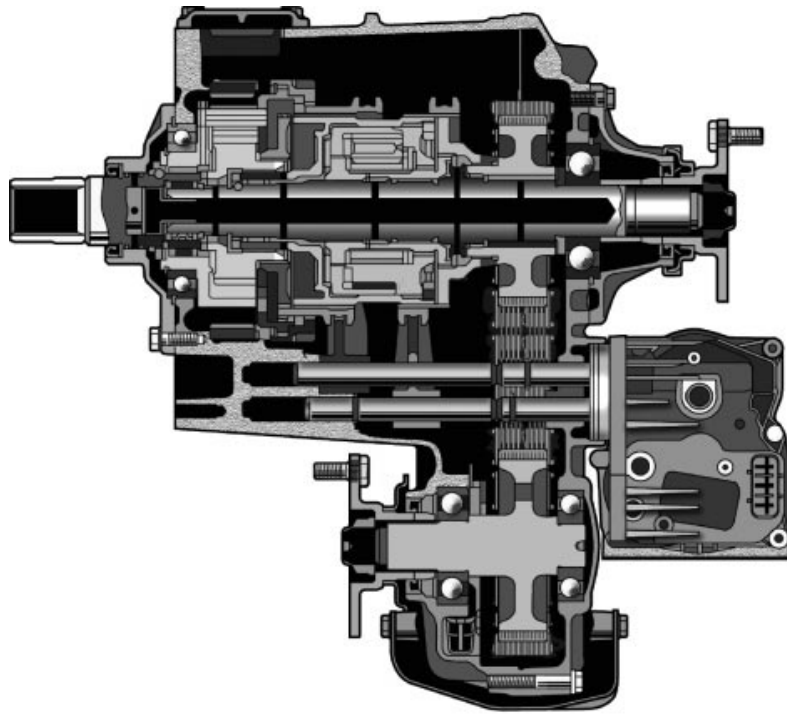


Section 5

Transfer Case



T302F531

- Learning Objectives:**
1. Identify the purpose and function of the transfer case.
 2. Describe 4WD operation.
 3. Describe AWD operation.
 4. Describe transfer case operation
 - a. Gear drive transfer case
 - b. Chain drive transfer case
 - c. Planetary gear type
 5. Identify and describe the operation of the following transfer case and transaxle components:
 - a. Planetary gear unit
 - b. Center differential
 - c. Shift mechanism
 - d. Wait mechanism
 6. Identify and describe the operation of the differential lock
 7. Identify and describe the operation of the Automatic Disconnecting Differential (A.D.D.)
 8. Identify transfer case lubrication
 - a. Describe the trochoid pump used on some transfer cases

Transfer Case

Introduction A four-wheel drive (4WD) vehicle has more pulling power and traction since it drives all four wheels. To drive all four wheels, the powertrain requires a drive axle at each end of the vehicle, a second propeller shaft and a transfer case. The transfer case is mounted to the rear of the transmission and its purpose is to drive the additional shaft and provide a gear reduction mode in four-wheel drive only.

When torque is equally distributed to the front and rear axles and the vehicle is driven in a straight line, all wheels turn at the same speed, as do the two drive shafts. When the vehicle is driven in a turn however, all four wheels rotate at different speeds because each of the wheels has a different turning radius around the center of the turn. The outer front wheel turns the fastest, followed by the outer rear, the inner front and the inner rear wheels.

Since the front axle is turning faster than the rear axle, the drive shafts also turn at different speeds. This does not present a problem when the vehicle is driven on loose surfaces such as sand or snow because the tires will slip on the loose surface. However, when driven on pavement, the difference in speeds causes tire scuffing and bind up of the powertrain. At low speeds the bind up may cause the engine to stall. Some transfer case designs use a center differential to provide proportional distribution of torque to the axles eliminating the bind up effect in the powertrain.

All-Wheel Drive (AWD)

Full-time 4WD or all-wheel drive (AWD) transfer cases include a center differential between the front and rear drive shafts and maintain constant power to both the front and rear axles.

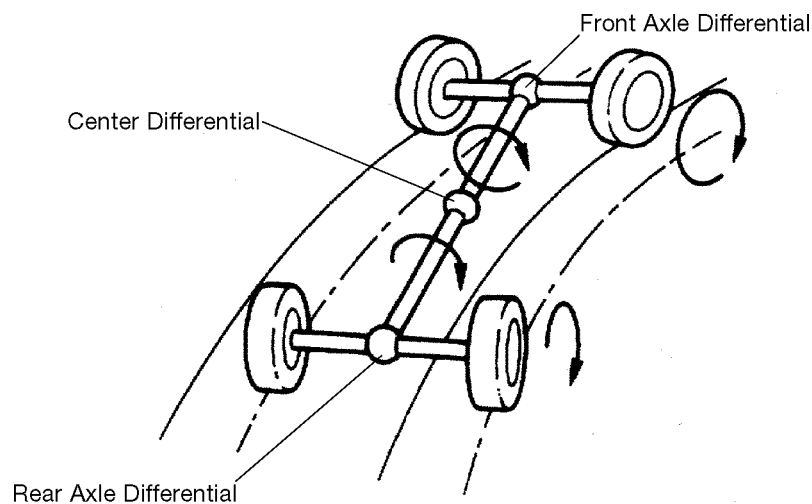


Fig. 5-1
T302F501

Understanding transfer case design features increases your knowledge of transfer case operation and provides for more accurate problem diagnosis.

Transfer Case Types

There are three types of transfer case operating systems: part-time, full-time and multi-mode. In each of these systems high and low gear can be selected.

A **part-time four-wheel drive system** allows two wheel or four-wheel drive. When four-wheel drive is selected, torque is evenly distributed to the front and rear axles. Because the wheels turn at different speeds as described earlier, part-time four-wheel drive vehicles should operate in two-wheel drive on pavement.

To further contrast the three types of transfer case designs it is important to understand the operating characteristics in 4WD when traction is lost. In the part-time system when one wheel loses traction, all the torque for that axle goes to the wheel with the least traction. However since the transfer case distributes equal torque to each axle, the opposite axle has torque delivered to the wheels.

In a **full time four-wheel drive system** or a **multi-mode four-wheel drive system**, if one wheel loses traction all torque goes to the wheel and axle with the least traction. This is when you would lock the center differential causing the torque to be equally distributed to the front and rear axle similar to part-time operation.

In the event one wheel on each axles lost traction, the torque would still go to the wheel with the least traction. What is needed at this point is a locking differential that causes both wheels at the rear axle to be driven together.

Transfer Case Construction

The transfer case is attached to the rear of the transmission. It has a single input shaft driven by the transmission output shaft and two output shafts, one for the front drive axle and one for the rear drive axle. There are two designs that have been used in various Toyota models. The first was a gear design used in pickup models and 4Runners that were used until 1995. The Land Cruiser has used an exclusive gear design that is used in the current model. The second design with several variations is the silent chain model used in all rear wheel drive model pickups and SUVs.

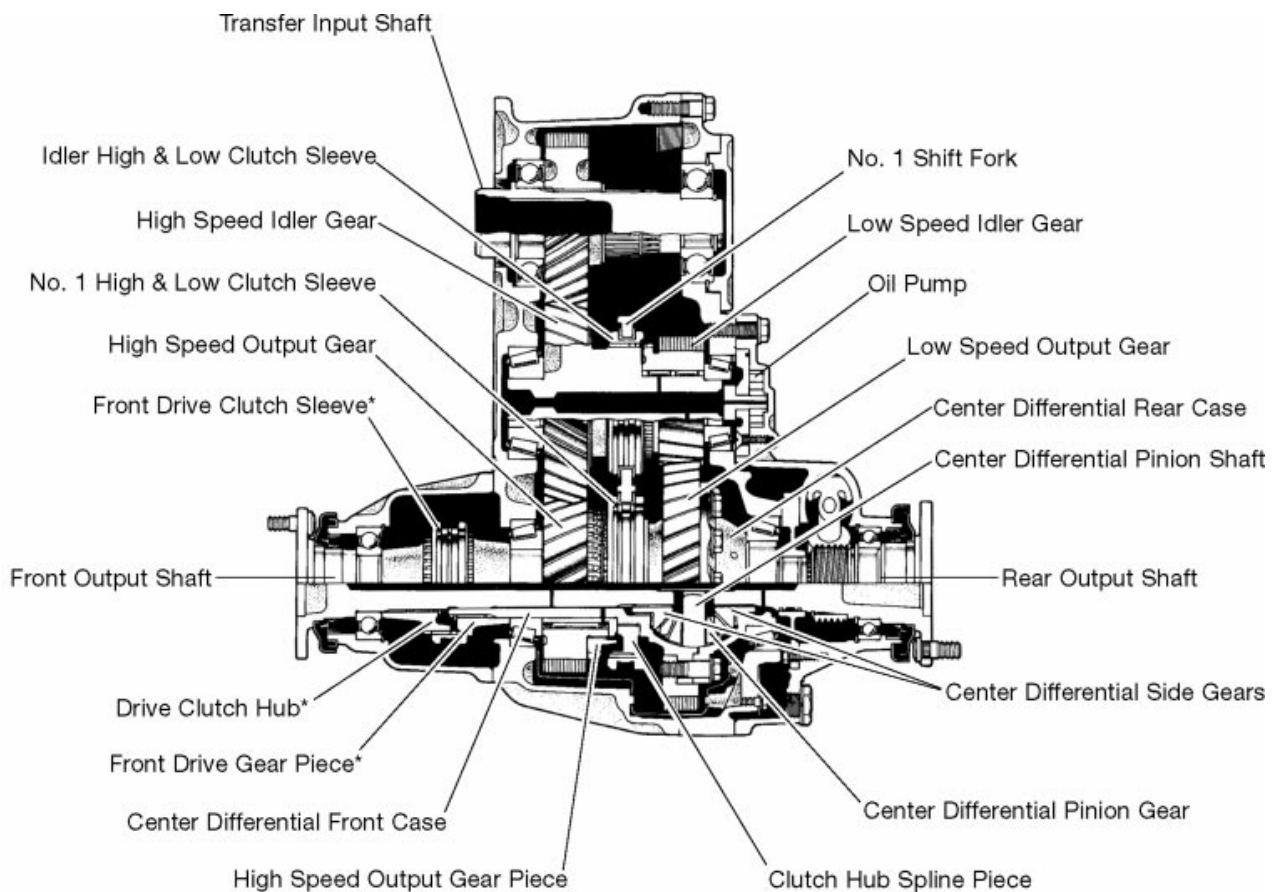
Gear Drive Transfer Case

The Land Cruiser gear drive transfer case has three major components: the input shaft assembly, the idler gear assembly and the center differential assembly. The input shaft assembly is driven by the transmission output shaft and has a single drive gear. The idler gear assembly is driven by the input drive gear and provides for high and low gear. The low speed idler gear is mounted to the idler gear assembly and rotates on a set of needle roller bearings. The high & low clutch sleeve engages the low speed idler gear and the high speed idler gear for low gear.

The center differential assembly is driven either by the high speed idler gear or the low speed idler gear on the idler gear assembly. The high speed output gear rotates on the center differential front case and is driven by the high speed idler gear. It is coupled to the center differential by the No. 1 high & low clutch sleeve. The low speed output gear is attached to the center differential case and is driven by the low speed idler gear. The front drive clutch sleeve locks the center differential by locking the front output shaft to the center differential front case. An oil pump, driven by the idler gear assembly, provides lubrication.

Land Cruiser Gear Drive Transfer Case

The Land Cruiser uses a gear drive transfer case; the power flows in through the input shaft and is transferred through gears to both the front and rear drive shafts.



*for Center Differential Lock Mechanism

Fig. 5-2
T3021502

Shifting between high speed and low speed is done with a floor mounted shift selector while the vehicle is stopped. When the shift selector is moved, the high & low clutch sleeve on the idler gear assembly and the No. 1 high & low clutch sleeve on the center differential assembly move to the right at the same time. When low speed is selected, the low speed idler gear is engaged with the high speed idler gear and the high speed output gear is disengaged from the center differential case. The high gear ratio (2.48:1) between the smaller low speed idler gear and the larger low speed output gear provides low gear.

When high speed is selected, the high speed idler gear is disengaged with the low speed idler gear and the high speed output gear is engaged with the center differential case. The gear ratio in high is 1:1 as the input drive gear and high speed output gear have the same number of teeth. When the center differential case is driven, the pinion shaft transfers torque through the pinion gears to the side gears, driving the front and rear output shafts.

Gear Drive Transfer Case Operation

When low speed is selected, the low speed idler gear is engaged with the high speed idler gear and the high speed output gear is disengaged from the center differential case.

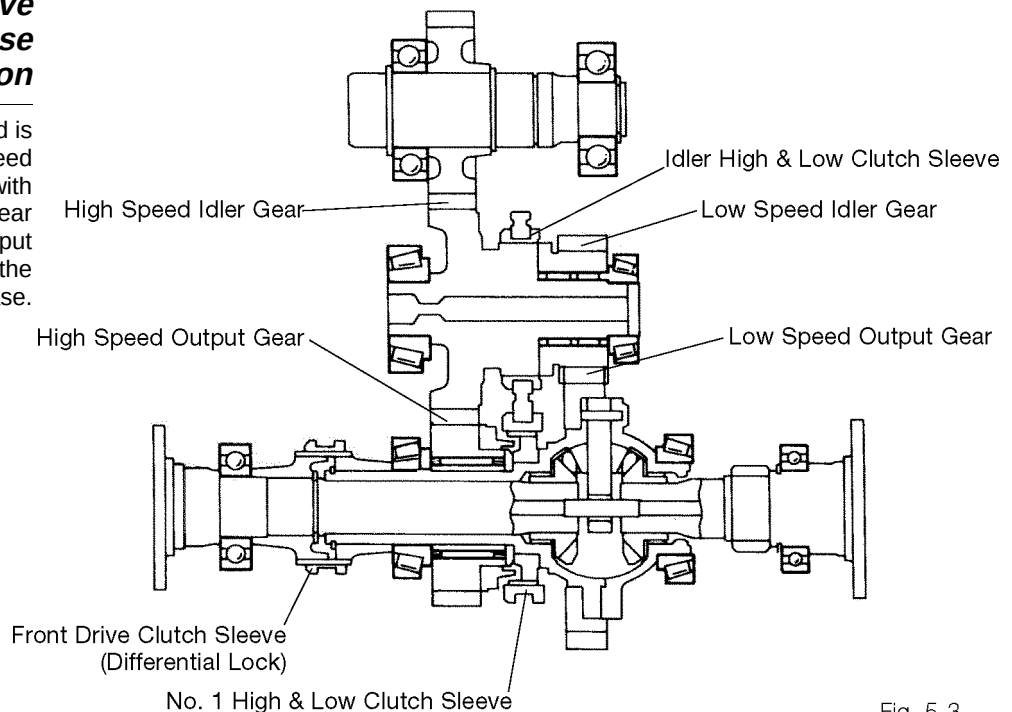


Fig. 5-3
T3021503

An electric shift actuator motor (discussed later in this section) causes the front drive clutch sleeve to lock the front output shaft to the center differential front case, completing the center differential lock function. The actuator is controlled by a center differential lock switch located on the instrument panel and a 4WD control relay.

Chain Drive Transfer Case The chain drive transfer case has a similar function to the gear drive transfer case. This type of transfer case uses a planetary gear set instead of a countershaft to provide low range gear reduction. It also uses a large silent chain instead of an idler gear to transfer power to the front output shaft. A synchronizer assembly allows changing ranges from L4 to H4 without stopping. In 4WD, the front drive clutch sleeve connects the output shaft to the chain sprocket and chain, which drives the front output shaft. This transfer case has its own oil pump to ensure proper lubrication.

Chain Drive Transfer Case

A chain drive transfer case uses a large silent chain to transfer power from the rear output shaft to the lower front output shaft.

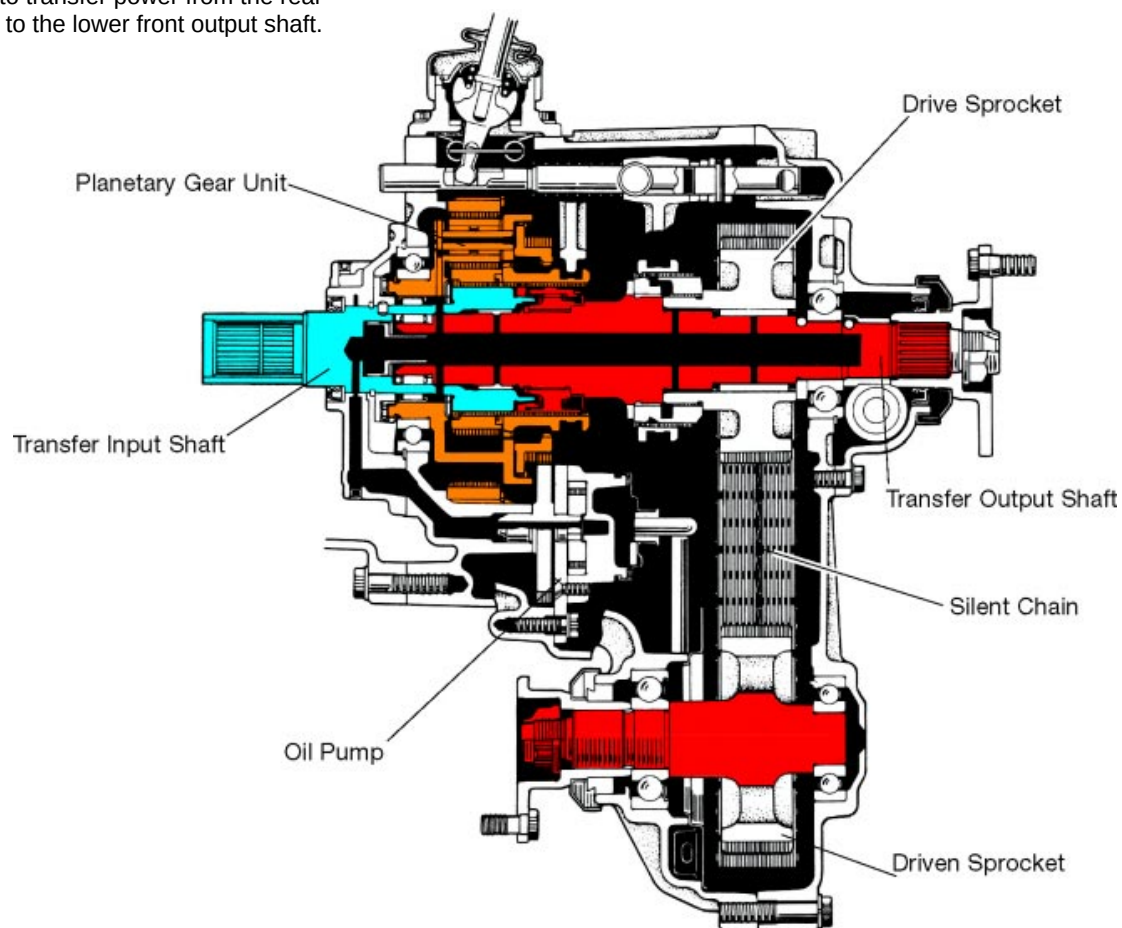


Fig. 5-4
T3021504

Planetary Gear Unit

The **planetary gear unit** is constructed in the following manner:

- The transfer input shaft is splined to the planetary sun gear.
- Four planetary pinion gears are fitted to the planetary carrier.
- A planetary spline piece is fitted to the rear of the carrier and internal gear teeth of the spline piece can be engaged with the external teeth of the high and low clutch sleeve.
- The planetary ring gear is fixed to the transfer case and the internal teeth are meshed with the planetary pinion gears.
- The high and low clutch sleeve can be engaged with the splines located on the rear portion of the transfer input shaft.

Planetary Gear Unit Construction

This view identifies the key components. A helical type planetary gear provides gear reduction for low-range operation.

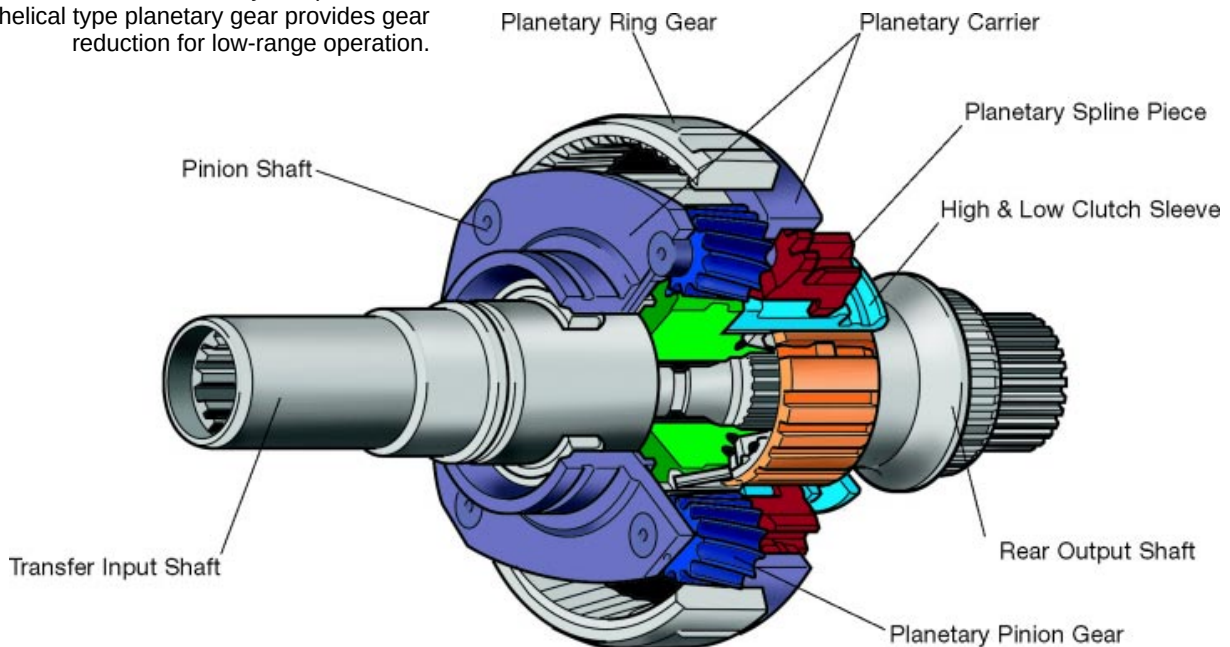
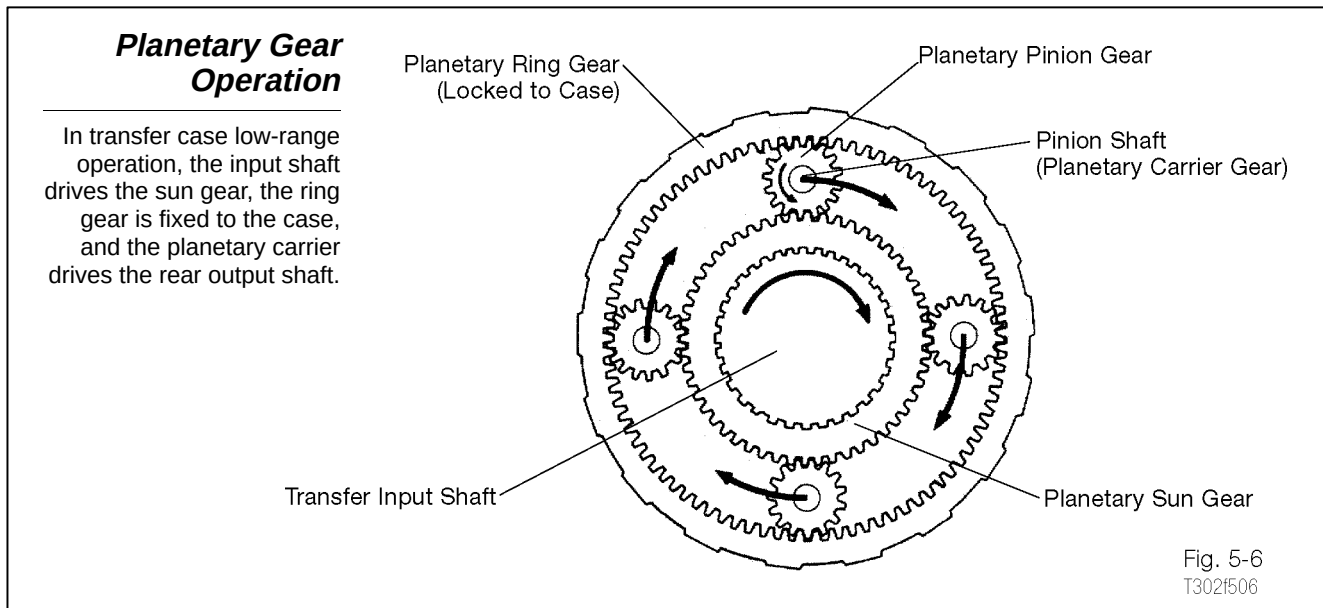


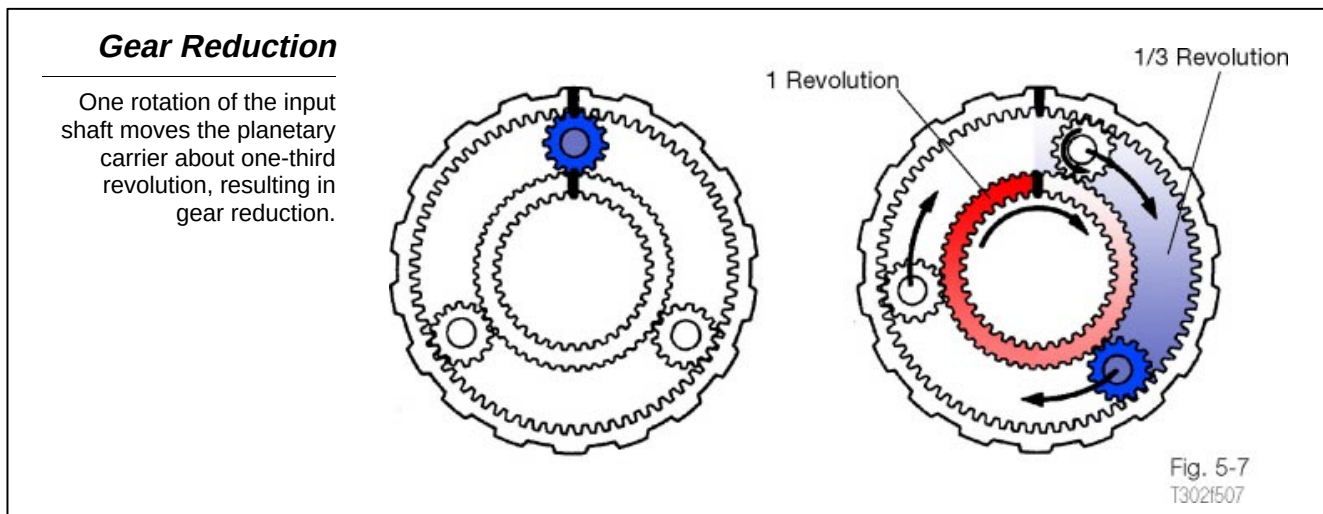
Fig. 5-5
T3021505

Planetary Gear Operation In transfer case high-range operation, the input shaft drives the high and low clutch sleeve (in high position), which in turn, drives the output shaft.



In transfer case low-range operation, the input shaft drives the sun gear, which with the planetary ring gear locked to the transfer case, drives the planetary pinion gears and planetary carrier gear. The planetary carrier gear then drives the output shaft.

Gear reduction is attained when power flows from the input shaft, turning the sun gear; the sun gear drives the planetary pinion gears, which rotate in the opposite direction around the ring gear. As the pinion gears “walk” around the ring gear, they rotate the planetary carrier at a slower speed than the input shaft, providing gear reduction. Gear reduction (as demonstrated in figure 5-7) is achieved when the pinion gears rotate the carrier 1/3 revolution for each revolution of the sun gear.



Planetary Gear Unit Powerflow The high and low clutch sleeve is used to engage the planetary gear set to provide gear reduction for low speed, and to connect the input shaft to the output shaft for high speed operation.

H2 and H4 Position In the high position (H2 or H4), the clutch sleeve locks the input shaft to the rear output shaft. The high and low clutch sleeve slides over the splines of the high and low clutch hub. As it moves to the left its internal splines engage the input shaft splines and locks the input shaft to the output shaft.

H2 and H4 Position

In the high position, the engine power is transmitted directly from the transfer input shaft to the rear output shaft.

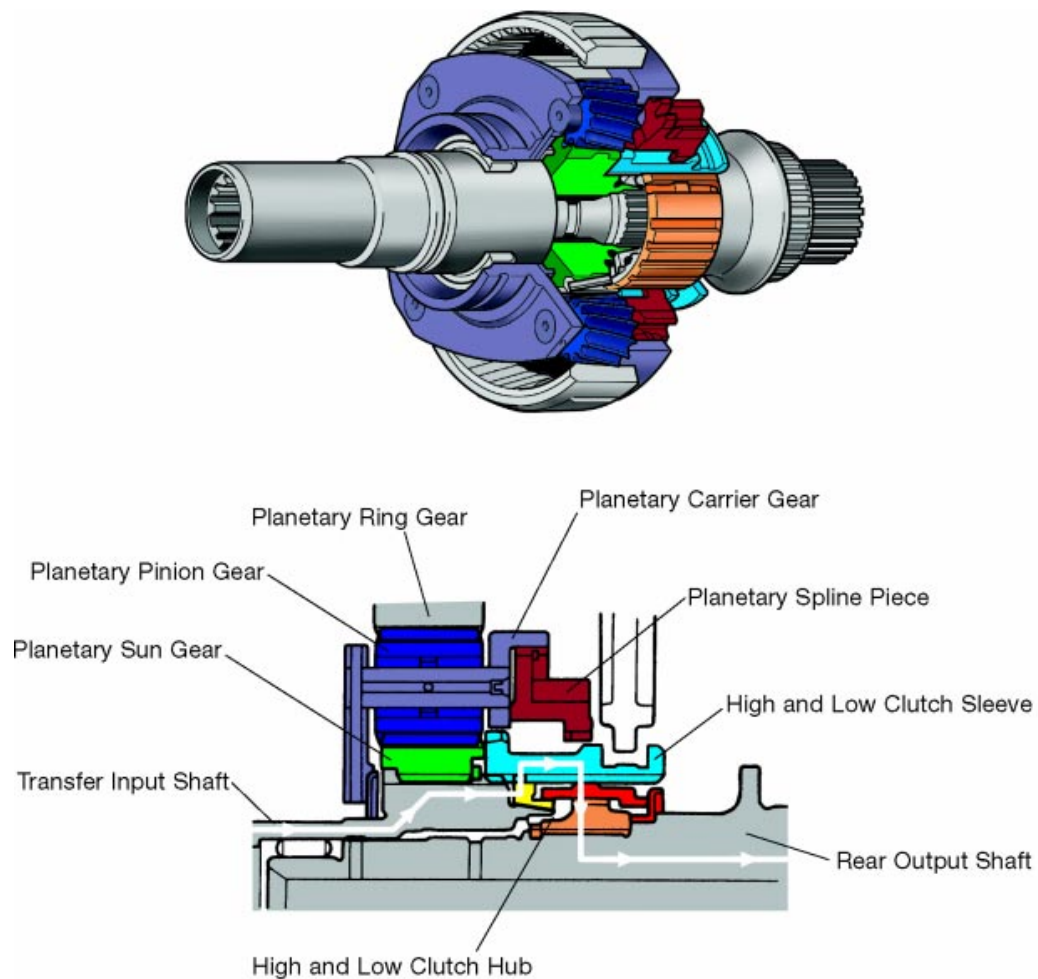


Fig. 5-8
T3021508

L4 Position In the L4 position, the engine power is transmitted from the input shaft to the output shaft through the planetary gear unit. The high and low clutch sleeve moves to the right and is now engaged with the planetary spline piece and the planetary carrier. The sun gear drives the pinion gears and causes the carrier to rotate at a slower speed. Gear reduction occurs at this time, causing the output shaft to rotate at a slower speed than the input shaft.

L4 Position

In this position, the engine power is transmitted from the input shaft to the output shaft, through the planetary gear unit.

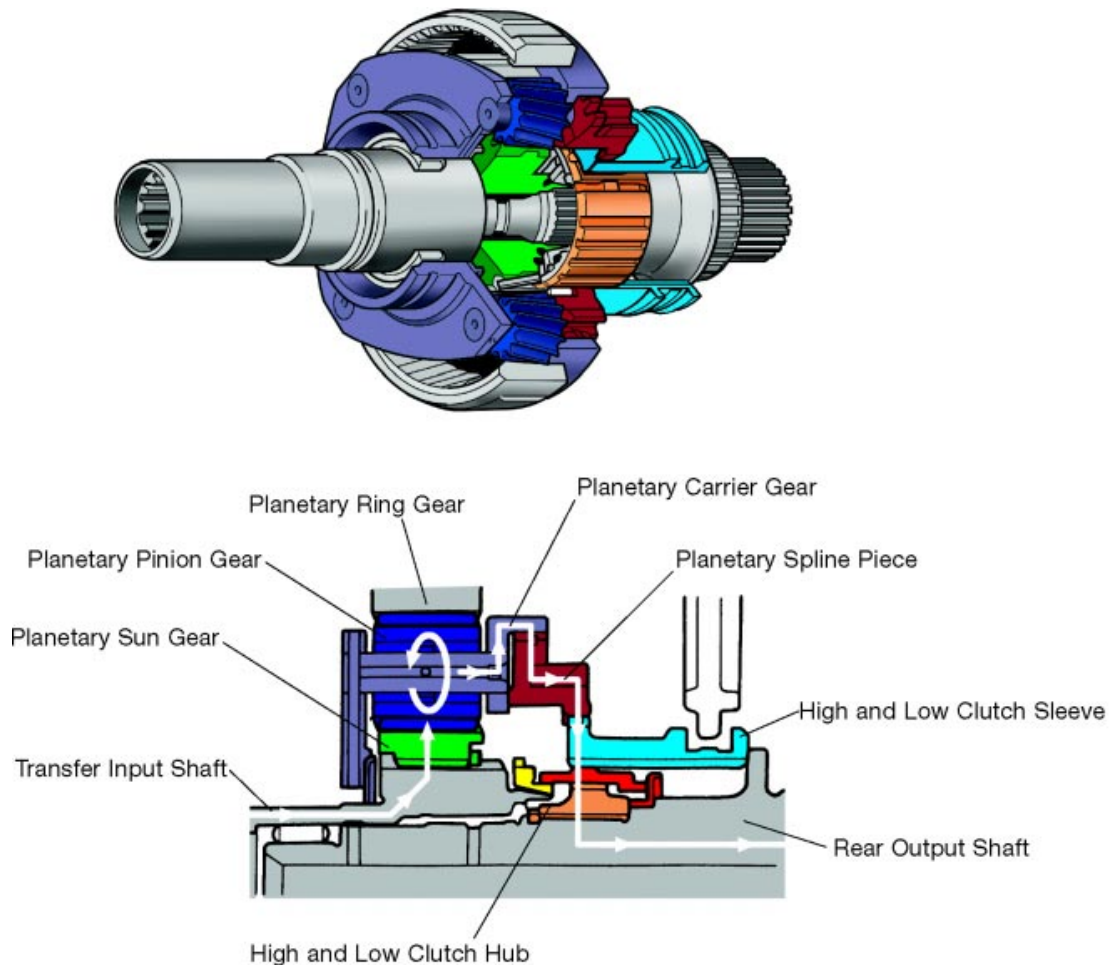
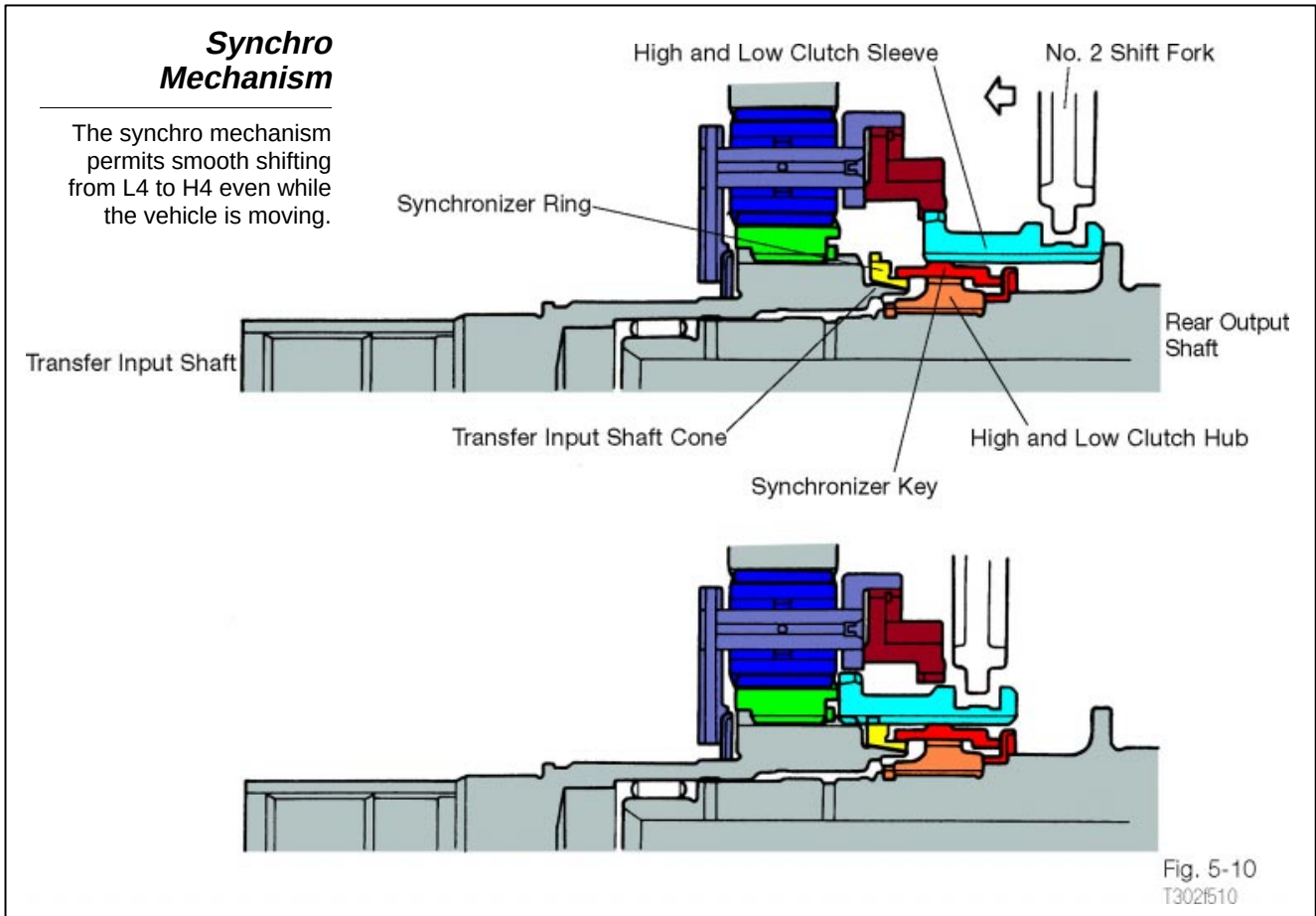


Fig. 5-9
T302f509

Synchro Mechanism The **synchro mechanism** permits smooth shifting from L4 to H4 even while the vehicle is moving. The clutch pedal must be depressed when shifting the lever from L4 to the H4 position.



Operation When the transfer shift lever is shifted from the L4 to the H4 position, the No. 2 shift fork moves to the left. The high and low clutch sleeve also moves to the left, causing the key to push the synchronizer ring against the cone at the rear of the transfer input shaft, causing synchronization.

While moving in L4, the speed of the input shaft is faster than the output shaft due to the action of the planetary gear unit. When the transfer is shifted to the H4 position, the synchro mechanism slows the input shaft and both shafts rotate at the same speed. The high and low clutch sleeve moves to engage the input shaft.

Since no synchro mechanism is provided for shifting from H4 into L4, the vehicle must be stopped for this shift to occur without gear noise. Even when the vehicle speed is 5 mph (8 km/h) or lower, gear noise will be generated when shifting to L4, so it is advised that the vehicle is stopped before making the shift.

Center Differential

All-wheel-drive (AWD) vehicles incorporate a differential between the front and the rear drive axles, because the front wheels travel a different distance through a turn than the rear wheels.

Center Differential

All-wheel-drive vehicles need a differential between the front and rear axles, as well as one on each axle between each of the wheels.

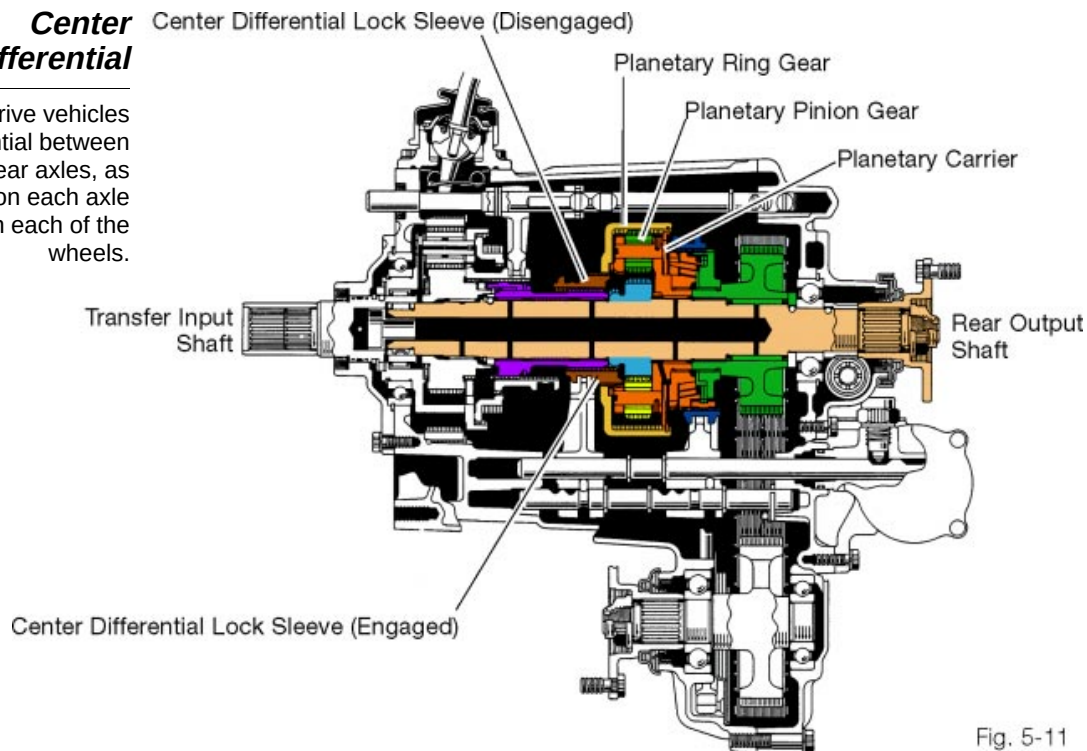


Fig. 5-11
T3021511

Center Differential Construction

The double pinion planetary gear type center differential consists of a planetary ring gear, a planetary sun gear, a planetary carrier and three pairs of planetary pinion gears.

Center Differential Construction

The double pinion planetary gear type center differential consists of a planetary ring gear, a planetary sun gear, a planetary carrier and six planetary pinion gears.

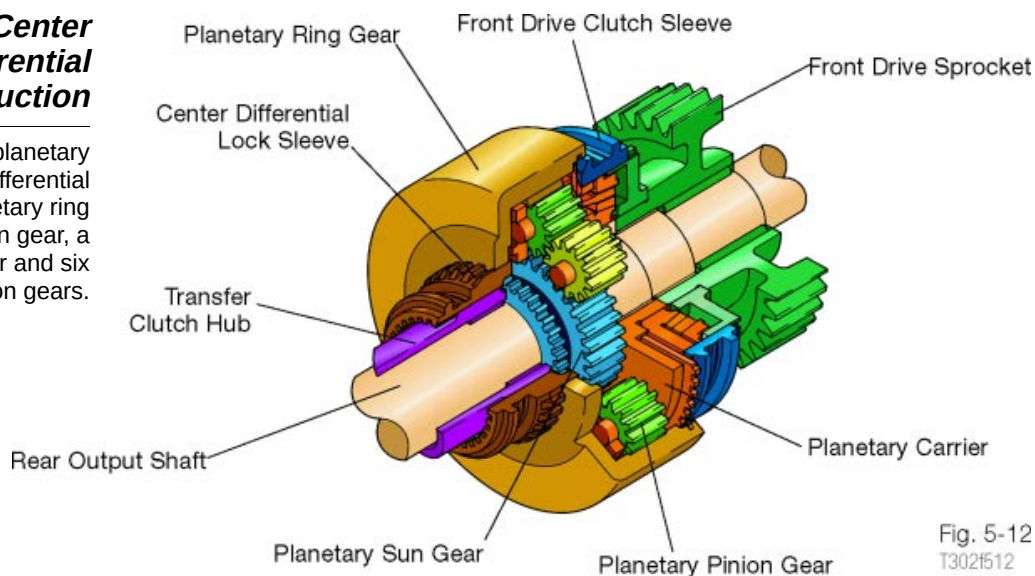


Fig. 5-12
T3021512

Three sets of planetary pinion gears, which are meshed in pairs are enclosed in the planetary carrier. The outer planetary pinion gear is meshed with the planetary ring gear and the inner gear is meshed with the planetary sun gear of the rear output shaft.

The drive force from the transfer clutch hub is transmitted to the planetary ring gear via the center differential lock sleeve. The planetary carrier transmits the drive force to the front wheels and the planetary sun gear transmits the drive force to the rear wheels.

Additionally, a center differential lock mechanism is provided in the front of the center differential.

Center Differential Operation The **center differential** uses planetary gears to distribute power between the front and rear axles.

Free Mode - Vehicle Travelling in a Straight Line When the vehicle is moving in a straight line, there is practically no speed difference between the front and rear wheels. In this case, the transfer clutch hub, front drive sprocket and rear output shaft rotate at the same speed with the center differential. The driving force from the transfer clutch hub is transmitted to the front and rear wheels through the planetary ring gear to the planetary pinion carrier and planetary sun gear.

Free Mode - Vehicle Traveling in Straight Line

The driving force from the transfer clutch hub is transmitted to the front and rear wheels from the planetary pinion carrier and planetary sun gear.

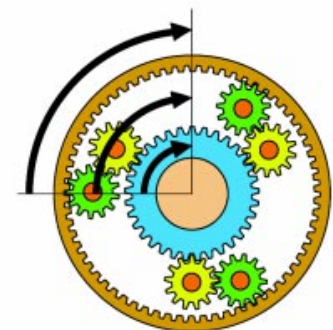
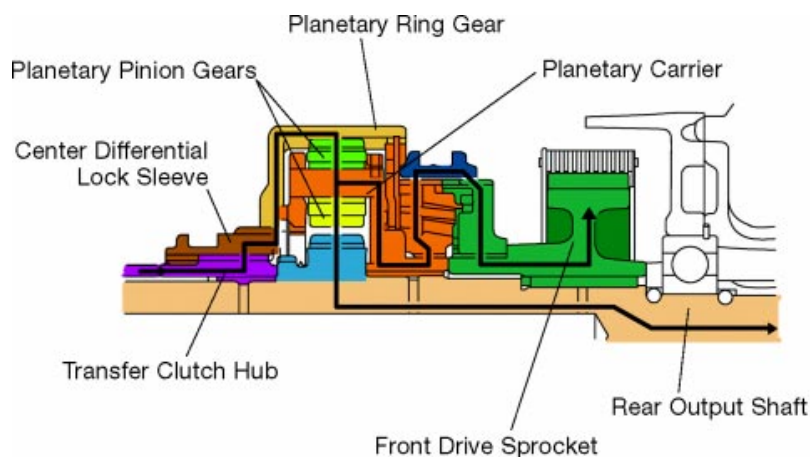


Fig. 5-13
T3021513

Free Mode - Vehicle Turning - If a speed difference is generated between the front and rear wheels because of a turn, the planetary pinion gears of the center differential rotate and absorb the speed difference. As a result, the planetary carrier rotates faster, but in the same direction as the planetary ring gear. This causes the outer pinion gear to rotate in the opposite direction while revolving around the ring gear in the same direction. The inner pinion gear rotates in the same direction as the ring gear and the rotation of the rear output shaft becomes slower than the drive sprocket by the amount of the rotating pinion gear.

Free Mode - Vehicle Turning

If a speed difference is generated between the front and rear wheels because of a turn, the planetary pinion of the center differential rotates and absorbs the speed difference.

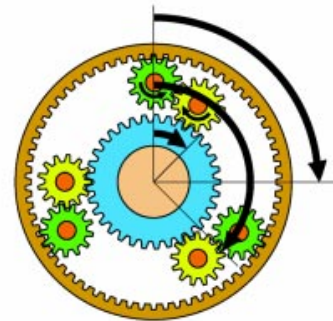
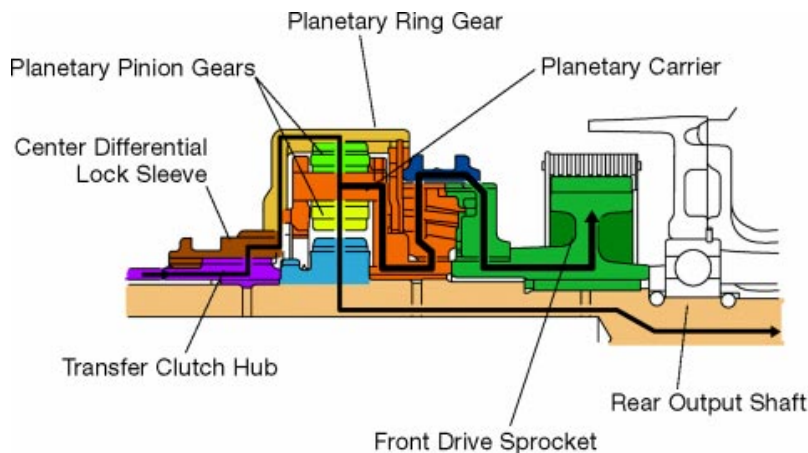


Fig. 5-14
T302F514

Lock Mode The center differential, much like the front and rear differentials in the axles, is an open differential distributing torque to the axle with the least traction. When in four-wheel drive mode, if one wheel is suspended or lost its traction, all the torque is sent to axle of the wheel with the least traction and the vehicle is stuck. By locking the center differential, torque is distributed to each propeller shaft equally, just like a part time or conventional transfer case, and the wheels on the opposite axle will move the vehicle.

The center differential lock sleeve moves to the right, enabling the inner teeth of the center differential lock sleeve to mesh with the rear output shaft. As a result, the center differential stops operating and is locked.

Lock Mode

The center differential lock sleeve locks the ring gear to the sun gear driving the front and rear axles equally.

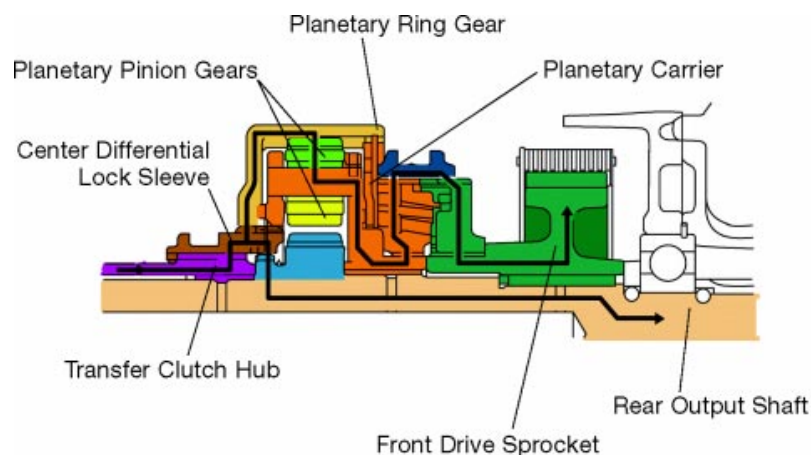


Fig. 5-15
T302515

NOTE

AWD vehicles should have four equal diameter tires, since unequal diameters create dissimilar axle speeds. Dissimilar axle speeds cause increased wear at the drive axle and/or center differential.

Torsen Limited Slip Differential

The Torsen Limited Slip Center Differential (LSD) is installed in the full-time and multi-mode electric shift transfer case found in the 2003 and later 4Runner. The Torsen LSD cannot be disassembled and is replaced as an assembly. As with the multi-mode center differential, it has a planetary gear set constructed of a sun gear, a ring gear and planetary gears connected to a planetary carrier. Additional

components include four clutch plates that assist the distribution of torque to the wheels with traction. The unit instantly applies the clutches to distribute torque and compensate for differences in front wheel speed to rear wheel speed.

Torsen Limited Slip Differential

The Torsen LSD has a planetary gear set made up of a sun gear, ring gear, planetary gears and a planetary carrier.

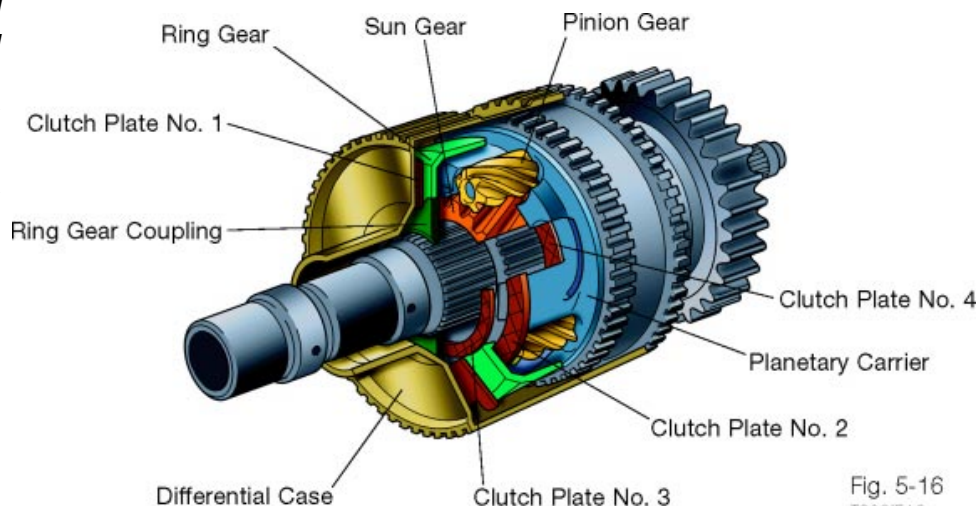


Fig. 5-16
T302F516

The differential case is driven by the high and low clutch sleeve that engages the planetary gear set. Depending on the high/low clutch sleeve, it will drive the differential case in high gear or low gear. The differential case drives the planetary carrier and eight pinion gears. These pinion gears are helically cut and drive the ring gear and sun gear that are connected to the two drive shafts. The sun gear is connected to the front output shaft and the ring gear is connected to the rear output shaft. When the vehicle is driven in a straight line the pinions do not rotate within the carrier and torque is transmitted equally to each drive shaft.

Operation

The differential case drives the planetary carrier and eight pinion gears that drive the ring gear and sun gear

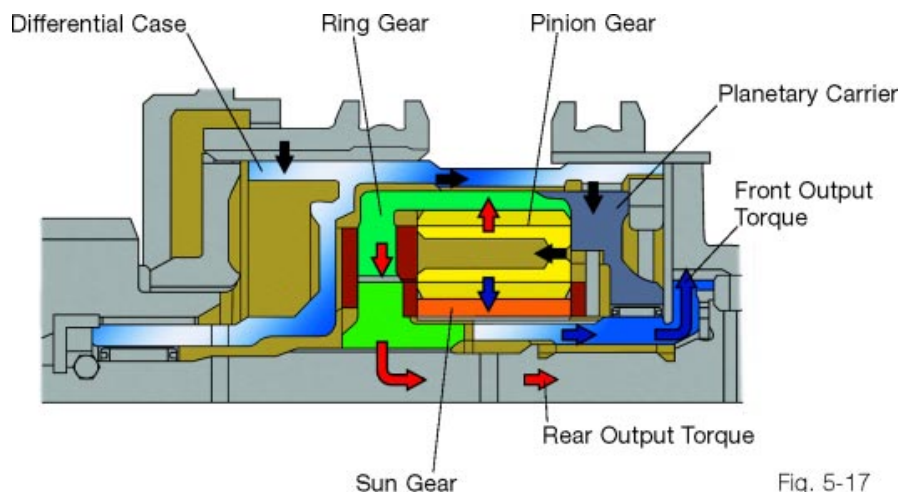


Fig. 5-17
T302F517

When turning corners without wheel slippage, the pinion gears rotate to distribute the torque proportionately according to the speed of the drive shafts. When the front drive shaft exceeds the speed of the rear drive shaft, beyond the normal difference that would be experienced while cornering, the sun gear rotates faster than the ring gear. The helical cut of the gears causes the sun gear to be thrust toward clutch plate No. 4 that transfers torque to the planetary carrier and differential case. The pinion gears exert a smaller amount of thrust to the ring gear pushing against clutch plate No. 1 and the differential case. Additional torque is exerted through clutch plate No. 1 to the ring gear and to the rear drive shaft.

Front Wheel Slippage

When the front drive shaft spins faster than the Rear drive shaft, the sun gear and ring gear create thrust that transfers torque to the axle with traction.

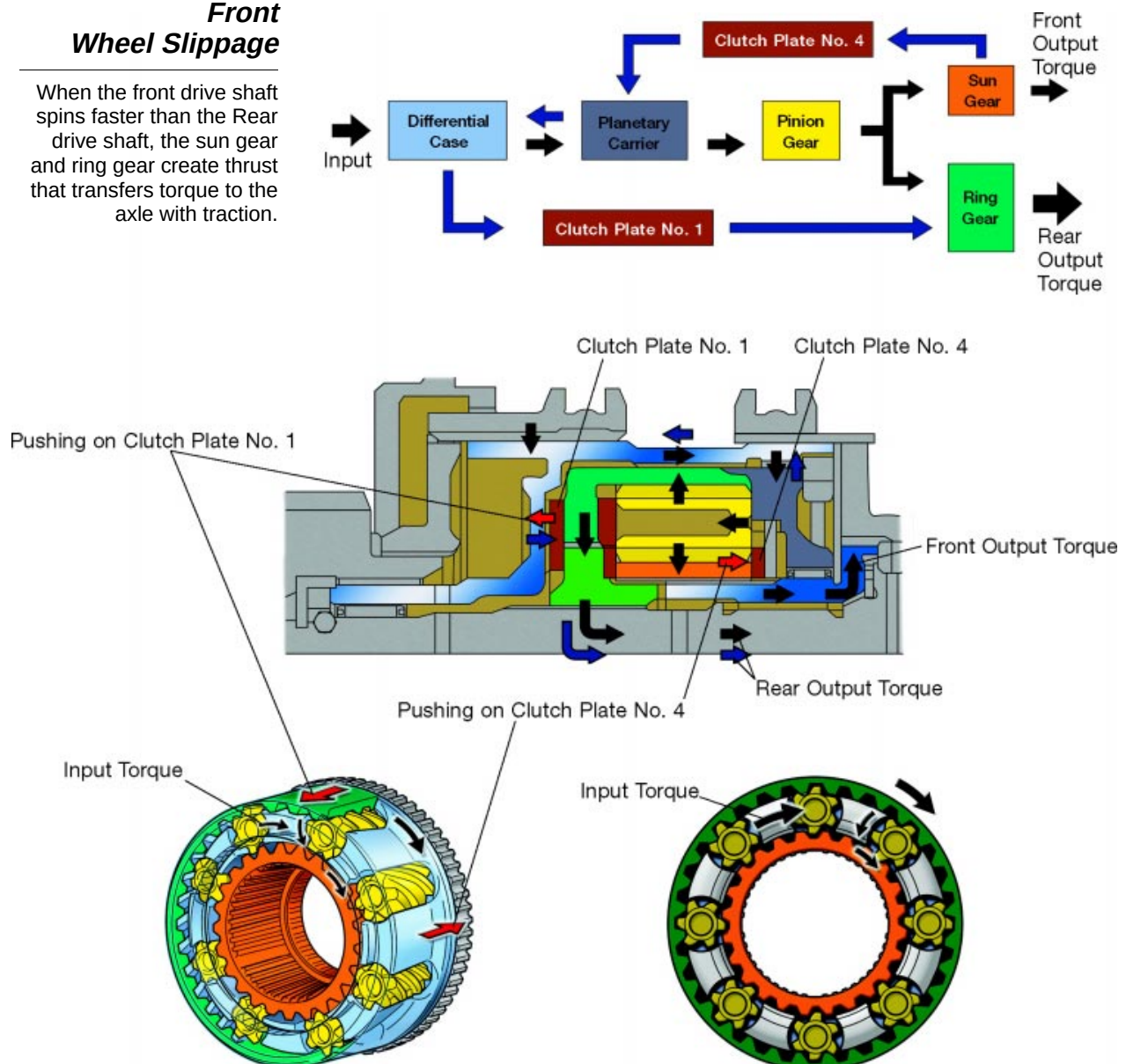


Fig. 5-18
T302/518

Similarly, when the rear drive shaft speed exceeds the speed of the front shaft, the ring gear creates the larger amount of thrust against clutch plate No.1 and the differential case and carrier drive the sun gear through clutch plate No.4 and provides added torque to the front drive shaft.

Shift Mechanism

The **shift mechanism** is used to provide a smooth engagement for shifting from H2 to H4 and L4 ranges. It features:

- A direct control type transfer shift lever that controls two shift fork shafts.
- A shift shaft interlock mechanism used to ensure that low range is only selected when in four-wheel drive.
- Detents are used to provide shift feel.
- A wait mechanism is used for shifting from H4 to H2.

Shift Mechanism

The shift mechanism provides for a smooth engagement for shifting from H2 to L4 and H4 ranges.

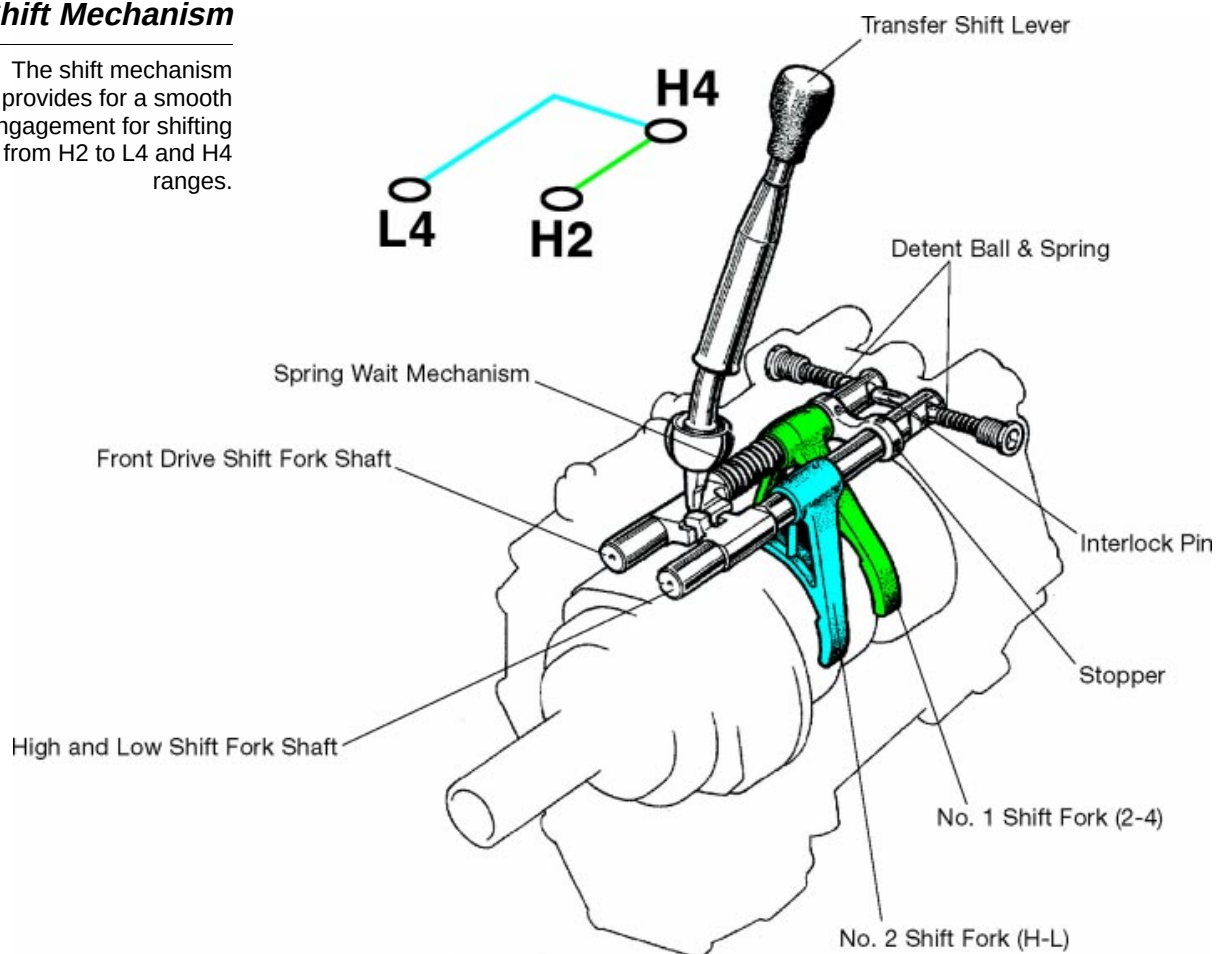


Fig. 5-19
T3021519

Shifting from H2 into H4 Position

In the H2 position, low gear is locked out by the interlock pin between the high and low shift fork shaft and the front drive shift fork shaft. When shifting from H2 to H4, the front drive clutch sleeve moves to the left to couple the output shaft to the drive sprocket and silent chain that drives the front propeller shaft.

Shifting from H2 into H4 Position

When shifting from H2 to H4, the front drive clutch sleeve moves to the left to couple the output shaft to the drive sprocket for the silent chain that drives the front propeller shaft.

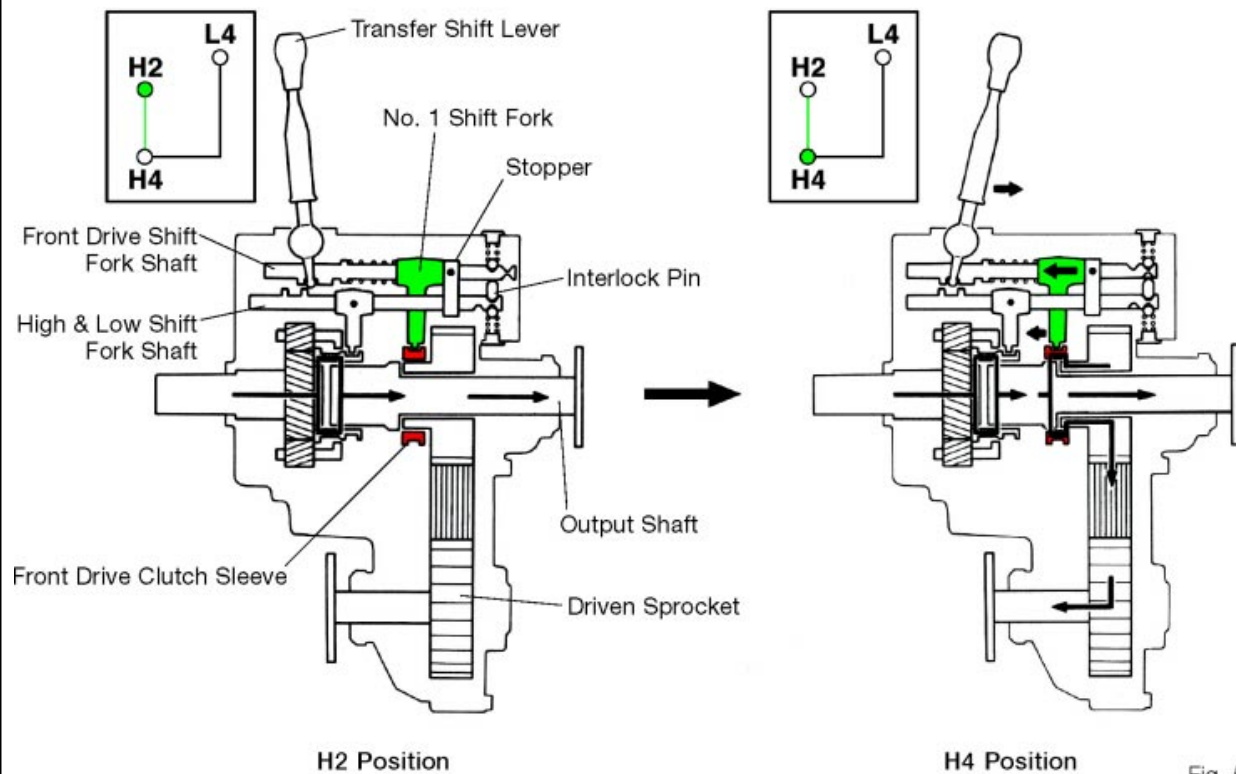


Fig. 5-20
T3021520

Shifting from H4 into L4 Position In the H4 position, the interlock pin allows the high and low shift fork shaft to move from the high position to the low position. When the high and low shift fork shaft is moved to the right, the interlock pin moves up into the groove of the high and low shift fork shaft, engaging L4.

Shifting from H4 into L4 Position

In the H4 position, the interlock pin allows the high and low shift fork shaft to move from the high position to the low position.

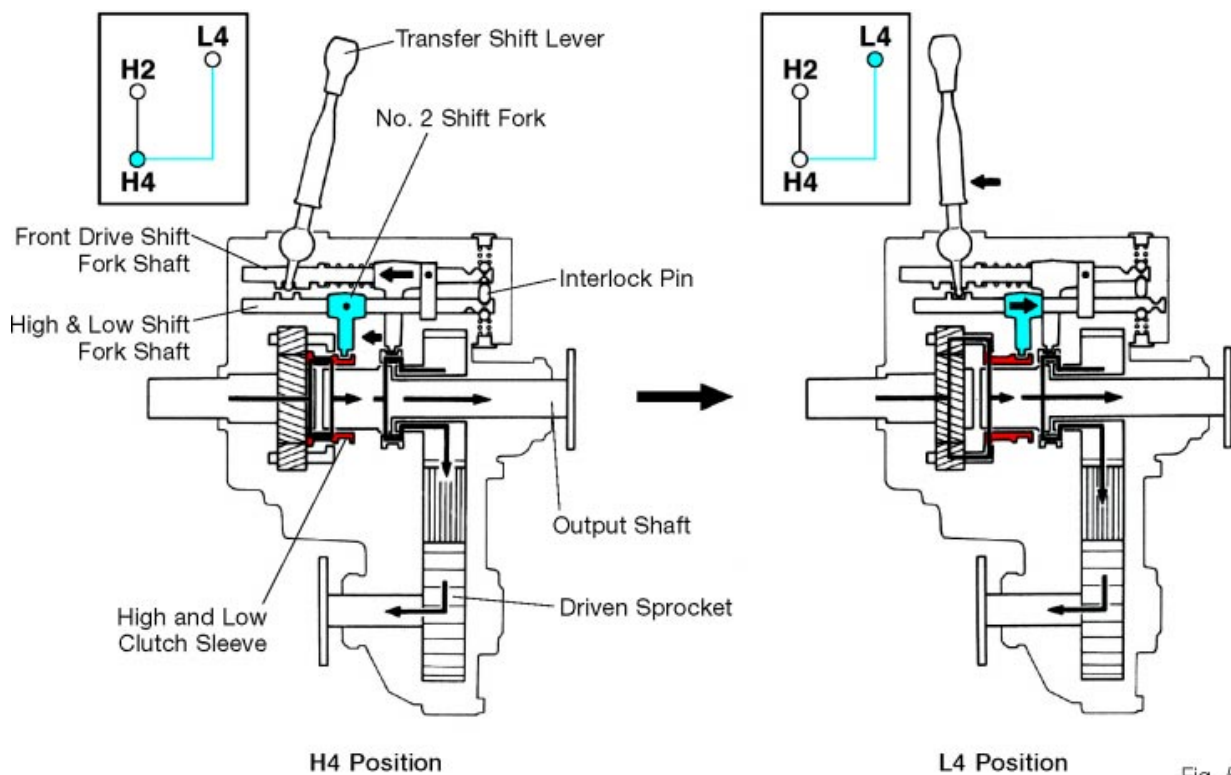
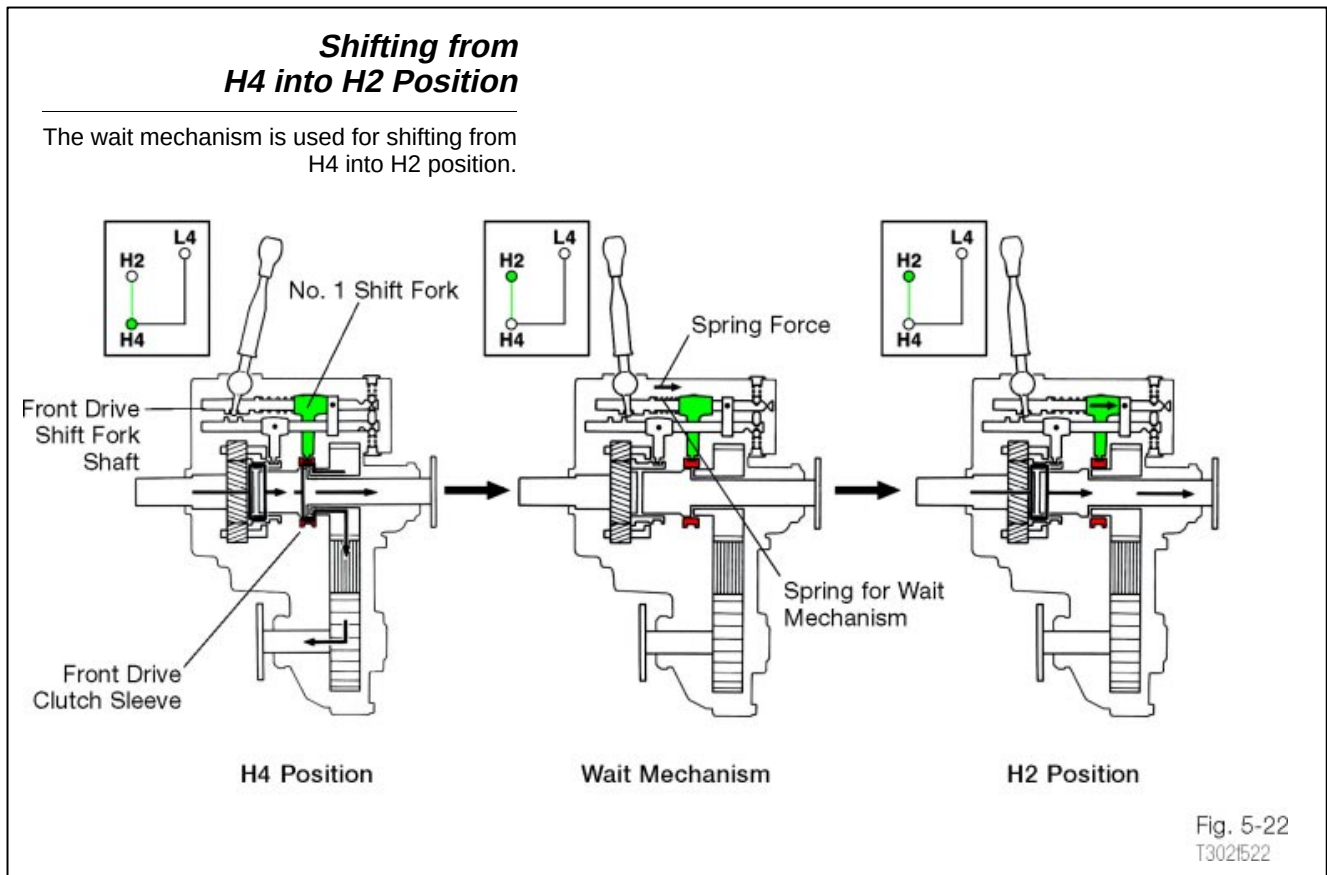


Fig. 5-21
T302f521

Wait Mechanism The **wait mechanism** is used for shifting from H4 into H2 position. When the front drive shift fork shaft moves to the right, the front drive shift fork will not move until the torque is removed from the front drive clutch sleeve. The compression spring pushes against the front drive shift fork No. 1. When torque is removed, front drive shift fork No. 1 and sleeve are pushed to the right by the spring force. The transfer case is now in H2 position.



Electric Shift Control

Electrical control of the transfer case functions is accomplished by means of a transfer shift actuator controlled by the 4WD control ECU. The ECU relies on input from the driver operated 2-4 switch and high-low switch or in some cases the differential lock switch. The ECU receives input from sensors—the 4WD and L4 position switches—that monitor transfer case shift shaft position to determine engagement. The ECU then engages the A.D.D (This topic is handled separately later in this section). actuator to lock the front differential. In addition, the ECU controls indicator lights mounted in the combination meter to indicate when H4 or L4 are engaged or, depending on the vehicle, when the locking differential is engaged. The indicator light on the switch will flash while this electric shift control is happening. This sequence of events is shown in figure 5-20.

Electric Shift ECU Control

Electric ECU control of the 4WD system follows a specific sequence of events from the time the switch is activated to the time the indicator light illuminates.

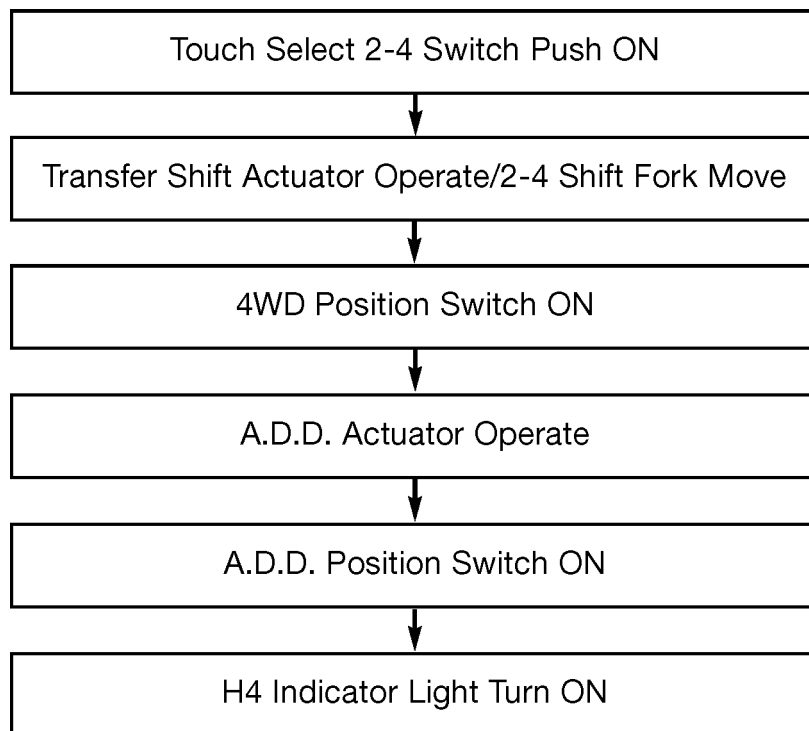


Fig. 5-23

Electric Shift Control

Electrical control of the transfer case functions is accomplished by means of a Transfer Shift Actuator controlled by the 4WD Control ECU.

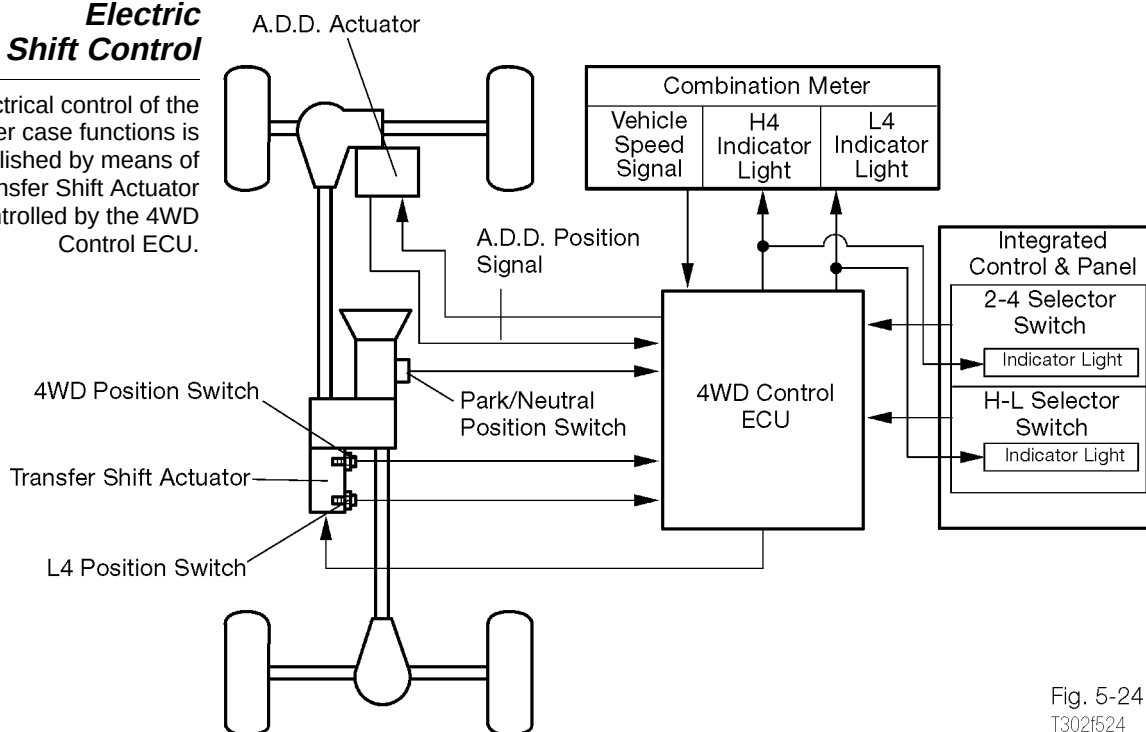


Fig. 5-24
T302f524

Transfer Shift Actuator The **transfer shift actuator** consists of an electrical motor driven screw gear that turns the driven gear and contact plate. The limit switches maintain contact with the contact plate, providing a position signal to ECU. Open gaps in the plate cause the motor circuit to open at precisely the right time in the driven gear's rotation to stop shift shaft movement. For this reason the actuator should never be removed without the shift shaft as the entire assembly is timed to the contact plate.

The driven gear turns the shaft and final gear that causes the transfer shift shaft and shift fork to move back and forth in the transfer case. A spring loaded wait mechanism separates the driven gear from the final gear so that during a shift from 4WD to 2WD, when tension at the 2WD/4WD clutch sleeve is released, it can move the clutch sleeve and release the front drive shaft.

Transfer Shift Actuator

The transfer shift actuator consists of an electrical motor driven screw gear that turns the driven gear and contact plate.

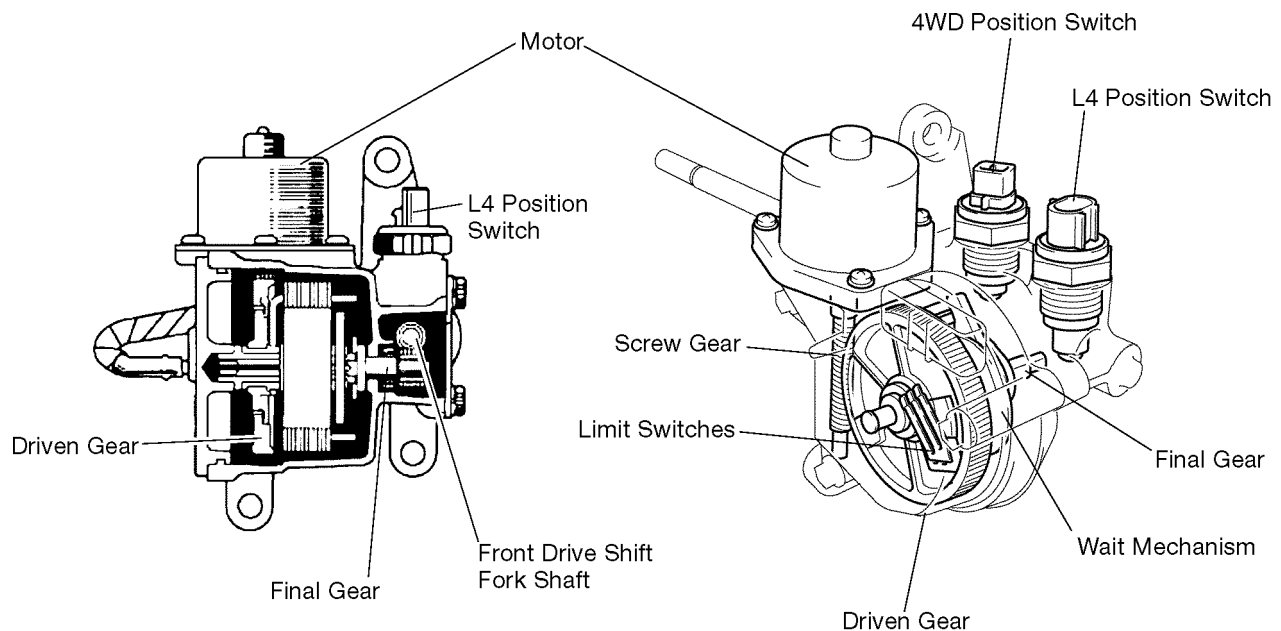


Fig. 5-25
T302/525

Motor Control Circuit The ECU controls the motor and monitors its position with the limit switches. When selecting H4 from H2 or L4 from H4, the 4WD Control ECU switches current to flow to actuator terminal 1 through the motor to terminal 2.

The monitoring path to ground in a H4 from H2 shift is through ECU terminal TL3 to actuator terminal 5 and the H2 contact plate through the sliding limit switch to terminal 4 and ground. When the sliding contact reaches the open gap at the H4 position shown in the illustration, the ground circuit is opened and the ECU shuts down the motor.

The monitoring path to ground in a L4 from H4 shift is through ECU terminal TL2 to actuator terminal 6 and the H4 contact plate through the sliding limit switch to terminal 4 and ground. When the sliding contact reaches the open gap at the L4 position shown in the illustration, the ground circuit is opened and the ECU shuts down the motor.

When selecting H4 from L4 or H2 from H4, the 4WD Control ECU switches current to flow to actuator terminal 2 through the motor to terminal 1 causing the motor to turn in the opposite direction which causes the shift shaft to move in the opposite direction also.

The monitoring path to ground in a H4 from L4 shift is through ECU terminal TL1 to actuator terminal 3 and the L4 contact plate through the sliding limit switch to terminal 4 and ground. When the sliding contact reaches the open gap at the H4 position shown in the illustration, the ground circuit is opened and the ECU shuts down the motor.

Transfer Shift Actuator Electric Motor Circuit

The ECU controls the motor and monitors its position with the limit switches.

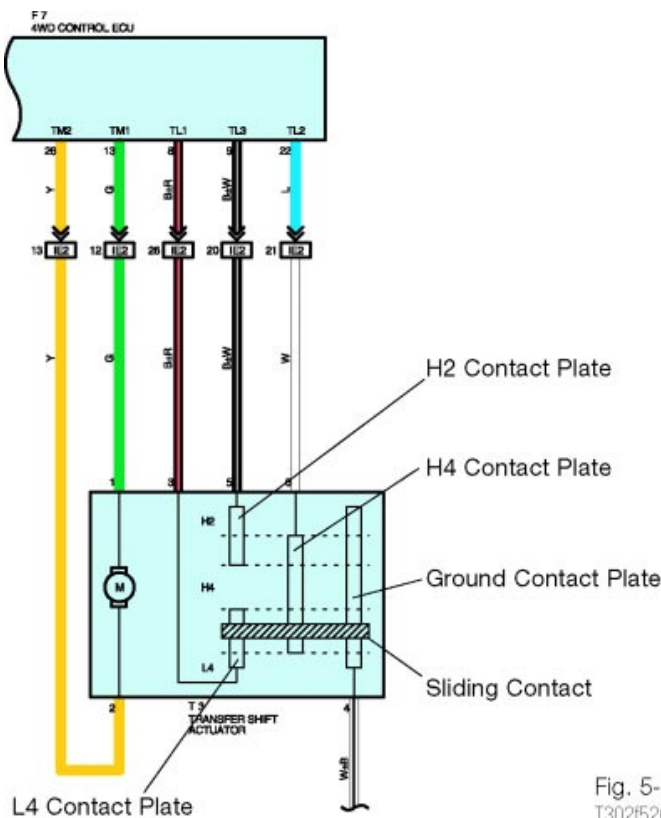


Fig. 5-26
T3021526

Position Switches The 4WD and L4 position switches monitor the shift shaft position and can be mounted to the transfer case or to the actuator body. These switches are normally open and when the shift shaft passes by the switch the plunger rises to close the switch, notifying the ECU of the transfer shift position. The ECU uses this input to activate the A.D.D. actuator on the front differential.

Position Switches

The 4WD and L4 Position switches monitor the shift shaft position and can be mounted to the transfer case or to the actuator body.

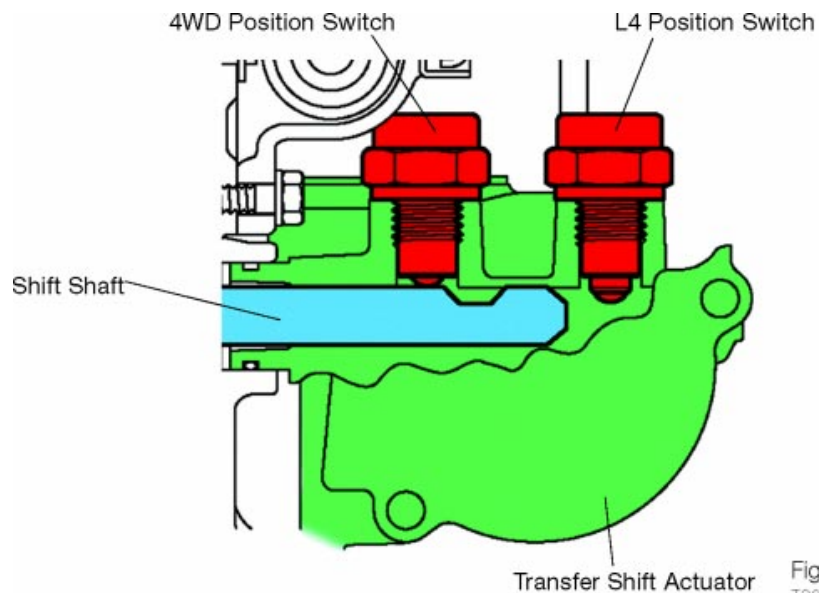


Fig. 5-27
T3021527

Electric Shift Control Types The transfer case actuator is mounted to the rear of the transfer case. Electric control of the transfer case functions is accomplished in different ways for different types of four wheel drive systems:

- There are two types of electrical control in **part-time** transfer cases:
 - In the first type the high and low synchronizer assembly is engaged and disengaged using a floor mounted shift lever and the 2WD/4WD synchronizer assembly is engaged by a single electrical motor transfer shift actuator.
 - In the second type—fully electric control transfer cases—the high/low shift and 2WD/4WD shift is accomplished by a single electrical motor transfer shift actuator.
- In **full-time** transfer cases, there are two electrical motors to control the transfer case; the high and low synchronizer assembly and another dedicated to the center differential lock function.
- In **multi-mode** transfer cases the high and low synchronizer assembly is engaged and disengaged using a floor mounted shift lever and 2WD/4WD and center differential lock are controlled by the transfer shift actuator.

Part Time Electric Shift Operation The electrical shift control moves a single shift fork shaft to accomplish 2WD/4WD as well as high/low range. It accomplishes this through the use of snap rings and interlock pins that function with a stationary transfer shift fork shaft. When selecting low range 4WD, the transfer has to select 4WD first and then low range is selected similar to manual shift mechanism.

Part-Time Electric Shift Transfer Case

The electrical shift control moves a single shift fork shaft to accomplish 2WD/4WD as well as high/low range.

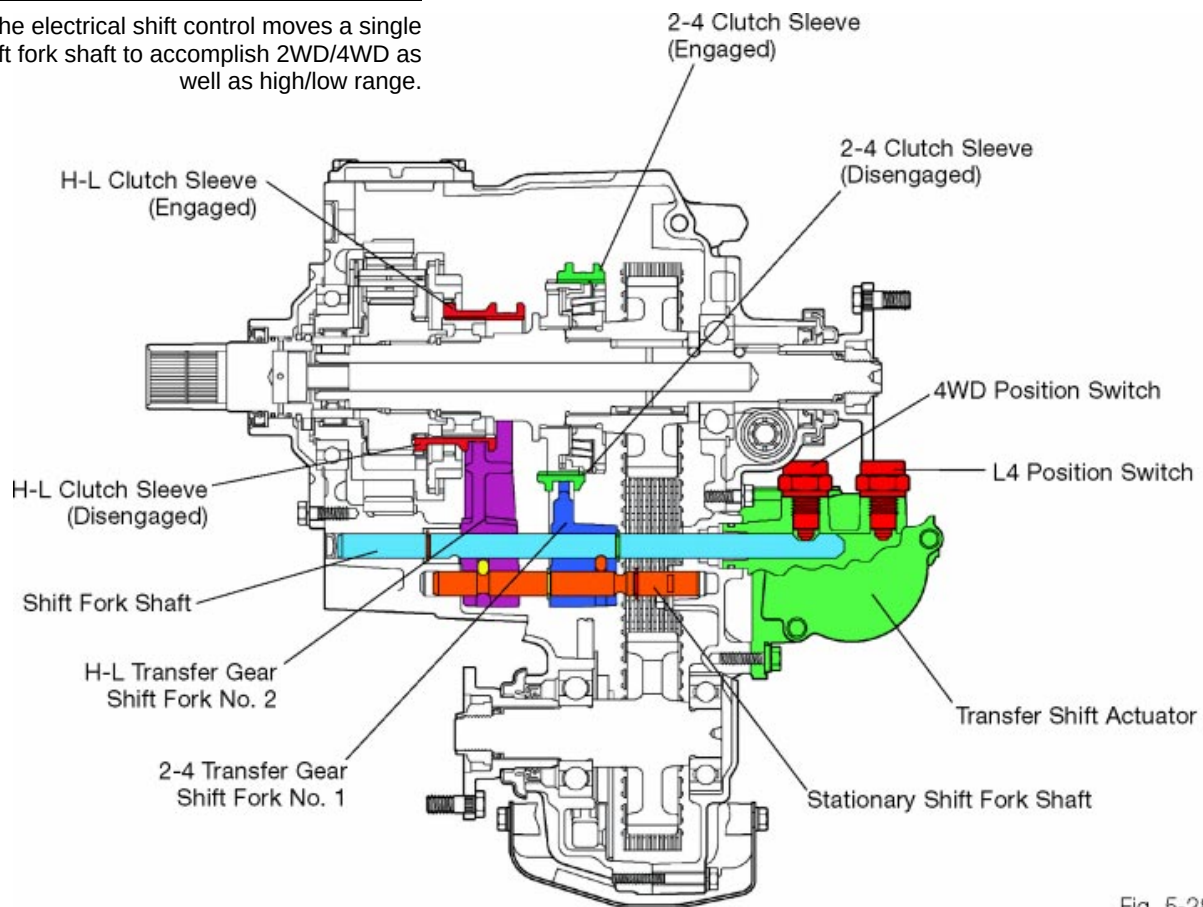


Fig. 5-28
T302f528

Shifting from H2 to H4 When shifting from H2 to H4, interlock pin A (as shown in figure 5-24) locks the 2-4 shift fork to the shift fork shaft so that when the actuator moves the shift fork shaft to the right, the shift fork moves the synchronizer sleeve to engage 4WD. The shift fork stops when it contacts snap ring C (as shown in figure 5-24) on the stationary shift shaft and the interlock pin drops into the shafts groove.

Shifting from H2 to H4

Interlock pin A locks the 2-4 shift fork to the shift fork shaft so when the actuator moves the shift fork shaft to the right, the shift fork moves the synchronizer sleeve to engage 4WD.

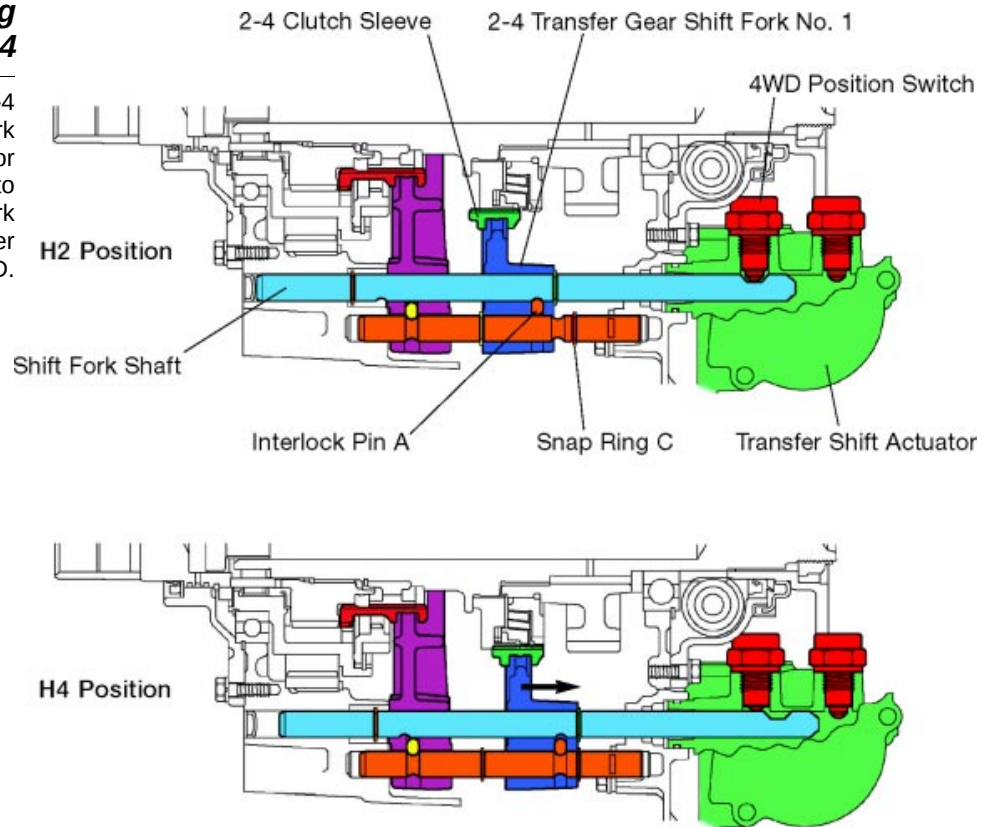


Fig. 5-29
T302f529

Shifting from H4 to L4 When shifting from H4 to L4, the actuator continues to move the shift shaft to the right, and snap ring E pushes the high/low shift fork, forcing interlock pin B into the groove in the shift shaft. (As shown in figure 5-25) The high/low shift sleeve is engaged. Snap ring D on the stationary shift fork shaft limits the high/low shift fork travel.

Shifting from H4 to L4

The actuator continues to move the shift shaft to the right, until the groove in the shift shaft picks up the high/low interlock pin B and moves the high low shift fork to engage the high/low shift sleeve.

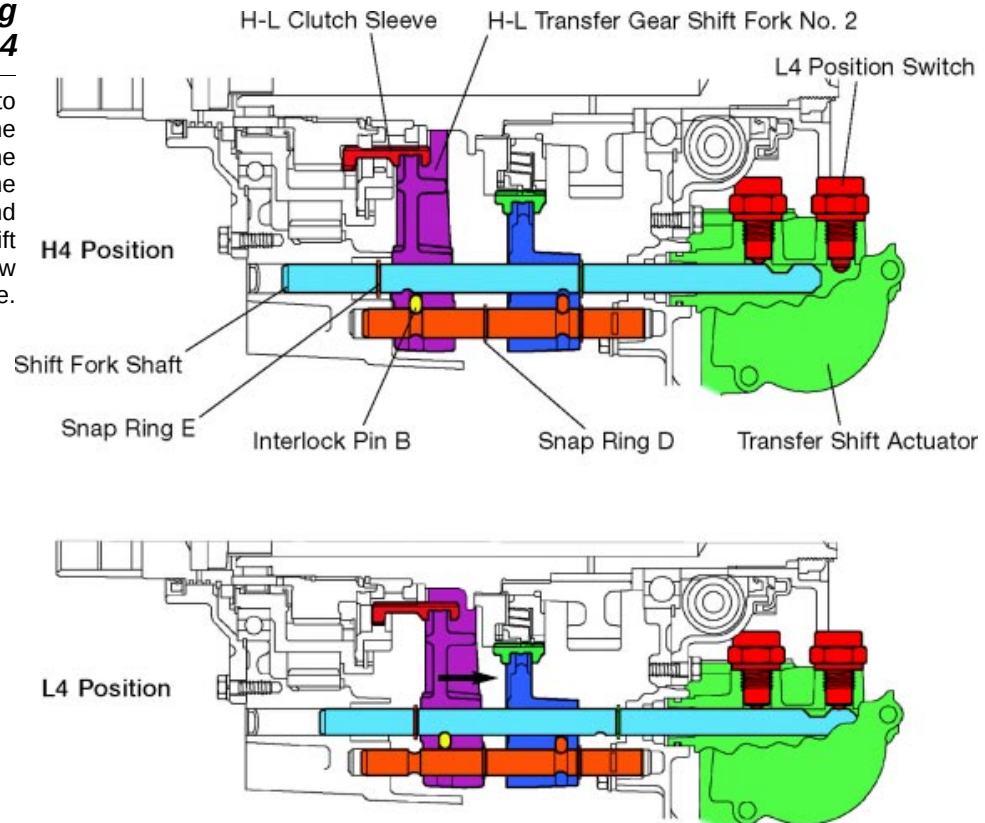


Fig. 5-30
T3021530

Full-Time Electrical Shift Operation

The full time transfer case electrical shift control is accomplished with one transfer shift actuator, housing two separate electrical motors and shift shafts. The motors are controlled by the 4WD control ECU based on the operation of the 4WD Control Switch and the center differential lock switch. The high/low shift motor controls the high/low shift shaft and shift fork. The center differential lock motor controls the center differential lock shift shaft and shift fork. Contact point switches in the actuator limit the travel of the shift forks. The transfer shift actuator is not serviceable and is replaced if found to be faulty.

Full-Time Electrical Shift Transfer Case

The full time transfer case electrical shift control is accomplished with one transfer shift actuator, housing two separate electrical motors and shift shafts.

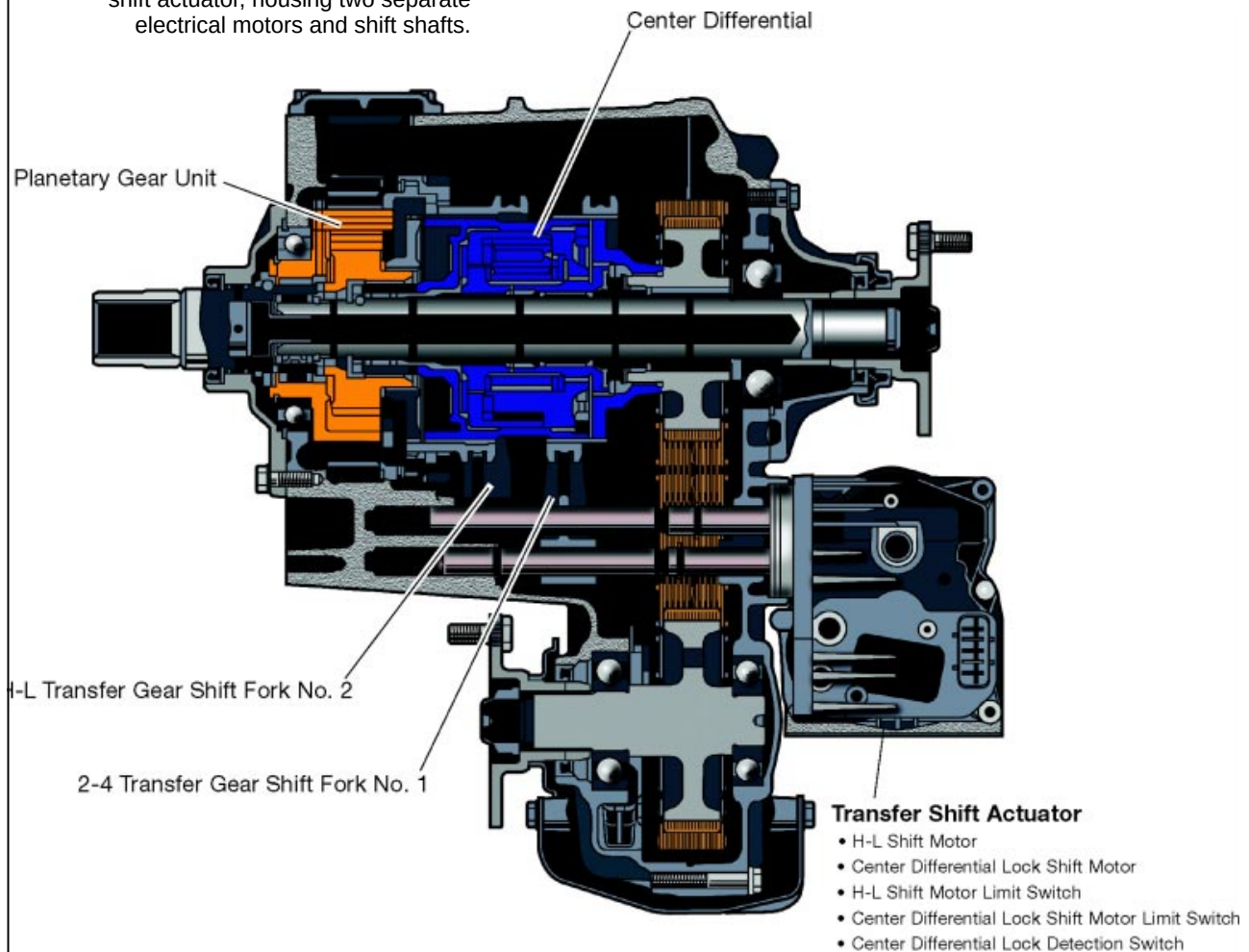


Fig. 5-31
T3021531

Multi-Mode Electrical Shift Operation

In multi-mode shift operation, the function of the actuator, the single shift rail and the interlock pins are the same as the Part-Time system described earlier. But instead of high/low control, the forward shift fork controls the center differential lock.

Multi-Mode Electric Shift Transfer Case

In multi-mode shift operation the forward shift fork controls center the differential lock.

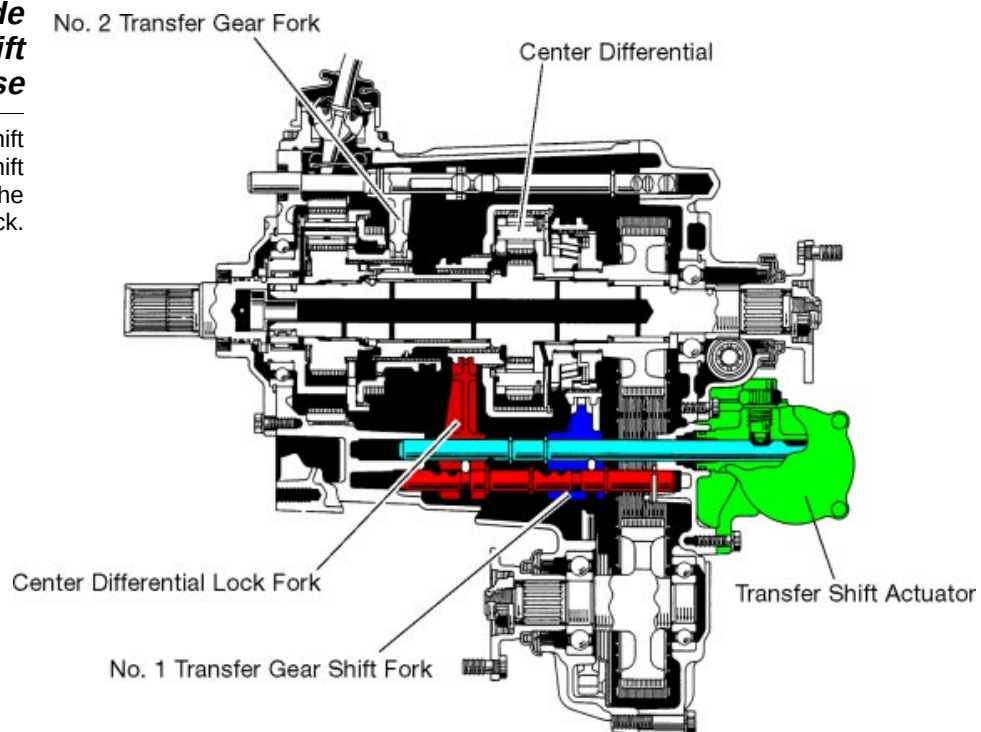


Fig. 5-32
T3021532

Automatic Disconnecting Differential (A.D.D.)

The purpose of Automatic Disconnecting Differential (A.D.D.) is to allow 4WD to be selected while the vehicle is moving because the front axle is locked following the shift to 4WD. The A.D.D. disengages the wheels from the powertrain in 2WD so the wheels do not drive the differential, the front propeller shaft and the silent chain components in the transfer case. In early 4WD systems, both front wheel hubs were locked to the front axles either manually or automatically when the vehicle was placed in 4WD. The A.D.D. system replaces the need for locking hubs.

The front drive axle is an open differential, which means if one wheel loses traction, all torque would go to the wheel with the least traction. This operation does not change when A.D.D. is activated.

The right axle in figure 5-28 below is connected to the differential side gear and intermediate shaft through a movable clutch sleeve. When the side gear is disconnected from the axle, the left drive axle still turns the left side gear but like a wheel with no traction, the pinion gears just rotate the right side gear. With proper lubrication and no load, wear to the differential components are negligible.

The A.D.D. locks the front drive axle to the differential side gear when four-wheel drive is selected. By coupling the side gear to the drive axle the front differential delivers torque to each front wheel.

Electric A.D.D. Actuator The actuator moves the clutch sleeve to engage the axle to the intermediate shaft and side gear. The actuator can be either vacuum or electric operated. The electric actuator uses a spring loaded wait mechanism to allow the splines of the intermediate shaft and clutch sleeve to match before the sleeve and shaft engage.

Electrical A.D.D. Actuator

The actuator moves the clutch sleeve to engage the axle to the intermediate shaft and side gear.

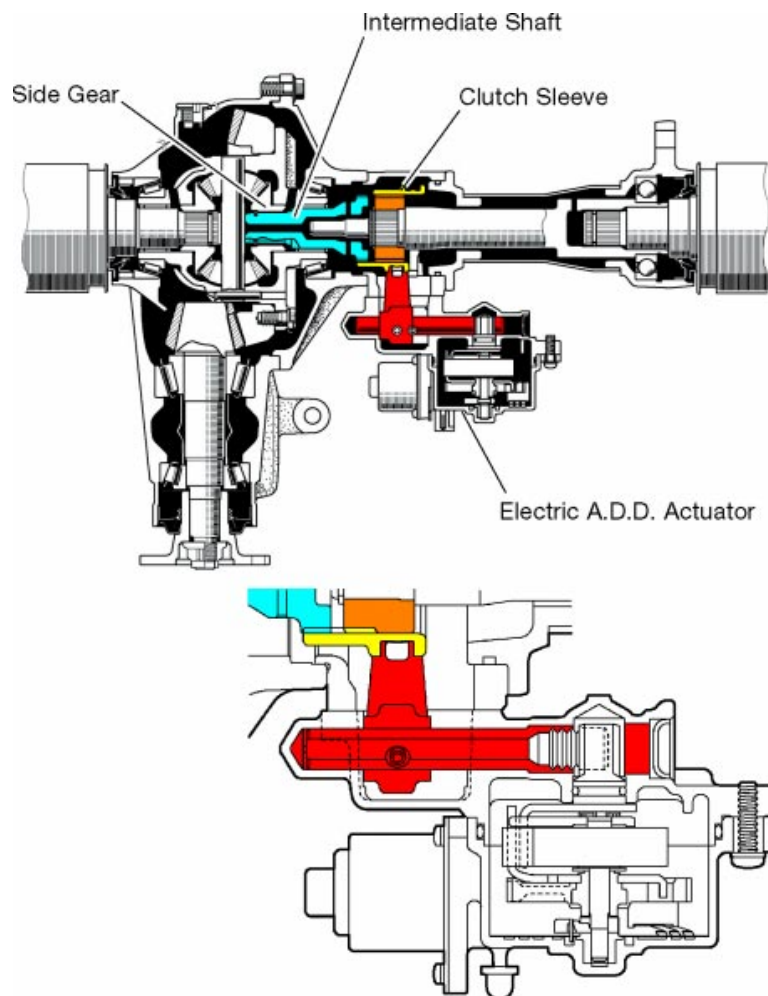


Fig. 5-33
T302#533

A.D.D. Electric Control Operation The 4WD control ECU controls the A.D.D. actuator and indicator lights in the combination meter. The actuator is activated whenever the transfer case is shifted into four-wheel drive. When the operator selects 4WD, the ECU waits for the 4WD position switch signal to activate the A.D.D. actuator. When the clutch sleeve engages the differential side gear, the A.D.D. position switch at the actuator closes to inform the ECU that the axle is engaged and the 4WD indicator light illuminates.

Electric A.D.D. Control

The 4WD control ECU controls the A.D.D. actuator and indicator lights in the combination meter. The actuator is activated whenever the transfer case is shifted into four-wheel drive.

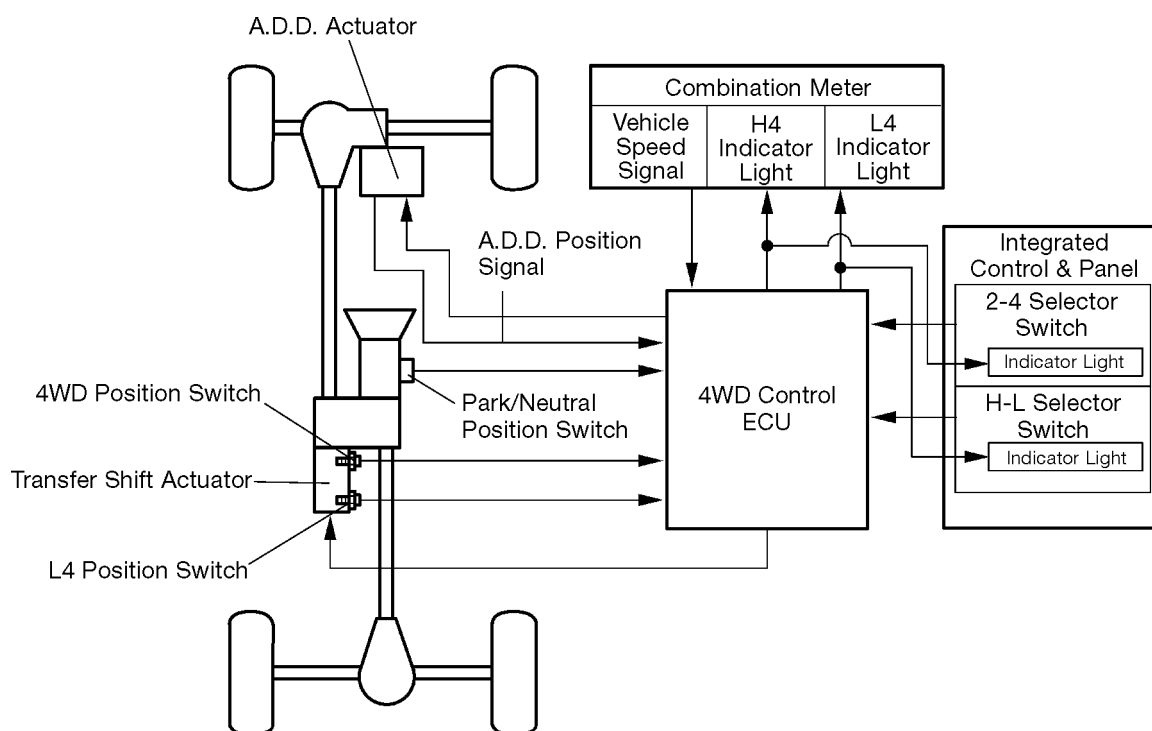


Fig. 5-34
T302f534

Vacuum A.D.D. Actuator The vacuum actuator performs the same function as the electric actuator in that it moves the clutch sleeve to engage the side gear and drive axle. If the splines of the sleeve do not align for engagement the vacuum actuator has a built in wait function when vacuum is applied to the diaphragm and as the side gear begins to rotate, the clutch sleeve moves as the splines align. The shift fork and shaft are positioned by the detent ball and spring.

***Vacuum A.D.D.
Actuator***

If engagement is delayed the electric actuator has a spring loaded wait mechanism and the vacuum actuator relies on vacuum to hold tension on the clutch sleeve.

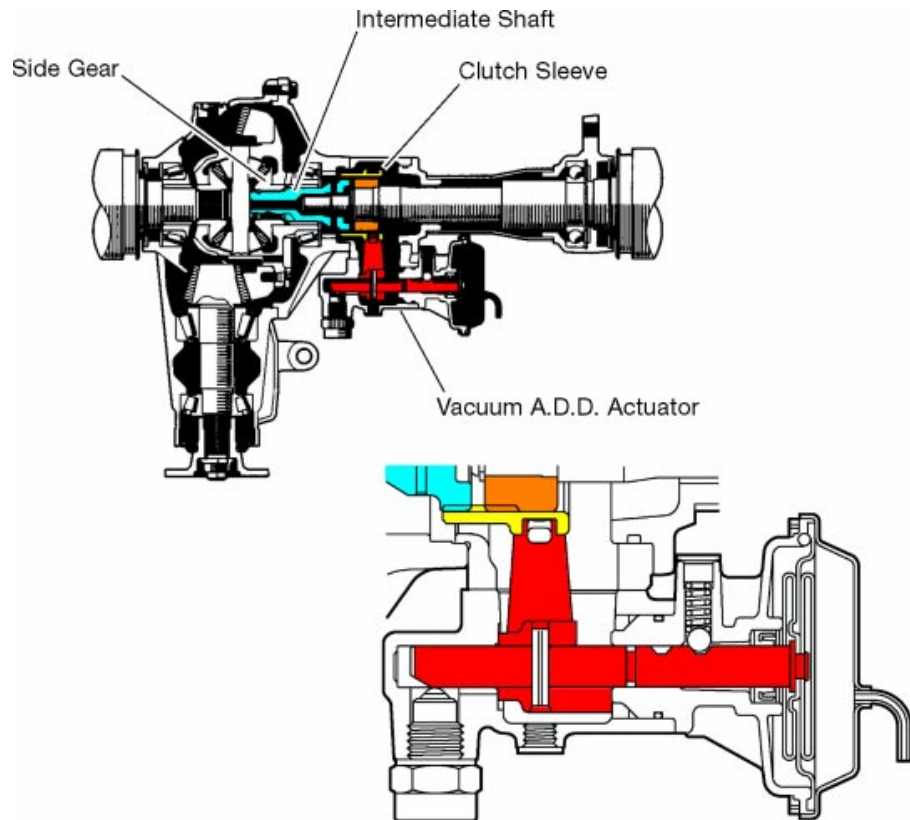
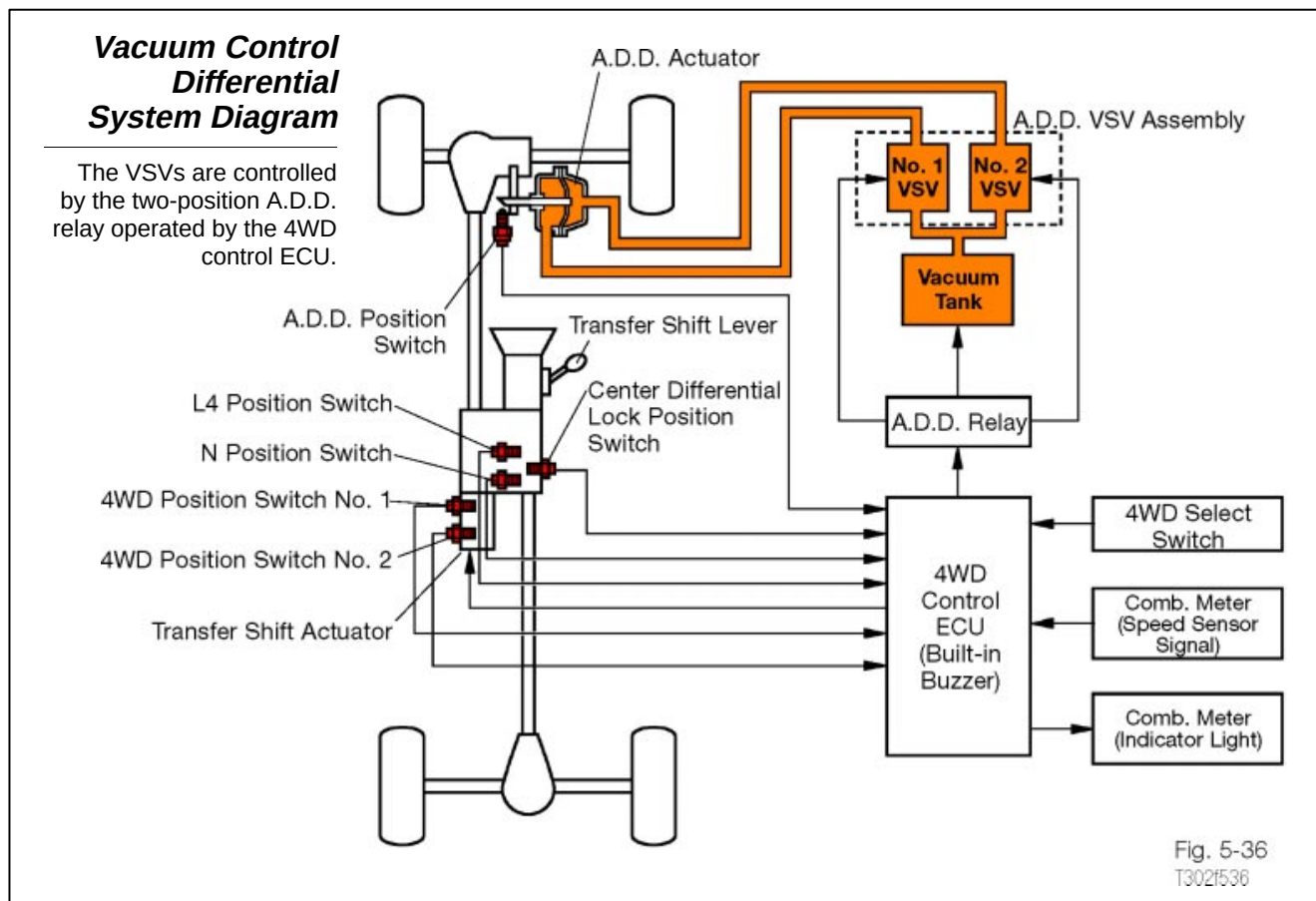


Fig. 5-35
T3021535

Vacuum Control Operation The A.D.D. vacuum actuator has two chambers, one on each side of the diaphragm. The diaphragm is connected to the shift fork shaft. In the diagram in figure 5-36, Vacuum Switching Valve (VSV) No. 1 controls vacuum to the apply chamber (left side) of the actuator. When vacuum is open to the apply chamber, the shift shaft and fork is moved to the left, engaging the drive axle and the differential side gear. VSV No. 2 controls vacuum to the release side (right side) of the chamber and when vacuum is applied, the shift rail moves to the right and disengages the drive axle from the differential side gear.

The VSV's operation is identical, when energized they block atmospheric pressure and are open to the vacuum source. When not energized they are open to atmospheric pressure and block the vacuum source.

The VSVs are controlled by the two-position A.D.D. relay operated by the 4WD control ECU. When the relay is energized the current flows to VSV No. 1 opening the apply chamber to the vacuum tank. Since VSV No. 2 is not energized it is open to atmospheric pressure and the release chamber. The opposite happens when the relay is not energized, VSV No. 1 opens to atmospheric pressure and VSV No. 2 opens the release chamber to the vacuum tank and the shift fork moves to the right.



A.D.D. 4WD Control ECU The ECU controls the motor and monitors its position with the limit switch. When the transfer case is shifted to H4 or L4 the ECU received a signal from the transfer case 4WD detect switch and switches current to flow to terminal 5 of the ADD Actuator to the motor, to terminal 1 and back to the ECU through terminal DM2. The monitoring path to ground is through ECU terminal DL2 to terminal 2 of the actuator, through the limit switch to terminal 4 and ground. When the limit switch opens, the ECU shuts down the motor.

When the transfer case is shifted to H2 from H4 or L4 the ECU received a signal from the transfer case 4WD detect switch and switches current to flow to terminal 1 of the ADD Actuator to the motor to terminal 5 and back to the ECU through terminal DM1. The monitoring path to ground is through ECU terminal DL1 to terminal 6 of the actuator, through the limit switch to terminal 4 and ground. When the limit switch opens, the ECU shuts down the motor.

4WD Control ECU

The 4WD control ECU monitors the A.D.D. actuator operation through the limit switch.

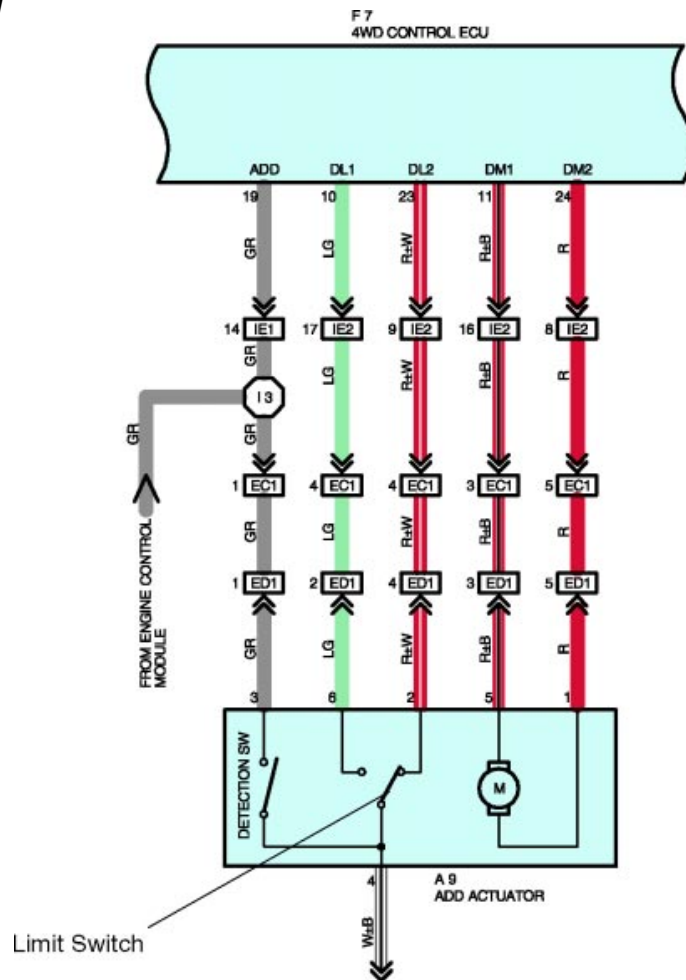


Fig. 5-37
T3021537

Rear Locking Differential

The rear locking differential is a selectable option that locks the differential to provide equal turning torque to each rear wheel regardless of turning radius. The differential operates as an open differential until the operator selects this function. The rear locking differential is available as an option with A.D.D. or separately on some 2WD models.

Under certain circumstances when one of the front wheels and one of the rear wheels lose traction at the same time, the vehicle will be unable to move. The ability to lock the rear differential will provide equal turning torque to each rear wheel. The vehicle should be stopped before selecting.

Rear Locking Differential

The rear differential locking system locks the differential to provide equal turning torque to each rear wheel.

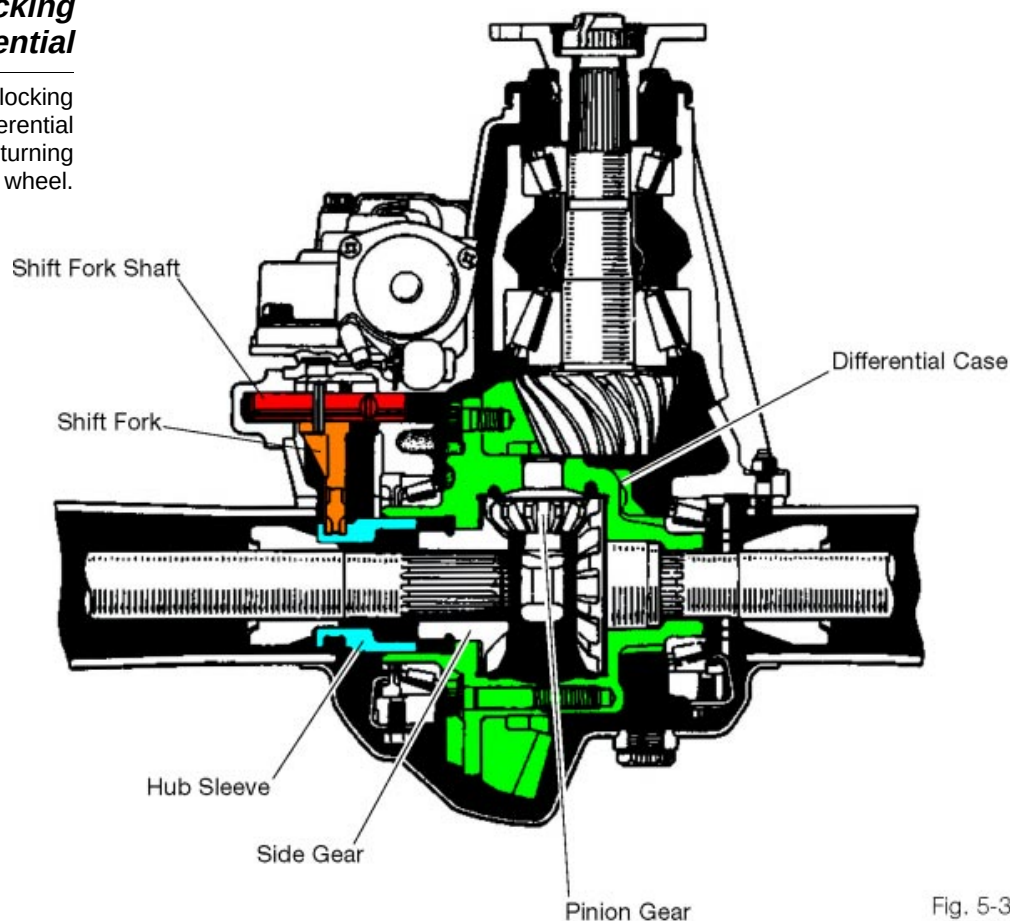


Fig. 5-38
T302f108

Rear Locking Differential Control Operation

The 4WD Control ECU controls the rear differential lock actuator. The transfer case must be in 4WD Low Range when the operator presses the rear differential lock switch. The ECU monitors the L4 position switch and then causes the lock actuator to engage the lock sleeve and the lock position switch causes the ECU to illuminate the indicator light. As with the A.D.D. actuator, the ECU monitors actuator operation through the limit switch to control the motor.

Rear Locking Differential Control Diagram

The ECU monitors the L4 position switch and then causes the lock actuator to engage the lock sleeve.

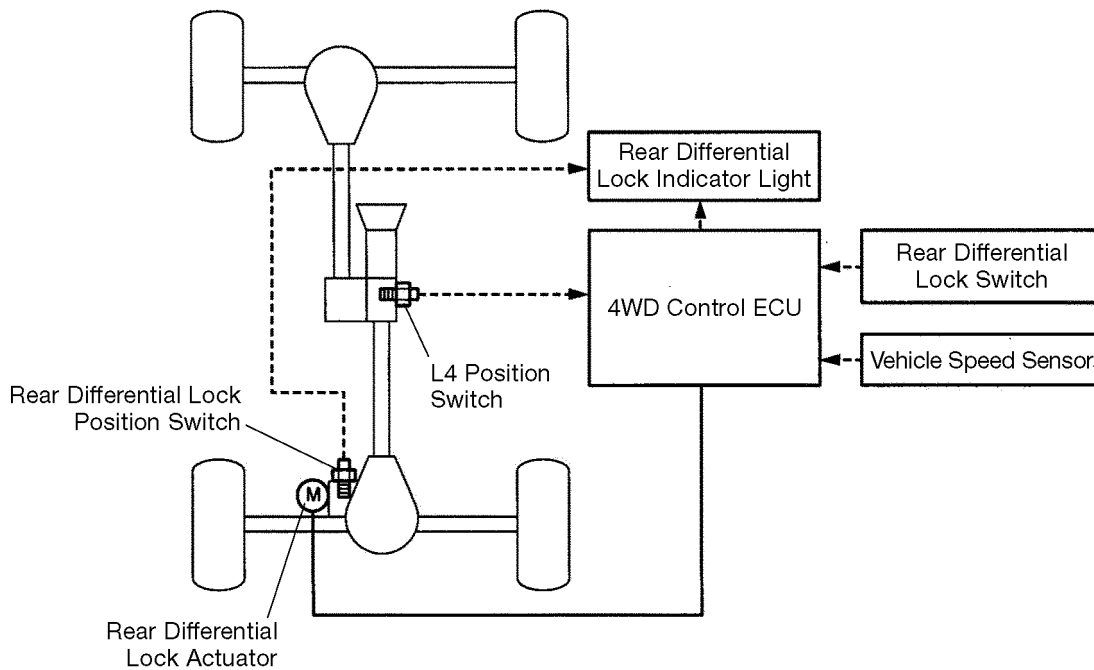


Fig. 5-39
T302f539

Rear Locking Differential Powerflow

The sleeve has splines on both the inner and outer diameter. When the differential is engaged the sleeve locks the left side gear to the differential case. With the side gear locked, the pinion gears are unable to turn on the pinion shaft and therefore the differential drives both wheels equally.

Rear Locking Differential Powerflow

With the side gear locked, the pinion gears are unable to turn on the pinion shaft and therefore the differential drives both wheels equally.

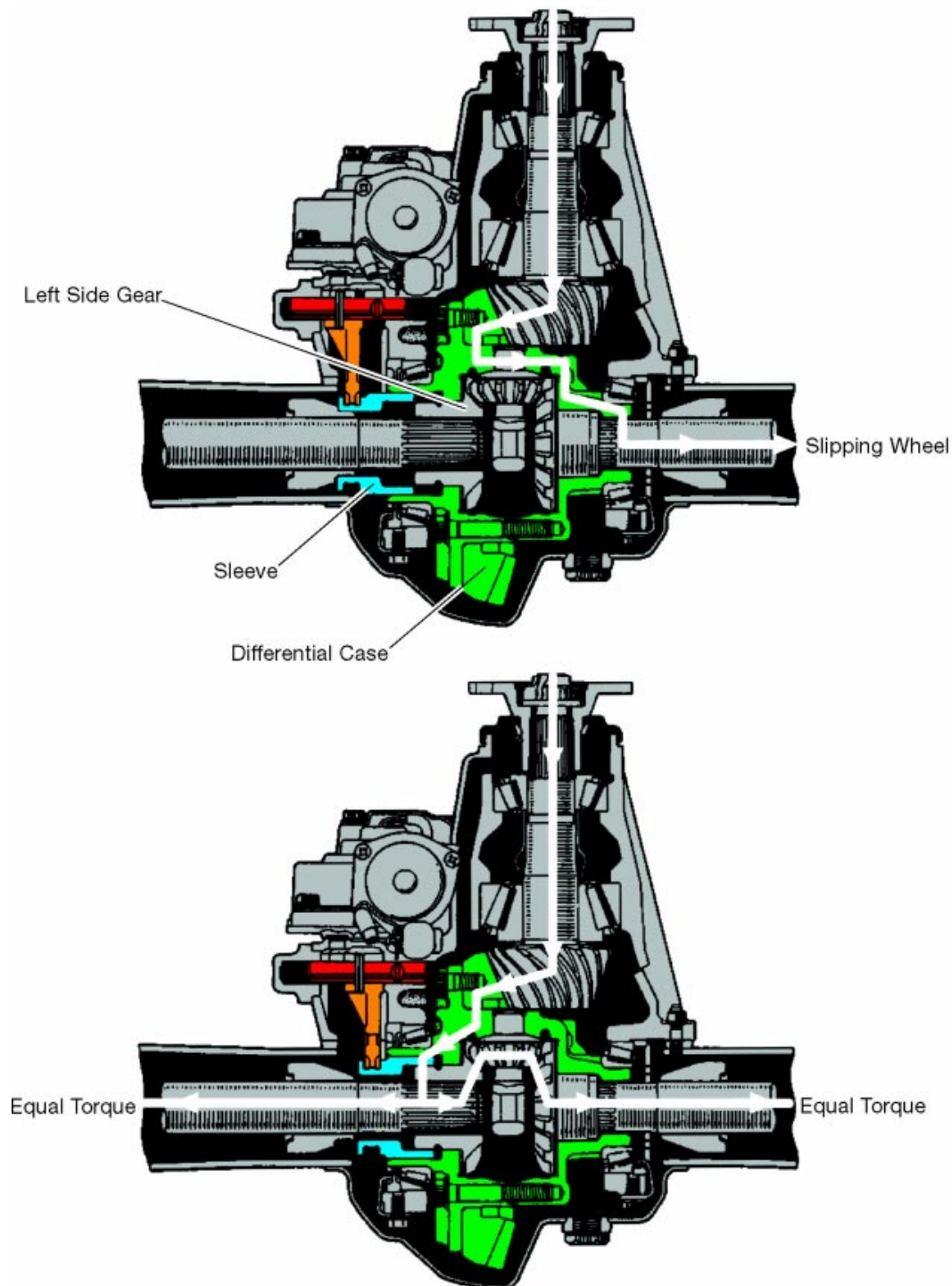


Fig. 5-40
T3021540

Lubrication System

Lubrication for gears and bearings in the transfer case is provided by an internal trochoid type oil pump.

Trochoid Pump Construction

A trochoid pump is used in the chain drive transfer case. Oil flows through the transfer input shaft and rear output shaft to the planetary gear assembly, bearings and other parts.

Trochoid Pump

A trochoid pump is used in the chain drive transfer case.

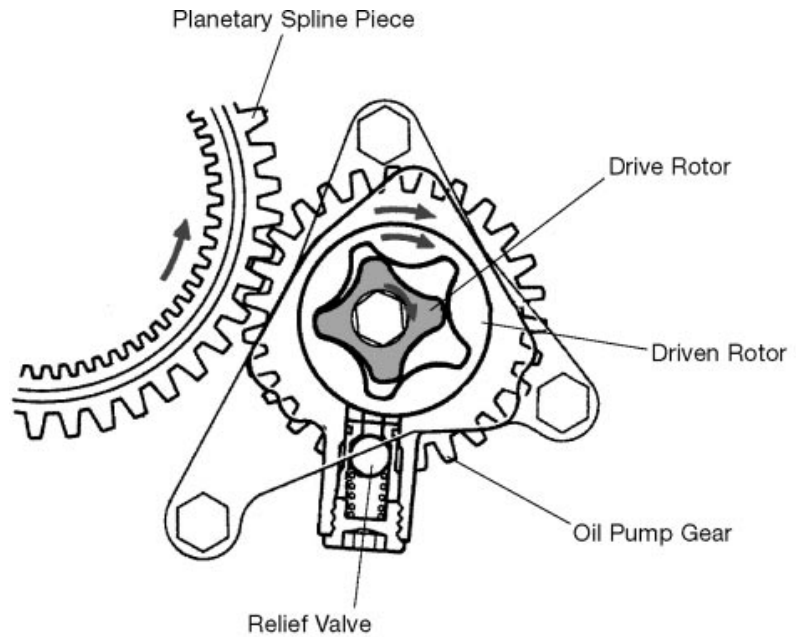


Fig. 5-41
T302f5341

Trochoid Pump Operation The transfer case oil pump is driven by the outer gear on the planetary spline piece. It circulates oil onto the gears and friction areas through various channels and paths provided for this purpose. A relief valve regulates the oil pressure.

Trochoid Pump Operation

The oil pump is driven by the outer gear on the planetary spline piece.

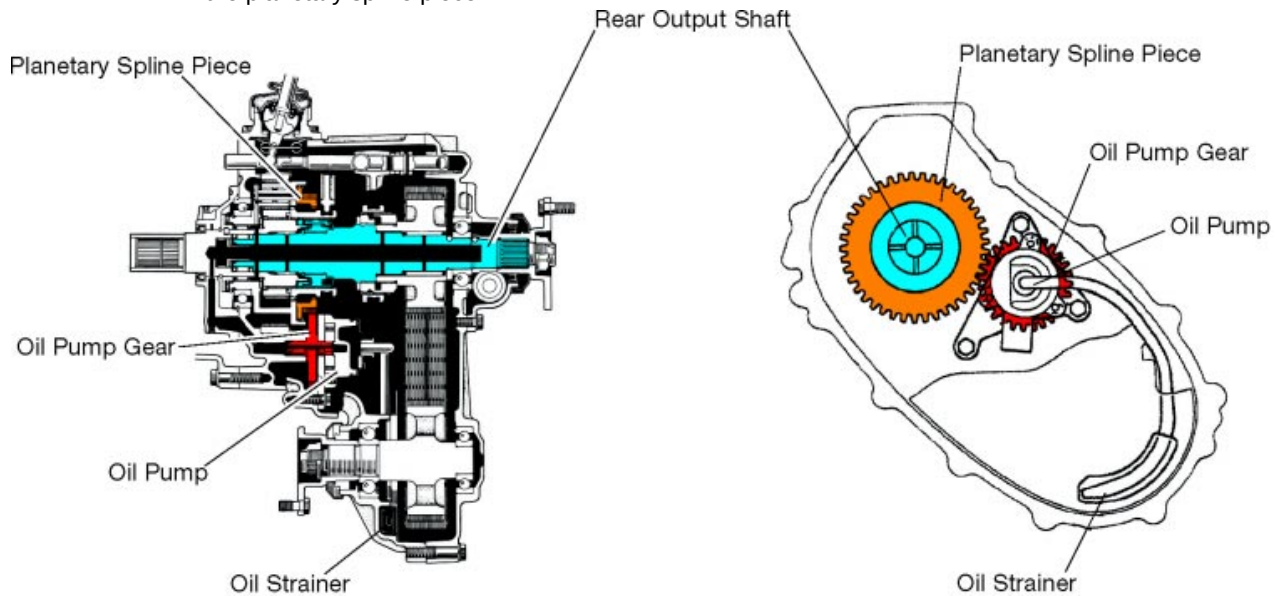


Fig. 5-42
T30215342



Notes