Aug. 16, 1927. 1,639,019

F. AUTY

MANDREL

Filed July 25, 1924

Fig. 1.

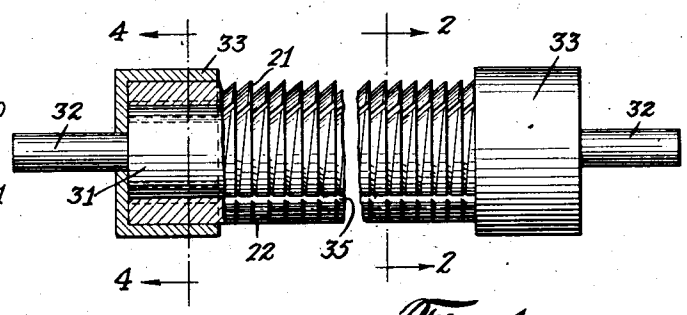


Fig. 2.

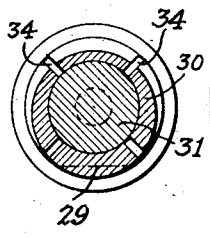


Fig. 3.

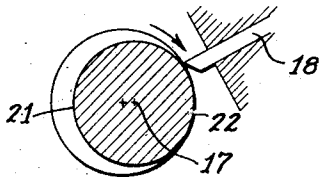


Fig. 3a

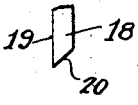


Fig. 4.

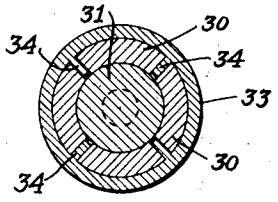


Fig. 5.

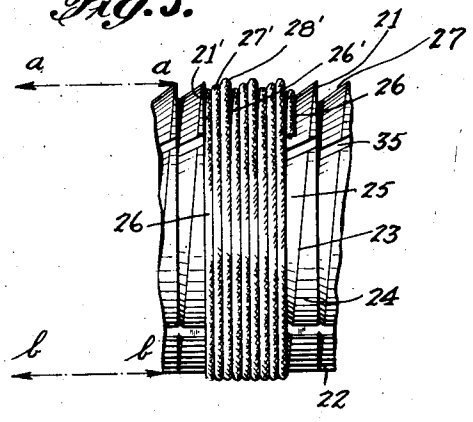


Fig. 6.

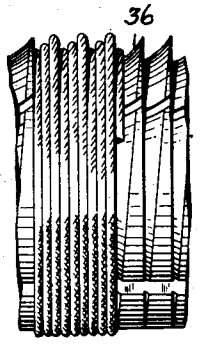
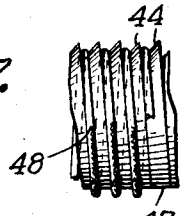


Fig. 7.



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Patented Aug. 16, 1927. 1,639,019

UNITED STATES PATENT OFFICE.

FRANK AUTY, OF NEW YORK, N. Y.

MANDREL.

Original application filed March 5, 1924, Serial No. 697,063. Divided and this application filed July 25, 1924. Serial No. 728,072.

My present invention is primarily concerned with mandrels for use in winding toroidal coils more especially of wire.

It is among the objects of the invention to provide a mandrel of simple, inexpensive and rugged construction that can be easily made and that can be used without the exercise of substantial skill for the formation of a generally cylindrical coil formed to adapt itself readily for bending into a torus formation.

In the preferred mode of executing the invention, the entire effective length of the mandrel is provided with peripheral notches of appropriate shape, said notches of maximum depth and width along one element of the generally cylindrical mandrel, progressively decreasing to a minimum, preferably zero depth and width at the diametrically opposite element of the mandrel. The cross section of the notch being preferably V-shaped with one side substantially radial of the mandrel and the other side inclined, it follows that in winding the wire thereon, the successive convolutions thereof will contact to cover the inclined side of the notch, whereupon the next convolution will drop into the base of the succeeding notch, until the effective length of coil has been formed. The mandrel is preferably of collapsible type, so that it can be readily removed from within the wound coil, without disturbing the winding thereof.

Other objects and features of the invention will be in part obvious and in part set forth hereinafter.

In the accompanying drawings in which are shown one or more of various possible embodiments of the several features of the invention:

Fig. 1 is a fragmentary view of one form of mandrel for making the coil,

Fig. 2 is a sectional view taken along the line 2—2 of Fig. 1,

Fig. 3 is a diagrammatic view illustrating the method of making the mandrel,

Fig. 3ª is a fragmentary view of the tool for cutting the mandrel.

Fig. 4 is a view in transverse cross-section taken along the line 4—4 of Fig. 2,

Fig. 5 is a fragmentary view on an enlarged scale illustrating the detailed construction of the mandrel of Fig. 2 and the method of winding the wire thereon.

Fig. 6 is a view similar to Fig. 5 of a modified form of the invention, and;

Fig. 7 is a view similar to Figs. 5 and 6 of a further modification.

Similar reference characters refer to similar parts through out the several views of the drawings.

The present application is a division of my copending application, Serial No. 697,-063, filed March 5, 1924, issued March 31st, 1925 as Patent No. 1,531,681.

The mandrel by which the torus is produced, includes a winding surface modified from the cylindrical form as will appear best from Figs. 1 to 5. The mandrel construction will be most readily understood from the method by which it is made. For this purpose, a tube of diameter equal to the inner diameter of the torus convolutions is mounted eccentrically, for instance, on centers 17 within a lathe (not shown). A tool 18 is employed having a cutting edge of buttress thread type, that is a V-shaped cutting edge with one side 19 substantially longitudinally of the tool shank and the other side 20 oblique as best shown in Fig. 7ª. The tool being held by an appropriate rest (not shown) so that its point substantially engages with the mandrel at the element thereof nearest the eccentric mount, the mandrel is rotated, whereby, as will be easily understood, a peripheral groove or notch V-shaped in cross-section will be cut, of maximum depth as at 21 at the side nearest the eccentric mount, progressively decreasing to a minimum or zero depth at the side 22 diametrically opposite thereto. The operation set forth is repeated at intervals corresponding to the cutting width of the cutting tool, so that the entire effective length of the mandrel will be notched, as best shown in Figs. 1 to 5. It will be seen that as the depth of cut decreases, peripherally about the mandrel from the maximum at one side thereof, the width thereof decreases correspondingly. A plane oblique edge 23 is therefore formed at each peripheral notch. The portion 24 to the right of the edge 23 remains cylindrical. The portion 25 to the left of oblique edge 23 is V-shaped in cross-section of maximum depth and width at the element *a*—*a* corresponding to the side 21 and gradually decreasing both in depth and width progressively about the mandrel in both directions

to zero at the diametrically opposite element *b*—*b*, corresponding to side 22.

The mandrel described being mounted concentrically in a lathe or equivalent driving means, the wire or other element 26 to be wound thereon is applied at the base of one of the notches 21′. When the mandrel is now rotated, the wire will form substantially a helix. Consecutive convolutions thereof will be in lateral contact with each other along the straight element *b*—*b* at one side of the mandrel while at the diametrically opposite side *a*—*a*, the consecutive convolutions will climb up the incline 27′ of the notch 21′ until after the apex 28′ of the notch is reached, the next convolutions 26′ will drop into the base of the succeeding notch for consecutive turns to build up along the corresponding notch incline. Thus, the conformations of the successive convolutions will vary to correspond with the mandrel, the convolutions 26′ engaging the bases of the notches having a maximum eccentricity or degree of flattening extending substantially entirely within the original cylinder from which the mandrel was cut, while the convolutions corresponding to the apex or outer edge 28′ of the notches are substantially circular without eccentricity, since as will be seen, they substantially follow along the uncut part of the mandrel surface.

The mandrel being of appropriate collapsible type, best shown in Figs. 1, 2, and 4 which will be described hereinafter, it is removed from within the wound coil after the adhesive tape (not shown) has been applied along the element *b*—*b* of the latter.

It will be seen that the coil when removed from the mandrel and before it is curved into torus form, will present a segmented appearance, the convolutions being in contact with each other along element *b*—*b* but arranged in groups at other elements thereof. By reason of this segmental or stepped conformation, as the coil is curved to form the torus, the successive segmented groups will readily lap or telescope with respect to each other, the convolutions of smaller diameter entering into the neighboring convolutions of larger diameters in the manner more fully described in the parent application.

If desired, the mandrel may be flattened as along line 29 at the side 22 where the notches are of minimum or zero depth. The wire when wound on the mandrel will have its convolutions correspondingly flattened, and the plane determined by said flattened portions will more readily curve into a cylinder forming the outer periphery of the toroidal coil, than if the turns were cylindrical at the part of the helix that is to be curved into the outer periphery of the toroidal coil. Moreover, the tape in that event will develope no folds or wrinkles in curving into a cylindrical loop as the torus is formed.

By the use of a mandrel with corresponding width of notch relative to the diameter of the wire, a toroidal coil with any ratio of outer to inner diameter can be produced.

To render the mandrel collapsible, any appropriate construction may be provided. In a preferred embodiment, the stepped cutting mandrel tube is slit longitudinally in a number of segments 30 preferably four, said segments embracing a solid cylindrical core 31, which may be of vulcanite and which has protruding metal center pieces 32. The segments are maintained assembled upon the core by end caps 33 preferably formed with integral spacing fins 34 to maintain the uniformity of the narrow gap 35 between the successive mandrel segments. It follows, therefore, that after the coil has been wound on the mandrel, the latter is collapsed by simply removing one of the end caps and drawing out the core whereupon the multiplicity of segments of the mandrel tube will collapse within the coil and can be removed without in any way distorting the wound product.

It will be understood that though I prefer to make my mandrel according to the method set forth, it can be produced by other methods.

In Fig. 6 is shown a somewhat modified form generally similar to that described except that instead of forming the oblique side 27 of each notch straight in cross-section, the same is formed curved in cross-section as shown at 36. By this curvature in some cases, the lapping or telescoping action in curving the helix into the torus may be somewhat facilitated.

In Fig. 7 is shown a further embodiment which in certain special applications may be desirable, although in general, I prefer the embodiment shown in Fig. 2. The mandrel here instead of being formed with distinct peripheral notches is cut on a continuous thread, using, however, the identical buttress thread cutting tool 18 and mounting the mandrel in exactly the same manner as shown in Fig. 7 in the process of making the same. By this construction, the tool 18 being fed lengthwise of the mandrel, as in thread-cutting machines, a buttress thread 44 is formed of pitch equal to the maximum width of the individual notch cut, which notch cut decreases both in width and depth peripherally about the mandrel to a minimum or zero at the diametrically opposite element 47 substantially as in the embodiment of Fig. 1.

When a coil is wound on the mandrel just described, it will be seen that it will be fed forward by the pitch of the thread 44, as best shown in Fig. 7. One such wire 48 having been thus wound along the mandrel, a second or independent wire (not shown) would be placed against the first and would

thereby be wound in lateral contact therewith, whereupon a third, and depending on the dimensions of the torus to be produced, further wires would be wound, each in contact with the previously applied wire until the incline of the thread notch is substantially entirely covered. Thereafter the helical coil would be curved to form the torus in the manner already described.

In some applications, it may be desirable to form the individual turns of the toroidal coil generally elliptical rather than generally circular. For this purpose, the mandrel would be formed as a generally elliptical cylinder with the notches heretofore described.

The invention is not limited in its application to wireless apparatus but can be applied to other uses and many of the aspects thereof are more broadly applicable to winding and reeling, apart from electrical application.

It will thus be seen that there is herein described apparatus in which the several features of this invention are embodied, and which apparatus in its action attains the various objects of the invention and is well suited to meet the requirements of practical use.

As many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:—

1. A mandrel for use in winding toroidal coils, said mandrel having a notch formation of maximum depth along one element thereof decreasing peripherally about the mandrel progressively to a minimum at the diametrically opposite element.

2. A mandrel for use in forming toroidal coils, said mandrel being of zigzag form in one longitudinal section thereof, the zigzag having alternate radial and inclined segments, the depth and width of said zigzag decreasing progressively in successive radial sections of the mandrel to substantially a straight line or a zigzag of zero depth at the section diametrically opposite the first section.

3. The combination set forth in claim 2, in which the mandrel has a flattened face at the side opposite that of maximum depth of zigzag cross-section.

4. The combination set forth in claim 2, in which the mandrel is of collapsible type to permit removal thereof with respect to the coil of wire wound thereon.

5. A mandrel for use in winding toroidal coils, said mandrel having a succession of identical peripheral notches therein along the entire effective length thereof, said notches of maximum depth along one element of the generally cylindrical mandrel and decreasing progressively to a minimum at the diametrically opposite element.

6. A mandrel for use in winding toroidal coils, said mandrel having a succession of identical peripheral notches therein along the entire effective length thereof, each notch generally V-shaped in cross-section with one side thereof extending radially of the mandrel and the other side thereof inclined, said notches of maximum depth along one element of the generally cylindrical mandrel progressively decreasing to a minimum along the diametrically opposite element.

7. The mandrel as claimed in claim 6, in which the width of each notch decreases progressively from the portion of maximum depth to that of minimum depth.

8. A mandrel for use in winding toroidal coils, said mandrel being generally cylindrical and having thereon a thread formation of pitch substantially equal to the width of the thread, all of said thread convolutions having a maximum depth along one common element of the cylinder decreasing progressively peripherally about the mandrel to a minimum at the diametrically opposite element of the cylinder.

9. A mandrel for use in winding toroidal coils, said mandrel being generally cylindrical and having thereon a buttress thread formation of pitch substantially equal to the width of the thread, all said thread convolutions having a maximum depth along one common element of the cylinder decreasing progressively peripherally about the mandrel to a minimum at the diametrically opposite element of the mandrel.

Signed at New York in the county of New York and State of New York this 24th day of July, A. D. 1924.

FRANK AUTY.