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May 9, 1933. W. A. MARRISON 1,907,426

PIEZO ELECTRIC CRYSTAL

Original Filed Dec. 19, 1928

FIG. 1

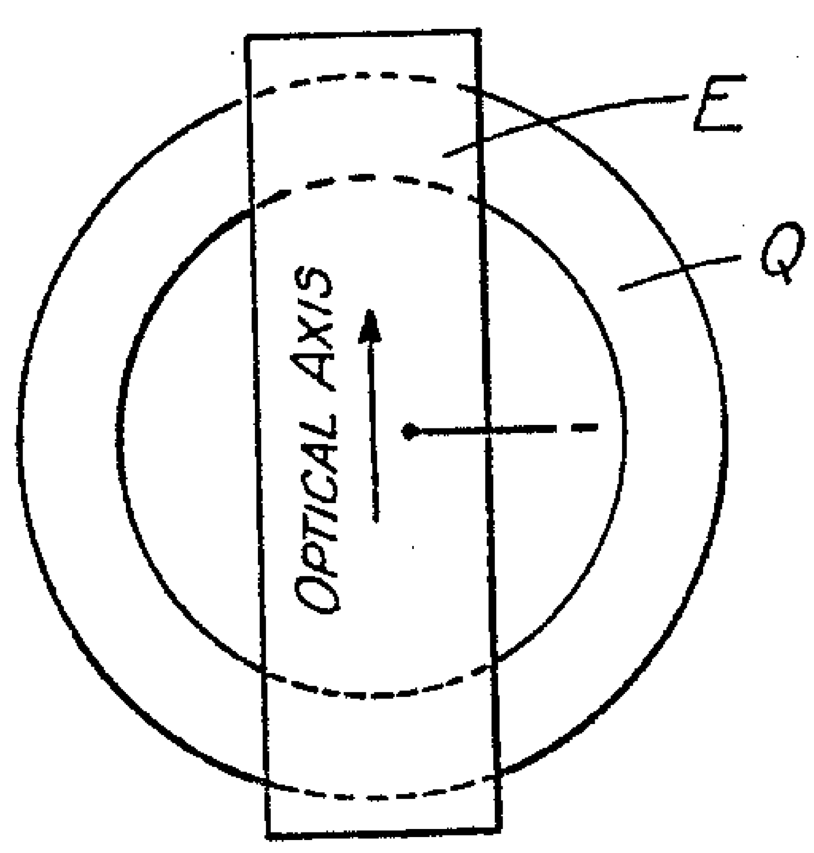


FIG. 2.

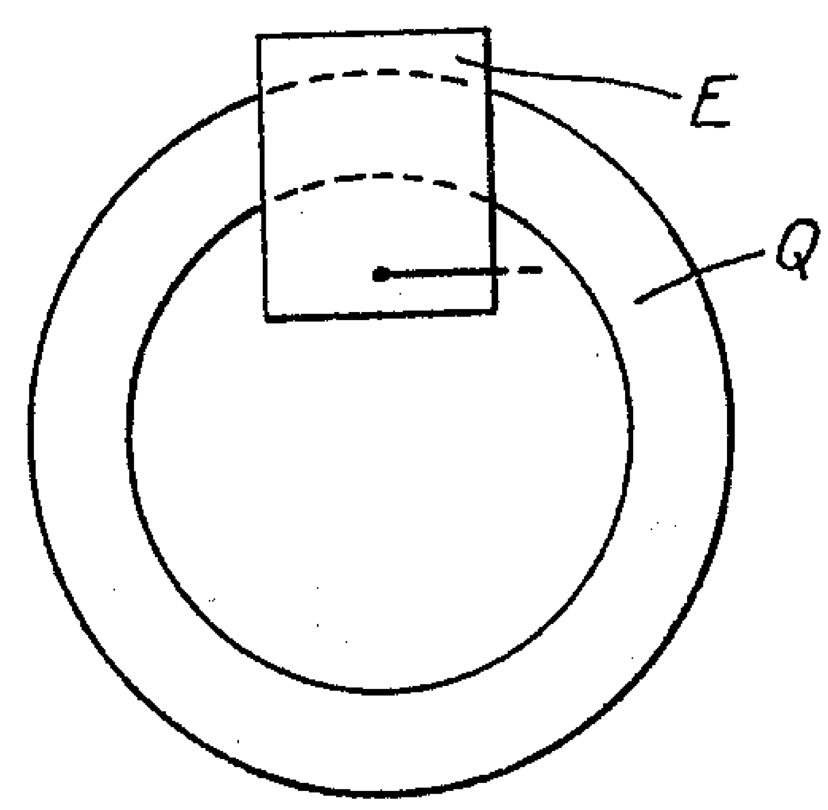
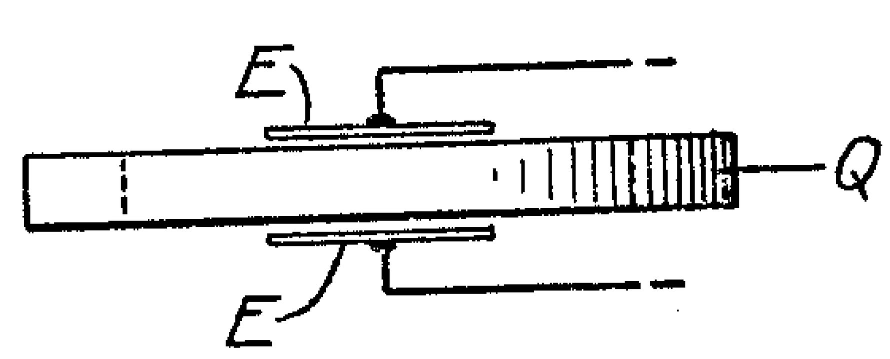


FIG. 3.



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UNITED STATES PATENT OFFICE

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PIEZO-ELECTRIC CRYSTAL

Original application filed December 19, 1928, Serial No. 327,017. Divided and this application filed November 1, 1930. Serial No. 492,669.

This application is a division of my copending application Serial No. 327,017, filed December 19, 1928.

This invention relates to piezo-electric crystals cut in the shape of a ring or toroid, and means for mounting such crystals in an electrical circuit.

The advantages of utilizing the piezo-electric effect of substances possessing such properties in the control of electrical oscillations of constant frequency have been known for some time. The uses for a constant frequency control, and especially the need of control within more rigid limits, are constantly increasing. Such uses include the control of broadcasting stations on their assigned wave lengths whether locally or upon transmission of a controlling wave from a central station, and control of the frequency of the local oscillations in a heterodyne receiver. Frequency control means are also useful in connection with sending and receiving sets in picture transmission and television, in order to avoid the necessity of a synchronization channel, and similarly in systems of carrier wave telephony and telegraphy, and are also important elements of laboratory reference standards.

An object of this invention is to control the frequency of vibrations of a piezo-electric crystal at a desired frequency.

A feature of this invention is the provision of electrodes for such a resonator which will permit control of its frequency vibration at a desired frequency by impressing a wave of such frequency on said electrodes. In my copending application, of which this application is a division, it is disclosed that a ring-shaped piezo-electric quartz crystal resonator the principal plane of which is parallel to the optical and one of the electrical axes of the crystal may be cut to have a zero or approximately zero temperature coefficient of frequency, and that certain advantages are inherent in the use of a resonator of this shape in circumstances where it is desired to use a zero-coefficient crystal.

If a ring of piezo-electric material, whether cut to have a zero temperature coefficient of frequency or not, is inserted between two electrodes whose length is equal to or greater than the outside diameter of the ring, and whose width is equal to or less than the inside diameter of the ring, with the long side parallel to the direction of the optic axis, it may be set into resonant vibration having 4, 6, 8 or any even number of nodes (within limits) approximately evenly spaced around the ring, by impressing a voltage on the electrodes of the frequency of the resonant vibration desired. If the electrodes cover one side only of the ring it may similarly be set in vibration.

In the drawing Fig. 1 is a diagrammatic plan of a toroidal resonator with electrodes covering part only of the plane surfaces of the resonator.

Fig. 2 is a diagrammatic plan of a toroidal resonator with electrodes covering the plane surfaces of one segmental portion only of the resonator.

Fig. 3 is an end view of Fig. 1 or Fig. 2.

In Fig. 1 a ring Q of piezo-electrically active quartz crystal, which has its principal plane parallel to the optical and one of the electrical axes of the crystal is inserted between two electrodes E whose length is equal to or greater than the outside diameter of the ring and whose width is equal to or less than the inside diameter of the ring, with the long side parallel to the direction of the optical axis. The ring may be set into resonance vibration having 4, 6, 8 or any even number of nodes (within limits) approximately evenly spaced around the ring by impressing a voltage on the electrodes of the frequency of the resonance vibration desired. If the electrodes cover one side only of the ring as shown at E, Fig. 2, the ring may similarly be set in vibration.

What is claimed is:

1. A ring-shaped resonator and a pair of electrodes associated therewith adjacent opposite faces of the ring and lying outside the space included between the boundary planes of said opposite faces said electrodes overlying a portion only of the adjacent faces of said ring.

2. A ring-shaped resonator cut from a plate of quartz, the principal plane of which

lies parallel to the optical and electrical axes of the quartz, and an electrode associated with each plane faces of the resonator, each electrode having a length such that it extends entirely across both sides of its associated ring face and having a breadth such that it overlies less than half the surface area of said face.

3. A ring-shaped piezo-electric resonator of quartz, the principal plane of the ring being parallel to the optical and electrical axes of the quartz, and a pair of electrodes, each electrode disposed adjacent one of the opposite faces of the ring to overlie a relatively small portion thereof whereby an electromotive force, which is an even multiple of the natural resonant frequency of said element, applied to said electrodes will set said ring in vibration at the frequency of said applied electromotive force.

4. A toroidal shaped piezo-electric resonator of rectangular cross-section produced from slab of quartz, the principal plane of which lies parallel to the optical and one of the electrical axes of the quartz crystal, a pair of similar plane electrodes of rectangular shape associated with the plane faces of said resonator, the length of which is greater than the outside diameter of the toroid and is parallel to the optical axis of the crystal, and the width of which is less than the inside diameter of the toroid, said electrodes being centrally located with respect to the resonator whereby said resonator will vibrate at an even harmonic of its fundamental frequency.

5. A quartz crystal piezoelectric resonator being in the form of a toroid of rectangular cross-section and a pair of electrodes associated with the opposite plane faces of a small sector of said resonator whereby said resonator will resonate at a harmonic of its fundamental resonant frequency.

In witness whereof, I hereunto subscribe my name this 31st. day of October, 1930.

WARREN A. MARRISON.