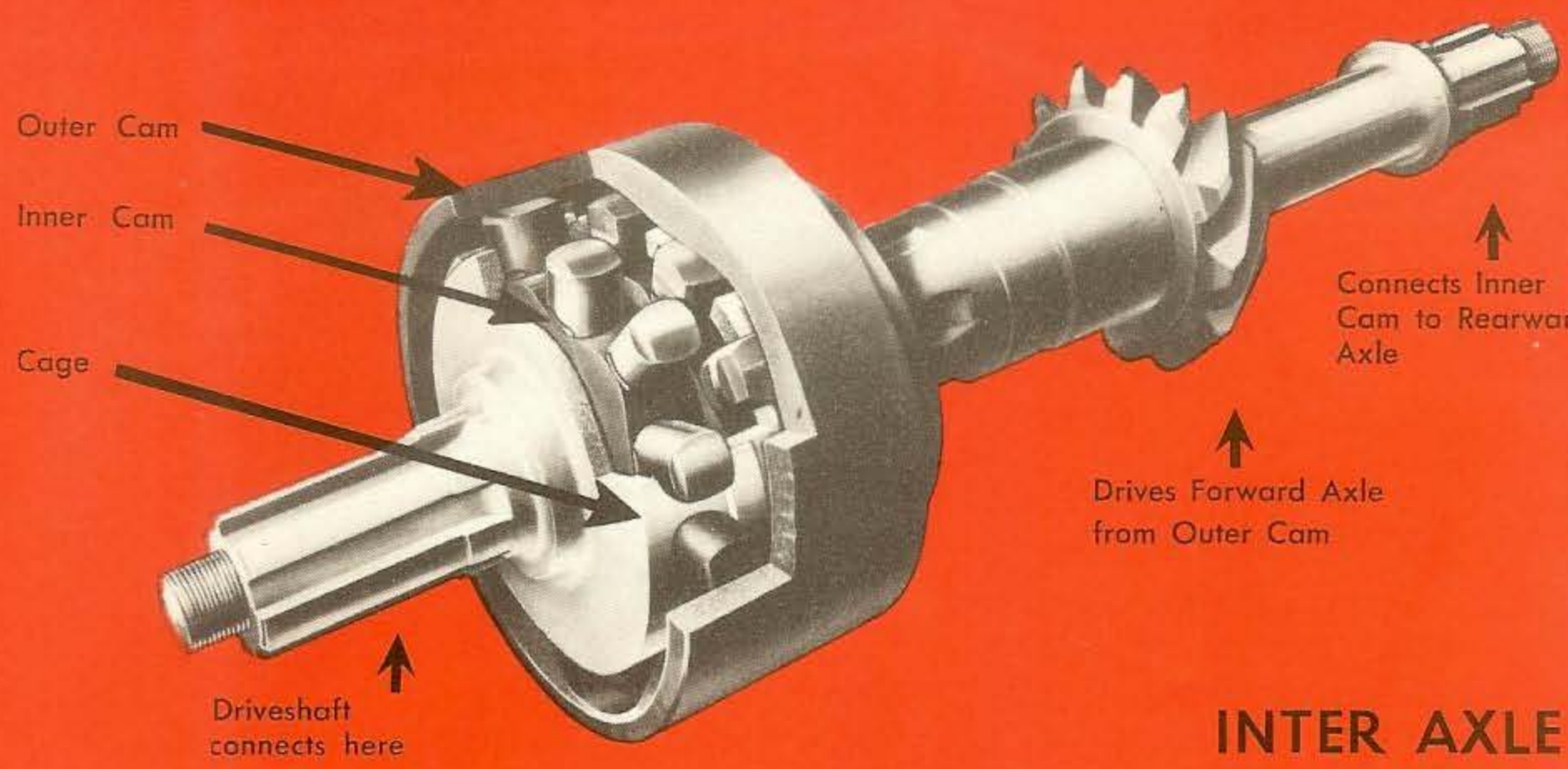


INTER AXLE TYPE

Enlarged view, cut-away to show cams, cage and plungers.

THE MACK POWER DIVIDER

POSITIVE traction with true differential effect, combined with smooth action, great durability and stamina are produced by the Mack Power Divider. This original and exclusive development has been thoroughly proven over a period of several years in commercial, military and off-highway service and has been developed in two forms. The first of these is the inter-axle type, used in all Mack four-wheel-drive bogies for six-wheelers as a third differential. The other is the axle type, replacing the standard differential in rear axles of off-highway types of trucks. Both forms are similar in design and operate on the same principle.

Performing as a true differential, the Mack Power Divider differs from conventional types in that it contains no gears, exerts no end-thrust and is capable of distributing the torque unequally. It is not a friction device or a differential lock. It is simply a cam-and-plunger differential with a torque bias toward the side offering the greatest resistance.

Advantages of the Power Divider

Chief among the advantages of the Power Divider, of course, is that it preserves traction in slippery going, but it is distinguished from other devices offered for the same purpose in that it operates without power-wasting friction, preserves true differential action, maintains its effectiveness indefinitely and transmits the drive smoothly, without surging or vibration and without developing harmful lost-motion.

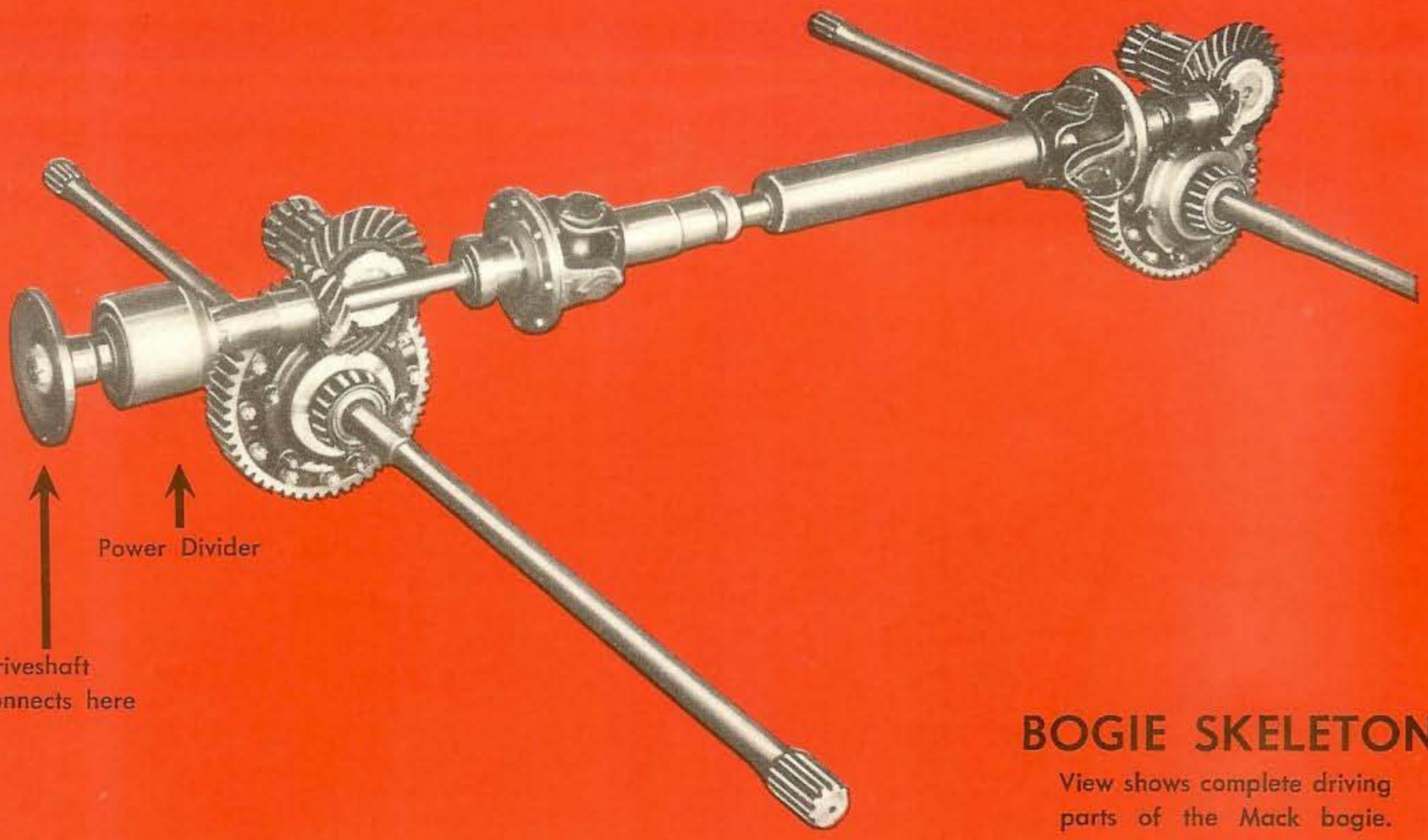
Excessive driving loads are not imposed, though, for the percentage of torque bias thus impressed on the side retaining traction is predetermined in the design to provide enough torque to keep the vehicle moving, but not enough to overstress the parts.

How It Acts

When driving under normal conditions, it acts in the same manner as the familiar bevel-gear differential, maintaining equal torque while permitting differences in speed between the two sides at a constant average speed. When traction is lost on one side, however, idle spinning of that side is prevented by the fact that an increased amount of torque is transmitted to the side retaining traction so that the vehicle is not stalled.

Just three elements comprise the Power Divider: a driving member and two driven members. The driving member is a wide ring or cage carrying twenty-four short, radial plungers in two rows, which are free to slide inwardly and outwardly a short distance. An inner and an outer cam constitute the driven members. The inner cam is placed within the ring of plungers and the outer cam surrounds them, so that the three elements are in concentric relation, with the plungers bearing on both inner and outer cams. The two rows of plungers are indexed alternately, or staggered, as are the two rows of cam lobes on the inner cam. The outer cam, however, is indexed uniformly across its width.

Relative motion between the driving ring and either of the cams will cause the plungers to reciprocate, being



BOGIE SKELETON

View shows complete driving parts of the Mack bogie.

pushed into their holes as they ride over the crests of the lobes and allowed to move outwardly as they slide into the valleys. As the two cams are opposed, however, inward motion of a plunger, as it surmounts the crest of one lobe, causes outward motion on its other end, so that it forces the other cam to turn in the opposite relative direction. This action is exactly like a conventional differential, being accomplished by cams and plungers instead of by gears.

In operation, the drive causes the cage to turn, carrying with it the twenty-four blunt, chisel-pointed radial plungers. These plungers are at all times in contact with both the inner and outer cams and, because of the angles of contact, cause the two cams to be carried around with the cage, so that normally the whole Power Divider revolves as a unit, driving the two sides at the same speed.

Simple Construction

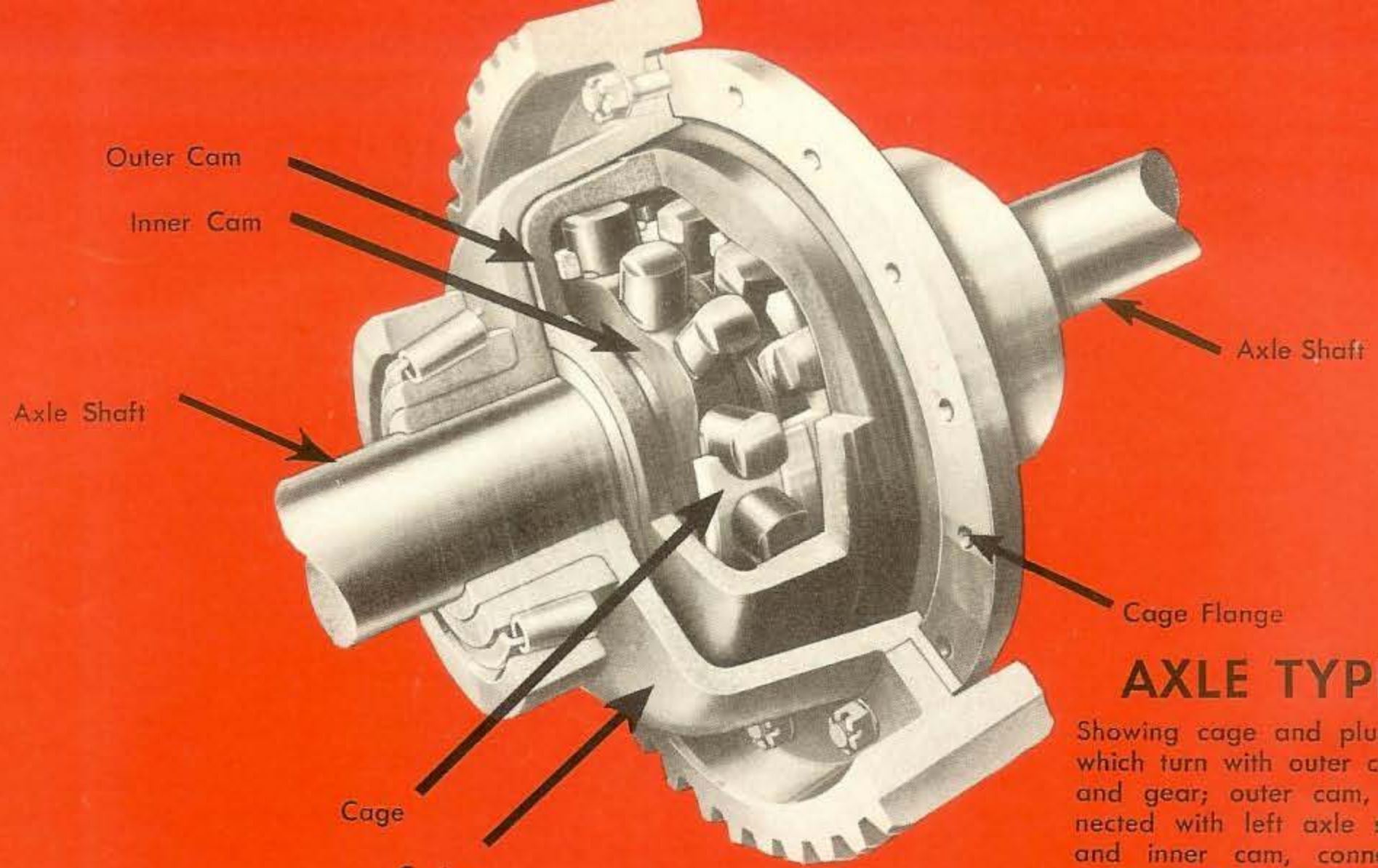
It will be noted that there are two rows of plungers and that the lobes on the inner cam are correspondingly in two sets, indexed alternately, while the outer cam has its lobes indexed uniformly straight across. Were it not for this, the Power Divider would not drive, for turning the cage would merely cause the plungers to reciprocate into and out of the convolutions of the cams while the latter remained stationary. The fact that the two sides have the cams indexed differently makes it impossible for this to occur. If both cams attempt to lag, then the two series of cams and plungers go into a wedging action, causing both cams to be carried around with the cage.

Where differential action is required, as in rounding a curve, then, of course, one cam will tend to over-run the speed of the cage while the other lags correspondingly behind it. This is accommodated by the Power Divider through the plungers. The over-running cam moves ahead of the plungers, thus either forcing them inward or allowing them to move outwardly, as they travel over the cam surfaces. At their opposite ends they similarly work on the inclined surfaces of the lagging cam, forcing it to turn at a speed slower than the cage, which exactly corresponds with the over-run of the other cam. Thus true differential action is effected, the average speed of the two cams being always equal to that of the cage, regardless of the difference in speed between the two cams.

When both sides of a conventional gear-type differential encounter equal driving resistance, the torque is correspondingly equally divided between them, as in straight-ahead running, but where one side meets with a lack of resistance, as in the case of loss of traction due to a slippery spot on the road, then, there being no fulcrum for the spider gears to operate against, little or no torque is exerted on the side where traction is preserved. This results in all of the motion being transmitted to the low-resistance side, causing futile spinning of the wheel connected with it.

Prevents Idle Spinning . . . Loss of Traction

In the Mack Power Divider, on the other hand, this effect is different. Were there no appreciable resistance whatever on one side, then it, too, would cause idle spinning and complete loss of traction. But, because of the cam angles, any resistance whatever on the low resistance side is multiplied three times so that three times the torque



AXLE TYPE

Showing cage and plungers which turn with outer casing and gear; outer cam, connected with left axle shaft; and inner cam, connected with right axle shaft

required to overcome its resistance is transmitted to the opposite side. In other words, the cams and plungers provide a fulcrum effect favorable to the side encountering the greatest resistance.

The effectiveness of this action is controlled by the angularity of the cams and plunger noses. By varying these angles in the design, the extent of this biasing action may be established to suit requirements. As the result of extensive experimentation, angles have been determined by which a torque bias of 3 to 1 is produced. This means that under no conditions can the torque on one side exceed 75 per cent of the total or a 50 per cent overload for that side.

Of course, as the resistance of the low-resistance side decreases, the torque impressed on the other side correspondingly falls off, so that at zero resistance on one side, three times zero or zero torque will be transmitted to the other. Of course zero torque never exists, but as a certain amount is required to overcome the inertia of the vehicle, there must be appreciable resistance on the low side if sufficient torque is to be available on the other side to move the vehicle. In practical operation, even on extremely slippery ground, there is nearly always sufficient resistance to the spinning of the slippery wheel to result in an appreciable torque being transferred to the side maintaining traction.

If the truck were jacked up on one side, so that the wheels turned idly in the air, insufficient torque would be transmitted to the wheels retaining traction to move the vehicle off the jacks. However, in the worst conditions, when the traction of one side is reduced to the slip point, the inertia of the slipping wheels is sometimes sufficient so that by sudden and repeated acceleration of the engine the truck may be made to inch forward. A better method is to make a light application of the foot brakes. Strange as it seems, the increased resistance thus offered to the spinning wheel, multiplied by three and transferred to the other side, results in a net gain of 2 to 1, which will pull the vehicle through.

True Differential

As used in the inter-axle location, the Power Divider is located just ahead of the forward bogie axle pinion housing. The central ring or cage is in the form of a cup, open toward the rear, extended forward as a splined shaft to receive the rear universal joint of the driveshaft. The outer cam is also in the form of a cup, larger of course, than the central member and telescoped over it from the rear. Its thick, closed end is splined to receive the hollow quill shank of the bevel pinion of the forward bogie axle. Within this quill is a driveshaft which extends from back of the carrier to the inner cam, to which it is splined. This driveshaft connects, through a universal joint, to the inter-axle driveshaft, driving the bevel pinion of the rearward bogie axle. Thus it provides separate drives for the two bogie axles, connected with the main driveshaft only through the Power Divider.

In the axle type, the Power Divider simply replaces the conventional differential, with which it is interchangeable. This type, because of the more difficult traction conditions encountered in off-highway service, is used only in off-highway models of Mack trucks—both four-wheeled and six-wheeled.

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