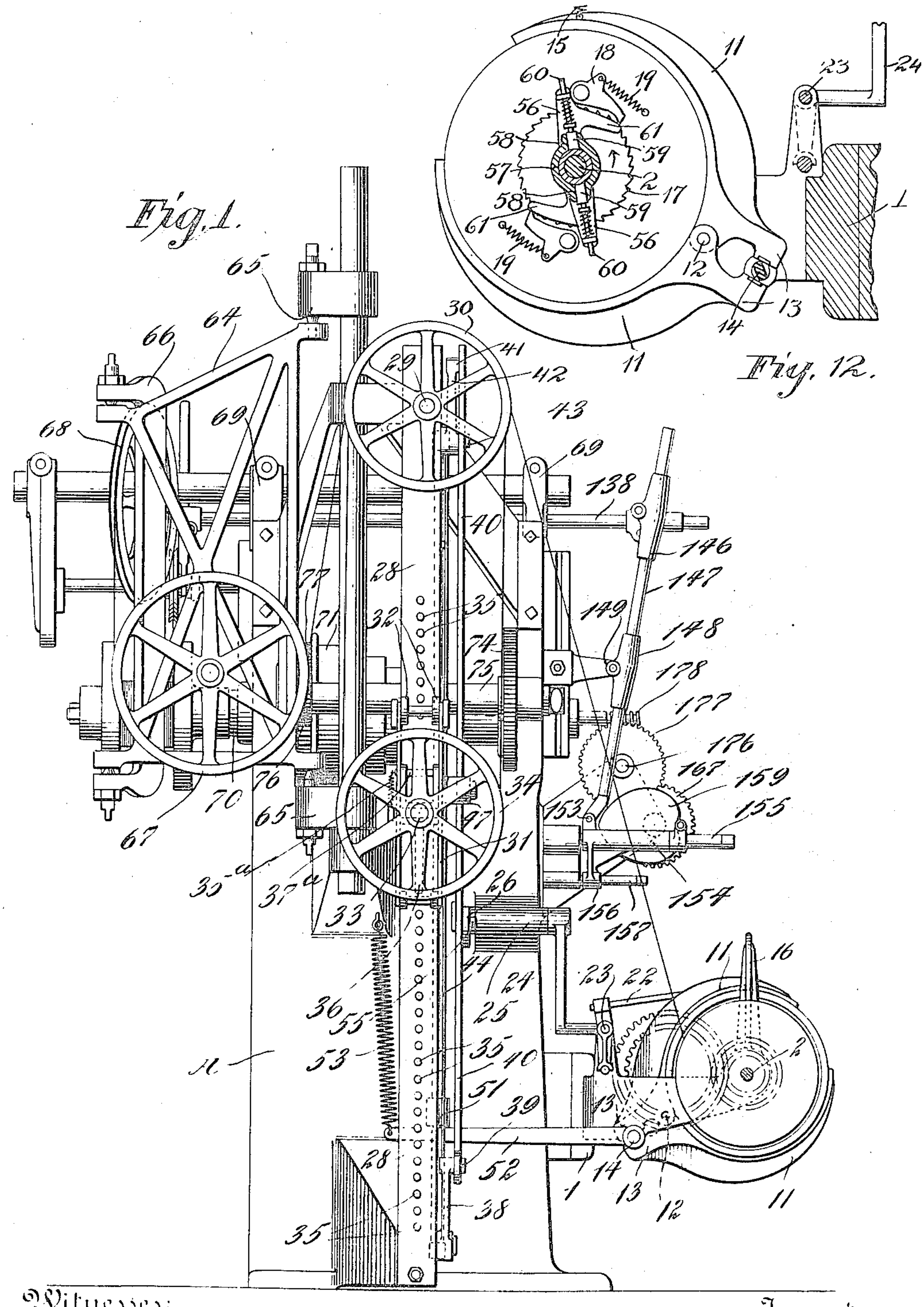
A. D. SCOTT.
MACHINE FOR WINDING COILS.
APPLICATION FILED SEPT. 27, 1910.

1,167,720. Patented Jan. 11, 1916.

6 SHEETS—SHEET 1.



Witnesses:
Geo. Abbey
C. J. Heylmun

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By his Attorneys Gifford & Bull

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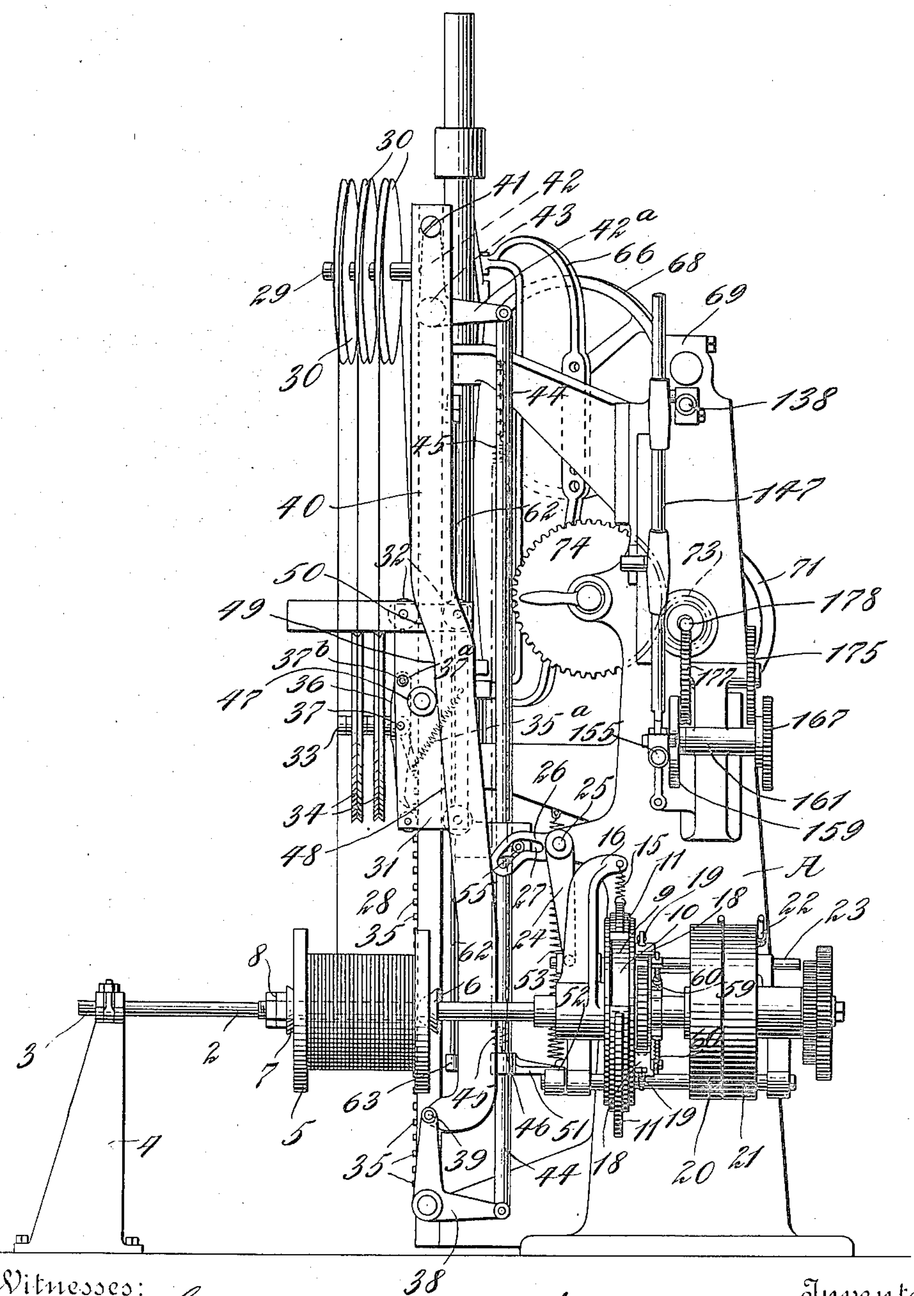
6 SHEETS—SHEET 2.

Fig. 2.



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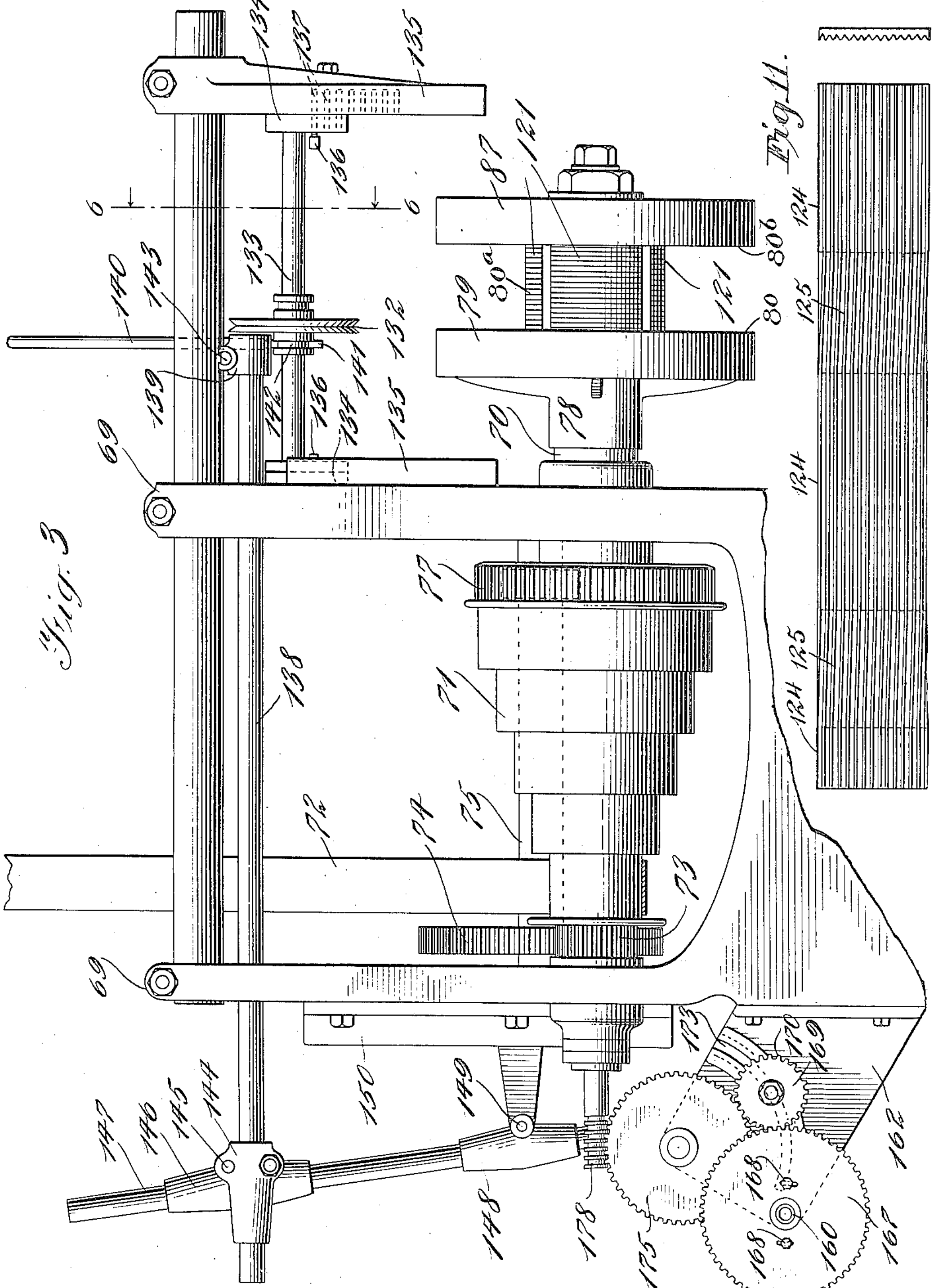

Witnesses:

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6 SHEETS—SHEET 4.

Fig. 4.

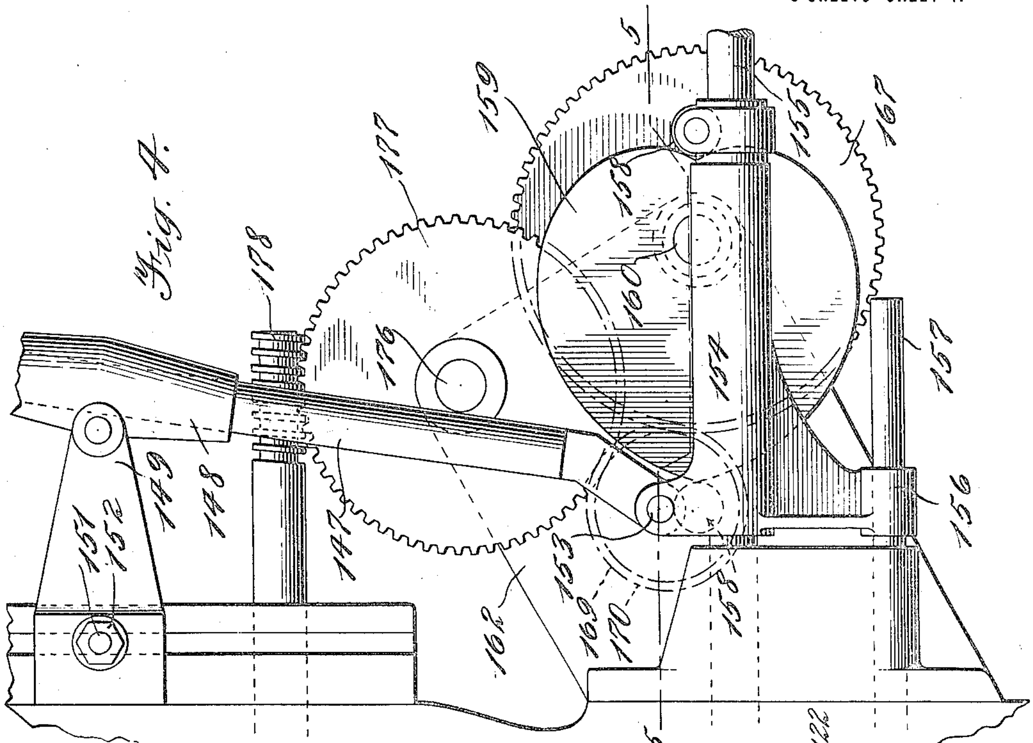


Fig. 5.

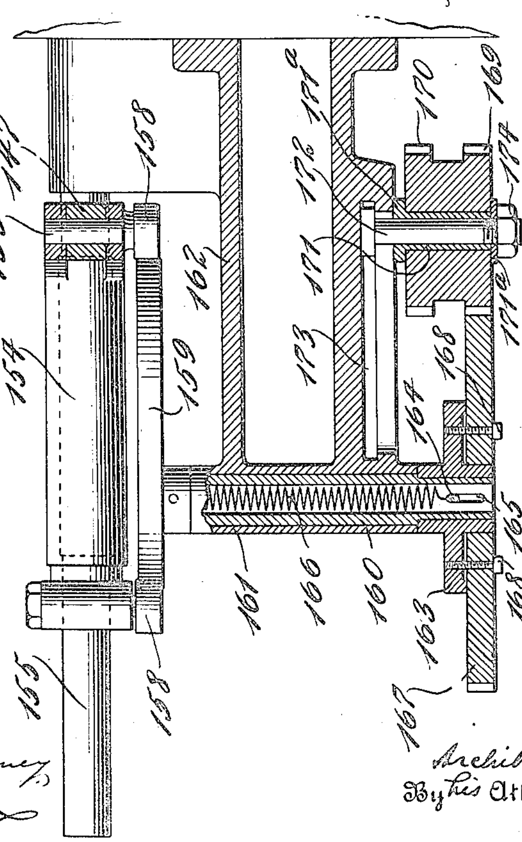
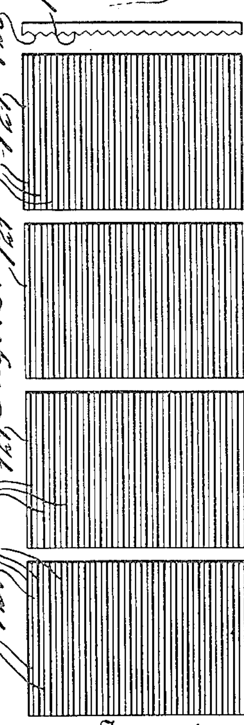


Fig. 10.



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6 SHEETS—SHEET 5.

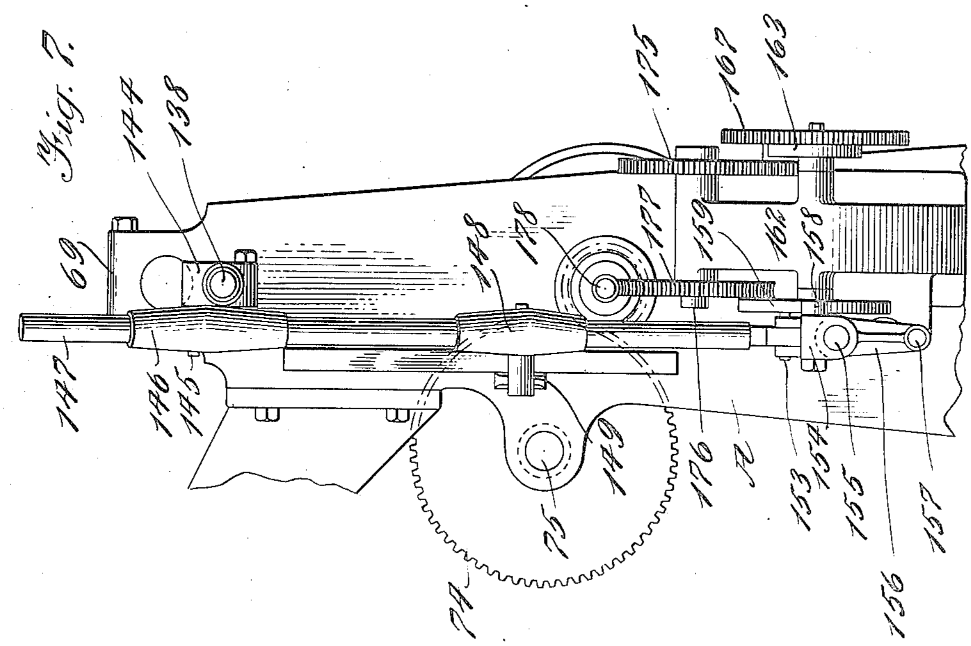

Fig. 7.

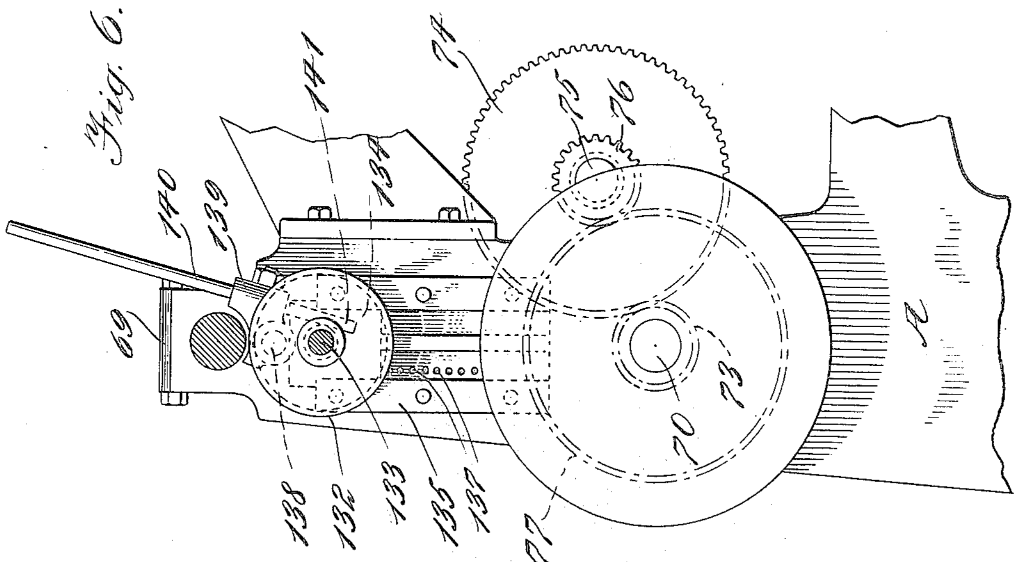

Fig. 6.

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6 SHEETS—SHEET 6.

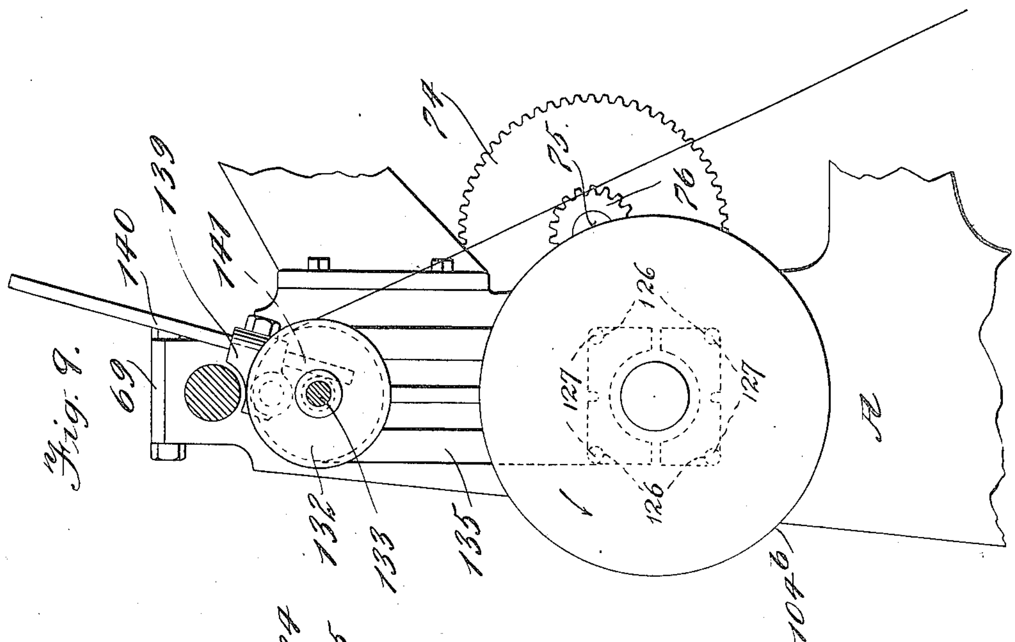

Fig. 9.

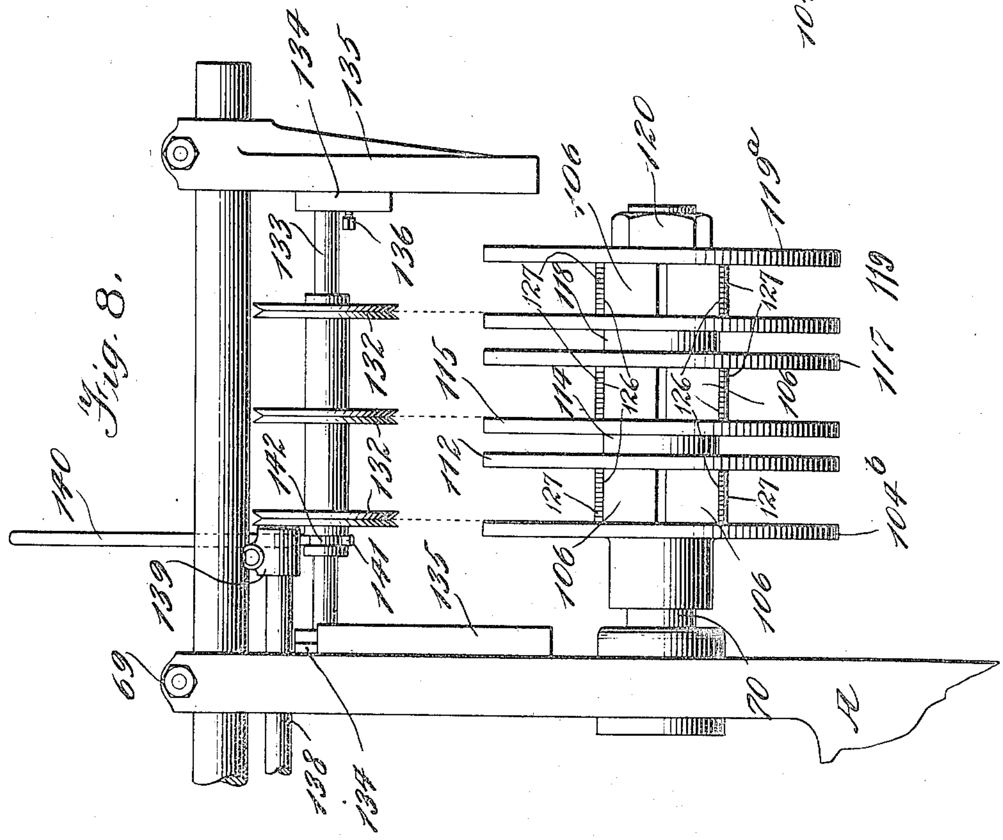

Fig. 8.

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Archibald D. Scott Inventor

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UNITED STATES PATENT OFFICE.

ARCHIBALD D. SCOTT, OF JERSEY CITY, NEW JERSEY, ASSIGNOR TO VARLEY DUPLEX MAGNET COMPANY, OF JERSEY CITY, NEW JERSEY, A CORPORATION OF NEW JERSEY.

MACHINE FOR WINDING COILS.

1,167,720. Specification of Letters Patent. Patented Jan. 11, 1916.

Application filed September 27, 1910. Serial No. 584,040.

To all whom it may concern:

Be it known that I, Archibald D. Scott, a citizen of the United States, residing in Jersey City, in the county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Machines for Winding Coils.

My invention relates to new and useful improvements in machines for winding coils and more particularly for winding wire into a coil or winding for use in connection with electrical apparatus, for example, electromagnets or the windings for field magnets of motors or dynamos.

The invention consists in the improvements to be fully described hereinafter and the novelty of which will be particularly pointed out and distinctly claimed.

I have fully and clearly illustrated my invention in the accompanying drawings to be taken as a part of this specification, and wherein:

Figure 1 is a view in rear elevation of a machine embodying my present invention. Fig. 2 is a view in end elevation from the right of Fig. 1. Fig. 3 is an enlarged detail view of the winding spindle and the strand guide with its operating means. Fig. 4 is an enlarged detail view in elevation of the means for operating the strand guide taken from the opposite side from Fig. 3. Fig. 5 is a horizontal section on the line 5, 5 of Fig. 4. Fig. 6 is an enlarged detail view in end elevation taken from the left of Fig. 1. Fig. 7 is an enlarged detail view in end elevation of the strand guide operating means. Fig. 8 is a detail view of a mandrel for making a multiple winding and the guiding means for the strand. Fig. 9 is a view in end elevation of the mandrel arranged on the winding spindle. Fig. 10 is a plan view of a foundation guide for receiving and guiding the windings on the mandrel. Fig. 11 is a plan view of another form of the foundation guide. Fig. 12 is an enlarged detail view of the means for controlling the rotation of the supply spool.

Before entering into a detail description of the complete invention, I will first describe a machine for producing the desired results and in describing the machine, would state that the same embodies a supply mechanism, a winding mechanism, a strand guide for guiding the strand to the winding mechanism, and means for regulating the passage of the strand from the supply mechanism to the winding mechanism, the winding mechanism including a mandrel of novel construction, and means associated therewith for guiding the strands of wire as they are laid thereon, said mandrel and said guiding means associated therewith *per se* being made the subject-matter of separate applications as hereinafter stated.

Referring to the drawings, I will first proceed to describe the supply mechanism, referring particularly to Figs. 1, 2 and 12 of the drawings. A designates a frame consisting of a substantial casting which may be of any form or construction necessary to attain the objects for which it is employed. At the base of this frame is arranged a bracket 1, in which is journaled one end of a spool shaft 2, the opposite end of said shaft being journaled in a bearing 3 on a standard 4, the spool for carrying the supply of wire to be supplied to the winding mechanism, is shown at 5, the same being secured on the shaft in any suitable manner as by a fixed abutment 6, against which it is held by a movable abutment 7, and nuts 8, the latter being threaded on the shaft, the arrangement being such that the spool is rigidly connected to the shaft. Arranged on the shaft 2 to turn loosely thereon, is a brake wheel 9, having a peripheral groove 10, which is engaged by the brake shoes 11, said brake shoes being pivotally connected as at 12, and having arms 13, extending on the opposite side of the pivot from said shoes, a squared rod 14, being arranged between the arms 13 and adapted upon rotation in one direction, to force the shoes into engagement with the brake wheel and when turned to another position, to relieve the frictional engagement of the shoes with the brake wheel. The upper shoe may be held out of engagement with the brake wheel by means of a spring 15 by means of which said shoe is suspended from a bracket 16 on the bracket 1.

Fixed to the shaft 2, adjacent the brake wheel, is a ratchet disk 17, adapted to be engaged by pawls 18, pivoted to the brake wheel and held in engagement with the ratchet disk by springs 19. The arrangement is such that when the shaft is rotated in the direction of the arrow in Fig. 12, the brake wheel will be turned therewith, the pawls locking the said disk and wheel together and the brake will act on the brake wheel so as to retard the rotation of the shaft as the strand is pulled off of the spool by the winding mechanism.

On the shaft 2, adjacent each other, are mounted a fixed pulley 20 and a movable pulley 21, adapted to be driven by an endless belt not shown, from any suitable source of power. During the normal running of the machine, this endless belt travels on the loose pulley without revolving the shaft, but is adapted to be shifted to the fixed pulley under the conditions to be set forth hereinafter, to revolve the shaft positively in the direction opposite to that taken by it during the normal winding operation. For this purpose I provide a sliding belt shifting arm 22 mounted on a reciprocating rod 23, which is connected to the lower end of one arm 24 of a bell crank lever fulcrumed on the frame at 25, the opposite arm 26 of the bell crank lever having a curved slot 27 for a purpose to be presently described.

I will now proceed to describe the means for regulating the amount of the strand to be paid out from the supply mechanism in accordance with the amount taken up by the winding mechanism and coöperating with the brake and belt shifting means just described, for controlling the revolution of the supply spool. Supported on the frame is a vertically disposed guide post 28 from the upper end of which projects a horizontal stud shaft 29 upon which are rotatably mounted a plurality of circumferentially grooved wheels 30, in the present instance three in number, and arranged to revolve in parallel vertical planes. Slidably mounted on the guide post 28 is a carriage 31 having running wheels 32 engaging opposite sides of said post to provide for a free and smooth movement of the carriage thereon. On this carriage is a horizontally disposed stud shaft 33 on which is rotatably mounted a plurality of grooved pulleys or wheels 34, in this instance two in number. The face of the post 28 next the wheel bearing side of the carriage, is provided with a plurality of outwardly projected pins 35 so located as to be engaged by a pawl 36, pivoted at 37 on the carriage, said pawl serving as a support for the inner end of the stud shaft 33 heretofore referred to, and adapted to be thrown into engagement with the projections 35 by the weight of the wheels mounted on the stud shaft and by a spring 35ª connected to the pawl and the carriage. The movement of the pawl is limited by a pin 37ª projecting through an opening 37ᵇ in the carriage of greater diameter than the pin, and so located that the pin engages the side of the hole nearest the guide post to limit upward movement of the stud shaft and maintain the same horizontal. The wire strand coming from the under side of the spool 5 is first passed over the outer wheel 30 on the guide post and is then passed under the outer wheel on the carriage, over the middle wheel on the post, under the inner one on the carriage, then over the inner one on the post, whence it passes to the winding mechanism to be presently described. During the normal winding operation, the wire is held taut and this serves to maintain the stud shaft 33 in horizontal position to hold the pawl 36 out of engagement with the projections on the guide post, but should, for any reason, the wires slacken off suddenly or break, the guide wheels 34, will drop and throw the pawl into engagement with the said projections and arrest the fall of the carriage.

It is obvious that during the winding operation, the strand is subjected to pull by the winding mechanism and this pull and the amount of wire wound is employed to act on the movable carriage just described, to regulate the feed of wire from the supply spool. During this operation the carriage moves up and down on the guide post, being pulled up on the post by the wire when the demand of the winding machanism is great, the upward movement being employed to operate the supply spool to let off more wire, while, when the demand is reduced, the carriage drops or moves down to act on spool controlling means to reduce the amount of the strand paid out. This is accomplished by mechanism which I will now describe.

Fulcrumed at the base of the machine is a bell crank lever 38 to one arm of which is pivoted as at 39, the lower end of a transmission member 40 consisting of a vertically disposed bar located adjacent the guide post, the upper end of said bar extending beyond the normal extent of movement of the carriage 31, and having its upper end pivoted as at 41, to a vertical arm 42 of a bell crank lever, fulcrumed at 43 on the guide post. The other arm 42ª of this bell crank lever is connected by a connecting bar 44 with the arm of the bell crank lever 38 heretofore described, opposite to that to which the bar 40 is pivoted.

The transmission member 40 is normally urged toward the sliding carriage 31 by means of a spring 45 having one end fixed to the frame of the machine and the other end connected to the bar 44 as at 46. The member 40 normally engages along one edge with a running roller 47 on the carriage, and said bar is so formed on said edge engaging the carriage that its position is changed by the spring 45 according to the position of the carriage, so that the supply is regulated or the spool is reversed to take up the wire. For this purpose the bar is formed with an intermediate inclined face 48 inclining upwardly and outward toward the carriage, a straight portion 49 just above the inclined portion, and a second outwardly inclined portion 50 above said straight portion. Under normal winding conditions the carriage takes a position on the guide post with the roller 47 in engagement with the face 50. Should the winding spool take up the wire sufficiently to raise the carriage so as to raise the roller 47 on the face 50, the bar 40 will be moved back moving the rod 44 down, and pressing an arm 51 thereon down upon the lever 52 forcing the latter down against the force of the spring 53 to relieve the pressure of the brake shoes to permit the supply to let off the strand more freely. Should the carriage drop below its normal position so as to carry too much wire, the roller 47 will engage the straight face 49 of the bar 40 which will permit the bar 40 to move the rod 44 to raise the arm 51 out of engagement with the lever 52 so that the spring 53 will lift said lever to set the brake to stop the rotation of the shaft, such being the condition of the parts shown in Figs. 1 and 2. If the carriage should descend low enough to permit the roller 47 to pass onto the inclined face 48 of the transmission bar 40, the bar 44 will act to release the lever 52 to permit the latter to set the brake and a pin 55 on the bar 40, in the slot 27 of the bell crank lever 26, will move said lever to shift the belt shifter to move the belt from the loose pulley 21 to the fixed pulley 20, to reverse the spool to take up the strand.

Means is provided for holding the pawls 18 out of engagement with ratchet 17 when the backwinding is taking place, said means comprising a pair of oppositely disposed arms 56, 56 carried by a hub 57 loosely mounted on the hub of said ratchet disk, said hub 57 having apertures 58, 58 in each of which is mounted a fiber plug 59 adapted to engage the hub of the disk, and held in such engagement by a spring plunger 60 carried by the adjacent arm 56. On each arm 56 is a forwardly projecting finger 61 which is adapted to extend under one of the pawls 18 to hold the same out of engagement with the ratchet when the brake wheel is held by the brake. When the winding is going on and the ratchet disk rotates in the direction of the arrow, by virtue of the slipping frictional engagement with the hub 57 the latter will be moved with the disk to release the pawls to engage with the teeth of the ratchet. However, when the brake is set and the disk rotates with the shaft when the latter is reversed, the hub 57 will be moved with the disk to throw the fingers 61 under the pawls to release the same, and prevent chatter of the same which would result if they passed over the teeth of the ratchet.

Associated with the carriage is means to catch the same should it drop and to act as a buffer to take up the shock. This means consists of a depending vertical rod of soft steel 62 secured at its upper end to the guide post 28, and having its lower end terminating adjacent the base of the said post, where it has an abutment 63. This rod extends through the carriage and should the latter drop it will hit the abutment 63, the soft steel rod being stretched to take up the shock when the falling carriage hits the abutment. One of the advantages of this shock absorber is that the carriage will not bounce up and down after hitting the abutment, which would be the case were spring or other cushion devices employed.

From the inner wheel 30 on the vertical guide post the strand of wire passes to a guiding crane, the movements of which are under control of the strand being wound. This crane comprises a frame 64 pivoted at one side to brackets 65, 65, on the main frame A, said crane frame 64 being arranged in a vertical plane to swing horizontally, and to the free end of this frame is pivoted a second frame 66 also arranged in a vertical plane to swing horizontally. The frame 64 carries a guide wheel 67 having a channeled periphery, said wheel being arranged to revolve in a vertical plane and so that its periphery will lead to the inner guide wheel 30. The frame 66 also carries a vertically disposed grooved guiding wheel 68, located in a vertical plane at an angle to that occupied by the wheel 67 but with its periphery on a common tangent with that of said wheel 67.

Rising from the main frame are two spaced standards 69, 69, and journaled in these standards is the winding spindle or shaft 70, the same being horizontally disposed, and mounted thereon is a cone pulley 71 adapted to be driven by any suitable power belt as shown at 72 in Fig. 3. Also on the shaft 70 and turning with the cone pulley is a pinion 73 in mesh with a larger gear 74 carried by a shaft 75 journaled on the frame parallel to the shaft 70. On the opposite end of the shaft 75 from that carrying the gear 74 is a pinion 76 meshing with a larger gear 77 mounted rigidly on the shaft 70. By this arrangement the shaft 70 is driven from the cone pulley by means of the pinion 73, gear 74, shaft 75, pinion 76 and gear 77. The gear 77 normally runs independently of the cone pulley, which is loose on the shaft, but said gear may be connected directly to said pulley by which arrangement the spindle shaft will be driven directly from the cone pulley. When said shaft is driven directly, the shaft 75 with its gears is disengaged from the gears on the spindle, any suitable means being provided for this purpose, not shown, as for instance, that shown in my Patent No. 1,047,844.

In connection with the machine described I employ a winding mandrel upon which the coil is laid by a guide means, to be presently described. This mandrel may be either of a cylindrical form for the production of coils of substantially clindrical contour, or it may be of a polysided form in order to produce polysided windings. As this mandrel is made the subject-matter of a separate application, I do not deem it necessary to describe the same in detail herein, except in so far as it enters into combination with the machine described herein. Briefly stated this mandrel may consist of a hub member 78 threaded onto the end of the driving spindle 70, said hub member supporting a flange plate 79 constituting one head of the mandrel and having preferably a smooth inner face 80. The receiving portion or body of the mandrel is shown at 80^a and is cylindrical in form, and 87 designates the other flange plate or head between which and the head 79 the said body of the mandrel is located, the inner face 80^b of the head 87 being in a smooth plane at right-angles to the face 80^a and parallel to the face 80. The receiving portion or body 80^a of the mandrel is provided with guide means for the strand which means will be presently described.

In Figs. 8 and 9 I show a polyfaced mandrel constructed to have wound thereon simultaneously a plurality of polysided windings. This form of the mandrel includes receiving bodies 106, constituting three mandrels each adapted to have a winding formed thereon, said bodies 106 being respectively provided with end flanges or heads 104^b, 112; 115, 117; and 119, 119^a. The respective mandrels are separated by cores 114, 118, connecting the end plates 112, 115, and 117, 119, respectively. This form of mandrel is polyfaced, having four sides at right angles to each other, as shown in dotted lines in Fig. 9, and is provided with guide grooves preferably in the form of interchangeable members 121, arranged at the juncture between the sides of the receiving faces of the mandrel, said sets of guide grooves being offset lengthwise of the mandrel, as hereinafter described, so as to cause the strands being laid to take the desired position. This form of the mandrel and the sets of guide grooves is specifically described in my said application Serial No. 670,794, filed January 12, 1912, the same being a division of this application.

It will be understood that in the present invention I do not limit myself to any of the particular forms of sets of guide grooves shown herein, as the mandrel may be of any of the constructions, and have any of the forms of guide means shown in said application Serial No. 670,794.

An important feature of this invention consists in providing the mandrel, whether it is designed to make round windings or polysided windings, with means whereby the turns of the layers constituting a winding, will be arranged in regular form so that alternate layers are counterparts of each other throughout the entire winding, the result being that I provide a completed article which is much more compact for a given weight of wire than any winding which has been produced heretofore, as far as I am aware, and which not only makes a winding which is much more compact, but results in a great saving of wire, which, of course, in copper windings is important. In order to arrive at this result, my invention broadly contemplates the provision of the mandrel with means whereby the first layer of the winding is laid between the flanges of the mandrel with absolute accuracy, this winding serving then as a guide for the next layer and so on throughout the article produced. I have, up to the present time, contemplated and demonstrated the usefulness of several means for accomplishing this result and I will now proceed to describe the same. Before proceeding to this detail description, I believe the invention will be better understood if it is borne in mind that the invention is based on the fact that the distance from the flange of any wire which is the nearest one of its layer must be either zero or one-half the diameter of the strand, in order that the arrangement of strands in layers will be such that it is repeated as layer after layer is wound on the core.

In Fig. 10, I have shown one form of guide which consists of a plurality of curved plates 121 adapted to be laid on the outer surface of the mandrel, of the form shown in Fig. 3, for making a round winding, these plates being formed with a plurality of grooves 122 and intervening ridges 123, which grooves are to receive the strands of the initial winding, which strands are separated by the ridges. Of course, in making a winding of this character, the strand is laid on the mandrel in the form of a coil and in order that the strand be guided laterally so as to take substantially the direction of a coil, two of the plates, as for instance the two middle ones as shown in the diagram, are formed with a half groove adjacent the flanges, while the two outer plates are formed with a whole groove adjacent the flanges. If now, for instance, the start of the winding is against the end plate in one of the whole grooves of the plate *a*, it will follow the same as the mandrel revolves, until it reaches the alining whole groove in the plate *b*, which it follows until it reaches the first whole groove in the plate *c* when it will be forced laterally into said whole groove and follow the same. The strand follows this whole groove in the plate *c* until it reaches the plate *d* when it likewise follows the whole groove therein. The winding then continues until the second whole groove in the plate *a* reaches the strand when the strand will drop into the latter and follow this whole groove and the corresponding alining groove in the plate *b*, which it follows until it reaches the second whole groove in the plate *c* which, as shown in Fig. 10, is offset laterally the distance of a half a groove from the second whole groove in the plate *b*, which continues throughout the entire winding, the strand being successively offset from the plate *d* onto the plates *a* and *b* and then offset from the latter onto the plate *c*. The points of offset, that is, between the plates *d* and *a* and *b* and *c*, are preferably arranged at diametrically opposite points on the mandrel so that each half of a layer of the winding is offset a distance equal to one-half the diameter of the strand being wound. By this operation, under the influence of the guide described, every turn in the first layer is laid in exactly the same direction and form as any other turns, and the turns of the layer first formed, form a rigid guide in which the turns of the next layer are laid with the same accuracy as the first layer was forced to take by the foundation guide, and this continues throughout the winding. I prefer to form these plates separately instead of in a continuous piece for the reason that in making a round winding it is desirable to get as much of the winding as possible parallel with the flanges, and therefore, the offset must be as short as practicable. It will be seen that while each turn is offset twice in going around the mandrel, the portions between the offsets lie parallel to the end plates. It will be understood that the plates 121 may also be applied to the opposite sides of a polysided mandrel, in which case the plates will be made flat instead of being curved, as is necessary in applying them to a cylindrical mandrel of the form shown in Fig. 3.

In Fig. 11, I have shown the foundation guide as being made in a continuous piece in substantially the same arrangement as shown in Fig. 10, except that I am unable to obtain the short offsets accomplished by this arrangement. In Fig. 11, the foundation guide is shown in plan and embodies 4 zones, the cut being made through one of the zones so that in the figure shown, a portion of a zone appears at each end of the figure. In this embodiment two zones 124 are provided, each formed with a plurality of parallel grooves which run at right angles to the axis of rotation of the mandrel or parallel to the flat faces of the mandrel end flanges, the grooves of one of said zones being offset laterally from those of the other the distance of one half a groove, and said zones being joined at their ends by zones 125 of inclined grooves, each groove of which joins one of the straight grooves of one of the zones 124 with the next offset groove of the other zone 124. The arrangement may be stated to be practically the same as that shown in Fig. 10, except that the zones of parallel grooves are joined by zones of inclined grooves instead of being separated from each other. The result produced in the winding is substantially the same.

When the form of winding to be made is polysided, I preferably do not employ the guide plates shown in Fig. 10, or the continuous plate of Fig. 11, but may provide each of the outer angles which join the receiving faces of the filler blocks with a plurality of grooves or corrugations so that the wire or strand in passing from one face of a polysided mandrel to the other, will be guided by these corrugations.

I prefer to provide the mandrel at the juncture of the flat faces with a grooved pin 127 which is of a length selected according to the length of the coil to be formed, said pin being provided with grooves which are formed to correspond with the diameter of the wire to be wound. It will be understood that preferably there is a pin arranged at the outer angle formed by the juncture of the meeting faces of the mandrel, as shown in Figs. 8 and 9, each pin being of a length equal to that of the receiving portion of the mandrel and abutting the end plates of the mandrel at their outer ends, as shown in Fig. 8. Each of these pins is provided with a plurality of annular grooves and intervening ridges, the grooves being intended to receive and guide the strand as it turns the angle of the filler piece. It will be understood that there is a separate set of pins to be used for each winding, the same being selected according to the length of the coil and diameter of the wire. All four of the pins are not the same in the arrangement of the grooves therein. For instance, the first two are arranged with a whole groove at the starting point of the winding against the end plate, while the second two would be provided with a half groove at the starting end. For instance, suppose the first two pins were to start adjacent the flange with a full groove and to end with a full groove, then the second two pins would start and finish with half grooves at their ends. If the starter pins should commence with a full groove and end with a half groove, then the finishing pins would start with a half groove at one end and end with a full groove at the opposite end.

It will be understood that the distance between the apexes of the ribs between the grooves is equal to the diameter of the wire to be wound on any particular set of pins, and that a half groove will be equal to one-half of the diameter of the wire. In using the pins, supposing a winding is started in the full groove adjacent one of the end plates, as the mandrel is turned the wire passes to the full groove of the next pin adjacent the end plate and then comes to one of the pins which has a half groove adjacent the end plate; the wire cannot enter the half groove and must take the next full groove which is adjacent to the half groove so that the wire is deflected laterally across the face of the mandrel, a distance equal to one-half its diameter. As the revolution of the mandrel continues, the wire passes to the first full groove of the fourth pin and then reaches the second full groove of the first pin which will again cause the wire to deflect laterally a distance equal to its diameter to the right of the turn first made and this continues until the whole face of the mandrel between the end plates is covered with a layer. If the starter pins terminate with a full groove, then the finishing pins terminate with a half groove and after the first layer has been completed, the strand will ride up on the half groove ends of the finishing pins adjacent the flange and constitute the first turn of the return layer, which is to lie upon the top of the first layer. Then during the return of the wire the return layer is guided by the first layer laid on the mandrel. These pins or members are preferably arranged in grooves 126 in the corners of the mandrel and may be secured therein by any suitable means.

As heretofore set forth, means is provided for causing the windings of the first layer to take a determined position, so that said first layer forms a foundation guide to determine the location of each and every turn of the superimposed layers, and means is provided to present or guide the strand to the mandrel so as to lay it in engagement with the proper guide. This means consists preferably of a circumferentially grooved pulley 132 arranged to turn loosely on a horizontal shaft 133 and capable of free and easy movement longitudinally of the shaft. The horizontal shaft 133 is mounted in suitable bearing blocks 134 which are vertically adjustable in guides 135 so that the said pulley 132 may be adjusted toward and away from the winding mandrel. The bearings 134 may be held in adjusted position by any suitable means, as for instance, pins or bolts 136 let through said bearings and adapted to enter sockets 137 formed in said guides 135. This pulley 132 is mounted so as to move back and forth on the shaft 133 as the turns of each layer are progressively laid on the mandrel and means is provided for positively imparting this movement to the pulley so that as a turn is being laid the bottom of the groove in the pulley will be substantially opposite the point in the groove of the winding in which the strand is being placed. Any means which will efficiently accomplish this result may be employed, but I prefer to interpose a novel driving means under control of the mandrel so that as the latter is revolved and successive turns are laid thereon, said pulley will progressively follow the turns so as to always be opposite the last one being laid. Mounted in guides on the vertical standards 69 is a reciprocating rod 138 carrying thereon a collar 139 having a guide hole through which projects a rod 140 having a squared end 141 adapted to engage a groove 142 in the hub of the pulley 132, the arrangement being such that when the rod 140 is reciprocated, the pulley will be moved back and forth on the shaft 133. The rod 140 is mounted for longitudinal adjustment through the collar 139 and is held fixed therein by a binding screw 143. This adjustment is provided so that the end 141 will always engage the pulley 132 at all positions of adjustment of the latter toward and away from the mandrel. At its rear end the rod 138 is provided with a collar 144 to which is pivoted as at 145 a sleeve 146 through which slidably extends a lever 147 which is also slidably disposed in a sleeve 148 fulcrumed to a bracket 149 which is vertically adjustable on the machine frame. The bracket is preferably adjustable along a guide member 150 having an under cut T slot in which slides the head of a clamping bolt 151 which bolt projects through the bracket and is engaged by a clamping nut 152 in a manner well known in mechanism. At its lower end the lever 147 is pivoted as at 153 to a sleeve 154 slidably mounted on a horizontal guide bar 155, on the machine frame. The sleeve 154 is prevented from turning on the bar 155 by an arm 156, rigid with said sleeve and engaging a guide bar 157 also mounted on the frame and parallel to the first mentioned bar 155. Projecting laterally from this sleeve 154 are spaced projections 158 between which is positioned a heart cam 159 arranged to turn on a horizontal axis, said cam being mounted on a horizontal shaft 160 turning in a bearing 161 in a bracket 162 on the machine frame. The cam is so arranged that as it turns its circumference engages the said spaced projections 158 to reciprocate the sleeve 154 and rock the lever 147 to move the rod 138 back and forth in its bearings whereby the guide pulley 132 is moved across the face of the mandrel.

The shaft 160 is hollow as shown in Fig. 5 and on the end opposite to that carrying the cam 159 is a disk 163 which is slidable lengthwise of the shaft but is secured thereto by a cross pin 164, projecting through slots 165 in the wall of said shaft, said cross pin and the disk being held in the position shown in Fig. 5 by a contractile spring 166 having one end connected to said pin and the other end anchored within the shaft.

Detachably mounted on the hub of the disk 163 is a spur gear 167 the same being secured in position by bolts 168 let through said gear and threaded into the disk 163. This gear 167 meshes with a gear 169 which is integral with a gear 170 both being arranged to turn on a bushing 171 mounted on a stud bolt 172. the head of which is slidably in a curved guide 173 on the bracket 162, said bolt and twin gear being held in position by a clamping nut 174. The bushing 171 is provided with flanges 171ª between which the twin gear turns so that the said gear will not be bound against the frame when secured in position.

The gear 170 meshes with a gear 175 on a horizontal shaft 176 which carries a second gear 177, of the same size and number of teeth as the gear 175, said second gear being driven by a worm shaft 178, driven by the mandrel spindle 70. The arrangement is such and the gearing so proportioned that for each turn of the mandrel to lay one turn of strand the guide pulley 132 will be moved from its position opposite one groove to a position substantially opposite the next succeeding groove into which the strand is to be placed, and the cam 159 moves the pulley the entire length of the winding and then reverses its movement. The vertical adjustment of the fulcrum 149 for the lever 147 determines the extent of movement of the pulley to correspond to the length of the winding. The movement of the pulley 132 is controlled according to the number of turns to each layer and the cam moving gears are proportioned and made interchangeable so that the proper motion will be given to said pulley 132 irrespective of the number of turns to be wound.

In the embodiment illustrated, the gears 175 and 177 are each fixed, that is, are the same under all circumstances, are each of the same diameter and have each 100 teeth, and a set of interchangeable gears to be used on the shaft 160, are provided with teeth from 60 to 120 in number in steps of one tooth. The twin idler gears are also interchangeable, three in number being employed, one having 48 teeth gearing into the gear 175 and 48 teeth into the change gear 167; the second having 48 teeth in mesh with the gear 175 and 24 onto the change gear; and the third having 48 teeth gearing into the gear 175 and 96 teeth gearing into the change gear. It will be seen that the number of teeth gearing into the gear 175 is constant while the number gearing into the change gear is progressively doubled.

The idlers and the change gear are each selected according to the number of turns on the first layer of the winding, and the method of determining the gears to be selected is to determine first the average number of turns per layer throughout the winding and should the average number be fractional, subtracting $\frac{1}{2}$ from that number to obtain the next lowest whole number. For example: should the cuts in the foundation guides be 43 in number, the lowest layer would have 43 turns and the next layer have 42 turns and so on throughout the winding, the average being $42\frac{1}{2}$ turns to a layer, and the $\frac{1}{2}$ is subtracted to obtain a whole number as it would be impossible to provide any of the cam driving gears with a fraction of a tooth. If the foundation guide should have a fraction of a full number of cuts, say, for example, $19\frac{1}{2}$ cuts or grooves, then the plan is to subtract the fraction one-half from the whole number and use the remainder 19 as the basis of the selection. In the present embodiment wherein I employ a gear 175 having one hundred teeth, and the gear 170 meshing therewith has forty-eight teeth, these calculations would show that where the basis number of turns is between fifteen and thirty, a change gear will be employed that has teeth four times in number that of the average number of turns per layer with an idler of forty-eight teeth geared into the gear 175 and ninety-six teeth onto the change gear. If the number of turns is between thirty and sixty, a change gear will be employed having twice as many teeth as the number of turns, and both idlers will have forty-eight teeth. Should the number of turns be over sixty, I would use a change gear with the same number of teeth as the average turns per layer with the idler having forty-eight teeth geared into the gear 175 and twenty-four teeth in gear with the change gear.

It will be seen that the change gear 167 may be moved out of engagement with the idler by pulling the same outward, this being permitted by reason of the sliding movement between the disk 163 and the cam shaft 160. I provide this arrangement in order that the cam may be revolved to move the connections to adjust the guide pulley without turning the spindle for the mandrel. Other means may be employed for obtaining this object but the one illustrated is simple and efficient.

The idlers 169, 170 are mounted in the curved guide 173 so that they may be adjusted toward and away from the change gear as may be necessitated by changes in diameter of said change gear and the gear 169 of the idler.

Instead of using a rigid metal guide, such as shown in Figs. 10 and 11, said guide may be formed of thick paper or other suitable material and applied to the receiving face of the mandrel to guide the strand while being laid, said guide being left in place within the winding when it is removed from the mandrel.

The construction of the collapsible mandrel, the guide means on the mandrel, and the method of winding and the product disclosed herein are made the subject-matter of divisional applications filed by me and serially numbered, respectively, 670,794, filed January 12, 1912; 718,812, filed September 6, 1912, and 714,777, filed August 13, 1912.

What I claim for my invention and desire to secure by Letters Patent, is:

1. In a coil winding machine, a revoluble core or mandrel having interchangeable sets of parallel guide grooves offset from each other lengthwise of the mandrel, a movable guide, and interchangeable means driven from the mandrel independent of said guide grooves to progressively feed said second guide lengthwise of the mandrel in a determined relation to said guide grooves.

2. In a coil winding machine, a revoluble mandrel or core, an interchangeable strand guide on the mandrel to cause the turns laid to take a determined position to form a guide for a subsequent layer, a guide separate from the mandrel, and interchangeable means for operating said second guide to lay the strand of said subsequent layer between the turns of said guide layer.

3. In a coil winding machine, a revoluble mandrel or core, an interchangeable strand guide on the mandrel having grooves to receive the strand to cause the same to take a determined position to form a guide for a subsequent layer, a guide movable parallel to the axis of the mandrel, and change gearing for causing the second guide to move progressively to take a position opposite each groove for each revolution of the mandrel.

4. In a coil winding machine, a frame, a mandrel spindle, a shaft having a gear driven by said spindle, a second gear on said shaft, a counter-shaft having a gear, a gear connecting said second gear and the gear on the counter-shaft, an adjustable bearing for said connecting gear, said bearing consisting of a stud shaft upon which said gear is mounted, means for adjustably fixing said stud shaft on the frame. a cam on said countershaft, and a strand guide operated by said cam.

5. In a coil winding machine, a frame, a mandrel spindle, a shaft having a gear driven by said spindle, a second gear on said shaft, a counter-shaft having a gear, a curved undercut groove in the frame, a shaft having a head slidable in said groove, a sleeve on said last-named shaft, a nut engaging said sleeve, a gear on said sleeve meshing with said second gear and the gear on the counter-shaft, and a strand guide driven by said counter-shaft.

6. In a coil winding machine, a frame, a mandrel spindle, a shaft having a gear driven by said spindle, a second gear on said shaft, a counter-shaft having a gear, a curved undercut groove in the frame, a shaft having a head slidable in said groove, a sleeve on said last-named shaft, a nut engaging said sleeve, a gear on said sleeve meshing with said second gear and the gear on the counter-shaft, a cam on the counter-shaft, and a strand guide driven by said cam.

7. In a coil winding machine, a mandrel driving spindle, a reciprocatory strand guide movable parallel to the axis of the mandrel, means for moving the guide comprising a shaft and a heart cam mounted thereon, and change speed gearing for driving the heart cam from the spindle, said gearing including a transmission member mounted on the same shaft and movable longitudinally thereof so that it may be disconnected from the gearing to permit rotation of the cam independently of the gearing.

8. In a coil winding machine, a mandrel driving spindle, a reciprocatory strand guide movable parallel to the axis of the mandrel, means for moving the guide comprising a shaft and a heart cam mounted thereon, change speed gearing for driving the heart cam from the spindle, said gearing including a transmission member mounted on the said shaft and movable longitudinally thereof so that it may be disconnected from the gearing to permit rotation of the cam independently of the gearing, and a spring holding said transmission member in normal driving connection with said gearing.

In testimony whereof I have hereunto signed my name to this specification in the presence of two subscribing witnesses.

ARCHIBALD D. SCOTT.

Witnesses:
M. E. McNinch,
C. G. Heylmun.

Corrections in Letters Patent No. 1,167,720.

It is hereby certified that in Letters Patent No. 1,167,720, granted January 11, 1916, upon the application of Archibald D. Scott, of Jersey City, New Jersey, for an improvement in "Machines for Winding Coils," errors appear in the printed specification requiring correction as follows: Page 5, line 18, after the word "half" insert the word *turn;* page 7, line 8, for the word "slidably" read *slidable;* and that the said Letters Patent should be read with these corrections therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 1st day of February, A. D., 1916.

[SEAL.]

J. T. NEWTON,

Acting Commissioner of Patents.

Cl. 242–9