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SYSTEM OF PROTECTION OF ELECTRIC APPARATUS

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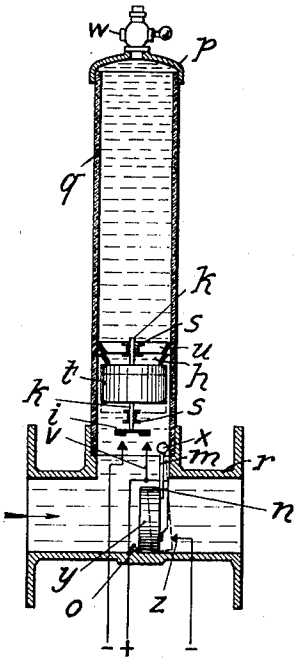


FIG. 2.

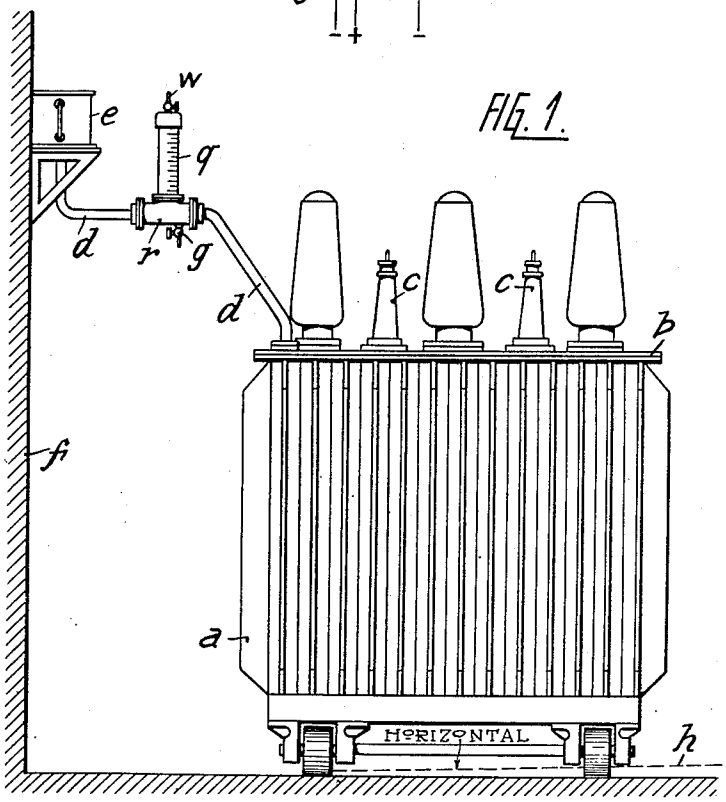


FIG. 1.

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UNITED STATES PATENT OFFICE.

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SYSTEM OF PROTECTION OF ELECTRIC APPARATUS.

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My invention refers to means for keeping under constant observation electric apparatus operating in an insulating liquid, such as oil transformers, oil switches, grounding throttling coils, resistances and the like and it is one of the important objects of my invention to provide a device of very simple construction which allows permanently observing and ascertaining whether the operation of the liquid insulated apparatus or the like is disturbed and whether the defect which may have occurred increases or remains stationary.

It is a further object of my invention to provide means whereby that part of the liquid insulated apparatus or the like which may have become defective can be readily ascertained.

My invention also contemplates combining with the observing and ascertaining means aforesaid means whereby the liquid insulated apparatus or the like is effectually protected against grave injury which may occur by sparking, overloading or from other causes.

My invention is particularly based on the fact that in the case of a disturbance in the operation of liquid insulated electric apparatus, such as transformers, switches or the like, no matter how slight such disturbance may be, heat is generated which leads to the development of vapors, gases or fumes of decomposition of either the insulating liquid, such as oil, or of other insulating material connected with the apparatus or the like. As has been ascertained by experiment, the quantity of such gases, vapors or fumes is in definite proportion to the output of the appartus or the like at the moment when the disturbance occurs, and this quantity therefore also discloses the proportion in which destruction proceeds per unit of time. By carefully observing the phenomena occurring in consequence of such destruction and becoming visible in the form of gases, vapors or fumes it can easily be ascertained whether the defect increases or whether it remains stationary, so that the observer receives timely warning and is in a position to provide for a reserve.

It is further known that the color of the gases, vapors or fumes formed by decomposition differs according to the material affected by the disturbance. The gases of decomposition of oil are clouds resembling lamp black, those formed by wood are yellow, gases or vapors emitted by paper are white. The oil impregnated windings develop thick yellow clouds. The observation of the color of the products of decomposition therefore allows of ascertaining the character and place of destruction and to provide in time for an exchanging of the parts thus affected.

In order that any defect which may arise in the apparatus to be protected be easily observable at any time, I provide a suitable collecting vessel, such as for instance a calibrated glass cylinder arranged for the reception of the gases, vapors or fumes of decomposition and I preferably combine this vessel with protective means such as contact making or breaking apparatus inserted in a protective circuit comprising an oil switch or fuses or an annunciator device such as an alarm, whereby either the apparatus to be protected can be cut out or a signal will announce the defect. The gases or vapors collected in this vessel can readily be extracted therefrom for chemical analysis.

In the drawings affixed to this specification and forming part thereof a device embodying my invention is illustrated diagrammatically by way of example.

In the drawings

Fig. 1 is an elevation showing the casing of an oil-insulated transformer with an observation and protective device connected therewith.

Fig. 2 is a vertical section of this device drawn to a larger scale.

Referring to the drawings, *a* is the transformer casing or vessel containing the transformer and a supply of insulating liquid such as oil, *b* is the cover closing the vessel and *c*, *c* are the insulators for the leading-in conductors. *d* is a pipe mounted on the cover *b* and communicating with the interior of the vessel *a*, this pipe leading to an expansion vessel *e* secured to the wall *f*. *r* is a three-way pipe inserted in the pipe *d* and carrying a tap cock *g* and a calibrated glass cylinder *q* completely filled with insulating liquid, the liquid level in the expansion vessel *e* being higher than the top end of cylinder *q*. *u* is a ring-shaped collar mounted in the lower half of the cylinder *q*. *t* is a float guided in bearings *s* and carrying a collar *h* adapted to apply itself from below against the collar *u*. *i* is a contact bar secured to the spindle *k* guiding the float *t* and *v*, *v* are the terminals of a protective circuit comprising an alarm or other an-

nunciator device or a switch, fuse or the like (not shown).

y is another float suspended from a point *x* near the lower end of cylinder *q* by an arm *m* attached to the float *y* on one side so that this float, provided that the three-way pipe were not filled with liquid, would assume an oblique position shown in dotted lines, where it would make contact with a contact piece *z* forming one of the terminals of the protective circuit before described, the other terminal being connected with the float itself at *n*. *o* is an abutment preventing the float from moving angularly beyond the position shown in the drawings. *w* is a cock mounted on the cap *p* closing the glass cylinder. It will thus be understood that if the tube *r* is filled with oil the float *y* will be held against the abutment *o* owing to its being suspended at *x* and being forced toward the left by the action of buoyancy. However, when a leakage occurs which causes the oil from the expansion vessel E to flow in the direction of the arrow, or if the tube *r* is emptied entirely, the float *y* will swing back into the position shown in dotted lines where it is in contact with the terminal *z*.

Assuming the insulating liquid which surrounds the apparatus to be protected to suffer decomposition, owing to unnormal working conditions of this apparatus, gases, vapors or fumes will be developed in the liquid and will rise above the liquid level, collecting below the cover *b* and rising first in the pipe *d* and thereafter in the glass cylinder *q*. The formation of such bubbles can therefore be ascertained easily and the color and general character of the gases, vapors or fumes will indicate the nature of the material subjected to decomposition. The bubbles of gases or vapors rising in the cylinder *q* will first collect between the cylinder wall, the float *t* and the collar *u*, at the same time displacing the oil surrounding the float. This will cause the float to descend and in doing so to close the contacts *r* and the protective circuit, thereby operating the switch, fuse or annunciator device inserted in this circuit. This position of the float is shown in dotted lines. At the same time the gas bubbles are free to pass between the collars *h* and *u* and to collect below the cap *p*.

In the case where greater quantities of bubbles or larger bubbles pass through the three-way pipe *r*, their impact will cause the second float *y* to rock and to be temporarily forced against the contact *z*, thereby also closing the protective circuit. The same operation of the float *y* will take place in the case where for some reason the liquid level in the system should sink below the level of the three-way pipe *r*, float *y* being then free to assume the position shown in dotted lines.

The cylinder *q* is filled with insulating liquid by opening the cock *u*, whereby liquid from the expansion vessel will rise in the cylinder. In the case where it should be desirable to place the top of the cylinder *q* at a higher level than the expansion vessel, the cylinder could be filled with liquid by drawing it in through the cock *w*.

The circuit to be controlled by the contacts referred to excites either directly or by the medium of an intermediate relay the releasing coil of an oil switch which interrupts the endangered circuit. In the case of apparatus the circuit of which does not include an oil switch, as frequently occurs, for instance in the cases of transformers mounted in the field at wide distances apart, other provisions should be made for the purpose of this invention. Thus, for example, the closing of the contacts may be caused to operate a switch, a pawl, or an equivalent member adapted to establish an artificial or harmless short-circuit at the outside of the apparatus, so as to cause wire fuses or the like in series with the apparatus to be protected to be released.

Besides the form of construction herein shown and described, the invention is susceptible of a variety of other modifications and forms of application of the principle of my invention all of which operate substantially in a similar manner. The means of connecting the contacting device with the releasing circuit and the switching means are open to changes and alterations without any material importance for the operation of the apparatus according to my invention which in its broad aspects comprises the operation of safety devices for electric apparatus or the like, adapted for operation by vapors, fumes, gases or similar emanations liberated and expelled from the insulating medium, and means adapted to be operatively influenced by such emanations, and connected to fuses or equivalent safety means, the instrumentalities shown and described in this specification as embodiments of these principles being susceptible of modifications without deviating from the spirit of my invention as set forth in the claims.

In the claims the term "gases" is meant to comprise also vapors and fumes.

I claim:—

1. Protective device for liquid-insulated electrical apparatus comprising a casing containing said apparatus, a body of insulating liquid filling said casing and a container of transparent material mounted above and communicating with said casing for receiving gas developed in said liquid under abnormal conditions of said apparatus and normally filled with said liquid.

2. Protective device for liquid-insulated electrical apparatus comprising a casing con-

taining said apparatus, a body of insulating liquid filling said casing, an expansion vessel above and communicating with said casing and a container of transparent material inserted between and communicating with both said casing and said vessel for receiving gas developed in said liquid under abnormal conditions of said apparatus and normally filled with said liquid.

3. Protective device for liquid-insulated electrical apparatus comprising a casing containing said apparatus, a body of insulating liquid filling said casing, a container of transparent material mounted above and communicating with said casing for receiving gas developed in said liquid under abnormal conditions of said apparatus and normally filled with said liquid and protective means in said container adapted to be operated by said gas.

4. Protective system for liquid-insulated electrical apparatus comprising a casing containing said apparatus, a body of insulating liquid filling said casing, a container of transparent material mounted above and communicating with said casing for receiving gas developed in said liquid under abnormal conditions of said apparatus and normally filled with said liquid, a protective circuit and means in said container adapted to be influenced by said gas for varying the operative condition of said circuit.

5. Protective system for liquid-insulated electrical apparatus comprising a casing containing said apparatus, a body of insulating liquid filling said casing, a container of transparent material mounted above and communicating with said casing for receiving gas developed in said liquid under abnormal conditions of said apparatus and normally filled with said liquid, a protective circuit and a float in said container adapted to be influenced by said gas for varying the operative condition of said circuit.

6. Protective system for liquid-insulated electrical apparatus comprising a casing containing said apparatus, a body of insulating liquid filling said casing, a container of transparent material mounted above and communicating with said casing for receiving gas developed in said liquid under abnormal conditions of said apparatus and normally filled with said liquid, a protective circuit, a float in said container adapted to be influenced by said gas, a collar in said container above and serving as an abutment for said float and a contact device below said float adapted to vary the operative condition of said circuit.

7. Protective system for liquid-insulated electrical apparatus comprising a casing containing said apparatus, a body of insulating liquid filling said casing, a container of transparent material mounted above and communicating with said casing for receiving gas developed in said liquid under abnormal conditions of said apparatus and normally filled with said liquid, a protective circuit, a float in said container adapted to be influenced by said gas, means adapted to be displaced by a change of liquid level and means adapted to cooperate with said float and said displaceable means for varying the operative conditions of said circuit.

8. Protective system for liquid-insulated electrical apparatus comprising a casing containing said apparatus, a body of insulating liquid filling said casing, a container of transparent material mounted above and communicating with said casing for receiving gas developed in said liquid under abnormal conditions of said apparatus and normally filled with said liquid, a protective circuit, a float in said container adapted to be influenced by said gas, a second float suspended in said container and adapted to be displaced automatically, when the liquid level in the container is lowered and means adapted to cooperate with said floats for varying the operative conditions of said circuit.

9. Protective device for liquid insulated apparatus comprising a casing containing said apparatus, a body of insulating liquid filling said casing, and means for visually detecting the presence of products of decomposition in the casing and developed in the insulation due to abnormal conditions of said apparatus.

In testimony whereof I affix my signature.

MAX BUCHHOLZ.