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2,081,077

MEANS FOR KEEPING A TANK FILLED WITH OIL

Filed June 6, 1929

2 Sheets-Sheet 1

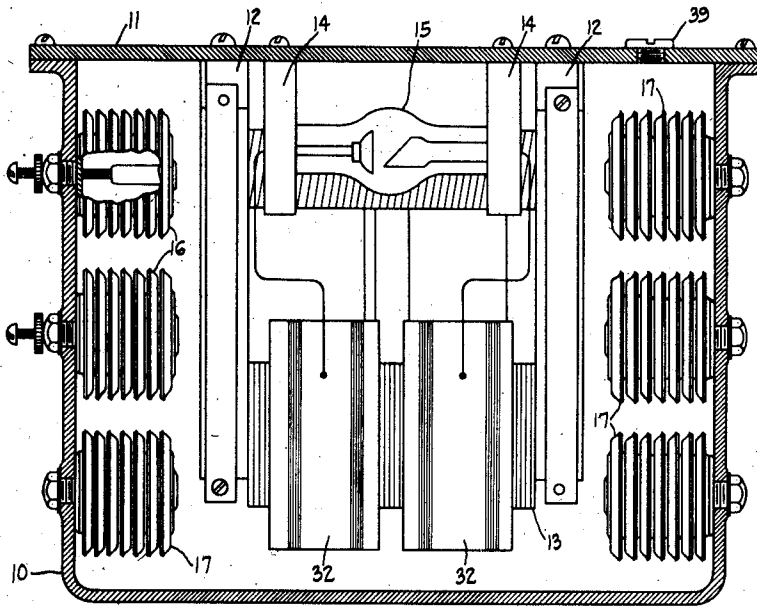


FIG. 1

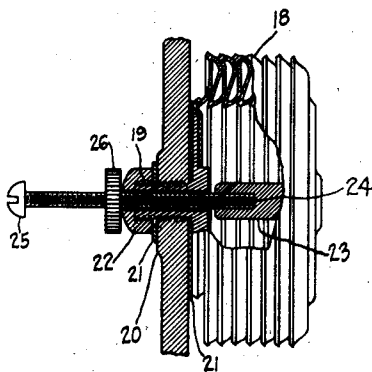


FIG. 2

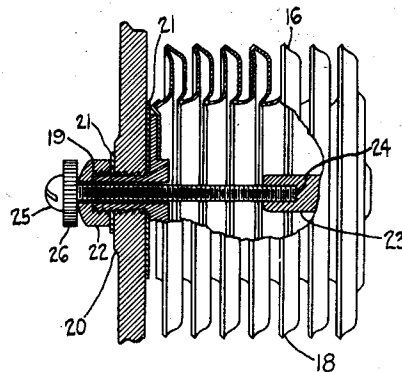


FIG. 3

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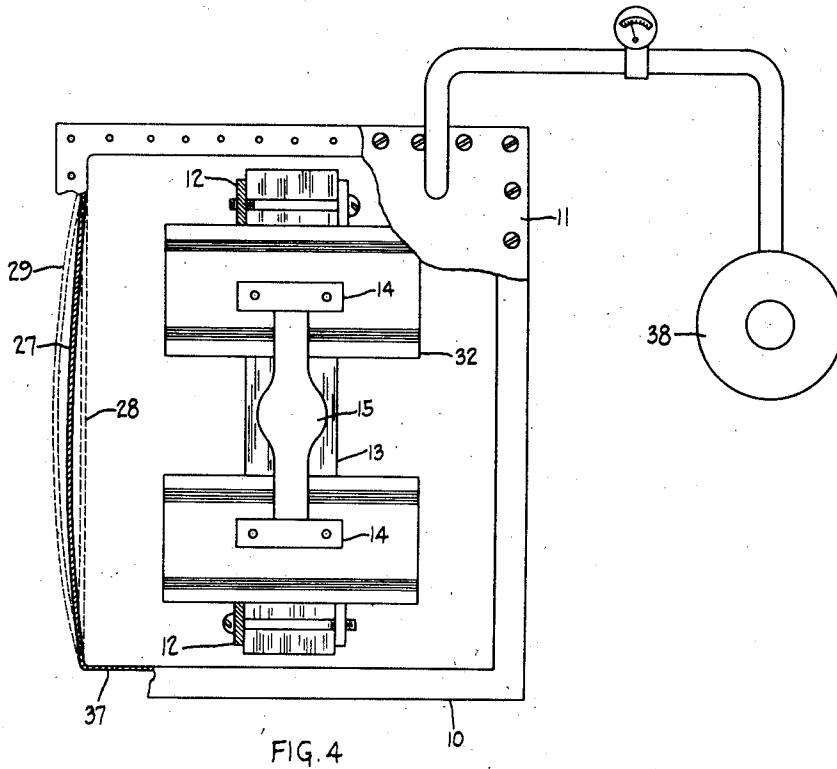


FIG. 4

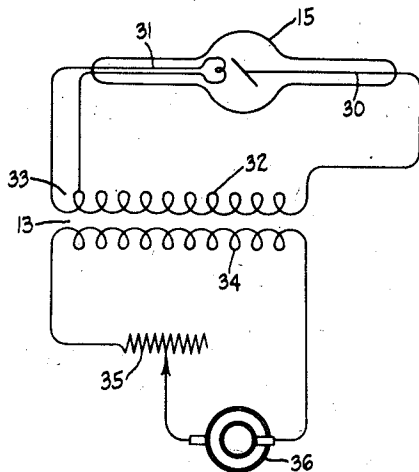


FIG. 5

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MEANS FOR KEEPING A TANK FILLED
WITH OILJulius B. Wantz, Oak Park, Ill., assignor to Gen-
eral Electric X-Ray Corporation, a corporation
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2 Claims. (Cl. 250—34)

The present invention relates to oil immersed electrical apparatus and has particularly to do with means for maintaining the tank properly filled with an insulating oil.

5 In the operation of oil immersed high tension electrical apparatus, a prime essential is to maintain the insulating oil level such that all parts of the apparatus carrying high tension current are kept entirely immersed in such oil and also
10 below the surface of the oil to a definite extent depending upon the particular value of voltage employed therewith.

This particular problem of maintaining complete and sufficient oil immersion is capable of
15 very simple solution in the case of stationary equipment, such as a permanently located high tension transformer. In such equipment, sufficiently large space is provided at the upper end of the enclosing tank. This space is filled with
20 oil leaving a certain amount of air space in the enclosing tank to permit of the expansion of the oil when the transformer is operating and the oil becomes heated therefrom.

On the other hand, in such an apparatus, there
25 is a sufficiently large volume of oil provided that, when the transformer is not operating or is exposed to low temperatures and the insulating oil contracts, the depth of oil above the current carrying parts is still sufficient to prevent an arc-
30 over above the oil.

Where oil-immersed equipment must be moved or rotated or adjusted so that no particular part of it can be considered the top because, due to the different angular positions assumed by the
35 apparatus, every point will, at one time or another, be at the top, the solution of the problem of complete and proper oil immersion becomes considerably more difficult.

This is exactly the problem which confronts
40 the designer of oil immersed X-ray equipment in which either the X-ray tube itself or the X-ray tube and a part of its exciting equipment is immersed in an oil-filled container. It is among the
45 objects of this invention to provide a container of suitable design and a method of filling such tank so that the creation of a space in the tank not filled by the oil insulation or the employment of oil temperatures greater than a certain definite amount are avoided.

50 The present invention is applicable, as has been indicated before, to oil insulated X-ray apparatus as well as to other apparatus, and it is illustrated in the accompanying drawings as applied to X-ray equipment where it is particularly useful.

55 In the accompanying drawings,

Figure 1 is a sectional view of oil immersed X-ray apparatus in which both the X-ray tube and its exciting transformer are immersed in a single container filled with insulating oil;

Figure 2 is a longitudinal section of an expansion device, fully contracted, the purpose of such device to be later described;

Figure 3 is a similar section of the device shown in Figure 2 fully expanded;

Figure 4 illustrates a second method of taking
10 care of oil expansion and contraction and wherein one or more sides of the oil container are made of thin material and advantage taken of this to compensate for oil expansion and contraction, the figure being partly in section and partly in end
15 elevation; and

Figure 5 is a simple diagrammatic illustration of a circuit such as could be applied in the device shown in Figures 1 or 4.

Like reference characters are used to designate
20 similar parts in the drawings and in the description of the invention which follows.

A tank or container 10 is shown in section in Figure 1 of the drawings, there being a cover 11
25 for said tank secured thereto in any desired manner, as for instance, by means of screws as illustrated.

Depending brackets 12 are secured to cover 11 and support a high tension transformer 13. Another set of depending brackets 14 are also
30 secured to said top 11 for supporting an X-ray tube 15.

Expansion and contraction devices 16 constructed in accordance with the invention are
35 arranged at one side of the tank 10, and three other expansion and contraction devices 17 are arranged at the opposite side. More or fewer expansion devices could be employed and their arrangement or positioning changed without departing from the spirit of the invention.

Each expansion and contraction device 16 and
40 17 comprises a bellows section 18, there being a tubular securing stud 19 for attaching the bellows 18 to the boss 20 in the wall of tank 10 through which said stud 19 passes.

Gaskets 21 are associated with said boss 20 and the stud 19 to prevent oil leakage from the tank 10. A nut 22 engages the stud 19 to hold each
45 of the expansion devices 16 and 17 in position upon the wall of the tank 10. A bushing 23 is attached to the inside end wall of expansion device 16, and therein is a centrally disposed threaded hole 24. A screw member 25 is provided
50 for engaging the threaded hole 24, there being a thumb nut 26 engaging the screw member 25 and 55

for contracting and expanding the bellows 18 of the expansion member.

The foregoing describes the expansion device or mechanism employed in the form of device shown in Figure 1, and reference will now be had to the form of the device shown in Figure 4. In such form of device, there is a movable or flexible side 27 for the container 10 and which is adapted to move inwardly and outwardly with the expansion and contraction of the oil in the tank 10.

The line 23 designates the inner limit of movement of said side 27, and the line 29 indicates the outer limit of the movement of said flexible side section. Any suitable flexible material, preferably a relatively thin sheet of metal of high elasticity, may be used for this side.

The X-ray tube 15 has a target 30, and a hot cathode 31. (See Figure 5.) In the high tension transformer 13 in the tank 10, there are secondaries 32, there being a filament winding 33 in said high tension transformer 13. The primary winding of said high tension transformer 13 is designated 34.

A regulatory resistance 35 is provided for controlling the electromotive force impressed upon the transformer 13, and suitable conduits are arranged between a source of power 36 and said regulatory resistance 35.

During the manufacture of the devices, and particularly the device illustrated by Figures 1, 2 and 3, the X-ray tube 15, the high tension transformer 13, the container 10, etc., are all assembled and the cover 11 sealed in position on the container 10 so that the entire equipment is ready for operation as soon as the container 10 is filled with oil. Thumb nut 26 upon expansion devices 16 (one or more) is now rotated and by the interaction of the threads of this nut with the threads on the screw device 25, the heads of expansion and contraction devices 16 are manipulated, pulled in and contracted until they assume the position indicated in Figure 2.

It depends upon the relative size of the bellows 18 and of the tank 10, and also on the temperature at which the device is to run, as to whether one or more of said devices 16 is contracted as described.

The tank is next filled with oil and all air allowed to escape from the windings of the transformer 13 and any other part in which air might be trapped.

During this air removing operation, a filling tube (not shown) is used and by this pressure is kept on the oil. The tank 10 is agitated in every possible fashion so as to dislodge air bubbles. If desired, a preliminary exhausting of air from the tank can be gone through with to reduce the possibility of there being any entrapped air therein.

After the tank 10 has been filled in this manner and all air has been removed, the filling tap 39 of the tank 10 is sealed up. The tension on the bellows 18 of expansion and contraction device 16 is then released, whereby the oil in the tank 10 is put under a slight pressure at room temperature, generally about 70° F. The temperature at which the tank is filled is herein spoken of as "normal" temperature. Such temperature is average working room temperature. Variations in the temperature after the tank is filled are spoken of as above or below "normal".

As the oil in the tank 10 is practically incompressible, only a small portion of the space gained by the contraction of the bellows 18 men-

tioned above will be taken up by the oil. The balance of space will divide itself among all the expansion devices, (16 and 17), causing these to contract, each approximately in the usual case about one-third of its length. The expansion devices 17 are like expansion devices 16 except that they may be devoid of the manually operated contraction devices applied to devices 16.

From the foregoing it can be readily seen that when the insulating oil is permitted to cool and thus decreases in its volume, the expansion and contraction devices 16 and 17 are capable of taking up the space thus left vacant to an amount equal to one-third of their total volume, while on the other hand, if the oil becomes heated, they can contract an even further distance or volume to permit of the expansion of the oil within the tank 10.

Referring now to Figure 4 which shows a means of attaining a similar result without the use of auxiliary expansion and contraction devices, it will be noted that there are ends 37 on the container 10 and which are made of relatively stiff material and that the sides 27 of the tank are of flexible material, such as thin sheet steel. The ends 37 and sides 27 are held together in any desirable way such as welding, soldering or brazing.

The tank 10 is filled with oil in a manner similar to that outlined above except that during the tank filling operation the sides 27 are kept partially expanded as indicated by the full line 27 indicative of the side itself, either by forcing the oil in through pressure by means of a pump 38 shown in Figure 4 or by filling the tank with oil at a very low temperature, and allowing the oil to expand after filling the tank 10 so as to bring the side 27 of the tank to the position indicated by the full lines 27. Reduction of oil volume is then compensated for by movement of the sides 27 to a position such as indicated at 28 and oil expansion by movement to position such as indicated at 29.

The two arrangements described are of great advantage in the case of X-ray apparatus where the container 10 holds the X-ray tube 15 and must be handled and adjusted to a great number of different positions. As has just been mentioned, the use of the present structures permits of the reduction of the size of the tank 10 and hence the weight of the unit. This reduction can be most material and of the highest utility in the manufacture and use of X-ray apparatus.

Such reduction not only reduces the cost of manufacture but also permits the X-ray unit to be more easily handled by a physician or operator. In the case of portable equipment, it makes for increased portability, the device being much more easily transported.

While the use of expansion and contraction devices in connection with X-ray apparatus is not wholly new, their use has always been for the purpose of permitting the expansion of liquids to thus prevent the breaking of seals, etc., due to increased oil pressure, but the operation of X-ray or similar devices normally in a partially contracted condition, whereby dual use is made of the expansion device, i. e., to take care of both contraction and expansion, is entirely new.

In the particular application herein described, there is exceedingly great utility and usefulness. Under the formerly employed scheme of operation, the use of these devices had only a single

purpose in mind, namely, alleviating the danger of the breaking of seals due to augmented oil pressure resulting from the increase in the temperature of the oil.

5 The much greater danger, namely, the formation of open spaces in the tank was allowed to remain. In the past, this greater danger has sometimes been overcome, at least to some measure, by permitting larger clearances at the ends, 10 the top, and the bottom of the tank 10. By the use of bellows and other devices arranged and employed as described herein, the extra spacing thus required in this fashion in tanks is entirely eliminated and the possibility of breaking 15 down due to arc-over made more remote than ever before.

While the expansion and contraction devices as shown are of the so-called bellows type and a diaphragm, it is understood that the invention 20 is not limited to these particular arrangements as any type of expansion and contraction device capable of the same adjustments and uses may be substituted therefor. I should also be understood that while the device, as shown, is applied 25 to X-ray apparatus, there is no intent to limit the invention to this particular use, as it may be applied to other devices which are filled with a liquid subject to heat changes.

30 I claim:

1. X-ray apparatus comprising an X-ray tube, tube energizing instrumentalities, a sealed container for said tube and tube energizing instrumentalities, resilient deformable means on said

container, said deformable means having two extreme positions determining a minimum and a maximum capacity for said container, a body of insulating oil in said container, the bulk of such oil at normal temperature being such that it 5 completely fills said container and maintains said deformable means in a mean position between its two extreme positions, and means adjustable outside of the container for limiting the movement of the resilient deformable means. 10

2. X-ray apparatus comprising an X-ray tube, tube energizing instrumentalities, a sealed container for said tube and tube energizing instrumentalities, resilient deformable means on said container, said deformable means having two extreme positions determining a minimum and a maximum capacity for said container, a body of insulating oil in said container, the bulk of such oil at normal temperature being such that it completely fills said container and maintains said 20 deformable means in a mean position between its two extreme positions, said resilient deformable means comprising a corrugated, longitudinally expansible, cylindrical element connected 25 at one end on the wall at an opening therein, the cylindrical, expansible element being sealed at its other end, and means connected on the sealed end of said expansible element and co-operatively associated with the wall of said container and adjustable for limiting the longitudinal contraction 30 and expansion of said cylindrical element.

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