United States Patent [19]

Kazansky et al.

[11] **3,871,070**

[45] **Mar. 18, 1975**

[54] **METHOD FOR MAKING WINDING OF SMOOTH-CORE ARMATURE**

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[52] **U.S. Cl.** **29/598,** 29/605, 140/92.1, 310/266

[51] **Int. Cl.** **H02k 15/04**

[58] **Field of Search** 29/598, 605; 310/266, 264, 310/265, 268, 154; 140/92.1

[56] **References Cited**

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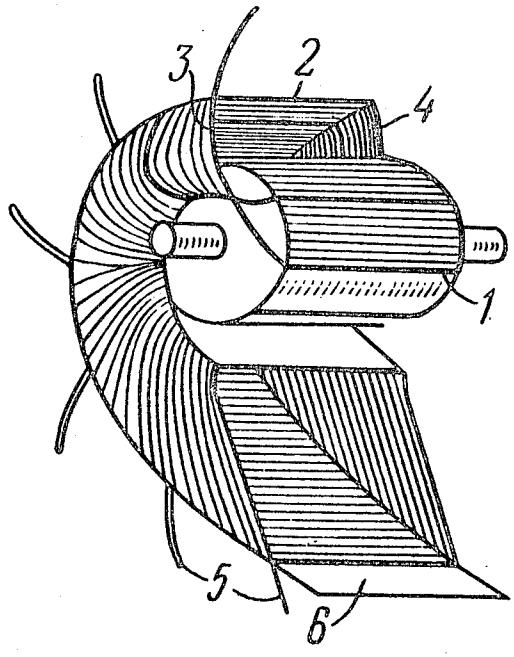
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Primary Examiner—Carl E. Hall

[57] **ABSTRACT**

A method of making a smooth-core armature winding, and preferably for fractional horse-power commutator machines. The method is characterized in that a wire is wound on a former after which the turns of a winding blank are maintained in spaced relationship on the former in four parts by attaching two equally wide strips to the blank, and in which the blank removed from the former is then arranged on a cylindrical frame with the top layer of the conductors shifted relative to the bottom layer by one winding pitch thus shaping end connectors of the winding while fixing the latter on said frame.

4 Claims, 12 Drawing Figures



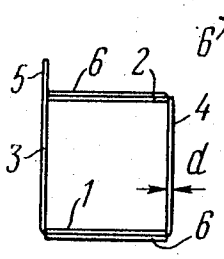


FIG.1

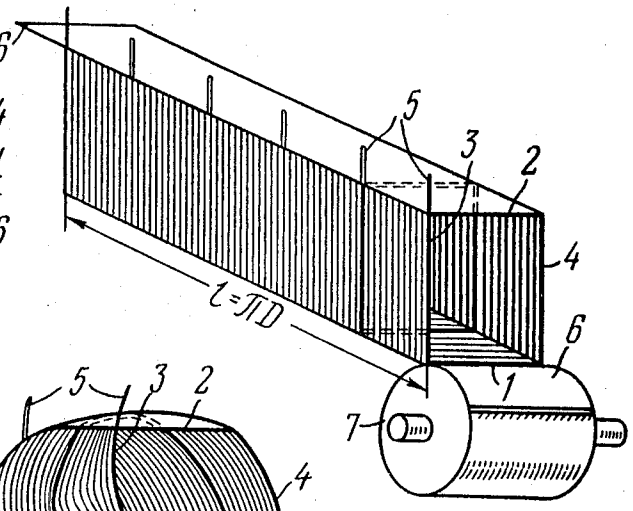


FIG.2

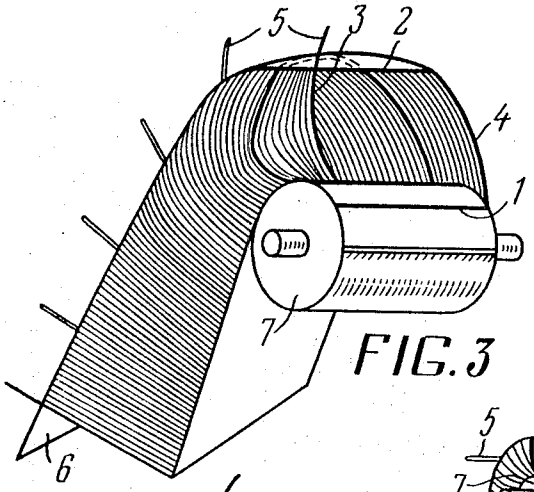


FIG.3

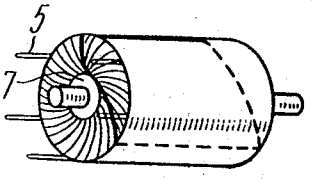


FIG.5

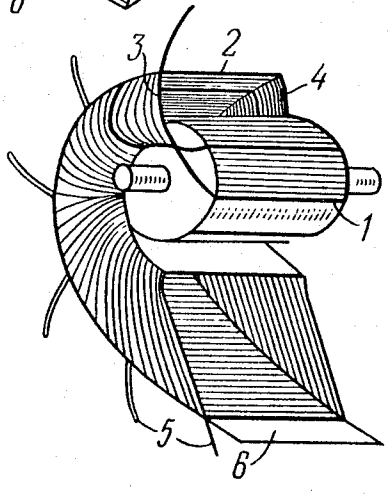


FIG.4

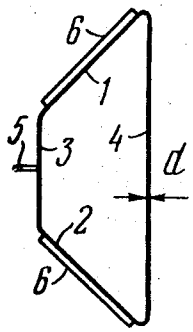


FIG. 6

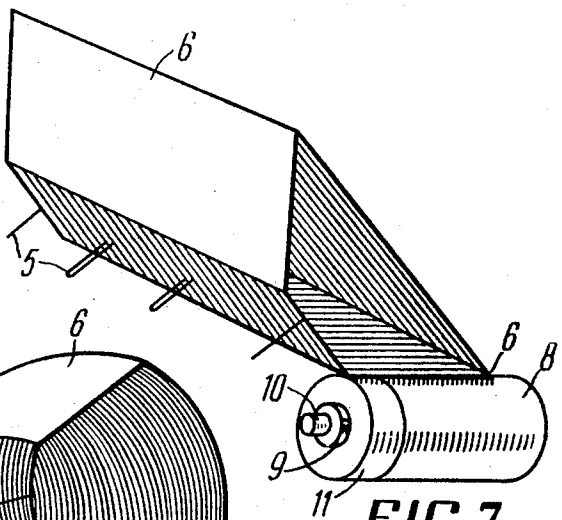


FIG. 7

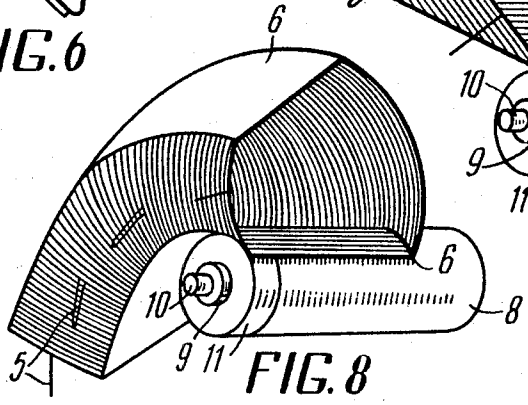


FIG. 8

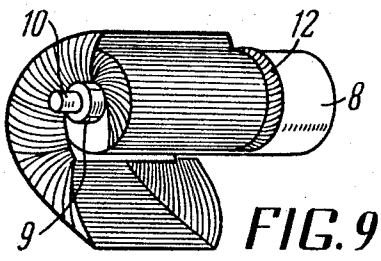


FIG. 9

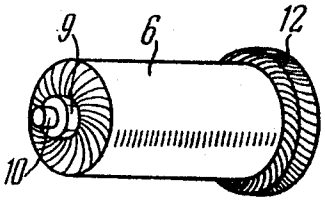


FIG. 10

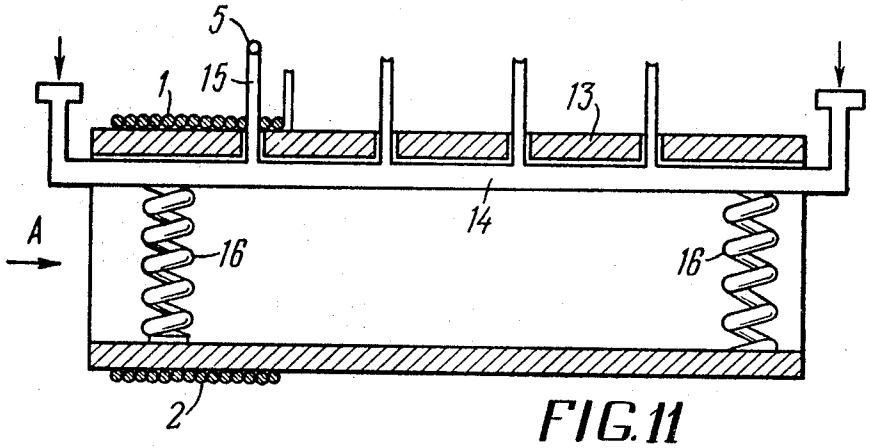


FIG. 11

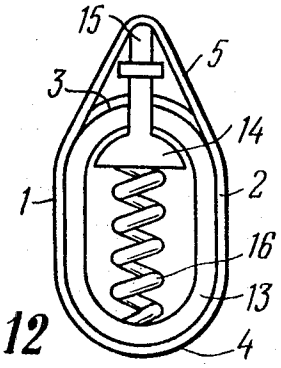


FIG. 12

METHOD FOR MAKING WINDING OF SMOOTH-CORE ARMATURE

The present invention relates to the art of electrical engineering, and more particularly to methods of making smooth-core armature windings in various fractional horse-power machines such as actuating fractional horse-power motors in automated systems, and electromotors in home appliances, particularly in electric shavers and the like.

It is generally known that the winding of a fractional horse-power commutator machine is arranged in the slots of the armature. Such an arrangement is technologically complicated, especially in cases when the number of the slots exceeds three, and, apart from that, when the armature is rotated in the magnetic field, intensified sparking develops under the brushes as a result of the armature winding turns being concentrated in the slots, i.e. being non-uniformly distributed, thus producing radio-reception disturbances and adversely affecting the reliability of the fractional horse-power machine during operation.

The desire to simplify the winding technology necessitates a reduction in the number of the armature slots, yet in this case, the electromagnetic parameters of a fractional horse-power motor deteriorate, the electromagnetic noise intensifies and the rotation of the armature in the magnetic field of the stator becomes irregular.

The above disadvantages of fractional horse-power machines with a slotted armature can be eliminated by providing smooth-core armatures for fractional horse-power machines having a general industrial application, and hollow smooth-core armatures for quick-acting fractional horse-power machines.

A number of techniques have been proposed for making smooth-core armature windings, some of them involving chemical etching or machining of the gaps between the conductors in a sheet material followed by fixing these sheets to a cylindrical frame.

These techniques are characterized by high labor costs.

Alternatively, the winding of a smooth-core armature can be made through a method wherein separate portions of the winding are wound about by an insulated winding wire, the portions being then attached to a cylindrical frame, and in order to reduce the radial height of the armature winding determining the effective non-magnetic gap width, the winding turns are arranged along the lateral surface of the cylindrical frame. The arrangement of winding turns is technologically complicated due to a number of difficulties arising while shaping the end connectors of the armature winding, and because the insulation of the winding wire may be damaged as it is being attached to the frame.

A method of making a smooth-core armature winding is also known which allows partially to obviate the above disadvantages wherein the wire is wound on a former in a dense row while effecting simultaneous tapping thereof. The contour of the former is selected in accordance with the required shape of the armature winding turns. The winding is then removed from the former and spread out in a two-layered flat band which is thereafter arranged and fixed so as to extend along the surface of the cylindrical frame.

However, when this method is used, the length of the coil end inevitably increases due to spreading of the whole winding along the lateral surface of the armature core. This also results in increasing losses through the winding and enhances the consumption of copper. Additionally, the above method generally involves manual spreading of the winding in a two-layered flat band. In order to simplify the process of shaping of the end connectors according to the above method, the conductors of the coil ends are bent, which causes the insulation of the winding wire to be damaged.

It is an object of the present invention to obviate the above disadvantages.

The principal object of this invention is to provide a method of making a smooth-core armature winding wherein the length of the coil ends is shortened, the technological process is simplified and the possibility of any insulation damage being caused when the winding conductors are arranged on the armature core is minimized.

This is accomplished in that the proposed method for making a smooth-core armature winding, preferably for fractional horse-power commutator machines, consists of winding a wire on a former with simultaneous tapping thereof to form a winding blank, and arranging the winding blank after removing from the former on a cylindrical frame in two layers the required winding pitch the turns of the winding blank then being according to the invention, positioned into four parts by attaching to the conductors two equally wide strips extending along the winding blank, then upon the material winding blank removed from the former being arranged on a cylindrical frame with the top layer of the conductors shifted relative to the bottom layer by one pitch thus shaping the end of the winding and fixing the latter on the frame.

In the case of arranging the winding directly on the armature core, it is expedient that the edges of the strips along the contour of the turn be evenly spaced and that their spacing be equal to the length of the chord corresponding to the pitch of the armature winding, in which case the inactive conductors will be drawn to the central line of the armature core during the course of arranging the winding, thereby shaping helical coil ends on the end faces of the core which remains fixed thereon.

In the case of making a winding for a hollow armature, it is essential that the spacing between the strip edges along the contour of the turn on the side of the winding taps be equal to the length of the chord corresponding to the winding pitch of the armature and on the opposite side be equal to the length of an arc confined by the chord. In this case, when the winding blank is arranged on a cylindrical frame, and in particular on a cylindrical mandrel, the in-active conductors on the side of the winding taps are drawn to the central line, and on opposite sides are arranged in the form of a braid extending circumferentially around the mandrel, with the mandrel being removed after shaping.

Additionally, the armature winding can be wound on a former by alternating ferromagnetic and current-carrying conductors.

As compared with prior-art methods of making smooth-core armature windings in fractional horse-power machines, the herein proposed method is characterized by the following features: it makes it technologically possible to provide minimum permissible sizes for the coil end, thus saving armature copper; provides a uniform arrangement of the conductors in rows

within the active zone of the armature with a desirable winding pitch which in turn, ensures a more uniform rotational speed and torque for the motor; enables mechanization of the process of winding on a former and to arrange the winding material on the armature core while providing, at the same time, layer-to-layer and complete insulation by means of the strips fastening the winding turns, as well as automatically formulating taps to the commutator, to substantially extend the range of winding wire sizes without the expense of losing technological effectiveness in shaping the coil end while maintaining a degree of high accuracy in the technological construction of the winding; and substantially simplifying the technological construction of any winding pitch without altering the manufacturing equipment.

A fuller understanding of the nature of the invention will be had from the following detailed description of the embodiments thereof taken in conjunction with the accompanying drawings wherein:

FIG. 1 is a lateral view of a winding material for a smooth-core armature winding after removing from a former;

FIG. 2 shows a process of attaching the material of the winding to the lateral surface of a smooth-core armature according to the invention;

FIG. 3 shows a process of arranging the winding along the lateral surface of the smooth-core armature according to the invention;

FIG. 4 shows an intermediate step of arranging the winding along the lateral surface of the smooth-core armature according to the invention;

FIG. 5 shows a smooth-core armature with a winding made by the method according to the invention;

FIG. 6 is a lateral view of a blank of a hollow armature winding after removing from a former;

FIG. 7 shows a process of attaching the blank of the hollow armature winding to the mandrel according to the invention;

FIG. 8 shows a process of arranging the hollow armature winding on the mandrels according to the invention;

FIG. 9 shows an intermediate step of arranging the hollow armature winding on the mandrel according to the invention;

FIG. 10 shows a hollow armature winding made by the method according to the invention;

FIG. 11 shows a device for tapping the winding made by the method according to the invention; and

FIG. 12 is a view taken along arrow "A" of FIG. 11.

The wire is wound in one dense row on a quadrihedral former (not shown), two opposite sides whereof are equal in length to conductors **1, 2** (FIG. 1) of the active part of the armature winding and the other two sides are equal in length to inactive conductors **3, 4** of the winding. In this case, when the wire is wound, taps **5** in the form of loops are simultaneously obtained. The length of the winding is chosen so as to be equal to that of the circumference of the armature core: $l = tD$ where D is the diameter of the armature core.

The turns of the winding are then fastened by strips **6** which may be made, for example of some adhesive insulating material and thereafter the winding is removed from the former. One end of each strip **6** of the winding thus removed from the former is attached to the lateral surface of an armature core **7** (FIG. 2) after which the winding is arranged along the lateral surface of the armature core **7** by rotating the armature core **7**, the arrangement being carried out in two layers by holding the free end of the strip **6**. In this case, the top layer of the active conductors **2** starts to shift with respect to the bottom layer of the active conductors **1**, and the non-active conductors **3, 4** start to shift towards the central line of the armature core **7** (FIGS. **3** and **4**). When the armature core **7** is further rotated, first the extreme active conductors **1** of the bottom layer of the winding are drawn together and then the extreme active conductors **2** of the top layer of the winding and the terminal taps of both layers are electrically connected. If required, the armature core **7** together with the bottom layer of the active conductors **1** attached to it is additionally rotated with respect to the top layer of the active conductors **2** by one winding pitch. In this case, the inactive conductors **3, 4** are completely drawn to the central line of the armature core **7**, and, as shown in FIG. **5**, the helical coil ends on the end faces of said armature core **7** are shaped. After the winding is arranged and shaped on the armature core, the core is pressed with added ferromagnetic powder.

When a hollow armature is used, then, according to the proposed method, the winding thereof is made in the following manner.

A wire is wound on a former (not shown) made in the form of an equilateral trapezium with two lateral sides equal in length to the conductors **1, 2** of the active part of the armature winding, the trapezium having its top base equal in length to the chord of the circumference of the armature core, corresponding in turn to the armature winding pitch, and the bottom base equal in length to the arc of the armature core confined by this chord, both bases being equal in length to the conductors **3, 4** of the inactive part of the winding, with the taps **5** being made in the form of simultaneous loops. The length of one winding is chosen so as to be equal to that of the circumference of the armature core. The size of the former thus chosen provides such shape of the coil ends whereby it becomes possible to with draw the mandrel from the winding after the pressing is completed.

When the wire is wound on the former, the insulating strip **6** is pasted on the conductors **1, 2** thus shaping the winding, after which the winding is removed from the former. The winding is then placed on a mandrel **8** (FIGS. **7, 8** and **9**) preassembled together with a commutator **9**, a shaft **10** and an armature frame **11**.

The arrangement of the winding on the mandrel **8** is accomplished similar to that on the armature frame as described above. In this case, the inactive conductors also begin to be drawn towards the central line on the side of the commutator **9** shaping helical coil ends while the inactive conductors on the opposite side are arranged circumferentially about the mandrel in the form of a braid **12** (FIG. **10**).

This is followed by pressing the winding and by a subsequent withdrawal of the mandrel.

With the object of decreasing the effective air gap of a fractional horse-power machine which is defined by the radial height of the armature winding, the winding is wound on the former by alternating ferromagnetic and current-carrying conductors which are made, for example, of transformer steel and copper.

In order to provide automatic tapping in making a winding for a smooth-core armature, a device has been

developed in the form of a hollow former **13** (FIG. **11**) whereupon a wire is wound. A cleat **14** is placed into the inner cavity of the former **13** with supporting elements **15** in the form of pins normal to the cleat **14**, and with the distance between these supporting elements being equal to the width of one section of the armature winding. In order to provide a more reliable holding of the wire on the supporting elements, the end faces of the elements are recessed. The cleat **14** with the supporting elements is loaded by springs **16**.

The proposed device is placed in a winding machine where the wire is wound there upon and automatically caught by the pins **15** where it is held, thus forming elongated loops which are then used as the taps **5**. When a desired number of sections have been wound and the turns fixed, the pins **15** are removed by withdrawing the cleat **14** from within the former **13**. The winding removed, the cleat **14** with the pins **15** returns to the initial position through the action of the springs **16**.

It is to be understood that the present invention is not limited by the above embodiments of the method for making a smooth-core armature winding. Without altering the scope of the present invention, formers of other shapes such as round, oval, etc may be used.

What is claimed is:

1. A method of making a winding for a smooth-core armature for fractional horse-power commutator machines; comprising winding a continuous length of a conductor on a former to form a winding blank having active and inactive conductor portions while simultaneously tapping said winding blank; partitioning said winding blank length on said former into four parts of respectively two active and two inactive conductor portions by attaching two equally wide strips of an adhesive insulating material to said blank so as to longitudinally extend along said winding blank on said former; removing said winding blank from the former; and arranging said winding blank on a cylindrical frame by winding one of said strips about the cylindrical surface thereof while shifting the conductor portion attached to the other strip relative to the conductor portion attached to the first mentioned strip by one winding pitch to thereby form an armature winding and to also shape the ends of the winding for fixing the latter on said frame.

2. A method as claimed in claim **1**, including spacing the edges of said strips evenly along the contour of a turn while maintaining their spacing equal to the length of the chord of an armature winding pitch and, concurrently with arranging said winding blank on said cylindrical frame, drawing said inactive conductor portions towards a center axis of said armature core, so as to form helical coil ends on end faces of said core and fastening said coil ends thereon.

3. A method as claimed in claim **2**, the distances between the edges of said strips along the contour of a turn on the side of the winding taps being equal to the length of the chord corresponding to a pitch of said armature winding, while on the opposite side these distances are equal to the length of an arc confined by said chord and, concurrently with arranging the winding blank on said cylindrical frame, drawing said inactive conductor portions on the side of said winding taps toward the center axis of said winding, and arranging said inactive conductor portions circumferentially about a mandrel in the form of a braid on the side opposite to said taps.

4. A method according to claim **1**, said armature winding comprising alternating ferromagnetic and current-carrying conductors.

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