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SMALL SIZED HELIXES AND METHOD OF THEIR FABRICATION

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FIG. 1

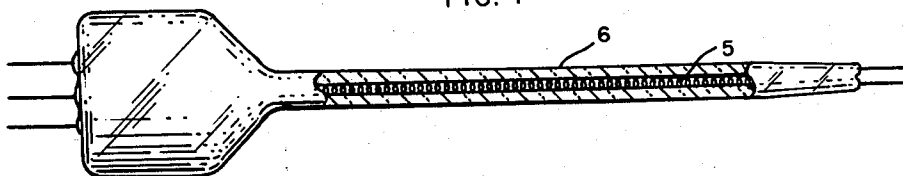


FIG. 2

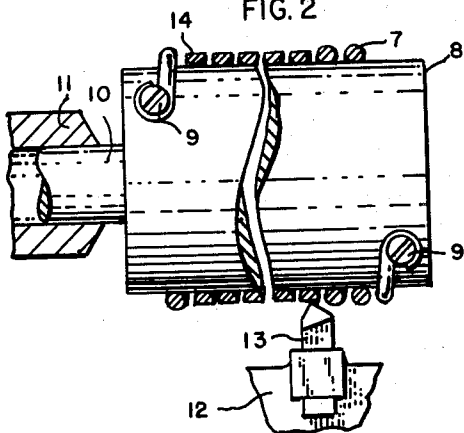


FIG. 3

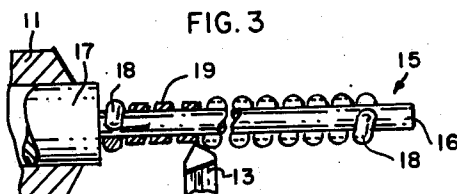
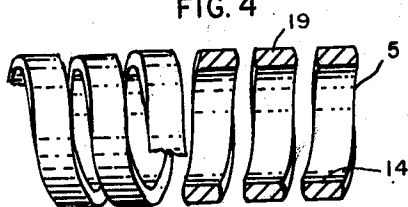


FIG. 4



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SMALL SIZED HELIXES AND METHOD OF THEIR FABRICATION

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4 Claims. (Cl. 29—155.5)

(Granted under Title 35, U.S. Code (1952), sec. 266)

The invention described herein may be manufactured and used by or for the Government for governmental purposes without the payment of any royalty thereon.

This invention relates to miniature helixes made of metallic wire and the manner of making them. The invention relates particularly to a method of making such helixes to close dimensional tolerances despite the inherent fabricating difficulties in the use of materials as refractory metals.

In the electronics art and in other arts as well certain components of the apparatus used must be fabricated with a high degree of precision and moreover the material out of which these components are made in many instances have inherent properties which render conventional fabricating techniques ineffective. One of the most difficult problems encountered is the fabrication of wire helixes which must conform to rigid specifications. Such helixes may be elements of electronic tubes, filaments for electric lamps and the like.

A particularly difficult fabricating operation is the forming of helixes for use in traveling wave tubes. When such tubes are to be operated in the millimeter wave bands and helixes along which the electromagnetic waves are propagated are very small and the convolutions of the helix must be spaced very close. Such an element is extremely delicate and difficult to manufacture while holding its dimensions within rigidly specified tolerances.

Since the present invention is particularly well adapted to the fabrication of the above type of helixes it will be presented in connection with their fabrication as one example of the broad applications of the principles of the invention. In a traveling wave tube the helix 5 extends between the input and the output ends of the tube and is contained in an elongated glass inclosure 6. The helix 5 must fit the inclosure accurately to overcome tendencies of vibration of the helix within its envelope. This requirement coupled with the fact that it is not possible to obtain glass tubing for the inclosure having consistently accurate internal dimensions, makes the satisfactory construction of such tubes by conventional techniques very difficult. The invention provides readily applied dimensional controls which enable the tube elements to be assembled to conform with the rigid standards necessary for proper function of the tube.

It should be pointed out also that the techniques to be described hereinafter make possible fabrication of delicate wire helixes of refractory metals such as tungsten, molybdenum, tantalum and similar metals.

It is a primary object of the invention to provide efficient means to precisely fabricate miniature type metallic helixes.

A further object of the invention is to provide accurately formed coils or helixes made of wire having refractory characteristics.

A further object of the invention is to provide means and method for fabricating small precision helixes of flat ribbon wire having uniform dimensions held within close dimensional tolerances.

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Other objects and features of the invention will more fully appear from the following description and will be particularly pointed out in the claims.

To present a better understanding of the invention a particular embodiment thereof will be described and illustrated in the accompanying drawings wherein

Fig. 1 is an illustration of an electronic tube wherein the product of the invention is used.

Fig. 2 illustrates one step in the fabricating process showing the wire at an enlarged scale for clarity.

Fig. 3 illustrates the final fabricating step in the process, and

Fig. 4 is a view in partial cross-section of a helix constructed in accordance with the invention.

The practice of the invention involves the reforming of round wire to a flat ribbon. The wire from which the final helix is formed must have dimensions greater than the dimensions of the convolutions of the final product. For purposes of illustration a round wire has been chosen as the basic material from which the helix is made. The material in the example to be described may be tungsten, tantalum, or similar metal suitable for the particular application desired. The cross-sectional size of the round wire must be large enough to encompass the rectangular cross-sectional final shape of the wire of a finished helix.

A required length of wire 7 is first wound upon a cylindrical mandrel 8. Preferably the diameter of the mandrel should be several times that of the diameter of the finished helix to avoid unduly flexing the wire. A specified minimum diameter for this mandrel should be maintained depending upon the diameter of the round wire. The correct diameter for the mandrel may be established by setting up a ratio of wire diameter to mandrel diameter. A ratio of 1 to 300 has been found to be satisfactory. After winding the wire on the mandrel its ends are secured thereto in any suitable manner such as by clamping screws 9. Other means for anchoring the wire such as spot-welding may be employed. The winding operation may be performed in any suitable manner. Desirably, the mandrel 7 may be provided with a shank portion 10 which may be chucked accurately on its axis in the spindle 11 of a winding machine, a lathe or other means for rotating the mandrel.

The wire is now ready for a first machining operation which may be done in the same machine as that in which the winding was accomplished. In any event, it must be a machine capable of performing a precision machining operation such as a precision lathe wherein the mandrel is accurately rotated on its axis. The machine also must have a carriage 12 for traversing a cutting tool 13 or its equivalent which may be a grinding wheel. A fine control of the depth of cut of the tool must also be provided. The machine is operated to remove a predetermined amount of metal from the periphery of the wire. A careful check of the depth of the cut is made during the machining operation which may require one or more traverses of the tool 13. Measurement of the depth of the cut may be made in the conventional manner as by the use of a micrometer caliper.

The extent of the first machining operation which produces the flat surface 14 upon the wire is determined by the rectangular cross-sectional shape of the final form of the wire. The extent of the first machining operation should be such that the final ribbon will be composed of the metal substantially along the center portion of the round wire. A polishing operation may then be performed upon the flat surface 14.

A second mandrel 15 is prepared having a cylindrical portion 16 whose diameter is the exact size of the internal dimension of the finished helix. This mandrel is also provided with a shank portion 17 which is chucked in a

machine capable of rotating it upon its axis and of performing a precision machining operation. Such machine may be the same or similar to that used in the first machining operation. The partially processed wire is removed from the mandrel 7 and rewound upon the mandrel 15 with its flat face 14 engaging the cylindrical portion 16 of the mandrel. This winding operation is carefully performed to establish the required pitch in the helix. The wire is then anchored upon the mandrel in any suitable manner such as by spot-welding 18.

The second machining operation is then performed to produce a second flat face 19 upon the wire parallel to the face 14. During this machining operation the depth of the cut is precisely controlled to produce a helix having an exact predetermined uniform outside diameter. The polishing operation may also be performed in connection with the second machining operation and serves not only to provide a fine finish but also may serve as a final sizing operation. The helix is then fired in the usual manner to stabilize its dimensions and conformation. The firing operation may be performed while the helix is on the mandrel 15 providing the material of the mandrel is chosen to have a coefficient of expansion the same or very close to that of the helix material. The mandrel material should also resist distortion during heat treatment so that it may be used repeatedly for successive helices made by the process.

The precise control it is possible to exercise over the dimension of the helix makes possible a close fit within the inclosure envelope 6 in a traveling wave tube as has been suggested, irrespective of slight variations in the internal dimension of glass tubing available to inclose the helix. It is obvious also that the ability to control the size of the helix within close tolerances makes it possible thru the practice of the invention to construct helices used in other devices such as multi-element electron tubes of many types and especially in those applications where high precision is essential.

The flat wire helices produced by the invention are well adapted for use as filamentary cathodes, cathode heaters or incandescent lamp filaments wherein fine coils of refractory type metal are used.

What is claimed is:

1. A method of fabricating small metallic wire helices of high precision such as those used in traveling wave tubes comprising helically winding a wire of larger size than that of the finally processed wire upon a cylindrical mandrel having a diameter several times that of the finished helix, securing the wire in contact with the mandrel, while rotating the mandrel on its axis machining the outer peripheral surface of the wire to form a cylindrical conformation coaxial parallel to the mandrel axis and defined by the flat faces on the periphery of the wire, removing the wire from the first mandrel and helically winding it upon a second cylindrical mandrel in a helix having the desired pitch with its flat face engaging the mandrel, said second mandrel having its outside diameter equal to the internal diameter of the finished helix, securing the wire in contact with the mandrel, while rotating the mandrel on its axis machining the outer peripheral surface of the wire to form a cylindrical conformation coaxial parallel to the mandrel and defined by the flat faces on the periphery of the wire, during each machining accurately controlling the outside diameter of the helix until its final diameter is obtained with a high degree of precision such as that required for use in traveling wave tubes.

2. A method according to claim 1 and in addition the step of firing the helix to stabilize its dimensions and conformation after the completion of its forming steps.

3. A method of fabricating small helices of high precision, such as those used in traveling wave tubes, using refractory metallic wire having a cross sectional size and shape slightly larger than the processed wire is to be, helically winding the wire upon a cylindrical mandrel at least several times the diameter of the finished helix, securing the wire in contact with the mandrel, while rotating the mandrel on its axis machining the periphery of the wire to form a cylindrical conformation coaxial to the mandrel axis and defined by the flat faces on the periphery of the wire, during the machining controlling the extent of such machining to obtain an accurate predetermined diameter for the said cylindrical conformation, preparing a second cylindrical mandrel having the exact diameter of the desired internal diameter of the completed helix, removing the wire from the first mandrel and helically winding it upon said second mandrel with its flat face in contact with the mandrel, said winding operation being controlled to produce a predetermined helix pitch, securing the wire in contact with the mandrel, while rotating said second mandrel upon its axis machining the outer peripheral surface of the wire to form a cylindrical conformation coaxial to the mandrel axis and defined by the flat faces on the periphery of the wire, during such machining controlling the outside diameter of the helix until its final diameter is obtained with a high degree of precision such as that required for use in traveling wave tubes.

4. A method of fabricating a miniature flat ribbon type helix of high precision such as are used in traveling wave tubes from a refractory metallic wire comprising selecting a round wire of the said metal having a diameter equal to the width of the desired ribbon, helically winding a portion of the wire upon a cylindrical mandrel at least several times the diameter of the finished helix, securing the wire in contact with the mandrel, while rotating the mandrel on its axis machining a flat surface upon the periphery of the wire coaxial with the mandrel axis while controlling the extent of such operation accurately to place the flat face thus formed in a position where it will bound one side of the finished ribbon lying in the central cross-sectional area of the round wire, helically winding the processed wire upon a second cylindrical mandrel having the exact diameter of the internal dimension of the finished helix with its flat face against the mandrel and simultaneously establishing the desired helix pitch, securing the wire in contact with the mandrel, while rotating the mandrel upon its axis machining a second flat surface upon the wire parallel to the first flat while controlling the outside diameter of the helix to a predetermined cylindrical dimension having a high degree of precision such as that required in traveling wave tubes.

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