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**[54] TRANSFORMER USING NONCOMBUSTIBLE
FLUID DIELECTRIC FOR COOLING
10 Claims, 3 Drawing Figs.**

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174/17, 336/90, 336/94
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[50] **Field of Search**..... 336/90, 51,
94, 58, 100; 174/110.8, 52.6, 15, 17, 17.1, 17.11,
52.6

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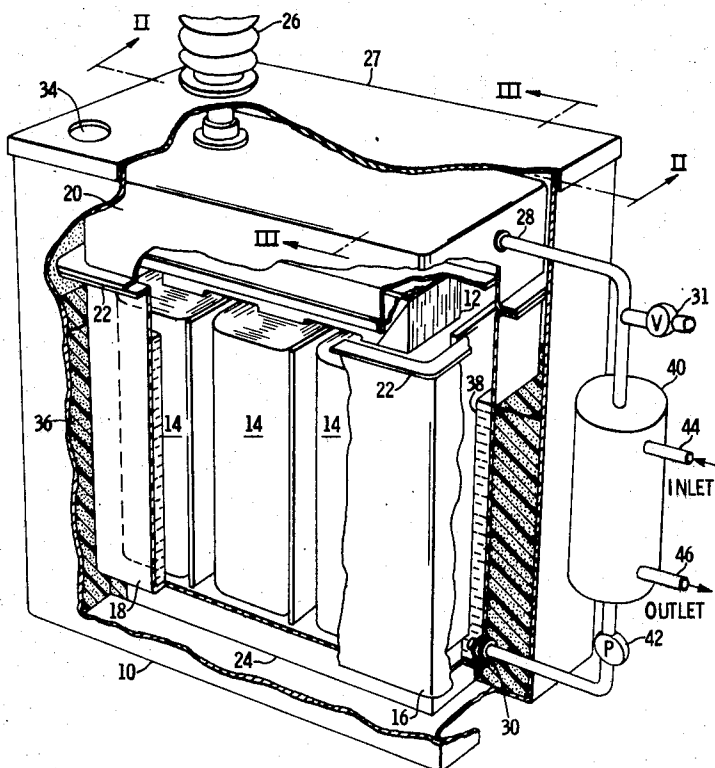
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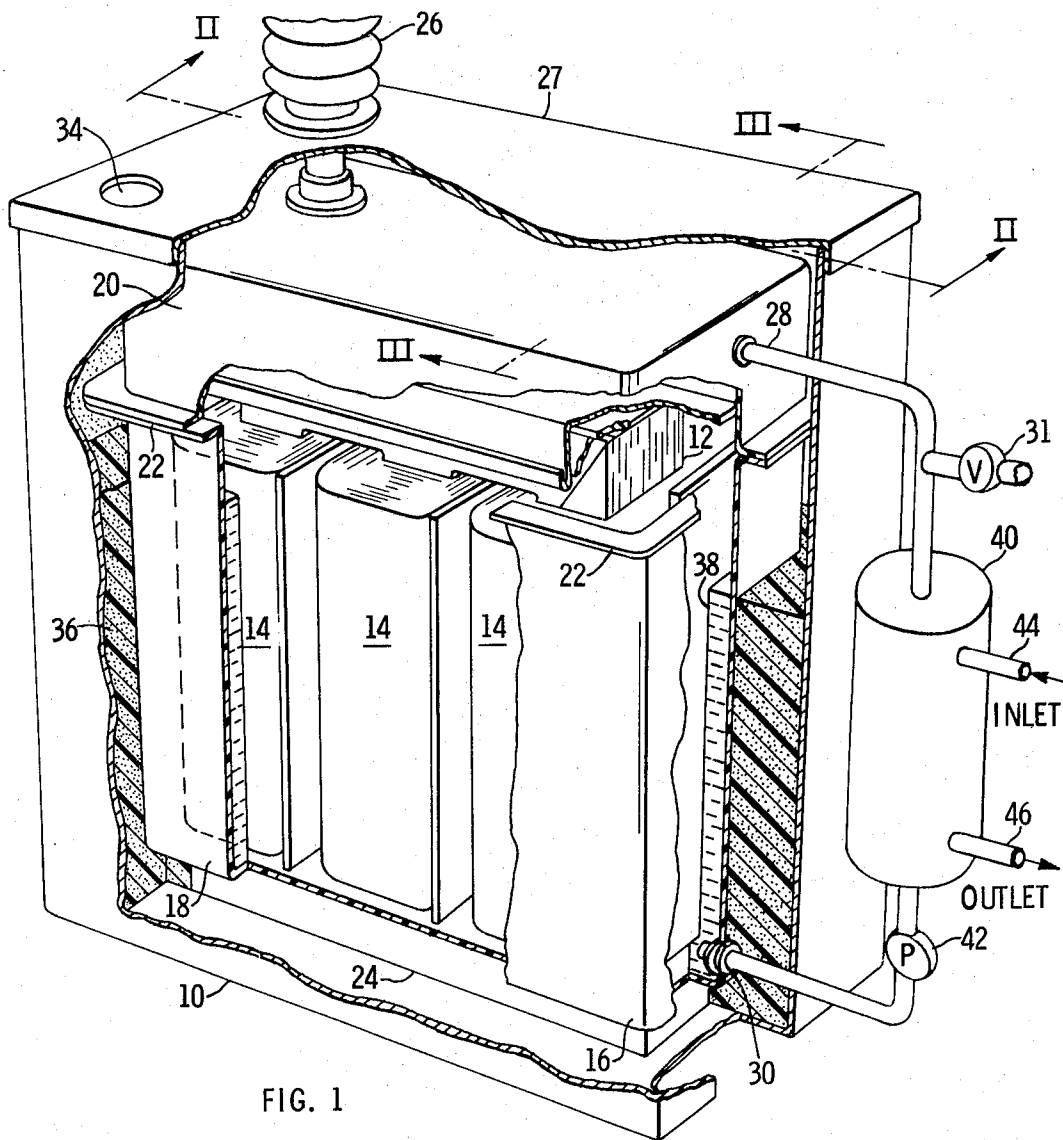
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ABSTRACT: A fluid-cooled transformer having an outer casing of metal and an inner casing of electrical insulating material. The space between the outer and inner casings being substantially filled with solid or cellular insulating material. The inner casing has therein a core-coil assembly with fluid dielectric material filling the inner casing to a predetermined height. Bushings extend through the outer and inner casings for making necessary electrical connections to the coil.





WITNESSES

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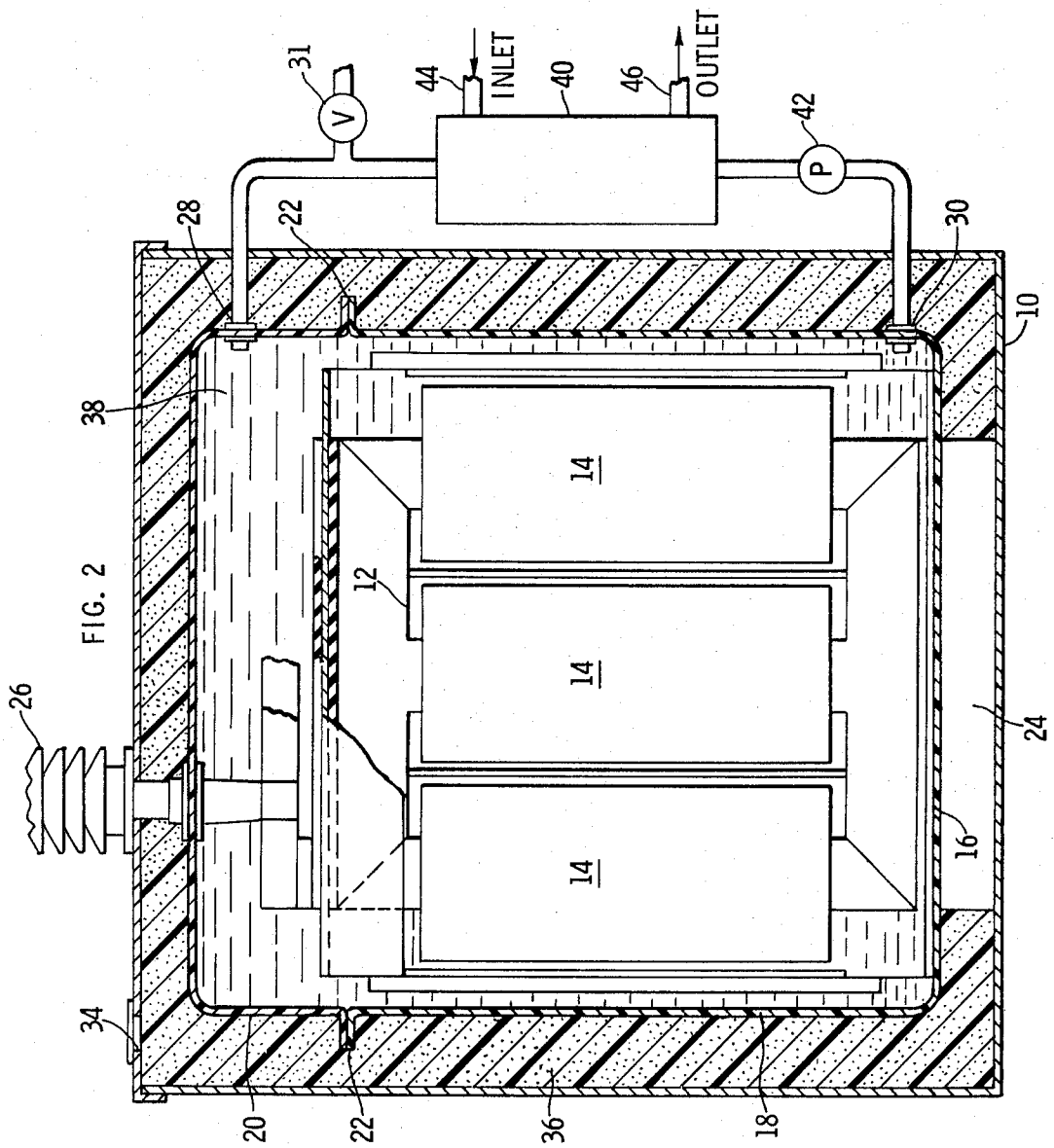
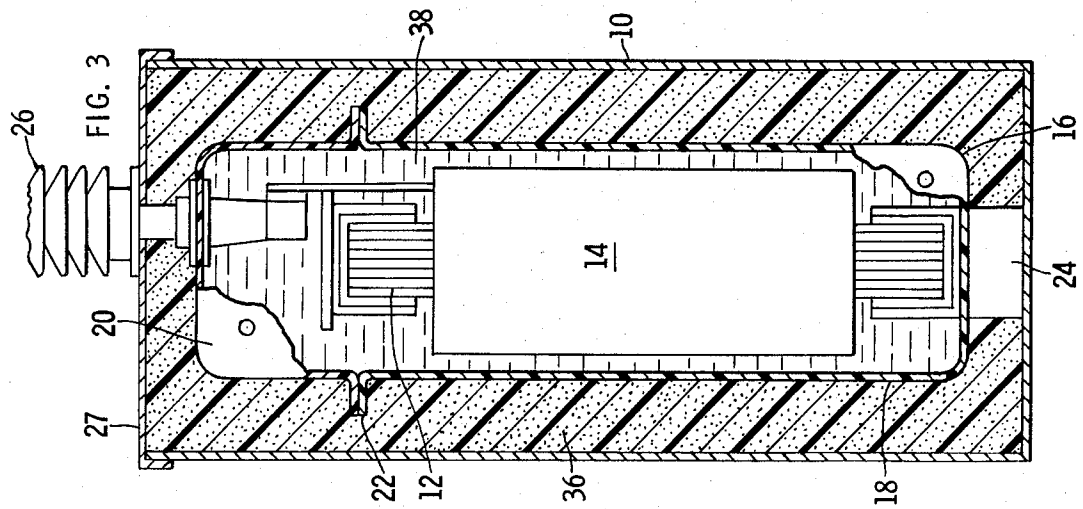
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TRANSFORMER USING NONCOMBUSTIBLE FLUID DIELECTRIC FOR COOLING

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to power transformers and more particularly to power transformers using a noncombustible fluid dielectric for cooling and insulating the core-coil assembly.

2. Description of the Prior Art

In the prior art apparatus using noncombustible fluid dielectric, the transformer is provided with a large metal outer housing for enclosing the core and coil assembly. A fairly large outer metal housing is necessary to provide the required electrical insulation or breakdown distance from the core-coil assembly to the housing. In this prior art apparatus the entire housing is usually filled to a predetermined height, usually to a height to cover the core-coil assembly, with noncombustible fluid dielectric. This practice makes the apparatus very expensive since a large amount of noncombustible fluid dielectric is required to fill the large outer housing and the noncombustible fluid dielectric is expensive in that it costs in the order of seven or eight times more than a good grade of mineral oil dielectric material. This large quantity of noncombustible fluid dielectric also makes the transformer very heavy since the density of the fluid dielectric is in the order of 87 pounds per cubic foot. The invention of this application eliminates the objections to the prior art practice, by providing a power transformer with equivalent rating of the prior art apparatus, which uses less noncombustible fluid dielectric to cool and insulate the core-coil assembly than the prior art apparatus thereby providing a much cheaper and lighter weight transformer than the prior art apparatus.

SUMMARY OF THE INVENTION

This invention provides a power transformer using a noncombustible fluid dielectric for insulating and cooling the core-coil assembly of the transformer. This invention provides a large outer metal casing for the transformer and a smaller electrical insulating casing surrounding the core-coil assembly. The smaller electrical insulating casing enclosing the core-coil assembly is placed inside the large outer metallic casing and the space between the large outer casing and the inner electrical insulating casing is filled with foam resin. This resin may have a density of from 1 to 8 pounds per cubic foot. It may be cellular or it may be fairly dense.

The inner casing fits fairly closely around the core-coil assembly. The inner casing is filled with a noncombustible fluid dielectric will not escape and permeate the foam resin filling the space between the outer casing and the inner casing. Bushings extend through the outer and inner casings with fluidtight joints for making the necessary electrical connections to the coils. Fittings extend through the outer casing and are connected to the inner casing with fluidtight joints for circulating and cooling the noncombustible fluid dielectric. With this construction fluid dielectric is placed only in the inner casing, rather than filling the outer casing as is practiced in the prior art, which means that much less noncombustible fluid dielectric is required than in the prior art devices.

One type of noncombustible fluid dielectric used in this invention is sold under the trademark "ASKAREL." "ASKAREL" is the generic name for noncombustible (fire-resistant) fluid insulation sold by Monsanto Chemical Company. This insulation is resold by others under such trade names as "INERTEEN" and "PYRANOL." Whatever the trademark name, "ASKAREL" contains chlorobiphenyl. It may also contain Trichlorobenze, Tetrachlorobenze, Tin tetraphenyl, Phenoxy propene oxide, and Diepoxide. This inert compound is chemically stable, fire-resistant, heat stable, noncorrosive and has high dielectric strength under the operating conditions encountered in transformers. This material has a density of about 87 pounds per cubic foot.

In addition to "ASKAREL" other materials, such as fluorocarbon materials and fluorosilicone materials may be used for the fluid dielectric in this invention.

The term "solid insulation" as used herein means any insulation which is not flowable, such as cellulosic material or foamed resin. It is also understood that the solid insulation used is porous or cellular. The solid insulation used in the specific illustration of the drawings is foamed material and has a density of between 1 1/4 and 8 pounds per cubic foot. The resin used in foaming the insulation between the outer housing and the inner housing may be a foaming resin such as polyurethane, or any other of the foamable resins such as phenolics, epoxies, silicones styrofoam and the like. The process described in detail in U.S. Pat. No. 3,072,582 may be used for foaming the material into the space between the outer and inner casings.

This invention provides an improved power transformer using a noncombustible fluid dielectric insulation by providing a large outer metallic casing, which outer casing provides the necessary electrical insulation and breakdown distance between the core-coil assembly and the outer casing, and enclosing the core-coil assembly in a smaller electrical insulating casing, which smaller casing is placed inside the outer casing. The space between the large outer metallic casing and the smaller inner electrical insulation casing is filled with a lightweight foam material having a density of between 1 and 8 pounds per cubic foot. This material occupies a large proportion of the space inside of the large outer casing and reduces the overall weight of the transformer substantially since it replaces a large volume of the noncombustible fluid dielectric which weighs in the order of 87 pounds per cubic foot. This solid insulation material is cellular in structure which also assists in cutting down noise transmitted from the core-coil assembly to the outer casing. The cost of the insulating system is substantially reduced since the volume between the outer and inner casing which would normally be filled with noncombustible fluid dielectric in the prior art devices is filled with a cheap foamed resin material, rather than expensive noncombustible fluid dielectric.

The outer casing of this invention is made of sheet steel and the inner electrical insulation casing is made from high strength plastic material such as polyolefin or polyamide-imide film, or some other good grade of plastic material that will not be affected by the noncombustible fluid dielectric material. The plastic of the inner casing is of the order of 25 to 30 mils thick and all joints to the inner casing are sealed to provide fluidtight seals so that the noncombustible fluid dielectric cannot leak from the inner casing into the outer casing to permeate the foam resin insulation filling the space between the inner casing and the outer casing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view, with parts broken away for purpose of illustration, of a transformer constructed in accordance with this invention;

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

FIG. 3 is a sectional view taken along line III—III of FIG. 1.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. 1 is a perspective view with parts broken away of a transformer constructed in accordance with the teachings of this invention. The transformer of FIG. 1 comprises an outer metallic casing 10 having a core-coil assembly therein. The core-coil assembly comprises a laminated metallic core 12 having three coils 14 associated therewith. Each of the coils 14 comprises a concentric high voltage winding and a low voltage winding. The core and coil assembly is enclosed in an inner casing 16 of electrical insulating material. The electrical insulating casing 16 is made of electrical insulating material in the order of 25 to 30 mils thick. This casing 16 may be made of polyolefin or polyamide-imide film or any other suitable material that will not be affected by the noncombustible fluid dielectric contained therein.

The casing 16 is made in two parts. It has a lower part 18 which is adapted to receive the core-coil assembly and an

upper part 20 which is fitted in place after the assembly comprising core 12 and the coils 14 has been placed in the lower part 18. The upper part 20 is placed in position and the two parts 18 and 20 of the casing 16 are sealed together at 22 to provide a fluidtight seal all the way around the casing 16. Then the casing 16, enclosing the core 12 and the coils 14, is placed inside the outer metallic casing 10. The assembly comprising the casing 16 and the core 12 and the coils 14 is supported from the bottom of the casing 10 by a pad member 24. Bushings 26 are inserted through the top 28 of the casing 10 and sealed to the top of the inner electrical insulating casing 16. Although only one bushing 26 has been shown in the drawings it is understood that as many high voltage and low voltage bushings may be installed as is necessary to make the necessary electrical connections to the high voltage and low voltage windings of the coil assemblies 14. Fluid tight connections 28 and 30 are also made to the inner electrical insulating casing 16 for connection to a circulating system for circulating noncombustible liquid dielectric through a heat exchanger 40 for cooling the liquid dielectric.

After the inner housing 16, enclosing the core 12 and the coils 14, has been assembled with the bushings 26 and connections 28 and 30 installed, a slight pressure is applied to the inside of the inner casing 16. This pressure can be applied through a valve 31 in the tubing connected to the electrical insulation housing at 28 and 30. The purpose of this positive pressure inside the casing 16 is to prevent the casing 16 from collapsing against the core-coil assembly during the foaming of the insulation between the inner casing 16 and the outer casing 10.

The foaming of the solid insulation is performed by pouring the foaming agents into the casing 10 through a hand hole indicated at 34. These foaming materials are poured into the outer casing 10 through the hand hold 34. The foaming operation fills the space between the casing 10 and 16 with foamed insulation. This foamed insulation is indicated on the drawings with the reference character 36. Although this material 36 has been illustrated, for the purposes of clarity, as extending only part of the way upward in the casing 10, it is understood that it substantially completely fills the space between the outer casing 10 and the inner electrical insulating casing 16. This is clearly shown in FIGS. 2 and 3 of the drawings.

After the solid insulation 36 has been foamed between the outer casing 10 and the electrical insulating casing 16, the positive pressure is released from the inner casing 16. The inner casing 16 is then substantially filled with the noncombustible fluid dielectric such as "ASKAREL," as indicated at 38. In FIG 1 the "ASKAREL" 38 is not shown completely filling the inner casing 16, but has been broken away short of the top of the casing 16 for the purpose of more clearly illustrating all the parts in FIG. 1. As shown in FIGS. 2 and 3 the "ASKAREL" 38 substantially fills the entire space in the inner electrical insulating casing 16.

A heat exchange device 40 is connected to the connections 28 and 30 of the inner casing 16 and a pump 42 is provided for circulating the noncombustible fluid dielectric to the heat exchanger 40 for extracting heat from the fluid dielectric

material. The heat exchanger 40 may be cooled by circulating a cooling medium such as cool water or the like to the heat exchanger through an inlet 44 and out of an outlet 46 as illustrated in FIGS. 1 and 2.

As seen from the drawings and the description herein, this invention has provided a power transformer using noncombustible fluid dielectric for cooling the core-coil assembly wherein means has been provided for providing adequate electrical insulation between the core-coil assembly and the outer casing to prevent breakdown between the core-coil assembly and the outer casing; and, also to provide adequate cooling and insulation of the core-coil assembly using a minimum amount of noncombustible fluid insulation. This structure has reduced the overall weight of a transformer having substantially the same rating as a like prior art device and has also decreased the expense of the transformer in that it permits the use of a minimum amount of noncombustible fluid dielectric to provide adequate cooling of core-coil assembly.

I claim:

1. A transformer comprising a core-coil assembly, an inner casing of electrical insulating material enclosing said core-coil assembly, an outer metallic casing enclosing said inner casing and said core-coil assembly, said inner casing being spaced from said outer casing, solid insulation substantially filling the space between said outer and inner casings, and liquid insulation in said inner casing, said liquid insulation surrounding said core-coil assembly.

2. The apparatus of claim 1 wherein said inner casing is made of plastic material.

3. The apparatus of claim 1 wherein the space between said outer and inner casings is substantially filled with cellular solid insulation.

4. The apparatus of claim 1 wherein the space between said outer and inner casings is substantially filled with foamed resin.

5. The apparatus of claim 1 wherein said inner casing contains a predetermined quantity of liquid dielectric containing chlorobiphenyl.

6. The apparatus of claim 1 wherein said inner casing contains a predetermined quantity of liquid dielectric containing fluorocarbon.

7. The apparatus of claim 1 wherein said inner casing contains a predetermined quantity of liquid dielectric containing fluorosilicone.

8. The apparatus of claim 1 comprising bushings passing through said outer and inner casings for connecting electrical conductors to the coil of said core-coil assembly.

9. The apparatus of claim 1 comprising means for cooling the liquid dielectric contained in said inner casing.

10. The apparatus of claim 7 wherein the means for cooling the liquid dielectric comprises an outlet connection and an inlet connection to said inner casing, conduits connected to said outlet and inlet connections, means connected to said conduit for force circulating said liquid dielectric, and heat exchange means associated with said conduit for removing heat from said liquid dielectric.

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