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TEMPERATURE CONTROL APPARATUS

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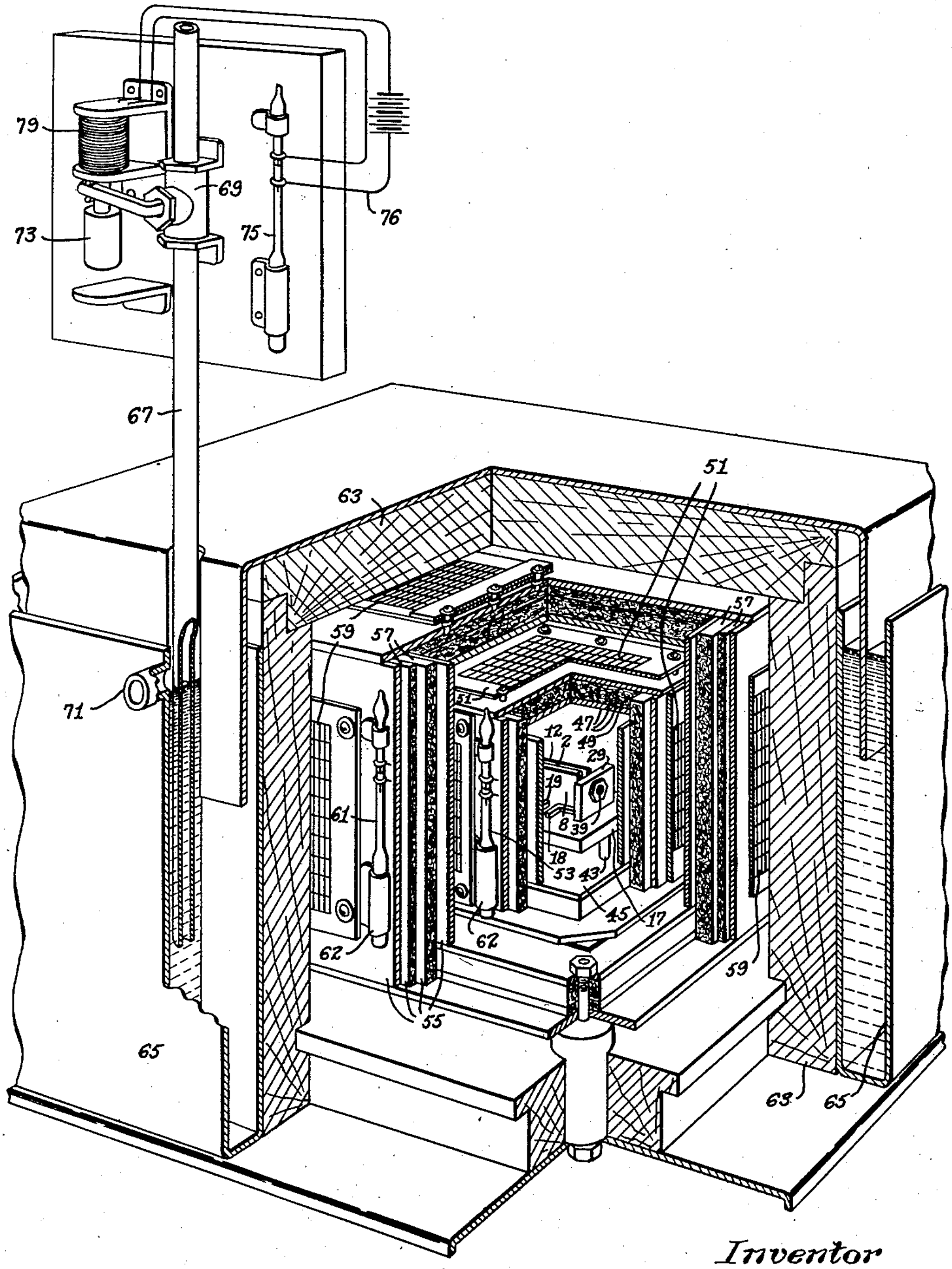

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TEMPERATURE CONTROL APPARATUS

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19 Claims. (Cl. 257—3)

The present invention relates to temperature-controlled apparatus, and more particularly to temperature-controlled housings for electromechanical vibrators, like piezo-electric crystals.

The dimensions and the elasticity of piezo-electric crystals, like those of other bodies, vary with changes in temperature. Such variations, in turn, introduce changes in the frequency of the crystal.

It is therefore an object of the present invention to provide a new and improved housing device that shall be maintainable at substantially constant temperature.

Another object is to provide a new and improved temperature control for an electromechanical vibrator.

A further object is to provide a novel system for preventing the temperature of the housing device rising above or falling below predetermined values.

Other and further objects will be explained hereinafter and will be particularly pointed out in the appended claims.

The invention will now be explained in connection with the accompanying drawing, the single figure of which is a perspective illustrating a preferred embodiment of the invention, parts being broken away, for clearness.

A rectangular quartz plate 2 is illustrated in the center of the figure, resting upon an insulating base 17, between parallel conducting electrodes 8 and 12, suitably connected in an electric circuit (not shown). For adjustment purposes, the electrodes 8 and 12 may be provided with projections 18 and 19. Supports 29 are disposed on the base 17 near the ends of the crystal and are adapted to be adjusted towards and from the crystal ends. The supports 29 each carries a threaded shaft 39 the end of which supports a baffle plate (not shown) disposed parallel and near to the corresponding end face of the crystal. It is thus rendered possible to adjust the electrodes 8 and 12 toward and from the sides of the crystal, and the baffle plates towards and from the end faces of the crystal, and all without disturbing the crystal. The advantages of this construction are fully described in application Serial No. 571,930, filed October 29, 1931, of which the present application is a division. The present application is restricted to the temperature-controlled, enclosing structure. The said parent application is directed to the oscillator-holder assembly.

The insulating base 17 may be provided with legs 43 adapted to rest freely upon a felt layer 45 or the floor of a housing or container 47 which entirely encloses the crystal. If desired, of course, the legs may be firmly fixed to the floor of the housing. The housing 47 may contain also other apparatus, such as the vacuum tubes of the crystal oscillator. The baffle plates (not shown) are separate from the housing and may be adjusted independently of the housing. The crystal operates wholly independently of the housing in which it is placed.

The walls 49 of the housing may be of heat-insulating or attenuating material, like asbestos, disposed between layers or walls of heat-distributing material, like aluminum, having a relatively low heat capacity and high conductivity, and may carry heating resistors 51, adapted to be connected into and out of an electric circuit (not shown) by a mercury switch 53. As soon as the temperature falls below a predetermined value, the circuit of the heating resistors 51 will become closed by the mercury switch 53 to generate or supply heat to the housing; and it will become opened again when the temperature rises too high. This heating circuit may become opened and closed directly, or through relays, not shown.

The housing 47 is disposed in a second or outer housing 55 the walls 57 of which are likewise constituted of one or more layers of heat-insulating material carrying heating resistors 59. The temperature of the second housing is similarly maintained within predetermined limits by a second mercury switch 61. In this manner, the permissible change of temperature of the inner housing 47 is maintained to within smaller limits than might otherwise be the case, and "hunting" or "overshooting" is, to a very great degree, prevented.

The supply of heat to the housing is thus regulated so that the crystal 2 is maintained at substantially constant temperature during operating periods, notwithstanding variations of temperature of the ambient atmosphere outside the housing. The frequency of oscillation of the crystal is thus rendered independent of atmospheric conditions outside the housing.

It will be noted that the thermostatic switches 53 and 61 are disposed outside the spaces the temperatures of which they regulate, though preferably in intimate contact with the aluminum walls on the outside surfaces of the corresponding housings, preferably in aluminum pockets 62 secured to the aluminum walls. This construction allows the mercury switches quickly and accurately to take the temperature of the aluminum walls, giving more accurate control. The temperature of the air in the temperature-controlled space will not rise and fall by the amount required to operate the mercury switches because of the heat storage and attenuation in the container walls. Preferably, the thermostatic switches are disposed between the walls to which they are attached and the heating resistors carried by those walls.

As the temperature within the housings 47 and 55 is thus regulated entirely by the addition of heat, the operating temperature must be substantially higher than the highest room temperature under which the control is to be maintained. The temperature to which a quartz vibrator may be subjected, on the other hand, should not be too high. It should be only so high as can be maintained successfully. It is found, in practice, that, in temperate climates, an operating temperature of about 122 degrees F. is very satisfactory for the inner housing 47.

The heat radiated through a wall or housing depends upon the difference in temperature between the two sides of the wall. Satisfactory control, furthermore, can not be maintained by means of thermometer switches, or similar devices, unless heat is radiated from the controlled space with sufficent rapidity to cause the regular and recurring operation of the thermometer switches.

To protect the controlled space from variations in temperature due to sudden changes in ambient temperature, it is necessary to insulate the entire assembly from the room temperature. This also economizes on the energy required, particularly if the room temperature becomes low. A differential of at least 5 degrees C. may be required, as shown by experience, to insure proper operation of each unit. Assuming, then, that the space in the inner housing 47 is maintained, through the action of the inner heaters 51, as controlled by the inner thermometer switch 53, at a temperature of 122 degrees F. (50 degrees C.), the temperature of the outer unit, as maintained by the outer switch 61 and the outer heaters 59, may be fixed at not over 45 degrees C. (112 degrees F.). Allowing a further differential of at least 5 degrees C. between the temperature of the outer unit and the room temperature to insure proper operation of the outer system 55, the maximum room temperature at which satisfactory and reliable control of the entire assembly may be obtained may thus be brought down to approximately 40 degrees C. (102 degrees F.). As the heat lost decreases rapidly as the room temperature rises, the operation of the unit begins to be affected at 95 degrees F.

When the room temperature is in the range from 95 degrees F. and higher, the operation of the temperature control is impaired unless means are provided to keep the heat lost from the unit at more nearly normal. This could successfully be accomplished by raising the operating temperature, but this is ruled out by considerations having nothing to do with temperature control. Means are therefore provided for cooling the outer walls to a point roughly in the range of normal room temperatures.

An outermost housing 63 is provided, also of heat-insulating material, such as balsa wood. The housing 63 is surrounded by a water tank 65, into which water may be supplied by a water pipe 67, through a valve 69. An overflow is shown at 71. A weight 73 normally keeps the valve 69 closed. When the temperature gets high enough, a mercury switch 75 will close a circuit 76 to energize a solenoid coil 79, thereby acting to open the water valve 69; and when the temperature is lower, the mercury switch 75 will open the circuit 76 of the coil 79, permitting the weight 73 to close the valve 69, thereby shutting off the water supply when the temperature falls below the critical, predetermined value. The mercury switch 75 may be set for an air temperature just below that at which the temperature-control unit fails to function,—say, 95 degrees F. Where ordinary tap water is employed, its temperature may range from 40 degrees F. to 70 degrees F.—that is, in the representative room-temperature range. The water will naturally be ordinarily at lower temperature than the air and will thus allow sufficient loss of heat from the unit to permit the thermostatic switches 53 and 61 to effect their contact.

More heat is, of course, required to operate with the cooling means in use since, obviously, if the room temperature were 122 degrees F., no heat would be required to maintain the unit at 122 degrees F. The heat required is, however, no more and no less than would be required if the room temperature were the same as the water temperature.

Though energy is thus expended in heat energy for the sole purpose of maintaining the temperature constant, the expenditure is justified, since it accomplishes this purpose. Efficiency is hardly to be considered as an economic issue. The cost of operation of such a unit as that described is, furthermore, very small—only two or three times the cost of running an electric clock. The degree of insulation between the unit and the room largely governs the economic aspect—simply as to whether a small amount of heat confined where wanted serves the purpose, instead of a large amount of heat much of which is used to heat up the room.

Access to the units may be obtained in any desired way, as by hinging the tops to the side walls of the respective housings, or arranging the tops to be completely removable. The tops should be closed in such a manner, however, as to provide a hermetic seal to prevent free passage of atmosphere to and from the housings. The selected, operating, resonant frequency of the crystal 2 will then be maintained substantially constant. The electrodes 8 and 12 of the crystal may be electrically connected in an electric circuit to outside terminals in any desired way.

It will, of course, be understood that the invention is not restricted to the exact embodiment thereof that is illustrated and described herein, as modifications may be made by persons skilled in the art, and all such are considered to fall within the spirit and scope of the invention, as defined in the appended claims.

What is claimed is:

1. Apparatus comprising two housings, one within the other, means for preventing the temperatures within each of the housings from rising or falling from predetermined values, the temperature within the inner housing being higher than that within the outer housing, an outermost housing in which the other housings are disposed, and means for preventing the temperature of the outermost housing rising above a predetermined value.

2. Apparatus comprising two housings, one within the other, means for preventing the temperatures within each of the housings from rising

or falling from predetermined values, the temperature within the inner housing being higher than that within the outer housing, a water tank for cooling the external wall of the outer housing when the temperature of the air exceeds a predetermined value, and means for shutting off the water when the temperature falls below this value.

3. Apparatus comprising two housings, one within the other, and means for preventing the temperatures within each of the housings from rising or falling from predetermined values, the said means comprising thermometer switches disposed outside the respective housings, and the temperature within the inner housing being higher than that within the outer housing.

4. Apparatus comprising two housings, one within the other, and means for preventing the temperatures within each of the housings from rising or falling from predetermined values, the temperature within the inner housing being higher than that within the outer housing, the walls of the housings comprising a heat-attenuating material disposed between layers of heat-distributing material.

5. Apparatus comprising two housings, one within the other, means for preventing the temperatures within each of the housings from rising or falling from predetermined values, the temperature within the inner housing being higher than that within the outer housing, a water tank for cooling the external wall of the outer housing, and means for supplying water to the tank when the temperature of the air exceeds a predetermined value.

6. Apparatus comprising two housings, one within the other, thermometer switches disposed outside the respective housings for preventing the temperatures within each of the housings from rising or falling from predetermined values, the said temperature within the inner housing being higher than that within the outer housing, an outermost housing in which the other housings are disposed, and means for preventing the temperature of the outermost housing rising above a predetermined value.

7. Apparatus comprising two housings, one within the other, and means for preventing the temperature of the inner housing from rising or falling from a predetermined value, the said means comprising a thermometer switch the sensitive part of which is disposed in direct contact with the outside surface of the inner housing so as to be directly responsive to the temperature of said outside surface.

8. Apparatus comprising two housings, one within the other, the outside surface of the inner housing being constituted of heat-conducting material, and means for preventing the temperature of the inner housing from rising or falling from a predetermined value, the said means comprising a thermometer switch the sensitive part of which is disposed in direct contact with said outside surface so as to be directly responsive to the temperature of said outside surface.

9. Apparatus comprising two housings, one within the other, the outside surface of the inner housing being constituted of heat-conducting material, and means for preventing the temperature of the inner housing from rising or falling from a predetermined value, the said means comprising a heater disposed between the inner and outer housings, and a thermometer switch the sensitive part of which is disposed in direct contact with said outside surface so as to be directly responsive to the temperature of said outside surface for controlling the heater.

10. Apparatus comprising a plurality of housings, one within another, the outside surfaces of two of the housings being constituted of heat-conducting material, and means for preventing the temperatures within each of the said two housings from rising or falling from predetermined values, the said means comprising a thermometer switch disposed on each of said outside surfaces so as to be respectively responsive to the temperature of the corresponding housing.

11. Apparatus comprising three housings, one within another, and means for preventing the temperatures within each of the two inner housings from rising or falling from predetermined values, the said means comprising heaters disposed between each two of said three housings and means responsive to the temperatures of the two inner housings for respectively controlling the heaters.

12. Apparatus comprising three housings, one within another, the outside surfaces of the two inner housings being constituted of heat-conducting material, and means for preventing the temperatures within each of the two inner housings from rising or falling from predetermined values, the said means comprising heaters disposed between each two of said three housings and a thermometer switch disposed on each of said outside surfaces so as to be respectively responsive to the temperature of the two inner housings for respectively controlling the heaters.

13. Apparatus comprising two housings, one within the other, two heating means, one for heating each of the housings, means for controlling the heating means for the outer housing to prevent the temperature within said outer housing from rising or falling from a predetermined value, and means for controlling the heating means for said inner housing to prevent the temperature within said inner housing from rising or falling from a predetermined value that is higher than that within the outer housing.

14. Apparatus comprising a plurality of housings, one within another, two heating means, one for heating each of two of the housings, means for controlling the heating means for the outer of the said two housings to prevent the temperature within said outer housing from rising or falling from a predetermined value, and means for controlling the heating means for said inner housing to prevent the temperature within said inner housing from rising or falling from a predetermined value that is higher than that within said outer housing.

15. Apparatus comprising two housings, one within the other, two heating means, one for heating each of the housings, means for controlling the heating means for the outer housing to prevent the temperature within said outer housing from rising or falling from a predetermined value, and means for controlling the heating means for said inner housing to prevent the temperature within said inner housing from rising or falling from a predetermined value that is higher than that within the outer housing, the walls of the housings comprising a heat-attenuating material disposed between layers of heat-distributing material.

16. Apparatus comprising two housings, one within the other, the outside surface of the inner housing being constituted of heat-conducting material, means for heating the inner housing, and means for controlling the heating means to pre-

vent the temperature of the inner housing from rising or falling from a predetermined value, the said means comprising a thermometer switch the sensitive part of which is disposed in direct contact with said outside surface so as to be directly responsive to the temperature of said outside surface.

17. Apparatus comprising two housings, one within the other, the outside surfaces of the housings being constituted of heat-conducting material, two heating means, one for each of the housings, means for controlling the heating means for the outer housing to prevent the temperature within said outer housing from rising or falling from a predetermined value, and means for controlling the heating means for said inner housing to prevent the temperature within said inner housing from rising or falling from a predetermined value that is higher than that within the outer housing, the said means comprising a thermometer switch disposed on each of said outside surfaces so as to be respectively responsive to the temperature of the corresponding housing.

18. Apparatus comprising two housings, one within the other, the outside surface of the inner housing being constituted of heat-conducting material, means for heating the inner housing, and means for controlling the heating means to prevent the temperature of the inner housing from rising or falling from a predetermined value, the said means comprising a heater disposed between the inner and outer housings and a thermometer switch disposed on said outside surface so as to be responsive to the temperature of said inner housing.

19. Apparatus comprising a plurality of housings, one within another, means for heating two of the housings, and means for each of said two housings located outside of the respective two housings for independently preventing the temperatures within each of the said two housings from rising or falling from predetermined values, the temperature within the inner of the said two housings being higher than that within the outer of the said two housings.

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