Dec. 24, 1963 L. J. O'BRIEN Re. 25,500

DIFFERENTIAL GEARING

Original Filed Feb. 4, 1960 3 Sheets-Sheet 1

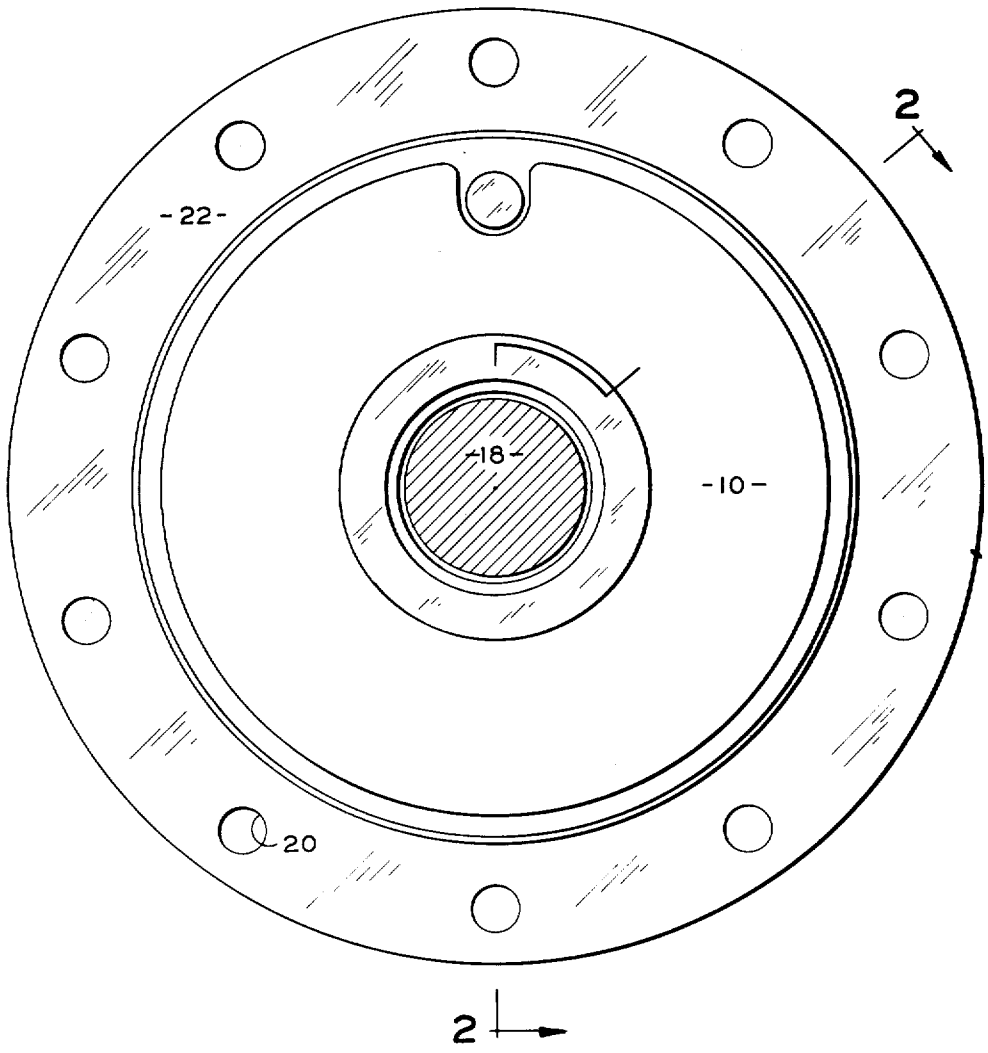


FIG. 1

INVENTOR.
LOREN J. O'BRIEN
BY Walter E. Pavlich

ATTORNEY

Dec. 24, 1963 L. J. O'BRIEN Re. 25,500

DIFFERENTIAL GEARING

Original Filed Feb. 4, 1960 3 Sheets-Sheet 2

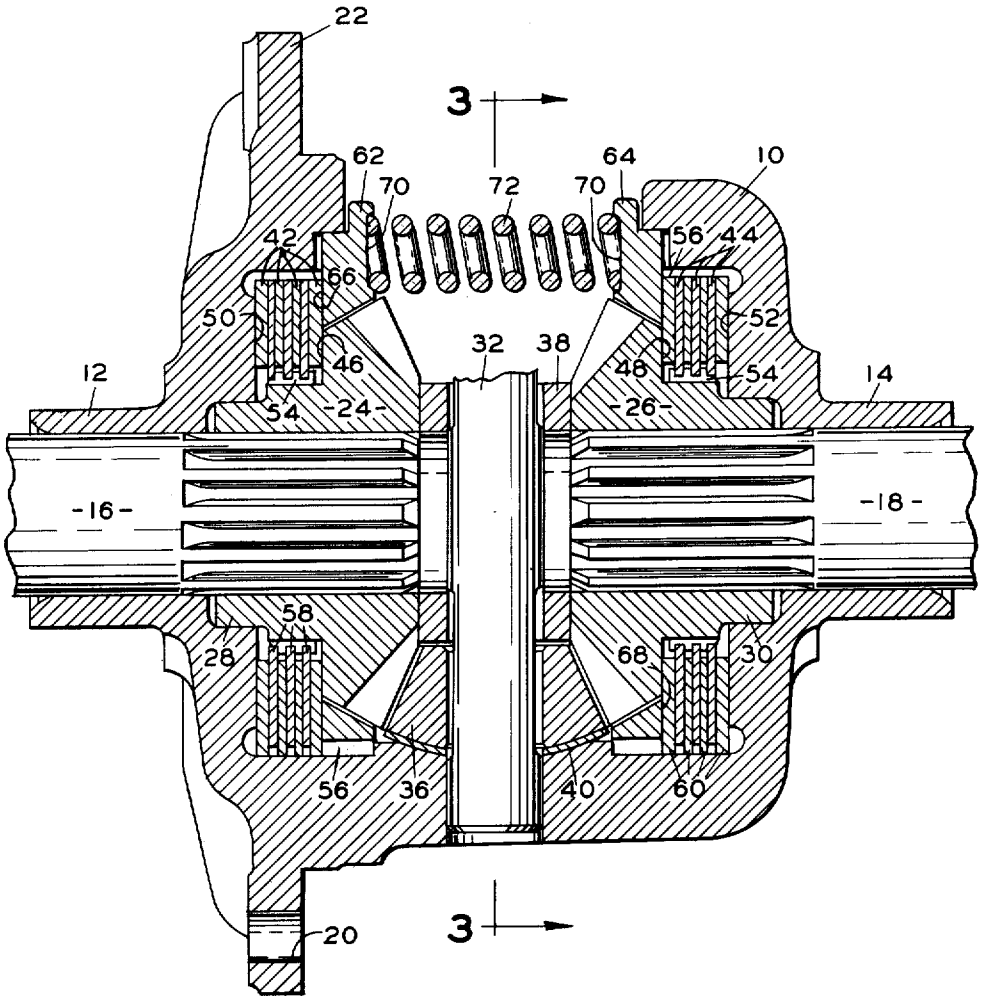


FIG. 2

INVENTOR.
LOREN J. O'BRIEN
BY Walter E. Pavlick

ATTORNEY

Dec. 24, 1963 L. J. O'BRIEN Re. 25,500

DIFFERENTIAL GEARING

Original Filed Feb. 4, 1960 3 Sheets-Sheet 3

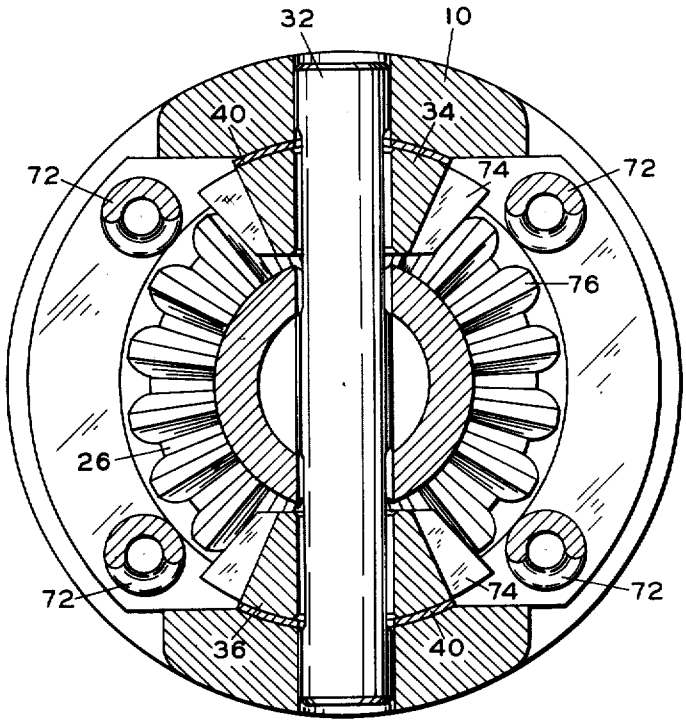


FIG. 3

INVENTOR.
LOREN J. O'BRIEN
BY Walter E. Pavlick
ATTORNEY

United States Patent Office

Re. 25,500
Reissued Dec. 24, 1963

25,500
DIFFERENTIAL GEARING

Loren J. O'Brien, Grabill, Ind., assignor to Dana Corporation, Toledo, Ohio, a corporation of Virginia

Original No. 2,966,076, dated Dec. 27, 1960, Ser. No. 6,779, Feb. 4, 1960. Application for reissue Dec. 19, 1962, Ser. No. 247,457

22 Claims. (Cl. 74—710.5)

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

This invention relates to differential gearing and more particularly to limited slip differentials or semi-locking differentials wherein the compensating action of the gearing is retarded.

As is well known to motorists and to others skilled in the art, when one of the driving wheels of a motor vehicle loses traction and begins to spin, the other driving wheel remains stationary, if it has traction, and does not operate to move the vehicle. Because of this condition, a motor vehicle is completely immobilized if one of the driving wheels loses traction, as so frequently occurs when driving on wet, slippery or muddy surfaces.

To provide the best possible performance there should be at least a minimum amount of resistance torque available in the differential when one wheel is subject to very low resistance so that wheel slippage can be eliminated on low traction surfaces. In addition to this, it is desirable to provide a [braking or] resistance torque in the differential which is variable in proportion to the amount of differential input torque being transmitted to the axles.

Many prior art constructions have been provided in an attempt to satisfactorily incorporate the above features. Generally, these prior constructions have utilized the axial thrust of the differential side gears to load a friction clutch [or braking] means. Resilient means in the form of coil springs has been provided between the side gears to bias the side gears outwardly to provide a minimum load on the friction clutch [or braking] means. However, this minimum bias has adversely affected the normal operation and backlash of the side gears. Furthermore, the mounting of the coil springs between the side gears has subjected the springs to forces which have caused excessive failures due to buckling.

Prior constructions, such as Wildhaber Patent No. 1,750,981, have also utilized a minimum bias on a differential to retard differentiation, the bias being independent of the side gears; however, such constructions have not provided means for increasing the retarding effect.

Therefore, an object of this invention is to provide a minimum retarding action independent of the side gears which retarding action is increased by axial thrust of the side gears upon increase of input torque.

Another object of this invention is to utilize an independent spring thrust and the axial thrust of the differential side gears to provide a simple and self-adjusting braking means on the differential action to control slippage at varying load conditions, at the same time allowing differentiation for turning.

Yet another object of this invention is to provide in a differential having a clutch for retarding the differentiation thereof, a plurality of means for imposing an engaging force to the clutch, which means separately loadingly engage the clutch.

A still further object of this invention is to provide a differential which is of simple construction, being composed of a minimum of parts, which are not only easy to fabricate and install but also very economical to manufacture.

In the preferred embodiment of this invention, a power transmission gear train is operatively disposed within a gear case. Resilient means independent of *at least a side gear of* the gear train [and the gear case] biases a clutch means to oppose relative rotative movement of members of the gear train. The gears of the gear train are meshed in a relationship to provide a component of tooth pressure for urging gears of the gear train axially outward to increase the loading of the clutch means in proportion to the input torque to the transmission.

These and other objects and advantages of this invention will become apparent from the following detailed description when taken in connection with the accompanying drawings wherein:

FIG. 1 is an end elevation view of the differential embodying this invention;

FIG. 2 is a sectional view taken on line 2—2 of FIG. 1; and

FIG. 3 is a partial sectional view taken on lines 3—3 of FIG. 2.

Referring more particularly to the drawings a casing 10 is provided with opposed hubs 12, 14 extending outwardly from the ends thereof. Axle shafts 16, 18 have their adjacent or inner ends projecting in rotatable relation into the hubs 12 and 14. The axle shafts 16, 18 at their outer ends are connected to the driving wheels of a vehicle equipped with this invention. A conventional ring gear (not shown) is attached by means of bolts which are secured through apertures 20 to a circumferential flange 22 of the case 10 for the reception of the power drive from a propeller shaft (not shown). As is very well known, the case 10 is enclosed in the conventional manner within a differential housing (not shown), which carries the usual supply of lubricant for the differential.

Positioned within the case 10 are axially aligned side gears 24 and 26 arranged in spaced apart facing relation. The side gears 24 and 26 are provided with hubs 28 and 30 extending outwardly and splined to receive mating splines of the axle shafts 16 and 18.

Extending diametrically through the case 10 and centrally between the side gears 24 and 26 is a spider member or pin 32. The spider member 32 is of elongated cylindrical configuration and carries compensating or pinion gears 34 and 36 adjacent its ends. A spacer block 38 of annular configuration is disposed centrally on the spider member 32 and is engaged by the opposed side gears 24 and 26. The compensating gears 34 and 36 intermesh with the side gears 24 and 26 and are held in spaced apart relation on the spider 32 by the [bearing] *spacer* block 38. It is now apparent that the [bearing] *spacer* block 38 prevents inward movement of the side gears 24 and 26 to eliminate possible bottoming of the teeth thereof with the compensating gears 34 and 36. Thrust washers 40 of suitable bearing material are inset in the casing 10 and having a contour conforming to the outer facing of the pinion or compensating gears 34 and 36 to limit outward thrust thereof upon rotation of the gears.

Clutch means is disposed between each side gear 24 and 26 and the case 10 to retard relative rotative movement of the gears and thus retard the compensating action. The clutch means takes the form of sets of interleaved friction plates or discs 42 and 44 interposed between surfaces 46 and 48 of the side gears 24 and 26, respectively, and the opposing side walls 50 and 52 of the casing 10. More specifically, the hub of each side gear is formed with external spur gear teeth 54, and the casing 10 is provided with internal annular spur gear teeth 56 opposed to and concentric with each set of spur gear teeth 54. Each of the friction plates 44 is formed with internal spur gear teeth 58 interlocked with spur gear teeth 54 of the contiguous side gear. Each friction plate plate 42 is provided with external gear teeth 60 inter-

locked with the contiguous internal annular gear teeth **56** of the case. While the friction plates **42** and **44** are mounted for rotation with the [side gears] *case* and the [case] *side gears* respectively, it is readily apparent that the discs are slidable in an axial direction. *It is also apparent from a consideration of FIG. 2, that a friction plate 42 is positioned at the axially inner and outer end of each clutch means.*

To maintain a predetermined preload or bias on the clutch means, a pair of truncated annular pressure plates **62** and **64** are positioned within the case **10** in spaced relationship. *As clearly shown in FIG. 3, the truncated portions of the pressure plates 62 and 64 abuttingly engage the bore of the case 10 so that no relative rotation may take place therebetween.* The pressure plates are arranged concentrically with the side gears **24** and **26** and each has an inner rim portion **66, 68** engageable with the clutch means; *the engagement being continuous circumferentially with a friction plate 42 of the clutch means and being radially outwardly from the respective side gear 24 or 26.* Each of the pressure plates **62** and **64** is also provided with a plurality, four in this instance, of opposed cup shaped notches **70**. Coil springs **72** are seated in the opposed notches **70** and urge the pressure plates **62, 64** axially outward *against the inner friction plates 42* to compress the friction plates **42** and **44** *into frictional engagement and the outer plates 42 of the clutch means* against the surfaces **50** and **52** of the case. The coil springs **72** are disposed intermediate the compensating gears **34** and **36** and, being positioned outside the side gears **24** and **26**, exert a force outwardly toward the case completely independent of the gears of the power transmission gear train. Hence, it is apparent that no interference exists on the mesh between the side gears and the compensating gears. *Further, since the pressure plates 62 and 64 are mounted for unitary rotation in the case 10, the coil springs 72 are not subjected to rotary twisting tending to buckle the same.*

To increase the frictional resistance to compensating action of the differential in proportion to the input torque thereto, the angle of the pitch cone of the compensating or pinion gears **34** and **36** is less than that of the side gears **24, 26** and owing to the abnormally large pressure angles of the gear teeth **74** and **76** of the compensating gears and side gears, the side gears which are larger than the compensating gears and hence have a greater brake surface, tend to move axially outward during rotation of the gears. *During this outward movement the back faces 46 and 48 of the side gears, which now serve as a second pressure plate for each clutch means, move into engagement with the friction plates 42 of the clutch means. This engagement is at a position radially inward from the pressure plates 62 and 64 and increases the frictional engagement of the clutch means. With the engagement of the pressure plates 62 and 64 disposed at a radially outward position and due to the radial mechanical advantage and higher rotational speeds at the periphery of the friction plates 42 and 44, maximum initial retardation is obtained with a minimum biasing effect from the springs 72.*

Since the friction plates 42 of the clutch means are engaged by the side gears 24 and 26 and the pressure plates 62 and 64 engage the friction plates 42 separate from the engagement of the side gears, a double engagement is provided on the friction plates. This double engagement produces more desirable and more uniform plate loading than a single pressure plate engaging the plates. Such is the case even though the total forces applying the load in both instances are equal.

The friction between the discs **42** and **44** is not sufficient to lock the side gears **24** and **26** to the case **10** under normal operating torques but is sufficient to retard relative rotation of the gears and thus reduce the compensating action.

From the foregoing it is apparent that a differential transmission has been provided wherein an initial bias or preload independent of the side gears of the differential resists differential action and upon [increase] *commencement* of [the] input torque to the differential the side gears thereof are moved axially outwardly by the positive pressure angled teeth of the side and compensating gears to increase the resistance to differential action.

While only a single embodiment of this invention has been shown and described, it is apparent that there may be many changes in structure as well as operation without departing from the scope of this invention as defined by the appended claims.

What is claimed is:

1. In a differential transmission unit the combination comprising a gear case, a power transmission gear train *operatively* positioned within said case *and driven thereby and including at least a pair of gears,* clutch means *operatively connected to said gear train and said case* for opposing relative rotative movement of *said gears* [members of said gear train], and resilient means independent of said gear train and said case [for loading] *and operatively connected to* said clutch means *for loading the same,* the gears of said gear train being meshed in a relationship to provide a component of tooth pressure for urging at least one gear of said gear train axially outward to increase the loading of said clutch means in proportion to input torque to the transmission.

2. In a differential transmission unit the combination comprising a rotatable gear case, a power transmission gear train operatively positioned within said case *and including at least a pair of gears,* and clutch means operatively disposed between said gear train and said gear case for opposing relative rotative movement of *said gears* [members of said gear train] said clutch means including a pair of friction surfaces at least one of which is associated with said gear train for rotation therewith and another of which is associated with said gear case for rotation therewith, and resilient means independent of said gear train and said gear case *and operatively connected to said clutch means* for causing engagement of said friction surfaces, the gears of said gear train being meshed in a relationship to provide a component of tooth pressure for urging at least one gear of said gear train axially outward to increase the force applied to said friction surfaces in proportion to input torque to the transmission.

3. In a differential transmission unit, the combination comprising a rotatable gear case, a power transmission gear train operatively positioned within said case and including a pair of side gears, clutch means operatively *connected to and* disposed between each of said side gear and said case for opposing relative rotative movement of *said side gears* [members of said gear train], said clutch means comprising at least a pair of cooperating friction surfaces, and resilient means independent of said side gear and said case *and operatively connected to said clutch means* for loading said friction surfaces, the gears of said gear train having positive pressure angled teeth biasing said side gears axially outward to increase the loading of said frictional surfaces and resist differential action by an amount proportional to the input torque.

4. In a differential transmission unit, the combination comprising a rotatable gear case, a power transmission gear train operatively positioned within said case and including a compensating gear and a pair of side gears intermeshng therewith, clutch means operatively *connected to and* disposed between each of said side gears and said gear case for opposing relative rotative movement of members of said gear train, said clutch means including at least a pair of cooperating friction surfaces, and resilient means independent of said side gears, *and operatively connected to said clutch means for* applying a force on said friction surfaces acting outwardly toward said case for loading said friction surfaces, the compen-

sating gear and the side gears being meshed in a relationship to provide a component of tooth pressure for urging said side gears axially outward to increase the force applied to said friction surfaces in proportion to input torque to the transmission.

5. In a differential transmission unit the combination comprising a rotatable gear case, a power transmission gear train operatively positioned within said case and including a plurality of compensating gears and side gears, clutch means operatively *connected to and* disposed between each of said side gears and said gear case for opposing relative rotative movement of members of said gear train, said clutch means including a plurality of interleaved friction plates, some of which are [secured to] *carried by* said side gear [train] for rotation therewith and others of which are [secured to] *carried by said* gear case for rotation therewith, and spring means independent of said gear train *and operatively connected to said clutch means for* biasing said interleaved friction plates axially outward against said case, the pitch line of said side and compensating gears being disposed at an angle to utilize the axial thrust of the meshing teeth of said gears to supplement said spring means and increase the force applied to said friction plates in proportion to the torque input to the transmission.

6. In a differential transmission unit the combination comprising a rotatable gear case, a power transmission gear train operatively positioned within said case and including compensating gears and side gears, clutch means operatively *connected to and* disposed between each of said side gears and said gear case for opposing relative rotative movement of members of said gear train, said clutch means including at least a pair of cooperating friction surfaces, a pair of pressure plates movably mounted in said casing each adapted to load said friction surfaces, and spring means independent of said side gears and compressed between said pressure plates for applying a force to said friction surfaces, the pinion gears and side gears being meshed in a relationship to provide a component of tooth pressure for urging said side gears axially outward to increase the force applied to said friction surfaces in proportion to input torque to the transmission.

7. In a differential transmission unit the combination comprising a rotatable gear case, a power transmission gear train operatively positioned within said case and including compensating gears and side gears, said side gears being adapted for receiving axle shafts and each having a plurality of friction plates axially movable thereon, axially shiftable friction plates interleaved with the friction plates of each side gear and mounted in said case to rotate therewith, a pair of pressure plates axially movable in said casing and each adapted to engage said friction plates, and resilient means independent of said side gears compressed between said pressure plates for biasing the friction plates against said case to oppose relative rotative movement of members of said gear train, the pitch line of said side and compensating gears being disposed at an angle to utilize the axial thrust of the meshing teeth of said gears to supplement said resilient means to increase the force applied to said friction surfaces in proportion to the input torque to the transmission.

8. In a differential transmission unit, the combination comprising a rotatable gear case, a power transmission gear train operatively positioned within said case and including a pair of opposed side gears each adapted for connection to an axle shaft, a plurality of friction plates positioned between each of said side gears and said case, some of said friction plates being rotatable with and axially movable relative to each side gear, and other of said friction plates being rotatable with and axially movable in said case, a pair of pressure plates axially shiftable within said case and each adapted to engage the friction plates between one side gear and the case, and resilient means independent of said side gears compressed between said pressure plates and biasing the friction plates against said casing to oppose relative movement of members of said gear train, the member of said gear train having positive pressure angled intermeshing teeth for moving said side gears axially outwardly into engagement with said friction plates to increase the loading thereof and resist differential action by an amount proportional to the input torque.

9. In a differential transmission unit the combination comprising

(a) a gear case,

(b) a power transmission gear train operatively positioned within said case and driven thereby and including a pair of gears,

(c) clutch means operatively connected to said power transmission gear train and said case for opposing relative rotative movement of said gears of said gear train,

(e) and resilient means independent of said gear train and operatively connected to said clutch means for loading said clutch means,

(f) the gears of said gear train being meshed in a relationship to provide a component of tooth pressure for urging at least one gear of said gear train axially outward to increase the loading of said clutch means in proportion to input torque to the transmission.

10. In a differential transmission unit the combination comprising

(a) a gear case,

(b) a power transmission gear train operatively positioned within said case

(1) and including at least a side gear,

(c) clutch means operatively connected to said gear train for opposing rotative movement of said side gear relative to another gear of said gear train,

(d) and resilient means operatively connected to said clutch means and independent of said side gear for loading said clutch means,

(e) the gears of said gear train being meshed in a relationship to provide a component of tooth pressure for urging at least said side gear axially outward to increase the loading of said clutch means in proportion to input torque to the transmission.

11. In a differential transmission unit the combination comprising

(a) a gear case,

(b) a power transmission gear train drivenly positioned within said case

(1) and including at least a pair of side gears,

(c) a clutch means operatively connected to said gear train and said case and

(1) including a pressure plate for opposing relative rotative movement of said gears of said gear train,

(2) said pressure plate being mounted for axial movement relative to and unitary rotative movement with said gear case,

(d) and resilient means operatively connected to said clutch means and independent of said side gear for loading said pressure plate of said clutch means.

(e) the gears of said gear train being meshed in a relationship to provide a component of tooth pressure for urging at least one of said side gears axially outward to increase the loading of said clutch means in proportion to input torque to the transmission.

12. In a differential transmission unit the combination comprising

(a) a gear case,

(b) a power transmission gear train drivenly positioned within said case

(1) and including a pair of side gears,

(c) clutch means operatively connecting and opposing relative rotative movement of said side gears,

(e) and resilient means operatively connected to said

clutch means and independent of said side gears for loading said clutch means,

(f) the gears of said gear train being meshed in relationship to provide a component of tooth pressure for urging at least said side gear axially outward to increase the loading of said clutch means in proportion to input torque.

13. In a differential transmission unit the combination comprising

(a) a rotatable gear case,

(b) a power transmission gear train operatively positioned within said case

(1) and including compensating gearing and a pair of side gears,

(c) clutch means operatively connected to and disposed between one of said side gears and said gear case for opposing relative rotative movement of members of said gear train,

(1) said clutch means including a plurality of friction plates, some of which are carried by said one side gear for rotation therewith and others of which are carried by said gear case for rotation therewith,

(d) and spring means operatively connected to said clutch means and independent of said one side gear for biasing said friction plates axially outward against said case,

(e) the pitch line of said side and compensating gearing being disposed at an angle to utilize the axial thrust of the meshing teeth of said gears to supplement said spring means and increase the force applied to said friction plates in proportion to the torque input to the transmission.

14. In a differential transmission unit the combination comprising

(a) a gear case,

(b) a power transmission gear train operatively positioned within said case and driven thereby and including at least a pair of gears,

(c) clutch means operatively connected to said gear train and said case including at least a pair of cooperating friction surfaces for opposing relative rotative movement of said gears,

(d) a first means including a pressure plate operatively connected to said clutch for urging said pair of friction surfaces into frictional engagement, and

(e) a second means operatively connected to said clutch for urging said pair of friction surfaces into frictional engagement,

(f) said first and second means operatively engaging said clutch at separate locations and urging the same from substantially the same direction.

15. In a differential transmision the combination comprising

(a) a gear case,

(b) a power transmission gear train operatively positioned within said case,

(1) including a pair of side gears and compensating gearing,

(c) clutch means operatively connected to said gear train and said case for opposing relative rotative movement of members of said gear train,

(d) a first means including a first pressure plate and being independent of said side gear and operatively connected to said clutch means for operatively engaging the same,

(e) and a second means including a second pressure plate means and being operatively connected to said clutch means for operatively engaging the same separately from the operative engagement of said first pressure plate with said clutch means whereby a double engagement is provided on said clutch means.

16. In a differential transmission unit the combination comprising

(a) a gear case,

(b) a power transmission gear train drivenly positioned within said case and

(1) including a pair of side gears and compensating gearing,

(c) clutch means positioned between at least one of said side gears and said case for opposing relative rotative movement of members of said gear train,

(d) first means operatively connected to said clutch means including a first pressure plate rotatable with and axially movable relative to said gear case and being independent of said side gear for engaging said clutch means,

(e) and second means operatively connected to said clutch means including a second pressure plate means for engaging said clutch means separately from the engagement of said first pressure plate with said clutch means whereby a double engagement is provided on said clutch means.

17. In a differential transmission unit the combination comprising

(a) a gear case,

(b) a power transmitting means drivenly positioned within said case and including a plurality of members,

(c) clutch means operatively connected to said power transmitting means and said case including at least a pair of cooperating friction surfaces for opposing relative rotative movement of said members,

(d) a resiliently biased means operatively connected to said clutch and urging said pair of friction surfaces into initial frictional engagement, and

(e) a second means constituting a portion of said power transmitting means operatively connected to said clutch and additionally urging said friction surfaces into frictional engagement,

(f) the urging of said second means being in response to and proportional to the torque transferred by said differential transmission unit, and

(g) said resiliently biased means and said second means operatively engaging said clutch at separate locations and urging the same from substantially the same direction.

18. In a differential transmission unit the combination comprising

(a) a gear case,

(b) a power transmission gear train drivenly positioned within said case

(1) and including a pair of side gears and compensating gearing,

(c) clutch means operatively connected to said gear train and said case for opposing relative rotative movement of gears of said gear train,

(d) and resilient means operatively connected to said clutch means independent of at least one of said side gears for engaging said clutch means,

(e) the gears of said gear train being meshed in a relationship to provide a component of tooth pressure for urging at least one gear of said gear train to engage said clutch means separately from the engagement of the resilient means with said clutch means whereby a double engagement is provided on said clutch means.

19. In a differential transmission unit the combination comprising

(a) a gear case,

(b) a power transmission gear train drivenly positioned within said case

(1) and including a pair of side gears and compensating gearing,

(c) clutch means operatively connected to and disposed between at least one of said side gears and said case for opposing relative rotative movement of members of said gear train,

(d) a pressure plate mounted for unitary rotary move-

ment with and axial movement relative to said gear case and adapted to cause engagement of said clutch means,

(e) and resilient means independent of said side gear and engaging said pressure plate to apply a load on said clutch means,

(f) the gears of said gear train being meshed in a relationship to provide a component of tooth pressure for urging said one side gear outwardly to engage said clutch means separately from the engagement of said pressure plate with said clutch means whereby a double engagement is provided on said clutch means.

20. In a differential transmission unit the combination comprising

(a) a rotatable gear case,

(b) a power transmission gear train operatively positioned within said case

(1) and including a pair of opposed side gears each adapted for connection to an axle shaft,

(c) a plurality of friction plates positioned between at least one of said side gears and said case,

(1) some of said friction plates being rotatable with and axially movable relative to said one side gear,

(2) and other of said friction plates being rotatable with and axially movable in said case,

(d) a pressure plate axially shiftable within said case and adapted to engage the friction plates between said one side gear and the case,

(e) and resilient means independent of said side gears compressed against said pressure plate and biasing the friction plates against said casing to oppose relative movement of members of said gear train,

(f) the members of said gear train having positive pressure angled intermeshing teeth for moving at least said one side gear axially outwardly into engagement with said friction plates to increase the loading thereof and resist differential action by an amount proportional to the input torque.

21. In a differential transmission unit the combination comprising

(a) a rotatable gear case,

(b) a power transmission gear train operatively positioned within said gear case

(1) and including compensating gears and side gears,

(2) each side gear being adapted for receiving an axle shaft and one of said side gears having a plurality of friction plates axially movable thereon,

(3) a plurality of friction plates carried by said gear case for unitary rotation and axial movement relative thereto and being interleaved with the friction plates of said side gear,

(4) one of said friction plates carried by said gear case being disposed axially inward relative to said friction plates carried by said side gear,

(c) a pressure plate mounted for unitary rotary movement with and axial movement relative to said gear case and positioned co-axial with said one side gear,

(1) said pressure plate and said side gear being adapted to engage said one friction plate with the engagement of said pressure plate being at a greater radial distance than said one side gear,

(d) and resilient means independent of said one side gear and compressed against said pressure plate for biasing the friction plates against said case to oppose relative rotary movement of the members of said gear case,

(e) the pitch line of said side and compensating gears being disposed at an angle to utilize the axial thrust of the meshing teeth of said gears to supplement said resilient means to increase the force supplied to said friction surfaces in proportion to the input torque to the transmission.

22. In a differential transmission unit the combination comprising

(a) a rotatable gear case,

(b) a power transmission gear train operatively positioned within said case

(1) and including compensating gears and side gears,

(2) each side gear being adapted for receiving an axle shaft and one of said side gears having a plurality of friction plates axially movable thereon,

(3) a plurality of friction plates carried by said gear case for unitary rotation and axial movement relative thereto and being interleaved with the friction plates of said side gear,

(c) a substantially annular pressure plate mounted for unitary rotary movement with an axial movement relative to said gear case and positioned co-axial with and surrounding a portion of said side gear,

(1) said pressure plate and said side gear being adapted to engage one of said friction plates with the engagement of said pressure plate at a greater radial distance than said side gear,

(d) and resilient means independent of said side gear and compressed against said pressure plate for biasing the friction plates against said case to oppose relative rotative movement of members of said gear train,

(e) the pitch line of said side and compensating gears being disposed at an angle to utilize the axial thrust of the meshing teeth of said gears and supplement said resilient means to increase the force supplied to to said friction surface in proportion to the input torque to the transmission.

References Cited in the file of this patent
or the original patent

UNITED STATES PATENTS

1,750,981	Wildhaber	Mar. 18, 1930
3,053,114	Singer	Sept. 11, 1962