Feb. 15, 1927. 1,617,995

A. L. R. ELLIS

PIEZO ELECTRIC DEVICE

Filed July 14, 1925

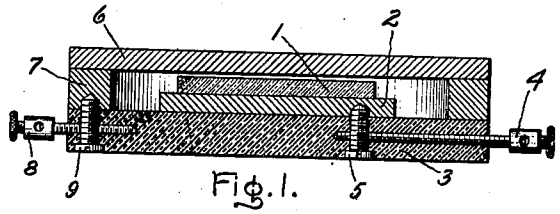


Fig. 1.

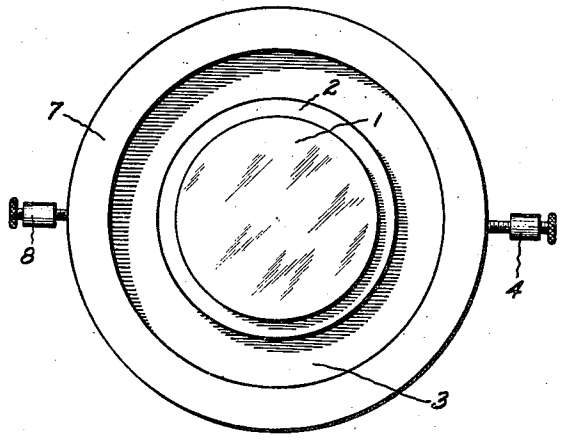


Fig. 2.

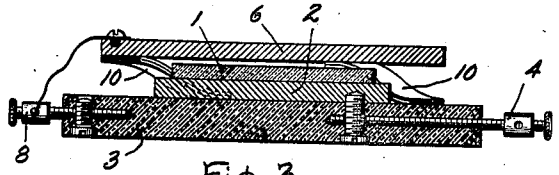


Fig. 3.

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UNITED STATES PATENT OFFICE.

ALVARADO L. R. ELLIS, OF SWAMPSCOTT, MASSACHUSETTS, ASSIGNOR TO GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

PIEZO-ELECTRIC DEVICE.

Application filed July 14, 1925. Serial No. 43,628.

My invention relates to piezo-electric devices, and has for its principal object the provision of an arrangement and method whereby the free vibration period of the piezo-electric member comprised in such a device is maintained substantially constant irrespective of changes in the conditions under which it is operated.

The free vibration period of a piezo-electric oscillator, such as a slab or disk of quartz for example, is determined for the most part by the dimensions of the slab but is affected to some extent by the conditions under which the oscillator is operated. Thus the thermal expansion of crystalline quartz, though slight, is appreciable and the velocity of sound in this material varies slightly with temperature. These combined effects are not serious at low frequencies but become of great importance at frequencies of two million cycles or more. It so happens that the utilization of the quartz oscillator is most desirable in this range of frequencies. While the maintenance of constant temperature in the laboratory is not a difficult matter, it is a serious problem under ordinary operating conditions. In accordance with my invention, this difficulty is avoided by the provision of means operable in response to temperature changes to vary the spacing between the electrodes and the oscillator slab in a manner to maintain the resonance frequency of the slab substantially constant irrespective of temperature changes.

My invention will be better understood from the following description when considered in connection with the accompanying drawing and its scope will be pointed out in the appended claims.

Referring to the drawings, Fig. 1 shows a view of an oscillator constructed in accordance with my invention; Fig. 2 shows a plan view of the oscillator with its cover removed; and Fig. 3 shows a modification thereof.

Figs. 1 and 2 show a quartz crystal 1 supported upon an electrode 2 which is mounted on an insulation base 3 and is connected to a terminal 4 through means shown as a screw 5. An electrode 6 is spaced from the crystal 1 and base 3 by means of a conductive ring 7 connected to the terminal 8 through a screw 9. While the device is shown as circular in form, it will be apparent that it may be of any suitable shape. In order to simplify the drawing, the spacing between the oscillator 1 and electrode 6 has been shown as of considerable extent. It should be noted, however, that in an actual construction this spacing is only a few thousandths of an inch.

Assuming for the purpose of explanation that the crystal 1 is suspended in air so that it can be made to oscillate freely, it will be readily understood that a layer of air adjacent the oscillating surfaces of the crystal will vibrate just as though it formed an integral part of the crystal. The resonance frequency of the crystal under these conditions depends to a large extent on the dimensions of the quartz slab and to a lesser extent on the mass of air which vibrates in unison with the crystal surfaces. Changes in temperature, however, produce variation in the resonance frequency both due to change in the size of the slab and to changes in the density and elasticity of the ambient air.

It is of course necessary that the oscillator be provided with some sort of a mounting and it is desirable that it be protected from dust and moisture by a suitable casing. Variation in the resonance frequency with temperature changes is likely to be accentuated by the mounting and casing, of the oscillator. Thus with the usual and convenient construction shown by Fig. 1, any change in the thickness of the slab 1 due to changes in temperature causes variation in the spacing between the oscillator 1 and electrode 6, thereby forcing the air into and out of the space surrounding the oscillators 1 and electrode 2 and changing the loading and resonance frequency of the oscillator. Expansion and contraction of the electrode 2 and ring 7 are likely to produce further changes of this character.

I propose to avoid these difficulties by constructing the supporting electrode 2 and ring 7 of materials having such a combined coefficient of thermal expansion that the proper spacing between the oscillator 1 and electrode 6 is maintained irrespective of temperature changes. To this end, the supporting electrode 2 may be made of metal having a zero coefficient of thermal expansion, such as invar for example, and the ring 7 may be made of a metal having the same coefficient of thermal expansion as the oscillator or of a composite ring comprising

copper and invar layers of such thickness that their combined thermal expansion is equal to that of the oscillator. Where it is desired to compensate for changes in the density and elasticity of the air due to variation in temperature, the ring 7 or electrode 2 may be made of a material or materials having a coefficient of thermal expansion adapted to change the spacing between the electrode 6 and oscillator 1 in the proper manner.

As indicated in Fig. 3, where direct expansion and contraction of the supporting electrode 2 or ring 7 is insufficient to produce the proper degree of compensation, bimetallic strips 10 similar to those commonly utilized in thermostats are interposed between the insulation base 3 and electrode 6. While the electrode 6 has been shown as adapted to be moved for purposes of temperature compensation, it will be readily understood that the same effect may be produced by moving either the insulation base 3 or both the insulation base 3 and the electrode 6 with respect to the oscillator 1.

The embodiments of the invention illustrated and described herein have been selected for the purpose of clearly setting forth the principles involved. It will be apparent, however, that the invention is susceptible of being further modified to meet the different conditions encountered in its use and I therefore aim to cover by the appended claims all modifications within the true spirit and scope of my invention.

What I claim as new and desire to secure by Letters Patent of the United States, is:

1. The combination of a piezo-electric oscillator, a support for said oscillator, an electrode adjacent a surface of said oscillator, and thermal responsive means interposed between said support and electrode whereby the spacing between said electrode and surface is controlled to maintain the resonance frequency of said oscillator constant irrespective of variation in temperature.

2. The combination of a piezo-electric oscillator, an electrode adjacent a surface of said oscillator, and an electrode support having a co-efficient of thermal expansion which is substantially the same as that of said oscillator.

3. The combination of a plurality of electrodes, a piezo-electric oscillator interposed between said electrodes, and a thermal responsive support for one of said electrodes whereby the spacing between said electrodes is controlled to maintain the resonance frequency of said oscillator constant irrespective of variation in temperature.

4. The combination of a pair of electrodes, a quartz slab interposed between said electrodes, and a thermal responsive support for one of said electrodes whereby the spacing between said electrodes is controlled in accordance with the temperature of the ambient air.

5. The combination of a pair of electrodes, a piezo-electric slab interposed between said electrodes, and a bi-metallic strip arranged to control the spacing between said electrodes in accordance with variation in temperature.

6. The method of controlling the resonance frequency of a piezo-electric oscillator interposed between a plurality of electrodes, which comprises changing the spacing between said electrodes in accordance with variation in the temperature thereof.

In witness whereof, I have hereunto set my hand this 10th day of July, 1925.

ALVARADO L. R. ELLIS.