Aug. 19, 1958 PAUL-ALBERT DECAUDAVEINE 2,848,634

MEANS AND METHOD OF SECURING WINDING COIL ENDS

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Fig. 1

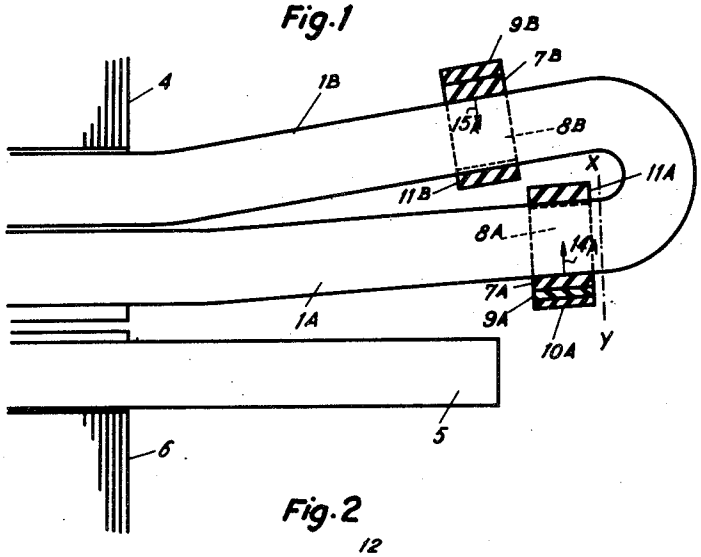


Fig. 2

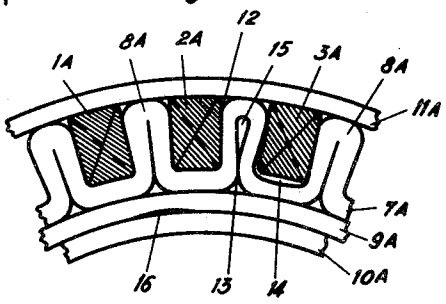
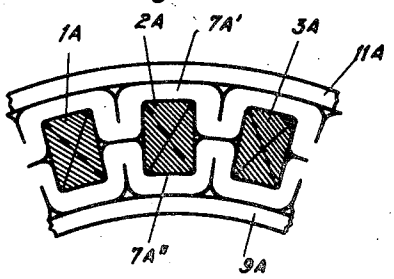


Fig. 3



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MEANS AND METHOD OF SECURING WINDING COIL ENDS

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6 Claims. (Cl. 310—260)

This invention relates to electrical windings and more particularly to a means and method of securing and holding in place windings comprising coil ends as employed in rotary electrical machines and the like.

Heretofore, windings comprising coils or sections having coil end exposure from their associated magnetic structure, as for example, a stator in rotary electrical equipment have had the coil ends secured or otherwise anchored and secured in fixed relationship by means of metallic hoops, non-magnetic binding wire, insulated clamp means disposed clamping the conductors forming either side of the coil ends or secured by use of varnishes or other similar adhesive means combined with tying the coil ends with cords, twine and the like. It is known that the above techniques are subject to the disadvantages in that they require expensive materials and are time-consuming increasing labor and production costs.

The present invention has a principal object of providing a means and method for holding in place winding coil ends by inexpensive means easily employed in a simple, inexpensive, labor-saving and material-saving method.

Another object is to provide means and method of fixing coil ends in fixed spaced relationship and improving the disposition and spacing of the conductors therein in optimum relationship to improve the characteristics of the machine.

Still another object is to provide a means and method of fixing the coil ends by inexpensive, moisture-resistant, non-magnetic means which will not detract from the magnetic characteristics and providing coil and fixing means free of metallic elements.

Another object is to provide a means and method applicable to all types of electrical machines and to all types of winding coils, having coil end exposure from their associated magnetic structure or other structure, whether these be formed winding coils or windings mechanically or otherwise disposed on a structure as, for example, by known winding methods.

A feature of the means and method in accordance with the invention is that a continuous tape made of a flexible, non-magnetic material is impregnated with a rigidifying agent, for example, an insulating thermal-setting resinous impregnating composition and is inserted, without cutting, in reversably folded relationship between the corresponding sides of the corresponding loop portions of the coil ends exposed from, or otherwise mounted, on associated magnetic structure, thus forming an insulating spacer or core-like structure fixing the coil ends in spaced relationship when the impregnant is set thereby fixing the coils. Other tapes impregnated with adhesive substances may be additionally tightly disposed or wound on the coil conductors or sides of the coil loop portions binding and permanently holding by adhesion the coil ends in fixed position relative one another against movement thereof.

Another feature is that the tape thickness may be selected according to the spacing to be effected between the coils and that voids in the reversably folded portions of the tape are filled by the impregnant or removed by mechanically compressing the coil ends during the setting

of the impregnant. The width of the tape is suitably selected for being disposed adjacent the looped portion of the coil ends without reducing the heat transfer effected by the coil end exposure.

While the invention is applicable and of particular value as applied to stator formed coil windings, it is accordingly illustrated by way of example in the accompanying drawings as applied to fixing and spacing formed coils in stator windings, it being understood that the invention is applicable to windings or coils thereof other than those on a stator.

Other objects and features of the invention will be more fully understood from the following description and claims in conjunction with the accompanying drawings which illustrate, by way of example, the means and method in accordance with the invention. In the drawings:

Fig. 1 is a fragmentary axial cross-sectional view on an enlarged scale of an electrical machine provided with coil end fixing means in accordance with the invention.

Fig. 2 is a cross-section view taken at a plane x—y of Fig. 1.

Fig. 3 is a cross-section view of a variant of the invention as shown in Fig. 2.

The invention shown by way of example in Figs. 1, 2 and 3 comprises winding coils having coil ends, the looped portion of the coil end being formed by conductors, comprising a side **1A** and an opposite or opposed side **1B** of the coil disposed as shown in slots of its associated magnetic structure comprising laminations **4** as, for example, a stator. A winding **5** is shown disposed in a rotor **6**.

Once the individual coils are disposed in the slots in the stator, the conductors or sides **2A** and **3A** etc. in the adjacent coils and corresponding to side **1A** will be disposed as shown in Fig. 2 to form the winding ends. A continuous tape **7A** preferably of the "stratified" type, impregnated with a rigidifying and adhesive agent comprising, as for example, a thermal-setting resinous impregnating composition, is disposed with reversably folded portions **8A** between the corresponding sides of adjacent conductors properly spacing the coils. The reversable folded portions or loops **8A** are easily inserted, in place, by means of a flat tool (not shown) shaped somewhat similarly to a spatula, after the coils are in place. The corresponding sides **1A**—**3A**, etc. may be pulled up tight by wrapping their corresponding sides with inside and outside layers of adhesive tapes **9A**, **10A**, **11A**, the inside layers being fastened by their adhesive impregnant and the whole binding the formed coils and holding them in position. It will be understood that the side **1B** of the coil and corresponding sides (not shown) are similarly provided with a continuous tape **7B**—**8B** between said upper coil sides, and tapes **9B** and **11B** are wound on the inner and outer peripheries of these conductors, as shown in Fig. 1. Moreover, it will be understood that the tapes used to clamp or hold the coil ends may be of selected and different thicknesses, as shown.

While inserting, wrapping or winding the tapes **7A**—**11A** or **7B**, **9B** or **11B** between and on the coil ends as shown, if it is found that voids or spaces, as for example, **12**—**16**, are rather large, spacers (not shown) of insulating material may be disposed between the folded and wound layers. These may be employed prior to disposing the tape around the coils as heretofore discussed. Generally, however, it will be found that if the thickness of the tape is properly selected, the impregnant material exudes from the tape, filling the voids **12**—**16** once the tapes **9A**, **10A** and **11A** are wound thereon. Once the tapes are so wrapped, the setting of the impregnant is effected in accordance with the proper curing cycle for the material being employed as an impregnant. Me-

chanical pressure may be applied with clamp means (not shown) during the setting of the impregnant if found necesary to eliminate spaces such as **12—16**. However, the wrapping of the tapes on the coils and the exuding of the impregnant generally makes this unnecessary.

Fig. 3 shows another embodiment of the invention, using two continuous tapes **7A'** and **7A''** having portions foldedly disposed between the sides **1A—3A** of the coil ends and wound with inside and outside binding tape layers **9A** and **11A** similarly to the embodiment in Fig. 2. In the embodiment shown in Figs. 1 and 2, the reversibly folded portions or looped portions **8A** and **8B** may be inserted between the coils as shown by use of the spatula, inserting it between the coils in the direction shown in Fig. 1 by arrows **14A** and **15A**, respectively. The embodiment in Fig. 3 can readily be employed where the coil sides are easily accessible and the spatula can be applied from two directions so as to form the reversably folded portions on the tapes as shown.

It will be understood that the term "tape" is used generically herein and includes bands and continuous strips of material. The tape may be made of glass fibers which may be, for example, twisted or braided, comprising a single layer or a plurality of layers of material; it being understood that the material need be non-conductive and capable of being impregnated with a resinous composition. The impregnant or rigidifying agent itself may comprise a polymerizable resin having the characteristic of being fluid enough to impregnate a tape as herein disclosed and being thermal-setting, and once set forming a hard material. It has been found that the epoxy resins as well as certain other commercially known polyesters known in the art may be employed. The tape itself must remain flexible once impregnated and prior to the setting of the impregnant. Preferably, the thickness thereof should be a dimension slightly greater than one-half the space or distance between the adjacent sides of the various coil ends.

Thus, it can be seen that the invention provides an inexpensive and easily applied means for fixing the coils in the slots in fixed spaced relationship upon the machine, greatly enhancing its electrical characteristics and reducing production costs. Moreover, the application of the tapes by wrapping around the coil ends or sides aside from securing the coils and compressing them so as to properly fill the voids or spaces left in the reversably folded portions of the tape **8A** greatly improves the mechanical structure. Thus, the finished construction is free of metallic elements which, as is known, present insulation problems and increase the so called additional losses of the machine.

While preferred embodiments of the invention have been illustrated and described, it will be understood that the invention is in no way limited to these embodiments and that changes may be made without departing from the spirit and scope of the invention as defined by the following claims.

What I claim and desire to secure by Letters Patent is:

1. In combination, a magnetic structure having slots, electrical windings disposed in the slots, said windings comprising coils having coil and exposure from at least one end of the magnetic structure and slots, said coils having conductors forming substantially corresponding coil ends comprising looped portions having opposed sides formed by the conductors, improved means for holding said coil ends substantially in fixed spaced relationship comprising a continuous spacing tape impregnated with a rigidifying, thermal-setting resinous impregnating composition and having portions disposed reversably folded between corresponding sides of said looped portions of said coil ends, and at least another continuous binding tape impregnated with an adhesive, thermal-setting resinous impregnating composition disposed wrapped on the corresponding sides of the coils binding the coil ends together.

2. In combination, a magnetic structure having slots, electrical windings disposed in the slots, said windings comprising coils having coil end exposure from at least one end of the magnetic structure and slots, said coils having conductors forming substantially corresponding coil ends comprising looped portions having opposed sides formed by the conductors, improved means for holding in place said coil ends substantially in fixed spaced relationship comprising at least one continuous spacing tape impregnated with a rigidifying, thermal-setting resinous impregnating composition and having portions disposed reversably folded between corresponding sides of said looped portions of said coil ends, said tape having a thickness substantially corresponding to one-half the distance between next adjacent coil ends.

3. In combination, a magnetic structure having slots, electrical windings disposed in the slots, said windings comprising coils having coil end exposure from at least one end of the magnetic structure and slots, said coils having conductors forming substantially corresponding coil ends comprising looped portions having opposed sides formed by the conductors, improved means for holding said coil ends substantially in fixed spaced relationship comprising two continuous spacing tapes impregnated with a rigidifying, thermal-setting resinous impregnating composition and having portions disposed reversably folded between corresponding sides of said looped portions of said coil ends, and said tapes being arranged so that said portions are disposed directed toward each other and said tapes together substantially surround the corresponding sides of said coil ends.

4. The combination according to claim 3, in which at least a third adhesive inside tape and a fourth outside tape are wound on the looped portions of said coils comprising the ends of said coils so as to bind and hold said coil ends.

5. In a rotary electrical machine having a stator with slots and windings disposed in the slots, said windings comprising coils having coil end exposure from at least one end of the stator, said coils having conductors forming substantially corresponding coil ends comprising looped portions having opposed sides formed by the conductors, improved means for holding said exposed coil ends substantially in fixed spaced relationship comprising a continuous tape impregnated with a rigidifying, thermal-setting, resinous impregnating composition and having portions disposed reversably folded between corresponding sides of said looped portions of said coil ends, and at least one layer of binding tape impregnated with an adhesive, thermal-setting resinous impregnating composition disposed wrapped on the corresponding sides of the coils binding the coil ends together.

6. In a rotary electrical machine having a stator with slots and windings disposed in the slots, said windings comprising coils having coil end exposure from at least one end of the stator, said coils having conductors forming substantially corresponding coil ends comprising looped portions having opposed sides formed by the conductors, improved means for holding said exposed coil ends substantially in fixed spaced relationship comprising two continuous spacing tapes impregnated with a rigidifying, thermal-setting, resinous impregnating composition and having portions disposed reversably folded between conductors forming corresponding sides of said looped portions of said coil ends and said tapes being arranged so that said portions are disposed directed toward each other and said tapes together substantially surround the corresponding sides of said coil ends.

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