Feb. 8, 1944. H. H. RACE 2,340,898

ELECTRIC APPARATUS

Filed Nov. 29, 1941

Fig. 1.

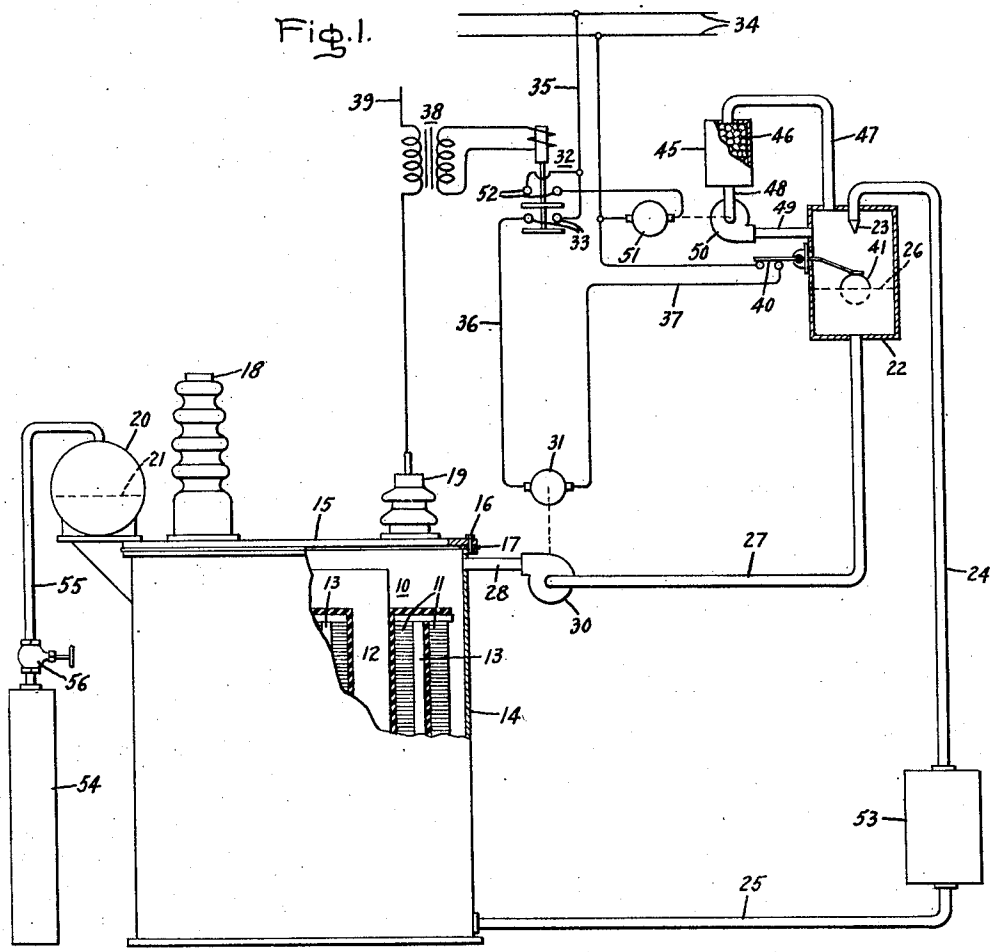


Fig. 3.

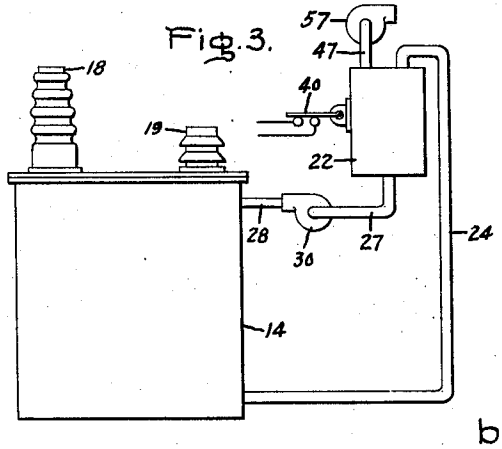
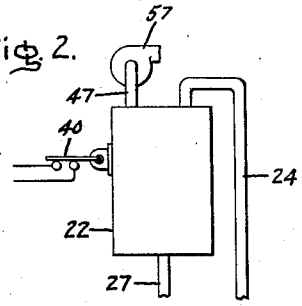


Fig. 2.



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ELECTRIC APPARATUS

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Application November 29, 1941, Serial No. 420,941

11 Claims. (Cl. 174—14)

My invention relates to an electric apparatus having an insulating fluid, and to an arrangement and method of removing contaminants, such as moisture from the insulating fluid during operation of the apparatus.

When an insulating fluid, such as oil or other insulating liquids are used in electric apparatus, such as stationary induction apparatus, the breakdown characteristics of the insulating fluid are dependent upon the degree of purity thereof or the amount of contaminants therein, such as water or moisture and solid floating particles. In order, therefore, to guard against the entrance of impurities into the insulating fluid the electric apparatus structure is usually thoroughly dried at the time of manufacture before the liquid dielectric is introduced into the apparatus casing. Also, such apparatus has been enclosed in order to keep out moisture during operation and a suitable gas space is usually provided at the top to take care of expansion and contraction during changes in the temperature of the apparatus. In addition, it has been proposed to employ filters for removing impurities during operation of the apparatus.

Even though great precaution is taken to dry the apparatus, and in particular the windings with their insulation, before the insulating fluid is introduced, it has been found that traces of moisture remain in the solid insulation which will pass into the fluid dielectric during operation of the apparatus. Furthermore, since small leaks may develop through gaskets between the cover and the tank and between pipe gaskets, impurities may enter the apparatus during operation. Also, it may become necessary at times to remove the cover of the apparatus to inspect or repair the apparatus at which time the surface of the liquid will be contaminated by moisture and other impurities from the surrounding atmosphere.

It is, therefore, an object of my invention to provide an improved arrangement for removing moisture from an insulating fluid of an electric apparatus.

Another object of my invention is to provide an improved method of maintaining the purity of an insulating liquid in an electric apparatus during operation thereof.

A further object of my invention is to provide an improved arrangement for removing impurities from the liquid dielectric of an electric apparatus during operation thereof.

Further objects and advantages of my invention will become apparent from the following description referring to the accompanying drawing, and the features of novelty which characterize my invention will be pointed out with particularity in the claims annexed to and forming a part of this specification.

In the drawing, Fig. 1 diagrammatically illustrates a transformer system having an insulating liquid and a circulatory system which is provided with an embodiment of my invention, and Figs. 2 and 3 illustrate modifications of the system of Fig. 1.

In the arrangement illustrated in the drawing, I have provided a transformer structure with an improved arrangement for continuously circulating insulating liquid during operation or during an operation of a transformer and for continuously degasifying the circulating liquid to remove impurities, such as moisture therefrom. Although my invention finds efficient application in stationary induction apparatus of the transformer type, it is to be understood that my invention may be employed in any other suitable electric apparatus which employs an insulating or dielectric liquid.

Referring to Fig. 1 of the drawing, I have illustrated a transformer structure with a fluid circulating system which includes a core 10 with concentric windings 11 surrounding a winding leg 12, suitable ducts 13 being provided between the concentric windings and through which any suitable fluid dielectric may circulate. The core and coils are enclosed in a casing including a tank 14 having a cover 15 which may be attached thereto by any suitable means such as bolts 16. A conventional gasket 17 may be placed between the cover and the tank. Any other suitable means may be provided to obtain a substantially fluid tight system. Terminals 18 and 19 are provided of any suitable type, through which electrical connections may be made between power lines and load lines and the coil sections 11. The transformer is also provided with a conservator or gas expansion tank 20 which is filled with liquid to any suitable level, such as 21, the remainder of the tank being filled with gas so as to provide for thermal expansion and contraction of the liquid. Any suitable type of fluid dielectric may be employed in the tank, such as conventional mineral oil, or a synthetic liquid such as of the type described in Patent 1,931,373 and issued to Clark on October 17, 1933, and which is assigned to the same assignee as this present invention.

In order to provide an improved arrangement for removing impurities, such as moisture dur-

ing operation of the transformer, I provide a degasifying arrangement which includes a chamber 22 which has a suitable nozzle or spray means 23 at the top thereof. The spray 23 is in turn connected to the transformer tank through pipes 24 and 25. The chamber 22 is adapted to be filled with liquid from the tank to any suitable amount such as to the level 26, the level being sufficiently below the spray 23 so as to provide a chamber into which the liquid may be sprayed from the nozzle 23. The portion of the chamber 22 normally filled with liquid is connected to the transformer tank through pipes 27 and 28. Thus the casing 14, tank 20, chamber 22, and connecting parts provide an enclosed fluid system including a liquid portion and a gas portion in contact with the liquid. Any suitable arrangement, such as a pump 30 may be provided for forcing the liquid from the tank through the pipes 24 and 25 to the nozzle and out the bottom of the degasifying chamber and through the pipes 27 and 28 back into the tank 20. The pump 30 may be of any suitable construction and is connected between the pipes 27 and 28 which has its intake end connected to the pipe 27 and its exhaust end connected to the pipe 28. The pump may be rotated in any suitable manner, such as by an electric motor 31.

In order to control the energization of the pump motor 31 in response to operation of the transformer I provide a relay 32 of any suitable type having contacts 33 which when closed will connect the pump motor 31 across a suitable source of electric supply 34 through conductors 35, 36, and 37. The relay 32 has an operating coil which may be energized in response to operation of the transformer in any suitable manner, such as by a connection to a current transformer 38 which will be energized on the passage of current through the load cable 39. A switch 40 is also provided in the line 37 of the pump motor which switch is adapted to close through the operation of a float 41 when the level of the liquid is at the level 26 as shown in the drawing, or above that level, the contacts 40 being adapted to open to deenergize the pump motor whenever the level of the liquid in the degasifying chamber 22 lowers below the level 26.

In order to provide an arrangement for removing impurities such as water or moisture from the gas in the top of the degasifying chamber 22 I provide a water or moisture removing device 45 which may be of any suitable type, such as having activated aluminum particles 46 therein which have well known deliquescent properties. One end of the water removing arrangement 45 is connected to the portion of the gas expansion chamber which is normally filled with gas by a pipe 47 and the other end of the water removing device 45 is also connected to that portion of the chamber 22 which is normally filled with gas by the pipes 48 and 49. A suitable pump 50 having an operating motor 51 is employed, the intake end of the pump being connected to the pipe 48 and its exhaust end being connected to the pipe 49 for circulating gas from the degasifying chamber through the water removing means and back into the degasifying chamber. The pump motor is also operated in response to energization of the transformer through contacts 52 which are in turn operated by energization of the relay 32 but it is, of course, to be understood that the pump motor 51 as well as the motor 31 may be operated in response to any other suitable condition or during any operation interval of the electric apparatus.

It will, therefore, be seen that upon operation of the transformer, the pump 30 will be operated so as to continuously circulate the liquid dielectric through the degasifying chamber and back into the transformer tank. A conventional filter 53 may also be connected in the lines 24 and 25 for filtering out solid floating contaminates. By correlating the characteristics of the pumps 30 and 50, any suitable pressure drop may be provided between the spray nozzle 23 and the gas in the degasifying chamber surrounding the spray. With a sufficient pressure differential obtaining, such as one atmosphere, gas in the liquid which is sprayed will be liberated or removed and the liquid will fall into the bottom of the degasifying chamber and be drawn out through the pipes 27 and 28 and returned to the transformer, the returned liquid being substantially free of any traces of moisture. The water vapor will then be drawn off through the pipe 47 with the rest of the gas, the moisture being removed from the gas by the water removing arrangement within the chamber 45. The dry gas will then be returned into the degasifying chamber through the pipes 48 and 49 and pump 50. By returning the dry gas to the degasifying chamber the pressure therein may be maintained within any suitable limits. Even though continual circulation of the liquid through the chamber 22 may cause the dissolved gas to come into equilibrium with the gas in the chamber 22, water vapor present in the fluid passing through the nozzle 23 will be liberated since the water vapor is being constantly removed. The idea of maintaining the dissolved gas in a state of equilibrium with the gas in the expansion chamber during transient conditions of temperature and pressure so as to maintain the pressure within the fluid system within predetermined limits and spraying to prevent bubble formation during rapid decreasing pressure conditions is a feature of the invention described and claimed in application S. N. 420,943, Paluev, filed concurrently herewith, and assigned to the same assignee as this present invention.

In order to provide an arrangement for replenishing the amount of gas in the gas expansion chamber 20 from time to time, a bomb 54 may be provided which is connected to the top of the gas expansion chamber through a pipe 55, the bomb containing any suitable inert gas, such as nitrogen. A valve 56 may be provided in the line 55 for controlling the passage of gas from the bomb to the chamber 20.

Instead of continually circulating gas in the gas expansion chamber through a water removing means, the gas may be withdrawn at a predetermined rate through a vacuum pump and discharged into the atmosphere. Such a system is shown in the fragmentary view of Fig. 2 which shows the gas expansion chamber 22 with a vacuum pump 57 connected to the pipe 47, the exhaust end of the vacuum pump discharging into the atmosphere. With such a construction, of course, the gas which is discharged into the atmosphere may be replenished by allowing gas to feed into the gas expansion chamber from the bomb 54 at approximately the same rate as gas is withdrawn by the pump 57. The rate at which the gas is withdrawn through the pump 57 may be controlled by controlling the speed of the pump 57, and the rate at which the gas

enters the system from the bomb 54 may be controlled by the valve 56.

If desired, the system of Fig. 1 may be provided without the gas expansion chamber. Such a system is shown in Fig. 3 with a fluid containing system being composed of sufficiently strong material to withstand changes in pressure, the pump 57 being also provided for withdrawing the liberated moisture. The chamber 22 in this case may be of sufficient size so as to allow for expansion and contraction of the insulating liquid due to changes in temperature.

Modifications of the particular arrangements which I have disclosed embodying my invention will occur to those skilled in the art, so that I do not desire my invention to be limited to the particular arrangements set forth and I intend in the appended claims to cover all modifications which do not depart from the spirit and scope of my invention.

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

1. An electric apparatus including an insulating liquid, means for continuously circulating a portion of said liquid during operation of said apparatus, degasifying means in the path of said circulating means for removing gas from said circulating liquid, means for removing moisture from the removed gas, and means for restoring the dried gas to said apparatus.

2. An electric apparatus including an insulating liquid, means for continuously circulating a portion of said liquid during operation of said apparatus, filter means in the path of said circulating liquid for removing solid floating contaminants, degasifying means in the path of said circulating liquid for removing gas from said circulating liquid, moisture removing means, and means for passing the removed gas through said moisture-removing means and for restoring the dried gas to the liquid circulating system.

3. An electric apparatus comprising an insulating liquid, means for continuously circulating a portion of said liquid during operation of said apparatus, filter means in the path of said circulating liquid for removing solid floating contaminants, degasifying means in the path of said circulating liquid for removing gas from said circulating liquid, moisture removing means, means for passing the removed gas through said moisture removing means, and means connecting said degasifying means and said moisture removing means for returning the dried gas to said degasifying means.

4. An electric apparatus including an enclosing tank, an insulating liquid therein, a degasifying chamber having spray means, means for fluidly connecting said tank and said spray means, means for fluidly connecting said chamber with said tank, pump means operable upon an operation of said apparatus for circulating liquid through said spray means into said chamber and back to said tank, moisture removing means, means for fluidly connecting said chamber with said moisture removing means, and pump means for circulating gas removed from the liquid through said moisture removing means and back to said chamber.

5. An electric apparatus having core and coils, an enclosing tank, an insulating liquid therein, a degasifying chamber having a portion normally filled with liquid and the remainder with gas, means for removing liquid from said tank and spraying it in the portion of said chamber filled with gas, means for fluidly connecting the liquid portion of said chamber with said tank so that the degasified liquid may be returned to said tank, water removing means, and means for circulating said gas from said gas portion of said chamber through said water removing means and back to said gas portion of said chamber.

6. An electric apparatus having core and coils, an enclosing tank, a liquid dielectric therein, a degasifying chamber having a portion normally filled with liquid and the remainder with gas, spray means in the gas portion of said chamber, pipe means connecting said spray means with said tank and for connecting the liquid portion of said chamber with said tank, pump means in said pipe means for forcing liquid through said spray means and back to said tank, means for controlling said pump means in response to the level of liquid in said chamber, and means for drying gas removed from said liquid in said chamber.

7. The method of maintaining the purity of an insulating liquid within an electric apparatus during an operation of the apparatus which includes removing a portion of said liquid, filtering said portion to remove solid floating contaminants, degasifying said portion, removing moisture present in the gas liberated during the degasifying step, and returning the degasified portion to the apparatus.

8. An electric apparatus including an insulating liquid, degasifying means, means for circulating a portion of said liquid through said degasifying means during an operation of said apparatus for liberating gas from said circulating liquid, and means for drying the gas liberated by said degasifying means during the operation of said apparatus.

9. An electric apparatus including an insulating liquid, degasifying means, means for continuously circulating a portion of said liquid through said degasifying means during operation of said apparatus for removing gas from said circulating liquid, means for continuously withdrawing the removed gas from said degasifying means during operation of said apparatus, and means for introducing gas into said apparatus at a rate substantially the same as that rate at which removed gas is withdrawn from said degasifying means.

10. An electric apparatus comprising an enclosed fluid system including a liquid portion and a gas portion in contact with said liquid portion, spray means in said gas portion, means for circulating liquid from said liquid portion through said spray means for liberating moisture from said liquid, and means for drying the gas in said gas portion.

11. An electric apparatus including an insulating liquid, degasifying means, means for continuously circulating a portion of said liquid through said degasifying means during operation of said apparatus for removing gas from the circulating liquid, means for continuously withdrawing the removed gas from said degasifying means during operation of said apparatus, and means for introducing gas into said apparatus for replenishing the gas in said electric apparatus withdrawn from said degasifying means.

HUBERT H. RACE.