Nov. 17, 1931. L. H. ROLLER 1,832,427

METHOD OF AND MACHINE FOR WINDING FLAT SPIRAL COILS

Filed Oct. 6, 1927 3 Sheets-Sheet 1

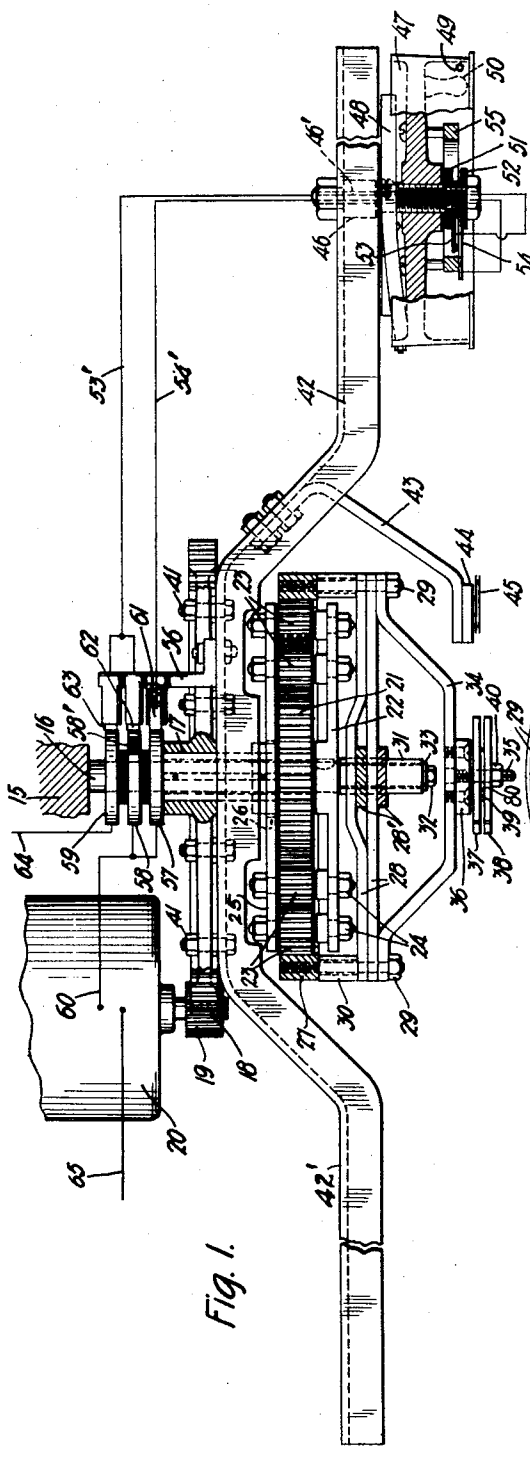


Fig. 1.

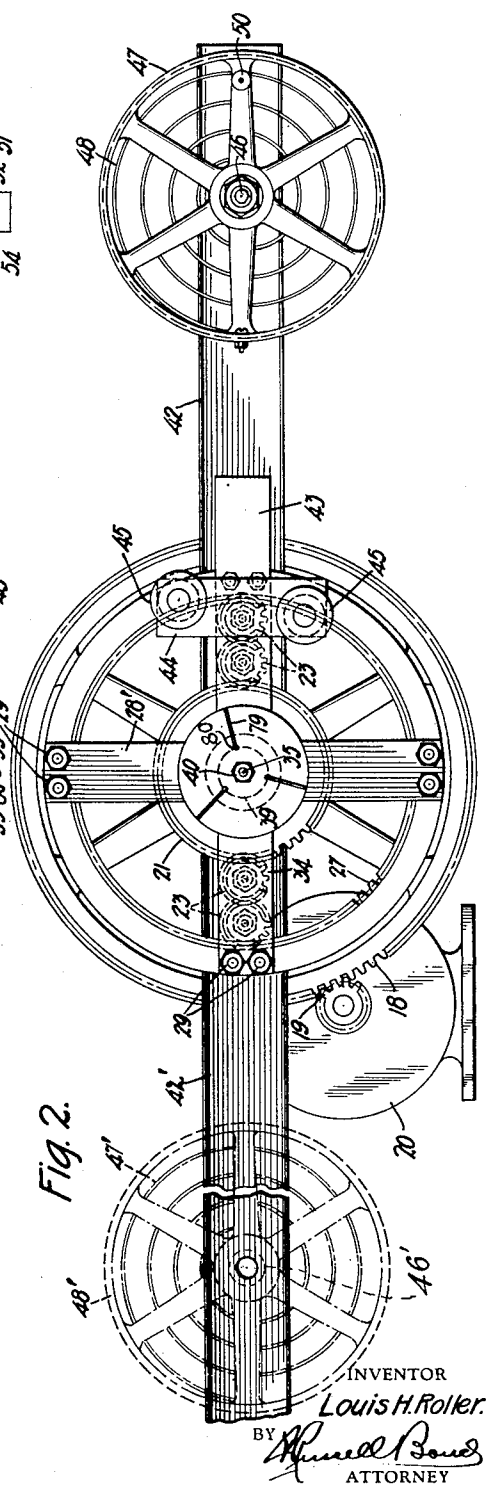


Fig. 2.

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Fig. 4.

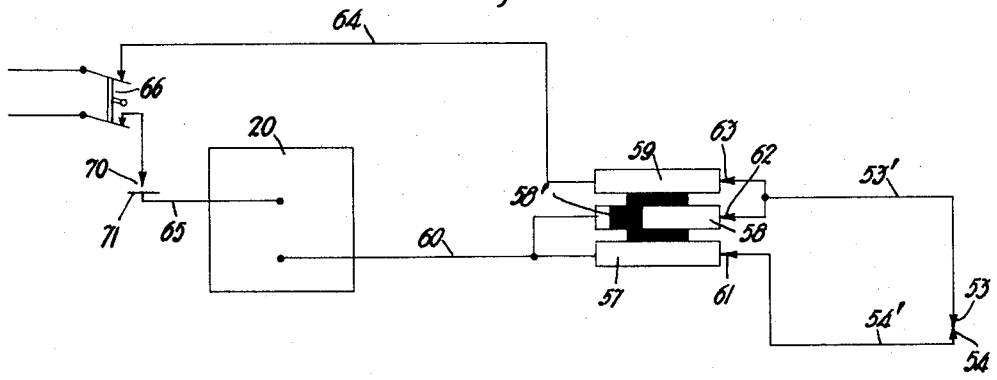
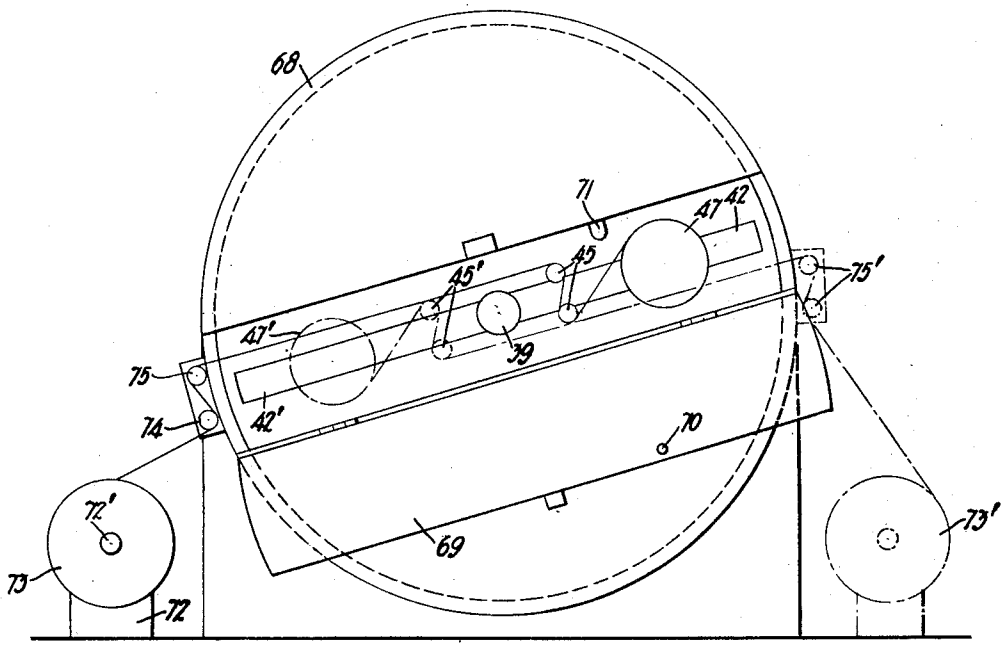


Fig. 3.



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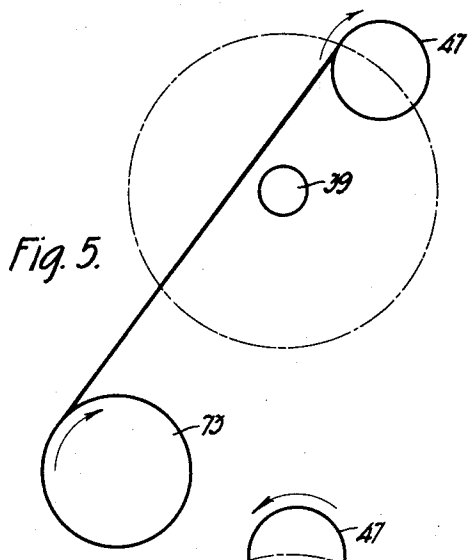


Fig. 5.

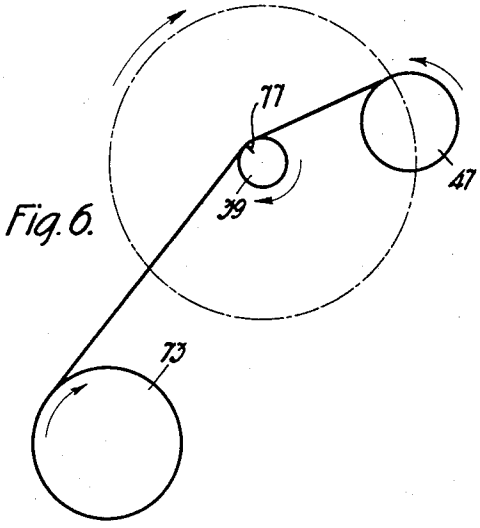


Fig. 6.

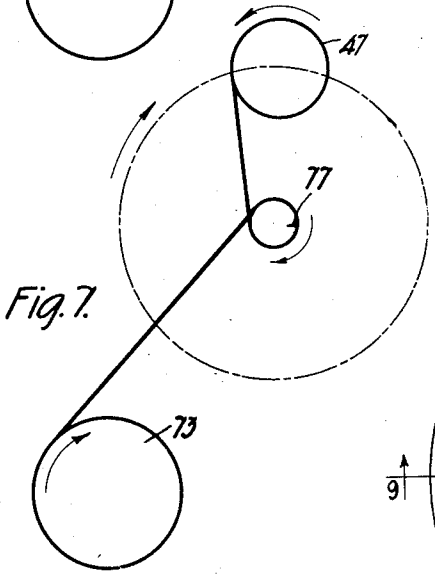


Fig. 7.

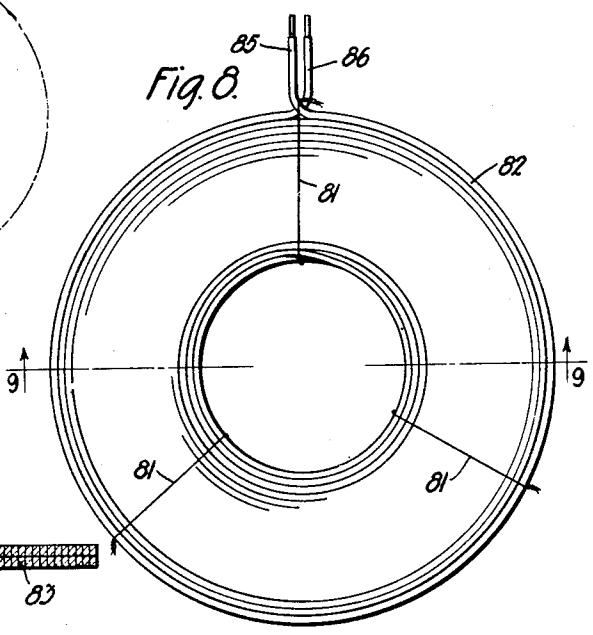


Fig. 8.

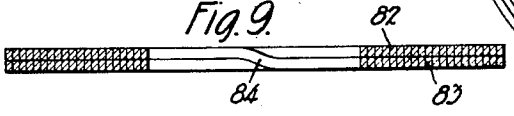


Fig. 9.

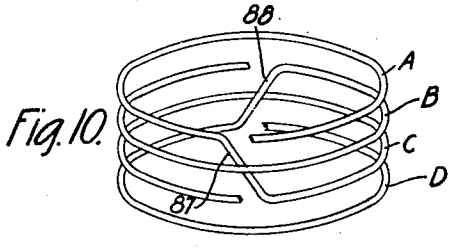


Fig. 10.

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Patented Nov. 17, 1931 1,832,427

UNITED STATES PATENT OFFICE

LOUIS H. ROLLER, OF WHITE PLAINS, NEW YORK

METHOD OF AND MACHINE FOR WINDING FLAT SPIRAL COILS

Application filed October 6, 1927. Serial No. 224,359.

My invention relates to a new type of flat spiral coil and to a method of and means for winding such a coil.

The advantages of using flat spiral or "pancake" coils in transformers, induction coils, and other electrical apparatus, are well recognized. However, there has been a drawback to the use of such coils in the fact that, as heretofore constructed, one of the leads has had to come from the inner periphery of the coil which makes an awkward and expensive assembly. It is an object of my invention to overcome this difficulty by providing double flat spiral coils which are integrally connected at their inner ends so that the two leads are disposed at the outer periphery of the coil. In other words, two flat spiral windings are formed of one continuous length of wire, with the same direction of winding throughout. An advantage of this construction lies in the fact that the leads are accessibly located, so that a series of such double coils will make a very compact assembly, and the coils may be conveniently connected together at a minimum of expense.

Another advantage of my improved coil is that it lends itself particularly to the use of wire of rectangular cross-section, so that the space factor of the coils is very high.

Another object of my invention is to provide a convenient method by which coils of this type may be wound.

Another object of my invention is to provide a machine in which both windings of the double coil are simultaneously wound and in which one of the windings is taken off an auxiliary spool which revolves about the axis of a bobbin or winding form at double the speed of rotation of said form.

With these and other objects in view which will appear hereinafter, I shall now describe a preferred form of machine for carrying out my improved method and winding my improved coils and shall thereafter define the novelty and scope of my invention in the claims.

In the accompanying drawings,

Figure 1 is a plan view of my improved winding machine with the housing of the machine removed and the main frame and certain parts partly broken away;

Fig. 2 is a side elevation of the same;

Fig. 3 is a somewhat diagrammatic side view of the complete machine housed and with the door of the housing open to show the normal position of the winding arm of the machine when at rest;

Fig. 4 is a diagram of electrical connections;

Figs. 5 to 7 inclusive are diagrammatic views, showing successive positions of the winding parts;

Fig. 8 is a side elevation of a double spiral coil wound on my improved machine;

Fig. 9 is a view in section taken on the line 9—9 of Fig. 8; and

Fig. 10 is a perspective view of a quadruple spiral coil showing only the first turn of each winding, with the windings spread open.

I have used the reference numeral 15 to indicate the main frame of my improved winding machine. Mounted in the body 15 is a fixed shaft 16 which provides a bearing for a driving sleeve 17. Fixed to the driving sleeve is a main driving gear 18 which meshes with a pinion 19. The latter may be fixed to the rotor shaft of a motor 20, as shown, or it may be indirectly connected with the motor by suitable reduction gearing. The driving sleeve 17 also carries a small driving gear 21 fixed thereto.

Secured to the shaft 16 outside of the driving gear 21 is a fixed arm 22 which carries two pairs of idler pinions 23. These idler pinions are mounted on studs 24 which at one end are supported in the fixed arm 22 and at the other end are supported by an arm 25. The latter is formed with a central bore 26 to clear the hub of the gear 21. The inner pinion of each pair of idlers meshes with the driving gear 21, while the outer pinion of each pair meshes with an internal gear 27 carried by a spider journalled on the fixed shaft 16. The spider may be of any suitable form but is here shown as composed of two pairs of arms 28 and 28′ crossing at right angles at the center of the spider and, at their outer ends, carrying bolts 29 which are threaded into the face of the internal gear

27. Suitable spacers 30 are provided on each bolt to space the spider arms 28 and 28′ from the gear 27 so as to provide clearance for the arm 22 and the forward ends of the studs 24. The spider arms 28 and 28′ are secured to a central sleeve 31 which turns freely on a reduced outer portion of the main shaft 16. A nut 32 and washer 33 on the end of the shaft 16 serve to hold the sleeve 31 on said shaft.

The bolts 29 on the arms 28 serve also to anchor to the spider the opposite ends of an arched bracket arm 34. This bracket is of such form as to clear the forward end of the shaft 16. Threaded into the bracket 34 and in axial alinement with the shaft 16, is a stud 35 which carries a bobbin or winding form. The bracket 34 may be reinforced with a bearing member 36 to provide a substantial support for the stud 35. The bobbin consists of two flanges or disks 37 and 38 which are spaced apart by a smaller disk 39, the latter constituting the body of the bobbin. The three disks are clamped together on the stud and against the member 36 by means of a nut 40 threaded on the stud and bearing against the outer flange 38.

Secured to the driving gear 18 by means of bolts 41 is an arm 42 which projects considerably beyond the periphery of the main driving gear 18 and is bent forwardly, as shown in Fig. 1, so that its outer end lies approximately in the plane of the spider. Fastened to this arm is a bracket 43 on which is secured a plate 44. Journalled on this plate are two tension pulleys 45, one being placed preferably above the other. The tension pulleys lie approximately in the plane of the rear flange 37 of the winding form.

Fixed on the outer end of the arm 42 is a stud 46 formed with an axial bore 46′. This stud projects forwardly and is externally threaded to receive the internally threaded hub of an auxiliary winding spool 47. A coil spring 48 is connected at one end to the spool 47 and at the other end to the stud. The spool is formed with an aperture 49 to provide an anchorage for one end of the wire which is to be wound upon the bobbin. A handle 50 on the spool permits of turning the latter by hand.

Fixed upon the forward end of the stud 46 are two plates of insulating material 51 and 52 which carry contact springs 53 and 54 respectively. The spring 54, projects beyond the spring 53 and is adapted to be engaged by a ring 55 carried by the spool 47. Normally the contacts 53 and 54 are in engagement, but when the spool has made a predetermined number of turns in counter-clockwise direction, it is fed outward by its threaded engagement with the stud 46, far enough to cause the ring 55 to force the contact member 54 clear of the contact member 53, thereby breaking an electric circuit. Wires from the contact members 53 and 54 pass through the bore 46′ in the stud 46 and lead to brushes which engage collector rings fixed to the shaft 16. The brushes are supported in a brush holder 56 which is carried by the arm 42. There are three collector rings 57, 58 and 59 fixed to the shaft 16. The ring 58 is formed with a segment 58′ of insulation material, the purpose of which will be explained presently.

The electrical connections are clearly shown in Fig. 4. One terminal of the motor 20 is connected by a lead 60 to the collector rings 57 and 58. Bearing against the collector ring 57 is a brush 61 which is connected by a wire 54′ to the contact spring 54. The contact spring 53 is connected by a conductor 53′ to two brushes 62 and 63 which bear respectively on the collector rings 58 and 59. The collector ring 59 is connected by a conductor 64 to one of a pair of power lines leading to a suitable source of electric current, so that current may flow to the motor from the line 64 by way of the collector ring 59 and brush 63, either through brush 62 and collector ring 58 or through contact members 53 and 54, brush 61 and collector ring 57, to the lead 60. The other terminal of the electric motor is connected by a wire 65, through a safety switch presently to be described, to the other of the pair of power lines above referred to. A double pole switch 66 in the lines 64 and 65 permits of turning the motor on or off.

As shown in Fig. 3, the machine is entirely enclosed by a housing 68 which is provided with a door 69. The latter is arranged on a slant from the horizontal, corresponding to the angle in which it is desired to have the winding arm lie when the machine is at rest. On the door frame there is a contact pin 70 which is adapted to engage a contact spring 71, so that when the door is closed these contacts are moved into engagement. The contacts 70 and 71 constitute the safety switch above referred to and when in engagement close the circuit of the motor through the conductor 65. Whenever the door 69 is opened the motor 20 is stopped by interruption of the supply of current thereto and danger of injury to the operator of the machine is thereby avoided. The only way in which the operator can start the machine is to close the door of the housing.

At the base of the machine outside of the housing there is a bracket 72 supporting a shaft 72′ on which may be mounted a spool 73. From the latter, wire is reeled off to form the coils. The wire passes through an opening in one side of the housing and at this point is located a tension device consisting of a plate 74 on which are mounted two tension pulleys 75. These are similar in form to the tension pulleys 45 but are slightly advanced with respect to the pulleys 45, being located substantially in the plane of the forward flange 38 of the winding form, so that the wire fed

through these tension pulleys will clear the tension pulleys 45 and auxiliary winding spool 47 as the latter revolve about the shaft 16.

It will be observed from the description given above that the internal gear 27 is driven through the medium of the idler pinions 23 by the small driving gear 21 and in the same direction as said gear rotates. The parts are so proportioned, however, that the internal gear makes only one revolution to two revolutions of the main driving gear 18 which carries the winding arm 42.

The operation of my machine is as follows: assuming that the parts are in the position indicated in Fig. 3, the spool 47 is first turned counter-clockwise to tension the spring 48. Wire is then drawn from the main spool 73, over the bobbin, and to the auxiliary spool 47, where it is anchored by inserting the end of the wire in the aperture 49. The spool 47 is now turned clockwise to wind wire thereon from the main spool 73, until enough wire has been drawn off on the auxiliary spool to form one of the windings of the double coil. The position of the parts during the winding of wire on the auxiliary spool, is diagrammatically indicated in Fig. 5. A kink (as indicated at 84 in Fig. 9) is now formed in the wire at a point tangent to the bobbin or form and the wire is fitted between the flanges 37 and 38 against the body 39 of the form. The wire is then bent about the tension pulleys 45 and 47. The door of the housing is now closed, thereby completing the circuit through the motor 20 and starting the machine.

When the machine is actuated the arm 42 carries the auxiliary spool 47 about the winding form at double the speed of rotation of the winding form. Fig. 6 shows the position of the parts just after the machine has started to wind and, for purposes of reference, a point 77 is indicated on the bobbin body 39 to show where the kink in the wire first comes into contact with the bobbin body. Referring now to Fig. 7, it will be observed that the point 77 has moved through an angle of approximately 150 degrees while the spool 47 has moved through an angle of 300 degrees. But the wire laid on the bobbin 39 from the auxiliary spool 47 is exactly equal to that laid on the bobbin from the main spool 73. Thus for each turn of the bobbin one turn will be taken off the main spool and another turn of wire will be taken off the auxiliary spool which has a planetary movement about the bobbin.

As the spool 47 revolves, it is also rotated counter-clockwise against the tension of the spring 48, by the wire being wound on the bobbin. The parts are so arranged that when a proper amount of wire has been taken off the auxiliary spool to complete the winding of a coil, the spool will have been fed forward by its threaded engagement with the stud 46, sufficiently to press the contact spring 54 clear of the contact spring 53, thereby breaking the circuit to the motor through the collector ring 57. It is desirable, however, that the parts stop in the position indicated in Fig. 3 where the auxiliary spool 47 will be conveniently accessible when the door of the housing is opened, and where the wire leading from the main spool 73 to the auxiliary spool 47 will lie approximately tangent to the winding form when the machine is to be started. It is to insure stopping of the arm at this angle that the collector ring 58 is provided. This ring, as will be seen by referring to Fig. 4, provides a shunt across the contact points 53 and 54. The segment of insulation 58′, in the ring 58, interrupts the current through the shunt, at each revolution of the brush 62 about said ring, but the current to the motor is maintained through the contact points 53 and 54. When, however, the spool 47 has been fed forward on the shaft 46 sufficiently to break the circuit through these contact members, the motor will be stopped at the next succeeding break in the shunt circuit effected by the insulating segment 58′, and the position of the latter is such that the winding arm 42 will stop at the angle indicated in Fig. 3.

It will be noted from Fig. 1 that flanges 37 and 38 are formed with radial slots 79 which communicate with transverse grooves 80 formed in the body of the bobbin. After the machine is automatically stopped the operator opens the door of the housing and binds the double coil formed on the bobbin, by passing flexible members, such as thin copper wire, through the slots and grooves and binding the ends of the flexible members about the coils, as indicated at 81 in Fig. 8. The operator now unscrews the nut 40 and removes the flanges 38, upon which the coil may be slipped off the bobbin.

In practice two machines may be served by a single operator, so that while one machine is winding, the operator may be removing the coil from the other machine and preparing it for winding another coil.

As shown in Figs. 8 and 9, the coil consists of two flat spiral windings 82 and 83, arranged side by side, integrally connected at their inner ends, both coiled in the same direction, and each terminating in a lead at the outer periphery of the coil.

The kink 84 shows where the two windings are integrally joined, while the two terminal leads 85 and 86 of the double coil lie on the outer periphery of the coil.

With a coil of this sort wire of rectangular cross-section may be used to advantage, with the result that the cross section of metal with respect to that of insulating material is much higher than if round wire were used. However, my invention is not confined to the use

of wire of rectangular cross-section but could also be used with wire of circular cross-section. The coils are so evenly wound that there is no objection to using round wire. It will be noted that the tension of the wire as it is being wound from the main supply spool on one hand and the auxiliary spool on the other hand, is uniform throughout. The machine is adapted for winding coils of various sizes, it being merely necessary to change the winding form correspondingly. Bobbin bodies 39 of different thickness may be employed to accommodate wires of different gage.

In addition to winding double coils my winding machine is capable of winding a quadruple coil, i. e. a coil made up of two interlocked double coils. To provide for this, the arm 42 is provided with a diametrically opposed extension 42′ on which is mounted a spool 47′ as indicated by dotted lines in Figs. 2 and 3. The spool 47′ is mounted on a stud 46′ fixed in the extension 42′, and a spring 48′ is anchored at one end to the spool and at the other end to the stud. A pair of tension pulleys 45′ (Fig. 3) similar to the pulleys 45 may be carried by the extension 42.

A second main spool 73′ is suitably journalled at the opposite side of the machine from the spool 73 and wire from the spool 73′ is led about tension wheels 75′ mounted on the housing, under the winding bobbin about the tension wheels 45′ and to the auxiliary spool 47′. With the parts in the position indicated in Fig. 3 a kink is formed in the wire above the bobbin and also in the wire below the bobbin. The tension wheels 45′ and 75′ may be set slightly in advance of the wheels 45 and 75 respectively so that when the machine starts winding, the first full turn of the bobbin will cause the windings to assume the form shown in Fig. 10. It will be understood of course that for purposes of illustration the windings are shown as laterally spaced, whereas in actual fact the turns will be laterally in contact. Continued operation of the machine will result in a coil made up of four parallel flat spiral windings indicated as A, B, C, and D, of which the windings A and C are integrally connected at the inner periphery of the coil as are B and D at the opposite side of the inner periphery. At the outer periphery there will be four terminal leads, one from each winding, which may be interconnected or connected to other electrical parts in any manner desired. There will be only two crossings of wire, namely: at the diametrically opposite points where the kink 87 from winding A to C is traversed by a turn of winding B, and where the kink 88 from winding B to D is traversed by a turn of winding C.

If desired the coils may be impregnated with "bakelite" or similar phenol condensation material and baked to produce a solid disk inseparably binding the windings together.

While the winding machine described above represents a preferred embodiment of my invention, it will be obvious that various changes in form, structure and arrangements of parts may be made without departing from the spirit and scope of my invention. What I claim and desire to secure by Letters Patent is:

1. In a machine for winding flat spiral coils, a form, an arm revoluble relatively to the form, a stud fixed on the arm, a reel having threaded engagement with the stud and adapted to carry a coil of wire, means for revolving the arm to draw wire from the reel and wrap the wire on the form whereby the reel will be rotated and fed axially on the stud, and means for interrupting operation of the machine after the reel has moved axially to a predetermined point.

2. In a machine for winding flat spiral coils, a form, an arm revoluble about the form, an electric motor adapted to actuate the arm, a reel carried by the arm for feeding wire to the form, a normally closed switch in the circuit of the motor and adapted to be opened when the reel has been moved to a predetermined point, a shunt across said switch, and means for interrupting said shunt at each rotation of the arm.

3. In a machine for winding flat spiral coils, a form, an arm revoluble about the form, an electric motor adapted to actuate the arm, an electric circuit therefor, a reel carried by the arm for feeding wire to the form, a normally closed switch in the circuit of the motor and adapted to be opened when the reel has been moved to a predetermined point, a shunt across said switch, means for interrupting said shunt at each rotation of the arm, a housing for the machine, a door in the housing, and a second switch in the circuit of the motor controlled by opening and closing of the door.

4. In a method of winding double flat spiral coils from a single wire the steps which consist in applying the wire to a form intermediate two parts thereof, rotating the form to coil one of said parts thereon, rotating the other wire part about the form in the same direction as that of the form but at a higher angular velocity than that of the form to coil the latter wire part thereon.

5. In a method of winding double flat spiral coils from a single wire the steps which consist in forming a kink in the wire intermediate its ends so that one portion of the wire will be offset with respect to the other, applying the kink to a form, rotating the form to coil one portion of the wire in a flat spiral thereon, and revolving the other portion of the wire about the form in the direction of rotation of the form but at double the angular velocity of the form so as to wrap

said other portion of the wire on the form in a flat spiral parallel to the first mentioned spiral.

6. In the method of winding coils comprising a plurality of interlocked flat spiral windings, the steps which consist in applying a pair of wires to a form intermediate their ends, laterally kinking each wire at such points of application so that the portions of the two wires at one side of the kinks will lie in planes parallel to but outside the planes of the wire portions at the other side of the kinks, rotating the form to wind up one portion of each wire thereon, and revolving the other portion of the wire about the form in the direction of rotation of the form but at double the angular velocity thereof to wrap the other portion of each wire thereon.

7. In a machine for winding two strands on the same bobbin, a guide for each strand, a bobbin, means for rotating the bobbin relatively to one of the guides, to wind one of the strands on the bobbin, and means for revolving the other of the guides about the bobbin to wind the other strand on the bobbin.

8. In a machine for winding two strands on the same bobbin, a guide for each strand, one of the guides being fixed and the other revoluble, a bobbin, means for rotating the bobbin relatively to the fixed guide to wind one of the strands on the bobbin, and means for revolving the revoluble guide about the bobbin to wind the other strand on the bobbin, the fixed guide being located without the plane of revolution of the revoluble guide.

9. In a strand winding machine, a bobbin adapted to engage a strand intermediate two portions thereof, means for rotating the bobbin to wind thereon one of said portions, and means for carrying the other of said portions about the bobbin in the direction of rotation of the bobbin but at a higher angular speed so as to wind said other portion on the bobbin.

10. In a strand winding machine, a bobbin adapted to engage a strand intermediate two portions thereof, a fixed guide for one of the strand portions, a revoluble guide for the other of the strand portions, means for rotating the bobbin to wind thereon a strand portion guided by the fixed guide, and means for revolving the revoluble guide about the bobbin in the direction of rotation of the bobbin but at double the angular speed thereof to wind the second strand portion about the bobbin.

11. In a machine for winding double wire coils, a reel carrying one portion of wire, an auxiliary reel carrying another portion of the wire, a bobbin adapted to engage the wire intermediate said reels, means for rotating the bobbin to wind wire thereon from the first named reel, and means for revolving the auxiliary reel about the bobbin in the direction of rotation of the bobbin but at a higher angular velocity so as to wind wire from the auxiliary reel on the bobbin.

12. In a machine for winding double wire coils, a reel carrying one portion of wire, an auxiliary reel carrying another portion of the wire, a bobbin adapted to engage the wire intermediate said reels, means for rotating the bobbin to wind wire thereon from the first named reel, means for revolving the auxiliary reel about the bobbin in the direction of rotation of the bobbin but at a higher angular velocity so as to wind wire from the auxiliary reel on the bobbin, and means for maintaining tension in each of the wire portions.

13. In a machine for coiling a wire intermediate its ends into a pair of contiguous flat spiral windings, a form on which the two windings are coiled, a fixed mounting for a spool from which a wire portion from one of the windings is drawn, a reel from which a wire portion of the other of the windings is drawn, a planetary mounting for said reel, means for rotating the form to coil one of the windings thereon, means for revolving the reel about the form in the direction of rotation of the form but at double the angular velocity thereof to coil the other winding on the form, and a coil spring connecting the reel and the planetary mounting thereof, said coil serving to resist rotation of the reel during revolution of the reel about the form.

14. In a machine for winding wire coils, an arm mounted to revolve about a fixed center, a bobbin mounted concentrically with the arm, a reel mounted on the arm near one end thereof whereby the reel will be revolved about the bobbin when the arm is revolved, means for revolving the arm, and means for rotating the bobbin in the direction of revolution of the arm but at half the angular velocity of the arm.

15. In a machine for winding wire coils, an arm mounted to revolve about a fixed center, a bobbin mounted concentrically with the arm, a reel mounted on the arm near one end thereof whereby the reel will be revolved about the bobbin when the arm is revolved, means for revolving the arm, means for rotating the bobbin in the direction of revolution of the arm but at half the angular velocity of the arm, a tension guide on the arm for guiding wire from the reel to the bobbin, and a fixed tension guide for guiding wire from a source of supply to the bobbin.

16. In a machine for winding wire coils, an arm mounted to revolve about a fixed center, a bobbin mounted concentrically with the arm, a reel mounted on the arm near one end thereof whereby the reel will be revolved about the bobbin when the arm is revolved, means for revolving the arm, means for rotating the bobbin in the direction of revolution of the arm but at half the angular velocity of the arm, a tension guide on the arm for guiding wire from the reel to the bobbin,

and a fixed tension guide for guiding wire from a source of supply to the bobbin, said two tension guides being mutually offset in the direction of the axis of the bobbin.

Signed at New York, in the county of New York and State of New York, this 5th day of October, A. D. 1927.

LOUIS H. ROLLER.