March 17, 1953 R. W. PALMER 2,631,639

SPRING WINDER

Filed June 13, 1947

Fig. 1.

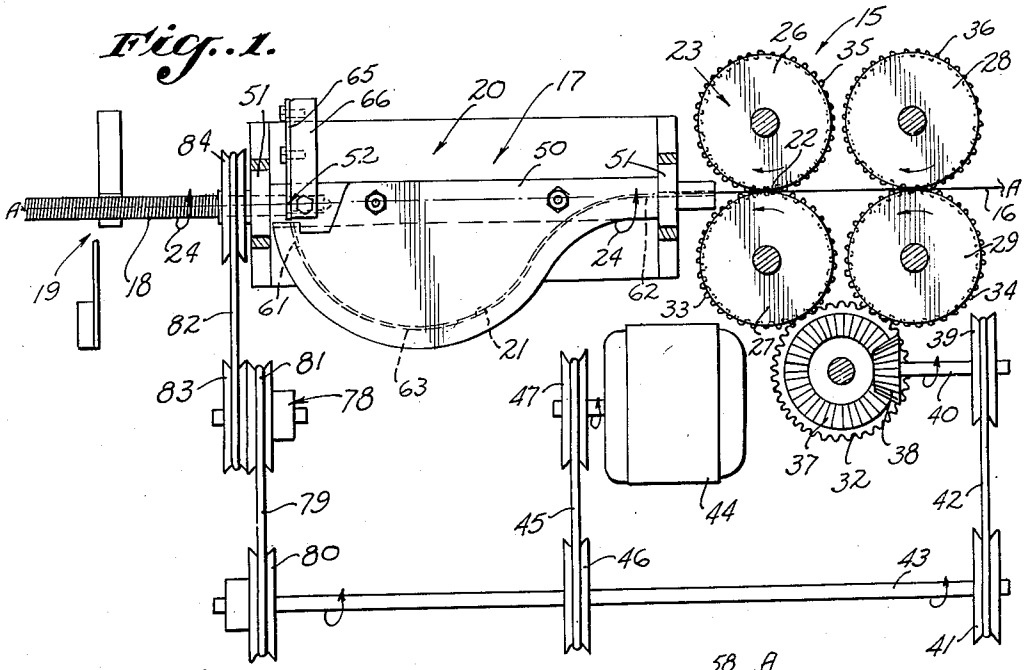

Fig. 3.

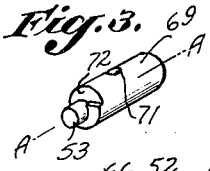

Fig. 2.

Fig. 8.

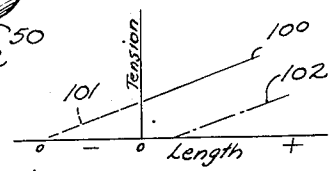

Fig. 7.

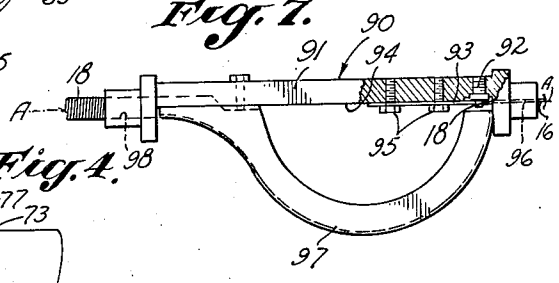

Fig. 5.

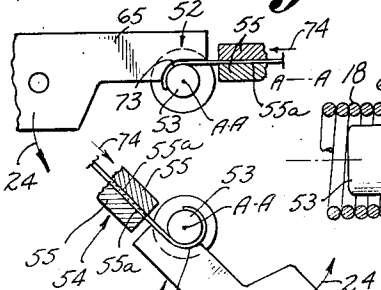

Fig. 4.

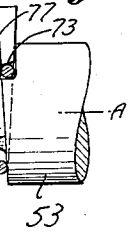

Fig. 6.

INVENTOR:
RICHARD W. PALMER;
BY HIS ATTORNEYS
HARRIS, KIECH, FOSTER & HARRIS,
BY Fad W Harris

Patented Mar. 17, 1953 2,631,639

UNITED STATES PATENT OFFICE

2,631,639

SPRING WINDER

Richard W. Palmer, Whittier, Calif.

Application June 13, 1947, Serial No. 754,335

4 Claims. (Cl. 153—65)

1

My invention relates in general to apparatus for forming wire, or the like, into coils and, more particularly, to an apparatus for forming spring wire into coil springs.

A primary object of the invention is to provide an apparatus for forming a pre-tensioned spring, i. e., a spring which is in tension when undeflected and which thus tends to shrink upon itself. Another object is to provide such a pre-tensioned spring.

Coil springs of this character may be formed by twisting the spring wire to an extent sufficient to produce a permanent set therein as the wire is coiled, an important object of my invention being to provide an apparatus which includes a simple and improved means for twisting the wire as it is fed to a coil forming means.

Another object of the invention is to provide a wire forming apparatus wherein the coil forming means is rotatable and wherein the wire is fed to the coil forming means along a path such that the rotation of the coil forming means results in twisting of the wire to the desired extent. More specifically, it is an object of the invention to provide an apparatus wherein the wire to be coiled moves along a path which extends in the direction of the axis of rotation of the coil forming means so that the coil forming means rotates the wire about the longitudinal axis of the wire as it rotates. A further object is to provide a restraining means for preventing such rotation of the wire about its own axis at a point spaced from the coil forming means so that the wire is twisted intermediate the restraining means and the coil forming means.

Still another object of the invention is to provide an apparatus of the foregoing general character wherein the coil forming means includes a rotatable arbor and includes means carried by the arbor for coiling the wire around a mandrel. A related object is to provide means carried by the arbor for rotating the wire about its own longitudinal axis as it is fed to the coiling means, the aforementioned restraining means cooperating with the wire rotating means to twist the wire.

An object in connection with one embodiment of the invention is to provide a coil forming means which comprises a mandrel whose longitudinal axis substantially coincides with the axis of rotation of the arbor, and which comprises means carried by the arbor for guiding the wire along a path having a first portion which is substantially perpendicular to the axis of rotation of the arbor and which leads to the mandrel, and having a second portion which substantially coincides with

2

the axis of rotation of the arbor, whereby the coil forming means rotates the wire about its own longitudinal axis when the arbor is rotating and cooperates with the restraining means to twist the wire.

In another embodiment of the invention it is an object to provide a coil forming means wherein the mandrel around which the wire is wound by the aforesaid coiling means on the arbor is perpendicular to the axis of rotation of the arbor so that the mandrel serves as a wire rotating means which cooperates with the restraining means to twist the wire fed to the coiling means.

A further object of the invention is to provide an apparatus for forming a continuous coil spring which may be severed into suitable lengths.

An important object is to provide a spring winder which is capable of twisting the wire to be coiled to such an extent that the resulting spring has a load-deflection curve which intersects the zero tension axis at a negative length. More specifically, it is an object to provide a spring winding apparatus which is capable of twisting the wire to such an extent that the tension in the resulting spring, when undeflected, approaches the maximum tension therein when the spring is fully deflected. An important object of the invention is to provide such a spring.

The foregoing objects of my invention and the advantages suggested thereby, together with various other objects and advantages which will be evident hereinafter, may be attained through the employment of the exemplary embodiments illustrated in the accompanying drawing and described in detail hereinafter.

Referring to the drawing:

Fig. 1 is a semi-diagrammatic view showing a wire forming apparatus which embodies the fundamental principles of my invention;

Fig. 2 is a perspective view showing a coil forming means which forms part of the apparatus;

Fig. 3 is a perspective view of a mandrel forming part of the coil forming means shown in Fig 2;

Fig. 4 is an elevational view showing a coiling means, or coiling head, and mandrel which form part of the coil forming means shown in Fig. 2;

Figs. 5 and 6 are views illustrating the operation of the coiling head and mandrel;

Fig. 7 is a plan view of another embodiment of a coil forming means; and

Fig. 8 is a diagram showing the load-deflection curve of a spring produced by my invention.

Referring to Fig. 1 of the drawing, I show a spring winding apparatus which includes means 15 for feeding wire 16 from a suitable

source (not shown) to rotatable means, indicated generally by the numeral 17, for forming the wire into a continuous coil 18 which may be severed periodically to provide coil springs of the desired lengths, as by a cutting mechanism indicated generally at 19, for example. The coil forming means 17 is rotatable relative to supporting structure indicated generally by the numeral 20 about an axis A—A, and the wire 16 is fed to the coil forming means along a path 21 which extends generally in the direction of the axis A—A so that the coil forming means rotates the wire about the longitudinal axis of the wire. Such rotation of the wire 16 by the coil forming means 17 is prevented at a point 22 spaced from the coil forming means by restraining means 23 so that the wire is twisted throughout that portion thereof which lies between the coil forming means and the restraining means. Such twisting of the wire fed to the coil forming means results in a pre-tensioned coil 18 which tends to shrink upon itself in the manner previously discussed herein, provided, of course, that the direction of rotation of the coil forming means is as indicated by the arrows 24 in the drawing. It will be apparent that if the direction of rotation is reversed, the resulting coil will not be pre-tensioned, but will tend to extend or straighten itself.

Considering my spring winding apparatus in more detail, in the particular construction shown in the drawing the feeding means 15 is adapted to push the wire 16 through the coil forming means 17, although it will be understood that I may employ a feeding means which is adapted to pull the wire through the coil forming means as will be pointed out in more detail hereinafter. Also, in the particular construction illustrated the restraining means 23 forms part of the feeding means 15, i. e., the feeding means performs the function of the restraining means, although a separate restraining means may be employed if desired.

The feeding means 15 includes a pair of counter-rotating rollers 26 and 27 which receive the wire 16 therebetween and which push it through the coil forming means 17, the spacing between the rollers being such that the rotation of the wire 16 which is caused by the coil forming means 17 is prevented at the point 22 so that such rotation is not carried back to the source of the wire. Thus, in addition to serving as the feeding means, the rollers 26 and 27 serve as the restraining means 23 so as to produce a twist in the wire fed to the coil forming means. If desired, an additional pair of counter-rotating rollers 28 and 29 may be employed for feeding the wire 16 through the coil forming means 17 and for further preventing twisting of the wire back to the source.

Although any suitable means for driving the rollers 26 to 29 may be employed, I have shown a construction wherein these rollers are all driven by a common gear 32 which is meshed with gears 33 and 34 on the rollers 27 and 29, respectively, the gear 33 being meshed with a gear 35 on the roller 26 and the gear 34 being meshed with a gear 36 on the roller 28. Connected to the common drive gear 32 is a bevel gear 37 which is meshed with a pinion 38, the latter being driven by a pulley 39 through the medium of a shaft 40. The pulley 39 is driven by a pulley 41 through a belt 42, the pulley 41 being mounted on a countershaft 43 which is driven by a motor 44 through the medium of a belt 45 trained over pulleys 46 and 47 mounted on the countershaft and on the shaft of the motor, respectively.

The coil forming means 17 includes an arbor 50 which is supported by bearings 51 carried by the supporting structure 20 as shown in Fig. 1. The arbor carries die means 52 for coiling the wire 16 around a mandrel 53, and carries means 54 for guiding the wire to the coiling means along the path 21 so that rotation of the arbor results in twisting of the wire throughout that portion of its length which lies between the coiling or die means 52 and the restraining means 23. As best shown in Figs. 1 and 2, the guiding means 54 may include a pair of plates 55 which are mounted on a flat portion 56 of the arbor 50 and which are connected to the arbor by bolts 57, the plates 55 being provided with complementary grooves 55a therein which form part of the guide path 21. The arbor 50 is provided with an opening 58 on the axis of rotation A—A of the arbor through which the wire 16 may be fed into the grooves 55a in the plates 55. As best shown in Fig. 1, the grooves 55a provide the guide path 21 with a portion 61 which is substantially perpendicular to the axis of rotation A—A of the arbor 50 and which leads to the coiling means 52, and provide the guide path with a portion 62 which substantially coincides with the axis of rotation A—A, the portions 61 and 62 of the guide path being connected by a curved or looped portion 63 which is spaced from the axis of rotation of the arbor.

It will be apparent that causing the wire 16 to follow the guide path 21 in this manner will result in rotation of the wire about its own longitudinal axis as the arbor 50 rotates, such rotation of the wire being prevented back of the point 22 by the restraining means 23. Thus, that portion of the wire 16 lying between the restraining means 23 and the coiling means 52 is twisted so that the coiling means produces a pre-tensioned coil 18 as will be discussed in more detail hereinafter. To insure that the twist produced in the wire 16 in this manner will be distributed substantially uniformly, the grooves 55a in the plates 55 forming the guiding means preferably provide a guide passage which is a little larger than the wire so that the wire may rotate freely therein.

As previously mentioned, the twisted wire fed to the coiling means 52 is wound around the mandrel 53 to form the continuous coil 18. In general, the coiling means 52 includes a coiling member 65 which is attached to a supporting arm 66 by bolts 67, the supporting arm being mounted on the flattened portion 56 of the arbor in a rigid manner by a bolt 68. The mandrel 53 is provided with an enlarged shank 69 which is disposed in an axial bore 70 in the arbor 50 and is rigidly connected to the arbor by the bolt 68, which bolt extends through an opening 71 in the shank of the mandrel.

Considering the structure of the coiling means 52 in more detail, the shoulder 72 formed by the enlarged shank 69 of the mandrel 53 has the form of one turn of a helix, the portion 61 of the guide path 21 for the wire 16 being in registry with this helical shoulder so that the wire 16 is required to follow a helical path as it engages the shoulder. At the same time, the wire 16 engages a curved portion 73 of the coiling member 65 which bends the wire and coils it around the mandrel 53 as best shown in Figs. 5 and 6, the direction of motion imparted to the

wire by the feeding means 15 being indicated by the arrows 74. As best shown in Fig. 4, the curved portion 73 of the coiling member 65 converges in the direction of movement of the coil 18 along the mandrel 53 to hold the wire against the helical shoulder 72 as it is formed around the mandrel, the direction of movement of the coil along the mandrel being toward the left as viewed in Fig. 4. The coiling member 65 is relieved somewhat, as indicated at 77, to allow for spring back of the convolutions of the coil as they move axially along the mandrel.

It will thus be apparent that as the wire 16 is fed through the coiling means 52 by the feeding means 15, the helical shoulder 72 on the mandrel 53 and the curved portion 73 of the coiling member 65 cooperate to coil the wire 16 around the mandrel to produce the continuous helical coil 18 which may be severed periodically into springs of suitable lengths by the cutting mechanism 19. It will also be apparent that the coiling means 52 will operate to produce the coil 18 even though the arbor 50 is not rotated, but such a coil will not be pre-tensioned whereas pre-tensioning of the coil 18 does occur when the wire 16 fed to the coiling means 52 is twisted in the manner previously described by rotating the arbor 50 in the direction indicated by the arrows 24 throughout the drawing.

In the particular construction illustrated in the drawing, the arbor 50 is driven from the countershaft 43 through a variable speed mechanism 78 to permit varying the amount of twist produced in the wire 16 fed to the coiling means 52 so as to vary the amount of pre-tensioning of the coil 18. The variable speed mechanism is driven by the countershaft 43 through the medium of a belt 79 trained over pulleys 80 and 81, and the variable speed mechanism drives the arbor 50 through the medium of a belt 82 trained over pulleys 83 and 84.

Although the spring winding apparatus thus far described includes the feeding means 15 for pushing the wire 16 through the coil forming means 17, a feeding means (not shown) which acts on the completed coil 18 to pull the wire through the coil forming means may be employed if desired. With such a pull type feeding means the rollers 26 to 29 would serve merely as the restraining means 23 for preventing twisting of the wire back to the source. In all other respects, the operation of the spring winding apparatus incorporating a pull type feeding means is identical to that of the apparatus with the push type feeding means 15.

In Fig. 7 of the drawing, I show a coil forming means 90 whose operation is somewhat different from that of the coil forming means 17 which was described previously. The coil forming means 90 includes an arbor 91 which is substantially identical to the arbor 50 and which is interchangeable therewith. The arbor 91 carries a mandrel 92 which is substantially identical to the mandrel 53 except that it is attached to the arbor with its axis perpendicular to the axis of rotation A—A instead of being attached thereto with its axis coinciding with the axis of rotation. The mandrel 92 may, for example, be threaded into an opening in the arbor 91 as indicated in Fig. 7.

A coiling member 93, which is substantially identical to the coiling member 65 described previously, is mounted on a flattened portion 94 of the arbor 91 in a position such that the coiling member lies substantially on the axis of rotation A—A of the arbor, the coiling member being attached to the arbor by bolts 95, for example. In the coil forming means 90 shown in Fig. 7, the wire is fed through an axial opening 96 in the arbor 91 and is coiled around the mandrel 92 by the coiling member 93 in a manner similar to that previously discussed. However, since the axis of the mandrel 92 is perpendicular to the axis of rotation A—A of the arbor 91, the resulting coil 18 comes off the mandrel at right angles to the axis of rotation of the arbor instead of along the axis of rotation. In order to return the coil 18 to the axis of rotation of the arbor 91, I provide a curved guide 97 which conducts the coil to an axial opening 98 in the arbor. The coil 18 emerging from the axial opening 98 may be severed into suitable lengths by the cutting mechanism 19, for example.

It will be noted that if the arbor 91 is rotated about the axis A—A in a manner similar to that previously described, the mandrel 92 rotates the wire 16 about its longitudinal axis, such rotation of the wire being prevented by the restraining means 23 in the manner previously described so as to twist the wire as it is coiled around the mandrel 92. Thus, the coil 18 formed by the coil forming means 90 is pre-tensioned due to the twisting of the wire as it is formed into the coil.

Referring to Fig. 8, the straight line 100 represents the load-deflection curve for a typical coil spring produced with either the coil forming means 17 or the coil forming means 90, the abscissa in the diagram being the length of the spring and the ordinate being the tension in the spring. In other words, the line 100 represents the tension in the spring expressed as a function of the degree of deflection (extension) of the spring. It will be noted that if the load-deflection curve 100 is extended as indicated by the dotted portion 101 thereof until it intersects the zero tension axis of the diagram, it intersects this axis at a point indicating a negative length. The load-deflection curve 100 for a spring produced by my invention may be expressed by the equation $t=k\ (l-c)$ wherein t is the tension in the spring, k is its spring constant, l is the length of the spring, and c is a negative constant representing the length which the spring would have to assume to reduce the tension therein to zero, i. e., c is a negative constant representing the intercept of the extension 101 of the line 100 with reference to the zero tension axis.

In the diagram shown in Fig. 8, the numeral 102 represents the load-deflection curve for a spring which has not been pre-tensioned and it will be noted that this curve intersects the zero tension axis at a positive value of the length of the spring. Thus, in effect, pre-tensioning a spring in the manner described herein shifts its load-deflecting curve so that the spring operates on a higher portion of the curve for the same deflection. In other words, the apparatus disclosed herein is capable of producing a spring which, when undeflected, provides a spring force equal to that provided by a normal spring of comparable size when partially or fully extended, depending on the extent to which the wire is twisted in forming my pre-tensioned spring.

Such pre-tensioned springs may be used in any installation where large spring forces must be attained with limited deflection.

I have found, for example, that the apparatus disclosed herein may be used to produce a spring which, when undeflected, provides a spring force

in excess of 75% of that attainable therewith when fully extended. However, the degree of pre-tensioning may be varied as desired by varying the extent to which the wire **16** is twisted in coiling it, i. e., by varying the speed of rotation of the coil forming means **17** or **90** with respect to the rate of feed of the wire. For example, 100% of the maximum spring force which a spring is capable of providing may be pre-tensioned in it by increasing the speed of rotation of the coil forming means with respect to the rate of feed of the wire to a sufficient extent, the only limit to the degree of pre-tensioning being the torsional stress limit of the wire.

Although I have disclosed exemplary embodiments of my invention herein for illustrative purposes, it will be understood that I do not intend to be limited thereto since various changes, modifications and substitutions may be incorporated in such embodiments without departing from the spirit of the invention, and I hereby reserve the right to all such changes, modifications and substitutions as properly come within the scope of the invention as set forth in my appended claims.

I claim as my invention:

1. In a wire forming apparatus, the combination of: a supporting structure; an arbor carried by and rotatable relative to said supporting structure; a mandrel having a longitudinal axis which coincides with the axis of rotation of said arbor, said mandrel being carried by said arbor and being rotatable therewith; coiling means carried by said arbor so as to be rotatable therewith for coiling the wire around said mandrel and having a helical shoulder to advance the resulting coil along said mandrel; guide means carried by said arbor so as to be rotatable therewith and providing a continuous guide path having a first portion which is generally perpendicular to the axis of rotation of said arbor and which leads to said coiling means, and having a second portion which is spaced from said coiling means and which extends in the direction of the axis of rotation of said arbor, whereby, when said arbor is rotated, the wire fed to said coiling means is rotated about the longitudinal axis of the wire; feeding and restraining means for feeding the wire to said coiling means and for preventing rotation of the wire about its longitudinal axis at a point spaced from said coiling means so as to twist the wire intermediate said feeding and restraining means and said coiling means; and means for rotating said arbor, thereby also rotating said mandrel, said coiling means and said guide means.

2. A wire forming apparatus as set forth in claim 1 wherein said second portion of said guide path substantially coincides with the axis of rotation of said arbor.

3. In a wire forming apparatus, the combination of: a supporting structure; an arbor carried by and rotatable relative to said supporting structure; a mandrel carried by said arbor so as to be rotatable therewith and having a longitudinal axis which is substantially perpendicular to the axis of rotation of said arbor; coiling means carried by said arbor so as to be rotatable therewith for coiling the wire around said mandrel and having a helical shoulder to advance the resulting coil along said mandrel; means on said arbor so as to be rotatable therewith for guiding the wire fed to said coiling means along a path which, at least in part, extends generally parallel to the axis of rotation of said arbor, whereby said mandrel rotates the wire fed to said coiling means about the longitudinal axis of the wire when said arbor is rotated; means for rotating said arbor, thereby also rotating said mandrel, said coiling means and said guiding means; and feeding and restraining means for feeding the wire to said coiling means and for preventing rotation of the wire fed to said coiling means about its longitudinal axis at a point spaced from said coiling means so as to twist the wire intermediate said feeding and restraining means and said coiling means.

4. A wire forming apparatus as set forth in claim 3 wherein said path of the wire fed to said coiling means substantially coincides with the axis of rotation of said arbor.

RICHARD W. PALMER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
488,230	Taylor	Dec. 20, 1892
498,099	Allen	May 23, 1893
873,430	Harter	Dec. 10, 1907
1,207,880	Doerr	Dec. 12, 1916
1,213,480	Hart	Jan. 23, 1917
1,382,258	Turgeon	June 21, 1921
1,453,431	Blount	May 1, 1923
1,537,632	Turgeon	May 12, 1925
1,671,951	Angell	May 29, 1928
1,804,705	Paulus	May 12, 1931
1,953,502	Reimers	Apr. 3, 1934
1,961,379	Morgan	June 5, 1934
2,002,754	Prange	May 28, 1935
2,056,028	Wadsten	Sept. 29, 1936
2,062,552	Burgess	Dec. 1, 1936
2,091,245	Thomas	Aug. 24, 1937
2,131,893	Jessen	Oct. 4, 1938
2,248,149	Wilson	July 8, 1941
2,260,053	Platt	Oct. 21, 1941
2,386,172	Wisoff	Oct. 2, 1945
2,445,109	Ferguson	July 13, 1948
2,491,228	Swift	Dec. 13, 1949