Jan. 3, 1961 A. F. SULLIVAN 2,966,741

METHOD OF MAKING GROOVED RINGS

Filed July 15, 1957 2 Sheets-Sheet 1

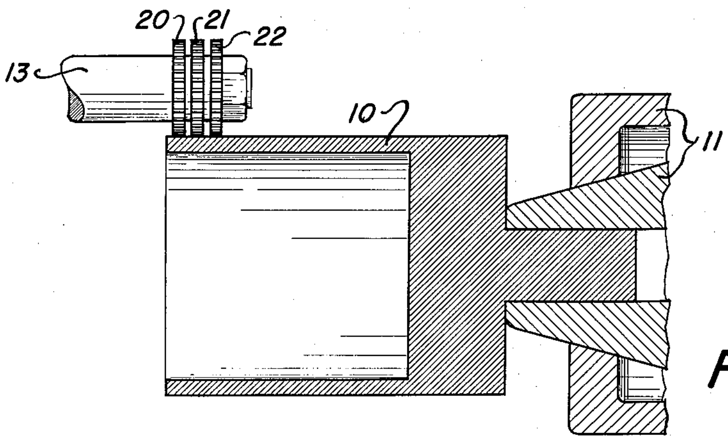

Fig. 1

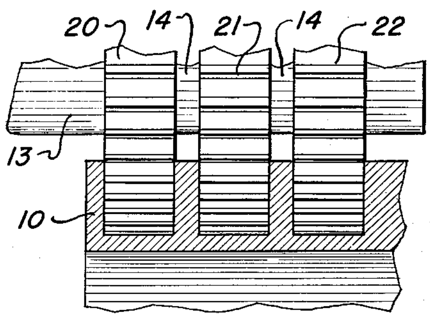

Fig. 2

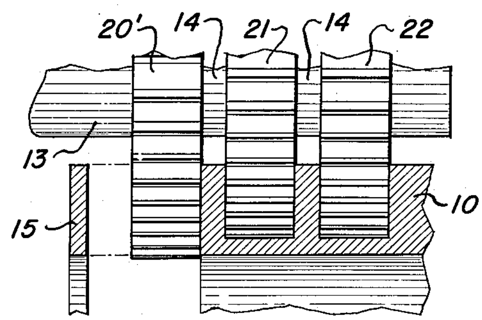

Fig. 3

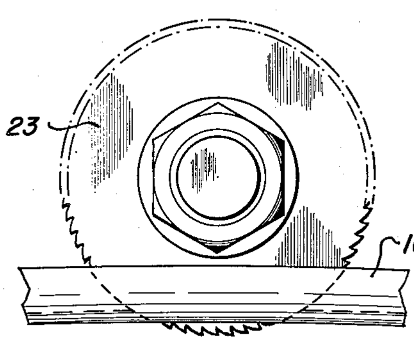

Fig. 4

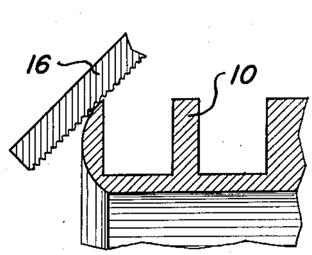

Fig. 5

INVENTOR:
Anthony F. Sullivan
BY
Edward L. Amonette
AGENT

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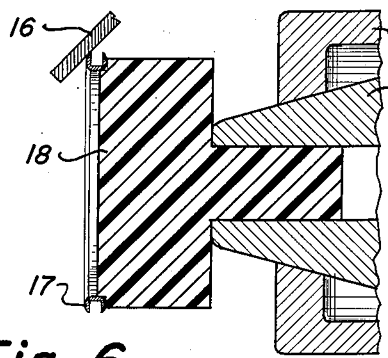

Fig. 6

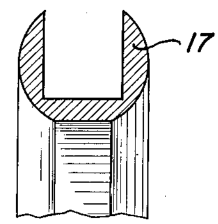

Fig. 7

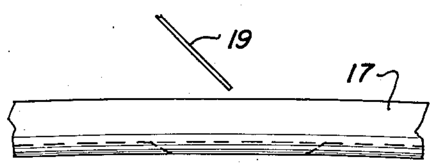

Fig. 8

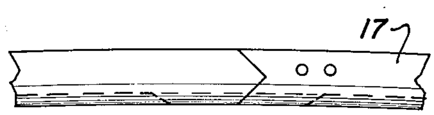

Fig. 9

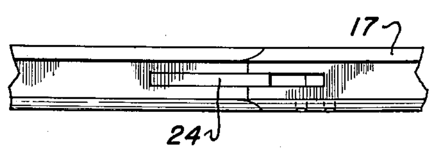

Fig. 10

INVENTOR:
Anthony F. Sullivan
BY
Edward L. Amonette
AGENT

United States Patent Office

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METHOD OF MAKING GROOVED RINGS

Anthony F. Sullivan, 704 Palomas Drive NE., Albuquerque, N. Mex.

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2 Claims. (Cl. 29—558)

My invention relates to an improved method of making grooved rings and is of particular value in making grooved ring shuttles such as are commonly used in toroidal coil winding machines, although the method is applicable in the manufacture of grooved rings for many other uses.

The grooved rings I refer to have the common feature of a generally U-shaped cross section, open at the outer periphery. When such a ring is used as a shuttle, in a toroidal coil winding machine, it is broken at one point and linked with a toroidal core and wire is wound on the shuttle, filling the groove. Then the shuttle is rotated about its axis in a direction to unwind the wire, one end of which is attached to the core. As the wire unwinds it rewinds itself upon the core, forming a toroidal coil. It is apparent that the amount of wire that can be wound on a core of a given size is dependent not only upon the capacity of the shuttle, but also upon its cross-sectional dimensions, since the size of the center opening of the toroid decreases with each winding layer until the opening is only large enough to pass the shuttle.

In the past ten years the increase in complexity and size of electronic and electrical apparatus has created a demand for smaller circuit components which not only will take up less room, but also will require less power, reducing the size of the power supplies. As smaller toroidal cores were demanded, the ring shuttles were decreased in size to some extent. However, due to the methods commonly used in the manufacture of shuttles, and due to the way in which they were driven in the winding machines, the desired degree of miniaturization could not be attained. Until recently, all shuttles were mechanically driven in rotation. This required that a ring shuttle have thick sidewalls to prevent distortion of the shuttle and poor windings resulting therefrom. A common method of making shuttles included a rolling or lathing operation, satisfactory in producing shuttles with thick sidewalls, but not compatible with the manufacture of smaller shuttles having thin sidewalls.

With the invention of the toroidal coil winding machine using magnetic forces to support and drive the shuttle, the use of more fragile shuttles has become possible, since practically no strain is imparted to the shuttle during use. In order to wind a toroidal coil having a finished center .035 or less in diameter, a ring shuttle was needed whose cross section would freely pass through that center. When the volume of the wire load to be carried in the shuttle groove was considered, I realized that the walls and bottom of the shuttle could be only a few thousandths of an inch in thickness. It soon became apparent that rolling and lathing operations are not applicable to the manufacture of a ring shuttle of those cross-sectional dimensions. For instance, when I attempted to manufacture on a lathe a ring shuttle having the required cross-sectional dimensions and a diameter of two inches, the pressure of the tool on the sidewalls introduced stresses which warped the shuttle to the extent that it could not be used in the winding machine.

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By the use of my new method, which I will now briefly describe, equal tool pressure is applied to both sides of the sidewalls of the grooved ring during manufacture, preventing the introduction of stresses into the walls, and hence preventing warping of the ring. I start out with a hollow cylindrical blank having a wall thickness equal to the desired radial thickness of the finished ring shuttle and a diameter equal to the shuttle diameter. Then I rotate the blank about its longitudinal axis while three spaced rotating cutting tools simultaneously remove material from the blank, leaving the desired U-shaped cross section of the ring. After the cuts have been made to the desired depth of the center cut, any of several procedures which I will later describe may be followed in finishing up the ring shuttle.

I have defined my invention in the appended claims, and have described certain apparatus with particularity below, intending only to illustrate one way in which my invention may be practiced, without limiting my invention thereto. In the accompanying drawing:

Fig. 1 is a view of the tool setup for making the initial cuts in the cylindrical blank, shown in section;

Fig. 2 is a detailed view of a portion of Fig. 1, showing the relationship of the cutting tools to the wall of the blank;

Fig. 3 is similar to Fig. 2, illustrating an alternate cutting tool setup;

Fig. 4 is a fragmentary end view of the blank, showing the operation of forming a slot in the bottom of the center cut;

Fig. 5 is a fragmentary sectional view of the blank after the initial cuts have been made and the waste material removed, illustrating the step of shaping the edge of the blank;

Fig. 6 is a sectional view of the rough grooved ring being held on a stub arbor for shaping of its remaining rough side;

Fig. 7 is a cross-sectional view of the finished grooved ring;

Figs. 8 and 9 are fragmentary views of the ring shuttle, showing the step of "breaking" the shuttle; and

Fig. 10 is another fragmentary view of the ring shuttle, showing the addition of a locking tongue at the point of the break.

As shown in Fig. 1, hollow cylindrical steel blank **10** is rotatively supported at one end by chuck **11**. The blank previously has been rough-turned from a casting, then hardened and finish-turned to the desired inside and outside diameters of the grooved ring to be manufactured. The wall thickness of the blank, then, equals the desired radial thickness of the finished ring. Three slitting saws **20**, **21**, and **22** are spaced on shaft **13** in cutting relationship to the outer periphery of the blank, shaft **13** being parallel to an element of the cylindrical blank.

The first operation in forming a rough cross section of the grooved ring is to rotate shaft **13** at high speed, so that the slitting saws remove material from the blank, leaving a pair of spaced sidewalls. As the material is removed, blank 10 is slowly rotated by means of chuck 11 so that the cuts progress around the periphery of the blank. If saws 20, 21 and 22 are sturdy enough, the desired depths of the cuts may be made in one revolution of the blank. However, if a fragile ring is being made, having sidewalls several thousandths of an inch in thickness, I have found it necessary to deepen the cuts a fraction of their final depths with each revolution of the blank. Thus, the tiny slitting saws are subjected to relatively small stresses and more accurate cuts can be made with less damage to the saws.

Fig. 2 shows in detail the relationship of the slitting saws to the wall of the blank. Each of the three saws is seen to have the same diameter, and they are shown in the position of maximum depth of cut, the saw 21 having cut the center groove to its desired depth. The width of saw 21 is chosen according to the desired width of the center groove, while the widths of saws 20 and 22 are not critical. Spacers 14 are chosen to be the same thickness as the sidewalls of the rough ring. The diameters of spacers 14, shaft 13 and the retaining piece to the right of saw 22 should be substantially equal, so tha all three saws are subjected to equal stresses. It is apparent from an examination of Fig. 2 how I can manufacture grooved rings with thin sidewalls having practically no distortion or unrelieved stresses. The sidewalls on either side of the center groove are seen to be supported on both sides by the slitting saws at all times during the cutting operation. Further, the cutting is done in a direction parallel to the sidewalls, so that there is no pressure directly against them.

If desired, a tool setup as shown in Fig. 3 may be used, so that two of the manufacturing operations may be accomplished with one setup. In the arrangement of Fig. 3 the slitting saw 20′, nearest the free edge of the blank, has a diameter greater than that of the center saw by an amount equal to the thickness of the bottom of the center groove when finished. Thus, when the cutting is started, only the outside saw removes material from the blank. When its cut is the depth of the difference in diameters, the other two saws begin to make their cuts. When saw 21 reaches the prescribed depth of the center groove, the outside saw 20′ then cuts its way through the wall of the blank, and waste piece 15 is removed. If the setup of Fig. 2 is used, the removal of waste piece 15 is removed. If the setup of Fig. 2 is used, the removal of waste piece 15 is a separate operation, requiring the removal of slitting saws 21 and 22 and the deepening of the cut by saw 20 until the waste piece is severed from the blank.

Fig. 4 is an end view of the blank, showing the next step of manufacture following the removal of the waste piece. This step is necessary in forming the ring shuttle for use in toroidal coil winding machines, and may be omitted in manufacturing other types of grooved rings. In this step slitting saw 23, which is about one-third the thickness of saw 21, is used to cut a slot in the bottom of the center groove at one point.

Either before or after the step illustrated by Fig. 4 the side of the ring from which the waste piece was removed is shaped and smoothed, as shown in Fig. 5. The blank, with the unfinished ring still attached, is rotated by the chuck as in Fig. 1, and a file or piece of abrasive material 16 is held against the rough side of the ring and manipulated until the desired shape is obtained. In order to add strength to the fragile ring shuttle I shape the rough side until it is approximately semicircular.

Next, the rough ring shuttle is parted from the remainder of the blank by completing the cut started by saw 22, shown in Figs. 2 and 3. This may be done by using a single slitting saw, such as saw 22, or by using the tool setup shown in Fig. 3 in the following manner: Shift the position of the blank longitudinally relative to the slitting saws until saw 20′ will engage the slot previously cut by saw 22. Then, providing saws 20′ and 22 have the same width, a new grooved ring may be cut from the blank coincident with the operation of parting the first ring from the blank. This procedure is most economical in the use of both time and material, there being no waste piece 15 after the first ring is cut.

As shown in Fig. 6, rough ring shuttle 17 is placed, finished side inwards, on the close-fitting ledge of stub arbor 18, the arbor being rotatably held by chuck 11. As the stub arbor is rapidly rotated by the chuck, carrying with it the ring shuttle, the rough side of the shuttle is shaped by abrasive 16 in the same manner as was its other side. A cross section of the ring shuttle 17 now appears as shown in Fig. 7.

Since the ring shuttle must be separable at one point so that it can be linked with a toroidal core when used with a toroidal coil winding machine, the next operation is to "break" the shuttle. Fig. 8 is a fragmentary side view of the shuttle as it is held in a vise (not shown) and the first of two cuts is being made by a saw or edged file 19. Each cut extends halfway through the shuttle and they meet at right angles, as shown in Fig. 9.

In order to prevent misalignment of the ring shuttle at the break, a locking tongue 24 must be added, as shown in Fig. 10. The tongue fits into the slot in the bottom of the center groove, flush with the groove bottom. It is soldered to the ring shuttle at one side of the break and extends across the break into the remainder of the slot, where it fits snugly but removably.

I have described a new and novel method of making grooved rings, and suggested added steps to be followed if it is desired to make ring shuttles from the grooved rings. A person skilled in the art will recognize that among the advantages of my method is the fact that it is much less time-consuming than methods practiced in the past; also that the method is particularly adapted to the making of fragile grooved rings having wall thicknesses of several thousandths of an inch, but it is not limited thereto. Almost any size of grooved ring may be made by my method by the proper choice of the size of the tools used. Many variations in the preferred method described above may be practiced without leaving the sphere and scope of my invention as claimed below. For instance, although only slitting saws are shown in the drawing, it is not intended that the invention be limited to the use thereof; other cutting tools, such as abrasive wheels, may be used. Regardless of the cutting tools used, a person practicing the method will find it expedient to continuously remove the chips from the cut by means of a flowing liquid or gas.

I claim as my invention:

1. The method of making a grooved ring from a hollow cylindrical blank having a wall thickness equal to the desired radial thickness of the ring, which comprises rotatively supporting the blank at one end, simultaneously rotating the blank about its longitudinal axis and forming the U-shaped cross section of the ring by means of three spaced rotating cutting means operating on the outer periphery of the blank, the cutting means nearest the unsupported end of the blank being arranged to sever the waste piece of the blank from the ring when the desired depth of the center cut is attained, separating the ring from the remainder of the blank by completing the cut nearest the supported end of the blank, forming a slot through the bottom of the groove, shaping the sides of the ring, breaking the ring, and adding aligning means to the ring at the break.

2. The method of making a grooved ring from a hollow cylindrical blank having a wall thickness equal to the desired radial thickness of the ring, which comprises rotatively supporting the blank at one end, simultaneously rotating the blank about its longitudinal axis and forming the U-shaped cross section of the ring by means of three spaced rotating cutting means operating on the

outer periphery of the blank, the cutting means nearest the unsupported end of the blank being arranged to sever the waste piece of the blank from the ring when the desired depth of the center cut is attained, and relocating the blank with respect to the three spaced cutting means so that the cutting means nearest the unsupported end of the blank separates the ring from the remainder of the blank while the remaining cutting means form another grooved ring from the blank adjacent the aforementioned grooved ring.

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