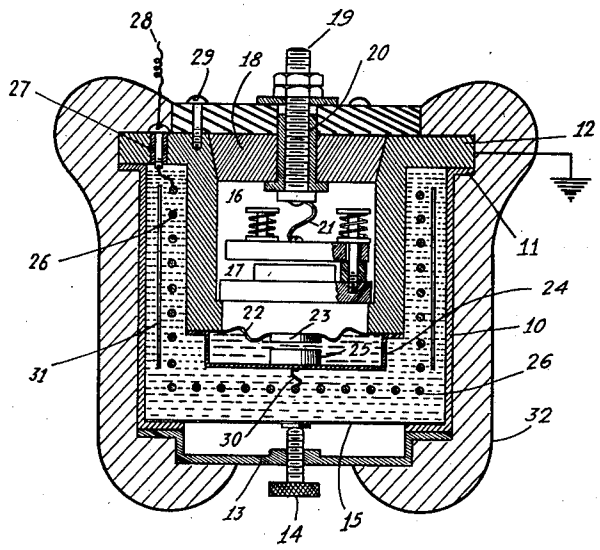
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THERMOSTAT

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INVENTOR
JAMES W. CONKLIN
BY
ATTORNEY

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JAMES W. CONKLIN, OF ROCKY POINT, NEW YORK, ASSIGNOR TO RADIO CORPORATION OF AMERICA, A CORPORATION OF DELAWARE

THERMOSTAT

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This invention relates to the art of temperature control and deals more specifically with a thermo-control device for maintaining an enclosure at a substantially constant temperature and more specifically with a means for maintaining a piezo-electric crystal resonator at a substantially constant temperature.

It is well known in the piezo-electric art that variations in temperature of a piezo-electric frequency control element, used in connection with a radio transmission system, produce certain definite and undesirable variations in frequency of that system. It has therefore been proposed heretofore to provide the crystal control element with means to minimize variations in temperature of the crystal element during its operation. These temperature control devices of the prior art have been large and cumbersome devices, which occupy considerable space and which are particularly undesirable in connection with mobile radio apparatus such as that used on aircraft, for example. Also, in connection with radio transmission systems utilizing more than one crystal element it has been found desirable in practice to provide each of the crystal elements with a separate temperature control device. This necessitates the use of several bulky temperature control devices, one for each crystal element, with the result that there is a great waste of auxiliary space, and with the further disadvantage of involving complicated control circuits.

It is therefore an object of this invention to provide a temperature control device for a piezo-electric resonator which device is of compact structure and of higher efficiency in operation.

Also, in connection with temperature control devices of the prior art, utilizing some means for turning the heating element on and off either partially or wholly, in accordance with the temperature variations, it has been found that the most suitable results are obtained when the operating temperature variations are so slight as to be inappreciable. It has been found, as a practical matter, that the more the on and off over-travel of the heater is limited, the better will the temperature regulation be. It has also been found that the amount of over-travel can be materially reduced by putting the heater element in as intimate contact as possible with the temperature responsive device.

It is therefore a further object of this invention to construct a temperature control device in which the heater element and temperature responsive device are enclosed in a unitary structure.

And it is a further object of this invention to provide a temperature control device which is immersed in a bath of a suitable liquid completely enclosed in a vessel and arranged to exert a hydro-static pressure upon this vessel, which pressure is due to temperature variations of the liquid, whereby to actuate the means for turning on or off the heating element.

These and other objects of the invention will be readily apparent to those skilled in the art from the following description taken in connection with the accompanying drawing in which the single figure is a cross-sectional view of a device constructed in accordance with the principles of this invention.

Referring in detail to the drawing, the temperature control device is seen to comprise a cylindrical casing 10 provided with an annular flange 11 upon which is supported a metal block 12. A bottom wall 13 rigidly jointed to the casing 10 carries an adjusting screw 14 threaded through the wall 13 and contacting adjustably with a heavy diaphragm 15 which, together with the casing 10, forms a closed vessel. The block 12 is shaped to fit within the casing 10 as shown and is provided with a cavity 16 into which the crystal and its mounting 17 are placed. A cover 18 serves completely to enclose the crystal and its housing 17. A terminal 19 insulated from the cover 18 by a bushing 20 connects with one terminal of the crystal housing 21. A second similar terminal may be provided by grounding the block 12 at G. It will be understood that the details of the crystal housing and mounting form no part of the present invention but that any suitable crystal mounting may be used. The side walls 12*a* of the block 12 are provided

with shoulders 12*b* which serve as a support for the housing 17. Mounted across the bottom of the walls 12*a* is a flexible diaphragm 22 which carries upon its bottom face a contact point 23. A bracket 24 is attached to the block 12 and supports a second contact point 25. Obviously the bracket 24 may be made of insulating material, or, it may be of metal, and the contact 25 insulatingly supported thereon in a manner in any of several ways well known to the art. Any suitable resistance coil 26 for heating may be mounted between the block 12 and the cylinder 10. An insulating bushing 27 carrying the lead 28, which passes through the bushing in water-tight relation therewith, serves as one of the terminals for connecting the heating element to an electric current source. The other terminal is the screw 29 which is embedded in the block 12 and makes contact through the wall 12*a*, the diaphragm 22, and the contact point 23. A conductor 30 connects the terminal 25 with the resistance coil 26. A cylindrical baffle 31 is provided, if necessary, to induce the thermo-siphon effect for stimulating the circulation and uniform distribution of the heated liquid. The entire device may be packed in any suitable heat insulating material 32 to reduce heat losses. A cover plate 33 of any suitable electrical and heat insulating material is mounted on the top of the device as shown in the drawing. Within the space between the block containing the crystal element and the casing 10 there is placed a suitable amount of liquid having a high thermal coefficient of expansion as well as suitable electrical and chemical properties. Benzene may be used advantageously for this purpose, but it is understood, of course, that many other solutions having the desired property may be used with equal facility.

The operation of this device is as follows: The resiliency of the diaphragm 22 normally presses the contact 23 against the contact 25 whereby to close the electrical circuit 28, 26, 30, 25, 23, 22, 12*a*, 29, which connects the heating coil to the source of electrical energy.

When the liquid has been heated to the desired temperature it expands sufficiently to cause a pressure on the diaphragm 22 which will lift the contact 23 out of connection with the contact 25, thereby breaking the heater circuit. As soon as the temperature of the liquid has again fallen to the point where the liquid contracts sufficiently to permit the diaphragm 22 to fall, the heating circuit will again be closed through the contacts 23 and 25.

In the device as described, the pressure variations are arranged to fully open and close the contacts. It is also possible to utilize the pressure variations to regulate the heating current in such a manner that the heating current would vary with the hydrostatic pressure. This could be accomplished by replacing the contacts with a pair or series of discs of such substance that the contact resistance will vary with pressure.

Another variation would be to have the contacts actuate an external relay and under such an arrangement, an increase in pressure may act either to open or close the contacts.

It will be understood that the specific illustration given in the foregoing description is for the purpose of furnishing a practical example of the application of the principles of this invention. Many variations will readily suggest themselves to those skilled in the art.

Having thus described my invention, I claim:

1. A temperature control apparatus for a piezo-electric device comprising an outer casing, an inner casing within said outer casing, both of said casings being mounted with respect to each other to provide a closed chamber, a body of liquid contained in said chamber, means to heat said liquid, and means responsive to the expansion, and contraction of said liquid to control said heating means, said inner casing having means to receive and support the said device.

2. A temperature control apparatus for a piezo-electric device comprising an outer casing, an inner casing within said outer casing, both of said casings being mounted with respect to each other to provide a closed chamber, means to vary the cubical content of said chamber, a body of liquid contained in said chamber, means to heat said liquid, and means responsive to the expansion and contraction of said liquid to control said heating means, said inner casing having a chamber to receive and support the said device.

3. A temperature control apparatus for a piezo-electric device comprising an outer casing, said casing being provided with a yieldable wall, adjustable means for distending said wall, an inner casing, said inner casing also being provided with a yieldable wall, both of said casings being mounted with respect to each other to provide a closed chamber, a body of liquid contained in said chamber, means to heat said liquid, and means including said last yieldable wall responsive to the expansion and contraction of said liquid to control said heating means, said inner casing having a chamber to receive the said device.

4. A temperature control apparatus for a piezo-electric device comprising an outer casing, an inner casing, both of said casings being mounted with respect to each other to provide a closed chamber, a body of liquid contained in said chamber, means mounted within said chamber to heat said liquid, and means responsive to the expansion and contraction of said liquid to control said heating

means, said inner casing having means to receive and support the said device.

5. A temperature control apparatus for a piezo-electric device comprising an outer casing, an inner casing, both of said casings being mounted with respect to each other to provide a closed chamber, a body of liquid contained in said chamber, means to heat said liquid, a baffle plate mounted in said chamber to cause circulation of liquid therein whereby uniform temperature of the liquid throughout said closed chamber may be obtained, and means responsive to the expansion and contraction of said liquid to control said heating means, said inner casing having a chamber to receive the said device.

6. A temperature control apparatus for a piezo-electric device comprising an outer casing, an inner casing, both of said casings being mounted with respect to each other to provide a closed chamber, means associated with said outer casing to vary the cubical content of said chamber, a body of liquid contained in said chamber, means to heat said liquid, a baffle plate mounted in said chamber, and means responsive to the expansion and contraction of said liquid to control said heating means, said inner casing having a chamber to receive the said device.

7. A temperature control apparatus for a piezo-electric device comprising an outer casing, said casing being provided with a yieldable wall, adjustable means for distending said wall, an inner casing, both of said casings being mounted with respect to each other to provide a closed chamber, a body of liquid contained in said chamber, means to heat said liquid, a baffle plate mounted in said chamber to cause circulation of liquid therein whereby uniform temperature of the liquid throughout said closed chamber may be obtained, and means responsive to the expansion and contraction of said liquid to control said heating means, said inner casing having a chamber to receive the said device.

8. A temperature control apparatus for a piezo-electric device comprising an outer casing, an inner casing, both of said casings being mounted with respect to each other to provide a closed chamber, a body of liquid contained in said chamber, means mounted within said chamber to heat said liquid, a baffle plate mounted in said chamber to cause circulation of liquid therein whereby uniform temperature of the liquid throughout said closed chamber may be obtained, and means responsive to the expansion and contraction of said liquid to control said heating means, said inner casing having a chamber to receive and support the said device.

9. A temperature control apparatus for a piezo-electric device comprising an outer casing, an inner casing, both of said casings being mounted with respect to each other to provide a closed chamber, a body of liquid contained in said chamber, means to heat said liquid, means responsive to the expansion and contraction of said liquid to control said heating means, said inner casing having a chamber to receive the said device, and heat insulating means surrounding said apparatus.

10. In a temperature control apparatus having heating means adapted to be turned on or off intermittently, means to control said heating means, said means comprising in combination, an outer wall, an inner wall joined thereto and forming therewith a closed chamber, a body of liquid having a predetermined coefficient of thermal expansion enclosed in said chamber, means to control the temperature of said liquid, said liquid exerting variable hydrostatic pressures upon said walls in accordance with its expansion and contraction with temperature changes, means responsive to the pressure exerted upon said walls to actuate said second mentioned means, and additional means to adjust the said hydrostatic pressures.

11. In a temperature control apparatus having heating means adapted to be turned on or off intermittently, means to control said heating means, said means comprising in combination, an outer wall, an inner wall joined thereto and forming therewith a closed chamber, a body of liquid having a predetermined coefficient of thermal expansion enclosed in said chamber, means to control the temperature of said liquid, said liquid exerting variable hydrostatic pressures upon said walls in accordance with its expansion and contraction with temperature changes, said temperature controlling means including an electrical circuit having relatively movable contact points, means responsive to said hydrostatic pressures to actuate said points, whereby to turn said heating means on and off, and additional means to adjust the said hydrostatic pressures.

12. A temperature control apparatus for providing a substantially constant temperature enclosure comprising an outer casing, an inner casing within said outer casing, both of said casings being mounted with respect to each other to provide a closed chamber, a body of liquid contained in said chamber, means to heat said liquid, and means responsive to the expansion and contraction of said liquid to control said heating means, said inner casing having a chamber to receive and support the device whose temperature it is desired to control.

JAMES W. CONKLIN.