Jan. 23, 1962 O. E. JOHANSSON 3,018,097

POWER SPRINGS

Filed April 8, 1959

FIG. 1

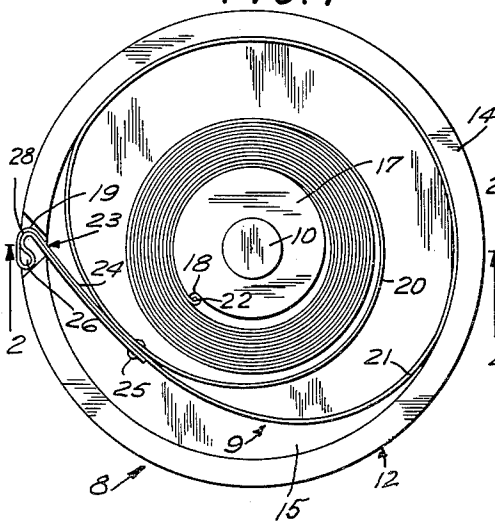


FIG. 3

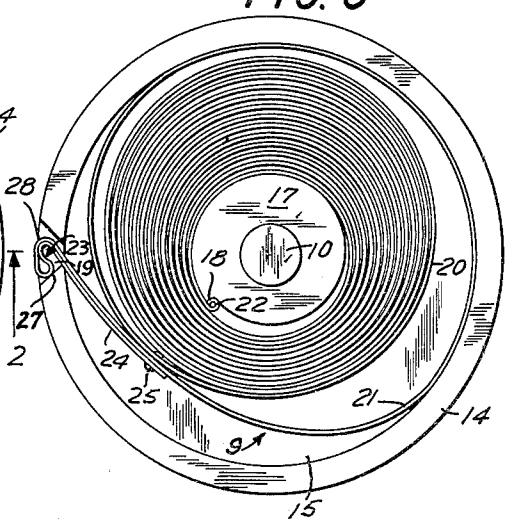


FIG. 2

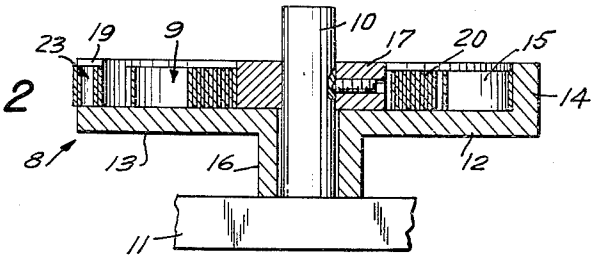


FIG. 5

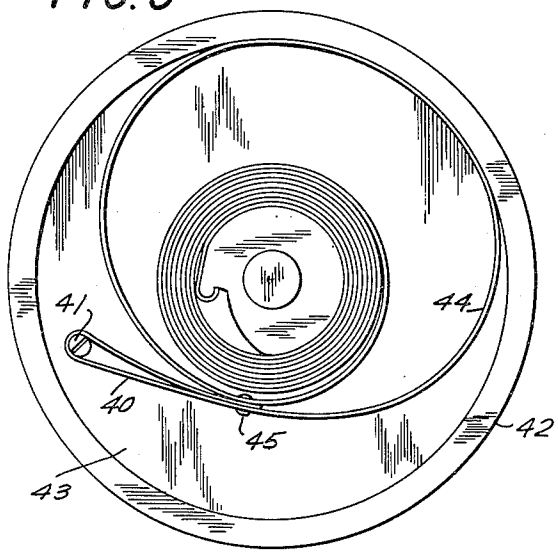
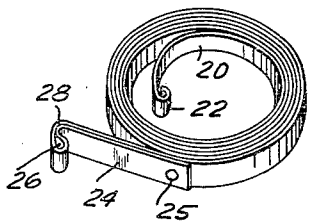


FIG. 4



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POWER SPRINGS

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The present invention relates to power springs, and more particularly to a power spring assembly having a helically coiled spring connected at its inner and outer ends to relatively rotatable elements.

Power springs of the type indicated are used extensively for supplying power from a pair of relatively movable elements. The elements are rotated relative to each other to wind the spring, and stored power is then delivered to one of the elements as the spring unwinds. With such springs it is difficult to confine the coils when the spring is mounted on or removed from the apparatus with which it is used, or during handling or shipment of a replacement spring.

In prior types of helical power springs, adjacent coils tend to bind at one side of the axial arbor or center element, thus to produce excessive binding and friction between the coils during winding and unwinding. Such binding is accentuated when springs of different length are used in the same barrel. When a prior type of power spring is wound by turning one of its ends relative to the other, the outer coil is tensioned between its anchored end and the zone of contact with the next adjacent coil. This tension tends to pull the outer end portion of the spring into a straight tangential line at one side of the coil, and to press the underlying coils radially inwardly toward the axis. This radial inward force crowds the underlying coils of the spring against each other into binding contact and produces friction as the contacting portions slide by each other during winding and unwinding operations.

One of the objects of the present invention is to provide an improved construction in a power spring assembly which materially reduces binding and friction between adjacent coils during winding or unwinding.

Another object is to provide an improved power spring assembly which permits springs of different lengths to be used with the same arbor and barrel without excessive binding or friction.

Another object is to provide an improved construction in power spring assemblies by which the coils of the springs are confined to facilitate handling and mounting in the apparatus with which they are used.

Still another object is to provide a power spring of the type indicated which is of simple and compact construction, economical to manufacture, safe and reliable in operation and one which opposes the effect of gravity which tends to produce binding and friction in certain installations.

These and other objects will become more apparent from the following description and drawing in which like reference characters denote like parts throughout the several views. It is to be expressly understood, however, that the drawing is for the purpose of illustration only and is not a definition of the limits of the invention, reference being had for this purpose to the appended claims.

In the drawing:

FIGURE 1 is a plan view of a power spring assembly incorporating the present invention and showing the enclosing resilient band deformed in the barrel housing to oppose the force tending to crowd the coils toward the arbor;

FIGURE 2 is a sectional view on the line 2—2 of FIGURE 1 and showing the arrangement of the spring in the barrel;

FIGURE 3 is a view similar to FIGURE 1 showing the spacing of the coils with the spring partly unwound;

FIGURE 4 is a perspective view of the spring contained within its enclosing band or keeper; and

FIGURE 5 is a view similar to FIGURE 3 showing a spring of different construction tightly wound on the arbor.

The power spring assemblies of the present invention may have many different applications, and each comprises a self-contained helically-coiled spring enclosed in an outer flexible band which confines the inner coils when expanded or unwound. The self-contained spring unit is mounted between relatively rotatable parts for storing energy, the parts being relatively rotated in one direction to wind the spring, and delivering the stored energy by rotating one of the parts when the spring unwinds. The relatively rotatable parts may comprise a rotatable arbor at the axis of the assembly and stationary means for anchoring the enclosing band; or it may comprise a stationary arbor and a rotatable means for anchoring the enclosing band; or, it may comprise two rotatable parts or means. In any case, the inner end of the spring is connected to the arbor and the enclosing band is anchored to the other relatively rotatable part.

In the embodiment of the invention illustrated in the drawing the power spring assembly 8 comprises a spring unit 9, an axial spindle 10 projecting from a stationary support 11, and a relatively rotatable part in the form of a barrel 12 mounted to rotate on the spindle. Barrel 12 has a base plate 13 with a peripheral flange 14 concentric with spindle 10 and forming an annular chamber 15 within which spring unit 9 is positioned. A boss 16 depends from base plate 13 of barrel 12 and surrounds the spindle 10 to form a bearing. The lower end of boss 16 rests on the stationary support 11 to provide the rotary mounting for barrel 12 for rotation relative to spindle 10.

An arbor 17 is mounted upon and fixed to spindle 10 to provide a cylindrical surface upon which spring unit 9 is wound. Arbor 17 is notched to provide a shoulder 18 to which the inner end of the spring unit is anchored, and barrel 12 has a notch or slot 19 to which the outer end of the spring unit is anchored.

Spring unit 9 is a single piece or length of a steel spring strip formed into a helical spring 20 and its enclosing and confining band 21. A rivet 25 holds the band 21 together with the spring 20 extending counter-clockwise from the rivet, and with the end portion 24 of the strip extending tangentially from the band. The inner end of spring 20 is bent into a hook 22 by which it is anchored to shoulder 18 on arbor 17. The tangential outer end portion 24 of the strip is bent into an anchor portion 23 which is positioned within a slot 19 of barrel 12 so as to anchor band 21 and the outer end of spring 20 to the barrel. Anchor portion 23 is formed by a semi-cylindrical reverse bend 28 and an end loop or bead 26 which presents a curved surface which rests upon the side surface 27 of slot 19.

Surface 27 is at substantially right angles to the longitudinal extent of the end portion 24. Hence, the anchor portion 23 cooperates with the slot to provide a secure anchor for the outer end of the spring unit, and yet the anchor portion 23 may rock or swing with respect to the slot surfaces, and no part of the anchor portion is subjected to objectionable flexing. Barrel 12 is turned to wind spring 20, thus to store energy and the stored energy is delivered to turn the barrel in the opposite direction when the spring unwinds.

The enclosing band 21 acts as a keeper to confine the coils of spring 20, thus to adapt the entire spring unit 9 for easy and quick mounting in and removal from barrel 12 without danger of sudden expansion of the wound coils. In addition, the enclosing band 21 flexes and deforms during winding and unwinding of the spring to produce an outward force on the outermost free coil

of the spring, which force opposes the tension force which normally crowds the underlying coils toward the arbor 17 and into binding engagement. Hence, spring unit 9 operates automatically to prevent binding between adjacent coils of spring 20 as it is wound and unwound, and that action reduces the friction between the adjacent coils.

As indicated above, spring 20 comprises a strip of resilient material, e.g., spring steel, which is wound into a helical coil as shown in FIGURES 1 and 4. In the illustrated embodiment, the overlapping portions of the outermost coil are attached by a suitable fastening means to form the enclosing band of keeper 21 with the end portion 24 extending substantially tangent to the band beyond the fastening means for attachment to the barrel 12. Under some circumstances, the overlapping portions of the spring strip may be attached by spot welding or by another suitable fastener.

The overlapping portions of the outer coils are attached during manufacture by producing holes in the flat strip at spaced points therealong to form the band or keeper 21 of the required diameter to properly fit in the barrel 12. The strip is then wound on a mandrel or suitable fixture. The outer coil of the spring is so wound as to align the spaced holes and then the rivet 25 is inserted through the aligned holes and headed to attach the overlapping portions and form the enclosing band 21. When the spring is unwound, the inner coils expand radially outward against each other and the band or keeper 21 to provide a self contained spring unit. The inner and outer ends of the spring 17 also are formed to provide the enlarged anchoring abutments 22 and 23 as by folding the end portions of the spring back on itself.

The self contained spring unit 9 with the inner coils confined by the band 21 is then inserted into the annular chamber 15 of the barrel 12. The enlarged abutment 22 at the inner end of the spring is anchored to the shoulder 18 on the arbor 17 and the extension 24 is positioned in the slot 19 in the peripheral wall 18 of the barrel 12 so that the enlarged abutment 23 at its terminal end is anchored to the wall. With this construction, the extension or outer end portion 24 extends tangential to band 21, and is free to pivot about its anchored end.

Furthermore, the spring unit 9 and barrel 12 are so constructed and arranged that the enclosing flexible band 21 engages the peripheral flange 14 of barrel 12 at a single zone and is positioned eccentrically therein with sufficient space therebetween to permit the band to freely flex. The end portion 24 extends from its anchored end 23 to the point of attachment with the band 21 at rivet 25, through an arc of less than 90° of the circular band, and extends tangent to the band in all operative positions. Theoretically, the band 21 initially engages the peripheral flange 14 of the barrel at substantially a single point diametrically opposite rivet 25. In practice, the flexible band 21 is somewhat deformed due to the initial tension applied to the band by the extension 24 at its point of attachment 25 so that there is a zone of contact between band 21 and flange 14.

When the barrel 12 is rotated clockwise relative to the arbor 17, as viewed in FIGURE 1, the inner coils of the spring 20 wind tightly around the arbor 17. During such winding, the end of the outer free coil of the spring 20 which is attached to the band 21 by rivet 25 is tensioned and tends to force the underlying coils toward the arbor 17 at a zone centered 90° away from the point of attachment of the band. This tension is applied to the band 21 at the point of its connection at rivet 25 and is opposed by the anchored end 23 of the extension or end portion 24. These opposed forces, acting on the band 21 at the point of connection by rivet 25, deform the band (FIGURE 1) against the peripheral wall or flange 14 of the barrel 12 at the side opposite the point of connection, and flex the band to a flattened condition at and through the point of connection. Because the side of the band 21 is flattened at its point of connection at rivet 25 and the end of the outer coil of the spring is attached to band 21 at rivet 25, the end of the outer free coil adjacent the point of connection is flattened to a curve of greater radius. This tends to draw or warp each outer coil radially outward away from the next adjacent coil. The tension force tending to pull the end portion of the outer coil radially inward and the opposing force tending to move the coil radially outward are in equilibrium when each outer free coil is spaced slightly from the next adjacent coil. The radial outward force applied to the end portion of each outer free coil is transmitted to the adjacent coil throughout the spring to maintain the successive coils spaced from each other. As the winding continues, the tension force at the outer free coil progressively increases and progressively deforms the band 21 to further flatten the attached portion of the band to a curve of greater radius to oppose the increased tension and hold the coils in spaced relation until the spring is fully wound as illustrated in FIGURE 1.

The diameter of band 21 relative to the diameter of the chamber 15 in barrel 12 and the length of end portion 24 from the point of connection at rivet 25 is so proportioned for any spring of a particular thickness and resistence to bending that the band and adjacent spring coil will flex sufficiently to space each outer free coil from the next adjacent coil. Furthermore, the point of connection at rivet 25 is so arranged with respect to the length of the extension 24 that the extension is always positioned substantially tangent to the band 21 as the latter flexes from a curve of smaller radius at the outer periphery of the unwound spring to the curve of larger radius when the band is deformed to its inner position adjacent the tightly wound spring.

As the spring unwinds, the same forces are applied to the end portion of spring 20 adjacent the band 21 to hold it spaced from the next adjacent coil. As the tension on the outer coil decreases during unwinding the band 21 flexes back toward its normal circular form, but always maintains the force required to oppose crowding of the underlying coils toward the arbor 17. Thus, binding of adjacent coils and the friction produced thereby are eliminated during both winding and unwinding of the spring 20.

While the flexible band 21 is illustrated as a continuation of spring 20 in the illustrated embodiment, it will be understood that the band may comprise a separate element to which the end of the spring is connected by the fastening means. Also, it will be apparent that other forms of housing may be used having means for anchoring the end of the extension 24 for pivotal movement and an abutment opposite the fastening means 25 to provide a reactive force against which the band 21 is deformed. In other words, the housing need not include the continuous peripheral flange 14 as illustrated.

In the embodiment of FIGURE 5, the tangential extension from the band 44 is a loop 40 of the spring material anchored to a post 41 projecting upwardly from the base plate 43 of the barrel 42. With this form of construction three holes are initially formed in the end portion of the spring strip. The end of the spring is then folded back on itself to align two of the holes and form the loop 40 and the spring wound to align these holes with the third hole to form a flexible band 44. A single rivet 45 is then passed through the aligned holes to form the self contained spring unit. Thus, a single rivet is used to provide a looped end construction as well as the flexible band 44. With this construction the looped extension 40 pivots on the post 41, extends substantially tangent to the periphery of the band 44 in both the wound and unwound positions of the spring and flexes inwardly from the outer periphery of the wound spring to progressively flatten the side adjacent the outer coil to a curve of greater radius to hold the outer coil in spaced relation to the next adjacent coil.

While the above description has been directed to a construction in which the central arbor **17** is fixed and the barrel **12** rotates; it will be understood that the barrel **12** may be fixed and the arbor **17** rotated relative to the barrel. Such rotating arbor constructions are particularly adapted for use in tool balances, reels, timers and the like having especially long springs **20**. For example, the barrel **12** of the power spring used as a tool balancer is mounted in a vertical plane on a fixed support and a cord reel is attached to the rotating arbor **17**. The tool is supported by the reel cord so that it may be drawn toward the workpiece where it is to be used, usually from overhead, and then moved away from the workpiece when not in use. The spring construction of the present invention is particularly useful in such installations for opposing the effect of gravity on the successive overlying coils of the spring **20** tending to move the coils toward the arbor **17** and bear on the underlying coils to produce binding and friction. In such applications the point of connection, rivet **25** between the band **21** and outer coil of spring **20**, is positioned on a vertical axis so that the tension applied to the outer coil by the retaining band **21** tends to warp the outer coil in a curve having a long radius to oppose gravity tending to warp the coil toward the axis. This tension produced by the deformed band **21** is transmitted from the outer coil to the successive inner coils as previously explained to reduce binding due to gravity. In such installations the size of the retaining band **21** and spring **20** are so designed as to counteract the effect of tension as well as gravity.

It will now be observed that the present invention provides a power spring assembly which materially reduces binding and friction between adjacent coils during winding or unwinding operations. It will also be observed that the present invention provides a power spring unit of improved construction which confines the coils of the spring within a peripheral band or keeper to facilitate mounting the spring in and removing the spring from the assembly of elements with which it is used. It will still further be observed that the present invention provides a power spring assembly of the type indicated which is of simple and compact construction, adapted for economical manufacture and one which is safe and reliable in operation.

While only two embodiments of the invention are herein illustrated and described, it will be understood that changes may be made in the construction and arrangement of elements without departing from the spirit or scope of the invention. Therefore, without limitation in this respect, the invention is defined by the following claims:

I claim:

1. In a power spring of the spiral type which is adapted to be wound from an expanded to a tightly coiled condition around a central arbor, the combination of a resilient retaining ring, a spiral spring enclosed within said retaining ring and held thereby in its expanded condition with its outer end attached to said retaining ring, a central arbor attached to the inner end of said spring, anchor means exterior of said retaining ring and spaced radially outwardly therefrom, said central arbor and anchor means being relatively rotatable to wind the spring in a tight coil around the arbor, an elongated attaching means extending from the retaining ring at its point of attachment to the outer coil of the spring and having a looped end attached to said anchor means for pivotal rocking movement thereon, said point at which the looped end of the extension is anchored being related to its point of attachment to the retaining ring so that the extension at all times extends substantially tangent to said retaining ring at its point of attachment to the spring, and anvil means exterior of said retaining ring and adapted to be engaged thereby diametrically opposite said zone of tangency whereby said retaining ring is flexed and deformed between said point of tangency and the anvil means during the winding of the spring on the arbor to progressively flatten the surface of the ring and produce a force on the outer coil to hold it spaced from the next adjacent coil.

2. A power spring assembly comprising an axial arbor, a relatively rotatable member, a spring comprising a strip of resilient material wound helically to provide successive coils positioned one within the other between the arbor and relatively rotatable member, means connecting overlapping portions of the outer coil to form a fixed resilient band at the outer periphery of the spring with an extension projecting from the connecting means, anchoring means for connecting the inner end of the spring to the arbor and end of the extension to the relatively rotatable member, respectively, said means connecting the end of the extension and member having a structure to provide a pivotal connection, said relatively rotatable member having an abutment opposite the connecting means engaged by the periphery of the band, said anchoring means and connecting means being so located with respect to the abutment and said extension projecting from the connecting means being of such length as to at all times position the extension substantially straight between the anchoring and connecting means and substantially tangent to the outer periphery of the spring, and said band being deformed and compressed by the tension on the connecting means as the spring is wound on the arbor to flex the band and move the connecting means radially inward relative to the abutment from a circular contour at the outer periphery of the unwound spring to a flattened contour at the periphery of the spring when tightly wound on the spindle.

3. A power spring of the type having its opposite ends connected to a central arbor and outer concentric housing rotatable relative to each other comprising a strip of resilient material wound helically to provide successive coils positioned one within the other, means connecting overlapping portions of the outer coil to form a resilient band at the outer periphery of the spring with an extension projecting tangentially from the band at the connecting means, means at the ends of the spring and extension for connection to the arbor and housing, respectively, said means connecting the end of the extension to the housing providing a pivot about which the extension rocks, and said housing, band and length of the extension being so related that the extension at all times is positioned substantially tangent to the band at the point of connection of the overlapping portions and the band is free to flex inwardly from the outer periphery of the unwound spring to the periphery of the wound spring in a flattened curve whereby to produce a radial outward thrust on the coil of the spring adjacent the band to avoid binding of adjacent coils.

4. A power spring assembly in accordance with claim 2 in which one of the relatively rotatable members is a barrel having a cylindrical recess for receiving the spring and a peripheral wall forming the abutment engaged by the band, and the peripheral wall of the barrel being of sufficient diameter to permit the band to flex to a flattened condition across the cylindrical recess in the barrel to a position adjacent the periphery of the spring when tightly wound on the arbor.

5. A power spring assembly in accordance with claim 2 in which the extension extends through an arc around the arbor of less than ninety degrees, and the abutment opposite the connecting means controlling the deformation of the band and curvature of the outer coil of the spring.

6. A power spring assembly in accordance with claim 2 in which the extension of the spring is folded back on itself to form a loop, the end of the spring being positioned between the overlapping connected portions of the outer coil, the connecting means attaching the overlapping portions and end of the spring to form a loop, and an anchoring post on the housing parallel to the axis of the arbor and engaging the inside of the looped end of the spring.

7. A power spring assembly in accordance with claim 6 in which the connecting means is a single rivet extending through the overlapping portions of the outer coil and end of the spring positioned therebetween.

8. A power spring assembly in accordance with claim 7 in which the anchoring post on the housing and rivet lie in a line substantially tangent to the outer periphery of the flexible band.

References Cited in the file of this patent

UNITED STATES PATENTS

950,848	Gardner	Mar. 1, 1910
1,478,173	Clark	Dec. 18, 1923
1,964,280	Witchger	June 26, 1934