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G. CAMILLI

2,297,605

TRANSFORMER

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Fig. 1.

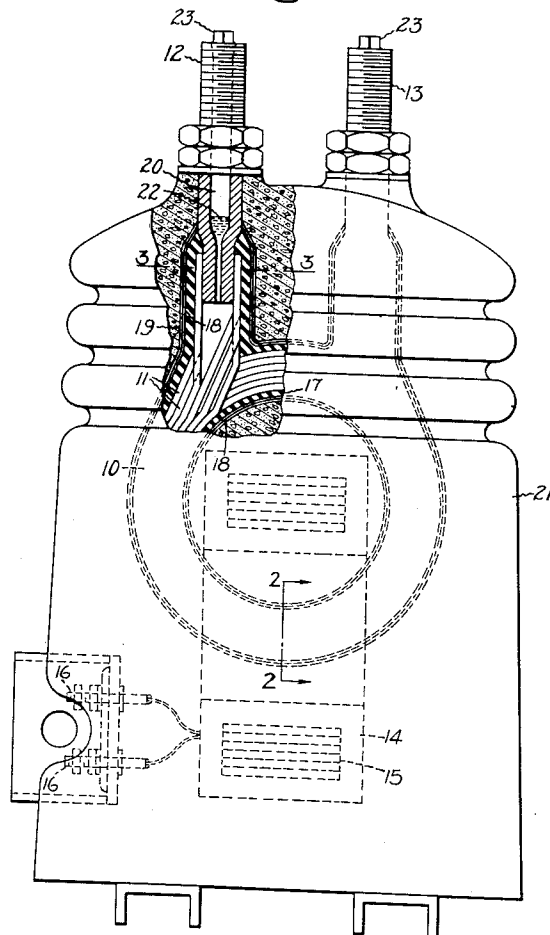


Fig. 2.

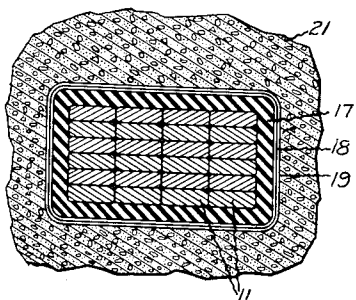
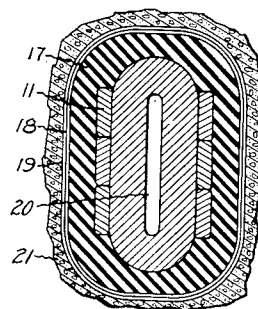


Fig. 3.



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UNITED STATES PATENT OFFICE

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TRANSFORMER

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11 Claims. (Cl. 175—358)

The invention relates to electric apparatus, such as transformers and although not limited thereto it finds efficient application to current transformers. The primary or high voltage winding of a current transformer is connected in series with an electrical circuit which may operate at a very high voltage so that the voltage of this winding may be very high above ground although the voltage between the different parts of the winding and between its terminals is usually very low. Very little insulation is therefore necessary between different parts of the winding but considerable insulation is necessary between the winding and ground and between the winding and the low voltage or secondary winding and the magnetic core. Liquid insulation, such as a suitable mineral oil, has been found to be very satisfactory for insulating high voltage electrical windings but there is sometimes the possibility of leakage and any large quantity of inflammable oil may cause trouble if it escapes and becomes ignited.

The general object of the invention is to provide an improved current transformer construction in which the high voltage winding is immersed in an insulating liquid so that no air-pockets are present in the winding, the construction being such, however, that an extremely small quantity of liquid is necessary.

Another object of the invention is to provide an improved current transformer construction which is very compact and inexpensive. A further object of my invention is to provide an electric apparatus with an improved winding structure.

The invention will be better understood from the following description taken in connection with the accompanying drawing in which Fig. 1 is a view partly in section of a current transformer constructed in accordance with the invention; Fig. 2 is a sectional view on the line 2—2 of Fig. 1; Fig. 3 is a sectional view on the line 3—3 of Fig. 1.

Like reference characters indicate similar parts in the different figures of the drawing.

The transformer shown in the drawing includes a high voltage winding 10 formed of parallel strands 11 brazed to the high voltage terminals 12 and 13. As shown in the drawing, the high voltage winding 11 is formed of six parallel strands wound four times around one side of the low voltage winding 14 and the core 15. The separate strands may be individually insulated with enamel to reduce eddy currents between the

strands. The low voltage winding 14 is connected to low voltage terminals 16.

The high voltage winding 10 is insulated from ground and from the low voltage winding 14 and the magnetic core 15 by an insulating layer or covering 17 which is preferably porous, a good material for this purpose being crepe paper. This porous insulating layer 17 is covered by a layer 18 of a suitable fluid impervious material, such as a flexible material or adhesive tape to enclose the winding and its insulating covering 17 in a liquid-tight or impervious casing. This adhesive layer 18 may be covered with an outer layer or covering 19 of some suitable mechanically strong tape to prevent mechanical injury to the adhesive layer during assembly. The porous insulating layer 17 and the outer layers 18 and 19 are extended along the terminal leads of the winding to the terminals 12 and 13 which are formed with longitudinal openings or passages 20, as indicated in Figs. 1 and 3. The high voltage winding 10 is thus effectively sealed except for the openings 20 in the terminals 12 and 13 which communicate with the spaces and interstices between the strands 11 of the winding. After the windings 10 and 14 with their terminals and the magnetic core 15 have been assembled, as shown in Fig. 1, they are enclosed in a solid block 21 of molded material, such as concrete. During the molding of the concrete casing 21, the high voltage winding 10 is protected from any moisture in the concrete by the sealed impervious layer 18 and the low voltage winding 14 and magnetic core 15 may be protected from this moisture by an asphaltic or other suitable coating.

After assembly of the transformer, as much air as practicable is pumped out of the high voltage winding space and the interstices or restricted passages between the turns inside its sealed covering 18 and the insulating covering which encloses and relatively closely fits the winding, the air being withdrawn through one of the hollow terminals 12 and 13 which have openings beneath the insulating cover and communicating with the interstices or restricted passages between the turns. Thus, while the enclosing insulating covering which is relatively close to or is contiguous with outside surfaces of winding turns thereby restricts passages through which gaseous impurities may be withdrawn, since the terminal leads have openings beneath the insulating covering, gaseous impurities such as air may be withdrawn from these restricted passages or interstices through one of the hollow leads. While under vacuum, this high voltage winding

space is filled with an insulating liquid, such as a suitable mineral oil, or any other suitable insulating fluid through the other of the hollow terminals 12 and 13 so that all empty spaces between the strands 11 and in the porous insulating covering 17 are completely filled or permeated with the liquid. The idea of withdrawing gaseous impurities from interstices between a winding turns having a layer of insulation relatively closely fitting and substantially enclosing the winding, through a tube or hollow terminal communicating beneath the insulating layer is described and claimed in my copending application S. N. 385,263, filed March 26, 1941, and assigned to the same assignee as this present invention. The insulating liquid is filled in to a level 22 well above the turns of the high voltage winding 11 but far enough below the upper ends of the terminals 12 and 13 to leave spaces in the openings 20 in these terminals for thermal expansion and contraction of the liquid during operation of the transformer. The outer ends of the terminals 12 and 13 are sealed by threaded plugs 23 to exclude air, moisture and other matter which might contaminate the insulating liquid and reduce its dielectric strength. The insulating liquid may be introduced into the high voltage winding space while hot so as to fill more effectively all empty spaces and also so as to cure the sealing layer 18 and the protective layer 19 and make them more impervious to outside moisture or to the insulating liquid inside them. These outer sealing and protective layers 18 and 19 may also be cured by heating them before the molded casing 21 is formed. This might reduce the amount of moisture which would have to be dried out of the high voltage winding before the insulating liquid is introduced. Instead of using concrete in the molded casing 21, any other suitable material may be used. A mixture of casting resin and sand has given good results but is of course more expensive than concrete. As will be seen from the drawing, the casing 21 supports and protects the sealed impervious flexible covering 18 and provides a unitary structure. Furthermore, if the casing 21 should become cracked or damaged the possibility of leakage of the insulating fluid from the insulation with the consequent entrance of air and moisture thereto is minimized due to the sealed impervious flexible covering, since this flexible covering will not originally become cracked or damaged.

The invention provides an extremely compact current transformer having practically all the advantages of a dry transformer, due to the extremely small quantity of insulating liquid necessary as the impervious covering which surrounds and may closely fit or follow the contour of the insulation minimizes the volumetric capacity of the space containing the liquid, but having also the advantages of liquid insulation for the high voltage winding.

The invention has been explained by describing and illustrating a preferred embodiment thereof, but changes may obviously be made without departing from the spirit of the invention and the scope of the appended claims.

What I claim as new and desire to secure by Letters Patent of the United States is:

1. A transformer including a winding, solid porous insulation surrounding and closely fitting said winding, a terminal connected to the winding, a sealed impervious flexible covering around the winding and extending to the terminal, the terminal having an opening therethrough com-

municating with the winding space in said covering, an insulating liquid in said winding space, said sealed impervious flexible covering surrounding and closely fitting said insulation so as to minimize the volumetric capacity of the space containing said liquid, and a casing surrounding and substantially closely fitting said sealed impervious flexible covering for supporting and protecting said covering.

2. A transformer including a winding, solid porous insulation surrounding and closely fitting said winding, a terminal connected to the winding, a sealed impervious flexible covering around the winding and extending to the terminal, the terminal having an opening therethrough communicating with the winding space in said covering, an insulating liquid in said winding space, a removable seal closing the outer end of the terminal, the level of the liquid being below said seal to permit thermal expansion and contraction of the liquid, said sealed impervious flexible covering surrounding and closely fitting said insulation so as to minimize the volumetric capacity of the space containing said liquid, and means surrounding and closely fitting said sealed impervious flexible covering for supporting and protecting said covering.

3. A transformer including a winding, a terminal connected to the winding, a porous insulating covering around the winding, a sealed covering of adhesive tape around the insulating covering and extending to the terminal, the terminal having an opening therethrough communicating with the winding space in said insulating covering, an insulating liquid in said winding space and porous covering, said sealed covering of adhesive tape substantially following the contour of said insulating covering so as to minimize the amount of liquid necessary to substantially fill the winding space, and a protective covering surrounding and substantially following the contour of said sealed covering.

4. A transformer including a winding, terminals connected to the winding, a porous insulating covering around the winding, a sealed impervious flexible covering around the winding and extending to the terminals, the terminals having openings therethrough communicating with the winding space in said coverings, an insulating liquid in said winding space, said sealed impervious flexible covering surrounding and closely fitting said insulating covering so as to minimize the volumetric capacity of the space containing said insulating liquid, and a casing surrounding and closely fitting said sealed impervious flexible covering for supporting said covering.

5. A transformer including a winding, terminals connected to the winding, a porous insulating covering around the winding, a sealed impervious flexible covering around the winding and extending to the terminals, the terminals having openings therethrough communicating with the winding space in said coverings, an insulating liquid in said winding space and porous covering, removable seals closing the outer ends of the terminals, at least one of the terminals having a space above the liquid level to permit thermal expansion of the liquid during operation of the transformer, said sealed impervious flexible covering surrounding and closely fitting said porous insulating covering in order to minimize the volumetric capacity of the space containing said insulating liquid, and means surrounding and closely fitting said sealed impervious flexible covering for supporting said covering.

6. A current transformer including a winding, said winding comprising a plurality of strands, a terminal connected to the winding, a relatively thin covering of solid porous insulation surrounding said winding, a sealed impervious flexible covering around said winding and extending to the terminal, the terminal having an opening there-through communicating with the space within said covering and the interstices between the strands of the winding, an insulating liquid in said space and said interstices, said sealed impervious flexible covering surrounding and closely fitting said insulating covering so as to minimize the volumetric capacity of the space containing said insulating liquid, and a casing surrounding and closely fitting said sealed impervious flexible covering for supporting said covering.

7. A current transformer including a relatively high voltage winding, said winding comprising a plurality of strands, terminals connected to the winding, a porous insulating covering around the winding, a sealed impervious flexible covering around the first-mentioned covering and extending to the terminals, the terminals having openings therethrough communicating with the space within said impervious covering and the interstices between said strands, an insulating liquid in said space, said interstices and said porous covering, said sealed impervious flexible covering surrounding and substantially following the contour of said insulating covering and extending to the terminals so as to minimize the amount of liquid necessary to substantially fill the winding space, a low voltage winding linking said covered high voltage winding, and a molded casing surrounding and closely fitting said windings for supporting said flexible covering and providing a unitary structure.

8. A transformer including a winding, a terminal lead extending from said winding, solid porous insulation surrounding said winding and lead, an insulating fluid surrounding said winding and lead and penetrating said insulation, a protective and enclosing casing surrounding said winding, and a sealed impervious flexible covering within said casing and surrounding said insulation so as to minimize the possibility of leakage of the insulating fluid from the insulation upon damage to said casing.

9. A transformer including a winding, solid porous insulation around said winding, an insulating

fluid surrounding said winding and penetrating said insulation, fluid impervious flexible means surrounding and substantially following the contour of said solid porous insulation so as to substantially limit the amount of fluid necessary to surround said winding and penetrate said insulation, covering means surrounding and substantially supporting said fluid impervious means for protecting said fluid impervious means from injury or damage, and passage means extending through said fluid impervious means and said covering means and communicating with the winding space through which said fluid may be introduced.

10. A transformer including a winding, solid porous insulation around said winding, an insulating fluid surrounding said winding and penetrating said insulation, a substantially fluid tight enclosing casing surrounding said winding and insulation, fluid impervious flexible means within said enclosing casing and surrounding and substantially following the contour of said solid porous insulation so as to substantially limit the amount of fluid necessary to surround said winding and penetrate said insulation and for minimizing the possibility of leakage of the insulating fluid from the insulation upon damage to said enclosing casing, and passage means extending through said enclosing casing and said fluid impervious means and communicating with the winding space through which said fluid may be introduced.

11. In an electric apparatus, a winding having a plurality of turns, a porous insulating covering substantially enclosing and relatively closely fitting said winding, a molded casing surrounding and relatively closely fitting said winding and insulating covering, and a pair of conducting terminal leads connected to said winding, each of said terminal leads having a fluid passage adapted to communicate outside said insulating covering and having an opening beneath said insulating covering and communicating with the interstices between said winding turns so that gaseous impurities may be withdrawn from the interstices through one of said terminal leads as an insulating fluid is introduced through the passage of the other of the terminal leads, the insulating fluid permeating said insulating covering and filling a portion of each of said fluid passages of said terminal leads.

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