TOROID WINDING MACHINE

Michael W. Tanny, 501 Jefferson SE.,
Albuquerque, N. Mex.
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This invention relates to winding machines and more particularly to a toroid winding machine that is especially useful for winding magnet wire onto very small toroidal cores.

Until recent years almost all existing toroid winding machines utilized a separable bobbin that could be linked with the toroid core. This bobbin carries the magnet wire which is to be wound upon the core.

This type of toroid winding machine has several inherent disadvantages. One of the greatest disadvantages is that the magnet wire must be wound on the bobbin after the bobbin is linked with the core, thus increasing production time and restricting the minimum cross-sectional area of the bobbin. As the bobbin must pass through the toroid core during the winding operation, bobbin-type machines are restricted to use in winding toroidal cores having an inside diameter at least twice the diameter of the bobbin.

Another important disadvantage of the bobbin-type machine is that they usually require a shuttle to feed the magnet wire from the bobbin to the core. As this shuttle or slider must be accelerated by the magnet wire with each revolution of the bobbin, breakage of the magnet wire is a great problem when the magnet wire is of a very small diameter.

Still a third important disadvantage of the bobbin-type winding machine is that all parts must be manufactured to very close specifications, thus increasing the cost of manufacturing the machines.

The present trend toward miniaturization of electronic equipment has created a great interest in miniature magnetic cores. Needless to say, it is completely impractical to consider winding these very small cores using a bobbin-type toroid winder. Winding are usually placed on these very small cores using hand winding procedures, usually involving the use of a needle the same size or similar to the hand needles used in the textile industry.

In an effort to reduce the very expensive and time consuming hand operations, several toroid winding machines have been devised that do not utilize a bobbin as such. Thus, for example, machines have been devised in which a needle pulling the magnet wire is controlled by one or more moveable magnets. Although this type of machine has a true advantage in the art that they have made it possible to wind the very small miniature cores without resorting to an extremely laborious manual operation, difficulties have arisen in accurately controlling the path of the needle.

The present invention provides a toroid winding machine that is less complex than the prior art machines and therefore more economical to produce. It is extremely simple to operate yet capable of mechanically applying windings to smaller toroid cores than was hitherto possible. Using the toroid winding machine of the present invention, cores having an inside diameter as small as 0.015 inch have been wound with number 50 A.W.G. magnet wire.

According to the present invention, a separable leader is passed through the toroidal core and one end of the magnet wire is attached to the leader. The leader is held light to a rotating disk that supports and drives the leader. Due to the unique manner in which the disk supports and drives the leader, it is practical to use a leader having a diameter of 0.002 inch or less for winding very small wire.

Means are provided to control the loop formed as the wire is wound onto the toroidal core and to tighten the winding formed on the toroidal core.

It is therefore, one object of this invention to provide a toroid winding machine capable of placing windings on toroidal cores of a smaller inside diameter than was hitherto possible.

Another object of this invention is to provide a toroid winding machine that operates without a shuttle or bobbin.

Still another object of this invention is to provide a toroid winding machine that controls the tension of the magnet wire without danger of breaking even small diameter wire.

Still another object of this invention is to provide a toroid winding machine that is of a simpler construction and easier to operate than previous machines.

These and many other objects and advantages of the present invention will be apparent as the following description of the invention unfolds when taken in conjunction with the appended drawings wherein like reference numerals denote like parts and in which:

FIGURE 1 is a plan view of a toroid winding machine according to the preferred embodiment of the present invention:

FIGURE 2 is a view in cross-section illustrating a second embodiment of the invention:

FIGURE 3 is a view, partially in cross-section, taken along line 3—3 of FIGURE 1 that illustrates a tensioning device useful in practicing the present invention:

FIGURE 4 is a view, partially in cross-section, illustrating the manner in which the wire leader may be made separable:

FIGURE 5 is a plan similar to FIGURE 1, but which illustrates a wire control device; and

FIGURE 6 is a view, partially in cross-section, taken along line 6—6 of FIGURE 5.

Turning now to the detailed description of the invention and more particularly to FIGURE 1 of the drawings, a relatively large disk 10 is shown. A groove 12 is formed in the upper surface of the disk 10 that is concentric with and slightly removed from the edge of the disk 10. The preferred configuration of the groove 12 is best illustrated in FIGURE 3. A series of axially spaced holes 14 that contain permanent magnets 16 are formed in the base of the groove 12.

As best seen in FIGURE 2, the disk 10 is positioned within a hole formed in a mounting plate 17 on a bearing 19 and driven by suitable means such as an electric motor 18 and pulley arrangement 21. The motor 18 should be of the variable speed type. The core 20, upon which the winding is to be wound, is held by a core holding fixture 22, above the groove 12, at a height slightly above the upper surface of the disk 10 with its axis perpendicular to the radius of the disk 10 at that point.

The core holding fixture 22 may be either a very simple vice-type attachment or a more complex fixture capable of rotating the core as the winding is applied, depending upon the type of winding required.

A tensioning device designated generally by the reference numeral 26 is located adjacent the rim of the disk 10. Referring to FIGURE 3 of the drawings, the tensioning device 26 comprises a pair of spring members 28 and 30 mounted on a post 32. The lower spring member 28 is shaped to define a notch that extends down into the groove 12 and then up above the surface of the disk 10. The upper spring member 30 extends across the groove 12 and contacts the lower spring member 28 at region 34. Screw 39 controls the pressure with which spring member 30 bears against spring member 28, thereby controlling the tension on the magnet wire that is necessary to cause the wire to slide between the spring members 28 and 30.
The inwardly projecting portion 50 of the groove wall is desirable to control the magnet wire 48. The leader 40 used in practicing the invention is preferably of a very stiff material of high permeability, such as spring steel wire. FIGURE 4 shows one manner in which the leader 40 may be assembled to form a separable loop. As illustrated, one end 42 of the leader 40 is connected to a thin bushing 44 by soldering or other means. The joint between the bushing 44 and the leader 40 should be tapered and smoothed to prevent damage to the insulation on the magnet wire 48 that is wound on the toroidal core. To assemble the separable loop formed by the leader 40, the other end 46 of the leader 40 is inserted in the open end of the bushing 44. The resiliency of the leader 40 will cause the separable loop to be maintained.

The magnet wire 48 that is to be wound on the core may be anchored to the leader 40 by either knotting the wire around the end 42 of the leader 40 adjacent the bushing 44 or a hole 45 can be provided in the bushing 44 in which the magnet wire 48 is inserted as shown in FIGURE 4.

To operate the machine, a toroidal core 20 having the desired size and magnetic characteristics is inserted in the core holding device 22. A leader 40 having a length slightly longer than the circumference of the groove 12 is threaded through the tensioning device 26 as shown in FIGURE 3 and through the core 20. The leader 40 is then assembled as shown in FIGURE 4 to form a separable loop and the magnet wire 48 that is to be wound onto the core 20 may then be attached to the leader 40 as shown in FIGURE 4 or by the simple expedient of tying the magnet wire 48 to the leader 40. The motor 18 is then operated causing the disk 10 to rotate until a length of magnet wire 48 approximately equal to the circumference of the disk 19 has passed through the core 20. At this time the motor 18 is stopped and the loose end of the magnet wire 48 is either held by the operator or tied to the core-holding fixture 22.

The magnet 16 placed in the small holes 14 hold the leader 40 lightly against the bottom of the groove 12, thereby maintaining the position of the leader 40 relative to the disk 10. However, the force of attraction between the leader 40 and the magnets 16 is small enough that the core and the tensioning device can easily hold the leader away from the bottom of the groove 12 as necessary. Except for the portion of the leader 40 that is raised up by the core-holding device and the tensioning device, the magnets will maintain the wire lightly held against the rotor.

After the loose end of the magnet wire 48 has been secured, the motor 18 is again turned on causing the disk 10 to rotate. As the disk 10 rotates carrying the end of the magnet wire 48 connected to the leader 40 in a circular path, the magnetic wire 48 tends to slide across the top of the disk 10 due to the placement of the core 20 slightly above the upper surface of the disk 10. However, before the magnet wire 48 can slide across the top of the disk 10, it must pass through the tensioning device 26 thereby removing any slack that may be in the magnet wire 48 at this point.

When the leader 40 moves in a circular path due to the rotation of the disk 10, the magnet wire 48 moves across the surface of the disk 10 forming a loop as shown in FIGURE 1. That portion of the leader 40 not sliding across the upper surface of the disk 10 is maintained in the groove 12 by the inwardly projecting portion 50 of the groove wall as is desired to control the magnet wire 48 as it slides across the surface of the disk 10 to insure that the magnet wire 48 does not become tangled or knotted. FIGURES 5 and 6 illustrate a means for controlling the movement of the magnet wire 48 whereby a stationary plate 60, provided with a band 62 of felt on its bottom surface, is positioned above the rotating disk 10. The band 62 of felt tends to hold the magnet wire 48 such that a definite tension is required to cause it to move across the face of the rotating disk 10, thereby effectively controlling the movement of the magnet wire 48. The plate 60 may be supported by straps 64, attached to the plate 60 and blocks 66 mounted on the mounting plate 17. The spring members 28 and 30 of tensioning device 26 extend over the surface of the rotating disk 10 a short distance to insure that the magnet wire 48 will feed between the felt 62 and disk 10.

Instead of magnets, a vacuum system can be utilized to hold the leader 40 lightly against the core. According to this embodiment of the invention, the holes 14 are open and extend into the chamber formed by the disk 10 and case 72. Gasket means are provided between the disk 10 and the mounting plate 17 to restrict the flow of air. A suitable opening 76 is formed in one part of the mounting case 72 and a vacuum pump 78 is connected to the opening 76 through tubing 80. When the vacuum pump 78 is operated, the flow of air down through the holes 14 is sufficient to hold the leader 40 lightly against the base of the groove 12 in the disk 10 much in the manner of the magnets 16. The vacuum system has one advantage in that it assists in controlling the magnet wire 48. However, this method is not as satisfactory as the one utilized in the magnets in that the construction utilized in the magnets is somewhat simpler and less expensive to manufacture and maintain.

From the above description it is evident that a toroidal winding machine capable of winding almost any size magnet wire upon any size toroidal core has been provided by this invention. The machine is exceedingly simple to manufacture and operate, yet very reliable in its operation. Although the invention has been described with regard to only two preferred embodiments, many changes and modifications would be obvious to one skilled in the art. The invention, therefore, is not to be limited to what is shown or described herein, but only as necessitated by the scope of the appended claims.

What I claim is:

1. A toroid winding machine comprising a rotatable member having an upper surface, means for rotating said member, means for supporting a toroidal core at a point adjacent to but spaced apart from said rotatable member, a leader for pulling a strand of wire through said core to form a loop, said strand of wire passing over said upper surface as said loop is formed, and means for holding said leader lightly against said rotatable member to produce rotation of said leader responsive to rotation of said member.

2. A toroid winding machine as defined in claim 1 wherein said member defines a disk.

3. A toroid winding machine as defined in claim 2 wherein said member defines a core.

4. A toroid winding machine as defined in claim 3 including additional means to tension said strand of wire and tighten said loop about said core.

5. A toroid winding machine as defined in claim 4 including control means for controlling the movement of said wire across said upper surface.

6. A toroid winding machine as defined in claim 4 wherein said leader is of a magnetically permeable mate-
rial and said means for holding said leader lightly against said disk comprises a plurality of magnets.

7. A toroid winding machine as defined in claim 4 wherein said means for holding said leader lightly against said disk comprises a vacuum system.

8. A toroid winding machine comprising a rotatable disk having an upper surface, means for rotating said disk, means for supporting a toroidal core at a point adjacent to but spaced apart from said rotatable disk, a separable leader for pulling a strand of wire through said core to form a loop, said strand of wire passing across said upper surface as said loop is formed, tensioning means for tightening said loop about said core, means for controlling the movement of said wire across said upper surface as said loop is formed and tightened, and magnetic means for holding said leader lightly against said disk to produce rotation of said leader responsive to rotation of said disk.

9. A toroid winding machine as defined in claim 8 wherein a concentric groove is formed in the upper surface of said disk near the edge of said disk, said magnetic means being placed in the base of said groove.

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