

Sept. 11, 1956

F. E. THROW

2,762,895

CONSTANT TEMPERATURE DEVICE

Filed Oct. 25, 1952

2 Sheets-Sheet 1

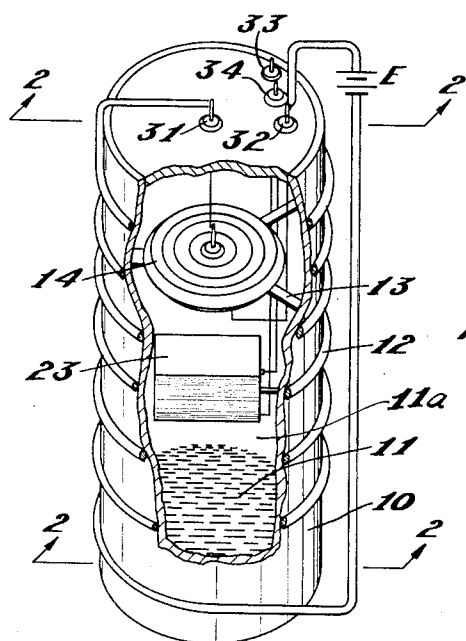


Fig 1

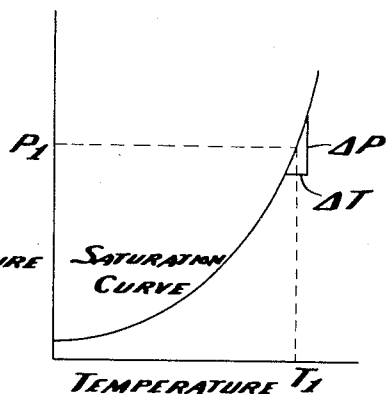


Fig 4

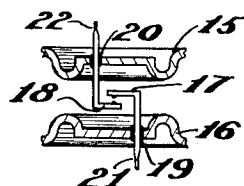


Fig 3

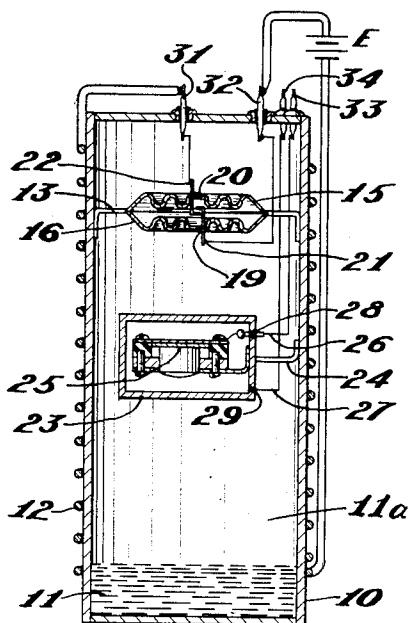


Fig 2

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2 Sheets-Sheet 2

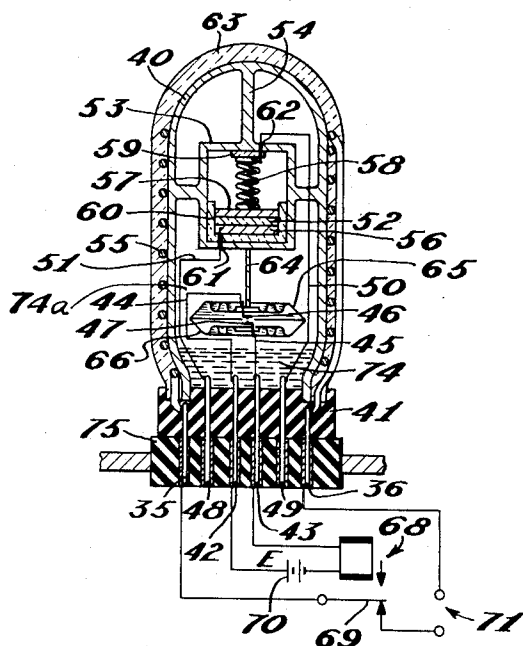


Fig 5

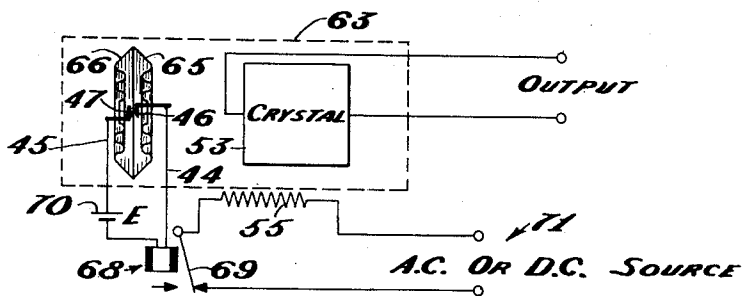


Fig 6

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1

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2 Claims. (Cl. 219—19)

The present invention relates to a constant temperature device and more particularly to an improved mechanism for controlling the temperature of a piezo electric crystal, or any other electrical or mechanical element, requiring operation under constant temperature conditions.

An object of this invention is to control temperature within exceedingly small tolerances.

Still another object is to provide a constant temperature device which can operate in any position.

Another object is to provide a constant temperature device which will not be affected by acceleration.

Yet another object is to provide a constant temperature device which is very small and light and can be mounted in a conventional radio tube socket.

Another object is to provide a constant temperature device which will reach an operating temperature very quickly after it is placed in operation.

A principal feature of the present invention is to obtain constant temperature by pressure regulation of a saturated vapor. A fluid is selected which has suitable saturated vapor characteristics and is placed in a sealed container. A pressure responsive switch is mounted in the container and is connected to temperature control means surrounding the container.

A physical characteristic of a saturated vapor is that its pressure is not a function of volume. Its pressure is a function of temperature only. This characteristic may be utilized to control temperature.

Other objects, features and advantages will be apparent from the following specifications and drawings, in which:

Figure 1 is a cut away perspective view of my device; Figure 2 is a sectional view taken on plane 2—2—2—2 of Figure 1;

Figure 3 is an enlarged detail view of a portion of the pressure switch;

Figure 4 is a graph of the pressure-temperature characteristic of a saturated fluid;

Figure 5 is a sectional view of a particular embodiment adapted to be mounted in a tube socket. The sectional view is taken viewing a plane through the longitudinal axis; and

Figure 6 is a schematic diagram of the control circuit of this invention.

The embodiment shown in Figure 1 consists of a sealed container 10. It may be made of any material of sufficient strength. A conducting material has the advantage of electrically shielding any electrical elements which may be enclosed.

Liquid 11 partially fills container 10. Saturated vapor 11a from liquid 11 fills the remaining volume in the container. The properties of liquid 11 will be described hereafter.

A heating coil 12 surrounds the outside of container 10.

Mounted within container 10, by suitable brackets 13, is a pressure switch 14. The pressure switch may be of any suitable type. The switch shown consists of two cupped spring diaphragms 15 and 16 which are connected

2

about their outer peripheries to form an air-tight seal. They enclose, seal and support contacts 17 and 18 which are connected to leads 21 and 22.

Sealed bushings 19 and 20 insulate leads 21 and 22, respectively, from the diaphragm. The diaphragms may be filled with any suitable gas, or may be evacuated. Figure 3 shows contacts 17 and 18 and a portion of the diaphragms. In and out movement of the diaphragms relative to each other controls the position of contacts 17 and 18. For example, when the diaphragms 15 and 16 move apart due to a decrease in vapor pressure in container 10, the contacts 17 and 18 engage. When the vapor pressure increases, the diaphragms move toward each other and the contacts open.

Pressure switch leads 21 and 22 pass through bushings 32 and 31, respectively, in the wall of container 10 which insulate the leads and provides a gas-tight seal.

Leads 21 and 22 may directly connect heating coil 12 to a suitable voltage source through switch contacts 17 and 18 or they may control a relay which connects a voltage to the heating coil.

Figure 2 illustrates a direct connection between leads 21 and 22 and the heating coil, whereas in Figure 6 a relay is shown. The relay gives an increase in sensitivity. A relay 68 is connected to a suitable voltage source E which may be either A. C. or D. C. and to leads 21 and 22. The relay controls a second voltage supply which is connectable to the heating coil 12.

Holder assembly 23 is supported by the inside walls of the container 10 by supports 24. Its purpose is to hold and support any electrical or mechanical device that requires a constant temperature. A piezoelectric crystal 25 is used as an example. The holder assembly 23 may seal the item from the surrounding vapor if desired.

Leads 26 and 27 extend from the controlled device 25 through sealed bushings 28 and 29, respectively mounted in the holder assembly 23. They then pass through the container 10 by means of sealed insulating bushings 33 and 34.

Figure 5 shows another embodiment of this invention with a container 40 shaped in the form of a radio tube (either regular or miniature in size). Aluminum or other metal may be used as the material for container 40. Container 40 is mounted on a tube base 41 which is receivable in a tube socket 75.

Container 40 is partly filled with fluid 74 which produces a vapor 74a in container 40.

A support 54 is fastened to the inside wall of container 40 and supports a chamber 53.

A crystal 52 is mounted within sealed chamber 53. In this embodiment chamber 53 is made of copper. Chamber 53 contains a conducting plate 56 which contacts the lower surface of crystal 52. Plate 56 is supported by chamber 53 but is electrically insulated therefrom by insulation 60.

The opposite surface of crystal 52 is engaged by a conducting plate 57. The crystal contacting surfaces of plates 56 and 57 may be silver plated to give good contact.

Plate 57 is held against crystal 52 by a spring 58. Spring 58 is insulated from chamber 53 by insulation 59, and the crystal 52 and plates 56 and 57 are electrically insulated from chamber 53 by insulation 60.

The plate 57 and spring 58 are connected electrically. Lead 51 is connected to plate 56 and passes through sealed insulating bushing 61 which insulated it from chamber 53.

A lead 50 is connected to the fixed end of spring 58 and passes through sealed insulating bushing 62. Conductors 50 and 51 are then connected to plugs 49 and 48, respectively mounted in the tube base 41. Chamber 53 may be evacuated or filled with a suitable gas such as dry air or helium.

A heating element 55 surrounds container 40 and leads from the heating element 55 connect to plugs 35 and 36. Insulation 63 surrounds the container 40 and heating element 55 to damp heat fluctuations and conserve power.

A support 64 is attached to the bottom of chamber 53 and supports the spring diaphragm 65. A second diaphragm 66 is attached to diaphragm 65 by a gas-tight seal. A contact 46 is attached to an insulating bushing which extends through diaphragm 65 and a contact 47 is attached to an insulating bushing which extends through diaphragm 66.

Contacts 46 and 47 are connected and disconnected by pressure changes in the vapor. Contacts 46 and 47 are connected to leads 44 and 45 which connect to plugs 42 and 43, respectively.

The contacts 46 and 47 are connected to a relay 68 which operates a switch 69. The switch 69 controls power to the heating element 55. Relay 68 and heating element 55 may be energized by A. C. or D. C. voltage supplies 70 and 71, respectively.

This invention utilizes the physical characteristics of a saturated vapor to obtain constant temperature regulation.

One such characteristic is that if any surface in contact with a saturated vapor has a temperature even slightly below that of the saturated vapor, heat is transferred to it at a very high rate by the condensation of vapor on it. This results in the maintenance of an almost perfectly uniform temperature throughout the region in contact with the vapor.

A second characteristic of a saturated vapor is that its pressure is independent of volume but depends on temperature as shown in Figure 4 which illustrates a typical saturated vapor curve with pressure and temperature as ordinates and abscissa. It is to be noted that the slope of the curve rapidly increases at higher temperatures, and it is this fact which is utilized by this invention. As the slope increases the same increment of temperature change results in a greater increment of pressure change.

In selecting a fluid, the desired operating temperature T_1 for the crystal (or other item) must be known. The maximum and minimum pressures which the container can safely withstand must also be known.

With the above known, the saturated vapor tables for organic and inorganic compounds should be consulted. They may be found in most handbooks of chemistry or physics, such as "Handbook of Chemistry and Physics" by Hodgman. First, the vapor pressure at the selected operating temperature should be found for any material. If it is outside the pressure limits of the container, it must be rejected. If inside those limits, its rate of pressure change per degree temperature change should be calculated

$$\frac{\Delta P}{\Delta T}$$

at the selected operating temperature. If the increment of pressure is large enough to obtain response of the pressure switch for a desired small increment of temperature, the material is satisfactory. The greatest sensitivity is obtained with materials with the largest ratio of

$$\frac{\Delta P}{\Delta T}$$

If special insulating, or conducting, or corrosive properties are desired, the material must be selected which meets these requirements.

Examples of a few compounds and their physical properties are illustrated below:

Material	Selected operating temperature, °C.	Vapor pressure at operating temp., mm. of Hg	Approximate rate of pressure change per °C. at operating temperature $\frac{\Delta P}{\Delta T}$ mm. of Hg/°C.
Water (H ₂ O).....	50	92	4.5
Carbon Disulfide (CS ₂).....	50	860	26
Ethyl Alcohol (C ₂ H ₅ O).....	50	222	9
C ₂ H ₆ O.....	60	353	16
n-Octane (C ₈ H ₁₈).....	60	77.5	2.5
Ethyl Acetate (C ₄ H ₈ O ₂).....	50	232	10
Propyl Acetate (C ₆ H ₁₂ O ₂).....	60	172	10
n-Propyl Alcohol (C ₃ H ₈ O).....	50	87	9
Propyl formate (C ₄ H ₈ O ₂).....	60	365	10
Trichloroethylene (C ₂ HCl ₃).....	40	149	5.5

While certain embodiments of this invention are shown, it is to be understood that it is capable of many modifications. For example, more than one crystal (or other item) may be contained in one container. Changes, therefore, in construction and arrangement may be made without departing from the spirit and scope of the invention as disclosed.

I claim:

1. A temperature controlling device comprising, a hermetically-sealed container, a fluid partly filling said container member, a saturated vapor from said fluid with a characteristic such that small changes in temperature result in large changes in pressure at the operating temperature, a pair of diaphragms connected together at their peripheries and supported from the inside of said container, a pair of contacts extending through said diaphragms and terminating adjacent each other, a pair of leads connected to said contacts and extending through said container in a sealed and insulated manner, a heating element connected to said container member and connected electrically to one of the leads from one of said contacts, a power supply connected to the other lead from the other contact, and said power supply connected to said heating element.

2. Saturated vapor apparatus for maintaining constant temperature by means of vapor pressure comprising, a hermetically-sealed container, a saturated vapor contained in said container, a liquid condensate of said vapor contained in said container, a pressure responsive switch supported within said container, an inner portion of said switch sealed from said vapor, a pair of contacts supported within said sealed inner portion, a holder assembly mounted within said container, the inner portion of said holder sealed from said vapor, a device to be temperature controlled supported within said holder and sealed from said vapor, a heating coil surrounding said container, first wiring means connected to said device and passed through said holder and container, and second wiring means connected to said pressure switch and passed through said container.

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