

Feb. 6, 1945.

A. D. ROBBINS

2,369,075

DIRECTIONAL POWER DIVIDER

Filed Sept. 10, 1943

2 Sheets-Sheet 1

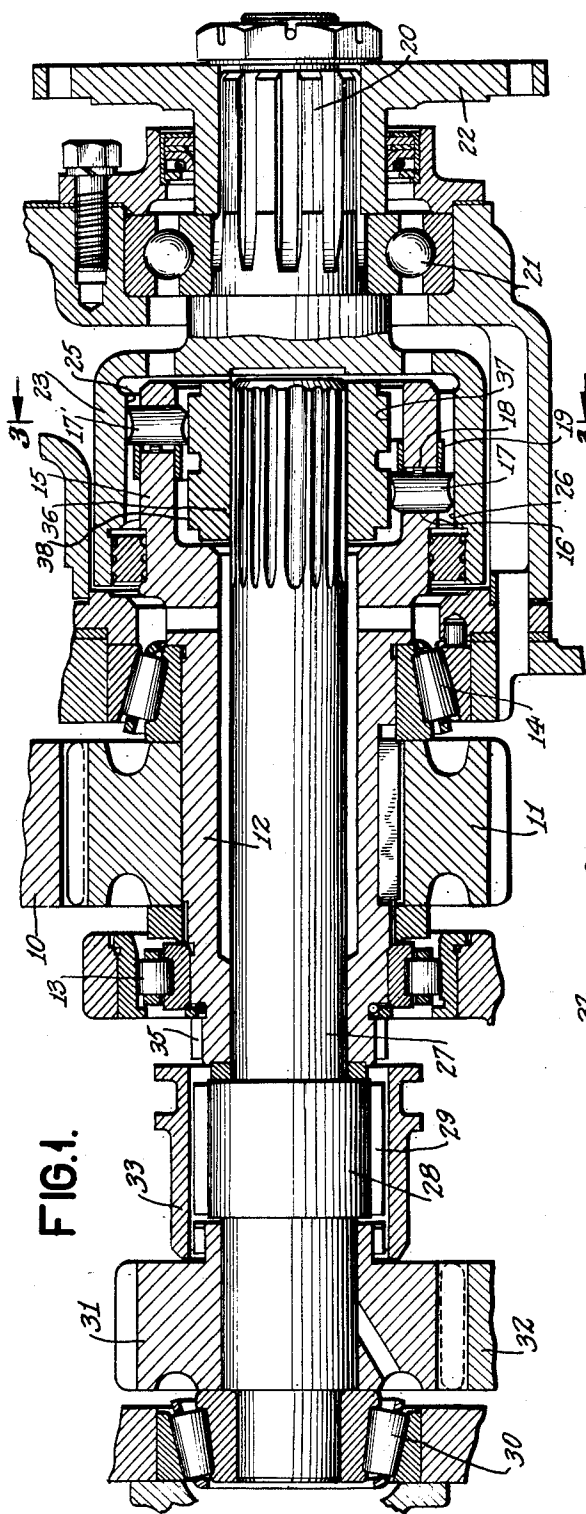


FIG. 1.

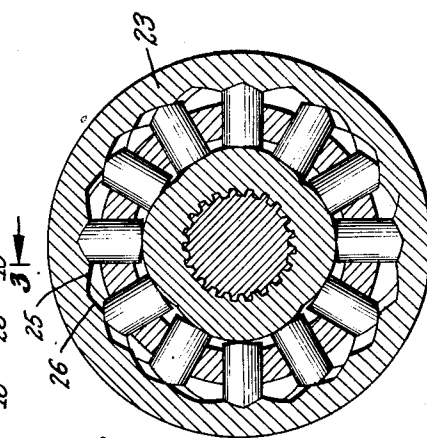


FIG. 3.

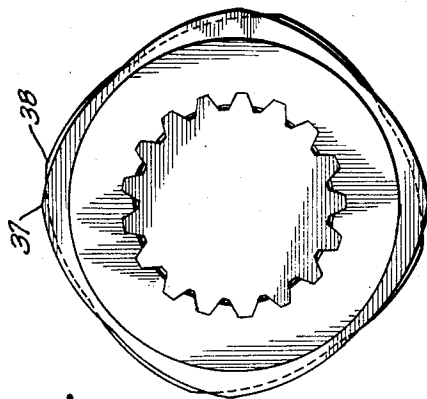


FIG. 2.

INVENTOR.
AZOR D. ROBBINS
BY *Hoguel, Henry & Campbell*
his ATTORNEYS

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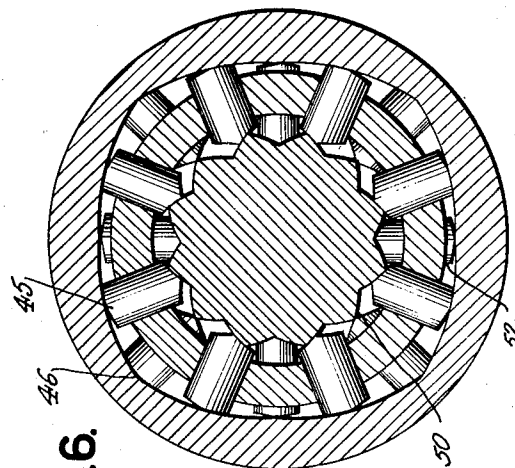
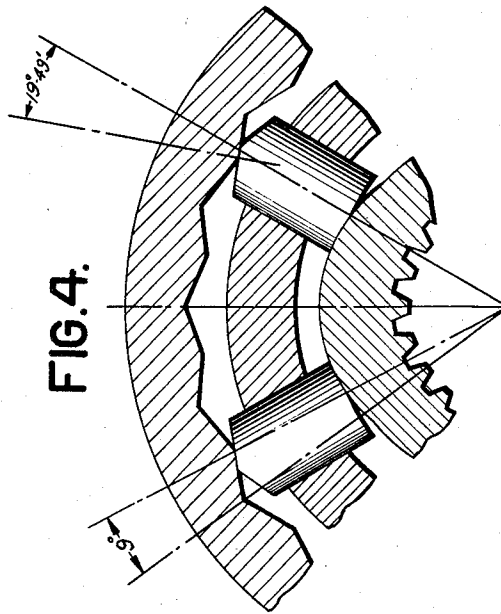
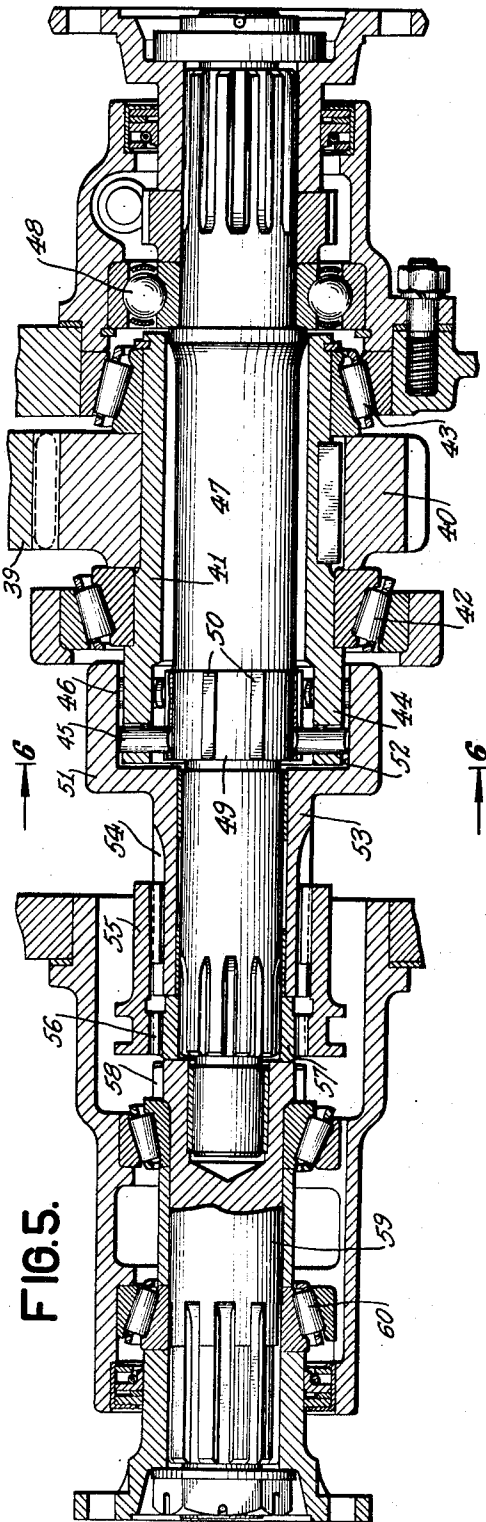
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2 Sheets-Sheet 2



INVENTOR.
AZOR D. ROBBINS
BY *Hoguet, Henry & Campbell*
his ATTORNEYS

UNITED STATES PATENT OFFICE

2,369,075

DIRECTIONAL POWER DIVIDER

Azor D. Robbins, Glen Cove, N. Y., assignor to
Mack Manufacturing Corporation, Long Island
City, N. Y., a corporation of Delaware

Application September 10, 1943, Serial No. 501,757

5 Claims. (Cl. 74—389.5)

The present invention relates to power dividing mechanisms and embodies, more specifically, an improved form of power dividing mechanism by means of which a desired directional effect may be accomplished in apportioning power between a plurality of driven elements.

In my prior Patent No. 1,857,978, there is shown and described a power apportioning means in which a plurality of wedge elements are utilized between cooperating cam surfaces in order to apportion power between a plurality of driven members. The present mechanism utilizes, in general, a plurality of wedges, as well as the inner and outer cam surfaces or lobes, but accomplishes certain new and important advantages through the utilization of certain structural features that distinguish the present invention over the structures heretofore available.

More particularly, an object of the present invention is to provide a power apportioning mechanism by means of which all of the power of the driven member may be supplied to one of the driven elements.

A further object of the invention is to provide a mechanism of the above character wherein the entire power of the driving element may be apportioned between several driven elements in accordance with a desired ratio.

A further object of the invention is to provide a mechanism of the above character wherein the desired ratio of the total power may be apportioned between the driven elements and, under certain conditions, all of the power may be apportioned to one of the driven elements.

Further objects of the invention will appear as it is described in greater detail in connection with the accompanying drawings, wherein

Fig. 1 is a view in longitudinal section taken through a power apportioning means constructed in accordance with the present invention;

Fig. 2 is a detailed view showing the inner cam surfaces or lobes of the device of Fig. 1;

Fig. 3 is a view in section taken on the line 3—3 of Fig. 1 and looking in the direction of the arrows;

Fig. 4 is an enlarged detailed partial view of the angular relationship of the driving wedges and cam lobes, and of the angularity of the contacting surfaces therebetween;

Fig. 5 is a view similar to Fig. 1, showing a modified form of the invention; and

Fig. 6 is a view in section taken on the line 6—6 of Fig. 5 and looking in the direction of the arrows.

Referring to the above drawings and particu-

larly to Figs. 1, 2, 3, and 4, power from any desired source is supplied by means of a driving gear 10 to a gear 11 which is keyed to a sleeve 12 journaled in bearings 13 and 14 and provided with a driving cage 15. The driving cage is a cup-shaped hollow cylindrical element provided with a plurality of apertures 16 within which longitudinally spaced series of driving wedges 17 and 17' are slidably received. The wedges may be formed with keys 18 that cooperate with retaining rings 19 to maintain them in position within the apertures 16, as illustrated in Fig. 1.

A driven stub shaft 20 is journaled at 21 and provided with a flange 22 which is adapted to be connected to any desired driven element, the stub shaft 20 being formed with a cup-shaped driven member 23 which, as illustrated in Fig. 3, is provided with a plurality of cam surfaces or lobes 25 and 26 on the interior surface thereof. The cam lobes 25 are formed in one plane perpendicular to the axis of the stub shaft, whereas the lobes 26 are formed in a plane also perpendicular to the axis of the stub shaft but spaced longitudinally thereof, as illustrated in Fig. 1. Moreover, the position of the lobes 25 and 26 circumferentially of the stub shaft is such that the respective lobes are offset, as illustrated in Fig. 3, in order that continuous action of the mechanism will always be insured.

Within the sleeve 2 a driven shaft 27 is provided, the shaft being formed with an enlarged portion 28 having clutch teeth 29 formed thereon and being journaled in a bearing 30. A driven gear 31 may be journaled upon the shaft to supply power to a mating gear 32.

A slidable clutch sleeve 33 is mounted upon the clutch teeth 29 and formed with internal clutch teeth that are adapted to be engaged with clutch teeth formed on the gear 31 and also with clutch teeth 35 which are formed on the sleeve 2. In this fashion the driven shaft 27 may be clutched to the sleeve 12 by movement of the clutch sleeve 33 to the right, as viewed in Fig. 1, or the shaft 27 may be clutched to the gear 31, as illustrated in Fig. 1, where the clutch sleeve 33 is in its extreme lefthand position. When the clutch is in the righthand position, as viewed in Fig. 1, the power apportioning means is locked to supply all of the power to the driven stub shaft 20.

Upon the righthand end of driven shaft 27 a collar 36 is splined, the collar being formed with longitudinally spaced series of cam lobes 37 and 38, respectively. The cam lobes 37 cooperate with wedges 17' and with cam lobes 25, while the cam lobes 38 cooperate with the wedges 17 and the

series of cam lobes 26. As illustrated in Fig. 2, the cam lobes 37 are in staggered position radially in order to provide the continuous action previously referred to.

In order to accomplish the objects hereinabove set forth, certain structural relationships must exist between the cam lobes and the driving wedges previously described. It will be seen, from Figs. 2 and 4, that a greater number of lobes are provided in the outer member 23 than on the inner member 36. Because of this greater number of lobes in the outer member, the angle of the surfaces of the outer lobes will be greater in relationship to the tangential force transmitted by the driving wedges than the angle of the inner lobes. This is illustrated in Fig. 4 by suitable legends.

Referring to Fig. 4 it will be seen that one side of each of the inner lobes defines a 45° segment, whereas one side of each of the outer lobes defines only a 9° segment. When power is applied to the driving cage 15, the cage will cause the plungers or wedges 17 and 17' to apply the driving force against the surfaces of the cam lobes on the inner and outer members and, under normal conditions, the driving cage and the cams will be driven at the same speed. If the inner cams are held, the outer cams will be driven by the driving cage, the plungers moving in and out of the apertures 16 to force the outer member 23 in the driving direction at a speed greater than the driving wedge. This is because a plunger, in one of its outward strokes, will travel over the 45° surface of the inner cam and, while traveling such a distance, will force the outer cam 9° ahead of the cage.

The difference in the number of cam lobes between the inner and outer cam members provides a ratio of action between the driving cage and the members, as illustrated in Fig. 4, and, as previously stated, movement along the 45° of the inner cam lobe will cause the outer member to move the 45° plus the 9° of the one side of the outer cam lobe. Accordingly, rotating the driving cage five times will turn the driven member 23 six times. Contrariwise, if the driving cage is held, rotating the inner member 36 will force the plungers or wedges outwardly against the lobes of the outer driven member 23 to turn it in the opposite direction and rotation of the outer member once will require rotation of the inner member five times.

If the outer member 23 is held against rotation and the inner member 36 is free to turn, the force applied to the driving cage 15 tends to drive the inner member 36 forward faster than the driving member 15. However, the angle between the direction of movement of the wedge and the inner cam lobe is such that the inward movement of the plunger, though tending to move the cam, cannot overcome the friction between the plunger and the cam and, therefore, cannot cause the inner cam to turn. In other words, the angle between the inner cam lobe and the direction of movement of the wedge is less than the angle of repose between these members.

If the movement is such that the wedges are forced outwardly, the angle of the lobes on the outer member 23 is such that movement of the wedges will cause relative movement between the members without undue friction.

Inasmuch as the number of cam lobes on the outer member is greater than the number on the inner member, and therefore the angle of the cam surfaces on the outer lobes with respect to

the direction of tangential force furnished by the plungers is greater than the angle of the inner lobes, the tangential force applied by the wedges will be greater on the outer lobes than on the inner ones. Moreover, when the inner member 36 is without load and free to turn, all the load can be applied to the outer member without causing the inner member to run ahead of the driving cage. On the other hand, the tangential load on the inner cams can only rise to a certain percentage of the total, in the structure shown in Figs. 1, 2, 3, and 4, the percentage being 40% of the total load.

With the ratio of angles as shown, the division of power between the two driven members would be approximately 83.3% to the outer member 23 and 16.6% to the inner member 36. Due to friction, however, each member is capable of transmitting a greater percentage of load than these figures represent before relative movement takes place between the members.

It will be readily apparent that any ratio of angles of the inner and outer cams may be used and, if desired, the inner cam member may be made with the greater number of lobes instead of the outer cam, as illustrated in the drawings.

As previously stated, it is desirable to stagger the relationship of cams and wedges in order that, when some of the wedges are at the ends of their strokes, other wedges will be in intermediate positions on the cam lobes to afford continuous action in either direction.

In the form of the invention shown in Figs. 5 and 6, the driving gear is shown at 39 as meshing with a mating gear 40 keyed to a sleeve 41 that is journaled in bearings 42 and 43. The sleeve 41 is formed with a driving cage 44 having spaced circumferential series of driving wedges 45 and 46. A driven shaft 47 is journaled at 48 and provided with an inner driving member 49 formed with cam lobes 50. A driven member 51 is provided with a plurality of cam lobes 52 and is mounted upon a sleeve 53 having splines 54 formed thereon. A slidable clutch member 55 engages the splines 54 and is formed with teeth 56 that are adapted to be engaged with teeth 57 that are secured to the driven shaft 47. The sleeve 55 may be moved to the left, as viewed in Fig. 5, to engage teeth 58 formed on a driven shaft 59 journaled in bearings 60. The sliding clutch, being carried on the outer member, is thus adapted to engage a drive shaft for a front axle or to lock the outer and inner members together.

In the form of the invention shown in Fig. 5, the inner and outer driven members are formed with cams that extend across the entire axial direction covered by the wedges, instead of being in staggered relationship as illustrated in the form of the invention shown in Fig. 2. The plungers 45 and 46, however, are in staggered relation in order to provide the continuous action previously referred to. This is illustrated in Fig. 6.

In the form shown in Figs. 5 and 6, the outer driven member is formed with four cam lobes while the inner member is provided with twelve lobes. The characteristics of the mechanism shown in Figs. 5 and 6 are similar to the form shown in Fig. 1, except that because of the angles provided, the inner member is capable of receiving all of the input torque, whereas the outer member can only be loaded to 57.5% of the total torque. Since the ratio of the driven power is proportional to the number of cam lobes, ignoring friction, 25% of the power would be sup-

plied to the outer member and 75% to the inner member.

It will be understood that the foregoing mechanism is of particular importance in connection with the operation of motor vehicles in which two or more driving axles are utilized. For example, where both the front and rear wheels of a vehicle are driven, it is necessary to provide some power apportioning means between them. In conventional forms of such power apportioning means, where the power is divided by means of differential mechanisms, difficulty is sometimes experienced because of drive failures where the wheels of one axle slip. Inasmuch as the power supplied to an axle depends upon the tractive resistance of the other axle, if the other axle slips the one axle will have no power applied to it, and the structure herein described will be seen to overcome this difficulty.

A further feature of importance resides in the fact that, where both front and rear axles are driven, the front axle is usually designed to take a smaller proportion of the load than the rear axle to avoid unnecessary weight and cost in manufacturing the vehicle. It thus becomes necessary to avoid overloading the front axle, and this is readily accomplished by means of the present invention.

While the invention has been described with particular reference to the accompanying drawings, it is to be understood that it is not limited thereto save as defined in the appended claims.

I claim:

1. A power apportioning device comprising opposed outer and inner driven members and a driving member therebetween, driving wedges carried by the driving member to engage the driven members, a plurality of cam lobes on one of the driven members and a different number of cam lobes on the other of the driven members, the angle of the cam surface of the cam lobes on one of the driven members with respect

to the tangential direction of application of force of the wedges to such cam lobes being such that radial movement of the wedges toward the cam surfaces will not result in movement between the wedges and such surfaces.

2. A power apportioning device comprising opposed outer and inner driven members and a driving member therebetween, driving wedges carried by the driving member to engage the driven members, a plurality of cam lobes on one of the driven members and a different number of cam lobes on the other of the driven members, the angle of the cam surface of the cam lobes on one of the driven members with respect to the tangential direction of application of force of the wedges to such cam lobes being less than the angle of repose.

3. A power apportioning device comprising opposed outer and inner driven members and a driving member therebetween, driving wedges carried by the driving member to engage the driven members, four cam lobes on one of the driven members, and twenty cam lobes on the other of the said driven members.

4. A power apportioning device comprising opposed outer and inner driven members and a driving member therebetween, twelve driving wedges carried by the driving member to engage the driven members, four cam lobes on one of the driven members, and twenty cam lobes on the other of the said driven members.

5. A power apportioning device comprising opposed outer and inner driven members and a driving member therebetween, driving wedges carried by the driving member to engage the driven members, a plurality of cam lobes on one of the driven members and a different number of cam lobes on the other of the driven members, and clutch mechanism between the outer and inner driven members.

AZOR D. ROBBINS.