United States Patent

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[54] **DISTRIBUTION TRANSFORMER**
7 Claims, 4 Drawing Figs.

[52] U.S. Cl. ..... **336/92,** 174/17 LF, 336/60, 336/94, 336/100
[51] **Int. Cl.** **H01f 27/06**
[50] **Field of Search** ..... 336/90, 92, 94, 96, 100, 60; 174/17 LF, 17 R, 52

[56] **References Cited**

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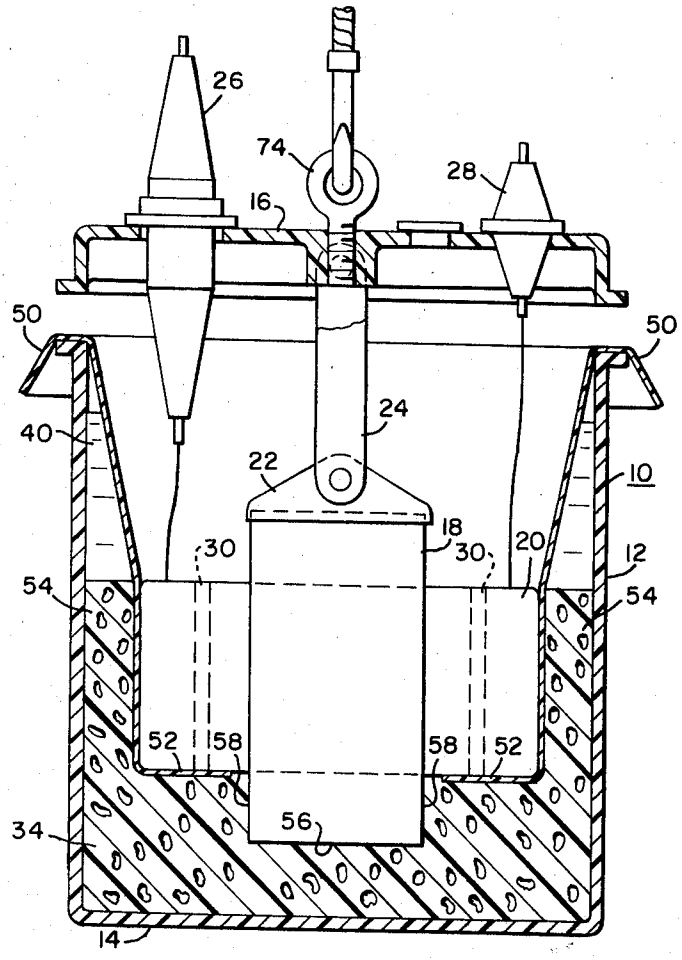
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ABSTRACT: A distribution transformer having a core-coil assembly enclosed in a casing or tank with the core-coil assembly and other associated hardware, such as bushings, partially supported from the top of the casing or tank and partially supported from the bottom of the casing or tank by a foamed resin cushion positioned in the casing or tank and resting on the bottom of the casing or tank.



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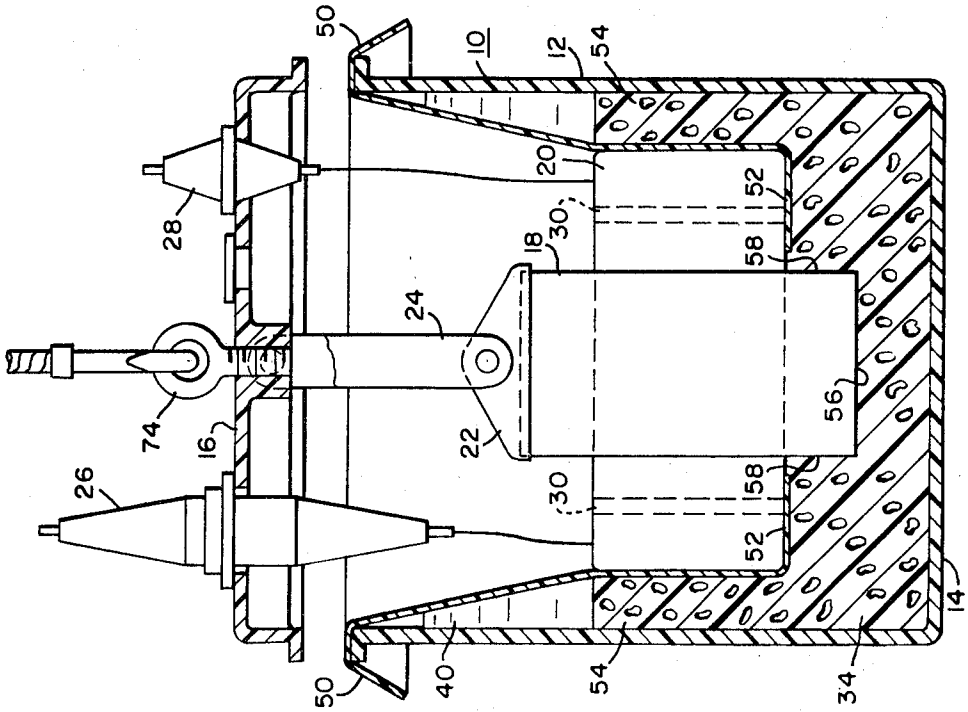


FIG. 2.

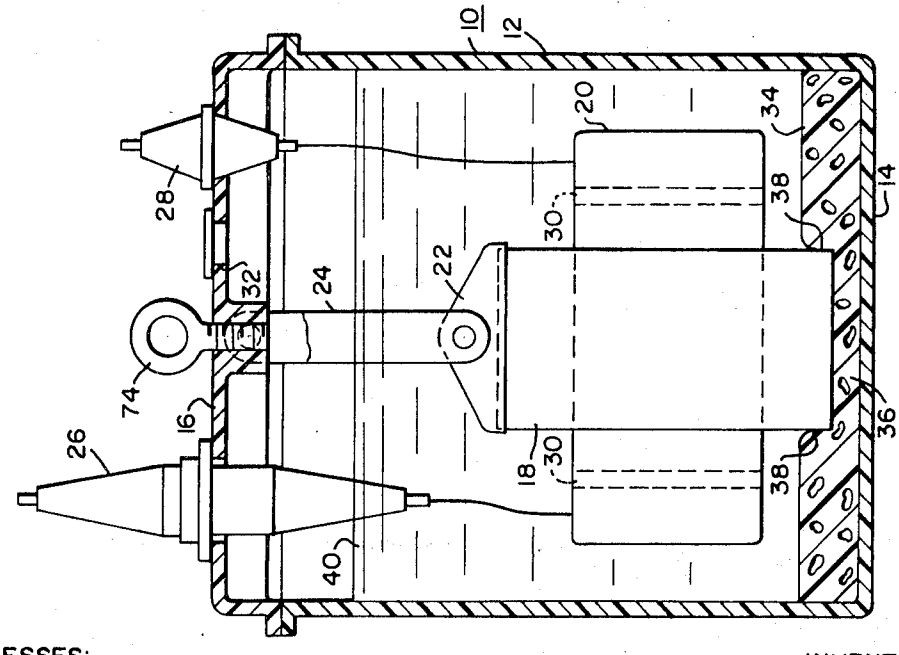


FIG. 1.

WITNESSES:

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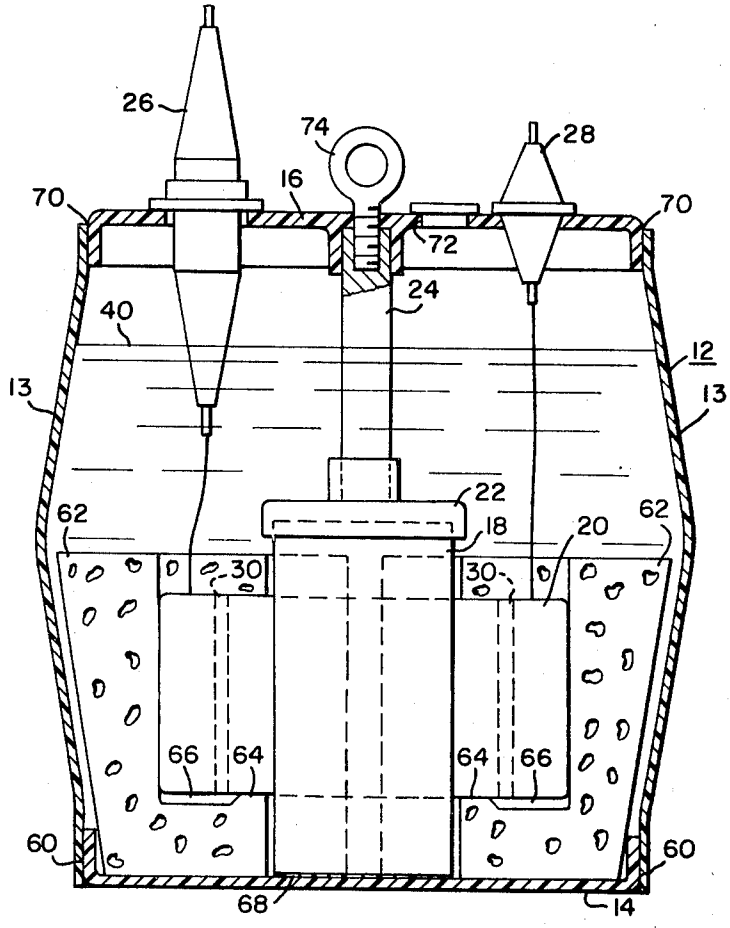

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FIG. 3.

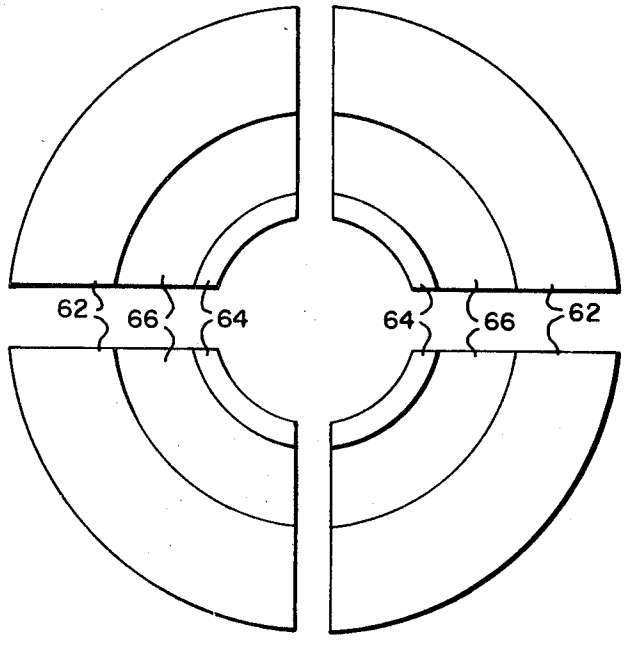

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FIG. 4.

DISTRIBUTION TRANSFORMER

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to static induction apparatus, more particularly to distribution transformers comprising a core-coil assembly housed in a casing or tank with the core-coil assembly and associated hardware, such as bushings, partially supported from the top of the casing or tank and partially supported from a cushion of foamed resin positioned on the bottom of the casing or tank.

2. Description of the Prior Art

In the prior art, transformers have been assembled with a core-coil assembly and the associated hardware, such as bushings, supported entirely from the top or cover of the casing or tank. In this type of transformer it is usually necessary to provide a protuberance on the bottom of the tank, on the inside, for centering the core-coil assembly. In this arrangement the core and coil assembly is free to move from side-to-side when the tank is titled or bumped, such as sometimes happens in transportation. In this arrangement the entire weight is carried by the tank cover and shifting of the core and coil assembly radially tends to place undue stress on the tank cover and in some instances the core and coil assembly may be disengaged from the protuberance in the bottom of the tank wall; and, if the core and coil assembly comes in contact with the tank it will in all probability cause complete destruction of the usefulness of the transformer.

This invention overcomes this objection to the prior art method of supporting the core and coil assembly and associated hardware, such as bushings, from the tank cover. This invention accomplishes this by providing a resilient, resin foam cushion layer in the bottom of the tank. This foam layer usually surrounds a portion of the sides of the core-coil assembly to prevent lateral movement and also provides partial support of the core and coil assembly and the associated hardware from the tank bottom, as well as from the tank top. This foamed layer is elastic and permits the core-coil assembly and the associated hardware to settle down and firmly nest in the elastic foam layer. With this invention the weight of the core and coil assembly is jointly supported by the tank cover and the tank bottom. The need for a protuberance on the inside of the bottom of the tank wall for positioning the core and coil assembly in the tank is eliminated, or is less critical. The weight supported by the tank bottom is distributed over the entire bottom and not concentrated at a few points as in the prior art. Side-to-side or lateral motion of the core and coil assembly is damped in all directions. Vertical shocks are damped by the foam resin cushion thereby reducing flexural stresses of the tank cover and the bottom. The foamed cushion in the bottom of the housing or tank displaces liquid coolant or dielectric which does not substantially aid in cooling the transformer. The foam resin cushion creates compressible volume in addition to the top airspace in the transformer, which thereby reduces flexural stresses imposed by thermal cycling. Closed pore foam resin may be used for the cushion which selectively absorbs water but not liquid dielectric, this characteristic reduces insulation and tank degradation by the presence of water inside the tank.

SUMMARY OF THE INVENTION

This invention provides a distribution transformer comprising a core-coil assembly installed in a casing or tank which is at least partially filled with a liquid dielectric or coolant. The core-coil assembly and the associated hardware, such as bushings, are partially supported from the tank cover and partially supported from the tank bottom by a resilient, compressible foam resin cushion. This compressible foam resin distributes the weight supported by the foam resin cushion over the entire bottom of the tank wall and partially supports the weight of the core-coil assembly. This cushion layer also eliminates lateral movement of the core and coil assembly in the tank. This invention eliminates the objections of the prior art wherein the core-coil assembly is supported entirely from the tank top and an internal protuberance is provided in the bottom of the tank for centering the core-coil in the tank. In the present invention the support of the core-coil is distributed between the tank top and the tank bottom and because the resilient foam cushion maintains the core-coil centered in the tank, no protuberance is required in the bottom tank wall for centering the core-coil assembly. In the present invention the resilient foam resin cushion in the bottom of the tank serves to absorb stresses due to shocks in transportation or installation of the transformer which in the prior art would be transmitted to the tank cover.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view illustrating one embodiment of the invention provided herein using a resilient resin cushion for partially supporting the core-coil assembly of a distribution transformer;

FIG. 2 is a vertical sectional view illustrating another embodiment of the invention provided herein for providing a resilient resin cushion for partially supporting the core-coil assembly;

FIG. 3 is a vertical sectional view showing still another embodiment of the invention provided herein using resilient resin members for positioning the core-coil assembly and partially supporting the tank sidewalls of a distribution transformer; and

FIG. 4 is a top view illustrating one embodiment of the resilient resin members used in FIG. 3.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the description which follows, like reference characters represent like parts on the various figures of the drawings.

Referring specifically to FIG. 1, this figure illustrates a distribution transformer **10** comprising a housing or tank **12** having sidewalls, a bottom **14**, and a top or closure **16**. The transformer has a core-coil assembly comprising a core **18** and a coil **20**. The core **18** has a bracket **22** attached to the upper side thereof. A rigid support member **24** is attached to the bracket **22** and to the underside of the cover **16**. The core-coil assembly **18** and **20** is supported by means of the bracket **22** and the rigid rod support **24** from the underside of the cover member **16**. Also supported on the cover member **16** are high-voltage bushings **26** and low-voltage bushings **28** for bringing the necessary electrical conductors through the top member **16** for connection to the coil **20**. The coil **20** has ducts **30** extending therethrough for the circulation of liquid coolant to cool the coil **20**. After the cover member **16** has been placed on the body member **12** and the necessary electrical connections made to the bushings **26** and **28** and the coil **20**, the top member **16** is sealed or fastened to the body member **12** of the housing or tank and foaming materials are placed into the tank or casing **10** through a fill opening **32**. A measured amount of foaming material is placed in the tank **12** to foam a resin cushion **34** in the bottom of the tank or casing **12**. As seen in FIG. 1 this foam resin cushion insulates the bottom of the core **18** from the bottom **14** of the tank **12** as indicated at **36** and it also surrounds the bottom of the core **18** as indicated at **38**. When the foamed resin cushion **34** is formed around the core **18** in the manner just described no critical centering means is required on the bottom **14** of the tank for centering the core-coil assembly into the tank or casing **12**. After the foamed resin cushion **34** has been formed it is seen that the bottom of the core is insulated and cushioned from the bottom **14** of the tank or casing **12**. The portion **36** of the resin cushion **34** vertically braces the bottom of the core **18** from the bottom **14** of the tank **12**. The resin cushion **34** also braces the core **18** at **38** to prevent lateral movement of the core-coil assembly. Since the resin cushion **34** is resilient, this construction provides a distribution transformer wherein the core-coil assembly and the associated hardware, such as the bushings **26** and **28**, are partially supported from the top wall **16** of the transformer

casing 12 and also partially from the bottom wall 14 of the transformer casing 12. The resin cushion 34 also distributes the weight carried by the resin cushion evenly over the entire area of the bottom wall 14 of the transformer casing. After the core 18-coil 20 assembly and the top cover 16 have been placed in position on the casing or tank 12 and sealed thereto the casing or tank 12 is usually filled to the required level with a liquid dielectric or coolant 40. The foam resin cushion 34 may be formed of a porous resin so that the liquid dielectric may freely penetrate the cushion 34. This penetration of the liquid dielectric assists the foam cushion 34 in absorbing vertical vibrations of the core-coil assembly.

FIG. 2 illustrates a second embodiment of a transformer 10 as provided by this invention. In this embodiment the transformer comprises a casing or tank 12 having a bottom 14 and a cover member 16. As in the embodiment described in FIG. 1 the cover member 16 has mounted thereon high-voltage bushings 26 and low-voltage bushings 28 for carrying the necessary electrical conductors through the cover 16 for connection to a coil 20 to be mounted in the casing or tank 12. A core 18-coil 20 assembly is attached to the top member 16 by means of the bracket 22, which attaches to the core 18, and a rigid rod of support 24. To assemble the structure illustrated in FIG. 2 the top member 16 with the bushings 26 and 28 mounted thereon and the core 18-coil 20 assembly rigidly attached to the rod of support 20 is placed in a position similar to that shown in FIG. 2; that is, with the top member 16 slightly above the top of the tank or casing 12. A sheet 50 of plastic is placed inside the casing 12 and the lower end 52 of the sheet of plastic 50 is positioned to cover the lower ends of the oil ducts 30 in the coil 20. Then the necessary foaming materials are poured into the tank 12 and a resin cushion 34 is formed against the bottom wall 14 of the tank 12 and along the sides of the tank 12, as indicated at 54. After the cushion 34 has been foamed into position then the plastic sheet 50 are removed from the tank 12 by simply pulling them out of the top of the tank 12. These sheets are attached at 52 to the bottom of the winding 20 so as to cover the bottoms of the cooling ducts 30 to prevent the resin from filling the bottoms of the cooling ducts 30. The lower edges 52 of the sheet 50 are attached to the winding 20 by means of a release material and will permit the edges 50 to easily pop off once the sheet 50 is pulled on from the top so that the sheet 50 may be removed from the casing 12. After the sheets 50 have been removed, the top member 16 with the core 18-coil 20 assembly attached thereto is lowered further into position until the flange on the top member 16 mates with the flange on the tank or casing 12. The foamed resin cushion 34 is sufficiently compressible to permit the lower end of the core 18-coil 20 assembly to sink into the foam resin cushion 34 sufficiently so that the flange on the top member 16 will mate with the flange on the housing or casing 12. After the top member 16 has been lowered into position, the top member 16 is sealed to the top of the casing or housing 12 and the casing or housing 12 is filled to the required height with a liquid dielectric 40.

After the sheets 50 have been removed from the casing or tank 12 a space equal to the thickness of the sheets 50 is provided between the sides 54 of the foam resin cushion 34 and the sides of the coil 20, and between the bottom of the coil 30 and between the top edge of the resin cushion 34 for circulation of liquid dielectric or coolant. The core 18 and coil 20 are maintained in position by that part of the resin cushion contacting the core at 56 and 58. With this construction it is seen that the weight of the core 18 and coil 20 assembly is supported jointly from the top member 16 and from the bottom 14 of the casing 12. The resin cushion 34, because of the portions 58 which extends up around the core 18, prevents lateral movement of the core 18 and coil 20 assembly in the casing 12. Like the resin of FIG. 1 the resin used in this embodiment for forming the cushion 34 is likewise porous and permits the penetration of the liquid dielectric or coolant. The liquid dielectric or coolant aids the porous foamed resin 34 in absorbing vertical and radial shocks, which in the prior art would be transmitted to only the top member 16 of the casing.

In the embodiments of FIGS. 1 and 2, the casing or tank 12 including the bottom member 14 and the top 16 may be made of metal or some suitable resin, such as reinforced epoxy, filled resin, or rubber.

FIG. 3 illustrates a third embodiment of this invention. In FIG. 3 a distribution transformer is illustrated comprising a tank or casing 12 having a bottom 14 and a top or closure member 16. As described hereinbefore for the embodiments of FIGS. 1 and 2 the top of closure member 16 carries bushings 26 and 28 for permitting the passage of conductors through the top cover member 16 for connection to the coil 20 of the transformer. In this embodiment the bottom member 14 and the top member 16 are constructed from some cast or molded insulating material such as epoxy resin, or the like. The body portion of the casing or tank 12 is made of flexible rubber or a flexible sheet plastic material 13. In the construction of the embodiment shown in FIG. 3 the sheet material 13 of the body portion 12 of the casing or tank 12 is first sealed to the bottom member 14 as indicated at 60, then four preformed foamed resin cushion members 62 are placed in the bottom of the tank or casing 12. As seen from FIG. 3 the members 62 are formed so as to permit an open space 66 opposite the coolant ducts 30 in the coil 20 to permit dielectric or coolant material to freely enter the ducts 30. After the members 62 have been placed in the tank or casing 12, the top member 16 having the core 18 and coil 20 assembly rigidly attached thereto by means of the clamp 22 and the rigid support 24 is lowered into position so that the core 18 rests on the bottom wall 14, as indicated at 68. The core 18 may be cemented to the bottom wall 14 at 68 to maintain the core 18 properly positioned on the bottom wall 14. It is thus seen that the members 62 extend up along the sides of the core-coil assembly and protects the flexible tank wall 13 from being damaged by collapsing against sharp edge of the core-coil assembly.

After the top member 16 with the core 18 and coil 20 attached thereto has been placed in position in the casing or tank 12 the upper edge of the sheet 13 comprising the body portion of the casing of tank 12 is sealed to the top member 16 as indicated at 70. After top member 16 has been sealed to the tank or casing 12 at 70, the casing of tank 12 may be filled with the required liquid dielectric or coolant through a filler opening 72. The sides of the resilient resin members 62 extent beyond the upper edges of the core-coil assembly, this is necessary to prevent the flexible sides 13 of the tank, or casing 12 from the collapsing against the core-coil assembly and being damaged by contact with sharp edges on the coil assembly.

It is seen that this embodiment provides a transformer comprising a casing or tank 12 made of flexible material with the core 18 and coil 20 assembly. As in the previous embodiments the resin material used in the members 62 is characterized by open pores which permits the liquid dielectric or coolant to penetrate the foam resin.

FIG. 4 is a top view of four preformed foam cushion members 62 used in the embodiment described for FIG. 3. It is understood that the preformed members 62 may be of any desired or required shape.

In each of the embodiments described the rigid support member connected between the top member 16 and the core 18-coil 20 assembly is drilled and tapped to receive a lifting eye 74. The lifting eye 74 is usually removed after the transformer is installed and the hole for the lifting eye is usually filled with a plastic screw-threaded plug.

From the foregoing description taken in connection with the drawings it is seen that this invention has provided a distribution transformer structure wherein the core-coil assembly and associated hardware such as bushings may be mounted on the top cover for the tank or casing and assembled in the tank or casing without the requirement of any detail centering devices in the tank or casing. A foam resin cushion is provided in the bottom of the tank of casing to assist in the centering of the core-coil assembly during the assembly of the transformer and serves to absorb vertical and radial vibrations. This cushion supports part of the weight of the core-coil assembly

as well as part of the weight being supported on the top of the transformer casing or tank.

The foamed resin cushion or support described herein before may be fabricated by foaming resins, such as polyether urethane, or any other of the foamable resins, such as phenolics, epoxies, silicones, styrofoam and the like. The resins used herein and the process used herein to provide the foam resin cushions or supports is described in detail in U.S. Pat. No. 3,072,582.

The foaming agents and resins used in this invention may be any of those described in the U.S. Pat. No. 3,072,582.

We claim as our invention:

1. A transformer comprising a casing having a bottom portion, a top portion, and an intermediate body portion, a core-coil assembly attached to said top portion and positioned in said body portion of said casing a resilient resin cushion in said casing and resting on the bottom portion of said casing, said resilient resin cushion being located between the bottom portion of said casing and the bottom portion of said core and extending along side portions of said core, the weight of said core-coil being partially suspended from said top portion of said casing and partially supported from said bottom portion of said casing through said resilient resin cushion.

2. The transformer of claim 1 wherein said resin cushion extends along sides of said core to dampen lateral movement of said core-coil assembly.

3. The transformer of claim 1 wherein said resin cushion comprises polyether urethane.

4. The transformer of claim 1 wherein said resin cushion is made from foamed resin.

5. The transformer of claim 1 wherein said resin cushion has open pores.

6. The transformer of claim 1 wherein said resin cushion extends along the sides of said coil at least substantially coextensive with said coil to dampen lateral movement of said coil.

7. A transformer comprising a casing having bottom and top portions connected to an intermediate body portion which is more flexible than said bottom and top portions, a core-coil assembly attached to said top portion and positioned in said body portion of said casing, said core-coil assembly resting on said bottom portion of said casing, resin members positioned in said casing between said core-coil assembly and the sides of said flexible body portion, said resin members having sides at least coextensive with the height of said core-coil assembly to prevent the sides of said flexible body member from collapsing against said core-coil assembly.

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