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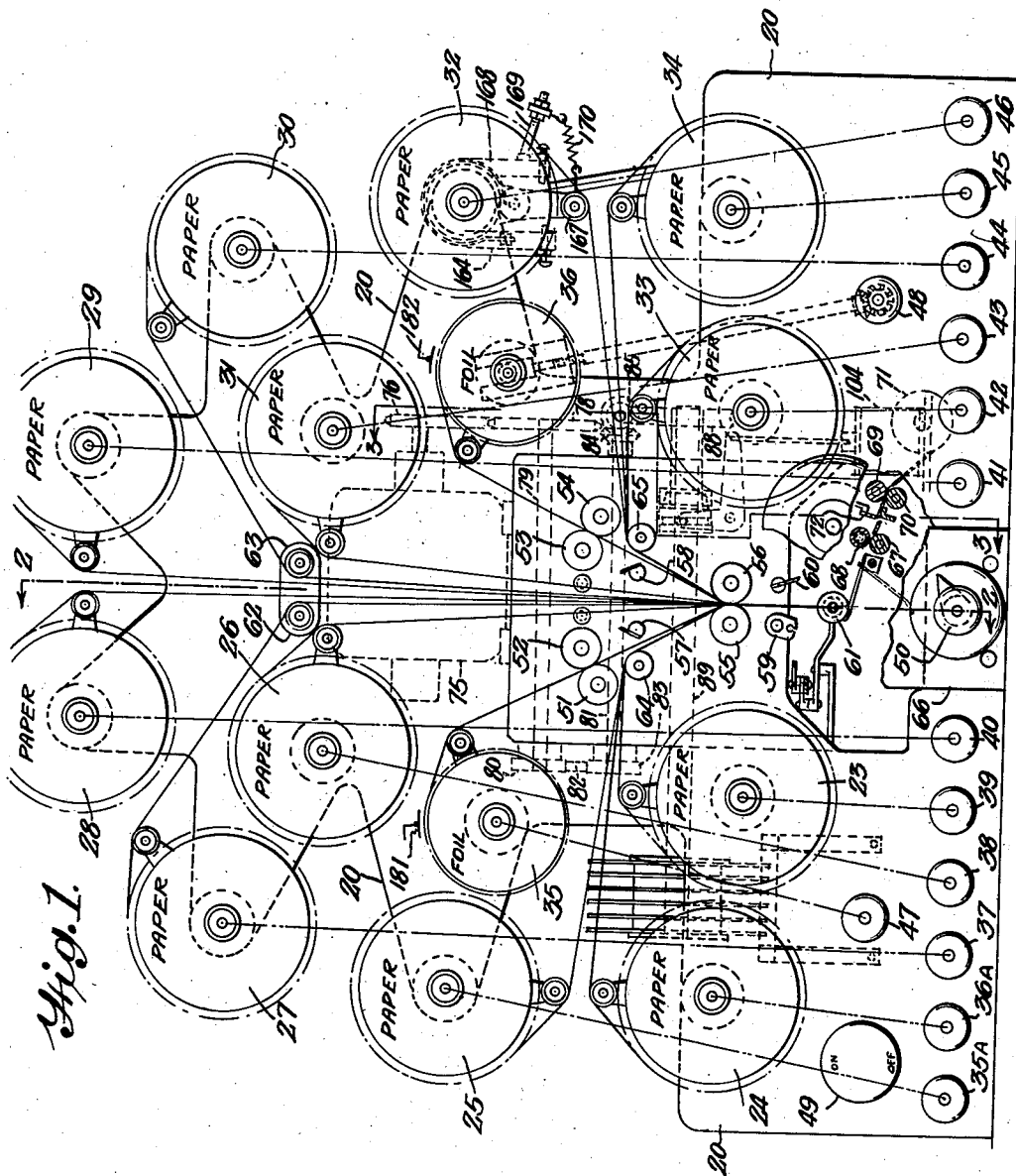
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2,199,603

CONDENSER WINDING MACHINE

Filed July 22, 1936

7 Sheets-Sheet 1



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CONDENSER WINDING MACHINE

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Fig. 3.

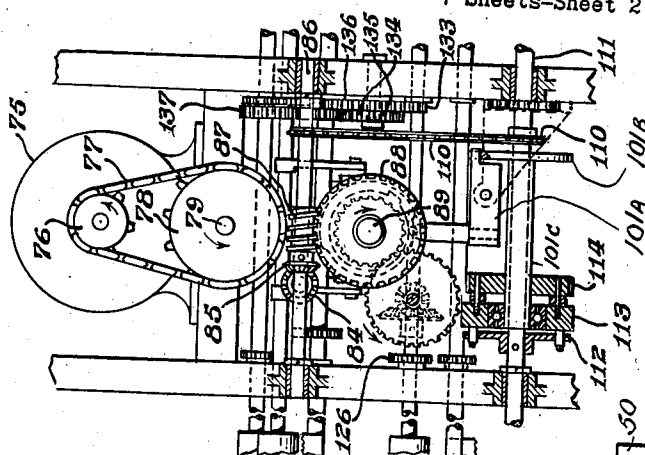
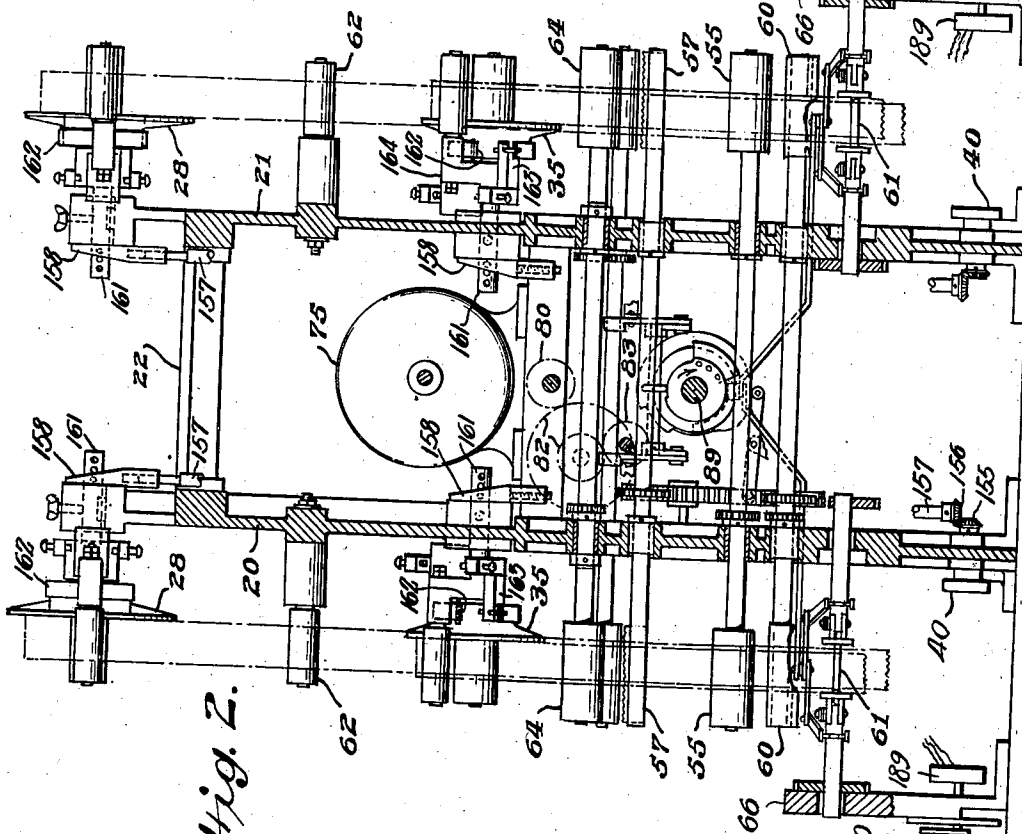


Fig. 2.



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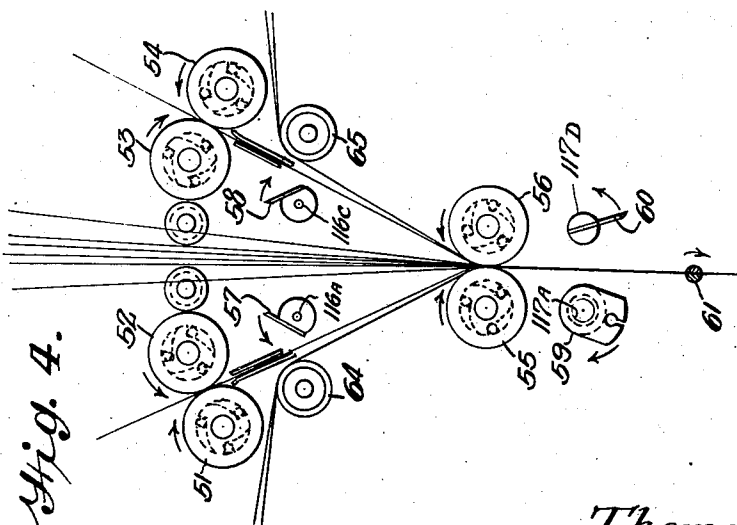
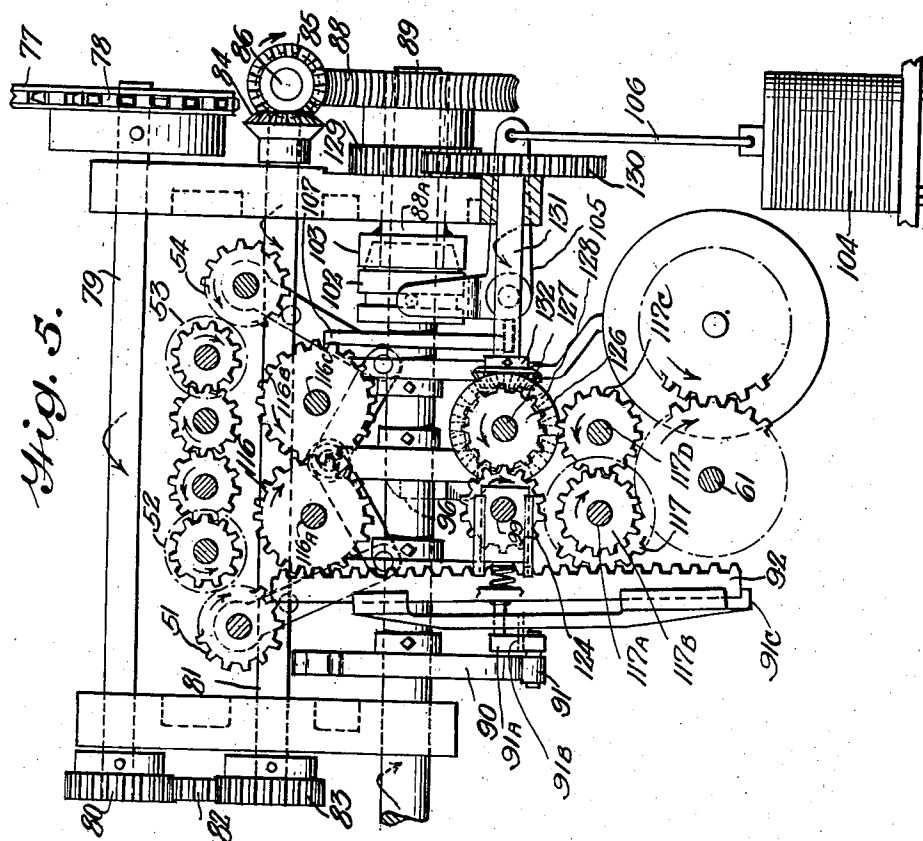
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CONDENSER WINDING MACHINE

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7 Sheets-Sheet 3



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CONDENSER WINDING MACHINE

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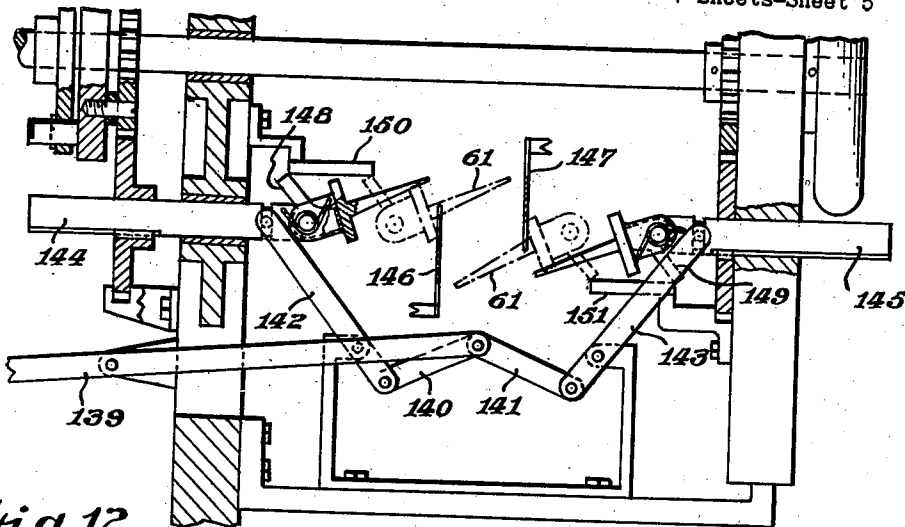


Fig. 12.

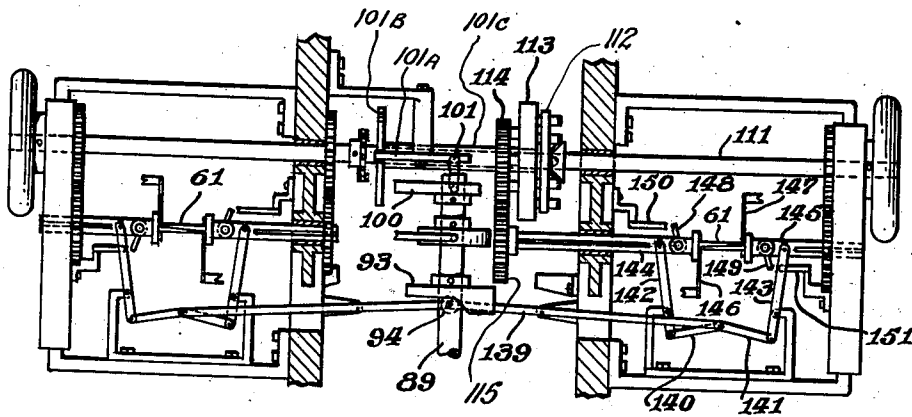


Fig. 11.

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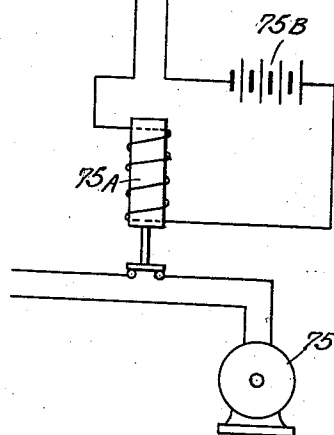
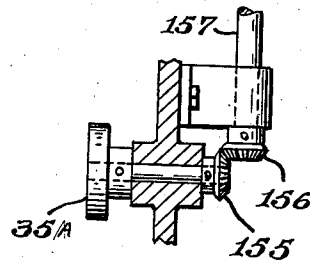
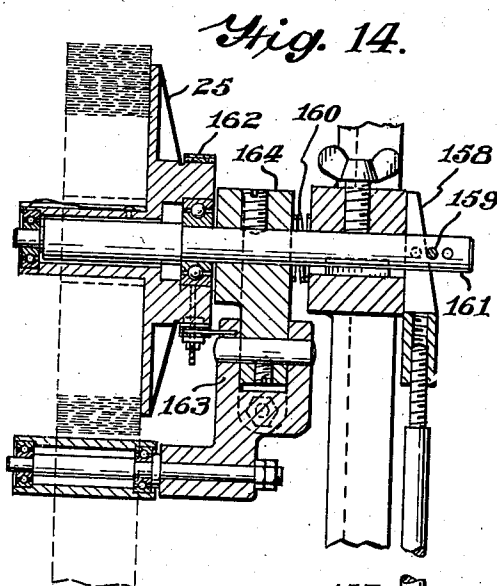
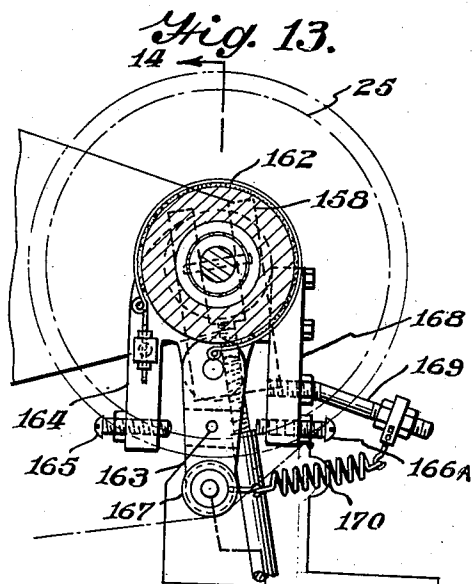
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CONDENSER WINDING MACHINE

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7 Sheets-Sheet 6



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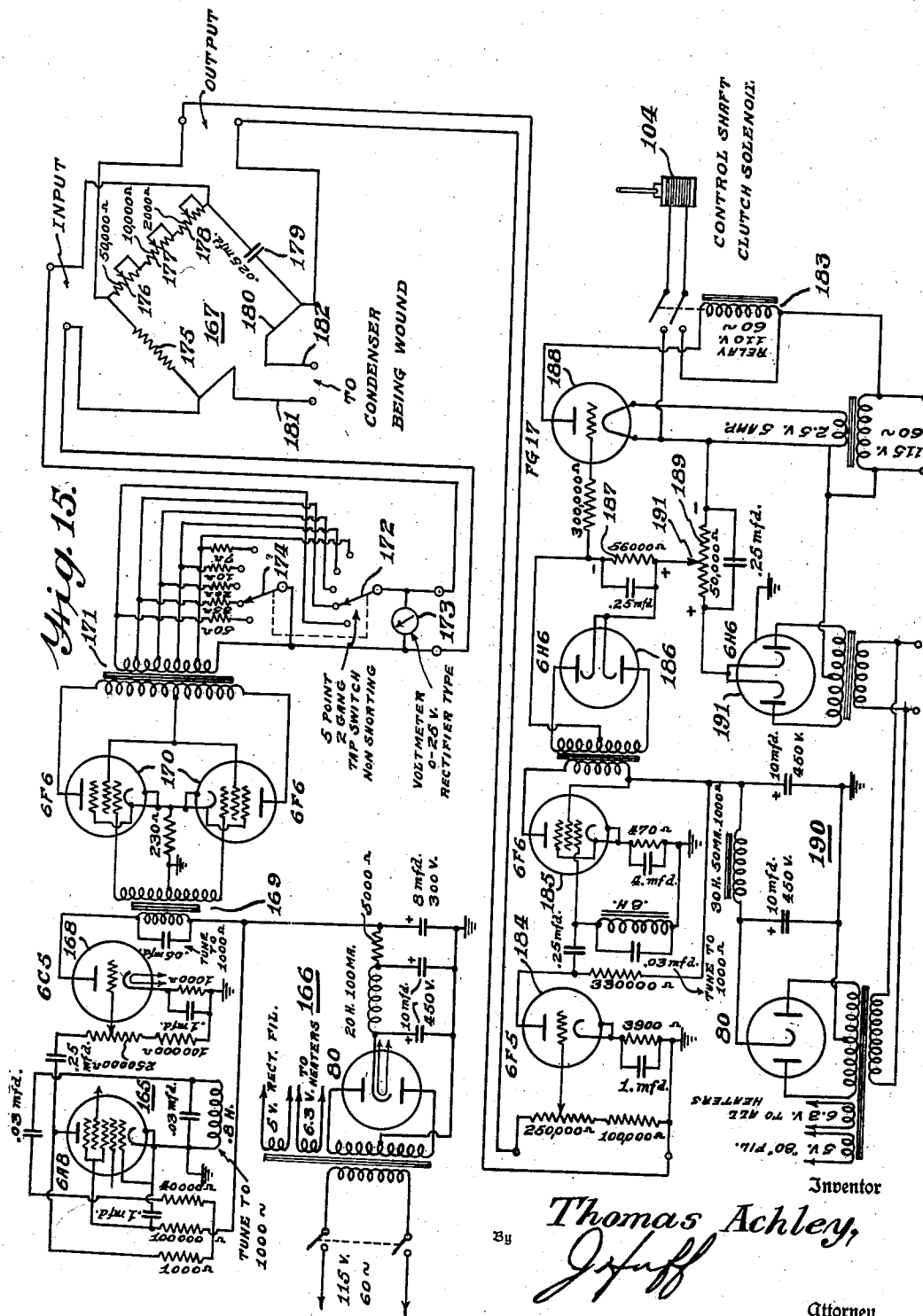
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CONDENSER WINDING MACHINE

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7 Sheets-Sheet 7



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UNITED STATES PATENT OFFICE

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CONDENSER WINDING MACHINE

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of Delaware

Application July 22, 1936, Serial No. 91,882

23 Claims. (Cl. 242—56)

This invention relates to the manufacture of electrical condensers, and has for its principal object the provision of an improved condenser winding machine and method of operation whereby (1) the necessity of manual attention during the operation of the machine is avoided, (2) condensers identical as to capacity and other characteristics are readily produced, (3) adjustment of the machine to produce condensers of various sizes are readily effected, (4) needed adjustments of the apparatus are readily made during its operation, and (5) a number of different condensers are simultaneously produced by the same machine.

As hereinafter explained, the machine operates successively to (1) close an automatic mandrel for gripping the ends of the paper and metal foil strips, (2) rotate the shaft for winding the paper and foil on it, (3) disengage the paper and foil feed rollers to permit the paper and foil to be drawn forward by the mandrel, (4) engage the paper and foil feed rollers so as to be ready to receive and feed the foil and paper strips, (5) cut the foil which is fed slower than the paper for securing proper overlap of the paper and foil at the beginning and end of the condenser, (6) cut off the paper, (7) apply a sticker to seal the outer turns of paper together, (8) stop the automatic mandrel, (9) eject the completed condenser, and (10) open the automatic mandrel to receive the ends of the paper and foil for rewinding the next succeeding condenser.

Other objects and advantages of the invention are the provision of an improved and compact condenser winding mechanism which may be utilized simultaneously to wind a plurality of condensers, the provision of means for readily adjusting the capacity of the condensers automatically produced by the machine and the provision of readily accessible means for adjusting the various parts of the mechanism properly to align and otherwise direct and control the movement of the paper and foil strips during the winding operation. This makes possible a very considerable reduction in the time required to set up the machine for condensers of different capacities.

The invention will be better understood from the following description when considered in connection with the accompanying drawings and its scope is indicated by the appended claims.

Referring to the drawings:

Fig. 1 is a view facing one of the two identical control panels mounted at opposite sides of the machine for simultaneously winding a pair of similar condensers,

Figs. 2 and 3 are sectional views taken on lines 2—2 and 3—3 of Fig. 1,

Figs. 4 to 10 illustrate various features of the drive mechanism,

Figs. 11 and 12 show various details of the automatic mandrel and its operating mechanism,

Figs. 13 and 14 illustrate the brake, adjusting and automatic protective mechanism of the strip feed and guide rollers, and

Fig. 15 is a wiring diagram of the system through which operation of the machine is controlled.

As shown by Figs. 1 and 2, the framework of the machine includes a pair of upright members 20 and 21 between which extend crosspieces 22 and upon which are rotatably mounted a plurality of paper reels 23 to 34 and a pair of metal foil reels 35 and 36. Also mounted on the upright members 20 and 21 are a plurality of control knobs 35A, 36A and 37 to 46 for endwise adjustment of the paper reels 23 to 34, a pair of similar control knobs 47 and 48 for endwise adjustment of the foil reels 35 and 36, a drive motor control switch knob 49 and a control knob 50 for adjusting the capacity of the condenser to be wound. It should be noted that Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1 but that certain of the reels and other elements have been omitted to avoid confusion.

Centrally mounted on the upright members 20 and 21 are metal foil feed rollers 51 to 54, paper feed rollers 55 and 56, foil cutters 57 and 58, paper cutter 59—60, automatic mandrel 61 and paper guide rollers 62 to 65. Mounted between the member 20 and a plate 66 are a plurality of rollers 67 to 70 for feeding a strip of adhesive tape from a roll 71 to the periphery of the completed condenser, a cutter 72 being arranged to sever the tape in proper lengths for sealing together the outer layers of the condenser.

Bearing in mind the features thus far described, it will be readily understood that (1) paper is fed from the reels 23 to 25 to the mandrel 61 on one side of the foil supplied from the reel 35, (2) paper is fed from the reels 26 to 28 to the mandrel 61 on the opposite side of this foil, (3) paper is fed from the reels 29 to 31 to the mandrel 61 on one side of the foil supplied from the reel 36 and (4) paper is fed from the reels 32 to 34 to the mandrel 61 on the opposite side of this foil. These various reels are so aligned with one another that the centers of the paper strips are substantially midway between the ends of the condenser and the centers of the foil strips are spaced in opposite directions from the center of the condenser so that an edge of one foil strip is exposed at one end of the condenser and one edge of the other foil strip is exposed at the opposite end of the condenser. The capacity and consequently the size of the condenser is determined by the adjustment of the knob 50.

The mechanisms for coordinating the functions of the above described elements are shown

in Figs. 3 and 5 to 12 which are now to be considered in detail.

The main drive mechanism includes a motor 75 (Fig. 3) which operates through a sprocket 76, a chain 77 and a sprocket 78 to drive a shaft 79. Mounted on the opposite end of the shaft 79 (Fig. 5) is a gear 80 which is coupled to a shaft 81 through gears 82 and 83. The shaft 81 bears at its opposite end a miter gear 84 meshing with a similar gear 85 mounted on a shaft 86 which bears a worm 87 (Fig. 3) and through this worm drives a worm gear 88 fixed to a collar 88A rotatably mounted on the shaft 89 and arranged to drive this shaft through a clutch 102—103 the member 102 being fixed to the shaft 89.

The control shaft 89 is the heart of the operating mechanism for the reason that it has mounted on it (1) a cam member 90 which operates through a follower 91 and a rack 92 to operate the foil cutter 57—58 and to operate the paper cutter 59—60, (2) a cam 93 (Fig. 6) which operates through a follower 94 to control operation of the automatic mandrel 61, (3) a cam 96 which operates through a collar 97 on a shaft 98 to disengage foil feed rollers 51 and 54 and through a shaft 99 to disengage the paper feed rollers 55 and 56, (4) a cam 100 which operates through a follower 101 to stop rotation of the automatic mandrel 61, (5) a clutch 102—103 coupled to a control solenoid 104 through a bell crank 105 and a rod 106, and (6) a cam 107 which operates through an extension 108 fixed to the crank 105 to predetermine operation of the clutch 102—103.

How these various functions are effected and timed with respect to one another will be readily understood. Thus starting at the beginning of the winding operation, (1) the cam 93 functions to close the mandrel 61 and grip the ends of the paper and foil strips, (2) the cam 96 functions to disengage the foil and paper feed rollers, (3) the cam 107 functions to open the clutch 102—103 and stop rotation of the control shaft 89, and (4) the mandrel 61 is driven from the shaft 86 through a chain 110 (Fig. 3), a shaft 111, a slip clutch 112—113, and gears 114 and 115 (Fig. 11) to wind the condenser.

When the condenser has been wound to a capacity determined by the setting of the knob 50 (Fig. 1), (1) the solenoid 104 (Fig. 5) is energized to close the clutch 102—103 and start rotation of the control shaft 89, (2) the cam 96 functions to engage the foil and paper feed rollers, (3) the cam 90 operates through the rack 92 and its associated gears 116 and 117 first to cut the foil and second to cut the paper so as to overlap the cut ends of the foil, (4) the cam 100 operates through follower 101 and the clutch member 112 to stop rotation of the mandrel 61 (5) the rollers 67 to 70 function to apply a strip of adhesive tape to the periphery of the condenser, and (6) the cam 93 operates through the lever systems of Figs. 11 and 12 to discharge the finished condenser and open the mandrel 61.

Although not necessary to an understanding of the above described operations, a complete and full disclosure of the invention requires a more detailed explanation of the mechanisms interposed between (1) the cam 96 and the foil and paper feed rollers, (2) the cam 93 and the mandrel, for opening the mandrel, and (3) the cam 100 and the mandrel drive shaft. A detailed description of the electrical control and drive system is also required for a complete understanding of how the machine is made to produce condensers of any desired capacity.

As shown more clearly in Figs. 6 and 8, the cam 96 operates through the shaft 98 and levers 120 pivoted at one end to the shaft 98 and at the other end to the ends of members 121 (pivoted to supports 122) to control engagement and disengagement of the foil feed rollers 51 and 52 and 53 and 54. The cam 96 also operates through the shaft 99 and the resiliently mounted support 123 of a gear 124 (Figs. 4 and 5) fixed to a shaft 99 to disengage the paper feed rolls 55 and 56. Mounted on the same shaft 127 as the gear 126 is a bevel gear 128 which is driven from the worm gear 88 through gears 129 and 130, shaft 131 and a bevel gear 132. Also mounted on the shaft 127 is a gear 133 (Fig. 6) from which the foil feed rollers are driven through gears 134 to 137.

During the winding of the condenser, the cooperative foil feed rollers 51—52 and 53—54 and the cooperative paper feed rollers 55—56 are disengaged and the foil and paper strips are drawn from their respective reels at a comparatively high rate of speed by the mandrels 61. Since these feed rollers are driven through slip-clutch couplings (Fig. 4) at a lower rate of speed, their engagement serves (1) to subject the foil and paper strips to a tension which facilitates their cutting and (2) to feed the severed ends of the strips to the mandrel 61 at a slow enough speed to allow time for completion and ejection of the previously wound condenser.

The mechanism for operating the foil cutters 57 and 58 and the paper cutter 59—60 includes the cam 90 (Figs. 5 and 9) which operates through the follower 91 and a link 91A pivoted at 91B to reciprocate the rack 92 in its bearing 91C. It will be noted that (1) the rack 92 meshes with a gear 116 mounted on the shaft 116A of the foil cutter 57 and with a gear 117 mounted on the shaft 117A of the paper cutter member 59, (2) the gear 116 meshes with and drives a gear 116B mounted on the shaft 116C of the foil cutter 58 and (3) the gear 117 operates through a gear 117B (also mounted on the shaft 117A) to drive a gear 117C mounted on the shaft 117D of the paper cutter member 60.

The operation of this mechanism is controlled by the cam 90 (Fig. 9) which operates through a part "a" of its rotation to effect cutting of the foil strips and through a part "b" of its rotation to effect cutting of the paper strips, these various operations being so related that the paper strip ends extend beyond the ends of the foil strips.

As previously indicated (1) each of the mandrels 61 is driven from the shaft 86 (Fig. 3) through a chain 110, shaft 111, a gear 114 mounted on the friction driven member 114 of a clutch 112—113 and a gear 115 (Fig. 11), and the friction driven member 114 is brought to a stop at a predetermined point (during ejection of the completed condenser) by movement of the cam 100 and its follower 101, which operates through a latch 101A and notched disk 101B mounted on a rotatable sleeve 101C fixed to the slip clutch member 114 (Figs. 3 and 11).

The mechanism for ejecting the completed condenser and gripping the foil and paper ends of the condenser next to be wound is controlled by the cam 93 which operates through its follower 94 and levers 139 to 143 (pivoted together as shown in Figs. 11 and 12) to slide the spindle shafts 144 and 145 endwise from one another in opposite directions to free the completed condenser which is discharged between the plates 146 and 147. During this endwise movement of the shafts 144 and 145, the resiliently pivoted

members 148 and 149 ride under the guides 150 and 151 and the spindle is maintained in an almost closed position. During the return movement of the shafts 144 and 145, however, the spindle members are separated, the foil and paper strip ends are fed down between them and then come together to grip these ends only after the members 148 and 149 are disengaged from the guides 150 and 151. The further steps in the winding of the condenser have been described above and need not be repeated here.

Figs. 13 and 14 indicate (1) how endwise adjustment of the foil and paper reels 23 to 36 (Fig. 1) is effected by means of the control knobs 35A, 36A and 37 to 46, (2) how braking action is applied to these reels, and (3) how the machine is stopped in response to breakage of one of the strips.

Thus, rotation of the control knob 35A, for example operates through miter gears 155 and 156, a shaft 157, a bifurcated wedge shaped member 158 and a pin 159 to move the shaft 161 in either direction against the tension of a spring 160.

Surrounding the hub of the reel 25 is a brake band 162 fixed at one end to a member 163 pivoted at the lower end of a member 164 which is fixed to the shaft 161. At the other end the brake band is fixed to the member 164. An electrical contact 166A is mounted on the insulation member 168 which is stationary. An adjustable stop 165 is mounted on the member 164. Rotatably supported at the lower end of the pivotally supported member 163 is a roller 167 and interposed between the member 163 and an extension 168—169 of the member 164 is a spring 170. The reel 25 rotates upon a roller bearing fixed to the end of the stationary shaft 161.

Since the brake band 162 is attached to the upper end of the member 163 and this member is pivoted at a point intermediate the point of the brake attachment and the roller 167, it will be apparent that movement of the roller 167 to the left will loosen the brake band and that movement of the roller in the opposite direction will tighten the brake band. When the strip breaks, the member 163 is of course moved into engagement with the contact 166A by means of the spring 170. These contacts are connected in the control circuit of the drive motor 75 and function to stop this motor in response to breakage of the strip. For the purpose of controlling the operation of the motor under these conditions, there may be employed any suitable means such as the relay 75A (Fig. 13) and a source 75B from which it is energized.

With this construction, it will be apparent that (1) the pressure of the brake is controlled in response to the tension of the strip passing from the reel 25 over the roller 167 and (2) the member 163 is moved into engagement with the contact 166A when the strip breaks, thus stopping the machine. Two important advantages are realized from this construction. In the first place, the brake band pressure is increased in response to decrease in the tension of the paper and vice versa, thus maintaining a substantially constant tension irrespective of the size of the roll. This, of course, applies to all the strip feed rollers. In the second place, static electricity and its consequent disadvantages are avoided by eliminating all frictional contact with the strips, as they pass through the machine. As will be readily understood, the machine operates to produce condensers of substantially identical ca-

capacity, thus avoiding the necessity of large tolerances in its product.

The electrical control circuit of Fig. 15 includes an oscillator 165 (Fig. 15) which may be tuned to a frequency of 1000 cycles, is energized from a socket power unit 166 and is coupled to the input terminals of a bridge network 167 through an amplifier 168, a coupling transformer 169, a push-pull amplifier 170 and a transformer 171. Interposed between the transformer 171 and the bridge 167 are a voltage control switch 172, a voltmeter 173 and a switch 174 associated with a plurality of compensating resistors connected to the various secondary leads of the transformer.

The bridge 167 consists of an arm including a resistor 175, an arm including adjustable resistors 176 to 178, an arm including a capacitor 179 and an arm 180 connected through terminals 181 and 182 to the terminals of the condenser or condensers being wound by the machine.

The output potential of the bridge 167 is applied to the operating coil 183 of clutch solenoid 104 through a channel including amplifiers 184 and 185, a rectifier 186, a resistor 187 and an amplifier 188. Connected in the input circuit in series with the resistor 187 is an adjustable resistor 189 which is supplied with current through a rectifier 191 from the same socket power unit 190 as the amplifier channel.

With these connections, the output current of the bridge 167 is controlled by the capacity of the condenser which is being wound and which is connected to the bridge terminals 181—182 (Figs. 1 and 15). This output current is amplified by the channel 184 to 186 and appears in the resistor 187 as a direct current which decreases as the capacity of the condenser increases. The control grid of the output amplifier is therefore subjected to a negative bias potential component which becomes less negative as the capacity of the condenser increases. It is also subjected to a positive bias potential component which may be adjusted by means of the adjustable terminal through the control knob 50 (Fig. 1) for adjusting the condenser capacity at which current is released through the amplifier 188 for operating the solenoid 104 which controls the clutch 102—103 of the control shaft 89 to produce the successive functions previously explained.

This electrical control system is disclosed and claimed in a copending application of R. W. Knight, Serial No. 91,881, filed July 22, 1936, now Patent No. 2,111,786, and assigned to the same assignee as the present application.

I claim as my invention:

1. A condenser winding apparatus including a mandrel provided with a pair of members movable laterally and axially to and from one another for gripping the ends of insulation and conductive strips to be wound upon it to form a roll in which said insulation strips are interposed between said conductive strips, means affording a continuous measure of the instantaneous capacity between said strips, and means operable in response to said capacity for terminating the winding of said roll and separating said members to discharge said roll from said apparatus.

2. In a condenser winding apparatus including a mandrel and means for supplying insulation and conductive strips to be wound on said mandrel to form a roll in which said insulation strips are interposed between said conductive strips, means affording a continuous measure of the instantaneous capacity between said con-

ductive strips, and the combination of means operable in response to the capacity between said conductive strips for severing said conductive and insulation strips with the ends of said insulation strips overlapping the ends of said conductive strips.

3. A condenser winding apparatus including a mandrel provided with members movable laterally and longitudinally with respect to one another for gripping the ends of insulation and inductive strips to be wound on said members in the form of a roll, a control shaft, and means mounted on said shaft for controlling the positions of said members.

4. A condenser winding apparatus including a mandrel provided with members movable laterally and longitudinally with respect to one another for gripping the ends of insulation and inductive strips to be wound on said members in the form of a roll, a control shaft, and means including a cam mounted on said shaft for controlling the positions of said members.

5. A condenser winding apparatus including a mandrel provided with members movable laterally and longitudinally for gripping the ends of insulation and inductive strips to be wound on said members in the form of a roll, a control shaft, means mounted on said shaft for controlling the positions of said members, means affording a continuous measure of the instantaneous capacity of said condenser, and means operable to control the rotation of said shaft in response to said capacity.

6. A condenser winding machine including power supply means, a mandrel comprising a pair of movable members, a coupling interposed between said means and said mandrel, means for deriving the instantaneous capacity of said condenser during its winding operation, and means operable in response to a predetermined value of said capacity to stop rotation of said mandrel and impart longitudinal and lateral movement to said members.

7. A condenser winding machine including means affording a continuous indication of the capacity of said condenser during its winding operation, a mandrel comprising a pair of rotatable members movable laterally and longitudinally with respect to one another, means for feeding the ends of the conductive and insulation strips of said condenser between said members, and means operable in response to said capacity to move said members laterally toward one another to grip the ends of said strips.

8. A strip winding machine including a drive motor, means including a control shaft operable from said motor to sever said strip, a mandrel arranged to be driven from said motor independently of said shaft and comprised of a pair of rotatable members, and means operable from said control shaft to move said members axially and longitudinally with respect to one another laterally from and toward one another to grip the end of said strip.

9. A strip winding machine including a drive motor, means including a control shaft operable from said motor to sever said strip, a mandrel arranged to be driven from said motor independently of said shaft and comprised of a pair of rotatable members, and means operable from said control shaft to stop rotation of said mandrel and to move said members laterally and longitudinally from and toward one another to grip the end of said strip.

10. In a condenser winding machine including

a drive motor, means including a control shaft operable to sever successively the conductive and insulation strips of said condenser, a clutch interposed between said motor and said shaft and a mandrel arranged to be driven from said motor independently of said shaft, the combination of means affording a continuous measure of the instantaneous capacity of said condenser during its winding operation, means operable in response to a predetermined value of said capacity to close said clutch, and means operable from said shaft to stop rotation of said mandrel.

11. A condenser winding machine including a drive motor, means including a control shaft operable to sever successively the conductive and insulation strips of said condenser, a clutch interposed between said motor and said shaft, a mandrel arranged to be driven from said motor independently of said shaft and comprised of a pair of rotatable members movable laterally and longitudinally with respect to one another, means affording a continuous measure of the instantaneous capacity of said condenser during its winding operation, means operable in response to a predetermined value of said capacity to close said clutch, and means operable from said shaft to move said members laterally from and toward one another to grip said strips.

12. A strip winding machine including a drive motor, means including a control shaft operable from said motor to sever said strip, a clutch interposed between said motor and said shaft, a mandrel arranged to be driven from said motor independently of said shaft and comprised of a pair of rotatable members, a friction coupling interposed between said motor and said mandrel, and means operable from said control shaft to stop said mandrel and to move said members laterally and axially from and toward one another to grip the end of said strip.

13. In a condenser winding machine of the type wherein the winding operation is terminated in response to a predetermined capacity between conductive strips separated by strips of insulation, the combination of a shaft, a clutch mounted on said shaft and arranged to be closed in response to said capacity, a mandrel including separable rotatable members arranged to be driven with said shaft, conductive and insulation strip feed rollers arranged to be driven with said shaft, means responsive to operation of said clutch for successively moving said mandrel members to engage the ends of said strips, initiating rotation of said mandrel, disengaging said strip feed rollers, engaging said feed rollers, cutting said conductive and insulation strips one after the other, stopping rotation of said mandrel, and separating said mandrel members, and means to open said clutch after the winding of said coil is initiated.

14. In a condenser winding machine of the type wherein the winding operation is terminated in response to a predetermined capacity between conductive strips separated by strips of insulation, the combination of a shaft, a clutch mounted on said shaft and arranged to be closed in response to said capacity, a mandrel including laterally separable rotatable members arranged to be driven with said shaft, conductive and insulation feed rollers arranged to be driven with said shaft, means responsive to operation of said clutch for successively moving said mandrel members to engage the ends of said strips, initiating rotation of said mandrel, disengaging said strip feed rollers, engaging said feed rollers, cut-

