- Limited Slip Differential or Self-Locking Differential or Differential Lockout

- The standard differential works well in most situations. However, on very slippery surfaces such as icy or muddy roads, a lack of driving force, called traction force, can cause rear wheels to slip because the standard differential will drive the wheel with the least traction. If one drive wheel is on dry pavement and the other is on ice or mud, the ring gear and differential case will drive the pinion gears. But, the pinion gears will not drive both side gears. When the pinion gears are driven by the differential case, they will walk around the side gear related to the wheel on dry pavement. It results the pinion gears driving the slipping wheel and the vehicle will not move. The standard differential sends almost all engine power to the slipping wheel. This problem can be avoided by using differential locks. Differential locks overcome traction problems by sending the same power to both wheels while allowing the vehicle to make normal turns.

The limited slip differential (LSD) restricts the differential rpm between two wheels, two thrust washers and a clutch plate which are incorporated in the differential case shown in Figure 3.51. When the resistance of left side differential gear is larger than the wheel, the right side differential gear will rotate. It makes the teeth of the right side differential clutch member climbing the teeth of the left side differential clutch member. So, it makes two ciutch members to move away from each other. Hence, the side gears are pushed against the thrust washers. Due to this, the rpm of the rear axle shafts comes closer to the differential case due to the friction between side gears and thrust washers. So, it is called the limited slip effect

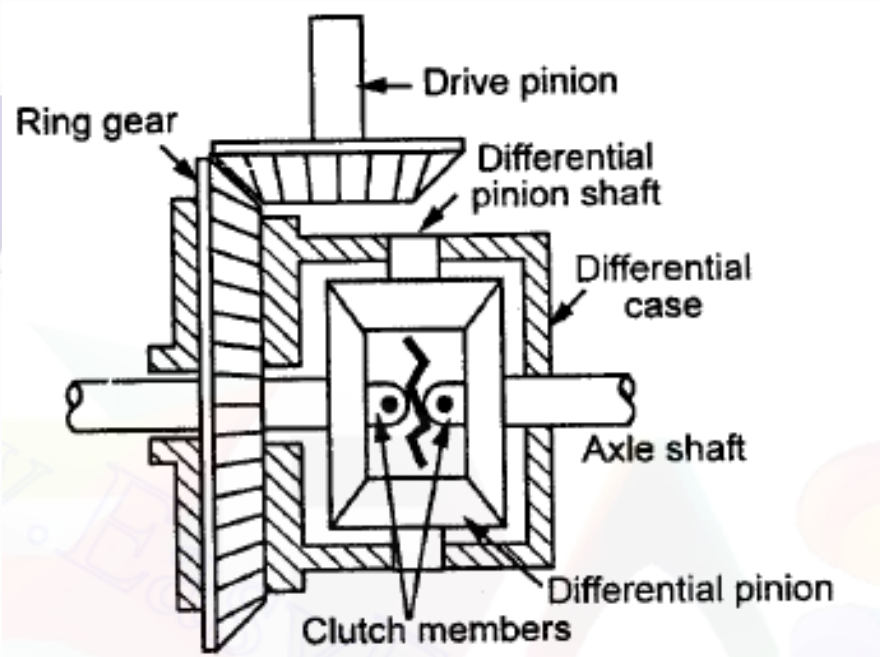

Figure 3.51 Limited slip differential

- (Types of limited-slip differential:
- The two most common types of limited-slip differential are as follows.
- I. Clutch-plate differential
- 2. Cone clutch differential.
- 1. Clutch-plate differential:
- The clutch-plate differential uses several friction discs which are similar to small manual clutch discs. The main difference between this limited-slip differential and a standard differential is the clutch packs placed between side gears and differential case. The clutch friction discs are made of steel covered with a friction material. The clutch plates are made of steel. The discs and plates are alternately splined to the side gear and dogged (meaning tabs fit into grooves) to the differential case. Grooves in discs or plates are for better grabbing power.

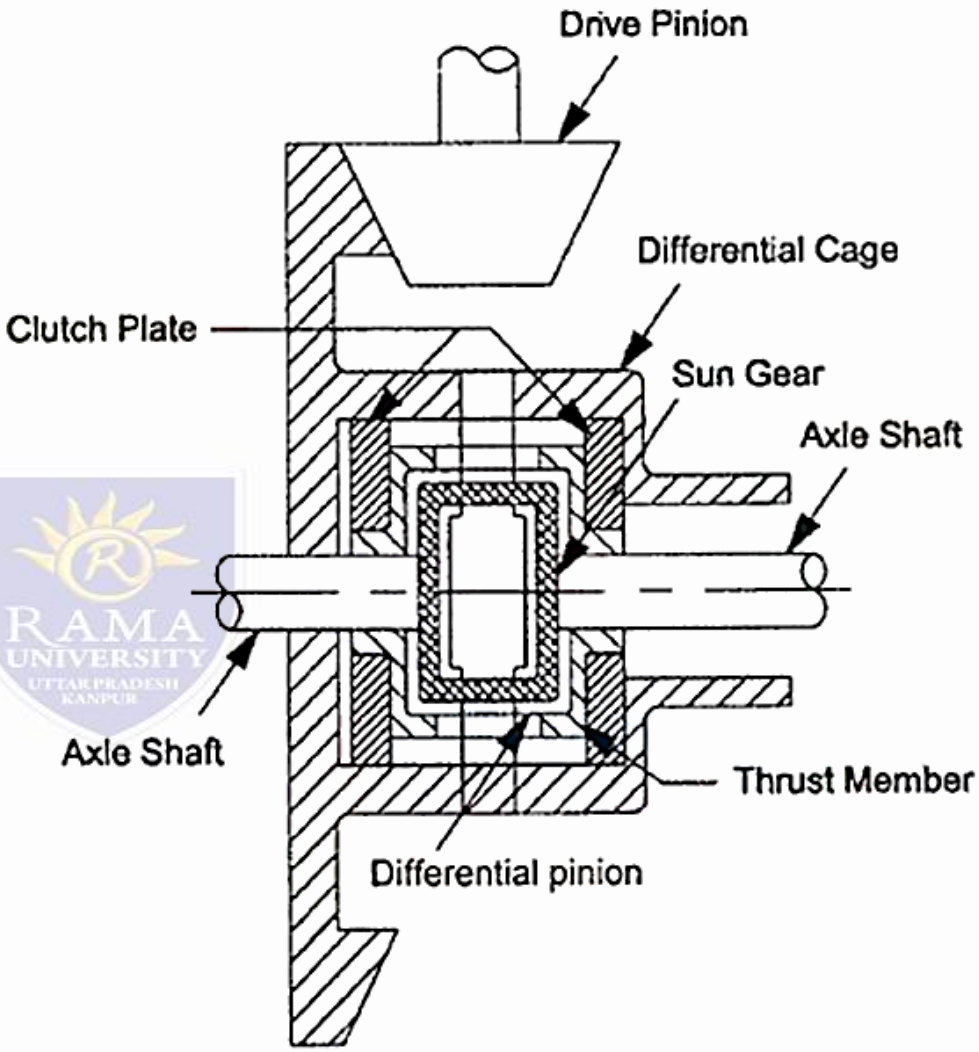

Figure 3.52 Clutch-plate differential

- The pinion gears, side gears and other parts are similar to a standard differential.
- The differential case of the limited-slip differential is made in two parts to allow for clutch pack removal.
- The discs and plates are applied by the preload springs and by the mechanical pressure of the pinion gears on the side gears. Since, the pinion and side gears are bevel gears, their teeth try to come out of engagement when the differential is transmitting engine torque.
- It creates a pushing action on the side gears and forces them outward against the differential case.
- The outward pressure of the side gears presses the friction discs and steel plates together between side gears and case. Whenever the discs and plates are pressed together, the splined and dogged connections ensure the side gear and differential case are locked together.
- When the vehicle is moving straight ahead, the clutch-plate differential operates similar to a standard differential.
- The rear wheels and the differential case tum at the same speed.
- The clutch packs are applied but they are not needed.
- When the vehicle is making a tum, a high torque caused by the outer wheel rotating faster than the case and it causes the clutch pack to slip. It allows the differential to operate similar to a standard differential when making turns.
- The discs and plates slide against each other discs turn with side gears, plates turning with case allowing different rotating speeds between case and side gears. Therefore, rear wheels rotate at different speeds

- **2. Cone clutch differential:**
- It is next version of the limited-slip differential. In place of clutch packs, the friction lined cones are used.
- The cone differential uses a cone-shaped clutch which engages a matching cone-shaped receptacle.
- The operation is similar to the clutch-plate differential.
- Preload spring and side gear pressures force the cone into a dished depression in the differential case.
- Friction tries to lock the cone. Therefore, the side gear sends power to the wheel with the most traction.
- Both clutch-plate and cone differentials require a special limited-slip gear oil
- .**Non Slip Differential**
- The differential is a torque controlled differential. Preloading the system is possible. So, he differentials operated by resultant moments. Pre load can be adjusted.
- Advantages:
- (i) Maximum traction can be achieved for all grip levels (adjustable).
- (ii) Fuel consumption is reduced.
- (iii) Tyre wear is reduced.
- (iv) A comfort driving is obtained.
- (v) Constant speed drive is ensured.
- (vi) Understeer in corners is reduced.

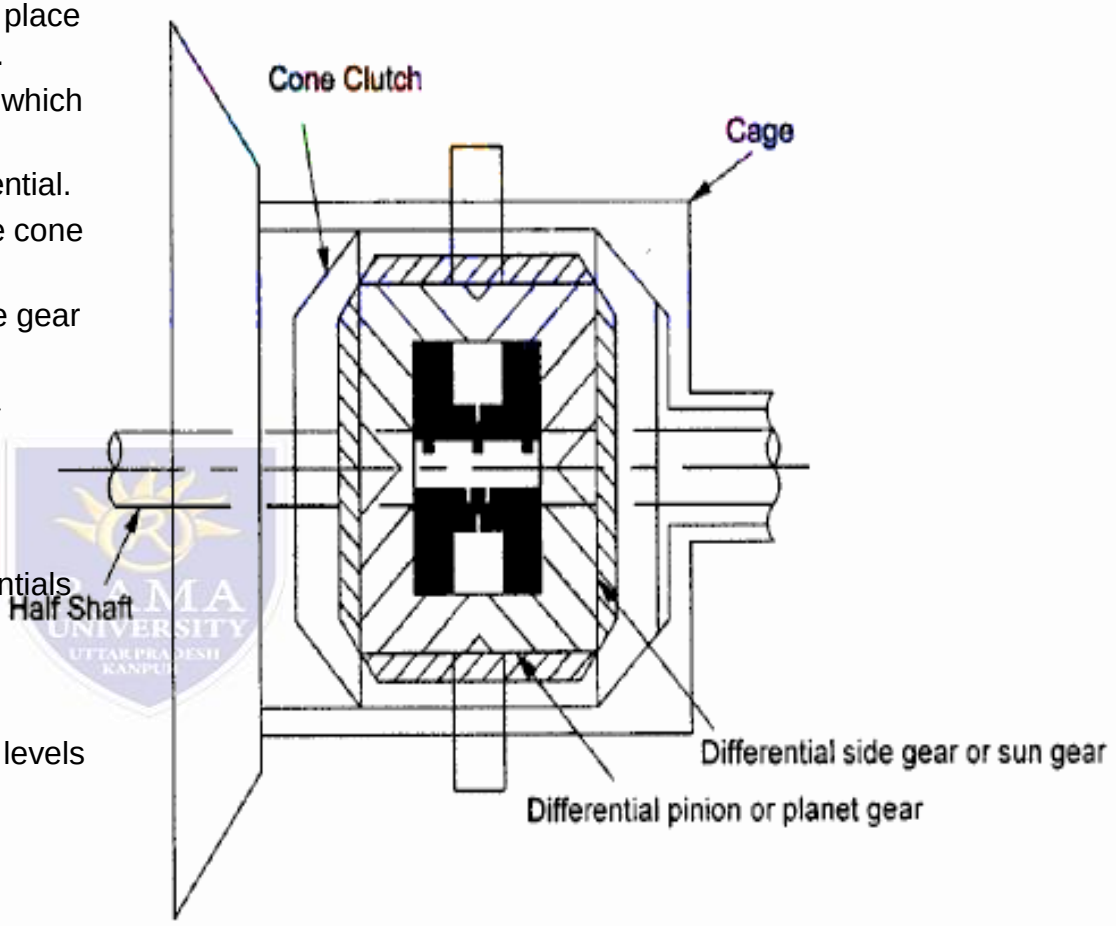

Figure 3.53 Cone differential

- Double Reduction Type Differential
- In final drives, there is a single fixed gear reduction.
- It is the only gear reduction in most automobiles and light- and some medium duty trucks between drive shaft and wheels.
- Double reduction final drives are used for heavy-duty trucks
- . In this arrangement, it is not necessary to have a large ring gear to get the necessary gear reduction.
- The first gear reduction is obtained through a pinion and ring gear as the single fixed gear reduction final drive.
- The secondary pinion is mounted on the primary ring gear shaft.
- The second gear reduction is the result of the secondary pinion which is rigidly attached to the primary ring gear and driving a large helical gear which is attached to the differential case

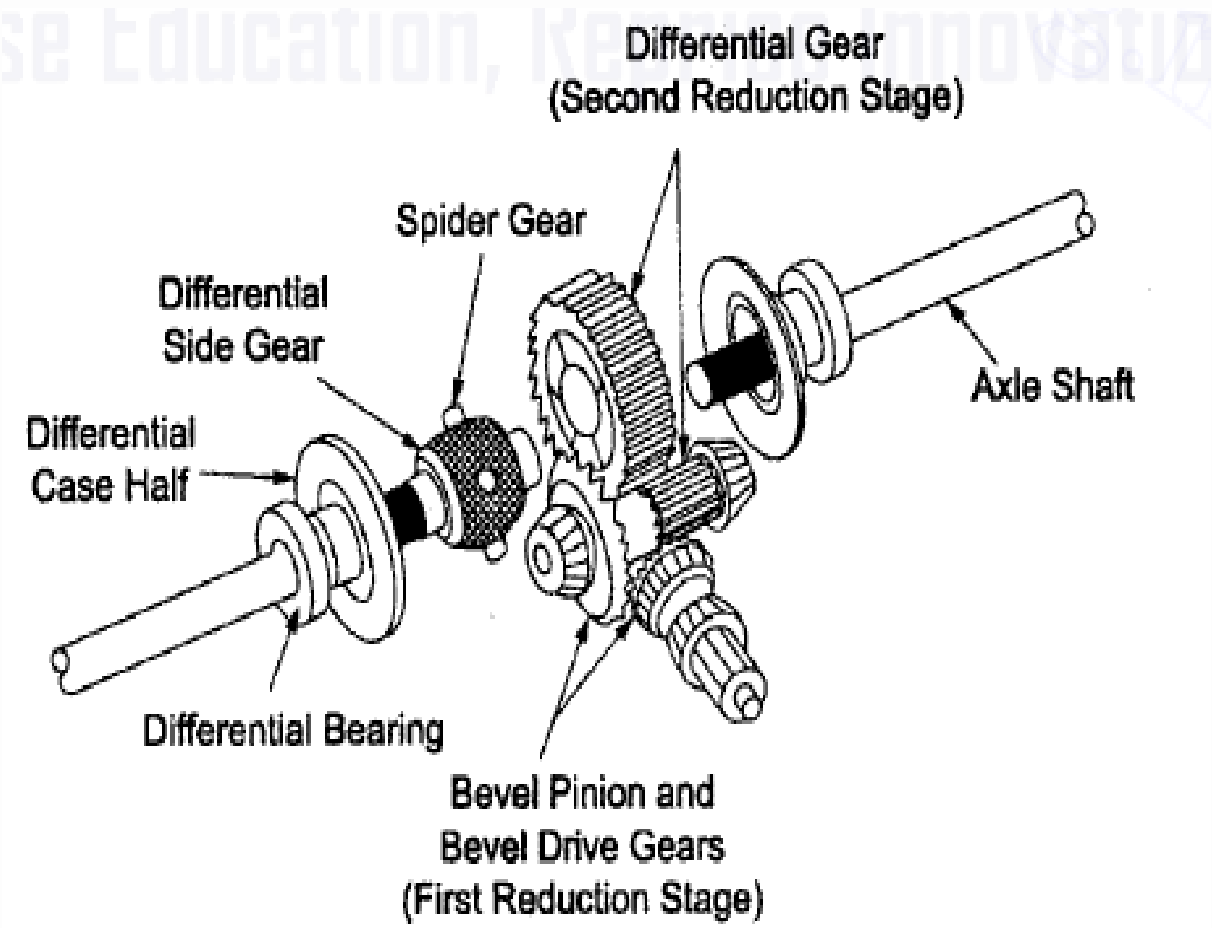

Figure 3.54 Double-reduction differential