

Oct. 29, 1957

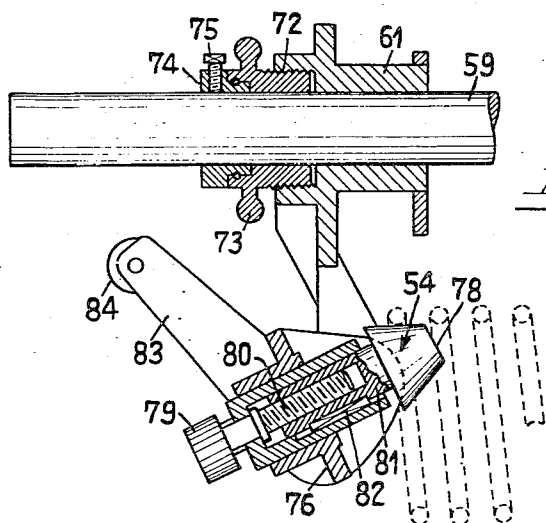
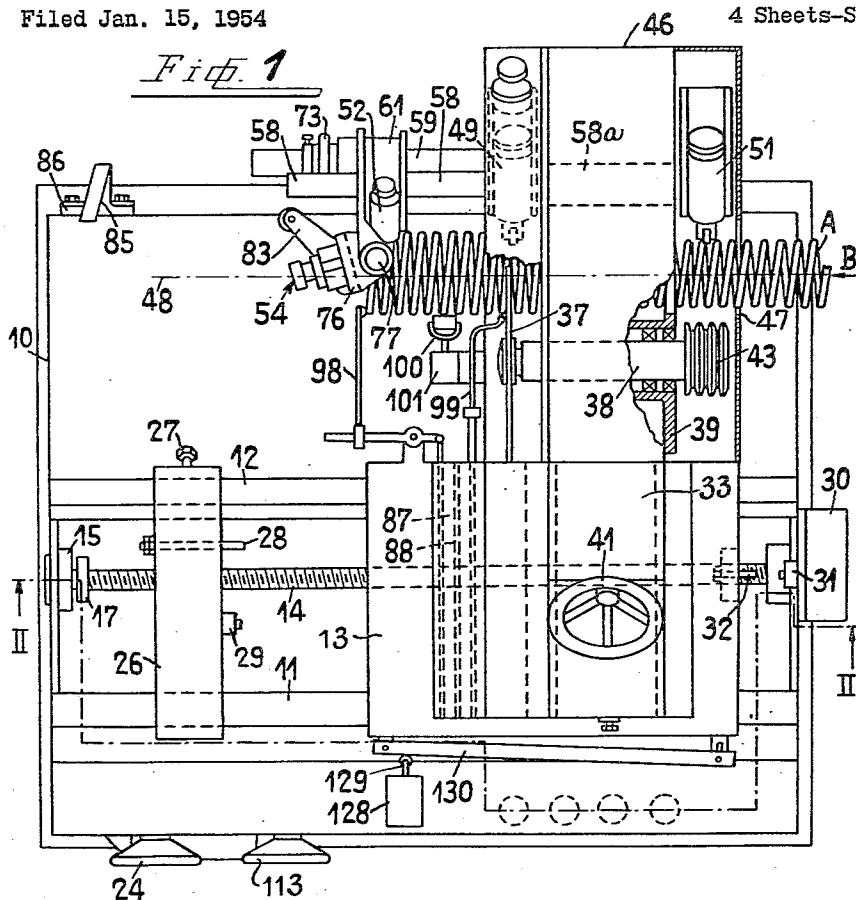
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2,810,993

PRODUCTION OF HELICAL SPRINGS HAVING FACE-GROUND ENDS

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4 Sheets-Sheet 1



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PRODUCTION OF HELICAL SPRINGS HAVING FACE-GROUND ENDS

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4 Sheets-Sheet 2

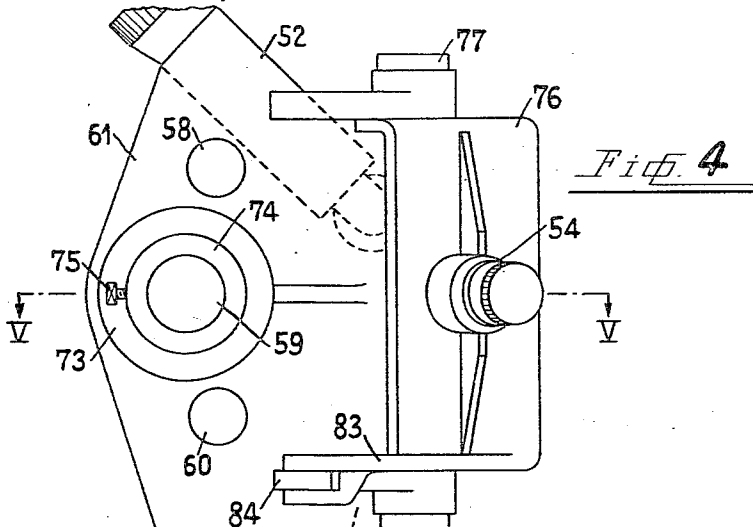


Fig. 4

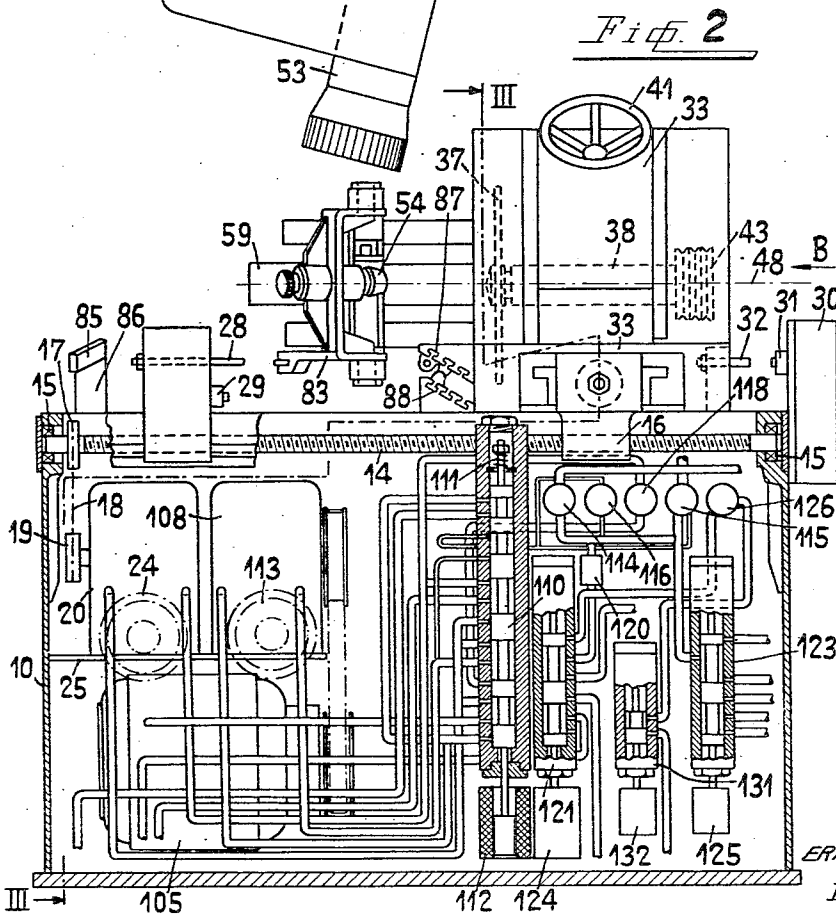


Fig. 2

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Fig. 3

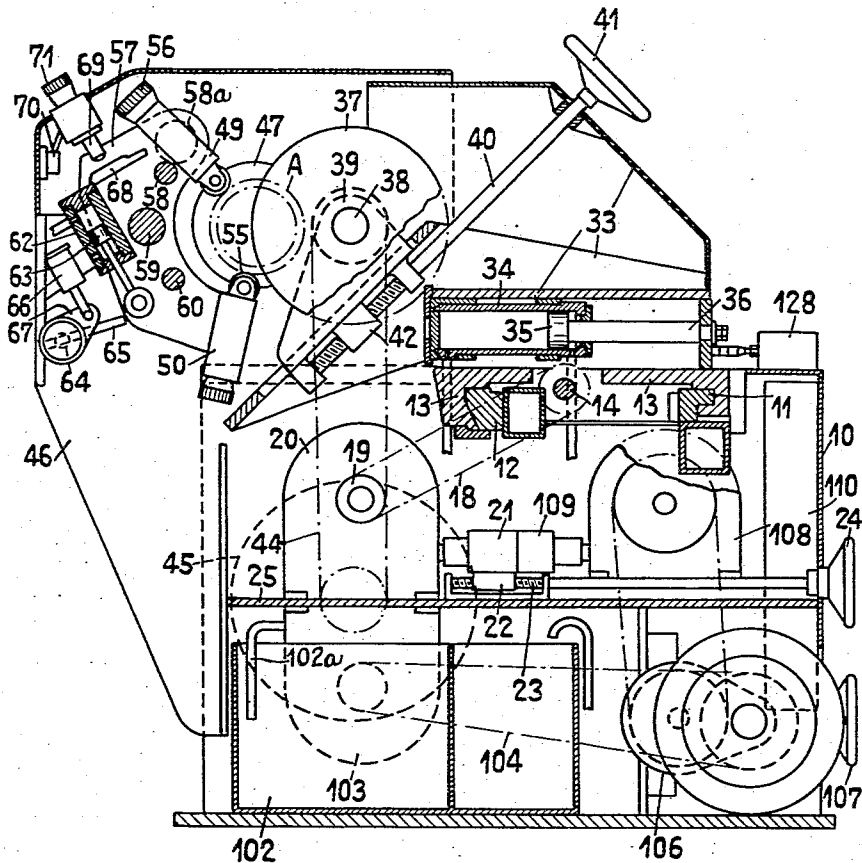


Fig. 7

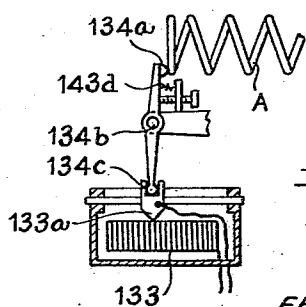
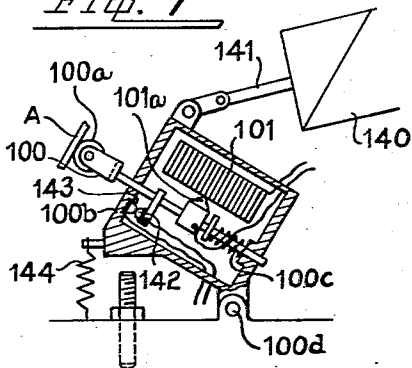


Fig. 8

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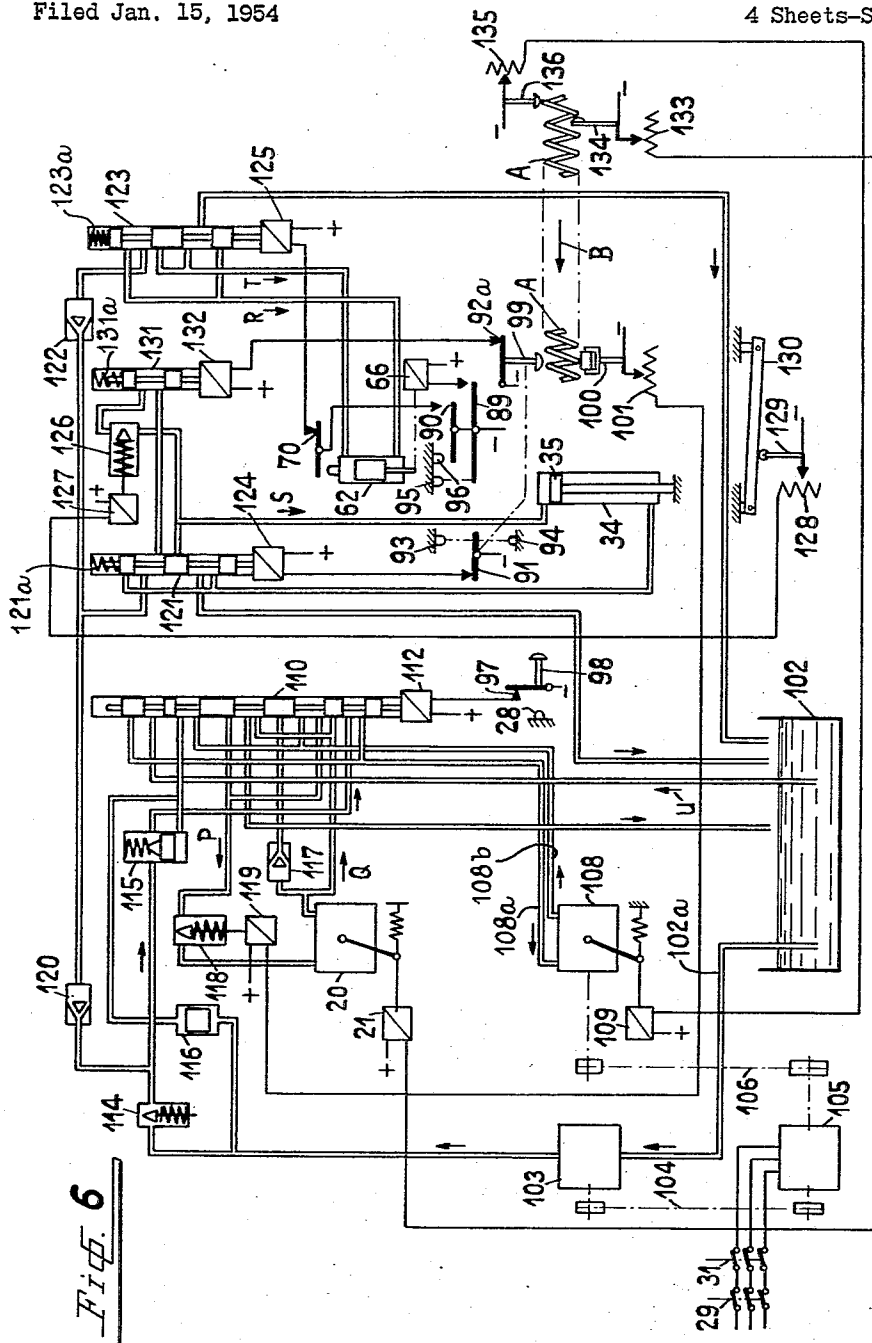
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4 Sheets-Sheet 4



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PRODUCTION OF HELICAL SPRINGS HAVING FACE-GROUND ENDS

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9 Claims. (Cl. 51—105)

In various arts, helical springs are used which have face-ground ends. Such springs up to the present have been manufactured by making them somewhat longer than prescribed, whereupon their two ends were ground down until the ends were plane and the springs had attained their desired length. Obviously, such practice entails relatively large losses of material and requires much time for the operations of severing the springs and grinding the spring-ends.

The present invention aims to overcome said disadvantages and shortcomings, and relates to an improved apparatus for producing helical springs having face-ground ends.

The procedure disclosed herein comprises the steps of continuously coiling a helical spring and cutting the same successively into parts of the desired length by means of at least one parting tool which is moved, at the speed of production of the spring, longitudinally in parallel direction to the spring axis, the parting tool operating in a plane extending at right angles to the spring axis in order to produce the plane bearing ends of the spring parts simultaneously with their parting or severing.

This type of procedure permits parting of the spring and production of the plane bearing ends in a single operation, a substantial saving in material and continuous production being made possible thereby.

The translatory or longitudinal movement of the parting tool suitably is controlled in dependence upon the speed of feeding of the spring wire to be coiled and, further, in dependence upon the movement of those elements of a spring-winding machine which determine the pitch and the diameter of the helical spring to be produced.

The organization or apparatus provided in accordance with the present invention for implementing the aforesaid procedure is characterized by a carriage movable in parallel direction to the axis of the helical spring to be produced, a slide movable on said carriage in a plane extending perpendicularly to the spring axis and carrying a parting tool operating in said plane, means for driving the parting tool and slide and carriage, and means for controlling the carriage speed in accordance with the speed of production of the helical spring.

Heretofore, the production of helical springs, for example, tension or compression springs, from straight wire stock has always been effected in separate operational stages in which the coiled springs are first formed and then ground flat at their opposite ends by means of a suitable grinding arrangement. The spring severing or parting apparatus according to the present invention renders possible the production of such springs in a much more economical manner.

More particularly, the springs are manufactured continuously from an endless wire, i. e., without any interruption of the wire feed and of the advancing movement of the formed springs, and a controlled carriage is moved

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parallel to the axis of the springs and in synchronism with said advancing movements thereof. The carriage carries a disc-shaped severing tool which severs the spring from the stock during the aforesaid advancing movement of the spring.

After the severing has been completed, the carriage is again brought to its starting position. When a subsequently formed spring attains the desired length, the carriage, as mentioned above, is again set into motion and brought to the same speed as the speed of said advancing movement of the spring, whereby the latter can be severed from the stock while in motion.

One embodiment of the present invention is shown, partly schematically, in the accompanying drawings, in which:

Fig. 1 is a top plan view, partly in horizontal section, of the machine serving to sever the spring pieces,

Fig. 2 is a front view of Fig. 1, partly in vertical section on the line II—II of Fig. 1,

Fig. 3 is a vertical cross-section on the line III—III of Fig. 2,

Fig. 4 shows a detail of the machine in side view in direction of the arrow IV of Fig. 1,

Fig. 5 depicts a horizontal section on the line V—V of Fig. 4,

Fig. 6 shows a scheme of the hydraulic and electric control means of the apparatus,

Fig. 7 is an enlarged, partly sectional view of a further detail of the machine, and

Fig. 8 is an enlarged, partly sectional view of yet another detail of the machine.

In Figs. 1 to 3, a casing 10 of a severing machine comprises on its top surface two horizontal guide rails 11 and 12 on which is movable a carriage 13. The latter is moved by means of a threaded spindle 14 extending between said rails and parallel thereto and being rotatably mounted at its ends in casing 10 by means of bearings 15. A nut member 16 which is a constituent of carriage 13 threadedly engages spindle 14. At one end of spindle 14 there is situated a sprocket 17 which through a driving chain 18 is connected to a further sprocket 19. The latter is mounted on the driven shaft of a hydraulic motor 20 of which the pressurized driving-liquid input is regulable by means of an electromagnetic changer of which the control circuit will be described later with reference to Fig. 6 and which essentially comprises an electromagnet 21. The latter is movable by means of a nut 22 secured thereto and a threaded spindle 23 engaged by said nut and carrying a handwheel 24 for adjusting purposes. The hydraulic motor 20 is secured, inside the casing 10, to a horizontal partition 25 thereof which also carries bearing means for spindle 23. Handwheel 24 is disposed on the front side of casing 10.

On the two rails 11, 12 there is additionally and movably mounted a stopping bridge 26 which may be clamped in adjusted position by means of a set screw 27. On bridge 26 are disposed a movable and adjustable stop 28 and an electric tumbler switch 29 which is actuated by abutment against carriage 13 when the latter moves entirely to the left as seen in Figs. 1 and 2. On the opposite side of carriage 13, a fixed stop carrier 30 is disposed on casing 10, which carrier supports an electric tumbler switch 31 which is actuated by abutment against a pin 32 of carriage 13 when the latter moves entirely to the right as seen in Figs. 1 and 2.

On carriage 13 a slide 33 is horizontally movable at right angles to the rails 11, 12 and is driven through a hydraulic cylinder 34 secured thereto. The piston 35 disposed in cylinder 34 is immovably connected to carriage 13 through a rod 36. Slide 33 carries a parting tool 37 for severing the spring-parts, such tool having the form of a circular disc. By means of a shaft 38, the parting

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tool 37 is rotatably mounted on a support 39 which in turn is movably disposed on slide 33 at an angle with respect to the horizontal so that the elevation of the tool is variable. A threaded spindle 40 is rotatably mounted on slide 33 and serves to move support 39, such spindle carrying a handwheel 41. A nut 42 immovably disposed on support 39 threadedly engages spindle 40. The shaft 38 of parting disc 37 carries a multiple V-belt pulley 43 which through belts 44 is connected to an electric motor 45 disposed in casing 10. The parting disc 37 is disposed at right angles to the direction of movement of carriage 13 and parallel to that of slide 33.

To carriage 13 is secured a lateral portion 46 which projects to the rear side of casing 10 and has lateral openings 47 so that the springs to be operated on may be passed therethrough in parallel direction to the rails 11, 12 along the axis 48 in Figs. 1 and 2. A plurality of holders 49 to 54 are provided for guiding and supporting the springs, as described below in detail. Approximately in the plane containing the parting disc 37 there are disposed two holders 49, 50 which, as shown in Fig. 3, coact at an oblique angle relative to the horizontal from above and from below, respectively, with the spring to be severed. Each of said holders comprises a rotatably mounted roller 55 which may contact the spring circumference and is adjustable with respect to the spring axis 48 by means of a knob 56 in order to be adapted to springs of different diameters. The appurtenant adjusting mechanism will be described later, with reference to Fig. 5 for holder 54. The two holders 49, 50 are disposed between two brackets 57 which are connected to each other and to an axle 58a which is parallel to axis 48 and rotatably mounted on portion 46 so that the brackets 57 and the rollers 55 of the holders 49 and 50 may be swung away from the spring to be operated on or towards the same. To the brackets 57 are fixedly secured three cylindrical carrier arms 58 to 60 which are parallel to each other and to the axis 48 and project away from the brackets 57 to the left in Figs. 1 and 2. On these arms is movably mounted a member 61 on which are disposed the two holders 52 and 53 in a manner analogous to said two holders 49 and 50. The two holders 52, 53 are destined to hold the spring piece to be parted off. When the two holders 49, 50 move away from the spring when the brackets 57 are moved, the two holders 52, and 53 also move away from the spring in an analogous manner.

Holder 51 is secured to portion 46 in a manner similar to holder 49 but cannot be swung away from the spring. A further holder, not shown in the drawings, which is disposed substantially parallel to holder 50 in the vertical plane containing holder 51, also is secured to portion 46 but cannot be swung away from the spring.

The brackets 57 are moved by means of a hydraulic cylinder 62 which is immovably mounted on portion 46 except for pivotal movement. A piston 63 disposed in cylinder 62 is provided with a connecting rod which is pivoted on a pin to one of the brackets 57. Cylinder 62 is double-acting and, in a manner which will be described later, is inserted in the circuit of a pressurized fluid. In the operating position shown in Fig. 3, the brackets 57 are locked by means of a finger 65 which is pivoted on a pin 64 to portion 46. For actuating the finger 65 there is provided an electromagnet 66 of which the armature is subjected to the influence of a spring (not shown in the drawings) and is articulated to an operating arm 67 which is rigidly connected to finger 65. During the motion of the brackets 57 from the position shown in Fig. 3, a stop 68 secured to the brackets contacts a counterstop 69 which serves to actuate an electric tumbler switch 70. Stop 69 is adjustable by means of a threaded spindle which is actuable through a knob 71.

The sliding member 61 comprises, as shown in Fig. 5, internal threads 72 disposed concentrically with respect to carrier arm 59 and engageable by corresponding external

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threads disposed on the hub of a handwheel 73. The latter is rotatable about the carrier arm 59 and is connected rotatably but axially immovably to an adjusting ring 74. The latter may be clamped to arm 59 with the aid of a set screw 75 after the member 61 has been set substantially in the desired position. Member 61 subsequently may be finely adjusted within certain limits by turning of the handwheel 73.

Holder 54 is disposed on a stirrup 76 of which the legs are pivoted on vertical pins 77 (Fig. 4) to member 61. This holder, in contrast to the other holders, comprises a conical roller 78 which is capable of supporting from the inside the terminal turn of the spring piece to be severed, as indicated in Fig. 5. This roller 78 also is adjustable by means of a knob 79. The adjusting mechanism comprises, as in the case of the other holders 49 to 53, a rotatable but axially immovable threaded spindle 80 to which is connected knob 79. Spindle 80 is engaged by the internal threads of a bushing 81 which is longitudinally movable in the holder casing. A key 82 prevents bushing 81 from rotating, and the roller 78 is rotatably mounted on the external end of bushing 81. Rigidly secured to the lower leg of stirrup 76 is an arm 83 of which the free end carries a rotatable roller 84. The latter serves to coact with a cam 85 when the carriage 13 has been moved up to the stop bridge 26, i. e., to the left as seen in Figs. 1 and 2, and the brackets 57 have been swung out. Cam 85 is disposed on a base 86 which is arranged on casing 10 of the machine, adjustable longitudinally of the rails 11 and 12.

On slide 33 which serves as carrier for the parting tool 37 are disposed a plurality of T-shaped grooves 87 (Figs. 1 and 2) in which are secured a series of electric switches 89 to 92 which are indicated in Fig. 6. On carriage 13 are provided similar grooves 88 in which are adjustably disposed a plurality of stops 93 to 96 which coact with said switches, and also a switch 97 which is actuable through stop 28. Fig. 6 shows the manner in which the electric switches are put in circuit, and the cooperation of the stops with the appurtenant switches. The switches 89 and 92 are closed only as long as they are being acted upon, while the other switches are tumbler switches which remain in their switching position after having been actuated.

On carriage 13 there is movably mounted an adjustable feeler 98 which, in a manner not further shown, is operatively connected to tumbler switch 97 to close same. Feeler 98 is disposed so as to be actuable through the free end of the spring piece to be severed (Fig. 1). A further feeler 99 is movably mounted on slide 33 so that it scans, immediately at the parting disc 37, the periphery of the spring to be parted. Feeler 99 is operatively connected to both switches 91 and 92. On the carriage an additional feeler 100 is connected to the actuating element or slider 101a of a variable electric resistor 101 which is secured to carriage 13. Feeler 100 carries a rotatably mounted friction roller 100a which may abut against the circumference of turns of the spring to be worked on to sense the difference between the feed speeds of the formed spring and of carriage 13. Feeler 100, as more particularly shown in Fig. 7, is displaceably arranged in a housing 100b and is biased in the direction of the spring being produced by means of a compression spring 100c located within the housing. Feeler 100 preferably is disposed as closely as possible to parting disc 37, only for the sake of clarity it is shown in Fig. 1 relatively far away therefrom. All of the feelers 98 to 100 are not shown in Fig. 2 for the sake of clarity, but they are schematically shown in Fig. 6.

The pressure fluid for operating the hydraulic motor 20 is a liquid contained in a supply tank 102. The suction side of a principal pump 103 is connected to the supply tank through a pipe line 102a. Pump 103 is driven by an electric motor 105 which through a chain drive is coupled to the pump and drives the latter at constant speed.

The same motor is coupled to a control pump 108 through a continuously variable gear mechanism 106 which is adjustable by means of a handwheel 107. The output of pump 108 is continuously variable by means of an electro-mechanical changer 109. In a manner analogous to that described with reference to changer 21, changer 109 also is movable by means of a handwheel 113 so that its influence on control pump 108 may be regulated within certain limits. The suction side as well as the pressure side of pump 108 are connected through pipes 108a and 108b, respectively, to a multiple-way slide control valve 110 of which the control element may be moved to two positions and which on the one hand is subjected to the influence of a spring 111 and, on the other hand, is actuable through an electromagnet 112.

The pressure port of principal pump 103 is connected on one hand to one chamber of valve 110 via a maximum-pressure valve 114 and a load valve 115, and on the other hand to another chamber of valve 110 via a balancing valve 116. The last-named chamber also communicates with the control cylinder of load valve 115. One side of hydraulic motor 20 is directly connected to two different chambers of valve 110 and, through a check valve 117, to a further chamber of valve 110. The other side of motor 20 is connected to valve 110 via a regulating valve 118 which is actuable through an electromagnet 119. In the circuit of magnet 119 there is included the resistor 101 which is regulated through feeler 100 which scans or senses the spring production speed. When the straight wire is fed toward the coil-forming or wire deflecting means, it has a predetermined linear feed speed, while those portions of the wire constituting the coils or turns of the formed springs move arcuately about the axis 48. In other words, coil portions of the wire have a rotational speed about said axis 48 the magnitude of which, in general, is obtained by dividing the linear feed speed by the length of wire forming one of the spring windings or turns. It will, therefore, be readily realized that the linear, longitudinal movement of the carriage 13 must be accurately synchronized with the rate of spring production which in turn depends on the aforesaid rotational speed of the spring being formed. Under such a condition, the effective value of the variable resistance will remain constant since the feeler 100 senses the rotational speed or, alternatively, the axial speed of movement of the spring as a whole. Should this axial speed vary from the carriage speed, the resistance 101 will be automatically changed to reequalize these two speeds to one another.

A pipe is tapped from between the two valves 114 and 115 and leads via a check valve 120 to a control slide valve 121 and, via a further check valve 122, to a further control slide valve 123. Valve 121 is actuable, against the action of a spring 121a, through an electromagnet 124, and valve 123 is actuable through an electromagnet 125. Valve 121 is connected to cylinder 34 for traversing the slide 33, partly directly and partly through a regulating valve 126 and a further slide valve 131 which also is actuable through an electromagnet 132 against the action of a spring 131a. An electromagnet 127 which serves to actuate the valve 126, is placed in series with a rheostat 128 which is controllable through a feeler element 129 (Fig. 1). The latter coacts with a graduated ruler 130 which is adjustably mounted on carriage 13. Cylinder 62 which serves to swing the spring holders 49, 50, 52 and 53, is connected to various chambers of slide valve 123. From each of the three control slide valves 110, 121 and 123, a drain pipe leads into the supply tank 102 for the pressure medium.

In the circuit of electromagnet 21 which serves to regulate the capacity of hydraulic motor 20, is included a rheostat 133 which is coupled to a scanning element 134 which scans the pitch of the helical spring. In the circuit of electromagnet 109 which serves to regulate the output of pump 108, is included a variable resistor 135 which is me-

chanically connected to a scanning element 136 which scans the diameter of the helical spring. The two elements 134, 136 may, for example, be disposed on the spring-winding machine and preferably constitute the turn-forming elements of such machine.

The mode of operation of the machine according to the present invention is as follows:

A spring A is wound by means of a spring-winding machine (not further shown here), the spring wire being fed thereto throughout the operation at constant speed. The speed of production of the resulting spring, i. e. the speed of a certain spring section in a direction parallel to the spring axis, then depends on the diameter and the pitch of the resulting spring turn at the moment under consideration. Designating the wire speed by v_w , the diameter of the spring-turn by D , and the pitch of said spring-turn by p , the speed of production of the spring is:

$$v_p = \frac{v_w \cdot p}{D}$$

Each element of the spring produced travels at such speed v_p forwardly in direction of the spring axis, as indicated by the arrow B in Figs. 1 and 6.

Assuming now, for example, that carriage 13 is in the position shown in Figs. 1 and 2, that parting disc 37 rotates, and that electric motor 105 is in operation, the spring produced then moves along axis 48 through the recesses 47 until its end abuts against feeler 98, thus closing tumbler switch 97. It is assumed that the leading spring-end already has been ground flat. When switch 97 closes, magnet 112 is excited and the control valve 110 is moved to the position shown in Fig. 6. Pump 103 moves liquid from tank 102 through the valves 114, 115 into the lowermost chamber of valve 110. From the latter, the liquid flows into pump 108 and returns to valve 110, as indicated in Fig. 6 by arrows. Afterwards, the liquid flows in the direction of the arrow P through valve 118 into hydraulic motor 20 and further via valve 110 back into tank 102, as indicated by the arrow Q. Hydraulic motor 20 drives carriage 13 so that the latter moves in the direction of the arrow B in Figs. 1 and 2. While principal pump 103 supplies a constant output, the output of regulating pump 108 is automatically regulated in dependence on the diameter of the spring-turn just produced. To such end, the current in the exciter circuit of magnet 109 is varied, by means of element 136 and resistor 135, in dependence on the turn-diameter, and magnet 109 regulates the output of pump 108 against the action of a spring. The input of hydraulic motor 20 is varied, in an analogous manner, by means of magnet 21, resistor 133 and element 134 in dependence on the pitch of the spring-turn just produced. This may best be seen from Fig. 8, according to which the feeler 134 has a sensing element 134a arranged at one end of a double-armed lever pivotally mounted at 134b and being connected at its other end by means of a universal joint 134c to a slider 133 movable along and in electrical contact with the resistor 133. A light spring 134d biases the lever in such a manner as to keep the sensing element 134a in engagement with the appropriate turn of the spring A. Thus, whenever the pitch of a spring-turn varies from the desired predetermined magnitude, the feeler 134 is pivoted to move the slider 133a so as to vary the effective resistance of the resistor 133 accordingly, thereby altering the input of hydraulic motor 20 in a corresponding manner. In this way at a constant speed of feeding the spring-wire, carriage 13 moves at substantially the same speed as spring A. The selected spring-wire supply speed may be taken care of with the aid of the continuously variable gearing 106 which permits the pump 108 to be driven at a number of revolutions which is proportional to the wire speed v_w .

Since spring A between the spring-winding machine and the carriage 13 may be subjected to certain deformations through tension or compression in direction of the

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spring axis 48, the carriage speed has to be influenced in some additional manner so as to ensure in any case an accurate conformance between carriage speed and production speed v_p of the spring. Such fine control of carriage 13 is attained with the aid of the regulating valve 118 of which the actuating magnet 119 is excited more or less by resistor 101. The latter is controlled, as may be seen in Fig. 7 by feeler 100 which is disposed on carriage 13 and responds to differences between the carriage speed and the speed of production of spring A in one or the other direction. Such differences may be balanced practically at once and nearly completely by adaptation of the carriage speed.

During the forward movement of carriage 13, spring A is guided and supported by the holders 49 to 54. The brackets 57 and the sliding member 61 are swung to their effective positions, as shown in Figs. 3 and 4, finger 65 maintaining such position. Spring holder 54 under the influence of torsional springs (not shown) in the spindle bearings 77 abuts against the inner circumference of the terminal turn of spring A. Feeler 98 is so disposed that parting disc 37 during the forward movement of carriage 13 always is spaced from the spring-end a distance corresponding to the length of the spring-part to be severed.

In known spring-winding machines, the spring produced rotates about its axis 48 and moves forwardly at the same time in the manner of a screw. When, during the forward motion of carriage 13 and the rotation of the spring, a spring-turn intended to be the last one of the formed spring arrives in the operating range of parting disc 37, feeler 99 is actuated. The latter closes tumbler switch 91 and quick-break switch 92, whereby the magnets 124 and 132 of the two slide valves 121 and 131 are excited. The latter thus occupy the positions shown in Fig. 6. Principal pump 103 via valves 114 and 120 supplies pressurized liquid into the top chamber of valve 121 and thence through valves 131 and 126 into cylinder 34, as shown by the arrow S, i. e. on the upper side of piston 35 in Fig. 6 and on the left side thereof in Fig. 3. Consequently, slide 33 in Fig. 3 is moved to the left, and parting disc 37 moves into the spring-turn to be severed. In Fig. 3, slide 33 is shown in the outermost left-hand position. When the spring-turn which has to be severed leaves feeler 99 and thus moves out of the range of parting disc 37, contact 92 opens to interrupt the circuit of magnet 132. Slide valve 131 under the influence of its associated spring 131a then is moved into the other operating position in which no pressurized liquid is admitted to cylinder 34. Slide 33 thus is not further advanced. Excess liquid supplied by pump 103 flows off through valve 114. Only when a new final spring-turn again moves into the range of parting disc 37, switch 92 again is closed through feeler 99, and magnet 132 again is energized so that further liquid can flow into cylinder 34 and slide 33 is advanced together with parting disc 37. The liquid present on the other side of piston 35 in cylinder 34 thereby can flow off via valve 121 back into tank 102. When the last-mentioned final spring-turn again leaves feeler 99, slide 33 is again arrested, and so on.

Parting disc 37 thus always is moved further into the spring-turn to be severed, any time when the latter passes through the range of the parting disc, until the spring has been entirely severed. Since slide 33 together with carriage 13 moves in the direction of arrow B at the speed of production of spring A, the spring is parted in a plane normal to the spring axis, the end of the spring piece to be severed and the end of the remaining spring winding simultaneously being face-ground.

While carriage 13 is moving forwardly, rheostat 128 is adjusted with the aid of ruler 130 and feeler 129. Thereby the intensity of current of electromagnet 127 is changed, which serves to actuate valve 126. The latter thus is opened more and more in dependence on ruler 130 so that the speed of carriage 33, which carries the parting disc 37, is constantly controlled during the parting operation. By shifting of ruler 130, which also could

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comprise a curved control edge, the increment of the penetrating speed of parting disc 37 may be selected in accordance with the requirements met.

Shortly before the spring is entirely parted, stop 95 runs up on the actuating element of quick-break switch 89 whereby electromagnet 66 is excited. Finger 65 thus moves to an inoperative position to release the brackets 57 for swinging movement. The latter, however, for the time being still is prevented by cylinder 62 into which flows liquid through check valve 122 and slide valve 123 in accordance with arrow R in Fig. 6. When the spring has been parted or severed, stop 96 moves towards the actuating element of switch 90 to close the circuit of magnet 125. The latter is excited to move slide valve 123 to the other operating position. Liquid then flows from check valve 122 via slide valve 123 in direction of arrow T into cylinder 62. The brackets 57 and the sliding member 61 thereby are moved clockwise in Figs. 3 and 4 so that the spring holders 49, 50, 52 and 53 move away from the parted spring piece. During such swinging movement, roller 84 of arm 83 also moves up on cam 85 whereby holder 54 is swung away from the inner periphery of the parted spring piece and releases the latter. The spring piece thus is ejected.

When the spring holders 49, 50, 52 and 53 have been entirely swung out, stop 68 of brackets 57 moves up on the adjustable stop 69 whereby switch 70 is opened. Magnet 125 thus is de-energized and slide valve 123 returns to the position shown in Fig. 6 under the influence of its associated spring 123a. Liquid now again flows in direction of arrow R into cylinder 62 which is relieved, in the opposite direction of arrow T, via slide valve 125, the ejected liquid flowing off into tank 102. The holders 49, 50, 52 and 53 thereby return to their operative positions.

After the parted spring piece has been ejected, stop 94 moves up on the actuating element of switch 91, whereby the latter is opened and magnet 124 is de-energized. Valve 121 under the influence of its associated spring 121a moves to the other operating position. Liquid now can flow from cylinder 34 in the direction opposite to arrow S through valve 121 back into tank 102, while on the other hand liquid flows from check valve 120 via slide valve 121 into cylinder 34 to return slide 33 in Fig. 3 to the right. Contact 89 thereby is opened so as to de-energize magnet 66 which under the influence of its associated spring swings finger 65 into its locking position to support the brackets 57. At the end of the return movement of slide 33, stop 93 moves up on the actuating element of switch 91 whereby the latter is closed and magnet 124 is energized. Control valve 121 now again occupies the position shown in Fig. 6 to make slide 33 move forwardly. As long as, however, feeler 99 is not acted on by the turn to be severed, slide 33 is not yet advanced.

After the spring has been parted and carriage 13 is moving forward, stop 28 contacts the actuating element of switch 97 to open the latter. Magnet 112 thereby is de-energized, and control slide valve 110 under the influence of its associated spring 111 is moved to the other switching position. Liquid delivered by main pump 103 now first flows again via valves 114, 115 into the bottom chamber of valve 110 and thence into hydraulic motor 20 in the opposite direction of arrow Q. On the other side of said motor, the liquid flows through valve 118 in the direction opposed to arrow P into valve 110 and thence into tank 102. Pump 108 then sucks liquid, via the top chamber of valve 110 and in direction of arrow U, from tank 102 and delivers same via valve 110 and check valve 117 into motor 20 too. The latter thus is accelerated. Since liquid flows through motor 20 in the direction opposite to the previous direction, it now rotates in the other direction, whereby carriage 13 is returned to its initial position until the now leading end of spring-winding A runs up on feeler 98 to thereby close contact 97, whereupon the operations described are repeated in sequence.

When carriage 13 is returning, feeler 129 also returns to its initial position under the influence of a spring, whereby also resistor 128 is returned to its initial position.

Suitable means are provided to swing the feelers 99 and 100 mechanically or electro-magnetically out of the path of movement of spring A during the return of carriage 13, and to let these feelers again contact said spring only when carriage 13 has arrived in its initial position.

Merely by way of example, such means are shown in Fig. 7 for the feeler 100 and may comprise an electro-magnet 140 having a movable core or armature 141 linked to the housing 100b of the feeler 100. Two cooperating electric contacts 142 and 143 are mounted on the feeler 100 and the housing 100b, respectively, and control the state of energization of the magnet 140.

During the manufacture of a spring A, the housing 100b, which is pivotally mounted on carriage 13 at 100d, is biased downwardly by a spring 144, while the contacts 142 and 143 are separated and the magnet 140 deenergized due to the displacement of the feeler 100 against the force of the spring 100c because of the engagement of the roller 100a with one of the turns of the spring A. As soon as a last spring-turn has been severed by the tool 37 and the formed spring ejected, the spring 100c causes closing of the contacts 142 and 143 to energize the magnet 140, whereby, during return of the carriage 13 to its starting position, the housing 100b is pivoted against the force of the spring 144 and out of the range of the next spring A being formed.

The two switches 29 and 31 serve to stop the slides 13 and 33 by throwing motor 105 out of action when one of the means described fails and carriage 13 has travelled entirely to the left or right.

Various changes and modifications may be made without departing from the spirit and scope of the present invention and it is intended that such obvious changes and modifications be embraced by the annexed claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent, is:

1. An apparatus for operating on a helical spring at predetermined longitudinal locations of the latter when said spring is continuously rotated and continuously fed thereto; comprising casing means, carriage means supported by said casing means, carriage moving means for moving said carriage means relative to said casing means in longitudinal direction of said spring, first feeler means on said carriage means and operatively connected with said carriage moving means for actuation of the latter upon feeding of a predetermined length of said spring, second feeler means for determining the diameter of said spring, third feeler means for determining the pitch of said spring, said second and third feeler means being operatively connected with said carriage moving means for proportioning the speed of said carriage means to the pitch and diameter of said spring, slide means supported by said carriage means, slide moving means for moving said slide means relative to said carriage means in transverse direction to the longitudinal direction of said spring, fourth feeler means on said slide means and operatively connected with said slide moving means for actuation of the latter during movement of said carriage means when said spring is in predetermined position relative to said slide means, and tool means on said slide means, whereby upon movement of said spring and said carriage means at the same longitudinal speed actuation of said slide moving means causes said tool means to operate upon said spring in transverse direction to the longitudinal direction of the latter.

2. In an apparatus according to claim 1, said slide moving means including cylinder means on said slide means, and piston means on said carriage means and operatively engaging with said cylinder means for moving of said slide means.

3. In an apparatus according to claim 1, said carriage

moving means and said slide moving means including hydraulic motor means provided with valve means controlling movement of said carriage means and of said slide means.

4. In an apparatus according to claim 3, including fifth feeler means on said carriage means and disposed adjacent said tool means for determining the difference between the speed of said carriage means and the longitudinal speed of said spring adjacent a location where the latter is to be operated upon by said tool means, said fifth feeler means being operatively connected with said hydraulic motor means, whereby the latter is regulated to equate the speed of said carriage means with the longitudinal speed of said spring where the latter is to be operated upon by said tool means.

5. An apparatus for severing a helical spring into predetermined longitudinal lengths when said spring is continuously rotated and continuously fed thereto; comprising casing means, carriage means supported by said casing means, carriage reciprocating means for advancing and returning said carriage means in parallel direction to said spring, first feeler means on said carriage means and operatively connected with said carriage reciprocating means for actuation of the latter and advancing said carriage means upon feeding of a predetermined length of said spring, second feeler means for determining the diameter of said spring, third feeler means for determining the pitch of said spring, said second and third feeler means being operatively connected with said carriage reciprocating means for proportioning the advancing speed of said carriage means to the pitch and diameter of said spring, slide means supported by said carriage means, slide reciprocating means for advancing and returning said slide means in perpendicular direction to the longitudinal direction of said spring, hydraulic motor means including reversible valve means operatively connected with said carriage reciprocating means and said slide reciprocating means for controlling advance of said carriage means and of said slide means in performing a severing operation and for controlling return of said carriage means and of said slide means upon completion of said operation, fourth feeler means on said slide means and operatively connected with said slide reciprocating means for intermittent advance of said slide means during advance of said carriage means when a predetermined turn of said spring is in predetermined position relative to said slide means, and severing tool means on said slide means, whereby upon feed of said spring and advance of said carriage means at the same longitudinal speed actuation of said slide reciprocating means causes said tool means to sever said spring in perpendicular direction to the longitudinal direction of the latter.

6. In an apparatus according to claim 5, including holder means supported by said carriage means for retaining said spring against lateral shifting during severing by said tool means.

7. In an apparatus according to claim 6, including means for pivoting said holder means relative to said carriage means, said pivoting means being operatively connected with said slide means, whereby upon movement of said slide means to a position corresponding to completion of a severing operation pivoting of said holder means is affected to thereby release the severed spring length.

8. In an apparatus according to claim 7, including piston means operatively connecting said holder means with said carriage means, said piston means normally preventing pivoting of said holder means, and electromagnetic means for actuating said piston means to effect pivoting of said holder means, said electromagnetic means being operatively connected with and actuated by said slide means upon movement of the latter to a position corresponding to completion of a severing operation.

9. In an apparatus according to claim 5, including at least one holder supported by said carriage means, said holder normally engaging the interior of a spring when

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fed through said apparatus, and cam means on said casing means, said holder engaging said cam means upon completion of a severing operation, whereby said holder moves away from the interior of the severed spring length for releasing the latter.

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