

June 20, 1939.

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2,163,019

WIRE COILING MACHINE

Filed Feb. 15, 1938

5 Sheets-Sheet 1

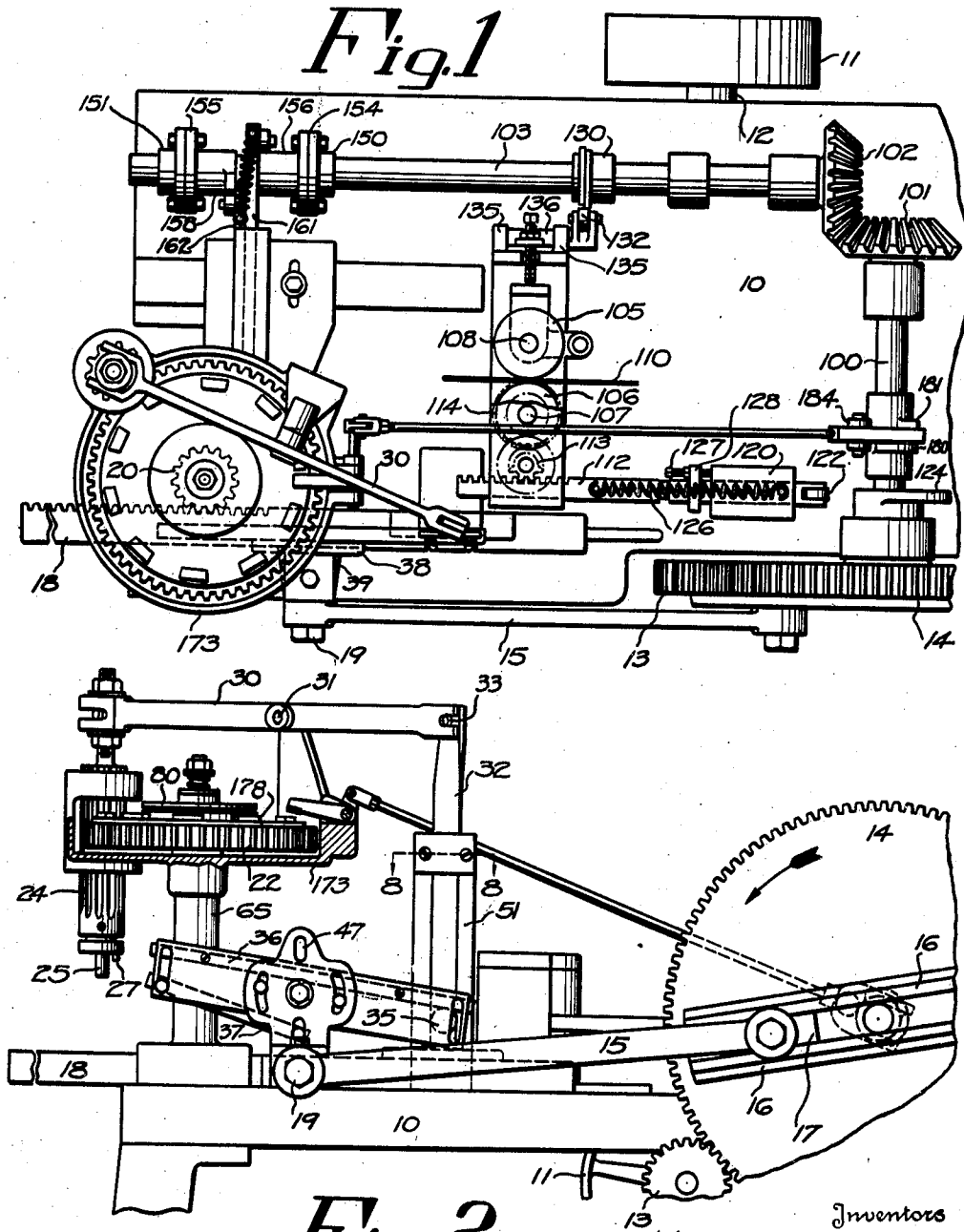


Fig. 2

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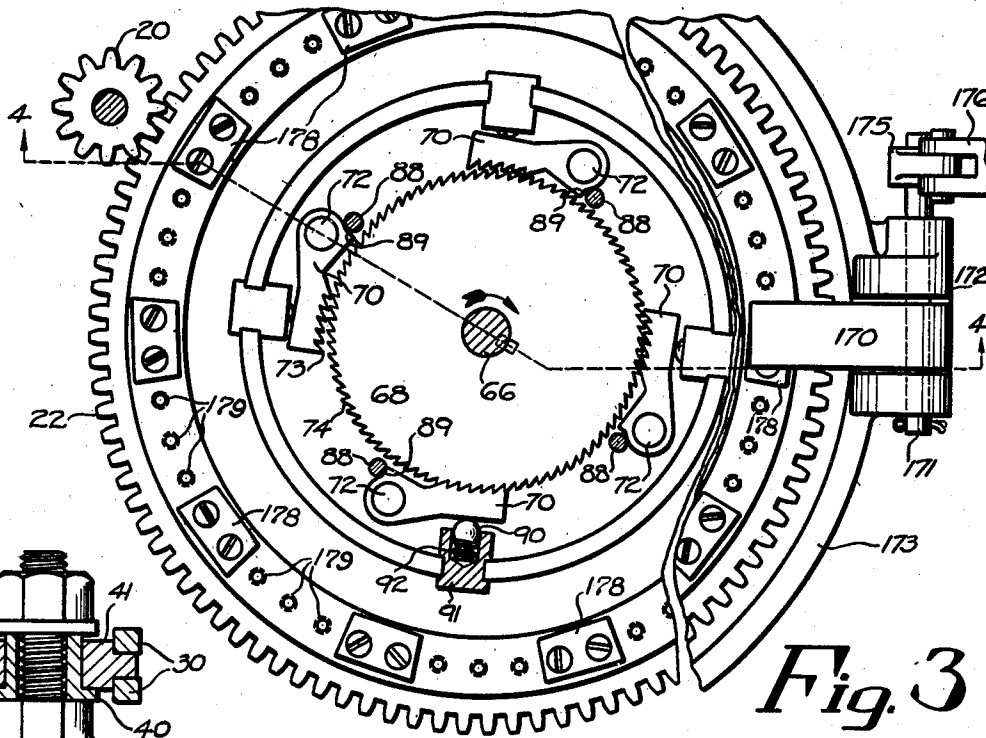


Fig. 3

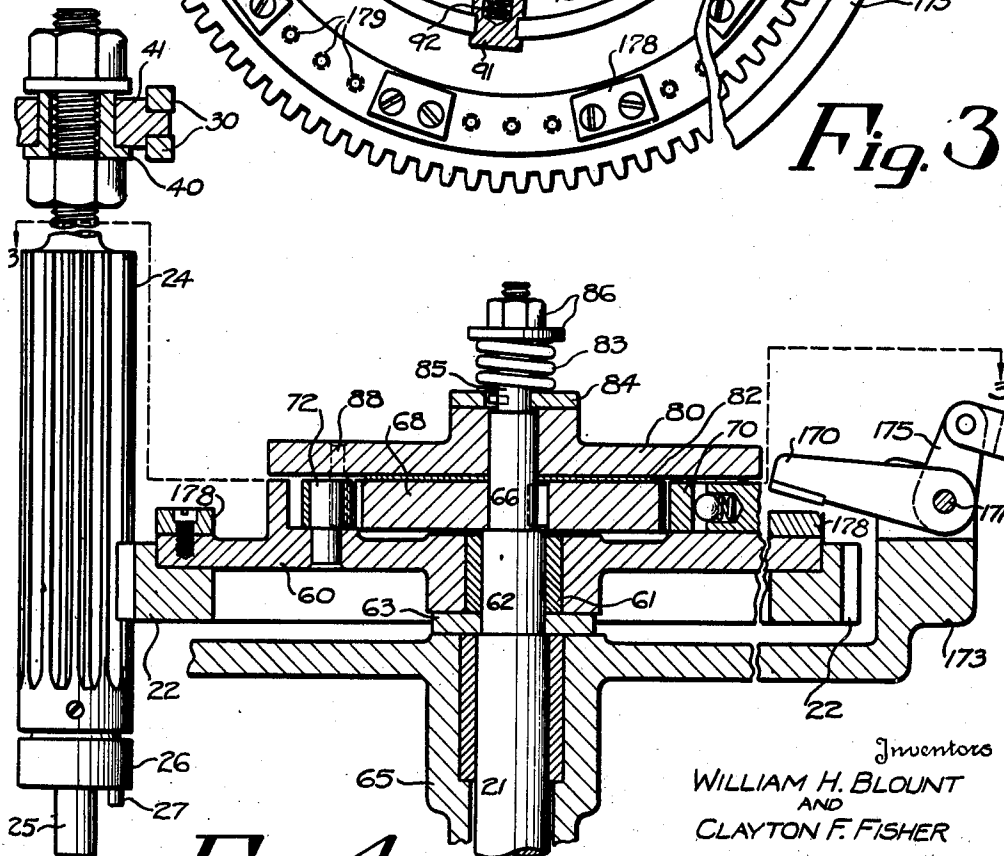


Fig. 4

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Fig. 5

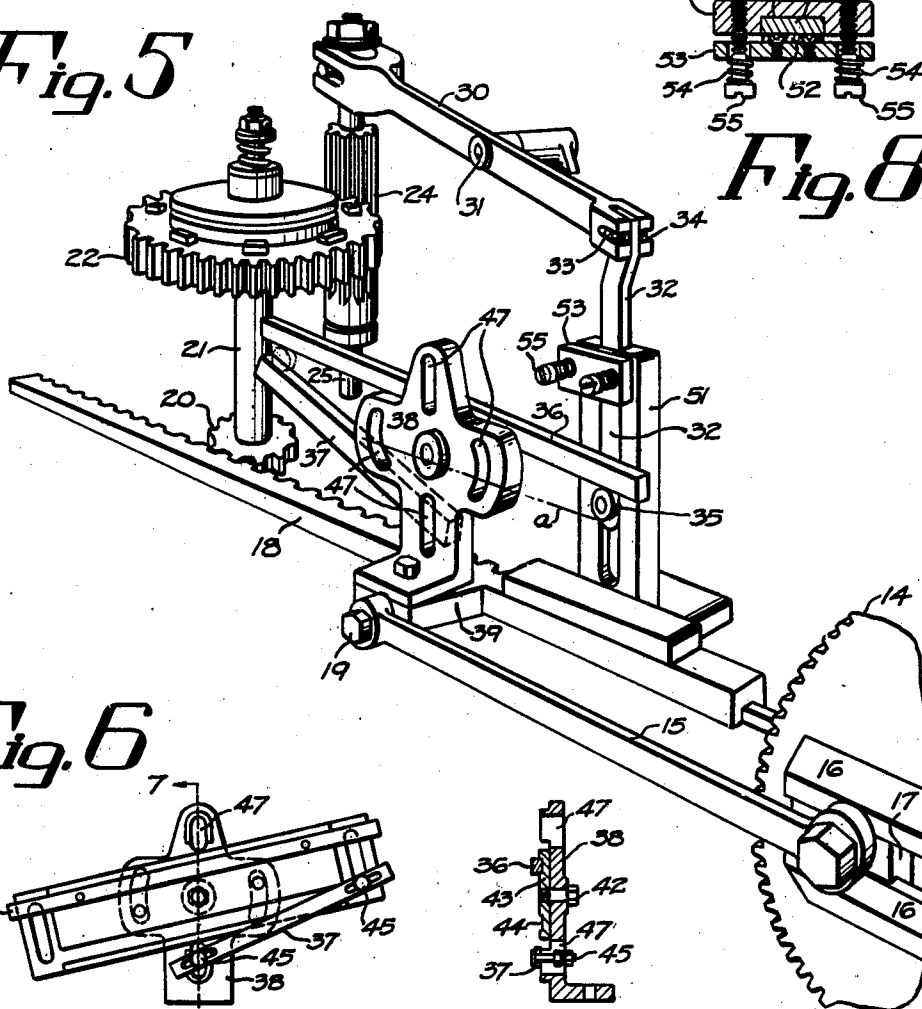


Fig. 6

Fig. 7

Fig. 8

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Fig. 9

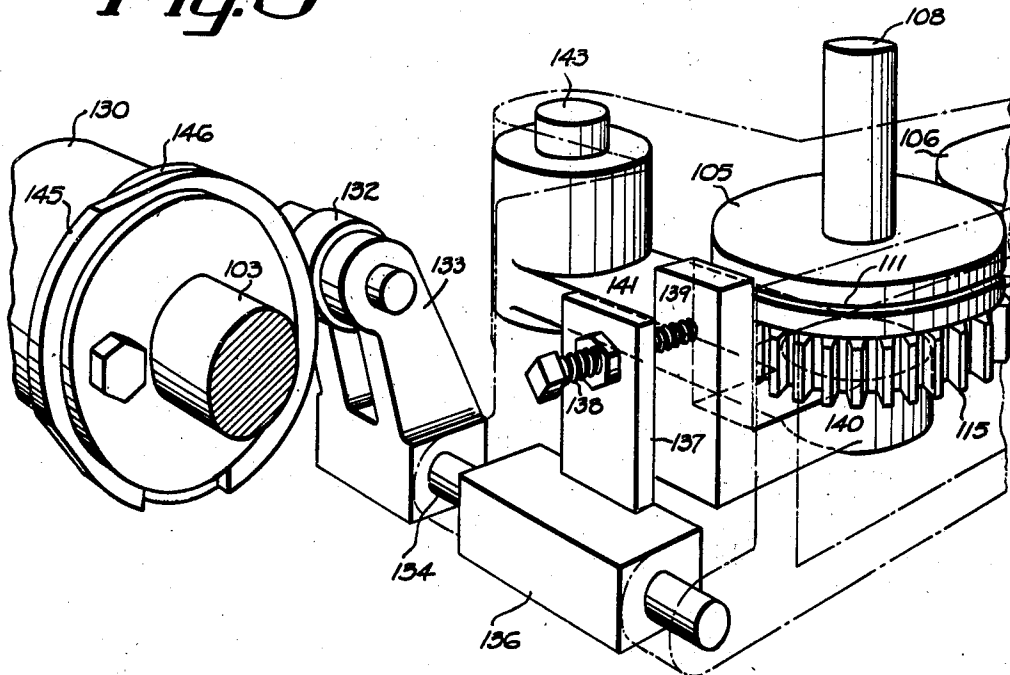


Fig. 12

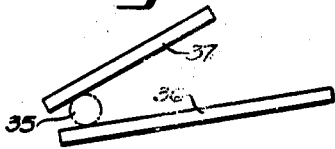


Fig. 13

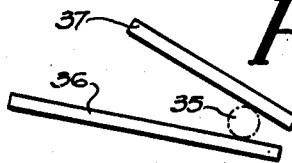
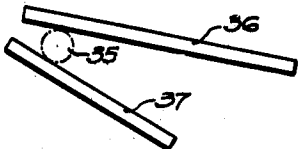


Fig. 14

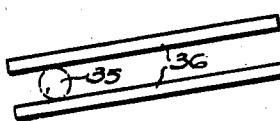


Fig. 15

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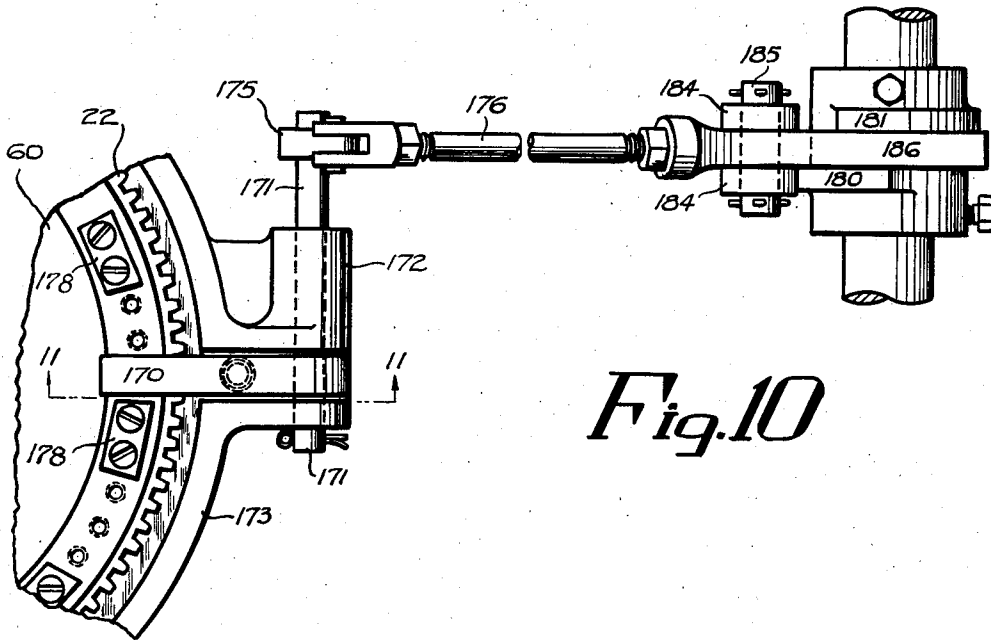


Fig. 10

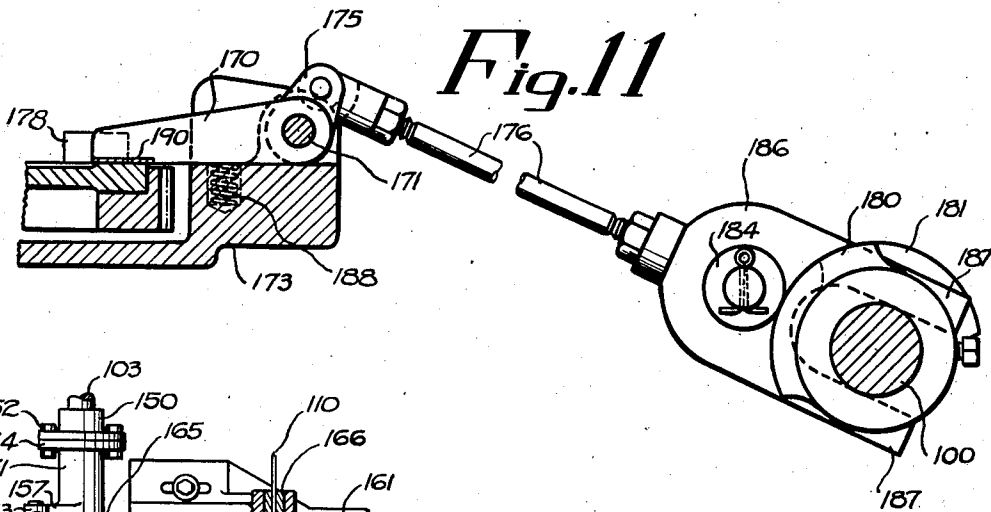


Fig. 11

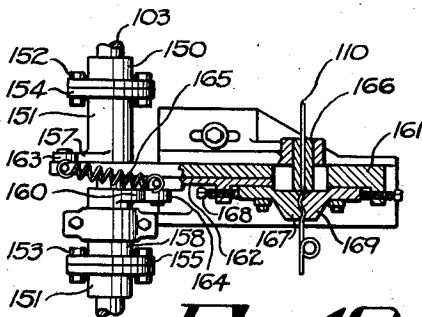


Fig. 16

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UNITED STATES PATENT OFFICE

2,163,019

WIRE COILING MACHINE

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Application February 15, 1938, Serial No. 190,612

24 Claims. (Cl. 153—67)

This invention relates to a wire coiling machine, and more particularly to a machine which is capable of coiling a wire into a helix of variable pitch, length and diameter.

In machines of the general type shown in the patents to Sleeper Nos. 1,045,900 and 1,368,297, a wire coiling operation is accomplished by means of an arbor which is rotated intermittently by means of an oscillating rack bar but is reciprocated continuously endwise by means of either a screw or a cam mechanism which controls the pitch of the coil. As shown in the patent to Thomas No. 1,935,137, the machine may also be equipped with a resilient clutch mechanism which causes the rotating arbor to stop momentarily in a predetermined angular position for receiving the free end of the wire after the pre-made coil has been severed therefrom; but this period of pause is necessarily very short because of the inherent nature of the mechanism and it cannot be varied to meet other requirements. It is, however, often desirable that the wire coiling arbor be held in a stationary position for a considerable or variable period of time at the end of the coiling step, so that an end of the wire may be bent or shaped by means of tools actuated automatically in timed relation with the coiling mechanism.

One object of this invention is to provide a machine of this type wherein the coiling arbor is held stationary, both axially and rotatively, for a considerable, and preferably a variable, period of time after the coil has been made, so that ample opportunity may be afforded for a desired wire fashioning operation.

A further object is to provide a wire coiling mechanism of this type which permits the production of coils of variable lengths and pitch, but causes the winding arbor to stop always in proper position for receiving the free end of the severed wire for making a new coil.

It, moreover, is desirable that the arbor move to its starting position and remain axially stationary at the time that the free end of the severed wire is fed thereto, since otherwise, if the free wire end is fed into coiling association with the arbor before the latter finishes its return movement, then the wire will have to spring laterally to a sufficient extent to permit that return, and this may cause trouble if the wire is not sufficiently resilient.

It is, therefore, a further object of the invention to provide a mechanism, and preferably one controlled by a cam, which causes the wire to be coiled with a desired or uniform pitch and then permits the arbor to remain axially and rotatably

stationary during a required period of time and then returns the arbor quickly in an axial direction to its starting position while it remains rotatably stationary, so that the free end of the severed wire may be thereafter fed into operative association therewith, after which the wire coiling operation proceeds anew.

A still further object of the invention is to provide a continuously operated driving mechanism arranged for rotating the arbor intermittently in one direction and then stopping it in a desired position, which comprises a stop mechanism so associated with an intermittently rotated driving head that the arbor may be selectively stopped in a predetermined position after any number of 360 degree rotations thereof, whereby a wire coil of variable length may be made and its end fashioned and the free end of the severed wire will be fed into a correct coiling position without material loss of time.

Owing to the different characteristics of the various types of wire to be coiled, it is desirable that the machine permit a coil to unwind or recoil through a variable angle and often through several turns of 360 degrees, so that the coil may be released from frictional engagement with the arbor and thus drop off when severed. A further object is to control the position of stoppage of the arbor and yet permit that desirable recoil through a variable angular distance, so that the arbor will be correctly positioned for receiving the free end of the severed wire although the arbor has turned backwards through a considerable distance.

A still further object is to provide a wire coiling machine having adjustable mechanisms which may be fully coordinated in their operations, whereby wire of various sizes may be shaped as coils of variable length and pitch and one or both of the free ends of the coil may be fashioned as desired, and which is simple in construction, economical in operation and may be adjusted or modified to meet a large number of industrial requirements. Further objects will be apparent in the following disclosure.

Referring now to the drawings which illustrate one embodiment of this invention:

Fig. 1 is a top plan view, with parts broken away, showing a wire coiling machine of the general type described in said prior patents;

Fig. 2 is a vertical elevation, with parts broken away, of the parts of the machine shown in Fig. 1;

Fig. 3 is a top plan view, partly broken away, of the driving head, with the friction and cover

plates removed, taken on the line 3—3 of Fig. 4;

Fig. 4 is a section on the line 4—4 of Fig. 3, looking in the direction of the arrows;

Fig. 5 is an isometric view, with parts broken away, which illustrates diagrammatically the operation of a portion of the mechanism required to rotate and reciprocate the wire coiling arbor;

Fig. 6 is a vertical elevation, looking from the rear of Fig. 2, of the cam bars and their support which serve to reciprocate the wire coiling arbor;

Fig. 7 is a section on the line 7—7 of Fig. 6;

Fig. 8 is a section on the line 8—8 of Fig. 2, showing the brake mechanism which resists vertical movement of the arbor;

Fig. 9 is a fragmentary isometric view of the cam controlled wire feeding rolls;

Fig. 10 is a fragmentary plan view of the cam operated stop mechanism which positions the arbor and holds it stationary after a wire coil has been made;

Fig. 11 is a vertical elevation, partly in section on the line 11—11 of Fig. 10;

Figs. 12, 13, 14 and 15 show diagrammatically various arrangements for the cam bars which control the vertical movement of the arbor; and

Fig. 16 is detail in plan view, partly broken away, which shows the cam operated wire cutting and fashioning slides.

A machine embodying all of the various features of our invention, and which may include any of the desired constructions found in the patents to Sleeper and Thomas above mentioned may be constructed as shown in the drawings.

This type of machine comprises in general a supporting base 10 on which is suitably mounted a driving pulley 11 and its shaft 12 or other suitable source of power. The shaft 12 carries a gear 13 on one end thereof and this gear meshes in driving engagement with a large gear or driver 14 which in turn serves to reciprocate a pitman rod 15 through a variable stroke. Variation of the length of stroke may be accomplished by means of any suitable mechanism. As illustrated, this may comprise two parallel flanged slideways 16 within which the block 17 may be suitably clamped in a desired position, and the pitman 15 is pivotally connected to the slidable block 17. The pitman rod 15 is in turn connected to a reciprocable rack bar 18 by means of a pivot pin 19 projecting horizontally therefrom. The rack bar is suitably mounted in horizontal ways on the machine.

As shown in Figs. 1 and 2 and diagrammatically illustrated in Fig. 5, the rack bar 18 in turn rotates a pinion 20 intermittently in opposite directions. This pinion 20 is keyed on the lower end of the shaft 21 which is suitably mounted on the framework. The pinion serves to drive through a special mechanism the large gear 22, and the latter in turn meshes with an elongated pinion 24 which is mounted to reciprocate vertically and axially as it is being revolved. This pinion 24 serves to rotate the wire coiling arbor 25 and to coil a wire thereon.

As shown in Fig. 4, the cylindrical arbor 25 projects downwardly from a head 26 which is suitably and removably secured in a recess within the bottom of the long pinion 24. A pin 27 projects downwardly from the head 26 and is spaced from the arbor 25, so that the leading end of a piece of wire may be inserted between the two parts at the beginning of a coiling operation, whereupon the pin 27 will carry the end of the

wire around as the arbor 25 rotates and thus cause the wire to be coiled on the latter.

Arbor reciprocating mechanism

The arbor 25 and its driving gear 24 are reciprocated vertically, as shown particularly in Figs. 2 and 5, by means of a rock bar 30 which is pivotally mounted on a pin 31 carried on a fixed arm. The bar 30 is oscillated by a vertical slide 32 pivotally and slidably connected thereto by means of a pin 33 on the slide 32 riding in an elongated slot 34 on the end of the rock bar 30. The slide 32 carries a roller 35 pivotally mounted on its lower end. The movement of the roller 35 is controlled by a pair of reciprocable cam bars 36 and 37 which are adjustably supported on the L-shaped bracket 38 mounted on a laterally projecting arm 39 of the rack bar 18. The long pinion 24 has its upper reduced end threaded and secured by nuts in a sleeve 40 (Fig. 4) which has an outer cylindrical surface rotatably mounted in a bearing block 41. The latter is mounted on the end of the arm 30 by a pin and yoke connection the same as parts 33 and 34, as shown in Fig. 5, whereby the pinion 24 may rotate freely while reciprocated axially. Hence, as indicated diagrammatically in Fig. 5, the reciprocation of the rack bar 18 by means of the driving gear 14 serves to rotate the gear 22 and the arbor 25, while the arbor is reciprocated vertically by means of the cam bars 36 and 37, thus causing a piece of wire to be coiled as a helix while the arbor 25 moves vertically.

A primary feature of this invention involves the nature and arrangement of the cam bars 36 and 37. Heretofore, a pivotally mounted cam bar having a straight cam slot has been provided for the purpose of determining the pitch of the wire coil. This arrangement has, however, required that the cam roller 35 remain always in contact with the cam and that the arbor reciprocate constantly during the operation of the machine. It, however, is desirable that both the rotational movement of the spindle and its vertical reciprocation cease for a short period of time after a wire has been coiled and the wire end severed, so that further manipulative operations may be performed upon the ends of the wire, while the driving gear 14 and the rack bar 18 are going through their return strokes. This desired pause in the vertical reciprocation of the arbor is provided, in accordance with the arrangement shown in the drawings, by having the cam which controls the vertical movement of the roller 35 made of the two spaced bars 36 and 37. These are so arranged that the long bar 36 will cause vertical movement of the arbor during the coiling operation as the sloping cam surface moves along the roller. At the end of the movement of the rack 18 and its cams 36 and 37 towards the left in Fig. 2 or in the wire coiling direction, this movement reverses and the cam bar 36 leaves the roller free. The cam bar 37 now approaches the roller and the relative positions of roller and cam bars are indicated by the dot and dash line "a" in Fig. 5. That is, the roller is free and the rack bar 30 is stationary, while the driving gear 14 turns through about 90 degrees. Then the roller is struck by the steeply sloping cam bar 37 and the roller is moved quickly thereby to the initial position at the left hand ends of the cam bars. The cam bars may be arranged to cause the arbor 25 to travel either upwardly or downwardly during the wire coiling step, as shown in Figs. 12, 13 and 14.

The cam bars may be mounted as shown in Figs. 2 and 6. The standard 38, which is mounted on the lug 39 projecting laterally from the rack bar 18, has a central supporting pin 42 on which is pivotally mounted the plate 43. This plate has two parallel grooves 44 in its exposed face and these are arranged to carry the cam bar 36 suitably and removably mounted in one of the grooves. The extra groove is provided so that a cam bar may be placed therein if desired, as indicated in Fig. 15. The other cam bar 37 is mounted at its two ends by means of bolts 45 which pass through the slots 47 and clamp against the sides of the standard 38. The plate is provided with various arrangements of the slots 47 which permit the bars to be mounted in the various positions shown in Figs. 6 and 12 to 14 inclusive.

The slide 32 may be mounted in a slideway 50 in the vertical support 51 (Figs. 2, 5 and 8). In order to hold the arbor 25 stationary when the cams do not engage the roller 35, we provide a brake which comprises a friction member 52 secured on the inner face of an adjustable clamp plate 53. This plate is held resiliently in position by the springs 54 engaging its outer surface and surrounding the cap screws 55 which pass freely through holes in the plate 53 and are adjustably threaded into the support 51. Thus, the pressure of the friction member against the slide 32 may be adjusted and the parts so set that the slide cannot move except when forced to do so by the cams. This holds the arbor 25 stationary while the cam roller 35 is out of engagement with the cam bars 36 and 37.

Mechanism for rotating the arbor

In order that the arbor may be held against rotation during a part of the cycle of reciprocation of the rack bar 18, we provide a construction which involves a ratchet and pawl drive mechanism and a brake and stop device which can be adjusted to stop and hold the arbor in a definite position while the rack bar 18 and the driven pinion 20 travel through a definite portion of the return stroke. As shown particularly in Figs. 3 and 4, the driving gear 22 is fashioned as a ring or annulus which is suitably secured on the under side of a plate 60. This plate is provided with a bushing 61 and is freely mounted to rotate on a reduced portion 62 of the shaft 21, and the plate is supported on a collar 63 which is in turn supported on the shoulder therebeneath. The shaft is suitably supported in bearings within the column 65 which is mounted on the frame 10 of the machine.

The spindle 21 has a further reduced portion 66 to which is keyed the ratchet wheel 68, so that the ratchet is revolved with the shaft 21. A set of pawls 70 are pivotally mounted on supporting pins 72 which project upwardly from the plate 60. Each of the pawls 70 have teeth 73 so arranged relative to teeth 74 of the ratchet wheel 68 that when the driving shaft 21 is rotated in the direction of the arrow (Fig. 3) the plate 60 and the arbor 25 will be driven thereby; and when the ratchet moves in the opposite direction the pawls 70 will tend to ride idly over the ratchet teeth 74. Hence, a forward reciprocation of the rack 18 (towards the left in Figs. 1, 2 and 5) which serves to pull down on slide 32 and to raise the arbor 25, will cause the ratchet and pawls to drive the ring gear 22 and the elongated pinion 24 and thus rotate the arbor.

Freely mounted upon the reduced end 66 of the shaft is a disk 80 (Fig. 4) which frictionally engages and is spaced from the ratchet 68 by a loosely mounted fiber disk 82. This fiber disk 82 frictionally engages the sides of the ratchet 68, so that, due to the friction, the ratchet tends to rotate the plate 80 with it. A coiled spring 83 engaging a collar 84 loosely pinned on a further reduced end 85 of the spindle is held in place by a nut and collar 86 and thus serves to press the plate 80 into frictional engagement with the fiber disk 82 with sufficient force to hold the parts in their required relationship. A set of pins 88 are secured to and depend from the under side of the friction plate 80 and these pins, as shown in Fig. 3, are each located closely adjacent to a shoulder 89 on the adjacent pawl 70. When the ratchet wheel starts in the opposite direction and through the friction disk 82 tends to turn the plate 80 with it, the pins 88 carried by the plate 80 will lift each of the driving pawls 70 out of contact with the ratchet 68, so that the reverse motion of the ratchet wheel may take place without the pawls noisily dragging over the ratchet. A ball 90 in a hollow receptacle 91 and pressed against the back of each of the pawls 70 by means of spring 92 serves ordinarily to hold the pawls in driving engagement with the ratchet except when the pin 88 is acting to hold the parts released. The plate 60 and gear 22 will, however, be held immovable during the major portion of the reverse movement of the rack bar 18, and during this period, the ratchet may turn freely except for the frictional drag of the top plate 80 which is held stationary by a stop mechanism provided for the purpose, as will be later described.

It will also be noted that the pawls 70 have their teeth so arranged relative to the ratchet teeth that only one pawl may mesh with the ratchet teeth in a given time. This is accomplished by having the teeth so spaced on the pawls that if they formed a continuous ring there would be one more or one less in number of pawl teeth than the number of teeth on the ratchet. The same condition may be produced by spacing the centers of the pins 72 so that these vary from a 90° arrangement by one-quarter the distance between the tops of two ratchet teeth. Hence, very little lost motion is permitted when the driving ratchet starts in its operative direction, since it can move through a distance of only one-quarter of a tooth length before one of the pawls will be seated. As many of these pawls may be provided as is consistent with the mechanics of the machine in order to cut down that lost motion.

Wire feed mechanism

Referring now to Fig. 1, the driving gear 14 is mounted on and turns with a shaft 100 which is suitably supported in bearings on the base 10. The shaft has a bevel gear 101 meshing with a bevel gear 102 of the same size on a further shaft 103 suitably mounted at right angles to shaft 100. The wire is adapted to be fed from a suitable source of supply to the coiling arbor 25 by means of a pair of driving rollers 105 and 106 (Figs. 1 and 9). The roller 106 is suitably mounted on a fixed vertical spindle 107, while the roller 105 is mounted on a vertical spindle 108 that is adapted to be moved laterally so as to force the grooves 111 on the peripheries of the driving rollers 105 and 106 either into gripping engagement with the wire 110 or to permit

the wire to pass freely therethrough. The wire driving rollers are rotated at stated intervals by means of a rack bar 112 which engages a pinion 113 mounted on a shaft parallel with the roller axes. This pinion 113 in turn operates through a pawl and ratchet (not shown) located beneath the pinion 114 to drive the latter only in a forward direction for feeding the wire. This pinion 114 is located beneath the wire feeding roller 106, and it also engages the pinion 115 (Fig. 9) which is mounted beneath and connected to rotate the driving roller 105 on the movable shaft 108. The shaft 108 moves laterally only to a slight extent so that the pinions are never out of driving engagement.

The rack bar 112 is suitably mounted in ways on the machine, which comprises the block 120 (Fig. 1) having a groove on its under side through which the rack bar 112 passes. The rack bar has a roller 122 pivotally mounted on its outer end, and this roller is adapted to be engaged at intervals by a high spot on the periphery of a cam 124 that is mounted on and rotates with the shaft 100. This cam mechanism is so timed that the rack bar is reciprocated and the wire feeding rollers are caused to feed the wire 110 to a position at which it will pass between the pin 27 and the arbor 25 (Fig. 4) at that moment immediately after a previously fashioned coil of wire has been allowed to drop from the arbor 25. This cam 124 may be suitably shaped and made adjustable as desired so as to feed the wire coil to the required extent. A spring 126 fastened at one end to the rack bar and at the other end to the stationary slideway 120 serves to draw the rack bar back towards the starting position after it has been thrust forward to feed a length of wire. An adjustable set screw 127 carried in an arm 128 projecting laterally from the rack bar 126 may be so adjusted that the rack bar may move backwards only to a limited extent, and thus the forward thrust of the cam 124 can feed only the predetermined length of wire that is needed.

It is desirable that the wire be released from engagement with the driving rolls 105 and 106 immediately after the pin 27 and the arbor 25 have seized the end of the wire and have started coiling it on the arbor. That is, the arbor should draw the wire freely forward as it is needed and the wire should not be fed positively to the arbor by the driving rolls. The gripping and the release of the driving rolls may be accomplished by a cam mechanism which is shown particularly in Figs. 1 and 9. As there indicated, adjustable cams 145 and 146 mounted on cam hub 130 on the shaft 103 serves, once for each rotation of the driving gear 14 to thrust forward against a roller 132 pivotally mounted on the upper end of a bifurcated swinging arm 133. This arm is secured on a shaft 134 which is suitably mounted in bearings in the spaced arms 135 (Fig. 1). Also fastened to this shaft 134 is the block 136 which carries a thin leaf spring 137 projecting upwardly therefrom. This spring, which is shown in exaggerated size in Fig. 9, carries near its upper end a set screw 138 threaded through it and secured in an adjusted position. This set screw 138 is so located that its far end engages the vertical portion of the arm 139 that projects from the bearing support 140 and its position is adjustable to vary the tension of the feed rolls on the wire. The support 140 carries the lower end of the shaft 108 in a suitable bearing which causes the shaft to move laterally with the support. This

support 140 is formed as the outer end of a lever or swinging arm 141 that is pivotally mounted on the vertical shaft 143 which is supported in suitable fixed bearings. By this arrangement, the two relatively rotatable and adjustable cam disks 145 and 146 serve periodically to thrust the driving roller 105 towards and into gripping engagement with the wire. This takes place while the roller 132 is riding on the high parts of the cams 145 and 146. When the roller reaches the lower part of these cams, then this pressure on the wire is released and the wire may be pulled freely by the winding arbor. Hence, during a portion or all of the period that the rack bar 112 is driving the rollers in a feeding direction, the wire will be gripped by the driving rollers under an adjustable tension and thus fed forward to the arbor when desired. The adjustable cams 145 and 146 and the adjusting screw 127 provide a delicate adjustment of the time when the wire will be fed forward and the extent to which it will be fed.

Wire cutting and shaping mechanism

At the end of the wire coiling operation, a wire cutter is caused to move forward and cut off the coiled wire and suitable mechanism may be brought into play to bend or otherwise work on the ends of the wire. These parts may be arranged suitably or as shown in the prior patents above mentioned. A simple construction for the purpose is shown in Figs. 1 and 16. Secured on the shaft 103 are two flanged sleeves 150 and 151. The flange of each of these sleeves may be provided with a series of holes near its periphery which may be 10 in number. By means of a set of bolts 152 and 153 these two flanges may be secured to adjacent flanges 154 and 155 respectively, which have a different number of bolt holes therethrough, such as 12, whereby the two sets of flanges may be adjusted in many different positions. The flange 154 forms the end of a sleeve 156 which carries at its opposite end a cam 157 which may be made of a suitable shape if desired. Similarly, the other flange 155 is a part of the sleeve 158 having a cam 160 thereon. Two slides 161 and 162 are suitably mounted in slideways on the top of the machine base and in the proper shapes and positions for the wire cutting and shaping operations. The slide 162 has a roller 163 mounted on its outer end which is adapted to be engaged periodically by the cam 157 as it rotates with the shaft 103. The other slide 162 has a roller 164 mounted on its end which is similarly periodically engaged by the cam 160 as it revolves. The two slides may be secured together by means of a spring 165 which tends to hold them in position against the peripheries of the two cams. The wire 110 is fed forward through a sleeve 166 having a plane end surface and the sharp cutting edge of the cutting tool 167 moves closely adjacent thereto to sever the wire. This cutting tool 167 is suitably secured on the slide 162 by means of a clamping plate, and its position may be adjusted by means of a set screw 168, as shown, so that the forward edge of the cutter may contact with the wire at the right time in the cycle of events. The other slide 161 carries a forming or wire shaping tool 169 suitably and adjustably mounted therein as shown in the drawings. The tool 169 may have its forward face shaped as desired to bend the coiled wire as needed and the other tool 167 may have as illustrated its forward face near the cutting edge so shaped as to form a support against which the end of the wire of the coil may be

fashioned by the forming tool 169. The sequence of events is preferably such that the coil will be severed from the wire 110 just at the moment when the forming tool 169 is drawn into engagement with the wire so that the severed coil will be gripped between the two tools 167 and 169 and the coil will be held in place on the arbor 25 until the end can be properly fashioned. It will be appreciated that other shapes and types of forming tools may be employed to work the opposite free end of the coil at the same time or as desired. Many modifications may be made in this construction depending upon the nature of the article to be made. The cams 157 and 160 will, of course, be so located that the wire severing and forming operations will be in their proper timed relation to those of the other mechanisms.

Arbor positioning and stop mechanisms

At the moment when a piece of wire has been fed between the pin 27 and the arbor 25, the upper end of the long cam bar 36 engages the roller 35, and the bar will now move towards the left and force the cam roller 35 downwardly and raise the arbor at a uniform rate until it reaches the position shown in Fig. 2, which is the end of the coiling stroke. During this previous 180° rotation of the driving gear 14, the rack bar 18 will be driving the ratchet 68 and through the pawls 70 force the gear 22 to revolve therewith and thus rotate the arbor 25 at a uniform rate. This serves to coil a definite number of turns of wire on the arbor, depending upon the number of revolutions imparted to the arbor and upon the pitch of the coil which is determined by the slope of the cam bar 36. At the end of that wire coiling stroke, when the parts are in substantially the positions shown in Figs. 2 and 5, the rack bar 18 starts towards the right and will rotate the pinion 20 in the opposite direction. At this moment of reversal of rotation, the friction of the fiber disk 92 will move the plate 80 backwards with the ratchet wheel, and thrust the pins 88 carried thereby into engagement with the backs of the pawls 70 and lift them from contact with the ratchet teeth. Hence, the ratchet may now go backwards without there being any noise of pawl teeth dragging over the ratchet. At this moment of reversal, the wire cutter comes forward and cuts the wire, and any forming tools that are to engage the ends of the wire will likewise grip the same and the forming operations on the ends of the wire may now be accomplished. For this purpose, it is desirable that the arbor be stationary and not rotate or move vertically for a considerable period of time. We, therefore, provide a stop mechanism which holds immovable the gear 22 and its supporting plate 60 and which at the same time insures that these parts are so located that the pin 27 will be in the exact position required for the new end of the wire to be fed forward into coiling association therewith at the beginning of the next coiling cycle.

This special stop mechanism is illustrated particularly in Figs. 3, 4, 10 and 11. As there shown, the plate 60 is provided on its upper surface with a series of evenly spaced stops 178, and these may be adjustably positioned by means of cap screws fitting into threaded holes 179 suitably positioned around the plate 60. A brake and stop finger 170 is fixed on a pin 171 which is pivotally mounted within bearings in a bracket 172 projecting laterally from the housing 173 which surrounds the gear 22 and associated parts. At one end of the shaft 171, is a further lever 175 fixed thereto so

that the lever 175 and finger 170 constitute a bell crank. The upper end of the lever 175 is pivotally connected to a rod 176 by suitable connections. This rod 176, which is adjustably threaded into the connecting parts at its ends so as to vary its effective length, is adapted to be moved back and forth at stated intervals by a cam mechanism and thus to raise and lower the stop finger.

The cam mechanism comprises two adjustable cams 180 and 181 suitably mounted on the shaft 100 (Fig. 10) and made adjustable relative to each other. These cams may be fashioned as sleeves secured to the shaft by set screws and provided with high and low cylindrical surfaces so arranged as to provide a partial circular high path of variable length. This high portion of the adjustable cam is adapted to engage the two rollers 184 pivotally mounted on a pin 185 passing through a hole in the bifurcated block or yoke 186 which is adjustably threaded on the end of the rod 176. The two ends 187 of the yoke 186 are spaced apart and located on opposite sides of the shaft 100 so as to be supported by the shaft while reciprocated by the cam. A coiled compression spring 188 set in a recess in the housing 173 beneath the finger 170 tends to hold the finger raised and the cam rollers against the cam. The brake finger 170 has a piece of fiber or other friction material 190 (Fig. 11) secured on its under surface, and this is adapted to engage the top of plate 60 between the stops 178 and apply a force which gradually stops the rotation of the driving gear 22 and also prevents rebound when the finger strikes the stop.

The parts are so arranged that the stop finger 170 will come down into position against the end of one of the blocks 178 and stop the arbor 25 in position for receiving the free end of the wire and hold the arbor from movement during that period of time which is required for working on the ends of the wire after the coil has been made. To that end, the number of teeth on the gear 22 is made a multiple of the teeth on the elongated pinion 24 and the number of stops 178 will be that same whole ratio number. That is, if the gear 24 has ten teeth and the gear 22 one hundred and twenty teeth, there will be twelve stops located at equal intervals about the plate 60, and the stops will be of such dimensions and locations that when the stop finger 170 engages the forward face of any one of these stops the arbor pin 27 will be in an exact position for receiving a new piece of wire. Owing to the gear and stop relationship, one stop will pass beneath the finger for each turn of the arbor; hence the finger may be brought down into its stopping position after any desired number of coil turns has been made, without regard to the number of rotations which the gear 22 may make. That is, the crank block 17 may be adjusted to turn the gear 22 through the desired angular distance, greater or less than 360 degrees, and which will cause as many stops 178 to pass the finger 170 as there are numbers of turns of wire to be made in the coil. Then, when the coil turns have been completed, the ratchet will turn backwards only to a desired extent to release the coiled wire, and the stop finger will come down and stop the gear 22 without unnecessary lost motion or waste of time.

When the wire is coiled, it is put under a certain amount of tension which tends to cause the wire to unwind or recoil. Hence, by letting the gear 22 and arbor 25 go backwards to a slight extent, the unwinding or recoiling of the wire

serves to loosen it from the arbor and allows it to drop freely therefrom, after it has been released by the wire cutting and wire working mechanisms. For some types of wire, this tension requires a recoil through out, two or several turns. Hence, the stop cam mechanism may be so adjusted as to permit the stop plate 60 to move backwards until one or more stops 178 have passed beneath the stop finger 170. Then at the right time, the stop finger 170 comes down and its friction material 190 engages and slows down the stop plate and then the finger 170 drops into place against the end of the stop 178 and causes the stop plate to stand still thereafter and until the stop finger is again lifted. It will be noted that the cams on shafts 100 and 103 operate once for each revolution of the driver 14, so that the cycle of all operations is carried out at the rate of the driver.

20 *Operation of the mechanism*

The operations of the different parts of the mechanism have been explained above. Their coordination will depend upon the settings of the cams. If a coil of six turns, for example, is to be made, then the crank block 17 will be so adjusted that the rack bar 18 will turn the stop plate 60 far enough to cause six of the stops 178 to pass beneath the stop finger 170 and the elongated pinion 24 will be rotated through six turns. At the start of operations, the wire feeding cam 124 moves the rack bar 112 and rotates the rollers 105 and 106, which are forced by cam 130 to grip the wire, and these will feed the cut end of the wire 110 through the sleeve 166 (Fig. 16) until it slips between the pin 27 and the stationary arbor 25. Then the cam 130 releases the driving rolls from engagement with the wire. The stop finger 170 has been holding the plate 60 and gear 22 from rotation. It is now lifted by the spring therebeneath, as is permitted by the rollers 184 dropping from the high to the low parts of the cams 180 and 181. The gear 22 is now free to turn. At this moment, the pitman rod or crank 15 has passed dead center and starts the ratchet in a wire coiling direction. The springs 92 force one of the pawls 70 into engagement with the ratchet teeth, this being permitted by the friction of the ratchet wheel through the fiber disk 82 causing the plate 80 to travel with the ratchet and release the pins 88 from engagement with the pawls. This causes the arbor 25 to start its rotational movement. At that time, the roller 35 is located at the high point of the cam bar 36 and it now starts moving down and thus lifts the rotating arbor 25 at a continuous rate and the wire is wound thereon. When the arbor gets to its topmost position as determined by movement of the cam bar 36 to the left, the coil is finished; and the driver 14 and its pitman rod are in substantially the positions shown in Fig. 2. The cam bars 36 and 37 now start back in the right hand direction and the brake shown in Fig. 8 holds the rock bar 30 and arbor 25 axially stationary while the cam bars move until the steeply inclined bar 37 strikes the roller 35 and forces it quickly upwards and moves the arbor down to its starting position. During that period in which the roller 35 is out of contact with the cam bars, the driver 14 is rotating through about 90°. Hence the arbor 25 is not moved axially through that 90° period, and time is provided for the wire cutting and fashioning operations. When the crank 15 passes dead center (Fig. 2) the ratchet starts back and turns

the arbor 25 in the opposite direction enough to release the tension in the wire or to permit it to recoil. During this time the stop finger 110 has been held out of contact with any of the stops. Then, according to the adjustment of the cams 180 and 181, this stop finger will come into play and slow down the gear 22 and then stop it. During the period when the cam roller 35 is out of contact with the cam bars and as soon as the recoiling has started or ceased, depending on the adjustments, the wire cutter 167 comes forward and cuts the wire and the forming cam 169 moves backwards against the wire; and between the negative and positive faces of these two members the severed end of the wire coil is shaped. Then the two shaping tools move out of contact with the coil, as is caused by contraction of the spring 165 when permitted by the associated cams, and the freed coil of wire will drop from the arbor 25 and a new length of wire will again feed forward into position between the pin 27 and the arbor 25, and the cycle will be repeated, once for each revolution of the driver 14.

Modifications

It will be appreciated that many modifications may be made in this machine, and that it may also embody various constructions heretofore manufactured and as shown in the prior art patents. The machine is capable of a great many adjustments so as to make both left and right hand coils, and double and single coils, and tapered coils, and coils of varying pitch, as well as many other shapes and types of coils as will be understood by one skilled in this art. For example, the shapes and arrangements of the cam bars 36 and 37 will determine the pitch of the coil and a curved cam bar 36 will cause a variation in that pitch. Certain of these cam bar arrangements are shown in Figs. 6 and 12 to 15 inclusive. As above described, the coil is made while the arbor is moving upwards and this involves the arrangement of bars shown in Fig. 6. If the bars are arranged as shown in Fig. 14 the arbor will move downwards during the coiling operation. Likewise, the bars 36 and 37 may be reversed in the slots in the holder so that the short bar 37 is at the top as shown in Figs. 12 and 13. The arrangements of Figs. 6 and 14 produce a right hand coil and the arrangements of Figs. 12 and 13 produce a left hand coil provided the other parts of the mechanism are suitably adjusted and modified for that purpose. The arrangement of bars in Fig. 15 is one in which two parallel bars 36 are used and no dwell period is required for a wire forming operation. It will also be appreciated that the pawl and ratchet parts in the driving head shown in Figs. 3 and 4 may be reversed, since it is merely necessary that one of these parts constitute the driver while the other is the driven member that rotates the arbor. Various other arrangements and mechanical equivalents of the parts illustrated may be employed as desired. It will, therefore, be appreciated in view of the above disclosure that the drawings and the description thereof are to be considered as illustrative of the principles and the main features of the invention but as not constituting limitations thereon, and the claims are to be interpreted accordingly.

What we claim and desire to secure by Letters Patent is:

1. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, driving mechanism including a reciprocable member.

means connected with said member for alternately rotating the arbor and then holding it stationary and means operated in timed relationship with the arbor rotating means for reciprocating the arbor axially during its rotation and for holding the arbor axially stationary while it is not rotating and for a predetermined and variable length of time.

2. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, a driver, a cam mechanism operated thereby which includes an adjustable cam bar and a follower therefor connected to reciprocate the arbor intermittently in an axial direction at a predetermined but variable rate, means for alternately rotating the arbor during its axial reciprocation and then stopping and holding it in a predetermined position, and means associated with said cam mechanism which causes the arbor to remain axially stationary during a predetermined length of time while it is not rotating.

3. A wire coiling machine comprising a reciprocable and rotatable arbor, means for rotating the arbor intermittently to coil wire thereon, a cam mechanism including two cam bars arranged at angles to each other and a follower which are connected to reciprocate the arbor axially and means for reciprocating the cam bars and follower relative to each other to cause said axial movement, said bars being arranged at angles to each other and to the relative path of motion of the bars and follower and being so spaced and arranged that the arbor moves relatively slowly during wire coiling, then remains axially stationary for a period of time and then is returned quickly to its initial starting position.

4. A wire coiling machine comprising a reciprocable and rotatable arbor, means for alternately rotating the arbor and then holding the same stationary, means for reciprocating the arbor axially during its rotation and for preventing reciprocation while it is not rotated and means operated in timed relationship therewith which serves to cut the wire and to fashion the end of the coiled wire during the period when the arbor is axially and rotatably stationary.

5. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, means for alternately rotating the arbor and then holding it stationary, means for moving the arbor axially during its rotation and then holding it axially stationary while it is not rotating, means for feeding a predetermined length of wire to the arbor while it is stationary, means for severing the wire coil at the end of the coiling operation, means for fashioning the severed end of the coiled wire during the period while the arbor is rotatably and axially stationary, and driving mechanism for operating said means in their timed relationships.

6. A wire coiling machine comprising a rotatable wire coiling arbor, a driving head connected to rotate said arbor through a whole number of turns for each rotation of the head, a set of stops on the head equal in number to the ratio of the rotational turns of the arbor and the head, means for rotating the head, and a stop mechanism adapted to interpose a stop finger in the path of any selected one of the stops on the head and thus stop the arbor always in a predetermined position after any desired number of rotational turns thereof irrespective of the position of the driving head.

7. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, mechanism including a rotating head connected to rotate the arbor and coil wire thereon, a set of adjustable stops on the head, a finger arranged to be interposed in the path of the stops, and cam mechanism to move the finger into the path of a selected stop at the end of a coiling operation and hold it there during a substantial period of time.

8. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, friction driving mechanism including a rotating head connected to rotate the arbor and coil wire thereon, a set of adjustable stops on the head, a finger arranged to be interposed in the path of the stops, mechanism including an adjustable cam to move the finger into the path of a selected stop at the end of the wire coiling step and hold the arbor stationary and to release the stop after a predetermined but variable interval, and means for reciprocating the arbor to determine the pitch of the coil.

9. A wire coiling machine comprising a rotatable wire coiling arbor, ratchet and pawl mechanism including a relatively rotatable ratchet wheel and a pawl carrier, one of which is operatively connected to rotate the arbor, means for rotating one of said ratchet parts through a predetermined angle to cause the wire to be coiled and then in a reverse direction to its initial position, and means including a stop mechanism which serves to stop and hold the arbor in a predetermined position after any predetermined number of turns of rotation thereof and during the period while the ratchet mechanism returns to its initial position.

10. A wire coiling machine comprising a rotatable wire coiling arbor, ratchet and pawl mechanism including a relatively rotatable ratchet wheel and a pawl carrier, one of which serves as a driver while the other is a driven member connected to rotate the arbor during forward rotation of the driver, means for rotating the driver alternately in opposite directions, and means including a set of stops and a stop finger actuated in timed relationship with the ratchet mechanism which serves to stop the arbor in a predetermined position after any desired number of turns thereof and to hold it stationary during reverse rotation of the driver.

11. A wire coiling machine comprising a rotatable wire coiling arbor, ratchet and pawl mechanism including a relatively rotatable ratchet wheel and a pawl carrier, one of which serves as a driver while the other is a driven member connected to rotate the arbor during forward rotation of the driver, means for rotating the driver alternately in opposite directions, a friction plate normally rotatable with the driver, means thereon for removing a pawl from contact with the ratchet when reverse rotation of the driver starts and means associated with the ratchet mechanism for holding the driven member stationary and in a predetermined position during said reverse rotation.

12. A wire coiling machine comprising a rotatable wire coiling arbor, a ratchet and pawl mechanism having a driver rotated alternately in opposite directions and a driven member connected for rotating said arbor intermittently in one direction, means for rotating the driver in opposite directions, and means for stopping the driven member and holding the arbor in a predetermined position during reverse rotation of the driver, said ratchet mechanism comprising a set of driving pawls having their teeth so arranged

5 ranged that but one pawl at a time seats in driving engagement with the ratchet teeth and lost motion upon reversal is thereby minimized and means for lifting the pawls out of contact with the ratchet teeth during said reverse rotation.

10 13. A wire coiling machine comprising a rotatable and reciprocable arbor, mechanism for feeding the free end of a wire into coiling relationship therewith, means for rotating the arbor and for moving it axially during a wire coiling operation and means for severing the coil from the wire, said wire feeding mechanism comprising positively rotated feeding rollers arranged to move relatively to grip or release the wire and a cam operated device which causes said rollers to grip the wire and feed the same forward until it is in operative association to the arbor and thereafter to release the same.

20 14. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, a driver movable through a forward and a return stroke, means for reciprocating the arbor axially during the forward stroke, means connecting the driver with the arbor to rotate the arbor during the forward stroke for coiling wire thereon, and mechanism associated therewith which permits recoil movement of the arbor and immediately thereafter holds it rotatably stationary during the return stroke.

30 15. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, driving mechanism operating through a forward and a return stroke which serves to rotate the arbor intermittently for coiling wire thereon, and mechanism including a stop device operated in timed relationship with the rotatable arbor which stops the rotation thereof after the coiling step and holds it non-rotatable during the major portion of the return stroke of the driving mechanism.

45 16. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, mechanism reciprocating through forward and return strokes for rotating the arbor intermittently to coil wire thereon, means to reciprocate the arbor during the coiling rotation of the arbor to determine the pitch of the coil, and stop mechanism which stops the arbor at substantially the beginning of the return stroke and holds it stationary during the remainder thereof and thereafter releases it for a further coiling operation.

50 17. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, mechanism operating through a forward and return stroke for rotating the arbor intermittently to coil wire thereon, mechanism independent of the arbor rotating mechanism which serves to reciprocate the arbor axially during the forward stroke to determine the pitch of the coil and which holds the arbor axially stationary during a substantial portion of the return stroke and mechanism for shaping the end of the wire during the period of non-reciprocation of the arbor.

65 18. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, mechanism for rotating the arbor intermittently for coiling wire thereon and then holding the arbor non-rotatable, independently adjustable mechanism for reciprocating the arbor during the wire coiling stage to determine the pitch of the coil and which holds the arbor stationary during a variable and predetermined period while the arbor is not rotating and reciprocating.

19. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, mechanism for intermittently rotating the arbor during a wire coiling step and thereafter stopping it, independently adjustable mechanism for intermittently reciprocating the arbor axially and producing a wire coil of variable pitch and thereafter holding the arbor axially stationary while it is not rotating, and means operated in timed relation therewith to feed wire to the arbor while it is not rotating or reciprocating.

20. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, mechanism for rotating the arbor during a wire coiling operation and thereafter holding it non-rotatable, means for feeding the end of the wire to the arbor while it is non-rotatable, mechanism for reciprocating the arbor axially during its rotation to determine the pitch of the wire coil thereon and which prevents reciprocation of the arbor at a time when it is not rotating but returns the arbor to its initial starting position for making a new coil, and means for adjusting the reciprocating mechanism so as to vary the pitch of the coil.

25 21. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, mechanism for alternately rotating and holding the arbor stationary, independently adjustable mechanism for intermittently reciprocating the arbor and producing a wire coil of variable pitch and thereafter holding the arbor axially stationary, and mechanisms operating in timed relationship therewith for severing the wire and for shaping an end of the coil during the period in which the arbor is not rotating or reciprocating.

30 22. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, reciprocable mechanism for alternately rotating the arbor and then holding it stationary, independent mechanism for intermittently reciprocating the arbor to determine the pitch of the wire coil thereon and then holding the arbor stationary during a substantial portion of the time while it is not rotating, means for varying the rate of reciprocation of the arbor and means for varying the number of turns of rotation thereof.

45 23. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, means for intermittently rotating the arbor in one direction to coil the wire thereon, mechanism including adjustable stops for holding the arbor non-rotatable for a predetermined and variable period of time after the coiling step and then releasing the arbor for another wire coiling operation, and independent mechanism for reciprocating the arbor axially in opposite directions and which serves to stop the reciprocation of the arbor at substantially the end of the coiling step.

60 24. A wire coiling machine comprising a rotatable and reciprocable wire coiling arbor, mechanism operating through a forward and a return stroke for intermittently rotating the arbor in a wire coiling direction, mechanism including adjustable stops which serves to stop the rotation of the arbor for a predetermined but variable portion of substantially all of the return stroke, means for reciprocating the arbor axially during the wire coiling stage, and means for forming the end of the wire while the arbor is neither rotating nor reciprocating.

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