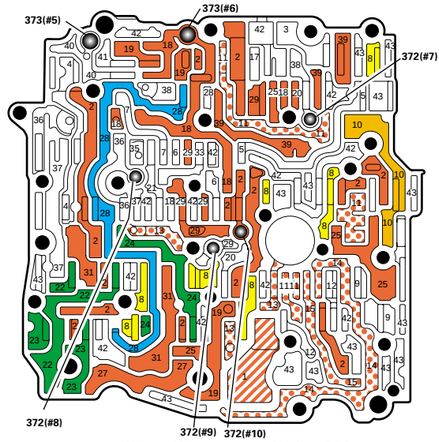


OIL PUMP BODY (202)
(Pump Cover Side)

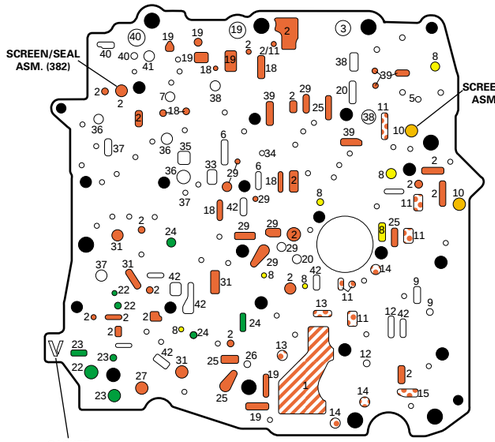
OIL PUMP BODY (202)
(Control Valve Body Side)



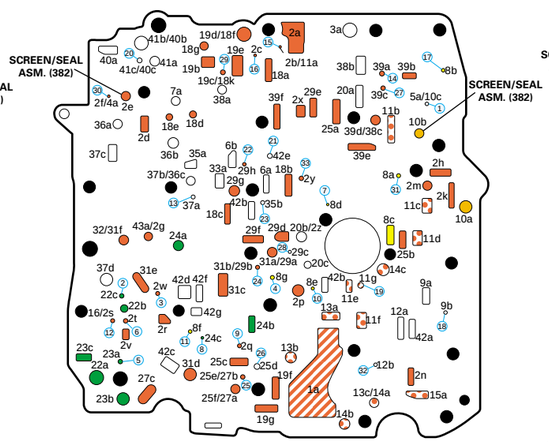
CONTROL VALVE BODY (300)
(Oil Pump Body Side)



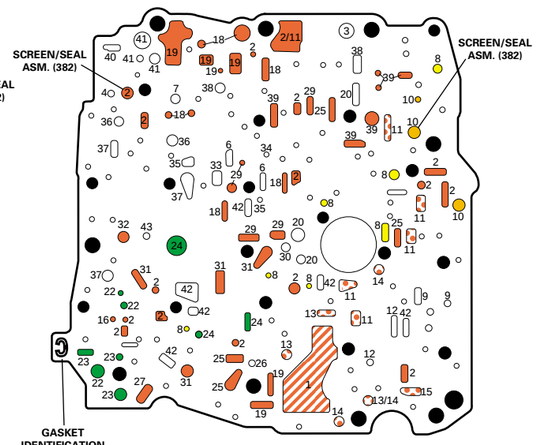
CONTROL VALVE BODY (300)
(Case Cover Side)



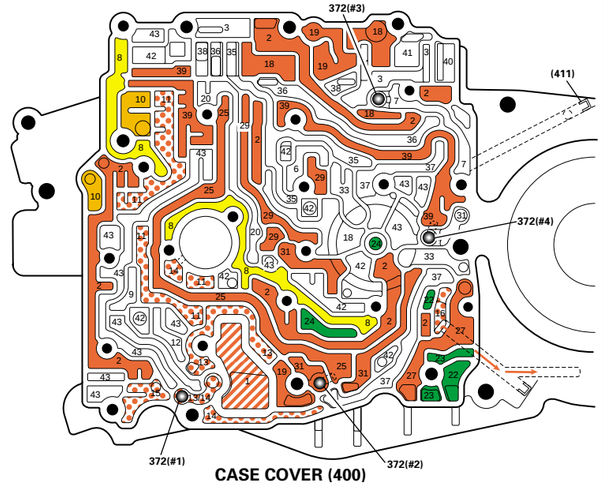
GASKET(371)
(Control Valve Body/Spacer Plate)



SPACER PLATE (370)



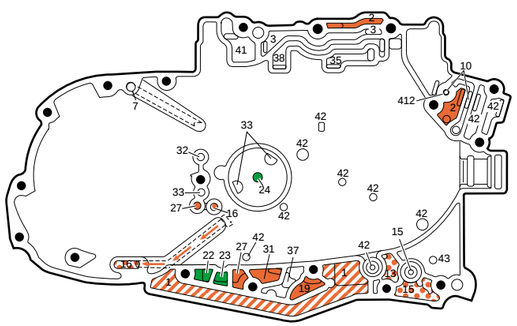
GASKET(369)
(Spacer Plate/Case Cover)



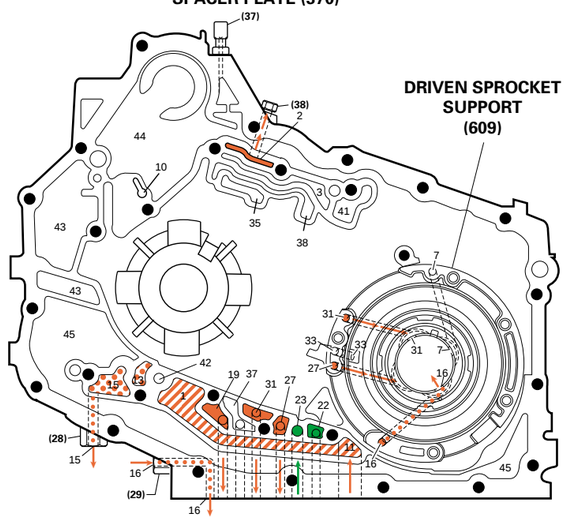
CASE COVER (400)
(Control Valve Body Side)

NOTE:

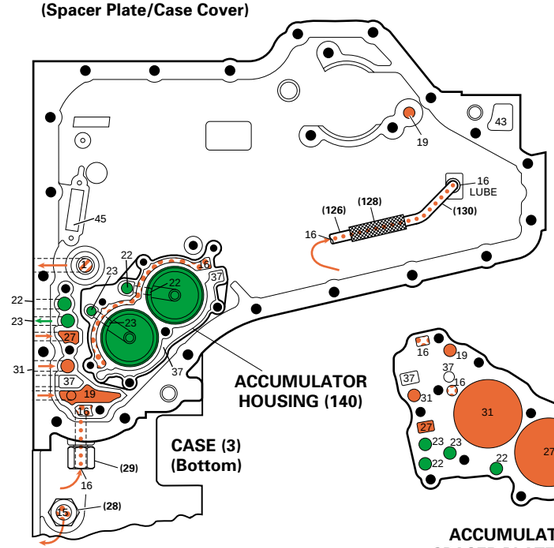
- ● INDICATES BOLT HOLES
- NON FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE NUMBERS LISTED FIRST
- EXHAUST FLUID NOT SHOWN



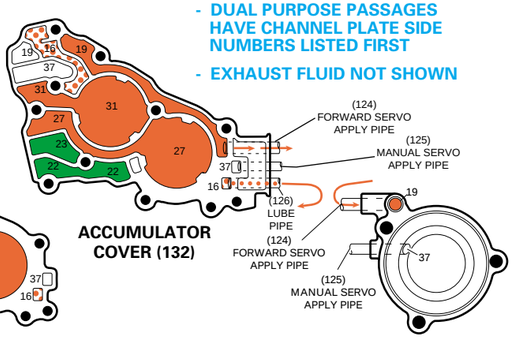
CASE COVER (400)
(Case Side)



CASE (3)
(Case Cover Face)



ACCUMULATOR SPACER PLATE (134)



ACCUMULATOR COVER (132)

2/1 MANUAL SERVO BODY COVER (104)

Figure 92

FOLDOUT ➤ 97

DRIVE RANGE – MANUAL THIRD

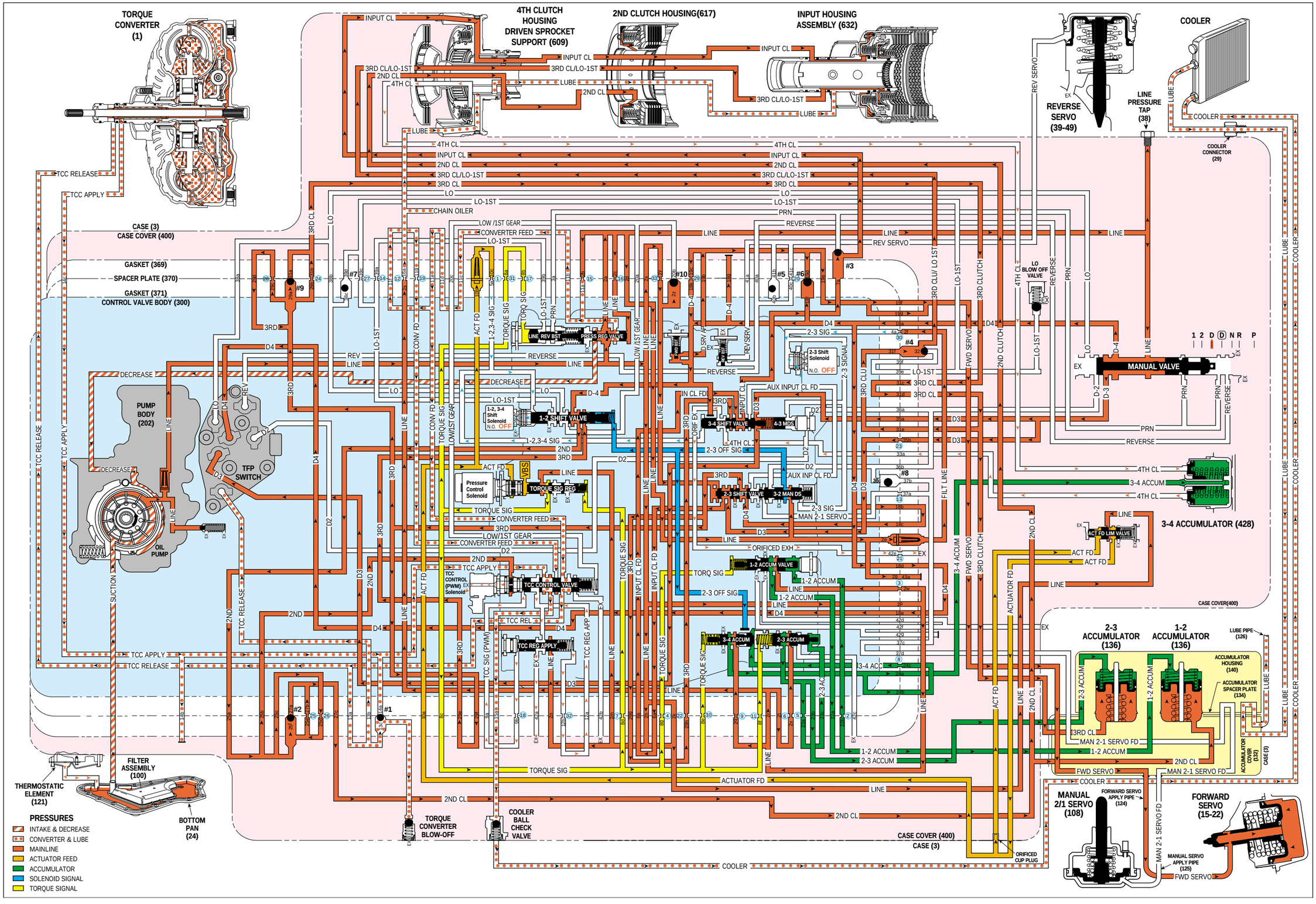


Figure 93

DRIVE RANGE - MANUAL THIRD

(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

- **Input Clutch**
  - Piston (636) and Seals (634, 635) – Binding, cracked, leaking.
  - Clutch Plates (654-658) – Friction material worn, splines broken.
  - Spring and retainer assembly (637) – Binding, broken.
  - Input Housing Sleeve and Shaft (632) – Damaged, cracked, fluid feed holes restricted, seal rings leaking.
  - Housing Retainer and Ball Assembly (633) – Missing, loose, plugged.
- **Input 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.
- **Fluid Level or Pressure**
  - Low (See PARK page 82A).
- **3-4 Shift Valve (362)**
  - Stuck in 4th gear position. (No input clutch apply).
- **Manual Valve (404) / Shift Linkage**
  - Misaligned.

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
@OFF	@OFF			APPLIED	APPLIED	HOLDING	APPLIED	HOLDING		OVERRUN	*

* APPLIED BUT NOT EFFECTIVE

DRIVE RANGE - MANUAL THIRD

(From Overdrive Range - Fourth Gear)

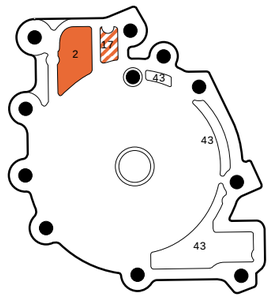
PASSAGES

1	SUCTION
2	LINE
3	PRN
4	2-3 SIGNAL
5	1-2, 3-4 SIGNAL
6	INPUT CLUTCH FEED
7	INPUT CLUTCH
8	TORQUE SIGNAL
9	TCC SIGNAL (PWM)
10	ACTUATOR FEED
11	CONVERTER FEED
12	TCC REGULATED APPLY
13	TCC RELEASE
14	TCC APPLY
15	COOLER
16	LUBE/LINE
17	DECREASE
18	D-4
19	FORWARD SERVO
20	LO/1ST GEAR
21	AUXILIARY INPUT CLUTCH FEED
22	1-2 ACCUMULATOR
23	2-3 ACCUMULATOR
24	3-4 ACCUMULATOR
25	2ND
26	2ND EXHAUST
27	2ND CLUTCH
28	2-3 OFF SIGNAL
29	3RD
30	3RD/EXHAUST
31	3RD CLUTCH
32	3RD CLUTCH/LO -1ST
33	4TH CLUTCH
34	4TH CLUTCH EXHAUST
35	D3
36	D2
37	MANUAL 2-1 SERVO
38	LO
39	LO-1ST
40	REVERSE
41	REVERSE SERVO
42	EXHAUST
43	CASTING VOID

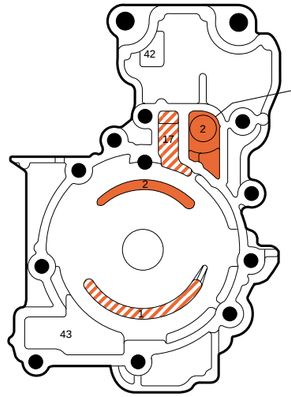
COMPONENTS ( )

(28)	COOLER LINE CHECKBALL ASSEMBLY
(29)	COOLER LINE CONNECTOR
(37)	VENT ASSEMBLY
(38)	PLUG, PIPE
(124)	PIPE, FORWARD SERVO APPLY
(125)	PIPE, MANUAL SERVO APPLY
(126)	PIPE, LUBE OIL
(219)	SCREEN ASSEMBLY, OIL PUMP PRESSURE
(372)	CHECKBALLS #1, #2, #3, #4, #7, #8, #9, #10
(373)	CHECKBALL #5, #6
(382)	SCREEN ASSEMBLY

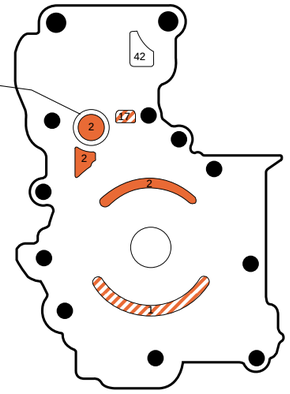
DRIVE RANGE – MANUAL THIRD



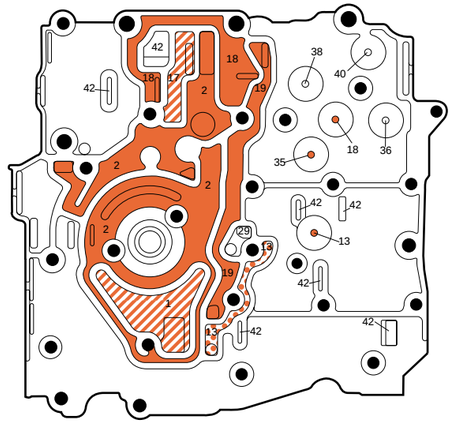
PUMP COVER (201)
(Oil Pump Body Side)



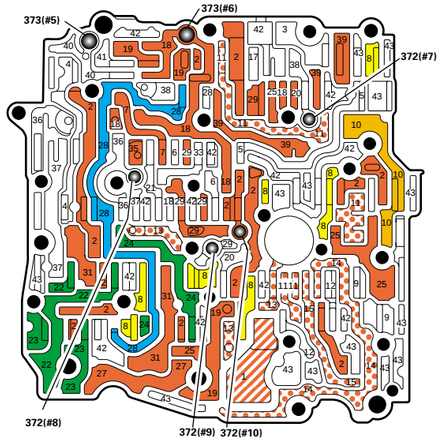
OIL PUMP BODY (202)
(Pump Cover Side)



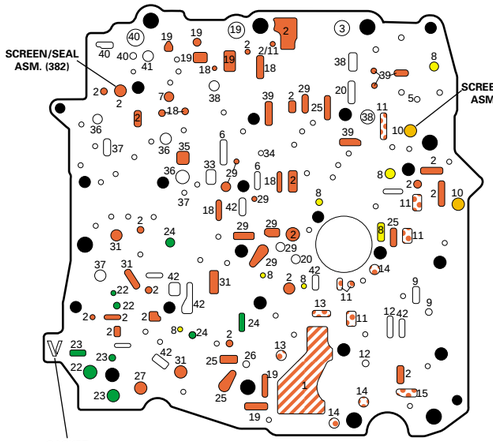
OIL PUMP BODY (202)
(Control Valve Body Side)



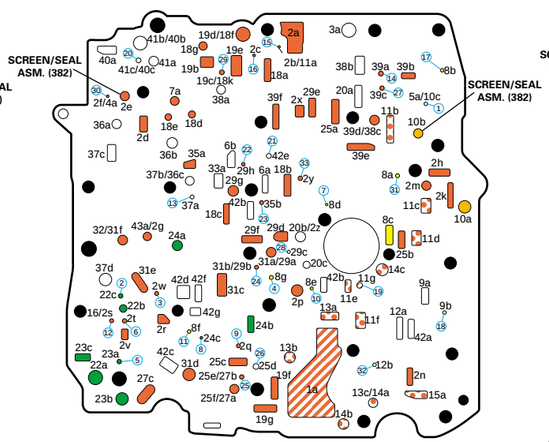
CONTROL VALVE BODY (300)
(Oil Pump Body Side)



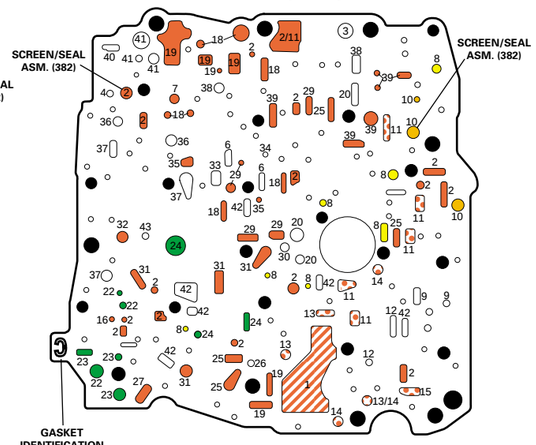
CONTROL VALVE BODY (300)
(Case Cover Side)



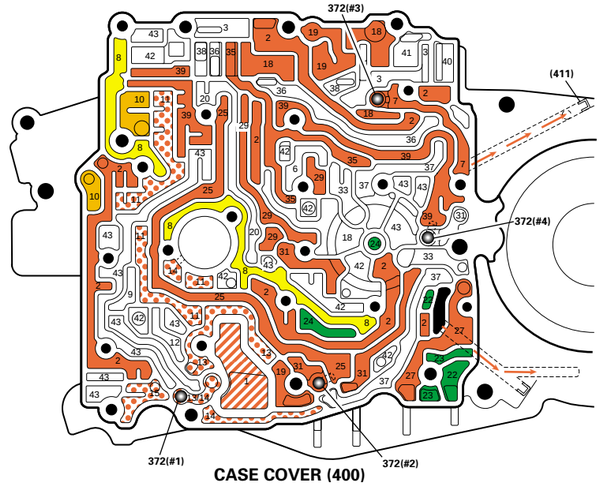
GASKET(371)
(Control Valve Body/Spacer Plate)



SPACER PLATE (370)



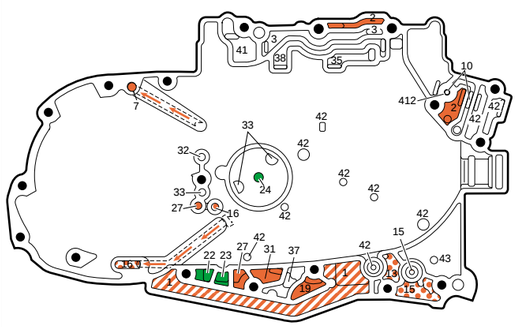
GASKET(369)
(Spacer Plate/Case Cover)



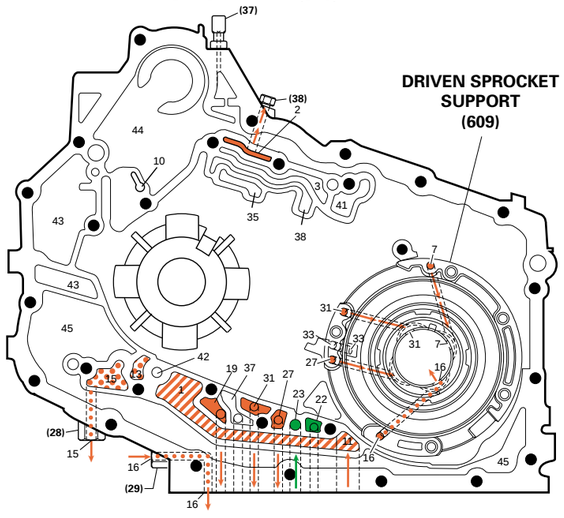
CASE COVER (400)
(Control Valve Body Side)

NOTE:

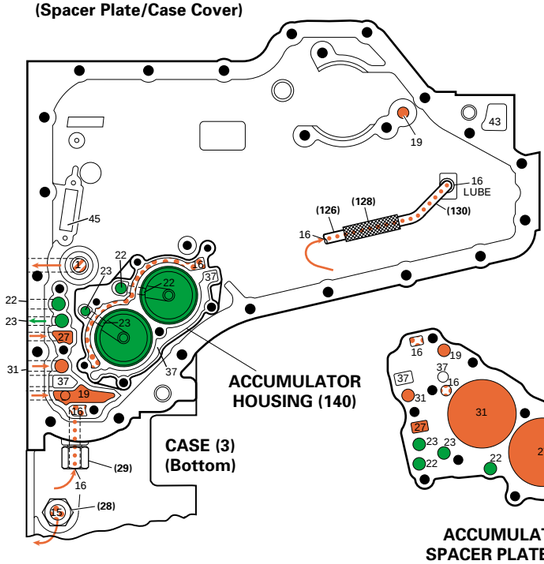
- ● INDICATES BOLT HOLES
- NON FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE NUMBERS LISTED FIRST
- EXHAUST FLUID NOT SHOWN



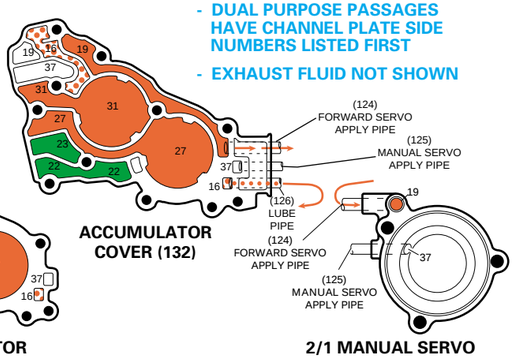
CASE COVER (400)
(Case Side)



CASE (3)
(Case Cover Face)



ACCUMULATOR SPACER PLATE (134)



ACCUMULATOR COVER (132)

2/1 MANUAL SERVO BODY COVER (104)

Figure 94

FOLDOUT ➤ 99

DRIVE RANGE – MANUAL SECOND

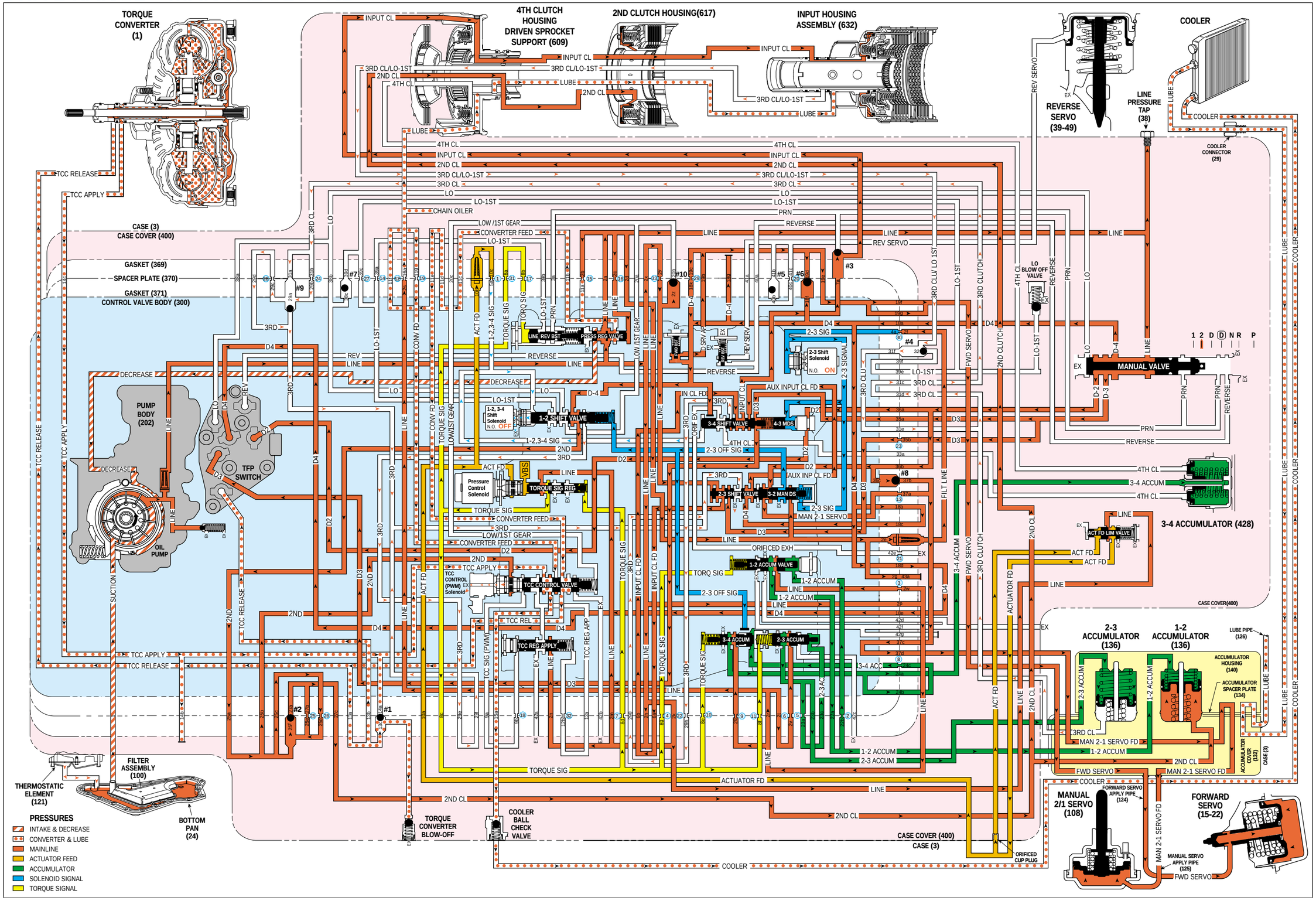


Figure 95

DRIVE RANGE - MANUAL SECOND

(From Drive Range - Manual Third)

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

- **Input Clutch**
  - No apply / slipping (See MANUAL THIRD page 98A)
- **2-1 Manual Band Servo**
  - No apply / slipping.
  - Servo Piston (108) – Broken, binding.
  - Servo Piston Seal (107) – Leaking.
  - Servo Pin (111) and Springs (109, 112) – Binding, broken.
  - Servo Cover (104) – Broken, loose, leaking.
  - Band (680) – Broken, worn, out of position.
  - Case (3) – 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.
- **TFP Valve Position Switch (395)**
  - Leaking, inoperative.
- **2-3 Shift Valve (357)**
  - Stuck in third gear position.
- **Manual Valve (404) / Shift Linkage**
  - Misaligned.

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
@OFF	@ON			APPLIED			*	OVERRUN		HOLDING	APPLIED

* APPLIED BUT NOT EFFECTIVE

DRIVE RANGE - MANUAL SECOND

(From Drive Range - Manual Third)

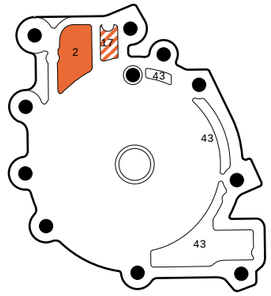
PASSAGES

1	SUCTION
2	LINE
3	PRN
4	2-3 SIGNAL
5	1-2, 3-4 SIGNAL
6	INPUT CLUTCH FEED
7	INPUT CLUTCH
8	TORQUE SIGNAL
9	TCC SIGNAL (PWM)
10	ACTUATOR FEED
11	CONVERTER FEED
12	TCC REGULATED APPLY
13	TCC RELEASE
14	TCC APPLY
15	COOLER
16	LUBE/LINE
17	DECREASE
18	D-4
19	FORWARD SERVO
20	LO/1ST GEAR
21	AUXILIARY INPUT CLUTCH FEED
22	1-2 ACCUMULATOR
23	2-3 ACCUMULATOR
24	3-4 ACCUMULATOR
25	2ND
26	2ND EXHAUST
27	2ND CLUTCH
28	2-3 OFF SIGNAL
29	3RD
30	3RD/EXHAUST
31	3RD CLUTCH
32	3RD CLUTCH/LO -1ST
33	4TH CLUTCH
34	4TH CLUTCH EXHAUST
35	D3
36	D2
37	MANUAL 2-1 SERVO
38	LO
39	LO-1ST
40	REVERSE
41	REVERSE SERVO
42	EXHAUST
43	CASTING VOID

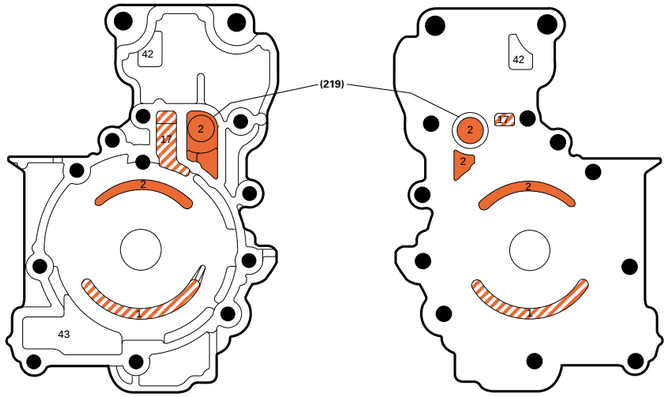
COMPONENTS ( )

(28)	COOLER LINE CHECKBALL ASSEMBLY
(29)	COOLER LINE CONNECTOR
(37)	VENT ASSEMBLY
(38)	PLUG, PIPE
(124)	PIPE, FORWARD SERVO APPLY
(125)	PIPE, MANUAL SERVO APPLY
(126)	PIPE, LUBE OIL
(219)	SCREEN ASSEMBLY, OIL PUMP PRESSURE
(372)	CHECKBALLS #1, #2, #3, #4, #7, #8, #9, #10
(373)	CHECKBALL #5, #6
(382)	SCREEN ASSEMBLY

DRIVE RANGE – MANUAL SECOND

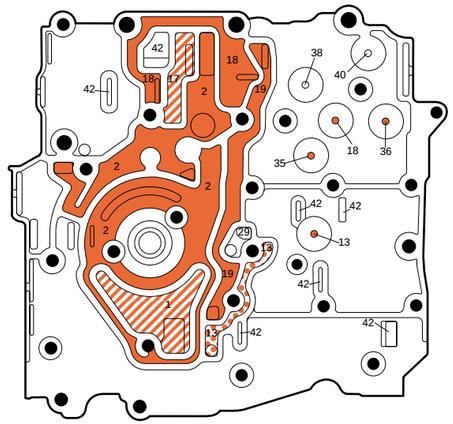


PUMP COVER (201)
(Oil Pump Body Side)

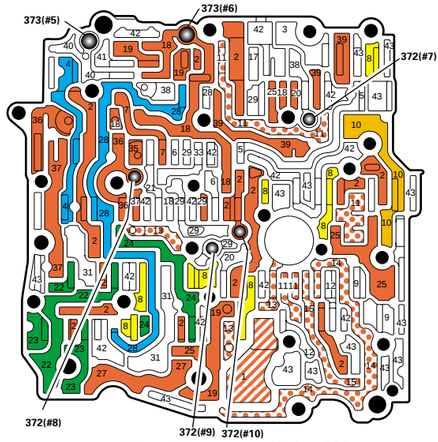


OIL PUMP BODY (202)
(Pump Cover Side)

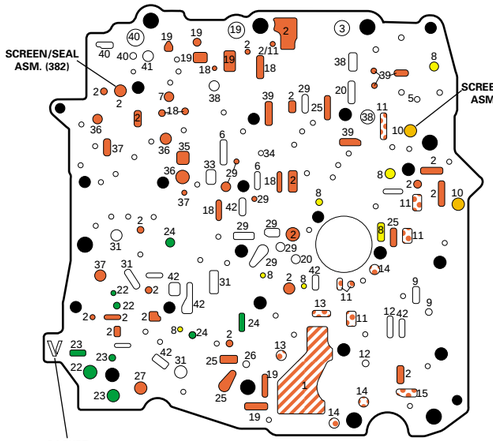
OIL PUMP BODY (202)
(Control Valve Body Side)



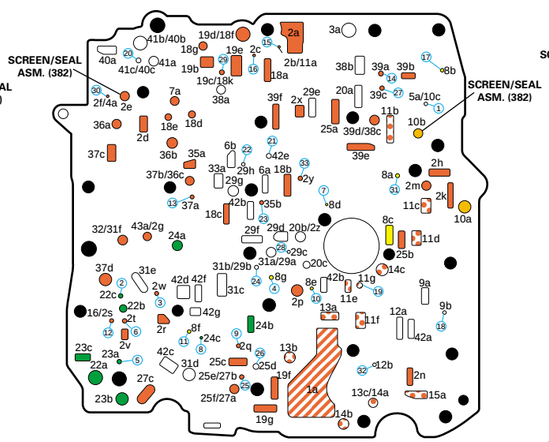
CONTROL VALVE BODY (300)
(Oil Pump Body Side)



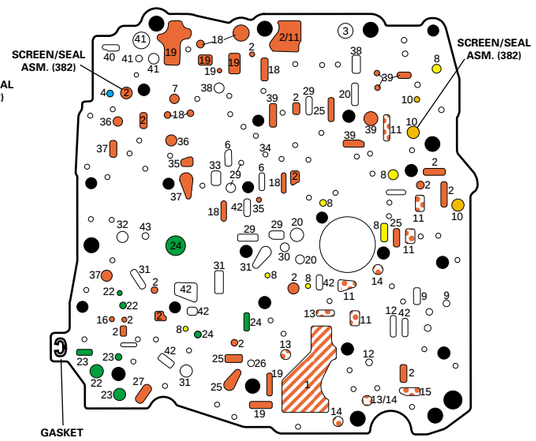
CONTROL VALVE BODY (300)
(Case Cover Side)



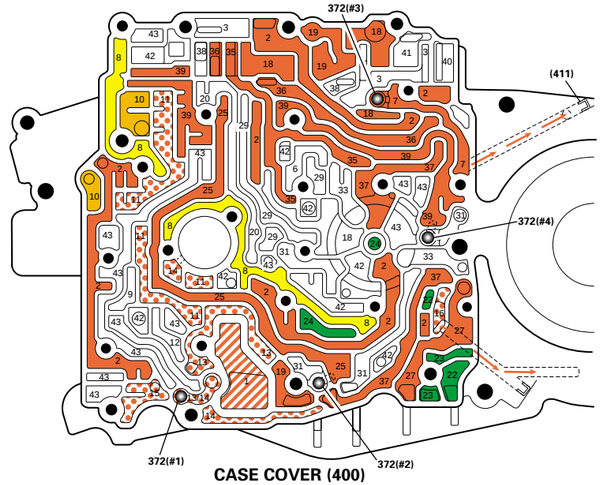
GASKET(371)
(Control Valve Body/Spacer Plate)



SPACER PLATE (370)



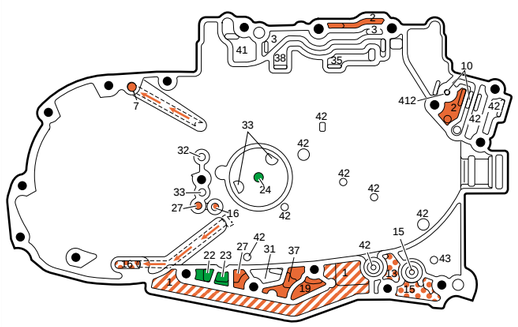
GASKET(369)
(Spacer Plate/Case Cover)



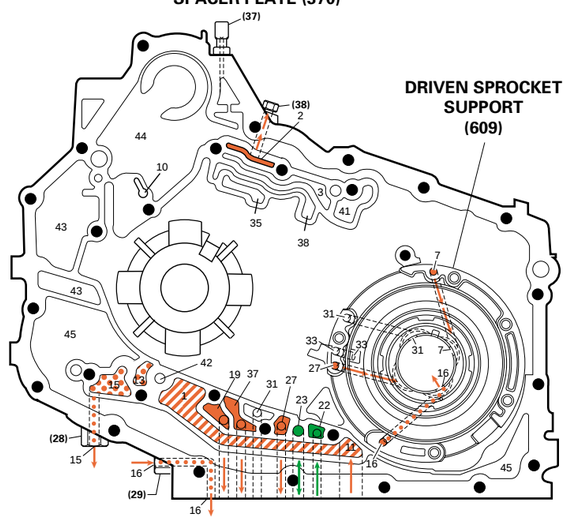
CASE COVER (400)
(Control Valve Body Side)

NOTE:

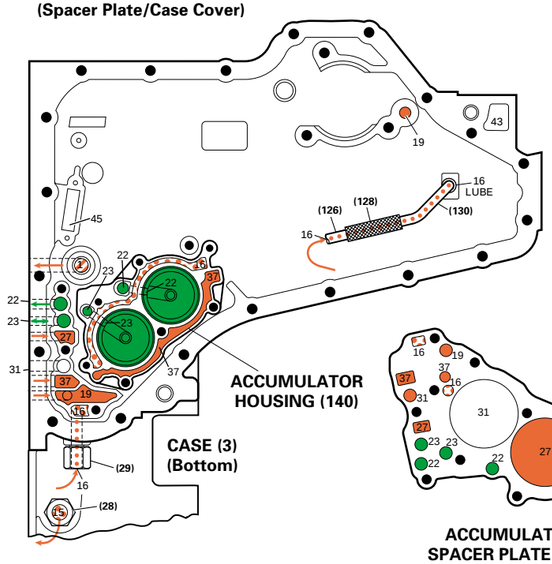
- ● INDICATES BOLT HOLES
- NON FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE NUMBERS LISTED FIRST
- EXHAUST FLUID NOT SHOWN



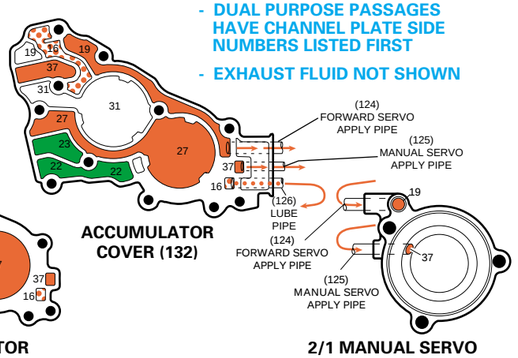
CASE COVER (400)
(Case Side)



CASE (3)
(Case Cover Face)



ACCUMULATOR SPACER PLATE (134)



ACCUMULATOR COVER (132)

2/1 MANUAL SERVO BODY COVER (104)

DRIVE RANGE – MANUAL FIRST

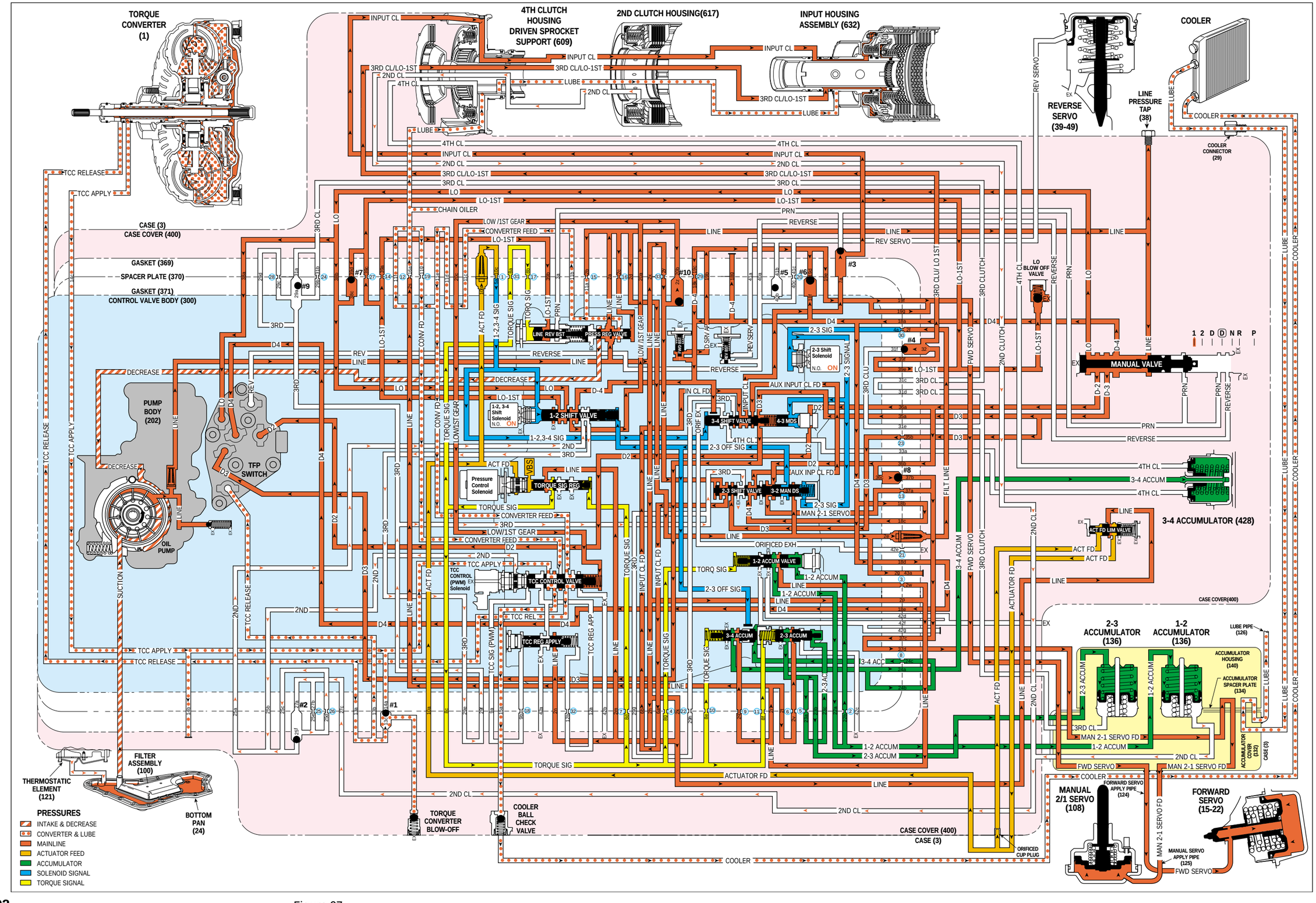


Figure 97

DRIVE RANGE - MANUAL FIRST

(From Drive Range - Manual Second)

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

- **Input Clutch**
  - No apply / slipping (See MANUAL THIRD page 98A)
- **Third Clutch**
  - No apply / slipping (See Overdrive Range Third Gear page 92A)
- **2-1 Manual Band Servo**
  - No apply / slipping.
  - Servo Piston (108) – Broken, binding.
  - Servo Piston Seal (107) – Leaking.
  - Servo Pin (111) and Springs (109, 112) – Binding, broken.
  - Servo Cover (104) – Broken, loose, leaking.
  - Band (680) – Broken, worn, out of position.
  - Case (3) – 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.
- **TFP Valve Position Switch (395)**
  - Leaking, inoperative.
- **2-3 Shift Valve (357)**
  - Stuck in third gear position.
- **Manual Valve (404) / Shift Linkage**
  - Misaligned.

1-2, 3-4 SHIFT SOL	2-3 SHIFT SOL	4TH CLUTCH	REVERSE BAND	2ND CLUTCH	3RD CLUTCH	3RD SPRAG CLUTCH	INPUT CLUTCH	INPUT SPRAG CLUTCH	2/1 BAND	1/2 SUPPORT ROLLER CLUTCH	FORWARD BAND
@ON	@ON				APPLIED	HOLDING	APPLIED	HOLDING	APPLIED	HOLDING	APPLIED

* APPLIED BUT NOT EFFECTIVE

DRIVE RANGE - MANUAL FIRST

(From Drive Range - Manual Second)

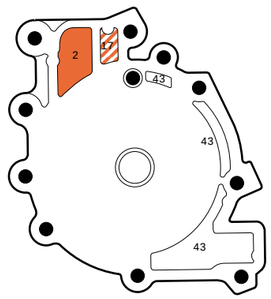
PASSAGES

1	SUCTION
2	LINE
3	PRN
4	2-3 SIGNAL
5	1-2, 3-4 SIGNAL
6	INPUT CLUTCH FEED
7	INPUT CLUTCH
8	TORQUE SIGNAL
9	TCC SIGNAL (PWM)
10	ACTUATOR FEED
11	CONVERTER FEED
12	TCC REGULATED APPLY
13	TCC RELEASE
14	TCC APPLY
15	COOLER
16	LUBE/LINE
17	DECREASE
18	D-4
19	FORWARD SERVO
20	LO/1ST GEAR
21	AUXILIARY INPUT CLUTCH FEED
22	1-2 ACCUMULATOR
23	2-3 ACCUMULATOR
24	3-4 ACCUMULATOR
25	2ND
26	2ND EXHAUST
27	2ND CLUTCH
28	2-3 OFF SIGNAL
29	3RD
30	3RD/EXHAUST
31	3RD CLUTCH
32	3RD CLUTCH/LO -1ST
33	4TH CLUTCH
34	4TH CLUTCH EXHAUST
35	D3
36	D2
37	MANUAL 2-1 SERVO
38	LO
39	LO-1ST
40	REVERSE
41	REVERSE SERVO
42	EXHAUST
43	CASTING VOID

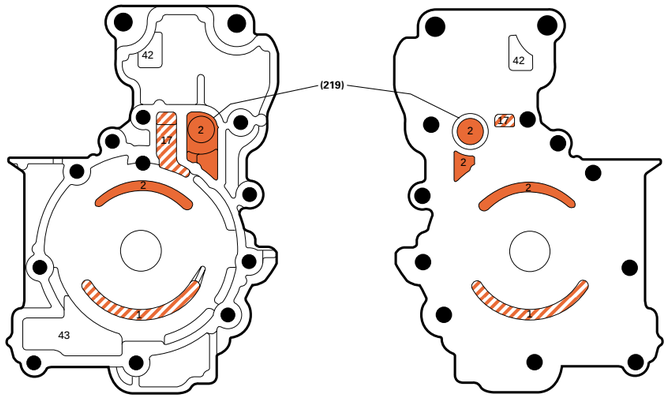
COMPONENTS ( )

(28)	COOLER LINE CHECKBALL ASSEMBLY
(29)	COOLER LINE CONNECTOR
(37)	VENT ASSEMBLY
(38)	PLUG, PIPE
(124)	PIPE, FORWARD SERVO APPLY
(125)	PIPE, MANUAL SERVO APPLY
(126)	PIPE, LUBE OIL
(219)	SCREEN ASSEMBLY, OIL PUMP PRESSURE
(372)	CHECKBALLS #1, #2, #3, #4, #7, #8, #9, #10
(373)	CHECKBALL #5, #6
(382)	SCREEN ASSEMBLY

DRIVE RANGE – MANUAL FIRST

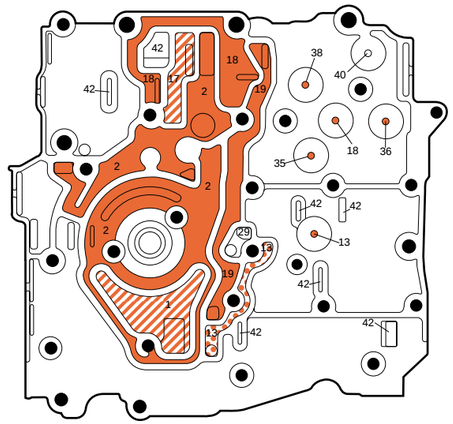


PUMP COVER (201)
(Oil Pump Body Side)

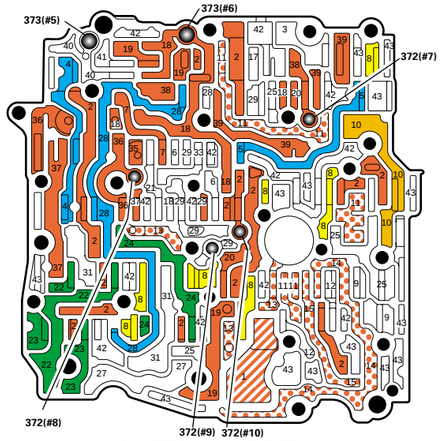


OIL PUMP BODY (202)
(Pump Cover Side)

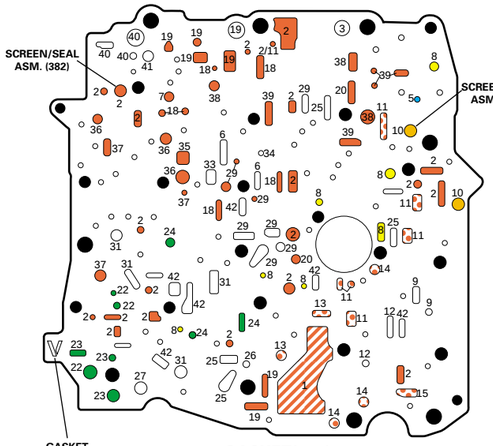
OIL PUMP BODY (202)
(Control Valve Body Side)



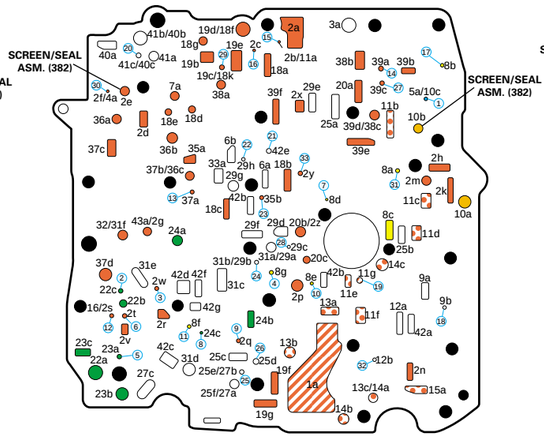
CONTROL VALVE BODY (300)
(Oil Pump Body Side)



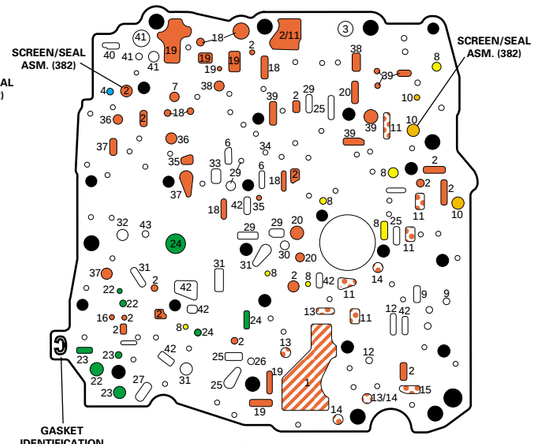
CONTROL VALVE BODY (300)
(Case Cover Side)



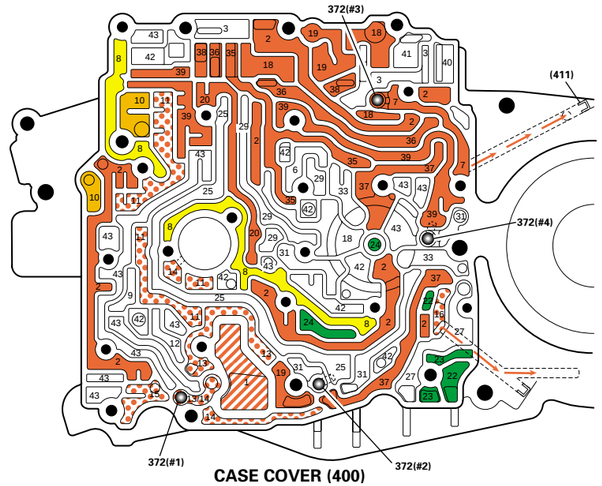
GASKET(371)
(Control Valve Body/Spacer Plate)



SPACER PLATE (370)



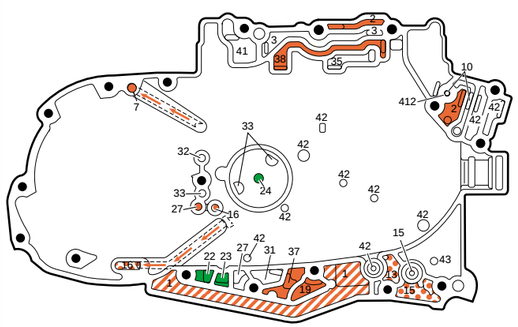
GASKET(369)
(Spacer Plate/Case Cover)



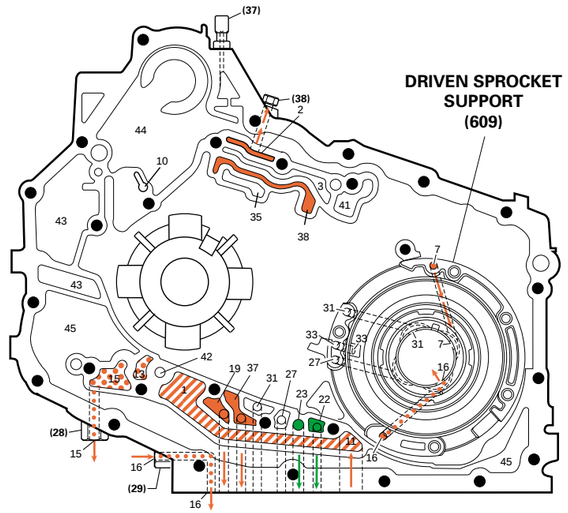
CASE COVER (400)
(Control Valve Body Side)

NOTE:

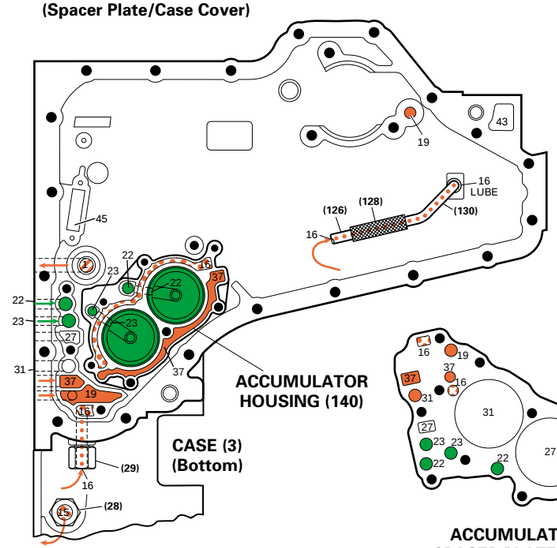
- ● INDICATES BOLT HOLES
- NON FUNCTIONAL HOLES HAVE BEEN REMOVED FROM COMPONENT DRAWINGS TO SIMPLIFY TRACING FLUID FLOW.
- DUAL PURPOSE PASSAGES HAVE CHANNEL PLATE SIDE NUMBERS LISTED FIRST
- EXHAUST FLUID NOT SHOWN



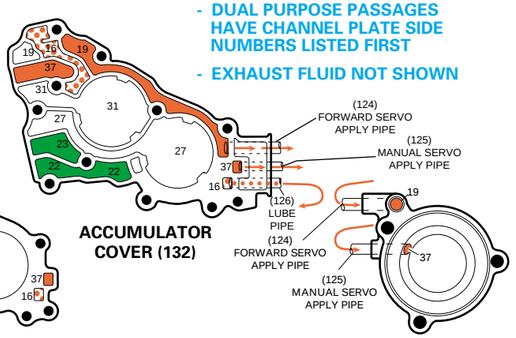
CASE COVER (400)
(Case Side)



CASE (3)
(Case Cover Face)



ACCUMULATOR SPACER PLATE (134)



ACCUMULATOR COVER (132)

2/1 MANUAL SERVO BODY COVER (104)

Figure 98

FOLDOUT ➤ 103

LUBRICATION POINTS

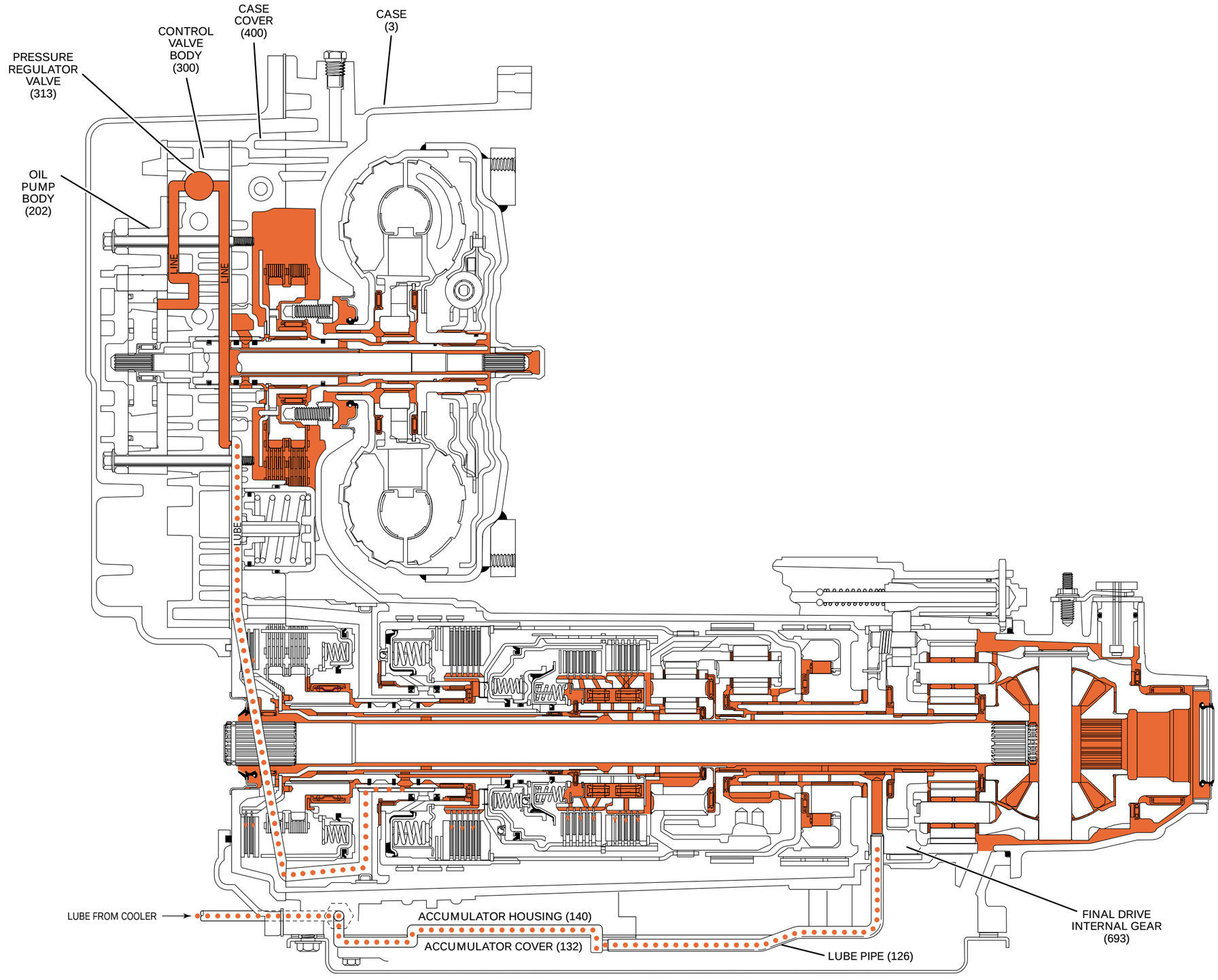
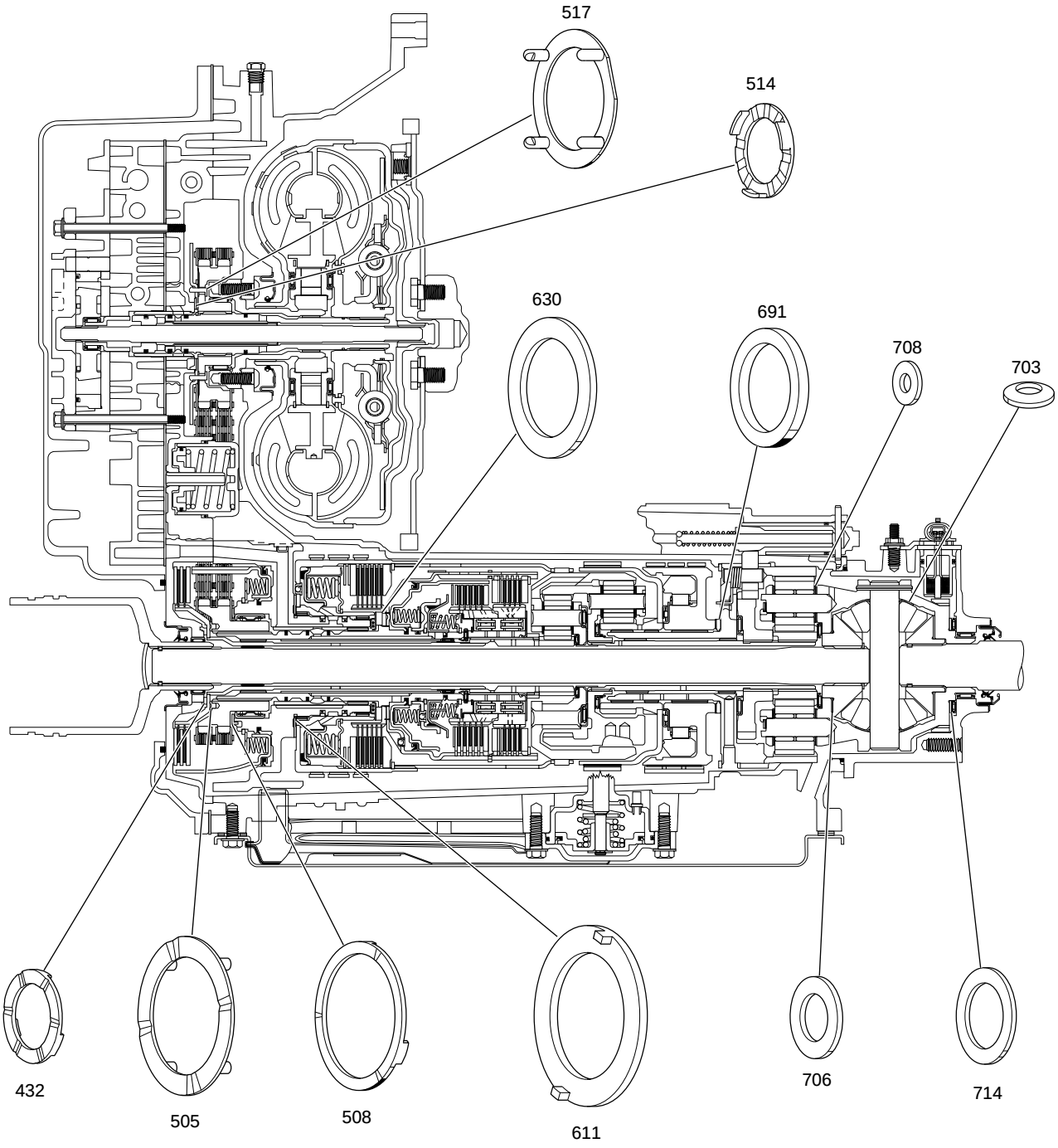


Figure 99

THRUST WASHER LOCATIONS

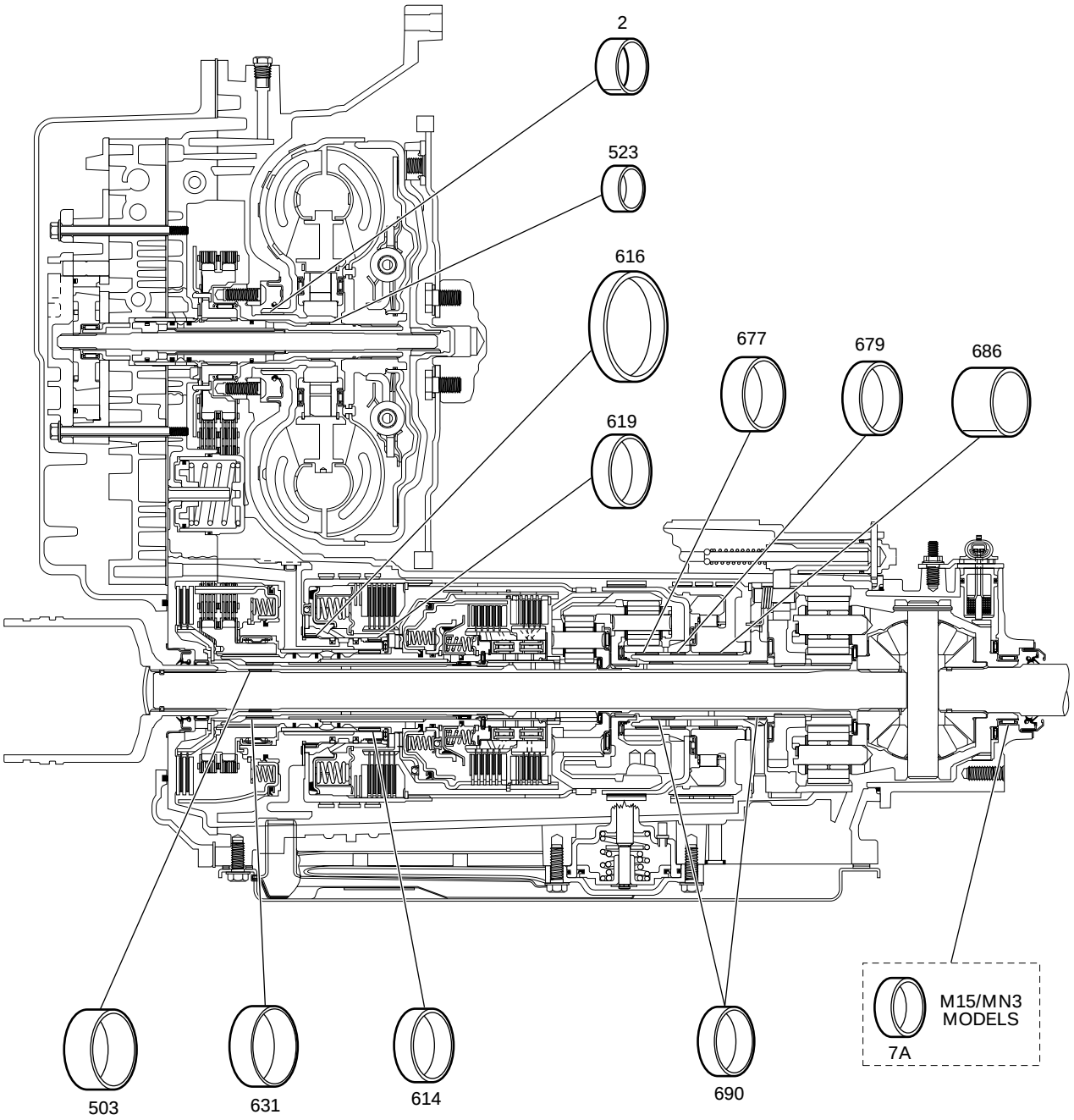


432	FOURTH CLUTCH SHAFT THRUST WASHER
505	FOURTH CLUTCH SHAFT THRUST WASHER
508	DRIVEN SPROCKET THRUST WASHER
514	DRIVE SPROCKET THRUST WASHER
517	DRIVE SPROCKET THRUST WASHER
611	SECOND CLUTCH HOUSING THRUST WASHER
630	INPUT CLUTCH HOUSING THRUST WASHER (SELECTIVE)
691	1/2 SUPPORT/INTERNAL GEAR THRUST WASHER
703	DIFFERENTIAL PINION THRUST WASHER
706	DIFFERENTIAL SIDE GEAR THRUST WASHER (BRONZE)
708	PLANETARY PINION GEAR THRUST WASHER (STEEL)
714	DIFFERENTIAL CARRIER/CASE THRUST WASHER

WH51129-4T65-E

Figure 100

BUSHING LOCATIONS



2 TORQUE CONVERTER BUSHING

7A FRONT DIFFERENTIAL CARRIER BUSHING

503 FOURTH CLUTCH SHAFT BEARING BUSHING

523 TURBINE SHAFT BUSHING

614 SECOND CLUTCH HOUSING BUSHING

616 SECOND CLUTCH HOUSING FRONT BUSHING

619 SECOND CLUTCH HOUSING REAR BUSHING

631 INPUT SHAFT BUSHING

677 REACTION SUN GEAR BUSHING (LEFT SIDE)

679 REACTION SUN GEAR BUSHING (RIGHT SIDE)

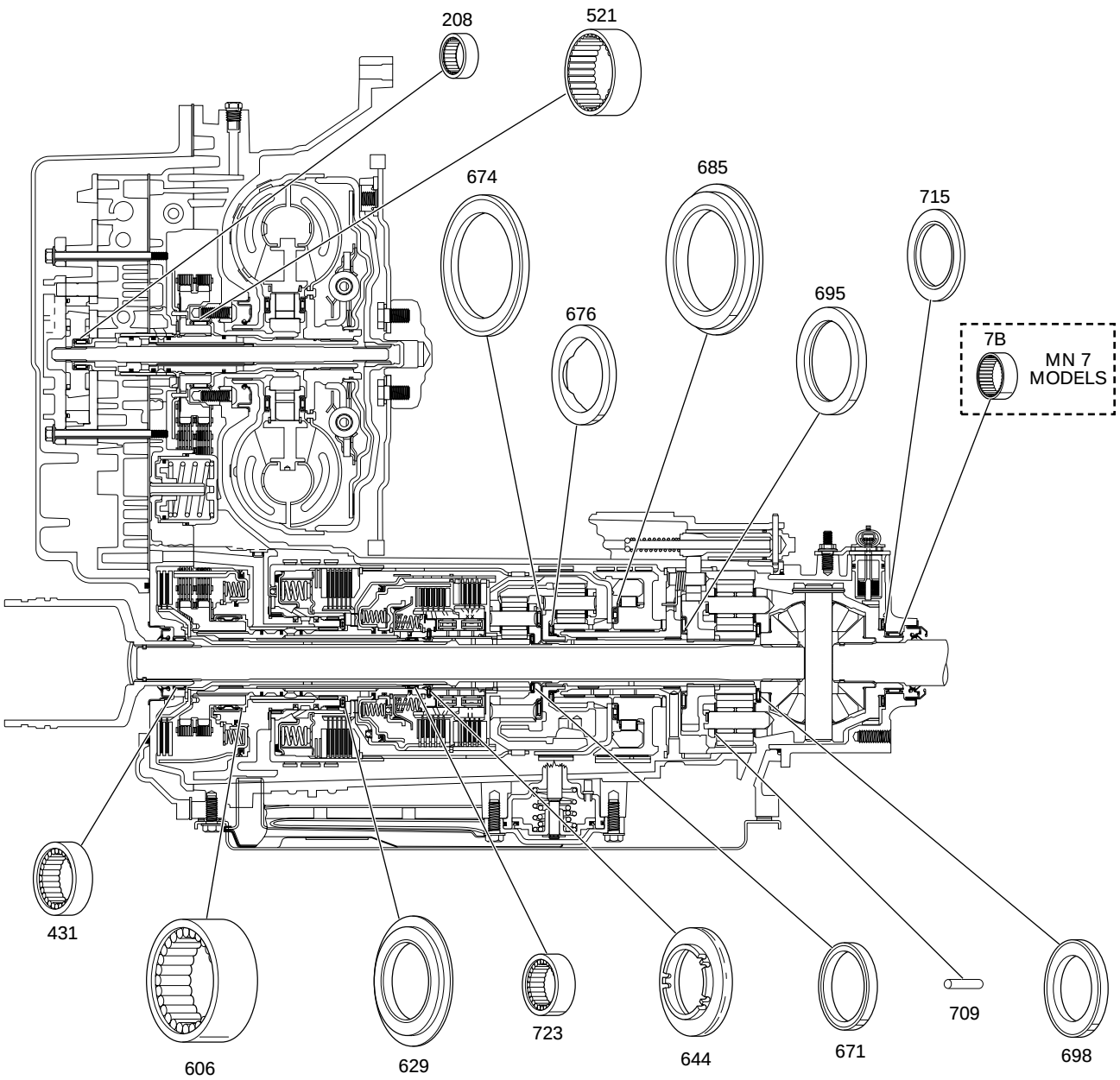
686 FORWARD DRUM BUSHING

690 FRONT DIFFERENTIAL CARRIER INTERNAL GEAR BUSHING

WH51133-4T65-E

Figure 101

BEARING LOCATIONS



7B OUTPUT SHAFT BEARING ASSEMBLY

208 OIL PUMP DRIVE SHAFT BEARING

431 FRONT WHEEL DRIVE SHAFT BEARING

521 DRIVE SPROCKET BEARING ASSEMBLY

606 DRIVEN SPROCKET BEARING ASSEMBLY

629 INPUT CLUTCH HOUSING THRUST BEARING ASSEMBLY

644 INPUT SHAFT THRUST BEARING ASSEMBLY

671 INPUT SUN GEAR THRUST BEARING ASSEMBLY

674 REACTION CARRIER THRUST BEARING ASSEMBLY

676 REACTION SUN GEAR THRUST BEARING ASSEMBLY

685 1–2 DRUM SUPPORT THRUST BEARING

695 FRONT DIFFERENTIAL CARRIER INTERNAL GEAR THRUST BEARING

698 FRONT DIFFERENTIAL CARRIER SUN GEAR THRUST BEARING

709 FRONT DIFFERENTIAL CARRIER PLANETARY PINION BEARING

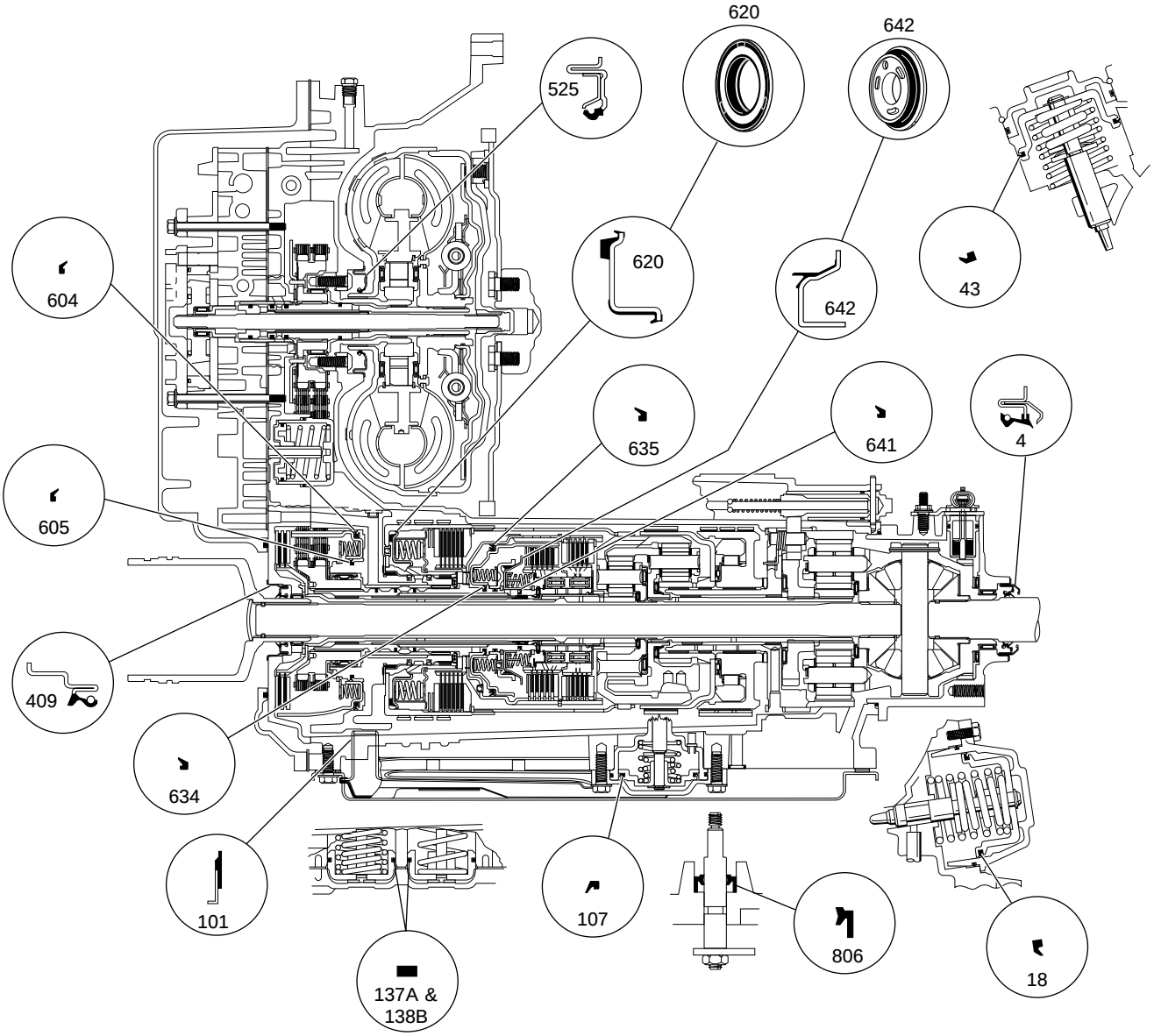
715 FRONT DIFFERENTIAL CARRIER THRUST BEARING

723 INPUT CLUTCH HOUSING THRUST BEARING

WH51142-4T65-E

Figure 102

LIP SEAL LOCATIONS



4 FRONT WHEEL DRIVE SHAFT OIL SEAL ASSEMBLY (RIGHT SIDE)

18 FORWARD BAND SERVO PISTON OIL SEAL RING

43 REVERSE BAND SERVO PISTON OIL SEAL RING

101 AUTOMATIC TRANSAXLE OIL FILTER SEAL

107 MANUAL 2–1 BAND SERVO PISTON SEAL

137A 1–2 ACCUMULATOR PISTON OIL SEAL RING

137B 2–3 ACCUMULATOR PISTON OIL SEAL RING

409 FRONT WHEEL DRIVE SHAFT OIL SEAL ASSEMBLY (LEFT SIDE)

525 TORQUE CONVERTER OIL SEAL ASSEMBLY

604 FOURTH CLUTCH PISTON SEAL (OUTER)

605 FOURTH CLUTCH PISTON SEAL (INNER)

620 SECOND CLUTCH PISTON AND SEAL ASSEMBLY

634 INPUT CLUTCH PISTON SEAL (INNER)

635 INPUT CLUTCH PISTON SEAL (OUTER)

641 THIRD CLUTCH PISTON SEAL (INNER)

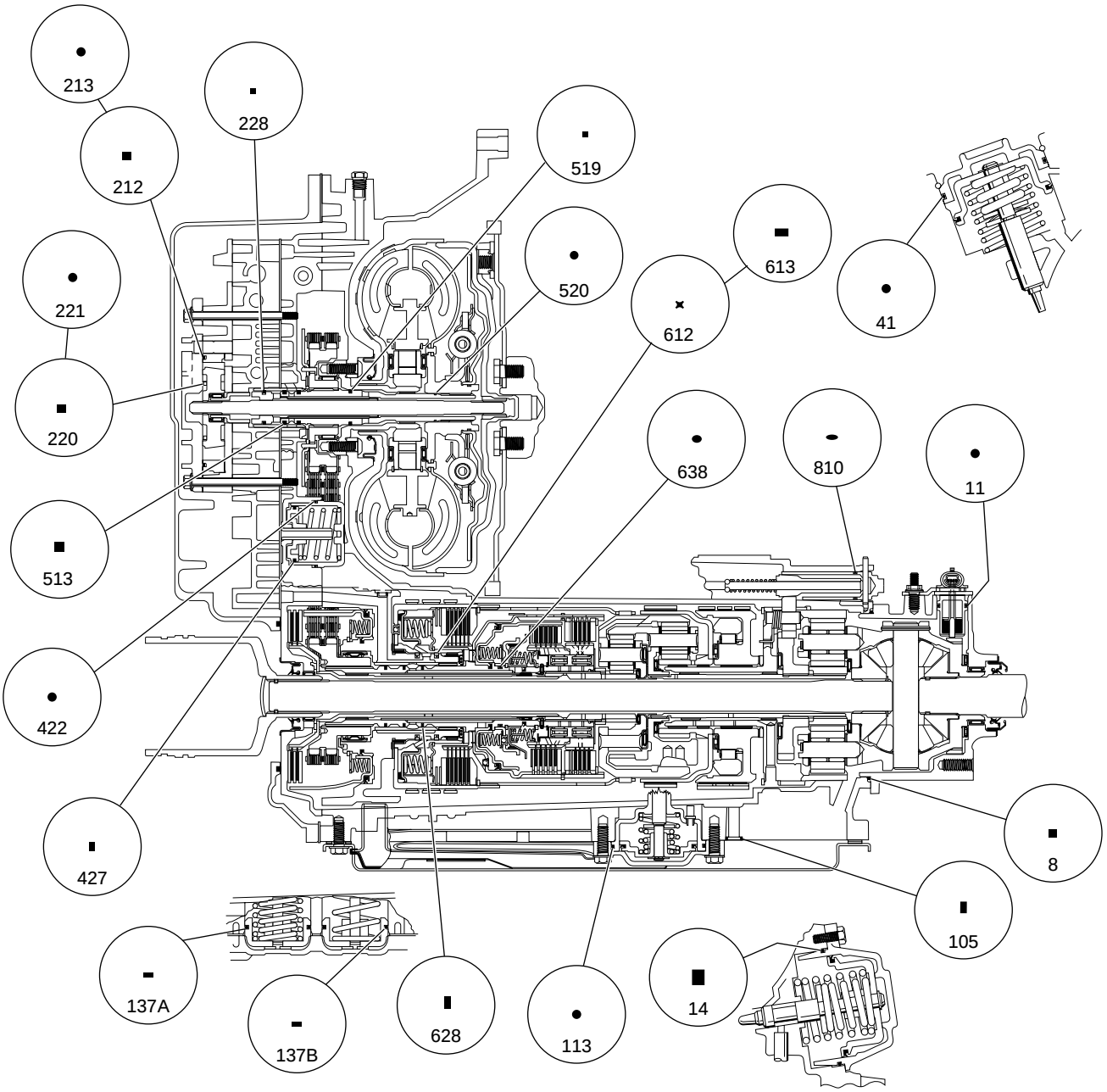
642 THIRD CLUTCH PISTON AND SEAL ASSEMBLY

806 MANUAL SHIFT SHAFT SEAL

WH51144-4T65-E

Figure 103

SQUARE AND O-RING SEAL LOCATIONS



8 AUTOMATIC TRANSAXLE CASE EXTENSION SEAL

11 VEHICLE SPEED SENSOR (O-RING) SEAL

14 FORWARD BAND SERVO COVER SEAL

41 REVERSE BAND SERVO COVER (O-RING) SEAL

105 MANUAL 2–1 BAND SERVO COVER GASKET

113 MANUAL 2–1 BAND SERVO PISTON CYLINDER (O-RING) SEAL

137A 1–2 ACCUMULATOR PISTON OIL SEAL RING

137B 2–3 ACCUMULATOR PISTON OIL SEAL RING

212 AUTOMATIC TRANSAXLE OIL PUMP SLIDE OIL SEAL RING

213 AUTOMATIC TRANSAXLE OIL PUMP SLIDE (O-RING) SEAL

220 AUTOMATIC TRANSAXLE OIL PUMP SLIDE SEAL

221 AUTOMATIC TRANSAXLE OIL PUMP SLIDE SEAL SUPPORT

228 AUTOMATIC TRANSAXLE OIL PUMP DRIVE SHAFT

422 3–4 ACCUMULATOR PISTON CYLINDER (O-RING) SEAL

427 3–4 ACCUMULATOR PISTON OIL SEAL

513 TURBINE SHAFT OIL SEAL RING

519 TURBINE SHAFT OIL SEAL RING

520 TURBINE SHAFT (O-RING) SEAL

612 SECOND CLUTCH HOUSING OIL SEAL RING (FOUR LOBE) SEAL

613 SECOND CLUTCH HOUSING OIL SEAL RING

628 INPUT CLUTCH HOUSING OIL SEAL RING

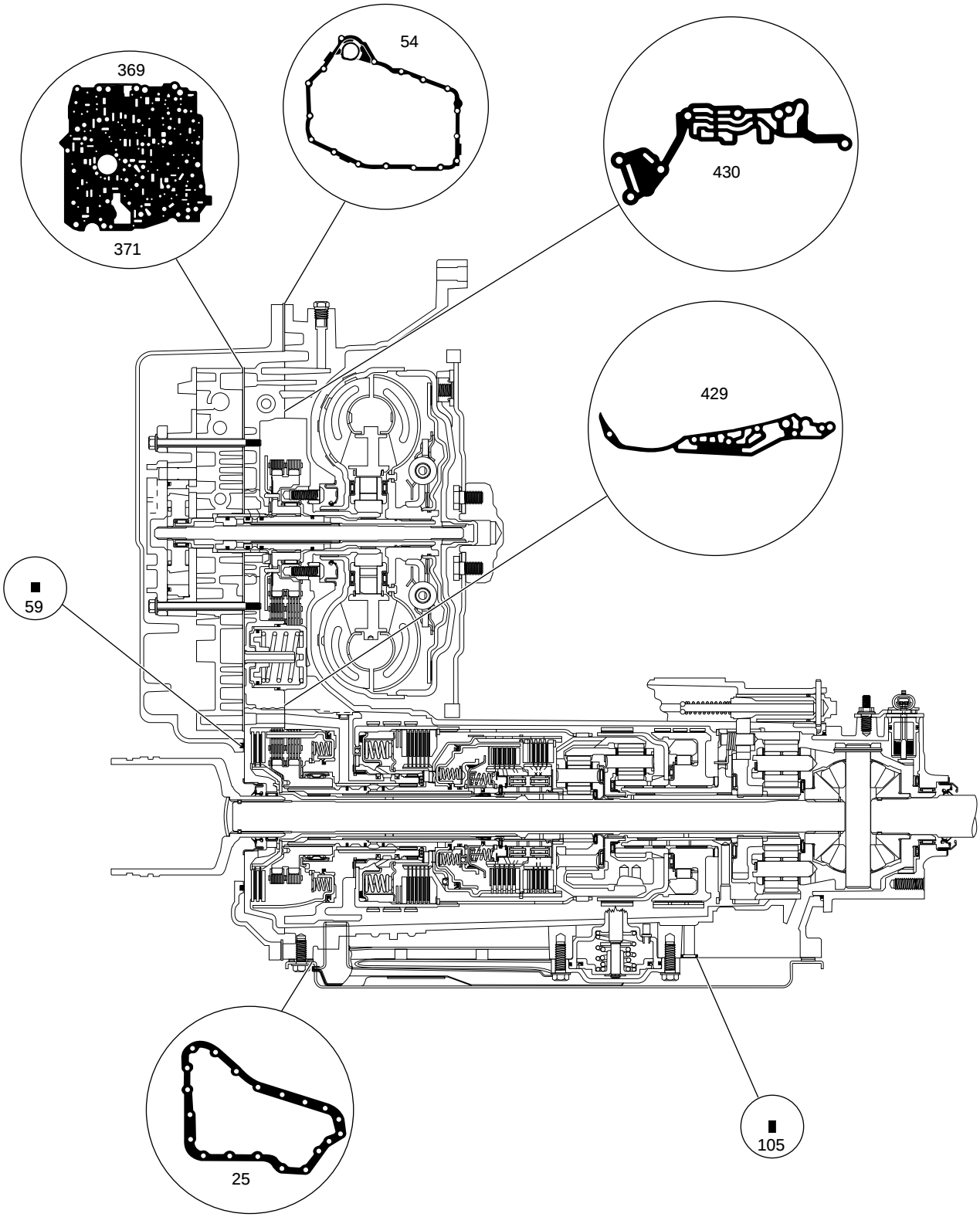
638 THIRD CLUTCH HOUSING (O-RING) SEAL

810 PARK PAWL ACTUATOR GUIDE (O-RING) SEAL

WH51146-4T65-E

Figure 104

GASKET LOCATIONS



25 GASKET, AUTOMATIC TRANSAXLE OIL PAN

54 GASKET, CONTROL VALVE BODY COVER

59 GASKET, CONTROL VALVE BODY COVER INNER

105 GASKET, MANUAL 2-1 BAND SERVO COVER

369 GASKET, CONTROL VALVE BODY SPACER PLATE

371 GASKET, CONTROL VALVE BODY SPACER PLATE

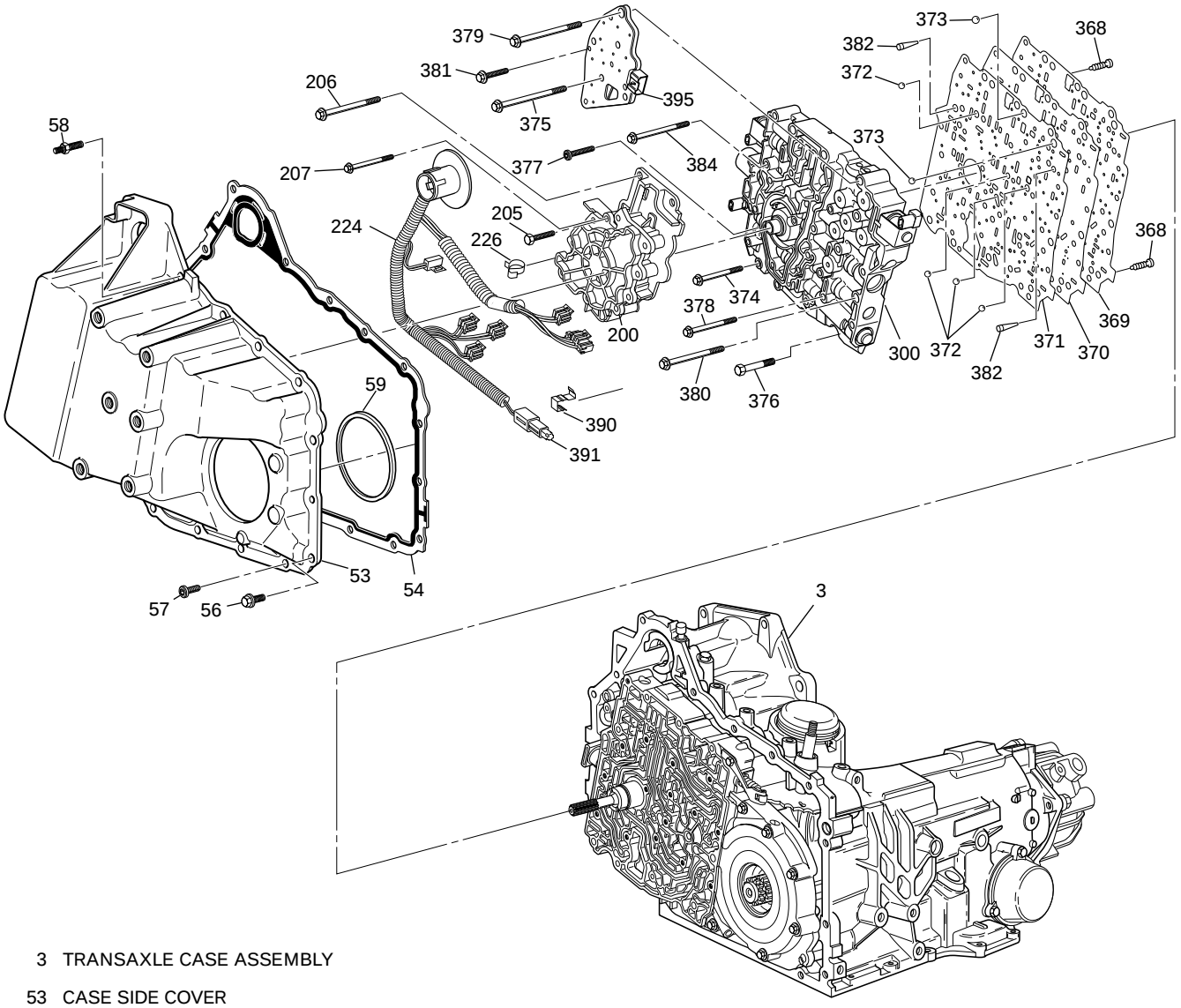
429 GASKET, AUTOMATIC TRANSAXLE CASE COVER LOWER

430 GASKET, AUTOMATIC TRANSAXLE CASE COVER UPPER

WH51146-4T65-E

Figure 105

CASE AND ASSOCIATED PARTS (1 of 4)



3 TRANSAXLE CASE ASSEMBLY

53 CASE SIDE COVER

54 CASE SIDE COVER GASKET

56 CASE SIDE COVER BOLT M8 X 1.25 X 25 (11)

57 SIDE COVER TORX® HEAD BOLT M8 X 1.25 X 21 (4)

58 SIDE COVER TO CASE STUD M8 X 1.25 X 24 (2)

59 SIDE COVER TO CHANNEL PLATE SEAL

200 OIL PUMP ASSEMBLY

205 PUMP COVER TO PUMP BODY BOLT M6 X 1.0 X 20.0 (1)

206 PUMP BODY TO CASE BOLT M6 X 1.0 X 95.0 (2)

207 PUMP COVER TO CHANNEL PLATE BOLT M6 X 1.0 X 85.0 (9)

224 WIRING HARNESS ASSEMBLY

226 WIRING HARNESS CLIP

300 CONTROL VALVE BODY ASSEMBLY

368 SPACER PLATE AND GASKETS/VALVE BODY BOLT

369 CASE COVER/SPACER PLATE GASKET

370 VALVE BODY SPACER PLATE ASSEMBLY

371 VALVE BODY TO SPACER PLATE GASKET

372 BALL CHECK VALVE

373 BALL CHECK VALVE

374 CONTROL VALVE BODY BOLT M6 X 1.0 X 65.0 (3)

375 VALVE BODY TO CASE BOLT M6 X 1.0 X 60.0 (3)

376 VALVE BODY TO CASE BOLT M6 X 1.0 X 30.0 (1)

377 VALVE BODY TO CHANNEL PLATE BOLT M6 X 1.0 X 45.0 (2)

378 VALVE BODY TO CHANNEL PLATE BOLT M6 X 1.0 X 55.0 (3)

379 VALVE BODY TO CASE BOLT M6 X 1.0 X 95.0 (1)

380 VALVE BODY TO CASE BOLT M8 X 1.25 X 90.0 (1)

381 VALVE BODY TO CASE BOLT M6 X 1.0 X 20.0 (1)

382 TCC SOLENOID VALVE SCREEN/SEAL ASSEMBLY

384 VALVE BODY TO CASE BOLT M6 X 1.0 X 85.0 (1)

390 TEMPERATURE SENSOR CLIP

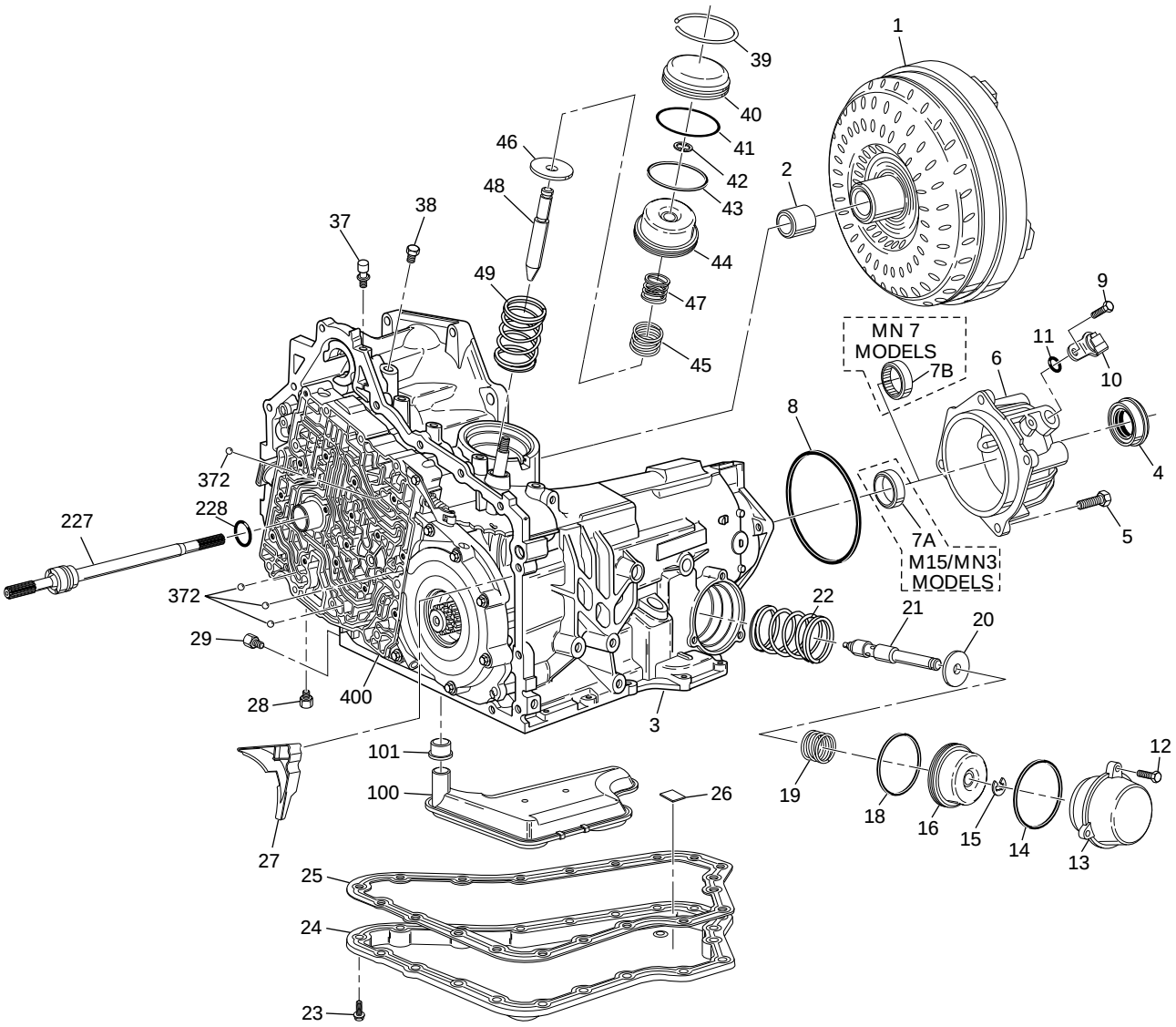
391 FLUID TEMPERATURE SENSOR

395 FLUID PRESSURE MANUAL VALVE POSITION SWITCH ASSEMBLY

WH49319-4T65-E

Figure 106

CASE AND ASSOCIATED PARTS (2 of 4)

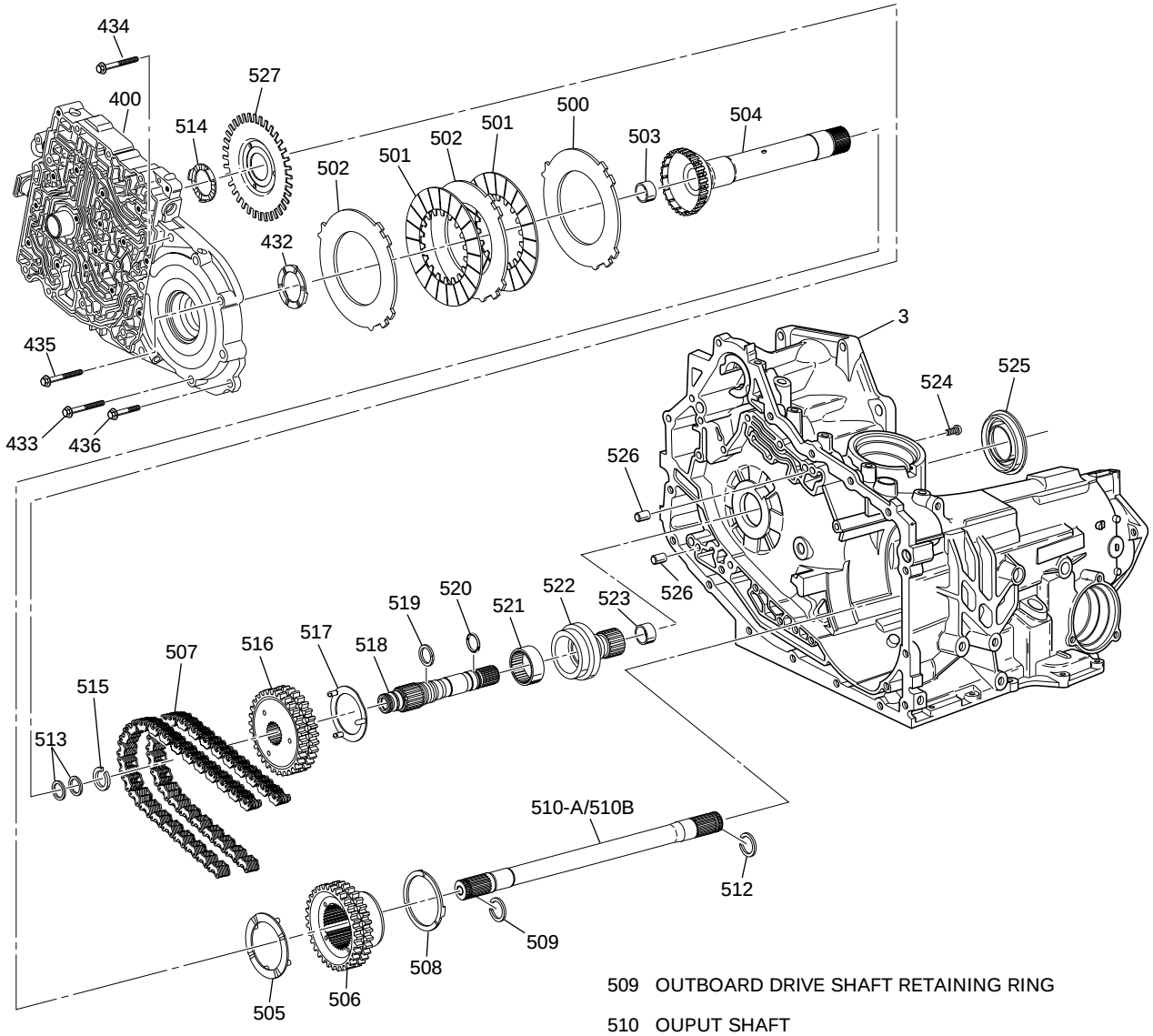


1 TORQUE CONVERTER ASSEMBLY
2 TORQUE CONVERTER BUSHING
3 TRANSAXLE CASE
4 RIGHT AXLE OIL SEAL ASSEMBLY
5 CASE EXTENSION BOLT M10 X 1.5 X 35.0
6 CASE EXTENSION ASSEMBLY
7A FRONT DIFFERENTIAL CARRIER BUSHING
7B OUTPUT SHAFT BEARING ASSEMBLY
8 CASE EXTENSION SEAL
9 VEHICLE SPEED SENSOR BOLT M8 X 1.25 X 12.0
10 VEHICLE SPEED SENSOR ASSEMBLY
11 VEHICLE SPEED SENSOR O-RING SEAL
12 FWD SERVO COVER BOLT M6 X 1.0 X 20.0
13 FORWARD BAND SERVO COVER
14 FORWARD BAND SERVO COVER SEAL
15 FORWARD BAND SERVO PIN RETAINING RING
16 FORWARD BAND SERVO PISTON
18 FORWARD BAND SERVO PISTON OIL SEAL RING
19 FORWARD BAND SERVO PISTON CUSHION SPRING
20 FORWARD SERVO CUSHION SPRING RETAINER
21 FORWARD BAND SERVO PISTON APPLY PIN
22 FORWARD BAND SERVO PISTON RETURN SPRING
23 TRANSMISSION OIL PAN BOLT M8 X 1.25 X 18.0
24 TRANSMISSION OIL PAN
25 TRANSMISSION OIL PAN GASKET
26 TRANSMISSION OIL PAN MAGNET
27 OIL DAM
28 COOLER PIPE FITTING 1/4 18 NPSF
29 COOLER PIPE FITTING 1/4 - 18 NPSF
37 TRANSMISSION VENT ASSEMBLY
38 OIL PRESSURE TEST HOLE PLUG 1/8 27 NPTF
39 REVERSE BAND SERVO COVER RETAINING RING
40 REVERSE BAND SERVO COVER
41 REVERSE BAND SERVO COVER O-RING SEAL
42 REVERSE BAND SERVO PIN RETAINING RING
43 REVERSE BAND SERVO PISTON OIL SEAL RING
44 REVERSE BAND SERVO PISTON
45 REVERSE BAND SERVO PISTON CUSHION SPRING
46 REVERSE BAND SERVO PISTON CUSHION SPRING RETAINER
47 REVERSE BAND SERVO PISTON CUSHION SPRING (INNER)
48 REVERSE BAND SERVO PISTON APPLY PIN
49 REVERSE BAND SERVO PISTON RETURN SPRING
100 TRANSMISSION OIL FILTER ASSEMBLY
101 TRANSMISSION OIL FILTER SEAL ASSEMBLY
227 OIL PUMP DRIVE SHAFT ASSEMBLY
228 OIL PUMP DRIVE SHAFT SEAL
372 CASE COVER BALL CHECK VALVE
400 CASE COVER ASSEMBLY

WH49402-4T65-E

Figure 107

CASE AND ASSOCIATED PARTS (3 of 4)



3 TRANSAXLE CASE ASSEMBLY

400 COMPLETE CASE COVER ASSEMBLY

432 4TH CLUTCH SHAFT THRUST WASHER

433 CASE COVER BOLT/SCREW (TORX® SPECIAL) M6 X 1.0 X 32.0

434 CASE COVER BOLT/SCREW M6 X 1.0 X 40.0

435 CASE COVER BOLT/SCREW M8 X 1.25 X 50.0

436 CASE COVER BOLT/SCREW M6 X 1.0 X 30.0

500 4TH CLUTCH BACKING PLATE

501 4TH CLUTCH FIBER PLATE ASSEMBLY

502 4TH CLUTCH STEEL PLATE

503 4TH CLUTCH SHAFT BEARING BUSHING

504 4TH CLUTCH SHAFT ASSEMBLY

505 4TH CLUTCH SHAFT THRUST WASHER

506 DRIVEN SPROCKET

507 DRIVE LINK ASSEMBLY

508 DRIVEN SPROCKET THRUST WASHER

509 OUTBOARD DRIVE SHAFT RETAINING RING

510 OUPUT SHAFT

512 INBOARD DRIVE SHAFT RETAINING RING

513 TURBINE SHAFT OIL SEAL RING

514 DRIVE SPROCKET THRUST WASHER

515 DRIVE SPROCKET RETAINING RING

516 DRIVE SPROCKET

517 DRIVE SPROCKET THRUST WASHER

518 TURBINE SHAFT

519 TURBINE SHAFT OIL SEAL RING

520 TURBINE SHAFT O-RING SEAL

521 DRIVE SPROCKET BEARING ASSEMBLY

522 DRIVE SPROCKET SUPPORT

523 DRIVE SPROCKET SUPPORT BUSHING

524 DRIVE SPROCKET SUPPORT BOLT/SCREW M8 X 1.25 X 24.0

525 TORQUE CONVERTER OIL SEAL ASSEMBLY

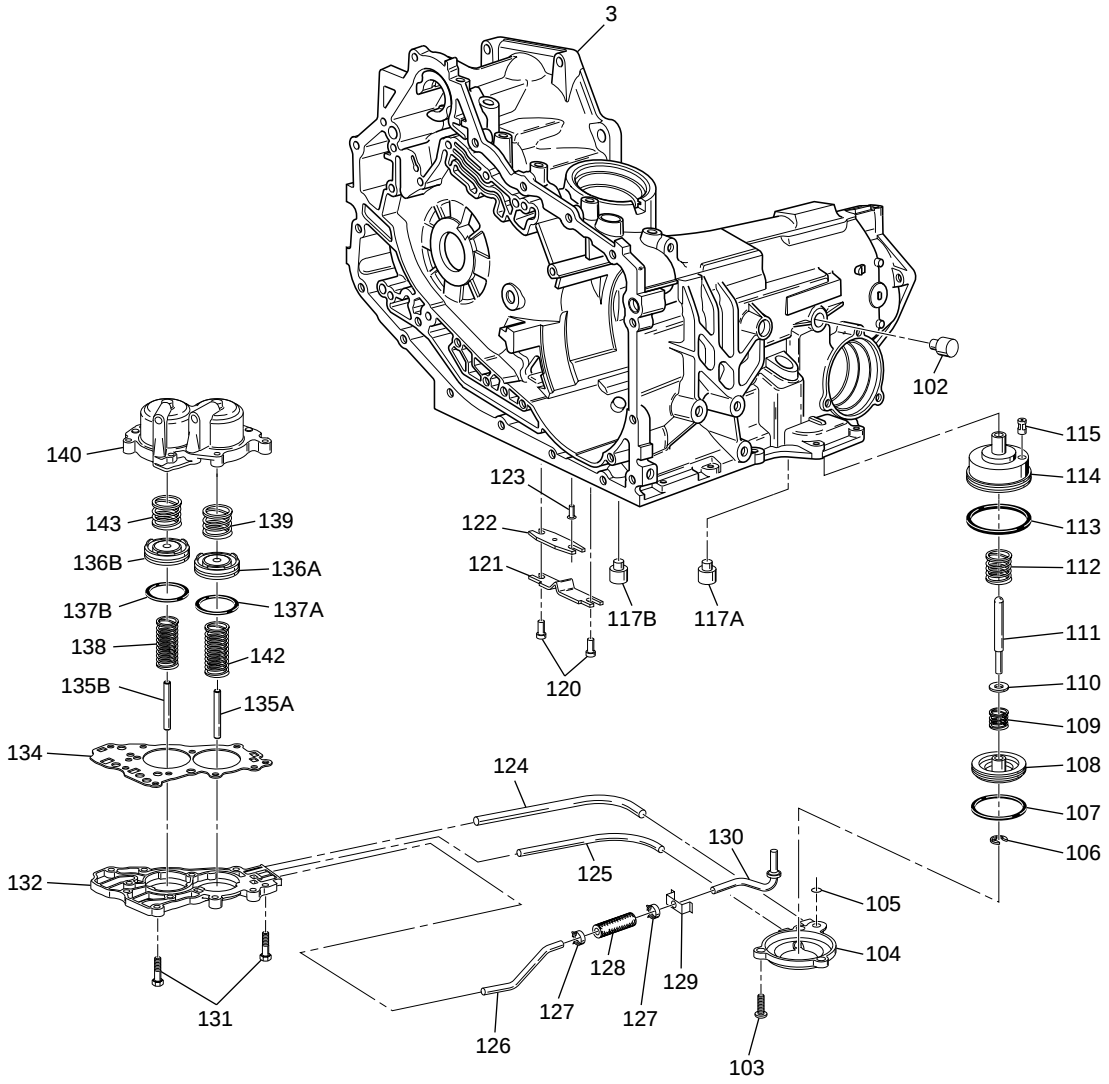
526 CASE COVER PIN

527 VEHICLE SPEED SENSOR RELUCTOR WHEEL ASSEMBLY

WH49404-4T65-E

Figure 108

CASE AND ASSOCIATED PARTS (4 of 4)



3 TRANSAXLE CASE ASSEMBLY

102 PIN, BAND ANCHOR (2-1 MANUAL)

103 2–1 MANUAL BAND SERVO COVER BOLT/SCREW M8 X 1.25 X 25.0 (3)

104 2–1 MANUAL BAND SERVO COVER

105 2–1 MANUAL BAND SERVO COVER GASKET

106 2–1 MANUAL BAND SERVO PISTON PIN RETAINING RING

107 2–1 MANUAL BAND SERVO PISTON SEAL

108 2–1 MANUAL BAND SERVO PISTON

109 2–1 MANUAL BAND SERVO PISTON CUSHION SPRING

110 2–1 MANUAL BAND SERVO PISTON SPRING RETAINER

111 2–1 MANUAL BAND SERVO PISTON PIN

112 2–1 MANUAL BAND SERVO PISTON SPRING

113 2–1 MANUAL BAND SERVO PISTON CYLINDER O-RING SEAL

114 2–1 MANUAL BAND SERVO PISTON CYLINDER

115 2–1 MANUAL BAND SERVO EXHAUST SCREEN ASSEMBLY

117A FORWARD BAND ANCHOR PIN

117B REVERSE BAND ANCHOR PIN

120 THERMO ELEMENT PLATE PIN

121 THERMO ELEMENT

122 THERMO ELEMENT PLATE

123 THERMO ELEMENT PLATE CENTER PIN

124 FORWARD BAND SERVO OIL PIPE

125 2–1 MANUAL BAND SERVO OIL PIPE

126 LUBE OIL PIPE

127 LUBE OIL HOSE CLAMP

128 LUBE OIL HOSE

129 LUBE OIL PIPE RETAINER

130 LUBE OIL PIPE AND WASHER ASSEMBLY

131 ACCUMULATOR COVER BOLT/SCREW M6 X 1.0 X 28.0 (11)

132 ACCUMULATOR COVER

134 ACCUMULATOR COVER SPACER PLATE ASSEMBLY

135A 1–2 ACCUMULATOR PISTON PIN

135B 2–3 ACCUMULATOR PISTON PIN

136A 1–2 ACCUMULATOR PISTON

136B 2–3 ACCUMULATOR PISTON

137A 1–2 ACCUMULATOR PISTON OIL SEAL RING

137B 2–3 ACCUMULATOR PISTON OIL SEAL RING

138 2–3 ACCUMULATOR PISTON OUTER SPRING

139 1–2 ACCUMULATOR PISTON CUSHION SPRING ASSEMBLY

140 1–2 AND 2–3 ACCUMULATOR HOUSING

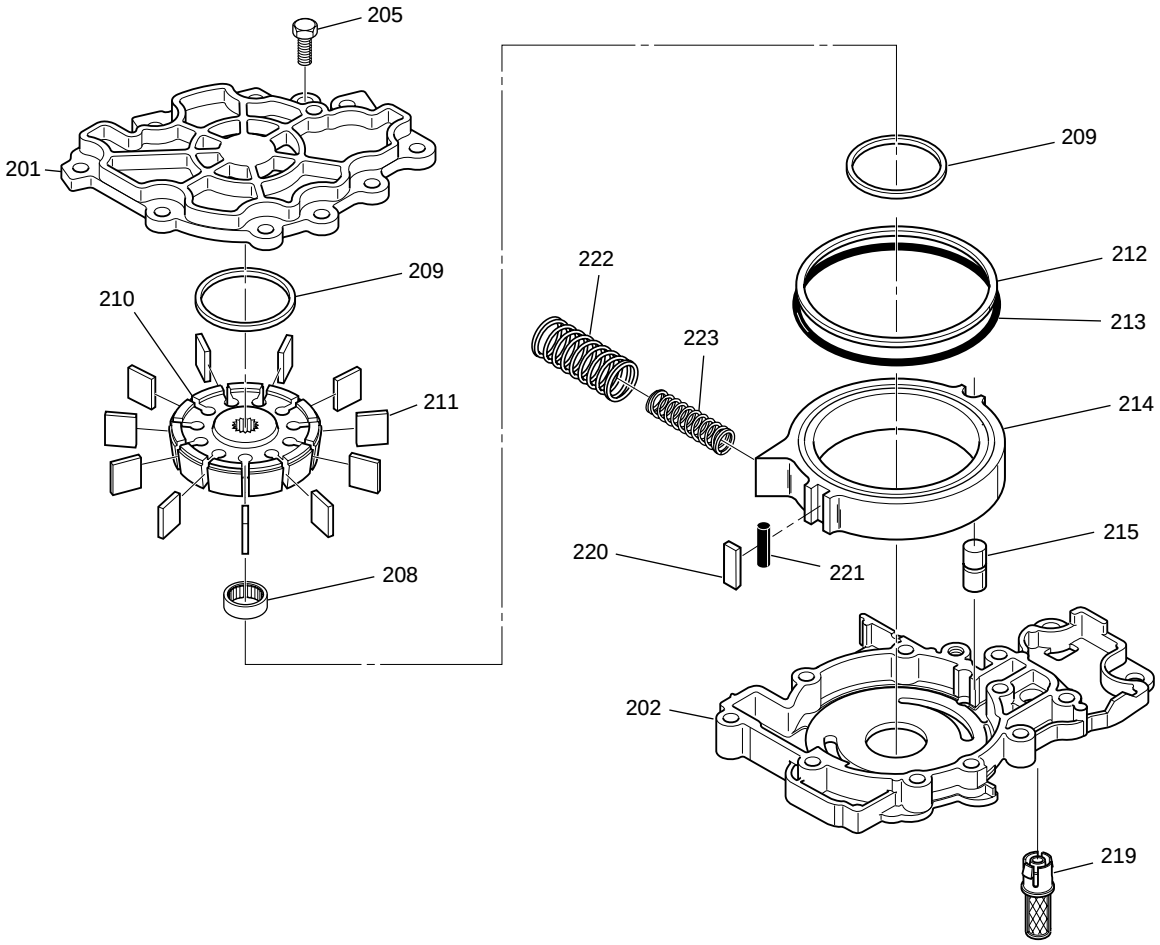
142 1–2 ACCUMULATOR PISTON OUTER SPRING

143 2–3 ACCUMULATOR PISTON SPRING

WH49405-4T65-E

Figure 109

OIL PUMP ASSEMBLY



201 PUMP COVER

202 OIL PUMP BODY

205 OIL PUMP COVER BOLT/SCREW — M6 X 1.0 X 20.0 (1)

208 OIL PUMP DRIVE SHAFT BEARING ASSEMBLY

209 OIL PUMP VANE RING

210 OIL PUMP SELECTIVE ROTOR

211 OIL PUMP SELECTIVE VANE

212 OIL PUMP SLIDE OIL SEAL RING

213 OIL PUMP SLIDE O-RING SEAL

214 OIL PUMP SELECTIVE SLIDE

215 OIL PUMP SLIDE PIVOT PIN

219 OIL PUMP OUTLET SCREEN ASSEMBLY

220 OIL PUMP SLIDE SEAL

221 OIL PUMP SLIDE SEAL SUPPORT

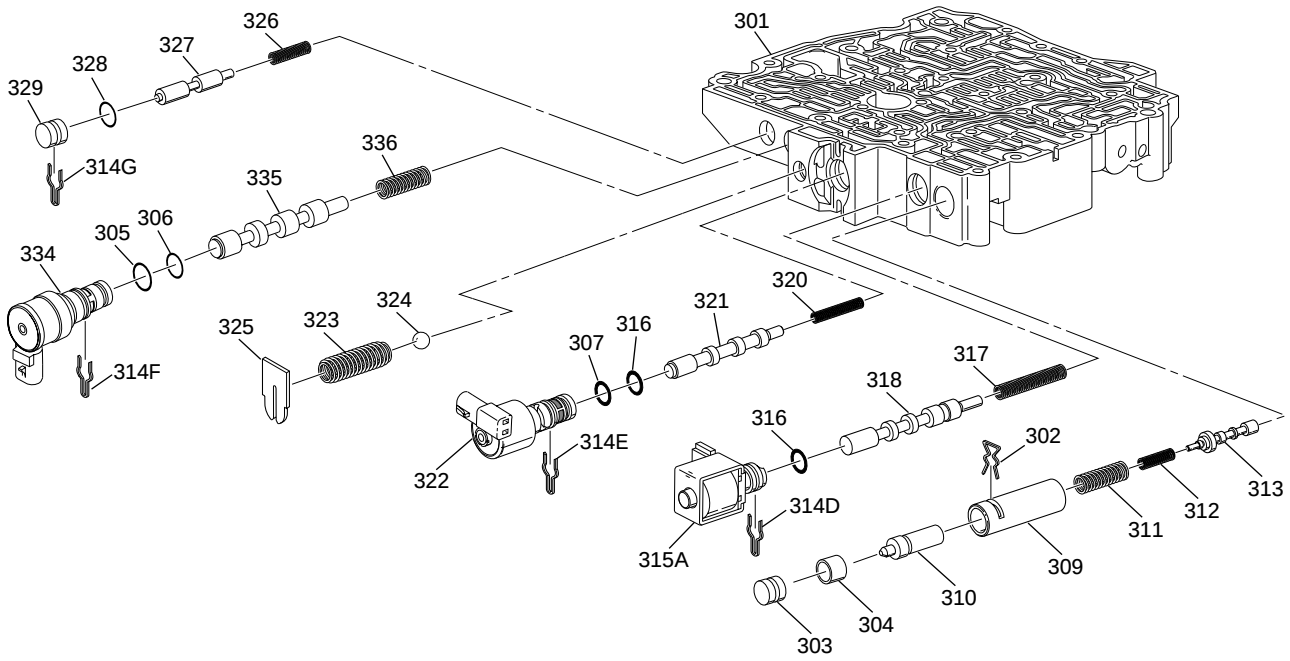
222 OIL PUMP PRIME OUTER SPRING

223 OIL PUMP PRIME INNER SPRING

WH51116-4T65-E

Figure 110

CONTROL VALVE BODY ASSEMBLY (1 of 2)



301 CONTROL VALVE BODY (MACHINED)

302 LINE BOOST VALVE AND BUSHING RETAINER

303 LINE BOOST VALVE BORE PLUG

304 LINE BOOST VALVE

305 TCC PWM SOLENOID VALVE O-RING SEAL

306 TCC PWM SOLENOID VALVE O-RING SEAL

307 PRESSURE CONTROL SOLENOID VALVE O-RING SEAL

309 REVERSE BOOST VALVE BUSHING

310 REVERSE BOOST VALVE

311 PRESSURE REGULATOR VALVE SPRING OUTER

312 PRESSURE REGULATOR VALVE INNER SPRING

313 PRESSURE REGULATOR VALVE

314D 1–2, 3–4 SHIFT SOLENOID VALVE RETAINER

314E PRESSURE CONTROL SOLENOID VALVE RETAINER

314F TCC PWM SOLENOID VALVE RETAINER

314G TCC REGULATOR APPLY VALVE BORE PLUG RETAINER

315A 1–2, 3–4 SHIFT SOLENOID ASSEMBLY

316A 1–2, 3–4 SHIFT SOLENOID VALVE O-RING SEAL

316B PRESSURE CONTROL SOLENOID VALVE O-RING SEAL

317 1–2 SHIFT VALVE SPRING

318 1–2 SHIFT VALVE

320 TORQUE SIGNAL REGULATOR VALVE SPRING

321 TORQUE SIGNAL REGULATOR VALVE

322 PRESSURE CONTROL SOLENOID VALVE ASSEMBLY

323 LINE PRESSURE RELIEF VALVE SPRING

324 LINE PRESSURE RELIEF VALVE

325 LINE PRESSURE RELIEF VALVE SPRING RETAINER

326 TCC REGULATOR APPLY VALVE SPRING

327 TCC REGULATOR APPLY VALVE

328 TCC REGULATOR APPLY VALVE BORE PLUG O-RING SEAL

329 TCC REGULATOR APPLY VALVE BORE PLUG

334 TCC PWM SOLENOID VALVE ASSEMBLY

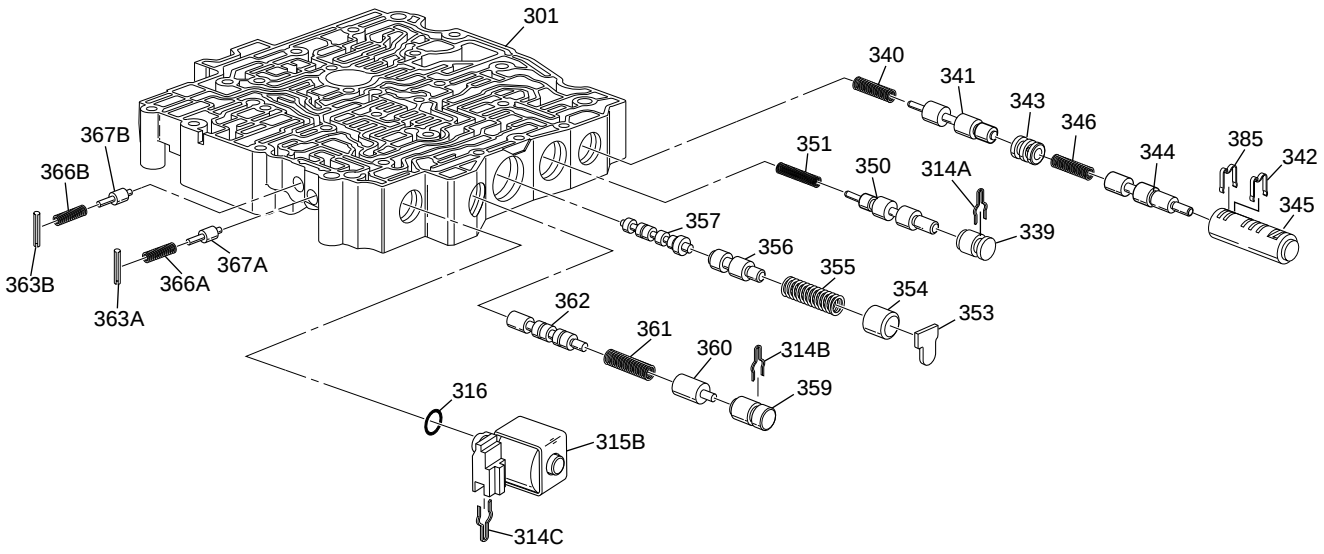
335 TCC CONTROL VALVE

336 TCC CONTROL VALVE SPRING

WH51107-4T65-E

Figure 111

CONTROL VALVE BODY ASSEMBLY (2 of 2)

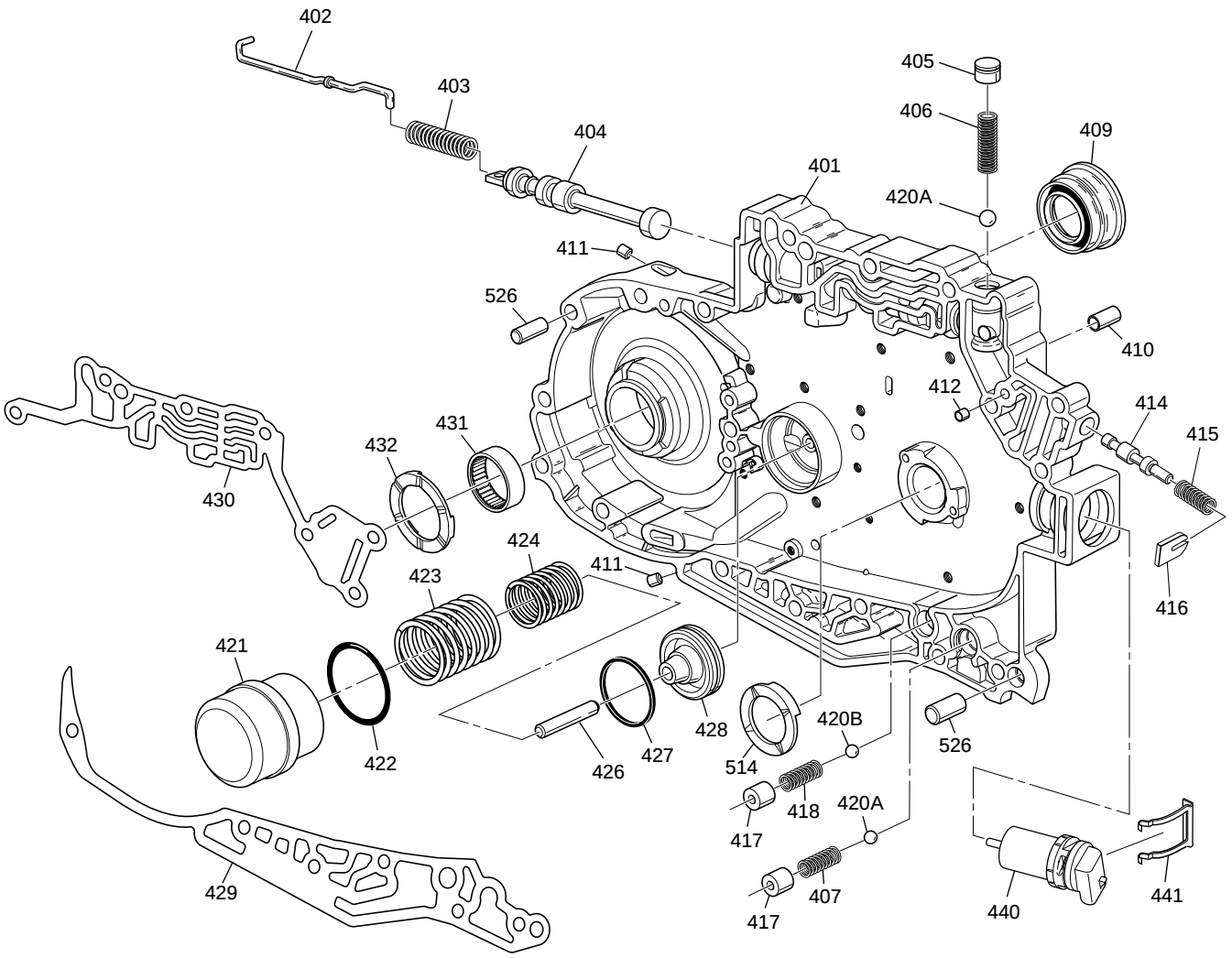


301	CONTROL VALVE BODY (MACHINED)
314A	1–2, 3–4 ACCUMULATOR VALVE RETAINER
314B	4–3 MANUAL DOWNSHIFT VALVE RETAINER
314C	2–3 SHIFT SOLENOID VALVE RETAINER
315B	1–2, 3–4 SHIFT SOLENOID VALVE ASSEMBLY
316	O-RING SEAL
339	1–2 ACCUMULATOR VALVE BORE PLUG
340	3–4 ACCUMULATOR VALVE SPRING
341	3–4 ACCUMULATOR VALVE
342	2–3 ACCUMULATOR VALVE BUSHING
343	2–3 ACCUMULATOR VALVE BORE PLUG
344	2–3 ACCUMULATOR VALVE
345	2–3 ACCUMULATOR VALVE BUSHING
346	2–3 ACCUMULATOR VALVE SPRING
350	1–2 ACCUMULATOR VALVE
351	1–2 ACCUMULATOR VALVE SPRING
353	3–2 MANUAL DOWNSHIFT VALVE RETAINER
354	3–2 MANUAL DOWNSHIFT VALVE BORE PLUG
355	3–2 MANUAL DOWNSHIFT VALVE SPRING
356	3–2 MANUAL DOWNSHIFT VALVE
357	2–3 SHIFT VALVE
359	4–3 MANUAL DOWNSHIFT VALVE BORE PLUG
360	4–3 MANUAL DOWNSHIFT VALVE
361	4–3 MANUAL DOWNSHIFT VALVE SPRING
362	3–4 SHIFT VALVE
363A	REVERSE SERVO BOOST VALVE BORE PIN
363B	FORWARD SERVO BOOST VALVE BORE PIN
366A	REVERSE SERVO BOOST VALVE SPRING
366B	FORWARD SERVO BOOST VALVE SPRING
367A	REVERSE SERVO BOOST VALVE
367B	FORWARD SERVO BOOST VALVE
385	2–3 ACCUMULATOR VALVE RETAINER

WH51113-4T65-E

Figure 112

CASE COVER ASSEMBLY

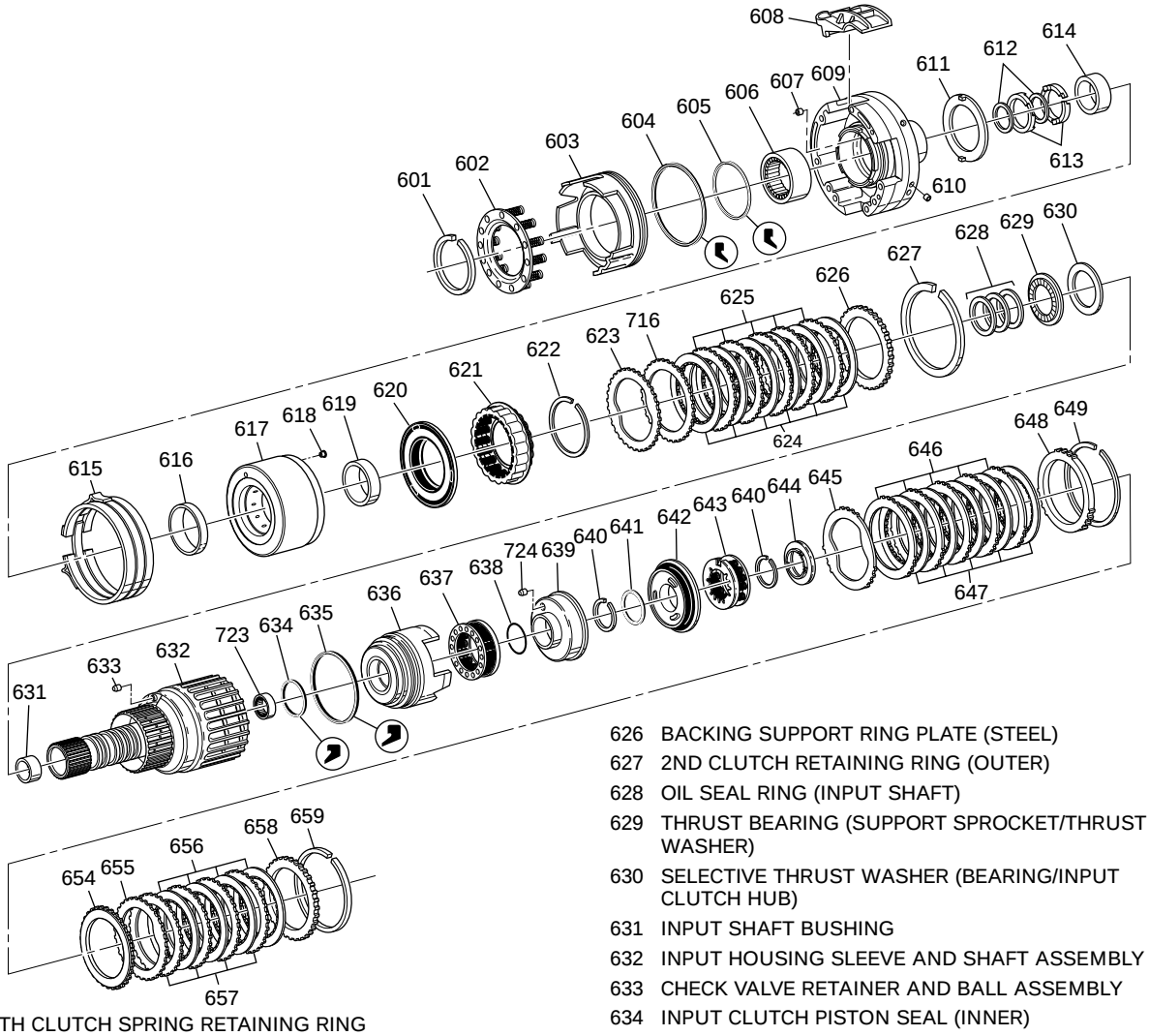


401 CASE COVER ASSEMBLY
402 MANUAL VALVE LINK
403 MANUAL VALVE LINK RETAINER
404 MANUAL VALVE
405 LOW BLOW OFF BALL VALVE BORE PLUG
406 LOW BLOW OFF BALL VALVE SPRING
407 COOLER BALL VALVE SPRING
409 LEFT SIDE AXLE OIL SEAL ASSEMBLY
410 CONTROL BODY ALIGNMENT SLEEVE
411 BORE PLUG
412 ORIFICED CUP PLUG
414 ACTUATOR FEED LIMIT VALVE
415 ACTUATOR FEED LIMIT VALVE SPRING
416 ACTUATOR FEED LIMIT VALVE SPRING RETAINER
417 BALL VALVE BORE PLUG
418 TCC BLOW OFF BALL VALVE SPRING
420A LOW BLOW OFF BALL VALVE
420B TCC BLOW OFF BALL VALVE
420C COOLER BALL VALVE
421 3–4 ACCUMULATOR PISTON CYLINDER
422 3–4 ACCUMULATOR PISTON CYLINDER O-RING SEAL
423 3–4 ACCUMULATOR PISTON OUTER SPRING
424 3–4 ACCUMULATOR PISTON INNER SPRING
426 3–4 ACCUMULATOR PISTON PIN
427 3–4 ACCUMULATOR PISTON OIL SEAL RING
428 3–4 ACCUMULATOR PISTON
429 CASE COVER LOWER GASKET
430 CASE COVER UPPER GASKET
431 FRONT WHEEL DRIVE SHAFT BEARING ASSEMBLY
432 FOURTH CLUTCH SHAFT THRUST WASHER
440 INPUT SPEED SENSOR ASSEMBLY
441 INPUT SPEED SENSOR CLIP
514 DRIVE SPROCKET/CASE COVER THRUST WASHER
526 CASE COVER DOWEL PIN

WH49406-4T65-E

Figure 113

INTERNAL COMPONENTS (1 of 2)

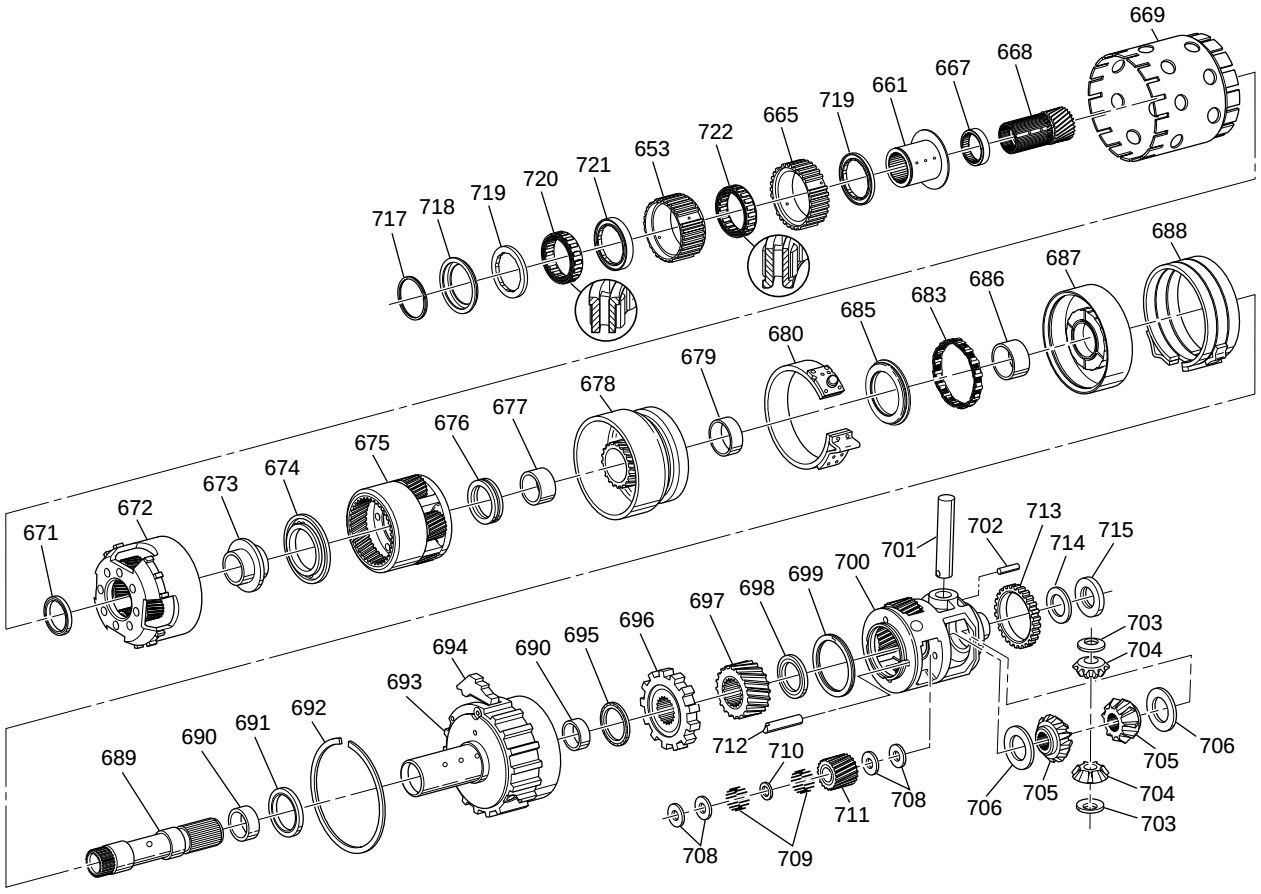


601 4TH CLUTCH SPRING RETAINING RING
602 4TH CLUTCH PISTON RETURN SPRING ASSEMBLY
603 4TH CLUTCH PISTON ASSEMBLY
604 4TH CLUTCH PISTON SEAL (OUTER)
605 4TH CLUTCH PISTON SEAL (INNER)
606 DRAWN CUP BEARING ASSEMBLY
607 ORIFICED CUP PLUG
608 DRIVE LINK LUBE SCOOP
609 DRIVEN SPROCKET SUPPORT ASSEMBLY
610 CUP PLUG
611 THRUST WASHER (DRIVEN SPROCKET SUPPORT 2ND CLUTCH DRUM)
612 RING FOUR LOBED SEAL
613 OIL SEAL RING
614 DRIVEN SPROCKET SUPPORT BUSHING
615 REVERSE BAND ASSEMBLY
616 75.5 O.D. X 8.0 BUSHING
617 2ND CLUTCH HOUSING
618 CHECK VALVE RETAINER AND BALL ASSEMBLY (2ND CLUTCH)
619 70.0 O.D. X 11.0 BUSHING
620 2ND CLUTCH W/MOLDED SEAL PISTON
621 2ND CLUTCH APPLY RING AND RELEASE SPRING ASSEMBLY
622 RETAINING RING
623 2ND CLUTCH PLATE (WAVED)
624 2ND CLUTCH PLATE ASSEMBLY (FIBER)
625 2ND CLUTCH REACTION PLATE (STEEL)
626 BACKING SUPPORT RING PLATE (STEEL)
627 2ND CLUTCH RETAINING RING (OUTER)
628 OIL SEAL RING (INPUT SHAFT)
629 THRUST BEARING (SUPPORT SPROCKET/THRUST WASHER)
630 SELECTIVE THRUST WASHER (BEARING/INPUT CLUTCH HUB)
631 INPUT SHAFT BUSHING
632 INPUT HOUSING SLEEVE AND SHAFT ASSEMBLY
633 CHECK VALVE RETAINER AND BALL ASSEMBLY
634 INPUT CLUTCH PISTON SEAL (INNER)
635 INPUT CLUTCH PISTON SEAL (OUTER)
636 INPUT CLUTCH PISTON
637 INPUT CLUTCH SPRING AND RETAINER ASSEMBLY
638 O-RING SEAL
639 3RD CLUTCH PISTON HOUSING
640 RETAINING RING (3RD CLUTCH PISTON HOUSING/ INPUT SHAFT)
641 3RD CLUTCH PISTON SEAL (INNER)
642 3RD CLUTCH PISTON SEAL AND BALL CAPSULE ASSEMBLY
643 3RD CLUTCH SPRING RETAINER AND GUIDE ASSEMBLY
644 THRUST BEARING ASSEMBLY
645 3RD CLUTCH PLATE (WAVED)
646 3RD CLUTCH PLATE ASSEMBLY (O.D. SPLINE)
647 3RD CLUTCH PLATE ASSEMBLY (I.D. SPLINE)
648 3RD CLUTCH BACKING PLATE
649 3RD CLUTCH BACKING PLATE RETAINING RING
654 INPUT CLUTCH APPLY PLATE
655 INPUT CLUTCH PLATE (WAVED)
656 INPUT CLUTCH PLATE ASSEMBLY (FIBER)
657 INPUT CLUTCH PLATE (STEEL)
658 INPUT CLUTCH BACKING PLATE (STEEL)
659 INPUT CLUTCH BACKING PLATE RETAINING RING
716 2ND CLUTCH APPLY REACTION PLATE (TAPERED)
723 4TH CLUTCH SHAFT TO INPUT HOUSING BEARING
724 3RD CLUTCH PISTON BALL CHECK VALVE ASSEMBLY

WH51080-4T65-E

Figure 114

INTERNAL COMPONENTS (2 of 2)

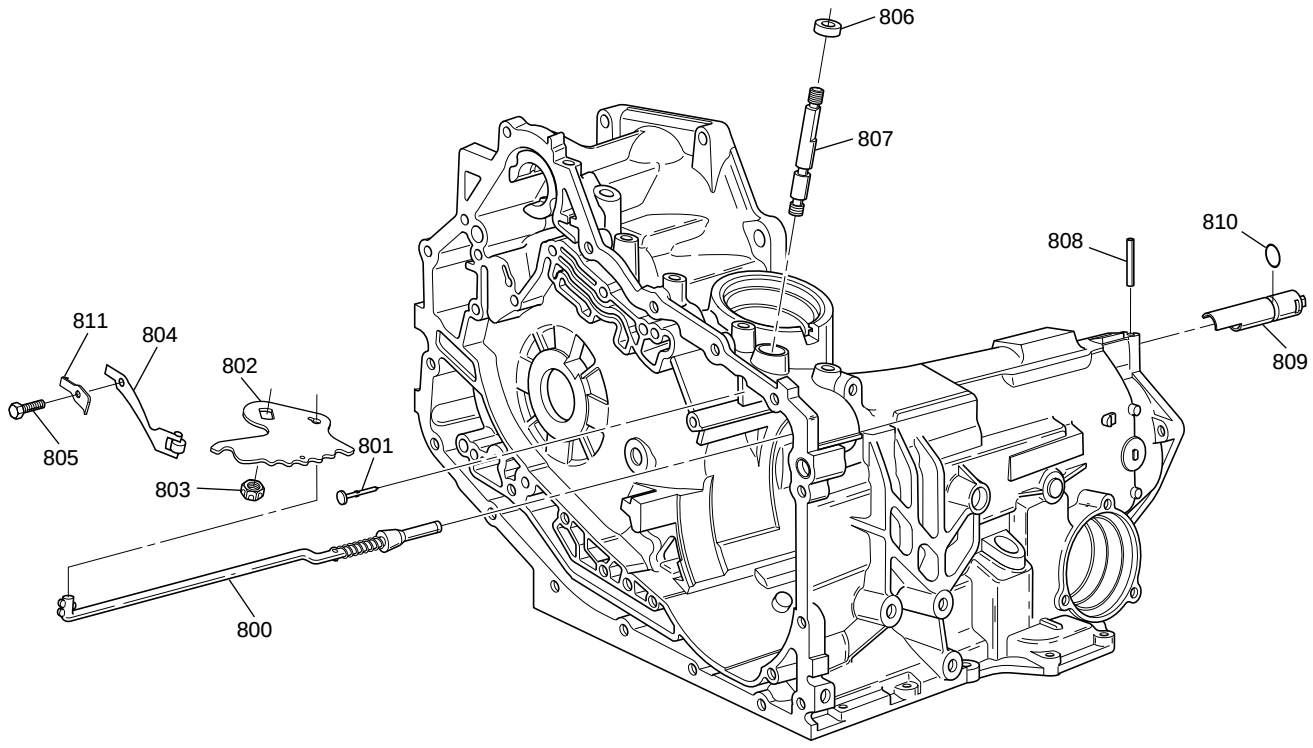


653 THIRD CLUTCH SPRAG OUTER RACE
661 INPUT AND THIRD CLUTCH SPRAG INNER RACE
665 INPUT CLUTCH SPRAG OUTER RACE
667 INPUT SUN GEAR SPACER
668 INPUT SUN GEAR
669 REVERSE REACTION DRUM
671 INPUT SUN GEAR THRUST BEARING ASSEMBLY
672 INPUT COMPLETE CARRIER ASSEMBLY
673 INPUT CARRIER/REACTION CARRIER LUBE DAM
674 INPUT/REACTION CARRIER THRUST BEARING ASSEMBLY
675 REACTION COMPLETE CARRIER ASSEMBLY
676 REACTION CARRIER/SUN GEAR THRUST BEARING ASSEMBLY
677 LEFT HAND REACTION SUN GEAR BUSHING
678 REACTION SUN/DRUM GEAR ASSEMBLY
679 RIGHT HAND REACTION SUN GEAR BUSHING
680 2/1 MANUAL BAND ASSEMBLY
683 1/2 SUPPORT ROLLER CLUTCH ASSEMBLY
685 THRUST BEARING ASSEMBLY
686 1/2 SUPPORT BUSHING
687 1/2 SUPPORT AND DRUM
688 FORWARD BAND ASSEMBLY
689 FINAL DRIVE SUN GEAR SHAFT
690 FINAL DRIVE INTERNAL GEAR BUSHING
691 THRUST WASHER (1/2 SUPPORT/INTERNAL GEAR)
692 RETAINING RING (FINAL DRIVE INTERNAL GEAR)
693 FINAL DRIVE INTERNAL GEAR
694 PARK PAWL ASSEMBLY
695 THRUST BEARING ASSEMBLY (INTERNAL GEAR/ PARKING GEAR)
696 PARKING GEAR
697 FINAL DRIVE SUN GEAR
698 CARRIER/SUN GEAR THRUST BEARING ASSEMBLY
699 SPIRAL PINION GEAR PIN RETAINING RING
700 DIFFERENTIAL/FINAL DRIVE CARRIER ASSEMBLY
701 DIFFERENTIAL PINION SHAFT
702 DIFFERENTIAL PINION SHAFT RETAINING PIN
703 THRUST WASHER (DIFFERENTIAL PINION)
704 DIFFERENTIAL PINION GEARS
705 DIFFERENTIAL SIDE GEAR (MN7 HAS UNIQUE LEFT/ RIGHT GEARS)
706 BRONZE THRUST WASHER (DIFFERENTIAL SIDE GEAR)
708 PINION THRUST WASHER (STEEL)
709 ROLLER NEEDLE BEARING
710 PINION NEEDLE BEARING SPACER
711 FINAL DRIVE PLANETARY PINION GEAR
712 PLANETARY PINION GEAR PIN
713 VEHICLE SPEED SENSOR RELUCTOR WHEEL
714 DIFFERENTIAL CARRIER/CASE WASHER (THRUST)
715 THRUST BEARING ASSEMBLY
717 SPIRAL LOCK RETAINING RING
718 3RD CLUTCH SPRAG OUTER RACE RETAINER
719 INPUT AND THIRD CLUTCH SPRAG END BEARING
720 3RD CLUTCH SPRAG ASSEMBLY
721 INPUT AND THIRD CLUTCH SPRAG CENTER
722 INPUT CLUTCH SPRAG

WH51086-4T65-E

Figure 115

MANUAL SHAFT AND PARKING PAWL ACTUATOR ASSEMBLY



800 PARK PAWL ACTUATOR ASSEMBLY
801 MANUAL SHIFT SHAFT PIN
802 MANUAL SHIFT DETENT LEVER
803 MANUAL SHIFT DETENT LEVER NUT
804 MANUAL SHIFT DETENT ASSEMBLY
805 MANUAL SHIFT DETENT BOLT/SCREW
806 MANUAL SHIFT SHAFT SEAL ASSEMBLY
807 MANUAL SHIFT SHAFT
808 PARK PAWL ACTUATOR GUIDE PIN
809 PARK PAWL ACTUATOR GUIDE
810 PARK PAWL ACTUATOR GUIDE O-RING SEAL

WH51123-4T65-E

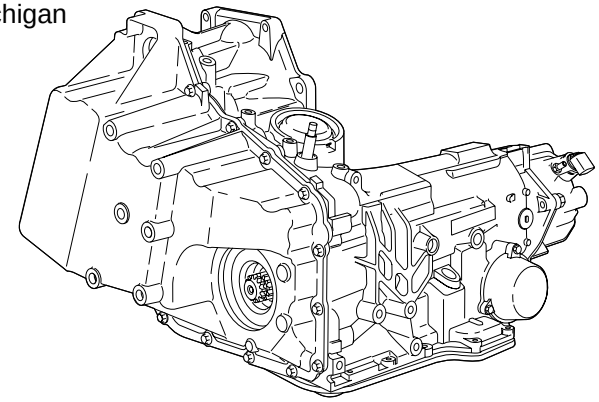
Figure 116

BASIC SPECIFICATIONS

HYDRA-MATIC 4T65-E TRANSAXLE

RPO MN4

Produced at: Warren, Michigan
U.S.A.



HYDRA-MATIC 4T65-E
(FOUR-SPEED)

Vehicles used in:

	DIVISION	MODEL
C Car	Buick	Park Avenue
G Car	Buick	Riviera
H Car	Oldsmobile	LSS
H Car	Pontiac	Bonneville
W Car	Buick	Regal
W Car	Chevrolet	Lumina/Monte Carlo
W Car	Pontiac	Grand Prix

Transaxle Type

4T65-E = 4: Four Speed
T: Transverse Mount
65: Product Series
E: Electronically Controlled

Automatic Overdrive with a Torque Converter Clutch Assembly.

Transfer Design

Two-axis design, link chain assembly

Control Systems

Shift Pattern – (2) Two-way on/off solenoids
Shift Quality – Pressure Control Solenoid
Torque Converter Clutch – Pulse Width Modulated solenoid control

Current GM NAO Vehicle Platforms

C (MN3, MN7), G (MN3, MN7),
H (MN7), W (M15, MN7)

Current Engine Range

3.4L to 3.8L Gasoline

Maximum Engine Torque

280 lb-ft (380 Nm)

Maximum Gearbox Torque

400 lb-ft (544 Nm)

Gear Ratios

1st	2.921
2nd	1.568
3rd	1.000
4th	0.705
Rev	2.385

Maximum Shift Speed

1-2	6500 rpm
2-3	6250 rpm
3-4	4900 rpm

Maximum Gross Vehicle Weight

2,903 Kg (6,400 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

Wet: 93.0 kg (205 lb) M15, MN3
Wet: 97.0 kg (214 lb) MN7

Converter Size

245 mm & 258mm (Reference)
(Diameter of Torque Converter Turbine)

Seven Position Quadrant

(P, R, N, (D), D, 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. "65"), 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 4T65-E is a 4-speed, transversely mounted, 65 series unit, with electronic controls.

HYDRA-MATIC 4T65-E

HYDRA-MATIC	4	T	65	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

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.

Ball Check Valve: A spherical hydraulically controlled component (usually made of steel) that either seals or opens fluid circuits. It is also referred to as a check valve or checkball.

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.

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 Valve: 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
A/T - Automatic Transmission

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

ISS - Input Speed Sensor
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

OSS - Output Shaft Speed Sensor

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
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

INDEX

A

Abbreviations 126
Accumulators 38-39
- 1-2 accumulator 39
- 2-3 accumulator 39
- 3-4 accumulator 38

Apply Components, 15-26
- driven sprocket support, 16
- forward band, 25
- forward servo, 25
- hydraulic feed circuits, 16
- input clutch, 22
- input sprag clutch, 23
- reverse band, 18
- reverse servo, 18
- 1/2 support roller clutch, 26
- 2/1 band, 24
- 2/1 manual servo, 24
- 2nd clutch, 19
- 3rd clutch, 20
- 3rd sprag clutch, 21
- 4th clutch, 17

B

Basic Specifications 122
Bushing Locations 106
Bearing Locations 107
Ball Check Valve Location and Function 42-43

C

Case and Associated Parts 111-114
Color Legend 10A-B
Complete Hydraulic Circuits 81-103
- park 82-83
- reverse 84-85
- neutral 86-87
- overdrive range – first gear 88-89
- overdrive range – second gear 90-91
- overdrive range – third gear 92-93
- overdrive range – fourth gear 94-95
- overdrive range – 4-3 downshift 96-97
- manual third – third gear 98-99
- manual second – second gear 100-101
- manual first – first gear 102-103

Contents, Table of 2
Control Valve Assembly 116-117
Cross Sectional Views 8-8A

D

Differential Components 31
Driven Sprocket Support 16

E

Electrical Components 45-51
- component locations 45
- fail safe mode 45
- automatic transmission fluid pressure manual valve position switch 46
- automatic transmission fluid temperature sensor 49
- automatic transmission input (shaft) speed sensor 48
- shift solenoid valves 47
- torque converter clutch control PWM solenoid .. 50
- transaxle pressure control solenoid valve 51
- vehicle speed sensor 48

Explanation of Gear Ranges 9

F

Fail Safe Mode 45
Final Drive Components 30
First Gear (overdrive) 62-63, 88-89
Forward Band Assembly 25
Forward Servo 25

G

General Description 9
Glossary Of Technical Terms 124

H

How To Use This Book 4-5
Hydra-matic Product Designation System 123
Hydraulic Control Components 33-44
- location of major components 33
- oil pump assembly 34
- pressure regulation 35
- valves located in the case cover 36-37
- accumulators 38-39
- valves located in the valve body 40-41
- ball check valves location and function .. 42-43
- thermostatic element 44

Hydraulic Feed Circuits 16

I

Illustrated Parts List 111-121
- case and associated parts 111-114
- oil pump assembly 115
- control valve body assembly 116-117
- case cover assembly 118
- internal components 119-120
- manual shaft and parking pawl actuator assembly 121

Input Clutch 22
Input Sprag Clutch 23
Introduction 3

INDEX

L

Lip Seal Locations 108
Lubrication Points 104

M

Major Mechanical Components 10
Manual First – First Gear 78-79, 102-103
Manual Second – Second Gear 76-77, 100-101
Manual Shaft and Parking Pawl
Actuator Assembly 121
Manual Third – Third Gear 74-75, 98-99

N

Neutral 60-61, 86-87

O

Oil Pump Assembly 34, 115
Overdrive Range – First Gear 62-63, 88-89
Overdrive Range – Fourth Gear 68-69, 94-95
Overdrive Range – Second Gear 64-65, 90-91
Overdrive Range – Third Gear 66-67, 92-93
Overdrive Range – 4-3 Downshift 72-73, 96-97
Operating Conditions - Range Reference Chart ... 80

P

Park 56-57, 82-83
Planetary Gear Sets 27-29
description 27
reduction 28-29
direct drive 28-29
overdrive 28-29
reverse direction of rotation 228-9
Power Flow 53-79
mechanical powerflow from TC 54-54A
common hydraulic functions 54B-55
park 56-57
reverse 58-59
neutral 60-61
overdrive first 62-63
overdrive second 64-65
overdrive third 66-67
overdrive fourth 68-69
overdrive fourth, TCC apply 70-70A
overdrive fourth, TCC release 70B-71
overdrive 4-3 downshift 72-73
manual third - third gear 74-75
manual second - second gear 76-77
manual first - first gear 78-79
Preface 1
Pressure Control Solenoid Valve 51
Pressure Regulation 35
Principles of Operation 9A-51
major mechanical components 10
color legend 10A-B
range reference chart 11
torque converter 12-14
apply components 15-26
planetary gear sets 27-29
final drive components 30
differential components 31
hydraulic control components 33-44
electrical components 45-51

R

Range Reference Charts ..... 11 & 80
Reverse Servo Assembly 18
Reverse Band 18

S

Seal Locations 108-109
Shift Solenoid Valves 47
Stator Assembly 13
Square and O-Ring Seal Locations 109

T

Table of Contents 2
TCC Control (PWM) Solenoid 50
TFP Val. Position Sw. 46
Thermostatic Element 44
Third Gear (overdrive) 66-67, 92-93
Thrust Washer Locations 105
Torque Converter Clutch 12-14
converter pump and turbine 12
pressure plate 12
stator assembly 13
torque converter apply and release 14
Torque Converter Clutch Applied 70B-71, 94-95
Torque Converter Clutch Released 70-70A
TFT sensor 49
Transaxle Adapt Function 51

U

Understanding The Graphics 6-8A

V

Valves Located In The Case Cover 36-37
manual valve 36
low blow off 37
TCC blow off 37
cooler blow off 37
actuator feed limit 37
accumulators 38-39
Valves Located In The Valve Body 40-41, 116-117
Vehicle Speed Sensor 48

NOTES

NOTES