Jan. 16, 1962 G. P. ADAMS 3,016,571

APPARATUS FOR FORMING SPRING-LIKE ARTICLES

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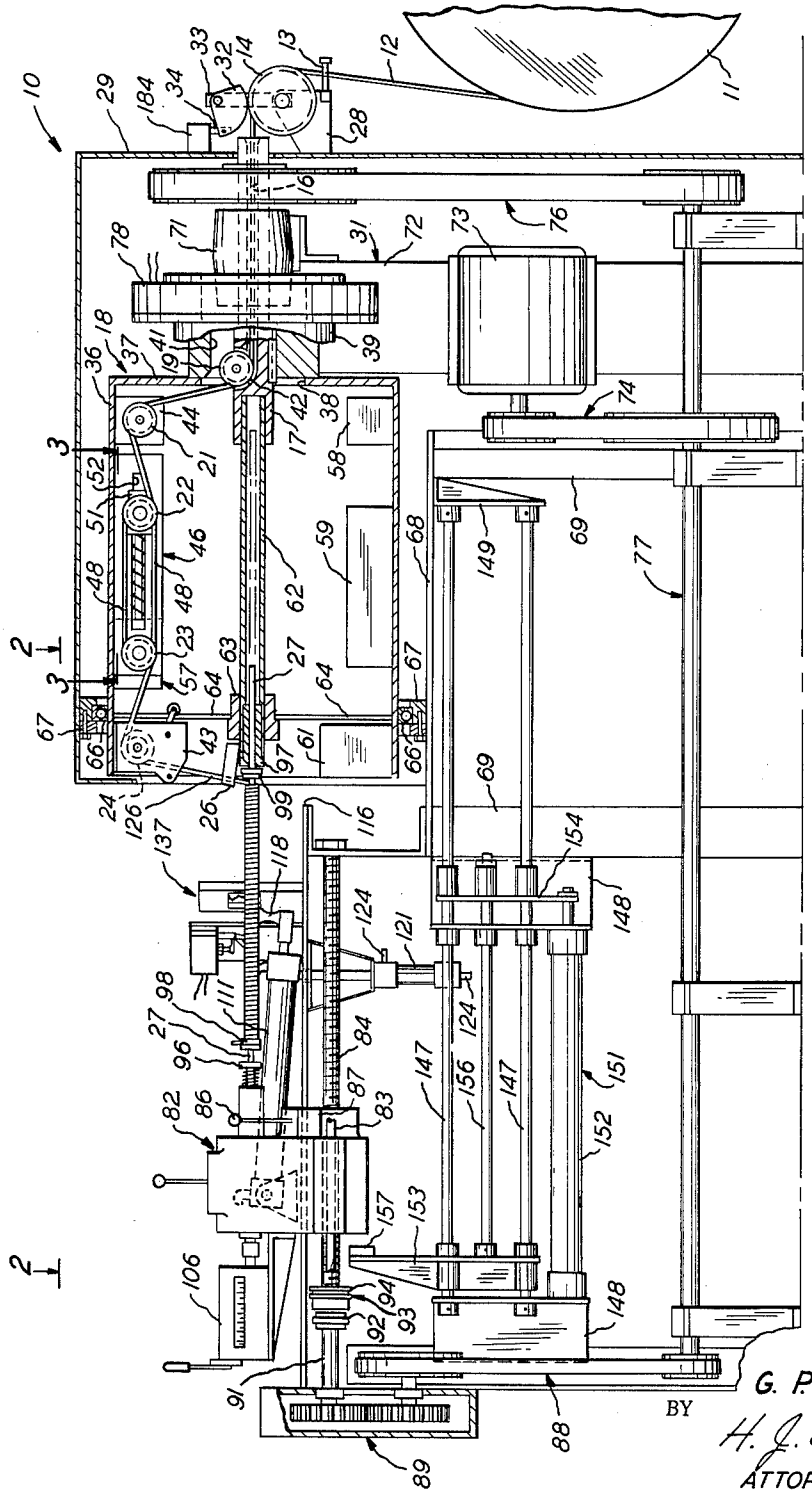


FIG. 1

INVENTOR.
G. P. ADAMS
BY
H. J. Winegar
ATTORNEY

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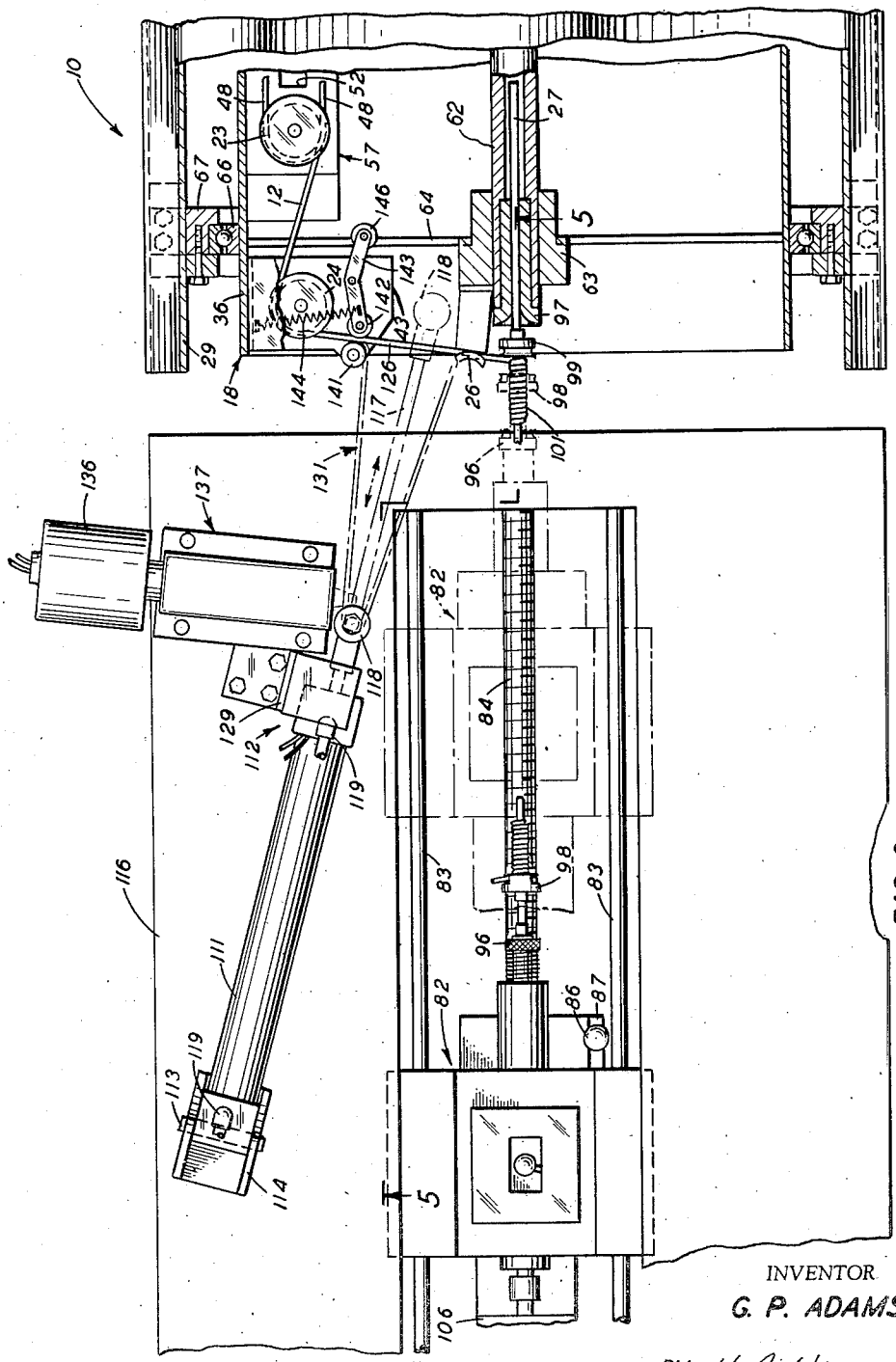


FIG. 2

INVENTOR
G. P. ADAMS

BY H. J. Winegar
ATTORNEY

Jan. 16, 1962 G. P. ADAMS 3,016,571

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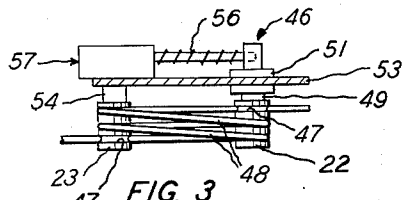


FIG. 3

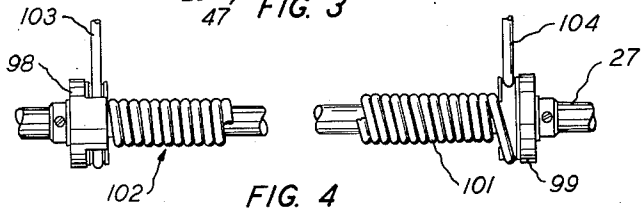


FIG. 4

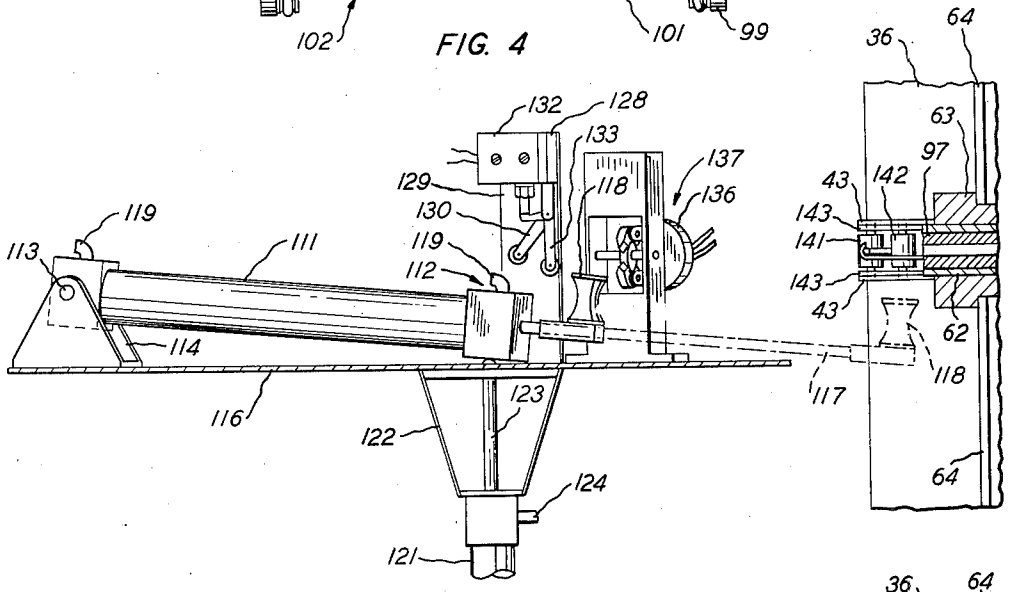


FIG. 5

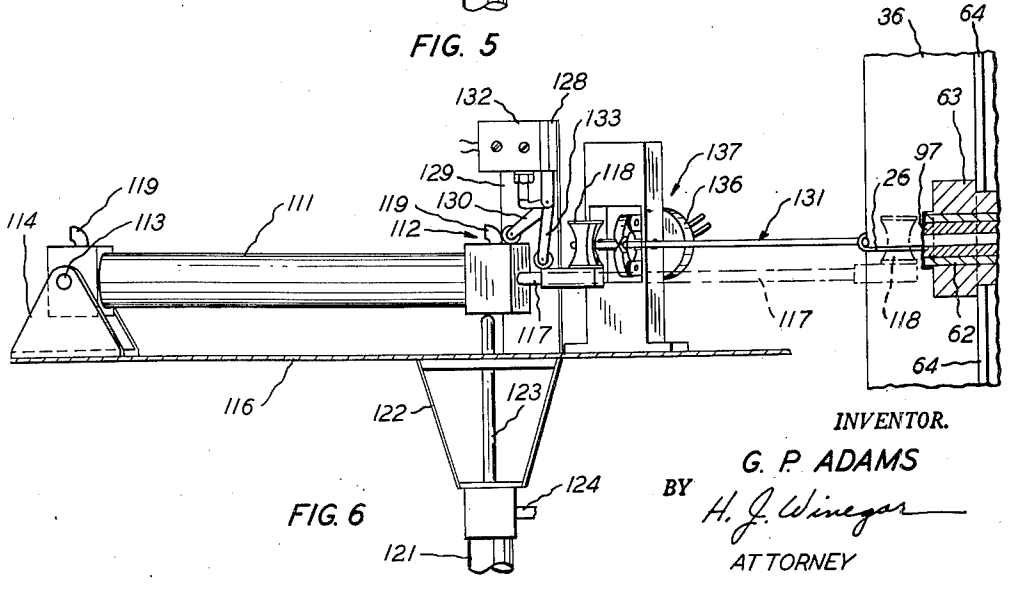


FIG. 6

INVENTOR.
G. P. ADAMS
BY H. J. Winegar
ATTORNEY

Jan. 16, 1962 G. P. ADAMS 3,016,571

APPARATUS FOR FORMING SPRING-LIKE ARTICLES

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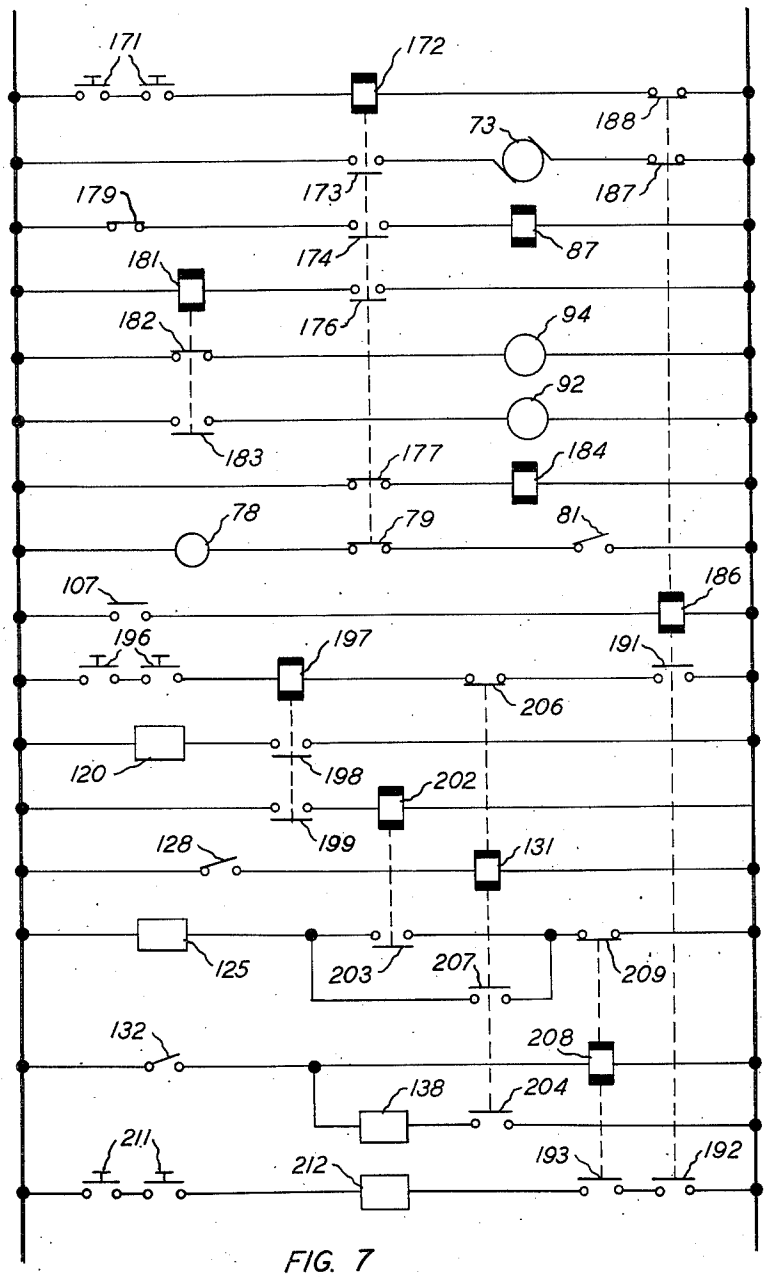


FIG. 7

INVENTOR.

BY G. P. ADAMS

H. J. Winegar

ATTORNEY

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3,016,571

APPARATUS FOR FORMING SPRING-LIKE ARTICLES

George P. Adams, Baltimore, Md., assignor to Western Electric Company, Incorporated, New York, N.Y., a corporation of New York

Filed Dec. 23, 1959, Ser. No. 861,662
15 Claims. (Cl. 18—19)

The present invention relates to apparatus for forming spring-like articles and more particularly to apparatus for forming spring cords having straight ends of predetermined lengths extending from a helically coiled portion thereof and for incorporating predetermined amounts of axial pretwist in cordage forming the coiled portion of the cord.

Retractile electrical cords, commonly referred to as spring cords, are widely used in the telephone field and in connection with various electrical appliances. A well-known example of such cords is the spring cord utilized to connect the handset of a telephone instrument to the telephone base. The spring cord is formed so that the major portion thereof is in the form of a compact helical coil which may be extended by slight tension and which will return to the compact form when the tension is relieved.

One method of manufacturing spring cords having the above properties, as described in the patent to A. R. Kemp et al. 2,413,715, includes steps of axially pretwisting rubber or synthetic rubber-jacketed cordage as it is wound in the form of a helix upon a mandrel, the pretwist being applied in such a direction as to force the adjacent turns closer together. The mandrel with a helically wound cordage clamped thereon is then placed in an oven and subjected to heat treatment, which relieves partially the stresses in the spring cord. Such spring cords possess desired retractability and should retain their retractile characteristics during their useful life.

One of the problems arising in the manufacture of spring cords by such a method results from the necessity of providing means for pretwisting axially the cordage being formed into spring cords and of having predetermined lengths of free, uncoiled, untwisted cordage at each end of the helical portion of the spring cord. The particular application for which the spring cord is to be used determines the lengths of the uncoiled portion.

It is an object of the present invention to provide a new and improved apparatus for forming spring-like articles.

Another object of the present invention is to provide a new and improved apparatus for forming spring cords having straight ends of predetermined lengths extending from a helically coiled portion thereof for incorporating a predetermined amount of axial pretwist in cordage of the coiled portion thereof.

Apparatus for forming spring-like articles, which illustrates certain features of the invention may include means for supplying a continuous length of strand-like material and a rotatable mandrel to which an end portion of the material to be coiled in a helix thereon is attached. Rotatable flyer means is positioned in the path of travel of the material from the supply means to the mandrel and is designed to rotate a bight of the material about the rotational axis of the mandrel. Means are provided for rotating the mandrel at a predetermined speed such that the material is coiled helically upon the mandrel and the flyer means imparts simultaneously a predetermined axial pretwist to the cordage in a direction so as to tend to urge the thus-formed coils together to enhance the retractability of the finished spring-like article.

In addition, means may be provided for withdrawing a predetermined length of the material from the flyer whereby a length of the material is provided to form straight ends of the article.

Other objects and features of the invention will be more readily understood from the following detailed description of apparatus forming a specific embodiment of the invention, when read in conjunction with the accompanying drawings, in which:

FIG. 1 is a side elevation of the apparatus, certain portions thereof being broken away for clarity;

FIG. 2 is an enlarged plan view of a portion of the apparatus shown in FIG. 1, the flyer unit for purposes of clarity being illustrated in a position displaced 90° about its longitudinal axis from its position in FIG. 1;

FIG. 3 is a fragmentary, sectional view of a cordage storing mechanism, taken along line 3—3 of FIG. 1;

FIG. 4 is an enlarged fragmentary view of a mandrel having a spring cord fastened thereon by means of clamps;

FIG. 5 is a vertical section of the apparatus taken along line 5—5 of FIG. 2;

FIG. 6 is a vertical section of the apparatus taken along line 5—5 of FIG. 2, showing the apparatus in a different operating position than FIG. 5, and

FIG. 7 is a schematic diagram of an electrical control circuit forming a part of the apparatus.

Referring now to the drawings, FIG. 1 shows an apparatus, designated generally by the number 10, for making spring cords having a helically coiled central portion and straight ends of predetermined lengths. A supply reel 11 is provided for supplying a continuous length of jacketed cordage 12, such as a rubber-jacketed or synthetic rubber-jacketed (e.g. neoprene cordage) cordage. The cordage 12 is directed from the supply reel 11 over a guide 13, over a guide roller 14, through an aperture 16 extending longitudinally through a rotatable drive shaft 17, and along the central axis of a flyer unit, designated generally by the numeral 18, over or under idler rollers 19, 21, 22, 23 and 24 of the flyer unit, and over a guide 26 which directs it to a coiling mandrel 27.

The guide 13 and the guide roller 14 are mounted upon a bracket 28 secured to a guard portion 29 of the main frame, which is designated generally by the numeral 31. The guard 29 encloses the flyer unit end of the apparatus 10. A sector-shaped stop 32 is pivotably mounted upon a support 33 fixedly secured to the bracket 28. Solenoid-operated plunger means 34 are operatively connected to the stop 32 and when energized the plunger means pivot the stop in a counterclockwise direction to urge the stop against the cordage 12 and the guide roller 14 so as to prevent longitudinal movement of the cordage.

The flyer unit 18, is mounted for rotation about its longitudinal axis, as shown in FIG. 1. The flyer unit 18 includes an elongated, cylindrical, cup-shaped housing 36 closed at one end by a flange 37 having a centrally located aperture 38. A hollow flanged hub 39 is secured fixedly to the flange 37 and is keyed to the drive shaft 17 for rotation therewith. This construction permits the flyer unit 18 to rotate with the shaft 17 as a unit. The idler roller 19 is mounted rotatably to the drive shaft 17 and rotates partially within a recess 41 in the flanged hub 39 and partially within a recess 42 in the drive shaft 17 which communicates with the aperture 16 in the drive shaft. The idler rollers 21 and 24 are mounted upon brackets 43—43 and 44—44, respectively, depending radially from the inner surface of the housing 36. The rollers 14, 19, 21 and 24 are similar in design and are provided with cord retaining circumferential grooves.

The rollers 22 and 23, which are elements of a pretwisted cordage storing mechanism, designated generally by the numeral 46, (FIG. 3), each have a plurality of

grooves 47—47 for receiving therearound the cordage 12 in a plurality of loops 48—48. The pretwisted cordage storing mechanism 46 cooperates with the stop 32 to allow sudden withdrawal of predetermined lengths of cordage from the flyer unit 18 without introducing any axially untwisted cordage into the flyer unit. The roller 22 is mounted rotatably upon a shaft 49 carried by a bearing block 51, which is mounted slidably about a slot 52 in a bracket 53. The bracket 53 is secured rigidly to the housing 36. When a predetermined length of pretwisted cordage is suddenly withdrawn from the storing mechanism 46 the roller 22 is advanced from its normal position shown in FIG. 3 toward the roller 23 mounted on a shaft 54. A compression spring 56 urges the roller 22 into its normal cordage storing position shown in FIG. 3.

A dashpot, designated generally by the numeral 57, is provided to dampen the action of the spring 56 so as to delay the return of the roller 22 into its normal cordage storing position, after the stored pretwisted cordage has been suddenly withdrawn from the storage mechanism 46 to eliminate sudden introduction of untwisted cordage 12 from the supply means after the cordage locking action of the stop 32 has been released. The flyer unit 18 is also provided with suitable counterweights 58, 59 and 61 disposed diametrically from the idler rollers 19 and 21 to 24, inclusive, to counterbalance the weights of the corresponding idler rollers and their associated brackets.

A sleeve 62 is secured to the drive shaft 17 and extends coaxially with respect to the axis of rotation of the shaft and the flyer unit 18. A bearing hub 63, which is secured to radial spokes 64—64 rigidly connected to the housing 36, is mounted rotatably on the sleeve 62 and acts as a support and a reinforcing member for the flyer unit 18. The flyer unit 18 is further restrained from undesirable axial or radial motion during rotation thereof by supporting the housing 36, at a portion removed from the drive shaft 17 and the flanged hub 39 upon ball-bearings 66—66. The ball-bearings 66—66 are mounted upon support blocks 67—67 secured to the guard 29 and to a plate 68, supported by upright support members 69—69 of the main frame 31.

The drive shaft 17 is mounted rotatably within a bearing block 71, which is mounted to an upright support member 72 of the main frame 31. The drive shaft 17 is driven by a motor 73 through an array of belts and pulleys, designated generally by the numerals 74 and 76, and a main drive shaft 77. A stationary electromagnetic brake, designated generally by the numeral 78, is secured to the upright support member adjacent to the flanged hub 39 of the flyer unit 18. The brake 78 is energizable by means of a normally closed switch 79 (FIG. 7) to positively stop the flyer unit 18 when desired. An electromagnetic normally open trip-switch 81 (FIG. 7) is provided in series with the normally open switch 79 to insure stoppage of the flyer unit 18 at the same predetermined position when both the switches 79 and 81 are closed at the same time.

A movable mandrel carriage, designated generally by the numeral 82, is mounted slidably upon a pair of parallel guide rods 83—83. The carriage 82 is similar in construction to a mandrel carriage disclosed in U.S. Patent 2,898,630 to G. P. Adams. The mandrel carriage 82 may be selectively connected operatively to a lead screw 84 to move the carriage longitudinally of the rods 83—83 and axially with respect to the flyer unit 18.

Selective engagement and disengagement of the lead screw 84 by a split nut clutch unit (not shown) within the mandrel carriage 82 may be accomplished by manually actuating an operating lever 86. The operating lever 86 may also be operated automatically by a solenoid 87 operatively connected to the lever.

The lead screw 84 is operated by means of power transmitted from the main drive shaft 77 through a belt and pulley drive, designated generally by the numeral 88, a gear drive, designated generally by the numeral 89, a stub-shaft 91 and an electromagnetic clutch 92 of the electromagnetic clutch-brake coupling, designated generally by the numeral 93. The clutch-brake coupling 93 includes the electromagnetic clutch 92 and an electromagnetic brake 94. The electromagnetic clutch-brake coupling 93 is caused automatically to couple or to brake the rotation of the lead screw 84 in correlation to the operation of the motor 73 and rotation of the flyer unit 18.

The mandrel carriage 82 is provided with a chuck 96 designed to receive detachably therein one end of the mandrel 27. The other end of the mandrel 27 extends into the sleeve 62 and is supported by a bushing 97, secured within the sleeve, for both rotational and longitudinal movement with respect thereto. The chuck 96 is rotated by suitable gear means (not shown), disposed within the mandrel carriage 82, which transmit the rotary motion of the lead screw 84 to the chuck and, therefore, to the mandrel 27, to rotate the mandrel about its longitudinal axis at rotational speeds different from those of the flyer unit.

A cordage clamp 98 is securely fastened to the mandrel 27 by suitable securing means provided on the clamp. A cordage clamp 99 is normally loosely positioned on the mandrel 27 and is slidable axially therealong as convolutions of the cordage 12 are coiled onto the mandrel. The cordage clamps 98 and 99 are similar in construction and operation to clamps disclosed in FIG. 9 of U.S. Patent No. 2,565,465 to W. L. Ames. The cordage clamps 98 and 99 are designed to clamp the helically coiled portion 101 of a spring cord, designated generally by the numeral 102, to the mandrel 27, as shown in FIG. 4, so that straight ends 103 and 104 extend beyond the clamps 98 and 99.

A counter 106 is provided for registering a number of revolutions of the mandrel 27 during a spring cord forming operation. After the mandrel completes a predetermined number of revolutions, the counter 106 actuates an electrical switch 107, shown in FIG. 7 and described hereinafter in relation to electrical control means for the apparatus, to stop the operation of the apparatus.

A first double-action air cylinder 111 of a cordage pulling mechanism, designated generally by the numeral 112, is pivotably mounted by a pin 113 upon a bracket 114, which in turn is pivotably mounted upon a horizontal portion 116 of the frame 31. A piston rod 117 of the air cylinder 111, which carries at its extremity a roller 118 for reciprocable motion therewith, is shown in its normal retracted position in solid lines in FIGS. 2, 5 and 6. The roller 118 is secured to the free end of the piston rod 117 and is so positioned that the roller is above, and its longitudinal axis is perpendicular to, the longitudinal axis of the piston rod. By admission of compressed air selectively into one end of the air cylinder 111 or the other end thereof by means of fluid lines 119—119 controlled by actuating means 120 described hereinbelow with respect to control means and operation of the apparatus, the piston rod 117, and therefore the roller 118, can be reciprocated into an extended or retracted position. The roller 118 in its extended position is shown in phantom lines in FIGS. 2 and 5.

A second double-action air cylinder 121, constructed similarly to the first air cylinder 11 is secured to the bracket 122, depending from the horizontal portion 116 of the main frame 31, in such position that its piston rod 123 moves vertically upward upon actuation thereof. The piston rod 123 may be extended or retracted by admission of the compressed air through the fluid lines 124—124, control and actuating means 125 for which are described hereinbelow with respect to control means and operation of the apparatus. After the first cylinder 111 is operated for a predetermined time, the second air cylinder 121 is actuated, whereby the piston rod 123 swings the first air cylinder in a counterclockwise direction, as viewed in FIG. 1, to move the roller 118 subsequently to second extended position illustrated in phantom lines in FIG. 6. When the roller 118 is in this second extended position, a horizon-

tally disposed portion 126 of the cordage 12 extending between the idler roller 24 and the guide 26 is in front of and between the roller 118 of the pulling mechanism 112 and the first air cylinder 111 and traverses the path of retraction of the piston rod 117 at a distance above the piston rod equal to about one-half the height of the roller 118.

A normally open switch 128 is attached to a bracket 129 depending from the main frame 31 in such a position that when the first air cylinder 111 is pivoted about the pin 113 by the piston rod 123 of the second air cylinder 121 into the position shown in FIG. 6, the first air cylinder will operate a rocker arm 130 associated with the switch 128 to energize a solenoid 131. Thereupon the piston rod 117, carrying the roller 118, is caused to be retracted to its normal retracted position, shown in solid lines in FIG. 6. The roller 118 while being retracted engages the portion 126 of the cordage traversing its path of retraction, whereby a predetermined length, designated generally by the numeral 131, of the cordage 12 is pulled out from the pretwisted cordage storing mechanism 46.

A normally open switch 132 is also attached to the bracket 129 in such a position that when the roller 118 is in the position shown in solid lines in FIG. 6, the rocker arm 133, associated with the switch 132, is actuated by the piston rod 117 to close the switch 132 and to operate control means 134 of an air cylinder 136 of a cutting mechanism, designated generally by the numeral 137. The cutting mechanism 137 is similar in construction and operation to a cutting mechanism disclosed in FIGS. 6 and 7 of U.S. Patent 2,898,630 to G. P. Adams. The cutting mechanism 137 cuts the pulled-out length 131 of the cordage 12 into two straight lengths 103 and 104 of predetermined lengths.

When the switch 132 is closed, a suitable control means 138 associated with the second air cylinder 121 is energized, whereupon the piston rod 123 of the second air cylinder is retracted. The first air cylinder 111 then returns by gravity into its original position, shown in solid lines in FIG. 5. The operations of the electrical control means of the pulling mechanism 112 and the cutting mechanism 137 are described later in detail with respect to operation of the apparatus 10.

Referring again to FIG. 2 there is provided adjacent to the idler roller 24 a guide roller 141 which is mounted rotatably upon the brackets 43—43 for engaging the cordage 12 as it is being pulled out by the roller 118 of the pulling mechanism 112. A roller 142 is mounted upon one extremity of levers 143—143, which are mounted pivotably to the brackets 43—43.

A tension spring 144 is secured to one of the brackets 43—43 and to one of the levers 143—143 for retaining the levers, when the flyer unit 18 is stationary, in such position that the cordage 12 is gripped between the guide roller 141 and roller 142, thereby preventing any possibility of the cordage moving in the reverse direction and being dislodged from its course over the various idler rollers.

When the cordage 12 is being cut by the cutting mechanism 137, this last-mentioned arrangement prevents untwisting of the cordage beyond the point where the cord is being held between the rollers 141 and 142. During the rotation of the flyer unit 18 a counterweight 146, attached to the other extremity of the levers 143—143, due to the action of centrifugal forces applied thereto, tends to pivot the levers 143—143 in a counterclockwise direction so that the roller 142 tends to move away from the guide roller 141 allowing free passage of the cordage 12 therebetween.

A pair of rods 147—147 (FIG. 1) which are secured rigidly to brackets 148—148 and 149 of the main frame 31 support a pusher mechanism, designated generally by the numeral 151 and similar in construction and function to one described in detail in the above-mentioned U.S. Patent 2,898,630 to G. P. Adams. An air cylinder 152, of the pusher mechanism 151, is rigidly supported by the brackets 148—148. A pusher arm 153 and a bracket 154, slidably supported by the rods 147—147, are interconnected by a rod 156, mounted slidably in the bracket 154 and rigidly to the pusher arm 153. When the bracket 154 is moved by a piston rod 156 of the air cylinder 152, the pusher arm 153, which has an elastic bumper 157 at one end thereof to engage the carriage 82, will slide along the rods 147—147 and move the carriage into its original operating position, shown in phantom lines in the FIG. 2, with the mandrel 27 extending into the sleeve 62.

Operation

At the beginning of a spring cord coiling operation the mandrel carriage 82 is in a position shown in phantom lines in the FIG. 2. The mandrel 27 is held in the chuck 96, extends into the sleeve 62 and is supported rotatably and slidably within the bushing 97. For the purpose of this description, it will be assumed that the length of the cordage 12 extending between the guide roller 14 and the rollers 141 and 142 is already pretwisted axially as a result of previous operations of the apparatus so that only a predetermined straight length of the cordage needed to form a first straight end 103 of the spring cord 102, equal to the distance between the cutting mechanism 137 and the rollers 141 and 142, is untwisted.

To insure the production of uniform spring cords having a desired optimum degree of retractability each length of the cordage forming the helical portion of each spring cord 102 wound upon the mandrel 27 should have the same predetermined amount of axial pretwist per unit length thereof. Accordingly, it is desirable for an operator to grip the cordage 12 as close to the rollers 141 and 142 as practical to withdraw a length of the pretwisted cordage, equal to the distance between the rollers 141 and 142 and the fixed clamp 98, from the pretwisted cordage storing mechanism 46. The fixed clamp 98 is shown prior to the beginning of the spring cord coiling operation in phantom lines in FIG. 2 with respect to the carriage 82. The operator clamps the cordage in the fixed clamp 98 in such a manner that the straight untwisted portion of a predetermined length of the cordage protrudes beyond the fixed clamp to form the first straight end 103 of the spring cord 102. The operator should take care that the axially pretwisted portion of the cordage 12 is not accidentally untwisted during the clamping operation.

Thereafter, the operator actuates two, normally open push-button switches 171—171 to complete a circuit through a solenoid 172. The solenoid 172 closes a normally open switch 173 whereby the motor 73 is energized to drive the main drive shaft 77. The main drive shaft 77, in turn, drives the drive shaft 17 and the stub shaft 91. Simultaneously, the solenoid 172 closes normally open switches 174 and 176, and opens normally closed switches 177 and 79.

The normally open switch 174, when closed by the solenoid 172, completes a circuit through a solenoid 87 to operate the lever 86 to engage the split nut clutch with the lead screw 84 to connect the mandrel carriage 82 operatively to the lead screw. Manual control of the engagement of the mandrel carriage 82 with the lead screw 84 may be achieved by opening the switch 179, thereby breaking the circuit through the solenoid 87, and by manually actuating the operating lever 86 to selectively engage or disengage the lead screw to the mandrel carriage.

The closure of the normally open switch 176 completes a circuit through a solenoid 181 which, in turn, opens the normally closed switch 182 to deenergize the electromagnetic brake 94 of the clutch-brake coupling 93 to allow rotation of the lead screw 84. Simultaneously, solenoid 181 closes a normally open switch 183, thereby energizing the electromagnetic clutch 92 of the clutch-brake coupling 93 to transmit the rotary motion from the stub shaft 91 to the lead screw 84.

The opening of the normally closed switch 177 de-

energizes solenoid 184 whereby plunger means 34 release the stop 32 to be pivoted away from the roller 14 in a clockwise direction to allow free passage of the cordage 12 from the supply reel 11. The opening of the normally closed switch 79 deenergizes the electromagnetic brake 78 to allow rotation of the flyer unit by the drive shaft 17 and also produces deenergization of the electromagnetic trip-switch 81. So long as the switch 79 remains open the trip-switch 81, which will be closed for a short interval of time during each revolution of the flyer unit, will not remain closed until switch 79 is closed again and the circuit therethrough is completed.

Simultaneously, with the rotation of the flyer unit 18, rotation of the lead screw 84 produces axial movement of the carriage 82 and, therefore, axial movement of the mandrel 27 along the longitudinal axis of the flyer unit and from right to left, as viewed in FIGS. 1 and 2, and also rotation of the mandrel about its own longitudinal axis coaxially of the longitudinal axis of the flyer unit. The rate of the axial movement of the mandrel 27, the rate and direction of rotation of the mandrel, and the rate and direction of rotation of the flyer unit 18 must be closely correlated to produce a spring cord having a desired predetermined amount of axial pretwist incorporated in the cordage of the helically coiled portion thereof and having predetermined spacing between the convolutions of the cord upon the mandrel, so as to obtain a spring cord of a desired retractibility.

During rotation of the flyer unit 18 a portion of the cordage 12 between the idler roller 14 and the mandrel 27 passes through the flyer unit as a loop or a bight of cordage. The flyer unit is rotated preferably in a clockwise direction and the cordage 12 is also twisted clockwise, viewed from right to left in FIG. 1, about its own axis along its length between the idler roller 14 and the idler roller 19, which serves as a pivot for the cordage. To incorporate an axial pretwist in the cordage during the rotation of a bight of cordage by the flyer unit about its longitudinal axis, the mandrel 27 should be rotated in the same direction as the flyer unit 18 at rotational speed different from that of the flyer unit.

In one specific embodiment the flyer unit is rotated at 350 r.p.m. and the mandrel at 700 r.p.m. in the same direction. The longitudinal speed of the mandrel is then preferably regulated to approximately one cordage-width for each two revolutions of the mandrel in order to provide, generally, for winding of the cordage in a closely packed helix. Therefore, during an interval of rotation equal to one minute a length of cordage may be coiled upon the mandrel to form a helically coiled portion of the spring cord. This helically coiled portion will then contain approximately 350 convolutions of the cordage and will also have approximately a total of 350 axial twist turns incorporated in the length of the cordage thereof. The axial pretwist is in a direction such as to tend to force each convolution toward the other, so as to form a spring cord of desired retractability.

The length of the cordage used to form the coiled portion of a spring cord depends upon a number of different factors, such as the diameter of the mandrel, diameter of the cordage, or spacing of the convolutions of the spring cord upon the mandrel. By varying the speed of the axial movement of the mandrel with respect to the longitudinal axis of the flyer unit, it is possible to vary the spacing between the convolutions of the helically coiled portion of the spring cord and, therefore, to some degree the retractability thereof.

By varying the number of axial twists per unit of length of the cordage, comprising the helically coiled portion of the spring cord, it is also possible to vary the degree of retractability of such spring cord. The number of axial twists which may be incorporated in a unit length of the cordage forming helically coiled portions of a spring cord may be controlled within relatively wide limits by controlling the ratio of rotational speeds of the flyer unit and the mandrel.

At such time as the counter 106 indicates that the mandrel 27 has completed a predetermined number of revolutions corresponding to a desired predetermined number of convolutions of the cordage 12 formed upon the mandrel, during which time the mandrel carriage 82 travels from right to left as is shown in FIG. 2, the counter will actuate switch 107, which will energize the solenoid 186. The solenoid 186 opens a normally closed switch 187 to deenergize the motor 73, and also opens a normally closed switch 188 to deenergize the solenoid 172. Deenergization of the solenoid 172 will result in opening of the closed normally open switches 174 and 176 and closing of the normally closed switches 177 and 79. As a result, the motor 73 is deenergized, mandrel carriage 82 is disengaged from the lead screw 84, plunger means 34 locks the stop 32 against the idler roller 14, the electromagnetic trip-switch 81 remains closed when tripped by the flyer unit, and the electromagnetic brake 78 is energized to positively stop the rotation of the flyer unit 18.

Also, opening of the normally open switch 176 results in deenergization of the solenoid 181 whereby the open normally closed switch 182 is closed to energize the electromagnetic brake 94 of the clutch-brake coupling 93 and the closed normally open switch 183 is opened to deenergize the electromagnetic clutch 92 of the clutch-brake coupling 93. As a result of this operation the motor 73 and all motor driven means are positively stopped.

The solenoid 186 also closes a normally open safety switch 191 in the circuit of the cordage pulling mechanism 112 and cutting mechanism 137 and also closes a normally open safety switch 192 in the circuit of the pusher mechanism 151. The switch 191 is provided to prevent any possibility of starting accidentally the pulling and cutting operation before completion of the coil winding operation. The switch 192 is provided to prevent any possibility of operating accidentally the pusher mechanism 131 during the coiling operation. A second normally open safety switch 193, which will not be closed until the completion of the pulling and cutting operation, is provided in the pusher mechanism circuit to prevent any possibility of starting accidentally the pusher mechanism 151 during the pulling and cutting operation.

After completion of the coiling operation, and after the motor 73 and all motor driven means are positively stopped, the operator then secures the cordage on the right of the helically coiled portion 101 of the spring cord in the clamp 99, and fixedly secures the clamp, which prior thereto was mounted loosely and slidably upon the mandrel 27, to the mandrel to prevent the untwisting of the spring cord 102 when the cordage 12 is cut subsequently by the cutting mechanism 137. Since the rotation of the flyer unit 18 is stopped there will be no more centrifugal forces acting upon the counterweight 146 to counteract the tensional forces of the tension spring 144. The spring 144 therefore will pull the levers 143—143 clockwise and urge the roller 142 against the roller 141 whereby the cordage 12 will be gripped tightly between the rollers 141 and 142, so as to prevent any possibility of the cordage being retracted past these rollers. Further, the cordage 12 gripped between the rollers 141 and 142 is prevented from being untwisted beyond these rollers when the cordage is cut by the cutting mechanism 137.

Subsequently, the operator again actuates with both hands two normally open push-button switches 196–196 to energize a solenoid 197. For safety measures, the operator is to keep his hands on the push-button switches 196—196 during the whole cordage pulling and cutting operation.

The solenoid 197 closes normally open switches 198 and 199 thereby energizing actuating means 120 of the first air cylinder 111 of the pulling mechanism 112 and also energizing the time delay solenoid 202, respectively. The first air cylinder 111 is then operated by its actuating means 120 by admitting the compressed air at one end through the fluid line 119 so that the piston rod 117 car-

ries the roller 118 from the position shown in solid lines into the position shown in phantom lines in FIGS. 2 and 5.

After a predetermined time the solenoid 202 closes a normally open switch 203 thereby energizing the actuating means 125 of the second air cylinder 121 to move the piston rod 123 thereof vertically upward. The piston rod 123 of the second air cylinder 121 engages the first air cylinder 111 and pivots it upwardly from a position shown in FIG. 5 to a position shown in FIG. 6. The roller 118 will therefore be positioned vertically and adjacent to a portion 126 of the cordage 12 extending horizontally between the rollers 141 and 142 and the guide 26.

During any further upward movement of the piston rod 123 of the second air cylinder 121, the first air cylinder 111 actuates the rocker arm 130 which closes the normally open switch 128. The switch 128 then energizes the solenoid 131 which closes the normally open switch 204 inserted into the circuit of the cutting mechanism 137 for safety measures to prevent premature operation thereof. The solenoid 131 also opens a normally closed switch 206 to break the circuit of the solenoid 197. This results in the opening of the normally open switches 198 and 199, deenergization of the time-delay solenoid 202, deactivation of the operating means 120 of the first air cylinder 111 whereupon the piston rod 117 is allowed to be retracted. The retracted piston rod 117 carries therewith the roller 118 which engages the horizontally disposed portion 126 of the cordage 12 and withdraws the predetermined length 131 of the cordage from the pretwisted cordage storing mechanism 46.

Deenergization of the time-delay solenoid 202 results in opening of the normally open switch 203. To prevent premature retraction of the piston rod 123 of the second air cylinder 121 a bridge is provided with normally open switch 207 which also is operated by the solenoid 131 to maintain the circuit through the actuating means 125 closed until it is opened during the subsequent steps of the operation.

As the piston rod 117 is being retracted a portion thereof actuates the rocker arm 133 which causes the normally open switch 132 to be closed. The closing of the switch 132 energizes the suitable control means 138 of the cutting mechanism 137 to operate the air cylinder 136 thereof to cut the length 131 of the cordage 12 into two portions of predetermined lengths. One portion will form the second straight end 104 of the spring cord 102 (FIG. 4), while the other portion will be later used to form the first straight end 103 of the spring cord to be wound upon the mandrel during the subsequent spring cord forming operation.

Simultaneously, with the operation of the cutting mechanism 137, the switch 132 causes energization of a solenoid 208. The solenoid 207 opens a normally closed switch 209 in the circuit of the actuating means 125 for the second air cylinder 121, whereupon the piston rod 123 is retracted to its original position (FIG. 5). The first cylinder 111 is then allowed to return by gravity to its original position (FIG. 5). The solenoid 208 also closes the normally open switch 193 in the circuit of the pusher mechanism 151 to allow the pusher mechanism to be actuated by the operator by means of push-button switches 211—211.

The operator then takes his hands off the push-button switches 196—196 and proceeds to replace the mandrel 27 with the spring cord 102 formed thereon by an empty mandrel in preparation for the subsequent spring cord forming operation. By actuating the push-button switches 211—211 to energize the suitable control means 212 of the pusher mechanism 151, the air cylinder 152 of the pusher mechanism is operated to cause the elastic bumper 157 to engage the mandrel carriage 82 thereby to return the carriage into its original operating position shown in the phantom lines in FIG. 2. The straight portion 103, of the cordage 12, may then be secured in the clamp 98 and the whole operation may be started over.

It is to be understood that the above-described apparatus is simply illustrative of the application of the principles of the invention. It will be observed that various changes and modifications may be made therein without departing from the spirit and scope of the invention.

What is claimed is:

1. Apparatus for forming spring-like articles from strand-like material, which comprises means for supplying a continuous length of such material, a rotatable mandrel to which an end portion of the material to be coiled into a helix thereon is attached, rotatable flyer means through which said material is passed in the travel of said material from said supply means to the mandrel for rotating a bight, formed by successive portions of the material passing through the flyer means, about the rotational axis of the mandrel, means for rotating the mandrel at a predetermined rotational speed, and means for rotating the flyer means at such a speed and in such a direction relative to the speed and direction of rotation of the mandrel that the material is coiled helically upon the mandrel and the relative rotation of the flyer means with respect to the material being supplied by the supply means imparts simultaneously a predetermined axial pretwist to the material in a direction so that the resultant axial twist in the material forming the coils tends to urge the thus-formed coils together to enhance the retractability of the finished spring-like article.

2. Apparatus for forming spring cords from continuous elastic-jacketed cordage, which comprises means for supplying a continuous length of such cordage, a rotatable mandrel to which an end portion of the cordage to be coiled into a helix is attached, a cup-shaped flyer mounted for rotation about the rotational axis of the mandrel and positioned in the path of travel of said cordage from said supply means to the mandrel, first guide means for guiding the cordage from said supply means into said flyer along said rotational axis, second guide means provided on said flyer for guiding said cordage from the first guide means through the flyer and toward the mandrel in such a manner as to form said cordage into a bight for rotation by the flyer about the rotational axis of the mandrel, means for rotating the flyer in a predetermined direction and at a first predetermined speed, and means for rotating the mandrel at a second predetermined rotational speed, the direction and speed of rotation of the mandrel relative to the flyer and the flyer relative to the supply means being such that the cordage is coiled helically upon the mandrel and the flyer imparts simultaneously a predetermined axial pretwist to the cordage in a direction such that the resultant axial twist in the material forming the coils tends to urge the thus-formed coils together to enhance the retractability of the finished spring cord.

3. Apparatus for forming spring cords from continuous elastic-jacketed cordage, which comprises means for supplying a continuous length of such cordage, a rotatable mandrel to which an end portion of the cordage to be coiled into a helix thereon is attached, rotatable flyer means positioned in the path of travel of said cordage from said supply means to the mandrel for rotating a bight of cordage, formed by successive portions of the cordage passing through the flyer means, about the rotational axis of the mandrel, means for rotating the mandrel at a predetermined rotational speed, means for rotating the flyer means at such a speed and in such a direction relative to the speed and direction of rotation of the mandrel that the cordage is coiled helically upon the mandrel and the relative rotation of the flyer means with respect to the material being supplied by the supply means imparts simultaneously a predetermined axial pretwist to the cordage in a direction such that the resultant axial twist in the cordage forming the coils tends to urge the thus-formed coils together to enhance the retractability of the finished spring cord, and means for withdrawing a predetermined length of cordage from said flyer means whereby a length of cordage is provided to form straight ends of the spring cords.

4. Apparatus for forming spring cords from continuous elastic-jacketed cordage, each spring cord having a helically coiled portion with straight ends of predetermined lengths extending therefrom, which comprises means for supplying a continuous length of such cordage, a rotatable mandrel to which an end portion of the cordage to be coiled into a helix thereon is attached, a rotatable flyer positioned in the path of travel of said cordage from said supply means to the mandrel for rotating a bight of cordage, formed by successive portions of the cordage passing through the flyer about the rotational axis of the mandrel, means for rotating the mandrel at a predetermined rotational speed, means for rotating the flyer at such a speed and in such a direction relative to the speed and direction of rotation of the mandrel that the cordage is coiled helically upon the mandrel and the relative rotation of the flyer with respect to the cordage being supplied by the supply means imparts simultaneously a predetermined axial pretwist to the cordage in a direction such that the resultant axial twist in the cordage forming the coils tends to enhance the retractability of the thus-formed helically coiled portion of the spring cord, cordage storing means associated with said flyer for storing a length of the axially pretwisted cordage and designed to permit withdrawal of the stored length of axially pretwisted cordage therefrom, and means for withdrawing a predetermined length of axially pretwisted cordage from said cordage storing means to furnish a predetermined length of cordage required for forming two straight ends, one straight end extending from the helically coiled portion of a spring cord formed on said mandrel and the other straight end being provided for the next spring cord to be formed in the next subsequent operation of the apparatus.

5. Apparatus for forming spring cords from continuous elastic-jacketed cordage, each spring cord having a helically coiled portion with straight ends of predetermined lengths extending therefrom, which comprises means for supplying a continuous length of such cordage, a rotatable mandrel to which an end portion of the cordage to be coiled into a helix thereon is attached, a rotatable flyer positioned in the path of travel of said cordage from said supply means to the mandrel for rotating a bight of cordage, formed by successive portions of the cordage passing through the flyer, about the rotational axis of the mandrel, means for rotating the mandrel at a predetermined rotational speed, means for rotating the flyer at such a speed and in such a direction relative to the speed and direction of rotation of the mandrel that the cordage is coiled helically upon the mandrel and the relative rotation of the flyer with respect to the cordage supplied by the supply means imparts simultaneously a predetermined axial pretwist to the cordage in a direction such that the resultant axial twist in the cordage forming the coils tends to enhance the retractability of the thus-formed helically coiled portion of the spring cord, cordage storing means associated with said flyer for storing a length of the axially pretwisted cordage and designed to permit withdrawal of the stored length of axially pretwisted cordage therefrom, means for withdrawing a predetermined length of axially pretwisted cordage from said cordage storing means to furnish a predetermined length of cordage, and means for severing the withdrawn length at an intermediate point to form two straight ends, one straight end extending from the helically coiled portion of a spring cord formed on said mandrel and the other straight end being provided for the next spring cord to be formed in the next subsequent operation of the apparatus.

6. Apparatus for forming spring cords from elastic-jacketed cordage, which comprises means for supplying a continuous length of such cordage, a rotatable mandrel to which an end portion of the cordage to be coiled into a helix thereon is attached, a rotatable flyer positioned in the path of travel of the cordage from said supply means to the mandrel for rotating a bight of cordage formed by successive portions of the cordage passing through the flyer, about the rotational axis of the mandrel, means for rotating the mandrel at a predetermined rotational speed, means for rotating the flyer at such a speed and in such a direction relative to the speed and direction of rotation of the mandrel that the cordage is coiled helically upon the mandrel and the relative rotation of the flyer with respect to the cordage supplied by the supply means imparts simultaneously a predetermined axial pretwist to the cordage in a direction such that the resultant axial twist in the cordage forming the coils tends to urge the thus-formed coils together to enhance the retractability of the finished spring cord, cordage storing means on the flyer, said cordage storing means including a plurality of rotatable rollers mounted individually on spaced, parallel axes for receiving a portion of said bight of cordage in loop form thereon, spring-biasing means for normally urging said for allowing rapid withdrawal of a predetermined length of the axially pretwisted cordage stored thereon whereby the rollers move against the action of said spring-biased means, and a dashpot associated with said biasing means for retarding the relative movement of the rollers away from each other after the withdrawal of a predetermined length of the cordage therefrom, and cordage stop means for preventing introduction of lengths of axially untwisted cordage into said flyer during the rapid withdrawal of said predetermined length of axially pretwisted cordage from said rollers.

7. Apparatus for forming spring cords from elastic-jacketed cordage, which comprises means for supplying a continuous length of cordage, a rotatable mandrel to which an end portion of the cordage to be coiled into a helix thereon is attached, a rotatable flyer positioned in the path of travel of the cordage from said supply means to the mandrel for rotating a bight of cordage, formed by successive portions of the cordage passing through the flyer, about the rotational axis of the mandrel, means for rotating the mandrel at a predetermined rotational speed, means for rotating the flyer at such a speed and in such a direction relative to the speed and direction of rotation of the mandrel that the cordage is coiled helically upon the mandrel and the relative rotation of the flyer with respect to the cordage supplied by the supply means imparts simultaneously a predetermined axial pretwist to the cordage in a direction such that the resultant axial twist in the cordage forming the coils tends to urge the thus-formed coils together to enhance the retractability of the finished spring cord, a reciprocable member having a cordage-engaging portion at one end thereof designed to engage a portion of the cordage extending between the flyer and the mandrel, and means for moving said member so that said cordage-engaging portion of said member engages said portion of the cordage to withdraw a predetermined length of said cordage from said flyer to furnish a length of cordage required for forming two straight ends, one on the helix of cordage formed on said mandrel and one for a helix of cordage to be formed on a mandrel replacing said mandrel.

8. Apparatus for forming spring cords from elastic-jacketed cordage, which comprises means for supplying a continuous length of such cordage, a rotatable mandrel to which an end portion of the cordage to be coiled into a helix thereon is attached, a rotatable flyer positioned in the path of travel of said cordage from said supply means to the mandrel for rotating a bight formed by successive portions of the cordage about the rotational axis of the mandrel, means for rotating the mandrel at a predetermined rotational speed such that the cordage is coiled helically upon the mandrel and the flyer imparts simultaneously a predetermined axial pretwist to the cordage in a direction so as to tend to urge the thus-formed cords together to enhance the retractability of the finished spring cord, a pivotally mounted, fluid-operated cylinder having a reciprocable piston rod, a cordage-engaging element secured to the free end of said piston rod for movement therewith, means for operating said cylinder to move said rod to an extended position in a direction substantially transverse to a span of cordage extending between the flyer

and the mandrel, and means for pivoting said cylinder with the rod extended into a position whereat said element is located for engaging said span of cordage and withdrawing a loop of cordage when the piston rod is retracted, said loop furnishing the cordage required for forming two straight ends, one straight end on the helix of the cordage formed on said mandrel and the other straight end for a helix of cordage to be formed on a mandrel replacing said mandrel.

9. Apparatus for forming spring cords from continuous elastic-jacketed cordage, which comprises means for supplying a continuous length of cordage, a rotatable mandrel to which an end portion of the cordage to be coiled into a helix is attached, a cup-shaped flyer mounted for rotation about the rotational axis of the mandrel and positioned in the path of travel of said cordage from said supply means to the mandrel, a first guide means for guiding the cordage from said supply means into said flyer along said rotational axis, second guide means provided on said flyer for guiding said cordage from the first guide means along the length of the flyer and toward the mandrel to form said cordage into a bight about the rotational axis of the mandrel, means for rotating the mandrel at a predetermined rotational speed such that the cordage is coiled helically upon the mandrel and the flyer imparts simultaneously a predetermined axial pretwist to the cordage, a reciprocable member having a cordage-engaging portion at one end thereof for engaging a portion of the cordage extending between the flyer and the mandrel, means for reciprocating said member into a predetermined position whereat said cordage-engaging portion of said member engages said portion of the cordage and withdraws a predetermined length of said cordage from said flyer to furnish a length of cordage required for forming two straight ends, one on the helix of cordage formed on said mandrel and one for a helix of cordage to be formed on a mandrel replacing said mandrel.

10. Apparatus for forming spring cords from continuous elastic-jacketed cordage, which comprises means for supplying a continuous length of such cordage, a rotatable mandrel to which an end portion of the cordage to be coiled into a helix is attached, a cup-shaped flyer mounted for rotation about the rotational axis of the mandrel and positioned in the path of travel of said cordage from said supply means to the mandrel, first guide means for guiding the cordage from said supply means into said flyer along said rotational axis, second guide means provided on said flyer for guiding said cordage from the first guide means through the flyer and toward the mandrel in such a manner as to form said cordage into a bight for rotation by the flyer about the rotational axis of the mandrel, means for rotating the flyer at a first predetermined speed, means for rotating the mandrel at a second predetermined rotational speed, the direction and speed of rotation of the mandrel relative to the flyer being such that the cordage is coiled helically upon the mandrel and the flyer imparts simultaneously a predetermined axial pretwist to the cordage in a direction so as to tend to urge the thus-formed coils together to enhance the retractability of the finished spring cord, a reciprocable member having a cordage-engaging portion at one end thereof designed to engage a portion of the cordage extending between the flyer and the mandrel, means for reciprocating said member into a predetermined position whereat said cordage-engaging portion of said member engages said portion of the cordage and withdraws a predetermined length of said cordage from said flyer, and means for severing the withdrawn length of the cordage at an intermediate point to form two straight ends, one on the helix of cordage formed on said mandrel and one for a helix of cordage to be formed on a mandrel replacing said mandrel.

11. Apparatus for forming spring cords from continuous elastic-jacketed cordage, which comprises means for supplying a continuous length of such cordage, a rotatable mandrel to which an end portion of the cordage to be coiled into a helix is attached, a cup-shaped flyer mounted for rotation about the rotational axis of the mandrel and positioned in the path of travel of said cordage from said supply means to the mandrel, first guide means for guiding the cordage from said supply means into said flyer along said rotational axis, second guide means provided on said flyer for guiding said cordage from the first guide means through the flyer and toward the mandrel in such a manner as to form said cordage into a bight for rotation by the flyer about the rotational axis of the mandrel, means for rotating the flyer at a first predetermined speed, means for rotating the mandrel at a second predetermined rotational speed, the direction and speed of rotation of the mandrel relative to the flyer being such that the cordage is coiled helically upon the mandrel and the flyer imparts simultaneously a predetermined axial pretwist to the cordage in a direction so as to tend to urge the thus-formed coils together to enhance the retractability of the finished spring cord, a reciprocable member having a cordage-engaging element, means for reciprocating said member between a first position whereat the cordage-engaging element is juxtaposed to a portion of the cordage extending between the flyer and the mandrel and a second position whereat said cordage-engaging element is removed from said first position, said cordage-engaging element being designed to engage the cordage and withdraw a loop of said cordage of predetermined length during movement of the reciprocable member between said first and second positions thereof, and means positioned along the path of travel of said withdrawn loop of the cordage for severing the withdrawn cordage to form two predetermined straight ends of cordage, one straight end on the helix of the cordage formed on said mandrel and the other straight end for a helix of cordage to be formed on a mandrel replacing said mandrel.

12. In apparatus for forming spring cords wherein a first portion of a length of cordage normally extends between a cordage supply and a mandrel upon which a second portion of said length is coiled in a helix, the improvement which comprises a reciprocable member having a cordage-engaging element, and means for reciprocating said member between a first position whereat the cordage-engaging element is juxtaposed to said first portion of the cordage and a second position whereat said cordage-engaging element is removed from said first position, said cordage-engaging element being designed to engage the cordage and withdraw a loop of said cordage during movement of the reciprocable member between said first and second positions thereof.

13. In apparatus for forming spring cords wherein a first portion of a length of cordage normally extends between a cordage supply and a mandrel upon which a second portion of said length is coiled in a helix, the improvement which comprises a reciprocable member having a cordage-engaging element, means for reciprocating said member between a first position whereat the cordage-engaging element thereof is in the near vicinity of said cordage and a second position whereat said cordage-engaging element is removed from said first position, and means for moving said cordage-engaging element into a position whereat said cordage-engaging element traverses said cordage and withdraws a loop thereof of a predetermined length during the reciprocating of said member between said first and second positions, said cordage-engaging element following a closed path during the reciprocating cycle of the reciprocable member.

14. In apparatus for forming spring cords wherein a first portion of a length of cordage normally extends between a cordage supply and a mandrel upon which a second portion of said length is coiled in a helix, the improvement which comprises a fluid-operated cylinder having a reciprocable piston rod, a cordage-engaging element secured to the free end of said piston rod for reciprocable motion therewith, and means for operating said cylinder to reciprocate said rod substantially transversely to said first portion of the cordage, in a manner such that the

said cordage-engaging element engages said first portion of cordage and withdraws a loop of cordage of a predetermined length required for forming two straight ends, one straight end on the helix of the cordage formed on said mandrel and the other straight end for a helix of cordage to be formed on a mandrel replacing said mandrel.

15. In apparatus for forming spring cords wherein a first portion of a length of cordage normally extends between a cordage supply and a mandrel upon which a second portion of said length is coiled in a helix, the improvement which comprises a pivotally mounted, fluid-operated cylinder having a reciprocable piston rod, a cordage-engaging element secured to the free end of said piston rod for movement therewith, means for operating said cylinder to move said rod to an extended position in a direction substantially transverse to said first portion of the cordage, and means for pivoting said cylinder with

the rod extended into a position whereat said element is located for engaging and withdrawing a loop of cordage when the piston rod is retracted, said loop furnishing the cordage required for forming two straight ends, one straight end on the helix of the cordage formed on said mandrel and the other straight end for a helix of cordage to be formed on a mandrel replacing said mandrel.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,016,571 January 16, 1962

George P. Adams

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 7, line 28, for "retractibility" read -- retractability --; column 8, line 38, for "131" read -- 151 --; column 12, line 15, after "said" insert -- rollers apart, said rollers being movable toward each other --.

Signed and sealed this 15th day of May 1962.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents