

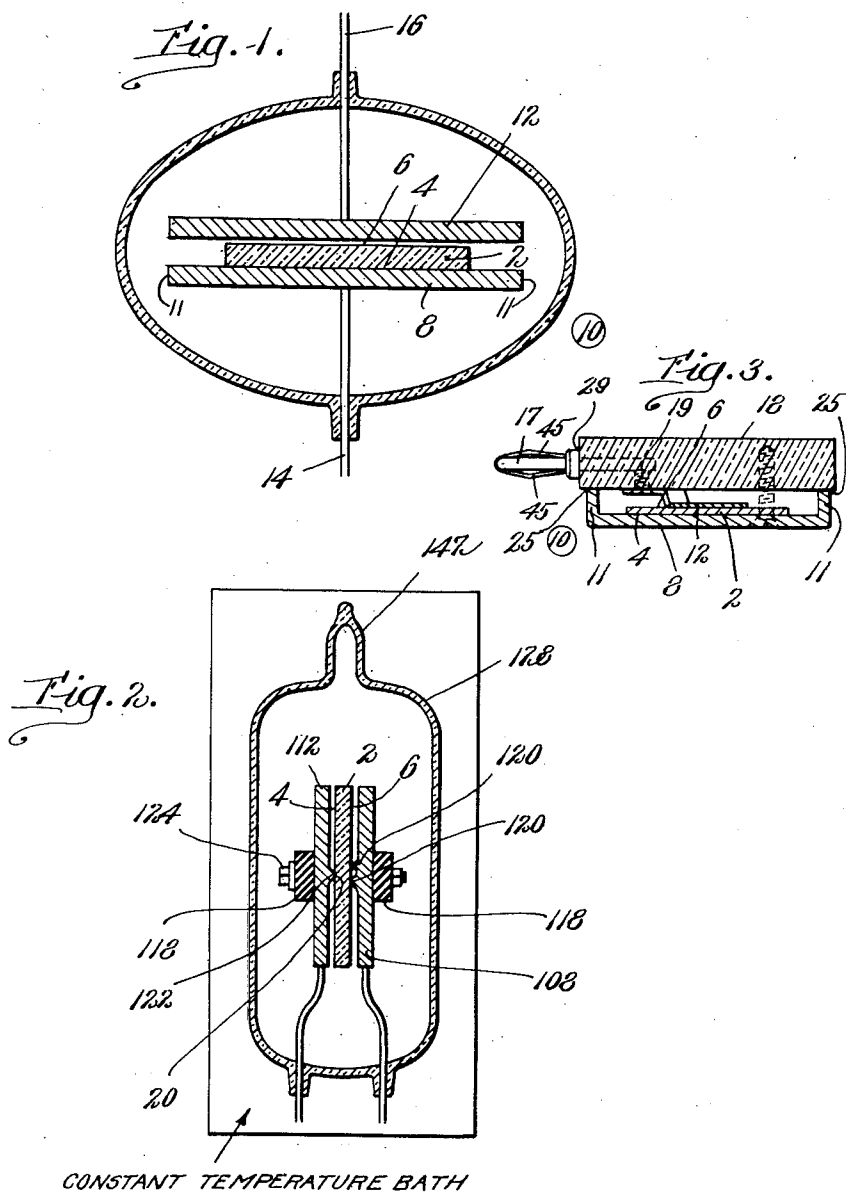
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ELECTROMECHANICAL VIBRATOR APPARATUS

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ELECTROMECHANICAL VIBRATOR
APPARATUS

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Original application March 29, 1926, Serial No. 98,220, now Patent No. 2,133,643, dated October 18, 1938. Divided and this application September 28, 1938, Serial No. 232,193

30 Claims. (Cl. 171—327)

The present invention relates to electromechanical vibrators, and more particularly to piezo-electric crystals, and to supports and holders therefor. The present application is a division of application, Serial No. 98,220, filed March 29, 1926, which matured, on October 18, 1938, into Letters Patent 2,133,643.

Such vibrators, as is now well known, execute mechanical vibrations under vibratory electrical stimulus and, conversely, develop electrical potentials as a result of their mechanical vibrations. Piezo-electric crystal bodies possess at least one, and usually two or more, axes—known as the electrical axes of the body—that have definite orientations in the original crystal. Quartz crystals have three such electric axes. Such bodies have, in general, a plurality of particular modes of mechanical vibration, of different frequency, corresponding to two or more of its dimensions. Among these are the longitudinal and the transverse modes of vibration. These mechanical and electrical effects are normally transitory, for the crystal body will not, of itself, persist in continuous vibration.

An object of the present invention is to provide an improved electromechanical vibrator. The improved vibrator of the present invention may be used for many purposes: for example, as a resonator, or to produce oscillations at very nearly constant frequency.

The frequency of vibration of electromechanical vibrators, like piezo-electric crystals depends upon the medium, such as air, in which they are disposed, and the temperature of that medium. Changes of the medium and of the temperature introduce frequency changes.

A further object of the invention, therefore, is to provide a new and improved holder for an electro-mechanical vibrator with the aid of which such frequency changes shall be obviated.

Other and further objects of the invention will be explained hereinafter, and will be pointed out in the appended claims, it being understood that it is intended to cover in the appended claims all the novelty that the invention may possess.

In the accompanying drawing, Fig. 1 is a longitudinal vertical section through a preferred holder for an electromechanical vibrator, comprising a piezo-electric body provided with electrodes in accordance with the present invention; Fig. 2 is a similar view of a modification employing a temperature bath; and Fig. 3 is a similar view of a further modification.

The preferred form of electromechanical vibrator is illustrated as of the piezo-electric type, 55

the oppositely disposed sides or surfaces 4 and 6 of the crystal 2 being provided with opposed, conducting preferably flat terminals, plates or electrodes 8 and 12, by means of which the crystal is adapted to be connected into an electric circuit. For high frequencies, it is necessary to use the period of the crystal determined by a dimension of the specimen that is small compared to its other dimensions; as by its thickness, the crystal plate vibrating in the thickness mode. The thickness dimension is assumed, for concreteness, to be the dimension along one of the electric axes of the crystal, perpendicular to the electrodes 8 and 12, and this must be of the order of one millimeter for a frequency of 3000 kilocycles per second. The apparatus of the present invention may, however, be employed equally well at high and at low frequencies.

The invention is not, however, in its broader aspects, limited to such a crystal body, but may employ any body or mechanism having like properties in itself, or like properties introduced by electric currents, electric polarization, magnetic fields, etc. The vibrator may be a parallelopiped in shape, but it may be lenticular, as illustrated in the said Letters Patent, or it may be of any other shape, as a flat disc, with rectangular, circular or irregular base. It may be constituted of any suitable substance having sufficiently pronounced piezo-electric properties. Quartz is preferred, because of its durability and constancy. The term "electromechanical vibrator"—or, more simply, the term "vibrator"—will be employed hereinafter in the specification and the claims to denote any substance or arrangement, whether or not crystalline in character, that is endowed with the above-referred-to property of changing shape or dimensions under the action of an electric force or an electric current and of reacting on the electric circuits.

In Fig. 3, the electrode 8 is shown constituted of a flat bottom or base plate of a metal box, container or housing 10, within which the vibrator 2 is centrally located, as shown. The electrode 12 here takes the form of a metal spring member that positively and intimately contacts with the upper surface 6 of the crystal 2. The spring member is electrically connected to plug binding posts 17 by a screw 19. This construction renders the electrical connection of the vibrator to its binding posts resilient. The spring pressure is, of course, made very light, so as not to press so heavily upon the vibrator as to interfere with its free vibration. The plugs 17 are provided with longitudinally extending spring

fingers 45 that are adapted to press outward against the inner walls of sockets (not shown) to hold the crystal holder firmly upon a mounting (not shown).

In Fig. 1, the vibrator 2 is shown centrally positioned freely between the electrodes 8 and 12, in a receptacle, casing, container or housing 10 constituted of glass or other material. The side walls 11 of the receptacle, which are shown in Figs. 1 and 3 as spaced from at least two sides of the crystal, and the top wall of the housing 10 may, in both cases, be integral with the base of the housing 10. The side or surface 4 of the vibrator is shown, in Fig. 3, engaging the electrode 8, and the opposite side or surface 6 may contact with, or may be near to, the electrode 12. In Fig. 1, the crystal is shown entirely free of and spaced from the electrode 12. In Figs. 1 and 2, the crystal is thus shown secured freely in the casing or housing 10 between the electrodes 8 and 12 without being in any way restricted, so that it is free to vibrate mechanically between the opposed electrodes 8 and 12, according to any of its modes or periods of natural vibration or any of its overtones of such modes of vibration.

In Fig. 1, the electrode 8 is shown electrically connected to a lead 14, and the plate 12 to a lead 16 suspended over the crystal 2. Electrical connection is thus established between the two sides 4 and 6 of the crystal and the leads exterior of the housing.

In Fig. 3, the cracks 25 between the side walls 11 and the cover member 18 and the cracks 29 between the binding post or posts 17 and the insulating members upon which they are mounted may be sealed by Celluloid varnish, wax or other coating to seal the receptacle 10 hermetically to the atmosphere. To attain great constancy of frequency, the housing may be evacuated so as to remove air or other gas and thus eliminate air-column resonance which, by its variation with temperature, introduces small changes of frequency. The vibrator becoming thus hermetically closed in the housing, it is further protected from the action of moist gases, dust and the like.

The evacuation of the vessel, if carried to a high degree, will prevent the formation of corona which, by electronic action and heating, may produce disintegration and breaking up of the crystal.

In the modification of Fig. 2, there is disclosed a crystal holder more particularly adapted for use for frequency standards, in which the crystal vibrates in the direction of its length. The electrode 112 is provided with an intermediately disposed projection 122 and the electrode 108 with two projections 120, disposed one on each side of the middle point. The vibrator 2, supported solely by and between the electrodes 108 and 112, is gripped or clamped by the projections 120 and 122 over or at medial areas that are relatively small compared to the dimensions of the vibrators. These medial areas correspond, therefore, to diametrically oppositely disposed medial nodal zones of movement of the crystal. When the crystal is vibrated transversely in the direction of the medially disposed electric axis, a node of motion, where there is small vibratory movement of the crystal, is produced at these relatively small nodal areas. Damping of the crystal is, by this construction, thus reduced to a minimum. The electrodes 108 and 112, with the crystal disposed between them, are clamped

together as a unit between two insulating members 118 by bolts 124. The whole is mounted in an evacuated sealed vessel of metal or glass. A glass vessel 128 is shown in Fig. 2, the evacuation of which may be effected through an integral glass tube 142. The sealed vessel, whether of metal or glass, may be kept in a constant-temperature bath, as illustrated in Fig. 2.

It will be understood that the invention is not restricted to the exact embodiments thereof that are 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 of the character described comprising an evacuated receptacle, means for maintaining the receptacle at constant temperature, and an electro-mechanical vibrator contained in the receptacle.

2. A piezo-electric crystal arranged for longitudinal or transverse vibration, the electrodes being spaced slightly apart from opposite faces of the crystal, and gripping means being jammed between the electrodes and the faces of the crystal near the middle of the length of the crystal or other nodal zones, the crystal, the electrodes and the gripping means being mounted in an evacuated vessel.

3. A piezo-electrical crystal apparatus comprising in combination a mounting, a piezo-electric crystal loosely held on the mounting, an evacuated, sealed housing surrounding said mounting, and an electrical connection with the said piezo-electric crystal through the housing.

4. In a piezo-electric crystal apparatus, the combination of a mounting, a piezo-electric crystal loosely secured on said mounting, and an evacuated housing around said mounting having terminals extending outwardly from within said housing for establishing electrical connection with said mounting.

5. A piezo-electric crystal holder comprising, in combination, an evacuated sealed closure and means within said closure for securing a piezo-electric crystal therein and establishing electrical connection therewith while permitting the free vibration of said piezo-electric crystal.

6. A crystal oscillator of the class described comprising a crystal and means surrounding the crystal to prevent a corona discharge thereon when the crystal oscillates.

7. A crystal oscillator of the class described comprising a container having a vacuum therein, and a crystal arranged within said container.

8. A crystal oscillator of the class described comprising a vessel, and a crystal in the vessel, said vessel having a vacuum therein to prevent a corona discharge on the crystal during oscillation thereof.

9. A crystal oscillator of the class described comprising a vessel, a crystal, and means to support the crystal within the vessel, said vessel having a high vacuum therein.

10. A crystal oscillator of the class described comprising a vessel, a crystal in the vessel, and means to cause said crystal to vibrate, said vessel having a vacuum therein to prevent an electrical discharge on the crystal.

11. As an article of manufacture, a crystal oscillator comprising a vessel having a vacuum therein and a crystal having piezo-electric properties mounted in the vessel.

12. In a device of the character described, a piezo-electric crystal mounted in a vacuum.
13. In a device of the character described, an oscillating crystal mounted in a vacuum.
14. In a device of the character described, an oscillating crystal and protective means surrounding the crystal to prevent a corona discharge thereon from the plates of the crystal which has a tendency to heat the crystal and make it break.
15. A piezo-electric crystal holder comprising in combination a base, an evacuated, sealed housing secured to said base, means for locating a piezo-electric crystal within said housing, and means for establishing electrical connection with the said piezo-electric crystal to a point outside of the housing.
16. A piezo-electric crystal holder comprising in combination supporting members, an evacuated housing surrounding the supporting members, a piezo-electric crystal carried by said supporting members and electrically connected with the opposite ends of said holder and means whereby said piezo-electric crystal may be electrically connected in a circuit established through electric leads through the housing.
17. A piezo-electric crystal holder comprising in combination an evacuated sealed container, a piezo-electric crystal centrally positioned in said container, and means for establishing an electrical connection with said piezo-electric crystal within said container for permitting free vibration thereof.
18. A receptacle for a piezo-electric crystal comprising in combination an evacuated and sealed housing, an element capable of mechanical vibration mounted within said housing and terminals through the walls of said housing connected with the opposite faces of said element, said element being supported for permitting free mechanical vibration thereof.
19. A piezo-electric crystal holder comprising an evacuated closure, a pair of separated metal supports supported within the closure, a piezo-electric crystal loosely held between the metal supports, and an electrical connection to each metal support, and communicating with the outside of the closure.
20. A piezo-electric crystal holder comprising an evacuated closure, a pair of separated metal plates supported within the closure, a piezo-electric crystal loosely held between the plates and an electric connection to each plate communicating with the outside of the closure.
21. A piezo-electric crystal holder comprising in combination a hermetically sealed vitreous vessel and means within said vitreous vessel for securing a piezo-electric crystal therein and establishing electrical connection therewith to said crystal through said vitreous vessel, while permitting the free vibration of said piezo-electric crystal with substantially no restriction, the space within said vitreous vessel being evacuated.
22. A piezo-electric oscillator having in combination a hermetically sealed vitreous vessel, a piezo-electric crystal therein, means within said vitreous vessel for mounting said crystal and establishing electrical connection therewith, and electrical connections extending through said vitreous vessel to said mounting, the space within said vitreous vessel being evacuated.
23. A piezo-electric crystal holder comprising in combination a support, an evacuated vessel secured to said support, means for supporting a piezo-electric crystal within said evacuated vessel, and means for establishing electrical connection with the said crystal from points on said support which are exterior to said vessel.
24. A piezo-electric crystal holder comprising in combination a hermetically sealed closure and means within said closure for securing a piezo-electric crystal therein and establishing electrical connection therewith, while permitting the free vibration of said piezo-electric crystal with substantially no restriction, the space within said closure being evacuated.
25. A piezo-electric oscillator having in combination a hermetically sealed vessel, a piezo-electric crystal therein, means within said vessel for mounting said crystal, and electrical connections for said crystal extending through said vessel, the space within said vessel being evacuated.
26. A piezo-electric oscillator having in combination a piezo-electric crystal, a mounting therefor, an evacuated housing surrounding said crystal and an electrical connection for said piezo-electric crystal extending through said housing.
27. A piezo-electric crystal apparatus comprising an electrode, a crystal resting on said electrode, a second electrode spaced from the crystal, and a vitreous evacuated envelope surrounding said electrodes and crystal.
28. A piezo-electric crystal holder comprising in combination a hermetically sealed bulb and means within said bulb for securing a piezo-electric crystal therein and establishing electrical connection therewith to said crystal through said bulb, while permitting the free vibration of said piezo-electric crystal with substantially no restriction, the space within said bulb being evacuated.
29. A piezo-electric oscillator having in combination a hermetically sealed bulb, a piezo-electric crystal therein, means within said bulb for mounting said crystal and establishing electrical connection therewith, electrical connections extending through said bulb to said mounting, the space within said bulb being evacuated.
30. A crystal oscillator of the class described comprising, in combination, a closure and means within said closure for securing a piezo-electric crystal therein and establishing electrical connection therewith, while permitting the free vibration of said piezo-electric crystal with substantially no restriction, the closure being evacuated and sealed to prevent a corona discharge on the crystal when the crystal oscillates.

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