

[54] SPRING-COILING MACHINE

[76] Inventor: Charles R. Bergevin, R.F.D. No. 2,
Winsted, Conn. 06098

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72/138

[51] Int. Cl. B30b 15/00, B21f 11/00

[58] Field of Search 72/30, 131, 132,
72/138

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Primary Examiner—Charles W. Lanham
Assistant Examiner—Robert M. Rogers
Attorney—Steward & Steward, Merrill F. Steward and
Donald T. Steward

[57] ABSTRACT

An automatic, spring-coiling machine of the gear-segment type in which the wire is fed into engagement with the coiling tools on each feed-stroke of the gear segment and having a cutter for severing the spring from the supply of wire at the end of the coiling cycle for each spring. The cutter may be de-activated in order to feed wire with more than one feed-stroke of the segment, and each of the coiling tools may be de-activated during any portion of the coiling cycle and then reactivated again at any point in order to make changes in the configuration of the spring anywhere along the length of the spring, as well as at its ends.

18 Claims, 19 Drawing Figures

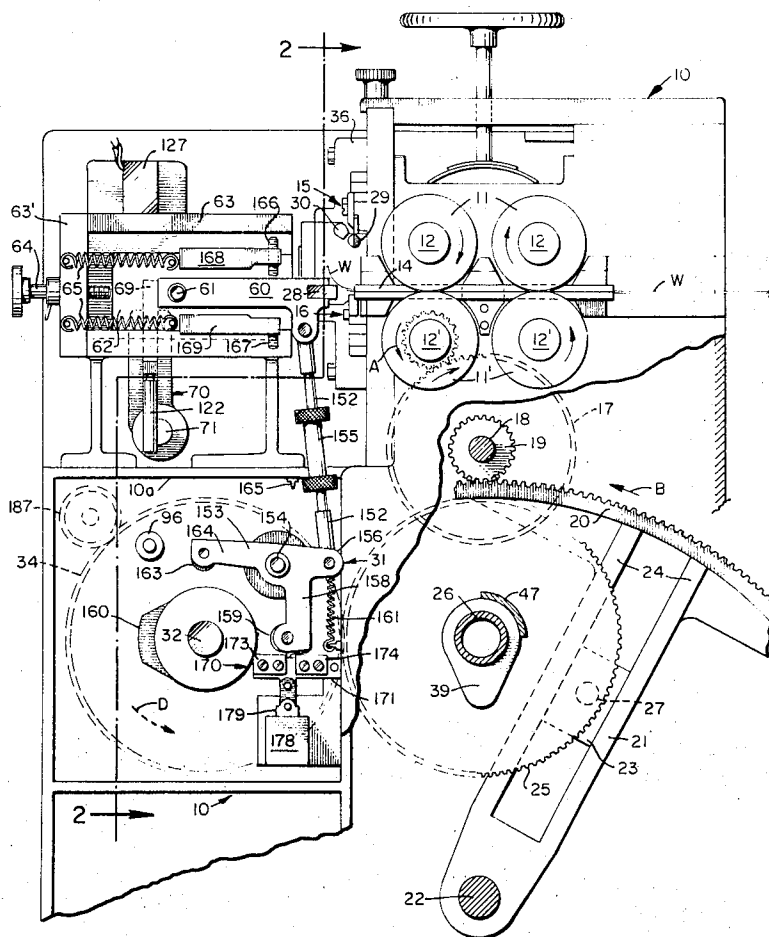
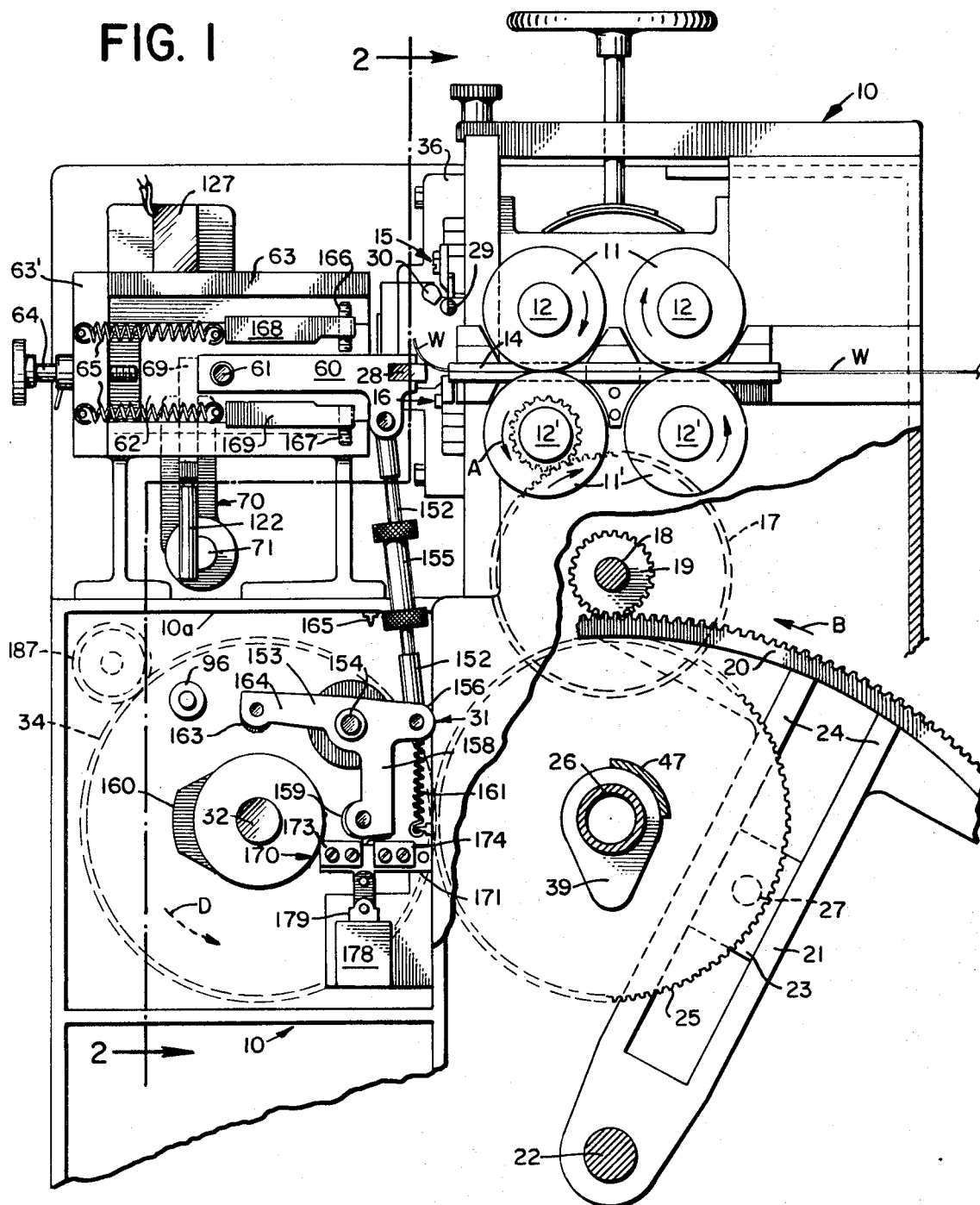


FIG. 1



INVENTOR
CHARLES R. BERGEVIN

BY *Stewart & Stewart*
his ATTORNEYS.

FIG. 3

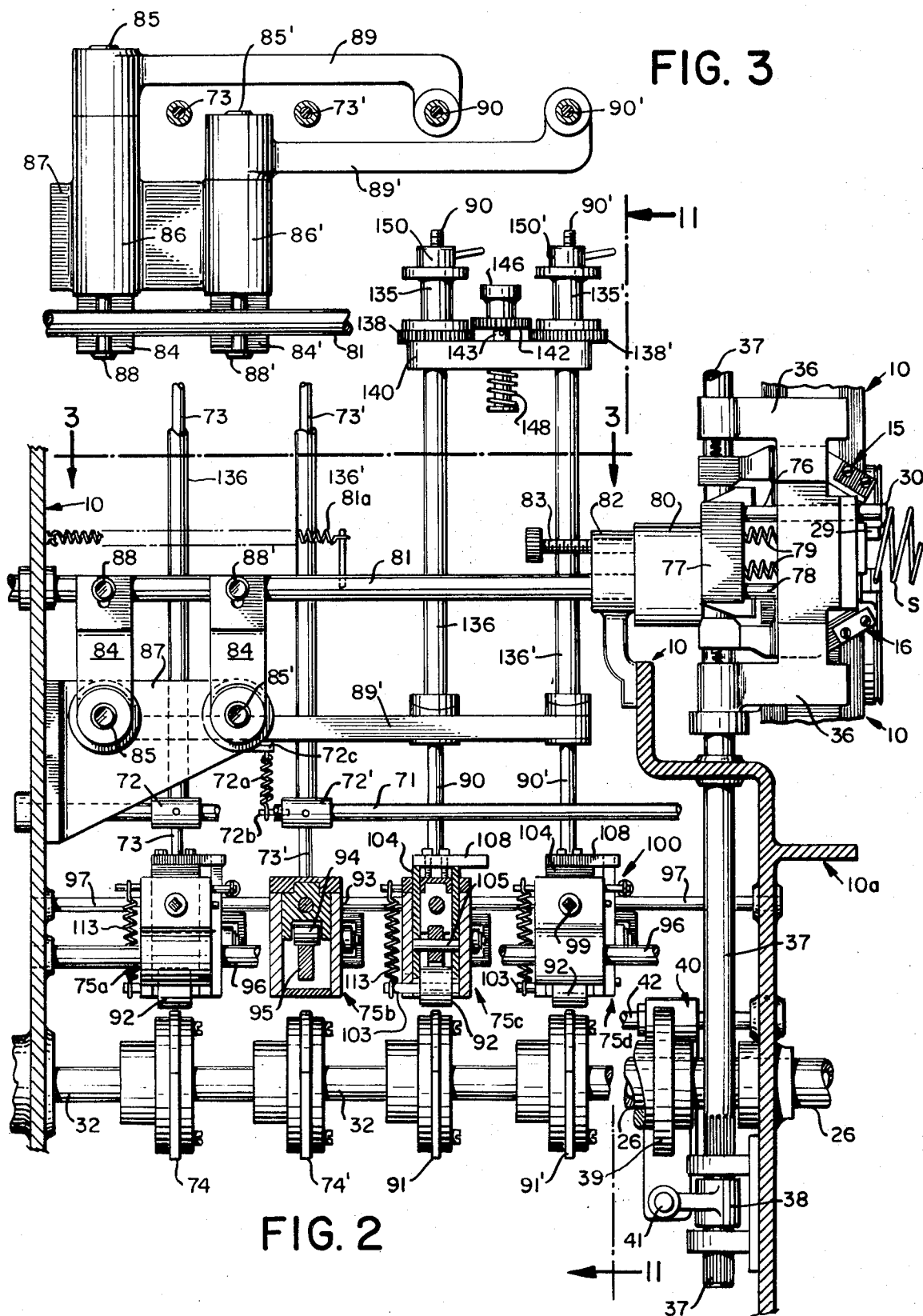


FIG. 2

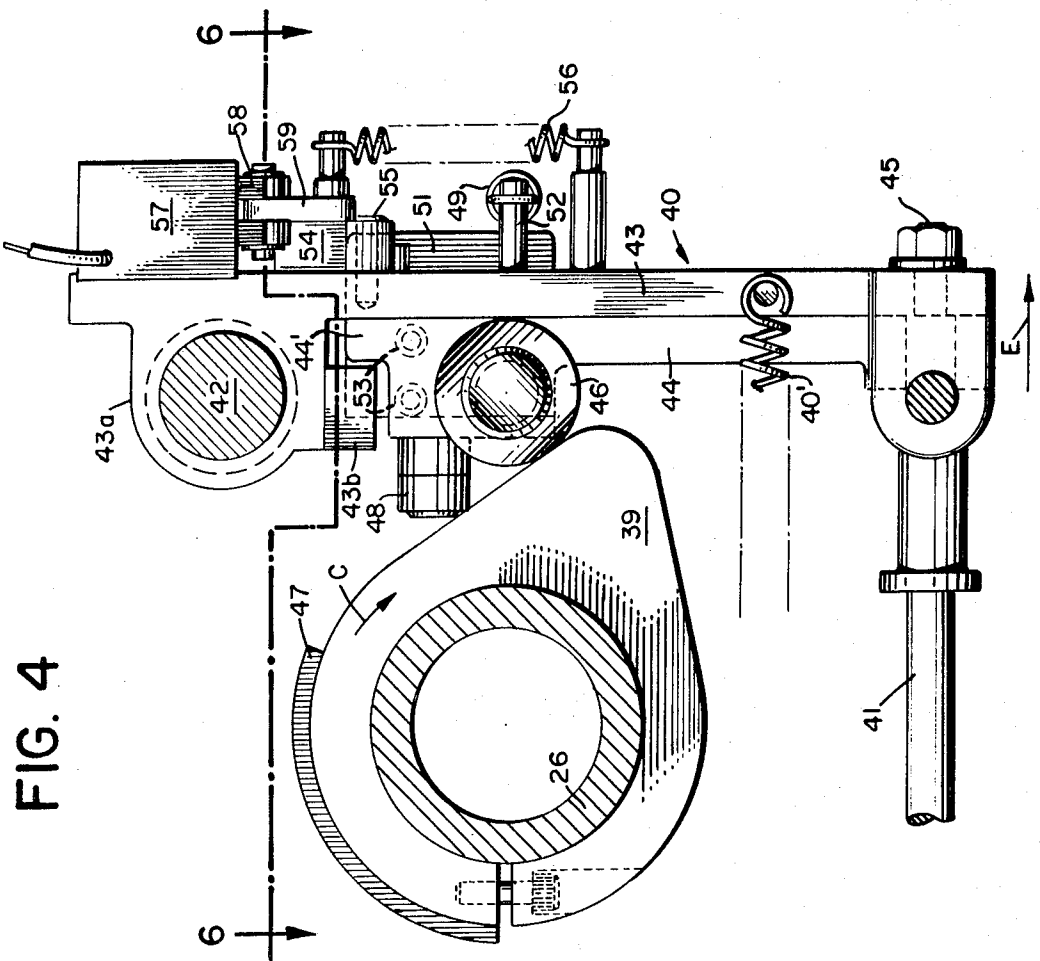
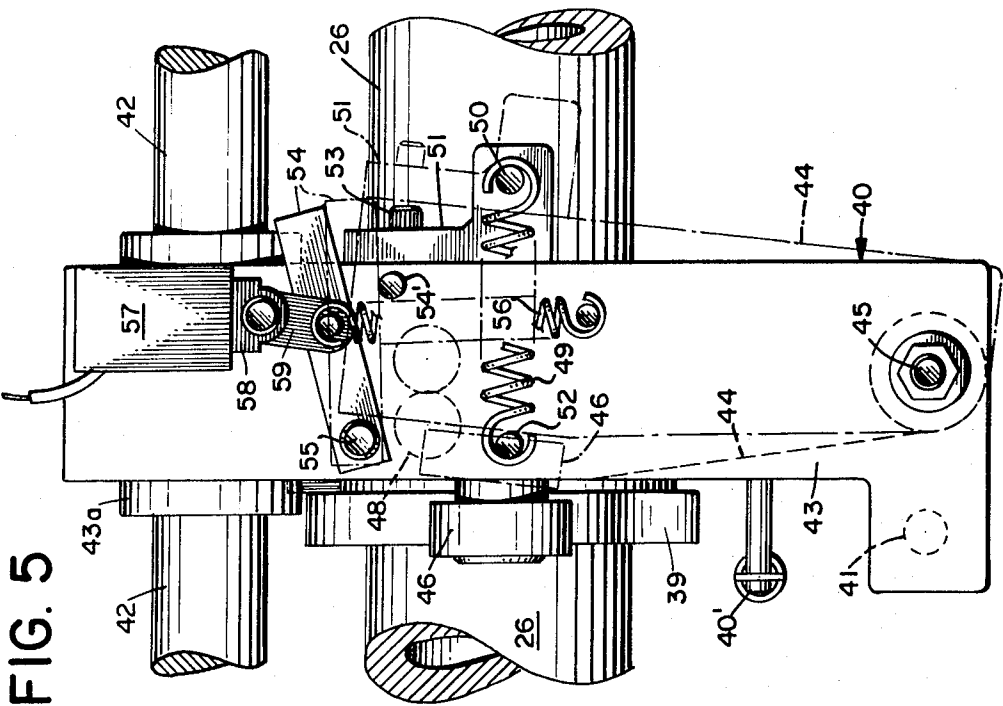


FIG. 6

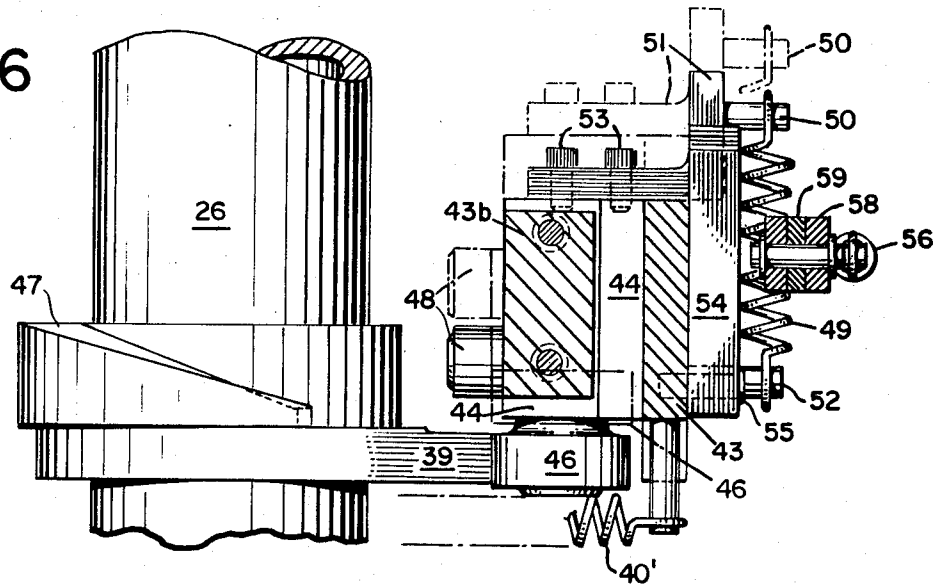


FIG. 7

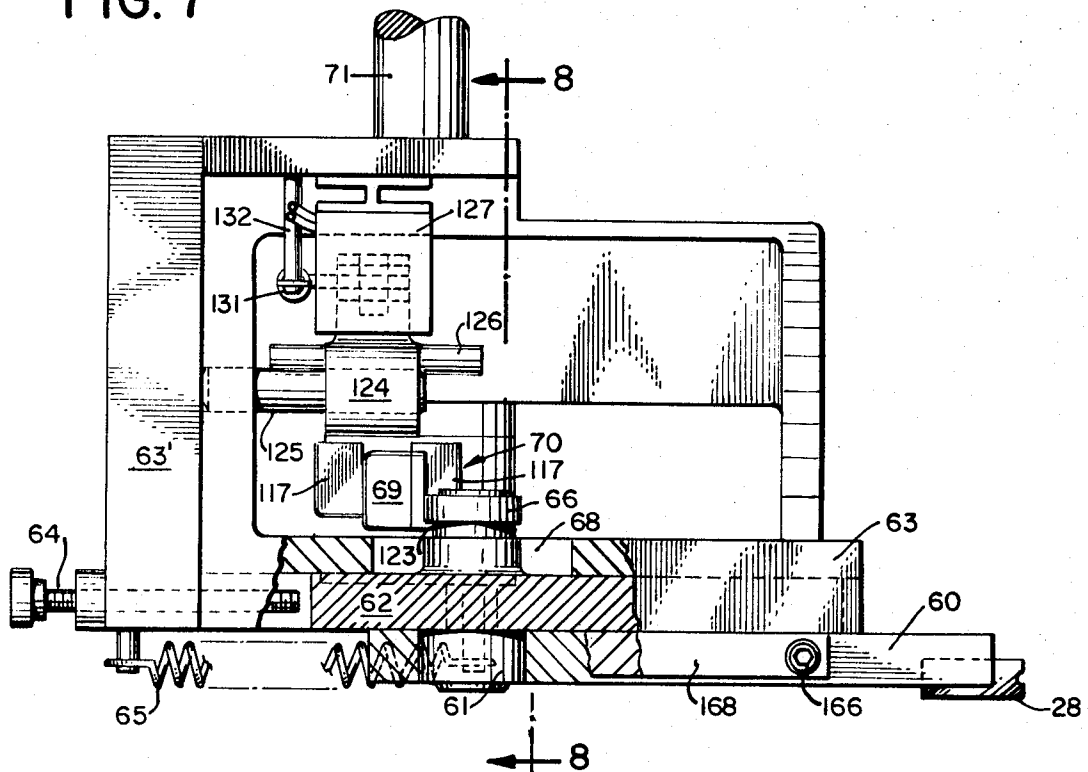


FIG. 10

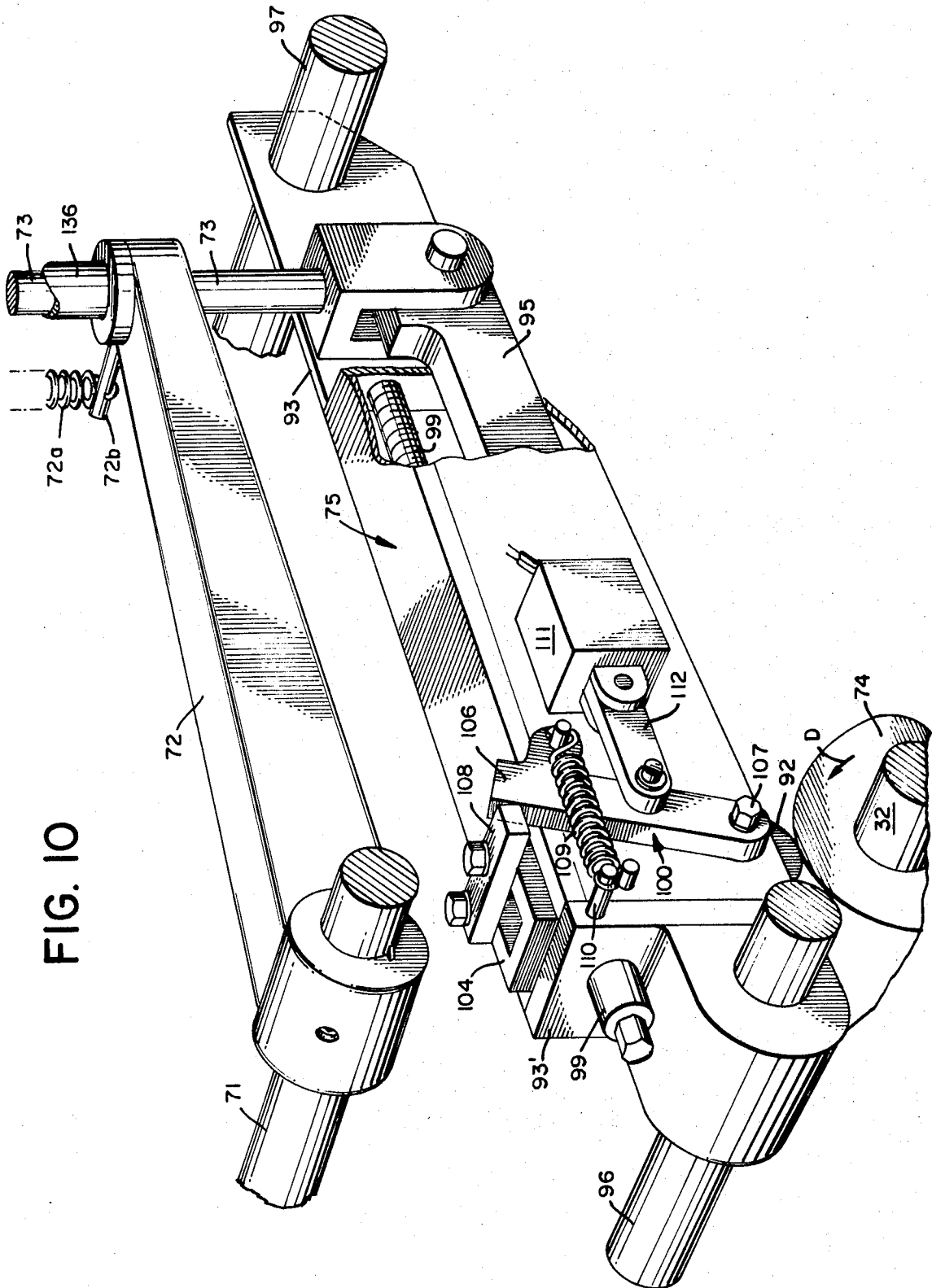


FIG. II

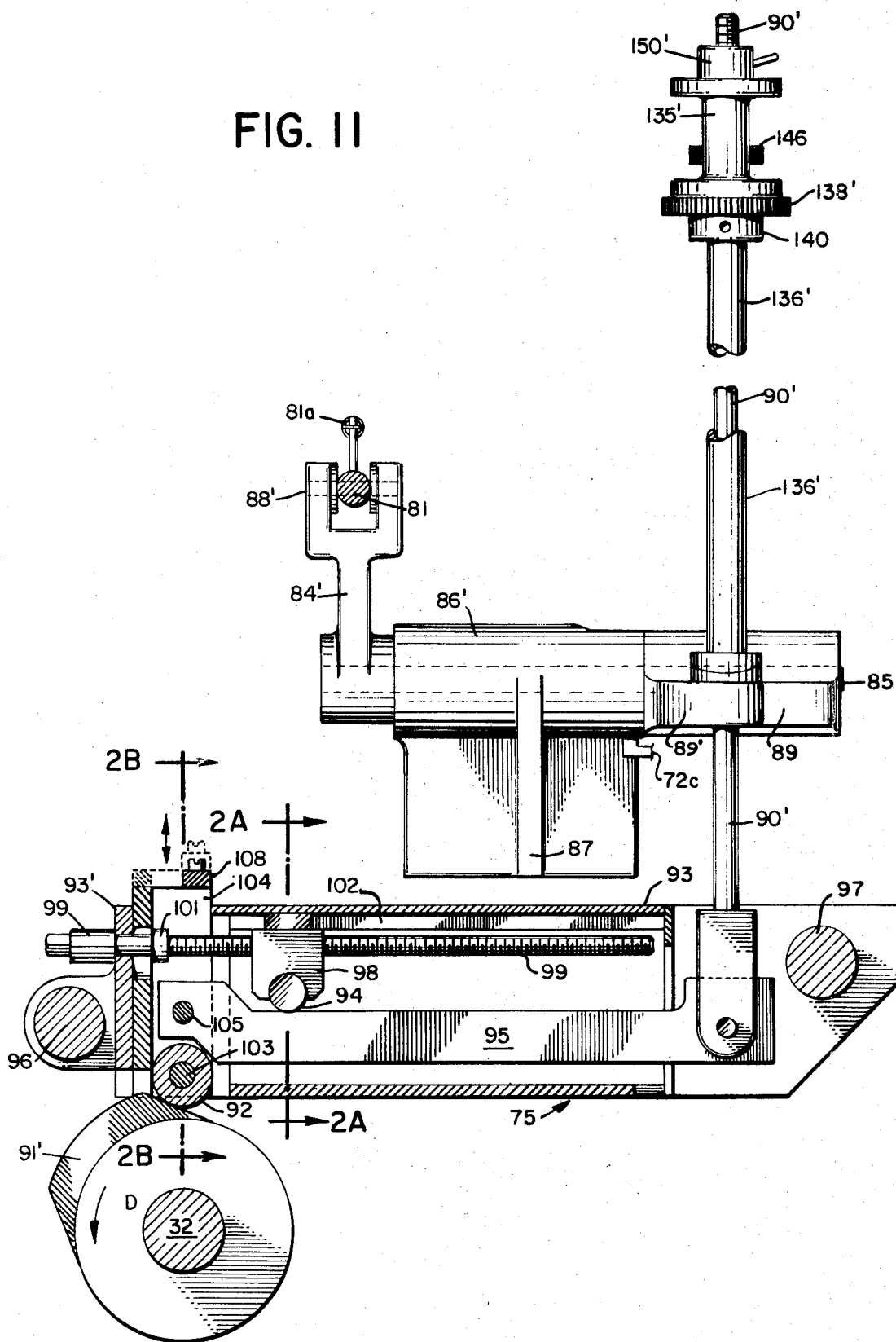


FIG. 13

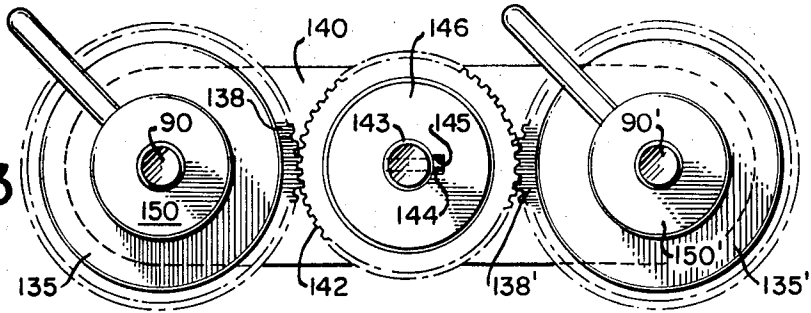
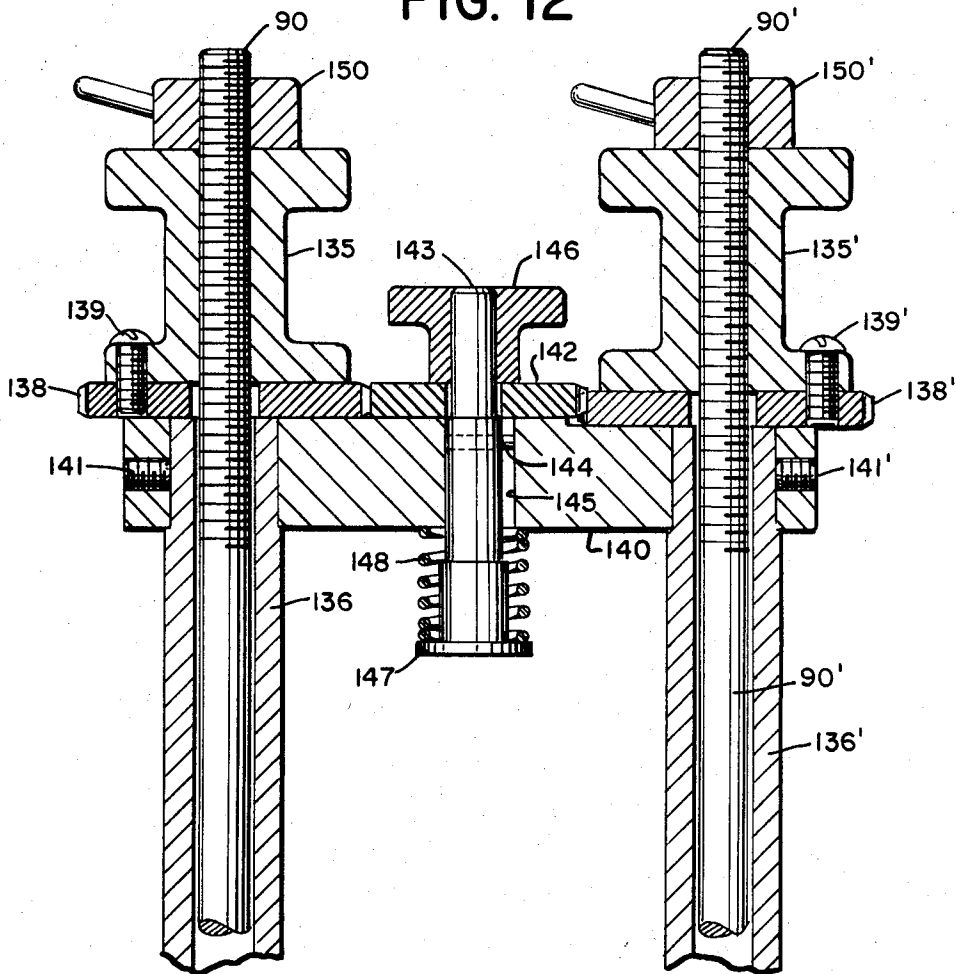


FIG. 12



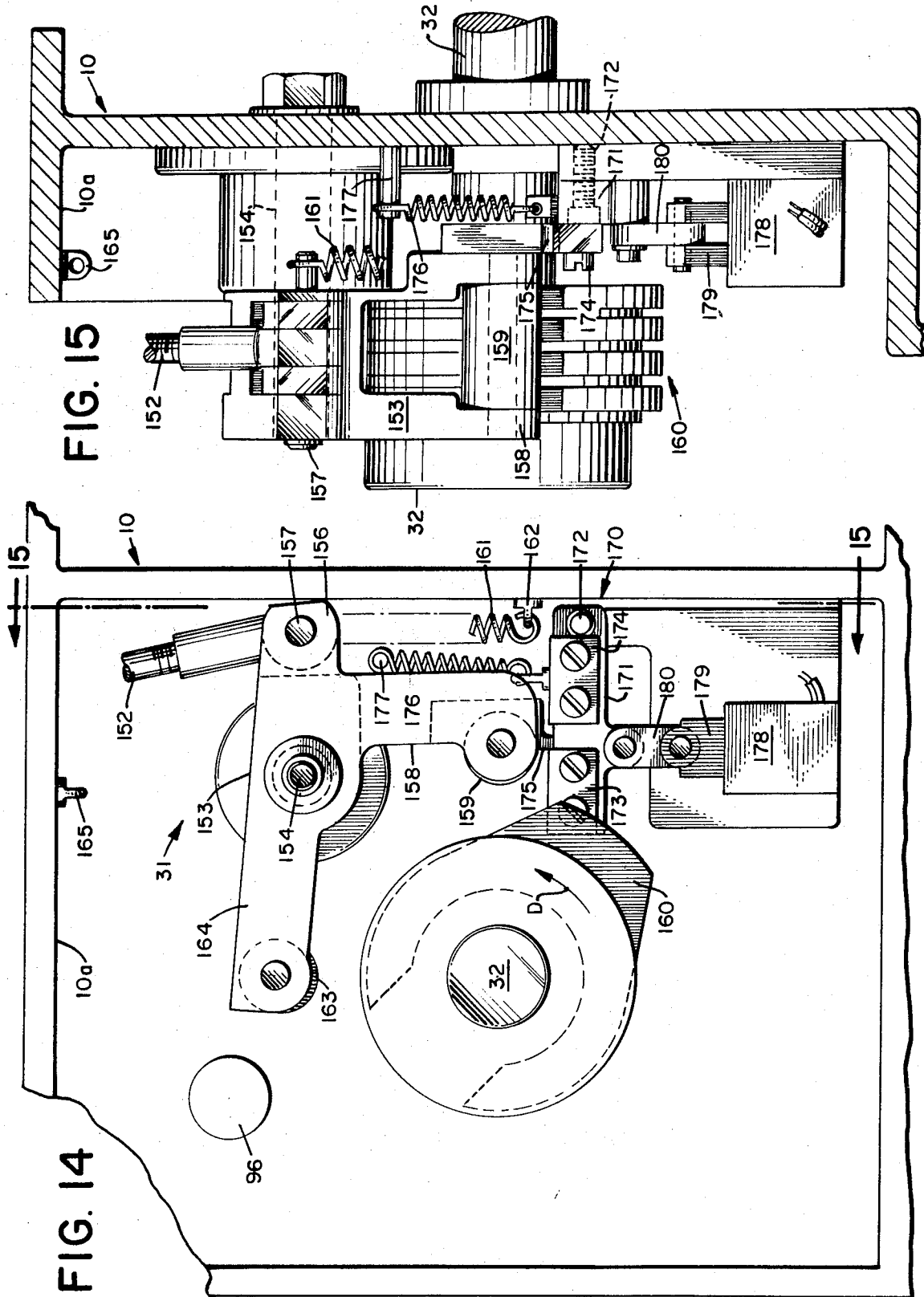


FIG. 16

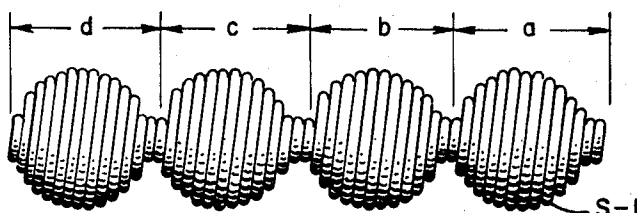


FIG. 17

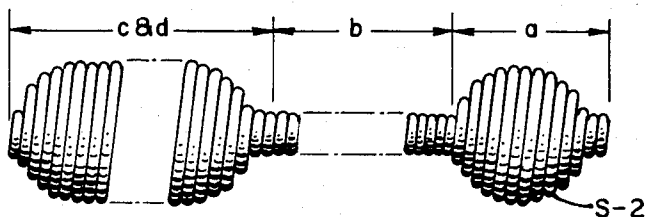


FIG. 18

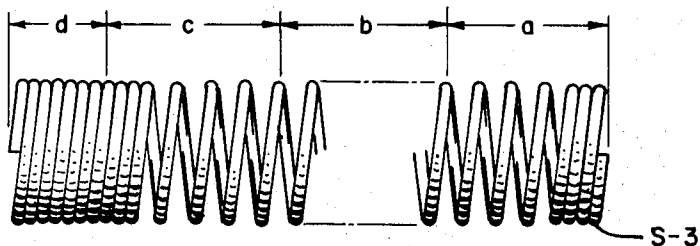
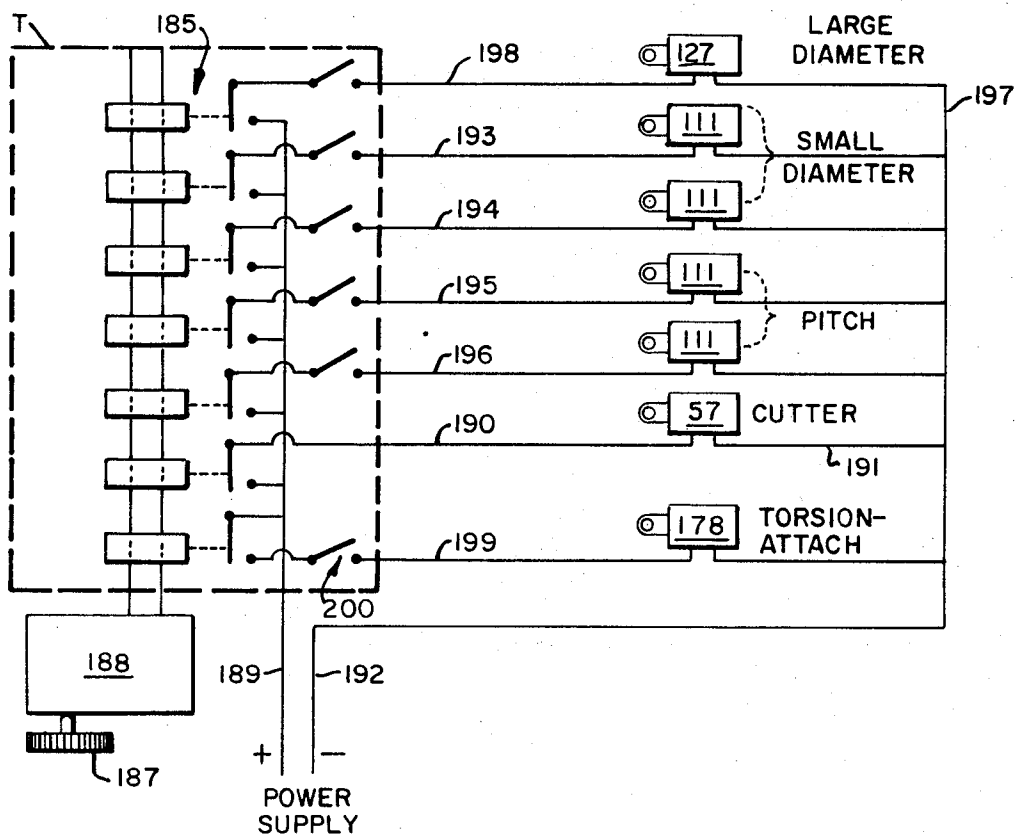


FIG. 19



SPRING-COILING MACHINE

BACKGROUND OF THE INVENTION

The present invention relates to spring-coiling machines, and it relates more particularly to improvements in spring-coiling machines of the so-called segment type in which a gear segment is employed for intermittently feeding wire to the coiling tools which bend the wire into coils of the desired shape.

Automatic spring-coiling machines must be capable of accurately reproducing in each spring coiled the desired physical dimensions for each run of springs to be produced. These dimensions include the diameter of the individual coils or groups of coils making up each spring and the pitch which the wire makes with respect to the longitudinal axis of the spring, the pitch determining whether the coils lie side-by-side in contact with each other or are spaced apart from each other. There is an increasing demand in industry today for substantial quantities of relatively complicated springs in which both the diameter and pitch may vary within each spring. In addition, complex springs may be required which have two or more groups of coils integrally connected together by straight lengths of wire or by short lengths of either straight or curved wire. Such springs have usually been made more or less by hand, which is extremely expensive, or have had to be made on continuous-feed coiling machines, which do not have the accuracy of the segment-type machine.

As is will understood in the art, automatic spring-coiling machines are capable of changing the diameter of the coils by moving the coiling point closer to, or farther from, the arbor over which the wire is bent as it is fed into contact with the coiling point. The pitch of the wire, or spacing of the coils, may also be changed during the coiling operation by increasing or decreasing the amount that the pitch tool bends the wire lengthwise of the spring. Straight lengths of wire are provided in the spring by moving the coiling point out of the path of the wire as it comes from the feed rollers. The mechanism for moving the coiling point in this manner is usually referred to as a torsion attachment, because it was originally devised for providing one or both ends of the spring with a straight section of wire such that when the spring is installed in the device for which it is designed, torque is applied to it by means of its straight end.

For many years a serious disadvantage of the segment-type coiler was its inability to coil springs that are longer than that which can be produced by a single stroke of the gear segment. A further drawback has been its limited capacity for making a spring having coils of different diameter and spacing one from another any place within the spring itself. Attempts have been made to provide long-feed attachments for segment-type machines for coiling springs which require more wire than a single stroke of the gear segment is capable of providing. The U.S. Pat. No. to Franks 3,009,505 discloses a segment-type machine which can coil longer springs by what is known as a multiple-feed system. This is accomplished in the Franks machine by stopping the cam shaft, by which the cutter cam is rotated so that the cutter is not actuated. However, the gear segment that drives the wire-feed rollers continues to oscillate, thereby intermittently feeding any amount of wire needed. As is pointed out in this patent, the Franks system is still not capable of actuating the coil-

ing tools or of bringing them into and out of operation, during the coiling cycle, except at the leading and trailing ends of each individual spring. Thus, in effect, the system proposed by Franks is capable only of producing long springs due to the fact that the cam shaft must be stopped before the cutter cam operates the cutter and can not be restarted again until it is necessary to cut the completed spring from the wire being fed. Consequently, in the Franks system only the coils at the leading and trailing ends of the spring can be varied in diameter, pitch, etc., because it is only during the first and last oscillations of the segment gear that the diameter and pitch cams can be rotated in order to make the necessary automatic adjustments in the coiling tools. The Franks system therefore does not satisfy present-day requirements for springs having coils of varying configurations at any point along their length.

An object of my invention is to improve upon the basic design of the segment-type, wire-spring coiler, so that such machines can be used to produce springs, not only of any desired length, but also of various configurations, almost without limitation.

SUMMARY OF THE INVENTION

Segment-type, spring-coiling machines have a drive shaft and crank-wheel that continuously oscillate a gear segment in well-known manner for intermittently driving wire-feed rolls on each feeding stroke of the gear segment. These machines also include various tools which work the wire into the desired shape, such tools including a coiling point, and a pitch tool for respectively bending the wire into helical coils and for spacing the coils apart. A torsion-attachment may also be provided for forming straight lengths of wire in the spring, and a cutter severs the completed springs from the supply of wire being fed by the feed-rolls. In addition, a cam-operated diameter-control mechanism is provided for moving the coiling point toward and away from the coiling arbor; a cam-operated pitch-control mechanism moves the pitch tool lengthwise of the spring being coiled; and a cam operated cutter-control mechanism activates the cutter, all as well understood in the art. When a torsion-attachment is also provided, suitable means for controlling the operation of this attachment must also be included. Each of these control mechanisms, includes a rotary cam that engages a roller for adjusting the coiling or pitch tools, or for actuating the cutter or torsion-attachment in precisely timed relation to the wire-feed. Moreover, all the operating cams rotate continuously.

Basically, my invention resides in providing means for automatically de-activating each of the control mechanisms at some point intermediate the particular tool involved and its cam and in providing each with means for re-activating such control mechanism separately, so that the cutter and all the coiling tools can be de-activated and re-activated independently of each other even though their cams continue to rotate. Such independent control of the various tools makes possible the use of a programmer for activating and/or de-activating the tools in any desired sequence so that large quantities of identical wire springs, each having any desired configuration including length, diameter and pitch, can be produced automatically at the full capacity of the machine. Preferably the invention is employed in connection with the segment-type coiling machine disclosed in my prior U.S. Pat. Nos. 3,466,906

granted Sept. 16, 1969 and 3,472,051 granted Oct. 14, 1969, to which reference is hereby made for specific details not required for an adequate understanding of the present invention.

A specific aspect of the invention when employed in connection with coilers of the type disclosed in my above-mentioned patents resides in providing means for latching each of the tool controlling or actuating mechanisms, so that each of the various control mechanisms is automatically de-activating each time it has been actuated by its cam. A timer is provided for releasing the latch means of each of the control mechanisms individually at any desired point during the formation of the spring.

In order to avoid confusion, a clear understanding is necessary of what is meant by the terms "de-activating" and "re-activating" the various tools, including the cutter, and attachments which control them. When a coiling machine is set-up to produce springs of a given configuration, the coiling-tools, namely the coiling point and pitch tool, may be moved completely out of engagement with the wire, or they may only be moved a small amount while still in contact with the wire in order to change the size of the coils in the spring or the spacing between the coils, for example. Such movement is produced by selecting and properly setting cams that are continuously rotated on the drive shaft of the machine or on a separate cam shaft. Normally each tool or attachment is moved or actuated by its cam during each revolution of the cam. When the action normally transmitted by a cam to a tool is prevented or nullified, the tool is said to be "de-activated," and when such cam-action is restored to the tool, it is "re-activated."

For example, it is normal for the cutter to be actuated once during each revolution of its cam and where such actuation is prevented by nullifying the action of the cam during one or more subsequent revolutions, the cutter is de-activated until normal cam-actuation is restored in order to re-activate the cutter. Similarly, where the spacing between the coils in the spring changes within the length of the spring, a cam normally actuates the pitch tool during each of its revolutions in order to change the position of the pitch tool with respect to the wire being coiled. When any part of such normal actuation of the pitch tool is prevented during one or more revolutions of its cam, the pitch tool is said to be de-activated during that period.

It is important to bear in mind, however, that the operation which the pitch tool performs in coiling the spring is not necessarily eliminated by "de-activating" such tool. For example, a pitch cam may be used in such a way that the pitch tool does not engage the wire at the start of the coiling cycle for a spring in order to coil closed coils at the leading end of the spring and then moves the pitch tool outward to produce open coils. However, if long springs are to be produced in accordance with the present invention, the pitch cam employed must rotate through more than one revolution. It is necessary, therefore, to "de-activate" the pitch tool during at least part of the next revolution of its cam in order to continue to coil open coils. In this case the pitch tool is "de-activated" while still in operative engagement with the spring being coiled. Consequently, the term "de-activating" as used throughout the present disclosure and claims in connection with the coiling tools, such as the pitch tool and coiling points, means

that the tools are prevented from being adjusted by their respective cams. It will be apparent, therefore, that while de-activating one of the tools, as in the case of the cutter or torsion attachment, may result in rendering such tool inoperative by completely eliminating the operation for which it is intended, that is not always the case.

DESCRIPTION OF PREFERRED EMBODIMENT

The advantages and features of the invention will become more apparent from the following detailed description of one embodiment of the invention shown in the accompanying drawings, wherein:

FIG. 1 is a partially schematic front view of a segment-type, wire-coiling machine similar to that disclosed in my hereinbefore-identified patents, in which the present invention is employed, portions of the housing being broken away and parts removed in order to expose internal parts of the machine;

FIG. 2 is a vertical section through the front portion of the machine shown in FIG. 1 and taken substantially along the line 2—2, the torsion-attachment, control mechanism being removed and the front end of the cam shaft broken away, in order to show the cutter control mechanism;

FIG. 3 is a detail view taken in horizontal section on line 3—3 of FIG. 2, showing the actuating levers for controlling the pitch tool;

FIG. 4 is an enlarged detail view of the cutter-cam mechanism, as viewed from the front of the machine, but internally thereof, and showing the cam-operated linkage and latch mechanism for de-activating the cutter;

FIG. 5 is a side view of the cutter linkage and latch mechanism, looking from right to left, as seen in FIG. 4;

FIG. 6 is a horizontal section taken on the line 6—6 of FIG. 4, portions being broken away in order to show the disconnecter cam-roll;

FIG. 7 is an enlarged top plan view of the coiling point mount or diameter slide for moving the coiling point along the line of wire feed in order to change the diameter of the coils being formed, parts of the slide frame and coiling point arm being broken away;

FIG. 8 is a vertical section through the diameter slide taken on the line 8—8 of FIG. 7 and showing the diameter slide actuating arm and means for disengaging and re-engaging it with the diameter slide;

FIG. 9 is a front view of the diameter slide, portions thereof being shown in vertical section taken generally along the line 9—9 of FIG. 8 in order to show the actuating arm and slide roll;

FIG. 10 is a perspective view of one of the cam-movement compounds and actuating levers for the diameter-control mechanism;

FIG. 11 is an enlarged vertical section of the pitch-control mechanism, taken on the line 11—11 of FIG. 2 through one of the cam-movement compounds, those parts of the machine not directly related to the pitch control being removed for purposes of illustration;

FIG. 12 is an enlarged detailed vertical section through a novel, dual adjusting device for pitch or diameter;

FIG. 13 is a plan view of the dual adjusting device shown in FIG. 12;

FIG. 14 is an enlarged front view of the torsion-attachment-control mechanism and latch therefor;

FIG. 15 is a vertical section taken on the line 15—15 of FIG. 14;

FIGS. 16, 17 and 18 are pictorial illustrations of typical spring configurations which can be made by the spring-coiling machine of the present invention; and

FIG. 19 is a wiring diagram for programming the release of the latch means employed.

A frame and supporting structure for the machine, generally indicated by the reference numeral 10, carries the wire feeding mechanism, coiling tools and control means therefor. Two sets of substantially tangent upper and lower feed rolls 11 and 11', respectively, are intermittently rotated on upper and lower drive shafts 12 and 12', respectively, in the directions shown in FIG. 1 in order to feed the spring wire W through a wire-guide 14. The wire W is projected by the feed rolls through the wireguide 14 into the coiling area of the machine where it is bent by spring-forming tools to be described hereinafter into helical coils of the desired configuration. During a complete cycle of operations of the machine, each spring is individually coiled and then cut by either one of a pair of cutters 15, 16 from the continuous length of wire W being fed through the wire-guide 14 from a supply (not shown). Each cycle of the machine for each spring is completed at a time when the wire is momentarily stopped and after each individual spring has been cut free, the next cycle beginning where the preceeding one ended. Successive coiling cycles are repeated until the desired number of springs have been coiled.

As is schematically shown in FIG. 1, a bull gear 17 on a clutch shaft 18 drives one of the lower feed-rolls 11' in the direction indicated by the arrow A. The other three feed rolls are driven in unison in the directions indicated by means of an endless chain (not shown) suitably trained over sprockets at the rear of each of the drive shafts. Clutch shaft 18 is driven through a one-way clutch-and-pinion 19 by a gear segment 20, such that rotation of gear 17 and drive shafts 12, 12' occurs only when the segment 20 moves from right to left, as indicated by the arrow B, in what is referred to as a feed-stroke.

Gear segment 20 is mounted on a radial arm 21 pivoted on a rock shaft 22 which is suitably supported in the frame 10 of the machine. A slide block 23 is guided in a radial slot 24 in arm 21 for reciprocal sliding movement therein. A crank gear 25 fixed to a main drive shaft 26 is provided with a crank pin 27, which is received by, and pivots in, slide block 23 such that rotation of crank gear 25 causes gear segment 20 to oscillate back and forth in order to drive the wire-feed rolls 11, 11'. Main drive shaft 26, which is disposed from front to back of the machine and mounted in suitable bearing blocks on the frame 10, is rotated at any desired speed by an electric motor (not shown). For a more detailed description of the feed-roll drive, reference is made to my U.S. Pat. No. 3,466,906 granted Sept. 16, 1969.

Referring now in greater detail to the coiling tools and to the means by which these tools are arranged and operate to coil springs of specified configurations, it will be noted that in addition to the wire-guide 14, the spring-forming tools consist basically of: a single coiling abutment or point 28 against which the wire is projected directly from the guide 14, in order to bend it upward or downward into helical coils; a cutting anvil 29 which is mounted for vertical adjustment into sup-

porting engagement with the inner surface of the coil; a pitch tool 30 which is likewise mounted for vertical adjustment with anvil 29 so that it is always in position for engagement with the wire as it is coiled and can bend the coil along its longitudinal axis; a torsion-attachment indicated generally at 31 for moving the coiling point out of the path of the wire W as it is being fed in order to form straight lengths of wire in the spring being coiled; plus the hereinbefore-mentioned cutters 15 and 16. As shown in FIG. 1 the upper cutter 15 is depicted as being in use, anvil 29 being positioned for meshing engagement by the blade of cutter 15 for severing the wire after each spring is completed. As is well understood in the art, the lower cutter 16 is employed only when the wire is bent downward in order to coil springs in the opposite direction.

The coiling machine is also provided with the usual cam-shaft 32, which extends from the front toward the rear of the machine and parallel to both the main drive shaft 26 and wire-feed shafts 12, 12'. Cam-shaft 32 is rotatably mounted at its opposite ends in the machine frame 10 and has a gear 34 (shown in broken lines in FIG. 1), which meshes with, and is driven by, crank gear 25 on main drive shaft 26. The gears 25 and 34 are the same size and have the same number of teeth, so that cam-shaft 32 rotates at the same speed as shaft 26. It will be noted that gears 25 and 34 are shown only schematically in FIG. 1, and that cam-shaft 32 extends rearward of the portion of the machine shown in FIG. 2, gears 25 and 34 as well as gear segment 20, all being located in the rear part of the machine which is not visible in FIG. 2. In addition, the cam-shaft 32 is shown broken away in FIG. 2 before it reaches the front wall of the frame 10 in which it is journaled, in order to expose a short section of the main drive shaft 26, which lies directly behind it as viewed from that side. A series of cams are mounted on cam-shaft 32 for actuating the pitch tool, coiling point and torsion-attachment, all to be described in greater detail hereinafter.

The cutter mechanism as shown in FIGS. 1-6 is similar to that disclosed in my hereinbefore-identified U.S. Pat. No. 3,472,051 in that the cutter arms 15 and 16 are mounted on a vertically adjustable tool-holder 36 with the anvil 29 and pitch tool 30, the cutter arms being operated by means of a vertical shaft 37 (FIG. 2). Cutter shaft 37 is mounted for longitudinal movement with the holder 36 when the tools are adjusted vertically. Shaft 37 is also rotated about its longitudinal axis by a crank arm 38 mounted adjacent the lower end of shaft 37. A cam 39 for operating the cutter pivots a cam lever 40 (FIGS. 2, 4 & 5) connected to crank arm 38 by a horizontal pull-rod 41. As indicated more or less schematically in FIG. 1, cam 39 is in this instance mounted on the main drive shaft 26. For purposes of clarity in illustrating the basic components of the machine, the cutter-cam linkage is not shown in FIG. 1 and instead, is shown enlarged in FIGS. 4-6. De-activating Means for Cutter Control Mechanism (FIGS. 4-6)

In order to obtain a greater amount of wire-feed for each spring than is ordinarily possible in a segment-type machine of similar size, the cutter is de-activated by disconnecting its cam-follower from the cutter cam so that it does not operate each time the cutter cam 39 on drive shaft 26 makes one revolution. This is accomplished by moving the cam-roll 46 to an inoperative position out of the path of the cutter cam 39 and by latch-

ing the cam-roll in this inoperative position for as many revolutions of shaft 26 as is necessary to feed the amount of wire required. Thus, by rendering the cutter cam inoperative while the segment gear 20 continues to oscillate, any predetermined length of wire W can be fed by the machine before the cutter is actuated.

It will be appreciated that it is immaterial whether the cutter cam 39 is located on the drive shaft 26 or on the cam-shaft 32, because as stated before, the cam-shaft rotates at a 1-to-1 ratio with respect to the drive shaft. Furthermore, if space within the machine permitted, all the cams could be located on the main drive shaft or all could be located on the cam-shaft. For the sake of clarity, it should also be pointed out that what is referred to herein as the main drive shaft may sometimes be designated by those skilled in the art as the bull-gear or crank-gear shaft.

Cam lever 40 is pivotally mounted on a fixed shaft 42 suitably supported in the frame 10 of the machine and consists of vertically elongated lever-plate 43 and a similarly shaped pivot-plate 44, which lie flush with each other, the lever-plate 43 extending above plate 44 where it is provided with a boss 43a, through which shaft 42 extends. Pivot-plate 44 is carried by lever-plate 43 for pivotal movement with respect thereto at its lower end on a bolt 45, so that it can be swung transversely outward, as indicated in phantom lines in FIG. 5. A guide-block 43b is bolted to the underside of the boss 43a and is spaced from the back side of lever-plate 43 to receive between them an upper extension 44' of pivot-plate 44. Pivot-plate 44 is accordingly guided at its upper end for pivotal movement about the bolt 45. A cam-roll 46 is rotatably mounted on an enlarged upper portion of pivot-plate 44 for engagement by the cutter cam 39, such that the entire cam lever 40 is pivoted counterclockwise, as indicated by the arrow E in FIG. 4, by the lobe on cam 39. Such movement causes the crank arm 38 to rotate the cutter shaft 37 through a predetermined arc of rotation for actuating the cutters. A coil spring 40' is stretched between a suitable mounting pin on lever-plate 43 and a fixed portion (not shown) of the frame 10 of the machine, in order to urge cam lever 40 toward cam 39. Pull-rod 41 is provided with the usual adjustment means (not shown), by which to adjust the position of cam-roll 46 with respect to cam 39.

The manner in which cam-roll 46 is moved to its inoperative position in order to render cutter cam 39 ineffective, can be readily observed by reference to FIGS. 4-6, which illustrate how the pivot-plate 44 of cam-lever 40 pivots transversely of its mating lever-plate 43, carrying with it the cam-roll 46 to an inoperative position shown in phantom lines in FIG. 5. Pivot-plate 44 is moved to its inoperative position by means of a cylinder cam 47, best shown in FIG. 6, which is located directly in back of the cutter cam 39 on main drive shaft 26. Cam 47 engages a second cam-roll 48 mounted on pivot-plate 44 to the rear of cam-roll 46. As can be seen in FIG. 4, the cylinder cam 47 is positioned with respect to cutter cam 39 circumferentially of shaft 26 such that it first engages cam-roll 48 about 90° from the high point on cutter cam 39 when the shaft is rotated in the direction indicated by the arrow C (FIG. 4), and the cam-roll 48 engages the high point on cam 47 after approximately 90° of additional rotation. At this point the pivot-plate 44 has been moved to the phantom-line position, shown in FIG. 5, and

cam-roll 46 has moved to its inoperative position out of the path of cutter cam 39. Pivotal movement of pivot-plate 44 in this direction with respect to lever-plate 43 is resiliently resisted by a return spring 49, connected at one end to a pin 50 fixed to an L-shaped bracket 51 on pivot-plate 44 and at its other end to a pin 52 on lever-plate 43. Bracket 51 is mounted by means of screws 53, 53 to the back side of pivot-plate 44 such that it projects across the back edge of lever-plate 43. Spring 49 pulls pivot-plate 44 with considerable force, pressing bracket 51 firmly against the edge of lever-plate 43, thereby positioning cam-roll 46, in alignment with cutter cam 39. It is apparent that unless pivot-plate 44 is held in its phantom-line position, it can immediately swing back to its operative position each time cam-roll 48 reaches the end of the cylinder cam 47, some 190° to 200° of rotation of shaft 26 after the point at which the high point of cutter cam 39 first engages cam-roll 46.

The latch-means for holding the cam-roll 46 in its inoperative condition includes a latch-bar 54, which is pivoted to lever-plate 43 on a pivot pin 55 so that it can swing from its unlocked position shown in full lines to its latching position shown in phantom lines in FIG. 5. Bracket 51 not only extends across the back edge of lever-plate 43, but also beyond it for engagement with the free end of latch-bar 54. When pivot-plate 44 is swung to its phantom-line position, bracket 51 moves outward of the end of latch-bar 54, which drops into its latching position in engagement with a positioning pin 54', blocking bracket 51 so that pivot-plate 44 cannot move back to its full-line position. A latch spring 56, mounted at one end to the mid-portion of latch-bar 54 and at its other to a mounting pin on lever-plate 43, continuously urges latch-bar 54 toward its latching position. Release of cam-roll 46 so that it can return to its operative position for cutting the wire W on completion of each spring is achieved by means of an electric solenoid 57 mounted above latch-bar 54 on lever-plate 43. The plunger 58 of the latch-release solenoid 57 is connected to latch-bar 54 by a link 59 so that when solenoid 57 is energized, it pulls latch-bar 54 upward against the force exerted by latch spring 56, releasing pivot-plate 44, which then snaps back to its operative position where cam-roll 46 is again aligned with cutter cam 39 for engagement thereby on the next revolution of shaft 26.

As was previously noted, each actuation of cam-lever 40 by cutter cam 39 results in a cut by one of the cutters 15, 16 during a return stroke of segment gear 20 while the wire W is momentarily stationary. However, by latching-out the cutter cam 39 independently of the other control mechanisms, while permitting the wire to feed with each stroke of the gear segment, any amount of wire can be fed for making springs of any desired length. Furthermore, as will become apparent hereinafter, the cams for actuating the other coiling tools can continue to operate normally in order to increase or decrease the diameter or pitch of the coils at any point along the length of the spring or, if desired, they too can be individually latched-out in a manner to be described similar to that employed in rendering the cutters inoperative. Similarly, straight lengths of wire can be provided at any point in the spring by activating and de-activating the torsion-attachment 31. For that matter, by providing a device (not shown) for independently rotating feed rolls 11, 11 in limited amounts dur-

ing the return or non-feed strokes of the segment gear 20, lengths of wire shorter than the length to which the segment gear is adjusted can be introduced at any desired point during the coiling of each spring.

Diameter-control Mechanism (FIGS. 7 14 10)

Coiling point 28 is removably mounted on an arm or holder 60, which is pivoted on a shaft 61 to a slide-plate 62 and extends from its pivot shaft 61 toward the wire-guide 14 (FIG. 1), the end of which in this case acts as the arbor over which the wire is bent. Slide-plate 62 is movable axially of the line of feed of the wire in a slide-frame 63 such that the coiling point 28 can be moved toward and away from wire-guide 14. As best seen in FIG. 1, slide-frame 63 is rigid with the main frame 10 of the machine, being supported on a shelf 10a at the front, left side thereof. A stop-screw 64 is threaded horizontally through the outer end 63' of slide-frame 63 for abutting engagement with slide-plate 62 for adjustably limiting its rearward movement. A pair of parallel tension springs 65, 65 are each connected at one end to the slide-plate 62 and at the other end to the outer end of slide-frame 63 for continuously urging the slide-plate rearward against the butt-end of screw 64. In order to coil a spring of variable diameter, adjusting screw 64 is set to limit the rearward travel of slide-plate 62 at the position where coils of the largest diameter will be coiled, and slide-plate 62 is moved forward or back during each spring-forming cycle by a cam-actuated control mechanism similar to that of prior spring-coiling machines. The control mechanism of the present invention however, differs from those employed heretofore in that it is provided with latch means for holding the slide at either of its limits of travel, so that coils of the same diameter continue to be coiled until the latch is released, thereby re-activating the control mechanism.

Slide-plate 62 is provided with a roll 66, which is mounted on pivot pin 61 for the coiling-point arm 60 but projects rearwardly through a laterally elongated opening 68 in slide-frame 63. The head-portion 69 of an actuating arm 70 for moving the slide-plate 62 from left to right, as viewed in FIGS. 1, 7 and 9, is disposed outward of roll 66 for engagement therewith. Actuating arm 70 is mounted at its lower end on a pivot shaft 71, which is rotatably supported at one end in a portion of slide-frame 63 and at its other end in a rear portion of the machine frame 10.

Near the rear end of pivot shaft 71 is fixed a pair of elongated levers 72, 72' which extend horizontally therefrom as best seen in FIG. 10. Each of levers 72, 72' is connected to one of a pair of pull-rods 73, 73' each operated by one of a corresponding number of cams 74, 74' through one of four cam-movement-compounding devices designated generally at 75a and 75b, respectively. In this instance, a dual cam-operating system is employed for actuating the diameter slide, so that the machine can be used in a conventional manner to change the diameter of the spring at both its leading and trailing ends.

Pitch-control Mechanism (FIGS. 2, 3 and 11)

As best seen in FIG. 2, the pitch tool 30, is disposed at the outer end of an elongated cylindrical shank 76, which extends rearwardly through the tool-holder 36 for longitudinal movement therein, so that it can be forced against the wire of the spring S as it is coiled, in order to bend it outward longitudinally of the spring. The rear end of shank 76 is gripped within a clamping

block 77 extending downward in back of the tool-holder 36 and is supported by at least one guide-rod 78 extending parallel to shank 76 into a guide-hole in tool-holder 36. A pair of coil springs 79, 79 are compressed between the tool-holder 36 and clamping block 77 for moving the latter rearwardly against a plunger head 80, thereby retracting pitch tool 30 as plunger head 80 moves rearward (from right to left as viewed in FIG. 2). Plunger head 80 is fixed to one end of an elongated plunger 81, which is mounted for longitudinal movement through a bearing bracket 82 supported on the frame 10 of the machine. The opposite end of plunger 81 is supported in a guide in a rear portion of the frame 10 for longitudinal movement therein. A stop-screw 83 is threaded through the upper portion of bearing bracket 82 for adjustably limiting the rearward travel of plunger head 80.

As in the case of the diameter-control, a dual cam-operating system is employed for actuating the pitch tool in a conventional manner. To this end, a pair of upwardly extending levers 84, 84' for moving plunger 81 forward are each fixed to corresponding pivot shafts 85, 85' that extend transversely of plunger 81 for rotary movement within corresponding bearing bosses 86, 86' (FIG. 3) in a mounting bracket 87 on the rear wall portion of the machine. Each of levers 84, 84' is forked at its upper end to receive a corresponding one of a pair of horizontal cross-pins 88, 88' which are fixed in plunger 81. Levers 84, 84' are accordingly in driving engagement with plunger 81 for moving it longitudinally.

A pair of horizontal levers 89, 89' are rigidly connected to pivot shafts 85, 85' at their ends on the opposite side of bearing bosses 86, 86' from levers 84, 84'. Horizontal levers 89, 89' extend forwardly for actuation by a pair of pull-rods 90, 90' in a manner similar to the pull-rods 73, 73' of the diameter-control. Upon downward movement of either of pull-rods 90, 90', levers 84, 84' are pivoted clockwise as viewed in FIG. 2, causing plunger 81 to move forward against the pressure of a return spring 81a and against clamping block 77, which forces pitch tool 30 outward in order to change the pitch of the coils in the springs S being coiled. Pull-rods 90, 90' are actuated by a pair of corresponding cams 91, 91' on cam shaft 32 through individual cam-movement compounds 75c and 75d, respectively, similar to those employed for the diameter-control.

Cam-movement Compounds (FIGS. 2, 10 and 11)

It will be noted that since the compounds 75 for both the diameter-control and the pitch-control are identical, the description herein of these devices refers to those employed in either control system, and similar reference characters are applied to their parts, whether the particular compound is shown in the diameter-control mechanism of FIG. 10 or the pitch-control mechanism of FIG. 11. It will also be noted that in FIG. 2 the compound 75b is shown in section on the line 2A—2A of FIG. 11, while the compound 75c is shown in section of the line 2B—2B in FIG. 11. A cam-roll 92 projects through the underside of each of the compounds for actuation by one of the cams 74, 91.

Each of the compounds consists basically of a rigidly supported, box-shaped housing or frame 93 that supports a fulcrum (roll 94 of FIG. 11) for a lever-arm 95.

Housing 93 is fixed at both its ends on a pair of support bars 96 and 97, mounted on the frame 10 of the

machine. The top, bottom, side and end walls of housing 93 completely enclose the lever-arm 95 and fulcrum adjusting parts therefor, protecting them against being fouled by dirt and other foreign matter. Roll 94, about which lever-arm 95 pivots within housing 93, is adjustably held in a block 98, through which an adjusting screw 99 is threaded. Adjusting screw 99 extends outwardly through an end wall 93' of housing 93 to an accessible location above support rod 96. An enlarged outer end on screw 99 positions it lengthwise against movement in one direction on housing 93, and a coupling 101 fixed on the inner side of end wall 93' positions screw 99 in the other direction relative to housing 93, so that when screw 99 is rotated, fulcrum 94 is moved in one direction or the other longitudinally of lever-arm 95. The outer end of adjusting screw 99 is provided with a squared connection for the socket of a hand or power tool (not shown), by which adjustment of the fulcrum 94 along lever-arm 95 can be made in order to increase or decrease the action of the cam 74 or 91. Mounting block 98 for fulcrum roll 94 is guided longitudinally in an elongated groove 102 in the underside of the top of housing 93.

Cam-roll 92 rotates freely on a pin 103 mounted in a vertical slide assembly 104, which is guided within the housing 93 for vertical movement as the lobe of its cam 74 or 91, as the case may be, rotates into and out of engagement with roll 92. The adjacent end of lever-arm 95, which is pivoted to slide assembly 104 at 105, moves vertically upward with roll 92, thereby pivoting lever-arm 95 about its fulcrum 94 and lowering its opposite end, which in the case of the diameter-control is pivotally connected to one of the pull-rods 73, 73', and in the case of the pitch-control to one of the pull-rods 90, 90'. As may be seen in the end views of several of the compounds 75 shown in FIG. 2, a spring 113 is stretched between a mounting pin on housing 93 and an extended portion of roller pin 103. Spring 113 maintains lever-arm 95 in engagement with its fulcrum 94 when cam-roll 92 is not in contact with its cam. It will be apparent that by rotating the adjusting screw 99 of any of the compounds 75 in the proper direction its fulcrum 94 can be moved to a point which produces the desired amount of movement of its pull-rod on each pass of its cam.

De-activating Means for Diameter and Pitch (FIGS. 2, 8-11)

As mentioned hereinbefore, the so-called multiple-feed coilers of the type shown in the U.S. Pat. No. to Franks 3,009,505 are capable of changing the diameter and pitch of the spring while the cam shaft is rotating during the first and last feed-strokes of the segment gear. Consequently only the leading and trailing ends of the spring can be treated in this manner due to the fact that rotation of all the cams is interrupted during the coiling of the body of the spring intermediate its ends. Machines embodying the improvement of the present invention, on the other hand, are not only able to treat both ends of the spring, but are also capable of changing at least the diameter and pitch at any point along the spring. This is a great advantage over prior machines and is attained by independently de-activating the cutter during the initial feed-stroke of segment gear 20, thereby obtaining multiple-feed without stopping the rotation of the cam shaft, and by independently activating and de-activating the various coiling tools. In order to further clarify the application of

this basic concept and the almost endless possibilities which it makes available for segment type, spring-coiling machines, a simple example will first be described in which only the multiple-feed and diameter control are employed to produce springs like the ones shown in FIGS. 16 and 17.

In this case, either one of the diameter cams 74, 74' may be used, the other being disconnected. The cam in this instance is shaped to produce what is known as "barrel" springs. The pitch-tool is also assumed to be disconnected, so that the springs to be coiled will have closed coils. Moreover, in making the spring S-1 of FIG. 16, the diameter slide 62 is actuated continuously by its cam 74 throughout the coiling cycle in the formation of each spring. Thus, when the cutter is latched-out during the first feed-stroke of the segment gear 20, springs S-1 are produced, each having a series of barrel-shaped sections *a*, *b*, *c*, and *d* formed by the continuous reciprocating movement of diameter slide 62 with successive revolutions of cam 74. During the last feed-stroke while the section *d* is being coiled the cutter cam-roll 46 is released so that it actuates cutter 15 at the end of section *d* on completion of each of springs S-1.

It will now be apparent that by interrupting the action of the diameter-control mechanism first at the high point and then at the low point of cam-roll 92 either during, or upon completion of, any of the feed-strokes, springs such as those designated S-2 in FIG. 17 may be produced. It is again assumed that the cutter is latched-out during the first feed-stroke and re-activated during the last, in order to provide multiple-feed operation of the machine for each spring. The barrel-shaped section at the leading end of spring S-2 is similar to the corresponding portion of the spring S-1 and is coiled during the first feed-stroke with one of the diameter cams 74 disposed so that its cam-roll 92 is located at the high point of the cam when the coiling cycle starts.

Referring again to FIGS. 8-10, it will be seen that with the cam-roll 92 at its high point, lever-arm 95 in the compound 75 will have been pivoted clockwise from the position shown in FIG. 10, so that the pull-rod 73 has been moved downward. Lever 72, pivot-shaft 71 and slide-actuating arm 70 will also have been pivoted in a clockwise direction from the positions shown in FIGS. 9 and 10. Diameter slide-plate 62 is therefore located in its most advanced position toward the wire-guide 14 for coiling small-diameter coils as the wire *W* begins to feed. Since cam-shaft 32 rotates continuously, the cam-roll 92 follows down the back side of the lobe on cam 74, so that lever 72 pivots counterclockwise under the pull of a spring 72*a* fastened at its lower end to a mounting pin 72*b* on lever 72 and at its upper end to a hook 72*c* (FIG. 2) on the underside of bracket 87. This pivots actuating arm 70 in the same direction, permitting diameter slide-plate 62 to move outward under the constant pull of tension springs 65, 65.

Further rotation of cam shaft 32 lowers cam-roll 92 to its lowest point on cam 74 and moves slide-plate 62 to its most remote position from the wire-guide 14, at which the largest coils in spring S-2 are coiled. Cam-roll 92 then starts back up the rise on cam 74, returning slide-plate 62 to its advanced position at the end of the first feed-stroke and completing the section *a* of spring S-2. At this point the wire *W* stops feeding momentarily while the gear-segment 20 swings through its return stroke for the start of another feed-stroke. It is at

this point that the means for de-activating the diameter-control mechanism may be brought into play, for the purpose of holding the slide-plate 62 at its advanced position in order to coil the section *b* of uniformly small-diameter coils in the spring S-2 of FIG. 17.

Such de-activating means desirably takes the form of a latch, indicated generally at 100, on the compound 75 from holding the cam-roll 92 out of engagement with its cam, much as the cam-roll for the cutter control shown in FIGS. 4-6 is latched-out of engagement with the cutter cam. It will be noted, however, that in the case of the cutter, it is necessary to latch the cam-roll out at a low point on the cam, whereas in the present case the cam-roll 92 is latched-out at the high point on the cam where it is not necessary to shift the cam-roll out of the path of the cam.

Referring more particularly to FIG. 10, latch 100 consists of a pivoted latch-bar 106 mounted freely on a bolt 107 on the side of the housing 93 of compound 75 adjacent the vertical slide assembly 104. Latch-bar 106 is long enough to project above the upper surface of housing 93 into engagement with a cross bar 108 fixed to the upper end of slide assembly 104 and extending laterally beyond the side of housing 93. A horizontally disposed coil spring 109, stretched between an upper portion of latch-bar 106 and a mounting pin 110 on the housing 93, pulls the upper end of latch-bar 106 into lateral engagement with cross bar 108 when the slide-assembly 104 is at its lowered position shown in FIG. 10. When cam-roll 92 is lifted by cam 74 to its high point, slide assembly 104 is raised so that latch-bar 106 can swing under cross bar 108, thereby latching the slide assembly 104 and cam-roll 92 in this position and, in effect, disconnecting the cam-follower from cam 74 in order to nullify further action of the cam. Latch-bar 106 can be withdrawn from latching engagement with cross bar 108 by a solenoid 111 which is mounted on the housing 93 and has a link 112 pivotally connecting its plunger to latch-bar 106. Energization of the latch-release solenoid 111 causes it to pivot latch-bar 106 in a clockwise direction, as viewed in FIG. 10, against the pull of latch spring 109.

In coiling the spring S-2 of FIG. 17, solenoid 111 will be energized at the start of each coiling cycle in order to prevent latch-bar 106 from locking-out the diameter control while the cam-roll is at the high point on the cam. As soon as cam-roll 92 starts down the back side of the cam 74 on the initial feed-stroke, solenoid 111 can be de-energized in order to allow the latch 100 to lock-out the diameter-control the next time cam-roll 92 reaches its high point. This results in the coiling of section *b* of spring S-2 during the second feed-stroke. At the end of the second feed-stroke, solenoid 111 is again energized in order to re-activate the diameter-control for increasing the diameter of the coils during the start of the third feed-stroke. It will be noted that on release of cross bar 108, the slide-assembly 104 and cam-roll 92 is free to move back into operative relation with the cam.

As will be noted in FIG. 17, the coils in the two sections *c* and *d* of the spring S-2 are uniformly large in diameter except at the beginning of section *c* and end of section *d*. In order to coil these sections of the spring, it is necessary to de-activate the diameter cam 74 when the diameter slide has been retracted to its setting for the largest coils, in other words, at the low point on

cam 74. Since it is not practical in this instance to move the cam-roll 92 for the diameter cam out of the path of the cam, as in the case of the cutter where the control mechanism is also de-activated at the low point on the cam, means have been devised for disconnecting the actuating arm 70 from the diameter slide-plate 62 whenever it is desired to interrupt the action of one of the diameter cams 74, 74' for coiling large-diameter portions of a spring.

Referring again more particularly to FIGS. 7 to 9, the head-portion 69 of actuating arm 70 is located at the upper end of a vertically disposed finger 116, which forms the upper part of arm 70 and is braced between a pair of spaced, parallel supports 117 which are integral with, and extend upward from, a cylindrical collar 118 by which the actuating arm assembly as a whole is fastened to pivot shaft 71. Finger 116 is pivoted at its lower end to the two supports 117, 117 by means of a pivot pin 119 extending through both of supports 117, 117, and on which finger 116 is free to swing transversely of its movement for actuating slide-plate 62 between a working position shown in full lines and an inoperative position shown in broken lines in FIG. 8. Projecting forwardly from, and at right angles to, finger 116 is a foot 120 which is engaged on its underside by a spring-loaded plunger 121 guided in a tubular housing 122 at the outer end of collar 118. Plunger 121 is disposed vertically for resiliently pressing finger 116 about pivot pin 119 toward its inoperative position.

The roll-engaging surface on the head-portion 69 of actuating arm 70 is provided with a forwardly projecting lip 123 (FIG. 7), which interlocks with roll 66 and holds finger 116 in its working position with respect thereto, in order to prevent it from being swung into its inoperative position by spring plunger 121. Since slide-plate 62 is constantly urged rearward by its return springs 65, 65, finger 116 remains latched in its working position as long as slide plate 62 is free to move back against it. Consequently, in order to prevent actuating arm 70 from moving the slide-plate 62 in again during the next revolution of cam 74, finger 116 must be moved rearwardly (to the left as viewed in FIGS. 7 & 9) of roll 66 so that the lip 123 on head-portion 69 is disengaged from roll 66, releasing finger 116 to pivot to its inoperative position. In order to accomplish the release of the head-portion 69 from roll 66, the rearward travel of slide-plate 62 must be arrested at the setting for the large diameter of the springs, while permitting the actuating arm 70 to continue to pivot rearward far enough to disengage its lip 123 from roll 66. Stop-screw 64 on the slide frame 63 is therefore adjusted to stop slide-plate 62 at the proper setting, and diameter cam 74 is designed such that actuating arm 70 continues to pivot out of engagement with roll 66 after rearward movement of slide-plate 62 is arrested by stop-screw 64. Actuating arm 70 therefore over-rides slide-plate 62 each time it is pivoted counterclockwise (FIG. 9) by cam 74 so as to disengage lip 123 from slide-roll 66, thereby releasing finger 116 to pivot to its inoperative position.

At this point, the diameter control is in effect latched-out, just as the cam-rolls 92 are latched-out on de-activation of the diameter slide at the setting for small coils. Subsequent pivotal movement of actuating arm 70 on pivot shaft 71 during succeeding revolutions of cam 74 results only in arm 70 by-passing slide-plate

62 until finger 116 is moved back into working alignment with slide-roll 66.

The diameter-control mechanism is re-activated by a bell crank 124 which is pivoted on a pin 125 mounted on a portion of the frame 10 of the machine to the rear of the slide-frame 63. Bell crank 124 swings in the same vertical plane as finger 116 for engagement therewith by a depending arm 126 when pivoted counterclockwise as viewed in FIG. 8. An electrical solenoid 127 mounted above bell crank 124 on frame 10 is connected by a link 128 to a rearwardly extending crank arm 129 of bell crank 124. Solenoid 127 is wired such that when energized its plunger 130 moves downward, rotating bell crank 124 clockwise to the position shown in phantom lines in FIG. 8 for resetting finger 116 of actuating arm 70 in its working position. A spring 131 is fixed at its upper end to a pin 132 on frame 10 and at its lower end to crank arm 129 urges bell crank 124 in a counterclockwise direction for withdrawing the arm 126 from engagement with finger 116 except when solenoid 127 is energized.

It will be noted that the actuating arm 70 is in effect latched-out until solenoid 127 is energized and that the pivoted lever 116 acts as a disconnecter between the cam-follower at the diameter cams 74, 74' and side-plate 62. Accordingly, the de-activating means for latching the diameter slide at both settings are similar in that both latch-out the diameter-control mechanism so that it cannot move the coiling point 28 until the latch is released.

Coiling of the sections *c* and *d* at the trailing end of spring S-2 of FIG. 17 continues as the diameter slide 62 is de-activated upon rotation of its cam 74 so that cam-roll 92 is at its lowest point, thereby retracting the coiling point 28 to its setting for the largest coils and carrying the actuating arm 70 out of engagement with the roll 66, where finger 116 automatically drops out of working relation with roll 66. The machine continues in this instance through two more feed strokes of segment 20, forming the large-diameter portion of spring S-2 while the diameter control is thus de-activated. Near the end of the last feed-stroke, solenoid 127 is energized while cam-roll 92 is at the low point of cam 74, so that when actuating arm 70 is pivoted forward again by cam 74, it re-engages roll 66 on the diameter slide. At the same time solenoid 57 in the re-activating means for the cutter-control mechanism is energized, releasing the cam-roll 46 so that the wire is cut at the end of the fourth and last feed-stroke of the segment. Release of the diameter, pitch and cutter controls upon energization of the solenoids 57, 111 and 127 is controlled by a timer T (FIG. 19) in the manner to be described hereinafter.

Coiling the spring S-2 described hereinbefore requires actuation of only the diameter control while the cutter is latched-out during four feed-strokes of the segment gear. FIG. 18 shows a spring S-3, in which the coils are of uniform diameter, so that the diameter control is inactive and the diameter slide held in the position to which it is initially adjusted. The pitch tool 30 is activated, for example by pitch-cam 91, in order to open the coils throughout most of the length of the spring. By adjusting cam 91 so that cam-roll 92 is at its low point at the start of each coiling cycle and is shortly thereafter lifted to its high point, the first coils of the spring S-3 will be closed and the next ones will be open as the pitch tool is advanced. On reaching the position

to which it is adjusted for producing the desired spacing between the coils, the pitch-control mechanism is latched-out as its compound 75c so that open coils are formed during the remainder of the first feed-stroke *a*, all of the next stroke *b* and part of stroke *c*. Release of the latch 100 at compound 75c during stroke *c* re-activates the pitch control, putting the pitch-tool back under the control of the pitch-cam 91, which permits the pitch-tool to retract during stroke *c* in order to coil closed coils. It will be apparent that the pitch-tool is then latched at a low point on the pitch-cams in a manner similar to that used in latching-out the diameter control at the low point of the diameter cam, so that the action of the pitch-cam is nullified during the last feed-stroke *d* in order to coil a long section of closed coils at the trailing end of the spring.

Dual-adjustment for Diameter and Pitch (FIGS. 12 and 13)

As mentioned hereinbefore and in accordance with prior practice, the present coiling machine is provided with dual sets of cams for actuating the diameter slide, together with dual cams for actuating the pitch tool. The primary reason for two actuating cams for each tool is to provide means for actuating either the diameter or pitch controls at both the leading and trailing ends of springs that can be coiled with one stroke of the feed segment. In other words, one of the diameter cams is usually for actuating the diameter slide at the leading end of the spring and the other for actuating it at the other end of the spring. The same is true of the pitch cams. Adjustment of the amount of action of each cam is made by increasing or decreasing the effective length of the pull-rods 73 or 90, each of which connects one end of the lever-arm 95 in each of the compounds 75 to the end of the lever 72 or 89, respectively, of the two control mechanisms.

For example, in the pitch-control linkage shown in FIGS. 11-13, both pull-rods 90, 90' extend freely through an opening in the ends of levers 89, 89' to an accessible position above the machine, the upper portion of each pull-rod being threaded for some distance back from its end. Threaded to the upper end of each pull-rod 90, 90' is an adjusting nut 135, 135' which engages the upper end of an elongated tubular sleeve 136, 136' through which each pull-rod extends. The lower end of each sleeve 136, 136' rests on the upper surface of the outer end of each lever 89, 89'. Sleeves 136, 136' act as spacers so that when adjusting nuts 135, 135' are turned down, pull-rods 90, 90' are moved upward through the respective openings in levers 89, 89' thereby shortening the distance between the respective levers 89, 89' and lever-arm 95, to which each pull-rod is pivoted at its lower end. This general means of adjusting the amount of action delivered by the cam is more or less conventional in spring coiling machines.

There are times when it is necessary to make the same adjustment in both pull-rods of either or both the pitch tool or diameter control when the machine is being set-up to coil springs of given specifications. For example, when the pitch for each end of the spring has been set to the required relationship, one end to the other, the spring may be too long or too short. By adjusting both pull-rods 90, 90' of the pitch control equally, the length of the springs coiled can be shortened or lengthened without disturbing the relative setting between them. Heretofore, it has only been possible to adjust each pull-rod separately for either the di-

ameter control or pitch control. The dual-adjusting hand-nuts shown in FIGS. 12 and 13 make it feasible to adjust both pull-rods simultaneously, whether for diameter or pitch.

While the dual adjustment described is specifically for the pitch control in adjusting the pull-rods 90, 90' the identical adjustment is also provided for the pull-rods 73, 73' in the diameter-control mechanism. It will be noted that the two pull-rods 90, 90' are adjacent and parallel to each other, each being provided with a hand-nut 135, 135' as before. In this case, however, each hand-nut 135, 135' has a spur gear 138, 138' fastened to its underside, as for example by means of screws 139, 139'. Each spur gear 138, 138' is concentric with its corresponding hand-nut 135, 135' and is centrally apertured to permit one of the pull-rods 90, 90' to extend freely through it. A cross-piece 140 is fixed by set screws 141, 141' to the upper ends of both spacing sleeves 136, 136', such that the undersides of spur gears 138, 138' rest on and are positioned by the upper surface of cross-piece 140.

A synchronizing gear 142 is rotatably mounted on cross-piece 140 midway between spur gears 138 and 138' for meshing engagement therewith. Gear 142 is free to rotate on a stud 143, which projects upwardly through cross-piece 140. Stud 143 is movable vertically in cross-piece 140 so that synchronizing gear 142 can be moved to an inoperative position by lifting it out of meshing engagement with spur gears 138, 138'. A latch-pin 144 extends laterally from stud 143 a suitable distance below synchronizing gear 142 for latching it in its inoperative position. When gear 142 is in meshing engagement with spur gears 138, 138', latch-pin 144 fits into a keyway 145 in the side of the vertical hole in cross-piece 140 through which stud 143 extends.

Fixed to the upper end of stud 143 is a knob 146, by which stud 143 may be lifted vertically and rotated in order to move latch-pin 144 out of alignment with keyway 145 for holding synchronizing gear 142 out of engagement with spur gears 138, 138'. Stud 143 also projects below cross-piece 140 and has an enlarged disc at its lower end forming an annular shoulder 147 against which one end of a coil spring 148 presses in order to hold sprocket 142 in meshing engagement with spur gears 138, 138' as shown in FIG. 12. Spring 148 surrounds the depending end-portion of stud 143 with its upper end pressing against the lower surface of cross-piece 140.

Since spur gears 138, 138' are identical in size and number of teeth, rotation of one will result in equal rotation of the other when synchronizing gear 142 is engaged. Accordingly by engaging gear 142 and rotating either of hand-nuts 135, 135', both pull-rods 90, 90' will be adjusted simultaneously by an equal amount. On the other hand, when it is desired to adjust either pull-rod 90, 90' independently of the other, the synchronizing gear 142 is disengaged, as shown in FIG. 2, and the knob 146 rotated to move latch-pin 144 out of alignment with its keyway 145. Conventional lock-nuts 150, 150' are provided on pull-rods 90, 90' outwardly of hand-nuts 135, 135' for locking the pull-rods in their adjusted positions.

Torsion-attachment Control Mechanism (FIGS. 1, 14 and 15)

The so-called torsion-attachment 31 is employed in conjunction with coiling point 28 in a manner similar to those provided in prior machines. Since the coiling-

point arm 60 is pivoted at 61 to the slide-plate 62, coiling point 28 can be moved up or down out of engagement with wire W permitting the wire to be fed in a straight line above or below the coiling point so that it is not bent into coils. The control mechanism for thus actuating the coiling point consists of a link 152 pivoted to the underside of arm 60 and extending downward for pivotal connection with a double-acting cam-lever 153 pivoted at 154 to the frame 10 of the machine. Link 152 is provided with a turnbuckle 155 (FIG. 1) for adjusting its length and is connected at its lower end to a lateral projection 156 on cam-lever 153 by means of a pivot pin 157.

A depending arm 158 of cam-lever 153 carries a cam-roll 159, which is engageable with a set of cams 160 at the end of cam-shaft 32 which projects outwardly of the front wall of the main frame 10 of the machine. The lobes on cams 160 are shown aligned with each other along cam shaft 32 for ease of illustration, but may be shifted peripherally in order to initiate cam-action at the desired points in each revolution of cam-shaft 32. Engagement of cam-roll 159 with the high portion of the lobes on cams 160 locates coiling-point arm 60 in its coiling position with respect to the wire W as shown in FIG. 1. As cam-roll 159 follows down the back side of the cam lobe 160 pivoting cam-lever 153 clockwise, arm 60 is swung downward moving coiling point 28 out of the path of wire W to form a straight length of wire as it is fed through wire-guide 14 by feed-rolls 11.

It will be noted that cam-roll 159 can be adjusted with respect to cams 160 by increasing or decreasing the length of link 152 through its turnbuckle 155. A tension spring 161 is connected at one end to a rearward projection of pivot pin 157 on cam-lever 153 and at its other to a spring anchor 162 on a vertical wall portion of the frame 10 of the machine. Spring 161 resiliently urges cam-lever 153 and cam-roll 159 in a clockwise direction into engagement with cams 160.

When it is desired to reverse the action of cams 160 when coiling springs in the opposite direction (i.e. the wire W is bent downward into coils instead of upward as shown in FIG. 1), cam-lever 153 is reset for engagement of cams 160 by a second cam-roll 163 on an upper arm 164 of lever-arm 153 instead of by cam-roll 159. This is accomplished by taking up on turnbuckle 155, thereby shortening link 152 to the coiling arm 60, and by shifting spring 161 from its anchor 162 to an anchor 165 fixed to the underside of the shelf 10a of the machine frame, so that lever-arm 153 is urged in a counterclockwise direction for engagement of cam-roll 163 with cams 160. Coiling point 28 is therefore raised out of engagement with wire W on movement of cam-roll 163 to the low point on cams 160.

Coiling arm 60 is provided with the usual coiling-point stop-screws 166, 167 (FIG. 1) which are threaded vertically through holders 168, 169 mounted on diameter slide 62 above and below the coiling arm 60. The upper stop-screw 166 may be turned down into abutting engagement with the upper surface of coiling arm 60 and the lower stop-screw 167 turned up into engagement with the underside of coiling arm 60 in order to steady the coiling point 28 when the torsion-attachment is not in use. In order to use the torsion-attachment, both stop-screws 166 and 169 are backed off to permit movement of the coiling arm for forming straight lengths of wire in the springs.

In order to form torsion ends or straight lengths of wire at any desired points along the length of each spring in accordance with the present invention, a latch mechanism designated generally at 170 is provided for locking the cam-rolls 159 and 163 at the high point of each of cams 160, so that the torsion-attachment 31 can be de-activated each time that it is actuated by one of its cams. Latch 170 consists of a T-shaped latch device 171 pivotally mounted on the frame 10 of the machine by means of a screw 172. A pair of rectangular latch plates 173, 174 are removably fastened to the outer face of latch device 171. Latch plates 173, 174 are spaced apart on latch device 171 in order to receive between them a latch lug 175 that extends downward from the end of depending leg 158 of cam-lever 153. A latch spring 176 stretched between a pin 177 on the front wall of the frame 10 and a spring anchor on the upper edge of latch device 171 urges latch plates 173, 174 upward into latching relation with latch lug 175. An electric solenoid or latch-release 178 has its plunger 179 pivotally connected by a link 180 to the lower edge of the mid-portion of latch device 171 for pulling latch plates 173, 174 out of latching relation with latch lug 175 against spring 176. Energization of release solenoid 178 causes plunger 179 to retract, pulling latch plates 173, 174 down and releasing cam-lever 153.

As shown in FIG. 14, cam-lever 153 is latched at the high point of cams 160, thereby holding coiling point 28 in the coiling position illustrated in FIG. 1. Upon energization of solenoid 178, latch device 171 is swung downward, releasing cam-lever 153 so that its cam-roll 159 can move into operative engagement with cams 160 under the force exerted on it by spring 161. On movement of cam-roll 159 to the low portion of cam 160, coiling point 28 is moved to an inoperative position below the feed-line of wire W. Further rotation of a lobe on one of cams 160 into engagement with cam-roll 159 causes cam-lever 153 to pivot counterclockwise back into the position shown in FIG. 14, where it is again latched by engagement of latch lug 175 with the latch surface of latch plate 173, provided release solenoid 178 is not energized. Coiling of the spring then continues until the cam-lever 153 is again released by energization of solenoid 178 in order to form another straight length of wire in the spring being coiled. It will be noted that in coiling springs of the opposite hand, in which event cam-roll 163 is used, cam-lever 153 is latched by engagement of its lug 175 with the other latch plate 174, thereby holding cam-roll 163 at the high point on the cam.

Operation of the control mechanism for the torsion-attachment is co-ordinated with that of the cutter in the same manner that the diameter and pitch controls are employed in producing long springs by (1) latching out the cutter at the start, (2) alternately operating the latch 170 on actuation of cams 160 to hold the coiling point in its coiling position and releasing latch 170 on a low point of cams 160 to produce straight sections of wire at any point along the spring, and (3) releasing the cutter control mechanism to sever the spring at the end of the coiling cycle. Release of the latch-means 170 of the torsion attachment is controlled by a programmer, which also releases the latch-means for the various other control mechanisms.

ELECTRICAL CONTROLS

The programmer is desirably an electro-mechanical

timer T such as that shown purely schematically in FIG. 19. Timer T has a plurality of cam-operated switches indicated generally at 185, which are actuated upon rotation of its cam-shaft 186. A gear 187, which meshes with gear 34 on the coiling-tool-actuating cam-shaft 32 (FIG. 1), drives a change-gear mechanism 188 for timer T so that its cam-shaft 186 can be rotated at a predetermined speed ratio with respect to the actuating cam-shaft 32. In order to co-ordinate the actions of cam switches 185 with the cam-shaft 32 and maindrive shaft 26 of the coiling machine, each of the cams for cam switches 185 may be adjusted to open or close its contacts at any time, during each revolution of the cam-shaft 186. Cam switches 185 energize and de-energize the release solenoids for re-activating the actuating controls of the machine.

A common lead 189 from one side of an electrical power supply is connected to the fixed contact for each cam switch 185. A lead 190 in a circuit for cutter solenoid 57 is connected to the movable contact of one of cam switches 185 and to one terminal of solenoid 57. The other terminal of solenoid 57 is connected to the opposite side of the power supply by a common lead 192. One terminal on each of the four solenoids 111 for releasing the latches 100 in the diameter and pitch controls is individually connected to the movable contact of separate cam switches 185 of timer T by leads 193, 194, 195 and 196, respectively. The circuit for each of solenoids 111 is completed through common 192. Solenoid 127 for the large-diameter control is connected in the same way to the movable contact on another of cam switches 185 by a lead 198 and to the opposite side of the power supply through common 192. In like manner, the release solenoid 178 for activating the torsion-attachment is connected in circuit with still another of cam switches 185 by means of leads 199 and 192. It will also be noted that each of the individual circuits for the release solenoids, with the exception of the cutter solenoid 57, is provided with a manual cut-out switch, indicated generally in a bank of switches 200 in the timer T. Each of cut-out switches 200 may be opened independently for the purpose of preventing release of any of the various latch means, thereby de-activating any or all of the control mechanisms which are not required for any particular run of springs.

For example, in the spring S-2 of FIG. 17, only the diameter controls are activated for coiling the springs of this configuration. The pitch control and torsion-attachment can be readily rendered inoperative simply by opening the cut-out switches 200 in either of the circuits to the two solenoids 111 for the pitch control and in the circuit to the solenoid 178 for the torsion-attachment. Since each of the control mechanisms must be re-activated by its release solenoid on being automatically latched-out following actuation of its cam, any of the controls can be readily latched-out indefinitely simply by opening the circuit to the release solenoid in the desired control. In prior machines, on the other hand, it is necessary either to remove the control cams entirely, or to adjust them or their cam-rolls in such a way as to nullify the action of the cams. Either way, the work involved is time-consuming, whereas in my system, the controls can be de-activated simply by opening switches 200. No cut-out switch is provided in the circuit for the cutter solenoid 57 because actuation of the cutter is always required.

Assuming that timer T is set-up to open and close the cam switch 185 in the circuit for cutter solenoid 57 once during each revolution of its cam-shaft 186, a speed ratio of four revolutions of the main-drive shaft 26 and actuating cam-shaft 32 to one revolution of the timer cam-shaft 186 is required to produce springs of the configurations illustrated in FIG. 16 through 18, each of which requires four feed-strokes of its gear segment. Similarly, more or less feed-strokes can be obtained by simply changing the speed ratio of the timer and main-drive shaft. Furthermore, by using a timer capable of actuating its cam switches 185 several times during each revolution of cam shaft 186, the controls for the coiling tools can be actuated more than once for each feed-stroke, provided of course, that the actuating cams for the coiling tools are likewise set to initiate such action.

What is claimed is:

1. In a spring-coiling machine having an oscillating gear segment for feeding a predetermined length of wire with each feed-stroke of said gear segment, a drive shaft for oscillating said gear segment, coiling-tool members for coiling springs of specified dimensions during a predetermined sequence of operations, a cutter member for serving each spring coiled from a continuous supply of wire, and individual cams continuously driven by said drive shaft for independently actuating each of said members, the improvement therein comprising in combination,

means for de-activating said cutter member during the initial oscillation of said gear segment in said sequence of operations in order to prevent actuation of said cutter member during at least such initial oscillation, thereby providing a plurality of feed-strokes during the coiling cycle for each spring,

means for de-activating each of said coiling-tool members during each oscillation of said gear segment, each of such coiling-tool de-activating means being independent of each other and of said cutter de-activating means,

means for independently re-activating each of said coiling tool members, and

a programmer for automatically actuating said de-activating and re-activating means in a desired sequence in order to coil springs of specified length and configuration.

2. Apparatus as defined in claim 1, wherein the cam for each of said coiling-tool members is mounted on a cam shaft continuously driven by said drive shaft, such that the cams for said members rotate together in unison,

each of said de-activating means for said members comprising individual latch means for holding each of said members disconnected from its cam, the said re-activating means for each of said coiling-tool and cutter members comprising a latch-release device for releasing each of said individual latch means independently.

3. In a spring-coiling machine having an oscillating gear segment for intermittently feeding wire from a continuous supply thereof during each feed-stroke of said gear segment, a drive shaft for oscillating said gear segment, a plurality of coiling-tool members for coiling springs of specified dimensions, and separate cam means for actuating each of said coiling-tool members

continuously driven by said drive shaft, the improvement therein comprising in combination,

individual latch means for holding each of said coiling-tool members disconnected from its cam means upon actuation of such coiling-tool member by its cam means,

a latch-release device for releasing each of said individual latch means independently,

said cam means being capable of actuating its corresponding coiling tool member a plurality of times during each feed-stroke of said gear segment and said latch-release device being provided with means for releasing each of said individual latch means a plurality of times during each such feed-stroke in order to vary the configuration of each spring any number of times within such feed-stroke.

4. Apparatus as defined in claim 2, wherein said coiling-tool members comprise

a coiling point mounted for movement along the line of wire feed for changing the diameter of the coils into which the wire is bent and

a pitch tool mounted for movement transversely of the line of wire feed for bending the coils longitudinally of the spring being coiled in order to form open-coils,

each of the de-activating means for both said coiling-point and pitch tool including separate ones of said individual latch means and each of the re-activating means for both said coiling-point and pitch tool including a separate one of said latch-release devices.

5. Apparatus as defined in claim 4, which further includes a torsion-attachment for moving said coiling point transversely out of the line of wire feed in order to form straight lengths of wire, said torsion-attachment having separate cam means for actuating it, individual latch means for holding it disconnected from its cam and a latch-release device for releasing its individual latch means.

6. Apparatus as defined in claim 5, wherein each of said members has a cam-follower mounted for engagement with a said cam, said individual latch means each being constructed and arranged to hold the corresponding one of said cam-followers out of the path of its cam.

7. Apparatus as defined in claim 6, wherein each said individual latch means for said coiling-tool members and said torsion-attachment holds the corresponding one of said cam-followers at the high point in its travel.

8. Apparatus as defined in claim 7, wherein each of said individual latch means operates automatically on actuation of the corresponding one of said members and said torsion-attachment, and said programmer comprises a timer for actuating said latch-release devices in a predetermined sequence, said timer being driven by said drive shaft such that it completes one timing cycle for each of said spring-coiling cycles.

9. Apparatus as defined in claim 8, which further includes a slide-plate on which said coiling point is mounted for movement along the line of wire feed, a disconnecter between the said cam-follower for said coiling point and said slide-plate for de-activating said coiling point at a low point in the travel of its said cam-follower.

10. Apparatus as defined in claim 6, which further includes a slide-plate on which said coiling point is mounted for movement along the line of wire feed, and

a disconnecter between said slide-plate and the said cam-follower for said coiling point for de-activating said coiling point at a low point in the travel of its said cam-follower.

11. Apparatus as defined in claim 10, wherein the said cam-follower for said cutter member is supported on a cam-lever for movement by its actuating cam in one direction for actuating said cutter member, said cutter cam-follower being also mounted for movement in a second direction transverse to said one direction to an inoperative position out of the path of its actuating cam, said means for de-activating said cutter member including

a de-activating cam driven in unison with said actuating cam and

a de-activating cam-follower supported on said cam-lever for movement by said de-activating cam in said second direction for moving said cutter cam-follower to its inoperative position for latching engagement by its said latch means.

12. Apparatus as defined in claim 11, wherein said timer is driven by said drive shaft such that it completes one timing cycle for each of said spring-coiling cycles.

13. Apparatus as defined in claim 12, wherein each of said individual latch means is spring-loaded into latching relation with its cam-follower.

14. Apparatus as defined in claim 13, wherein said latch-release device comprises an electric solenoid connected to its spring-loaded latch means such that energization of said solenoid by said timer withdraws said latch means against the force of its spring out of latching relation with its cam-follower.

15. Apparatus as defined in claim 9, wherein said disconnecter is spring-loaded to a position in which it dis-

connects said slide-plate from its said cam-follower and which further includes an electric solenoid connected to said disconnecter for moving it to a position in which it operatively connects said slide-plate with its cam-follower.

16. Apparatus as defined in claim 1, which further includes a cam-operated control mechanism for said cutter member comprising a cam-follower supported on a cam-lever for movement by the said cam for said cutter member in one direction for actuating said cutter member, said cam-follower being also mounted for movement in a second direction transverse to said one direction to an inoperative position out of the path of said cutter actuating cam, said means for de-activating said cutter member comprising

a de-activating cam driven in unison with said actuating cam,

a second cam-follower supported on said cam-lever for movement by said de-activating cam in said second direction for moving said cutter cam-follower to its inoperative position, and

latch means for holding said cutter cam-follower in its inoperative position.

17. Apparatus as defined in claim 16, wherein said means for re-activating said cutter member includes a latch-release device for releasing said latch means, and said programmer includes a timer for actuating said latch-release device after a predetermined number of feed-strokes of said gear segment.

18. Apparatus as defined in claim 2, wherein said cam for actuating said cutter member is mounted on said drive shaft.

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