

Dec. 15, 1931.

A. D. ROBBINS

1,836,684

SELF LOCKING DIFFERENTIAL

Filed April 26, 1930

4 Sheets-Sheet 1

Fig. 1.

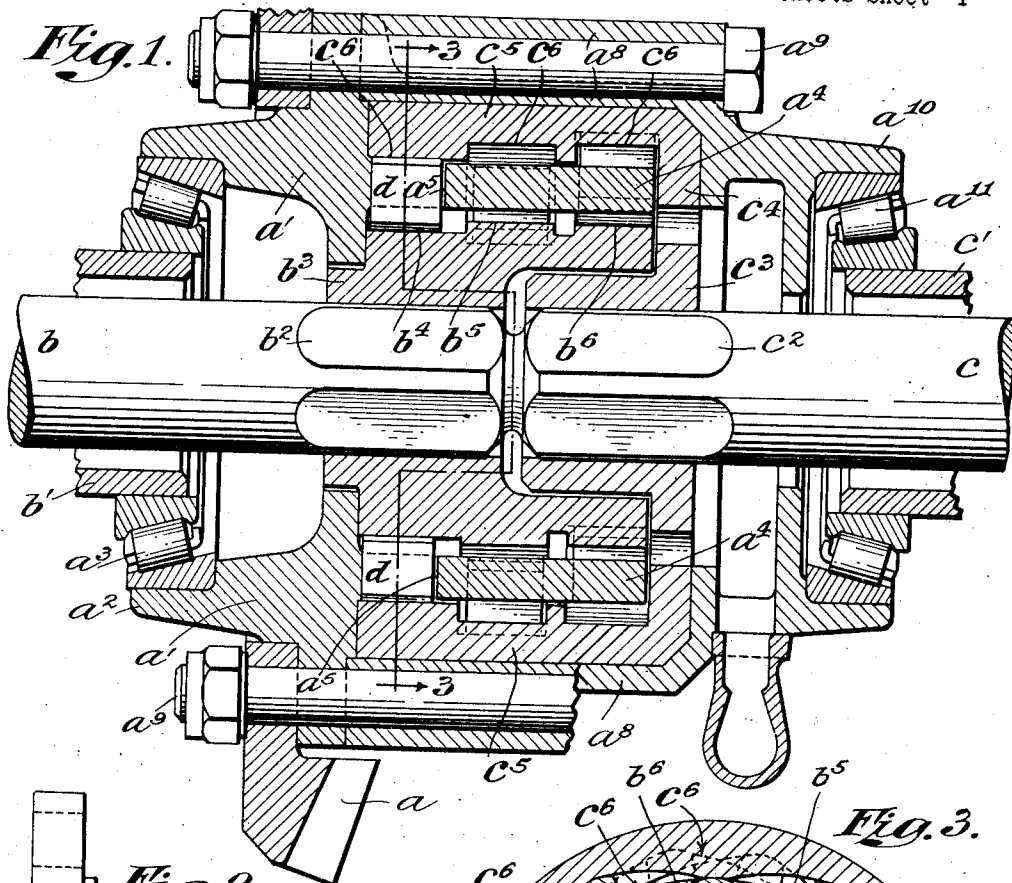


Fig. 2.

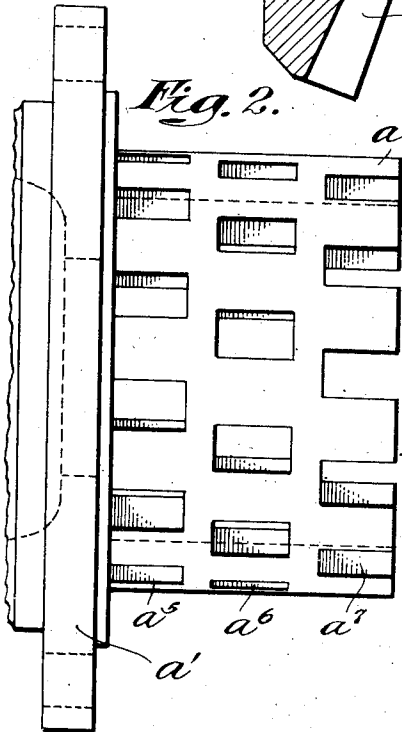
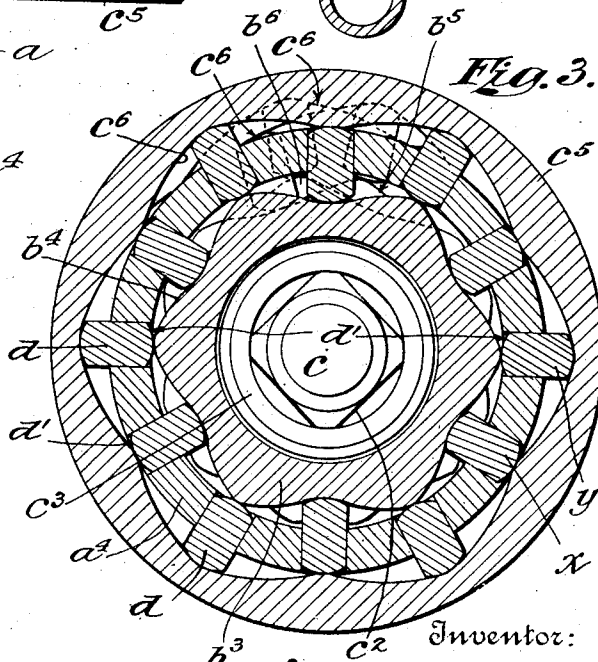


Fig. 3.



Inventor:
Alex. D. Robbins
By His Attorneys
Redding, Peck, O'Shea & Campbell

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A. D. ROBBINS

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Fig. 4.

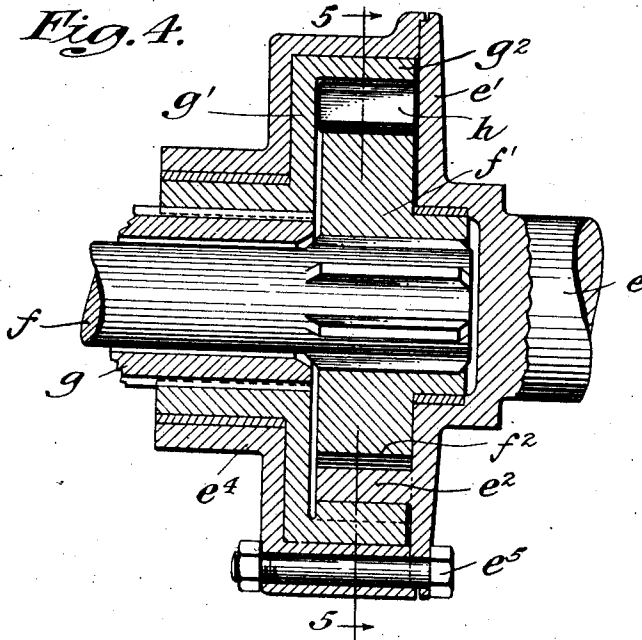
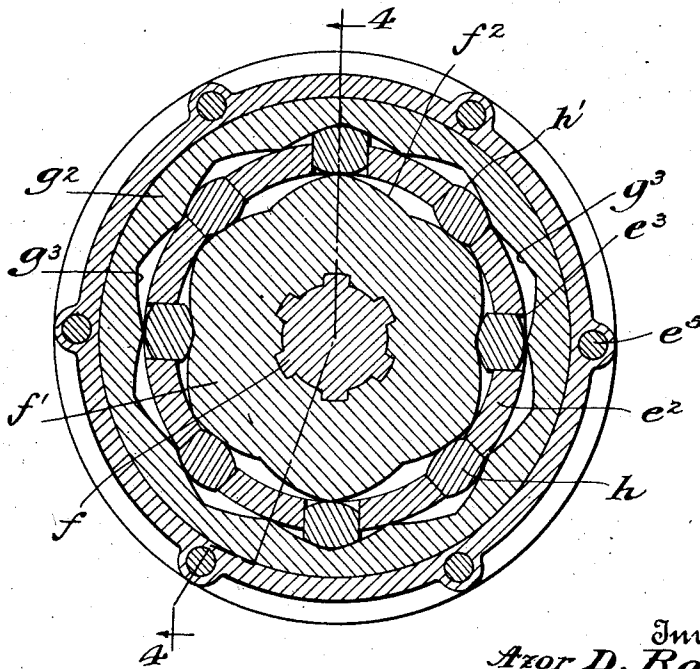


Fig. 5.



Inventor:
Aror D. Robbins

By his Attorneys
Redding, Greeley, O'Shea & Campbell

Dec. 15, 1931.

A. D. ROBBINS

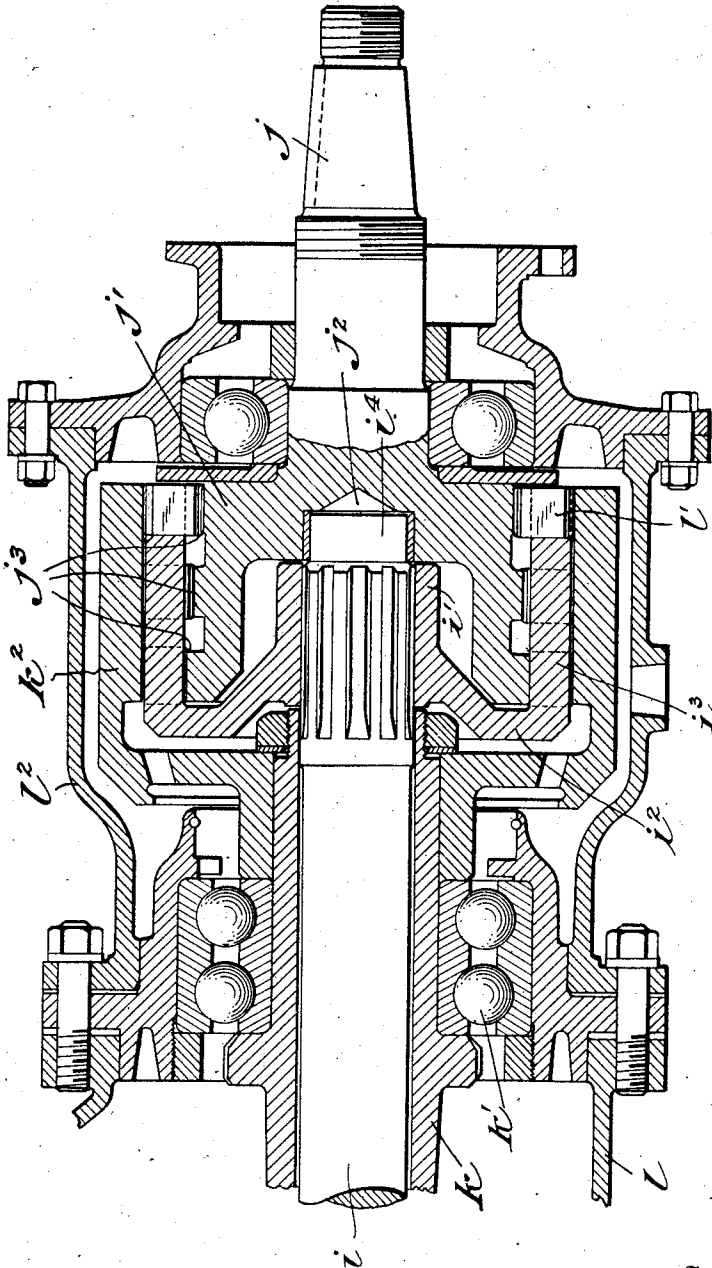
1,836,684

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Fig. 6.



Inventor:

A. D. Robbins

By His Attorneys
Redding, Gealey, O'Shea & Campbell

Dec. 15, 1931.

A. D. ROBBINS

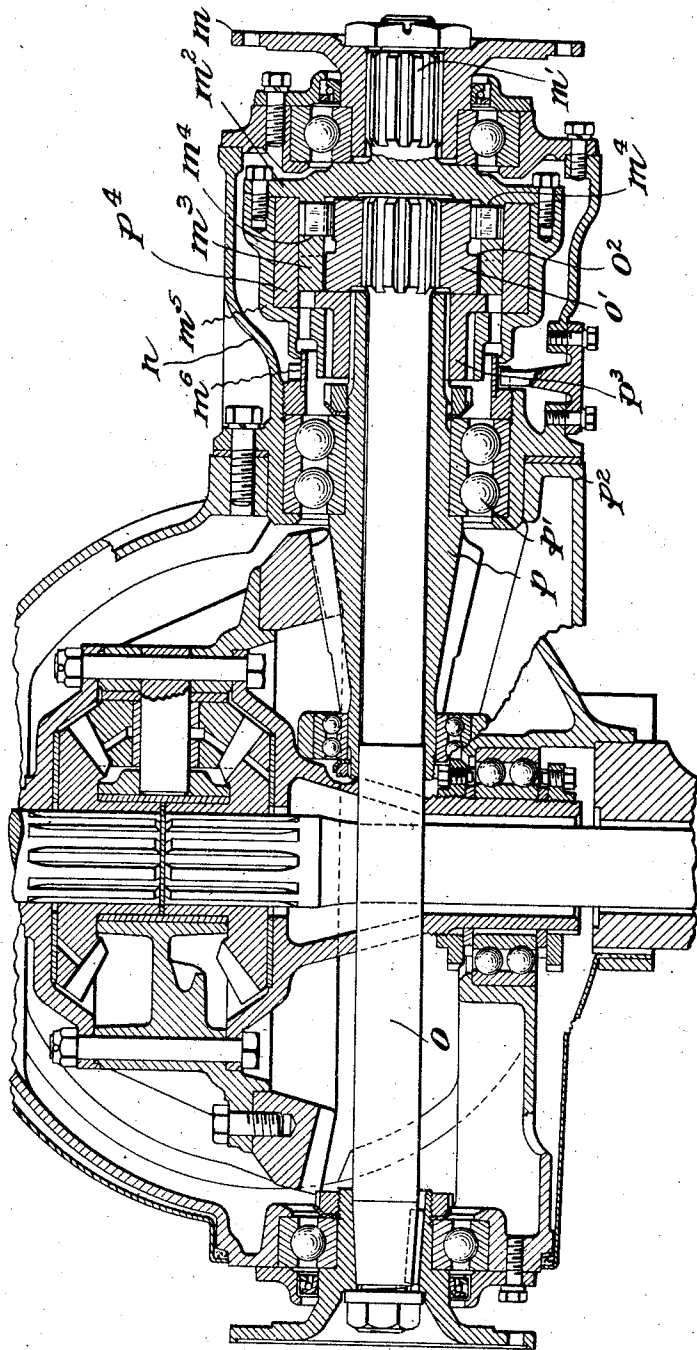
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Fig. 7.



Inventor:

Azor D. Robbins

By his Attorneys

Redding, Greeley, O Shea & Campbell

UNITED STATES PATENT OFFICE

AZOR D. ROBBINS, OF NEW BRUNSWICK, NEW JERSEY, ASSIGNOR TO INTERNATIONAL MOTOR COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

SELF-LOCKING DIFFERENTIAL

Application filed April 26, 1930. Serial No. 447,463.

The present invention relates to power apportioning means and embodies, more specifically, an improved differential construction by means of which a degree of locking is afforded between the driving mechanism and one of the driven members between which power is apportioned under conditions which would cause existing differential constructions to divert all of the power from another of the driven elements.

More particularly, the present invention embodies what may be termed a self-locking differential, that is, a differential which automatically compensates for loss in resistive effort of one of a plurality of driven elements in order that another of the driven elements may receive its portion of the driving power. It is a matter of common knowledge, particularly in the operation of motor vehicles, that the engine power is supplied only to one wheel when such driving wheel is stuck and slipping over the road bed upon which it rests. Under this condition, the other driving wheel, which is probably resting upon a relatively firm roadbed which affords good traction, receives no power and, in consequence, the vehicle cannot be moved. Various mechanisms have been provided for overcoming this condition, such mechanisms frequently employing the use of a mechanical lock to lock the differential positively and thus distribute the drive equally between the driving wheels. In addition to the complicated and expensive mechanism necessary in constructions of this character, the operation thereof is difficult and the resulting devices have proved unsatisfactory. The present invention provides a differential which automatically adjusts itself to the conditions under which the vehicle is operating and provides the desired degree of locking to afford adequate driving power for the vehicle.

An object of the invention, accordingly, is to provide an automatic mechanism for apportioning power between a plurality of

driven elements, such mechanism embodying means for affording a desired degree of locking under certain conditions.

A further object of the invention is to provide a self-locking differential for apportioning power between a plurality of driven elements, the self-locking mechanism automatically functioning when the traction of one of the driven elements is reduced a predetermined amount.

A further object of the invention is to provide a power apportioning means of the above character which is of rugged construction and the elements of which are simple and easily manufactured.

Further objects, not specifically enumerated above, will be apparent as the invention is described in greater detail in connection with the accompanying drawings, wherein:

Figure 1 is a view in transverse section, taken through a differential constructed in accordance with the present invention.

Figure 2 is a detail view showing the driving member of Figure 1.

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

Figure 4 is a view in section, taken on line 4—4 of Figure 5, and looking in the direction of the arrows, showing a modified form of the invention.

Figure 5 is a view in section, taken on line 5—5 of Figure 4, and looking in the direction of the arrows.

Figure 6 is a view in transverse section, taken through the axis of an apportioning device constructed in accordance with the present invention and showing a modified form wherein the structure is designed to receive power to be apportioned from a shaft which is coaxial with the apportioning device.

Figure 7 is a view in section, showing a form of mechanism similar to that shown in

Figure 6, but embodying a further modification thereof.

Referring to the above drawings, particularly Figures 1, 2, and 3, *a* designates a bevel gear to which power is supplied by a transmission shaft in the well known fashion. Upon the bevel gear *a*, a collar *a'* is mounted, the collar being formed with a flanged portion *a²* carrying a bearing *a³* by means of which the drum is journaled upon a jack shaft housing *b'*. A cylindrical drum *a⁴* is formed on the collar *a'* and provided with a plurality of series of apertures *a⁵*, *a⁶* and *a⁷*, respectively. These apertures are formed in spaced parallel planes perpendicular to the axis of the drum, as clearly shown in Figure 2, and offset 10° radially to provide a uniform staggering of the apertures of the respective series, thus distributing the forces transmitted by the drum over a uniformly extended area. A cylindrical housing *a⁸* is secured to the collar *a'* and bevel gear *a* by means of bolts *a⁹*, a flanged extension *a¹⁰* being provided to receive a bearing *a¹¹* which is carried upon a jack shaft housing *c'*.

The driven members are shown as aligned jack shafts *b* and *c*, respectively, these shafts having squared ends *b²* and *c²* upon which hubs *b³* and *c³*, respectively, are mounted. Hub *b³* is formed with a plurality of parallel peripherally disposed cam tracks *b⁴*, *b⁵*, and *b⁶*, these tracks being concentric with the respective series of apertures *a⁵*, *a⁶*, and *a⁷*, respectively.

A hub *c³* is formed with a flange *c⁴* upon which a cylindrical sleeve *c⁵* is formed. This sleeve is formed with an internal peripheral cam track *c⁶*, concentrically disposed with the respective series of apertures *a⁵*, *a⁶*, and *a⁷* and of sufficient axial length to provide a cam track for each of the apertures. Between the inner and outer cam tracks driving wedges *d* are mounted, such wedges being slidably received within the apertures in the drum *a⁴*. The wedges *d* are formed with rounded ends *d'* to engage the respective inner and outer cam tracks, as clearly shown in Figure 3.

In operation, the driving force is applied to the ring or bevel gear *a* which is rotated in the desired direction carrying with it the wedges *d*. These wedges engage against the respective cam surfaces on the driven members, thereby rotating the driven shafts *b* and *c* with equal effort.

When an occasion arises where one driven member rotates faster than the other, the wedges are forced by the protruding cam portions of such member into the recessed portions of the cam tracks of the other member. For example, consider the wedge designated in Figure 3. This shoe will be forced outwardly by the cams on the hub *b³* into a corresponding recess in the sleeve *c⁵*. In this manner, the ring or drum *a⁴*, together

with the shoes *d*, will rotate at half the speed of the hub *b³*. When the peak of the particular cam on hub *b³* which is forcing the wedge *x* outwardly is opposite the remotest point on the surface of the corresponding cam on sleeve *c⁵*, the wedge will lie between such points and in line with both, the wedge having traveled half the distance that the peak of the cam traveled during such movement. This particular wedge will then be in its neutral position as indicated at *y*, at which time, the drive is not transmitted through such shoe but through adjacent shoes.

By varying the angles of the cams of the driven members, the locking action can be varied at will. If one of the driven members is held against rotation and power applied to the drum *a⁴*, then the shoes *d* will be forced radially against the cam surfaces of the other driven member. This tends to force such cam surfaces and rotating member to rotate faster than the ring and shoes since the driving force is transmitted through the wedges, the reaction of which is taken by the cam surfaces of the first member. The angle of the cams may be such that radial force on the wedge acts to turn the cams ahead of the driving ring if desired, or the angle may be such that a slight load on the driven member carrying the lesser load will cause enough friction to prevent the cam from rotating and consequently the wheel from spinning.

From the foregoing, it will be apparent that a differential is provided which is small and compact having a great capacity for transmitting power. The parts thereof are few and simple of construction, thus rendering the device highly desirable from a production standpoint. By means of the plurality of cam surfaces, the driving strains and stresses are uniformly distributed, the wearing qualities being relatively large and thus capable of transmitting enormous forces.

With reference to the construction shown in Figures 4 and 5, the driving member is shown at *e*, being formed with a flange *e'* and a driving drum *e²*. A driven shaft *f* and driven sleeve *g* receive power from the drum *e²* through driving shoes or wedges *h*. These wedges are slidably carried in recesses *e³*, formed in the drum *e²* and are formed with rounded driving surfaces *h'*.

The shaft *f* has splined thereto a collar *f'* upon which a cam track *f²* is formed. This track is concentric to the series of apertures *g³* and serves to receive the driving forces of the wedges *h*. The driven sleeve *g* carries a flange *g'* formed with a cylindrical portion *g²* upon which an internal cam track *g³* is formed. A closure *e⁴* is secured to the driving disc *e'* by means of bolts *e⁵* and the operation of this device is similar to that described in connection with the construction shown in Figures 1, 2, and 3.

Referring particularly to the modification shown in Figure 6, i designates a driving shaft, upon the end of which a hub i' is splined. This hub is formed with a spider i^2 , having a cylindrical flange i^2 . Flange i^2 is formed with a plurality of apertures similar to the apertures a^5 , a^6 and a^7 in the drum a^4 , the apertures being indicated in dot and dash lines.

A device of the character described comprising a hollow cylindrical driving member having apertures therethrough, driven members disposed upon opposite sides of the apertures, a cam track on each driven member in the plane of the apertures, one of the tracks having a greater number of cams than the other, and wedge blocks having rectangular cross sections slidable in the apertures and having curved surfaces at the opposite ends thereof to engage the tracks.

This specification signed this 12th day of February, A. D. 1930.

A. D. ROBBINS.

A driven member j is formed with a hub j' and a recess j^2 within which the end i^4 of shaft i is journaled. The hub j' is formed with a plurality of cam tracks j^3 , similar in construction to the cam tracks b^4 , b^5 and b^6 . A second driven member k is journaled in a housing l at k' and has secured thereto a hollow cylindrical drum k^2 formed with a plurality of internal cam tracks similar to cam tracks c^6 , as described in connection with the structure shown in Figure 1. The cam tracks on the drums k^2 and j^3 lie in the same planes, respectively, such planes also including the detents l' carried by the cage or drum i^3 . The structure is suitably housed in a housing l^2 which is secured to the housing l which may be the differential and jack shaft housing of an axle of the vehicle. The operation of the aforementioned mechanism is similar to that described in connection with the construction shown in Figures 1, 2, and 3.

With reference to the construction shown in Figure 7, the driving member is shown at m , being splined to a stub shaft m' which carries a flange m^2 . A cylindrical drum or cage m^3 is formed on the flange m^2 and is provided with a plurality of apertures m^4 which are preferably spaced in parallel planes transverse to the axis of the driving member m' . A closure m^5 is secured to the driving member, a seal m^6 being provided between the closure and the relatively stationary portions of a housing n . A driven member o , extending rearwardly from the apportioning mechanism has a hub o' splined thereto and formed with a plurality of spaced cam tracks o^2 . These cam tracks fall in the same planes as the respective series of apertures m^4 and receive power from the wedges carried in such apertures. A second driven element p is journaled at p' in a stationary housing p^2 and has splined thereto a hub p^3 upon which a cylindrical drum p^4 is formed. This drum is provided with a plurality of cam tracks against which the wedges, above referred to, engage, power being apportioned in an obvious manner between the drum p^4 and the hub o' . The improved power apportioning means is thus effectively combined with the forward jack shaft and differential housing of a vehicle having dual driving axles.

While the invention has been described with specific reference to the accompanying drawings, it is not to be limited, same as defined in the appended claim.

I claim as my invention:

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