

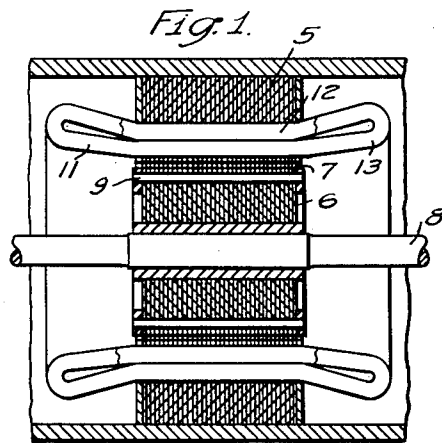
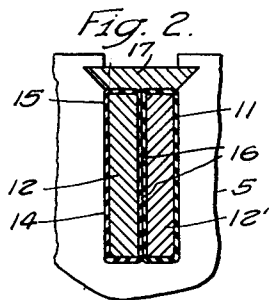
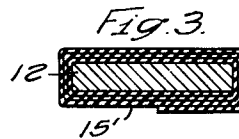
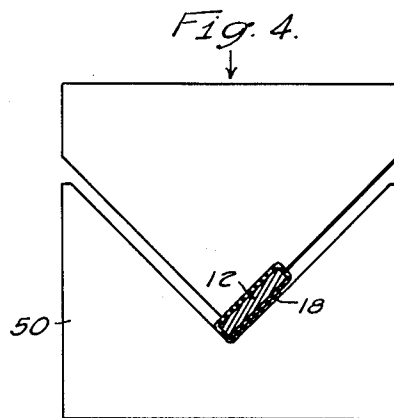
Jan. 8, 1952

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2,581,862

INSULATION

Filed Sept. 14, 1944



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2,581,862

INSULATION

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Application September 14, 1944, Serial No. 554,080

1 Claim. (Cl. 171-252)

1

Our invention relates to electrical insulation, and it has particular relation to the insulation of small-sized single conductors which are relatively long and which are inserted into slots in the magnetizable core of a dynamo-electric machine or other electrical apparatus.

While our invention is susceptible of many other uses, it is particularly adapted to the problem of insulating the coil-sides of motor-windings made of very thin strap-conductors of ribbon-like configuration, such as a conductor having a cross-section less than $\frac{1}{4}$ of an inch by $\frac{1}{2}$ of an inch.

Heretofore, it has been customary to insulate such coil-sides with a fish-paper slot-wrapper, the edges of which are overlapped at the top of the coil-side. When the coil-side or conductor is very thin, it is very difficult to keep these top overlapped liner-edges in place, with the result that the insulation has frequently been damaged in winding, sometimes necessitating the removal of a number of undamaged coils in order to replace a single damaged coil-side.

An object of our present invention is to overcome the foregoing and other difficulties by producing a molded insulation of highly consolidated class B material, having high dielectric strength, good mechanical properties such as toughness and ability to withstand winding-abuse, good thermal stability, good arc-resistance, and a novel method of application.

A further object of our invention is to provide a tubular member, made in one integral piece, composed of initially soft, circumferentially wound, impregnable sheet material having a dimension in an axial direction substantially equal to the axial length of the finished tubular member, and an impregnating binder of a thermosetting material.

A more specific object is to provide a molded tubular member composed of a butt-jointed layer of a circumferentially wound wrapper-material, and a compressed impregnating binder of a hardenable material, preferably thermosetting. The wrapper-material may also be lap-jointed, and it may be in as many layers as may be necessary, in order to build up the desired thickness.

A still further object of our invention is to provide a new combination making it feasible to

2

use a molded member which is composed of a thermosetting material which is capable, during thermosetting, of strongly attacking the usual forms of fibrous carbohydrates, and utilizing such binding material to bind a fibrous filler which is resistant to attacks of said binding material during and after the thermosetting action.

A still further object of our invention is to provide a motor or other electrical apparatus, having a slotted magnetizable core, carrying a winding having two coil-side portions lying in each slot, with flat sides adjacent to each other, each coil-side portion having an adherent butt-jointed layer of insulating material wound circumferentially around the coil-side portion, with the butt-joints of each pair of coil-side portions in any slot disposed in staggered relation to each other in said adjacent flat sides of the pair of coil-side portions. In this way, the insulation-joints are removed from the grounded core-portions of the machine, and they are staggered with relation to each other, so as to increase the creepage-insulation leakage-distance between the two conductors lying in the same slot of the core.

With the foregoing and other objects in view, our invention consists in the structures, parts, combinations, apparatus, systems and methods hereinafter described and claimed, and illustrated in the accompanying drawing, wherein:

Figure 1 is a longitudinal sectional view of a motor embodying our invention;

Fig. 2 is an enlarged cross-sectional view of a portion of the stator-core showing a slot with two of our coil-sides in place;

Fig. 3 is an enlarged view of a coil-side or conductor, showing a modified manner of wrapping the insulation; and

Fig. 4 is a somewhat diagrammatic view of a mold which is utilized to compress the insulation prior to, and during the thermosetting operation, and it also shows an end view of a conductor having a preferred form of wrapper in the form of a single lap-jointed layer of impregnated insulating material.

As indicated in Fig. 1, our invention is applicable to electrical apparatus such as a motor having a slotted stator-core 5, and a slotted rotor-core 6, having an annular air-gap 7 in-between. The

rotor-core 6 is carried by suitably journaled shaft 8. The rotor-core 6 is provided with any suitable type of induction-motor winding, such as a squirrel-cage winding 9.

The stator-core 5 carries a primary winding 11 which constitutes the subject-matter of our present invention. It has a number of coils or turns, having straight coil-side portions 12, lying in the slots of the core 5, and having bent end-turn portions 13. As shown in Fig. 2, each stator slot 14 has two coil-side portions 12 and 12' therein, lying side by side in the slot, each with its own insulating wrapper 15. The winding 11 is composed of insulated strap-conductors 12, 12', each pair of coil-sides, which lie in any one slot, having their flat sides adjacent to each other.

In the form of embodiment of our invention shown in Fig. 2, the insulating wrapper 15 which surrounds each individual coil-side is composed of a single butt-jointed layer of an initially soft, impregnated, insulating sheet-material, preferably non-ferrous asbestos paper, which is wrapped circumferentially around the substantially straight coil-side 12 which it covers. The width of this insulating wrapper is equal to the desired length of the finished insulating cell or tubular member surrounding the straight coil-side portion 12 which lies in a stator-slot 14, extending somewhat beyond the stator-core 5 at each end thereof. The two butt-joints 16 of the two insulating cells 15 which cover the two coil-sides 12 and 12' in any slot are disposed in the adjacent or abutting flat faces or sides of the two conductors lying in the slot, and the two butt-joints 16 are staggered with relation to each other, so as to provide a good creepage-distance between each other and also between each butt-joint and the grounded portions of the machine.

The two insulated coil-sides 12 and 12' of the winding, which lie in any stator-slot 14, are held in place by means of a slot-wedge 17, as shown in Fig. 2.

Either before or after being wrapped around its coil-side 12, each insulating asbestos-paper wrapper 15 is impregnated with a synthetic resin or other hardenable binding-material, preferably thermosetting. The resin may be a copolymer of propylene glycol-maleate and styrene. This material is a thermosetting material, that is, one which permanently changes from a liquid condition to a hard solid, when subjected, for a brief time, to a suitably elevated temperature, the material being thereupon capable of being heated to the same temperature, or even to high temperatures, without materially softening again. The particular resin which we prefer is initially so fluid (substantially like water) that it can frequently be utilized without a solvent, which facilitates the production of a relatively void-free, well-consolidated, insulation-wall.

Because this resin-material is also one which is capable of strongly attacking the usual forms of fibrous carbohydrates, such as wood-pulp paper, and cotton or silk cloth, or other cellulosic materials, particularly during the elevated temperature-conditions of the thermosetting operation, it is quite desirable either to altogether avoid the use of cellulosic materials in the impregnated insulating wrapper, or at least to utilize a wrapper in which the major portion, or a sufficient portion, of its constituency, is composed of non-cellulosic or inorganic fibers or absorbent material.

Instead of utilizing a single-layer butt-jointed insulating wrapper 15 or tube around each

straight coil-side 12, as shown in Fig. 2, we may utilize a plurality of layers of lap-jointed impregnated sheet-material, as shown at 15' in Fig. 3.

Preferably, however, in the particular application for which our invention was primarily designed, we utilize a single insulating layer, but with overlapping or lap-jointed ends 18, as shown in Fig. 4, in which case no care needs to be taken concerning the precise circumferential extent of the wrapper, or the precise amount of overlap, or the position of the overlapped joints, with respect to staggering, because in the finished product, the joints are pressed out and have as great insulating and mechanical strength as any other portion of the insulating cell.

Whatever may be the precise manner of wrapping the insulating cell around the straight coil-side portion 12, the wrapped coil-side portion, after wrapping and impregnation, is placed in a mold 50, Fig. 4, and set up under heat and pressure. This causes the initially soft wrapping-material to be compressed, while causing the polymerizing binding-resin to convert itself into a solid, integral mass, which is tightly adherent to the asbestos fibers, and also tightly coherent within its own particles, so that it has good mechanical properties, such as toughness and ability to withstand winding-abuse better than conventional coil-coverings.

The insulation thus produced is at least equal to class B insulation, which, according to AIEE standards, must be able to continuously withstand a hot-spot temperature of 130° C. In general, we may say that our insulation will continuously withstand a temperature higher than 125° C. This applies both to the asbestos paper and the thermosetting impregnating binding-material. The insulation is highly consolidated, and it has a high dielectric strength, so that a large percentage of the slot-area can be usefully utilized for the copper conductor of the wire or strap 12 which is utilized for the winding 11.

The electrical properties of the finished insulating material may be summarized as follows. Its short-time dielectric strength is 450 volts per mil. Its step-by-step dielectric strength is 300 volts per mil. Its arc-resistance, by A. S. T. M. standards, is 185 seconds. The material does not track.

While we prefer to utilize the particular resin which has previously been named, we are not limited to this particular resin. We are not even limited to a resin having an acid value of 50 or more, such as we prefer, referring to the number of milligrams of KOH necessary to neutralize each gram of the sample. It is believed to be mainly this acidity which causes the impregnating thermosetting material to be destructive to cellulosic fibers. Other thermosetting resins which might be utilized include the general class of alkyd resins dissolved in a vinyl compound, which include combinations of a polyhydric alcohol, an unsaturated dibasic acid, and a vinyl compound, or, in general, most or all of the resinous reaction-products of organic acids, as well as other hardenable impregnating agents, which could also be utilized.

We claim as our invention:

70 An electrical apparatus having a slotted magnetizable core and a winding having two straight coil-side portions lying side by side in each slot with flat sides adjacent to each other, each coil-side portion having an adherent butt-jointed layer of non-ferrous asbestos paper wound cir-

cumferentially around the coil-side portion and impregnated with a thermosetting resin consisting essentially of a copolymer of propylene glycolmaleate and styrene, said layer having a dimension in an axial direction substantially equal to the axial length of its straight coil-side portion, and with the butt-joints of each pair of coil-side portions in any slot disposed in staggered relation to each other in said adjacent flat sides of the pair of coil-side portions.

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