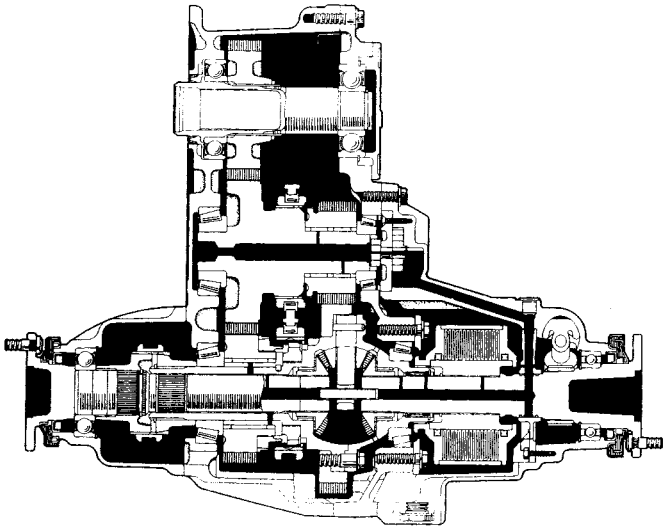
HF2AV TRANSFER

■ DESCRIPTION

The LX 450 uses HF2AV type full–time 2–speed transfer in which a center differential is enclosed. The center differential is equipped with a viscous coupling type LSD (Limited Slip Differential). In addition, a mechanism to mechanically lock the center differential when the transfer is shifted to “L” has been provided.



HF2AV Transfer

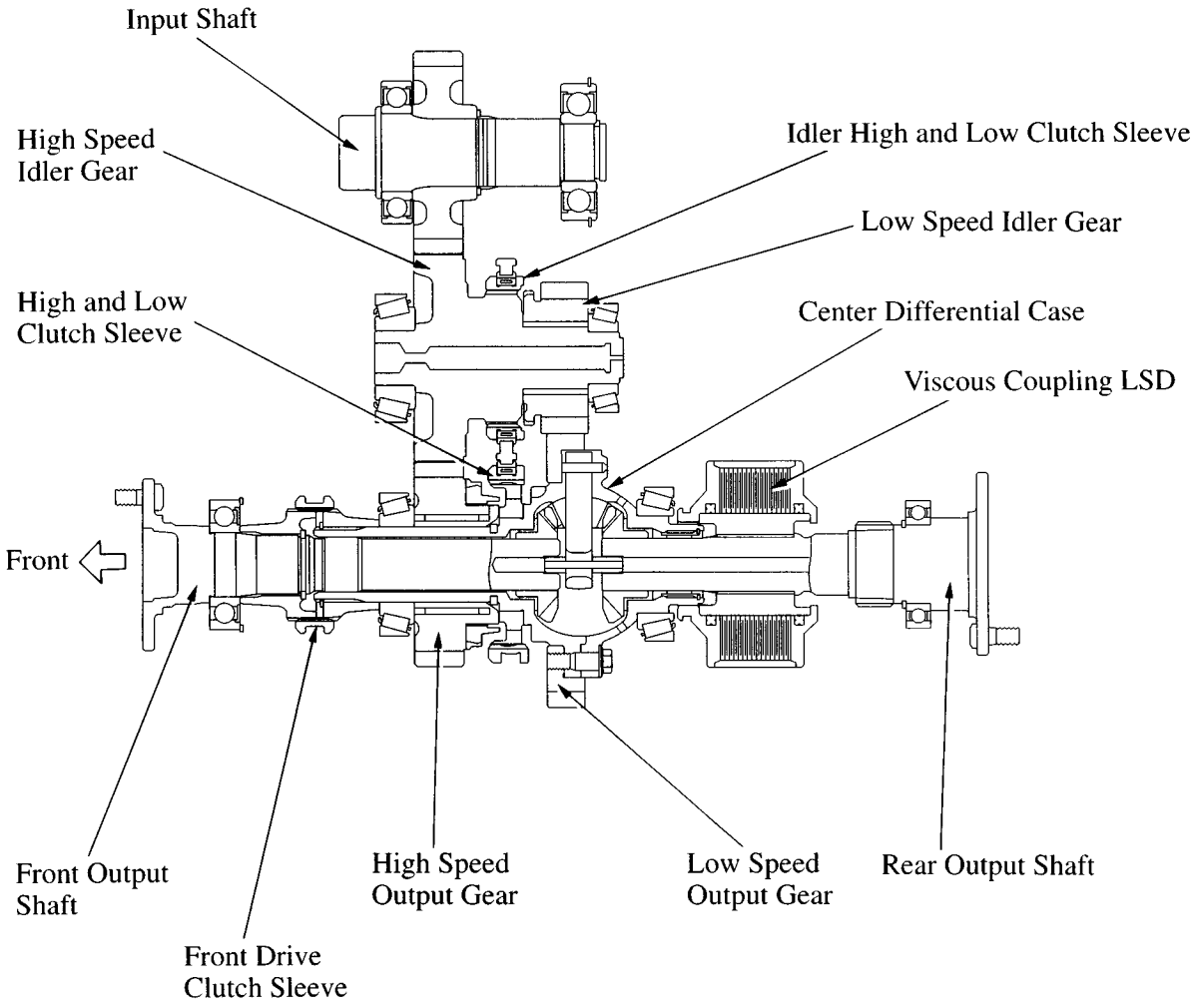
▶ Specifications ◀

Model		LX450
Transfer Type		HF2AV
Transmission Type		A343F
Item		
Reduction Gear Type		Idler Gear
Shift Control Type		Mechanically
Gear Ratio	High Speed Range	1.000
	Low Speed Range	2.488
Oil Capacity liter (US qts, Imp. qts)		1.7 (1.8, 1.5)
OIL Viscosity		SAE 75W–90
Oil Grade		API GL–4 or GL–S

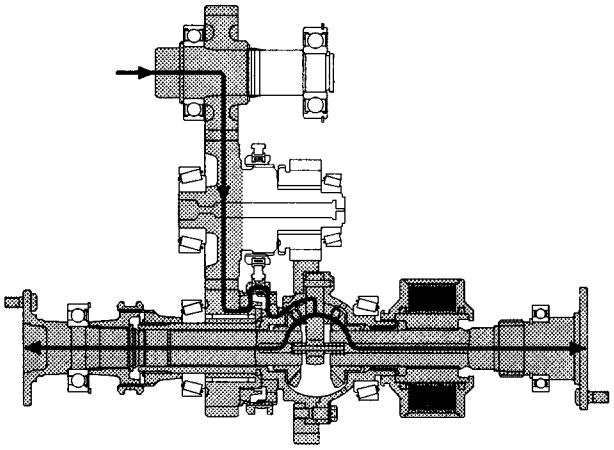
■ TRANSFER GEARS

1. General

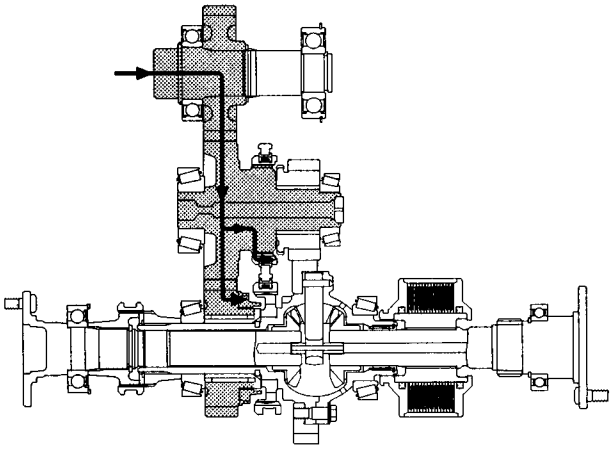
- The variable–speed gear for high or low speed is located on the idler gear and the output shaft.
- The shift mechanism is located in the idler gear and the output shaft.
- The center differential is located in the low speed gear on the output shaft.



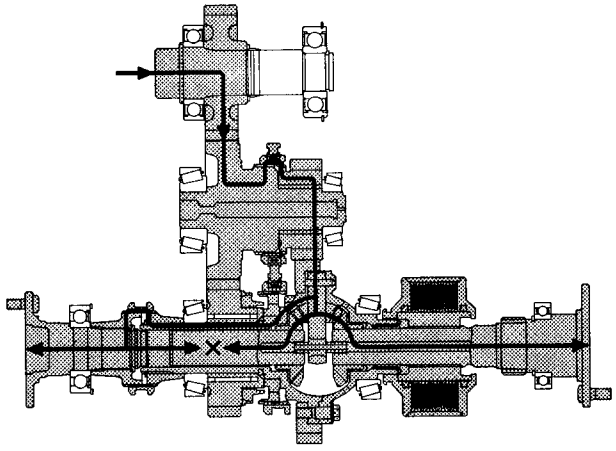
2. Power Transmission



H Range



N Range

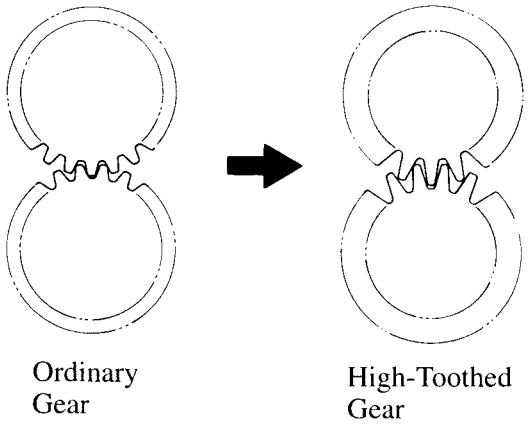


L Range

3. Construction

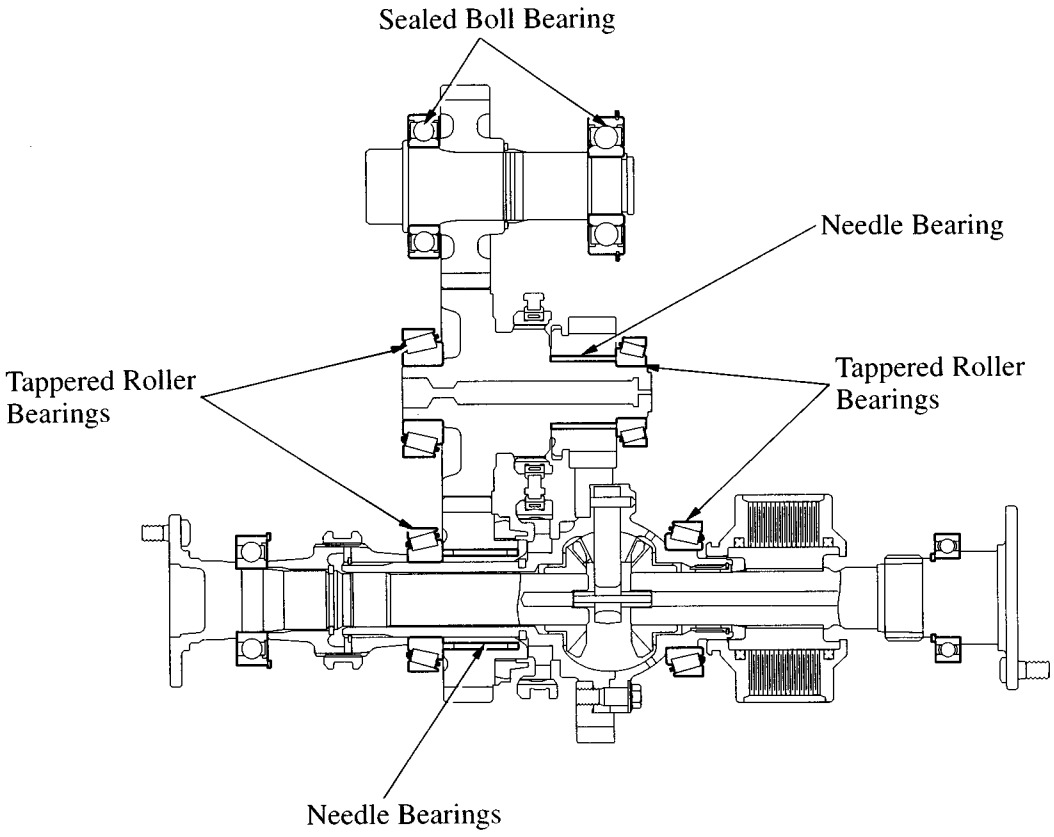
Gears

The height of the teeth on each gear is increased for quiet gear meshing.



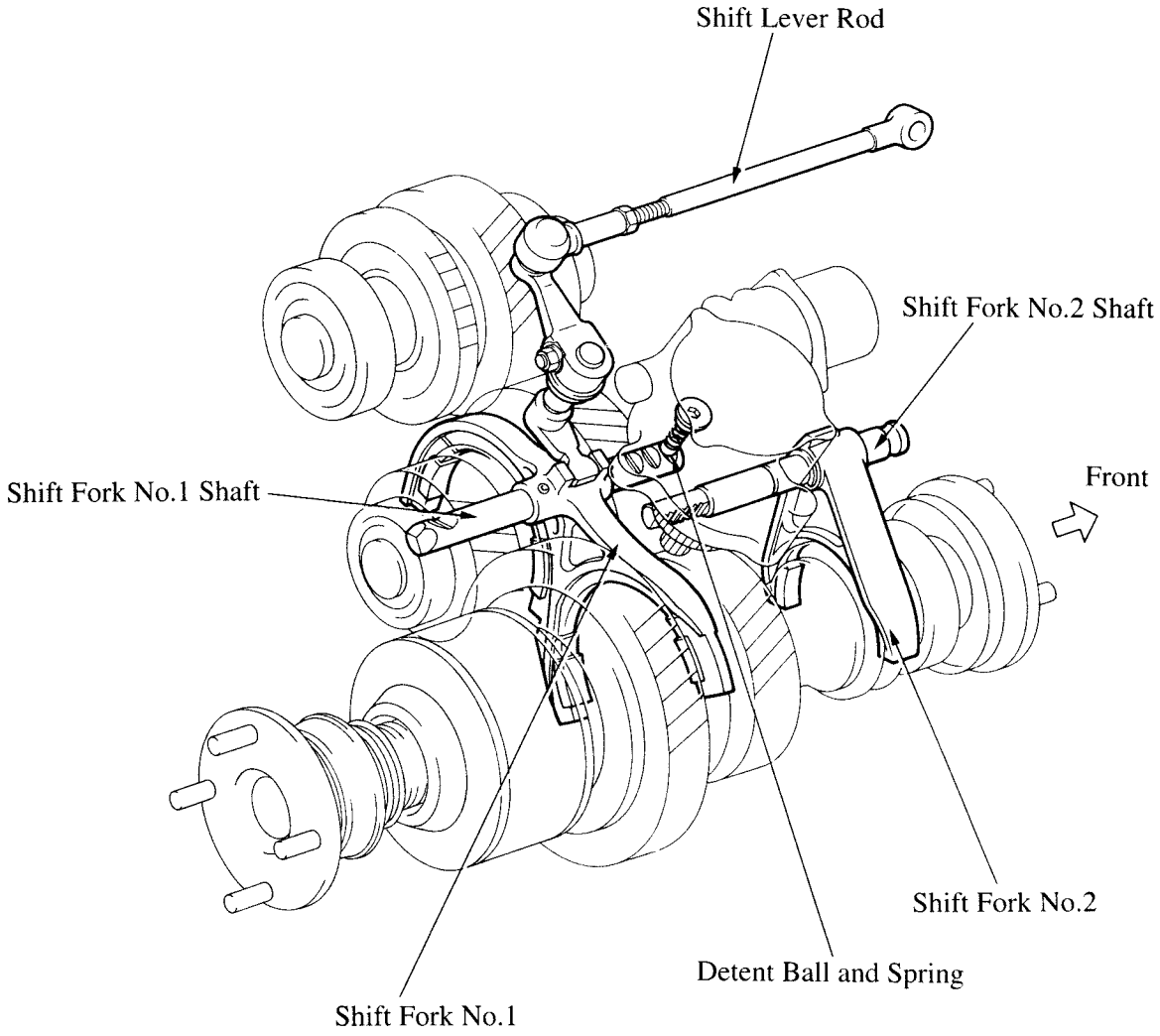
Bearing

- Sealed ball bearing are used for input shaft.
- Tapered roller bearings, having larger load capacity, are used on both sides of the idler gear and output shaft.
- Needle bearings are used for each gear bearings.



■ SHIFT MECHANISM

- Shifting between the “H” and “L” ranges is accomplished by sliding the shift fork No.1 shaft and the shift fork No.1, which are linked to the transfer shift lever.
- In the shift fork No. 1 shaft, there are 3 grooves. A detent ball is inserted in the groove and pushed down by a spring. This prevents the gears from jumping out and gives a good shift feeling.
- The shift fork No.2 for the center differential lock is moved by the shift actuator. For details, see page 70.



■ CENTER DIFFERENTIAL

1. Center Differential Case

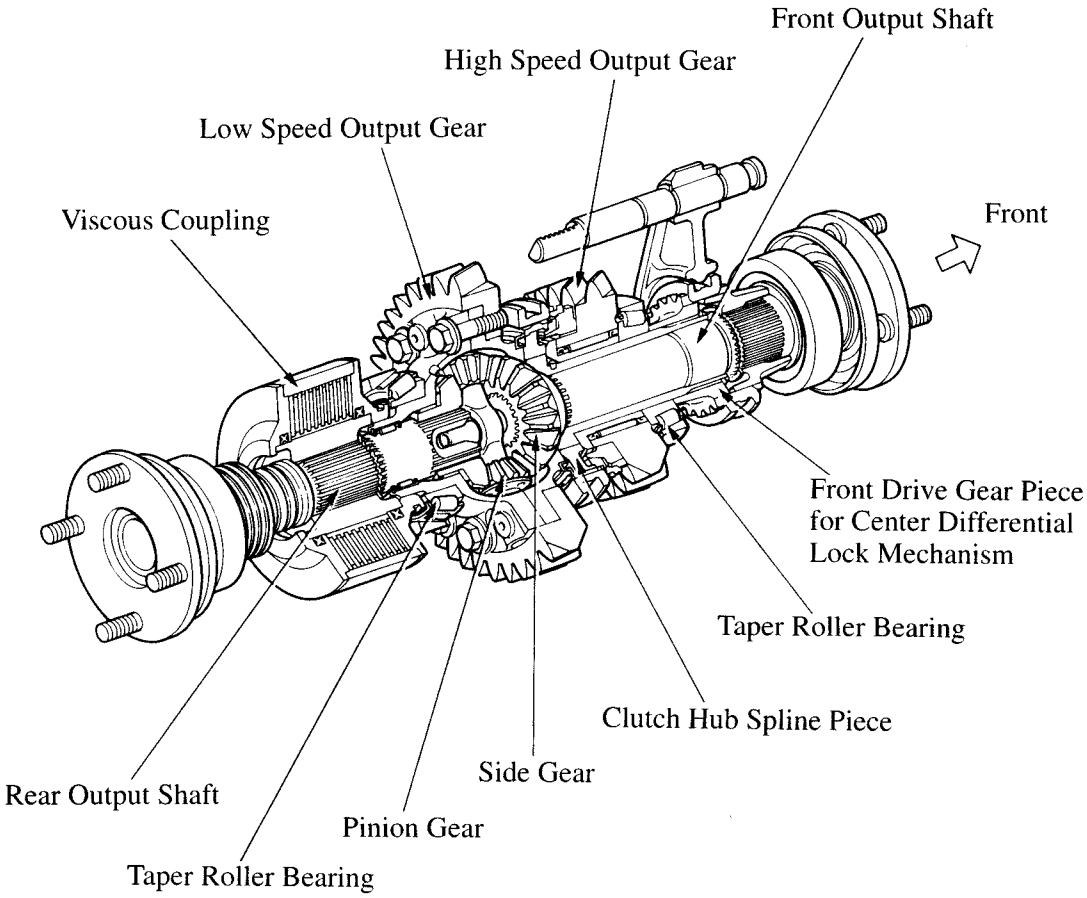
The center differential case is a split–in–two type and is combined with the low speed output gear set bolts.

The clutch hub spline piece which transmits power to the case from the high speed output gear and the front drive gear piece for locking the differential are splined in the center differential front case. The center differential front case is assembled on the transfer front case via tapered roller bearing. The center differential rear case is assembled on the transfer rear case via a tapered roller bearing as in the front case.

2. Center Differential Gear Unit

The center differential gear unit consists of two pinion gears, a pinion shaft and two side gears. The center differential front side gear transmits power to the front output shaft. The center differential rear side gear transmits power to the rear output shaft.

During straight line driving, when there is no speed difference between front and rear wheels, the center differential pinion gears do not revolve. When a speed difference between the front and rear wheels occurs due to cornering, etc., the center differential pinion gears revolve absorbing the speed difference.



3. Viscous Coupling Type LSD

General

Making use of the highly viscous property of silicon oil, the viscous coupling type LSD utilizes the force that is generated when the silicon oil is sheared to accomplish limited slip in the differential. This enables the differential to restrain the rotational difference between the front and rear wheels, thus providing the excellent vehicle's driving performance over slippery terrain such as rough or snowy roads.

Construction

1) Outer and Inner Housing

Using splines, the outer housing is connected to the center differential case, and inner housing to the rear output shaft respectively.

2) Outer and Inner Plates

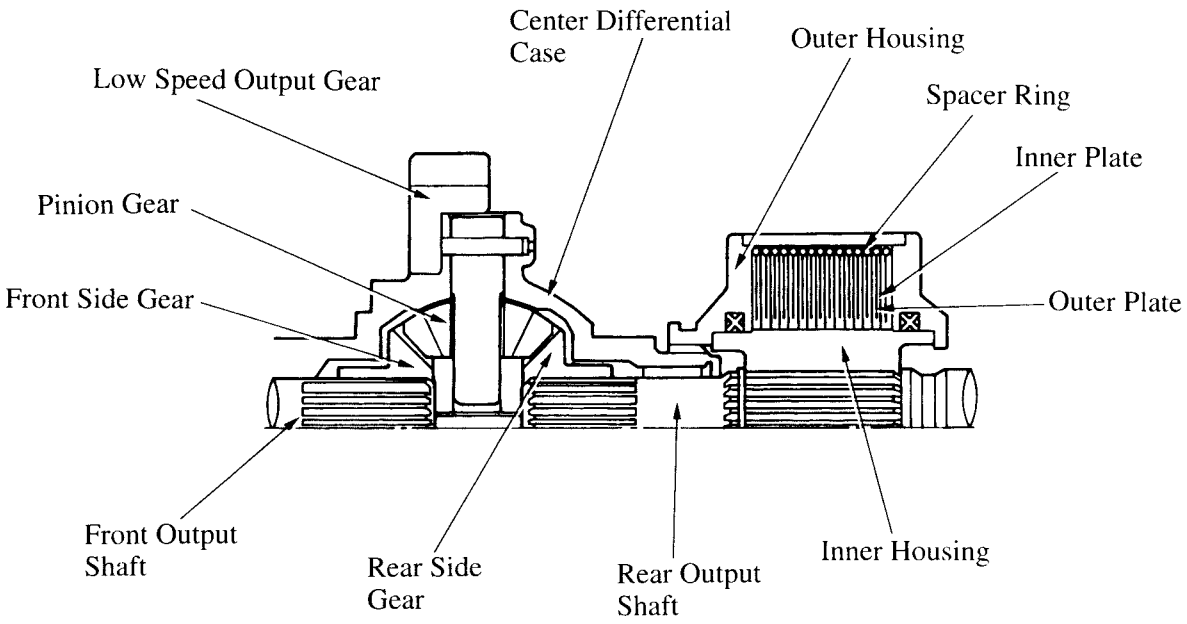
The outer and inner plates are steels disks that are assembled alternately. Outer plates have teeth along their periphery that mesh with inner splines of the outer housing. Inner plates have teeth along their inner edge which mesh with the splines of the inner housing and slide to right and left along the inner housing. Slits are provided on outer and inner plates to increase the resistance force of the oil.

3) Spacer Ring

Spacer rings are inserted between the outer plates to maintain the necessary clearance.

4) Silicone Oil

Silicone oil expands with heat. Therefor, silicon oil is filled approximately 80 percent of the housing.

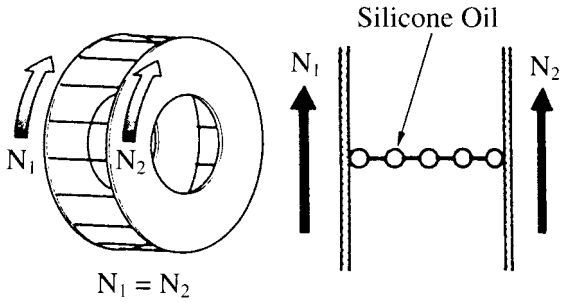


Fundamentals

Torque is transmitted by a resistance force which is caused by its viscosity when silicone oil is sheared.

1) When Plates Rotate at an Identical Speed

No viscous resistance is generated since silicone oil between two plates rotates at the same speed as the plates.

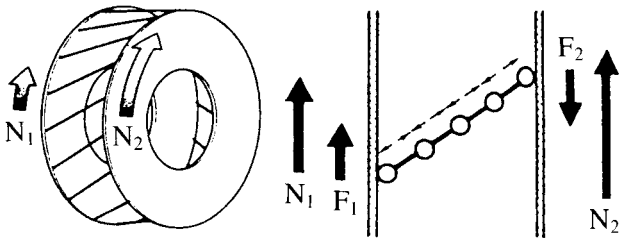


2) When Plates Rotate at Different Speeds

Silicone oil particles that are touching plates tend to move at the same speed as the plates.

When the plates begin to turn at different speeds, silicone oil particles are pulled away from each other and a resistance force is generated. Therefore, resistance F_2 acts in the opposite direction of rotation on plate N_2 which is rotating faster. Resistance F_1, which is equal to F_2, acts in the direction of rotation on plate N_1 which is turning at a lower speed.

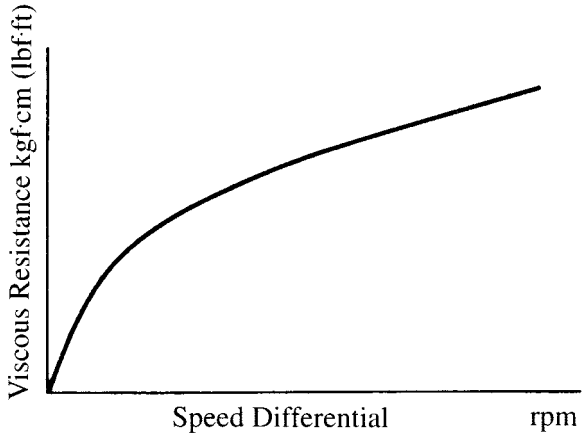
Forces which tend to cancel the difference in speed occur to the plates.



Transmitted Torque Characteristics

1) During Normal Operation

The amount of viscous resistance due to difference in rotation of the outer and inner plates increases or decreases according to the extent of its difference.



2) During Humping

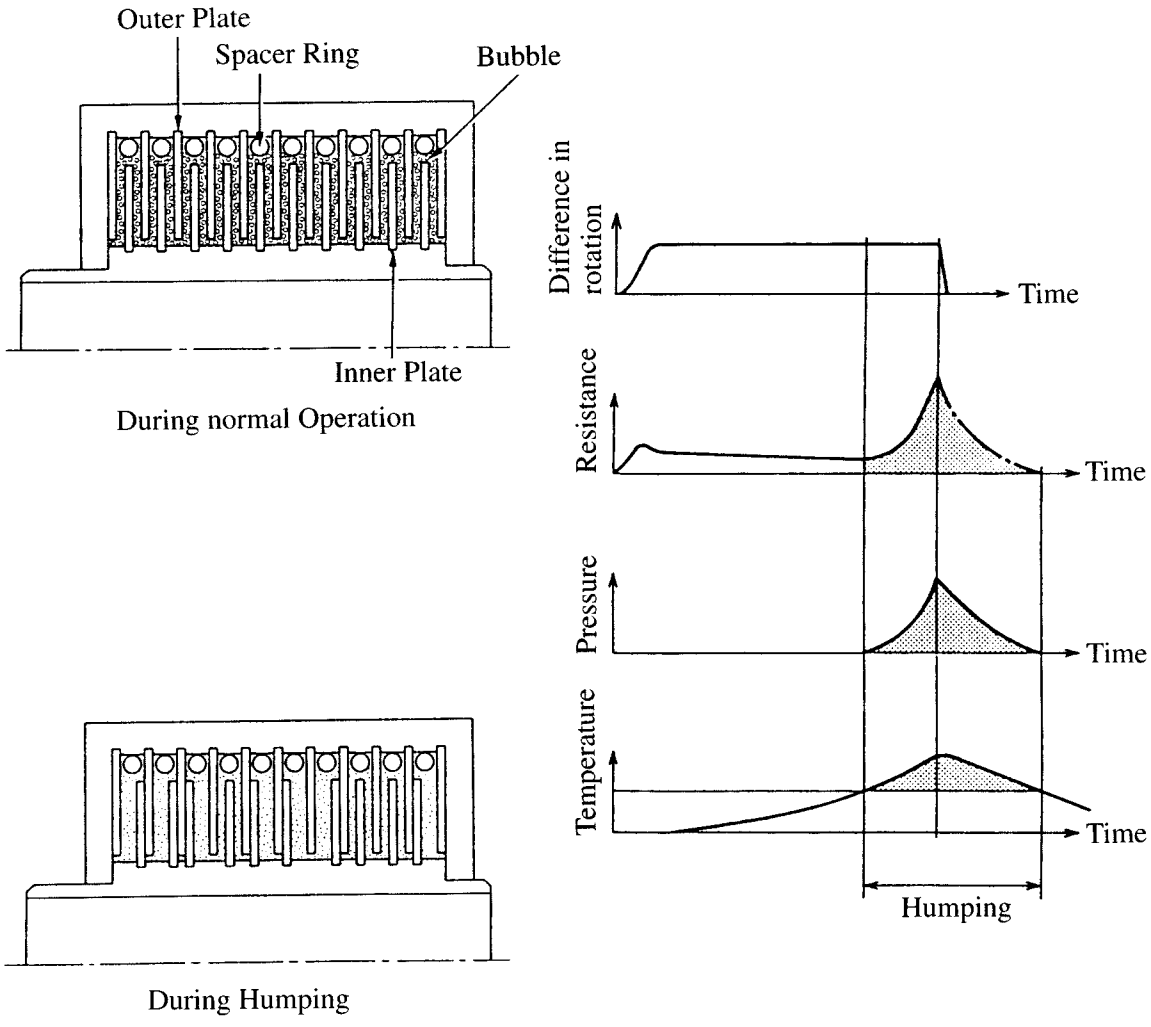
The viscous coupling is filled with silicone oil and air. The air is mixed in the silicone oil in the form of bubbles when the viscous coupling is operating. The bubbles absorbed the pressure difference is generated on both sides of the inner plate as it rotates.

As the viscous coupling continues to operate with the outer and inner plates rotating at different speeds, the temperature inside the viscous coupling increases due to agitated resistance of the silicone oil. And the silicone oil expands under heat.

As the silicone oil continues to expand, the bubbles in the silicone oil are caused to be decreased so that the pressure difference at the front and back of each inner plate is no longer absorbed by the bubbles.

The inner plate, which can move in an axial direction to a distance equal to the outer diameter of the spacer ring fitted between the outer plates, is pulled toward the side where pressure is lower. As a result, the inner plate contacts the outer plate directly to create a larger resistance. This condition is called humping.

Since there exists no speed difference between the inner and outer plates during humping, the temperature inside the viscous coupling decreases and reduces the internal pressure. The compressed bubbles expand again and separate the inner plate from the outer plate. Humping, however, does not occur when the vehicle is running in a normal condition.

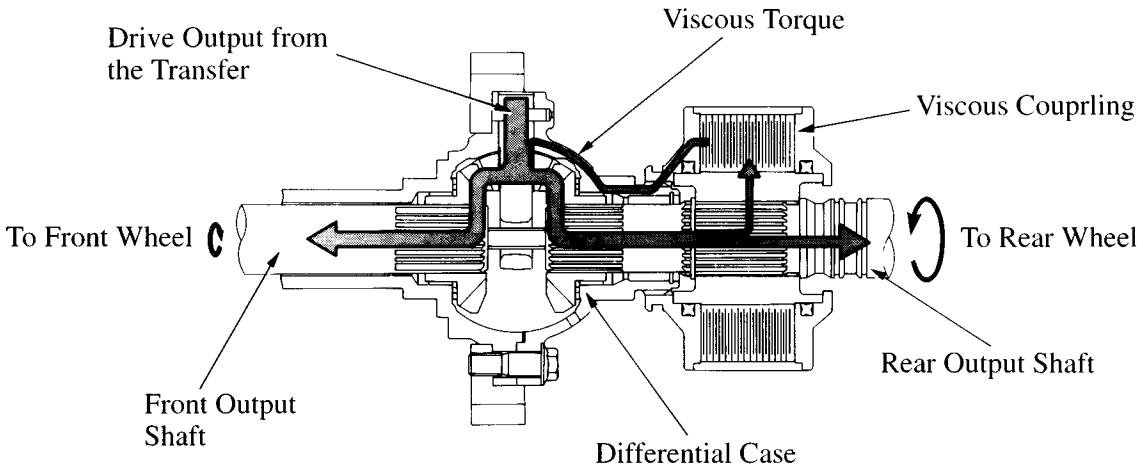


Operation

When a rotational difference is created between the front and rear wheels due to slippage, torque is transmitted by the viscous coupling from the high–speed wheels to the low–speed wheels, thus reducing the rotational difference. As a result, optimal torque is transmitted constantly to the wheels.

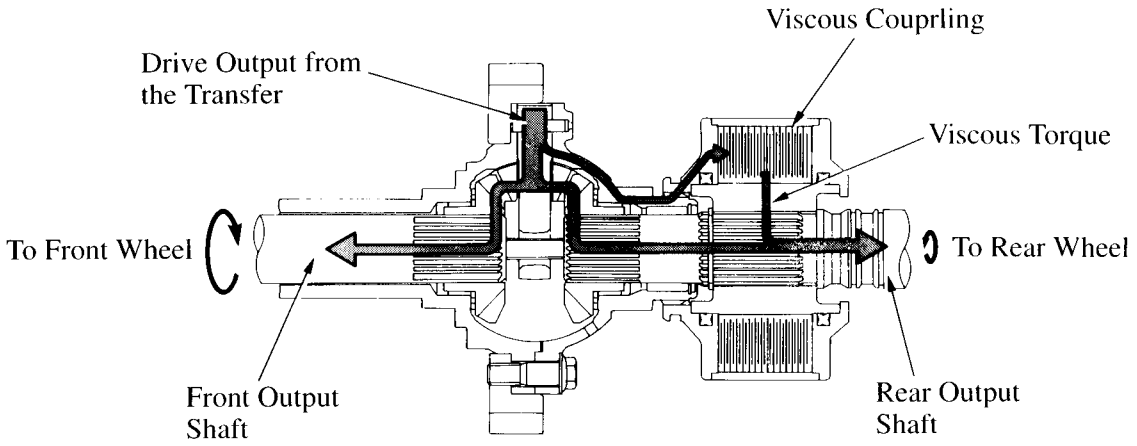
1) When the Rear Wheel Rotates Faster than the Front Wheel

When the rear output shaft rotates faster than the differential case, this difference in rotation generates viscous torque. This torque, along with the drive torque from the transfer is distributed to both the front and rear output shaft. As a result, the drive torque of front output shaft side, which does not have a viscous coupling, increases by the amount of the viscous torque. The drive torque of the rear output shaft, which is connected to the viscous coupling, decreases by the amount of viscous torque generated.



2) When the Rear Wheel Rotates Slower than the Front Wheel

When the rear output shaft rotates slower the differential case, this difference in rotation generates viscous torque. This decreases the drive torque transmitted from the transfer to the differential and is apportioned to both wheels. As a result, drive torque decreases in the front output shaft which has no viscous coupling. Conversely, the viscous torque form the viscous coupling is added to the drive torque of the rear output shaft.

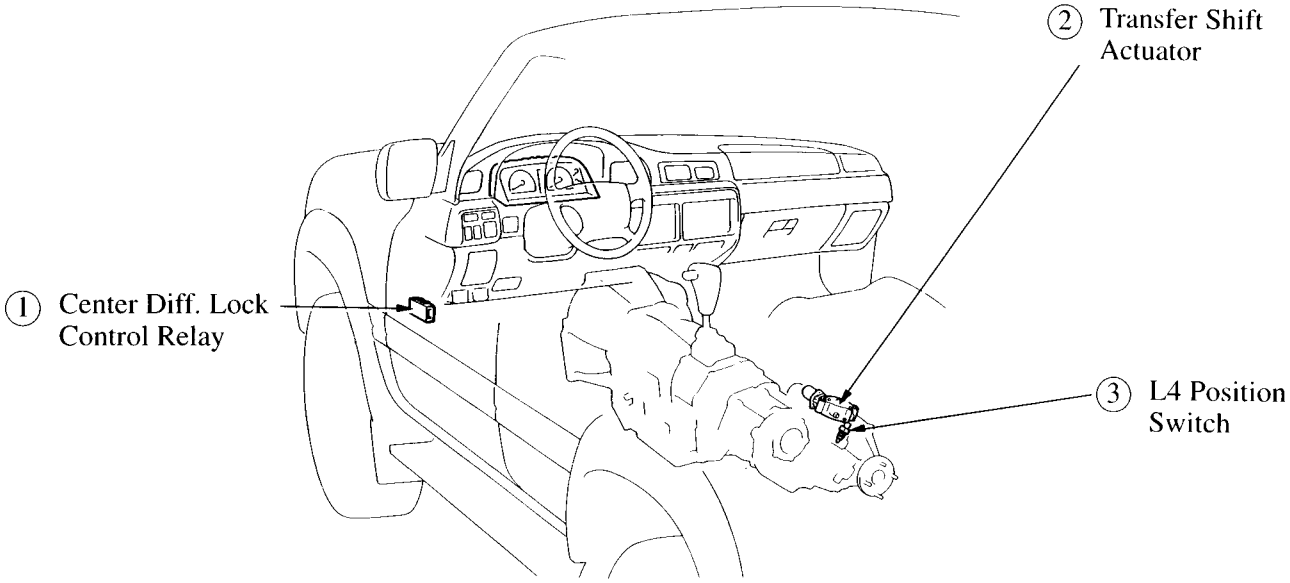


4. Center Differential Lock Mechanism

General

The center differential lock mechanism locks the center differential mechanically to stop the difference in rotation between the front and rear wheels. The differential locks automatically only when the transfer is in the “L” position.

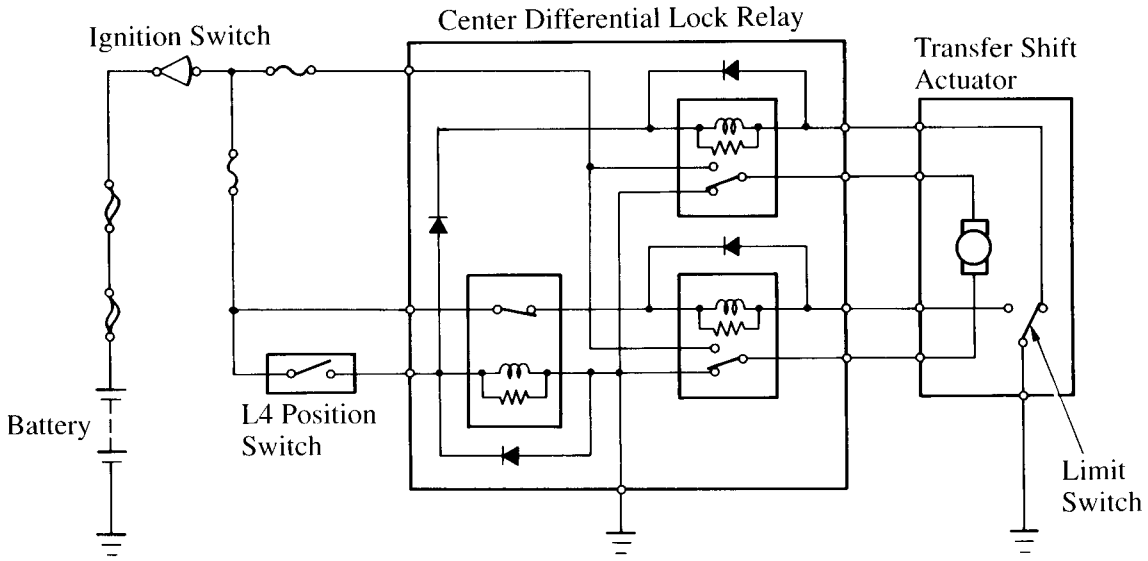
Layout of Electrical Components



Function of Electrical Components

No.	Component	Function
①	Center Differential Lock Control Relay	Changes the center differential operation according to the conditions L4 Position Switch.
②	Transfer Shift Actuator	Drives the motor and changes the center differential operation (Free and Lock) in accordance with signals from the Center Differential Lock control relay.
③	L4 Position Switch	Detects the transfer shift lever position (H or L).

Wiring Diagram

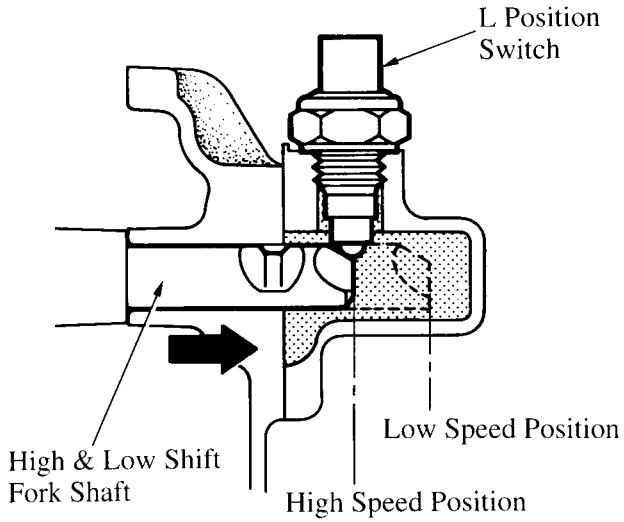


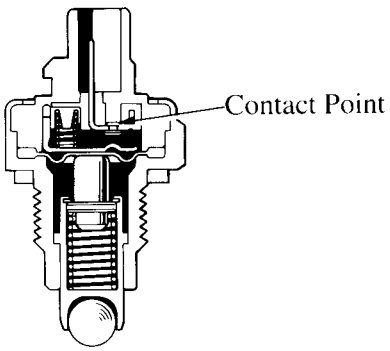
Construction and Operation of Electrical Components

1) L4 Position Switch

This switch is mounted on the top of the transfer rear extension housing. When the transfer shift lever is in the “H” position, the end of this switch fits in a groove in the high and low shift fork shaft.

Since the internal contact points are open, the switch is off at this time. If the transfer shift lever is shifted to the “L” position, the high and low shift fork shaft slides and pushes up the end of the switch, closing the contacts. This turns the switch on.



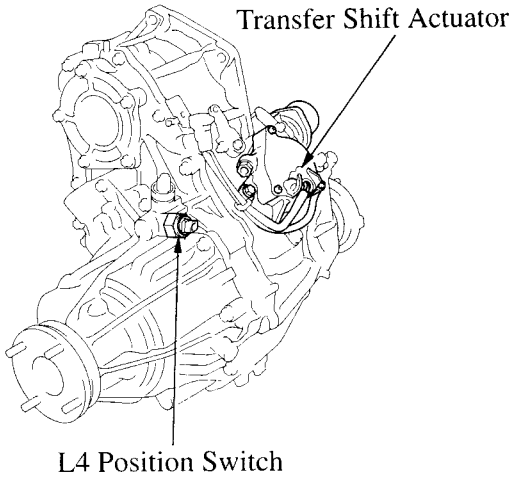


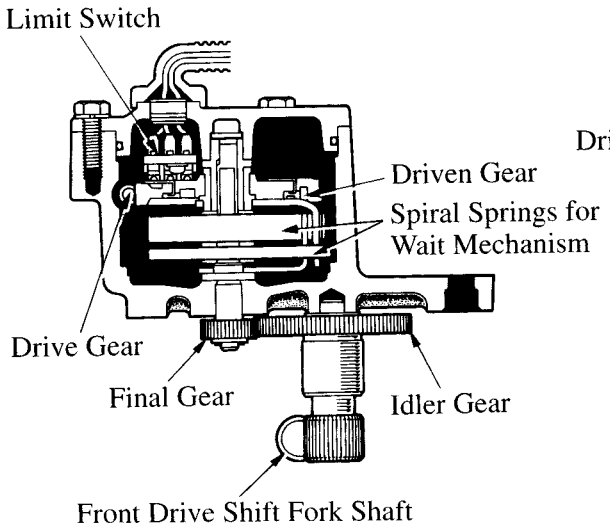
L Position Switch

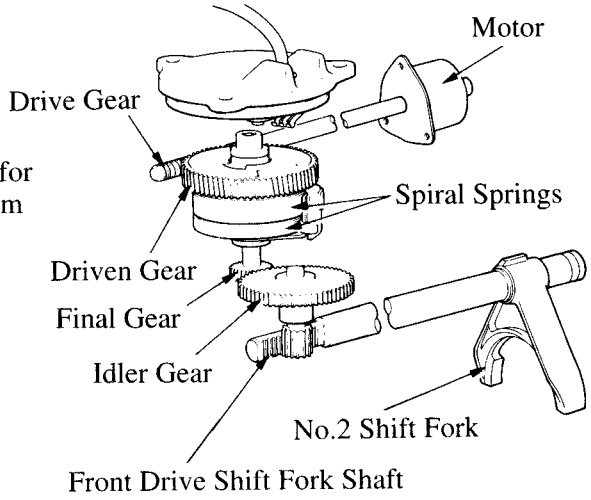
2) Transfer Shift Actuator

The transfer shift actuator is mounted on the top of the transfer front case. This actuator consists of gears which convert the rotation of the motor to the sliding motion of the shift fork shaft, a limit switch to control rotation of the motor and other components.

The motor rotates by the signals from the Center Differential Lock control relay. This rotation transferred in the order form the drive gear, driven gear, idler gear and to the shift fork shaft. Thus the shift fork shaft slides, shifting the front drive clutch sleeve.





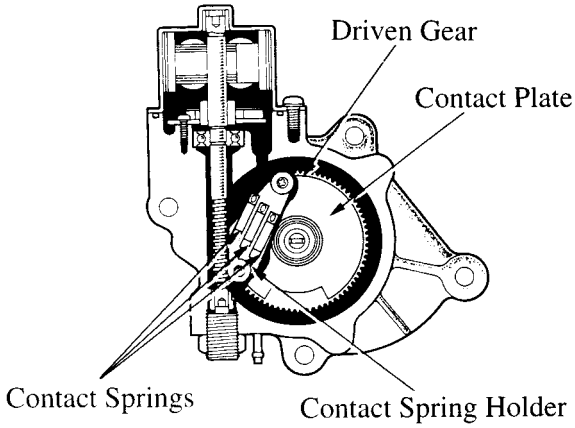


a. Motor Control Limit Switch

This limit switch consists of a contact plate mounted on the side of the driven gear and contact springs mounted in the actuator case.

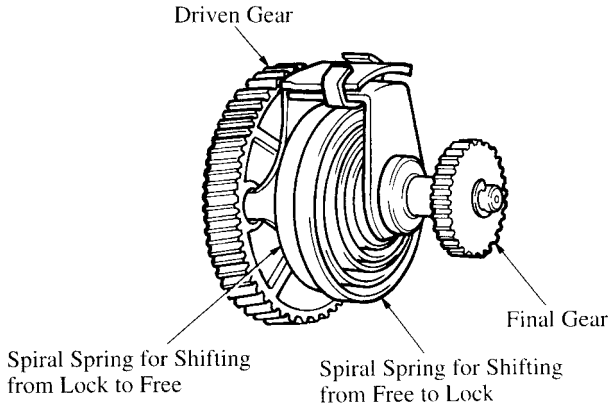
A notch is provided on the contact plate and the contact plate slides on the contact spring together with the rotation of the driven gear.

In this way the connection state of the contact springs changes, causing the motor to stop always in the optimum position.



b. Wait Mechanism Spiral Spring

If the operating resistance of the shift fork shaft is large, the motor force is partially stored in these spiral springs. Afterward, when the operating resistance is reduced, the spring force causes the shift fork shaft to slide. Two spiral springs are included in the wait mechanism, one for shifting form “Free” to “Lock” and the other for shifting from “Lock” to “Free”.



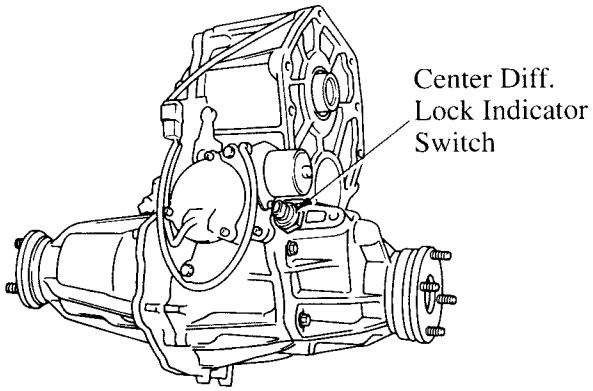
3) Center Differential Lock Control Relay

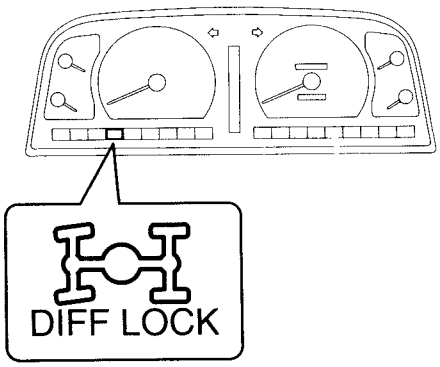
When the center differential control relay determines that the L4 position switch is ON and the the transfer shift lever is shifted in the “L” position, the relay activates the transfer shift actuator causing the center differential to lock. When the transfer shift lever is shifted to the “H” position, the L4 position switch is turned off freeing the center differential.

5. Center Differential Lock Indicator Light

General

A center differential lock indicator switch is mounted on the top of the transfer front extension housing. It turns on in the “Lock” condition and lights up the center differential lock indicator light located on the combination meter.

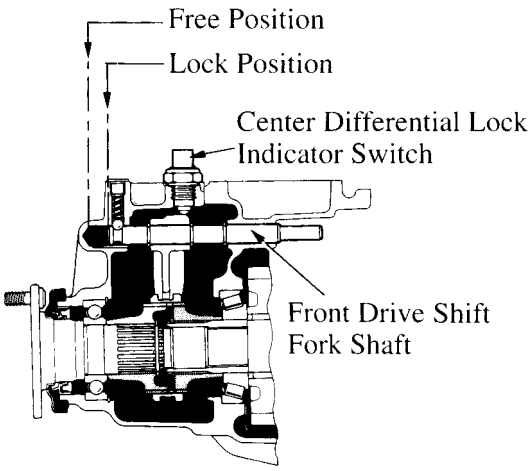




Center Differential Lock Indicator Light

Center Differential Lock Indicator Switch

The operation of this switch is the same as in the L position switch for the center differential lock mechanism. This switch goes on or off in accordance with the motions of the center differential lock shift fork shaft. It goes on when the transfer is shifted to the center differential "Lock" position.

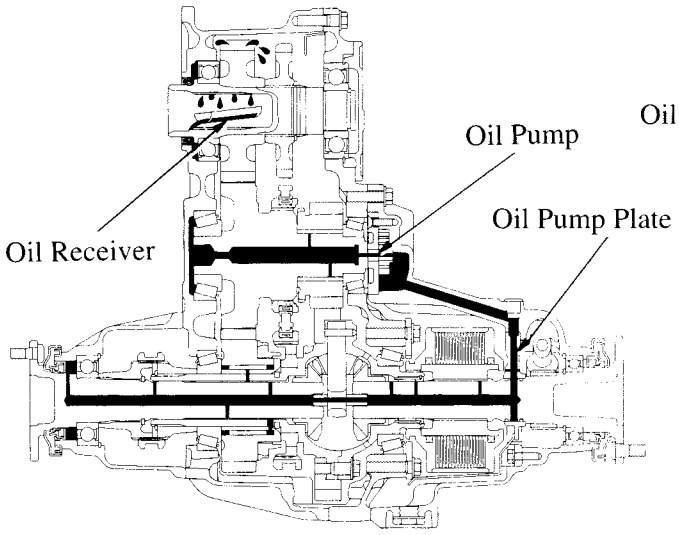


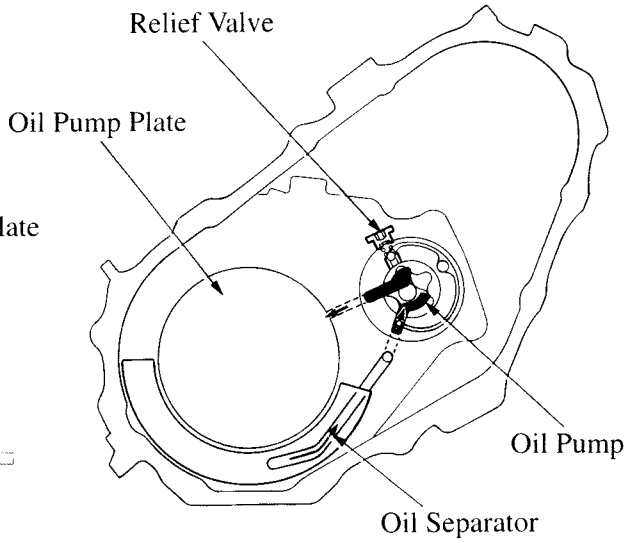
■ LUBRICATION

1. General

The transfer has an internal trochoid pump.

Oil pumped form the oil pump flows through the high speed idler gear, rear output shaft and front output shaft, the bearings and other components.

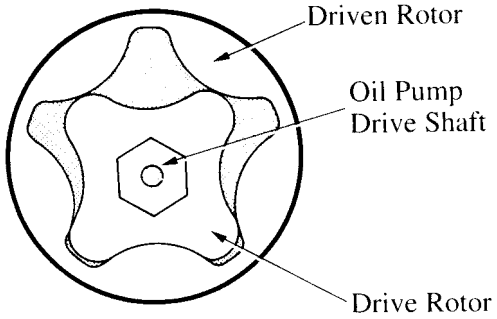




2. Oil Pump

The oil pump is driven by the speed idler gear.

A relief valve is built into the oil pump to prevent the oil pressure form becoming abnormally high.



Oil Pump