

March 13, 1962

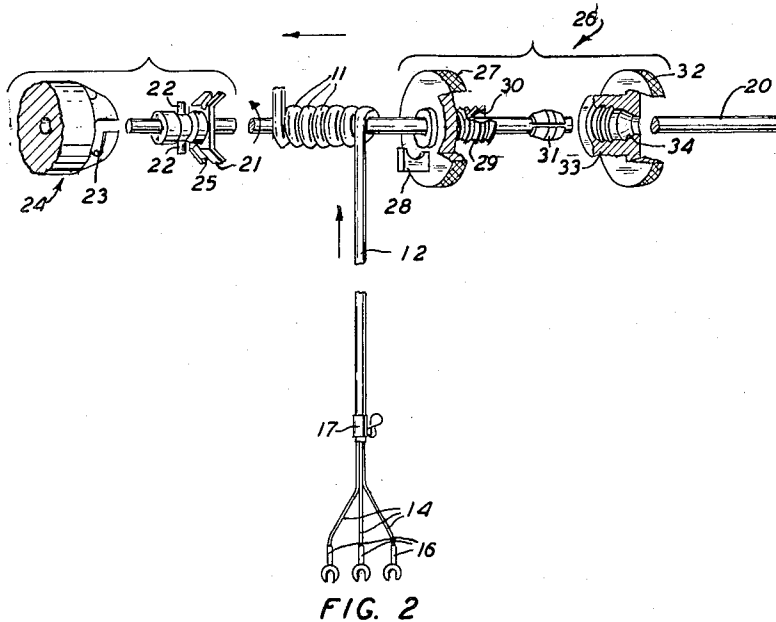
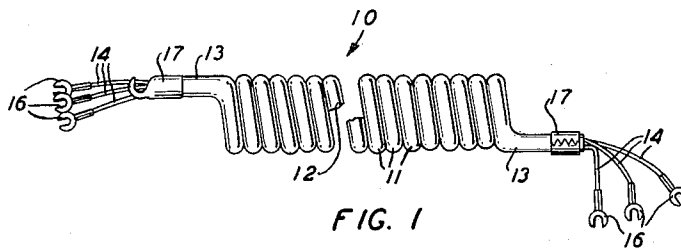
E. C. HARDESTY ET AL

3,024,497

APPARATUS FOR WINDING STRAND MATERIAL IN A HELIX

Filed May 28, 1958

10 Sheets-Sheet 1



INVENTORS
E. C. HARDESTY
D. L. MYERS
BY *a. c. Schwarz, Jr.*
ATTORNEY

March 13, 1962

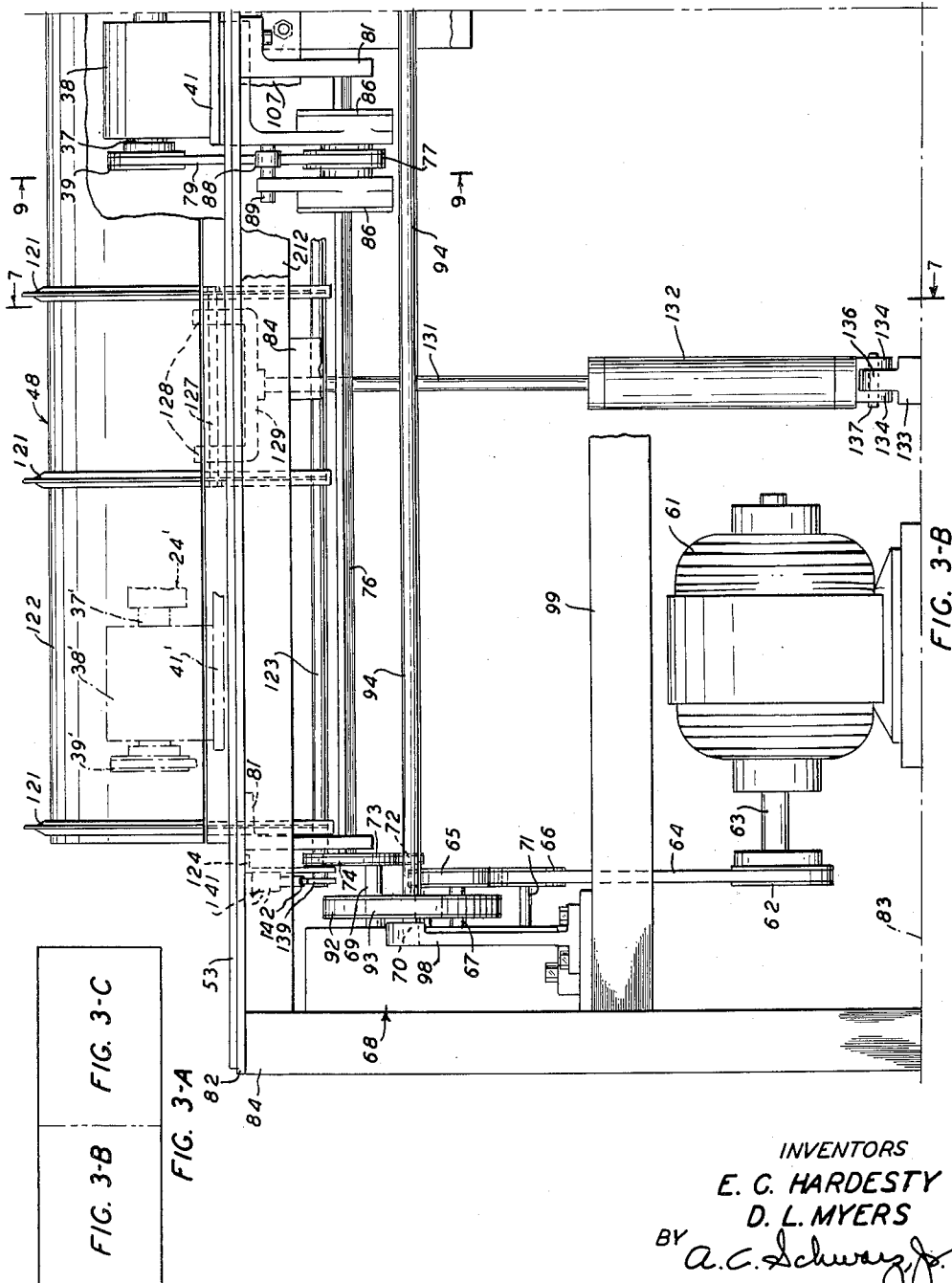
E. C. HARDESTY ET AL

3,024,497

APPARATUS FOR WINDING STRAND MATERIAL IN A HELIX

Filed May 28, 1958

10 Sheets-Sheet 2



INVENTORS
E. C. HARDESTY
D. L. MYERS
BY *A. C. Schwarz*
ATTORNEY

March 13, 1962

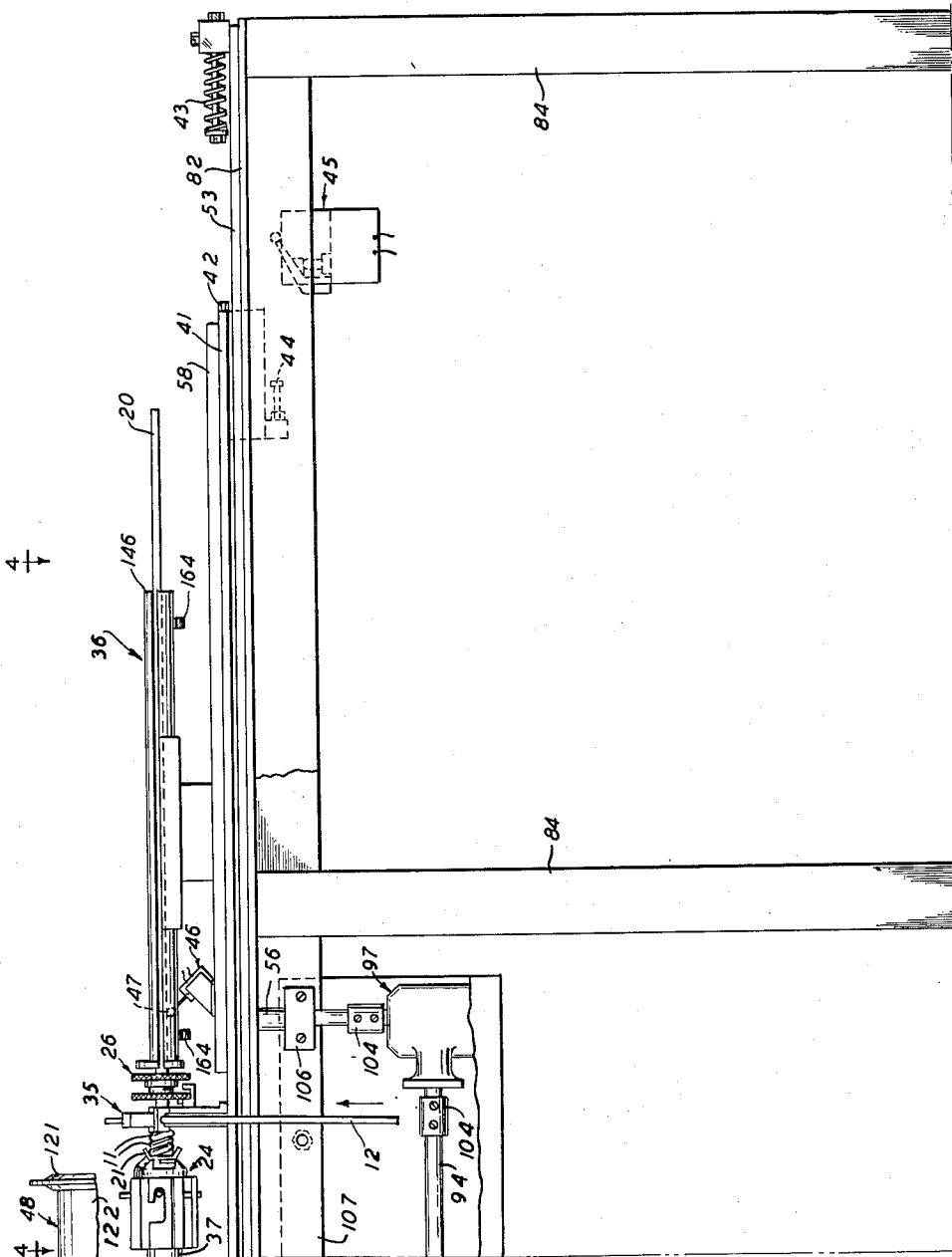
E. C. HARDESTY ET AL

3,024,497

APPARATUS FOR WINDING STRAND MATERIAL IN A HELIX

Filed May 28, 1958

10 Sheets-Sheet 3



March 13, 1962

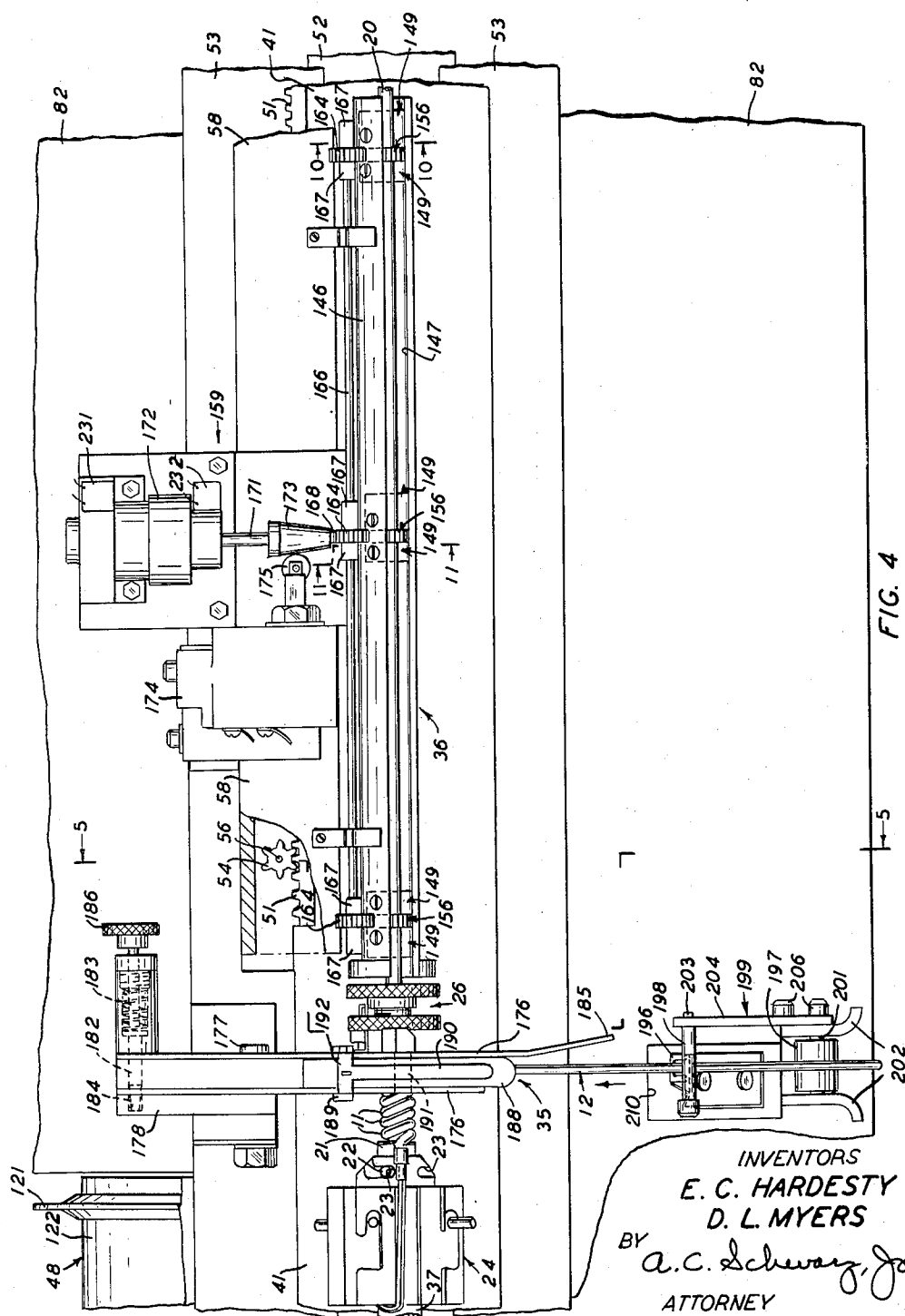
E. C. HARDESTY ETAL

3,024,497

APPARATUS FOR WINDING STRAND MATERIAL IN A HELIX

Filed May 28, 1958

10 Sheets-Sheet 4



March 13, 1962

E. C. HARDESTY ET AL

3,024,497

APPARATUS FOR WINDING STRAND MATERIAL IN A HELIX

Filed May 28, 1958

10 Sheets-Sheet 5

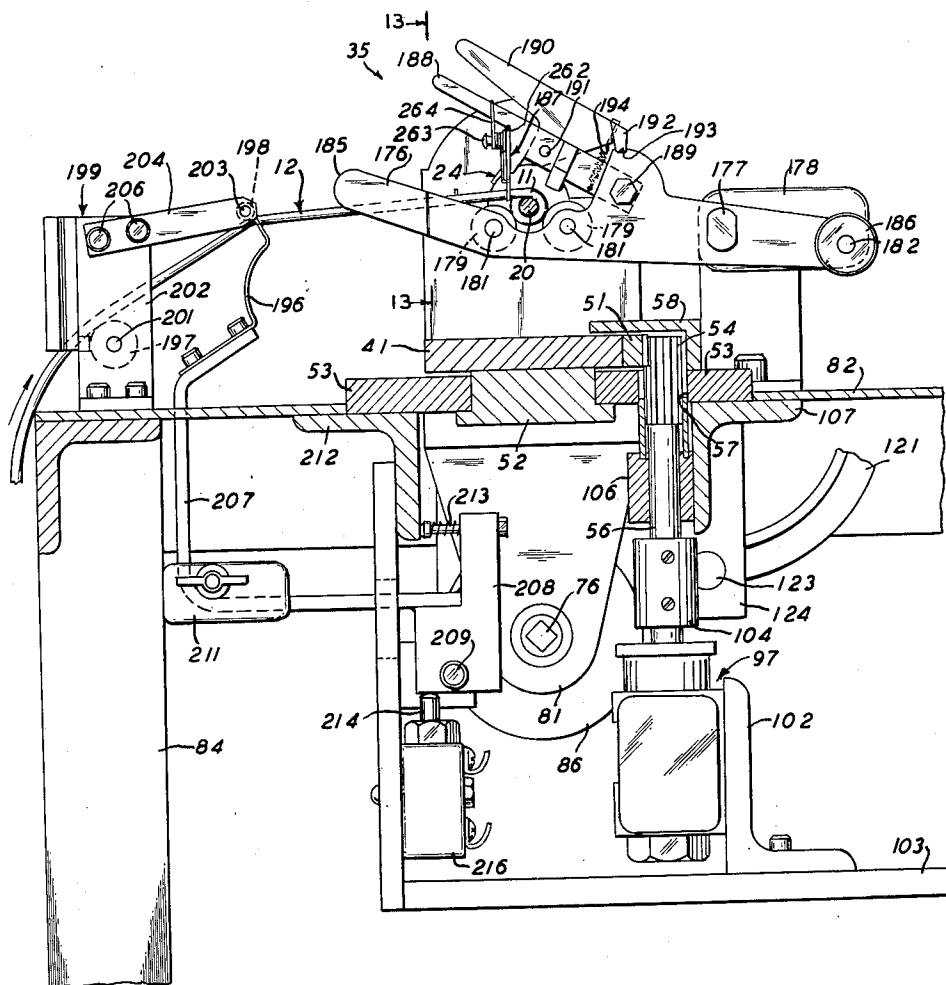


FIG. 5

INVENTORS
E. C. HARDESTY
D. L. MYERS
BY *a.c. Schwarz, Jr.*
ATTORNEY

E. C. HARDESTY ETAL

APPARATUS FOR WINDING STRAND MATERIAL IN A HELIX

10 Sheets-Sheet 6

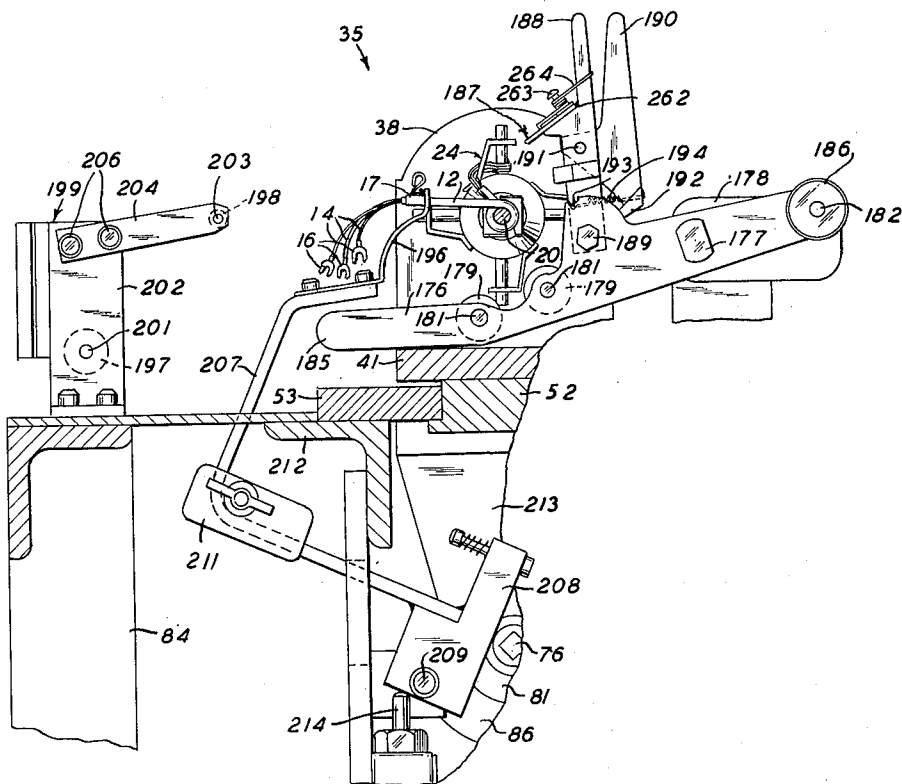


FIG. 6

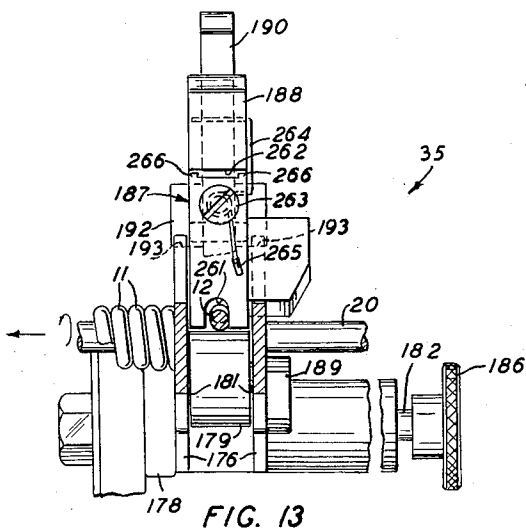


FIG. 13

INVENTORS
E. C. HARDESTY
D. L. MYERS
BY *a. c. Schwarz, Jr.*
ATTORNEY

March 13, 1962

E. C. HARDESTY ETAL

3,024,497

APPARATUS FOR WINDING STRAND MATERIAL IN A HELIX

Filed May 28, 1958

10 Sheets-Sheet 7

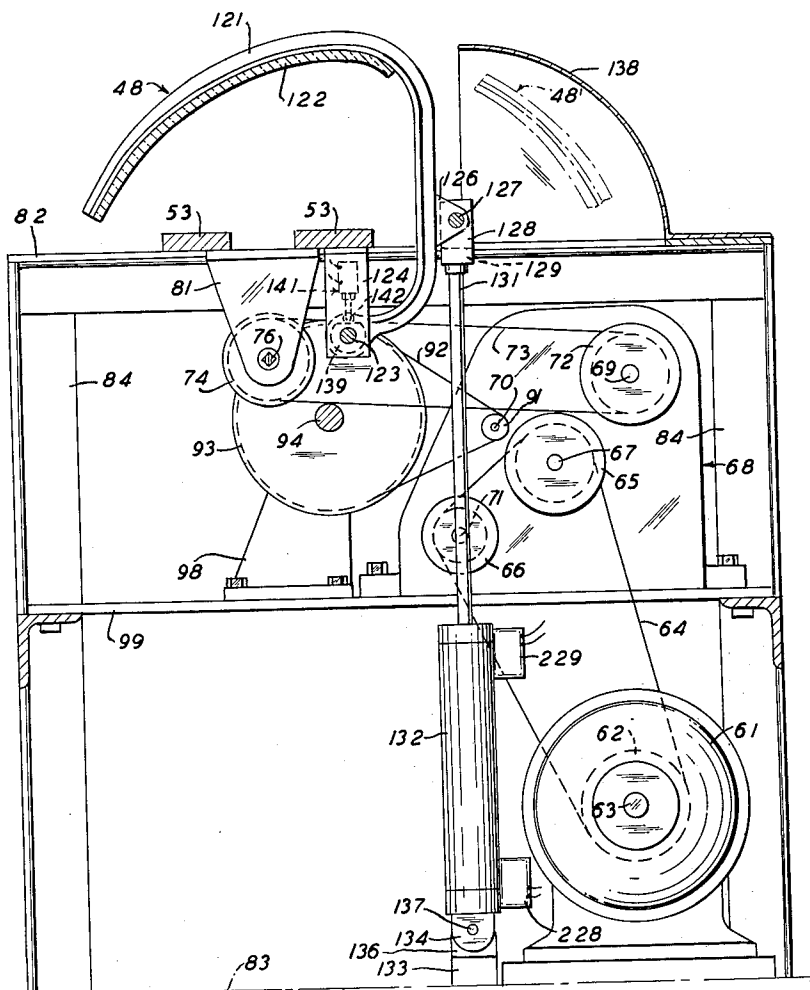


FIG. 7

INVENTORS
E. C. HARDESTY
D. L. MYERS
BY *A. C. Scherz, Jr.*
ATTORNEY

March 13, 1962

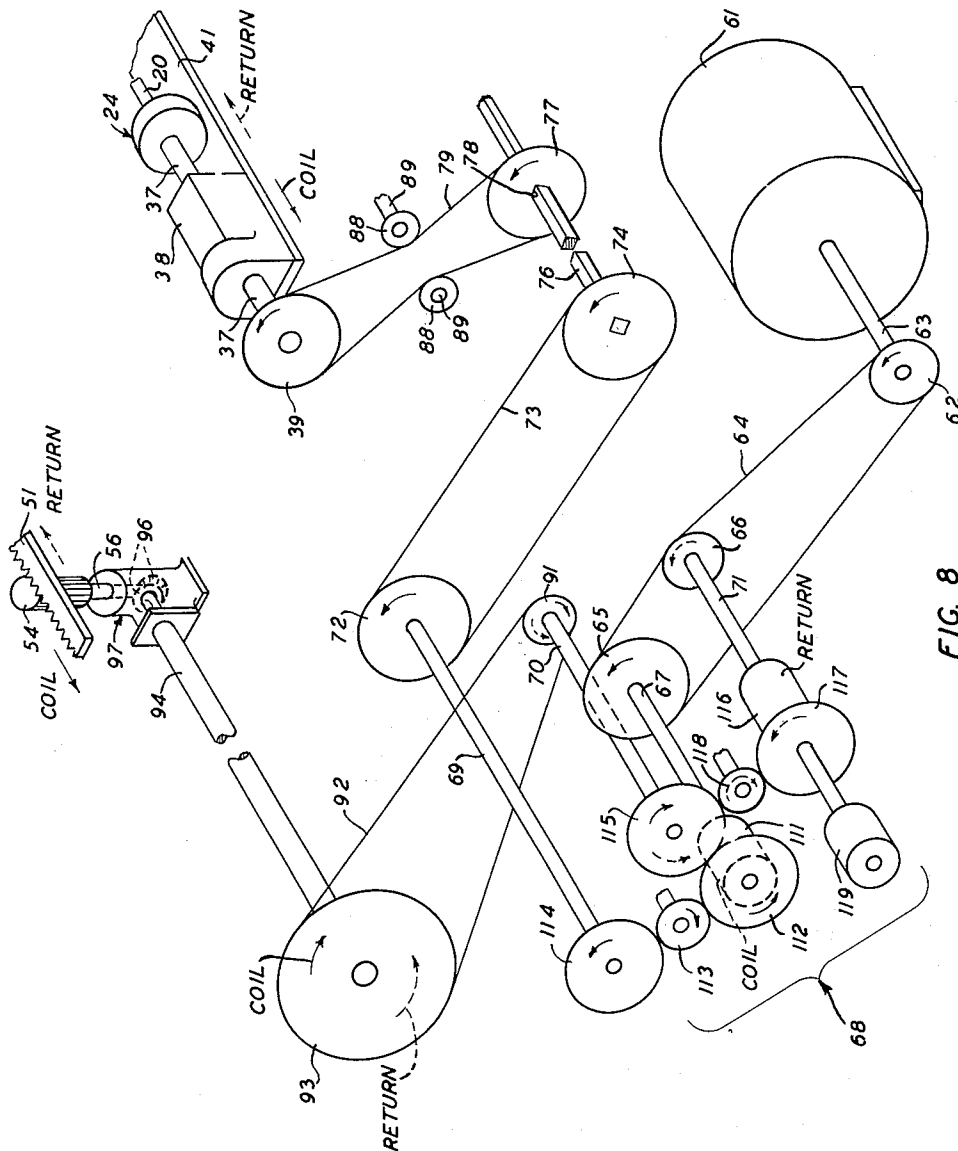
E. C. HARDESTY ETAL

3,024,497

APPARATUS FOR WINDING STRAND MATERIAL IN A HELIX

Filed May 28, 1958

10 Sheets-Sheet 8



INVENTORS
E. C. HARDESTY
D. L. MYERS
BY *A. C. Schwarz, Jr.*
ATTORNEY

March 13, 1962

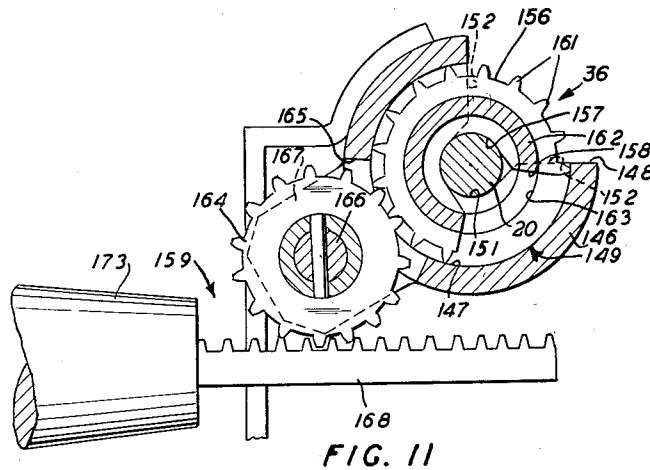
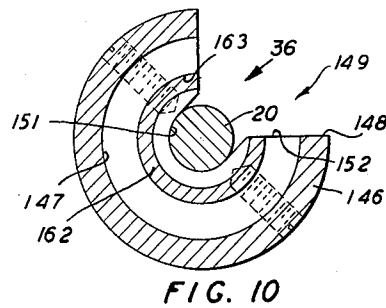
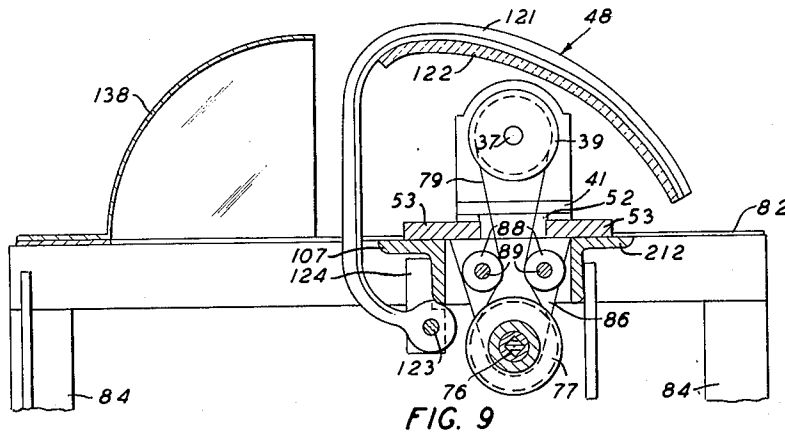
E. C. HARDESTY ETAL

3,024,497

APPARATUS FOR WINDING STRAND MATERIAL IN A HELIX

Filed May 28, 1958

10 Sheets-Sheet 9



INVENTORS
E. C. HARDESTY
D. L. MYERS
BY *a.c. Schweg, Jr.*
ATTORNEY

March 13, 1962

E. C. HARDESTY ET AL

3,024,497

APPARATUS FOR WINDING STRAND MATERIAL IN A HELIX

Filed May 28, 1958

10 Sheets-Sheet 10

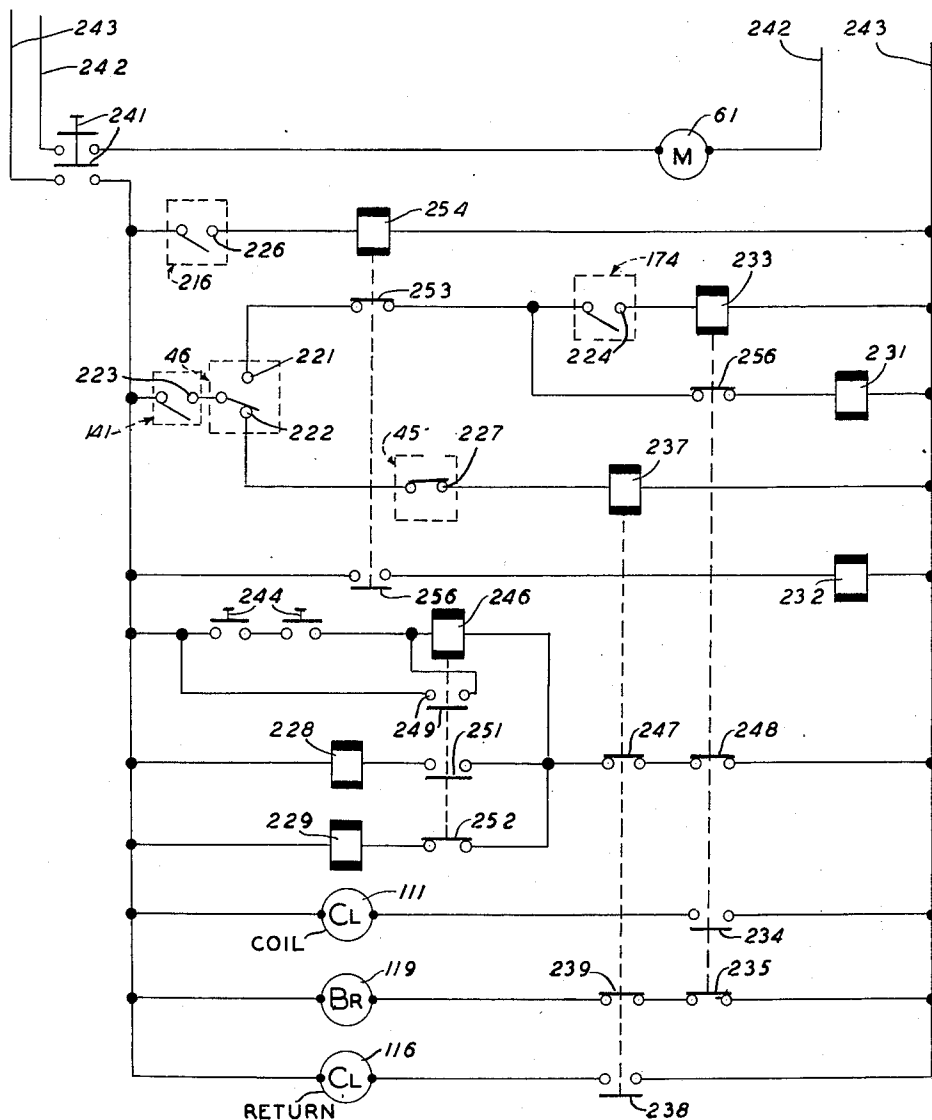


FIG. 12

INVENTORS
E. C. HARDESTY
D. L. MYERS
BY *a. c. Schwegel, Jr.*
ATTORNEY

1

3,024,497

APPARATUS FOR WINDING STRAND MATERIAL IN A HELIX

Edwin C. Hardesty and Daryl L. Myers, Baltimore, Md.,
assignors to Western Electric Company, Incorporated,
New York, N.Y., a corporation of New York

Filed May 28, 1958, Ser. No. 738,439

15 Claims. (Cl. 18—19)

The present invention relates generally to apparatus 10
for winding strand material in a helix, and more particu-
larly to apparatus for winding strand material in a helix
along a portion of the length of a rotating and longitudi-
nally moving mandrel. The apparatus is particularly use-
ful for coiling a jacketed, conducting cord in a compact 15
helix as a step in the manufacture of spring cords.

In the telephone field and in the field of various elec-
trical appliances, it has been the practice in certain appli-
cations to utilize spring or retractile cords, a common
example of which is the cord extending between the base
and the headpiece of a telephone handset. The spring
cords are formed so that the major portion thereof is in
the form of a compact helical coil, which will lengthen
when slight tension is applied thereto but will return to its
compactly coiled position when the tension is removed.

There are two general processes now used to form
spring cords satisfactorily, both of which require the wind-
ing of the cordage in a helix as a step in the process.
One method is disclosed generally in U.S. Patent No.
2,413,715, issued on January 7, 1947 to A. R. Kemp et al.,
and includes the step of winding a length of cordage in
a helix on a mandrel while imparting a predetermined
axial twist to the cordage being wound. The axially-
twisted helix is then heat treated to cure the jacketing
material and form the desired spring cord.

The second method is disclosed in applicants' copend-
ing application Serial No. 681,035, filed on August 29,
1957, now Patent No. 2,920,351, issued January 12, 1960,
and includes the steps of winding a length of cordage in
a helix without axial pretwist, heat treating the cord to
set the helical shape therein, reversing the pitch of the
convolutions of the cord, overtwisting the cord during the
reversal of pitch thereof, and then removing substantially
all of the overtwist from the cord. A preferred apparatus
for practicing the last-mentioned method is disclosed in
a copending application Serial No. 681,034, filed on Aug-
ust 29, 1957 in the name of E. L. Franke, Jr., now Pat-
ent No. 2,920,348, issued January 12, 1960. With this
apparatus, the ends of a coiled cord are secured between
a pair of chucks, which advance along a conveyor. Dur-
ing the advancement along the conveyor, the chucks are
driven in opposite directions designed to reverse the pitch,
overtwist, and then remove the overtwist.

The present invention relates generally to apparatus
for coiling the cordage and is applicable as a step in the
manufacture of spring cords under either of the general
methods just described. The apparatus will be described
specifically for winding the cordage according to the sec-
ond method, without axial pretwist. This is the preferred
and simplest form, the product formed according to this
invention being especially suitable as the starting material
for the apparatus disclosed in the Franke, Jr., patent.

The primary object, therefore, of the present invention
is to provide new and improved apparatus for winding
strand material in a helix along a portion of the length
of a mandrel.

In more detail, an object of the invention is to pro-
vide apparatus for winding a jacketed, conducting cord
in a compact helix along a portion of the length of a
rotating and longitudinally moving mandrel as a step in
the manufacture of spring cords.

2

Another object of the invention is to provide a new
and improved support for a rotatable rod, particularly
for the rotatable and longitudinally movable mandrel
forming a part of the helix-winding apparatus.

A further object of the invention is to provide a com-
bined strand guide and operation-terminating means, es-
pecially suitable for use in combination with the helix-
winding apparatus to terminate the operation at a desired
point.

Still another object of the invention is to provide ap-
paratus for guiding a strand being wound in a helix along
a portion of the length of a rotating and longitudinally
moving mandrel and for forming the strand being wound
into a uniform, tight helix about the mandrel.

Yet another object of the invention is to provide ap-
paratus for constraining a strand being wound in a helix
on a rotating and longitudinally moving mandrel to wind
in closely packed convolutions.

An apparatus for winding strand material in a helix
along a portion of the length of a mandrel, the strand
material being provided with an enlarged portion adjacent
to a point therealong where it is desired to terminate the
helix-winding operation, illustrating certain features of
the invention, may include rotatable means for clamping
one end of mandrel to which the strand to be wound is
secured. A mandrel support is provided, designed for
first receiving portions of the length of the mandrel extend-
ing from the clamping means and for then supporting the
mandrel for both rotation and longitudinal move-
ment with respect thereto. Also provided are means po-
sitioned adjacent to the mandrel for guiding the strand
to the mandrel and means for rotating the clamping means
and for moving the same longitudinally to wind the strand
in a helix along a portion of the length of a mandrel.
Roller means are provided, mounted adjacent to the wind-
ing point, for smoothing and compressing the strand ma-
terial into a uniform, tight helix about the mandrel. Also
provided are operation-terminating means, which are so
constructed and arranged as to respond to the advance-
ment of the enlarged portion of the strand and to termi-
nate the helix-winding operation at a point where the
enlarged portion is positioned a desired distance from
the mandrel.

A mandrel support, which is generally designed to sup-
port any rotatable rod for ready insertion and removal,
may include a plurality of retaining members, each hav-
ing an arcuate rod-receiving seat extending therethrough
and an entrance aperture extending between the outer
surface of the member and the seat. The retaining mem-
bers are normally mounted so that their seats and en-
trance apertures are in alignment to permit sidewise in-
sertion of a mandrel to the aligned entrance apertures for
support across the aligned seats. Means are provided for
causing relative rotation between the retaining members
about the center line of the mandrel and through an angle
designed so that the entrance apertures and seats of cer-
tain ones of the retaining members are angularly displaced
from the apertures and seats of other ones of the retain-
ing members and the mandrel is supported about its pe-
riphery by the now-displaced arcuate seats for rotation
therewithin.

Operation-terminating means, useful especially with the
helix-winding apparatus but applicable generally to other
strand-working apparatus may include a strand-engaging
member having a restricted guide aperture designed to
fit closely about normal-diameter portions of the strand
advancing therethrough to the mandrel. The strand-en-
gaging member is mounted for movement toward and
away from the mandrel substantially along the line of
advancement of the strand and means are provided for
biasing the strand-engaging member to a first position
spaced a first distance from the mandrel. The strand

3

is provided with an enlarged portion adjacent to a point therealong where it is desired to terminate the winding operation, and the enlarged portion engages and catches in the restricted aperture of the strand-engaging member so that further advancement of the strand is designed to move the strand-engaging member, against the action of the biasing means, toward the mandrel. Means are provided, responsive to a predetermined amount of movement of the strand-engaging member, for terminating the winding operation at a point where the enlarged portion of the strand is positioned a desired distance away from the mandrel.

A strand-guiding and helix-forming apparatus, according to the invention, may include means for guiding a strand into a winding engagement with a rotating and longitudinally moving mandrel. A pair of helix-forming rollers are mounted for rotation about individual axes parallel to the mandrel and positioned, with respect to the mandrel and the guiding means, so that the peripheries of the rollers engage compressively each strand convolution as it is wound on the mandrel in order to smooth and compress the strand being wound into a uniform, tight helix about the mandrel.

Conveniently, the strand-forming rollers are mounted on a support, which is pivotable between a closed position wherein the rollers engage the strand being wound and an open position wherein the rollers are pivoted away from a fully-wound mandrel to facilitate removal thereof and insertion of a subsequent mandrel. The means for guiding the strand include a strand guide, which is mounted on a supporting lever for pivoting movement independent of the pivoting movement of the roller support. The lever is pivotable between a closed position, wherein the strand guide is positioned to engage the advancing strand close to the mandrel and guide the same into winding engagement therewith, and an open position, wherein the strand guide is pivoted away from the fully-wound mandrel to facilitate removal thereof and insertion of a subsequent mandrel.

An apparatus for constraining a strand being wound in a helix on a rotating and longitudinally moving mandrel to wind in closely packed convolutions, illustrating certain features of the invention, may include a strand guide having a guide aperture for directing the strand toward the mandrel. The strand guide is movable in a plane generally transverse to the line of advancement of the strand and means are provided for biasing the strand guide in the direction of the helix being wound on the mandrel. With this arrangement, the advancing strand bears on the wall of the guide aperture on the side opposite to the helix being wound on the mandrel, so that the strand guide may be moved by the preponderating one of the forces exerted by the biasing means and the strand, respectively, to assume a position where the strand is wound in closely packed helical convolutions on the mandrel.

Other objects and advantages of the invention will appear from the following detailed description of a specific embodiment thereof, when read in conjunction with the appended drawings, in which:

FIG. 1 illustrates a complete spring cord that may be produced with apparatus embodying the invention;

FIG. 2 is a perspective view of a mandrel showing cordage partially wound thereon, a chuck for rotating the mandrel, and cordage clamps, portions of the apparatus being shown exploded from their normal positions to illustrate structural details;

FIG. 3-A is a diagram illustrating how to combine FIGS. 3-B and 3-C into a composite view;

FIGS. 3-B and 3-C combined as shown in FIG. 3-A, constitute a front view of an apparatus embodying the invention, with portions broken away to reveal structural details;

FIG. 4 is an enlarged, top plan view of a portion of the apparatus shown in FIG. 3-C, taken generally along the line 4-4 of FIG. 3-C but with portions broken away to reveal details of the internal structure;

4

FIG. 5 is a sectional, side view taken generally along the line 5-5 of FIG. 4 and illustrating, among other things, details of a cordage-guide assembly, shown in helix-winding position;

FIG. 6 is a view of a portion of the apparatus illustrated as in FIG. 5, but showing the cordage-guide in its after-winding position;

FIG. 7 is a sectional, side view taken along the line 7-7 of FIG. 3-B and illustrating primarily portions of a mandrel-moving mechanism and a protective guard for the apparatus;

FIG. 8 is a schematic, exploded view of the gearing provided for the mandrel-moving mechanism shown in FIGS. 3-B, 3-C and 7;

FIG. 9 is a sectional, side view taken along the line 9-9 of FIG. 3-B and illustrating primarily portions of the mandrel-rotating mechanism;

FIG. 10 is an enlarged, sectional, side view taken generally along the line 10-10 of FIG. 4 and illustrating details of a mandrel support;

FIG. 11 is an enlarged, sectional, side view taken generally along the line 11-11 of FIG. 4 and illustrating other details of the mandrel support;

FIG. 12 is a schematic diagram of an electrical control circuit forming a part of the apparatus, and

FIG. 13 is a fragmentary, side view taken along the line 13-13 of FIG. 5 and illustrating portions of the cordage guide assembly.

Mandrel and Coiling Operation in General

Referring now in detail to the drawings and in particular to FIG. 1, there is shown a complete spring cord 10, which may be formed utilizing the apparatus of the invention. The spring cord 10 has a central section consisting of a plurality of closely-packed helical turns 11-11 of jacketed cordage 12 and a pair of straight end portions 13-13. The present invention is concerned generally with apparatus for winding strand material into a helix and particularly with apparatus for winding a predetermined length of jacketed cordage into the helical turns 11-11 as a step in the manufacture of spring cords.

The jacketed cordage 12 includes a core composed of a plurality of individually insulated conductors 14-14, preferably tinsel conductors, positioned parallel to each other and enclosed in a paper tape. The paper-covered core is then enclosed in a tough elastic jacket, such as polyvinyl chloride. The jacketing material is preferably extruded over the paper-covered core to form a long, straight length of jacketed cordage. Portions of this cordage are then wound into helical form, being cut to length either after or preferably before the helix-winding operation, and the coiled cord is thereafter cured by appropriate heat treatment to set the jacketing material in its coiled form.

A portion of the jacket adjacent to each of the ends 13-13 of the spring cord 10 is stripped from the conductors 14-14, a solderless terminal tip 16 is secured to the end of each of the conductors 14-14, and then a stay band 17 is crimped about the jacket near each extremity thereof. The stripping, tipping and banding operations may be performed after the helix-winding operation, as was the practice heretofore; however, in accordance with certain features of the invention, a predetermined straight length of the jacketed cordage may be cut and the ends stripped, tipped and banded previous to coiling in helical form. This latter sequence of operation is preferred, since it is easier to cut, strip, tip and band the cordage before coiling than after and such a sequence is more susceptible to mass-production assembly techniques.

In FIG. 2, a straight length of the cordage 12 is shown partially wound in helical turns 11-11 about a winding mandrel 20. A square, notched flange 21 is secured to one end of the mandrel, which becomes the first-wound or lead end thereof. The lead end of the

mandrel 20 is formed with a pair of opposed pins 22—22 projecting radially therefrom, which may be inserted within a pair of L-shaped retaining slots 23—23 formed within a rotary chuck, generally designated by the numeral 24. This pin-and-slot connection allows the mandrel 20 to be readily connected to and disconnected from the chuck 24, but provides a positive connection for rotating the mandrel 20.

Prior to the coiling operation, a lead end of the cordage 12 is threaded through a notch 25 in the flange 21 and the individual conductors 14—14 protruding from that end are secured to the chuck 24 to prevent flapping thereof during rotation of the mandrel. The chuck 24 is then rotated to draw the following cordage 12 onto the mandrel and is simultaneously moved longitudinally, in predetermined synchronism with the speed of rotation, to wind the following cordage 12, generally, in a uniform series of closely-packed helical turns 11—11 along a desired portion of the length of the mandrel 20. The longitudinal speed should preferably be regulated to approximately one cord-width (as wound) for each revolution of the mandrel in order to provide, generally, for winding of the cordage 12 in a closely-packed helix; however, it should be understood that various relative speeds might be employed depending on the pitch of the helix desired.

A retaining member, designated generally by the numeral 26, the components of which are shown in exploded positions in FIG. 2, is mounted on the mandrel 20 for sliding movement therealong during the winding operation. After the winding operation, the member 26 is designated to be tightened on the mandrel 20 in abutment with the last-wound helical convolution 11.

The retaining member 26 consists of an inner knurled wheel 27 fitting loosely about the mandrel 20 and having a cordage-retaining clip 28 extending therefrom. An externally threaded boss 29 projects from the wheel 27 on the side opposite from the clip 28 and is formed with a conically tapered aperture 30 at its extremity. A bushing 31, made of nylon tetrafluoroethylene, sold under the trademark Teflon, or other resilient material, is likewise mounted loosely on the mandrel 20 and is designed for partial reception in the aperture 30.

An outer knurled wheel 32 is also loosely mounted on the mandrel 20 and has an internally threaded hub 33 facing the boss 29 for threadable reception thereabout. The hub 33 is formed with an inner conically tapered aperture 34 designed for partial reception of the bushing 31. The outer wheel 32 is normally screwed on the boss 29 of the inner wheel to a point where the bushing 31 is received loosely within the opposing conical apertures 30 and 34, this assembly constituting the retaining member 26 and being slidable along the mandrel 20 during the winding operation.

After the winding operation, the retaining member 26 is slid into contact with the last wound turn 11, the free end of cordage 12 is placed through the clip 28, and then the outer wheel 32 is further tightened about the boss 29 to compress the bushing 31 into contact with the mandrel 20, thus locking the retaining member 26, as a unit, about the mandrel 20.

The mandrel 20, with the cordage 12 coiled thereon and firmly affixed thereto is next conveyed to a heat treating oven to set the cordage in its helical shape. Upon completion of the heating operation, the coiled cordage 12 may be removed from the mandrel 20 by backing off the outer wheel 32 a fraction of a turn, so that the bushing 31 is no longer compressed against the mandrel 20, and then sliding the retaining member 26 lengthwise off of the free end of the mandrel 20. The lead end 13 of the coiled cordage 12 may then be unfastened from the notch 25 so that the coiled cordage likewise may be drawn lengthwise off the mandrel. The retaining member 26 is then slid back onto the mandrel,

which may be returned to the coiling station for a subsequent coiling operation.

The withdrawn coil of cordage will appear as shown in FIG. 1 and may in some cases comprise a complete spring cord, especially if an axial pretwist was imparted to the cordage during the coiling operation as described in the Kemp et al. patent or the copending application of applicant Hardesty. In other cases, the pitch of the convolutions of the cord wound according to this invention may be reversed in a subsequent operation, preferably as described in applicants' before-mentioned copending application to form the complete spring cord. In either case, the apparatus to be described now is effective in winding the helically coiled portion rapidly and effectively.

Overall Arrangement of Apparatus

Referring now to FIGS. 3-B and 3-C, combined as indicated in FIG. 3-A, a complete coiling apparatus, embodying certain features of the invention, is shown in side elevation. A mandrel 20, such as the mandrel just described, is inserted into a mandrel support, designated generally by the numeral 36, best seen in FIGS. 5, 10 and 11, and to be described in detail hereinafter under the heading Mandrel Support. The mandrel 20 is positioned within the support 36 so that the left-hand or lead end of the mandrel extends to the left, as seen in FIG. 3-C, of the support 36 with the slidable retaining member 26 positioned just to the left of the support 36. In this before-coiling position, a major portion of the length of the mandrel 20 rests across and within the support 36, being supported thereby for both rotational and longitudinal movement with respect thereto.

The lead end of the mandrel 20 is then fastened to a rotary chuck 24, such as the chuck described above, and one end of a length of cordage 12 is secured to the mandrel 20 by the flange 21, as previously described, to enable the winding of the cordage in a helix on the mandrel. The cordage 12 advances to the mandrel 20 through a cordage-guide assembly, designated generally by the numeral 35, best seen in FIGS. 4, 5, 6 and 13, and to be described in detail hereinafter under the heading Cordage Guide. The cordage guide 35 includes generally means for guiding the cordage 12 to the mandrel 20, means for forming the cordage as it is wound into a uniform, tight helix about the mandrel, means for constraining the cordage to wind in closely packed convolutions, and means for terminating the winding operation when a desired length of cordage has been wound.

As seen in FIGS. 3-C and 4, the rotary chuck 24 is mounted at one end of a shaft 37 for rotation therewith. The shaft 37 is journaled within bearings in a housing 38 (FIG. 3-B) and is keyed to a toothed driving pulley 39, mounted on the other side of the housing 38. The housing 38 is mounted on a reciprocable carriage 41 for sliding movement therewith, which sliding movement draws the rotating mandrel 20 from right to left, as viewed in FIGS. 3-B and 3-C, to enable winding of the cordage 12 in a helix thereon. During the winding operation, the mandrel 20 slides partially out of and also rotates within the mandrel support 36.

The carriage 41 and the elements secured thereto are moved during the winding operation from the solid-line position shown in FIG. 3-C to the phantom-line position shown in FIG. 3-B, wherein the left-hand portion of the carriage is designated 41', the pulley 39', the housing 38', the shaft 37', and a portion of the chuck 24'. The means for moving the carriage 41 and for rotating the chuck 24 are best seen in FIGS. 7 and 8 and will be described in detail hereinafter under the heading Drive Means.

Upon completion of the winding operation, the trailing end of the cordage 12 is clamped to the mandrel 20 by the retaining member 26, as illustrated in FIG. 2, and the fully-wound mandrel 20 is removed from the chuck 24 and the mandrel support 36. After removal of the

7

mandrel 20, the carriage 41 and the elements secured thereto are reciprocated from the phantom-line position shown in FIG. 3-B and a short distance past the solid-line position of FIG. 3-C to a point whereat the right-hand portion of the chuck 24 is juxtaposed to the cordage-guide assembly 35. This last-mentioned position is the final position in each cycle of operation and in this position a subsequent mandrel is inserted into the mandrel support 36 and is connected to the chuck 24 for a subsequent coiling operation.

Just before a trailing end 42 of the carriage 41 strikes a spring-loaded stop member 43, an actuator 44 secured to the under side of the carriage 41 engages a limit switch, designated generally by the numeral 45, to stop the carriage travel at the desired point. The limit switch 45 forms a part of the control circuit for the apparatus, which control circuit is illustrated in FIG. 12 and will be described, in detail hereinafter, under the heading Control Circuit and Operation.

As seen in FIG. 3-C, a second limit switch, designated generally by the numeral 46, is mounted below the mandrel support 36 and has a movable actuator member 47 extending into the support 36. The actuator 47 is biased to an upper position in the absence of a mandrel and is depressed to a lower position upon insertion of a mandrel 20 in the support 36. The limit switch 46 also forms a part of the control circuit seen in FIG. 12 and is designed to close either of two operating contacts thereof depending on the presence or absence of a mandrel 20 in the support 36.

A curved safety guard, designated generally by the numeral 48 and seen at least partially in FIGS. 3-B, 3-C, 4, 7 and 9, is mounted for movement before both the coiling operation and the carriage-returning operation to a position shown in the drawings. In its closed position, the guard 48 covers the moving parts of the apparatus to prevent possible injury to an operator. During the intervals in which the carriage 41 is stationary, the guard 48 is moved to an open position wherein the chuck 24 and the mandrel 20 are uncovered in order to permit removal of a fully-wound mandrel and insertion of a succeeding mandrel into the apparatus. The guard 48 and its operation will be described in detail hereinafter under the heading Safety Guard.

The carriage 41 is best seen in FIGS. 3-C, 4 and 5 and comprises generally a long, flat rectangular member having a toothed rack 51 secured along a relatively long portion of the rear side thereof, as best seen in FIGS. 4 and 5. A T-shaped bar 52, generally coextensive in length with the carriage 41, is bolted to the under side thereof and is received for sliding movement along the length of a pair of stationary guide members 53—53.

A pinion gear 54 is keyed for rotation with a shaft 56 and is designed to mesh with the teeth of the rack 51 for reciprocating the carriage 41 and the elements secured thereto upon rotation of the shaft 56. As seen in FIG. 5, the shaft 56 is vertically mounted and extends upwardly through an aperture 57 formed in the right-hand guide member 53. An L-shaped cover plate 58 is secured to the right-hand guide member 53 and is generally coextensive in length with the rack member 41, which it covers.

Drive Means

The means for rotating the toothed driving pulley 39 (FIGS. 3-B and 8) to rotate the chuck 24 and for rotating the pinion gear 54 (FIGS. 4, 5 and 8) to move the carriage 41 forward, simultaneously and in predetermined synchronism with the speed of rotation, and also for rotating the pinion gear 54 in the opposite direction to reciprocate the carriage 41 back to its original position after the completion of each helix-winding operation, will now be described in detail with particular reference to FIGS. 3-B, 3-C, 7 and 8.

A drive motor 61 is provided which, through suitable

8

gearing, is designed to accomplish all of the movements just mentioned. With the gearing employed, the motor 61 need only be a constant-speed, unidirectional motor of any conventional type. The motor 61 drives a toothed output pulley 62, which is keyed to a motor shaft 63. A toothed timing belt 64 passes around the output pulley 62, being driven thereby, and also around each of two secondary, toothed control pulleys 65 and 66 of different sizes, which may be selectively connected through appropriate clutches to direct the coiling movement and the return movement, respectively.

The larger, coil-controlling pulley 65 is keyed to a shaft 67, which forms one input shaft to a gear box, designated generally by the numeral 68. The intermediate gears within the gear box 68 are shown in FIG. 8 in schematic perspective and will be described in detail hereinafter; but for the present, only the inputs to and outputs from the gear box 68 will be described and the linkages connecting the outputs from the gear box to the chuck-rotating pulley 39 and the carriage-reciprocating pinion 54. The first input shaft 67 is designed, upon energization of a first clutch within the gear box 68, to rotate the chuck 24 through a first gear-box output shaft 69 and simultaneously to reciprocate the carriage 41 from right to left, as viewed in FIGS. 3-B and 3-C, through a second gear-box output shaft 70.

The smaller, return-controlling pulley 66 is keyed to a shaft 71, which forms a second input to the gear box 68 and is designed to drive the second output shaft 70 in the reverse direction, and preferably at a much higher rate of speed, to reciprocate the carriage 41 from left to right, as viewed in FIGS. 3-B and 3-C, from its after-coiling position to its mandrel-inserting position.

The chuck 24 is rotated by the rotation of the first output shaft 69 through the intermission of the following elements: a toothed pulley 72 keyed to the shaft 69; a toothed belt 73 passing around the pulley 72; a toothed pulley 74, about which the belt 73 also passes; a square shaft 76 to which the pulley 74 is keyed; a toothed pulley 77 mounted for sliding movement along the square shaft 76 and for rotation therewith, the pulley 77 having a square, central aperture 78 for receiving the square shaft 76, the pulley 77 being slidable along the square shaft 76 under the influence of the carriage-reciprocating means to be described hereinafter; and a toothed belt 79 passing about both the slidable pulley 77 and the earlier-mentioned, toothed driving pulley 39, to which the chuck-rotating shaft 37 is keyed.

The rotatable square shaft 76 is journaled for rotation between a pair of bearing brackets 81—81, which depend from a table 82, as illustrated in FIG. 3-B. The table 82 extends across the entire area of the machine, as seen in FIGS. 3-B, 3-C and 7, and is supported above the machine frame 83 on a plurality of supporting columns 84—84. A pair of guide bearings 86—86, best seen in FIGS. 3-B and 9, are also mounted, one on either side of the pulley 77, on the square shaft 76 for sliding movement therealong. The guide bearings 86—86 are secured to and depend from the movable carriage 41, serving to constrain the pulley 77 to move along the square shaft 76 in accordance with the movement of the carriage 41.

The mandrel-rotating connection is particularly detailed in FIG. 9 and, as there seen, a pair of pulleys 88—88 are provided, which engage opposite sides of the driving belt 79 extending between the pulleys 77 and 39. The belt-guiding pulleys 88—88 are spaced closely together to compress opposing portions of the belt 79 inwardly toward each other so that the belt 79 may pass between the guide members 53—53 without interfering with the reciprocating travel of the entire unit. The belt-guiding pulleys 88—88, best seen in FIGS. 3-B, 8 and 9, are mounted for rotation on a pair of shafts 89—89, which are in turn journaled for rotation between the support bearings 86—86.

The means for rotating the pinion gear 54 to reciprocate

cate the carriage 41 are best seen in FIGS. 3-B, 3-C, 7 and 8 and include, in sequence, the following intermediate elements: the second gear-box output shaft 70; a toothed pulley 91 keyed to the shaft 70; a toothed belt 92 passing around the pulley 91; a toothed pulley 93, about which the belt 92 also passes and which is driven thereby; a shaft 94 to which the pulley 93 is keyed; a pair of meshing bevel gears 96—96 (FIG. 8) mounted within a gear box, designated generally by the numeral 97; a first bevel gear 96 being connected to the shaft 94; and the upright shaft 56 previously described, which is connected between the second bevel gear 96 and the carriage-reciprocating pinion 54.

The shaft 94 is journaled at its left-hand end (FIG. 3-B) within a bearing bracket 98, which is in turn mounted on top of a horizontal platform 99 extending between the two support columns 84—84, seen in FIG. 3-B. The right-hand end of the shaft 94 is supported within bearings in the gear box 97, which is mounted, as seen in FIG. 5, on an angle iron 102 projecting from a second platform 103. A pair of couplings 104—104 are provided and are positioned one on either side of the bevel gear box 97, one for connecting the input shaft 94 to the bevel gear assembly and the other for connecting the bevel gear assembly to the output shaft 56. As seen in FIG. 5, the output shaft 56 is journaled within a bearing 106, which is in turn secured to an angle iron 107 depending from the table 82.

The intermediate gears within the gear box 68 are shown in schematic perspective in FIG. 8 and will now be described. With the arrangement shown, the first input shaft 67, extending from the coil-controlling input pulley 65, may be connected through a clutch 111, preferably an electromagnetic clutch, to a gear 112 which, when the clutch 111 is energized, directs the coiling motion. The gear 112 meshes with an idler or rotation-reversing gear 113, which in turn meshes with a rotation-controlling gear 114, to which is keyed the first output shaft 69 previously described.

Assuming that the motor 61 always drives the output pulley 62 in a counterclockwise direction, as viewed in FIG. 8, the gear-box input pulleys 65 and 66 are also driven in the same direction as the coil-directing gear 112. The rotation-controlling gear 114 is also driven in a counterclockwise direction, which drives in sequence the pulleys 72, 74, 77 and 39 in the same direction, as indicated by the solid-line arrows, to rotate the chuck 24 and the mandrel 20 in a counterclockwise direction, as viewed in FIG. 8, to wind the cordage 12 passing over the top of the mandrel 20 therearound.

The coil-directing gear 112 also meshes with a second gear 115, which controls the reciprocation of the carriage 41 and is keyed to the second output shaft 70, previously described. Assuming the same counterclockwise rotation of the motor 61, then the gear 115 is driven in a clockwise direction to drive each of the pulleys 91 and 93 in a clockwise direction, as indicated by the solid-line arrow designated COIL on the pulley 93. Clockwise rotation of the pulley 93 (through the shaft 94, the bevel gears 96—96, the shaft 56, the pinion 54 and the rack 51) drives the carriage 41 from right to left in FIG. 8, according to the solid arrow designated COIL, to permit coiling of the cordage 12 in the desired helix upon the mandrel 20.

Obviously, the rate of rotation of the mandrel 20 with respect to the rate of longitudinal movement thereof may be controlled by regulating the number of teeth on the rotation-inducing gears and pulleys 114, 72, 74, 77 and 39 as compared to the number of teeth on the reciprocation-inducing gears 115, 91, 93, 96—96 and 54. Within limits, this control may be accomplished simply by making the gear 114 a "change gear," different speed ratios being established for different numbers of teeth on this gear. Also, obviously, if it were desired to rotate the mandrel 20 in a clockwise direction, as viewed in FIG. 8, the idler gear 113 could be eliminated and the gear 114

made to mesh directly with the gear 112 or a second idler gear could be inserted.

The second input shaft 71, extending from the return-controlling input pulley 66, may be connected by means of a second electromagnetic clutch 116 to a gear 117 which, when the clutch 116 is energized, directs the return motion of the carriage 41. The gear 117 meshes with an idler or rotation-reversing gear 118, which in turn meshes with the reciprocation-controlling gear 115. When the first clutch 111 is deenergized and the second clutch 116 is energized, because of the idler gear 118, the gear 115, the pulley 91 and the pulley 93 are driven in a counterclockwise direction, according to the dotted arrows designated Return, in order to reciprocate the carriage 41 back to its original position. In the illustration of FIG. 8, the coil-controlling pulley 65 is provided with twice as many teeth as the return-controlling pulley 66; therefore, the return motion will proceed at twice the rate of the forward motion. This rapid return motion conserves time and makes for more efficient operation.

Inspection of FIG. 8 will reveal that the rotation-controlling gears and pulleys will be operative during return motion to rotate the empty chuck 24 in the opposite direction from that during coiling and at twice the speed. This is not considered deleterious to this mechanism; however, it is obvious that a third clutch might be mounted to selectively connect the shaft 69 to the gear 114 only when the clutch 111 is energized and rotation is particularly desired.

An electromagnetic brake 119 is also provided and is designed for intermittent connection to one of the shafts within the gear box 68, being shown as applicable to the shaft 71. The brake 119 is deenergized simultaneously with the energization of either of the clutches 111 or 116 to permit movement and is energized to positively stop movement simultaneously with the deenergization of either of the clutches 111 or 116 upon completion of an operation. The selective control circuit for the clutches 111 and 116 and the brake 119 is illustrated in FIG. 12 and will be described in detail hereinafter under the heading Control Circuit and Operation.

Safety Guard

The safety guard, designated generally by the numeral 48 and previously described in general, is best seen in FIGS. 3-B, 7 and 9. The guard 48 includes four curved, spaced, pivotally-mounted ribs 121—121 having secured therebetween a similarly curved, transparent, flexible, plastic shield 122 manufactured from methyl methacrylate and sold under the trademark "Plexiglas." The guard 48 is pivoted before each reciprocation of the carriage 41 into its protecting position, whereat the shield 122 covers the entire line of motion, as seen in FIGS. 3-B and 3-C, to protect the operator.

The ribs 121—121 are keyed at their lower ends to a rocker shaft 123, which is journaled at its ends between a pair of bearing brackets 124—124 depending from the table 82. A pair of supporting ears 126—126, best seen in FIG. 7, protrude from the right-hand side of the central pair of ribs 121—121 and a pin 127 is mounted for rotation therebetween. Also mounted for rotation about the pin 127 are a pair of end forks 128—128 of a forked support member 129.

The forked support member 129 is mounted at the top of a reciprocable piston rod 131, which is reciprocable within and is actuated by an air cylinder 132. The air cylinder 132 is mounted pivotally at its base within a supporting bracket 133 secured to the machine frame 83. The pivotable connection of the air cylinder 132 is accomplished by providing the cylinder 132 with a pair of spaced, depending tabs 134—134 at the lower end thereof, which tabs are designed to straddle a reduced, upstanding portion 136 (FIG. 3-C) of the support bracket 133. A pin 137 is keyed between the tabs 134—134 and extends through an aperture in the upstanding portion 136 of the bracket 133, being rotatable within the aperture.

The safety guard 48 is shown in its protecting position in the drawings, which position results from a full, upward extension of the piston rod 131. Upon completion of each carriage-reciprocating operation, the piston rod 131 is retracted within the cylinder 132 to move the guard 48 from the closed position shown in FIG. 7 to an open position, shown fragmentarily in phantom lines in FIG. 7 and designated 48'. In its open position the guard 48 is received within a housing 138, which is shaped to receive the guard.

Upon retracting or downward movement of the piston rod 131 within the air cylinder 132, the forked support 129 pulls downwardly upon the connecting pin 127 and this downward force tends to pivot the guard 48 in a clockwise direction, as viewed in FIG. 7, about the rocker shaft 123. The commencement of pivoting motion about the rocker shaft 123 causes the piston rod 131 and the cylinder 132 to pivot about the lower pivot pin 137, the two pivoting motions complementing each other to move the guard 48 to the phantom-line position 48' within the housing 138.

As seen in FIGS. 3-B and 7, a generally circular cam 139 is keyed at one end of the rocker shaft 123 and a cam-actuated switch, designated generally by the numeral 141 and mounted to the bracket 124, has a depending, reciprocable cam follower 142, which contacts and follows the surface of the cam 139. The cam 139 is so shaped that the switch 141 closes a normally-open contact thereof when the guard 48 has been fully pivoted to its protecting position. The normally-open contact of the switch 141 is so disposed in the control circuit, illustrated in FIG. 12 and to be described in detail hereinafter, that neither of the operating clutches 111 or 116 may be energized and the brake 119 may not be de-energized until after the guard 48 has been pivoted to its protecting position.

Mandrel Support

The mandrel support, designated generally by the numeral 36 and earlier described briefly with respect to its overall arrangement with respect to FIGS. 3-B and 3-C, is best seen in FIGS. 4, 10 and 11. The support 36 includes an elongated, tubular shell 146 having a central bore 147 extending throughout its length and an aperture 148, preferably a sectorial aperture of about 90°, connecting with the bore 147, as best seen in FIG. 10. The shell 146 is mounted on top of the table 82 (FIGS. 3-C and 4) in a position coextensive with a major portion of the length of a mandrel 20, in its starting position.

A plurality of stationary mandrel-retaining discs, designated generally by the numerals 149—149, are secured within the bore 147 at spaced intervals along the length of the tubular shell 146. Six retaining discs 149—149 are indicated in dotted lines in FIG. 4, mounted in three equally spaced, aligned groups of two relatively closely spaced retaining discs each. This illustrates the preferred arrangement, with the groups being spaced at intervals along the length of the shell 146, thus at intervals along the path of longitudinal movement of the mandrel 20 to support the same during such movement.

FIG. 10 illustrates a preferred configuration of the stationary retaining discs 149—149, showing one such disc secured within the outer shell 146. The disc 149 is formed with an arcuate, preferably semicircular, mandrel-receiving seat 151 extending therethrough and having a radius slightly larger than the radius of the mandrel 20, which may be inserted thereacross as illustrated in FIG. 10. Each of the discs 149—149 is provided with an entrance aperture 152, extending between the outer surface of the disc 149 and the seat 151, to permit sidewise insertion of a mandrel 20 through the aperture 152 for support across the seat 151.

The entrance aperture 152 is preferably a sectorial aperture of about 90°, the disc 149 being oriented within the shell 146 so that the apertures 152 and 148, respectively, of those members are aligned to permit ready in-

section of a mandrel 20 into all of the seats 151—151 of the six retaining discs 149—149. The discs 149—149 are made entirely of, or their seats 151—151 are lined with, a suitable wear-resistant material such as brass or tetrafluoroethylene, sold under the trademark of Teflon, so that the seats 151—151 may support the mandrel 20 for both sliding and rotary motion therewithin.

A number of rotatable retaining discs, designated generally by the numerals 156—156 and best seen in FIG. 11, are positioned one in the center of each group of the stationary retaining discs 149—149 and are designed to cooperate therewith to support and guide the mandrel 20 during its helix-winding movement. Each of the rotatable discs 156—156 has an overall configuration similar to that of the stationary discs 149—149, including a similar semicircular seat 157, which is likewise designed to fit closely about the mandrel 20 so as to permit rotating and sliding movement of the mandrel 20 therewithin.

An entrance aperture 158, preferably a 90° sectorial aperture, is also provided and extends between the outer surface of each disc 156 and the seat 157 so that, when the rotatable discs 156—156 are angularly and axially aligned with the stationary discs 149—149, a mandrel 20 may be inserted into the now-aligned entrance apertures 148—148, 152—152 and 158—158 for support across the now-aligned semicircular seats 151—151 and 157—157.

Means, designated generally by the numeral 159, are provided for rotating the rotatable retaining discs 156—156, as a group to the position just described, wherein their entrance apertures 158—158 align with the corresponding apertures 152—152 of the stationary retaining discs 149—149. In this position, an operator may easily insert a mandrel 20, upon which a length of cordage 12 is to be wound, into the guide 36 for support therein. The mandrel 20 is inserted into the guide 36 so that the lead or left-hand end thereof, as viewed in FIGS. 3-C and 4, protrudes therefrom and the major portion of the mandrel 20 is supported across the guide 36.

The lead end of the mandrel 20 is secured to the chuck 24, the cordage 12 is threaded through the cordage guide 35 and attached to the mandrel 20, and then the safety guard 48 is closed. Before the engagement of the driving clutch 111 to initiate the coiling motion of the mandrel 20, the rotating means 159 are operated to rotate the rotatable retaining discs 156—156 about the center line of the mandrel 20 through an angle to closed positions, as depicted in FIG. 11. In their closed or operating positions, the entrance apertures 158—158 and the seats 157—157 of the rotatable discs 156—156 are angularly displaced from those of the stationary discs 149—149 so that the mandrel 20 is closely supported about its periphery by the seats 151—151 and the now-displaced seats 157—157 for both rotational and longitudinal movement therebetween.

As a part of a preferred form of the rotating means 159, the outer periphery of the rotatable discs 156—156 is provided with gear teeth 161—161, so that the discs 156—156 comprise, generally, segmental gears mounted for rotation within the tubular shell 146. An arcuate hub 162 extends from either side of each rotatable disc 156 and is received for rotation within an arcuate slot 163 formed in the inner surfaces of the adjacent, stationary retaining discs 149—149 so that the discs 156—156 are supported by the adjacent discs 149—149 for rotation within the shell 146.

A plurality of circular gears 164—164 are provided, one of which is mounted adjacent to and in mesh with the toothed surface of each of the rotatable discs 156—156, as seen in FIGS. 4 and 11. To permit this engagement, a plurality of sectorial slots 165—165 are formed at appropriately spaced intervals along the tubular shell 146 to permit extension of the gears 164—164 thereinto, so that they may mesh with the teeth 161—161 comprising the geared outer surface of the internally mounted,

13

rotatable discs 156—156. The gears 164—164 are keyed to a common shaft 166 for rotation as a unit therewith. The shaft 166 is journaled at intervals along its length within a number of supporting tabs 167—167, extending from the outer periphery of the shell 146.

A reciprocable rack 168 is provided, which meshes with the under, toothed surface of the central one of the gears 164—164. The rack 168 may be moved from left to right, as viewed in FIG. 11, to rotate all of the rotatable discs 156—156 from their open positions, wherein the entrance apertures 152—152 and 158—158 are in alignment, to their closed positions depicted in FIG. 11, wherein a mandrel 20 is supported for rotation and longitudinal movement. The rotatable retaining discs 156—156 are maintained in their closed positions throughout the entire coiling operation to provide continued support for the moving mandrel 20. After completion of the coiling operation, the rack 168 is moved from right to left, as viewed in FIG. 11, back to its original position, to rotate the retaining discs 156—156 back to their original, open positions so that the now-stationary, wound mandrel 20 may be readily removed from the guide 36.

The rack 168 is secured to one end of a piston rod 171, which fits within and is reciprocated by an air cylinder 172. The air cylinder 172 is equipped with a first solenoid valve 231, energizable to induce rotation of the discs 156—156 to their closed positions, and a second solenoid valve 232 to induce the reverse movement. A tapered camming member 173 is secured to the piston rod 171, between the cylinder 172 and the rack 168, and is designed to close a contact of a limit switch, designated generally by the numeral 174 and indicated in FIG. 4, after the full rotation of the discs 156—156 to their closed positions. For this purpose, the switch 174 is mounted close to the camming member 173 so that a follower-actuator 175 of the switch 174 engages and rides on the tapered surface of the camming member 173. Closing of the contact of the switch 174 is required before energization of the carriage-forward clutch 111 is permitted, as will be described hereinafter in the description of the control circuit seen in FIG. 12.

Cordage Guide

The cordage-guide assembly, designated generally by the numeral 35 and earlier described with respect to its overall arrangement as regards FIGS. 3-B and 3-C, is best seen in FIGS. 4, 5, 6 and 13. The assembly 35 includes a pair of support arms 176—176, which are secured for pivoting movement to a pivot pin 177, which is in turn journaled for rotation with respect to a supporting frame 178. A pair of helix-forming rollers 179—179 are rotatably mounted on a pair of shafts 181—181, which are journaled for rotation between the support arms 176—176. The shafts 181—181 are spaced from each other and are parallel to the mandrel 20 so that the rollers 179—179 may rotate about individual axes parallel to the mandrel 20 but spaced, generally, on opposite sides thereof.

In operation, the arms 176—176 are first pivoted to a closed position, wherein the rollers 179—179 are positioned so that their peripheries engage compressively each cordage convolution 11 as it is wound on the mandrel 20 in order to smooth and compress the cordage being wound into a uniform, tight helix about the mandrel. This is the normal, winding position and is illustrated in FIG. 5. The rollers 179—179 are preferably mounted, in their winding positions, to exert sufficient force on the cordage being wound to flatten the same slightly between the rollers and the mandrel, which flattening is desired in the finished spring cord. The rollers, in winding position, also furnish additional support for the mandrel 20 at its point of greatest strain to steady the mandrel and prevent vibration thereof.

After completion of the helix-winding operation, the arms 176—176 are pivoted to an open position, wherein

14

the rollers 179—179 are positioned away from the fully-wound mandrel to facilitate removal thereof, which after-winding position is illustrated in FIG. 6. The arms 176—176 are retained in the open position until a succeeding mandrel has been inserted across the mandrel support 36 and connected to the chuck 24 and the lead end of a cord has been fastened to the succeeding mandrel.

A locating pin 182 is provided and is designed to lock the arms 176—176 in their closed positions, as seen in FIG. 5. The pin 182 is mounted transversely between the arms 176—176, as best seen in FIG. 4, and is biased by a spring 183 toward the left, as viewed in that figure, so that it normally extends outwardly from the arms 176—176. The frame 178 is provided with a pin-receiving aperture 184 at a level corresponding to the closed position of the arms 176—176. Before each winding operation, the rollers 179—179 are moved upwardly from the position illustrated in FIG. 6, by lifting a projecting end 185 of one of the arms 176—176, until the pin 182 registers with and is forced into the pin-receiving aperture 184 by the spring 183.

After the coiling operation has been completed and it is desired to remove the mandrel 20, the pin 182 is drawn out of the aperture 184 by pulling outwardly, against the action of the spring 183, on a pinhead 186. When the pin 182 has been so withdrawn, the arms 176—176 are designed to descend by gravity, pivoting about the pin 177, back to the open position shown in FIG. 6. This movement is stopped when the arms 176—176 contact the top of the carriage 41.

A cordage guide, designated generally by the numeral 187 and best seen in FIGS. 5, 6 and 13, is provided, mounted above the cordage 12 and close to the mandrel 20 for pivoting movement with respect to the arms 176—176. The guide 187 is secured to and depends from a support lever 188, which is mounted for rotation with respect to the arms 176—176 about a second pivot pin 189. The pin 189 is mounted between the arms 176—176 so that the lever 188 and the guide 187 are carried for movement with the arms 176—176, but may be pivoted independently thereof. The lever 188 might also have been mounted separate from the arms 176—176 for entirely independent movement; however, the structure illustrated is convenient and permits the desired independent, opposing pivoting movements of the rollers 179—179 and the guide 187.

In operation, the lever 188 is first pivoted to a closed position, illustrated in FIG. 5, wherein the guide 187 is positioned to engage the advancing cordage 12 close to the mandrel 20 and guide the cordage into winding engagement therewith. In this closed position, as illustrated in FIG. 13, the guide 187 is positioned with respect to the rollers 179—179 so that the rollers engage each strand convolution 11 as it is wound.

As seen in FIG. 13, the guide 187 is provided with a guide aperture 261 in the shape of an inverted U extending from the lower end thereof, into which the cordage 12 is initially inserted, and which functions during the entire winding operation to guide the cordage 12 toward the mandrel 20. The cordage 12 is forced to remain within the guide aperture 261 by the left-hand roller 179 (FIG. 5), which, as seen in FIG. 13, is positioned so that its top fits close to the open end of the U-shaped guide aperture 261. The cordage is prevented from arcing above a line tangent to the mandrel 20 by the curved top surface of the inverted U-shaped aperture 261, which is locked against vertical movement. The vertical locking of the guide 187 prevents the cordage from winding on top of the previously wound convolutions and constrains the successive convolutions to lie, generally, side by side. The top and sides of the aperture 261 are preferably polished to prevent excessive friction and it is contemplated that, for this purpose, small anti-friction rollers might be provided along the top and sides of the aperture.

15

After the helix-winding operation, the lever 188 is pivoted to an open position, illustrated in FIG. 6, wherein the guide 187 is positioned away from the fully-wound mandrel to facilitate removal thereof. The lever 188 is maintained in the open position of FIG. 6 until a cord is connected to a succeeding mandrel, whereupon, after the raising of the rollers 179—179 to their closed positions, the guide 187 is lowered to its closed position about the succeeding cord.

A latching finger 190 is provided and is designed to lock the lever 188 in its closed position, as seen in FIG. 5. The latching finger 190 is mounted on a third pivot pin 191 for independent pivoting movement with respect to the lever 188. The latching finger 190 is provided with a detent 192 extending therefrom, which may be received within notches 193—193 formed in each of the support arms 176—176 and designed for receiving and retaining the detent 192. A spring 194 is mounted between the latching finger 190 and the lever 188 and is designed for biasing the latching finger 190 about the pivot pin 191 so that the detent 192 is forced within the notch 193, which forcing engagement operates to lock the lever 188, the guide 187 and the finger 190, as a unit, in their closed positions.

Upon completion of each winding operation, the latching finger 190 is pivoted toward the lever 188, against the action of the biasing spring 194, to free the detent 192 from the notch 193 so that the lever 188, the guide 187 and finger 190 may be moved, as a unit, about the second pivot pin 189, from the closed position shown in FIG. 5 to the open position shown in FIG. 6 to permit removal of the fully-wound mandrel.

If the cordage diameter and the degree of flattening of the cordage 12 by the rollers 179—179 were always constant, then a closely-packed helix could be wound with a fixed guide, occupying the place of the guide 187, by regulating the longitudinal speed of the mandrel 20 to one cordage width, as flattened, for each revolution of the mandrel. However, certain slight variations in cordage diameter and degree of flattening do occur, which variations make absolute control by speed regulation with a fixed guide difficult or impossible. For example, if the cordage is too thin or is insufficiently flattened, the turns 11—11 of the helix will not be closely packed; whereas, if the cordage is too thick or is overly flattened, then the turns 11—11 will tend to wind on top of each other.

To accommodate these variations, the guide 187 is mounted for limited pivoting movement transversely of the cordage 12, as best seen in FIG. 13, to facilitate the winding of the cordage in a closely packed helix. For these purposes, the guide 187 comprises a thin member, generally coextensive in width with the support lever 188 and mounted within a niche 262 extending across the width of the lever 188. The guide 187 is pivotable about a pin 263, which is carried by the lever 188. A torsion spring 264 is wrapped at its upper end around the lever 188, extends downwardly and is wrapped for a few turns about the pin 263, extends into a small hole 265 formed in the guide 187, and is then wrapped around the guide 187 to secure the lower end of the spring 264 to the guide 187.

The normal winding position is illustrated in FIG. 13, wherein the guide 187 assumes a vertical position under the influence of two counterbalancing forces: (1) the torsion spring 264 urges the guide 187 in a clockwise direction, as viewed in FIG. 13, about the pin 263; and (2) the cordage 12 being wound in closely-packed helical turns (no piling up is possible due to the fact that the guide 187 is locked vertically by the latching finger 190) bears against the right-hand wall (FIG. 13) of the guide aperture 261 and thus urges the guide 187 in a counterclockwise direction about the pin 263. The vertical position shown is maintained as long as the cordage diameter and degree of flattening have their normal, desired values

16

and are thus precisely correlated with the established gear ratios for the movement of the mandrel 20.

However, if the cordage 12 becomes abnormally thin or is under-flattened by the rollers 179—179, the force exerted by the cordage on the right-hand wall of the guide aperture 261 is diminished, and the torsion spring 264 operates to pivot the unit in a clockwise direction through the slight distance necessary to re-establish the dominating force of the winding cordage, in which position the cordage 12 is again winding in closely-packed turns. If, on the other hand, the cordage 12 becomes abnormally thick or is over-flattened, the cordage cannot wind on the last turn due to the locked vertical position of the guide 187 and will thus pivot the guide 187, against the action of the spring 264, in a counterclockwise direction about the pin 263 to the point where the cordage winds in closely-packed turns 11—11.

The guide 187 is formed with a pair of projecting portions 266—266 at the top thereof, which are designed to engage the top surface of the niche 262 in order to limit the amount of pivoting movement of the guide 187 in each direction to an extent that the cordage 12 is positively precluded from jumping out of its constricted guide seat between the aperture 261 and the left-hand roller 179 (FIG. 5).

In starting a succeeding mandrel, the cordage is first secured to the left-hand portion (FIGS. 3-C and 4) of the mandrel and wound over the top of the mandrel, as seen in FIG. 5. The support arms 176—176 are then raised by the operator from the open position shown in FIG. 6 to the closed position shown in FIG. 5, the arms 176—176 pivoting in a clockwise direction as viewed in FIGS. 5 and 6 about the first pivot pin 177 until the spring-biased locating pin 182 is forced into the pin-receiving aperture 184 by the spring 183. In this position, the peripheries of the rollers 179—179 are in their closed or operating positions, ready to engage the strand convolutions compressively as they are wound. The lever 188 and finger 190 are then rotated, as a unit, in a counterclockwise direction as viewed in FIGS. 5 and 6, about the second pivot pin 189, the cord 12 being placed so that the aperture 261 of the guide 187 is fitted about the cord 12, until the detent 192 enters the notches 193—193, which is the proper position for winding the cordage.

A cordage-engaging member 196 is mounted generally to the left of the guide 187, as viewed in FIGS. 5 and 6. The cordage-engaging member 196 is preferably mounted below the line of advancement of the cordage 12 and has a guide aperture, preferably a U-shaped aperture extending from the top thereof, through which the cordage 12 advances. The generally similar but opposing guide apertures of the guide 187 and of the cordage-engaging member 196 are aligned so that the guide 187 and the cordage-engaging member 196 cooperate to direct the advancing cordage 12 to the mandrel 20. The U-shaped guide aperture formed in the cordage-engaging member 196 is restricted to fit closely about normal-disaster portions of the cordage 12 advancing therethrough to the mandrel. The sides of this aperture should also be polished to reduce friction or anti-friction rollers should be provided.

Previous to the advancement through the cordage-engaging member 196, the cordage 12 is advanced between a pair of spaced rollers 197 and 198, which are mounted on a support member, designated generally by the numeral 199. The lower roller 197 is keyed for rotation with a shaft 201, which is in turn journaled for rotation between a pair of upstanding brackets 202—202 of the support member 199. The upper roller 198 is keyed for rotation with a shaft 203, which is in turn mounted for rotation on a supporting arm 204. The supporting arm 204 is secured to the right-hand bracket 202 (FIG. 4) by a pair of bolts 206—206 and is so constructed that the roller 198 is mounted above the cordage 12 in close proximity to the U-shaped guide aper-

17

ture of the cordage-engaging member 196 so as to constrain the advancing cordage 12 to ride within the guide aperture of the cordage-engaging member.

The cordage-engaging member 196 is mounted on and extends upwardly from the upper end of a generally L-shaped supporting rod 207. A camming block 208 is secured to the other end of the L-shaped rod 207 and the entire assembly (the L-shaped support 207, the guide 196 and the camming block 208) is mounted for pivoting movement about a pivot pin 209, while the L-shaped rod extends through an aperture 210 in the table 82. A weight 211 is secured to the rod 207 and is designed to bias the pivotable assembly in a counterclockwise direction, as viewed in FIG. 5, about the pivot pin 209.

A spring-loaded stop member 213 is mounted at the upper end of the camming block 208 and is designed to abut against the angle iron 212 to limit the counterclockwise rotation of the rod 207 and define a first position for the cordage-engaging member 196, wherein the cordage-engaging member is spaced a first distance from the mandrel 20. This first position is the normal coiling position and is illustrated in FIG. 5. When a cord is to be started, the cordage-engaging member 196 is pivoted by hand away from the roller 198, so that the cordage may be inserted into the guide aperture in the cordage-engaging member, then the cordage-engaging member is released so that the weight 211 returns the same to its normal position wherein the roller 198 traps the cordage in the aperture.

The weight 211, which is preferably adjustable in weight and/or position, is designed to maintain the cordage-engaging member 196 in its first position (FIG. 5) against the force of friction due to normal-diameter portions of the cordage passing through the restricted guide aperture in the cordage-engaging member. However, when an enlarged portion of the cord, such as that provided by the stay band 17 at the end of the particular cord shown, approaches the cordage-engaging member 196, the enlarged portion will engage and catch in the restricted guide aperture of the cordage-engaging member so that further advancement of the cord 12 by the rotating mandrel 20 will operate to pivot the guide 196 and the supporting shaft 207, in a clockwise direction as viewed in FIGS. 5 and 6, against the action of the biasing weight 211 to the end-of-coiling position illustrated in FIG. 6. During this pivoting movement, the cordage-engaging member 196 moves from its first position, generally along the line of advancement of the cord 12, toward the guide 187 and the mandrel 20.

During the pivoting movement, the left-hand bottom surface (FIGS. 5 and 6) of the camming block 208 moves upwardly, as seen in those figures, to allow an upwardly-biased actuator 214 of a limit switch, designated generally by the numeral 216, to move upwardly. The limit switch 216 includes a normally-open contact, which is designed for closure upon sufficient upward movement of the actuator 214 to deenergize the clutch 111 and energize the brake 119 (both seen in FIG. 8) to stop the coiling operation. The coiling operation is so stopped after the cordage-engaging member 196 has been moved a predetermined distance toward the mandrel 20, that the stay band 17 is located a desired distance away from the mandrel 20 at the end of the coiling operation. The normally-open, end-of-coiling contact of the switch 216 forms a part of the control circuit illustrated in FIG. 12, which will be described in detail hereinafter.

Control Circuit and Operation

The control circuit is best seen in FIG. 12 and includes (in order of operation starting with the carriage 41 in its extreme-right position as viewed in FIG. 3-C) contacts of the following limit switches previously described: the switch 46 (FIG. 3-C), which closes an upper contact 221 when a mandrel 20 is in place within the mandrel support 36 and closes a lower contact 222 when no man-

18

drel is present; the limit switch 141 (FIGS. 3-B and 7), which closes a normally-open contact 223 when the guard 48 has been pivoted into its closed, protecting position by the air cylinder 132; the limit switch 174 (FIG. 4), which closes a normally-open contact 224 when the mandrel-retaining discs 156—156 have been rotated into their closed, mandrel-retaining positions by the air cylinder 172; the limit switch 216 (FIGS. 5 and 6), which closes a normally-open contact 226 when the cordage-engaging member 196 has been moved to the position shown in FIG. 6 at the end of each coiling operation; and the limit switch 45 (FIG. 3-C), which opens a normally-closed contact 227 upon completion of each cycle of operation and the return of the carriage 41 to its starting position at the extreme right in FIG. 3-C.

Also included are a pair of solenoid valves 228 and 229 (FIG. 7) designed to advance and retract, respectively, the piston rod 131 within the air cylinder 132 to close and open, respectively, the safety guard 48. Further included are the solenoid valves 231 and 232 (FIG. 4) designed to advance and retract, respectively, the piston rod 171 within the air cylinder 172 to close and open, respectively, the mandrel-retaining discs 156—156. The piston rods 131 and 171 of the air cylinders 132 and 172 are advanced by the energization of their respective "advance" solenoid valves 228 and 231 and remain in that position until positively retracted by their respective "retract" solenoid valves 229 and 232; they then remain in their retracted positions until they are again positively advanced by the valves 228 and 231.

Also included in the control circuit are the energization circuits for the drive motor 61, the electromagnetic clutches 111 and 116, and the electromagnetic brake 119, all of which were described earlier in conjunction with FIG. 8 under the heading Drive Means.

A first control relay 233 is provided to initiate the coiling motion which, upon energization, closes a first contact 234 to energize the first electromagnetic clutch 111 and simultaneously opens a second contact 235 to deenergize the electromagnetic brake 119. This reversal of connections functions to move the carriage 41 from right to left as seen in FIGS. 3-C and 4 and to rotate the chuck 24 in order to wind the cordage 12 in a helix along the length of the mandrel 20.

A second control relay 237 is provided to initiate the return motion which, upon energization, closes a first contact 238 to energize the second electromagnetic clutch 116 and simultaneously opens a second contact 239 to deenergize the electromagnetic brake 119, which reversal of connections functions to return the carriage 41 from left to right, back to its original position.

The two-position selector switch 46 operates to select the proper one of the control relays 233 and 237 for operation. When a mandrel is present (so that coiling motion is desired), the upper contact 221 of the switch 46 is closed, which permits energization of the coil-controlling relay 233 and precludes operation of the parallelly-connected, return-controlling relay 237. When no mandrel is present (so that return motion is desired), the lower contact 222 of the switch 46 is closed, which permits energization of only the return controlling relay 237.

The coil-controlling relay 233 may be energized, assuming that the upper contact 221 of the selector switch 46 is closed indicating that a mandrel 20 is in place, provided that the contact 223 of the switch 141 is closed signifying that the guard 48 is in place and further provided that the contact 224 of the switch 174 is closed signifying that the mandrel-retaining discs 156—156 are in their closed positions.

The return-controlling relay 237 may be energized, assuming that the lower contact 222 of the selector switch 46 is closed indicating the absence of a mandrel, provided that the contact 223 of the switch 141 is closed signifying that the guard 48 is again in place and also provided that the contact 227 of the switch 45 is closed (its

normal position) signifying that the carriage 41 is not already in its extreme rightward position.

A pair of power-supply switches 241—241 are provided, a first of which connects the motor 61 across a first pair of power-supply conductors 242—242. The second power-supply contact 241 connects the control circuit across a second pair of power-supply conductors 243—243. As seen, the motor 61 runs continuously and is selectively connected, through alternate energization of the clutches 111 and 116, to drive the carriage 41 first in the coiling direction and then in the return direction during each cycle of operation.

After a lead end of a straight length of cordage 12 to be wound has been secured to a mandrel 20, as seen in FIG. 2, after the various guide members constituting the cordage guide 35 have been set in their starting positions as seen in FIGS. 5 and 13, and assuming that the power-supply contacts 241—241 have been closed manually so that the motor 61 is running, the operating cycle is initiated by the closing of a pair of starting, push-button switches 244—244.

The push-button switches 244—244 are spaced apart so as to occupy both of the operator's hands at this time to prevent possible injury. Simultaneous closure of both of the push-button switches 244—244 operates to energize a starting relay 246 through the lower, closed, power-supply contact 241, the now-closed, push-button switches 244—244, the operating coil of the relay 246, a normally closed contact 247 of the deenergized control relay 237, and a normally-closed contact 248 of the deenergized control relay 233.

The starting relay 246 latches in around the push-button switches 244—244 through the closure of a latching contact 249. The starting relay 246 also closes a second contact 251 and opens a third contact 252 to energize the guard-closing solenoid valve 228 and prohibit energization of the guard-opening solenoid valve 229, respectively, the energization circuits for each of these solenoids also extending across the normally-closed contacts 247 and 248 of the control relays 237 and 233.

Energization of the solenoid valve 228 operates to supply air to the lower end (FIGS. 3-B and 7) of the air cylinder 132, which pivots the safety guard 48 to its closed position in the manner earlier described under the heading Safety Guard. When the guard 48 has been moved to its fully closed position, the cam-follower actuator 142 of the switch 141 rides into a recessed portion of the circumference of the rotary cam 139 to close the normally-open contact 223 of the switch 141.

Closure of the contact 223 of the switch 141 permits energization of the ring-close solenoid valve 231 through the closed contact 221 of the selector switch 46 (mandrel in place), a normally-closed contact 253 of a now deenergized relay 254, and a normally-closed contact 256 of the now deenergized, coil-controlling relay 233. Energization of the ring-close solenoid valve 231 operates to supply air to the rear end (FIG. 4) of the air cylinder 172, which functions to rotate the mandrel-retaining rings 156—156 from their open positions to their closed positions, as seen in FIG. 11 through the mechanisms described previously under the heading Mandrel Guide.

When the discs 156—156 have been fully rotated to their closed, mandrel-retaining positions, the tapered camming member 173 (FIG. 4) depresses the follower-actuator 175 of the switch 174 so that the normally-open contact 224 of the switch 174 is closed. Closure of the contact 224 of the switch 174 permits energization of the coil-controlling relay 233, through the now-closed contacts 223, 221, 253 and 224.

The coil-controlling relay 233 opens its normally-closed contacts 248 and 256 to break the energization circuits for the solenoids 228 and 231, respectively, controlling the air cylinders 132 and 172, respectively, which had just been energized to close the guard 48 and the discs 156—156, respectively. As previously mentioned, the air

cylinders 132 and 172 are of the type wherein the associated piston rods 131 and 171, respectively, will remain in either moved position until positive reciprocation thereof in the reverse direction; therefore, even though the advancing solenoids 228 and 231 have been deenergized, the guard 48 and the retaining discs 156—156 will remain in their closed positions until positive opening thereof by the energization of their associated retracting solenoids 229 and 232.

The coil-controlling relay 233 also opens its normally-closed contact 235 to release the electromagnetic brake 119 and closes its normally-open contact 234 to energize the first electromagnetic clutch 111. Upon energization of the clutch 111, the coiling operation proceeds at the desired rate through the intermission of the gearing described under the heading Drive Means. The chuck 24 is rotated to rotate the mandrel 20 and at the same time the carriage 41 is moved from right to left (FIGS. 3-B and 3-C) in predetermined synchronism with the speed of rotation to wind the cordage 12 on the mandrel 20, generally, in a plurality of even, closely-packed helical convolutions, substantially as described under the heading Overall Arrangement of Apparatus. The advancing cordage 12 is guided as it approaches the mandrel 20 by the cordage guide 35 illustrated in FIGS. 5, 6 and 13 and described under the heading Cordage Guide, the pivotable guide 187 operating as earlier described to constrain the cordage 12 to wind in closely-packed convolutions.

When the cordage 12 is almost fully coiled on the mandrel 20, the stay band 17 near the end of the cord 12 engages the restricted aperture of the cordage-engaging member 196, which causes the cordage-engaging member 196 to pivot about the pin 209 from the coiling position shown in FIG. 5 to the end position illustrated in FIG. 6. In this end position, the camming block 208 releases the plunger-actuator 214 of the switch 216, thus closing the contact 226 of that switch.

Upon closure of the contact 226, the relay 254 (which may be considered as the end-of-coiling relay) is energized and opens its normally-closed contact 253 to deenergize the coil-controlling relay 233. Upon deenergization of the relay 233, the contact 235 is reclosed to apply the brake 119 to stop the coiling motion and the contact 234 is reopened to deenergize the clutch 111. The end-of-coiling relay 254 also closes a second, normally-open contact 256, which energizes the disc-opening solenoid 232 to apply air to the opposite side of the air cylinder 172 so as to rotate the mandrel-retaining discs 156—156 to their open positions and enable removal of the wound mandrel 20 from the mandrel guide 36.

Deenergization of the coil-controlling relay 233 also results in a reclosing of its formerly-open contact 248 to complete an energization circuit for the guard-opening solenoid 229, through the normally-closed contact 252 of the deenergized starting relay 246, the closed contact 247 of the deenergized return-controlling relay 237, and the now-reclosed contact 248 of the coil-controlling relay 233. Upon energization of the solenoid valve 229, air is applied to the opposite side of the air cylinder 132 to pivot the safety guard 48 back to its open position to permit removal of the wound mandrel 20.

The elements of the cordage guide 35 are then pivoted to the positions shown in FIG. 6 and described under the heading Cordage Guide and the trailing end of the cordage 12 is clamped to the mandrel 20 with the end-clamp 26 (FIG. 2) as described under the heading Mandrel and Coiling Operation in General. The wound and clamped mandrel 20 is next removed from the mandrel support 36, which removal operates to close the lower contact 222 of the selector switch 46 to enable operation of the return-controlling relay 237.

The starting push-button switches 244—244 are then closed again so that the starting relay 246 is again energized to energize the guard-closing solenoid 228 in order

21

to close the safety guard 48 for the second time during the cycle. This second closure of the safety guard 48 again closes the normally-open contact 223 of the switch 141 but, because the lower contact 222 of the switch 46 is now closed (mandrel absent), the return-controlling relay 237 is now energized through the now-closed contacts 223 and 222 and the normally-closed contact 227 of the switch 45.

The relay 237 closes its contact 238 and opens its contact 239 to energize the clutch 116 and deenergize the brake 119, respectively. The energization of the clutch 116 connects the motor 61 through the alternative gearing, illustrated in FIG. 8 and earlier described, to reciprocate the carriage 41 back to its original position at a high rate of speed. Upon energization, the control relay 237 also opens its normally-closed contact 247 to break the energization circuit for the starting relay 246.

When the carriage 41 has returned to its original position, the normally-closed contact 227 of the limit switch 45 is opened by the actuator 44 (FIG. 3-C), which opens the energization circuit for the control relay 237 to disconnect the clutch 116 and reapply the brake 119 to stop the carriage 41 in its mandrel-inserting position. Upon deenergization thereof, the control relay 237 also recloses its normally-closed contact 247 so that a circuit is established through the closed contact 252 of the deenergized starting relay 246 to energize the guard-opening solenoid 229 to again open the safety guard 48. The apparatus has now completed one full cycle of operation and a succeeding mandrel may now be inserted into the guide 36 and connected to the chuck 24 to start a succeeding cycle of operation.

It will be manifest that this invention is not limited to the specific details described in connection with the above embodiment of the invention, but that various modifications may be made without departing from the spirit and scope thereof.

What is claimed is:

1. A support for a rotatable rod, which comprises a plurality of retaining members, each having an arcuate rod-receiving seat extending therethrough and an entrance aperture extending between the outer surface of the member and the seat, said members being normally mounted so that their seats and entrance apertures are in alignment to permit sidewise insertion of a rod into the aligned entrance apertures for support across the aligned seats, and means for causing relative rotation between said retaining members about the center line of the rod and through an angle designed so that the entrance apertures and seats of certain ones of said members are angularly displaced from the apertures and seats of other ones of said members and the rod is supported about its periphery by the now-displaced arcuate seats for rotation therewithin.

2. A support for a rotatable mandrel, which comprises a plurality of stationary, spaced, aligned retaining discs, each having an arcuate mandrel-receiving seat extending therethrough and an entrance aperture extending between the outer surface of the disc and the seat, a plurality of rotatable retaining discs having substantially the same configurations as said stationary retaining discs and mounted therebetween, said rotatable discs being normally positioned so that their seats and entrance apertures align with those of said stationary retaining discs, in which position a mandrel may be inserted sidewise into the now-aligned entrance apertures for support across the now-aligned arcuate seats, and means for rotating said rotatable discs about the center line of the mandrel through an angle to closed positions wherein their entrance apertures and seats are angularly displaced from those of said stationary discs and the mandrel is supported about its periphery by the now-displaced arcuate seats for rotation therewithin.

3. A support for a rotatable and longitudinally movable mandrel, which comprises a plurality of stationary,

22

aligned retaining discs, each having a semicircular mandrel-receiving seat extending therethrough of a radius slightly larger than the radius of the mandrel and an entrance aperture extending between the outer surface of the disc and the seat, said stationary retaining discs being arranged in several groups of two relatively closely spaced discs each, the groups being spaced at intervals along the path of longitudinal movement of the mandrel, a plurality of rotatable retaining discs having substantially the same configurations as said stationary retaining discs and mounted one between each group of two stationary retaining discs, said rotatable retaining discs being normally positioned so that their seats and entrance apertures align with those of said stationary retaining discs, in which position a mandrel may be inserted sidewise into the now-aligned entrance apertures for support across the now-aligned semicircular seats, means for rotating said rotatable discs about the center line of the mandrel through an angle to closed positions wherein their entrance apertures and seats are angularly displaced from those of said stationary discs and the mandrel is closely supported about its periphery by the now-displaced semicircular seats for both rotational and longitudinal movement therewithin, and means operable after cessation of the movement of the mandrel for rotating said rotatable discs in the reverse direction back to their original, aligned positions to permit ready removal of the mandrel from the support and insertion of a succeeding mandrel thereacross.

4. The support defined in claim 3, wherein each of said rotatable retaining discs has a toothed outer periphery; wherein said rotating means for said rotatable discs comprises gear means meshing with the toothed outer peripheries of said rotatable discs, means for driving said gear means in a first direction to rotate said rotatable discs about the center line of the mandrel to their closed positions; wherein switching means are provided, responsive to the rotation of said rotatable retaining discs to their closed mandrel-supporting positions, for permitting energization of the mandrel rotating and moving means; and wherein means are provided, operable after cessation of the movement of the mandrel, for driving said gear means in the reverse direction to rotate said rotatable discs back to their initial, aligned positions to permit ready removal of the mandrel from the support and insertion of a succeeding mandrel thereacross.

5. In apparatus for winding strand material in a helix along a portion of the length of a rotating and longitudinally moving mandrel, the improvement for guiding and forming the strand which comprises a frame, a pair of support arms mounted for pivoting movement with respect to said frame, a pair of helix-forming rollers mounted between said arms for rotation about individual axes parallel to the mandrel, said arms being pivotable between a closed position, whereat said rollers are positioned so that their peripheries engage compressively each strand convolution at it is wound on the mandrel in order to smooth and compress the strand being wound into a uniform, tight helix about the mandrel, and an open position, whereat said rollers are pivoted away from the fully-wound mandrel to facilitate removal thereof, releasable means for locking said arms in the closed position during the helix-winding operation, said locking means being released after the helix-winding operation so that said arms may be pivoted to their open position and means movable generally transverse to the line of advancement of the strand and positionable adjacent to the mandrel for guiding the strand into winding engagement with the mandrel so that said rollers engage each strand convolution as it is wound.

6. The apparatus defined in claim 5, wherein the strand guide means comprises a strand guide, and a supporting lever for said strand guide mounted for pivoting movement independent of the pivoting movement of said support, said lever being pivotable, so as to move the

strand guide generally transverse to the line of advancement of the strand, between a closed position, whereat said guide is positioned adjacent to the mandrel to engage the advancing strand and guide the strand into winding engagement with the mandrel, and an open position, whereat said guide is pivoted away from the fully-wound mandrel to facilitate removal thereof.

7. The apparatus defined in claim 6, wherein the roller support comprises a pair of pivoted support arms between which the rollers are mounted; wherein the lever is mounted between said support arms for pivoting movement with respect thereto; wherein releasable means are provided for locking said support arms in the closed position during the helix-winding operation; and wherein releasable means are provided for locking said lever in the closed position, which means comprises a latching finger mounted for independent pivoting movement about said lever and having a detent extending therefrom, one of said support arms being provided with a notch designed for receiving the detent, and a spring mounted between said lever and said latching finger and designed for biasing said finger about its pivot point so that the detent is forced within the notch in order to lock said lever in its closed position, said latching finger being pivoted, against the action of said biasing spring, after the winding of each mandrel to free the detent from the notch and permit pivoting of said lever back to its open position and said locking means for said support arms being also released after the winding of each mandrel so that said arms may be pivoted to their open position.

8. Apparatus for constraining a strand being wound in a helix on a rotating and longitudinally moving mandrel to wind in closely packed convolutions, which comprises a strand guide having a guide aperture for directing the strand toward the mandrel, said guide being movable in a plane generally transverse to the line of advancement of the strand, and means for biasing said guide in the direction of the helix being wound on the mandrel, the advancing strand bearing on the wall of the guide aperture on the side opposite to the helix being wound on the mandrel, so that the guide may be moved by the preponderating one of the forces exerted by the biasing means and the strand, respectively, to assume a position where the strand is wound in closely packed helical convolutions on the mandrel.

9. Apparatus for constraining a strand being wound in a helix on a rotating and longitudinally moving mandrel to wind in closely packed convolutions, which comprises a strand guide having a generally U-shaped guide aperture for directing the strand toward the mandrel, said guide being movable in a plane generally transverse to the line of advancement of the strand, means for biasing said guide in the direction of the helix being wound on the mandrel, the advancing strand bearing on the wall of the guide aperture on the side opposite to the helix being wound on the mandrel, so that the guide may be moved by the preponderating one of the forces exerted by the biasing means and the strand, respectively, to assume a position where the strand is wound in closely packed helical convolutions on the mandrel, a roller positioned close to the open portion of the U-shaped guide aperture to engage the advancing strand and force the strand to be retained within the guide aperture, and means for limiting the movement of said guide so that the strand is prevented from jumping out of the guide aperture.

10. In combination with a helix-winding apparatus wherein a mandrel is secured to a rotatable and longitudinally movable clamp and a strand is fastened to the mandrel for winding thereon in a helix as the clamp is rotated and moved longitudinally, the strand being provided with an enlarged portion adjacent to a point therealong where it is desired to terminate the helix-winding operation; the improvement which comprises a mandrel support designed for first receiving portions of the length of the mandrel extending from the clamp and for sup-

porting the mandrel for both rotational and longitudinal movement with respect thereto, a guide located adjacent to the mandrel for guiding the strand into winding engagement with the mandrel, roller means mounted adjacent to the winding point for smoothing and compressing the strand being wound into a uniform, tight helix about the mandrel, said guide being movable in a plane generally transverse to the line of advancement of the strand and biased so that said guide is constrained by the strand to assume a position where the strand is wound in closely packed convolutions on the mandrel, a cordage-engaging member for guiding the strand to said guide, said cordage-engaging member being normally biased away from said guide, said cordage-engaging member engaging the enlarged portion of the strand which causes movement of said cordage-engaging member toward said guide, and means responsive to the movement of said cordage-engaging member for terminating the helix-winding operation.

11. Apparatus for winding strand material in a helix along a portion of the length of a mandrel, which comprises means for clamping one end of a mandrel to which the strand to be wound is secured, a mandrel support having a plurality of mandrel-supporting members provided with mandrel-receiving recesses, the members being rotatable with respect to each other between a normal position, whereat the recesses are in alignment to permit side-wise insertion of a mandrel into the recesses and removal of the mandrel therefrom, and an operating position, whereat certain ones of the recesses are displaced with respect to recesses of nonrotated members so that the mandrel previously inserted thereinto and extending from the clamping means is supported about the periphery for both rotation and longitudinal movement with respect to the clamping means, strand guide means for guiding the strand into winding engagement with the mandrel, and means for rotating the clamping means and for moving the clamping means longitudinally of the mandrel to wind the strand in a helix along a portion of the length of the mandrel, the strand guide means being pivotable in a plane transverse to the line of advancement of the strand between a closed position, whereat the strand guide means is positioned adjacent to the mandrel to engage the advancing strand and guide the strand onto the mandrel, and an open position, whereat the strand guide means is pivoted away from the mandrel to facilitate insertion and removal of the mandrel.

12. The apparatus defined in claim 11 wherein the strand-guiding means include a strand guide having an aperture through which the strand is directed toward the mandrel, a supporting lever for the strand guide mounted for pivoting movement between said closed and open positions, the strand guide being mounted on the supporting lever for movement in a plane generally transverse to the line of advancement of the strand, and means for biasing the strand guide in the direction of the helix wound on the mandrel, the advancing strand bearing on a wall of the guide aperture on the side opposite to the helix being wound on the mandrel, so that the strand guide may be moved in said plane by the preponderating one of the forces exerted by the biasing means and the strand to guide the strand on the mandrel in closely packed helical convolutions.

13. Apparatus as defined in claim 11 having roller means including at least one roller movable between a closed position with respect to the mandrel, whereat the roller is in rolling pressure engagement with each strand convolution as the convolution is wound on the mandrel in order to smooth and compress the strand being wound into a uniform, tight helix about the mandrel, and a removed position, whereat the roller is displaced with respect to the closed position thereof to facilitate insertion and removal of the mandrel.

14. Apparatus defined in claim 13 wherein the roller means include two rollers, and a pivotally mounted support for the rollers, the rollers being mounted between

25

portions of the support for rotation about individual axes parallel to the mandrel, the support being pivotable between said closed and open positions, one of the rollers, when both the rollers and the strand guide are in the closed positions thereof, is so positioned with respect to the strand guide as to confine the strand within the guide aperture.

15. Apparatus for constraining a strand being wound in a helix on a rotating and longitudinally moving mandrel to wind the strand in closely packed convolutions thereon, which comprises a strand guide having a guide aperture for directing the strand toward the mandrel, a supporting lever for the strand guide, the supporting lever being mounted for pivoting movement between a closed position, whereat the strand guide is positioned to engage the advancing strand and guide the strand onto the mandrel, and an open position, whereat the strand guide is pivoted away from the mandrel to facilitate insertion and removal thereof, the strand guide being mounted on the supporting lever for movement in a plane generally transverse to the line of advancement of the strand, means for biasing the strand guide in the direction of the helix being wound on the mandrel, the advancing strand bearing on the wall of the guide aperture on the side opposite to the helix being wound on the mandrel, so that the strand guide may be moved in said plane by the preponderating one of the forces exerted by the biasing means and the stand to guide the strand on the mandrel in closely packed

26

helical convolutions, a pivotally mounted support, and a pair of helix-forming rollers mounted between portions of the support for rotation about individual axes parallel to the mandrel, the support being pivotable between a closed position whereat said rollers are positioned, with respect to the mandrel and the strand guide, so that the peripheries of the rollers engage compressively each strand convolution as it is wound on the mandrel in order to smooth and compress the strand being wound into a uniform, tight helix about the mandrel, and an open position whereat the rollers are pivoted away from the mandrel to facilitate insertion and removal thereof, one of the rollers, when both the rollers and the strand guide are in the strand-engaging positions thereof, is so positioned with respect to the strand guide as to force the strand to be retained within the guide aperture.

References Cited in the file of this patent

UNITED STATES PATENTS

20	11,296	Macintosh	Dec. 27, 1892
	861,608	Richardson	July 30, 1907
	965,240	Sloper	July 26, 1910
	1,137,412	Loutrel	Apr. 27, 1915
	2,565,465	Ames	Aug. 28, 1951
25	2,736,505	Furst et al.	Feb. 28, 1956
	2,881,982	Miller	Apr. 14, 1959
	2,898,630	Adams	Aug. 11, 1959

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,024,497

March 13, 1962

Edwin C. Hardesty et al.

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 5, line 32, for "designated" read -- designed --;
column 16, line 57, for "normal-disaster" read -- normal-
diameter --; column 22, line 57, for "at" read -- as --;
column 25, line 28, for "stand" read -- strand --.

Signed and sealed this 3rd day of July 1962.

(SEAL)

Attest:

ERNEST W. SWIDER
Attesting Officer

DAVID L. LADD
Commissioner of Patents