

## LIMITED SLIP DIFFERENTIAL (LSD) (MECHANICAL TYPE)

DIFFERENTIALS

### 3. Limited Slip Differential (LSD) (Mechanical Type)

#### A: GENERAL

When controlling the differential action between left and right wheels during cornering or when either of the wheels spins due to slip or bumping, cams will expand the pressure rings to press the friction plates together, thus enabling the driving torque be transmitted to the non-spinning wheel too for more stable driving.

This differential is suitable for high powered and high output torque vehicles also because it responds to the acceleration pedal operation quickly.

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#### B: CONSTRUCTION

Pressure rings with V-grooves are assembled in the case of the mechanical differential. The four lugs (protrusions) on the periphery of the pressure rings fit in the grooves provided inside the differential case when the pressure rings are assembled, and the pressure rings can slide in axial directions.

The tips of the pinion shaft are chamfered to assemble the pinion shaft into the V-grooves of the pressure rings, forming V-shaped cams. Similar to the pressure rings, the friction plates and spring plates also have four lugs (protrusions) on the periphery and these lugs fit in the grooves provided inside the differential case when the plates are assembled.

On the internal circumference of the friction disks and spring plates there are 4 or 6 lugs (protrusions) which fit in the grooves provided on the outer circumference of the side gears, and the friction disks and spring plates can slide in axial directions.

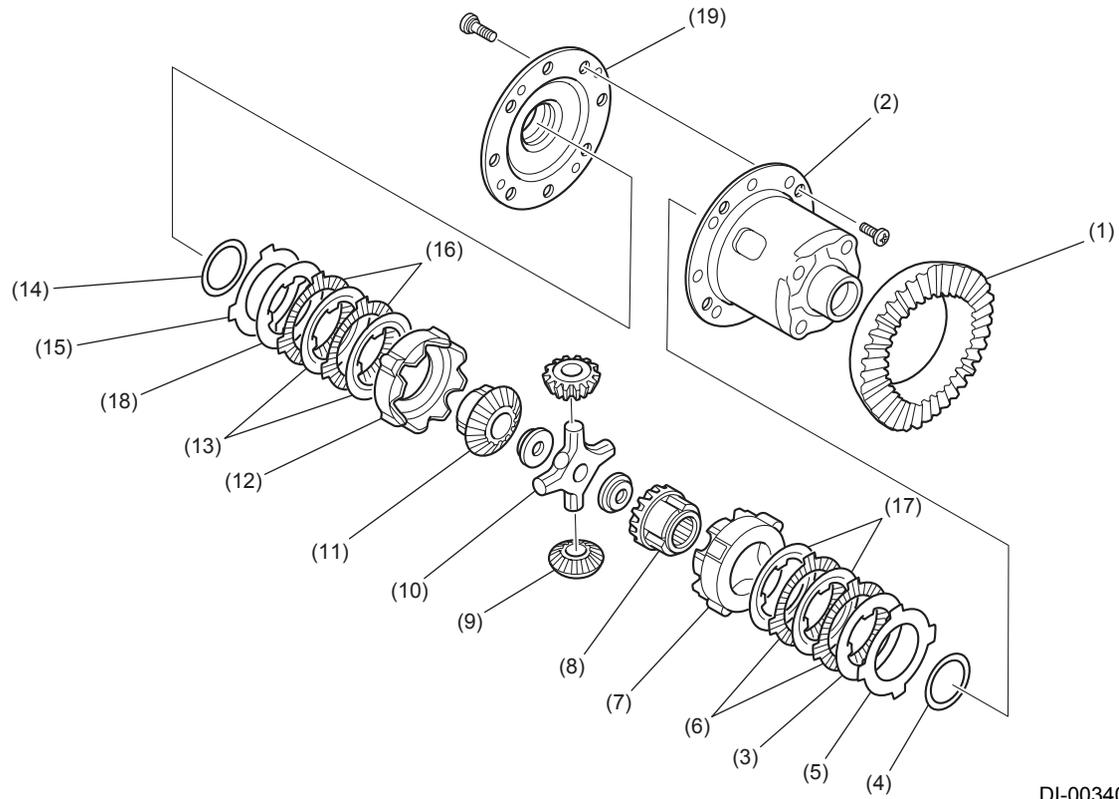
These friction plates, friction disks, spring plates, spring disks are alternately arranged and form a clutch as a whole.

The spring plates and spring disks act as Belleville springs and provide initial torque. Moreover, thrust washers are inserted between the side gears and differential case halves to adjust clearance in the axial direction and prevent thrust from the side gears to work against the pressure rings.

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- |                          |                     |                           |
|--------------------------|---------------------|---------------------------|
| (1) Ring gear            | (8) Side gear       | (15) Spring plate         |
| (2) Differential case RH | (9) Pinion          | (16) Friction disc        |
| (3) Spring disk          | (10) Pinion shaft   | (17) Friction disk        |
| (4) Thrust washer        | (11) Side gear      | (18) Spring disk          |
| (5) Spring plate         | (12) Pressure ring  | (19) Differential case LH |
| (6) Friction plate       | (13) Friction plate |                           |
| (7) Pressure ring        | (14) Thrust washer  |                           |

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## LIMITED SLIP DIFFERENTIAL (LSD) (MECHANICAL TYPE)

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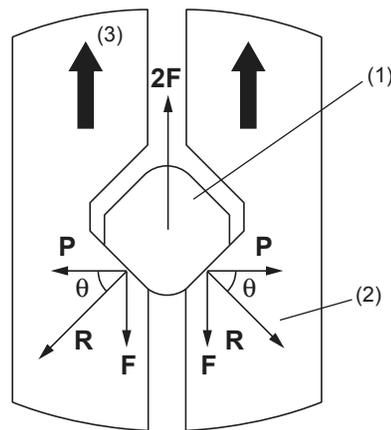
#### C: OPERATION

The torque transmitted from the crown gear to the differential case is then transmitted to the pressure rings via their four lugs (protrusions) causing the pressure rings and the differential to rotate as a unit.

The torque is further transmitted from the pressure rings to the V-shaped cams of the pinion shaft causing reaction force  $F$  opposing the rotational direction and load  $P = F \cot \theta$  in the axial directions to be applied on the cam faces.

The reaction force  $F$  opposing the rotational direction is transmitted through the pinion gears to the side gears in the same way as a conventional differential. The force  $P$  in axial directions push open the pressure rings and act as engaging load for the multi-plate clutches.

This load is needed as a force to cause friction between the friction plates and friction disks to let them work as clutches.



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(1) Pinion shaft

(2) Pressure ring

(3) Rotational direction

**F:** Reaction force that occur when the pressure rings cause the pinion shaft to rotate in driving direction.

**P:** Reaction force which the pressure rings receive from the pinion shaft in axial direction and this reaction force becomes the clutch engaging load.

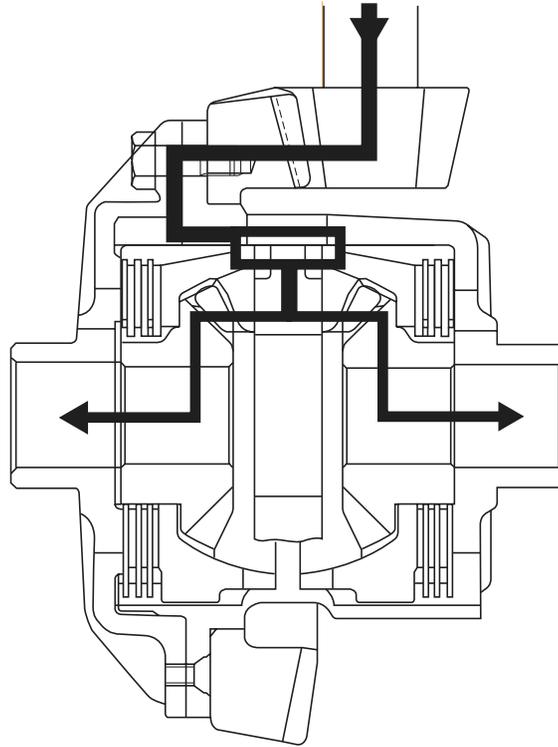
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## LIMITED SLIP DIFFERENTIAL (LSD) (MECHANICAL TYPE)

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### 1. WHEN RIGHT AND LEFT WHEELS ROTATE AT THE SAME SPEED

During normal straight-ahead driving where the right and left wheels rotate at the same speed, the differential case and side gears rotate together, just as in conventional differentials. As a result, driving torque is distributed equally to the right and left side gears.



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## LIMITED SLIP DIFFERENTIAL (LSD) (MECHANICAL TYPE)

### DIFFERENTIALS

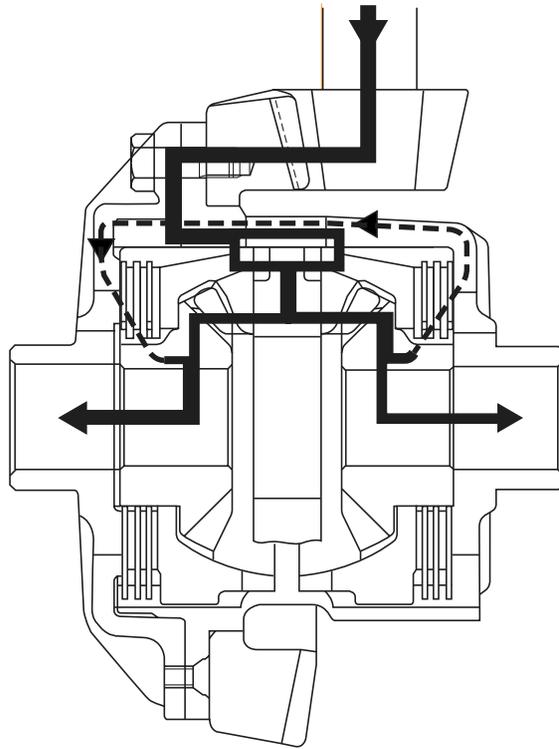
#### 2. WHEN RIGHT AND LEFT WHEELS ROTATE AT DIFFERENT SPEEDS

The right differential bevel gear tries to turn faster than the differential case, however, since the right differential bevel gear is braked by the clutch, a part of the torque is transferred from the right differential bevel gear via the clutch to the differential case as shown by the broken line.

While the left wheel is not spinning and the differential bevel gear is turning at a low speed, the differential case is turning at a high speed, and in contrast with the right side, torque is transferred from the differential case via the clutch to the differential bevel gear.

As a result, the left side differential bevel gear receives a torque which is transferred from the right side differential bevel gear through the clutch, differential case, left side clutch and left side differential bevel gear, in addition to the torque transferred from the differential bevel pinion via the differential bevel gear.

#### When right wheel spins



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#### D: SERVICE PROCEDURES FOR LSD

It is not recommended to disassemble the LSD assembly as component parts of LSD assembly are not available individually.

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