United States Patent

Galloway

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[54] **TRANSFORMER HAVING A NONMETALLIC CASING**

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[52] **U.S. Cl.** ....**336/92,** 174/17 LF, 336/94

[51] **Int. Cl.** **H01f 27/02**

[58] **Field of Search** ....336/90, 92, 94, 96; 174/17 R, 174/17 LF, 17 VA, 18; 317/15

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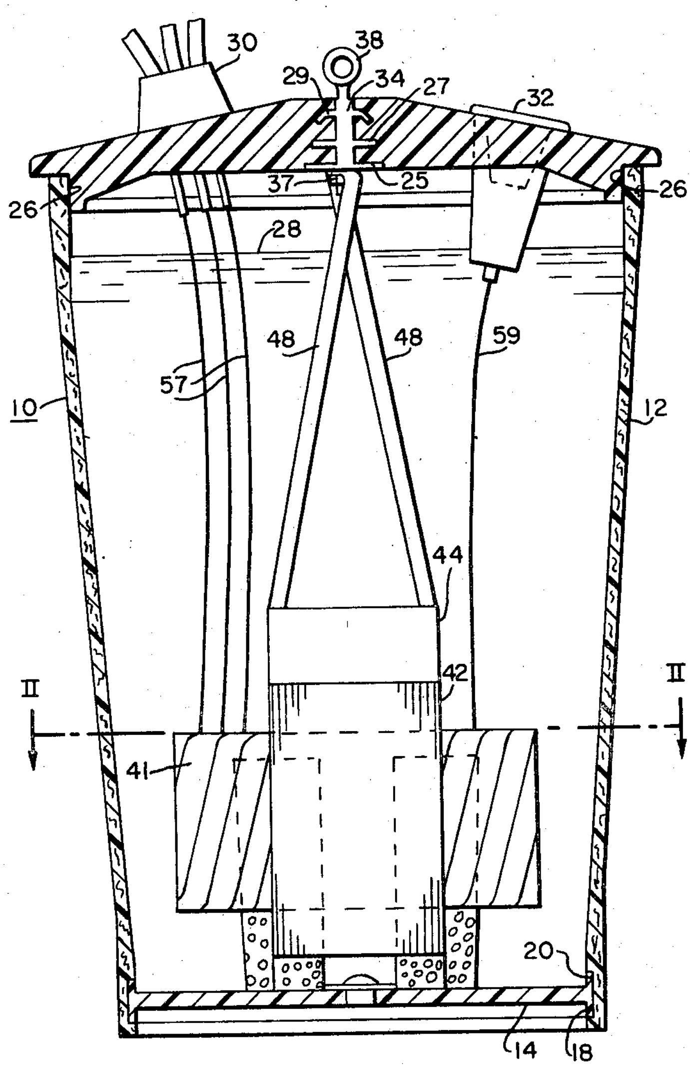
[57] **ABSTRACT**

An electrical transformer having a core-winding assembly, with the core-winding assembly and all other metallic parts of the transformer totally enclosed within a nonmetallic casing. The core-winding assembly is supported in the nonmetallic casing from the top cover of the casing. The nonmetallic casing comprises a nonmetallic bottom which is keyed into the sidewalls of the nonmetallic casing to provide a fluidtight joint.

8 Claims, 5 Drawing Figures



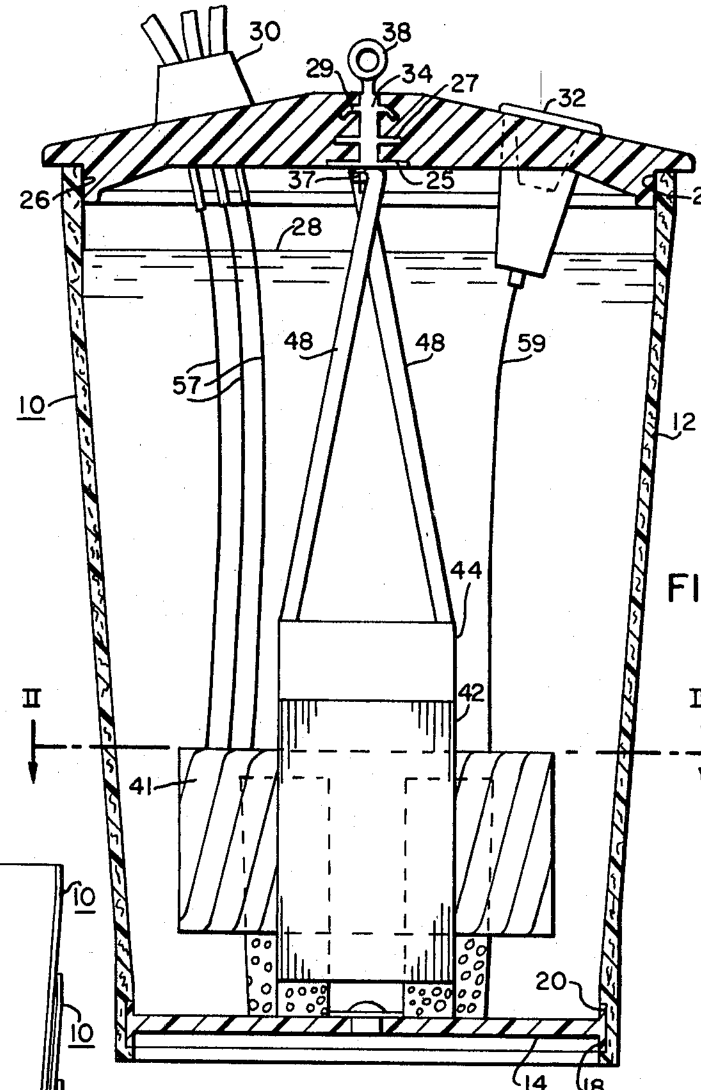


FIG. 1

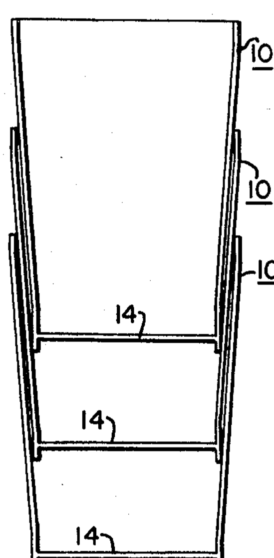


FIG. 5

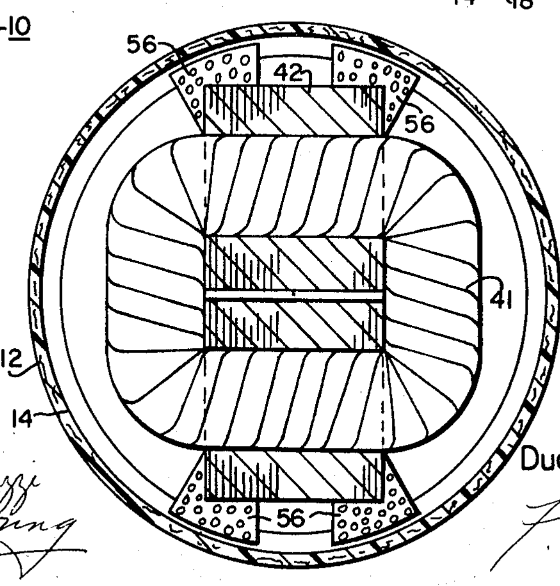


FIG. 2

WITNESSES

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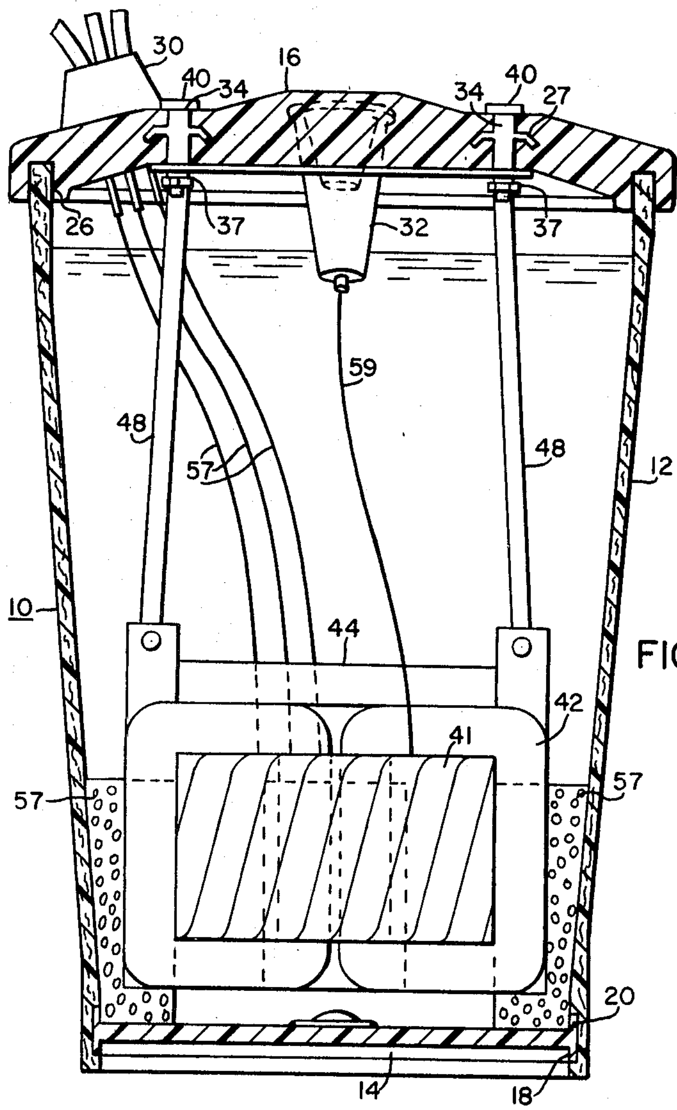
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FIG. 4

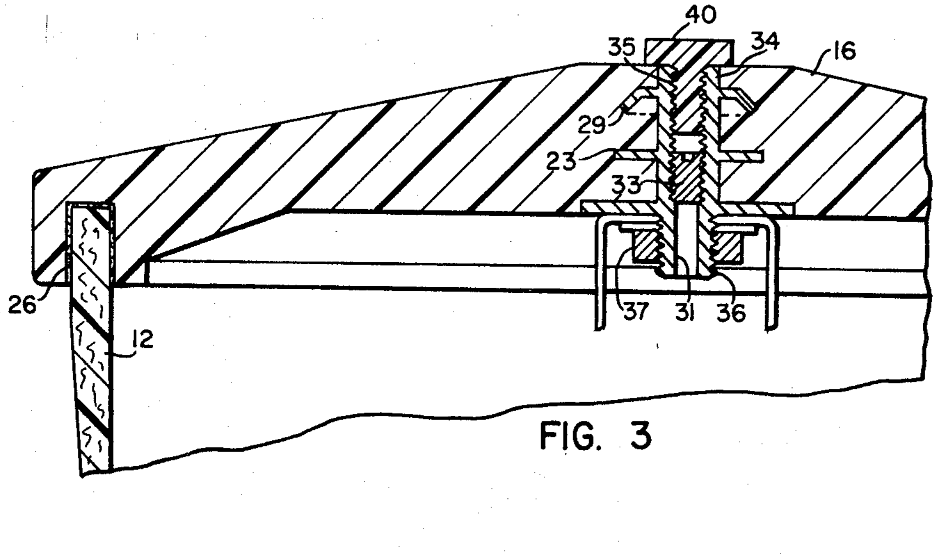
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FIG. 3

TRANSFORMER HAVING A NONMETALLIC CASING

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to electrical transformers, and more particularly to submersible transformers adapted for use in underground electrical distribution systems.

2. Description of the Prior Art

Transformers used in underground electrical distribution systems are often subjected to an extremely corrosive environment. The vaults in which the transformers are installed may be very damp and they often contain water. The transformer may be at least partially submerged in water for extensive periods of time. The environment surrounding a transformer in an underground electrical distribution system may be so corrosive that even the stainless steels are subjected to attack. Even if such steel could be made absolutely corrosionproof against all corrosion chemicals found in soil water, it would still have the disadvantage of higher cost.

Efforts to solve the corrosion problems through organic or plastic coatings disposed on steel transformer tanks have not been successful, as the coating must be applied without flaws, and the coated transformer must be shipped and installed without experiencing a single chip or scratch in the coating. Constructing the entire transformer casing of plastic has also many disadvantages, as the plastic bottom of the tank is subject to abuse during shipping and installing which may bend the bottom inwardly or flex the corner at the edge between the bottom and side wall causing the plastic to crack. The manufacturing and handling of the transformer is complicated by the problem of securing the magnetic core-winding assembly to the plastic tank, and by the fact that the plastic tank may be unduly stressed while the transformer is being lifted.

The above objections to the plastic tanks of the prior art have been eliminated by the nonmetallic tank of the present invention wherein the nonmetallic tank comprises a tubular portion which is wound on a mandrel using nonmetallic material such as a filament wound glass fiber impregnated with a resin such as epoxy resin. The tubular portion of the tank is provided with a nonmetallic bottom which is strong enough to resist stresses induced during handling of the tank. This nonmetallic bottom member is keyed to the sidewalls of the tubular portion of the tank during the winding process to provide a fluidtight seal between the bottom of the tank and the sidewalls of the tubular portion of the tank. This bottom member is made of epoxy laminate or molded glass epoxy, or other suitable reinforced plastic. The tank is provided with a nonmetallic cover which may be cast from a resin such as epoxy resin. Metallic inserts are cast into the cover member and the core-winding assembly is supported from these metallic inserts by metallic structural members connected between the inserts and the end frame of the core-winding assembly. These metallic inserts are also provided with threaded holes for insertion of eye bolts for lifting the core-winding assembly without inducing undue stresses in the nonmetallic cover member. When the eye bolts are not required for lifting they are removed from the holes in the inserts in the nonmetallic cover and the holes are filled with nonmetallic plugs or screws. All necessary bushings for connecting primary and secondary leads to the core-winding assembly are cast through the nonmetallic top member in such manner that no metallic parts are exposed after the electrical connections are made to the bushings. This invention provides a transformer including a core-winding assembly wherein all of the metallic components of the transformer are totally enclosed within a nonmetallic, noncorrosive, housing or casing. The nonmetallic cover member is sealed to the top of the tubular member of the housing or casing by means of a good sealant such as epoxy cement. This cement sealing the top of the casing to the top of the tubular member of the casing is strong enough to permit lifting of the transformer with the eye bolts even when the transformer is filled with a coolant, such as oil.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a vertical sectional view of a transformer provided in accordance with this invention;

FIG. 2 is a sectional view taken along line II—II of FIG. 1;

FIG. 3 is a partial sectional view illustrating in detail a metallic insert in the insulating top member from which the core-winding assembly is supported;

FIG. 4 is a vertical sectional view of a second embodiment of the invention provided by this invention, illustrating a second arrangement for supporting the core-winding assembly from the top of the casing; and

FIG. 5 is a schematic view illustrating how the tubular portions of the transformer casing with the bottom members installed may be nested for shipping or storing.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Throughout the description which follows, like reference characters refer to like parts in all of the various figures of the drawings.

Referring now to the drawings, and FIG. 1 in particular, there is shown a vertical sectional view of a transformer as provided by this invention. The transformer shown in FIG. 1 comprises a nonmetallic tank **10**. The nonmetallic tank **10** includes a nonmetallic cylindrical or tubular portion **12**, a nonmetallic bottom **14** which closes the bottom end of the tubular portion **12** and a nonmetallic top member **16** which closes the top of the tubular or cylindrical portion **12**. The tubular or cylindrical portion **12** of the tank **10** is made of nonmetallic material such as a filament wound glass fiber impregnated with a resin such as an epoxy resin. The portion **12** is wound on a rotating mandrel from filamentary material such as glass fiber impregnated with epoxy resin. The bottom portion **14** is also made from a nonmetallic material such as glass epoxy laminate or molded glass epoxy or other suitable reinforced plastic. The bottom portion **14** has a flange portion **18** circumferentially about the bottom portion **14**. This bottom portion **14** is placed on the mandrel when the cylindrical or tubular portion **12** is being wound and the flange portion **18** is keyed into the sidewalls of the tubular or cylindrical portion **12** as indicated at **20** to lock the bottom portion **14** to the sidewalls of the portion **12** and provide a fluidtight joint between the bottom portion **14** and the tubular or cylindrical portion **12**.

The upper end of the tubular or cylindrical portion **12** of the casing is closed by the top member **16**. This top member **16** is formed of some suitable nonmetallic material such as epoxy resin or reinforced glass polyester resin. The top member **16** is sealed to the top edges of the wall portions **12** of the tubular or cylindrical member **10** at **26** with a good grade of cement which has sufficient strength to lift the casing filled to a predetermined height, as indicated at **28**, with fluid dielectric. A good grade of epoxy cement has been found to be satisfactory for making the seal at **26**.

The top member **16** has cast therein during the manufacture of the top member **26** low voltage bushings **30** for bringing low-voltage conductors through the top member **16** and high-voltage bushings **32** for bringing high-voltage electrical conductors through the top member **16**.

The top member **16** also has cast therein metallic inserts **34**. The metallic insert **34** extends entirely through the top member **16** and has an opening **31** entirely therethrough, see FIG. 3. The metallic insert **34** has a threaded portion **36** on the underside of the cover member **16** for attaching the core-winding assembly to the top member **16** by means of a nut **37**. The opening **31** through the metallic member **34** is threaded on the inside as indicated at **35**. This opening **31** is used for pulling a vacuum in the casing after the top **16** has been assembled thereto and for filling the casing with liquid dielectric **28** and then a threaded nonmetallic plug **33** is inserted into the opening **31** from above to close the opening **31** to atmosphere. For lifting the transformer an eye bolt **38**, FIG. 1, may be also screwed into the threads **35** of the opening **31** in the metallic member 34 after the closure plug 33 has been inserted. When the eyebolt 38 is not being used it is removed from the opening 31 and a screw threaded nonmetallic plug 40, as shown in FIG. 3, is inserted into the opening 31. The insert member 34 is provided with flanges 25, 27 and 29 to assist in distributing stresses in the nonmetallic cover member 16.

The core-winding assembly comprises a laminated metallic core 42 having an end frame 44 attached thereto. An electrical coil 41 comprising high-voltage windings and low-voltage windings is associated with the core 42. A pair of metallic brackets 48 are attached to the end frame 44 of the core 42 and these brackets 48 are attached to the metallic insert 34 by means of a nut 37 which is threaded onto the lower threaded end 36 of the metallic insert 34. This structure just described supports the core-winding assembly comprising the core 42 and the windings 41 from the nonmetallic cover member 16 through the metallic brackets 48.

To cushion the core-winding assembly from the bottom member 14 of the casing and also to partially support the core-winding assembly from the bottom 14 of the casing four blocks 56 of foam resin, such as porous polyurethane resin, are placed under the corners of the core 42 as indicated in FIG. 2. This support by the foam resin blocks 56 provides a cushion and partially distributes the support of the core-winding assembly from both the bottom member 14 of the casing and the top member 16. The blocks 56 extend up the sidewalls of the casing 10, as indicated at 57, to prevent lateral movement of the core-winding assembly within the casing 10. The blocks 56 are porous to permit saturation of the blocks 56 by the fluid detecting in the casing 10.

Low-voltage leads 57 connect through the low-voltage bushing means 30 and to the low-voltage coil of the winding 41. High-voltage leads 59 connect through the high-voltage bushing 32 to the high-voltage winding of the winding 41.

A second embodiment of the transformer as provided by this invention is illustrated in FIG. 4. In the embodiment illustrated in FIG. 4 the core-winding assembly is supported from the nonmetallic top member 16 by two metallic struts or bracket members 48 which are connected to two separate spaced metallic inserts 34 in the nonmetallic cover member 16. In this embodiment it is seen that the top member 16 has two metallic inserts 34 therein for supporting the core 42-winding 41 assembly from the top members 16. In all other respects this embodiment is substantially identical to the embodiment shown in FIG. 1 The metallic inserts 34 of this embodiment are substantially identical to the inserts 34 described above for FIGS. 1 and 3 except that the metallic inserts 34 in FIG. 4 do not have but one stress reducing flange 27. This embodiment using two widely spaced inserts 34 is believed to provide more stability against lateral movement of the core-winding assembly within the casing 10 in case the casing 10 is tilted or bumped. As in the embodiment shown in FIG. 1 the top member 16 is cemented to the cylindrical or tubular portion of the casing 10 at 26. This cement 26 is strong enough to lift the fluid dielectric 28 when eyebolts 38 are inserted into the metallic inserts 34 for lifting the transformer.

It is observed from FIGS. 1 and 4 that the tubular or cylindrical portion of the casing 10 is larger at the top than at the bottom, in other words it is similar to a frustrum of a tube. The main purpose of this configuration is illustrated in FIG. 5. FIG. 5 illustrates a plurality of casings 10 nested when empty. The slanting sides 12, of frustum shape, of the members 10 permit nesting of a plurality of casings 10 in a small space when being shipped or stored.

From the foregoing description taken in connection with the drawings it is seen that this invention has provided a distribution transformer assembled in a nonmetallic casing with no metallic parts exposed to the atmosphere wherein the transformer comprising the core-winding assembly may be lifted by placing eyebolts in metallic inserts in the top of the transformer casing or housing without causing undue stress on the transformer casing or housing. It is also seen that this invention provides satisfactory means for partially supporting the weight of the core-winding assembly from the top of the casing and partially from the bottom of the casing and bracing the core-winding assembly against lateral movement during shipping in case the transformer is bumped. The nonmetallic casing or housing is made of resinous material which is resistant to corrosion in practically any type of atmosphere and any type of environment in which the transformer may be installed. There are no metallic components exposed to the environment in which the transformer is installed. It is also seen that this invention provides a simple single means for pulling a vacuum on the transformer and filling the transformer through the same opening which also provides for insertion of an eyebolt in the same opening for lifting the transformer.

I claim:

1. A transformer comprising a nonmetallic casing, said nonmetallic casing comprising a longitudinal tubular portion, a nonmetallic bottom portion closing one end of said tubular portion, said nonmetallic bottom portion having its periphery keyed in a circumferential groove in the inside wall of said longitudinal tubular portion, said periphery of said bottom portion being sealed in the groove in the inside wall of said longitudinal tubular portion to provide a gasketless fluidtight joint between said bottom portion and said longitudinal tubular portion of said casing, a nonmetallic top closing the other end of said longitudinal tubular portion, metallic insert means mounted in said nonmetallic top portion, a core-winding assembly positioned in said casing, and means connecting said core-winding assembly to said metallic insert means in said nonmetallic top portion to provide support of said core-winding means, said metallic insert means permitting lifting of said transformer by applying a lifting force to said metallic insert means without creating excessive stress concentrations in said nonmetallic top portion.

2. The transformer of claim 1 wherein said longitudinal tubular portion of said nonmetallic casing has one end having a diameter substantially smaller than its other end wherein the walls of said tubular member between its two ends is substantially a tubular frustrum.

3. The transformer of claim 1 wherein cushion means are provided between said core-winding assembly and said bottom portion of said casing to partially support said core-winding assembly from said bottom portion and reduce lateral movement of said core-winding assembly in said casing.

4. The transformer of claim 3 wherein said cushion means comprises foamed resin.

5. The transformer of claim 3 wherein said cushion means comprises polyester-urethane.

6. The transformer of claim 1 wherein said metallic insert means mounted in said nonmetallic top portion provides means for evacuating said casing and inserting fluid dielectric into said casing.

7. The transformer of claim 1 wherein said metallic insert means comprises a plurality of spaced metallic members.

8. The transformer of claim 1 wherein said nonmetallic top portion has high potential and low potential electrical bushing means cast therethrough.

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