June 26, 1951 W. M. BROWN 2,558,417

DIFFERENTIAL FOR MULTIPLE-DRIVE VEHICLES

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Fig. 1

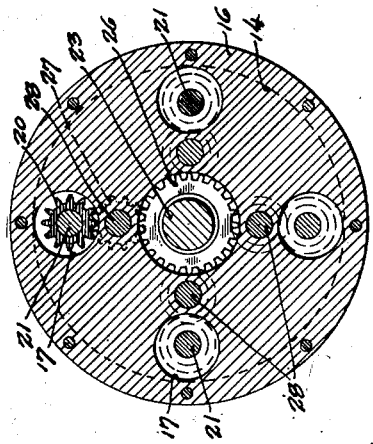

Fig. 2

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DIFFERENTIAL FOR MULTIPLE-DRIVE VEHICLES

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7 Claims. (Cl. 74—710)

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This invention relates to proportional differentials for use in vehicles which drive through both the front and rear wheels, and has for its general object the perfecting of a differential drive for vehicles having a single driven axle at the front and multiple driven axles at the rear.

Proportional differentials for the purpose described are now commonly incorporated by truck manufacturers in very nearly all front and rear drive trucks having multiple driven axles at the rear, and their purpose is to provide compensation for differences in the torque requirements between the front and the rear axles. There have been devised quite a number of proportionate differential arrangements, but all of the prior arrangements of which I am aware have one common fault, and that is the fact of their being engineered as a unitary part of a vehicle's transfer case, and which is to say that a truck manufacturer, wishing to embody a proportional differential into his truck, is precluded from the employment of a standard transfer case selected either from his own inventory or purchased upon the open market and in order to utilize a marketed proportional differential is required to also procure therewith the associated transfer case with the particular transfer mechanism which the latter may house. The consequence is that the manufacturer must revamp the lay-out of his truck to bring the center line of his own drive shaft into axial coincidence with the center line which the said transfer mechanism's output shaft prescribes, and to overcome this disadvantage it is a particular object of the present invention to devise a proportional differential which is self-contained to the extent that it carries its own housing separate and apart from the casing which houses the transfer mechanism and may thus be applied to substantially any standard transfer case, the matter of adapting the one to the other being a matter of little time and effort and requiring at the utmost only a minor re-working of the output openings of the transfer case, an operation which can be expeditiously and inexpensively performed and which the shop of even the smallest truck manufacturer is fully equipped to handle.

It is a still further and important object to provide a proportional differential for the described purpose so engineered as to employ spur gearing throughout and which, as distinguished from the bevel gearing heretofore customarily employed, accomplishes better balancing of the torque forces encountered.

It is a further object still to devise a proportional differential of unusually simple construction, one which is extremely rugged, and which, however, is readily accessible and can, where occasion demands, be replaced in its entirety or repaired at considerably less expense both in point

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of labor and materials than has been heretofore possible.

The above, together with other and still more particular objects and advantages in view, will appear and be understood in the course of the following description and claims, the invention consisting in the novel construction and in the adaptation and combination of parts hereinafter described and claimed.

In the accompanying drawing:

Figure 1 is a longitudinal vertical sectional view of my improved proportional differential and incorporating a fragmentary showing of a transfer case associated therewith; and

Fig. 2 is a transverse vertical sectional view on line 2—2 of Fig. 1 with the scale being somewhat reduced.

Referring to said drawing, the numeral 5 denotes the casing for a train of transfer gears and there is represented only three of the several gears housed thereby, and namely an output gear 6 driven off a gear 7 and which latter gear is splined to and driven by a supporting shaft (not shown) which carries upon its other end a gear 8 powered from another of the multiple gears in the train, all of which parts are or may be of ordinary construction and arrangement.

In order that this casing and the gears therein contained may adapt themselves to the present invention it is only requisite that the hub of the output gear have a center bore of the diameter necessary to enable the same to be splined upon a tubular shaft such as the indicated member 10 and that the output openings provided in the front and rear walls of the casing be of a size to accommodate the two ends of said shaft together with suitable bearing assemblies, as 11 and 12, for the journal mounting thereof. This shaft, projecting front and rear beyond the casing, has each of its two ends suitably splined, the front end to accommodate the mounting of a clutch element 13 and the rear end to accommodate the mounting of one of two congruent bell members 14 and 15 acting with a complementing interposed ring-shaped plate 16 to describe a closed differential housing, or cage, as it will be hereinafter termed. Such plate, within the confines of the cage, is apertured at circumferentially spaced intervals to provide openings 17, and received in these openings to extend by opposite ends into the chambers described at opposite sides of the plate are respective spur pinions 20 journaled upon through-bolts 21 which tie the components of the cage together. Within the back chamber, and which is to say the chamber which is provided within the bell member 15, said spur pinions mesh a single spur gear 22 rotatively journaled for rotation about an axis coinciding with that of the cage. The spur gear 22 is made integral with a stud shaft 23

the tail end of which projects rearwardly from the cage, and splined on said exposed end is one section 24, shown by dotted lines, of a suitable coupling powering a driving shaft (not shown) leading to the back axles, it being usual to pass the drive from the driving shaft into a distributing differential carried by the foremost of the tandem rear axles and thence working through a take-off shaft back to a conventional differential carried by the rearmost axle.

Reverting to my proportional differential mechanism, there is contained within the front chamber of the cage an epicyclic train composed of a central spur gear wheel 26 driven through intermediate spur pinions 27 from the spur pinions 20, these intermediate spur pinions being carried by stud pins 28 the ends of which are journal-mounted in suitable openings provided within the cage. The development of the train is such as to provide a ratio of 2 to 1 as between the gear 26 and the gear 22. Said central gear wheel 26 is made an integral part of a driving shaft 30 piloted within the tubular shaft 10 and prolonged by its frontal end a material distance beyond the latter. This prolonged end has an extended spline which is turned down centrally of its length to accommodate a split bearing retainer 31, and at the inner end of this spline there is applied a shipping spool 32 presenting clutch teeth 33 which constitute the mating complements of the teeth of the clutch element 13, this shipping spool being movable by the action of a shipping finger 34 carried for reciprocal movement by a slidably mounted shifting rod 35, the rod being yieldingly held in two extremes of endwise movement by the action of a spring-pressed ball 36 lodging in a selected one of two circumferential grooves 37. The casing which houses said clutch mechanism and which also carries the bearing assemblies to which said retainer 31 is functional is composed of boltably interconnected outer and inner members 40 and 41 and with the latter being bolted in turn to the transfer case 5. A coupling, not shown, but which is like or similar to that which is shown by dotted lines for the rear end of the driving stud shaft 23 is connected to the frontal end of the driving shaft 30 by means of the terminal splines and provides driving connection to a conventional differential applied to the vehicle's driven front axle.

The operating principles of the present invention are well known in the art and should, therefore, be clearly understood without tracing the same. With the parts occupying the positions in which they are shown in Fig. 1, and namely with the clutch elements disengaged, the shafts 23 and 30 are driven differentially through the caged differential mechanism with the result that automatic compensation is made for any change in speed or torque requirements as between the driven front axle and the tandem rear axles. Under those circumstances where it may be desirable to inactivate the compensating differential, such end is accomplished by shifting the shipping spool to couple the shaft 30 to the tubular shaft 10 whereupon it follows that the differential gearing contained within the cage is locked against differential transfer and the two shafts 30 and 23 turn as one.

Inasmuch as any transfer case engineered to carry the driving power of the output gear therein contained to both the front and the rear axles of a vehicle perforce makes provision for the passage of the output shaft through both the front and the rear walls of the case, it will be readily apparent that every such transfer case requires little re-working in order that the same may adapt itself to the installation of my proportional differential. It will also be seen that my said unit is extremely compact, a result which can be largely attributed to the use of spur gearing, that such spur gearing additionally has the advantage of best distributing the torque forces encountered with consequent minimizing of wear upon both the teeth and the journal surfaces, and that the unit is readily accessible for ease of replacing or servicing.

It is self-evident that minor changes may be resorted to without departing from the spirit of the invention and I therefore intend that the hereto annexed claims be given a scope fully commensurate with the broadest interpretation which the language fairly permits.

What I claim is:

1. In a vehicle of the described character, namely one having a single driven axle at the front, and tandem driven axles at the rear, and with the power of the prime mover being transmitted through a transfer case having co-axial openings in the front and rear walls thereof, a tubular output shaft journal-mounted within the case and having its opposite ends protruding through said wall openings, a closed cage fixedly carried upon the exposed rear end of the output shaft, a clutch element fixedly carried upon the exposed front end of said output shaft, a driving shaft piloted within the tubular shaft with its rear end extending into the cage and with its front end protruding beyond the clutch element and adapted to connect by its front end with the front axle of the vehicle, a second driving shaft co-axial with the shaft last mentioned extending by its forward end into the cage and adapted to connect by its rear end with the tandem rear axles, gears fast upon said cage-housed ends of the driving shafts, gearing contained within the cage and acting with the cage and with the shaft-carried gears to produce a proportional differential dividing the power of the output shaft between front and rear axles, and a clutch element driven in unison with the first-mentioned driving shaft and complementing the first-named clutch element to act, by engagement therewith, to functionally couple the two driving, shafts by inactivating the differential process.

2. In a vehicle of the described character, namely one having a single driven axle at the front, and tandem driven axles at the rear, and with the power of the prime mover being transmitted through a transfer case having co-axial openings in the front and rear walls thereof, a tubular output shaft receiving a journal mounting from the transfer case and protruding by its rear end through the rear wall-opening of the latter, a closed cage fixedly carried upon said exposed end of the output shaft, co-axial driving shafts one of which extends rearwardly from the cage and the other of which is piloted within the tubular output shaft and which extend by their front and rear ends, respectively, into the cage and with the former said shaft being adapted to connect with the tandem rear axles and the latter said shaft with the front axle, and a train of spur gears contained within said cage and acting with the latter to produce an epicyclic connection between the tubular output shaft and the forwardly extending driving shaft, said gear train including a spur gear fast to the rearwardly extending driving shaft.

3. In a vehicle of the described character, namely one having a single driven axle at the front, and tandem driven axles at the rear, and with the power of the prime mover being transmitted through a transfer case having co-axial openings in the front and rear walls thereof, a tubular output shaft receiving a journal mounting from the transfer case and protruding by its rear end through the rear wall-opening of the latter, a closed cage fixedly carried upon said exposed end of the output shaft, co-axial driving shafts one of which extends rearwardly from the cage and the other of which is piloted within the tubular output shaft and which extend by their front and rear ends, respectively, into the cage and with the former said shaft being adapted to connect with the tandem rear axles and the latter said shaft with the front axle, and a train of spur gears contained within said cage and acting with the latter to produce an epicyclic connection between the tubular output shaft and the forwardly extending driving shaft, said gear train including a spur gear fast to the rearwardly extending driving shaft, means being provided and which are operable at will to inactivate the differential process of the gears contained within said cage and cause the two driving shafts to responsively rotate as one.

4. In a proportional differential for a vehicle having a single driven front axle and tandem driven rear axles, the combination with co-axial shafts one adapted to drive the front axle and the other to drive the tandem rear axles and upon their adjacent ends having spur gear wheels of different radius of which the gear wheel applied to the front-driving shaft is the smaller, a cage journal-mounted for rotation about the center of said shafts as an axis and arranged to be rotatively driven from the engine of the vehicle, said cage being composed of congruent halves bolted upon opposite sides of an intervening plate and with one of said halves encasing the large gear wheel and the other of said halves encasing the small gear wheel, a set of bolts placed in concentric paralleling relation to the rotary axis of the cage and passing through the end walls of the latter to secure the components of the cage together, a set of elongated spur pinions journal-mounted upon the bolts and extending substantially the full length of the cage with one end thereof in mesh with the larger gear wheel, and a set of stubbed intermediate spur pinions receiving a rotary journal from the plate and from an end wall of the cage and interposed as a driving connection from the other end of the elongated spur pinions to the smaller gear wheel.

5. In a vehicle of the described character, namely one having a single driven axle at the front, and tandem driven axles at the gear, and with the power of the prime mover being transmitted through a transfer case having co-axial openings in the front and rear walls thereof, a tubular output shaft receiving a journal mounting from the transfer case and protruding by its rear end through the rear wall-opening of the latter, a closed cage fixedly carried upon said exposed end of the output shaft, co-axial driving shafts one of which extends rearwardly from the cage and the other of which is piloted within the tubular output shaft and which extend by their front and rear ends, respectively, into the cage and with the former said shaft being adapted to connect with the tandem rear axles and the

latter said shaft with the front axle, and two trains of gears contained within said cage and acting with the latter to produce epicyclic connections of differing gear-reduction ratios the lower of which reduction connections takes the drive from the tubular output shaft to the forwardly extending driving shaft and the higher of which reduction connections takes the drive from the output shaft to the rearwardly extending driving shaft, one gear of said trains being common to both and a respective gear of each of said trains being fast to the related driving shaft.

6. In a vehicle of the described character, namely one having a single driven axle at the front, and tandem driven axles at the rear, and with the power of the prime mover being transmitted through a transfer case having co-axial openings in the front and rear walls thereof, a tubular output shaft receiving a journal mounting from the case front and rear ends and having its rear end protruding through and exposed beyond the front and rear openings, respectively, of the transfer case, a driving shaft piloted within the tubular shaft with its front end protruding through and exposed beyond said exposed front end of the output shaft and adapted to connect by said front end with the front axle of the vehicle, a second driving shaft adapted to connect by its rear end with the tandem rear axles, a proportional differential unit located outside the transfer case to the rear of the latter and operatively interconnected with the rear end of the output shaft and with the front and rear ends, respectively, of the second-named and first-named driving shafts to divide the power of the output shaft between the front and rear axles, a housing auxiliary to the transfer case and removably bolted to the latter so as to occupy an exposed position at the front of the transfer case, the exposed front end of the output shaft projecting into said auxiliary housing while the exposed front end of the first-named driving shaft extends through and beyond said auxiliary housing, and means housed within said auxiliary housing operable at will to establish a direct driving couple from the output shaft to the first-named driving shaft and thereby inactivate the differential working of the differential unit.

7. Structure according to claim 6 in which the auxiliary housing carries a thrust and journal bearing for the first-named driving shaft.

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