March 19, 1935. L. L. YOUNG ET AL 1,994,740

PIEZO ELECTRIC CRYSTAL HOLDER

Original Filed Oct. 15, 1931

Fig. 1

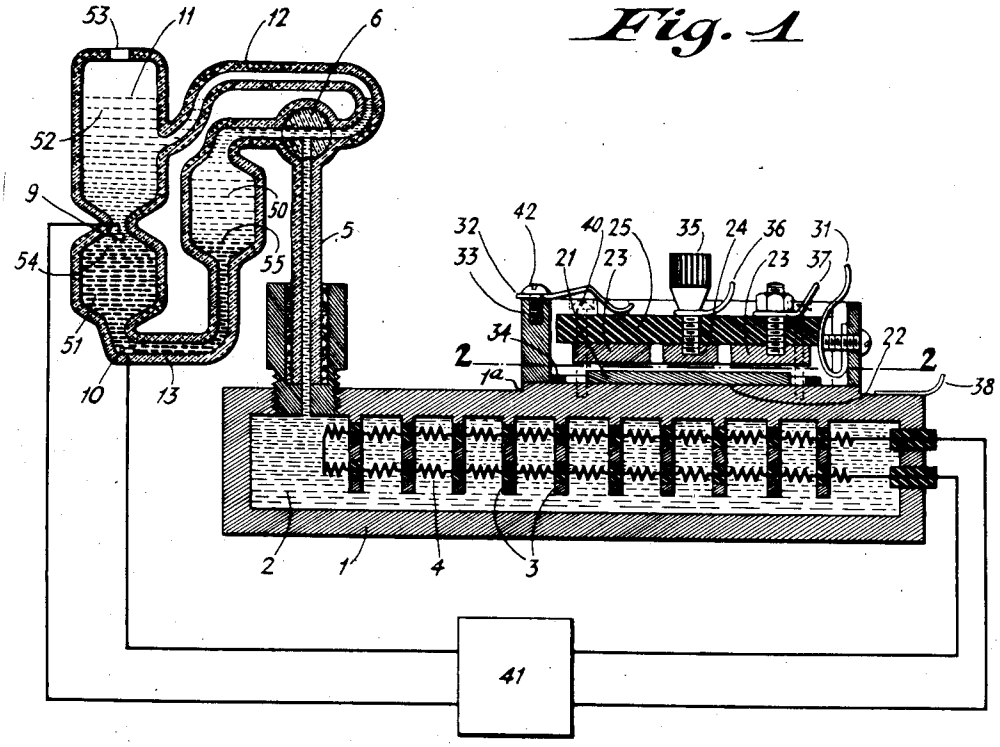
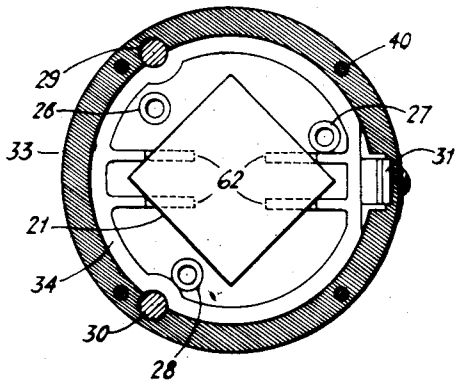


Fig. 2



INVENTORS
JAMES L. FINCH
BY LLOYD L. YOUNG
ATTORNEY-

Patented Mar. 19, 1935

1,994,740

UNITED STATES PATENT OFFICE

1,994,740

PIEZO-ELECTRIC CRYSTAL HOLDER

Lloyd Lee Young and James Leslie Finch, Patchogue, N. Y., assignors to Radio Corporation of America, a corporation of Delaware

Original application October 15, 1931, Serial No. 568,962. Divided and this application February 9, 1933, Serial No. 655,938

6 Claims. (Cl. 171—327)

This invention relates to a piezo-electric crystal holder which is particularly adapted to apparatus for controlling the temperature of the crystal.

This application is a division of our copending application, Serial No. 568,962, filed October 15, 1931.

An object of this invention is to simplify and improve piezo-electric crystal holders, and also to insure maintenance of accurate temperature control of the crystal.

Piezo-electric crystals are frequently employed in radio signal transmitters for controlling the frequency of high frequency oscillators. It has been found that these crystals, in order to function properly, must be maintained at substantially constant temperature. Heretofore it has been customary in order to control the temperature of the piezo-electric crystal to enclose the crystal in a receptacle and to regulate the temperature of the air within the container. In such case, the heat liberated by the crystal resonator while vibrating is conducted to the walls of the receptacle through the medium of the air within the container. Since air is a poor conductor of heat it has been found that the crystal, frequently, is at a much higher temperature than the receptacle. Conversely, when the receptacle is heated by a heating unit, the crystal is, for an appreciable length of time, at a lower temperature than the walls of the container, due to the poor conducting qualities of the air within the receptacle. These differences of temperature between the crystal element and the receptacle have been found to affect, to a degree at least, the operating properties of the piezo-electric crystal resonator. In accordance with the present invention, a temperature regulating system is provided which entirely avoids such temperature differences.

It is also known that piezo-electric crystals in the state of oscillation vibrate vigorously and tend to move from their normal position between their electrodes. Inasmuch as the frequency of oscillation of the crystal is affected by its position between its electrodes it is a desideratum that for good frequency stability the position of the crystal be fixed. This tendency of the crystal to move while vibrating is appreciably diminished, if not entirely overcome, in accordance with one feature of this invention which prevents movement of the crystal from its fixed position. This feature resides in the aparatus employed to hold the crystal in fixed relation with respect to its electrodes.

In accordance with this invention, the temperature of a piezo-electric crystal resonator is controlled by utilizing one wall of a metallic block as one of the crystal electrodes. A fluid, contained within the block, is caused to control a circuit device by the variations in temperature of the crystal and block, in turn, controlling the flow of current in the apparatus.

One advantage of the present invention is that there is no substantial difference in temperature between the piezo-electric crystal resonator and the walls of the cell or block. This is due to the fact that one of the electrodes of the frequency control device forms an integral part of the cell wall.

Another advantage of this invention is that the temperature of the system can fall materially far below or rise far above the operating temperature at which the system is designed to function without destroying the calibration of the control element.

Other objects, features and advantages will appear in a subsequent detailed disclosure.

Referring now to the drawing,

Fig. 1 is a longitudinal cross-section of the piezo-electric crystal holder and its associated temperature controlling apparatus;

Fig. 2 is a plan view partly in section of the crystal holder, the section being taken on lines 2—2 of Fig. 1. This view illustrates the manner in which the crystal is held firmly in position by the prongs extending inwardly from the crystal housing.

In Fig. 1 is shown a piezo-electric crystal resonator mounted directly on a metallic block 1, which is filled with a non-electrical conducting fluid 2. This fluid may be any suitable non-conducting fluid such as castor oil, kerosene and ether, which are herein mentioned only as being illustrative of any fluid which may be used. Metallic fins 3 extend downwardly from one surface of the block 1 into the fluid 2. A large surface of contact is thus provided between the block and the fluid which tends to prevent any appreciable difference in temperature between these two elements. For heating the unit a heater wire 4 is provided which connects with a source of current supply. This heater wire is supported by the metallic fins 3 and insulated therefrom. The heating element or wire may comprise any means known to the art and is not limited to the exact form shown in the drawing. In the particular embodiment illustrated in the drawing, a 220 volt source of supply was connected to the electrical resistance element 4.

Attached to block 1 by means of the tube 5 are a plurality of glass chambers, 50, 51 and 52, which are adapted to communicate with block 1 by means of cock 6 and tube 5. Chamber 52 is provided with an opening 53 leading directly to the atmosphere. The purpose of this opening will be described later. This chamber is filled with the fluid 2 to the level 11. Chamber 51 connected to chamber 52 by tubing is provided with a heavy electrical conducting fluid such as mercury, which is adapted to complete an electrical circuit between metallic plates 9 and 10, extending through the glass walls, whenever the heavy fluid makes contact with both plates simultaneously. The level of the mercury being indicated at 54 in chamber 51 and 55 in the chamber 50, a position which is just slightly below the upper contact in chamber 51. A relay circuit extends from metallic plates 9 and 10 to the box indicated at 41. Circuit 41 may comprise any type of circuit known to the art which is adapted, when electrical conducting path across plates 9 and 10 is closed, to open the source of electrical supply connected to the heater wire 4 and, whenever the circuit across the plates 9 and 10 is opened, to again connect the source of current supply to the heater element. This relay circuit is not shown since it forms no part of the present invention.

The operation of the above mentioned temperature control system is briefly as follows: Assuming a temperature of 50 degrees C. is desired, the cork 6 will be set as shown by the drawing. An electric current flowing through the heater wire 4 will heat the fluid 2 which in turn heats the block 1. When the fluid 2 expands due to heating, it will flow through tubes 5 and 12 into the glass chamber 52, causing the fluid within chamber 52 to rise. When the desired temperature of 50 degrees C. is reached the cork 6 will be turned 90 degrees so as to close the fluid communication between the block 1 and chamber 52, after which fluid communication will then be only between chamber 50 and the block 1. Therefore, any further rise in temperature will cause additional expansion of the fluid and will force the mercury level 54 to rise, thus completing the electrical circuit between contacts 9 and 10 and close the relay circuit 41 which will cut off the current supplying the heater wire 4. When the temperature falls below the desired temperature the fluid will contract and the mercury level 54 will then drop and open the circuit which will cause the relay circuit 41 to open to again supply current to the heater wire 4. A more detailed description of the temperature control system is described in our copending application.

A particular feature which aids in maintaining the crystal cell at a constant temperature is the raised boss 1A on the metallic casing 1, forming the lower electrode 22 of the cell. This boss is relatively thicker than the piezo-electric crystal so as not to be subjected to frequent interruptions of temperature changes. The surface of the boss is ground to a smooth finish and may be plated with a special conducting metal such as silver. Secured to lower electrode 22 in such a manner that its temperature is also regulated, is a metallic ring 33 forming part of the crystal holder and is secured to casing 1 by screws 40. Located within the ring 33 is another ring 34 for holding the crystal in its proper position. This ring 34 is designed to fit tightly against the inner surface of ring 33 and is held firmly in place by rods 29 and 30. Two parallel prongs 62, 62 are provided on each side of ring 34 and extend inwardly toward the center for holding the crystal 21 in place. These prongs may be cut off to any desired length so that the crystal will be restrained from movement except within very narrow limits. Insulating spacers 26, 27 and 28, which are made of fused quartz and are ground to a required thickness, are provided for spacing the upper electrodes 23 and 24 the desired amount above electrode 22 to secure the proper air gap for the piezo-electric crystal. These spacers may be provided with screws not shown which fit into electrode 22. In this embodiment the upper electrode is divided into two concentric electrodes 23 and 24, which are mounted on a disk of insulating material 25 such as phenolic condensation product. These electrodes may either be screwed into the disk or if the disk is made of a material such as a porcelain like substance, the electrodes 23 and 24 may be fused to it. The surfaces of these electrodes are ground very accurately to a true plane surface with the faces plated with a special conducting metal such as silver. The insulated disk 25 is designed to have a slightly smaller diameter than the inner diameter of ring 33 with segments cut at two points to permit insertion of retaining rods 29 and 30.

This upper electrode assemblage is adapted to the central so as to slide between rods 29 and 30 and to be held securely in place by the pressure of spring 31. A plurality of springs 32 pressing down upon the top of the assemblage are utilized to force it to rest on the quartz spacers 26, 27 and 28. These springs may be rotated out of the way if it is desired to remove the upper electrode assemblage. Although one spring 32 is shown, it is to be understood that there may be as many such springs as are considered desirable. Terminals 36, 37 and 38 provide electrical connection from the crystal cell to other parts of the system not shown.

Although a piezo-electric crystal holder has been described which is especially adapted to be used with apparatus for controlling the temperature of the crystal, it is to be understood that this form of crystal holder is not limited in scope thereto but may be employed with other forms of temperature control apparatus, or may also be complete in itself without the association of temperature controlling apparatus.

What is claimed is:

1. Means for firmly securing a piezo-electric crystal to a crystal holder comprising, an outer ring and an inner ring located within said outer ring having two groups of narrow finger-like prongs extending inwardly from the holder and adapted to restrict the movement of said crystal.

2. Means for restraining the movement of a piezo-electric crystal, comprising an outer ring and an inner ring located within said outer ring having two groups of relatively narrow parallel finger-like prongs oppositely disposed to said crystal and adapted to hold said crystal between them.

3. Retaining means for a piezo-electric crystal comprising an outer ring and an inner ring located concentric within said outer ring and having two groups of finger-like prongs adapted to maintain said crystal in a fixed relation with respect to its electrodes.

4. A piezo-electric crystal resonator comprising a crystal, a stationary electrode and a plurality of removable electrodes, a disk adapted to hold said removable electrodes in fixed relation with respect to each other, an outer ring and an inner ring located concentric with said outer

ring and having a plurality of finger-like prongs adjusted to retain said crystal in a fixed relation with respect to said electrodes, and a spacing device for maintaining said removable electrodes a pre-determined distance above said crystal.

5. A piezo-electric crystal holder comprising a lower metallic supporting boss and electrode, a metallic ring secured to said boss surrounding and enclosing a piezo-electric crystal, a plurality of parallel prongs secured to the inside of said ring, said prongs extending inward toward the center to guide said crystal, a plurality of insulating spacers to space a plurality of upper electrodes from said crystal to provide an air gap, an insulating disk for securing said upper electrodes, a plurality of terminals passing through said disk to provide the electrical connections for said electrodes, and a plurality of springs for applying pressure and retaining said disk in an operating position.

6. A crystal holder comprising a support, a ring carried by said support, said ring having only four narrow finger-like inwardly projecting prongs arranged in two diametrically opposite pairs, said prongs being cut of such a length as to restrain substantially rotary movement of a polygonally-shaped crystal placed with a pair of its corners within the confines of said narrow finger-like inwardly projecting prongs.

LLOYD LEE YOUNG.
JAMES LESLIE FINCH.