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W. H. COX ET AL

3,370,808

COIL WINDER

Filed Aug. 18, 1966

2 Sheets-Sheet 1

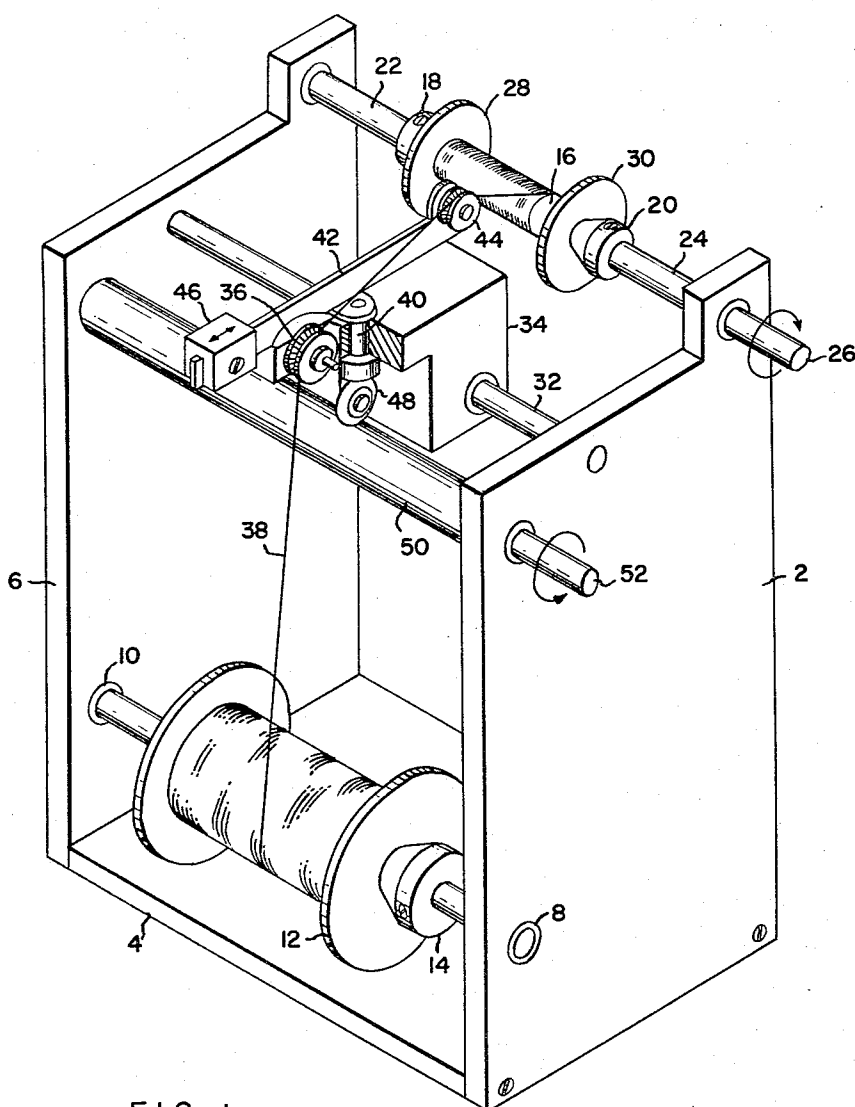


FIG. 1.

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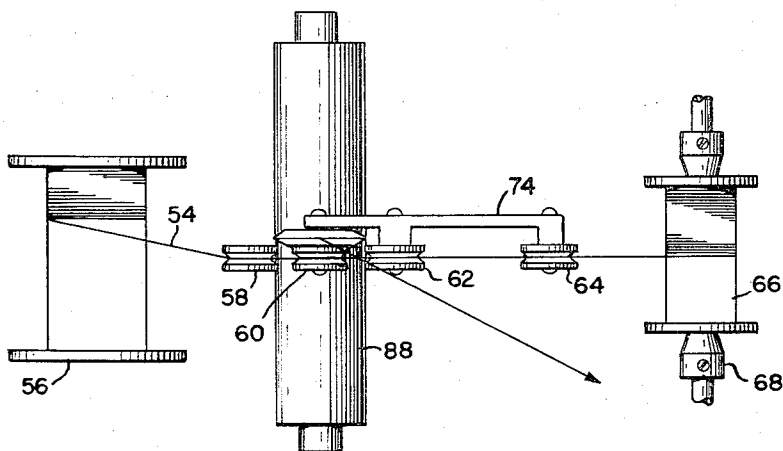


FIG. 2.

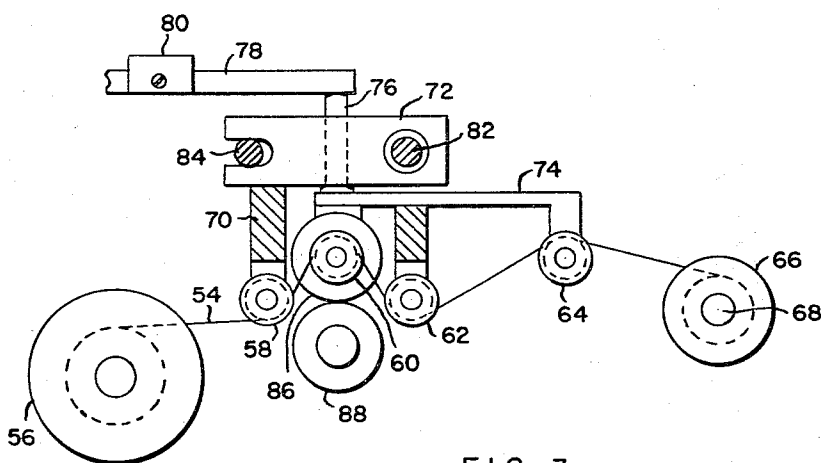


FIG. 3.

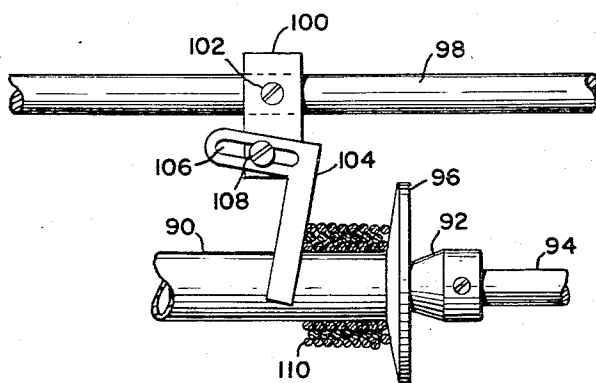


FIG. 4.

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COIL WINDER

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ABSTRACT OF THE DISCLOSURE

A guide for feeding wire onto a rotating coil form is driven in response to deflection of the wire by the previously formed turn by providing a carriage, driven in a path parallel to the axis of the coil form by the action of a roller against a pivoted wheel. The angle between the axis of the roller and the wheel is determined by lateral displacement of a guide pivoted on the carriage by the length of wire between the guide and the coil form. In order to produce multiple layers, automatic reversal of the carriage is accomplished by providing stops for engaging the length of wire between the guide and the coil. The guide is provided on one end of a pivoted arm, on the other end of which there is provided a weight. The wheel engaging the roller is positioned by the arm, and causes reversal of carriage movement when the wire engages a stop, since the inertia of the weight causes the axis of the wheel to rotate past its central position.

This invention relates to coil winders and particularly to an improved means for guiding wire onto a rotating coil form for the production of uniform, close-wound single or multi-layered coils.

In accordance with this invention, wire fed from a supply spool is guided by a carriage movable parallel to the axis of rotation of the coil form, the position of the carriage determining the position from which wire is fed to the coil form.

In hand winding of layer-wound coils, wire is guided onto a rotating coil form by hand to provide tension on the wire and to sense its deflection as it slides into place against the previously formed turn. The position of the hand with which the operator feeds the wire is adjusted in accordance with this deflection. Adjacent turns are thus held tightly against each other, and overlapping of adjacent turns is avoided. The operator also detects the sudden stoppage of deflection when the wire runs against a flange or other stop as a cue to start the next layer.

This invention simulates the manual technique of winding coils in that a means is provided for sensing the deflection, by previously formed turns or by the coil form flange, of the wire being fed onto the coil form, and also in that the position and the rate of movement of the feed means will be responsive to the magnitude of this deflection. The main advantage of the present invention over prior coil winding machines in which a lead screw or cam is used to advance a wire feeding carriage is that no speed adjustment or preset travel range adjustment is required for the wire guide carriage. While lead screw or cam driven systems require careful presetting to accommodate different wire sizes and different coil lengths, it will be apparent from the following description that the source supplying operating power for movement of the wire guide in the present invention may operate at any speed within a very wide range and its speed can be completely independent of the speed of rotation of the coil form.

The positioning of the wire feeding means or carriage in this invention is accomplished by a servomechanism comprising a rotating cylindrical roller frictionally engaged by a pivoted wheel constrained to move in a direction parallel to the axis of rotation of the cylindrical roller. The opera-

2

tion of the servomechanism is such that if the axes of rotation of the wheel and the roller are parallel, no lateral movement of the wheel will take place, but if the wheel is "steered" slightly in one direction so that the axes of rotation are no longer parallel, the wheel will be advanced in one or the other of the directions along the axis of the roller. Considering the roller as a stationary reference for the sake of illustration, the wheel follows the path of a helix about the roller, the helix angle being equal to the angle between the axis of the roller and that of the wheel.

In accordance with the invention, the carriage feeding wire to the rotating coil form is driven by the action of a roller against a pivoted wheel as described above, and the angle between the axes of the roller and the wheel is determined by the deflection of the wire.

The most important feature of this invention involves the manner in which the carriage is caused to reverse its direction automatically in order to produce coils having multiple layers. This automatic reversal is accomplished by providing a combined guide and sensor which reacts to a sudden change in deflection of the wire as the winding reaches a flange at an end of the coil form or other fixed stop to deflect the wire being fed onto the form in the direction opposite the motion of the carriage. This opposite deflection causes the pivoted wheel to rotate through its neutral position, thus causing the carriage to stop and to move in the reverse direction. The weighted arm causing reversal of the direction of winding performs the reversal operation with great reliability.

The general object of this invention is to provide an apparatus for winding uniform, closely spaced layers on a coil form which does not require preliminary adjustment to compensate for differences in wire diameter or coil length. The servomechanism insures that the carriage is in the proper position to deliver wire to the coil form regardless of the wire diameter.

A further object of this invention is to provide an automatic coil winder in which reversal of the direction of motion of the wire feeding means is accomplished automatically in order to produce multiple layered coils.

Other objects of this invention will become apparent from the following description, read in conjunction with the accompanying drawings, in which:

FIGURE 1 is a perspective view, partly cut away, showing a coil winding apparatus in accordance with the present invention;

FIGURE 2 is a plan view illustrating a modification of the invention;

FIGURE 3 is an elevation, partly in section, showing the same modification as is shown by FIGURE 2; and

FIGURE 4 is an elevation showing a further modification applicable to either of the modifications shown in the preceding figures.

Referring to FIGURE 1, a framework provided by members 2, 4, and 6 is provided with bearings 8 and 10 on which is rotatably mounted a wire supply reel 12 between a pair of mounting cones, one of which is illustrated at 14. A coil form 16 is similarly mounted in the framework between cones 18 and 20 fixed respectively to shafts 22 and 24. Cones 18 and 20, like cones 14, are adjustable with respect to their positions on the shafts so that various sizes and shapes of coil forms and supply reels can be accommodated.

Rotating power is provided at the end 26 of shaft 24, and in the direction indicated, so that wire is taken up by the coil form. Flanges 28 and 30, the function of which, as will be discussed later, is to cause reversal of the direction of motion of the feed means, are provided at the ends of coil forms 16.

A rod member 32 is fixed between frame members 2 and 6, and a carriage 34 is slidably mounted on rod member 32. A rotatable sheave 36, borne by carriage 34,

serves to guide wire 38 from supply reel 12 so that it is always fed over the same point on the carriage. Sheave 36 acts as a tensioning device producing tension in the wire segment extending between itself and the coil form.

A shaft 40, rotatable about a vertical axis, is carried by carriage 34 in a suitable bearing extending vertically through the carriage. At its upper end, there is fixed an arm 42 which supports wire guiding sheave 44 at the end nearest the coil form. At the other end of arm 42, there is mounted an adjustable weight 46 which may be positioned at various points along the length of arm 42 to effect changes in the location of the center of gravity of arm 42.

A wheel 48 is mounted at the lower end of shaft 40, and is free to rotate about a horizontal bearing. The direction of the axis about which wheel 48 rotates is controlled by shaft 40 so that wheel 48 is effectively "steered" by arm 42.

A cylindrical roller 50 is rotatably mounted between frame members 2 and 6, and is arranged to be provided with continuous rotational power through shaft 52 to rotate it in the direction indicated. It will be apparent that roller 50, since it provides part of the support for carriage 34, is engaged by wheel 48 with some force so that carriage 34 will be moved if the axes of rotation of wheel 48 and roller 50 are brought out of parallelism. It will be evident that the materials from which wheel 48 and roller 50 are manufactured must be chosen so that a good deal of friction exists between them. Roller 50 may be formed of a slightly yielding material which will resist a sidewise movement of the wheel. It is also desirable that wheel 48 be in the form of a sharp-edged disc, this form being ideal for preventing sidewise movement when the wheel engages a roller.

The operation of the above-described embodiment of the invention is as follows:

As wire is pulled onto the coil form 16 by the rotation of shaft 26, tension in the segment of wire 38 between sheave 36 and coil form 16 causes arm 42 to be deflected slightly in the direction in which wire is being wound onto the form. Consequent steering of wheel 48 causes carriage 34 to move in the direction in which wire is being wound onto the form. It will be apparent that sheave 44 (the point at which wire is being fed from the carriage) will not pass the point at which wire contacts the coil form since, as soon as the carriage reaches the point at which this will occur, the axes of wheel 48 and roller 50 are parallel and the carriage will cease to move. In fact, a steady-state equilibrium is established so that the carriage lags behind the point at which wire contacts the coil form by a small amount. The adjustable weight 46 controls the transient response of the servomechanism. Constant or slowly changing deflection of wire being wound does not cause an appreciable transient disturbance. The weight has little effect under these conditions.

When the first coil layer is completely wound, a sudden change in the deflection of the wire segment between sheave 36 and the coil form is caused by the contact of this wire segment with flange 30. The important function of weight 46 will be apparent here. The position of weight 46 on arm 42 is adjusted so that when deflection of the wire segment is arrested suddenly by contact with one of the flanges, the speed of the carriage is reduced suddenly and inertia of weight 46 reacts to such an extent that arm 42 passes its neutral position to deflect the wire in the opposite direction, and wheel 48 is steered in the opposite direction. Carriage 34, now starts moving in the opposite direction, a new layer is begun, and steady-state equilibrium is re-established in the opposite direction. Carriage 34 lags behind the point at which wire is being fed onto the coil form and this lagging serves to pull each new turn tightly against the previously formed turn.

It will be noted that, in the above-described embodiment of the invention, rotating power is supplied both to shaft 26 and to shaft 52. Referring to FIGURES 2

and 3, a modification of the invention is shown in which rotational power for the roller is supplied by the wire itself. It will be apparent that this modification can only be used where the wire being wound is not delicate, since very fine wire would not ordinarily be capable of supplying the power required to rotate a roller without breaking occasionally.

Wire 54 from supply reel 56 is fed under sheave 58, over sheave 60, under sheave 62, over sheave 64 and thence to a coil form 66 to which rotating power is supplied through shaft 68. The members 70 of carriage assembly 72 carry sheave 58, and sheaves 60, 62 and 64 are carried by member 74. Sheaves 60, 62 and 64 are held in alignment by member 74 and member 74 is fixed to a shaft 76 extending through a suitable bearing in carriage 72. An arm 78, also fixed to shaft 76 carries a weight 80. Carriage 72 slides on members 82 and 84 so that it can follow the feeding of wire onto coil form 66. A wheel 86 is provided coaxial with and fixed to be rotated with sheave 60. A roller 88 is provided to rotate freely in suitable bearings (not shown).

In operation, power provided by the rotation of shaft 68 is transmitted to wheel 86 by the wire segment between sheave 60 and the coil form, and this power is, in turn, transmitted to roller 88. The same "steering" action takes place in this modification as takes place in the apparatus of FIGURE 1. Deflection of the wire segment between the coil form and sheave 64 causes arm 74 to deflect from its neutral position, and carriage 72 follows up by the action of the servomechanism. The reversal of the direction of motion of the carriage to form new layers on the coil form is exactly the same as the operation of the apparatus in FIGURE 1 and will not be described. It will be apparent that the sheave 62 is provided in order to maintain contact of the wire with sheave 60 through a substantial arc in order to avoid slippage between the wire and sheave 60.

Referring to FIGURE 4, there is shown a coil form 90 mounted in a clamp comprising cone 92 and a similar cone (not shown) located at the opposite end of the coil form. The coil form is arranged to rotate under power supplied through shaft 94. In this modification, a flange 96 is provided at one end of the coil form.

A bar 98 is supported between frame members (not shown). A slide 100 is provided and can be held in place at any desired point along bar 98 by a set screw 102. A member 104 is suspended from slide 100, and its attitude is made adjustable by the provision of a slot 106 through which passes a set screw 108 to hold member 104 stationary.

Member 104, which acts as a wire stop, is suspended between the wire feed carriage and the coil form so that it causes reversal of the carriage motion when it is engaged by wire being fed onto the form. A multiple layered coil section 110 is formed, carriage reversal being actuated at one end by flange 96 and at the other end by member 104. Bank wound or sectional coils can be produced with this modification. In some instances, it may be desired to eliminate flanges altogether by using wire stops such as members 104 at both ends of the coil section. The shape of the coil is determined by adjustment of the attitude of the wire stops. This modification can be used in conjunction with either of the modifications illustrated in FIGURES 1, 2 and 3.

With the special servomechanism used in conjunction with wire stops of various forms, multiple layered coils of various shapes can be wound automatically with great accuracy and reliability.

It will be apparent that various modifications other than those specifically described may be made and that the physical forms of the various components may be varied without departing from the scope of the invention as defined in the following claims.

What is claimed is:

1. A coil winding apparatus comprising a coil form,

5

means rotating said coil form to wind a strand of wire or the like onto said form, means guiding said strand onto said form, a rotatable roller, a movable carriage supporting said means guiding said strand, said means guiding said strand being moveable under the action of said strand, said carriage including rotatable means frictionally engaging said roller for transfer of power between said rotatable means and said roller, means supplying rotational power to said roller, and means responsive to displacement of said means guiding said strand under the action of said strand for altering the angular relationship between the axes of rotation of said rotatable means and said roller to cause translational acceleration of said carriage in the direction of movement of said guide means.

2. A coil winding apparatus according to claim 1 in which said rotatable means is in the form of a sharp-edged disc.

3. A coil winding apparatus according to claim 1 including means, disposed adjacent the desired ends of the coil section being wound, for engaging said strand being fed from said means guiding said strand.

4. A coil winding apparatus comprising a coil form, means rotating said coil form to wind a strand of wire or the like onto said form, means comprising a pivoted arm having a weight on one side of its pivot and means guiding said strand onto said form at the other side of said pivot, said means guiding said strand being movable about said pivot under the action of said strand, a rotatable roller, a moveable carriage supporting said pivoted arm, said carriage including rotatable means frictionally engaging said roller for transfer of power between said rotatable means and said roller, means supplying rotational power to said roller, and means responsive to displacement of said pivoted arm under the action of said strand for altering the angular relationship between the axes of rotation of said rotatable means and said roller to cause translational acceleration of said carriage in the direction of movement of said guide means.

5. A coil winding apparatus according to claim 3 including means, disposed adjacent the desired ends of the

6

coil section being wound, for engaging said strand being fed from said means guiding said strand.

6. A coil winding apparatus comprising a coil form, means rotating said coil form to wind a strand of wire or the like onto said form, means guiding said strand onto said form, a rotatable roller, a moveable carriage supporting said means guiding said strand, said means guiding said strand being moveable under the action of said strand, said carriage including rotatable means frictionally engaging said roller and means transferring power from said strand through said rotatable means to cause rotation of said roller, and means responsive to displacement of said means guiding said strand under the action of said strand for altering the angular relationship between the axes of rotation of said rotatable means and said roller to cause translational acceleration of said carriage to the direction of movement of said guide means.

7. A coil winding apparatus comprising a coil form, means rotating said coil form to wind a strand of wire or the like onto said form, means disposed adjacent the desired ends of the coil section being wound for engaging said strand, means comprising a pivoted arm having a weight on one side of its pivot and means guiding said strand onto said form at the other side of said pivot, said means guiding said strand being movable under the action of said strand, a movable carriage supporting said pivoted arm, and means responsive to displacement of said pivoted arm under the action of said strand and causing translational acceleration of said carriage in the direction of movement of said means guiding the strand.

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