Jan. 15, 1935. A. MUTSCHELLER 1,987,790

X-RAY APPARATUS

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FIGURE 1

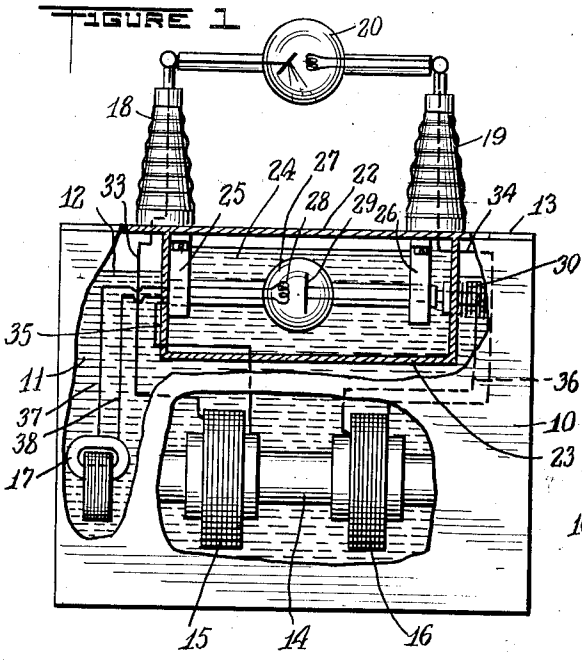


FIGURE 2

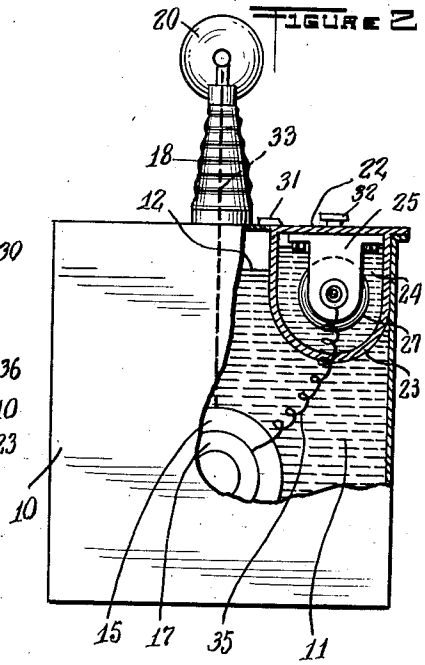


FIGURE 3

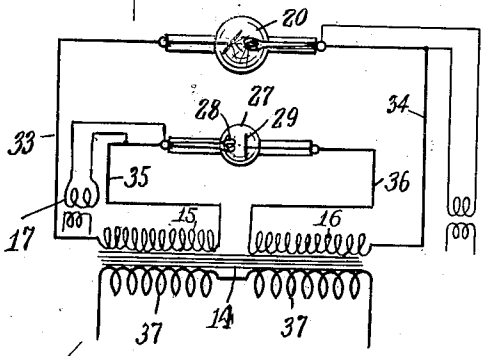
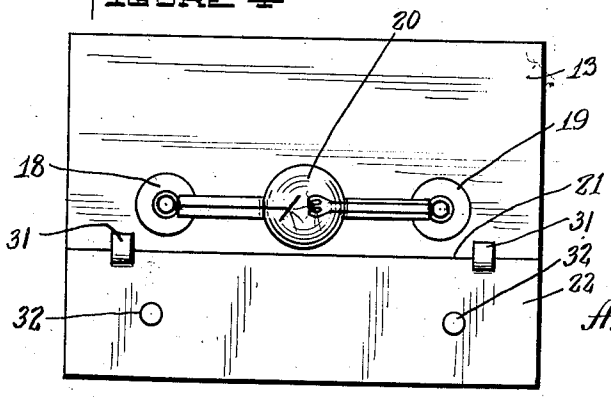


FIGURE 4



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FIGURE 5

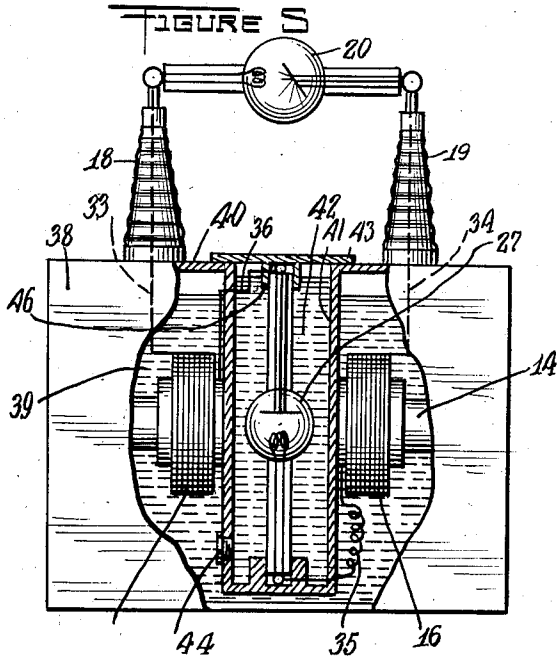


FIGURE 6

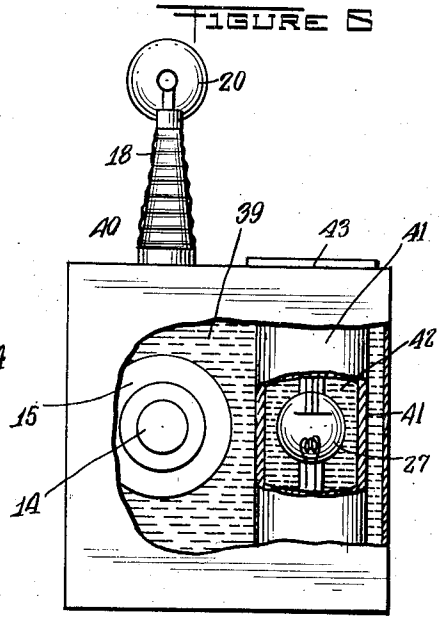


FIGURE 7

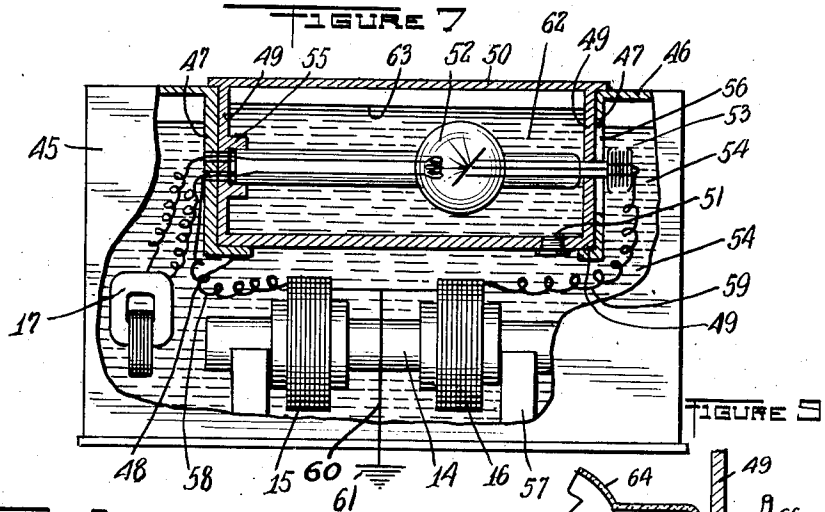


FIGURE 8

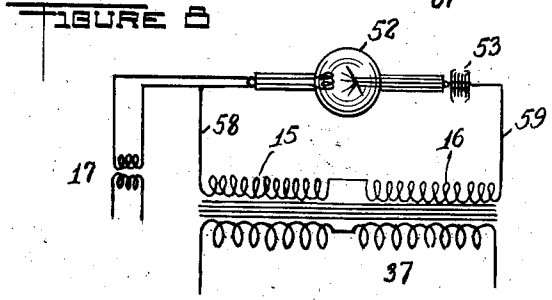
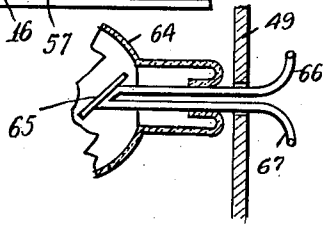


FIGURE 9



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UNITED STATES PATENT OFFICE

1,987,790

X-RAY APPARATUS

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Application February 9, 1929, Serial No. 338,693

5 Claims. (Cl. 250—34)

My invention relates to X-ray apparatus, and more especially to means for mounting an X-ray tube or other vacuum discharge tube having a heat-controlled cathode, this tube being in immediate association with an oil transformer.

More particularly stated, I seek to provide a high tension transformer casing, in the form of a main tank containing oil or similar liquid or plastic insulating material with which the high tension transformer is covered or into which it is submerged, and an auxiliary tank containing oil or similar insulating material and into which is submerged a vacuum discharge tube associated with X-ray work, preferably an X-ray tube or a valve tube, and provided with a heat-controlled cathode.

Among the objects I seek to accomplish by my invention are the following:—

1. To promote compactness, by placing the auxiliary tank within the main tank, so that the effective space occupied by both tanks is practically no greater than the space ordinarily occupied by the main tank alone.

2. To improve the insulation and promote other desirable objects, by enabling the main transformer to be submerged in one kind of oil or equivalent insulating material, the tube within the auxiliary tank being submerged in oil or similar insulating material, preferably but not necessarily of a different quality from that in the main tank.

3. To facilitate the removal and replacement of the oil or equivalent insulating material in the main and auxiliary tanks, independently of each other.

4. To facilitate the removal and replacement of the auxiliary tank bodily, in relation to the main tank.

5. To facilitate the removal and replacement of the X-ray tube or of the valve tube carried by the auxiliary tank.

6. To facilitate the removal of the vacuum tube housed within the auxiliary tank, without disturbing the insulation of the high tension transformer.

7. To prevent injury to the main transformer, and to prevent the fouling or soiling thereof, in case of accident to the tube housed within the auxiliary tank.

8. To improve the insulation between the tube and the main transformer, by the insertion therebetween of a separating wall of insulating material, such as glass, phenolic condensation product or porcelain, having oil or the like on each side of said wall.

9. To provide a different cooling means in the auxiliary tank from that used in the main tank.

10. To facilitate the distribution of heat from the anode of the X-ray tube or at the valve tube, and to cause said heat to be absorbed by a body of oil or equivalent insulating material, thus preventing overheating of the body of oil used as a cooling medium for the tube.

11. To promote the general efficiency of the main tank and the auxiliary tank, by various mechanical improvements hereinafter described.

Reference is made to the accompanying drawings forming a part of this specification and in which like reference characters indicate like parts throughout the several figures.

Figure 1 is a front view, partly an elevation and partly a section, showing one form of my device.

Figure 2 is an end view, partly an elevation and partly a section, of the form shown in Figure 1.

Figure 3 is a diagram of the wiring of the form of my device shown in Figures 1 and 2.

Figure 4 is a plan view of the mechanism shown in Figures 1 and 2.

Figure 5 is a front view, partly an elevation and partly a section, of another form of my device.

Figure 6 is an end view, partly an elevation and partly a section, of the form shown in Figure 5.

Figure 7 is a front view, partly an elevation and partly a section, of still another form of my device.

Figure 8 is a diagram of the wiring used in the form of my device appearing in Figure 7.

Figure 9 is a fragmentary section, corresponding to the right-hand portion of Figure 7, and showing a cooling system for the anode, differing slightly from that contemplated by Figure 7.

I will first describe the form of my device appearing in Figures 1 to 4 inclusive.

A main tank is shown at 10, and has the form of a box. This tank as here shown is of metal, but this is not essential.

Contained within the tank 10 is a body of oil 11, or equivalent insulating medium, such as wax. The upper level of this material is shown at 12.

Mounted upon the tank 10 is a lid 13, serving the double purpose of a closure member for the tank and a support for other parts, as hereinafter more fully explained.

Housed within the tank 10 is a high tension transformer 14, known in X-ray work as a main

transformer, and suitable for energizing X-ray and valve tubes.

The main transformer 14 carries high tension windings 15 and 16.

A small transformer 17, of a type known in this art as a heating transformer, is also housed within the tank.

Mounted upon the lid 13 and extending upwardly therefrom are a pair of post insulators 18, 19, and supported by these insulators is an X-ray tube 20.

The lid 13 is somewhat narrower than the tank 10, so as to provide an opening 21 in the top of the tank.

A shelf 22 is removably fitted into this opening, and is thus detachably mounted upon the tank 10.

Carried by the shelf 22, and hanging therefrom into the tank 10 when the shelf 22 occupies its normal position, is an auxiliary tank 23, made in this instance of glass.

The auxiliary tank 23 has the form of a trough, and is somewhat shorter than the tank 10. By this arrangement, when the auxiliary tank 23 hangs into the main tank 10 as above described, it is well insulated by means of the insulating medium 11.

The auxiliary tank 23 carries a body 24 of oil or equivalent insulating material, the level of which is independent of the level of the oil or other insulating medium contained within the main tank.

Secured to the shelf 22, and pending therefrom into the auxiliary tank, are a pair of tube supporters 25 and 26. Carried by these tube supporters is a valve tube 27.

The valve tube 27 is provided with a cathode 28 in the form of a filament adapted to be heated, and is further provided with an anode 29, in this instance of a kind suitable for use in a valve tube.

The valve tube 27 carrier a radiator 30, so mounted and arranged as to extend through the end wall of the auxiliary tank 23, and thus out into the body of oil 11. By this arrangement excessive heat of the anode 29 is distributed into the body of oil 11. Because this body of oil is quite large, it does not heat up readily; and yet the heat it receives from the radiator 30 enables the anode 29 to be kept relatively cool.

The lid 22, carrying the auxiliary tank 23, as above described, is provided with a pair of lugs 31, 31, which extend slightly over the adjacent edge portion of the lid 13 of the main tank. This practically strengthens the lid 22, by bracing it relatively to the lid 13.

The lid 22 is provided with a pair of knobs 32, 32, serving as handles for enabling the auxiliary tank 23 to be removed and replaced by hand.

A conductor 33 is connected with the X-ray tube 20 and extends downwardly therefrom through the insulator 18 and the intervening portion of insulating medium 11, to the high tension secondary winding 15. Similarly another conductor 34 is connected with the X-ray tube and extends therefrom through the post insulator 19 and the adjacent portion of the insulating medium 11, to the secondary winding 16.

From the secondary winding 15 a conductor 35 extends to the cathode end of the valve tube 27. Another conductor 36 extends from the anode end of this tube to the secondary winding 16.

The high tension transformer 14 is provided with primary windings 37, 37, shown diagrammatically in Figure 3, whereby it is energized.

The conductors 35 and 36 are of adequate length to enable the auxiliary tank 23 to be lifted out of the main tank. For this purpose, in practice, the conductors 35 and 36 are preferably wound in helical form as may be understood from Figure 2.

The cathode of the X-ray tube 20 and the cathode of the valve tube 27 are energized from the transformer 17 and thus heated, after the manner in which cathodes have heretofore been heated in this art.

The secondary circuit of the high tension transformer 14 may be traced as follows: Secondary winding 15, conductor 35, valve tube 27, conductor 36, secondary winding 16, conductor 34, X-ray tube 20 and conductor 33, back to secondary winding 15. From this circuit it will be noted that the X-ray tube 20 and the valve tube 27 are in series with each other, and also that the valve tube serves to prevent discharges from taking place in the wrong direction through the X-ray tube.

The operator, by lifting the auxiliary tank 23 out of the main tank, can readily inspect, repair and replace the valve tube and various other parts carried by the auxiliary tank.

As an independent step the operator can inspect, remove and replace the main transformer or any part thereof, without disturbing the auxiliary tank.

Should the valve tube burst or become disabled in any way, this can do no harm to anything outside of the auxiliary tank.

Should the X-ray tube burst or become disabled, this can occasion no injury to anything contained within the auxiliary tank.

The insulating medium 11 may be different from the insulating medium 24. If each of these insulating mediums is an oil, one of them can be thick and the other thin. A fine and thin oil is preferably used in the auxiliary tank, and it need not be renewed except at long intervals. A somewhat coarser and cheaper oil may be used to advantage in the main tank, and it may be renewed as often as required.

The insulation between the valve tube 27 and the main transformer is greater than would ordinarily be the case, owing to the intervening wall 23 of the auxiliary tank.

In the form of my device appearing in Figures 5 and 6 the general arrangement is the same, but the auxiliary tank containing the valve tube is arranged somewhat differently.

The main tank is shown at 38, and the volume of oil or equivalent insulating material contained within the tank appears at 39. The main tank is provided with a lid 40, and hanging from this lid is a receptacle 41, which is the tube holder, and is, of substantially cylindrical form. This auxiliary tank is provided with a lid 43, which rests at its edges upon the larger lid 40 of the main tank 38.

The auxiliary tank 41 contains a volume of oil 42 serving as insulating material, in which the valve tube 27 is submerged. It will be noted that in this instance the valve tube extends vertically, like the tube holder 43.

The auxiliary tank 41 is provided with a closure plug 44, which admits of more than one use. With this closure plug in position, as indicated in Figure 5, the volume of insulating material 42 is completely separated from the volume of insulating material 39. By removing the plug 44, the volume of insulating material within the auxiliary tank 41 is merged into the volume of insulating material carried by the main tank.

With the closure plug 44 in position as shown, the insulating material 42 may be of different quality, or different limpidity, from that of the insulating material 39.

The electrical connections for the mechanism shown in Figures 5 and 6 may be the same as indicated by the diagram, Figure 3.

In the form of my device shown in Figure 7 the main tank appears at 45, and its cover is shown at 46.

The cover 46 carries a hanging wall 47, the bottom edge of this wall being provided with a supporting flange 48.

The auxiliary tank is shown at 49, and serves the purpose of a tube holder. This auxiliary tank is provided wtih a cover 50, which is preferably integral with it. By means of this cover, the auxiliary tank may be lifted bodily out of the main tank.

The auxiliary tank 49 is provided with a closure plug 51, like the closure plug 44 above described.

In the form shown in Figures 7 and 8 the X-ray tube appears at 52, and is located within the auxiliary tank 49. The X-ray tube carries a heat radiator 53, which is in threaded connection with the anode stem of the X-ray tube and extends out into the body of insulating material 54, carried by the main tank 45. When it is desired to remove the auxiliary tank from the transformer tank the radiator 53 is disconnected from the former and the X-ray tube through a hand hole or covered opening (not shown) in the cover plate 46 adjacent this end of the X-ray tube.

The tube holder 49 is provided with a supporting neck 56, into which is fitted one end of the X-ray tube, and with a support 55 for the opposite end of the X-ray tube.

In this form of my device a pair of conductors 58, 59 extend from the secondary windings 15, 16 to the terminals of the X-ray tube.

The secondary windings are connected with a conductor 60, which leads to the ground at 61.

The tube holder contains a body of oil 62 or equivalent insulating material, the level of which is shown at 63.

In Figure 9 I show fragmentarily a form of my device, differing from the one above described with reference to Figures 7 and 8.

The X-ray tube appears at 64, and its anode at 65. Connected with the anode are a pair of tubes 66, 67, through which oil is circulated, by means of a pump or the like. This cools the anode to a relatively low temperature. Except as otherwise just described, the mechanism contemplated by Figure 9 is like that above described with reference to Figures 7 and 8.

As may be noted from the foregoing description, the vacuum discharge tube housed within the auxiliary tank may be either an X-ray tube or a valve tube.

I do not limit myself to the precise construction illustrated in the drawings and above described, as variations may be made therein without departing from my invention, the scope of which is commensurate with my claims.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is as follows:—

1. In a device of the character described the combination of a main tank serving as a transformer casing, a body of insulating material contained in said main tank, a high tension transformer mounted within said main tank and covered by said body of insulating material, an auxiliary tank housed within said main tank and extending into said body of insulating material, a valve tube mounted within said auxiliary tank, a body of liquid insulating material contained within said auxiliary tank and covering said valve tube, an X-ray tube carried by said main tank and insulated therefrom, and connections from said high tension thansformer to said valve tube and said X-ray tube.

2. The combination of a main tank serving as a transformer casing, a high-tension transformer mounted within said tank, a body of insulating and cooling material contained within said main tank and covering said high-tension transformer, an auxiliary tank detachably connected with said main tank and when in position partially surrounded by the body of insulating and cooling material in said main tank, said auxiliary tank containing a body of material serving as an insulating and cooling medium independent of the body of insulating material in said main tank, a vacuum tube housed within said auxiliary tank and provided with an anode having a portion extending into contact with the body of insulating and cooling medium in said main tank and cooled thereby, and flexible connections from said transformer to said auxiliary tank and said vacuum tube housed therein for the purpose of energizing said vacuum tube.

3. The combination with a main tank, a high-tension transformer mounted therein, a body of insulating material contained within said main tank and covering said transformer, an auxiliary tank detachably carried by said main tank and substantially immersed in a body of insulating material in said main tank, said auxiliary tank containing a body of insulating material serving as an insulating and cooling medium independent of the body of insulating material in said main tank, a vacuum tube housed within said auxiliary tank and provided with an anode, a portion of said anode being in contact with the insulating and cooling medium in said auxiliary tank for cooling the same, and said anode provided with a portion thereof in contact with the body of insulating and cooling medium in said main tank and additionally cooled thereby, and connections from said main transformer to said auxiliary tank and to said vacuum tube for the purpose of energizing the latter.

4. The combination of a main tank serving as a transformer casing, a high tension transformer mounted within said main tank, a body of insulating material contained within said main tank and covering said high tension transformer, an auxiliary tank connected with said main tank and detachable therefrom, said auxiliary tank containing a body of material serving as an insulating medium and also as a cooling agent independent of the body of insulating material in said main tank, a vacuum tube housed within said auxiliary tank and provided with an anode extending into contact with said first mentioned body of insulating material and cooled thereby, and connections from said transformer to said auxiliary tank and said vacuum tube housed therein, for the purpose of energizing said vacuum tube.

5. The combination of a main tank, a high tension transformer mounted therein, a body of insulating material contained within said main tank and covering said transformer, an auxiliary tank detachably carried by said main tank and substantially surrounded by the insulating material in said main tank, said auxiliary tank con-

taining a body of insulating material serving as an insulating medium and also as a cooling agent independent of the body of insulating material in said main tank, a vacuum tube housed within said auxiliary tank and provided with an anode, a portion of said anode being in contact with said first mentioned body of insulating material and being cooled thereby, and connections from said main transformer to said auxiliary tank and said vacuum tube for the purpose of energizing the latter.

ARTHUR MUTSCHELLER.