Dec. 18, 1934.

P. H. BETTS

1,984,514

CONSTANT TEMPERATURE APPARATUS

Original Filed Sept. 20, 1928

2 Sheets-Sheet 1

FIG. 1

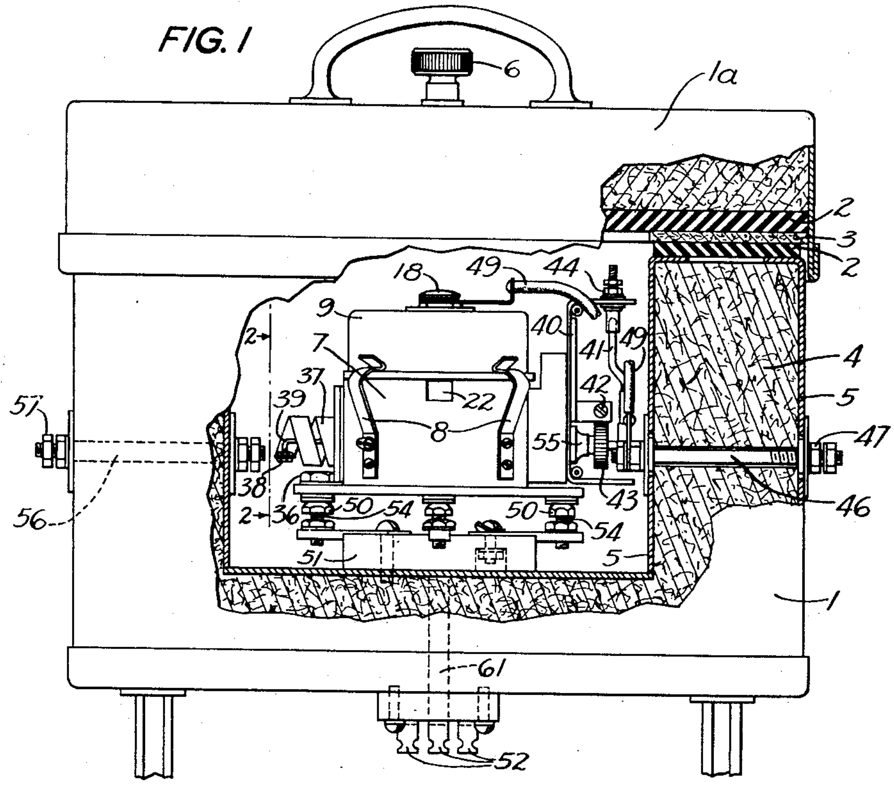

FIG. 2

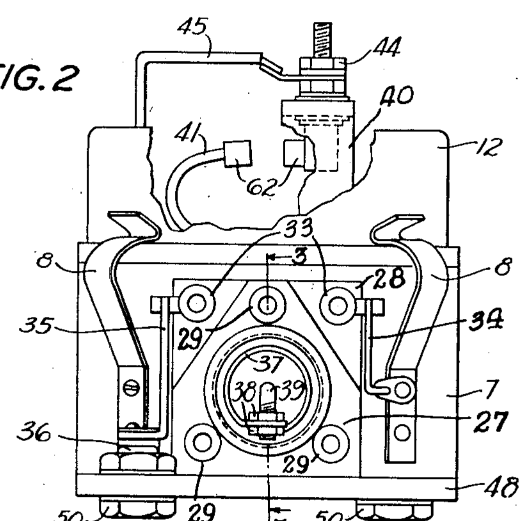

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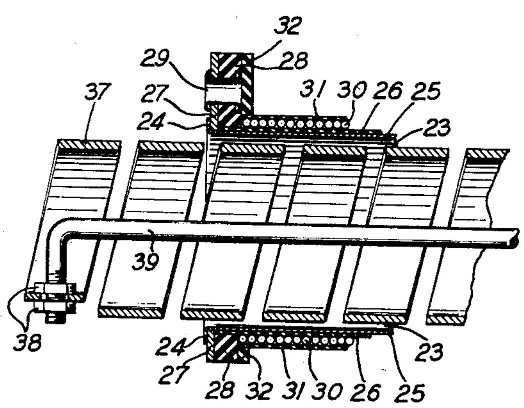
FIG. 3



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UNITED STATES PATENT OFFICE

1,984,514

CONSTANT TEMPERATURE APPARATUS

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Original application September 20, 1928, Serial No. 307,118. Divided and this application February 24, 1930, Serial No. 430,546

3 Claims. (Cl. 219—19)

This invention relates to constant temperature apparatus, and particularly to means for maintaining the temperature of a piezo-electric oscillator, which is used to stabilize the frequency of apparatus associated therewith, constant within narrow limits. This application is a division of my copending application Serial No. 307,118, filed September 20, 1928, for Constant temperature apparatus.

With the increase in the number of radio broadcasting stations in the United States and the consequent increasing propinquity of carrier waves used to disseminate the broadcast signals, it has become more important in order to avoid interference between stations in radio receiving sets, that each station remain on its assigned wave length within narrow limits. This problem has become so acute that it has been made the subject of legislation, so that the stations are now required by law to stabilize their carrier waves within the limits prescribed.

A satisfactory means for attaining this stabilization is found in the use of piezo-electric crystals, preferably of quartz. Since the resonant frequency of such crystals varies with changes in temperature, it is necessary, for precision control, to maintain the temperature of a control crystal constant within very narrow limits.

There are other uses for constant frequencies precisely maintained such, for example, as carrier telephony and telegraphy, and control of sending and receiving apparatus used in television and picture transmission, eliminating the necessity for a synchronization channel. This invention contemplates any use which may be found for constant temperature or constant frequency apparatus.

An object of this invention is to provide apparatus for controlling the temperature of a piezo-electric crystal oscillator or the like which is sufficiently rugged for commercial use, and the inevitable rough and careless handling incident thereto, sufficiently reliable and simple to be satisfactorily supervised and operated by relatively unskilled personnel, sufficiently accurate to maintain a radio broadcasting station on its allotted wave length well within limits prescribed by law, and sufficiently compact to be adaptable for use with existing apparatus within the physical dimensions to which that apparatus is confined in its present location.

Another object of this invention is to provide, in association with an element whose temperature is to be controlled, that is heated by thermal conduction, and a temperature regulating element heated by thermal radiation from the same source, means for compensating variations in the rate of radiation from the heating source due to changes in temperature of the ambient atmosphere.

A feature of this invention is the physical association of elements of a constant heat regulating apparatus, including a thermostatic element, relative to one another in such a manner that part of the thermostatic element is exposed to the ambient atmosphere to compensate variations in the rate of radiation of heat from the heating source to the control element.

Another feature of this invention is the disposition of an element to be heated, on a cylindrical metallic block, and a heating element and temperature regulating element concentrically mounted within said block.

In the drawings, Fig. 1 shows a view of an insulated container for a thermal element, partly broken away to show the thermal element contained therein;

Fig. 2 is a view of the thermal element looking from the lines 2—2 of Fig. 1, partly broken away to show the thermostat contact points at the other end of the thermal element; and

Fig. 3 is an enlarged cross-section along lines 3—3 of Fig. 2 showing the thermostat, the heating element and the details of the heater element construction.

In Fig. 1, a box 1 with cover member 1*a* is adapted to contain a thermal element to be described. On the parting surfaces of the box and the cover therefor, there is a thin layer of laminated phenol fibre 2, or other suitable material, and to prevent air circulation between these two smooth surfaces a soft felt gasket 3 is used. The walls of box 1 are composed of insulating material 4, confined and bounded by sheet metal element 5, which effectively constitutes a pair of concentrically arranged metallic boxes with the interstices filled by the insulating material 4. The outside metallic surface of the box is highly polished nickel plate to keep radiation at a minimum and the inside surface is finished in a dull black to absorb heat and reradiate it, the resultant effect being to keep the temperature of the air surrounding the thermal element at as near the temperature of the thermal element itself as possible. The cover is securely clamped to the base of the insulating box by means of tension bolts 6. It is constructed similarly to the box proper.

The thermal element itself comprises a metallic block 7, to which is secured by means of spring clips 8 a piezo-electric crystal holder 9.

This crystal holder is described in my copending application Serial No. 307,118, filed September 20, 1928, of which this application is a division.

The cylindrical metallic block 7 is provided with a groove 22 adapted to engage a thermometer for measuring its temperature. Concentrically mounted through a hole in the metallic block is a heating organization comprising in part a hollow cylindrical copper core 23, (Fig. 3) the edges of which are turned out at one end, as shown at 24, to provide an abutment for a metallic end piece or head 27. Wrapped around the metallic core are two layers of paper 25, 26 or other insulating material. The ends of the paper are cut on the bias, and it is so wrapped that the outer sharp pointed end will come on the side toward the head 27. The paper is secured at the end by an insulating head 28, which may be slipped over the paper insulation from the opposite end of the cylinder. The heads 27, 28 are securely fastened together by means of eyelets 29 and the ring 28 is counter-bored so that the inner edge of the eyelet does not project beyond its inner surface. Over the two layers of insulation is wound a heating coil 30 of suitable electrical characteristics. Over this coil is wound another layer of paper 31, or other insulating material, and the inner edge of this paper is secured at one end by a ring 32 which slips over the coiled wire and sets flush against the inner surface of the head 28. Through the head 28, which is not co-terminal with elements 27 and 32 and therefore not opposed to them at all points, are secured two eyelets 33, Fig. 2, through which are threaded the ends of the heating coil 30. These ends are connected by leads 34, 35 to the metallic block 7 and the terminal 36 respectively. Mounted in a hole in the block 7, and, if a heating coil as in my above application occupies the same hole, so as to be concentrically disposed with relation to this heating element, is a bimetallic, helical, thermostatic, or heat regulating, element 37, which is adapted to wind or unwind with variations in temperature. Attached to one end thereof by means of nuts 38 is a shaft 39 which extends through the thermostatic element and through a head piece 40, where it is secured to a thermostatic contact element 41 by means of a screw (not shown). The thermostat may be adjusted by means of a screw threaded shaft 42 which may be turned by means of an adjusting rod (not shown) extending through the box 1. This shaft 42 engages the adjusting gear 43 which is secured to the head (not shown) of the thermostatic element by means of a shaft through bearing 55. The thermostat contact points are shown at 62 in Fig. 2. The bimetallic thermostatic element itself forms no part of this invention and is described merely for the purpose of having a complete disclosure of the method of operation of the invention which will be claimed herein. Mounted on the head-piece 40 is a binding post 44, to which may be attached a lead 45 to be connected to a suitable point in an electrical circuit associated with this apparatus or for example a circuit controlling the heater circuit. Attached to a binding post 18 on the crystal holder 9 is a lead 49 which may connect the upper electrode of the crystal by means of connector 46 and binding post 47 to the grid of a three-electrode vacuum tube device, or other suitable point in an associated electrical circuit. This lead may alternatively connect to connector 56 and binding post 57 for mounting in the reverse position.

The cylindrical metallic block 7 is mounted on an insulating base 48 to which it is secured by means of screws. Mounted in the base 48 are three jacks 50 adapted to engage plugs 54 on a mounting block 51 for connection to suitable points in the electrical circuit associated with the heating unit at binding posts 52 on the outside of the insulated box 1. The leads are connected to binding posts 52 through tube 61.

In a preferred connection of the device herein described to an associated electrical circuit, lead 49 connects the upper electrode of the piezo-electric crystal plate to the grid of a three-electrode thermionic device. The bottom electrode is connected to a suitable point in the circuit through metal block 7, which is grounded, connection being through tube 61 and one of the binding posts 52. The metal block is also a ground connection for the circuit through the heater element, the other connection being through lead 35, terminal 36, jack 50, plug 54, conductor through tube 61 to another of the binding posts 52. The thermostat contacts 62 are in another circuit, one side of which is grounded by connection to the metal block and the other side of which is connected to a circuit through leads to a jack 50, plug 54, and connector through tube 61 to binding post 52. The electrical circuits associated with this apparatus constitute no part of this invention.

In the operation of the heating unit per se it is necessary to keep the metallic block 7 at a constant temperature. As before noted the temperature of the air within the metallic box is kept as near to the temperature of the metallic block as possible by polishing the outside of this box to prevent radiation to the outer air and finishing the inside in a dull black to absorb and reradiate heat within. The metallic block should have a uniform temperature throughout and to accomplish this it must not be allowed to cool off rapidly at the outside. It is therefore finished with a highly polished nickel plate to keep radiation at a minimum and the rate of radiation is kept constant by means of a chromium flashing over the nickel plate, which prevents corrosion or dulling of the polished surface. The metallic block 7 is heated by conduction from the heating element while the thermostatic element is heated by radiation. This arrangement is desirable as there should be as little thermal lag as possible between the heater and the thermoregulator. Heat loss from the block does, however, occur on account of the temperature gradient between the block and the ambient atmosphere, this tending to lower the temperature of the block. What loss that does occur from the metallic block and especially a variation of such loss must be compensated for, and this is accomplished by exposing one end of the thermostatic element beyond the end of the heater so that it will be affected by the ambient temperature. When the air surrounding the metallic block becomes considerably cooler than the metallic block itself, the block will tend to become cooler, this indicating the necessity of a greater cyclic interval of inflow of heat to the heated element to maintain it at a stable temperature. This effect is achieved since one end of this thermostatic element is exposed to this atmosphere, which is cooler, and is therefore affected oppositely to the remainder of the element. The change in the rate of radiation from the block is thereby compensated.

It is contemplated that with this apparatus the temperature of a quartz plate may be controlled within .1° C. and the frequency of an oscillator associated therewith controlled within 30 cycles in one million, in commercial operation.

What is claimed is:

1. The method of compensating a temperature responsive element for changes in the rate of heat loss from an element to be maintained at constant temperature, which comprises heating said last mentioned element by conduction from a heating element surrounded thereby and in intimate heat association therewith, heating the temperature responsive element by radiation from the heating element, and positioning said responsive element so as to be partially within the circumscribing boundary of the heating element and in as close physical proximity thereto as possible and partially outside said circumscribing boundary, so that radiation from the heating element affects substantially only the portion within the circumscribing boundary and only the portion outside such circumscribing boundary is affected by the temperature of the ambient atmosphere.

2. A device for maintaining electrical oscillations constant, comprising a metallic block, a helically shaped heating element for said block in heat conductive contact therewith, and a heat regulating element, said heat regulating element being of helical form and concentrically disposed with relation to said heating element and in close proximity thereto, a portion being within the circumscribing boundary of said heating element so as to be exclusively affected by the radiation from the heating element and the remaining portion extending into the ambient atmosphere outside of said boundary so as to be exclusively affected by the temperature of the ambient atmosphere, and to such a distance as to enable the said regulating element to compensate for variations in temperature of said ambient atmosphere.

3. In combination, a metallic block with a highly polished surface, a heating element and a heat controlling element both in heat transfer relation to said block and extending through said block and in mutually concentric relation, said controlling element projecting beyond the circumscribing boundary of said block such a distance as to enable it to compensate for variations in temperature of the ambient atmosphere, the portions of said controlling element within and without the boundary of said block being adapted to individually function with respect to the temperature of said heating element and the temperature of the ambient atmosphere, respectively, and a metallic box surrounding the previously recited structure and having a dull black finish on the inside surface and a highly polished outside surface.

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