March 27, 1928. 1,663,549

J. J. HIGGINS ET AL

COIL WINDING MACHINE

Filed July 26. 1923 2 Sheets-Sheet 1

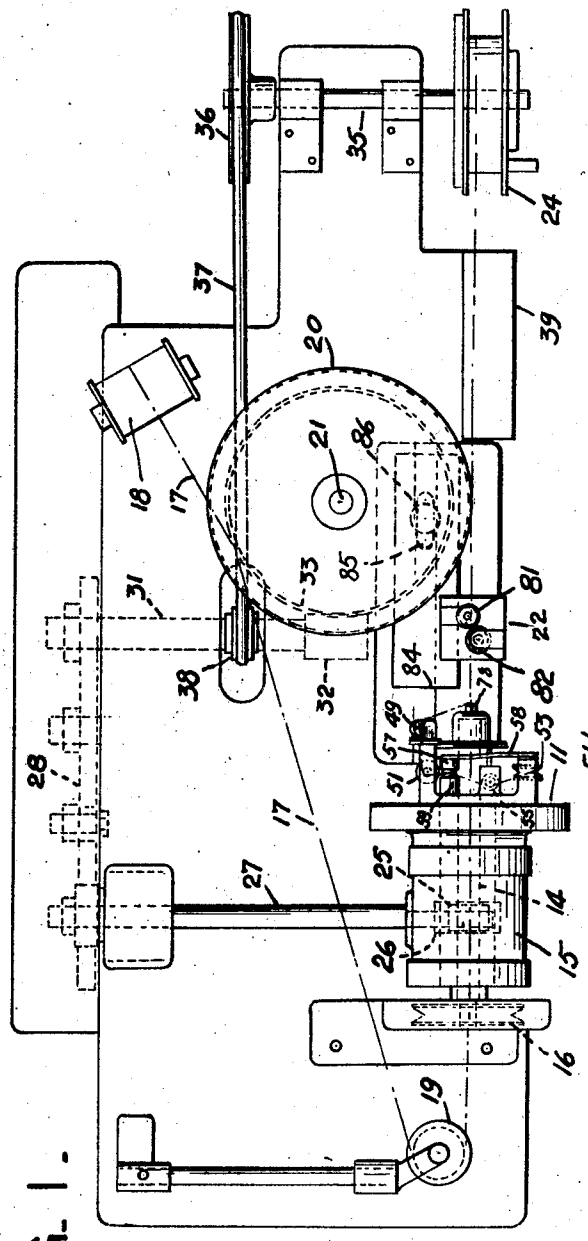

FIG. 1.

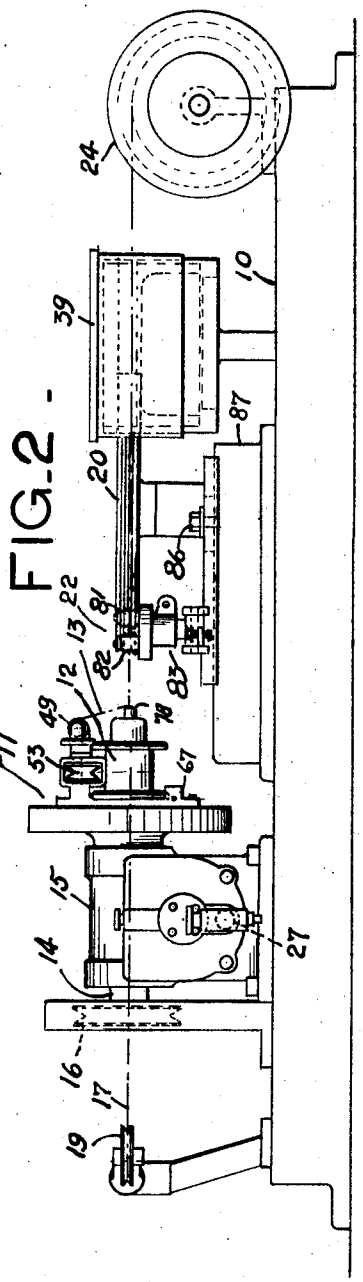

FIG. 2.

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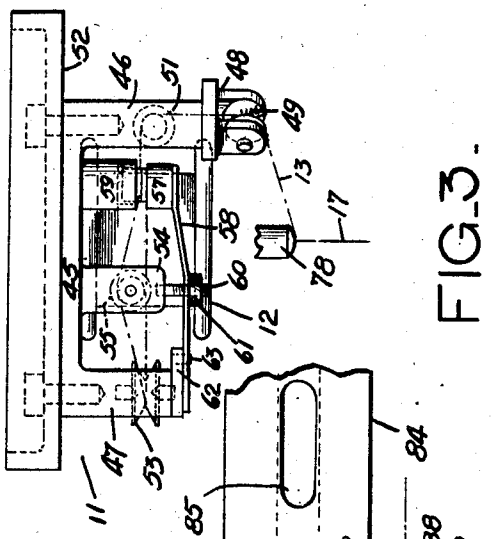


FIG. 4.

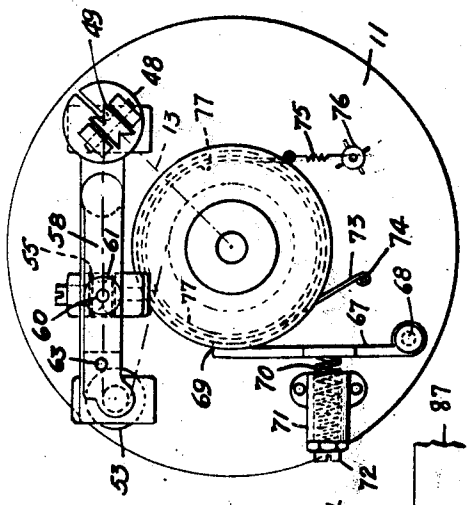


FIG. 3.

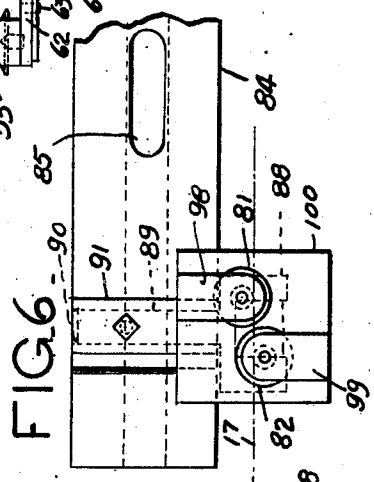


FIG. 6.

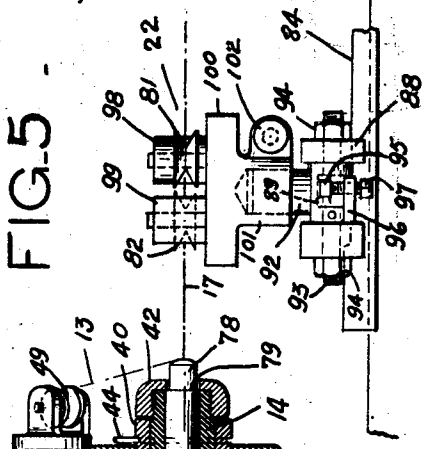


FIG. 5.

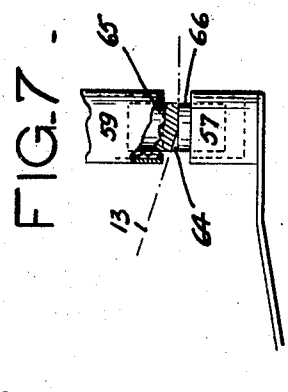


FIG. 7.

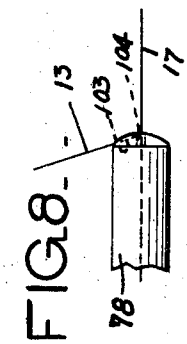


FIG. 8.

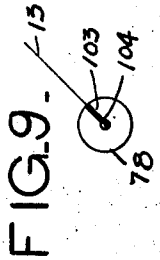
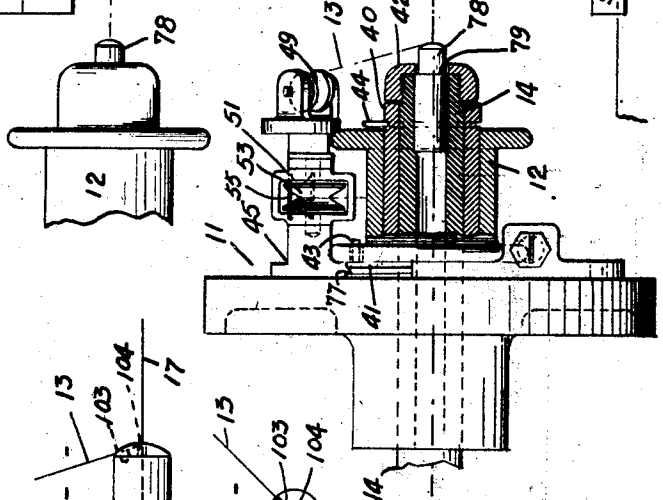


FIG. 9.



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Patented Mar. 27, 1928. 1,663,549

UNITED STATES PATENT OFFICE.

JOHN JOSEPH HIGGINS, OF EAST ORANGE, AND MILTON ARMSTRONG HOYT, OF BLOOMFIELD, NEW JERSEY, ASSIGNORS TO WESTINGHOUSE LAMP COMPANY, A CORPORATION OF PENNSYLVANIA.

COIL-WINDING MACHINE.

Application filed July 26, 1923. Serial No. 653,847.

This invention relates to lamp making machinery and more particularly to machines for winding helical filament for use in incandescent electric lamps.

An object of the invention is to wind a filament wire to helical form in which the stresses are uniformly distributed.

Another object of the invention is to provide a tensioning device which will maintain a uniform tension upon the filament wire during the winding thereof upon a mandrel.

Another object of the invention is to provide coordinating machine elements for controlling applied forces to govern the tension of filament wire during its application to a mandrel.

A further object of the invention is to provide a device for guiding and controlling the movement of a filament wire during the operation of winding thereof to helical form.

A still further object of the invention is to maintain the mandrel wire in a given rectilinear path during its translation after a filament wire is wound thereon.

Other objects and advantages will be apparent as the description proceeds.

Machines for winding helical filaments are well known in the art and usually comprise necessary elements to wind a filament with the proper degree of spacing between each turn of the coil thereof. The filament is wound on a mandrel and the proper spacing is generally obtained by moving the mandrel slowly through a winding head, which carries a spool of filament upon its axis. The head is revolved at a relatively high rate of speed, such speed depending upon the size of the wire to be wound.

The mandrel passes from the spool around suitable guide pulleys and through a hollow spindle of the winding head. The filament is carried from the spool to the mandrel over a system of guide pulleys and the speed at which the mandrel is drawn through the head, relative to the speed of the head, obviously determines the number of turns of the wire per inch upon the mandrel.

The machine may be provided with means for electrically heating the wire prior to its application to a mandrel and means may also be provided for effecting a relatively quick movement of the mandrel longitudinally after a given number of turns have been applied thereto. These last mentioned operations are well known in machines of this character and are, therefore, not illustrated in the drawing since the invention is equally applicable whether a machine is equipped with a heating device or with means for spacing the coils effected by a quick movement of the mandrel at given intervals.

It is obvious that great importance resides in the proper tensioning of the filament wire during the winding thereof about a mandrel. Heretofore, it has been the practice to apply a tensioning force to the spool of filament wire, in order to maintain a tension upon the filament as it was drawn from the spool.

The application of a force to the spool is subject to certain disadvantages. When a full spool of wire was inserted into the machine, the tension upon the wire being drawn therefrom, was of a given degree depending upon the tension exerted upon the the spool. However, as the spool unwound and the circumference from which the wire was drawn decreased, the leverage about the fulcrum point or axis of the spool decreased, thus the tension upon the filament materially increased.

Owing to the extreme accuracy required in the production of an article of this character and by reason of the wire of extremely fine diameter employed, such variation in the tensional stress during winding, resulted in variations or non-uniform distribution of the stresses in the coil when wound upon the mandrel. A filament when produced under such conditions, gave unsatisfactory results when used, because of the unequal stress imposed thereon, due to changes in temperatures when the filament became a component part of an incandescent lamp.

The present invention, therefore, aims to avoid any variation in the tensional stress imparted to the filament during the winding thereof upon a mandrel. This is accomplished by eliminating any material tensional opposition to the movement of the spool and in effecting the necessary tension during the winding operation by means independent of the spool. Thus the spool may be free

to rotate, and since the tension is applied after the filament leaves the spool, it is immaterial whether the diameter of the spool including the wire wound thereon changes or not.

The present invention may be applied to the well known coil winding machine and may comprise suitable guide pulleys over which the filament from the spool is led. The filament may then pass from the guide pulleys between a compression member which opposes its movement and from thence, it may be wound upon the mandrel.

The material employed for the filament, generally tungsten wire, is extremely hard and in order to lengthen the useful life of the compression member, it has been found desirable to use a bearing surface composed of a sapphire or other jewel, which possesses the property of hardness to a greater degree than tungsten wire. Since the compression member is movable with the winding head, the jewel is provided with means for preventing the displacement of the filament by centrifugal force acting thereon.

The invention also contemplates suitable guide-rollers for frictionally engaging the wound filament, which members may be conveniently removed from their operative positions. Means are also employed comprising a suitable guide-member to prevent a movement of the mandrel from a given path during the winding operation. This guide-member in conjunction with the guide-rollers, prevents vibration and the non-uniform winding as heretofore found prevalent.

The invention will be more fully understood by reference to the annexed drawings in which:—

Figure 1 is a plan view of a machine embodying the present invention;

Fig. 2 is a side elevation of the machine shown in Fig. 1;

Fig. 3 is a front elevation of the winding head showing the tensioning device applied thereto;

Fig. 4 is a top view of the tensioning device shown in Fig. 3;

Fig. 5 is a fragmentary view of the machine partly in section and shows guide-rollers in their operative relation to the winding head;

Fig. 6 is a plan view of the guide-rollers shown in Fig. 5 and also shows a portion of the winding head;

Fig. 7 is an enlarged detail, partly in section, of compression members for gripping the filament wire;

Fig. 8 shows an enlarged portion of a filament guide having the filament disposed in a groove therein, and

Fig. 9 shows an end view of the guide shown in Fig. 8.

A machine of the type to which the present invention may be applied may comprise a suitable base 10 upon which are mounted a plurality of machine elements to perform a winding operation. A machine of this type is known in the art and it is believed that a brief description thereof will suffice to set forth its general principles and the present invention will be fully described in connection therewith.

The winding machine may comprise a winding head 11 which carries a spool 12 of filament wire 13 upon its axis. The head 11 is mounted on a suitable hollow-spindle 14, journaled in a bearing 15, which bearing is suitably secured to the base 10. An end of the hollow-spindle opposite to that at which the head is secured, is provided with a driving pulley 16. The pulley 16 may be connected to any suitable source of power, as for instance a motor (not shown).

Mandrel wire 17 is led from a spool 18 and over a multiple groove sheave 20, supported on a vertical shaft 21 rotatably supported in the base 10. The mandrel 17 then passes over a suitable pulley 19 and thence through the hollow-spindle 14 and may be associated by one or more turns with the sheave 20, from which it passes to a drum 24. Interposed between the sheave 20 and the winding head 12, is positioned an additional guide, designated as a whole, by the numeral 22.

For the purpose of drawing the mandrel through the spindle, the sheave 20 is rotated by means of its geared connection with the driving-pulleys 16. Such connection may comprise a worm 25 and a worm wheel 26, secured to the hollow spindle 14, the worm being secured to a shaft 27 connected by a train of gears 28 to a shaft 31 having a worm 32 secured thereto and in mesh with a worm wheel 33 suitably secured to the vertical shaft 21 upon which, the sheave 20 is fastened.

The filament wire 13 may be led over guide members and a tensioning device, to be later described, and secured to the mandrel 17 at a point adjacent an end of the hollow-spindle 14. A rotation of the head will thus cause a helical winding of the filament about the mandrel and the number of turns of wire per inch upon the mandrel is controlled by the rate of movement of the mandrel through its path of travel.

The wire-wound mandrel is carried about the sheave 20 and thence to the drum 24 as above described. The drum 24 is rotated at a given rate of speed in order to maintain the mandrel tight about the sheave 20. The rotation of the drum 24 may be effected by providing a shaft 35 upon which the drum is mounted with a sheave 36. The sheave 36 may be connected by a belt 37 to a sheave 38 fastened to the shaft 31, through which motion is translated to the sheave 20.

Suitably positioned in the path of the

wound mandrel, is provided a heater 39 and the wound mandrel is annealed prior to its reception by the drum 24.

The foregoing description generally describes the type of machine to which the present invention is shown applied.

An embodiment of the invention may include the spool 12 (see Figs. 3, 4 and 5 mounted on the hollow-spindle 14, carried by the head 11. The spindle 14 may be provided with a sleeve or bushing 40 having a flange 41 and adapted to fit the spindle 14 so that the flange 41 will bear against the face of the head 11. The sleeve 40 may be held in place by a cap 42. The spool may be so dimensioned as to fit the bushing 40 and when slipped thereover, may be secured thereto from relative rotary movement by a pin 43. Longitudinal movement of the spool 12 is prevented in one direction by the flange 41 and in another direction by a spring clip 44 which may be disposed in a groove in the sleeve 40. By reason of the running fit of the bushing 40 with the spindle 14, the spool 12 is rotatable about the spindle and, therefore, may be rotated to permit the unwinding of filament therefrom during a rotation of the head 11.

A tensioning mechanism may comprise a bracket mounted upon the head 11 in a given relation to the spool 12. The bracket may consist of a base portion 45 having right angle projections 46 and 47. The projection 46 may terminate in a bearing 48 in which a guide-sheave 49 may be journaled with its axial line in suitable angular relation to the axial line of a pulley 51, journaled in a bearing provided in the projection 46 intermediate the face-plate 52 of the head 11 and the bearing 48. The projection 47 may be provided with a guide-sheave 53 mounted on bearings. A third projection 54 may extend from the bracket and serve as a bearing for a guide-sheave 55.

For the purpose of frictionally engaging the filament wire, a compression device is provided which may comprise a friction head 57 secured to the end of a resilient arm 58 and normally urged toward a bearing block 59. The arm 58 may be carried by a stud 60 secured in the exposed end of the projection 54. A nut 61 may be provided to compress the arm 58 and compress the head 57 more firmly against the filament wire, the opposite end of the arm 58 being disposed in contact with a lug 62 and secured from lateral movement by a pin 63.

Since the winding head is rotated at high speed during the movement of the filament wire between the friction head 57 and the block 59, means are provided, in the form of a slot or groove 64 (see Fig. 7) suitably positioned to prevent the movement of the filament wire from between the friction members by reason of the centrifugal force during the winding operation. As will be noted, the compression device may comprise, as the bearing surfaces, contact members 65 and 66 of a material of extreme hardness, such for instance as a sapphire, which members may be embedded in a hard solder and thus secured in sockets of their respective holders.

The filament wire may be led from the spool 12 over guide-sheave 53, guide-sheave 55 and thence between the friction head 57 and the block 59, after which the filament may be led over the guide-pulley 51 and guide-sheave 49, from which it is led to the mandrel 17 and secured thereto, to be helically wound about the mandrel as the head is rotated and the mandrel is given its relative rectilinear movement.

For the purpose of temporarily retarding the relative rotary movement of the spool 12, a brake device comprising a lever arm 67 may be provided. The arm may be pivoted at one end on a pin 68 secured in the face-plate of the winding head 11. The free end of the arm 67 may be provided with a friction plate 69 normally urged into frictional engagement with an outer surface of the flange 41 of the sleeve which carries the spool 12. The contact between the arm 67 and the flange 41 may be effected through the action of a spring 70 disposed in a casing 71. A set screw 72 may be provided to vary the degree of compression exerted by the spring upon the arm 67. The lever arm 67 may have its fulcrum point at any suitable position upon the winding head 11 and such position may determine the rate of speed at which sufficient centrifugal force will be generated to move the friction plate 69 from contact with the flange 41. The friction plate may, if desired, be weighted to facilitate its action.

When desirable, an additional brake band 73 may be provided having one end secured to a pin 74 and the opposite end secured to one end of a helical spring 75. The opposite end of the spring may be fastened to a capstan 76 rotatable in the head to permit a variation in the tension of the spring 75. The brake band 73 may be disposed in a groove 77 in the periphery of the flange 41 to frictionally oppose its movement during the winding operation. It is to be understood that the brake band 73 may be omitted when winding fine wire. It has been found desirable, however, to employ a brake of this character when winding relatively heavy wire which has a tendency to unwind and produce too great a slack between the spool and the tensioning device.

For the purpose of cooperating with the tensioning device in the production of a more uniform winding, the hollow-spindle 14 is provided with a removable guide member 78. This guide member is provided

with a shoulder 79 adapted to engage with the cap 42 to prevent outward movement. Movement in the opposite direction may be opposed by a suitable shoulder within the spindle 14. The longitudinal passage-way in the guide member 78 is of a diameter sufficient to provide a passage for the mandrel and prevent lateral movement thereof, thus maintaining the mandrel upon the axial line of the winding head.

Operating in conjunction with the guide 78, is the aforementioned guide 22 composed of a pair of guide sheaves 81 and 82 maintained in relatively close relation at opposite sides of the path of movement of the mandrel. The sheaves are mounted upon a universal carrier which may comprise a slidable plate 84 having a slot 85 through which a tap-bolt 86 may pass to secure the plate in position upon a platform 87 secured to the base 10. The carrier may include a yoke 88 having a shank 89 adapted to enter a transverse aperture 90 disposed in a raised portion 91 of the plate 84. The forked end of the yoke may provide a bearing for a stud 92 secured to a shaft 93 and adapted to be maintained in any given angular position by nuts 94.

For the purpose of enabling an operator to adjust guide sheaves 81 and 82 to a given position, means are provided in the form of a lug 95 integral with the stud 92, and a projection 96 may be provided integral with the yoke 88. A set screw 97 may be provided in the projection 96 and adapted to engage with the lug 95 to limit the movement of the stud at which position it may be secured by the nuts 94.

As described, the mechanism provided, allows for the lateral and oscillatory movement of the guide-sheaves 81 and 82. A rotary movement of the sheaves about a common axis is provided. For this purpose, the sheaves are mounted in bearings 98 and 99 supported on a carrier 100. The carrier is provided with a split sleeve 101 adapted to be disposed over the stud 92 and secured in a given position by a manipulation of a thumb screw 102. It will thus be evident that the sheaves 81 and 82 may be so disposed that the wound mandrel may pass therebetween without any appreciable amount of tension or frictional engagement thereon. However, by rotating the sheaves about a vertical axis passing through the path of movement of the wound mandrel, a variation in the degree of frictional engagement between the sheaves and wound mandrel may be had. By thus confining the mandrel between the two rollers, vibration of the mandrel is greatly reduced.

The winding of spaced coiled filament requires that the filament wire be fed to the mandrel at a predetermined angle. It will be obvious, that although the wire may be fed to the mandrel through a rectilinear path, it will be diverted from such path at the point of application to the mandrel.

When a wire is wound upon a mandrel, the degree of contact between the mandrel and the wire depends largely upon the resiliency of the wire. It will be understood that a soft or malleable wire may more intimately be disposed in a helix about a mandrel than will a wire having a more resilient property.

The wire employed for use as a filament is relatively resilient, therefore, during the winding operation, the wire takes a slight bend as it is applied to the mandrel. Owing to the extreme accuracy necessary in the production of a helical filament, it is required that all the coils be spaced a uniform distance and the pitch remain uniform.

By reason of the slight inaccuracy in the manufacture of wire, it is found that some portions of the wire are less resilient than others. Heretofore, this variation resulted in a change in the pitch of the coils wound on the mandrel. This undesirable result is believed to have been due to the change in the degree of hardness of the wire. Thus if a wire of a given resiliency was used and the tensioning device adjusted accordingly, the wire would be wound upon the mandrel and the coils properly spaced, until a variation in the degree of hardness occurred throughout a given portion of the wire, whereupon a section of coils would be produced having a different pitch from that desired. Such variation is believed to have been due to either the opposition of the wire at a portion of its length, because of excessive hardness, to follow the same path during its application to the mandrel. On the other hand, if a relatively soft section of wire existed, a change in the pitch of the coil would also occur by reason of the reduced opposition of the wire which would obviously follow a different path from that of a harder or more resilient portion of the wire.

The present invention provides a means for overcoming the difficulty above set forth. Such means may comprise a guide member adapted to engage the wire at the point of its application to the mandrel and thus avoid the detrimental variation in the rectilinear path of the filament wire 13 to the mandrel 17.

As illustrated in Figs. 8 and 9, the guide 78 is provided with a groove 103 to form a shoulder 104 for engagement with the filament wire to positively carry it about the mandrel and avoid any diversion of the wire from a rectilinear path during its application to the mandrel thereby producing coils of a uniform pitch and spaced equally.

It will be noted that the wire is led from the guide sheave 49 to the mandrel at an

angle. It has been found that accurate winding is obtained by causing the filament to travel to the mandrel through an angular path which is substantially the same as the angle or pitch of the wound wire.

The machine may be prepared for operation by passing an end of the mandrel wire through the hollow spindle, around the sheave 20 and thence over the drum 24 to which an end is secured for winding. A spool of filament wire may then be positioned on the hollow-spindle 14. The spool being free to rotate, the filament wire may be drawn therefrom and threaded over the guide sheaves 53, around the guide sheave 55 between the friction head 57 and the bearing block 59 thence around pulley 51 and over guide sheave 49. An end of the wire, may in starting, be suitably secured to the mandrel wire until several turns of the wire have been made thereon.

The machine may then be started and the winding head 11 will be rotated and the mandrel moved through its rectilinear path. As the mandrel moves, the filament wire will be wound thereon and gradually accumulated in the roll upon the drum 24. It will be apparent, that the coil may be continuously wound upon a mandrel and the length of the wound mandrel need only be limited by the length of the tungsten wire on the spool.

The operations of the machine are automatic and the present invention provides for the more practical automatic production of a coil since by reason of the improved tensioning device, an accurate control of the winding may be had. Accuracy is an important factor in the production of the present type of filament and the application of the filament wire to the mandrel must be uniform so that when the mandrel is severed into sections, each section will have a uniform length of filament wire therein, in order that the resistance may be accurately fixed.

The means provided for producing a tensional stress between the mandrel and a tensioning device disposed between the mandrel and the spool serves to release all strains from the spool and give the wire a uniform tension during the winding operation.

Although a preferred embodiment of the invention has been shown and described, it is obvious that modifications may be made therein without departing from the spirit and scope of the appended claims.

What is claimed is:

1. A coil winding machine comprising a winding head, a mandrel movable upon the axial line of said head, a spool for filament wire supported upon said head, means associated with said head for guiding filament wire from said spool to said mandrel, a tension member disposed in the path of travel of the wire between said spool and said mandrel to produce a tension upon a section of the filament wire adjacent the mandrel, means for rotating the head and means for maintaining the wire in engagement with said tension member in opposition to the centrifugal force during the rotation of said head.

2. A coil winding machine comprising a mandrel, a spool for filament wire rotatable about said mandrel, means for winding said filament upon the mandrel, means for normally opposing the rotary movement of said spool during a given period during the unwinding of the filament said means operating under centrifugal force to remove its opposition to the movement of said spool.

3. A coil winding machine comprising a mandrel, a spool for filament wire rotatable about said mandrel, means for winding the filament upon the mandrel, a tension member for producing a tensional stress in a portion of the length of the wire between said spool and mandrel, a frictional member, means for applying said friction member to retard the rotation of said spool during the initial movement thereof and means for subsequently removing said friction member to permit a free movement of the spool.

4. A coil winding machine comprising a winding head, a traveling mandrel movable upon the axial line of said head, a spool for filament wire supported on said head, means for normally maintaining the spool from relative rotary movement, means for rotating said head, said first-mentioned means operating upon a rotary movement of said head to permit a rotary movement of said spool.

5. A coil winding machine comprising a hollow spindle, a winding head mounted on said hollow-spindle, means for rotating said spindle, a spool for filament wire mounted on said spindle adjacent said head, a tubular guide member positioned in a projecting end of said spindle, a guide passage in said member, a mandrel movable through said spindle and through said guide passage, means for guiding the filament wire to said mandrel to effect a winding thereon during rotation of said head, guide members disposed in the path of movement of said wound mandrel, said members operating in conjunction with said tubular guide member to maintain the mandrel in a given rectilinear path during the winding operation.

6. A coil winding machine comprising a hollow spindle, a winding head mounted on said hollow-spindle, means for rotating said spindle, a spool for filament wire mounted on said spindle adjacent said head, a tubular guide member positioned in a projecting end of said spindle, a guide passage in said

member, a mandrel movable through said spindle and through said guide passage, means for guiding the filament wire to said mandrel to effect a winding thereon during rotation of said head, guide members disposed in the path of movement of said wound mandrel, said members operating in conjunction with said tubular guide member to maintain the mandrel in a given rectilinear path during the winding operation and means for adjusting said guide members to vary the degree of their frictional engagement with said wound mandrel.

7. A coil winding machine comprising a hollow spindle, a winding head mounted on said hollow-spindle, means for rotating said spindle, a spool for filament wire mounted on said spindle adjacent said head, a tubular guide member positioned in a projecting end of said spindle, a guide passage in said member, a mandrel movable through said spindle and through said guide passage, means for guiding the filament wire to said mandrel to effect a winding thereon during rotation of said head, guide members disposed in the path of movement of said wound mandrel, said members operating in conjunction with said tubular guide member to maintain the mandrel in a given rectilinear path during the winding operation and means for moving said members from the path of movement of said mandrel.

8. A coil winding machine comprising a hollow spindle, a winding head mounted on said hollow-spindle, means for rotating said spindle, a spool for filament wire mounted on said spindle adjacent said head, a tubular guide member positioned in a projecting end of said spindle, a guide passage in said member, a mandrel movable through said spindle and through said guide passage, means for guiding the filament wire to said mandrel to effect a winding thereon during rotation of said head, guide members disposed in the path of movement of said wound mandrel, said members operating in conjunction with said tubular guide member to maintain the mandrel in a given rectilinear path during the winding operation, means for removing said members from the path of said mandrel and means for positively repositioning the members in their former relation to the mandrel.

9. A coil winding machine comprising a winding head, a mandrel movable upon the axial line of said head, a spool for filament rotatably mounted upon said head, a tensioning member carried on said head, guide rollers for guiding the filament to said tensioning member, means for rotating said head and winding the filament on said mandrel, a guide sleeve positioned on the axial line of said head for the passage of said mandrel therethrough, means for engaging the wound mandrel, said means operating in conjunction with said sleeve to maintain the mandrel in a given path.

10. A coil winding machine comprising a traveling mandrel, a spool for filament wire mounted for rotation about said mandrel, means for helically winding the wire about the mandrel, means disposed in the path of travel between said spool and said mandrel for tensionally engaging the filament prior to the winding thereof upon the mandrel, said last mentioned means being so arranged as to effect a movement of the wire toward the mandrel in the direction of the pitch of the coil, and means for compressively engaging the filament wire to retard its movement prior to the application thereof to said mandrel.

11. A coil winding machine comprising a hollow spindle, a winding head mounted on said spindle, means for rotating said spindle, a spool for filament wire mounted on said spindle adjacent to said head, a tubular guide-member positioned in and extending from a projecting end of said spindle, a guide passage in said tubular guide-member, a mandrel movable through said spindle and through said guide passage, a groove in said tubular guide-member for directing the wire into intimate engagement with the mandrel at its point of application thereto during the winding operation.

In testimony whereof, we have hereunto subscribed our names this 23rd day of July 1923.

JOHN JOSEPH HIGGINS.
MILTON ARMSTRONG HOYT.