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O. M. HOVGAARD

1,896,513

PIEZO ELECTRIC CRYSTAL

Filed Oct. 8, 1930

FIG. 1

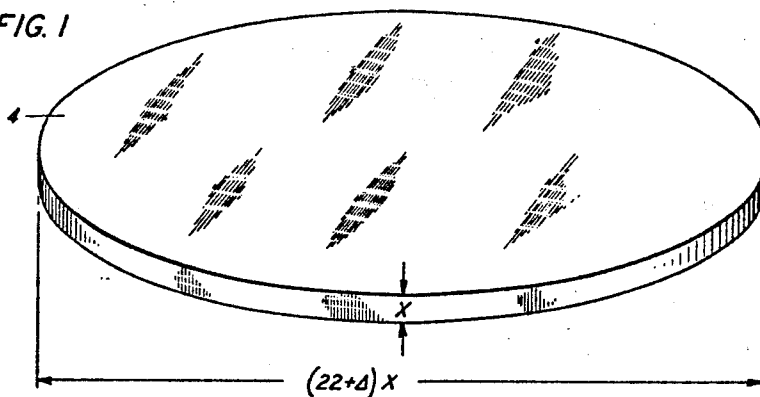


FIG. 2

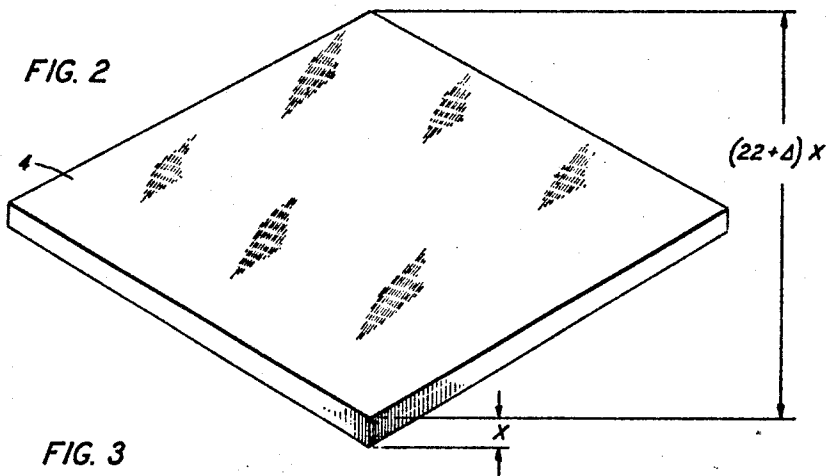


FIG. 3

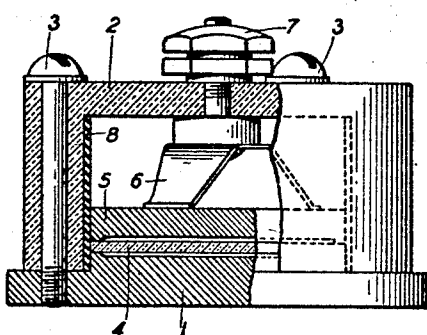
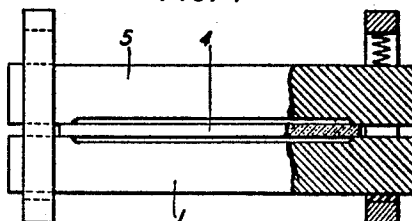


FIG. 4



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PIEZO-ELECTRIC CRYSTAL

Application filed October 8, 1930. Serial No. 487,193.

This invention relates to piezo-electric crystals, and particularly to crystals which are of quartz, and cut from a native crystal so as to form a crystal element in the form of a plate.

These crystals, or crystal elements, have come into general use in all places where a constant frequency is desired. They are also becoming of increasing importance in connection with filters and networks.

It has heretofore been discovered, as disclosed in application Serial No. 385,904, filed August 14, 1929 by G. M. Thurston, that such crystals will continue to vibrate even when substantially fixedly positioned as by clamping, at least when the restraint is effective at such points as to avoid too great damping. It has also been discovered that crystals so fixedly positioned have fewer spurious frequencies and variations in the space between the crystal and its electrodes become less important. Crystal holders of the type disclosed in this application for fixedly clamping crystals at their peripheries are disclosed and claimed in the Thurston application.

In conducting a series of tests with apparatus similar to that disclosed in the Thurston application it was discovered that certain crystals did not exhibit the expected piezo-electric characteristic when so mounted. Further investigation disclosed the fact that for a crystal mounted in such manner to be sufficiently active piezo-electrically for ordinary commercial use, it is necessary for its diameter, if circular, or its diagonal dimension, if rectangular, to be not less than twenty-two times its thickness. As a specific example, in a series of crystals cut parallel to the optical and an electrical axis, which were thirty-two millimeters square and of varying thickness, it was found that for a ratio of diagonal dimension to thickness exceeding 20.4 the crystals would vibrate under considerable clamping pressure, in some cases as much as 50 or 100 pounds, while if the ratio was less than 20.4 even a small degree of pressure would cause the crystal to cease vibrating. As another example, in a series of crystals of circular shape, also parallel cut, 25 millimeters in diameter, the

critical frequency was found to be 1750 kilocycles or a dimensional ratio of 22.3. These two values are in agreement within the limits of experimental error, and the critical dimensional ratio is therefore believed to be about 22. The ratio is quite critical, the curve of activity of the crystal turning sharply upward at the critical point.

While perhaps being most useful in an organization in which the crystal is fixedly positioned, as above described, because the need of the services performed by the invention are perhaps then the greatest, the invention should be understood as not being limited to such an organization. The ratio of dimensions, on which the invention depends, contributes to the efficient operation of piezo-electric crystals in any environment.

In the drawing, Fig. 1 shows a circular crystal cut in accordance with this invention;

Fig. 2 shows a rectangular crystal cut in accordance with this invention;

Fig. 3 is a partial sectional elevation of a holder for a circular crystal clamped at its periphery; and

Fig. 4 is an elevation partly in section of a holder for a rectangular crystal clamped at its ends.

In Figs. 1 and 2 the crystals are marked 4 and are shown by the notation to be so cut that the diameter and diagonal dimensions respectively are more than twenty-two times the thickness.

In Fig. 3 a metal base 1 and a cover portion 2 of insulation material, are rigidly secured together by screw fastening means 3 to provide a protective housing for the circular piezo-electric crystal plate 4, which is stimulated into vibration in accordance with well-known principles by electrodes positioned at opposite faces so as to impose an electrostatic stress thereon. The electrodes in the specific form of the device here illustrated are constituted by the base plate 1 and the plate 5. These electrodes, are of course, of conductive material. The base electrode may be connected to the circuit with which the crystal plate is associated by a conductor not shown. The upper plate 5 may be con-

ected to such circuit through spring retaining member 6 and a screw fastening means, represented generally by reference numeral

7. The configuration of the two electrodes is such, as shown, that the crystal plate is fixedly positioned therebetween by a clamping stress applied at the periphery of the crystal plate. The clamping stress applied is a function of the relative dimension of the holder and spring 6, that is, of the elastic distortion of the spring when the holder is assembled. Of course other means are available for producing an equivalent clamping effect. Such means for example as is disclosed in Fig. 4 and as a matter of fact the crystal plate may be fixedly positioned and subject to the benefits of the invention without clamping or pressure.

In Fig. 4 there is shown a holder for a rectangular crystal, the showing being somewhat more diagrammatic than that for the circular crystal of Fig. 3. Bottom and top plates 1 and 5 respectively are held together by suitable means, and the two members clamp a crystal 4.

What is claimed is:

1. A circular piezo-electric crystal plate, a holder therefor, means within said holder for fixedly positioning said crystal by applying pressure over an annular surface area at its periphery, said plate being so dimensioned that its diameter is at least twenty-two times its thickness.

2. A rectangular piezo-electric crystal plate, a holder therefor, means within said holder for clamping said plate by application of pressure over marginal surface areas at its boundary, said plate being so cut that its diagonal dimension is at least twenty-two times its thickness.

3. A piezo-electric crystal plate cut from a natural crystal with its major surfaces parallel to the optical and an electrical axis, and its thickness dimension parallel to a crystallographic axis, the dimension of said plate along the electrical axis being at least twenty-two times its dimension along the crystallographic axis, a holder therefor, and means within said holder for fixedly positioning said crystal by application of pressure over a marginal surface area at its periphery.

4. A piezo-electric crystal plate cut from a natural crystal with its major surfaces parallel to the optical and an electrical axis and its thickness dimension parallel to a crystallographic axis, the dimension of said plate along the optical axis being at least twenty-two times its dimension along the crystallographic axis, a holder therefor, and means within said holder for fixedly positioning said crystal by application of pressure over a marginal surface area at its periphery.

5. A circular piezo-electric crystal plate and holder therefor in accordance with claim 1, said plate cut from a natural crystal with

its major surfaces parallel to the optical and an electrical axis and its thickness dimension parallel to a crystallographic axis.

6. A rectangular piezo-electric crystal plate and holder therefor in accordance with claim 2, said plate cut from a natural crystal with its major surfaces parallel to the optical and an electrical axis and its thickness dimension parallel to a crystallographic axis.

In witness whereof, I hereunto subscribe my name this 6th day of October, 1930.

OLE M. HOVGGAARD.