May 8, 1962 E. E. FOSTER 3,033,316

LOW GRADIENT SPRINGS AND SPRING MOTORS USING THE SAME

Filed Oct. 20, 1958 5 Sheets-Sheet 1

Fig. 1

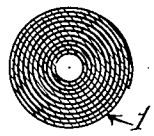


Fig. 1a.

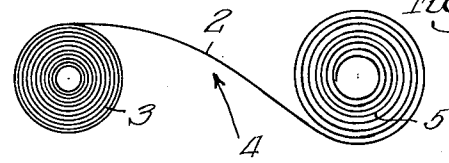


Fig. 2

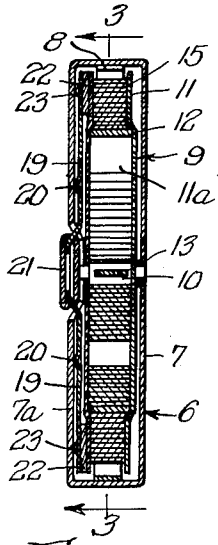


Fig. 3

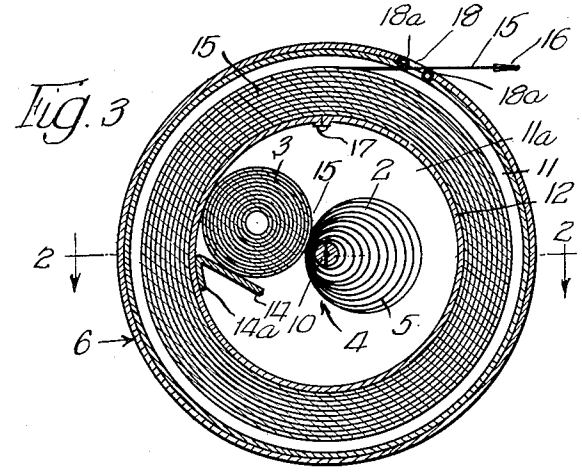


Fig. 5.

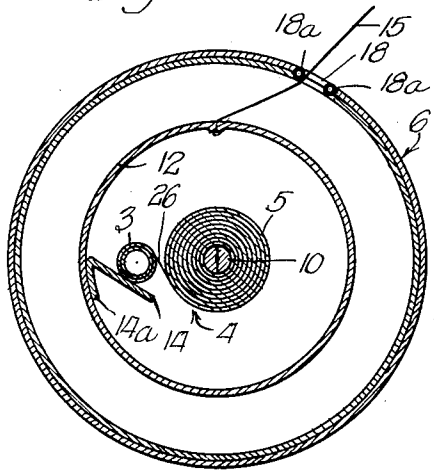
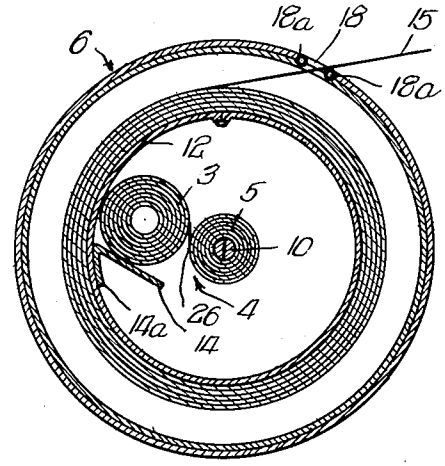


Fig. 4



INVENTOR.

Edwin E. Foster,

BY

Byron, Hume, Groom + Clement.

Attys.

May 8, 1962 E. E. FOSTER 3,033,316

LOW GRADIENT SPRINGS AND SPRING MOTORS USING THE SAME

Filed Oct. 20, 1958 5 Sheets-Sheet 2

Fig. 6

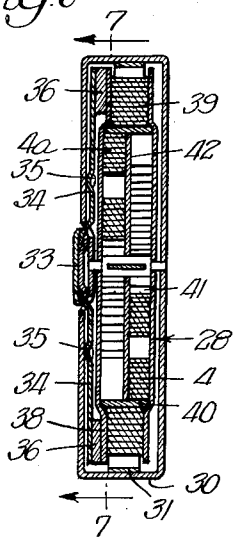


Fig. 7

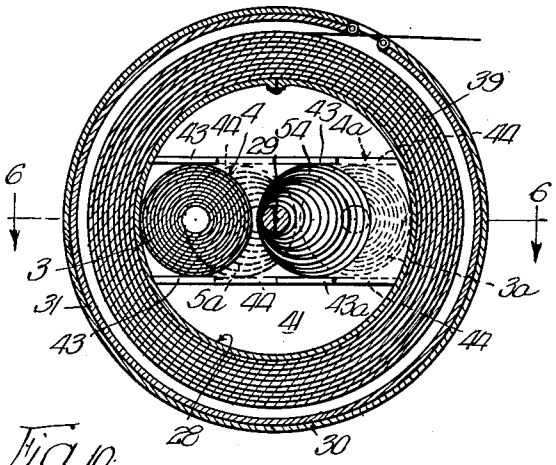


Fig. 10

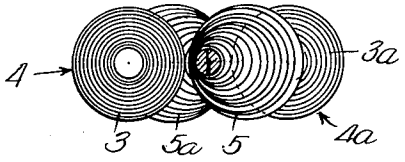


Fig. 9

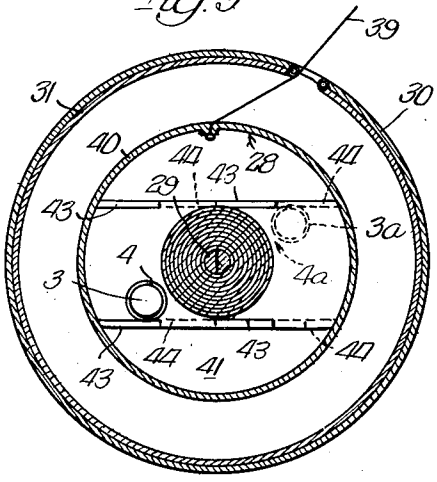
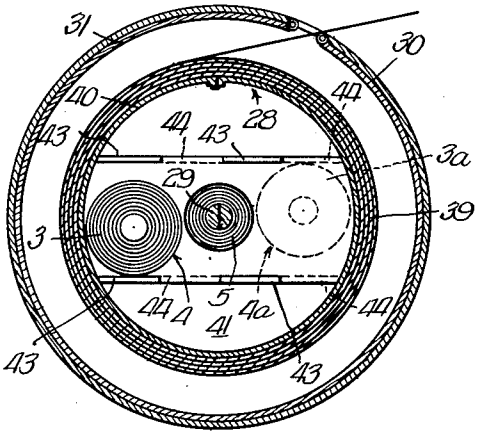


Fig. 8



INVENTOR.
Edwin E. Foster,
BY
Byron, Hume, Brown & Clement.
Attys.

May 8, 1962 E. E. FOSTER 3,033,316

LOW GRADIENT SPRINGS AND SPRING MOTORS USING THE SAME

Filed Oct. 20, 1958 5 Sheets-Sheet 3

Fig. 11

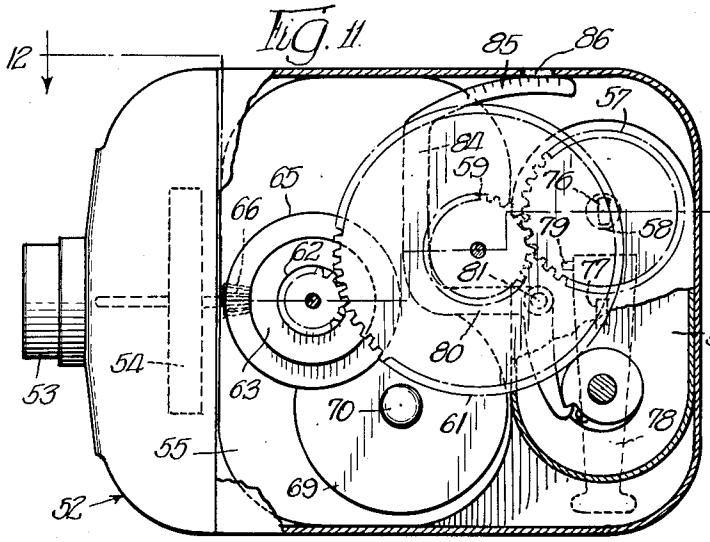


Fig. 13

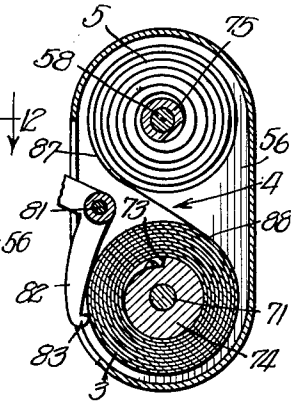


Fig. 12

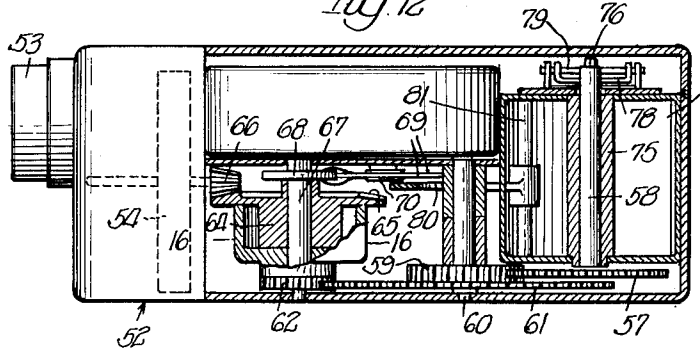


Fig. 14

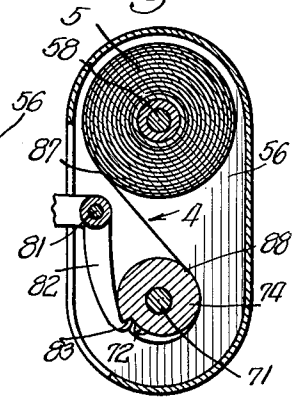


Fig. 15

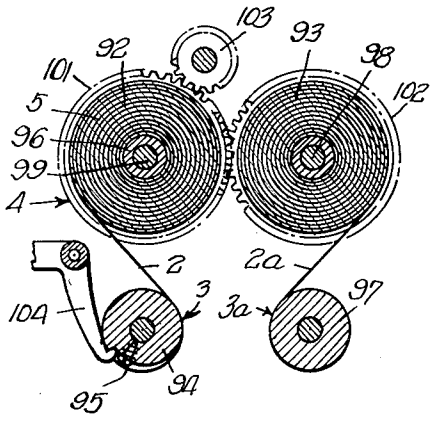


Fig. 16

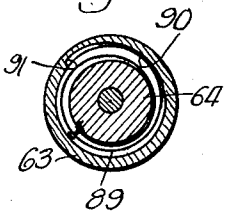
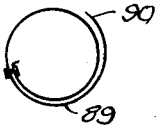


Fig. 17



INVENTOR.
Edwin E. Foster,
BY
Byron, Hume, Thorn + Clement
attys.

May 8, 1962 E. E. FOSTER 3,033,316

LOW GRADIENT SPRINGS AND SPRING MOTORS USING THE SAME

Filed Oct. 20, 1958 5 Sheets-Sheet 4

Fig. 19

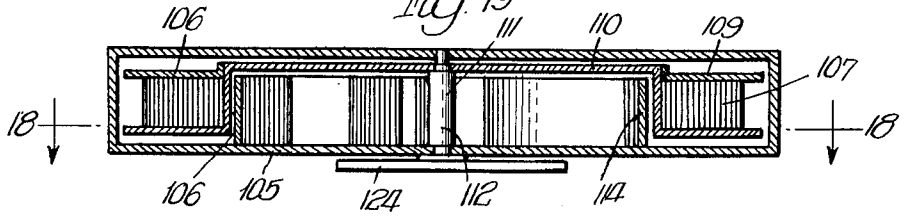
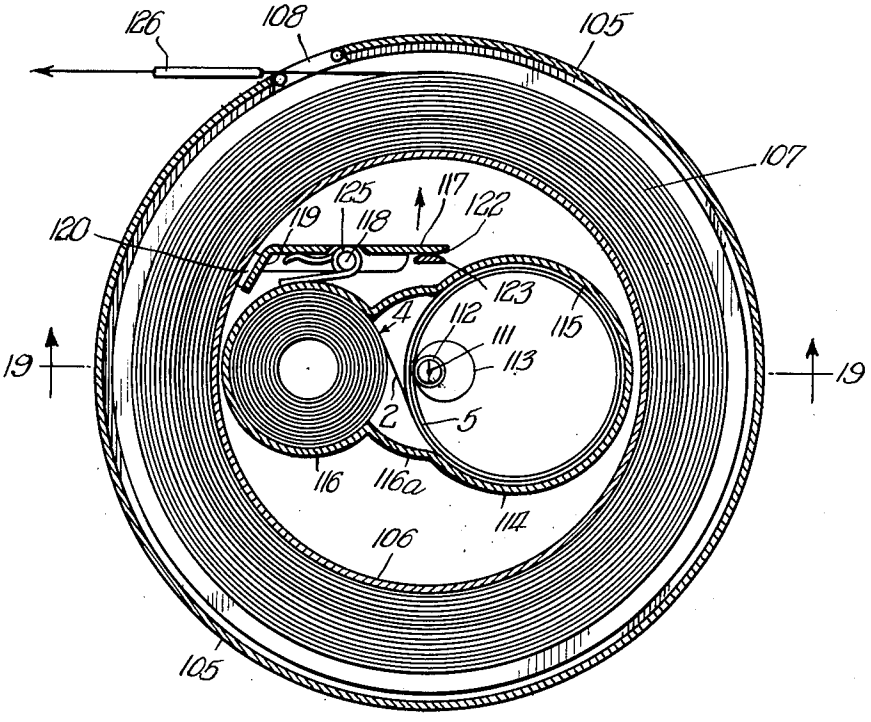


Fig. 18



INVENTOR.
Edwin E. Foster,
BY
Byron, Hunn, Brown & Clement
attys.

May 8, 1962 E. E. FOSTER 3,033,316

LOW GRADIENT SPRINGS AND SPRING MOTORS USING THE SAME

Filed Oct. 20, 1958 5 Sheets-Sheet 5

Fig. 20

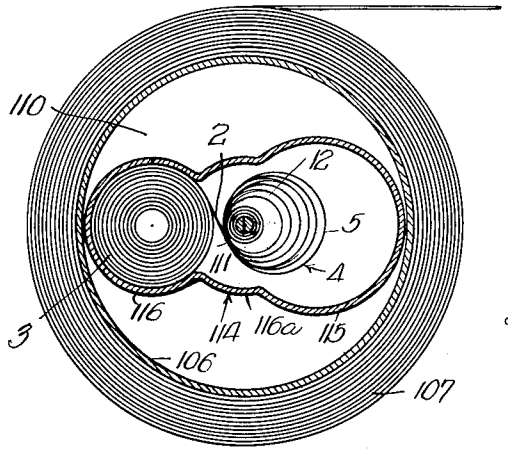


Fig. 21

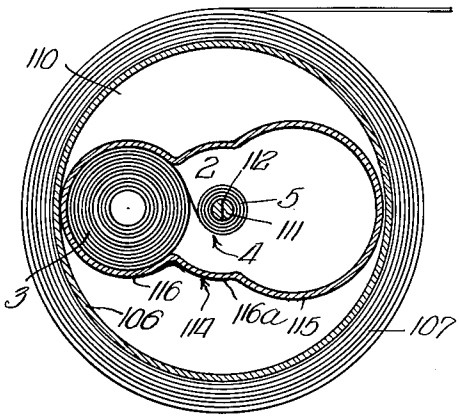
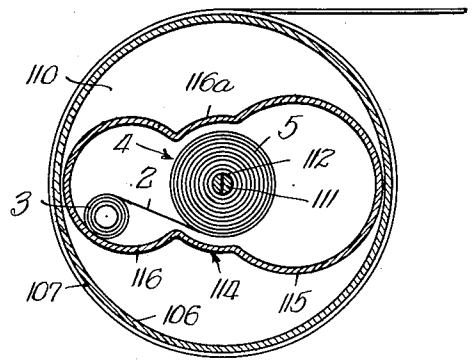


Fig. 22



INVENTOR.
Edwin E. Foster,
BY
Byron, Hume, Dorn & Clement
Attys.

United States Patent Office 3,033,316 Patented May 8, 1962

3,033,316

LOW GRADIENT SPRINGS AND SPRING MOTORS USING THE SAME

Edwin E. Foster, 2316 W. 7th St., Austin, Tex.

Filed Oct. 20, 1958, Ser. No. 768,496
16 Claims. (Cl. 185—37)

This invention pertains to spiral springs and spiral spring motors and in particular to spiral springs and spiral spring motors especially suited for use in tape measures, cameras, and the like. This application is a continuation-in-part of my application Serial No. 569,417, filed March 5, 1956, entitled, "Low Gradient Spring Motors for Tape Measures, Movie Cameras, and the like," now abandoned.

A serious limitation encountered by the manufacturers of tape measures and the like is the size of the spring motor used as a power source. In the ordinary 6 and 12 foot tape measures, the conventional spiral springs have been quite successful. In the longer tape measures, however, it becomes increasingly difficult to provide a spring motor that is of a size to be practical. In fact, in the 50 and 100 foot tapes the size of the spring motor when using a conventional spiral spring is so large that a spring driven tape of these lengths is extremely impractical. As a result it is the practice to construct tapes of these lengths with a manual rewind mechanism.

In movie cameras the same limitation has been encountered. In other words, the amount of film that can be wound with a single winding is limited by the size of the spring motor used in the camera.

For these reasons a foremost object and feature of the invention is the provision of a coil spring which will permit the construction of a spring motor that will wind a much greater length of a ribbon, such as a tape measure or a film strip, for a given length of spring ribbon than heretofore possible.

Another object of the invention is the provision of a spring motor which will wind a much greater length of ribbon such as a tape measure or a film strip, than a conventional spring motor of the same size.

Another object of the invention is the provision of a coil spring which can be used with a relatively small diameter power shaft so that a relatively short length of spring ribbon will rotate the power shaft or a reel mounted thereon a relatively large number of revolutions.

Another object of the invention is the provision of a coil spring which permits the construction of a spring motor in which a much greater percentage of the motor casing is used as actual working area for the coil spring than is possible with heretofore known springs.

Another object of the invention is the provision of a coil spring which eliminates the necessity of providing a power shaft of a relatively large diameter in order not to exceed the elastic limit of the portion of the coil spring backwound on the power shaft.

Another object of the invention is the provision of a coil spring which permits the construction of a spring motor having a much smaller casing for housing the coil spring than possible with heretofore known springs.

Another object of the invention is the provision of a spiral spring that is especially suited to be used in a spring motor.

Another object of the invention is the provision of a spring motor especially suited for use in the construction of a tape measure.

Another object of the invention is the provision of a spring motor which is especially suited for use in the construction of a movie camera.

Another object of the invention is the provision of a coil spring and a spring motor in which the coil spring is used, which are of a novel construction.

A still further object of the invention resides in the provision of a coil spring which is especially suited to be coupled with similar coil springs so as to provide a spring motor having a relatively large spring force.

These and other objects of the invention will be apparent upon reading of the specification with reference to the drawings.

In the drawings:

FIGURE 1 is a side elevation of a known spring which may be used in the construction of the coil spring and spring motor embodying the invention;

FIGURE 1*a* is a side elevation showing a coil spring embodying the invention;

FIGURE 2 is a cross-section taken through the tape measure on the line **2—2** of FIGURE 3;

FIGURE 3 is a sectional view of the tape measure showing the spring motor including the coil spring shown in FIGURE 1*a*, taken on line **3—3** of FIGURE 2 showing the tape completely retained on its reel;

FIGURE 4 is a view similar to FIGURE 3 showing the tape pulled out about one-half of its length;

FIGURE 5 is a view similar to FIGURES 3 and 4 showing the tape completely unwound from its reel;

FIGURE 6 is a cross-sectional view of a modified measuring tape taken on line **6—6** of FIGURE 7 in the direction of the arrows;

FIGURE 7 is a sectional view of the tape measure taken on line **7—7** of FIGURE 6 in the direction of the arrows and showing the tape completely retrieved and on its reel;

FIGURE 8 is a view similar to FIGURE 7 showing the tape pulled out about one-half of its length;

FIGURE 9 is a view similar to FIGURES 7 and 8 showing the tape entirely pulled out of the housing;

FIGURE 10 is a side elevation showing a detail of the springs;

FIGURE 11 is a side elevation of a further modified structure in which the spring motor is applied in a film camera;

FIGURE 12 is a cross-section taken on line **12—12** of FIGURE 11 in the direction of the arrows;

FIGURES 13 and 14 are side views of the spring motor in two different positions;

FIGURE 15 is a side view of a modified spring motor;

FIGURE 16 is a cross-section of a detail of the slip clutch taken on line **16—16** of FIGURE 12;

FIGURE 17 is an end view of a spring detail of the clutch of FIGURE 16;

FIGURE 18 is a cross-section of another modified tape measure taken on line **18—18** of FIGURE 19 in the direction of the arrows;

FIGURE 19 is a cross-section of the tape measure taken on line **19—19** of FIGURE 18 in the direction of the arrows; and

FIGURES 20 to 22 are cross-sectional views of a portion of the tape measure of FIGURE 18 showing three different positions of the spring as compared with the amount of the tape pulled out from the reel.

Referring now to FIGURE 1, there is shown a coil spring generally denoted by the numeral **1** composed of a spring ribbon internally stressed to form a plurality of tight convolutions when in repose. This type of coil spring is especially suited for the construction of the spring embodying the invention shown in FIGURE 1*a* and is shown in my Patent No. 2,609,191 issued September 2, 1952, although other types of coil springs may be used. The spring **1** is characterized as having high residual stresses which result in the tightly wound configuration shown in FIGURE 5. When the spring ribbon **2** is backwound from its reposed condition, the residual stresses tend to offset the stresses induced by the backwinding. By offsetting the backwinding stresses with the residual

stresses, a relatively large amount of backwinding stress can be imparted to the spring ribbon **2** without exceeding its elastic limit. As long as the elastic limit is not exceeded, the backwound portion of the spring ribbon when unrestrained will return to the forwardly wound reposed condition. However, if the elastic limit is exceeded, the backwound portion when unrestrained will remain in the backwound position or at least not return to the tightly wound configuration.

One method of exceeding the elastic limit is to backwind the spring ribbon **2** on a relatively small drum or mandrel so that a relatively large amount of stress is imparted to the ribbon. If the drum is small enough, the elastic limit will be exceeded for at least part of the ribbon. As the spring ribbon **2** builds upon the drum, the stresses induced by the backwinding will be diminished due to the increased radius of curvature so that they may fall below the level necessary to exceed the elastic limit. If that is the case, then the portion of the spring ribbon in which the elastic limit was exceeded will remain in the backwound condition on the drum and the portion in which the elastic limit was not exceeded will return to the forwardly wound condition the same as that shown in FIGURE 1*a*, when the spring ribbon is unrestrained from the drum. The relative amounts of the spring ribbon in the forward wound and backwound positions depend upon the relationship of the residual stresses to the stresses induced by the backwinding. If the residual stresses are small, then the stresses needed to exceed the elastic limit are proportionately less than if the residual stresses are large. It would follow then that the proportion of the spring ribbon in which the elastic limit is exceeded depends upon the magnitude of the residual stresses and the size of the drum on which it is backwound.

An example of the spring ribbon **2** which has been backwound and in which the elastic limit of the spring has been exceeded for a portion of its length is shown in repose in FIGURE 1*a*. The spring ribbon **2**, for a portion of its length when in repose, forms a forwardly wound coil **3** consisting of a plurality of tightly wound convolutions connected by a short length of spring ribbon to a backwound coil **5** formed by the remainder of the ribbon. This entire unit, consisting of the coils **3** and **5**, will hereinafter be referred to as a coil spring generally denoted by the numeral **4**. It should be further pointed out that the forwardly wound coil and the backwound coil will be designated throughout the specification by the numerals **3** and **5**, respectively, even in figures showing the coil spring **4** in a partially or fully wound condition in which a part of the spring ribbon **2** normally forming the coil **3** is wound on the coil **5**.

In order to fully appreciate the invention, the following is a brief discussion of two of the prior art springs that have been used in measuring tapes. Heretofore it has been proposed to use a coil spring in which the entire spring ribbon is backwound from its forwardly wound condition without exceeding the elastic limit and is allowed to return to its forwardly wound condition to obtain the desired driving action. In order to remain within the elastic limit when in the backwound condition, it was necessary to use a shaft or drum of relatively large diameter. This construction has two disadvantages which are overcome by the invention. Firstly, the space filled by the drum is wasted since it cannot be used as working space for the coiled spring and consequently results in a somewhat larger casing for the spring motor. Secondly, the increment of spring ribbon required to rotate for a single revolution the drum or a reel rotatably mounted thereon, is considerably longer than that required to rotate a shaft or drum of a smaller diameter. By using a small diameter shaft such as that shown in FIGURE 3 and designated by the numeral **10**, it is possible to use a much shorter length of spring ribbon.

A second type of spring used in construction of tape measures is a spring commonly called a clock spring.

This spring generates its energy by expanding from a tightly wound coil of relatively small diameter mounted on a power shaft to a loosely wound coil of a much greater diameter. In order for such a spring to provide sufficient energy to wind a 100 foot tape or even a 50 foot tape, it would be necessary to use a spring ribbon of considerable length. Moreover, it would be necessary to provide a motor casing of exceptionally large diameter in order to allow such a spring to expand to its unwound condition.

Referring now to FIGURES 2, 3, 4, and 5, there is shown the coil spring **4** mounted in a tape measure. The tape measure is composed of a casing **6** consisting of two housing members **7** and **7***a* secured together by means of an internal collar **8**, and a reel member **9** rotatably mounted on a stationary pin or shaft **10**. The reel **9** has two annular chambers **11** and **11***a* separated by an annular wall **12**. The coil spring **4** is mounted in the annular chamber **11***a* with one end secured to the stationary shaft **10** by means of the slot **13**.

In order to conserve space, the coil **3** is mounted as close to the shaft **10** as possible which causes the convolutions of coil **4** to be eccentric to the shaft when the coil spring **4** is in the unwound condition, as shown in FIGURE 3 but which has no material effect on its operation. The coil **3** bears against a partition section **14** secured at **14***a* to the internal periphery of the wall **12** by some suitable means such as rivets or the like.

A tape ribbon **15** of metal or of any other suitable material is secured at its inner end **17** to the wall **12** and passes out of the casing through a slot **18** in the peripheral circumference of the casing. The outer end of the tape may be provided with a ring **16** to facilitate pulling the tape out of the casing. If desired, the edges of the slot **18** may be provided with the spaced rollers **18***a* as shown in FIGURES 3–5 so as to reduce friction when the tape is pulled out from or drawn back into the casing.

The automatic tape measure is provided with a brake device shown in FIGURE 2 in which a pair of lever arms **19** are pivotally secured by a rivet or pin **20** to the side of casing **6**. Each arm **19** is secured at one end to a press button **21** and at the other end to a disk **22** adapted to bear against the side of the reel **9**. At the outer end of each arm **19** there may be a small leaf spring **23** in order to space the arm from the side of the casing **6**.

Referring now to FIGURE 3, it can be seen that the tape **15** is completely wound onto the reel **9**. When the tape is in this position, the coil spring **4** is in an unwound condition. The coil spring **4** when in the unwound condition is preferably slightly preloaded over its repose condition as shown in FIGURE 1*a*, so as to insure complete rewinding of the tape. As was mentioned previously, the coil **3** consists of a plurality of tightly wound convolutions in which there is a certain amount of residual stress. The coil **5** is a portion of the spring ribbon which is wound in a reverse direction from the coil **3**, when in repose, so that the elastic limit has been exceeded. This portion of the spring ribbon remains on the stationary shaft **10** as shown in FIGURE 3. In the preferred embodiment approximately ⅔ of the spring ribbon **2** when in repose is in the coil **3** with the remaining ⅓ in the coil **5**. As the tape **15** is withdrawn from the casing **6**, the reel **9** is rotated in a clockwise manner. When this happens, the coil **3** rotates about the fixed shaft **10** so that the convolutions of the coil **5** are caused to tighten on the shaft **10** as shown in FIGURE 4. When approximately 50 percent of the tape has been pulled out of the casing **6**, the spring ribbon constituting the coil **5** is tightly wound on the fixed shaft **10**. If the tape **15** is further withdrawn from the casing **6**, the coil **3** continues to rotate in a clockwise manner about the fixed shaft **10**. Since the coil **5** is tightly wound around the shaft **10**, the spring ribbon **2** from the coil **3** is wound onto the convolutions already on the shaft **10** causing the coil **3** to rotate about its own axis. When the tape **15**

is completely unwound from the reel 9, substantially all of the spring ribbon is wound about the fixed shaft 10 as shown in FIGURE 5. A small section of the spring ribbon 2 remains in the coil 3, preferably enough to form at least one or more convolutions. It was pointed out previously that the total diameter of the convolutions formed by the spring ribbon in the coil 5 when tightly wound is sufficient so that the elastic limit of the spring ribbon 2 when backwound from the coil 3 is not exceeded. When it is desired to rewind the tape onto reel 9, the brake is released by pressing the button 21 so that the reel is free to rotate. When the coil spring 4 is in the condition shown in FIGURES 4 and 5, the short length 26 of spring ribbon 2 between the coils 3 and 5 tends to return to its reposed condition on the coil 3 due to the residual stresses therein, as previously described.

In order for the spring ribbon to wind on the coil 3, since the shaft 10 is stationary, the coil 3 must rotate about its own axis and about the shaft 10. As the coil 3 rotates about the shaft 10, the tape ribbon 15 is wound on the reel 9 until it reaches approximately the halfway position shown in FIGURE 4. At this point substantially all of the spring ribbon in which the elastic limit was not exceeded is wound on the coil 3. The remaining length of spring ribbon will remain on the shaft 10, as previously described. This portion of the spring ribbon would tend to move into the loosely wound convolutions shown in FIGURE 3. Since the shaft 10 is stationary, it is necessary for the reel to rotate when the convolutions in the coil 5 move outwardly, which in turn causes the tape 15 to be retrieved. When the tape 15 is completely wound on the reel 9, the convolutions are in a loosely wound condition as shown in FIGURE 3.

In this particular embodiment of the invention, it has been found that a 100 foot tape can be completely rewound by a coil spring consisting of approximately 25 feet of spring ribbon. In a coil spring of this construction the coil 5 will rewind approximately fifty percent of the tape, with the coil 3 rewinding the remaining fifty percent. As was previously mentioned, one reason the coil 5 is able to rewind fifty percent of the tape is due to the relatively small power shaft on which it is mounted.

It should also be noticed that the annular chamber 11*a* which is primarily designed to accommodate the combined diameters of the coil 3 and the shaft 10, is large enough to accommodate the expansion of the coil 5 an amount sufficient to retrieve approximately fifty percent of the spring ribbon. Furthermore, the coil 5 when formed from approximately one-third of the spring ribbon provides a drum of tightly wound convolutions of sufficient total diameter to not exceed the elastic limit of the spring ribbon from the coil 3 when backwound thereon.

It can now be seen that the coil spring as described herein will wind a much greater length of tape for a given length of spring ribbon than will conventional coil springs constructed of an equal length of spring ribbon. A direct result of this invention is that the coil spring permits the construction of a spring motor designed to provide a given amount of energy, of a much smaller overall size than heretofore possible.

Referring now to FIGURES 6–10, there is shown a modification of the tape measure previously described in which two of the coil springs 4 and 4*a* shown in FIGURE 1*a* are used in the construction of a spring motor. As shown in the drawings, the coil springs 4 and 4*a* are 180° apart and always turn in that relationship. In this manner the coil springs are counterbalanced as to the reel so as to provide a smooth operation. The coil springs 4 and 4*a* are mounted in a reel 28 rotatably mounted on a stationary shaft 29 secured in the encasing 30. The casing 30 consists of two parts secured together by means of an internal sleeve 31. As shown in FIGURE 6 the tape measure is provided with a brake device, including an operating button 33 secured to two lever arms 34, each fulcrumed at 35 to the casing 30 and provided with a friction pad or disk 36 at their ends. The pads 36 are adapted to contact the peripheral section 38 of the reel 28 when the button is in the released position. An annular wall 40 divides the reel 28 into a central spring chamber 41 and the tape receiving chamber 38. The tape receiving chamber 38 of the reel 28 is adapted to receive the tape ribbon 39 as shown in FIGURE 6.

As shown in FIGURES 6–9, the central spring chamber 41 is provided with a partition 42, mounted at right angles to the shaft 29, having a plurality of right angle flanges 43 extending in the same direction and a second plurality of right angle flanges 44 extending in the opposite direction. The partition 42 with the flanges 43 forms a housing for the coil 4, whereas the partition 42 with the flanges 44 forms a housing for the coil spring 4*a*. As shown in FIGURES 8 and 9, the coil springs 4 and 4*a* act on the flanges 43 and 44 respectively, to turn the reel 28 so as to wind the tape thereon. In FIGURE 10 the coil springs 4 and 4*a* are shown in their relative positions but removed from the reel 28. It will be noticed that the springs are in separate planes as can also be seen in FIGURE 6. In this manner the convolutions of each spring which are wound on the shaft 29 do not interfere with the convolutions of the other spring wound on the shaft 29.

The operation of the coil springs 4 and 4*a* as the tape is wound and unwound is substantially the same as that described with regard to FIGURES 1–5. As the tape 39 is pulled from the casing 30, the convolutions in the coils 5 and 5*a* are tightened on the fixed shaft 29 by the rotation of the coils 3 and 3*a*. After the midway point of the tape has been reached, the spring ribbon 2 from the coils 3 and 3*a* will then begin winding on the convolutions already formed on the fixed shaft 29. When the tape is completely pulled out as shown in FIGURE 9, substantially all of the spring ribbon 2 in both of the coiled springs 4 and 4*a* will be wound on the fixed shaft.

If the brake is released, the straight portion of the spring ribbon in both of the coiled springs will cause the coils 3 and 3*a* to rotate about the shaft 29 and in turn cause the reel 28 to rotate and thus retrieve the tape. When approximately two-thirds of the spring ribbon has been wound on the coil 3, the remaining convolutions on the fixed shaft 29 will then move outwardly on themselves into the loosely wound condition as shown in FIGURE 7.

The embodiment shown in FIGURES 6–10 permits the use of two coil springs constructed of a steel ribbon of a narrower width and thinner stock and still have a spring motor of substantially the same torque as that shown in FIGURES 1–5. At the same time, two relatively strong coil springs can be used so as to obtain a spring motor having exceptionally strong torque.

In the modification disclosed in FIGURES 11 to 17 the spring motor is applied to a picture taking camera of the motion picture film type. The camera casing 52 is provided with the usual objective lens 53, the shutter disk 54, and the film spool container 55. A spring motor casing 56 is mounted and secured in the casing adjacent the film spool container 55. The drive connection from the spring motor casing includes a gear wheel 57 mounted on a shaft 58 of the spring motor and this gear meshes with a gear 59 mounted on a spindle 60 connected to rotate with a large gear 61. This gear 61 meshes with a pinion 62 integral with a casing 63 housing a one-way clutch 64, the latter being connected to rotate a gear 65 meshing with a pinon 66. The pinion 66 is connected to operate the shutter 54. The clutch 64 is mounted to rotate on and with a shaft 67 on which a disk wheel 68 is secured to rotate with the shaft. A pair of spring disks 69 is mounted on a shaft 70, the latter being mounted to rotate one of the film reels in the container 55. The disks 69 frictionally engage the wheel 68 in the form of a slip clutch engagement.

Referring now to FIGURES 13 and 14, the motor includes the coil spring 4 substantially the same as that shown in FIGURE 1*a*. The coil 3 is mounted by means of the stop notch 73 which receives the end of the spring ribbon 2, on the sleeve 74 which in turn is secured to the rotatable shaft 71. The coil 5 is mounted on the sleeve 75 which in turn is secured to the rotatable shaft 58.

As was mentioned previously, the shaft 58 is secured to the gear 57 and is the source of power for the operation of the camera. One end of the shaft 58 has the gear 57 secured thereon and the other end has a pair of flat surfaces constituting the reduced section 76 which is adapted to receive a key opening and a crank handle 78 pivotally mounted at 79. When the handle 78 is swung upwardly from the position shown in FIGURE 11, the key slot 77 in the crank handle 78 will engage the reduced section 76. The rotation of the handle 78 will wind the spring on the sleeve 75 as shown in FIGURE 14.

In order to prevent damage to the spring upon winding, the motor is provided with a double lever 80 which is pivotally mounted on rod 81 in the casing 56. The lever 80 has an arm 82 provided with a hook 83 which is adapted to engage the notch 73 in the sleeve 74 when the spring is fully wound, as shown in FIGURE 14. This arrangement prevents damage to the end of the spring due to overwinding. The other arm 84 is in the form of an indicator 85 which may be observed through an opening 86 in the casing of the camera, as shown in FIGURE 11. The indicator relates to the operator the length of film or footage yet to be exposed.

Referring back to FIGURES 13 and 14, the operation of the spring will now be described. In FIGURE 13 the coil spring is shown in its reposed condition, comprised of the coils 3 and 5. When the spring is in the fully wound condition substantially all of the spring ribbon is wound on the sleeve 75 as shown in FIGURE 14, as described previously. When the shaft 58 is released, the portion of the spring ribbon that is normally in the coil 3 will move from the sleeve 75 onto the sleeve 74. This movement of the spring ribbon will cause the shaft 58 to rotate and in turn drive the camera. When approximately ⅔ of the spring ribbon is wound on the sleeve 74 to form coil 3, the remainder of the spring ribbon 2 on the sleeve 75 constitutes the coil 5. This remaining portion of the spring ribbon will normally remain on the sleeve 75 but will tend to move from its tightly wound condition into the loosely wound condition shown in FIGURE 13. As the coil 5 moves to the loosely wound condition, it further rotates the shaft 58 so as to operate the camera.

This spring motor has substantially the same advantages as previously described with respect to that shown in FIGURES 1–5. For example, this motor can wind an extremely long length of film strip with a relatively short length of spring ribbon. This is the result of the coil 5 being mounted on a relatively small diameter shaft so that each revolution requires a short increment of spring ribbon.

Referring now to FIGURE 15, there is shown a spring motor generally denoted by the numeral 92 comprised of the two coiled springs 3 and 3*a*. Otherwise, the spring motor 92 is substantially the same as the spring motor sown in FIGURE 13. This embodiment makes it possible to use two spring ribbons of a relatively narrow width, which together deliver the same power as the single coil spring, shown in FIGURE 13. As shown in FIGURE 15, the ends of the spring ribbons 2 and 2*a* normally associated with the coils 3 and 3*a* are secured to the sleeves 94 and 97, respectively. The other ends of the spring ribbon 2 and 2*a* are secured to the sleeves 96 and 98, which in turn are secured to the shafts 99 and 100 respectively. The shafts 99 and 100 are geared together by the gears 100 and 102. The gear 101 also meshes with the gear 103 which is the power takeoff. The operation of the coil springs 4 and 4*a* is substantially

the same as that described with regard to FIGURES 11 and 14 and will not be repeated at this time.

As shown in FIGURE 15, the sleeve 94 is provided with the arm 104 to prevent the damage of the end of the spring ribbon due to overwinding.

In FIGURES 16 and 17 there is shown one type of clutch that may be used in the construction of the camera, so as to permit the winding of the spring ribbon. A spring 89 is secured at one end to the member 64 which is adapted to drive the pinion 66 and in turn the shutter disk 54 when rotated. The member 64 is mounted in the casing 63 which is drivingly connected to the shaft on which the coil spring 4 is mounted. When the casing 63 is turned in a clockwise direction by the unwinding of the spring ribbon on the drive shaft, the notch 91 engages the end of the spring 89 so as to transmit rotation to the member 64. Conversely when the casing 63 is rotated in a counterclockwise direction due to the winding of the spring member on the power shaft, the end of the spring 89 slides over the notch 91 so as to prevent rotary contact with the member 64. This arrangement provides a suitable one-way clutch that will permit winding of the spring ribbon on the power shaft without the rotation of the shutter disk 54.

FIGURES 18–22 disclose another modification of the spring motor. This modification includes a casing 105 enclosing a rotatable reel 106 on which the steel measuring tape 107 is wound. The tape 107 projects outwardly through an opening 108 in the periphery of the casing as shown in FIGURE 18. As shown in FIGURE 19, the reel 106 has an annular section 109 in which the tape 107 is adapted to be stored. This annular section 109 is secured and mounted on a disk 110 secured to the shaft 111 and adapted to rotate therewith. The shaft 111 has a slot 112 therein which receives the end of the spring ribbon 2 as shown in FIGURE 18.

The coil spring 4 is mounted in the housing 114 having the chambers 115 and 116 connected by the intermediate chamber 116*a*. When the coil spring 4 is in its unwound or nearly reposed condition, the coil 3 is disposed in the chamber 116. The coil 5 in turn is mounted on the rotatable shaft 111 and is disposed in the housing 114 fixedly secured to the casing 105.

The tape measure, according to FIGURE 18, is provided with a brake device suitable for controlling the rewinding of the tape. The brake is in the form of a lever 117 pivotally mounted on the pin 118. One end of the lever 117 is bent downwardly and is provided with a friction pad 120 adapted to contact the inner surface of the reel 106. The other end 122 of the lever 117 projects into the path of a bar 123 connected to an actuator 124 on the outside of the casing 105. The lever 117 is biased in a clockwise direction against the inside surface of the reel 106 into braking position by the spring 125 which is mounted on the pin 118. When the lever 117 is pivoted in the counterclockwise direction, the friction disk 120 is moved out of braking position so that the reel 106 and the shaft 111 are free to rotate.

Referring now to FIGURES 20–22, there are shown diagrammatic illustrations of the coil spring 4 as it moves from the unwound to the fully wound position and vice versa. In FIGURE 20 a short length of the measuring tape has been unwound from the reel 106 so that the coil 5 has started to tighten on the rotatable shaft 111 as compared with FIGURE 18. As a greater length of the measuring tape 107 is unwound from the reel 106, the coil 5 on the shaft 111 is moved into the tightly wound condition with some of the spring ribbon from the coil 3 being wound thereon, as shown in FIGURE 21. When the tape has been completely removed, substantially all of the spring ribbon 2 is wound on the shaft 111, as shown in FIGURE 22.

If the brake were to be released at this time, the spring ribbon normally wound on the coil 3 would unwind from the shaft 111 and wind on the coil 3 in the chamber

116, as was described previously. When the spring ribbon 2 unwinds, shaft 111 is rotated which in turn rotates the reel 106 so as to retrieve the steel tape 107. When substantially all of the spring ribbon 2 that forms the coil 3 is unwound from shaft 111, the remaining convolutions of the shaft 111 then tend to move outwardly on themselves as shown in FIGURE 20. As the convolutions move into the loosely wound condition, the shaft 111 is continued to be rotated until the winding of the steel tape 107 is completed.

Although it was stated previously that substantially ⅔ of the spring ribbon constitutes the forwardly wound coil 3 and the remaining ⅓ the backwound coil 5, it is to be understood that other proportions may be used. For example, it may be desirable to use approximately 50 percent of the spring ribbon in the forwardly wound coil and the remaining 50 percent in the backwound coil. However, the specific proportions will depend upon the result desired to be obtained.

It should be further pointed out that the point between the portion in which the elastic limit has not been exceeded and the portion in which it has been exceeded will not always be clearly defined. This means that the period in which the coil 3 is in operation will overlap the period in which the coil 5 is in operation. As a result, when the last few convolutions are being wound on the coil 3, the spring ribbon normally mounted on the shaft has already started to move toward its loosely wound condition. In any event, the subject coil spring may be characterized as a coil spring in which part of its force is generated by the movement of a part of the spring ribbon from a backwound condition to a forwardly wound or reposed condition and a movement of the remaining length of the spring ribbon from a tight backwound condition to a loose backwound condition.

Although certain specific embodiments of spring motors have been disclosed, it is to be understood that these are merely examples and not to be construed as limitations. The broad characterization of these spring motors should be kept in mind when considering the scope of the invention. These spring motors may be broadly characterized as the combination of a first restraining device, a second restraining device, at least one of which is rotatably mounted, and a coil spring of the type previously described.

By restraining device is meant a device which co-operates with one of the coils of the coil spring to aid in the utilization of the energy generated by the spring as it moves from the wound to the unwound condition. Such a restraining device may take on several forms and in this particular invention it is used in combination with another restraining device associated with the other coil of the coil spring, to utilize the spring energy. For example, one form of the first restraining device is the shafts 10, 53, and 111, which are shown in FIGURES 3, 13 and 18 respectively, on which the coil 5 is mounted. The first restraining device may be nonrotatably or rotatably mounted but restrained in the latter instance from rotating by a brake or similar device.

The second restraining member may, for example, take the form of the rotatable annular chamber or drum 11*a* with the partition 14, the rotatable shaft 71, or the fixed chamber 114, as shown in FIGURES 3, 13, and 18, respectively. The second restraining members may be either nonrotatably or rotatably mounted but should in any event permit rotation of the coil 3 about its axis. The second restraining member may also permit planetary rotation of the coil 3 about the first restraining member if the latter is nonrotatably mounted, as was described with respect to the embodiment shown in FIGURES 3 to 6. If the second restraining member is rotatably mounted, it is preferably provided with some suitable braking device such as that described previously.

The coil spring 4 is then mounted so that the coil 5 is associated with the first restraining member and the coil 3 is associated with the second restraining member. After the coil spring 4 is wound and released, it will drive the first restraining member if it is rotatably mounted or the second restraining member if the first is nonrotatably mounted.

It is contemplated that certain modifications of the embodiment described herein may be made within the scope of the claims without departing from the spirit of the invention.

It is claimed:

1. A coil spring comprising a spring ribbon comprised of a first portion and a second portion, said first portion permanently stressed to form a first coil composed of a plurality of tightly wound convolutions when in repose, said second portion being wound in a reverse direction with respect to said first coil to form a second coil composed of a plurality of loosely wound convolutions when in repose.

2. A coil spring comprising a spring ribbon comprised of a first portion and a second portion, said first portion permanently stressed to form a first coil composed of a plurality of tightly wound convolutions when in repose, said second portion being wound in a reverse direction with respect to said first coil to form a second coil composed of a plurality of loosely wound convolutions when in repose, said first portion of said spring ribbon being adapted to be backwound from said first coil onto said second coil.

3. A coil spring comprising a spring ribbon comprised of a first portion and a second portion, said first portion permanently stressed to form a first coil composed of a plurality of tightly wound convolutions when in repose, said second portion being wound in a reverse direction with respect to said first coil to form a second coil composed of a plurality of loosely wound convolutions when in repose, said first portion of said spring ribbon being adapted to be backwound from said first coil onto said second coil when said second coil is wound into a plurality of substantially tightly wound convolutions, said first portion of said spring ribbon when unrestrained returning from the backwound condition to said plurality of tightly wound convolutions.

4. A coil spring comprising a first coil composed of a plurality of tightly wound convolutions when in repose, and a second coil reversely wound with respect to said first coil and being composed of a plurality of loosely wound convolutions when in repose.

5. A spring motor comprising a first restraining member, a second restraining member, at least one of said first and second restraining members being rotatably mounted, and a coil spring comprising when in repose a spring ribbon permanently stressed to form a first coil of tight convolutions and a second coil of loose convolutions reverse wound with respect to said tight convolutions, said first coil mounted on said first restraining device, said second coil mounted on said second restraining device, at least a portion of the spring ribbon comprising said first coil adapted to be backwound on said second coil.

6. A spring motor comprising a first restraining member, an annular second restraining member rotatably mounted on said first restraining member, a partition extending inwardly from the periphery of said second restraining member, and a coil spring disposed within said second restraining member comprising when in repose a spring ribbon permanently stressed to form a first coil of tightly wound convolutions, and a second coil or loosely wound convolutions mounted on said shaft member, said second coil being reversely wound with respect to said first coil, said first coil normally abutting said partition member.

7. A spring motor comprising a first restraining member, a second restraining member rotatably mounted on said first restraining member, a partition extending inwardly from the periphery of said second restraining mem-

ber, and a coil spring disposed within said second restraining member comprising when in repose a spring ribbon permanently stressed to form a first coil of tightly wound convolutions and a second coil of loosely wound convolutions, said first coil abutting said partition member, at least part of the spring ribbon from said first coil being adapted to be backwound on said second coil when said second coil is wound into a plurality of substantially tight convolutions, said spring ribbon from said first coil being adapted when unrestrained to return from said backwound condition to said first coil to rotate said second restraining member with respect to said first restraining member, said second coil being adapted to expand from said substantially tight convolutions to said loose convolutions to further rotate said second restraining member with respect to said first restraining member.

8. A spring motor comprising a shaft member, a drum member rotatably mounted on said shaft member, a partition extending inwardly from the periphery of said drum, and a coil spring disposed within said drum member comprising when in repose a spring ribbon permanently stressed to form a first coil of tightly wound convolutions, and a second coil of loosely wound convolutions mounted on said shaft member, said second coil being reversely wound with respect to said first coil, said first coil normally abutting said partition member.

9. A spring motor comprising a shaft member, a drum member rotatably mounted on said shaft member, a partition extending inwardly from the periphery of said drum, and a coil spring disposed within said drum member comprising when in repose a spring ribbon permanently stressed to form a first coil of tightly wound convolutions and a second coil of loosely wound convolutions, said first coil abutting said partition member, at least part of the spring ribbon from said first coil being adapted to be backwound on said second coil when said second coil is wound into a plurality of substantially tight convolutions, said spring ribbon from said first coil being adapted when unrestrained to return from said backwound condition to said first coil to rotate said drum member with respect to said shaft member, said second coil being adapted to expand from said substantially tight convolutions to said loosely wound convolutions to further rotate said drum member with respect to said shaft member.

10. A spring motor comprising a shaft member, a drum member rotatably mounted on said shaft member, a partition extending inwardly from the periphery of said drum, and a coil spring disposed within said drum member comprising when in repose a spring ribbon permanently stressed to form a first coil of tightly wound convolutions and a second coil of loosely wound convolutions, said first coil abutting said partition member, at least part of the spring ribbon from said first coil being adapted to be backwound on said second coil when said second coil is wound into a plurality of substantially tight convolutions, said spring ribbon from said first coil being adapted when unrestrained to return from said backwound condition to said first coil to rotate said drum member with respect to said shaft member, said second coil being adapted to expand from said substantially tight convolutions to said loosely wound convolutions to further rotate said drum member with respect to said shaft member, and brake means for controlling the return of said spring ribbon from said second coil to said first coil and the expansion of said second coil from tight convolutions to said loose convolutions.

11. A spring motor comprising a first restraining member, a second restraining member, at least one of said first and second restraining members being rotatably mounted, and a coil spring comprising when in repose a spring ribbon permanently stressed to form a first coil of tight convolutions and a second coil of loose convolutions backwound with respect to said tight convolutions, said first coil mounted on said first restraining device, said second coil mounted on said second restraining device, at least a portion of the spring ribbon comprising said first coil adapted to be backwound on said second coil when said second coil is wound into a plurality of substantially tight convolutions, said spring ribbon from said first coil being adapted when unrestrained to return from said backwound condition to said first coil to rotate said rotatably mounted restraining member, said second coil being adapted to expand from said substantially tight convolutions to said loose convolutions to further rotate said rotatably mounted restraining member.

12. A spring motor of the character described in claim 11 wherein said first restraining member is rotatably mounted and said second restraining member is rotatably mounted.

13. A spring motor of the character described in claim 11 wherein said first restraining member is a rotatably mounted shaft and said second restraining member is a rotatably mounted shaft spaced from said first restraining member.

14. A spring motor of the character described in claim 11 wherein said first restraining member is rotatably mounted and said second restraining member is nonrotatably mounted.

15. A spring motor composed of at least one coil spring and first and second restraining members, said coil spring comprising when in repose a spring ribbon permanently stressed to form a first coil of tight convolutions and a second coil of loose convolutions, said first coil mounted on said first restraining member, said second coil mounted on said second restraining member, at least one of said restraining members being rotatably mounted, at least a portion of the spring ribbon comprising said first coil adapted to be backwound onto said second coil.

16. A spring motor composed of a plurality of coil springs and first and second restraining members, each of said coil springs comprising when in repose a spring ribbon permanently stressed to form a first coil of tight convolutions and a second coil of loose convolutions, said first coil mounted on said first restraining member, said second coil mounted on said second restraining member, at least one of said restraining members being rotatably mounted, at least a portion of the spring ribbon comprising said first coil adapted to be backwound onto said second coil.

References Cited in the file of this patent

UNITED STATES PATENTS

1,964,280	Witchger	June 26, 1934
2,063,799	Fornelius	Dec. 8, 1936
2,647,743	Cook	Aug. 4, 1953
2,673,694	Howell	Mar. 30, 1954
2,835,344	Allen	May 20, 1958
2,869,801	Foster	Jan. 20, 1959
2,899,193	Foster	Aug. 11, 1959
2,959,091	Richartz	Nov. 8, 1960