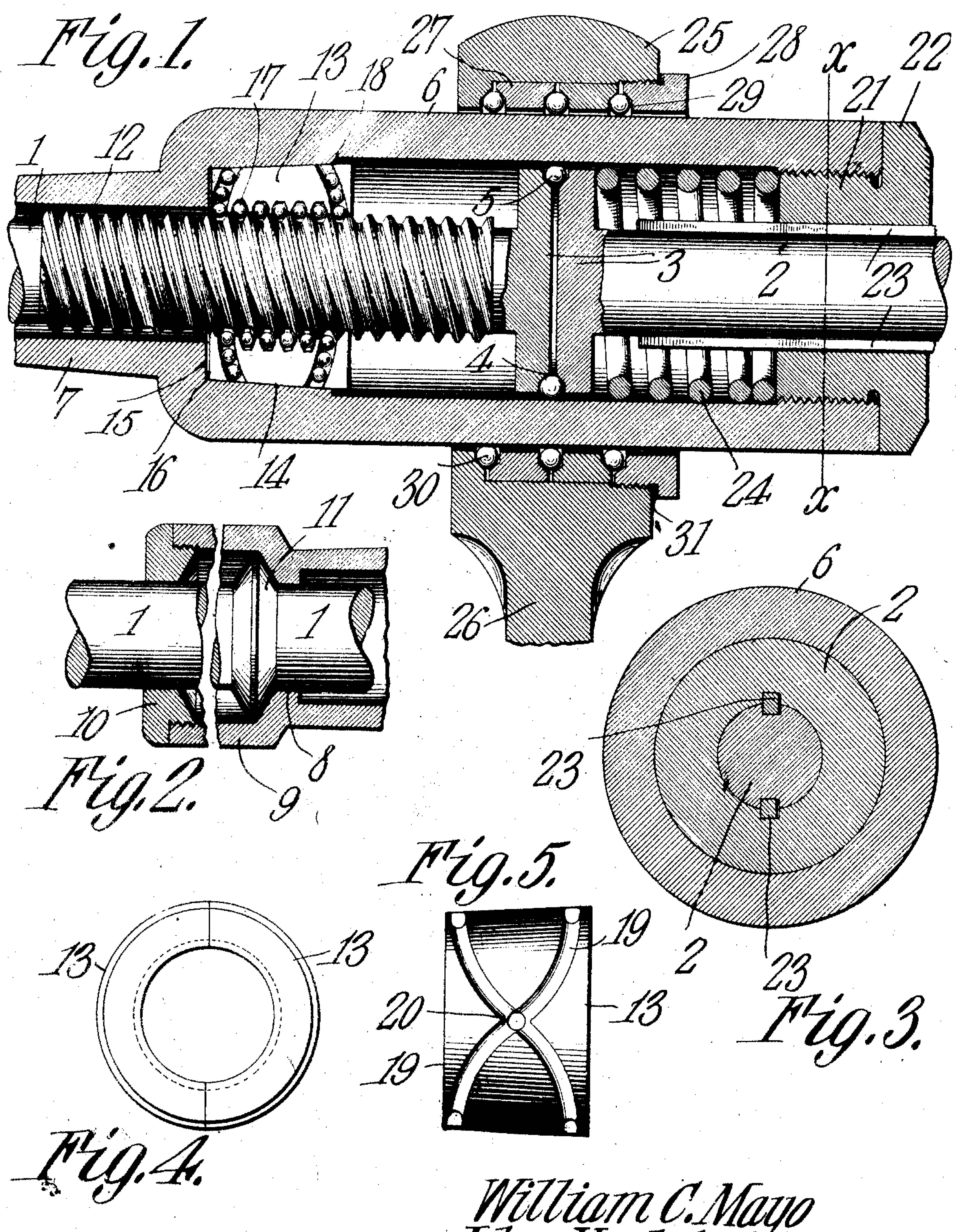
No. 879,286. PATENTED FEB. 18, 1908.

W. C. MAYO & J. HOULEHAN.

YIELDING POWER COUPLING.

APPLICATION FILED MAY 7, 1907.



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YIELDING POWER-COUPLING.

No. 879,286. **Specification of Letters Patent.** **Patented Feb. 18, 1908.**

Application filed May 7, 1907. Serial No. 372,337.

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 and State of Texas, have invented a new and useful Yielding Power-Coupling, of which the following is a specification.

This invention has reference to improvements in yielding power couplings, for connecting a power unit to a driven member, and forms part of a complete system of car operation intended more particularly for urban and suburban traffic, but which may be and is intended to be used for interstate traffic.

This invention will be more clearly understood by first considering the conditions under which it is designed to operate.

In traction systems it is advantageous to provide the cars with individual power units whereby each car becomes independent of every other car of the system. It is also advantageous in such a system that the explosive type of engine be used as the power element. Such power units are best operated when allowed to run continuously, whether the car be moving or standing still, and for the purposes of the system to which this invention most closely relates such a car unit should have a practically constant speed irrespective of the power demanded in the running of the car. However, under the conditions of traffic, the car must run at various speeds and thus bring upon the power unit various loads from time to time, and at other times the car must be brought to a standstill, and then again must be started. All these various conditions of the operations of the cars of a traction system produce a great variety of strains and sudden demands for power and also sudden periods when no power is required, thus subjecting the power unit to all sorts of variation of demand for speed.

The use of friction clutches as the intermediary for transmitting power from the driving element to the driven element is out of the question since they are largely unreliable for the transmission of such heavy power as it is designed to use at times upon the cars of our system, and since such clutches require constant repair and are in many ways not at all adapted for our purposes.

Our system contemplates the use of a constant speed driving element generating power in accordance with the demand, and in connection with such driving element we contemplate the use of means for changing from one speed to another. Under such conditions the cars are liable to be subjected to more or less sudden shocks, which are injurious to both the engine and the driving gear.

It is the object of the present invention to counteract these injurious effects and to cushion the shocks so that there is a certain elasticity or flexibility between the driving element and the driven element whereby the changes of speed or the effects of variation in the demand for power are not instantly transmitted from one element to the other but become effective only after a certain period of time, whereby the shocks are so distributed through such period of time that the equilibrium between the driving element and the driven element is gradually and not suddenly reëstablished.

To this end, the invention comprises an elastic or yielding connection between the driving element and the driven element which will yield in proportion to the power demanded and will then tend to establish an equilibrium between the two elements without their being subjected to any shock or jar. The invention comprises a drive shaft which may receive power from a suitable source, such, for instance, as an explosive engine of sufficient reserve power, and a driven shaft connected to the part which is to receive power from the engine whether this driven part be the drive wheels of a traction car or some intermediary part connected to said drive wheels, or whether any other driven element be included. These two shafts are in constant fixed relation one to the other. Upon them is mounted a sleeve having longitudinal movement with relation to the two shafts, the said sleeve being positively fixed to one shaft for rotation therewith and the other shaft having means whereby it may be coupled to the sleeve for rotation therewith or released from the sleeves so that the sleeve and last-named shaft may rotate relatively one to the other. Elastic connections are provided and means are also provided for putting these elastic connections under more or less stress so that the driven member under increased load may have a certain lag movement which will be gradually eliminated until synchronism of rotation is established, or the elastic connections will gradually assume a position of less stress when the demand for power is lessened.

The invention is by no means limited to the particular points which have just been enumerated, but comprises numerous features which will be fully understood from the following detailed description taken in connection with the accompanying drawings forming part of this specification, in which,—

Figure 1 is a longitudinal section, with parts in elevation, of the improved power coupling; Fig. 2 is a longitudinal section, with parts in elevation, of a continuation of the structure shown in Fig. 1, of the left-hand end thereof as viewed in said figure; Fig. 3 is a section on the line $x—x$ of Fig. 1; Fig. 4 is an end view of the split nut used in the structure; and Fig. 5 is a side view of the same.

Referring to the drawings, there is shown a shaft 1 and another shaft 2 in alinement, and for the purposes of the following description the shaft 1 may be considered as the drive shaft and the shaft 2 will be considered as the driven shaft. The shaft 1 may also be considered as forming one end of the crank shaft of an explosive engine of any suitable type for the purpose. In the present instance it may be considered as of the multi-cylinder type with means for causing the constant operation of the engine at constant speed under varying loads from zero load to the full load that the engine can carry. This engine in itself forming no part of the present invention, and the means for providing for constant speed under varying loads also forming no part of the present invention, need not be here further considered. The driven shaft 2 may be considered as connected to or forming part of a speed-changing gear, either of a special type which we have devised or of any other suitable type, or this shaft 2 may be considered as a driven shaft for transmitting power from the drive shaft to any mechanism of any kind wherein there is a variation of demand for power.

The contiguous ends of the shafts 1 and 2 are formed into disk-like heads 3 formed at the peripheries of their meeting faces with annular recesses 4 which together constitute a ball-race for anti-friction balls 5.

Surrounding the shafts 1 and 2 and suitably mounted thereon as will hereinafter appear is a cylindrical shell 6 reduced in diameter at one end to form a neck 7 which quite closely embraces the shaft 1 but is not in contact therewith except at the point 8 where there is formed a bearing for this shell upon said shaft. Beyond the bearing 8 the shell is again expanded to form another shell or cylinder 9 of considerably less diameter than the shell 6, and this shell has its outer end closed by a bushing 10 secured in the end of the shell or cylinder 9 and snugly fitting the shaft 1 at this point. Within the interior of the cylinder 9 the shaft 1 is formed with a collar 11 fitting the interior of the cylinder 9 quite snugly but not sufficiently close to produce undue friction.

Beginning close to the head 3 on the shaft 1 the latter is provided with screw-threads 12 for an appropriate distance away from said head 3 for a purpose which will presently appear. These threads are formed above the general surface of the shaft to avoid weakening it and they are of a very heavy type, similar to the U. S. standard, since, as will hereinafter appear, these threads are subjected to the full strain of the transmitted power.

Applied to the threaded portion of the shaft 1 there is a two-part nut 13 shown separately in Figs. 4 and 5 and the meeting edges of one of the parts being shown in elevation in Fig. 1. This nut is formed of tempered tool-steel and its exterior is turned to a slight taper which matches the tapered end 14 of the interior of the cylinder 6 where the neck 7 joins it, this taper ending in a shoulder 15. The meeting faces of the two halves of the nut are ground true so that when the nut is forced into the taper 14 the two sections of the nut will be brought into contact at their meeting faces. The parts are so proportioned that when the two sections of the nut are close together there is still a slight space between the smaller end of the nut and the shoulder 15, as indicated at 16, thus insuring the rigidity of the grip between the taper nut and the taper portion of the cylinder 6. The nut is split so that the threads may be ground true since the metal of the nut is hardened.

It will be observed that the interior diameter of the threads of the nut is equal to or slightly greater than the exterior diameter of the threads on the shaft so that the threads on the nut do not enter the threads on the shaft. In order to connect the nut and the shaft the matching threads are filled with hardened steel balls 17 and the end threads of the nut are connected by approximately radial raceways 18 with exterior crossed grooves 19, shown in Fig. 5. The nut 13 is always within the taper portion 14 of the cylinder 6 and the walls of this taper portion therefore coact with the grooves 19 to form raceways for the balls exterior to the nut. These exterior raceways and the connecting radial raceways are filled with balls, as well as the interior threads of the nut, so that the balls may have free passage through the threads and to the exterior of the nut and back again to the threads, exchanging at the crossed point 20 of the grooves 19. This structure gives an almost frictionless bearing between the shaft 1 and the nut 13, and it will be seen that this is needed when it is considered that the nut must be under the total driving strain of the car, which strain, in large cars, may amount to one hundred horse-power or more.

It will be understood, of course, that no attempt is made in the drawing to show proper proportions, but the nut will be of such length as to include a sufficient number of balls to give a safe bearing area for any strain which may be brought to bear thereon. It will also be understood that the end threads of the nut become gradually deeper until when they reach the passages 18 the movement of the balls therethrough is easy and the crossing of the grooves 19 at the point 20 insures an interchange of the balls so that all the balls will eventually follow all the threads during the movement of the nut. This insures equal wear on both the balls and the threads and maintains the balls all of the same size.

The end of the cylinder 6 remote from the neck 7 is closed by a screw-plug 21 ending in a cap 22 abutting against the end of the cylinder 6. This cap may be polygonal for the application of a suitable tool to screw it into place or unscrew it therefrom and the direction of the threads on the plug 21 may be such that the rotation of the shaft 2 will always tend to tighten the plug in its seat, thus avoiding any danger of loosening this part of the structure and doing away with the necessity of any special fastening devices. The center of the plug is bored out axially for the passage of the shaft 2, and key-ways are provided in the plug 21 for splines 23 carried by the shaft 2. These splines are of sufficient length to always engage in the key-ways in the plug as the plug is moved longitudinally on the shaft in a manner which will hereinafter appear.

Between the head 3 on the end of the shaft 2 and the inner end of the plug 21 there is confined a heavy helical spring 24, or, when necessary, more than one spring may be used at this point, the spring 24 being indicative of either one or a number of springs.

The cylinder 6 is supported in an annular head 25 formed on one end of a bracket 26 coming from any suitable fixed portion of the structure to which this invention is applied. This head is bored out to receive a number of rings 27 confined in the head 25 by a nut 28 screwed into one end of the bored out portion of the head 25. Between the corresponding end of the interior of the head 25 and the adjacent ring 27, and also between the meeting faces of adjacent rings, and of the nut 28 and the ring next to it, are formed ball-races 29 filled with hardened steel balls 30 bearing upon the exterior of the cylinder 6. Between the head of the nut 28 and the adjacent wall of the bearing head 25 there are interposed a number of thin washers 31 which may be removed from time to time to permit the taking up of wear between the balls and the ball-races. The nut or adjusting ring 28 may be provided with suitable set-screws for retaining it in any adjusted position, but such means being a very common expedient for this purpose are not shown in the drawings.

The exterior of the cylinder 6 may be provided with a hardened wearing sleeve upon which the balls 30 may travel, and the interior of said cylinder may also be provided with a hardened wearing sleeve upon which the balls 4 may travel, and the races for the balls 4 and 30 may also be formed of inserts of hardened metal, but these being structural details are not shown in the drawings.

Now, let it be assumed that the shaft 1 is being rotated at constant speed by a source of power ample for the purpose. The expansive force of the spring 24 maintains the nut 13 in the taper portion of the cylinder 6. Let it further be assumed that there is no load upon the shaft 2 and that the contiguous ends of the shafts 1 and 2 are at the end of the cylinder 6 close to the nut 13 with the spring 24 expanded. This will mean that the cylinder 6 has moved to the right as viewed in Fig. 1 until the nut 13 is about coincident with the left-hand end of the head 25. The two shafts are now rotating synchronously and the cylinder 6 is also rotating because of the connection with the shaft 2 through the plug 21 and splines 23. Now, if under these circumstances a load be placed upon the shaft 2, the latter will be either partially or wholly held against rotation, depending on the load. The result of this is that the cylinder 6 will be correspondingly held against rotation and the threaded portion 12 of the shaft 1 will begin to screw into and through the nut 13, causing the latter to engage more tightly into the taper portion 14 on the interior of the cylinder 6 and to pull the said cylinder 6 toward the left as viewed in Fig. 1. This longitudinal movement of the cylinder 6 proceeds until the spring 24 is compressed to such an extent as to equal the load upon the shaft 2 and the latter will then rotate, if, at the beginning of the operation, it was standing still. Under this latter supposition the starting torque is, of course, greater than the load after the shaft has come up to speed, and, therefore, the reaction of the spring 24 will cause the return of the cylinder 6 for a distance until the parts are again in equilibrium. Any variation in the load while the parts are running will be quickly responded to by the device, since it is very sensitive to any variation. But there is always sufficient time element entering into the response of the device to changes of load to prevent shocks or jars to the driving or driven machinery. In other words, there is a certain elasticity or flexibility of grip between the driving element and the driven element sufficient to absorb all shocks or jars which might otherwise occur when the load was applied or changed from time to time, especially where the application or change of load is sudden or takes place in a short time through a long range.

This invention is particularly applicable to the handling of heavy loads where great variations of load are liable to occur. In a car system such variations and violent variations of load occur constantly, but the device forming the subject of the present invention handles such loads without any undue shock or jar and without producing undue friction.

It will be understood, of course, that the screw-threads 12 extend over a sufficient length of the shaft 1 to permit the relative movement of this shaft and the cylinder 6 together with the space taken up by the nut 13, and the cylinder 9 will also be long enough for the movement of the cylinder 6, while the collar 11 will serve to prevent the escape of the lubricating oil with which the cylinder 6 may be filled, and this collar, engaging the ends of the interior of the cylinder 9, may operate as a stop for limiting the longitudinal extent of movement of the cylinder 6.

It will be observed that the expansion and compression of the spring 24 cannot take place instantly because of the movement of the threaded shaft through the nut 13, and, therefore, even when the change of load is sudden the compensating action of the connecting device must consume some time, while the inertia of the driven parts will also aid in preventing the throwing off of the load from acting too quickly upon the coupling device forming the subject-matter of the present invention.

We claim:—

1. A power transmission device comprising a drive shaft, a driven shaft in alinement therewith, a member connected for rotation to and slidable on the driven shaft, a spring interposed between the driven shaft and the slidable member and inclosed by the latter, and a screw connection between the drive shaft and the slidable member.

2. A power transmission device comprising a drive shaft, a driven shaft having one end contiguous to the corresponding end of the drive shaft, anti-friction bearings between the meeting ends of the two shafts, a member connected for rotation to and slidable on the driven shaft, a spring interposed between the driven shaft and the slidable member and inclosed by the latter, and a screw connection between the drive shaft and the slidable member, having threads coupled by anti-friction balls.

3. A power transmission device comprising a drive shaft having screw-threads formed thereon, a driven shaft in line with the drive shaft, a cylinder or sleeve surrounding the meeting ends of the two shafts and connected for rotation with and slidable on the driven shaft and also having a tapered interior portion adjacent to the drive shaft, a spring interposed between the driven shaft and the cylinder, and a nut surrounding the threaded portion of the drive shaft and tapered to seat in the tapered portion of the cylinder.

4. A power transmission device comprising a drive shaft threaded at one end, a driven shaft in line therewith and having one end contiguous to the drive shaft and there provided with an expanded head, a cylindrical member fast for rotation with but slidable on the driven shaft, a spring interposed between the expanded head of the driven shaft and the corresponding end of the slidable member, and a nut surrounding the threaded end of the drive shaft and contained in and acting on said slidable member to move it longitudinally with relation to the shafts in opposition to the action of the spring.

5. A power transmission device comprising a drive shaft having a threaded end, a driven shaft in line therewith, a cylindrical member connected to the driven shaft for rotation therewith but slidable longitudinally thereon, a spring interposed between the end of the driven shaft and the corresponding end of the cylindrical member, and a nut carried by the threaded end of the drive shaft, the said slidable member and nut coacting for frictional engagement one with the other to impart motion from the drive shaft to the said slidable member.

6. A power transmission device comprising a shaft having screw-threads formed thereon, a split nut surrounding the same and having a tapered exterior, a cylinder inclosing the threaded end of the shaft and having a tapered seat for the nut, another shaft having one end within the cylinder and rotatively connected to said cylinder, and a spring interposed between the second-named shaft and the corresponding end of the cylinder.

7. A power transmission device comprising a shaft having screw-threads formed on one end, a two-part taper nut applied thereto and provided with interior threads and exterior grooves with through connections between the interior threads and exterior grooves, anti-friction balls seated in the interior threads, exterior grooves and connections, a cylinder inclosing the threaded end of the shaft and having a taper seat for the nut and inclosing the balls contained in the exterior grooves on said nut, another shaft in the axial line of the first shaft and having one end contained in said cylinder and rotatively connected therewith, and a

spring interposed between the inclosed end of the last-named shaft and the corresponding end of the cylinder.

8. A power transmission device comprising a shaft having screw-threads formed on one end and terminating in an expanded head, a cylinder inclosing said threaded end of the shaft and the expanded head thereof, a nut seated in said cylinder and surrounding the threaded end of the shaft, anti-friction balls interposed between the nut and shaft, another shaft in the axial line of the first-named shaft, also provided with an expanded head contained within said cylinder, anti-friction bearings between the contiguous heads on the ends of the shafts and between the same and the interior of the cylinder, means for coupling the second shaft rotatively to the cylinder but permitting the latter to move longitudinally on the shaft, and a spring interposed between the headed end of the second shaft and the corresponding end of the cylinder.

9. A power transmission device comprising a shaft having screw-threads thereon near one end and a collar at a point near said end but more remote therefrom than the screw-threads, a cylinder inclosing the threaded end of the shaft, said cylinder having a continuation connected thereto by a neck and inclosing the collar on said shaft, a nut inclosing the threaded end of the shaft, anti-friction bearings between the nut and shaft, another shaft entering the cylinder and rotatively connected therewith and having its end contiguous with the corresponding end of the first-named shaft, anti-friction bearings between the contiguous ends of the shafts and the interior of the cylinder, a spring interposed between the inclosed end of the second shaft and the corresponding end of the cylinder, and an anti-friction support for the cylinder within which the latter may rotate and move longitudinally.

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:
W. A. Warnock,
Wm. W. Gillen.