U.S. Govt $27.00
FET 2.06
$29.06

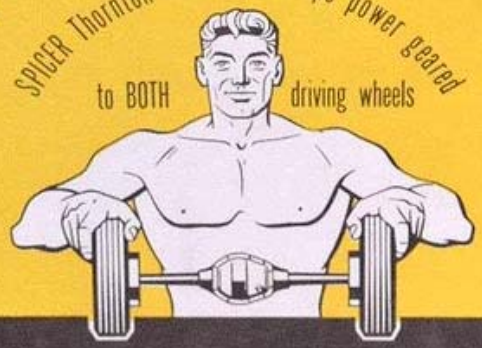
THE Spicer THORNTON

POWR-LOK

DIFFERENTIAL

Patent Pending

For Spicer Axles in Passenger Cars Station Wagons and Light Trucks



BULLETIN No. 360

JAN. 1956

Spicer

DANA CORPORATION • TOLEDO 1, OHIO

What is a Locking Differential?

A locking differential is a device which permits an automotive axle to transmit the major driving force to the wheel with the *better* traction.

What are the functions of a Locking Differential?

1. An efficient locking differential will prevent a vehicle from becoming immobile when one driving wheel loses traction.
2. An efficient locking differential provides vehicle safety and stability during high speed driving. It prevents wheel spinning and sudden shock loads due to wheel bounce over rough roads or non-uniform surface conditions such as ice and snow spots, wet and dry pavements, sand and gravel, and one wheel getting off the pavement.

What are the requirements of a good Locking Differential?

As specified by Dana, these requirements include:

1. It must maintain differential action.
2. It must prevent shock loads and the transfer of full engine torque to one axle shaft—so must *not* be of the *full* locking type.
3. It must provide sufficient traction torque to the non-spinning wheel at all times and under all operating conditions.
4. It must not interfere with steering.
5. It must provide increased safety, improved stability and handling by preventing wheel spinning under varying traction conditions.
6. It must be of long life and not subject to abnormal loads or wear.
7. It must continue to function efficiently regardless of the amount of wear.
8. It must be quiet in operation.
9. It must be of minimum cost, size and weight.
10. It must be interchangeable as a unit with present Spicer differentials.

Spicer

The Story Behind the Spicer Thornton POWR-LOK Differential

Eight years ago Dana Corporation set up a development program to make a complete analysis and study of locking differentials. The general idea of this type of differential is not new, as they were used by some of the very early cars. We have several hundred different designs in our technical files.

We made a careful study of all types including full locking, bias or power dividing, over running, hydraulic, etc. This covered all methods of construction, variable leverage, bastard teeth, eccentric pinions, cranks, shoe and band brakes, cams and sliding pins, spiral, crossed helical and worm gears, over running clutches, ball, roller and sprag, escapement clutches, also both hydrostatic and hydrodynamic arrangements.

During the past eight years we have tested 25 different designs of various types and construction. Many of these were of our own design and construction, others were submitted to us by outside sources, some were already being used, and some were from foreign sources.

We found that the THORNTON POWR-LOK differential fulfilled all of our requirements, and in addition, had two more worthwhile features.

1. Capacity is increased over conventional differentials, as the load is divided between the gear teeth and the cone clutches.
2. Action is the same for both drive and coast loads, and forward and reverse driving.

We decided upon the THORNTON POWR-LOK design, and during the past two years scores of them have been on test with very satisfactory results.

The Thornton POWR-LOK Differential is interchangeable as a unit with present Spicer Differentials.

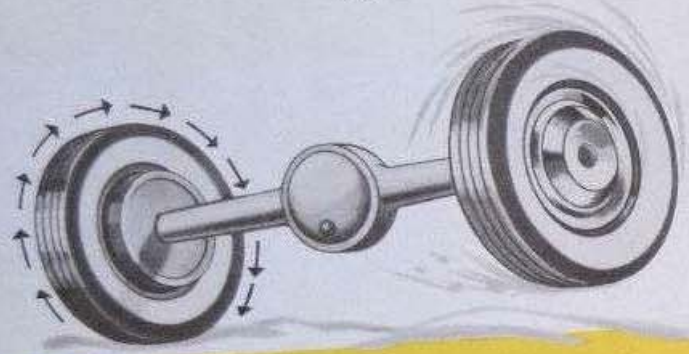
Spicer

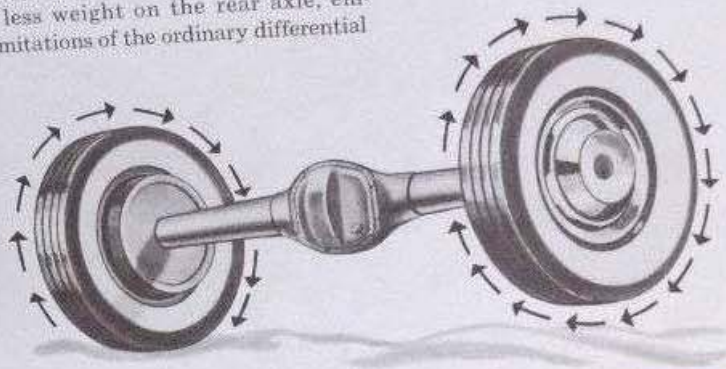
COMPARATIVE ACTIONS

on rough roads and non-uniform surfaces

Modern passenger cars with increasing horsepower and power-to-weight ratio present problems in high speed stability and handling. This problem has become more acute in recent years as the center of gravity of cars has moved forward.

This increased torque available at the rear wheels, coupled with less weight on the rear axle, emphasizes the limitations of the ordinary differential





ORDINARY DIFFERENTIAL

When a rear wheel is thrown into the air by a bump or obstruction and road contact is broken, the ordinary differential spins the wheel which rapidly gains momentum.

When this rapidly-spinning wheel hits the road surface, the sudden shock causes the car to swerve and the tire to scuff.

Spicer

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THORNTON POWR-LOK DIFFERENTIAL

Bumps do not adversely affect wheel action when wheels are controlled by the POWR-LOK. The free wheel does not spin and gain momentum. There is no sudden wheel stoppage to cause car swerve or tire scuffing, and wheel hop is reduced.

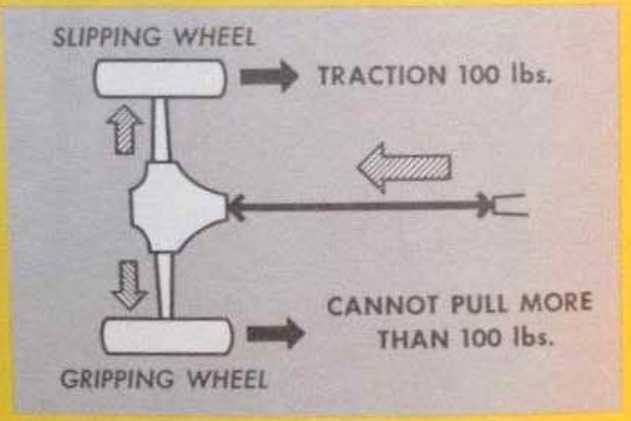
These characteristics of the Thornton POWR-LOK differential contribute substantially to highway safety through improved high speed stability and handling of the vehicle.

Spicer

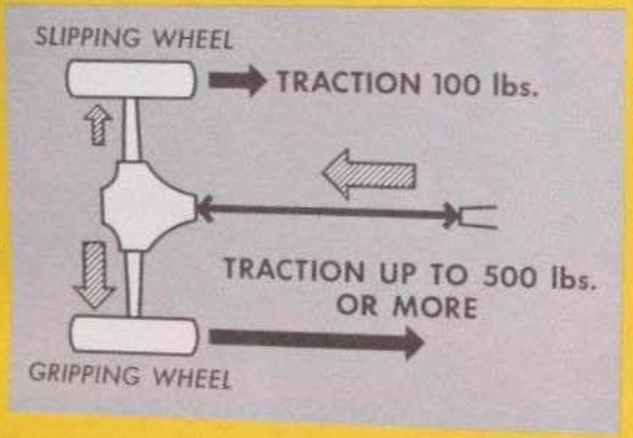
COMPARATIVE ACTIONS

in starting a vehicle in snow, ice, mud, sand, etc.

CONVENTIONAL DIFFERENTIAL



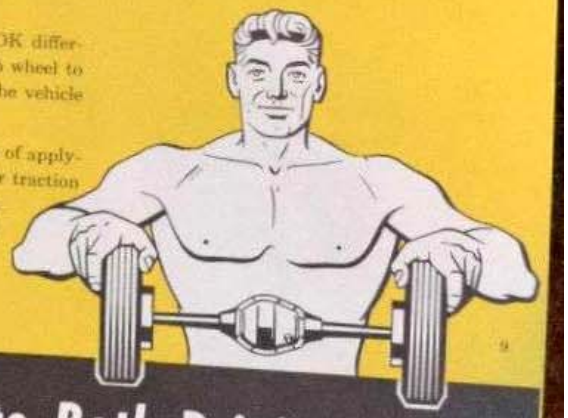
Snow at the curb presents a typical problem encountered by all types of vehicles in the winter months. This condition often offers traction on one wheel and no traction at the curb driving wheel. With the ordinary differential the curb wheel spins in the snow and the vehicle is stuck, as driving power to both wheels is equal and limited by the poor traction of the slipping wheel.



Spicer THORNTON POWR-LOK DIFFERENTIAL

Under the same conditions the Thornton POWR-LOK differential applies many times the driving force of the curb wheel to the wheel on the street with the better traction and the vehicle starts normally.

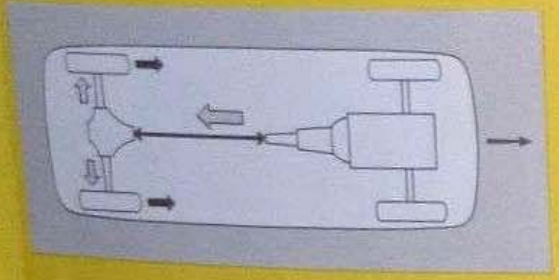
Similarly, the Thornton POWR-LOK's characteristic of applying the major driving force to the wheel with the better traction enables the vehicle to be operated in mud, sand and on ice which would stall a unit with an ordinary differential.



The Spicer Thornton POWR-LOK Differential Locks Constant Power into *Both* Driving Wheels

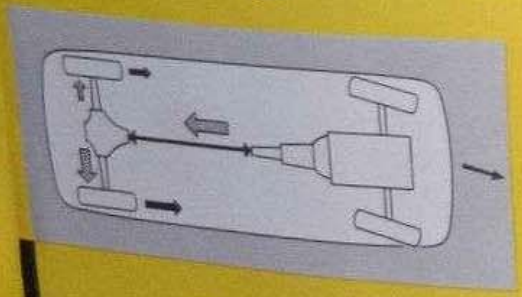
How the Spicer Thornton POWR-LOK Differential works in typical driving situations

1 Power Flow in Forward Driving

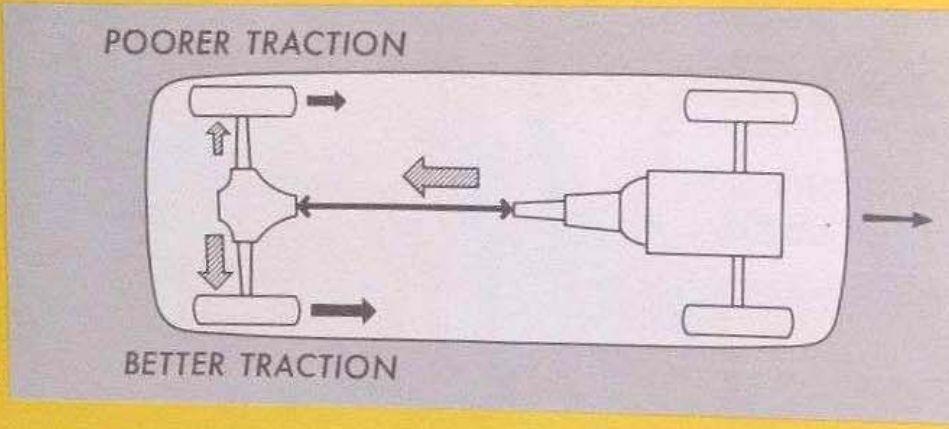


Under normal starting, shifting and operating conditions, the torque or power flow in both the POWR-LOK and conventional type differential is transmitted equally to each axle shaft and wheel. However, when sudden patches of ice, sand, loose gravel, or oil slicks are encountered, the POWR-LOK will not permit the wheel with the lesser traction to spin, gain momentum and swerve the car when dry pavement is regained.

2 Power Flow in Turns



In turning, the POWR-LOK Differential gives normal differential action and permits the outer wheel to turn faster than the inner wheel. At the same time the POWR-LOK differential applies the major driving force to the inside rear wheel, improving stability and cornering, and tending to compensate for oversteer.



3 Power Flow with Poor Traction

When traction conditions under the rear wheels are dissimilar, the driving force with an ordinary differential is limited by the wheel with the *poorer* traction. Typically, in this situation, the wheel with the poorer traction spins, and the vehicle remains immobile. The POWR-LOK Differential enables the wheel with the *better* traction to apply the major driving force to the road. In this way the POWR-LOK equipped vehicle can operate in snow, ice, and mud which might stop a conventionally equipped unit.

In an emergency situation, when one rear wheel drops off the pavement, traction with the ordinary differential is limited to that of the wheel off the pavement. This wheel tends to spin, and when the pavement is regained, the car swerves as the momentum of the spinning wheel is absorbed. With the Thornton POWR-LOK the wheel on the pavement continues to drive the car, and the wheel on the shoulder *does not spin*. In this way complete vehicle control is maintained and there is no dangerous swerve.

The Mechanical Principles in THE Spicer THORNTON POWR-LOK DIFFERENTIAL

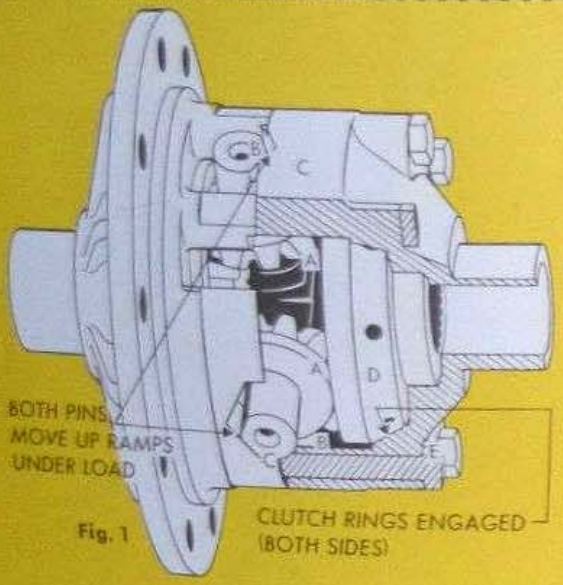
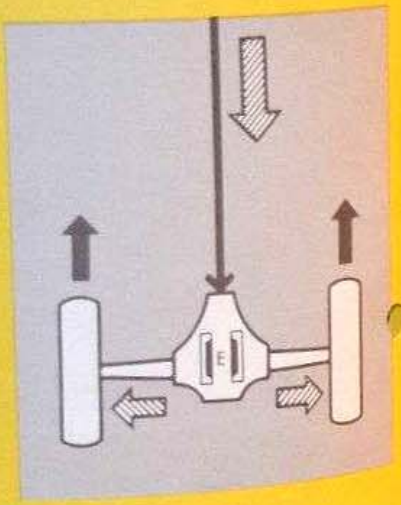


Fig. 1



The conventional differential, as used today, divides the load equally between both driving wheels. In this connection, it should be remembered that the conventional differential will always drive the wheel which is easiest to turn. This is a definite disadvantage under adverse conditions of driving where the traction of one wheel is limited.

The main purpose of the Thornton POWR-LOK differential is to overcome this limitation. The Thornton POWR-LOK will provide many times the torque of the slipping wheel to the driving wheel, thus permitting improved operation under all conditions of driving. In the Thornton POWR-LOK, the torque is transmitted from the differential case to the cross pins and differential pinions to the side gears in the same manner as torque is applied in the conventional differential.

The driving force moves the cross pins B (see fig. 1) up the ramps of the cam surfaces C, applying a load to the clutch rings D and restricts turning of the differential through the friction clutches E. This provides a torque ratio between the axle shafts which is based on the amount of friction in the differential and the amount of load that is being applied to the differential.

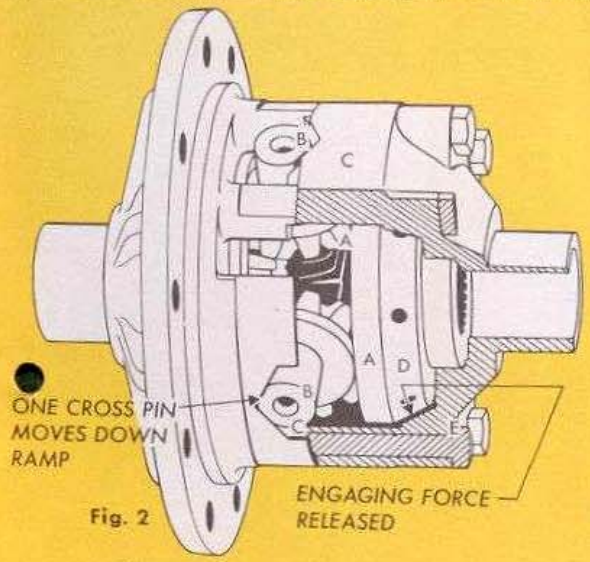
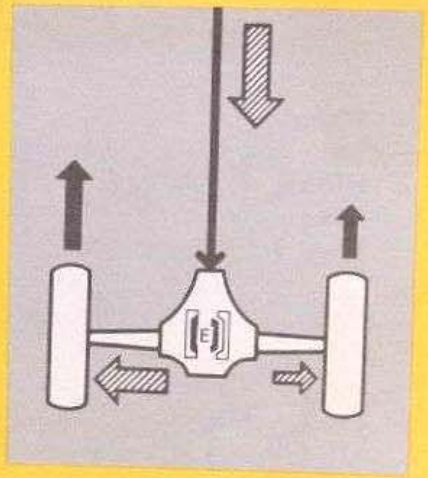


Fig. 2



When turning a corner, this process is in effect partially reversed. The differential gears become a planetary gear set, with the gear on the inside of the curve becoming the fixed gear of the planetary. The outer gear of the planetary over runs as the outside wheel on the curve has a further distance to travel. With the outer gear over-running and the inner gear fixed, the pinion mates A (see fig. 2) are caused to rotate, but inasmuch as they are restricted by the fixed gear, they first must move pinion mate shafts B back down the cam surface C relieving the thrust loads on the cone clutches E. Thus when turning the corner, the differential, for all practical purposes, is similar to a conventional differential and the wheels are free to rotate at different speeds.

The engagement of the clutches in the Thornton differential provides many features in this unit that are not common in other types of locking differentials. On straight driving, the clutches are engaged and thus prevent momentary spinning of the wheels when leaving the road or when encountering poor traction. In turning a corner, the load is relieved from the clutch surfaces so that wear is reduced to a minimum.

THE Spicer THORNTON POWR-LOK KEEPS POWER GEARED TO BOTH DRIVING WHEELS