July 25, 1933. W. N. BRIGGS 1,919,928

COIL WINDING MACHINE

Filed Jan. 31, 1931 2 Sheets-Sheet 1

Fig. 1.

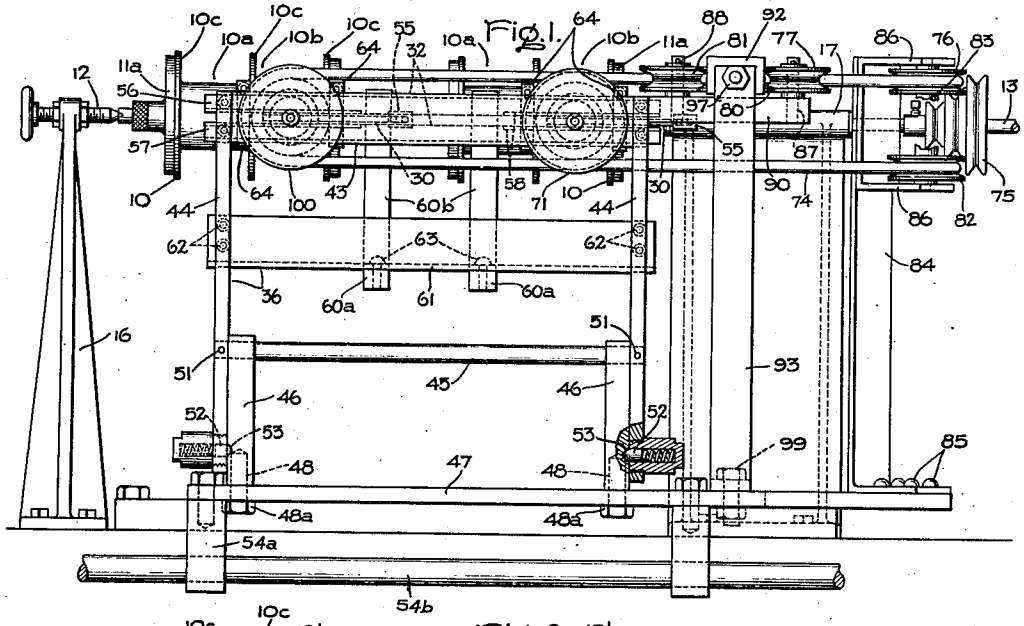


Fig. 2.

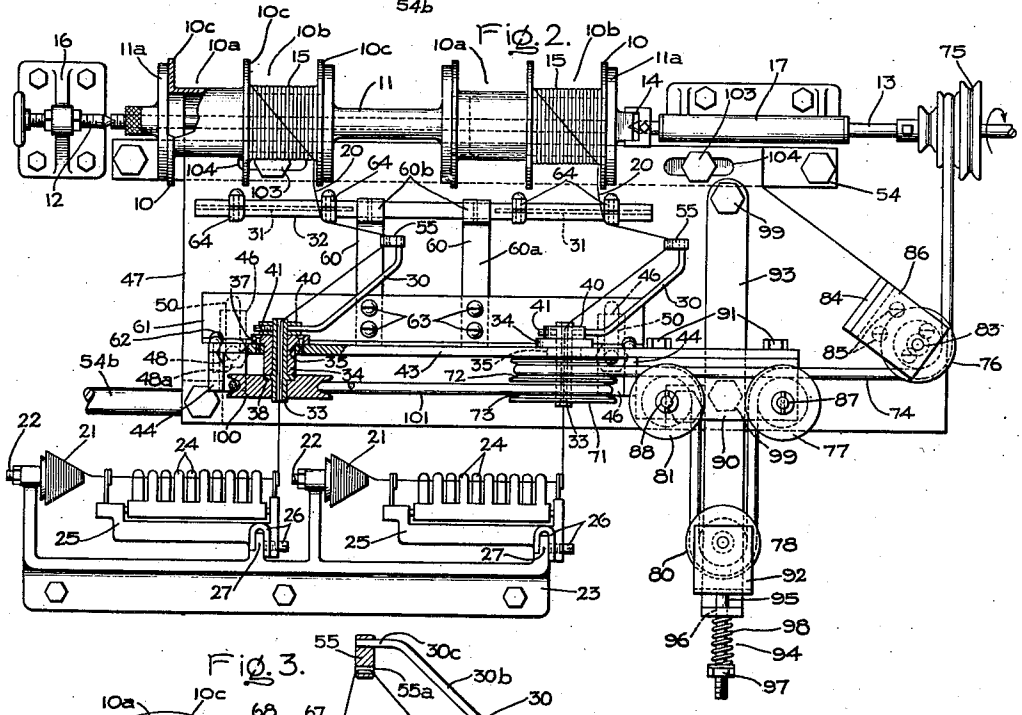
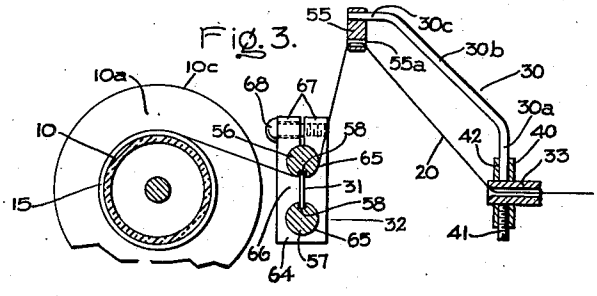


Fig. 3.



Inventor:
William N. Briggs,
by Charles R. Mullen
His Attorney.

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Fig. 4.

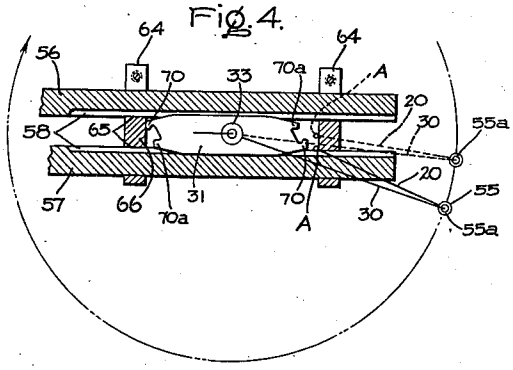


Fig. 5.

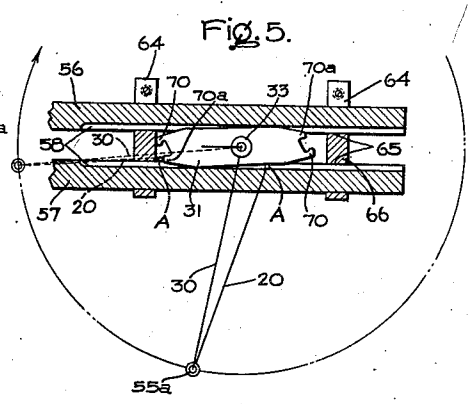


Fig. 6.

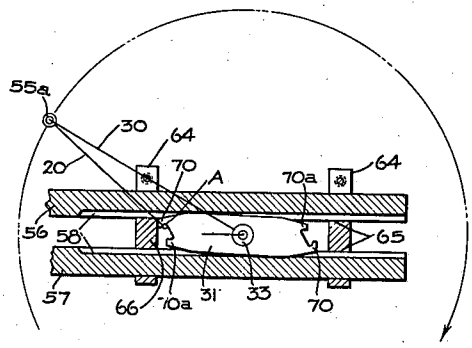


Fig. 7.

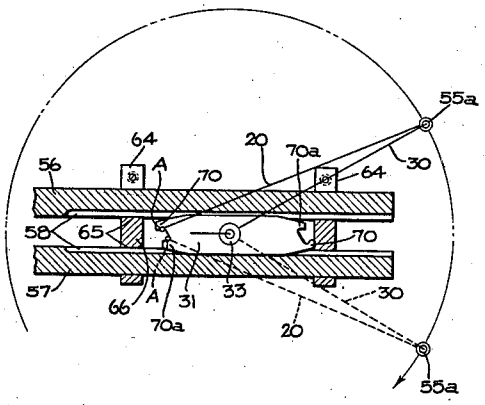
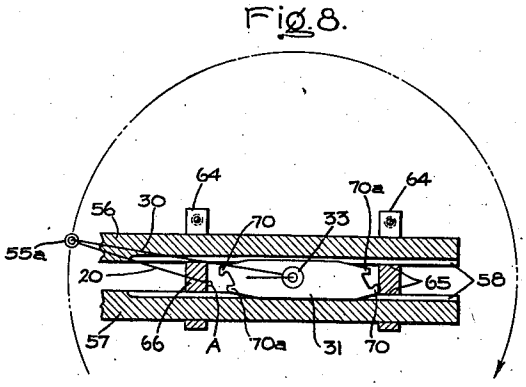


Fig. 8.



Inventor:
William N. Briggs,
by Charles R. Mullen
His Attorney.

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UNITED STATES PATENT OFFICE

WILLIAM N. BRIGGS, OF PITTSFIELD, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK

COIL WINDING MACHINE

Application filed January 31, 1931. Serial No. 512,663.

My invention relates to coil winding machines, more particularly to coil winding machines wherein layers of insulating material are deposited between the layers of wire or conductors as they are being wound to form a coil, and has for its object the provision of an improved coil winding machine of this character.

Although it is not limited thereto, my invention is particularly useful in connection with machines for winding transformer coils and the like.

When an electrical conductor is wound into a coil for use in such apparatus as transformers, for example, it is necessary to insulate the layers of the conductors from each other with great care; it is particularly important that ample insulation be provided between the end portions of the layers since it is in these portions that the highest potential in the winding occurs by reason of the fact that the electrical potential from layer to layer is proportional to the number of turns in each layer and also to the potential existing between each turn.

In order to insulate the layers of the coil, it is common to apply the insulating material to the winding spool concurrently with the electrical conductor so that a layer of the insulating material is deposited between each pair of adjacent conductor layers. In one arrangement for thus applying insulation to the coil, cotton thread or some similar insulating material is used to insulate the layers and is wound crosswise of the coil several times while one turn of the conductor is being wound on. In this manner the cotton thread forms insulating surfaces upon which the successive turns of the layer being wound on and the turns of the next succeeding layer are supported. Moreover, a layer of insulating thread is deposited between the successive turns forming each layer. It will be understood that the cotton thread thus applied serves both to insulate and to secure the electrical windings.

In one of its aspects my invention contemplates the provision of an improved coil winding machine whereby the insulating material is applied in layers throughout the full length of the coil and in relatively large amounts between the end turns of successive layers where the highest potential between the layers occurs.

In carrying out my invention in one form thereof, I provide suitable means for guiding the insulating thread to the winding spool so that the length of thread passed to the spool is caused to move through an intermittent closed path of motion arranged lengthwise of the spool whereby the thread is wound crosswise of the spool in a plurality of layers. The pauses in the motion of the length passed to the spool occur at the end portions of the spool so that relatively large amounts of the thread are deposited at these portions.

For a more complete understanding of my invention, reference should be had to the accompanying drawings in which Fig. 1 is an elevation of a portion of a winding machine embodying my invention; Fig. 2 is a plan view of the winding machine of Fig. 1, and illustrating certain auxiliary elements used in connection with the winding machine; Fig. 3 is a fragmentary view mainly in section of a portion of the winding machine of Figs. 1 and 2 and illustrating certain structural details, and Figs. 4, 5, 6, 7 and 8 are diagrammatic views illustrating the operation of certain elements of the winding machine of Figs. 1, 2 and 3.

Referring to the drawings, in one form of my invention the spools 10 on which the coils are to be wound are carried on a suitable arbor 11. For the purpose of illustration I have shown a winding arbor arranged to accommodate two spools, and further have shown each spool provided with two compartments 10*a* and 10*b* defined by suitable heads or flanges 10*c*; it is to be understood, however, that my invention is not limited to the winding of a plurality of spools of the character shown, but is equally as applicable to the winding of a single spool provided with either one or a plurality of compartments as it is to the winding of a plurality of spools, as shown, each having a plurality of compartments. The arbor 11 is supported on one end by means of an ad-

justable spindle 12 and is arranged to be mechanically connected at its opposite end with an operating shaft 13 by means of a suitable clutch 14 so that the spools can be rotated in order to wind electrical conductors 15 thereon in their respective compartments. As shown the spindle 12 is mounted in a suitable standard 16, while the operating shaft 13 is supported in a suitable bearing member 17. The arbor 11 is provided with removable head portions 11*a* so that the coils may be removed from the winding machine after they have been formed.

It will be understood that the electrical conductors 15 will be guided to the spools by means of suitable distributers or guiding means (not shown) so as to be wound thereon in a plurality of layers. One form of such a winding machine is described and claimed in the United States Patent No. 1,504,004, granted to J. J. Vienneau, dated August 5, 1924.

As has been pointed out in a previous portion of this specification, the successive turns of each layer and likewise the successive layers themselves will be insulated from each other by means of suitable cotton or like insulating layers or surfaces. For this purpose I prefer to insulate the winding by means of layers of insulating material formed by winding onto the spools simultaneously with the conductors, cotton threads 20 or some similar insulating material. Each cotton thread 20 preferably will be wound crosswise of its spool compartment a plurality of times while one turn of the conductor is being wound on and moreover, preferably will be deposited in relatively large amounts at the end portions of the layers where the highest potential in the winding occurs.

The insulating threads 20 are supplied from suitable reels or bobbins 21 (Fig. 2) which as shown are supported for rotary motion on spindles 22. These spindles in turn are mounted on a suitable supporting frame 23. This frame may be arranged in any suitable location, but preferably will be attached to the supporting framework (not shown) of the winding machine. The thread is passed from the bobbins 21 through suitable tensioning jaws 24 also mounted on the frame 23 and which may have any suitable well known preferred construction. The tensioning jaws 24 are mounted upon suitable frames 25 which are adjustably secured by means of suitable clamping devices 26 to upright portions 27 formed on and preferably integrally with the frame 23. From these tensioning jaws 24 the threads 20 are directed to suitable distributing and guiding means whereby the threads are applied to the spool portions being wound in a manner to provide the above-mentioned insulating layers.

The insulating thread guiding and distributing means comprises suitable rotatably mounted guiding arms 30, shuttles 31 and shuttle guide members 32.

The guiding arms 30 are mounted for rotation upon axes arranged substantially perpendicular to the longitudinal axes of the winding spools 10 and substantially midway of the lengths of the respective winding compartments in which the conductors 15 and insulating threads 20 are being wound, as for instance the compartments 10*b* of Figs. 1 and 2. Suitable spindles 33 mounted for rotary motion in bushings 34 are provided for rotatably supporting the arms 30. The bushings 34 as shown are received in suitable apertures 35 provided for them in a supporting framework 36 and are detachably secured to this framework by some suitable means, such for example as screw fastening means 37.

The spindles 33 are secured against lateral displacement in one direction by means of flanges or heads 38 preferably formed integrally with the spindles intermediate their ends so as to bear against the outer ends of the bushings 34, and are secured against lateral displacement in the opposite direction by means of collars 40 secured to their inner ends so as to bear against the inner ends of the bushings 34. These collars 40 may be secured to their respective spindles in any suitable manner, but preferably will be secured thereto by means of set screws 41.

The collars 40 perform the further function of supporting the guiding arms 30. As shown each collar is provided with a suitable hole or aperture 42 for receiving one end portion 30*a* (Fig. 3) of its associated arm 30. The arms were rigidly secured to the collars by any suitable means, as by brazing or soldering.

The framework 36 comprises a transverse plate 43 for supporting the bushings 34, a pair of upright column plate members 44 to the upper ends of which the transverse plate 43 is mechanically secured and a rodlike shaft member 45 secured to the columns intermediate their ends. This rodlike member 45 serves to pivotally mount the frame on two upright bearing arms 46 which are secured to a base plate 47 provided for the framework. As shown the bearing arms 46 are secured to the base plate 47 by means of suitable stud bolts 48 passed through elongated apertures 50 (Fig. 2) provided for them in the base plate and arranged with their longitudinal axes perpendicular to the axes of the spools so that the framework may be adjusted toward and away from the spools. It will be understood that the heads 48*a* provided on these stud bolts are sufficiently large to prevent the bolts from pulling through their apertures, and that the framework may be locked in any position

within the length of the apertures by tightening the stud bolts and may be shifted to a different position merely by unscrewing the bolts, moving the frame to the desired position and then tightening the bolts. It will also be understood that the upright column plates will be secured to the opposite ends of the shaft member 45 by any suitable means, such for example as by suitable pins 51.

It will be observed that by reason of the foregoing construction the framework 36 may be rotated as a unitary structure about the shaft 45. The framework, however, normally is located in a vertical position and is secured in this position by spring-pressed plunger members 52 on the lower ends of the columns 44 and normally received in recesses 53 provided for them in the adjacent faces of the associated bearing members 46. It is to be understood that while this locking arrangement will effectively lock the framework in its upright position during the normal operation of the machine, it is sufficiently yielding to allow the frame to be moved away from its upright position and to a position remote therefrom.

As shown, the base plate 47 is supported at its inner edge on a portion 54 of the frame of the winding machine, and at its outer edge is supported by means of suitable posts 54*a* slidably mounted on a rodlike member 54*b* arranged longitudinally of the machine and supported by any suitable means (not shown).

The body portions 30*b* (Fig. 3) of the guiding arms 30 are angularly disposed with respect to the secured end portions 30*a* of the arms and also with respect to their free end portions 30*c* so that the end portions 30*a* and 30*c* are disposed at an angle of 90° with respect to each other. On the free ends 30*c* of the arms are arranged eyelets 55, the eyes 55*a* of which are directed inwardly toward the axes of rotation of the arms; and as shown, the arms 30 are so proportioned that the eyelets move on a radius substantially greater than one-half of the length of the spool compartments being wound.

The lengths of threads passed to the winding spool from the tensioning jaws 24, it will be observed, are directed to the eyes 55*a* through the spindles 33 so that the thread portions passed through the eyes are caused to move in closed circular paths of motion, the centers of these paths being the axes of the spindles 33.

As shown, the shuttles 31 and the supporting frames 32 provided therefor are interposed between the planes of motion of the eyelets 55 and their respective winding spools 10. The shuttles 31 are mounted in their guide frames 32 so that they may float therein. In other words, the shuttles and guides are so proportioned relatively to each other that the shuttles can be moved in their frames both longitudinally and vertically for limited distances.

It will be observed (Figs. 4, 5, 6, 7 and 8) that the guides 32 provided for the shuttles 31 comprise suitable members 56 and 57 disposed one above the other in a vertical direction so as to receive the shuttles between them and that each is provided with guideways 58 for receiving the adjacent edge portions of the shuttles for reciprocatory motion therein and so that the shuttles are maintained in a substantially vertical position in the guides. For convenience of construction the shuttle guides 56 and 57 for the two shuttles provided for the machine are shown as unitary members (Fig. 2). In other words, the members 56 and 57 may be and as shown are formed from a suitable solid member which has its end portions slit or cut away to form pronglike or forked ends, these ends defining the upper and lower guide members 56 and 57. The central portion of this member is left solid and is supported on two standards 60 (Figs. 1 and 2) which have horizontally extending portions 60*a* and upright portions 60*b* to which latter portions the central portion of the guide member is secured. The horizontal portions 60*a* which are formed at substantially 90° with the upright portions 60*b* are secured to a suitable supporting plate 61 which in turn is secured to the column members 44 provided for the frame 36. This member 61 is shown to be of angular form, the upright portion of which is secured to the column members by means of screw fastening means 62 and the horizontal portion of which serves to support the member 60 by means of suitable screw fastening means 63.

The longitudinal limits of motion of the shuttles 31 are defined by suitable stop members 64. Each of these members as shown (Figs. 3, 4, 5, 6, 7 and 8) is provided with a pair of apertures 65 which are received by the upper and lower guide members 56 and 57 respectively so that the solid portion 66 left between the apertures is received between the guide members so as to define a stop for the shuttles. The members 64 are further provided with clamping jaw members 67 which may be drawn together so as to lock the stops on the guides by means of a suitable screw 68 passed freely through an aperture provided in one of the members, as for example, the left-hand member, as received in Fig. 3, and having a threaded engagement with the other member. It will be understood that by unscrewing these members 68 the stops 64 are released so that they may be moved longitudinally of the shuttle guides to suitable positions thereon after which they may be locked in their adjusted position by tightening up the screws 68.

The lengths of threads 20 passed from the eyelets 55 to the respective spools 10 are guided through the shuttle frames between the shuttle members and the frames. It will be observed that the shuttle frames 56 and 57 and the stop members 64 define closed paths of motion about the shuttle members for the lengths of thread passed therethrough.

It will also be observed that in view of the fact that the shuttle stops generally will be adjusted to positions substantially at the ends of the spool compartments which are being wound and in view of the fact that the eyelets 55 are moved on radii considerably greater than one-half of the lengths of the compartments being wound and also considerably greater than one-half of the distance between the guides 56 and 57 that as the guiding arms 30 are being rotated the portions of the lengths of thread which are passed through the shuttle frames will tend to move in their closed paths of motion defined by the shuttle guides and stops.

It is the function of the shuttles 31 to convert the continuous rotary motion imparted to the thread portions passed through the eyelets 55 to an intermittent motion in its closed path about the shuttles so that the threads will be wound crosswise of the spool but will be delayed at the end portions thereof so that relatively great amounts will be deposited at these portions.

For this purpose each shuttle is provided with inversely disposed hooklike arms 70 on its opposite ends, the direction in which these arms are directed depending upon the direction of rotation of the guiding arms 30. It will be observed (Figs. 4, 5, 6, 7 and 8) that if the arms 30 be moved in a clockwise direction, as viewed in these figures, the left-hand hook member 70 will be curved in a downward direction while the right-hand member will be directed in an upward direction. If the arms 30 are to be rotated in the opposite direction, that is, in a counterclockwise direction, the arrangement of these arms will be reversed.

These arms 70 are so arranged that they will close or shut the path of motion provided for the thread about the shuttle when the shuttle is moved to either of its limiting positions in its longitudinal direction of motion. In other words, if the shuttle be moved to its left-hand limiting position, as shown in Fig. 4, the hook member on the left-hand end of the shuttle will close the path of motion about this end of the shuttle, whereas if the shuttle be moved to its right-hand limiting position, as shown in Fig. 7, the right-hand hook member 70 will close the path of motion about the right-hand end of the shuttle.

As will be pointed out hereinafter in greater detail, each shuttle is further arranged so that it will be moved to its respective limits of travel by the tension in the length of thread passed through the shuttle and by the motion imparted to the length by the associated guiding arm 30.

The shuttles preferably will be provided with a second pair of arms 70*a* arranged on its opposite ends and opposite the arms 70; the functions of these arms 70*a* will be pointed out in greater detail hereinafter. Preferably the end portions of the shuttles will be tapered inwardly toward the longitudinal axis of the shuttle as shown so as to facilitate the movement of the thread lengths about the shuttle.

The guiding arms 30 are rotated preferably by motion received from the main drive shaft 13 provided for the winding machine.

As shown one of the arms 30, as for example the right-hand arm, as viewed in Figs. 1 and 2, is provided with a sheave 71 which is secured to the driving spindle 33 provided for the arm so that it can impart motion thereto, and which is provided with a pair of grooves 72 and 73. About the first of these grooves a suitable belt 74 is passed, this belt serving to transmit motion to the sheave and consequently to the arm 30 from the main drive shaft 13. As shown, a suitable cone sheave 75 is secured to the main drive shaft 13 for transmitting motion to the pulley by means of the belt 74. As shown, (Figs. 1 and 2) the belt 74 is directed from this cone sheave 75 over an idler sheave 76, thence over a second idler sheave 77 of a suitable tensioning device 78, thence around a second sheave 80 of this device, and thence is passed around a third sheave 81 of the tensioning device from whence it is turned about the groove 72 provided in the guiding arm operating sheave 71 from which sheave it is directed to an idler sheave 82 arranged below the sheave 76 and from there is directed back to the operating cone sheave 75. The idler sheaves 76 and 82, it will be observed, are disposed one above the other so as to rotate freely on a vertical shaft 83 arranged in a supporting member 84. As shown, this supporting member 84 is secured at its lower end to the base plate 47 by any suitable means, as by rivets or bolts 85, and at its upper end is provided with a pair of horizontally projecting arms 86 which are arranged to support the sheave shaft 83.

The idler sheaves 77 and 81 of the belt tensioning device are mounted for rotation on suitable spindles 87 and 88 respectively which in turn are arranged on a suitable supporting plate 90 which is secured to the upper supporting plate 43 provided for the framework 36. As shown, this plate 90 is secured to this plate by suitable bolts 91. The sheave 80 of the belt tensioning device is provided with a suitable U-shaped support-

ing member 92 (Fig. 2) between the arms of which the sheave 80 is rotatably mounted. This member 92 is supported on a suitable bracket 93 by means of a resilient connection 94. As shown, the sheave support 92 is provided with a rodlike member 95 secured thereto and passed through a suitable aperture 96 provided for it in the upper end of the supporting bracket 93; on the projecting end of this rod is threaded a suitable nut 97 between which nut and the bracket 96 is interposed a compression spring 98. It will be readily understood in view of the foregoing arrangement that this spring serves to tension the driving belt 74, the tension of which may be controlled by adjusting the nut 97 on the rod 95. The bracket 93 is rigidly secured to the plate 47 by means of suitable bolts 99.

The groove 73 of the sheave 71 is utilized to transmit motion to the left-hand guiding arm 30 of Figs. 1 and 2. As shown, this left-hand guiding arm is provided with a suitable driving sheave 100 secured to its driving spindle 33. A suitable belt 101 serves to transmit motion between the pulleys 71 and 100. Thus it will be observed that the drive shaft 13 which is used to rotate the winding spools 10 also serves to rotate the guiding arms 30, the speed at which the driving arms 30 are rotated depending upon which one of the grooves of the cone sheave 75 is utilized. In other words, the cone sheave 75 provides for an adjustment of the speed ratio between the spools 10 and the guiding arms 30.

The arrangement of the driving belt 74 and of the tensioning device is such that if the framework 36 carrying the thread guiding arms 30 and the shuttles 31 be moved about its shaft 45 away from the spools to a certain extent, the tension in the belt will be reduced to such a degree that the arms 30 will cease to rotate even though the operating shaft 13 be rotating. Thus, if for any reason it be desired to stop the insulation feed during the operation of the machine it is merely necessary to move the supporting frame 36 away from the spools.

The base plate 47, together with the guiding arms arranged thereon and the shuttles and their associated mechanism, is arranged to be moved longitudinally with respect to the spools so as to adjust the positions of the axes of rotation of the arms 30 with respect to the spools 10. For the purpose of this adjustment the base plate 47 is secured to the portion 54 of the main frame of the winding machine by means of suitable stud bolts 103 passed through elongated slots 104 arranged in the base plate 47 longitudinally of the winding machine.

In the operation of the machine, it will be understood that the base plate 47 will be adjusted longitudinally of the machine so that the spindles 33, or in other words, the axes of rotation of the guiding arms 30 will be brought to positions substantially midway of the lengths of the spool compartments in which coils are to be wound; that the frame 36 will be adjusted toward or away from the spools used so as to accommodate the shuttles to the diameter of the spools; and further that the shuttle stops 64 will be adjusted a distance apart substantially equal to the lengths of the spool compartments and also so that the paths between the guides for the lengths of the thread passed through the shuttles will be substantially coextensive with the winding portions of the spool.

As the main drive shaft 13 is rotated so as to impart rotary motion to the spools 10 the guiding arms 30 will be rotated by means of the belt connections between them and the drive shaft and at a speed dependent upon which of the grooves of the cone sheave 75 is being used. It will be understood that as the spools are being rotated and as the threads 20 are being wound thereon, the lengths of thread passed to the spools will be maintained under a slight tension by means of the friction jaws 24. It will also be understood that those portions of the lengths of the threads passed from the jaws 24 to the spools which are directed through the eyes 55*a* will be moved in continuous circular paths or motion by the rotary motion of the arms. This motion imparted to the threads tends to cause those thread portions which are directed through the shuttles to move in continuous closed paths of motion about the shuttle members, these paths being defined by the upper and lower shuttle guides 56 and 57 and by the stop members 64. As has been pointed out, however, the shuttles operate to give the thread portion passed through the guides an intermittent motion, the pauses in this motion occurring at the end portions of the spool.

The operation of the shuttles may be more clearly understood by reference to Figs. 4–8, inclusive. In these figures the arms 30, the spindles 33 and the eyelets 55 are represented diagrammatically. The length of the arm 30 in these figures is the radius on which the eye 55*a* revolves. The positions assumed by the portion of the thread 20 which is passed through the shuttle as the arm 30 revolves is designated by the small circle A. As has been pointed out, the eye 55*a* is moved through a continuous curved path of motion. Let it be assumed that the arm 30 and the eyelet 55 are in the positions shown in solid lines in Fig. 4 and that the arm is being rotated in the direction of the arrow shown in this figure, i. e., in a clockwise direction, as viewed in the figure. In this position of the arm 30 the shuttle thread portion will be in the position A shown in Fig. 4 having

been moved from its dotted line position A to this position by the motion of the arm from its dotted to its solid line position.

As the arm 30 is rotated in a clockwise direction the position of the thread portion passed through the shuttle frame will be moved beneath the shuttle as shown in Fig. 5 and will continue to pass beneath the shuttle until the arm has been moved to its dotted line position in Fig. 5 in which position of the arm the thread portion will have been moved to its dotted line position indicated. During this portion of the motion of the arm 30 the thread will have been moved crosswise of the spool so as to be wound thereon from one end of the spool to the other end of the spool in a right to left direction. As the arm 30 moves from this dotted line position in Fig. 5 toward its solid line position of Fig. 6 the thread portion will be moved upwardly until finally when the arm 30 has reached its solid line position shown in Fig. 6 the thread will be engaged by the left-hand shuttle arm 70. The thread will be held in this position during the succeeding complete revolution of the arm 30 so that during this revolution of the arm the thread will be wound on the left end portion of the winding surface of the spool. It will be observed that as the arm 30 moves from its solid line position of Fig. 6 to its solid line position of Fig. 7 that the thread portion passed through the shuttle will be held in its left-hand position by the arm 70 but that during this motion of the arm the shuttle will be moved toward its right-hand limiting position by the motion of the arm and the tension in the thread, it being understood that the tension will be sufficient to move the shuttle to its right-hand position. As the arm moves from its solid line position of Fig. 7 to its dotted line position of Fig. 7 the thread portion passed through the shuttle will be moved downwardly to its dotted line position A, in which position it will engage the second arm 70*a* provided on the left-hand end of the shuttle. This second arm is provided on the shuttle to prevent the thread from passing backwardly beneath the shuttle to the right-hand end of the shuttle frame as the arm 30 is moving in a clockwise direction from its solid line position of Fig. 7. The thread portion will be secured in its dotted line position of Fig. 7 until the arm 30 has been moved substantially to its solid line position shown in Fig. 8. When the arm 30 has been moved substantially to this position the thread will be moved away from the shuttle and will occupy its position A shown in Fig. 8. It will be observed that with the elements in their positions shown in Fig. 8 the thread portion will not be locked at the left-hand end of the shuttle frame upon continued motion of the arm 30 in view of the fact that the shuttle will have been moved to its extreme right-hand position as the arm moved from its position shown in Fig. 6 to its solid line position shown in Fig. 7. In other words, while the arm is being moved in a clockwise direction from the position shown in Fig. 8 the shuttle thread portion will be allowed to move along the upper edge of the shuttle to the right-hand end of the shuttle frame so as to be wound crosswise on the spool from left to right. At the right-hand end of the shuttle the thread portion will be engaged by the right-hand shuttle arm 70 so that the motion of the thread portion will be stopped for a subsequent revolution of the arm 30 after the thread has engaged the arm 70. In this manner the shuttle thread portion is moved intermittently through a closed path of motion the pauses occurring at the ends of this path of motion.

In other words, the shuttle will be controlled by the motion of the guiding arm 30 and the tension in the thread so as to allow the thread to be moved back and forth crosswise of the spool and will operate to hold the thread at the end portions of the shuttle frame so that the thread will be wound in relatively heavy deposits on the end portions of the spool.

It will be observed that after the shuttle arm 70 has engaged the thread as shown in Fig. 6 and has been moved to its extreme right-hand limiting position as shown in Fig. 7 that the thread A will have been moved slightly toward the right and that as the arm 30 moves from its solid to its dotted line position in Fig. 7 the thread portion in moving from its solid line position A (Fig. 7) to its dotted line position A (Fig. 7) will be moved still slightly further toward the right. This is important because it provides for a distribution of the thread over a considerable area of the left-hand end portions of the winding layers. If this were not the case the thread would build up on practically a single line and would not be distributed over the end turns of the winding. In like manner the thread is distributed over a considerable area of the right-hand end portion of the spool.

It will be understood that the quantity of thread deposited at the end portions of the winding layers and the number of crossovers of the thread will be controlled by the speed of the arms 30 relative to the speed of the winding spools. The slower that the arms 30 revolve the greater will be the quantity of insulation placed at the ends of the winding layer and next to the flanges of the spool, and conversely the faster the spools revolve relative to the speed of the spools the less will be the amount of insulation placed at the ends of the spool. The speed of the arms, as has been pointed out, will be controlled by means of the cone

pulley 75. Preferably, the speed of the arms 30 will be such that the cotton will be wound crosswise of the spool several times while one turn of the conductor is being wound on. By reason of this a considerable amount of cotton is placed between the turns and layers of the winding and furthermore relatively large amounts are deposited between the end turns of the windings where the highest electrical tension occurs.

When the right-hand compartments 10*b* of the spool have been completely wound the framework carrying the thread guiding arms 30 and the shuttles will be moved about its shaft 45 away from the spools, and then the arbor 11, together with the spools, will be removed from the winding machine and turned end to end and the remaining compartments 10*a* will be wound in the same manner as that just described in connection with the winding of the first compartments 10*b*.

As has been pointed out the framework 36 provided for supporting the guiding arms 30 and the shuttles 31 is adjusted toward and away from the spools so as to accommodate spools of various widths. The longitudinal adjustment of the base plate 47 is provided to adapt the mechanism to spools having different lengths. In other words, the base plate 47 will always be positioned so that the axes of the spindles 33 will be substantially midway of the length of the spool compartments being wound. The shuttle stops 64, of course, may readily be adjusted lengthwise of their guides 56 and 57.

It is to be understood that one shuttle will accommodate several different length spools provided the lengths do not vary beyond a certain degree and that shuttles of larger or smaller proportions will be provided to accommodate spools having lengths greater or less than those which fall within the range that one shuttle will take care of.

It is to be noted that the mechanism which I have provided is of an extremely simple and inexpensive construction and further that it is a construction conducive to long wear. All the parts of the mechanism with the exception of the shuttle are rotary, and the reciprocatory motion of the shuttle is very limited; consequently none of the parts is subjected to excessive wear.

Furthermore, no part of the mechanism comes in contact with the spools or the windings thereby eliminating any possible damage to the spools or windings. Furthermore, in view of the fact that no part of the mechanism comes in contact with the winding the mechanism is adapted to provide insulation on windings having square, rectangular or other irregularly-shaped cross sections.

It is also to be noted that all of the thread passageways are rather large so as to facilitate the threading in of the thread lengths passed to the spool.

While I have shown a particular embodiment of my invention, it will be understood, of course, that I do not wish to be limited thereto since many modifications may be made, and I, therefore, contemplate by the appended claims to cover any such modifications as fall within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is,—

1. In a winding machine, the combination with a winding spool of means for guiding the material to be wound to said spool comprising means for causing the length of material passed to said spool to move through a closed path of motion arranged so that the material is wound crosswise of said spool and means engaging said length only at the end portions of said path of motion so as to delay its motion temporarily at the end portions of said spool.

2. In a winding machine, the combination with a winding spool of means for guiding the material to be wound to said spool so that a traversing motion is effected between said spool and the length of material passed to said spool and means temporarily engaging said length to delay its traversing motion relative to said spool whereby a relatively heavy amount of said material is deposited at a preselected portion of said spool.

3. In a winding machine, the combination with a winding spool of means for guiding the material to be wound to said spool comprising means for causing the length of material passed to said spool to move through a closed path of motion arranged so that said material is wound crosswise of said spool in a plurality of layers and means engaging said length only at each end of said path of motion for delaying temporarily the motion of said length so that said material is deposited in relatively heavy amounts at the end portions of said spool.

4. In a winding machine, the combination with a winding spool of means for guiding the material to be wound to said spool comprising means for causing the length of material passed to said spool to move back and forth lengthwise of said spool and means including a shuttle operably associated with said length of material so as to guide said length to the end portions of said spool and to give to the motion of said length a pause at each of said end portions.

5. In a winding machine, the combination with a winding spool of means for guiding the material to be wound to said spool comprising a shuttle, means tending to continuously move the length of material passed to said spool around said shuttle and means on said shuttle for temporarily interrupting said movement.

6. In a winding machine, the combination with a winding spool of means for guiding the material to be wound to said spool comprising a shuttle, means tending to pass said material transversely around said shuttle and means on said shuttle engaging said material to interrupt alternate passes of said material around said shuttle.

7. In a winding machine, the combination with a winding spool of means for rotatably mounting said winding spool and means for distributing the material to be wound on said spool comprising a shuttle and means for causing the length of material passed to said spool to move through a closed path of motion around said shuttle so that the material is wound crosswise of said spool, said shuttle being arranged to delay the motion of said length temporarily at each end of said path of motion.

8. In a winding machine, the combination with a winding spool of means for rotating said spool, a shuttle, guides for said shuttle arranged so that said shuttle floats therein, said shuttle and guides defining a closed path of motion around said shuttle for the length of material passed to said spool, and an arm for guiding said length of material to said shuttle, means mounting said arm for rotation and for imparting rotary motion thereto whereby said length is caused to move in said closed path of motion around said shuttle, said shuttle being arranged to give said length a pause at each end of said closed path of motion so as to deposit relatively large amounts of said material at the end portions of said spool.

9. In a winding machine, the combination with a winding spool of means for rotating said winding spool, an arm for guiding the material to be wound toward said spool, means rotatably mounting said arm and for imparting rotary motion thereto so that one portion of the length of said material between said arm and said spool is caused to move through a continuous circular path of motion and a shuttle interposed between said arm and said spool operably associated with said length of material so that the portion of said length intermediate said arm and said spool is caused to move through an intermittent closed path of motion.

10. In a winding machine, the combination with a winding spool of means for rotating said spool, a shuttle disposed adjacent said spool, guides mounting said shuttle for limited vertical and longitudinal motions thereon so that the material to be wound can be passed to said spool between said shuttle and said guides and can be moved about said shuttle in a closed path of motion, arms on the ends of said shuttle arranged to close said path of motion at the ends thereof when said shuttle is at the respective limits of its longitudinal path of travel, an arm, means mounting said arm for rotary motion and means for rotating said arm, said arm being provided with an eye through which said material to be wound is passed to said shuttle so that when said arm is rotated the length of said material between said arm and said spool and passed between said shuttle and its guides tends to move in its closed path of motion around said shuttle, the arms carried on the opposite end portions of said shuttle being arranged to alternately engage said material as it is being moved about said shuttle by the motion of said guiding arm so that when either one of said shuttle arms engages said material the motion of said material about said shuttle is stopped while said guiding arm is moved through the succeeding revolution of its motion and during which revolution said shuttle is moved to the opposite limit of its longitudinal path of travel to allow said material to move freely past said one arm during the second successive revolution of said guiding arm and so as to render said other shuttle arm effective to stop said material in its path of travel.

11. In a winding machine, the combination with a winding spool of means for guiding the material to be wound to said spool comprising means for causing the length of material passed to said spool to tend to move through a closed path of motion arranged lengthwise of said spool and a shuttle mounted to be moved between a pair of limiting positions and arranged to engage said length of material when in either of said positions so as to stop the motion of said length, said shuttle being operably associated with said material so as to be moved alternately to said limiting positions by the tension in said material as said length tends to move about said path.

12. The combination with a winding machine comprising a spool on which an electrical conductor is wound in successive layers so as to form an electrical coil of means for applying threadlike insulating material between said successive layers and between the succeeding turns of each layer, said means comprising a framework through which said thread is passed to said spool arranged lengthwise of said spool, a shuttle floating in said framework for limiting vertical and longitudinal motions therein so that the portion of the length of said thread passed through said frame can be moved about said shuttle, means for imparting to a second portion of said length a rotary motion so that the first portion thereof passed through said framework tends to move about said shuttle and thereby move lengthwise of said spool, said shuttle being arranged so that when it is in either of the limiting positions of its longitudinal path of motion it engages said first portion to delay its motion tempo-

rarily at the corresponding end of its path of motion and means for maintaining a tension in said thread, said shuttle being operably associated with said first portion so as to be moved alternately to its limiting positions by the tension in said thread and by the rotary motion imparted to said second portion.

13. In a winding machine, the combination with a winding spool of means mounting said spool for rotation and for imparting rotary motion thereto and means for guiding the material to be wound to said spool comprising means for moving a portion of the length of material passed to said spool through a continuous closed path of motion and means operably associated with said length so as to convert the rotary motion imparted thereto to an intermittent path of motion arranged lengthwise of said spool.

14. In a winding machine, the combination with a winding spool mounted for rotation of means for rotating said winding spool, an arm for guiding the length of material passed to said spool, means mounting said arm for rotary motion on a fixed axis substantially perpendicular to the longitudinal axis of said spool, whereby a portion of said length is moved through a continuous curved path of motion and means interposed between said arm and said spool operably associated with said length of material so as to convert the rotary motion imparted thereto by said arm to an intermittent closed path of motion arranged lengthwise of said spool and having the pauses in the motion of said length occurring at the end portions of said spool.

15. In combination with a winding machine comprising a flanged winding spool on which an electrical conductor is wound on in successive layers so as to form an electrical coil of means for applying threadlike insulating material between said successive layers and between the succeeding turns of each layer, said means comprising an arm, pivotal means mounting said arm for rotation on a fixed axis substantially perpendicular to the longitudinal axis of said spool and substantially midway of the length of said spool, an eyelet through which said threadlike insulating material is passed to said spool carried by said arm on a radius greater than one-half of the length of said spool, means for rotating said arm so that said eyelet carries the thread portion passed therethrough in a continuous curved path of motion, a frame interposed between said spool and the plane of motion of said eyelet through which said thread is passed from said eyelet to said spool, said frame having a length substantially equal to that of the effective winding length of said spool and arranged substantially coextensively therewith, a shuttle mounted to float in said frame so as to have a limited longitudinal and vertical motion therein whereby said thread can be moved in a closed path around said shuttle by the motion of said rotary arm, inversely disposed hooklike arms on the ends of said shuttle arranged to alternately engage said thread as it is being moved about said shuttle by the motion of said guiding arm so that when either one of said shuttle arms engages said thread the motion of said thread about said shuttle is stopped while said guiding arm is moved through the succeeding revolution of its motion and during which revolution said shuttle is moved to the opposite limit of its longitudinal path of travel to allow said thread to move freely past said one arm during the second successive revolution of said guiding arm and so as to render said other shuttle arm effective to stop said thread when it is moved about said shuttle to the position of said other arm.

16. In a winding machine, the combination with a winding spool, of means for rotatably mounting said winding spool, means for rotating said winding spool and means for distributing the material to be wound to said spool comprising a shuttle, a rotatably mounted guiding arm arranged to cause the material passed to said spool to move through a closed path of motion around said shuttle so that said material is wound crosswise of said spool, said shuttle being arranged to delay the motion of said length temporarily at each end of its said path of motion and a driving connection between said spool rotating means and said arm whereby a substantially fixed speed ratio is maintained between said spool and said arm.

17. In a winding machine, the combination with a winding spool, of means for rotating said winding spool, an arm for guiding the material to be wound toward said spool, means mounting said arm for rotary motion so that when said arm is rotated one portion of the length of material passed to said spool is caused to move through a continuous curved path of motion, a driving connection between said means for rotating said spool and said arm whereby a substantially fixed speed ratio is maintained between said spool and said arm, means interposed between said arm and said spool operably associated with said arm for causing a portion of said length of material between said arm and said spool to move through an intermittent closed path of motion, means providing for movement of said arm to a working position with respect to said spool and to a position remote therefrom, and means for automatically rendering said driving connection between said driving means

and said arm ineffective when said arm is moved to its said remote position.

18. In a winding machine, the combination with a winding spool mounted for rotation of a shaft for rotating said winding spool, an arm for guiding the material to be wound toward said spool, a framework, means mounting said arm for rotary motion on said framework, said arm being arranged so that when said arm is rotated a portion of the length of the material passed to said spool is caused to move through a continuous curved path of motion, means interposed between said arm and said spool operably associated with said length of material for converting the rotary motion imparted thereto by said arm to an intermittent closed path of motion arranged lengthwise of said spool and having the pauses in the motion of said length occurring at the end portions of said spool, means including a driving belt between said shaft and said arm for imparting rotary motion to said arm, and means pivotally mounting said framework for movement to a working position with respect to said spool and to a position remote therefrom, said framework and driving belt being operably associated with respect to each other so that said belt is rendered ineffective to transmit motion from said shaft to said arm when said framework is moved to said remote position.

WILLIAM N. BRIGGS.