April 10, 1945. F. S. STICKNEY 2,373,427

SPRING WINDING MECHANISM

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Fig. 1

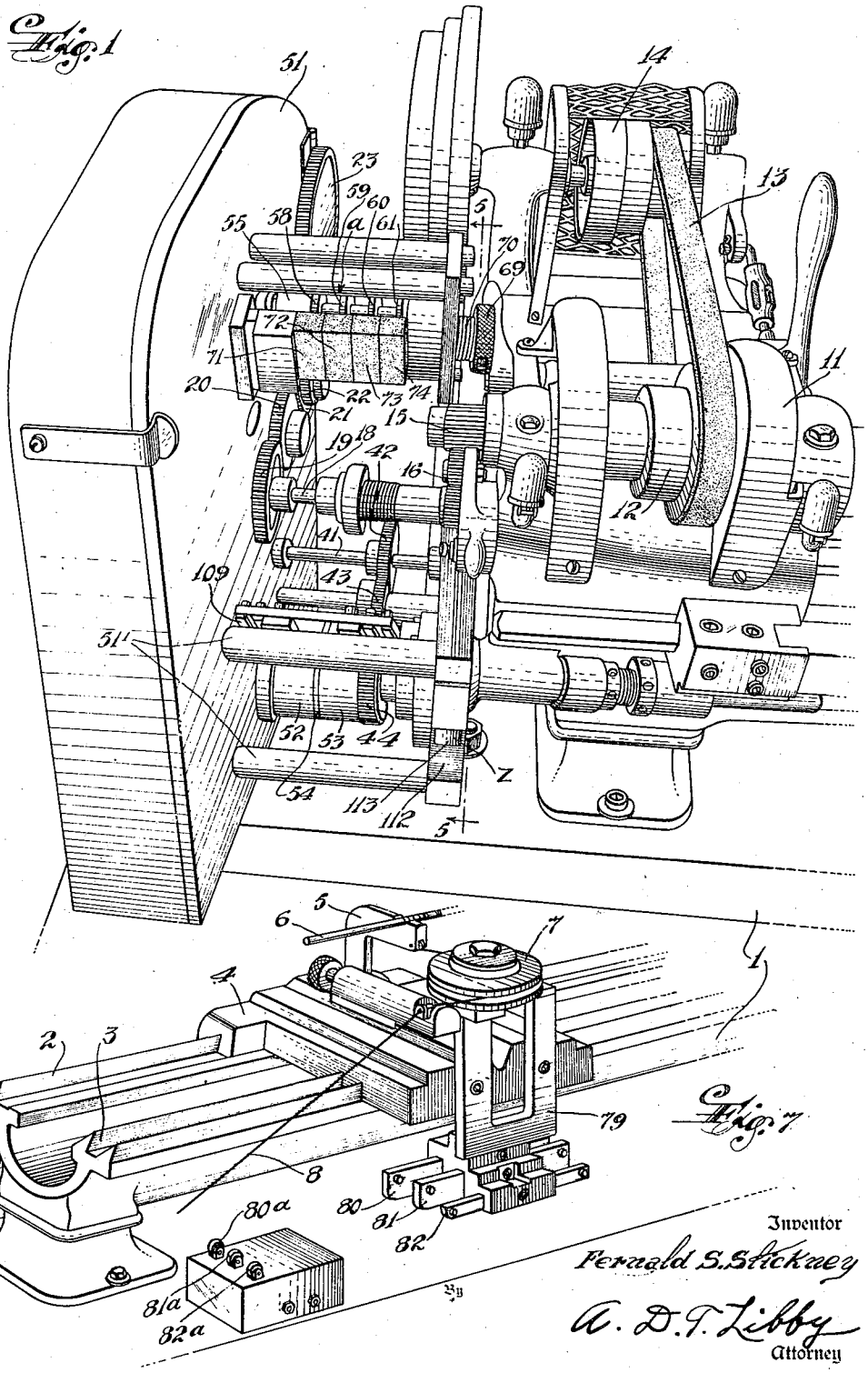

Fig. 7

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SPRING WINDING MECHANISM

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Fig. 2

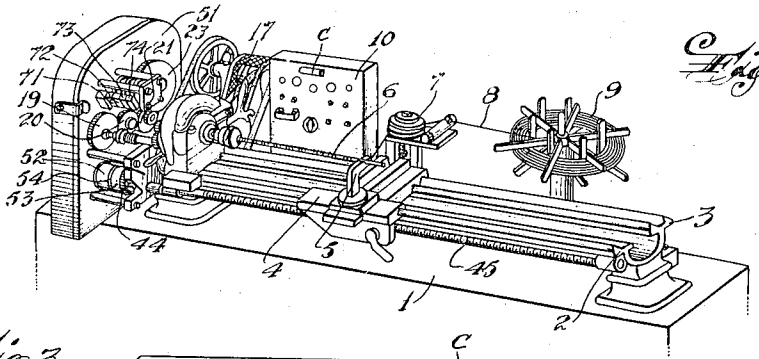
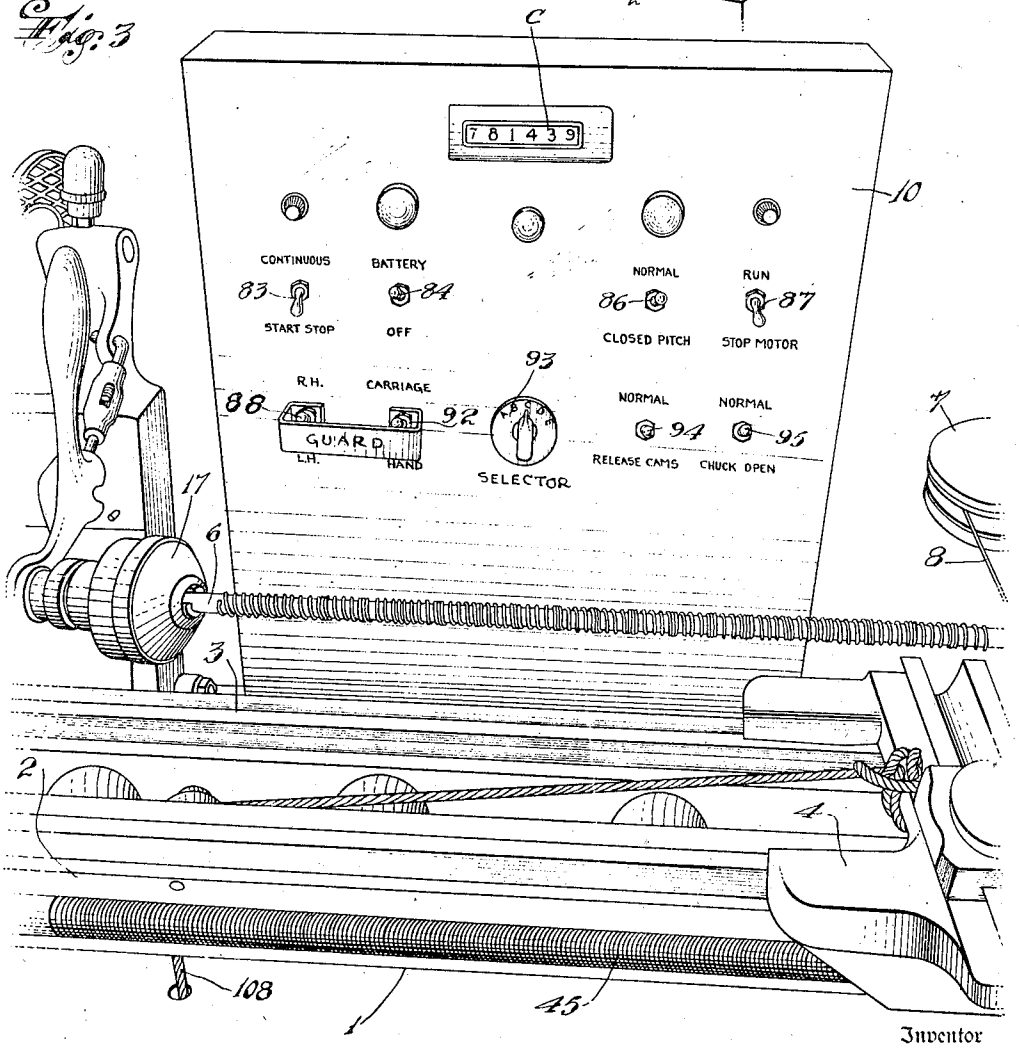


Fig. 3



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SPRING WINDING MECHANISM

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Fig. 4

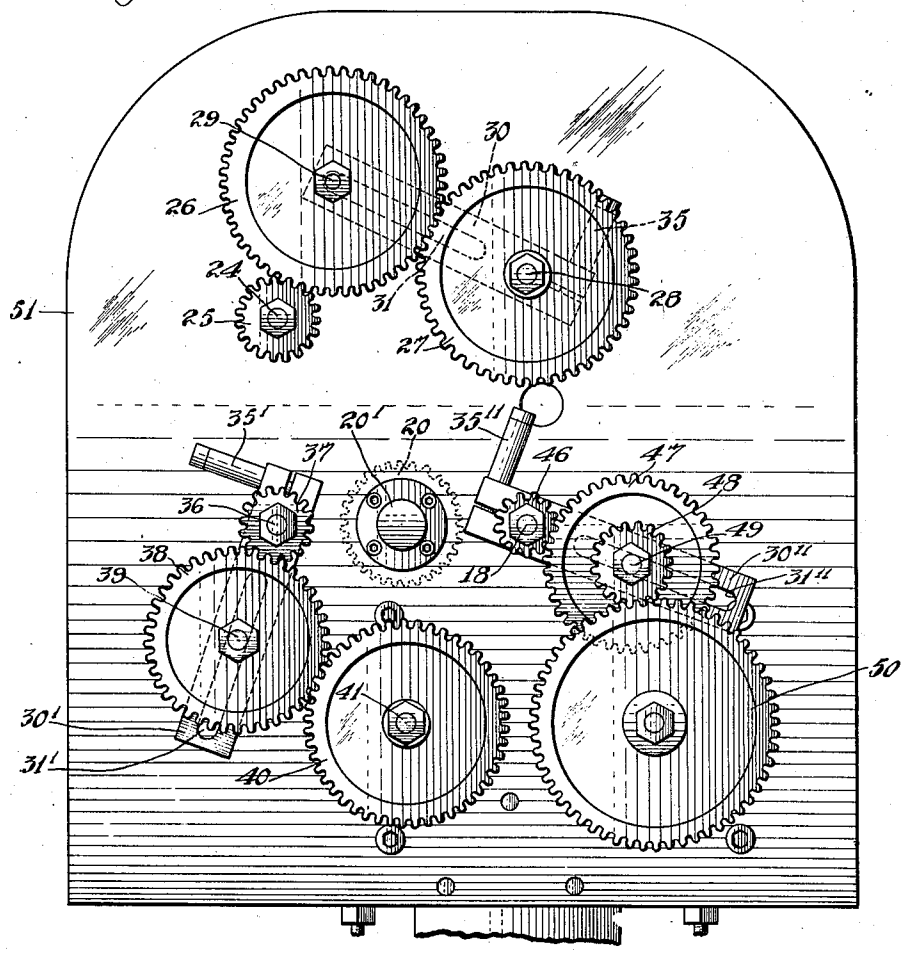
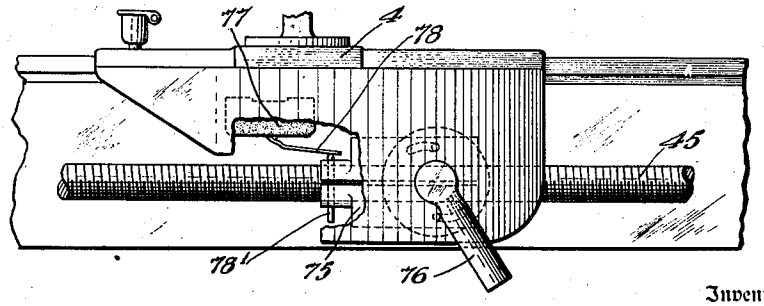


Fig. 8



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SPRING WINDING MECHANISM

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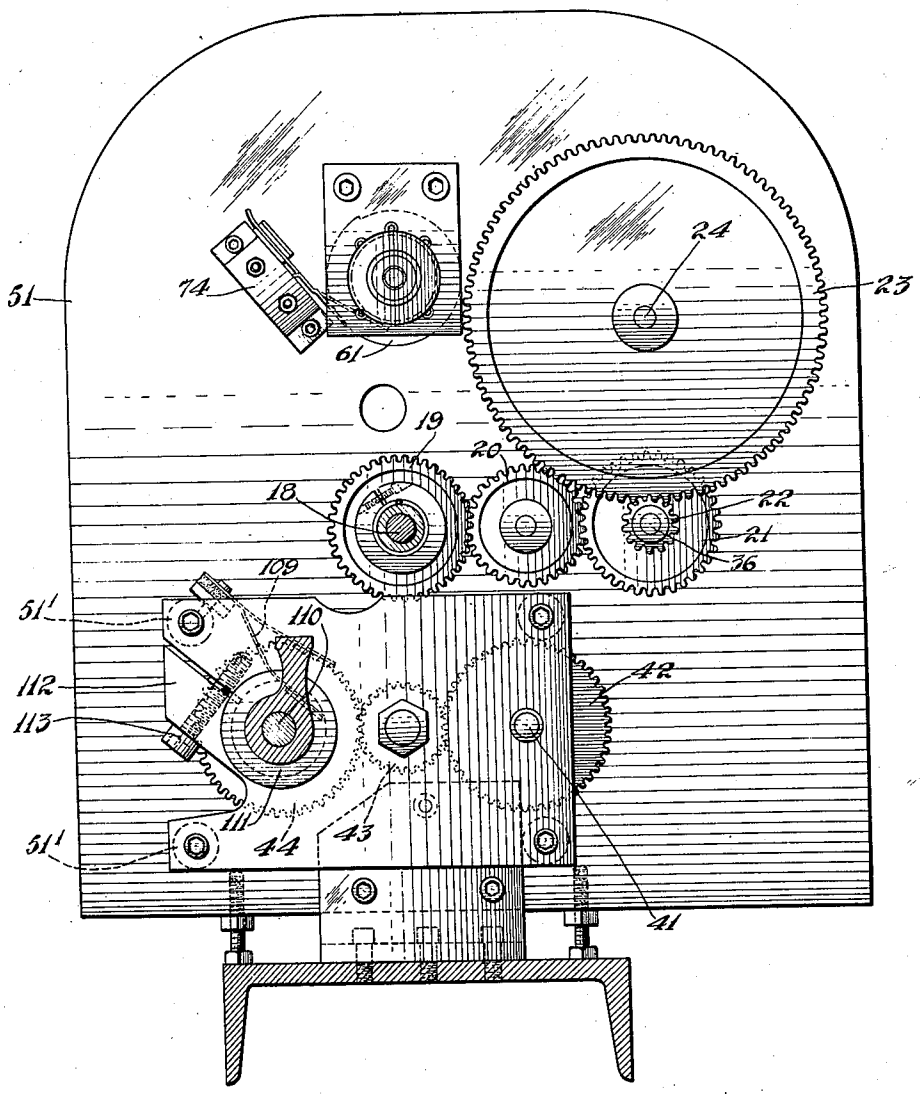
Fig. 5



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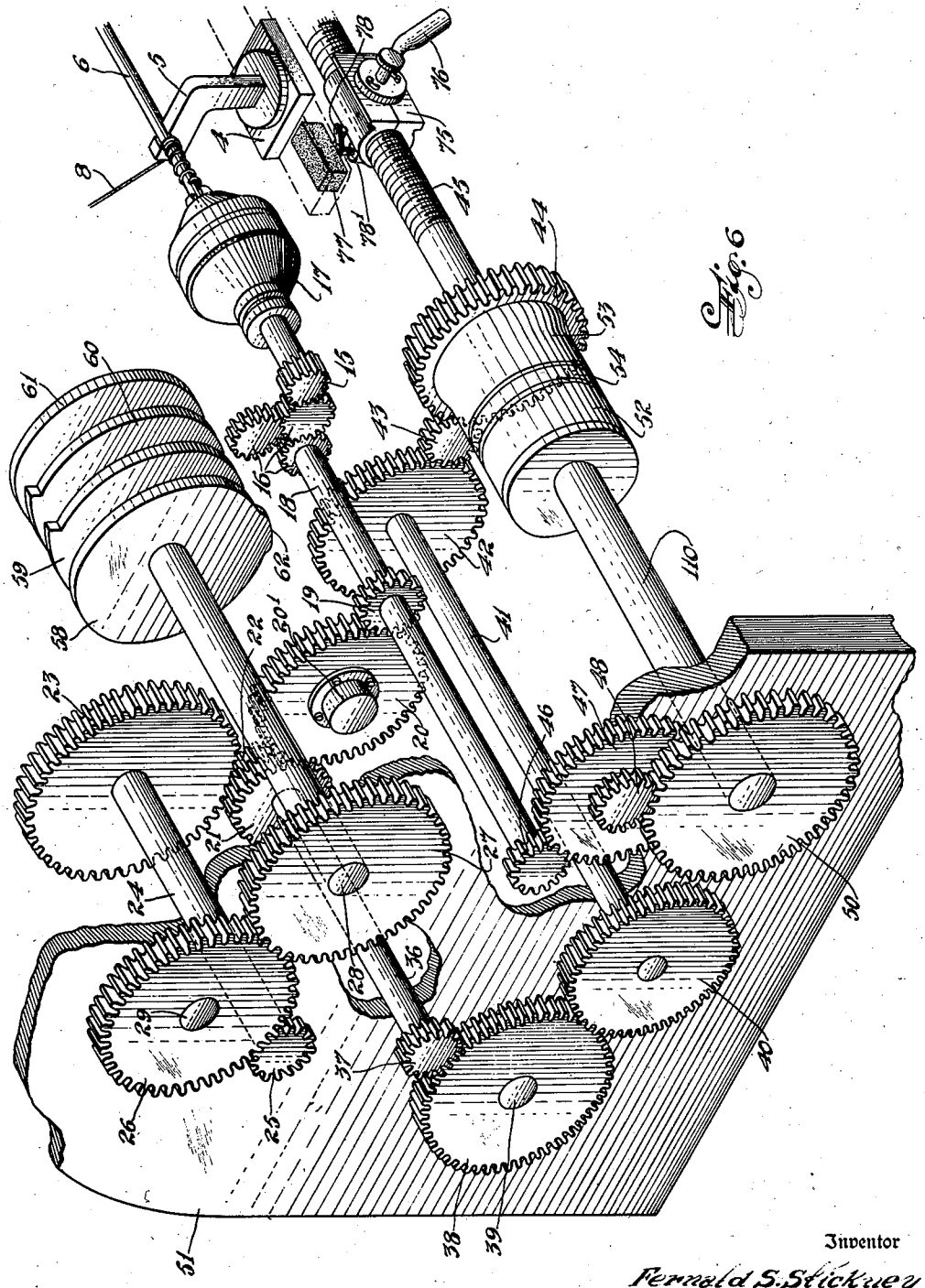

Fig. 6

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SPRING WINDING MECHANISM

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Fig. 10

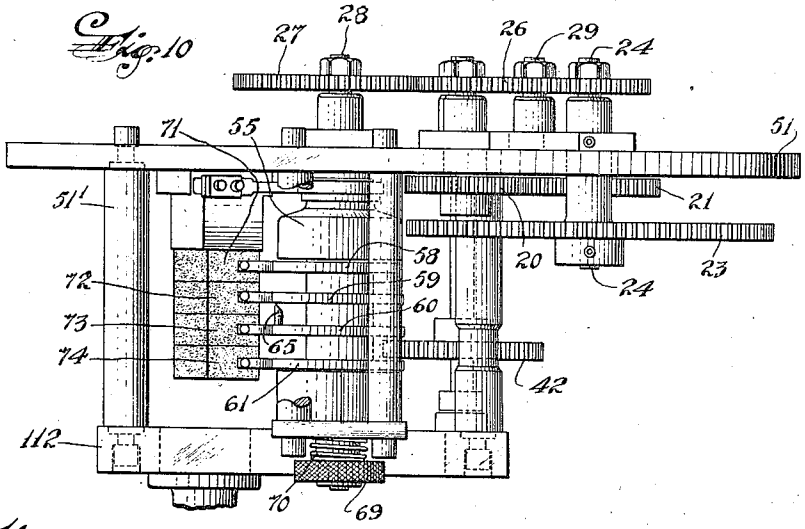


Fig. 9

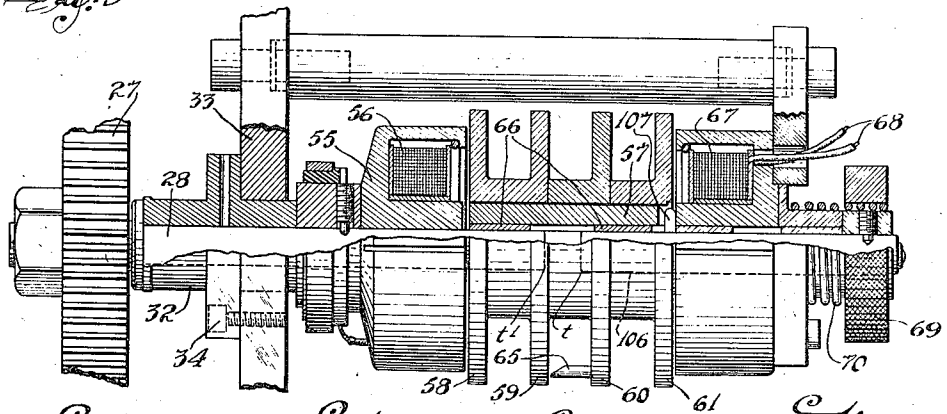


Fig. 12

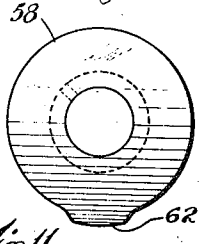


Fig. 13

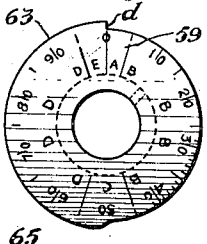


Fig. 15

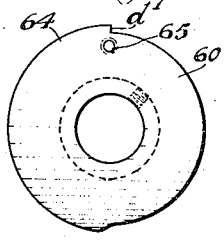


Fig. 17

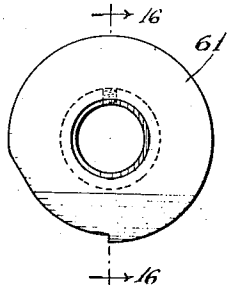


Fig. 11

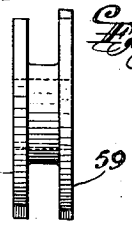
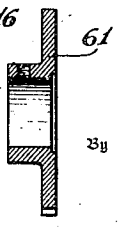


Fig. 14

Fig. 16



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SPRING WINDING MECHANISM

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Fig. 18

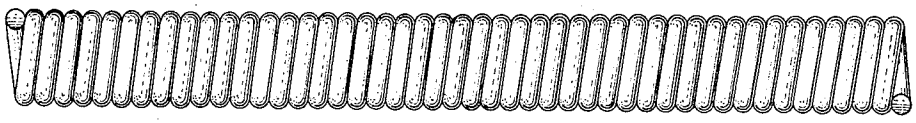

Fig. 19

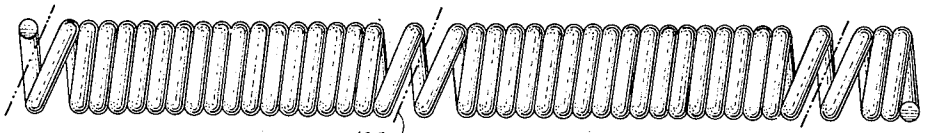

Fig. 20

Fig. 21

Fig. 22

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SPRING WINDING MECHANISM

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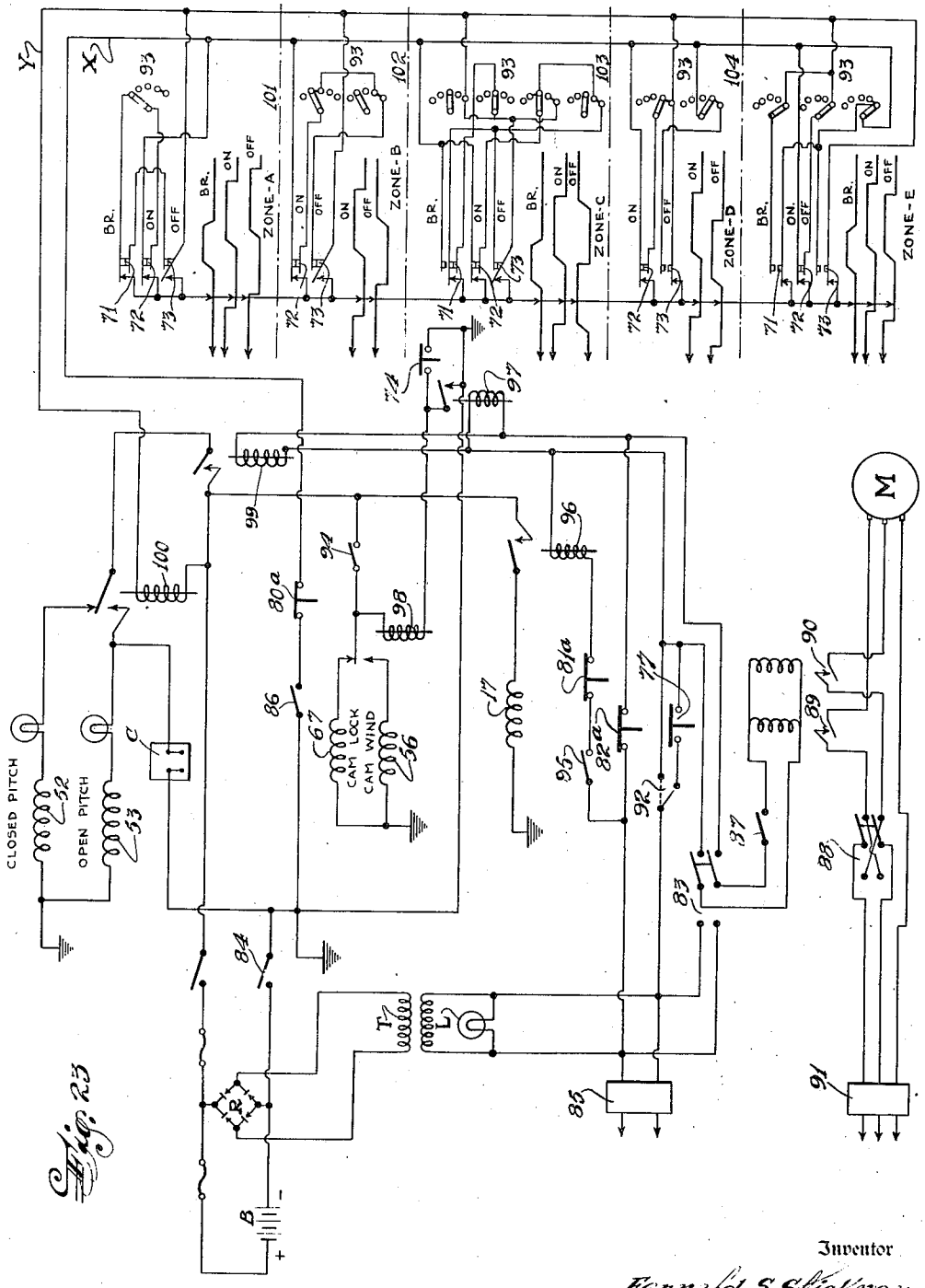

Fig. 23

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2,373,427

UNITED STATES PATENT OFFICE

2,373,427

SPRING WINDING MECHANISM

Fernald S. Stickney, West Caldwell, N. J.

Application April 21, 1943, Serial No. 483,955

39 Claims. (Cl. 153—64)

This invention relates to a mechanism for and a process for making helical springs. In order that my improved process and mechanism for making helical springs may be more readily understood and appreciated, it seems essential to set forth a few definitions; to wit, a helical spring is one made from wire in the general shape of a helix having the general outline of a cylinder. Such springs can be classified as tension or compression springs, a tension spring being one in which the turns forming the helix are spaced closely together and usually provided with hooks at the ends of the spring for attachment or loading purposes.

A compression spring is one in which the turns are spaced a desirable distance apart so that it can be compressed by pressure applied at its ends. Usually compression springs are made with a few closely wound turns at each end thereof to make a more upright spring and thereby take its load in the best manner. In some cases the ends of a compression spring are ground flat to accomplish this purpose. In the specification which follows, the closed turns are those wound at each end of a typical compression spring, while the open turns are the spaced turns between the closed end turns, thus becoming the real active part of the spring, there being little or no movement to the closed end turns under load.

The free length of a helical spring is its length when no load is applied in any way, whereas the solid length is the length of the spring when it is compressed or loaded so heavily that the open turns engage each other and the spring can be compressed no further. The number of turns of wire per inch of the free length defines the pitch, tension springs being usually wound with a uniform pitch throughout the entire length, whereas compression springs are usually wound with two different pitches—a high pitch at the ends for the closed turns, and a lower pitch for the open turns. The closed pitch in a helical spring is the number of turns per inch of the length in the closely wound portion of the spring; hence it is determined entirely by the diameter of the wire used. Thus a compression spring has an active length of the open wound turns and an inactive length of all its closed turns. Therefore the total length of a helical spring is the sum of its active and inactive lengths, and the turn ratio for a compression spring is the number of open turns divided by the total number of turns.

It may be said in passing that in the ordinary commercial machine used for producing springs, the wire is fed longitudinally through rollers which push the wire through a long straight hole against a hardened plate set at a compound angle to the axis of the hole. The wire strikes the said plate at an angle and comes off in a curl. Thus the diameters and pitch of these curls depend upon the compound angles of the plate. While these angles are adjustable for setting up purposes and are varied during the operation of the machine by an adjustable cam or cams, the springs are subject to variations in diameter and pitch, due to variations in temper or curvature of the wire; and when beryllium copper springs are formed on such a machine, it is necessary to heat-treat the wire before coiling the spring as heat-treatment thereafter would produce severe distortion; but I have found that to get the best physical properties of beryllium copper springs they should be fully heat-treated after they have been formed.

If beryllium copper wire is given full heat treatment before being formed into springs, the material is rendered too brittle to be handled in the ordinary conventional machine. It has been customary to use over-heat-treated wire in the conventional machines, resulting in failure to develop the maximum physical properties of the material, especially beryllium copper.

It is therefore the principal object of my invention to be described herein, to provide a composite mechanism and process which is especially adapted for the manufacture of beryllium copper springs which will be more accurate and of more uniform diameter and precise pitch and better quality than it is now possible to make with the prior-art structures to which reference has been made.

Another object of my invention is to provide a mechanism which will have substantially automatic characteristics so that it can be set to produce compression springs of any diameter, turn ratio, closed pitch, open pitch and total number of turns within, of course, a certain range of the particular machine. To accomplish the main object of my invention, I have chosen to utilize an engine lathe modified so as to obtain the desired results by feeding spring wire from a reel onto a mandrel carried by the lathe spindle chuck by way of a wire guide mounted on a carriage which is moved by the lathe lead screw parallel with the mandrel. By various changes and additions to the lathe, such as a change in gears for any given type of spring, I may, as will be later pointed out, wind helical springs without it being necessary to stop the machine to change gears to move from closed to open pitch, and vice-versa for each and every spring.

A further object of my invention is to provide a gear case or mounting plate so arranged on or positioned with respect to the lathe, that a change in gears for both closed and open pitch and number of turns can be very easily and quickly made.

A still further object of my invention is to provide an electrical clutch structure which is automatically actuated for turning the lead screw at

different speeds to wind closed and/or open pitch springs on the mandrel.

Another object of my invention is to provide a cam structure placed in an easily accessible position with electrically associated features for controlling the time of winding closed and open turns of the springs.

Another object is to provide an electrical control panel in front of the machine operator whereby the various parts of the mechanism may be easily put into operation with certain indications visually before the operator.

A still further object is to provide automatic means for stopping the mandrel and the winding operation when a mandrel is fully wound.

A further advantage is obtained in that the beryllium copper springs are heat-treated on the mandrel on which they are wound, and thereby maintain close tolerances after heat treatment.

Besides these advantages the mechanism automatically determines the percentage of turns which shall be closed and what percentage shall be open. In other words, the mechanism automatically determines the ratio between closed and open pitch turns. In addition, the mechanism counts the total number of turns per spring, the diameter of which is determined by the diameter of the winding mandrel.

Many other objects and advantages will be readily perceived from a reading of the following description taken in connection with the annexed drawings wherein:

Figure 1 is a view partly in plan and partly in perspective of the gear end of the winding lathe.

Figure 2 is a perspective view of the winding mechanism on a much reduced scale.

Figure 3 is an enlarged view of the control panel showing a portion of the lathe of Figure 2.

Figure 4 is a view of the outer side of the change-gear panel shown in the left-hand portion of Figure 1.

Figure 5 is a view similar to Figure 4 but of the inner side of the change-gear panel.

Figure 6 is a schematic and isometric arrangement of the gears shown in Figures 4 and 5, which gears are on opposite sides of a gear-case plate, certain change gears of the lathe—with the mandrel, clutch, lead screw and slide shown in Figure 1, also being shown.

Figure 7 is a partial view of one end of the back portion of the lathe, showing the slide for supporting one end of the mandrel and the tension pulley for the wire, as well as certain control or limit switches used in the operation of the machine.

Figure 8 is a fragmentary view of the front side of the lathe showing, somewhat diagrammatically, the lead screw and means for connecting the slide to the lead screw, as well as a control switch used in the operation of the mechanism.

Figure 9, which is illustrated partly in section and partly in elevation, is a side view of the cam shaft assembly used for operating the switches included in the control used in the circuits controlling the pitch winding of the springs.

Figure 10 is a plan view of the cam switches and cam assembly looking down in the direction of the arrow *a* of Figure 1.

Figure 11 is a side elevation of the assembly of two of the cams shown in the left-hand portion of the cam assembly of Figure 9.

Figure 12 is a view of the "bridge" cam forming the left-hand portion of the combination shown in Figure 11, looking from left to right.

Figure 13 is a view of the "on" cam which comprises the right-hand portion of the assembly shown in Figure 11, looking from right to left.

Figure 14 is a side elevation of the "off" cam, the same being the third from the left in the cam assembly of Figure 9.

Figure 15 is a view of Figure 14 looking from right to left.

Figure 16 is a view of the resetting cam, the same being the one to the right of the cam assembly of Figure 9.

Figure 17 is a view of Figure 16 looking from right to left.

Figure 18 shows a spring as wound on the mandrel with 0% open pitch.

Figure 19 shows a spring wound on the mandrel with 5% open pitch, the individual springs being formed by cutting on the diagonal, broken lines.

Figure 20 is a view similar to Figure 19, but with 50% open pitch.

Figure 21 is a view similar to Figure 19, but with 95% open pitch.

Figure 22 is a view similar to Figure 18, but with 100% open pitch.

Figure 23 is a wiring diagram of the electrical circuits used in the mechanism.

In the various views wherein like numbers refer to corresponding parts, 1 illustrates generally a lathe preferably of the so-called engine type, having slide rests 2 and 3 on which is positioned a slide or carriage 4 carrying an arm 5 for supporting the outer end of a mandrel 6 and guiding the wire thereonto. The slide also carries a tension wheel 7 for regulating the tension on the wire 8 from a reel 9, carried on or closely adjacent the lathe 1, onto the mandrel 6, around which it is wound in the manner as somewhat diagrammatically illustrated in Figure 3 and to be later described more in detail. The carriage is returned to start position by a rope 108 and a weight (not shown) after being released by a split nut 75 to which reference will be later made.

Supported on the lathe or immediately adjacent thereto, is a control panel or cabinet 10 within and on which are mounted various relays, switches, signals, etc., used in the electrical circuits comprising part of the mechanism, certain of these switches being identified on the cabinet 10, at the top portion of which is indicated a counter *c* for counting the springs as they are wound. The head end of the lathe is the usual head stock 11 carrying speed-change pulleys 12 which are connected by a belt 13 to cooperating pulleys 14.

A gear 15 connected to reverse gears, generally referred to as 16, drives the lathe spindle carrying an electro-magnetic chuck 17 for engaging and driving the mandrel 6. A power shaft 18, which supplies power through the reverse gears 16, carries a gear 19 in mesh with a gear 20 which in turn is in mesh with a gear 21 carried on a shaft supporting a gear 22 in mesh with a gear 23. The gears 21, 22 and 23 comprise a gear reduction for a cam assembly which will be later referred to. The gear 23 is carried on a shaft 24 which carries a gear 25 in mesh with an idler gear 26 which is in mesh with a gear 27 that operates the cam shaft assembly through a shaft 28 (see Figure 9). The gears 25, 26 and 27 form

a combination which I term the "cam change gears."

The gear 26 is supported on a shaft 29 carried by a suitable idler bearing support arm 30 having a slot 31 therein, within which the shaft 29 is slidably adjustable toward and away from the shaft 28. The bearing arm 30 is carried on a bearing bushing 32 fastened to a frame member 33 in any suitable manner as by a set screw 34 (see Figure 9). The arm 30 is arcuately adjustable on the bearing bushing 32 and locked in position by a set screw 35.

The gear 21 is carried on a shaft 36 having a pinion 37 on its outer end. The shaft 36 is supported in a bearing bushing similar to the bushing 32 which supports the shaft 28. The pinion 37 meshes with a gear 38 carried on a shaft 39 supported by a suitable idler bearing support arm 30' having a slot 31' therein, within which the shaft 39 is slidably adjustable toward and away from the shaft 36. The bearing arm 30' is carried on a bearing bushing similar to the bushing 32 fastened to the same frame member 33 in any suitable manner as by a set screw 35'.

The gear 38 is in mesh with a gear 40 carried on a shaft 41 on the inner end of which is a gear 42 which is in mesh with an idler gear 43 meshing with a gear 44 on a shaft 110 associated with or forming a part of the clutch structure used to make driving connection with the engine lead screw 45. The shaft 110 is carried in a bushing 111 held in a frame plate 112 by a screw 113. The gears 37, 38 and 40 comprise a combination which I term "open pitch change-gears."

The outer end of the shaft 18 carries a pinion 46 which is in mesh with a gear 47 that is fixedly mounted with a gear 48 on a shaft 49, on which shaft is carried a support arm 30'' having a slot 31'' and a lock pin 35'' for fixing the arm 30'' in its adjusted position, it being understood that this arm is carried on a bearing bushing similar to 32. The gear 48 is in mesh with a gear 50 which is fastened to a stub shaft forming a part of the electro-magnetic clutch structure that drives the lead screw of the lathe. The gears 46, 47, 48 and 50, which are all mounted on the front or left-hand side of the gear casing 51, form a combination which I term "closed pitch change gears." The plate casing 51 is carried by the lathe on suitable supports 51'.

The clutch structure is composed of two portions 52 and 53 which house electrical energizing windings to be described more in detail in connection with Figure 23. Current is conveyed to these windings through the medium of brushes, only one, 109, of which is shown in Figure 5, and slip rings which, for the purpose of clarity, are not shown in Figures 1 and 2. Between these electromagnetic windings is positioned an armature 54. The armature 54 is fastened to a shaft forming an extension of the engine lathe lead screw 45, so that when this armature 54 is attracted to the electro-magnetic structure 53, the lead screw 45 is driven by the open pitch change gears 37, 38 and 40 heretofore described.

When the armature 54 is attracted and held by the electromagnetic structure 52, the lead screw 45 will be driven at a different speed by the closed pitch change gears 46, 47, 48 and 50.

The cam change gears 25, 26 and 27 operate a cam structure which is shown in assembled relation in Figure 9. Mounted on the shaft 28, for rotation therewith, is a housing member 55 within which is located an electromagnetic winding 56, current being conveyed thereto through slip rings and brushes which for the purpose of clarity are not shown.

Mounted on a sleeve 57, which is preferably slidably mounted on Oilite bearings 66 and free from the shaft 28, are four cams—a bridge cam 58, an "on" cam 59, an "off" cam 60, and a reset cam 61. The cams 58 and 59 are assembled as an integral structure as shown in Figure 11, which is fastened in any suitable manner as by a set screw to the sleeve 57. The cam 58 has an indicated camming surface 62 of approximately thirty-six degrees arcuate length, the purpose of which will be later described in connection with Figure 23.

The "on" cam 59, having an indicated camming surface 63 of approximately 180 degrees, is calibrated into sectors or zones A, B, C, D and E, each sector or zone being subdivided so that there are one hundred divisions in the entire circumference of the cam for a purpose to be hereinafter described.

The "off" cam 60, which is adjustably mounted on the sleeve 57 and has an indicated camming surface 64 of approximately 180 degrees, has an index pin 65 for assistance in setting the cam to one of the sectors and divisions thereof on the cam 59.

The reset cam 61, which is also preferably adjustably mounted on the sleeve 57, is in operative relationship with a stationary electro-magnetic structure having an energizing winding 67 energized by current coming through the leads 68 for a purpose to be later described.

It is intended that the clutch relay 100, to be later referred to, be energized only by closing of the micro-switch 72, operated by the "on" cam 59 at its drop-off point d. It is also intended that the said clutch relay 100 be deenergized only by opening of the "off" switch 73 operated by the "off" cam 60 at its drop-off point d'; the switches 72 and 73 will be later deferred to. Since these two cams are adjustable with respect to each other throughout an angle of 360 degrees, it is necessary to divide this angle into five different zones and to use five different circuits, one at a time, for each zone as will be later described.

A hand knob 69 is attached to the cam structure so that the cam assembly can be turned by this knob, it being understood that the knob is carried on a shaft 106 which terminates at the point t, whereas the shaft 28 terminates at the point t'. The shaft 106 has a pin 107 that is positioned, after assembly, in a recess in the end of the sleeve 57 so this sleeve, with the cams mounted thereon, may be turned by the knob 69 for adjustment purposes, at which time both the windings 56 and 67 are deenergized.

A lock spring 70 is provided for the purpose of preventing rotation of the cam assembly in the wrong direction when adjusting the cam structure as is sometimes necessary, which would permit damage to certain switch-operating levers that are operated by the cams and which will be later referred to.

The cams 58, 59, 60 and 61 are shown in Figure 10 in operative position with their cooperating micro-switches 71, 72, 73 and 74, a side view of one of these switch structures being indicated in Figure 5, and the switches being shown diagrammatically in Figure 23.

Positioned on the lead screw 45, is a split nut 75 which is adapted to be operated by a lever 76 whereby the nut may be engaged or disengaged from the lead screw 45. The split nut 75 is operatively connected to the slide or carriage 4 so that

when the split nut 75 is in operative engagement with the lead screw 45, the carriage 4 is moved with the lead screw. On the carriage is mounted a switch 77 having a switch-operating member 78 which is adapted to be moved by an adjustable pin 78' on the split nut 75 for completing a circuit which will be later described. The slide or carriage 4 has a support bracket 79 on which are mounted three bars 80, 81, 82, of suitable material. These bars are arranged in echelon so as to engage their respective roller contacts 80*a*, 81*a* and 82*a* in slightly spaced time relationship. The said rollers are a part of limit switch members used in the circuits shown in Figure 23, as will be later described.

Referring now to the electrical circuits which control the operation of the mechanism as illustrated in Figure 23, in association with the control panel 10 of Figure 3, the mechanism is operated substantially as follows, it being kept in mind that the cams are shown in partially developed position at the right-hand portion of Figure 23, below their associated switches, the different zones, to which reference will be made, being divided by the broken lines 101, 102, 103 and 104.

The operation selector switch 83 is thrown to the "start-stop" position, and the battery switch 84 is closed whereby battery current is supplied to the circuit from the battery B which is charged by the rectifier R supplied with current from the transformer T, the primary of which is connected to a suitable source of A. C. current via a junction box 85. A pilot lamp L may be used to indicate that the battery-charging circuit is supplied with A. C. power.

A clutch switch 86 is moved to normal or closed position; a stop switch 87 is closed or moved to running position, and a reversing switch 88 is moved to a position for giving a proper direction of rotation of the three-phase motor M when the motor control relays 89 and 90 are closed, current being supplied to the motor M from a suitable source of current passing through a junction box 91.

A change-over switch 92 is thrown to the position marked "Carriage" in Figure 3, or to the position shown in full lines in Figure 23, which completes one side of a circuit down to the carriage switch 77. A selector switch 93 is set to the letter-zone indicated on the cam 59 (see Figure 13) corresponding to the position of the index finger 65 according to the adjustment of the "off" cam 60. This selector switch will be found to be quite necessary in securing one hundred per cent. flexibility in adjusting the angular relation between the "on" and "off" cams, to which reference will be later made.

A cam-release switch 94 is thrown to the normal or closed position which transfers the control of the cam electro-magnets 56 and 67 to the cam release relay 97. A chuck switch 95 is thrown to the normal or closed position, transferring control of the chuck 17 to the chuck relay 96. Since the split nut 75, carried by the lead screw 45, is in open or released position, the carriage switch 77 is open and the mechanism is now ready for regular operation. From this point on all the control is automatic except for the operation of the carriage switch 77 that is operated by the same lever that operates the split nut 75, and this is the only thing an operator has to do outside of changing mandrels after once starting the machine into operation.

The mandrel 6 has one end inserted into the chuck 17 and the other end resting on the guide and support arm 5. The end of the wire 8 is drawn from the reel 9 and passed from the guide and support arm through a hole in the mandrel and bent over so as to hold this end in position on the mandrel. The carriage or slide 4 is then moved toward the head stock 11. The split nut 75 is then closed into engagement with the lead screw 45, which action simultaneously closes the carriage switch 77, thereby energizing the chuck relay 96 that in turn energizes the chuck 17 and causes the same to grasp the mandrel. At the same time, a cam release relay 97 is energized and this energizes the reset relay 98. The energization of the relay 98 deenergizes the cam lock electro-magnet 67 and energizes the cam wind magnet 56; also the clutch release relay 99 is energized which passes control of the clutch relay 100 over to the cam-operated micro-switches 71, 72, and 73. The closure of the carriage switch 77 closes a circuit through the motor control relays 89 and 90 by way of the limit switch 82*a*, and the motor is started and the mechanism begins to wind springs. While the springs are being wound on the mandrel, all of the above conditions remain constant, except the clutch relay 100 and this is alternately energized and deenergized under the control of the cam switches 71—73 as actuated by the cams 58—60.

The actuation of the clutch relay 100 alternately energizes the closed and open pitch clutches 52 and 53, and these in turn transmit alternate speeds to the lead screw 45 as heretofore explained in the description of the gearing shown in Figure 6.

To meet all the requirements of the trade, I have found it highly essential to divide the winding operations into five zones, A, B, C, D and E, as indicated by the switch 93 and as separated by the broken lines 101, 102, 103 and 104 in Figure 23.

Zone A

When it is desired to wind springs from 0% to 5% open pitch, the "off" cam 60 is set to one of the divisions in sector A (see Figure 13) and the selector switch 93 is set to the position A. Under this condition, the clutch relay 100 is controlled by the "bridge," "on" and "off" cams 58, 59 and 60 and their cooperating micro-switches 71, 72 and 73. The relative position of the cams and their direction of movement is shown in the upper right-hand corner of Figure 23, above the broken line 101. Referring to this part of the diagram, the operating point of the "on" cam precedes the operating point of the "off" cam from zero to approximately 18 degrees and the "bridge" cam operates to hold the circuit open in the reset zone. The conductors extending from the switches 71, 72 and 73 are designated X and Y, the Y conductor going to the clutch relay 100, while the X conductor goes to the clutch limit switch 80*a*.

Zone B

When it is desired to wind springs from 5% to 45% open pitch, the "off" cam 60 is set to one of the divisions in sector B (see Figure 13) and the selector switch 93 is set to the position B. Under this condition, the clutch relay 100 is controlled only by the "on" and "off" cams 59 and 60 and their cooperating micro-switches 72 and 73 which are positioned between the broken lines 101 and 102, it being understood that none of the other arrangements apply. Under this condition of operation, the operating point of the "on" cam precedes the operating point of the

"off" cam from 18 degrees to approximately 162 degrees, no bridging switch being required because the resetting zones do not coincide or give trouble.

Zone C

When it is desired to wind springs from 45% to 55% open pitch, the "off" cam **60** is set to one of the divisions in sector C (see Figure 13) and the selector switch **93** is set to the position C. Under this condition, the clutch relay **100** is controlled by the "bridge," "on" and "off" cams **58**, **59** and **60** and their cooperating micro-switches **71**, **72** and **73**. These switches and cams are positioned between the broken lines **102** and **103**, it being understood, the same as before, that none of the other arrangements apply. Under this condition of operation, the operating point of the "on" cam precedes the operating point of the "off" cam from 162 degrees to approximately 198 degrees. The bridge switch shunts the "off" switch between 0 and 162 degrees, and between 198 degrees and 360 degrees. The bridge switch shunts the "on" switch between 162 degrees and 198 degrees. This arrangement is necessary to prevent false operation of the "on" and "off" switches during their resetting periods.

Zone D

When it is desired to wind springs from 55% to 95% open pitch, the "off" cam **60** is set to one of the divisions in sector D (see Figure 13) and the selector switch **93** is set to the position D. Under this condition, the clutch relay **100** is controlled only by the "on" and "off" cams **59** and **60** and their cooperating micro-switches **72** and **73** which are positioned, as diagrammatically illustrated, between the broken lines **103** and **104**, it being understood that none of the other arrangements apply. Under this condition of operation, the operating point of the "on" cam precedes the operating point of the "off" cam from 198 degrees to 342 degrees, no bridging switch being required because the resetting zones do not coincide or give trouble.

Zone E

When it is desired to wind springs having an open pitch from 95% to 100%, the "off" cam **60** is set to one of the divisions in sector E (see Figure 13) and the selector switch **93** is set to the position E. Under this condition, the clutch relay **100** is controlled by the "bridge," "on" and "off" cams **58**, **59** and **60** and their cooperating micro-switches **71**, **72** and **73**, as illustrated below the broken line **104**, it being understood that none of the other arrangements apply. In other words, all of the five settings illustrated on the right-hand side of Figure 23 operate individually according to the setting of the selector switch and the "off" cam. Under this condition of operation, the operating point of the "on" cam precedes the operating point of the "off" cam from 342 degrees to 360 degrees, the bridge cam operating to hold the circuit closed in the reset zone.

Figures 18 to 22 inclusive illustrate one condition of the springs wound in the various zones as above described. The individual springs are made by cutting on the broken lines **105**. It may be mentioned at this point that one revolution of the cam structure shown in Figure 9 makes a complete spring.

When the mandrel has been completely wound with a plurality of springs, the mechanism must be stopped to put in another mandrel if, as has been explained, the springs are to be tempered while on the mandrel on which they are wound. The mechanism is stopped by the action of the three limit switches **80***a*, **81***a* and **82***a*, shown in Figure 7. The first limit switch to operate is the clutch limit switch **80***a* which is operated by the bar **80** as the slide or carriage **4** approaches the end of its outward movement. When the limit switch **80***a* is opened, this deenergizes the clutch relay **100** and energizes the closed pitch winding **52**, thereby causing the machine to wind on a closed pitch, which is desired for binding the wire to the end of the mandrel.

The second limit switch to operate is the chuck limit switch **81***a* which is operated by the bar **81** on the carriage. This deenergizes the chuck relay **96** and the chuck **17**, thereby stopping the rotation of the mandrel instantly, although other parts of the machine may continue to rotate under their own inertia.

The carriage limit switch **82***a* is the last to be operated by its bar **82**. Opening of this limit switch deenergizes the cam release relay **97** and throws control of the reset relay **98** to the reset cam **61** and its associated switch **74**, whereby the reset relay **98** will be deenergized on the next opening of the reset switch **74** by its cam **61**. The opening of the switch **82***a* deenergizes the relay **99** and cuts off the supply of direct current from both the clutches **52** and **53**, thus instantly stopping rotation of the lead screw; it also deenergizes the motor control relays **90** and **89**, thereby disconnecting the motor from the source of current supply, and the mechanism will now coast to a stop.

While the above describes the preferred operation of the limit switches, the carriage limit switch **82***a* may operate simultaneously with chuck limit switch **81***a*, or may precede or follow it.

As the machine slows down to a stop, the operator cuts the wire and removes the wound mandrel from the deenergized chuck **17**, ready to insert another mandrel. In the meantime, the inertia of the machine rotates the reset cam **61** and it eventually reaches the drop-off position, thereby moving the reset switch **74** to open position as shown in Figure 23. This delayed action deenergizes the reset relay **98** that in turn deenergizes the cam winding **56**, and directly thereafter energizes the cam lock winding **67**. This stops and locks the cam assembly in the proper position for starting the next mandrel of springs.

The position of the reset cam **61** can be adjusted and locked with respect to the other cams so that each time the machine is started it first winds open pitch for a few turns before winding closed pitch, thereby minimizing waste of wire and producing a maximum number of perfect springs per mandrel. If the operation selector switch **83** is thrown to the "continuous" position, the machine is operated in the same manner as heretofore described, but the lathe spindle never stops during a change of mandrels.

If springs having closed pitch only are desired, the clutch switch **86** is moved to the closed pitch or open position, thus deenergizing the clutch relay **100** and the open pitch clutch **53**.

The machine may be stopped at any time by opening the stop switch **87** which cuts off current from the motor control relays **89** and **90**, but does not have any effect on the other circuits of the machine. The change-over switch **92** is used mainly for adjusting purposes when it may be desired to operate the machine without engaging the split nut **75** and running the slide or carriage

4. As will be seen, this switch simply shunts the carriage switch 77. The cam release switch 94 is necessary for use during setting up operations to deenergize the cam electro-magnets 56 and 67 so as to permit turning the cam assembly by means of the hand knob 69 to which reference has already been made.

It may be further noted that the chuck switch 95 is used during setting up operations for deenergizing the magnetic chuck 17 without throwing other parts of the machine out of operation.

While I have described a very practical working mechanism especially adapted for use in the manufacture of beryllium copper springs, but not necessary limited thereto, it will be apparent that many changes may be made in various details of the construction without departing from the spirit of my invention or the scope of the appended claims.

What I claim is:

1. A mechanism for making plural-pitch helical springs comprising, the basic parts of an engine lathe such as a bed plate carrying slide means, lead screw, spindle and speed-change pulleys for the spindle; a chuck carried by the spindle, a mandrel adapted to be carried by the chuck for rotation therewith, a carriage movable on the slide means, means for operatively connecting the carriage to the lead screw, a wire guide carried by the carriage for guiding spring wire onto the mandrel, means for automatically changing, at any desired revolution, the speed of rotation of the lead screw and hence the speed of the carriage with respect to the speed of rotation of the spindle and mandrel to vary the pitch of the turns of the spring being wound on the mandrel.

2. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that said means for automatically changing the relative speeds of the lead screw and mandrel include, primarily, a preset switch-controlled cam structure and, secondarily, an electro-magnetic clutch structure having two energizable portions between which a single-piece armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, one of said speeds producing closed-pitch turns of the spring, while another speed produces open-pitch turns of the spring.

3. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that an electro-magnetic clutch structure is provided for controlling the relative speeds of rotation of the lathe lead screw and mandrel, said structure having two energizable portions between which an armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, said clutch portions being energized by a relay directly under control of cooperative cam and switch structures, at least the cam structure having parts adjustable for obtaining a desired winding of spring.

4. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that the speed of rotation of the lathe lead screw is controlled by an electro-magnetic clutch structure having two energizable portions between which an armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, said clutch portions being energized by a relay directly under control of cooperative cam and switch structures, at least the cam structure having parts adjustable for obtaining a desired winding of spring, and a master selector switch for controlling the action of said cam and switch structures.

5. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that the speed of rotation of the lathe lead screw is controlled by an electro-magnetic clutch structure having two energizable portions between which an armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, said clutch portions being energized by a relay directly under control of cooperative cam and switch structures, at least the cam structure having parts adjustable for obtaining a desired winding of spring, said relay contacts being activated by a release relay controlled by a limit switch operated by the lathe carriage at the end of its winding travel.

6. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that said means for operatively connecting the carriage to the lead screw comprises a split nut adapted to be closed onto the lead screw or released therefrom for the purpose described, and means actuated by said split nut when moved into engagement with the lead screw for starting the said automatic action of the mechanism.

7. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that said means for operatively connecting the carriage to the lead screw comprises a split nut adapted to be closed onto the lead screw or released therefrom for the purpose described, and still further defined in that the lathe spindle carries an electro-magnetic chuck and the carriage supports a switch which is operated on actuation of the split nut for energizing and deenergizing the electro-magnetic chuck for engaging and disengaging a mandrel on which springs are wound.

8. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that the speed of rotation of the lathe lead screw is controlled by an electro-magnetic clutch structure having two energizable portions between which an armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, said clutch portions being energized by a relay directly under control of cooperative cam and switch structures, at least the cam structure having parts adjustable for obtaining a desired winding of spring, the mechanism being further defined in that said cam structure includes electro-magnetic means for controlling the functioning of the cams.

9. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that the speed of rotation of the lathe lead screw is controlled by an electro-magnetic clutch structure having two energizable portions between which an armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, said clutch portions being energized by a relay directly under control of

cooperative cam and switch structures, at least the cam structure having parts adjustable for obtaining a desired winding of spring, the mechanism being further defined in that said cam structure includes electro-magnetic means for controlling the functioning of the cams, and relay means for governing the action of the cam electro-magnets.

10. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that the speed of rotation of the lathe lead screw is controlled by an electro-magnetic clutch structure having two energizable portions between which an armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, said clutch portions being energized by a relay directly under control of cooperative cam and switch structures, at least the cam structure having parts adjustable for obtaining a desired winding of spring, the mechanism being further defined in that said cam structure includes electro-magnetic means for controlling the functioning of the cams, and relay means for governing the action of the cam electro-magnets, said relay means comprising a cam release relay which is actuated on closure of a switch supported by the carriage as set forth herein, and a reset relay as defined herein operated by said cam release relay.

11. A mechanism for making plural-pitch helical springs as set forth in claim 1, further, defined in that said means for operatively connecting the carriage to the lead screw comprises a split nut adapted to be closed onto the lead screw or released therefrom for the purpose described, and still further defined in that the lathe spindle carries an electro-magnetic chuck and the carriage supports a switch which is operated on actuation of the split nut for energizing and deenergizing the electro-magnetic chuck for engaging and disengaging a mandrel on which springs are wound, said carriage switch acting under one condition of operation of the lathe to actuate means for starting a motor used for driving the lathe, with further manual means for controlling the motor circuit.

12. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that said chuck is of the electro-magnetic type controlled primarily by a chuck relay and a limit switch, said limit switch being opened by the carriage when the mandrel is wound with springs to a desired point, to deenergize the chuck and release the mandrel.

13. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that said means for operatively connecting the carriage to the lead screw comprises a split nut adapted to be closed onto the lead screw or released therefrom for the purpose described, and still further defined in that the lathe spindle carries an electro-magnet chuck and the carriage supports a switch which is operated on actuation of the split nut for energizing and deenergizing the electro-magnetic chuck for engaging and disengaging a mandrel on which springs are wound, said carriage switch acting under one condition of operation of the lathe to actuate means for starting a motor used for driving the lathe, with further manual means for controlling the motor circuit, and means for shunting the carriage switch when it is desired to adjust parts of the mechanism without running the carriage.

14. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that the speed of rotation of the lathe lead screw is controlled by an electro-magnetic clutch structure having two energizable portions between which an armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, said clutch portions being energized by a relay directly under control of cooperative cam and switch structures, at least the cam structure having parts adjustable for obtaining a desired winding of spring, the mechanism being further defined in that said cam structure includes electro-magnetic means for controlling the functioning of the cam, release means for deenergizing said electro-magnets, and a hand-operated means for turning the cam assembly for adjustment purposes.

15. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that the speed of rotation of the lathe lead screw is controlled by an electro-magnetic clutch structure having two energizable portions between which an armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, said clutch portions being energized by a relay directly under control of cooperative cam and switch structures, at least the cam structure having parts adjustable for obtaining a desired winding of spring, the mechanism being further defined in that said cam structure includes electro-magnetic means for controlling the functioning of the cams, release means for deenergizing said electro-magnets, and a hand-operated means for turning the cam assembly for adjustment purposes, and a lock spring positioned for cooperation with said hand-operated means for preventing rotation of the cam assembly in the wrong direction.

16. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that said chuck is of the electro-magnetic type controlled primarily by a chuck relay and secondarily by a manually operable switch for deenergizing the chuck without disturbing other parts of the mechanism during setting-up operations.

17. A mechanism for making plural-pitch helical springs comprising, the basic parts of an engine lathe such as a bed plate carrying slide means, lead screw, spindle and speed-change pulleys for the spindle; a chuck carried by the spindle, a mandrel adapted to be carried by the chuck, a carriage movable on the slide means, means for operatively connecting the carriage to the lead screw, a wire guide carried by the carriage for guiding spring wire onto the mandrel, a two-part electro-magnetic rotary clutch having an armature operatively connected to said lead screw, the two parts of the clutch adapted to turn at different speeds and a gear box at the end of the lathe carrying gears, certain of which may be readily changed and adjusted to drive said clutch parts at desired speeds, with means for automatically causing said armature to engage said chuck parts to produce the desired winding of springs.

18. A mechanism for making plural-pitch heli-

cal springs comprising, the basic parts of an engine lathe such as a bed plate carrying slide means, lead screw, spindle and speed-change pulleys for the spindle; a chuck carried by the spindle, a mandrel adapted to be carried by the chuck, a carriage movable on the slide means, means for operatively connecting the carriage to the lead screw, a wire guide carried by the carriage for guiding spring wire onto the mandrel, a two-part electro-magnetic rotary clutch having an armature operatively connected to said lead screw, the two parts of the clutch adapted to turn at different speeds, one to wind the closed pitch and the other to wind the open pitch of a spring, and a gear box associated with the lathe and having gears driven by the lathe, certain gears being quickly changeable for others to drive said clutch parts to give the required pitches, means being carried by the lathe to automatically cause said armature to engage the clutch parts desired.

19. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that said chuck is of the electro-magnetic type energized by a relay, a carriage switch closed when the carriage is connected to the lead screw for establishing a circuit to one side of the chuck relay, a limit switch and a manual switch in the circuit of said relay, both serving to close a circuit through the chuck relay, and means on the carriage for opening said limit switch to deenergize the relay and chuck and to stop rotation of the mandrel.

20. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that said chuck is of the electro-magnetic type and said means for automatically changing the speed of rotation of the lead screw includes an electro-magnetic clutch structure having two parts driven at different speeds with an armature connected to the lead screw but capable of being rotated by either of said two parts, separate relay means for controlling the chuck and the clutch structures and separate limit switches actuated by the carriage for opening both relay control circuits.

21. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that said chuck is of the electro-magnetic type and said means for automatically changing the speed of rotation of the lead screw includes an electro-magnetic clutch structure having two parts driven at different speeds with an armature connected to the lead screw but capable of being rotated by either of said two parts, a clutch relay for directly controlling the action of said clutch structure for the purpose described, a clutch release relay for controlling the activation of the contacts of said clutch relay, an electro-magnetically controlled cam structure for actuating the clutch relay, a cam release relay for controlling at least in part the operation of the cams, a switch for limiting the outward movement of the carriage by cutting off the driving power of the lathe, said switch also opening a circuit through the chuck and cam release relays, a further limit switch for opening a circuit through the chuck and a limit switch for opening a circuit through the clutch structure.

22. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that said chuck is of the electro-magnetic type and said means for automatically changing the speed of rotation of the lead screw includes an electro-magnetic clutch structure having two parts driven at different speeds with an armature connected to the lead screw but capable of being rotated by either of said two parts, a clutch relay for directly controlling the action of said clutch structure for the purpose described, a clutch release relay for controlling the activation of the contacts of said clutch relay, an electro-magnetically controlled cam structure for actuating the clutch relay, a cam release relay for controlling at least in part the operation of the cams, a reset relay actuated by the cam release relay and controlling the actuation of the electro-magnet of the cam structure, and means for opening the circuits of all the relays and electro-magnets when the mandrel is wound with a wire to a predetermined length.

23. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that the speed of rotation of the lathe lead screw is controlled by an electro-magnetic clutch structure having two energizable portions between which an armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, said clutch portions being energized by a relay directly under control of cooperative cam and switch structures, the cam structure including an "on" cam with its switch for energizing said relay and an "off" cam with its switch for deenergizing said clutch relay, said two cams being adjustable with respect to each other so as to get a plurality of adjustments for controlling the relative number of open turns with respect to the number of closed turns per spring.

24. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that the speed of rotation of the lathe lead screw is controlled by an electro-magnetic clutch structure having two energizable portions between which an armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, said clutch portions being energized by a relay directly under control of cooperative cam and switch structures, the cam structure including an "on" cam with its switch for energizing said relay and an "off" cam with its switch for deenergizing said clutch relay, said two cams being adjustable with respect to each other so as to get a plurality of zones throughout a full circumference, said zone adjustments controlling the pitch winding of the springs on the mandrel, and a bridge or safeguarding cam with its switch for holding the clutch relay circuit open while the back sides of the "on" and "off" cams operate their respective switches.

25. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that the speed of rotation of the lathe lead screw is controlled by an electro-magnetic clutch structure having two energizable portions between which an armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, said clutch portions being energized by a relay directly under control of cooperative cam and switch structures, the cam structures including two energizing windings, one mounted for rotation with the cams and one stationary, a reset relay for energizing and deenergizing these windings, a plurality of rotary cams with their respective stationary switches associated with said first-mentioned winding, one

of the cams with its switch acting to energize said clutch relay while another of said cams with its switch deenergizes said clutch relay, while another of said cams acts as a guardian over the first two cams mentioned, another adjustable cam with its switch acting to control said reset relay to cause it, at the end of the winding operation on the mandrel, to deenergize the first-mentioned cam winding and to energize the second-mentioned or cam lock winding to thereby stop and lock the cam assembly in proper position for starting the next winding operation.

26. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that the speed of rotation of the lathe lead screw is controlled by an electro-magnetic clutch structure having two energizable portions between which an armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, said clutch portions being energized by a relay directly under control of cooperative cam and switch structures, the cam structure including an "on" cam with its switch for energizing said relay and an "off" cam with its switch for deenergizing said clutch relay, said two cams being adjustable with respect to each other so as to get a plurality of zones throughout a full circumference, said zone adjustments controlling the pitch winding of the springs on the mandrel, a bridge or safeguarding cam with its switch for holding the clutch relay circuit in status quo while the back sides of the "on" and "off" cams operate their respective switches, a still further cam known as a reset cam and windings included in the cam structure, and a reset relay controlled at the end of the winding operation by said reset cam for causing said windings to govern the movement of said cams.

27. A mechanism for making plural-pitch helical springs as set forth in claim 1, further defined in that the speed of rotation of the lathe lead screw is controlled by an electro-magnetic clutch structure having two energizable portions between which an armature operatively connected to the lead screw is positioned for attraction to either portion, said two portions being operated at different speeds through suitable gearing associated with the lathe, said clutch portions being energized by a relay directly under control of cooperative cam and switch structures, the cam structures including two energizing windings, one mounted for rotating the cams and one stationary, a reset relay for energizing and deenergizing these windings, a plurality of rotary cams with their respective stationary switches associated with said first-mentioned winding, one of the cams with its switch acting to energize said clutch relay while another of said cams with its switch deenergizes said clutch relay, while another of said cams acts as a guardian over the first two cams mentioned, another adjustable cam with its switch acting to control said reset relay to cause it, at the end of the winding operation on the mandrel, to deenergize the first-mentioned cam winding and to energize the second-mentioned or cam lock winding to thereby stop and lock the cam assembly in proper position for starting the next winding operation, and a cam release switch for deenergizing both of said cam windings, manual means for turning the cam structure when said cam release switch is open, and means for preventing the cam structure from being turned in the wrong direction.

28. A mechanism for making plural-pitch helical springs in successive units comprising, the basic parts of an engine lathe such as a bed plate carrying slide means, lead screw, spindle and speed-change pulleys for the spindle; a chuck carried by the spindle, a mandrel adapted to be carried by the chuck, a carriage movable on the slide means, means for operatively connecting the carriage to the lead screw, means for feeding spring wire to the mandrel to wind successive spring units, means for automatically establishing different speeds of rotation of the lead screw whereby the carriage speed is varied with respect to the speed of rotation of the mandrel to wind turns of closed or open pitch or both in each successive unit, and means for automatically stopping all of said means when the desired number of units have been wound on the mandrel.

29. A mechanism for making plural-pitch helical springs in successive units as set forth in claim 28, further defined in that the means for operating the lead screw automatically at different speeds includes primarily, a preset switch control cam structure and, secondarily, a magnetic clutch structure having an armature connected to the lead screw and electro-magnets operated at different speeds by different sets of gears driven by the lathe for attracting and holding said armature for a predetermined time, and further means for exciting said electro-magnets according to the pitch of the turns desired in said spring units.

30. A mechanism for making plural-pitch helical springs in successive units as set forth in claim 28, further defined in that the means for operating the lead screw automatically at different speeds includes a magnetic clutch structure having an armature connected to the lead screw and electro-magnets operated at different speeds by different sets of gears driven by the lathe for attracting and holding said armature for a predetermined time, said gears being carried by a gear case with certain of said gears being adjustably mounted for easy changeability to suit the speed requirements of the lead screw, and further means for exciting said electro-magnets according to the pitch of the turns desired in said spring units.

31. A mechanism for making plural-pitch helical springs in successive units as set forth in claim 28, further defined in that the means for operating the lead screw automatically at different speeds includes a magnetic clutch structure having an armature connected to the lead screw and electro-magnets operated at different speeds by different sets of gears driven by the lathe for attracting and holding said armature for a predetermined time, this time being governed by a plurality of cams with associated switches, and relay means for passing energizing current to said electro-magnets according to pitch of turns required in each spring unit, as defined by said cams.

32. A mechanism for making plural-pitch helical springs in successive units as set forth in claim 28, further defined in that the means for operating the lead screw automatically at different speeds includes a magnetic clutch structure having an armature connected to the lead screw and electro-magnets operated at different speeds by different sets of gears driven by the lathe for attracting and holding said armature for a predetermined time, this time being governed by a plurality of cams with associated switches, and relay means for passing energizing current to

said electro-magnets according to pitch of turns required in each spring unit, as defined by said cams, means operated by said slide means for limiting the action of said winding clutch structure, the cams and associated structures and relays when the mandrel has been substantially fully wound, one of said cams with an associated electro-magnet acting at the end of said mandrel winding operation to lock the cams against further rotation until the start of winding of another mandrel.

33. A mechanism for making plural-pitch helical springs in successive units as set forth in claim 28, further defined in that the means for operating the lead screw automatically at different speeds includes a magnetic clutch structure having an armature connected to the lead screw and electro-magnets operated at different speeds by different sets of gears driven by the lathe for attracting and holding said armature for a predetermined time, this time being governed by a cam structure consisting of four cams carried on a slidable sleeve with a cam-winding electro-magnet rotatably mounted on a shaft operated by the lathe, this electro-magnet being positioned closely adjacent one end of the said sleeve whereby it will attract the sleeve for rotation with itself, means for exciting this cam electro-magnet when the spring winding operation is to be started, means for deenergizing said electro-magnet when said mandrel is wound with spring units, a cam-lock electro-magnet at the end of the sleeve opposite to the rotating electro-magnet, and means for energizing this electro-magnet directly after the cam-winding magnet is deenergized, said cams with associated switches and relays acting to control the winding of the springs.

34. Mechanism for automatically winding wire springs of plural pitch comprising a machine having a driven shaft carrying an electro-magnetic chuck for receiving a mandrel on which the wire is wound with means for energizing and deenergizing the chuck winding, the machine having a lead screw, a carriage movably mounted on the machine and provided with guide means for guiding the wire onto the mandrel, means for operatively connecting and disconnecting the carriage from the lead screw, and means for automatically driving the lead screw at different speeds of rotation with respect to the speed of the mandrel to vary the pitch of the turns of the spring, and means, actuated by said means for operatively connecting and disconnecting the carriage from the lead screw, for starting into operation all of said automatic means.

35. A mechanism for winding wire springs of plural pitch as set forth in claim 34, further defined in that said means for automatically varying the speed of rotation of the lead screw includes electro-magnets driven at different speeds by suitable means comprising part of the mechanism, a member fastened to the lead screw and positioned so as to be attracted and held for predetermined periods of different length by said electro-magnets thereby winding springs having a desired plural pitch.

36. A mechanism for winding wire springs of plural pitch as set forth in claim 34, further defined in that said means for automatically varying the speed of rotation of the lead screw includes electro-magnets driven at different speeds by suitable means comprising part of the mechanism, a member fastened to the lead screw and positioned so as to be attracted and held for predetermined periods of different length by said electro-magnets thereby winding springs having a desired plural pitch, and a cam structure with associated switches and relays for governing the action of said electro-magnets.

37. Mechanism for automatically winding beryllium copper wire springs of substantially uniform diameter and any two desired pitches comprising a machine having a shaft carrying a chuck to receive a mandrel on which the wire is wound, a lead screw for the machine, a carriage movable on the machine and engageable with the lead screw and adapted to feed the wire onto the mandrel, means actuated when the carriage is engaged with the lead screw for starting the automatic winding operations and a magnetizable member fastened to the lead screw, a pair of electro-magnets rotated by the machine at different speeds, one with respect to the other, and each located so as to attract and hold said member for a predetermined time, and means for automatically selecting the length of time and hence the pitches of the spring turns.

38. Mechanism for automatically winding beryllium copper wire springs of substantially uniform diameter and any two desired pitches comprising a machine having a shaft carrying a chuck to receive a mandrel on which the wire is wound, a lead screw for the machine, a carriage movable on the machine and engageable with the lead screw and adapted to feed the wire onto the mandrel, a magnetizable member fastened to the lead screw, a pair of electro-magnets rotated by the machine at different speeds, one with respect to the other, and each located so as to attract and hold said member for a predetermined time, a cam structure electrically controlled from the carriage for starting it into operation, the cam structure having cams for determining the predetermined time or the pitches of the spring winding.

39. The process of making completely finished beryllium copper springs using an engine lathe having the usual bed plate carrying slide means and a carriage for movement on the slide means, a lead screw, spindle, speed change means for the lead screw, carriage and spindle, and a chuck carried by the spindle, which includes the following steps; placing a mandrel in the chuck for rotation therewith, connecting a wire guide to the carriage, mounting a reel of beryllium copper wire in cooperative relation to said guide, passing one end of the wire through the guide and fastening it to the mandrel, operatively attaching the carriage to the lead screw and starting rotation of the spindle, chuck and mandrel, presetting, prior to attaching the carriage to the lead screw, means for automatically changing at any desired revolution the speed of rotation of the lead screw and carriage with respect to the speed of rotation of the spindle and mandrel to vary the pitch of turn of the spring being wound on the mandrel, binding the finished end of the winding to the mandrel, then taking the mandrel with the springs wound thereon in a continuous length and heat-treating the springs on the mandrel, and then withdrawing the springs from the mandrel and cutting them into individual springs.

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