Sept. 3, 1946. A. H. MULLER 2,406,846

WINDING MACHINE

Filed June 28, 1940 2 Sheets-Sheet 1

FIG. 1

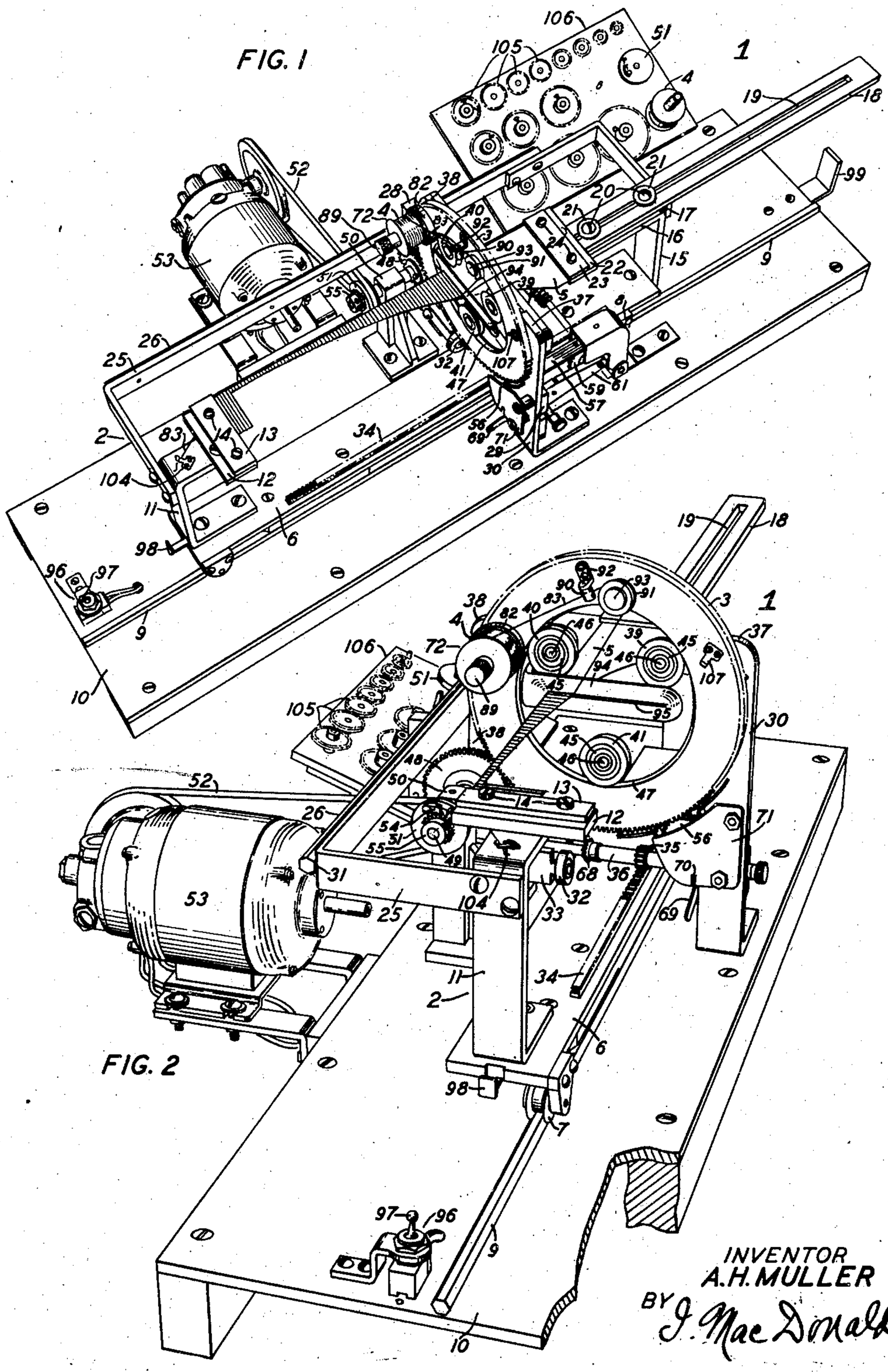

FIG. 2

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FIG. 3

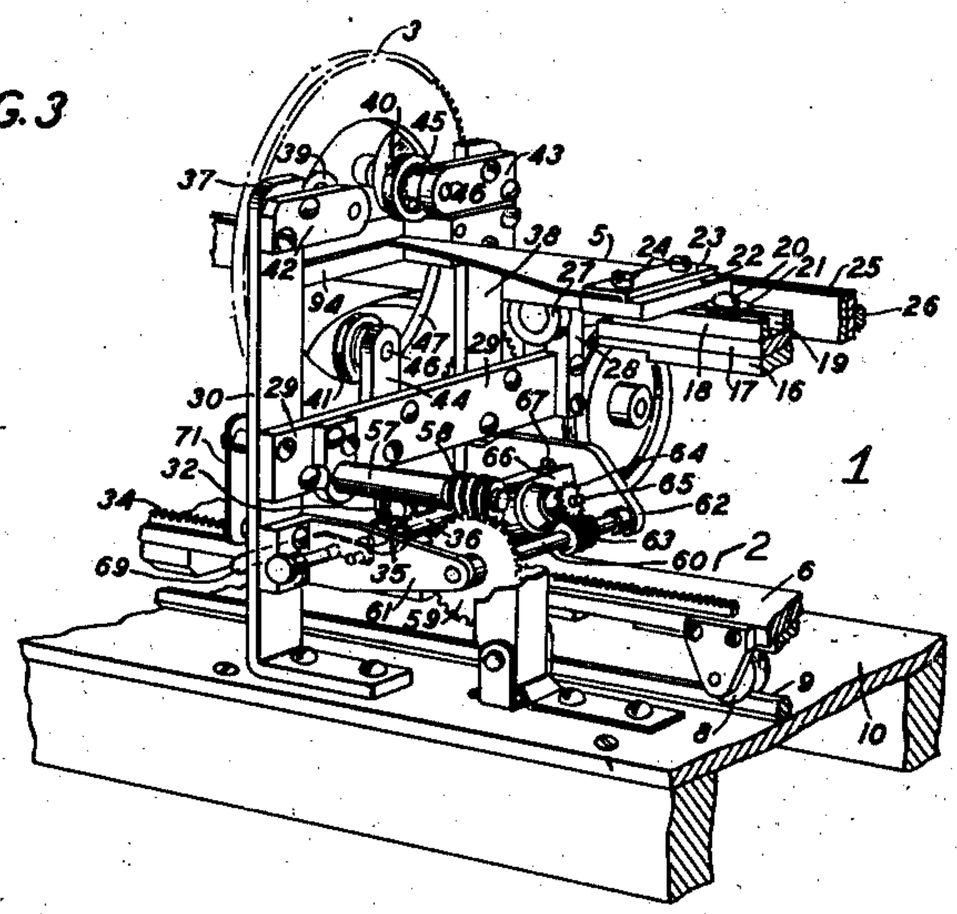


FIG. 4

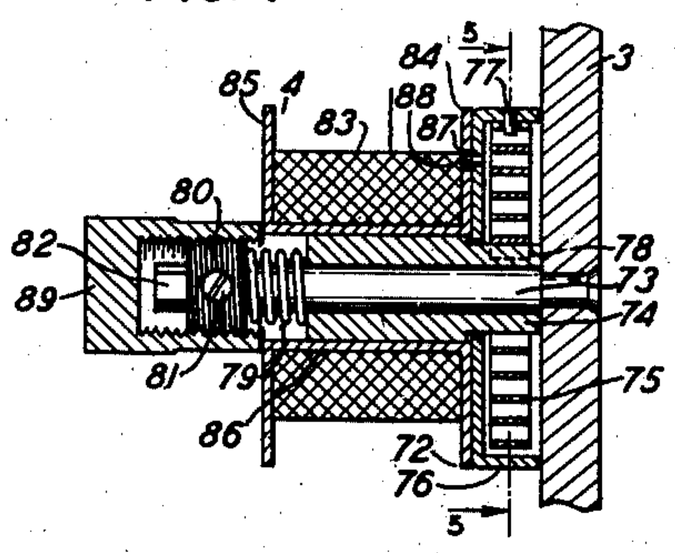


FIG. 5

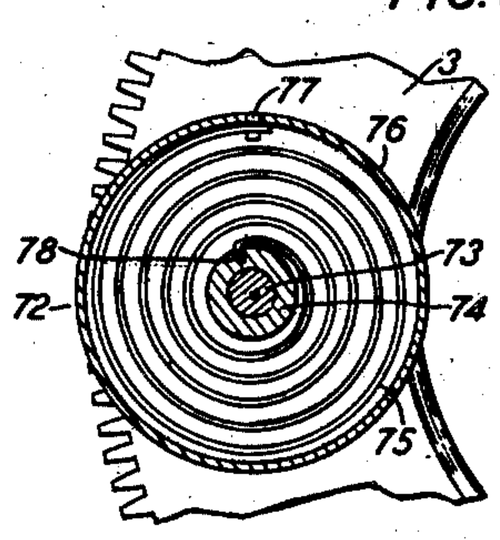


FIG. 6

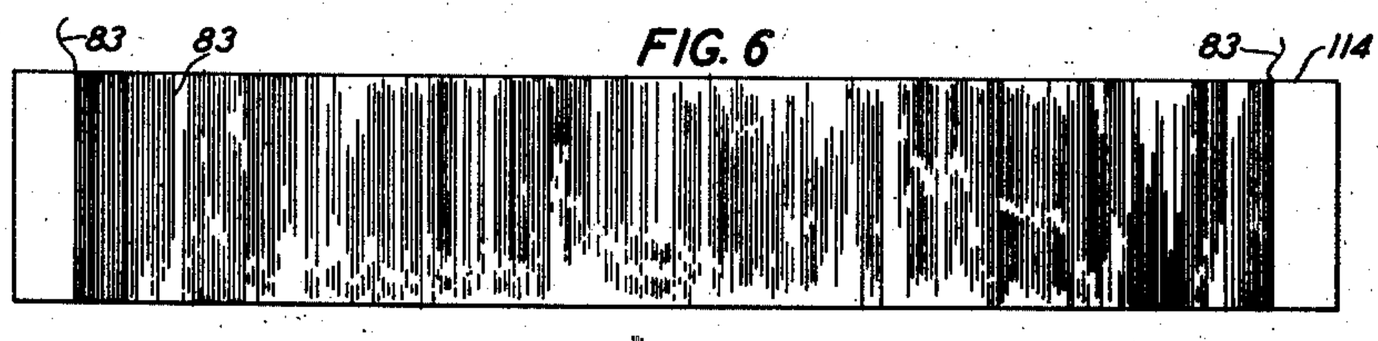


FIG. 7

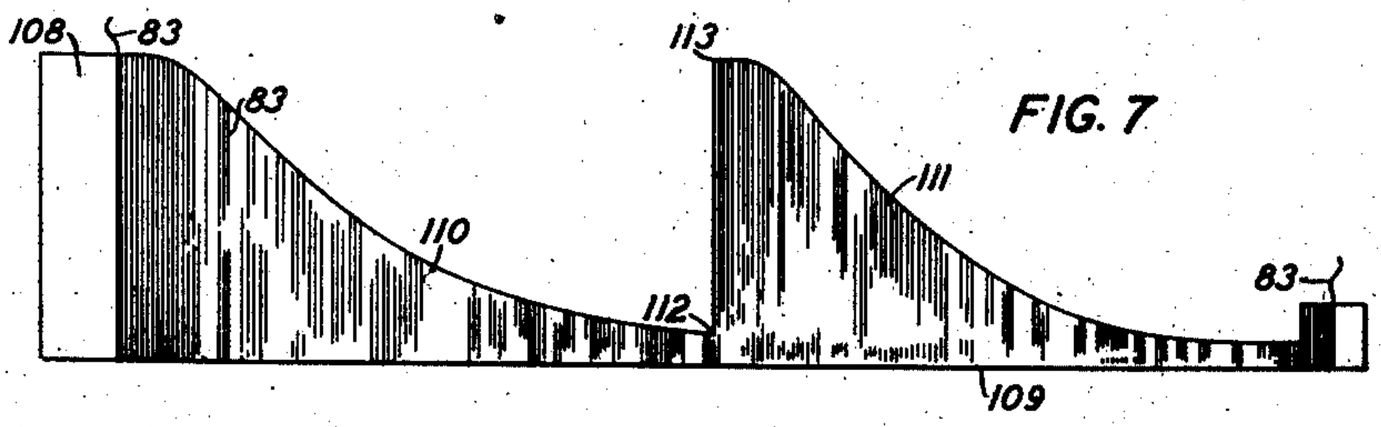
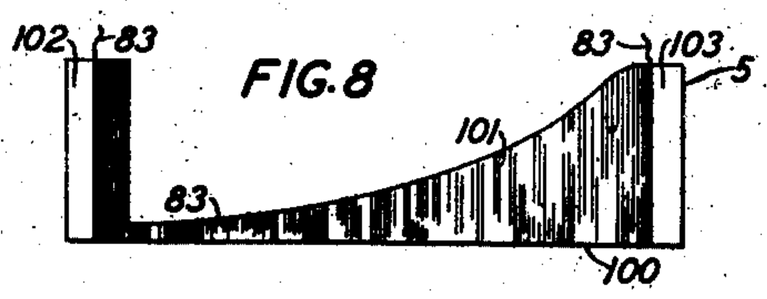


FIG. 8



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UNITED STATES PATENT OFFICE

2,406,846

WINDING MACHINE

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Application June 28, 1940, Serial No. 342,885

4 Claims. (Cl. 242—9)

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This invention relates to winding machines and more particularly to machines for winding strand material onto supports.

The object of the invention is to provide a machine capable of accurately winding a wire onto a support when the distance between a spool of the wire and the point of application of the wire to the support is changing during the winding operation.

A feature of the invention resides in a carriage means for holding the support on which the wire is being wound.

Another feature resides in a brace for holding the support against distortion.

Another feature resides in wire guiding means for guiding the wire onto the support.

Another feature resides in a windlass involving means for automatically controlling the tension of the wire as it runs from a spool to the support upon which the wire is being wound.

Other features reside in the particular form of the parts and their arrangement in combination.

In the drawings:

Figs. 1 and 2 are respectively a top and an end view in perspective of the winding machine;

Fig. 3 is a view in perspective and partly in section of a portion of the machine and taken from the lower right corner of Fig. 1;

Fig. 4 is a side view, partly in section, of the windlass with a supply of wire supported thereon and a portion of a ring gear of the machine, the windlass being supported on the ring gear;

Fig. 5 is an end view, partly in section, of a portion of the windlass and a portion of the ring gear of the machine taken on the line 5—5 in Fig. 4; and

Figs. 6, 7 and 8 show various forms of supports and resistance windings on the supports.

In making wire wound electrical devices comprising a strip of comparatively thin insulating material and a winding of wire on the strip, and more particularly in making so-called tapered form resistance elements comprising a tapered strip of insulating material and a winding of resistance wire on the strip, it is often found difficult to accurately wind the wire on the strip due to the fact that there is a constantly changing distance between the point of application of the wire to the strip and the means for feeding the wire onto the strip. The wire must be maintained in a taut condition while it is being fed onto the strip in order that accurate winding may be accomplished. The tension of the wire,

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however, must not be such as to cause breaking of the wire or distorting of the strip.

In the winding machine I have invented and which is shown in Figs. 1, 2 and 3, means are provided for holding a flat strip of insulating material against distortion while the wire is being wound on the strip and means are also provided to maintain a constant tension on the wire during the winding operation.

The machine 1 comprises a longitudinally movable carriage 2 and a relatively large rotatable ring gear 3 which is adapted to carry a spool of wire 4 around the line of travel of a strip of insulating material supported on the carriage 2. The strip of insulating material may be of any desired form, one of which is shown at 5, and in Fig. 8. The carriage 2 comprises a rectangular platform 6 equipped with flanged wheels 7 and 8 which ride on a track 9 supported on a base plate 10. Supported on and extending upward from one end portion of the platform 6 is an arm 11 on the upper end of which is a block 12 and a clamp plate 13 equipped with screws 14. An arm 15 is carried by and extends upward from the other end portion of the platform 6, the arm 15 being in alignment with the arm 11 and having a relatively long flat upper portion 16 secured to the upper surface of which is a plate 17. Adjustably supported on the plate 17 is a relatively long flat bar 18. The bar 18 has an elongated aperture 19 running almost the full length of the bar and is adjustably held on the plate 17 by means of screws 20 and washers 21, the screws 20 extending through the aperture 19 and into the plate 17. A block 22 is welded or otherwise secured across one end portion of the bar 18 to support a clamp plate 23 which is secured in place by means of screws 24 extending through the clamp plate 23 and into the block 22. The bar 18 with its block 22 and clamp plate 23 and the arm 11 with its block 12 and clamp plate 13 are used in cooperation as supporting means for a strip of insulating material on which a wire is to be wound, one end of the strip being clamped between the block 12 and the clamp plate 13 and the other end of the strip being clamped between the block 22 and the clamp plate 23. The bar 18 is arranged to be adjustably supported on the plate 17 to accommodate different length strips of insulating material. A U-shaped bracket 25 equipped with a track 26 is supported on the arms 11 and 15 and so that the track 26 runs parallel with and in an elevated and offset position relative to the track 9. The track 26 rests on a flanged wheel 27 which is suitably supported on

a post 28 on a cross-bar 29 which forms part of a stationary frame 30. It will be seen that the bracket 25 and the track 26 are entirely clear of the ring gear 3 and that the carriage 2 may be moved lengthwise along the bed plate 10, the carriage 2 having three points of support comprising the wheels 7 and 8 riding on the track 9 and the track 26 riding on the wheel 27. The tracks 9 and 26 are made hexagonal in cross-section and the forms and arrangements of the wheels operating thereon are such that extremely true running of the carriage 2 is obtained. The track 9 has its under flat surface secured to the base plate 10 and presents three upper flat surfaces to the wheels 7 and 8 which are suitably formed to bear against the three upper flat surfaces of the track 9. The track 26 has one of its flat faces secured against the flat portion of the bracket 25 as shown at 31 in Fig. 2 and presents a V-shaped surface to the wheel 27 supported on the post 28, the wheel 27 having a V-shaped peripheral groove to receive the lower faces of the track 26. Side play of the carriage 2 is thus reduced to a minimum by the form and arrangement of the tracks and wheels. A roller 32 supported on an arm 33 of the frame 30 bears against an upper surface of the platform 6 to prevent tilting of the carriage 2 on its points of support. A rack 34 supported on the upper surface of the platform 6 and a pinion 35 on a rotatable shaft 36 are provided to longitudinally move the carriage 2.

The frame 30 is mounted in an upright position on the base plate 10 and comprises spaced L-shaped brackets 37 and 38 and the cross-bar 29. Three wheels 39, 40 and 41 are supported in equally spaced relation by posts 42, 43 and 44 extending from the frame 30, the wheels 39, 40 and 41 being arranged in a triangular formation and operating on suitable bearings 45 supported on pins 46 supported on and extending from the posts 42, 43 and 44. The wheels 39, 40 and 41 have V-shaped peripheral grooves adapted to receive the inner surface 47 of the ring gear 3, the inner surface 47 being double beveled to fit into the peripheral groove on the wheels 39, 40 and 41.

The ring gear 3 is supported by and is rotatably movable on the wheels 39, 40 and 41 and is driven by means of a pinion 48 mounted on a rotatable shaft 49 supported in a suitable bearing in a stand 50 which extends upward from the base plate 10. A pulley 51 rotatably supported on the shaft 49 is driven by means of a belt 52 running from a motor 53. A dog 54 pivotally supported on the pulley 51 engages a ratchet wheel 55 which is secured to the shaft 49. When the pulley 51 is driven in one direction the dog 54 transmits rotational movement of the pulley 51 to the shaft 49 and causes corresponding rotation of the pinion 48. The normal direction of movement of the pulley 51, the shaft 49 and the pinion 48 is clockwise when viewed in the position shown in Fig. 2 and the normal direction of movement of the ring gear 3 is counterclockwise. The ring gear 3 may be manually moved in this direction without applying a pull to the motor 53. If the dog 54 is lifted out of engagement with the teeth of the ratchet wheel 55 the ring gear 3 may be manually rotated in a reverse direction without pulling the motor 53.

The ring gear 3 is in mesh with a pinion 56 which is attached to a rotatable shaft 57 suitably supported in the frame 30. The shaft 57 has a worm end 58 in mesh with a worm wheel 59 attached to a rotatable shaft 60 which is journaled

in two spaced brackets 61 and 62 supported on the frame 30. The shaft 60 is equipped with a worm 63 in mesh with the worm wheel 64 which is removably mounted on a stub shaft 65 journaled in a block 66. The block 66 is adjustably supported on the bracket 62 by means of a screw, not shown, but which projects through an elongated aperture 67 in the bracket 62 and into the block 66. The stub shaft 65 is equipped on one end with a bevel gear, not shown, but which is adapted to engage a bevel gear 68 on the shaft 36. When the stub shaft 65 is rotating and the bevel gear on the stub shaft is in engagement with the bevel gear 68 the shaft 36 is rotated to move the carriage 2 along the track 9 on the bed plate 10 of the machine, the pinion 35 on the shaft 36 being in engagement with the rack 34 on the carriage 2. The shaft 36 is rotatably supported in suitable bearings in the brackets 61 and 62 and is longitudinally movable within the bearings so that the bevel gear 68 may be moved into or out of engagement with the bevel gear on the stub shaft 65 and the pinion 35 may be moved into or out of engagement with the rack 34. A latch arm 69 pivotally supported on the bracket 61 is provided to hold the shaft 36 in longitudinally adjusted position, the latch arm 69 having a notch formed in its lower edge and the shaft 36 having two spaced annular grooves to receive the notched portion of the latch arm. When the latch arm 69 is lifted into a notch 70 in a plate 71, on the frame 30, the latch arm is out of engagement with the shaft 36. The shaft 36 may then be longitudinally moved to move the bevel gear 68 relative to the bevel gear on the stub shaft 65 and bring one of the annular grooves in the shaft 36 under the notch portion of the latch arm 69. Release of the latch arm 69 will then result in engagement of the latch arm 69 in the selected groove on the shaft 36 to hold the shaft 36 in a required position.

A windlass 72 is carried by the ring gear 3 to carry a spool 4 of wire around the line of travel of a support upon which the wire is to be wound. The support may be, for instance, the support 5 shown in Figs. 1, 2, 3 and 8 or may be any other desired form of support such, for instance, as shown in Figs. 6 and 7. The windlass 72 comprises as shown in Figs. 4 and 5 a cylindrical rod 73 secured at one end to the ring gear 3 and projecting normal to the plane of the ring gear, a sleeve 74 rotatably supported on the rod 73, a spiral spring 75 and a cup-shaped housing 76 for the spring 75. The cup-shaped member 76 is rotatably supported on the sleeve 74 and is secured by means of a pin 77 to the outer end of the spring 75. The inner end of the spring 75 is secured in a slot 78 in the sleeve 74. The sleeve 74 is normally held against rotation on the rod 73 by means of a helical spring 79 which is disposed on the rod 73 between an outer end of the sleeve 74 and a male-threaded collar 80, the collar 80 being adjustably supported on the rod 73 by means of a set screw 81 engaging a flat portion 82 of the rod 73. The spring 79 is compressed to a sufficient extent to press the inner end of the sleeve 74 into frictional engagement with the ring gear 3, the spring pressure being regulated by moving the collar 80 along the rod 73. By suitable adjustment of the collar 80 along the rod 73 the sleeve 74 may be so pressed against the ring gear 3 as to hold the sleeve 74 against rotation on the rod 73 while the housing 76 is being rotated to wind up the spiral spring 75. When the spring 75 is fully wound up and a further rotational force is applied

to the housing 76, the sleeve 74 will slip around on the rod 73 since it is only frictionally held by the pressure of the spring 79. Any desired spring pressure may be obtained by movement of the collar 80 along the rod 73 or by making the spring 79 of relatively light or heavy spring material. The windlass 72 is equipped with a spool 4 containing a supply of wire 83, the spool 4 comprising the spoolheads 84 and 85 and the barrel portion 86. The spoolhead 84 is apertured or indented at 87 to receive a pin 88 projecting from the cup-shaped housing member 76. The spool 4 is mounted on the sleeve 74 so that the spoolhead 84 is against the bottom of the cup-shaped housing member 76 and the pin 88 is in the aperture or indentation 87. An internally threaded cap 89 is mounted on the collar 80 to prevent accidental withdrawal of the spool 4 from the sleeve 74, the cap 89 having its inner end located adjacent the outer face of the spoolhead 85. The cap 89 is not turned down tight enough on the collar 80 to prevent rotation of the spool 4 but is only turned to a sufficient extent to prevent disengagement of the pin 88 from the aperture or indentation 87 in the spoolhead 84. The cap 89 may be readily removed by hand to permit withdrawal of the spool 4 from the sleeve 74 and to permit changing of the position of the collar 80 to change the pressure of the spring 79.

When wire is being withdrawn from the spool 4 the pull on the wire 83 causes rotation of the spool 4 and corresponding rotation of the housing 76 to wind up the spring 75. The energy stored up in the spring 75 will cause a reverse movement of the housing 76 and the spool 4 if the pull on the wire 83 is released or lessened to a sufficient extent to create a slack in the wire extending from the spool. This reverse movement of the housing 76 and the spool 4 will cause rewinding of the wire 83 onto the spool 4. Should the spring 75 become fully wound up during the withdrawal of the wire 83 from the spool and the pull on the wire is continued, the sleeve 74 will slip around on the rod 73 and thus prevent breaking of the wire 83. Since the pressure of the spring 79 can be readily adjusted by the setting of the collar 80 and the spring 79 can be replaced by a lighter or a heavier spring the windlass 72 can be made to take care of wires of different tensile strengths.

Wire guiding means are provided on the ring gear 3 as shown in Figs. 1 and 2 to guide the wire 83 from the spool 4 onto a support 5 carried by the carriage 2. The wire guiding means comprise a roller 90 and a pulley 91. The roller 90 is supported by a bracket 92 on the ring gear 3 and is disposed in parallel spaced relation with the front face of the ring gear 3. The pulley 91 has a V-shaped peripheral groove and is rotatably supported on a stud 93 extending normal from the front face of the ring gear 3. The wire 83 passes between the roller 90 and the front face of the ring gear 3 and then into the groove in the pulley 91. The wire 83 is extended from the pulley 91 and halfway across the convex surface of a brace 94 to the support on which the wire is to be wound. The brace 94 is supported on the frame 30 and extends diametrically of the ring gear 3. An elongated aperture 95 is provided in the brace 94 to receive a portion of the support 5, the support 5 being extended transversely through the brace 94. The brace 74 has two functions, one of which is to steady the support 5 at the particular point of application of the wire 83 to the support and

the other to serve as a guiding means for the wire 83. The brace 94 is disposed slightly forward of the plane of the pulley 91 so that the wire 83 is snubbed over the convex surface of the brace and is guided directly to the particular instant point it is desired to apply the wire to the support.

A snap switch 96 equipped with a handle 97 is mounted on the base plate 10 in the line of travel of the carriage 2. The snap switch 96 controls the operation of the motor 53. An adjustably mounted bumper 98 is provided on one end of the carriage 2 to operate the switch 96 when the carriage 2 has traveled a predetermined distance in one direction. At the opposite end of its line of travel the carriage 2 is prevented from running off the base of the machine by means of a stop 99, which is secured to the base plate 10.

To explain more fully in detail the operation of the machine 1 it will be assumed that the wire 83 is to be wound on a support 5 of the form shown in Fig. 8 and which comprises a strip of sheet insulating material having a straight lower edge 100, a curved edge 101 and a rectangular end portion 102 corresponding in width to the opposite end portion 103. The support 5 is extended through the aperture 95 in the brace 94 and end portions of the support 5 are secured to the carriage 2, one end of the support 5 being clamped in place by means of the block 12 and the plate 13 and the other end being secured between the block 22 and the plate 23, the bar 18 having been adjusted to a required position to hold the support 5 in a taut condition. The carriage 2 is set so that the rectangular end portion 102 of the support 5 is within the aperture 95 in the brace 94. An end of the wire 83 is passed under the roller 90 and through the groove in the pulley 91 and is then secured in a clip 104 supported on the arm 11. In the manual setting of the machine, preparatory to its automatic operation, energy is stored up in the spring 75 as the wire 83 is being withdrawn from the spool to extend the wire 83 through the groove in the pulley 91 to the clip 104. The energy thus initially stored up in the spring 75 maintains the wire 83 in a taut condition since the windlass 72 is being urged by the spring 75 to rewind the wire on the spool 4. The winding machine is then set in condition for operation by longitudinally moving the shaft 36 so that the pinion 35 is in engagement with the rack 34 and the bevel gear 68 is in engagement with the bevel gear, not shown, but which is mounted on the lower end of the stub shaft 65, the shaft 36 being latched in the required position by means of the latch arm 69. When the winding machine is started by manual closing of the switch 96, the ring gear 3 is rotated in a counterclockwise direction and carries the wire 83 around the support 5 which by reason of its support in the carriage 2 is moved longitudinally forward through the ring gear 3. During the winding of the wire 83 onto the support 5 the distance between the point of application of the wire to the support 5 and the pulley 91 and also the windlass 72 is shortening or lengthening due to the particular form of the support 5. When the distance is lengthening, the wire 83 is drawn from the spool 4 at a faster rate and more tension is built up in the spring 75. Shortening of the distance between the pulley 91, the spool 4 and the point of application of the wire to the support 5 will result in a slowing down of the paying out of the wire and in some cases a

rewinding movement of the windlass 72 to prevent slackening of the wire 83. Faster paying out of the wire is required, for instance, when the wire is being wound on the rectangular portion 102 of the support 5 than when the wire is being wound on the portion having the curved edge 101. The windlass 72 will permit rapid withdrawal of the wire 83 from the spool 4 when the wire is being wound on the wider portion of the support 5 and will operate to maintain the wire 83 in a taut condition even when there is a sudden change in the width of the support at the point of application of the wire to the support. By suitable adjustment of the bumper 98 the winding machine may be set so that the switch 96 will be opened to stop the motor 53 when the carriage 2 has traveled a predetermined distance.

The operating speed of the carriage 2 may be changed by replacing the worm wheel 64 with a larger or smaller worm wheel. A set of worm wheels 105 for this purpose are mounted on a board 106. Also mounted on the board 106 are an extra spool 4 and an extra pulley 51. Since the block 66 supporting the stub shaft 65 is adjustably supported on the bracket 62, the stub shaft may be tilted to accommodate different sizes of worm wheels, the screw holding the block 66 being moved upward within the elongated aperture 67 when a larger worm wheel is used in place of the worm wheel 64. Changing the speed of the carriage 2 will obviously result in a change in pitch in the wire winding.

When the wire 83 has been wound on the support 5 as required, the wire may be severed at some point between the pulley 91 and the support. After the wire has been severed the end nearer to the pulley 91 may be placed in a clip 107 provided on the ring gear 3 to hold the wire against rewinding on the spool 4 and in readiness to be applied to another support.

Fig. 7 shows a support 108 having a lower straight edge portion 109 and an opposite edge portion cut away to provide two curves 110 and 111. It will be seen that in winding a wire 83 on this form of support the rate of paying out of the wire would have to be gradually decreased as it progresses down the curved portion 110 and then would have to be suddenly increased to start from the top of the curved portion 111. The winding machine above described will readily and accurately wind wire on this form of support since the windlass 72 will maintain the required tension on the wire 83 even when there is a sudden change in the width of the support from the narrow point 112 to the wider point 113. When the support on which the wire is to be wound has a curved edge, the support should be made of such material and the tension on the wire should be regulated so that the wire will slightly dig into the edge portions of the support to prevent sliding of the turns of wire along the support.

The machine will accurately wind a wire on a thin strip of insulating material such, for instance, as a strip of cellulose acetate without collapsing or buckling the strip. The strip 114 as shown in Fig. 6 may be in the form of a ribbon or may have curved edge portions corresponding, for instance, to the curved edge portions of the insulating strips shown in Figs. 7 and 8. The strip 114 may be clamped in place on the carrier 2 and held in a taut condition while the wire 83 is being wound thereon, the wire 83 being maintained at a required tension during the winding operation by the windlass 72 so that the pull of

the wire will not bend or buckle the strip 114. The brace 94 will prevent distortion of the strip 114 at the instant point of winding.

It is obvious that forms of support different from those shown in Figs. 6, 7 and 8 may be supported on the carriage 2, that the winding machine will operate to accurately wind wire on the support and that the pitch of the winding may be regulated by changing the speed of movement of the carriage 2, also that certain changes may be made in the structure of the winding machine without departing from the spirit of the invention.

What is claimed is:

1. A machine for winding strand material onto a support comprising a longitudinally movable carriage, spaced and relatively movable arms mounted on said carriage, each of said arms being equipped with a clamp for holding an end of said support and one of said clamps being adjustable so that said support may be held in a taut condition, a rotatable ring encircling the line of travel of said support, means to operate said carriage and said ring, a spring operated windlass carried by said ring and extending normal to the plane of said ring, said windlass being adapted to support a supply of said strand material, said windlass comprising a rod supported on said ring, a sleeve rotatably supported on said rod, means supported on said rod and normally pressing said sleeve into sufficient frictional engagement with said ring to prevent rotation of said sleeve on said rod, a spool and spool holding means rotatably supported on said sleeve, a wind-up spring attached to said sleeve and to said spool holding means and said windlass being adapted to maintain said strand material taut during the winding operation and being also adapted to slip around on said rod to prevent overtensioning of said strand material when said spring is wound up to a predetermined extent and a further pull is applied to said strand material.

2. A machine for winding strand material onto a support comprising a longitudinally movable carriage, spaced and relatively movable arms supported on said carriage, each of said arms being equipped with a clamp to hold an end of said support and one of said clamps being adjustable so that said support may be held in a taut condition, a ring rotatable around the position of said support, means to operate said carriage and said ring, a wind-up spring type windlass carried by said ring and adapted to support a supply of said strand material and maintain said strand material taut during the winding operation, said windlass comprising a rod supported on said ring, a sleeve rotatably supported on said rod, means supported on said rod and normally pressing said sleeve into sufficient frictional engagement with said ring to prevent rotation of said sleeve on said rod, but not sufficient to prevent rotation of said sleeve on said rod when undue tension is applied to said strand material, a spool and a wind-up spring operated member rotatably supported on said sleeve, said spool and said member being in driving engagement with each other, and a wind-up spring attached to said sleeve and to said member, an apertured brace supported diametrically of said ring and said brace extending around said support to hold said support against distortion during the winding operation.

3. A machine for winding strand material onto a support comprising in combination, a base plate, a track supported on said base plate, a carriage operating on said track, spaced arms on said car-

riage, relatively movable clamping means supported on said arms to hold ends of said support, said clamping means being relatively adjustable so that said support may be held in a taut condition, a frame supported on said base plate, wheels supported on said frame in spaced relation, a rotatable ring supported on said wheels and operating around the line of travel of said support, means to operate said carriage and said ring, an apertured brace supported on said frame and adapted to receive and brace said support against distortion while said strand material is being wound on said support and a spring operated windlass carried by said ring around the line of travel of said support and adapted to support a supply of said strand material, said windlass operating to maintain said strand material taut while said strand material is being wound on said support, said windlass comprising a rod fixedly supported on said ring and extending normal to the plane of said ring, a sleeve rotatably supported on said rod, a helical spring supported on said rod and pressing said sleeve into frictional engagement with said ring, a spool and a wind-up spring operated member rotatably supported on said sleeve, said spool being in driving engagement with said wind-up spring member, and the wind-up spring being attached to said sleeve and to said member, and means adjustably supported on said rod and engaging said helical spring to

adjust the pressure of said helical spring against said sleeve so that said sleeve will be held against rotation on said rod while said wind-up spring member is winding up to a predetermined extent or is operating to drive said spool in a rewinding movement, the pressure of said helical spring being insufficient however to prevent rotation of said sleeve when said wind-up spring member has been wound to a predetermined extent.

4. In a wire winding machine comprising means to hold a support on which the wire is to be wound, a rotatable ring adapted to be rotated around the support and means to rotate said ring, a windlass supported on said ring, said windlass comprising a rod supported on said ring, a sleeve rotatably supported on said rod, a spool rotatably supported on said sleeve, a collar adjustably supported on said rod, a spring supported on said rod and pressed against one end of said sleeve by means of said collar, said spring pressing said sleeve into frictional engagement with said ring, a cup-shaped member rotatably supported on said sleeve, a wind-up spring attached to said cup-shaped member and to said sleeve, means holding said cup-shaped member and said spool against relative movement and means supported on said collar to prevent accidental withdrawal of said spool from said sleeve.

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