United States Patent

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[33] **Great Britain**
[31] **52,961/68**

[54] **TRANSFORMER INSULATION CONSTRUCTION COMPRISING CONCENTRIC CYLINDERS AND SPACING STICKS**
6 Claims, 2 Drawing Figs.

[52] **U.S. Cl.** **174/138E,** 310/65, 336/60, 336/199
[51] **Int. Cl.** **H01f 27/08,** H01f 27/30
[50] **Field of Search** 174/138.3; 336/60, 185, 199, 207; 310/65

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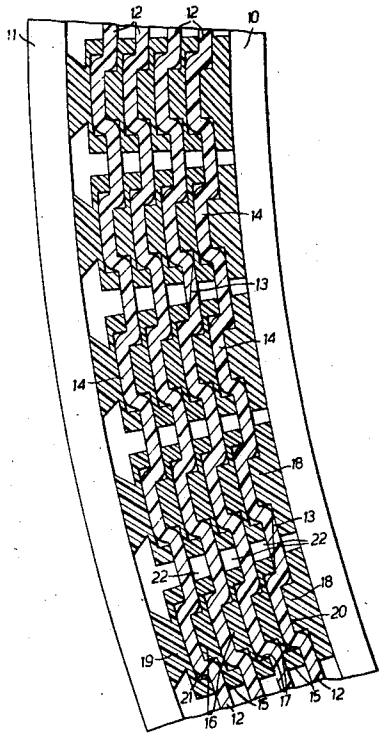
ABSTRACT: Transformer interwinding insulation construction which comprises a plurality of concentric spaced cylinders of insulating pressboard and a plurality of axially directed sticks arranged between each pair of adjacent cylinders for maintaining a radial spacing therebetween, integral portions of said cylinders adjacent each of the sticks forming lateral locating means for said sticks.



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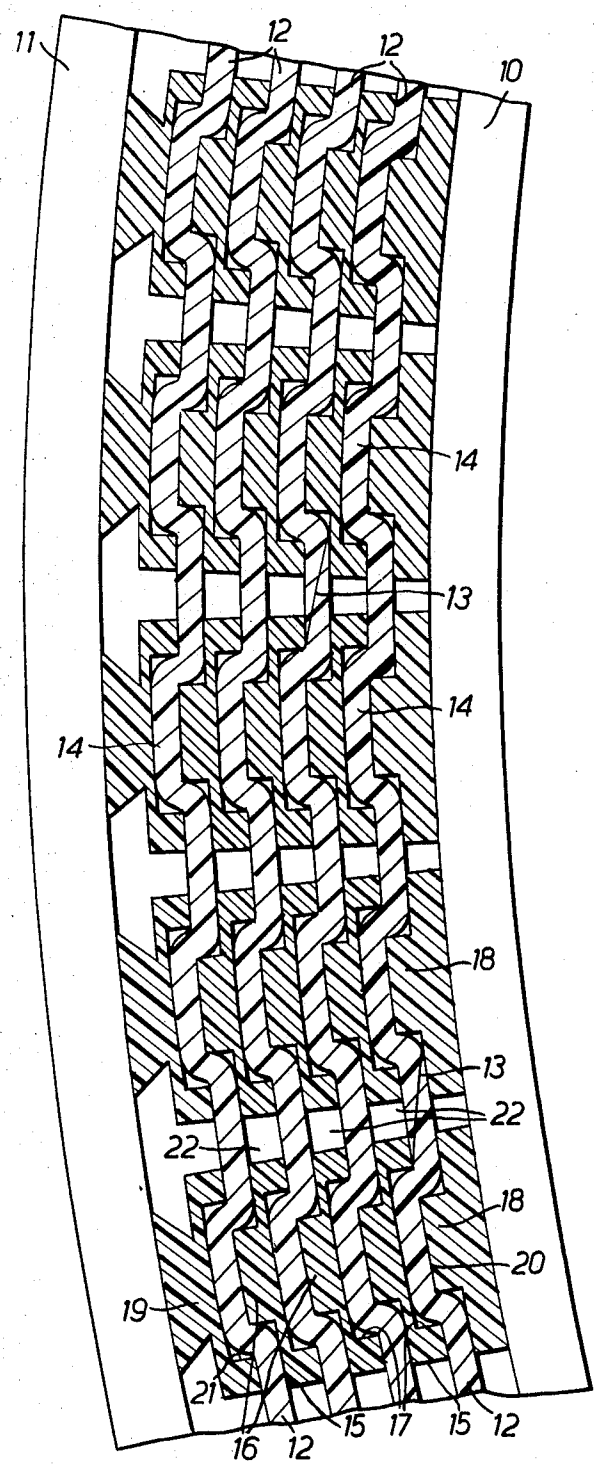

FIG. 1.

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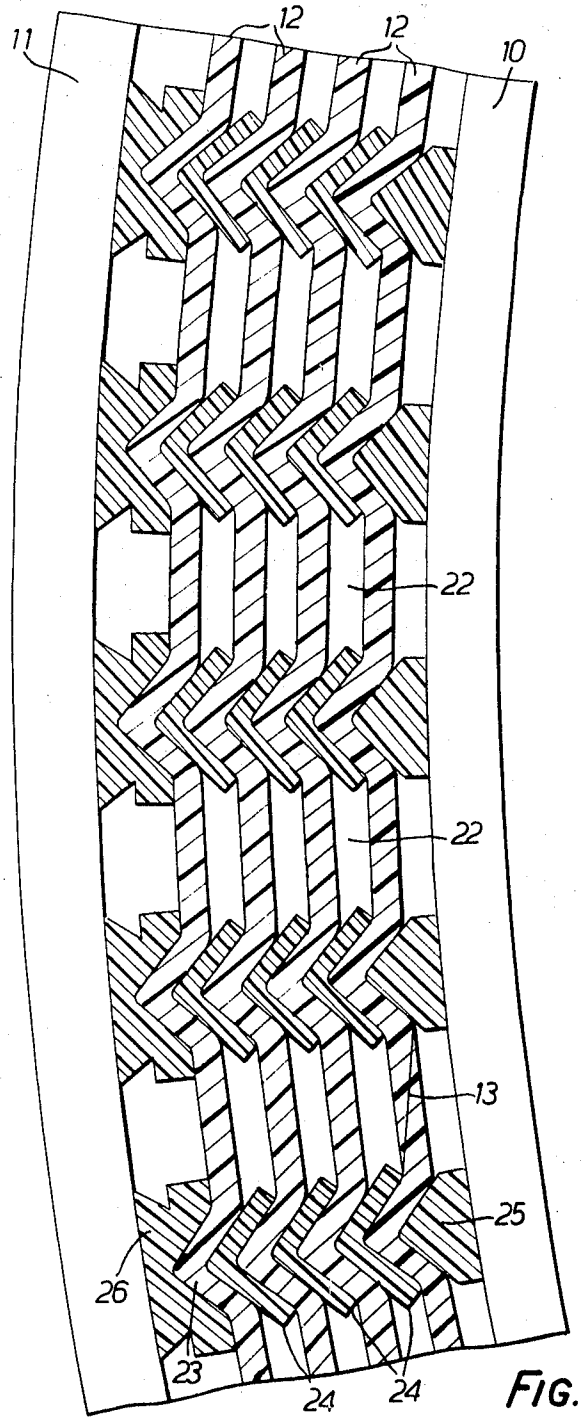

FIG. 2.

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TRANSFORMER INSULATION CONSTRUCTION COMPRISING CONCENTRIC CYLINDERS AND SPACING STICKS

This invention is concerned with the construction of interwinding insulation for transformers.

Transformers comprise a magnetic core having two or more legs depending on whether the AC supply is single or multiphase and formed of laminations of transformer alloy steel, and on which two or more coils are wound. Whilst the low voltage and high voltage coils may be wound on different legs, this arrangement is not usual and the present invention is concerned only with transformers in which a low voltage coil, a high voltage coil and, where required, a tap winding and/or a tertiary coil are positioned on top of one another, although not necessarily in the order mentioned, on the same leg, the coils being separated by interwinding insulation. More than one leg of the transformer may be provided with such an assembly of coils and interwinding insulation. Passages are provided within the coils themselves and within the interwinding insulation for the passage of transformer oil which acts as a coolant. At the present time a preferred form of interwinding insulation for heavy duty transformers comprises a plurality of concentric cylinders of insulating material, the cylinders being separated from each other by longitudinally disposed spacers known as "sticks." Each cylinder of insulating material is formed either of many laps of paper or of a single layer of insulating pressboard; the sticks are formed of insulating pressboard. In order to obtain the necessary mechanical strength and to maintain adequate coolant passages between the layers of insulating material forming the interwinding insulation, it is necessary that in each space between the layers the sticks should be accurately parallel and that the sticks should be accurately radially aligned from one space to the next. Cotton tapes or adhesive have been used to position the sticks in correct alignment in each space but the use of either of these means gives rise to disadvantages.

We have now developed an improved interwinding insulation construction which comprises a plurality of concentric spaced cylinders of insulating pressboard, the cylinders being provided with longitudinal corrugations which are radially aligned from one cylinder to the next and the cylinders being maintained in spaced relation by axially directed sticks positioned between the cylinders, each stick being located laterally by its interengagement with a pair of radially aligned corrugations of adjacent cylinders.

In a preferred embodiment, the corrugations of all the cylinders are directed in the same sense, that is outwardly or inwardly in relation to the axis of the cylinders, and the sticks have one surface formed to fit within a reentrant corrugation and an opposed surface formed to fit over a projecting corrugation.

Further features and advantages of the invention will appear from the following description of two embodiments of interwinding insulation construction, given by way of example only and with reference to the accompanying drawings in which:

FIG. 1 is a section transverse to the leg axis of a transformer, of a portion of interwinding insulation; and

FIG. 2 is a similar cross section of a portion of another construction of interwinding insulation.

In the insulation construction of FIG. 1, there are provided between the outermost turn **10** of the low voltage winding of a transformer and the innermost turn **11** of the high voltage winding, four concentric, radially spaced, cylinders of corrugated insulating pressboard **12**, the diameter of the cylinders increasing, of course, from the innermost to the outermost. Each cylinder may be formed in a single piece, the free ends being joined together by a scarf joint **13**, or may be formed from two or more pieces, abutting pieces being joined together again by a scarf joint. Each cylinder is provided with spaced, regular, longitudinal corrugations **14**. The circumferential spacing of the corrugations increases from the innermost cylinder to the outermost so that the corrugations can be radially aligned from one cylinder to the next as shown in the Figure; the depth of the corrugation is preferably approximately equal to the thickness of the pressboard. The cylinders are spaced from each other by sticks **15** formed of laminated or resin bonded pressboard which extend over the whole height of the cylinders. One surface of each stick **15** is provided with a rib **16** adapted to fit into a reentrant corrugation and the opposed surface is provided with a channel **17** adapted to fit over a projecting corrugation. The inner cylinder **12** is spaced from the turn **10** by sticks **18** and the outer cylinder **12** is spaced from the turn **11** by sticks **19**, the sticks **18** and **19** being radially aligned with the radially aligned sets of sticks **15**. The sticks **18** and **19** are formed of laminated or resin bonded pressboard and extend over the whole height of the cylinders; the sticks **18** have a rib **20** similar to the rib **16** of the sticks **15** and the sticks **19** have a channel **21** similar to the channel **17** of the sticks **15**. The spaces between the sticks **15**, **18** and **19**, as indicated at **22**, are available for the passage of coolant.

The construction of FIG. **2** is generally similar to that of FIG. **1**, but the cylinders **12** are provided with V-section corrugations **23** and the sticks **24**, formed in this case simply of pressboard, are of L-shaped section with the two arms being of equal length.

The inner cylinder **12** is spaced from the turn **10** by sticks **25** and the outer cylinder **12** is spaced from the turn **11** by sticks **26**, the sticks **25** being provided with a V-shaped projecting surface and the sticks **26** with a V-shaped reentrant surface. The sticks **25** and **26** are formed of laminated or resin bonded pressboard.

In the case of both the illustrated embodiments and for transformers in which the outside diameter of the low voltage coil is, say 96 inches or more, the cylinders are suitably formed of insulating pressboard one-fourth inch thick. The midpoints of the corrugations are spaced apart by a distance determined by the design criteria of the transformer manufacturer; this distance will normally be from 1 to 4½ inches. The separation between the cylinders is preferably about the same as the thickness of the pressboard.

It is a matter of convenience only whether the cylinders are formed from a single piece of corrugated insulating pressboard or from a plurality of pieces, shipment and assembly of the pressboard being in most cases facilitated by using a number of smaller pieces rather than one large piece. Although in the illustrated embodiments we have shown the joining together of the free ends of the pressboard by means of scarf joints and these are, in fact, preferred, other types of joints can be used. The joints are preferably glued with a thermosetting adhesive, but this is not essential.

Whilst we have described and illustrated two forms of corrugation and associated stick, it will be apparent that other forms of corrugation and stick can equally be used provided that such other forms provide for positive location of the sticks in relation to the corrugations.

Similarly, whilst we have described and illustrated constructions comprising four concentric corrugated cylinders or pressboard, larger or smaller numbers of cylinders can equally well be used, the number of cylinders being determined by the transformer design requirements.

The principal advantages provided by the interwinding insulation constructions described are (i) that the sticks are positively located throughout their length so that there is substantially no risk of their becoming laterally displaced during operation of the transformer so that the interwinding insulation can be relied upon to withstand the severe mechanical stresses to which it is liable to be subjected and (ii) that the interwinding insulation is better able to adjust to dimensional changes arising from changes in its moisture content and other factors owing to the corrugated form of the pressboard cylinders. In addition, the interwinding insulation is easier to assemble than the insulation constructions previously used.

I claim:

1. In or for a transformer interwinding insulation comprising a plurality of concentric cylinders of insulating pressboard and a plurality of axially directed sticks arranged between each pair of adjacent cylinders for maintaining a radial spacing therebetween, the improvement which comprises lateral locating means for each of said sticks, said means comprising cooperating, integral portions of opposed surfaces of adjacent cylinders engaging and positively locating each said stick in relation to said integral portions.

2. The improved insulation of claim 1, wherein said locating means are constituted by longitudinal corrugations in each of said cylinders.

3. In or for a transformer, interwinding insulation which comprises a plurality of concentric spaced cylinders of insulating pressboard, said cylinders having longitudinal corrugations which are radially aligned from one cylinder to the next and a plurality of axially directed sticks positioned between said cylinders, each stick being located laterally by its interengagement with a pair of radially aligned corrugations of adjacent cylinders and serving to maintain radial spacing of said adjacent cylinders.

4. The insulation construction set forth in claim 3, wherein the corrugations of all of the cylinders are directed in the same sense relative to the axis of the cylinders and each of said sticks has one surface formed to fit within a reentrant corrugation and an opposed surface formed to fit over a projecting corrugation.

5. The insulation construction set forth in claim 4, wherein the corrugations are of V-section and the sticks are of L-shaped section having two arms of equal length.

6. The insulation construction set forth in claim 3, wherein each of said cylinders comprises at least one longitudinal scarf joint.