C. W. FRANCIS.

APPARATUS FOR MAKING WINDINGS.

APPLICATION FILED FEB. 3, 1920.

1,379,755.

Patented May 31, 1921.

4 SHEETS—SHEET 1.

Fig. 2a

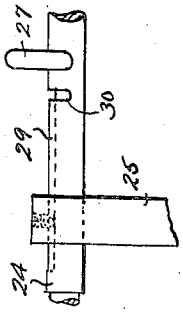


Fig. 2

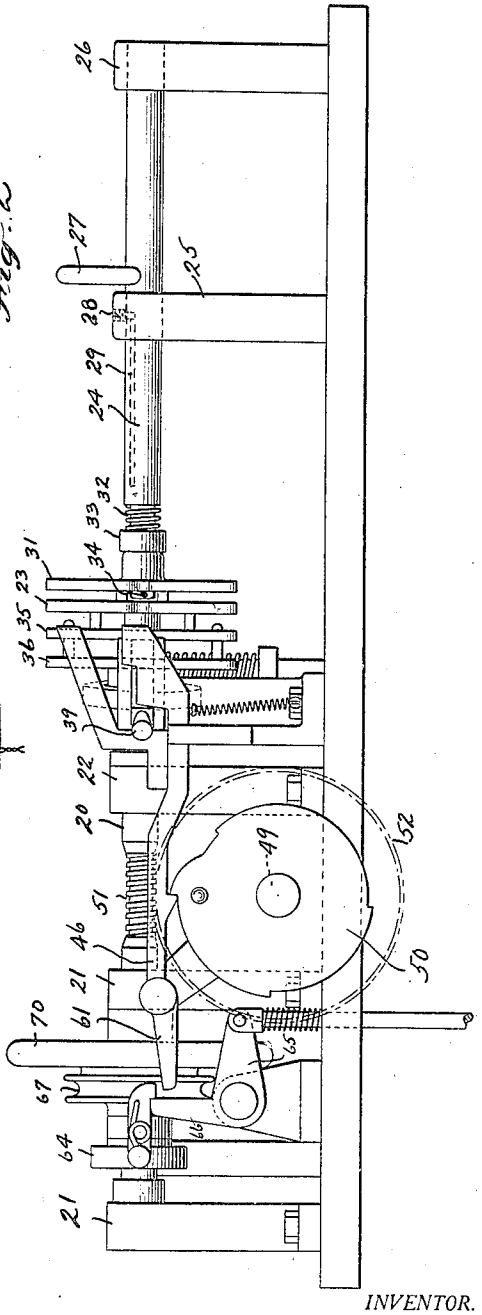
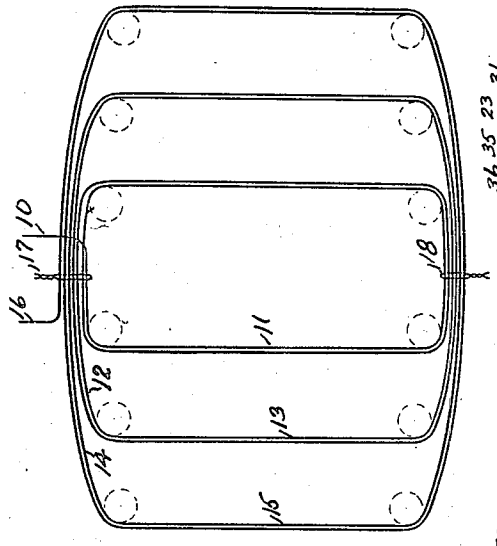


Fig. 1



WITNESS:

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4 SHEETS—SHEET 2.

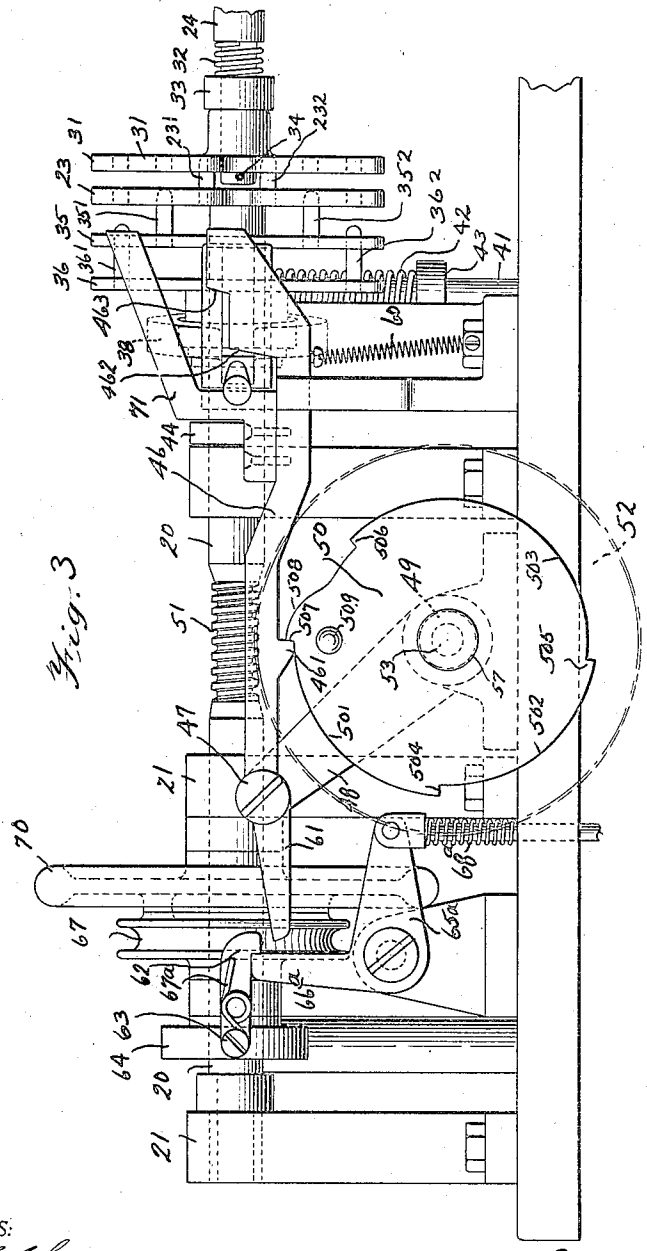

Fig. 3

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4 SHEETS—SHEET 3.

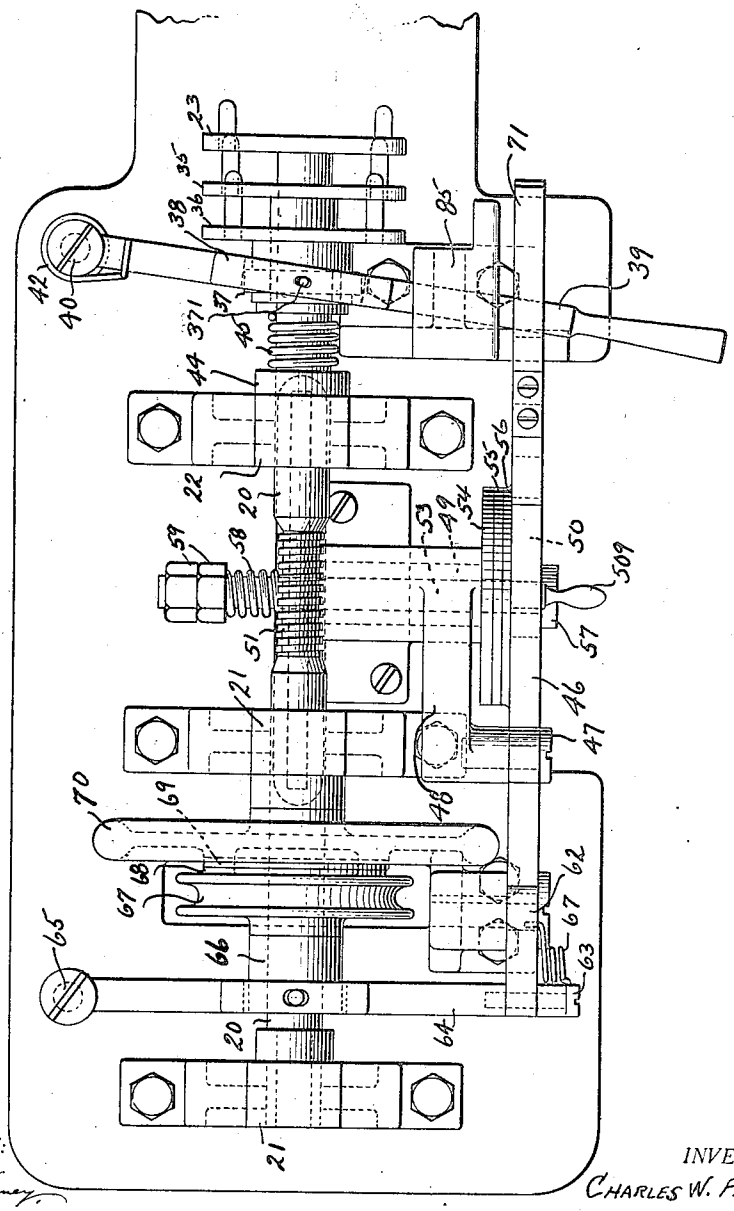

Fig. 4.

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4 SHEETS—SHEET 4.

Fig. 5

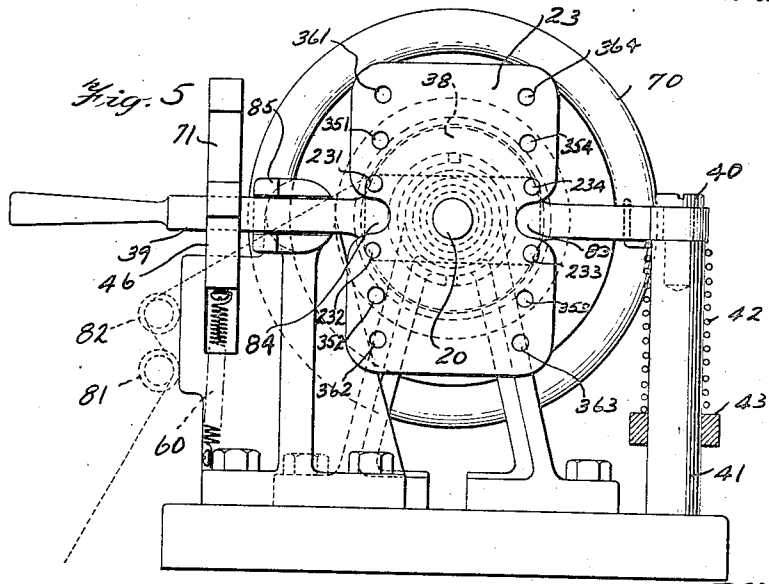


Fig. 6

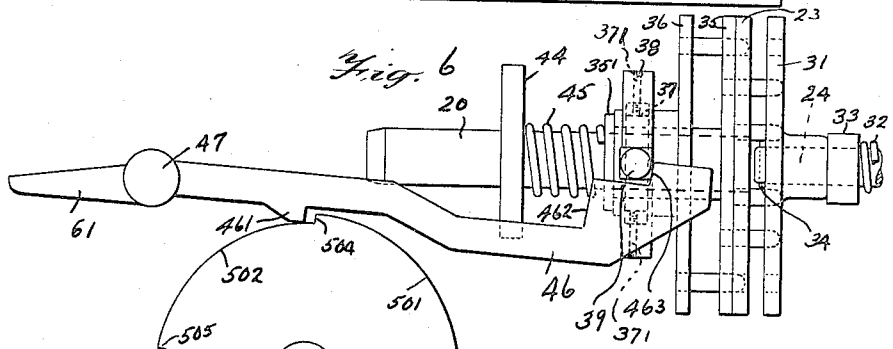
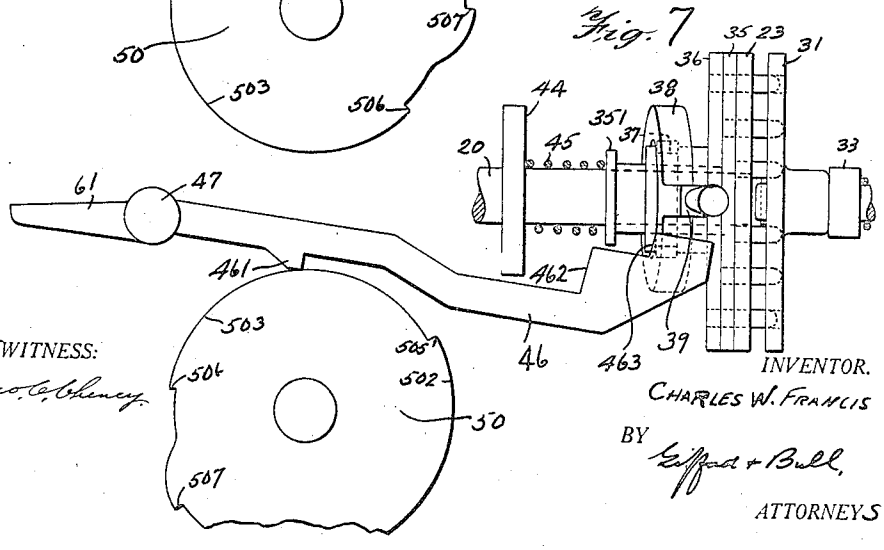


Fig. 7



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APPARATUS FOR MAKING WINDINGS.

1,379,755. Specification of Letters Patent. Patented May 31, 1921.

Application filed February 3, 1920. Serial No. 356,027.

To all whom it may concern:

Be it known that I, CHARLES W. FRANCIS, a citizen of the United States, residing at Paterson, in the county of Passaic and State of New Jersey, have invented certain new and useful Improvements in Apparatus for Making Windings, of which the following is a specification.

My invention relates to apparatus for making a winding which is particularly adapted for the field coils of multi-polar electric machines, it being understood that the apparatus is capable of use in the making of windings of a large variety of shapes and for different purposes.

One of the objects of my invention is to provide apparatus for making a winding in which there shall be a number of flat, separate coils of increasing sizes and arranged with sufficient space between the sides of the coils so that the same may be slipped around the poles of a multi-polar field piece, which winding shall be of one continuous piece of wire so that the winding can be made cheaply and at the same time have its insulation uniform throughout the completed winding.

Another object of my invention is to provide an apparatus for making such a winding as has just been described, and others of a similar character in which coils occupying the same plane may be wound so that each succeeding coil surrounds the preceding inner coil and yet is separated therefrom by a considerable space, and particularly an apparatus by which such winding may be carried out in a continuous manner by the placing of suitable forms in position after the preceding form has received its predetermined number of turns of wire.

Another object of my invention is to provide an apparatus by which such a winding may be made expeditiously and preferably automatically.

With these and other objects in view, my invention consists of the apparatus hereinafter fully described and particularly pointed out in the appended claims.

In the drawings, Figure 1 illustrates one form of winding; Fig. 2 a side elevation on a relatively small scale of an illustrative form of machine for carrying out my invention; Fig. 2ª is a fragmentary portion of Fig. 2; Fig. 3 a side elevation somewhat enlarged, of a portion of Fig. 2; Fig. 4 a plan view of Fig. 3; Fig. 5 an end elevation of Fig. 3 with the follower plate and its support removed, and Figs. 6 and 7 enlarged partial views of the mechanism shown in Fig. 3 with the parts in different positions.

In the drawings, the same parts are referred to by the same reference characters in the several views.

Fig. 1 is a side elevation, more or less diagrammatic, of a form of winding such as the form of apparatus illustrated is particularly designed to make. In this drawing only two layers of wire have been shown in each coil, but it will be understood that as many as desired may be provided, and particularly that the number of turns in each plane, which will determine the width of the winding, may be of any desired number. Beginning at the terminal 10 the wire, which is continuous throughout the winding, passes into the inner coil 11 around which, in the diagrammatic view, it passes twice completely, the end 12 then passing to the next coil 13 around which it again passes twice completely, with its end 14 passing to the outer coil 15, the end of which, 16, is preferably bent upwardly parallel or around the terminal 10. It will be understood that any desired number of coils may be formed in the winding.

It will be observed that in the form shown in Fig. 1, the top and bottom of the respective coils are adjacent each other, whereas the sides are widely separated from the sides of adjacent coils.

In order to provide an easy method by which the winding may be kept in shape and position until the winding is placed in the machine in which it is to be used, I preferably provide a temporary binding wire such as 17, 18, at the top and bottom of the winding, this temporary binding wire being fastened so as to hold the coils together until they are in position of use.

It, of course, is not new to form a winding of a number of coils, but the particular advantage of my apparatus consists of forming such a winding from a continuous piece of wire so that the insulation on the wire is continuous throughout the winding. Furthermore, in the forming of such a winding, the delay occasioned by fastening the ends of successive coils together is avoided.

In order to form such a coil as that shown in Fig. 1, I preferably wind the desired number of turns around a former which is shaped to give the required interior shape to the inner coil 11, such turns being continued until the desired size of coil is obtained. Then, without removing the inner coil 11 from its former, I place a secondary former around the inner coil 11 and continue the winding from the coil 11 around this secondary former, which winding is continued again for the required number of turns when I again place another secondary former around the preceding one, and continue the winding around this. The placing of successively larger secondary formers around the preceding formers is thus continued until the desired number of coils is obtained, when the ends of the winding are carried up adjacent to each other, and preferably the entire winding temporarily bound, as by temporary binders 17, 18 of Fig. 1.

While, of course, my novel method of winding may be carried out by hand in connection with any suitable formers, I prefer to do such winding by a machine and to that end I provide as my preferred mechanism the arrangement shown in Figs. 2 to 7, inclusive.

My illustrative form of mechanism is shown in complete side elevation in Fig. 2 in which a driving shaft 20 is supported in bearings 21 and 22, and rotated by a mechanism to be more fully described hereinafter. On the end of the shaft 20 and fastened thereto, is a plate 23 which constitutes part of the primary former, as will be described hereinafter. In alinement with the shaft 20 is a bar 24 supported in bearings 25, 26, the bar having a handle 27 and being arranged to slide longitudinally through its bearings. In the bearing 25 is a screw 28 having one end located in a longitudinal slot 29 in the bar 24, this slot having a right angle turn 30.

On the end of the bar 24 and slidingly mounted thereon, so as to be free to turn, is a follower plate 31 normally held to the left of Fig. 2 by a spring 32 pushing against a shoulder on the bar 24 and against a loose collar 33, a pin 34 holding the follower 31 on the bar 24.

By grasping the handle 27 the operator may move the bar 24 to the left of Fig. 2 from the position shown in Fig. 2ª to the position shown in Fig. 2, the bar being then rotated so as to bring the end of the screw 28 into the portion 30 of the slot in bar 24. The bar is then locked against motion to the right of Fig. 2. The effect of this motion will be referred to after the formers with which the follower coöperates, are described.

As a preferred form of former particularly adapted for winding the coils of the winding shown in Fig. 1, I have illustrated formers consisting of flat plates having projecting pins, four in number in the case illustrated, these pins being set to mark the boundaries of the area of the coil to be formed on that particular former, the pins 231, 232, 233, and 234 being located in the plate 23, preferably, so as to determine the corners of the inner coil 11 of the winding shown in Fig. 1. The plate 23 is attached to the end of the shaft 20 so as to rotate therewith and to be immovable longitudinally thereon. Slidingly mounted on the shaft 20 is the plate 35 of a secondary former, the pins 351, 352, 353 and 354 of which are located in relation to the pins on the primary former plate 23 so as to constitute the corners or boundaries of the area of the next larger coil of the winding to be formed. In the shape of coil illustrated, the top and bottom wires are slightly bowed to enable the top and bottom wires of the second coil to lie outside the top and bottom wires of the primary coil although the side wires of the second coil are slightly shorter than the side wires of the primary coil. To give this form to the winding the pins of the secondary former are spaced closer across the former than are the pins of the primary former. The pins of the plate 35 project through holes formed in the plate 23 and normally, the plate 35 is moved far enough from the plate 23 so that the ends of the pins do not project to the right of the plate 23.

Similarly, in the form illustrated, another secondary former composing the plate 36 and the pins 361, 362, 363, and 364, is mounted on the hub of the plate 35 so as to slide thereon, the pins on the plate 36 projecting through holes in the plate 35, and the plate 23 being provided with corresponding holes to receive them when they are moved, as described hereinafter. The end of the hub of the plate 36 is grooved, in this groove being placed a member 37 which is free to turn therein. Surrounding the member 37 and connected thereto by pins 371 is the eye 38 of a handle 39 pivoted at 40 on a vertical member 41, this member being provided with a spring 42 one end of which is fastened to a fixed collar 43, the other end of which bears against the handle 39 so as to normally tend to rotate that handle counterclockwise in Fig. 4. Between the inner end of the hub of the plate 35 and a collar 44 on the shaft 20 is a spring 45, the collar 44 bearing against the end of the bearing 22. So long as the handle 39 is held in the position shown in Fig. 4, the primary and secondary formers are held in the positions shown in Figs. 3 and 4, the follower plate 31 being in the position indicated with the pins on the plate 23 projecting into corresponding holes in the follower plate 31, so as to leave an operative

space between the plates 23 and 31 into which the strand of wire may be fed to be wound around the pins of the primary former as the latter are rotated, such a winding being indicated in dotted lines in Fig. 5. The follower plate is loosely mounted on the end of the bar 24 so that as it is brought up into the position shown in Fig. 3, the plate 31 may be rotated by hand, if necessary, until the holes in this plate coincide with the pins on the plate 23, when the spring 32 will force the plate 31 forward into the position shown in Fig. 3.

Preferably, the motion of the handle 39, which controls the operation of the successive formers, is controlled by automatic means, and as one embodiment of such a means I have illustrated a detent member 46 pivoted at 47 on a bracket 48 extending up from the bed plate of the machine. Extending across the machine is a cam shaft 49 having on the end thereof, a cam 50. On the shaft 20 is a worm 51 geared to a worm wheel 52 on the cam shaft 49. Preferably, the cam shaft 49 is hollow to permit a compression rod 53 to extend therethrough so as to frictionally connect the cam 50 with the shaft 49. To this end the shaft 49 is provided with a friction disk 54 and a friction piece 55, which contacts with a friction hub 56 on the cam 50. The head 57 of the compression rod 53 is outside of the cam 50 and at the opposite end the head 53 is provided with a spring 58 and adjusting nuts 59. As is well understood with this form of construction, when the nuts 59 are screwed up, the spring 58 is compressed, and this serves to draw the cam 50 against the disk 54, the amount of friction between the members of the friction coupling being dependent on the amount of pressure exerted by the spring 58.

The cam 50 is provided with a number of concentric parts of which 501 is the largest in diameter, 502 the next, and 503 the last, it being understood that there would be as many of these concentric portions as there are coils in the winding to be formed. These concentric portions are separated by sudden drops as 504, 505, 506 and 507, the space between the drops 506 and 507 being occupied by a concentric portion, and then a sudden rise 508. The cam 50 may also be provided with a handle 509.

The detent member 46 is provided with a toe piece 461 and two detent faces 462 and 463.

In the position shown with the toe 461 resting on the concentric portion 501 of the cam, the handle 39 is held in the position shown in Figs. 3 and 4 by contact between the handle and the detent face 462. In this position of the handle the end of the hub of the plate 36 contacts with the collar 351 of the hub of the plate 35, so that the springs 45 and 42 are restrained from action.

As the cam 50 is rotated by the turning of the shaft 20 during the winding of the inner coil, the toe 461 moves along the concentric portion 501 until the drop 504 is reached. The member 46 is then pulled downward by the spring 60 into the position shown in Fig. 6, which will permit the springs 42 and 45 to move the handle 39 to the position shown in Fig. 6, and the secondary former plates 35 and 36 to the position shown in Fig. 6 with the pins 351, 352, 353 and 354 projecting through the plate 23 and across the operative space between the plate 23 and follower 31. As the cam 50 continues to be turned by the rotation of the shaft 20, when the toe 461 reaches the drop 505, the member 46 is moved to the position shown in Fig. 7, at which time the handle 39 may pass freely over the top of the member 46 to move the plate 36 against the plate 35 to bring the pins 361, 362, 363 and 364 into the position shown in Fig. 7 extending across the operative space between the plates 23 and 31.

The continuous rotation of the cam 50 finally permits the toe 461 to drop past the portion 506, and I utilize this drop for the purpose of bringing the machine to rest automatically. To this end, in the form illustrated, I provide a toe 61 on the member 46 which is adapted to strike a latch 62 pivoted at 63 on a lever 64 pivoted at 65 and connected in the usual manner with the hub of a collar 66 on the shaft 20, so that as the lever 64 turns on the pivot 65 the collar 66 may be moved longitudinally of the shaft. When the lever 64 moves counterclockwise in Fig. 4, pressure is exerted against the hub of a driving pulley 67 to cause pressure to be exerted between friction surfaces 68 on the driving pulleys 67 and 69 on a hand wheel 70 which is connected to the shaft 20. When the lever 64 is in the position shown in Fig. 4, therefore, power from the driving pulley 67 will be transmitted through the hand wheel 70 to the shaft 20.

In the form illustrated, the lever 64 is moved by a bell crank 65^a which may be foot operated, this bell crank having a toe 66^a which engages with a projection on the member 62, this member being normally held in a downward position by a spring 67^a. The bell crank 65 is normally moved counterclockwise by a spring 68^a. In the position shown in Figs. 3 and 4 the bell crank 65^a has been turned clockwise so that the toe 66^a, engaging with the member 62, has caused the driving friction surfaces to contact to set the driving shaft 20 into rotation. It will be understood that the foot treadle which moves the bell crank 65 will be provided with a suitable detent arrangement to hold it in its downward position.

When the toe 461 reaches the drop 506, the member 46 is then turned on its pivot to such an extent that the toe 61 strikes the member 62 and lifts it above the toe 66[a] so as to free it therefrom. This releases the pressure between the driving surfaces, and the shaft 20 comes to a stop.

Attached to the member 46 is a fixed cam member 71 which extends over the handle 39. When the member 46 is in the position shown in Fig. 7, the further rotation of the shaft 20 is made impossible because the member 46 cannot be swung upward to throw the toe 61 downward, so as to permit the toe 66 to engage with the hook on the member 62, because the end of the member 46 is directly beneath the handle 39. The operator, however, by throwing the handle to the left of Fig. 4 will automatically move the member 46 to correct position by reason of the contact of the cam 71 with the top of the handle 39. Then, the machine may be turned by hand, if necessary, so that the high portion 508 will first swing the member 46 unnecessarily high, and when the toe 461 drops past the portion 507, the machine is in position again to resume its cycle. At this time the toe 61 is sufficiently far below the member 62 to permit the driving clutch to be engaged to begin the rotation of the shaft 20.

In practice, with the parts in the position shown in Fig. 3, the follower plate is first moved to the left of Fig. 2 by means of the handle 27, and locked in position, the spring 32 permitting this locking, even when the holes in the plate 31 are not opposite the pins on the plate 23. The plate 31 may be turned until its holes coincide with these pins. Then the wire is led in over suitable guide rolls as 81, 82 and around the pins on the plate 23, the rotation of the former 23 and with it the follower plate 31, being commenced by throwing in the driving clutch. After the predetermined number of turns have been made on the primary former, which number of turns is determined, of course, by the length of the concentric portion 501, the end of such concentric portion is reached, and the member 46 turned to permit the plate 35 to move against the plate 23 to project its pins across the operative space. Since the turning of the shaft 20 is continuous, the winding thereupon is passed around the pins 351, 352, 353 and 354. When the plate 35 moves forward the plate 36 also moves forward, but since it is stopped so as to maintain the same relative position to the plate 36 which it had before, its pins do not project across the operative space until the next motion of the member 46. When this projection takes place the wire in turn is passed around the outermost pins of the second secondary former. When the winding has been completed and the machine brought to a stop automatically by a further motion of the member 46, the operator preferably places temporary fasteners around the top and bottom of the winding, and to permit this to be done I provide recesses 83, 84 in the plate 23, and corresponding recesses in the follower 31, these recesses permitting the temporary fastening wire to be passed around the coils. After the coils are thus fastened, the follower plate 31 is moved to the right of Fig. 2 and the completed winding slipped from the pins. If desired, the plates may be restored to the position shown in Fig. 3, which has the effect of withdrawing the pins of the outer coils from those coils.

In order to guide the handle 39 I provide a guide 85 which is simply a horizontal member having a horizontal slot bearing against the top and bottom of the handle 39, this guide being cut away at one end to provide clearance for the plate 36.

I provide the friction drive for the cam 50 so that if, because of carelessness on the part of the operator, the shaft 20 is turned before the handle 39 is brought to the neutral position shown in Fig. 4, after a winding has been completed, there will not be a jamming of the parts. In such case the friction slips. When, however, the jam is relieved the cam 50 may be returned to its proper initial position by relieving the friction and then restoring it, the handle 509 being used, if desired, to turn the cam.

It will be understood that the construction of my illustrative form of mechanism may be varied within wide limits. It will be also understood that the construction of the formers will be dependent on the shape and dimensions of the winding to be formed. While I prefer to use pins as the operative portion of the former, it will be understood that any other supporting means for the coil being wound, may be used.

It will also be understood that the number of secondary or movable formers will be dependent on the number of successive coils to be formed, and that the numbers of such formers, which can be arranged to be moved into operative position successively, is substantially without number.

I claim:—

1. In a coil winding machine, a plurality of unitary forms of progressively increasing area, with the smallest form only in operative position, means to rotate the forms and means to move each form as a unit into operative position.

2. In a coil winding machine, a plurality of forms of progressively increasing area, with the smallest form only in operative position, means to rotate the forms and means to move the forms progressively into operative position, and a follower adapted

to be moved toward and away from said forms.

3. In a coil winding machine, a plurality of forms of progressively increasing area, with the smallest form only in operative position, means to rotate the forms and automatic means to move the forms progressively into operative position.

4. In a coil winding machine, a plurality of forms of progressively increasing area, each comprising a plate with four pins projecting therefrom and the plates being arranged side by side, each plate of the smaller forms having openings through which the pins of the next adjacent form may pass and means to move said plates together to bring each set of pins progressively into operative position.

5. In a coil winding machine, a plurality of forms of progressively increasing area, each comprising a plate with four pins projecting therefrom and the plates being arranged side by side, each plate of the smaller forms having openings through which the pins of the next adjacent form may pass and means to move said plates together to bring each set of pins progressively into operative position, and a follower plate having openings adapted to receive the ends of all of said pins and arranged to be moved toward and away from said forms.

6. In a coil winding machine, a first form comprising a plate and a plurality of pins projecting therefrom, a second form comprising a plate parallel to the plate of the first form and having a plurality of pins projecting therefrom normally out of the plane of the pins of the first form and located so as to bound an area larger than the area of the first form, the plate of the first form being adapted to permit the pins of the second form to pass into the plane of the pins of the first form, means to rotate said forms and means to move the second form into the plane of the pins of the first form.

7. In a coil winding machine, a first form comprising a plate and a plurality of pins projecting therefrom, a second form comprising a plate parallel to the plate of the first form and having a plurality of pins projecting therefrom normally out of the plane of the pins of the first form and located so as to bound an area larger than the area of the first form, the plate of the first form being adapted to permit the pins of the second form to pass into the plane of the pins of the first form, means to rotate said forms and automatic means to move the second form into the plane of the pins of the first form.

8. In a coil winding machine, a plurality of forms of progressively increasing area with the smallest form only normally in operative position, means to rotate said forms, springs arranged to move said forms into operative position, a member arranged to restrain said springs and a cam connected to said rotating means and arranged to permit said forms to move successively into operative position after a predetermined number of rotations of each form.

9. In a coil winding machine, a plurality of forms of progressively increasing area with the smallest form only normally in operative position, means to rotate said forms, springs arranged to move said forms into operative position, a member arranged to restrain said springs and a cam connected to said rotating means and arranged to permit said forms to move successively into operative position after a predetermined number of rotations of each form, and a follower adapted to move toward and away from the front of the form which is in operative position.

10. In a coil winding machine, a plurality of forms of progressively increasing area with the smallest form only normally in operative position, means to rotate said forms, springs arranged to move said forms into operative position, a member arranged to restrain said springs and a cam connected to said rotating means and arranged to permit said forms to move successively into operative position after a predetermined number of rotations of each form, and automatic means to stop said rotating means after the last form has turned a predetermined number of times when in operative position.

11. In a coil winding machine, a plurality of forms of progressively increasing area with the smallest form only normally in operative position, means to rotate said forms, and automatic means to move said forms successively into operative position after the preceding form has been rotated a predetermined number of times.

12. In a coil winding machine, a plurality of forms of progressively increasing area with the smallest form only normally in operative position, means to rotate said forms, and automatic means to move said forms successively into operative position after the preceding form has been rotated a predetermined number of times, and automatic means to stop the rotation of the forms after the last form has been rotated a predetermined number of times when in operative position.

13. In a coil winding machine, a primary form comprising a plate having a plurality of pins extending from the face thereof, a follower arranged to be moved toward and away from said plate and to be held spaced therefrom to form an operating space therebetween with the pins extending across said space, a secondary form comprising a set of pins parallel with the pins of the primary form and normally out of said oper-

ating space, and arranged to bound an area larger than the area bounded by the pins of the primary form, means to rotate said forms and said follower together and means to move the pins of said secondary form across said operating space.

14. In a coil winding machine, a primary form comprising a plate having a plurality of pins extending from the face thereof, a follower arranged to be moved toward and away from said plate and to be held spaced therefrom to form an operating space therebetween with the pins extending across said space, a secondary form comprising a set of pins parallel with the pins of the primary form and normally out of said operating space and arranged to bound an area larger than the area bounded by the pins of the primary form, means to rotate said forms and said follower together and means to move the pins of said secondary form across said operating space while said forms are rotating.

15. In a coil winding machine, a primary form comprising a plate having a plurality of pins extending from the face thereof, a follower arranged to be moved toward and away from said plate and to be held spaced therefrom to form an operating space therebetween with the pins extending across said space, a secondary form comprising a set of pins parallel with the pins of the primary form and normally out of said operating space and arranged to bound an area larger than the area bounded by the pins of the primary form, means to rotate said forms and said follower together and automatic means to move the pins of said secondary form across said operating space while said forms are rotating and after the primary form has made a predetermined number of rotations.

16. In a coil winding machine, a primary form comprising a plate having a plurality of pins extending from the face thereof, a follower arranged to be moved toward and away from said plate and to be held spaced therefrom to form an operating space therebetween with the pins extending across said space, a secondary form comprising a set of pins parallel with the pins of the primary form and normally out of said operating space and arranged to bound an area larger than the area bounded by the pins of the primary form, means to rotate said forms and said follower together, automatic means to move the pins of said secondary form across said operating space while said forms are rotating and after the primary form has made a predetermined number of rotations and automatic means to stop the rotation of said forms after a predetermined number of turns of the last form to be moved into operative position.

17. In a coil winding machine, a primary form comprising a plate having a plurality of pins extending from the face thereof, a follower arranged to be moved toward and away from said plate and to be held spaced therefrom to form an operating space therebetween with the pins extending across said space, a secondary form comprising a set of pins parallel with the pins of the primary form and normally out of said operating space and arranged to bound an area larger than the area bounded by the pins of the primary form, means to rotate said forms and said follower together, automatic means to move the pins of said secondary form across said operating space while said forms are rotating and after the primary form has made a predetermined number of rotations and automatic means to stop the rotation of said forms after a predetermined number of turns of the last form to be moved into operative position, and means whereby said secondary form may be returned to normal position.

18. In a coil winding machine, a primary form comprising a plate having a plurality of pins extending from the face thereof, a follower arranged to be moved toward and away from said plate and to be held spaced therefrom to form an operating space therebetween with the pins extending across said space, a secondary form comprising a set of pins parallel with the pins of the primary form and normally out of said operating space and arranged to bound an area larger than the area bounded by the pins of the primary form, means to rotate said forms and said follower together, automatic means to move the pins of said secondary form across said operating space while said forms are rotating and after the primary form has made a predetermined number of rotations and automatic means to stop the rotation of said forms after a predetermined number of turns of the last form to be moved into operative position, said automatic stopping means being adapted to prevent further rotation of said forms until said secondary form has been returned to normal position.

19. In a coil winding machine, a primary form comprising a plate having a plurality of pins extending from the face thereof, a follower arranged to be moved toward and away from said plate and to be held spaced therefrom to form an operating space therebetween with the pins extending across said space, a plurality of secondary forms each having a set of pins parallel with the pins of the primary form, the pins of the form next the primary form bounding an area larger than the area bounded by the pins of the primary form and the pins of each successive form bounding an area larger than the area bounded by the pins of the form next adjacent toward the primary form, a follower plate adapted to be moved toward

and away from the plate of the primary form and arranged to be held spaced therefrom to form an operating space therebetween, means to rotate said forms and said follower, and means to move the pins of each form successively across said operating space.

20. In a coil winding machine, a primary form comprising a plate having a plurality of pins extending from the face thereof, a follower arranged to be moved toward and away from said plate and to be held spaced therefrom to form an operating space therebetween with the pins extending across said space, a plurality of secondary forms each having a set of pins parallel with the pins of the primary form, the pins of the form next the primary form bounding an area larger than the area bounded by the pins of the primary form and the pins of each successive form bounding an area larger than the area bounded by the pins of the form next adjacent toward the primary form, a follower plate adapted to be moved toward and away from the plate of the primary form and arranged to be held spaced therefrom to form an operating space therebetween, means to rotate said forms and said follower, and automatic means to move the pins of each form successively across said operating space after the preceding form has made a predetermined number of turns when in operative position.

21. In a coil winding machine, a primary form comprising a plate having a plurality of pins extending from the face thereof, a follower arranged to be moved toward and away from said plate and to be held spaced therefrom to form an operating space therebetween with the pins extending across said space, a plurality of secondary forms each having a set of pins parallel with the pins of the primary form, the pins of the form next the primary form bounding an area larger than the area bounded by the pins of the primary form and the pins of each successive form bounding an area larger than the area bounded by the pins of the form next adjacent toward the primary form, a follower plate adapted to be moved toward and away from the plate of the primary form and arranged to be held spaced therefrom to form an operating space therebetween, means to rotate said forms and said follower, and automatic means to move the pins of each form successively across said operating space after the preceding form has made a predetermined number of turns when in operative position, and automatic means to stop the rotation of said forms after the last form has made its predetermined number of rotations when in operative position.

22. In a coil winding machine, a primary form comprising a plate having a plurality of pins extending from the face thereof, a follower arranged to be moved toward and away from said plate and to be held spaced therefrom to form an operating space therebetween with the pins extending across said space, a plurality of secondary forms each having a set of pins parallel with the pins of the primary form, the pins of the form next the primary form bounding an area larger than the area bounded by the pins of the primary form and the pins of each successive form bounding an area larger than the area bounded by the pins of the form next adjacent toward the primary form, a follower plate adapted to be moved toward and away from the plate of the primary form and arranged to be held spaced therefrom to form an operating space therebetween, means to rotate said forms and said follower, and automatic means to move the pins of each form successively across said operating space after the preceding form has made a predetermined number of turns when in operative position, said means comprising springs arranged to move said secondary forms into operative position, a member to restrain said springs and a cam rotated in unison with said forms and adapted to operate said member to permit said springs to move said secondary forms successively into operative position after a predetermined number of turns of each preceding form.

23. In a coil winding machine, a primary form comprising a plate having a plurality of pins extending from the face thereof, a follower arranged to be moved toward and away from said plate and to be held spaced therefrom to form an operating space therebetween with the pins extending across said space, a plurality of secondary forms each having a set of pins parallel with the pins of the primary form, the pins of the form next the primary form bounding an area larger than the area bounded by the pins of the primary form and the pins of each successive form bounding an area larger than the area bounded by the pins of the form next adjacent toward the primary form, a follower plate adapted to be moved toward and away from the plate of the primary form and arranged to be held spaced therefrom to form an operating space therebetween, means to rotate said forms and said follower, and automatic means to move the pins of each form successively across said operating space after the preceding form has made a predetermined number of turns when in operative position, said means comprising springs arranged to move said secondary forms into operative position, a member to restrain said springs and a cam rotated in unison with said forms and adapted to operate said member to permit said springs to move said secondary forms successively into operative position after a

predetermined number of turns of each preceding form, said member being adapted to stop the rotation of said forms after the last form has made its predetermined number of rotations when in operative position.

24. In a coil winding machine, a primary form comprising a plate having a plurality of pins extending from the face thereof, a follower arranged to be moved toward and away from said plate and to be held spaced therefrom to form an operating space therebetween with the pins extending across said space, a plurality of secondary forms each having a set of pins parallel with the pins of the primary form, the pins of the form next the primary form bounding an area larger than the area bounded by the pins of the primary form and the pins of each successive form bounding an area larger than the area bounded by the pins of the form next adjacent toward the primary form, a follower plate adapted to be moved toward and away from the plate of the primary form and arranged to be held spaced therefrom to form an operating space therebetween, means to rotate said forms and said follower, and automatic means to move the pins of each form successively across said operating space after the preceding form has made a predetermined number of turns when in operative position, said means comprising springs arranged to move said secondary forms into operative position, a member to restrain said springs and a cam rotated in unison with said forms and adapted to operate said member to permit said springs to move said secondary forms successively into operative position after a predetermined number of turns of each preceding form, said member being adapted to stop the rotation of said forms after the last form has made its predetermined number of rotations when in operative position, and means whereby said secondary form may be returned to inoperative position.

25. In a coil winding machine, a primary form comprising a plate having a plurality of pins extending from the face thereof, a follower arranged to be moved toward and away from said plate and to be held spaced therefrom to form an operating space therebetween with the pins extending across said space, a plurality of secondary forms each having a set of pins parallel with the pins of the primary form, the pins of the form next the primary form bounding an area larger than the area bounded by the pins of the primary form and the pins of each successive form bounding an area larger than the area bounded by the pins of the form next adjacent toward the primary form, a follower plate adapted to be moved toward and away from the plate of the primary form and arranged to be held spaced therefrom to form an operating space therebetween, means to rotate said forms and said follower, and automatic means to move the pins of each form successively across said operating space after the preceding form has made a predetermined number of turns when in operative position, said means comprising springs arranged to move said secondary forms into operative position, a member to restrain said springs and a cam rotated in unison with said forms and adapted to operate said member to permit said springs to move said secondary forms successively into operative position after a predetermined number of turns of each preceding form, said member being adapted to stop the rotation of said forms after the last form has made its predetermined number of rotations when in operative position, and means whereby said secondary form may be returned to inoperative position, said member being arranged to prevent the further rotation of said forms until said secondary forms have been returned to inoperative position.

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