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TRANSFORMER COIL CONSTRUCTION

Filed Nov. 28, 1955

Fig. 1

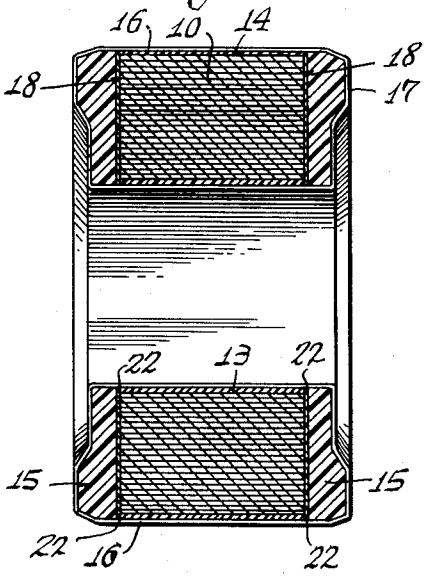


Fig. 2

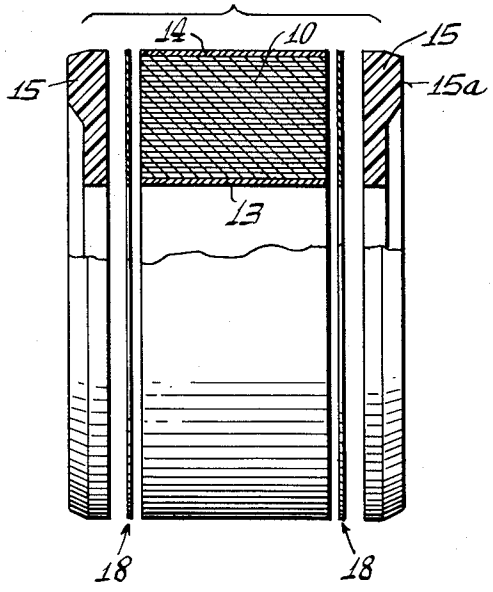


Fig. 4

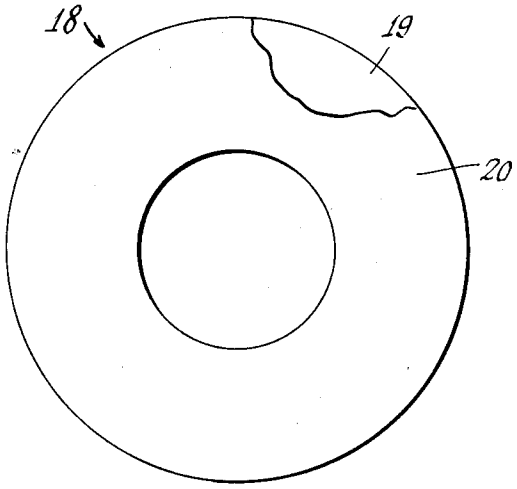
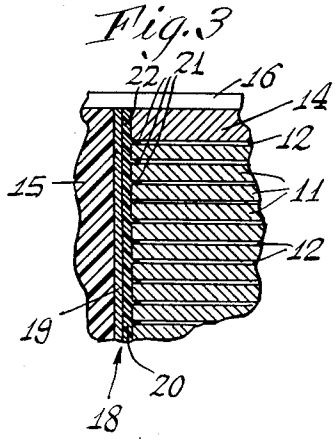


Fig. 3



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TRANSFORMER COIL CONSTRUCTION

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1 Claim. (Cl. 336—198)

This invention relates to transformer construction and more particularly to a protective means for iron cores used in transformers.

In transformers having an iron core, it has long been realized that a protective means for the core should be employed to protect the core from eventual ruin by the corrosive action of the moisture in the air on the iron. In addition thereto, certain manufacturing operations performed when constructing the core accelerate the corrosion. For example, where the windings of the transformer are to be plated, such as with rhodium, the only feasible method of plating requires that a portion of the iron core be submerged in the rhodium bath. Even with great care in washing the transformer after the dipping, a portion of the rhodium solution remains on the core which upon drying out form salts thereon. When moisture from the air contacts the core, it combines with the salts to form an acid solution which reacts with the iron, causing an increased corroding or rusting of the iron core. Moreover, a reaction between the iron and plating solution would contaminate the solution.

An object of the present invention is to provide a protective covering for surfaces of a core of a transformer which forms a protective barrier for the surfaces so covered.

Heretofore, protective casings for a transformer core have been costly, requiring special machinery and excessive labor, with the result wherever practical, that such casings have not been used. However, one method of forming a protective layer on the core consists of spraying the core with a varnish or other liquid sheet forming material and then baking the core to harden the material. This required a spraying booth with the usual loss of spray material and also the extra steps of spraying and baking. Moreover, a varnish deposited in such a manner does not form a complete barrier against corrosive elements since "pin holes" or minute openings are present. Another method that may be employed, utilizes a tape of the type which may be adhesive and waterproof or which may be just adhesive and then sprayed with moistureproof solution and baked as in the prior method. It will be apparent that such methods in addition to being expensive, require special apparatus and machinery plus being time-consuming.

Another object of this invention is to provide a protective casing for surfaces of a core of a transformer which is economical to manufacture, facilitates the assembly of the transformer and in which there are no special machinery or time-consuming steps required in the construction of the transformer.

The cores of transformers may be formed of a solid piece of iron but they commonly are formed of thin sheets of iron having the desired shape, with sufficient sheets placed together to obtain the wanted thickness as in the case of rectangularly shaped cores, while annular cores may be formed from a strip of thin sheet iron spirally and tightly wound. A core formed in such

a manner has surfaces which are of the shape of the sheets or laminae and surfaces formed by the edges of the laminations; hereafter, the latter are referred to as the laminar surfaces of the core. The laminar surfaces are more susceptible to corrosion because there are crevices formed between the layers which permits a greater area of iron to be subject to corrosive action per unit of surface area and also these crevices may act as capillary tubes causing corrosive elements to enter further into the core. Moreover, corrosive action in the laminar surfaces causes a greater distortion of the core than on the other surfaces with, accordingly, a quicker ruination of the transformer.

A further object of this invention is to provide a protective means for the laminar surfaces of a core which not only covers the surfaces but also penetrates the crevices between the laminae to form an effective barrier against corrosive elements.

The broader aspects of the invention are applicable to either a rectangular or annular core. However, in the specific embodiment of the invention illustrated and described, the protective means is shown in conjunction with and applied to an annular core of the coil of a variable autotransformer. In manufacturing such a coil, a length of thin sheet iron is spirally wound to form the core, a tube of stiffened protective material such as "Bakelite" may be inserted in the center and an outer peripheral wrapping which may be of coated paper, varnished cambric or glass tape may be applied to the periphery of the core. The core is then provided with two end caps which may be also "Bakelite" or other hard plastic or insulating material, and a length of electrically conducting wire is toroidally wrapped about this unit. The assembly is then coated with varnish or other protective material and baked. The next operation consists of milling or grinding the portions of the convolutions adjacent one of the end caps to form a flat commutator surface on which a brush rides, and finally the commutator surface is dipped into a rhodium bath solution to plate the surface.

One feature of the present invention resides in the provision of having protective means insertable between the side surfaces, which are also the laminar surfaces of the core, and the end caps. This protective means in the illustrated embodiment is shaped to fit the laminar surfaces and accordingly are annular. They advantageously consist of a somewhat stiff material such as paper, having adhered on one surface only a heat-activated dry film composed of a synthetic thermosetting resin. The film softens and flows when heat is applied, and bonds itself to the adjacent surfaces. One example of such a film is known as "Permacel 18." When the film softens, it flows into the crevices between the laminae forming the core and also flows to seal the crack between the peripheral covering and the annular protective member and the crack between the annular protective member, and the tube in the center of the core. Moreover, the heat required to bake the varnish is also the heat required to soften and thermoset the film. After the film has been thermoset, it is impervious to corrosive elements such as moisture and the manufacturing solutions used in constructing the coil.

Other features and advantages will hereinafter appear.

In the accompanying drawings:

Figure 1 is a sectional view through an autotransformer coil.

Fig. 2 is an exploded, partial sectional view showing the core, the protective means and the end caps before assembly.

Fig. 3 is an enlarged and exaggerated view of a laminar surface of the transformer core after heat has been

applied to melt the film and the film has set as a coating and impregnant.

Fig. 4 is a view of one of the annular protective members with a portion broken away to show the underlying stiff layer.

In constructing the annular autotransformer coil of the illustrated embodiment, the core, generally indicated by the reference numeral **10**, is formed by spirally winding tightly, a length of thin sheet iron or steel to the desired thickness. Each of the whorls in a cross-section of the core as shown in Figs. 1, 2 and 3 forms one of the layers **11** in between which there are minute crevices **12**. Preferably, a tube **13**, which may be formed of a hard insulating material such as "Bakelite" is inserted in the center of the core. The outer periphery of the core in the instant embodiment is covered by a tape **14** having a width substantially equal to the width of the sheet of iron wound thereabout. The tape **14** may be of varnished cambric or paper or woven glass fibers, but preferably of varnished paper. Annular end caps **15** having a cross-sectional shape as illustrated in Figs. 1 and 2 are placed on opposite sides of the core **10**, and the protective means generally indicated by the reference numeral **18** is positioned therebetween. An electrical winding **16** consisting of a length of insulating copper wire is toroidally wound about the core **10** and the end caps **15**. The winding assumes a shape corresponding to the configurations of the assembled end caps and core. The unit as thus far constructed is then completely coated with a varnish or similar substance and baked to harden the coated material. This material besides forming insulation also assists in maintaining the winding convolutions in position. A commutator surface **17** is milled or ground on the portions of the winding **16** on a flat portion **15***a* of the end cap **15** to provide the necessary surface on which the autotransformer brush may ride. The coil is then dipped into a rhodium bath to plate the surface **17** with rhodium to provide a pit resistant surface and also a good wear resistant surface. When dipping the unit into the bath an end cap **15** and a part of the core **10** also enter the solution. Without the protective means **18**, some of the solution would enter the crevices **12** and upon drying, form salts which, when later combined with moisture from the atmosphere would produce an acid solution that would attack the iron core causing excessive corrosion.

The protective means, generally indicated by the reference numeral **18**, is employed to prevent the entrance of the rhodium solution into the crevices **12** of the core **10** and also to seal the sides of the core **10** from moisture. The protective means **18** is shown in Fig. 4 and consists of an annular disk composed of two layers **19** and **20**. The layer **20** is approximately .002" thick and is a heat-activated dry film composed of a synthetic thermosetting resin. While the layer **19** may be of any stiff material to maintain the shape of the film, it is preferably formed of paper which has been treated to be substantially non-porous to prevent the film **20**, when soft, from flowing therethrough.

The layer **20** and layer **19** are preferably adhered together to facilitate the handling of both layers together without deformation. The layer **20** shown in Fig. 2 is positioned against the laminar surface or side of the core **10** and conforms substantially to the shape of the surface The outer diameter of the disk **18**, in the present embodiment, is equal to or a little larger than the outside diameter of the core **10** and tape **14**, while the inner diameter of the aperture in the disk **18** is equal to the inside diameter of the tube **13**.

During the baking or heating operation the temperature required to bake the varnish is also the temperature required to soften and thermoset the layer **20**. Moreover, in view of the sequence of operations previously set forth it will be apparent that the winding exerts a compressive force on the end caps **15**, the disks **18** and the sides of the core which cause the softened film to more readily flow into cracks and crevices and to conform to the space between the sides of the core and the end caps.

In the detailed enlarged view of Fig. 3 showing a section of the coil after the baking step, portions **21** of the layer **20** have entered into and become bonded to the layers **11**, sealing the minute crevices **12**. Also the cracks formed between the adjacent surface of the protective means **18** and the tube **13** and tape **14** are sealed by portions **22** of the layer **20** squeezed out by the compressive force exerted thereon. This effectuates a tight, moistureproof casing for the transformer core which is impervious to atmospheric moisture and liquid solutions such as the rhodium bath solution and the grinding compounds used in forming the commutator surface **17**.

It will be appreciated that the use of the protective means **18** consisting of the layers **19** and **20** result in a great economy in manufacture and the formation of a cheap, though impervious, protection for surfaces of the core. Furthermore, if need should occur to salvage the core **10**, the end caps **15** are not bonded or adhered thereto because the layer **19** is interposed therebetween which provides for disassembling without mutilation of the core or end caps. Though the protective means has been shown as being annular, it will be apparent that the shape is dictated by the shape of the surfaces of the transformer to be protected and accordingly, should not be limited solely to an annular disk.

Variations and modifications may be made within the scope of the claim and portions of the improvements may be used without others.

We claim:

An annular coil for a variable autotransformer comprising an annular core formed of thin sheet iron spirally wound and presenting laminar side surfaces; annular end caps positioned against the laminar side surfaces of the core and a toroidal winding of wire wound about the core and end caps; the improvement which comprises protective means for the core including two annular protective disks, each disk consisting of a thermoset resin film and a layer of paper, positioned between the end caps and the laminar side surfaces of the core, said film coating the laminar side surfaces of the core, and having portions penetrating spaces in the laminar side surfaces of the core to provide a protection for the laminar side surfaces of the core, and said paper adhering to the film and being substantially non-porous and non-perforate and engaging its associated end cap but being unbonded thereto.

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