

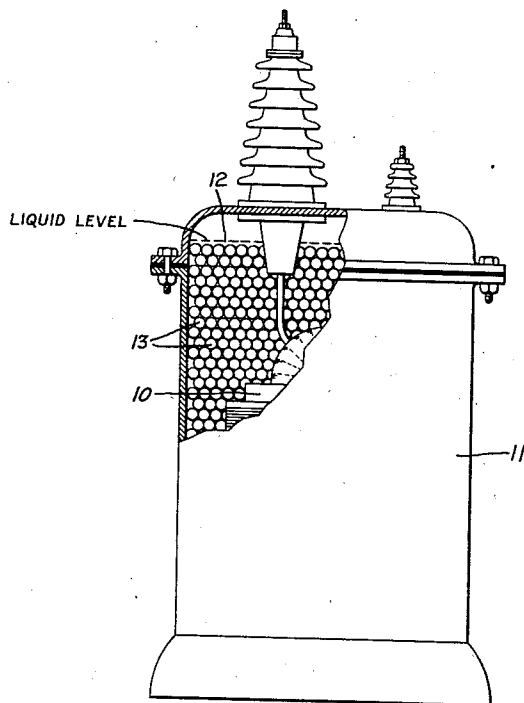
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LIQUID IMMERSED ELECTRICAL APPARATUS

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LIQUID IMMERSED ELECTRICAL
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4 Claims. (Cl. 175—361)

My invention relates to liquid-immersed electrical apparatus. A transformer, reactor or similar electrical apparatus is often enclosed in a casing containing an insulating liquid in which the apparatus is immersed, the purpose of the liquid being to provide effective insulation and cooling of the apparatus. In order to be effective for these purposes, the liquid should have high dielectric strength and fluidity, and a mineral oil which has been specially treated and refined and which is therefore rather expensive has been commonly used. Such an oil is of course inflammable, particularly when heated by the apparatus, and a non-inflammable liquid is sometimes used to avoid fire hazard. A non-inflammable liquid which has been used successfully is the halogenated aryl or ring compound disclosed in U. S. Patent No. 1,931,373 to Frank M. Clark, issued October 17, 1933, and assigned to the General Electric Company. One of the ingredients commonly used in such a liquid is liquid chlorinated diphenyl and the liquid is therefore considerably more expensive even than the specially treated mineral oil. A considerable quantity of insulating liquid is often necessary in the casing of a piece of electrical apparatus and it is the general object of the present invention to provide an improved and inexpensive means for displacing a substantial amount of the liquid in order to reduce the cost of the complete apparatus. It is an object of the invention not only to displace a substantial part of the liquid by some means which is relatively inexpensive but to provide this means in a form which will not impair the insulation of the electrical apparatus immersed in the liquid and which also will not reduce the effectiveness of the liquid in absorbing and carrying away the heat produced by the immersed apparatus during its operation.

Further objects and advantages will be apparent from the following description taken in connection with the accompanying drawing which shows an encased liquid-immersed transformer, a part of the casing being broken away, the transformer being provided with means in accordance with the invention for displacing or reducing the quantity of liquid necessary in the casing.

The transformer 10 shown in the drawing is enclosed in a metal casing 11 containing a body of insulating liquid 12 in which the transformer is immersed. The volume of the space inside the casing 11 and not occupied by the transformer is considerable and in accordance with the invention the space is more or less filled, preferably

ably to near the upper level of the insulating liquid, with a large number of closely packed bodies shown as small spheres or balls 13 formed of insulating material. If these spheres or balls are too large, they cannot pack so closely together along the surfaces and into any cavities or depressions of the casing and the transformer. On the other hand, if the spheres or balls are too small, then the spaces between them will be so restricted as to interfere objectionably with free circulation of the insulating liquid 12 and therefore with its ability to absorb heat from the transformer and carry it to the casing to be dissipated. It has been found that if spheres of about one and one-half inches in diameter are used, the cooling effect of the liquid will not be appreciably affected and spheres of this size will reduce the quantity of liquid necessary by something like 50 to 60 per cent. However, the size of the spheres may be selected within a considerable range. As the size is increased, the proportion of liquid displaced will decrease. It has been found that spheres of smaller diameter may be used successfully but if they are smaller than about one-half inch in diameter, the passages between them will be so small that the circulation of the liquid and therefore its effectiveness in cooling the transformer will be materially reduced. The means for displacing liquid has been shown as a large number of insulating spheres. While a spherical form is most desirable, it may of course be varied to some extent but not to such an extent as to permit such close packing as to interfere too seriously with a free circulation of the liquid.

The spheres 13 and the insulating liquid between them are in series between the high voltage windings of the transformer and the casing which is usually grounded. Some of the spheres 13 may also be in series with some of the liquid between parts of the transformer which are at very different voltages. For this reason, the spheres 13 should be formed of a material which has a high dielectric strength. The puncture strength through the material should be at least equal to the creepage strength over its surface. The material forming the spheres 13 should also have a dielectric constant as high as and preferably about the same as that of the liquid 12 so that the potential drop along any path through the spheres and liquid will be approximately uniform and neither the spheres nor the liquid will be subject to a disproportionately high part of the voltage.

The spheres 13 should be formed of some insu-

lating material which will not soften, disintegrate or be otherwise affected by the liquid and which will not on the other hand affect the liquid either chemically or otherwise.

5 The spheres 13 should be of high density so as not to absorb much of the liquid and thereby partially defeat their purpose in displacing as much of the liquid as possible. A non-absorbent material is desirable for the further reason that
10 it will not absorb moisture which may be present in small quantities in the liquid and thereby impair the dielectric strength of the spheres.

The spheres 13 may be formed of any suitable insulating material having the desired characteristics and the adaptability of any particular
15 material may be easily determined by test. It has been found that with the halogenated aryl compound type of insulating liquid, such as is disclosed in the Clark patent already referred to,
20 spheres formed of a good grade of clay and hardened by firing are extremely satisfactory. They have the desired characteristics which have been explained and they are much less expensive than the volume of liquid which they displace.
25 It was found in one case, for example, that the use of approximately spherical fired clay balls about one and one-half inches in diameter reduced the quantity of insulating liquid necessary by between 50 and 60 per cent. and the cost of
30 the complete transformer was materially reduced because the clay balls were materially less expensive than would have been the quantity of liquid which they displaced.

The invention has been explained by describ-

ing and illustrating a particular form and application thereof but it will be obvious that changes may 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. The combination with electrical apparatus immersed in an insulating and cooling liquid in a casing, of insulating approximately spherical
10 bodies packed in the liquid between said apparatus and its casing, the diameters of said bodies being at least about one half inch.

2. The combination with electrical apparatus immersed in an insulating and cooling liquid in
15 a casing, of approximately spherical fired clay balls packed in the liquid between said apparatus and its casing, the diameters of said balls being at least about one half inch.

3. The combination with electrical apparatus
20 immersed in a liquid halogenated aryl compound in a casing, of fired clay bodies packed in said liquid between said apparatus and its casing, there being passages between said bodies of sufficient size to permit effective circulation of the
25 liquid to transfer heat between said apparatus and casing.

4. The combination with electrical apparatus immersed in a liquid halogenated aryl compound in a casing, of approximately spherical
30 fired clay balls packed in said liquid between said apparatus and its casing, the diameters of said balls being at least about one half inch.

VINCENT M. MONTSINGER.