Aug. 19, 1952 E. L. CRANDALL 2,607,822

ELECTRIC CABLE LEAD WITH CREPE PAPER INSULATION

Filed March 31, 1950

Fig. 1.

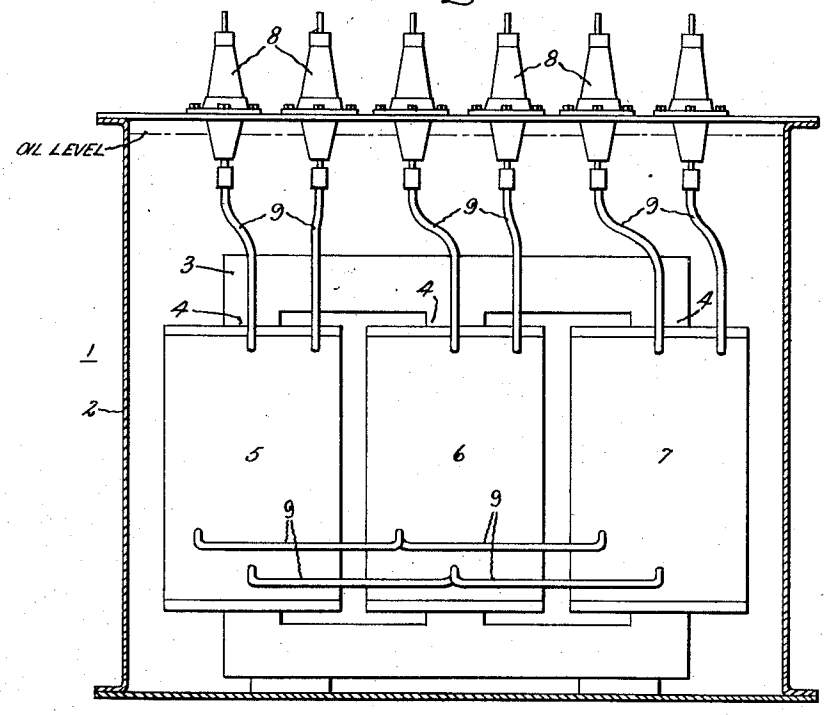
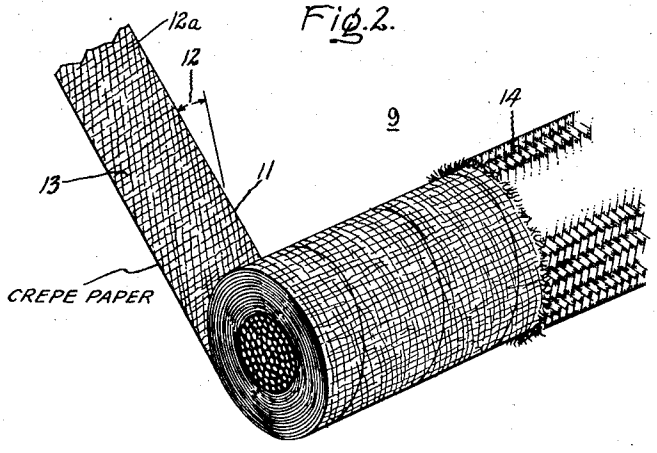


Fig. 2.



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ELECTRIC CABLE LEAD WITH CREPE PAPER INSULATION

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2 Claims. (Cl. 174—18)

1

This invention relates to an improved insulating fluid-filled electrical apparatus, and more particularly to apparatus such as transformers employing a number of interconnection conductor cables having an improved insulating material within the apparatus.

It is common practice in large electrical apparatus of the stationary type, such as transformers, to employ a structure which is enclosed within a tank filled with oil or other liquid dielectric such as a suitable askarel, for example, chlorinated diphenol. This liquid dielectric acts as insulation and also as a cooling medium which circulates around the windings of the apparatus and through portions of the casing which may be designed especially for the dissipation of heat. It is desirable to operate the apparatus at as high a temperature as possible, without unduly accelerating aging, in order to obtain maximum utilization. This temperature is generally allowed to range up to 90° centigrade, with intermittent service ratings which may result in temperatures appreciably higher than this.

Interconnection conductors are commonly used between various windings within the apparatus and between the coils or components and leadout terminals for exterior connections to the apparatus, and these interconnection conductors are commonly insulated with materials such as varnished cambric. These conductors are of necessity below the level of the oil which fills the apparatus and are therefore directly subjected to the heat which is present within the apparatus. Under these circumstances the varnished cambric insulation has been known to swell slightly. In apparatus of the above description which is intended for use at high voltages, the interconnection conductors must have insulation which is in the order of three-eighths of an inch thick, or greater, and with such a thickness this swelling or expansion of the varnished cambric insulation sometimes causes portions of the insulation to burst and become separated from the interconnection conductors. A further circumstance which may cause destructive swelling and bursting of this varnished cambric insulation is the common practice, in the manufacture of such apparatus, of removing all moisture from the apparatus, before filling with the liquid dielectric, to assure good electrical and insulation properties, by subjecting the apparatus to a vacuum with the concurrent application of heat.

Accordingly, it is an object of this invention to provide a liquid dielectric-filled electrical apparatus employing interconnection conductors having insulation which will not deteriorate by swelling and bursting when subjected to normal conditions of heating.

It has been found that in apparatus of the

2

above description which is filled with askarel instead of oil, the varnish in the varnished cambric causes a certain undesired contamination of the askarel liquid. It has therefore been the frequent practice in askarel-filled apparatus to employ manila paper as insulation for these interconnection conductor cables. However, the manila paper insulated cables are not so flexible as the varnished cambric cables and do not possess the desirable electrical qualities of the varnished cambric insulated cables. Further, the lack of flexibility limits the practical thickness to which the manila paper insulation can be applied, thus limiting the voltage at which the apparatus may be used.

It is therefore another object of this invention to provide an apparatus of the above description which may be filled with askarel and employing interconnection cables which are highly flexible even in thickness suitable for high voltages, and having desirable electrical qualities while failing to contaminate the askarel liquid.

Another object of the invention is to provide an apparatus of the above description having interconnection cables which are suitable for immersion in either oil or askarel, or in any other suitable dielectric liquid.

A still further object of the invention is to provide an apparatus of the above description employing interconnection cables which are appreciably lower in cost, while at the same time representing a technical improvement.

Further objects and advantages of the invention will be apparent from the following specification.

Accordingly, in carrying out the objects of this invention, a liquid, dielectric-filled electrical apparatus is employed having interconnection and leadout conductors which are insulated with a number of layers of crepe kraft paper.

For a better and more complete understanding of the invention, reference should be had to the following specification and the accompanying drawings, in which Figure 1 is a view, partially in section, of an electrical apparatus incorporating this invention, and Figure 2 is a detail view of a section of interconnection conductor cable as used in the apparatus of this invention.

Referring more particularly to Figure 1, there is shown a transformer generally designated as 1, which is enclosed within a casing 2, and comprises a magnetic core 3 having three vertical core members or legs 4. Three windings 5, 6 and 7 are wound around magnetic core members 4. Terminal members 8 are provided for making exterior electrical connections to the transformer. A multiplicity of interconnection and leadout conductor cables 9 are provided to connect terminals 8 to windings 5, 6 and 7 and to establish interconnections between the windings themselves.

Each of these conductors 9 is insulated with layers of crepe paper insulation. The paper of the insulation used is preferably entirely untreated; that is, this paper is not filled with insulating varnishes or insulating filling materials of any kind. The insulating oil, or askarel or other liquid dielectric, which will be generally referred to below as oil, with which the apparatus is filled, completely penetrates this paper insulation within a very brief interval of time after filling. The oil itself thus performs the office of an insulating impregnant.

The crepe paper insulation is formed of a kraft paper which has been creped and then cut into tape of appropriate width, with lines of creping preferably running at an angle to the longitudinal dimension of the tape. This angle corresponds generally to the angle at which the tape is applied to the cable or conductor, so that after the tape is applied, the lines of crepe form rings around the conductor in planes perpendicular to the axis thereof. This structure is shown in the enlarged detail view of Figure 2, where the tape is designated as 11, and the angle of these crepe lines 12*a* is shown and designated at 12.

The crepe paper insulation for conductors having such an angle of crepe is shown and described and forms a portion of the subject matter of a copending patent application entitled, "Crepe Paper Cable Insulation," Serial No. 118,292, filed September 28, 1949, by Guglielmo Camilli and Leo Mulligan, and assigned to the same assignee as this application. In that application it is pointed out that such a crepe paper insulation has a number of advantages, including ease and economy in assembly in the cable structure and in a high degree of flexibility resulting in a capability for unusually short-radius conductor bends without injury to the insulation.

It has also been found desirable to additionally crepe the paper of tape 11 with lines of crepe in a direction transverse to the above-described crepe angle disclosed in the Camilli et al. cable structure. This additional creping permits greater ease in applying the tape and adds further flexibility to the cable. The additional lines of creping are indicated by broken lines in the drawing at 13.

The above described crepe kraft paper is preferably of the "secondary" crepe variety wherein the creping is done as a separate operation after manufacture of the paper, as distinguished from "primary" crepe in which the creping is formed at the time of manufacture.

A braided fibre or cloth sheath 14 may be added to the exterior of the conductor to serve as an outer protective covering. This sheath 14 must be porous for the admission of oil.

It has been found that, in apparatus of the above description, where the crepe kraft paper has been used, no further difficulties were encountered from swelling and bursting of the insulation due to heating, either in the vacuum drying process, or in subsequent operation of the apparatus. Higher operating temperatures of the apparatus are therefore possible, with longer interconnection cable life. This interconnection cable insulation also provides excellent electrical properties; that is, low power factor, good dielectric strength, and so on. Further, no contamination of the fluid filling the apparatus is encountered and the interconnection cables are more flexible

than either those insulated with manila paper or varnished cambric, providing greater ease in the manufacture of the apparatus.

It will be seen from the above description that in addition to the above enumerated advantages of the new structure of the invention, the cost of apparatus produced according to the invention is appreciably lower than prior art apparatus. This is due to the greater flexibility of the interconnection cable, providing greater ease and lower labor costs in installation, and because the interconnection cable insulating material itself is less expensive. Also, the apparatus employing the above interconnection cable may be filled with either oil or askarel, permitting greater standardization.

While a particular embodiment of the invention has been shown and described above, it will be understood that the following claims are intended to cover all modifications which fall within the true spirit and scope of the invention.

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

1. In combination, a high voltage electrical apparatus comprising an enclosing casing substantially filled with an insulating liquid, an electrical device contained within said enclosing casing and immersed in said insulating liquid, short flexible connection leads for said electrical device, said connection leads being immersed in said insulating liquid, said connection leads including as substantially their only solid insulation a plurality of layers of crepe paper insulation positioned on said respective leads, said insulating liquid penetrating said crepe paper insulation.

2. In combination, a high voltage electrical apparatus comprising an enclosing casing substantially filled with an insulating liquid, an electrical device contained within said enclosing casing and immersed in said insulating liquid, short flexible connection leads for said electrical device, said connection leads being immersed in said insulating liquid, said connection leads including as substantially their only solid insulation a plurality of layers of crepe paper positioned on said respective leads, said layers of crepe paper being surrounded by an abrasion-resistant liquid-permeable sheath having a radial thickness which is small compared to the total radial thickness of said plurality of layers of crepe paper, said insulating liquid penetrating said sheath and said crepe paper insulation.

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