Sept. 2, 1941. W. W. WATROUS, JR 2,254,922

DOUBLE WALL DISCHARGE DEVICE

Filed July 13, 1940

Fig. 1.

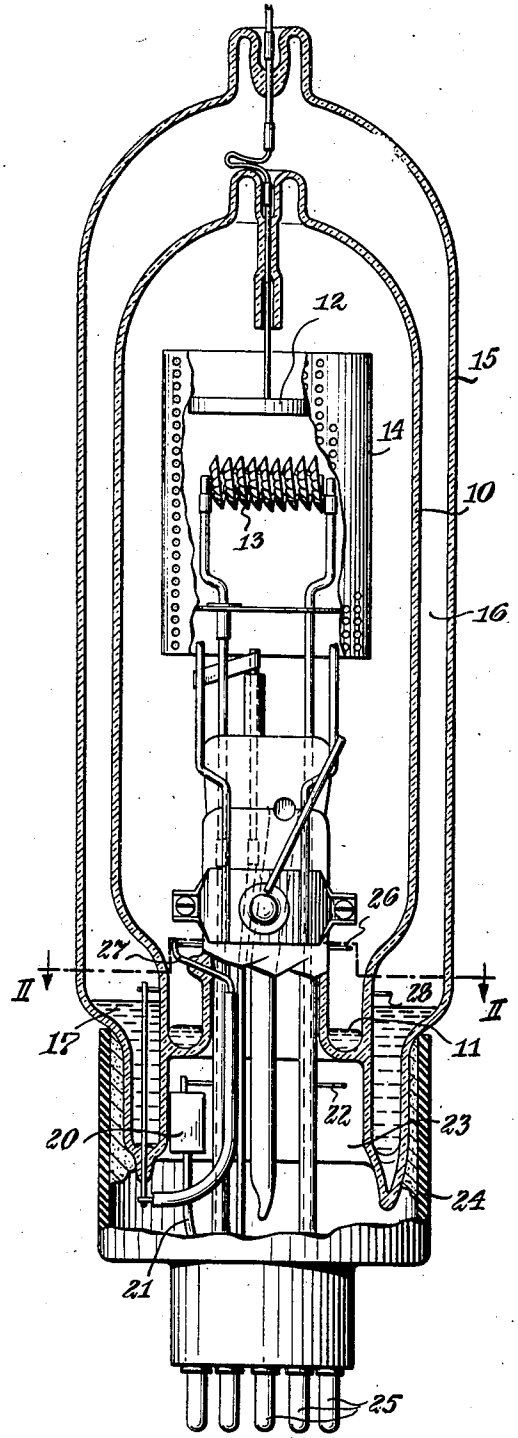


Fig. 2.

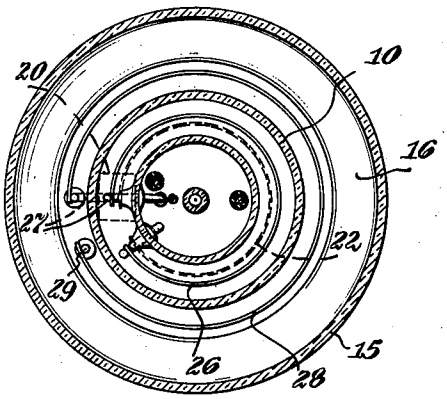
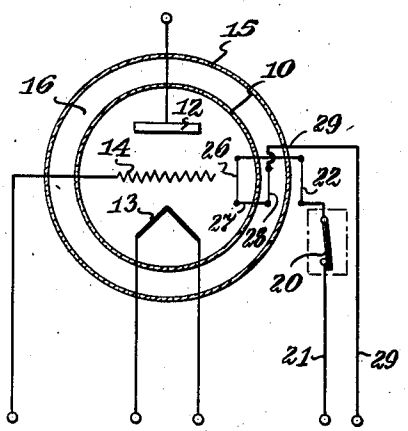


Fig. 3.



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DOUBLE WALL DISCHARGE DEVICE

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Application July 13, 1940, Serial No. 345,275

6 Claims. (Cl. 250—27.5)

My invention relates to a discharge device and especially to discharge devices having a gaseous medium affected by ambient temperature.

An object of my invention is to provide a discharge device whose operation will not be interfered with by wide variation in the temperature of the atmosphere.

Other objects and advantages will be apparent from the following description and drawing in which:

Fig. 1 is a view mainly in cross section of a discharge device embodying my invention.

Fig. 2 is a cross-sectional view on lines II—II of Fig. 1.

Fig. 3 is a diagrammatic view illustrating the electrical circuit of Fig. 1.

Certain gaseous atmospheres utilized in discharge devices, such as mercury vapor, have the defect that the vapor pressure of the saturated mercury varies rapidly with changes in temperature. This fact greatly limits the use of a mercury filled tube as the tube properly operates only over a limited range of condensed mercury temperature. The tube might be installed, for example, on an airplane which may rise to such a height that the ambient temperature falls to a very low value, such as —40° C. Such a low temperature would make the usual mercury vapor tube incapable of properly operating.

It is a specific object of my invention to provide an arrangement whereby such a mercury vapor filled device operates independent of the ambient temperature variation. In Fig. 1 I have illustrated a typical tube 10 and electrode arrangement having a vapor from the mercury 11 located therein.

In my preferred embodiment, this envelope 10 is an inner sealed glass container with an anode 12 and cathode 13. The discharge between these electrodes may or may not be controlled by one or more grids 14. The tube 10 is surrounded in turn by a sealed tube 15 having a space 16 surrounding the inner sealed envelope 10. This space between the inner tube 10 and the envelope of the outer tube has a substance 17 therein which is preferably liquid at the operating temperatures of the inner electrodes. This substance should have a low specific heat, but at the maximum operating temperature of the inner tube should have a high heat conductivity and a relatively high vapor pressure.

At low temperatures, such as 20° C., the substance should have a pressure less than 100 mm. of mercury, at 0° C. the pressure should be less than 50 mm., and at lower temperatures such as —40° C. or —50° C. the substance is condensed in the lower part of the tube 15 and the vapor pressure therefrom should be so low as to provide practically a vacuum effect in the upper portion of the space between the double walls of the device surrounding the electrodes. The substance should have a very steep rise in the pressure curve with increased temperature from —50° C. through the range to the operating temperature of the discharge device.

In the preferred embodiment illustrated in Fig. 1, I have disclosed a heater arrangement that may be located in any one or all three positions here described. A thermostat 20 is located in the heater connecting lead 21, and a heat-producing filament 22 extends around the base space 23 enclosed by the insulating cap 24 to which are attached the connecting prongs 25.

A heater 26 in the inner discharge device is connected in series with the heater 22 as disclosed in Fig. 2. The heater 26 is in turn connected by 27 to a heater 28 located in between the lower portion of the double walls. The connection from the heater 28 extends outwardly of the device at 29. In place of the three heaters disclosed, a combination of any two may be used, or the heating arrangement may be limited to one heater at one of the locations, as desired. The thermostat is preferably set to cut out the heating current when the mercury temperature reaches 35° C. The heating supply source and thermostat control may be connected parallel with the cathode connections.

Suppose the ambient temperature is —40° C. The filament and heater potential have been applied. At this temperature of —40° C. the vapor pressure in the outer chamber is very low and is to all practical purposes a good vacuum. The double wall then acts as a good heat insulator, forcing the mercury to condense in the lower portion of the bulb. As the point of maximum heat conduction in the inner bulb is opposite the filling substance in the outer chamber, the mercury condenses at this point. Due to the low specific heat of the filling substance, it absorbs heat from the heater and rapidly brings the mercury temperature to 35° C. where the thermostat interrupts the current through the heater. The thermostat 20 as disclosed in Fig. 1 is placed in the base 24 directly under the condensed mercury so as to respond to the temperature thereof.

If the temperature on the outside changes, then the vapor pressure in the space 16 rapidly increases with the change in temperature, and

at approximately 70° C. may be as high as one or more atmospheres. This increased vapor pressure in turn increases the rate of cooling due to convection between the inner and outer walls. The net result is that less heat is available in the bulb to raise the condensed mercury temperature.

The mercury continues to condense at the point opposite the filling substance of the outer chamber, as this becomes the coolest spot in the bulb due to the conductivity through the filling substance. Thus the temperature of the filling substance at the base of the tube becomes the controlling factor in determining the mercury pressure. Inasmuch as the insulating effect of the double wall thickness at the base is counteracted by the greater cooling efficiency of the filling substance over the air, the result is that the condensed mercury temperature is not enough higher to interfere with the operation of a tube such as illustrated in the drawing.

The rate of cooling in such a device is proportional to the vapor pressure multiplied by the square root of the absolute temperature of the vapor divided by the molecular weight of the vapor. It is accordingly desirable to have a vapor of low molecular weight in order to obtain better cooling.

The material in the outer envelope which I have found most suitable is carbon tetrachloride (CCl_4). This carbon tetrachloride has approximately a pressure of 10 mm. at —20° C., a pressure of 33 mm. of mercury at 0° C., a pressure of 91 mm. at 20° C., and a pressure of one atmosphere at 76° C.

Another suitable substance is trichloro-ethylene (C_2HCl_3). Other substances might be used, but the two specifically mentioned have the advantage of being non-inflammable.

It is apparent that many modifications may be made in the preferred embodiment disclosed on the drawing and described above. Accordingly, I desire only such limitations to be imposed upon the invention as are necessitated by the spirit and scope of the following claims.

I claim:

1. A discharge device comprising an inner sealed envelope having therein two electrodes and a gaseous medium affected by ambient temperature, an outer sealed envelope enclosing said first sealed envelope, said second sealed envelope having a substance therein liquid at 0° C. and having a high vapor pressure and high heat conductivity at the maximum operating temperature of said inner sealed envelope and electrodes, and a heater in said outer sealed envelope.

2. A discharge device comprising an inner sealed envelope having therein two electrodes and a gaseous medium affected by ambient temperature, an outer sealed envelope enclosing said first sealed envelope, said second sealed envelope having a substance therein liquid at 0° C. and having a high vapor pressure and high heat conductivity at the maximum operating temperature of said inner sealed envelope and electrodes, a heater in said outer sealed envelope, and a thermostat within the confines of said device to cut out said heater when the temperature of the device has reached a predetermined value.

3. A discharge device comprising an inner sealed envelope having therein two electrodes and a gaseous medium affected by ambient temperature, an outer sealed envelope enclosing said first sealed envelope, said second sealed envelope having a substance therein liquid at 0° C. and having a high vapor pressure and high heat conductivity at the maximum operating temperature of said inner sealed envelope and electrodes, and a heater in said outer sealed envelope, a heater in said inner envelope and a thermostat within the confines of the device to cut out said heaters when the temperature of the device has reached a predetermined value.

4. A discharge device comprising an inner sealed envelope having therein two electrodes and a gaseous medium affected by ambient temperature, an outer sealed envelope enclosing said first sealed envelope, said second sealed envelope having a substance therein liquid at 0° C. and having a high vapor pressure and high heat conductivity at the maximum operating temperature of said inner sealed envelope and electrodes, a heater within said envelopes and a thermostat within the confines of said device to cut out said heater when the temperature of the device has reached a predetermined value.

5. A discharge device comprising an inner sealed envelope having therein two electrodes and a gaseous medium affected by ambient temperature, an outer sealed envelope enclosing said inner sealed envelope, a pool of a substance remaining liquid at atmospheric temperatures below 0° C. in the lower portion of said outer envelope, said substance, at the temperature of operation of said electrodes, providing a vapor pressure of high heat conductivity in the outer envelope surrounding the electrodes and said substance at temperatures below 0° C., condensing in the lower portion of said outer envelope and reducing the heat conductivity in the outer envelope surrounding the electrodes to a value approaching that of a vacuum in the outer envelope.

6. A discharge device comprising an inner sealed envelope having therein two electrodes and a gaseous medium affected by ambient temperature, an outer envelope enclosing said inner sealed envelope and a pool of a substance remaining liquid at atmospheric temperatures below 0° C. in the lower portion of said outer envelope, said substance, at the temperature of operation of said electrodes, providing a vapor pressure of high heat conductivity in the outer envelope surrounding the electrodes, said substance, at 0° C., having a vapor pressure of less than 50 mm. of mercury in the outer envelope surrounding the electrodes and said substance, at temperatures below —20° C. having a vapor pressure of only a few millimeters of mercury in the outer envelope surrounding the electrodes.

WARD W. WATROUS, JR.