No. 896,739. PATENTED AUG. 25, 1908.

W. C. MAYO & J. HOULEHAN.

TRANSMISSION GEARING.

APPLICATION FILED SEPT. 5, 1907.

2 SHEETS—SHEET 1.

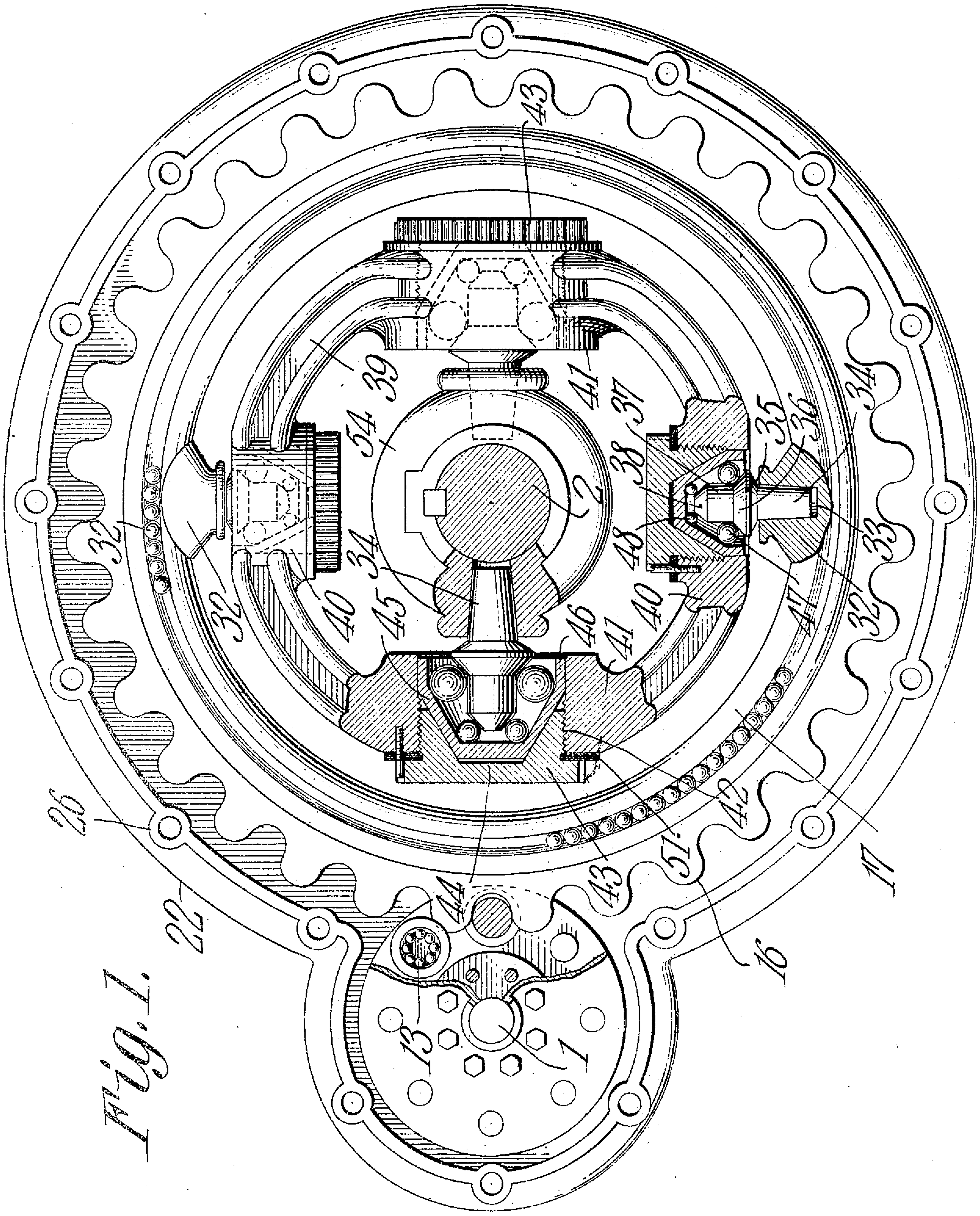


Fig. 1.

WITNESSES:

E. J. Stewart

F. T. Chapman

William C. Mayo,

John Houlehan, INVENTORS

By C. A. Snow & Co.

ATTORNEYS

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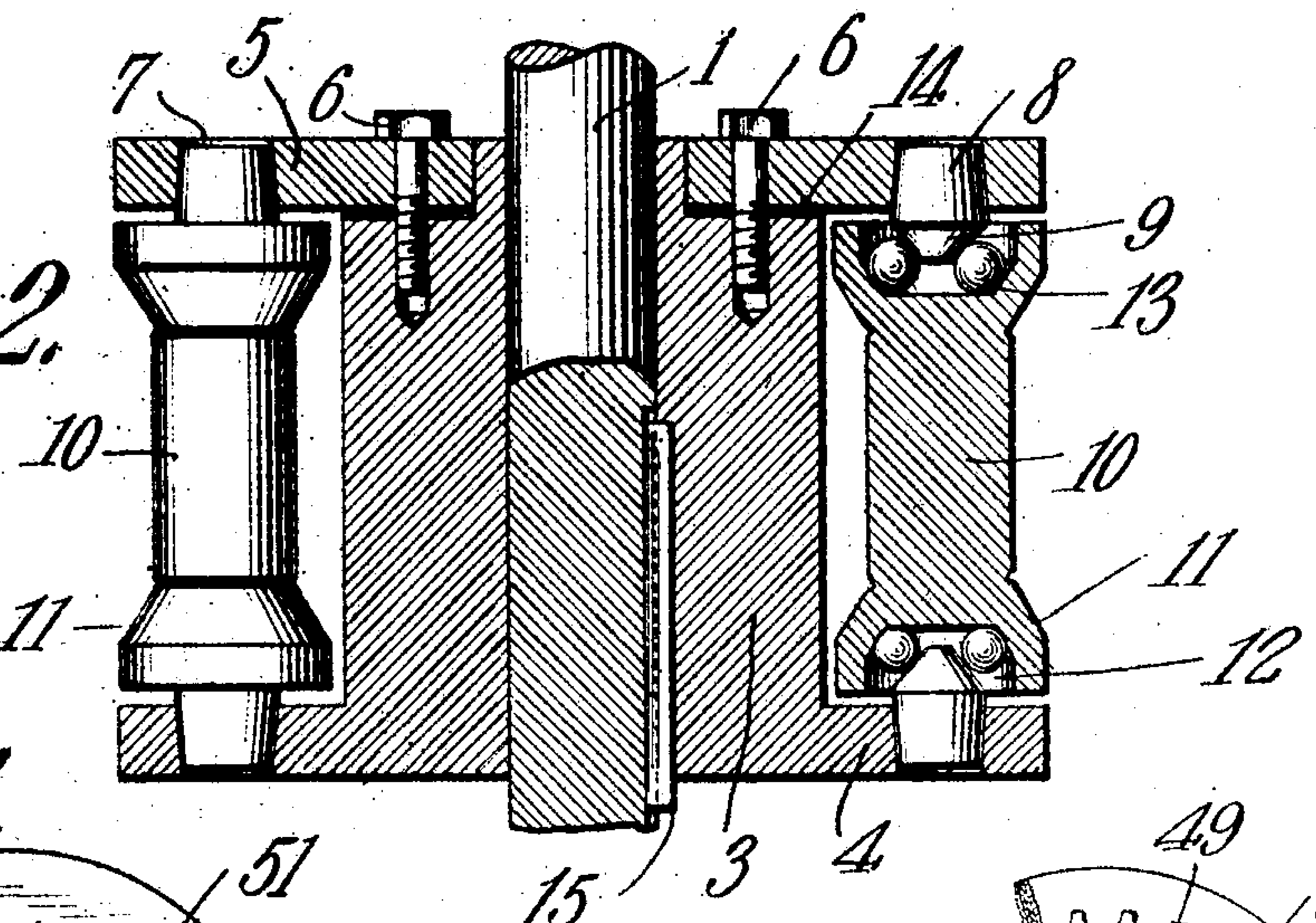
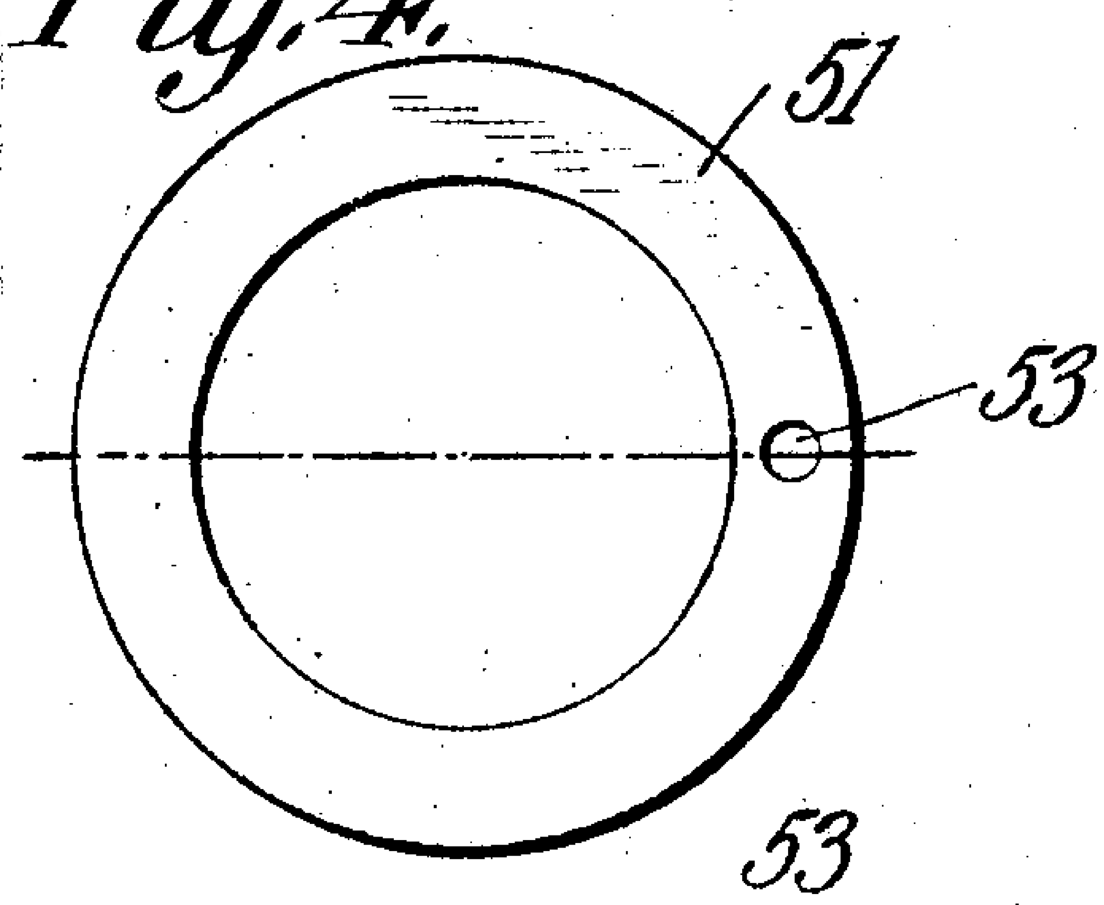



Fig. 2.

Fig. 4.



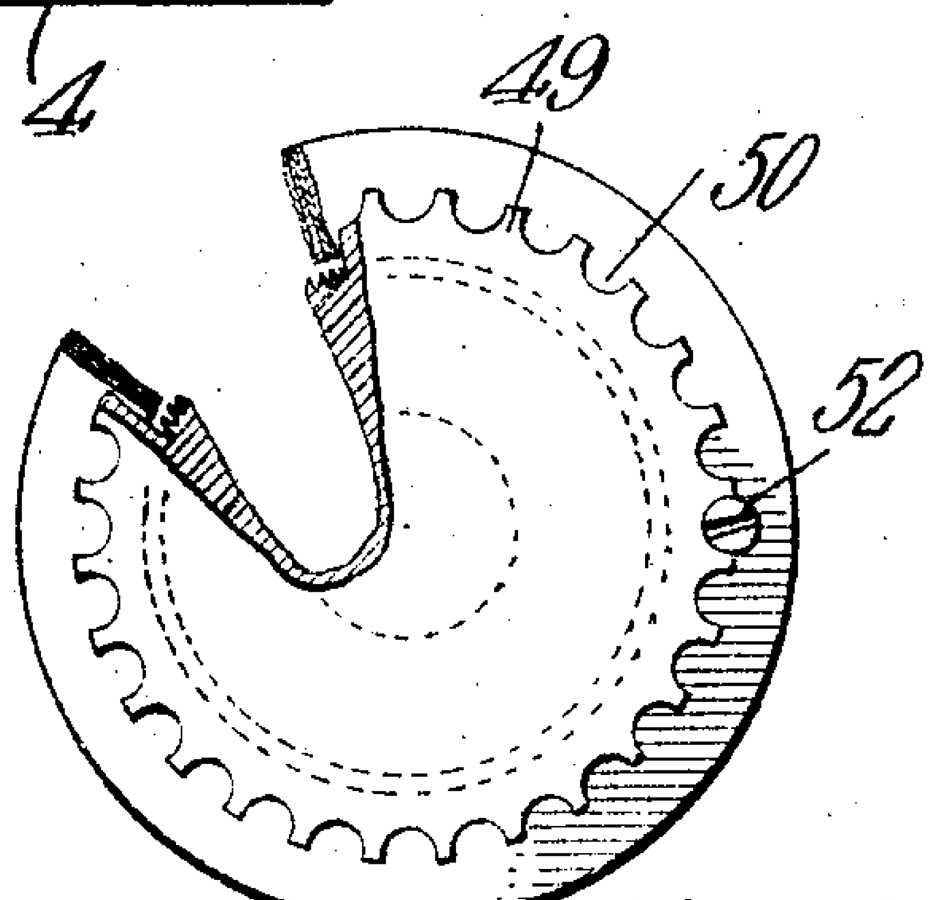




Fig. 6.

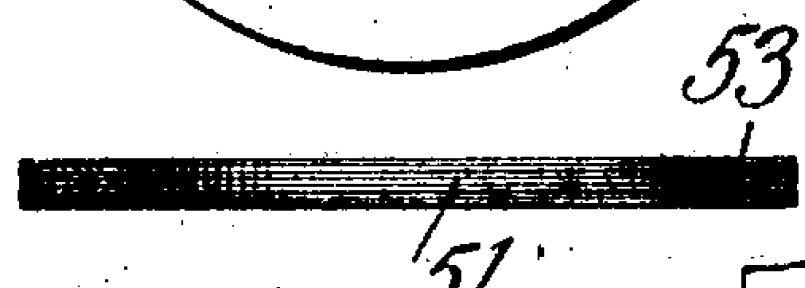



Fig. 5.

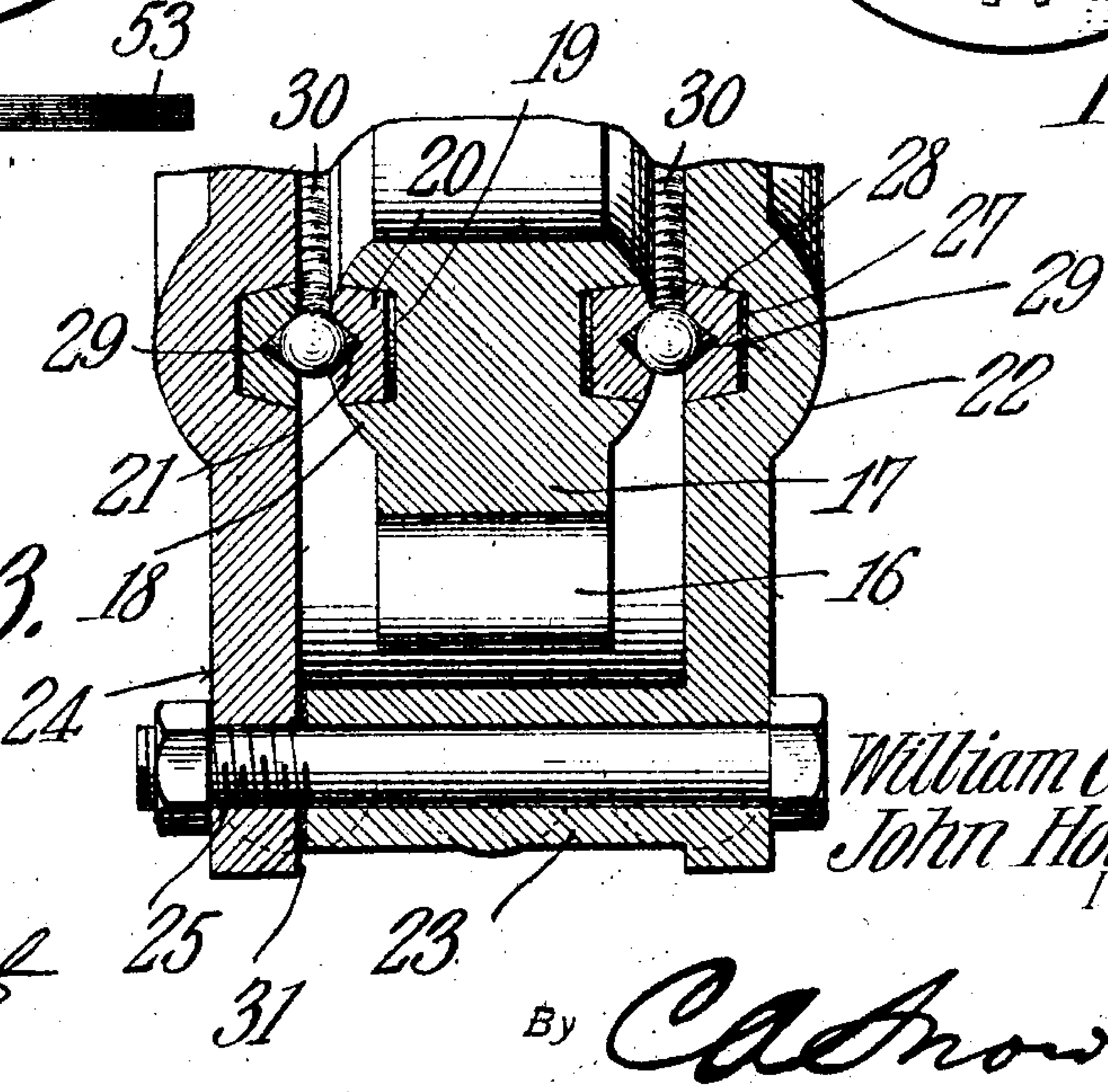



Fig. 3.

WITNESSES:

E. J. Stewart

F. T. Chapman

William C. Mayo &

John Houlehan

INVENTORS

By C. A. Snow & Co.

ATTORNEYS

# UNITED STATES PATENT OFFICE.

WILLIAM C. MAYO AND JOHN HOULEHAN, OF EL PASO, TEXAS, ASSIGNORS OF ONE-THIRD TO GEORGE E. BRIGGS, OF BARSTOW, TEXAS.

## TRANSMISSION-GEARING.

No. 896,739. Specification of Letters Patent. Patented Aug. 25, 1908.

Application filed September 5, 1907. Serial No. 391,525.

*To all whom it may concern:*

Be it known that we, WILLIAM C. MAYO and JOHN HOULEHAN, citizens of the United States, residing at El Paso, in the county of El Paso, State of Texas, have invented a new and useful Transmission-Gearing, of which the following is a specification.

This invention has reference to improvements in transmission gearing designed more particularly for use in connection with our motor traction system of which the present invention forms a part, but it is to be understood that while the present invention is an integral part of our system, still it may be used, either wholly or with regard to some of its essential features, in other connections.

We have devised a traction system wherein each car, whether considered separately or as an element of a train, is a complete unit in itself, and, among other things, comprises a prime mover, preferably in the form of an explosive or internal combustion engine, from which power for driving the car is transmitted to the wheels through mechanism of which the present invention constitutes a coactive part.

The cars used in our system are designed for urban, suburban and interstate traffic, and, therefore, provision must be made whereby the cars may be adapted to the short radius curves of city railroads, and the moderately sharp curves found on many suburban roads, as well as the long gentle curves such as are used on trunk lines. To accommodate the cars to the curves the trucks must necessarily move about vertical axes and because in our system the prime movers are not carried upon the trucks but upon the main frame of the car, we have devised a means whereby motion may be transmitted from a power shaft positively to the car axle carrying a pair of drive wheels, which means permits the driven shaft to change its relation to the drive shaft from that of parallelism to angular relations sufficient to allow the truck to pass around any curve in any road upon which the car may travel. This is accomplished without subjecting the shafts to any strain whatsoever because of their changed relations when the car passes around a curve, it being understood that suitable provision may be made for compensating for vertical motion between the drive and driven shafts due to the spring connections between the truck and car body, but since such compensating means form no necessary part of the present invention they will not be here considered.

In the broader aspect, the invention comprises essentially a drive shaft which for the purposes of the present invention may be considered as rotating about an axis having a fixed relation to the car body. Upon the drive shaft there is mounted a pinion, and meshing with said pinion there is a gear wheel of suitable size, mounted upon and causing the rotation of a shaft which may be connected to the car axles through suitable bevel or miter gears. Since the driven shaft is not in fixed relation to the drive shaft but participates in the movement of the truck about its vertical axis, therefore, in order that the gear wheel and the pinion may always rotate in the same plane one with relation to the other, the gear wheel is provided with a connection to the driven shaft of the universal type, whereby the driven shaft may change its angular relation to the drive shaft and at the same time receive motion from the gear wheel without undue strain to the parts or the consumption of unnecessary energy.

The invention also comprises special constructions designed to adapt the power transmission gear to the particular conditions to which it is subjected when used upon a railroad car or in situations similar thereto.

The present invention will be best understood by the consideration of a specific embodiment, and, therefore, we will describe in detail the embodiment of the invention illustrated in the accompanying drawings forming part of this specification, in which,—

Figure 1 is a side elevation, with parts in section and other parts broken away, of a transmission gear between a drive and a driven shaft, constructed in accordance with our present invention; Fig. 2 is a cross section, with parts in elevation, of the drive pinion and a portion of the power shaft; Fig. 3 is a cross-section through a portion of the gear wheel and casing therefor; and Figs. 4, 5 and 6 are detail views of a portion of the adjusting mechanism for certain ball-bearings used in the structure.

Referring to the drawings, there is shown a drive shaft 1 and a driven shaft 2. The shaft 1 is, in our system, not directly connected to the explosive engine or other prime mover but certain intermediate structures are employed for reasons which need not be referred to here, but for the purposes of the present invention the shaft 1 may be and will be referred to as the drive shaft. The driven shaft 2 might be utilized for the purpose of carrying the drive wheels of the car, but we prefer that this driven shaft be connected to the car axles through other gearing. Since it is desirable in our system that the shafts 1 and 2 lie in longitudinal planes with reference to the car body, the shaft 2 may be connected to the car axles by suitable bevel or miter gears.

Upon the shaft 1 there is keyed a hub 3 having at one end an annular flange 4, preferably integral with the hub 3, and at the other end carrying a ring or annulus 5 held to the hub 3 by suitable bolts 6 or otherwise. Evenly disposed about the flange 4 and ring 5, which latter may also be termed a flange, are perforations 7, the perforations in one flange matching those in the other flange. These perforations are made with a slight taper from the inner face toward the outer face, and seated in the taper perforations are taper plugs 8 having their inner or rear ends projecting toward each other beyond the inner faces of the flanges, and finally terminating in frusto-conical extensions 9 which should be turned true. Between the flanges 4—5 are as many rollers 10 as there are matching holes 7, and at each end the rollers are expanded, as shown at 11, and are axially recessed to form cups 12, the bases of which are frusto-conical. The rollers with their heads 11 are slightly shorter than the space between the flanges 4—5, and the cups 12 receive the frusto-conical ends of the plugs 8, while between the ends 9 of the plugs 8 and the bases of the cups 12 are disposed ball-bearings 13 of sufficient number to fill up the space, as indicated in Fig. 1, although in Fig. 2 only two such balls are shown.

Although the ball-bearings are made of hardened steel and the walls of the cups 12 and also the plugs 8 may be suitably hardened, there will still be some wear, and for this reason provision should be made for taking up such wear, at least to a certain extent. In Fig. 2 the flange or annulus 5 is shown underlaid by a number of ring-shaped shims or laminæ 14 of suitable material, one or more of which may be removed from time to time so that the said flange 5 may be brought closer to the flange 4 to compensate for the wear of the ball-bearings 13 and their seats in the cups 12 and plugs 8. The hub 3, with its flanges 4—5 and rollers 10, constitutes a gear pinion of the barrel type, but the pins are formed of anti-friction rollers which offer practically negligible resistance. The pinion is made fast to the drive shaft 1 by a key or spline 15.

Meshing with the barrel pinion is a large gear wheel having its teeth 16 formed on the outer periphery of a ring 17, which ring is expanded laterally interior to the teeth, as shown at 18, and is there formed with annular taper grooves 19, one on each side, in which grooves are seated taper rings 20 having their outer faces formed with V-shaped grooves 21 constituting ball races. Now, the barrel pinion and the gear ring 17 are inclosed in a suitable casing 22 formed of two cheek plates separated by a peripheral flange 23. One of the cheek plates, which is designated by the numeral 24, is removable from the casing, while the other cheek plate is formed integral with the flange 23. The removable cheek plate 24 is secured to the remainder of the casing by through bolts 25 extending through bosses 26 formed in one piece with the flange 23. The casing is shaped to conform approximately to the shape of the intermeshing pinion and gear, and said casing may be so put together that the interior thereof is practically dust-proof. For this purpose the shaft 1 may be provided with dust-proof journals in the casing and the shaft 2 may likewise be provided with dust-proof journals, but since the shaft 2, as will hereinafter appear, has universal movement within a restricted zone, the bearings for this shaft, while made dust-proof in any well known manner, should likewise have a certain freedom of movement to permit the shaft 2 to change its angular relation to the axis of the shaft 1.

The casing 22 is provided with tapered annular grooves 27 located opposite the grooves 19 in the gear ring 17, and these grooves 27 receive tapered annular rings 28 having V-shaped grooves 29, also constituting ball races. Seated in the matching grooves 21 and 29 are circular series of balls 30 forming side-thrust bearings for the gear ring 17 and preventing any lateral play thereof but offering no material frictional resistance to the rotation of this ring. Since these anti-friction bearings formed by the balls 30 are liable to wear, the cheek plate 24 may have interposed between it and the corresponding end of the flange 23 a number of shims or laminæ 31 which, as the ball-bearings wear, may be removed one or more at a time to compensate for such wear. These laminæ should be very thin so that the adjustment for wear may be correspondingly delicate.

At diametrically opposite points on the ring 17 are formed bosses 32 projecting radially inward toward the axis of the ring. In these bosses are formed radial taper holes 33 in each of which is seated a taper plug 34 having an expanded head 35 which is again contracted to form a taper ledge 36 from which there is an extension 37 of the plug finally terminating in a frusto-conical end 38.

Located concentric to and within the ring 17 is another ring 39 having formed in it two bosses 40—40 at diametrically opposite points, and other two bosses 41—41, also at diametrically opposite points but on a diameter ninety degrees displaced with relation to the pair of bosses 40. Each boss is provided with a central radial perforation, one portion of which is provided with screw-threads 42 in which is seated a nut 43 having its inner face provided with a taper countersink 44 receiving a taper cup 45, which cup has its open end formed into a cylindrical portion 46 fitting the bore of the opening through the boss 40 or 41 as the case may be. Into each cup 45 there extends the end 37 of one of the taper pins 34, and interposed between the taper ledge 36 and the taper portion of the cup 45, and also between the frusto-conical end 38 and the taper portion of said cup, are ball-bearings 47 and 48 respectively, the balls being of appropriate size to fit the spaces intended. The nut 43 has an expanded head 49 with its periphery formed into a series of notches 50. This head 49 overhangs the corresponding face of the boss 40 or 41, and between this head and the boss is a series of shims or laminæ 51 of suitable material, but each shim or lamina is made very thin. A set-screw 52 engages one of the notches 50 and passes through a perforation 53 in the laminæ 51 and finally enters a suitable threaded opening formed in the corresponding boss 40 or 41. When it is desirable to adjust the nut 43 so as to take up wear which may occur between the balls 47 and 48 and their seats, the screw 52 is removed and one or more of the laminæ 51 are taken out, after which the nut may be screwed down into place until the screw 52 may be made to engage another notch 50, when the nut will be held against accidental displacement.

The taper plugs 34 and also the cups 45, as well as the taper plugs 8 and the rollers 10, may ultimately wear to an extent too great to be any longer taken up by the removal of the laminæ provided for the purpose. This is also true of the rings 20 and 28. It will be observed that these several parts all have taper seats, so that they may be easily loosened from their seats by a slight blow and may then be replaced by new parts. The taper plugs 34 entering the ball-bearing receptacles in the bosses 41 have seats in a hub 54 keyed to the shaft 2.

It will be observed that the taper plugs 34 entering the hub 54 and the parts coacting with these taper plugs, as well as the bosses 41, are made considerably heavier than the taper plugs 34 entering the bosses 32 and coacting with the bosses 40. The parts are so made because the strain upon the taper plugs 34 entering the hub 54 is greater than the strain upon the taper plugs 34 entering the bosses 32. This is due to the fact that the larger plugs are located much nearer the shaft 2 than are the smaller plugs.

It is to be understood that the gear teeth shown in the drawing are to be taken only conventionally, since instead of being made rounded as shown in the drawing they may be brought to a more or less conical shape, or the teeth may be otherwise shaped if so desired.

Now, let it be supposed that the shaft 1 receives rotative movement from any suitable power source, either such as we have already referred to or some other power source, the barrel pinion carried by said shaft will participate in such movement. The gear ring 17 will also be rotated because of its engagement with the barrel pinion, and the ring 39 and hub 54, together with the shaft 2, will participate in this rotative movement. Let it be supposed that the shafts 1 and 2 are in exact parallelism. Power will be transmitted from the shaft 1 to the shaft 2 through the gearing described without other strain than that incident to the transmission of the power. Let it now be supposed that the shaft 2 is connected up to a car axle and that the car truck enters upon a curve. Under these conditions the car truck will swing about the vertical axis and the shaft 2, being connected to the car axle, will, of course, be swung about a vertical axis cutting the hub 54, thus putting the shaft 2 out of parallelism with the shaft 1. Taking the position of the parts shown in Fig. 1, the ring 39 will also be swung upon the same vertical axis as the hub 54, moving about the plugs 34 entering the bosses 40. However, as the gear wheel is rotated the bosses 40 move out of this vertical plane toward the horizontal plane, while the bosses 41 are carried into such vertical plane. When the bosses 41 have reached such vertical plane the ring 39 has returned into the plane of the gear wheel, while the taper plugs 34 entering the ball seats in the bosses 41 have turned sufficiently to compensate for the return of the ring 39 to coincidence with the plane of the gear wheel. Of course, the return of the ring 39 is gradual, and because of the universality of the supports the ring 39 moves about the plugs entering the bosses 40 without any strain upon the parts, and because of the anti-friction bearings the frictional resistance is practically negligible.

By virtue of the universal mounting of the shaft 2 in the gear wheel, the latter may be kept strictly in the plane of rotation of the barrel pinion, while the angular displacement of the shaft 2 without appreciable increase of strain upon the parts may be quite marked. Thus, under the conditions of traffic, a car may enter upon the sharpest curve used in practice and the shaft 2 will respond thereto without subjecting any of the parts to any greater strain than they are subjected to when the shafts 1 and 2 are strictly parallel.

It will be observed that in the gearing which we have devised there are no rubbing parts but all bearing surfaces have rolling contact with the adjacent surfaces, thus reducing all friction to a negligible point.

The casing has been described as dust-proof, which is, of course, a practically necessary protection under the conditions of actual practice for such parts as are inclosed in the casing. In order that the parts may be thoroughly lubricated, even though the bearings are largely of the anti-friction type, the casing may be made sufficiently tight to hold lubricating oil and the gearing may therefore run in oil.

It has been stated that there are interposed shims or laminæ between the nuts 43 and their seats, which laminæ are removable so that the nuts may be screwed up from time to time to take up wear. It is, of course, possible to omit these laminæ but the nuts might then be more or less loose in their seats. The laminæ furnish a firm bearing against which the nuts may be screwed up tight and so all looseness be avoided.

In the foregoing description the shaft 1 with its pinion has been considered as the drive shaft, but the shaft 2 may be made the drive shaft and the shaft 1 become the driven shaft, and the entire casing might have a movement in space with relation to the shaft 2. This, however, would constitute a mere reversal of the parts without change of function or operation.

We claim:—

1. In a transmission gear, an annular gear wheel having an annular ball race on each face, a pinion meshing with the gear wheel, a casing inclosing the gear wheel and pinion and provided with an annular ball race corresponding to one of the ball races of the annular gear, a removable cover for the casing adjustably connected thereto, and an annular series of balls seated in the ball races on each side of the gear wheel and in the respective ball races on the inner faces of the casing and cover.

2. In a transmission gear, an annular gear wheel, a pinion meshing therewith, removable annular ball race members seated in the opposite faces of the annular gear, a casing for the gear and pinion, a removable annular ball race member in the casing matching one of the ball race members on the gear, a removably adjustable cover for the casing, a removable annular ball race member in the cover matching the other ball race member in the gear, and a series of balls seated in the ball races in the race members.

3. In a transmission gearing, a gear wheel composed of an annulus with gear teeth of its periphery, radially inwardly-projecting plugs at diametrically opposite points on the gear annulus, said plugs terminating in cones, a ring interior to the gear annulus, ball cups at diametrically opposite points on the ring and entered by the cone ends of the plugs, balls in said cups engaged by said cones, a shaft central to the gear, a hub on said shaft plugs extending at diametrically opposite points from said hub and terminating in cones, ball cups carried by the ring and entered by the cone ends of the plugs on the hub on the shaft, and balls in said cup engaging the cones on the plugs.

4. In a transmission gearing, a gear wheel composed of an annulus with gear teeth on its periphery, radially inwardly-projecting plugs at diametrically opposite points on the gear annulus, said plugs terminating in cones, a ring interior to the gear annulus, ball cups entered by the cone ends of the plugs on the gear, adjustable seats for the cups, balls in the cups engaging the cone ends of the plug, a shaft central to the gear wheel, a hub on said shaft, plugs extending from said hub at diametrically opposite points and terminating in cone ends, ball cups in the ring entered by the cone ends of the plugs, adjustable seats for the cups, and balls in said cups engaging the cone ends of the plugs.

5. In a transmission gearing, a gear wheel, inwardly-projecting plugs at diametrically opposite points on said gear wheel, each plug having a taper seat in the gear wheel and terminating at its free end in cones, a shaft central to the gear wheel, a hub on the shaft, plugs having taper seats in the hub at diametrically opposite points on the same and formed with cones on their free ends, and a ring interposed between the gear wheel and the hub and having ball cups entered by the plugs on the gear wheel and hub respectively, said cups having adjustable seats, and balls interposed between the conical ends of the plugs and the balls of the cups.

6. A transmission gearing comprising a drive shaft, a barrel pinion carried thereby and provided with rotatable teeth, an annular gear wheel engaging the said teeth, a casing inclosing said gear and pinion and provided with an adjustable cover, anti-friction bearings between the sides of the casing and sides of the annular gear, a ring internal to said gear wheel, trunnions on said gear wheel entering said ring, a driven shaft central to the gear wheel, trunnions carried thereby, and anti-friction seats for said trunnions in the ring.

7. A transmission gearing comprising driving shaft, a gear mounted thereon, an annular gear in mesh with the first named gear, a driven shaft, universal connections between the driven gear and driven shaft, a casing inclosing both gears, a cover for the

casing adjustably connected thereto, continuous annular anti-friction ball bearings between the sides of the annular gear and the walls of the casing and cover for maintaining the annular gear in alinement with the first-named gear.

In testimony that we claim the foregoing as our own, we have hereto affixed our signatures in the presence of two witnesses.

WILLIAM C. MAYO.
JOHN HOULEHAN.

Witnesses:
MABEL O. FAHNESTOCK,
P. G. STEARNS.