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GAS COOLED AND INSULATED TRANSFORMER

Filed Jan. 6, 1960

2 Sheets-Sheet 1

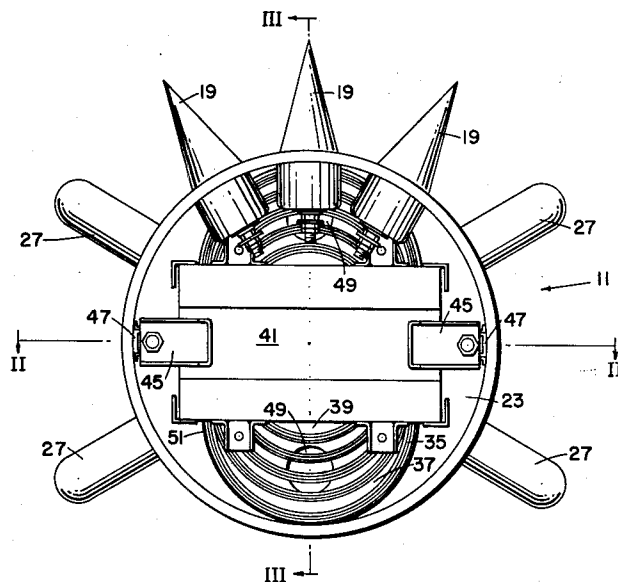


Fig. 1

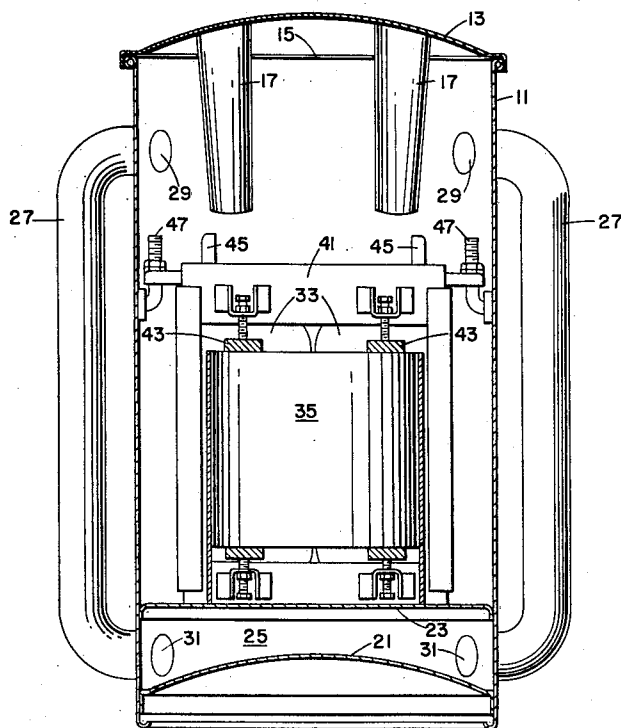


Fig. 2

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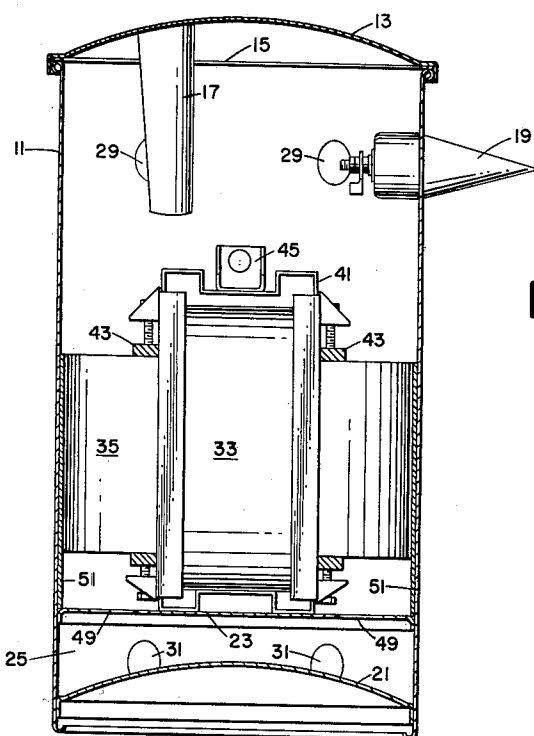


Fig. 3

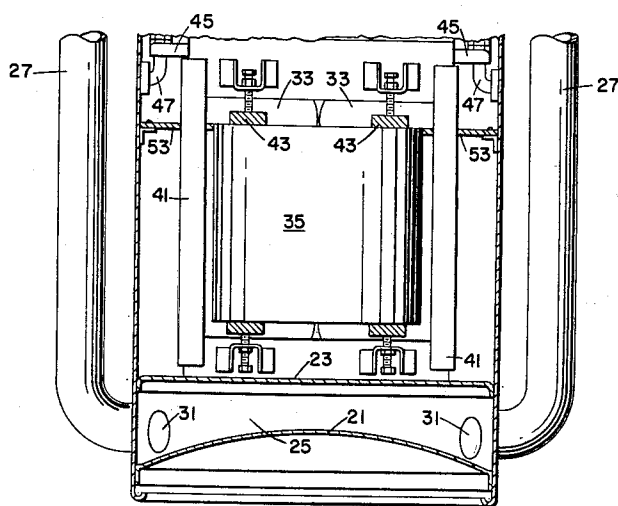


Fig. 4

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1

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GAS COOLED AND INSULATED TRANSFORMER
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This invention relates to certain new and useful improvements in transformer constructions, and it is particularly pertinent to the category of transformers which are characterized in the industry as distribution transformers. More particularly, this invention relates to the provision of a transformer structure which is gas cooled and insulated.

Under the standards established in the transformer industry there are a number of classes of transformers, classified in accordance with their type and location of usage, and further classified with respect to the coolant and insulation with which the tank or container for the transformer is filled. Thus there is one class of transformers recognized in which the core and coil assembly is liquid immersed preferably in oil or askarel or other suitable type of coolant and insulant. Another is a so-called dry type transformer, which is an air filled transformer but which is limited in its type of service and places of usage. Yet another type is a dry type transformer which is air filled and which with certain safety features may be utilized and under different temperature ranges than those in the prior mentioned classes of dry type transformers.

The present invention contemplates the provision of a transformer, and specifically a transformer of the distribution category which may be utilized under outdoor or indoor conditions, and which will meet the safety requirements prescribed by the transformer industry without necessitating an increase in the cost of such production, and additionally providing a substantial saving in weight and size per transformer rating over and above the conventional transformers heretofore known.

In order to carry out the purpose of this invention, it has been found that the usage of halogen compound gases provide a highly suitable coolant and insulating medium which has minimum deleterious characteristics under the heat imparted during the normal or extraordinary operation of the transformer, and which may, therefore, replace oil or askarel with which many transformers are currently conventionally filled, reducing to a substantial minimum the weight of the completed transformer and further enabling the reduction in the size thereof, since by the use of such a gaseous medium it becomes unnecessary to provide the tank for containing transformer core and coil assemblies with such volume as is necessary to compensate for expansion in liquid coolant and insulating material such as oil or askarel or the like.

The primary characteristic desired for the gas used is that it be inert, non-toxic and non-inflammable. Among the halogen compounds which have been considered and utilized is sulphur hexafluoride. This gaseous halogen compound is inert, non-toxic and non-inflammable, and has the further characteristic of maintaining a high dielectric strength which increases as the pressure of the gas is increased. Inasmuch as sulphur hexafluoride has a density of approximately five times the density of normal atmosphere it provides a medium which is extremely convenient in handling and enables the quick usage of this halogen gas in the transformer units under consideration.

It is further found that if the pressure upon a volume of sulphur hexafluoride is of the nature of 30 pounds per square inch the dielectric strength of the gas is substan-

2

tially equivalent to presently known insulating and cooling oils.

In the preferred embodiment of the present invention it is preferred that the coil of the core and coil assembly of the transformer should be treated with an epoxy resin, a substance which serves admirably to coat the coil for all purposes necessary in the transformer and which is resistant to reactive decomposition with halogen compounds.

The present invention contemplates the employment of a pressure type tank adapted to retain the gaseous contents at pressures in excess of 30 pounds per square inch, and which includes means for circulating the gaseous contents so as to provide a circulating cooling flow of the gaseous fluid through the area of the coil, forming part of the core and coil assembly, thence externally of the tank through cooling tubes, and thus accomplishing in the desired manner the cooling of the transformer.

The principal object of the present invention is to provide a transformer filled with an inert, non-toxic and non-inflammable gaseous fluid as a coolant and insulant.

A further object of the invention is to provide such a transformer which includes a core and coil assembly, and in which the coil is provided with passageways for conducting the flow of such gaseous fluid through the coil.

A further object of the invention is to provide such a transformer which includes a lowermost pressure chamber communicated by apertures into adjacency with spaced apart passageways in the transformer coil, pipe means communicating the uppermost part of the transformer tank with the lowermost pressure chamber for flow of gaseous fluid from the tank into the pressure chamber and thence upwardly through the apertures and into the coil, and means substantially completely blocking the flow of such gaseous fluid except to pass through the openings formed in the transformer coil.

A further object of the invention is to provide in such a transformer such flow blocking means which embrace peripherally the coil of the transformer.

A further object of the invention is to provide such flow blocking means as a substantially vertically disposed sleeve embracing the peripheral surface of the coil.

A further object of the invention is to provide a substantially horizontal baffle ring which embraces the upper periphery of the coil.

A further object of the invention is to provide a transformer which is charged with a gaseous halogen compound of the nature of sulphur hexafluoride.

A further object of the invention is to provide a distribution transformer in which the interior of the transformer is charged with a gaseous fluid under pressure; and

A further object of the invention is generally to improve the design, construction, efficiency and operation of transformers, particularly distribution transformers.

The means by which the foregoing and other objects of the present invention are accomplished and the manner of their accomplishment will be readily understood from the following specification upon reference to the accompanying drawings, in which:

FIG. 1 is a top plan view of a typical transformer embodying the present invention, with the upper lid and accessories carried thereby removed.

FIG. 2 is a vertical view, partly in section as along the line II—II of FIG. 1 and partly in elevation, illustrating the embodiment of the invention shown in FIG. 1.

FIG. 3 is a vertical view substantially at 90 degrees to FIG. 2, and partly in section as on the line III—III of FIG. 1 and partly in elevation, further illustrating the embodiment shown in FIGS. 1 and 2.

FIG. 4 is a fragmentary sectional view similar to FIG. 2 and illustrating a modification in the invention.

Referring now to the drawings in which the various parts are indicated by numerals, the present invention is illustrated as applied to a distribution type transformer. The assembled construction includes a tank 11 having a lid 13 provided with suitable sealing means as at 15 for pressure tightly engaging the body of tank 11. As is substantially conventional, lid 13 carries high voltage bushings indicated at 17, and the body of tank 11 carries low voltage bushings indicated at 19. Lid 13 is pressure tightly mounted upon and removable from tank 11 and may be fastened in such position by any suitable means, the same not being here shown.

The lower end of tank 11 is closed by a bottom 21, and spaced above bottom 21 is a floor 23, floor 23 being spaced sufficiently above tank bottom 21 to define a pressure chamber 25. Tank 11 is provided with a plurality of external cooling tubes 27 which are preferably substantially C-shaped and which are hollow. Each of tubes 27 at its upper end communicates with the upper part of the interior of tank 11, as by ports 29, and at its lower end each tube 27 is communicated as by a port 31 into pressure chamber 25.

Supported within tank 11 is a core and coil assembly preferably including a pair of cores 33 which are preferably laminated wound type cores, but the laminations of which are not here shown in order to simplify the present drawings. Linked with the legs of cores 33 is a coil 35.

As is apparent, coil 35 is of substantially oval cross sectional shape, as best shown in FIG. 1, and the turns of the coil are spaced apart to provide openings 37, as best shown in FIG. 1. Openings 37 are adapted to provide flow passageways through and between the layers or turns of the coil, and while in FIG. 1 these openings are substantially large relative to the size of the coil it will be understood that the size of the openings may be adjusted to suit varying conditions in the core and coil assembly with which the present invention may be employed. The coil has a central opening 39 providing the eye through which the legs of cores 33 are passed in the linkage of the cores with the coil, and in providing the assembly.

The core and coil assembly includes a framework 41 which includes clamp parts above and below the core and coil assembly, and which further includes suitable coil braces 43. Framework 41 includes suitable ears 45 which are apertured for mounting upon support brackets 47 which are fixed to and carried by the interior of tank body 11.

The assembly, consisting of cores 33, coil 35, and framework 41, is at its lower end seated upon and supported by floor 23. Directly underlying the extended portions of coil 35, and underlying openings 37 in coil 35, floor 23 is provided with a pair of apertures 49 which effect communication between pressure chamber 25 and the interior of tank 11 directly at the areas of the openings or passageways formed in coil 35. It will be seen that communication is thus established between the interior of tank 11, chamber 25 and the core and coil assembly interposed, through cooling tubes 27 and their upper and lower ports 29, 31.

As is well known, during the usage of a transformer substantial heat is generated and it is necessary to provide a coolant and an insulant from such heat. For this purpose in the present invention the interior of the tank is charged with a gaseous halogen compound, preferably sulphur hexafluoride, which may easily be applied to the interior of the tank, since due to its density substantially in excess of atmospheric density the interior of the tank may be purged of atmospheric contents by the introduction of the halogen gaseous compound, and effectively the interior of the tank may be charged thereby with such a gaseous compound, and if desired the gaseous com-

pound may further be injected under an initial head of pressure in excess of atmospheric pressure in order to provide an operating initial pressure prior to the increase in pressure which will result from the heat generated from the usage of the transformer.

With the tank charged with the gaseous compound it will be seen that a convection flow of the gas will result from the heat generated under usage of the transformer and that the gaseous compound will flow from upper tube ports 29 through cooling external tubes 27 into pressure chamber 25 through lower ports 31, thence upwardly through floor apertures 49 to pass alongside and beyond the core and coil assembly.

In order to increase the efficiency of this convection flow for the purpose of effecting cooling of the core and coil assembly it is a further purpose of this invention to provide means substantially completely blocking the flow of the gaseous compound except as such as may pass through the openings formed in coil 35. For this purpose, in the preferred embodiment coil 35 is preferably provided with a substantially vertically disposed sleeve-like baffle 51 which relatively closely surrounds and embraces the periphery of coil 35, and which at its lower edge is seated upon floor 23, embracing the area in which apertures 49 are formed. As can be seen from the drawings the flow of the gaseous compound from pressure chamber 25, being directed upwardly to escape through floor apertures 49, is confined by baffle 51 so that it may only flow upwardly through the openings 37, 39 in coil 35. While a minimum amount of the gaseous compound may eddy as it is emitted from the upper end of coil 35, it may only flow further upwardly to return into upper part of tank 11 for further flow through tubes 27.

In FIG. 4 a variation in the means substantially completely blocking the flow of gaseous compound except to pass between the openings in the coil is illustrated, in this instance in the form of a substantially horizontally disposed ring baffle 53 which surrounds and embraces the upper part of the periphery of coil 35 and extends outwardly into contact with the wall of tank 11. As can readily be seen, baffle 53 is effective to block the passage of any flow of gaseous compound except such as may pass through the openings 37, 39 in coil 35.

Thus it will be observed that the present invention contemplates charging a transformer tank with a coolant in the form of a gaseous halogen compound, preferably sulphur hexafluoride, providing a pressure chamber underlying the floor of the tank and providing cooling tubes communicating the upper part of the tank with the pressure chamber together with apertures leading from the pressure chamber to flow directly toward the coil of the core and coil assembly of the transformer, and that the present invention further insures the maximum efficiency of such flow by providing means substantially completely blocking the flow of such gaseous compound from the pressure chamber except such as passes between the openings in the coil.

The maximum efficiency of use of this coolant is provided for, and thus this coolant, which has proven highly efficient and which includes the desirable characteristics of inertness, non-toxicity and non-inflammability, may be employed, particularly in connection with distribution type transformers of ratings up to 500 k.v.a., thus enabling a substantial reduction in tank size and a marked reduction in the overall weight of the completed transformer from previously known and conventional types.

We claim:

1. In a transformer, a pressure-tight tank including a body, a lid on said body, a bottom fixed adjacent the lower end of said body, a floor within said body spaced above said bottom, said tank floor and tank bottom defining a pressure chamber at the lower part of said tank; a core and coil assembly supported within said tank and seated on said floor, said assembly including an oval coil having passage-like openings formed between layers of

5

said coil; said tank being charged and filled with an inert, non-toxic, non-inflammable gaseous compound having a density in excess of the density of atmosphere; a plurality of hollow cooling tubes attached to the exterior of said tank, said tubes at their upper ends being in flow communication with the upper part of said tank and at their lower ends communicating with said chamber; apertures through said floor underlying said openings in said coil and communicating said chamber with said coil openings; whereby to establish gas flow communication upwardly from said chamber toward said coil and outwardly from said tank through said tubes for cooling said transformer and dissipating the heat generated during transformer operation; and baffle means substantially completely blocking the flow of gas from said chamber except to pass through the openings in said coil, said baffle means comprising a vertically disposed sleeve closely embracing the periphery of said coil, said sleeve extending from substantially the upper edge of said coil downwardly along the exterior thereof and being seated on said floor at its lower edge below the lower edge of said coil and spaced therefrom, said sleeve engaging the

6

floor part of said tank outwardly from said floor apertures, and said sleeve engaging the wall part of said tank at the axially opposite parts of said oval coil.

2. A transformer in accordance with claim 1 in which said gas is a halogen compound gas.

3. A transformer in accordance with claim 2 in which said gas is sulphur hexafluoride gas.

4. A transformer in accordance with claim 1 in which said gas in said tank is under a pressure in excess of atmospheric pressure.

5. A transformer in accordance with claim 4, in which said gas in said tank is under a pressure in excess of atmospheric pressure when said transformer is at rest and is under a pressure more substantially in excess of atmospheric pressure when said transformer is in use.

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