

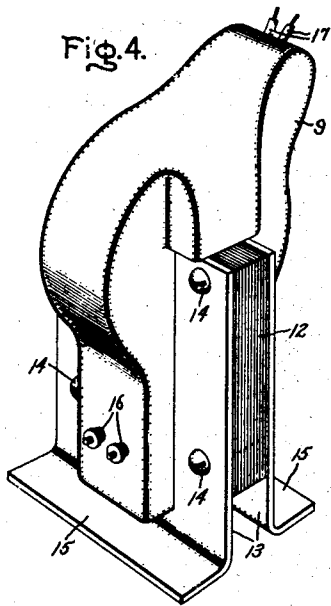
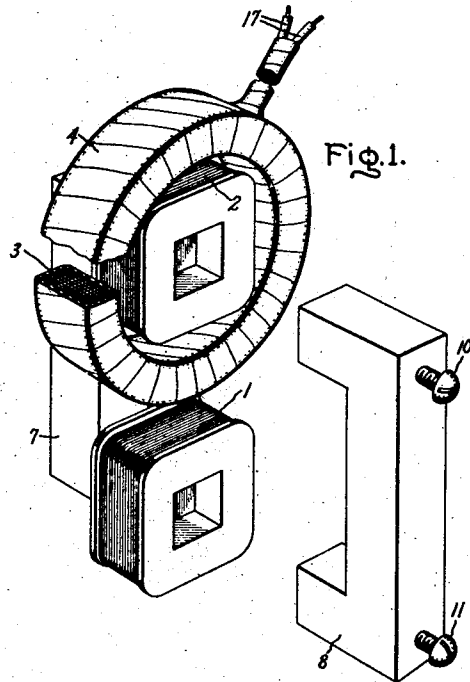
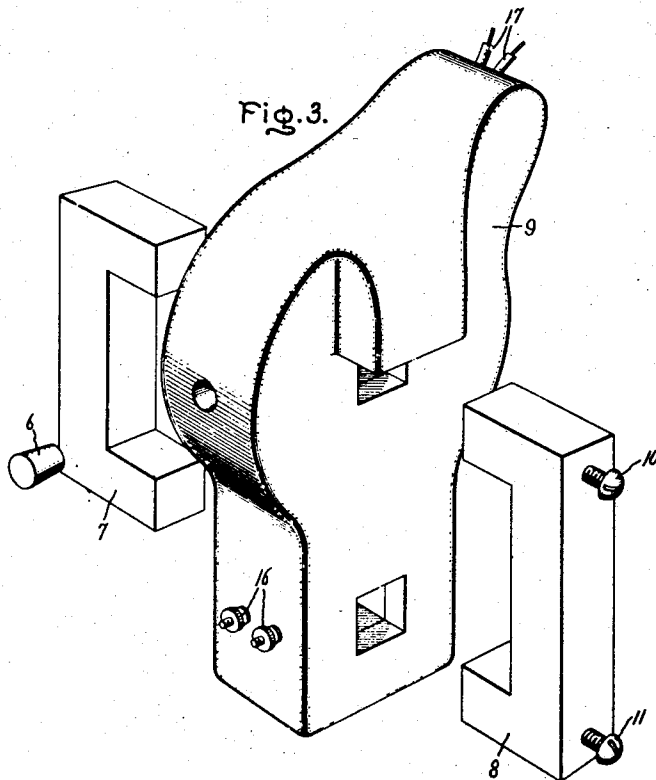
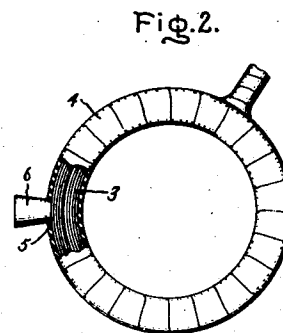
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METHOD OF MAKING TRANSFORMERS

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METHOD OF MAKING TRANSFORMERS

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This invention relates to electrical apparatus and more particularly to an improved method of making, and especially insulating, such apparatus.

One way of insulating the coils of stationary electric induction apparatus, such as instrument transformers, is to cast them in a matrix of insulation, such as suitable synthetic resins or varnishes, used with or without a filler, which are originally liquid but which are hardenable upon the application of heat or other hardening treatment. The hardened matrix not only serves as insulation but it serves as the outer protective covering for the coils so that no separate enclosing casing or housing is necessary. It is often desirable to cast the coils in an insulating matrix after they are assembled on the core so as to insure their proper orientation and to insure maximum insulation between the core and coils. However, except in the smallest sizes of transformers it is uneconomical to cast the entire core as well as the coils in the insulating matrix.

In the past considerable trouble has been experienced with cracks which occur in the insulating matrix near the edges of the core where they enter the coil window when certain types of insulation are cast. Also, when a plurality of the coils are coaxially arranged, cracks develop in the casting in the region of the outermost coil. All such cracks are highly undesirable as they not only constitute weak spots in the insulation itself but they permit the entrance of foreign material, such as moisture, into the apparatus and thus further decreases its electrical resistance. It is believed that these cracks are caused by the shrinking of certain types of insulation as it hardens and this invention includes a novel method of preventing the occurrence of cracks which can be caused by such shrinkage.

In accordance with one feature of the invention a coil, especially the outermost of two or more substantially concentric coils, is provided with an outer layer of resilient or compressible material. This does two things. It provides a yielding cushion so that the surrounding insulating matrix can shrink without cracking and it keeps the material which forms the matrix out of the coil so that the cushion and the coil are more readily compressed by the shrinkage of the matrix. Provision is also made for filling the coil with hardenable fluid insulation after the outer matrix is formed so as to moisture-proof the coil. In accordance with another feature of this invention a dummy core is used when the insulating matrix is cast. This core is not a laminated structure and consequently it can be in-

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serted and removed much more quickly and easily than the real core which ordinarily is stacked by hand from flat punchings or laminae. The dummy core is removed during the hardening of the matrix and in this way cracks at the edges of the core are eliminated.

An object of the invention is to provide a new and improved electric apparatus.

Another object of the invention is to provide a new and improved method of insulating electric apparatus.

A further object of the invention is to provide a new and improved method of making electric apparatus.

The invention will be better understood from the following description taken in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

In the drawing Fig. 1 is a partly broken away perspective view of certain parts of the invention during the early stages of its construction, Fig. 2 is a side elevation view partly in section of one of the coils used in my invention, Fig. 3 is a perspective view of a partially completed induction apparatus embodying my invention, and Fig. 4 is a perspective view of a completed electrical induction apparatus embodying my invention.

Referring now to the drawing and more particularly to Fig. 1, there is shown therein two conductive coils 1 and 2 which may be preformed on suitable spools or forms, as is common practice. These together may constitute the primary winding of a transformer. Surrounding the primary coil 2 is a coil 3 which may comprise the secondary winding of the transformer. This latter coil is provided with a layer of compressible or resilient insulation 4 which surrounds it. As shown in both Figs. 1 and 2, the layer 4 is formed by winding a strip of material around the coil. A suitable material for this purpose is ordinary crepe paper.

In order to make it possible to insulate thoroughly and moisture-proof the coil 3 during a subsequent step in the formation of the transformer an opening 5 is left in the outer surface of the layer 4 and a plug 6 of any suitable material is inserted in this opening.

A dummy core which may consist of two solid metal members 7 and 8 is provided and the two members are pressed together with the coil 1 on one winding leg of the dummy core and coils 2 and 3 on the other winding leg of the core. As shown, the coils are in place on the member 7 and when the member 8 has its winding leg portions inserted in the windows of the coils 1 and 2 until

the winding leg portions of the two parts 7 and 8 are in abutting relation this stage of the assembly of the transformer is completed.

The coils are next surrounded by a matrix of insulation such, for example, as the solventless varnishes forming the subject matter of an application Serial No. 302,165, filed October 31, 1939 in the name of Birger W. Nordlander, now abandoned, and an application Serial No. 302,168, filed October 31, 1939 in the name of Gaetano F. D'Alelio, now Patent No. 2,428,787, both of which applications are assigned to the present assignee. Preferably, a filler, such as sand or talc, is used in the varnish. A mold (not shown) may or may not be used, as desired. This material is hardenable upon the application of heat and it also shrinks somewhat in hardening. One suitable form of the resulting matrix is shown at 9 in Fig. 3. As the cast matrix 9 hardens and shrinks cracks are likely to develop at the corners of the windows of the coils 1 and 2. In order to prevent this the dummy core is removed before the matrix 9 shrinks sufficiently. This may be readily accomplished in any suitable manner, such as by turning in screws 10 and 11 which are threaded into the part 8 and whose inner ends come into contact with the ends of the winding leg portions of the part 7 and thus force the two parts 7 and 8 away from each other.

The insulating matrix 9 in shrinking around the outer coil 3 compresses the layer of insulation 4 and thus does not crack in the region of this larger coil.

In Fig. 4 the completed transformer is provided with a permanent laminated core 12. This core may consist, for example, of two L-shaped punchings in each layer whose joints butt against each other. The L-shaped punchings, however, are reversed in alternate layers so that the butt joints in each layer overlap in alternate layers. The core is held together by core clamps 13 on each side and bolts 14 which pass through the core 12 and clamps 13. As shown, the clamps are also provided with flanges 15 which can serve as mounting brackets. Primary winding terminals are shown at 16 and the secondary winding leads are shown at 17.

In Fig. 4 the hole made by the removal of the plug 6 in Fig. 3 has been completely filled up by the same material which forms the casting 9. Preferably, the coil 3 is first vacuum dried through this hole and then it is filled with the hardenable liquid insulation so as thoroughly to water-proof it.

While there has been shown and described a particular embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications can be made therein without departing from the invention and, therefore, it is aimed in the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. The method of forming an induction apparatus which comprises the steps of assembling a plurality of conductive coils on a readily removable dummy core, surrounding said coils with a matrix of hardenable insulation which shrinks as it hardens, hardening said matrix, removing said dummy core during the hardening of said matrix after said matrix is hard enough to retain its shape and before shrinkage around said dummy core causes said matrix to crack, and providing said coils with a laminated magnetic

core after said matrix has been thoroughly hardened, said laminated magnetic core occupying the space in said matrix previously occupied by said dummy core.

2. The method of making a crack-free matrix of insulation around a conductive coil for induction apparatus which includes the steps of surrounding the coil with a layer of resilient material which layer has an opening therein, surrounding said resilient layer with a heat hardenable matrix of insulation which shrinks as it hardens, said matrix having an opening in registry with the opening in said resilient layer, and moisture-proofing said coil through said registering openings after said matrix has attained a predetermined hardness.

3. The method of making an insulated electrically conducting coil which includes the steps of surrounding said coil with a layer of resilient material, providing said layer with an opening, closing said opening with an elongated plug, surrounding said resilient layer with a heat-hardenable matrix of insulation which shrinks as it hardens and through which said plug extends, removing said plug after said matrix has been hardened, and subsequently moisture-proofing said coil through the registering openings in said matrix and resilient layer which were previously filled by said plug.

4. The method of making a crack-free matrix of insulation around a conductive coil for induction apparatus which includes the steps of surrounding the coil with a layer of compressible material, fitting an elongated removable plug in said layer, placing a dummy core in said coil, surrounding said coil with a heat hardenable matrix of insulation which shrinks as it hardens and through which said plug extends, removing said dummy core during the hardening of said matrix, removing said plug after said matrix has attained its final degree of hardness, and moisture-proofing said coil through the opening made by the removal of said plug.

5. The method of making a transformer which includes the steps of mounting a pair of coils concentrically on a dummy core which has at least two readily separable parts, surrounding the outer coil with a layer of compressible insulating material, surrounding said coils with a heat-hardenable matrix of insulation which fills the space between said coils and which shrinks as it hardens, hardening said matrix, removing said dummy core after said matrix has hardened sufficiently to retain its shape and before it has shrunk enough to crack where it makes contact with said dummy core, and providing said coils with a permanent laminated magnetic core, said laminated magnetic core occupying the space in said matrix previously occupied by said dummy core.

6. The method of making a transformer which includes the steps of providing a pair of different diameter coils, winding a layer of crepe paper around the larger diameter of said coils, providing an opening in said layer, fitting a plug in said opening, mounting said coils substantially concentrically on a dummy core which has at least two readily separable parts, surrounding said coils with a heat-hardenable matrix of insulation which fills the spaces between said coils and which shrinks as it hardens, hardening said matrix, removing said dummy core after said matrix is hard enough to retain its shape and before it shrinks sufficiently around said dummy core to crack said matrix, removing said plug

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after said matrix has attained a predetermined degree of hardness, moisture-proofing said coil to the registering openings in said matrix and crepe paper layer which were previously filled by said plug, and providing said coils with a permanent laminated magnetic core, said laminated magnetic core occupying the space in said matrix previously occupied by said dummy core.

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