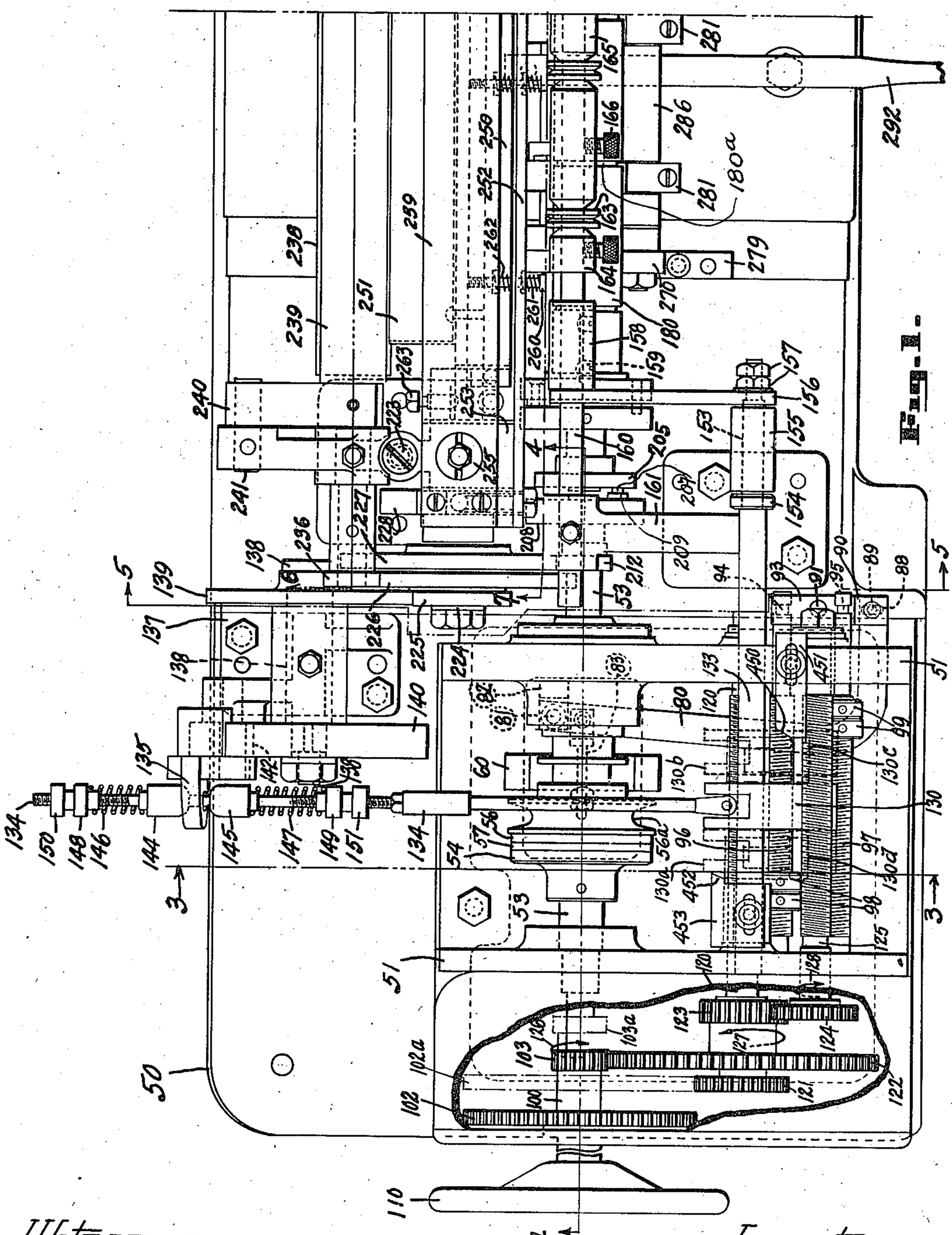
June 19, 1923. 1,459,013

E. F. CREAGER ET AL

COIL WINDING MACHINE

Filed Nov. 25, 1918 12 sheets-sheet 1



Witnesses
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Warren Lehmieding

By

Inventors
Edwin F. Creager and Samuel Rogers
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June 19, 1923.

1,459,013

E. F. CREAGER ET AL

COIL WINDING MACHINE

Filed Nov. 25 1918

12 sheets-sheet 2

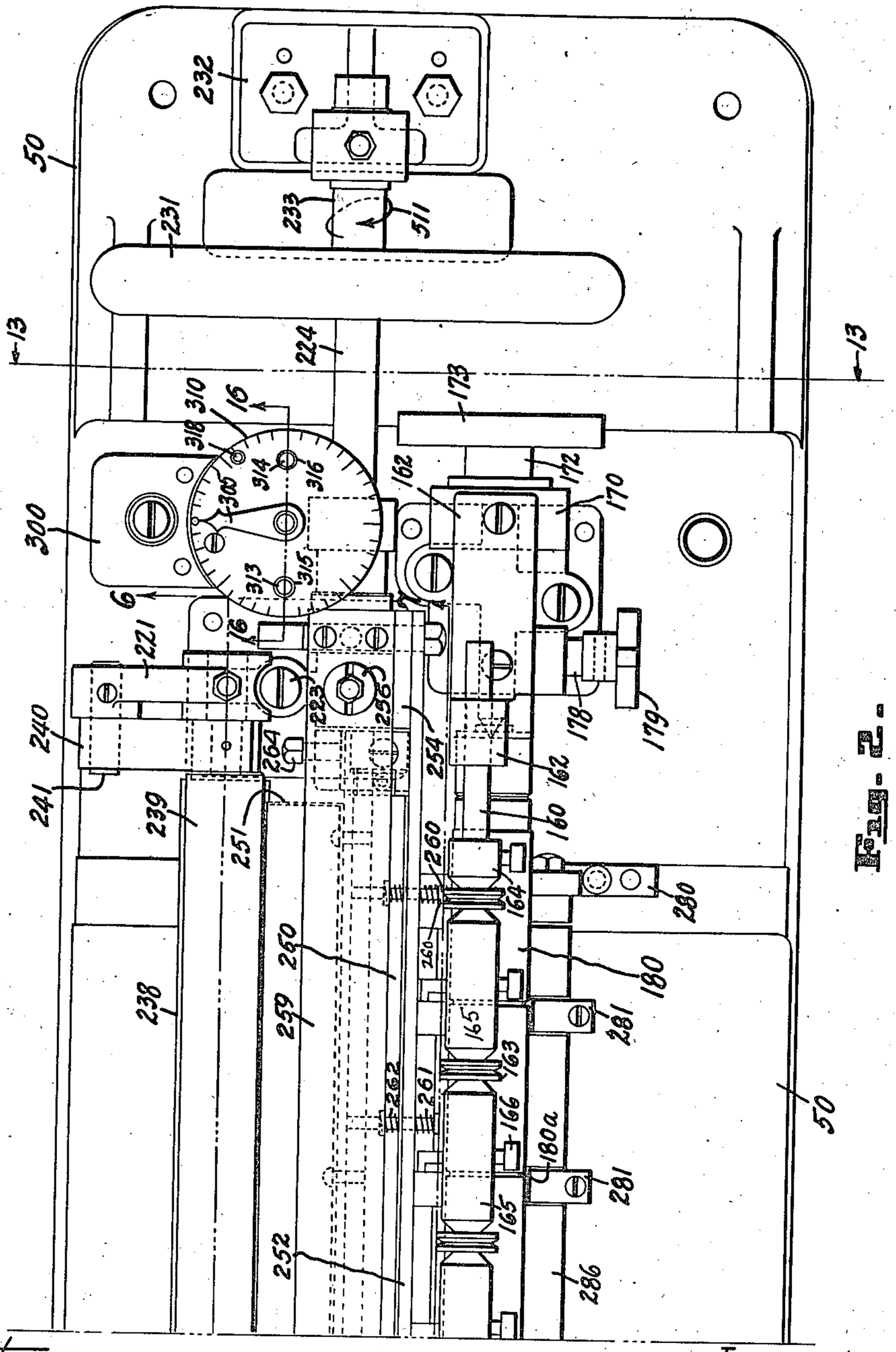

Fig. 2.

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E. F. CREAGER ET AL.

COIL WINDING MACHINE

Filed Nov. 25, 1918

12 sheets-sheet 3

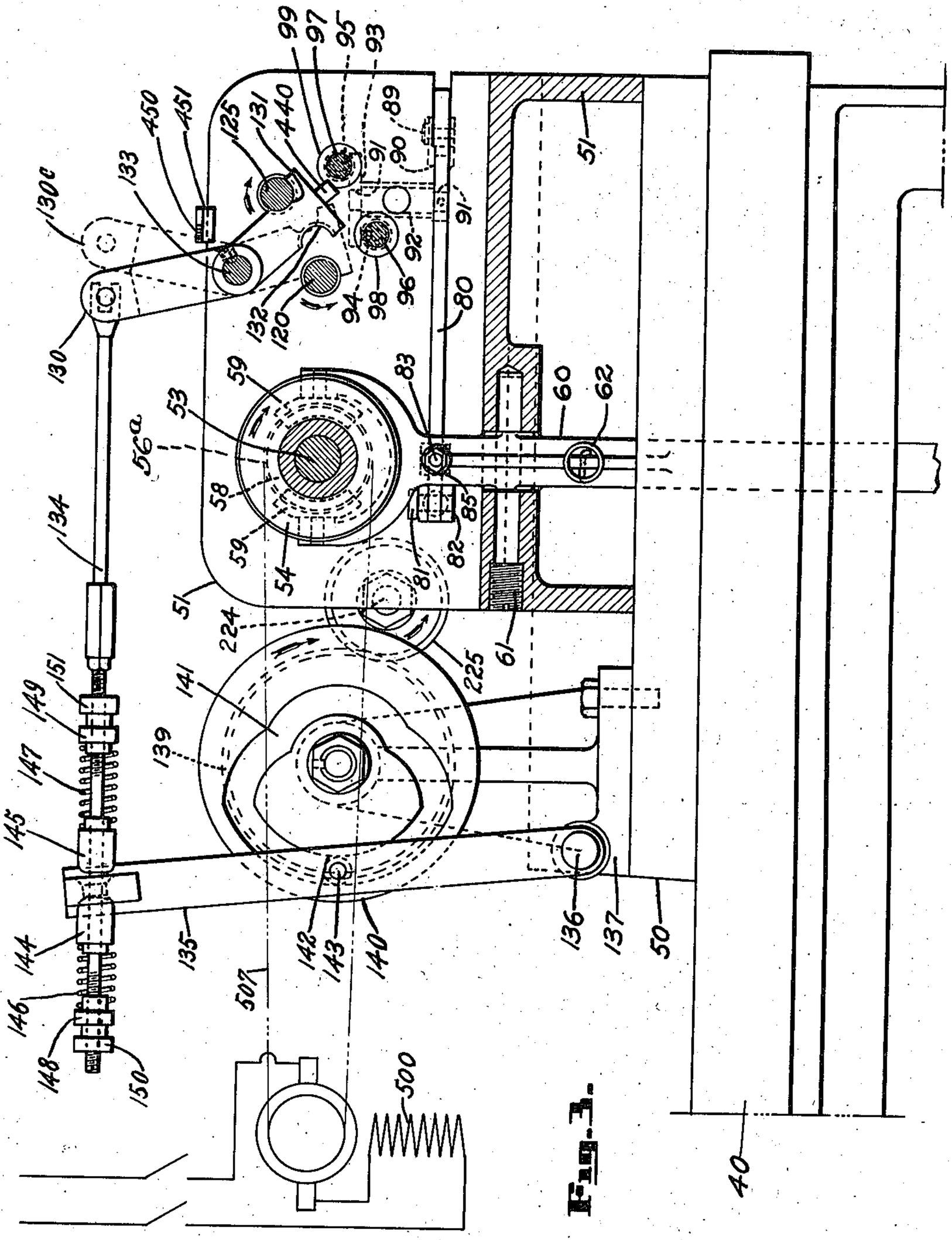

Fig. 3.

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COIL WINDING MACHINE

Filed Nov. 25, 1918 12 sheets-sheet 4

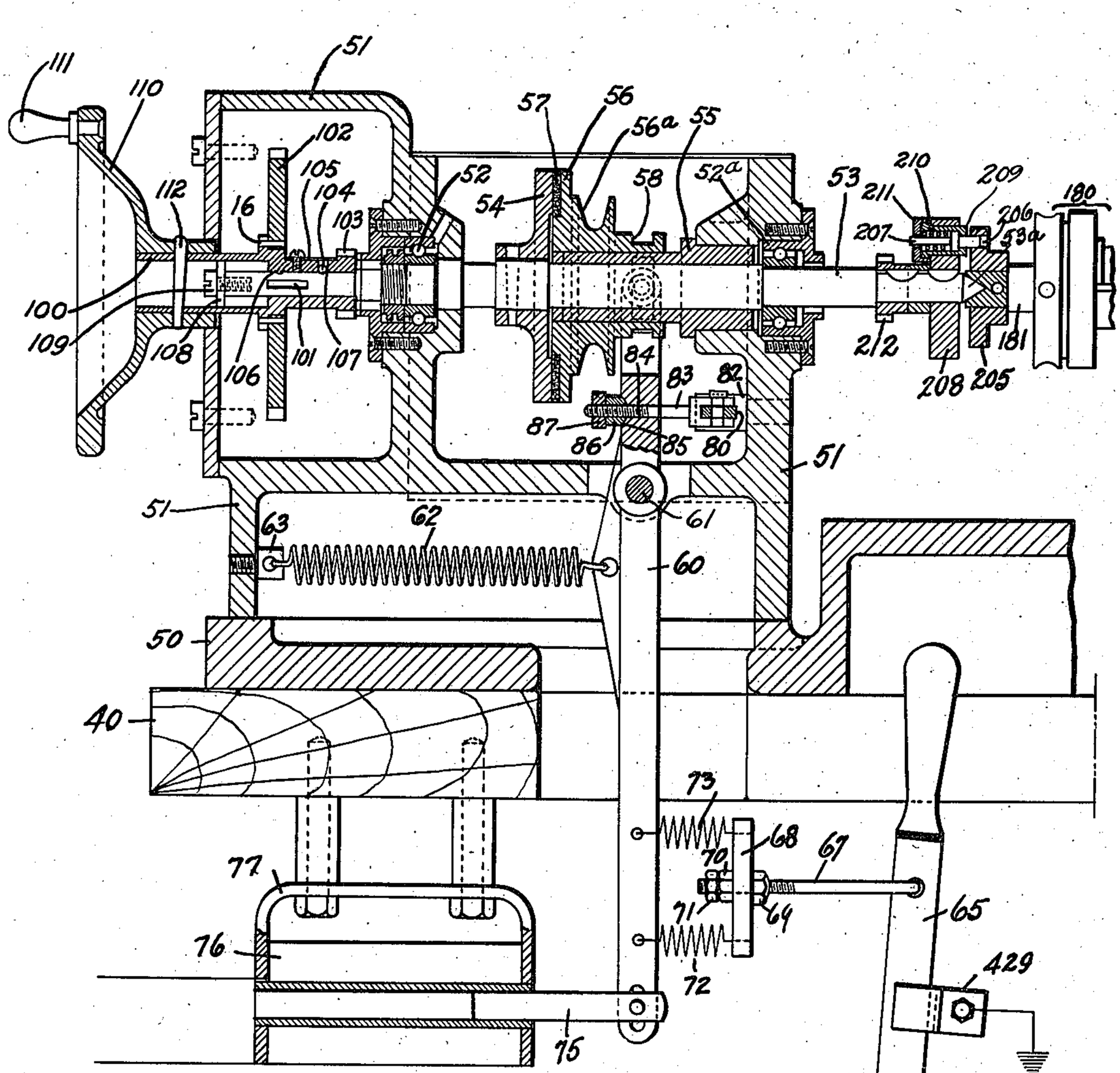

Fig. 4.

Witnesses
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COIL WINDING MACHINE

Filed Nov. 25, 1918 12 sheets-sheet 5

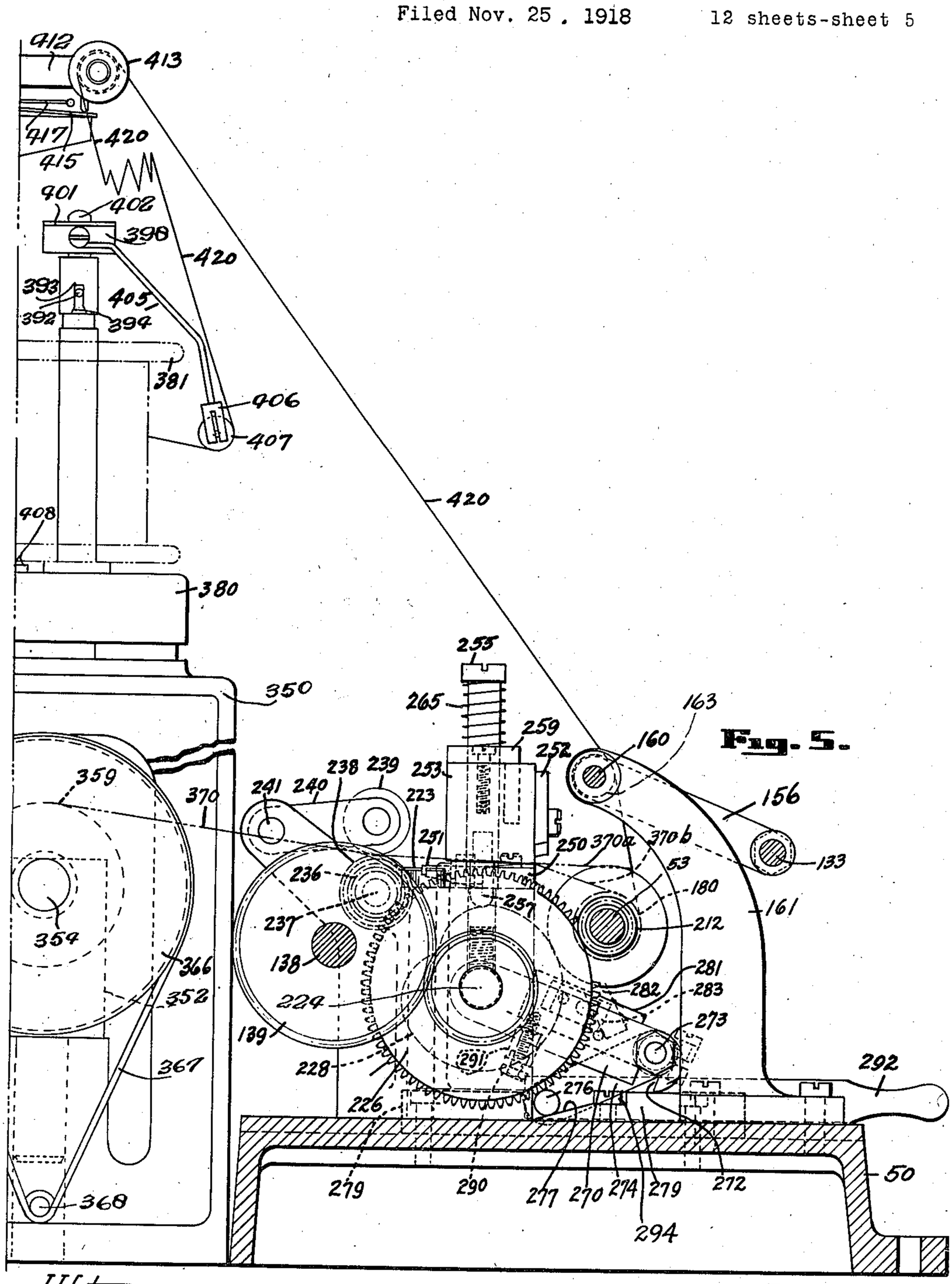

Fig. 5.

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1,459,013

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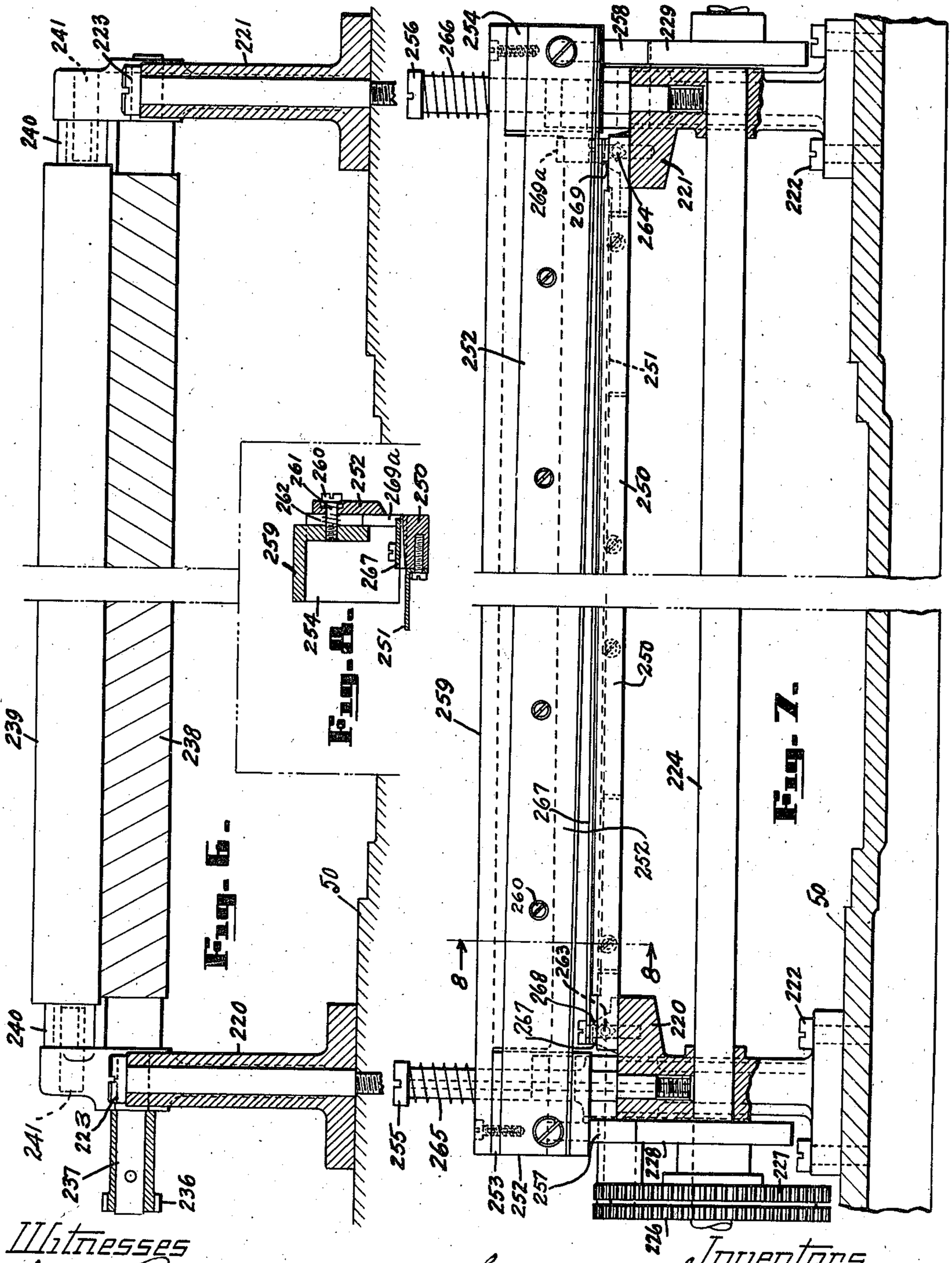
COIL WINDING MACHINE

Filed Nov. 25, 1918

12 sheets-sheet 6



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COIL WINDING MACHINE

Filed Nov. 25, 1918 12 sheets-sheet 7

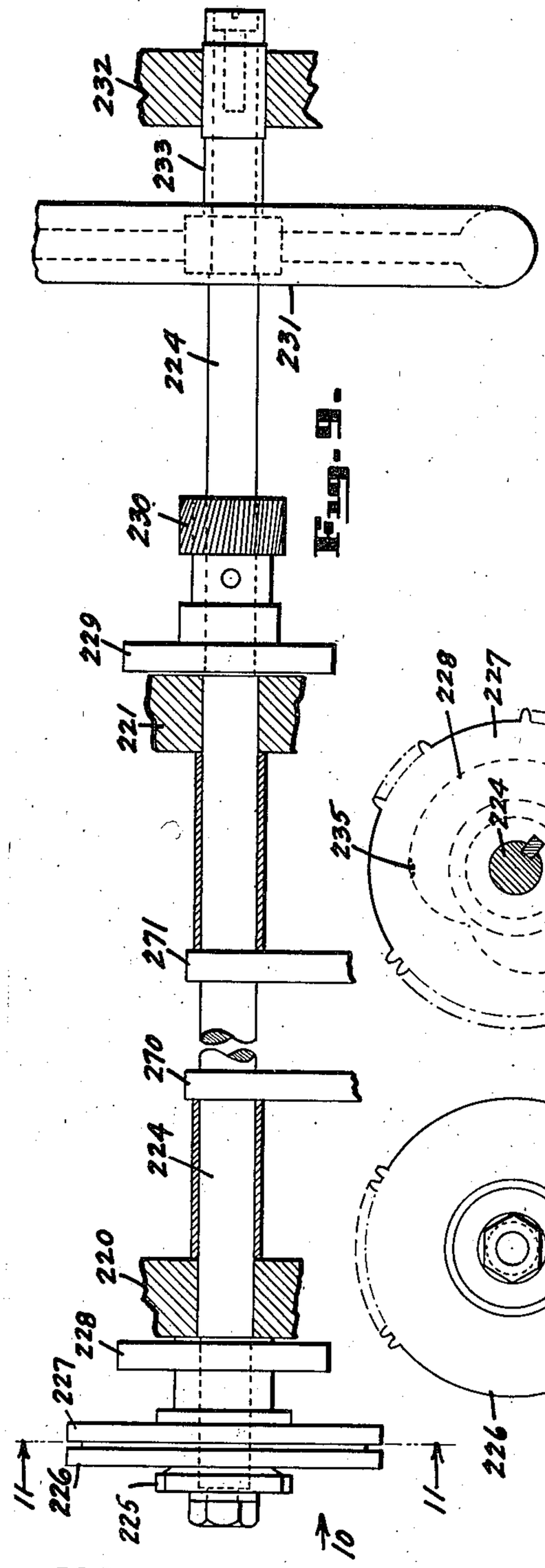

Fig. 11.

Fig. 10.

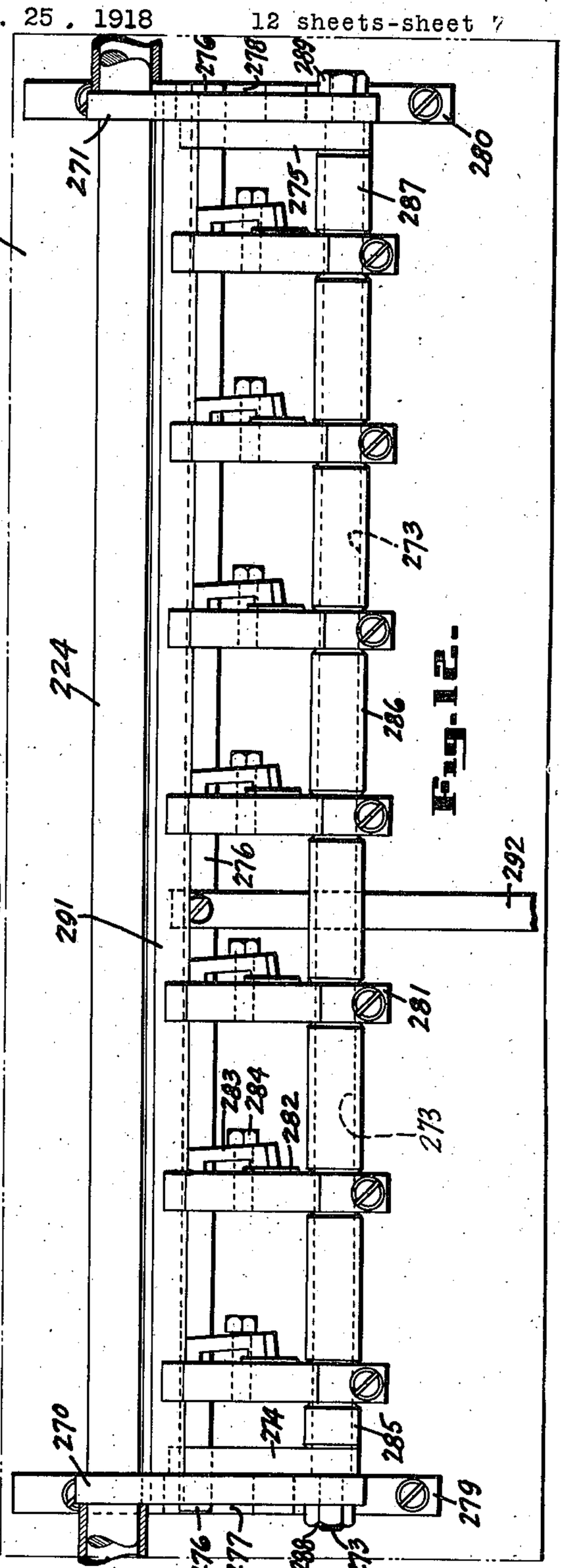

Fig. 12.

Witnesses
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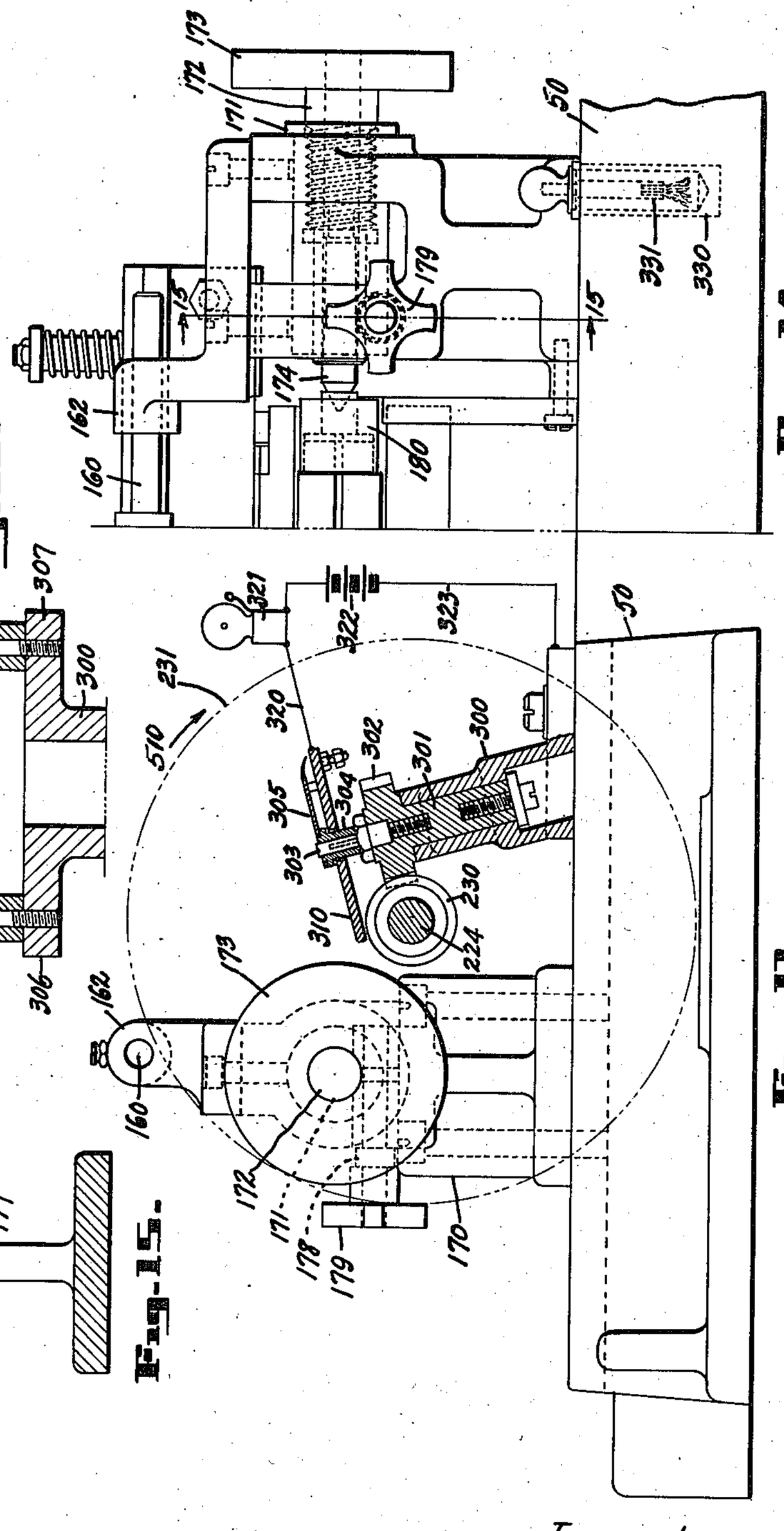
E. F. CREAGER ET AL

COIL WINDING MACHINE

Filed Nov. 25, 1918

12 sheets-sheet 8



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COIL WINDING MACHINE

Filed Nov. 25, 1918 12 sheets-sheet 9

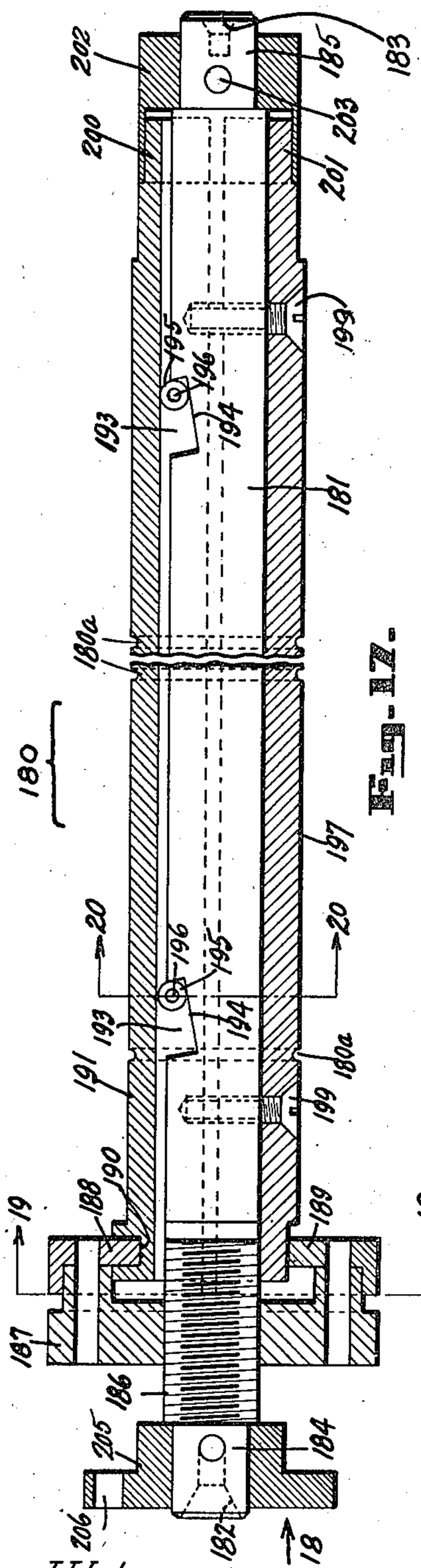

Fig. 17.

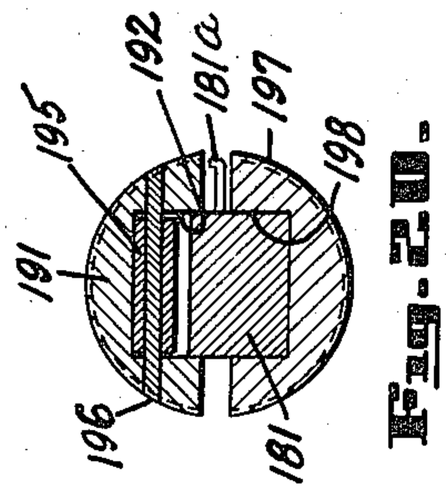

Fig. 20.

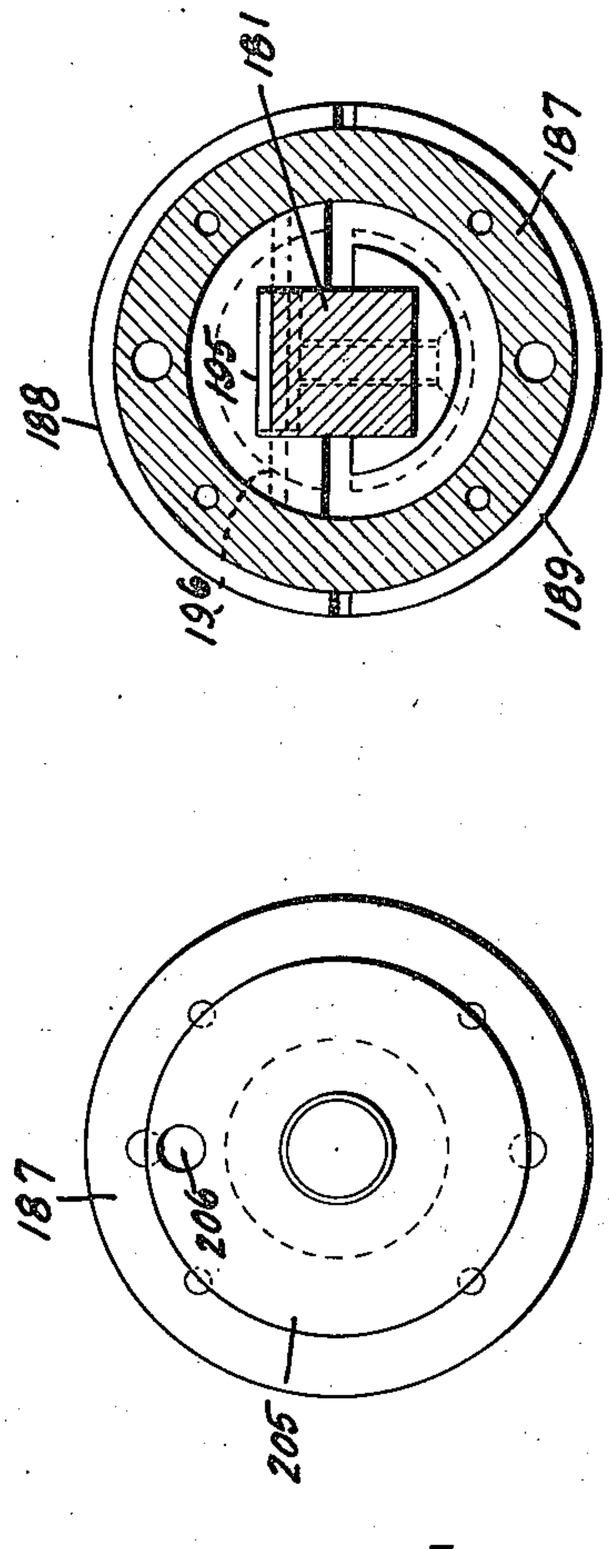

Fig. 19.

Fig. 18.

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E. F. CREAGER ET AL

COIL WINDING MACHINE

Filed Nov. 25, 1918 12 sheets-sheet 10

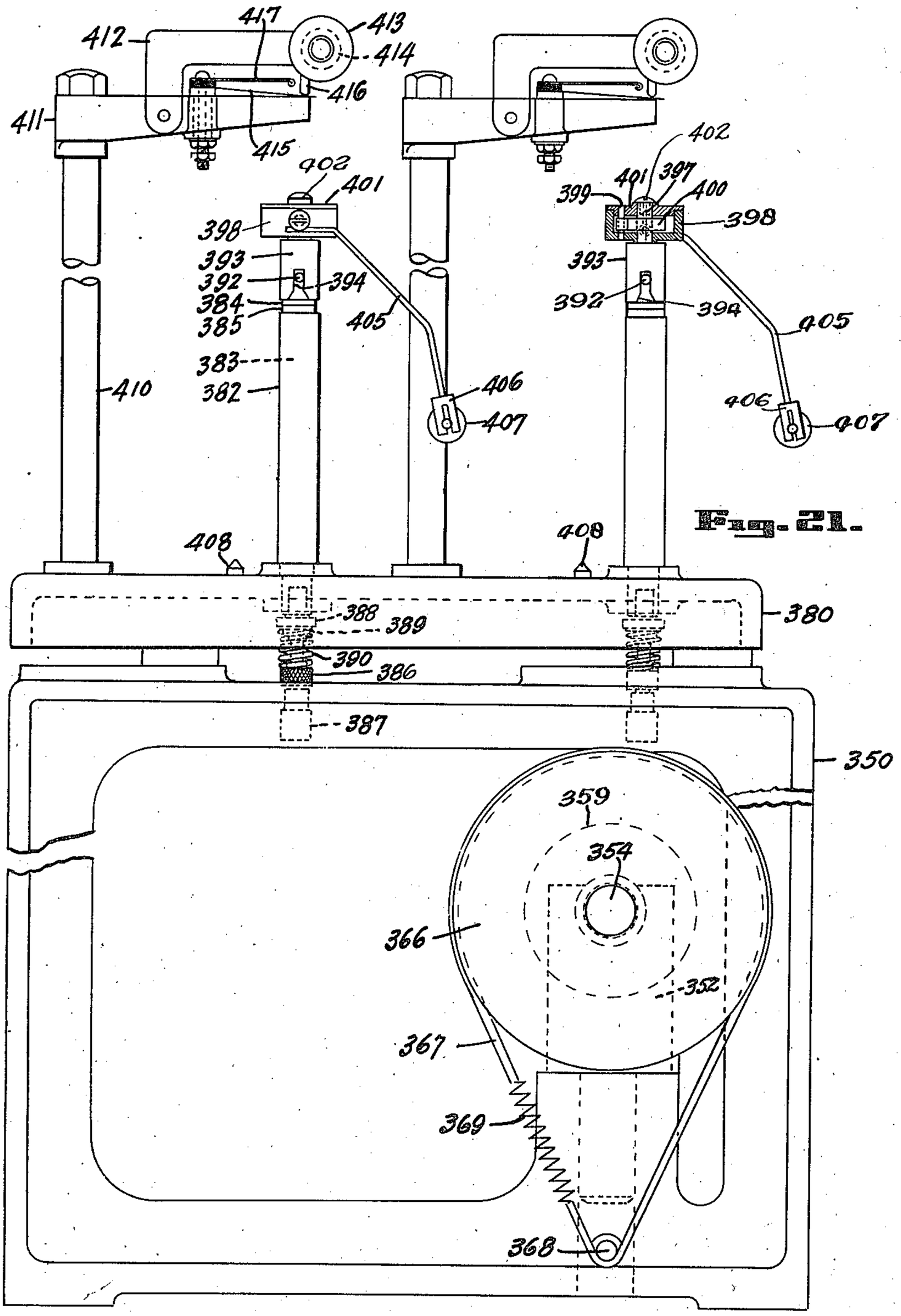

Fig. 21.

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June 19, 1923. 1,459,013

E. F. CREAGER ET AL

COIL WINDING MACHINE

Filed Nov. 25, 1918 12 sheets-sheet 11

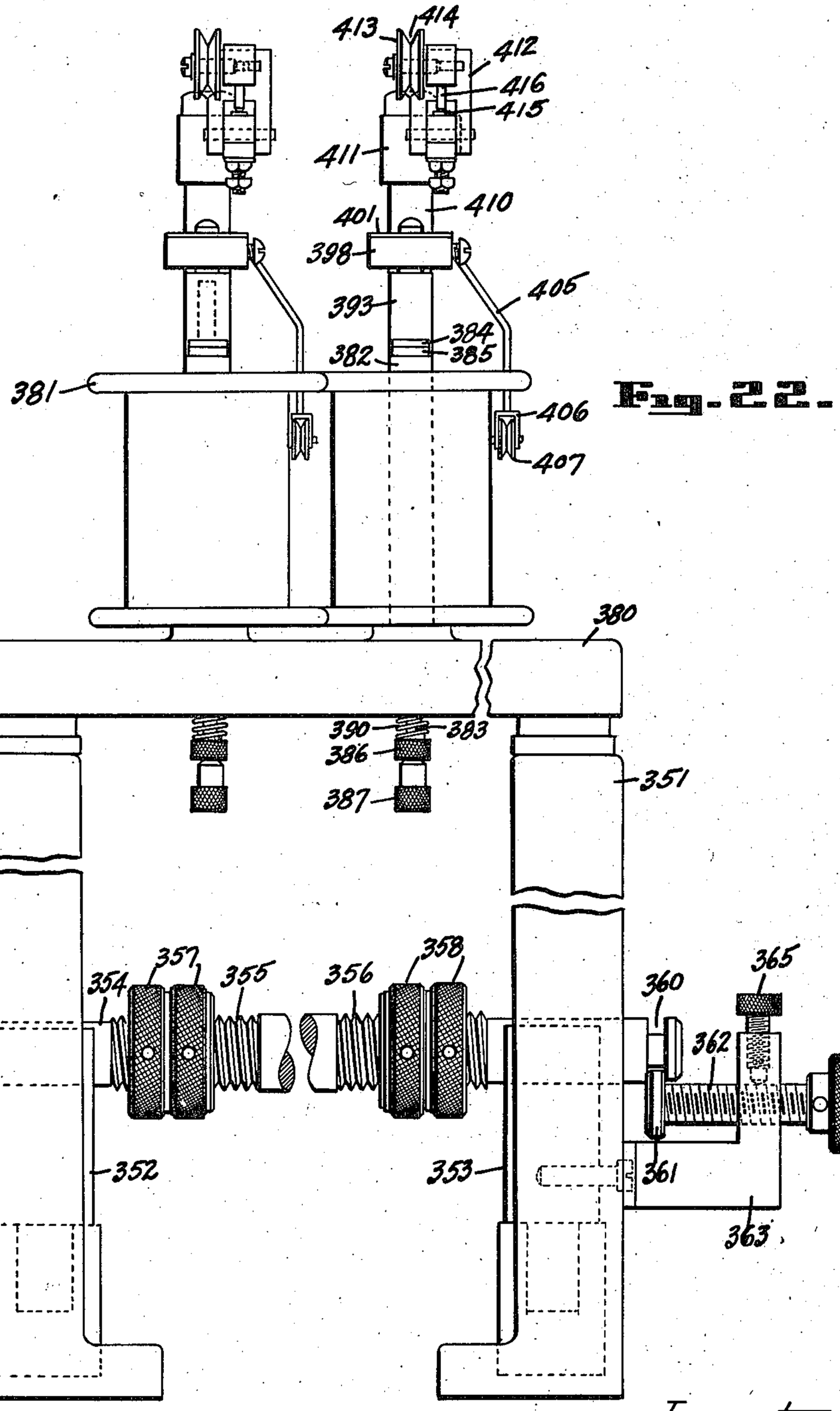

Fig. 22.

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COIL WINDING MACHINE

Filed Nov. 25, 1918 12 sheets-sheet 12

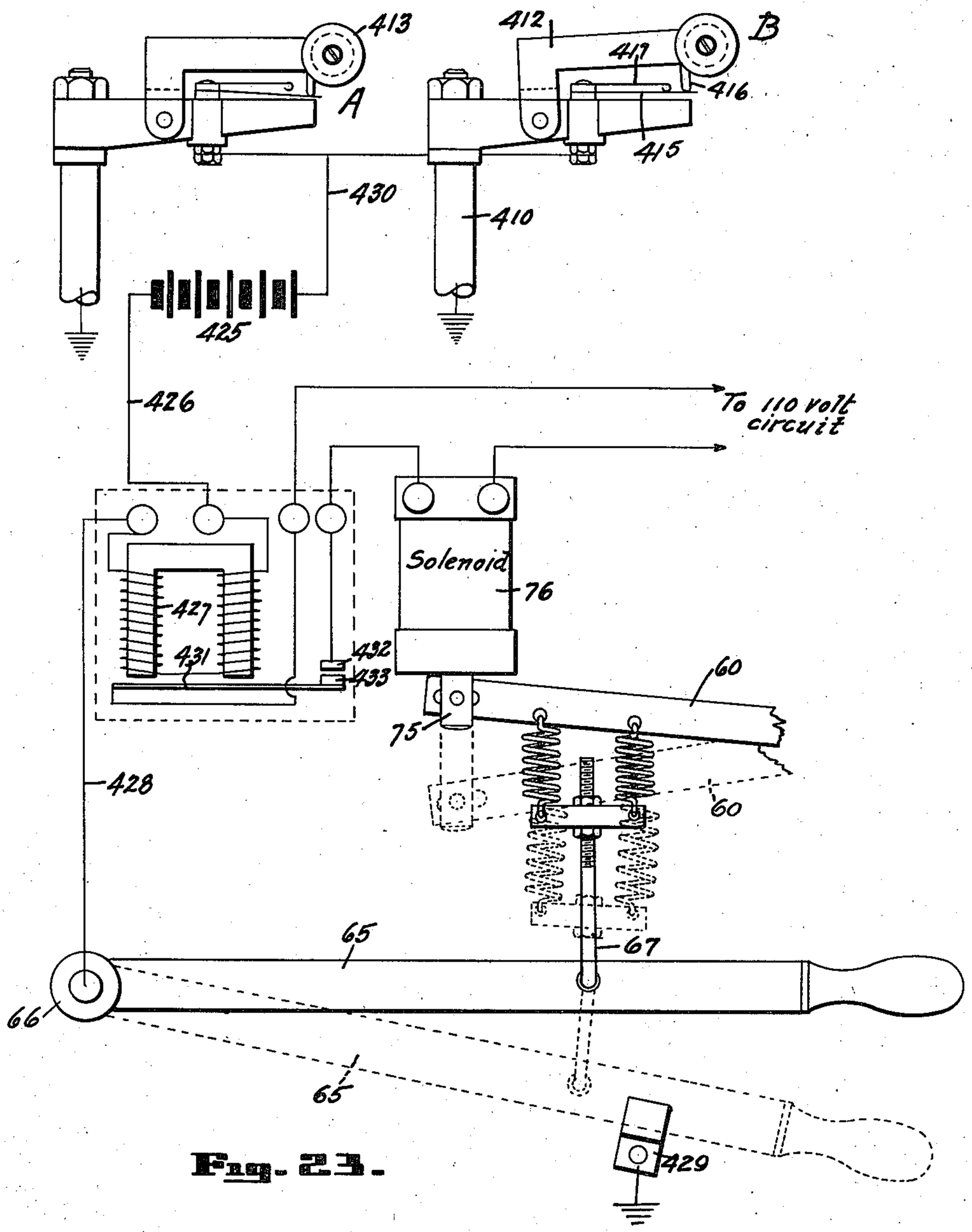

Fig. 23.

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Patented June 19, 1923. 1,459,013

UNITED STATES PATENT OFFICE.

EDWIN F. CREAGER AND SAMUEL ROGERS, OF ANDERSON, INDIANA, ASSIGNORS TO THE REMY ELECTRIC COMPANY, A CORPORATION OF INDIANA.

COIL-WINDING MACHINE.

Application filed November 25, 1918. Serial No. 263,989.

To all whom it may concern:

Be it known that we, EDWIN F. CREAGER and SAMUEL ROGERS, citizens of the United States of America, residing at Anderson, county of Madison, State of Indiana, have invented certain new and useful Improvements in Coil-Winding Machines, of which the following is a full, clear, and exact description.

This invention relates to machines for winding coils of wire, and particularly for forming inductive windings of electrical apparatus, consisting of a plurality of layers of wire insulated from one another.

The principal objects are to provide means for manufacturing a coil having successive layers of wire windings separated by insulating tubes, each tube comprising a plurality of layers formed from a relatively wide sheet of insulating material, without cutting the sheet into the different lengths required for the tubes prior to the forming of the latter, to insure attention on the part of the operator to the forming of the tubes so as to avoid the use of imperfect insulating material, and to provide controlling devices which insure a uniform product with a large capacity production.

Other and further objects and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings, wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Figs. 1 and 2 taken together form a plan view of the coil winding machine embodying the present invention.

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 1.

Fig. 4 is a longitudinal sectional view of the head stock shaft taken on the line 4—4 of Fig. 1.

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

Fig. 6 is a sectional view taken on the line 6—6 of Figs. 1 and 2.

Fig. 7 is a sectional view taken on the line 7—7 of Figs. 1 and 2.

Fig. 8 is a sectional view taken on the line 8—8 of Fig. 7.

Fig. 9 is a plan view of the hand wheel shaft assembly.

Fig. 10 is an end view of the shaft assembly, shown in Fig. 9 looking in the direction of the arrow 10.

Fig. 11 is a sectional view taken on the line 11—11 of Fig. 9.

Fig. 12 is a plan view of the coil separating mechanism.

Fig. 13 is an end view of the coil winding machine, certain parts being shown in section, and certain parts being omitted to the right of the line 13—13 of Fig. 2 for the sake of clearness.

Fig. 14 is a front elevation of the tail stock and parts associated therewith.

Fig. 15 is a sectional view taken on the line 15—15 of Fig. 14.

Fig. 16 is an enlarged scale sectional view taken on the line 16—16 of Fig. 2, certain parts being omitted for the sake of clearness.

Fig. 17 is a longitudinal sectional view of the coil winding spindle.

Fig. 18 is an end view of the spindle looking in the direction of the arrow 18 in Fig. 17.

Fig. 19 is a sectional view taken on the line 19—19 of Fig. 17.

Fig. 20 is a sectional view taken on the line 20—20 of Fig. 17.

Fig. 21 is a side elevation of devices for carrying the paper and spools of wire which are to be wound on the spindle.

Fig. 22 is a front elevation of the parts shown in Fig. 21.

Fig. 23 is a wiring diagram, certain of the controlling devices being shown in connection therewith.

Description of power driven devices and clutch.

Referring to the drawings:

50 designates a base upon which the parts of the coil winding machine are mounted. Upon the base 50 is mounted a head stock frame 51, see Figs. 1, 3 and 4. Frame 51 carries ball bearings 52 and 52ª upon which is journalled the head stock or arbor driving shaft 53. The shaft 53 carries in fixed relation therewith a clutch disc 54. A fixed bearing sleeve 55 for the shaft 53 sup-

ports a rotatable and longitudinally slidable clutch disc 56 carrying a contact rings 57 of leather or other suitable friction material, which contacts with the disc 54 when the clutch is engaged. The slidable clutch member 56 is formed with a pulley groove 56[a] and a second groove 58.

Control of clutch.

A fork lever 60 journalled upon a pin 61 which is fixed upon the frame 51, carries shipper yoke segments 59 which ride in the groove 58 formed in the member 56. A spring 62 is connected to the frame 51 at 63 and to the lever 60, and said spring 62 tends to move the lever 60 in such a direction as to cause the separation of members 54 and 56.

Movement is imparted to the lever 60 by means of a hand lever 65 which is pivoted at 66. Said pivot 66 may be some point on the bench 40, which supports the base 50, but for the sake of clearness is not shown located in this manner in Fig. 4. A link 67 is connected with the lever 65, and a screw threaded portion passes through bar 68. The relation of the link 67 to the bar 68 may be regulated by means of nuts 69, 70 and 71. The bar 68 is connected by means of springs 72 and 73 with the lever 60.

Another means of moving the lever 60 comprises the solenoid armature 75, which cooperates with the solenoid magnet 76, supported by a frame 77, said frame being mounted upon the bench 40.

A still further means of moving the lever 60 consists of an L-shaped bar 80, see Figs. 1, 3 and 4. The bar 80 is pivotally mounted upon a pin 81 which is carried by a block 82 mounted upon the frame 51. A link 83 is connected at one end to the bar 80 and passes through a hole 84 in the lever 60. Nut 86 threaded onto the end of link 83 and the portion of the bar 80 contacting with the nut are formed with complemental spherical surfaces 85. A lock nut 87 cooperates with the nut 86 to maintain the nut 86 in fixed relation with the link 83.

The free end of the bar 80 is provided with a slotted hole 88 which cooperates with a pin 89 carried by a lever 90. Lever 90 is fixed upon a shaft 91, said shaft 91 being journalled upon a block 92 carried by the frame 51. Upon the upper end of the shaft 91 is fixed a lever 93. Lever 93 carries pins 94 and 95 which cooperate, respectively, with the grooved ends of stop screws 96 and 97 which are mounted upon the frame 51 in such a manner as to be slidable in a direction parallel with the head stock shaft 53. The stop screw 96 carries stop nuts 98 and the screw 97 carries stop nuts 99. It is apparent therefore that any object moving in a direction parallel with the stop screws 96 and 97 which should strike the stop nuts 98 or 99, would impart movement to the stop screws 96 and 97 and, consequently, movement would be imparted to the lever 80 and the lever 60.

Wire feeding mechanism.

A sleeve 100 is slidably mounted upon the shaft 53 and is held in fixed rotative relation therewith by means of the key 101. Sleeve 100 carries gears 102 and 103. A plunger 104 is carried by the sleeve 100 and is yieldingly pressed against the shaft 53 by means of a spring 105. The shaft 53 is provided with longitudinally spaced notches 106 and 107 with which the plunger 104 cooperates to yieldingly lock sleeve 100 in one of two positions relative to the shaft 53. A washer 108 is secured upon the end of the shaft 53 by means of the screw 109 and serves to limit the movement of the sleeve 100 in one direction. Hand wheel 110 provided with a handle 111 is secured upon the sleeve 100 by means of a pin 112. By means of the hand wheel the shaft 53 may be manually rotated if desired, and sleeve 100 be moved longitudinally of the shaft 53 to either of the positions determined by the notches 106 and 107.

A feed screw shaft 120 is journalled upon the frame 51 and carries a gear 121 which is adapted to mesh with gear 102, and gear 122 which is adapted to mesh with the gear 103, and a gear 123 which meshes with a gear 124. Gear 124 is carried by a feed screw shaft 125 which is journalled upon the frame 51. The directions of rotation of shaft 53, feed screw shaft 120 and feed screw shaft 125 are indicated respectively, by means of the arrows 126, 127 and 128. It is apparent that the speed ratio between the feed screw shafts 120 and 125 and the shaft 53 can be varied by shifting the sleeve 100 axially of the shaft 53 in order to bring gear 102 into mesh with gear 121 or gear 103 into mesh with gear 122. Hereafter the feed screw shafts will be referred to as screws.

A feed nut 130 having screw threaded surfaces 131 and 132 which are adapted to engage with feed screws 125 and 120, respectively, is mounted upon the feed nut rod 133. Rod 133 is slidably and rotatably mounted upon the frame 51. In order to shift the nut 130 out of engagement with one of the feed screws and into engagement with the other there is provided a link 134 connected at one end with the nut 130 and passing through a hole formed in a nut shifting lever 135. Lever 135 is pivoted at one end upon a pin 136 carried by nut shifting cam shaft bracket 137. Bracket 137 supports for rotation nut shifting cam shaft 138 carrying at one end a gear 139 and at the other end the nut shifting cam 140. Cam 140 is provided with a cam race 141 which cooperates with the roller 142 rotatably journalled upon the pin

143 carried by the lever 145. The link 134 is provided with sleeves 144 and 145, and with springs 146 and 147 which are located respectively between sleeves 144, and 145, and nuts 148 and 149 which have screw threaded engagement with the link 134. When the lever 135 is in the position shown in Fig. 3, the nut 148 may be adjusted along the link 134 in order to put the proper amount of compression in the spring 146 whereby the sleeve 144 will be yieldingly held in engagement with the lever 135, and the nut 130, in yielding engagement with the screw 125. Likewise after moving the cam 180° from this position shown in Fig. 3, the nut 149 may be adjusted whereby to place compression in the spring 147 in order that the sleeve 145 may be yieldingly pressed against the lever 135. In this manner the nut 130 will be held yieldingly against feed screw 120. Lock nuts 150 and 151 are employed for holding the nuts 148 and 149, respectively, in adjusted positions on the link 134.

The feed nut rod 133 has a reduced outer end portion 153 upon which are mounted a collar 154 and hub 155 to which is fixed a bar 156. The rod 133 may be rotated with respect to the hub 155 and bar 156, but cannot be moved endwise relatively thereto on account of the collar 154 and the nuts 157 which have screw threaded engagement with the end of the rod 133. Bar 156 is attached to a hub 158 which is fixed upon wire guide rod 160, which is supported for axial movement by brackets 161 and 162 which are supported respectively by the base 50 and the tail stock frame 170 to be described later. The rod 160 carries a plurality of wire guide wheels 163 which are loosely journalled thereon. The wheels 163 are located with respect to one another and to the rod 160 by means of sleeves 164 and 165 which are prevented from movement relative to the rod 160 by means of set screws 166.

Arbor tail stock.

Referring to Figs. 2, 13 and 14, 170 designates the tail stock frame which is mounted upon the base 50 and supports the bracket 162 which has just been described. Frame 170 supports a nut 171 in which is mounted a screw 172 which may be turned by means of a hand wheel 173. The nut 171 carries the tail stock pin 174. While the nut 171 is in position in the frame 170, hole 175 is bored at right angles to the axis of the nut 171, and in this hole 175 are located clamping members 176 and 177, the former having screw threaded engagement and the latter having sliding engagement with the screw 178 provided with a hand wheel 179. The presence of the clamping members 176 and 177 within the hole 175 prevents longitudinal and rotative movement of the nut 171 with respect to the frame 170. By turning the hand wheel 179 in a clock-wise direction as viewed in Fig. 14 the clamping members 176 and 177 will be drawn together and will clamp the screw 172 in position relative to the support 170. Thus it will be seen that the hand wheel 173 may be turned to move the tail stock pin 174, and the hand wheel 179 may be turned to lock the pin 174 in position and to prevent accidental movement of the hand wheel 173.

By referring to Fig. 4, it will be seen that the head stock shaft 53 is provided with a tapered end portion 53ª, and it will be understood that the shaft 53 and the pin 174 are located in exact alinement with one another.

Coil winding arbor.

Referring now to Fig. 17, 180 designates as a whole the coil winding arbor, which includes arbor shaft 181 having conical recesses 182 and 183, by means of which the shaft 181 may be journalled upon the head stock shaft 53 and the tail stock pin 174. Shaft 181 is generally rectangular in cross section as shown in Figs. 19 and 20, but is provided with plain cylindrical portions 184 and 185 and a screw threaded cylindrical portion 186. A nut 187 cooperates with the screw thread 186 and supports half-ring members 188 and 189 which are adapted to project into a groove 190 formed upon the half-shell portion 191. The half-shell portion 191 has a cylindrical outer surface but is provided with a rectangular groove 192 into which projects a portion of the bar 181. The bar 181 is provided with notches 193 and portions 194 which are inclined with respect to the axis of the shaft 181. Rollers 195 journalled upon pins 196 carried by the shell 191 project into the notches 193 and ride upon the inclined surfaces 194. A half-shell portion 197 having an outer cylindrical surface is provided with a rectangular groove 198 into which projects a portion of the shaft 181. Shell portion 197 is fastened to the shaft 181 by means of screws 199. When the shell portions 191 and 197 are in the position as shown in Fig. 1, their outer cylindrical surfaces form a substantially continuous cylindrical surface upon which the paper and wire are wound. The shell portions 191 and 197 are provided with portions 200 and 201 which when in the position as shown in Fig. 7, form a substantial continual cylindrical surface over which projects a cup-shaped member 202 which is secured to the shaft 181 by the means of a pin 203. In this manner the movement of one end of the shell portion 191 away from the shaft 181 is limited. The movement of the other end of the shell portion 191 away from the shaft 181 is limited by the engagement of the half-ring

member 188 or 189 with the groove 190. It is apparent that when the nut 187 is turned in such a manner as to be moved toward the left hand end of the bar 181 as viewed in Fig. 17, the nut will move the upper shell section 191 relative to the shaft 181 and lower shell section 197 releasing the pressure on the rollers 195 and permitting the shell portion to approach each other. When this occurs it is apparent that the cross-sectional area of the spindle 180 will be reduced, thus facilitating the removal of the coils which are wound upon the spindle.

Arbor driving plate.

In order that the arbor 180 may be turned with the head stock shaft 53, the shaft 181 is provided with a disc 205 having a hole 206 which receives a plunger 207 supported by a face plate 208 fixed upon the shaft 53. The plunger 207 is mounted within a bushing 209 carried by the face plate 208, and the plunger 207 is yieldingly pressed in a direction to the right as viewed in Fig. 4, by means of a spring 210 pressing against a shoulder formed on the plunger 207 and against a plate 211 fastened to the face plate 208 and through which the plunger 207 passes. It will be apparent therefore that when power is applied to the pulley 57, and when the clutch members 54 and 56 are in engagement, the arbor 180 will be rotated. The shaft 53 is also provided with a pinion 212 by means of which the shaft 53 may be turned when said pinion is engaged by gearing to be described, in the following paragraph.

Paper feeding and cutting mechanism.

Referring particularly to Figs. 6, 7 and 9, 220 and 221 designate shaft brackets which are mounted upon the base 50 and secured thereto by means of screws 222 and 223. Brackets 220 and 221 support for rotation the shaft 224. Referring to Fig. 9 in which the hand wheel shaft assembly is shown, shaft 224 carries a nut shifting cam driving gear 225, a paper feed roll driving gear 226, arbor driving gear 227, shear cams 228 and 229, counter-driving gear 230 and the hand wheel 231. The base 50 supports a bracket 232 which carries a bearing 233 in which the right hand end of the shaft 224 is journalled.

The gears 226 and 227 are mutilated, as shown in Figs. 10 and 11. When the shaft 224 is in the "home" position, gears 226 and 227 and the cams 228 and 229 will be in the position shown in Figs. 5, 10 and 11. The cams 228 and 229 are provided with shallow notches 235 which in the "home" position of the shaft 224 occupy positions vertically above the axis of the shaft 224.

As shown in Fig. 3 the gear 225 meshes with the gear 139, so that by turning the hand wheel shaft in a clockwise direction as viewed in Fig. 13, the cam 140 will be moved in a clockwise direction. The ratio of the diameters of gears 225 and 139 is 1 to 2, so that one complete revolution of the hand wheel shaft 224 will cause the cam 140 to be moved 180° whereby the nut 130 may be moved out of engagement with the feed screw 125 and into engagement with the feed screw 120.

Referring more particularly to Fig. 7, 250 designates a stationary shear blade mounted upon brackets 220 and 221 and supporting a shelf 251 which serves to support the paper as it leaves the rolls 238 and 239, and to direct the paper across the upper surface of the shear blade 250. The movable shear blade 252 which cooperates with the shear blade 250 is mounted upon shear blade blocks 253 and 254, which are mounted for vertical movement upon screws 255 and 256, respectively, carried by brackets 220 and 221 respectively. Blocks 253 and 254 are provided with cam followers 257 and 258 which cooperate with shear cams 228 and 229, respectively. A shear block tie bar 259 is secured at either end upon the shear blocks 253 and 254 and is provided with holes through which the bolts 255 and 256 may extend. Adjusting screws 260 pass through the shear blade 252 and into the tie bar 259, and springs 262 are interposed between the blade 252 and the tie bar 259. Springs 261 are interposed between the heads of screws 260 and the shear blade 252. By means of adjusting the screws 260 relation of the blade 252 to the tie bar 259 may be adjusted, and the sharpened edge of the blade 252 may be maintained in correct relation with the sharpened edge of the blade 250. Screws 263 and 264, having threaded engagement with brackets 220 and 221, respectively, are employed for the purpose of adjusting the blade 250 relative to the blade 252. Springs 265 and 266 cooperate with the heads of bolts 255 and 256 respectively and with the upper surface of tie bar 259 in order to maintain the cam followers 257 and 258 in operative relation with the shear cams 228 and 229 respectively.

To prevent the edge of paper moving upwardly with the upward movement of the shear blade 252, a paper retaining bar 267 is mounted upon the blade 250 but separated therefrom by spacers 268 and 269. Spacer 269 has an upstanding leg 269ª against which the shear 252 bears, in order that interference with the edge of the blade 250 will be prevented.

Coil separating provisions.

When a plurality of layers of insulating paper have been wound upon the spindle,

a tube of paper is formed which must be divided in order that the coils may be separated from each other on being removed from the spindle. The mechanism for dividing the insulation will now be described. Referring more particularly to Figs. 5, 9 and 12 arms 270 and 271 are loosely journalled upon the shaft 224 and the free ends thereof are provided with notches 272 as shown in Fig. 5. These notched ends of the arms 270 and 271 hook over a rod 273 which is loosely journalled upon arms 274 and 275. These arms 274 and 275 are in turn loosely journalled upon a rod 276. The ends of rod 276 normally rest upon inclined surfaces 277 and 278 formed upon bars 279 and 280 respectively. Clamped upon the rod 273 are a plurality of knife blade holders 281, each of which carries a knife blade 282 which is clamped to the holder 281 by means of a clamping bar 283 and a screw 284. Sleeves 285, 286 and 287 serve to space the knife blade holders 281 at the correct distances from one another and from the arms 274 and 275. The location of the knife blade holders 281 is such that the cutting edges of the knife blades are located in alinement with the grooves 180ª of the spindle 180. Nuts 288 and 289 cooperate with the threaded end portions of the rod 273 and serve to maintain the parts supported upon the rod 273 in correct position. The lower surfaces of the free end of the knife blade holders 281 rest upon the upper ends of adjusting screws 290 which have screw threaded engagement with adjusting screw bar 291 which is secured at each end thereof upon the arms 270 and 271. A lever 292 is mounted upon the rod 276. By reference to Fig. 5 it will be seen that when the outer free end of the lever 292 is raised, the upper surface of said lever 292 will engage one of the sleeves 286 carried by the rod 273. This movement of the lever 292 will cause the rod 273 to move upwardly and the bars 270 and 271 to swing upwardly about the shaft 224 as an axis, thereby causing an upward movement of the knife blades 282. While the movements referred to are taking place the outer ends of the rod 276 are riding upwardly on the inclined surfaces 277 and 278 of the blocks 279 and 280. Thus it will be seen that the arms 270 and 274, and the arms 271 and 275 cooperate together as the links of toggle joints. Therefore it is apparent that very little force need be exerted upwardly upon the outer free end of the lever 292 in order to obtain sufficient pressure at the knife blades to force the latter through several thicknesses of paper wound upon the spindle. The upward movement of lever 292 is limited by the rod 276 striking against screws 294 passing through bars 279 and 280.

The form of mechanism for separating the coils just described provides for the ready removal of a part of said mechanism from the coil winding machine. When it is desired to renew the knife blades 282 it is only necessary to remove the arbor 180 from the machine and then to swing the arms 270 and 271 upwardly so that the free ends are out of engagement with the rod 273. When this is done the rods 273 and 276 and the parts attached thereto may be removed from the machine, in order that the knives may be replaced. By removing the arbor, the knife blade holders 281 can be swung toward the front of the machine to a more accessible position, without removing any of the separating knife mechanism from the machine.

Counter and signal.

Referring to Fig. 13, 300 designates a counter shaft bracket secured upon the base 50 and providing a bearing for a counter shaft 301 upon which is formed a gear 302 which meshes with the counter driving gear 230 carried by the shaft 224. (See Fig. 9.) The shaft 301 carries a post 303 upon which is mounted a split sleeve 304 having a friction fit therewith. The sleeve 304 carries an index or hand 305. The bracket 300 is provided with outwardly extending ears 306 and 307, see Fig. 16, which support sleeves 308 and 309 upon which is mounted the dial 310, but insulated therefrom by means of insulating washers 311 and 312. Screws 313 and 314 passing through insulating washers 315 and 316 secure the dial 310 upon the bracket 300, and in spaced relation with the upper surface thereof. The dial 310 is provided with a hole 317 which is located concentrically with the sleeve 304 but out of contact therewith. Referring to Figs. 2 and 13, the dial 310 carries a stud 318 located in the path of the hand 305. Referring to Fig. 13 the dial 310 is shown diagrammatically connected by wire 320 with a bell or other signaling device 321, connected with a source of current 322 which is grounded by means of wire 323 upon the bracket 300. It is apparent therefore that whenever the hand 305 strikes against the stud 318 an electric circuit will be formed causing bell 321 to ring. The use of this signal will be described in connection with the description of the operation of the machine.

The base 50 may be provided with an oil receptacle 330 from which a small quantity of oil may be removed by means of brush 331 and applied to the tail stock pin 174, in order to reduce friction between the spindle 180 and the pin 174.

Paper roll holder and tension device.

A device for holding the roll of insulating paper maintaining the required amount of tensioning thereon will now be described.

Mounted upon the bench 40 and to the rear of the frame 50, see Figs. 5, 21 and 22, are paper roll shaft brackets 350 and 351 which are secured upon the bench 40 in correctly spaced relation. These brackets 350 and 351 carry bearings 352 and 353, respectively, upon which is journalled the paper roll shaft 354. The shaft 354 has screw threaded portions 355 and 356 which are engaged by nuts 357, 357 and 358, 358. By removing the nuts 358, 358 it will be seen that a roll of paper may be slipped on the shaft 354 with one end of the roll touching one of the nuts 357, 357. By applying the nuts 358, 358 the roll of paper 359 (see also Fig. 5) may be clamped in position upon the shaft 354. One end of the shaft 354 is provided with a groove 360 which receives a shoulder 361 provided on a screw 362 which has screw threaded engagement with a bracket 363 supported by the frame 351. The screw 362 is provided with a hand wheel 364 by means of which the nut may be turned to effect longitudinal movement of the shaft 354. The adjustment described permits of aligning the paper roll with the arbor 180. A set screw 365 having screw threaded engagement with the bracket 363 serves to maintain the adjusting screw 362 in fixed position. Secured upon the other end of the shaft 354 is a grooved band wheel 366 around which passes a leather band 367. Said band 367 passes around a stud 368 fixed upon the bracket 350. The ends of the band 367 are united by means of a spring 369. Referring to Figs. 5, and 21 it will be seen that the paper which is represented by the dot and dash line 370 is wound off the roll of paper 359 in such a direction that the roll rotates in a clockwise direction. It will be seen that the spring 369 is located back of a vertical plane passing through the axis of shaft 354 and stud 368. This arrangement is necessary in order that the clockwise rotation of the paper roll 359 may be yieldingly restrained whereby to place a substantially uniform tension on the paper 370 as it is unwound from the paper roll, resulting in keeping the paper stretched and free from wrinkles.

Wire unwinding mechanism.

The device for unwinding the wire from the reels upon which the wire is wound when received from the manufacturer will now be described. Referring to Figs. 5, 21 and 22 the brackets 350 and 351 support a platform 380, upon which a plurality of reels 381 of wire may be mounted.

A tubular post 382 is fixed in a vertical position upon the platform 380, and supports for rotation a spindle 383. Said spindle 383 is provided with a shoulder 384 which rests upon a felt washer 385 which in turn is supported upon the upper surface of the post 382. The lower end of the spindle 383 is provided with screw threads which are engaged by nuts 386 and 387. A felt washer 388 and a metallic washer 389 are mounted upon the spindle 383 and are held in position by means of the spring 390. It is apparent that by adjusting the nut 386 the tension on the spring 390 may be varied whereby to vary the friction between the spindle 383 and the post 382. It is desirable that a certain amount of friction shall exist between the spindle 383 and the post 382 in order that a required amount of tension may be maintained in the wire as it is being unwrapped from the spool 381 and applied upon the spindle 180. By inserting the felt washers 385 and 388 between the post 382 and the shoulder 384 and the washer 389 carried by the spindle 383, the adjustment can be carried to a much finer degree, and to a degree suitable for all unwinding speeds, than where there is a metal to metal friction contact between the spindle and the post.

The upper end of the spindle 383 is provided with a pin 392 extending transversely of the spindle and beyond the cylindrical surface thereof. A thimble 393 fits over the upper end of the spindle 383 and is provided with notches 394 which receive the projecting ends of the pin 392. In this manner the thimble 393 is made to turn with the spindle 383.

The thimble 393 is provided with a reduced upper end portion 397 upon which is mounted for rotation a cup 398. The cup 398 carries a pin 399 to which one end of a coil spring 400 is connected. The other end of the spring 400 is connected with the reduced portion 397 of the thimble 393. A cover 401 cooperates with the cup 398 to form an inclosure for the spring. A screw 402 having threaded engagement with the reduced portion 397 of the thimble 393 maintains the cover 401 and cup 398 in position upon the thimble 393. A finger 405 is secured at one end upon the cup 398 and at its lower end carries a fork 406 in which is rotatably mounted a wheel 407, said wheel being located substantially midway between the ends of the reel 381. The device for unwinding the wire from the reels which has just been described is not our joint invention but is described and claimed in the co-pending application of Samuel Rogers, Patent No. 1,348,321, patented August 3, 1920.

A dog 408 is secured upon the platform 380 adjacent the post 382 and pierces the lower wooden end of the reel 381, in order to prevent said reel from turning upon the post 382.

Referring to Fig. 21 a plurality of posts 410 are shown mounted upon the platform 380, each of these posts being located in a

certain relation to one of the posts 382. Upon the upper end of each post 410 is secured a bracket 411 upon which is pivotally mounted a tension wheel frame 412 carrying at its free end a tension and guide wheel 413, provided with a groove 414.

It will be noted that the axis of the spindle 383 if extended would be tangent to the bottom of the groove 414. As will be apparent from the description of the operation of the device which is to follow, this arrangement is necessary in order that the turning couple acting upon the spindle 383 may be constant.

Control when wire breaks.

A leaf spring 415 is mounted at one end upon the bracket 411 and the outer free end thereof engages pin 416 carried by the tension wheel frame 412. This spring 415 tends to move the tension wheel 413 in an upward direction. The spring 415 has an electrical connection with the bracket 411. A spring contact 417 is mounted upon the bracket 411 but insulated therefrom.

Referring to Fig. 5 the line 420 designates the wire leading off from the spool 381 around the guide wheel 407 and upwardly around the tension wheel 413 then downwardly around the wire guide roll 163 and then around the arbor 180. On account of the friction maintained between the spindle 383 and the post 382, as previously described, sufficient tension will be maintained on the wire 420 to maintain the springs 415 and 417 out of engagement as shown in Figs. 5 and 21, and at A, in Fig. 23. If, however the wire 420 should break the spring 415 will be released and cause the tension roll frame 412 to move upwardly to the position shown at B in Fig. 23. When this occurs the following circuit will be established:— battery 425, wire 426, magnet 427, wire 428 to the lever 65. Assuming that the lever 65 is in the position as shown in Fig. 4 and in the dotted line position as shown in Fig. 23, current will flow through the lever 65 through switch contact 429 to ground and thence back through the post 410 which is grounded, and across contacts 415 and 417 and thence by wire 430 on to battery 425. When this circuit has been established an armature 431 will be attracted by the magnet 427 and cause a closing of contacts 432 and 433. When contacts 432 and 433 are closed current from a 110 volt light circuit or other source of electric current will flow through the solenoid 76 and thereby cause the attraction of solenoid armature 75. This movement of armature 75 will cause the clockwise movement of the lever 60 as viewed in Figs. 4 and 23, whereby to effect a separation of clutch members 54 and 56 and to stop the rotation of the spindle. The broken ends of the wire can then be secured together and the wire threaded around the tension roll 413, thus restoring conditions to normal and permitting the contacts 415 and 417 to be maintained out of engagement by the tension on the wire.

The electric circuits described permit not only the use of an available high voltage current for operating the solenoid magnet, but the complete insulation of such a current from the machine, whereby the operator will be protected from shock.

A motor 500 shown diagrammatically in Fig. 3 is connected by means of a belt 507 with the pulley 56ª for the purpose of driving the shaft 53 when the clutch members are engaged.

Mode of operation.

The operation of the machine will now be described.

Let it be assumed first that the reels of wire are in position upon the platform 380 and that the roll of paper used for insulating purposes is in position on the spindle 354, and that the arbor 180 is not in position in the machine.

The first operation is to grasp the end of the paper and to draw it forward and pass it between the feed rolls 239 and 238. This operation can readily be performed since the roll 239 can be swung upwardly away from the roll 238. The drawing of the end of the paper is continued until the edge of the paper passes over the shelf 251 and up to the cutting edge of the blade 250. Then the upper roll 239 is allowed to descend upon the paper and to hold it in the position described. The tail stock feed screw 173 is turned so as to recede the tail stock pin 174 from the head stock spindle 53. The arbor 180 is placed in position with its conical seat 182 resting on the tapered end 53ª of the head stock spindle 53. The arbor 180 is rotated manually until the spring pressed plunger 207 snaps into the hole 206 in the disc 205. A driving connection between the spindle 53 and the arbor 180 is thus effected. The tail stock screw 172 is then rotated until the tail stock pin 174 enters the conical seat 183 in the end of the arbor 180.

A portion of wire is unwound from each reel and trained around the wheels 407, 413 and 163 and is fastened to a hook 181ª secured upon the arbor shaft 181 (see Fig. 20).

The next operation is to rotate the hand wheel 231 360° in a clock-wise direction as shown by the arrow 510 in Fig. 13 and the arrow 511 in Fig. 2. While this manual operation of the hand wheel 231 is taking place the following events will take place automatically. Referring to Figs. 1 and 5 it will be seen that the teeth on the gear 226 will engage with the paper feed pinion 236 causing the same to rotate in a clockwise direction as viewed in Fig. 5. The

paper will be fed forward over the edge of the knife 250 until the edge of the paper strikes the wires 420 which are backwardly and upwardly inclined from the arbor 180. The position of the end of the paper at this instant is represented diagrammatically by a dot and dash line 370ª. Before the edge of the paper reaches the wires 420 the gear 227 will have moved sufficiently so that a portion of its tooth periphery will engage the gear 212 causing the arbor 180 to rotate in a clock wise direction as viewed in Fig. 5. A further feeding of the paper by the feed rolls will cause the paper to be depressed by the moving wires 420 until the paper occupies the position shown by the dot and dash line 370ᵇ in Fig. 5. Owing to the fact that the paper is first fed over and about the coil and then depressed onto it, it is not necessary to vary the relative positions of the arbor and paper guiding means as the diameter of the coil is increased. After a certain movement of gear 212, the gear tooth portion of the periphery of gear 226 will be free of the paper feed pinion 236, and the feed rolls will be free to turn independently of any gearing while the arbor 180 continues to rotate further upon further rotation of the hand wheel shaft 224 to wrap up the required number of layers of paper upon itself. At this time a mutilated portion of the gear 227 will come adjacent to the gear 212 and the motion of the arbor 180 will cease. Then, as the shaft 224 continues to rotate the movable shear blade 252 will descend into cooperation with the stationary blade 250 and shear off the paper. Then while the blade 252 is ascending to normal position, another tooth portion of the gear 227 will engage with the gear 212 and will rotate the arbor 180 in a clock-wise direction in order to wrap up the length of paper included between the arbor 180 and the shear blades 250 and 252. When the shaft 224 has been rotated the entire 360° the notches 235 in the cams 228 and 229 will have arrived at a position vertically above the center of the shaft 224, whereupon the cam followers 257 and 258 will drop into said notches under the influence of the springs 265 and 266 and yieldingly lock the shaft 224 in home position. At this time another multilated portion of the gear 227 will have come adjacent to the gear 212, thereby permitting the arbor to turn free of any gearing connected with the hand wheel shaft 224.

In this manner the required number of turns of paper have been wrapped about the arbor 180. Since the rotation of the arbor determines the amount of paper wrapped thereon, it is apparaent that, notwithstanding the constantly increasing diameter of the coil being wound upon the arbor, the number of turns and hence the thickness of the insulation between the several layers of wire will remain the same.

While the movements described in the foregoing paragraph have been taking place, the gear 225 (See Fig. 3) will have turned the gear 139 in a clock-wise direction, whereby to rotate the cam 140, 180°. Let it be assumed to start with that the nut 130 occupies the position 130ª shown in Fig. 1.

The arbor has now been prepared for wrapping on a layer of wire, and at this time a few turns of wire have been wrapped around the insulating paper as the paper was being wrapped upon the arbor 180. The next operation is to move the hand lever 65 into the position shown in Fig. 4 or in the dotted line position shown in Fig. 23. This movement of lever 65 will cause the lever 60 to be shifted counter-clock wise causing the clutch member 56 to be moved into engagement with the clutch member 54. As previously mentioned the pulley 56ª is being continuously rotated by the motor 500 through the medium of the belt 507. The arbor 180 will then be rotated in a clockwise direction as viewed in Fig. 5. Clockwise motions as viewed in Fig. 3, will be imparted to the screw 125 by means of the gearing 102, 121, 123 and 124. The turning of screw 125 will cause the nut 130 to move from its position 130ª to the full line position as shown in Fig. 1 and still further to the dotted line position 130ᵇ. When this occurs a lug 440 carried by the nut 130 will engage the stop nuts 99 and cause the screw 97 to move in a direction from left to right as viewed in Fig. 1. The screw 97 will at the same time impart motion to the lever 93 causing it to rotate in a counter-clock wise direction as viewed in Fig. 1. From the lever 93 motion will be imparted through the shaft 91, the arm 90, the lever 80, and the link 83 to the lever 60 causing said lever 60 to rotate in a clock-wise direction as viewed in Fig. 4. When this occurs the clutch members 56 and 54 will be disengaged and the arbor 180 will cease to rotate.

At this time a plurality of equally spaced turns of wire will have been wound upon the arbor 180 by reason of the uniform movement of the guide wheels 163, due to the uniform movement of the nut 130 from which motion is imparted to said guide wheels 163 through the rod 133, cross bar 156 and guide wheel shaft 160. The arbor is now ready for the application of the insulating paper.

Since the arbor 180 has been stopped automatically in the manner described the hand lever 65 may be released since its presence in the position as shown in Fig. 4 will not cause the arbor to rotate any further un-

til the nut 130 has been shifted to the other screw 120. The hand wheel 231 is again rotated 360° causing the automatic feeding of the paper to the arbor, the winding of the paper on the arbor, the cutting off of the paper and the winding of the cut off end of the paper upon the arbor. This operation of the hand wheel will cause the cam 140 to turn another 180° and cause the shifting of the nut 130 to the position 130^c as shown in Fig. 3, in which position the nut 130 will be in engagement with the screw 120. By referring to Fig. 1 it will be noted that the position 130^c corresponding to the same position shown in Fig. 3 is slightly displaced to the left of the position 130^b shown in Fig. 1. This displacement takes place by reason of the fact that as the nut is rotated in a clock-wise direction, as viewed in Fig. 3, the side edge of the nut will strike against a beveled camming edge 450 of the bar 451. This displacement of the nut causes the guide wheels 163 to move to the left during the time between the cutting off of the paper and the complete winding up of the cut off end of the paper upon the arbor 180. In this manner the preceding layer of wire cannot be effective to misguide the application of the first few turns of the next succeeding layer while the paper is being wound on, and the guide nut is not operated by one of the feed screws.

After the second application of insulating paper has been made upon the arbor 180, the lever 65 is moved as before into the position shown in Fig. 4 in order to rotate the spindle and to guide the wire longitudinally with respect to the spindle. It will be noted that this lever cannot render the clutch operative until after the feed nut has been moved away from the stop. Hence the power operated member or shaft cannot be connected with the arbor and feed screws until after the paper has been severed from the supply roll and substantially all of it wound about the arbor. During this operation the nut 130 will move from its position 130^c to a position 130^d, at which time the lug 440 will have engaged the nuts 98 on the stop screw 96, thereby causing the screw 96 to move in a direction to the left as viewed in Fig. 1. This movement of screw 96 will cause counter clock-wise rotation of the lever 93 whereupon the lever 60 will be moved as before to disengage the clutch members 54 and 56.

The next movement of the hand wheel shaft to cause the third application of insulating paper upon the arbor 180 will cause the nut 130 to be rotated counter clock-wise into the position shown in full lines in Fig. 3. The corresponding position of the nut 130 in this position is shown at 130^a in Fig. 1. It will be noted that position 130^a is slightly displaced to the right of position 130^d. This displacement takes place by reason of the fact that as the nut 130 is moved out of its position 130^d a portion thereof engages a beveled camming surface 452 of the bar 453. This displacement takes place likewise during the time between the shearing of the paper and the return of the hand wheel shaft 224 to its home position. The purpose of this movement is the same as has before been referred to in connection with the displacement from positions 130^b to 130^c.

Referring to Fig. 23 it will be noted that when the hand lever 65 is moved into dotted line position an electric connection will be made between it and the spindle contact member 429. In the diagram this contact member 429 is grounded. As has been explained, when the wire 420 is trained around the wheels 407, 413 and 163 and secured to the arbor 180, there will be sufficient tension in the wire to cause the wheel 413 to be in the position shown at A in Fig. 23. However, if the wire should break the wheel 413 will be released and the bracket 412 will move to the position B as shown in Fig. 23, under the action of the spring switch contact 415. When this occurs an electric circuit will be established through the relay magnet 427. The armature 431 will be attracted to cause the closing of contacts 433 and 432 whereupon the solenoid will be energized by some source of current to cause the attraction of the solenoid armature 75 and to move the lever 60 into clutch disengaging position. This operation may take place independently of the fact that lever 65 may still be held in contact making position, since the magnet 76 is strong enough to overcome the action of the springs 72 and 73. If, however, after the arbor has stopped and it is desired to remove the wire entirely from one of the rolls 413 even though it has not broken or one of the reels has been emptied and it is desired to replace the same with a full reel, it would not be desirable to have the battery 425 continue to discharge current through the relay magnet 427 during the time the switch contacts 415 and 417 are closed. Hence the lever 65 has been made a part of an extra switch in the relay circuit so that when said lever 65 is released, this relay circuit will be broken at the contact 429 although the contacts 415 and 417 may be closed. In this manner an unnecessary discharge of current from the battery 425 is prevented.

It will be noted that a comparatively heavy spring 62 has been provided for the purpose of normally maintaining the clutch members 54 and 56 out of engagement. Therefore, it is necessary that the lever 65 be held manually in the position shown in Fig. 4 continuously else the arbor 180 will

not rotate. This feature is considered a considerable advantage since it insures the presence of the operator at the machine all of the time while the machine is running.

It will be apparent that the nut 130 can act automatically through the mechanism described to move the lever 60 into clutch disengaging position without effecting the position of lever 65. This is of considerable advantage since although the hand may maintain the lever 65 in position as shown in Fig. 4, yet if the end of the layer of wire is reached the arbor will cease to rotate notwithstanding. It will also be noted that the hand lever can be moved to permit the spring 62 to move the lever 60 to clutch disengaging position, without effecting either of the automatic devices which effect the disengaging of the clutch.

Each time the hand wheel is turned 360° the counter hand 305 will be moved counter clock-wise one unit to indicate that one application of insulating paper has been made upon the arbor 180. Since a layer of wire is applied upon the paper before the next turning of the hand wheel 231, the hand 305 will also indicate the number of layers of wire applied upon the arbor. In order to indicate when the required number of layers of wire, for example, thirty-four, have been applied, when the hand 305 has moved 34 units it will strike a stud 318. By referring to Fig. 13 it will be seen that when engagement of the hand 305 with stud 318 occurs, an electric connection will be made from the battery 322 to the bell 321 causing the bell to indicate to the operator that the required number of turns of wire have been applied.

It may be desirable to apply an extra layer of wire and to have the turns of this layer spaced further apart than the turns of the preceding layers. In order to provide for this the wheel 110 (see Fig. 1) is moved to the right causing the gear 103 to move to position 103^a out of engagement with the gear 122, and the gear 102 to move to position 102^a into engagement with the gear 121 as indicated by the dot and dash line positions shown in Fig. 1.

While the spindle is rotating, some time during the application of each layer of wire the knife lever 292 is pulled upwardly to cause the knives 282 to separate the layers of insulating paper so that when the coils are removed from the arbor 180 they will all be separate from one another.

When the last layer of wire is applied and the wire is severed from the wire on the reel and tied in place upon the coil, the tail stock pin is receded and the arbor is withdrawn. The nut 187 is rotated in a counter clock-wise direction as viewed in Fig. 18 thereby causing the half shell 191 to move toward the left as viewed in Fig. 17, and downwardly toward the arbor shaft 181. In this manner the arbor is collapsed and the coils may be readily removed therefrom.

Referring to Figs. 5, 21 and 23 it will be observed that, due to the tension on the wire 420, a force will be applied at the axis of wheel 407 in such a direction as to cause the arm 405 to continuously rotate about the reel 381, whereby to effect the unwinding of the wire as long as the arbor 180 is rotating. When the arbor first begins to rotate, the arm 405 will commence to rotate immediately about the post 382 but the spindle 383 will not rotate until the spring 400 has been wound up sufficiently to overcome the friction between the spindle and the post 382. This yielding connection is necessary to prevent the sudden stressing of the wire when the arbor commences to rotate. The wire gradually stores energy in the spring 400 which is finally released to overcome the inertia of the spindle 383 and friction between said spindle and the post 382.

As has been explained, the tension in the wire can be regulated to a very fine degree by reason of the fact that felt washers are interposed between the spindle 383 and the post 382. It has been found that where a fine wire is used and there is a metal to metal contact between the spindle and the post to produce a required amount of friction to keep the wire in tension, that this friction pressure cannot be adjusted properly at different speeds and maintained substantially constant in order to prevent the breaking of the fine wire. However, the interposition of the felt washers between the post and the spindle has overcome this difficulty.

If it is desired to vary the length of the coils wound on the arbor 180 the travel of the feed nut 130 may be lengthened or shortened by adjusting the nuts 98 and 99 along their respective screws 96 and 97. In order that the members 451 and 453 may be functioned properly it is necessary also to adjust said members in a direction parallel to the screws 96 and 97.

It has been found that by adjusting the tension on the paper and the wire to the proper amount, that it is possible to form a coil on a solid arbor instead of a collapsible one in such a manner that the coil can be easily removed from the arbor after it has been completed.

It sometimes happens that the cure of the paper on the paper roll is such as to cause the paper to curl in such a manner it will necessitate the unwinding of the paper in a counter clockwise direction instead of a clockwise direction as shown in Fig. 5. The paper can be brought off from the underside of the paper roll and upwardly to the feed rolls, instead of being brought off from the upper side of the paper roll. The band 367 can be placed on the stud 368 and wheel 366 in a position reverse to that shown in

Fig. 5, with the spring 369 in front of the vertical plane intersecting the axes of shaft 354 and stud 368.

In order that the paper may be spread out from the center towards its side edges on being fed between the feed rolls, the lower feed roll is provided with tape wound thereon in a spiral fashion beginning with the center of the roll and extending to the ends thereof. Another means by which the paper may be spread out in the manner referred to consists in providing the lower feed roll with roughened surfaces near the ends thereof which act in such a manner, in conjunction with the upper feed roll, as to cause less slipping of the paper at the edges than at the middle thereof whereby to cause the paper to be slightly stretched from the middle towards the edges.

It is to be understood that the term "paper" signifies any flexible sheet of insulating material.

While the form of mechanism herein shown and described constitutes a preferred form of embodiment of the invention, it is to be understood that other forms might be adopted, all coming within the scope of the claims which follow.

We claim:

1. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of means for feeding the paper up to the arbor where the edge of the paper is inserted between the arbor and the wire, and for rotating the arbor to form an insulating tube thereon; and separate means for rotating the arbor and forming a coil of wire about the insulating tube.

2. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of means for feeding the paper up to the arbor where the edge of the paper is inserted between the wire and the arbor, and then for rotating the arbor and for guiding the wire longitudinally of the arbor to form a tube comprising a plurality of layers of paper encircling the arbor; and separate means for thereafter rotating the arbor and wrapping the wire about the tube.

3. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of means for directing the wire onto the arbor at a predetermined angle therewith; and means for feeding the leading edge of the paper against the wire in spaced relation to the arbor, whereby the inclination of the wire moves the paper into contact with the arbor, and then for rotating the arbor whereby to feed wire and paper onto said arbor.

4. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of means for directing the wire onto the arbor at an angle therewith; and means for feeding the leading edge of the paper above the arbor against the wire, whereby the inclination of the wire depresses the paper down onto the arbor, and then for rotating the arbor whereby to feed wire and paper onto said arbor, said means including mechanism for guiding the wire longitudinally of the arbor.

5. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of means for directing the wire onto the arbor at an angle therewith; and means for projecting the leading edge of the paper against the wire in spaced relation and above the arbor whereby the inclination and movement of the wire depress the paper into contact with the arbor.

6. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound into a tube; of means for directing the wire onto the arbor at an angle therewith; and means for projecting the leading edge of the paper against the wire at a substantially uniform distance from the arbor during the forming of successive tubes, the motion and inclination of the wire finally guiding the paper into position to be formed into a tube by the rotation of the arbor.

7. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of means for holding a roll of paper; and means for positively feeding the paper from said roll up to the arbor and for rotating the arbor while positively feeding the paper, then for rotating the arbor while not positively feeding the paper, to wrap paper and wire together about said arbor, then for cutting off the paper while the arbor is not rotating, then for rotating the arbor to wind up the end of the paper severed from the roll whereby the paper will be completely wrapped upon the arbor.

8. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of means for holding a roll of paper; means for directing wire onto the arbor; and means for positively feeding paper up to the arbor and for rotating the arbor while positively feeding the paper, then for rotating the arbor while not positively feeding, to wrap paper and wire together about said arbor, then for cutting off the paper while the arbor is not rotating, then for rotating the arbor to completely wrap up the paper severed from the roll upon the arbor, said means having provisions for guiding the wire longitudinally of the arbor while the paper is being wrapped on the arbor.

9. In a coil winding apparatus the combination of means for winding a relatively

wide sheet of insulating material into a tube comprising a plurality of layers of said material; means for severing the tube from the sheet after a predetermined number of revolutions of the tube; and means for winding a cylindrical layer of wire about the said tube.

10. In a coil winding apparatus, a roll of wire, a roll of insulating material having a width at least as great as the length of a coil, a spindle, means for rotating the spindle and simultaneously feeding the wire and insulating material directly from said rolls about the spindle to form an insulating tube having a plurality of layers of said material, said means including automatic devices for severing the tube from the said roll after a predetermined number of revolutions of the tube.

11. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of power means for rotating the arbor to wind wire thereon; other means for rotating the arbor to wind paper thereon; and control means for connecting the power means with the arbor, said control means being ineffective until substantially all of a section of paper has been wound upon the arbor by said other means.

12. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of power means for rotating the arbor to wind wire thereon; means for holding a paper supply roll; means for feeding a strip of paper from the supply roll up to the arbor; other means for rotating the arbor to wind thereon a portion of the strip of paper to form an insulating tube on the arbor; means for severing the tube from the paper strip leading from the supply roll; and controlling means for connecting the power means with the arbor, said controlling means being ineffective until after the paper tube has been severed from the paper strip leading from the supply roll.

13. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of means for holding a roll of paper; means for positively feeding the paper from the roll up to the arbor while rotating the arbor to wrap the paper thereon, then for cutting off the paper while the arbor is not rotating, then for rotating the arbor to wind up the severed end of the paper whereby the paper will be completely wrapped upon the arbor, said means having provisions for guiding the wire longitudinally of the arbor while the wire and paper are being wrapped upon the arbor.

14. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of means for simultaneously winding paper and wire upon the arbor and for guiding the wire longitudinally of the arbor during said winding operation; and independent means operable only after the paper has been substantially all wound on the arbor for rotating the arbor and for guiding the wire longitudinally of the arbor.

15. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of power operated means for rotating the arbor and for guiding the wire longitudinally of the arbor in either of two directions, said means including a shiftable member movable into certain positions whereby said member will be moved longitudinally of the arbor in either direction; and other means operable, while the power operated means is inoperative, to cause paper and wire to be simultaneously wrapped upon the arbor and for moving the shiftable member into either of its positions while at the same time guiding the wire longitudinally of the arbor.

16. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of power operated means for rotating the arbor; power operated means for guiding the wire longitudinally of the arbor in either of two directions, said means including rotating feed screws and a nut movable into cooperative relation with either of the feed screws, and a longitudinally shiftable wire guide connected with the nut; and other means operative, while said power operated means is inoperative, to cause paper and wire to be wrapped onto the arbor and to shift the feed nut from one feed screw to the other.

17. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of power operated means for rotating the arbor; power operated means for guiding the wire longitudinally of the arbor in either of two directions, said means including rotating feed screws and a nut movable into cooperative relation with either of the feed screws, and a longitudinally shiftable wire guide connected with the nut; and other means operative, while said power operated means is inoperative, to cause paper and wire to be wrapped onto the arbor and to shift the feed nut from one feed screw to the other while causing the wire to be guided longitudinally of the arbor.

18. The combination with a rotatable arbor upon which wire is to be wound; of power operated means for rotating the arbor; means including a member movable manually to operative position for rendering the power means operative to rotate the arbor, and spring returned to render the power means inoperative; and automatic means for rendering the power means inoperative when

the end of a cylindrical layer of wire is reached regardless of the maintaining of said manual member in operating position.

19. In a coil winding machine, the combination with a rotatable arbor upon which wire is to be wound; of power operating means including a clutch for rotating the arbor; manually operable means for controlling said clutch; automatic means for disengaging said clutch when the end of a cylindrical layer of wire is reached; and automatic means for disengaging the clutch when the wire breaks and for rendering the manual means inoperative to engage the clutch.

20. In a coil winding machine, the combination with a rotatable arbor upon which wire is to be wound; of power operated means for rotating the arbor, said means including cooperating clutch members one of which is connected with the arbor and the other with a source of power; of a clutch shifting member; means including a manually movable member for moving the clutch shifting member to operative position, and a spring for returning said manual member to inoperative position; and automatic means for moving the clutch shifting member when the end of a cylindrical layer of wire is reached regardless of the maintaining of said member in operating position.

21. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of power operated means for rotating the arbor to wind wire thereon; other means for rotating the arbor to wind paper thereon; controlling means for connecting the power means with the arbor, said controlling means being operative only after substantially all of a strip of paper has been wound upon the arbor; and automatic means for disconnecting the power means from the arbor in case the wire breaks and for rendering the manual means inoperative to connect the power means with the arbor.

22. In a coil winding machine, the combination with a rotatable arbor upon which wire is to be wound; of power operated means including a clutch for rotating the arbor; manually operated means for controlling the clutch under normal conditions, but ineffective to engage the clutch if the wire is broken.

23. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of power operated means for rotating the arbor and for guiding the wire longitudinally of the arbor; of automatic means for disconnecting the power means from the arbor when the end of a cylindrical layer of wire is reached; manual means normally operative for connecting or disconnecting the power means from the arbor, said manual means being inoperative to connect the power means with the arbor when the end of a layer of wire is reached; and other means for rotating the arbor to wind thereon a strip of paper and for rendering said manual means operative to connect the power means with the arbor whereby to wind thereon another layer of wire.

24. In a coil winding machine, the combination with a rotatable arbor upon which wire is to be wound; of power operated means for rotating the arbor, said power operated means including cooperative clutch members one of which is connected with a source of power and the other with the arbor; a clutch shifting member; an armature connected with the clutch shifting member; a source of current; an electro-magnet energized thereby, and cooperating with the armature; a relay switch adapted to connect said source of current with the magnet; a second source of current; and means for establishing a relay circuit through the relay switch and the second source of current when the wire breaks in order that the electro-magnet will be operative to move the clutch shifting member.

25. In a coil winding machine, the combination with a rotatable arbor upon which wire is to be wound; of power operated means for rotating the arbor, said power operated means including cooperative clutch members one of which is connected with a source of power and the other with the arbor; a clutch shifting member; an armature connected with the clutch shifting member; a source of current; an electro-magnet energized thereby, and cooperating with the armature; a relay switch adapted to connect said source of current with the magnet; a second source of current; a pair of contacts connected with the relay switch and the second source of current; and means rendered effective by the tension of the wire for holding the contacts apart.

26. In a coil winding machine, the combination with a rotatable arbor upon which wire is to be wound; of power operated means for rotating the arbor; electro-magnetic means for rendering the power operated means inoperative; a controlling device for said electro-magnetic means including a pair of cooperating contacts normally held out of engagement by the tension of the wire, but adapted when the wire breaks to complete a circuit whereby the electro-magnet will be rendered operative; and manually controlled means for rendering the said power means operative, but when moved to inoperative position to cause the interruption of said circuit whereby during the repairing of the wire when the said contacts are together, a waste of current will be prevented.

27. In a coil winding machine, the combi-

nation with a rotatable arbor upon which wire is to be wound; of power operated means for rotating the arbor; manually operable means for rendering the power means operative; and automatic means for rendering said power means inoperative when the wire breaks, said automatic means being rendered capable of operation by said manual means.

28. In a coil winding machine, the combination with a rotatable arbor upon which wire is to be wound; of power operated means for rotating the arbor; manually operable means for rendering said power means operative; electrically operated automatic means for rendering said power means inoperative when the wire breaks, said automatic means being rendered capable of operation by said manual means, but said automatic means being rendered inoperative when said power means is rendered inoperative by said manual means.

29. In a coil winding machine, the combination with a rotatable arbor upon which wire is to be wound; of power operated means for rotating the arbor, said means including cooperating clutch members one of which is connected with a source of power and the other with the arbor; a clutch shifting lever; a hand lever for shifting the clutch shifting lever and for making an electrical connection; and electrically operated automatic means rendered capable of operation by the making of said connection, said means operating by moving the clutch shifting lever when the wire breaks.

30. In a coil winding machine, the combination with a rotatable arbor upon which wire is to be wound; of power operated means for rotating the arbor; of manually operated means for rendering said power means operative or inoperative; of electrically operated automatic means for rendering said power means inoperative when the wire breaks, said electrical means including an electro-magnetic device, a source of current and electrical connections therewith including a plurality of switches, one of which is closed automatically when said manual means renders the power means operative, and the other of said switches being normally open but capable of closing automatically when the wire breaks whereby, when the machine is running, the breaking of the wire will establish an electric circuit through the electro-magnetic device to stop the machine, said circuit being opened by movement of said manual means to inoperative position.

31. In a coil winding machine, the combination with a rotatable arbor; of means for winding thereon a sheet of paper to form an insulating tube and for winding upon said paper tube a plurality of coils in separate zones; and means for separating the coils by severing the tube between the windings, said means including a pair of toggle links pivotally connected together, one link being pivotally mounted, a support upon which the other link is slidably mounted; means for moving the first mentioned link and for maintaining pressure between the second mentioned link and said support, and a series of knives supported by said first mentioned link.

32. In a coil winding machine, the combination with a rotatable arbor; of means for winding thereon a sheet of paper to form an insulating tube and for winding upon said paper tube a plurality of coils in separate zones; and means for effecting the separation of the tube between the windings, said means including pivotally connected toggle links, one link being pivotally mounted, a support having an inclined surface upon which one end of the other link is slidably mounted, means for moving the first mentioned link and for maintaining pressure between the second mentioned link and the inclined surface, and a plurality of knives supported by the first mentioned link.

33. In a coil winding machine, the combination with a rotatable arbor; of means for winding thereon a sheet of paper to form an insulating tube and for winding upon said tube a plurality of coils in separate zones; and means for separating the paper between the windings, said means including pairs of pivotally connected toggle links, one link of each pair being pivotally mounted at one end upon a support and having its other end provided with a hook, the other links of said pairs having their ends connected together by a rod with which the hooked ends of the first mentioned links may cooperate, a support upon which the other ends of said second mentioned links are slidably mounted, a plurality of knife blade holders carried by said rod, a knife blade carried by each holder, a knife blade holder supporting bar mounted upon said first mentioned links, said hook connection between the first and second mentioned links permitting the ready removal of the knife blade holders from the rest of the machine, and means for effecting the pivotal movement of the first mentioned links and the sliding movement of the second mentioned links relative to said support whereby the knife blades will be moved toward the axis of said arbor to effect the cutting of the paper.

34. In a coil winding machine, the combination with a rotatable arbor and means for forming thereon a plurality of coils with the adjacent layers of wire in each coil insulated by wrappings of insulated paper common to several coils; of means for effecting the separation of the paper between adjacent ends of the coils, said means including

a gang of knife blades and supports therefor detachably connected to said machine whereby said gang of knife blades may be removed from the machine as a unit.

35. In a coil winding machine, the combination with a rotatable arbor; of means for winding thereon a sheet of paper to form an insulating tube, and for simultaneously winding upon said paper tube a plurality of coils of wire in separated zones; a cutting mechanism; and means for guiding the mechanism between two adjacent coils to sever the tube.

36. In a coil winding machine, the combination with a rotatable arbor; of means for winding thereon a sheet of paper to form an insulating tube, and for winding upon said paper tube a plurality of coils of wire in separated zones; and means for simultaneously separating the coils by severing the tube between the windings.

37. In a coil winding machine, the combination with a rotatable arbor; of means for winding thereon a sheet of paper to form an insulating tube, and for winding upon said paper tube a plurality of coils of wire in separated zones; and means for simultaneously separating the coils by severing the tube between the windings, said means including a plurality of spaced knives and provisions for moving said knives simultaneously toward said arbor.

38. In a coil winding machine, the combination with a rotatable arbor having spaced annular grooves; of means for winding thereon a sheet of paper to form an insulating tube, and for winding upon said paper tube a plurality of coils of wire in separated zones each zone lying between two of said grooves; and means for simultaneously separating the coils, said means including a plurality of spaced knives, and provisions for moving said knives simultaneously toward the arbor, each knife moving into one of said grooves.

39. In a coil winding machine, the combination with a rotatable arbor having spaced annular grooves; of means for winding thereon a sheet of paper to form an insulating tube and for winding upon said paper tube a plurality of coils of wire in separated zones; and means for simultaneously separating the coils, said means including a plurality of spaced knives, and provisions for moving said knives simultaneously toward the arbor, each knife moving into one of said grooves, and including provisions for limiting the movement of said knives, whereby said knives will not engage the arbor.

40. In a coil winding machine, the combination with a rotatable arbor; of means for winding thereon a sheet of paper to form an insulating tube, and for winding upon said paper tube a plurality of coils of wire in separated zones; and means for simultaneously separating the coils by severing the tube between the windings, said means including a plurality of knives, a holder for each knife, means for adjustably attaching each knife to one of said holders and actuating means for moving all of said holders toward said arbor.

41. In a coil winding machine, the combination with a rotatable arbor; of means for winding thereon a sheet of paper to form an insulating tube, and for winding upon said paper tube a plurality of coils of wire in separated zones; and means for simultaneously separating the coils by severing the tube between the windings, said means including a plurality of knives, a holder for each knife, actuating means for moving said holders toward said arbor, and means for adjusting the position of each of said holders with respect to said actuating means.

42. In a coil winding machine, the combination with a rotatable arbor; of means for winding thereon a sheet of paper to form an insulating tube, and for winding upon said paper tube a plurality of coils of wire in separated zones; and means for simultaneously separating the coils by severing the tube between the windings, said means including a plurality of knives, a holder for each knife, means for removably attaching each knife to one of said holders, actuating means for moving said holders toward said arbor, and means for adjusting the position of each of said holders with respect to said actuating means.

43. In a coil winding machine, the combination with a rotatable arbor; of means for winding thereon a sheet of paper to form an insulating tube, and for winding upon said paper tube a plurality of coils of wire in separated zones; and means for separating the coils by severing the tube between the windings, said means including a plurality of knives, a holder for each knife, actuating means for moving said knife holders toward said arbor, said means having supporting provisions for said knife holders so constructed that said knife holders may be moved to a more accessible position without removal from the machine.

44. In a coil winding machine, the combination with a rotatable arbor; of means for winding thereon a sheet of paper to form an insulating tube, and for winding upon said paper tube a plurality of coils of wire in separated zones; and means for simultaneously separating the coils by severing the tube between the windings, said means including a plurality of knives, pivotally mounted knife actuating means for moving said knives toward said arbor, said means having supporting provisions for said knives so constructed that said knives may

be moved to a more accessible position without removal from the machine.

45. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of means for feeding paper to the arbor and for winding said paper thereon to form an insulating tube; mechanism for guiding wire onto said paper; automatic means for stopping the wire guiding means; devices for rendering said guiding means operative, said devices being ineffective until the paper winding operation is substantially completed.

46. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of means for holding a supply roll of paper; means for feeding paper to the arbor from said paper roll, for winding said paper upon said arbor to form an insulating tube, and for cutting off said paper; instrumentalities for guiding wire onto said paper to form a coil thereon; automatic means for stopping said instrumentalities; and devices for rendering said instrumentalities operative, said devices being ineffective until after the paper has been severed from the supply roll.

47. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of a wire guide shiftable in either direction longitudinally of said arbor; provisions for rotating said arbor and for shifting said wire guide in a certain direction; automatic means for stopping said provisions; and means for feeding paper to the arbor and for winding the same upon said arbor, while said provisions are inoperative, and for controlling said provisions whereby when said provisions are again set into operation, the wire guide will be shifted in the opposite direction.

48. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of a wire guide shiftable in either direction longitudinally of said arbor; provisions for rotating said arbor while feeding said wire guide in a certain direction; automatic means for stopping said provisions; and means for feeding paper to the arbor and for winding the same upon said arbor and for causing said provisions, when again set into operation, to effect the feeding of the wire guide in the opposite direction, said paper feeding and winding means also effecting a displacement of said wire guide in said opposite direction.

49. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of a wire guide shiftable in either direction longitudinally of said arbor; provisions for rotating said arbor while feeding said wire guide in a certain direction; automatic means for stopping said provisions; means for holding a supply roll of paper; and means for feeding paper to the arbor from said paper roll, for winding said paper upon said arbor, for cutting off said paper, and for causing said provisions, when again set into operation, to effect the feeding of the wire guide in the opposite direction.

50. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of a wire guide shiftable in either direction longitudinally of said arbor; provisions for rotating said arbor while feeding said wire guide in one direction; automatic means for stopping said provisions; means for holding a supply roll of paper; and means for feeding paper to the arbor from said paper roll, for winding said paper upon said arbor, for cutting off said paper, and for causing said provisions, when again set into operation, to effect the feeding of the wire guide in the opposite direction, said paper feeding, winding and cutting means also effecting a displacement of said wire guide in said opposite direction

51. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of a wire guide; wire guide feed means including rotatable feed screws and a shiftable feed nut; provisions for rotating said arbor and feed screws; automatic means for stopping said provisions means for feeding paper to said arbor, for winding the same upon said arbor and for causing said feed nut to be shifted from one feed screw to the other; and devices for rendering said provisions operative.

52. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of a wire guide; wire guide feed means including rotatable feed screws and a shiftable feed nut; provisions for rotating said arbor and feed screws; automatic means for stopping said provisions; means for holding a supply roll of paper; means for feeding paper to said arbor, for winding the same upon said arbor, for severing the paper from the supply roll and for causing said feed nut to be shifted from one feed screw to the other; and devices for rendering said provisions operative.

53. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of a wire guide; wire guide feed means including rotatable feed screws and a shiftable feed nut; provisions for rotating said arbor and feed screws; automatic means for stopping said provisions; means for feeding paper to said arbor, for winding the same upon

said arbor, for causing said feed nut to be shifted from one feed screw to the other and to be shifted longitudinally of the arbor; and devices for rendering said provisions operative.

54. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of a wire guide; wire guide feed means including rotatable feed screws and a shiftable feed nut; provisions for rotating said arbor and feed screws; automatic means for stopping said provisions; means for holding a supply roll of paper; means for feeding paper to said arbor, for winding the same upon said arbor, for severing the paper from the supply roll and for causing said feed nut to be shifted from one feed screw to the other and to be shifted longitudinally of the arbor; and devices for rendering said provisions operative.

55. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of a wire guide shiftable in either direction longitudinally of said arbor; provisions for rotating said arbor while feeding said wire guide in one direction; automatic means for stopping said provisions; and means for feeding paper to the arbor and for winding the same upon said arbor and for causing said provisions, when again set into operation, to effect the feeding of the wire guide in the opposite direction; and devices for rendering said provisions operative, said devices being ineffective until the paper winding operation is substantially completed.

56. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of a wire guide shiftable in either direction longitudinally of said arbor; provisions for rotating said arbor while feeding said wire guide in one direction; automatic means for stopping said provisions; means for holding a supply roll of paper; means for feeding paper to the arbor from said paper roll, for winding said paper upon said arbor, for cutting off said paper, and for causing said provisions, when again set into operation, to effect the feeding of the wire guide in the opposite direction; and devices for rendering said provisions operative, said devices being ineffective until after the cutting operation has been substantially completed.

57. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of a wire guide; wire guide feed means including rotatable feed screws and a shiftable feed nut; provisions for rotating said arbor and feed screws; automatic means for stopping said provisions means for feeding paper to said arbor, for winding the same upon said arbor and for causing said feed nut to be shifted from one feed screw to the other; and devices for rendering said provisions operative, said devices being ineffective until after the paper winding operation has been substantially completed.

58. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of a wire guide; wire guide feed means including rotatable feed screws and a shiftable feed nut; provisions for rotating said arbor and feed screws; automatic means for stopping said provisions; means for holding a supply roll of paper; means for feeding paper to said arbor, for winding the same upon said arbor, for severing the paper from the supply roll, and for causing said feed nut to be shifted from one feed screw to the other; and devices for rendering said provisions operative, said devices being ineffective until after the cutting operation has been completed.

59. In a coil winding machine, the combination with a rotatable arbor on which wire and paper are to be wound; of means for holding a supply roll of paper; wire guiding means; a power driven member; clutch means for connecting the power driven member with the arbor and wire guide means; automatic means for disengaging said clutch when a predetermined width of layer of wire is wound; and other means for operating the arbor and wire guide means, and for causing a predetermined number of turns of paper to be wound around said arbor and to be severed from said supply roll.

60. In a coil winding machine, the combination with a rotatable arbor on which wire and paper are to be wound; of means for holding a supply roll of paper; wire guiding means; a power driven member; clutch means for connecting the power driven member with the arbor and wire guide means; automatic means for disengaging said clutch when a predetermined width of layer of wire is wound; other means for operating the arbor and wire guide means, and for causing a predetermined number of turns of paper to be wound around said arbor and to be severed from said supply roll; and devices for causing the clutch to be engaged, said devices being ineffective until after the paper has been severed and substantially all of the severed portion wound upon said arbor.

61. In a coil winding machine, the combination with a rotatable arbor on which wire and paper are to be wound; of means for holding a supply roll of paper; wire guide means including a shiftable wire guide, a shiftable nut, and rotatable feed screws arranged on opposite sides of said nut; a power driven member; clutch means for connecting the power driven member with

the arbor and feed screws; automatic means including a stop member shiftable by said nut to disengage said clutch when a predetermined width of layer of wire is wound; and other means for operating said arbor and feed screws and for causing a predetermined number of turns of paper to be wound around said arbor and to be severed from said supply roll, and for moving said nut away from one feed screw to the other, and away from said stop, whereby to permit the re-engagement of said clutch members.

62. In a coil winding machine, the combination with a rotatable arbor on which wire and paper are to be wound; of means for holding a supply roll of paper; wire guide means including a shiftable wire guide, a shiftable nut, and rotatable feed screws arranged on opposite sides of said nut; a power driven member; clutch means for connecting the power driven member with the arbor and feed screws; automatic means including a stop member shiftable by said nut to disengage said clutch when a predetermined width of layer of wire is wound; other means for operating said arbor and feed screws and for causing a predetermined number of turns of paper to be wound around said arbor and to be severed from said supply roll, and for moving said nut away from one feed screw to the other, and away from said stop, whereby to permit the re-engagement of said clutch members; and devices for causing the clutch to be engaged, said devices being ineffective until after the feed nut has been shifted away from said stop.

63. In a coil winding machine, the combination with a rotatable arbor on which wire and paper are to be wound; of wire guide means including a shiftable wire guide, a shiftable nut, and rotatable feed screws arranged on opposite sides of said feed screw; a power driven member; clutch means for connecting the power driven member with the arbor and feed screws; other means for operating said arbor and feed screws and for causing paper to be wound around said arbor and for shifting said nut from one feed screw to the other; and a camming bar engaged by said nut during said shifting movement for effecting movement thereof longitudinally of said arbor.

64. In a coil winding machine, the combination with a rotatable arbor on which wire and paper are to be wound; of wire guide means including a shiftable wire guide, a shiftable nut, and rotatable feed screws arranged on opposite sides of said feed screw; a power driven member; clutch means for connecting the power driven member with the arbor and feed screws; automatic means including a stop member shiftable by said nut to disengage said clutch when a predetermined width of layer of wire is wound; other means for operating said arbor and feed screws and for causing paper to be wound around said arbor, for shifting said nut away from said stop and from one feed screw to the other; and a camming bar engaged by said nut during said shifting movement for effecting movement thereof longitudinally of said arbor.

65. In a coil winding machine, the combination with a rotatable arbor on which wire and paper are to be wound; of wire guide means including a shiftable wire guide, a shiftable nut, and rotatable feed screws arranged on opposite sides of said feed screw; a power driven member; clutch means for connecting the power driven member with the arbor and feed screws; automatic means including a stop member shiftable by said nut to disengage said clutch when a predetermined width of layer of wire is wound; other means for operating said arbor and feed screws and for causing paper to be wound around said arbor, for shifting said nut away from said stop and from one feed screw to the other; and a camming bar engaged by said nut during said shifting movement for effecting movement thereof longitudinally of said arbor, said stop and said camming bar being adjustable whereby to vary the width of the layer of wire.

66. The method of forming a coil upon an arbor which consists in attaching the end of a wire to the arbor, in feeding a strip of paper to the arbor between the wire and the arbor, in rotating the arbor a predetermined number of turns to wind paper from a source of supply thereon to a certain thickness, in cutting off the wound paper from said source of supply and then in rotating the arbor to wind wire thereon while feeding the wire to the arbor.

67. The method of forming a coil upon an arbor which consists in attaching the end of a wire to the arbor, in feeding a strip of paper to the arbor, between the wire and the arbor, in rotating the arbor a predetermined number of turns to wind paper from a source of supply thereon to a certain thickness while feeding the wire along the arbor in one direction, in cutting off the wound paper from said source of supply, and then in rotating the arbor to wind wire on said paper while feeding the wire along the arbor in the opposite direction.

68. In a coil winding machine, the combination with a rotatable arbor on which paper and wire are to be wound; of apparatus for winding a sheet of paper about said arbor and a plurality of coils of wire thereon in separated zones; and means for separating said coils, including a plurality of knives and provisions for moving said knives simultaneously against said paper while the arbor is rotating.

69. In a coil winding apparatus, a col-

lapsible arbor, means for forming on the arbor a plurality of coaxial coils joined by an insulating tube common to said coils, means for severing the tube to separate the coils during rotation of the arbor, and means for collapsing the arbor to simultaneously release the plurality of separated coils.

70. In a coil winding apparatus, a rotatable arbor, means for rotating said arbor and forming a coil of wire thereon, and means operable at a lower speed than said first named means for forming an insulating tube concentric with said coil.

71. In a coil winding apparatus, a rotatable arbor, means for rotating the arbor at a relatively slow speed and forming thereon an insulating tube comprising a plurality of layers of insulating material, and means for rotating said arbor at a higher speed and rapidly forming a layer of wire on said tube.

72. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of power means for rotating the arbor to wind wire thereon; of other means for rotating the arbor for winding paper thereon; and controlling means for connecting the power means with the arbor, said controlling means being operative after the other arbor rotating means is disconnected from the arbor.

73. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of power means for rotating the arbor and for guiding the wire longitudinally of the arbor in order to wind thereon a cylindrical layer of wire; automatic means for disconnecting the power means from the arbor when the end of a cylindrical layer of wire is reached; mechanism operable at the completion of a layer of wire for feeding a strip of paper to the arbor and for rotating the arbor to wind said strip of paper upon the arbor; and manual means for connecting the power means with the arbor, said means being operative after a substantial portion of the strip of paper has been wound upon the arbor.

74. In a coil winding machine, the combination with a rotatable arbor upon which paper and wire are to be wound; of power means for rotating the arbor and guiding wire longitudinally of the arbor to wind thereon a layer of wire; automatic means for disconnecting the power means from the arbor when the end of a cylindrical layer of wire is reached; means for holding a supply roll of paper; means operative when the end of a cylindrical layer of wire is reached for feeding a strip of paper from the supply roll to the arbor and for rotating the arbor to wind a portion of said strip upon the arbor to form an insulating tube upon the arbor, and for severing said tube from the supply roll; and manual means for connecting the power means with the arbor, said means being operative after the paper has been severed and a substantial portion thereof wound upon the arbor.

In testimony whereof we affix our signatures.

EDWIN F. CREAGER.
SAMUEL ROGERS.

Witnesses:
FREDERICK J. HARDMAN,
J. W. MCDONALD.