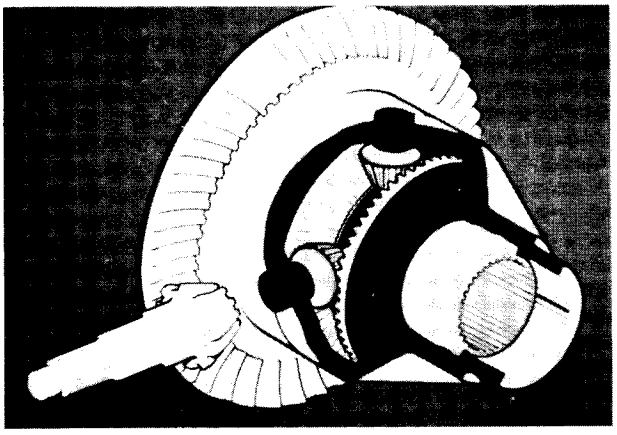
CLARK

CLARK DIFFERENTIALS

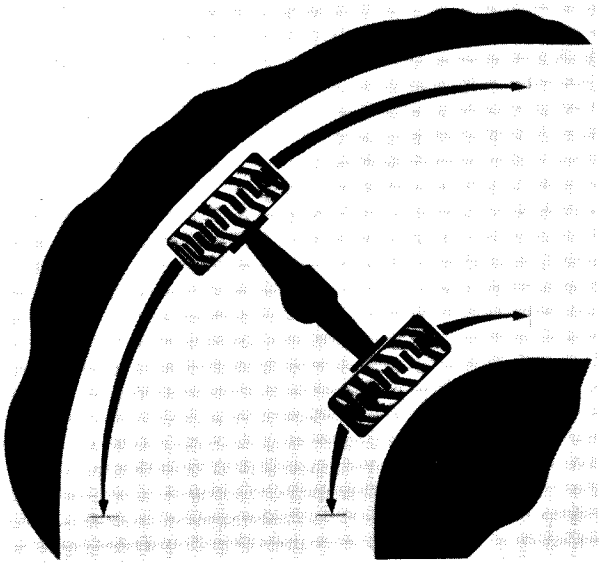
Theory of Operation

9035

THE DIFFERENTIAL



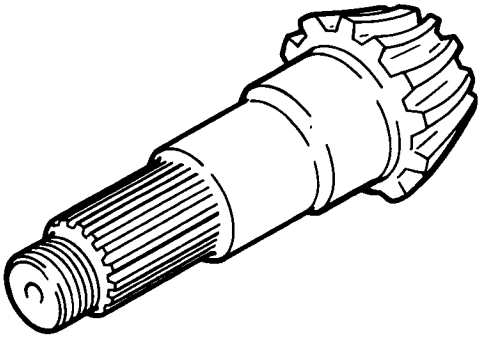
The purpose of a differential is to provide equal power to both wheels during normal operation, . . .



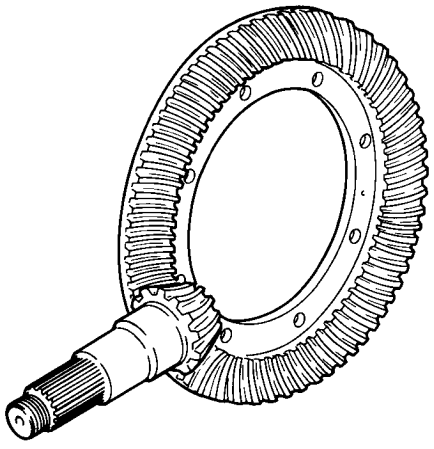
and to allow the wheels to rotate at different speeds while turning the machine.

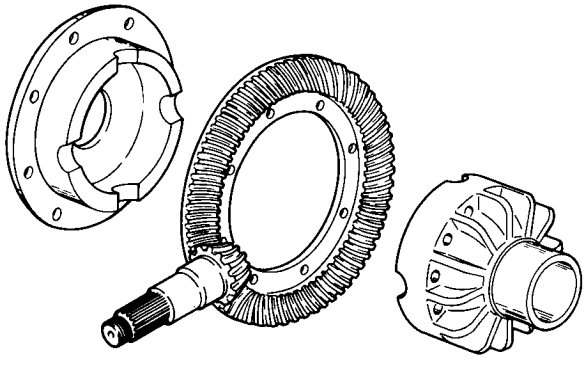
The parts that make up a differential include:

1. The Pinion Drive Gear



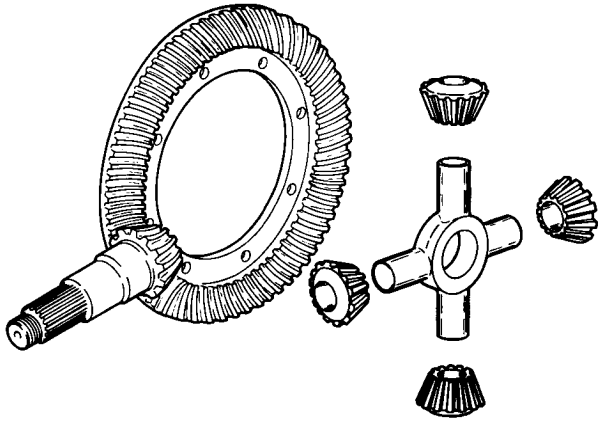
2. The Ring Gear (or Crown Gear)





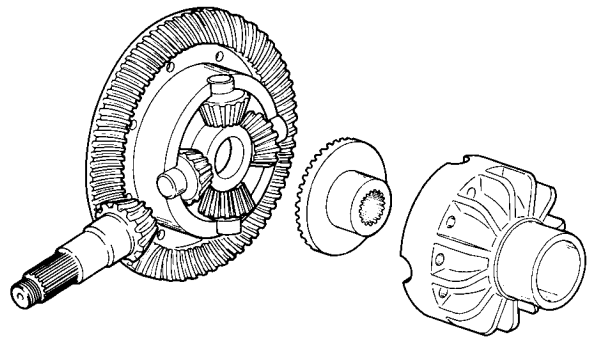
3. Case Halves

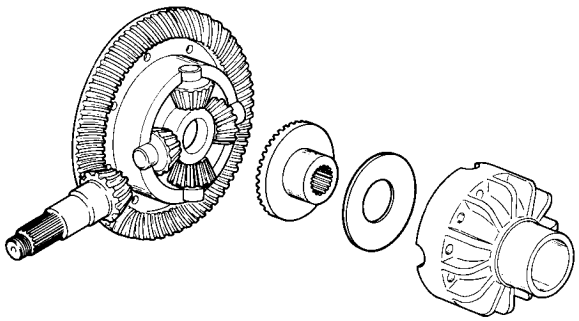
4. "Spider Assembly" which includes the cross and pinion gears



5. Side Gears

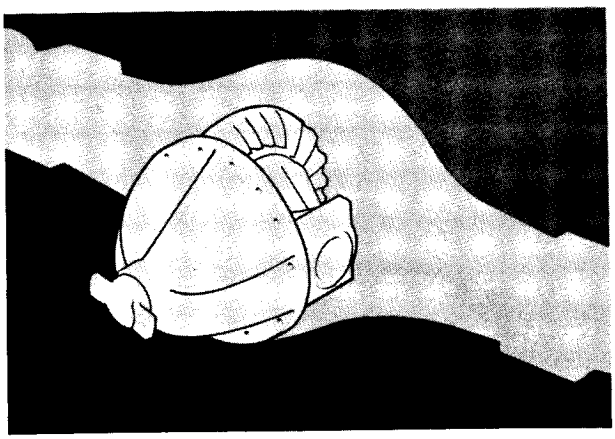
   A. Splined on the inside diameter to accept the splined ends on the axle shafts.



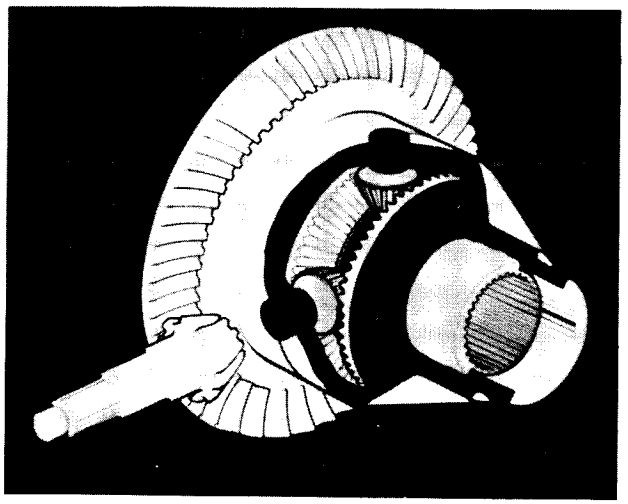


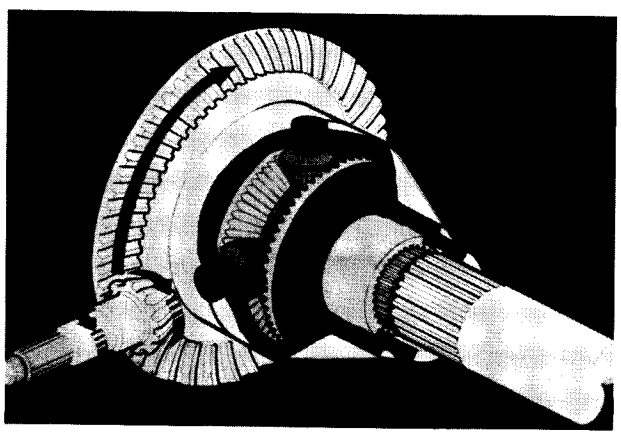
6. Thrust Washers which fit between the side gears and the case halves.

7. The carrier housing, bolted to the axle housing.



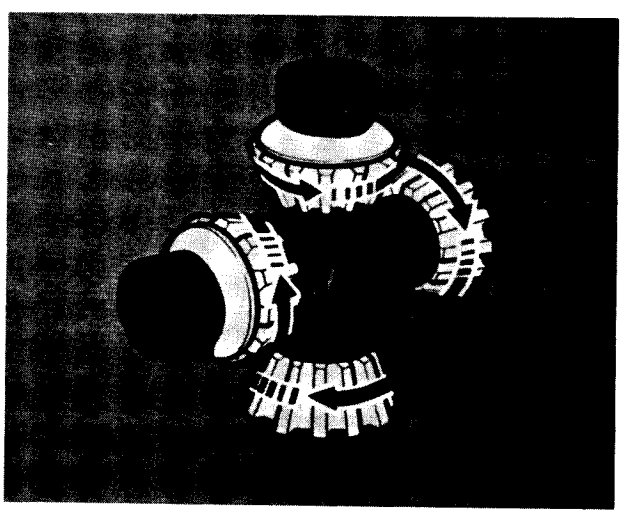
This is how the standard differential works when the machine is moving in a straight line. The ring gear is bolted to the case half, and the cross assembly is clamped into the case halves.



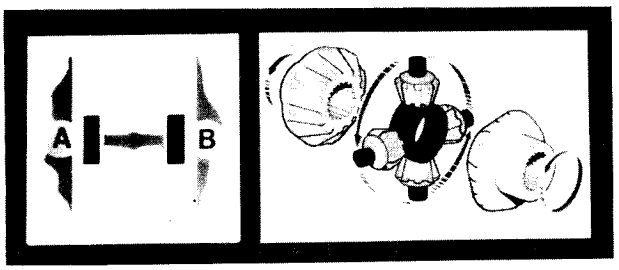


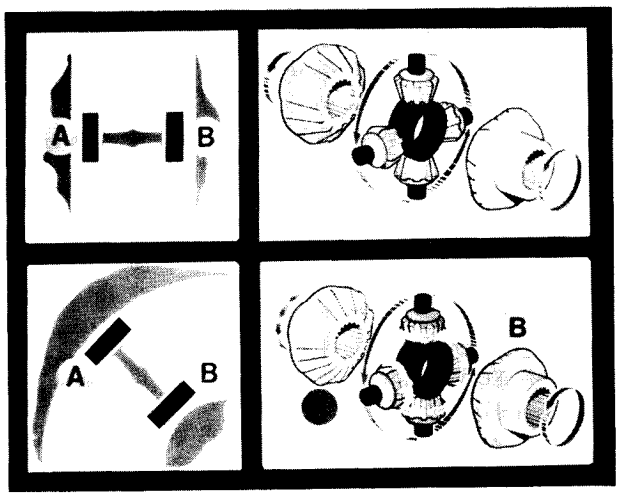
Therefore, as the pinion gear turns, it rotates the ring gear which causes the entire differential assembly to turn as one unit.

The pinion cross gears are forced to revolve with the cross, but are free to rotate on their own axis, when required.



When the machine is operating in a straight line, both wheels have equal traction, and both wheels "A" and "B" travel at the same speed. The complete assembly turns as one unit.

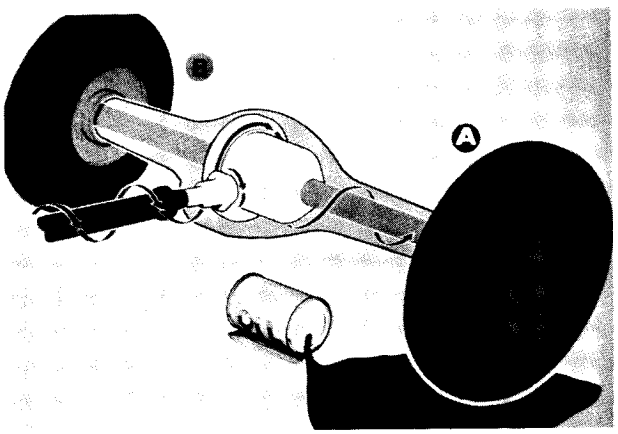




As the machine operates in a turn, the inside wheel "B" does not want to turn as fast as when it traveled in a straight line. The outside wheel "A" wants to speed up and turn faster because it has a greater distance to travel.

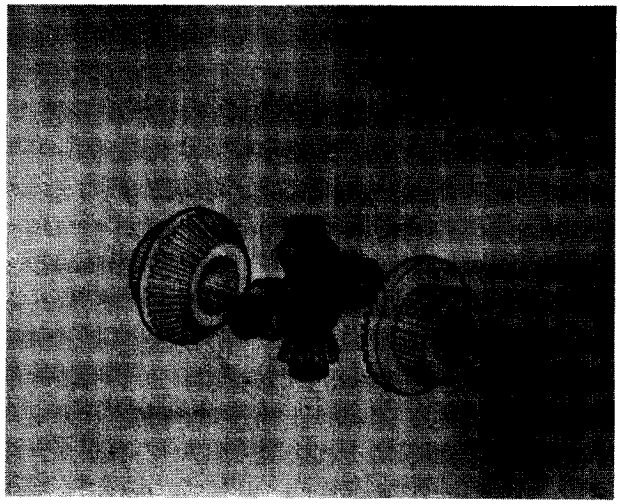
The side gears are attached to the axle shafts, and must turn at the same speed as the wheel to which they are attached. The side gears can slip on the thrust washers. Because the side gears contact the pinion cross gears, when they rotate at different speeds, it causes the pinion cross gears to rotate on their own axis. The gear assembly has now stopped turning as a unit as it did when both wheels were traveling at the same speed. This is how a standard differential works.

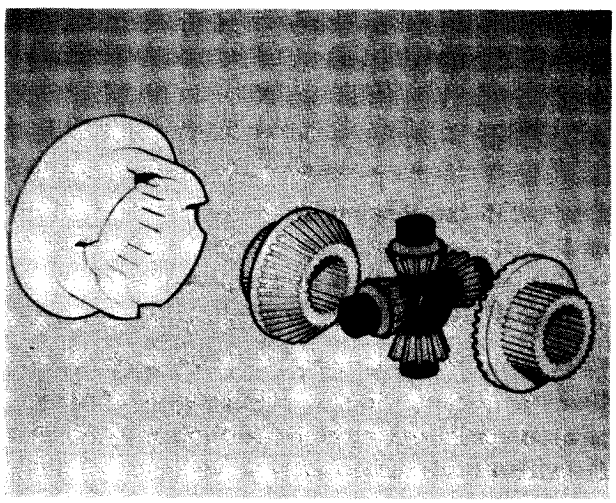
The original intention was to allow one wheel to rotate faster than the other. But when the faster rotating or slipping wheel "A" turns easier than the opposite wheel "B", it begins the differential action, and allows the available power to be used up by the slipping wheel. This happens anytime one wheel can rotate easier than the other.



To improve the differential, a new unit was developed called the Limited Slip. The following explains the operation of the limited slip differential.

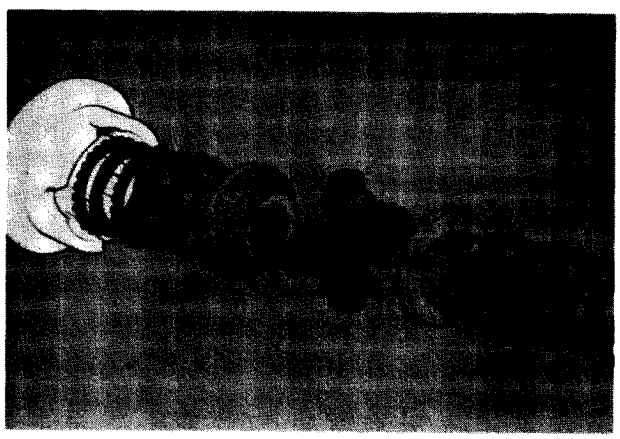
The two side gears are splined on the outer diameter as well as on the inner diameter.



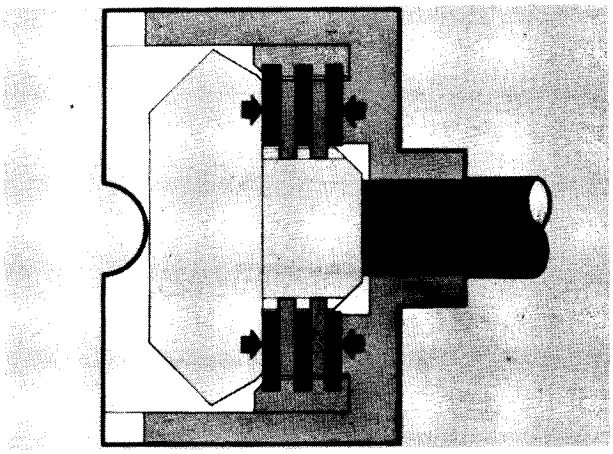


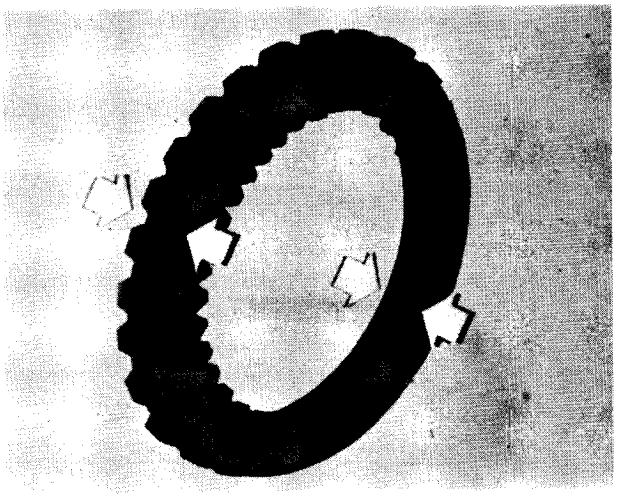
The case halves have internally cast splines.

Two clutch packs with clutch plates internally and externally splined are added. These clutch packs replace the thrust washers that were used in the standard differential. One clutch pack is put in each of the differential case halves.



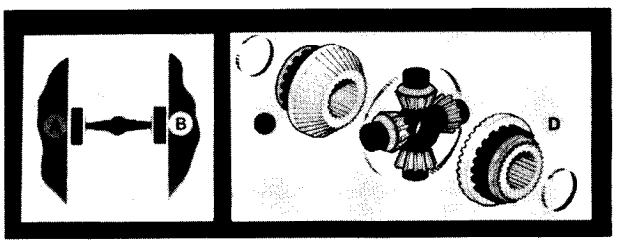
The case halves are bolted together so that the clutch plates are pressed against each other.



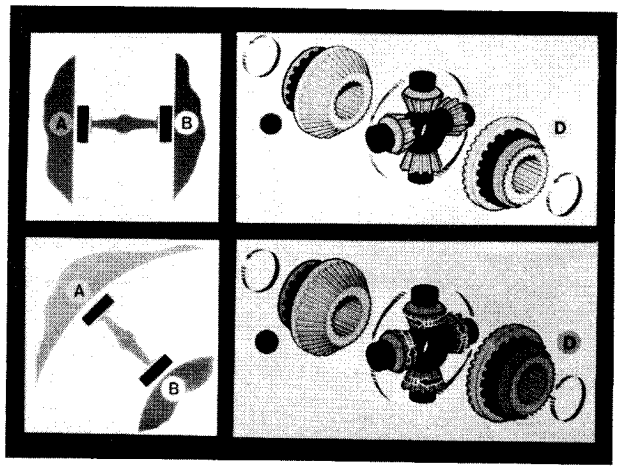


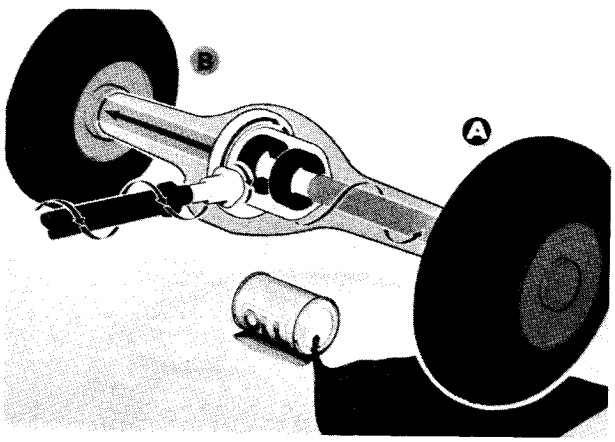
The friction grip of the clutch discs has to be overcome before the wheels are allowed to turn at different speeds.

When both wheels have equal traction, wheel "A" turns at the same speed as wheel "B" and the entire packs "C" and "D" simply ride between the side gear and housing with no effect.



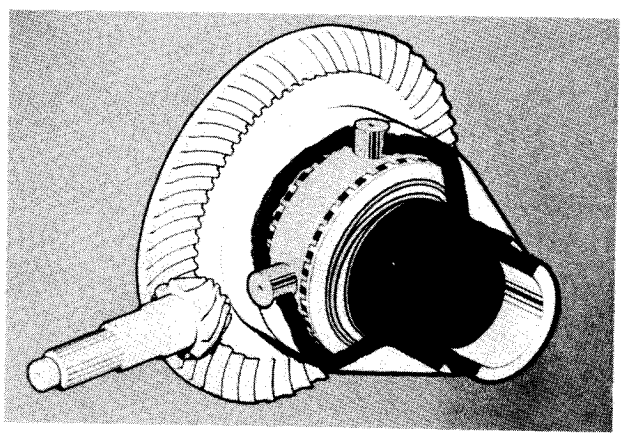
As the machine turns a corner and both wheels have equal traction, the inside wheel "B" does not want to travel as fast. The outside wheel "A", pushed by the swing action of the turn, wants to speed up. Enough force must be exerted to cause the clutch packs "C" and "D" to slip so that the standard differential gearing will take effect. This is very similar to the original differential, but limits the wheel slippage.



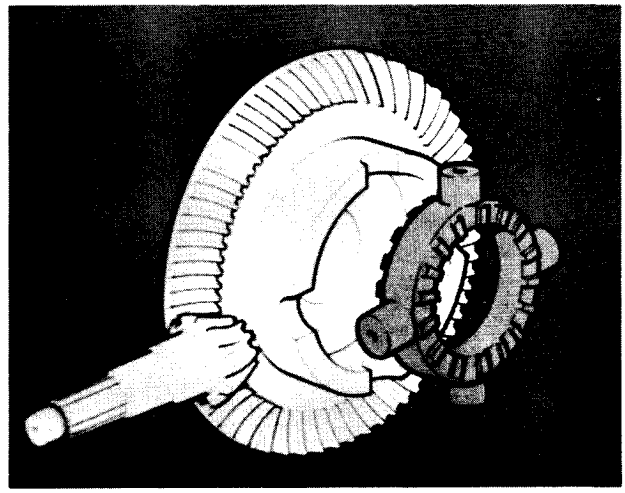


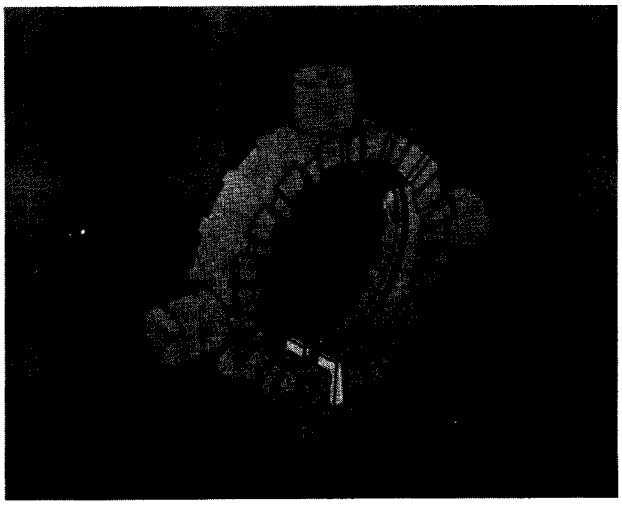
This assembly allows the wheels to turn at different speeds, with the clutch packs transferring some power to both wheels at all times. When one wheel "A" looses traction or begins to slip, the clutch packs will not allow it to consume all of the power but will transfer some power back to wheel "B" with the better traction. This is the basic principal of the Limited Slip Differential.

However, in some applications, it may be important not to have any power loss in either wheel. This is the reason for the No-Spin Differential.



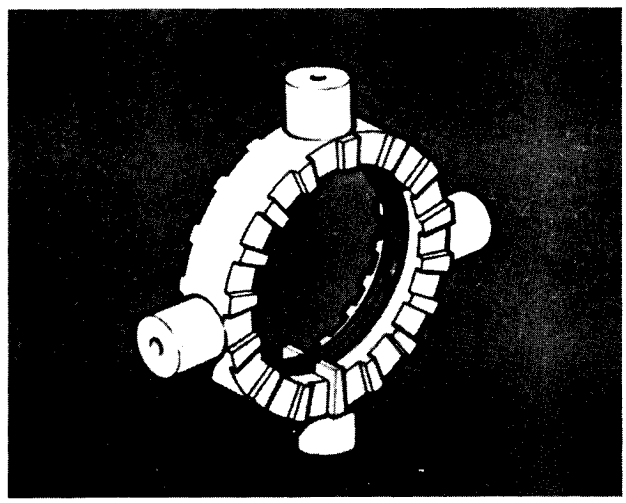
The No-Spin Differential consists of many common parts used in both the standard and limited slip differentials. The ring gear is bolted to the differential housing, and fitted together with the pinion drive gear. The cross assembly is clamped into the housing.



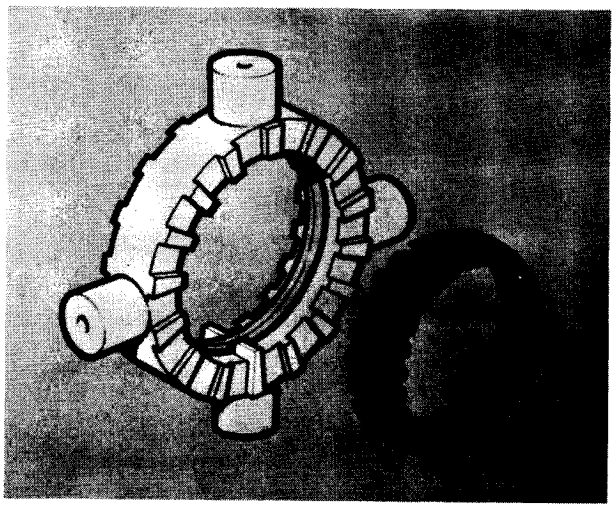


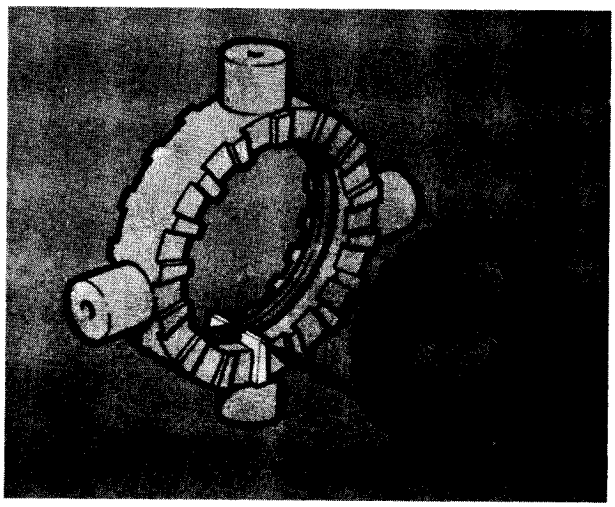
However, on the cross assembly, a key is put on the inside diameter. This key looks like a long tooth.

A snap ring fits into a groove on the inside diameter of the cross.



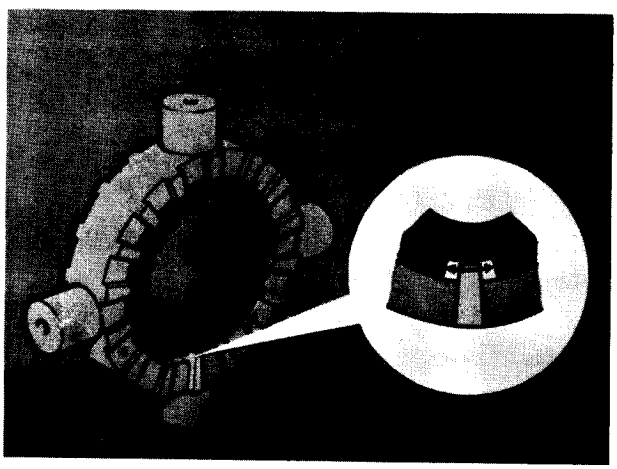
It fits into a groove on the outside diameter of the center cam when it is positioned inside the cross.



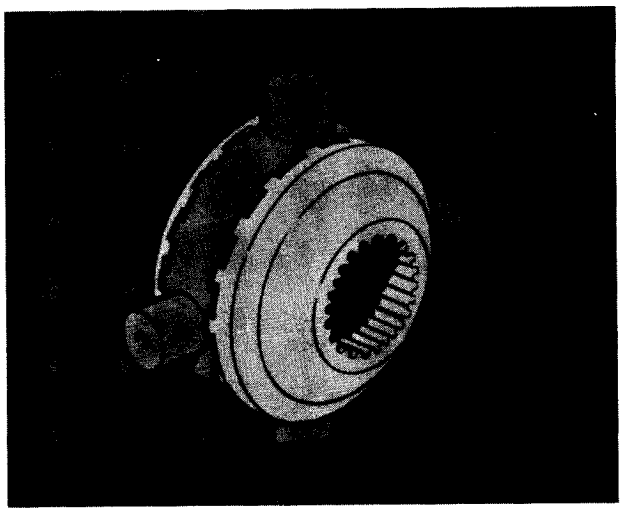


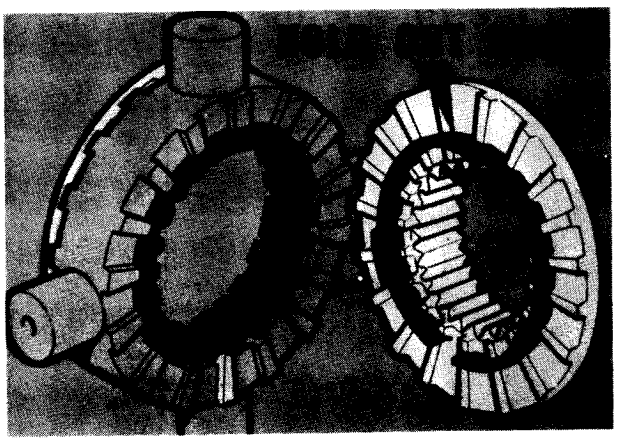
The narrow slot of the center cam accommodates the key of the cross when assembled together.

This slot is wider than the key and allows the center cam to rotate a short distance.



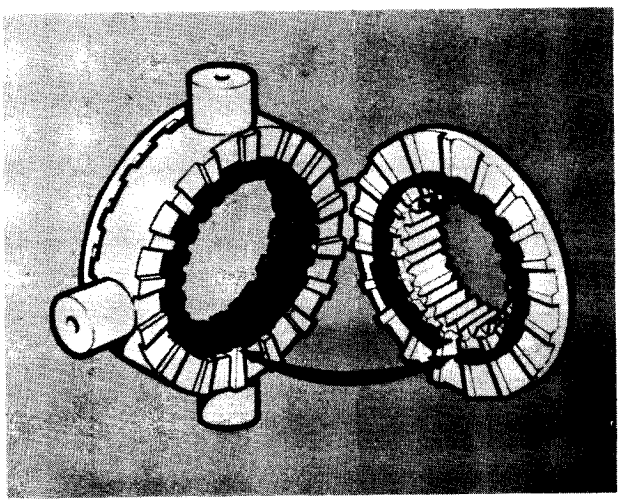
A driven clutch member fits on either side of the cross and center cam assembly.



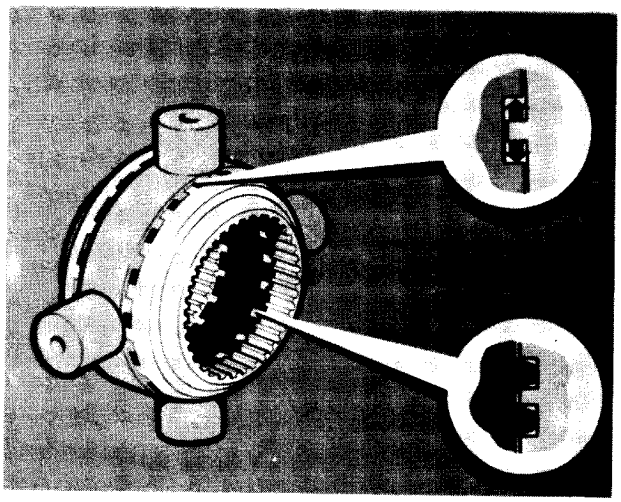


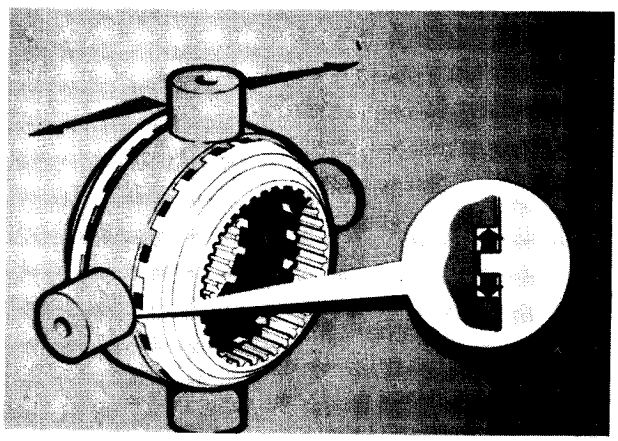
By removing the driven clutch member, the rotatable "hold out" ring can be seen held in position around the inner row of fixed clutch teeth.

The gap between the ends of the "hold out" ring meshes with the bottom section of the long tooth or key of the cross.



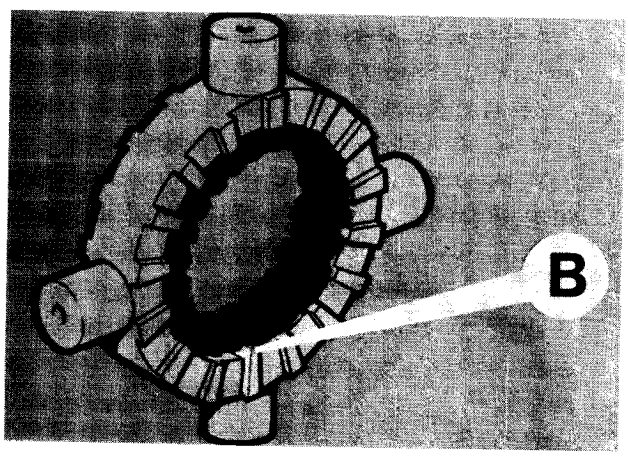
The inner row of clutch teeth on the driven clutch members, fit between the teeth of the center cam. The outer row of clutch teeth sits loose in the large gap between the teeth of the cross.



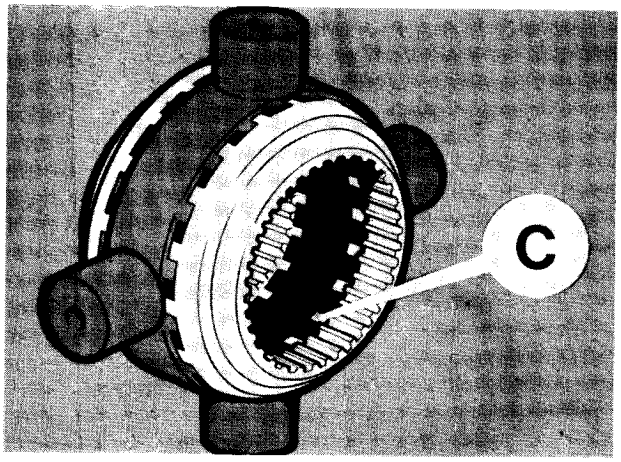


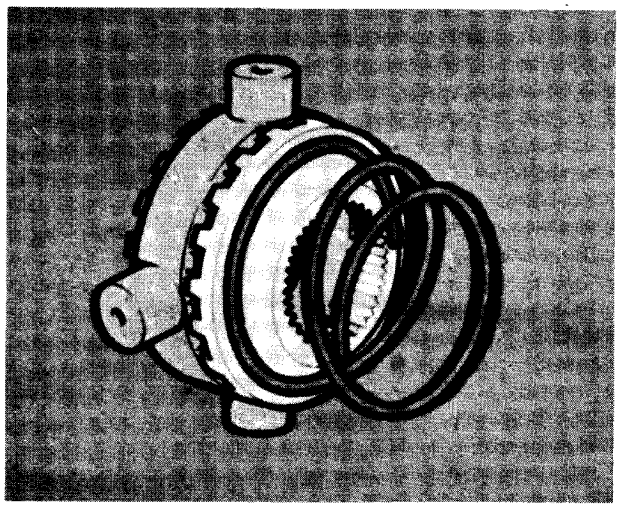
If the two driven clutch members are held against the cross and center cam assembly, only the cross will move back and forth in the gap between the teeth of the driven clutch members.

The center cam is allowed to turn a short distance inside the cross at point "B".



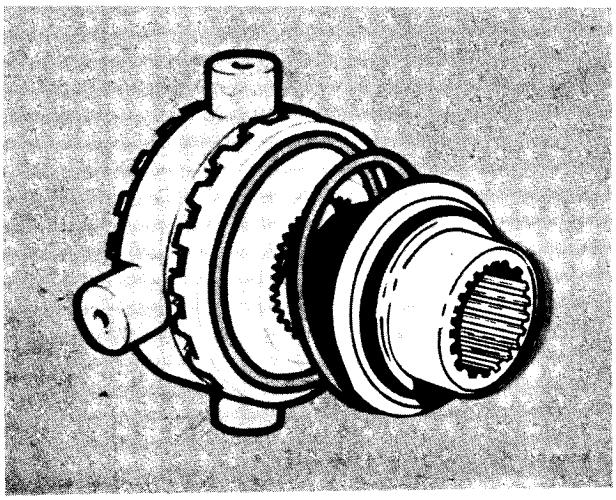
It is held by each driven clutch member by the inner row of teeth fitting snug into the teeth of the center cam at point "C".



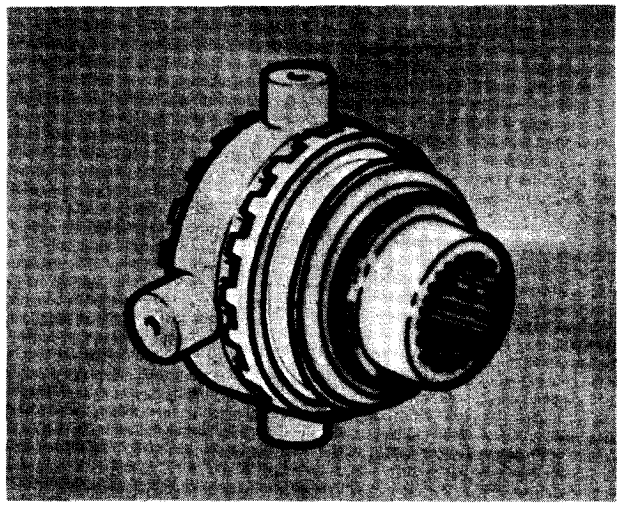


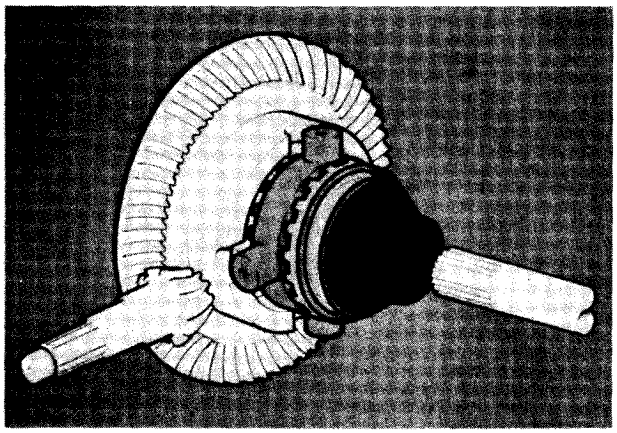
The return spring sits on the shoulder of each driven clutch member.

A spring retainer sits against the flange of each side gear.



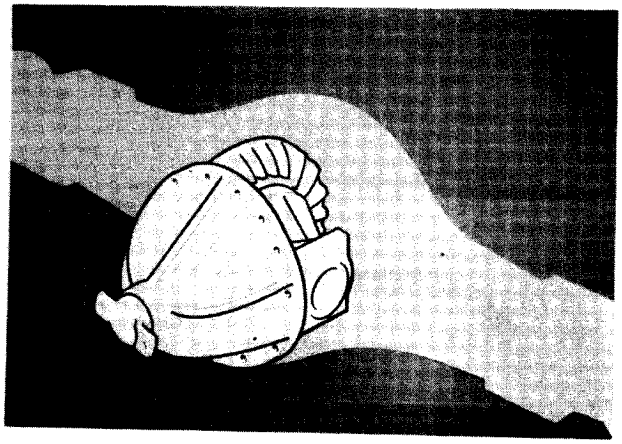
To allow the splined outside diameter of the side gear to fit into the splined inside diameter of the driven clutch member, the spring must be compressed.



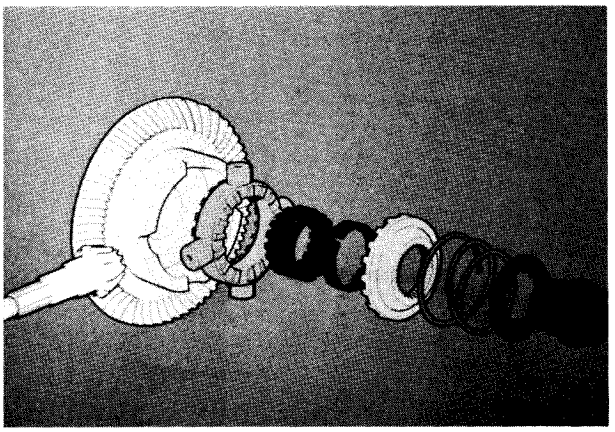


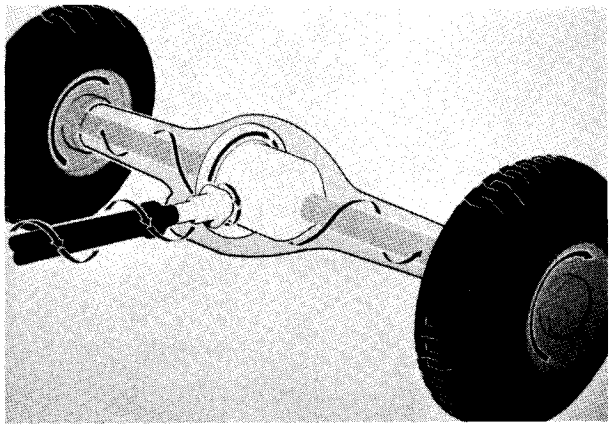
Each side gear sits in either end of the differential housing and is splined on their inside diameter to accept the splined ends of the axle shafts.

The carrier housing supports the pinion drive gear, ring gear, and differential assembly. This is bolted to the axle housing to complete the assembly.



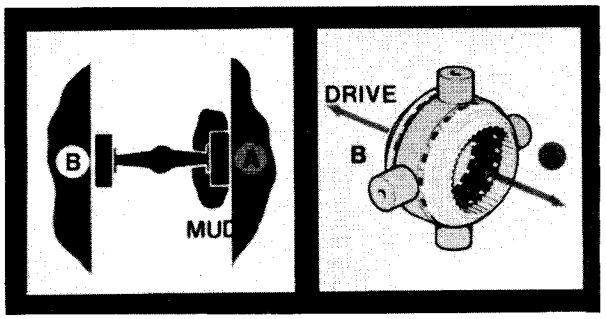
These are the No-Spin components. The No-Spin Differential really has only a few modifications from the standard and limited slip differentials.



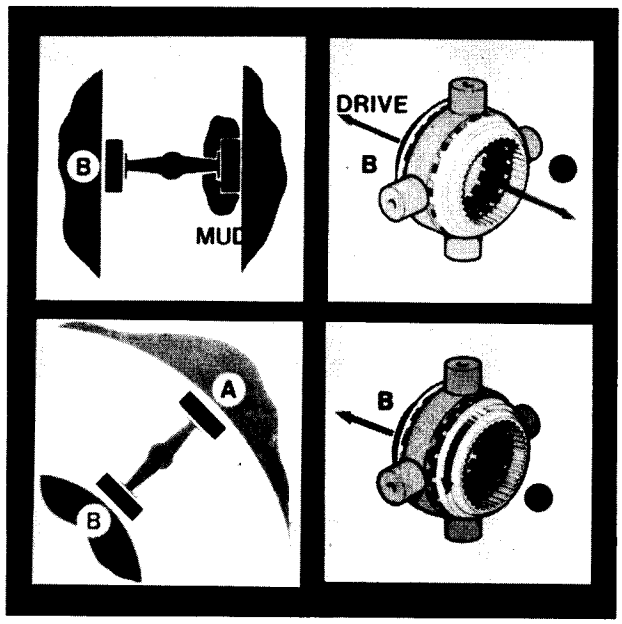


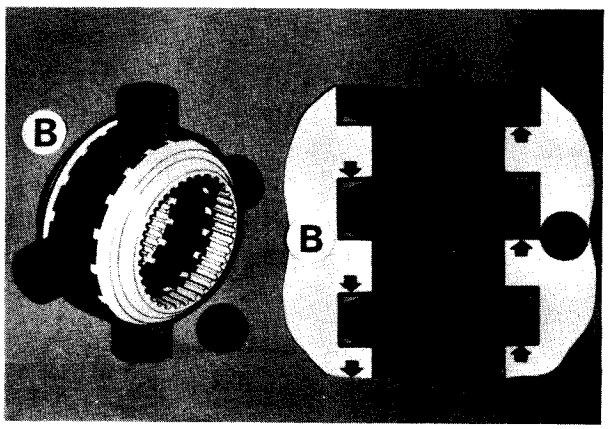
When there is equal traction on both wheels, the entire housing and differential turns as a unit. The two axle shafts are locked together through the side gears by the two driven clutches which are positively locked to the cross and ring gear.

When the machine is traveling in a straight line and one wheel looses traction, the positive locking differential allows equal power to be delivered to both wheels. This is the main advantage of this type of differential.



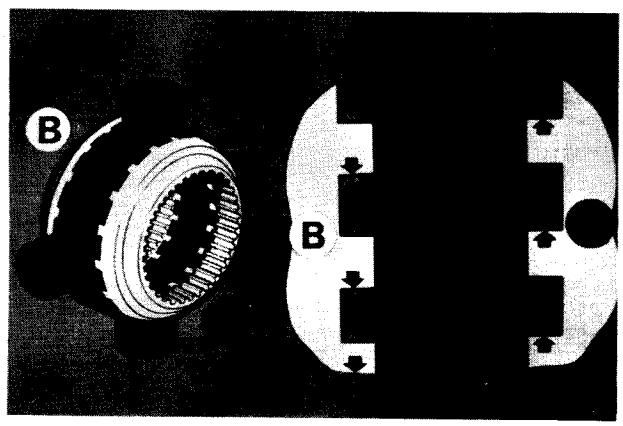
As the machine begins to turn, the outside wheel "A", pushed by the swing action of the turn, is allowed to disengage and turn faster than the inside wheel "B", to cover this longer distance in the turn. The inside wheel "B" continues to drive the vehicle through the turn.



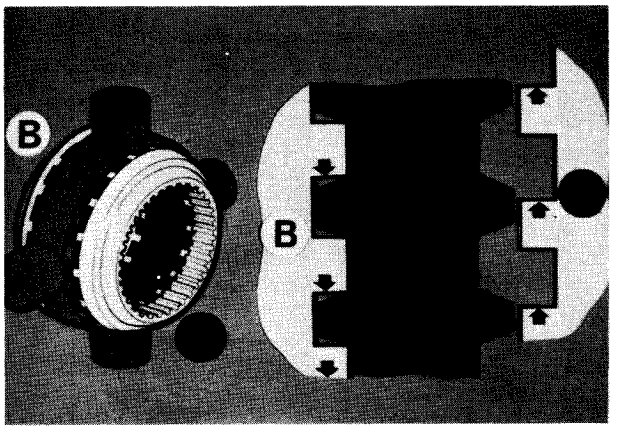


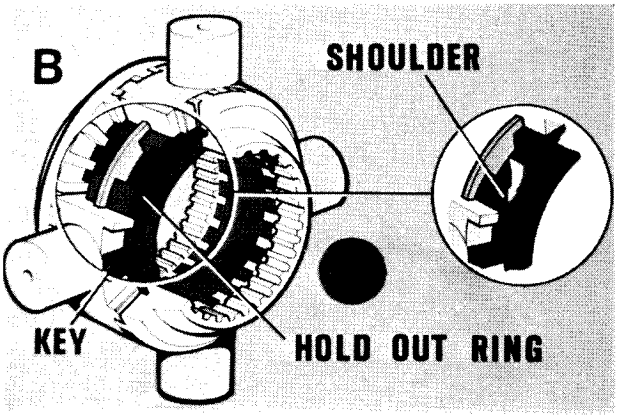
Clutch member "A" finds it easier to push back the return spring, and slide up the sloped teeth of the center cam, than it is to push the center cam ahead.

To understand how the outside wheel disengages, and turns faster than the inside wheel, consider this example. If clutch member "A" is pushed faster than clutch member "B", member "A's" inner row of teeth will try and push the center cam along with it. "B's" inner row of teeth prevents the center cam from moving.



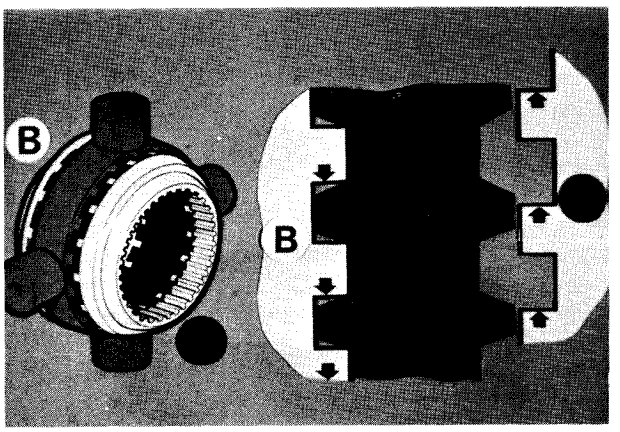
As clutch member "A" slides across the teeth of the center cam,



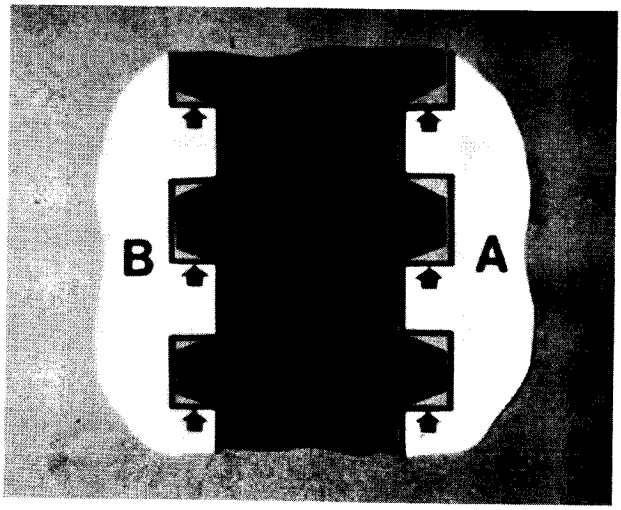


the teeth of the "hold out" ring slide out of the shoulder of the center cam. The "hold out" ring then slides up against the key of the cross and stops moving as fast as clutch member "A".

Clutch member "A" is now held out and away from the cross, as it rides around the "hold out" ring, free to be pushed faster than the cross is driving clutch member "B".



As soon as clutch member "B" returns to the same speed as clutch member "A", the "hold out" ring will slide back into place. Both wheels will now turn at the same speed. This is the basic principal of a No-Spin differential.



STANDARD
limited slip
NoSPIN

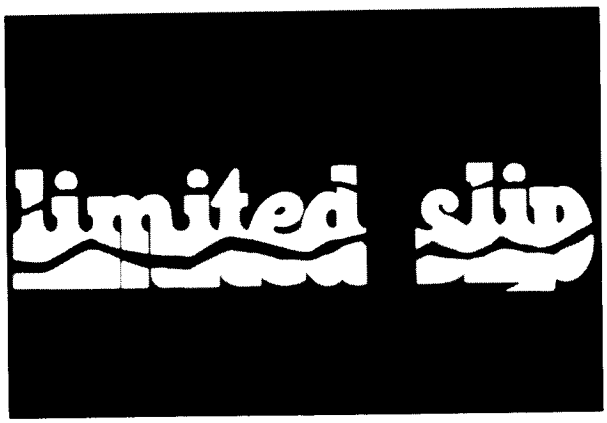
The standard, limited slip, and No-Spin differentials all do a good job depending on the work application. By providing all three types, there is a differential available for all applications.

TROUBLESHOOTING

Now here are some common problems that could cause a differential to fail, and reasons for rebuilding.

Differential failures could occur due to ring gear, pinion gear, side gear, or bearing failures. These failures would apply to all three types of differentials.

In the limited slip, further failures might occur to the clutch plates.



In the No-Spin type of differential, the spring cam and/or any other of the spider assembly components could fail.

All of these failures would be caused by abusive use, lack of/or contaminated lubricant, and/or an improper rebuild procedure. If any of these mentioned failures should occur, the evidence will be noise in the differential. In some cases, the machine will not steer properly or may totally lock up the differential. This sounds very elementary, but be sure that the problem is in the differential before attempting any disassembly.

The disassembly of a differential is not complicated, but be sure to refer to the appropriate shop manual for the proper procedures and instructions.