March 10, 1931. E. F. WHITE 1,796,255

FLEXIBLE DRIVING MEANS

Original Filed Nov. 25, 1929 2 Sheets-Sheet 1

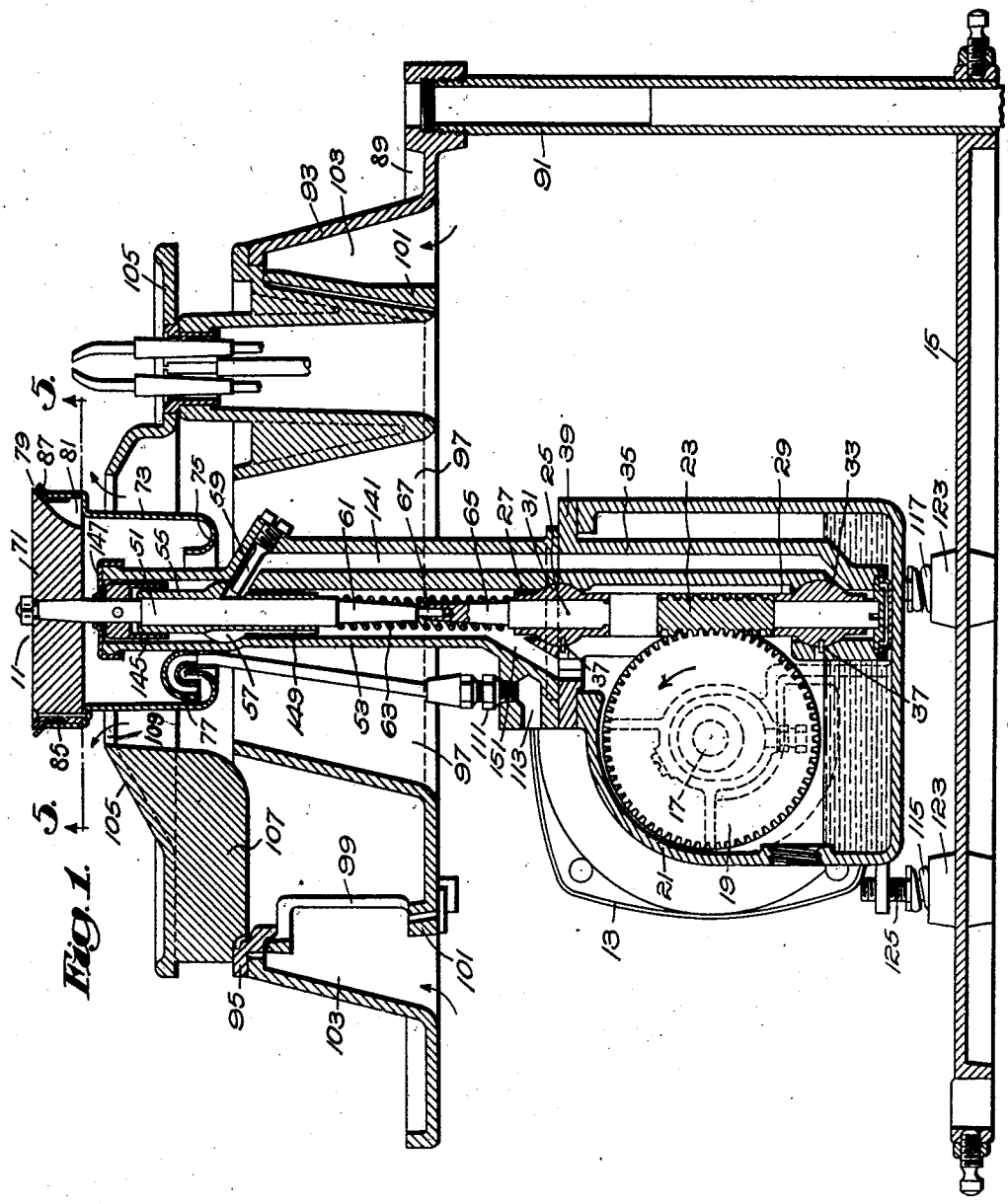


Fig. 1.

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Fig. 6.

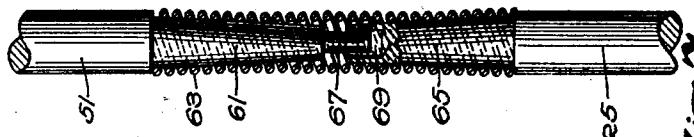


Fig. 7.

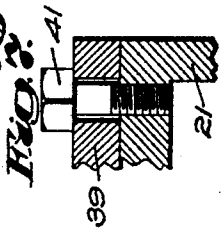


Fig. 3.

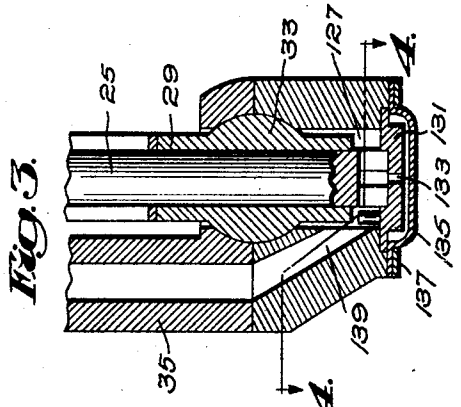


Fig. 4.

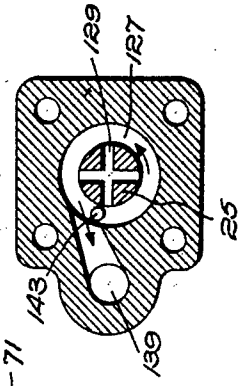


Fig. 2.

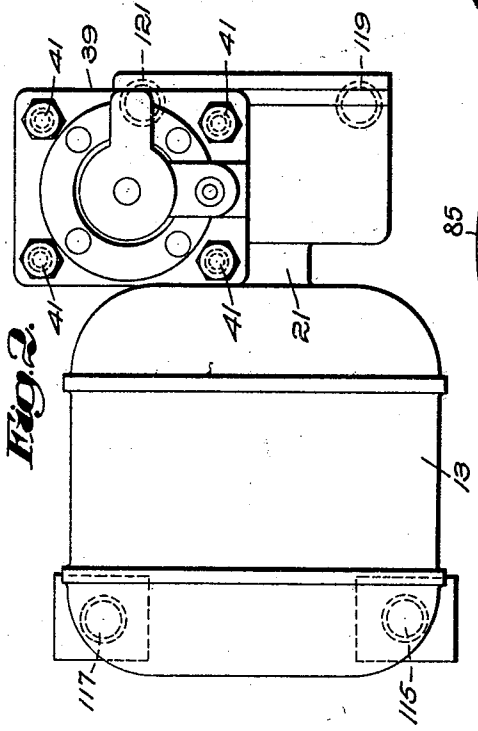


Fig. 5.

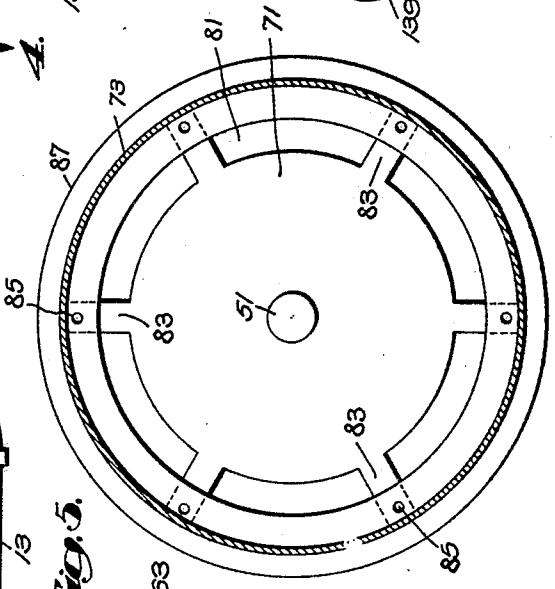
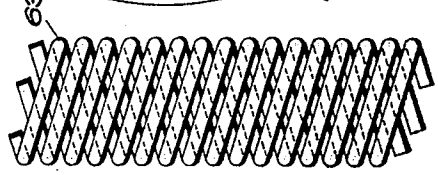


Fig. 8.



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UNITED STATES PATENT OFFICE

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FLEXIBLE DRIVING MEANS

Original application filed November 25, 1929, Serial No. 409,738. Divided and this application filed June 6, 1930. Serial No. 459,607.

This invention relates to flexible driving means, more particularly, though not exclusively, intended for driving a centrifugal element, such as a rotatable body, adapted under high speed to seek its natural center of rotation, one object of the invention being to provide a simple driving mechanism through which a body may be rotated at a relatively high speed with a minimum of noise, vibration and power consumption and with assurance of long life and durability in respect to the bearings and other parts subject to wear.

The invention as herein described is shown in its application to a liquid fuel, centrifugal burner, but it will be evident that various applications thereof may be made and uses other than that herein described.

This application is a division of my prior co-pending application, Serial No. 409,738, filed November 25, 1929.

The invention will be best understood by reference to the following description when taken in connection with the accompanying illustration of one specific embodiment thereof, while its scope will be more particularly pointed out in the appended claims.

In the drawings:—

Fig. 1 is a sectional elevation illustrating the centrifugal atomizing element and the driving mechanism therefor, as well as other parts of the burner apparatus which are located in or adjacent the combustion chamber of the boiler or other heater;

Fig. 2 is a plan view of the driving mechanism with the atomizing cup, its driving spindle and the oil feed pipe removed;

Fig. 3 is a sectional elevation on an enlarged scale, taken through the bottom of the main driving shaft, showing the provision for circulating the lubricant;

Fig. 4 is a section in plan taken on the line 4—4 in Fig. 3;

Fig. 5 is a sectional plan view of the atomizing member looking from beneath and taken on the line 5—5 in Fig. 1;

Fig. 6 is an enlarged, elevational view of the flexible spring driving connection between the main driving shaft and the atomizing spindle;

Fig. 7 is a detail showing the method of bolting the bearing support to the casing; and

Fig. 8 is a detail showing in elevation a portion of the triple spring driving connection between the driving shaft and the driven spindle.

Referring to the drawings, I have there shown for illustrative purposes one embodiment of the invention applied to a centrifugal liquid fuel burner, the liquid fuel, for the purpose of description, being herein assumed to be oil.

Referring to the drawings in detail, the burner comprises a centrifugal atomizing member designated generally at 11 which is located in the combustion chamber of the heater and is driven to rotate at high speed about an upright axis through appropriate gearing by means of a horizontal, relatively low speed, electric motor 13 mounted on the base plate 15. The armature shaft 17 of the motor carries at its end a worm gear 19 located within the casing 21 which is secured to the end of the motor frame, the gear 19 meshing with the worm 23 secured to the upright drive shaft 25.

The drive shaft 25 is mounted to rotate in upper and lower bearings 27 and 29, each of which is in the form of a sleeve having a spherical enlargement represented at 31 and 33, the latter being seated each in a spherical recess in the supporting casing 35. The bearing sleeves 27 and 29 are provided with pins 37 engaging recesses in the casing 35 which prevent the sleeves from turning about the axis of the shaft 25 but permit a slight, limited, rocking movement of each bearing sleeve in its socket to permit the sleeve to adapt itself to slightly different axial positions.

In assembling the parts, the supporting casing 35, with the sleeves and shaft assembled therein, is inserted through an opening in the top of the casing 21 and is secured thereto by the flanged plate 39 which is bolted to the casing by means of the bolts 41 (Fig. 2), the worm being brought into mesh with the teeth of the worm gear.

The holes in the flanged plate 39 through which the bolts 41 pass (see Fig. 7) are of

larger diameter than the bolts themselves, so that a certain amount of clearance is left. Accordingly, after the apparatus has been assembled the plate 39 with the supporting casing can be shifted within a limited range and the worm adjusted in any direction with relation to the gear 19 to secure the position of best interengagement.

Referring to the driving connections for the centrifugal atomizer, the latter is provided with the driven spindle 51 which is rotated within the upright casing 53 by a driving connection to the main drive shaft, hereinafter described. The driven spindle rotates in a bearing 55 of substantial length, the bearing being in the form of a sleeve provided with spherical enlargement 57 which rests in a spherical recess in the casing 53, so that the bearing is capable of moving freely within reasonable limits on its spherical seat, there being provided elsewhere a substantial clearance between the sleeve and the casing to permit such movement. The bearing sleeve 55 is prevented from turning by the pin 59 which permits, however, the necessary movement of the bearing. The spherical seat on which the movement of the spindle takes place is located well below the center of gravity of the atomizing cup, the latter in the illustrated form of the invention having its center of gravity in approximately the plane of the bottom of the hereinafter described head 71.

Referring now to the driving connection between the spindle 51 and the driving shaft 25 (see Fig. 6), the spindle, which is in a position of substantial alignment with the shaft, is connected to be driven thereby through a yieldable connection, permitting the spindle and its bearing 55 a certain freedom of movement so that the atomizer may automatically adjust its center of rotation, the extent of such movement, however, being limited by its relation to the drive shaft.

For this purpose the lower end of the spindle is tapered at 61 for a substantial distance and has applied thereto a coiled connecting spring 63, the opposite end of the spring being applied to a similarly tapered but closely opposing end 65 of the drive shaft 25.

Owing to the small scale of the drawing, a conventional showing of a single spring only is made in Fig. 1. While a single or a double wound spring may be employed, I preferably employ a triple wound spring, that is to say, a spring wound from three separate pieces of spring wire with parallel and adjacent convolutions, this preferred form of spring being shown in Figs. 6 and 8.

The inside diameter of the spring is preferably somewhat less than the greatest diameter of the tapered portions of the shaft and spindle and somewhat greater than the smallest diameter thereof. When assembled, and with the atomizer at rest, the outer ends of the spring are distended and tightly grip the tapered portions of the driving and driven members for a substantial part of their length, the intermediate part of the spring retaining its normal shape and diameter and clearing the tapered walls. The direction of the spring winding is such that when the burner is started up the spring tightens its grip on both the driving and driven members and, under the torque of the driving motor, the open part of the spring closes in and, in whole or in part, also wraps about and grips the tapered wall. In starting the torque is several times the normal running torque (in the disclosed form of burner nearly five times), so that the action of the middle portion of the spring is first to wrap about or close in on the tapered walls, yieldably enforcing an alignment of the driving and driven spindles, but to open up more or less and release the adjoining portions of the tapered driving and driven members as the normal speed is reached, allowing the atomizing member to float or seek its natural center of rotation.

Accordingly, during the starting of the burner and during the time the cup is undergoing acceleration, the spring is tensioned, contracted and elongated and tends to grip the tapered ends. When the normal speed is reached and the starting torque drops off, the tension on the spring is partly relieved and the latter tends to shorten and open up somewhat, permitting greater freedom of gyration to the spindle.

In assembling the parts, the tapered ends of the two members can be readily forced and twisted into engagement with the spring and the latter provides an adequate driving connection between the driving and driven members, but permits the driven spindle to have the described movement or adaptation on its bearing seat 57 when it is driven at high rates of speed.

It is desirable at all times, and particularly in starting up the rotation of the atomizer, that means should be provided for yieldably centering the driven spindle or drawing it into a position of true axial alignment with the driving spindle; also that some means should be provided for limiting the extent of the movement of the spindle away from its position of alignment. Otherwise vibration and unnecessarily wide and uncontrolled rocking or swaying of the atomizer and its spindle may result, and if initiated at starting it is apt quickly to get out of control with disastrous results.

To this end the ends of the two shafts are tapered as described, so as to provide two tapered aligned seats for the spring. The spring or springs are thereby maintained in true axial alignment under all conditions and variations of torque. In the case of a

spring forced about two adjoining, truly cylindrical shaft portions of slightly greater diameter than the inside diameter of the spring, each distended portion of the spring surrounding the shaft is concentric with the shaft but the intermediate portion which surrounds neither shaft is eccentric to the adjoining shafts. This creates an unbalanced condition, throwing the shafts out of alignment, which condition is eliminated under all conditions of torque through the use of the tapered spring-engaging portions.

A plurality of springs, and preferably three, is also employed for this purpose, since a single spring in wrapping about the shaft at starting provides a yielding resistance variable in different directions due to the characteristic of the spring. Through the use of a triple wound spring, however, the three separate windings may be so adjusted and disposed with relation to each other that in the case of each tapered shaft the final points of contact between the shaft and the three spring members may be located 120° apart giving a balanced condition and an equal yielding resistance in all directions and under all conditions.

To limit the extent of movement of the driven spindle from its aligned position, the tip of the spindle is reduced in diameter at 67 and this reduced end enters within an opening 69 in the tip of the driving shaft, there being provided a small but sufficient amount of clearance to permit the necessary movement of the spindle as the atomizer seeks its natural center of rotation at high speeds.

In practice it is found that the balancing of the cup can be so closely approximated in its initial construction, that, although some movement of the driving spindle is necessary to insure perfectly smooth running, such movement may be so slight that a relatively small clearance in the recess 69 will answer.

In operation the resilient, triple wound, spring connection, in cooperation with the tapered gripping portions of the two opposed shafts, tends to draw the two shafts yieldably into concentric or aligned relation, preserving such relationship when the apparatus starts into operation and tending at all times yieldably to restore such relationship if it is departed from. At the same time it provides a resilient connection permitting slight displacement of the spindle from an exactly aligned position and permitting the slight gyratory movement necessitated by the gyrostatic effect of the high speed, centrifugal atomizing member. The effect of the spring driving connection is also to cushion the shock between the cup and the motor, preventing the effect of irregularities in the driving of the motor from being transmitted to the cup.

It will be seen that while the ends of the driving and driven shafts are normally in a position of substantial alignment, they are separate and relatively movable in a lateral direction, the end of the driving shaft or spindle being free to move laterally within the limits imposed by the clearance between the spindle tip 67 and the opening 69 in the driving shaft, thereby permitting the gyratory movement of the spindle about a center of gyration at the spherical support 57. The spring, however, not only acts as a resilient driving connection between the separate driving and driven shafts, but also as a resilient aligning device, maintaining the spindle in a condition of alignment at the starting up of the burner, tending to maintain such alignment under all varying conditions of torque as the burner is being brought up to speed, and yielding only to afford the gyrations of the spindle which are necessary to permit the rotation of the cup about its natural center of rotation.

It will be observed also that in the illustrated embodiment of the invention, the driving spindle and cup are not axially fixed but are supported by the spring and free to move axially with relation to the journal bearing 55 and driving shaft 25 to permit, without constraint, the natural contraction and elongation of the spring as the torque is applied thereto or relieved therefrom.

Referring to the construction of the centrifugal atomizing cup, the latter is herein provided with a head 71 which projects into the combustion chamber, the head being of substantial mass and preferably constructed of a nonferrous metal, such as aluminum or brass, to provide a good conductor of heat.

Depending from the head and secured thereto is an annular oil receiving cup 73 having a trough-like bottom 75 in which the oil is adapted to be delivered by means of the stationary delivery pipe 77 entering through the annular opening in the bottom of the cup between the rim thereof and the casing 53. The sides of the cup are flared slightly upwardly and outwardly, so that when the atomizer is rotated the oil delivered to the trough 75 passes in the form of a thin film up the side of the cup and through a slot 79 formed between the sides of the cup and the edges of the head 71. The head is beveled or undercut at 81 to provide an escape for the oil, there being left, however, a series of radial ribs 83 (see Fig. 5) through which the cup is fastened to the head by means of rivets 85. The upper rim of the cup itself is provided with a lip 87 which, in conjunction with the beveled edge of the head, forms the slot 79 and directs the air radially outward at a slight upward inclination while the atomized oil is projected tangentially from the cup and in a horizontal plane.

The described burner may be employed in connection with air supply passages arranged

in any suitable manner. Herein the bottom of the combustion chamber is formed by the plate 89 supported on the base 15 by posts 91 (one of which only is shown) and carrying the wall 93 in the form of a truncated cone. On the top of the cone shaped wall 93 there is supported an air control casing 95 having an annular air admission passage 97 about the upright casing 53 for the atomizing cup spindle and adapted to deliver air immediately beneath and around the atomizing element. The air control casing is also provided with a plurality of additional air supply openings 99, the available area of which may be regulated by means of an adjustable damper ring 101 so that additional air may be admitted from beneath the plate 89 through the air space 103 and the air openings 99. Above the air control casing 95 there is also provided a deflector plate 105 which rests on the casing by means of several radial ribs 107 and serves to deflect the air entering through the openings 99 so that it passes into the combustion chamber in part about the outer edges of the deflector plate and in part through the central opening 109 in the deflector plate, where it commingles with the centrally fed air and passes in and about the atomizing member.

Any of the usual methods of feeding the oil to the atomizing cup or controlling and rgulating the oil feed in response to the requirements of the burner as well as controlling and regulating the action of the burner and the motor may be employed, and since these are well known no attempt is made to illustrate the same. The oil is herein supplied to the pipe 77 through the connection 111 and inlet passage 113 by means of any suitable feeding devices.

In the operation of the burner, the centrifugal atomizing element operating at high speed quickly finds its natural center of rotation. Any slight divergence of the axis of the spindle 51 from its required position is immediately corrected by the movement of the spindle axis, the bearing 55 adapting itself to this condition by a slight movement on its ball seat 57 and the resilient connection between the driving shaft and the spindle permitting this movement of adaptation to readily take place. Unnatural or unnecessary oscillations of the cup spindle, however, are prevented by the relationship of the reduced end 67 of the driving spindle to the recessed end of the driving shaft, the play between these two members, however, being sufficient to permit all necessary movements of adaptation. When the centrifugal member has been brought up to speed it runs smoothly and noiselessly in its bearings, operating in similarity to the spinning action of a top, and the spindle and shaft will run with a minimum of bearing wear.

Preferably the driving mechanism herein, including also the motor, is resiliently mounted, there being provided for this purpose the four springs 115, 117, 119 and 121 (Fig. 2), each seated in a socket 123 (Fig. 1) in the base plate 15 and supporting the motor and casing 21 by means of studs 125 preferably threaded into the bottom of the motor frame and casing respectively so as to be capable of adjustment. When the apparatus is assembled, the studs are adjusted to secure the best possible vertical alignment of the driving shaft. During the operation they provide a resilient support for the entire driving mechanism.

To assure lubrication for the driving mechanism, the bottom of the casing 21 forms a well in which there is maintained a quantity of lubricating oil, the bottom of the supporting casing 35 being immersed in the lubricant and the rotation of the driving shaft serving to circulate this oil through the bearings and other parts.

For this purpose it will be seen that the bearing support for the drive shaft terminates short of the bottom of the casing so that the oil has access to it. In the bottom of the casing 35 there is provided an oil chamber 127 (Figs. 3 and 4) surrounding the bottom of the drive shaft 25, the lower end of which is formed with four radial slots 129. The bottom of the casing is closed by a plate 131 having a central opening 133, the plate being covered by a gauze screen 135 retained by a holding plate 137. The slotted lower end of the drive shaft acts as a centrifugal pump, drawing the oil in through the central opening 133, discharging it radially into the oil chamber 127 and thence through the discharge passage 139 by which it is carried up through the bearing support 35 and through a registering passage 141 (Fig. 1) in the casing 53, being delivered between the spindle 51 and the spindle bearing 55 about the pin 59. The priming and operation of this pump are assisted by a baffle wall which is in the form of a pin 143 (Fig. 3) located in the oil chamber to divert the oil into the passage 139.

The upper end of the bearing 55 is surrounded by a thimble 145 secured to the spindle to prevent the escape of lubricating oil into the cup about the spindle, and the top of the casing is also protected by a small shield 147 secured thereto also to prevent the escape of lubricant and to preclude the possibility of fuel oil getting into the lubricating oil. The lubricating oil accumulating in the upper part of the casing 53 is drained through an oil groove 149 formed in the bearing sleeve 55 and, together with the oil gravitating from the spindle, passes down within the casing between the drive shaft 25 and its bearings, the excess oil being discharged through the groove 151 into the

casing and onto the worm wheel 19. During the operation of the burner, therefore, there is a constant circulation of the lubricating oil from the casing to the bearings of the spindle, thence to the bearings of the drive shaft, the worm and the worm wheel.

While I have herein shown and described for the purpose of illustration one specific embodiment of the invention, it is to be understood that extensive deviations may be made therefrom and widely different relationship of the various parts described may be had, all without departing from the spirit of the invention.

Claims:

1. The combination with a rotatable body adapted to seek its natural center of rotation, of a driving and a driven shaft therefor presenting adjacent ends normally aligned but free for relative lateral movement, and a resilient driving and aligning connection between the shafts comprising a coiled spring having a plurality of separate parallel windings in gripping engagement with the outer walls of said adjacent ends, thereby to provide a yielding resistance to the movement of the driven shaft away from a position of axial alignment substantially uniform in all directions.

2. The combination with a rotatable body adapted to seek its natural center of rotation, of a driving and driven shaft therefor normally aligned and having adjacent ends tapered for a substantial distance, and a resilient driving connection between the shafts comprising a triple wound, coiled spring in engagement with the tapered ends, the windings of said spring being so related to each other and to the shafts as to provide a yielding resistance to the movement of the driven shaft away from the position of axial alinement substantially uniform in all directions.

3. The combination with a rotatable body adapted to seek its natural center of rotation, of a driving and a driven shaft therefor, said shafts having tapered ends in closely aligned relationship, and a driving connection between the shafts comprising a coiled spring gripping said tapered portions, the spring when unstressed being of lesser inside diameter than the larger portions of said tapered ends and of greater inside diameter than the smaller portions of said tapered ends, the coils of said spring between points of engagement with said shafts being coaxial with the axes of the shafts whereby to yieldingly resist movement of the driven shaft out of axial alinement with said driving shaft.

4. The combination with a rotatable body adapted to seek its natural center of rotation, of a driving and a driven shaft therefor normally, axially aligned, the adjacent ends of said shaft being tapered, and a driving connection between the driving shaft and driven shaft comprising a coiled spring having a plurality of separate parallel windings in gripping engagement with the outer walls of said adjacent ends, the windings of said spring being so related to each other and to the shafts as to provide a yielding resistance to the movement of the driven shaft away from the position of axial alinement substantially uniform in all directions.

5. The combination with a rotatable body, of a spindle connected to drive the body, a journal bearing for the spindle movable to permit gyratory movement of the spindle axis, a driving shaft normally aligned therewith, the end of said spindle being movable laterally with relation to the end of the driving shaft, a resilient driving and aligning connection between the spindle and shaft comprising a coiled spring engaging and connecting the adjacent ends of the spindle and shaft, and means to limit the movement of the spindle axis comprising interengaging members carried by the spindle and shaft respectively.

6. The combination with a driving shaft and a driven shaft presenting opposed tapered ends in approximate alignment, of a resilient driving connection between the shafts comprising a triple wound, coiled spring in engagement with the tapered ends, the windings of said spring being so related to each other and to the shafts as to provide a yielding resistance to the movement of the driven shaft away from the position of axial alinement substantially uniform in all directions.

7. The combination with a driving and driven shaft presenting opposed tapered ends in approximate alignment, of a resilient driving connection between the shafts comprising a coiled spring gripping said tapered portions, the spring when unstressed being of lesser inside diameter than the larger portions of said tapered ends and of greater inside diameter than the smaller portions of said tapered ends, the coils of said spring between points of engagement with said shafts being coaxial with the axes of the shafts whereby to yieldingly resist movement of the driven shaft out of axial alinement with said driving shaft.

In testimony whereof, I have signed my name to this specification.

EZEKIEL F. WHITE.