Sept. 7, 1954 C. C. BELL 2,688,450

COIL WINDING MACHINE

Filed Feb. 14, 1951 3 Sheets-Sheet 1

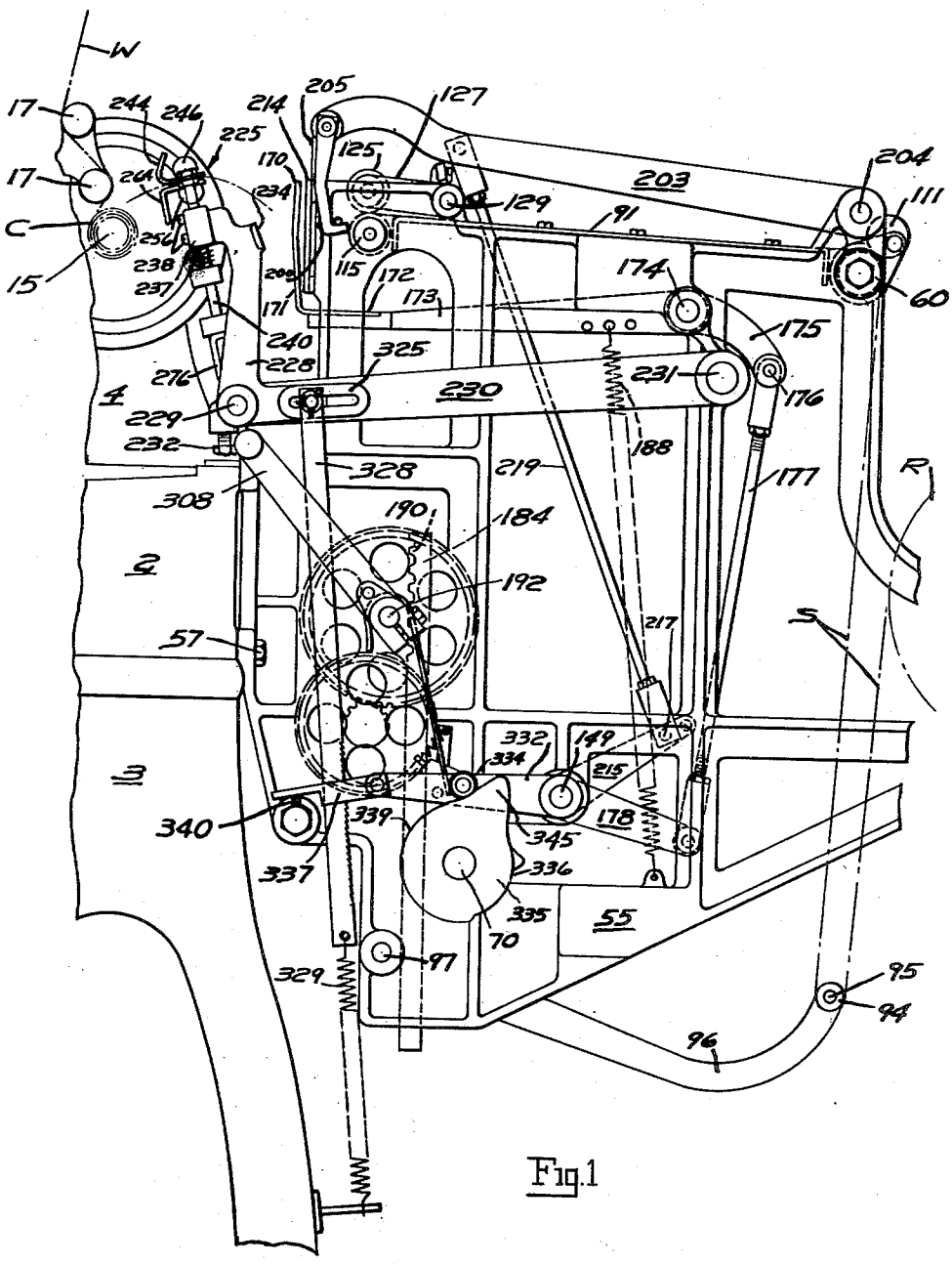


Fig. 1

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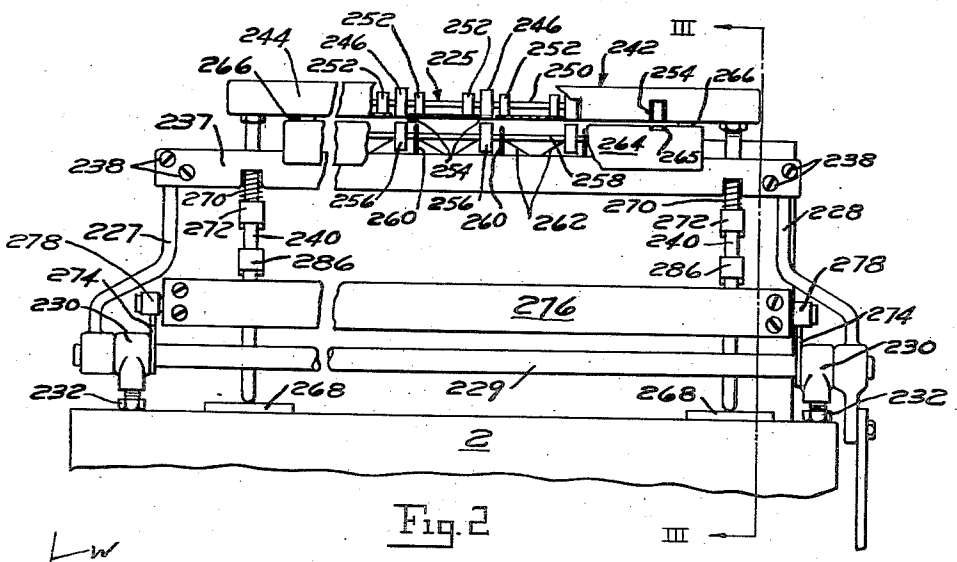


Fig. 2

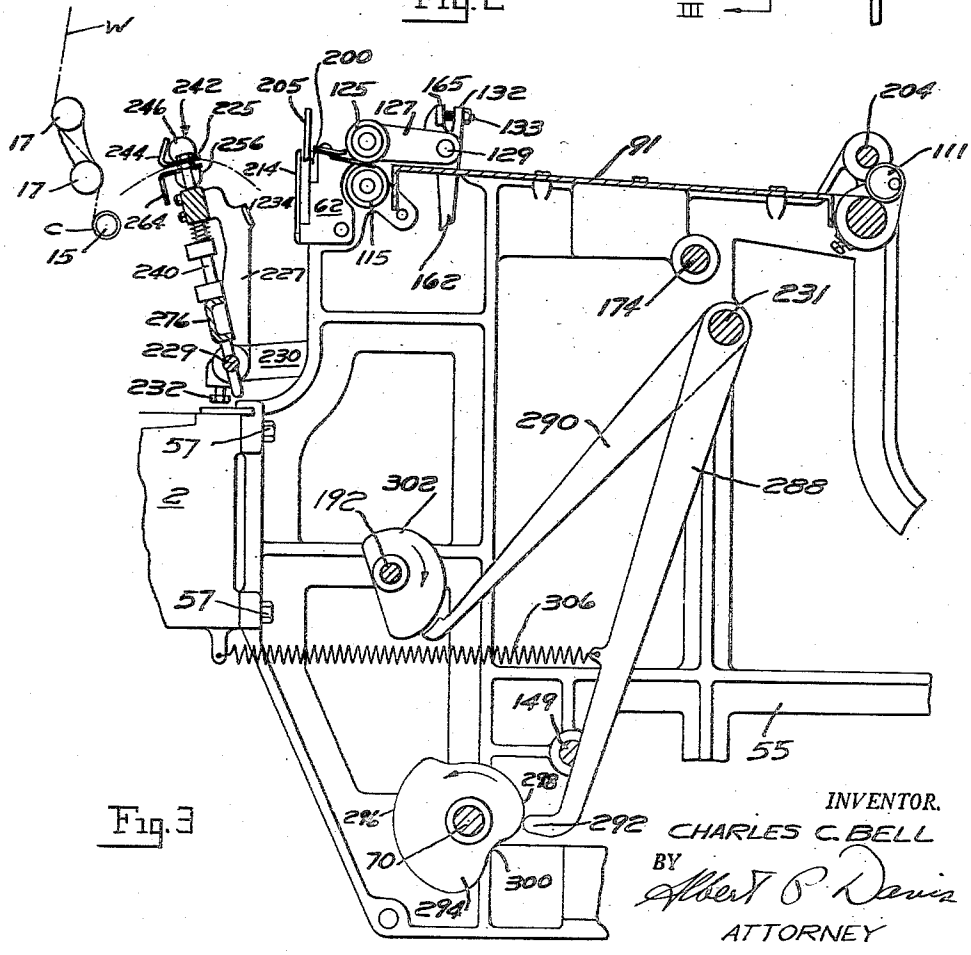


Fig. 3

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COIL WINDING MACHINE

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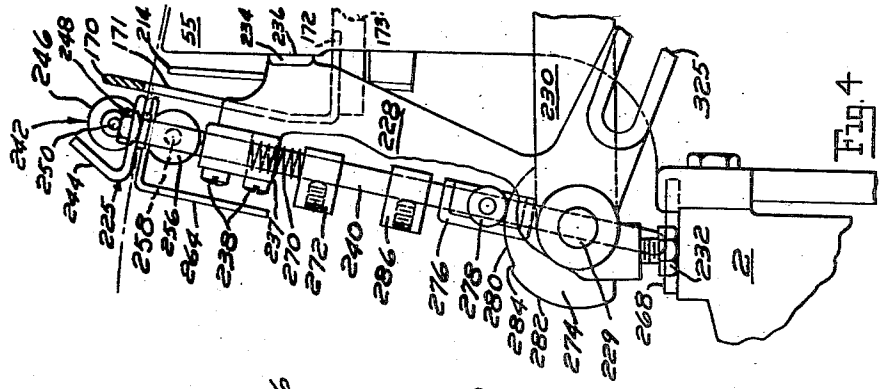


Fig. 4

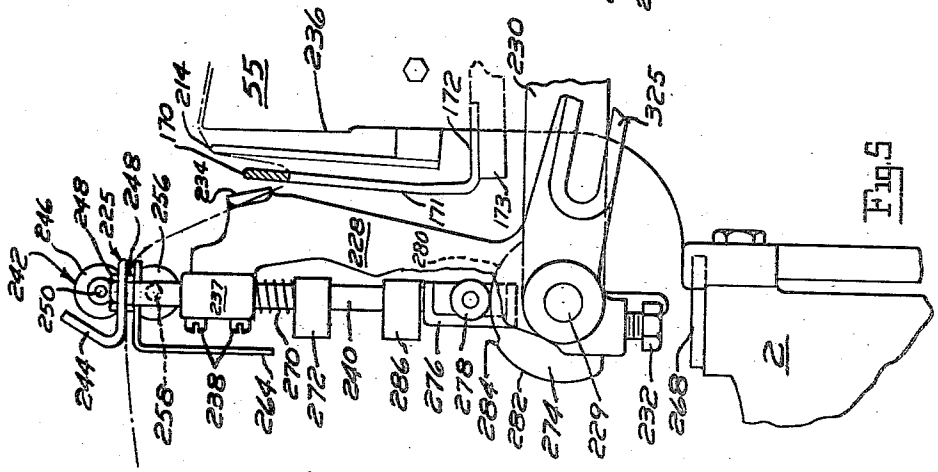


Fig. 5

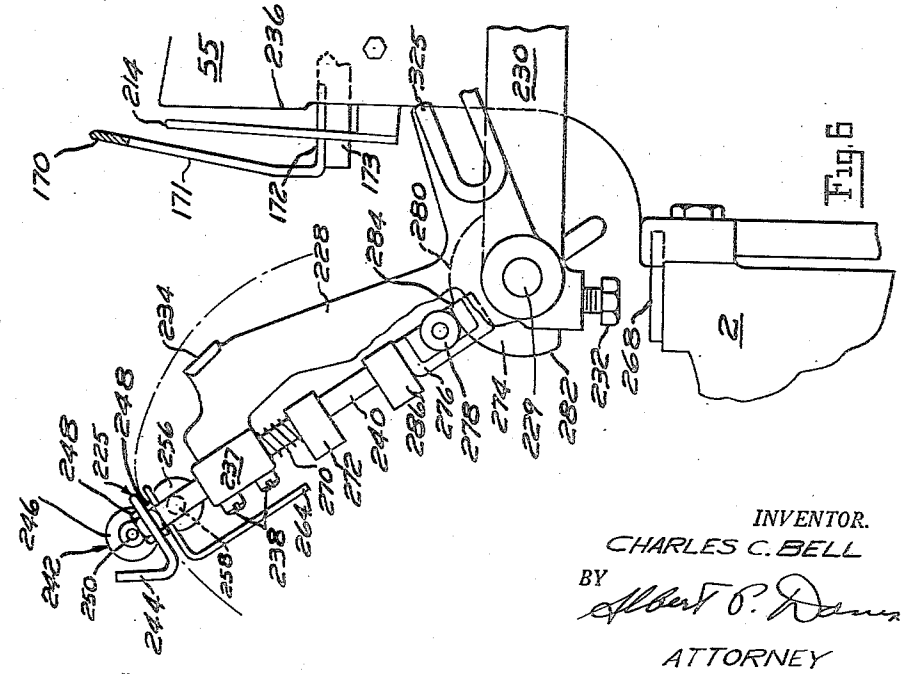


Fig. 6

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2,688,450

UNITED STATES PATENT OFFICE

2,688,450

COIL WINDING MACHINE

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Application February 14, 1951, Serial No. 210,976

14 Claims. (Cl. 242—10)

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This invention relates to improvements in winding machines and particularly to machines for winding electrical coils with sheets of paper or other insulating material inserted between the layers of wire or other conductor forming the coil.

In the following specification and claims the term "coil" is used in a broad sense to indicate any form of wound body; the term "wire" to designate all types of conductor; and the term "paper" to apply to sheet insulation generally.

One object of the invention is to provide a machine of the type specified having improved automatically-operated means for inserting the sheets of paper into the coils at intervals during the winding to provide insulation between the layers of wire.

Another object of the invention is to provide improved means for guiding the paper sheets into plate on the coils to insure their proper overlying relationship with respect to the layers of wire.

Another object of the invention is to provide guiding and feeding means for the paper or other insulating material which is capable of handling strips of different widths as used in coils of varying dimensions.

Another object of the invention is to provide a sheet-serving mechanism for use with a coil-winding machine which will operate without wrinkling, buckling, skewing or otherwise mishandling the paper or other insulating material if the sheet of paper is presented to the coil at an angle.

Another object of the invention is to provide a sheet-serving apparatus of the type specified which is of simple construction, positive in operation and proof against derangement or getting out of order.

Other objects of the invention will in part be obvious and will in part appear hereinafter.

The invention accordingly comprises the apparatus possessing the construction, combination of elements and arrangement of parts which are exemplified in the following detailed disclosure, and the scope of the application of which will be indicated in the claims.

For a fuller understanding of the nature and objects of the invention, reference should be had to the accompanying detailed description taken in connection with the accompanying drawings wherein:

Figure 1 is a fragmentary end view of a coil-winding machine showing the delivery-mechnism in operative position during the start of the transfer of the paper sheet to the coils being wound;

Fig. 2 is a fragmentary front elevation of a

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coil-winding machine showing the delivery-mechanism in position to receive a sheet of paper;

Fig. 3 is a fragmentary sectional end view taken on the line III—III of Fig. 2, but showing the delivery-shelf at the start of its paper delivery motion;

Fig. 4 is an enlarged fragmentary end view showing the paper delivery-shelf in position to receive the end of a piece of paper;

Fig. 5 is similar to Fig. 4 but shows the delivery-shelf locking the paper against movement while its length is measured and cut; and

Fig. 6 is similar to Figs. 4 and 5 but showing the paper-delivery shelf in position to insert the the paper in a coil being wound.

This invention is an improvement in the paper-delivery-shelf and elevating means and control therefor disclosed in United States Patent Number 2,029,577, issued February 4, 1936, to Arthur W. Le Boeuf, for "Machine for Winding Electrical Coils." Inasmuch as the coil-winding mechanism, paper supply mechanism, strip-feeding means, and strip-measuring mechanism employed in combination with the improved shelf are the same as those disclosed and described in detail in the above mentioned Patent No. 2,029,577 and they cooperate with the instant shelf and its elevating and control means in the same manner that they cooperate with those elements as disclosed in said patent, they will only be described herein to that extent necessary to a complete understanding of the present invention. If a more complete description of the functions and operations of the coil-winding mechanism, paper supply mechanism, strip-feeding means, and strip-measuring mechanism is desired, reference should be had to the above mentioned Patent No. 2,029,577.

Coil-winding mechanism.—The coil-winding mechanism herein illustrated comprises a bed or table **2** supported by legs **3** adapted to rest on the floor. Fixedly mounted at one end of the bed **2** is a headstock **4** carrying the journals for a rotatable winding spindle. The spindle is driven by means of a suitable belt and pulley connection to an electric motor (none of which are shown in the drawing). The spindle together with a tail-stock, not shown, carries a winding-mandrel or arbor **15** on which one or a plurality of coils C may be wound.

The strands of conductor or wire *w* are fed to the winding-mandrel **15** from above and caused to be traversed longitudinally of the axis thereof by means of reciprocating guides **17**. In the present type of machine a plurality of coils or electric windings are produced at one time by providing a series of wire-guides **17** which

are mounted in spaced relationship on a suitable sliding carriage or cross-head (not shown). The carriage or cross-head is reciprocated parallel to and longitudinally of the axis of winding-mandrel **15** by means of a suitable cam (not shown) and traverse rod (not shown) driven thereby. The cam is connected to be driven from the winding-spindle by means of suitable gearing (also not shown) so that wire-guides **17** will be reciprocated along winding-mandrel **15** at a predetermined speed with respect to the speed of rotation of said spindle.

Sheet-serving apparatus in general.—The serving mechanism for inserting sheets of insulating material into the coil, or coils, being wound is constructed as a complete unit adapted for attachment to the rearward side of the coil-winding machine. The serving attachment comprises, essentially, a pair of frame-members or brackets **55**, see Figs. 1 and 3, which are attached to the rearward side of bed **2** at each end thereof by appropriate fastening means as, for example, bolts **57**. The frame-members or brackets **55**, which are suitably cross braced to maintain their spacing, furnish supports or bearings for the various shafts of the mechanism.

A cam shaft **70** which constitutes the main driving element for the several sheet-serving mechanisms is journaled in frame-members **55** and is driven from the winding spindle by means of a suitable gear train (not shown). An adjustable means is provided between the gear train and shaft **70** to permit shaft **70** and the cams carried thereby to be adjusted to obtain proper timing of the insertion of each sheet of insulating material in a series of coils being wound on winding-mandrel **15**.

Paper supply mechanism.—Referring to Fig. 1 of the drawing a roll R of paper or other insulating material is rotatably mounted on the rear of frame-members **55**. The end of the paper strip S is drawn off from the roll R and passed around movable rollers **94**, to be later described, and thence upwardly and over the tie-rod **60** which also serves as a cross bracing member for frame-members **55**. The strip S is then drawn over a plate-like shelf **91** extending over the top of and fastened to the frame-members **55**. From the plate or shelf **91** the paper passes between a pair of feed-rollers **115** and **125** which feed the paper onto a delivery-shelf **225** in the manner to be later explained.

The paper strip S is drawn off from the roll R in the following manner. Referring to Fig. 1 the rollers **94** are rotatably mounted on a rod **95** secured to the end of a rockable supply-lever **96**. The lever **96** is rockably mounted on a pivot rod **97** extending between the side-frames **55**. Spaced a short distance from its pivot the lever **96** carries a cam-follower (not shown) adapted to engage the periphery of an eccentric disk-cam (not shown) fastened on cam shaft **70**. Supply-lever **96** is held with its cam follower bearing against the edge of its actuating cam by means of a suitable spring. Rotation of its actuating cam causes lever **96** to pivot downwardly to bring rollers **94** into engagement with the loop formed in the strip of paper S, continued downward movement of lever **96** draws a length of paper from roll R, continued rotation of its actuating cam permits lever **96** to pivot upwardly leaving a loop of paper hanging free to be drawn upwardly by feed-rolls **115** and **125** in the manner to be later explained. To prevent the strip S from being drawn rearwardly across the plate **91** and rod **60**, a pair of weighted grippers or retainer-elements in the form of eccentrically-mounted disks **111** positioned at the ends of the tie-rod **60** act to check any backward pull upon the strip S while it is being drawn off from the roll R as the lever **96** descends.

Strip-feeding means.—In general the strip-feeding means comprises a pair of opposed rollers **115** and **125** between which the strip S passes. The rollers are adapted to be rotated to feed the strip therethrough during a relatively short interval of the cycle of operation. Means are provided for swinging one of the rolls away from the other roll after completion of the feeding operation to release the strip so that it may be drawn freely forwardly by a measuring device to be later described.

Referring to Figs. 1 and 3 the roller **115** is rotatably mounted between the frame-members **55** in suitable bearings. The top roller **125** is rotatably mounted at the ends of a pair of arms **127** which are fastened on a shaft **129** journaled on frame-members **55**. One of the arms **127** is formed with an upstanding lug **132** carrying an adjustable limiting screw **133**. A lifter-lever **162** pivoted on shaft **129** is formed with a lug **165** adapted to engage the end of screw **133** to rock the arm **127** to raise the top roll **125** away from the lower roller **115** to permit strip S to be drawn freely forwardly by a measuring device. Roller **115** and roller **125** each carry a spur gear at their ends that mesh with each other so that rotation of one roller causes the other to rotate. Lifter-lever **162** is rocked at the appropriate time in the operating cycle of the mechanism by means of a cam (not shown).

Strip-measuring mechanism.—The strip-measuring mechanism comprises a horizontally extending bar or rod **170**, see Fig. 1, which is positioned between rest **62**, which extends between frame-members **55**, and delivery-shelf **225**, and is adapted to be lowered to pull downwardly on the paper strip to form a loop between the delivery-shelf and said rest. The length of this loop is governed by the circumference of the coil, or coils, being wound at the time the sheet is to be served thereto. As the circumference of the coil constantly increases with the growth of the winding, the length of the strip of insulation must increase accordingly. This progressive increase is governed automatically in the following manner.

The measuring rod **170** is supported by legs **171** and feet **172** which are attached to the forward ends of a pair of measuring levers **173**. Levers **173** have hubs secured fast on a horizontal rod **174** which is rockably mounted in bearings in frame-members **55**. The lever **173** has an arcuate tail piece **175** projecting rearwardly from its hub. A connecting rod **177** is pivotally connected at its upper end to tail piece **175** by means of a pin **176**. The lower end of connecting rod **177** is similarly joined to the rearward end of a lever **178**.

Lever **178** is pivoted on shaft **149**. The forward end of lever **178** carries a cam follower (not shown) adapted to engage the periphery of a disk-like measuring cam (not shown) fast on the main cam shaft **70**. The cam follower carried by lever **178** is not in constant engagement with its actuating cam but is held away therefrom during a part of the cycle of operation by means of a stop shoulder carried by a rack-bar or measuring gauge **184**. Rotation of this cam causes its high point to engage the cam follower

on lever 178 to lift the forward end of said lever. Lifting the forward end of lever 178 lifts measuring levers 173, by means of connecting rod 177 and arcuate tail piece 175, to the position illustrated in Fig. 1. Continued rotation of said arcuating cam causes the cam follower to pass from the high point of the cam permitting lever 178 to rotate in a counterclockwise direction under the influence of springs 188 thus lowering measuring levers 173 and horizontally extending bar or rod 170 until the cam follower on lever 178 engages the shoulder on rack bar 184. Continued rotation of the cam causes its high point to again engage the cam follower to lift lever 178 and measuring levers 173. The lowering of horizontal bar or rod 170 engages the strip S held in delivery-shelf 225 and released by feed rollers 115 and 125 to draw paper into a loop of predetermined length between said delivery-shelf and rest 62.

Means are provided for gradually lowering rack bar 184 to permit horizontal bar 170 to draw a slightly greater length of paper through feed rollers 115 and 125 each time measuring levers 173 are lowered. Rack bar 184 is slidably mounted in bearings carried by one of the frame members 55 and it is provided with rack-teeth 190 which mesh with the teeth of a pinion gear (not shown) fast on a rotatable shaft 192. Shaft 192 is indexed through a part of a complete revolution at each cycle of operation to gradually lower rack bar 184 and the stop shoulder carried thereby.

Strip-severing mechanism.—Two knives, one stationary and the other movable, cooperate to cut the paper strip to form a sheet of proper dimensions for insertion between the layers of windings. Referring particularly to Fig. 1, the forward side of rest 62 is recessed along its length to receive the lower or stationary knife-blade 200. The upper or movable knife-blade 205 is pivotally mounted between the forward ends of a pair of arms or levers 203. The arms 203 are fixedly secured to a rod or shaft 204 rotatably supported in hubs or bearings at the top of the frame-members 55. The knife 205 is arranged to slide downwardly between the knife 200 and a paper guide-plate 214 attached to the forward edge of block 62. The guide-plate 214 supports the paper strip in advance of the fixed knife 200 to provide for the proper cooperation of the edges of the two knives. The paper strip is drawn downwardly from the top of the plate 214 during the measuring operation and the upper edge of the plate is rounded off to provide for a free movement of the paper thereacross.

The arms 203 are operated to carry the knife 205 downwardly to perform the severing operation in the following manner. A knife-operating lever 215 is rockably mounted on shaft 149. A connecting rod 219 is connected to the end of the rearward arm of lever 215 by means of a pin 217. The upper end of connecting rod 219 is pivotally connected to a pin on one of the levers 203. The forward arm of lever 215 carries a cam follower (not shown) which engages the periphery of a knife-cam (not shown) fast on cam shaft 70. It will thus be seen that rotation of cam shaft 70 will rotate the knife-cam carried thereby to rock knife operating lever 215 and through connecting rod 219 and levers 203 raise and lower the movable knife-blade 205.

The above described mechanisms are all old and are completely described in the above mentioned Patent No. 2,029,577.

Delivery-shelf and actuating mechanism therefor.—The present invention resides in a novel delivery-shelf and actuating means therefor. The delivery-shelf is so constructed that when it is in its rearward position, as illustrated in Fig. 4, and feed rollers 115 and 125 are being rotated to feed the strip of paper, the delivery-shelf is open to permit the paper to pass freely therethrough. When feed rollers 115 and 125 have ceased rotating and have separated to permit measuring bar 170 to descend and measure a predetermined length of paper, the delivery-shelf has moved to the position illustrated in Fig. 5 and has clamped the paper securely to prevent bar 170 from withdrawing the paper therefrom. When the delivery-shelf is in its forward position, illustrated in Fig. 6, to insert the cut sheet of paper into the coil, or coils, being wound, the delivery-shelf is so adjusted that it will cause the sheet of paper to feed smoothly and evenly into the coil regardless of whether or not the leading edge of the piece of paper strikes the coil squarely.

The delivery-shelf 225 is positioned in front of the knives 200 and 205 and the measuring bar 170 and comprises a pair of elbow-shaped levers 227 and 228. The levers 227 and 228 have their hubs fixedly secured to a horizontal shaft 229 extending beyond the forward ends of a pair of relatively long arms 230. The hubs of the arms 230 are mounted fast on the ends of a horizontal shaft 231 projecting through bearings in the frame-members 55. The shaft 231 is adapted to be rotated in its bearings by elevating means, to be described in detail hereinafter, whereby to elevate the delivery-shelf 225 first to cause said shelf to clamp the paper sheet against withdrawal while said sheet is being measured, and secondly, to further elevate delivery-shelf 225 to the height necessary for effecting delivery of the sheet of paper in proper relation to the periphery of the coil being wound in accordance with the diameter of the latter. When delivery-shelf 225 is in its rearward position, as illustrated in Fig. 4, the ends of arms 230 are supported upon the top of bed 2 of the winding machine by means of adjustment bolts 232 screwed in the ends of said arms to position shelf 225 to receive paper being fed from rest 62 by feed rollers 115 and 125. The delivery-shelf 225 is normally maintained in close proximity with the measuring bar 170 by resilient means to be later described. To limit the rearward movement of shelf 225, lugs 234 are provided on the sides of levers 227 and 228 adapted to engage against finished faces 236 on frames 55.

A horizontal cross bar 237 is rigidly attached to the upper ends of levers 227 and 228 by means of screws 238. A pair of rods 240 are carried by aligned holes in cross bar 237 and horizontal shaft 229 for longitudinal sliding movement therein. A tension mechanism 242 comprising an upper elongated angular bracket 244 and tension rollers 246 is carried by the upper ends of rods 240. The upper ends of rods 240 extend through holes in the ends of upper elongated angular bracket 244 and said upper angular bracket 244 is adjustably held thereon by means of nuts 248 in threaded engagement with the upper end of said rods. Tension rollers 246 are fixedly secured on shaft 250 which is mounted for rotation on upper elongated angular bracket 244 by means of bearing blocks 252 carried by said upper angular bracket. Slots or openings 254 are provided in upper elongated angular bracket 244 through which the peripheries of tension rollers 246 project to cooperate with the sheet of

paper in a manner to be explained hereinafter.

A plurality of clamping and tension rollers **256** are fixedly secured to a shaft **258**. Shaft **258** is carried by horizontal cross bar **237** for rotation thereon, and for clamping thereagainst, by means of slotted bearing blocks **260** carried by said bar **237**. Bearing blocks **260** permit shaft **258** to move towards and away from bar **237**, and leaf springs **262** attached to said bar **237** and pressing against the underside of shaft **258** normally hold said shaft **258** and rollers **256** carried thereby away from said cross bar. A roller shielding and paper guiding angular member **264** is carried by upper elongated angular bracket **244** and is spaced therefrom by suitable spacers **266** to provide an opening between bracket **244** and member **264** through which the sheet of paper can be fed. Slots or openings **265** are provided in member **264** through which the peripheries of rollers **256** project to cooperate with the sheet of paper and rollers **246**.

Rods **240** are of such a length that when shelf **225** is moved to its rearward position, as illustrated in Fig. 4, and arms **230** are lowered to bring adjustment bolts **232** into engagement with bed **2**, the ends of said rods engage wear plates **268** carried by bed **2** prior to said arms **230** reaching their lowermost position to permit brackets **227** and **228** and horizontal cross bar **237** to move downwardly relative to said rods and upper elongated bracket **244** and tension rollers **246** carried thereby, to separate said rollers **246** and clamping and tension rollers **256**. The separation of rollers **246** and **256** makes it possible for a sheet of paper to be fed between said rollers by the action of feed-rollers **115** and **125** in the above described manner. When the point in the operating cycle of the winding machine is reached where feed-rollers **115** and **125** stop feeding paper and separate to permit measuring bar **170** to measure out the desierd length of paper strip, shelf **225** is rocked forwardly to the position disclosed in Fig. 5, by means of a mechanism to be described more fully hereinafter, to provide space between shelf **225** and rest **62** for said measuring bar **170** to descend. At the same time arms **230** are lifted sufficiently, by means also to be described more fully hereinafter, to remove the lower ends of rods **240** from wear plates **268** to thereby clamp the sheet of paper between rollers **246** and **256** and to press rollers **256** against horizontal cross bar **237** to lock said paper against withdrawal by measuring bar **170** as it descends. Each rod **240** is encircled by a helical spring **270**, the upper end of which engages the underside of horizontal cross bar **237**. The lower end of spring **270** abuts against a sleeve or collar **272** fixedly carried by rods **240** by any convenient means, as for example a set screw. It will, therefore, be seen that the initial lifting of brackets **227** and **228** and horizontal cross bar **237** causes a relative movement to take place between said cross bar and rods **240** inasmuch as springs **270** will hold the ends of said rods against wear plates **268**. As cross bar **237** continues to rise rollers **256** engage rollers **246**, through the sheet of paper, and said rollers **256** are held against further upward motion by said rollers **246** inasmuch as the combined force of springs **270** is greater than the combined force of leaf springs **262**. Continued upward movement of brackets **227** and **228** and cross bar **237** causes said leaf springs **262** to be depressed and the periphery of rollers **256** to be engaged by the upper surface of cross bar **237**. Continued upward movement of brackets **227** and **228** and cross bar **237** lifts the entire shelf mechanism as a unit, i. e. bar **237** acting through rollers **256** lifts rollers **246**, and rollers **246** acting through their shaft **250** and bearings **252** lifts upper elongated angular bracket **244** and rods **240**. The sheet of paper between rollers **246** and **256** is thus effectively held against withdrawal when measuring bar **170** descends inasmuch as rollers **256** are held against rotation by virtue of cross bar **237** pressing against their periphery.

After measuring bar **170** has measured the predetermined desired length of paper strip and movable knife blade **205** has severed it, delivery-shelf **225** rocks forwardly and is lifted by arms **230**, by mechanism to be described more fully hereinafter, to a position where said strip of paper is inserted into the coil, or coils, being wound. The forward rocking motion of delivery-shelf **225** causes rollers **246** and **256** to move away from horizontal cross bar **237** to release the peripheries of rollers **256** from said cross bar **237**. Rollers **256** are released from cross bar **237** by means of a pair of cams **274** rigidly attached to the forward ends of long arms **230** around horizontal shaft **229**. A horizontal cam actuated bar **276** is slidably carried by rods **240**. Each end of bar **276** is provided with a cam follower **278**, each of which rides upon the caming surface of its respective cam **274**. Cams **274** are substantially identical and comprise a low segment **280** which is substantially concentric with horizontal shaft **229** and a high segment **282** also substantially concentric with shaft **229**. Low and high segments **280** and **282** respectively are connected by an inclined cam section **284**. When delivery-shelf **225** is in its rearward and paper clamping positions, as illustrated in Figs. 4 and 5, cam followers **278** rest upon low segments **280** of the cams **274**, as delivery-shelf **225** is rocked forwardly to its paper-delivery position, as illustrated in Fig. 6, cam followers **278** ride up over inclined cam section **284** onto high segment **282** to thereby lift horizontal cam actuated bar **276**. As cam actuated bar **276** rises under the influence of cams **274**, its upper surface engages collars **286** fixedly secured to rods **240** whereby continued upward movement of said bar **276** lifts rods **240** and through upper elongated angular bracket **244** lifts tension rollers **246**. Lifting rollers **246** permits leaf springs **262** to in turn move shaft **258** and rollers **256** carried thereby away from horizontal cross bar **237**. It should be noted that cams **274** do not lift bar **276** and rollers **246** a sufficient distance to permit said rollers **246** and **256** to separate to release the sheet of paper held therebetween.

When the sheet of paper is gripped by the coil being wound, continued winding of the coil draws the paper from between rollers **246** and **256** inasmuch as the rollers are free to rotate. It will be noted that the paper will not twist, wrinkle or tear should the sheet of paper be skewed slightly with respect to the axis of the coils being wound so that instead of its entire leading edge being gripped at the same time by the coil, only one end of the sheet is gripped first. This is because the pull on one edge of the paper will rotate rollers **246** and **256** as that edge of the paper starts to move, and inasmuch as all of the rollers **246** and **256** are fixed to their respective shaft **250** and **258**, the rollers will feed the sheet forward smoothly and evenly.

Elevating means and control therefor.—The sheet of paper or other insulating material,

measured and cut in the manner previously explained, is delivered to the coils for insertion between the layers thereof by a forward swinging movement of the delivery-shelf 225 to the position shown in Fig. 6. The forwardly projecting end of the sheet is delivered to the upper surface of the coil and is drawn thereinto by the wire being wound. In order that the sheet may be fed forwardly to overlie the top of the coil as it increases in diameter, it is necessary that the delivery-shelf 225 be progressively elevated during the progress of the winding. The elevating movement of the shelf must be in proportion to the growth of the coil, its extent being substantially equal to the thickness of a layer of wire plus that of the previously inserted paper sheet. The means for effecting the progressive elevation of the shelf 225 and for elevating the shelf to clamp the sheet of paper between rollers 246 and 256 preparatory to the sheet being severed is arranged as next described.

Referring to Figs. 1 and 3, the rod or shaft 231 carrying the arms 230 also has fixed thereon a cam actuated arm 288 and a movement limiting arm 290. Cam actuated arm 288 extends generally downwardly and has its lower end 292 shaped to act as a cam follower. A lifter cam 294 having high segment 296, intermediate segment 298, and low segment 300 is carried by shaft 70 for rotation thereby, and is so located thereon that its cam surfaces are adapted to engage cam follower end 292 of cam actuated lever 288. A movement limiting cam 302 is carried for rotation by shaft 192. Shaft 192 is rotated a slight amount by shaft 70 each time it rotates by means of a ratchet and pawl connection therebetween which is explained in detail in the above mentioned Patent No. 2,029,577. Therefore, as shaft 70 rotates one complete revolution for each layer of wire wound on the coils, the shaft 192 and cam 302 carried thereby are rotated by said shaft 70 less than a full revolution. Cam 302 is located on shaft 192 so that it can be engaged by the end of movement limiting arm 290. A tension spring 306 having one of its ends attached to winding machine bed 2 and its other end attached to cam actuated arm 288 tends to rotate arms 288 and 290, and through them shaft 231, in a clockwise direction to cause either cam follower end 292 of cam actuated arm 288 to engage cam 294 or the end of movement lifting arm 290 to engage the surface of movement limiting cam 302 in a manner that will become more apparent hereinafter.

Lifter cam 294 rotates in a counterclockwise direction as viewed in Fig. 3. In the course of its rotation its high segment 296 engages lower cam follower end 292 of cam actuated arm 288 to pivot said arm 288 in a counterclockwise direction, thus rocking shaft 231 and lowering arms 230 to the position illustrated in Fig. 4 wherein adjustment bolts 232 engage bed 2. As cam 294 continues to rotate, its intermediate segment 298 passes under cam follower 292 permitting tension spring 306 to pivot arm 288 in a clockwise direction to keep said cam follower 292 in engagement with said intermediate segment 298. Arm 288 pivoting from high segment 296 to intermediate segment 298 rotates shaft 231 and lifts arms 230 to their paper clamping position illustrated in Fig. 5. Continued rotation of cam 294 brings its low segment under cam follower 292. When this occurs, tension spring 306 pivots arm 288 further in a clockwise direction until the end of movement limiting arm 290 engages the surface of movement limiting cam 302 to thus elevate arms 230 to the proper height for the insertion of the sheet of paper into the coil, or coils, being wound. As each layer of the coil, or coils, being wound is completed, the above described cycle is repeated. However, it will be noted that shaft 192 indexes through a small predetermined arc with each cycle thus permitting arms 288 and 290 to pivot a slightly greater distance in a clockwise direction at each cycle to lift arms 230 a slightly greater amount at each cycle whereby the sheet of paper is presented to the coil, or coils, being wound at the proper elevation.

For winding coils from wire of different size or gauge and using insulation of different thickness, the change in elevation of arms 230 for each cycle of operation must be varied accordingly. This can be accomplished by adjusting the ratchet and pawl mechanism by which shaft 70 rotates shaft 192 to thereby increase or decrease the rotation imparted shaft 192 by shaft 70.

The shaft 192 is periodically rotated throughout the coil-winding operation, and manually operable means, including crank 308, are provided for resetting the shaft 192 to initial position after the completion of coil winding in the manner described in detail in the above mentioned Patent No. 2,029,577. When the machine is first started to perform the winding operation, the movement limiting cam 302 must be turned to the position illustrated in Fig. 3 with its high point close to the end of movement limiting arm 290 so that as shaft 192 and cam 302 rotate during the coil-winding operation the distance between surface of said cam 302 and the end of movement limiting arm 290 progressively increases.

Delivery-mechanism.—The delivery or transfer of the sheet of paper or other insulating material to the coils is effected by rocking elbow-shaped levers 227 and 228 forwardly to carry the delivery-shelf 225 forwardly to the position shown in Fig. 6. Levers 227 and 228 are rocked forwardly by the same mechanism employed to rock the delivery-shelf in the above mentioned Patent No. 2,029,577 with the exception that the cam employed to move said levers in the instant invention is provided with an additional lobe or intermediate segment adapted to rock levers 227 and 228 forwardly to their clamping position as illustrated in Fig. 5.

The elbow-shaped lever 228 is constructed with a slotted arm 325 projecting rearwardly from its hub. A stud secured to the slot of arm 325 provides means for adjustably attaching a vertical bar 328 thereto. The bar 328 extends downwardly to a point below the axis of the cam-shaft 70 and has a tension spring 329 attached to its lower end. Spring 329 urges bar 328 downwardly to swing levers 227 and 228 rearwardly until their lugs 234 bring up against the forward faces 236 of the frame-members 55, as illustrated in Fig. 4.

Bar 328 is raised to swing levers 227 and 228 forwardly to the paper clamping position and following that to perform the delivery or transfer operation under the impulse of a delivery-cam 335 fixedly mounted on cam-shaft 70. A lever 332 pivoted on shaft 149 extends forwardly from said shaft. A cam follower 334 is mounted on lever 332 intermediate its ends in a position to engage the edge of delivery-cam 335. Cam 335 is provided with a low segment 336 concentric with its axis, an intermediate segment 339 also concentric with its axis, and a radially projecting point 345.

A dogging arm 337 pivotally mounted on the forward end of lever 332 encircles, in dogging relation, bar 328. The opening in dog 337 is slightly larger than bar 328 whereby the latter is permitted to slide freely therein as levers 227 and 228 are raised with arms 230. The free end of dog 337 normally rests on the upper end of an adjustable stop-screw 340 which acts to limit the downward movement of the end of dog 337 whereby the opening in said dog is maintained in parallel relation with respect to the sides of bar 328 when the lever 332 is lowered by cam 335.

The delivery mechanism functions in the following manner. With cam follower 334 bearing against low segment 336 of delivery-cam 335, lever 332 is in its lowermost position and dog 337 is released from vertical bar 328. Spring 329 has drawn bar 328 downwardly to rock elbow-shaped levers 227 and 228 rearwardly into their paper receiving position. After the paper has been fed through clamping and tension rollers 246 and 256, cam follower 334 and lever 332 are lifted by intermediate segment 339 on delivery-cam 335 to rock levers 227 and 228 forwardly to their paper clamping position and arms 230 are elevated to clamp rollers 246 and 256 together upon the paper and to press rollers 256 against bar 237. After the paper has been severed by movable knife-blade 205, arms 230 are further elevated, in the manner above described, to lift delivery-shelf 225 to the proper height for inserting the sheet of paper in the coil being wound. After arms 230 have thus raised levers 227 and 228 said levers 227 and 228 are rocked forward to the paper delivery position by means of radially projecting point 345 of delivery-cam 335 lifting cam follower 334, lever 332 and vertical bar 328. As cam 345 continues to rotate cam follower 334 rides down the other side of point 345 to again rest upon low segment 336 thus lowering lever 332 and permitting levers 227 and 228 to rock rearwardly so that upon the lowering of arms 230 delivery-shelf 225 is back at its paper receiving position.

Method of operation.—The coil-winding mechnism is prepared for operation by placing a suitable paper or fibre tube on arbor 15 and fixing said arbor in the winding machine. A supply of wire or other conductor is provided by mounting spools, not herein shown, in a convenient position above the winding arbor and the ends of the wires are attached to the tube on arbor 15 in the proper position to start the winding.

A roll of strip insulating material R, such as paper, is supplied for delivery to the sheet-feeding means with the forward edge of the strip drawn off from the roll R, passed around movable rollers 94 and over the tie-rod 60. The strip S is placed on top of plate-like shelf 91 and entered between the feed-rollers 115 and 125; the upper roller 125 being lifted manually for this purpose.

With the machine thus prepared for simultaneously winding a series of electrical coils, the operator starts its operation by closing the circuit to its electric driving motor. The motor is arranged to drive the winding spindle and the traverse-mechanism for distributing the wire along the length of the coil in even layers. The wire-traversing and paper-feeding mechanisms are driven in unison by means of suitable gearing and, as above stated, it is necessary that the delivery of each sheet of insulation to the coils take place as the wire-guides reach their extremes of traverse in either direction. For this purpose the cam-shaft 70 is adjusted for proper relationship with the wire-traverse mechanism by the means above described and more fully described in the above mentioned Patent No. 2,029,577.

Assuming that the wire W has just started winding a new layer of wire on the coils, and that delivery-shelf 225 has delivered a sheet of insulating material to the coils and has returned to its position, as illustrated in Fig. 4, for receiving another sheet of paper, the following sequence of operations takes place. Movable rollers 94 descend to draw a length of paper from roll R. As rollers 94 lift away from the paper drawn from roll R to leave said paper in a freely hanging loop, feed-rollers 115 and 125 rotate to feed the end of the paper strip between tension and clamping rollers 246 and 256 on delivery-shelf 225. After a predetermined length of paper has been fed between rollers 246 and 256, feed-rollers 115 and 125 stop revolving and open to permit the paper to be drawn freely between them, and delivery-shelf 225 is rocked forwardly to its locking position, as illustrated in Fig. 4, by means of delivery-cam 335 rotating to bring its intermediate section 339 under cam follower 334 to lift lever 332 and vertical bar 328 to rock elbow-shaped lever 228 forwardly. As soon as delivery-shelf 225 reaches its paper clamping position, arms 230 are lifted by lifter-cam 294 acting through cam actuated arm 288 to lift said delivery-shelf 225 to cause clamping and tension rollers 246 and 256 to grip the sheet of paper and to press rollers 256 against the upper surface of horizontal cross bar 237 to lock said paper against withdrawal from between said rollers. At this point in the cycle measuring bar 170 lowers to draw a predetermined length of paper, sufficient in length to form one complete wrap around the coil at the completion of the layer being wound, from between feed rollers 115 and 125. After the desired length of paper has been measured by measuring bar 170, movable knife-blade 205 descends to cooperate with stationary knife-blade 200 to sever the sheet of paper. After the sheet of paper has been cut feed-rollers 115 and 125 move together thus again gripping the paper therebetween and measuring bar 170 and knife-blade 205 lift to their normal inactive position. At this point in the cycle low segment 300 of lifter-cam 294 passes under cam-follower end 292 of cam actuated arm 288 permitting said arm to rotate in a clockwise direction until further rotation is prevented by the end of movement limiting arm 290 engaging the surface of movement limiting cam 302 to lift arms 230 and through them delivery-shelf 225 to the proper elevation for inserting the sheet of paper into the coils being wound. After delivery-shelf 225 has been lifted to the proper paper delivery height, said delivery-shelf is rocked forwardly by means of point 345 on delivery-cam 335 acting through cam follower 334, lever 332 and vertical bar 328 to present the leading edge of the sheet of paper to the coils being wound.

As delivery-shelf 225 rocks forwardly from its paper clamping position to its paper delivery position cam-followers 278 ride up cams 274 to thereby lift bar 276 which in turn acting through collars 286 lifts rods 240 and tension rollers 246 a sufficient distance to permit leaf springs 262 to move clamping and tension rollers 256 out of contact with horizontal cross bar 237. Rollers 246 are not lifted a sufficient distance to permit them to separate from rollers 256 to release the sheet of paper held therebetween, but it will

be seen that by releasing rollers **256** from horizontal bar **237** tension applied to the end of said sheet of paper will withdraw it from between said rollers and cause its withdrawal to rotate the rollers. Inasmuch as all of the rollers **246** are fast on shaft **250** and all of the rollers **256** are fast on the shaft **258** it will be apparent that tension applied at one end of the leading edge of the sheet of paper will cause the rollers to rotate and feed the paper uniformly and smoothly throughout its width. Therefor, perfect alignment of the leading edge of the sheet of paper and the axis of the coils being wound is not a prerequisite to the successful operation of the delivery-shelf of the present invention inasmuch as the presentation of a somewhat skewed sheet of paper to the coils causes said sheet to be fed evenly and smoothly by the rollers **246** and **256** onto the coil.

Following the presentation of the sheet of paper to the coils, cam follower **334** moves from point **345** of cam **335** to the low segment **336** of said cam causing delivery-shelf **225** to rock rearwardly to its paper receiving position, at the same time the cam follower end **292** of cam actuated arm **288** is engaged by high segment **296** of lifter cam **294** to lower arms **230** to thus return delivery-shelf to its paper receiving position and location.

Since certain changes may be made in the above apparatus without departing from the scope of the invention herein involved, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In a machine for producing electrical coils the combination comprising a movable insulation delivery-shelf having an insulation receiving position, an insulation locking position and an insulation delivery position, means for moving said shelf from said insulation receiving position to said insulation locking position and from said insulation locking position to said insulation delivery position, a set of rollers carried by said shelf, means adapted to cooperate with said rollers to clamp a sheet of insulation therebetween, means adapted to separate said cooperating means from said rollers when said shelf is in said insulation receiving position to permit insulation to be fed therebetween, means to bring said cooperating means and said rollers together to hold a sheet of insulation when said shelf is in said locking position, roller engaging means adapted to engage said rollers when said shelf is in said locking position to hold them against rotation and thereby prevent withdrawal of said insulation, and means adapted upon moving of said shelf from said locking position to said delivery position to release said rollers from said last mentioned means.

2. In a machine for producing electrical coils the combination comprising an insulation delivery-shelf, means for moving said shelf from an insulation receiving position to an insulation locking position, a locking member carried by said shelf, a set of rollers carried by said member and adapted to move towards and away therefrom, means adapted to cooperate with said rollers to clamp a sheet of insulation therebetween, means adapted to separate said cooperating means from said rollers when said shelf is in said insulation receiving position to permit insulation to be fed therebetween, and means adapted to urge said cooperating means towards said rollers when said shelf is in said locking position to thereby clamp a sheet of insulation therebetween and to move said rollers into engagement with said locking member to thereby prevent withdrawal of said insulation.

3. In a machine for producing electrical coils the combination comprising an insulation delivery-shelf, means for moving said shelf from an insulation receiving position to an insulation locking position and from said insulation locking position to an insulation delivery position, a locking member carried by said shelf, a set of rollers carried by said member and adapted to move towards and away therefrom, means adapted to cooperate with said rollers to clamp a sheet of insulation therebetween; means adapted to separate said cooperating means from said rollers when said shelf is in said insulation receiving position to permit insulation to be fed therebetween, means adapted to urge said cooperating means towards said rollers when said shelf is in said locking position to thereby clamp a sheet of insulation therebetween and to move said rollers into engagement with said locking member to thereby prevent withdrawal of said insulation, and means adapted upon movement of said shelf from said locking position to said delivery position to move said cooperating means away from said locking member to release said rollers therefrom.

4. In a machine for producing electrical coils the combination comprising an insulation delivery-shelf, means for moving said shelf from an insulation receiving position to an insulation locking position and from said insulation locking position to an insulation delivery position, a locking member carried by said shelf, a set of rollers carried by said member and adapted to move towards and away therefrom, means adapted to cooperate with said rollers to clamp a sheet of insulation therebetween, means adapted to separate said cooperating means from said rollers when said shelf is in said insulation receiving position to permit insulation to be fed therebetween, means adapted to urge said cooperating means towards said rollers when said shelf is in said locking position to thereby clamp a sheet of insulation therebetween and to move said rollers into engagement with said locking member to thereby prevent wtihdrawal of said insulation, and cam means adapted upon movement of said shelf from said locking position to said delivery position to move said cooperating means away from said locking member to release said rollers therefrom.

5. In a machine for producing electrical coils the combination comprising an insulation delivery-shelf, means for moving said shelf from an insulation receiving position to an insulation locking position and from said insulation locking position to an insulation delivery position, a set of rollers carried by said shelf, a second set of rollers carried by said shelf, a locking member carried by said shelf in a position to be engaged by one of said sets of rollers, means adapted to move said second set of rollers away from said first mentioned set of rollers when said shelf is in said insulation receiving position to permit insulation to be fed therebetween, means to urge said second set of rollers towards said first mentioned set of rollers when said shelf is in said locking position to thereby grip said insulation and to bring said locking member and one of the sets of rollers into engagement with each other to prevent rotation of said rollers, and

roller moving means for moving the set of rollers away from said locking member upon movement of said shelf from said locking position to said delivery position.

6. In a machine for producing electrical coils the combination comprising an insulation delivery-shelf, means for moving said shelf from an insulation receiving position to an insulation locking position, a locking member carried by said shelf, a set of rollers carried by said member and adapted to move towards and away therefrom, a second set of rollers carried by said shelf, means adapted to move said second set of rollers away from said first mentioned set of rollers when said shelf is in said insulation receiving position to permit insulation to be fed therebetween, and means adapted to urge said second set of rollers towards said first mentioned set of rollers when said shelf is in said locking position to thereby clamp a sheet of insulation between the two sets of rollers and to move said first mentioned set of rollers into engagement with said member to thereby prevent withdrawal of said insulation.

7. In a machine for producing electrical coils the combination comprising an insulation delivery-shelf, means for moving said shelf from an insulation receiving position to an insulation locking position and from said insulation locking position to an insulation delivery position, a locking member carried by said shelf, a set of rollers carried by said member and adapted to move towards and away therefrom, a second set of rollers carried by said shelf, means adapted to move said second set of rollers away from said first mentioned set of rollers when said shelf is in said insulation receiving position to permit insulation to be fed therebetween, means adapted to urge said second set of rollers towards said locking member when said shelf is in said locking position to thereby clamp a sheet of insulation between the two sets of rollers and to move said first mentioned set of rollers into engagement with said member to thereby prevent withdrawal of said insulation, and cam means adapted upon movement of said shelf from said locking position to said delivery position to disengage said first mentioned set of rollers from said member.

8. In a machine for producing electrical coils the combination comprising an insulation delivery-shelf, means for moving said shelf from an insulation receiving position to an insulation locking position and from said insulation locking position to an insulation delivery position, a locking member carried by said shelf, a set of rollers carried by said member and adapted to move towards and away therefrom, a second set of rollers carried by said shelf, means adapted to move said second set of rollers away from said first mentioned set of rollers when said shelf is in said insulation receiving position to permit insulation to be fed therebetween, means adapted to urge said second set of rollers towards said locking member when said shelf is in said locking position to thereby clamp a sheet of insulation between the two sets of rollers and to move said first mentioned set of rollers into engagement with said member to thereby prevent withdrawal of said insulation, and cam means adapted upon movement of said shelf from said locking position to said delivery position to move said second set of rollers away from said locking member to release said first mentioned set of rollers therefrom.

9. In a machine for producing electrical coils the combination comprising an insulation delivery-shelf, means for moving said shelf from an insulation receiving position to an insulation locking position and from said insulation locking position to an insulation delivery position, a locking member carried by said shelf, a set of rollers carried by said member and adapted to move towards and away therefrom, resilient means tending to move said rollers away from said member, a second set of rollers carried by said shelf, resilient means tending to move said second set of rollers towards said member, means adapted to move said second set of rollers away from said member against the action of said second mentioned resilient means when said shelf is in said insulation receiving position to separate the two sets of rollers to permit insulation to be fed therebetween, means for releasing said second mentioned resilient means to urge said second set of rollers towards said locking member when said shelf is in said locking position to thereby clamp a sheet of insulation between the two sets of rollers and to move said first mentioned set of rollers into engagement with said member to thereby prevent withdrawal of said insulation, and means adapted upon movement of said shelf from said locking position to said delivery position to move said second set of rollers against the action of said second mentioned resilient means away from said locking member a sufficient distance to permit said first mentioned resilient means to release said first mentioned set of rollers therefrom.

10. In a machine for producing electrical coils the combination comprising an insulation delivery-shelf, means for moving said shelf from an insulation receiving position to an insulation locking position and from said insulation locking position to an insulation delivery position, a locking member carried by said shelf, a shaft carried by said member for rotation thereon and adapted to move towards and away therefrom, a plurality of rollers fixedly mounted on said shaft, resilient means tending to move said shaft and the rollers carried thereby away from said member, a second shaft, a plurality of rollers fixedly mounted on said second shaft, means mounting said second shaft and the rollers carried thereby on said shelf for movement towards and away from said locking member, resilient means tending to move said mounting means towards said member, means adapted to move said mounting means away from said member against the action of said second mentioned resilient means when said shelf is in said insulation receiving position to separate the two sets of rollers to permit insulation to be fed therebetween, means for releasing said second mentioned resilient means to urge said mounting means towards said locking member when said shelf is in said locking position to thereby clamp a sheet of insulation between the two sets of rollers and to move the rollers carried by said first mentioned shaft into engagement with said member to thereby prevent withdrawal of said insulation, and means adapted upon movement of said shelf from said locking position to said delivery position to move said mounting means against the action of said second mentioned resilient means away from said locking member a sufficient distance to permit said first mentioned resilient means to release the rollers carried by said first mentioned shaft from said member.

11. In a machine for producing electrical coils

the combination comprising an insulation delivery shelf, means for moving said shelf from an insulation receiving position to an insulation locking position and from said insulation locking position to an insulation delivery position, a locking member carried by said shelf, a shaft carried by said member for rotation thereon and adapted to move towards and away therefrom, a plurality of rollers fixedly mounted on said shaft, resilient means tending to move said shaft and the rollers carried thereby away from said member, a second shaft, a plurality of rollers fixedly mounted on said second shaft, means mounting said second shaft and the rollers carried thereby on said shelf for movement towards and away from said locking member, resilient means tending to move said mounting means towards said member, means adapted to move said mounting means away from said member against the action of said second mentioned resilient means when said shelf is in said insulation receiving position to separate the two sets of rollers to permit insulation to be fed therebetween, means for releasing said second mentioned resilient means to urge said mounting means towards said locking member when said shelf is in said locking position to thereby clamp a sheet of insulation between the two sets of rollers and to move the rollers carried by said first mentioned shaft into engagement with said member to thereby prevent withdrawal of said insulation, and cam actuated means adapted upon movement of said shelf from said locking position to said delivery position to move said mounting means against the action of said second mentioned resilient means away from said locking member a sufficient distance to permit said first mentioned resilient means to release the rollers carried by said first mentioned shaft from said member.

12. In a machine for producing electrical coils the combination comprising an insulation delivery-shelf, means for moving said shelf from an insulation receiving position to an insulation locking position and from said insulation locking position to an insulation delivery position, a locking bar carried by said shelf, a shaft carried by said locking bar substantially parallel therewith for rotation thereon and adapted to move towards and away therefrom, a plurality of rollers fixedly mounted on said shaft, resilient means tending to move said shaft and the rollers carried thereby away from said locking bar, mounting means slidably carried by said locking bar for movement towards and away therefrom, a second shaft rotatably carried by said mounting means, a plurality of rollers fixedly mounted on said second shaft, resilient means tending to move said mounting means towards said locking bar, a portion of said mounting means being positioned to be engaged by said machine to cause relative movement between said mounting means and said locking bar as said delivery-shelf moves from said insulation delivery position back to said insulation receiving position to thereby separate the two sets of rollers to permit insulation to be fed therebetween, means for disengaging said portion of said mounting means from said machine when said delivery-shelf is in said insulation locking position to permit said second mentioned resilient means to urge said mounting means towards said locking bar to thereby clamp a sheet of insulation between the two sets of rollers and to move the rollers carried by said first mentioned shaft into engagement with said locking bar to thereby prevent withdrawal of said insulation, and cam actuated means adapted upon movement of said shelf from said locking position to said delivery position to engage a part of said mounting means and thereby move said mounting means against the action of said second mentioned resilient means away from said locking bar a sufficient distance to permit said first mentioned resilient means to release the rollers carried by said first mentioned shaft from said locking bar.

13. In a machine for producing electrical coils of the type having a supply of sheet insulation and means for drawing and severing a predetermined length of insulation from said supply the combination comprising, an insulation delivery-shelf, means for moving said shelf from an insulation receiving position to an insulation locking position and from said insulation locking position to an insulation delivery position, a locking member carried by said shelf, a set of rollers carried by said member and adapted to move towards and away therefrom, means adapted to cooperate with said rollers to clamp a sheet of insulation therebetween, means adapted to separate said cooperating means from said rollers when said shelf is in said insulation receiving position to permit insulation from said supply of sheet insulation to be fed therebetween, means adapted to urge said cooperating means towards said rollers when said shelf is in said locking position to thereby clamp a sheet of insulation therebetween and to move said rollers into engagement with said locking member to thereby prevent withdrawal of said insulation to permit said drawing and severing means to draw a predetermined length of insulation from said supply and said severing means to sever said lengths, and means adapted upon movement of said shelf from said locking position to said delivery position to move said cooperating means away from said locking member to release said rollers therefrom.

14. In a machine for producing electrical coils the combination comprising an insulation delivery-shelf, means for moving said shelf from an insulation receiving position to an insulation locking position and from said insulation locking position to an insulation delivery position, insulation clamping and controlling means carried by said shelf, locking means for engaging said clamping and controlling means to prevent the withdrawal of insulation therefrom, means adapted to open said clamping and controlling means to permit insulation to be fed therebetween when said shelf is in said insulation receiving position, means adapted to close said clamping and controlling means to engage a sheet of insulation therebetween and to engage said locking means with said clamping and controlling means when said shelf is in said insulation locking position, and means adapted to disengage said locking means from said clamping and controlling means as said shelf is moved from said locking position to said delivery position to permit said insulation to be delivered to a coil being wound.

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