Sept. 1, 1959 A. H. COSTELLO ET AL 2,902,079

SPRING COILING MACHINE WITH MEANS FOR SEPARATING FEED ROLLS DURING CUTTING CYCLE

Filed Feb. 20, 1957 3 Sheets-Sheet 1

FIG. 1

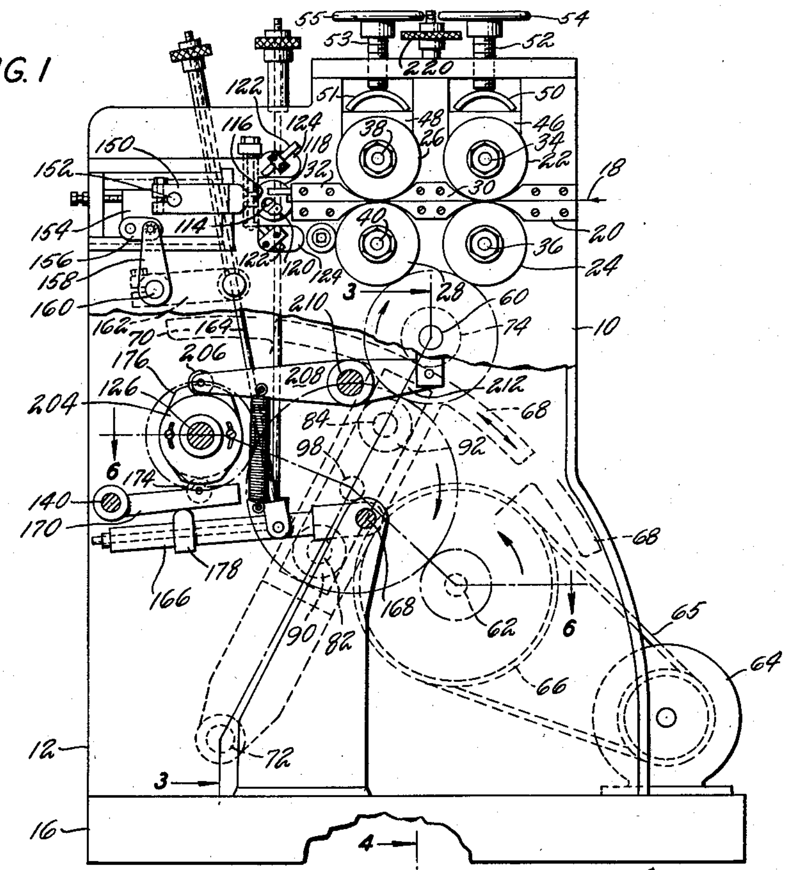

FIG. 2

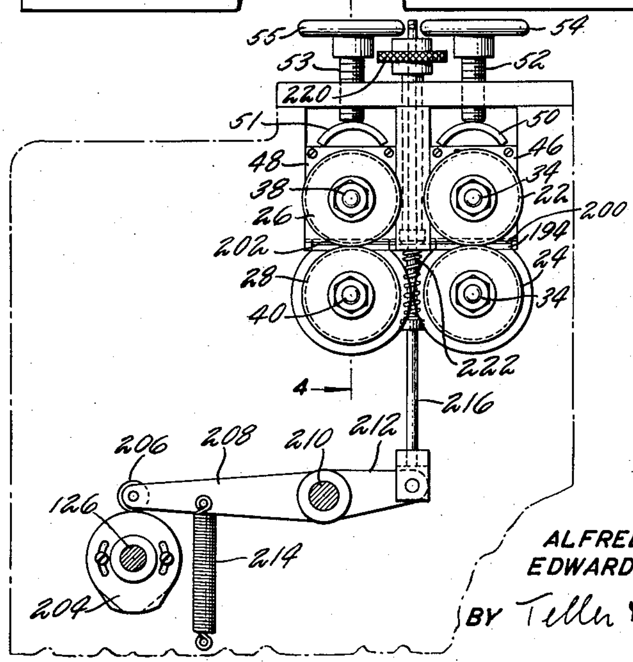

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FIG. 3

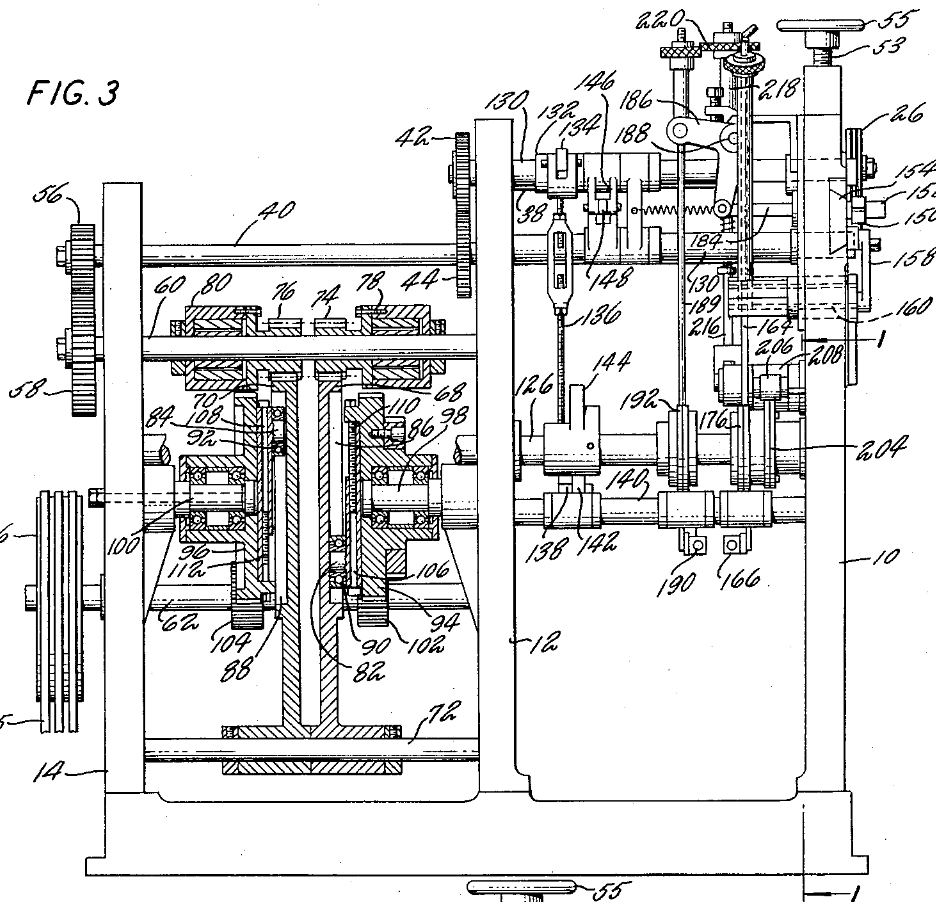

FIG. 4

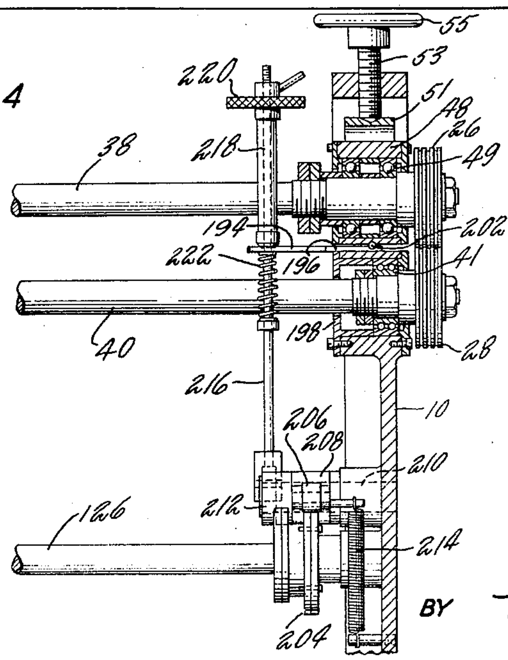

FIG. 5

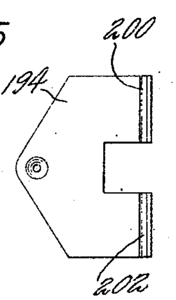

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FIG. 6

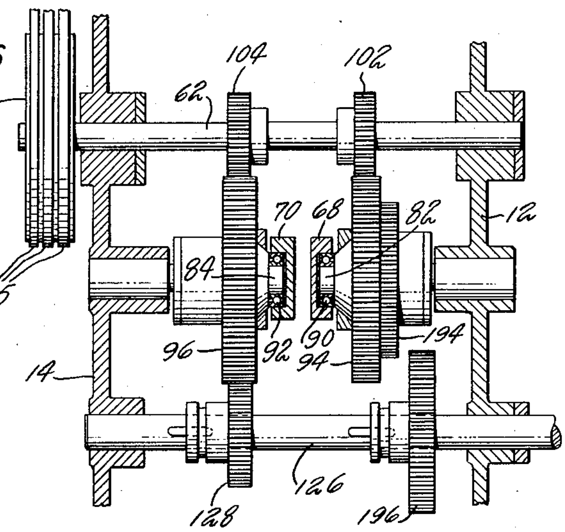


FIG. 7

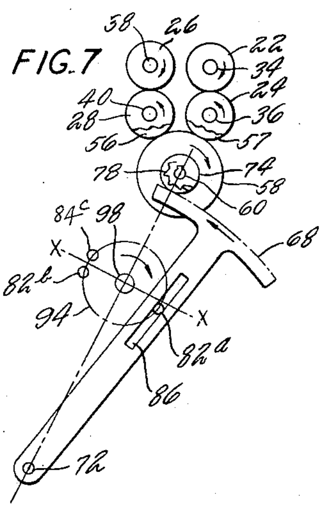


FIG. 8

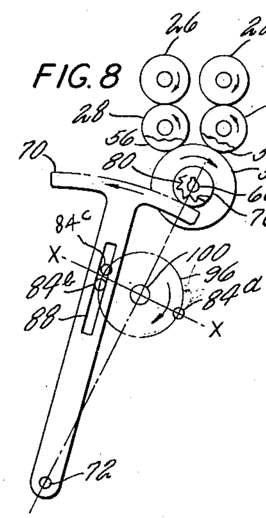


FIG. 9

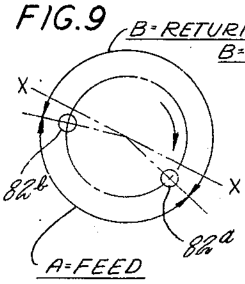


FIG. 10

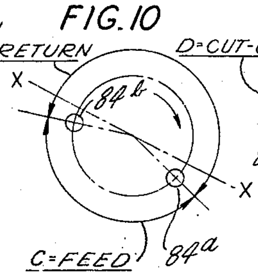


FIG. 11

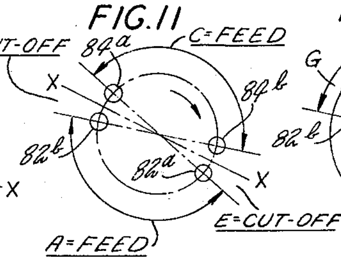
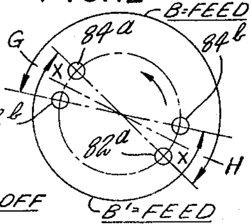


FIG. 12



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United States Patent Office

2,902,079

Patented Sept. 1, 1959

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SPRING COILING MACHINE WITH MEANS FOR SEPARATING FEED ROLLS DURING CUTTING CYCLE

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Application February 20, 1957, Serial No. 641,282

6 Claims. (Cl. 153—65)

This invention relates to a cyclically operable spring making machine wherein the springs are formed by the coiling of a longitudinally moving wire as the result of engagement thereof with a relatively fixed coiling point, and the invention relates more particularly to a machine of the type wherein the longitudinal movement of the wire is effected by a feed mechanism including wire engaging means and including a reciprocable or oscillable means having one reciprocation or oscillation during each machine cycle. A machine of the said type is shown in the Bergevin and Nigro Patent No. 2,119,002 for Spring Coiling Machine, dated May 31, 1938.

The Bergevin patent Re. No. 24,345, dated August 20, 1957, discloses a machine of the last said type wherein the wire engaging feed rolls of the feed mechanism are operable during movement of said cyclically reciprocable means in both directions, the feed rolls therefore being operable during a much larger portion of each cycle of the machine than is the case when the wire is only fed during the movement of the reciprocable means in one direction. Cut-off mechanism is provided which operates during the intervals between the successive movements of the feed rolls.

When a machine of the type disclosed in said Bergevin patent is operated very rapidly, difficulties may be encountered as the result of the inertia of the feed rolls and of the parts connected therewith. At high speeds, said feed rolls and connected parts overtravel or coast with the result that wire movement is not completely stopped and that the wire is still moving during the operation of the cut-off device. This continued wire movement causes the wire to buckle and it interferes with the cut-off action and the results are generally unsatisfactory.

The general object of the present invention is to provide a machine of the Bergevin type wherein special provision is made for the stopping of the wire after each coiling action, the wire being stopped notwithstanding high speed operation of the machine. More specifically, the feed rolls are momentarily separated from each other after each coiling action so that they cannot feed the wire during the interval of separation, even though the feed rolls as the result of inertia may continue to turn.

The drawings show a preferred embodiment of the invention and such embodiment will be described, but it will be understood that various changes may be made from the construction disclosed, and that the drawings and description are not to be construed as defining or limiting the scope of the invention, the claims forming a part of this specification being relied upon for that purpose.

Of the drawings:

Fig. 1 is a combined front elevational and sectional view of a spring coiling machine embodying the invention, the sectional portion of the view being taken along the line 1—1 of Fig. 3.

Fig. 2 is an enlarged fragmentary view similar to the upper right portion of Fig. 1.

Fig. 3 is a left side view of the machine with cover plates omitted, a portion of the machine at the left between the intermediate and rear frame members being in section along the line 3—3 of Fig. 1.

Fig. 4 is a fragmentary vertical sectional view taken along the line 4—4 of Fig. 2.

Fig. 5 is a plan view of one of the parts shown in Fig. 4.

Fig. 6 is a fragmentary sectional view of the machine taken along the line 6—6 of Fig. 1.

Fig. 7 is a schematic view showing the action of one of the gear segments that drive the feed rolls.

Fig. 8 is a view similar to Fig. 7 but showing the action of the other of the gear segments.

Fig. 9 is a diagram showing the timing incident to one gear segment.

Fig. 10 is a diagram similar to Fig. 9 but showing the timing incident to the other gear segment.

Fig. 11 is a diagram similar to Fig. 9 but showing the combined timing incident to both gear segments.

Fig. 12 is a diagram similar to Fig. 11 but showing the timing incident to an alternative manner of machine operation.

Figs. 1 to 8 of the drawings show a machine generally similar to those shown in the said Patents 2,119,002 and Re. 24,345 but having different and additional mechanism to which the present invention more particularly relates. Reference is made to the said patents for any details of construction or manner of operation not herein fully disclosed.

The machine comprises spaced upright frame members **10**, **12** and **14** mounted on a suitable base **16**, with the various wire feeding and coiling devices mounted on the front frame member **10** and with the several mechanisms for operating said devices mounted between the members **10** and **12** or between the members **12** and **14**. The machine may have cover plates on the sides thereof secured to said frame members, but such plates are omitted from the drawings for clarity of illustration.

The line of wire feed is indicated at **18** in Fig. 1, the wire being fed through a preliminary guide **20** and between pairs of cooperating rotatable feed rolls **22**, **24** and **26**, **28**. The feed rolls when rotated serve to project the wire toward the left so as to be engaged by wire coiling tools or devices as hereinafter described in detail. Wire guides **30** are provided between the feed rolls **22**, **24** and the feed rolls **26**, **28** and additional wire guides **32** are provided between the feed rolls **26**, **28** and the coiling devices.

The feed rolls **22**, **24** are carried by shafts **34**, **36** and the feed rolls **26**, **28** are carried by shafts **38**, **40**, all of the said shafts being mounted in bearings in the frame members **10** and **12**. The front bearings for the lower shafts **36** and **40** are in fixed relation to the frame and one of these bearings is shown at **41** in Fig. 4. Preferably the bearing **41** is an antifriction bearing, such as a ball bearing. The shafts **38**, **40** are connected by meshing gears **42**, **44** and the shafts **34**, **36** are connected by similar meshing gears which are not shown. The shafts **34** and **38** for the upper feed rolls **22** and **26** are capable of slight vertical movement, being mounted in vertically movable bearing blocks **46** and **48**. The front bearings for the upper shafts **34** and **38** are carried by said vertically movable blocks **46** and **48**, and one of these bearings is shown at **49** in Fig. 4. The bearings **49** are preferably similar to the bearings **41**. Bowed springs **50** and **51** are provided each of which rests at its ends upon the corresponding bearing block **46** or **48**. Said bowed springs **50** and **51** are respectively engaged by screws **52** and **53** having handwheels **54** and **55**. By turning the handwheels **54** and **55**, the springs **50** and **51** may be relatively flattened to apply downward pressure to the bearing blocks **46** and **48** and to thus apply downward pressure to the feed rolls 22 and 26 so that they grip the wire.

The lower feed roll shafts 36 and 40 are extended toward the rear of the machine and have additional bearings in the rear frame member 14. The shaft 40 is provided with a gear 56 and the shaft 36 has a similar gear 57 which is shown only in Figs. 7 and 8. Both of the last said gears mesh with a gear 58 on a feed shaft 60 mounted in suitable bearings in the frame members 12 and 14. The feed shaft 60 is rotated by the mechanism and in the manner to be described and, when rotated, it rotates to the shafts 36 and 40 which in turn rotate the several feed rolls for feeding the wire toward the left as previously stated.

A main drive shaft 62 is provided, this being mounted in suitable bearings in the frame members 12 and 14. The drive shaft 62 is continually driven, as for instance by a motor 64, the motor being connected with the shaft by belts 65 engaging a belt pulley 66 secured to said shaft.

For rotating the feed shaft 60 in the feeding direction thereof, there is provided a reciprocable means having gear teeth spaced in the direction of reciprocation and there is also provided means operable by the drive shaft 62 for causing one complete reciprocation of the reciprocable means during each cycle of the machine. The reciprocable means may be widely varied as will be hereinafter fully apparent but, as shown in Figs. 1 to 8, the feed means comprises two separate oppositely reciprocable members 68 and 70 which are preferably gear segments separately movable about a common horizontal pivotal axis. The said members or gear segments are hereinafter referred to as the first and second members or gear segments. As shown, said gear segments are mounted for pivotal movement on a horizontal pivot rod 72 extending between the frame members 12 and 14.

Two gears 74 and 76 are provided which mesh with the teeth of the reciprocable gear segments and each of which is rotatable thereby in one direction during the first portion of each cycle and is rotatable thereby in an opposite direction during the second portion of each cycle. As shown, the gears 74 and 76 are mounted directly on the feed shaft 60, but such mounting is not essential. When there are two separate gear segments such as 68 and 70 as shown, said gears 74 and 76 mesh respectively with the teeth of said segments, the gears being hereinafter referred to as the first and second gears.

Unidirectional clutches 78 and 80 are operatively interposed respectively between the gears 74 and 76 and the feed shaft 60. When said gears are mounted directly on the feed shaft as shown, the clutches are also mounted directly on the feed shaft, but when the gears are otherwise mounted the clutches may be also otherwise mounted. The unidirectional clutches may be of any usual or preferred type and each of them has its driving element connected with the corresponding gear 74 or 76 and has its driven element connected with the feed shaft 60. The clutches are so constructed that each of them serves to drive the feed shaft only in the feeding direction, and in the machine as shown the feeding direction is the clockwise direction.

For oscillating the gear segments 68 and 70 there are provided two oppositely disposed crankpins 82 and 84 which are rotatable about a common horizontal axis parallel with the axis of oscillation, the crankpins being entered in radial slots 86 and 88 formed respectively in the gear segments 68 and 70. Ball bearings 90 and 92 respectively surround the crankpins 82 and 84, the outer races of the ball bearings engaging the side walls of the radial slots 86 and 88 in the segments 68 and 70. A crankpin and its bearing are herein sometimes referred to collectively as a "crankpin."

The crankpins 82 and 84 are carried respectively by gears 94 and 96 which are rotatably mounted on studs

98 and 100 projecting respectively from the frame members 12 and 14. The gears 94 and 96 mesh respectively with gears 102 and 104 secured to the drive shaft 62 and the gears 94 and 96 are therefore rotated in the same direction and at the same speed. The crankpins 82 and 84 are mounted indirectly on the gears 94 and 96 by means of blocks 106 and 108 adjustable by means of screws 110 and 112 for changing the distances of the crankpins 82 and 84 from the axis of rotation.

By means of the screws 110 and 112 the pins 82 and 84 may be adjusted to change the amplitude of oscillation of the gear segments 68 and 70. Ordinarily the two segments will have the same amplitude of oscillation, but they may have different amplitudes. For some purposes, one of the pins may be moved to dead center so that the corresponding segment will have zero amplitude, that is, it will be stationary.

The gears 94 and 96 are continually rotated and as they rotate the gear segments 68 and 70 are caused to make one complete reciprocation during each complete rotation of the gears, that is, during each cycle of the machine. Inasmuch as the crankpins 82 and 84 are oppositely disposed, the gear segments 68 and 70 reciprocate oppositely with each gear segment moving in a direction opposite to that of the other.

Referring more particularly to Figs. 7 and 8, each cycle of the machine may be regarded as starting with the movement of the gear segment 68 toward the left, the gear segment 70 moving toward the right during the first portion of the cycle. During said first portion of the cycle the gear 74 is moved in the clockwise direction and the clutch 78 operates to drive the feed shaft in the clockwise direction, that is, in the feeding direction. During said first portion of the cycle the gear 76 is rotated in the counterclockwise direction, the clutch 80 being ineffective to drive the feed shaft. During the second portion of the cycle the gear segment 68 is moved toward the right and the gear 74 is moved in the counterclockwise direction, the clutch 78 being ineffective to drive the feed shaft. During said second portion of the cycle the gear segment 70 moves toward the left and the gear 76 is moved in the clockwise direction and the clutch 80 operates to drive the said shaft in the clockwise direction, that is, in the feeding direction. From the foregoing it will be apparent that through the alternating action of the two gear segments and the corresponding gears and clutches, the feed shaft 60 is driven in the feeding direction during both portions of each cycle.

The drive shaft 62 may be driven in either direction but when the segments, gears and clutches are constructed and arranged as shown, the drive shaft may be rotated in the counterclockwise direction, the gears 94 and 96 and the crankpins 82 and 84 resultantly rotating in the clockwise direction. Due to the relationship of the crankpins to the pivotal axis, each pin moves its gear segment faster in one direction than in the opposite direction, that is, each gear segment is moved in one direction in a little less than a half-cycle and is moved in the opposite direction in a little more than a half-cycle. Referring to Figs. 7 and 9, each cycle begins with the pin 82 at the extreme right position 82^a which is somewhat beyond or below a line x—x extending through the axes of the studs 98 and 100 and perpendicular to a plane through the last said axes and the axis of the pivot rod 72. The pin moves clockwise from the position 82^a to the opposite extreme left position 82^b and correspondingly moves the segment 68 toward the left as indicated by the arrow in a period that is a little less than a half-cycle as represented by A. The gear 74 is correspondingly rotated and the action of the clutch 78 is such that the feed rolls rotate in the feeding direction during said period. The pin 82 then moves clockwise from the left position 82^b to the right position 82^a and correspondingly moves the segment 68 toward the right in a period that is a little more than a half-cycle as represented by B. The gear 74 is correspondingly rotated but there is no feeding by the clutch **78** during the last said period.

Referring to Figs. 8 and 10, it will be seen that the pin **84** moves clockwise from the extreme left position **84**ᵇ to the extreme right position **84**ᵃ and correspondingly moves the segment **70** toward the right in a period that is a little more than a half-cycle, said period being of the same duration as the period B. The gear **76** is correspondingly rotated but there is no feeding by the clutch **80** during the last said period. Position **84**ᵃ of the pin **84** as shown in Fig. 8 is in alignment with position **82**ᵃ of the pin **82** as shown in Fig. 7, but the actual pins are 180° apart and are never in alignment. The described movement of the segment **70** toward the right from the Fig. 8 position is substantially simultaneous with the described movement of the segment **68** toward the left from the Fig. 7 position. The pin **84** then moves clockwise from the right position **84**ᵃ to the left position **84**ᵇ and correspondingly moves the segment **70** toward the left as indicated by the arrow in a period C that is a little less than a half-cycle, said period being of the same duration as the period A. The gear **76** is correspondingly rotated and the action of the clutch **80** is such that the feed rolls rotate in the feeding direction through the last said period. The two periods of rotation of the feed rolls resulting from the action of the segments **68** and **70** are within the same cycle but they are in opposite phase. It will be observed that, at the beginning of the cycle as shown in Fig. 7, the pin **84** is at the position **84**ᶜ which is diametrically opposite the position **82**ᵃ of the pin **82**. It is therefore evident that, at the beginning of the cycle, the pin **84** has moved beyond its extreme position **84**ᵇ at the left and has already started to move the segment **70** toward the right.

Fig. 11 shows the feeding period A for the segment **68** which is the same as shown in Fig. 9, and Fig. 11 also shows the feeding period for the segment **70** which is identified as C and which is of the same duration as the period A but in opposite phase. Inasmuch as each of the periods A and C is less than a half-cycle, there are intervals D and E between them as indicated in Fig. 11. During each feeding movement the feeding speed is increased from zero to a maximum and is then decreased from the maximum to zero. The feed rolls are not driven during the intervals D and E. The described construction and arrangement of the crankpins and the gear segments and the gears and the clutches constitute means for providing said intervals D and E.

The extent of wire feeding during the respective portions of each cycle can be changed within the capacity of the machine by adjusting the eccentricity of the pins **82** and **84**. Ordinarily the two pins are adjusted to have the same eccentricity but this is not always necessary.

As the wire is gripped between the feed rolls and is fed forward, that is, toward the left as viewed in Fig. 1, it passes over or under an arbor **114**, and against a coiling point **116**, which deflects the wire downward or upward, according to the adjustment of the coiling tools, and around the arbor to produce either a right or a left-hand spring. The arbor **114** is carried by a tool holder **118**, and a pitch tool **120** is also mounted on the holder **118**. The function of the pitch tool **120** is to deflect the coil after it has been formed, and to give to it the necessary pitch or space between adjacent convolutions, to which end the pitch tool is adjustable within the holder **118**. The diameter of the coil formed by the coiling point **116** is determined by the relative positions of said coiling point and the arbor **114**, and means is provided for adjusting the coiling point if necessary during the coiling operation. While a coil is being formed, the pitch tool **120** may press against the back side of the coil in such a manner as to deflect the wire continuously into a series of helices of the required pitch, and the adjustment of this tool **120**, as well as its movement during coiling, may also be provided for.

Following the feeding of a predetermined length of wire and following the completion of a series of coils to constitute a spring, cut-off mechanism including cutting tools **122** comes into operation to effect the severing of the wire at the arbor **114**. The cutting tools **122** are mounted on oscillatory heads **124** above and below the arbor **114**, and when right-hand springs are being coiled, the lower tool **122** is mounted in its head **124** so as to cooperate with the arbor **114** in cutting the wire. The upper tool **122** is then held to an inactive position, and is only brought into operation when forming left-hand coils.

As has been described, there may be two separate feeding movements of the wire during each cycle, and therefore two springs may be coiled during each cycle. When two separate springs are formed during each cycle, the cut-off mechanism is operated twice during each cycle. The means for operating the cut-off mechanism includes a horizontal cam shaft **126** which is mounted in bearings in the frame members **10**, **12** and **14**. Mounted on the shaft **126** is a gear **128** which meshes with the gear **96**. The pitch diameter of the gear **128** is one-half that of the gear **96** and therefore the gear **128** and the cam shaft **126** make two rotations during each rotation of the gear **96**, that is, two rotations during each cycle of the machine. The cam shaft **126** operates the cut-off mechanism and may also operate a mechanism for controlling the diameters of the springs during coiling and a mechanism for controlling the pitches of the springs during coiling. The three last said mechanisms are or may be the same as disclosed in the said Patent 2,119,002 and they need be only briefly described.

As best shown in Fig. 3, the heads **124** carrying the cutters **122** are mounted on shafts **130**, **130** rotatably supported in parallel relation between the frame members **10** and **12**. The upper shaft **130** carries a collar **132**, from which projects an arm **134** pivotally connected to a link **136** which extends downwardly and is indirectly connected at its lower end with an arm **138** mounted on a pivot shaft **140**. The arm **138** carries a roll **142** bearing on a cam **144** mounted on the cam shaft **126**, the cam **144** being so designed that an oscillatory movement is imparted to the upper cutter shaft **130** during each complete rotation of the cam shaft **126**. Turning movement of the upper cutter shaft **130** is imparted to the lower shaft **130** by means of arms **146** mounted on the shafts and connected by link **148**, so that the cutter heads **124** are adapted for synchronous turning movement, although in opposite directions with respect to the coiling arbor **114**. The cam **144** imparts two movements to the link **136** during each cycle, the appropriate cutter **122** being actuated twice during each cycle and serving in each instance to sever the wire and to separate a completed spring. The position of the cam **144** on the shaft **126** is such that the cutter **122** engages and severs the wire during each of the intervals D and E between successive periods A and C as indicated in Fig. 11.

The coiling point **116** consists of a bar having a groove at its end to receive the wire being coiled, and is carried by a holder **150** mounted on a pin **152** forming part of a slide **154** movable at right angles to the axis of coiling. Reciprocatory movement is imparted to the slide **154** by means of a link **156** connected at its ends to a pin on the slide and to a crank arm **158**. The arm **158** is turnable with a shaft **160** extending through the frame member **10** and provided at its inner end with an operating arm **162**. The arm **162** is connected by a link **164** to a lever **166** pivoted on a horizontal pivot rod **168**. The lever **166** cooperates with an arm **170** pivoted on said horizontal pivot shaft **140**. The arm **170** carries a roll **174** bearing on the face of a cam **176** mounted on the shaft **126**. In order to provide for adjustment of the form of a spring, the lever **166** carries an adjustable block 178, whereby the point of application of the force exerted by the cam roll arm 170 may be varied with respect to the pivot of the lever 166. The several elements of the mechanism for actuating the slide 154 are maintained in operative relation by means of a spring, not shown.

With the parts arranged as shown, each complete rotation of the cam 176 causes the coiling point slide 154 to move back and forth, with reference to the coiling axis, and thereby causes the coiling point 116 to control the diameter of the spring being coiled. By varying the form of the cam 176, it is possible to produce springs of varying contour, such as cone springs, barrel springs or two-diameter springs. The cam 176 imparts two movements to the diameter control mechanism during each cycle, and it therefore serves to control the diameters of two springs during each cycle. The cam 176 acts during the feeding intervals A and C as indicated in Fig. 11.

The pitch tool 120 has a shank, not shown, extending rearwardly through an opening in the tool holder 118 and pivotally connected to a link 184 which is shown in Fig. 3. The other end of the link 184 is connected to one arm of a bell crank lever 186, pivotally mounted at 188. The other arm of the lever 186 is connected by an adjustable link 189 to a lever 190 similar to the lever 166 and mounted on the same pivot rod 168. A cam 192 on the cam shaft 126 serves to operate the link 189 by mechanism similar to that shown and described for the link 164. The pitch tool may be moved by the mechanism referred to during the coiling of a spring so as to vary the pitch of the spring as required. With the parts arranged as shown, the pitch may be varied as the spring is coiled. The cam 192 imparts two movements to the pitch control mechanism during each cycle, and it therefore serves to control the pitches of two springs during each cycle. The cam 192 acts during the feeding intervals A and C as indicated in Fig. 11.

Either or both of the mechanisms for changing the diameter and for changing the pitch during coiling can be made inoperative when not needed.

After a spring has been coiled with the desired diameter and pitch, as determined by the functioning of the coiling point 116 and of the pitch tool 120, there is a very short interval D or E during which the feed rolls are not driven and one of the cutters 122 operates to sever the completed coil during the last said interval. The mechanisms for diameter control and pitch control and for cut-off operate twice during each cycle.

As stated, the feed rolls are not driven during the intervals D and E. However, with a machine constructed as disclosed in the Bergevin patent and as thus far described, the inertia of the feed rolls and of connected parts during high speed operation may cause said feed rolls to continue rotation during said intervals notwithstanding the cessation of driving force. The unidirectional clutches 78 and 80 freely permit such continued rotation of the feed rolls. As the result of continued rotation of the feed rolls, the wire continues in motion during said periods D and E and at the instants of cut-off, and such continued wire motion causes the wire to buckle and interferes with the cut-off action.

In accordance with the present invention, mechanism is provided for separating the feed rolls for short intervals in order to permit the wire to instantly stop notwithstanding the unavoidable continued rotation of the feed rolls. A suitable mechanism for this purpose is shown in Figs. 2, 3, 4 and 5.

The feed rolls are separated by moving the upper rolls 22 and 26 upwardly relatively to the lower rolls 24 and 28. The upper rolls are so moved by moving the slides 46 and 48 upwardly in opposition to the springs 50 and 51. For this purpose there is provided an approximately horizontal lever 194 which extends into a space below said vertically movable slides 46 and 48. As shown in Fig. 5, said lever is relatively wide so as to cooperate simultaneously with both slides. Said lever 194 has a fulcrum at 196 on a member 198 secured to the frame member 10. Secured to the lever 194 are aligned cylindrical lifting members 200 and 202 which engage respectively with the bottoms of the slides 46 and 48. It will be seen that when the lever 194 is moved counterclockwise about its fulcrum 196, the slides 46 and 48 are forced upwardly and serve to upwardly move the shafts 34 and 38 and the rolls 22 and 26. When the lever 194 is released, the slides and shafts and rolls are forced downwardly by the springs 50 and 51.

For moving the lever 194, there is provided a cam 204 on the cam shaft 126, preferably near the front thereof. Engaging said cam 204 is a roller 206 on a lever 208 pivoted on a transverse pin 210. Said lever 208 has a rearwardly offset portion 212. A spring 214 biases said lever 208 to hold said roller 206 in engagement with the cam. A substantially vertical link 216 is pivoted at its lower end to the offset portion 212 of the lever 208, and said link extends through an aperture in the rear portion of the lever 194. The upper portion of the link 216 is threaded and is engaged by a nut 218 operable by a knob 220. A spring 222 surrounding the link 216 holds the rear portion of the lever 194 against the bottom of the nut 218.

The cam 204 serves during each cam shaft rotation to move the lever 208 in the clockwise direction and to thus move the link 216 downwardly. Downward movement of the link serves to turn the lever 194 on its fulcrum 196 so that the lifting members 200, 202 lift the slides 46 and 48 together with the upper rolls 22 and 26 which are thus disengaged from the wire. As soon as the cam 204 releases the lever 208, the springs 50 and 51 return the said upper rolls to engagement with the wire. The timing of the lifting of the rolls can be adjusted by changing the position of the cam 204 on the cam shaft, and the length of time during which the rolls are lifted can be adjusted by changing the length of the effective portion of the cam 204. The extent of the lifting of the rolls can be adjusted by rotating the nut 218 by means of the knob 220.

The parts may be timed so that the rolls are separated substantially simultaneously with the end of power drive to the rolls and so that the rolls are re-engaged simultaneously with the resumption of power drive to the rolls. However, there may be considerable variation from the described timing, particularly as hereinafter described in connection with Fig. 12. The lifting of the upper feed rolls enables the movement of the wire to instantly stop, notwithstanding continued rotation of all of said feed rolls. The feed rolls are separated at least once in each cycle and approximately at the end of the feed roll rotating action of at least one of the first and second clutches 78 and 80. It is primarily essential only that the rolls be lifted and disengaged from the wire for a sufficient interval to enable the cut-off mechanism to act properly and without any buckling or other abnormal deformation of the wire.

The machine as shown in Figs. 1 to 6 may be variously adjusted for different manners of use, and one adjustment and manner of use have been described in detail for the making of two springs per cycle. In some instances it may be desirable to make one relatively long spring per cycle instead of two short ones. In a machine embodying the invention, it is possible to make much longer springs than would be possible with a conventional machine such as that shown in Patent 2,119,002. In order that the machine may make one long spring per cycle, gearing is provided for causing the cam shaft 126 to make one rotation per cycle instead of two rotations per cycle.

As shown, the gear 128 which provides two cam shaft rotations per cycle is longitudinally movable on the shaft 126 to an inoperative position toward the left from the position shown in Fig. 5. The gear may have an annularly grooved hub and a gear shift yoke, not shown, may be entered in the groove in the hub for moving the gear from and to its operative position. Rigidly connected with the gear **94** for rotation therewith is a gear **194**. A gear **196** is longitudinally movable on the shaft **126** and is adapted to mesh with the gear **194** when moved to an operative position toward the left from the position shown in Fig. 5. The two gears **194** and **196** have the same pitch diameters. The gear **196** may have an annularly grooved hub and a gear shift yoke, not shown, may be entered in the groove in the hub for moving the gear to and from its operative positions. With the gears **128** and **196** both shifted toward the left, the cam shaft **126** will have one rotation per cycle instead of two rotations per cycle.

The feeding of the wire is not in any way affected by the cam shaft rotation, and as indicated in Fig. 11 there are two feeding periods A and C with intervals D and E between them during which the feed rolls are not driven. However, the cut-off mechanism operates only once per cycle in one or the other intervals D and E. Assuming that cut-off takes place during the interval D, it will be seen that feeding takes place during the periods C and A, the amount of feeding being twice what it was for the first described adjustment of the machine, wherein the cut-off mechanism operates twice during each cycle. The cams **176** and **192** for controlling diameter and for controlling pitch operate exactly as previously described, but the cams must be so designed as to take into account the two separate feeding movements of the wire with an interval between the said feeding movements.

As thus far described, it has been assumed that the gears **94** and **96** are rotated in the clockwise direction as indicated in Figs. 7 and 8, this direction of rotation providing intervals D and E during which the feed rolls are not driven although they may continue to move by inertia. Inasmuch as the feed rolls are separated to definitely interrupt feeding, it is not necessary to actually interrupt the drive to the feed rolls, the separation of the feed rolls being solely relied upon to discontinue feeding. Therefore the gears **94** and **96** may advantageously be rotated in the counterclockwise direction instead of in the described clockwise direction.

The direction of rotation of the gears **94** and **96** and of the drive shaft **62** may be reversed by reversing the drive motor or otherwise. With the direction of rotation reversed, the pin **82** moves counterclockwise from the extreme right position 82^a to the opposite extreme left position 82^b and correspondingly moves the segment **68** and the gear **74** in a period that is a little more than a half-cycle as represented by B in Fig. 9, and the action of the clutch **78** is such that the feed rolls are driven in the feeding direction during said period. The pin **82** then moves counterclockwise from the left position 82^b to the right position 82^a and correspondingly moves the segment **68** and the gear **74** in a period that is a little less than a half-cycle. There is no feeding by the clutch **78** during the last said period. It will be observed that during the feeding movement of the pin **82** from position 82^a to position 82^b the gear **74** is rotated relatively slowly and during the return movement of the pin from the position 82^b to the position 82^a said gear is rotated relatively rapidly. With the direction of rotation reversed, the pin **84** moves counterclockwise from the extreme right position 84^a to the extreme left position 84^b and correspondingly moves the segment **70** and the gear **76** in a period that is a little more than a half-cycle as represented by B in Fig. 10, and the action of the clutch **80** is such that the feed rolls are driven in the feeding direction through the last said period. The pin **84** then moves counterclockwise from the left position 84^b to the right position 84^a and correspondingly moves the segment **70** and the gear **76** in a period that is a little less than a half-cycle. There is no feeding by the clutch **80** during the last said period. It will be observed that during the feeding movement of the pin **84** from position 84^a to position 84^b the gear **76** is rotated relatively slowly and during the return movement of the pin from the position 84^b to the position 84^a said gear is rotated relatively rapidly. The two feed roll rotation periods B, as shown in Figs. 9 and 10, result respectively from the action of the segments **68** and **70** and said periods are within the same cycle but are in opposite phase. Fig. 12 shows said periods in opposite phase, and they are respectively designated B and B'. Inasmuch as each of the periods B and B' is more than a half-cycle, there are overlapping intervals F and G as shown. It will be observed that the overlapping intervals F and G are at or near the reversals of motion of the gear segments **68** and **70**, the result being that the clutches tend to drive the feed rolls only quite slowly during said intervals.

With the last-described reversed direction of rotation, the mechanism for separating the feed rolls is timed to operate during one or both of said overlapping intervals F and G, the rolls being separated approximately at the beginning of the interval and re-engaged approximately at the end of the interval. With the feed rolls separated, feeding or movement of the wire is stopped, and the cut-off mechanism is automatically operable to engage and sever the wire during said short interval or intervals of feed roll separation.

There is considerable advantage in the last-described operation of the machine, as it utilizes the slower movements of the gears **74** and **76** rather than the faster movements thereof. The actual amount of wire feeding may be about the same, but power is continually applied to the feed rolls to drive them and the maximum speed is less.

With a machine embodying the present invention, springs of indefinite length can be readily made as fully explained in said Bergevin patent. In setting up the machine for such springs, both of the gears **128** and **196** are moved to their idle positions so that the diameter control mechanism and the pitch control mechanism and the cut-off mechanism will not operate. The coiling point **116** and the pitch tool **120** are manually set in fixed positions to provide the spring with the required diameter and pitch.

A machine embodying the invention can be adjusted to operate in the same manner as a standard machine as shown in the said Patent No. 2,119,002. To this end the gear **128** is moved to its inoperative position and the gear **196** is moved to its operative position so that the cam shaft **126** makes one revolution for each cycle. One or the other of the gear segments **68** and **70** is made inoperative by adjusting the corresponding pin **82** or **84** to its dead center position. The gears **94** and **96** are rotated in the counterclockwise direction, that is, in the direction opposite to that indicated in Figs. 7 and 8.

The invention claimed is:

1. In a cyclically operable spring coiling machine, a reciprocable means having gear teeth spaced in the direction of reciprocation, means for causing one complete reciprocation of the reciprocable means during each cycle of the machine, first and second gears meshing with the teeth of the reciprocable means and each rotatable thereby in one direction during the first portion of each cycle and rotatable thereby in the opposite direction during the second portion of each cycle, a feed shaft, opposed feed rolls operably connected with the feed shaft and normally in positions to engage a length of wire to effect wire feeding during rotation of the feed shaft, first and second unidirectional clutches operably connected respectively with the first and second gears which first clutch serves upon rotation of the first gear during the first portion of the cycle to rotate the feed shaft in the direction for feeding and which second clutch serves upon rotation of the second gear during the second portion of the cycle to rotate the feed shaft in said direction for feeding so that the two clutches act alternately and repetitively to rotate said feed rolls in said direction for feeding during the

first and second portions of all cycles, means engageable by the wire during feeding movement thereof to effect wire coiling so as to thereby form springs, mechanism automatically operable in each cycle and approximately at the end of the feed roll rotating action of at least one of said first and second clutches for momentarily separating said feed rolls for a short interval of time to definitely interrupt the feeding of said wire irrespective of possible continued feed roll rotation, and cut-off mechanism automatically operable to engage and sever the wire during said short intervals of feed roll separation.

2. A cyclically operable spring coiling machine as set forth in claim 1, wherein the mechanism for momentarily separating said feed rolls is constructed and arranged to provide two intervals of feed roll separation in each cycle which intervals are approximately at the ends of the feed roll rotating actions of said first and second clutches, and wherein said cut-off mechanism is constructed and arranged to engage and sever the wire twice in each cycle and during both of said short intervals of feed roll separation.

3. In a cyclically operable spring coiling machine, similar first and second oscillable gear segments, means for causing one complete oscillation of each gear segment during each cycle of the machine with each segment moving in directions opposite to those of the other, first and second gears meshing respectively with the first and second gear segments which first gear is rotated by its segment in a feeding direction during the first portion of each cycle and is oppositely rotated thereby during the second portion thereof and which second gear is rotated by its segment in the said feeding direction during the second portion of each cycle and is oppositely rotated thereby during the first portion thereof, a feed shaft, feed rolls operably connected with the feed shaft and engageable with a length of wire to effect wire feeding during rotation of the feed shaft, first and second unidirectional clutches operably connected respectively with the first and second gears and serving during rotation of the first and second gears in the said feeding directions thereof to rotate the feed shaft in the direction for feeding so that the two clutches act alternately and repetitively to effect a succession of wire feeding movements during the first and second portions of all cycles, means engageable by the wire during feeding movement thereof to effect wire coiling so as to thereby form springs, mechanism automatically operable in each cycle and approximately at the end of the feed roll rotating action of at least one of said first and second clutches for momentarily separating said feed rolls for a short interval of time to definitely interrupt the feeding of said wire irrespective of possible continued feed roll rotation, and cut-off mechanism automatically operable to engage and sever the wire during said short intervals of feed roll separation.

4. In a cyclically operable spring coiling machine, two separately reciprocable first and second members having teeth spaced in the direction of reciprocation, means for causing reciprocation of said members oppositely to each other during each cycle of the machine which means is constructed to move each member relatively rapidly in one direction during a relatively short period of less than half of a cycle and relatively slowly in the opposite direction during a relatively long period which is the remainder of the cycle, first and second gears meshing respectively with the teeth of said first and second members and rotatable respectively thereby in opposite directions and at different speeds during each cycle, a feed shaft, feed rolls operably connected with the feed shaft and engageable with a length of wire to effect wire feeding during rotation of the feed shaft, first and second unidirectional clutches operably connected respectively with the first and second gears which first clutch serves upon each relatively rapid and relatively short rotation of the first gear in one direction to rotate the feed shaft in the direction for feeding and which second clutch serves upon each relatively rapid and relatively short rotation of the second gear in the last said direction to rotate the feed shaft in said direction for feeding so that the two clutches act alternately and repetitively to effect rotation of said feed rolls twice during each cycle with short intervals of time between successive actions of said clutches, means engageable by the wire during each feeding movement thereof to effect wire coiling, mechanism automatically operable in each cycle and approximately at the end of the feed roll rotating action of at least one of said first and second clutches for momentarily separating said feed rolls for a short interval of time to definitely interrupt the feeding of said wire irrespective of possible continued feed roll rotation, and cut-off mechanism automatically operable to engage and sever the wire during said short intervals of feed roll separation.

5. In a cyclically operable spring coiling machine, two separately reciprocable first and second members having teeth spaced in the direction of reciprocation, means for causing reciprocation of said members oppositely to each other during each cycle of the machine which means is constructed to move each member relatively rapidly in one direction during a relatively short period of less than half of a cycle and relatively slowly in the opposite direction during a relatively long period which is the remainder of the cycle, first and second gears meshing respectively with the teeth of said first and second members and rotatable respectively thereby in opposite directions and at different speeds during each cycle, a feed shaft, feed rolls operably connected with the feed shaft and engageable with a length of wire to effect wire feeding during rotation of the feed shaft, first and second unidirectional clutches operably connected respectively with the first and second gears which first clutch serves upon each relatively slow and relatively long rotation of the first gear in one direction to rotate the feed shaft in the direction for feeding and which second clutch serves upon each relatively slow and relatively long rotation of the second gear in the last said direction to rotate the feed shaft in said direction for feeding so that the two clutches act alternately and repetitively to effect wire feeding movements which overlap so that the wire is fed without interruption, means engageable by the wire during feeding movement to effect wire coiling so as to thereby form a spring, mechanism automatically operable in each cycle and approximately at the end of the feed roll rotating action of at least one of said first and second clutches for momentarily separating said feed rolls for a short interval of time to definitely interrupt the feeding of said wire notwithstanding continued feed roll rotation, and cut-off mechanism automatically operable to engage and sever the wire during said short intervals of feed roll separation.

6. A cyclically operable spring coiling machine as set forth in claim 5, wherein the mechanism for momentarily separating said feed rolls is constructed and arranged to provide two intervals of feed roll separation in each cycle which intervals are approximately at the ends of the feed roll rotating actions of said first and second clutches, and wherein said cut-off mechanism is constructed and arranged to engage and sever the wire twice in each cycle and during both of said short intervals of feed roll separation.

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