Dec. 8, 1925. 1,564,478

M. B. GROUT

WINDING MACHINE

Original Filed April 14, 1922 4 Sheets-Sheet 1

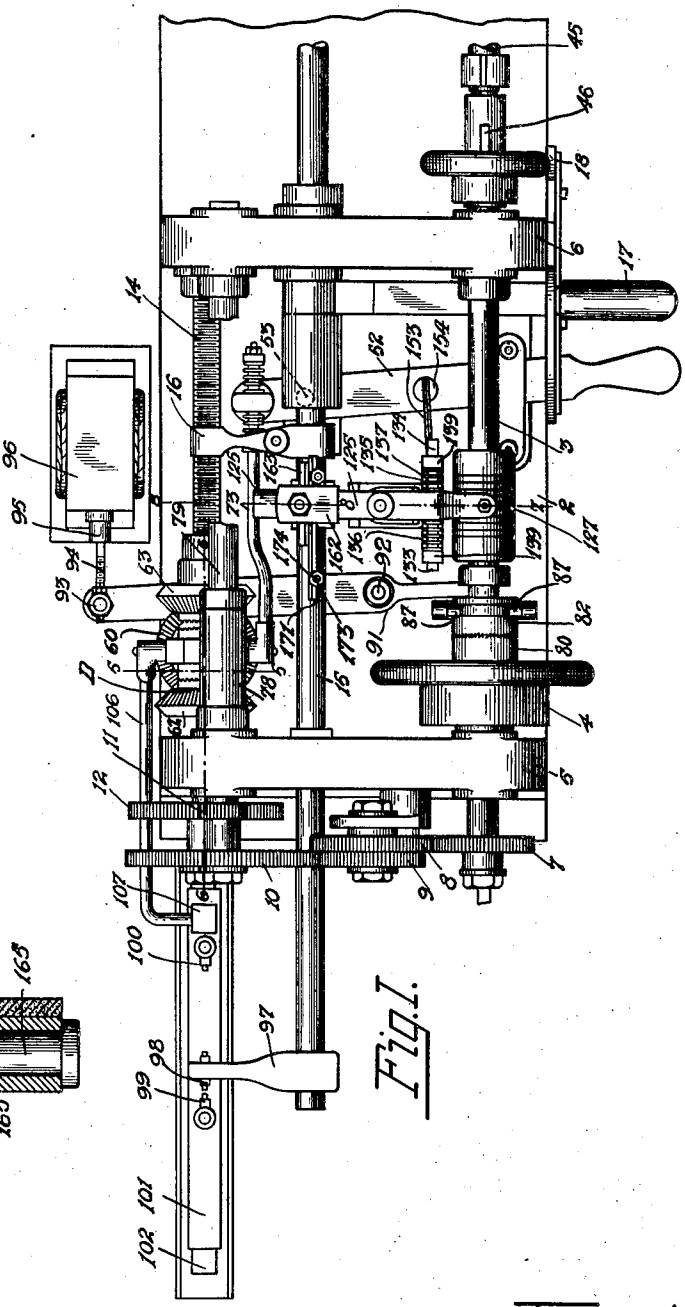

Fig. 1.

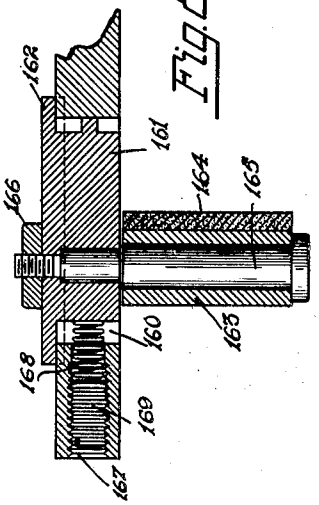

Fig. 8.

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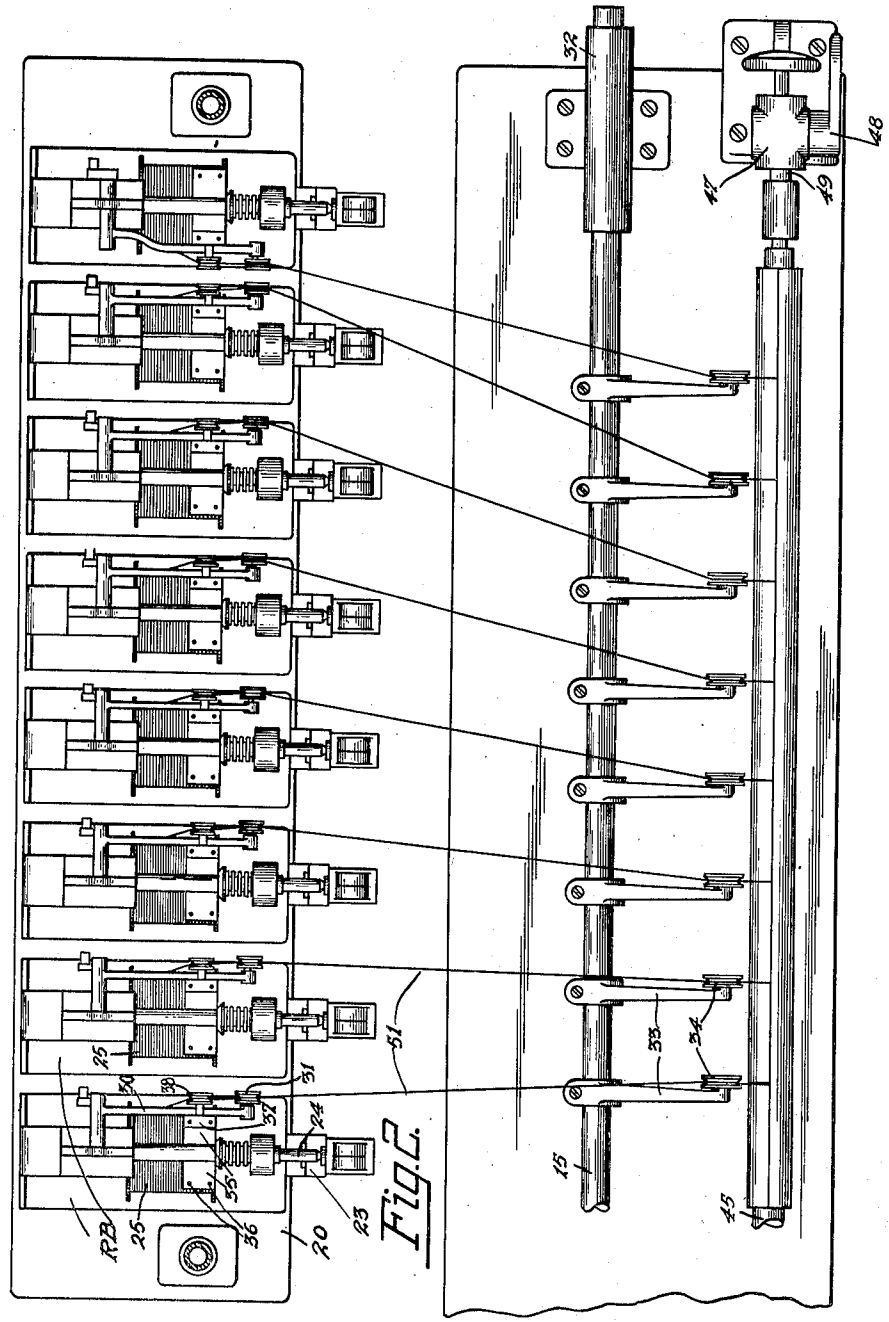

Fig. 2.

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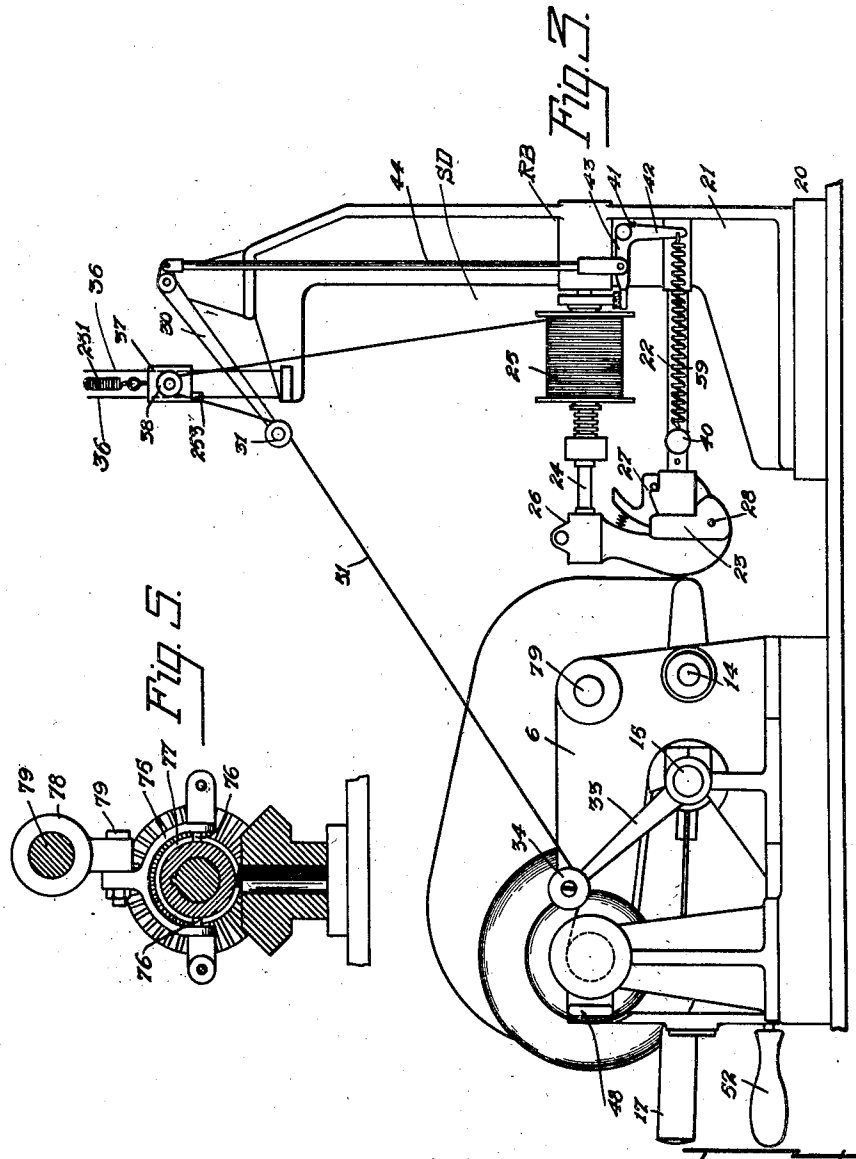

Fig. 5.

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WINDING MACHINE

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Fig. 7.

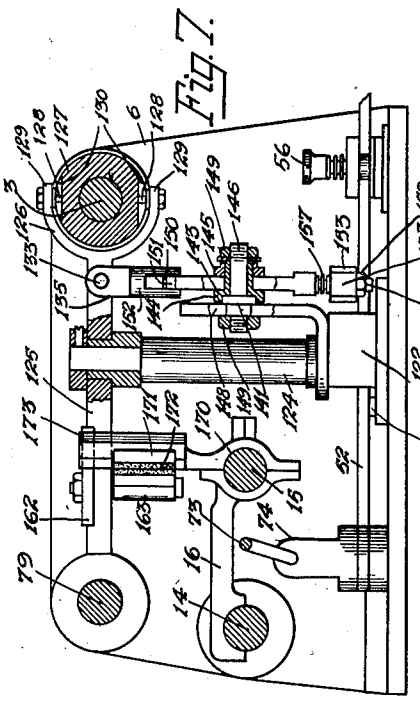


Fig. 4.

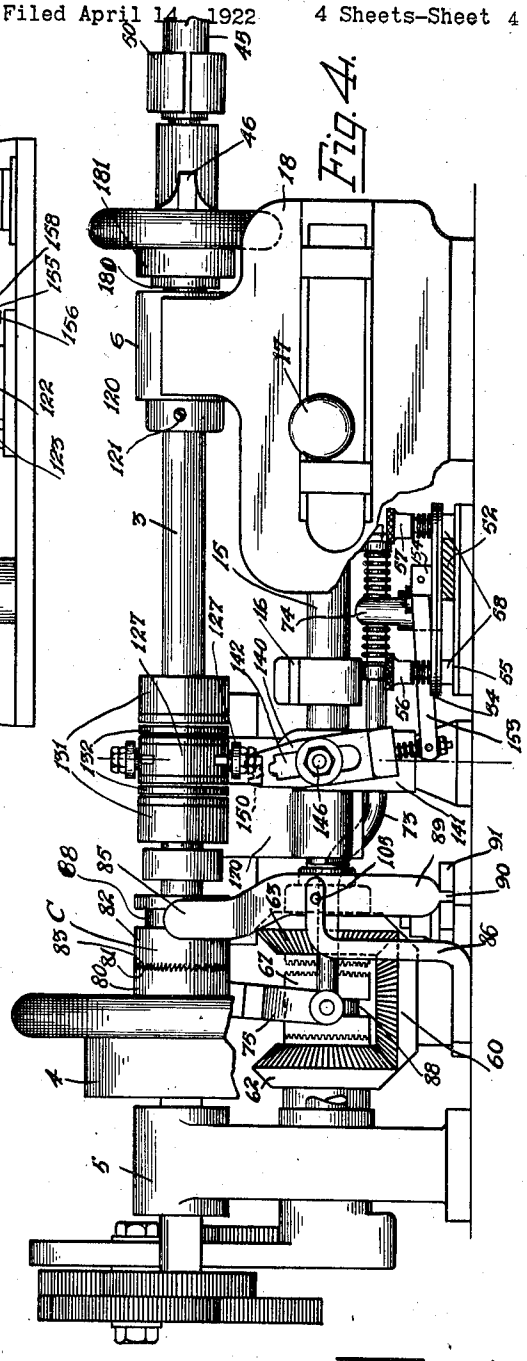
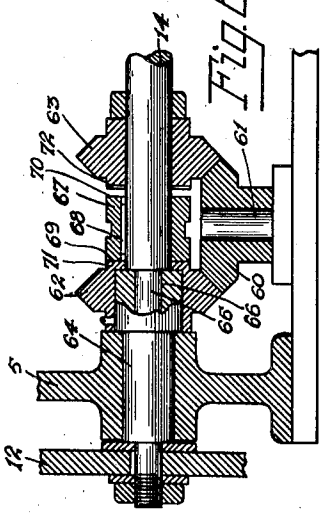


Fig. 6.



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UNITED STATES PATENT OFFICE.

MARTIN B. GROUT, OF CHICAGO, ILLINOIS, ASSIGNOR TO KELLOGG SWITCHBOARD AND SUPPLY COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF ILLINOIS.

WINDING MACHINE.

Application filed April 14, 1922, Serial No. 552,565. Renewed May 16, 1925.

To all whom it may concern:

Be it known that I, MARTIN B. GROUT, a citizen of the United States of America, and resident of Chicago, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Winding Machines, of which the following is a specification.

My invention relates to coil winding machines and has to do more particularly with winding machines of the multiple type in which a plurality of electromagnet coils are wound simultaneously, and an object of my invention is to provide a machine of the above type by which this work can be done in a rapid, efficient and economical manner.

In machines of the present multiple type, a plurality of helices or coils may be wound simultaneously, and when a number of coils are wound simultaneously a single tube common to all of them is used and the wire is wound upon it in separated zones or spaces and each sheet of insulating paper between each layer of convolutions of wire is common to all of the coils so as to mechanically connect all the coils together. When the coils have their predetermined number of convolutions, the common tube upon which the coils are simultaneously wound is removed and thereafter the plurality of coils may be separated into individual coils by sawing or cutting through the spaces between the zones of the coils.

The coils wound simultaneously by the multiple winding machine of the above type are built up of a plurality of layers of wire, each layer having a predetermined number of convolutions, while the convolutions of wire in one layer are insulated from those in the adjacent layer by means of several layers of interposed paper. The number of convolutions per layer to be placed upon the tube is gauged by means of suitable gearing mechanism. The travel of the wire from left to right, and vice-versa, is controlled by means of suitable mechanism.

A sheet of paper common to all the coils is introduced between each successive layer of convolutions and is of such length as to place several layers of paper insulation between each layer of convolutions of wire. The winding machine of the above type, by means of suitable shifting mechanism, travels from left to right, and vice versa, to wind successive layers of wire on the core or tube, and by means of suitable mechanism or manual means a sheet of insulating paper is introduced between each layer of convolutions. This sheet of paper is injected into the coil at the instant one layer is finished and the next one begins and is grasped by the strands of wire and wound into the coil simultaneously with the first, second and third turns of winding in the new layer, depending on the number of layers of paper insulation which are to be inserted between each layer of wire of the coil.

One of the objectionable features of the winding machine of the above type is that after the first layer of paper insulation is wound into the coil simultaneously with the first turn of winding of the new layer and the second layer of paper is wound into the coil, a space equal to the thickness of the paper is placed between the first and second wire turns of the new layer. Should a third layer of paper be required, a space equal to the thickness of the paper is placed between the second and third wire turns of the new layer. It may readily be seen that in addition to the thickness of the three first wire turns of a new layer the thickness of the paper between the first and second turns and the second and third turns place the beginning of the fourth wire turn slightly in advance of the predetermined feed which has been set to wind a certain number of convolutions of wire per layer. This slight advance is brought about by the two thicknesses of paper between the first and second and second and third wire turns of a new layer. Now, as the machine operates, the feed arms which carry the wire across the coil are traveling at a predetermined rate, which rate of travel is regulated by means of suitable gearing, and as the beginning of the fourth turn is slightly in advance of the feed arms, it may readily be seen that the next few turns will naturally pile up until the feed arms catch up. This piling up at the beginning of a new layer is very objectionable, as it produces a coil which is not uniform in diameter and there is more or less liability for short-circuited turns. In winding coils manually, the operator guides the wire by hand and the insertion of the paper at the beginning of a new layer and the first two or three wire turns of a new layer can be so spaced by the operator as to overcome this piling up of the first few turns. The multiple winding ma-

chines of the above type will not operate satisfactorily to prevent the above mentioned piling up when the convolutions of wire are wound closely together, and it is one of the objects of my invention to provide means which overcomes this piling up of the first few wire turns of a new layer as described above.

The movement of the rotatable spindle shaft at the instant a new layer starts in a direction opposite that of the direction of travel of the carrier, is adjustable and the spacing of these first few wire turns depends upon the adjustment of my compensating device. By means of the compensating device, the turns are not crowded ahead of the predetermined rate of travel of the carrier because, say for example, that the carrier is set to place, X number of turns of wire per inch to the layer, the instant a new layer is started the winding spindle upon which the plurality of coils is being wound is moved in a direction opposite that of the travel of the carrier feed a limited distance, and for the first few turns the number of turns per inch is reduced the desired or predetermined amount to about Y turns per inch, and this spacing of the first few turns of each new layer is brought about by means of the movement of the spindle shaft in a direction opposite that of the travel of the carrier feed for a short distance. The limited movement of the spindle shaft is adjustable by means of stops, and after the limited movement of the spindle shaft the carrier feed traveling at its predetermined rate now places X number of turns per inch on the coils until the end of the coil is reached. when again the shifting mechanism is operated and the compensating means again operates to permit the first few turns of the new layer to be spaced by means of the movement of the spindle shaft.

Another feature of my invention is the provision of a novel mechanical means for accomplishing the movement of the compensating device and the adjustable feature for limiting the movement of the spindle shaft in a direction opposite to the travel of the carrier feed at the beginning of a new layer.

Another feature of my invention is the provision of a novel differential gearing arrangement for accomplishing the movement of the carrier feed from left to right, and vice versa, as the case may be. The above features of my invention, as well as others not numerated herein, will be more fully described in the ensuing specification.

For a more complete understanding of my invention, reference may be had to the accompanying drawings, in which like reference characters in the several views denote like parts. The entire coil winding machine is of considerable size and for the purpose of more clearly illustrating my invention, I have placed the controlling mechanism, which is the left-hand portion of the machine on one sheet and the feed devices, which is the right hand portion of the machine, on a second sheet. Thus,

Fig. 1 is a plan view of the controlling mechanism of the machine, which is the left-hand portion of the machine;

Fig. 2 is a plan view of the feeding mechanism of the machine, which is the right-hand portion of the machine;

Fig. 3 is a right side elevation of the machine;

Fig. 4 is a front elevation of the controlling mechanism illustrated in Fig. 1.

Fig. 5 is a sectional view on the line 5—5 of Fig. 1;

Fig. 6 is a sectional view on the line 6—6 of Fig. 1, to illustrate the differential shifting mechanism;

Fig. 7 is an enlarged sectional view of a portion of the compensating device of my invention; and

Fig. 8 is a sectional view along the line 8—8 of Fig. 1.

Referring now more in detail to my invention as illustrated in the accompanying drawing, and first describing the main parts of the winding machine, it comprises a main frame or mounting plate 2, suitably supported upon a table or legs, not shown. The spindle shaft 3 has secured thereto a pulley wheel 4, which is connected to a power shaft by means of a suitable belt which is in turn connected to suitable tight and loose pulleys to transmit power to the pulley wheel 4 to rotate the spindle shaft 3. The power transmission mechanism is not shown, as it is not a part of my invention, and any suitable power transmission may be used for transmitting power to the spindle shaft 3.

The spindle shaft 3 is supported at its one end by means of an end plate 5, which is secured to the base plate 2 in any suitable manner, and the opening through which the shaft 3 extends serves as a bearing for the same. The spindle shaft 3 is also supported intermediate of its end in an end plate 6 and the opening through which it extends serves as a bearing for the same. The winding spindle shaft 3 has secured at its one end a gear wheel 7 and through the medium of a train of gear wheels 8, 9, 10, 11 and 12 rotary motion is transmitted to a screw shaft 14, and the ratio of the gear wheels 8, 9, 10, 11 and 12 to each other determine the number of convolutions per inch which are placed in each layer of wire of the coils that are to be wound. The screw shaft 14 is threaded and is suitably journaled in the end plates 5 and 6, and associated with the shaft 14 is a reversible gearing device D for purposes as will presently be described. A reciprocating shaft 15 is provided, which is journaled at its one

end in the end plate 5, and at an intermediate point in the end plate 6. An arm 16 is suitably secured to the shaft 15 and is provided with a threaded face which is adapted to mesh with the screw of the screw shaft 14. The shaft 15 has secured thereto a control lever 17 and has associated therewith a guide plate 18 suitably secured to the base plate 2, and the movement of the lever 17 rocks the reciprocating shaft 15 to either place the threaded face of the arm 16 in mesh with the threaded shaft 14 or rock the arm 16 so that its threaded face is out of engagement with the screw shaft 14, for purposes as will presently be described.

Referring now to Fig. 2, I illustrate the right-hand portion of the winding machine, which comprises the supply device SD supported upon a suitable base 20 upon which are secured the wire reel or spool racks or brackets RB of which I show eight, which indicates that the machine is adapted to wind eight coils simultaneously, and as each one is similar in construction, it is thought that the description of one will suffice. The spool holder RB comprises a bracket 21 to which is secured a rod 22 extending forward of the bracket 21, and secured to its free end I show a combination latch and spindle support 23. The spindle 24, which supports the spool of wire 25, has its one end journaled in the bracket 21 and its other end centered in the head 26 of the support 23, when the support is in position. The spindle support 23 is held in position by means of a latch 27, which when operated permits the support to be swung downward about its pivot 28 to permit the removal of an empty spool of wire and to permit the placing of a full spool. An arm 30 is pivotally supported on the bracket 21, and secured to its free end I show a grooved guide wheel 31. The reciprocating shaft 15 extends through the end plate 6 and lies forward of the reel or spool brackets RB, and its end is journaled in the bearing 32, which is in turn secured to the base 2. I show the reciprocating rod 15 equipped with eight guiding arms 33, which have rotatably secured thereto grooved guide wheels 34, which indicates that the machine is adapted to wind eight coils simultaneously. Wings 35, one on each side of the bracket 21 and integrally formed therewith, have secured thereto guide wires 36, and slidably mounted on the said wires is a block 37 carrying a rotatable guide wheel 38. The arm 30 is normally under tension through the agency of a coil spring 39, which has one end secured to an adjustable pin 40, which rests in a suitable orifice in the rod 22. The other end of the spring 39 is secured to one arm 41 of the bell crank lever 42 and the other arm 43 of the lever 42 has secured thereto a rod 44 whose other end is secured to the arm 30. The spindle shaft 3, which protrudes through its bearing in the end plate 6, has secured thereto a winding spindle 45 by means of a hinge joint 46, the other end of the spindle 45 being supported by means of a suitable block 47, which is secured to the base 2. The block 47 has a clamping member 48 which, when turned, permits the withdrawal of the center 49 so that the winding spindle 45 can be swung forward through the agency of the hinge 46 so that a tube may be slipped over the winding spindle 45 and forced into the chuck 50 and clamped therein by means of a suitable set screw. Next, the strands of wire 51 are led from the spools 25 which are located at the rear of the winding spindle 45, over the grooved wheel 38, thence under the guide wheel 31 on the arm 30, and thence under the guide wheels 34 on the arms 33, which arms 33 are secured to the reciprocating shaft 15, and finally to the tube on the winding spindle 45 and attached to suitable terminals in any suitable manner. The block 37 has secured to it a coil spring 251 of a very light tension, and under normal running conditions of the machine the pull of the wire strands 51 is such as to hold the block 37 against an adjustable stop 253 slidably secured to one of the guide wires 36. Now, if for any reason the strands 51 become slack, the spring 251, whose other end is suitably secured, takes up this slack and at all times holds the strands 51 taut.

Having described in general the essential parts of the multiple winding machine with which my invention is adapted to operate, I will now describe in detail the operation of my invention in connection with the winding machine to shift the spindle shaft 3 and winding spindle 45 as a whole a limited distance in a direction opposite that of the travel of the reciprocating shaft 15, for purposes as will now be described in detail. In Fig. 1, in which my invention is clearly illustrated, I show a lever 52 pivoted intermediate of its ends by means of the pivot bearing 53 secured to the base 2. The lever 52 is provided with a handle which extends forward of the machine proper, so it may be grasped by the operator. The lever 52 rests between two plates 54 and 55, and tension screws 56 and 57 are provided to exert downward pressure upon the upper plate 54 so as to produce frictional engagement between the faces of the plates 54 and 55, and the faces of the lever 52 so as to hold the lever in either of its positions. The studs 58, which serve as separators between the plates 54 and 55 also serve as stops for the lever 52 to limit the movement in its right or left direction. The lever 52 and its asso-

ciated mechanism controls the movement of the reciprocating shaft 15 to the right or left through the agency of a reversible gearing mechanism D and its associated screw shaft 14. The reversible gearing arrangement D comprises a bevel gear 60 rotatably supported upon a suitable bearing 61 which is secured to the base plate 2 and which meshes with a pair of bevel gears 62 and 63 operatively associated with the screw shaft 14. A shaft 64 is provided which is suitably journaled in the end plate 5 to permit its rotation and keyed to it is the gear wheel 12 which through its association with the gear train 8, 9, 10, etc., transmits motion to the screw shaft 14. The bevel gear 62 is secured to the shaft 14 in any suitable manner so that it rotates with the shaft 14, and being in mesh with the bevel gear 61 motion is transmitted to the said gear 61, and the said bevel gear 61 in turn transmitting motion to the bevel gear 63. The screw shaft 14 has a reduced end portion 65 of a size to fit in the orifice 66 in the end of the shaft 64, which serves as one bearing for the shaft 14, the other end being journaled in the end plate 6. The bevel gear 63 is loosely secured to the shaft 14 and suitably collared to prevent lateral movement of the same on the shaft 14. A sleeve 67 is provided which is slidably mounted upon the shaft 14 between the bevel gears 62 and 63 by means of a suitable keyway 68. The plane faces 69 and 70 of the sleeve 67 are toothed, as are the plane faces 71 and 72 of the bevel gears 62 and 63 so that when the sleeve 67 is moved to the left its toothed face 69 meshes with the toothed face 71 of the bevel gear 62, and when moved to the right its toothed face 70 meshes with the toothed face 72 of the bevel gear 63, and the meshing of these toothed faces determines the direction of travel of the reciprocating shaft 15, as will presently be described.

As illustrated, I show a connecting means between the lever 52 and the slidable sleeve 67 in the form of a rod 73, which has its one end secured to the head 74 secured to the lever 52, and its other end secured to a yoke 75, which spans the sleeve 67. The legs of the yoke 75 are provided with pins 76 which rest in the annular groove 77 in the sleeve 67 to permit the said sleeve 67 to be shifted to the right or left. The yoke 75 is pivotally supported by means of a collar 78 which is secured to the shaft 79. As illustrated in Fig. 1, I show the lever 52 moved to the right, and through the agency of the rod 73 this movement is transmitted to the yoke 75 which is in turn rocked about its pivot 79 to shift the sleeve 67 to the left to cause the toothed face 69 of the sleeve 67 to engage the toothed face 71 of the bevel gear 62. Motion is now transmitted to the sleeve 67 and as the sleeve 67 is slidably keyed to the screw shaft 14, the said screw shaft 14 is rotated and as the arm 16, which is secured to the reciprocating shaft 15, has its screw face in engagement with the thread of the screw shaft 14, the reciprocating shaft 15 is now carried to the right. By means of the gearing train and their pitch ratio to each other, the ratio of the number of revolutions of the screw shaft 14 to that of the spindle shaft 3 determines the number of convolutions of wire per inch that are to be placed in each layer of the coil.

I also provide a clutch mechanism C which is electrically controlled whereby when the last convolution of wire is put on a layer the clutch mechanism is operated to disengage the power device from the spindle shaft and stop further operation of the machine and permit the operator to actuate the lever 52 and automatically release the clutch to permit the power drive to again be placed in driving relation with the spindle shaft 3 so that the machine may start again and cause the reciprocating shaft 15 to move in a reverse direction. The pulley 4 is loose upon the spindle shaft 3 and is provided with an extension 80 whose plane face 81 is toothed. A slidable collar 82 is keyed to the spindle shaft 3 and its left face 83 is toothed so that when in mesh with the toothed face of the pulley extension 80, power may be transmitted to the spindle shaft 3. A yoke 85 pivotally supported intermediate of its ends by means of a suitable bracket 86 which cooperates with the collar 82 to move it into engagement with the power driven pulley or out of engagement with the power driven pulley 4. The legs of the yoke 85 which span the collar 82 are provided with pins 87 which rest in an annular groove 88 in the collar 82. The arm extension 89 of the yoke 85 has a reduced portion 90 which rests in the bifurcated end of the connecting rod 91, which is pivoted intermediate of its ends by means of a pivot pin 92 which is suitably secured to the base 2. The opposite end of the rod 91 is provided with a post 93 which is provided with an orifice of a size to receive a threaded stud 94 which is suitably secured to the core 95 of solenoid 96. The reciprocating shaft 15 has secured to its left extremity an arm 97 which carries a contact 98 which is operatively associated with a pair of contacts 99 and 100. The contacts 99 and 100 are mounted on a plate 101 which is slidably secured to a base 102, which base is in turn secured to the base 2. The plate 101 upon which the contacts 99 and 100 are secured is slidably supported and may be moved to the right or left a short distance for purposes as will now be described. Assuming that the reciprocating shaft 15 is traveling from right to left, at the instant that the last turn of wire is placed on the layer that the machine is winding in

a right to left direction, the contact 98 of the arm 97 engages the contact 99 on the slidable plate 101. This closure of contacts 98 and 99 establishes an energizing circuit for the solenoid 96 to attract its core 95, and due to the connection between the core 95 and the rod 91, the said rod 91 is moved about its pivot 92 to cause the end which engages the arm 89 of the yoke 85 to rotate the said yoke 85 about its pivot 105, and due to the connection between the collar 82 and the yoke 85, the said collar 82 is moved to the right to disengage the power driven pulley 4, thus stopping further winding of the machine as the pulley 4 is loose on the shaft 3. The operator now grasps the lever 52 and moves it to the right to place it in the position shown in Fig. 1. This movement of the lever 52 moves the rod 73 to the right and rotates the yoke 75 about its pivot 79 to move the sleeve 67 to the left, causing the toothed face 70 of the sleeve 67 to disengage the toothed face 72 of the bevel gear 63 and cause the toothed face 69 of the sleeve 67 to engage the toothed face 71 of the bevel gear 62. A rod 106 is provided which has its one end secured to the yoke 75 and its other end secured to a block 107 which is mounted on the sliding plate 101. Thus, when the yoke 75 is rotated about its pivot 79 when the lever 52 is actuated, the movement of the yoke 75 moves the rod 106 to the left, and as the rod 106 is connected to the plate 101, the said plate is also moved to the left, opening the contacts 98 and 99. This opening of contacts 98 and 99 opens the energizing circuit of the solenoid 96, and it releases its core 95, allowing the arm 91 to again rotate about its pivot 92 by means of suitable spring means (not shown on the drawing) and again permit the toothed face 83 of the sleeve 82 to again engage the toothed face 81 of the extension 80 of the power-driven pulley 4, and this is the position of the mechanism as illustrated in Fig. 1 and places the machine in condition to place a layer on the coils from left to right. To start the machine the operator actuates a suitable starting pedal and as the clutch is thrown in a position the shaft 3 is again connected to the power-driven pulley 4 and motion is transmitted to the screw shaft 3 in a direction to cause the reciprocating shaft 15 to travel from left to right to place another layer of wire in the core.

The foregoing description of my invention points out in detail the shifting mechanism for reversing the travel of the mechanism to place successive layers of wire on the coil. Now assuming that the operator is placing another layer of wire on the coil from left to right, and that the winding mechanism as illustrated in Fig. 1 is in a position to start placing the first convolution of wire of a new layer, I will now describe in detail the operation of the compensating device of my invention in connection with the winding mechanism. The spindle shaft 3, as before described, has a limited movement to the right or left, depending on the direction of travel of the reciprocating shaft 15, and the amount of movement or throw of the spindle shaft 3 and the winding spindle 45 is regulated by means of the collars 120—181 which are adapted to engage the bearing 6, the said collar 120 being adjustable and held in its adjusted position on the shaft 3 by means of a set screw 121. For the purpose of description, I have assumed that there are three layers of paper insulation between each successive layer of wire, and as before described, when the three layers of paper are placed between each layer, the beginning of the fourth turn of wire of a new layer is slightly in advance of the feed and causes the piling up of the next few turns of wire until the feed of the reciprocating shaft 15 has caught up. Now, to overcome this objection, I provide a compensating device which will take care of this crowding ahead of the first few turns of a new layer and comprises a supporting block 122 suitably secured to the base 2 by means of screws 123. A supporting post 124 is suitably secured to the mounting block 122 in any suitable manner and pivotally supports an arm 125. The arm 125 at its one end is provided with a yoke member 126 which spans a collar 127 loosely supported on the spindle shaft 3, and pins 128 secured to the legs 129 of the yoke 126 rest in suitable slots 130 in the collar 127, which is held in place upon the spindle shaft 3 by means of suitably secured collars 131. Thrust bearings 132 are provided and are placed on each side of the collar 127 and the secured collars 131 for the usual purposes. A pair of pins 133 and 134 are secured to each side of the arm 125, just back of the yoke 126, and slidably supported thereupon I provide a U-shaped member 135 which is held in its central position with relation to the arm 125 by means of spiral springs 136 and 137 which fit around the pins 133 and 134 and which bear respectively against the legs 139 of the U-shaped member 135 and each side of the arm 125. A connecting link 140 is provided which is pivotally supported by a bracket 141 secured to the mounting block 122 in any suitable manner. The connecting link 140 is provided with a slot 142 and is of a size to receive a threaded stud 143 which is provided with a head 144. A nut 145 is provided which has screw-threaded engagement with the threaded stud 143. A pivot pin 146 is provided which passes through a suitable opening in the stud 143 and is provided with an enlarged portion 147 which rests in a slot 148 in the bracket 141. The pivot pin

146 is threaded at each end to receive nuts 149 which pivotally support the link 140 and stud 143 as a whole on the bracket 141. One end of the link 140 is provided with a bifurcated end 150 which is adapted to receive a pin 151 which sets in a stud 152 secured to the U-shaped member 135. A link connection 153 is provided and its one end has secured thereto a stud 154 which rests in a suitable opening in the lever 52. The other end of the link 153 is bifurcated and secured to this bifurcated end is a member 155 which is provided with an opening of a size to receive the threaded reduced portion 156 of the link 140. A spring 157 is placed around the threaded portion 156 of the link 140 between the link 140 and member 155 and a bolt 158 which has screw-threaded engagement with the threaded portion 156 holds the link connection 153 in place on the link 140. The arm 125 is provided with a slot 160 which is of a size to receive a lug 161 which is integrally formed with a plate 162 supported upon the upper face of the arm 125 and which plate 162 is provided with extended sides which form guiding means for the plate 162. A friction plate 163 provided with a leather face 164 secured to the said plate 163 is pivotally secured to the plate 162 by means of a pivot bolt 165 which passes through suitable openings in the friction plate 163 and plate 162 and held against displacement by means of a nut 166 which has screw-threaded engagement with the threaded end of the bolt 165. An orifice 167 in the end of the arm 125 is of a size to receive a suitable helical spring 168 and is threaded to receive the screw 169 which, when tightened, places the spring 168 under compression to place the plate 162 and friction plate 163 as a whole under spring tension, for purposes which will presently be described. Secured to the reciprocating shaft 15 by means of a clamp 170 is a friction plate 171 provided with a leather face 172 suitably secured to the said plate 171, and which cooperates with the friction plate 163 supported by the arm 125. Adjustable stops 173 are mounted on the plate 171 and are adjustably secured thereto by means of screws 174.

Having described the apparatus which comprises my compensating device, I will now describe in detail its operation. When the lever 52 has been moved to the position shown in Fig. 1, which is the position of the lever 52 when the reciprocating shaft 15 starts its travel from left to right, the movement which placed the lever in this position causes the connecting link 140 to be rotated about its pivot 146 due to the link connection 153 between lever 52 and the link 140. This moves the bifurcated end 150 of the link 140 to the left, and due to its connection with the U-shaped member 135, the said member 135 is forced to the left, causing the right-hand spring 137 around the pin 134 to be compressed against its normal tension. Now, the instant that the operator operates the clutch pedal to apply power to the power drive pulley 4, motion is transmitted to the screw shaft 14 through the train of gearing and the gearing mechanism D, and as the arm 16 of the reciprocating shaft 15 is in engagement with the screw shaft 14, the shaft starts to travel to the right. The friction plate 171 which is secured to the reciprocating shaft 15 is carried along with the said shaft 15 the instant the movement of the shaft 15 starts, and as the friction plate 163 which is pivotally supported upon the arm 125 is spring-pressed into engagement with the plate 171, a drag is created between the two plates 163 and 171, and due to the fact that the arm 125 is pivotally supported upon the post 124, this drag between the plate 171 on the reciprocating shaft 15 and the plate 163 secured to the arm 125 causes the yoke portion 126 of the said arm 125 to move to the left, and as the pins 128 of the yoke 126 rest in suitable slots 130 in the collar 127, and due to the fact that the collar 127 is secured to the spindle shaft 3 against lateral movement, this movement is transmitted to the spindle shaft 3, moving it to the left a limited distance. To aid in making the movement of the shaft 3 take place simultaneously with the start of the travel of the reciprocating shaft 15, the spring 137 which was compressed when the lever 52 was moved to the right aids in forcing the arm 125 about its pivot to produce a positive movement of the shaft 3 the instant the reciprocating shaft 15 starts its travel from left to right. When the reciprocating shaft 15 is moving from left to right the spindle shaft 3 is moved to the left as described above, and its limited movement to the left is stopped by the face 180 of the collar 181 on the spindle shaft 3 engaging the bearing face of the shaft 3 in the end plate 6. Now, when the reciprocating shaft 15 is to travel from right to left, the lever 52 is moved to the left, causing the left spring 136 around the pin 133 of the member 135 to be compressed, and the instant that the shaft 15 starts its travel from right to left, the shaft 3 is moved to the right due to the drag between the two plates 163 and 171 and the compressed spring 136 as above described in association with the drag created between the plates 163 and 171 move the shaft 3 from left to right. From the above description it may be seen that the reciprocating shaft 15 which carries the feed arms 33 moves to the right at a predetermined rate, determined by the ratio of the gear train between the power drive and the screw shaft 14. The spindle shaft 3 rotates a prede-

termined number of times per minute, and due to the connection between the winding spindle 45 and the spindle shaft 3, the winding arbor or spindle 45 travels at the same rate, and as the reciprocating shaft 15 travels to the right at a predetermined rate, depending upon the gearing ratio, a certain number of turns of wire per layer are placed on the coils being wound. The instant that a new layer is started a sheet of paper insulation is inserted and injected in the coil by the operator, the sheet of paper insulation being caught between the last layer of wire and the strands of wire 51 and due to the rotation of the shaft 45 the sheet of insulation is wound into the coil and held therein by the new layer of wire, and at the instant that the new layer is started the movement of the spindle shaft 3 and winding spindle 45 takes place in a direction opposite that of the travel of the reciprocating shaft 15 and the rate of turns per inch for the first three turns is reduced and they are, therefore, spaced apart. Now, when the movement of the spindle shaft 3 is stopped due to the face of either collars 120 or 181 engaging the faces of the bearing of the shaft 3 in the end plate 6, depending upon the direction of travel of the reciprocating shaft 15, the said reciprocating shaft 15 continues to place the predetermined number of turns per layer on the coil. This spacing of the first few turns of a new layer eliminates the crowding of the first few turns of a new layer ahead of the predetermined feed rate, as is the case of the multiple winding machines of the type now in use, and produces a coil which is wound evenly, and all danger of piling up of the first few turns at the beginning of each layer is eliminated.

The amount of compression that may be placed upon the springs 136 and 137 around the pins 133 and 134, and which cooperate with the U-shaped member 135, is regulated by means of the stud 144 and nut 145 and pivot screw 146 which as a whole may be moved up in the slot 142 in the connecting link 140 to give the link a short throw about the pivot 146 in either direction to place a light tension on the springs 136 or 137 when the lever 52 is moved to the right or left and when the stud 144, nut 145 and pivot 146 as a whole is moved down in the slot 142, to give the bifurcated end of the link 140 a larger throw to give the springs 136 or 137 a stiff tension when the lever is moved to the right or left. The tension under which the springs 136 and 137 are to act may be accomplished by the means just described, and to obtain a finer adjustment of the springs 136 or 137 the nut 158 may be turned to move the end of the link 153 up or down, as the case may be, to change the distance between the centers of the pivot 146 and the connection link center, thus regulating the throw of the link to the right or left to a fine degree.

While I have described my invention operating in connection with a particular type of multiple winding machine, I do not wish to limit the application of my invention to a particular type of winding machine, as my invention is applicable to other types of winding machines. I also do not wish to be limited to the exact structure as shown, as changes and modifications will readily suggest themselves and I, therefore, aim to cover all such changes and modifications as come within the spirit and scope of the appended claims.

What I claim as new and desire to secure by United States Letters Patent, is:

1. A machine of the class described comprising a winding spindle, reciprocating means for feeding a strand of wire thereon in layers to form a coil, and means for shifting the winding spindle longitudinally a predetermined distance during the feeding operation of said reciprocating means and at the beginning of each layer.

2. A machine of the class described comprising a winding spindle, reciprocating means for feeding a strand of wire thereon in layers to form a coil, and means for shifting the winding spindle longitudinally a predetermined distance in a direction opposite to the travel of said reciprocating means and at the beginning of each layer.

3. A machine of the class described for winding strands of wire into coils, a winding spindle, power means for rotating said winding spindle, reciprocating means and guiding members therefor for directing the strands to said spindle, a gear train associated with said reciprocating means to transmit motion thereto from said power means, and means for shifting said winding spindle longitudinally a predetermined distance at the beginning of each layer during the feeding operation of said reciprocating means.

4. A machine of the class described for winding strands of wire into coils, a winding spindle and power means for rotating the same, a reciprocating means and guiding members therefor, a feed device associated with said reciprocating means, a gear train associated with said power means for operating said feed device to move said reciprocating shaft and means for shifting the winding spindle longitudinally a predetermined distance during a part of the travel of said reciprocating means.

5. A machine of the class described comprising a winding spindle, reciprocating means for feeding a strand of wire thereon in layers to form a coil, an arm associated with said reciprocating means, a threaded shaft in engagement with said arm for mov-

ing said reciprocating means in one direction, means for reversing the direction of travel of said reciprocating means, and means for effecting a predetermined longitudinal movement of said winding spindle at the beginning of each layer.

6. A machine of the class described comprising a winding spindle, a reciprocating shaft and guiding members therefor for feeding a strand of wire thereon in layers to form a coil, an arm associated with said shaft, a threaded shaft with which said arm is in engagement for moving said reciprocating shaft in one direction, gearing means, a lever for actuating said means to start the travel of said reciprocating shaft in a reverse direction, and means for effecting a predetermined longitudinal movement of said winding spindle at the beginning of each layer.

7. A machine of the class described comprising a winding spindle, a reciprocating rod and guiding members therefor for feeding a strand of wire thereon in layers to form a coil, an arm associated with said rod, a threaded shaft with which said arm is in engagement for moving said rod in one direction, reversible gearing means, and a lever for actuating said reversible gearing means at each end of the traverse of said reciprocating rod to reverse the direction of travel of said rod, and means for shifting the winding spindle longitudinally a predetermined distance in a direction opposite that of the travel of said rod at the beginning of each layer.

8. A machine of the class described comprising a winding spindle, a reciprocating rod for laying strands of wire in layers thereon, an arm on said rod, a threaded shaft in engagement with said arm to cause the travel of said rod, reversible gearing means, a lever for actuating said means at each end of the traverse of said rod to reverse the direction of travel of said rod and means also under the control of said lever when actuated to shift the winding spindle longitudinally a set distance in a direction opposite that of the longitudinal travel of said rod at the instant of reversing the travel of said rod to start a new layer.

9. A machine of the class described comprising a winding spindle, reciprocating means for feeding a strand of wire to said winding spindle, to form a coil, and means operatively associated with said reciprocating means and winding spindle for effecting predetermined longitudinal movement of said winding shaft relative to said reciprocating means at the beginning of each layer of the coil.

10. A machine of the class described comprising a winding spindle, feed mechanism for feeding strands of wire to said winding spindle where said strands of wire are wound into layers to form coils, reciprocating means for guiding said strands of wire to said winding spindle, and automatic means for moving said winding spindle a predetermined amount in a longitudinal direction at the beginning of each new layer of wire.

11. A machine of the class described including a winding spindle, feed mechanism for feeding strands of wire to said winding spindle where the same is wound in layers to form coils, a rod having guiding means secured thereon for guiding said strands of wire to said winding mechanism, means for moving said rod in a right and left longitudinal direction during the winding of said coil, and means associated with said rod and said winding spindle for causing said winding spindle to move longitudinally a predetermined distance in a direction opposite to the directional movement of said rod at the beginning of each new layer.

12. A machine of the character described including a winding spindle, feed mechanism for feeding strands of wire to said winding spindle to form coils, guiding means intermediate said feed mechanism and said winding spindle for guiding said strands of wire to said winding spindle, means for effecting a reciprocating movement of said guiding means during the winding of said coil, and means for effecting a limited longitudinal movement of said winding spindle in a direction opposite to the directional movement of said guiding means at the beginning of each new layer.

13. A machine of the character described including a winding spindle, a feeding mechanism for feeding a strand of wire to said winding spindle, where said strand is wound into layers to form a coil, a rod having guide arms secured thereon for guiding said strand of wire on said winding spindle, means for causing said rod to move in a longitudinal direction during the winding of said coil but alternating from right to left at each successive layer of wire, and automatic means for moving said winding spindle a predetermined distance in a longitudinal direction opposite to the longitudinal movement of said rod at the beginning of each new layer, and adjustable means for said automatic means for controlling the length of longitudinal movement of said winding spindle.

14. A machine of the character described including a winding spindle, feed mechanism for feeding strands of wire to said winding spindle to form coils, guiding means intermediate of said feed mechanism and said winding spindle for guiding strands of wire to said winding spindle, means for effecting reciprocating movement of said guiding means during the winding of said coil, means secured to said guiding means in frictional engagement with a frictional member

associated with a pivoted lever connected with said winding spindle, said mechanical means and frictional members causing a movement of said pivoted lever for effecting longitudinal movement of said winding spindle in a direction opposite to the directional travel of said guiding means.

15. A machine of the character described including a winding spindle, feed mechanism for feeding strands of wire to said winding spindle to form coils, guiding means intermediate of said feed mechanism and said winding spindle for guiding strands of wire to said winding spindle, means for effecting reciprocating movement of said guiding means during the winding of said coil, means secured to said guiding means in frictional engagement with a frictional member associated with a pivoted lever connected with said winding spindle, said means and frictional member causing movement of said pivoted lever for effecting a predetermined longitudinal movement of said winding spindle in a direction opposite to the directional travel of said guiding means at the beginning of each new layer of said coils.

16. A machine of the character described including a winding spindle, feed mechanism for feeding a strand of wire to said winding spindle in layers to form a coil, a reciprocating shaft intermediate of said feed mechanism and said winding spindle supporting guiding arms on said reciprocating shaft for carrying said strands of wire to said winding spindle, means for effecting to and fro movement of said reciprocating shaft during the winding of said coil, a member secured to said reciprocating shaft in frictional engagement with a second member associated with a pivoted lever connected with said winding spindle, said first and second members effecting a predetermined longitudinal movement of said winding spindle in a direction opposite to the directional travel of said reciprocating shaft at the beginning of each new layer of said coil.

17. A machine of the class described including a winding spindle, a reciprocating rod having members secured thereon for guiding a strand of wire to said winding spindle where the same are wound into layers to form a coil, means for driving said reciprocating rod and said winding spindle, manual means for starting the operation of said reciprocating rod and winding spindle, electrical means for stopping the operation of said rod and spindle upon the completion of each layer of wire, and means associated with said reciprocating rod and said winding spindle for causing said winding spindle to move in a predetermined longitudinal direction opposite to that of said reciprocating rod upon the first few revolutions of said winding spindle.

18. A machine of the class described including a winding spindle, a reciprocating rod having members secured thereon for guiding strands of wire to said winding spindle where the same are wound into layers to form coils, means for driving said reciprocating rod and said winding spindle, manual means for starting the operation of said reciprocating rod and winding spindle, electrical means for stopping the operation of said rod and spindle upon the completion of each layer of wire, means associated with said reciprocating rod and said winding spindle for causing said winding spindle to move in a longitudinal direction opposite to that of said reciprocating rod upon the first few revolutions of said winding spindle, and adjustable means for said last means for regulating the extent of longitudinal movement of said winding spindle.

19. A machine of the class described comprising a winding spindle, a reciprocating shaft and guiding members therefor for feeding strands of wire thereon in layers to form coils, a lever associated with said reciprocating shaft for shifting the said winding spindle longitudinally at the beginning of each new layer and means for limiting the amount the winding spindle is shifted longitudinally.

20. A machine of the class described comprising a supporting frame, a winding spindle, a reciprocating shaft and a guiding member therefor for feeding a strand of wire thereon in layers to form a coil, a lever associated with said reciprocating shaft for shifting the said winding spindle longitudinally at the beginning of each new layer and a pair of drums located on said winding spindle and on opposite sides of the said supporting frame, through which the winding spindle extends, for limiting the amount of longitudinal shifting of the said winding spindle.

21. A machine of the class described comprising a supporting frame, a winding spindle, a reciprocating shaft and guiding members therefor for feeding strands of wire thereon in layers to form coils, a lever associated with said reciprocating shaft for shifting the said winding spindle longitudinally at the start of each new layer and a pair of drums, located on said winding spindle and on opposite sides of said supporting frame through which the winding spindle passes, for limiting the amount the winding spindle is shifted longitudinally, one of said pair of drums entering into engagement with one side of said supporting frame when the spindle is shifted in one direction and the other of said drums entering into engagement with the opposite side of the said supporting frame when the spindle is shifted in the other direction, said engagements of said drums and said supporting frame effectually limiting the amount

of longitudinal shifting of the said spindle.

22. A machine of the character described comprising a supporting frame, a winding spindle, a reciprocating shaft and a guiding member thereon for feeding a strand of wire to said winding spindle in layers to form a coil, a lever associated with said reciprocating shaft for shifting the said spindle longitudinally at the start of each new layer in a direction opposite to that in which the reciprocating shaft is traveling and a pair of drums located on said spindle and on opposite sides of the said supporting frame through which the spindle passes, said drums adapted to engage with opposite sides of the said supporting frame to limit the longitudinal shifting of said winding spindle, the distance the winding spindle is shifted being substantially the same as the distance between the sides of the supporting frame and each of said drums.

23. A machine of the character described comprising a solenoid, a supporting frame, a winding spindle, a reciprocating shaft and guiding members thereon for feeding strands of wire thereon in layers to form coils, a threaded shaft, an arm associated with said threaded shaft and said reciprocating shaft for imparting a reciprocal movement to said reciprocating shaft, an arm, carrying an electrical contact, adapted to move with said reciprocating shaft, a pair of electrical contacts, located on said supporting frame but insulated therefrom, for completing an electrical energizing circuit for the said solenoid when either contact is engaged by the said movable contact.

24. A machine of the character described comprising a solenoid, a supporting frame, a winding spindle, a reciprocating shaft and a guiding member thereof for feeding a strand of wire thereon in layers to form a coil, a threaded shaft, an arm associated with said threaded shaft and said reciprocating shaft for imparting a reciprocal motion to said reciprocating shaft, an arm, carrying an electrical contact, adapted to move with said reciprocating shaft, a pair of electrical contacts, located on said supporting frame but insulated therefrom, for completing an electrical energizing circuit for the said solenoid when either contact is engaged by the said movable contact, one of said contacts engaging with said moving contact when the said reciprocating shaft has reached one of its extremities of movement and the other of said contacts adapted to engage with said moving contact when the reciprocating shaft has reached its other extremity of movement.

25. A machine of the character described comprising a supporting frame, a solenoid, a winding spindle, a reciprocating shaft, and guiding members thereof for feeding strands of wire thereon in layers to form coils, a movable electrical contact associated with said reciprocating shaft, a pair of contacts slidably located on said supporting frame but insulated therefrom, adapted to engage with said movable contact to complete an electrical energizing circuit for said solenoid, and means for disengaging either of said pair of contacts from said movable contact to de-energize the said solenoid.

26. A machine of the character described comprising a supporting frame, a winding spindle, power means for driving said winding spindle, a solenoid, a pair of contacts adapted to engage a moving contact to energize said solenoid to disconnect said power means from said winding spindle, means to disengage either of said contacts from said moving contact to de-energize said solenoid and means, actuable after said de-energization, to permit the reconnection of said power means to said winding spindle.

Signed by me at Chicago, in the county of Cook and State of Illinois, this 12th day of April, 1922.

MARTIN B. GROUT.